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# UMLINDI
## The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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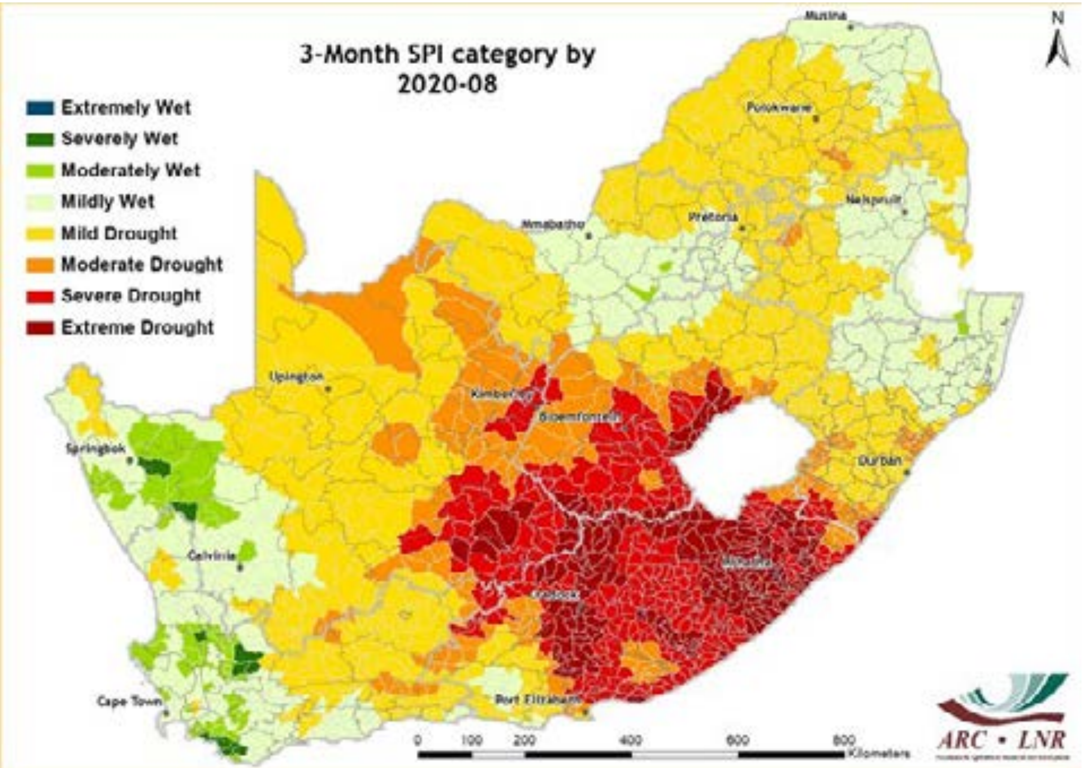
195th Edition

# Image of the Month

## Drought risk concerns persist in the Eastern Cape

Following extreme drought conditions over the Eastern Cape during the latter months of 2019, welcome rains were observed during January to April 2020. This is somewhat normal as the greater part of the province is situated in the mid- to late-summer rainfall region. However, only short-term relief was experienced as these rains were not enough to rehabilitate from the previous drought period. Mild drought conditions became apparent in the area in May and, as depicted in the 3-month Standardized Precipitation Index (SPI) map ending in August 2020, these have since intensified, implying a risk of severe widespread impending drought. Currently, dam water levels in the province remain low and common agricultural practices such as cattle and sheep production are most likely to be negatively affected should these conditions persist. When considering the all-year rainfall region which is situated in the southern belt of the province, the mildly wet conditions that were observed are an indication of above-normal rainfall that was experienced during the month of August. Other areas of concern include adjacent parts of the southern Free State and Karoo during this period, raising drought risk concerns for agricultural activities in these areas.




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, Land Reform and Rural Development.

## Overview:

In general, rainfall was largely absent over greater parts of the country during August 2020, while other areas such as the Western Cape, western parts of the Northern Cape, isolated parts of the Eastern Cape and KwaZulu-Natal, as well as the Mpumalanga and Limpopo Lowveld, recorded significant amounts of rain. Above-normal rainfall that occurred in July over the Vhembe district of Limpopo and the Lowveld of Mpumalanga continued into August, with a few rainfall days during the beginning and towards the end of the month.

Persistent above-normal rains occurred over the winter rainfall region in August as their season is now underway. The month began with a few dry days but rainfall was observed from the 4th over much of the Western Cape. Considerable rainfall activity occurred during the middle of the month following a cold front that made landfall on the 17th. This resulted in thunderstorms over the south coast with areas such as Plettenberg Bay recording 74 mm on the 18th. Snowfall was even observed over the high-lying areas of the Garden Route. Parts of the Eastern Cape and KwaZulu-Natal also received most of their monthly rainfall during this period. Subsequent to the cold front, temperatures started picking up over the country before decreasing again towards the end of the month.

# 1. Rainfall

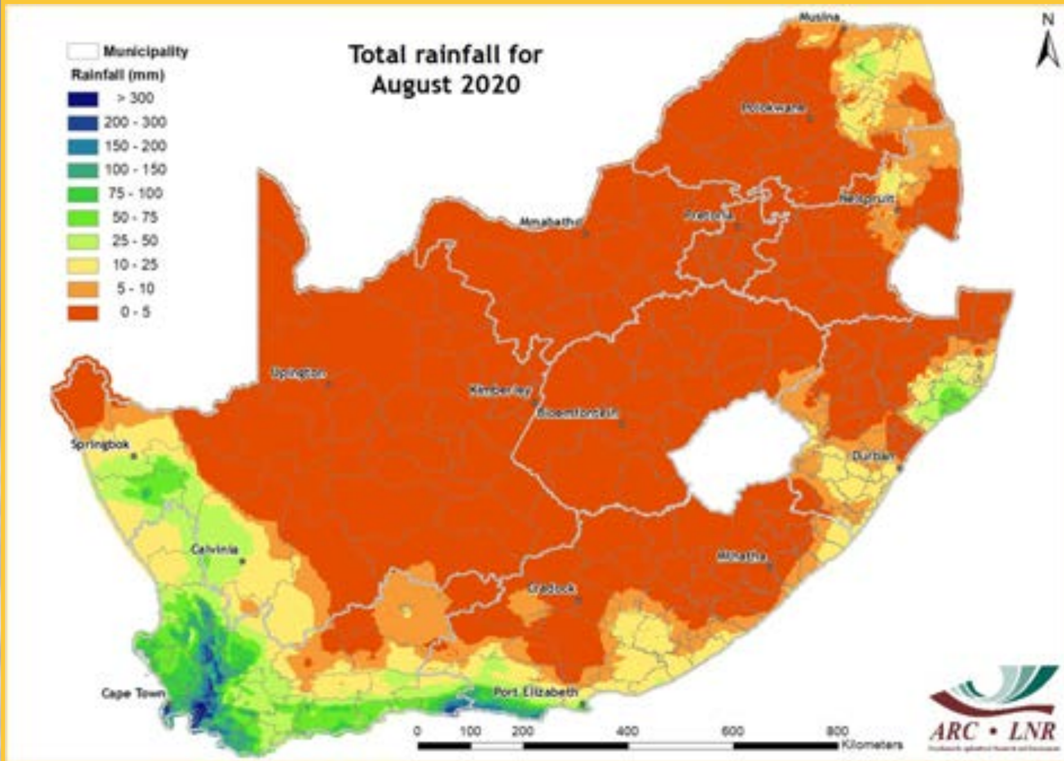



Figure 1

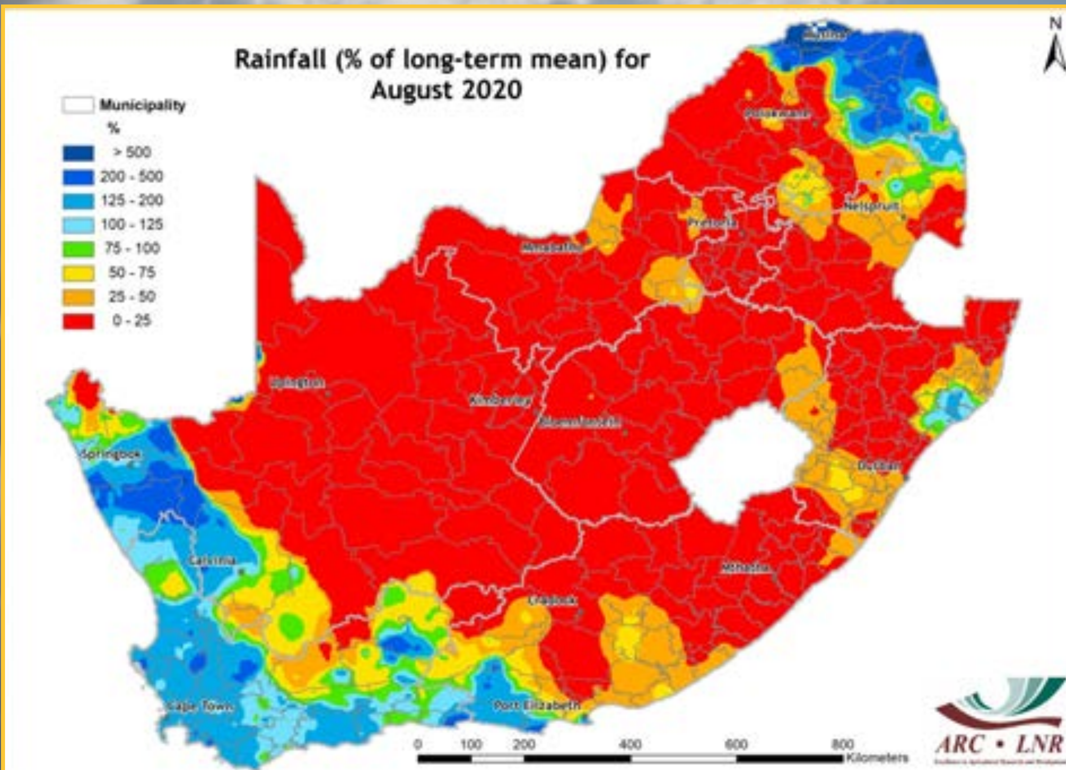



Figure 2

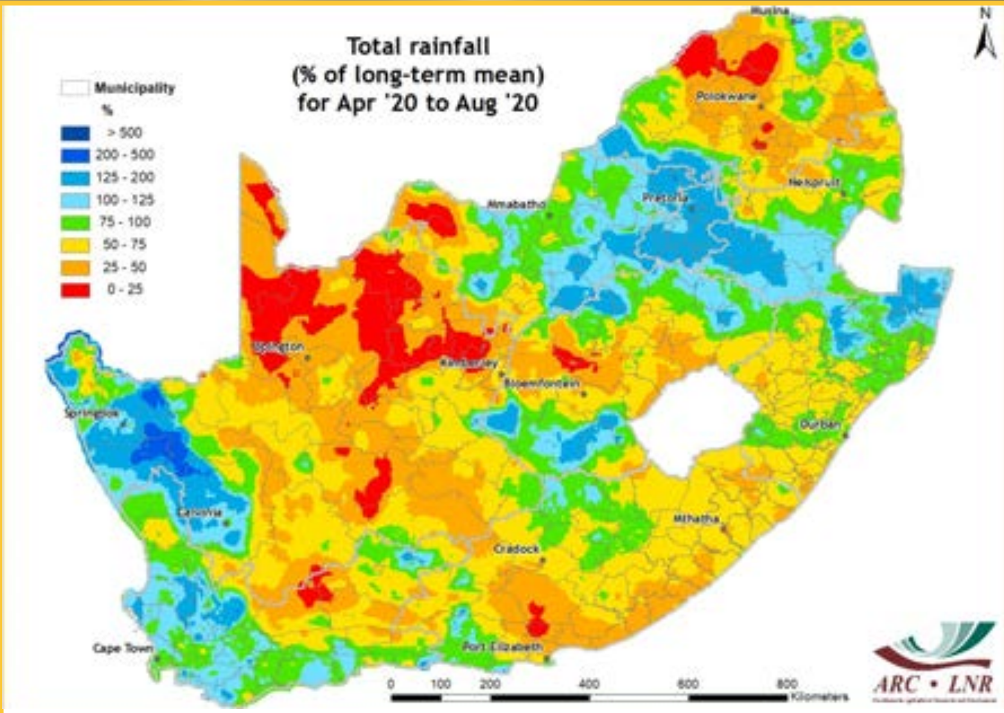



Figure 3

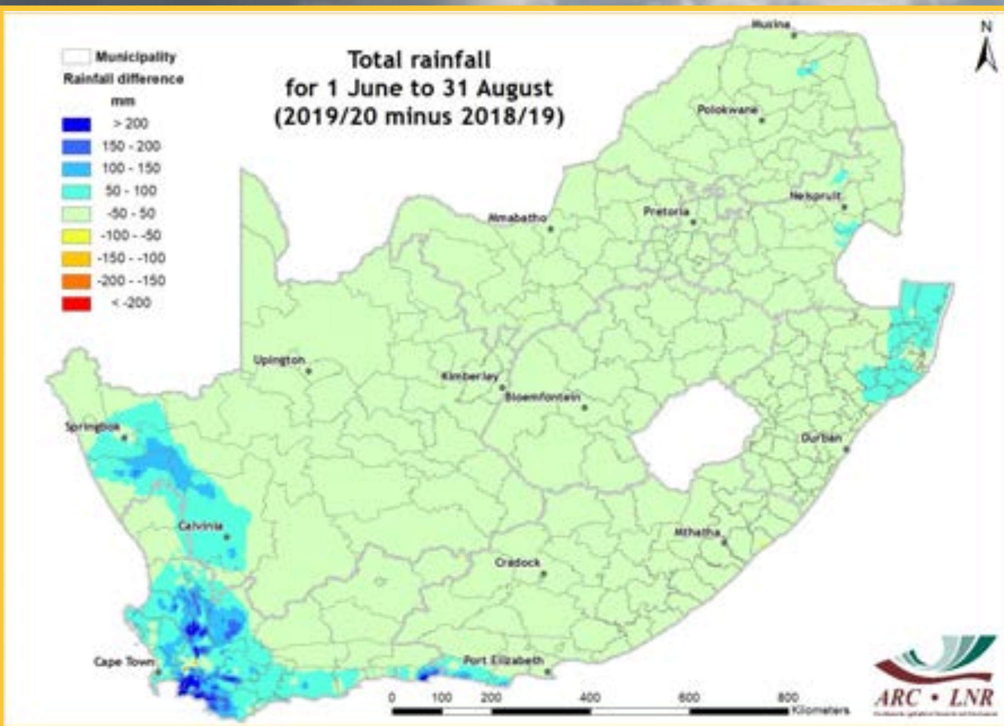



Figure 4

**Figure 1:**
Total rainfall of up to 200 mm was recorded over the southern parts of the winter rainfall region in August 2020. Other areas that recorded rainy days during the month include the all-year rainfall region, parts of KwaZulu-Natal and the Lowveld of Mpumalanga and Limpopo. The rest of the country remained dry.

**Figure 2:**
Above-normal rainfall conditions were observed over the winter rainfall region in August, as well as the north-eastern corner of the country and northern KZN. Below-normal rainfall conditions were observed over the rest of the country.

**Figure 3:**
Total rainfall for the period between April and August 2020 indicates above-normal conditions over the winter rainfall region, greater parts of the Highveld and northern KZN.

**Figure 4:**
The winter rainfall region and northern parts of KwaZulu-Natal received considerably more rain during June-August 2020 as compared to the same period in 2019. The rest of the country compared well with last year's rainfall during this period.

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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.

The SPI maps revealing short-term (6-month SPI), medium-term (12-month SPI) and long-term (24-month and 36-month SPI) drought conditions are shown in Figures 5-8. The short-term SPI map shows mild drought conditions over greater parts of the country, with the winter rainfall region and most parts of the summer rainfall region experiencing mildly wet conditions. The latter includes much of the North West, Free State, northern regions of the Eastern Cape, KwaZulu-Natal and Mpumalanga. The 12-month SPI map shows mild to moderate drought conditions over the country, while moderate to extreme drought over the Cape provinces, eastern Free State, parts of KwaZulu-Natal, Limpopo and Mpumalanga are visible on the 24-month SPI map.

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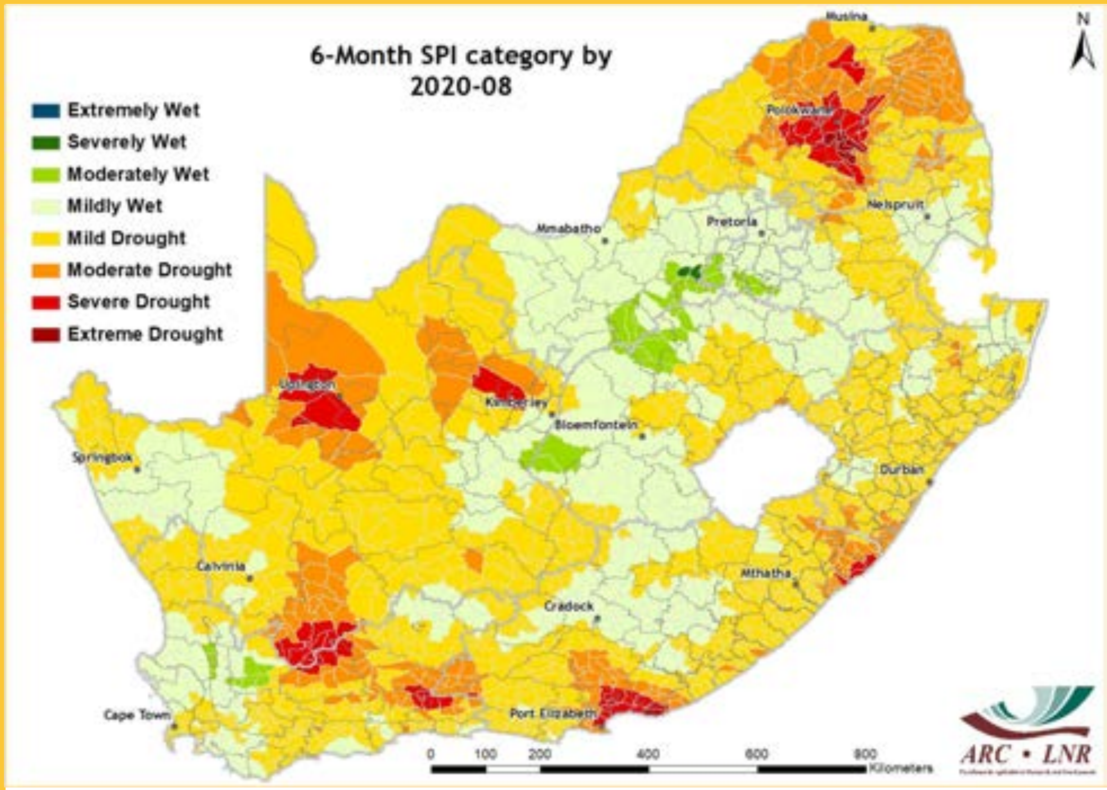


Figure 5

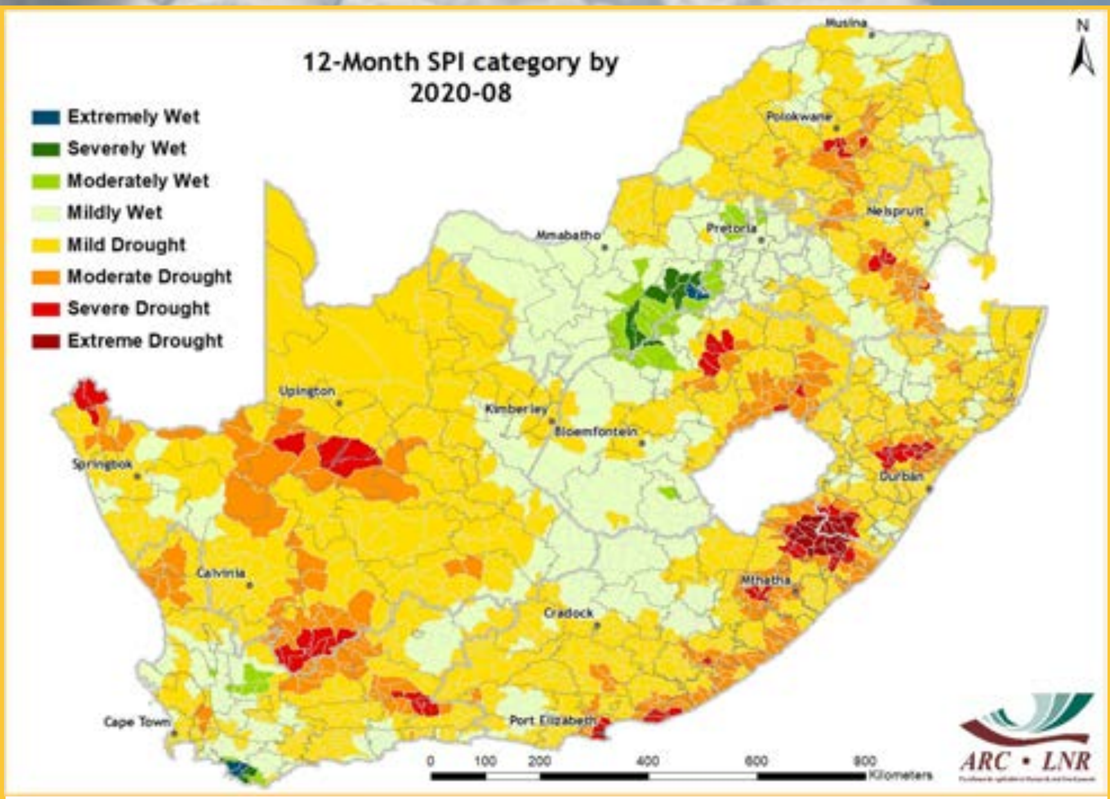


Figure 6

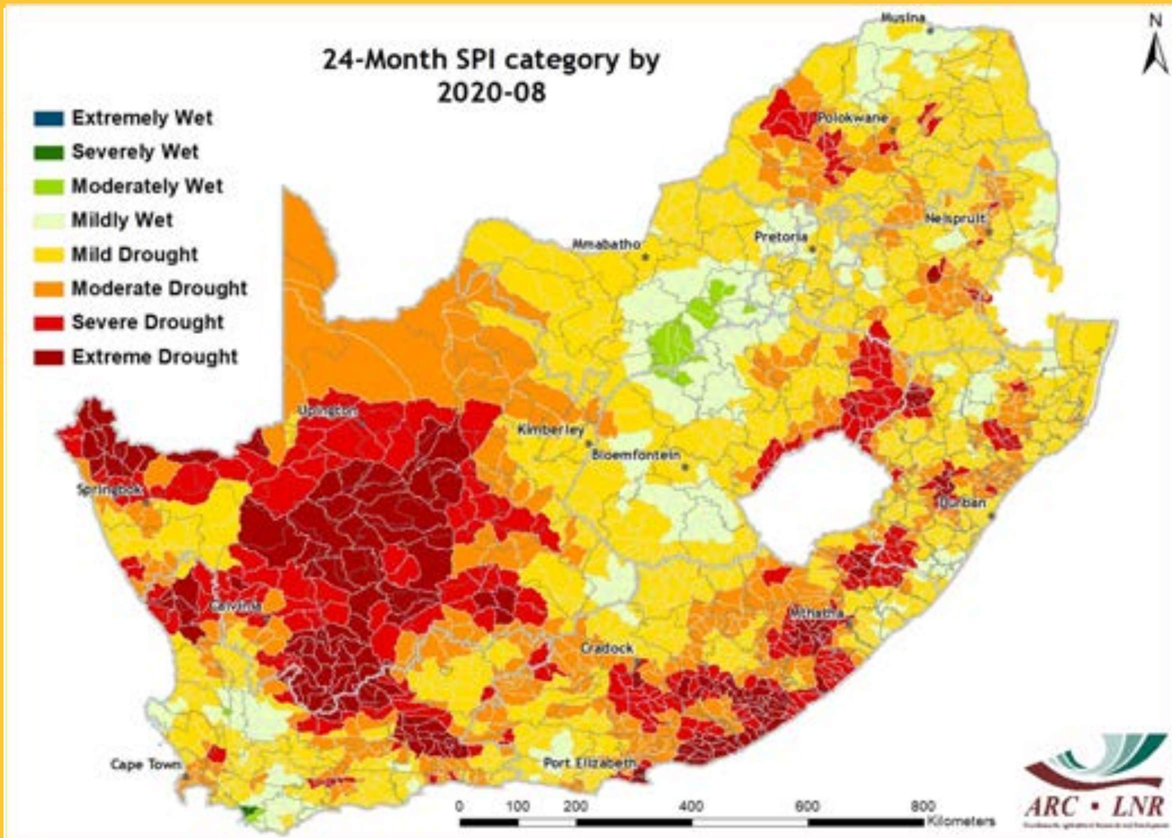


Figure 7

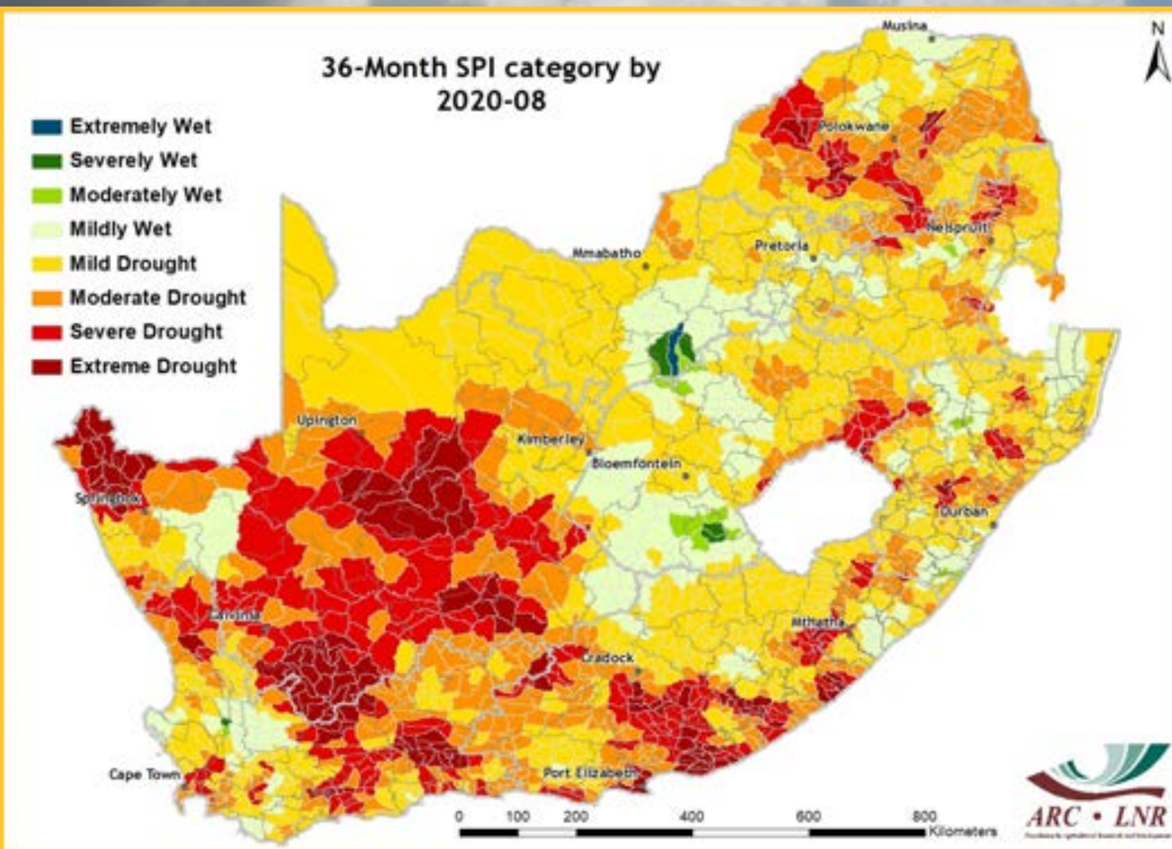


Figure 8

# 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.

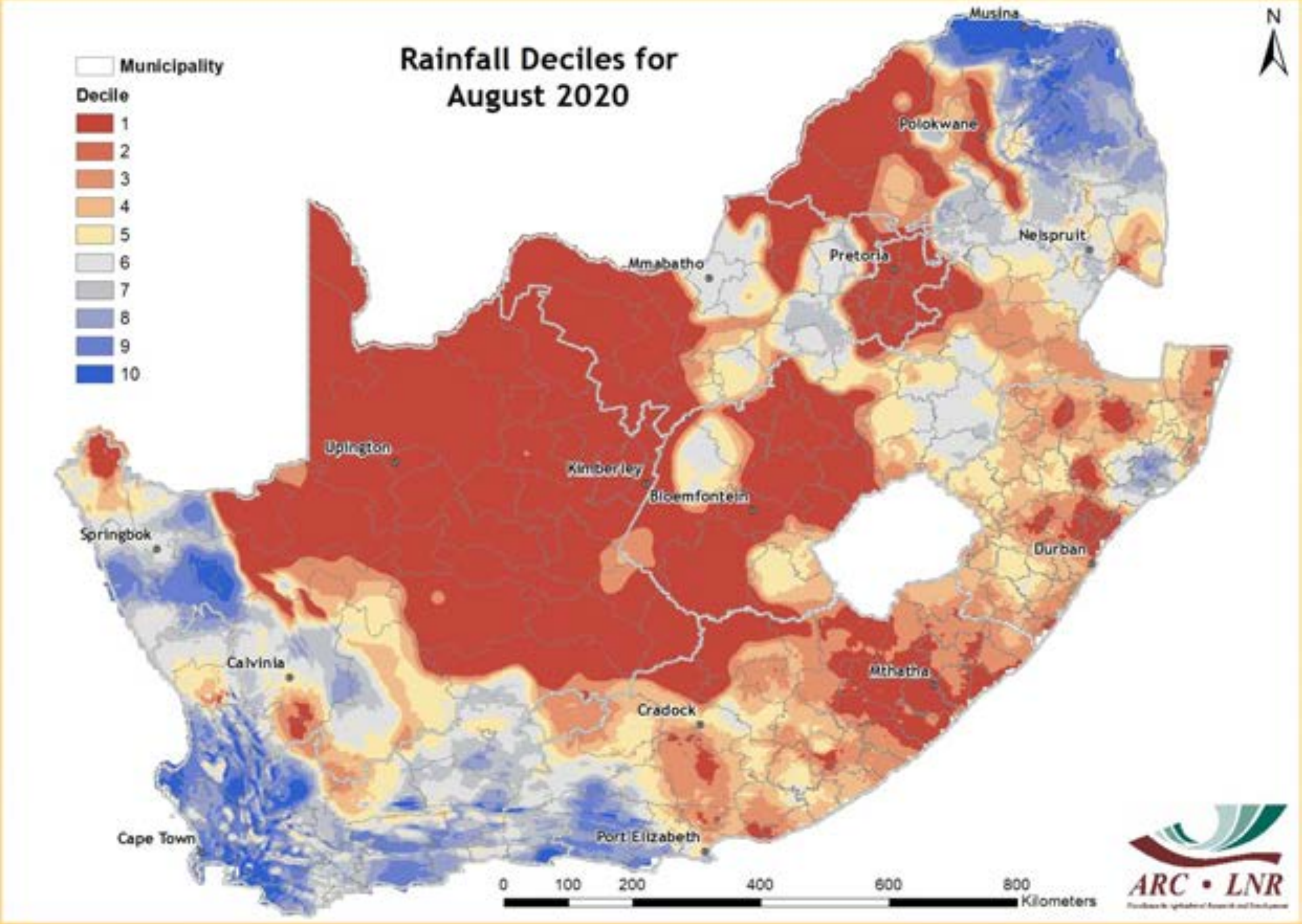


Figure 9

**Figure 9:**
The winter and all-year rainfall regions, as well as the eastern parts of the summer rainfall region, experienced rainfall totals that compare well with the historically wetter August rainfall totals. The rest of the country compared well with the historically drier August rainfall totals.

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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.

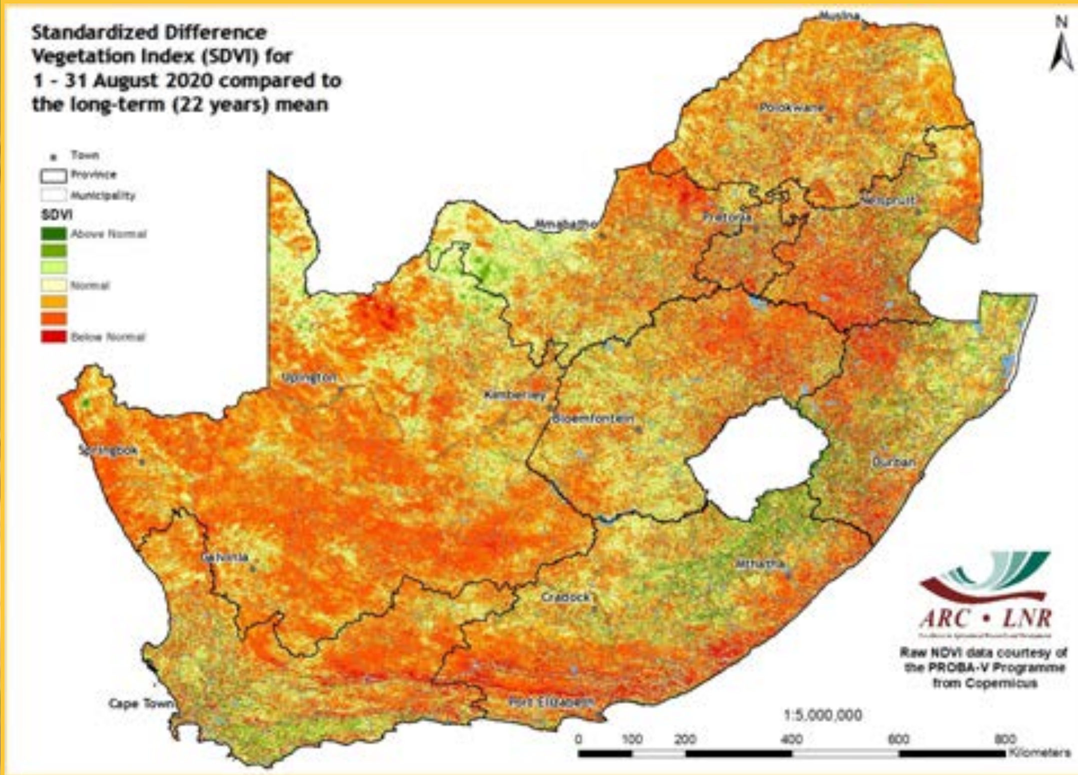


Figure 10

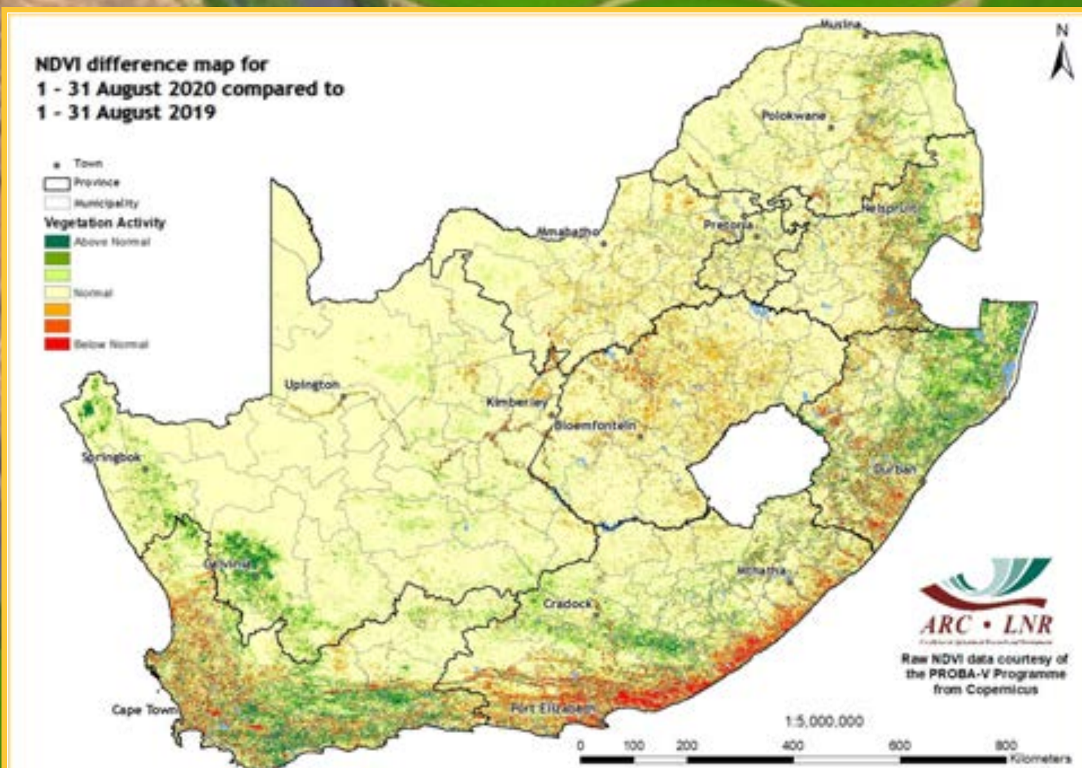


Figure 11

**Figure 10:**
Compared to the long-term average, the SDVI map for August 2020 shows that many parts of the country experienced poor vegetation conditions with patches of good vegetation activity over isolated areas.

**Figure 11:**
Compared to the same month last year, the NDVI difference map for August 2020 shows that normal to above-normal vegetation activity occurred over many parts of the country with pockets of below-normal activity over isolated areas.

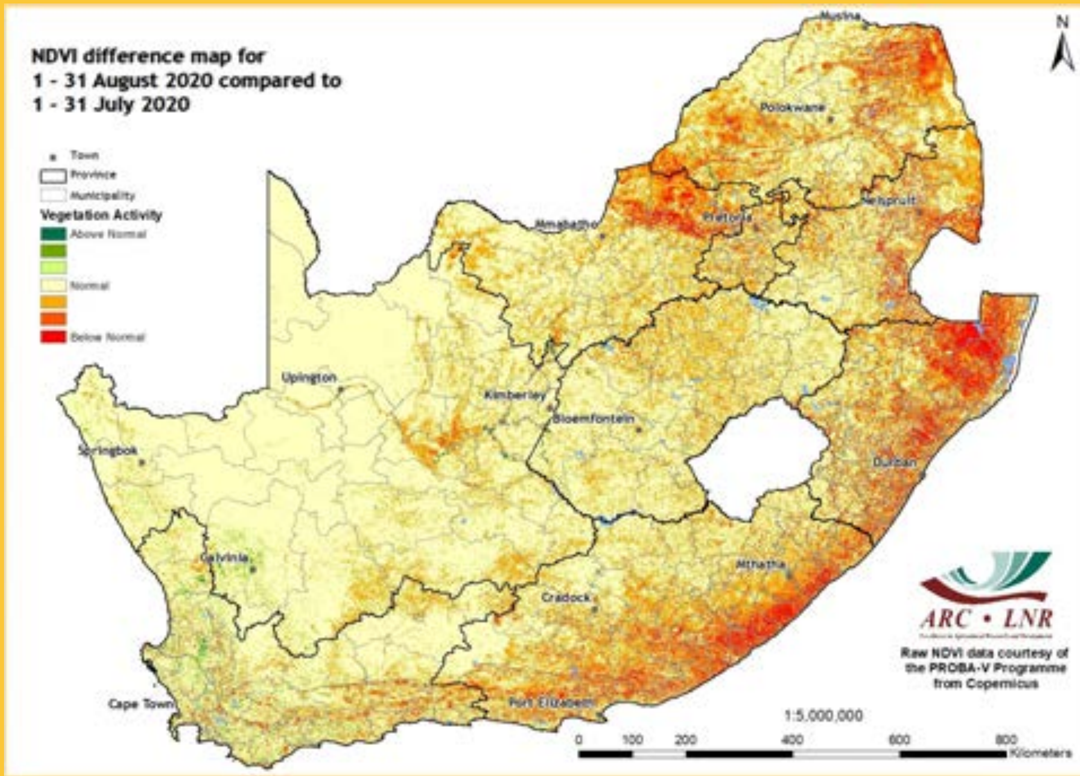


Figure 12

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

### Interpretation of map legend

NDVI-based 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

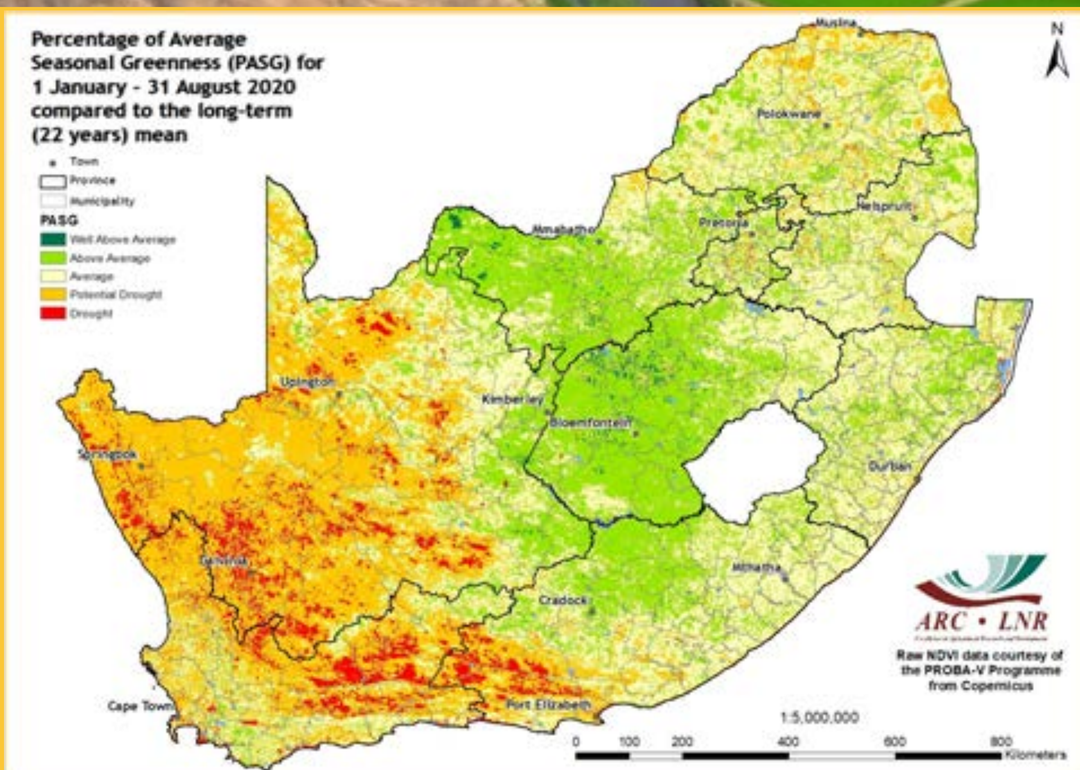


Figure 13

**Figure 12:**
Compared to the previous month, the NDVI difference map for August shows that the eastern half of the country experienced generally poor vegetation conditions. In contrast, the western half was characterized by normal or, to a smaller extent, above-normal vegetation activity.

**Figure 13:**
Cumulative vegetation conditions from January to August compared to the long-term mean show that the eastern the central parts of the country experienced high levels of seasonal vegetation greenness, with pockets spreading over the northern parts. Meanwhile, the western parts continue to experience low levels of seasonal greenness.

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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.

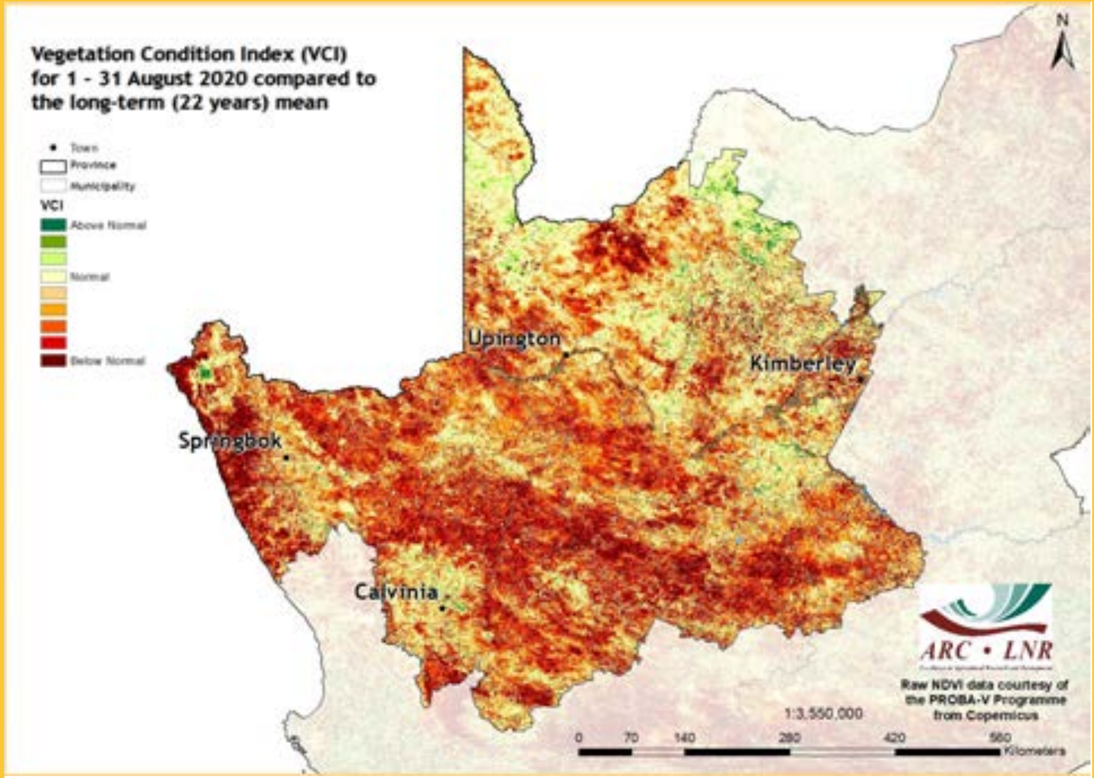



Figure 14

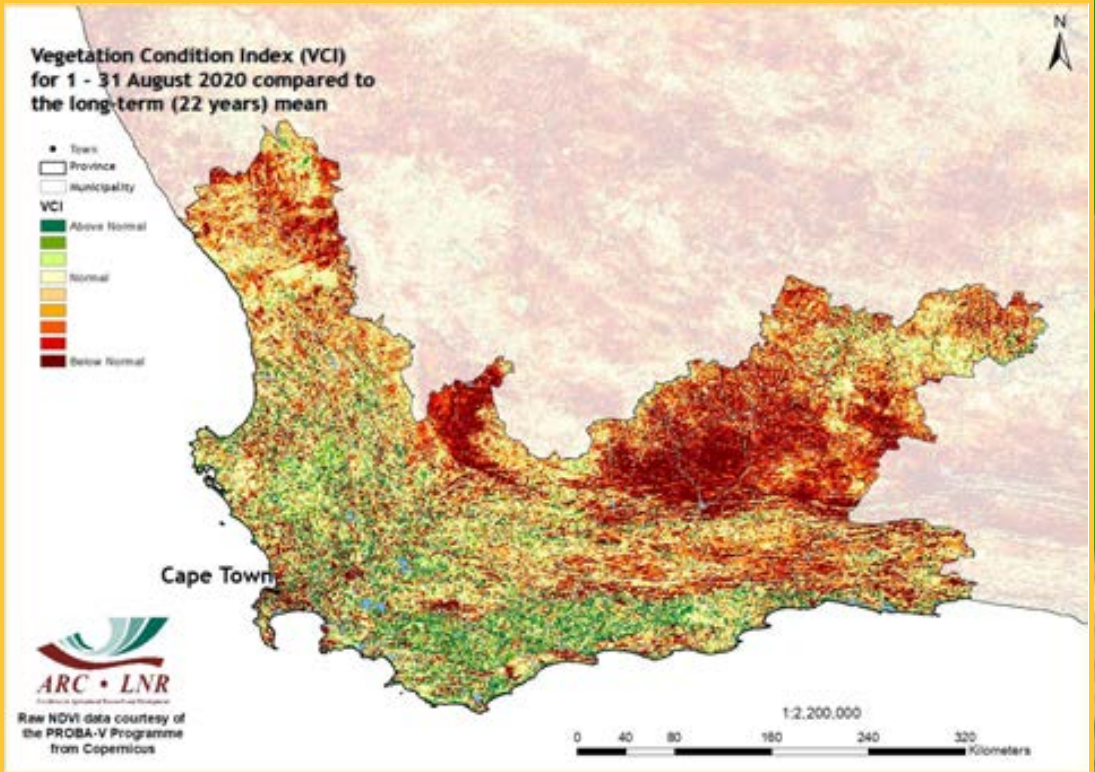
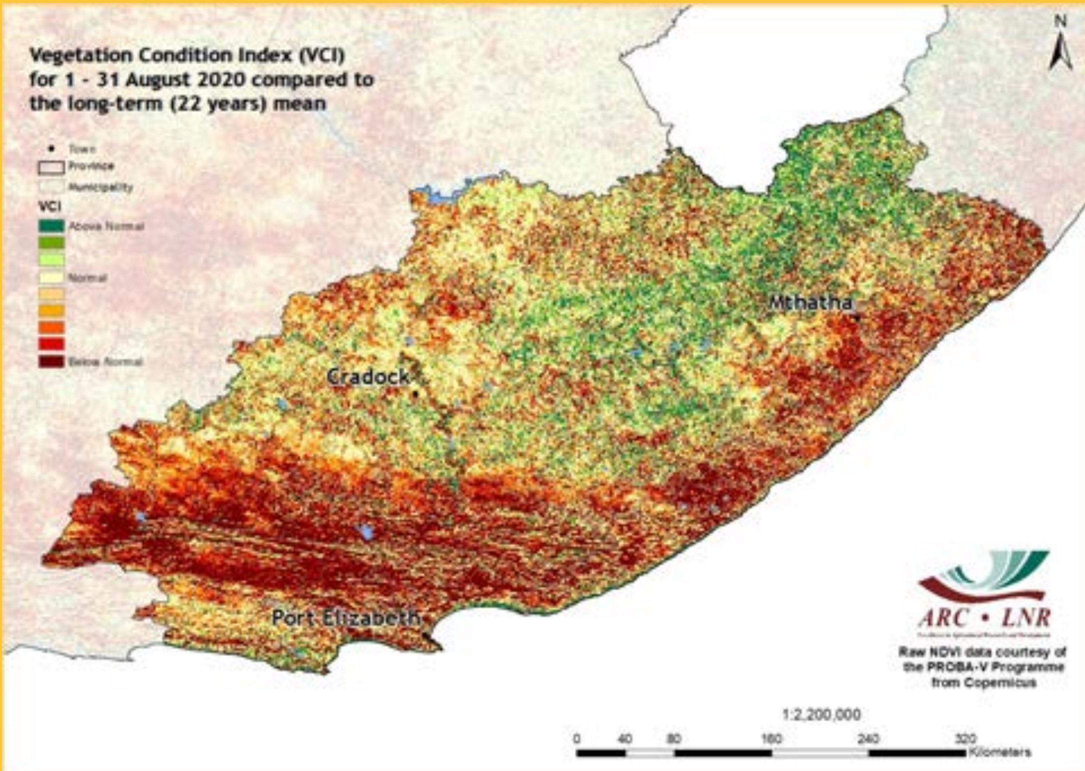



Figure 15

**Figure 14:**
The VCI map for August indicates that severe drought conditions continue to prevail in larger parts of the Northern Cape.

**Figure 15:**
The VCI map for August shows that poor vegetation conditions prevail in the Central Karoo, northern parts of the West Coast, as well as northeastern and western parts of the Eden District Municipality. Meanwhile, pockets of good vegetation conditions remain dominant in isolated areas of the western parts and the southern coastal areas of the Western Cape.

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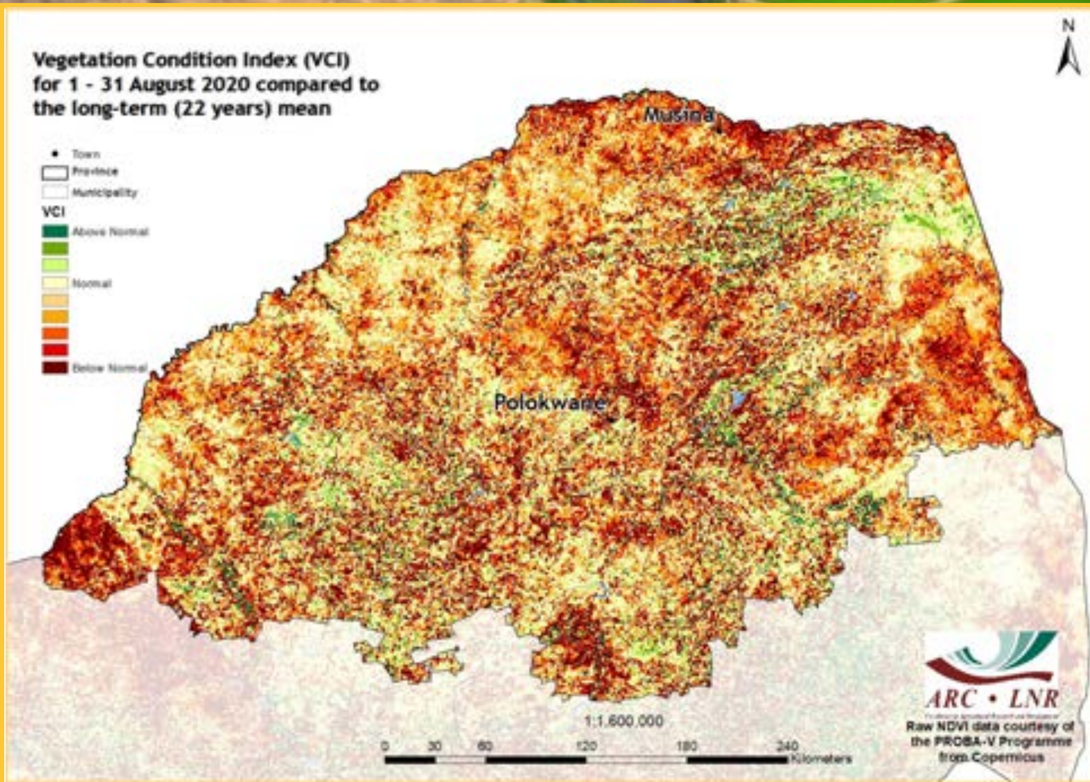


Figure 17

**Figure 16:**
The VCI map for August indicates that vegetation in the western half of the Eastern Cape remains extremely stressed, but pockets of good vegetation activity remain dominant in the eastern half of the province.

**Figure 17:**
The VCI map for August shows that poor vegetation activity is prevalent over greater parts of Limpopo.

**Questions/Comments:**
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# 6. Vegetation Conditions & Rainfall

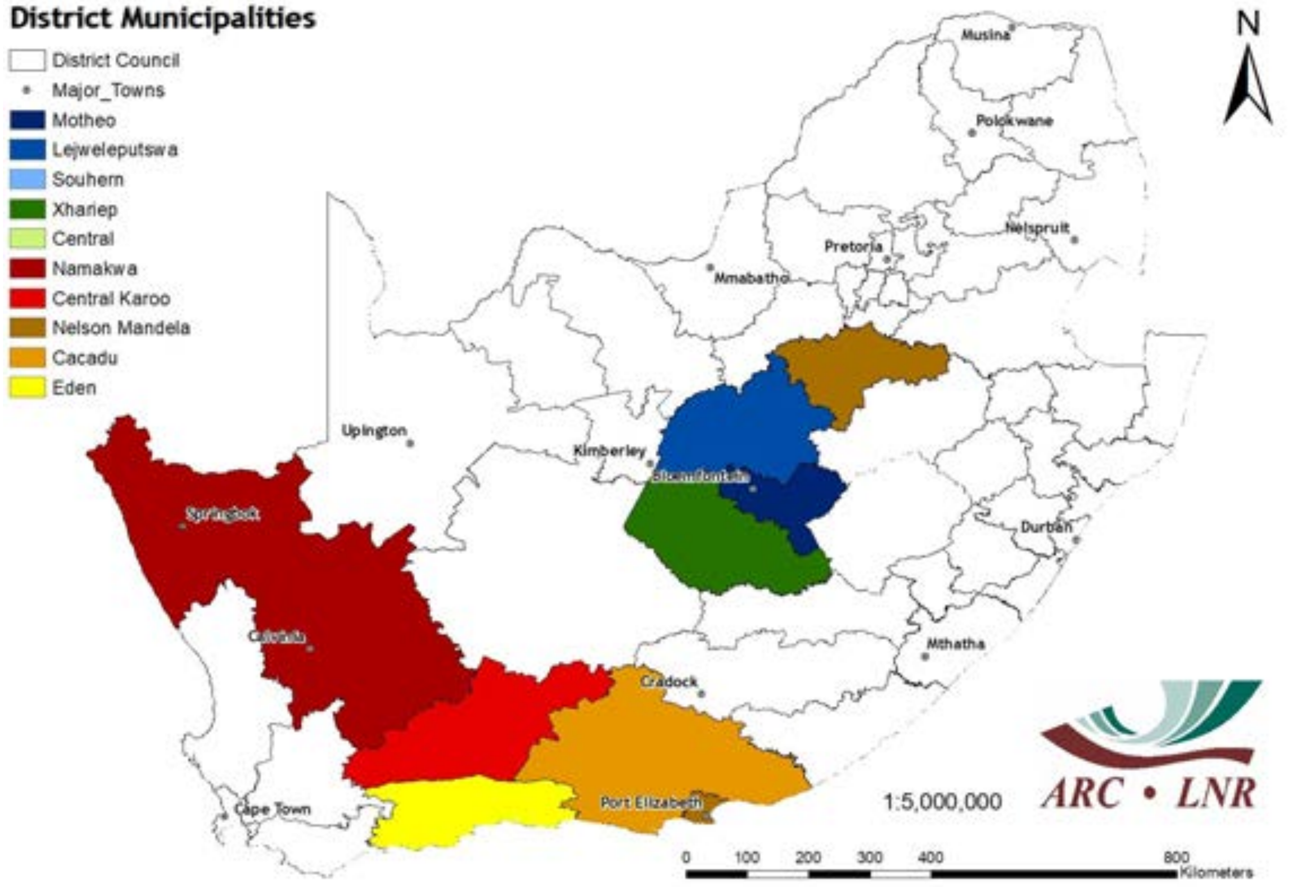


Figure 18

**Rainfall and NDVI Graphs**

**Figure 18:**
Orientation map showing the areas of interest for August 2020. The district colour matches the border of the corresponding graph.

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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.

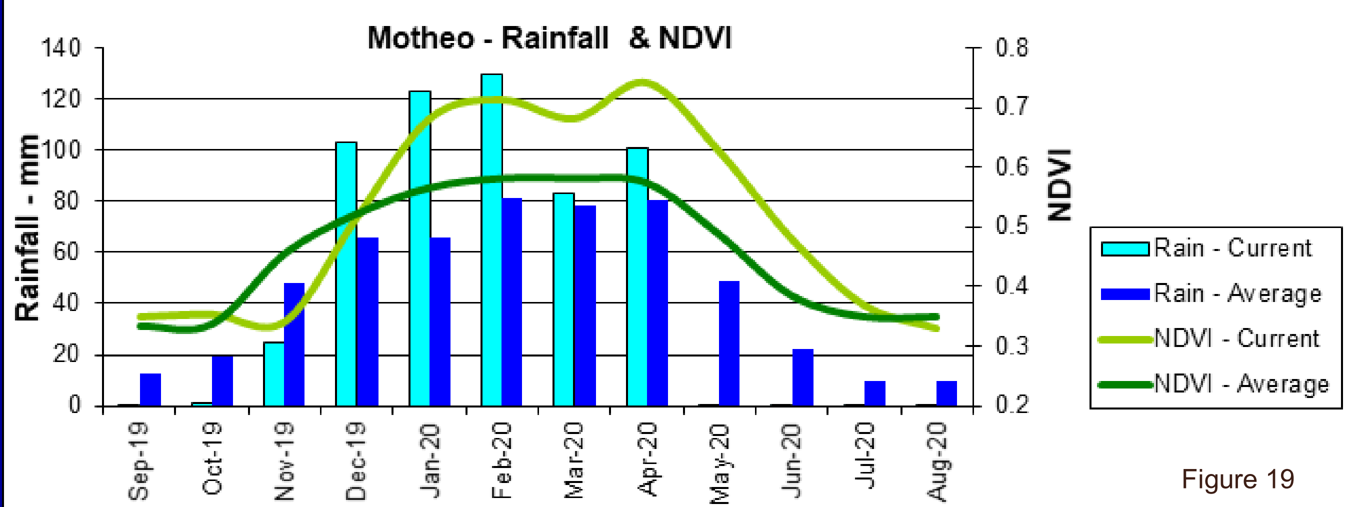
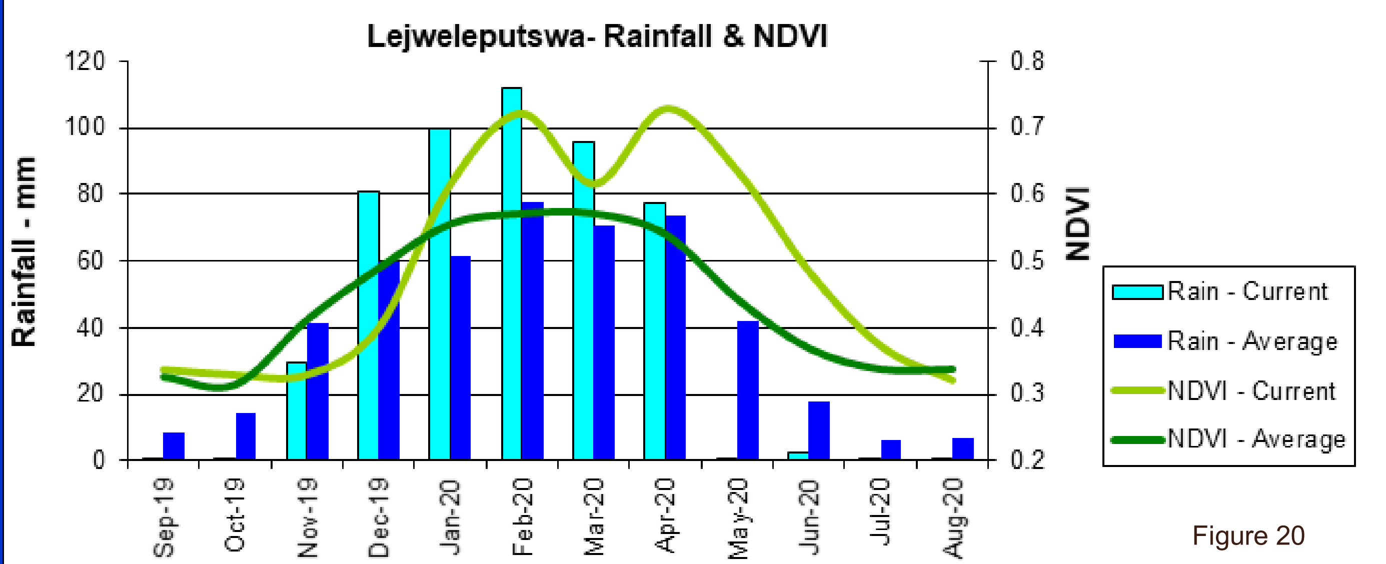



Figure 19

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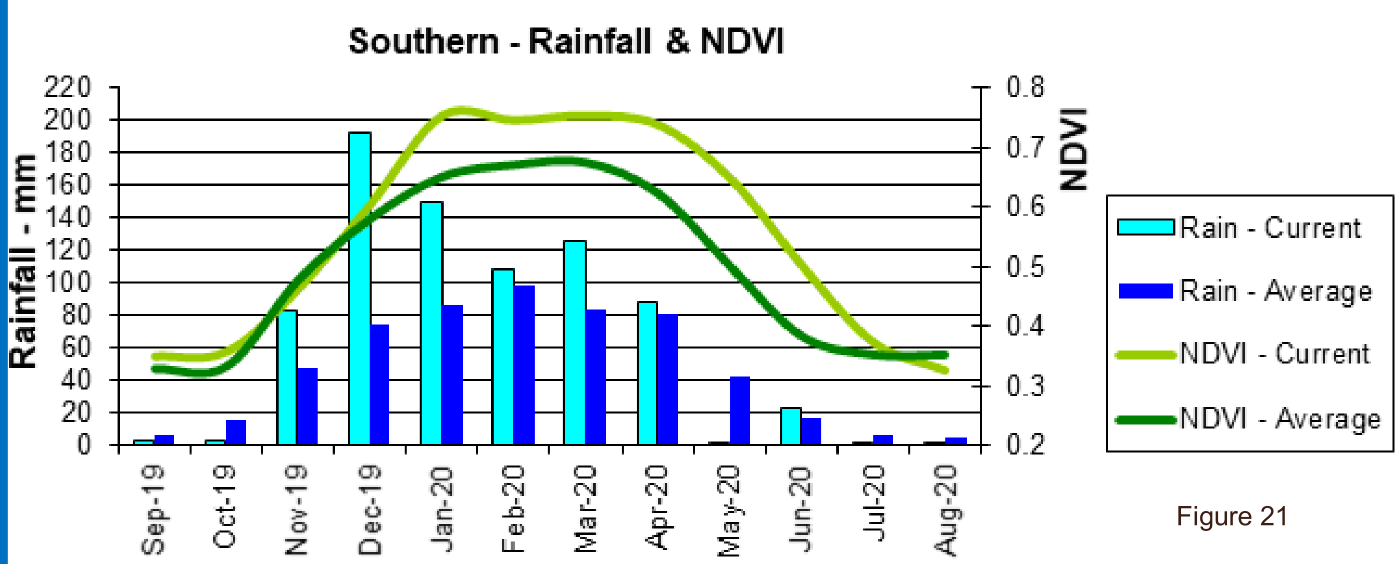



Figure 21

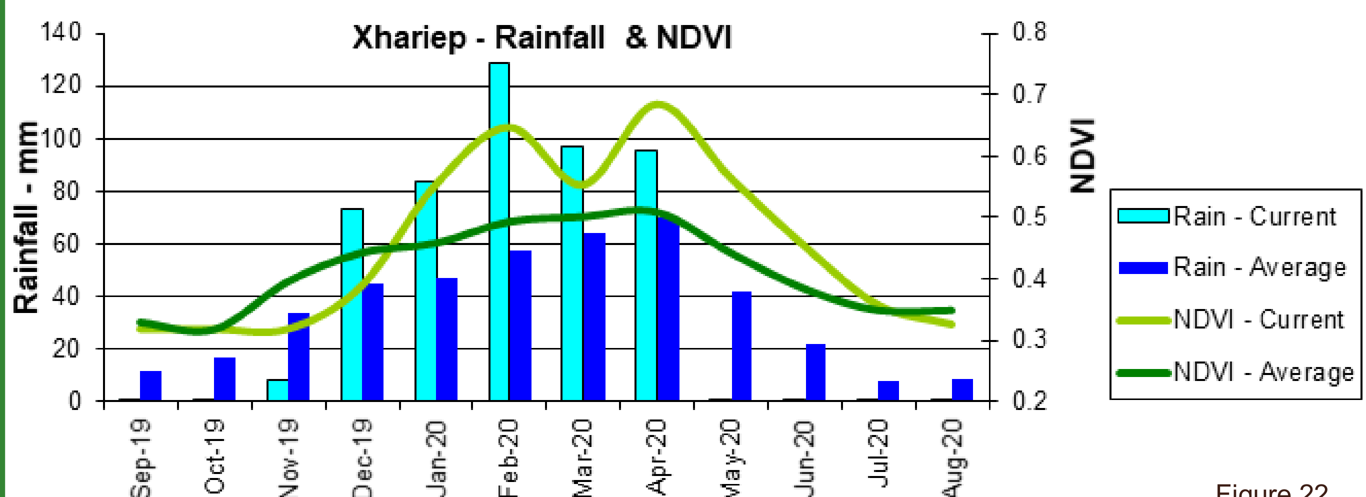
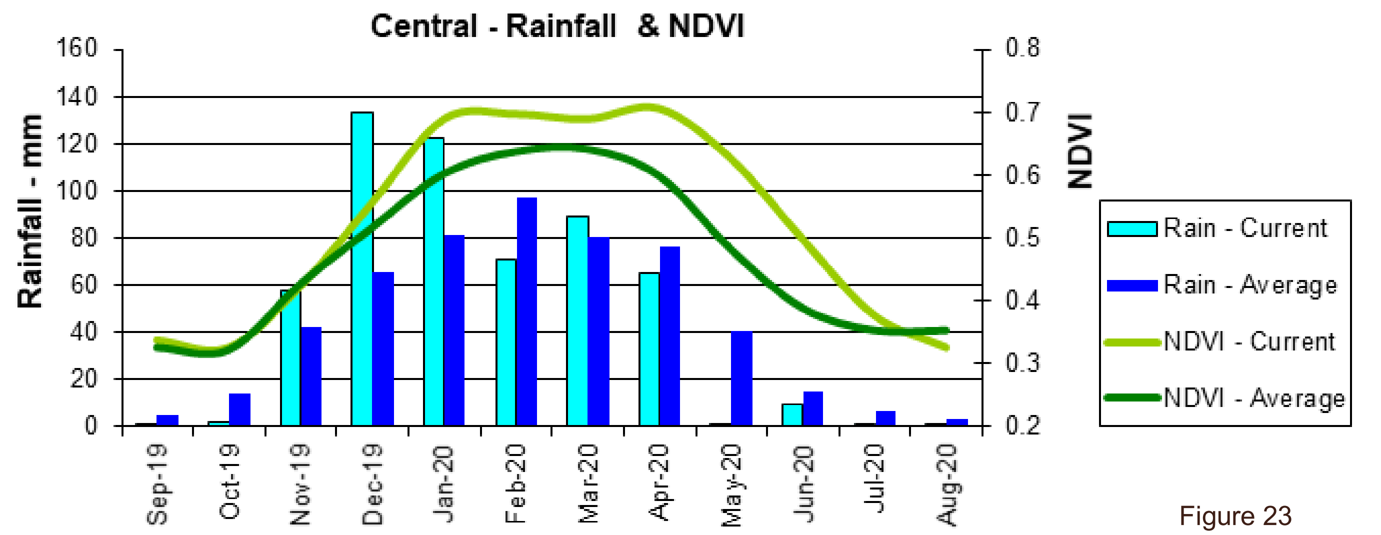



Figure 22

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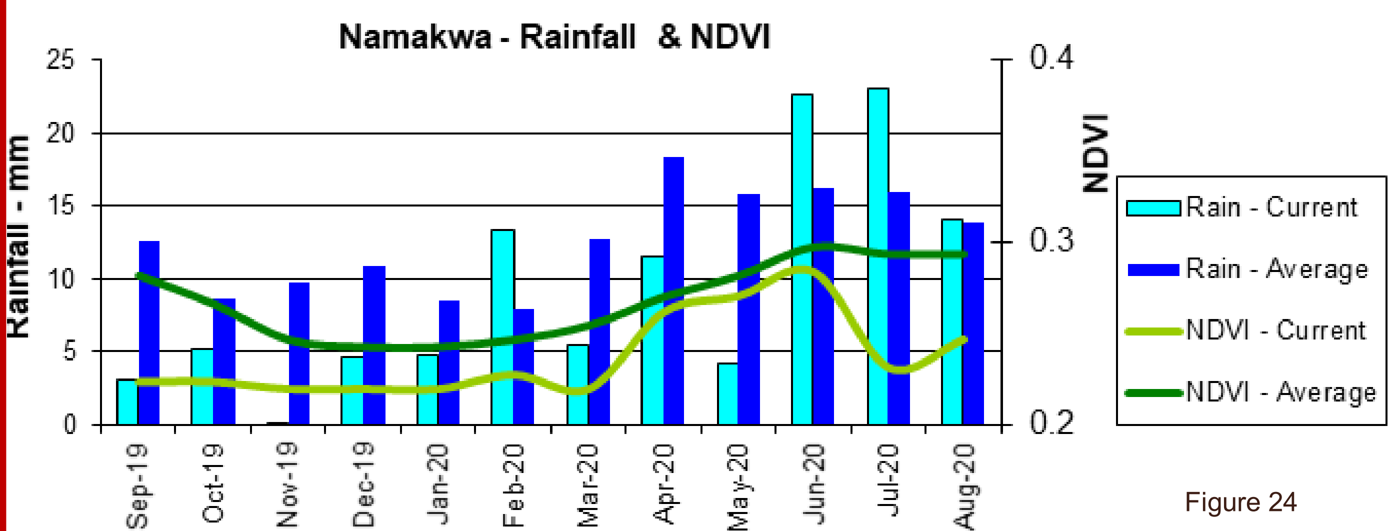


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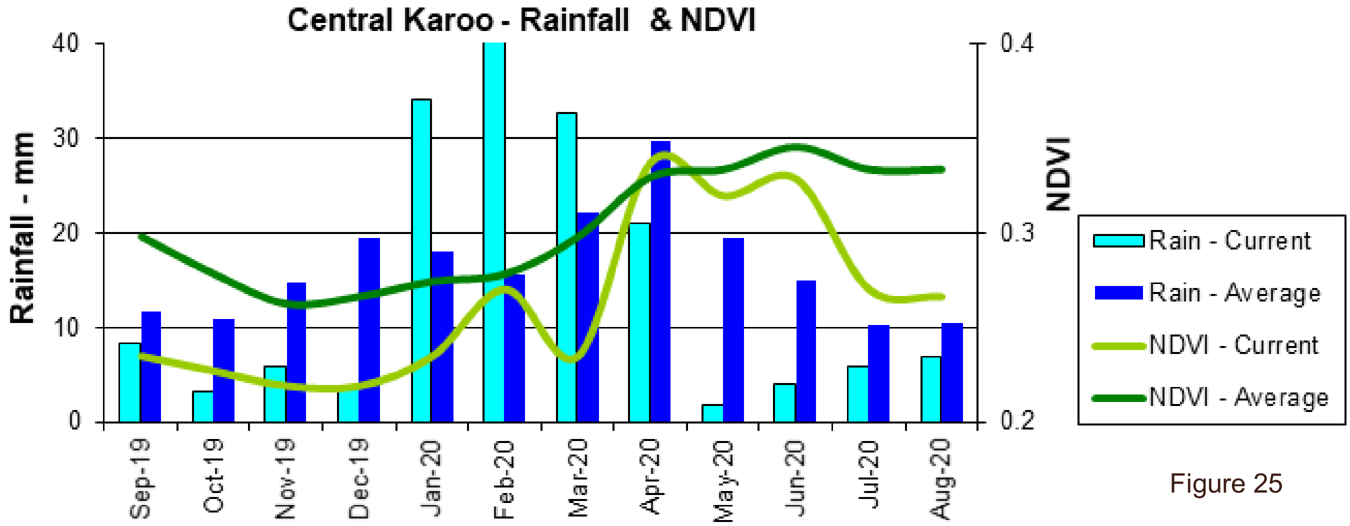


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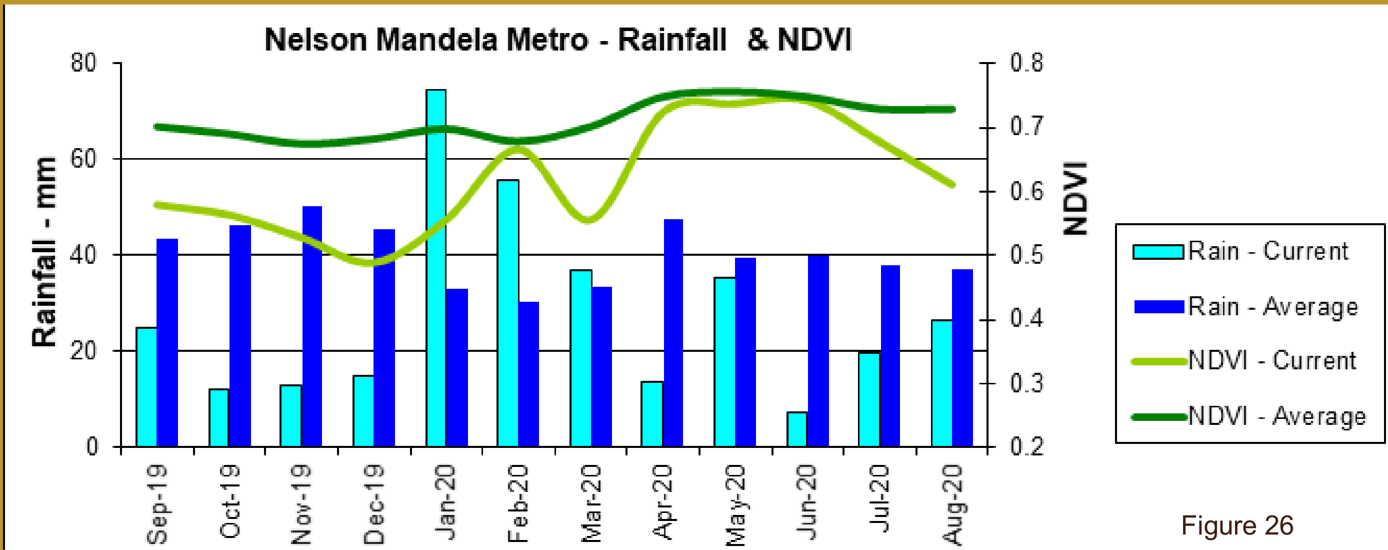


Figure 26

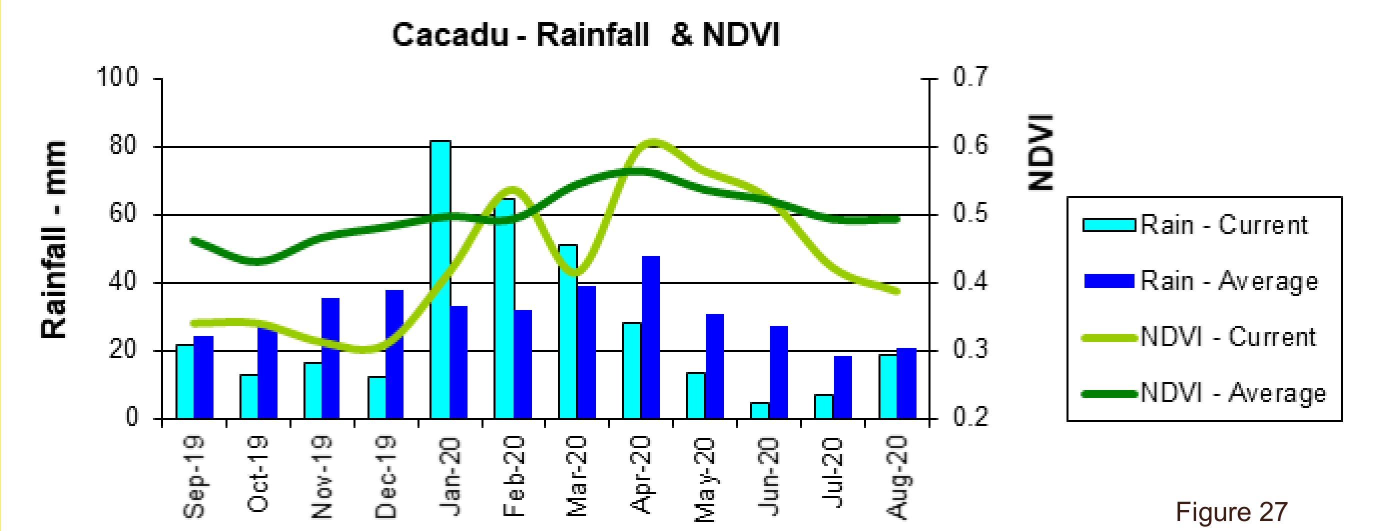


Figure 27

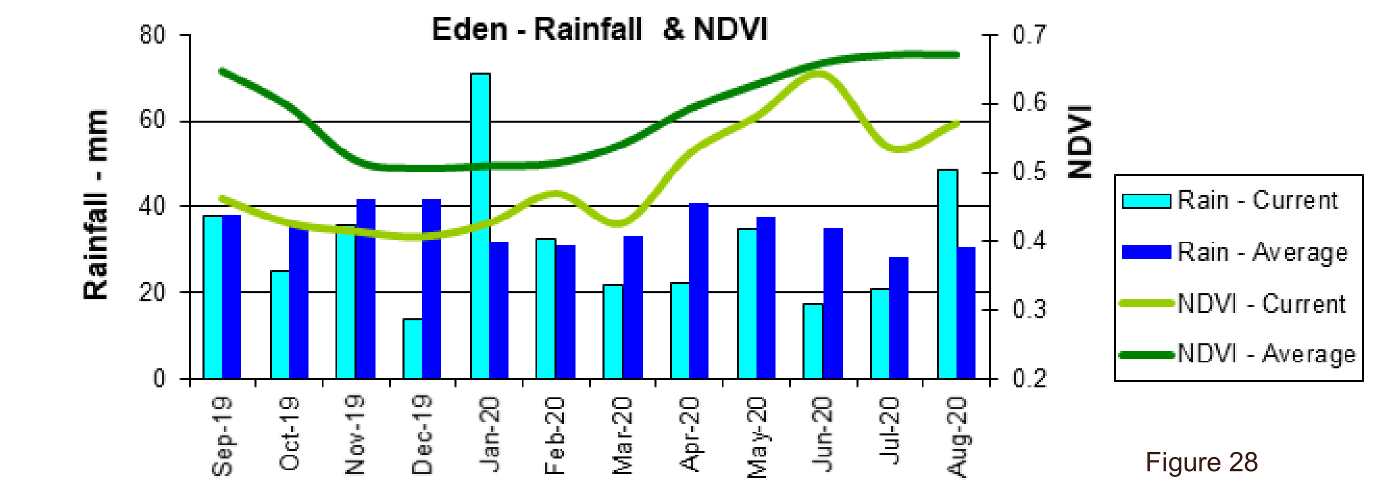


Figure 28

# 7. Fire Watch



**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 between 1-31 August 2020 per province. Fire activity was higher in the Free State, Mpumalanga, North West and KwaZulu-Natal compared to the long-term average.

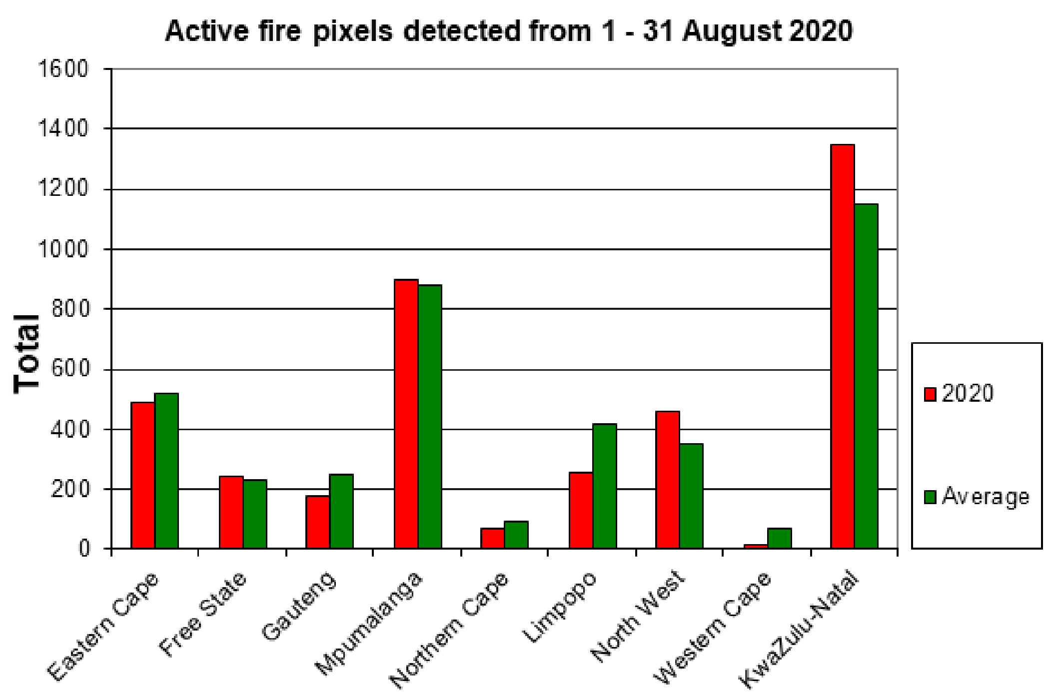


Figure 29

**Figure 30:**
The map shows the location of active fires detected between 1-31 August 2020.

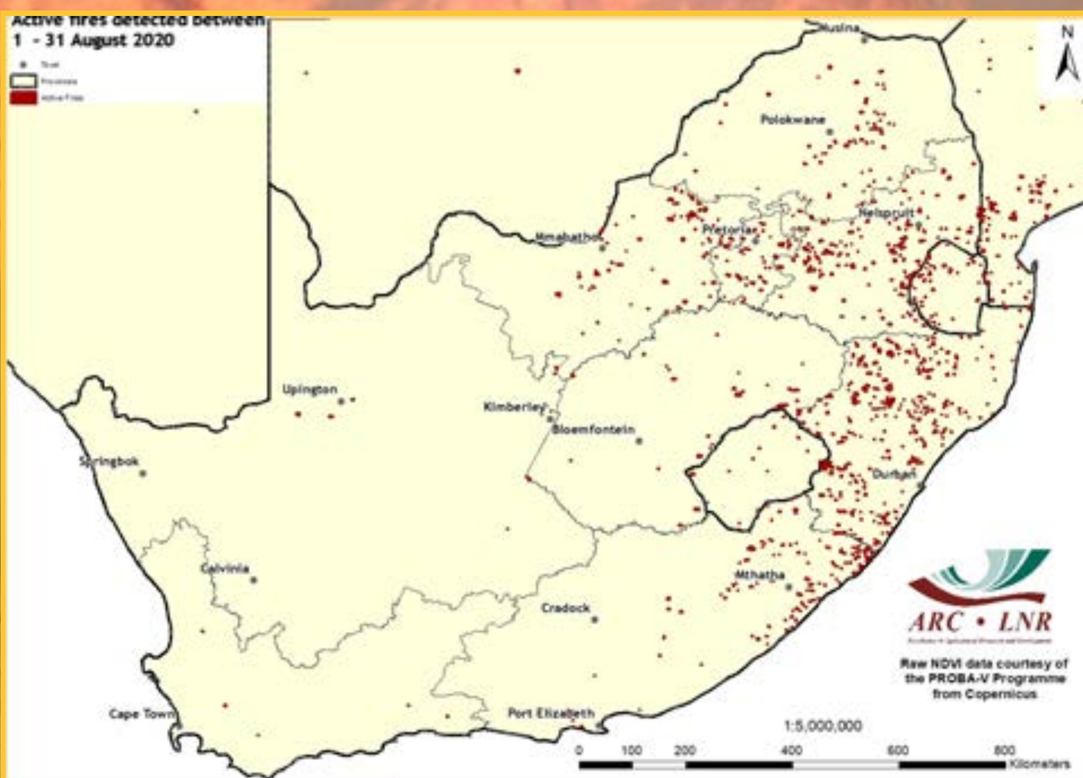


Figure 30

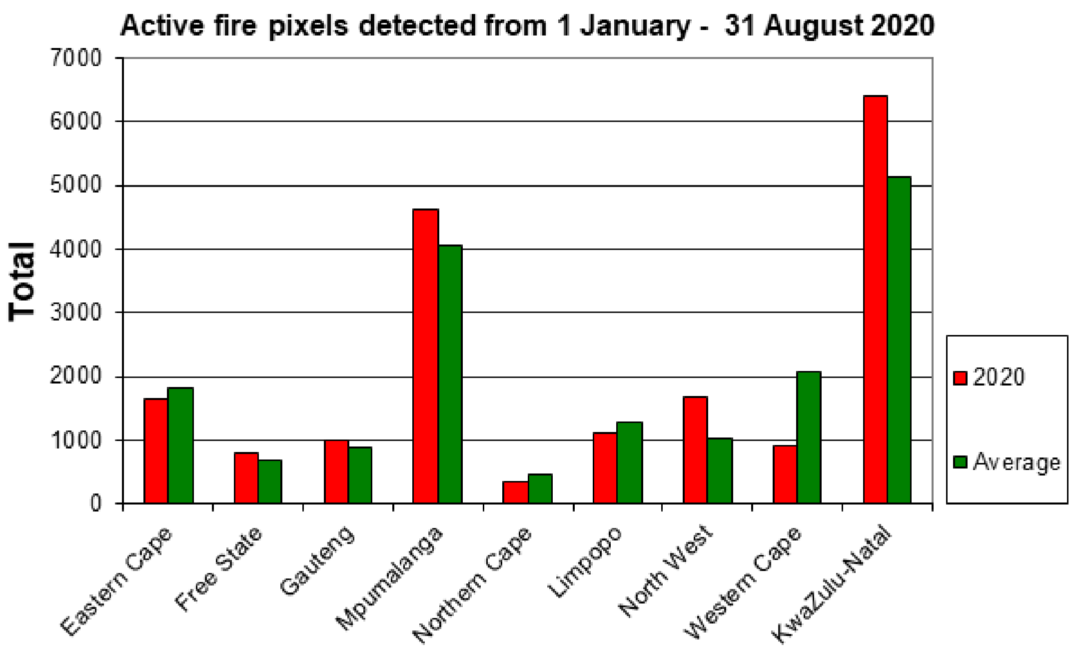


Figure 31

**Figure 31:**
The graph shows the total number of active fires detected between 1 January - 31 August 2020 per province. Cumulative fire activity was higher in the Free State, Gauteng, Mpumalanga, North West and KwaZulu-Natal compared to the long-term average.

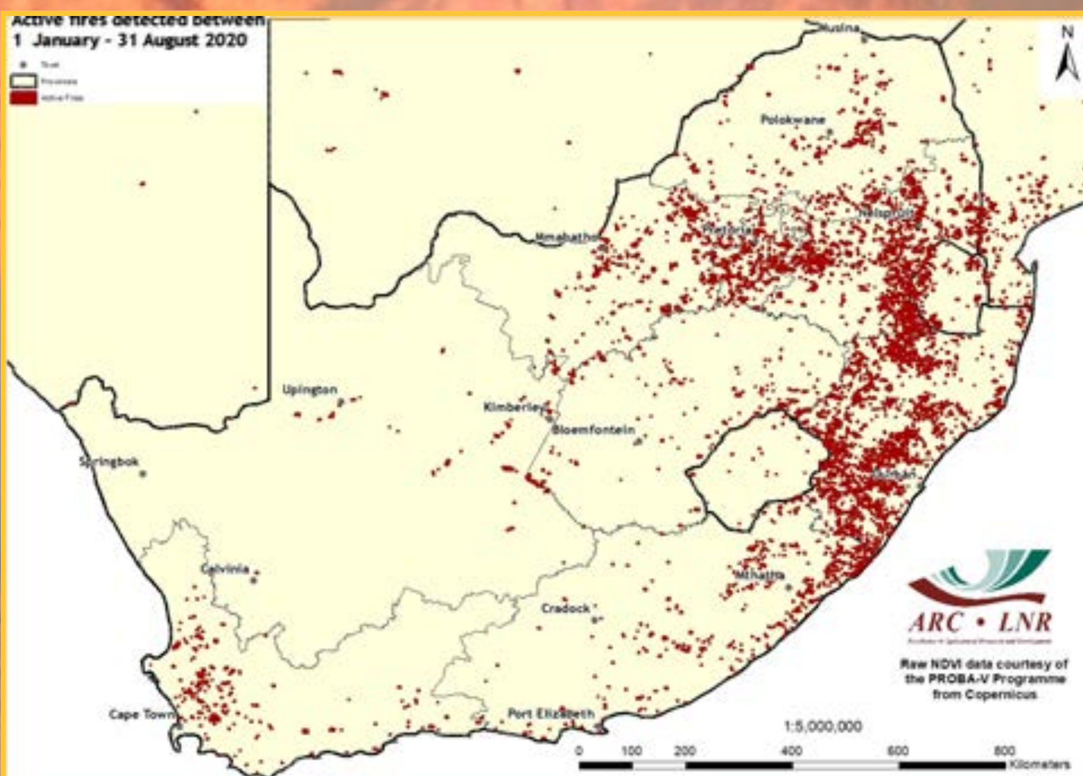


Figure 32

**Figure 32:**
The map shows the location of active fires detected between 1 January - 31 August 2020.

**Questions/Comments:**
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# 8. Surface Water Resources

**Countrywide surface water areas (SWAs) are mapped on a monthly basis by GeoTerraImage using Sentinel 2 satellite imagery from the start of its availability at the end of 2015.**

Figure 33 shows a comparison between the area of water available now and the maximum area of surface water recorded in the last 4 years. Values less than 100 represent water catchments within which the current month's total surface water is less than the maximum extent recorded for the same area since the end of 2015. Figure 34 shows a comparison between the area of water available now and for the same month last year. On this map, values less than 100 represent water catchments within which the current month's total surface water is less than that recorded in the same water catchment, in the same month, in 2019.

The long-term map for August 2020 shows a continuation of the May, June and July patterns and conditions, with the majority of catchments across the entire country now showing water levels equivalent to 60-80% of the 4-year, long-term maximum.

The comparison between August 2020 and August 2019 indicates a similar pattern to that reported last month, namely significantly higher water levels in the Karoo region but otherwise generally lower water levels in all other areas compared to last year. A few small catchments scattered across the Western and Eastern Cape as well as Limpopo are showing significantly lower water levels. This is also very similar to the pattern reported in June.

*The SWA maps are derived from the monthly data generated and available through GeoTerraImage's 'Msanzi Amanzi' web information service: https://www.water-southafrica.co.za*

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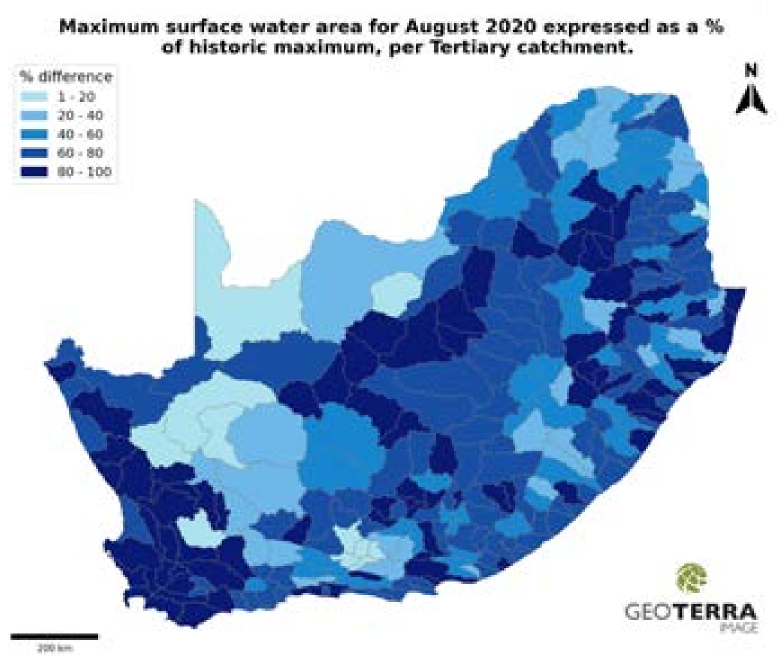



Figure 33

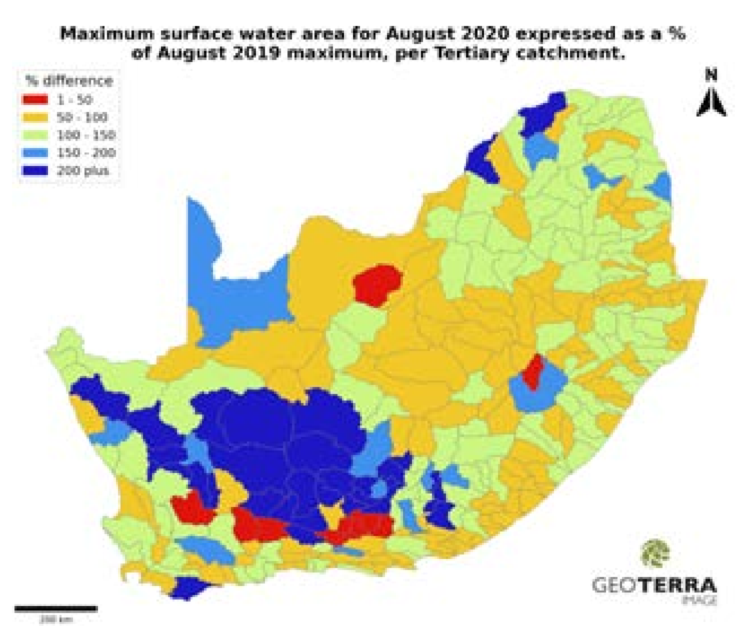
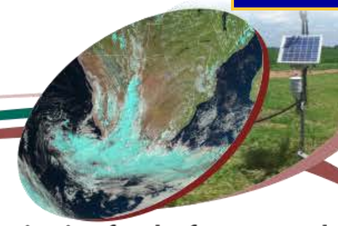



Figure 34

# Agrometeorology



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

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