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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

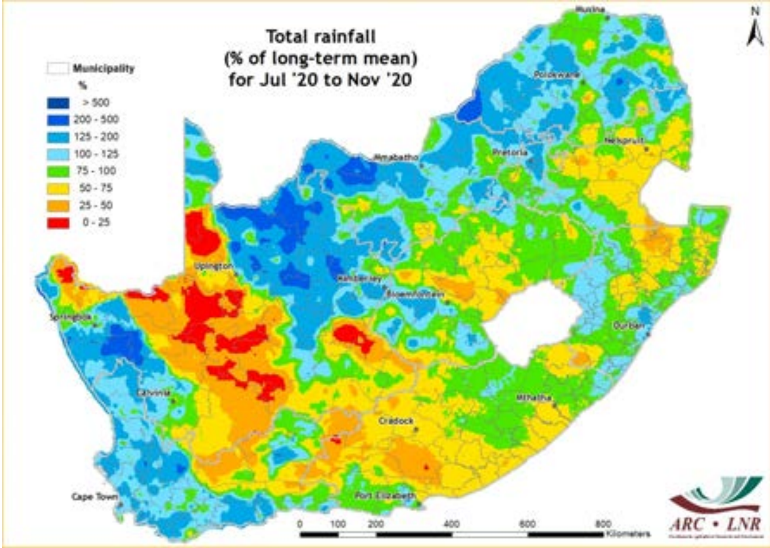
AMESD

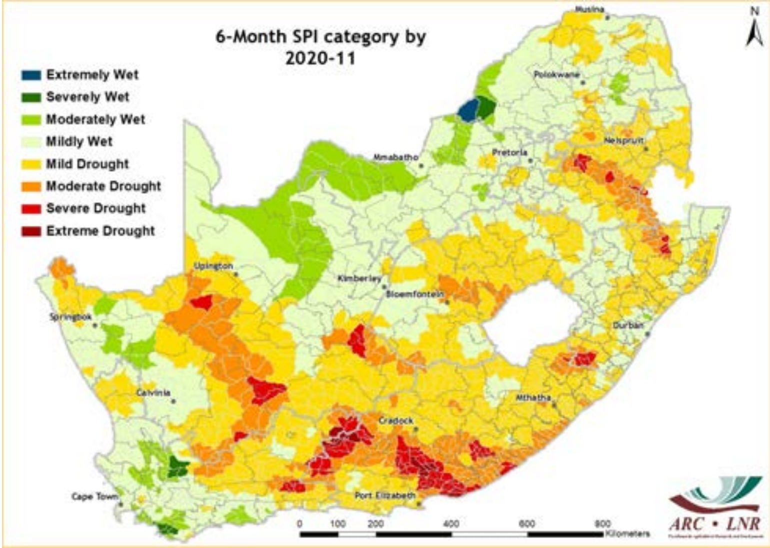
198th Edition

Images of the Month

Rainfall conditions since the beginning of the 2020/21 agricultural season

The total rainfall map for July to November 2020 shows that several rainfall events have resulted in near-normal (given by the green colour) to above-normal rainfall (blue colours) over the summer rainfall region. According to the 6-month Standardized Precipitation Index (SPI) map ending in November, mild to moderately wet conditions were confined to the northern provinces and adjacent interior, KwaZulu-Natal, as well as the winter rainfall region. Severe drought conditions are still visible over parts of the Karoo, the Eastern Cape, KZN and Mpumalanga. Moreover, little rain has occurred over large parts of the eastern maize production area which is currently experiencing mild drought conditions. However, it is important to note that those regions receive most of their rain only by December and January. Therefore, a successful drought recovery would suggest a period characterized by above-normal rainfall to restore ample soil water. Farmers should continue with production practices that can mitigate the effects of agrometeorological risks during this summer rainfall season. These include switching to crop varieties that are more tolerant to drought, considering various cropping strategies based on local soil moisture content and practising rotational grazing.





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:

A notable increase in total rainfall was observed in November 2020 compared to the previous month, as is typical of early summer. The month was characterized by above-normal rainfall over the summer rainfall region, viz. the northern provinces, moving south into the central interior as well as the eastern half of the Eastern Cape and KwaZulu-Natal. This rainfall was often associated with severe storms, accompanied by strong damaging winds and large hail, frequently over North West, Gauteng, Limpopo and the Eastern Cape. These conditions often resulted in flash floods, as large amounts of rain falling within a short time. Much of the winter rainfall region received above-normal rainfall during November, whilst the all-year rainfall region received mostly near-normal rainfall.

The month began with a series of storms over the summer rainfall region. Significant rainfall totals (>80 mm) were recorded in Frankfort (Free State) and Mbazwana (KZN) during the first two days. By the 7th, dry air invaded most of the interior whilst upper-air conditions became fairly unfavourable. However, scattered to widespread thundershowers reoccurred over the central to eastern interior, moving southeastwards by the 9th. Parts of the drought stricken Northern Cape remained exceptionally dry, particularly the Namakwa District and much of the Karoo. Areas that received good rainfall in November include Kathu, Kuruman, Prieska, Kimberley and the surrounding areas, recording totals up to 75 mm. Rainfall conditions persisted towards the end of the month, with much activity occurring over Limpopo, Mpumalanga, North West, Gauteng, the Free State, Eastern Cape and KZN.

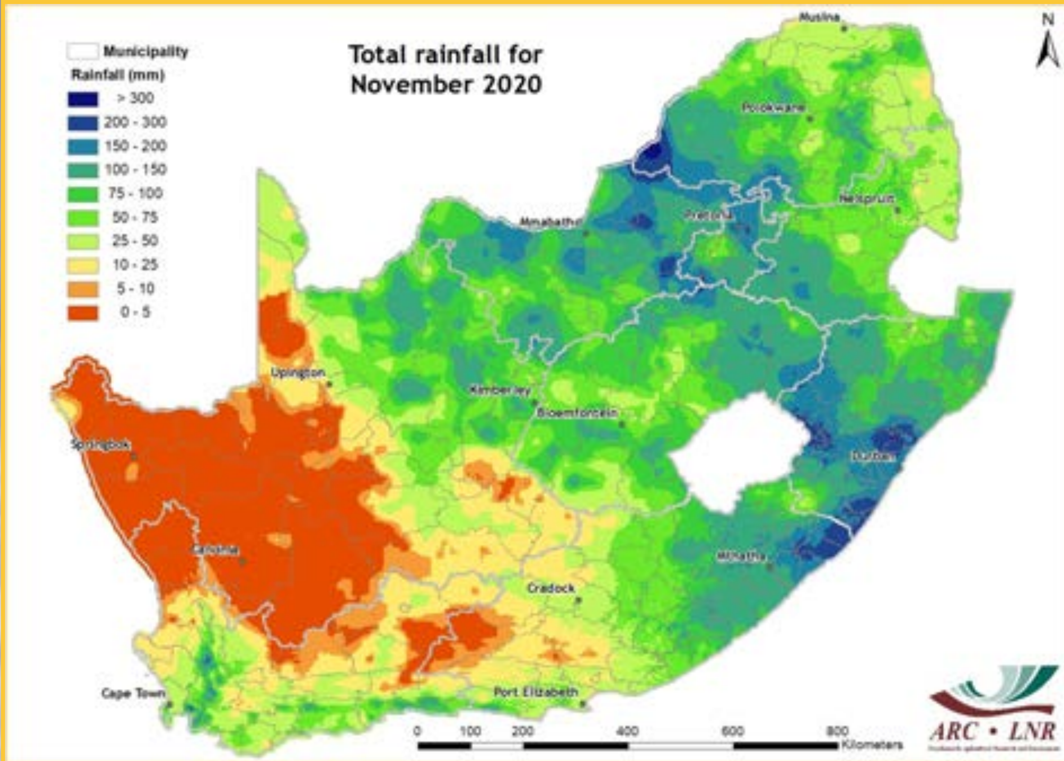


Figure 1

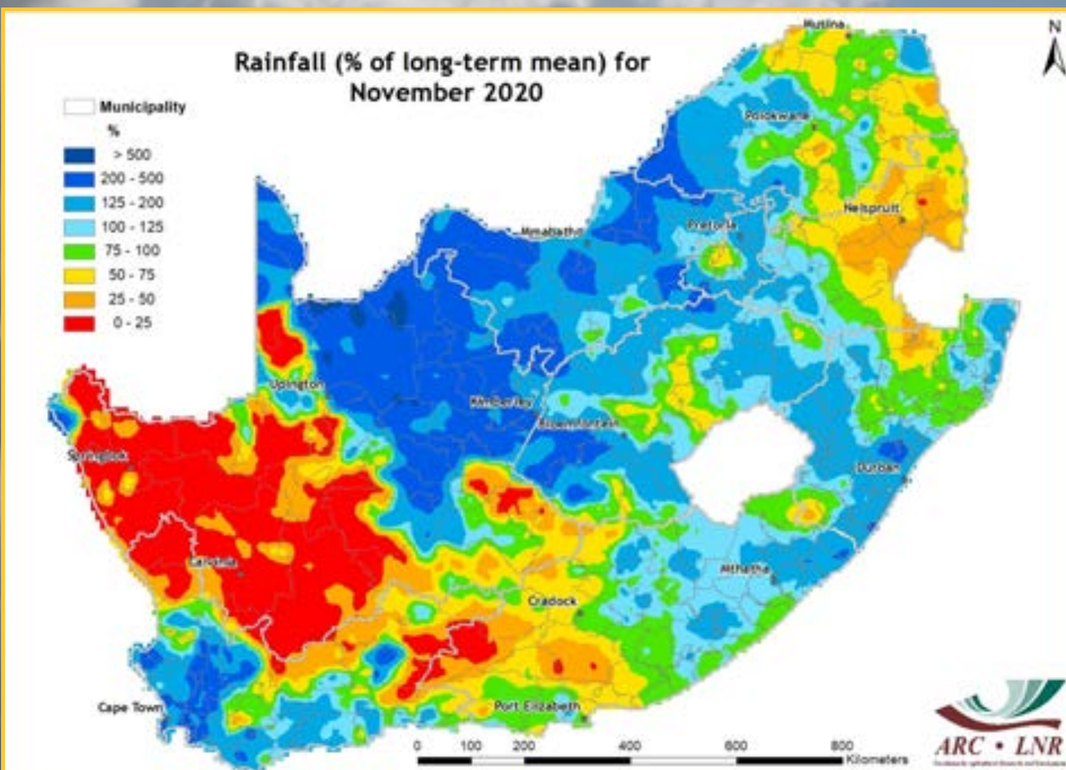


Figure 2

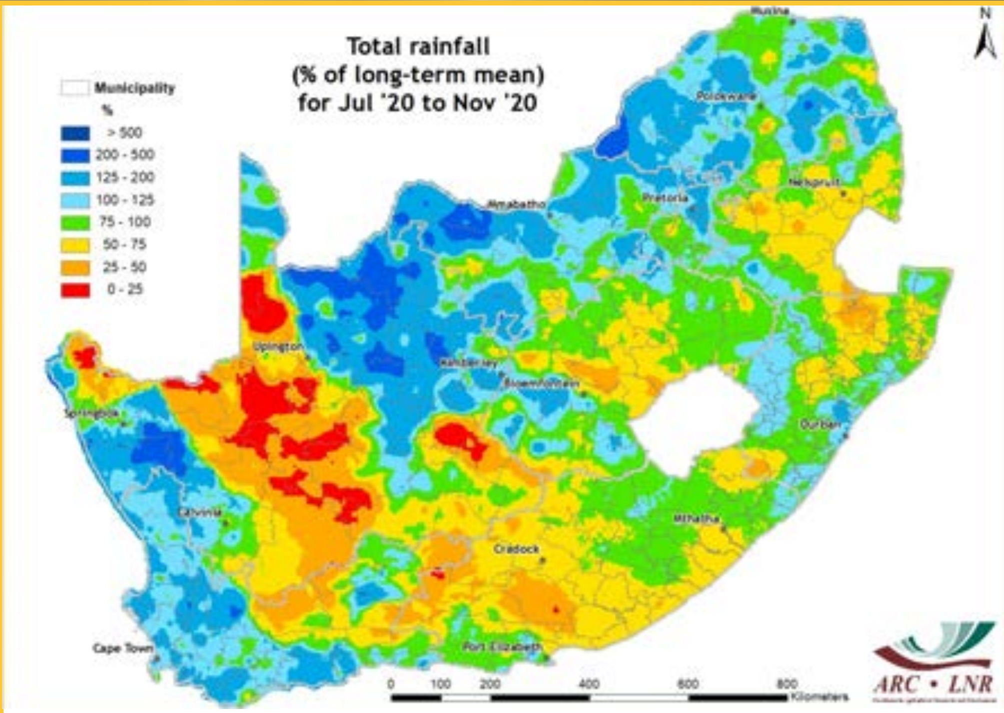


Figure 3

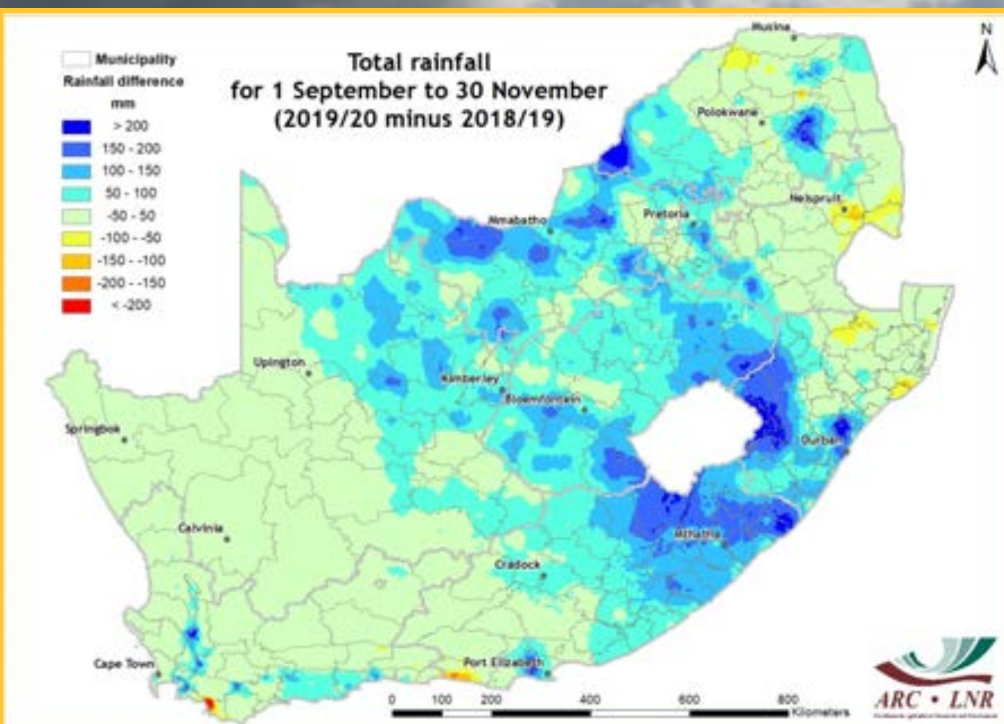


Figure 4

Figure 1:
Significant rainfall totals were recorded over the summer rainfall region during November 2020, with the highest falls (>150 mm) in North West, Gauteng, the Free State, southwestern parts of Limpopo, KwaZulu-Natal and the Eastern Cape. The western region of the Northern Cape as well as the Karoo remained dry.

Figure 2:
Above-normal rainfall occurred over the eastern interior, moving southeast towards the Midlands and coastal regions of KwaZulu-Natal and the Eastern Cape. Similar conditions were also observed over much of the Western Cape. However, below-normal rainfall occurred over the Namakwa District of Northern Cape, western parts of Eastern Cape, the Mpumalanga Lowveld and isolated parts of Limpopo, Gauteng, central Free State and northern KwaZulu-Natal.

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

Figure 4:
Isolated areas in the Western Cape, the eastern interior, including parts of the Escarpment and the subtropical coast received significantly more rain during September to November 2020 as compared to the same period last year. The rest of the country received somewhat similar amounts of rainfall during this period, with isolated negative values noted in the Lowveld, northern KZN, Tsitsikamma National Park and areas in and around Stanford in the Overberg District Municipality of the Western Cape.

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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. Given the short-term SPI for the month of November 2020, high rainfall totals resulted in wet conditions over the winter rainfall region as well as the northern provinces, viz. North West, parts of the Northern Cape and Limpopo. Similar although milder conditions were observed in isolated regions of the Free State, Eastern Cape, KwaZulu-Natal and Mpumalanga. The 12-month SPI shows mild severely wet conditions over the interior and parts of the Western Cape, while the prevalence of mild drought was visible over the rest of the country. The long-term SPI maps reveal that the Cape provinces, eastern Free State, parts of KZN, Limpopo and Mpumalanga are still under severe to extreme drought.

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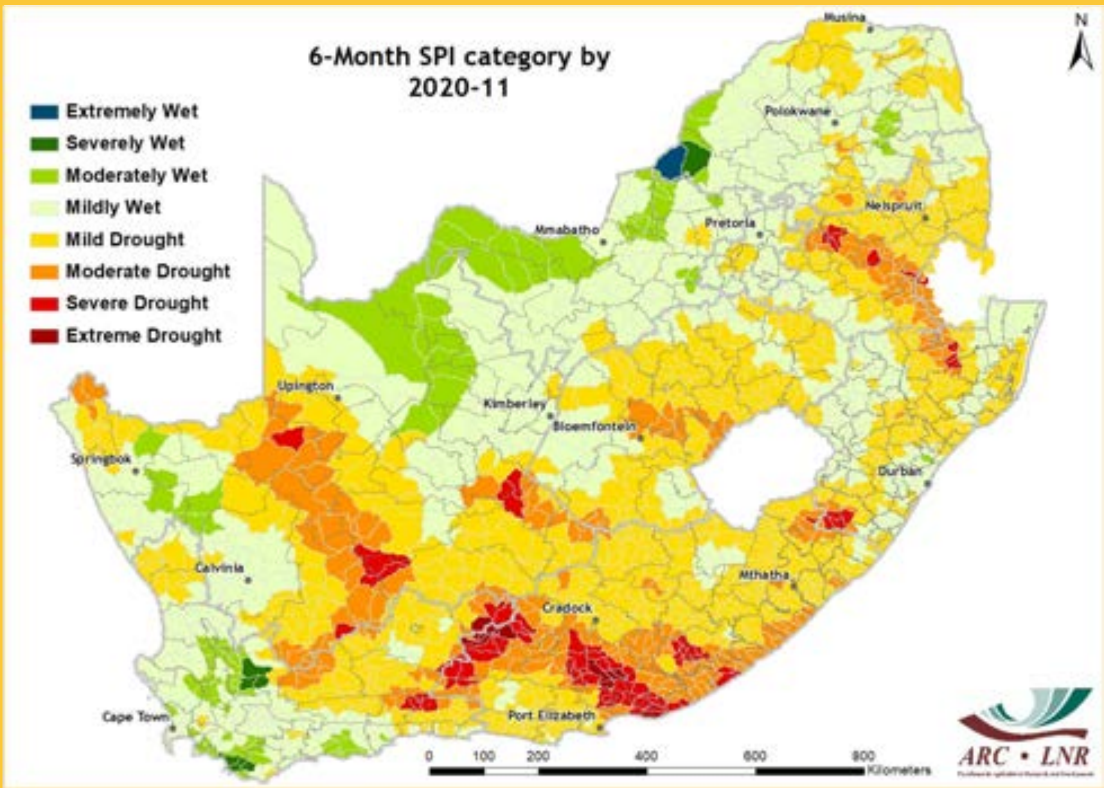
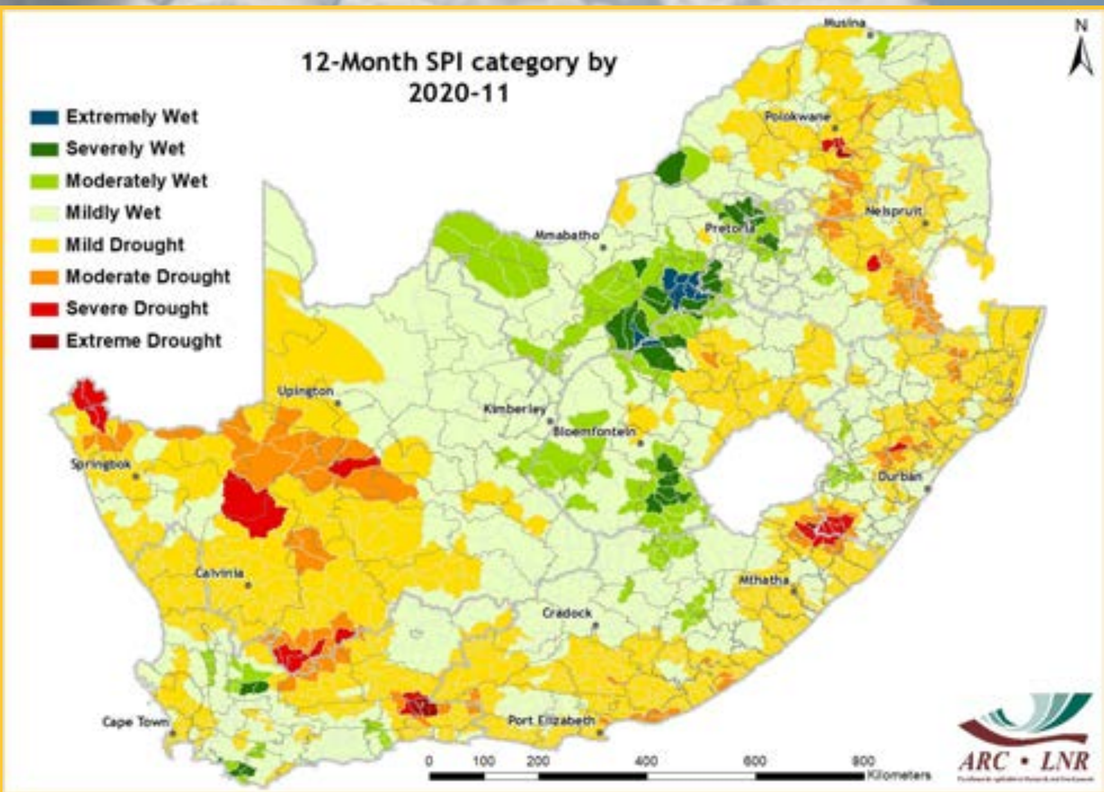


Figure 5



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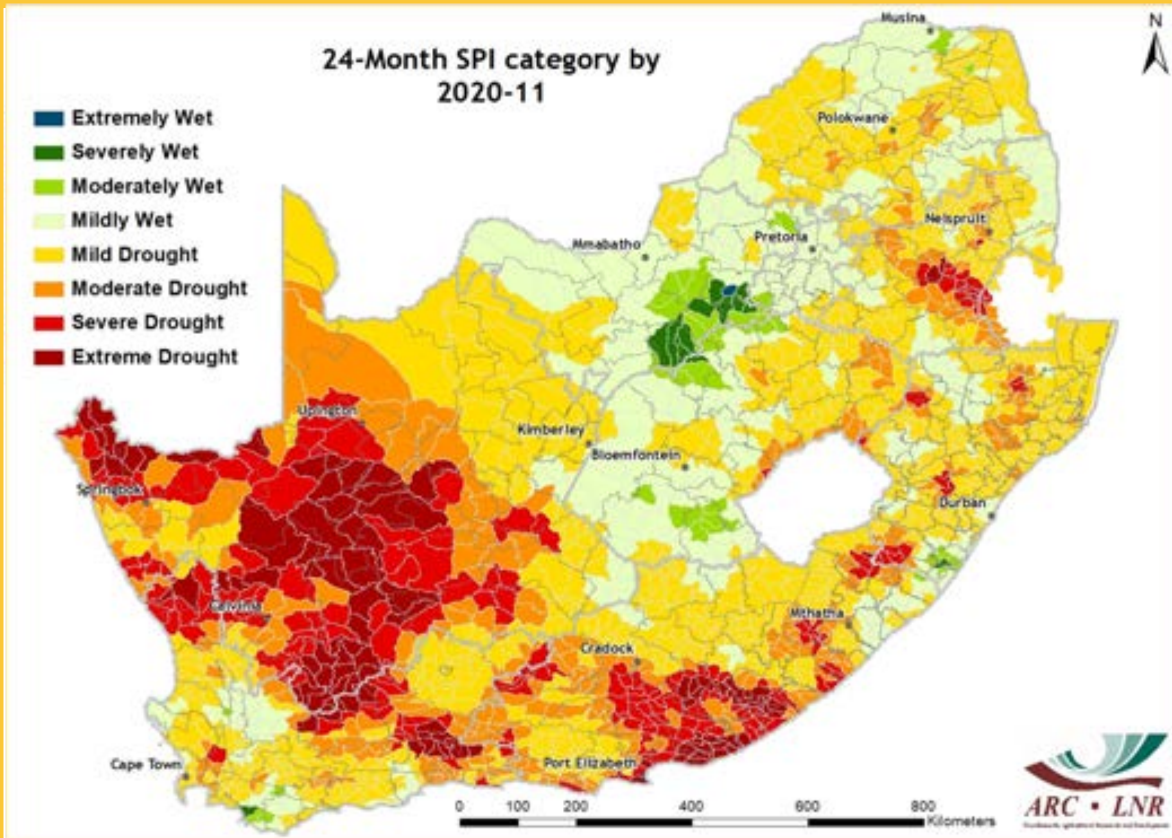

Figure 7

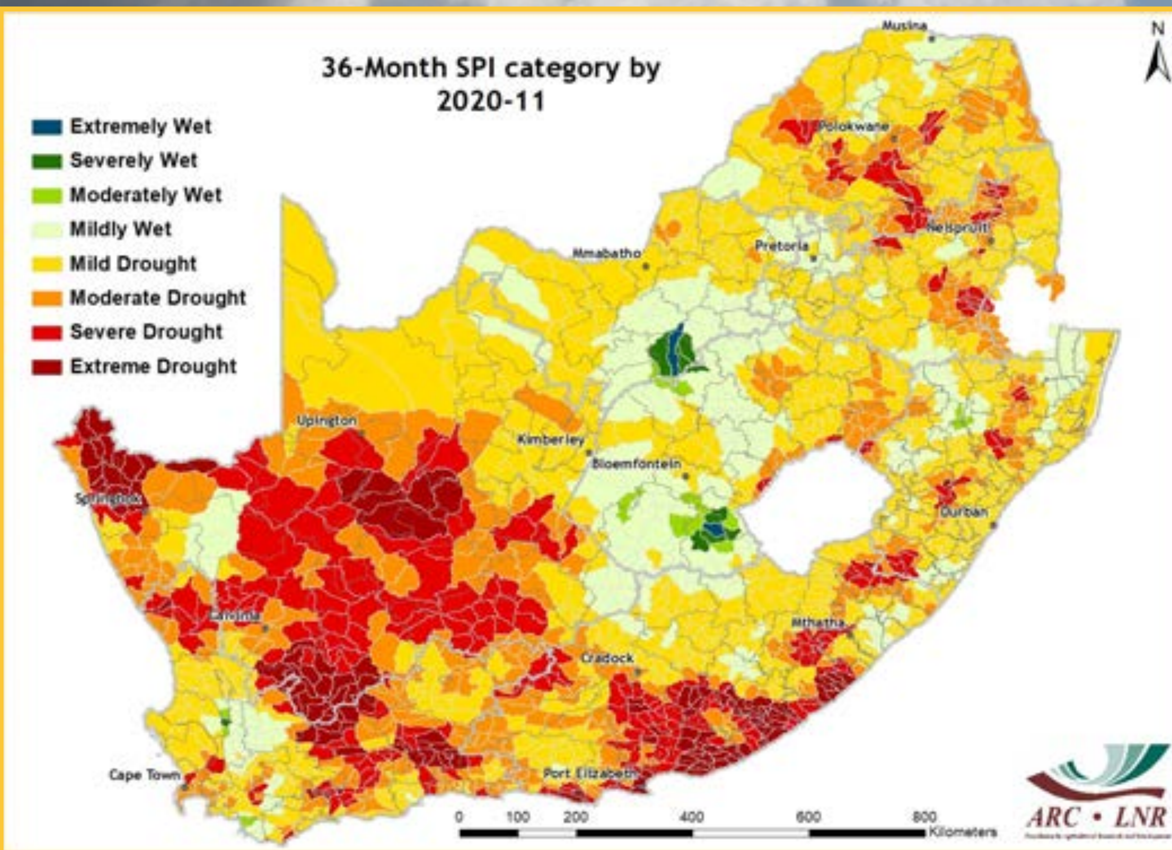

Figure 8

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.

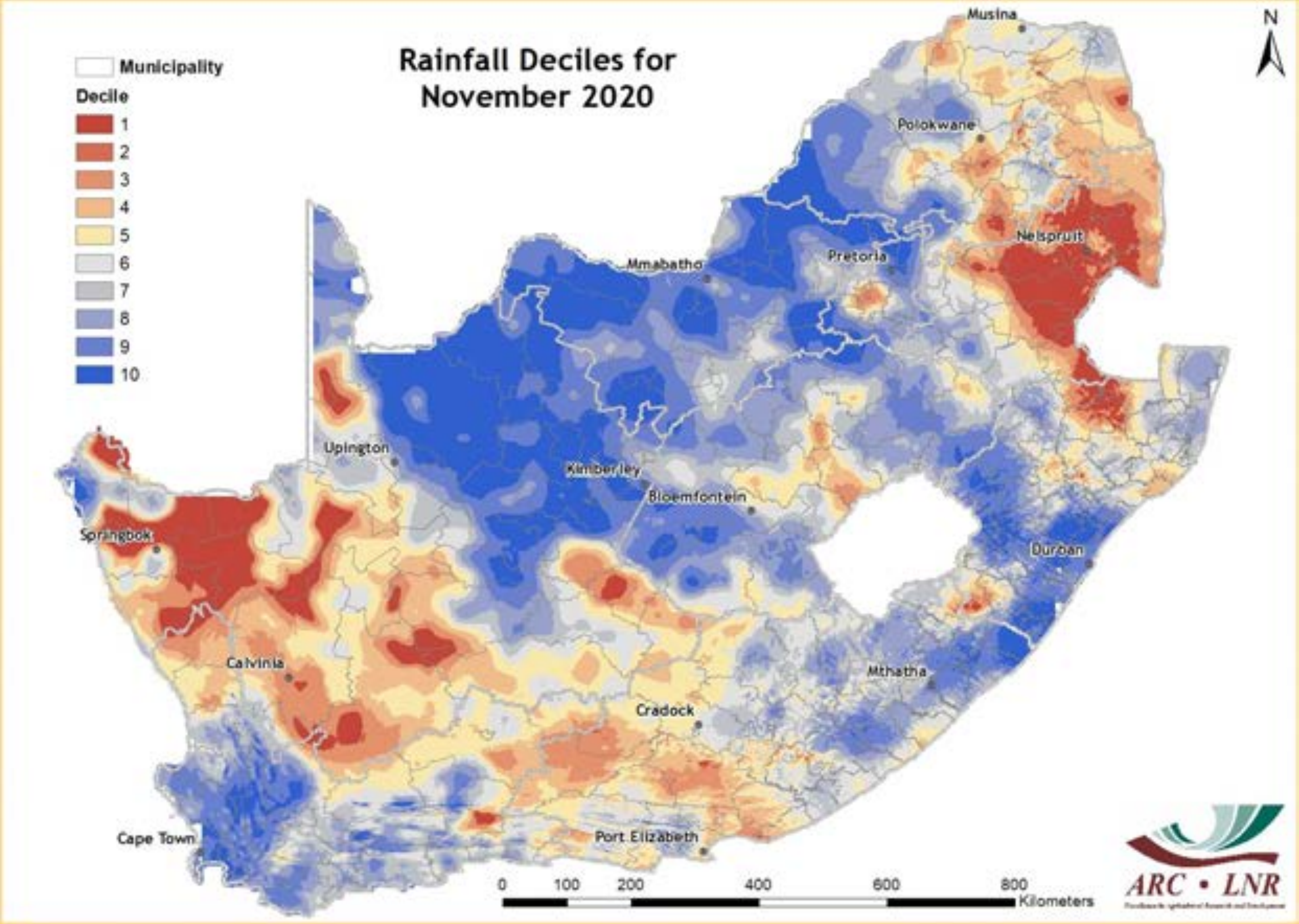

Figure 9

Figure 9:
In November 2020, greater parts of the country compared well with historically wetter November months. The only areas that recorded rainfall totals comparable with drier November months include the Namakwa District of the Northern Cape, western parts of the Eastern Cape, the Mpumalanga Lowveld and isolated parts of Limpopo, Gauteng, central Free State and northern 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.

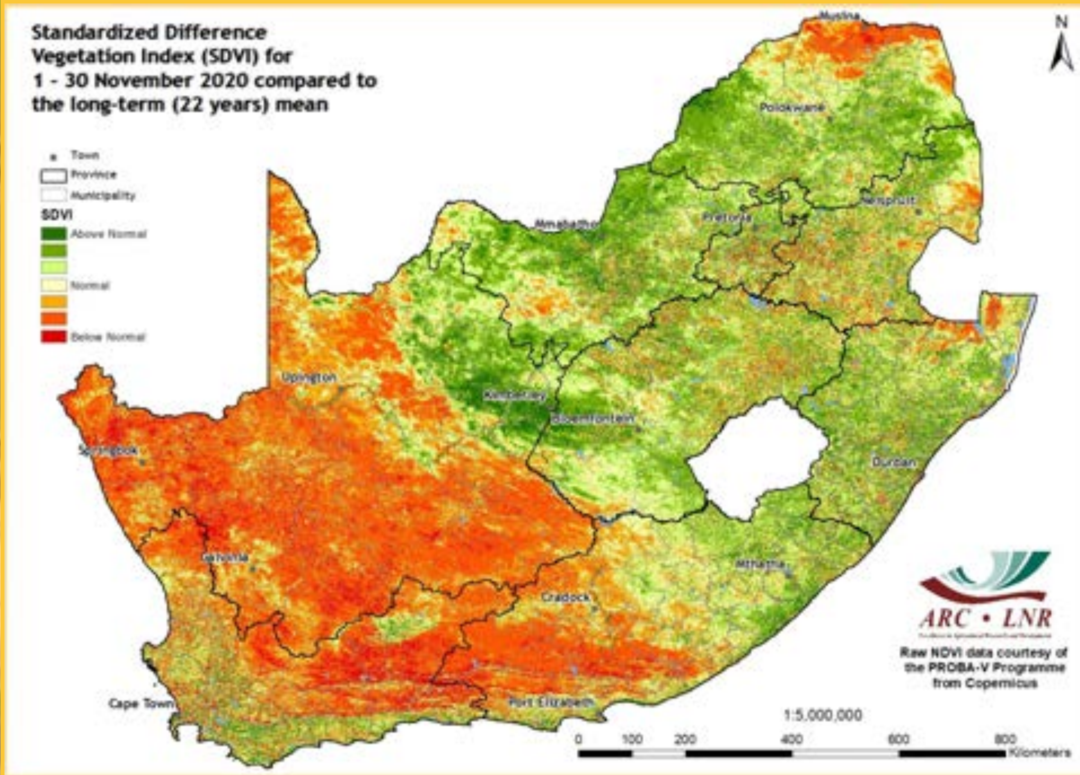

Figure 10

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

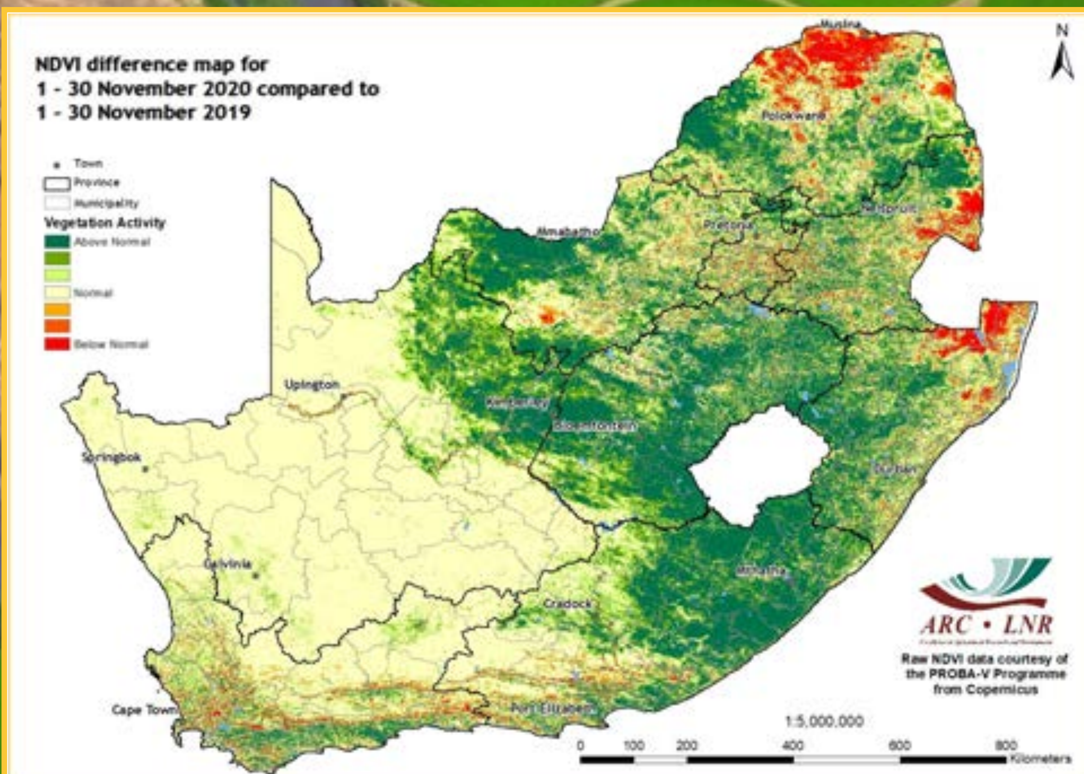

Figure 11

Figure 11:
The NDVI difference map for November 2020 compared to the same month last year shows that normal to above-normal vegetation activity occurred over much of the country, with pockets of below-normal activity over isolated areas in the northern parts.

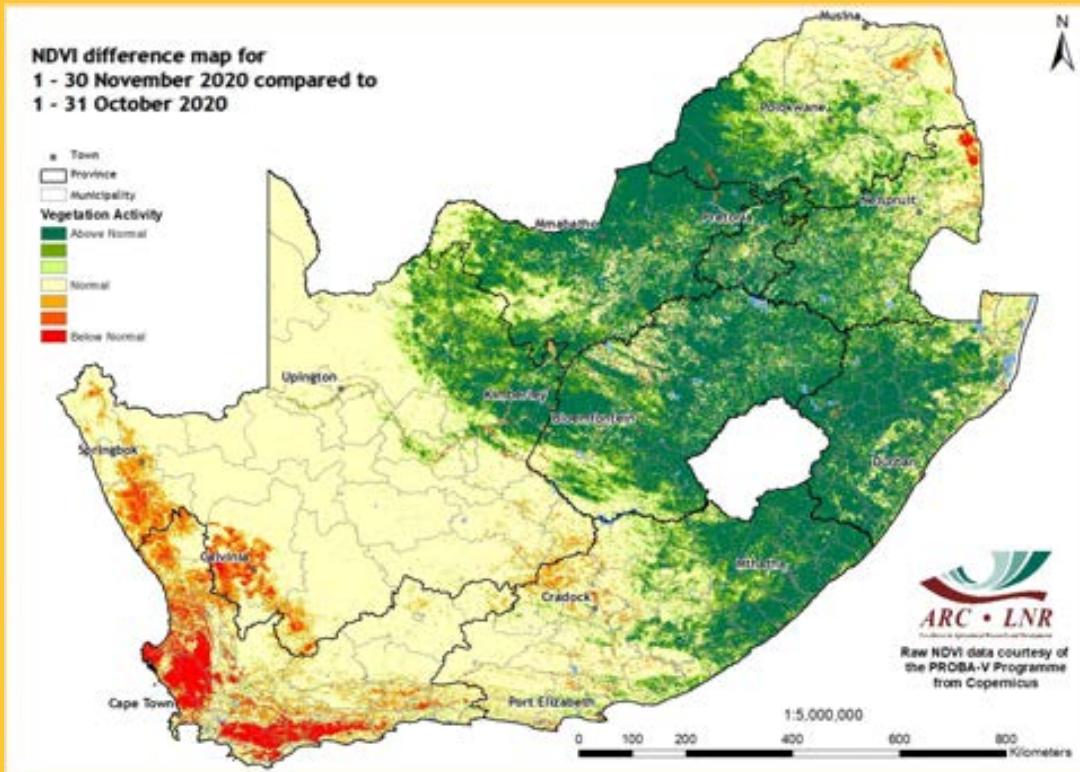

Figure 12

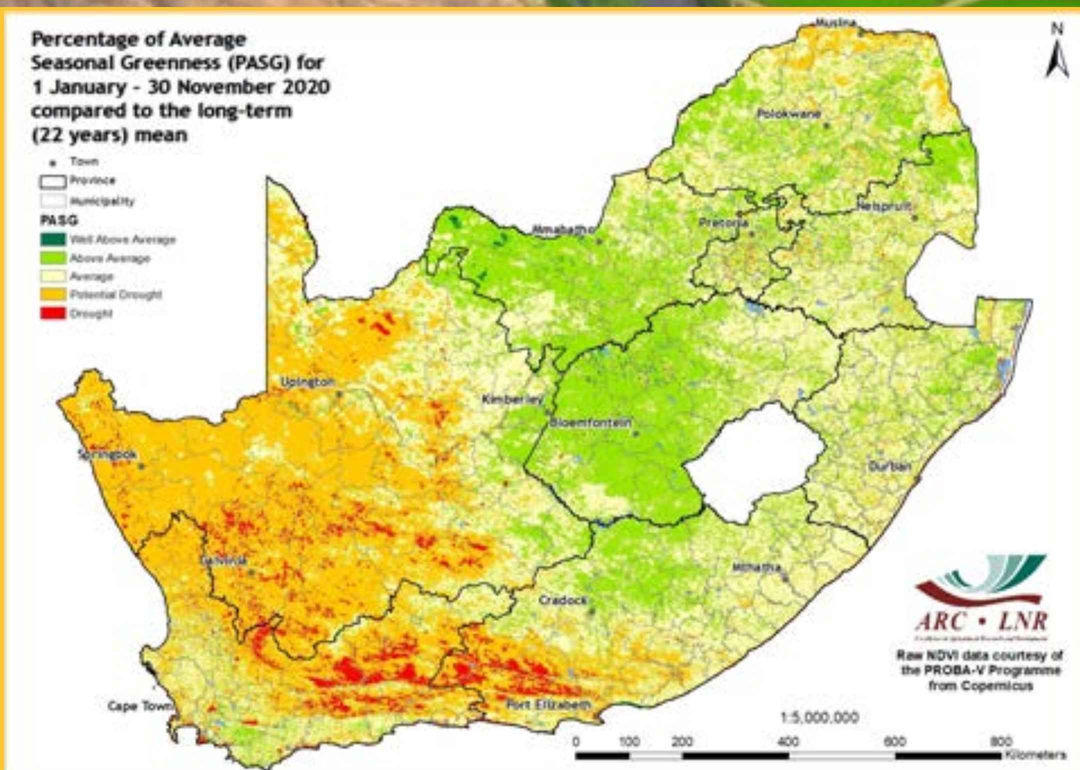

Figure 13

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 November shows that the central interior experienced above-normal vegetation conditions. Nevertheless, the larger part of the Cape region experienced normal vegetation conditions with pockets of below-normal vegetation activity in the far western parts.

Figure 13:
Cumulative vegetation conditions from January to November 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.

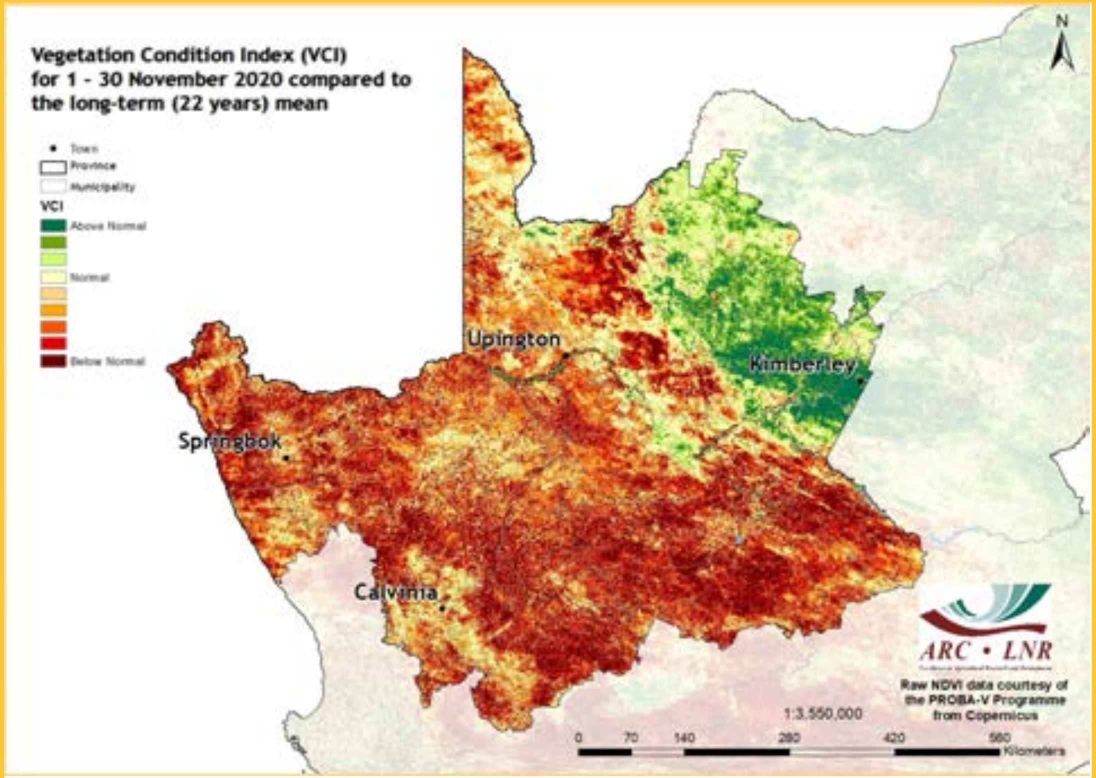


Figure 14

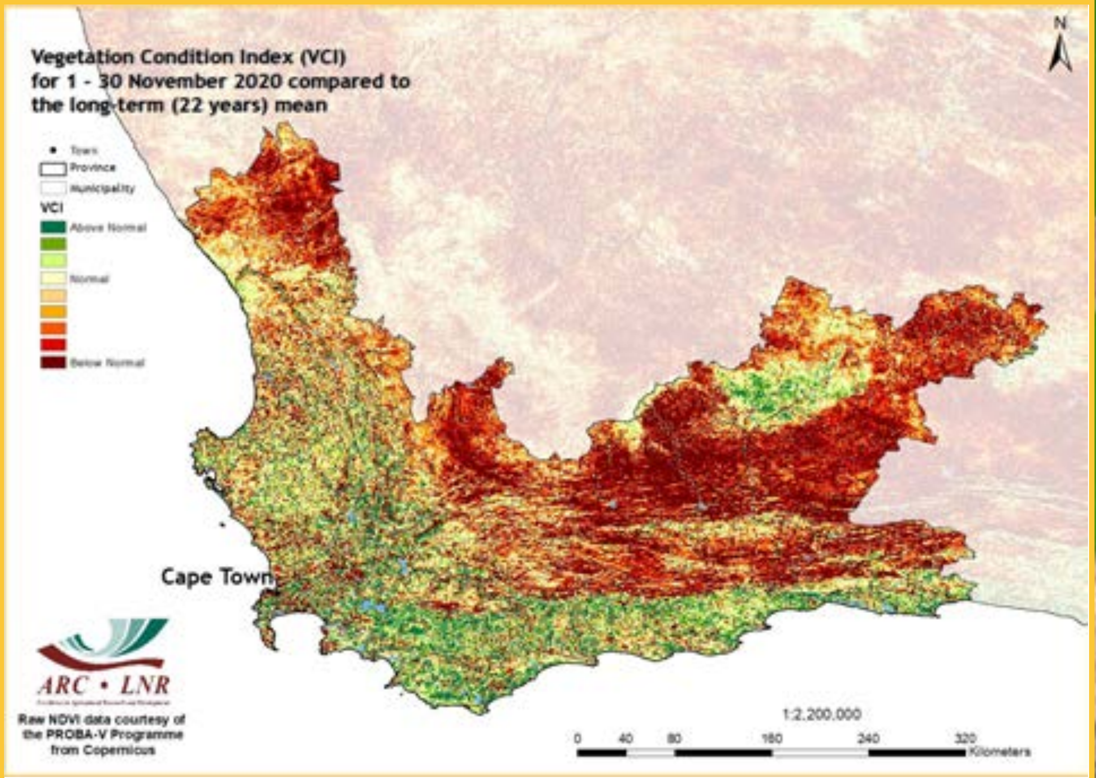
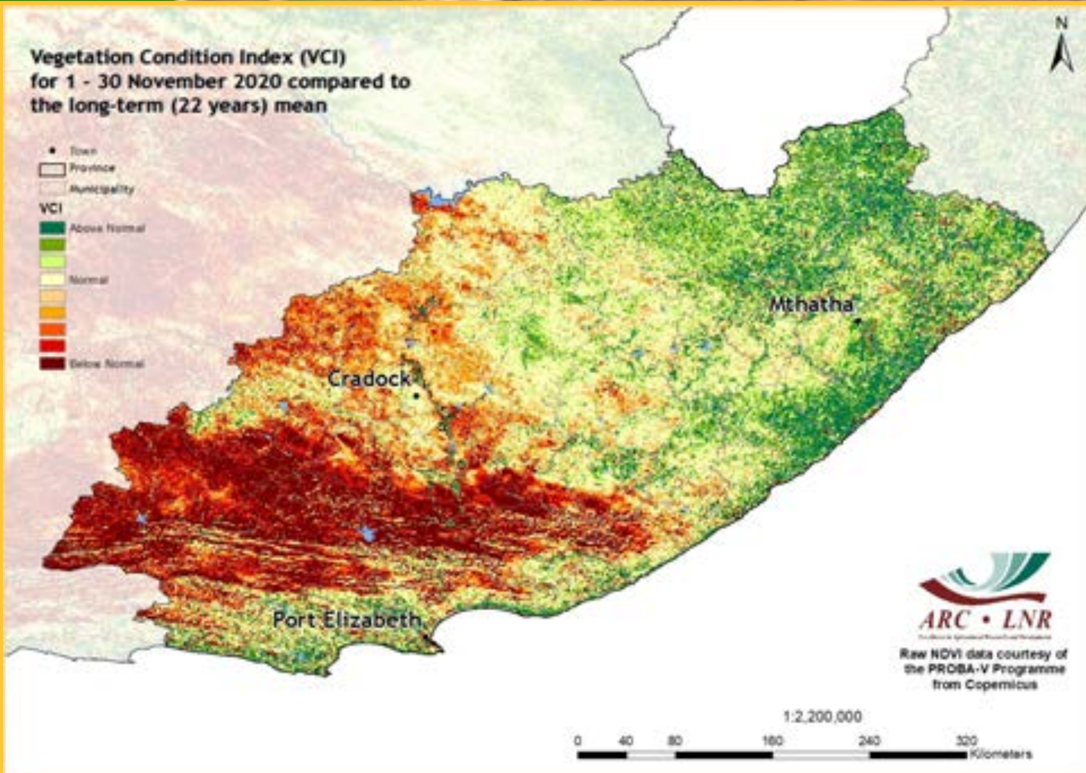


Figure 15

Figure 14:
The VCI map for November indicates that larger parts of the Northern Cape remain severely affected by drought.

Figure 15:
The VCI map for November 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.



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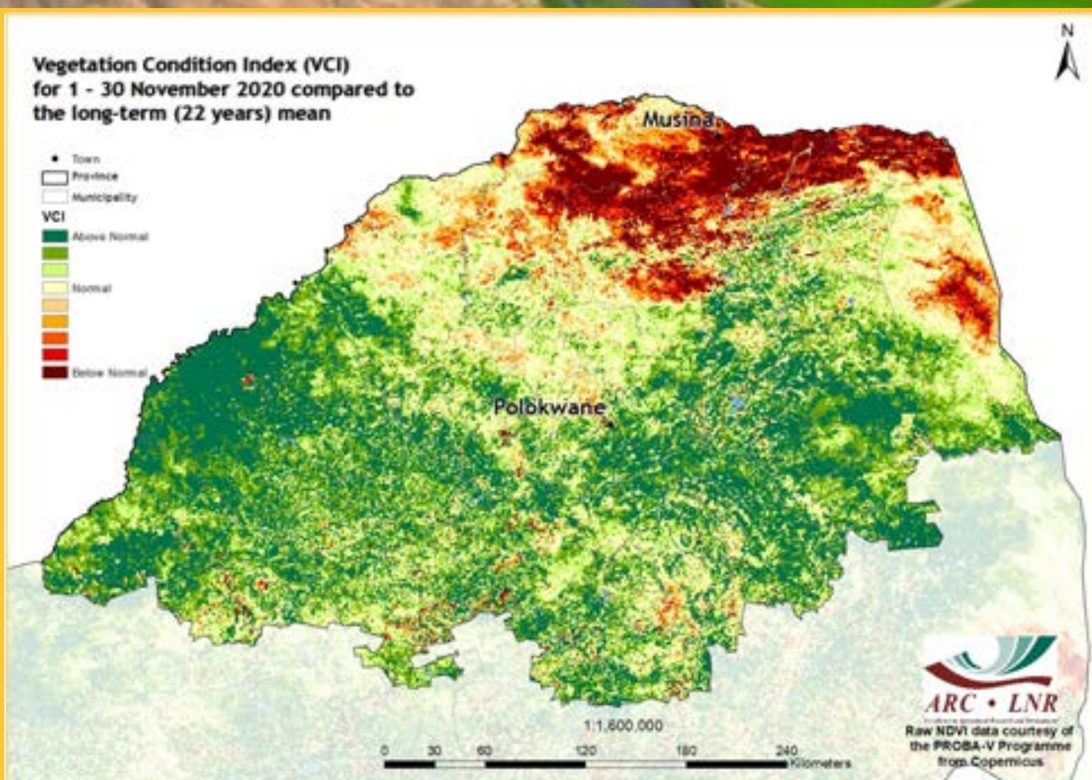

Figure 17

Figure 16:
The VCI map for November indicates that the western half of the Eastern Cape continues to experience poor vegetation conditions.

Figure 17:
The VCI map for November indicates that the far northern parts of Limpopo experienced poor vegetation activity, while the remaining parts of the province experienced above-normal vegetation activity.

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6. Vegetation Conditions & Rainfall

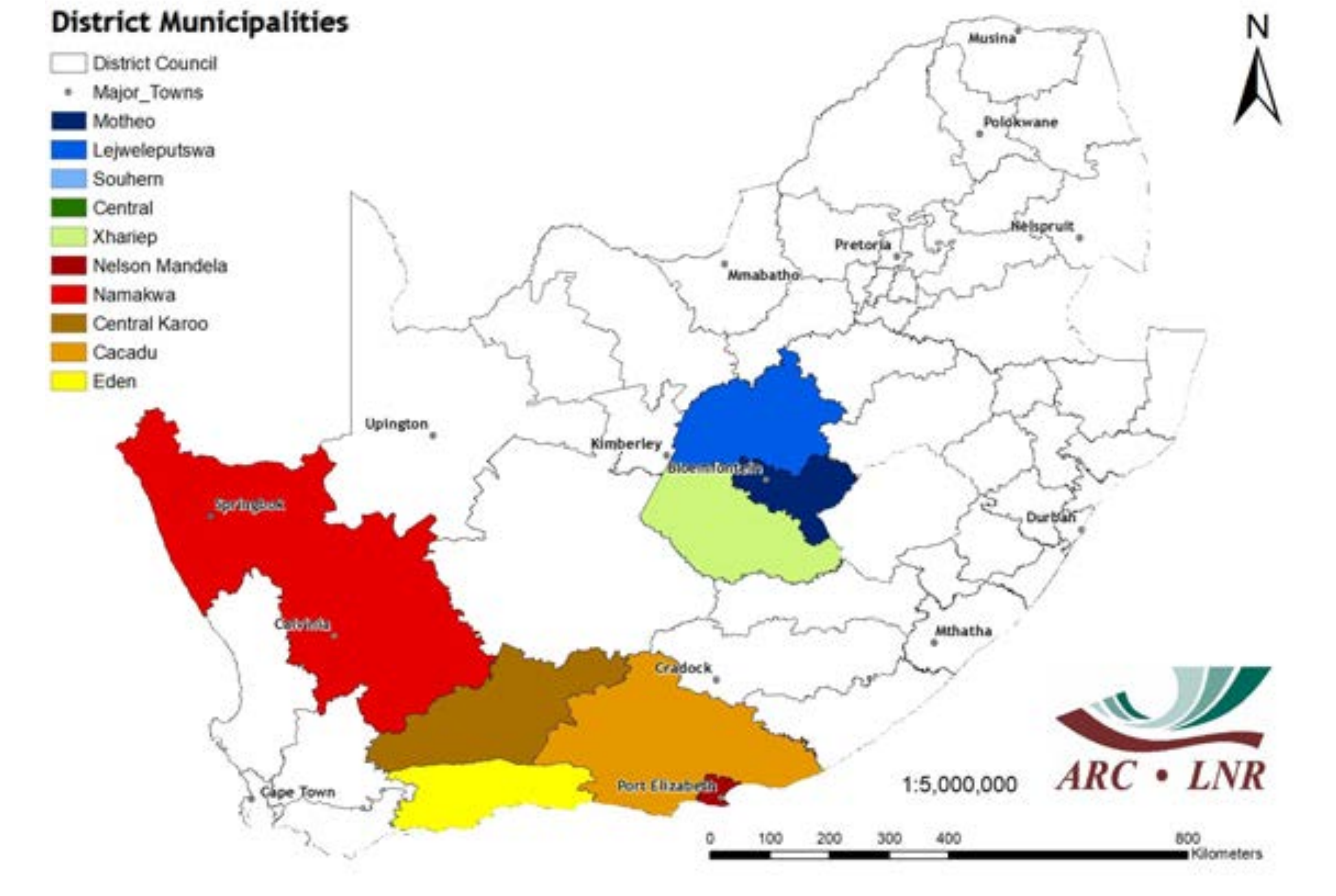

Figure 18

Rainfall and NDVI Graphs

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

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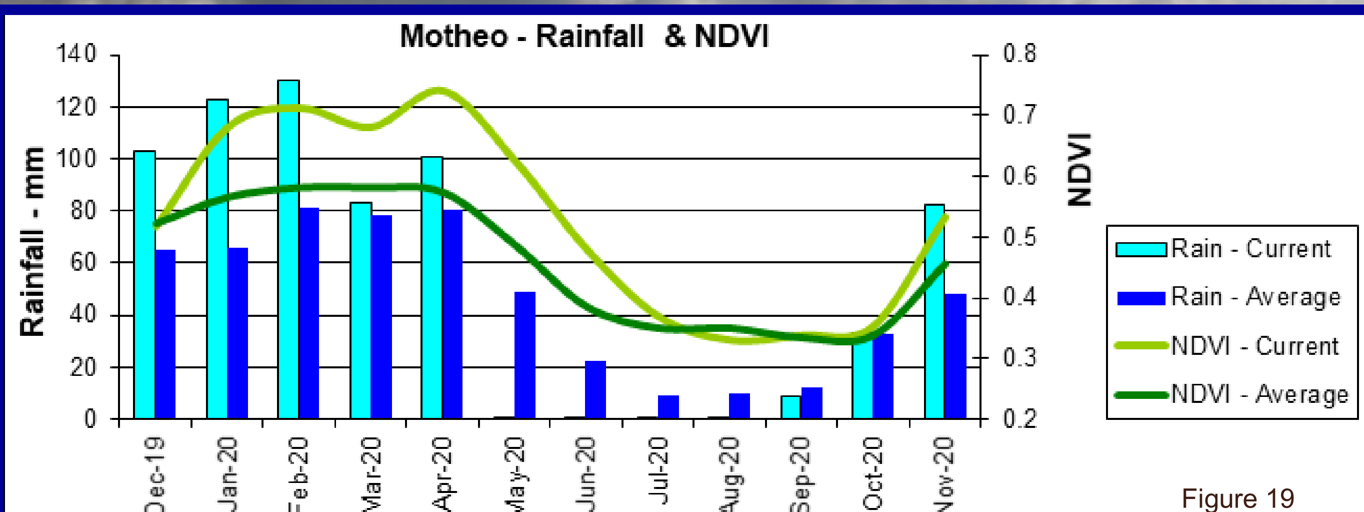
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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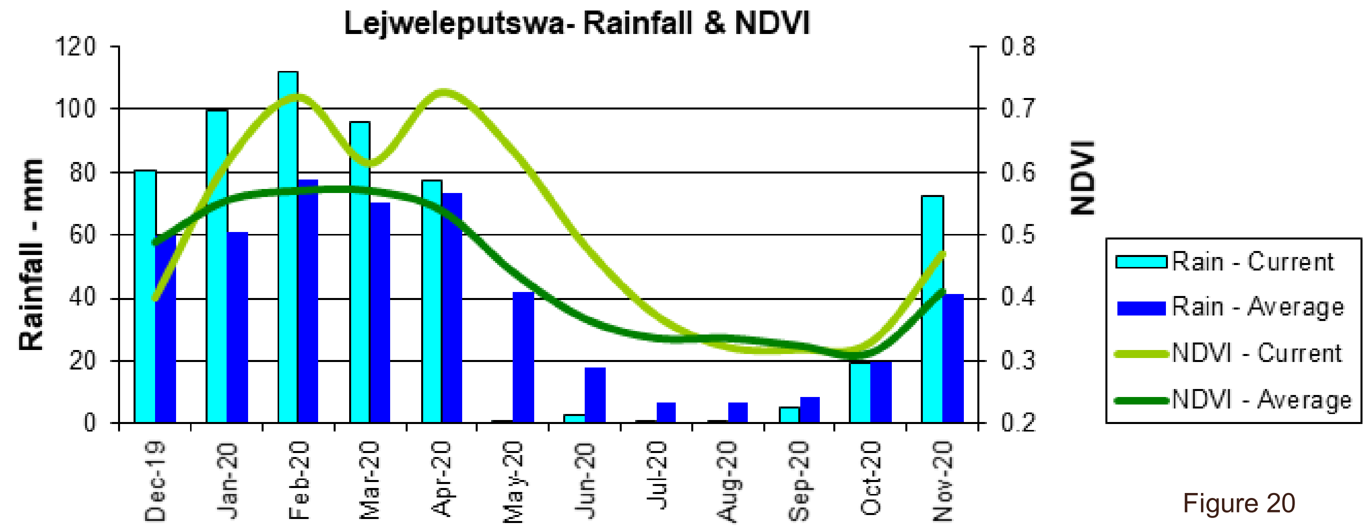

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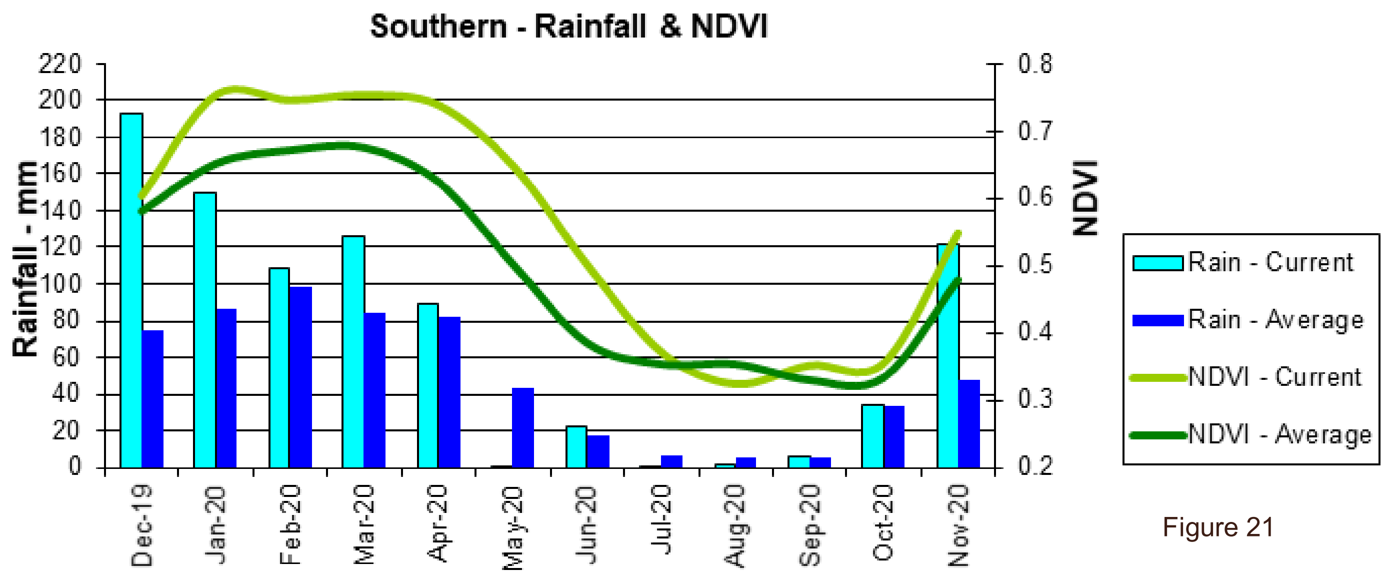

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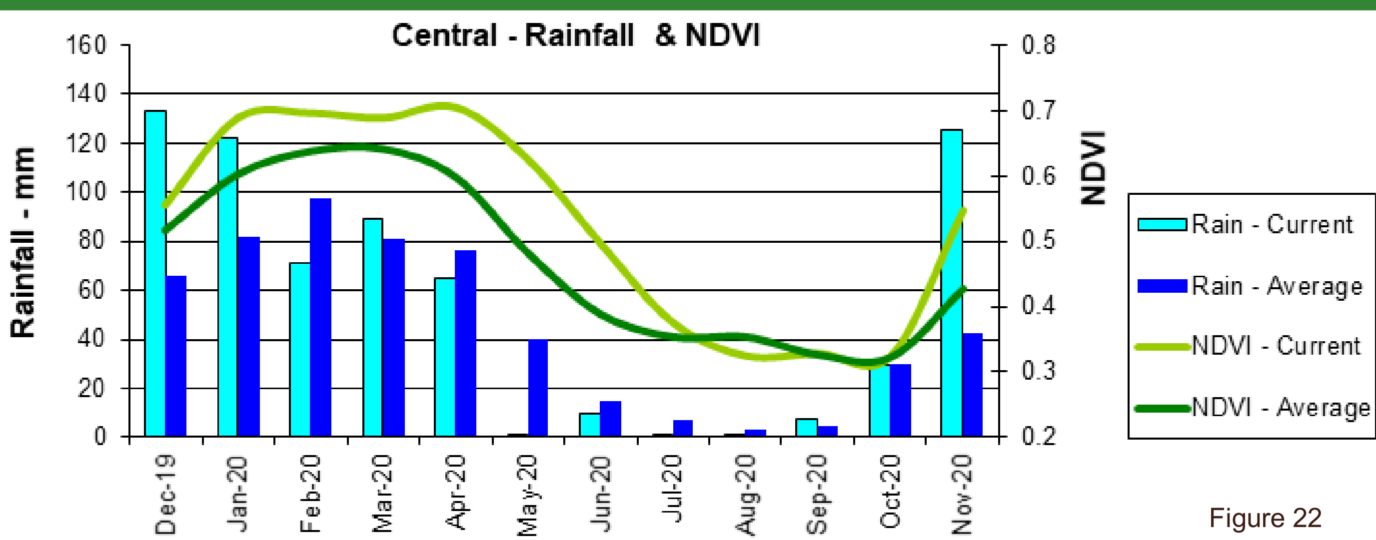

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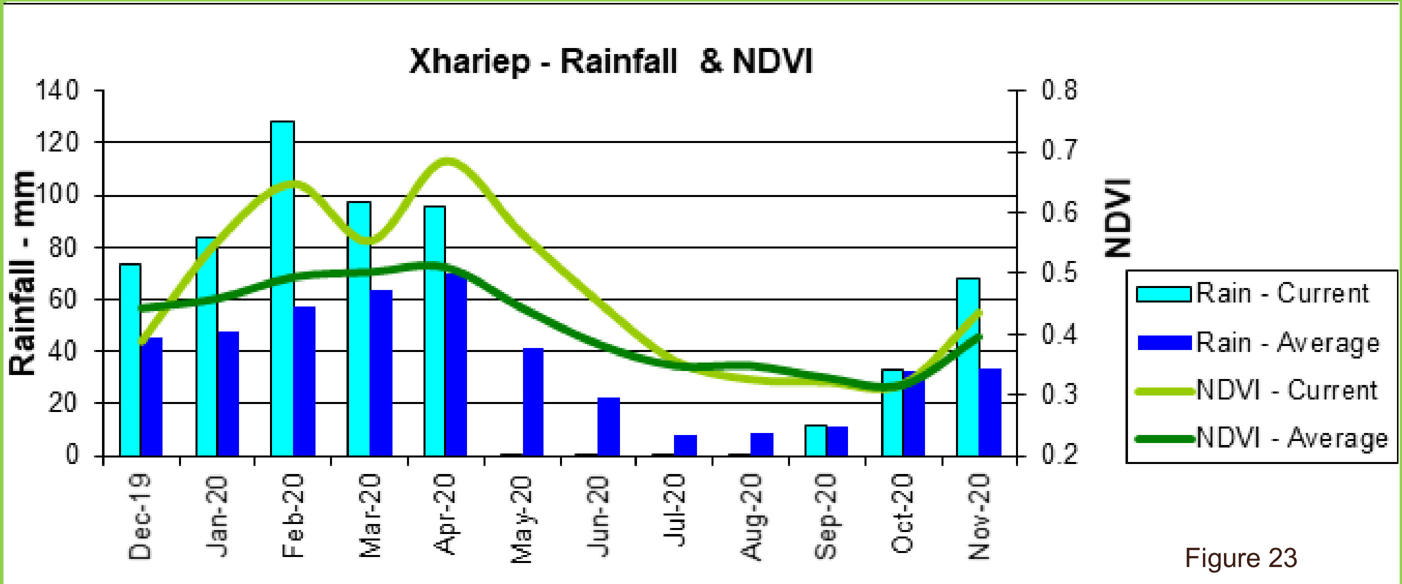

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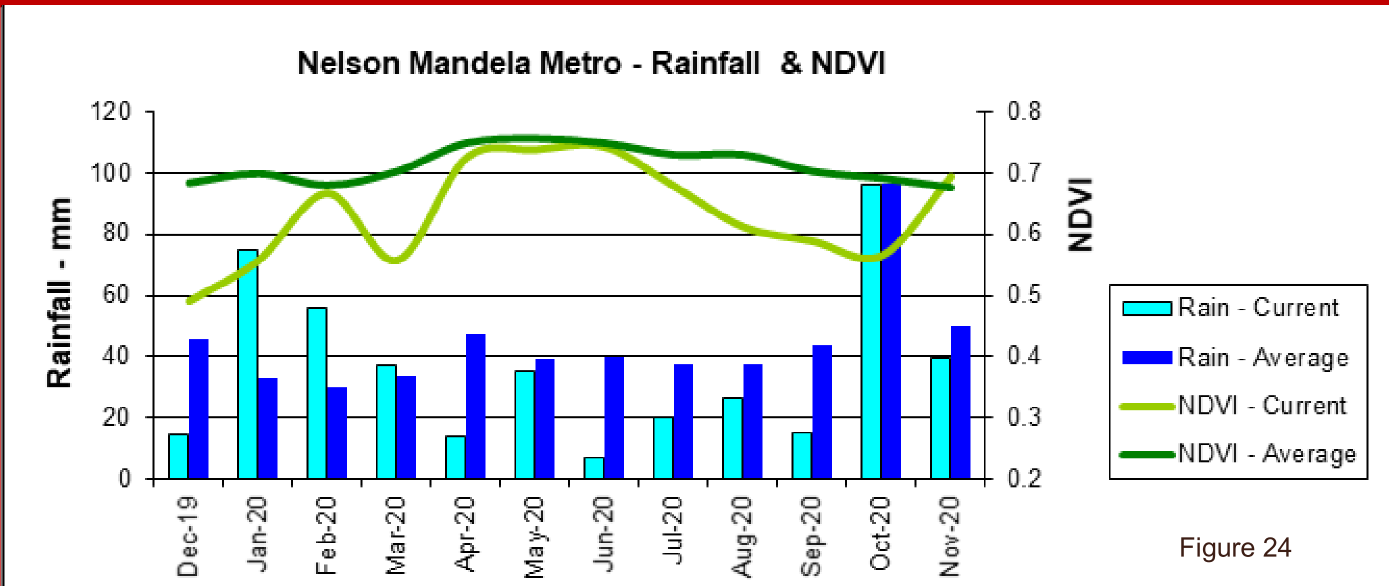

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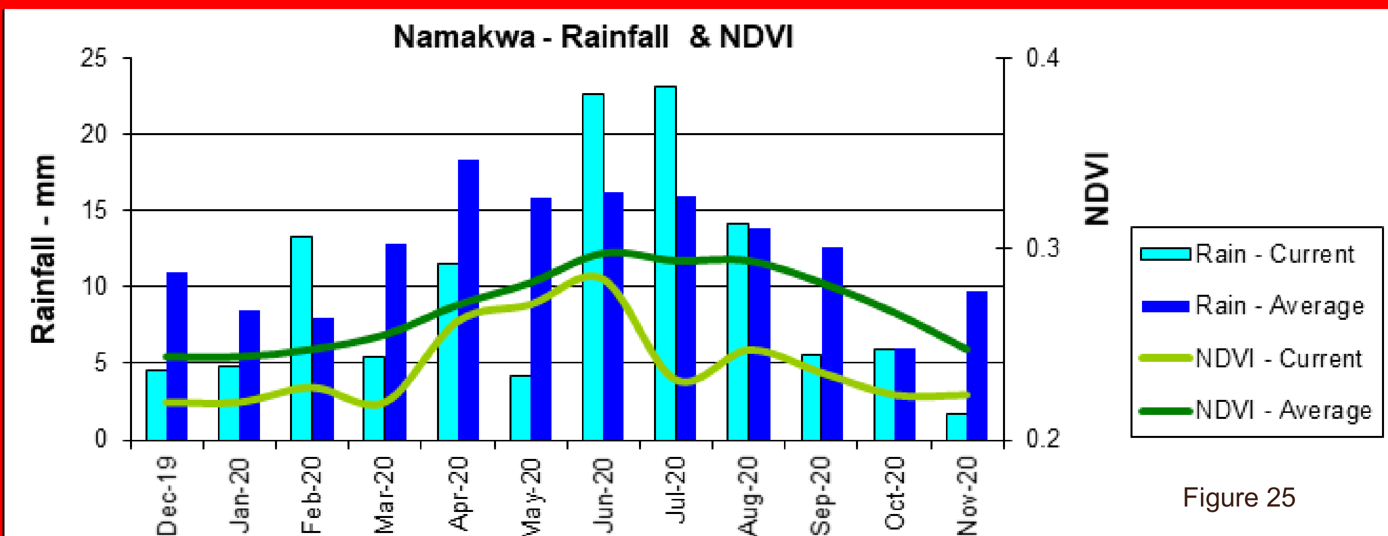

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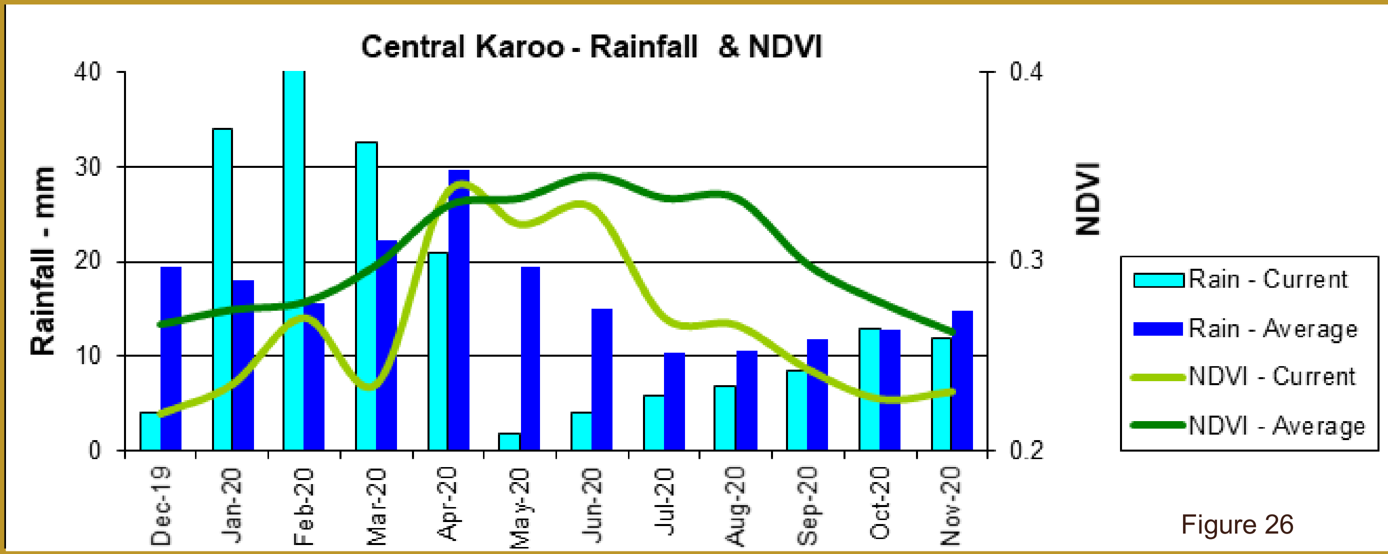

Figure 26

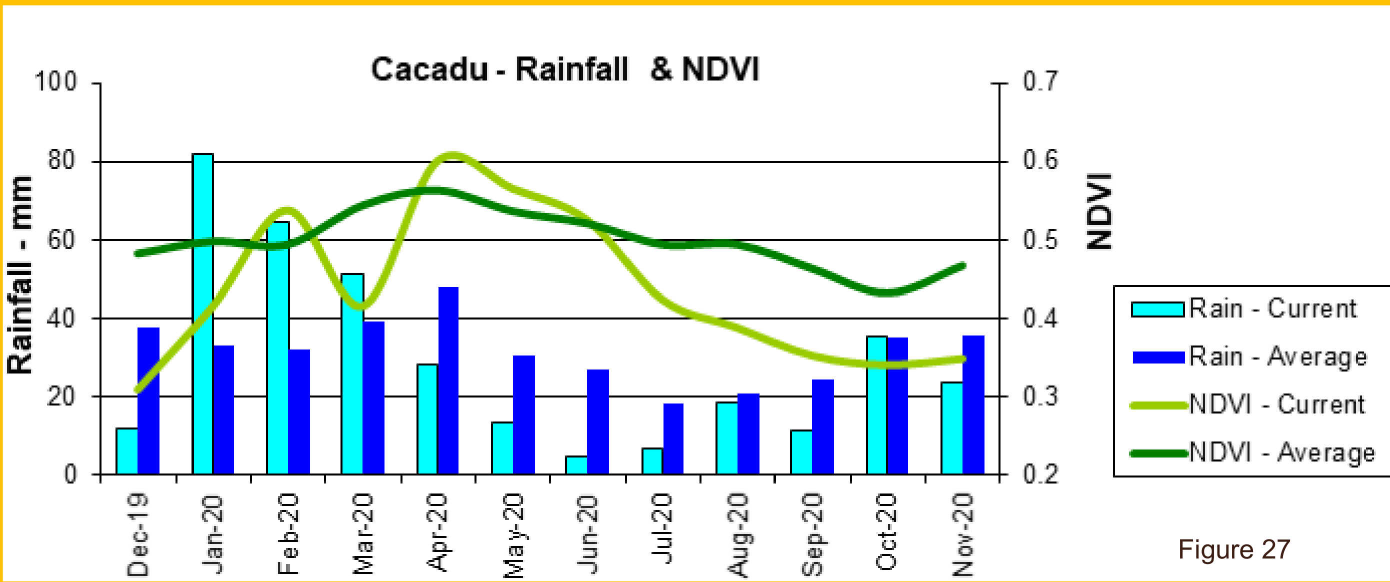

Figure 27

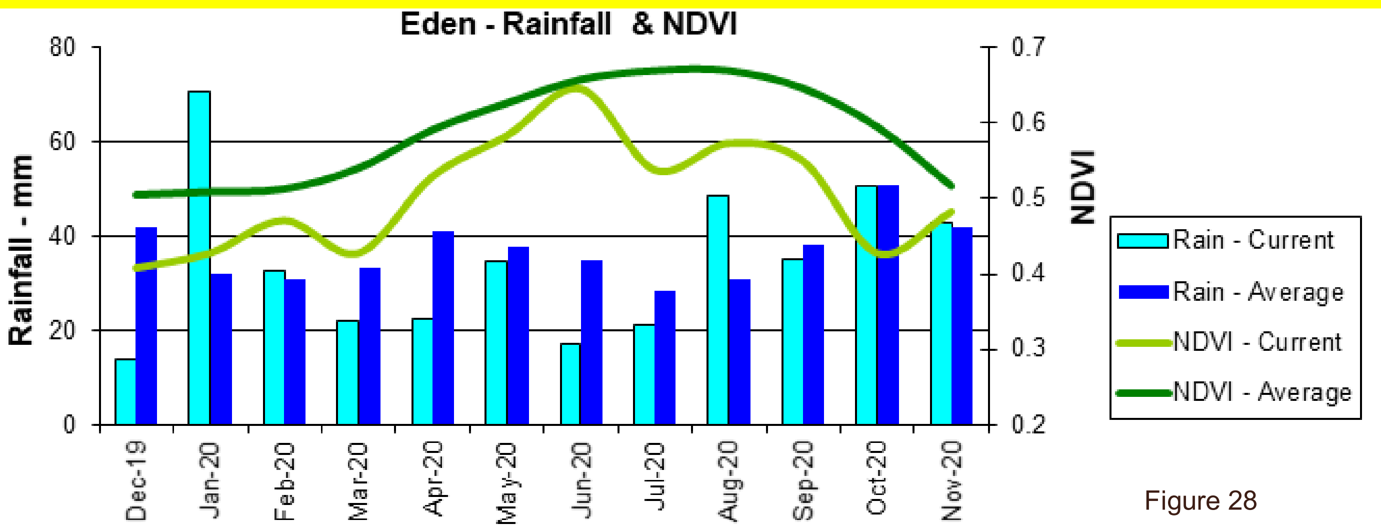

Figure 28

7. Fire Watch

Active Fires *(Provided when data is available)*

Forest and vegetation fires have temperatures in the range of 500 K (Kelvin) to 1000 K. According to Wien's Displacement Law, the peak emission of radiance for blackbody surfaces of such temperatures is at around 4 µm. For an ambient temperature of 290 K, the peak of radiance emission is located at approximately 11 µm. Active fire detection algorithms from remote sensing use this behaviour to detect "hot spot" fires.

Figure 29:
The graph shows the total number of active fires detected between 1-30 November 2020 per province. Fire activity was lower in all provinces compared to the long-term average.

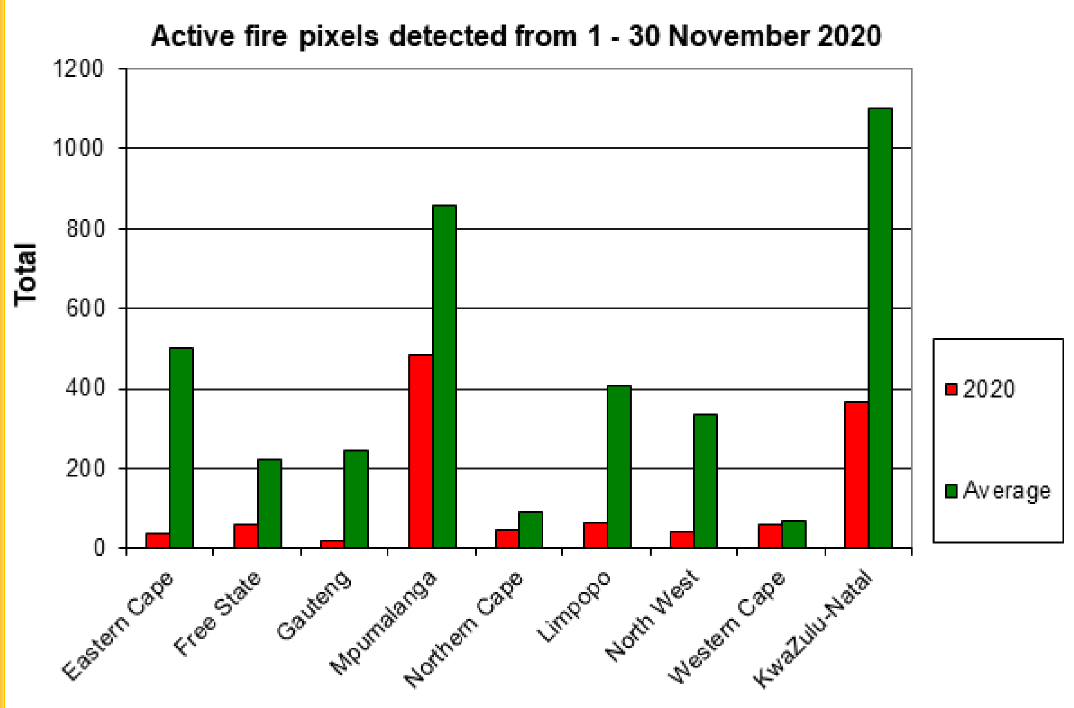

Figure 29

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

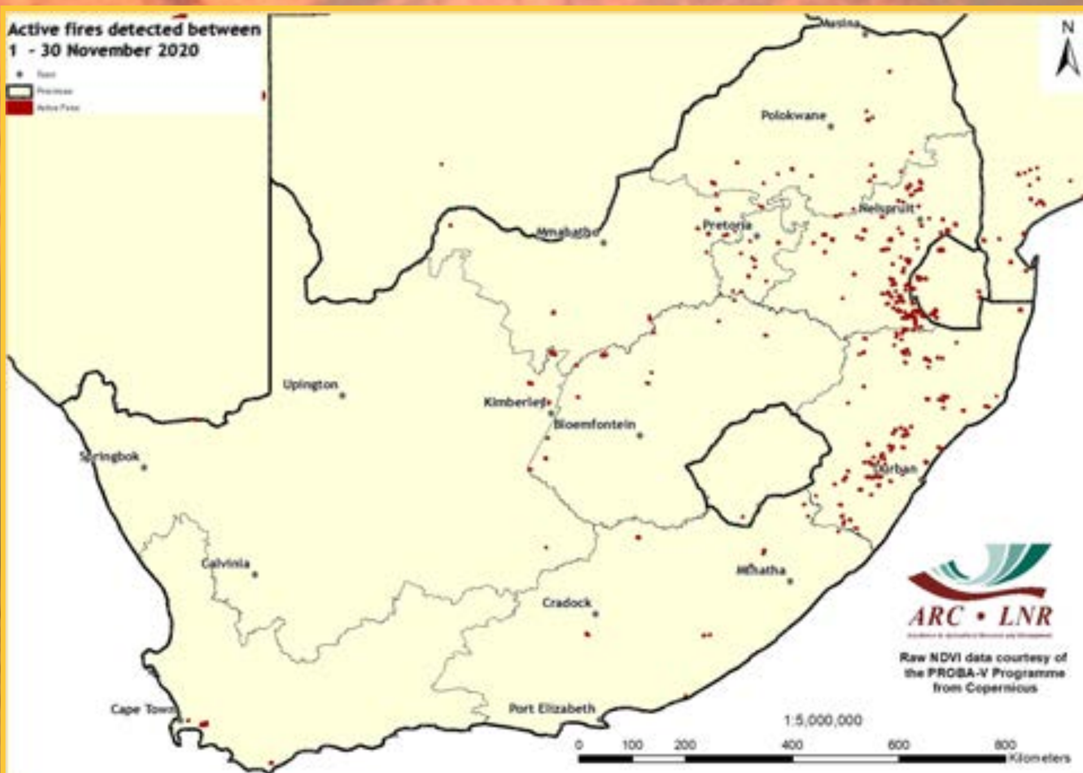

Figure 30

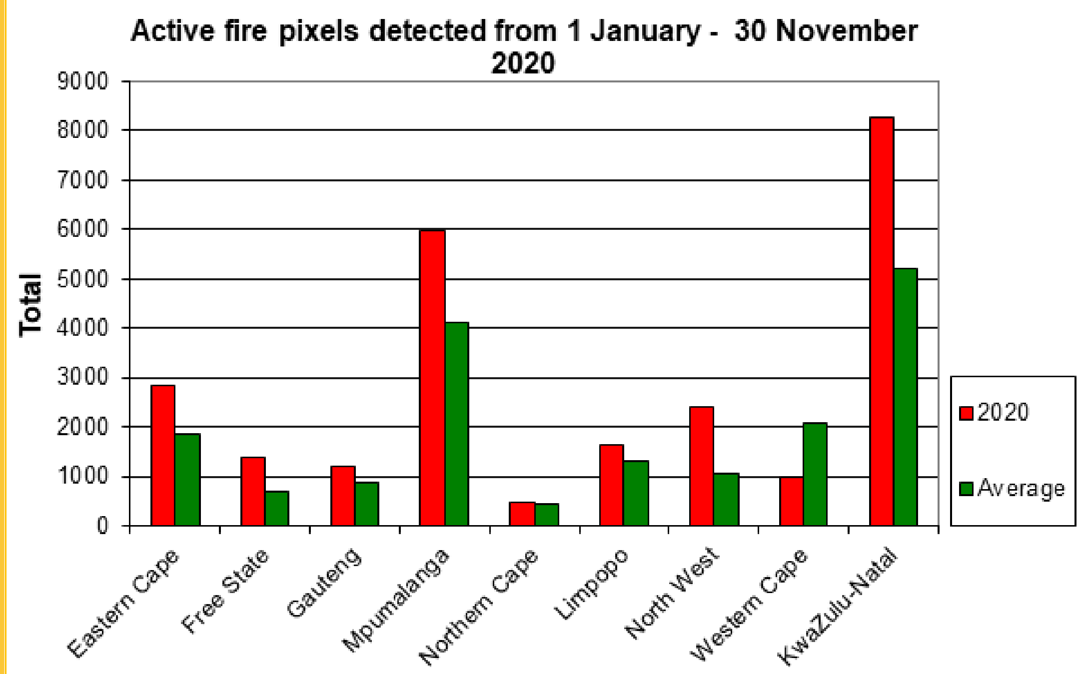

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January - 30 November 2020 per province. Cumulative fire activity was higher in all provinces except the Western Cape compared to the long-term average.

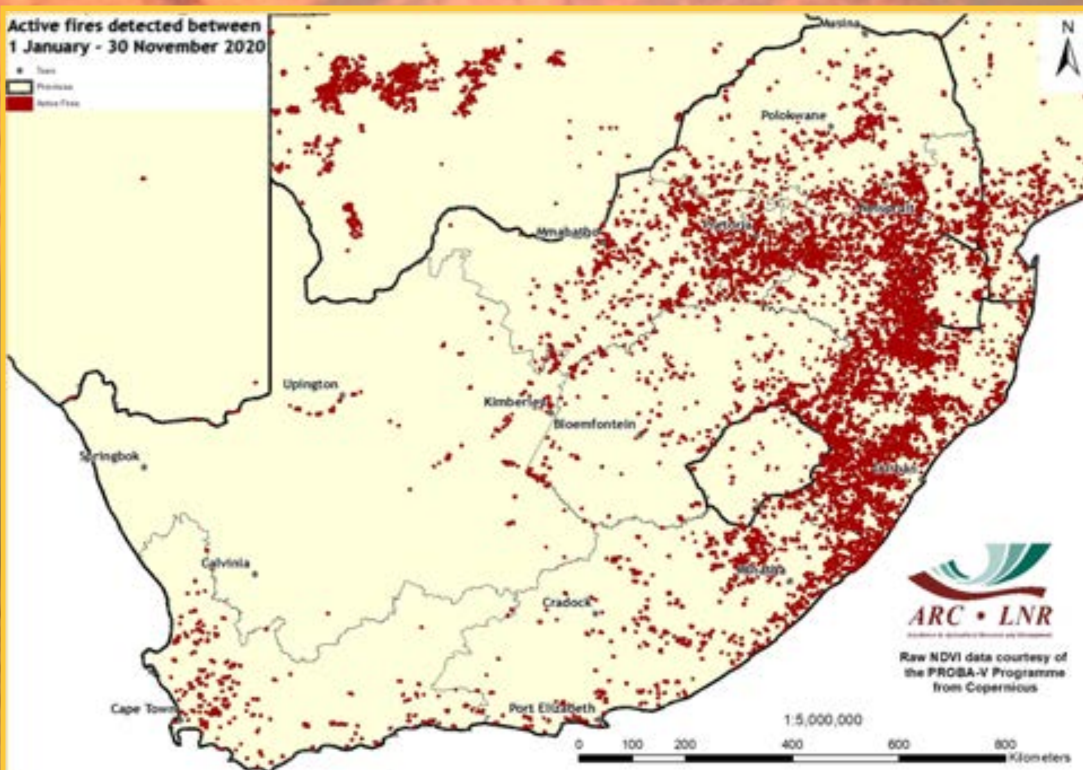

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January - 30 November 2020.

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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 November 2020 shows a continuation of the October 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 exceptions are in the central Northern Cape and Kalahari regions, which show significantly lower current water levels compared to long-term maximum values.

The comparison between November 2020 and November 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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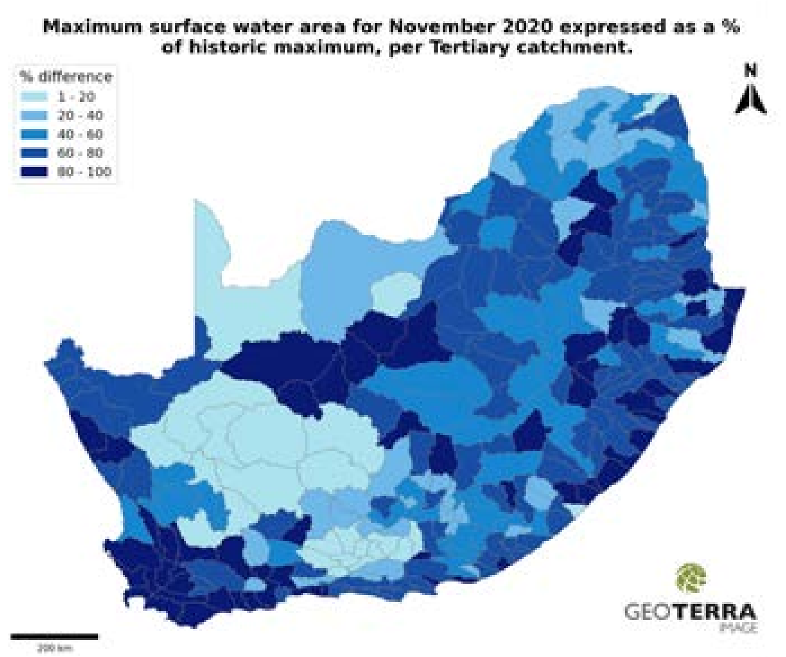


Figure 33

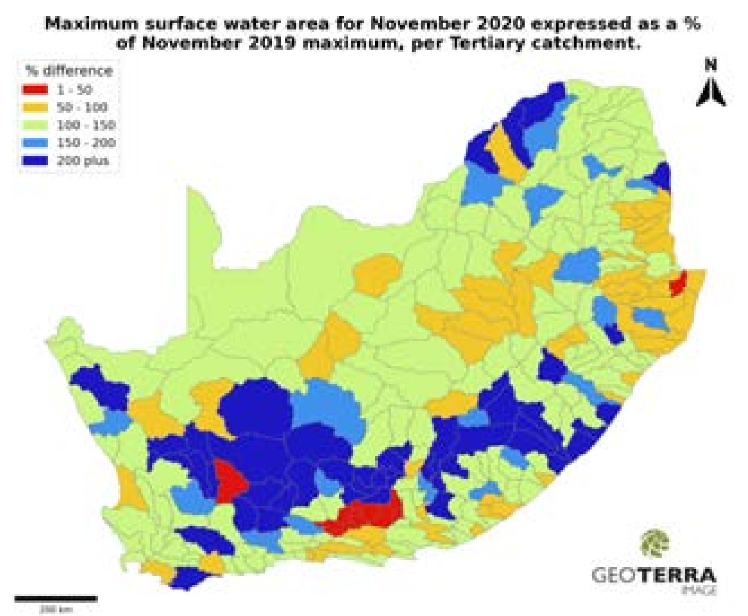
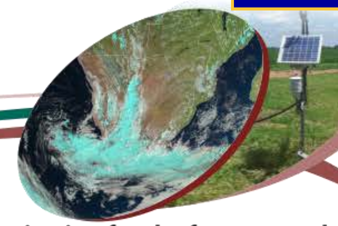


Figure 34

Agrometeorology



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

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".