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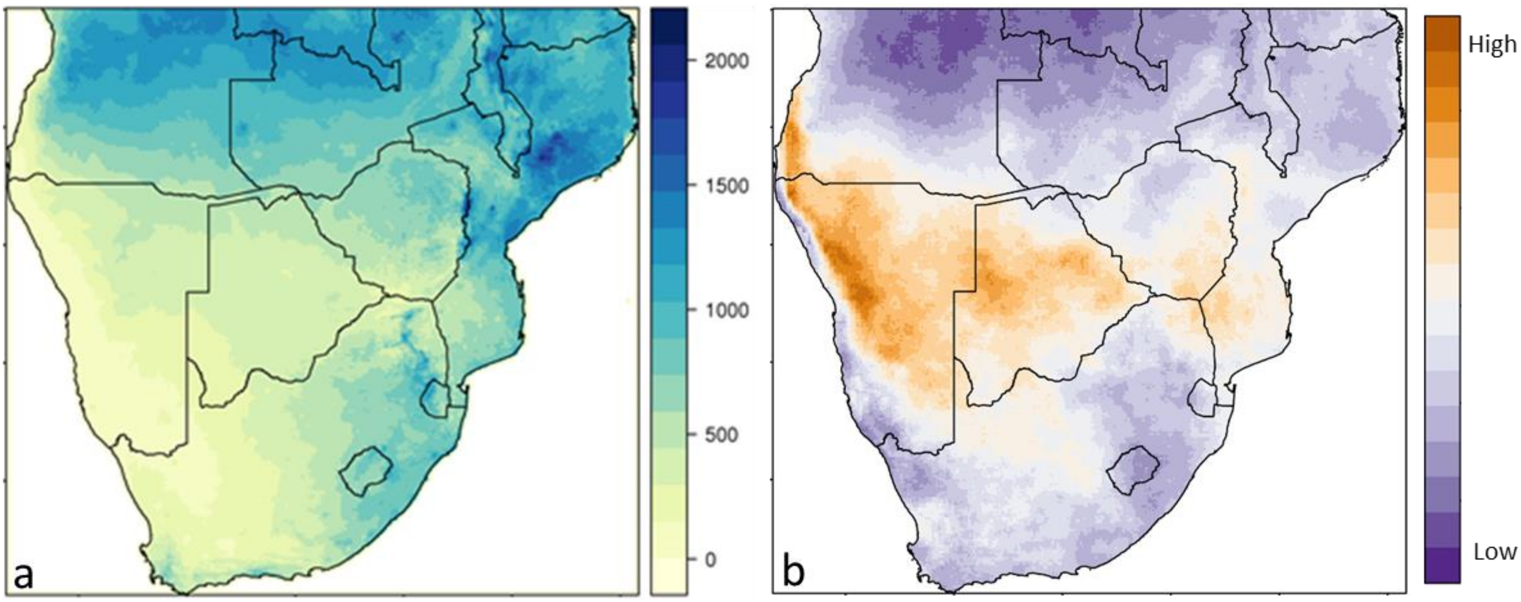
JRC TECHNICAL REPORTS

2018 – Drought and Water Crisis in Southern Africa

JRC GDO and WEFE4DEV

2018



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PART I – Drought in Western Cape Province – January 2018

Authors: D. Masante, N. McCormick, J. Vogt

1 Executive Summary of PART I

- Western Cape Province in South Africa is going through a severe drought, affecting in particular the highly populated urban area of Cape Town and its water supply.

- The current drought is the effect of a sustained below-average monthly rainfall series since 2015, which intensified in the last wet season (April to September 2017). The very exceptional nature of this event is highlighted by GDOs long-term indicators of precipitation anomalies (e.g. SPI-48).

- Cape Town's water supply is in critical emergency, water for any use has been restricted through water cuts and rationing. The day of "zero-water" has been established as 12 April 2018 by Cape Town water authorities[1]. Saldanha and Stellenbosch municipalities are facing a similar level of emergency for water supply.

- Very little precipitation may be expected before April.

[1]http://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/damlevels.pdf

2 Description of the Affected Area

South Africa's Western Cape Province is located at the southernmost part of the continent, over an area of more than a million square kilometres. The region has a set of mountain ranges running parallel to the coastline, which give rise to its varied climatic gradients and vegetation patterns. In general, climate is a mild Mediterranean type on the coasts (wet winter and dry summer), shifting to semi-arid and continental towards the interior and past the mountains. Vegetation is mostly made of scrubland, here called fynbos, a very typical and fire prone vegetation type. Agriculture is a growing sector in the region, which hosts renowned vineyards. Western Cape includes one of the country's capitals, Cape Town, also one of the main urban areas. General data are shown below.

Western Cape[2]	
Population, estimate (2017)	6 510 300
GDP per capita (current US$) (2016)	6201.88
Population density (per km2 of land Area)	45

While much of the southern African continent has been recovering, following heavy summer rains, from a drought caused by El Nino, Cape Town in Western Cape is still gripped by its worst drought in a century, having had very low rainfall for the last three years. The drought is reportedly having severe impacts on the population, with water supplies to Cape Town's residents due to be cut off on 12 April 2018 unless there is a drastic reduction in water consumption, while the water level of the Theewaterskloof dam (the largest in the Western Cape water supply system, holding 41% of the water storage capacity available to Cape Town) is critically low[3].

[2] https://en.wikipedia.org/wiki/Economy_of_the_Western_Cape

[3] https://www.theguardian.com/world/2018/jan/24/cape-town-to-run-out-of-water-by-12-april-amid-worst-drought-in-a-century

3 Likelihood of Drought Impact (LDI)

The LDI indicates the likelihood of having impacts from a drought, by taking into account the exposure and socio-economic vulnerability of the area (Figure 1).

Remarkably, almost none of the region is shown under risk, with a clear drop from the high levels of the last winter. This is because the LDI takes into consideration the overall precipitation in the past three months, which has been about normal during that time in the region. So, while LDI flags rising and short-term droughts, in this instance it does not highlight the long-term aspect of the drought.

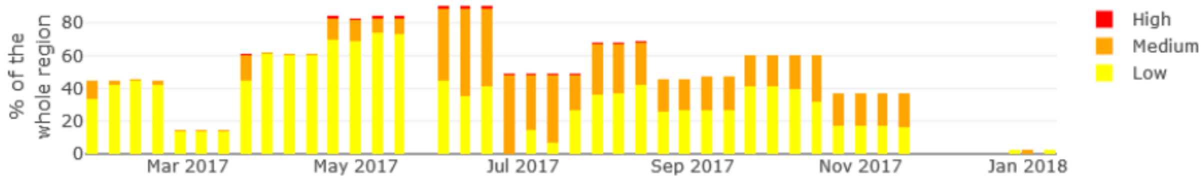


Figure 1 – Likelihood of drought impact (LDI), evolution over time in Western Cape (South Africa)

4 Precipitation Analysis

Precipitation includes total monthly of both rainfall and snow. Figure 2 shows the monthly precipitation pattern near Cape Town since January 2015: only one fifth of the months reached or exceeded the expected average, with the wettest period looking narrower than normal. As a result, in the past three years, the area received only 65% of the expected precipitation overall (Figure 3). During 2017 the figure went down to 60% and considering the last cold season, between April and September 2017, further down to 55% compared to the long-term measurements. July in particular, being the wettest month, received barely half its normal precipitation.

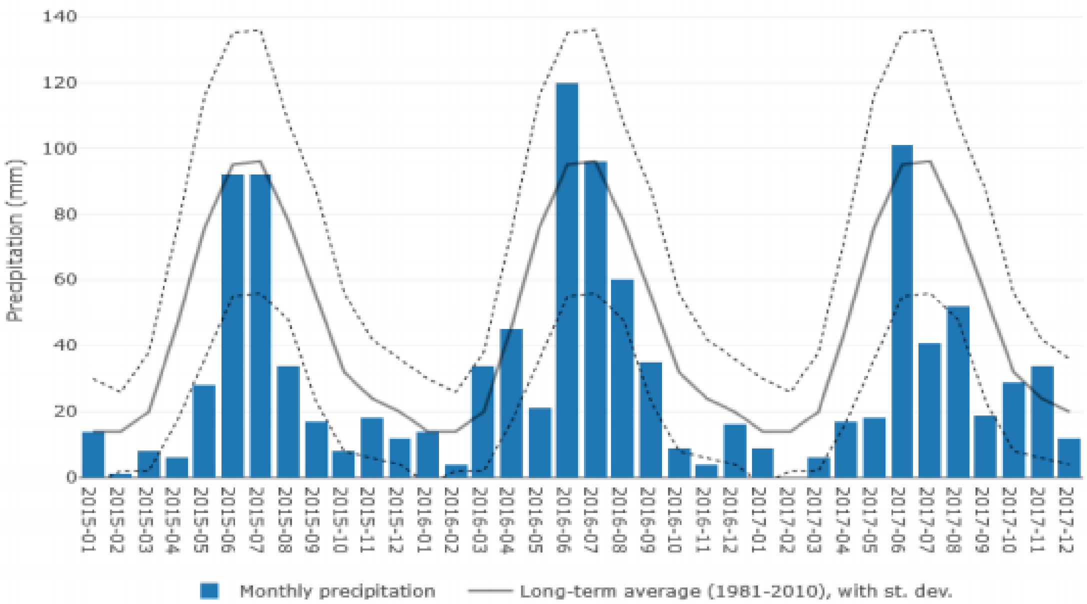


Figure 2 – Monthly total precipitation (blue bars) near Atlantis (Western Cape, South Africa, coordinates: N-33.57422, E18.62183). The solid line represents the long-term monthly average (1981-2010); the dotted lines are plus/minus one standard deviation.

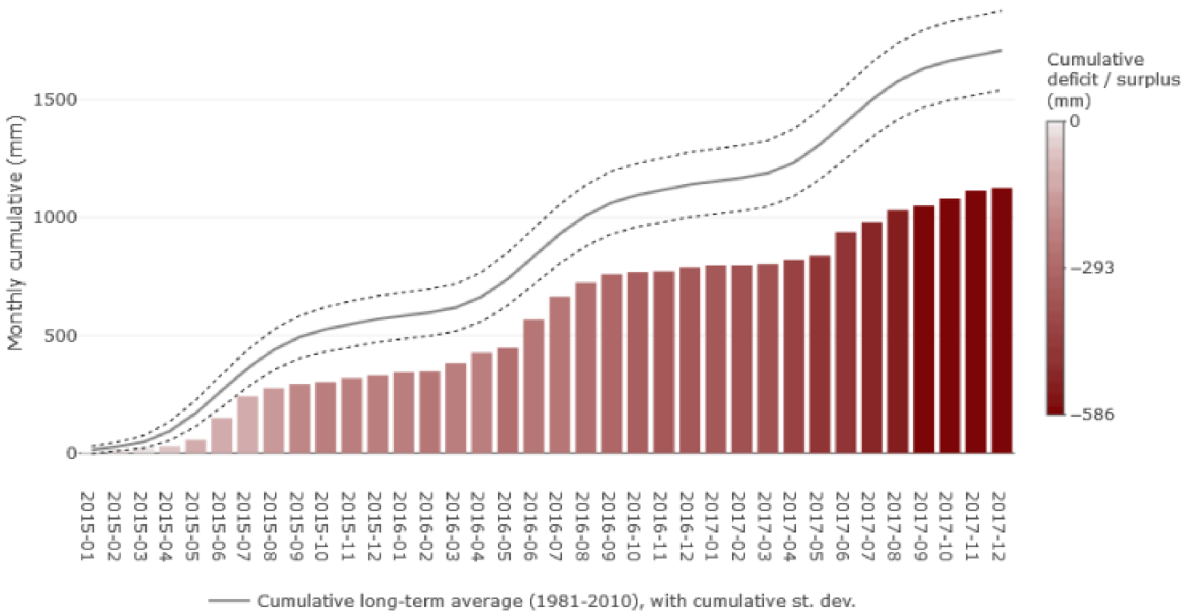


Figure 3 - Cumulative precipitation over a period of 3 years near Atlantis (Western Cape, South Africa, coordinates: N-33.57422, E18.62183). The bar colors indicate the cumulative deficit (red gradient) or surplus (blue gradient) compared to the cumulated monthly long-term average (solid line), for the same time span and location.

5 Standardized Precipitation Index (SPI)

The SPI is an index used to monitor the occurrence of meteorological drought. The lower the SPI, the more intense is the drought (Figure 4). Note that different accumulation periods are shown (3, 9, 24 and 48 months). As mentioned, precipitation in the last quarter of 2017 has been roughly within normal, so the 3-months SPI does not fall too far from normal fluctuations during the last few months, suggesting a mild drought at the most. However, the SPI 9-months from Figure 4 shows the serious lack of precipitation during late 2016 and 2017, with SPI values dropping to the threshold of minus three. In relation to impacts, more concerning are the long-term SPIs, which go past the "extreme drought" value. This entails a constant under-supply of water to reservoirs since at least 2015 (Table 1 and Figure 8), which explains the current crisis of water provisioning in Cape Town. The 24-months' time series shows the starting point for the drought, with precipitation of 2015 dragging the SPI to very negative values. The 48-months SPI reaches the rare value of SPI minus four, a level of truly exceptional drought.

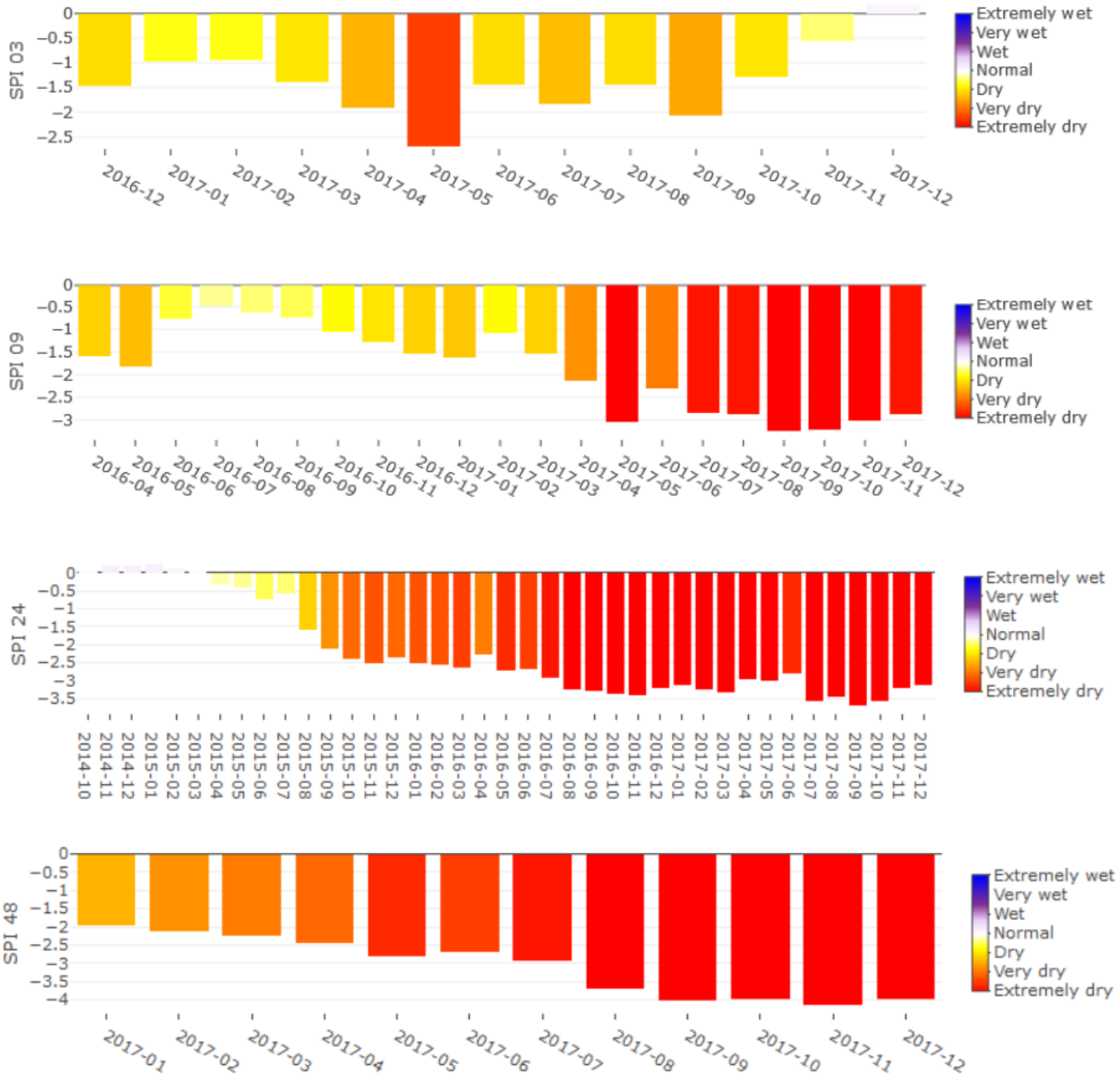


Figure 4 - SPI for a cumulative period of 3, 9, 24 and 48 months near Atlantis (Western Cape, South Africa, coordinates: N-33.57422, E18.62183).

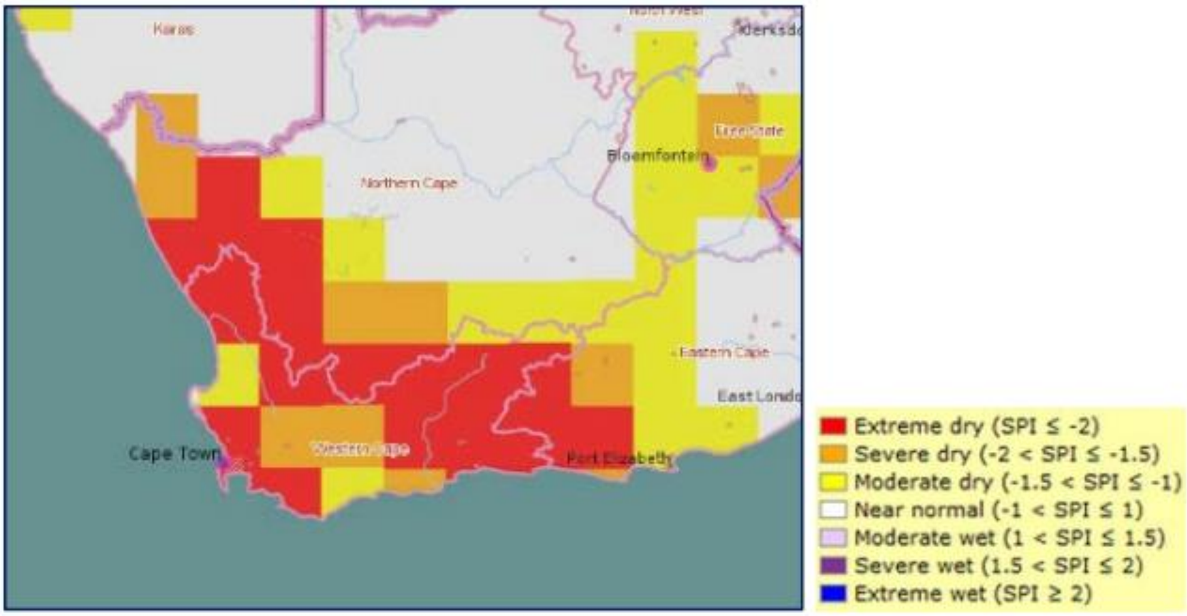


Figure 5 - SPI for a cumulative period of 24 months over Western Cape, December 2017.

6 fAPAR and Soil Moisture Anomaly

The fraction of Absorbed Photosynthetically Active Radiation (fAPAR) represents the fraction of the solar energy absorbed by leaves. fAPAR anomalies, specifically the negative deviations from the long term average over the same period, are a good indicator of drought impacts on vegetation (Figure 6). As expected from the recent precipitation pattern across Western Cape, vegetation greenness is affected by drought, showing negative anomalies in the very circumscribed region of Western Cape, especially around and North of the capital.

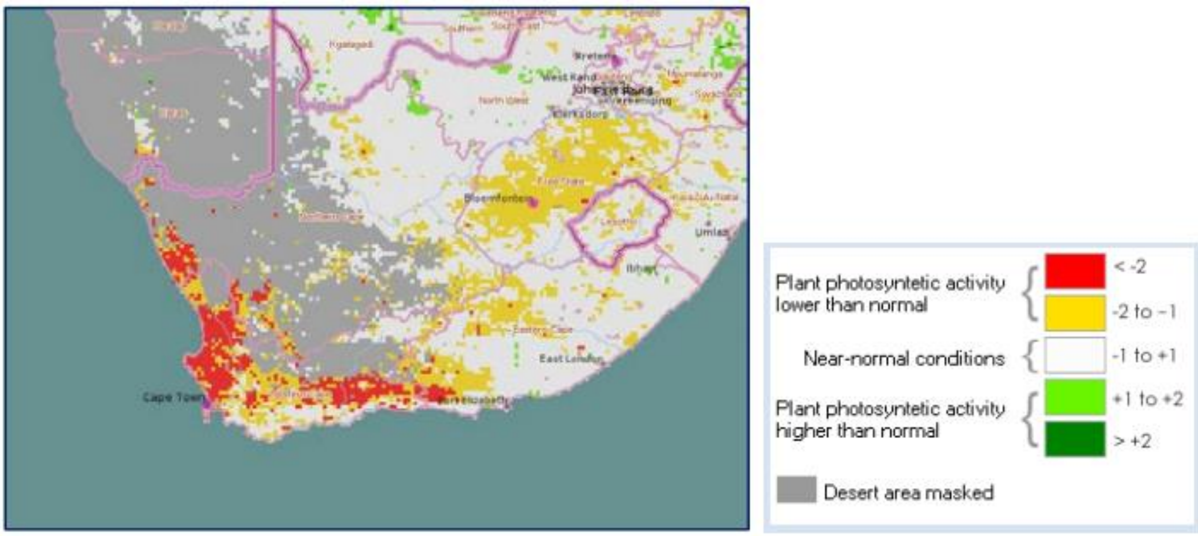


Figure 6 – fAPAR anomaly in Western Cape (South Africa) for the period 01-01-2018 to 10-01-2018.

Concerning soil moisture, a situation of severe drought is detected from September 2017 onwards (Figure 7), in particular on the westernmost part of the Province.

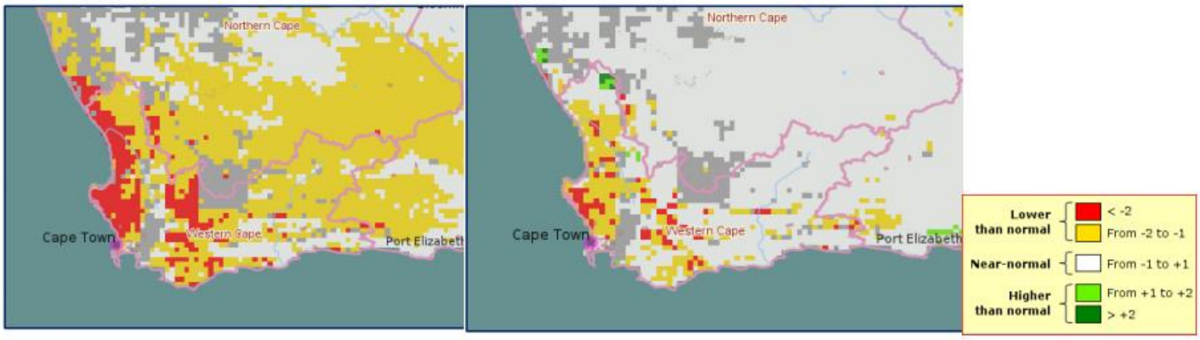


Figure 7 – Soil moisture anomaly in Western Cape Province in September 2017 (left) and in December 2017 (right).

7 Maps and Tables of the Western Cape Drought (various sources)

Figure 8 - Location of dams in Western Cape[4]

Table 1 – Current Dam Water Levels in Western Cape, 24/1/2018. Units of volume are megaliters (Ml).

Major Dams	Storage	
	Ml Capacity	**% 24/01/2018**
Berg River	130 010	54.8
Steenbras Lower	33 517	45.1
Steenbras Upper	31 767	86.0
Theewaterskloof	480 188	13.9
Voelvlei	164 095	18.5
Wemmershoek	58 644	52.4
Total Stored Ml	898 221	241 358
% Storage	100.0	26.9

[4] From: https://www.westerncape.gov.za/general-publication/latest-western-cape-dam-levels

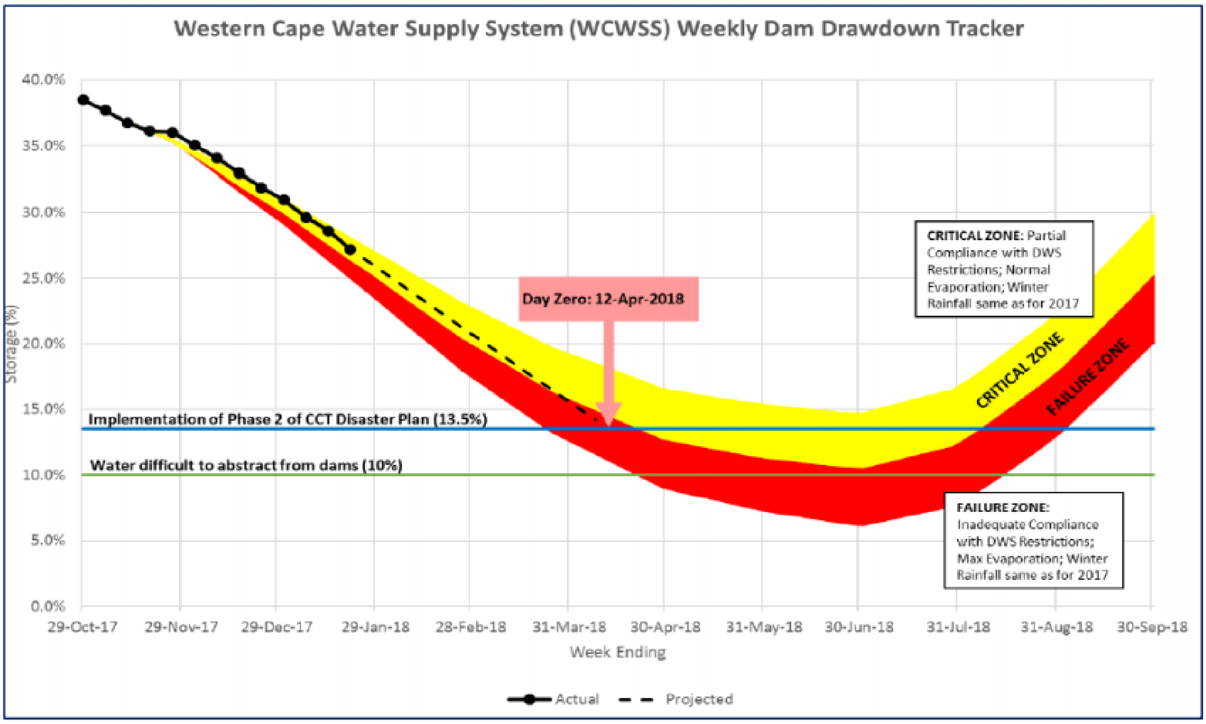


Figure 9: Projection of overall dam levels in Western Cape, as % of total capacity[5].

8 Media Coverage

- The Guardian. 24 January 2018. "Cape Town told to cut water use or face losing supply by 12 April". https://www.theguardian.com/world/2018/jan/24/cape-town-to-run-out-of-water-by-12-april-amid-worst-drought-in-a-century

- City of Cape Town. 22 January 2018. "Weekly Water Dashboard Report". http://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/damlevels.pdf

- GroundUp (Cape Town news agency). 22 January 2018. "How severe is the drought?An analysis of the latest data". https://www.groundup.org.za/article/how-severe-drought-detailed-look-data/

- Eyewitness News. 20 January 2018. "Spike in grape prices inevitable amid drought". http://ewn.co.za/2018/01/20/economist-spike-in-grape-prices-inevitable-amid-drought

- BBC News. 18 January 2018. "South Africa: Cape Town slashes water use amid drought". http://www.bbc.com/news/world-africa-42731084

- Western Cape Government. 2018. "Latest Western Cape dam levels". https://www.westerncape.gov.za/general-publication/latest-western-cape-dam-levels

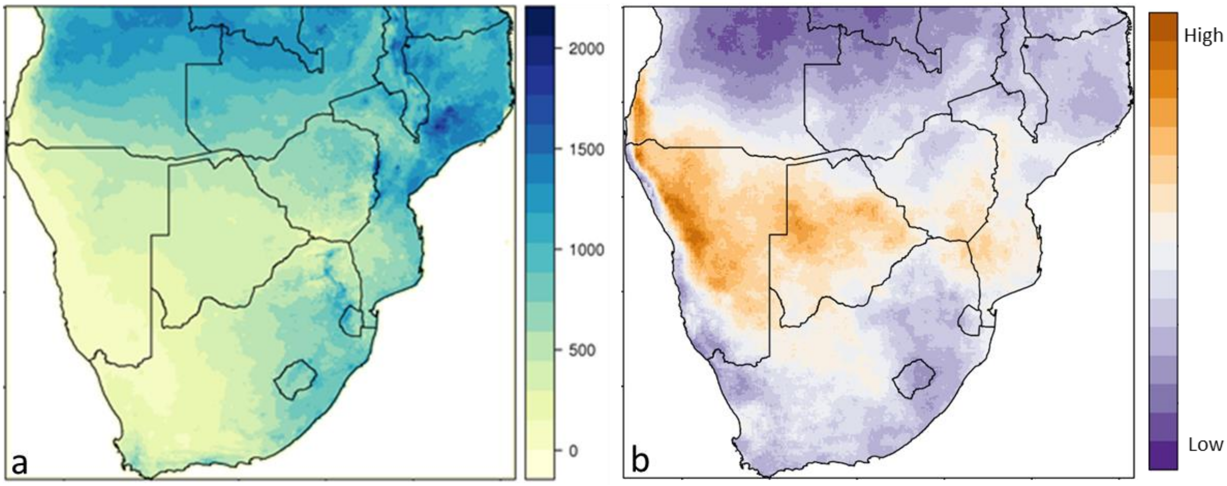
[5]From:http://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/damlevels.pdf

9 Information Sources

- Joint Research Centre (European Commission): Global Drought Observatory (GDO) -http://edo.jrc.ec.europa.eu/gdo/
- Global Precipitation Climatology Centre (GPCC) - http://gpcc.dwd.de/pub/data/gpcc/PDF/GPCC_intro_products_v2011.pdf
- Cape Town city Council http://www.capetown.gov.za/

PART II – The Water Crisis in Southern Africa: Spatio-Temporal Analysis

Authors: C. Carmona-Moreno, I. Ameztoy-Aramendi, E. Cordano



This part of the report presents an analysis of the medium to long-term spatial patterns and temporal behaviour of climate variables (precipitation and temperature) in Southern Africa. It gives a regional overview of the recent water crisis in Western Cape, and complements the first part of this report produced by the JRC's Disaster Risk Management Unit and the Global Drought Observatory (**GDO report**), compiled for DG ECHO.

The work presented in this Part II is carried out by the WEFE4DEV work package of the JRC's Water-Energy-Food-Ecosystems (WEFE) Project, and contributes to the online **African Atlas on WEFE Cooperation**. This atlas aims to help African policymakers in identifying current and future issues that impact water management, food and energy security in Africa.

The report shows the 2018 water crisis in Western Cape in a temporal and regional context, in order to help the community (including African policymakers) better understand the exceptional character of these phenomena, their periodicity and whether these exceptional events are occurring at a regional scale. It will help policymakers to better define future mitigation, resilience and adaptation policies and the spatial scale at which these measures should be implemented.

1 Executive summary of Part II

From the spatial-temporal analyses (1981 – 2017) carried out, this report shows that, in the Southern African region:

- Although this current event has a very exceptional nature as highlighted by GDOs in Part I of this report, the periodicity of very high precipitation deficits (close to 70-80% during the rainy season in Southern Africa!) is less than 10 years; and, the precipitation deficits of almost 50-70% (during the rainy season) can occur with a periodicity of 5 years;
- the frequency of moderate to extreme heatwaves has been increasing during the past 10 years.

The consequences and severity of these events in the Western Cape region have a direct impact on crop production and human health, particularly affecting the most vulnerable populations (children and the elderly). Given that the high recurrence rate of these phenomena in the region is likely to be exacerbated by climate change, one-off measures (such as the water restrictions imposed on Cape Town's residents) should be combined with more structural measures in the medium to long term in order to cope with and mitigate the consequences on the most vulnerable populations. Some suggestions:

- To explore the diversification of food production towards more drought-resistant crops and varieties;
- To invest in climate resilience and early preventative and mitigation actions with more appropriate infrastructures and decision support systems.

2 Introduction

Extreme temperature and precipitation events are important information sources for hazard mitigation and management. A comprehensive assessment of their spatio-temporal frequency characteristics is the initial step in defining public policies relating to, for example, Water Resource Management (Oki and Kanae, 2006; Maeda et al., 2012).

Extreme anomalies in both variables have obvious negative impacts in many socio-economic areas, including those related to the Water-Energy-Food-Ecosystems (WEFE) Nexus and many of those defined under the Sustainable Development Goals (SDGs). An understanding of the characterisation of climate variability and associated extreme events can help more effectively design food security policies.

Understanding, for example, the average frequency of a given precipitation deficit can occur or the magnitudes and associated trends of heatwaves is crucial to identify appropriate measures in the mid-long term. A recent study on heatwaves, for example, shows that such events are increasing number in Africa, where extreme conditions are affecting the vast majority of the African population (Ceccherini et al., 2017). Examples of water shortages are also increasingly common, as with the recent severe drought that is affecting the Western Cape Province in South Africa. The urban area of Cape Town is facing a critical emergency water supply situation due to below-average monthly rainfall since 2015 (***GDO Analytical Report, 2018***).

In order to provide a more general overview of the latter event in Southern Africa, this report presents some results derived from an analysis carried out on precipitation and temperature extremes at a regional scale. Precipitation frequency has been characterised using the L-moments approach (Hosking, 1990; Hosking and Wallis, 1997) while the temperature extremes have been assessed by mean of the Heat Wave Magnitude Index

(Russo et al., 2015). Both analyses have been spatially carried out in a regional context, covering the following countries: Namibia, Botswana, Zimbabwe, Mozambique, Swaziland, Lesotho and South Africa (Figure 10). The results are provided in the form of spatially explicit maps.

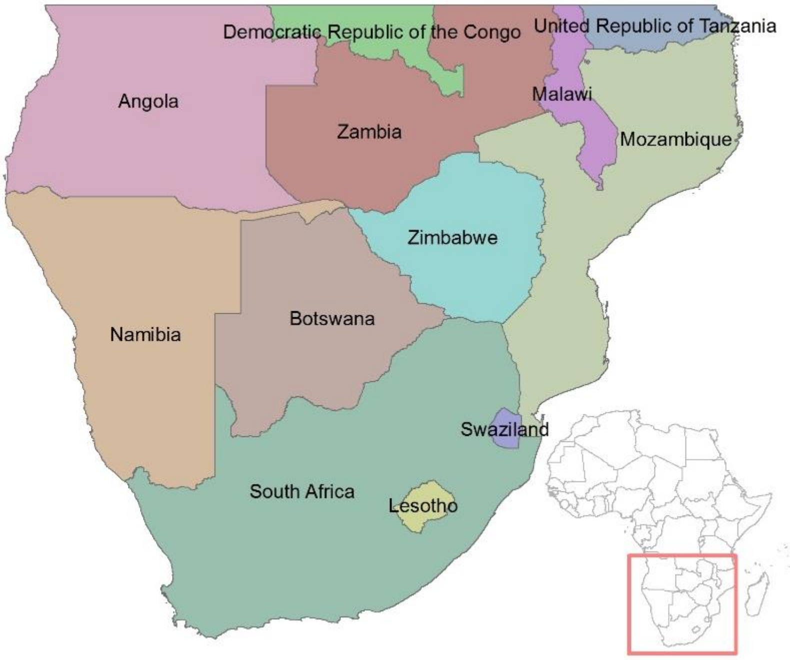


Figure 10 - Study area; Southern African countries

3 Data and Methodology

3.1 L-moments of Precipitation and Temperature

L-moments statistics have been calculated to study precipitation and temperature characteristics in the study area. For precipitation, the Climate Hazards Group InfraRed Precipitation with Station Data (CHIRPS) was used at the monthly scale for 1981-2017. CHIRPS is a gridded 30+ year quasi global rainfall dataset with a resolution of 0.05 degrees (Funk et al., 2014). Temperature characterisation (1979-2017) has been carried out using daily values derived from the ERA-INTERIM dataset for 1981-2017 (Berrisford et al., 2011). With a resolution of about 80 km, it is a global atmospheric reanalysis dataset produced by the European Centre for Medium-Range Weather Forecasts (ECMWF).

The L-moments are similar to other statistical moments, but with the advantage of being less susceptible to the presence of outliers and performing better with smaller sample sizes. For a random variable X, the first four L-moments are given by the following equations:

$$\Lambda 1 = E[X]$$

$$\Lambda 2 = E[X2:2 - X1:2]/2$$

$$\Lambda 3 = E[X3:3 - 2X2:3 + X1:3]/3$$

$$\Lambda 4 = E[X4:4 - 3X3:4 + 3X2:4 - X1:4]/4$$

For convenience, the second, third and fourth L-moments are often presented as L-moment ratios: $T2= \Lambda 2/ \Lambda 1$

$$T3= \Lambda 3/ \Lambda 2$$

$$T4= \Lambda 4/ \Lambda 2$$

The 1st L-moment (L-mean) is identical to the conventional statistical mean. The 2nd L-moment (L-cv) measures a variable's dispersion or the expected difference between two random samples. The 3rd and 4th L-moment (L-skewness and L-kurtosis) are measures relating to the shape of the sample distribution. The L-skewness quantifies the asymmetry of the sample distribution, and the L-kurtosis measures whether the samples are peaked or flat relative to a normal distribution.

3.2 Frequency Analysis of Precipitation

Once L-moments were calculated, precipitation was characterised by the Extreme Value Analysis (EVA). EVA aims to represent the likelihood of receiving a specific rainfall amount based on a given time frame by fitting a parametric statistical distribution. Monthly and annual cumulated precipitation, also derived from CHIRPS, has been modelled using a Pearson-3 distribution function.

From this, a number of indexes such as quantile and return period maps can be derived. In our case we present monthly and annual deficit maps in the form of percentages with respect to average precipitation levels. These maps have been calculated for 5-, 10- 20- and 50-year return periods.

3.3 Heat Wave Magnitude Index daily

According to *Russo et al. (2015)*, the HWMId is a simple numerical indicator that takes both the duration and the intensity of the heatwave into account. The HWMId is defined as the maximum magnitude of the heatwaves in a year. Specifically, a heatwave is defined as a period of 3 or more consecutive days with maximum temperatures above a daily threshold calculated for a 30-year reference period. The threshold is defined as the 90th percentile of daily maxima temperature, centered on a 31-day window.

The magnitude index sums excess temperatures beyond a certain normalised threshold and merges durations and temperature anomalies of intense heatwave events into a single indicator. As well as for the L-moment analysis, the ERA-INTERIM maximum and minimum temperatures for the period 1981-2015 were used to conduct the analysis.

For further information, the implemented methodologies are extensively described in:

- *Hosking 1990*, *Hosking and Wallis 1997* and *Maeda et al. 2013* for L-moments and precipitation frequency analysis;
- Heatwave analysis in *Russo et al. 2015*, as well as results for the entire African Continent are presented in *Ceccherini et al., 2017*.

4 Results Analysis

In this paragraph, the 2018 Water Crisis in Western Cape will be placed in a regional and temporal context.

4.1 In the Regional Context

Figure 11.a shows that the Mean Annual Precipitation for the **past 37 years (1981 – 2017)** is usually below 400 mm in the western region of Southern Africa, with minimum values of around 150 mm and even less along the Namibian coast. These values are lower than those of the eastern regions of South Africa and Mozambique. These low values are also characterised by a strong inter-annual variability (from year to year, Figure 11.b). This is particularly the case in Namibia and western Botswana, but it is also evident in the Western Cape region (medium variability level during the year). The **rainy season (summer season)** of Southern Africa typically lasts from **October to April** and reaches maximum strength between **November and March**, the period in which **most locations usually receive more than 75% of their annual precipitation**. For this reason, the analysis and the results shown in this report have focused on these months for the region. Also, due to its local Mediterranean climate, rainfall in **Cape Town** occurs in the winter months of **May through July**.

Figure 12 shows the variability in precipitation for the summer rainy season (November – March). It shows that the variability in precipitation is particularly strong in the western region and even stronger in the Western Cape Province during December and February. This strong variability therefore explains the occurrence of drought events (1981 – 2017). Figure 3 also shows that the **precipitation variability will probably slightly decrease (improve) after March 2018 reaching its average value according to the "typical temporal behaviour" (medium- to low level of variability)**.

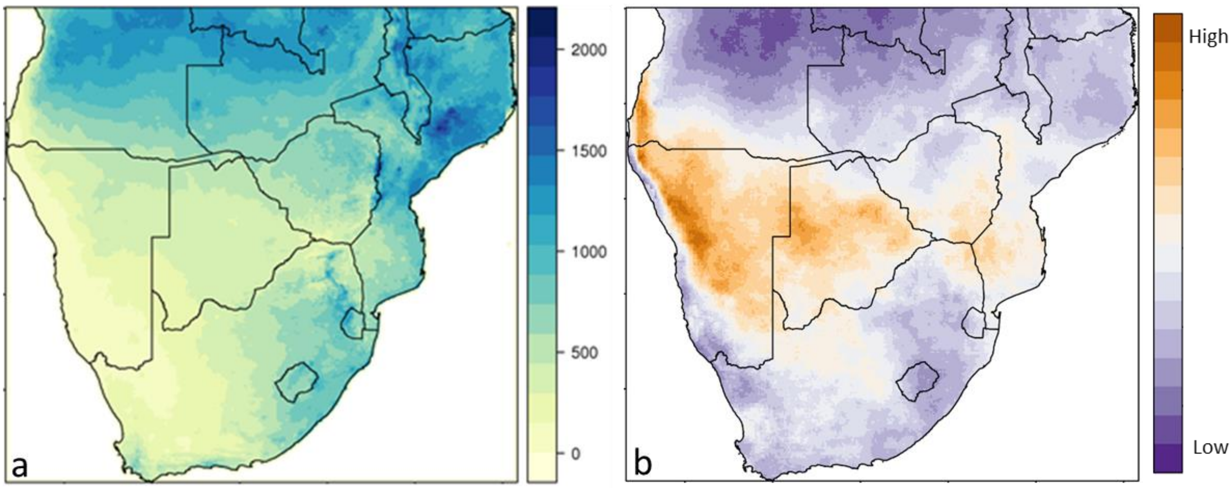


Figure 11 - Precipitation Analysis – Time series 1981-2017: a) Mean Annual Precipitation in millimetres (1st L-moment); b) Precipitation Variability (non-dimensional, 2nd L-moment).

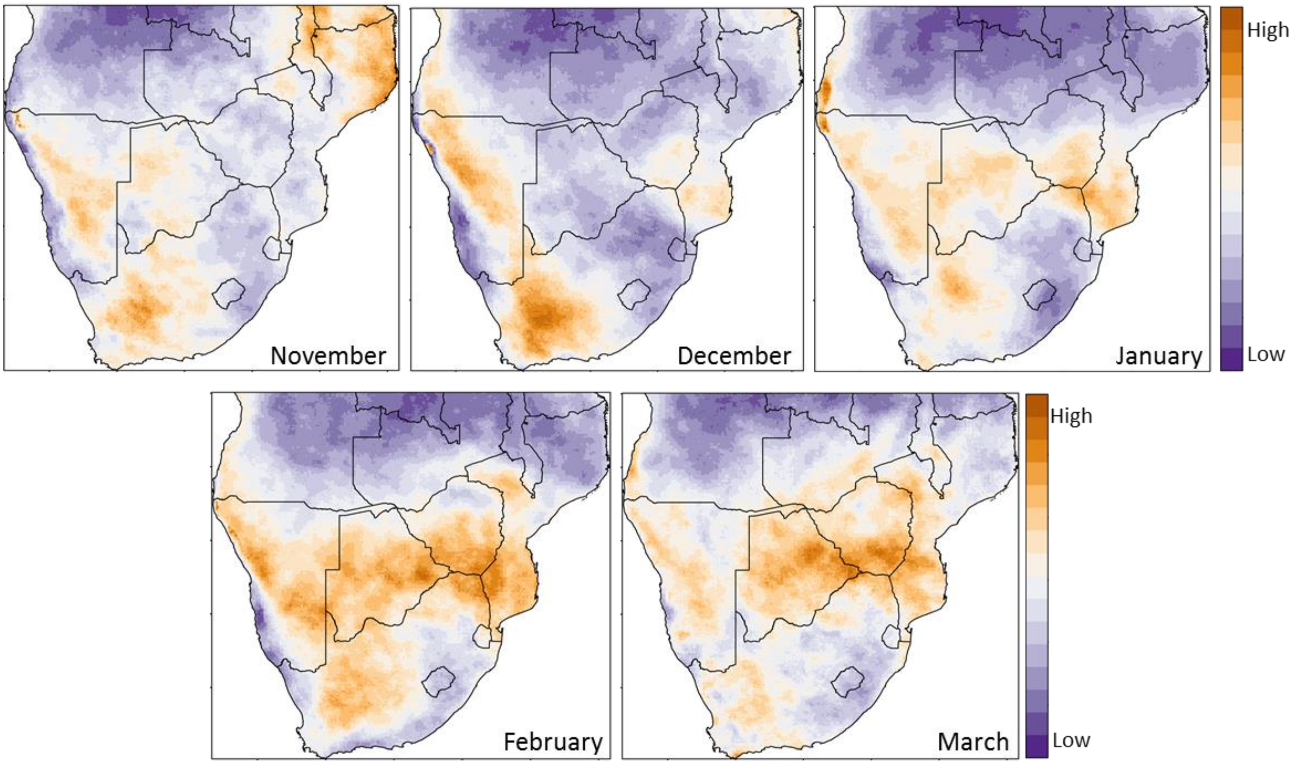


Figure 12 - Precipitation Analysis – Time series 1981-2017: Precipitation Variability during the last months of the Southern African summer season

Figure 13.a shows the mean annual temperature in the region based on an analysis of the time series 1981-2017. Figure 13.b shows the temperature variability along the year and its spatial distribution. The variability of the temperature in the Western Cape region is notably high. This strong variability leads to strong fluctuations on the surface water evaporation in Southern African, which explains the fAPAR and soil moisture anomalies and therefore clarifies the anomalies reported by the GDO Analytical Report. This has direct consequences on, among others, water (quality and quantity), agricultural production and the increased need for energy for water pumping, irrigation, cooling, etc.

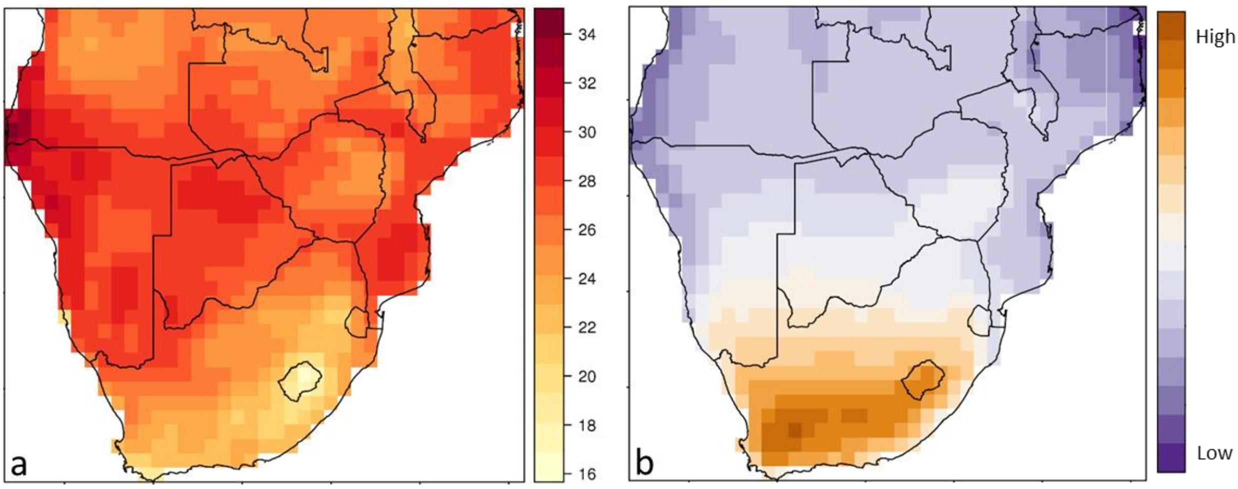


Figure 13 - Temperature Analysis Time series 1981-2017: a) Mean Annual Temperature (ºC) b) Temperature Variability (non-dimensional).

4.2 In the Temporal Context

PRECIPITATION

From a policymaking perspective, it is particularly important to put the 2018 water crisis in Western Cape in a temporal context, as this helps understand the exceptional nature of these events, in a general way:

1. Occurrences with return periods of **more than 50 years** suggest that **one-off measures** could be enough to mitigate the impact on populations because of their very exceptional nature; but,

2. Occurrences with return periods of **less than 50 years** would mean that **more structural measures** should be considered to combat these recurrent phenomena.

In the latter case, decision-makers should take into account these periods of occurrence in the definition of their short- and medium-term mitigation and resilience planning to combat climate variability. Given that frequently recurring water shortages can certainly have an impact on the regional socio-economy, decision-makers should plan appropriate infrastructures, develop specific water supply programmes, agriculture and energy strategies, etc., to mitigate the impacts.

Figure 14 shows precipitation deficits (**%**) with respect to the annual precipitation average calculated for four different return periods (5, 10, 20 and 50 years). It shows that the southern region could be affected by rainfall deficits of 10 to 20% every five years on average, and that these deficits can increase up to 20 to 30% with a frequency of ten years average.

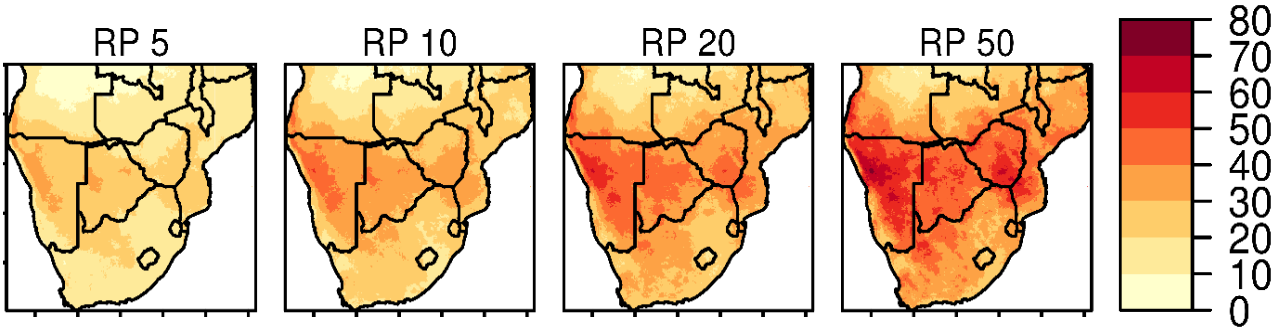


Figure 14 - Precipitation Analysis – Time series 1981-2017: Precipitation Deficit as a % of the mean rainfall calculated for different Return Periods (5, 10, 20 and 50 years) - (Annual maps).

Figure 15 shows the deficits during the months of the rainy summer season in Southern Africa when most locations receive up to 75% of their annual rainfall. Considering that the deficits during these months can reach up to 50-80% of the usual rainfall with a certain periodicity (5-10 return period) for the last 30 years, this should encourage policy makers to develop infrastructures or policies that mitigate the recurring effects on the population.

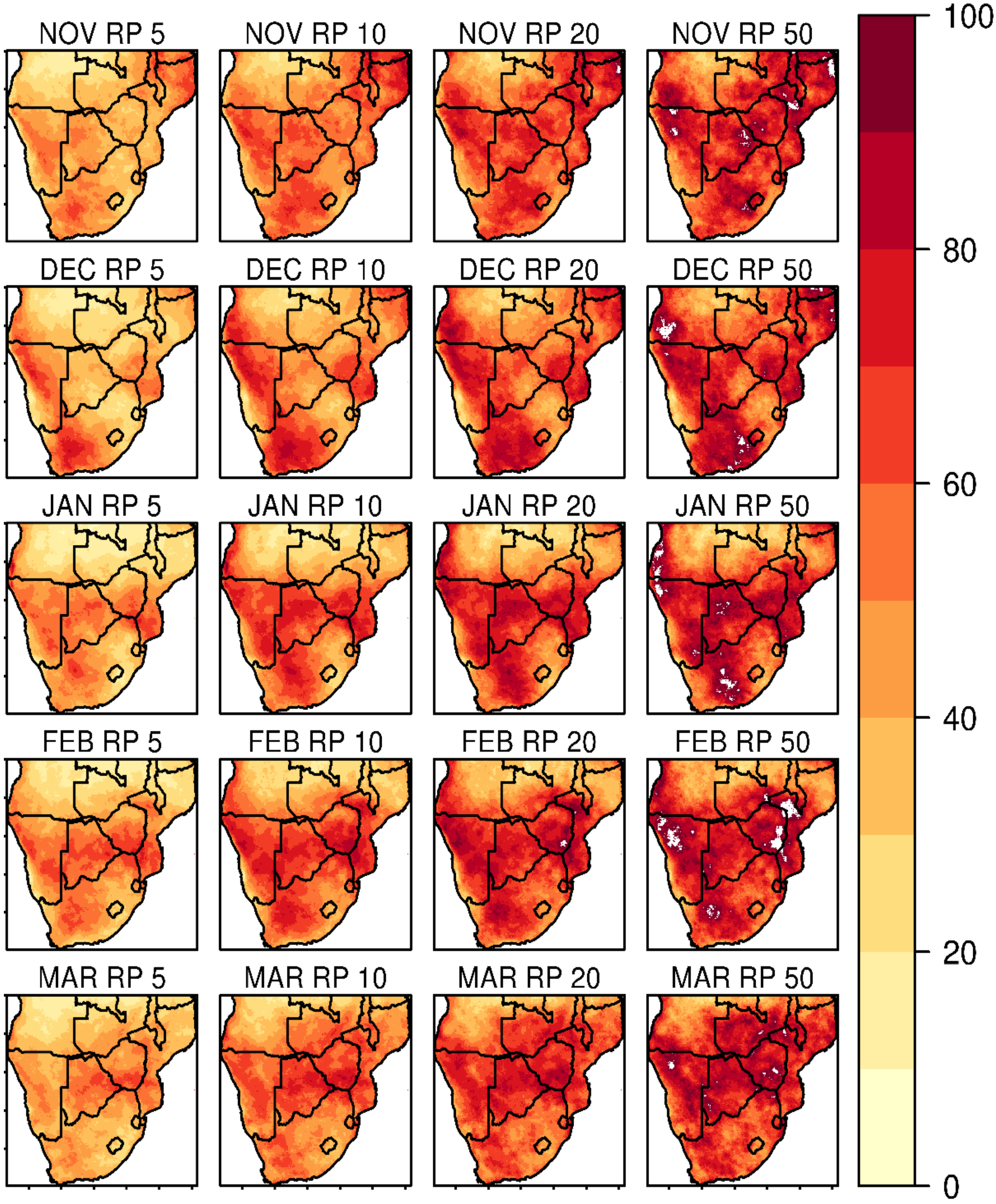


Figure 15 - Precipitation Analysis – Time series 1981-2017: Precipitation Deficit (%) with respect to the monthly mean rainfall for different Return Periods (RP 5, 10, 20 and 50 years) - (November, December, January, February, March)

A deficit of 50-70% of monthly precipitation during the rainy season occurs on average every 5 years in December and February. A precipitation deficit of 70-80% occurs every 10 years on average in the Western Cape.

The products presented in this report can help decision-makers build infrastructures to support and/or mitigate these large deficits of precipitation (to ensure water supply and sanitation), and also to decide whether a development project (agricultural, water supply, energy structure) should be allowed to proceed in the risk area, or on the design of infrastructure to mitigate an event with a certain return period.

TEMPERATURE

As stated in the methodology section, the HWMId is a simple numerical indicator that takes both the duration and the intensity of the heatwave into account. This index can be also classified into different categories (Table 2), from normal to moderate, severe and extreme temperature conditions. Figure 16 shows the year-by-year conditions between 1981 and 2017, highlighting, for example, the occurrence of some severe to very extreme heatwaves in 2008, 2011, 2015, 2016 and 2017. All in all, it shows an **increasing number of moderate to extreme events in the past 10 years**. This is in line with the conclusion also reported in *Ceccherini et al., 2017*.

Classification	Heat Wave Magnitude Index
Normal	$1 \leq HWMI < 2$
Moderate	$2 \leq HWMI < 3$
Severe	$3 \leq HWMI < 4$
Extreme	$4 \leq HWMI < 8$
Very extreme	$8 \leq HWMI < 16$
Super extreme	$16 \leq HWMI < 32$
Ultra extreme	$HWMI \geq 32$

Table 2 Classification of heatwaves (i.e. HWMI) scale categories

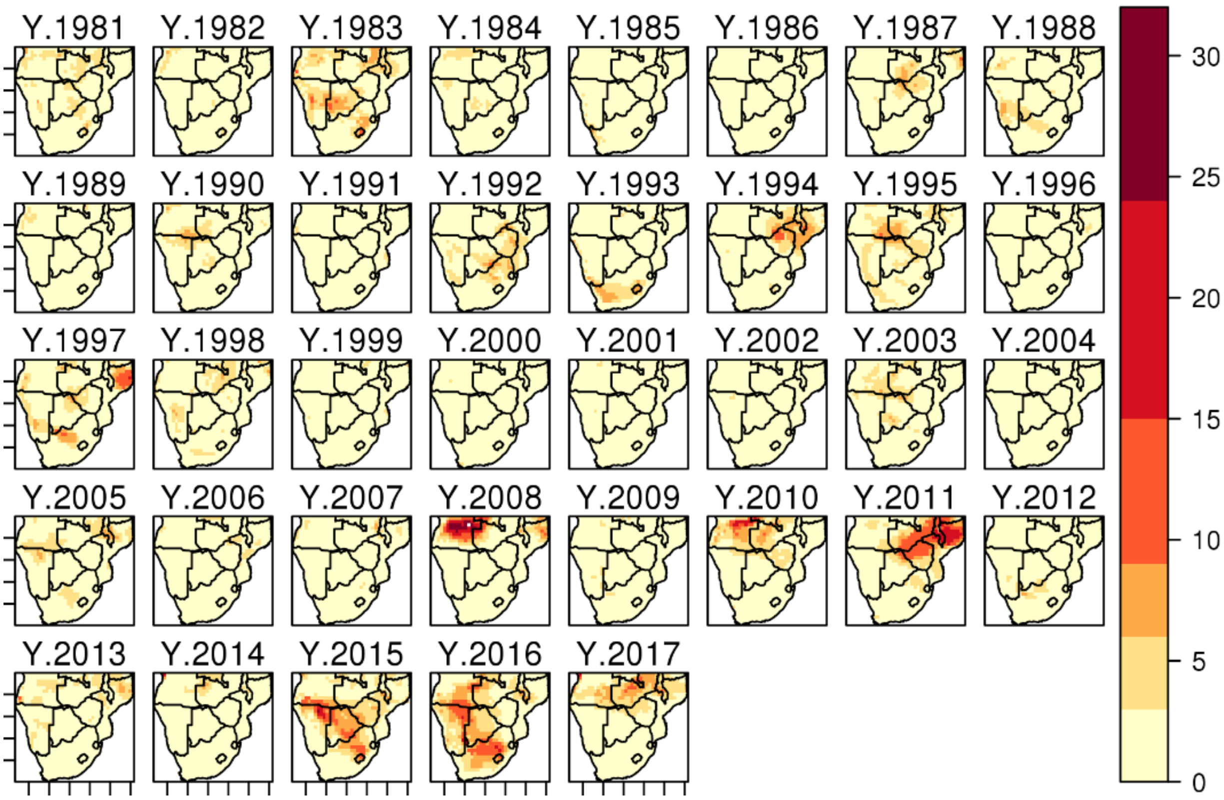


Figure 16 - Temperature Analysis – Time series 1981-2017: Yearly Heat Wave Magnitude Index between 1981 and 2017

Figure 17 shows the number of years since 1981 that had HWMI values greater than 4 or, in other words, events that fall into extreme to ultra-extreme categories. Most such events can be detected on the borders of Botswana, Zimbabwe, Zambia and Angola, where **more than 10 extreme events occurred in the past 36 years**.

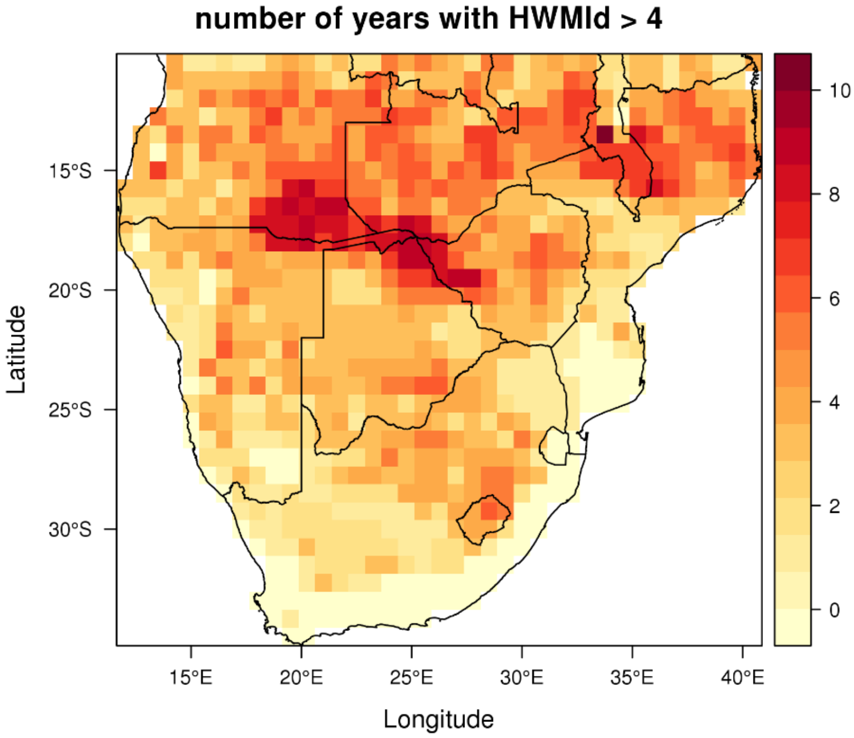


Figure 17 - Temperature Analysis – Time series 1981-2017: Number of years in the period 1981-2017 exceeding HWMI values of 4.

Children and the elderly are the most vulnerable to heatwaves because of the great impact on health. In Southern Africa, this impact is strongly related to malnutrition, clean water, access to water and sanitation (WASH).

5 2018 – Water Crisis in Southern Africa – Conclusions

The temporal analyses (time series 1981-2017) presented in this technical report show that a deficit of 50-70% of monthly precipitation during the rainy season can systematically occurs every 5 years in December and February. Deficits of 70-80% occur every 10 years in the Western Cape. The number of moderate to extreme heatwave events has been increasing over the past 10 years. These events have a clear impact on population health and on the regional socio-economic activities (agriculture, water supply and energy production).

The analyses show that exceptional precipitation deficits (of 5- and 10-year return periods) and extreme temperature events (heatwaves) occur frequently in Southern Africa in general, and particularly in the Western Cape. The recurrence of these events should be taken into consideration by policy- and decision-makers when defining medium- to long-term mitigation and resilience measures and the definition of strategic development plans. This is particularly important given that the metropolitan area of Cape Town currently has 4 million inhabitants, to which it is expected to add another 200 000 people (5%) in the next five years. Punctual measures such as strict water restrictions on its residents put by Cape Town (*The Washington Post, 8 Feb 2018*) should be combined with more structural medium- to long-term measures to fight against the recurrent events that will only be exacerbated by climate change. In this way the scientific suggestions are:

- To explore the diversification of food production towards more drought-resistant crops and varieties;

- To invest in climate resilience and early actions with more appropriate infrastructures and information systems.

The products presented in this technical report can help policymakers (particularly those in the Western Cape) make decisions regarding the building of infrastructures to support the large deficits in precipitation (to ensure water supply and sanitation, and mitigate the impact on agriculture and energy), and to decide whether a development project (agricultural, water supply, energy structure) should be allowed to proceed in the risk area or on the design of an infrastructure designed to mitigate an event with a certain return period.

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List of abbreviations and definitions

CHIRPS	Climate Hazards Group InfraRed Precipitation with Station Data
DG	Directorate General
DEVCO	International Cooperation and Development
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecast
ECHO	European Civil Protection and Humanitarian Aid Operations
GDO	Global Drought Observatory
HWMId	Heat Wave Magnitude Index daily
JRC	Joint Research Centre
RP	Return Period
SDG	Sustainable Development Goals
WEFE	Water-Energy-Food-Ecosystems

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