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# UMLINDI
## The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:



agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

South African Weather Service

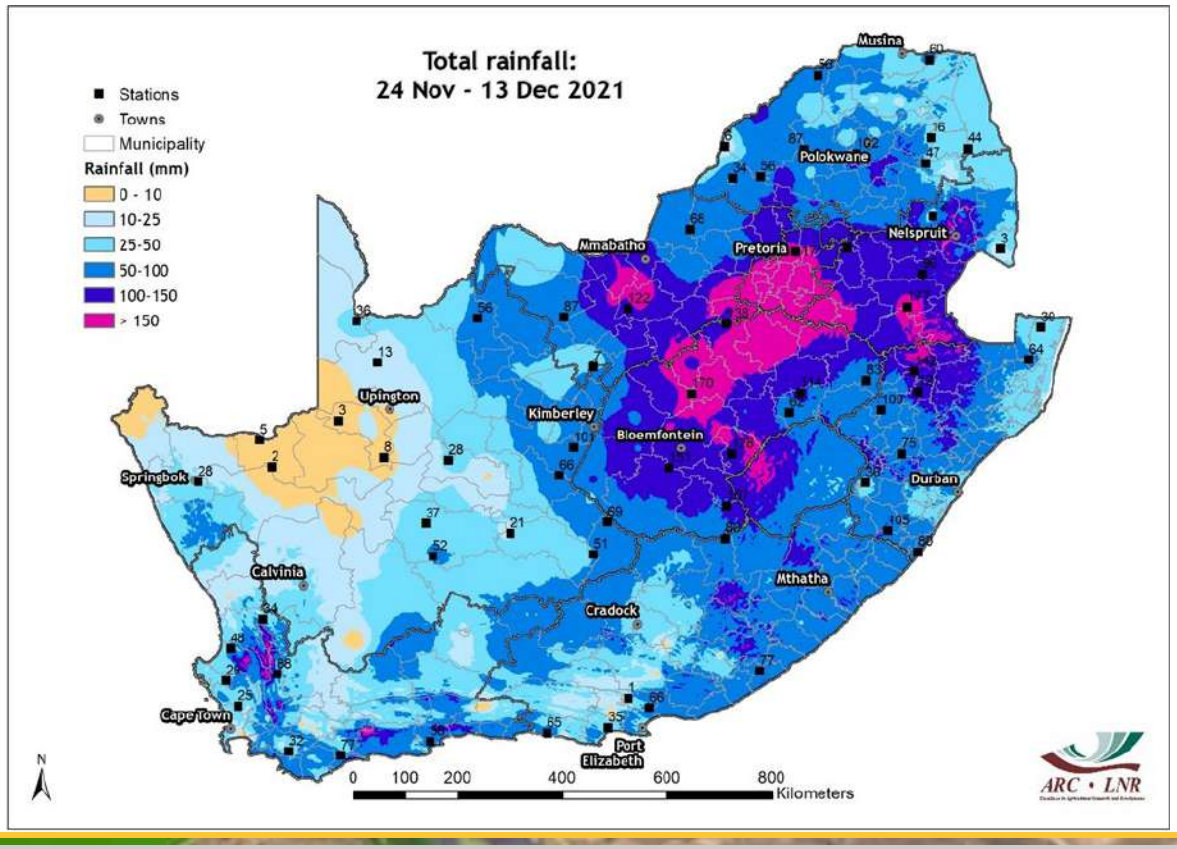
AMESD

210th Edition

# Image of the Month

## Notable wet spell during early summer

Typical summer atmospheric conditions resulted in good rainfall over most parts of the country in November/December 2021, particularly in the eastern regions. However, thunderstorms accompanied by strong winds and hail caused localized flooding and damage to infrastructure in some areas. On 25 November, an intense weather system resulted in strong northeasterly winds over the western regions of the country, while a damaging hailstorm occurred in and around Klerksdorp in North West Province and heavy rainfall was observed in Gauteng. The month ended with a cut-off low bringing strong winds and heavy downpours over the central parts of South Africa. These wet conditions continued into December, with the system resulting in widespread showers and severe thunderstorms over greater parts of the country, especially the Highveld where totals in excess of 150 mm were recorded between 24 November and 13 December, with up to 170 mm in places (see rainfall map below). Furthermore, severe hailstorms occurred over parts of the OR Tambo District Municipality in the Eastern Cape on 13 December, resulting in damage to developing crops and livestock mortality. Farmers are therefore advised to remain cognizant of the conditions associated with a typical La Niña summer. Although good rains may result in improved crop yields and regeneration of pastures, they are also likely to cause localized flooding and damage to infrastructure, as well as increased risk of insects, plant diseases and invasive weeds.




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.

# 1. Rainfall

***Overview:***

Greater parts of the country experienced scattered to widespread rainfall during November 2021, with strong winds and large hail over certain areas. A notable increase in total rainfall was observed over the eastern to northeastern regions, as compared to the previous months. Much needed rainfall was observed over the Limpopo Province, which had been subject to mild-moderate drought conditions during the past 3 months. Areas that recorded in excess of 100 mm of rain are in and around Thulamela Local Municipality, moving south towards Mokopane. Moreover, isolated areas in the North West, Gauteng, Mpumalanga and KwaZulu-Natal provinces also received up to 200 mm of rainfall in November. The only places that recorded >200 mm for the month were in the all-year rainfall region and the northern parts of KZN. Meanwhile, the Northern Cape was exceptionally dry, with isolated areas in the far south and east accumulating totals of 10-75 mm. These conditions are in contrast to the rainy conditions that were experienced over that region in October. Thus, spring concluded with normal to above-normal rainfall over the summer, winter and all-year rainfall regions, while below-normal rainfall occurred over most of the very late summer (March-May) region and isolated parts of KZN during the month of November.

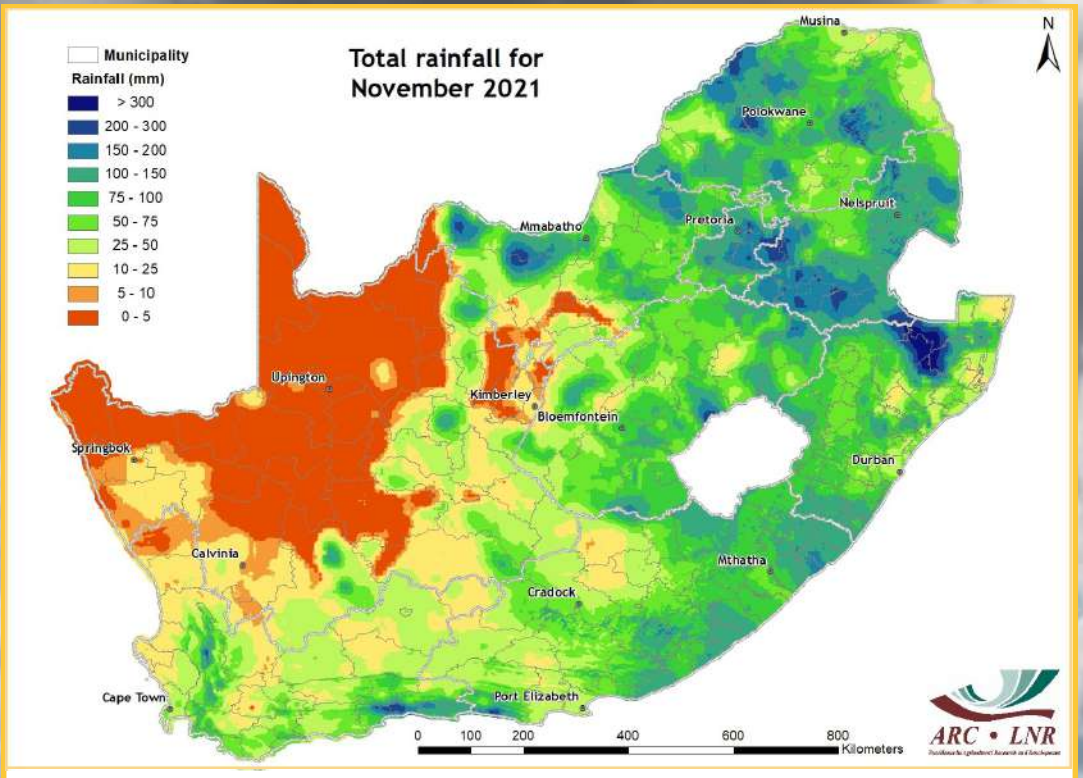



Figure 1

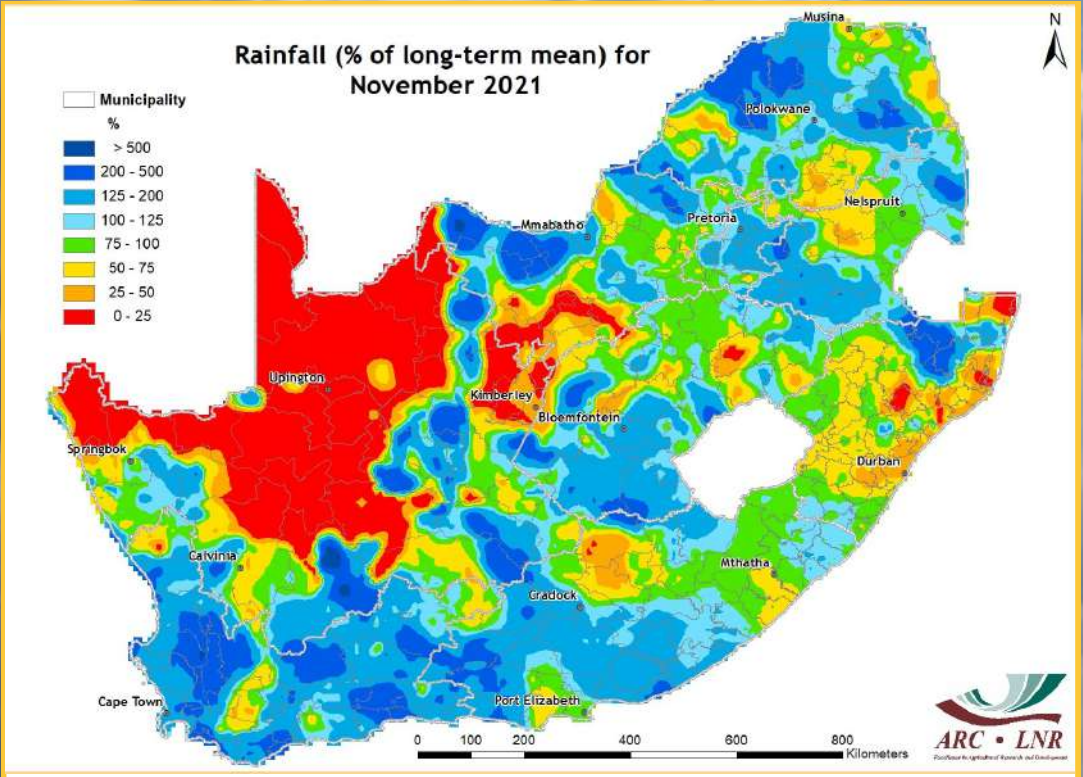
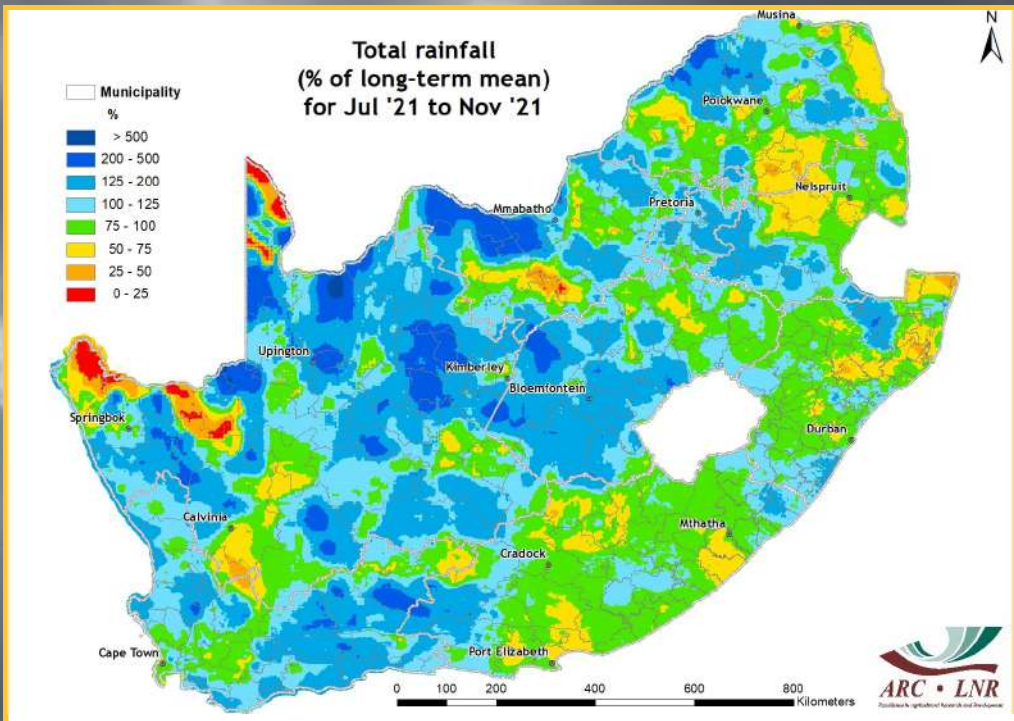



Figure 2

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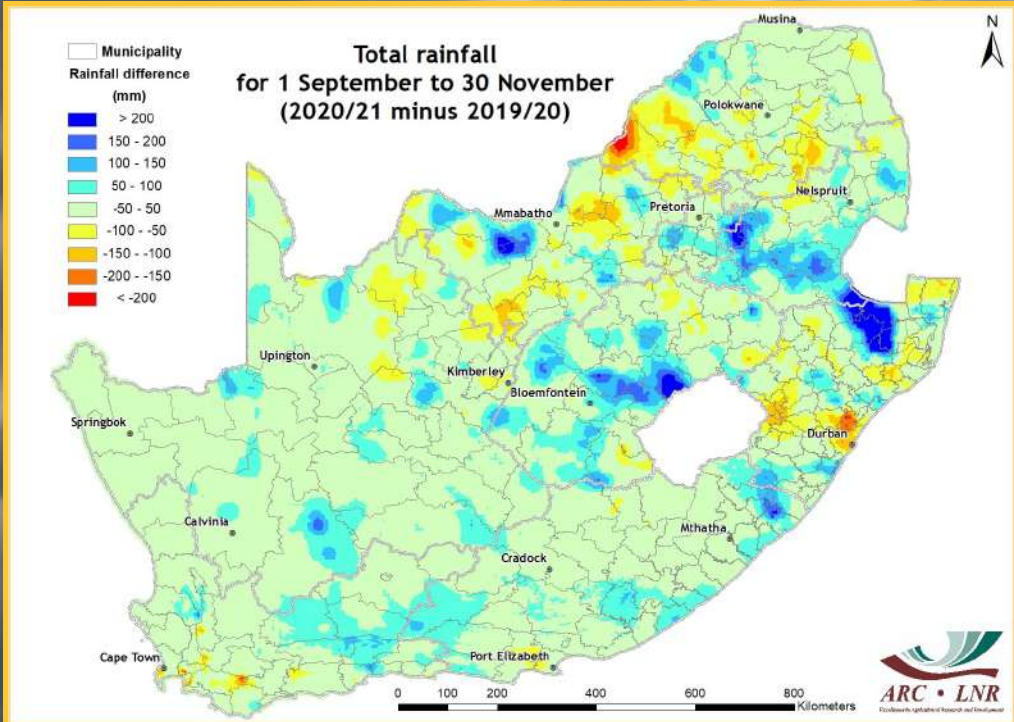


Figure 4

**Figure 1:**
Most of the summer and the all-year rainfall regions experienced an increase in total rainfall during November 2021. Certain parts of the winter rainfall region also experienced similar conditions, while much of the Northern Cape was generally dry.

**Figure 2:**
Unlike the previous month, normal to above-normal rainfall conditions were noted over the southwestern and northeastern parts of the country during November. Below-normal rainfall occurred over most parts of the Northern Cape and KwaZulu-Natal, as well as isolated areas of the Limpopo, North West, Free State, Mpumalanga and Eastern Cape provinces.

**Figure 3:**
Cumulative rainfall from July to November 2021 compared to the long-term mean for the same period indicates similar conditions to those that were observed last month, except for most parts of Limpopo and Mpumalanga which displayed below-normal conditions in the previous month.

**Figure 4:**
When comparing accumulated rainfall for September to November 2021 with that of the same period last year, it can be observed that isolated areas over the interior received more rain, whilst parts of the Cape provinces, KZN, North West, Free State, Limpopo and Mpumalanga experienced less rainfall this year. The rest of the country was mostly comparable.

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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 map ending in November indicates a development of wet conditions over most parts of the country, with mild drought still evident over the summer rainfall region and more intensely over the Namakwa District of the Northern Cape and the Limpopo/Mpumalanga border. The medium- to long-term time scales show to some extent similar conditions to the SPI of the previous 3 months, with wet conditions depicted over the northern interior, Lowveld of Limpopo and Mpumalanga, as well as isolated areas of the Western Cape and KZN. Meanwhile, severe to extreme drought conditions dominate the western regions of the country, extending towards the Eastern Cape, KZN, eastern Free State and the interior of Limpopo and Mpumalanga at the longer time scales (24-36 months).

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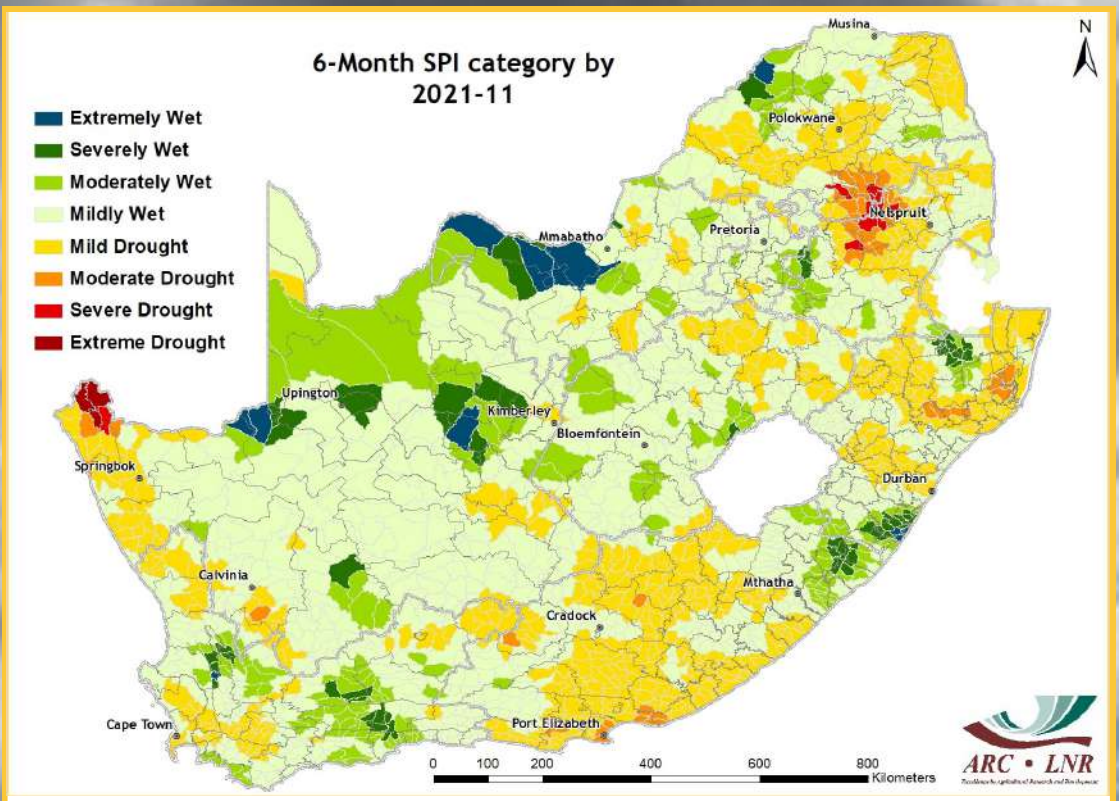


Figure 5

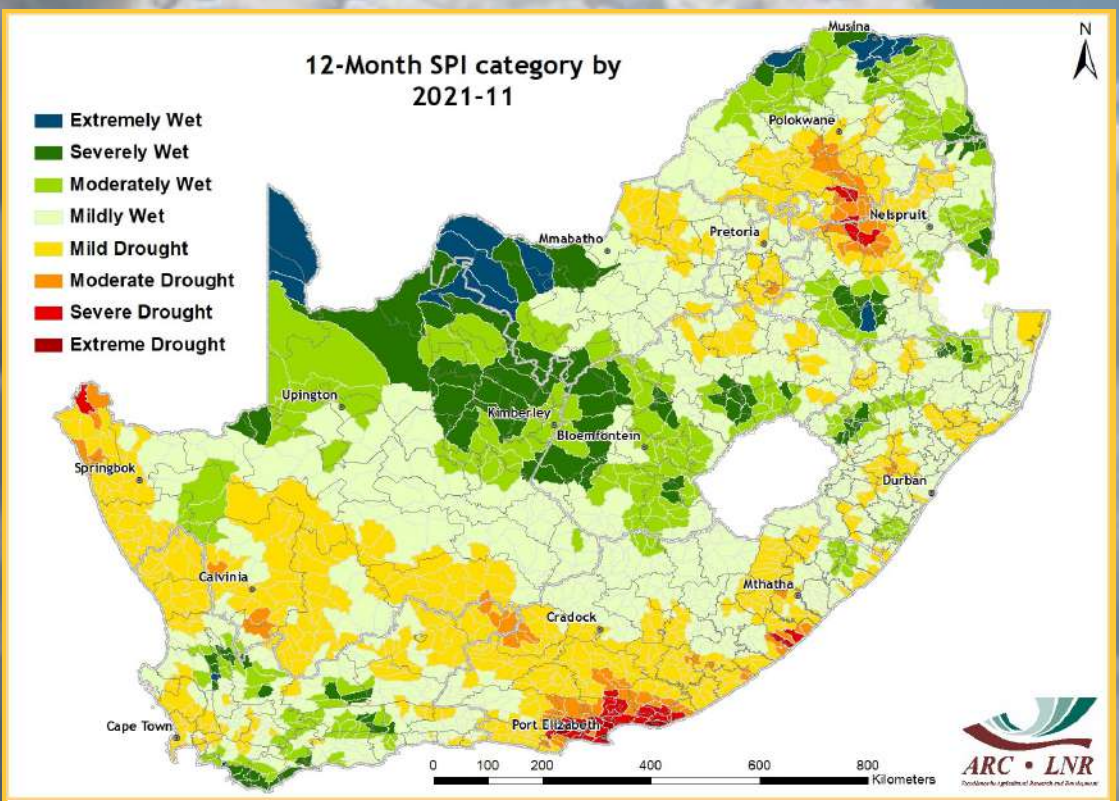


Figure 6

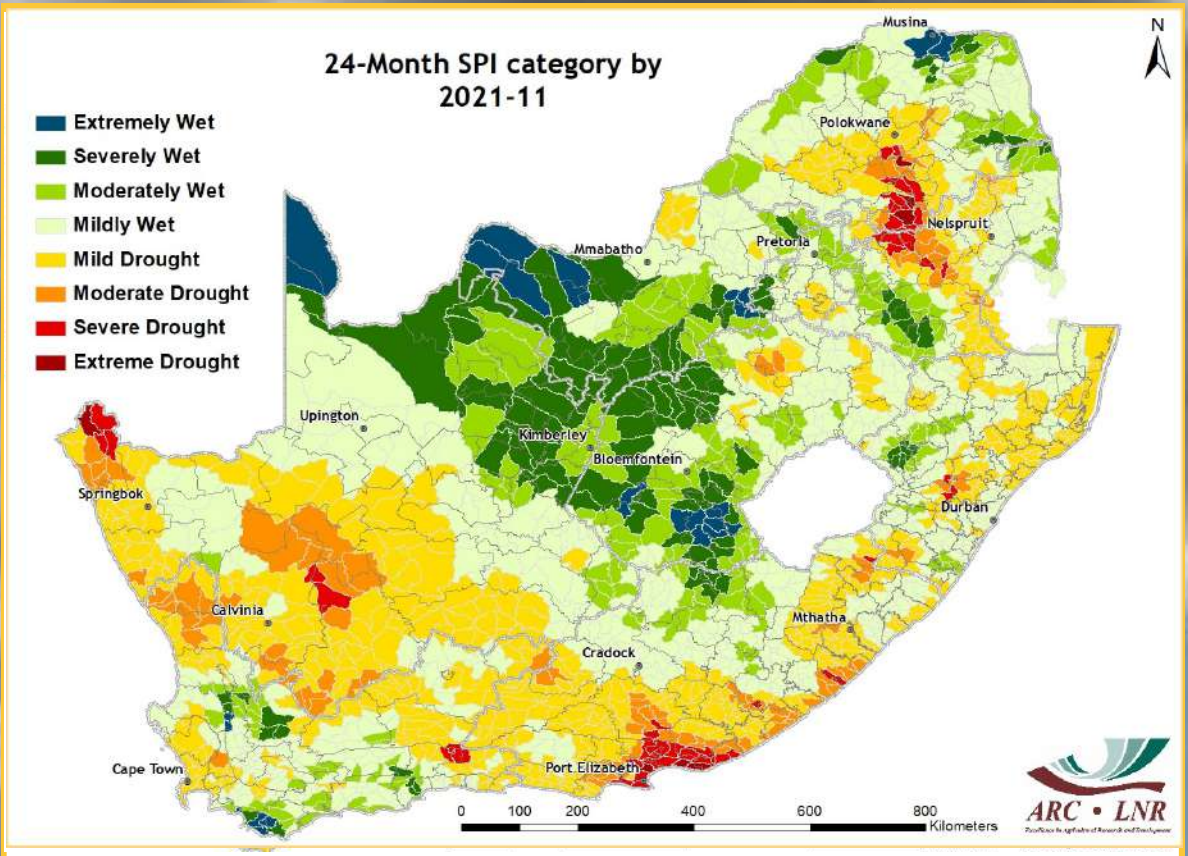


Figure 7

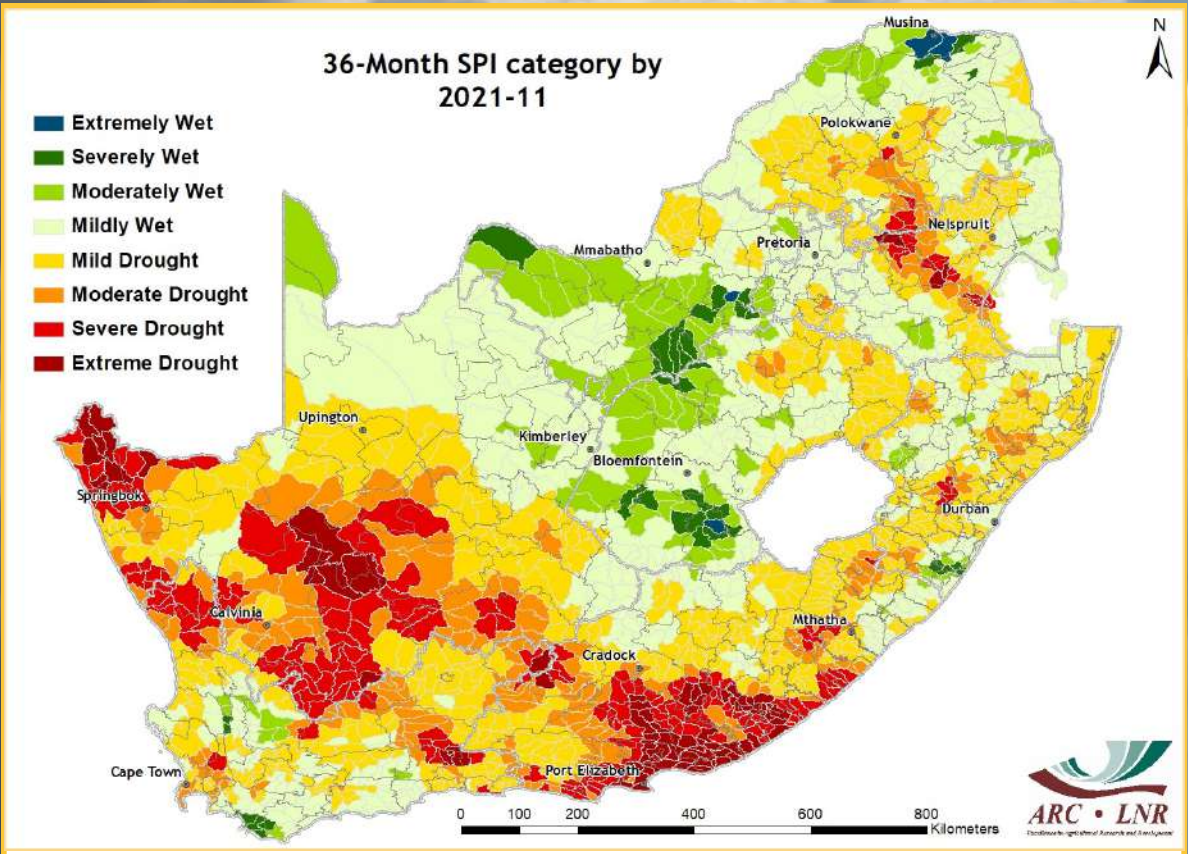


Figure 8

# 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.

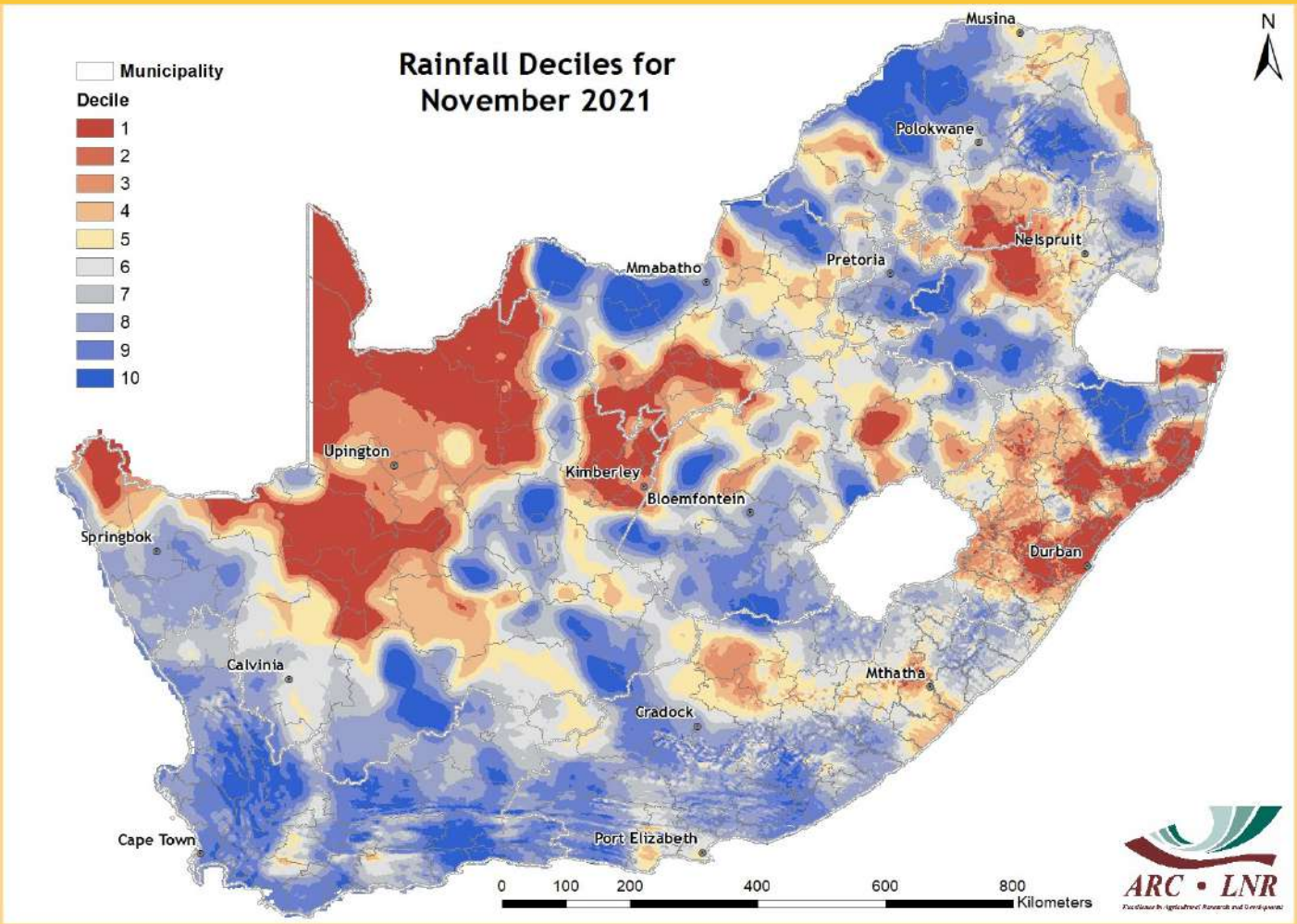


Figure 9

**Figure 9:**
The central and northern parts of the Northern Cape, adjacent areas of North West, and parts of the Free State, Limpopo, Mpumalanga, KwaZulu-Natal and Eastern Cape received rainfall totals that compare well with historically drier November months. The opposite is true for the rest of the country.

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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.

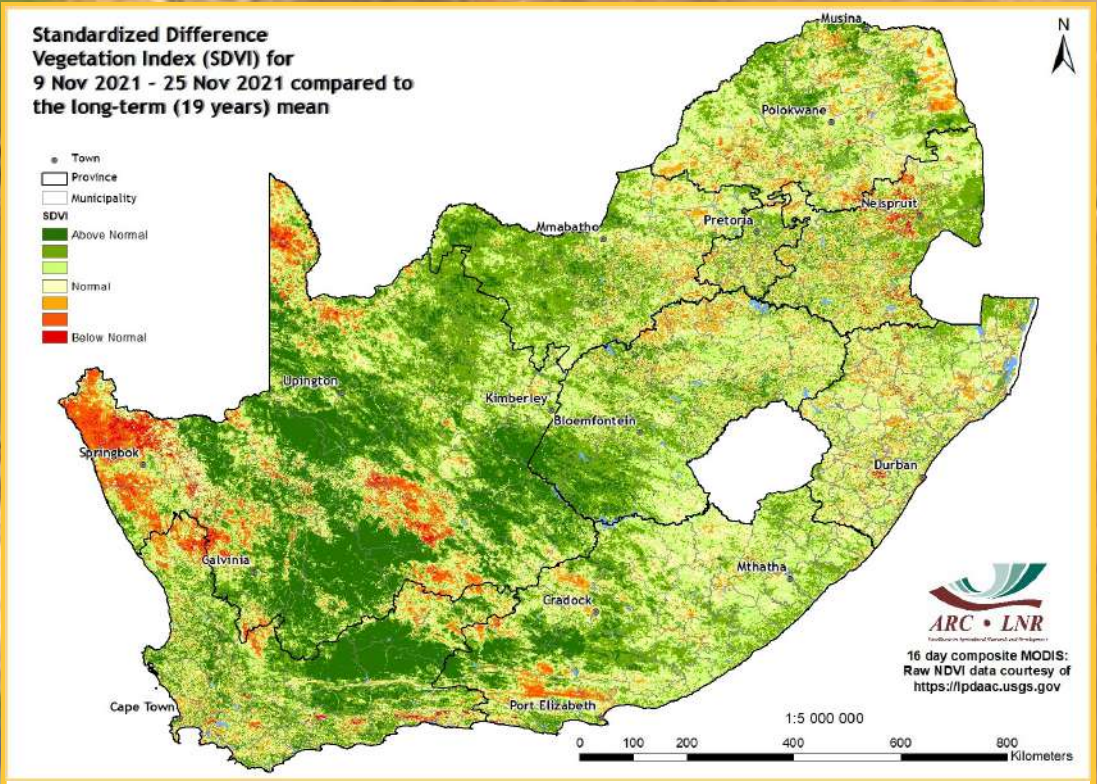


Figure 10

**Figure 10:**
Compared to the historical averaged vegetation conditions, the 16-day SDVI map for November 2021 shows that many parts of the country experienced above-normal vegetation activity with pockets of below-normal vegetation conditions in isolated areas.

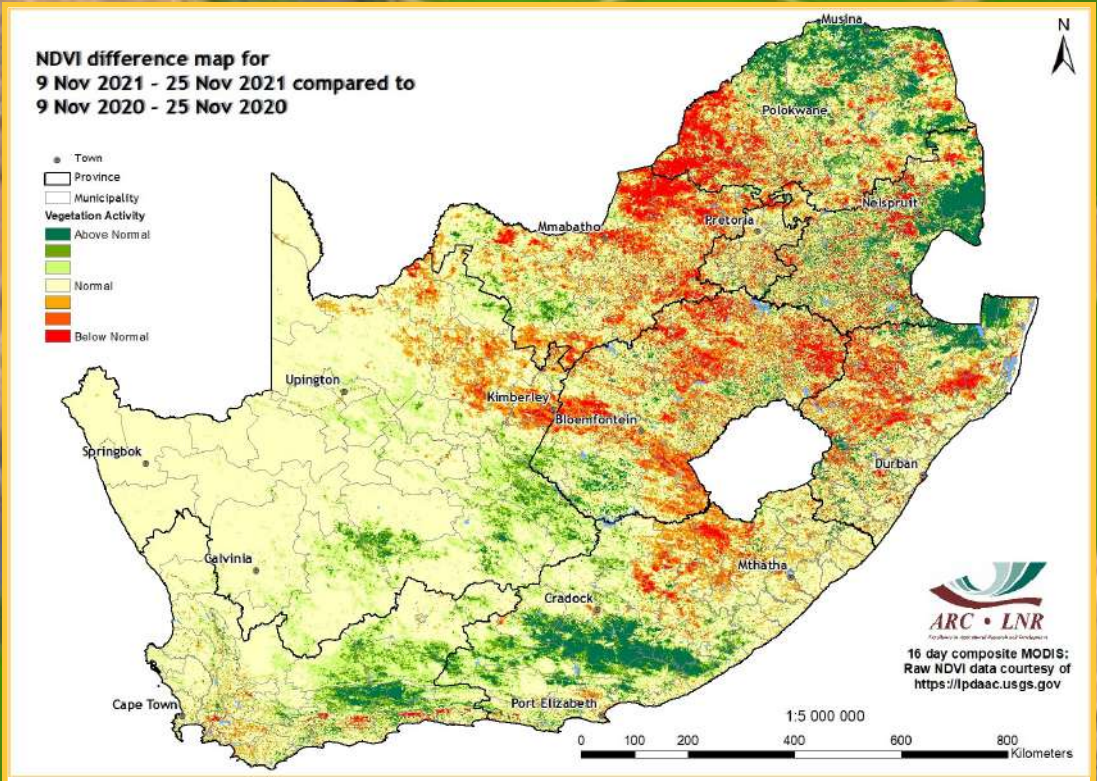


Figure 11

**Figure 11:**
When comparing the 16-day NDVI difference map for November 2021 to the same month last year, it can be observed that the central and northern parts of the country experienced below-normal vegetation activity. The remaining areas experienced normal vegetation conditions with pockets of above-normal activity.

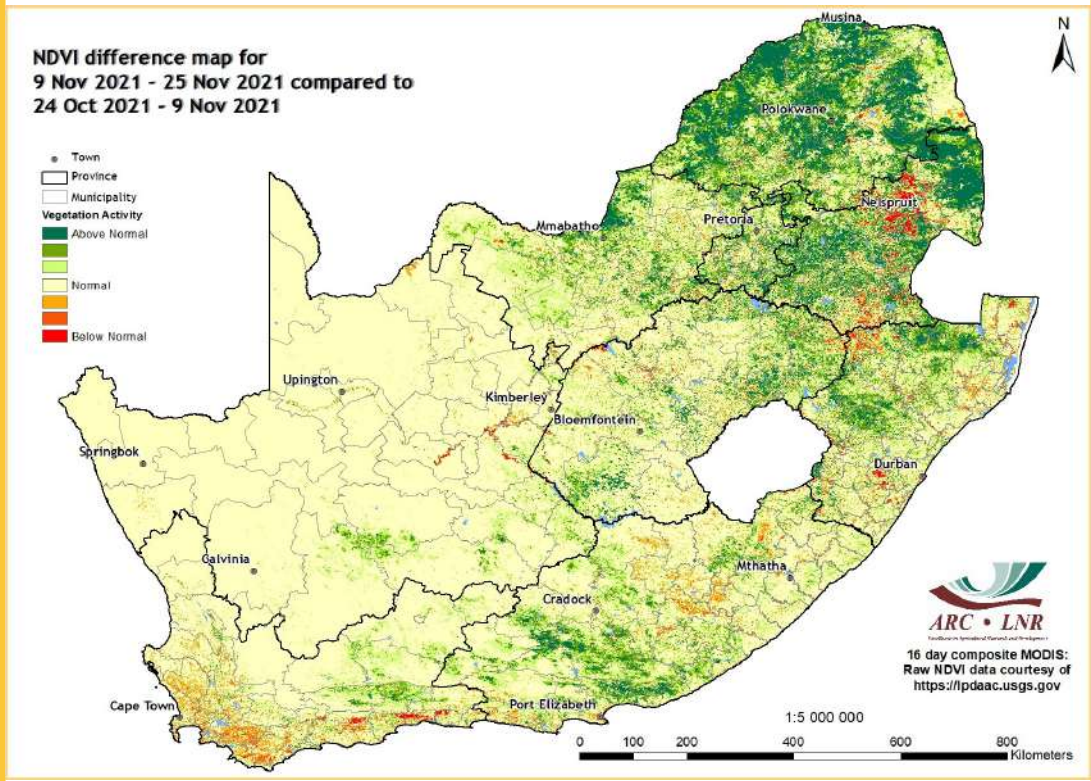


Figure 12

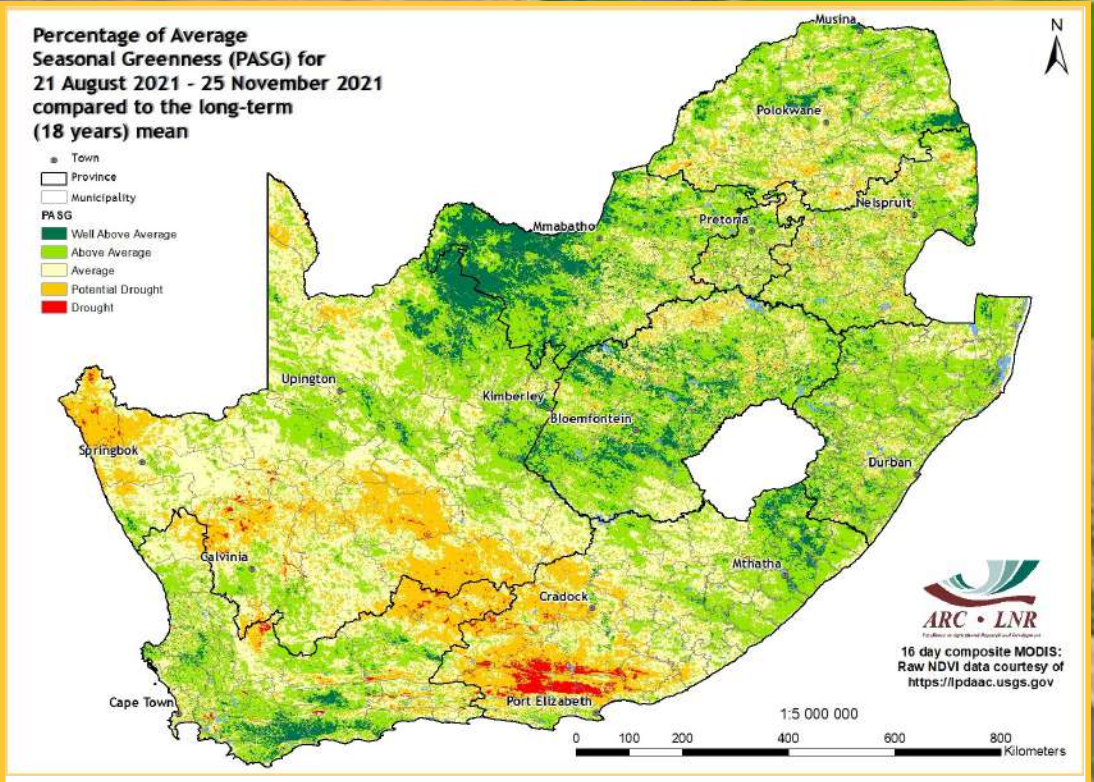


Figure 13

## 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 12:**
The 16-day NDVI difference map for November shows that the country experienced mostly normal to above-normal vegetation conditions with pockets of below-normal conditions in isolated areas.

**Figure 13:**
The Percentage of Average Seasonal Greenness (PASG) map over a 3-month period, compared to the long-term mean, shows that the central and northern parts of the country experienced high levels of seasonal vegetation greenness. However, potential drought or drought conditions are prevailing towards the western parts of the country.

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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.

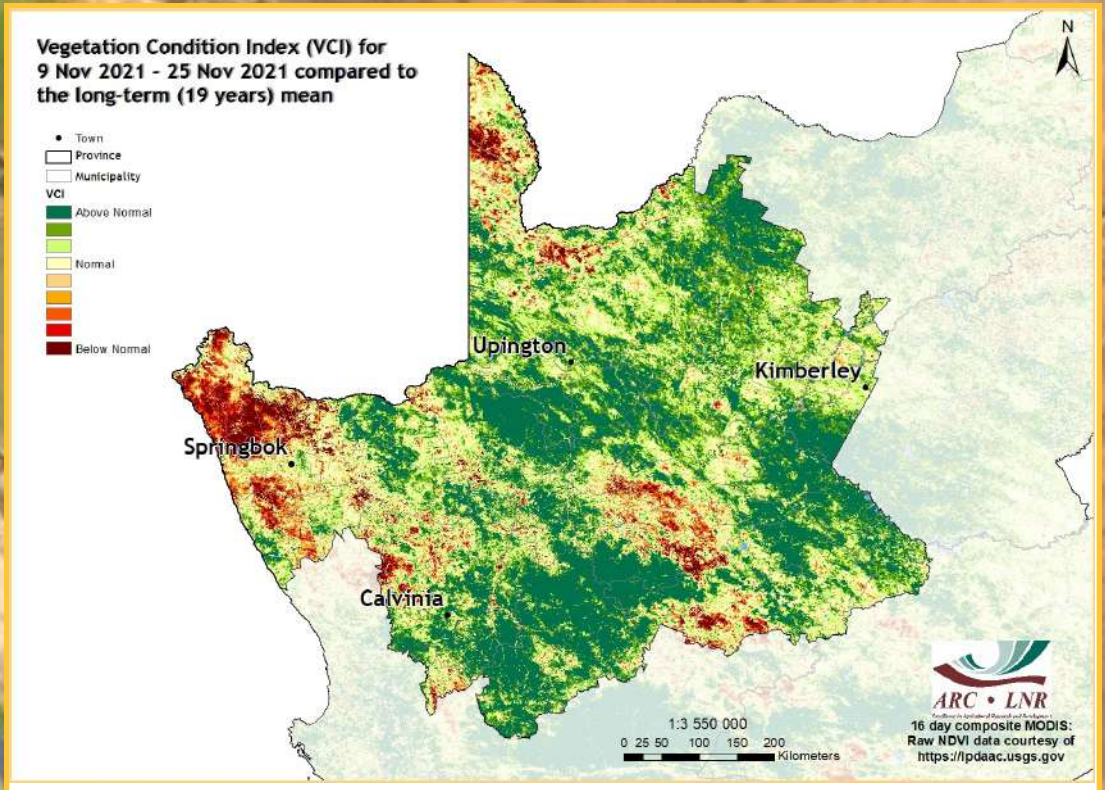


Figure 14

**Figure 14:**
The 16-day VCI map for November indicates that improved vegetation conditions have spread over many parts of the Northern Cape, with only a few areas still experiencing drought conditions.

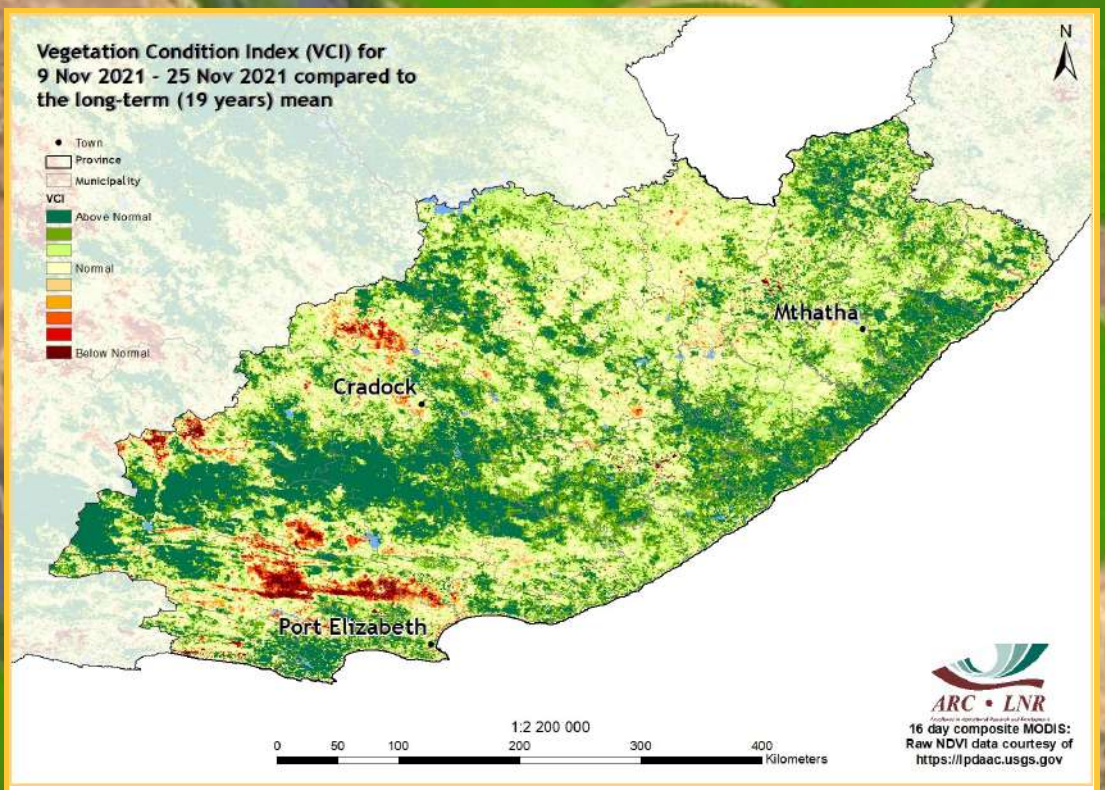


Figure 15

**Figure 15:**
The 16-day VCI map for November indicates that vegetation conditions have improved in many parts of the Eastern Cape, although pockets of poor vegetation activity remain in the westerm parts of the province.

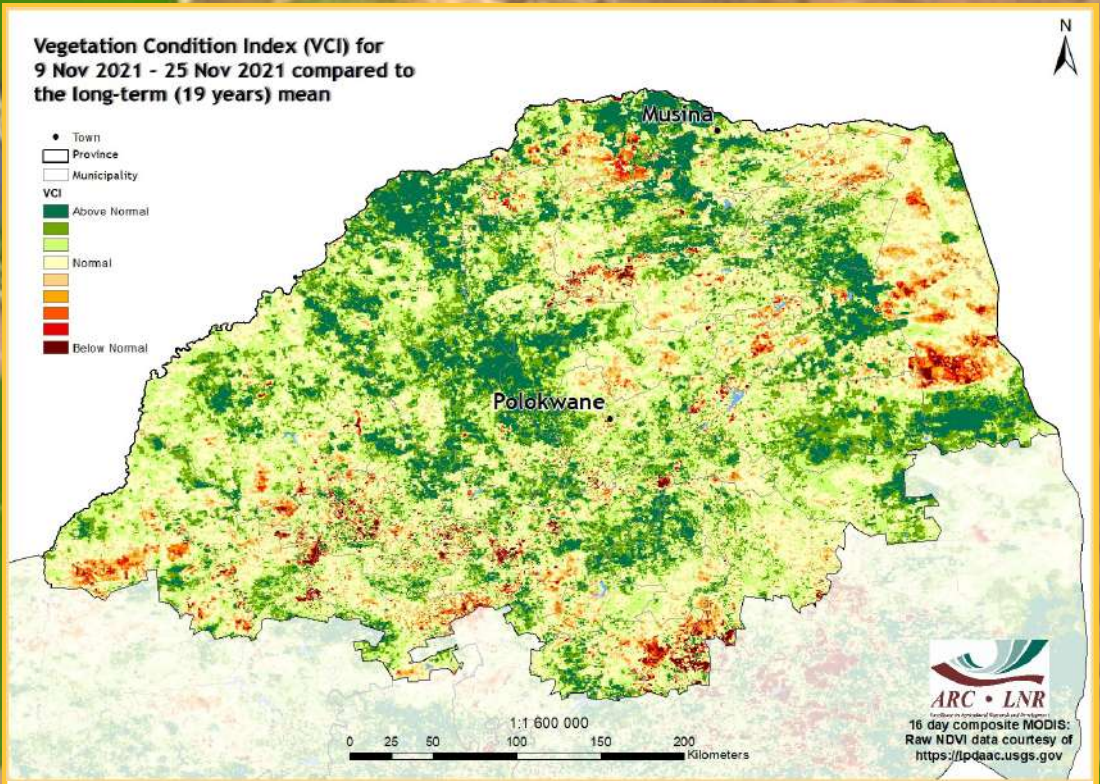


Figure 16

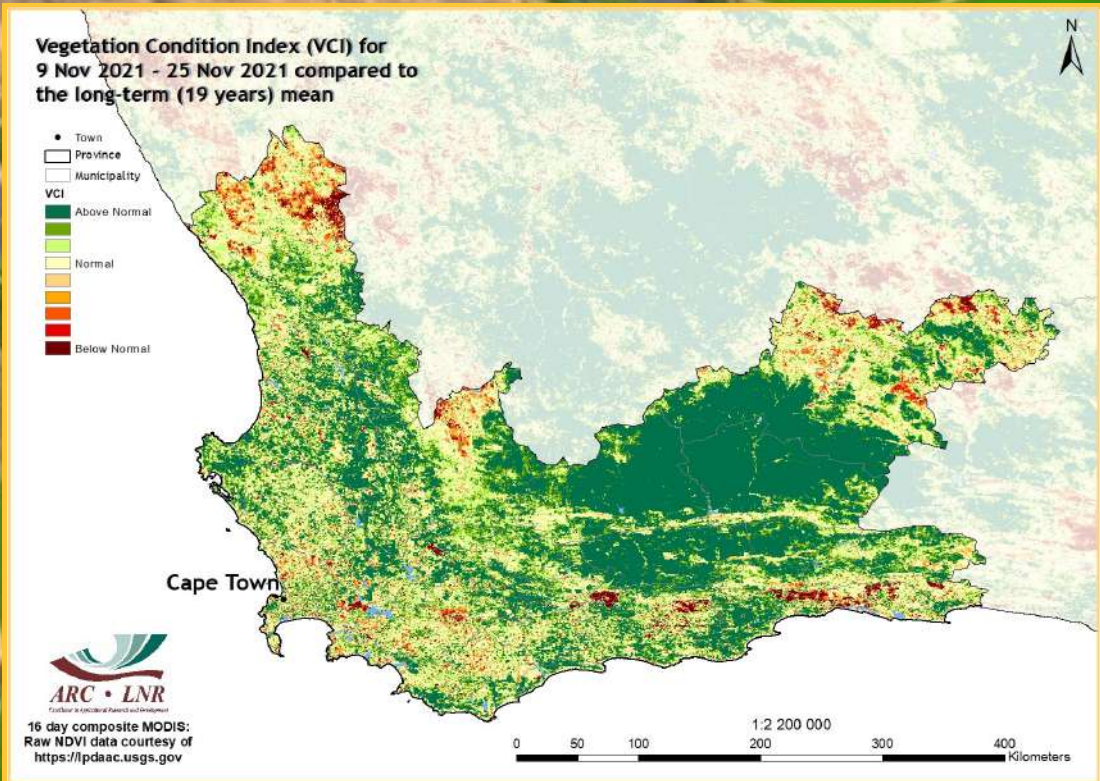


Figure 17

**Figure 16:**
The 16-day VCI map for November indicates that above-normal vegetation conditions have spread throughout Limpopo, although pockets of poor vegetation activity still remain.

**Figure 17:**
The 16-day VCI map for November shows above-normal vegetation conditions throughout most of the Western Cape, although pockets of poor vegetation activity can be observed in isolated areas of the province.

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



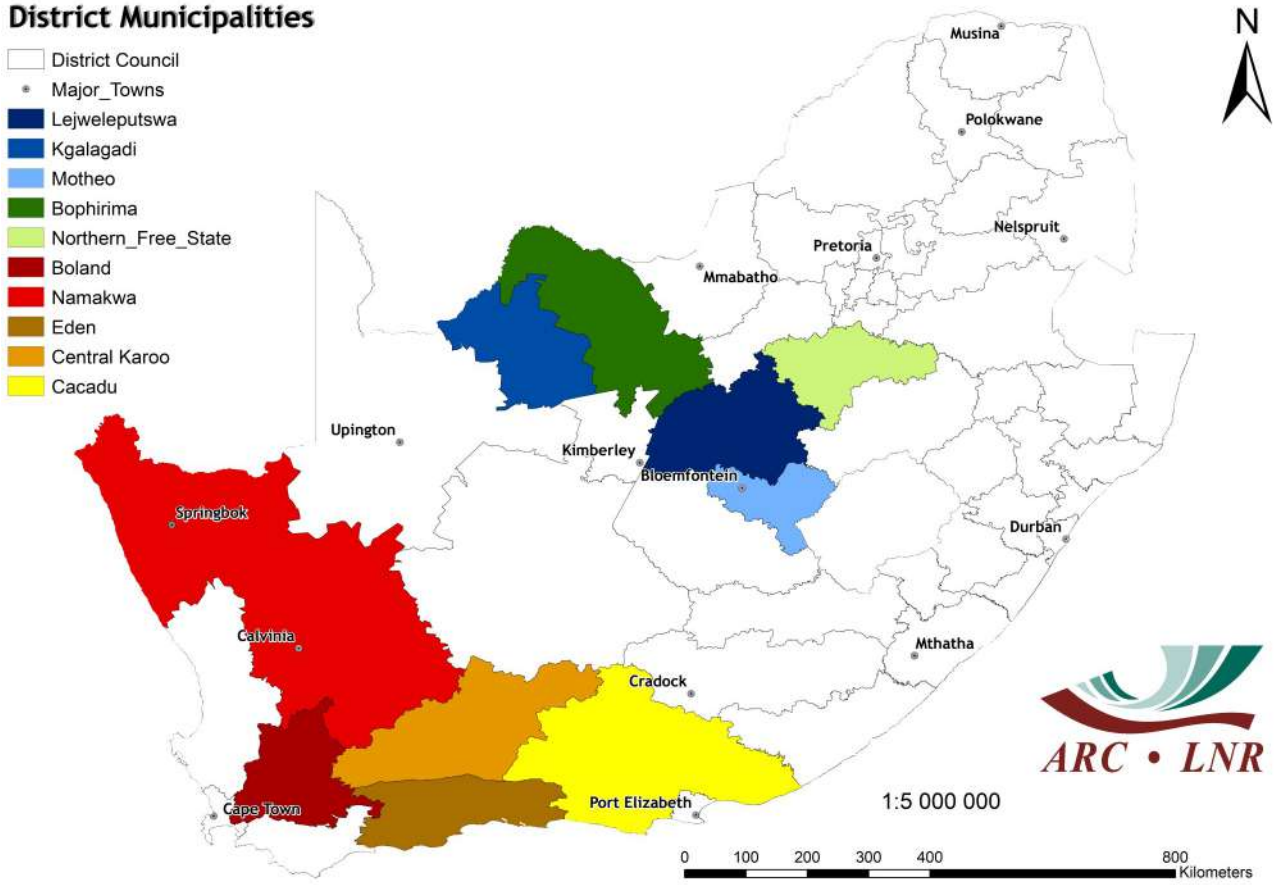


Figure 18

**Rainfall and NDVI Graphs**

**Figure 18:**
Orientation map showing the areas of interest for November 2021. 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.

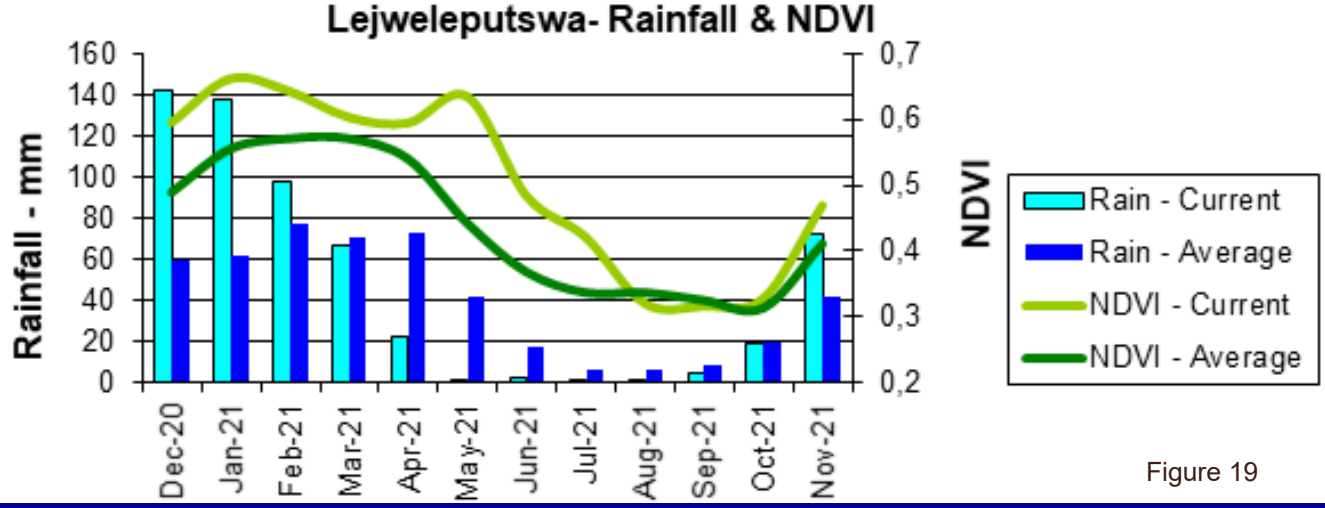
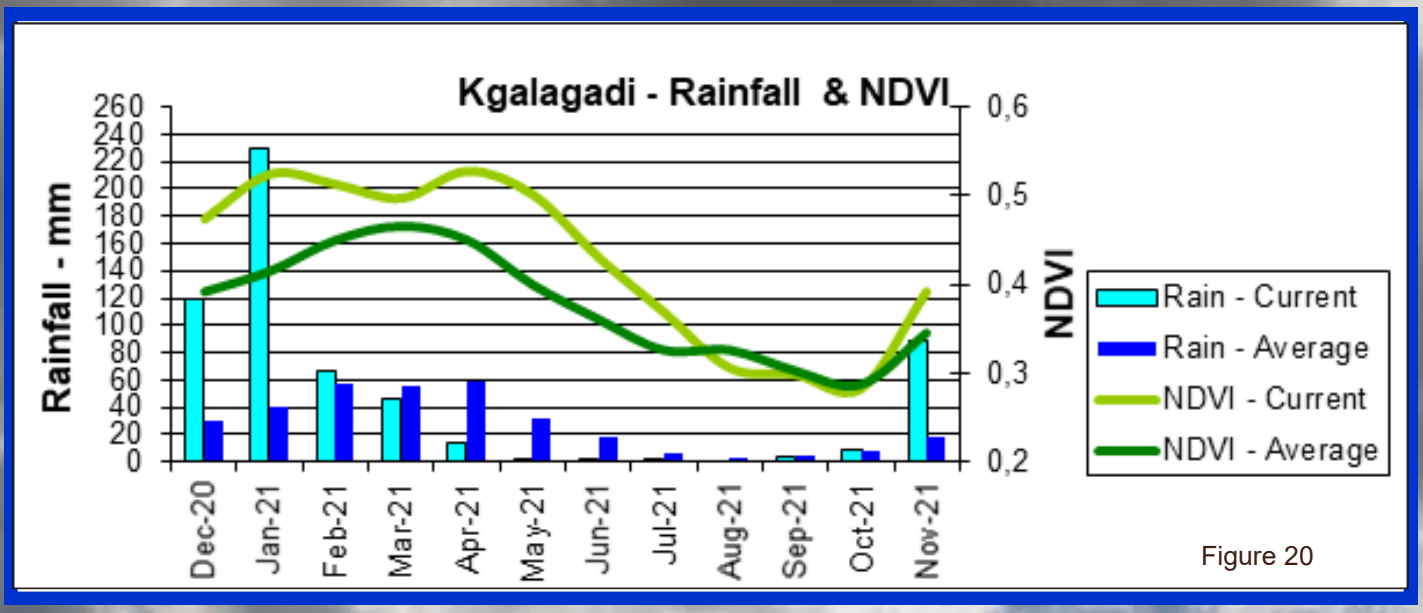



Figure 19

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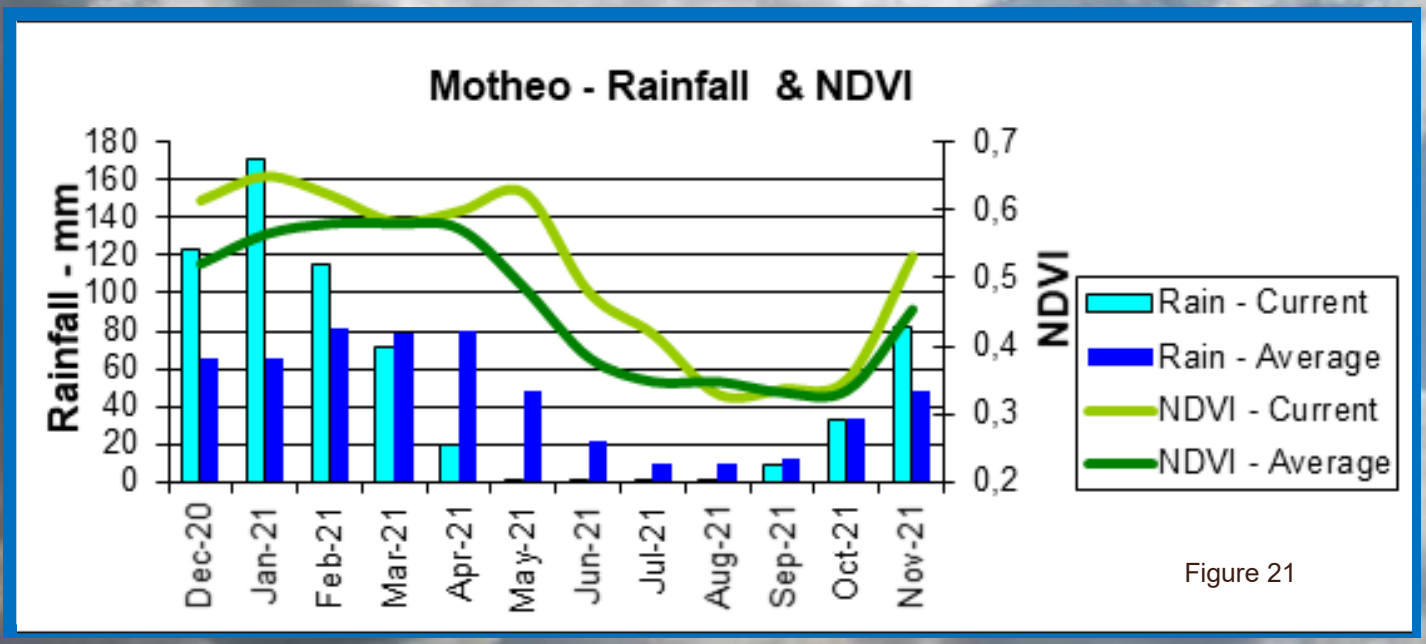


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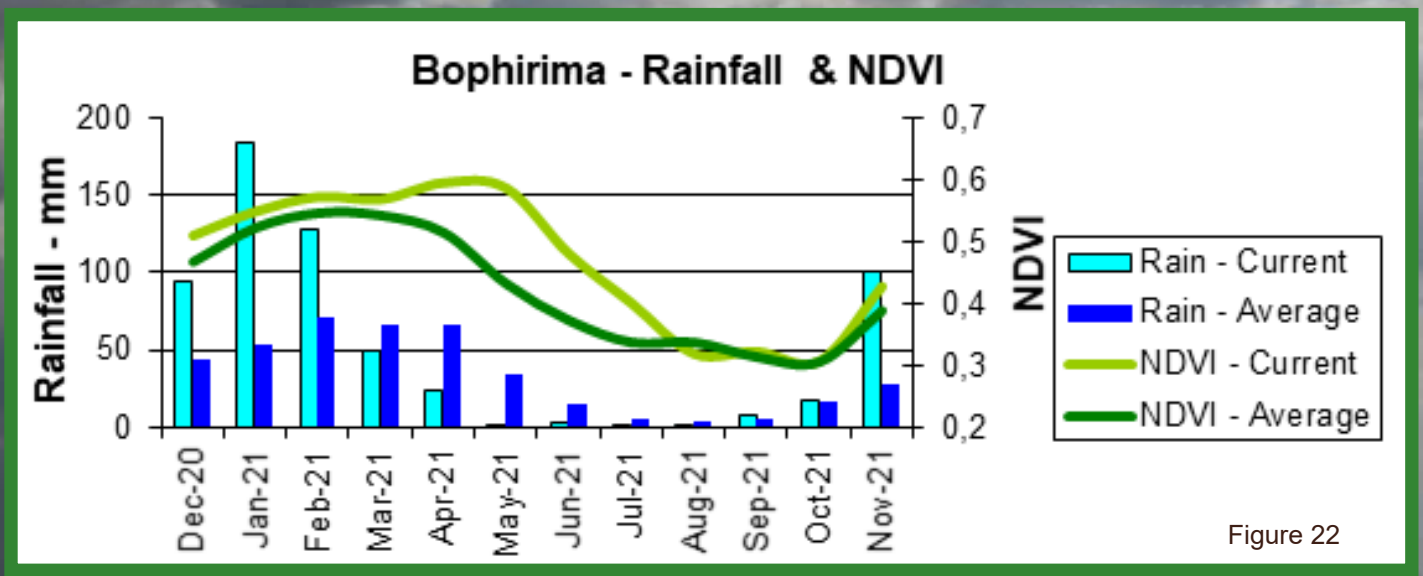


Figure 22

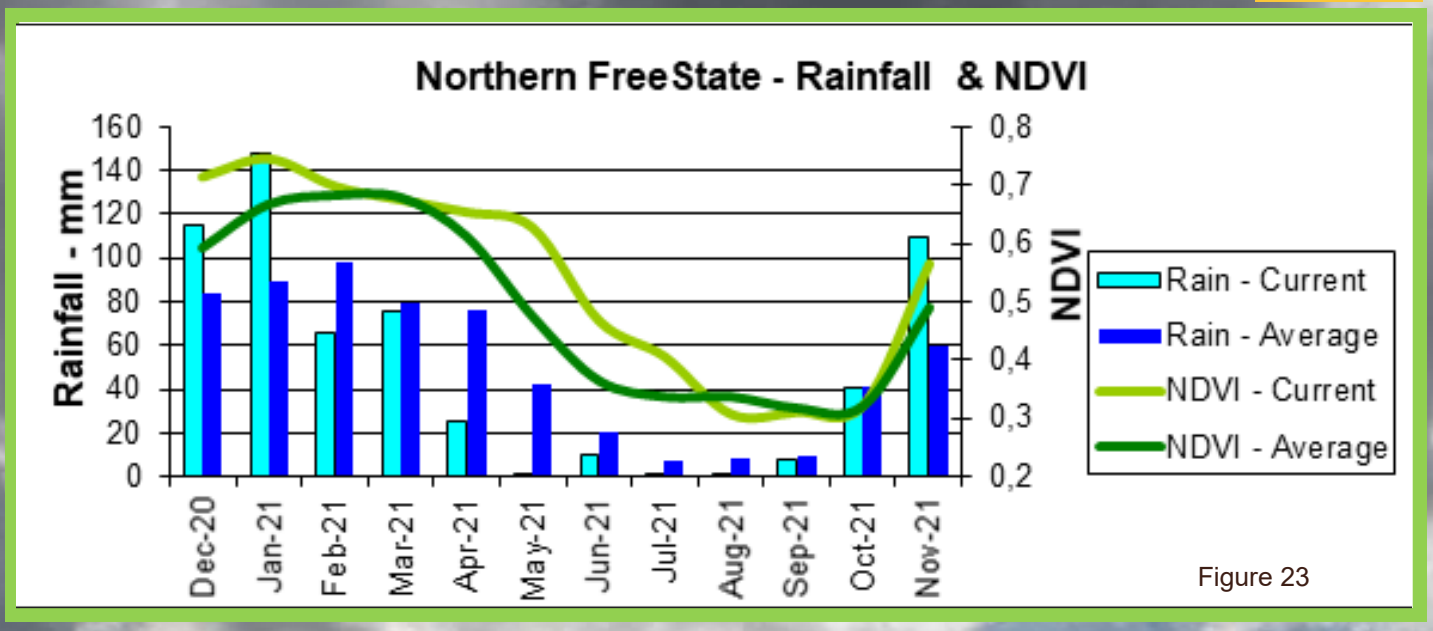


Figure 23

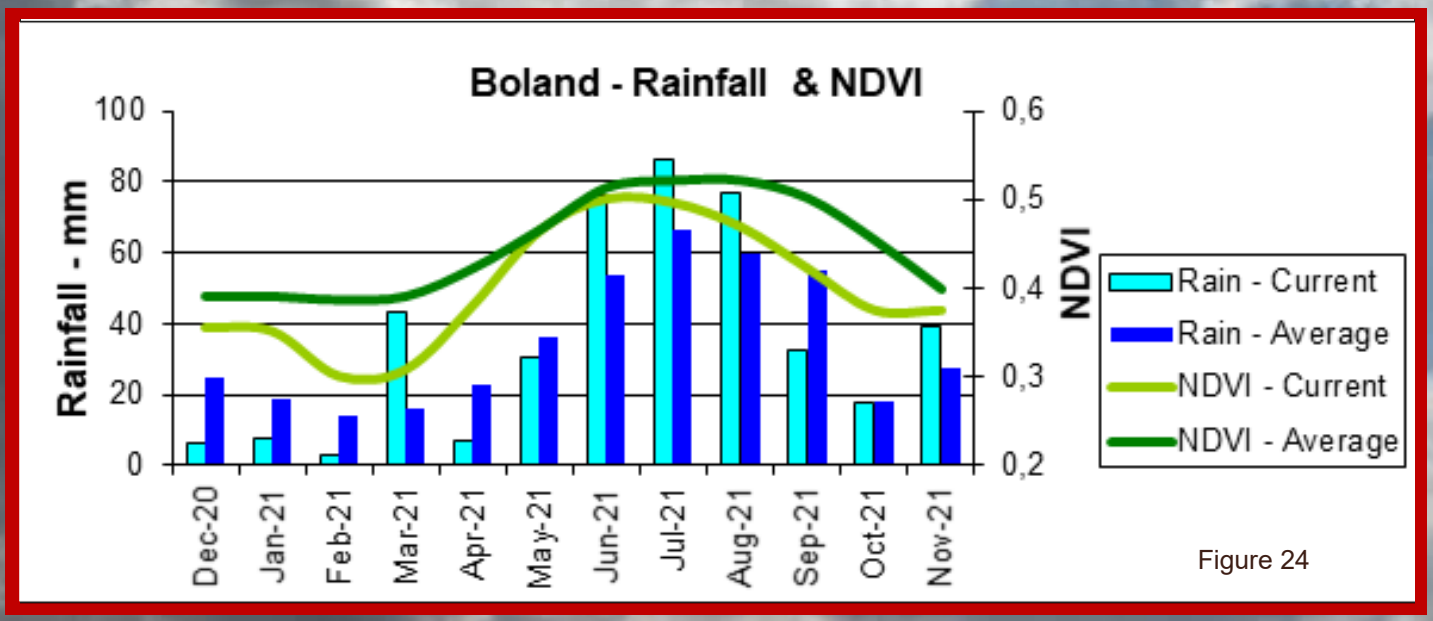


Figure 24

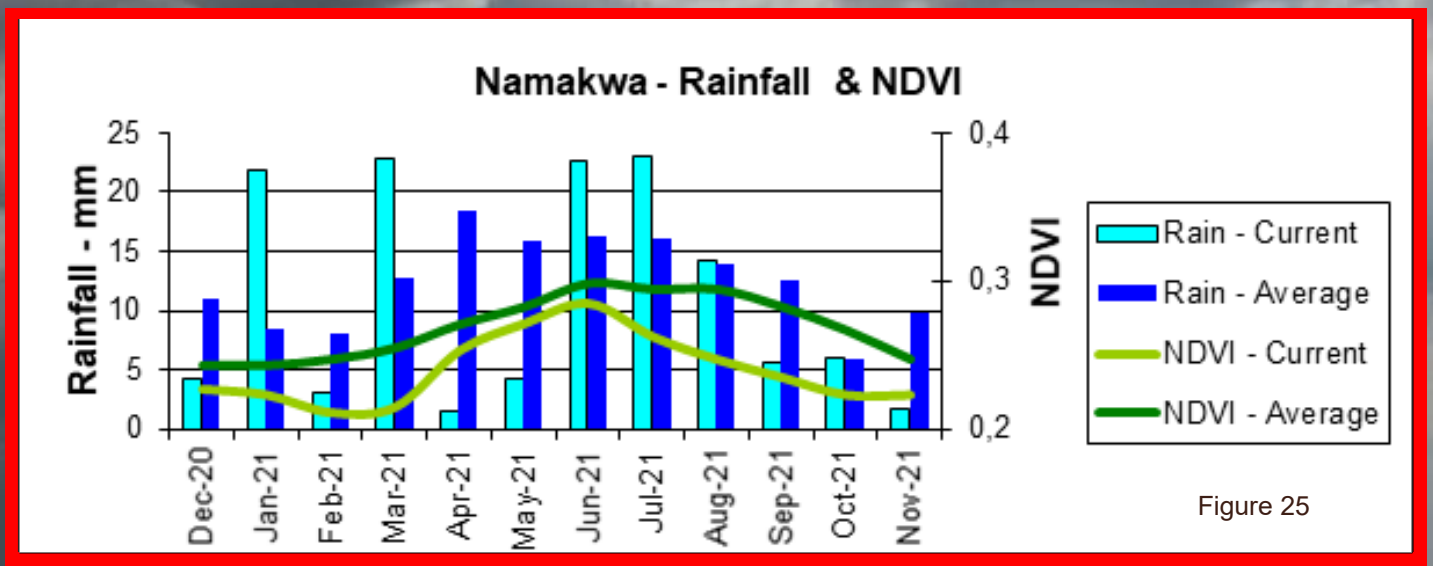


Figure 25

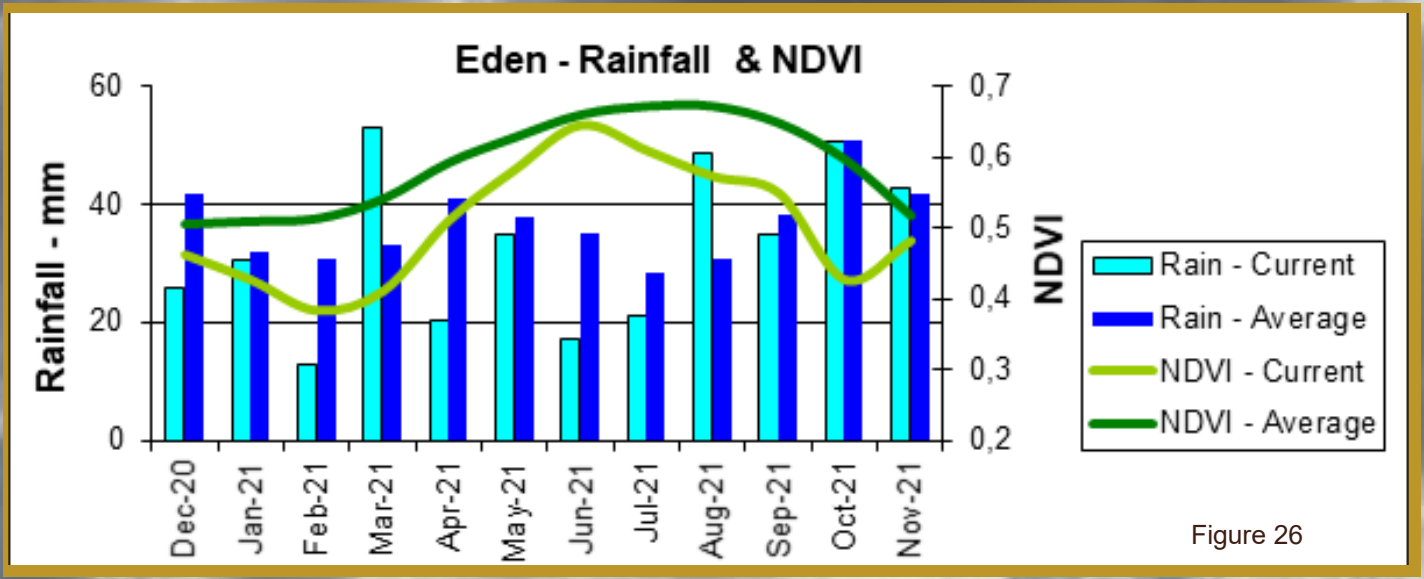


Figure 26

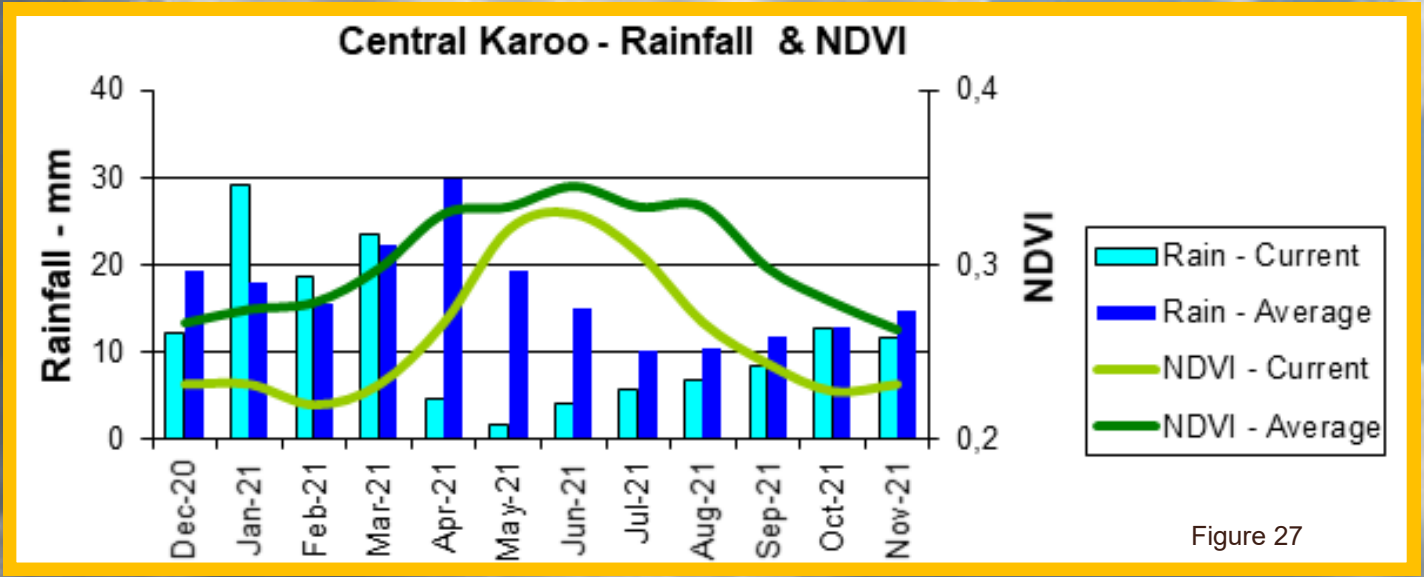


Figure 27

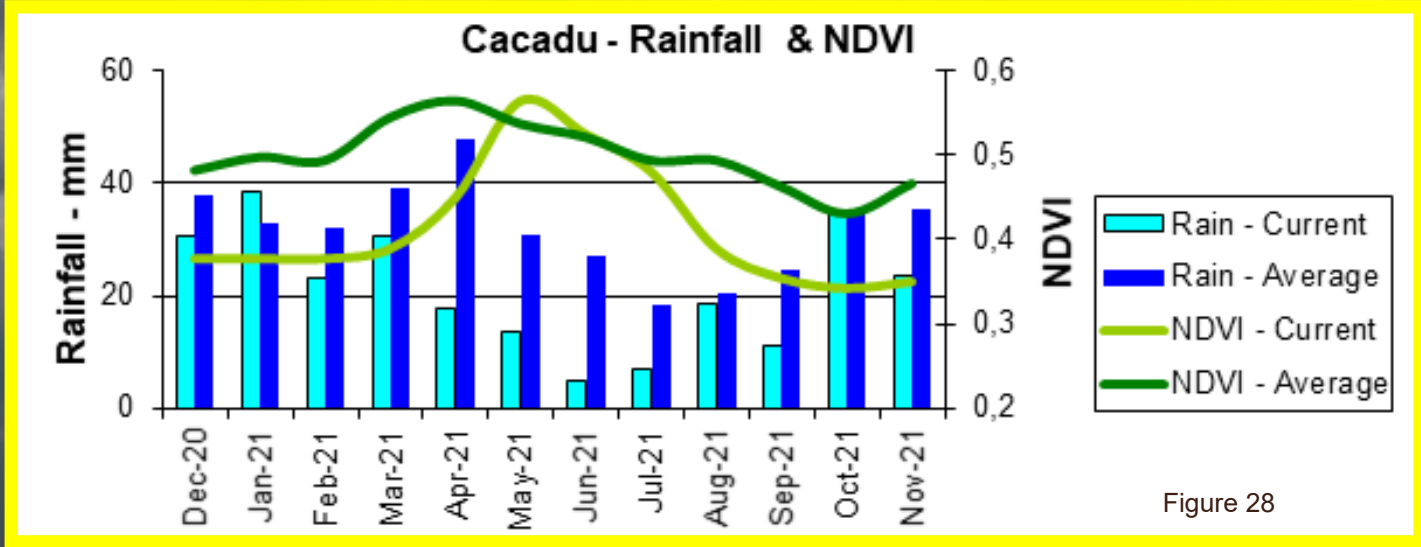


Figure 28

# 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 1-30 November 2021 per province. Fire activity was lower in all provinces except for the Northern Cape, compared to the long-term average.

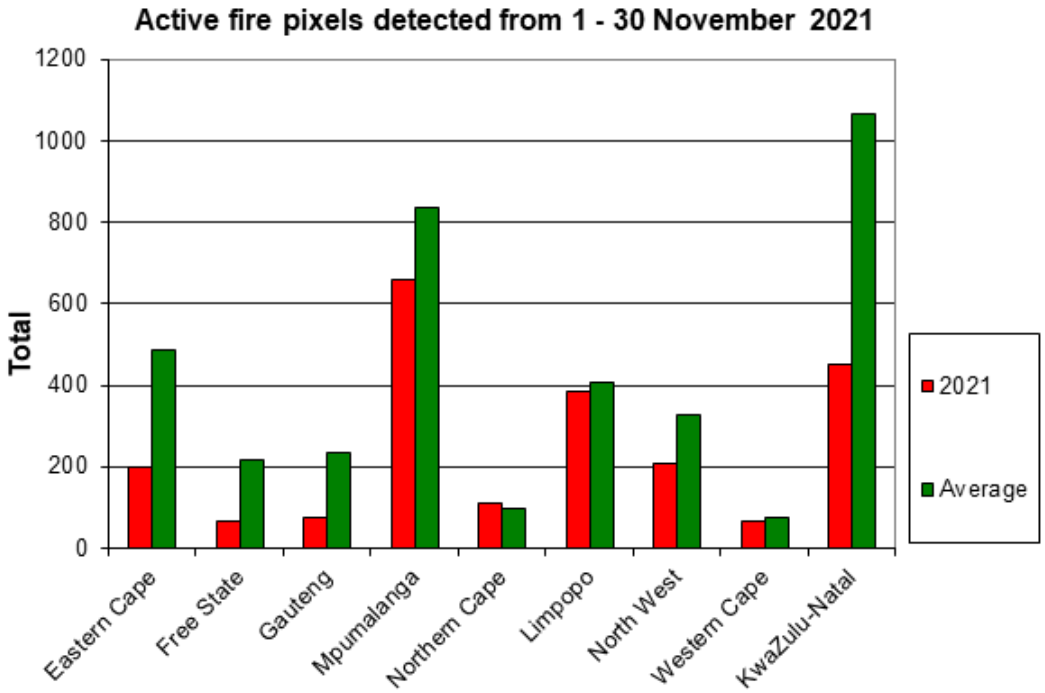


Figure 29

**Figure 30:**
The map shows the location of active fires detected between 1-30 November 2021.

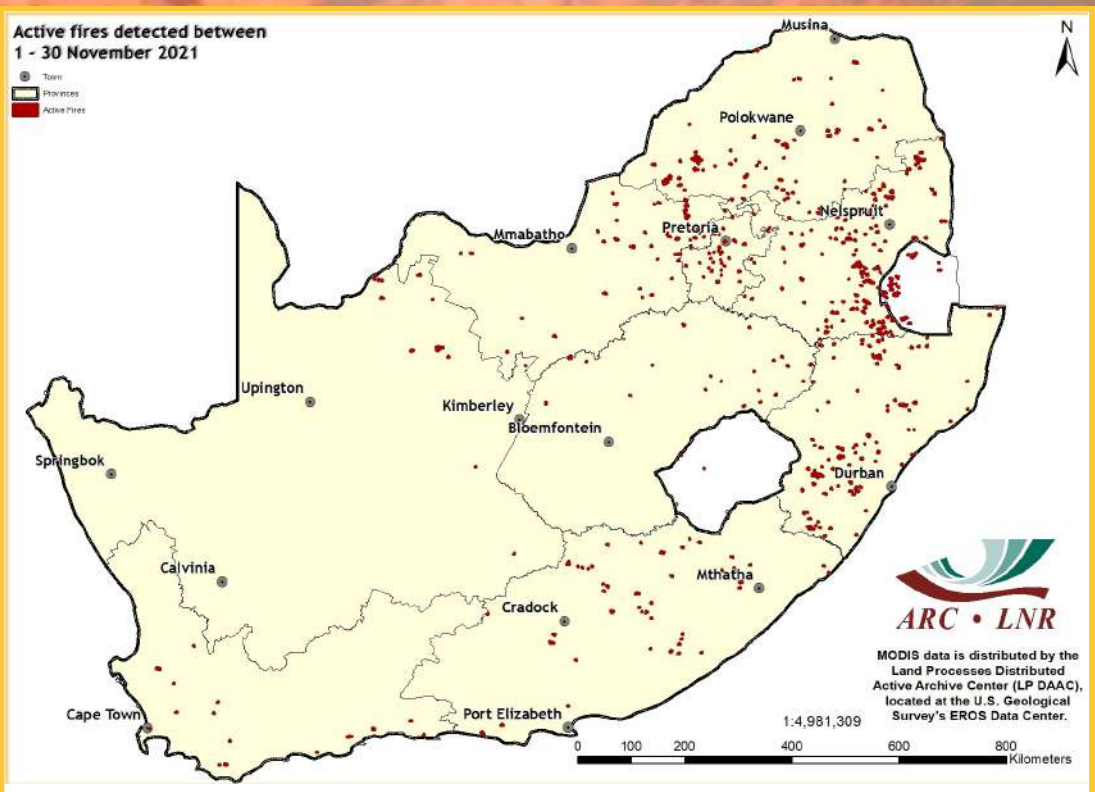


Figure 30

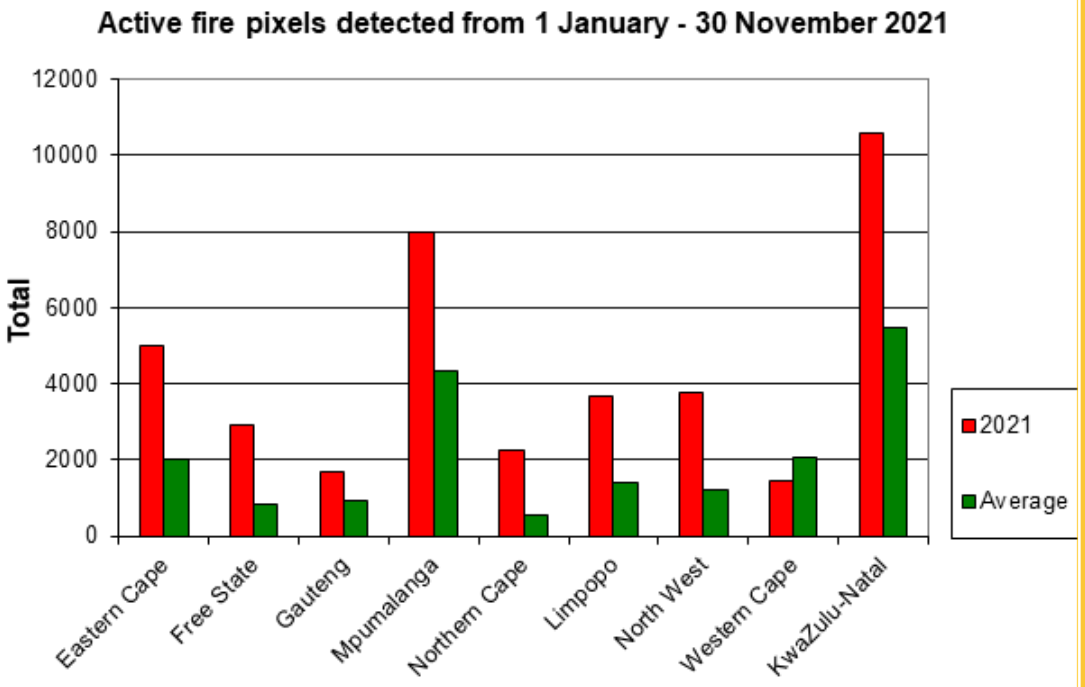


Figure 31

**Figure 31:**
The graph shows the total number of active fires detected between 1 January and 30 November 2021 per province. Cumulative fire activity was higher in all provinces except for the Western Cape, compared to the long-term average.

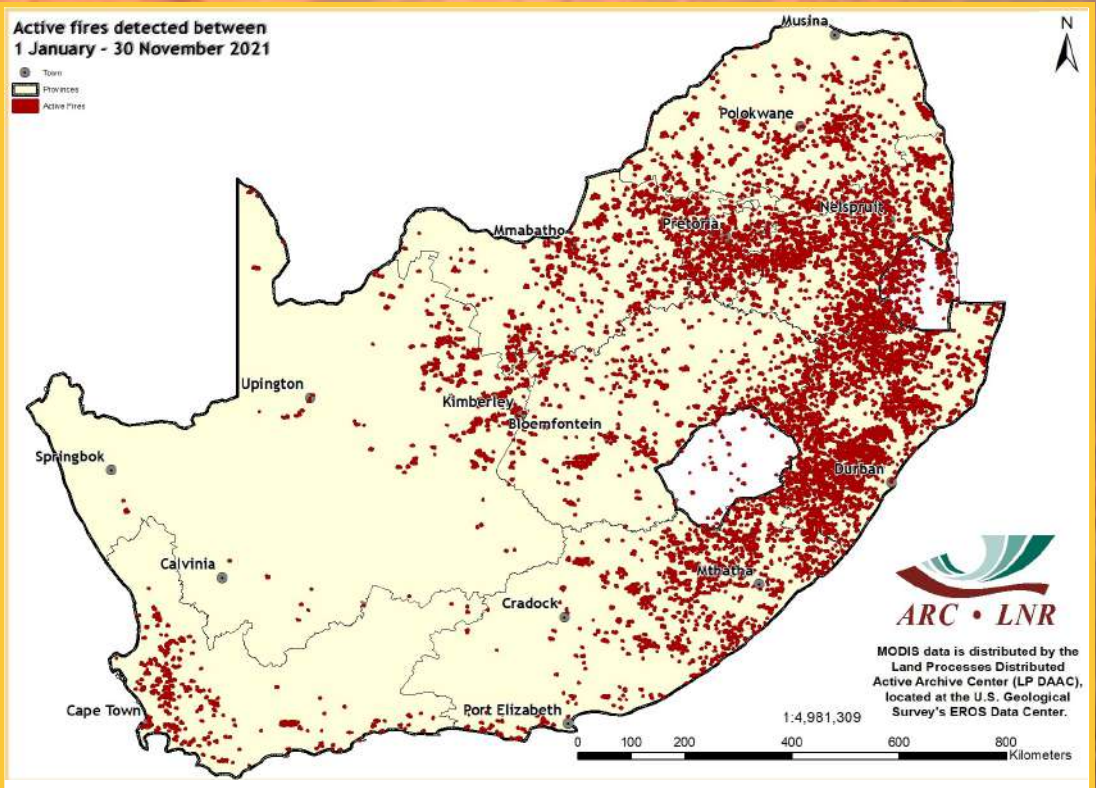


Figure 32

**Figure 32:**
The map shows the location of active fires detected between 1 January and 30 November 2021.

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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 represents a comparison between the area of water available now and the maximum area of surface water recorded in the last 5 years. This 5-year historical window represents the operational period of the satellite from which the water information has been generated. In this map, any value less than 100 represents 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 represents a comparison between the area of surface water now and for the same month last year. In this map, any value less than 100 represents 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, last year.

The long-term map for November 2021 shows very similar water patterns to the previous month, with the majority of the summer rainfall region catchments showing water levels equivalent to 80-100% of the 5-year, long-term maximum water. Catchments in the central Karoo, interior of the Western Cape and western coastal regions of the Eastern Cape continue to show significantly lower current water levels compared to long-term maximum values, although some areas in the central Karoo are showing slight improvements compared to October 2021.

The comparison between November 2021 and November 2020 indicates a near identical pattern to that recorded last month, with the majority of the country showing current water levels between 50% and 150% of the 2020 levels. Exceptions to this are the central Karoo, which is still showing significantly lower water levels, and a number of catchments bordering Botswana and Zimbabwe, which are still showing higher water levels in November 2021 compared to last year.

*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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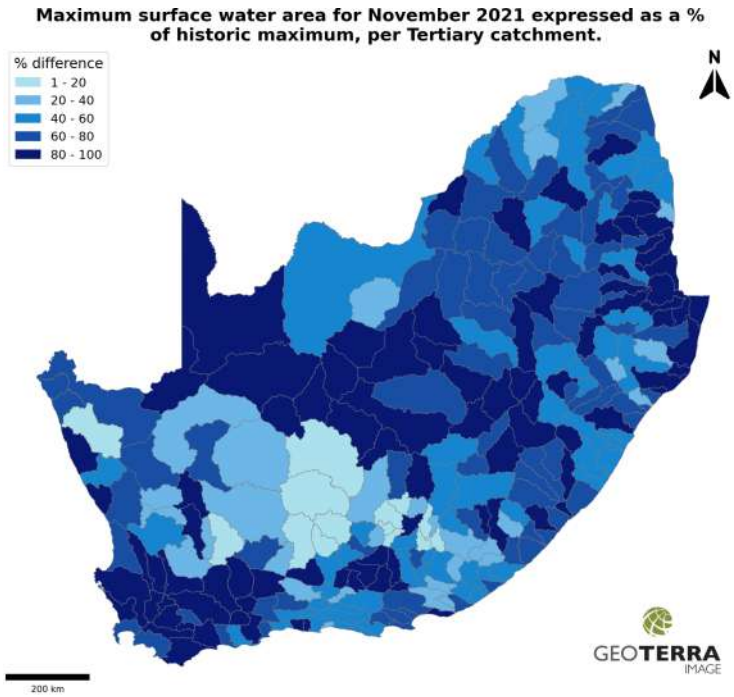


Figure 33

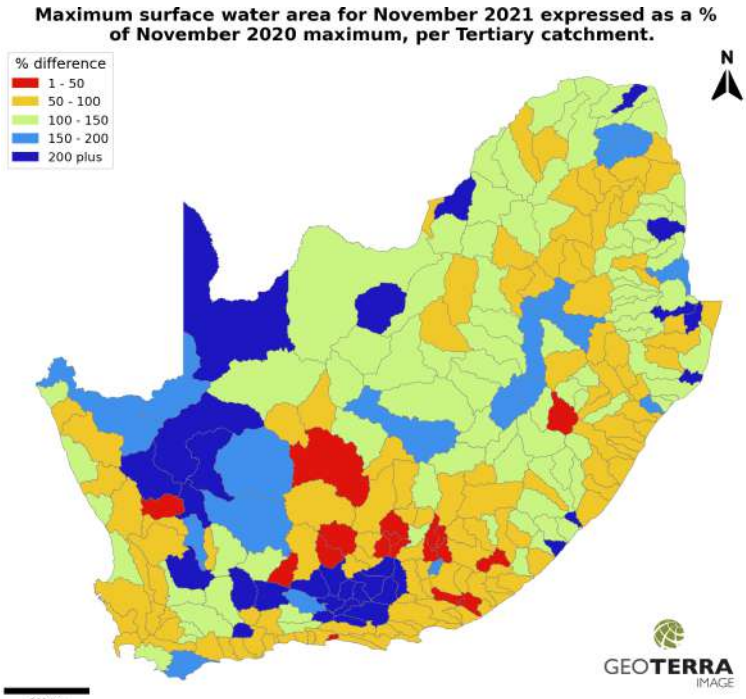


Figure 34

# Agrometeorology

ARC • LNR

**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

ARC • LNR

**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, Land Reform and Rural Development. 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".