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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

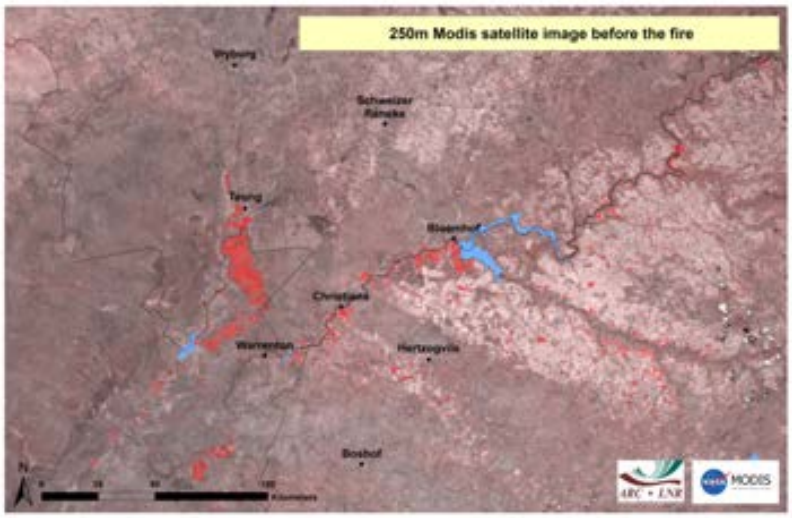
CONTENTS:

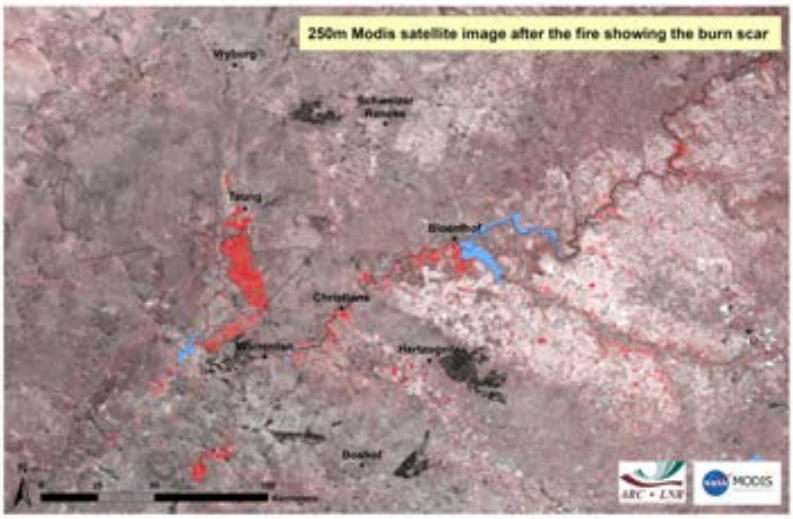
197th Edition

Images of the Month

Extensive fire damage over the central interior

Wild fires ravaged large parts of the western Free State and central/western North West Province during October, causing extensive damage to an area in the order of hundreds of thousands of hectares. These fires occurred around the 19th in the Free State and around the 22nd in North West, during a period when hot, dry and windy conditions dominated over the central to western interior. Damage to livestock, property and grazing amounted to millions of rands, with the largest fire in the Free State targeting the Boshof, Hertzogville, Bultfontein and Hoopstad area. The fires were started in some instances by service delivery protesters and arsonists taking advantage of the favourable weather conditions. These conditions also resulted in large fires over the central/western North West, focusing on the Vryburg and Schweizer-Renecke area. Isolated thunderstorms in the dry and windy environment were also responsible for igniting some fires. The fires were brought under control by 23 October with conditions becoming less favourable by month end due to widespread precipitation in the area. The MODIS 250m colour composite images show the burn scars (in black) over the western parts of the Free State and central/western North West compared with before the fires, bearing witness to the extensive damage caused.





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:

The month of October 2020 commenced with thunderstorm activity over the central to eastern parts of South Africa, as well as the southern coastal belt, from the 1st to the 7th. During this time, scattered to widespread severe thunderstorms with strong winds and lightning were observed over the interior. From the 9th to the 11th, rainfall activity occurred largely along the Garden Route, with areas such as George and the Tsitsikamma National Park recording totals of up to 49 mm and 46 mm, respectively. On the 12th, a well-developed weather system occurred and resulted in the development of a cloud band and rainfall over parts of Gauteng, North West, Limpopo, Mpumalanga and KwaZulu-Natal. The latter part of the month was characterized by isolated thunderstorms over the Western Cape and the summer rainfall region. Although very limited, these rainfall events contributed to most of the rain that occurred over the maize production regions of the Free State. By the end of the month, above-normal rainfall conditions were observed over Limpopo, the Lowveld of Mpumalanga, southern and eastern parts of the Highveld, and isolated parts of North West and the Cape provinces. These conditions resulted in higher amounts of rainfall as compared to the same period last year.

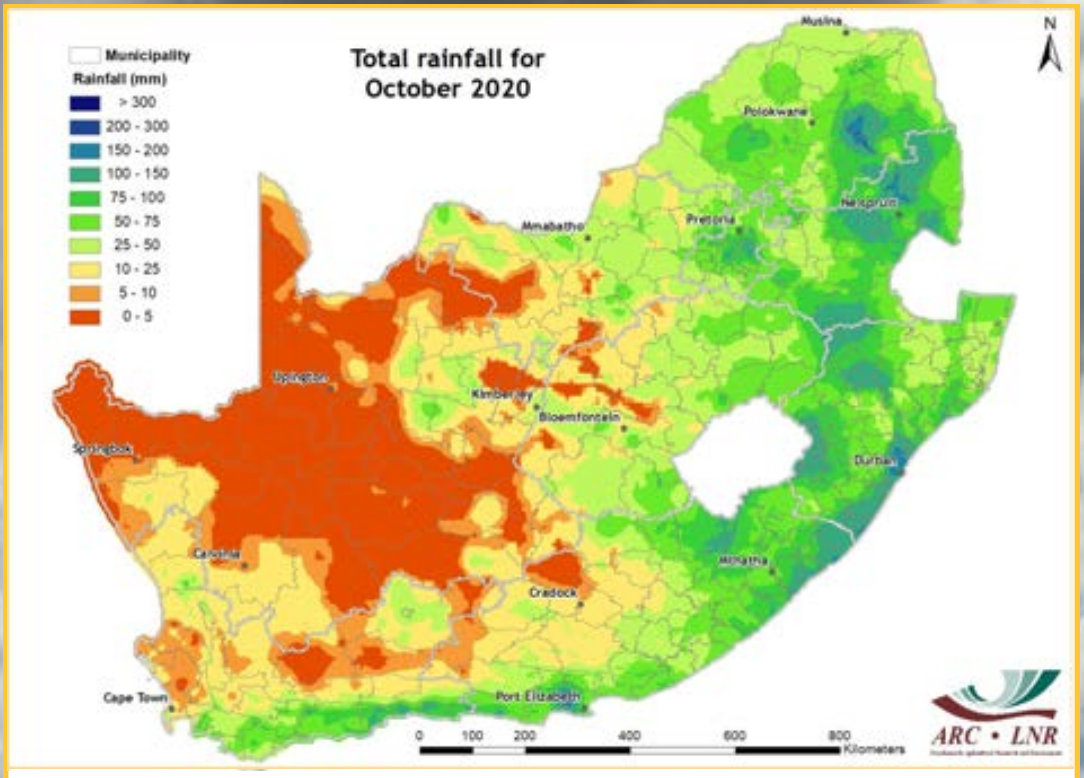


Figure 1

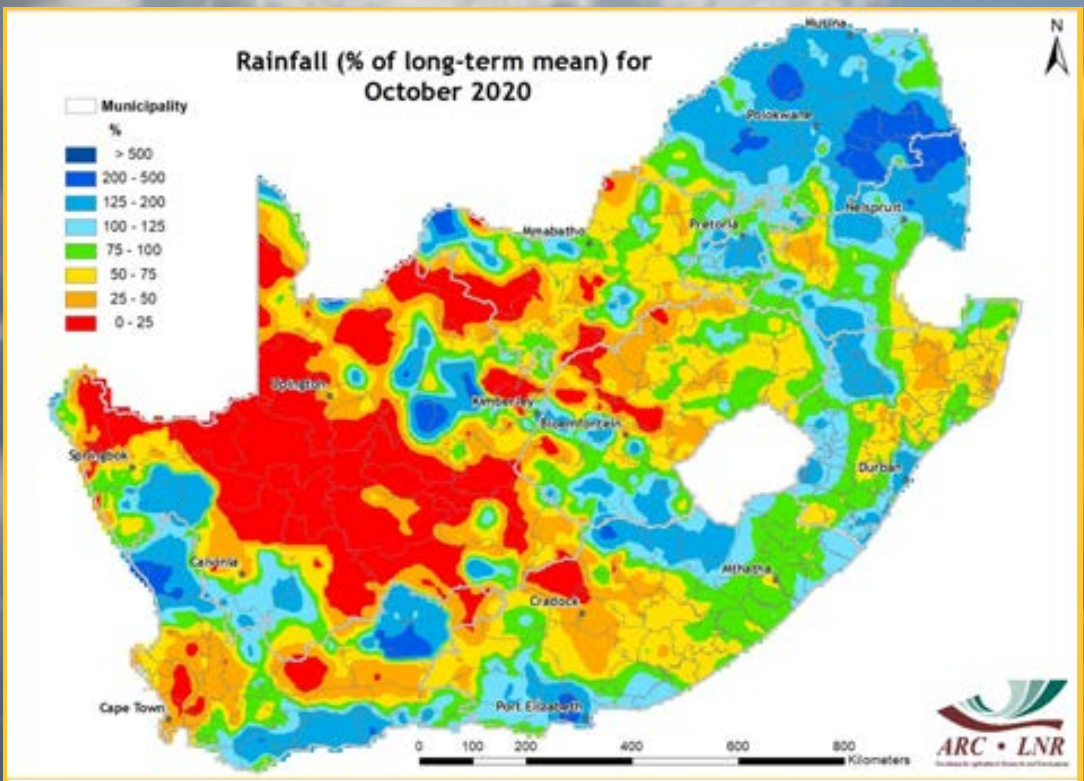
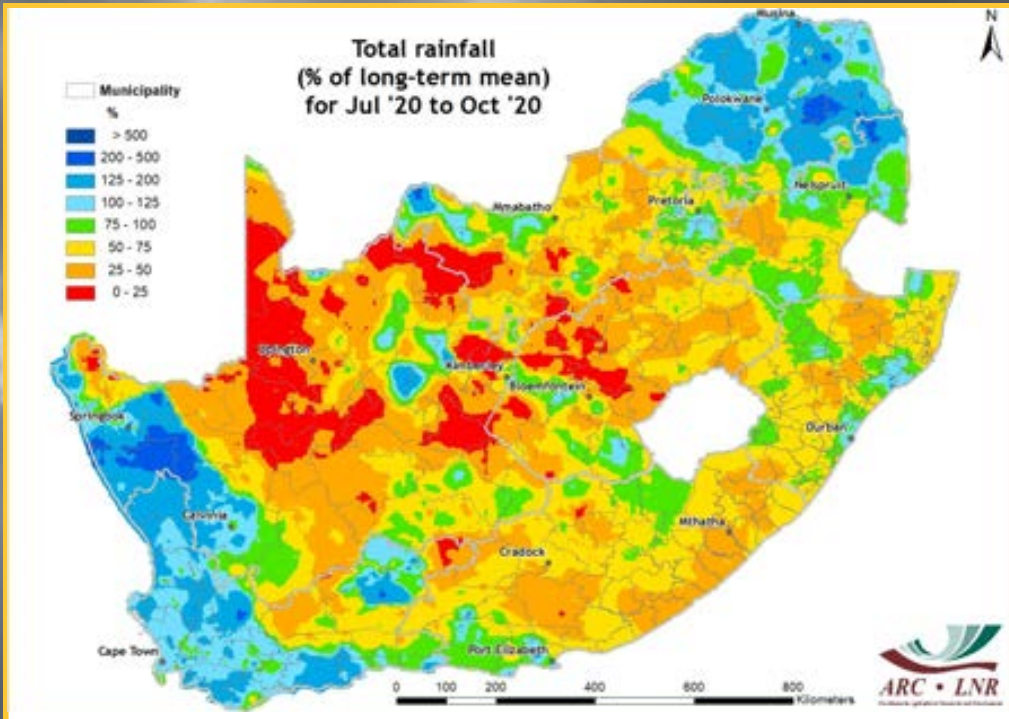


Figure 2



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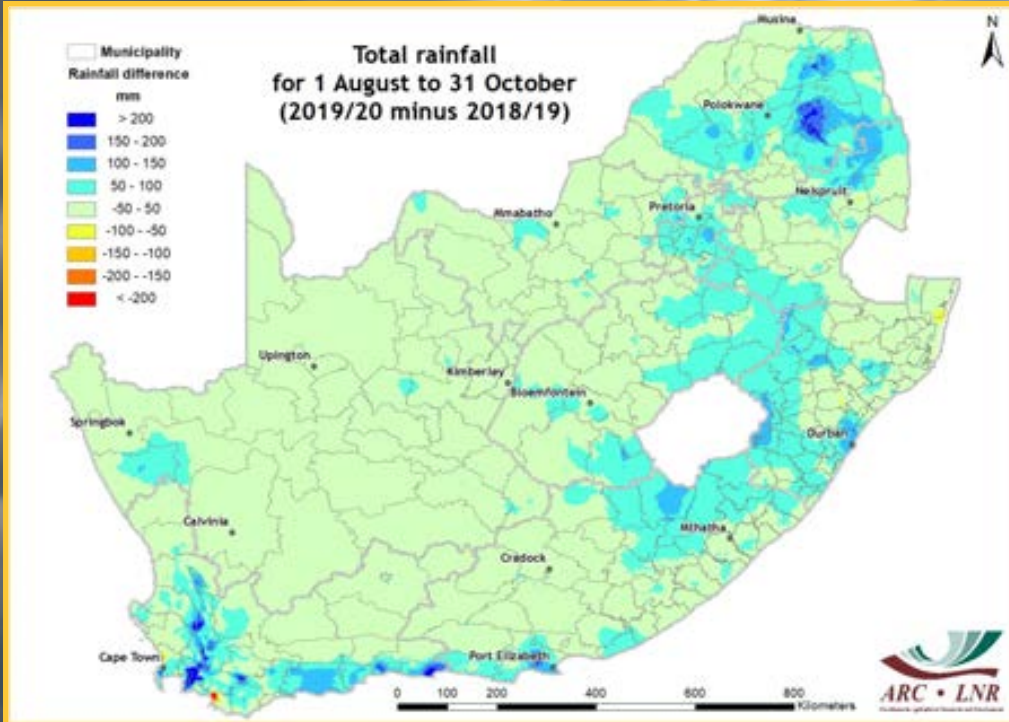

Figure 4

Figure 1:
Considerable amounts of rainfall occurred in October over the southern coastal belt and most of the eastern parts of the country, particularly along the coast and adjacent interior in the northeast. Greater parts of the Northern Cape, including the Greater Karoo, as well the Cape Peninsula region and the central interior received little rainfall.

Figure 2:
Above-normal rainfall occurred over large parts of the northeastern provinces, as well as isolated parts of North West, the Cape provinces and KwaZulu-Natal. Below-normal rainfall was observed over some areas in North West, Free State, Eastern Cape, Western Cape and greater parts of the Northern Cape.

Figure 3:
The accumulated rainfall for July to October 2020 compared to the long-term mean of the same period indicates above-normal conditions over Limpopo and the winter rainfall region. The rest of the country experienced generally below-normal rainfall.

Figure 4:
Much of the early summer rainfall region and parts of the winter and all-year rainfall regions received considerably more rain during August to October 2020 as compared to the same period last year. The rest of the country received somewhat similar amounts of rainfall during this period.

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2. Standardized Precipitation Index

Standardized Precipitation Index

The Standardized Precipitation Index (SPI - McKee *et al.*, 1993) was developed to monitor the occurrence of droughts from rainfall data. The index quantifies precipitation deficits on different time scales and therefore also drought severity. It provides an indication of rainfall conditions per quaternary catchment (in this case) based on the historical distribution of rainfall.

REFERENCE:
McKee TB, Doesken NJ and Kliest J (1993) The relationship of drought frequency and duration to time scales. In: Proceedings of the 8th Conference on Applied Climatology, 17-22 January, Anaheim, CA. American Meteorological Society: Boston, MA; 179-184.

The SPI maps revealing short-term (6-month SPI), medium-term (12-month SPI) and long-term (24-month and 36-month SPI) drought conditions are shown in Figures 5-8. The short-term (6-month) SPI ending in October 2020 indicates mild to extreme drought conditions over greater parts of the country, with the winter rainfall region, Limpopo and the Lowveld of Mpumalanga experiencing mildly wet conditions. The 12-month SPI shows moderate to extremely wet conditions over the Dr Kenneth Kaunda District Municipality in North West, while severe to extreme drought can be observed over the border of the Eastern Cape and KwaZulu-Natal, central regions of the Northern Cape and isolated parts of the Western Cape. Longer time scales (24- to 36-month SPI) indicate severe to extreme drought over the Cape provinces, eastern Free State, parts of KZN, Limpopo and Mpumalanga.

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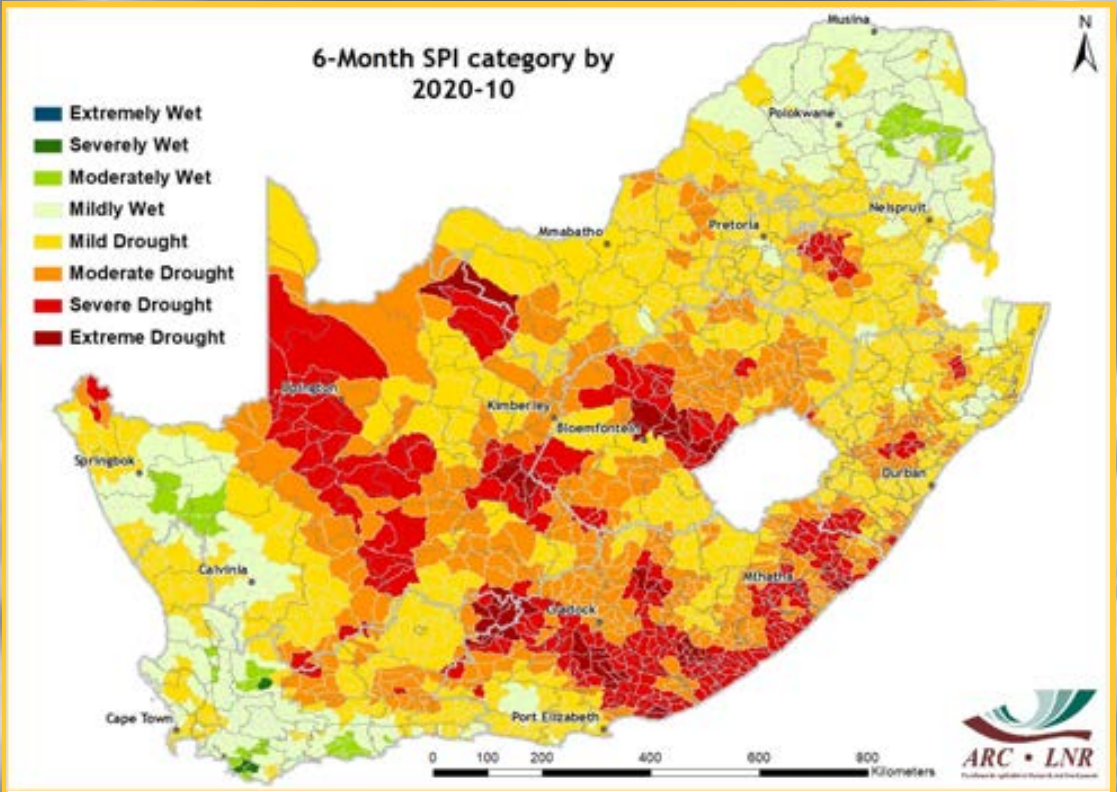

Figure 5

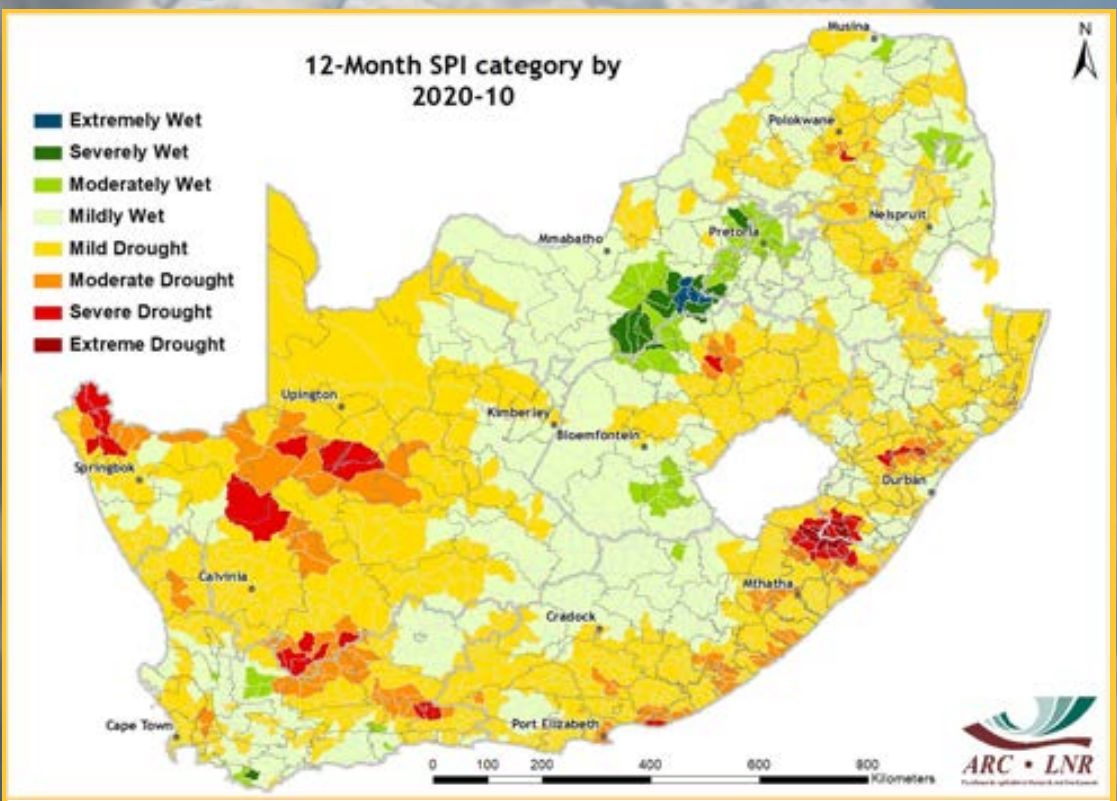

Figure 6

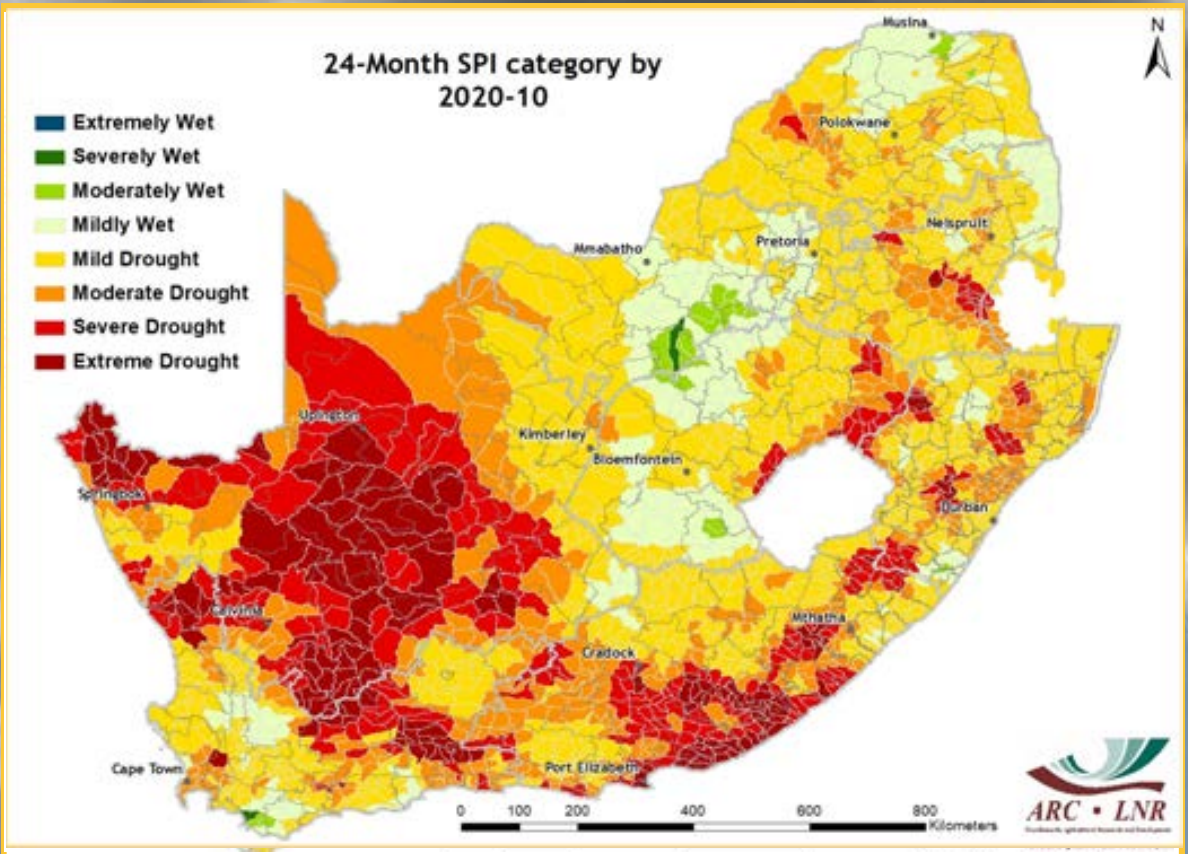

Figure 7

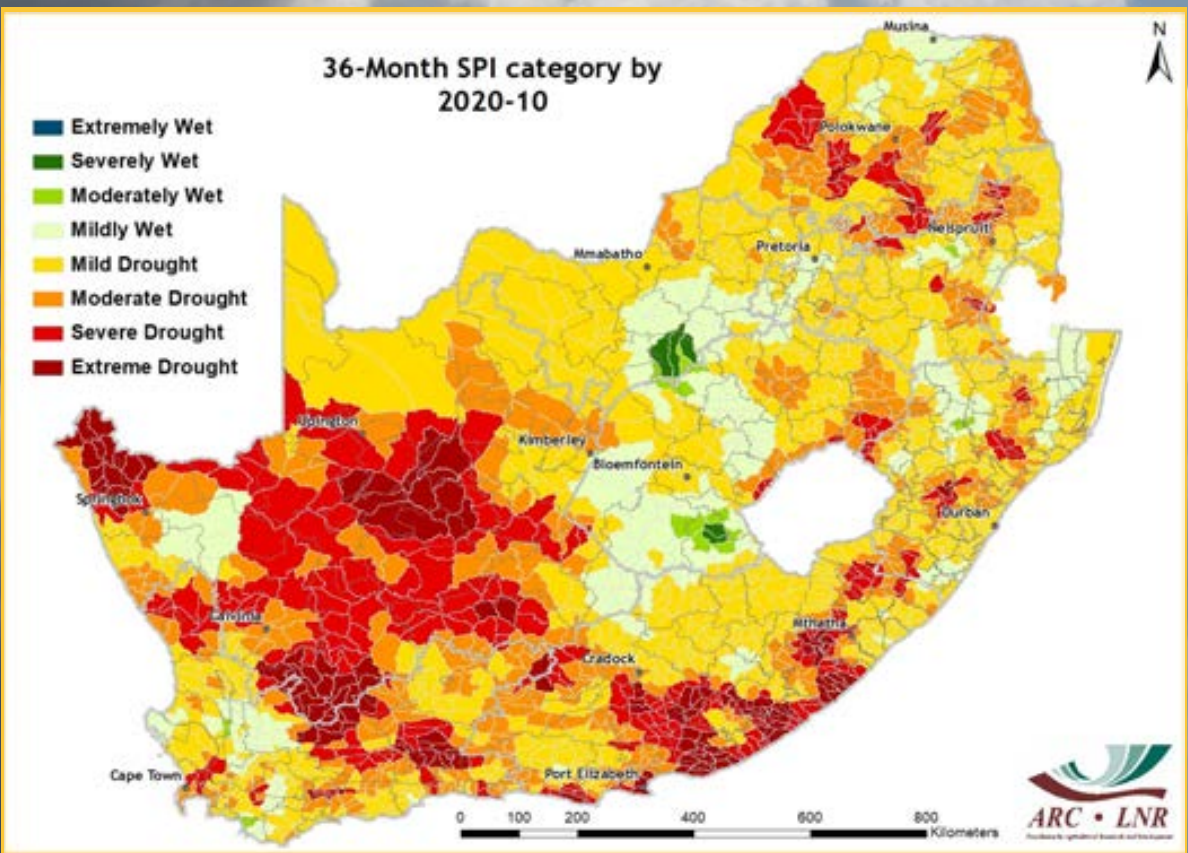

Figure 8

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.

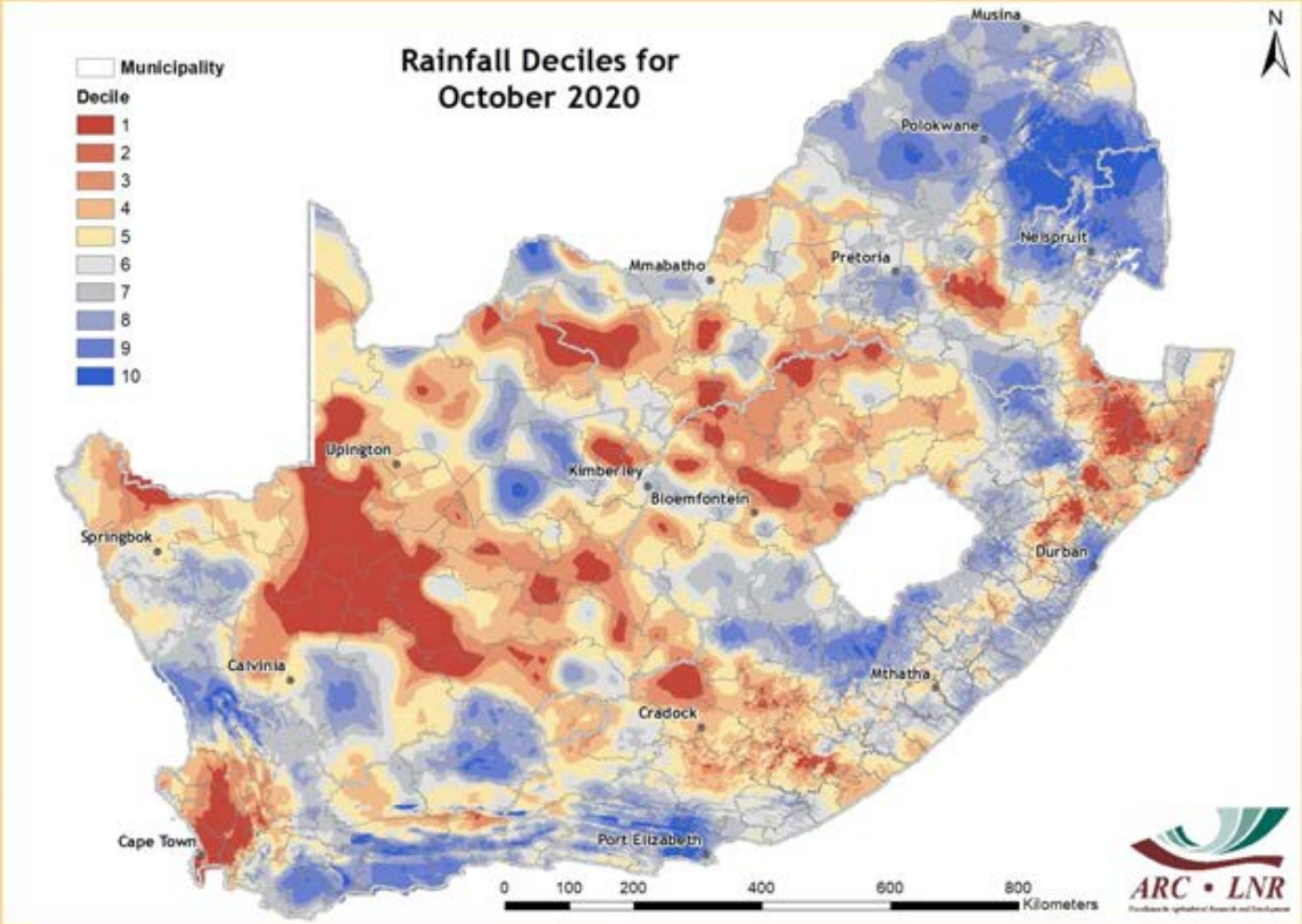

Figure 9

Figure 9:
October 2020 over most parts of the country compares well with the historically wetter October months. Areas that recorded rainfall that compares with the historically drier October months include greater parts of the interior, Cape Peninsula and the northern parts of 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.

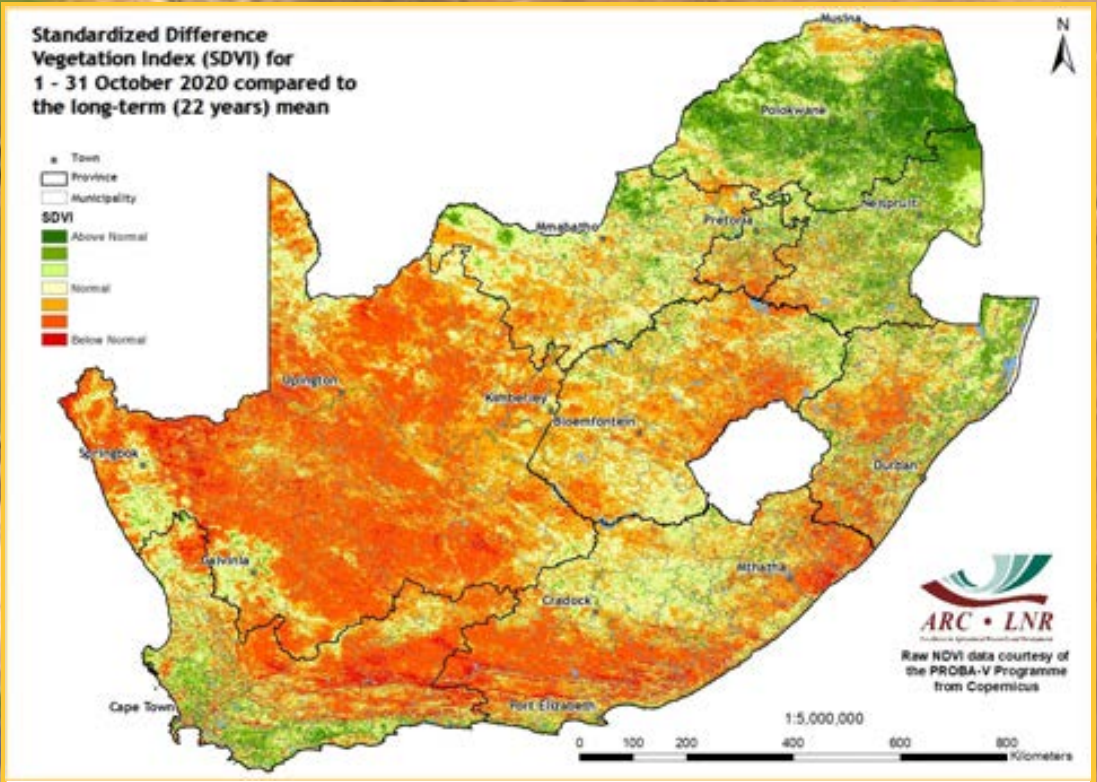

Figure 10

Figure 10:
Compared to the historical averaged vegetation conditions, the SDVI map for October 2020 shows that many parts of the country experienced poor vegetation conditions, particularly the central and coastal areas. The opposite was, however, observed for the far northern parts which experienced good vegetation conditions.

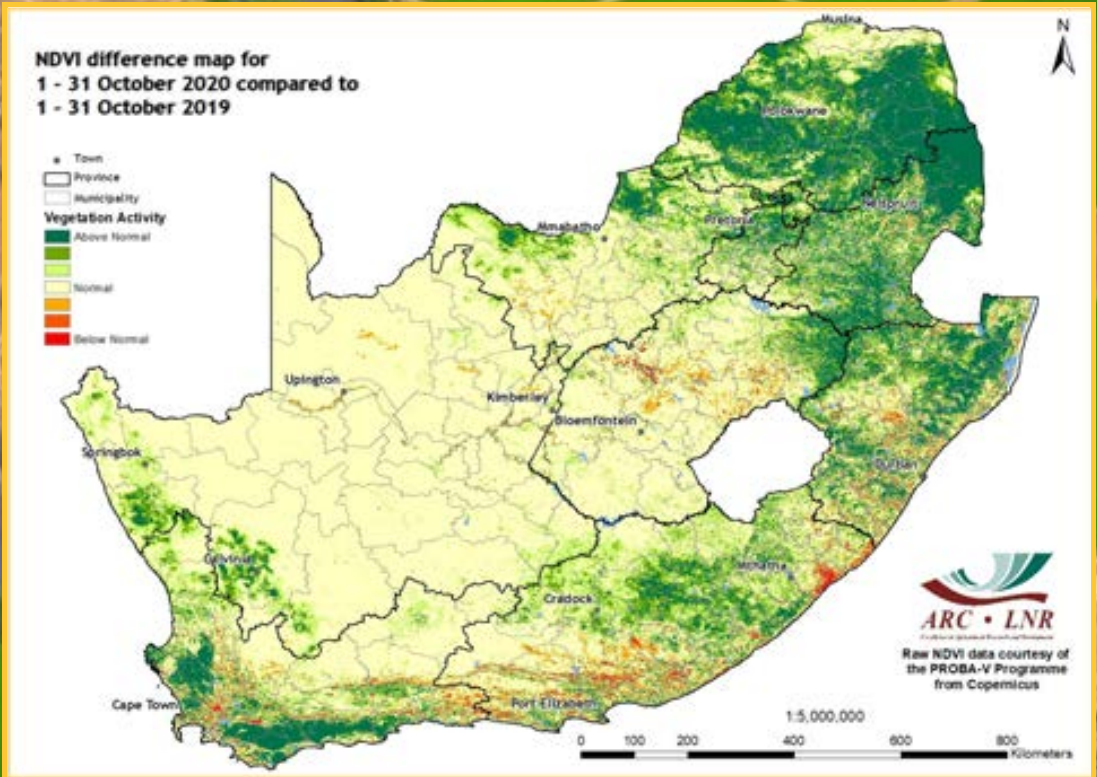

Figure 11

Figure 11:
Compared to October 2019, the NDVI difference map for October this year shows that normal to above-normal vegetation activity occurred over many parts of the country with pockets of below-normal activity over isolated areas.

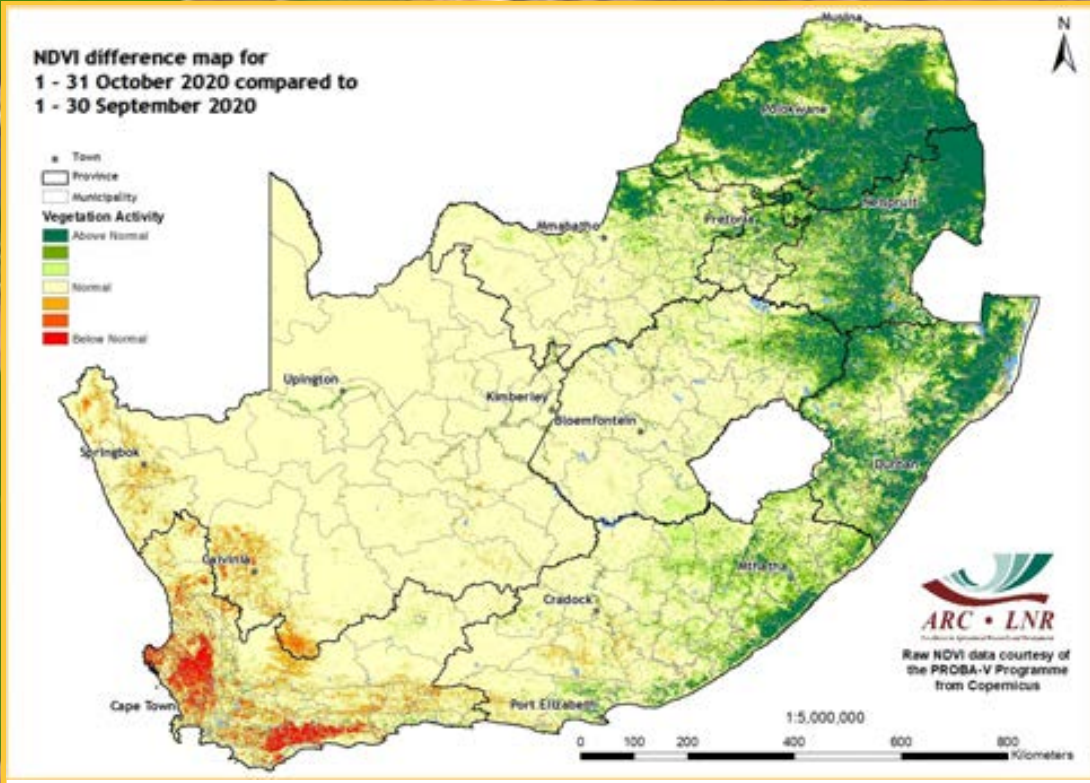

Figure 12

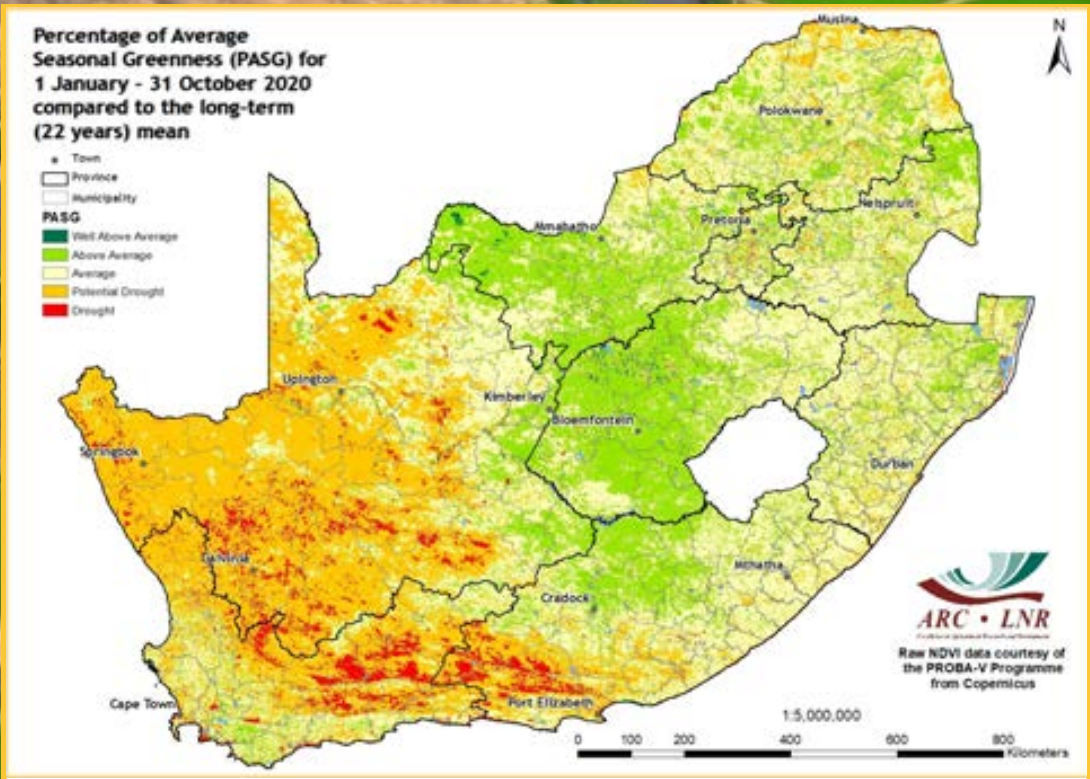

Figure 13

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 October shows that the central parts of the country and larger parts of the Northern Cape experienced normal vegetation conditions. In contrast, some isolated areas in the Western and Eastern Cape, as well as KZN, Mpumalanga and Limpopo, were characterized by a smaller extent of below-normal vegetation activity.

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

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5. Vegetation Condition Index

Vegetation Condition Index (VCI)

The VCI is an indicator of the vigour of the vegetation cover as a function of the NDVI minimum and maximum encountered for a specific pixel and for a specific period, calculated over many years.

The VCI normalizes the NDVI according to its changeability over many years and results in a consistent index for various land cover types. It is an effort to split the short-term weather-related signal from the long-term climatological signal as reflected by the vegetation. The VCI is a better indicator of water stress than the NDVI.

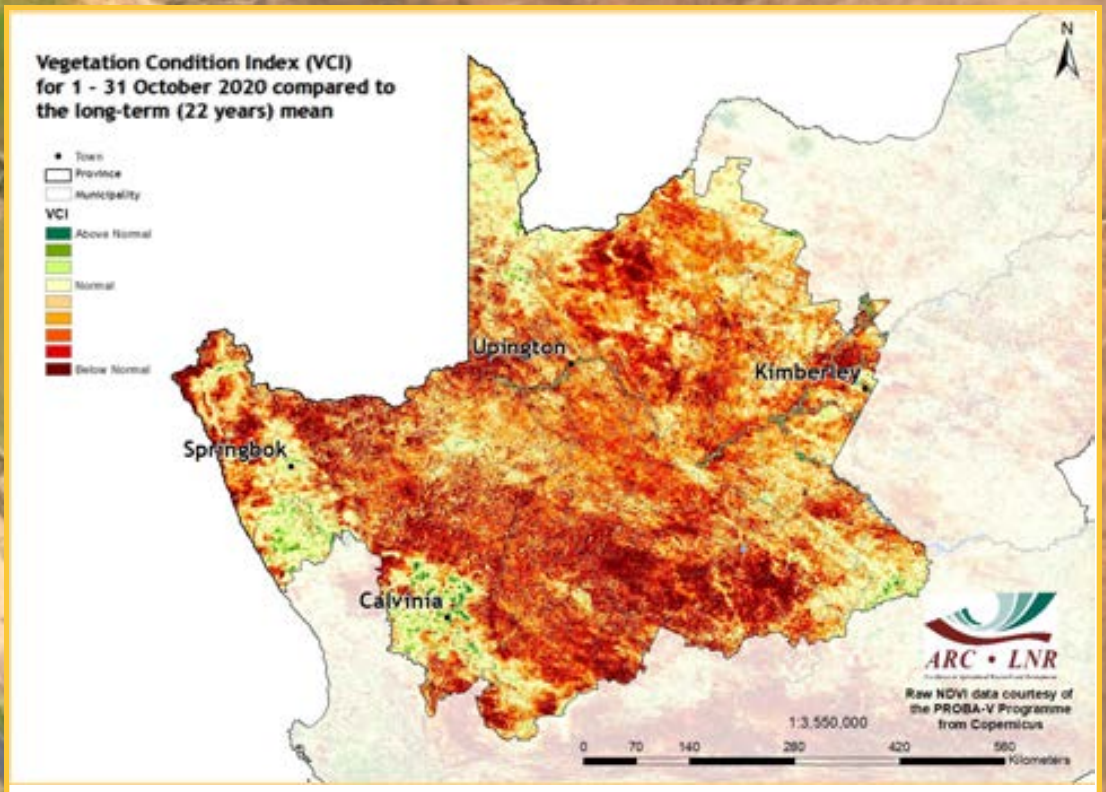

Figure 14

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

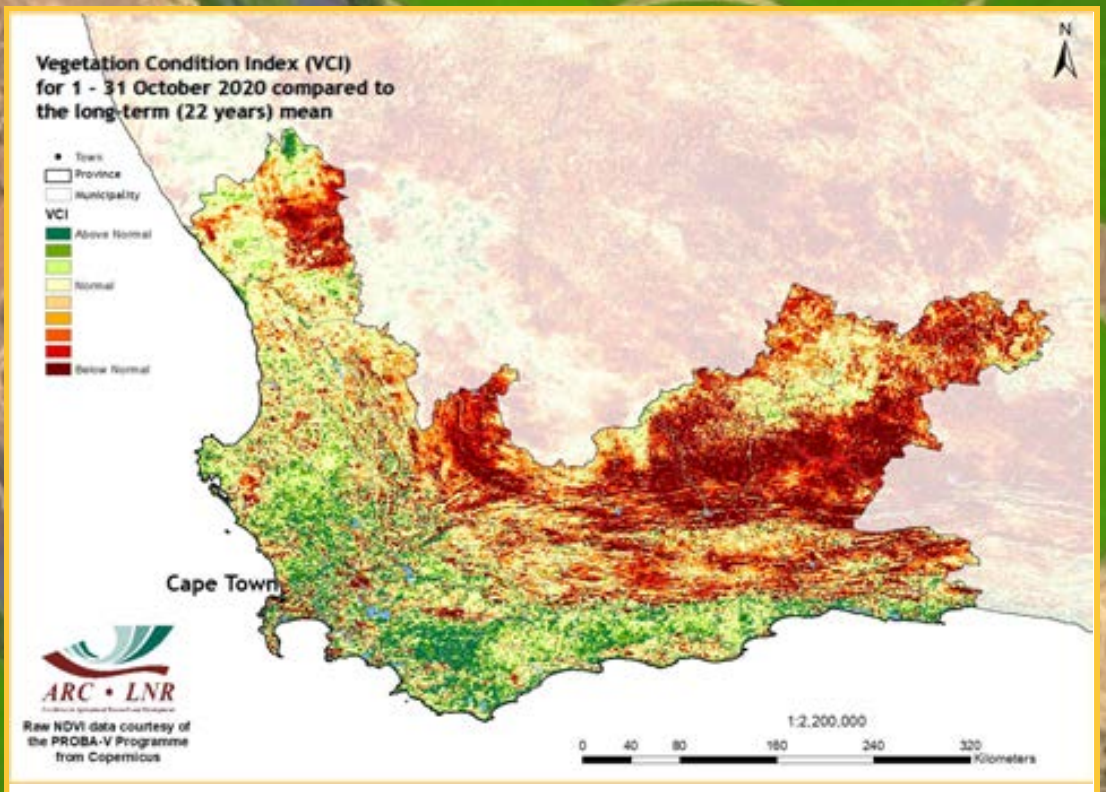

Figure 15

Figure 15:
The VCI map for October indicates that vegetation in the eastern half of the Western Cape remains stressed. Meanwhile, the western half of the province continues to experience pockets of good vegetation conditions, spreading to larger isolated areas of the southern parts.

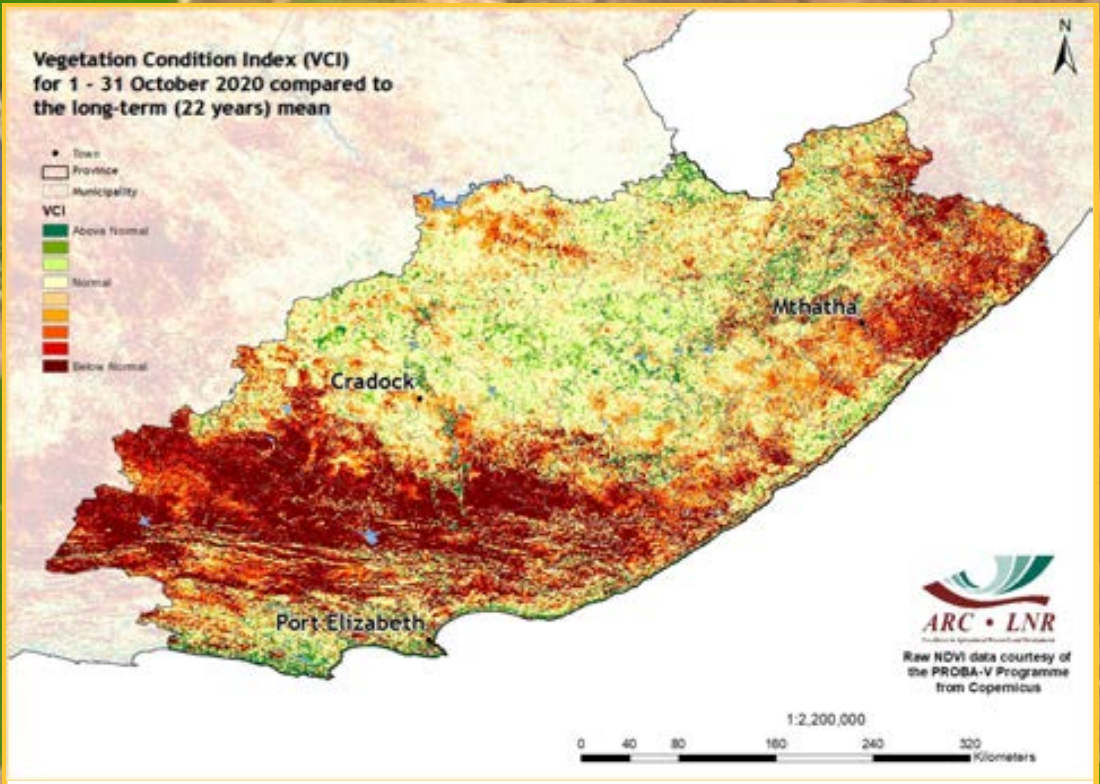

Figure 16

Figure 16:
The VCI map for October indicates that particularly the western half of the Eastern Cape, extending to the eastern half of the province, continues to experience poor vegetation conditions.

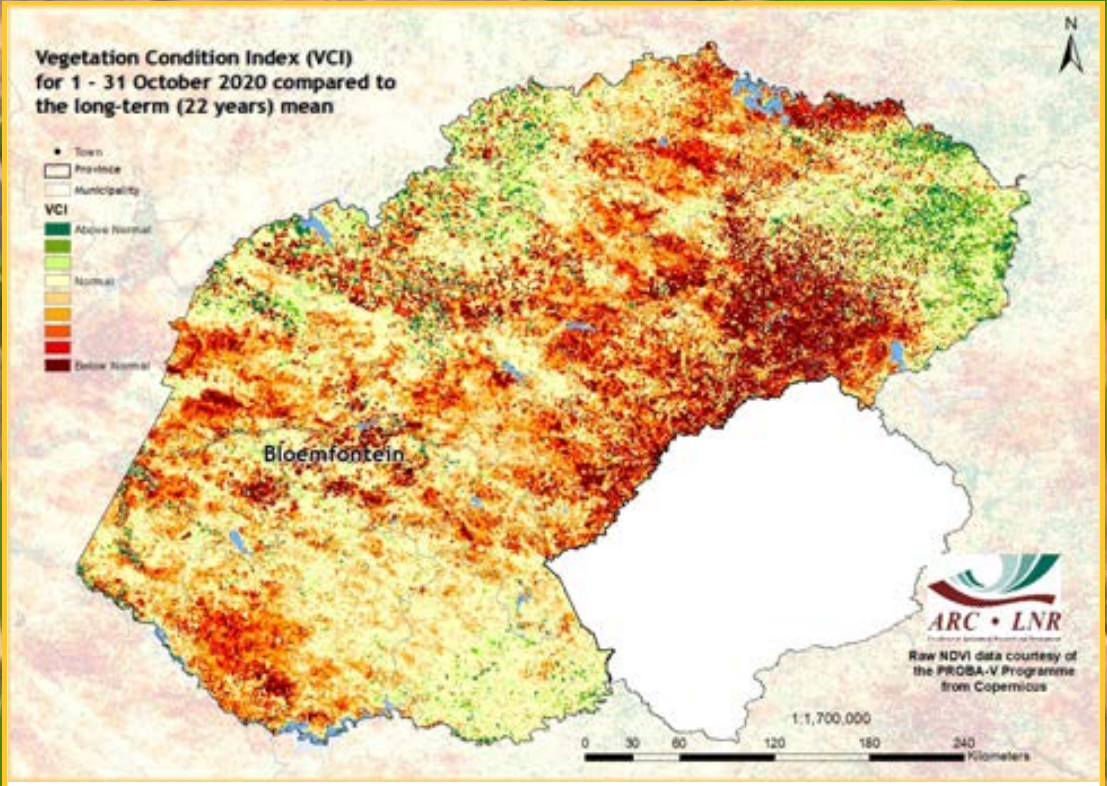

Figure 17

Figure 17:
The VCI map for October indicates that most parts of the Free State experienced poor vegetation activity.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

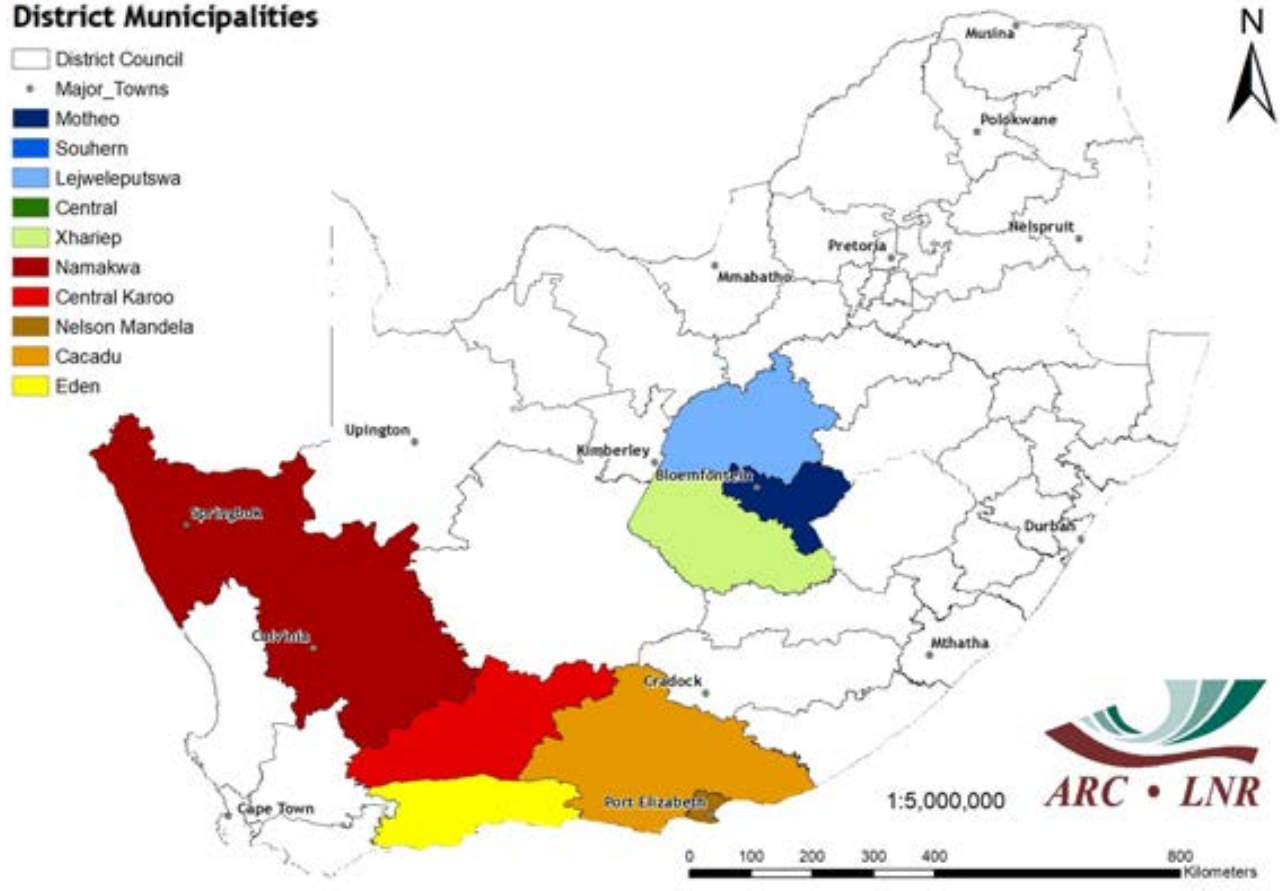

Figure 18

Rainfall and NDVI Graphs

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

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

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

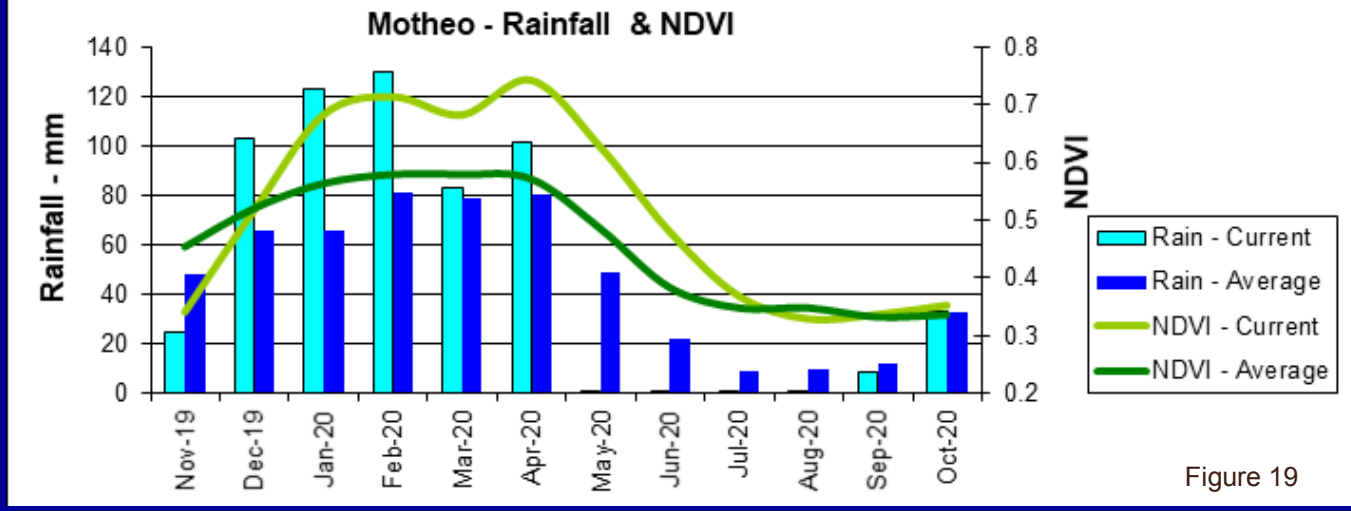
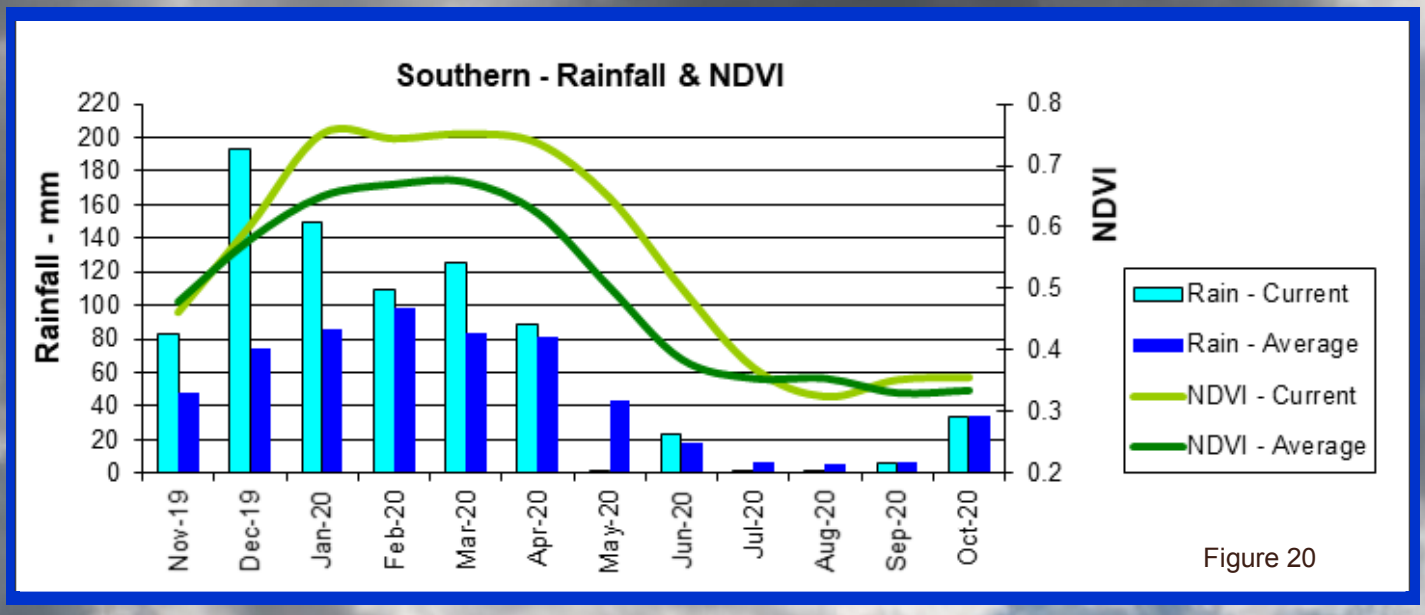


Figure 19



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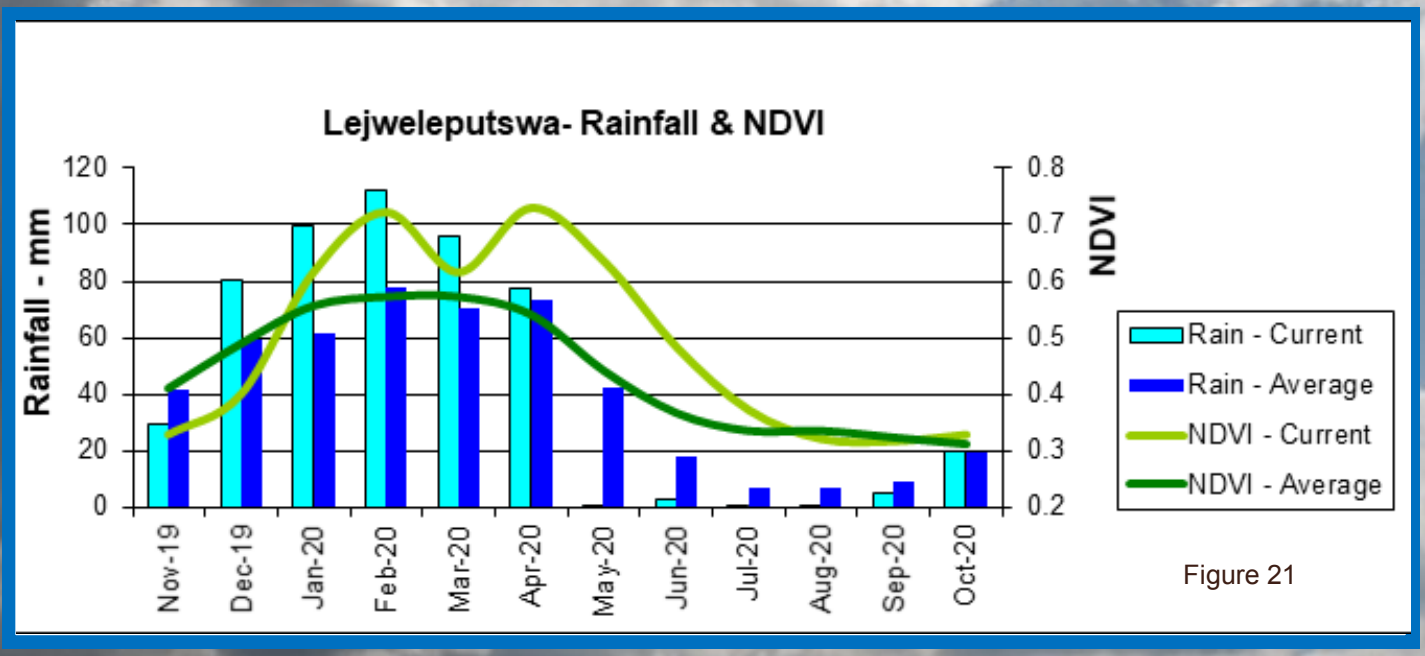

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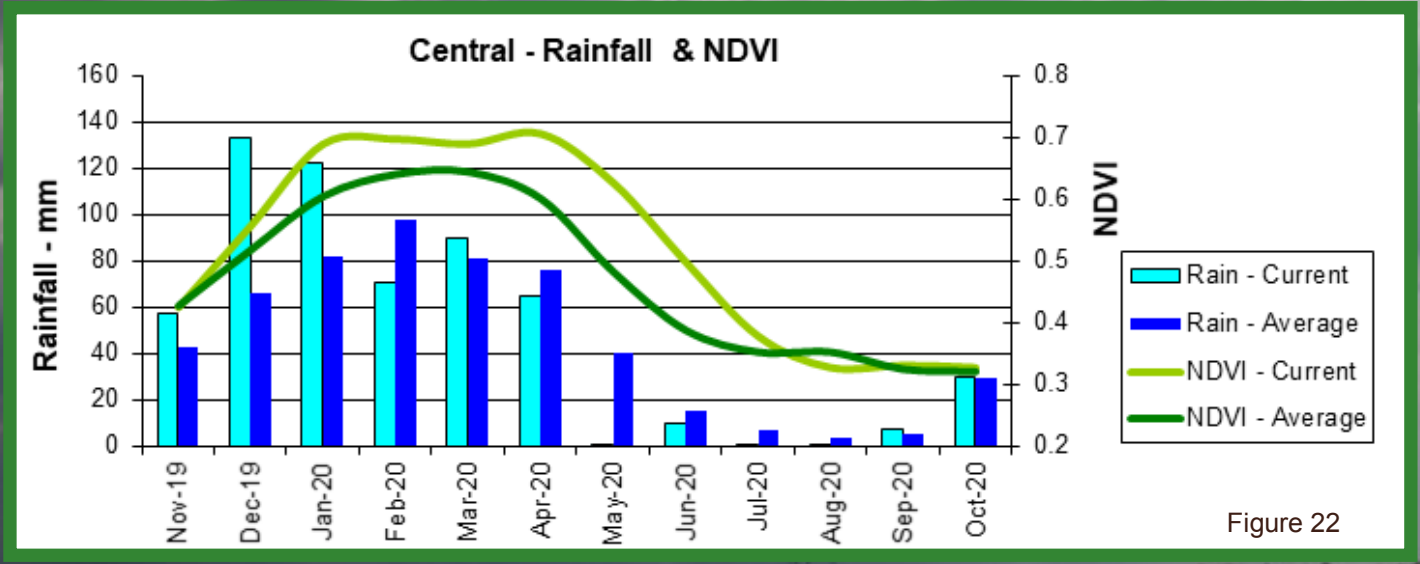

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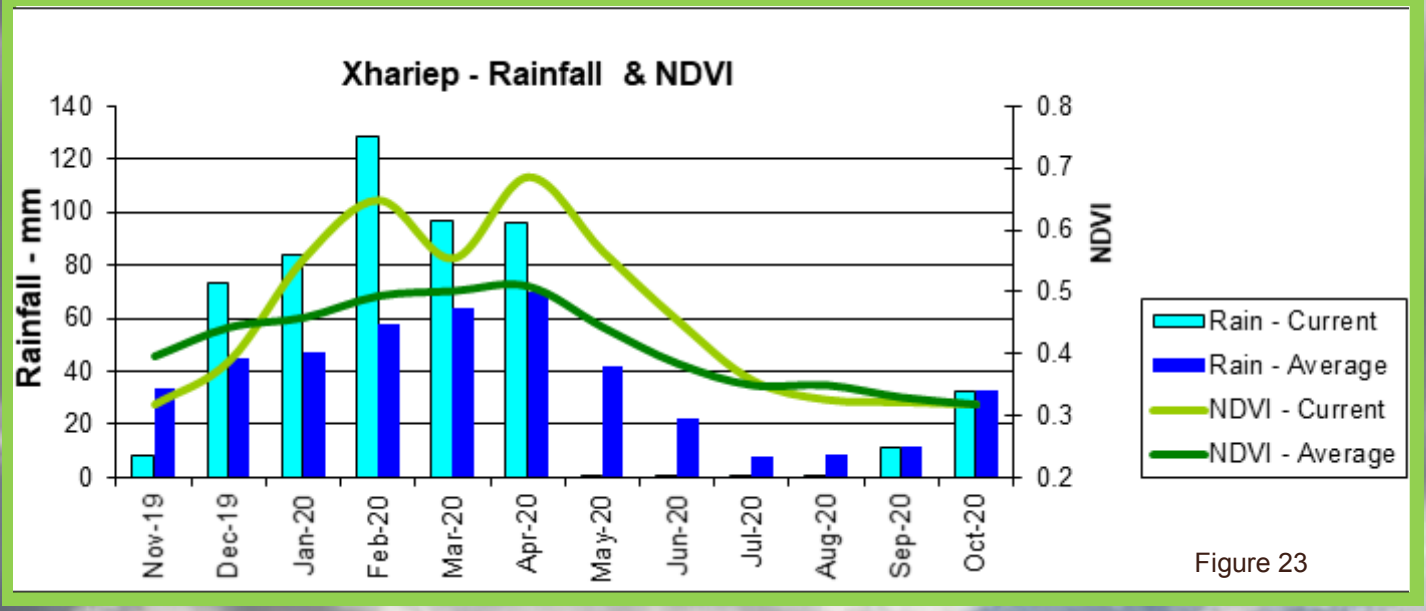
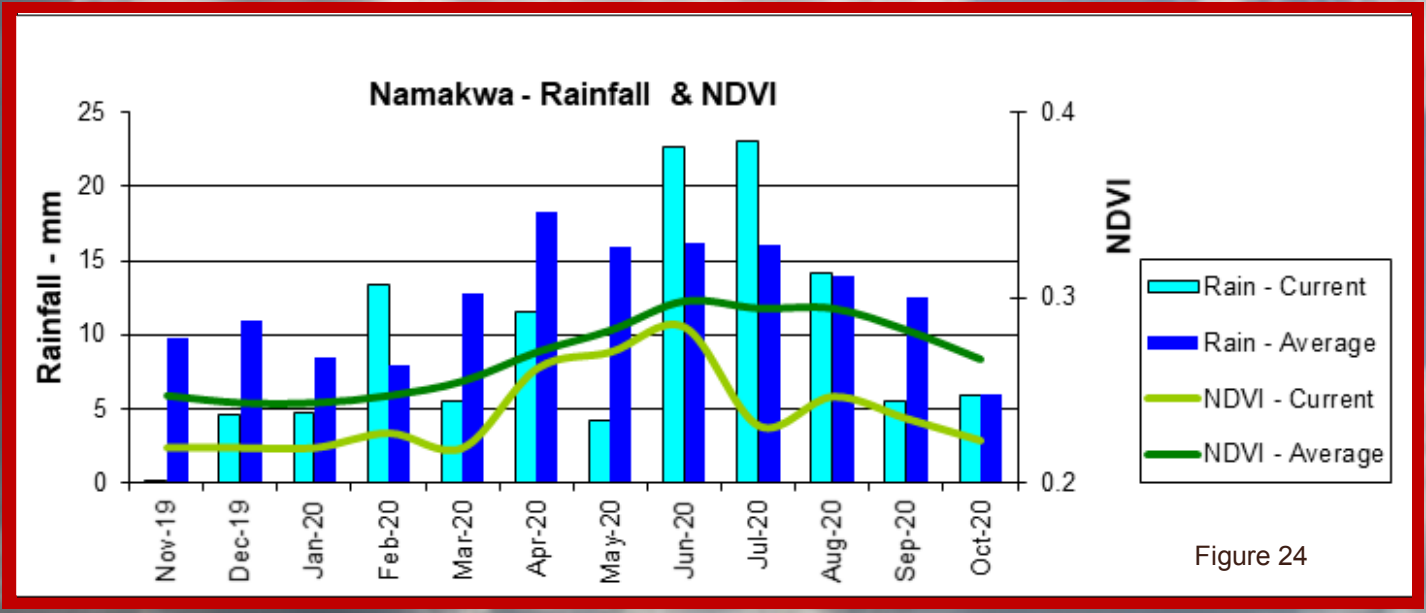


Figure 23



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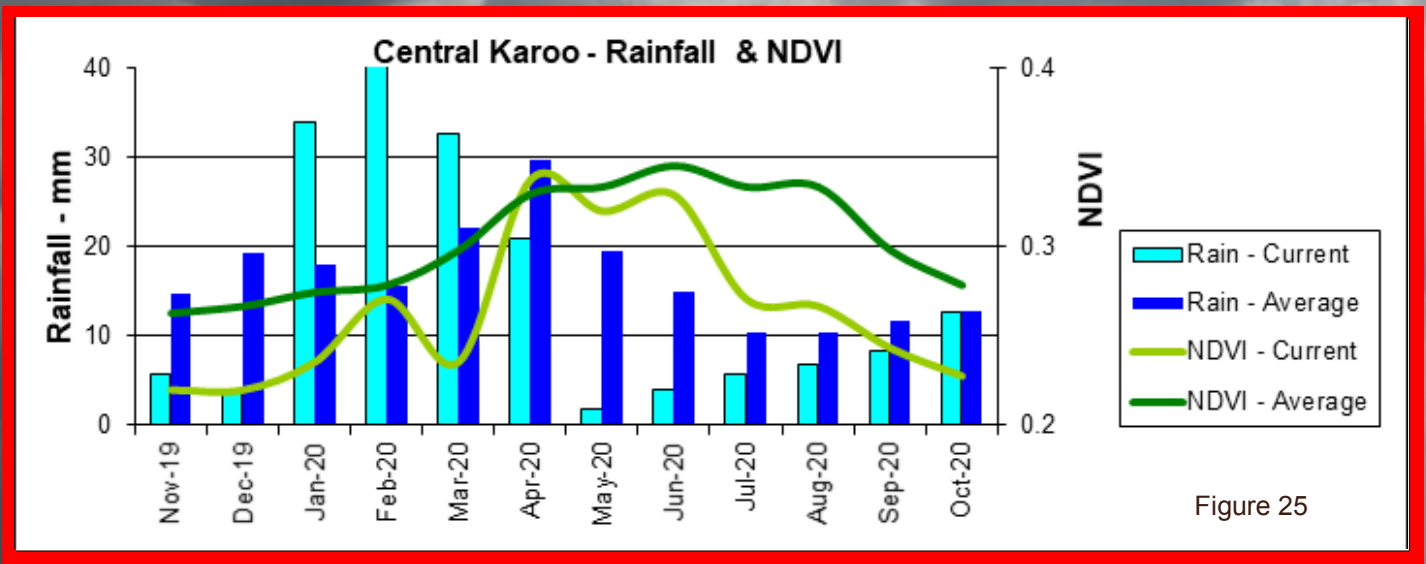
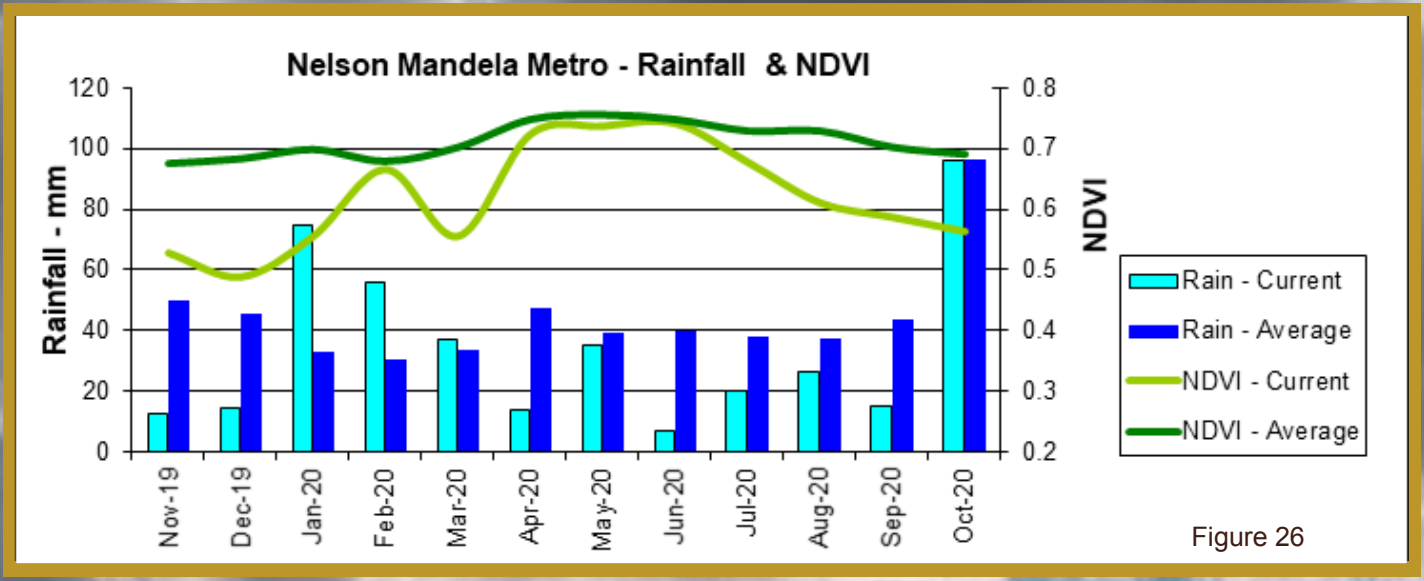


Figure 25



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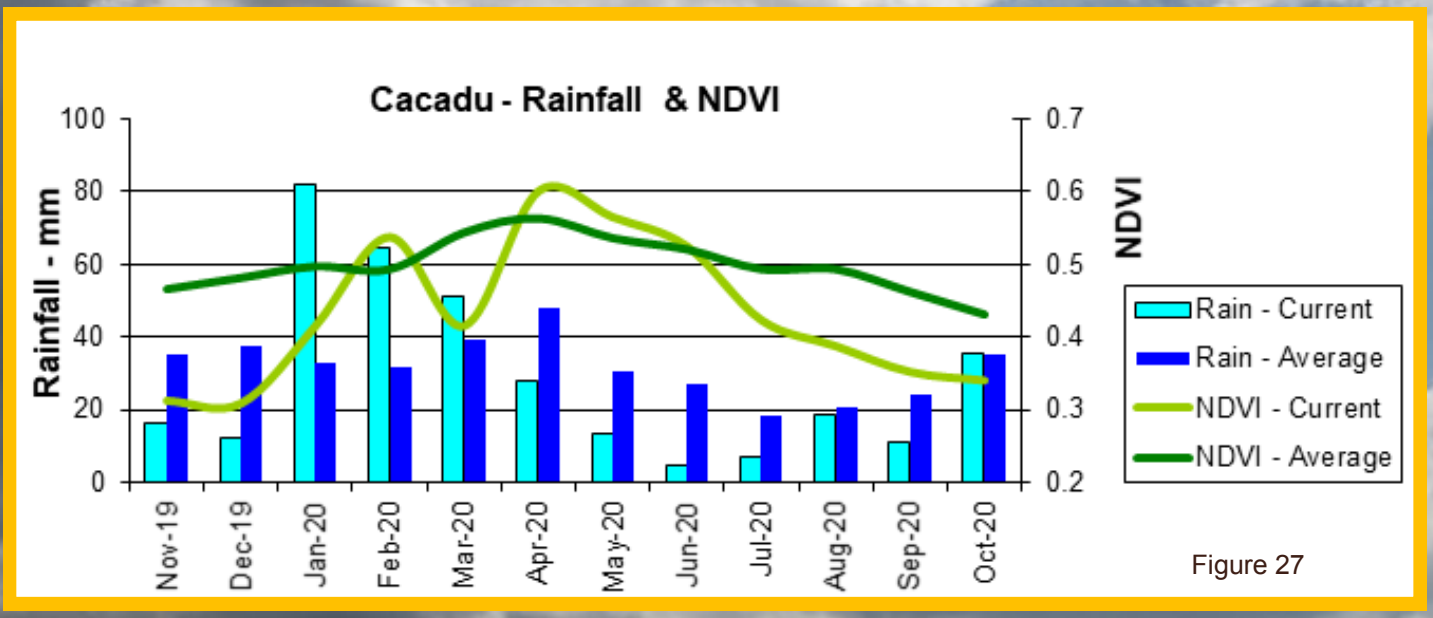

Figure 27

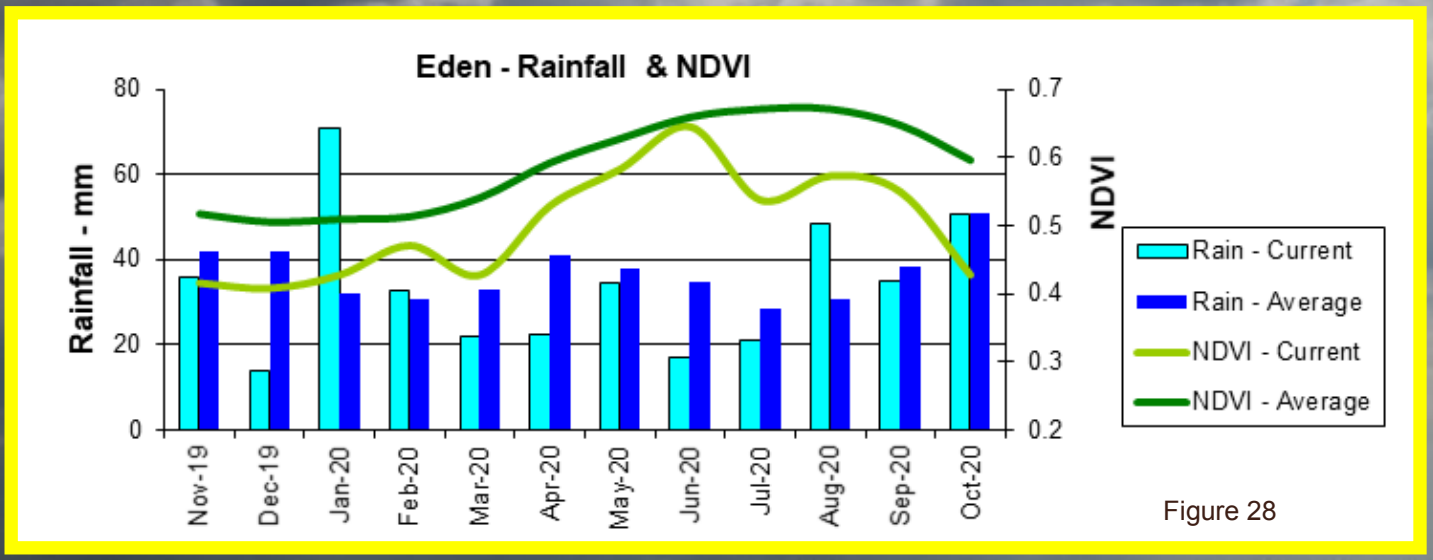

Figure 28

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 2020 per province. Fire activity was lower in all provinces compared to the long-term average.

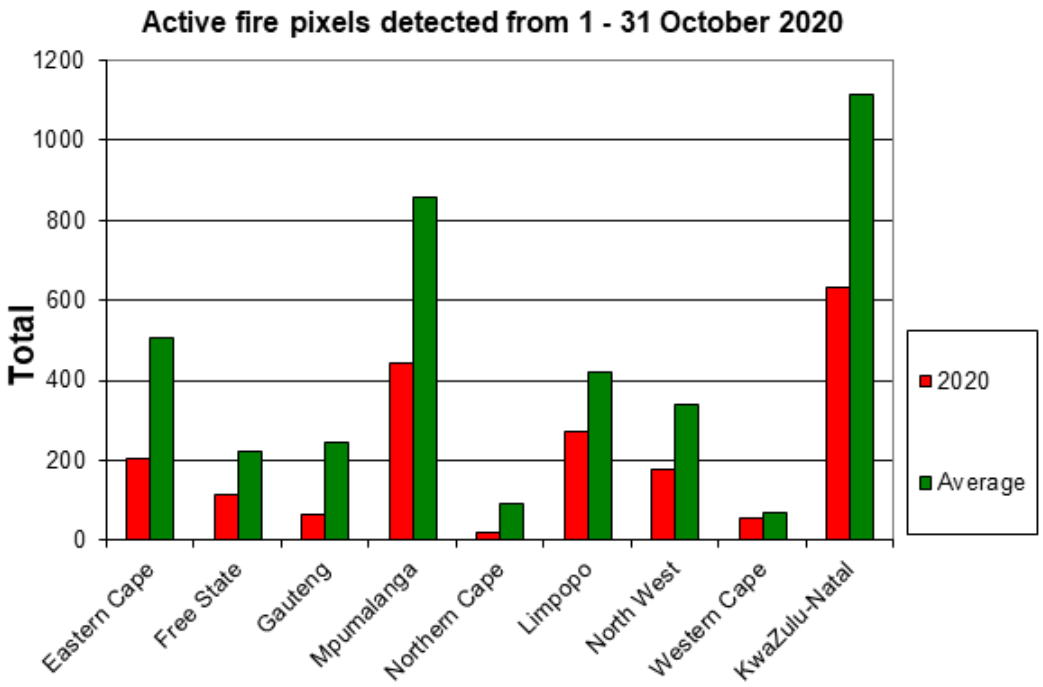

Figure 29

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

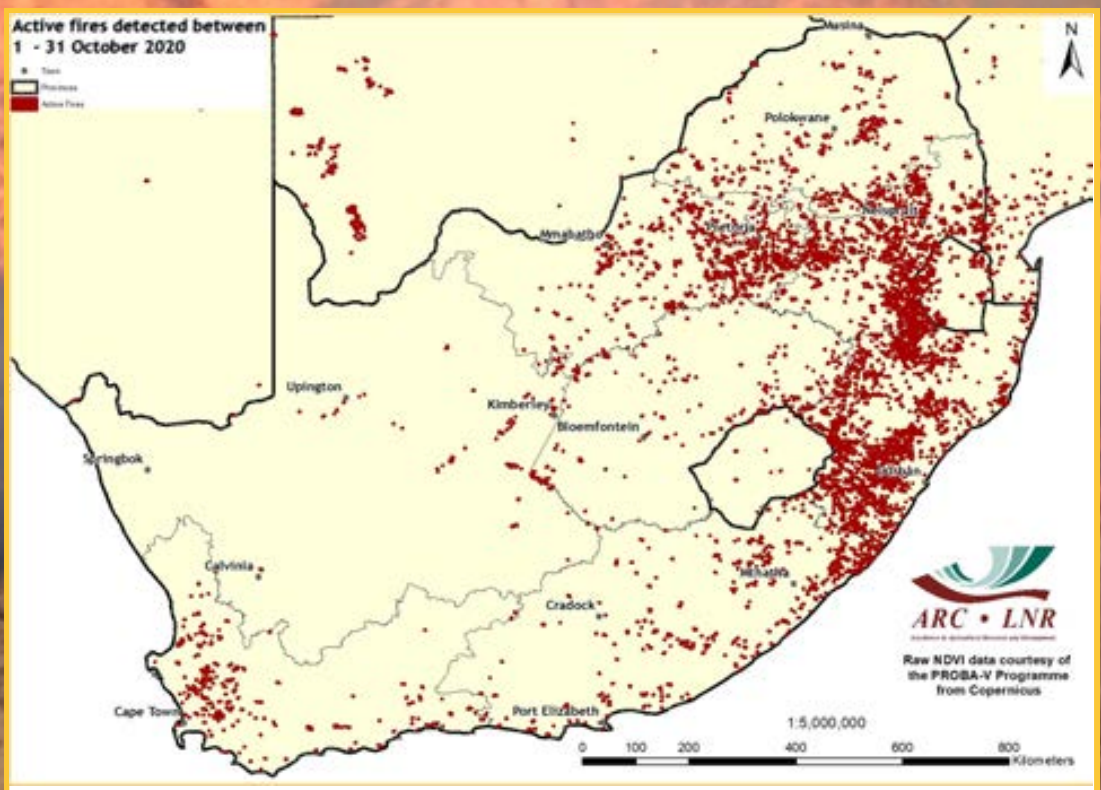

Figure 30

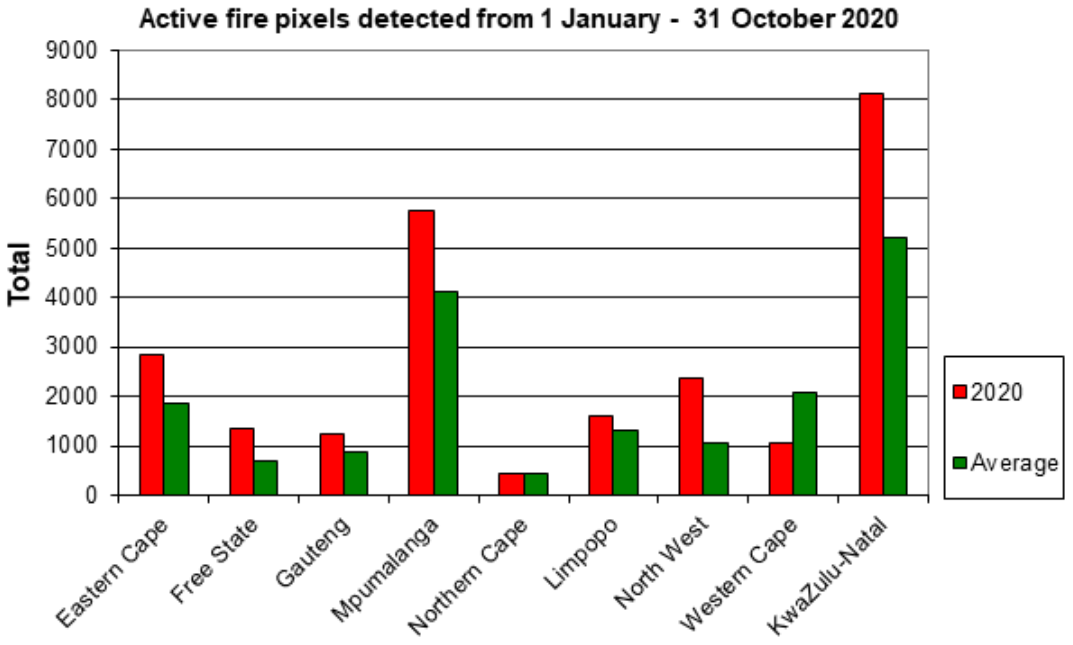

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January - 31 October 2020 per province. Cumulative fire activity was higher in all provinces except the Northern and Western Cape compared to the long-term average.

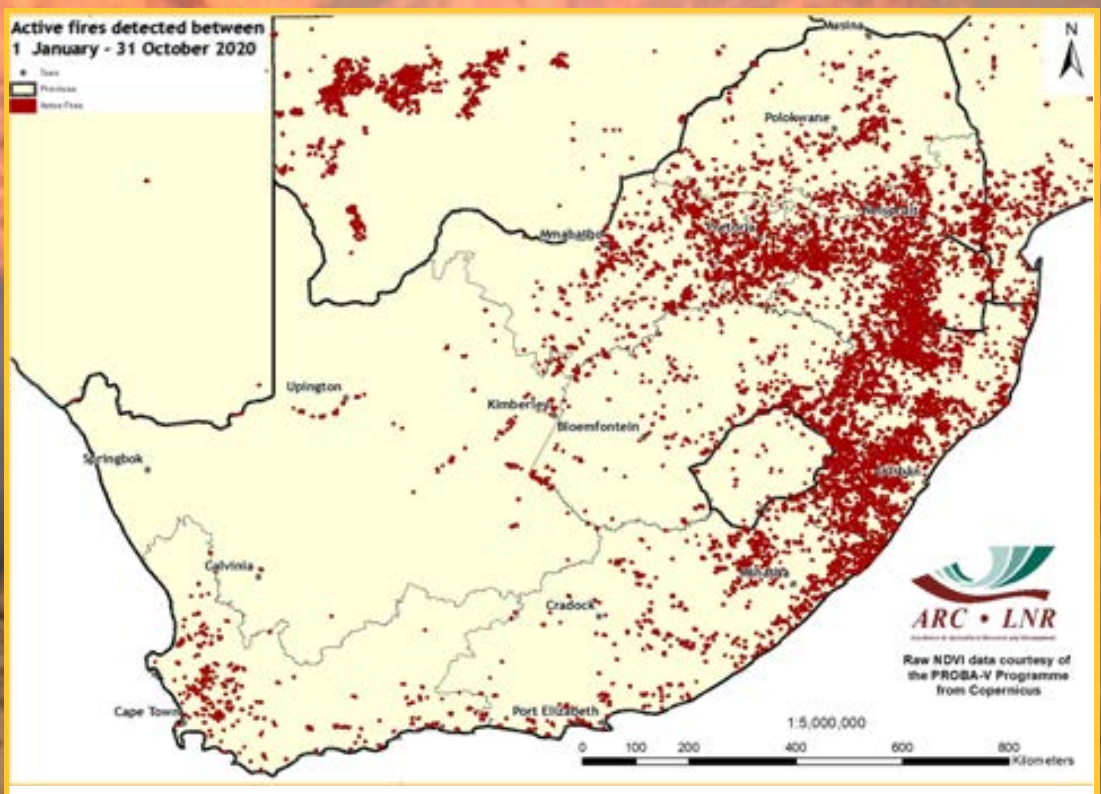

Figure 32

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

Questions/Comments:
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8. Surface Water Resources

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

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

The long-term map for October 2020 shows a continuation of the September pattern and conditions, with the majority of catchments across the entire country now showing water levels equivalent to 60-80% of the 4-year, long-term maximum water, especially in the Western Cape, central Vaal catchments and Maputaland.

The comparison between October 2020 and October 2019 indicates the same pattern as that reported last month, with significantly higher water levels in the Karoo and Overberg regions, as well as some boundary catchments in Limpopo, but otherwise generally the same or slightly lower water levels in all other areas compared to 2019. However, a few small catchments scattered across the Western and Eastern Cape, and now northern Maputaland, continue to show significantly lower water levels.

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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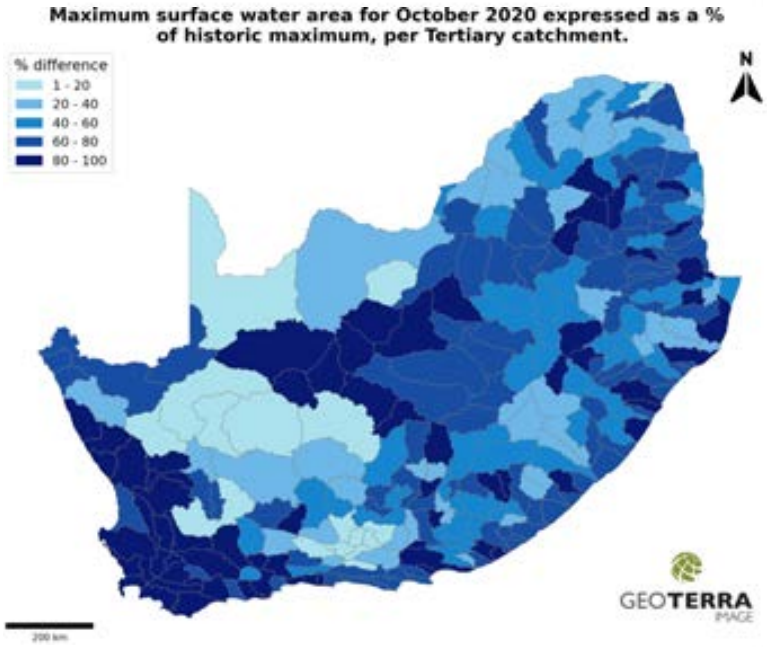

Figure 33

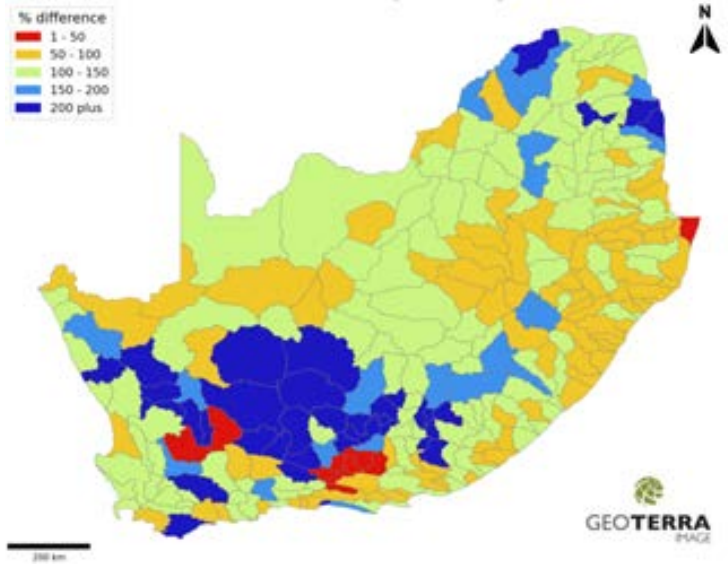

Figure 34

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".