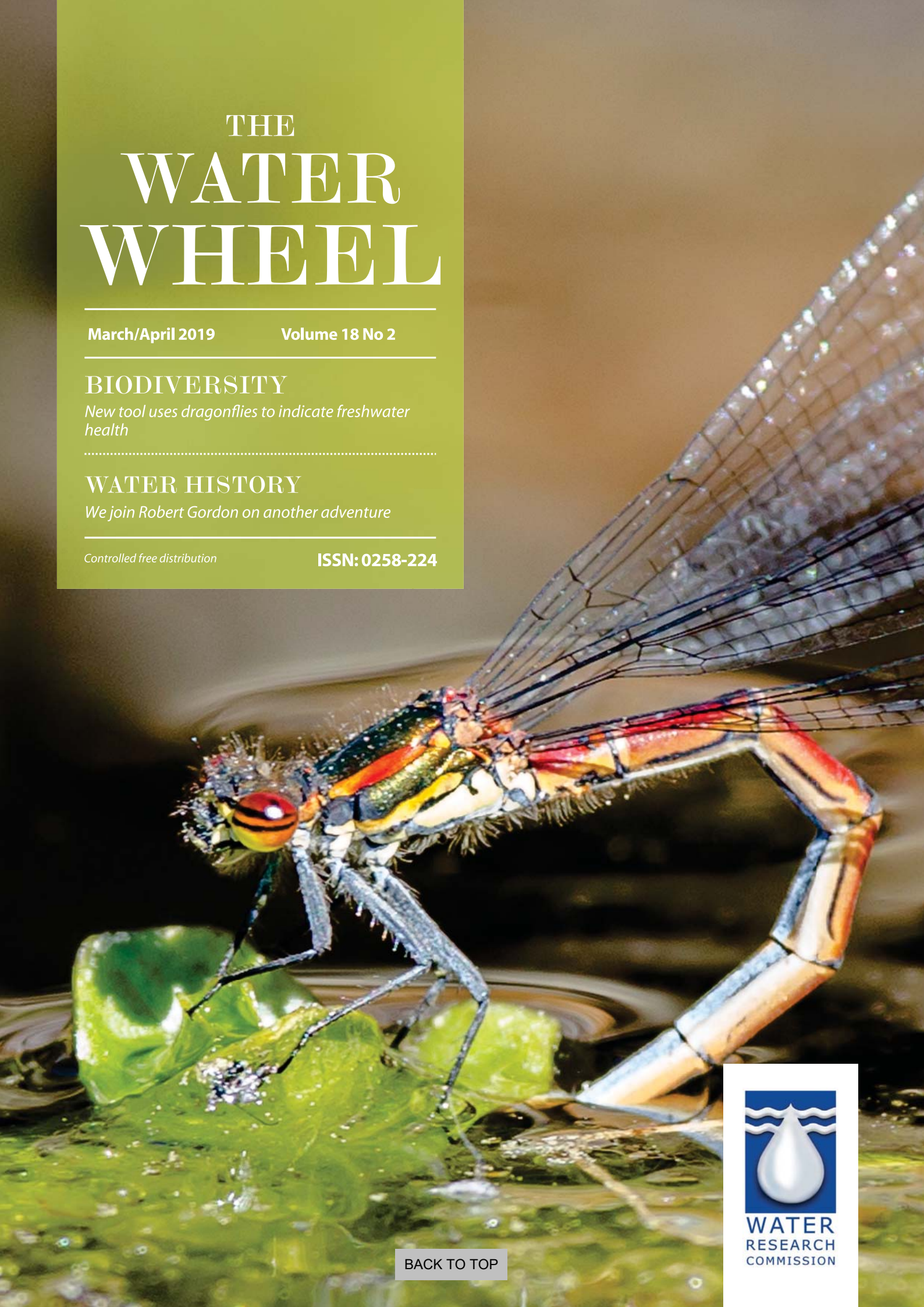

THE WATER WHEEL

March/April 2019 Volume 18 No 2

BIODIVERSITY

New tool uses dragonflies to indicate freshwater health

WATER HISTORY

We join Robert Gordon on another adventure

Controlled free distribution

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WATER RESEARCH COMMISSION

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WATER RESEARCH COMMISSION

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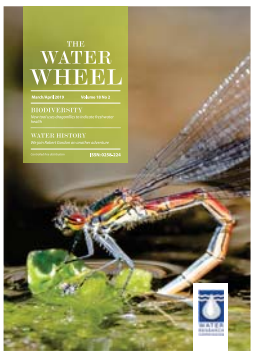

A new tool has been developed that employs African dragonflies as indicators of freshwater health. Story on page 12.

FLUID THOUGHTS

WRC CEO, Dhesigen Naidoo

A boost for African sanitation

Africa, which currently has the world's largest backlog in access to sanitation, can only come close to achieving the Sustainable Development Goal (SDG) on the back of new technologies and innovations. In doing so she may be able to lead a global sanitation revolution to low-water, low-carbon, decentralised, affordable and sustainable sanitation.

The African quest for universal access to safe and dignified sanitation was the topic for discussion when 1 300 delegates from 36 countries gathered at the first joint AfricaSan and Faecal Sludge Management conferences – in Cape Town. This is the first time the two conferences have been combined allowing for unique joint discussion between scientists and innovators who have the new solutions and technologies with practitioners as well as policymakers and political leadership.

The real coup was the participation of an emerging African sanitation business sector. These are a group of amazing individuals from across the African continent that have earned the title of sanitation entrepreneurs or 'sanipreneurs'. These range from small operations of first-time micro-enterprises, like the companies that have come out of the WRC-African Development Bank project on social franchising, to mid-sized companies that are already dotting the African landscape as significant service providers primarily in the sanitation and wastewater domain. The spectrum covers pit-emptiers, an enthusiastic group who met as an association for the first time on the margins of the conference, to large African companies providing wastewater services to cities and towns across the continent.

The African Ministers Council on Water (AMCOW) representatives were convened by South Africa's Minister, Gugile Nkwinti, in a Ministerial roundtable to deliberate on how to take forward the various African commitments around sanitation. Key among these are the United Nations SDGs, centre of which is SDG6, as well as the Ngor Declaration on Sanitation and Hygiene adopted at the previous AfricaSan. In the four years since both these commitments were made, we have seen rapid developments in technological solutions, social innovations, the regulatory environment and policy. Examples include a range of state-of-the-art toilets that have very low water use, separate waste in a single step. They can also be fitted directly into local processing units that treat the waste and produce valuable by-products like energy, chemicals, other compounds for reuse and of course clean water. On the regulatory front, we now have the first global ISO standard for non-sewered sanitation that our colleagues at the SABS are working on to produce the South African standard. The next step is the National Building Council creating the enabling regulatory environment to completely transform our sanitation environment.

The Ministerial representatives adopted the Cape Town Minute (CTM) which will serve at the next full meeting of AMCOW to take forward these issues. In addition to the Ministers and the represented governments, the CTM is supported by the AMCOW Secretariat, the Bill and Melinda Gates Foundation and the Water Research Commission. The highlights of the CTM include the concept of a Pan-African Test-Bed Network where we can pilot and demonstrate the new technology options in all sub-regions of Africa. The demonstration platforms will have the dual impact of further optimisation of the new technology for local conditions, and de-risk the solution for implementors and investors. A second component is the development of an African Water and Sanitation Knowledge Hub. This will begin with the expansion of the WRC Knowledge Hub to be accessible around the continent through multi-institutional linkages, but the goal is to eventually have a vibrant African knowledge repository and solutions exchange.

An important third component is to export the social franchising models into the different regions of the continent. This remarkable concept has been developed and piloted in the Eastern Cape province and has produced 22 companies led by sanipreneurs who work in first repairing and then being responsible for the maintenance of school toilets. The sanipreneurs have already had a very positive impact on 302 schools and 93 492 learners. They have also created 240 sanitation clubs with many more in the pipeline. The sanitation clubs are comprised of teachers and learners that together with the sanipreneur oversee the school programme. All of the sanipreneurs have started off a zero-base using the central support system provided by the franchisor ImpeloYabantu. With

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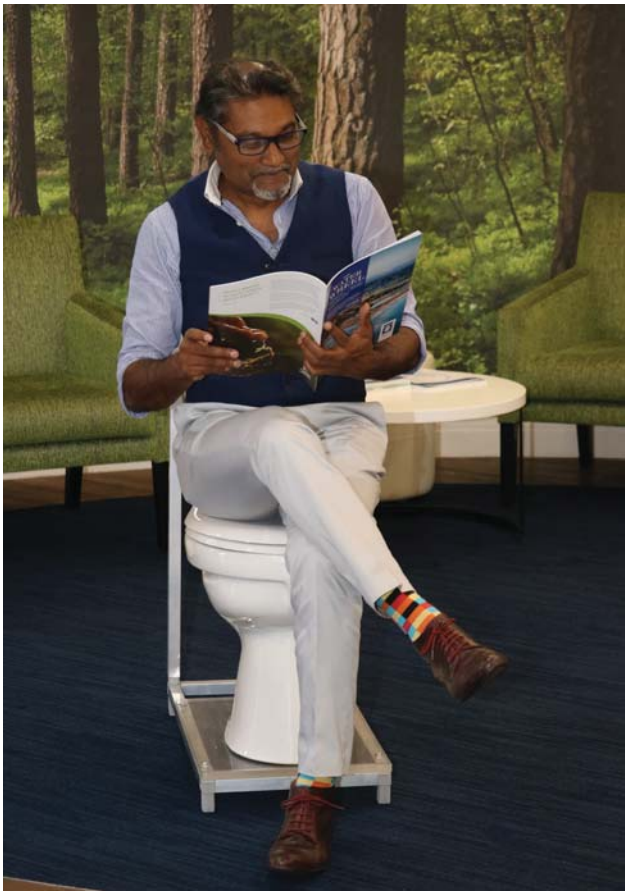
each company having an average of five employees, the cohort of companies is supporting over a hundred families in the programme.

The majority of sanipreneurs in this cohort are women. The local recruitment has been a pivotal factor in both sustainability and service excellence. Already some of the sanipreneurs have diversified to into biochar production from the waste as well as introduce other value-added services like menstrual hygiene education in the schools that they service. The regional Department of Water and Sanitation office has been a strong supporter and regular participant in the activities. Ma Nocawe Dokoda, one of these remarkable women, shared her story to the conference plenary inspiring the delegates with what is possible with innovation, commitment and pure grit.

It is a model that is easily exported beyond schools into other public facilities and the community at large. And it is a model that has the potential to thrive on the African continent. In addition to the achievement of the sanitation SDG, this kind of intervention directly engages the triple challenge of poverty, unemployment and inequality. This, combined with Africa being a first implementor of the latest innovations and technologies, means that this continent can lead a global sanitation revolution. A worthy goal that can have positive impact on the African development project.



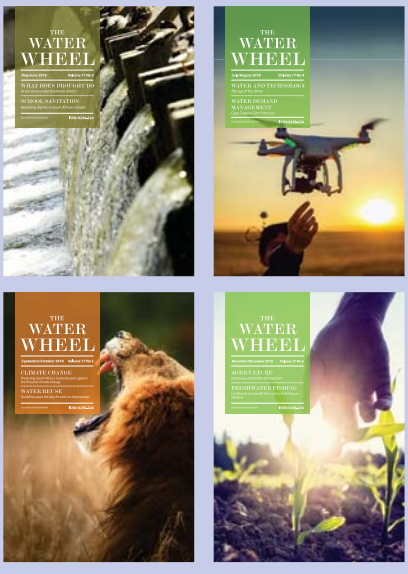
ANNOUNCEMENT
WATER WHEEL GOING SOLELY DIGITAL

The *Water Wheel* is going digital.

After 18 years in print, a changing publishing landscape and increasing economic limitations have forced the magazine, and its publisher, the Water Research Commission, to reassess its position in the market. A decision has been made to suspend the Water Wheel print edition in exchange for a digital offering.

Subscribers will be offered the opportunity to subscribe to a notification service that will provide direct access to the digital edition. We would like to take this opportunity to thank our loyal contributors and readers for their support and encouragement throughout the years. It is hoped that they will continue to support the magazine in its new format.

Any enquiries can be directed at the Editor, Email: laniv@wrc.org.za.



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NEWS

Maritzburg school boasts new toilets

Pretoria-based firm, Amalooloo, has donated 16 dry toilets to Ndlelayabasha Primary School, in Willowfontein, Pietermaritzburg.

This follows a report from non-governmental organisation, GroundUp, that stated that the school was struggling having only one pit toilet to cater for 455 learners.

Willowfontein had had an inconsistent water supply for the last three years. The school has flushing toilets but these cannot function if the water had not been delivered by a water tanker. Learners were sent home if there was no water because only the Grade 7 pupils are old enough to use the single pit toilet.

Amalooloo project manager, Curtis Diago, said his company learnt about the problem from the Groundup article. The company made contact with the school late last year. It finished installing the new toilets by December.

"Water is a basic need and it should not affect learning," noted Diago. "We have handed over 16 toilets. There is a unit for boys, girls, and two toilets for educators as well..We are happy to have donated these toilets to the school. No pupil will be sent home because of the shortage of water or toilets."

Source: Groundup

African Union recognises world leader in invasion biology

Leading scientist in the field of invasion biology, Prof Dave Richardson, from the DST-NRF Centre of Excellence for Invasion Biology (CIB) at Stellenbosch University (SU), is the recipient of the 2018 Kwame Nkrumah Award for Scientific Excellence. He was awarded the prize in February.

This continental award is one of three awards made annually by the Commission of the African Union to recognise outstanding African scientists for their achievements, discoveries and innovations. Established in 2008 in memory of Pan-Africanist leader, Dr Kwame Nkrumah, the continental award includes a monetary award of US$100 000.

Prof Richardson is a distinguished professor in the Department of Botany and Zoology at SU, and director of the CIB, described as one of the most productive and influential research groups working in the field of biological invasions in the world. Biological invasions are a rapidly growing threat to biodiversity and ecosystem functioning in Africa and many parts of the world.

Prof Richardson says he is extremely honoured to receive this award: "I hope that it will help to spread awareness of the massive problems with invasive species worldwide, and the urgent need for innovative solutions to prevent the escalation of impacts on biodiversity and human livelihoods."

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SA river flow champion wins international prize

South African aquatic science doyenne, Dr Jackie King, has been named the 2019 Stockholm Water Prize Laureate for her game-changing contributions to global river management. She has advanced the scientific understanding of water flows, giving decision-makers methods and tools to assess the full range of costs and benefits when managing or developing river systems.

Dr King led the early development of the methods as a researcher at the University of Cape Town, funded by the Water Research Commission. Later, she and colleagues, Dr Cate Brown and Dr Alison Joubert created ecosystem models to demonstrate the ecological and social implications of damming and dewatering rivers. This has enabled objective assessment of the costs of water resource developments that could emerge linked to benefits such as hydropower and irrigated crops.

One receiving news of the prize, Dr King said: "I find it humbling, energising and very rewarding. I have never sought high-profile jobs but was happy to be a working scientist, free to say what I felt needed to be said. I am delighted that the silent voices of river systems and their dependent people are increasingly being acknowledged. We all lose if rivers become severely degrade due to poorly informed development and management. It does not have to be like that."

Her commitment to raising awareness of the value of rivers and their importance for millions of people has made Dr King highly regarded by academics and water managers globally. In its citation, the Stockholm Water Prize Nominating Committee notes that: "Dr King has, through scientific rigour, selfless dedication and effective advocacy, transformed the way we think, talk and work with water as a flow of and for life."

Dr King's early work influenced South Africa's 1998 National Water Act and is increasingly guiding governments and institutions across the globe. First as a researcher and later as a consultant, she has worked in more than 20 countries and with governments of the Mekong, Zambezi, Indus and Okavango River Basins, among others.

"Governments developing their water resources understand the potential benefits but not necessarily the costs in terms of degrading rivers. We can now show these ecological and social costs at a similar level of detail to the benefits shown by planners. This is a new kind of information, not available until the last few years, that helps governments better understand the trade-offs involved in development as they decide on their preferred future," she adds.

Watch the announcement:
https://vimeo.com/324949272

WATER DIARY

Intermittent water supply
7-9 April
The first IWA Intermittent Water Supply Conference will be held in Kampala, Uganda. The conference aims to advance the knowledge and share experiences on intermittent water supply (IWS) and to frame the problem of IWS within its technical, institutional, financial and social contexts For more information,
Visit: www.iws2019.org

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

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

Ecological restoration
24 - 28 September
The 8th World Conference on Ecological Restoration will be held in Cape Town.
www.ser2019.org

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

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

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SA mourns the loss of mother whose life was dedicated to water

The South African community is mourning the death of grassroot development activist, Mma Tshepo Khumbane, in January at the age of 80.

Tshepo Thobakgale Khumbane was born on 26 April 1937 in the rural area of Tšhukudung, Limpopo. She proved herself to be a pioneer from an early age, being the first person in her family to matriculate and go to university. She qualified in social work.

Her mother passed away while she was still a child, and her grandmother played an important role in her upbringing. She started developing and mobilising poor women as a young social worker after witnessing children from poor households being admitted to hospital with acute malnutrition.

In the early 2000s, Mma Tshepo started specialising in development strategies focusing on nutrition and home food production and founded the Water for Food Movement. As an independent spirit, her role was to inspire, empower and mobilise communities around her. Her choice was to treat people as equals and to get them to determine their own destination path, rather than be passive recipients of state grants and handouts.

For many years she lived and breathed this philosophy from her plot outside Cullinan, outside Pretoria. From this base, with little donor or government funds she tackled poverty issues and inspired people to help themselves. Mma Tshepo taught communities about organic gardening, waste management, food storage and processing, time management, recordkeeping of crop production, self-reflection and vision building, among others. Her rainwater harvesting methods were unique and a best fit for the communities where they were applied.

She won several awards during her lifetime, including a Women in Water Award from the Department of Water and Sanitation and the Order of the Baobab from the South African Presidency.

Commented Water Research Commission (WRC) CEO, Dhesigen Naidoo: ""Mma Tshepo Khumbane was a water hero, an entrepreneur, a community builder and a visionary. Her exemplary selfless work in empowering local community to facilitate and achieve their own food security through smart water management, including water harvesting has earned her many accolades including WRC awards. She has set the benchmark for the rest of us to aspire to."

Mma Tshepo's life and work was captured in the book, ***The Journey of Mma Tshepo Khumbane***, which was published by the Water Research Commission in 2014. The book can be accessed here, https://bit.ly/2GdxKHR

Water and sanitation under the spotlight in North West

Water and sanitation challenges came to the fore at a number of summits hosted by the North West Department of Local Government and Human Settlements.

During February, the department hosted four summits in the Dr Ruth Segomotsi Mompati, Ngaka Modiri Molema, Bojanala Platinum and Dr Kenneth Kaunda districts.

"The purpose of these summits was to discuss water and sanitation challenges in the province in order to develop plans that will ensure that there is stability and sustainability in the provision of water and sanitation in all areas in the provinces," noted the provincial department.

Earlier this year, Water and Sanitation Deputy Minister, Pamela Tshwete, launched a state-of-the-art water laboratory in Brits. The Magalies Water Services Laboratory provides services ranging from water quality testing and sampling, research and other services.

Source: SAnews.gov.za

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GLOBAL

Unique course to address global water crisis

Stockholm International Water Institute (SIWI) together with the United Nations' SDG Academy have launched a unique, free course on water.

The open online course – available from January – is aimed at equipping students, business leaders and change-makers at all levels with tools to handle today's and tomorrow's water challenges. It is estimated that by 2030, global demand for freshwater will exceed available supply by 40%, forcing all sectors of society to adapt.

"Water is the defining issue of our age. We need a new awareness of the role water plays for humans, societies and nature. Both SIWI and the SDG Academy feel it's urgent to spread this knowledge to as many people as possible," notes Dr Therese Sjömander Magnussen, Chief Operations Officer at SIWI and Lead Faculty for the course.

SIWI was tasked to organise the training to create the most up-to-date course possible with the latest research on topics such as the link between water and health, why agriculture must rethink its water use and how water can be a tool for peacebuilding. The modules were filmed during the 2018 World Water Week in Stockholm, the most important yearly event for the water community.

"Thanks to this, we've been able to create a unique course with many of the world's leading experts. I hope many people will seize this opportunity to learn directly from them," said Magnussen.

She further emphasised the broad scope of the course, called Water – addressing the global crisis. The course explains how water is crucial to all the Sustainable Development Goals and features both academic lecturers and practitioners. After the two-week course, students will have a good understanding of key topics related to water scarcity, climate change, sanitation and much more.

For more information,
Visit: www.siwi.org/watercourse/

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Leftover brine threatens future desalination

The increased number of desalination plants around the world is threatening the sustainable use of the technology, a study warns.

The UN-backed study, published in the journal, ***Science of the Total Environment***, cautions that the disposal of leftover brine into the sea is expensive, harms the environment and threatens the future use of seawater in desalination.

It estimates that globally, nearly 16 000 desalination plants currently produce 95 million m^3 of freshwater per day. With each litre of freshwater, 1.5 litres of brine is produced – and amounts of brine at around 142 million m^3 per day, about 50% higher than previous estimates.

The research team, from the UN University's Institute for Water, Environment and Health at Wageningen University, The Netherlands, and the Gwangju Institute of Science and Technology, Republic of Korea, produced the new estimates by analysing the latest data to come up with what they say is the most comprehensive study of leftover brine to date.

Manzoor Qadir, a researcher at the UN University Institute, and one of the study's authors, said that he believed the study would raise awareness about the risks of brine production, and potentially lead to more effective management to maintain the benefits of desalination. "We see governments in water-scarce countries mainly look at the supply side of providing desalinated water."

Almost half of the world's current production of desalinated water lies in the Middle East and North Africa region (48%). Four in five desalination plants are located 10 km from the coastline, and the brine they produce is disposed directly into the marine environment. This poses a high risk to marine ecosystems, according to the authors.

To view the original article,
Visit: https://bit.ly/2S1vHgb

Alien water weed threatens southern African waters

Scientists have expressed their concern over the spread of a dangerous waterweed across water bodies in southern Africa.

The waterweed, called ***Limnobium laevigatum*** or South American sponge plant, floats on water bodies and has the potential to invade other plants and decrease biodiversity. "The repercussions are likely to be devastating. Any aquatic plant that completely covers the surface of a water body is likely to have severe impacts on ecosystem functioning and utilisation," said Philip Weyl from the Centre for Agriculture Bioscience International. According to Weyl, the South American sponge plant is a dangerous weed that needs not be underestimated because of its fast growth and incredible ability to disperse.

The sponge plant was first detected in Zimbabwe in the early 2000s but has since moved to Lake Kariba along the border between Zambia and Zimbabwe, as well as the Zambezi River. In September last year the species was sighted in the Kafue Flats, a vast area of swamp, open lagoon located in Zambia.

"This plant is very similar to water hyacinth and is likely to have negative impacts on biodiversity…fishing, water sport, hydroelectricity and recreation," explained Weyl. "It is also likely to provide habitat for many disease-carrying aquatic organisms such as mosquitoes and snails."

Weyl added that there is currently no biological control programme anywhere in the world for the South African sponge plant.

"We need to survey the native range to find natural enemies that are safe and could regulate the population of this weed in the invaded range. This process involves much scientific research into the biology and ecology of the natural enemies to select a safe and effective classical biological control agent for use in Africa."

Source: SciDev.Net

Collaborative effort leads to updated groundwater resources map of Africa

The Federal Institute for Geosciences and Natural Resources presented an updated map on the groundwater resources of Africa at the 7th Africa Water Week, held in Libreville (Gabon).

The publication was developed as part of UNESCO's Worldwide Hydrogeological Mapping and Assessment Programme (WHYMAP). The map has also been introduced as a German contribution to the plenary session of the Global Earth Observation System of Systems (GEOSS) initiative in Kyoto, Japan.

This hydrogeological map of Africa on a scale of 1:12 500 000 provides an additional planning tool for groundwater resources in Africa and helps to manage groundwater sustainably in the long term. It contains hydrogeological sections of regional aquifers as well as regional and transboundary hydrogeological surface information on the composition of geological units and their respective groundwater yield.

To access the map, Visit: https://bit.ly/2TAPEax

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Environmental laws 'only look good on paper' – UN report

A dramatic spike in the global adoption of environmental laws has failed to translate into better conservation efforts, according to a United Nations report, the first global evaluation of such laws.

The document called ***Environmental Rule of Law*** – which assessed national laws, regulations and policies around the world – found a lack of political will, underfunded agencies, unfair judicial systems and a poor implementation of the law had, in fact, hindered efforts to address some of the biggest challenges of our time, such as climate change and the loss of biodiversity.

To counter this, the report emphasises the need to strengthen the environmental rule of law through a regular global assessment to track progress or potential backsliding.

"What we have seen (in the last decades) is a growth of laws and institutions, but a lot of that progress is stalled," noted Carl Bruch, a law researcher at the Environmental Law Institute in Washington DC, and co-author of the report.

In fact, according to Bruch, the field has experienced a kind of hiatus for at least 26 years.

Following the Earth Summit held in Rio de Janeiro, Brazil, in 1992, hundreds of nations witnessed an explosion of environmental laws, according to the report. They incorporated environmental protections into their constitutions and created environmental ministries. As of 2017, about 90% of all nations had at least basic laws dedicated to protecting the environment to some extent.

But this has been undermined by ineffective and erratic enforcement. Most countries don't feel the need to implement these laws, and that isn't limited to the developing world, explains Bruch. "There are the laws that you have to follow and the laws that you may follow if you want to – in many countries, environmental laws fall into the latter category."

To view the report, Visit: https://bit.ly/2RIYt5c

Global community debates impact of climate change on peace

As climate change is increasingly recognised as a 'threat multiplier' by scientists, political representatives, and civil society across the world, the United Nations Security Council held an open debate in January to discuss its concrete impact on peace and security.

"The relationship between climate-related risks and conflict is complex and often intersects with political, social, economic and demographic factors," said Rosemary DiCarlo, the Under-Secretary-General for Political and Peacebuilding Affairs in her opening remark.

"The risks associated with climate-related disasters do not represent a scenario of some distant future. They are already a reality for millions of people around the globe – and they are not going away," she stressed.

The meeting took place almost two months after 197 parties to the UN Climate Change Convention agreed to a concrete way forward on implementing the 2015 Paris Agreement – which aims to keep global warming under 1.5°C from preindustrial levels – and ahead of the UN Secretary-General's Climate Summit, convened for 23 September this year.

For the first time in history, the UN World Meteorological Organisation was invited to brief the members of the Security Council on climate and exstreme weather issues.

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BIODIVERSITY

Dragonfly study provides new tool to determine freshwater health in Africa

A new tool that employs African dragonflies as indicators of freshwater health has been developed. This index, the first biomonitoring tool of its kind in Africa, can be applied on a continental scale. Jorisna Bonthuys reports.

All photographs supplied

It is a well-known fact that clean water is vital for the survival of both humans and the natural world. Yet freshwater ecosystems are also the most threatened systems on the planet.

Research shows that freshwater species are declining at an alarming rate — much faster than terrestrial or marine species. Freshwater ecosystems that provide valuable goods and services are under severe threat, including from pollution, overexploitation of water resources, the spread of alien invasive species, habitat loss and degradation, and climate change.

Many African countries are already considered hotspots for climate change, meaning that they are warming faster than other regions on the planet. Along with higher temperature levels and more evaporation, the implications of climate change for river flows and long-term assurance of water supply are potentially serious.

Understanding the status and ecological health of Africa's freshwater resources remains vital. Planners and decision-makers need access to reliable data to inform appropriate climate adaptation responses (actions that can help society cope with the effects of climate change).

Luckily, a new and practical tool that employs dragonflies as indicators of African freshwater health is now available to inform water resource management and conservation efforts on the continent.

This tool, called the African Dragonfly Biotic Index (ADBI), was refined by Dr Carlien Vorster as part of her PhD study. She works as a researcher at the Stellenbosch University's Faculty of

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AgriSciences in the Department of Conservation Ecology and Entomology. The project was funded by the JRS Biodiversity Foundation and the MONDI Group.

Tool for change

The ABDI is the first biomonitoring tool of its kind developed for use across the continent. This index can be used to rapidly assess and track changing conditions within Africa's diverse freshwater ecosystems. It is African-led science, for African application.

But why build this index on data about dragonflies? Invertebrates are sensitive to environmental change and can be used as indicators of changing ecological conditions for monitoring and conservation purposes. However, it is important to consider that a specific group of taxa may not be an effective indicator across different ecosystem types. Grasshoppers can, for instance, act as a good indicator of changing conditions in African grasslands, while they are less effective in central Europe.

The insect order Odonata ("true" dragonflies and damselflies), collectively known as "dragonflies", is considered a taxonomic group that can be widely used as an indicator of ecological health on the continent.

"Dragonflies are globally recognised as an excellent indicator species – they are bright, colourful, conspicuous, and well-known insects that are sensitive to changing water conditions and health," Vorster says in a recent media release issued by the faculty. "They are also fairly easy to identify in the field, and are relatively well-known taxonomically."

Arriving on the scene around 300 million years ago, this ancient group of insects are now offering scientists a new perspective on the status of Africa's freshwater resources. This is because different dragonfly species have different habitat requirements which characterise the different freshwater systems in which they occur (including lakes, fast-moving rivers, mud pools and artificial irrigation dams). These insects are also found in both freshwater and terrestrial ecosystems on the continent.

Dragonflies are highly mobile species and quickly respond to changing water conditions, either by moving away or towards them depending on the change, Vorster explains. These insects are also sensitive to changing habitat structures and conditions, as well as water conditions. A change in their species assemblages indicates some change in the state of a water body.

"Dragonflies, therefore, give us a broad perspective of what is going on in freshwater systems and their surroundings," Vorster highlights. "It is also cheaper and less labour intensive to use this index for analytical purposes than some of the other monitoring tools out there."

Building the dragonfly 'puzzle'

The ABDI was developed using the South African Dragonfly Biotic Index (DBI) as a template. Vorster's former PhD supervisor, Prof Michael Samways, and co-supervisor, Dr John Simaika, were instrumental in developing the DBI.

As there are considerable data available on Africa's dragonflies including their distribution, ecological sensitivity and regional uniqueness, the researchers modified and expanded the DBI to be applied across the entire continent.

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"Dragonflies are globally recognised as an excellent indicator species – they are bright, colourful, conspicuous, and well-known insects that are sensitive to changing water conditions and health."

A total of 708 dragonfly species have been recorded in Africa. The ADBI index covers 604 of these species. Using this information provides a cost-effective way to track the status of freshwater resources on the continent, Vorster points out.

The ABDI uses dragonflies as indicator species of freshwater health in biogeographical ecoregions. They are geographical units that are characterised by specific ecological patterns, such as fauna, flora, soil type and climatic conditions. These ecoregions stretch beyond political borders.

Vorster used approximately 115 000 distribution records of dragonflies collated in the spatial database, Odonata Database of Africa, as well the ADBI scores for each individual species studied, to determine how effective this index can be used in different countries and biogeographical ecoregions.

"The project was like a giant puzzle with thousands of pieces I had to assemble," Vorster says. "I embarked on this research because I wanted to contribute in some way to the conservation and management of our continent's freshwater systems as they are really in trouble," she says.

The ABDI index is based on three main pillars: a species' geographical distribution, the species' vulnerability (to human disturbance), and its threat status in terms of the International Union for the Conservation of Nature/Species Survival Commission (IUCN/SSC) Red List. This information is collated in scores for individual dragonfly species.

The index's scores range from "low" to "high" (from 0-9). A species that has a widespread distribution, is considered non-threatened, and is highly tolerant of habitat disturbances, scores low on this index ("generalists"), whereas a species that has a highly restricted distribution, is highly threatened, and is extremely sensitive to habitat disturbances, scores high ("specialists"). For example, the Red-veined Dropwing dragonfly (***Trithemis arteriosa***) is considered a "generalist" in South Africa, while the Ceres Streamjack damselfly (***Metacnemis angusta***) is very rare and found only in pools about 400 meters above sea level in the Western Cape (i.e. "specialist").

The combination of all species' scores in a freshwater system indicates the health of the system, and what conservation actions should be taken to improve it.

In the case of the terrestrial ecoregions studied, an average of 91% (93 of 102) ecoregions are occupied by generalists, while an average of 28% (29 of 102) ecoregions are occupied by specialists. For the freshwater ecoregions, an average of 97% (75 of 78) ecoregions are occupied by generalists, while an average of 32% (25 of 78) ecoregions are occupied by specialists.

As a consequence, either terrestrial or freshwater ecoregions can be used to assess the status of freshwater systems at a more local scale, according to Vorster's research.

Future applications

The ABDI index, like the DBI that it was based on, can be used to track the fast-changing conditions (including health and ecological integrity) of freshwater ecosystems.

"As this tool was created to assess freshwater systems at a continental scale and conservation usually occurs either at a national or biogeographical level, it can now also be moulded into national or local tools," Vorster says.

The index was tailored to individual countries for finer scale analysis and can now be used to develop local dragonfly biodiversity indexes for different ecoregions on the continent. The ABDI can be applied to both still and running freshwater bodies. Both political regions and biogeographical regions can also be used to determine conservation interventions. The political regions in this study are the 49 African countries, while the biogeographical regions are the 102 terrestrial and 78

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freshwater ecoregions.

Vorster's thesis provides a blueprint for countries like Zimbabwe and Gabon to develop their own (national) dragonfly biotic indices. "The ADBI has the potential to help identify threats and sensitivities to freshwater systems in these countries, which means that appropriate conservation action can be taken," she states.

Currently, African countries are at various levels of developing their own national versions of this index. This is because the spatial database created for Africa's dragonflies varies in quality and quantity.

Of the 48 African countries studied (excluding South Africa, which already has a national DBI), 12 countries are close to being able to implement national DBIs, while another 12 have insufficient data and are not currently able to put in place national DBIs. The other 24 countries need much more basic data to build national DBIs, according to her analysis.

Some countries are also perhaps not well suited for creating their own national DBIs as they are too arid (including Egypt, Algeria and Morocco). It may be possible that some of these countries could develop local DBIs in their wetter zones, including the Nile region in Egypt.

In terms of the IUCN/SSC Red list, all African countries need to develop their own national Red List threat statuses for their recorded dragonfly species, she highlights in her dissertation. This is because some species that may be classified as, for example, "near threatened" on a global scale, may be more vulnerable on a national level.

Efforts to improve the monitoring and understanding of freshwater resources remain key, not just in terms of understanding the rate of deterioration but also to show how conservation efforts are having a positive effect. The index can assist decisionmakers involved in the management and conservation of freshwater systems and biodiversity, Vorster indicates. "The ADBI offers conservationists and planners as a way to assess the status of various freshwater systems such as rivers, ponds and wetlands."

"The other main finding is that the ADBI has a strong relationship to the parent biotic index, the South African DBI, which means that the ADBI is a relatively strong research tool to use," she concludes.

Contact Dr Carlien Vorster for more information at cvorster@sun.ac.za

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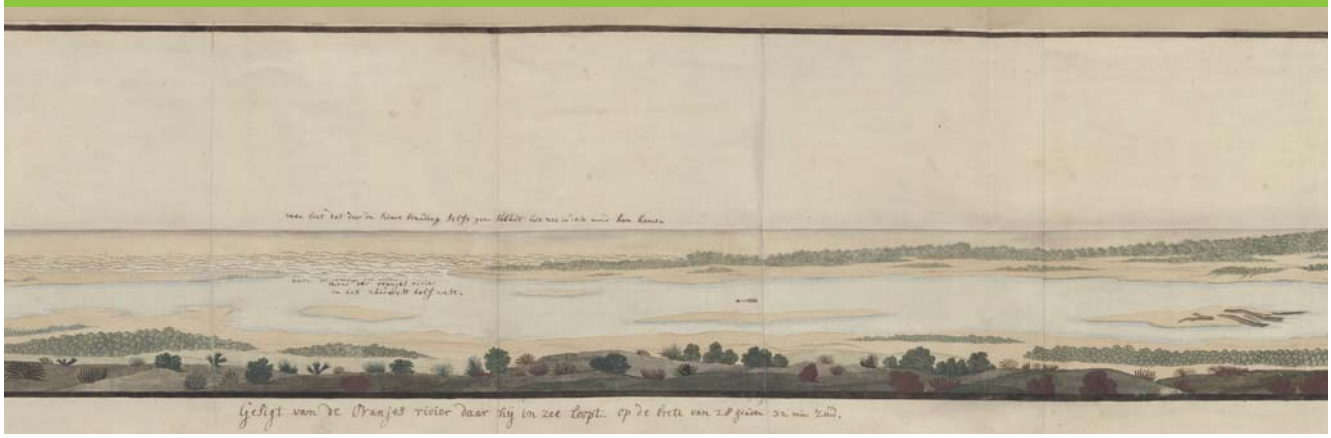
WATER HISTORY

Travels of Robert Jacob Gordon – Part 3

Parts 1 and 2 of this article covered Robert Jacob Gordon's journey from Cape Town to the confluence of the Orange and Caledon Rivers, returning via the Cape's eastern and southern coasts. Here we join him again as he embarks on another adventure. By Sue Matthews.



All images attributed to Robert Jacob Gordon, courtesy of the Rijksmuseum

Part of a large panorama of the Orange River mouth, as seen by Robert Jacob Gordon in August 1779.

Five months after returning from his journey in search of the 'Great River' in the interior, which he named the Orange River after the Dutch Republic's Prince of Orange, Gordon set off again on 28 August 1778. This time he was accompanied by the Governor of the Cape, Baron Joachim van Plettenberg, and they followed much the same route as Gordon's previous journey up to the river that he had named in Plettenberg's honour. On that first visit, Gordon's group had killed nine hippo. On this occasion, the final tally from a shooting spree on 3 October was 20. The river was later renamed the Seekoei River in memory of the hippo that once occurred in abundance there.

After leaving the area, the group travelled east alongside the Sneeuberg mountain range to the Klein Vis River near present-day Somerset East. On 19 October Gordon left the Governor's party, intending to cross over the Orange River, having brought a boat along on one of the ox-wagons. A week later he abandoned this plan due to ill health, and instead headed west to the vicinity of present-day Beaufort West, and then followed a route similar to today's N1 through the Karoo to the Hex River valley.

There Gordon waited out bad weather and illness for about two weeks as a guest of one De Vos. On 3 December he was able to set out once more, first travelling south-east via the Koo valley to 'the baths' – now part of the Montagu Springs Resort – before returning to the Touws River area and heading north through the Tankwa Karoo to present-day Calvinia. On New Year's Day the group started west, and a week later arrived at the Troe-Troe River at present-day Vanrhynsdorp. They detoured to the Olifants River mouth, seeing many elephant tracks along the way, as well as dolphins far up the river, and then headed south, skirting the eastern flank of the Piketberg, which at that stage had 21 farms around its base. Arriving at the ferry on the Berg River, they found that the water level was low enough for them to ride across the river, and from there it was just a few days to Cape Town, where they arrived on 25 January.

Just five months later, Gordon was off again, this time determined to reach the mouth of the Orange River. He departed on horseback on 27 June 1779, arriving at the first overnight stop a few hours ahead of his two wagons, one of which carried his boat and each drawn by 10 oxen. Rain slowed their progress over the next few days, but they soon crossed the Berg River – this time using the ferry because the river was full after the rain – and continued up to a farm on the Olifants River.

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Here Gordon found his old friend and travelling companion, the botanist William Paterson, as well as hunter and explorer Pieter Pienaar, who then joined Gordon's group with their own wagons.

In order to cross the river two days later, the wagons were dismantled and ferried over in pieces on the boat, which took the entire day. By 19 July the group had reached the Groen River, which they followed upstream to Garies – then just a farm, but now a small town with about 2 000 inhabitants. Once they had reached the vicinity of present-day Kamieskroon, Gordon split the group, sending one wagon due north along much the same route as today's N7 road to Namibia, while he and the other wagons headed for the coast. Now they were in the heart of the west coast's spring flower country, and Gordon recorded his impression in his diary.

"The veld blazed with flowers, the most beautiful colours in the world: yellow oxalis, orange arctotis, red, yellow and bluish-purple mesembryanthemums etc. There were many quiver trees (agave) in bloom here. There were three kinds of geranium. We called this place the Floraas- or Bloem Kloof."

Two days later, on 2 August, Gordon noted that they had seen many fresh tracks of elephant, zebra, eland, gemsbuck and hartebeest. But he was particularly taken with an animal that we know today as an elephant shrew. "Caught an animal today that looks like a field mouse. Called it elephant mouse because it had a long, very flexible trunk or snout," he noted. "It was very nimble."

As the group travelled northward along the shore, Gordon remarked upon the many washed-up thorn and willow trees, noting that they must have come from the Orange River. They also saw signs of human life, including sea shells, seal bones and abandoned huts, some of which "the wild people had made out of right whale bones", before they came across human footprints and the skin of a freshly slaughtered seal.

"As far as can be seen the sea breaks strongly at the mouth and the opening is not wide. Found many water-fowl here:"

Gordon befriended the indigenous people he found living near the mouth of the Orange River and was impressed by their handiwork and survival skills.

On 17 August, Gordon – accompanied by Paterson and one Van Rhenen – rode ahead to the mouth of the Orange River, which he noted "was low and about four hundred paces wide, not flowing fast and with a steep southern bank. There are large sand-banks with a few small thorn and willow trees. We found elephant and lion tracks."

When evening fell they went in search of the rest of their group. "We found the wagons unyoked close to the river where it makes a large vlei one hour from the mouth. At high tide this vlei is a good hour-and-a-half's journey wide, with an island on the left bank, but falls very low at ebb tide revealing many sand-banks, and one can then go over on foot to the island. As far as can be seen the sea breaks strongly at the mouth and the opening is not wide. Found many water-fowl here: pelicans, ducks, two different kinds of flamingo, etc. To our astonishment we found that the water, although ebbing and flowing strongly, was very sweet. I saw no hippopotamuses, which amazed me, and only one track; however there is not much to graze here."

"Brought the boat to the water, hoisted the Prince's flag and drank to His Highness's health and a welcome to the river to which I gave its name in 1777. And several other toasts such as the welfare of the Company, all to the accompaniment of gun-shots."

In the morning Gordon walked over to the island at low tide, which he then realised was only a sand-bank with a few reeds on it. After venturing further along the vlei and shooting some ducks, he returned to the wagons and organised a fishing party.

"At first we did not succeed because of the strong wind and rippling of the water, but on the second cast we caught enough for all our group. This caused great rejoicing, the catch consisting of so-called harders. My dog Keiser swam over to the sand-bank where we were fishing, and out of hunger greedily gobbled a live fish, surely for the first time in his life."

The next day, the men made a sail for the boat using the canvas cover on one of the wagons.

"After some trials it sailed well. But because it was calm we rowed over to the left side of the mouth, where we fished but

Robert Jacob Gordon gave the name 'oliphants muis' (now elephant shrew) to these nimble little animals he encountered in the area of what is today the Namaqua National Park.

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A pink-backed pelican.

did not catch much: some small harders and steenbras. Found the mouth to be a thousand paces wide, half of a quarter-hour's distance. The surf breaks so strongly into it that one cannot discern a current nor along the whole coast for a half a mile from the bank so that, although I saw not one rock along the shore, it is impossible for any vessel or boat to get in," noted Gordon. "The coast is low everywhere so that it must be completely covered when the sea and the river are high."

The following day, the group crossed the river to explore the other side and see whether they could find any people.

"It took us half an hour to cross the river because our boat kept on running aground on the sand-banks. There were eleven of us in it and we had to keep on jumping out to lift it. We were also too heavy for the boat with the fishing-net, so that our crossing was dangerous. Once on the other side our people went fishing, having first done a cast from a sand-bank in the river and caught some harders."

Gordon, Paterson and two of their staff left the group fishing and headed due north across the floodplain.

"After we had been going for an hour we came to a rainwater vlei. Beside this we found the small and large footprints of people, very fresh. We also found large, dry, washed-up trees here, over which soil had been washed and on which shrubs were growing, so that the river must have been very high some years back or there was a heavy storm at sea. We followed the footprints which led to the dunes, being very curious to see these people."

Soon they saw four people, who ran away, but Gordon and his companions continued on to their huts and left some small gifts in the form of copper tinderboxes, copper buttons that Gordon cut off his coat, and a piece of biscuit. Before they left, however, they made a small fire and cooked an ostrich egg they had brought along with them. While they were eating it, they realised that some of the huts' inhabitants were watching them from the dunes, so Gordon sent one of his men to them with more gifts before approaching them himself.
"When I saw that they had voluntarily laid down their weapons I went out to meet them and found the three men suspicious and frightened. But the women were talkative and merrier," he noted. "We all went together to their huts and showed them that we had left everything in order, and they were content with this. They speak a Hottentot dialect of which we and our Hottentots were able to understand almost all."

"They showed me two beautifully dressed seal-skins. Exchanged one for the last button that I had on the front of my coat and I cut off another from my sleeve in order to obtain a skin for Mr Paterson."

Gordon's party departed for the seashore to the north of the mouth, followed by nine of the 'wild people', and then walked back along the estuary's right bank.

"We came to our fishermen, who had caught a fair quantity of harders, I gave the wild people some fish which they first grilled and then ate. I ordered another cast to be made so that they returned to their huts with some fish, very happy, and they promised to come across the river to us next day. Because the party was eleven strong with many fish, we left our net on the bank. We started back for our camp, with the moon now shining. Having to pass many sand-banks with a fog forming made the crossing very dangerous in the deeply laden boat, which had no side-boards. At times we shipped water because of the rough river surface, but fortunately reached our camp, mostly guided by our fires on the bank by which I steered, though we often ran aground."

The following day Gordon and his men remained in their camp due to heavy mist, but they soon received visitors.

Steenbras.

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"The wild people came to us, numbering three men, four women and a child. They had gone upstream a little and there, with the water up to their bellies, had crossed by a path known to them. I gave them some fish and tobacco and having talked to them about this country, they departed happy around sunset."

Over the next few days the two groups interacted daily. Gordon examined their jackal traps, bartered with them for one of their water-carrying bags made from a seal bladder, and gave them some more fish and tobacco. On 25 August Gordon's group departed up river, but – realising the wagons could not traverse the steep-sided poort upstream of the estuary – he decided to return with them to the Buffels River (then called the Kouwsie River) and reach the Orange River via the same route that he had sent his other wagon when the group split up. Travelling on horseback and foot, Pienaar and six men would continue along the river and wait for Gordon at the 'Company's Drift', just upstream of present-day Goodhouse. On 4 September 1779 Gordon's group arrived back at the Buffels River and followed it southward, reaching the vicinity of present-day Kamieskroon before turning north again.

We will continue Gordon's journey inland along the Orange River in the next issue of ***The Water Wheel***.

Further reading: https://www.robertjacobgordon.nl/

Depiction of the shooting spree on what is now known as the Seekoei River (west of Colesberg) on 3 October 1778, when 20 hippo were killed in the space of a few hours.

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WATER RESOURCE MANAGEMENT

What was the impact of the 2017-18 drought? A research project dought the answer by using data derived from satellites

Western Cape farmers are using satellite data to determine the impact of recent droughts.
Article by Ruben Goudriaan, Caren Jarmain, Mechteld Andriessen, Kristin Abraham, Roan Naudé, Peter Keuck.

Dust-storm in Theewaterskloof Dam. Theewaterskloof Dam is the biggest dam in the Western Cape and responsible for feeding water to Cape Town as well as the local agricultural community.

All eyes were on the Western Cape's taps during the summer of 2017/18. Dust storms could be seen clouding the sky above bare dams. Three consecutive dry winters caused dam levels to drop to record low levels.

At the end of October 2017 the average dam storage level in the Western Cape was approximately 39%; by far not enough to fulfil all domestic, industrial and agricultural water demands during the South African summer. As a result, firm measures were implemented to avoid potential disaster by a combination of establishing new water sources, decreasing unproductive water losses (leakages) and firm water restrictions.

The impact of the drought on irrigated agriculture during the 2017/18 season has been high. The total economic loss is estimated at ZAR 6 billion, with 30 000 jobs lost in the agricultural sector.

During the 2017/18 summer production season water restrictions of 50% were implemented in the Breede Valley, 60% in the Berg River and Riviersonderend region and various other regions and 85% or more in the Lower Olifants River Valley. In response to the water limitations, in many areas, crops were removed and shredded to produce mulch for fields which were kept in production.

For orchards and vineyards, this approach will have a long-term impact on productivity as it will take substantial time to

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replace the trees and vines that were removed. Where such extreme actions were not followed, an insufficient amount of water resulted in a reduction in yield quantity and quality. It is further expected that the absence of post-harvest irrigations will negatively impact production in the 2018/19 season.

For this article the impact of the 2017/18 drought on the Western Cape agricultural sector is assessed using satellite-based data products available via FruitLook (www.fruitlook.co.za). The spatial FruitLook data is used to identify the impact of the drought in two distinct regions: the Groenland Water Management area and the Lower Olifants Water Management Area.

The Groenland area is relatively wet and indications are the impact of the drought on production levels was minimal during the 2017/18 season. The Lower Olifants area faced a water deficit of approximately 85% at the start of the season. The results from this analysis display the disastrous impact of a drought, but equally show how varied this impact can be in one single province.

FruitLook in numbers in 2017/18	
1	The FruitLook program is unique to the Western Cape in South Africa
5	The amount of water management areas covered by FruitLook. These include the Olifants-Doorn region, Berg, Breede, Gouritz and Fish to Tsitsikamma
9	FruitLook datasets describing crop growth, crop water usage and nitrogen content
50	Open FruitLook training sessions provided at Elsenburg and in various regions in the Western Cape during FruitLook 2017/18
63	Percentage of users who have indicated FruitLook made their water management at least 10% more efficient
74	Percentage FruitLook users that are farmers. FruitLook is also used by consultants, scientists, students and many others
218	The amount of raw satellite images processed to create the FruitLook data products for the 2017/18 season
776	Number of users in 2017/18
2011	The year FruitLook became available to farmers in the Western Cape The data of earlier seasons is still available via the FruitLook website for users
16 507	Fields ordered during 2017/18
53 049	Hectares ordered during 2017/18
85 000	The approximate amount of fruit fields available for use on FruitLook
200 000	The approximate amount of fruit hectares available on FruitLook

FruitLook 2018-19 provides data from 1 August 2018 to 31 July 2019 and can be used for planning, monitoring and evaluating farming activities:

- **Planning:** FruitLook data can be used to draw up water budgets and prioritise water allocations in terms of field water use efficiency.
- **Monitor:** FruitLook data can assist with water management (how much water should be applied where and when), probe placement, selective sampling prior to and during harvesting and general problem detection through deviations in the spatial pictures and data trends, and in subscribing to FruitSupport.
- **Evaluate:** FruitLook allows users to do a post-seasonal analysis, relating crop yield to the FruitLook data, analyse changes implemented.
- **Interested to learn more?** Hands-on training on FruitLook is offered for optimal use of this program. Training sessions are presented at Elsenburg free of charge, visit the FruitLook website for more information.

The Fruitlook project

Since 2011 farmers in the Western Cape have had access to satellite-based crop monitoring information via FruitLook (www.fruitlook.co.za). Complete funding by the Western Cape Department of Agriculture makes the use of FruitLook free of charge for the end user. Via the provision of smart satellite-based data products FruitLook assists in the efficient use of water resources by farmers. Between August 2017 and April 2018 via FruitLook over 750 users monitored more than 50 000 ha of agricultural land.

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Satellites can see more than the human eye: for example, near-infrared light, visible to insects but not humans can be captured via modern sensors mounted on satellites. Via an ingenious combination of satellite data sources, weather information and smart models, data is created each week, describing crop growth, water consumption (= actual evapotranspiration) and plant nitrogen content. Through the FruitLook portal this data has been helping farmers to assess crop development, and to take efficient and timely mitigation measures where needed, leading to an improved crop production process.

In the context of water management, farmers can use FruitLook for assessing and comparing field water consumption, assessment of water shortages and crop stress, getting an indication of efficiency of water use, probe placement and interpretation and detection of leakages.

Figure 1 shows biomass production for a table grape field as visible on the FruitLook web-portal. The image clearly displays in-field variation in growth. Variation in biomass production can be due to a myriad of reasons, including differences in soil or disease, fungi or other problems within the crop production process. Figure 2 shows information for only one field; each pixel represents an area of 20 x 20m. Analyses exceeding field scale can be done using the dataset as well. The information behind the FruitLook portal is available for all major agricultural areas in the Western Cape as can be seen in Figure 1.

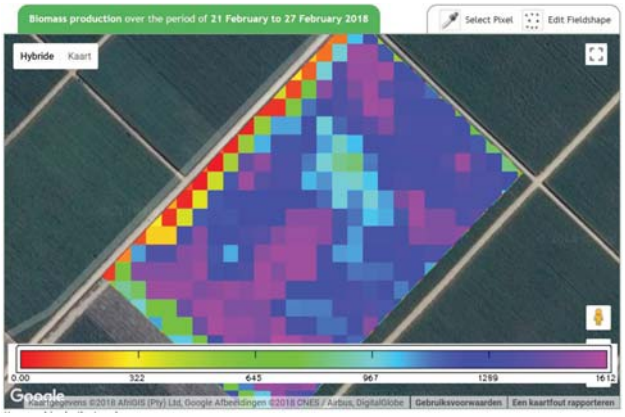

Figure 1. Actual Biomass Production for a table grape field covering the period 21 February to 27 February 2018. The actual biomass production is provided in kg/ha, providing a quantitative indicator of dry matter growth in a field. The biomass production includes roots, shoots, leaves, fruit and all in-between

Figure 2. The data behind FruitLook consists of raster maps describing production in the entire Western Cape on a weekly basis. In this case, a biomass production map shows the vegetation growth during from 25 to 31 October 2017.

FruitLook data was used to assess the effect of drought on production levels within the Groenland and Lower Olifants water management areas. The accumulated biomass production during the 2016/17 season is compared to the accumulated biomass production during the 2017/18 season, specifically for the months October to April, thereby covering the main fruit production season. By expressing the accumulated biomass for the 2017/18 season in relative terms to the 2016/17 season, the impact of drought is shown as a percentage reduction of biomass production from 2016/17 to 2017/18.

Assessing drought impact via FruitLook data

Groenland is located in the south of the Western Cape, near Grabouw. Eikenhof is the main dam in the Groenland water management area. The water in this dam is primarily used for irrigated fruit farming. The Groenland WUA, allowing for a 10% curtailment, could adequately supply water in the demand of their users. The major irrigated crop types in this region are pears and apples, with some wine grapes and stone fruit also present in the area.

When comparing the 2016/17 production season with the 2017/18 production season, accumulated biomass production figures are relatively similar. A comparison is made on a field-by-field basis for 4 302 fields covering close to 9 000 hectares. This comparison is visualised within the histogram for the Groenland area displayed in Figure 3.

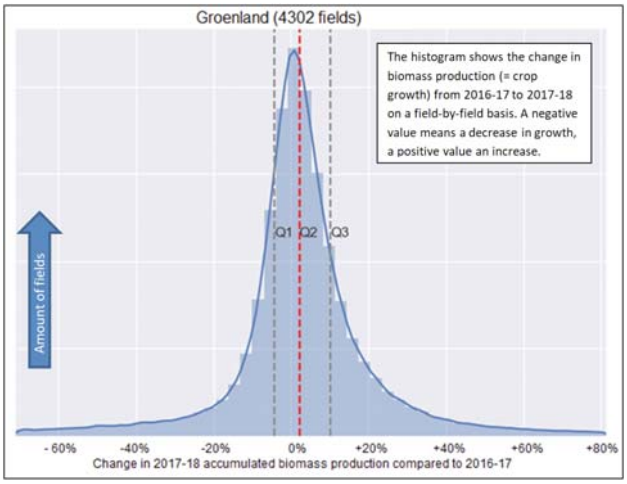

Figure 3 Histogram showing impact on actual biomass production due to the effect of the 2017-18 drought in the Groenland water management area. No particular impact of drought is visible.

The histogram shows a normal distribution and the average difference between 2016/17 and 2017/18 is almost 0%. This means, for the two years considered in the Groenland area, the amount of fields which showed an increase in growth (biomass production) is similar to the amount of fields showing a decrease in growth. For more than two thirds of all fields in the region, the difference in accumulated biomass production between the 2017/18 and the 2016/17 production season was less than 10%. It also indicates the amount of fields in production is relatively stable: almost as many fields show a sharp decrease

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in production as there are fields showing a sharp increase. According to the histogram this water management area displays little to no detrimental effects of drought. This suggest that this area had adequate water for plant growth and the data reflects the fact that little water conservations measures were needed in this area.

This is confirmed in Figure 4, showing the drought impact on a map, where vegetation growth in 2017/18 is expressed in relationship to 2016/17. Most fields show little drought impact (yellow) meaning production during 2017/18 is similar to 2016/17. The data suggests that some orchards were taken out (in red), but also that new fields were planted or came into production (dark green). Although the data considered in this assessment shows vegetation growth (total biomass production) and not crop yield, it would indicate a close to average production season compared to the year before.

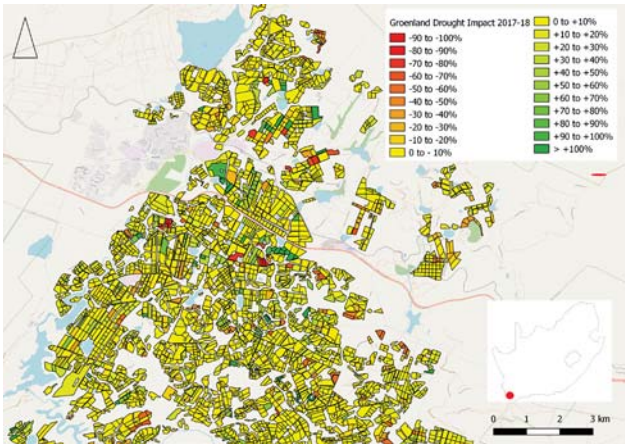

Figure 4. Map showing impact on actual biomass production due to the effect of the 2017-18 drought in the Groenland water management area. No particular impact of drought is visible on the biomass production figures. The dark red fields were likely removed over the past season. Simultaneously, the dark green fields are likely new in production.

A similar assessment for the Lower Olifants water management area (LORWUA) tells a completely different story. The LORWUA region is highly dependent on the Clanwilliam Dam, which feeds water through a system of canals to the water users downstream. In this area 90% of all irrigated fields are under wine and table grape cultivation. Especially table grapes are vulnerable for drought conditions.

At the start of the 2017/18 season, the Clanwilliam Dam was filled to 40% of its capacity causing the introduction of major water restrictions for irrigated crop production. Under 20% of the normal water quota was made available to producers.

The data clearly shows the dramatic consequences of a season experiencing a severe drought. The histogram (Figure 4. Histogram showing impact on actual biomass production due to the effect of the 2017/18 drought in the Lower Olifants water management area. Strong impact by drought is visible.5) displays the effect of the 2017/18 drought by comparing the biomass production figures to that from 2016/17. Close to 15 000 ha was analysed covering 5 027 fields. On average, nearly 25% less biomass was produced over the entire Lower Olifants water management area. This perceived drop in production is confirmed by the South African Wine Harvest Report 2018 from Vinpro: low water availability from the Clanwilliam dam let to reduced crop vigor, smaller canopies and increased water stress. Worrying is the number of fields which show a (close to) 100% reduction in growth, indicating the removal of vineyards or their complete die-off.

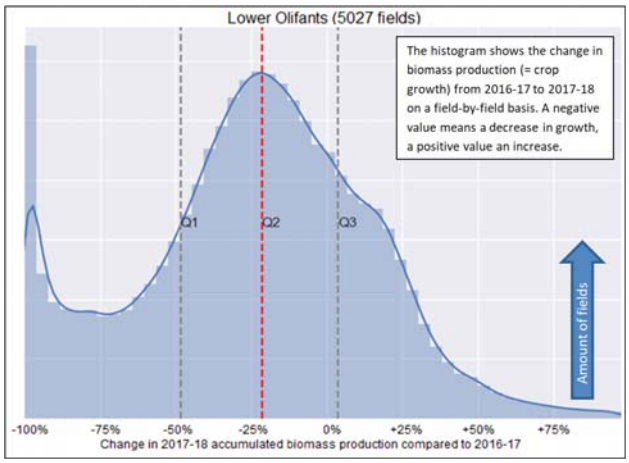

Figure 5. Histogram showing impact on actual biomass production due to the effect of the 2017/18 drought in the Lower Olifants water management area. Strong impact by drought is visible.

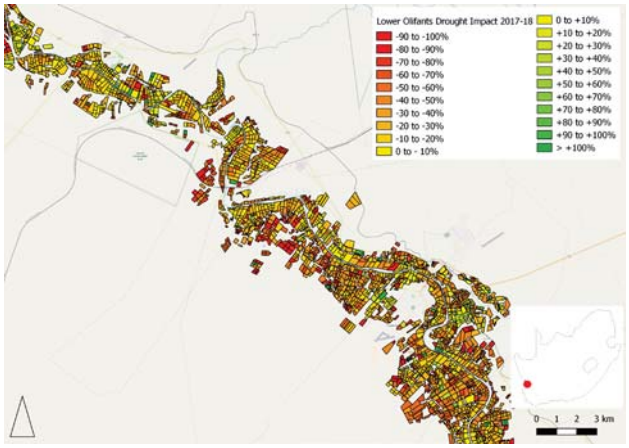

Figure 6. Map showing impact on actual biomass production due to the effect of the 2017/18 drought in the Lower Olifants water management area. A strong reduction in biomass production is visible for almost all production fields. Additionally, many fields show a (close to) 100% decline in growth which means these fields are likely cleared.

Figure 6 maps this significant decrease in crop growth (biomass production) resulting from decreased water availability. It shows a section of the canal between Klawer and Vredendal. Almost all fields visible on the map show a drop in production figures. The fields colored in deep-red are likely cleared. Assuming a drop larger than 90% indicates permanent removal of the crop, based on the FruitLook data it is estimated close to 200 fields were cleared over the course of the 2017/18 season. This accounts for close to 5% of all vineyards and orchards in the region. At the same time almost no darker green fields are visible, meaning there were nearly no new plantings during the 2017/18 season. The histogram displayed in Figure 5. Histogram showing impact

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on actual biomass production due to the effect of the 2017/18 drought in the Lower Olifants water management area. Strong impact by drought is visible.5 highlights this too; a significant part of the fields show a -90% drop (or more) in biomass production, while almost no fields show a sharp growth-increase between the two years.

Adding to the difficulties stated above, there was no water available to producers for post-harvest irrigation. The impact of this still remains to be seen during the 2018/19 season. The combined effect of decrease in productive area and the absence of post-harvest irrigation means the 2017/18 drought will be felt for years to come in this region.

Conclusion

Satellite based data is extremely useful to assess the impact of droughts. The effectiveness of doing so is shown within this article: although the causes, effects and predictions on the 2017/18 drought made headlines throughout the Western Cape, satellite imagery shows the agricultural impact of the drought varied strongly between regions. In Groenland, sufficient water was available enabling the farming community to run a relatively normal season. In stark contrast, farmers in the Lower Olifants region were watching the sky for rainfall which never came. As the FruitLook data analysis shows the farms in the Lower Olifants region were severely impacted during the 2017/18 production season.

It underlines the vital importance of available water as the number one resource most essential to agricultural production. Climate models predict a gradual to rapid change in climatic conditions and an increased likelihood of extreme weather conditions like hail, flooding and prolonged droughts in the Western Cape. Agriculture, and wine and fruit production in particular, is vulnerable to this changing of the climate and additional stress from droughts on the already limited water supplies. In combination with significant non-climatic pressures, like increasing competition for water from the urban and industrial sector, climate change forms a potent threat to agricultural sustainability.

To live-up to the challenges of the future, the agricultural sector needs to find ways to access more water, and at the same time irrigate more efficiently and with a higher precision. More water might be accessed via expensive measures like the introduction of new dams, increasing the storage of existing ones and increasing groundwater abstraction reducing vulnerability to drought. Simultaneously, fresh water is ultimately a limited resource and the efficient use of water in irrigation is essential for a sustainable (agricultural) future. This is where tools like FruitLook can help. Now and in the future.

Fortunately, the Clanwilliam Dam was completely refilled during the winter of 2018, making the future of agriculture in the Lower Olifants region a lot brighter than it seemed a few months ago. This is also true for most regions in the province where the water situation at the start of the 2018/19 production season was less dire than the previous year. This brings hope and perspective of better times to come. At the same time areas like the Little Karoo and Central Karoo continue to face drought challenges. As such the lessons learned from last year(s) remain vital: water is life, use it wisely and responsibly.

It might take a few years for agricultural production to recover from the drought.

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FISH MIGRATION

New book highlights the plight of migratory freshwater fish

On World Fish Migration Day 2018, fisheries experts released a new international book, From Sea to Source 2.0. This book reveals the importance of rivers as a critical natural resource that sustains and supports livelihoods, health and wellbeing. It gives best practice examples on how to manage these freshwater bodies. Article by Kerry Brink and Roxanne Diaz.

Photo supplied

Approximately 40% of all fish species in the world reside in freshwater ecosystems. Of the 15 000 freshwater fish species, there are over 1 100 iconic long-distance migratory fish that depend on free-flowing rivers to thrive. Many of these fishes and freshwater bodies provide ecological and economic value to the ecosystems that balance on them and the communities that rely on them. In fact, there are at least a quarter of a billion people who depend on freshwater fish as their primary food source and recreational fishing is worth millions of dollars annually. This excludes the obvious benefits that fishing has on people's health, well-being and sense of community, which many can relate to in some way.

It goes without saying, people around the world depend on healthy fish and rivers, and that fish and rivers also depend on people. In South Africa, there is no exception to this. Government recognises this with environmental legislation that protects the aquatic resources and biodiversity. The National Water Act No. 36 of 1998 recognises that water resources are part of a complex system with many different uses and promotes the protection of these resources.

Although there is no specific legislation focused toward migratory fish, the threats of constructing instream barriers that impede the upstream and/or downstream migration of fishes does require licensing.

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One of the biggest threats to migratory fish populations is instream barriers, such as dams and weirs. Physical barriers can disrupt connectivity, deteriorate water quality and influence downstream and upstream habitats. In South Africa, there are thousands of dams in almost every major river with more planned for the future. In fact, there are less than 25 free-flowing rivers that flow more than 100 km in South Africa. Here, dams are often revered and viewed as positive, in a country with high water scarcity. However there is a flip side to dams, which can severely influence the ecosystem functioning and the economy. In ***From Sea to Source 2.0*** we show how free-flowing rivers are critical to support livelihoods of rural populations and provide provisional services, regulatory services, cultural and economic services.

On World Fish Migration Day, the Managing Executive of the Kruger National Park, Glenn Phillips, received the ***From Sea to Source 2.0***. Mr. Phillips highlighted in his acceptance speech that "if we don't manage our river systems it doesn't only affect our wildlife it also affects humans."

Around the world, water managers are taking action to open rivers without impacting safety or access to freshwater. Removing unsafe and obsolete dams to restore fish passage and connectivity is becoming the most effective and used measure. These efforts show that by improving the natural functioning of the rivers, the rivers would have a natural resilience to climate change and other emerging impacts.

In the USA, 1 400 dams have been removed over the last 30 years. Similar initiatives have led to dam removals in Japan and Australia. In Europe, the Dam Removal Europe initiative has catalysed knowledge exchange and network growth to better facilitate and support dam removal projects. Now, barrier removal projects in Spain, Switzerland, France and Finland, are currently underway. In South Africa, Kruger National Park are leading efforts to restore rivers to a natural, healthy state in Africa. The park has identified several redundant dams and structures that act as barriers to the natural fish migration patterns and to their natural spawning areas, and that also impact the natural aquatic system processes and stream flow. Since the first removal in 2001, Kruger National Park has now removed 25 dams, which you can read about more in ***From Sea to Source 2.0***.

"With the cost of renewable solar and wind energy plunging, the world no longer needs so many new hydropower dams, which will block fish migration routes and devastate fish stocks, undermining food security and sustainable economic opportunities for countless communities across the world," said Stuart Orr, WWF Leader, Freshwater Practice.

The book was officially handed over to Kruger National Park Managing Executive, Glenn Phillips (centre with book) on Fish Migration Day.

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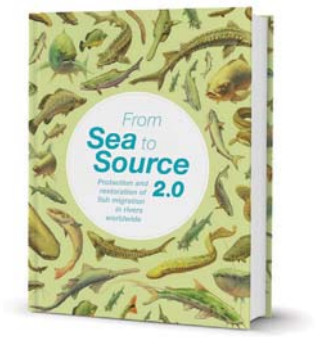
From ***Sea to Source 2.0*** is a result of a unique collaboration of over 100 international fisheries professionals and is supported by river managers, governments, research institutes and NGOs including WWF, University of Kwa Zulu Natal, SanParks and World Fish Migration Foundation. It highlights not only the global threats to migratory fishes and the importance of river connectivity but also presents implementable solutions at a local level. The importance of communication and how this can be realized is highlighted throughout the book and emphasized in a full chapter, that shows how effective communication can ultimately contribute toward a larger impact on rivers and humanity. It includes up-to-date and topical information on all aspects of fish migration that is suitable for a wide range of audiences – from students to consultants, water managers and policy makers.

Dr Jackie King, the Institute for Water Studies, South Africa remarks, "I commend this book for helping to create awareness of what can be lost as well as gained as dams are built and what can be done to reverse the losses."

In the book, we show many inspiring stories, hard lessons learned and great successes from nearly every continent dealing with river management issues. It shows how dam removals are possible with examples and a step-by-step guide. Other important measures to improve fish passage are also detailed including explaining the difference between the different technical fishways, which allow fish to pass at a barrier, with examples of innovative designs. Details of how to monitor and evaluate fishways after their construction are also included in the book.

Through this picture riddled book, the authors communicate the greater value of free-flowing rivers on local and global levels and hope to inspire new initiatives for and with people all around the world. Ultimately, the authors and supporters of this book aim to contribute to making a better world and a positive difference for humans, rivers and migratory fishes.



To find out more please download the free ***From Sea to Source 2.0*** book at www.fromseatosource.com

Living gold in southern Africa's rivers

The Orange-Senqu River basin is an iconic southern African watershed that extends over four countries. Prior to the 1950's more than half of the world's gold had been sourced from the basin resulting in widespread pollution. Additional development had fragmented the rivers in the basin and the population of fishes that occur within it. The most well known migrating species occurring in this river is yellowfish (***Labeobarbus aeneus*** and ***L. kimberleyensis***). Today, more than 100 weirs and dams act as physical barriers to fish migrations in the basin. Interestingly, although yellowfish populations have declined primarily due to water quality changes in the basin, the yellowfishes still dominate most of the catchment and thrive within the new impounds and in restricted river reaches of the basin. These ecologically important fishes are economically valuable, supporting a dedicated angling industry worth in excess of US$11 million per season in the upper parts of the basin alone.

Source: From Sea to Source 2.0

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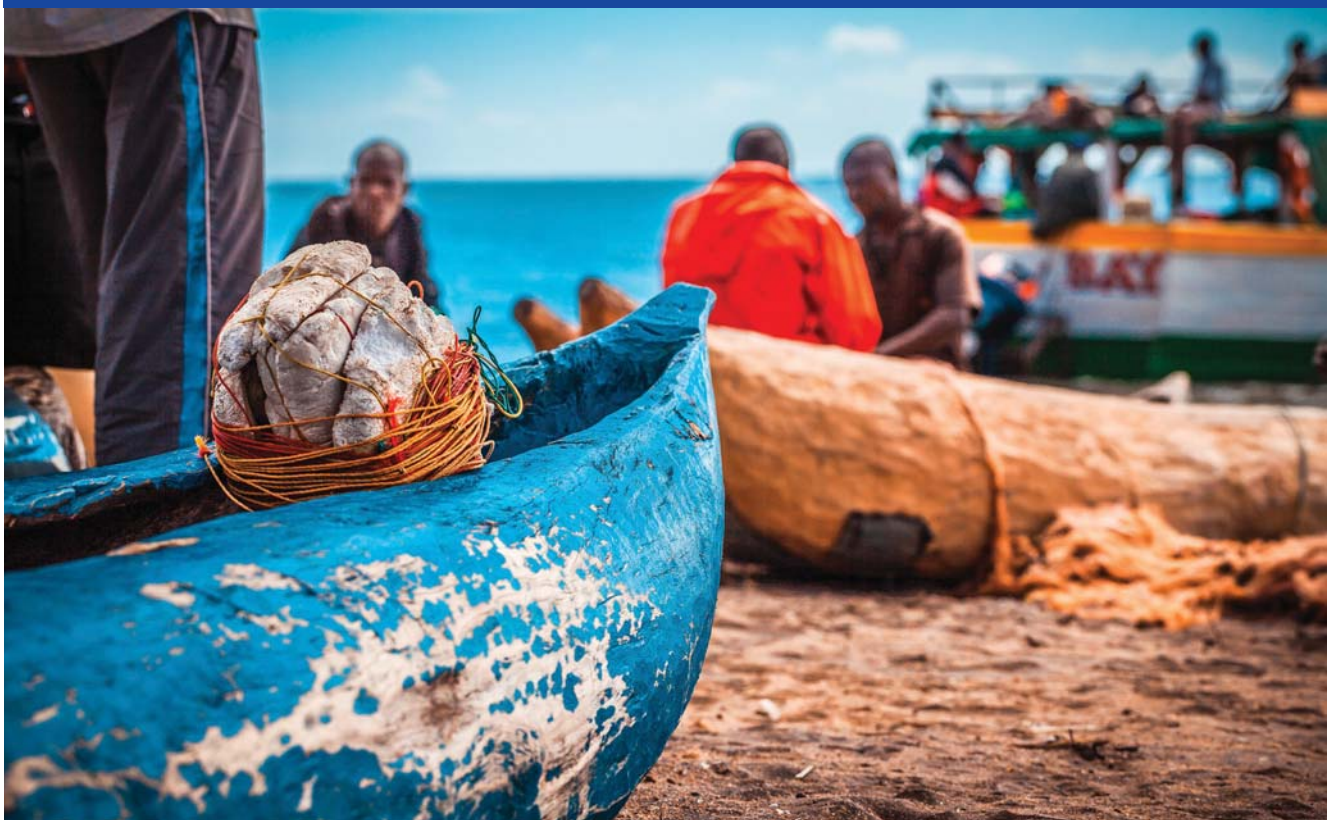
BIODIVERSITY

Lake Malawi – Home to unique fish species

An estimated 9% of the 458 fish species assessed in Lake Malawi are at high risk of extinction. This is worrying, not least because the lake, and the fish species that occupy it, are very unique, writes Olaf Weyl.



With more than 1 000 fish species, Lake Malawi has more distinct fish species than any other lake in the world. New species are discovered regularly and some scientists believe that the lake may contain more than 2 000 species. As a result of this exceptional diversity the lake is considered a global biodiversity treasure because all of the species that it contains occur nowhere else on the planet.

Lake Malawi is immense. Located between Malawi, Tanzania and Mozambique, it covers an area of more than 29 000 km^3 and holds 7% of the world's available surface freshwater. Despite this Lake Malawi is under threat. Human activities, like deforestation in the lake's catchment area and overfishing, are taking their toll on the lake. A recent assessment by the International Union for Conservation of Nature (IUCN) listed 9% of its evaluated species as 'endangered'.

This is worrying not only from a biodiversity perspective, but also because this is one of Africa's poorest regions and people rely on the fish for their livelihoods and for food.

The reasons

What happens on land affects the lake. Increasing agricultural activity in the lake's basin has caused soil erosion and sediments to end up in the water. This affects water clarity, light penetration

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and, on settling, it smothers plant and algae – ultimately harming the food resources on which fish depend.

Over-fishing has led to less diversity in the kinds of fish that are caught and has reduced the amount of fish caught by individual fishers. This particularly true in the larger, more valuable, species.

The worst hit fish species are migratory endemic cyprinids, such as the critically endangered Ntchila. These fish migrate into rivers to spawn and so depend on the health of rivers that feed into the lake for their survival. Once abundant, this species has almost disappeared mainly because of the degradation of river catchments and sedimentation that smothers the gavel beds that they need for spawning.

The Chambo, a species of endemic tilapia, is also under pressure. This fish is highly prized as a food fish but, because of unsustainable fishing practices, catches have plummeted. Today they are less than 10% of their historic high in the late 1980s when more than 10 million kgs of Chambo were landed by small-scale fishermen every year.

As a result, fisheries increasingly focus on smaller, less valuable species to sustain catches. When these smaller species were also eventually depleted, fishers were forced to go further offshore where it's harder for fishermen to catch fish and those that they do are of lower value. This puts a severe strain on fishers, many of whom are already some of the poorest members of society.

Unfortunately, it is very difficult for the riparian countries, with their large population of relatively poor people who are locked into a natural resource-based economy, to reduce their dependency on the fisheries. And so, the overriding cause for all these effects is the poverty of the lake shore communities.

Freshwater crisis

Freshwaters – and the animal and plant life that they contain – are in a state of crisis across the world. The fundamental driver of their degradation is the growth of human activity due to population growth, increased industrialisation and increased consumption of natural resources over the last century. As a result, the current rates of population decline in freshwater species are twice as high as those reported for marine and terrestrial life.

But there's hope. In Malawi, where fish and fisheries are high on the national agenda, initiatives such as the IUCN Red-List assessment and Key Biodiversity Area identification projects which assess the status and distribution of freshwater species, help to guide policy and prioritise conservation actions.

This article was first puplished by The Conversation (www.theconversation.com)

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CHILDREN DELIGHT AT URBAN WETLAND VISIT

miniSASS – finding 'goggas' in a sample taken from the stream.

On World Wetlands Day, celebrated each year on 2 February, around 200 children visited the Colbyn Wetland Nature Reserve in the east of Pretoria to learn about wetlands and why we need to protect them.

This annual event was hosted by the WESSA-affiliated Friends of Colbyn Valley and the Agricultural Research Council's Institute for Soil, Climate and Water. This year the organisers were assisted by WetResT Centre for Wetland Research and Training, the South African Wetland Society and BirdLife Northern Gauteng, with sponsorship from Ocean Breeze Food Merchants.

A number of environmental professionals and students volunteered as leaders and facilitators at the event, including, the Tshwane University of Technology Green Arcadia students, students from the University of Pretoria, and specialists from the Water Research Commission and departments of environmental affairs and water and sanitation.

The event was aimed at children aged 8-13, drawn from various school and youth groups across the city. In addition, the NGO, SOAPKidz, facilitated the attendance of vulnerable children from a local community development centre.

The day's activities were designed to create awareness about the value of wetlands, how they are formed, how they function and how to protect them. Among others, the children were taken on a wetland discovery walk; built a simple model to show how wetlands work; and performed a miniSASS assessment to determine quality of a stream based on the presence of invertebrates that they found there.

Hlengiwe Cele from the WRC demonstrates how to use a clarity tube to assess turbidity – an indicator of water quality.

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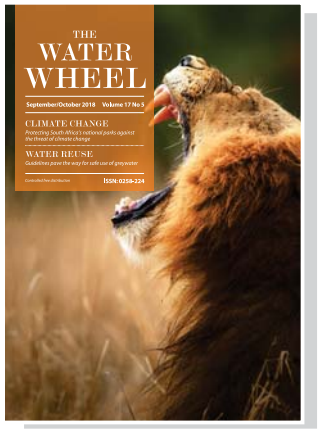
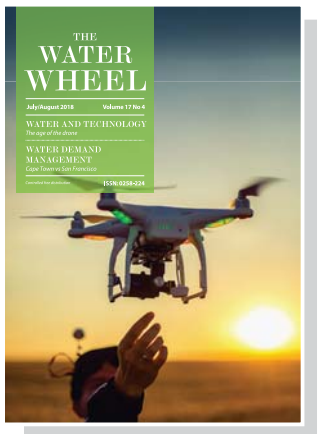
THE WATER WHEEL

SUBSCRIPTION





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WATER RESEARCH COMMISSION

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DEEPLY ROOTED IN SOUTH AFRICA WATER SOCIETY

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

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

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

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