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UMLINDI
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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

South African Weather Service

AMESD

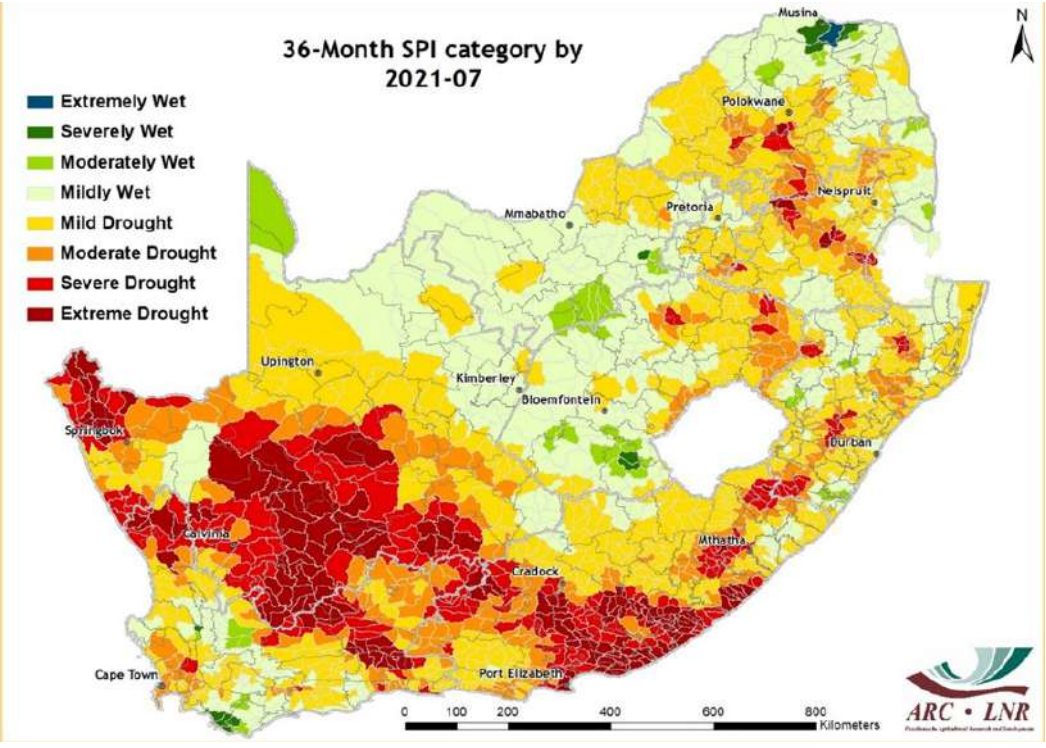
206th Edition

Image of the Month

Drought disaster in the Cape provinces

Severe to extreme drought conditions are prevalent over the Northern Cape, Western Cape and Eastern Cape provinces as depicted in the long-term (36-month) Standardized Precipitation Index (SPI) map ending in July 2021. These conditions have resulted in significant decreases in agricultural production, leading to food insecurity and reduced livelihoods. Consequently, in terms of Section 23(1)(b) of the Disaster Management Act, the Department of Cooperative Governance and Traditional Affairs (CoGTA) has classified the drought in the three Cape provinces as a national disaster (http://www.gpwonline.co.za/Gazettes/Gazettes/44876_20-7_CoopGov.pdf).

By definition, a drought disaster is a gradual deterioration of grazing land and crop failure due to precipitation deficiency. Such droughts are very difficult to predict and could last for long periods, usually between 12 and 36 months. It is noteworthy that these western parts of South Africa are identified as areas prone to frequent drought occurrences with severe droughts observed at intervals of 10-20 years over more than a century. However, some regions are more prone to drought disasters than others and the capacity of each region to effectively prepare for and respond to them mainly depends on various biophysical and socio-economic factors. Other areas of concern include parts of KwaZulu-Natal, the Free State and the interior of Limpopo and Mpumalanga, where isolated areas are also experiencing long-term drought and its resultant impacts.



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:

Rainfall during July 2021 was largely absent over the summer rainfall region due to unfavourable upper air conditions and/or dry surface conditions, as expected. Although insignificant, the only areas in that region that received some rain include Vhembe District Municipality in Limpopo and Graskop in Mpumalanga, as well as Richards Bay and surrounds in KwaZulu-Natal. Geographically, the aforementioned areas are situated in a region that commonly experiences dry winters and rainfall during this time of year is somewhat uncharacteristic. However, similar conditions have been occurring during the same period since 2015, with the exception of 2019. It was further observed that lesser totals of 5-10 mm recorded in the southern parts of Limpopo (Elias Motsoaledi Local Municipality) resulted in above-normal rainfall conditions, as given by the percentage of long-term mean for July records, also implying that the region is commonly dry during this time of year. In contrast, most rainfall activity was confined to the winter and all-year rainfall regions. The frequent passage of frontal systems and resulting rainfall over those parts of the country since May continued into July.

The month commenced with unseasonable high temperatures over the interior and light showers observed over the Cape provinces, Mpumalanga, Limpopo and KZN. Considerable rainfall activity occurred over the southwestern region following a cold front that made landfall on the morning of 12 July. Furthermore, as from the 20th, a succession of cold fronts made landfall and resulted in gale force winds and localized flooding due to heavy rainfall over the Western and Eastern Cape. Temperatures continued to drop due to the invasion of cold dry air from the west, resulting in severe widespread frost over the interior. Snowfall was also observed in some parts of the Northern Cape and over the mountainous areas of the Western Cape, Eastern Cape and Free State, with minimum temperatures dropping as low as -8°C. Subsequently, a high pressure system moved into the interior towards the end of the month and temperatures started increasing.

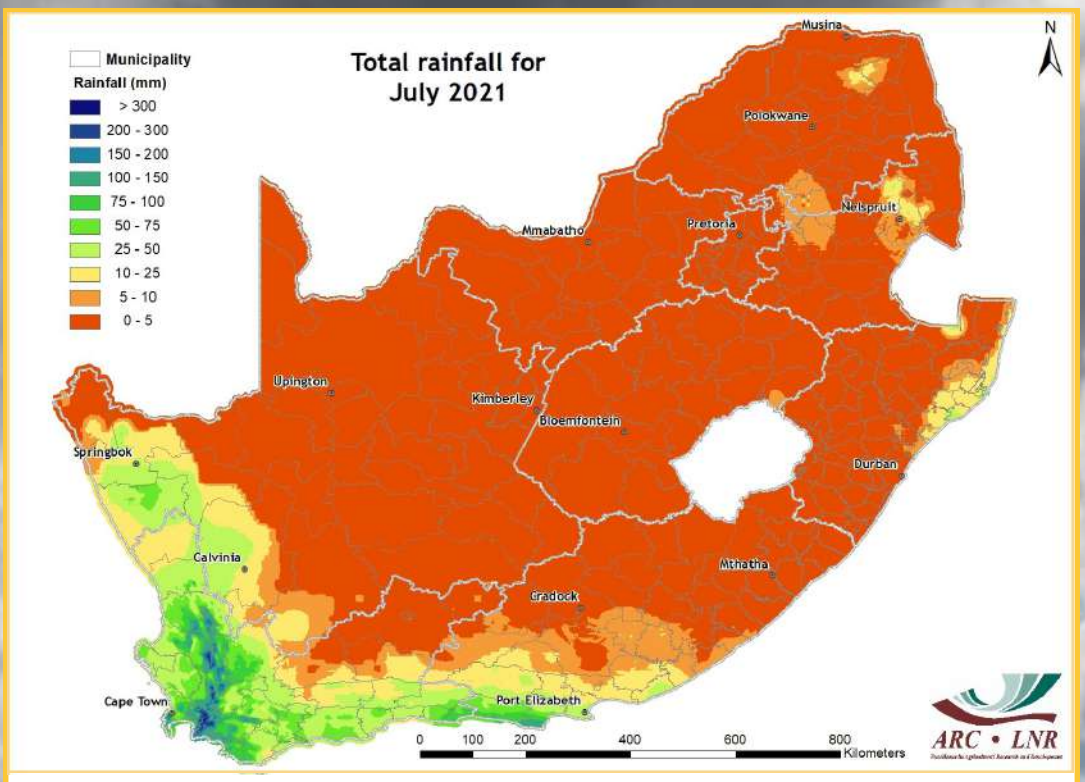


Figure 1

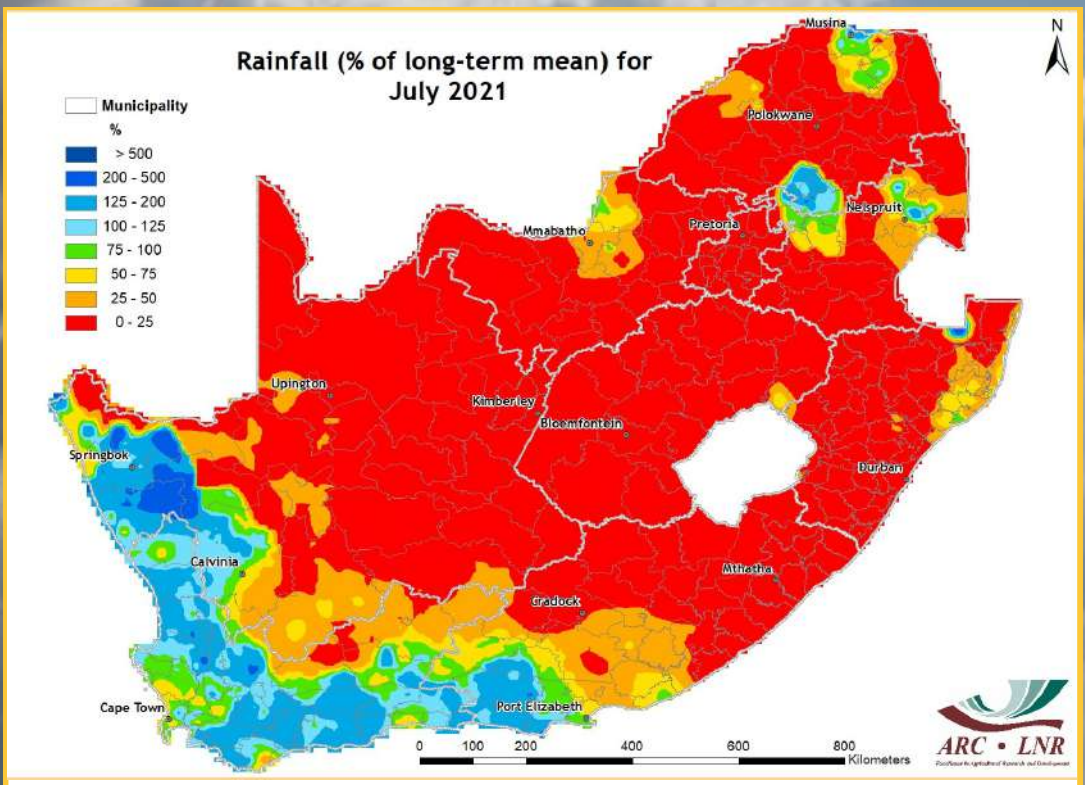
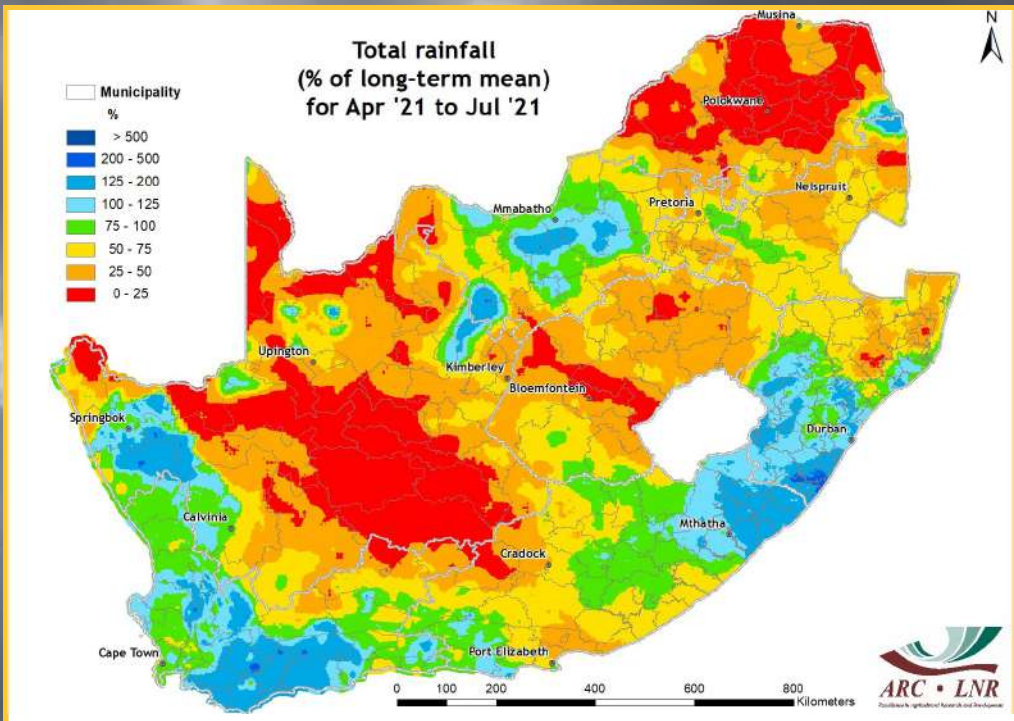


Figure 2



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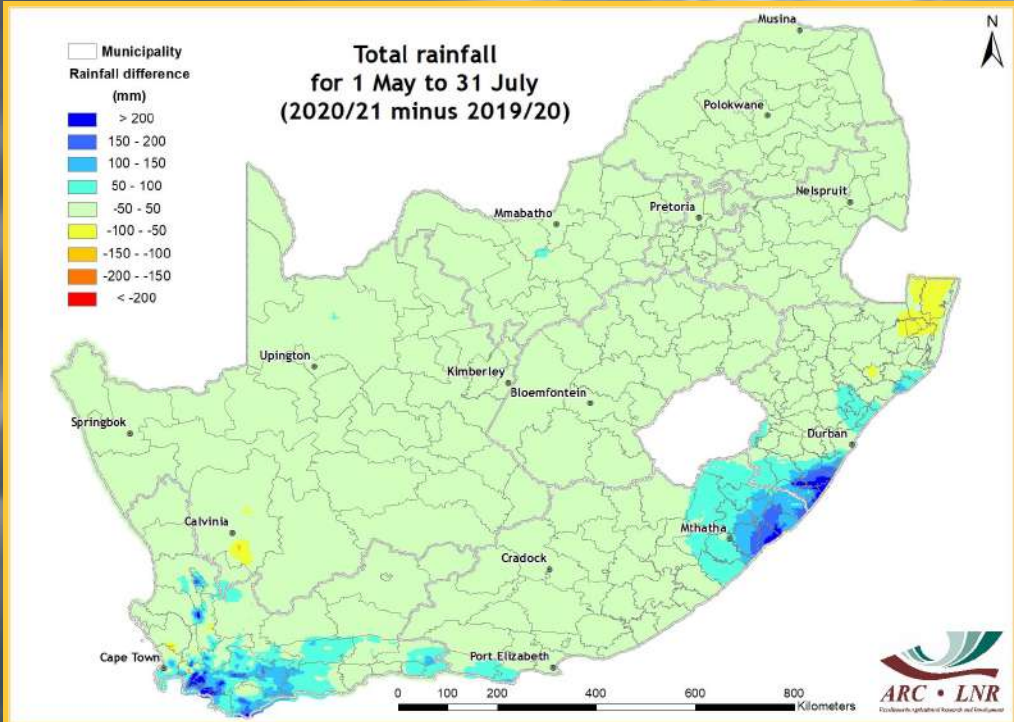

Figure 4

Figure 1:
Rainfall-producing weather systems over the winter and all-year rainfall regions were common during July 2021. Thus, rainfall was concentrated over those regions, with areas such as Cape St. Francis, Simon's Town, Paarl, Kirstenbosch National Botanical Garden, Bellville and Ceres receiving >130 mm of rain for the month. Although some areas of the summer rainfall region, including parts of the Limpopo, Mpumalanga and KwaZulu-Natal provinces, recorded some rainfall during this month, totals were generally below 50 mm.

Figure 2:
Rainfall in July was near to above normal over the far western and southern parts of the country, as well as in some parts of Limpopo, Mpumalanga and KZN. The rest of the country experienced below-normal rainfall activity.

Figure 3:
Cumulative rainfall since April 2021 was above normal over many of the western and southern parts of the country, northern parts of the Northern Cape, North West and the eastern coastline (including 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 May to July 2021 improved over the southern KZN coast and adjacent area of the Eastern Cape. Similarly, the south-western area of the country and parts of the all-year rainfall region received in excess of >100 mm of rain. 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 SPI map indicates widespread near-normal conditions (given by mild 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. Moderate to extreme wet conditions dominate at the medium-term time scales over the northern interior, Lowveld of Limpopo and Mpumalanga, as well as isolated areas of the Western Cape. Severe to extreme drought conditions still dominate over western regions of the country, parts of the Eastern Cape extending towards KZN, Free State and the interior of Limpopo and Mpumalanga at the longer-term time scales (24-36 months).

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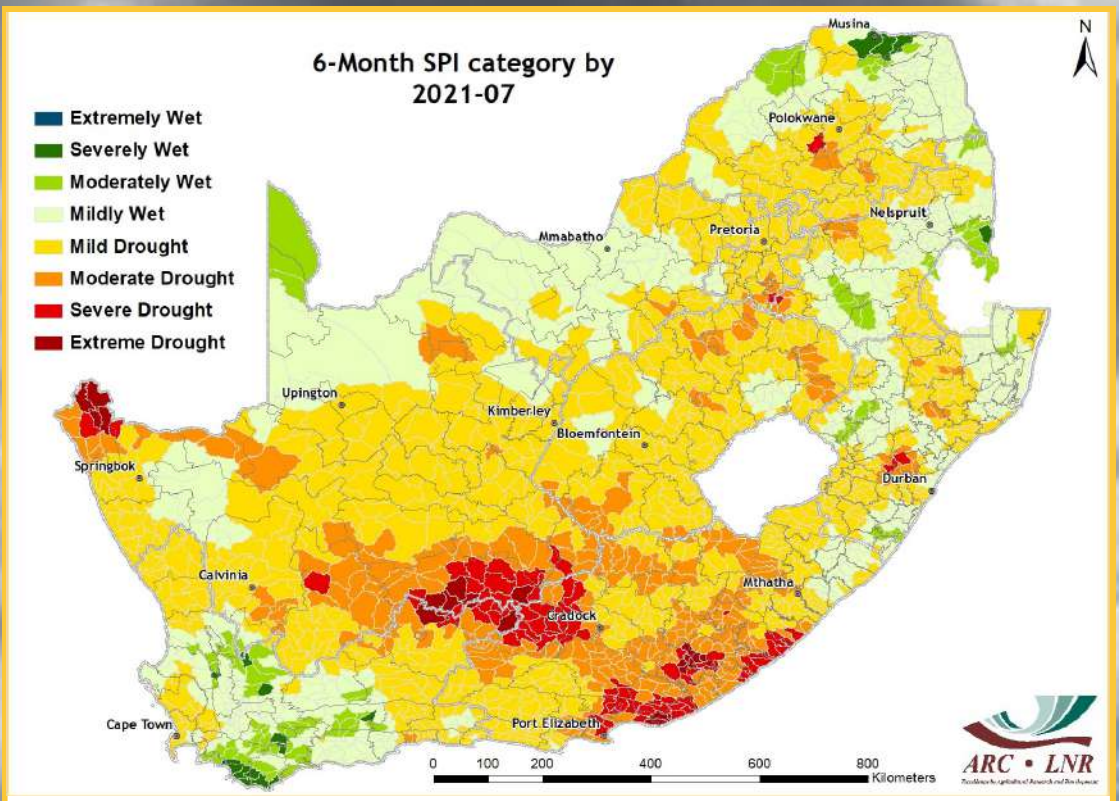

Figure 5

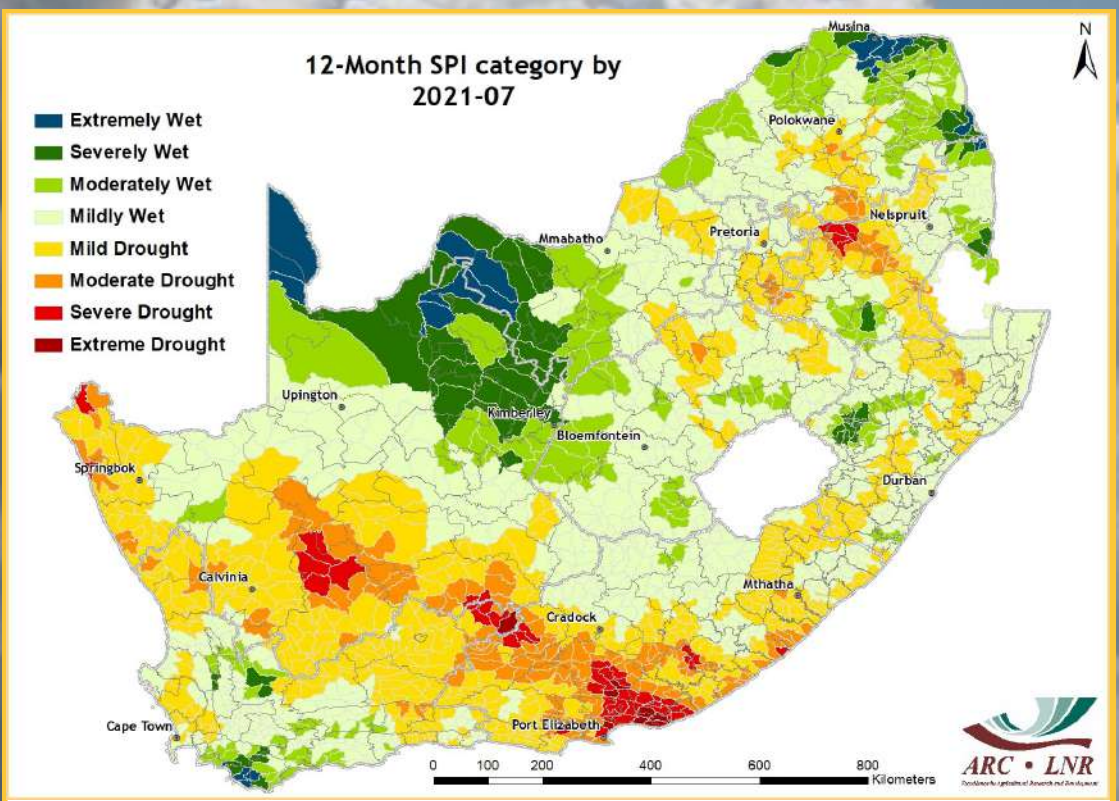

Figure 6

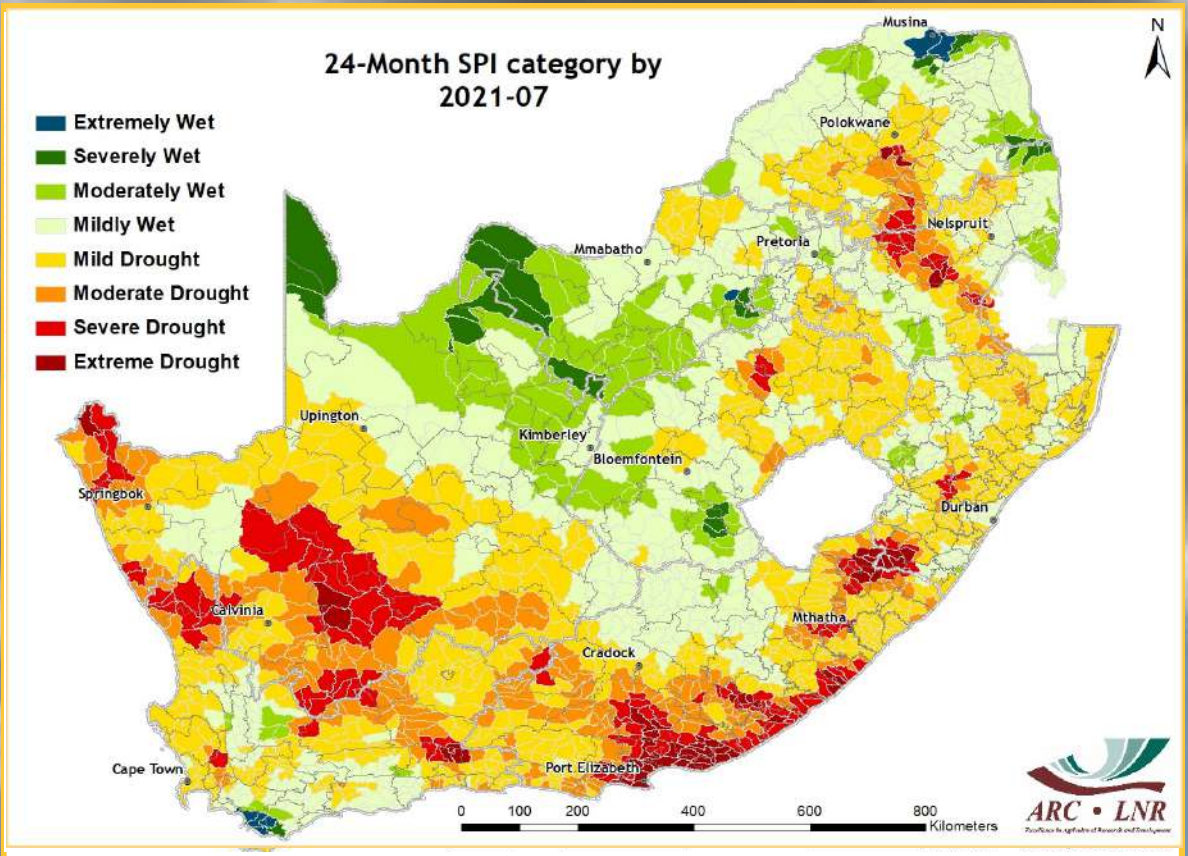

Figure 7

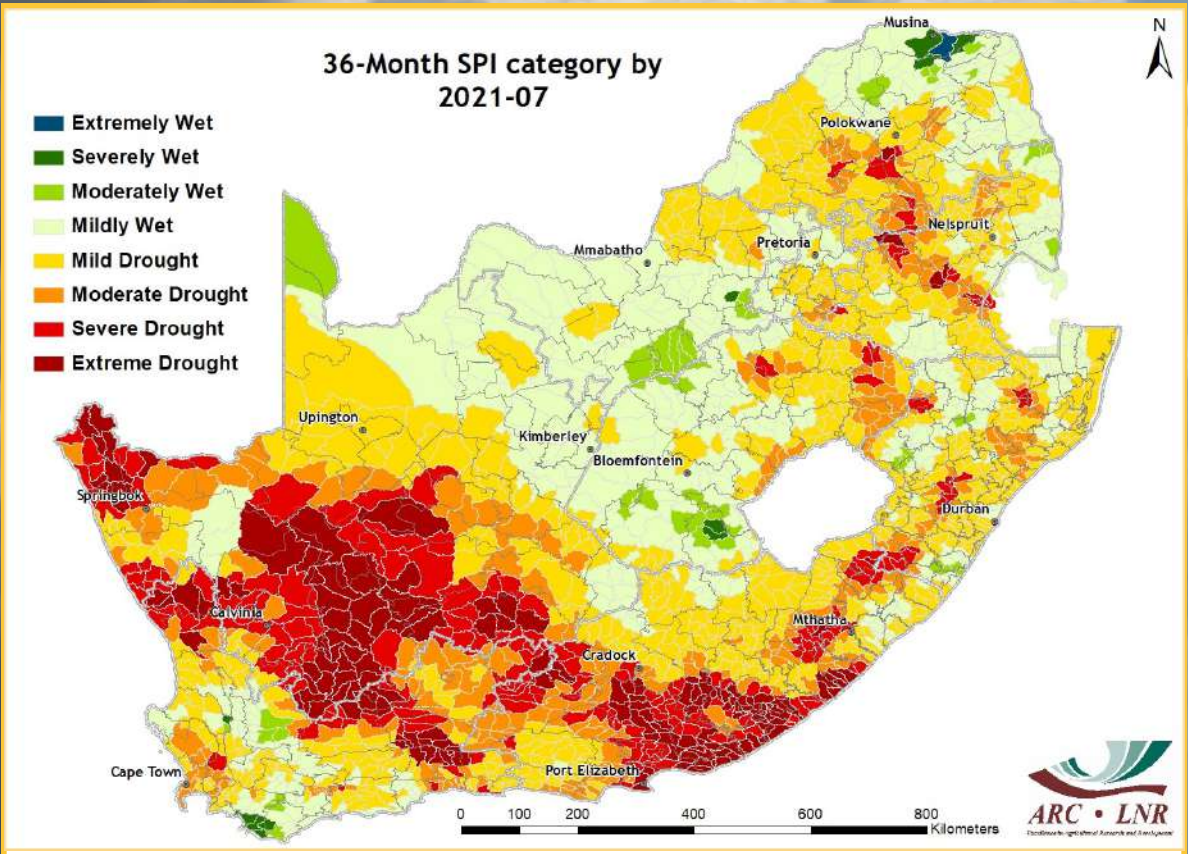

Figure 8

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.

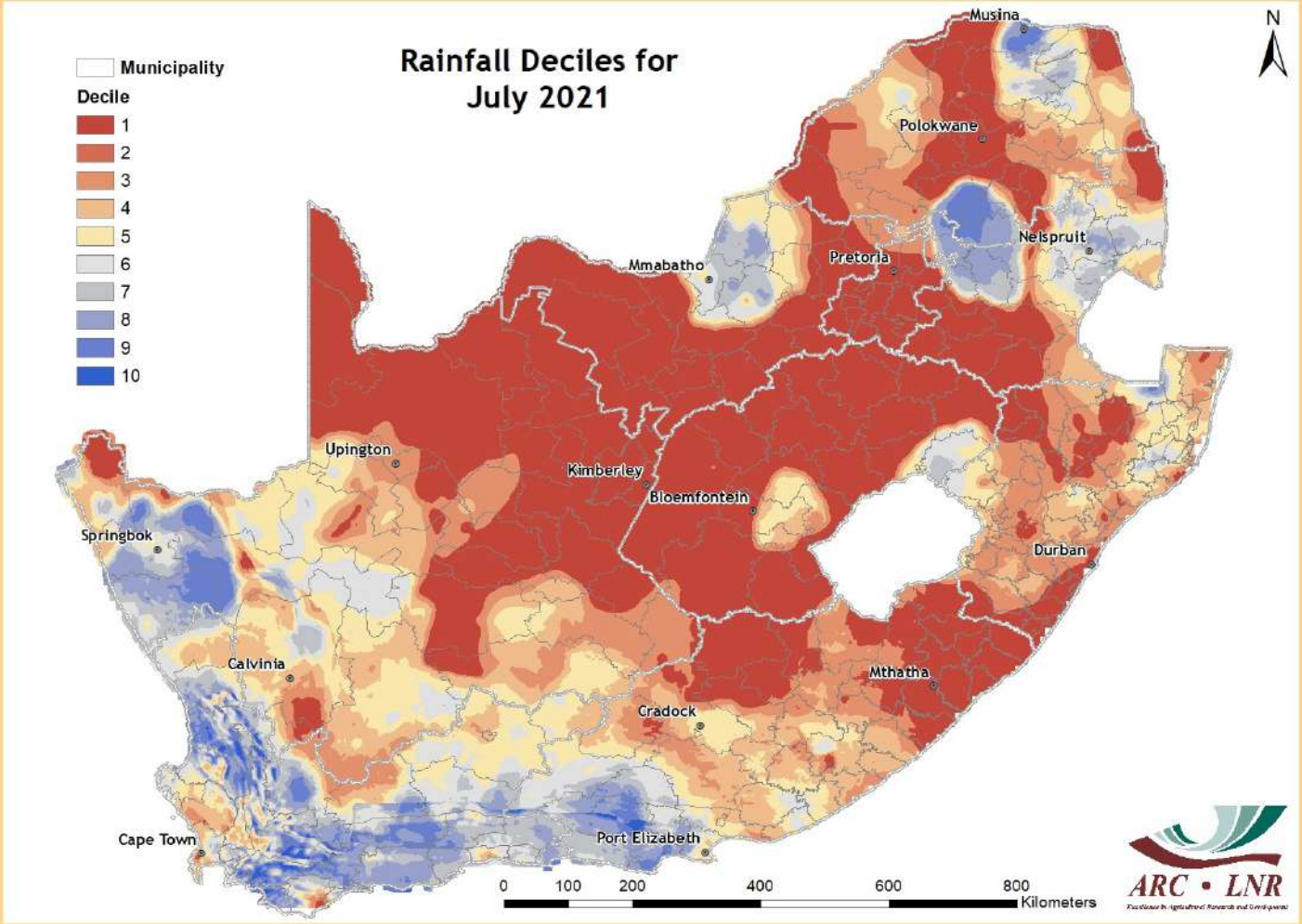

Figure 9

Figure 9:
Rainfall totals for July 2021 over the winter and all-year rainfall regions fall within the historically wetter July months. The summer rainfall region experienced a drier than normal July, except for isolated parts of Limpopo, North West, Mpumalanga and KwaZulu-Natal.

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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.

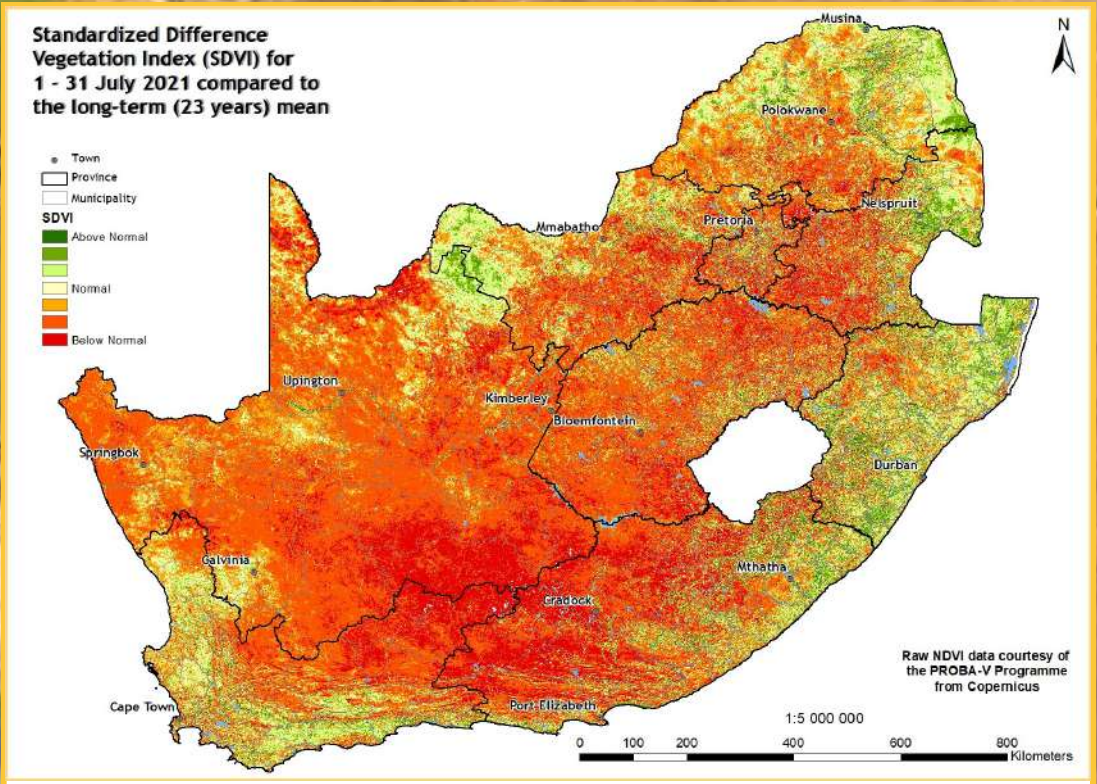

Figure 10

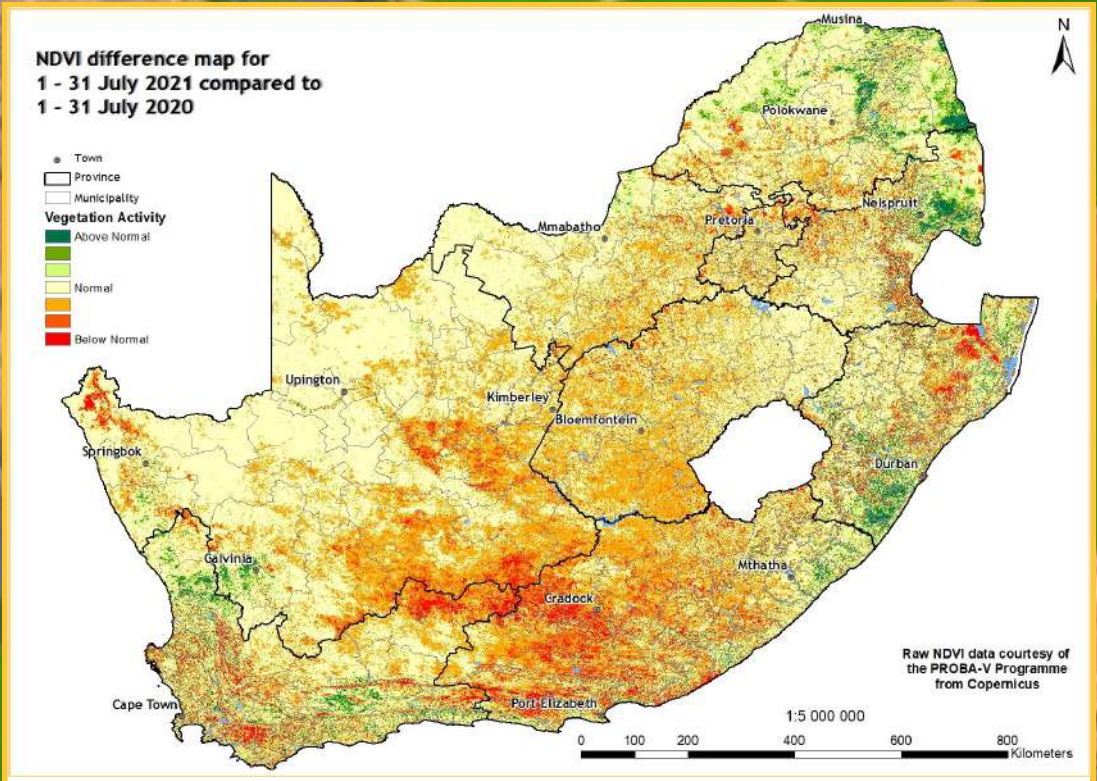

Figure 11

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

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

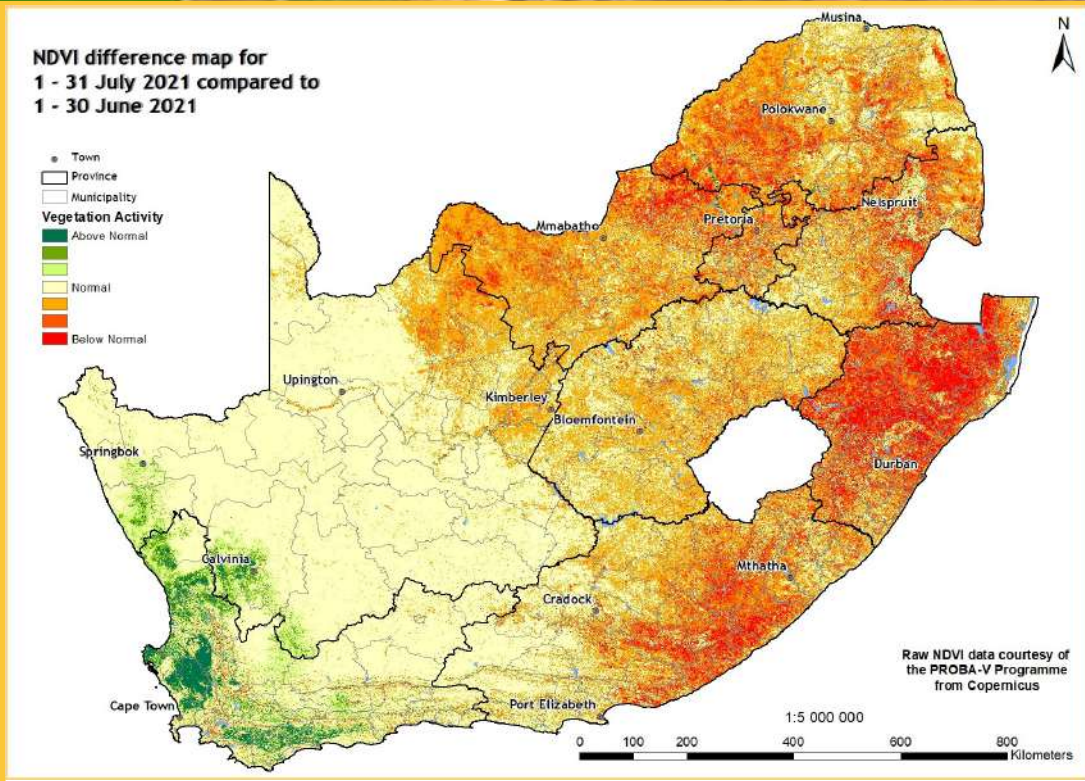

Figure 12

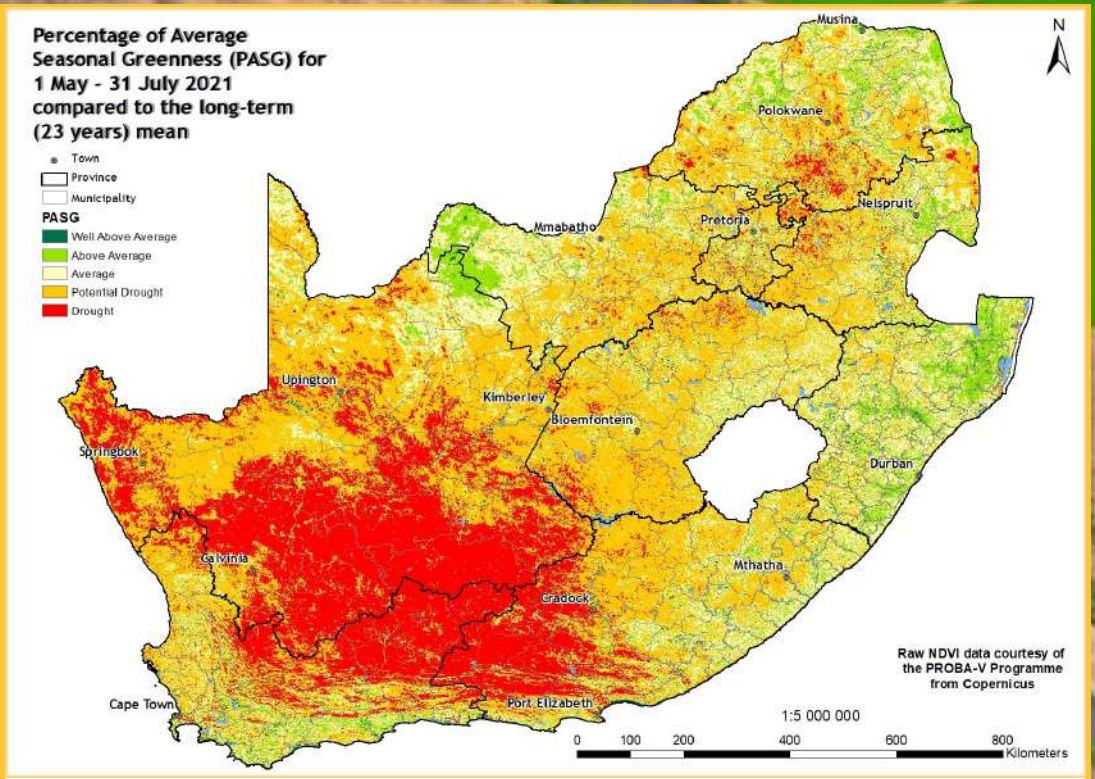

Figure 13

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 July shows that the eastern half of the country experienced below-normal vegetation activity while the western half experienced normal and 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, but the central parts are experiencing potential drought, with drought conditions prevailing towards the western parts.

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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.

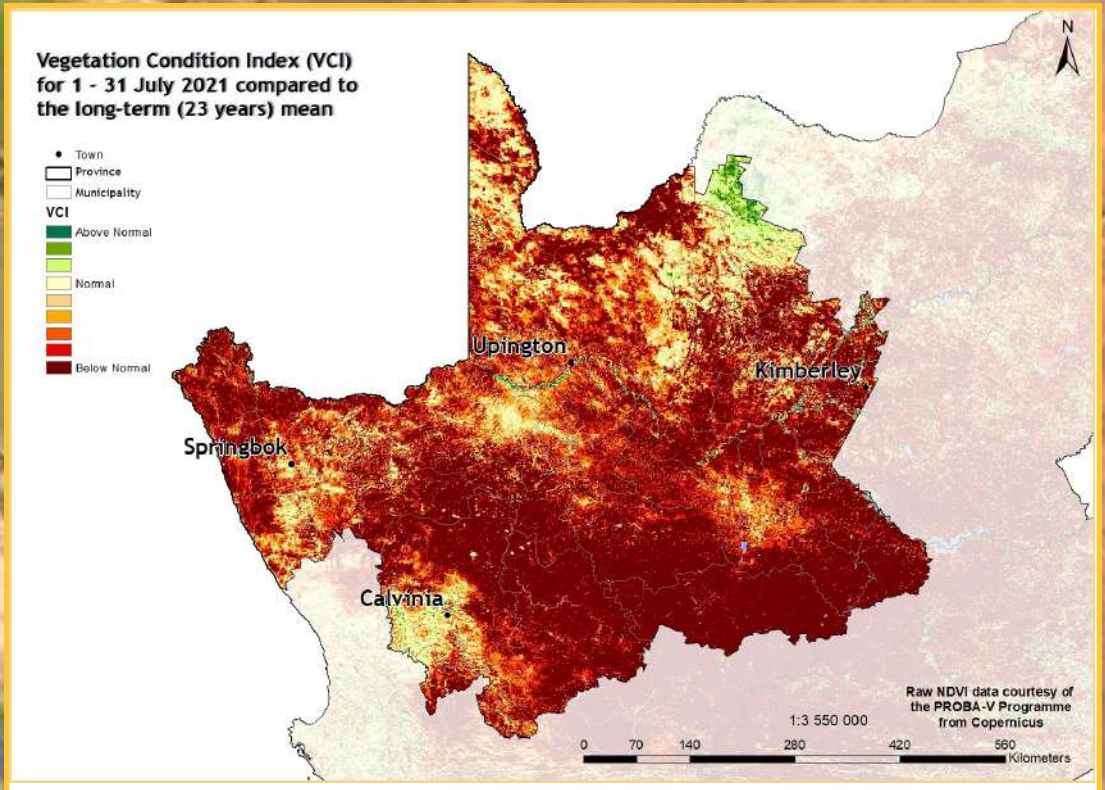

Figure 14

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

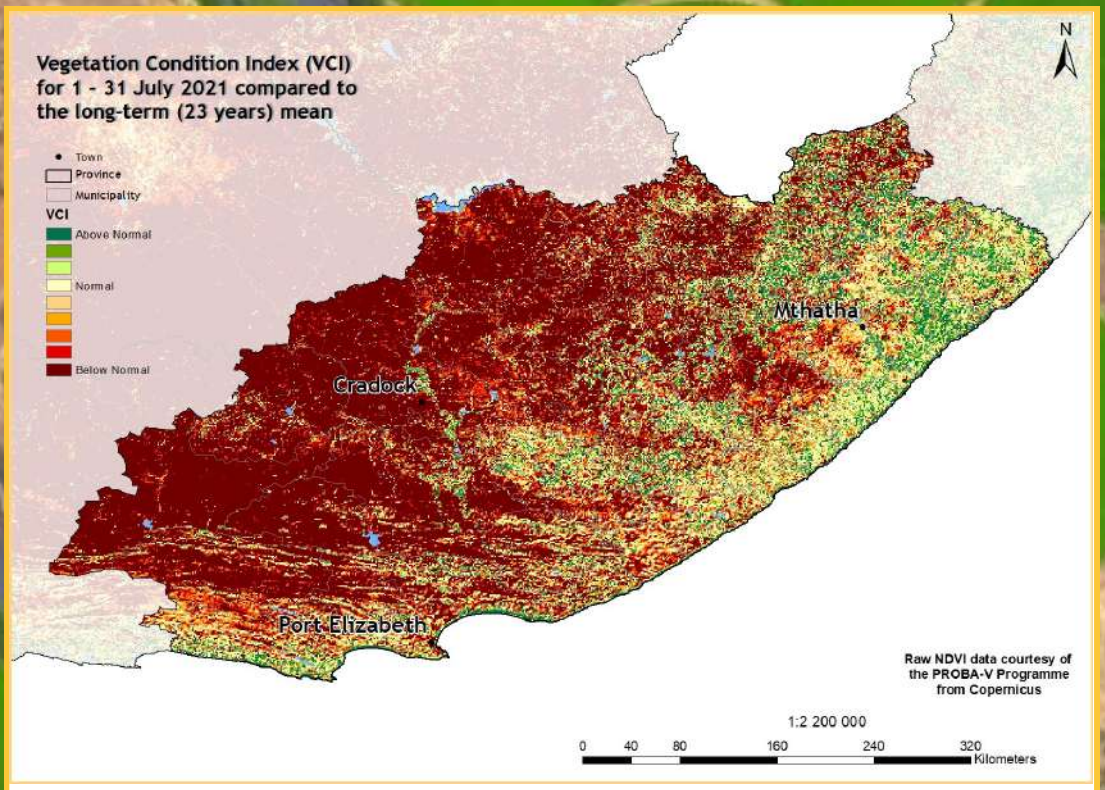

Figure 15

Figure 15:
The VCI map for July 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.

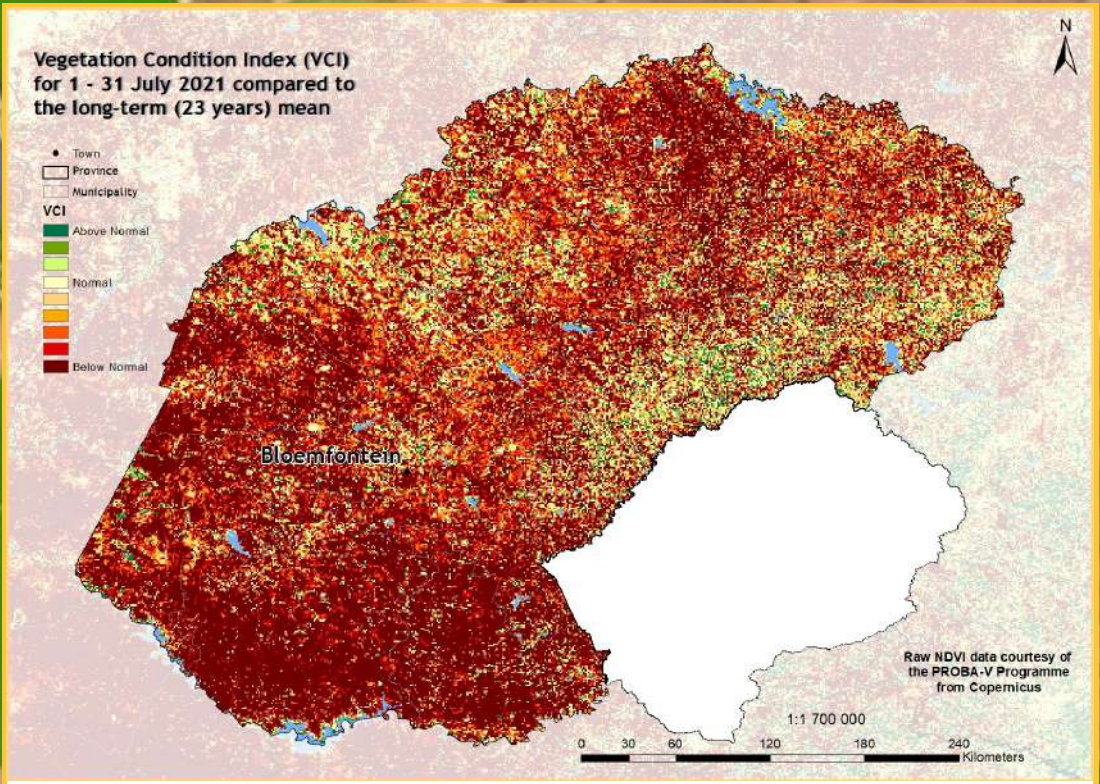

Figure 16

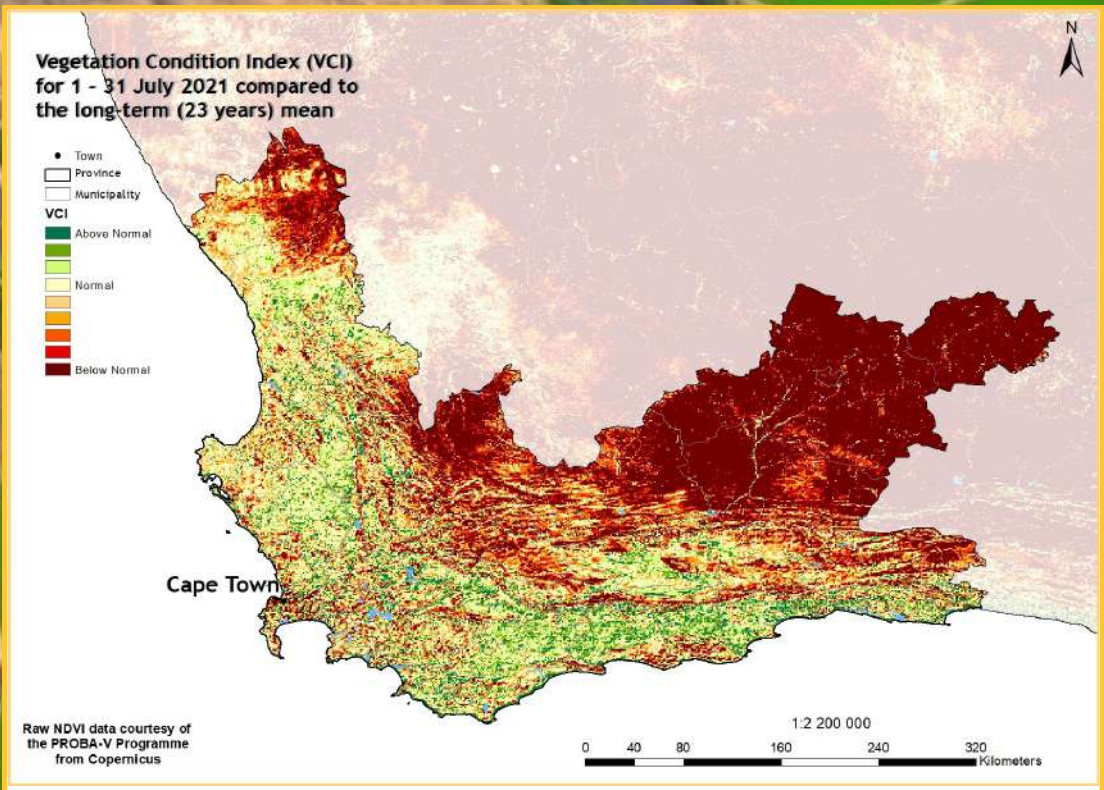

Figure 17

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

Figure 17:
The VCI map for July 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

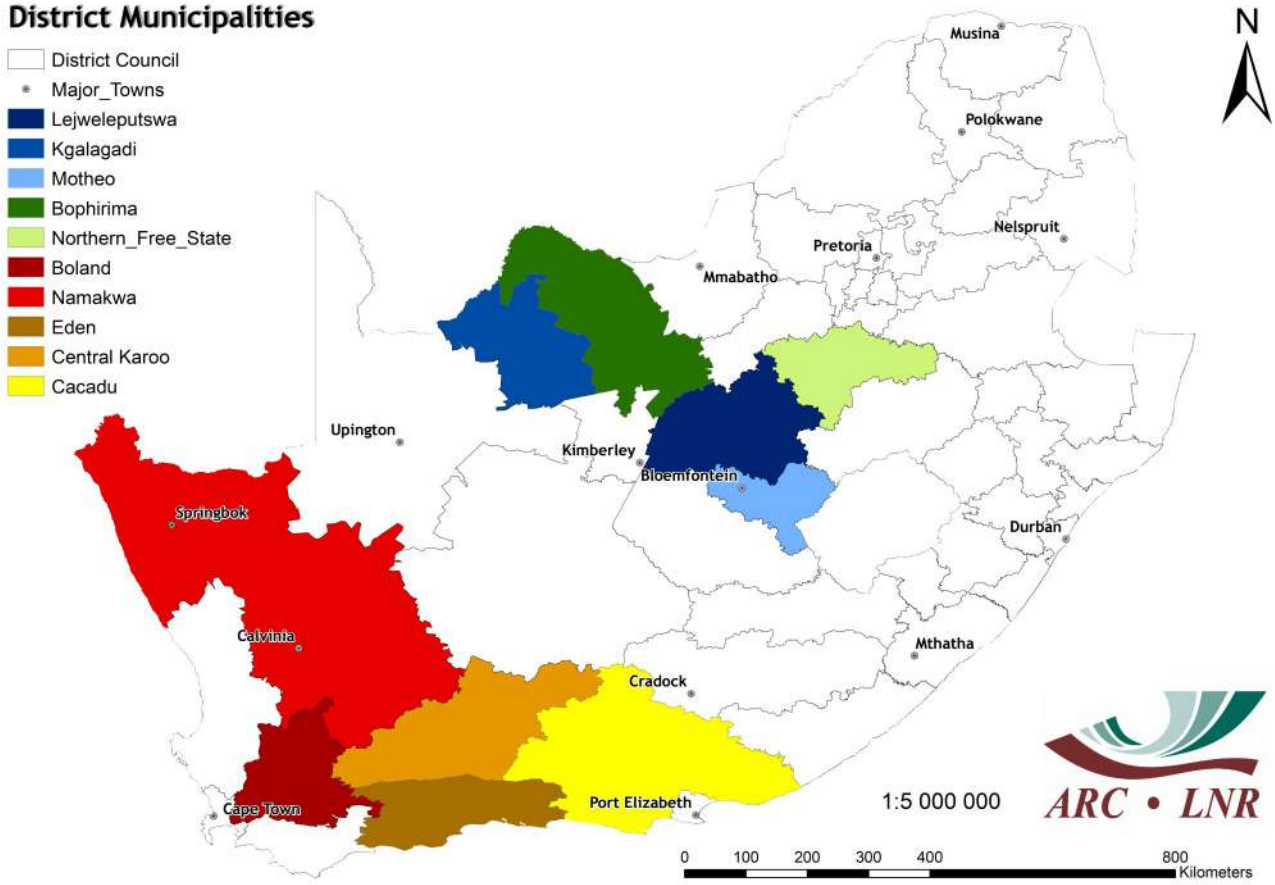

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for July 2021. The district colour matches the border of the corresponding graph.

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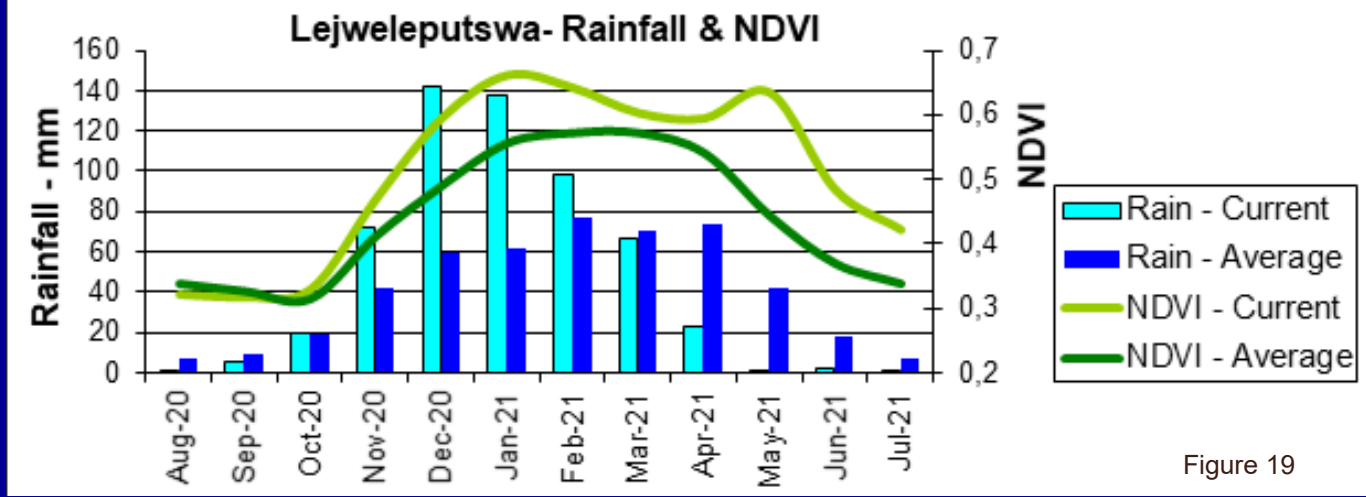
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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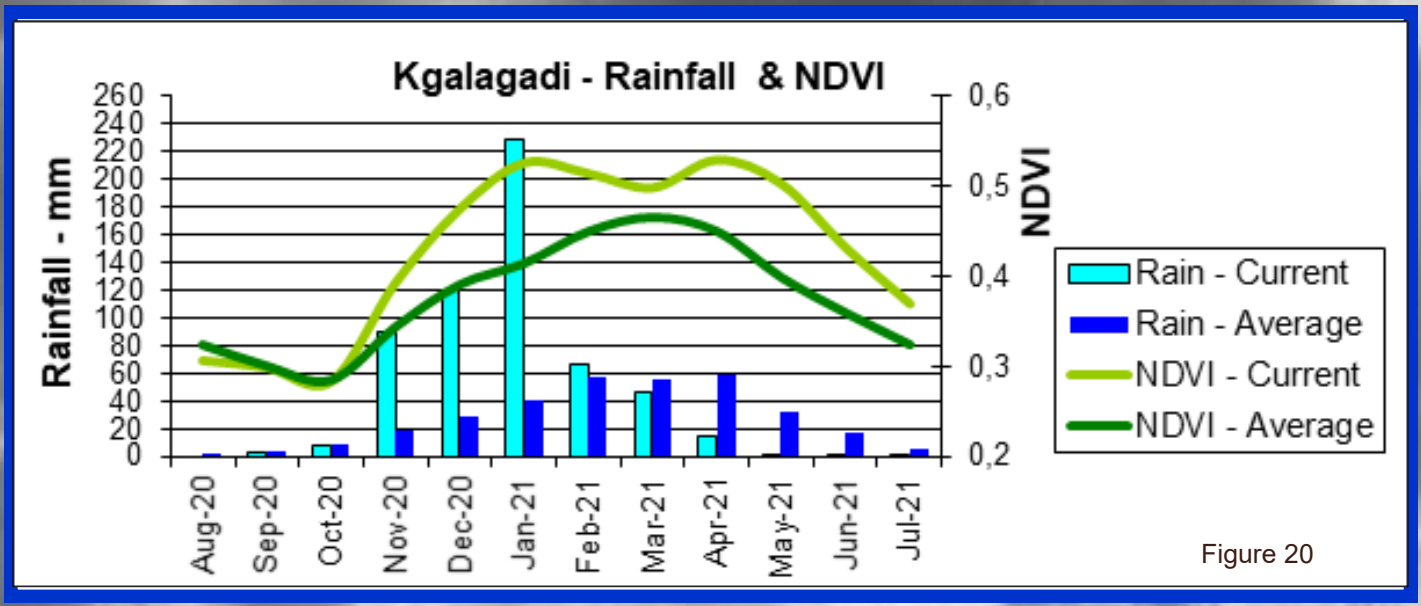

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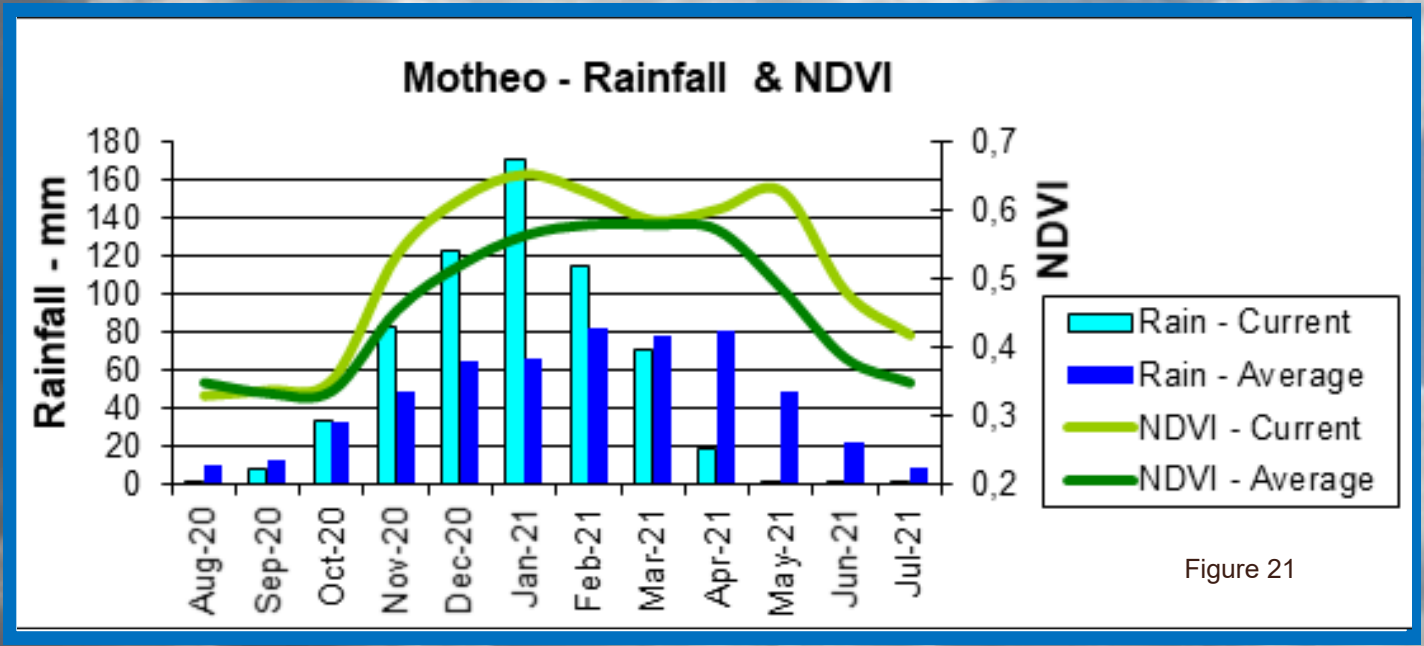

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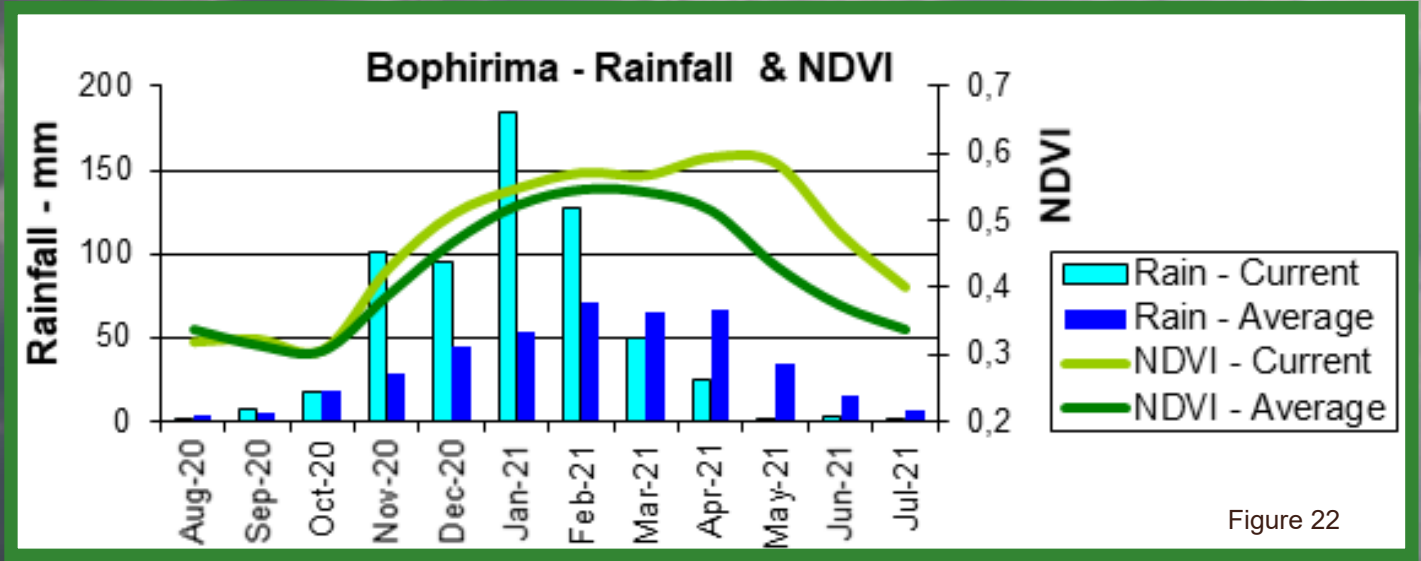

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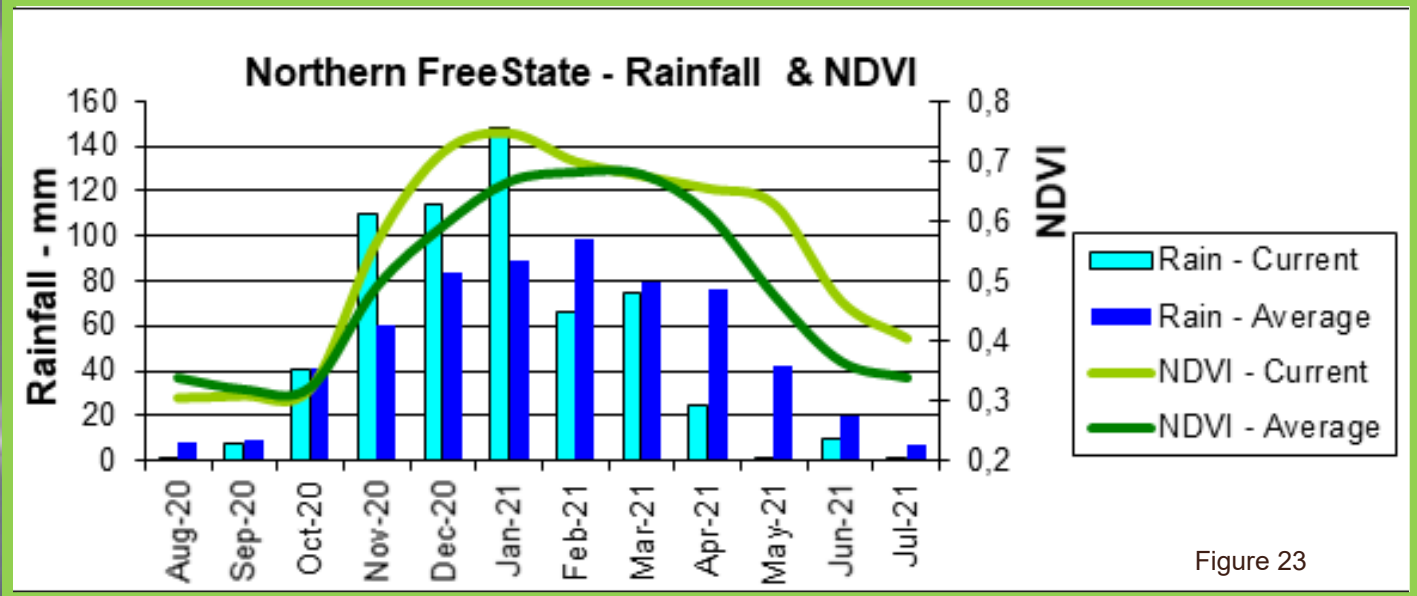

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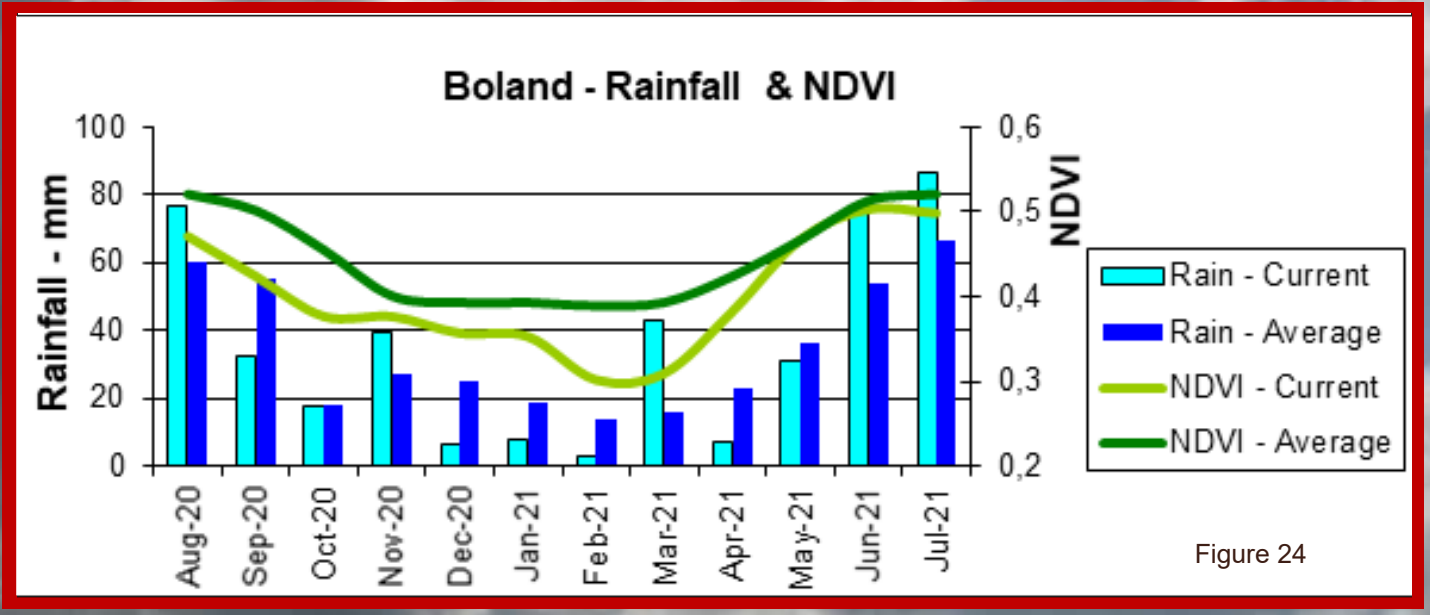

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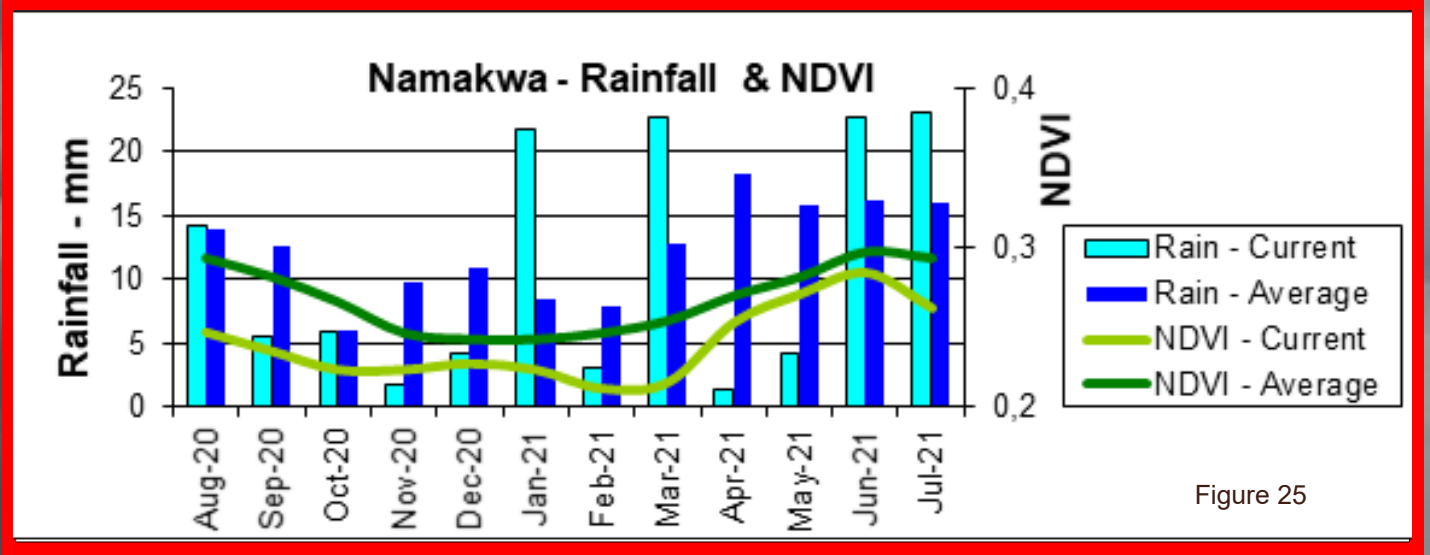

Figure 25

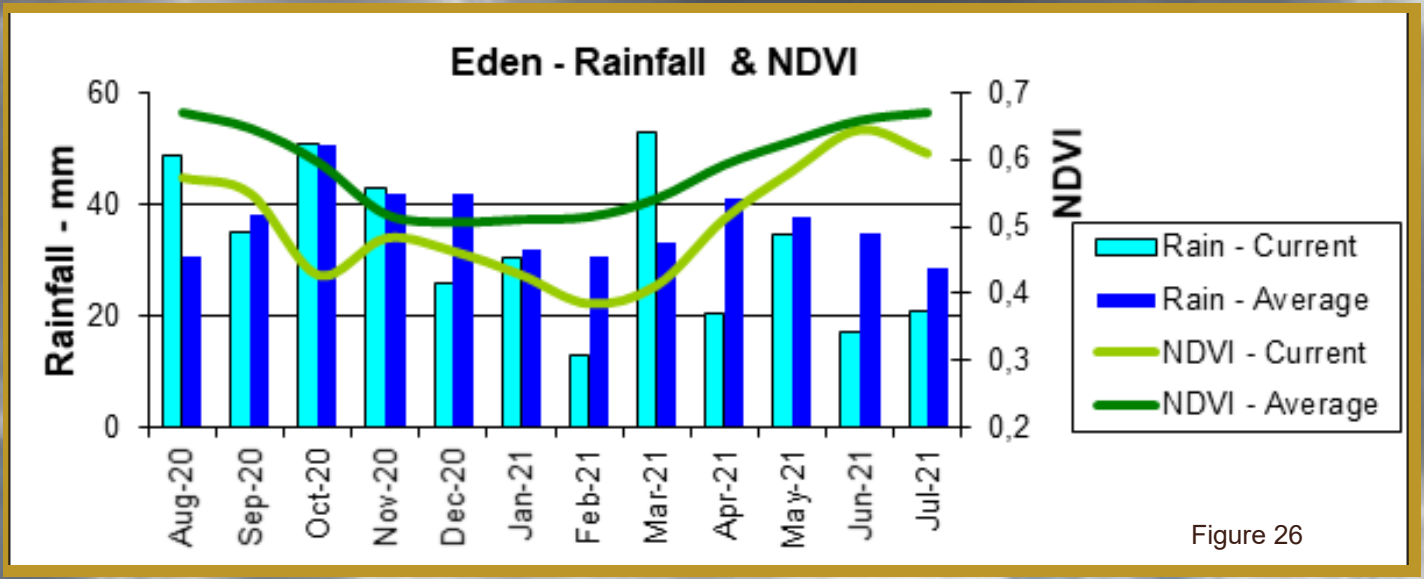

Figure 26

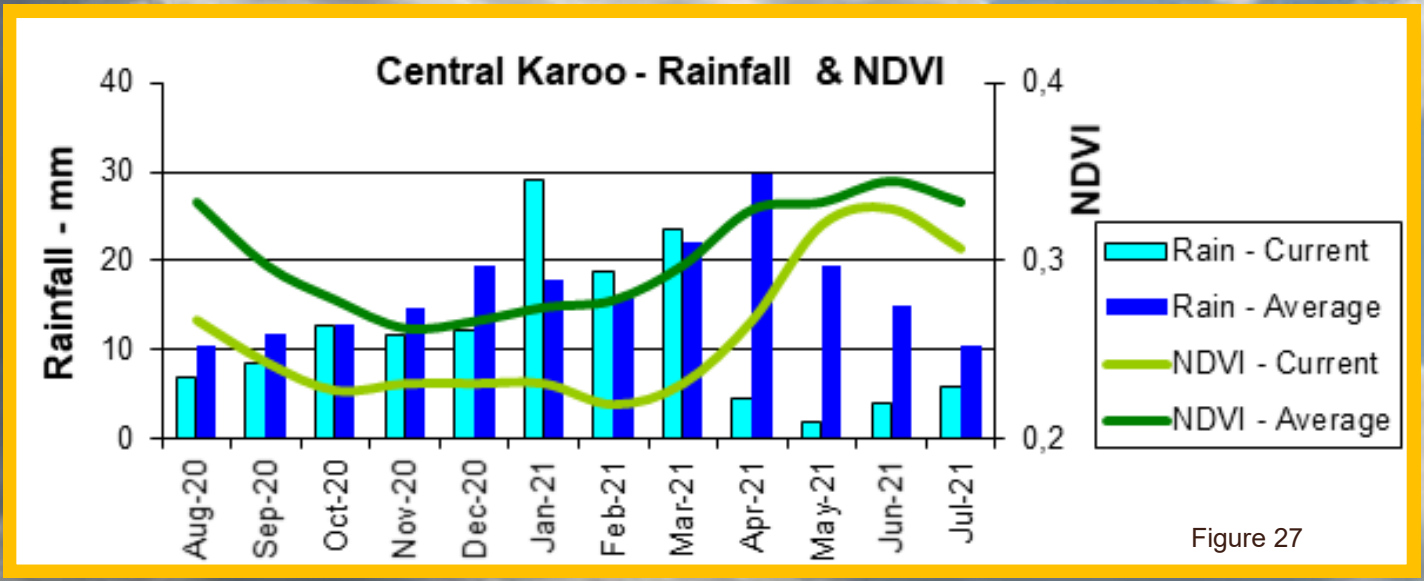

Figure 27

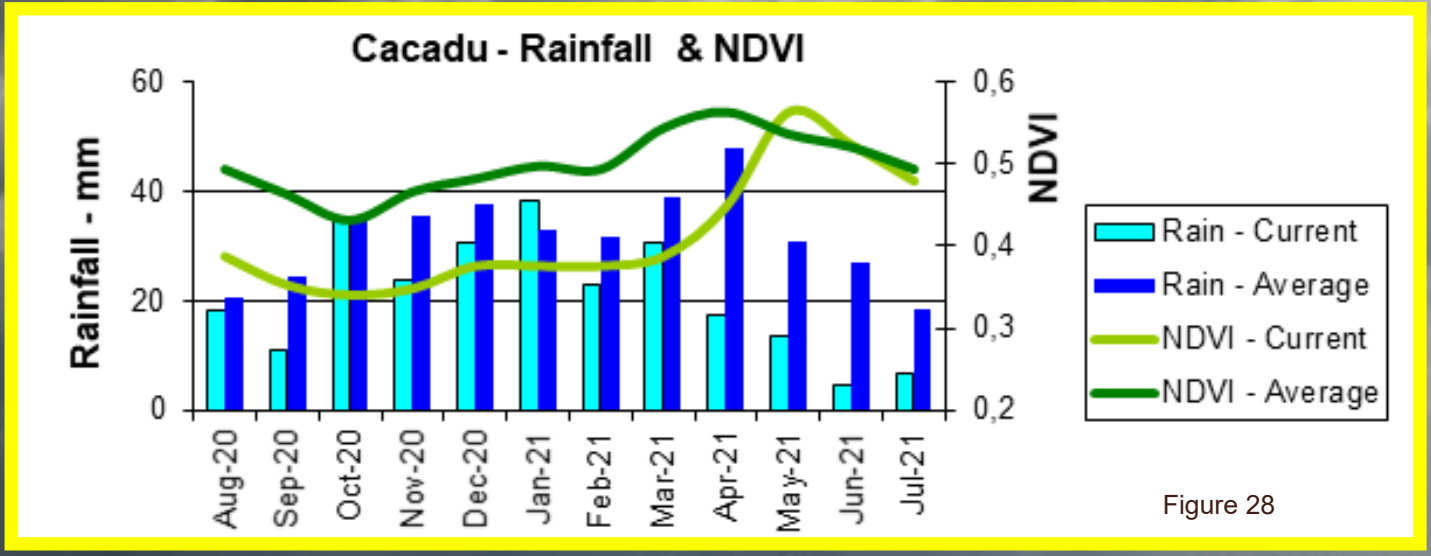

Figure 28

7. Fire Watch

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

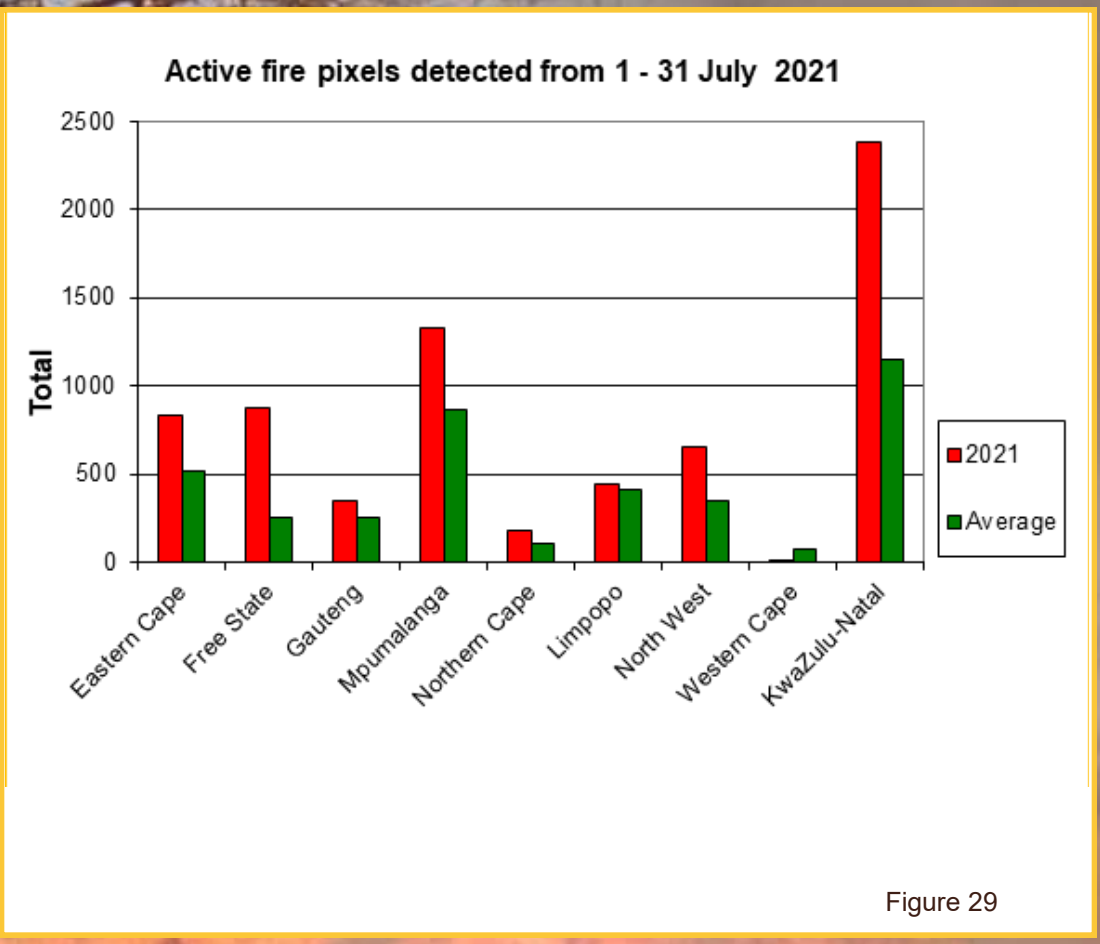

Figure 29

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

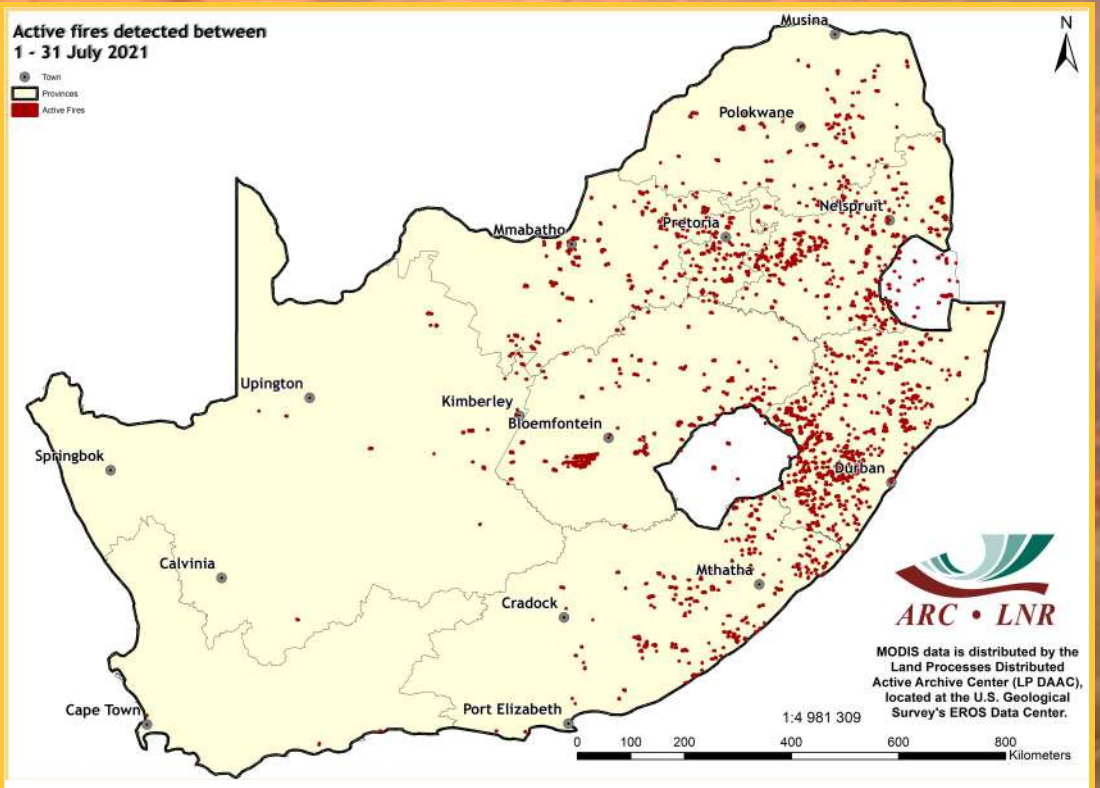

Figure 30

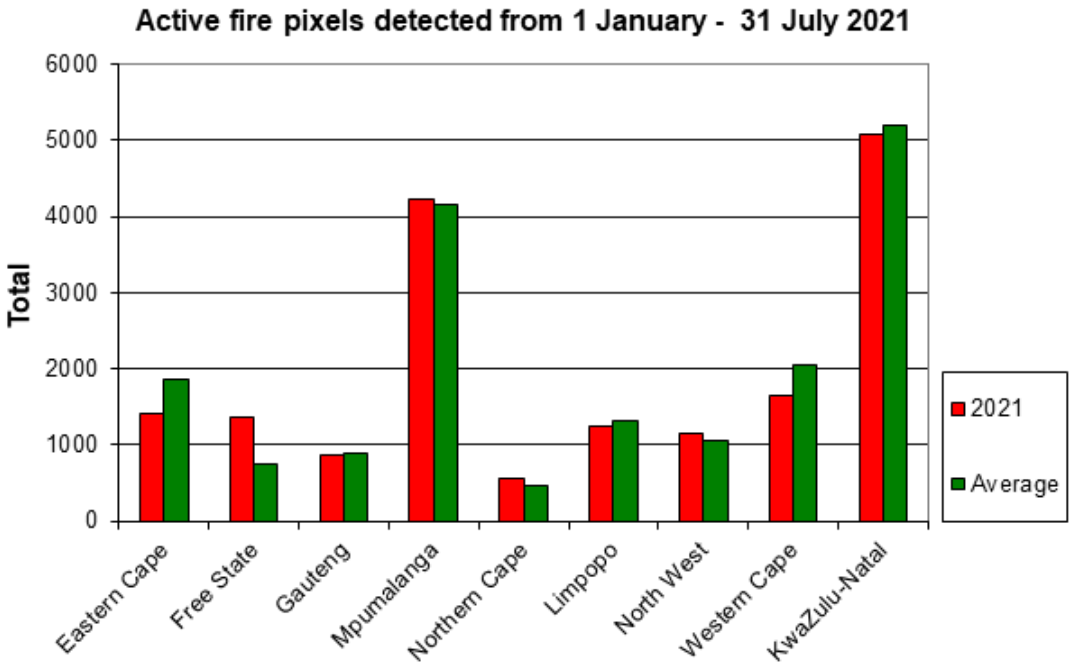

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January and 31 July 2021 per province. Cumulative fire activity was higher in the Free State, Mpumalanga, Northern Cape and North West, compared to the long-term average.

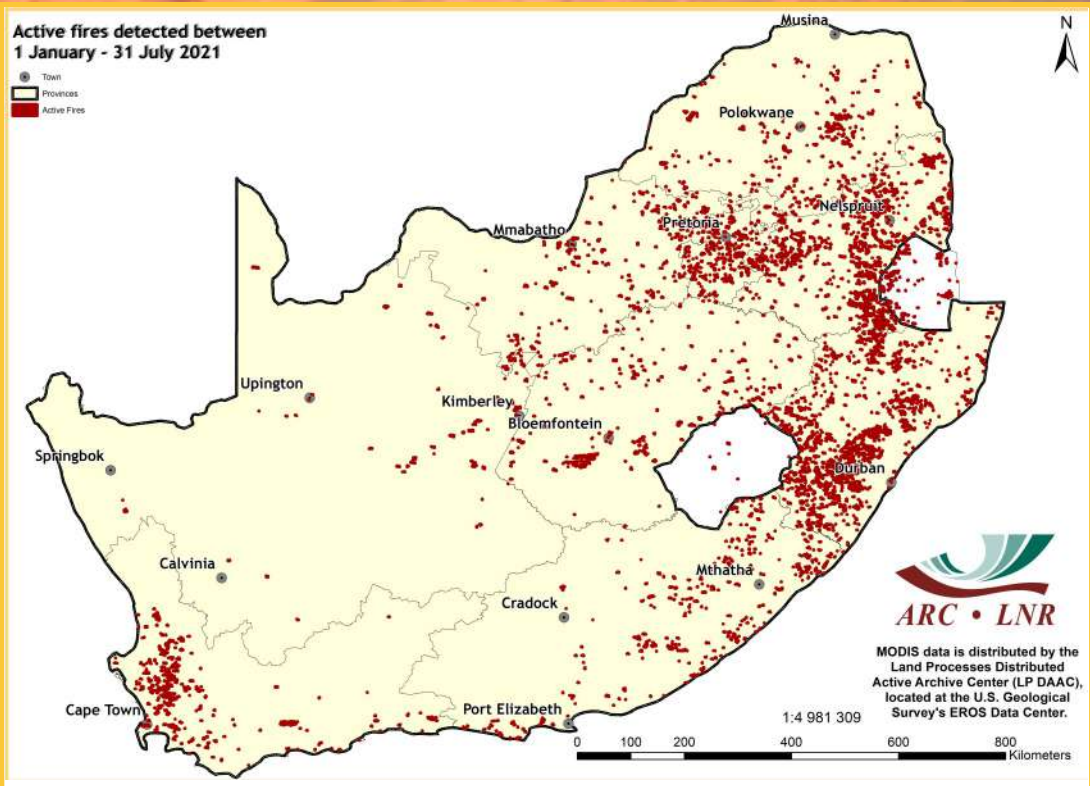

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January and 31 July 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 July 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, 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 July 2021 and July 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 July 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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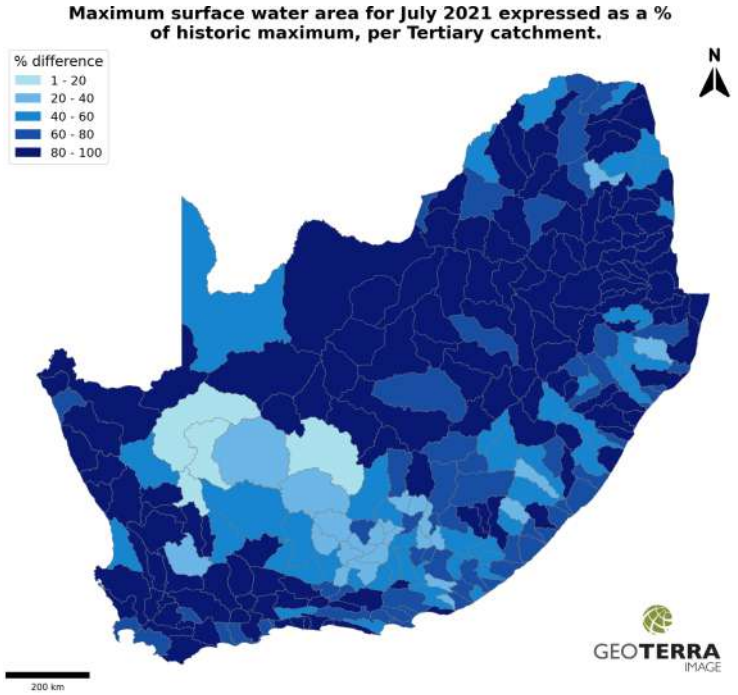

Figure 33

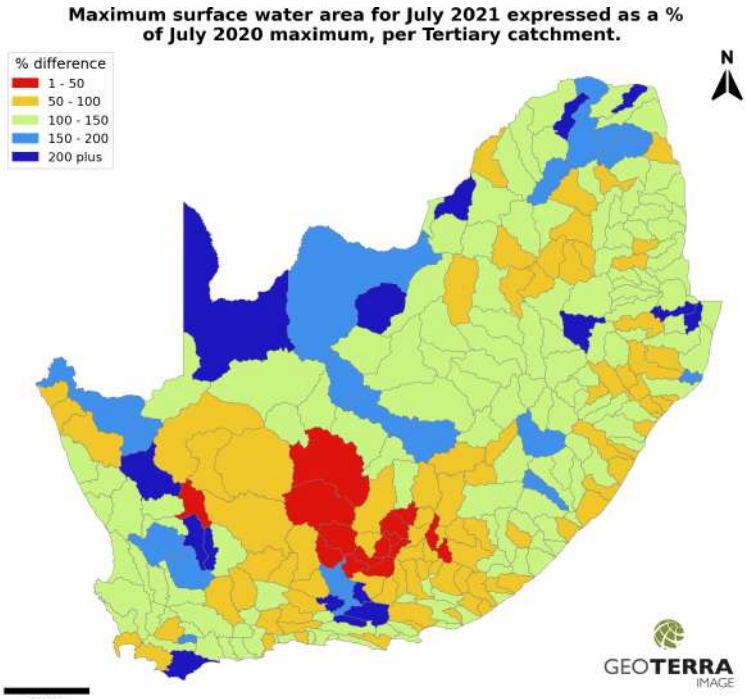

Figure 34

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".