

Water resource management

Drought management – Strengthening our knowledge armoury



As South Africa braces itself amidst increasing drought, a present Water Research Commission (WRC) study aims to improve the country's ability to prepare for and mitigate against such climatic events in the future.

Article by Lani van Vuuren.

By the end of October, water in the Hazelmere Dam – which serves residents of the eThekwinini and iLembe municipalities – had reached below 29%, forcing the municipality to tighten water restrictions while racing to implement alternative water-supply options. The dam serves as a visible barometer of the intense drought gripping parts of the country at present.

KwaZulu-Natal, Limpopo, North West, Free State, and the Northern Cape have been hardest hit in what has been described as the worst drought to hit the country in 23 years. The South African Weather Service (SAWS) has predicted that the situation might become more precarious as summer progresses amid predictions of above average temperatures combined with lower-than-expected rainfall. The current hot and dry climatic conditions seem to be driven – at least partly – by the strongest El Niño the world has seen since 1997, and which is expected to intensify by the end of the year.

Natural phenomenon

The World Meteorological Organisation describes drought as 'the world's most destructive natural hazard'. Droughts cause the deaths and displacement of more people than cyclones, floods and earthquakes combined, yet effective drought management policies are missing in most parts of the world and, some say, in South Africa.

Droughts are a major feature of the climate of South Africa. As a result of the country's location at the southern tip of Africa between cold and warm sea currents, as well as its topography, South Africa has an extremely variable climate over space and time. Because of these characteristics, the country is considered to have one of the most variable river flow regimes in the world – with drought being one manifestation of this variability.

Along with this climatic variability the country is naturally water scarce. South Africa's average annual rainfall falls well below the world average of 860 mm a year. Further, the distribution of rain varies widely across the country – generally reducing from east to west, with 65% of the country receiving less than 500 mm of rain a year.

The country's semi-arid nature results in much water being lost to evaporation, and in many areas evaporation from the surface exceeds the average annual rainfall. It is estimated that less than 9% of the precipitation that falls on the ground eventually finds its way into South Africa's river systems. This natural water scarcity makes South Africa particularly vulnerable to drought. Vulnerable communities are usually hardest hit as water for domestic use and rainfed subsistence crops dry up and food prices escalate.

Managing water in times of drought

Historically, South Africa has constructed sophisticated bulk water storage and conveyance systems to store water in times of surplus for use in times of need. By the early 2000s, the total storage capacity of the major dams in the country amounted to around 34 million m³ – or about 70% of the mean annual runoff from the land surface of the country.

Rising water demand as a result of population growth and socio-economic development is placing pressure on many of these systems. As pointed out by the Second National Water Resource Strategy, most of the economically available yield from surface water resources has already been fully developed and utilised, and opportunities for developing new and economic dams are few.

The Department of Water and Sanitation's (DWS's) Water Reconciliation All Town Study has shown that water resources in 30% of South African towns are already in deficit, with water resource shortages expected in another 13% of towns in the next one to five years, and a further 12% of towns in the next five to ten years. This situation has the country's water resource managers walking a constant tightrope between balancing supply and demand, and leaves little room for extreme situations, such as drought.

To manage its sophisticated water supply systems, the DWS makes use of operating rules. Operating rules serve to guide the system operation, not only under normal conditions but, very importantly, also during droughts. They help to inform decisions on whether or not restrictions should be implemented, at what level of severity, when they can be relaxed or when stricter restrictions need to be considered.

During periods of drought, water supply is prioritised in accordance with the assurance of supply of the various water use sectors. Basic human needs and water requirements of strategic users, such as power stations and major industries, are

Types of drought

- **Meteorological drought** – This type of drought occurs when there is a prolonged period of below average precipitation (usually lower than 70%), which creates a natural shortage of available water.
- **Agricultural drought** – This type of drought occurs when there isn't enough moisture to support average crop production on farms or average grass production on range land. Although agricultural drought often occurs during dry, hot periods of low precipitation, it can also occur during periods of average precipitation when soil conditions or agricultural techniques require extra water.
- **Hydrological drought** – This type of drought occurs when water reserves in aquifers, lakes and reservoirs fall below an established statistical average. This can happen even in times of average or above-average precipitation, if human demand for water is high and increased usage has lowered the water reserves.



the least curtailed. Urban water users will typically be curtailed at a lesser degree than agriculture. Each specific system will therefore have different levels of curtailment, according to the profile of water users reliant on the system.

Operating rules need to be updated and improved regularly, in response to improved understanding and knowledge of the water resources within the system, and the factors influencing water requirements. It is therefore crucial for water resource managers to keep an ear to the ground, and be provided with the most up-to-date information on a timely basis so that they can adapt their operating rules and so ensure that there remains water in the system for all.

A significant challenge in this regard has been the deterioration of observation networks in South Africa. There are serious concerns about the decline in monitoring of rainfall, streamflow,

groundwater levels, and water quality in South Africa, among others. Rainfall is an important variable through which the availability of water resources is gauged. However, rainfall observation in South Africa has declined to such an extent that the current number of useful rainfall stations we have now (about 700) is less than what we had in 1920. Additionally, the quality of the data from most of the observation networks (rainfall stations, gauging weirs, reservoirs, etc) is largely poor and this suggests the lack of quality control measures which is crucial for the integrity of the datasets.

Towards improved drought risk management

On the upside, since the last significant nationwide drought in 1991/92, South Africa has made positive strides towards improved drought mitigation. This includes the promulgation of the Disaster Management Act of 2002 and the National Disaster Risk Management Framework of 2005. However, despite these policies the focus of the South African government still seems to be largely centred around remedial action rather than on preventative mechanisms.

There is a growing realisation that South Africa requires a long-term, national drought policy and strategy to mitigate the risk of future occurrence of drought, notes WRC Research Manager, Wandile Nomqophu. Particularly, the the Water Research Commission (WRC) has identified the need for science-based mechanisms and monitoring that will deliver timely information

to decision-makers and so strengthen risk management measures and preparedness plans.

A three-year project funded by the WRC and undertaken by the University of Cape Town is looking to characterise extensive droughts over southern Africa, and to investigate the mechanism that produce and/or control these droughts. The study is also examining how climate change may influence the characteristics of these regionally extensive droughts in future.

An interesting aspect of this project is its use of the so-called Standard Precipitation Evapotranspiration Index (SPEI) to characterise the intensity, spatial coverage, duration and frequency of droughts. Nomqophu explains that drought monitoring traditionally only measures rainfall, however, this neglects other variables such as temperature, wind speed and direction as well as potential evapotranspiration, which equally have more influence on drought.

The SPEI is a modification of traditional drought monitoring approaches which accounts for the effect of temperature variability in monitoring droughts at different time-scales. "It has the capability to detect temporal and geographical extension of drought," explains Nomqophu.

During the first year of the project, SPEI was used to examine the occurrence of drought in South Africa between 1950 and

Drought – the role of water demand management

While the current drought is beginning to have its presence felt in most provinces in South Africa, the Department of Water and Sanitation (DWS) has called on municipalities to reduce non-revenue water with urgency.

Speaking at the Fifth Regional Water Leakage Summit, held in Midrand earlier this year, Paul Herbst, DWS Director: Water Use Efficiency, said that implementation of water conservation and water demand management (WC/WDM) strategies was now crucial if South Africa was to overcome the current dry spell. WC/WDM was also a critical element in all reconciliation strategies to balance water supply and demand. Yet while some municipalities had made a great start at water conservation, others were not even aware of their current water use and/or water losses. "As a country we need to do manage our water much better," he said.

The department had already started assessment for the new No Drop certification programme that measures municipalities' water loss reduction efforts.

Concern was expressed over available water in Gauteng, where some areas experienced high per capita water use, leaving the Vaal River system under strain. "Unless we change

consumer behaviour drastically, the writing is on the wall," said Herbst. "At the current rate of drawdown, if low rainfall persists the Vaal Dam will be dry in two to three years."

Already in October persistent highly high temperatures coupled with low rainfall caused Rand Water to send a warning out to residents in its area of supply. High water demand was projected to cause localised problems in some parts of Johannesburg, Pretoria and the East Rand.



South Africa's rainfed agricultural production, particularly maize, has already been negatively affected by present drought conditions.



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A dry Vaal River in 2005 with the Vaal Dam wall in the background.

2013. The research team found that since the 1980s droughts have been occurring more frequently and with greater intensity in South Africa. Where the country traditionally expects large-scale droughts every seven or so years, this has now reduced to every three to four years.

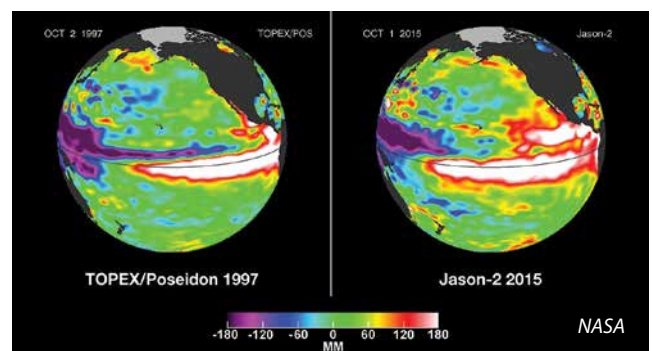
It is uncertain at this stage whether this is as a result of climate change, although the team hopes to answer this question as part of the project. The study will also be assessing the reliability of global and regional climate models in simulating regionally extensive droughts and projecting the impact of climate change on future characteristics of these droughts.

If we are to expect more intense droughts more frequently, interluded by bouts of high rainfall over short periods, South African water resource managers will have to become much smarter about the way they manage and operate South Africa's water systems, notes Nomqophu. "We will have to sharpen our focus in terms of adapting operating rules to fit current conditions, and intensely monitor our weather and water resources so that we can adequately prepare for any change."

"Water users, such as farmers, need to be warned well in time so that they can put proper contingency plans in place. Finally, ordinary South Africans will have to start realising that our water resources are finite and that we all need to do our part to ensure there is water for all."

It is hoped that this project will provide input into the development of a National Drought Policy and Strategy. As part of this project, which will conclude in 2017, an online drought monitoring system will be developed.

In the long term, the key to drought preparedness is to know the what, how and when of upcoming drought, adds Nomqophu. "To achieve this goal the scientific expertise to monitor and predict, the capability of the observation networks, as well as the information systems for early warning have to be improved drastically." To this end, the WRC has commissioned a call to investigate the feasibility of (re)establishing a Hydrology Institute to act as a clearinghouse for all hydrological datasets to support the water sector. The envisaged institute could play a critical role for the water sector in drought monitoring and research.



The 2015 drought in South Africa is said to be driven by one of the strongest El Niño events on record. Every two to seven years, an unusually warm pool of water develops across the eastern tropical Pacific Ocean to create a natural short-term climate change event. This warm condition (i.e. El Niño) spurs extreme weather patterns around the world – including drought in southern Africa. In this side-by-side visualisation, Pacific Ocean sea surface height anomalies during the previous strongest El Niño (1997-98) on the left are compared with the 2015 Pacific conditions (right).