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# UMLINDI
## The Watchman

ISSUE 2018-05 | 15 MAY 2018

INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

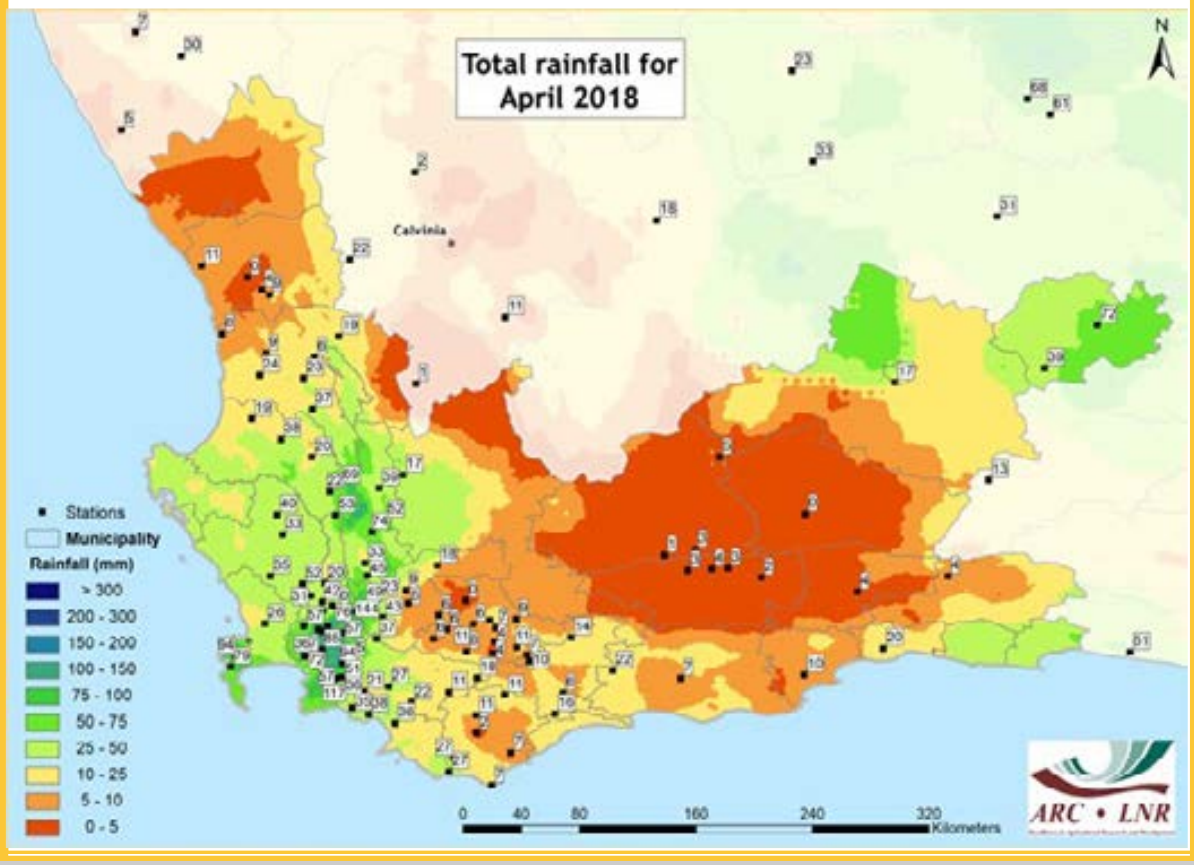


167th Edition

# Image of the Month

## Autumn rains in the Western Cape

All eyes remain on the Western Cape to see whether the upcoming autumn, winter and spring period will bring good falls of rain and break the drought that has been persisting over the past three years. The winter rainfall region usually receives about 20% of its annual rainfall in April and May. April 2018 did indeed bring some good falls of rain over an area to the north of Cape Town where above-normal rainfall occurred in the area of the Cederberg mountains with monthly totals exceeding 50 mm in places (see map below). However, to the south over the catchments directly contributing to the water supply of the city of Cape Town, rainfall was mostly near normal with only isolated places receiving above-normal amounts. Also, to the southeast along the Cape south coast and over much of the eastern interior of the Western Cape, below-normal rainfall persisted. It remains to be seen whether the May to September rains will break the Western Cape drought.




The Agricultural Research Council - Institute for Soil, Climate and Water (ARC-ISCW) collected the data, generated the products and compiled the information contained in this newsletter, as part of the Coarse Resolution Imagery Database (CRID) project that was funded by the Department of Agriculture and Department of Science and Technology at its inception and is currently funded by the Department of Agriculture, Forestry and Fisheries (DAFF).

# 1. Rainfall



***Overview:***

In the month of April 2018 the transition of summer to winter-like atmospheric circulation took place quite abruptly around the 17th. During the period when the summer-like circulation was still active, cloud bands developed over the far western interior of the country before moving eastwards in association with upper-air trough migrations. The presence of a surface high pressure system that ridged in over the eastern parts of the country during the second week of the month aided in maintaining a well-developed surface trough over the western interior that assisted in thunderstorm formation. A cut-off low pressure system that developed on the 15th to the west of the country also contributed to the above-normal rainfall that occurred over large parts of the western to central interior as it reinforced cloud band formation, with some areas receiving monthly rainfall totals exceeding 150 mm.

A frontal system, the strongest in quite some time in terms of spatial rainfall distribution rather than the rainfall amounts associated with it, made landfall over the southwestern part of the country on the 18th of April. Rainfall occurred over the west coast and adjacent interior as well as along the south coast and adjacent interior up to just westwards of Port Elizabeth. Along most parts of the Cape south coast this was the only rainfall event during the month of April. April is usually one of the main rainfall months for the Cape south coast region, currently still in the grip of drought conditions. Another cold front moved over the far southwestern parts of the country on the 23rd and brought some welcome rain over those areas, whilst causing offshore flow and warm to hot conditions over the remainder of the Cape south coast further eastwards. By the 25th a frontal system supported by a cut-off low pressure system in the upper-air moved in over the southwestern parts of the country. Even though the cut-off low system weakened to a trough, good rainfall occurred over the next few days over the southwestern parts of the country with the passage of the cold front. This weather system contributed to up to 80% of the April rainfall totals over the southwestern parts of the country and the subsequent above-normal April rainfall over those areas.

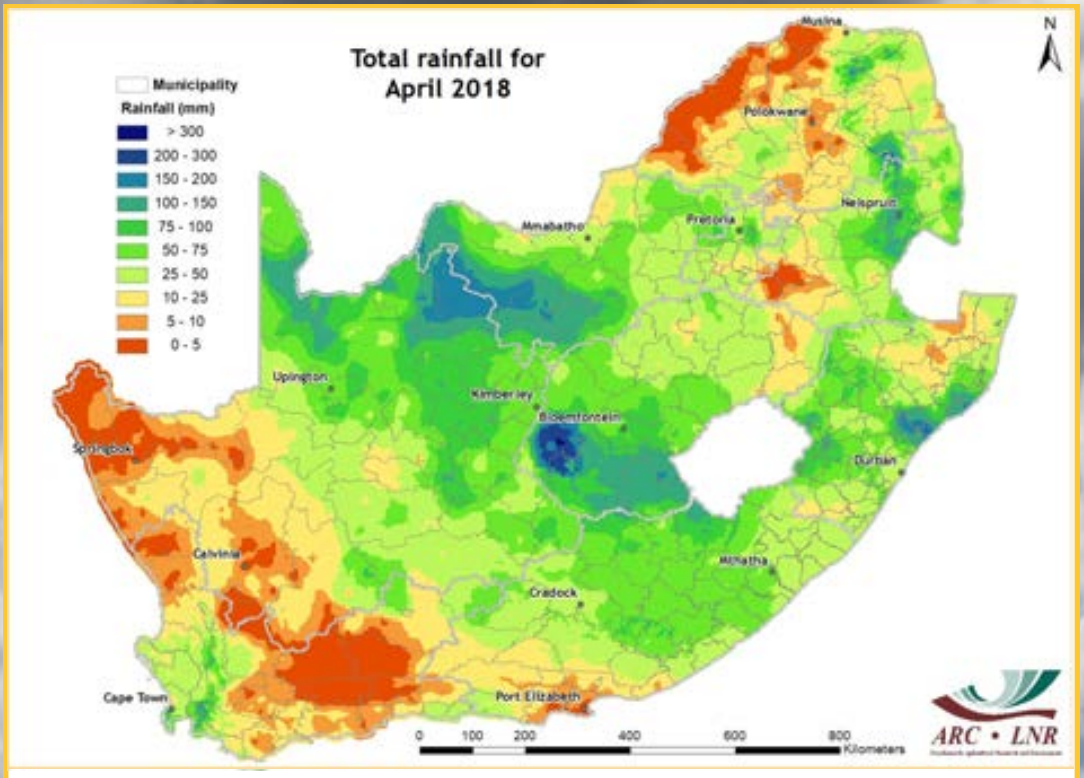



Figure 1

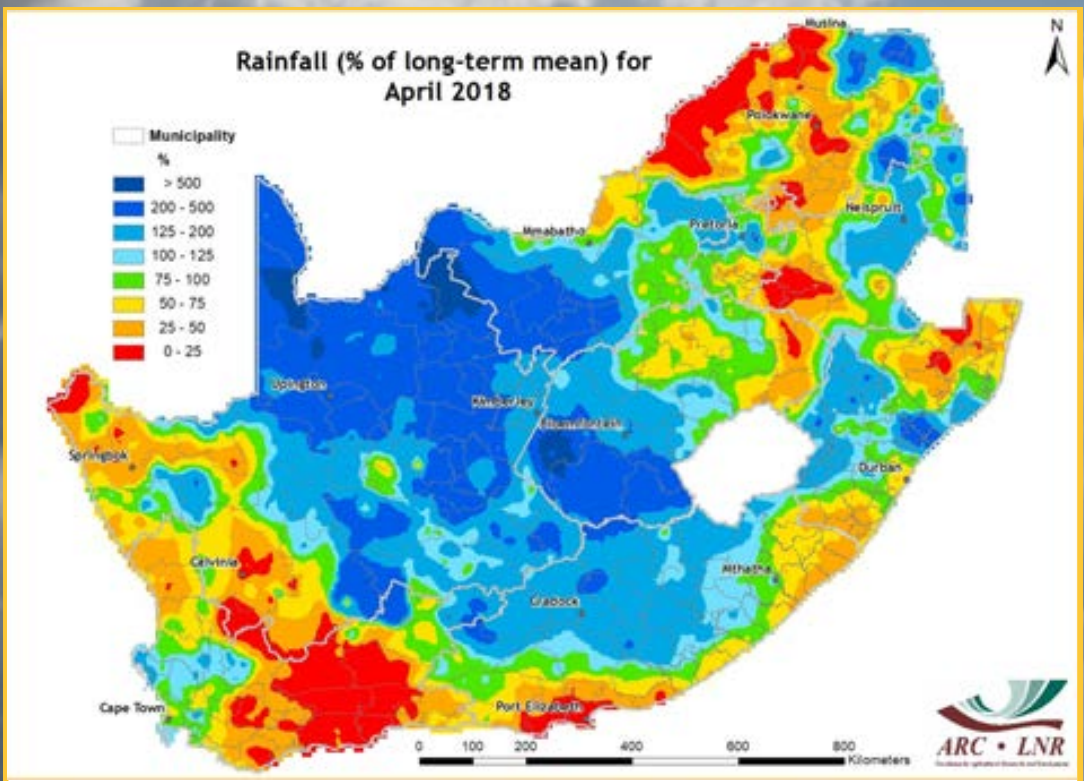
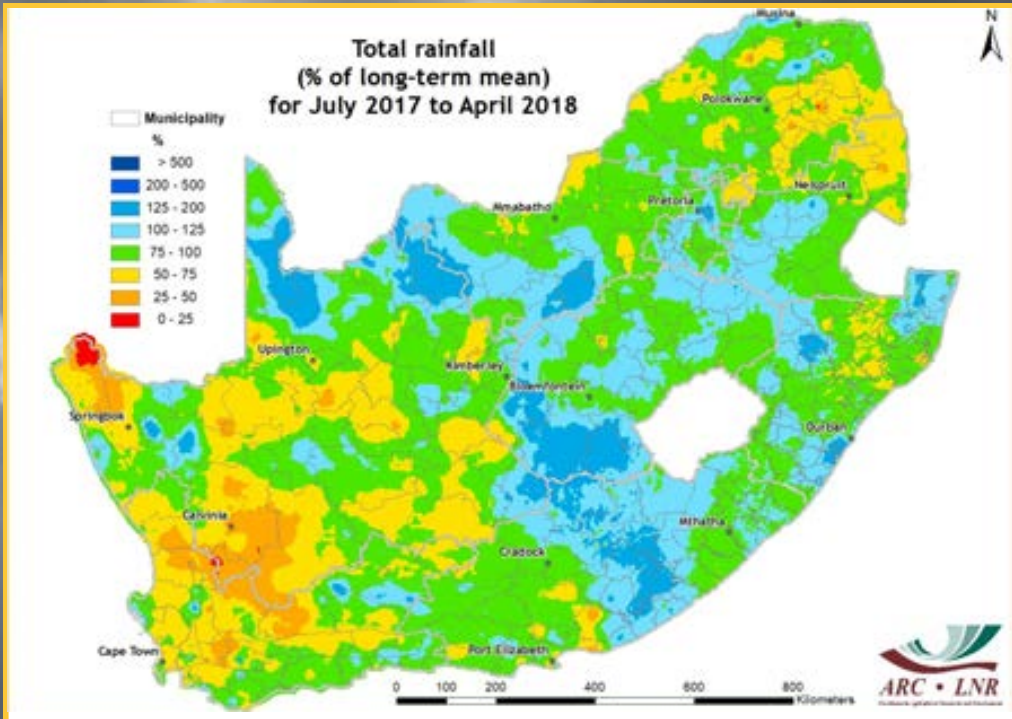



Figure 2

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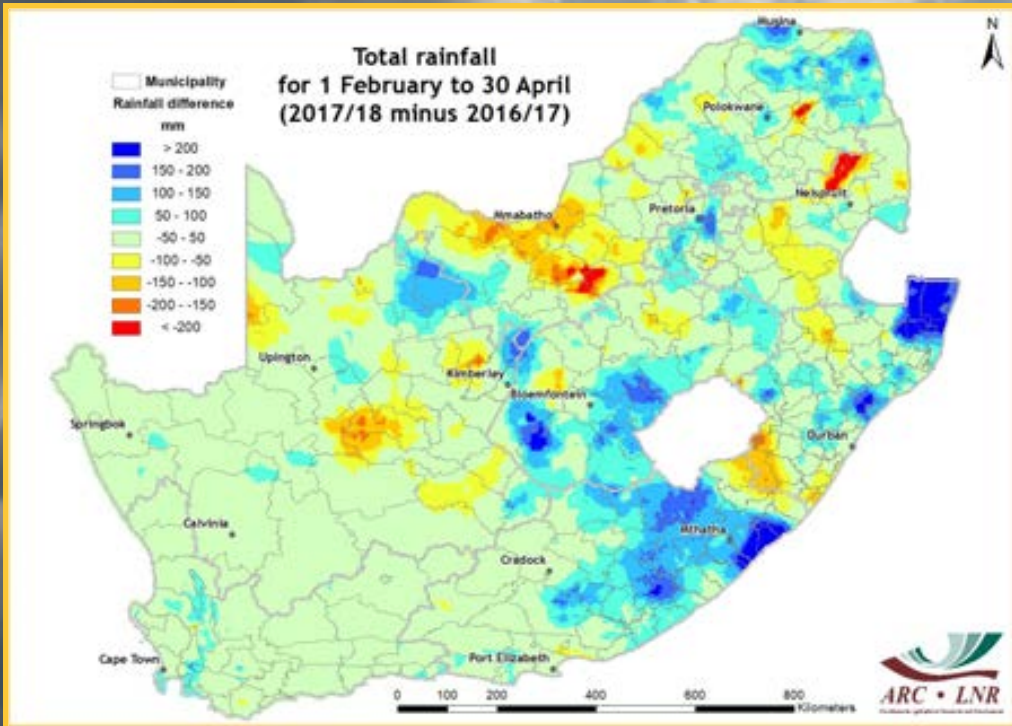


Figure 4

**Figure 1:**
Good rainfall totals occurred in a northwest to southeast aligned band that was located over the western to central interior of the country with areas that received more than 150 mm rainfall. Good rainfall also occurred over the far eastern parts of the country, mostly east of the escarpment. The southwestern parts received their best rainfall in quite some time with some places recording more than 50 mm during April.

**Figure 2:**
Above-normal rainfall occurred over large parts of the western to central interior as well as over the eastern parts of the country. The above-normal rainfall that occurred over summer rainfall regions occurred mostly as a result of frequent cloud band formation up to the 17th of April, after which summer-like atmospheric circulation ceased. Regular frontal landfall over the far southwestern part of the country resulted in above-normal rainfall over those areas, with the maximum contribution to rainfall from 25-27 April.

**Figure 3:**
Since the winter of 2017 to the end April 2018, near-normal to above-normal rainfall occurred over large parts of the summer rainfall region. Over the all-year rainfall region, near-normal rainfall occurred during this period, even though these areas are experiencing drought conditions (as can be seen on the SPI maps). Below-normal rainfall occurred over the winter rainfall region during this period.

**Figure 4:**
Compared to the corresponding period last year, most of the country experienced very similar rainfall totals. Exceptions are isolated areas over the northeastern parts of the country as well as over the mountainous regions in the far southwestern parts. A more coherent pattern of a better 2018 compared to the 2017 corresponding 3-month period occurred over the central interior.

**Questions/Comments:**
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# 2. Standardized Precipitation Index



## Standardized Precipitation Index

The Standardized Precipitation Index (SPI - McKee *et al.*, 1993) was developed to monitor the occurrence of droughts from rainfall data. The index quantifies precipitation deficits on different time scales and therefore also drought severity. It provides an indication of rainfall conditions per quaternary catchment (in this case) based on the historical distribution of rainfall.

REFERENCE:
McKee TB, Doesken NJ and Kliest J (1993) The relationship of drought frequency and duration to time scales. In: Proceedings of the 8th Conference on Applied Climatology, 17-22 January, Anaheim, CA. American Meteorological Society: Boston, MA; 179-184.

At the 36-month time scale, severe drought conditions occurred over many parts of the country, but in particular over the southwestern and eastern areas. Relief from the drought conditions occurred over the central parts as can be seen on the 24-month time scale. At the same time, the severe drought conditions over the southwestern parts extended eastwards along the Cape south coast region. On the 12-month time scale, drought conditions returned to some central parts of the country, after the brief relief seen on the 24-month time scale. The 6-month SPI indicates mildly wet conditions over the southeastern parts extending to the eastern high ground areas. An improvement from the severe drought conditions over the far western parts of the country is also visible on the 6-month time scale, with even mildly wet conditions now over the northern parts of the western coast and adjacent interior region.

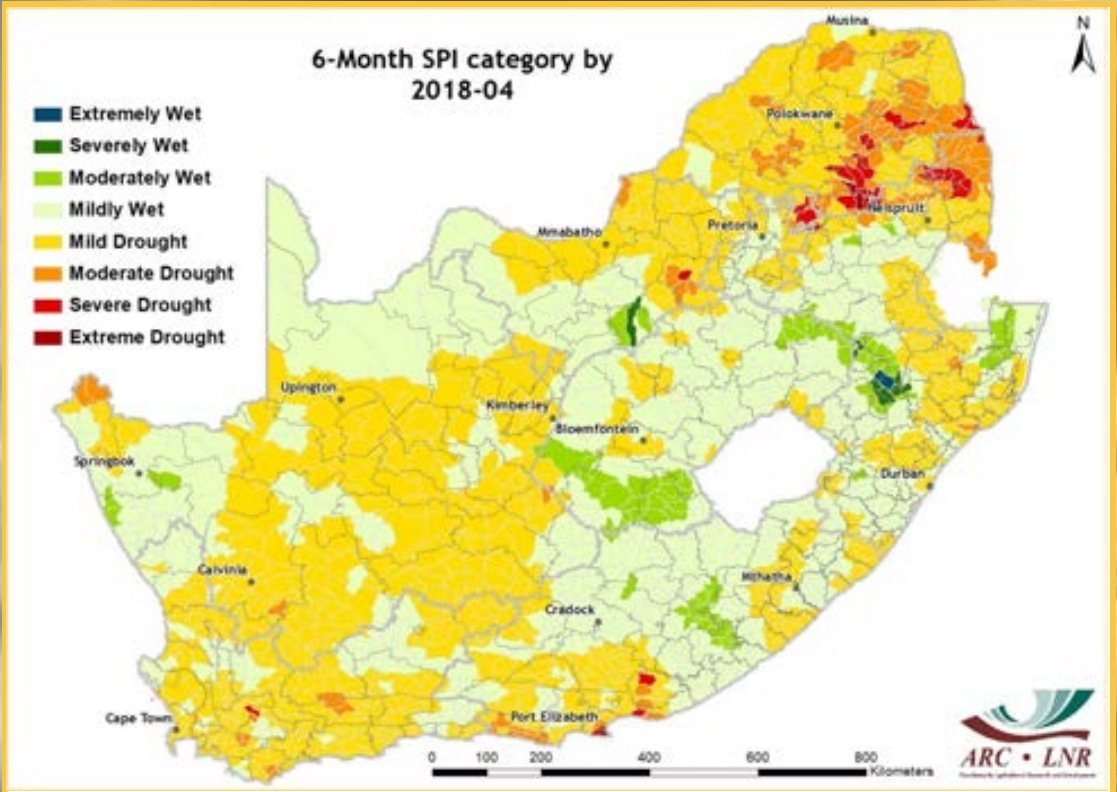


Figure 5

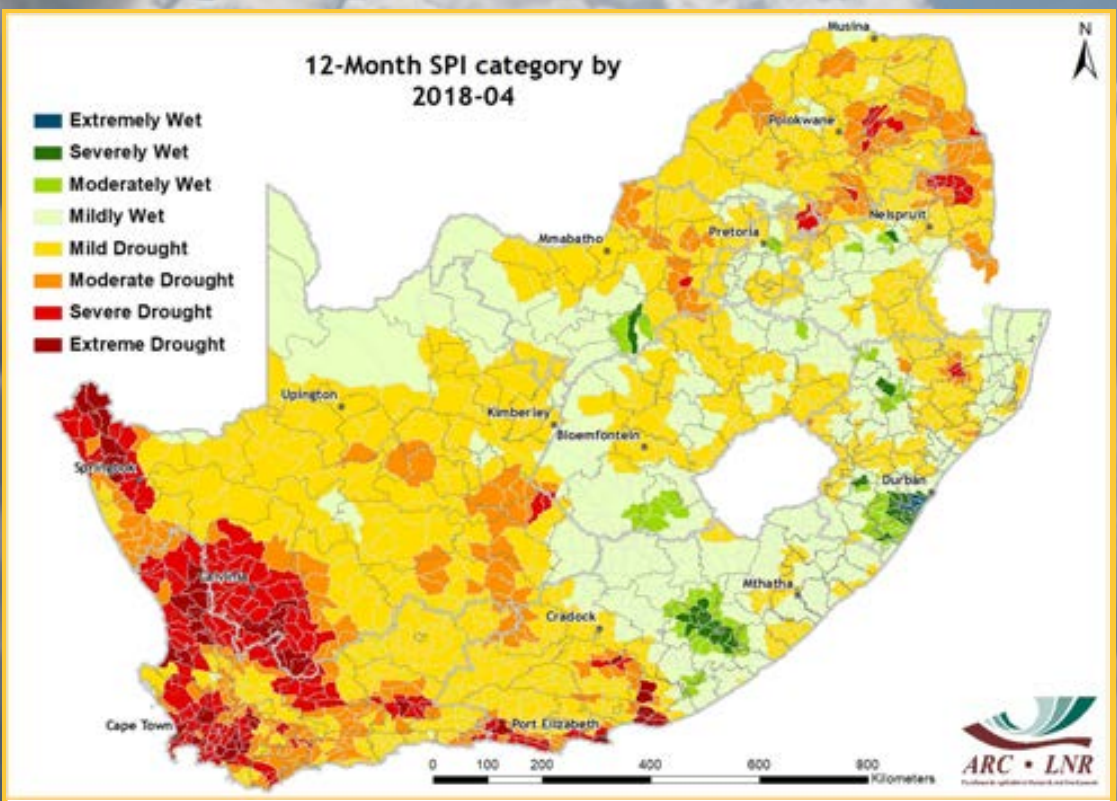


Figure 6

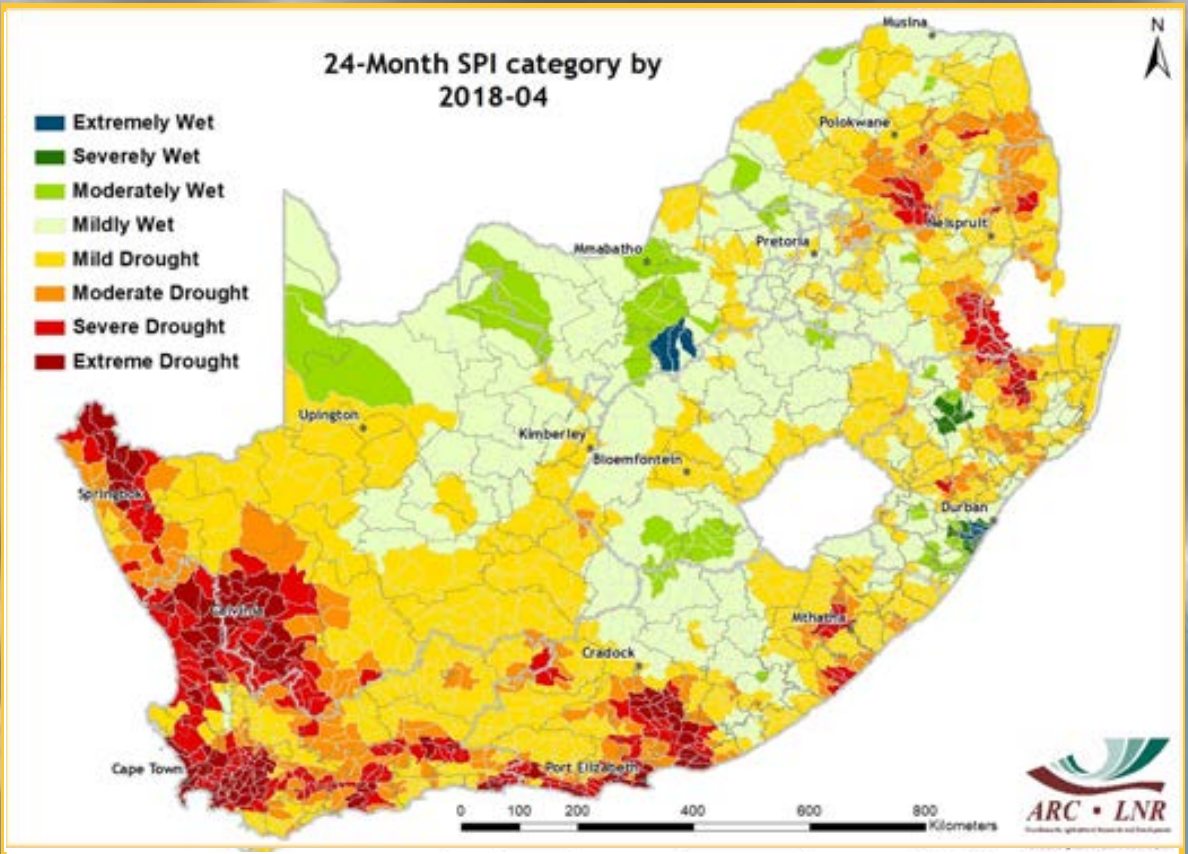


Figure 7

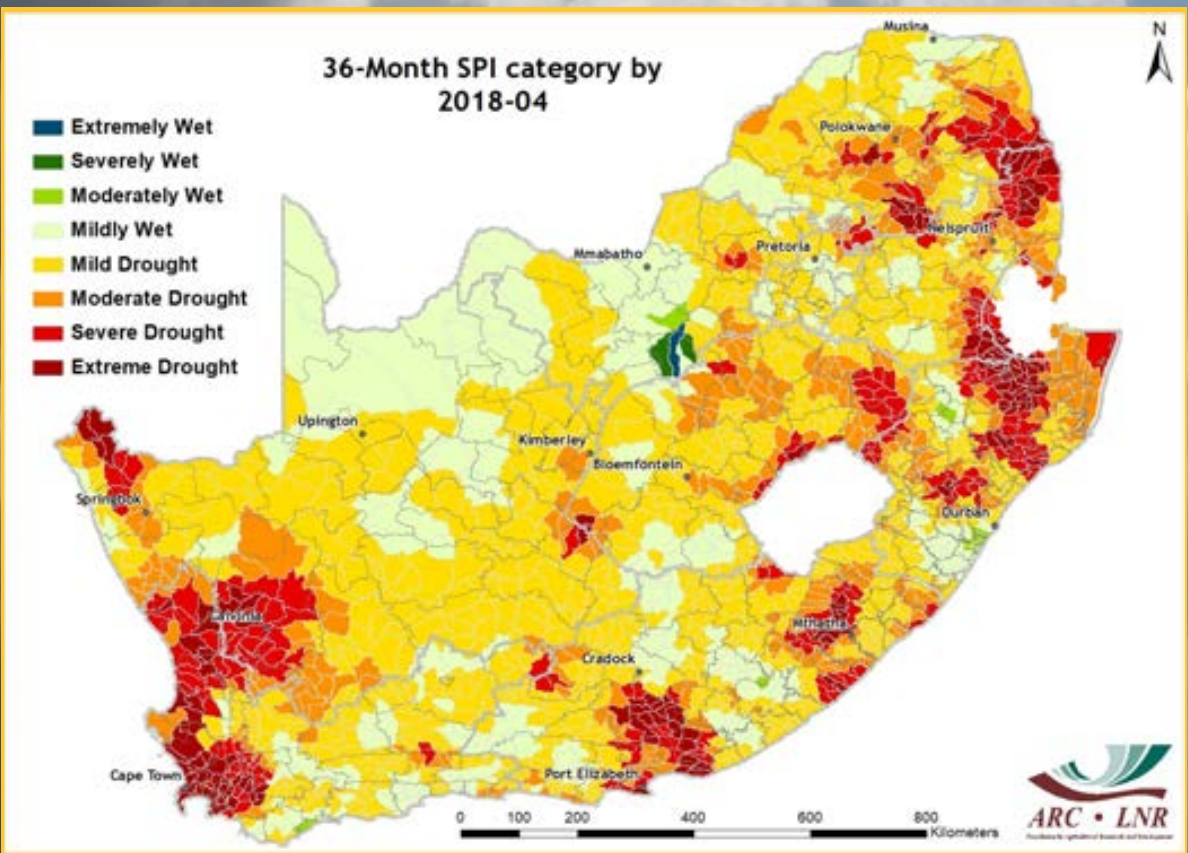


Figure 8

# 3. Rainfall Deciles



Deciles are used to express the ranking of rainfall for a specific period in terms of the historical time series. In the map, a value of 5 represents the median value for the time series. A value of 1 refers to the rainfall being as low or lower than experienced in the driest 10% of a particular month historically (even possibly the lowest on record for some areas), while a value of 10 represents rainfall as high as the value recorded only in the wettest 10% of the same period in the past (or even the highest on record). It therefore adds a measure of significance to the rainfall deviation.

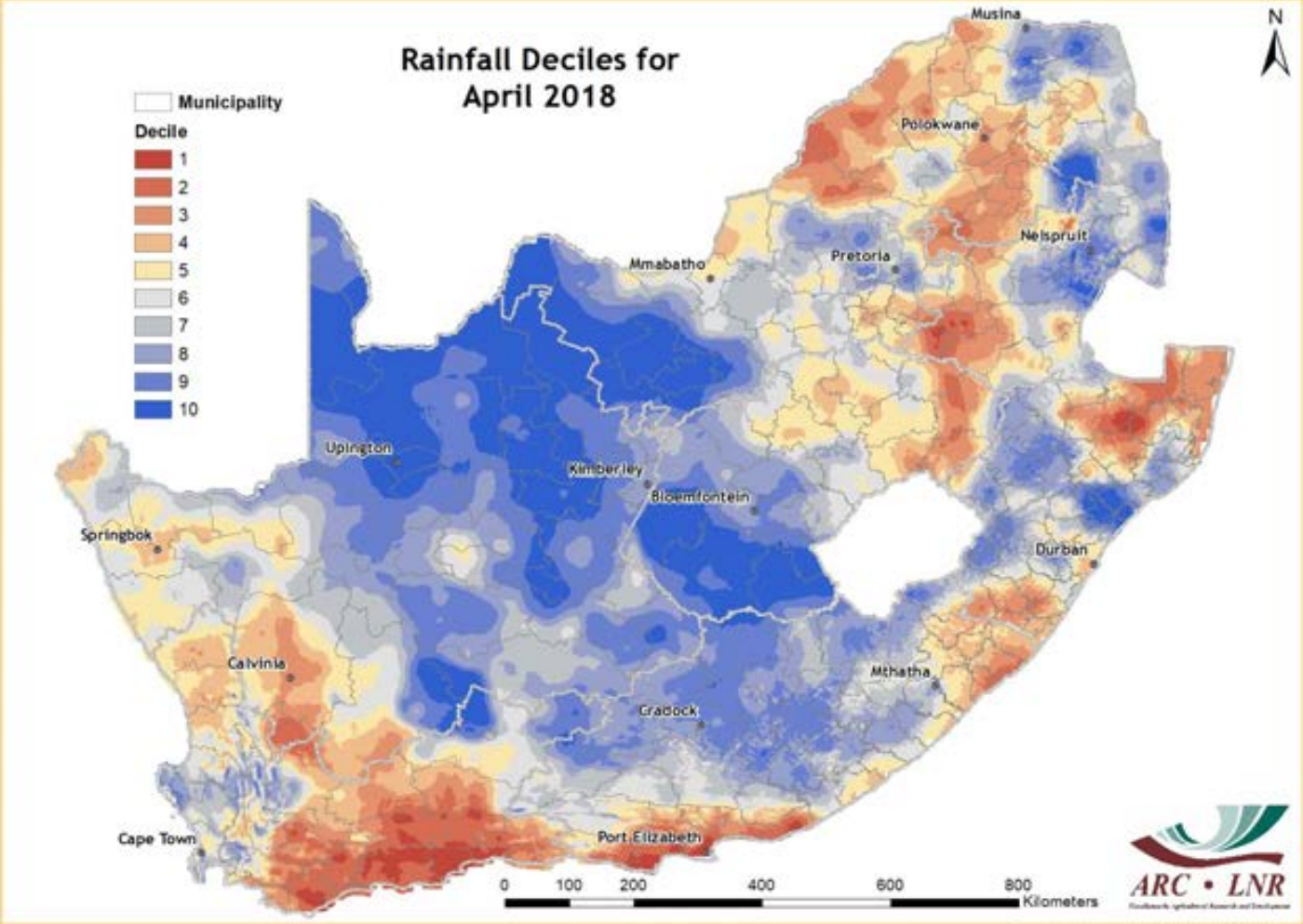


Figure 9

**Figure 9:**
Compared to historical rainfall totals during the month of April, April 2018 experienced rainfall totals that fall within the wetter April months over large parts of the western to central interior and to a lesser extent over the eastern parts east of the escarpment as well as over the far southwestern parts of the country. Over the Cape south coast and adjacent interior, April 2018 falls within the drier historical April months.

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# 4. Vegetation Conditions



**Vegetation Mapping**

The Normalized Difference Vegetation Index (NDVI) is computed from the equation:

NDVI=(IR-R)/(IR+R)

where:
IR = Infrared reflectance &
R = Red band

NDVI images describe the vegetation activity. A decadal NDVI image shows the highest possible "greenness" values that have been measured during a 10-day period.

Vegetated areas will generally yield high values because of their relatively high near infrared reflectance and low visible reflectance. For better interpretation and understanding of the NDVI images, a temporal image difference approach for change detection is used.

The Standardized Difference Vegetation Index (SDVI) is the standardized anomaly (according to the specific time of the year) of the NDVI.

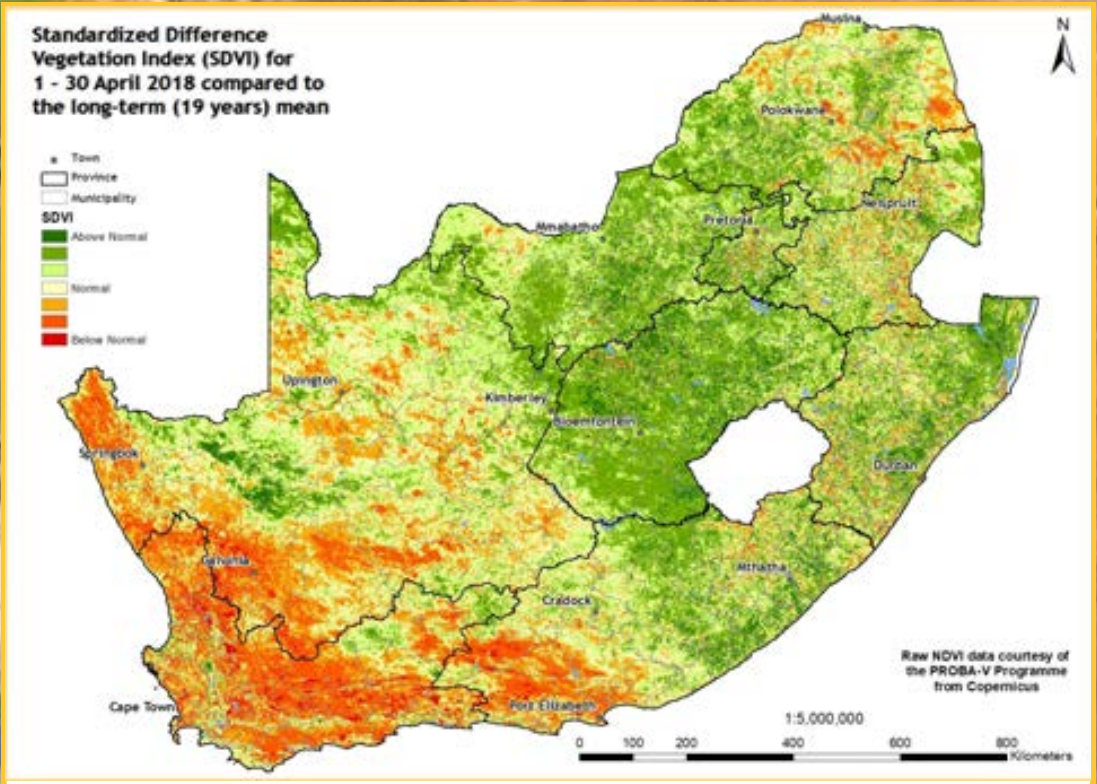


Figure 10

**Figure 10:**
The SDVI map for April shows that much of the country's interior experienced above-normal vegetation activity except for the Western Cape, Northern Cape, southwestern Eastern Cape and some distinct areas in Limpopo which experienced below-normal vegetation activity.

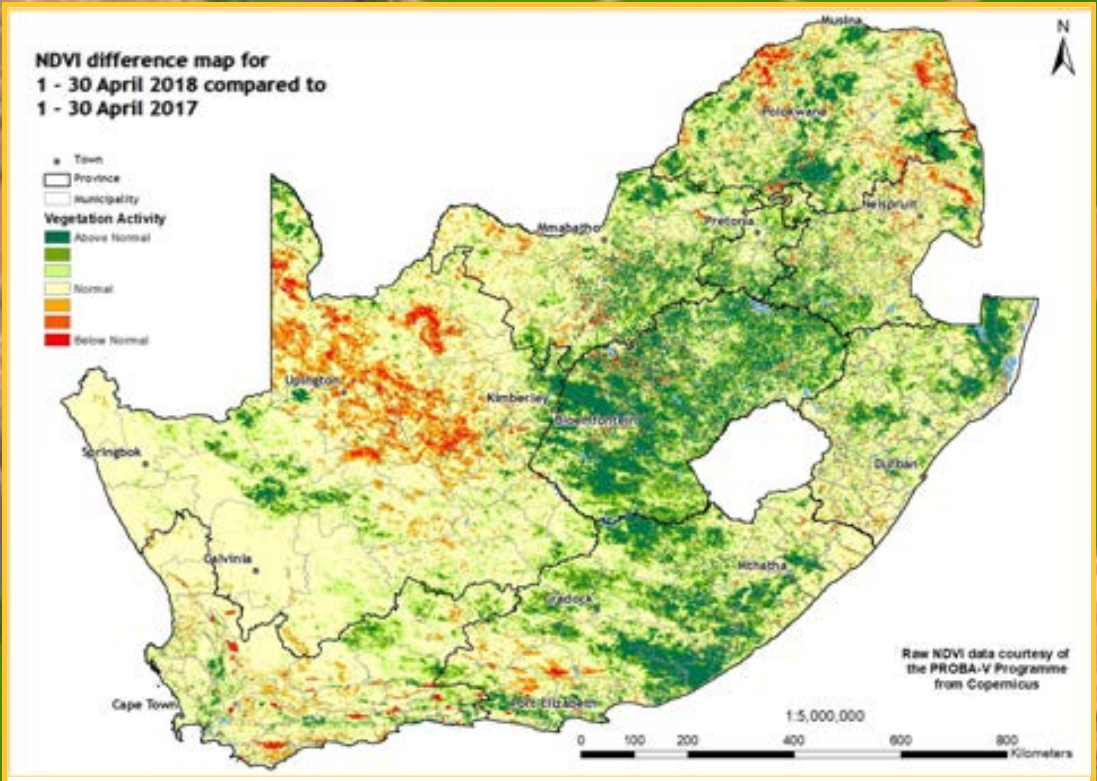


Figure 11

**Figure 11:**
The NDVI difference map for April shows that above-normal vegetation activity occurred over much of the Free State, isolated areas in the Eastern Cape, Limpopo, Gauteng, KZN, Mpumalanga and North West compared to the same month in 2017. Similarly, small pockets of below-normal vegetation activity occurred in some distinct parts of the Northern Cape, Western Cape, Limpopo and Mpumalanga compared to April 2017.

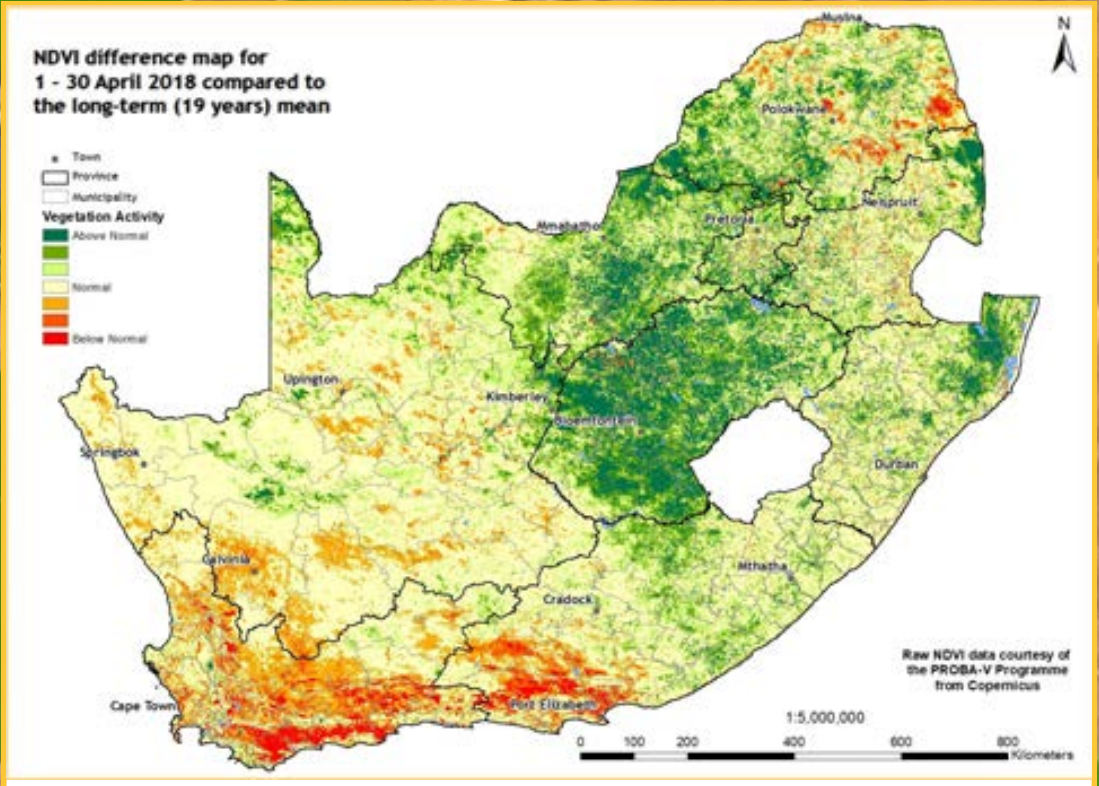


Figure 12

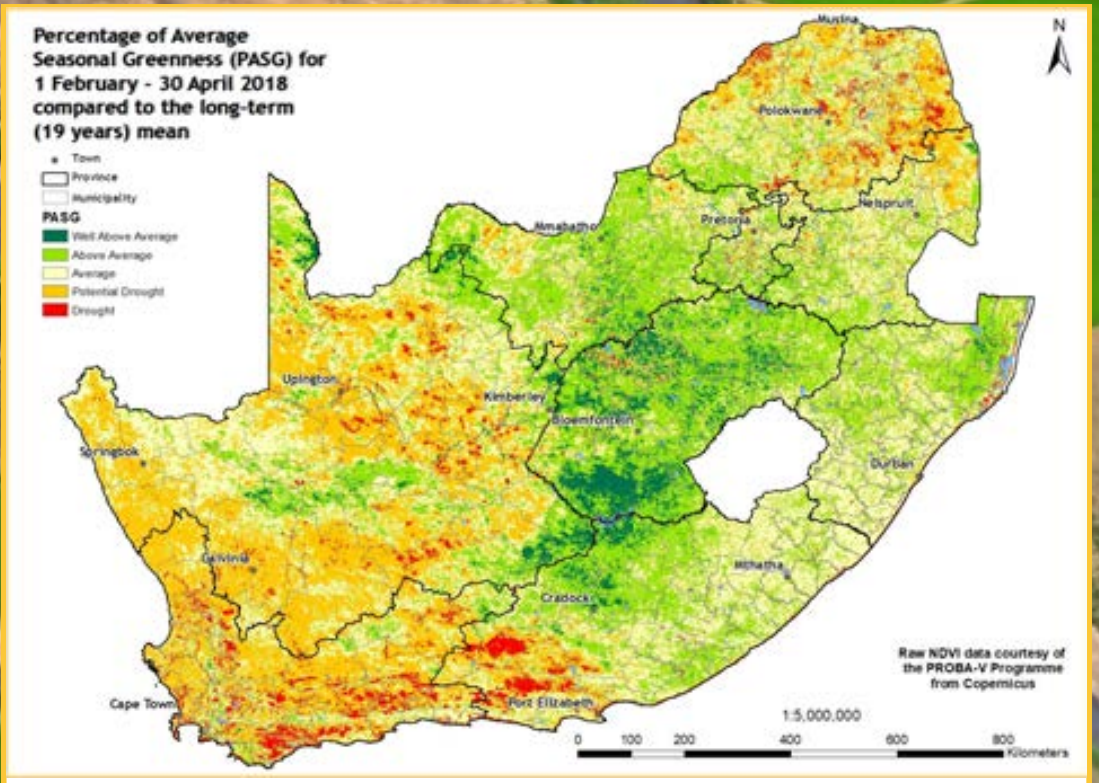


Figure 13

## Vegetation Mapping *(continued from p. 7)*

### Interpretation of map legend

NDVI values range between 0 and 1. These values are incorporated in the legend of the difference maps, ranging from -1 (lower vegetation activity) to 1 (higher vegetation activity) with 0 indicating normal/the same vegetation activity or no significant difference between the images.

### Cumulative NDVI maps:

Two cumulative NDVI datasets have been created for drought monitoring purposes:

**Winter:** January to December
**Summer:** July to June

**Figure 12:**
Above-normal vegetation activity occurred over much of the Free State, North West and Gauteng and in distinct areas of KZN, Limpopo and Mpumalanga compared to the long-term mean. Meanwhile, below-normal vegetation activity persists in the Western and Eastern Cape, and isolated areas of Northern Cape and Limpopo.

**Figure 13:**
Drought conditions persist in distinct areas of the Western and Northern Cape, Limpopo and far southeastern parts of Eastern Cape. Concurrently, much of the Free State experienced well above-average seasonal greenness, while North West, Gauteng, KZN, Mpumalanga and north-western Eastern Cape were all above average.

**Questions/Comments:**
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# 5. Vegetation Condition Index



**Vegetation Condition Index (VCI)**

The VCI is an indicator of the vigour of the vegetation cover as a function of the NDVI minimum and maximum encountered for a specific pixel and for a specific period, calculated over many years.

The VCI normalizes the NDVI according to its changeability over many years and results in a consistent index for various land cover types. It is an effort to split the short-term weather-related signal from the long-term climatological signal as reflected by the vegetation. The VCI is a better indicator of water stress than the NDVI.

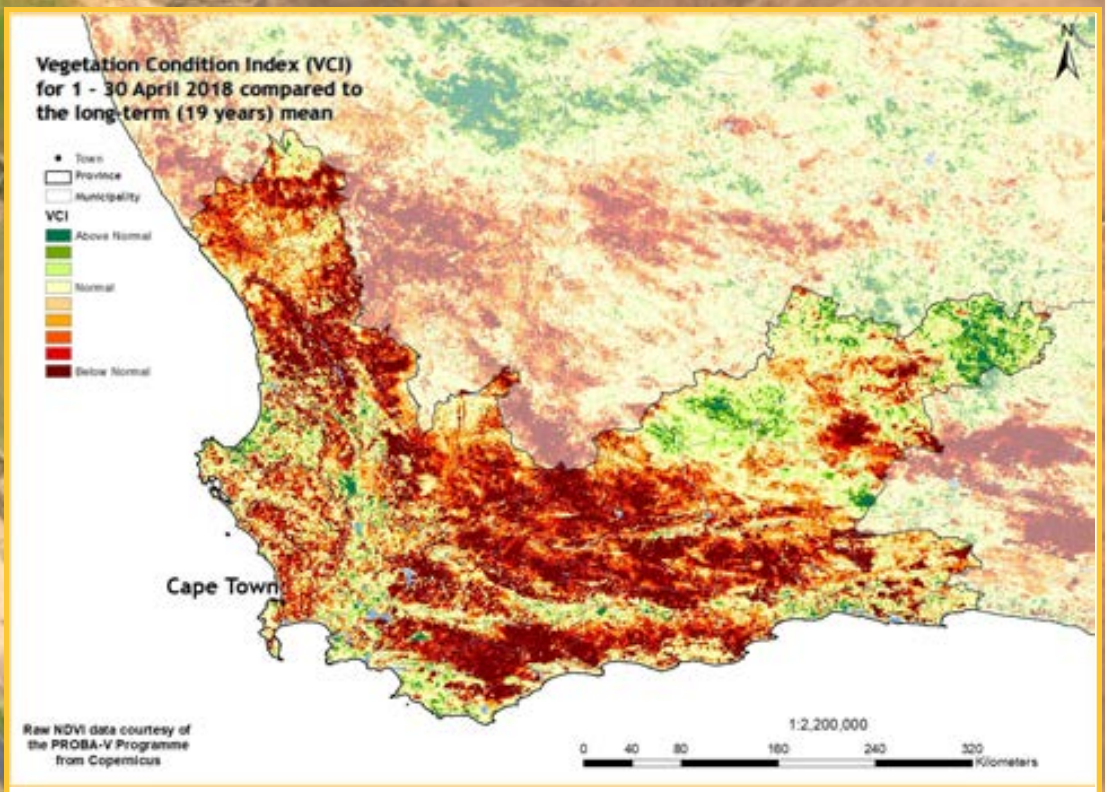


Figure 14

**Figure 14:**
The VCI map for April indicates below-normal vegetation activity over most of the Western Cape.

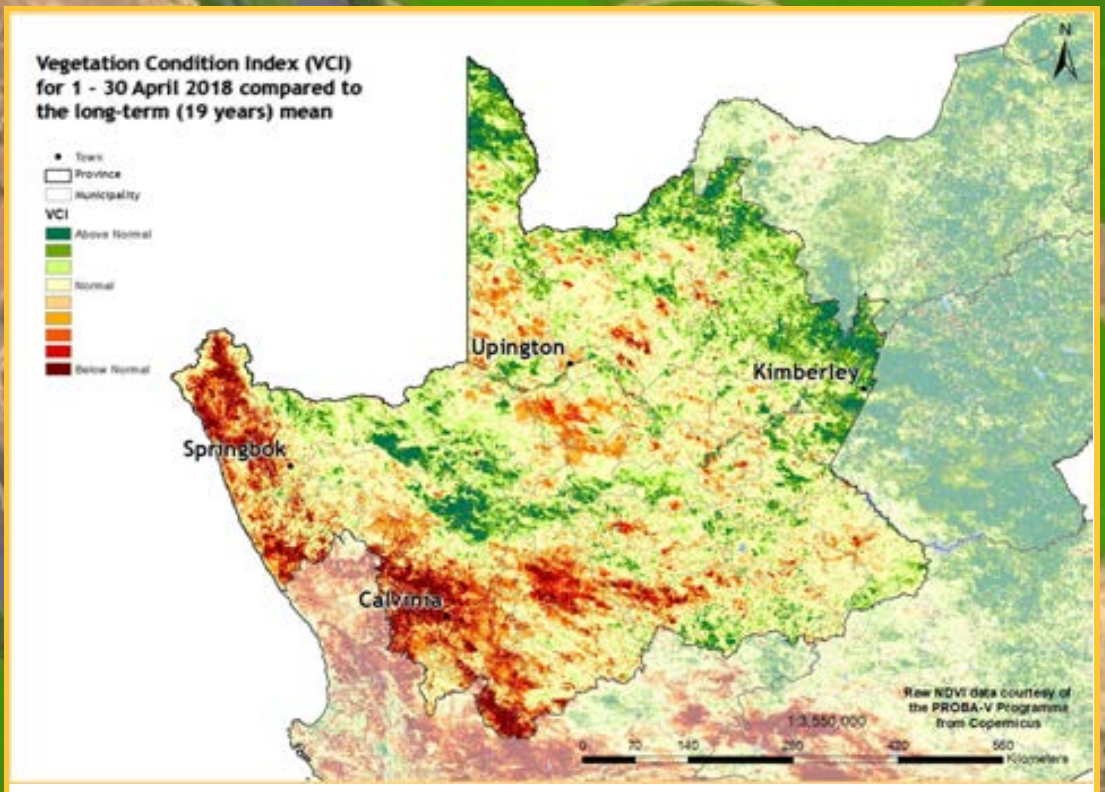


Figure 15

**Figure 15:**
The VCI map for April indicates below-normal vegetation activity in some isolated areas of the Northern Cape, mainly in the southwest.

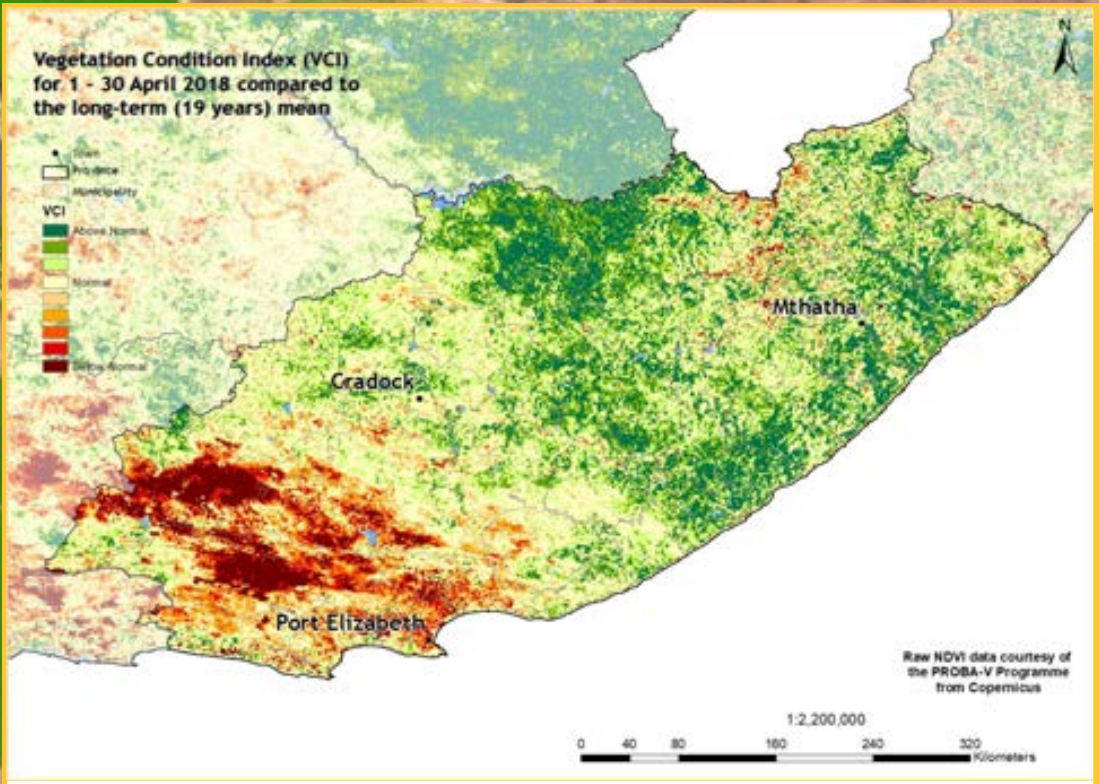


Figure 16

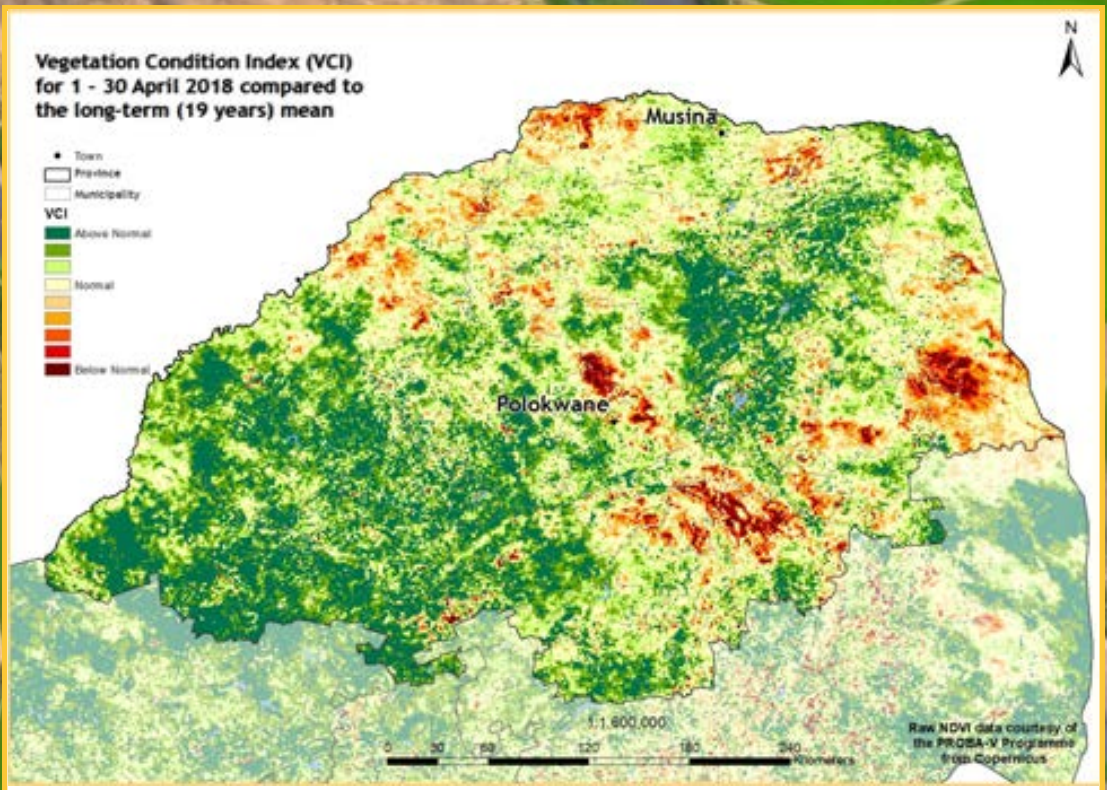


Figure 17

**Figure 16:**
The VCI map for April indicates below-normal vegetation activity in the western region and distinct parts of the Wild Coast and Berg areas of the Eastern Cape.

**Figure 17:**
The VCI map for April shows that vegetation conditions were below-normal in a few distinct areas of Limpopo compared to the long-term mean.

**Questions/Comments:**
*MaakeR@arc.agric.za*

# 6. Vegetation Conditions & Rainfall



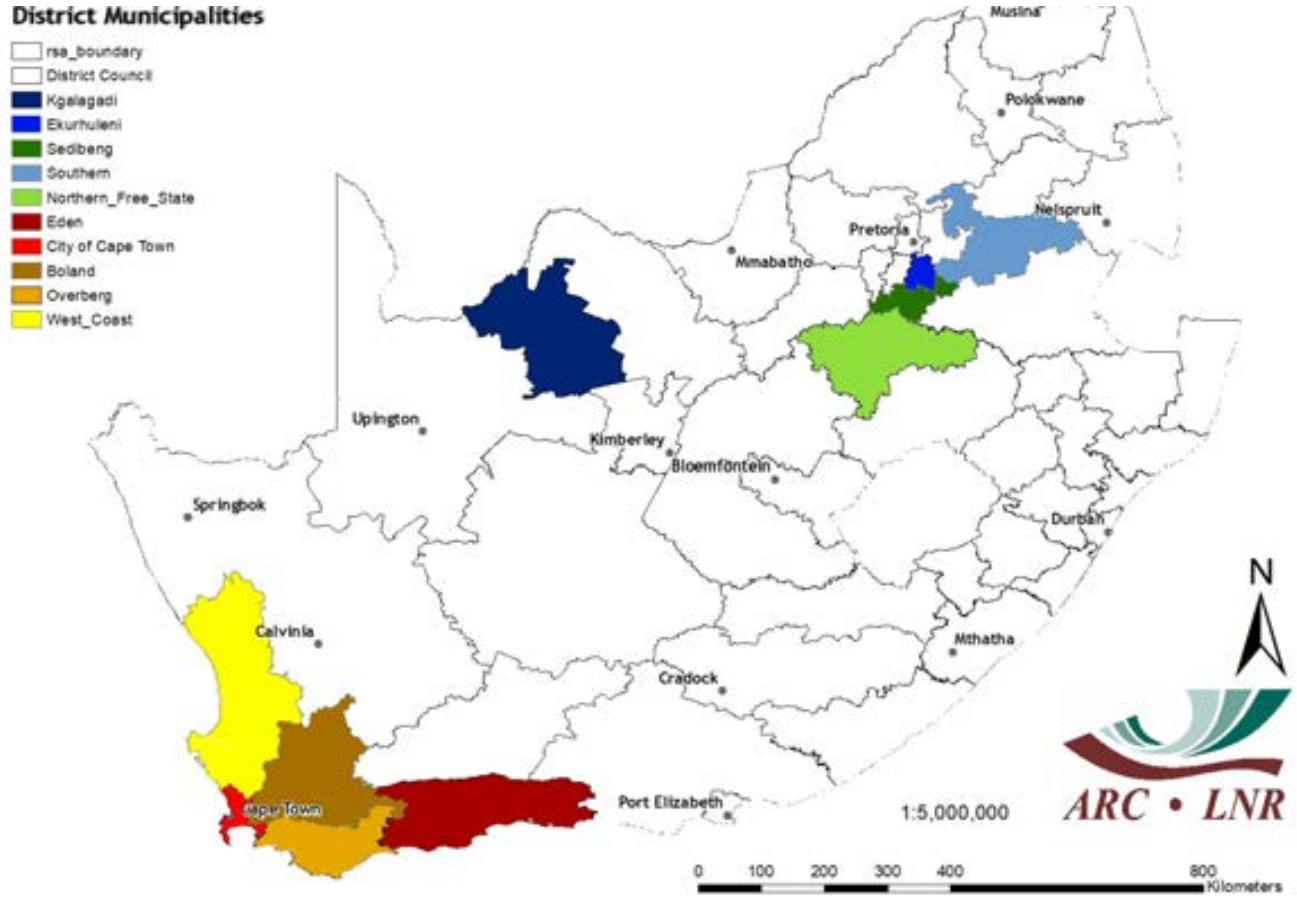


Figure 18

**NDVI and Rainfall Graphs**
**Figure 18:**
Orientation map showing the areas of interest for April 2018. The district colour matches the border of the corresponding graph.

**Questions/Comments:**
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**Figures 19-23:**
Indicate areas with higher cumulative vegetation activity for the last year.

**Figures 24-28:**
Indicate areas with lower cumulative vegetation activity for the last year.

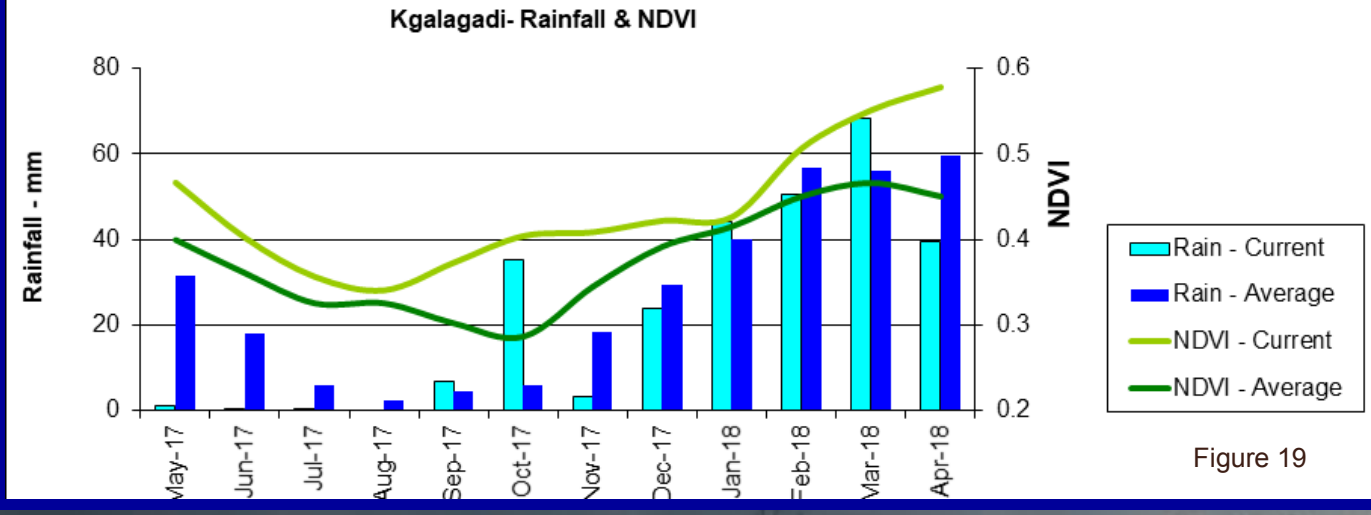
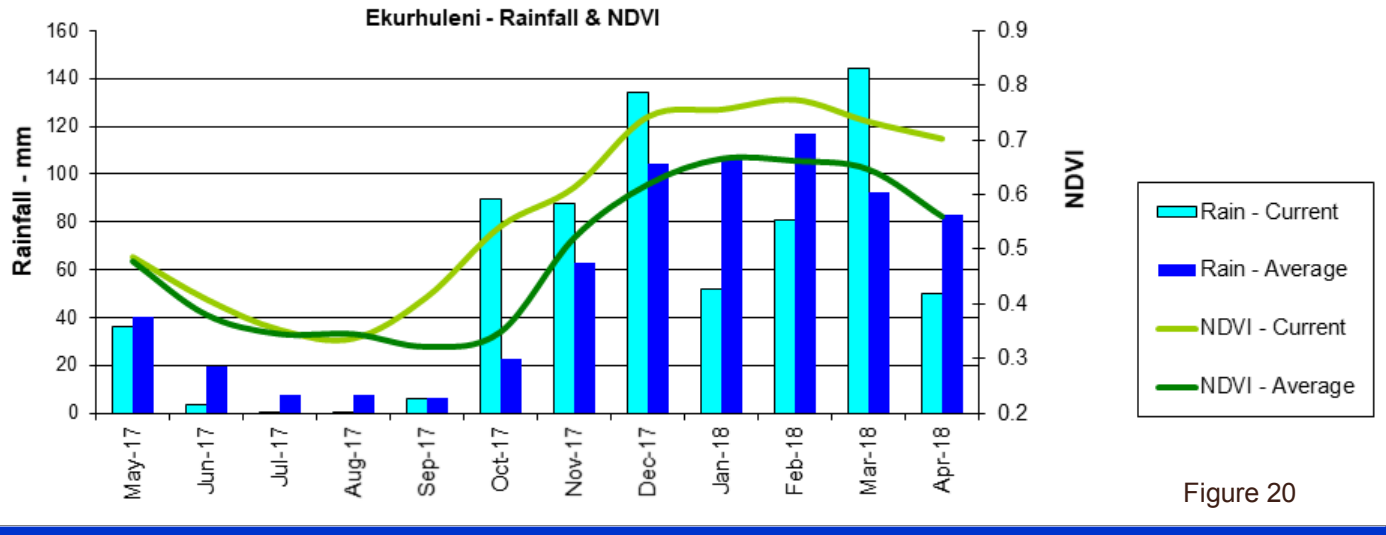



Figure 19

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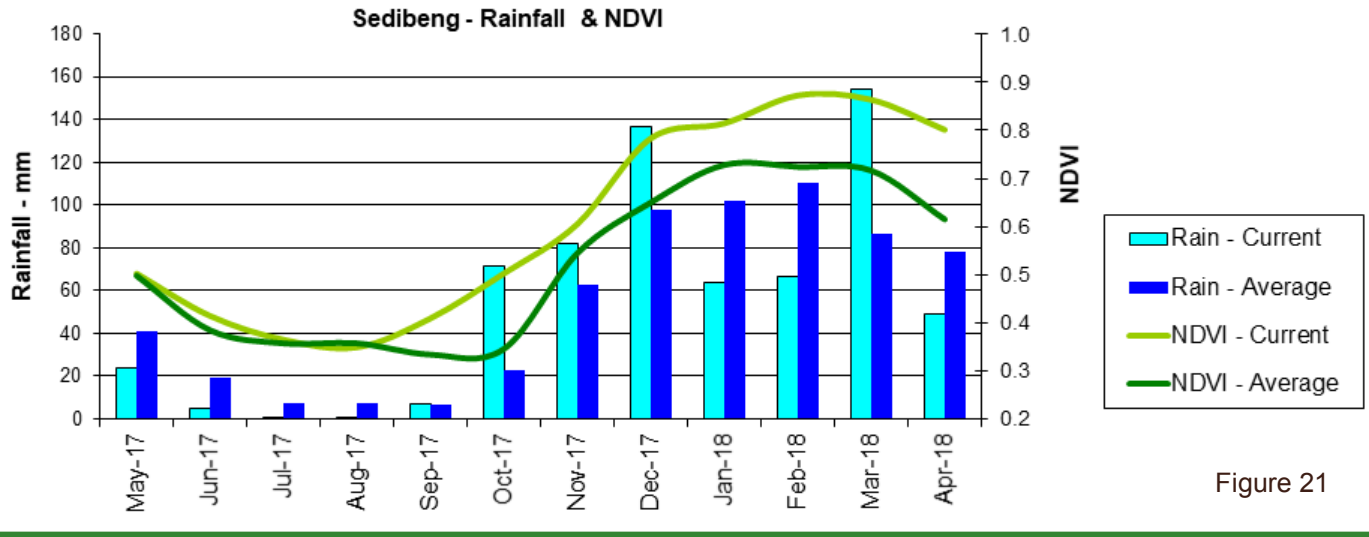


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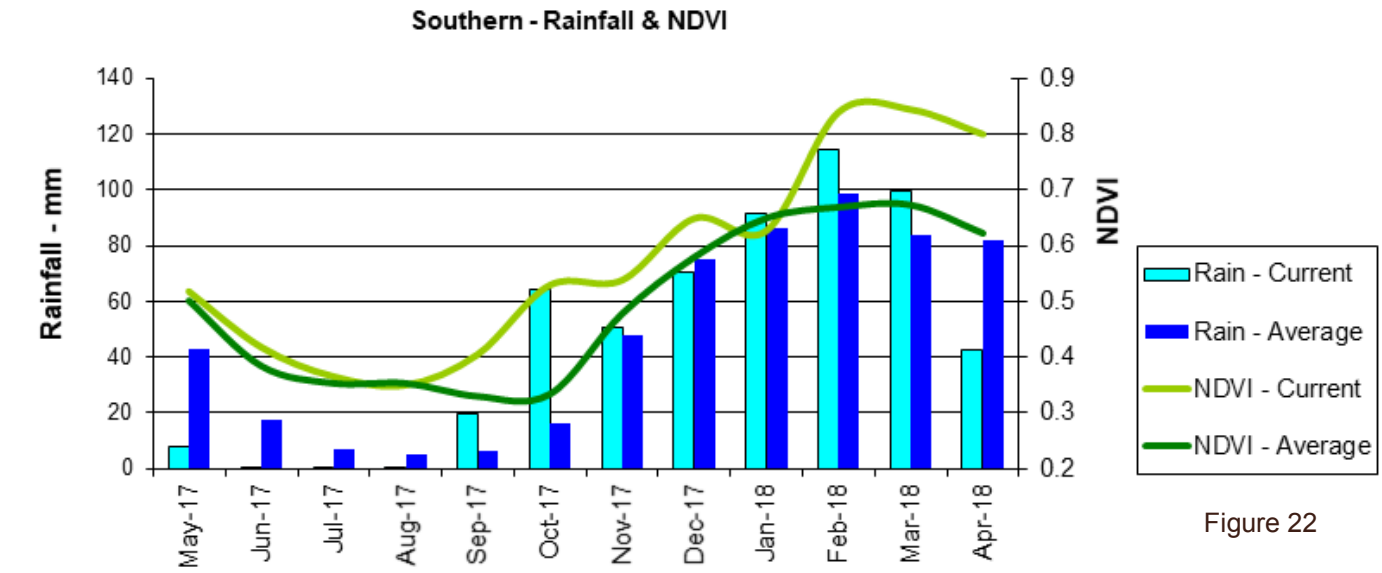


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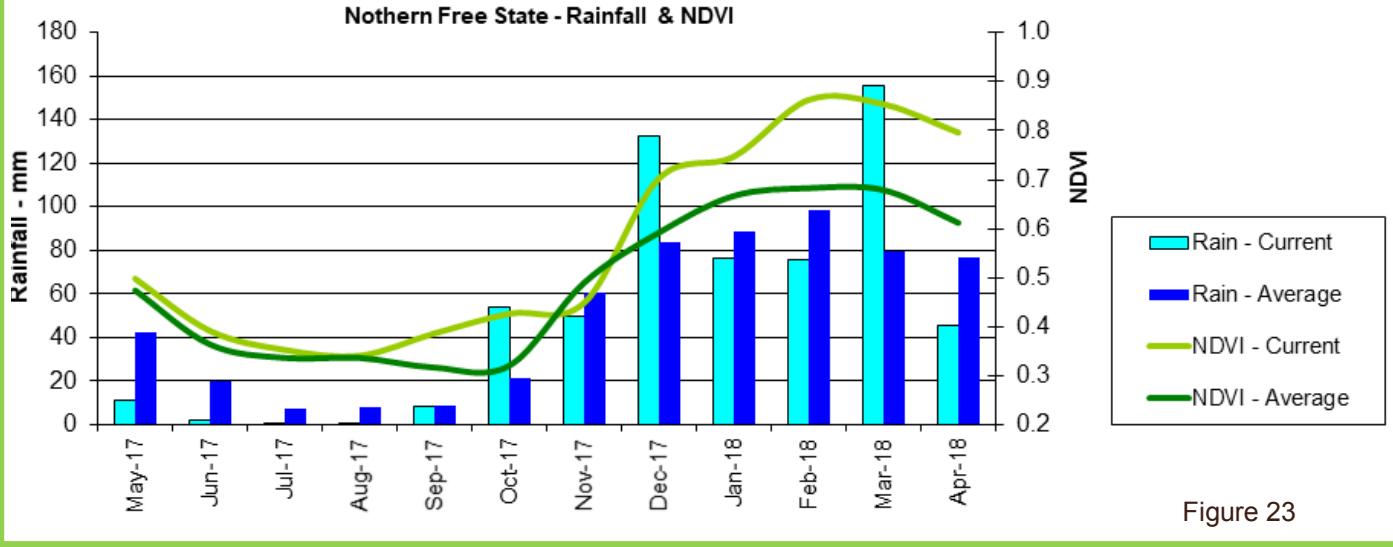


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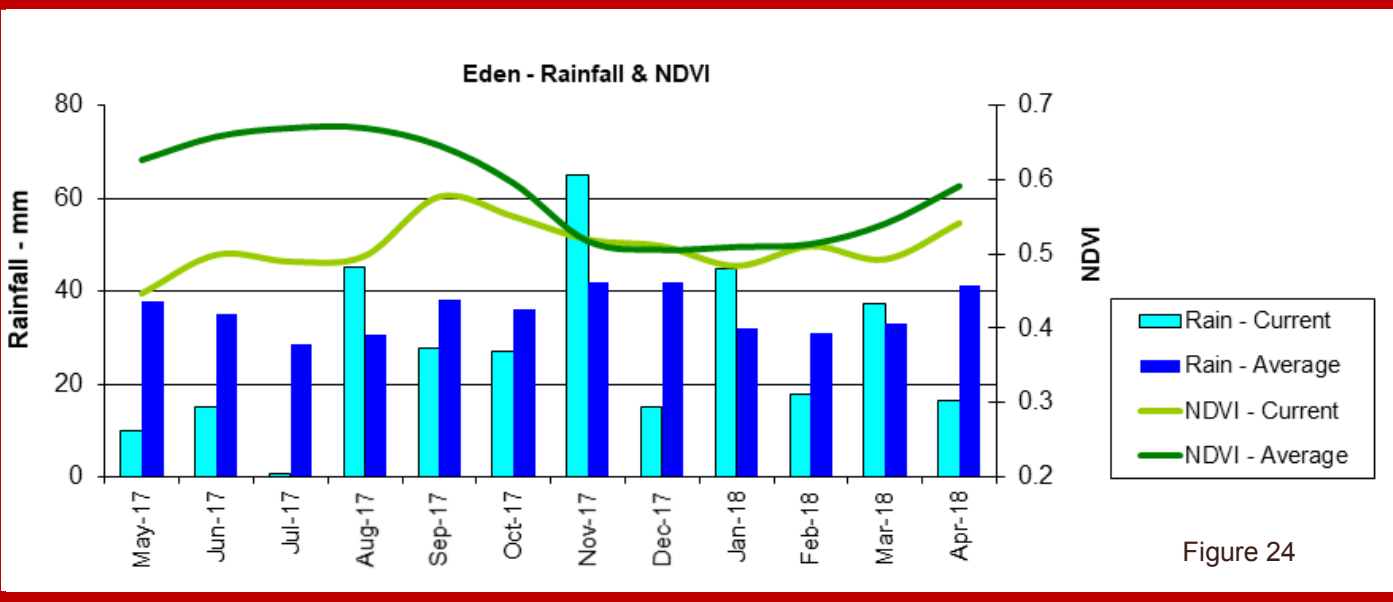


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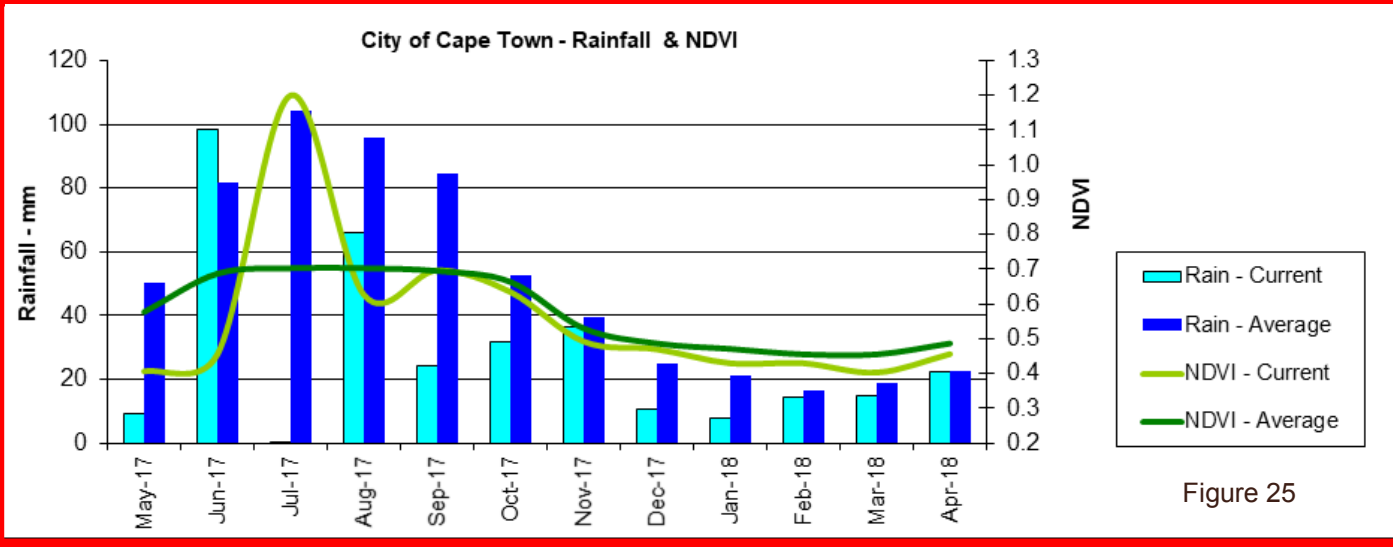


Figure 25

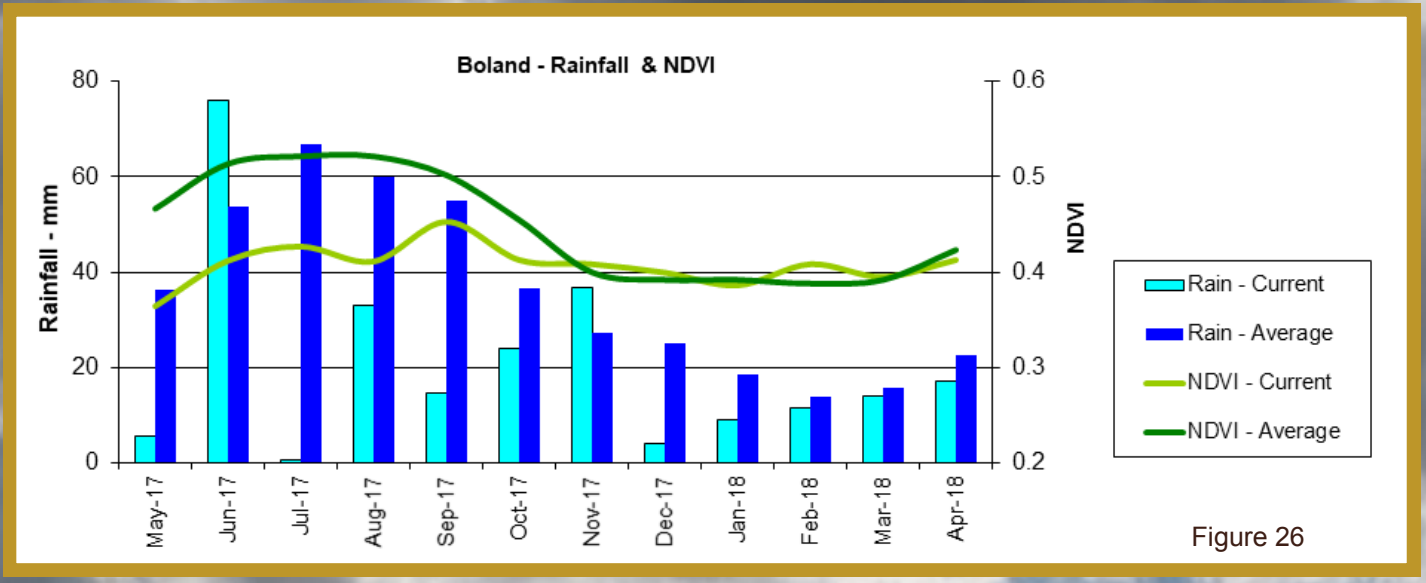


Figure 26

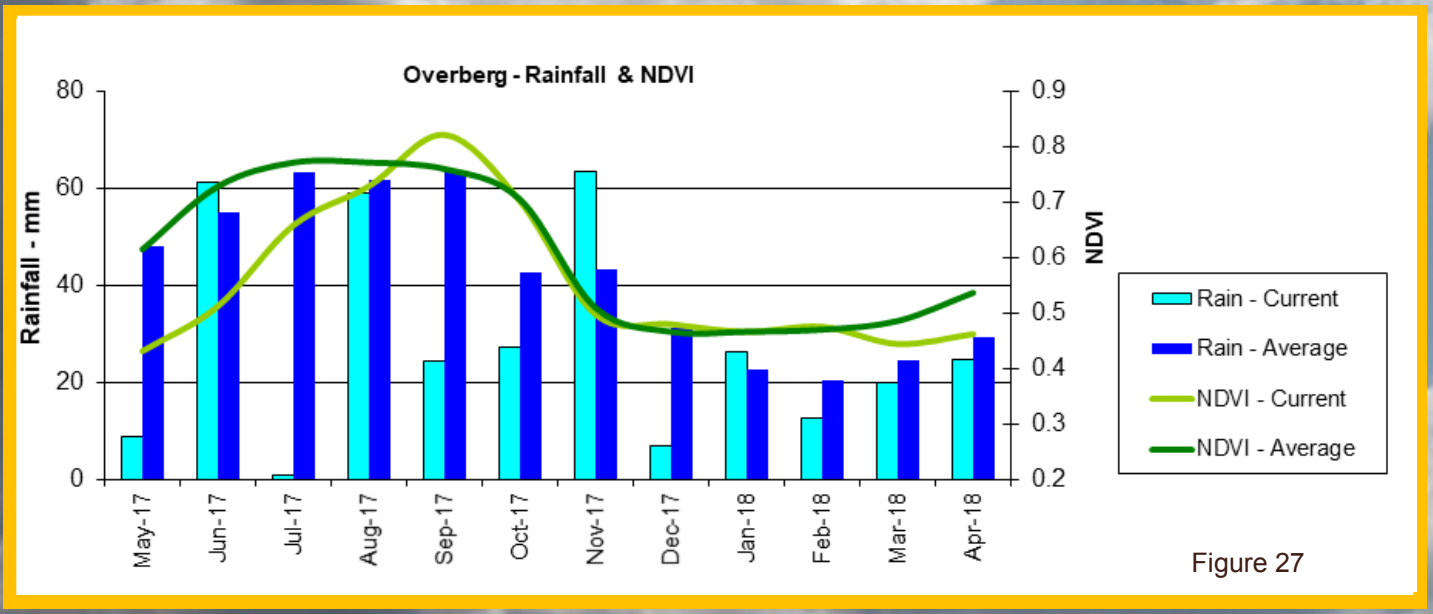


Figure 27

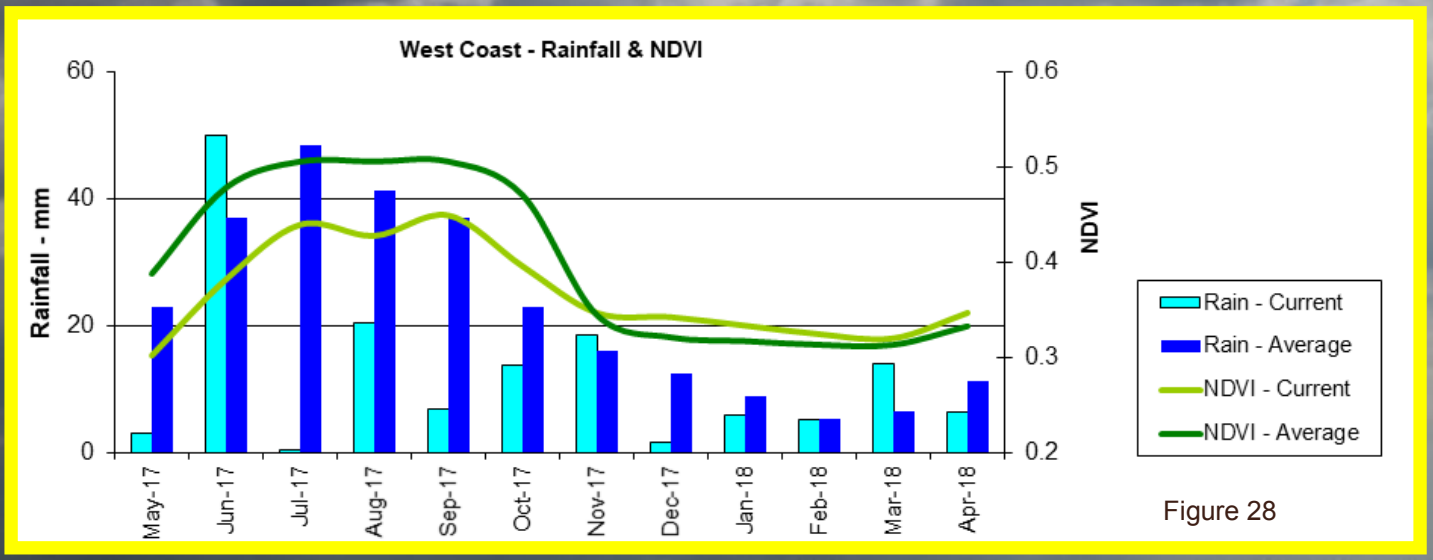


Figure 28

# 7. Fire Watch

PAGE 15

**Active Fires** *(Provided when data is available)*

Forest and vegetation fires have temperatures in the range of 500 K (Kelvin) to 1000 K. According to Wien's Displacement Law, the peak emission of radiance for blackbody surfaces of such temperatures is at around 4 µm. For an ambient temperature of 290 K, the peak of radiance emission is located at approximately 11 µm. Active fire detection algorithms from remote sensing use this behaviour to detect "hot spot" fires.

**Figure 29:**
The graph shows the total number of active fires detected during the month of April per province. Fire activity was higher in the Western Cape compared to the average during the same period for the last 18 years.

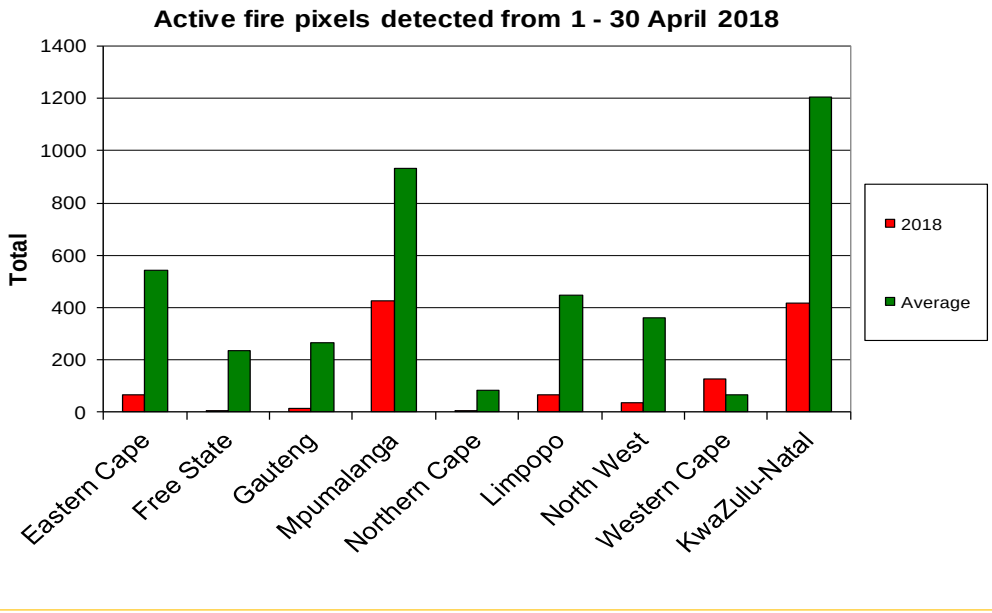


Figure 29

**Figure 30:**
The map shows the location of active fires detected between 1-30 April 2018.

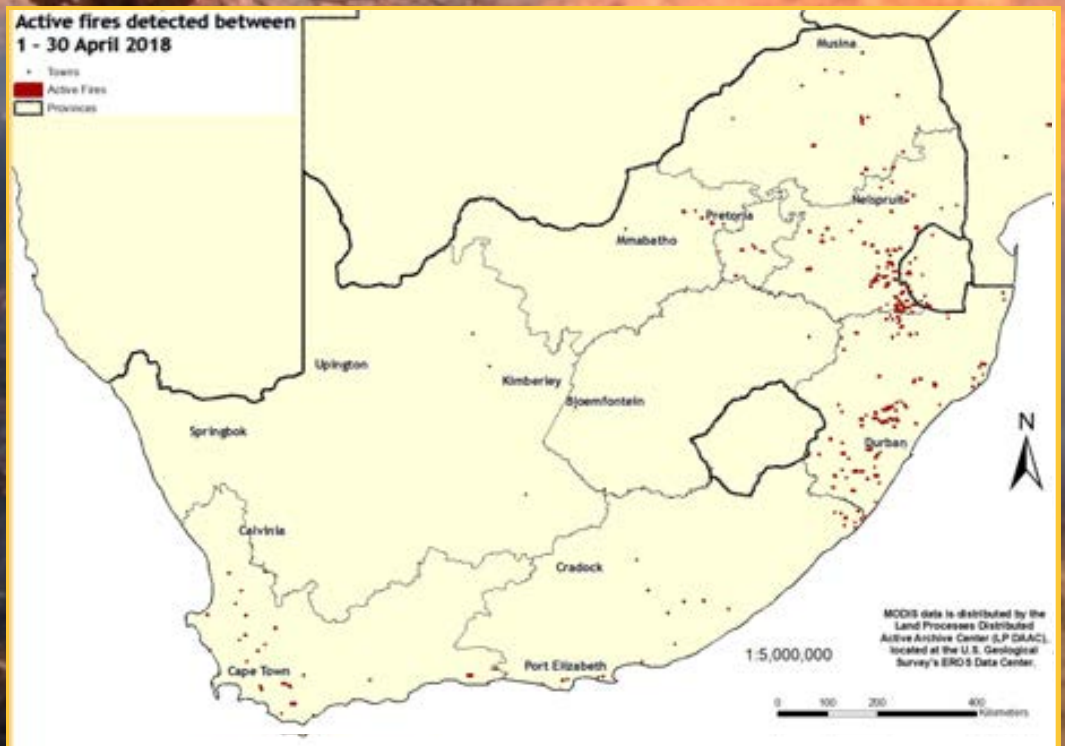


Figure 30

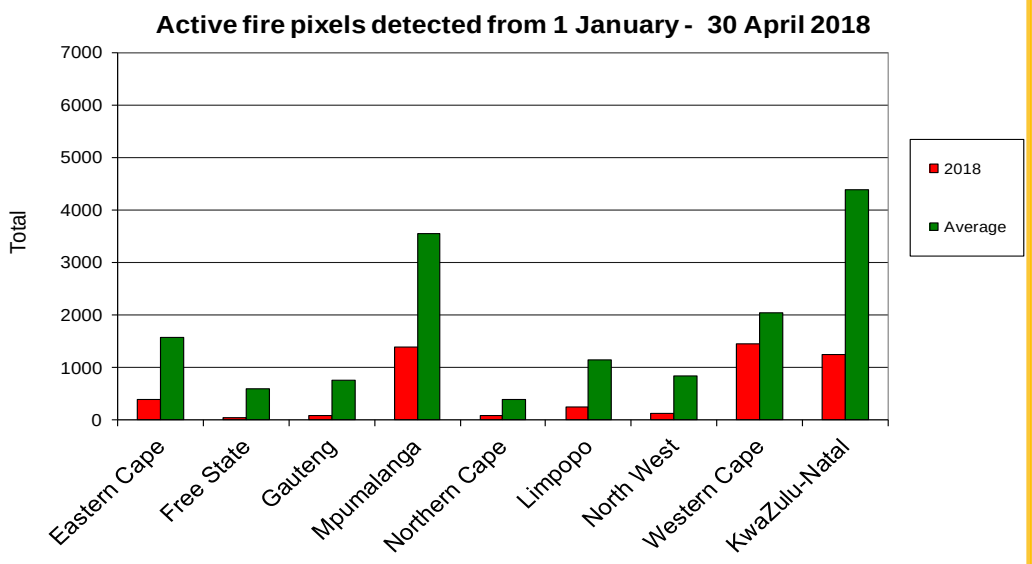


Figure 31

**Figure 31:**
The graph shows the total number of active fires detected from 1 January - 30 April per province. Fire activity was lower in all provinces compared to the average during the same period for the last 18 years.

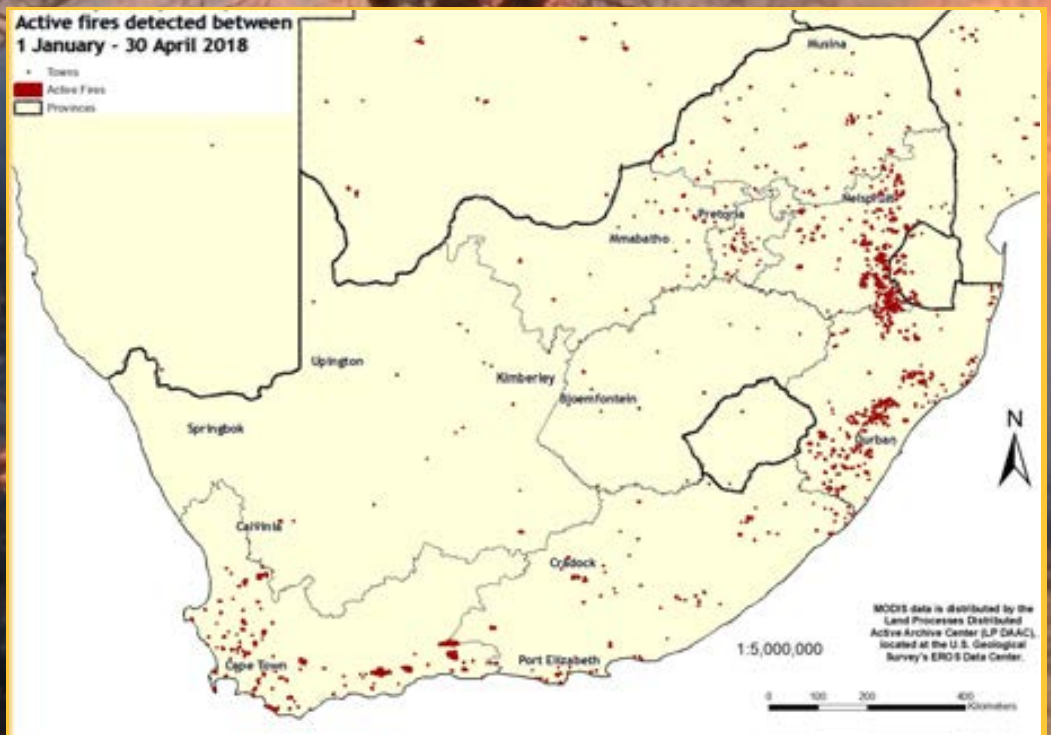


Figure 32

**Figure 32:**
The map shows the location of active fires detected between 1 January - 30 April 2018.

**Questions/Comments:**
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# Agrometeorology

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**The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national asset.**

## FOCUS AREAS

### Climate Monitoring, Analysis & Modelling

- Analysis of climate variability and climate model simulation
- Use of crop modelling to assess the impact of climate on agriculture
- Development of decision support tools for farmers

### Climate Change Adaptation & Mitigation

- National greenhouse gas inventory in the agricultural sector
- Improvement of agricultural production technologies under climate change
- Adaptation and mitigation initiatives, e.g. biogas production in small-scale farming communities

### Climate Information Dissemination

- Communication to farmers for alleviating weather-related disasters such as droughts
- Dissemination of information collected from weather stations
- Climate change awareness campaigns in farming communities

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# Geoinformation Science

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**The programme focuses on applied Geographical Information Systems (GIS) and Earth Observation (EO)/Remote Sensing research and provides leadership in applied GIS products, solutions, and decision support systems for agriculture and natural resources management. The Coarse Resolution Satellite Image Archive and Information Database is maintained as a national asset.**

## FOCUS AREAS

### Decision Support Systems

- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

### Early Warning & Food Security

- Drought and vegetation production monitoring
- Crop estimates and yield modelling
- Animal biomass and grazing capacity mapping
- Global and local agricultural outlook forecasts
- Disaster monitoring for agricultural systems

### Natural Resources Monitoring

- Land use/cover mapping
- Invasive species distribution
- Applications of GIS and EO on land degradation/erosion, desertification, hydrology and catchment areas
- Rangeland health assessments
- Carbon inventory monitoring

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# The Coarse Resolution Imagery Database (CRID)

### NOAA AVHRR

The ARC-ISCW has an archive of daily NOAA AVHRR data dating from 1985 to 2004. This database includes all 5 bands as well as the Normalized Difference Vegetation Index (NDVI), Active Fire and Land Surface Temperature (LST) images. The NOAA data are used, for example, for crop production and grazing capacity estimation.

### MODIS

MODIS data is distributed by the Land Processes Distributed Active Archive Center (LP DAAC), located at the U.S. Geological Survey's EROS Data Center. The MODIS sensor is more advanced than NOAA with regard to its high spatial (250 $m^2$ to 1 $km^2$) and spectral resolution. The ARC-ISCW has an archive of MODIS (version 4 and 5) data.

- MODIS v4 from 2000 to 2006
- MODIS v5 from 2000 to present

Datasets include:

- MOD09 (Surface Reflectance)
- MOD11 (Land Surface Temperature)
- MOD13 (Vegetation Products)
- MOD14 (Active Fire)
- MOD15 (Leaf Area Index & Fraction of Photosynthetically Active Radiation
- MOD17 (Gross Primary Productivity)
- MCD43 (Albedo & Nadir Reflectance)
- MCD45 (Burn Scar)

Coverage for version 5 includes South Africa, Namibia, Botswana, Zimbabwe and Mozambique.
More information:
**http://modis.gsfc.nasa.gov**

### VGT4AFRICA and GEOSUCCESS

SPOT NDVI data is provided courtesy of the VEGETATION Programme and the VGT4AFRICA project. The European Commission jointly developed the VEGETATION Programme. The VGT4AFRICA project disseminates VEGETATION products in Africa through GEONETCast.

ARC-ISCW has an archive of VEGETATION data dating from 1998 to the present. Other products distributed through VGT4AFRICA and GEOSUCCESS include Net Primary Productivity, Normalized Difference Wetness Index and Dry Matter Productivity data.

### Meteosat Second Generation (MSG)

The ARC-ISCW has an operational MSG receiving station. Data from April 2005 to the present have been archived. MSG produces data with a 15-minute temporal resolution for the entire African continent. Over South Africa the spatial resolution of the data is in the order of 3 km. The ARC-ISCW investigated the potential for the development of products for application in agriculture. NDVI, LST and cloud cover products were some of the initial products derived from the MSG SEVIRI data. Other products derived from MSG used weather station data, including air temperature, humidity and solar radiation.

### Rainfall maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network, 270 automatic rainfall recording stations from the SAWS, satellite rainfall estimates from the Famine Early Warning System Network: **http://earlywarning.usgs.gov** and long-term average climate surfaces developed at the ARC-ISCW.

### Solar Radiation and Evapotranspiration maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network.
- Data from the METEOSAT Second Generation (MSG) 3 satellite via GEONETCAST: **http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast/GEONETCast/index.html**.

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**The operational Coarse Resolution Imagery Database (CRID) project of ARC-ISCW is funded by the National Department of Agriculture, Forestry and Fisheries. Development of the monitoring system was made possible at its inception through LEAD funding from the Department of Science and Technology.**



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**What does Umlindi mean?**
UMLINDI is the Zulu word for "the watchman".