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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

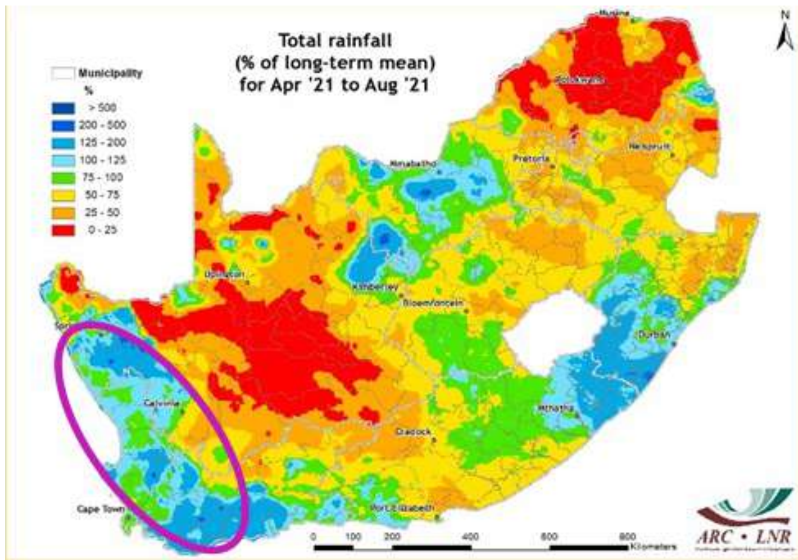
AMESD

207th Edition

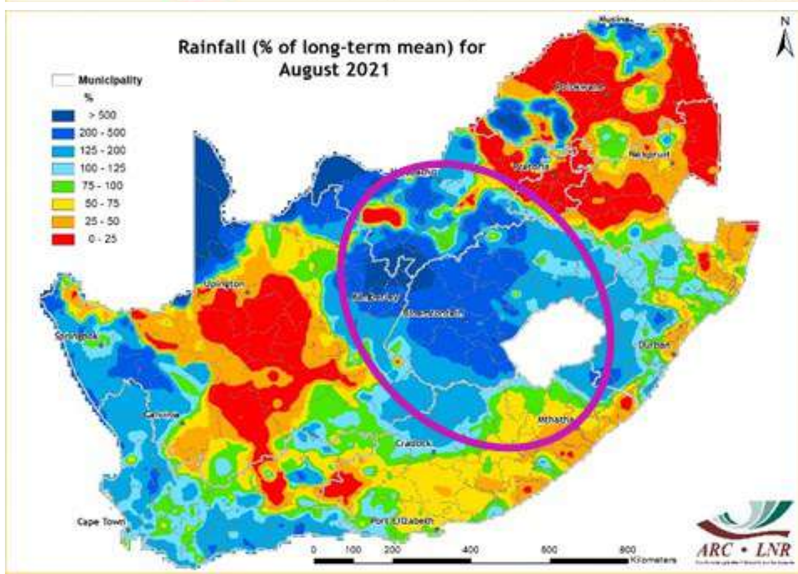
Images of the Month

Winter 2021 – a season characterized by favourable rainfall conditions

The winter rainfall region has received favourable rainfall since the onset of its rainfall season in May 2021, due to the frequent passage of numerous cold fronts over the southwestern parts of the country. These conditions continued consistently into August, as depicted on the rainfall map for April-August 2021 (given as a percentage of the long-term mean). It can be observed that this region was characterized by near- to above-normal rainfall conditions, implying satisfactory performance of winter crops. Likewise, livestock farmers may also benefit from higher dam levels and improved soil water contents, leading to increased pasture yields.



Another noteworthy feature of the climate that occurred during the 2021 winter season, specifically in August, was the occurrence of rainfall over the summer rainfall region (see map bottom right). This type of rainfall is called the 'first rain' and is usually expected during spring. To the agricultural community, the first rain is important for clearing the land following harvest of the summer crops and thus preparing for the next planting season. Hence, it is highly recommended to use the first rain for preparation in anticipation of the proper onset of the summer rains. Although the first rain is normally insignificant, it brings positive expectations.



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:

Following a wet and cold July over the southwestern region of the country, August 2021 was somewhat similar. Much rainfall activity occurred due to the passage of several cold fronts. These frontal systems resulted in near- to above-normal rainfall over the winter and all-year rainfall regions. A cold front that made landfall around the 8th resulted in widespread rain over the Western Cape, neighbouring southwestern parts of the Eastern Cape and the far western parts of the Northern Cape. Considerable amounts of rain also occurred towards the end of the month due to a strong cold front on the 26th. Places such as Kirstenbosch, Paarl and Villiersdorp recorded >70 mm of rain during the subsequent 2 days. Moreover, these frontal systems were accompanied by snow over the mountainous regions of the Cape provinces - extending towards Lesotho and thereby contributing to water storage over these areas.

Although recording smaller totals, the summer rainfall region also experienced above-normal rainfall in August, particularly over the Free State and surrounding areas of the Eastern Cape, Northern Cape, North West and KwaZulu-Natal. Isolated areas in Limpopo and Mpumalanga also received this unseasonable rainfall, although the greater parts of these provinces were generally dry. Other areas that recorded below-normal rainfall were in the Northern Cape, Eastern Cape, coastal and northern parts of KZN, Gauteng and eastern parts of North West.

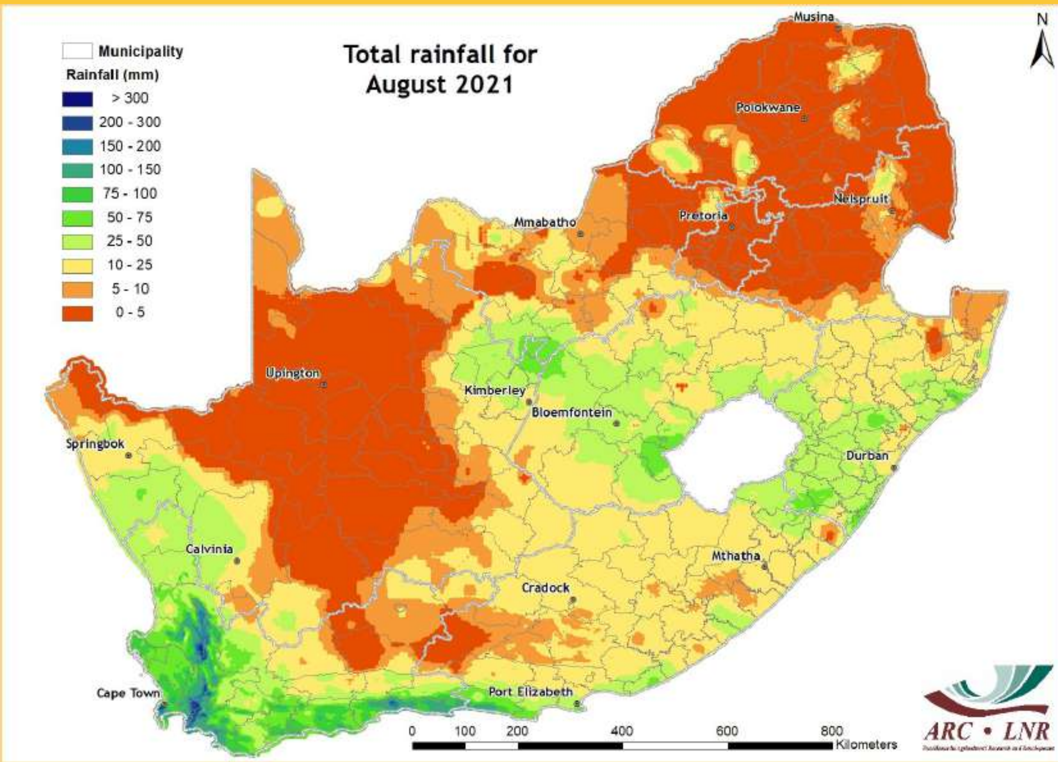


Figure 1

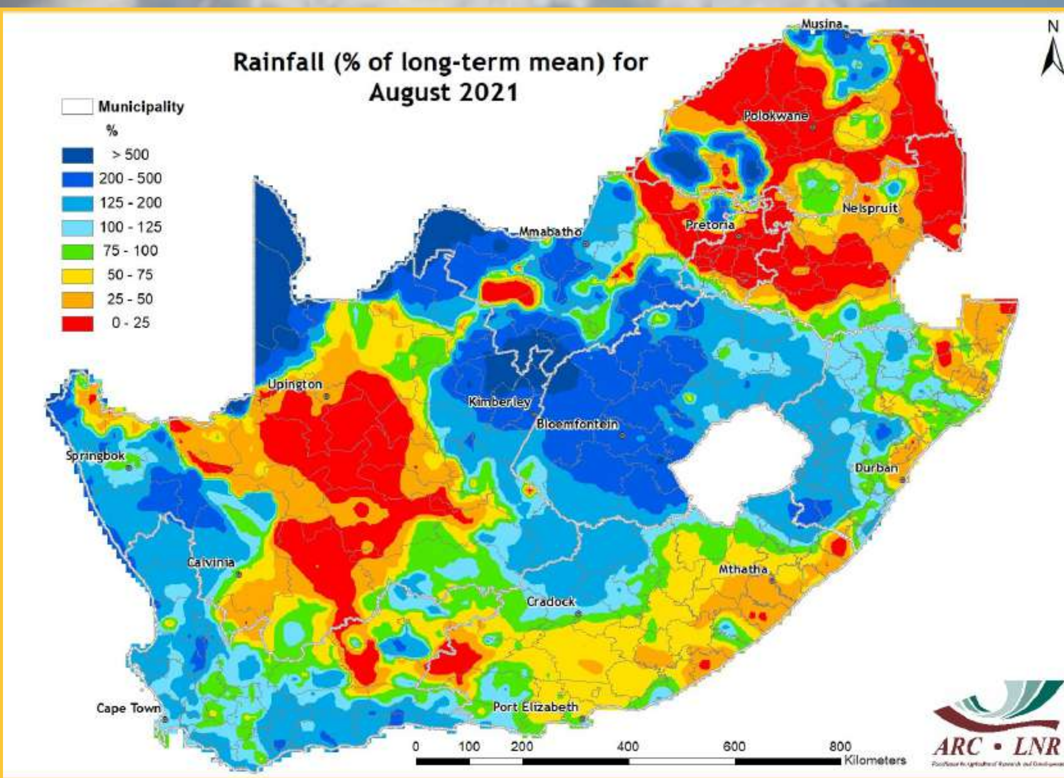


Figure 2

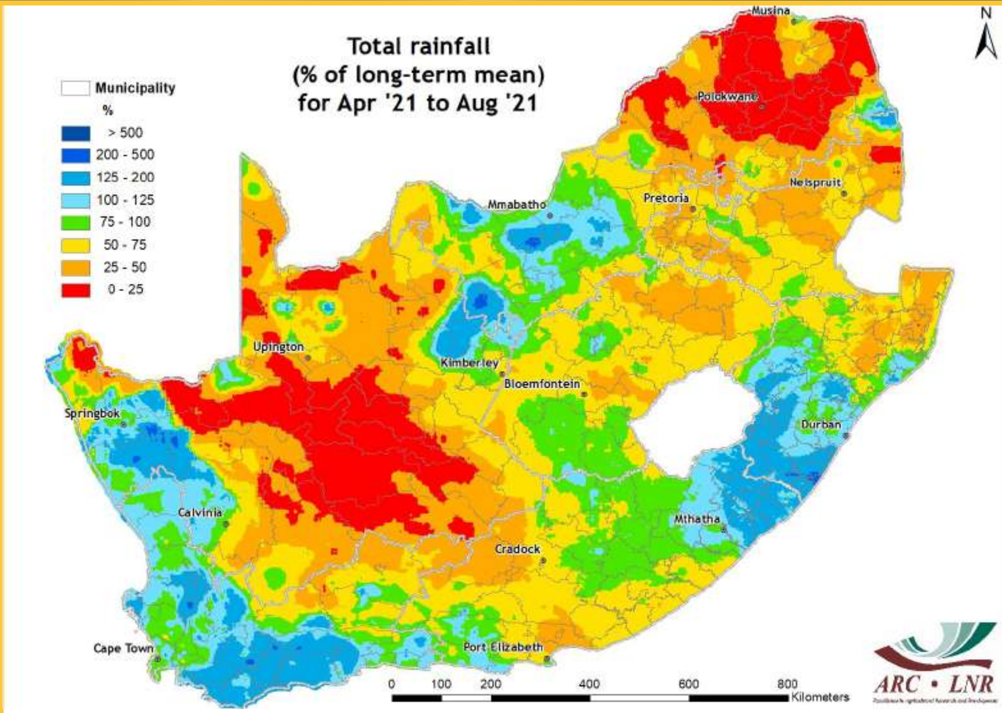


Figure 3

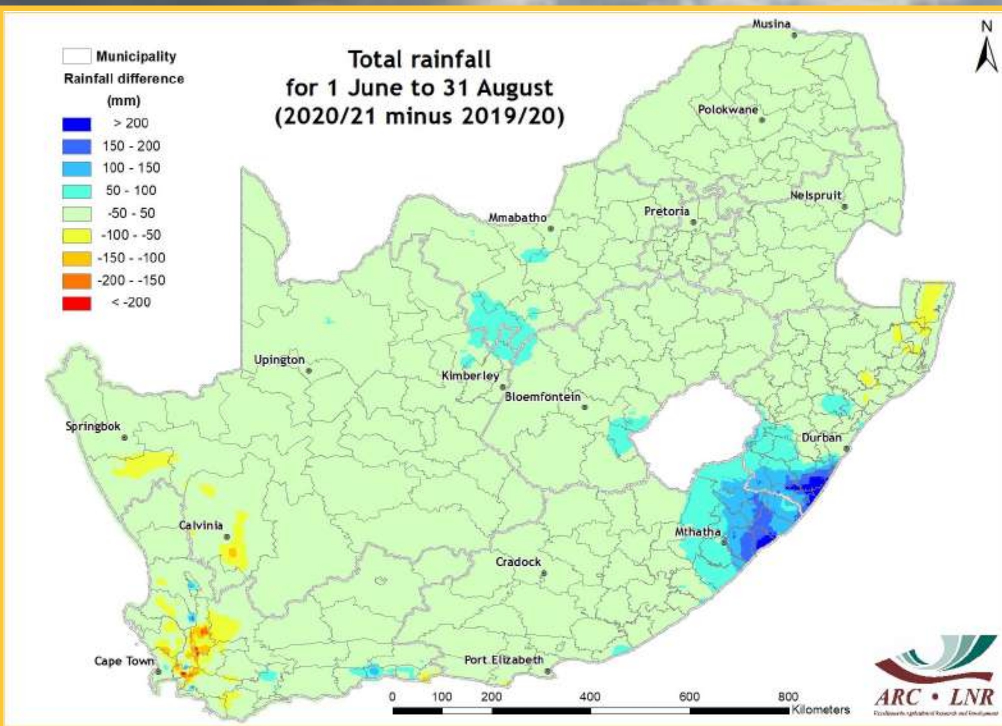


Figure 4

Figure 1:
The relatively frequent passage of frontal systems during August 2021 resulted in rainfall over the winter and all-year rainfall regions. Meanwhile, the presence of upper-air systems around the 14th and 25th also resulted in rainfall occurring over parts of the interior that typically receive summer rainfall.

Figure 2:
Near- to above-normal rainfall occurred over the winter rainfall region, the interior, parts of KwaZulu-Natal, Limpopo and Mpumalanga. The rest of the country, including the north-eastern parts, Northern Cape interior and Eastern Cape, experienced below-normal rainfall activity.

Figure 3:
Cumulative rainfall since April 2021 was above normal over the western and southern parts of the country, North West Province and adjacent areas of the Northern Cape (Frances Baard District Municipality), as well as the eastern coastline (including the KZN midlands and northern Eastern Cape). Below-normal rainfall occurred over most of the Northern Cape, Limpopo, Free State, Gauteng and Mpumalanga.

Figure 4:
Compared to the corresponding period last year, rainfall during June to August 2021 improved over the southern KZN coast and adjacent area of the Eastern Cape, with an excess of >150 mm recorded in some places. In contrast, parts of the Western Cape and Northern Cape received up to 200 mm less rainfall while the rest of the country received relatively the same amount of rainfall as last year.

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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 August indicates widespread near-normal conditions (given by mildly wet and mild drought classifications) over the country, except for the Karoo area and adjacent parts of the Eastern Cape, where moderate to extreme drought conditions are depicted. In addition, moderate to extreme drought conditions are visible over Limpopo, parts of Mpumalanga and Gauteng, with contrasting conditions (moderate-extremely wet) experienced in the Western Cape. The medium-term time scales are characterized by wet conditions over the northern interior, Lowveld of Limpopo and Mpumalanga, as well as isolated areas of the Western Cape and KZN. Severe to extreme drought conditions still dominate over 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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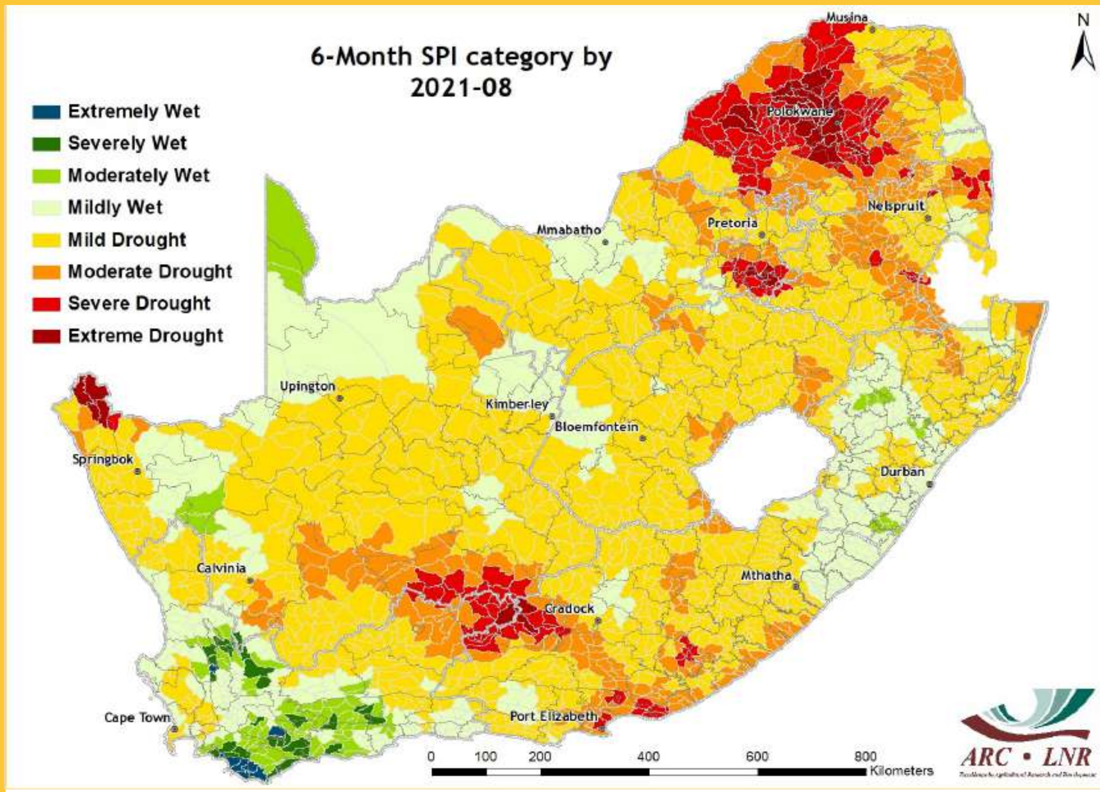

Figure 5

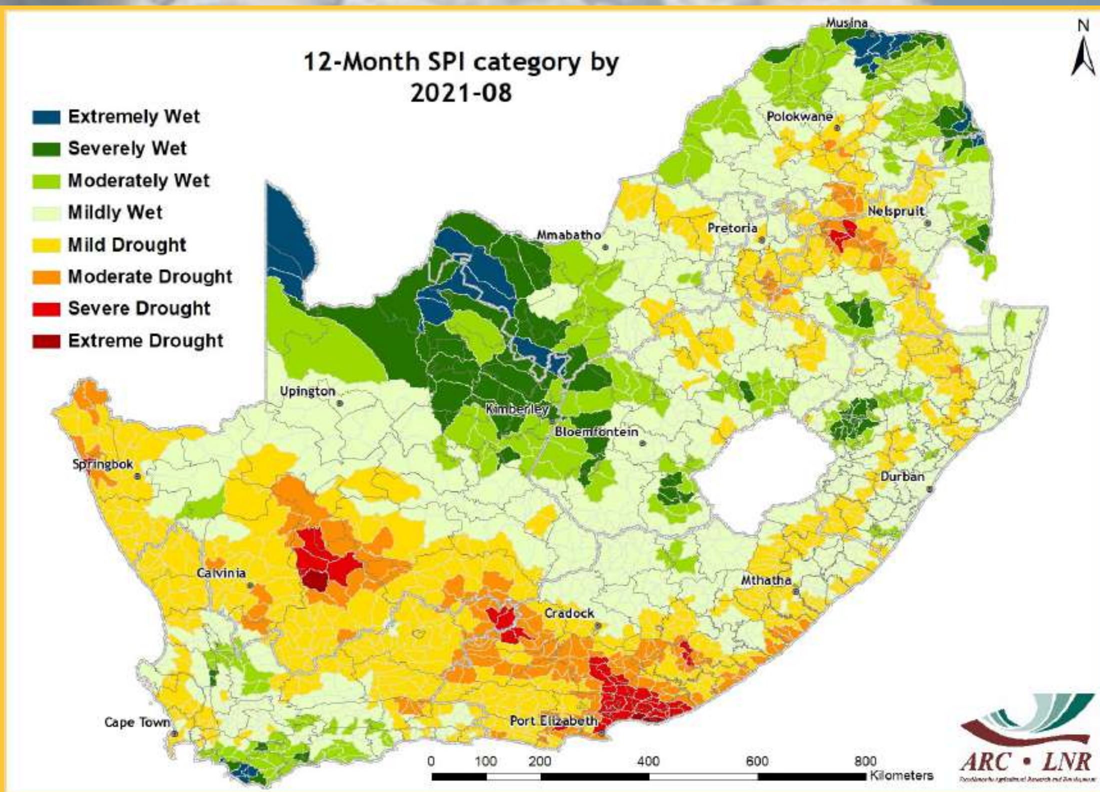

Figure 6

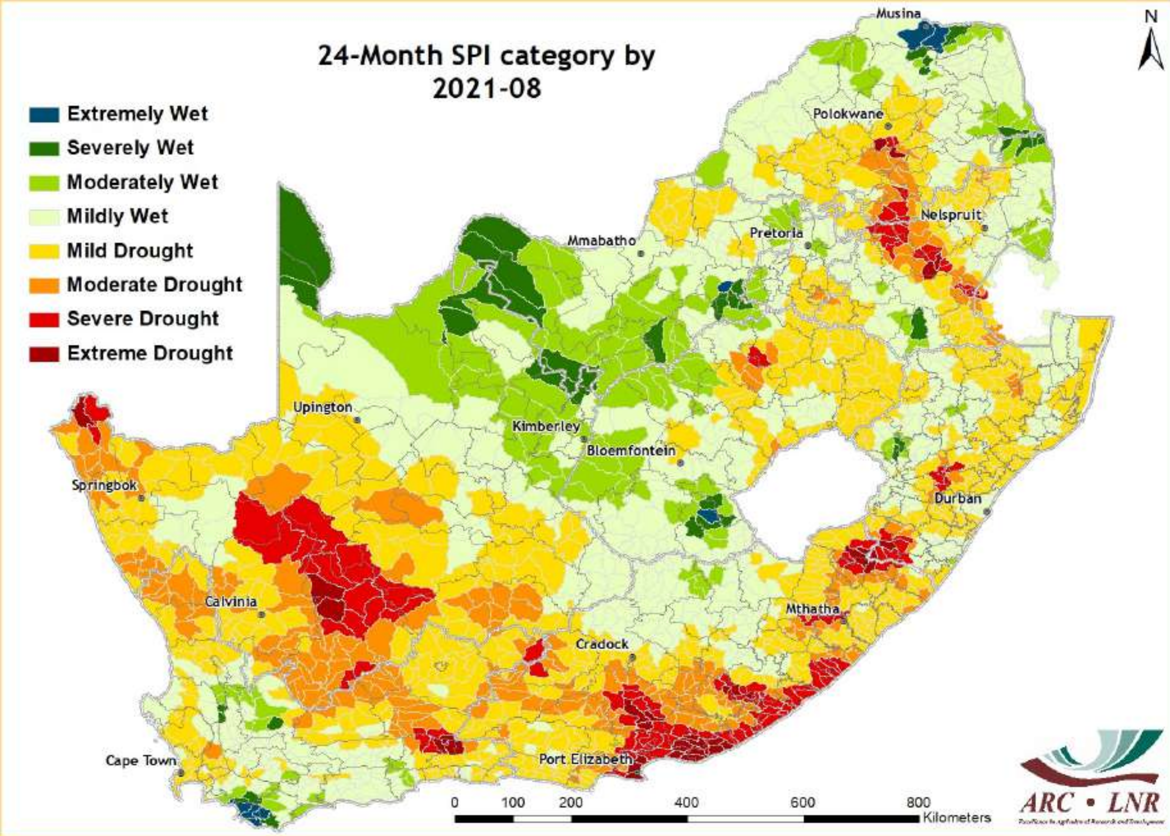

Figure 7

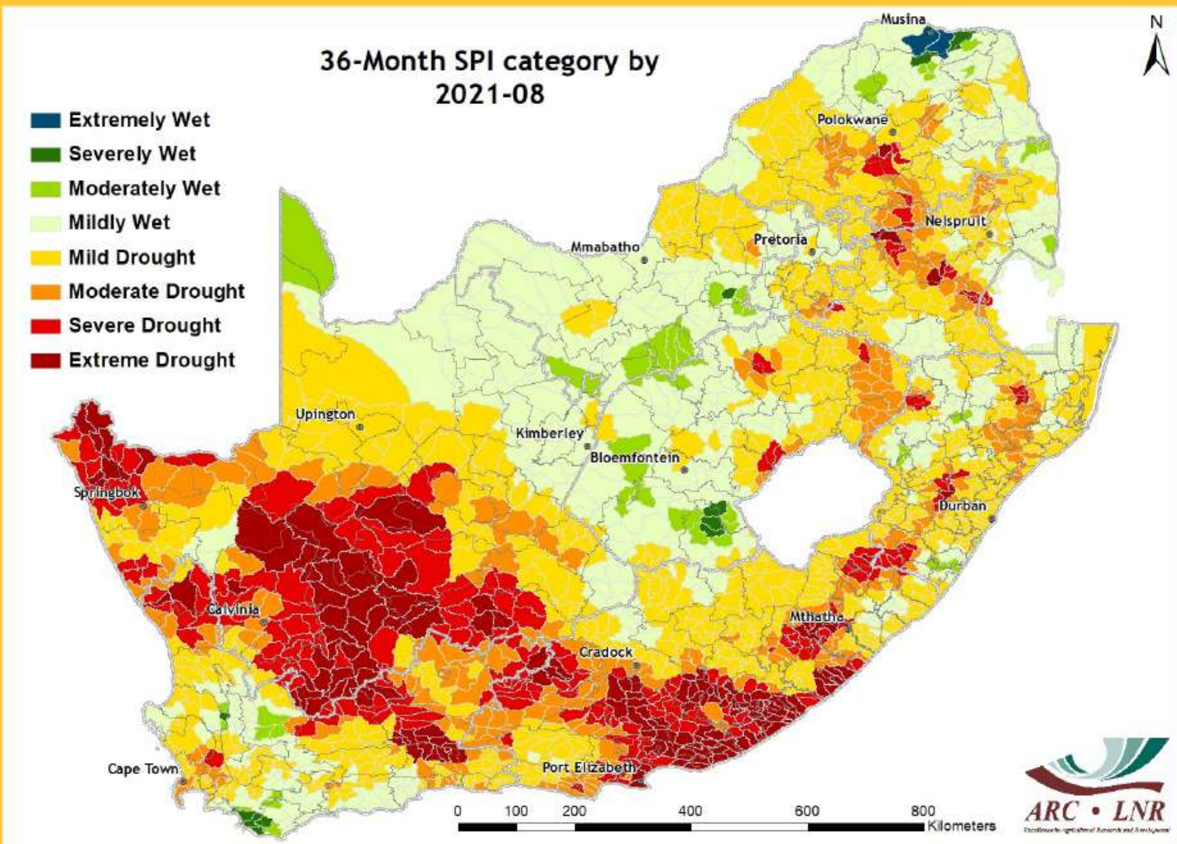

Figure 8

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.

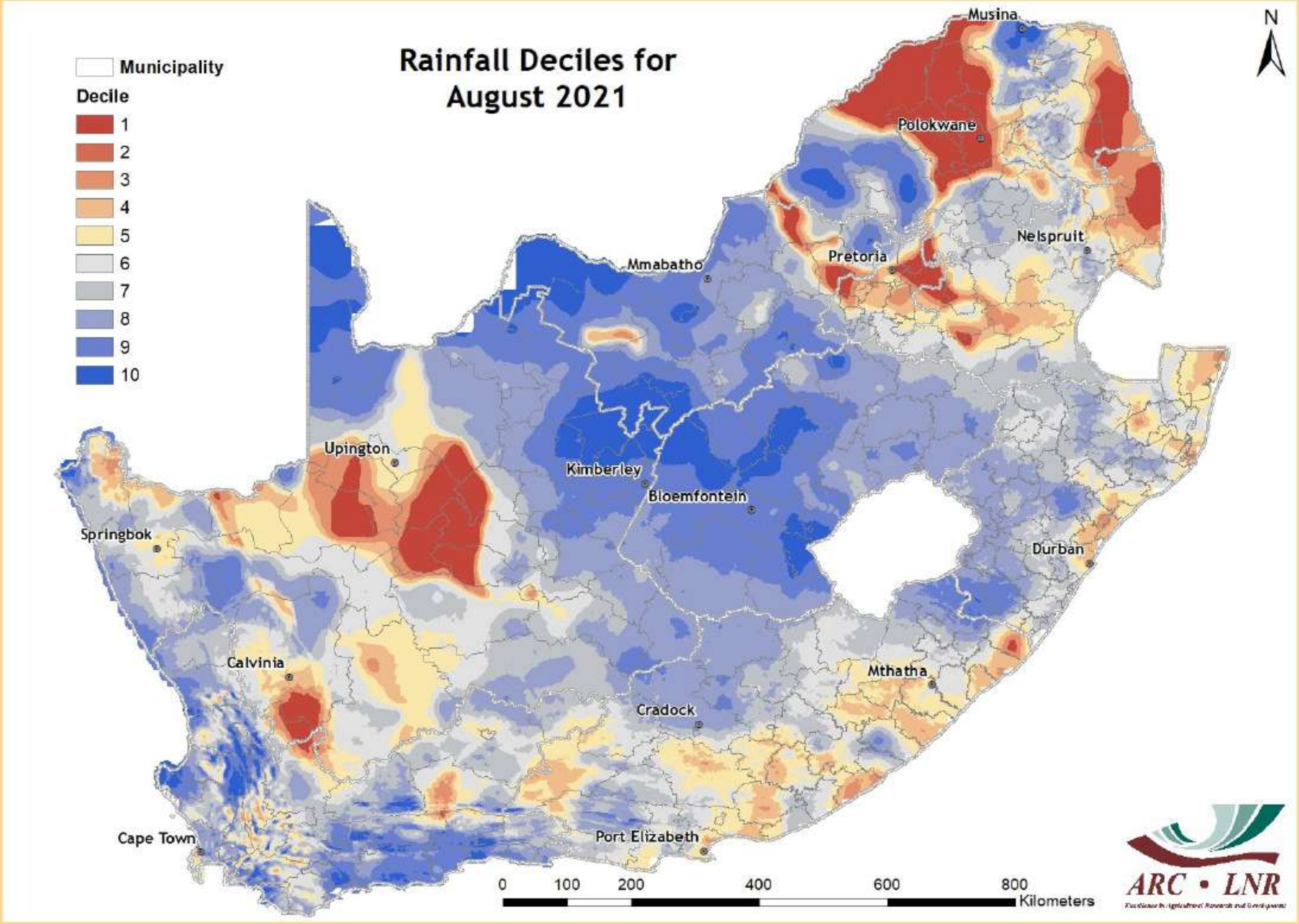

Figure 9

Figure 9:
Rainfall totals for greater parts of the country during August 2021 fall within the historical wetter August months, with the exception of isolated areas of the Eastern Cape, Northern Cape, KwaZulu-Natal, Gauteng and the Lowveld of Limpopo and Mpumalanga.

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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.

4. Vegetation Conditions

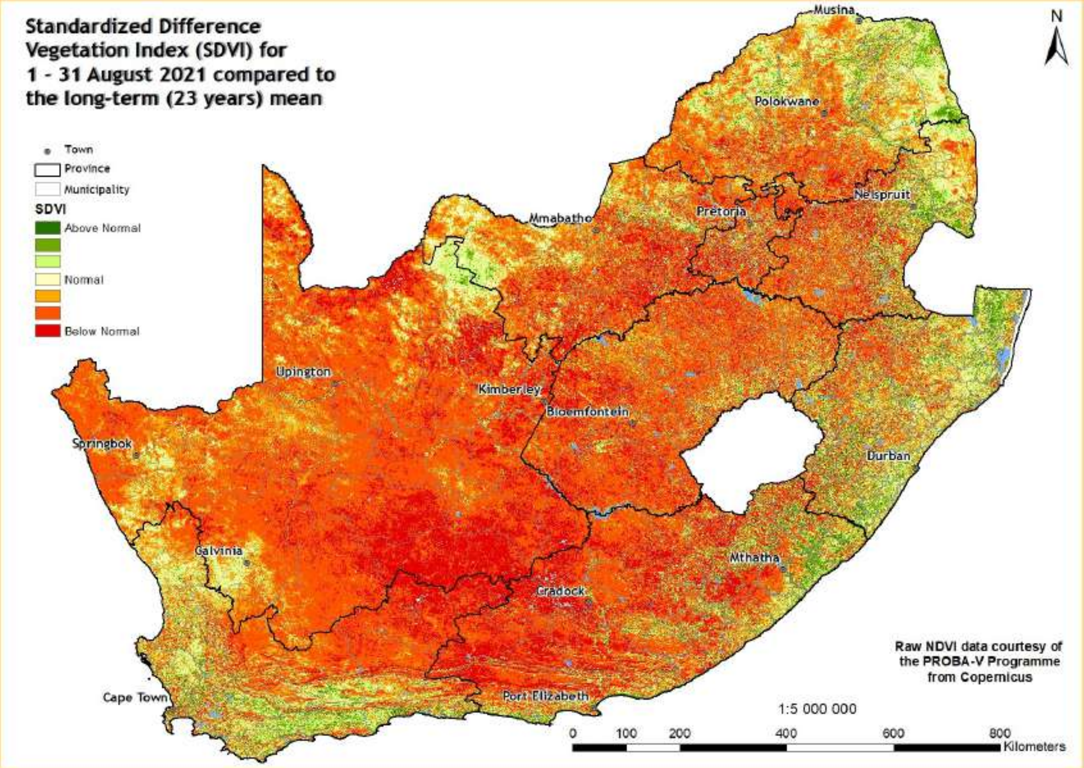

Figure 10

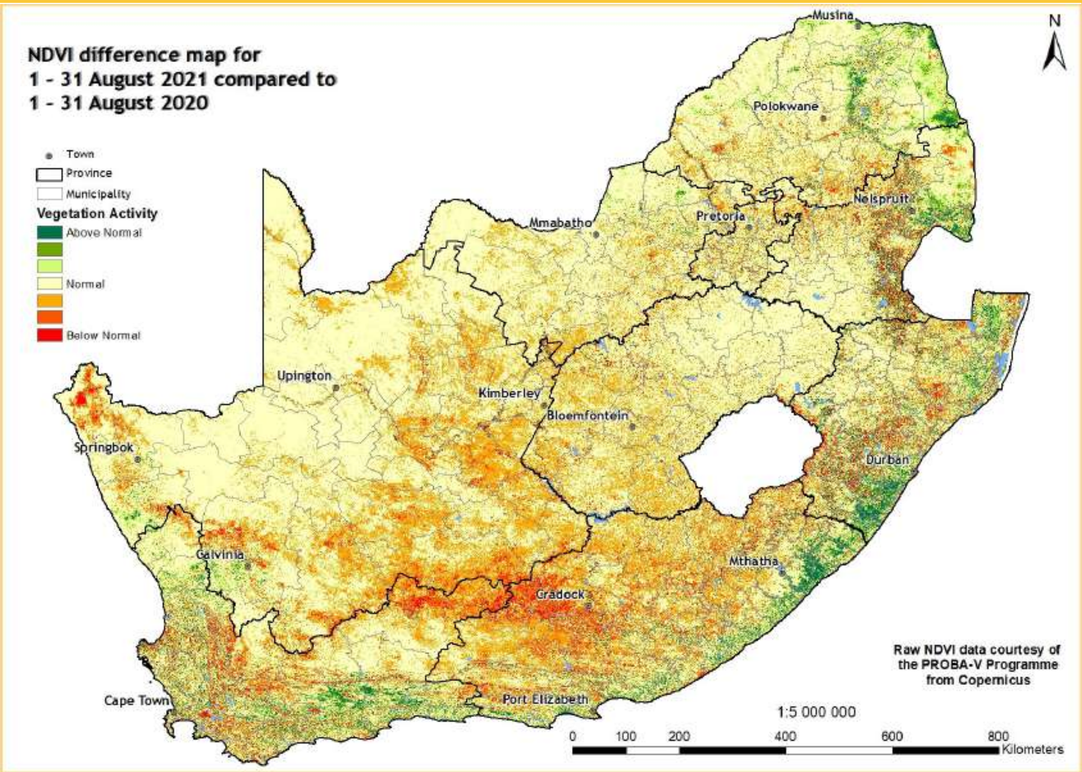

Figure 11

Figure 10:
Compared to the historical averaged vegetation conditions, the SDVI map for August 2021 shows that large parts of the country experienced below-normal vegetation activity.

Figure 11:
When comparing the NDVI difference map for August 2021 to the same month last year, it can be observed that the central interior experienced below-normal vegetation activity, with pockets of above-normal activity in the western and far eastern parts of the country.

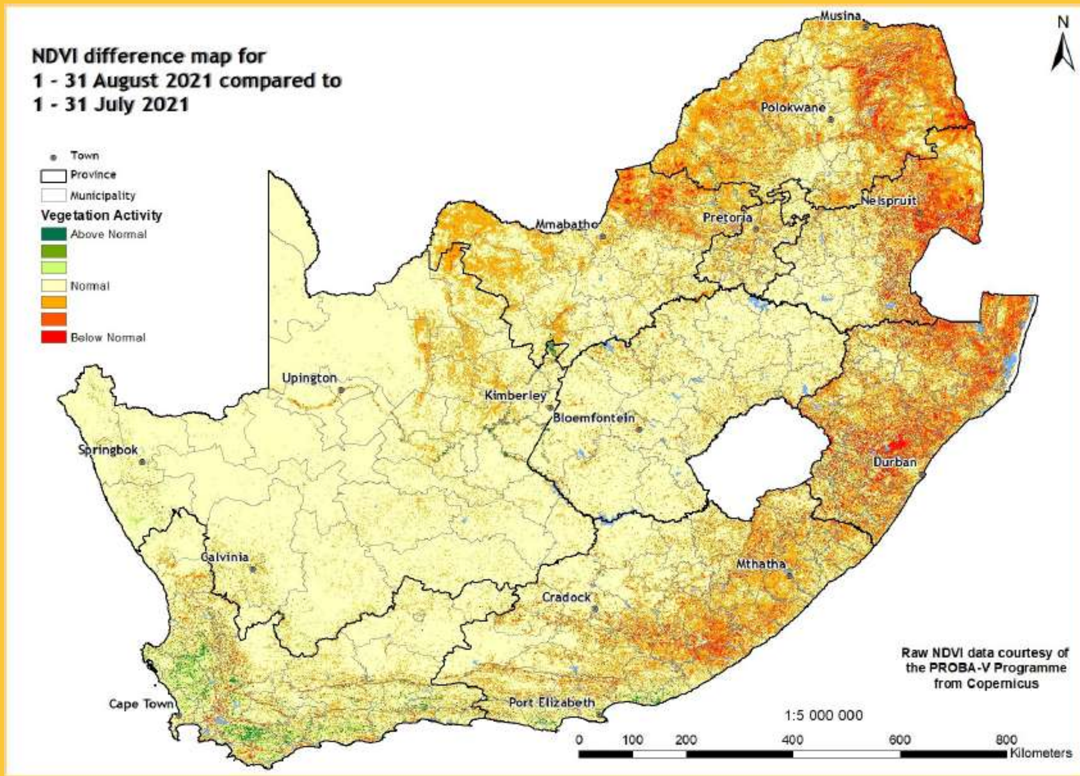

Figure 12

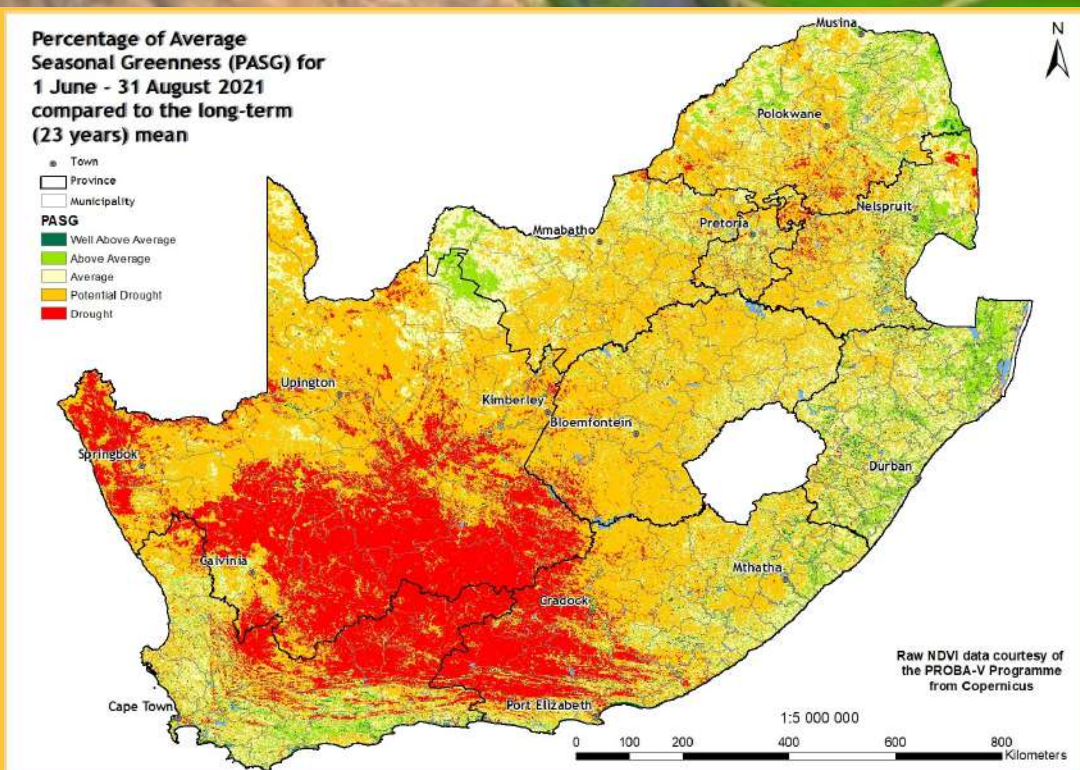

Figure 13

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:
Compared to the previous month, the NDVI difference map for August shows that the eastern half of the country experienced below-normal vegetation activity while the western half experienced normal and pockets of above-normal vegetation activity.

Figure 13:
Cumulative vegetation conditions over a 3-month period compared to the long-term mean show that high levels of seasonal vegetation greenness remain dominant in the northern parts of the country. The central parts are experiencing potential drought, with drought conditions 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.

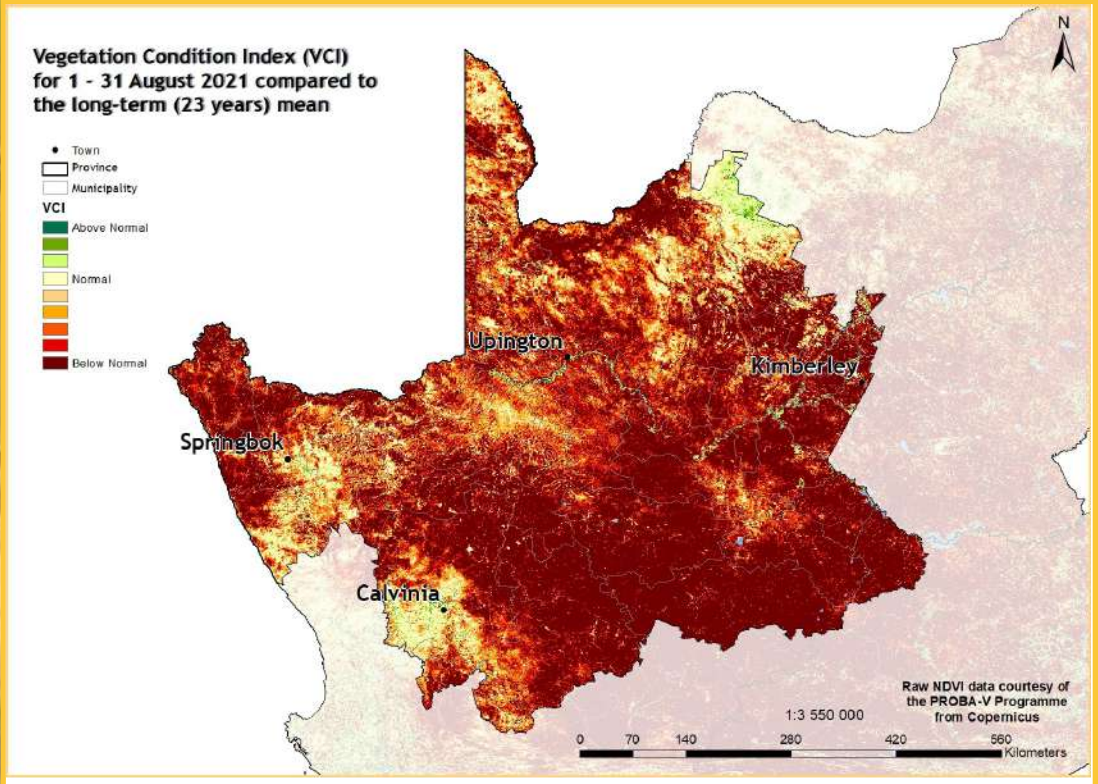
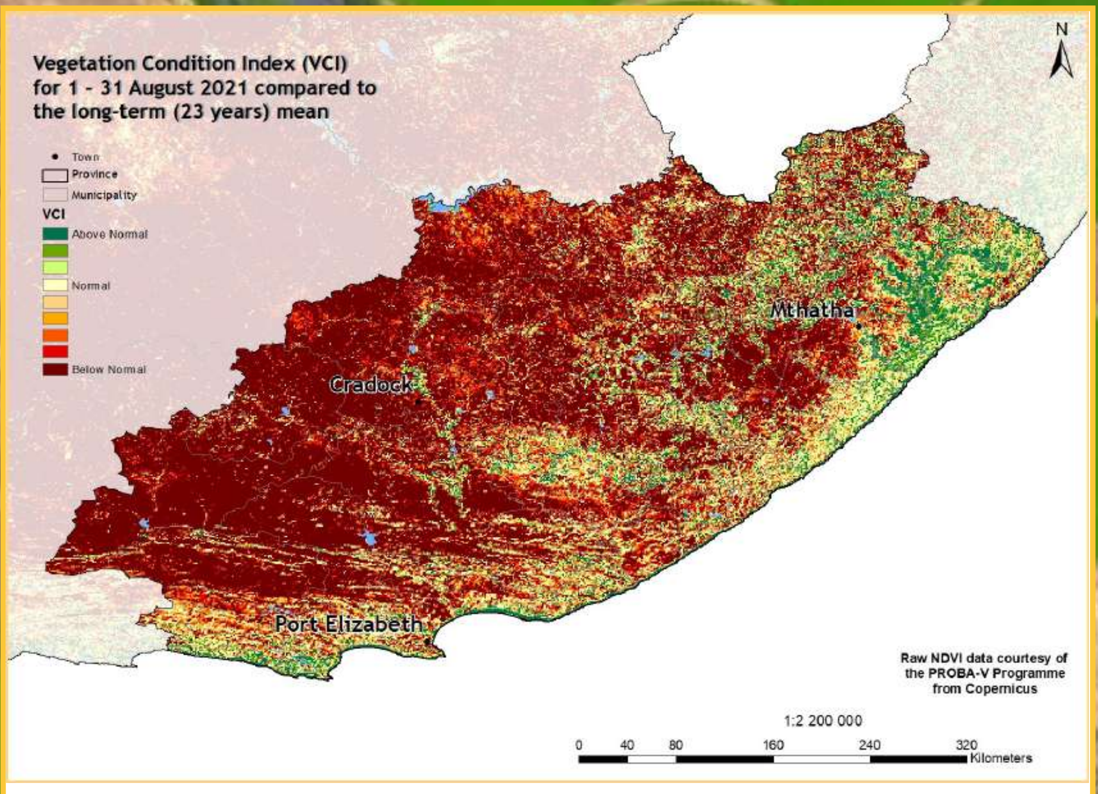


Figure 14

Figure 14:
The VCI map for August indicates that the far north-eastern parts of the Northern Cape continue to experience pockets of improved vegetation conditions while the remaining areas are still severely affected by drought.

Figure 15:
The VCI map for August indicates that vegetation conditions in almost the entire Eastern Cape remain poor with only pockets of good vegetation conditions in the eastern parts of the province.



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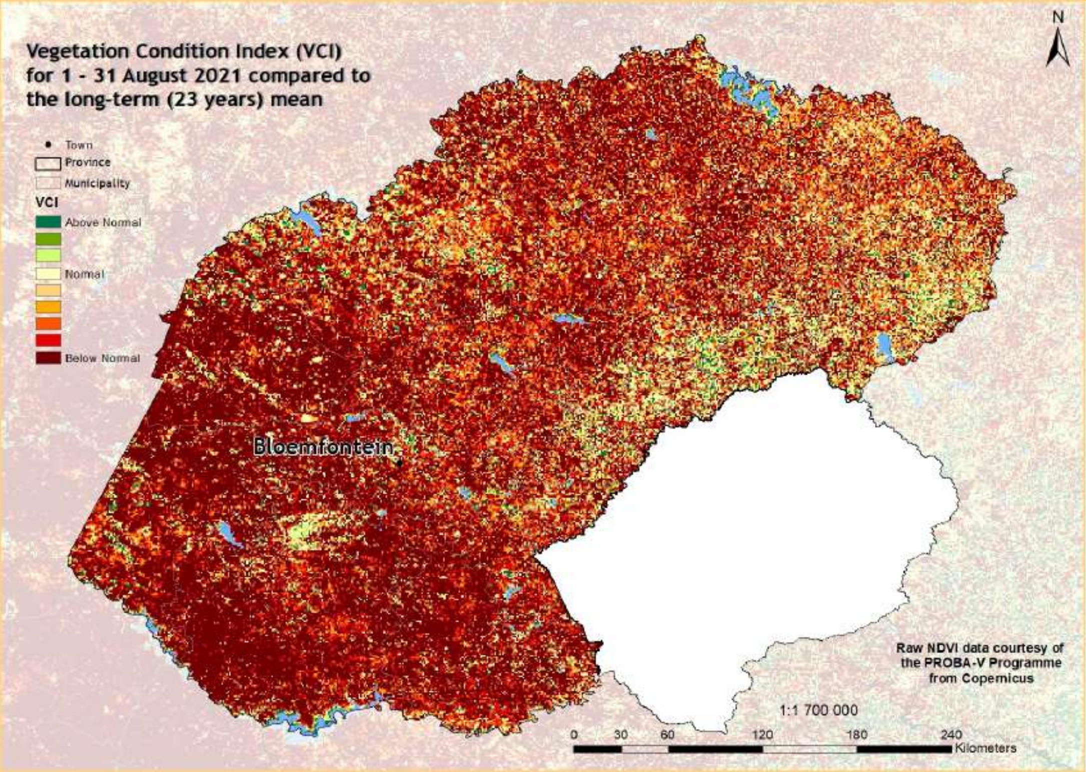

Figure 16

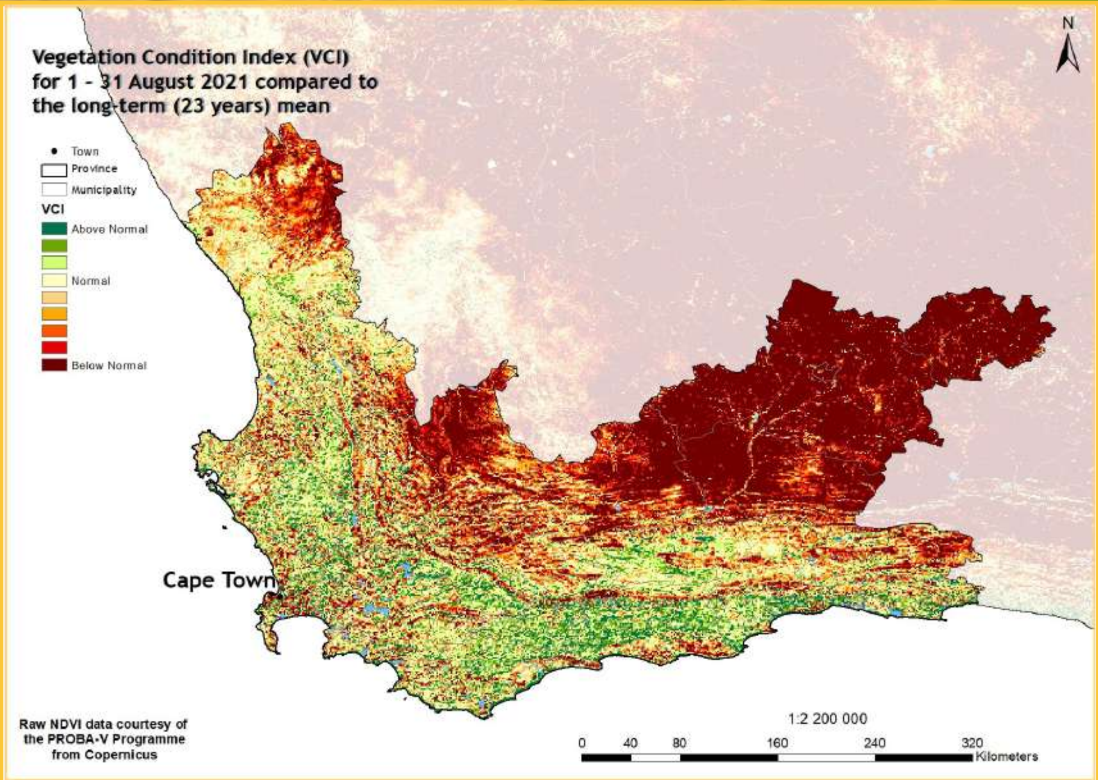

Figure 17

Figure 16:
The VCI map for August indicates that poor vegetation conditions continue to spread across the Free State Province.

Figure 17:
The VCI map for August indicates poor vegetation conditions in the northern parts of the Western Cape with areas of good vegetation dominating in the western and southern parts of the province.

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6. Vegetation Conditions & Rainfall

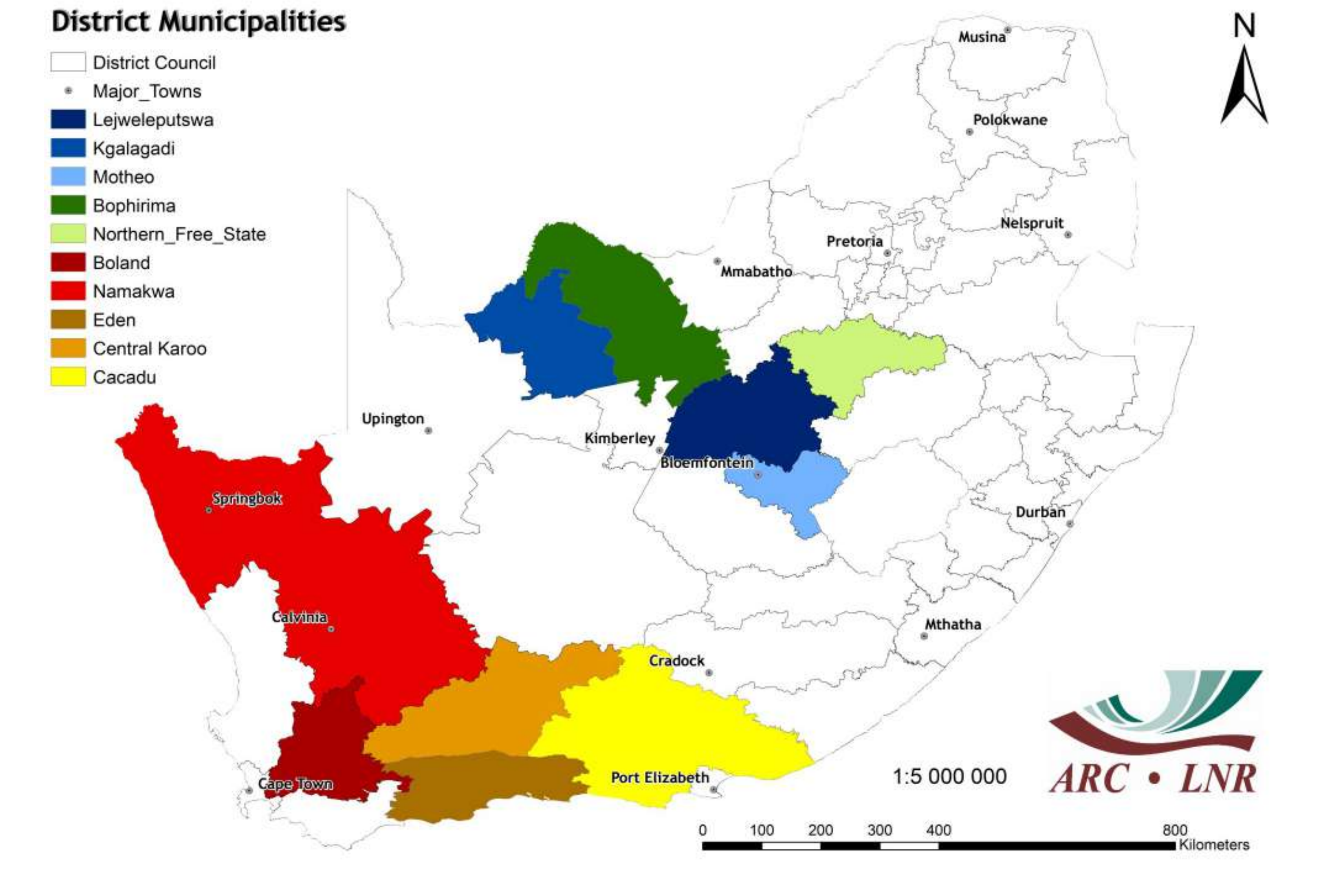

Figure 18

Rainfall and NDVI Graphs

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

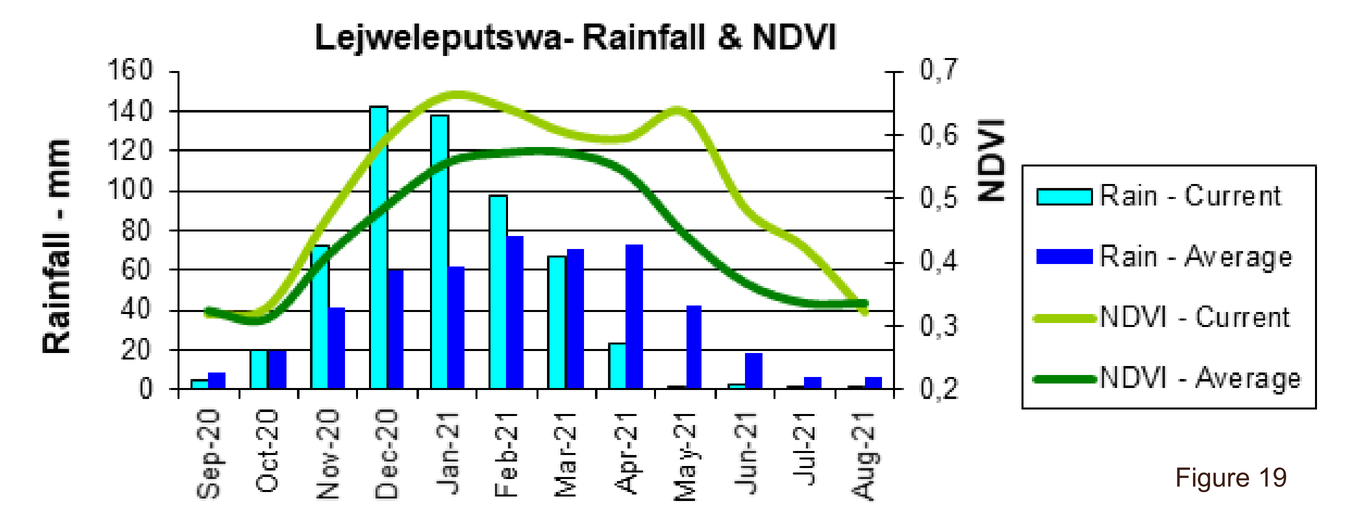


Figure 19

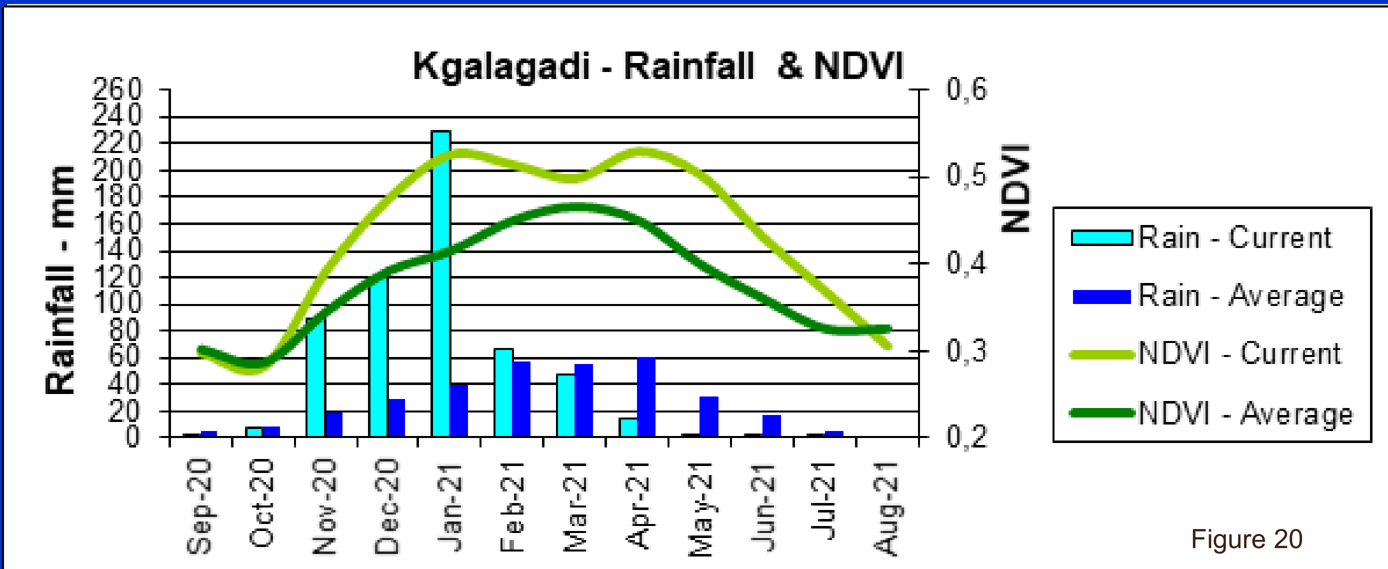
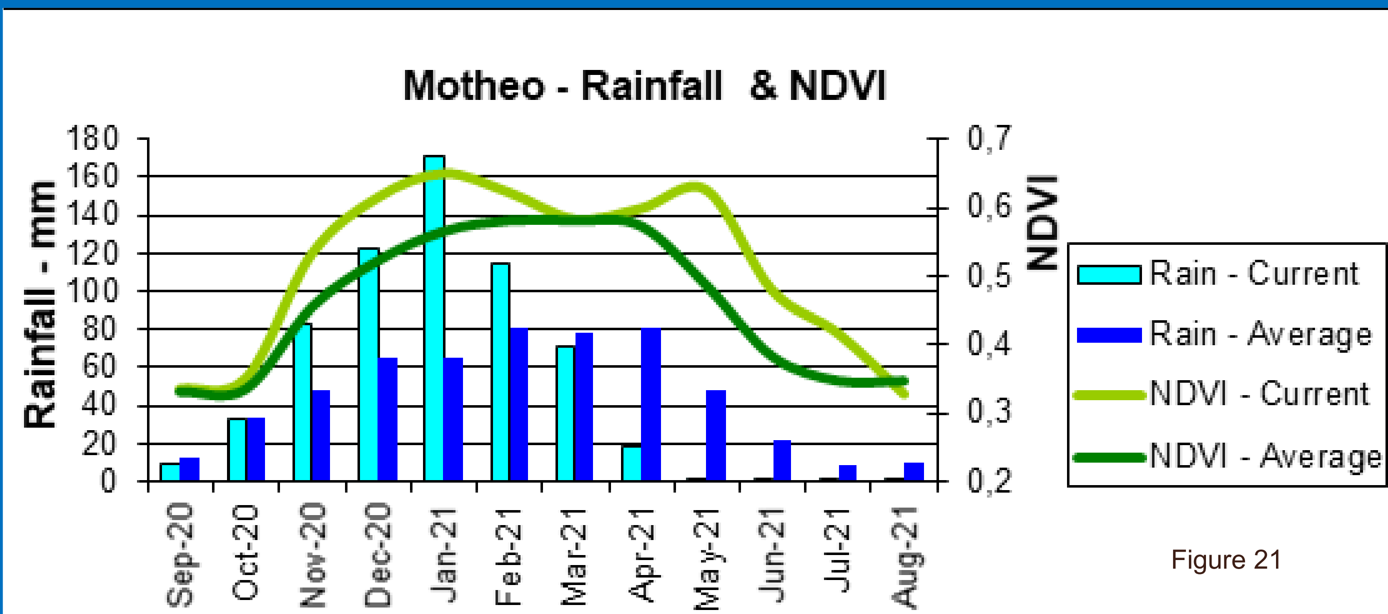


Figure 20



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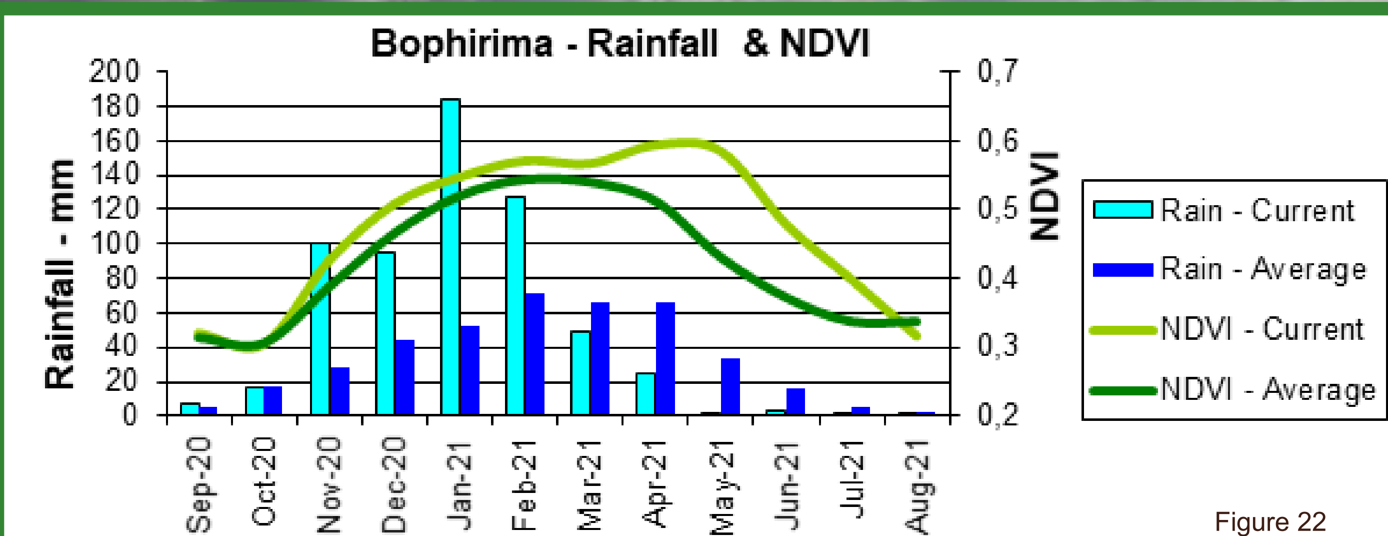
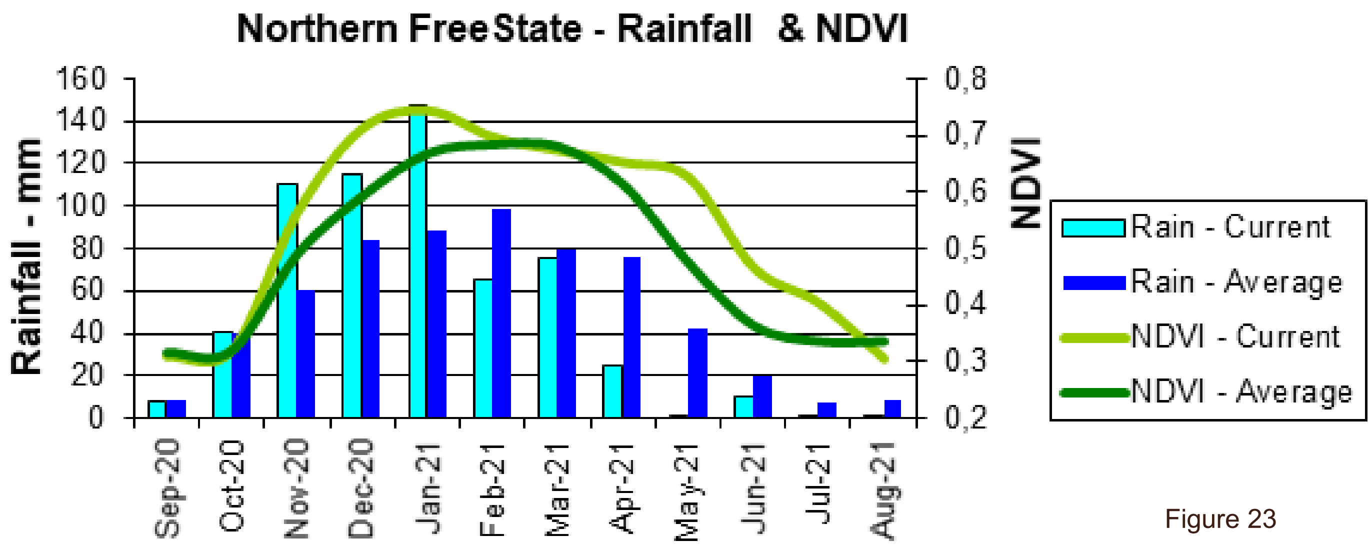


Figure 22



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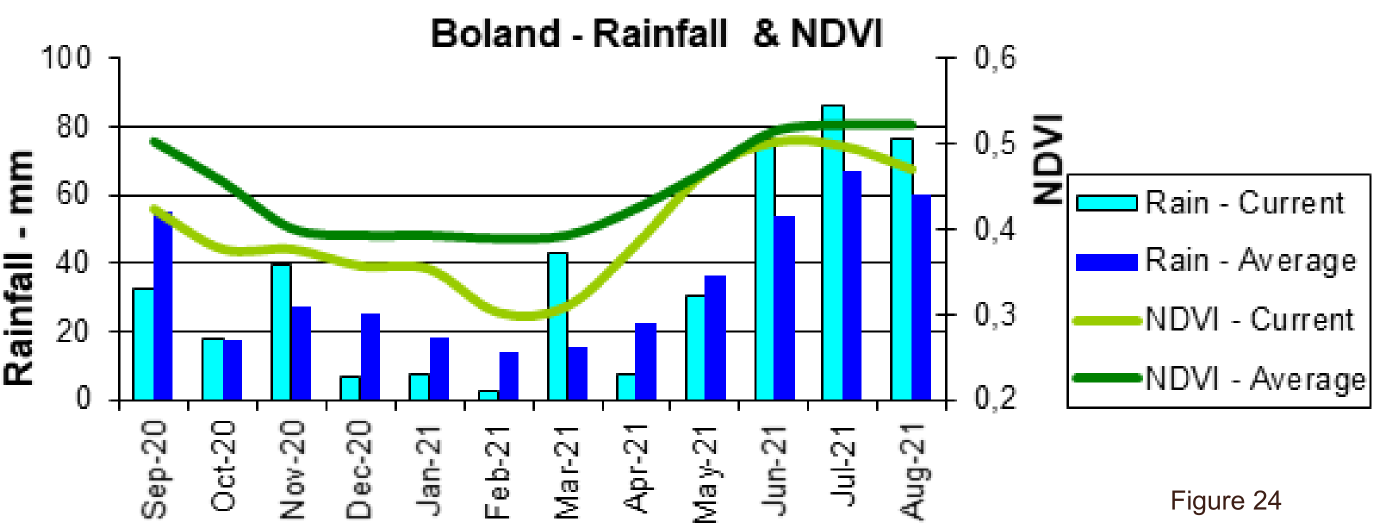

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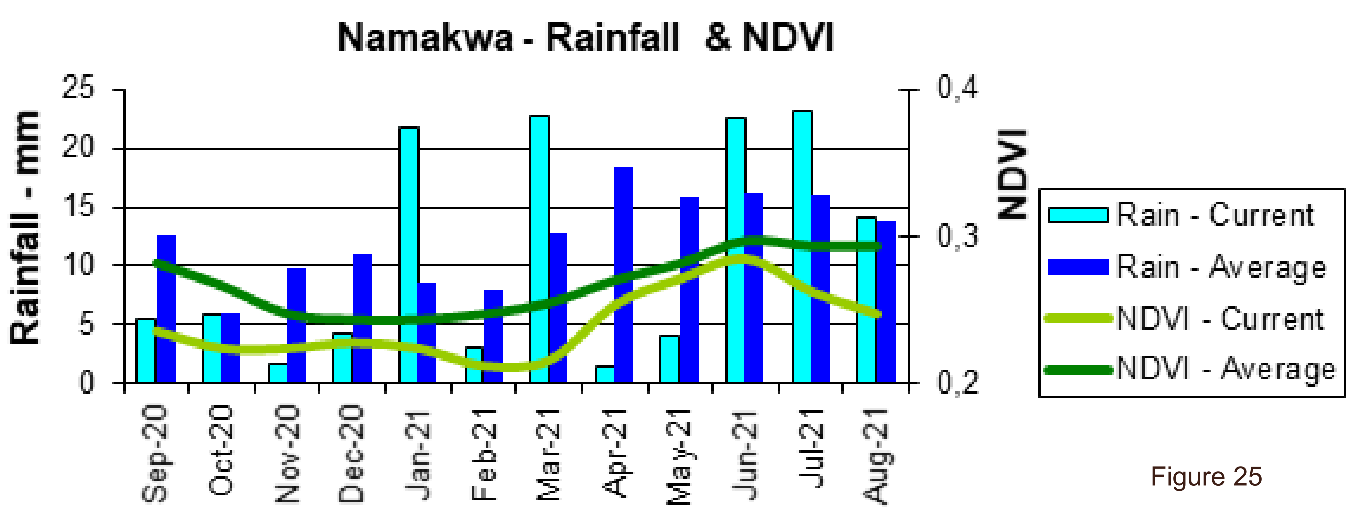

Figure 25

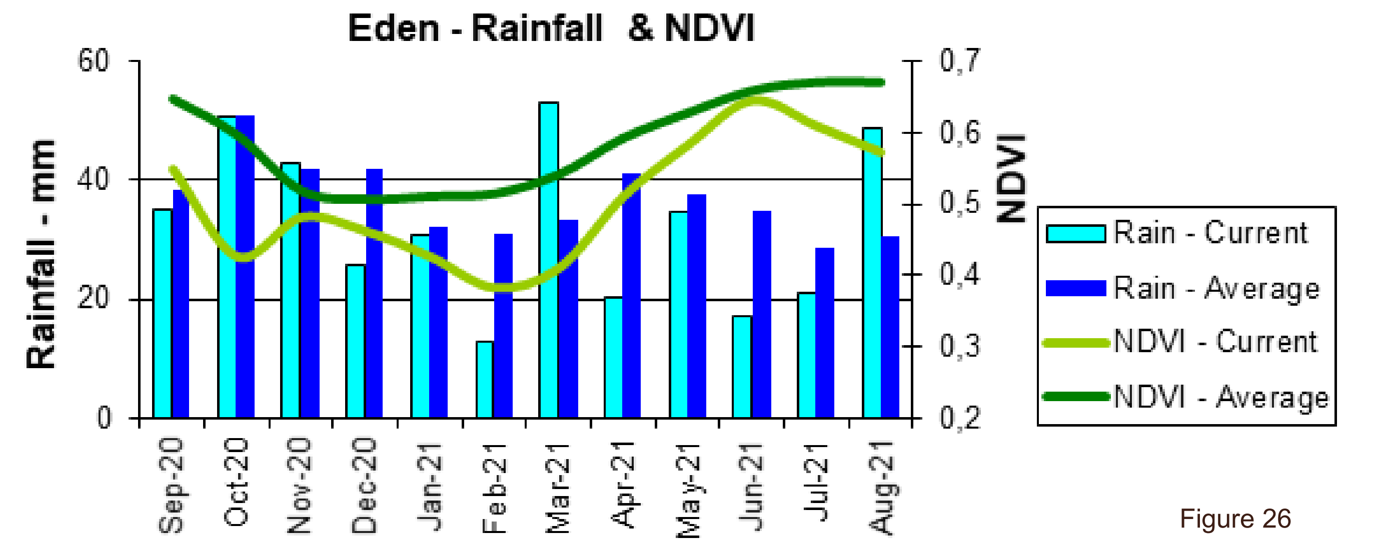

Figure 26

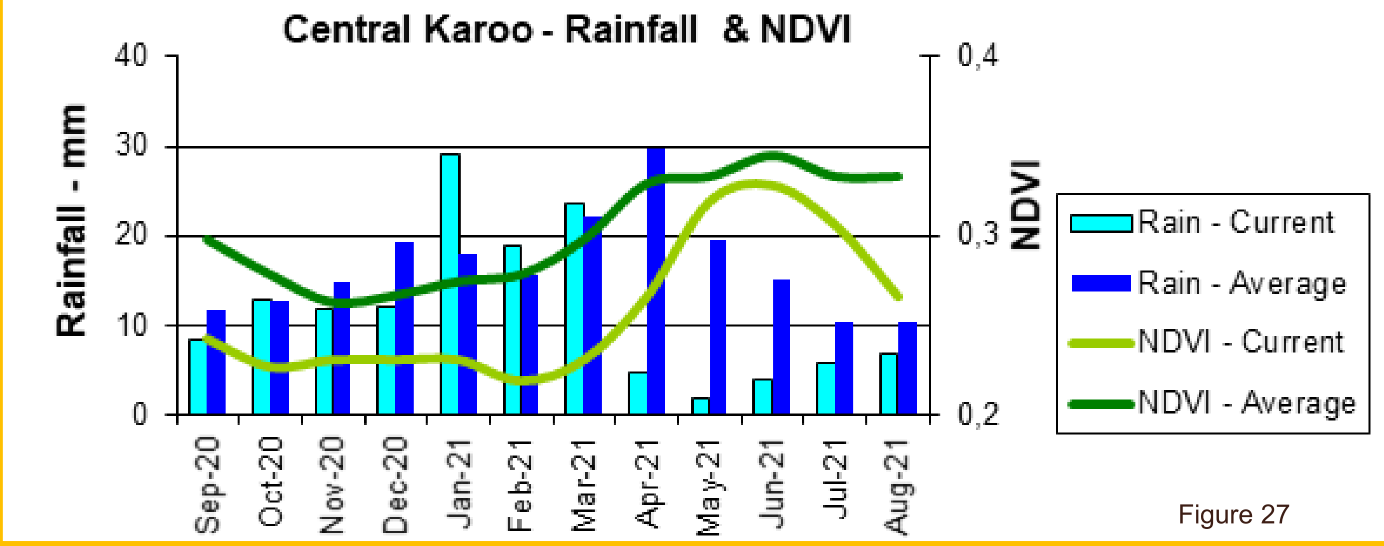

Figure 27

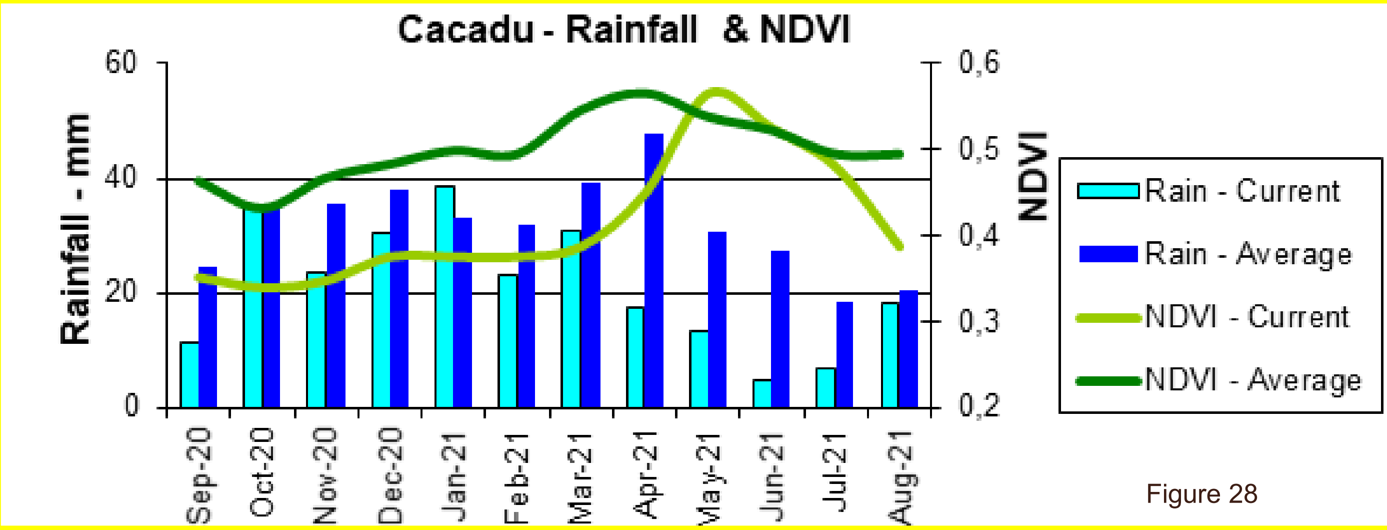

Figure 28

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 1-31 August 2021 per province. Fire activity was higher in all provinces except for the Western Cape, compared to the long-term average.

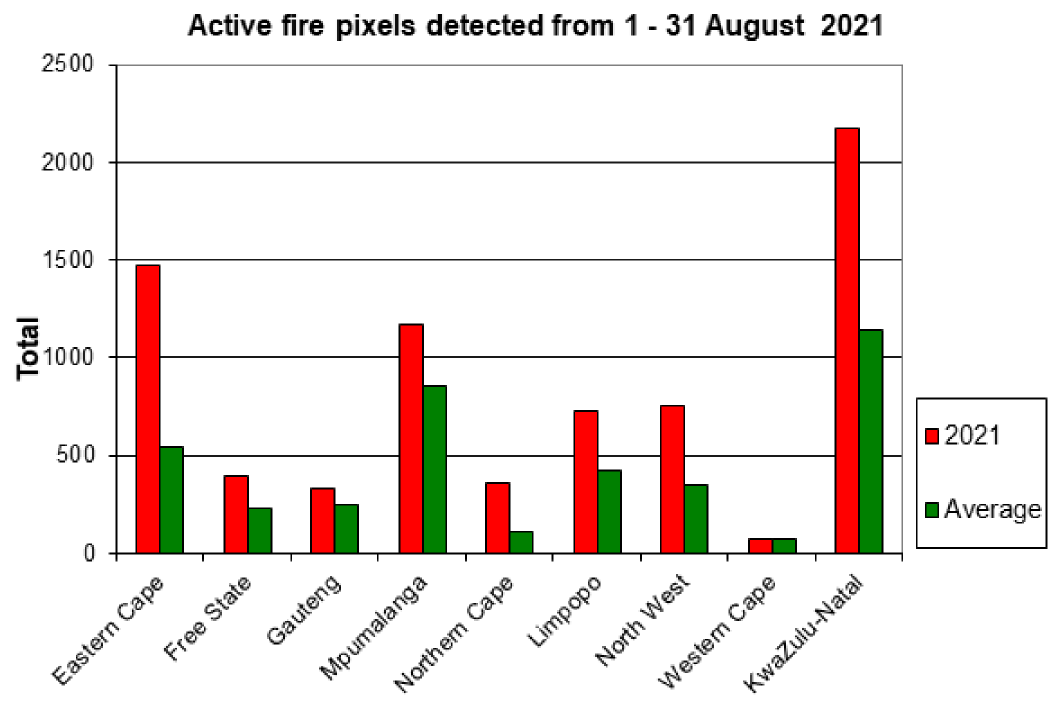

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-31 August 2021.

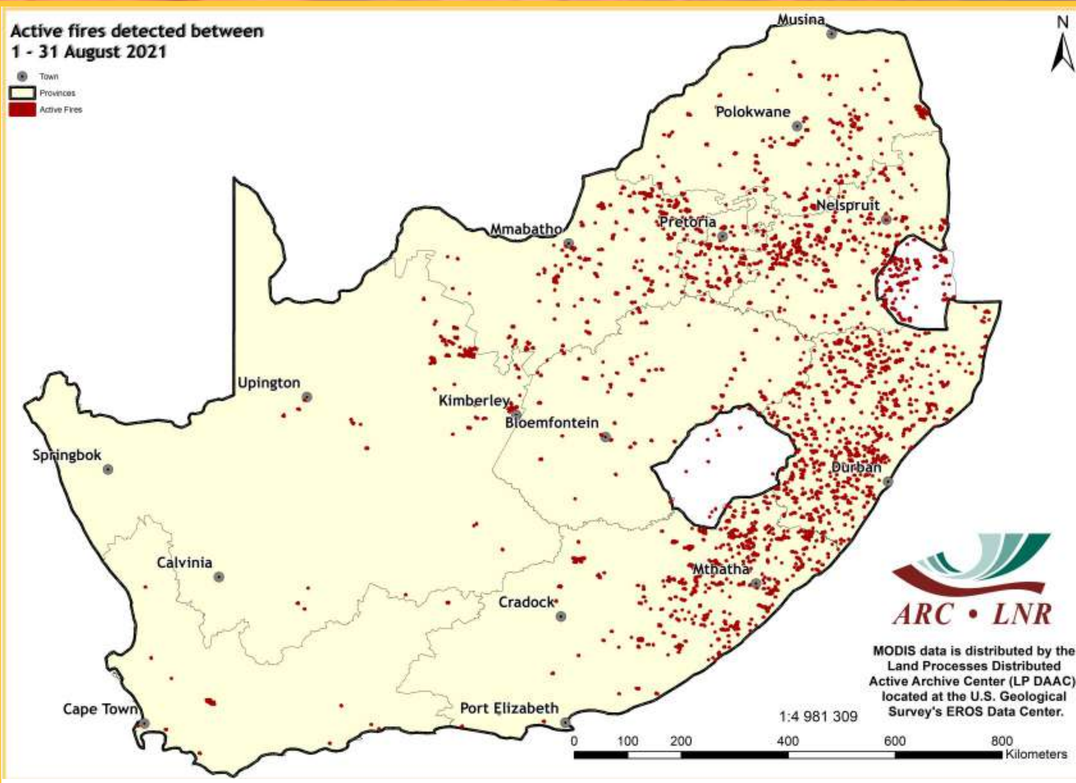

Figure 30

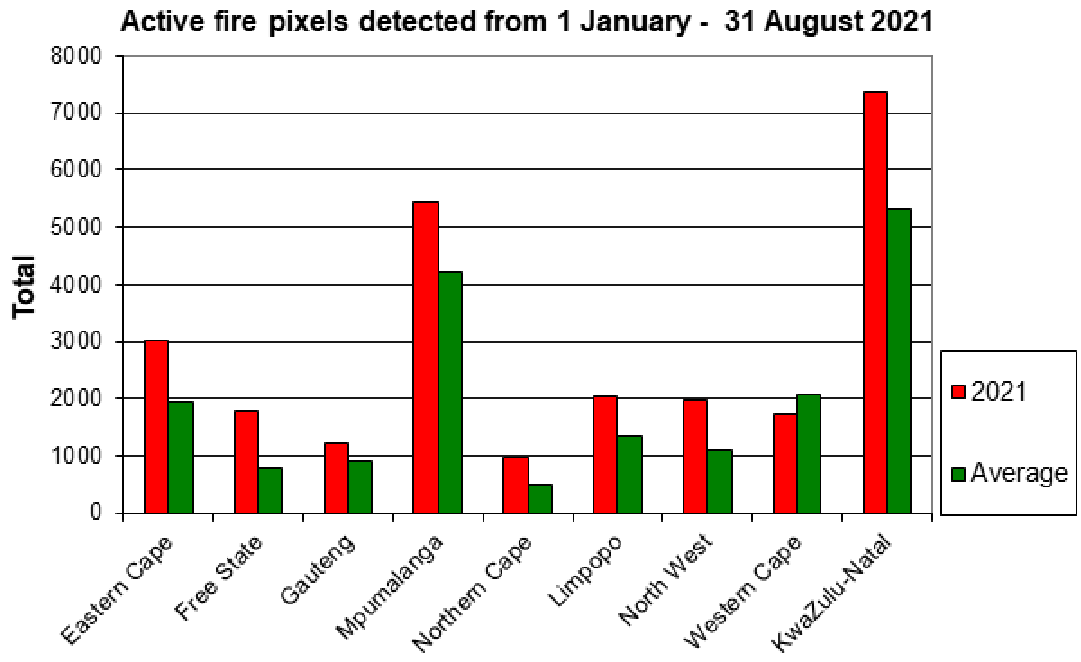

Figure 31

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

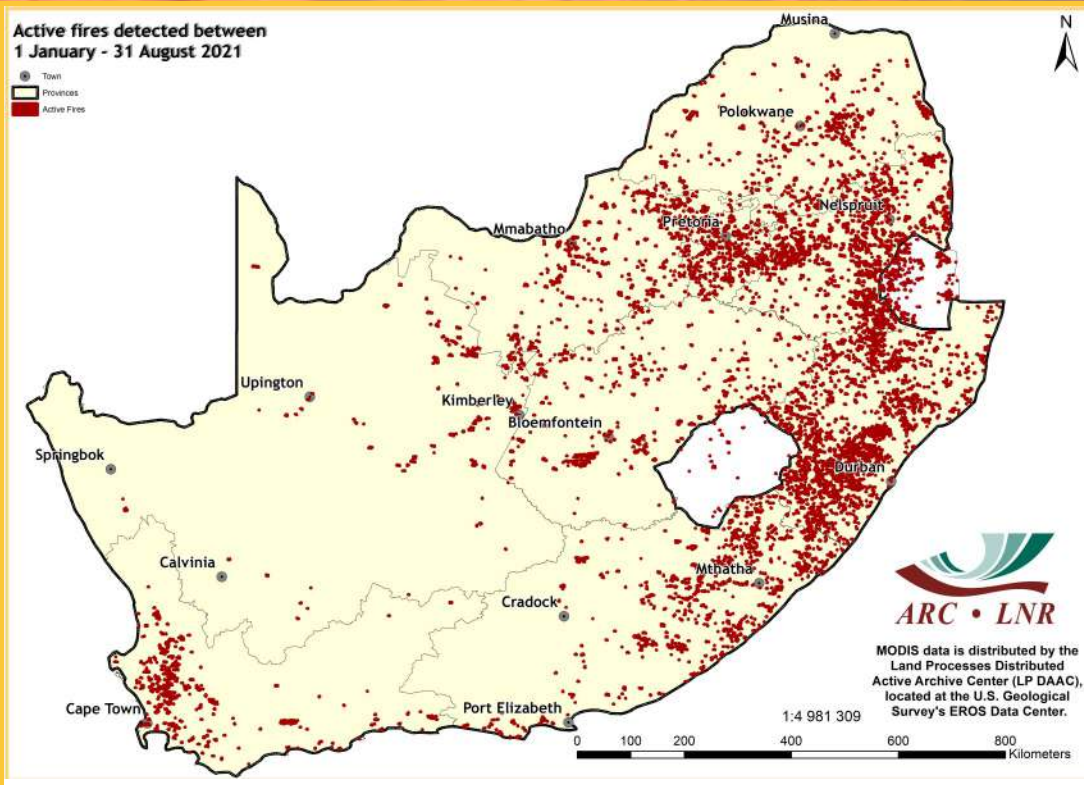

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January and 31 August 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 shows a comparison between the area of water available now and the maximum area of surface water recorded in the last 5 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 2020.

The long-term map for August 2021 shows very similar water patterns to the previous month, with the majority of the summer rainfall areas catchments showing water levels equivalent to 80-100% of the 5-year, long-term maximum water. Catchments in the central Karoo, Western Cape and western coastal regions of the Eastern Cape continue to show much more variable and typically lower current water levels compared to long-term maximum values.

The comparison between August 2021 and August 2020 indicates a similar 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 August 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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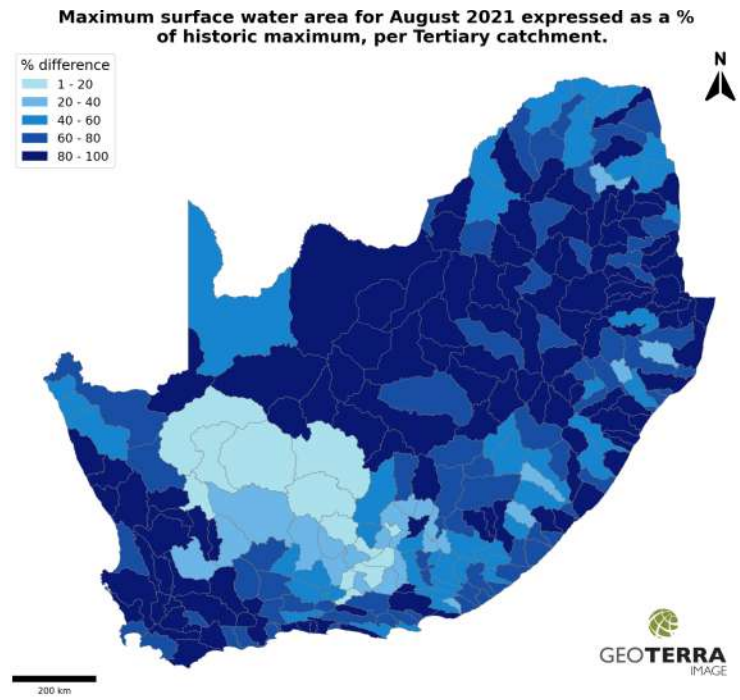

Figure 33

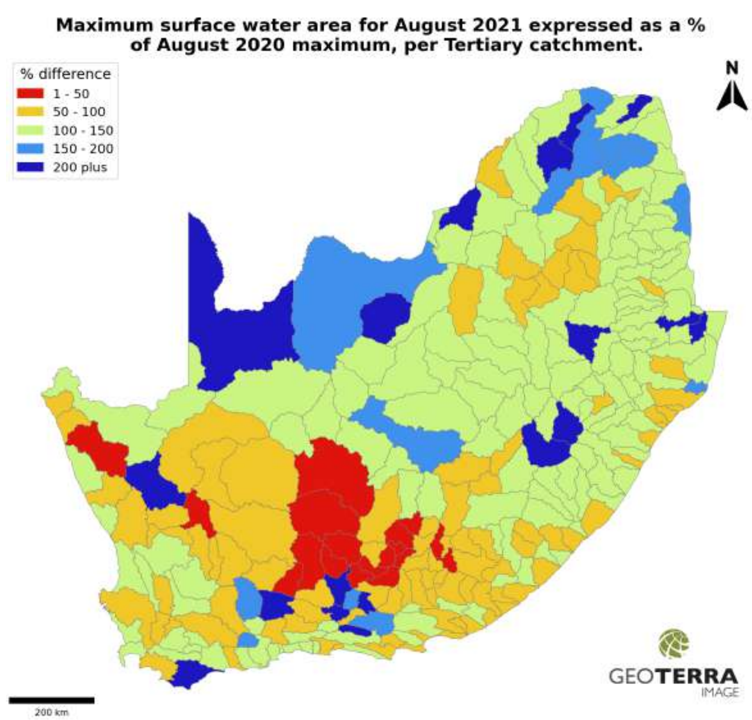

Figure 34

Agrometeorology

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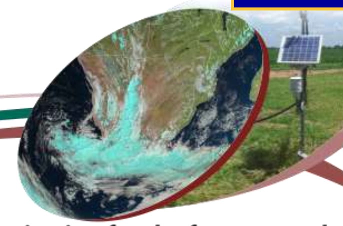

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national 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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What does Umlindi mean?
UMLINDI is the Zulu word for "the watchman".