WATER RESEARCH COMMISSION

WORKING PAPER

Planning for droughts during the wet season: Increasing the resilience to the new norm of recurring droughts

by
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Summary

Drought is a natural hazard with severe socio-economic impacts in many Southern African countries. It is a threat to water management, water-dependent activities, and livelihoods in Southern Africa. Impacts of drought are usually severe in communities where the socio-economic activities of the people depend of availability of water in surface and sub-surface sources. Of particular concern are regionally extensive droughts, which produce widespread impacts that cannot be compensated by redistribution of water, food and energy production from other parts of a resource system. Drought can have transnational and multifaceted impacts. In 1991 and 1992, drought depleted ground water reservoirs, reduced fresh water availability, and forced people to use water from unprotected sources; as a result, many people suffered from cholera, diarrhoea and dysentery and more than 90 per cent of small inland dams in the eastern part of Southern Africa dried. Drought is a recurring extreme climate event that is characterized by below-normal moisture availability over a period of months to years. The WRC regularly commissions work that focuses on drought in order to encourage resilience to this extreme event. This paper therefore reflects on the experiences of the recent droughts that occurred in South Africa and attempts to build upon lessons learnt looking at the challenges associated with response to drought, while looking into the future.

BACKGROUND

South Africa faced a new water crisis as a result of drought affecting the winter rainfall region from 2015 to 2017. This was over and above an El nino induced severe drought that was devastating the summer producing areas since 2014. From the period 2015 until 2017 the winter rainfall region of South Africa (Cape Town) received below normal rainfall. All those three years were considered to be drought years of increasing severity- with 2017 being the driest year recorded by several rain gauges. Some relief was only gained during the June winter rainfall in 2018.

The winter rainfall region experienced three consecutive years of below-normal rainfall from 2015-2017 that resulted in a prolonged drought and severe water shortages. The 2015-2017 drought was one of the droughts that this region has experienced with the most severe impacts on all sectors. Not only were the agricultural and water sectors affected, but the water crises disrupted the daily lives of households and individuals. The fact that the water supply to the population of the City of Cape Town was under threat, commonly referred to as “Day Zero”, resulted in further water restrictions to the agricultural sector in order to prioritise water availability to the City of Cape Town. Urbanization is responsible for a higher demand in water as well as the wastage of water, making years of below-normal rainfall more challenging. The additional challenge of urbanization together with climate variability and change on water supply to the City of Cape Town is not new and has been predicted to be the first major urban region in South Africa where the water demand will exceed the total potential yield for the area if the economic and population growth scenarios are realized or the expected impact of projected climate change manifests itself. Also, the fact that world has been continually warming characterized by temperatures that were generally warmer than normal over South Africa, including the southwestern Western Cape, has caused a further strain on the water demand. Continuous improvement of our understanding of climate variability over the southwestern parts of the country is therefore important, even more so within the climate change context as the 2015-2017 drought was found to be more likely by about a factor of 3 as a result of anthropogenic change.

The three-year deficit in rainfall, an event that is extremely rare with a probability of occurring in ~ 150 years resulted in distress within the entire Western Cape Province. Six large reservoirs in Cape Town which supply water to the ~3.7 million residences had insufficient water to meet the demand. Such a crisis brought enormous pressure on water demand and allocation in the city of Cape Town, with dams that supply the residents with water dropping to approximately 21 % Capacity in May 2018.

THE NATURE AND BEHAVIOUR OF RECENT DROUGHTS

The summer rainfall region

The summer of 2015/16 was associated with the most intense El Niño event ever recorded. The year 2015 also turned out to be the warmest calendar year in recorded history, only to be superseded in this regard by 2016 and 2019. Moreover, in 2015 a critical symbolic (and physical) threshold was exceeded – it was the first year for which the global average surface temperature was 1 °C warmer than the pre-industrial average. This period of unprecedented global temperatures is thought to have been the result of systematic global warming under the enhanced greenhouse effect in combination with natural variability in the form of an intense El Niño event. The impacts of the 2015/16 El Niño event were significant in southern Africa. The region experienced its warmest summer period in recorded history, in the order of 2 °C warmer than the present-day average climatological temperature. During this period numerous weather stations in the southern African interior recorded average monthly temperatures in the order of 5 °C above their monthly average climatological temperatures. Water restrictions followed over much of South Africa and the maize crop yield was reduced significantly. Over much of the summer rainfall region of southern Africa, the La Niña event of 2016/17 brought significant relief of the oppressive temperatures and drought.

The winter rainfall region

The 2015-2017 drought are considered to be one of the worst drought periods that the Cape Town and surrounding regions have experienced since 1904. Dry periods over the southwestern parts of South Africa have been associated with storm tracks that are displaced southwards and more specifically the 2015-2017 drought has been associated with a displacement of the jet stream, the South Atlantic storm track and the more poleward occurrence of the Southern Hemisphere moisture corridor. The monthly rainfall anomalies for the three consecutive years starting from 2015 were computed to track the deficit rainfall during the evolution of the 2015/2016 drought event. The results are shown in Figures 1 – 3. In 2015, from January to May, the majority of the Western Cape recorded rainfall less that climatological mean with May recording the highest deficit in the order of 50 mm/month (See fig 1). The month of May tends to mark the beginning of the rainy season however during that year the season appears to be been delayed. Around June 2015, the recorded rainfall amounts exceeded the climatology. This rainfall surplus only lasted for one month as more part of the Western Cape received lesser than normal rainfall in July and in August the drier conditions seemed to intensify and spread widely. For 2016 (see fig 2), during March and April the Western Cape recorded more rainfall compared to their respective climatological means. For May, lesser rainfall than normal was measured. June and July above normal rainfall conditions were observed although not as intense as what was recorded in the previous year. Figure 6 shows that winter season [June-July-August] on 2017 was the driest of the three years as during all these months less than normal rainfall was recorded.

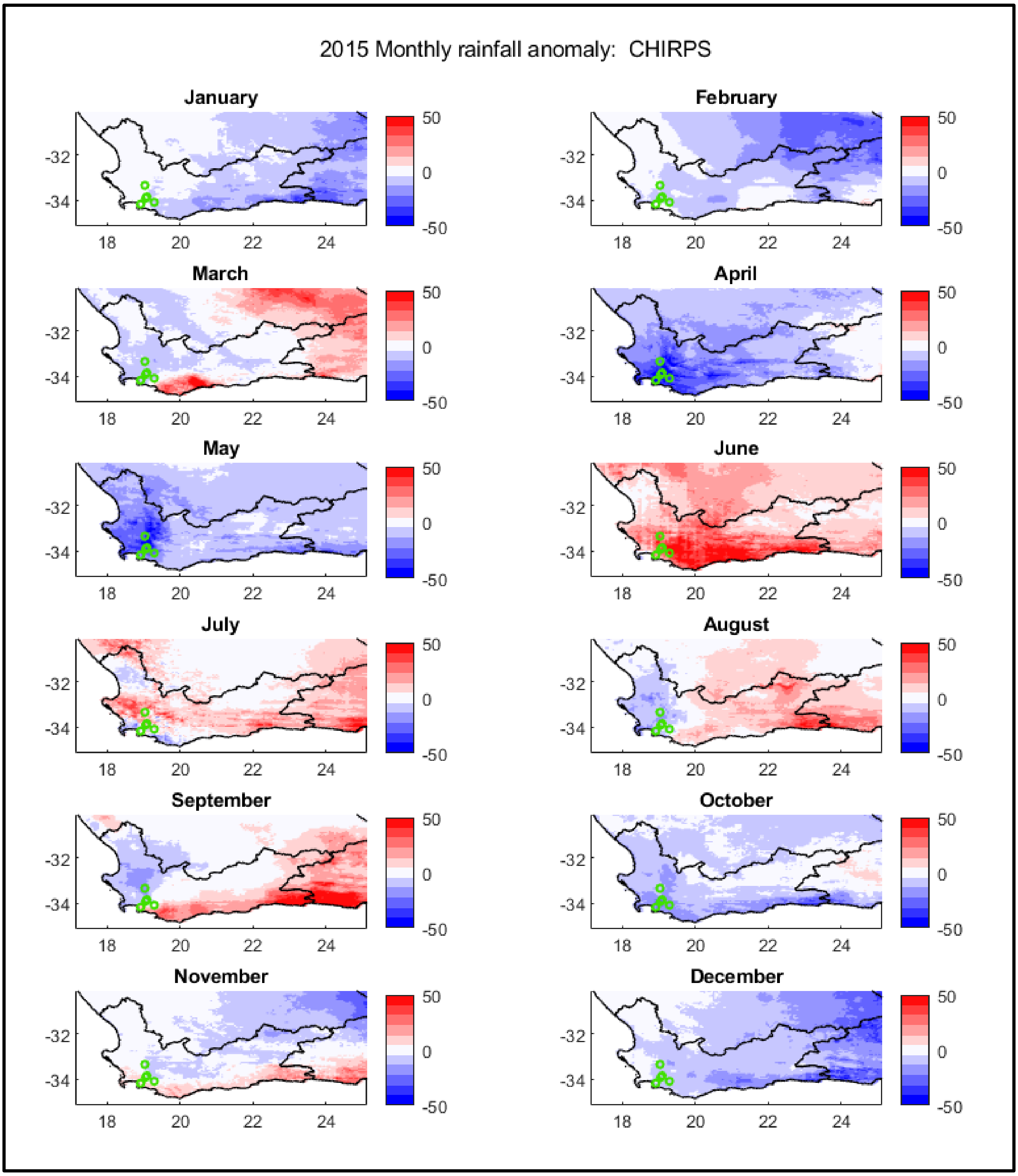

Figure 1: Observed monthly rainfall anomaly for 2015. The location of WCWSS dams are indicated by green circles

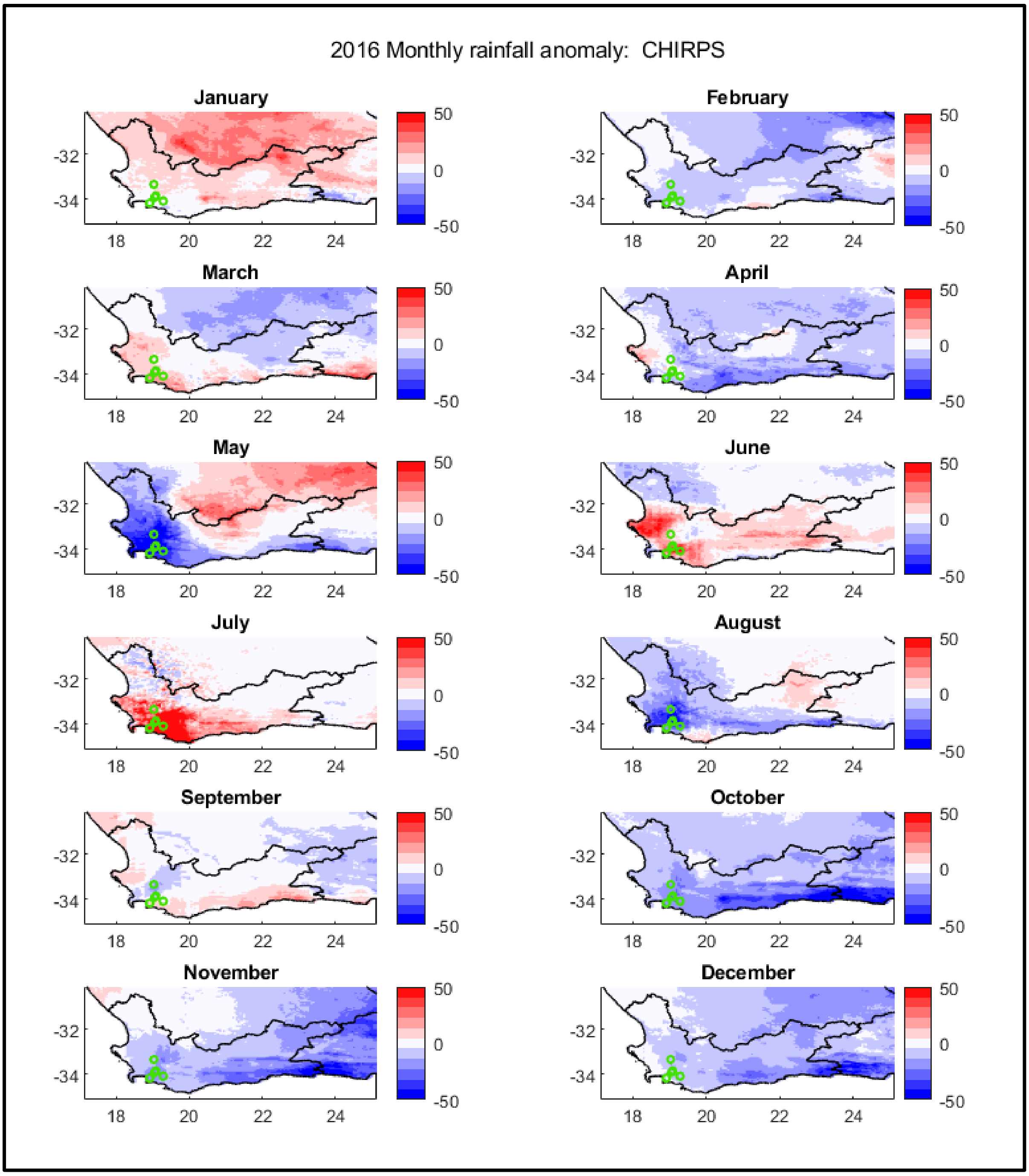

Figure 2: Observed monthly rainfall anomaly for 2016. The location of WCWSS dams are indicated by green circles

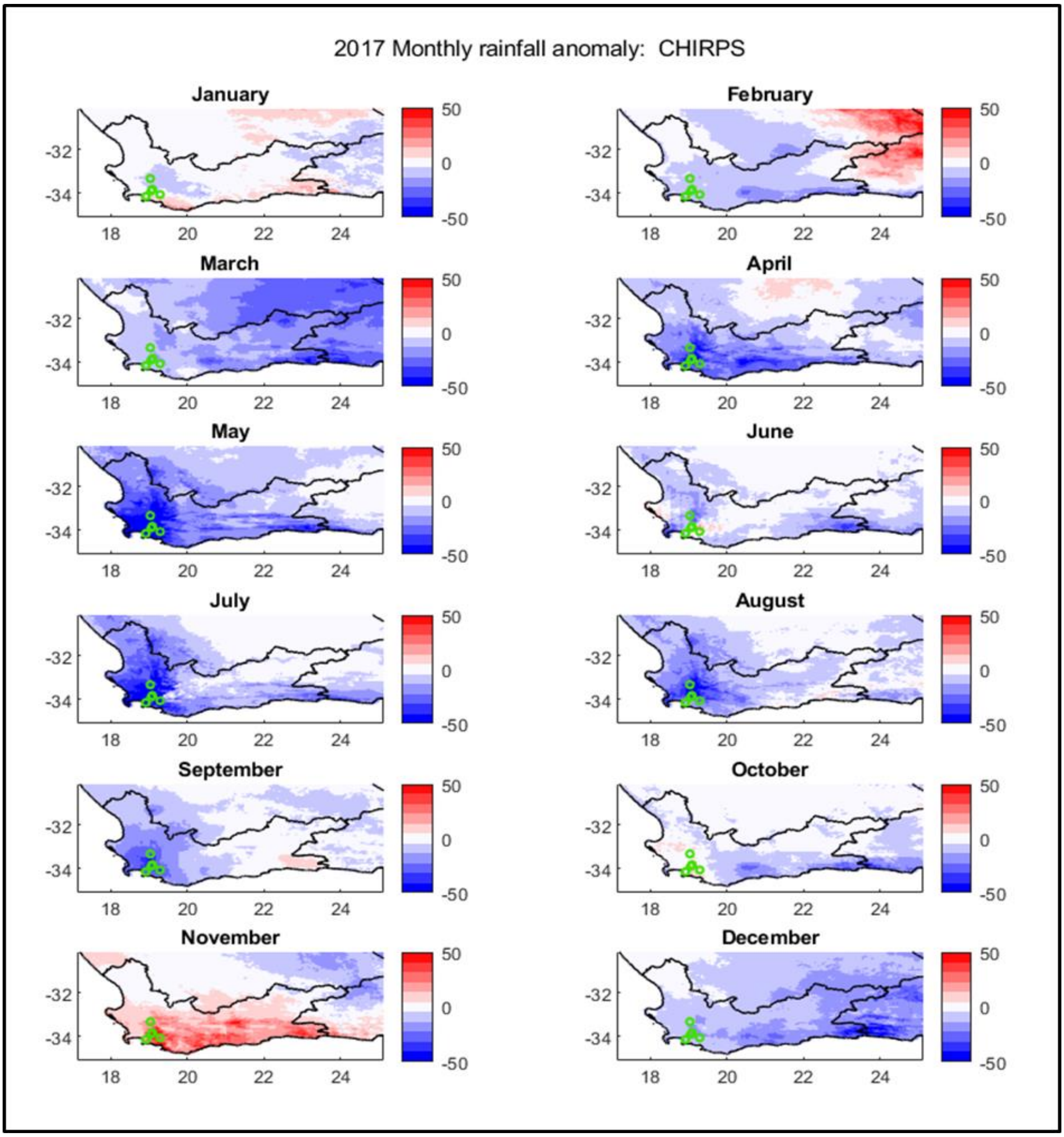

Figure 3: Observed monthly rainfall anomaly for 2016. The location of WCWSS dams are indicated by green circles

EXTENT AND SEVERITY OF DROUGHTS UNDER CLIMATE CHANGE

The southern African region is likely to become generally drier under climate change. Moreover, in its interior the region is warming at about twice the global rate of warming, with further drastic increases in temperature projected to occur under low mitigation futures. The projected general decreases in rainfall over southern Africa are simulated to occur in response to the southward expansion and strengthening of the subtropical high-pressure belt. The more frequent occurrence of mid-level high-pressure systems and associated subsidence under climate change are simulated to suppress convective cloud formation in summer, resulting in general reductions in rainfall over the summer rainfall region. During the winter season, the strengthening of the subtropical high-pressure belt is projected to have a blocking effect on the frontal systems that bring rainfall to the winter rainfall region of the southwestern Cape in South Africa. The consequent projected southward displacement of frontal systems also form part of the general poleward displacement of the Southern Hemisphere westerlies in a warming climate.

Southern African droughts are usually quantified with precipitation anomalies or the Standardized Precipitation Index (SPI), thereby neglecting the important roles of evapotranspiration in drought quantification. Furthermore, most drought studies over the sub-continent have been on local-scale drought, with little attention on regionally extensive droughts (RED) that usually cause more devastating impacts. This part overcomes these shortcomings by using the Standardized Precipitation Evapotranspiration Index (SPEI) to identify droughts and using two techniques to characterize regionally extensive droughts over Southern Africa. Figure 4 below shows the projections for South Africa using both indices.

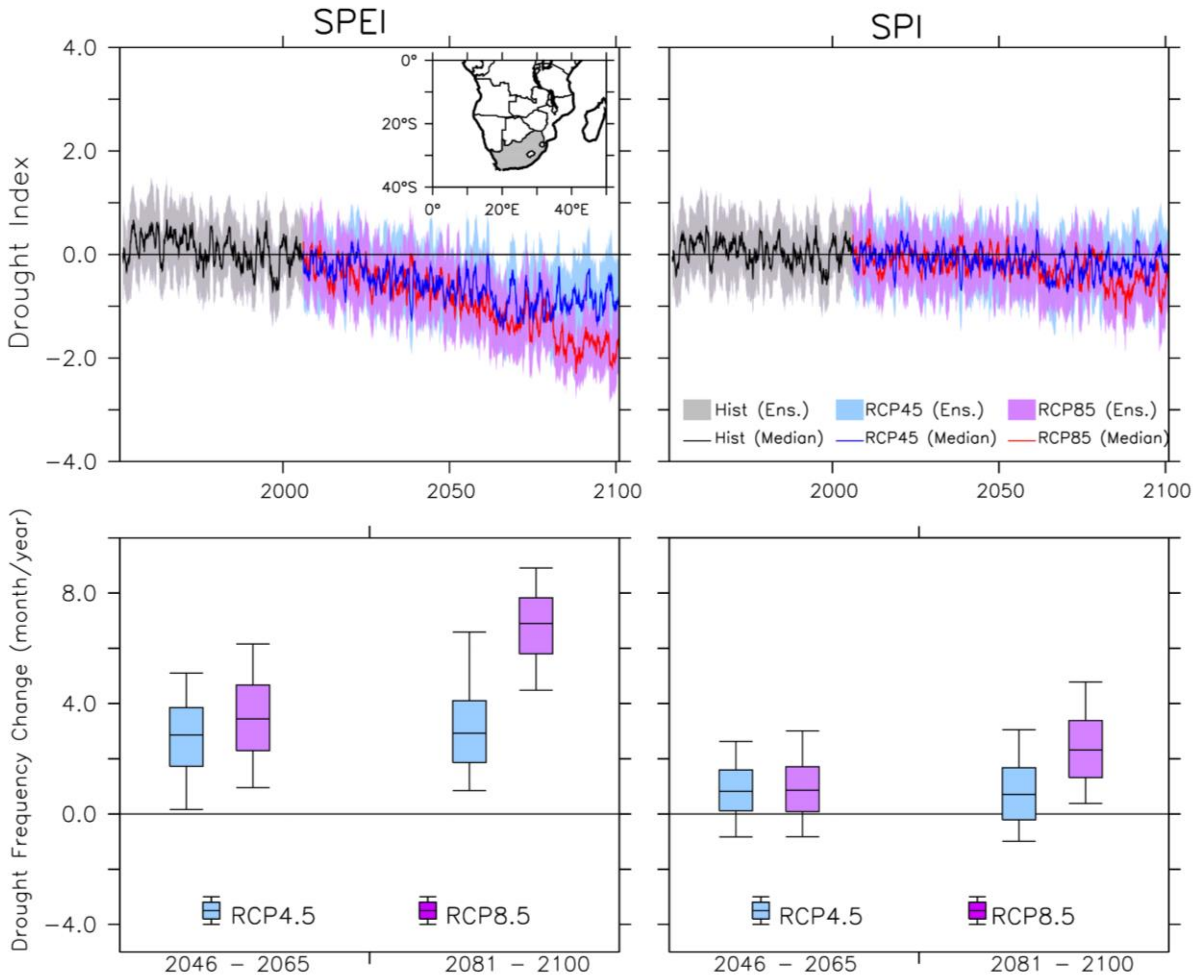

Figure 4: Future projections of annual drought index over South Africa.

The upper panels show (Fig. 4) the time series of the annual drought intensity (12-month SPE and SPI) in the period 1951 - 2100. The shadings indicate the 25th – 75th percentile model ensemble spread for the simulated historical climate (1951 – 2015; grey) and the future projection (2016– 2100) under RCP4.5 (light blue) and RCP8.5 (pink) scenarios, while the lines (black, dark blue, and red, respectively) depict the ensemble median. The lower panels show the projected changes in frequency of annual droughts (12-month SPEI < -1; 12-month SPI < -1) in two future periods 2046 - 265 and 2081 - 2100.

The changes are calculated with respect to the period 1986 - 2005. The box plots depict the model ensemble spread (lines: minimum, maximum, median; shading: 25th – 75th percentile range).

RATIONALE BEHIND THE RESPONSE AND BEHAVIOURAL EXPERIENCES

Whereas droughts are specific climatological/weather events, water scarcity is usually used to describe the general problem of supplying the society/economy with enough water. The main human drivers of water scarcity are increased consumption (not only of water directly), population growth (urbanization) and agriculture. Community behaviour and perception on drought and water scarcity is therefore reflected mainly through impacts on health, safety and economic losses. The impacts of drought have been vary for different sectors of the economy. In agriculture, these are mainly crop failure and death of livestock. In the environment, these impacts manifest in environmental degradation. Hydrologically, they manifest in reduction of streamflow and groundwater levels. The industrial sector is affected by drought resulting in a general loss of welfare. This results in socio-economic impacts such as loss of income, threat to household food security and even famine. The choice of coping strategy depends on numerous variables such as access to land, finance, market and information, income, experience, education and extension in particular amongst smallholder farmers.

Employing principles of behavioural economics have assisted municipalities to manage the demand on utilities such as water in order to encourage a behaviour change in household water consumption. Projects using these principles have employed three behavioural mechanisms to manage demand by using a randomised control trial which includes: raising the salience of the consumer's consumption to themselves, comparing the consumer's consumption to some social norm and providing information about how to consume less. In the City of Cape Town, salience was raised on water consumption by reporting previous consumption in a bar chart or by comparison with a neighbour via a bar chart. Raising the salience decreased water consumption. The study also concluded that simplifying the information communicated was more effective in lowering water consumption. More knowledge is, however, required on employing these strategies over a longer term and using them in combination with other appropriate strategies to manage domestic water demand. More research is required in applying principles of behavioural economics to other areas of water studies, such as designing assessments of water policy.

RECOMMENDATIONS

Managing drought in the near-future

Given that the probability of droughts similar to that of Cape Town drought of 2015-2017 is estimated to have already increased by a factor of three due to climate change, and that multi-year droughts are projected to occur with increasing frequencies already in the near-future (2019-2039) it is clear that the City of Cape Town and Western Cape Province need to take immediate action to improve the management of such events. The same applies to other regions of the country which regularly experiences drought. Suggested adaptation options include:

- Improved seasonal forecast systems for the southwestern Cape. If the occurrence of multi-year drought in the southwestern Cape can be skilfully predicted, or even if rainfall anomalies of the spring, winter and autumn seasons can be predicted skilfully with a lead-time of about 3 months, it would be of immense value for planning by water managers.

- Immediate and widespread action is required to minimise water losses and leakages that currently occur in the water distribution systems.
- Extensive usage of grey water is recommended, and all new developments need to have compulsory grey water systems.
- Behavioural change towards efficient use of water needs to be incentivised.
- Storage infrastructure needs to be revisited so that surplus water can be captured during wet seasons.

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