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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

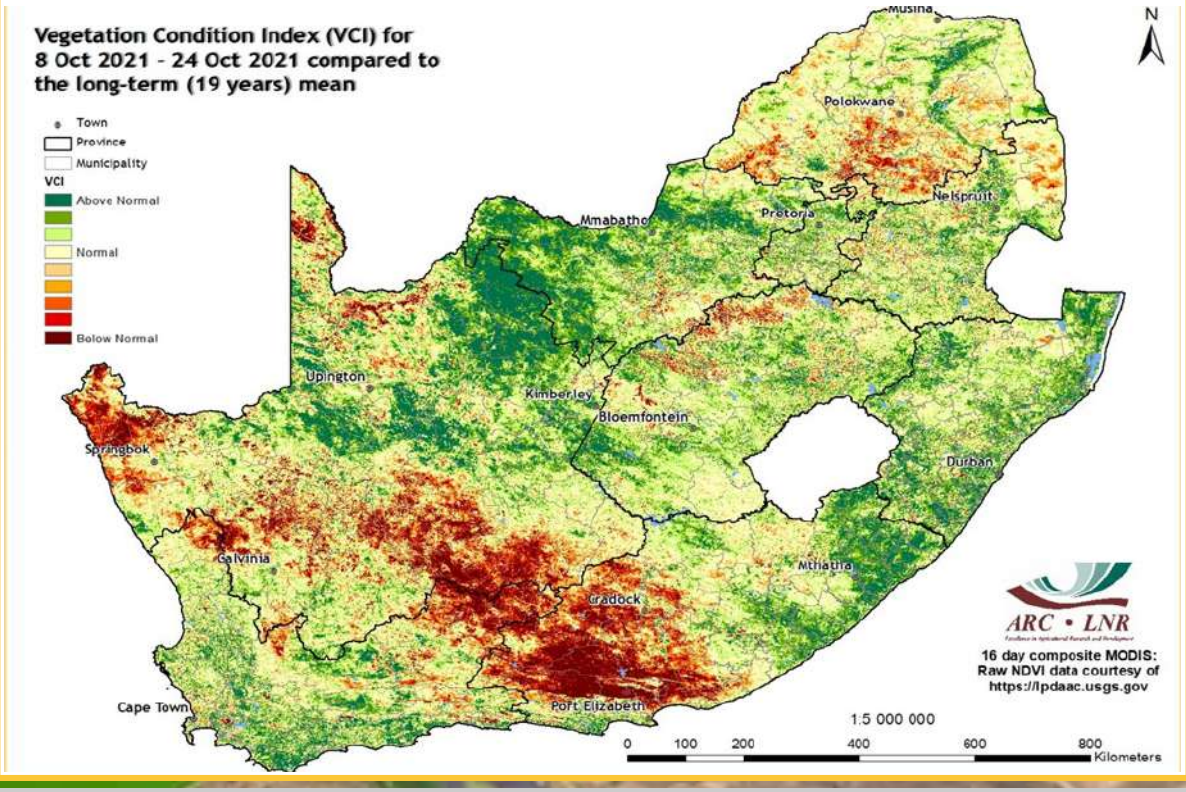
AMESD

209th Edition

Image of the Month

Widespread rainfall improves vegetation conditions over most parts of the country

Greater parts of the country have experienced above-normal rainfall since August 2021, which may be regarded as beneficial for agricultural production. The main contributors to these above-normal conditions were: (1) the occurrence of early rains that commenced in August over the summer rainfall region, and (2) the widespread rainfall in October which resulted in above-normal conditions over the western half of the country. These significant rainfall totals resulted in improved vegetation activity over most parts of the country, as depicted on the Vegetation Condition Index (VCI) map below, showing conditions during the period 8-24 October 2021 as compared to the long-term mean for the same period. Although the above-normal rainfall conditions may have brought short-term drought relief over the eastern parts of the Northern Cape, they were not enough to break the persistent drought that has been occurring over that region, specifically the southern parts, covering much of the Karoo, as indicated by the dark brown colour on the map. Other areas of concern, showing signs of potential drought, include parts of the Kalahari, northern parts of the Free State and the southern region of Limpopo. It is also noteworthy that in some areas, wildfires may have contributed to the low vegetation conditions shown on the map. Nonetheless, below-normal activity is an indication of poor grazing and poses an alarm for livestock production in the affected areas. Therefore, farmers should continue to implement resilient agricultural practices to mitigate the effects of agroclimatic risks.



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:

October 2021 turned out to be a relatively wet month, characterized by a series of rainfall events. Thunderstorms accompanied by strong winds and hail in some areas occurred during the beginning of the month over the central and southeastern parts of the country. This included the far eastern parts of the Northern Cape and adjacent areas of North West, Gauteng, Free State, KwaZulu-Natal Midlands and the northern regions of the Eastern Cape. Although lesser in severity, other areas including the central and southern parts of Limpopo, Mpumalanga, as well as some parts of the Western Cape, also experienced rain showers. These rainy conditions persisted throughout the first dekad (10 days) of the month while the second dekad was generally dry and hot over the summer rainfall region. However, by the 18th, rainfall was observed over some parts of Limpopo and Mpumalanga as well as the Eastern Cape and KZN. During this time, rainfall activity continued over the Western Cape due to a series of cold fronts over the southwestern parts of the country. By the 21st, greater parts of the Northern Cape, particularly the western region, began to receive heavy downpours and recorded above-normal rainfall as compared to the long-term means. Areas that recorded totals of >70 mm include Boegoeberg, Postmasburg, Deben, Upington, Victoria West and Williston. These rainy conditions extended south towards parts of the Western Cape, resulting in localized flooding and damage to infrastructure in vulnerable areas. From the 26th until the end of the month, rainfall was largely confined to the summer rainfall region.

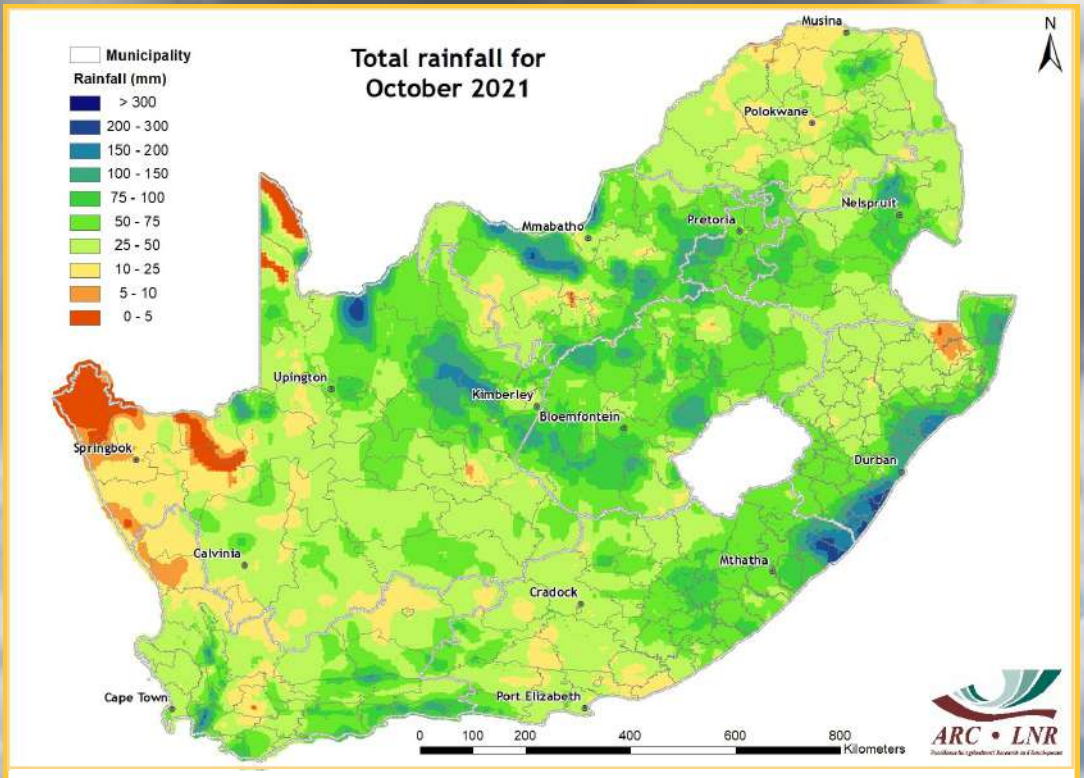


Figure 1

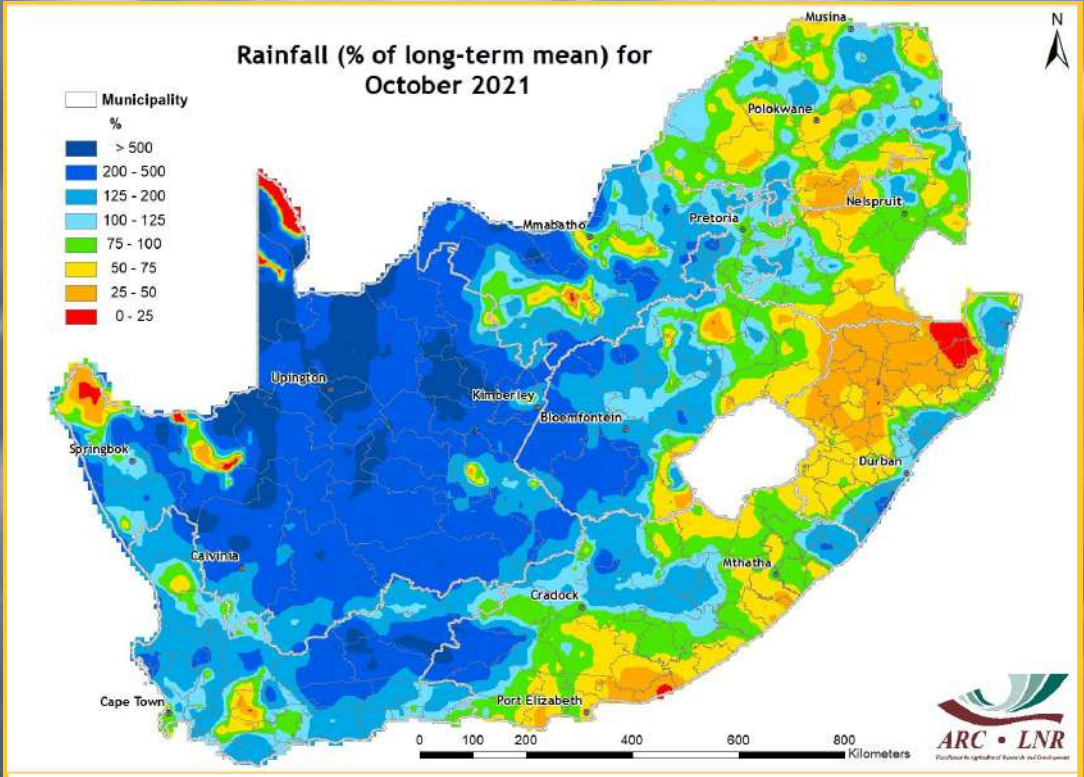


Figure 2

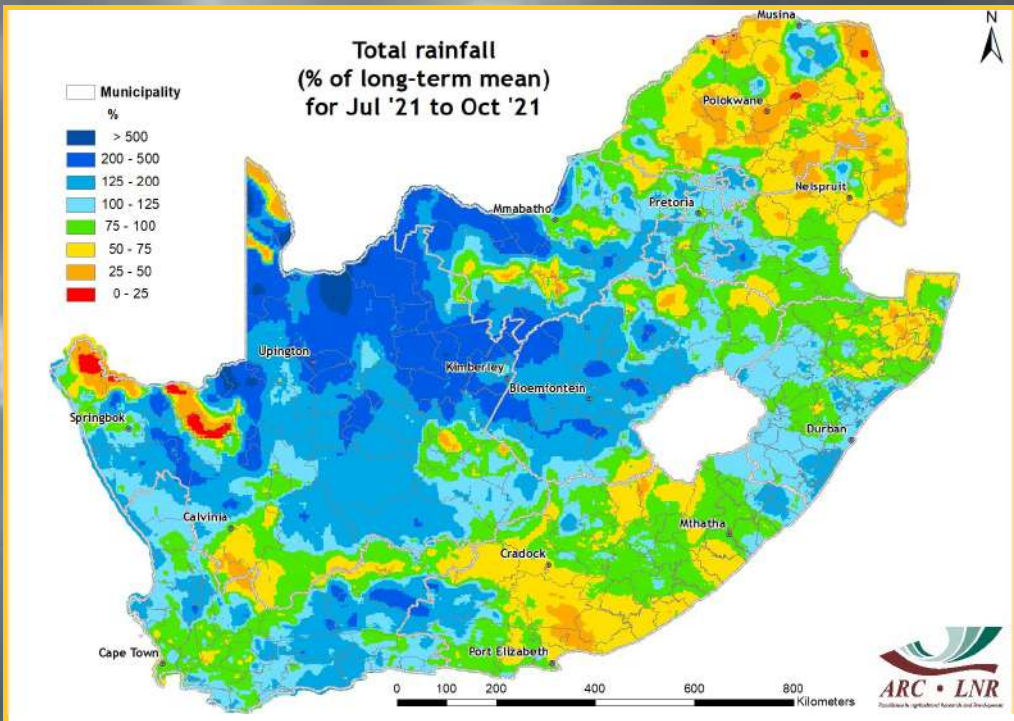


Figure 3

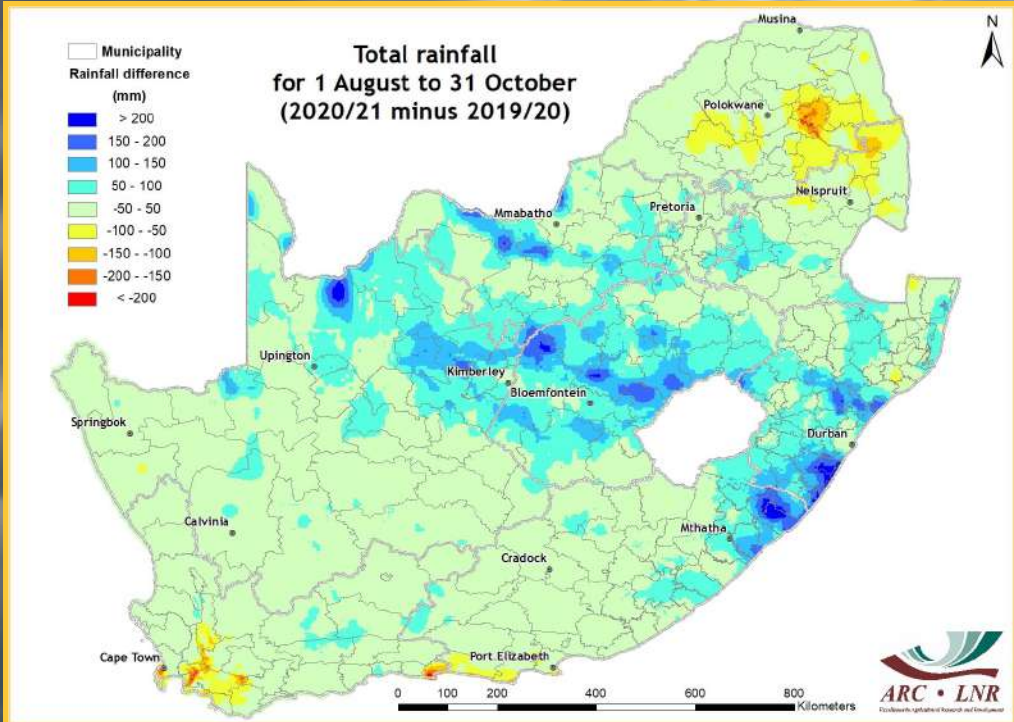


Figure 4

Figure 1:
Good widespread rainfall occurred in October 2021 over most parts of the country, with higher totals recorded over isolated parts of the Northern Cape, North West, Gauteng, Free State, KwaZulu-Natal and the Eastern Cape. The largest contribution to this rainfall occurred during the first and third dekads of the month, except for the Western Cape, where rainfall was observed throughout the month.

Figure 2:
Above-normal rainfall occurred over the western half of the country in October, with near- to below-normal rainfall observed over the eastern parts.

Figure 3:
Cumulative rainfall from July to October 2021 compared to the long-term mean for the same period indicates above-normal conditions over greater parts of the country, except for isolated areas in the Karoo, Eastern Cape, KZN, Free State, North West, Northern Cape and larger parts of Limpopo and Mpumalanga.

Figure 4:
The central and southeastern parts of the country, as well as isolated parts of the Cape provinces, received considerably more rain during August to October 2021 compared to the same period last year. Areas that received lower rainfall totals include parts of Cape Town, the Cape Winelands and Overberg of the Western Cape, towards George and adjacent areas of the Eastern Cape. Similar conditions were observed in the northeastern region of the country, viz. Limpopo and Mpumalanga, while the rest of the country received comparable rainfall totals to 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. An improvement of drought conditions was observed on the 6-month SPI map ending in October, as compared to last month. The rainfall that occurred in October contributed largely to these conditions and brought somewhat short-term relief. Medium- to long-term time scales showed to some extent the same conditions as compared to the SPI of the previous 2 months, whereby wet conditions characterized the northern interior, Lowveld of Limpopo and Mpumalanga, as well as isolated areas of the Western Cape and KZN. However, 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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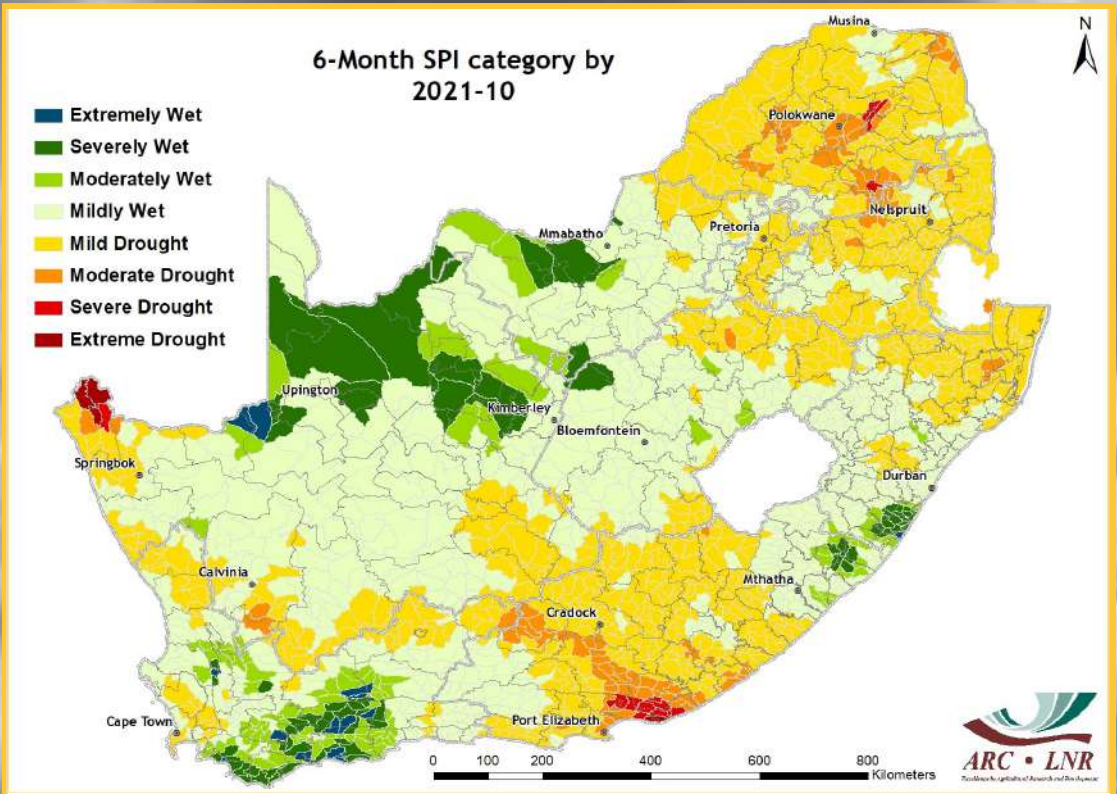

Figure 5

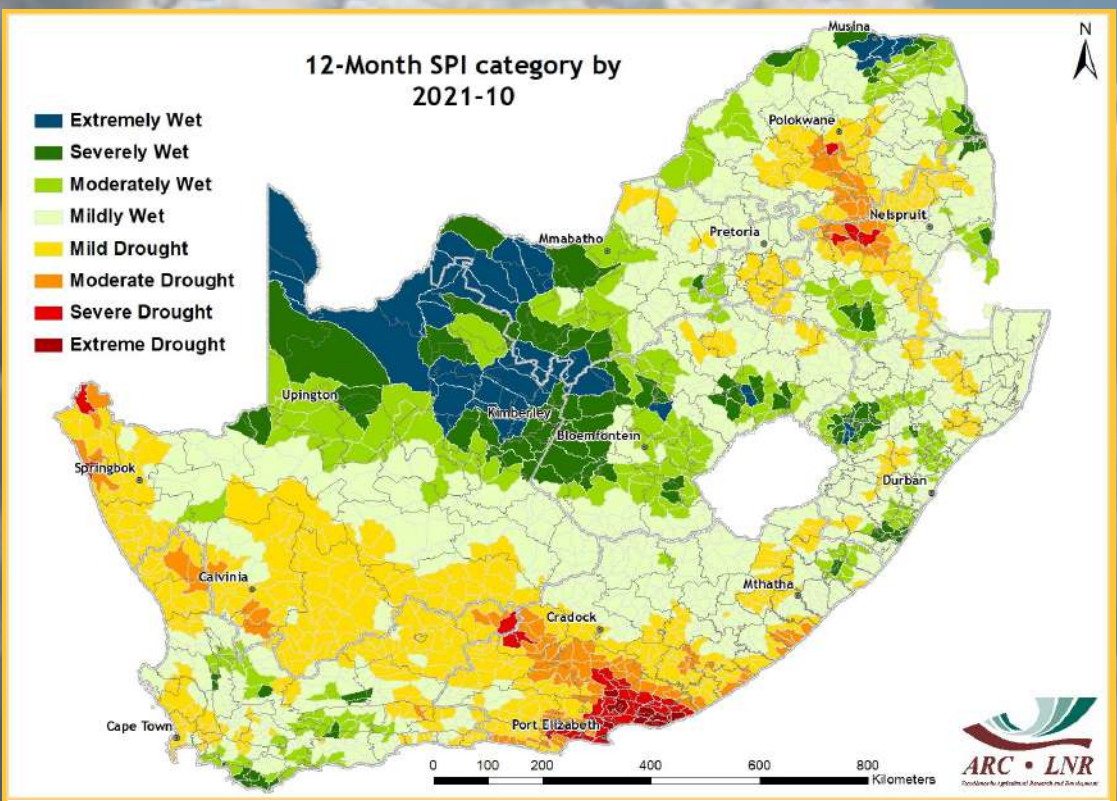

Figure 6

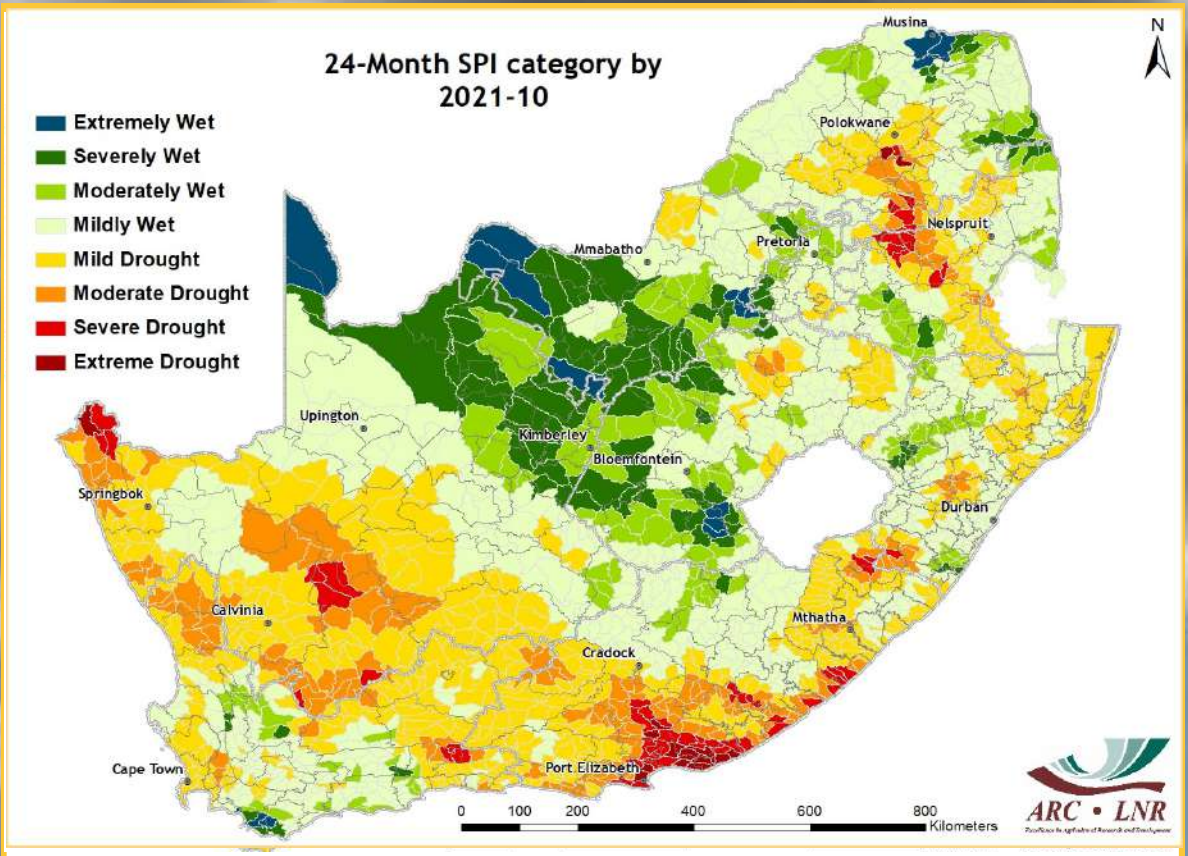

Figure 7

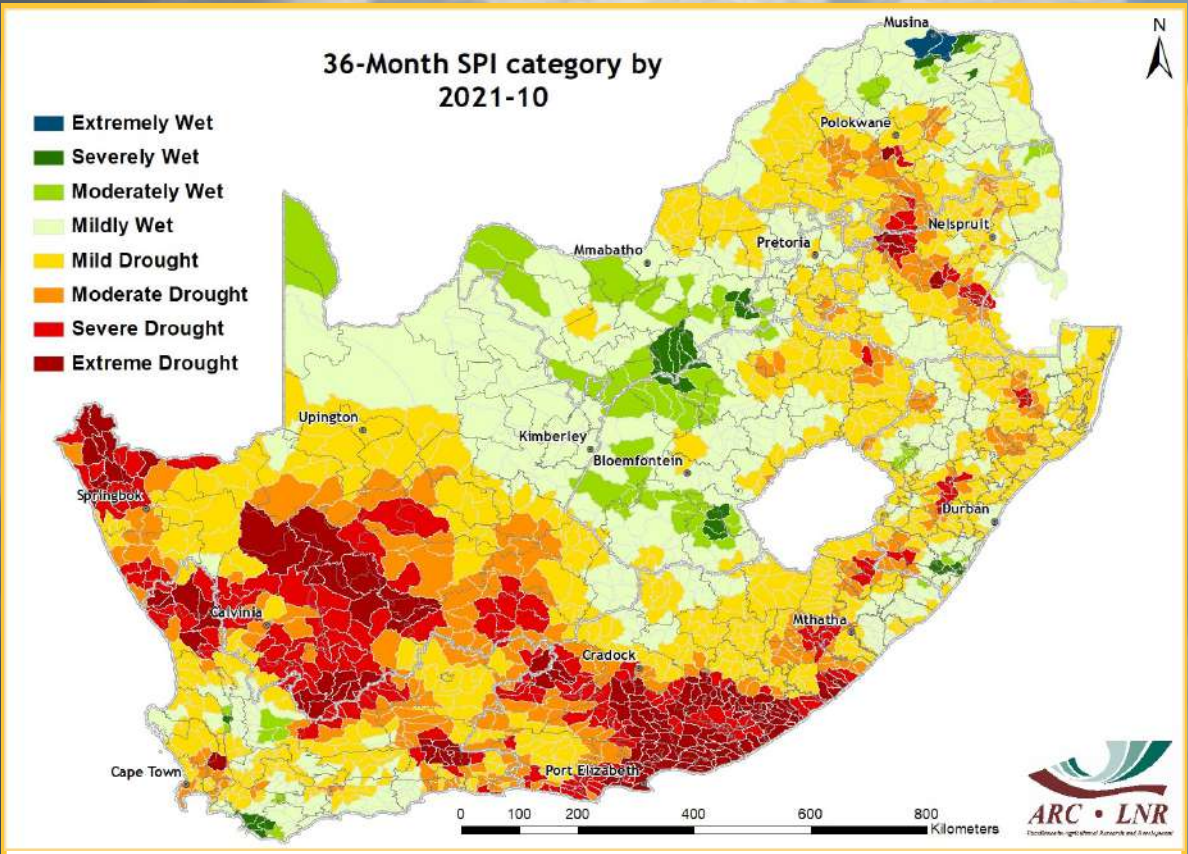

Figure 8

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.

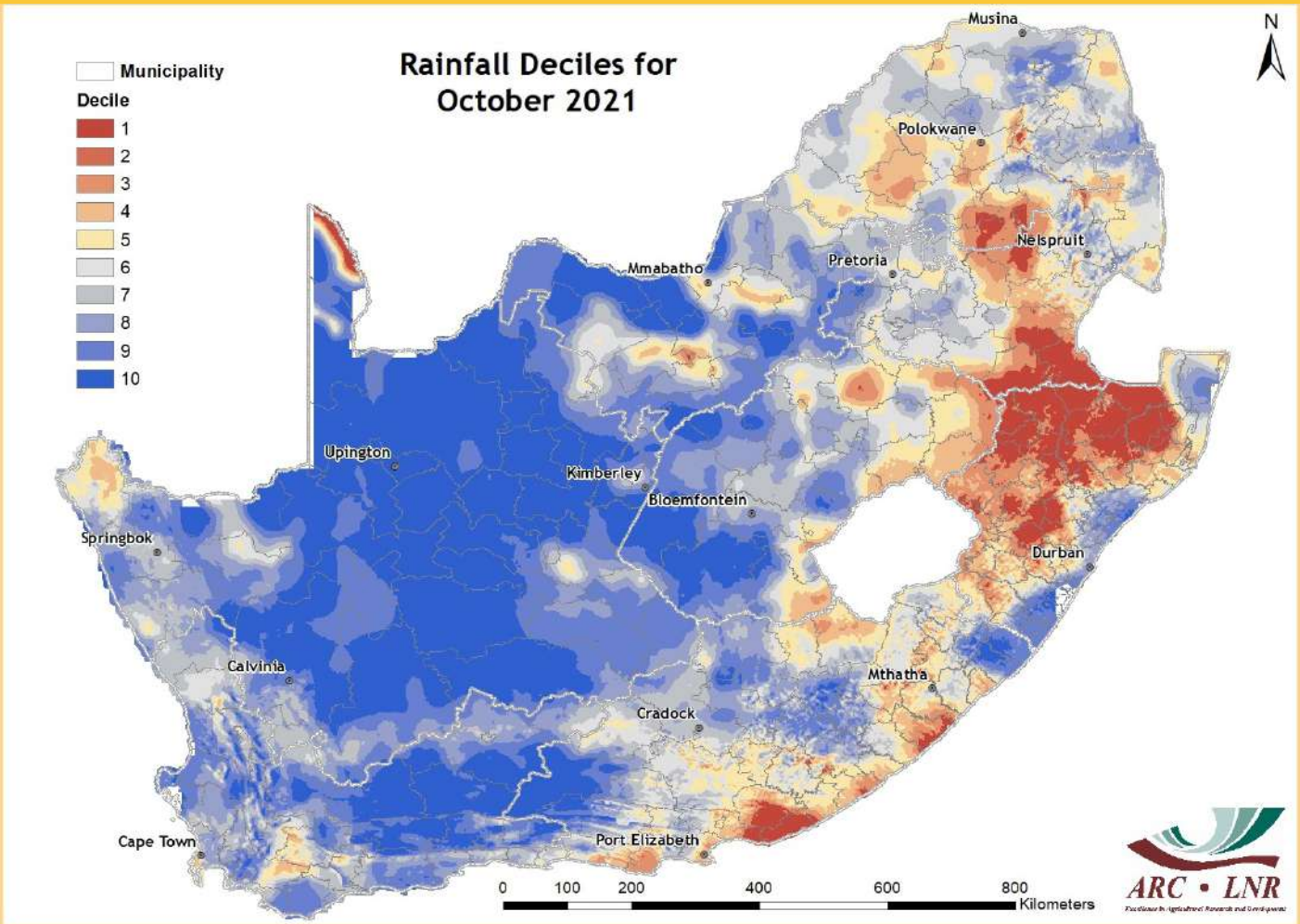

Figure 9

Figure 9:
Greater parts of the country received exceptionally high rainfall totals in October 2021, as compared to historical observations for the same month, but rainfall amounts that occurred over some parts of the summer rainfall region, particularly the eastern and northern regions, compared well with historically drier October months.

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4. Vegetation Conditions

Vegetation Mapping

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

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

where:
IR = Infrared reflectance &
R = Red band

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

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

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

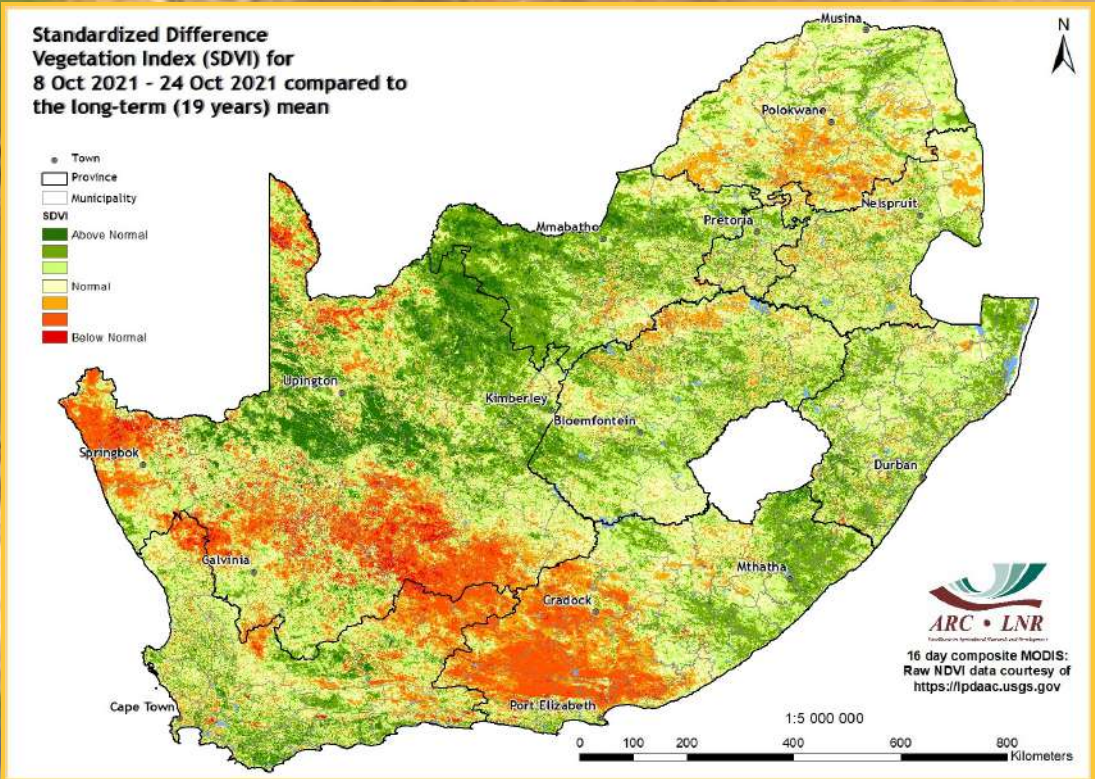

Figure 10

Figure 10:
Compared to the historical averaged vegetation conditions, the 16-day SDVI map for October 2021 shows that the western parts of the country experienced below-normal vegetation activity while the central and eastern parts experienced above-normal vegetation activity.

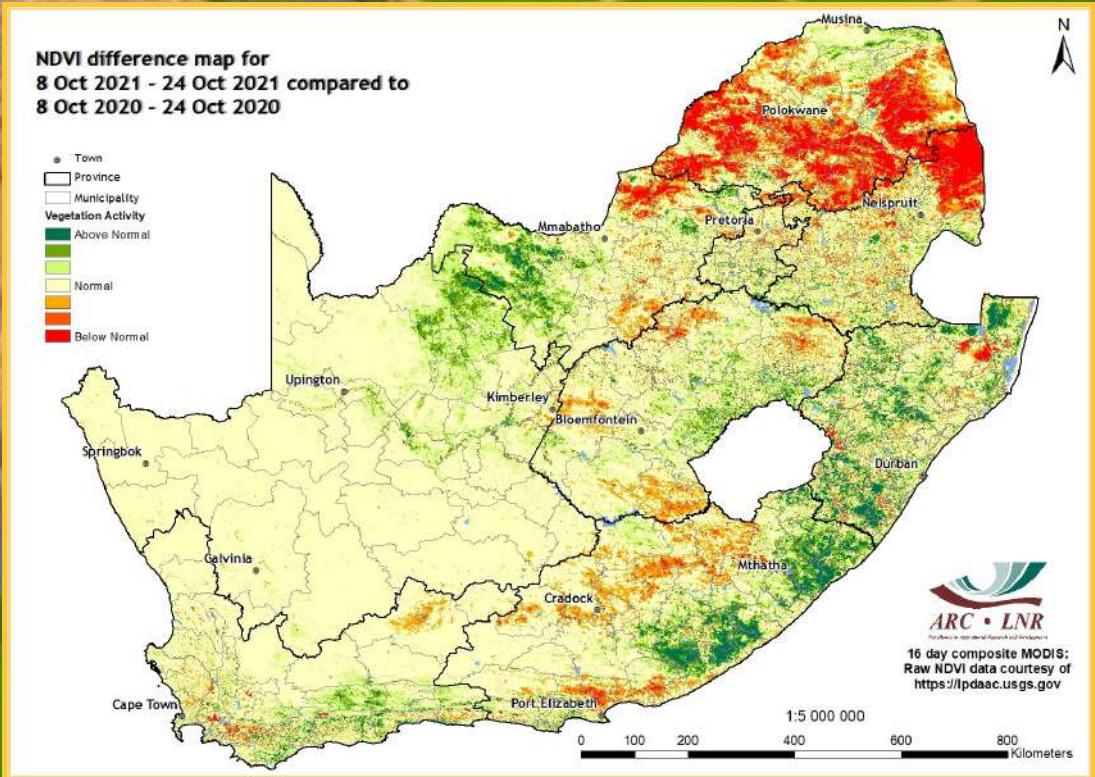

Figure 11

Figure 11:
When comparing the 16-day NDVI difference map for October 2021 to the same month last year, it can be observed that large parts of Limpopo experienced below-normal vegetation activity, while parts of KwaZulu-Natal experienced above-normal vegetation activity and the Eastern Cape experienced a mixture of above- and below-normal conditions. The rest of the country experienced normal vegetation conditions with pockets of above-normal activity.

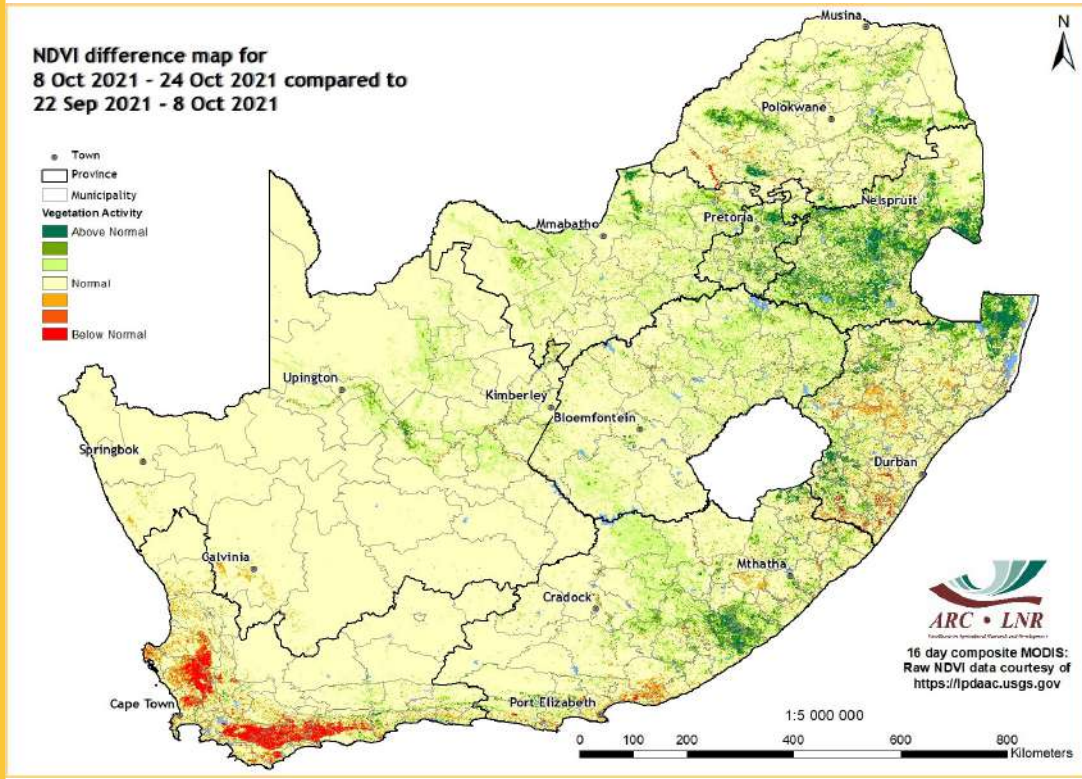

Figure 12

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 12:
Compared to the previous month, the 16-day NDVI difference map for October shows that the country experienced normal vegetation conditions with pockets of below-normal conditions in the Western Cape and pockets of above-normal conditions in the eastern parts.

Figure 13:
[Percentage of Average Seasonal Greenness (PASG) map currently not available.]

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Figure 13

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.

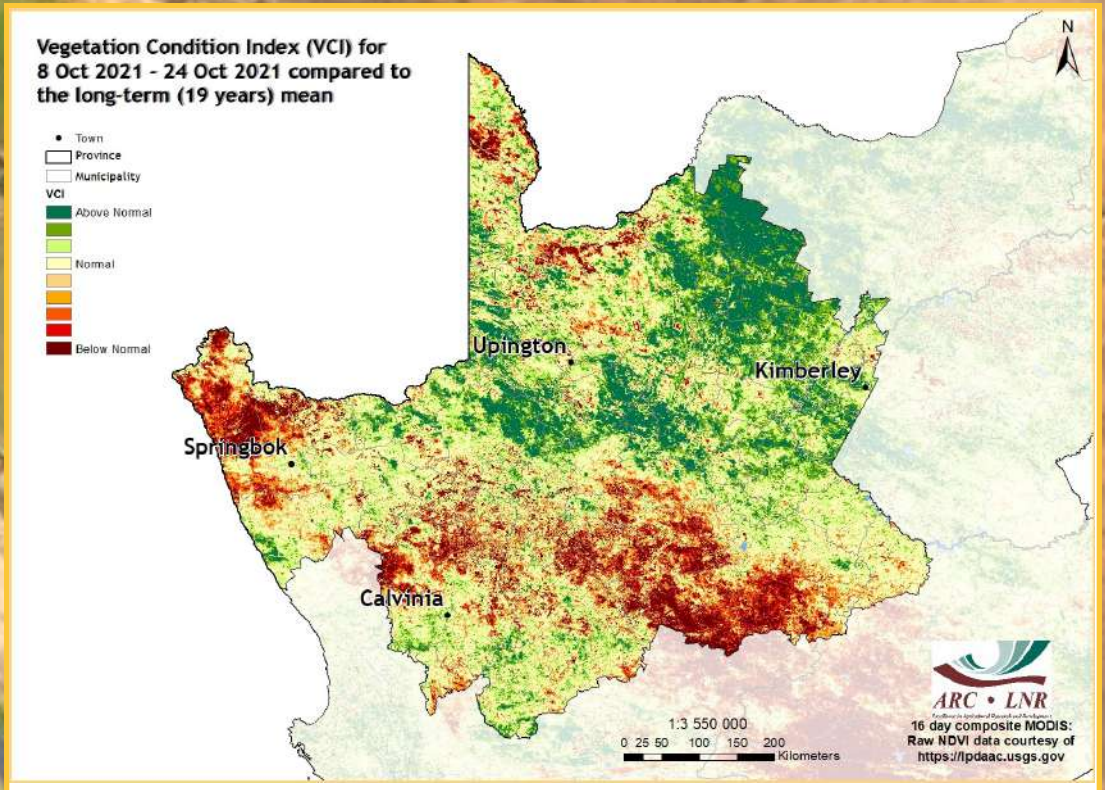


Figure 14

Figure 14:
The 16-day VCI map for October indicates that the Northern Cape continues to experience pockets of improved vegetation conditions while large parts of the province are still experiencing drought conditions.

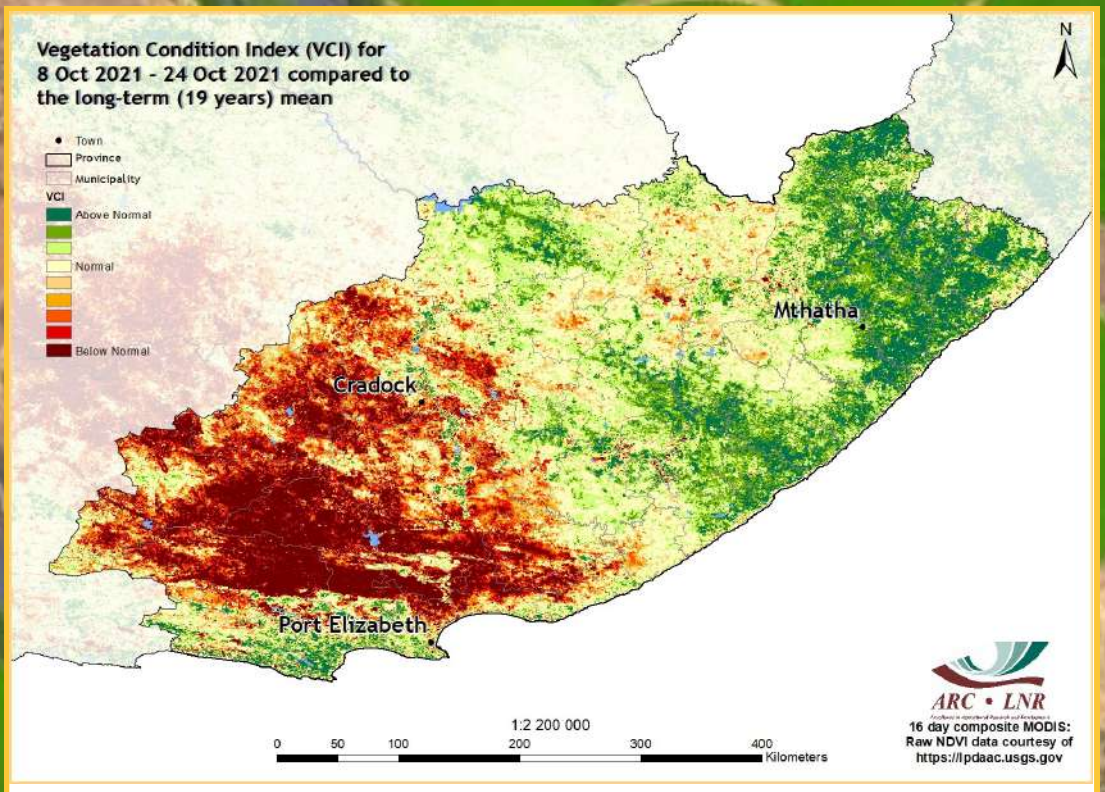
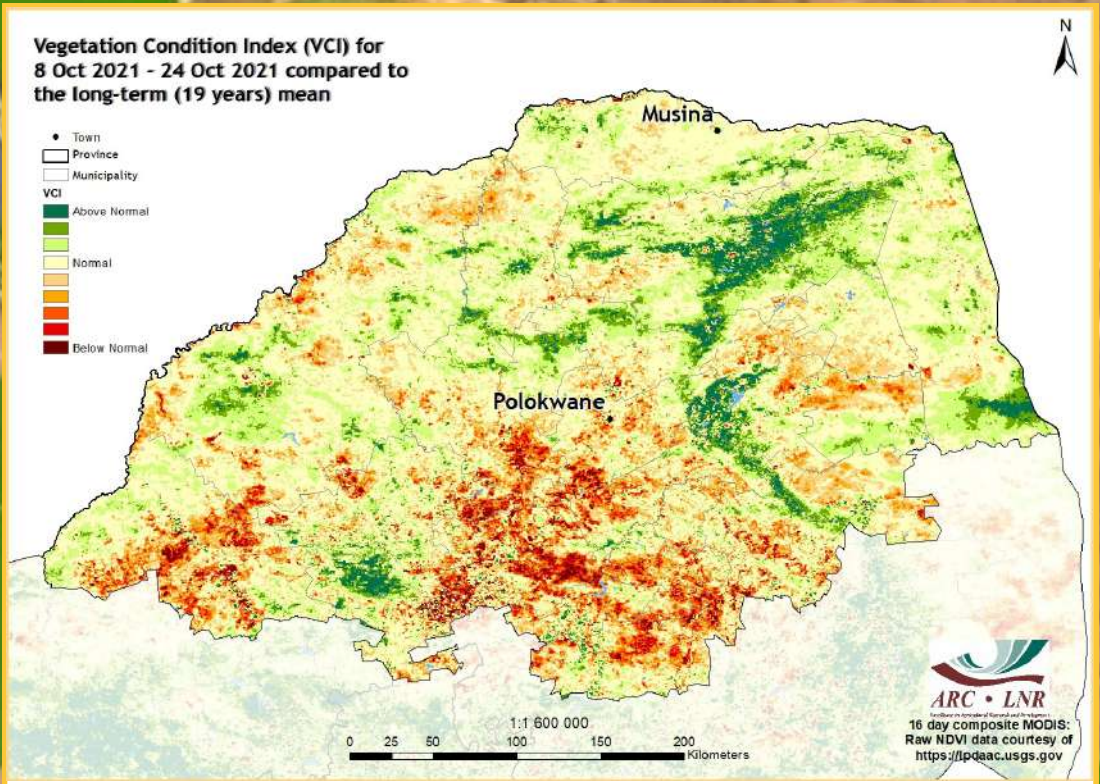


Figure 15

Figure 15:
The 16-day VCI map for October indicates that vegetation conditions remain poor in the westerm part of the Eastern Cape but show some improvement in the far eastern parts of the province.



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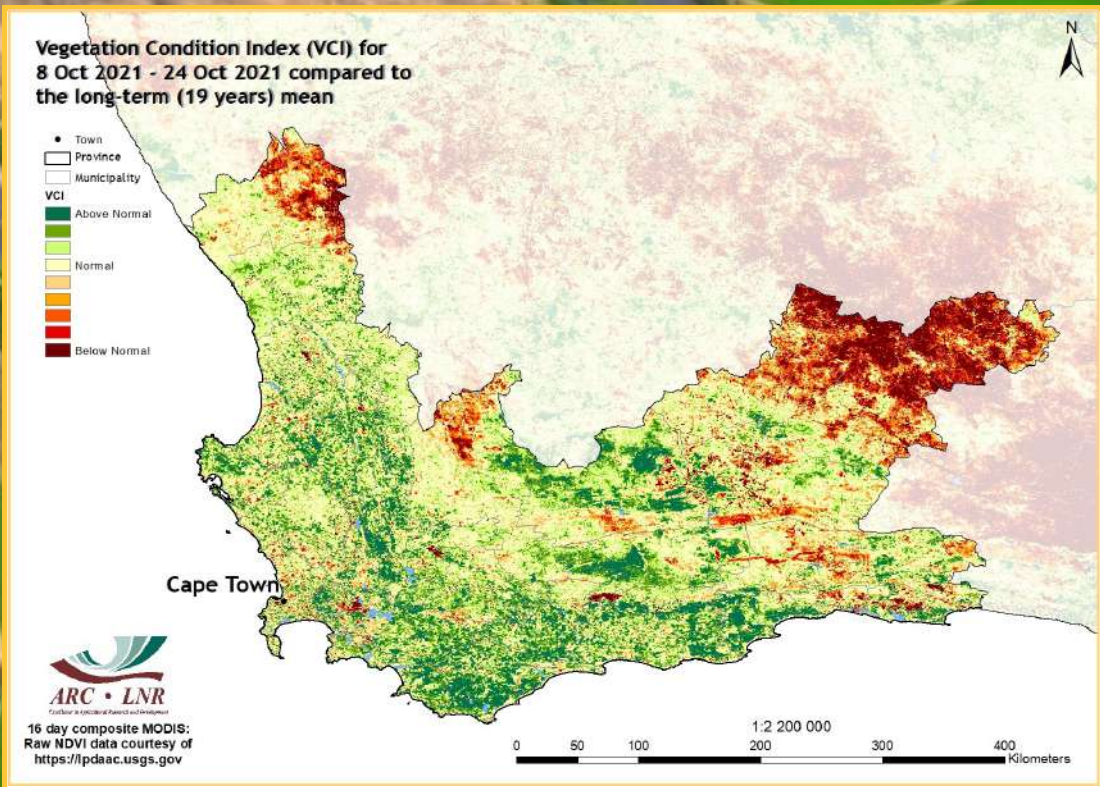

Figure 17

Figure 16:
The 16-day VCI map for October indicates poor vegetation conditions spread throughout the Limpopo Province, with pockets of above-normal conditions.

Figure 17:
The 16-day VCI map for October indicates a mixture of pockets of poor vegetation conditions and above-normal vegetation conditions spread across the Western Cape Province.

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6. Vegetation Conditions & Rainfall

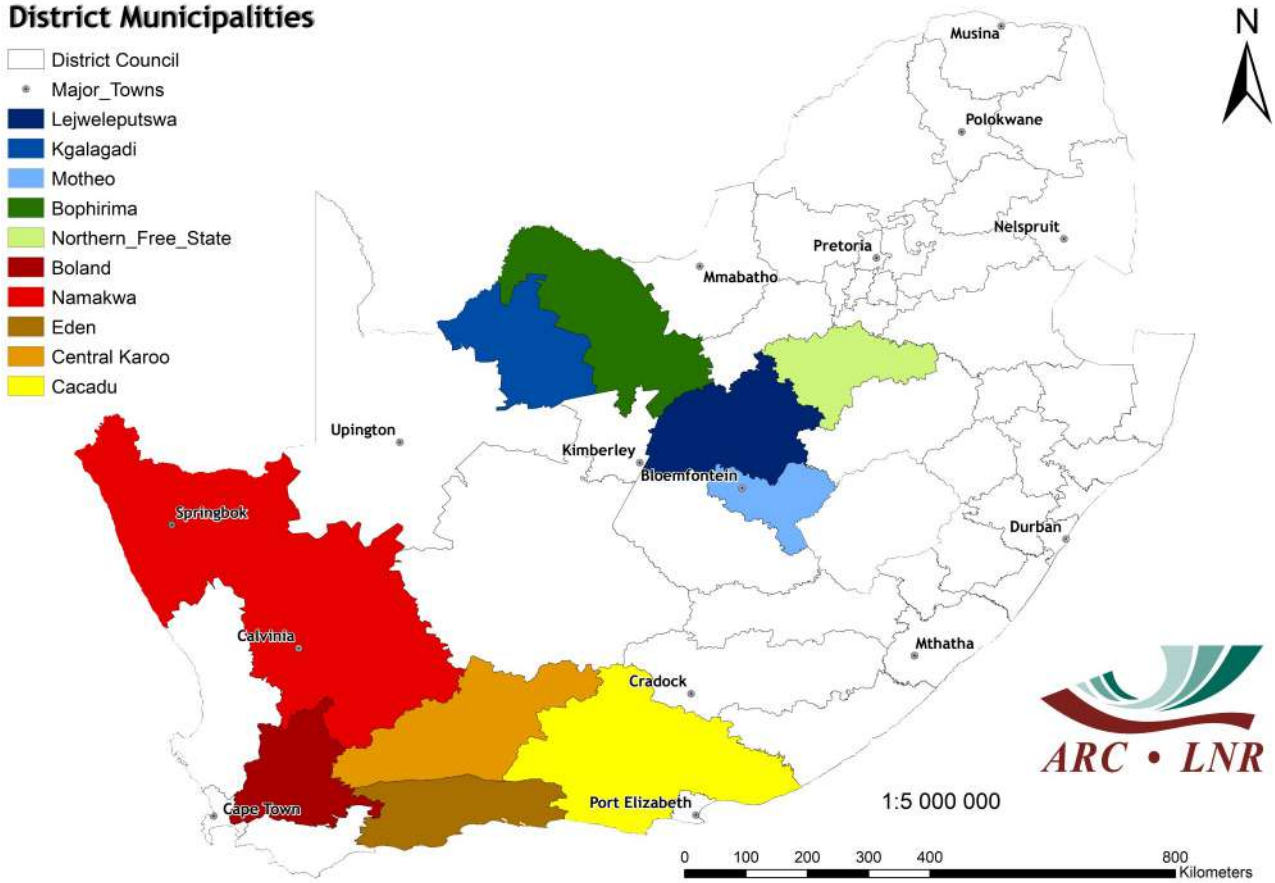

Figure 18

Rainfall and NDVI Graphs

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

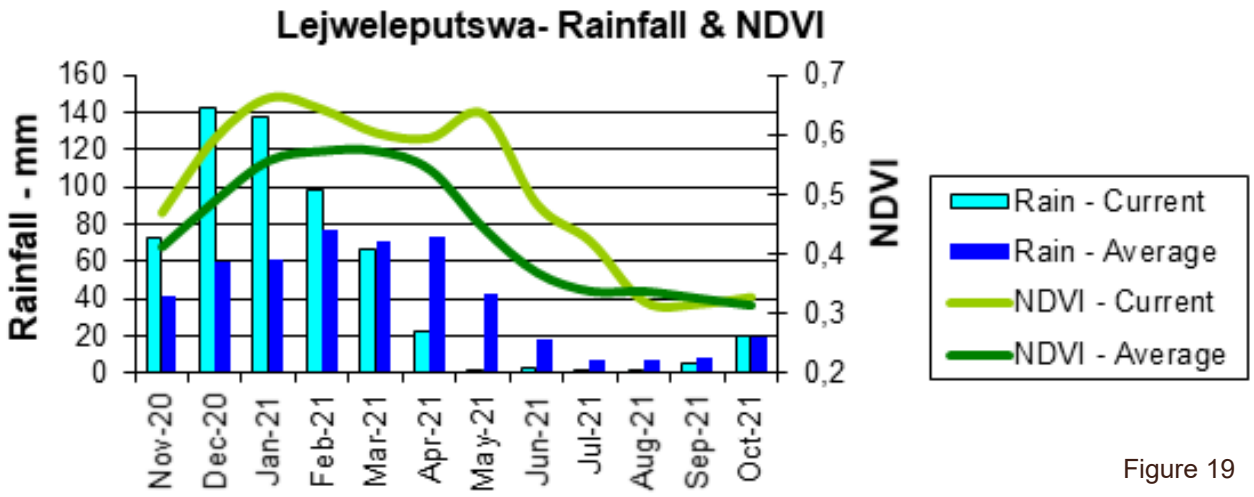
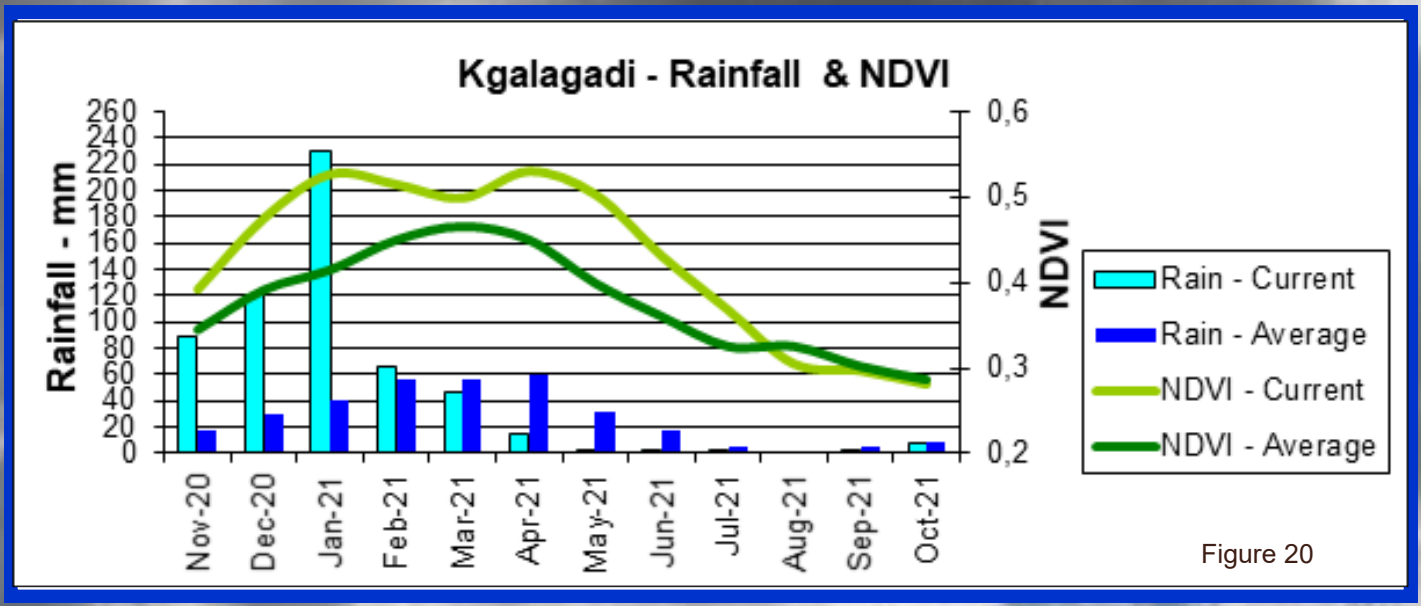


Figure 19



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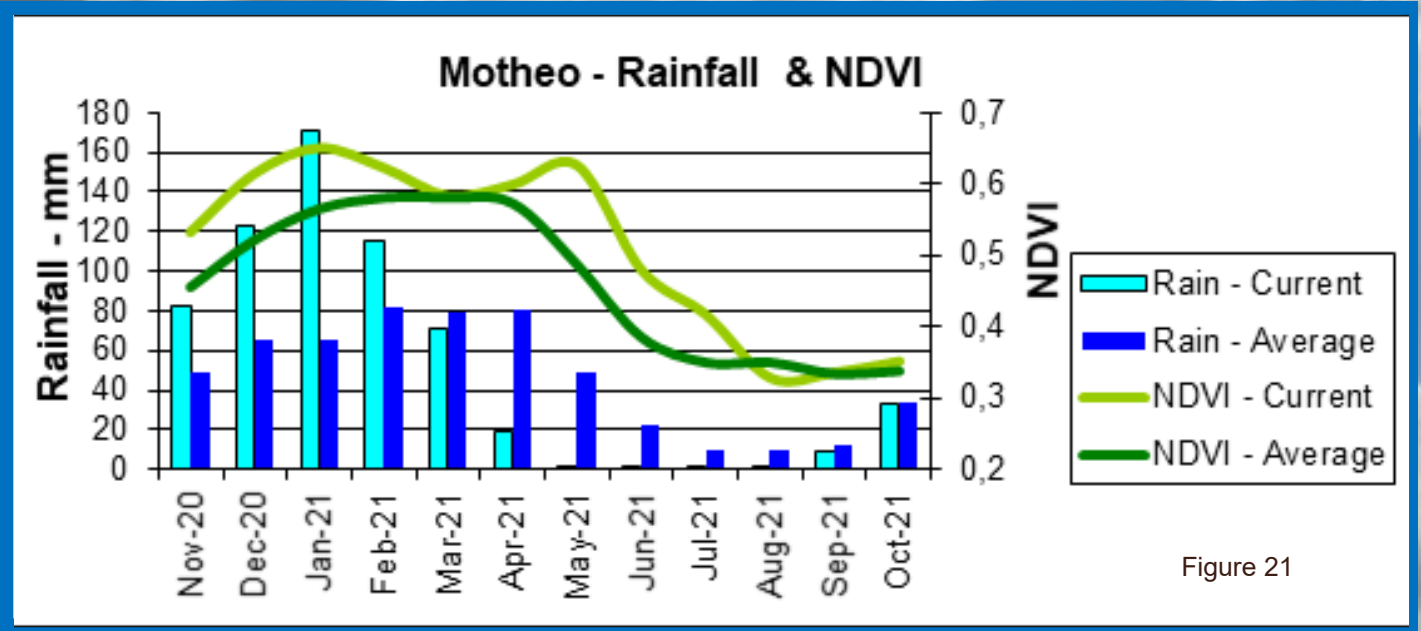

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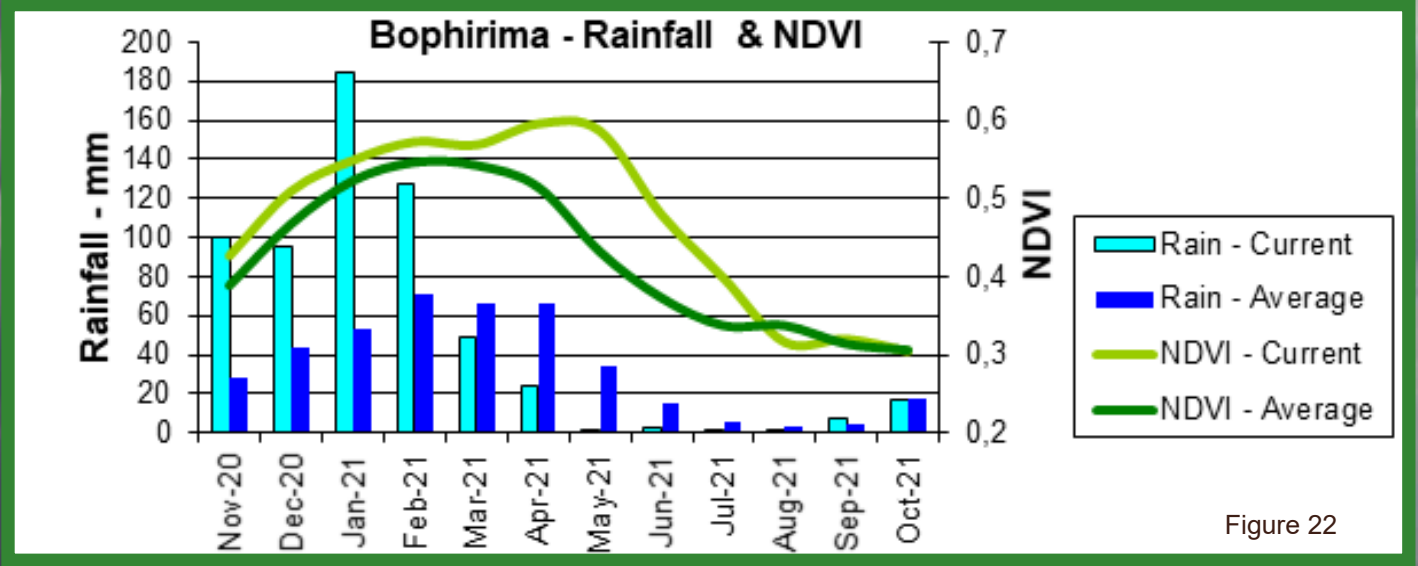

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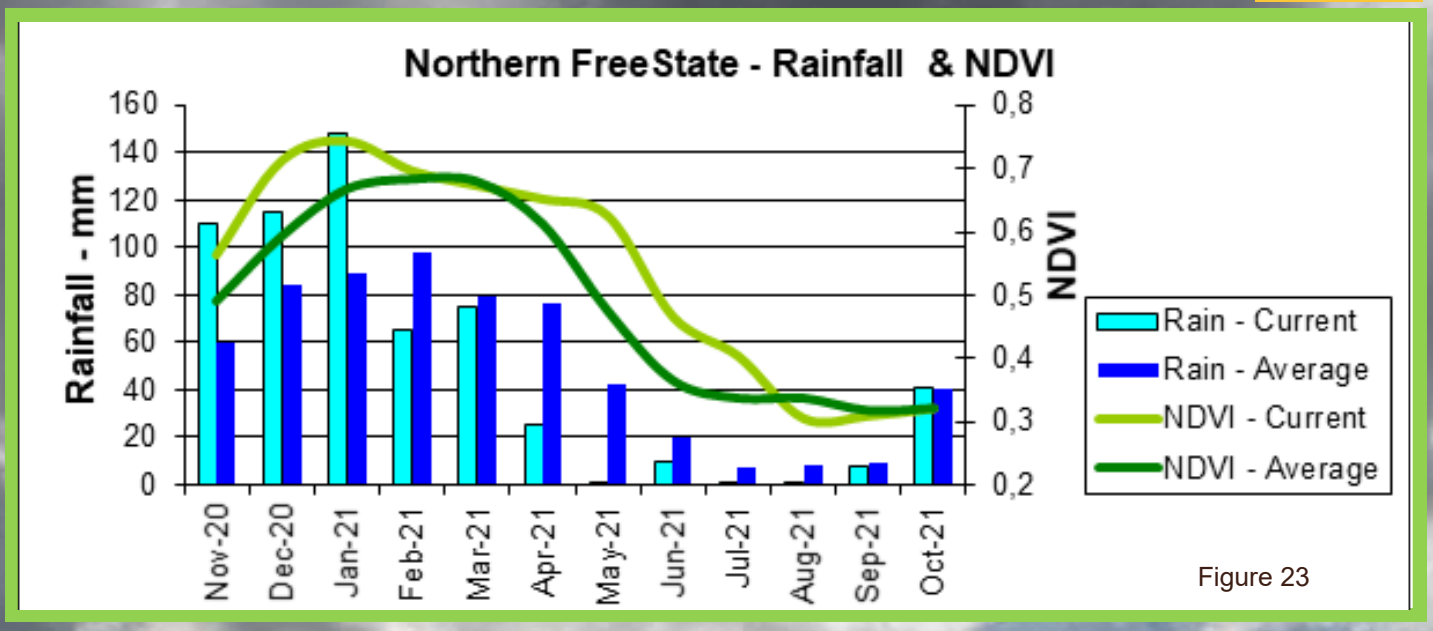

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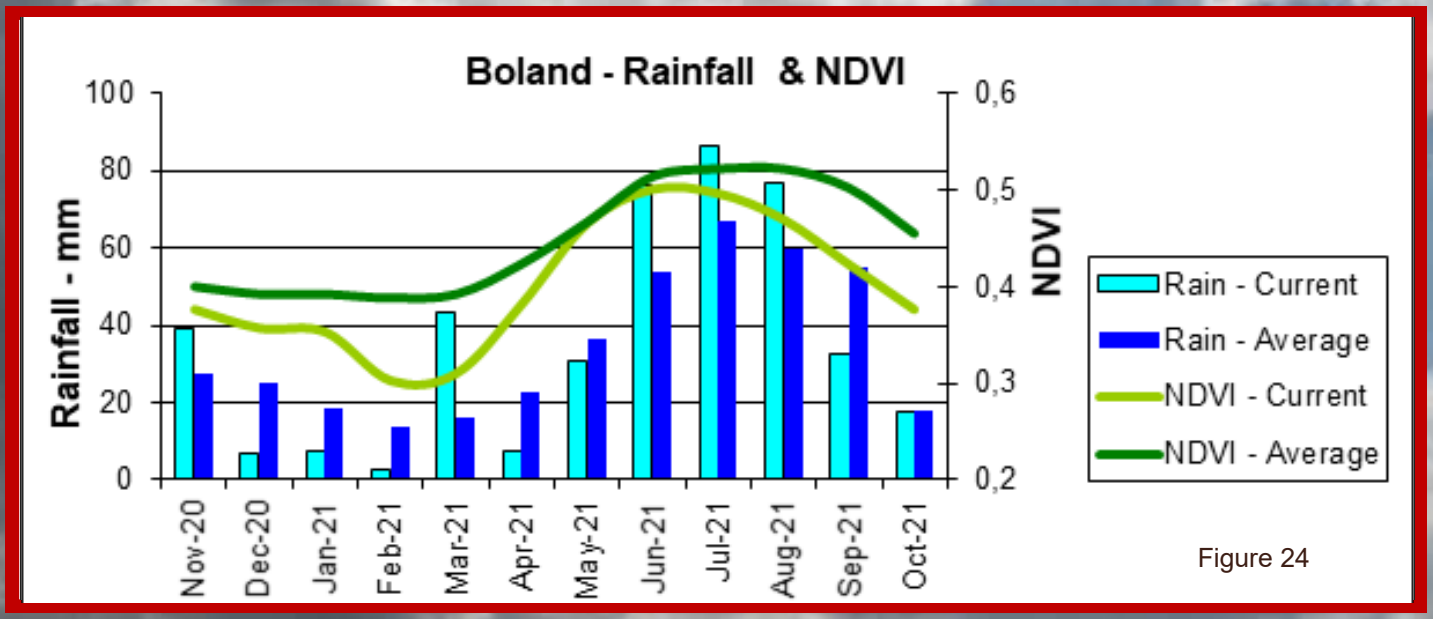

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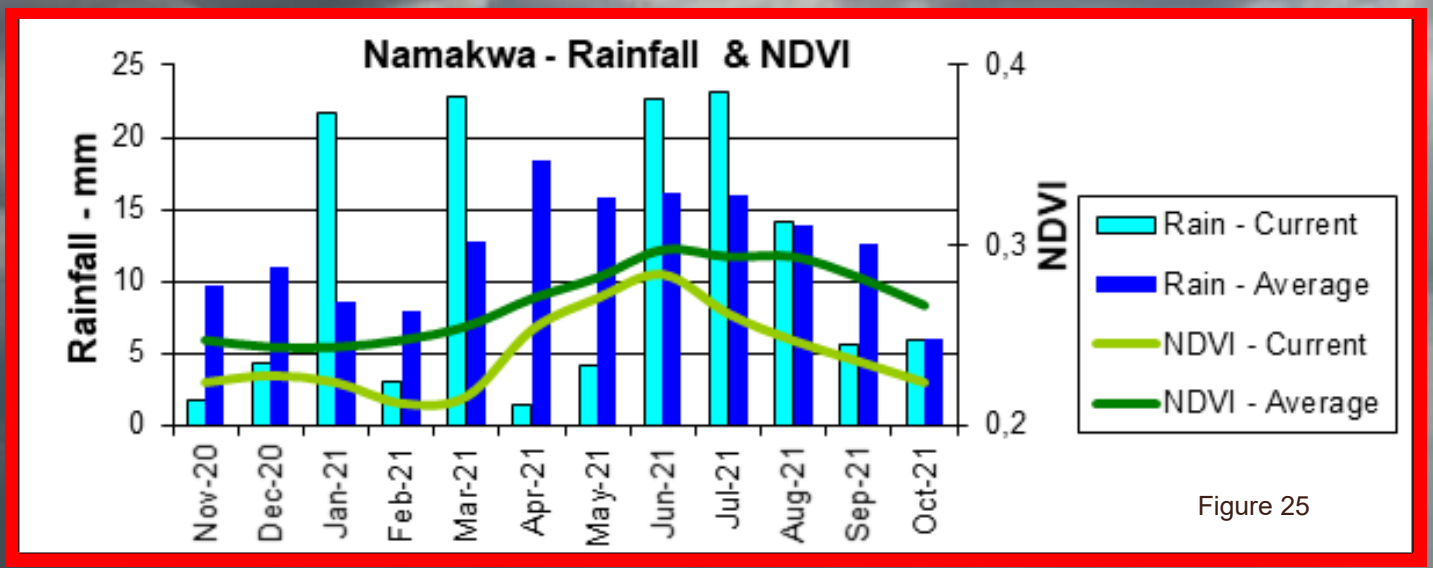

Figure 25

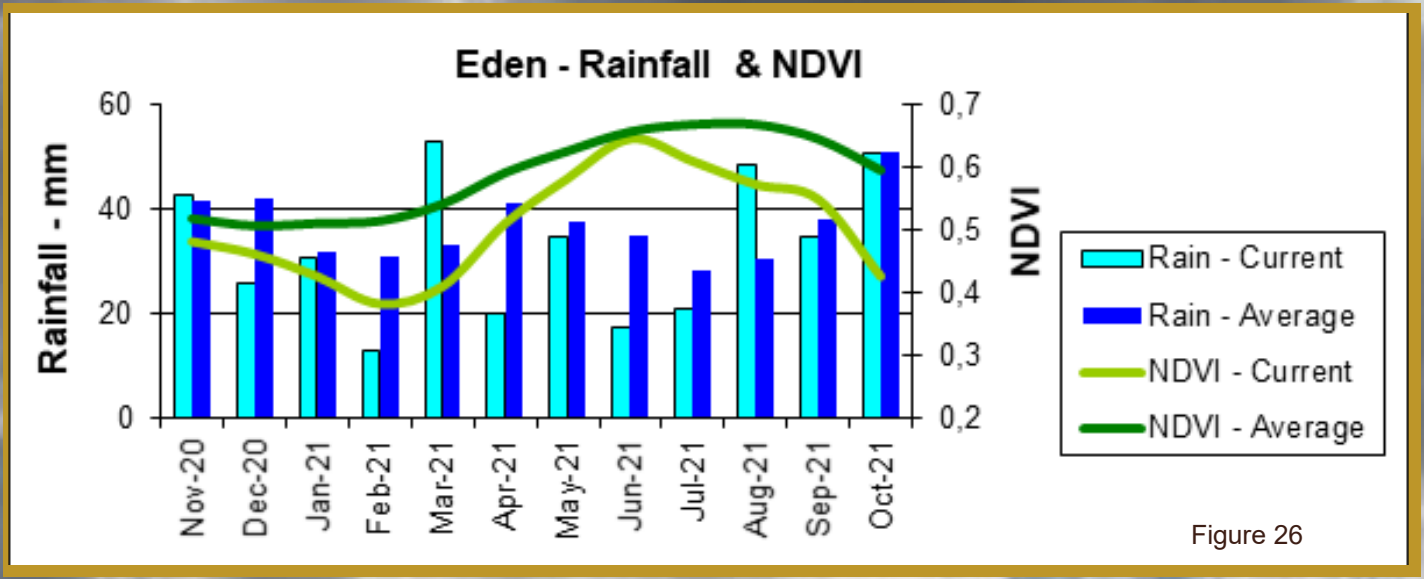

Figure 26

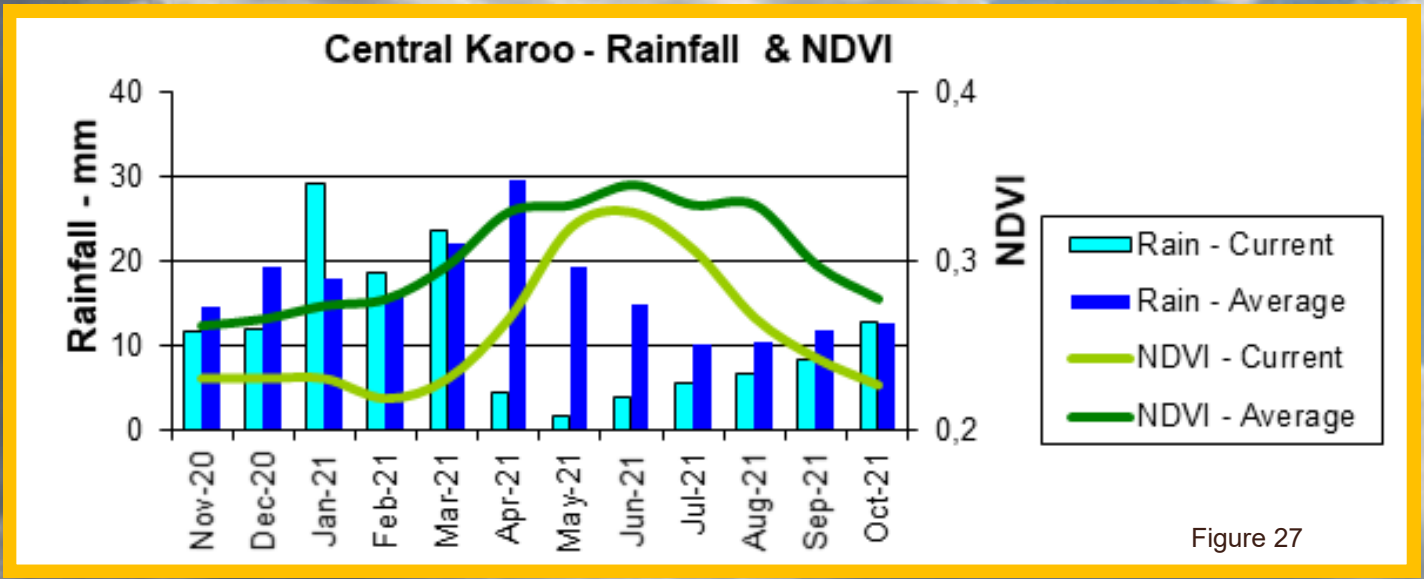

Figure 27

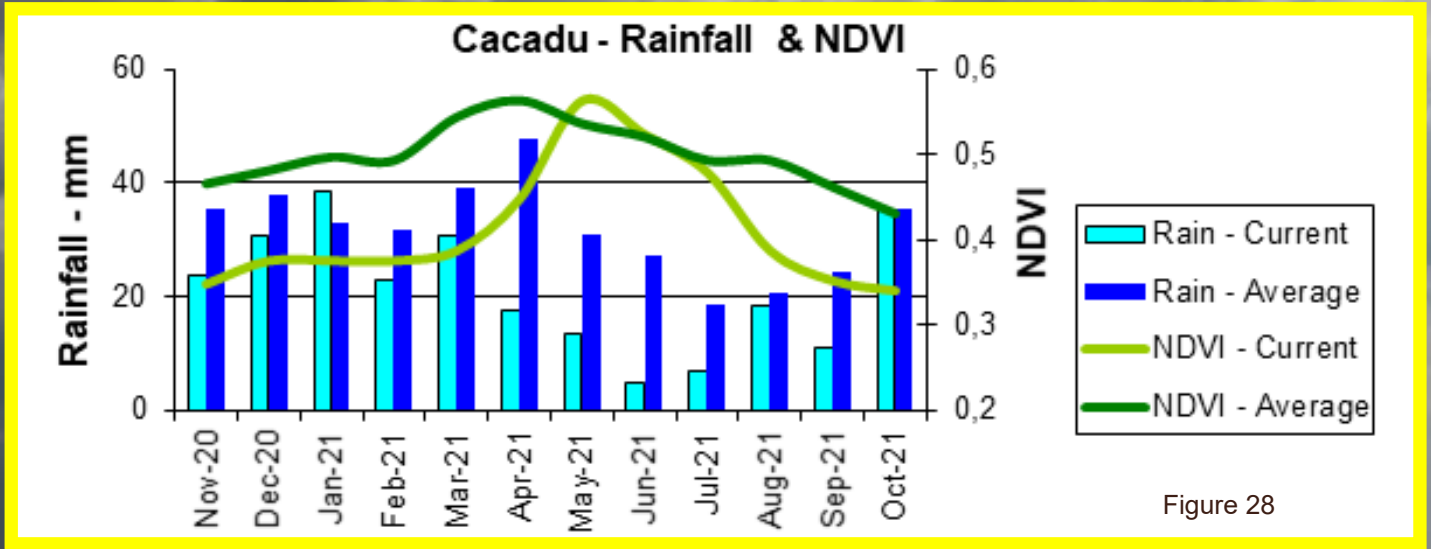

Figure 28

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 October 2021 per province. Fire activity was higher in all provinces except for Gauteng, the Western Cape and KwaZulu-Natal, compared to the long-term average.

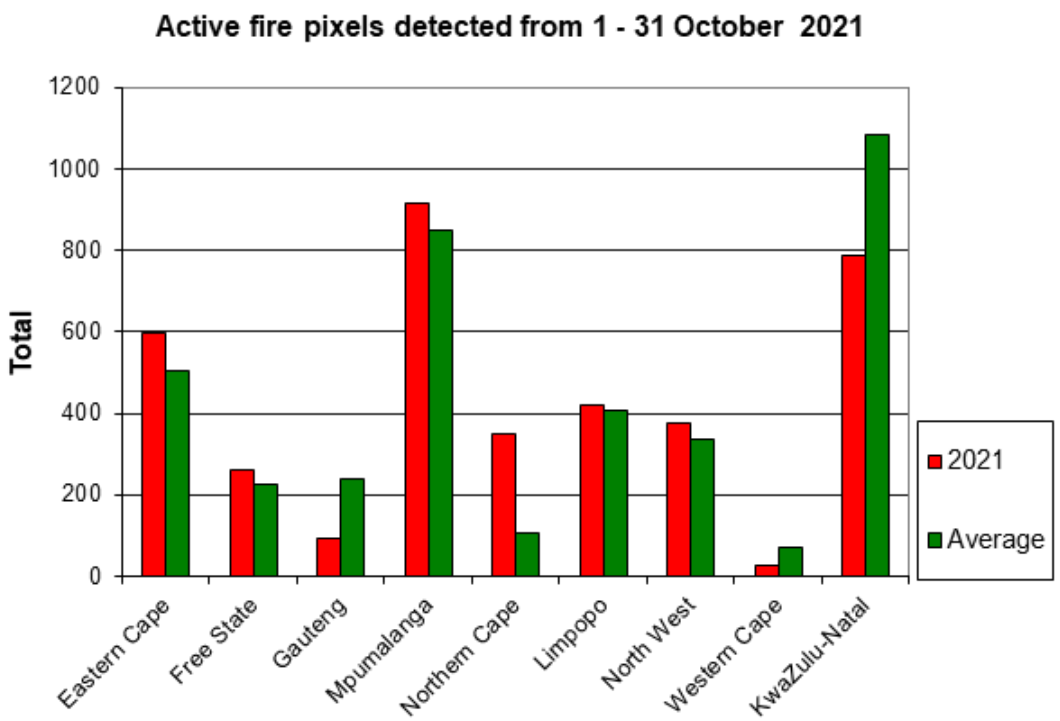

Figure 29

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

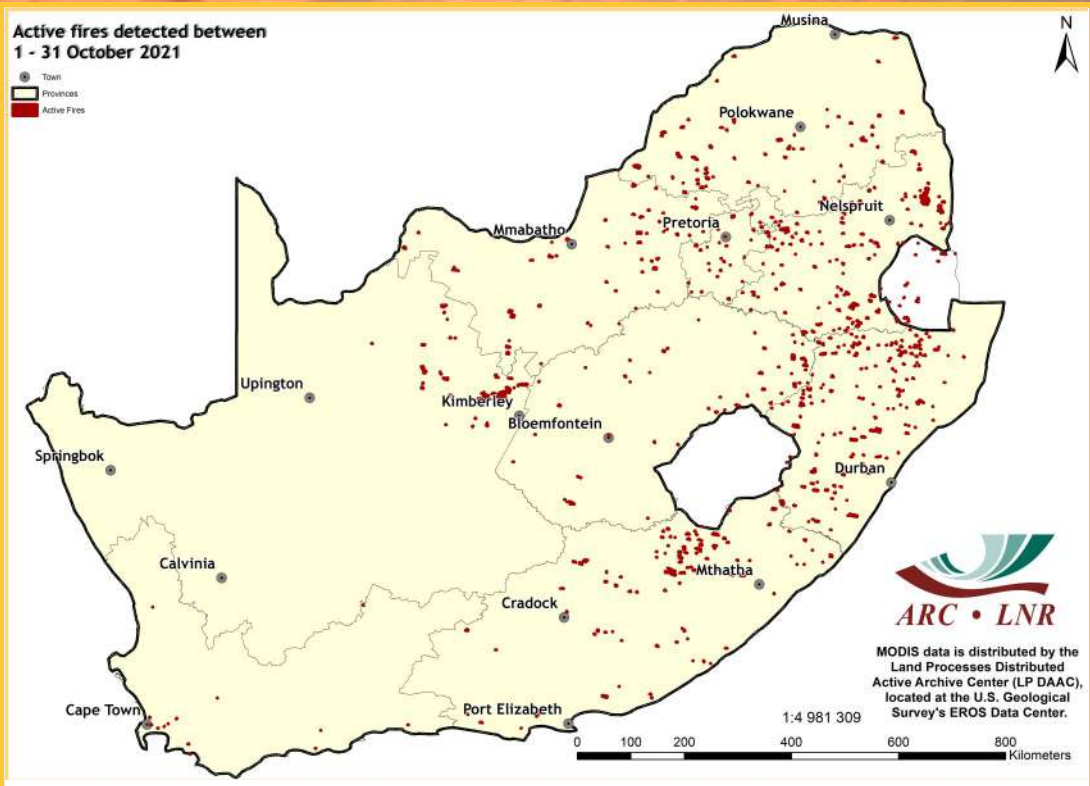

Figure 30

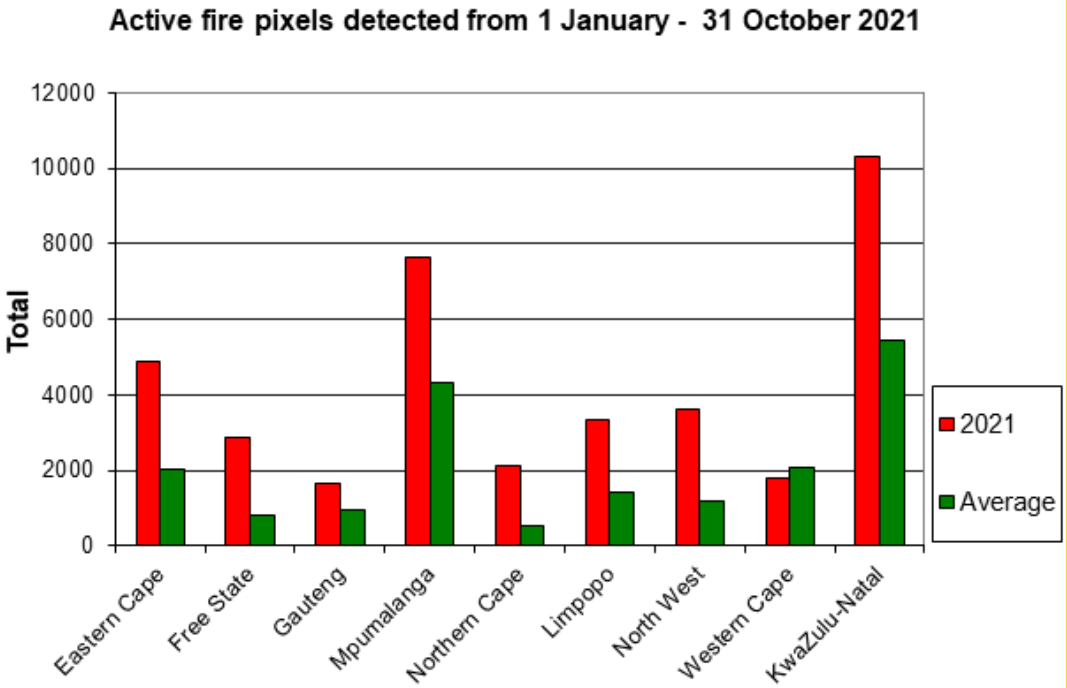

Figure 31

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

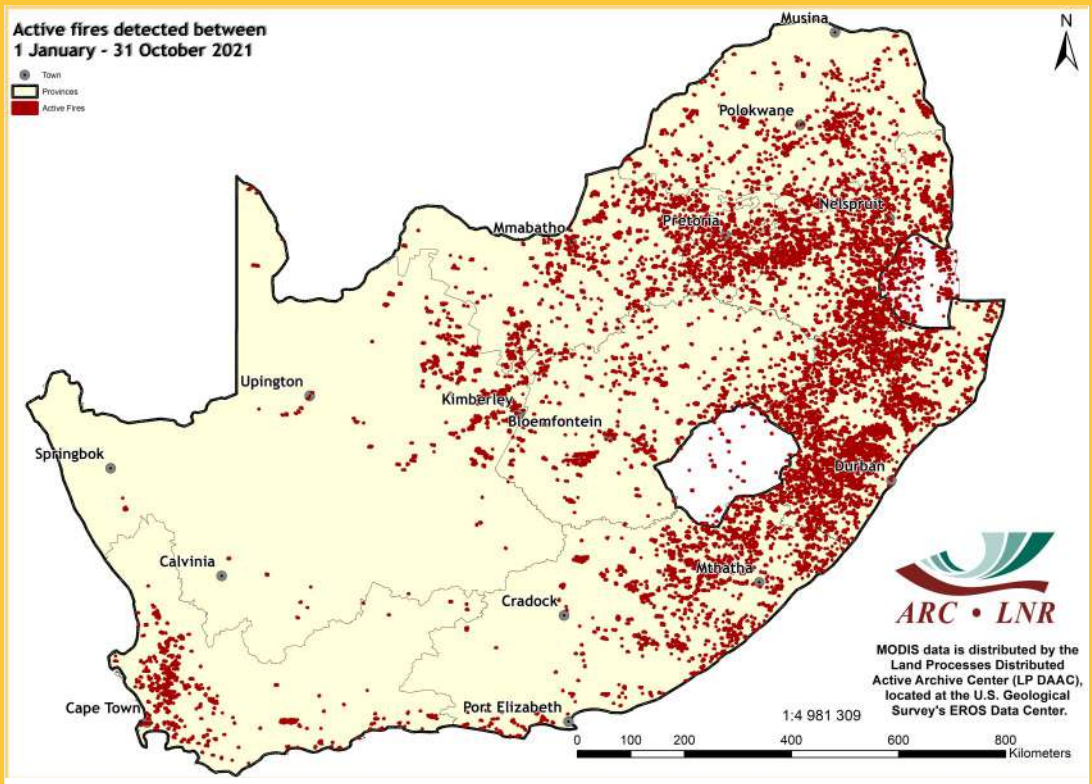

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January and 31 October 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 October 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.

The comparison between October 2021 and October 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 October 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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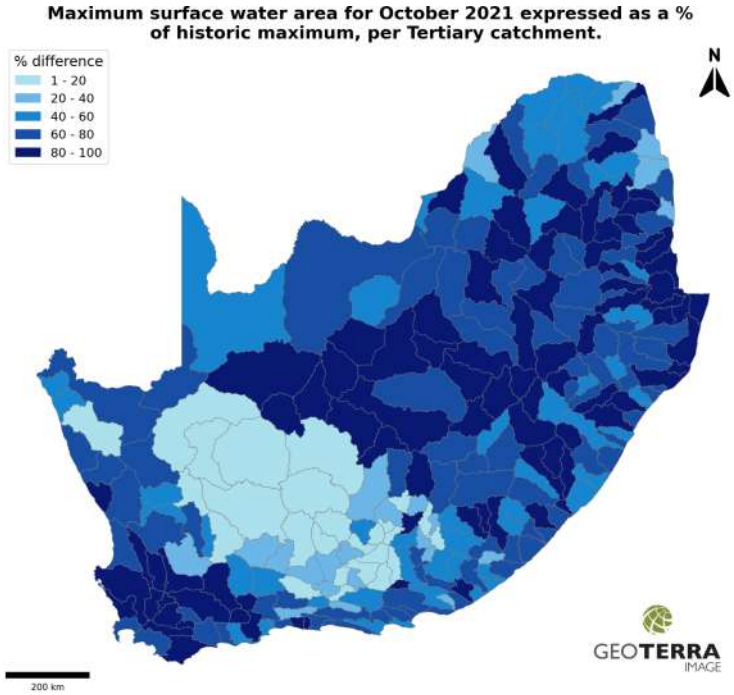

Figure 33

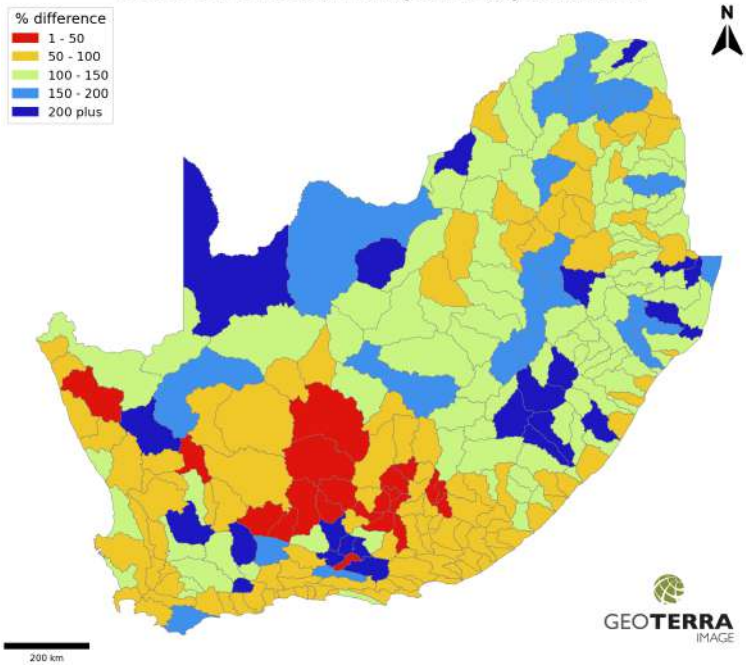

Figure 34

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

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