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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

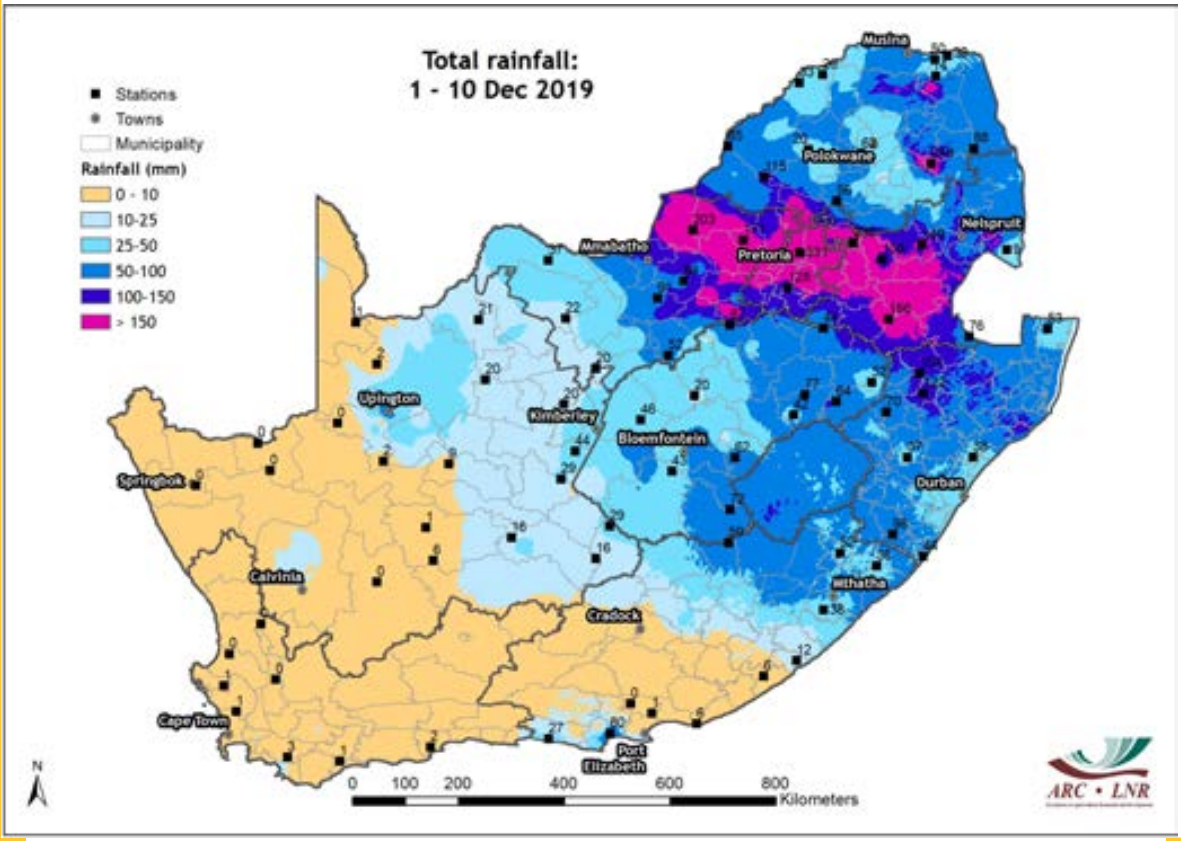
CONTENTS:

186th Edition

Image of the Month

Outbreak of storms and heavy rainfall during early December

Typical summer atmospheric conditions resulted in the first 10 days of December 2019 being characterized by widespread showers over the summer rainfall region, following a period of hot weather in November. Several flash floods occurred, mainly due to the slow movement of the storms and high rainfall volumes. These conditions resulted in structural damage, particularly in some areas of Gauteng and KwaZulu-Natal. Rainfall totals were high over western parts of the North West, southern Gauteng and central areas of Mpumalanga, recording ≥100 mm from 1-10 December (see map below). These rains came just in time for planting in the eastern maize production region, following the preceding dry months which caused much uncertainty and concern. Therefore, it is recommended that farmers start planting (based on soil moisture content) but be conservative with regard to their inputs. Various strategies relating to cultivar type and planting density should also be considered. The eastern parts of the Northern Cape also received rainfall totals of 10-50 mm during this period, providing somewhat temporary drought relief. However, it is noteworthy that multiple rainy days over several months are required to break a drought and return to normal conditions.



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 first significant summer rainfall occurred during November 2019. The month was characterized by scattered to widespread heavy showers with strong damaging winds and large hail over the eastern parts of the region. Large areas of KwaZulu-Natal, Gauteng, Limpopo and the eastern North West Province recorded rainfall totals of 50 -150 mm.

The month started with severe thunderstorms that resulted in tornados at New Hanover and Bergville in KZN. The Northern Cape remained exceptionally dry until the 20th when heavy downpours occurred over the eastern parts of the John Taolo Gaetsewe and Frances Baard District Municipalities, recording rainfall totals of up to 50 mm. Rainy conditions persisted towards the end of the month, accompanied by high temperatures in parts of Mpumalanga, Free State, North West and eastern parts of the Cape provinces.

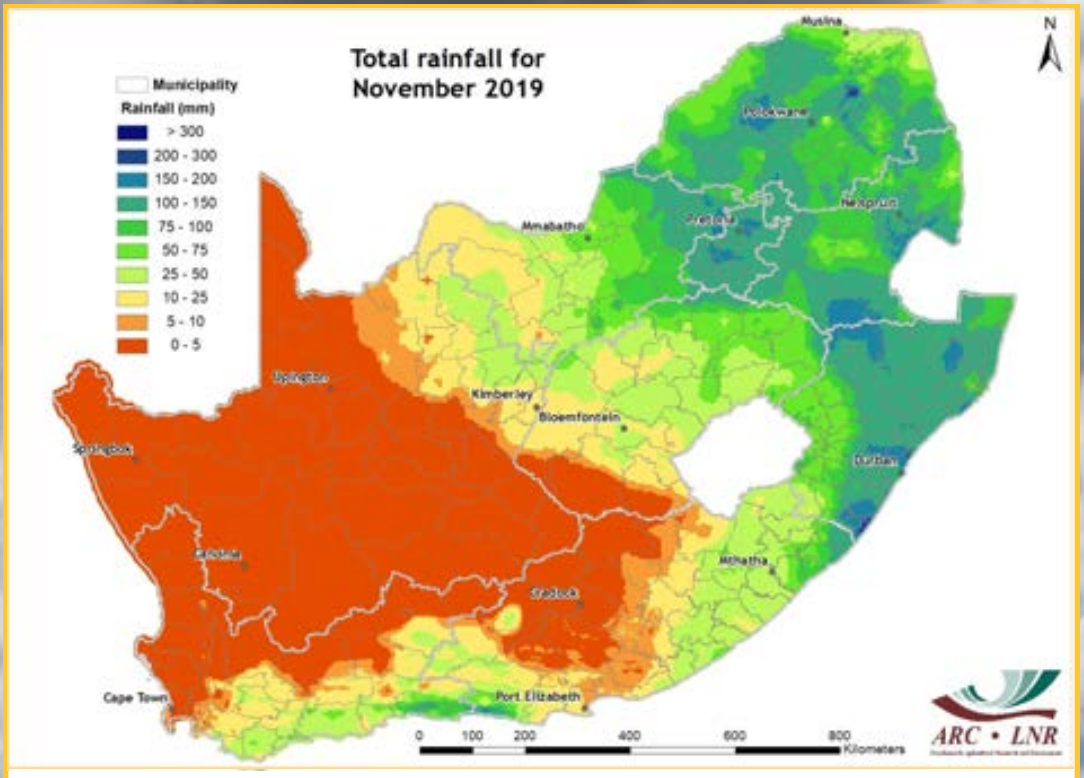


Figure 1

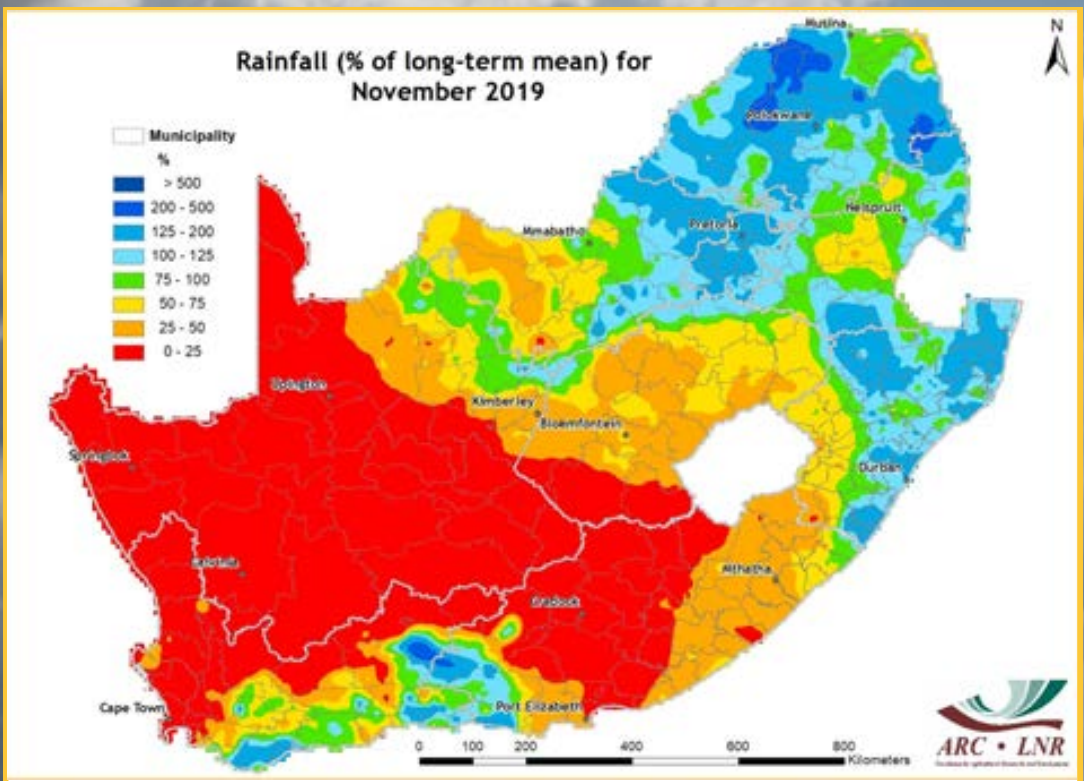


Figure 2

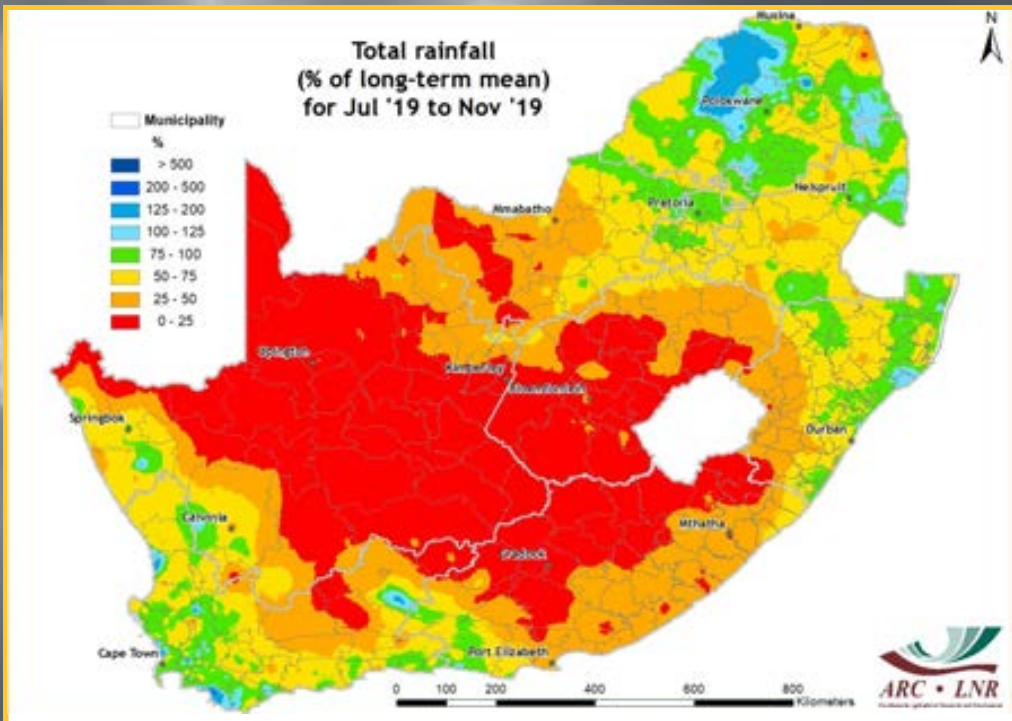


Figure 3

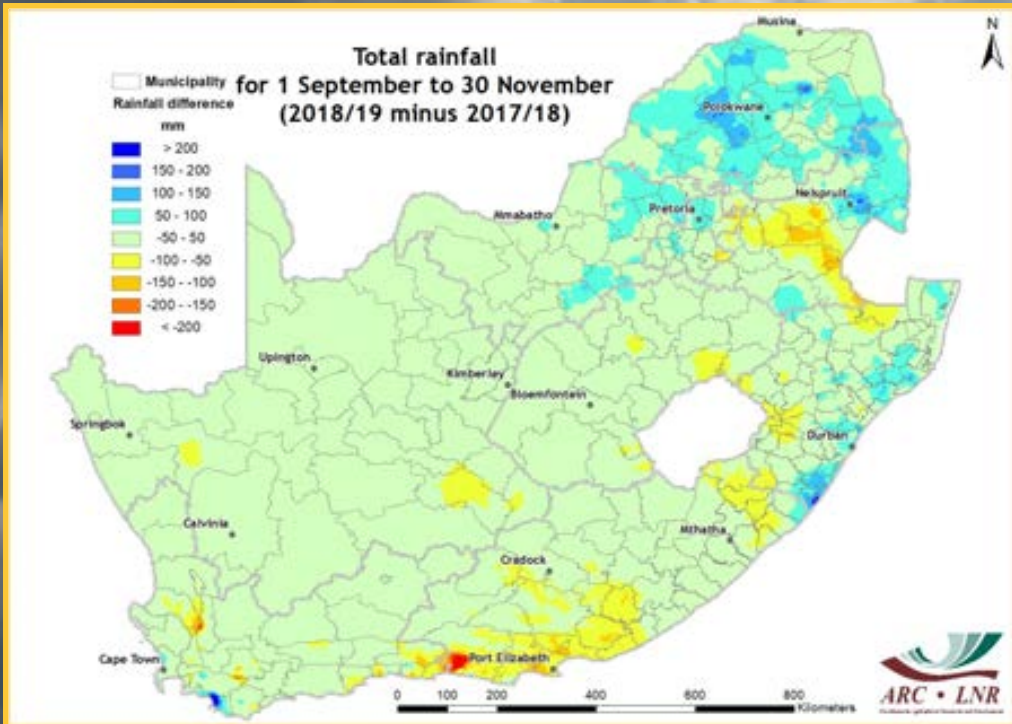


Figure 4

Figure 1:
Rainfall was mostly confined to the eastern summer rainfall region during November, with the highest totals over Gauteng, Limpopo and in the eastern and northern parts of KwaZulu-Natal. Greater parts of the Northern Cape Province, including the Karoo, remained dry.

Figure 2:
The central interior and western parts of the country were relatively dry in November, while normal to above-normal rainfall centred around Gauteng, North West, Limpopo, the Mpumalanga Lowveld and towards KwaZulu-Natal.

Figure 3:
Percentage of accumulated rainfall for July to November 2019 (compared to the long-term mean for the same period) indicate below-normal conditions over the interior, Northern Cape and Eastern Cape. Near- to above-normal rainfall conditions can be seen over the winter rainfall region, and isolated parts of KwaZulu-Natal, Mpumalanga, Gauteng, eastern North West and central Limpopo.

Figure 4:
The southern parts of the Eastern Cape Province received significantly less rain during the period September-November 2019 as compared to the same time last year. However, parts of Limpopo, Mpumalanga, KZN and the eastern North West Province received more rain during this period than 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.

Figures 5-8 show the SPI maps for the month of November 2019. The short-term (6-month) time scale shows that severe to extreme drought conditions dominate much of the Free State, Eastern Cape, Northern Cape and North West provinces. Other areas in the Lowveld of Limpopo, Mpumalanga, KwaZulu-Natal and Western Cape are also experiencing these drought conditions. Greater parts of the Capricorn District show mildly wet conditions, mainly due to the high amounts of rainfall that occurred late in October to November. When observing the 12-month time scale, extreme drought is only evident over much of the Northern Cape, Eastern Cape and parts of the Western Cape. Longer time scales (24- to 36-month), show widespread mild to extreme drought conditions over the whole country.

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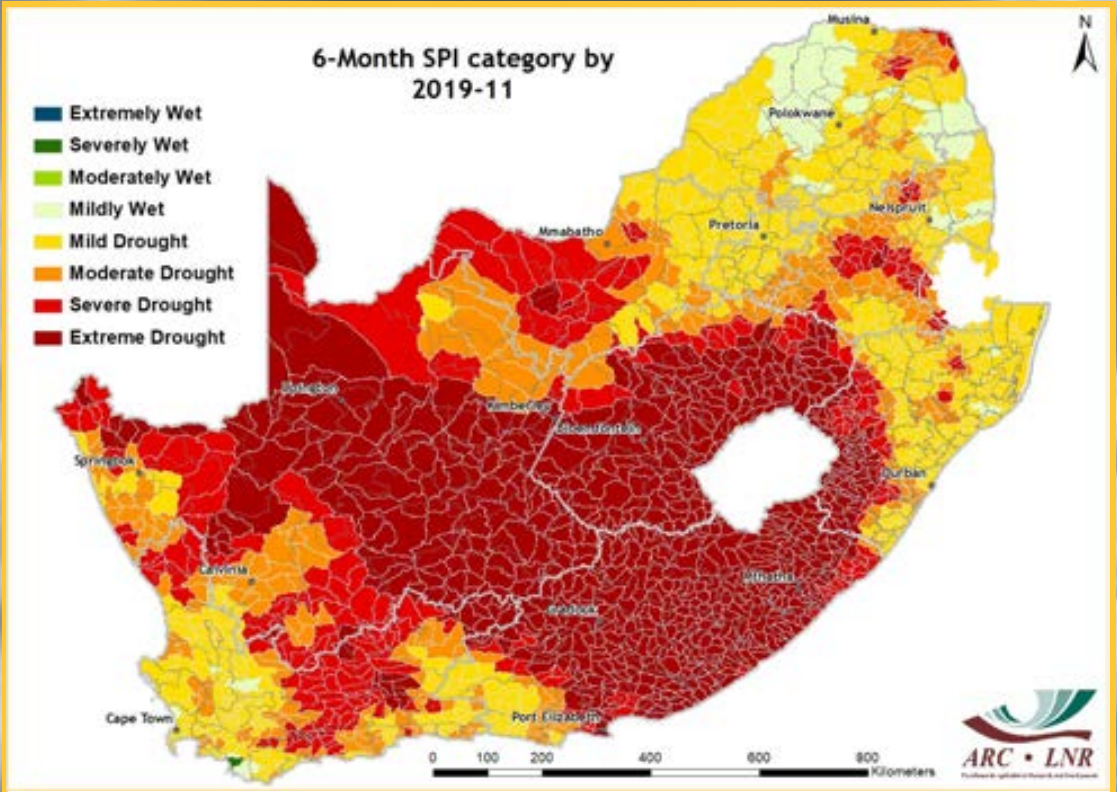

Figure 5

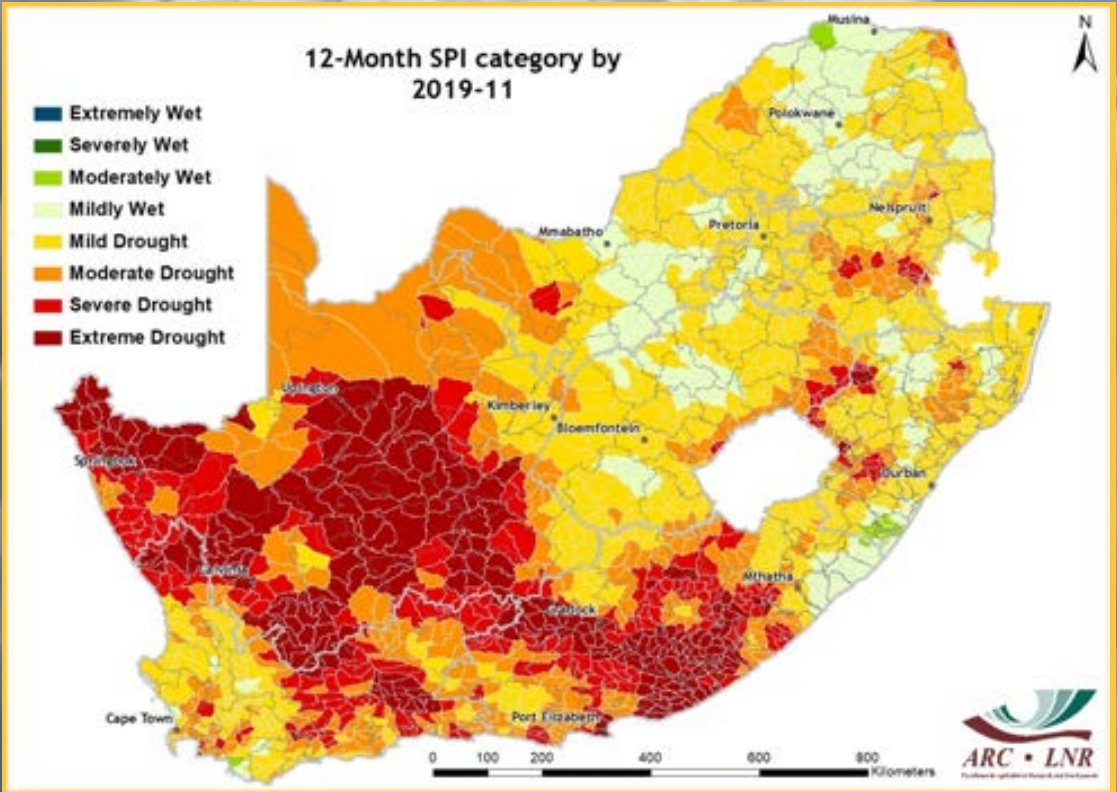

Figure 6

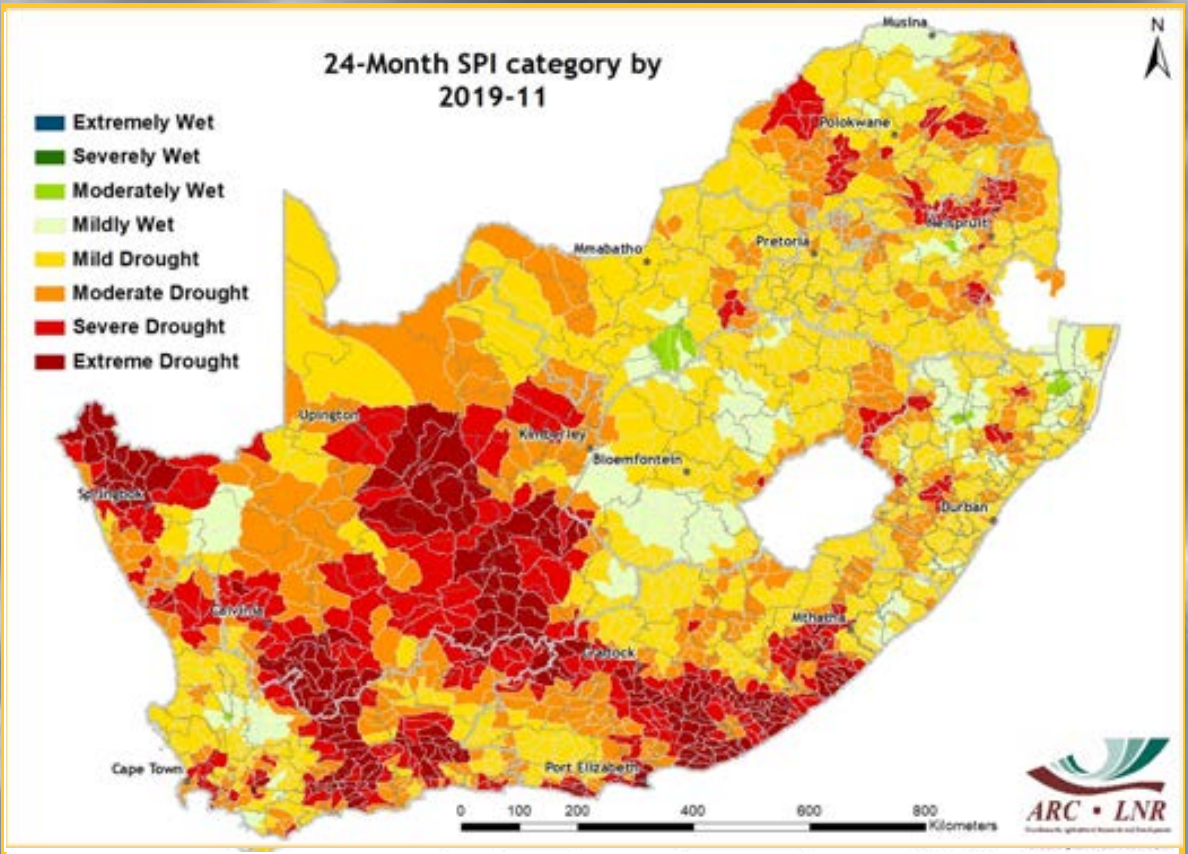

Figure 7

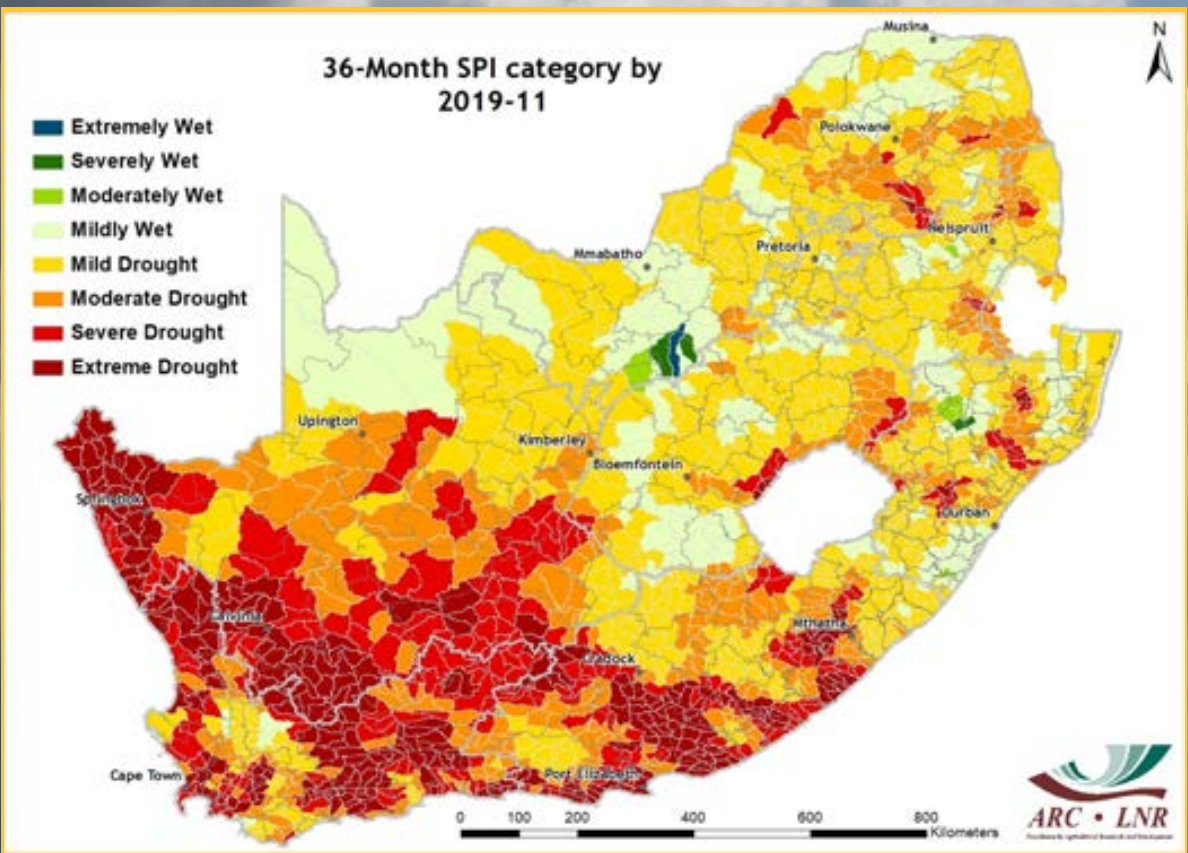

Figure 8

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.

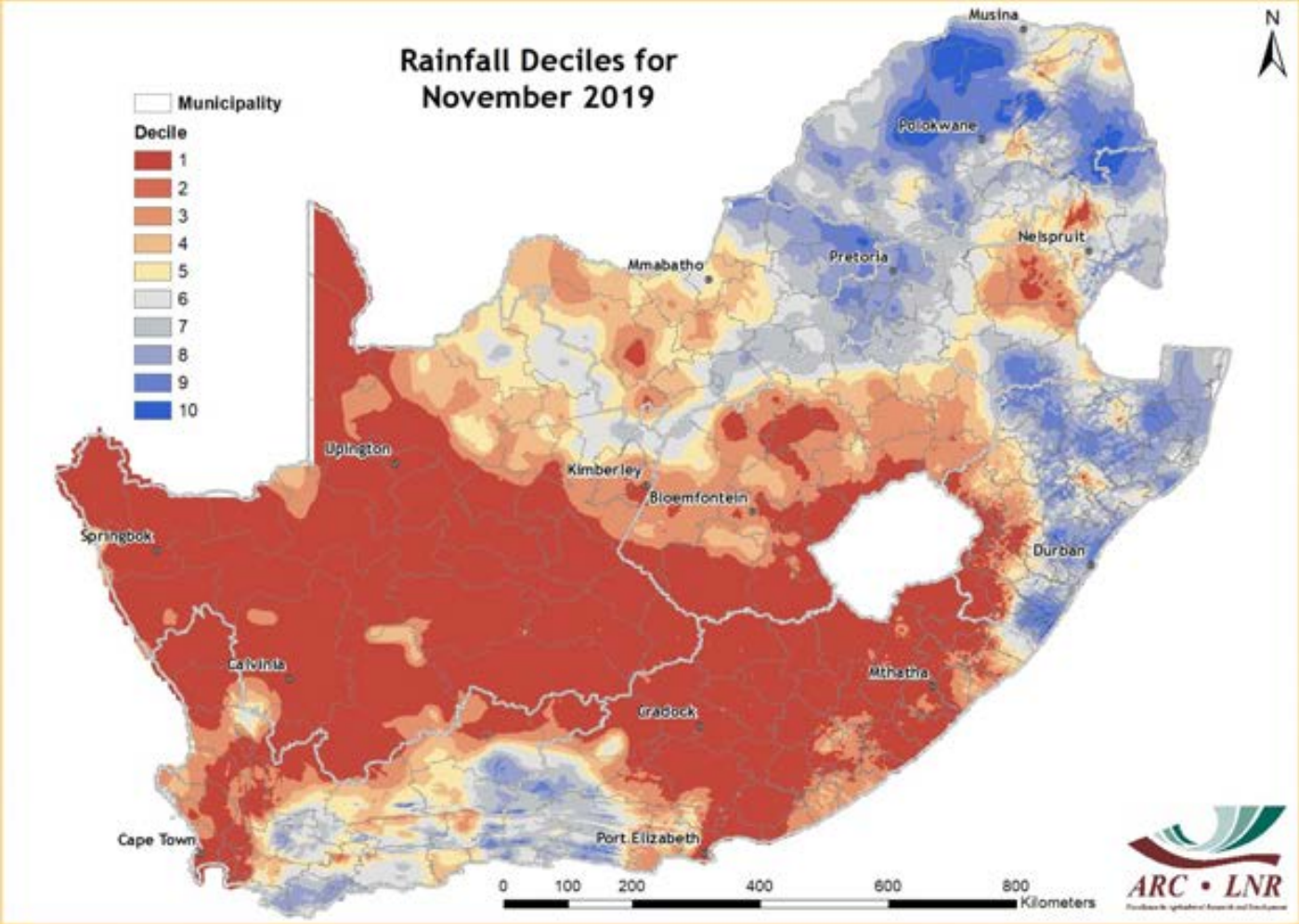

Figure 9

Figure 9:
The Northern Cape and the adjacent interior remain exceptionally dry, while the winter rainfall region and most parts of the summer rainfall region (Gauteng, North West, KwaZulu-Natal, Mpumalanga and Limpopo) compare well with the historically wet November 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.

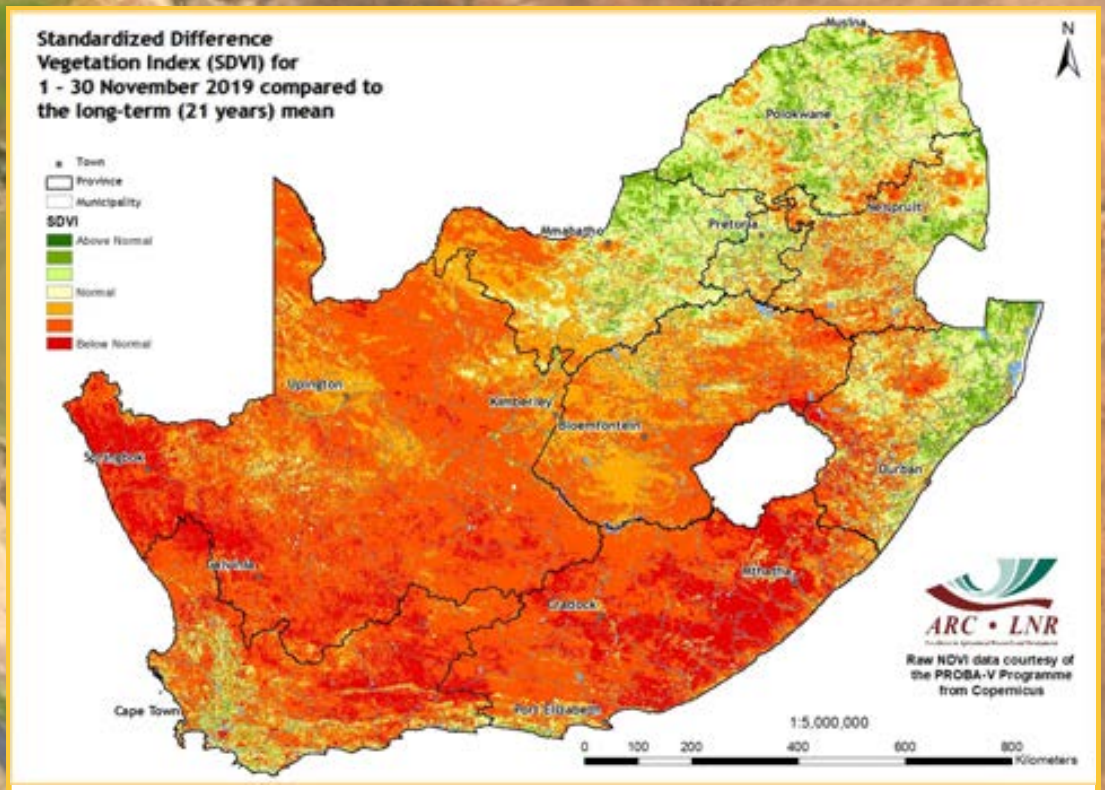

Figure 10

Figure 10:
Rainfall downpours brought some relief of the prolonged drought that spread over many parts of the country. The SDVI map for November shows that the northern parts of the country experienced above-normal vegetation activity. However, the rainfall had little effect in other parts of the country which continue to experience poor vegetation conditions. This means that more days of rain spread across the entire country are needed to stimulate the vegetation activity back to its normal condition.

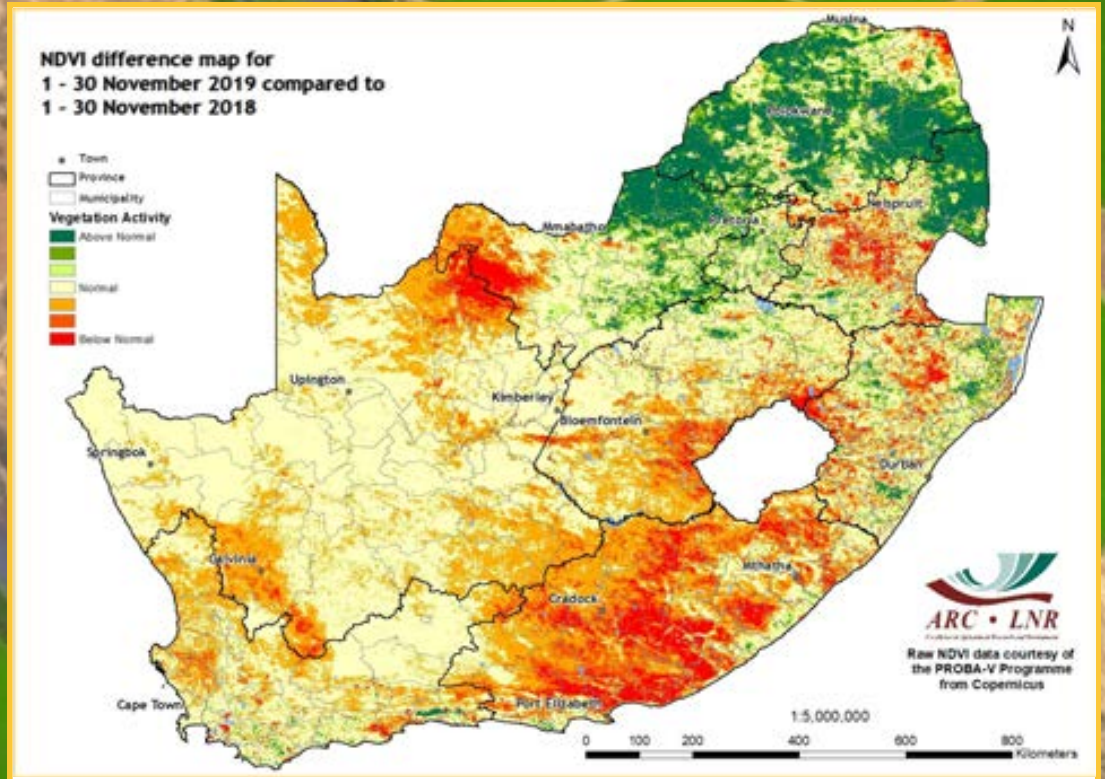

Figure 11

Figure 11:
Compared to the same period last year, the NDVI difference map for November shows that the northern parts experienced above-normal vegetation conditions, while the remainder of the country continues to experience below-normal activity.

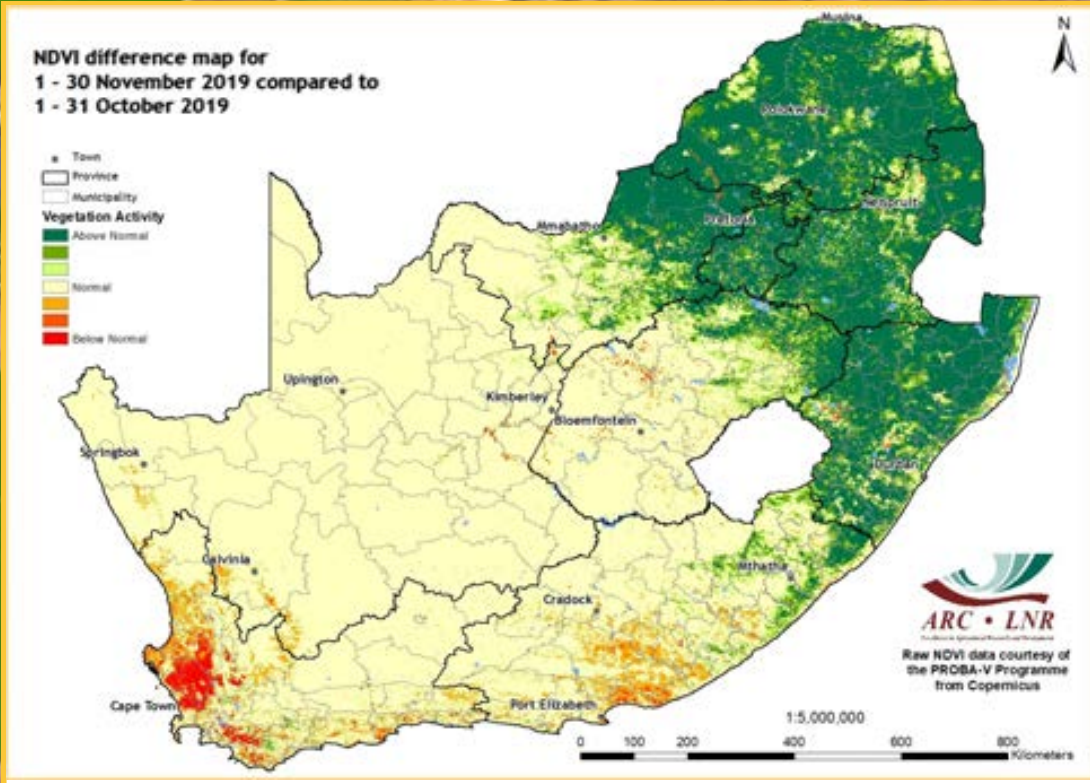

Figure 12

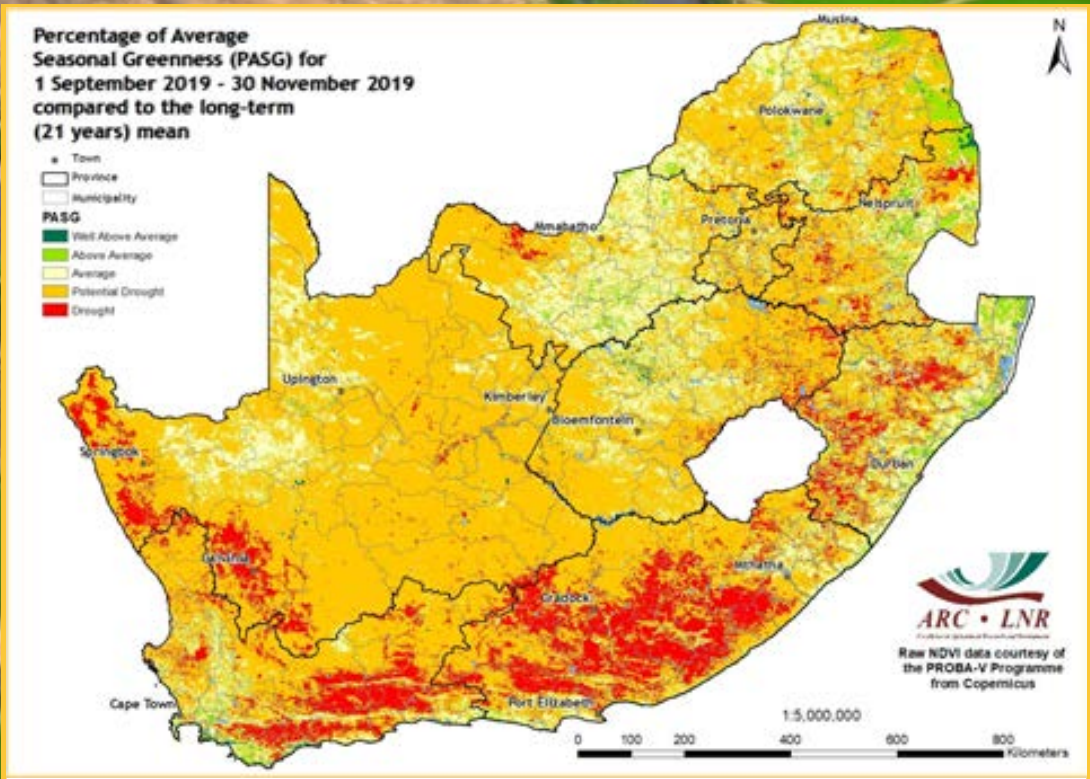

Figure 13

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 November NDVI map shows that the eastern half of the country experienced above-normal vegetation activity while the western half experienced normal activity. A notable exception is the far western parts of the Western Cape which experienced poor vegetation conditions.

Figure 13:
When looking at the PASG map over a 3-month period compared to the long-term mean, many parts of the country experienced potential drought while isolated parts in the Free State, North West, Limpopo, KZN and Mpumalanga experienced average to above-average vegetation 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.

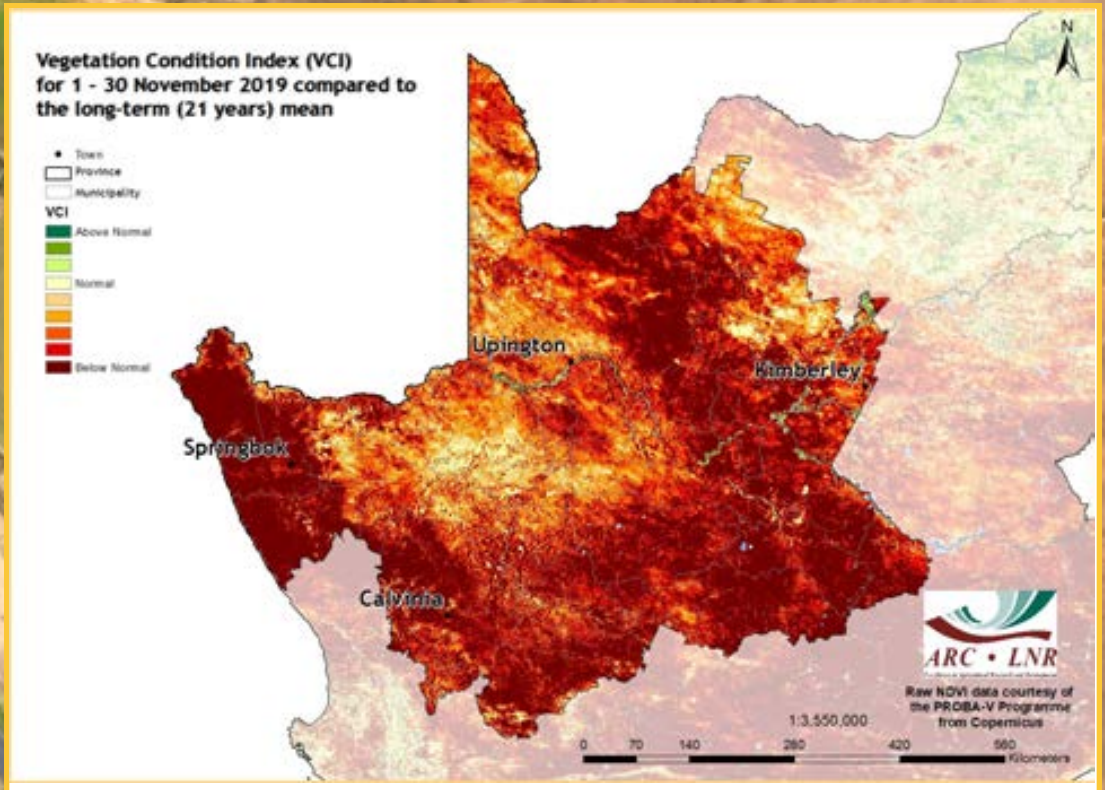

Figure 14

Figure 14:
The VCI map for November indicates that severe drought conditions continue to impact negatively on vegetation activity in the Northern Cape.

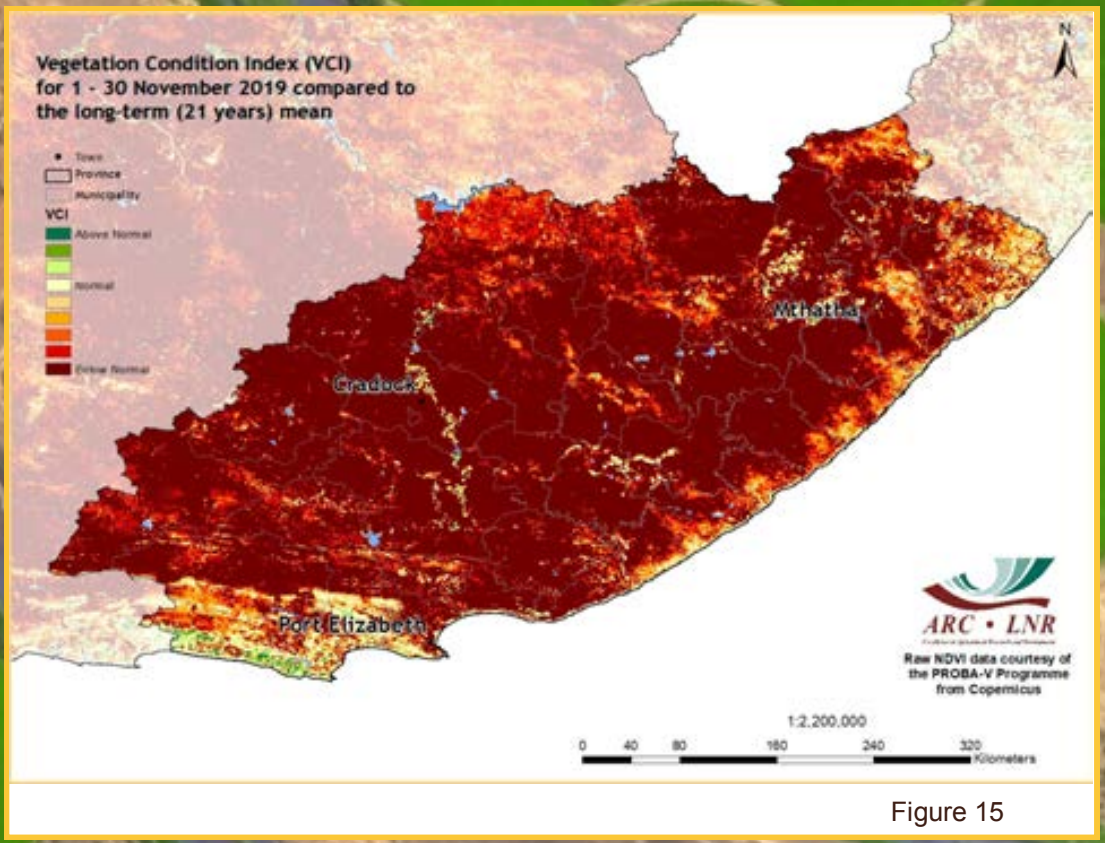

Figure 15

Figure 15:
The VCI map for November indicates that, compared to the long-term average, many parts of the Eastern Cape continue to experience poor vegetation activity.

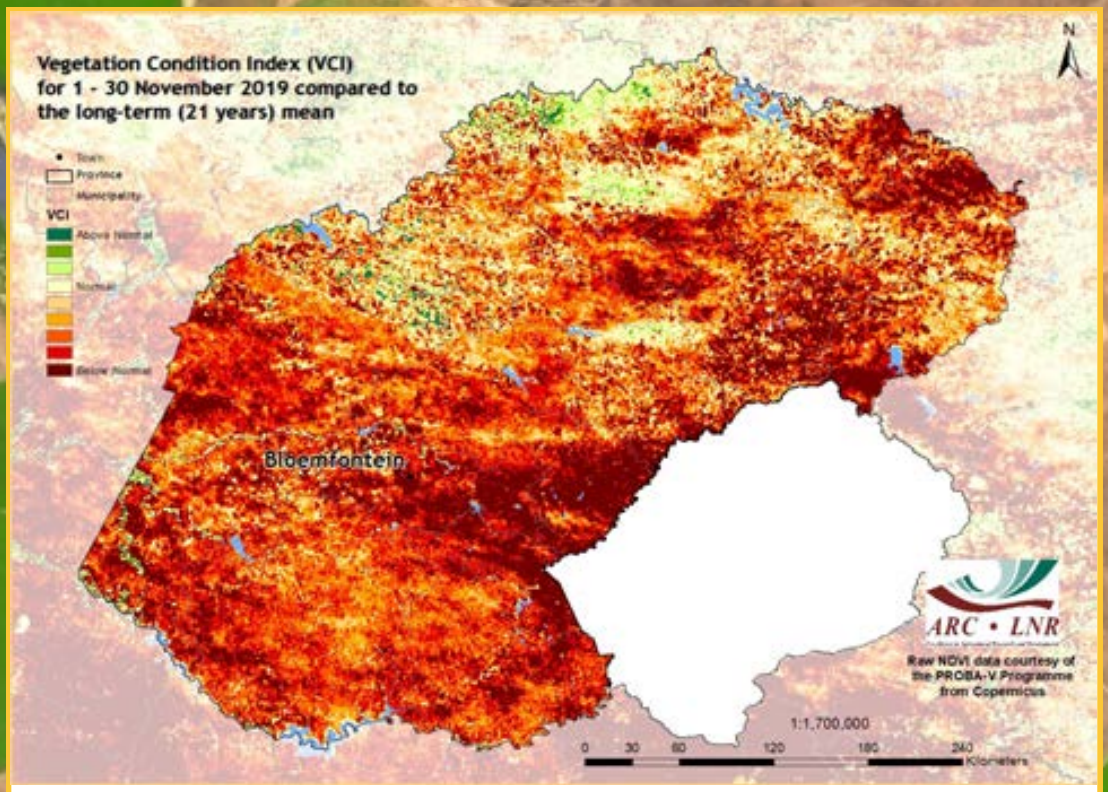

Figure 16

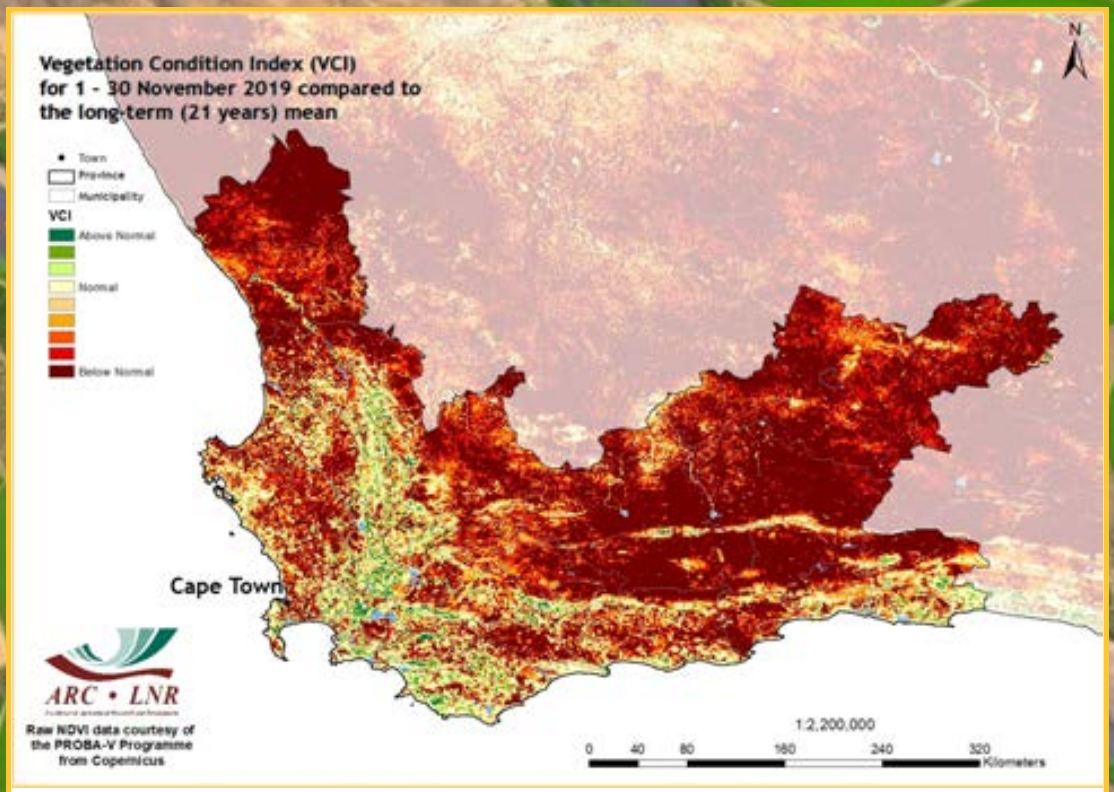

Figure 17

Figure 16:
The VCI map for November indicates that many parts of the Free State experienced poor vegetation activity. Minor exceptions were observed in some isolated areas of the Fezile Dabai District Municipality.

Figure 17:
The VCI map for November indicates that many parts of the Western Cape continue to experience poor vegetation conditions, particularly the Central Karoo, northern parts of the West Coast, as well as northeastern and western parts of the Eden District Municipality.

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6. Vegetation Conditions & Rainfall

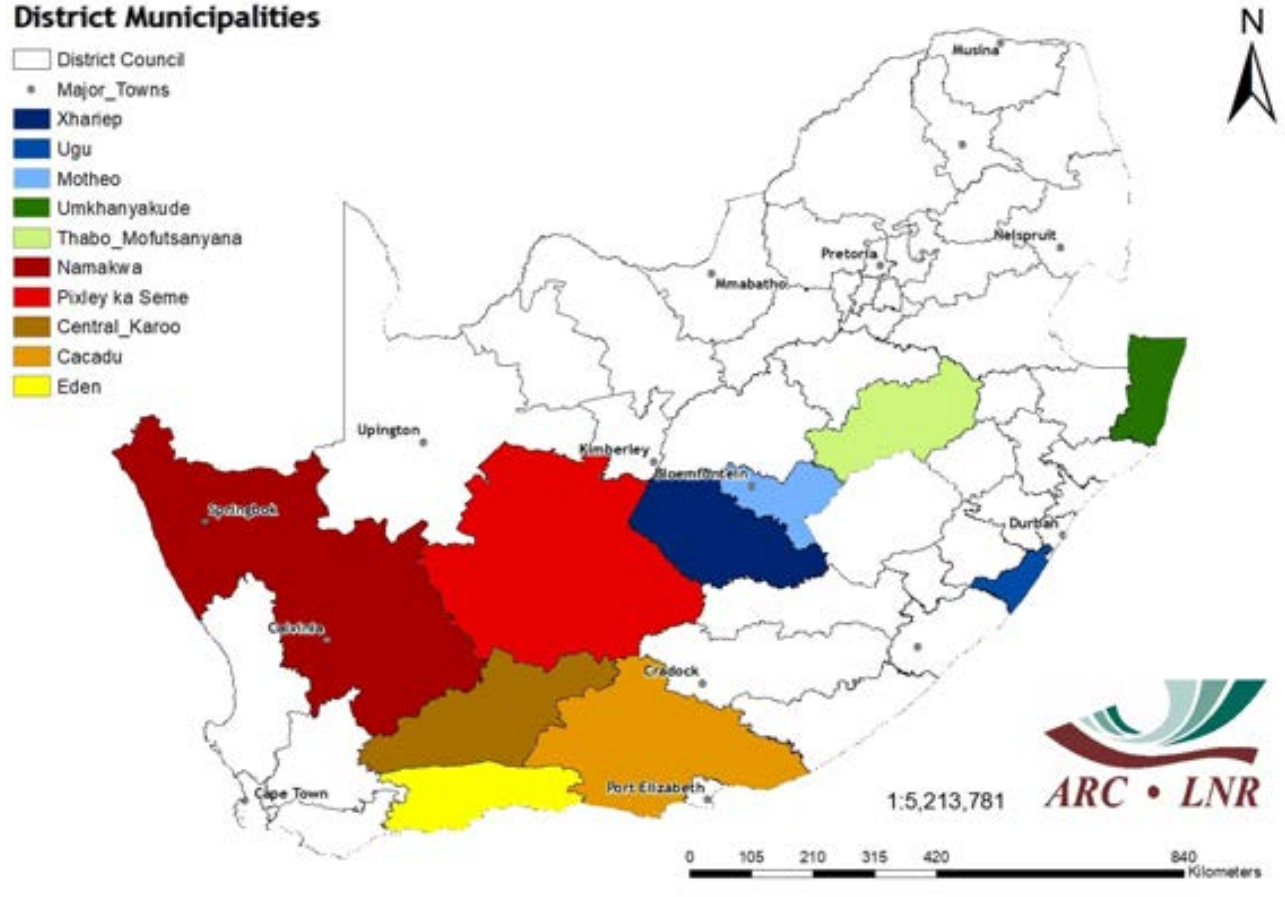

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for November 2019. The district colour matches the border of the corresponding graph.

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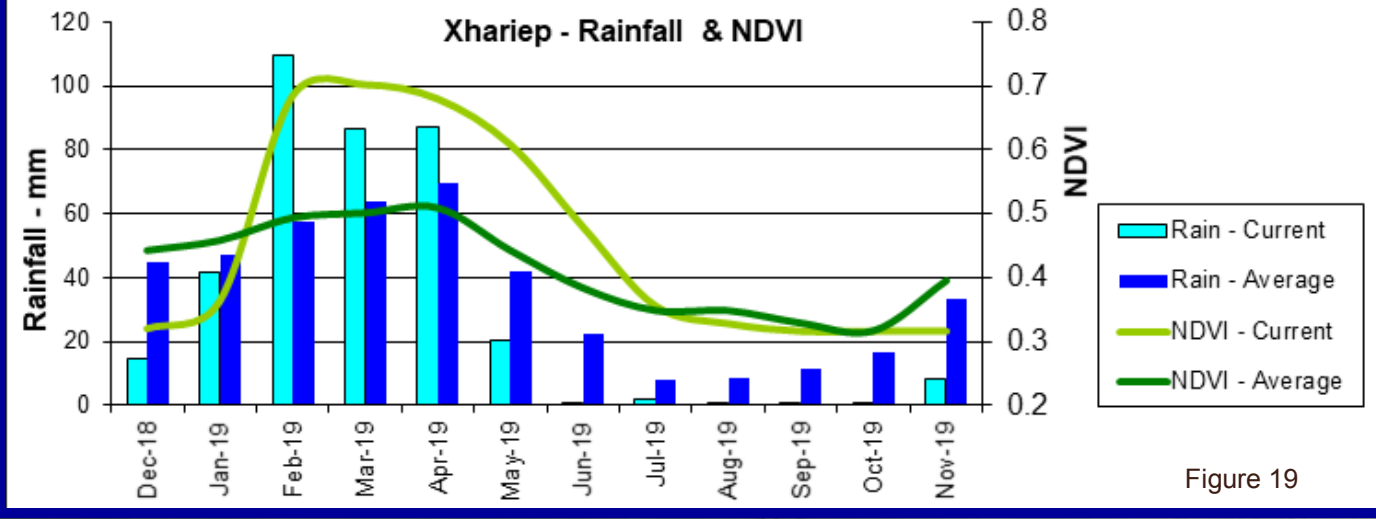
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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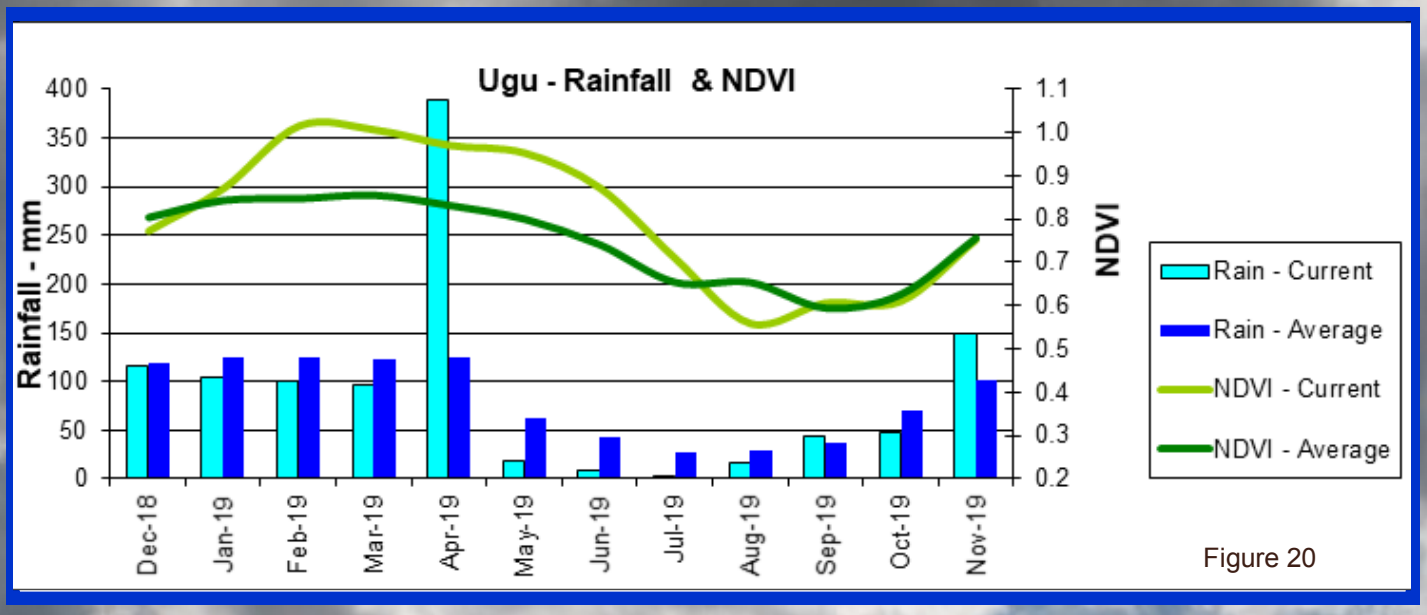

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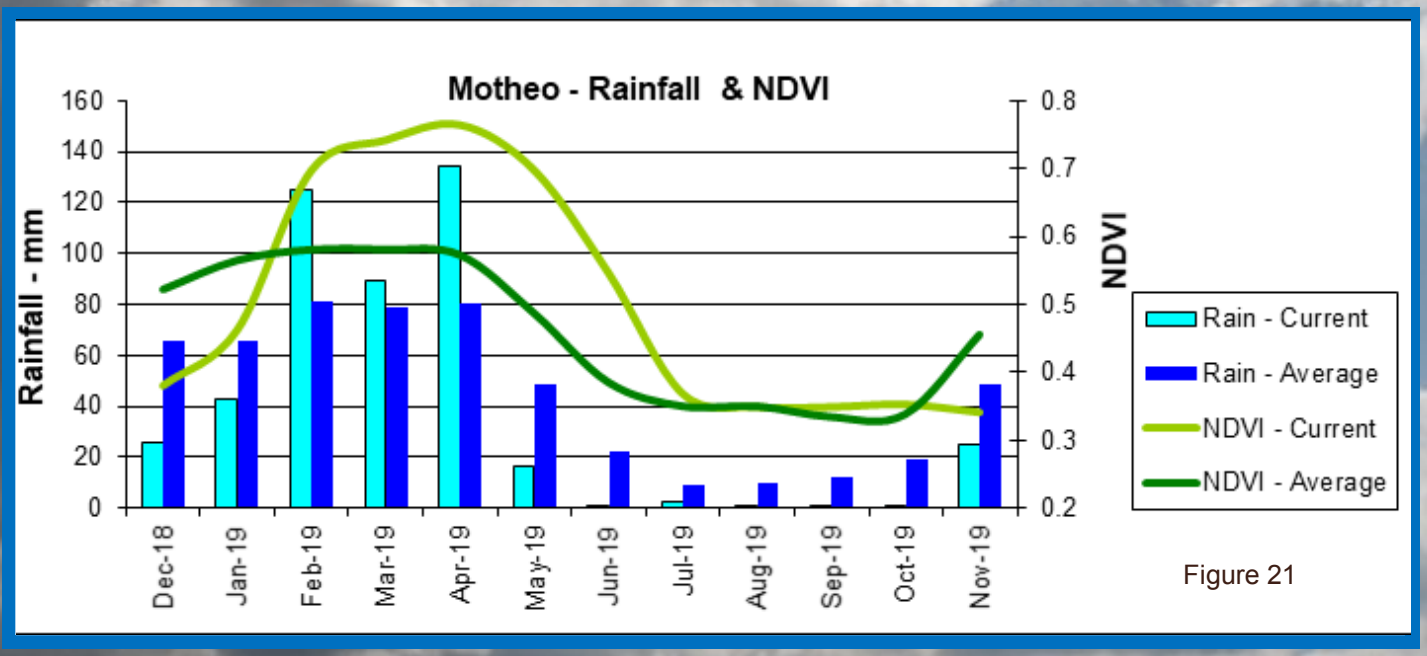

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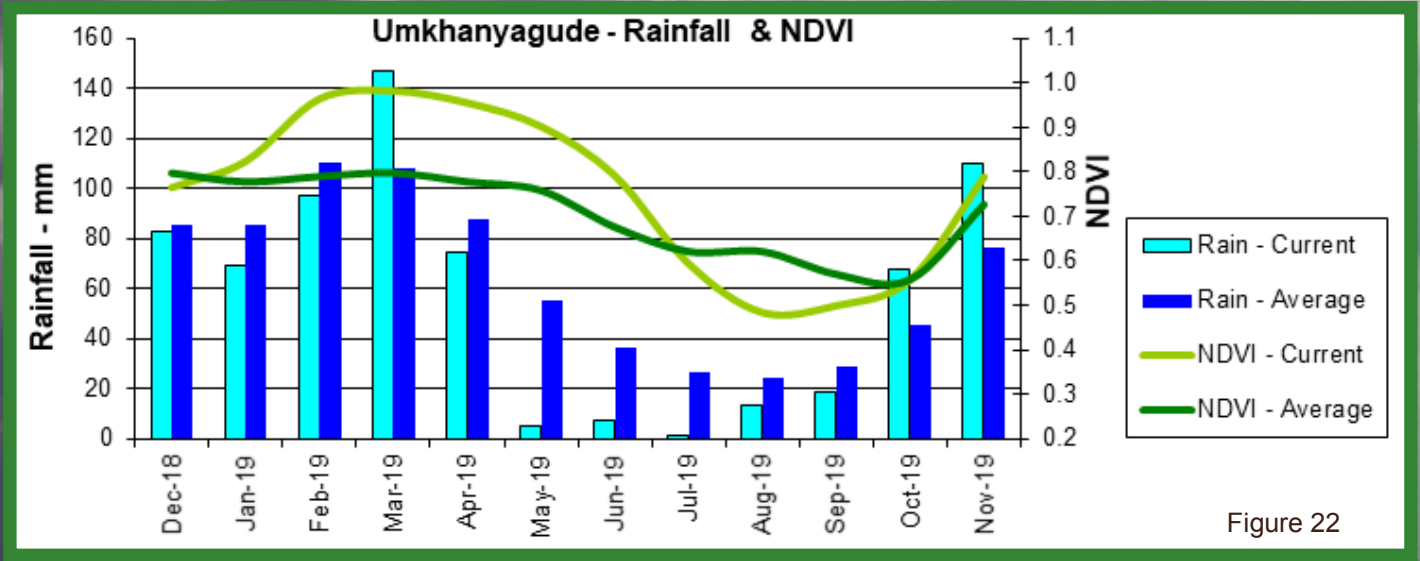

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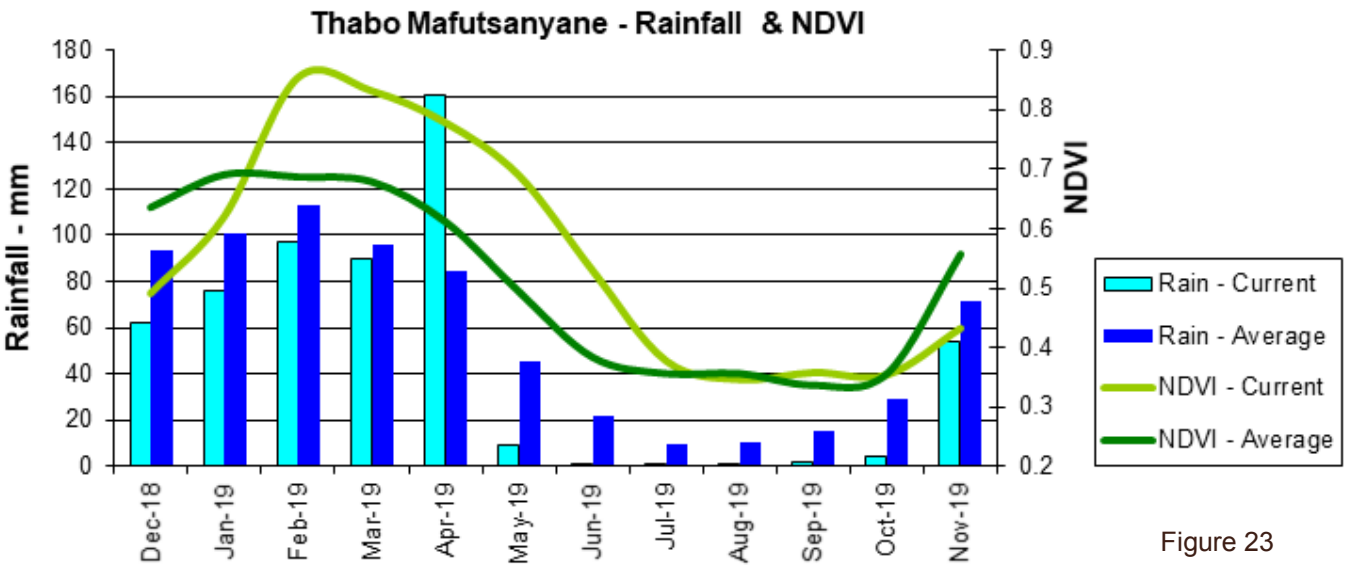
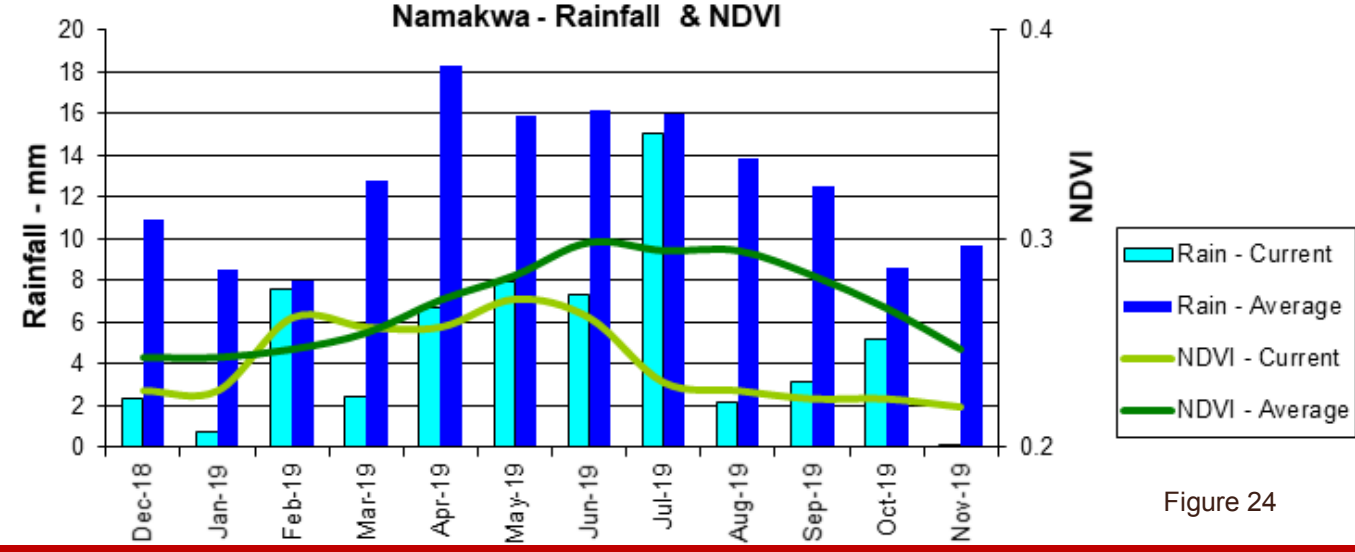


Figure 23



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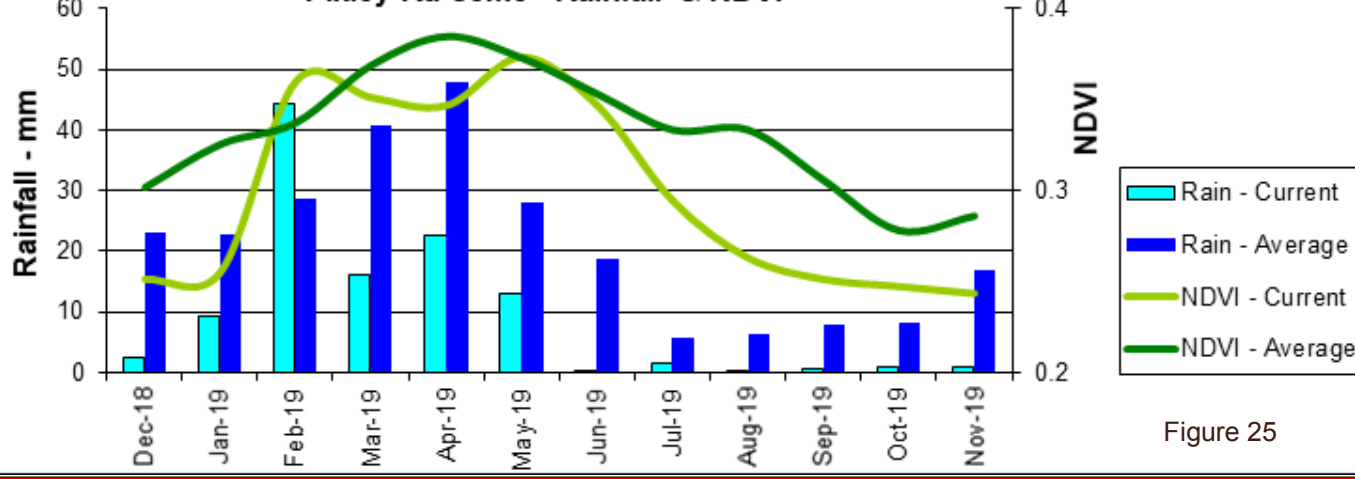
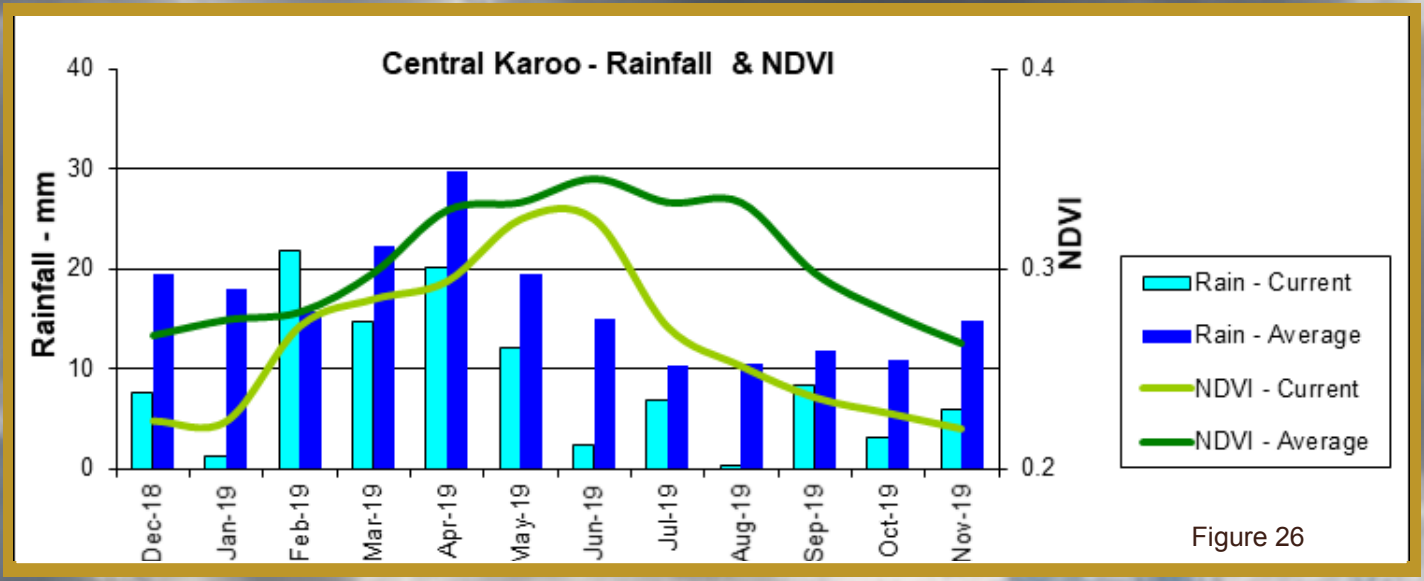


Figure 25



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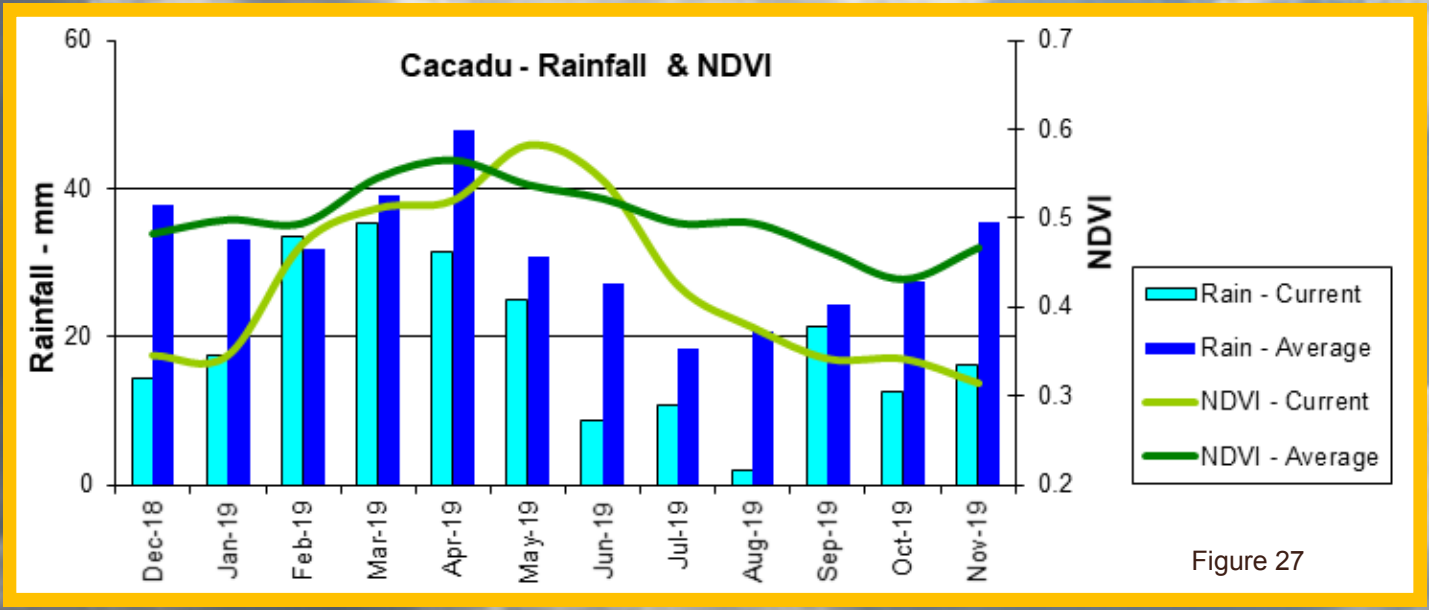

Figure 27

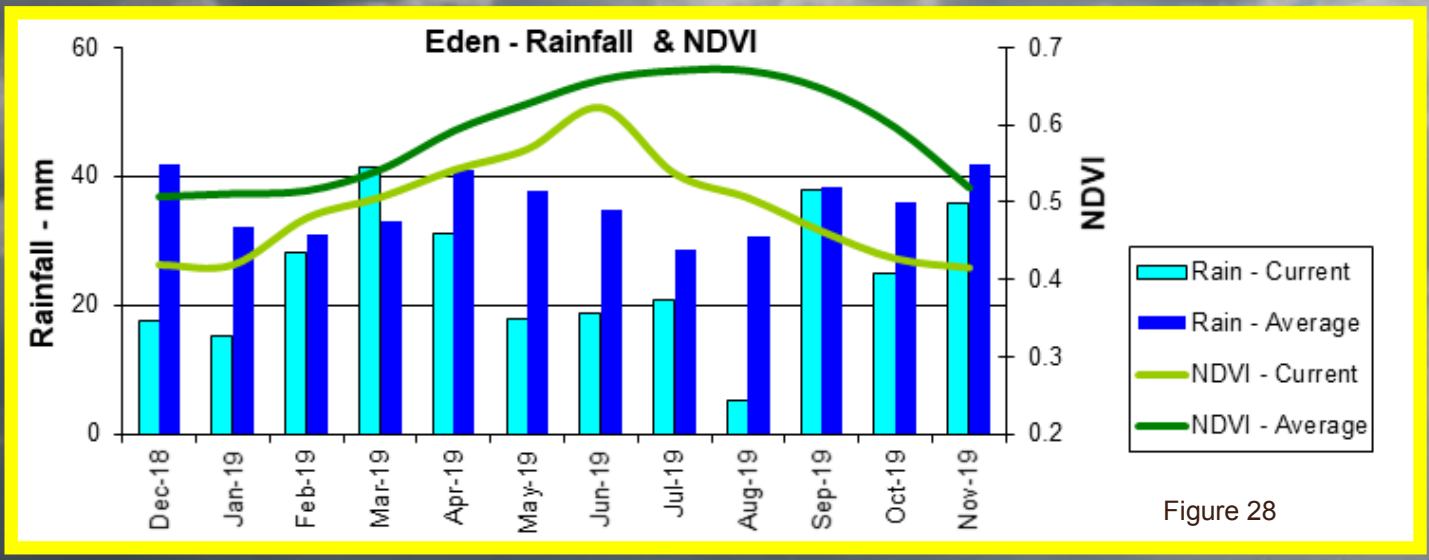

Figure 28

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 1-30 November 2019 per province. Fire activity was higher in the Western Cape compared to the long-term average.

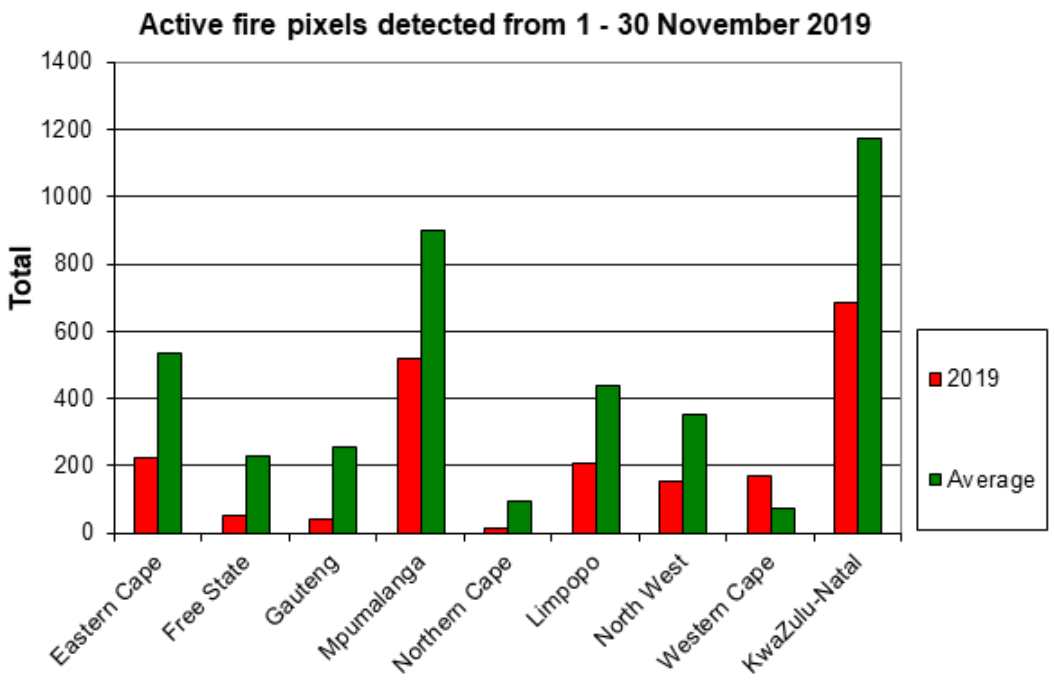

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-30 November 2019.

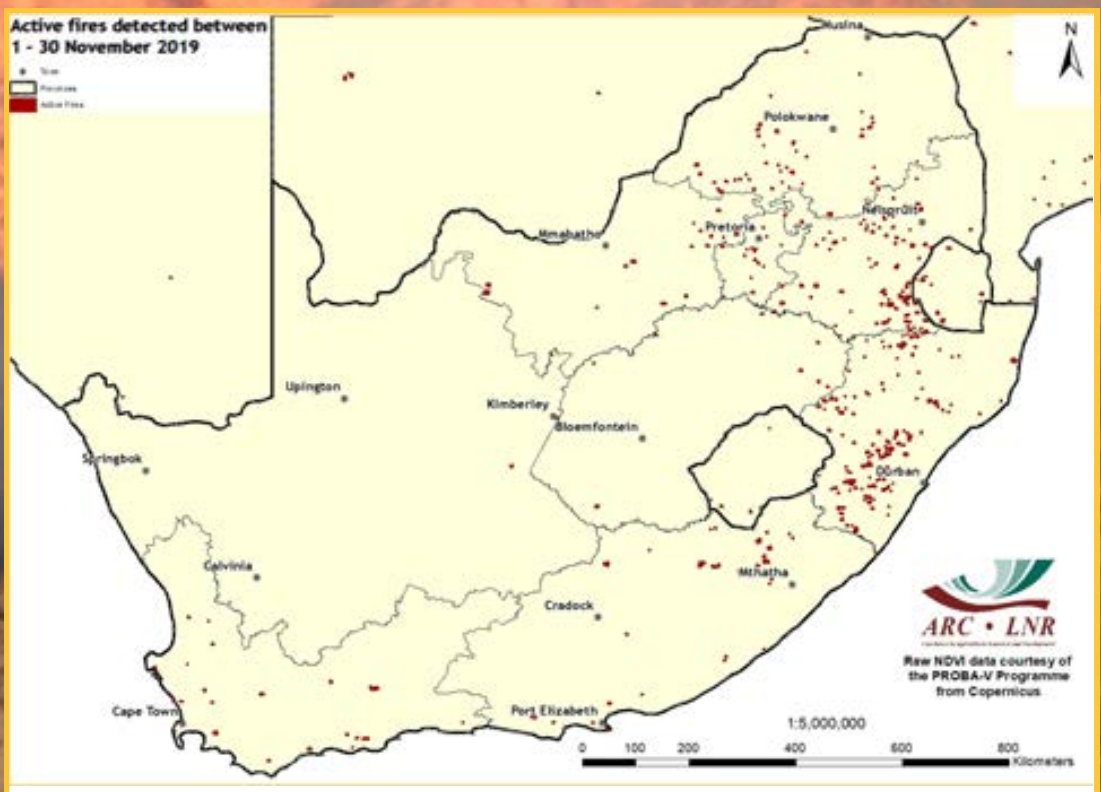

Figure 30

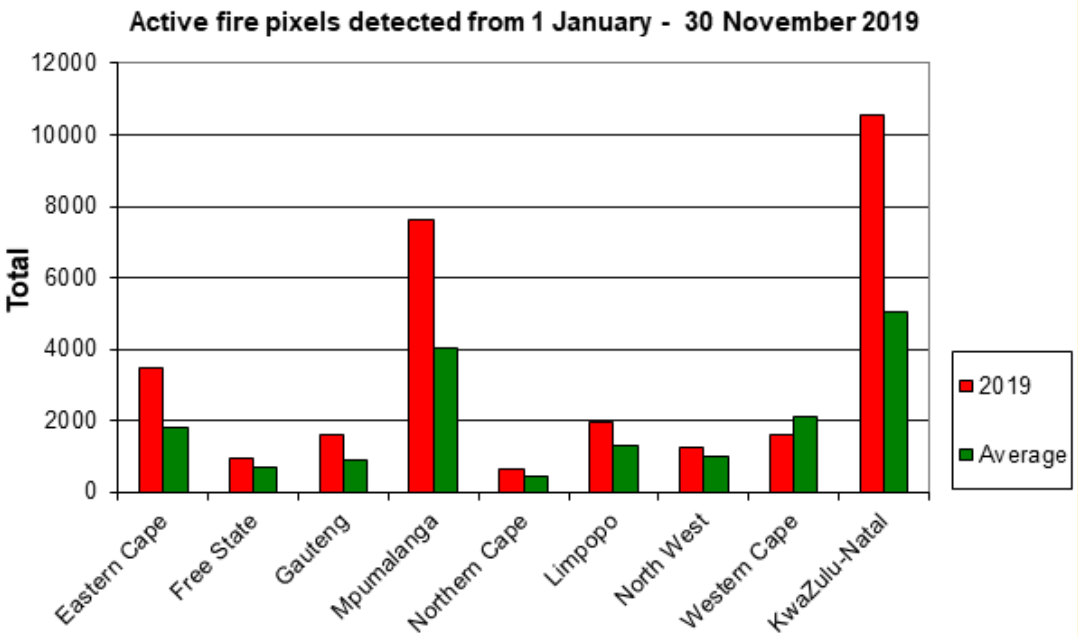

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January to 30 November 2019 per province. Fire activity was higher in all provinces except the Western Cape compared to the long-term average.

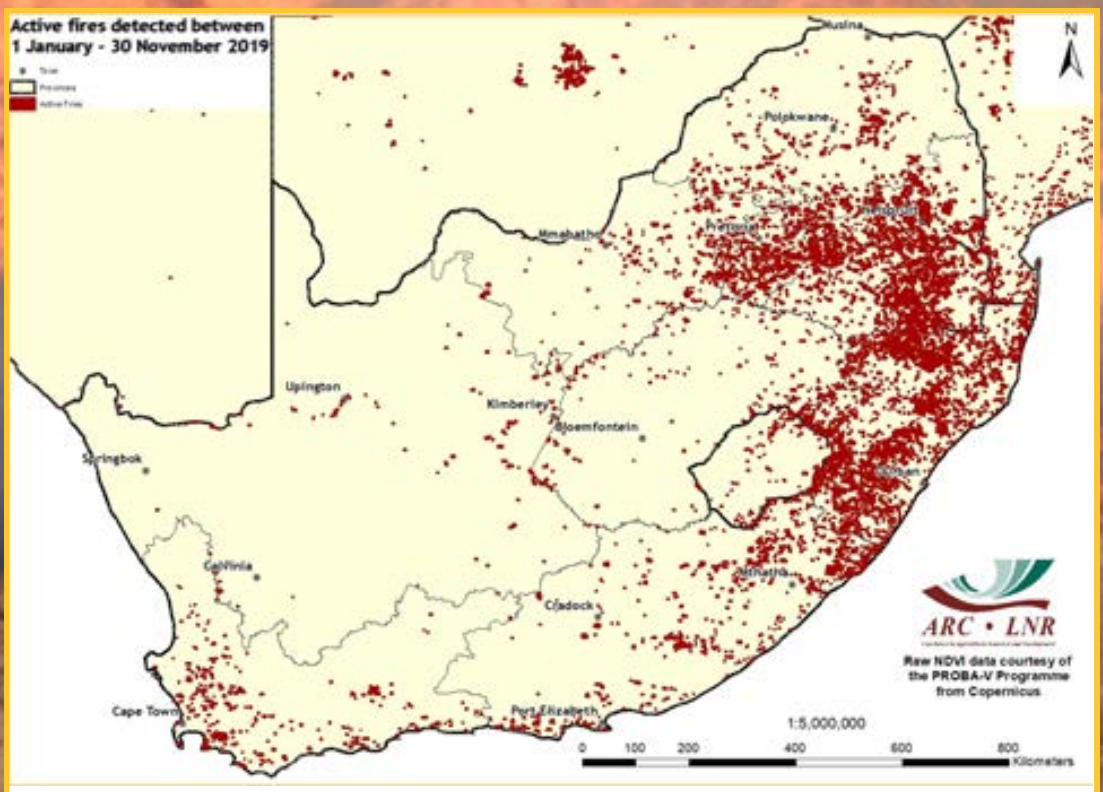

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January to 30 November 2019.

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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 3 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 in 2018. 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 2018.

The long-term map for November 2019 shows little change to the previous map for October, and again continues to show that the majority of water catchments across the country currently contain similar or slightly reduced surface water areas compared to the maximum recorded in the same catchment since the end of 2015.

Comparison between November 2019 and November 2018 continues to indicate that the majority of water catchments across the country are showing lower levels of surface water extent, with notable significant reductions in the Karoo, Kalahari and an increasing number of small local catchments in the Eastern Cape and KwaZulu-Natal.

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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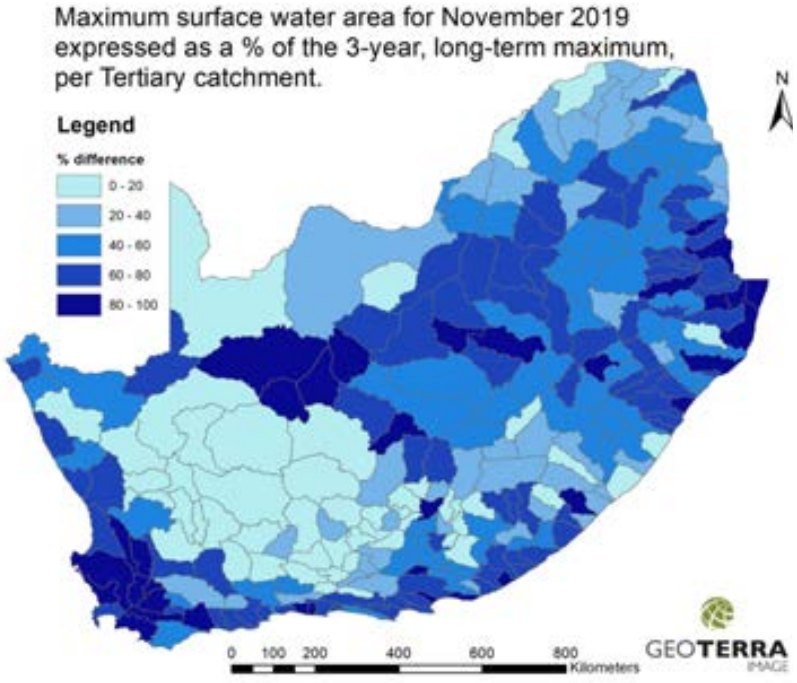

Figure 33

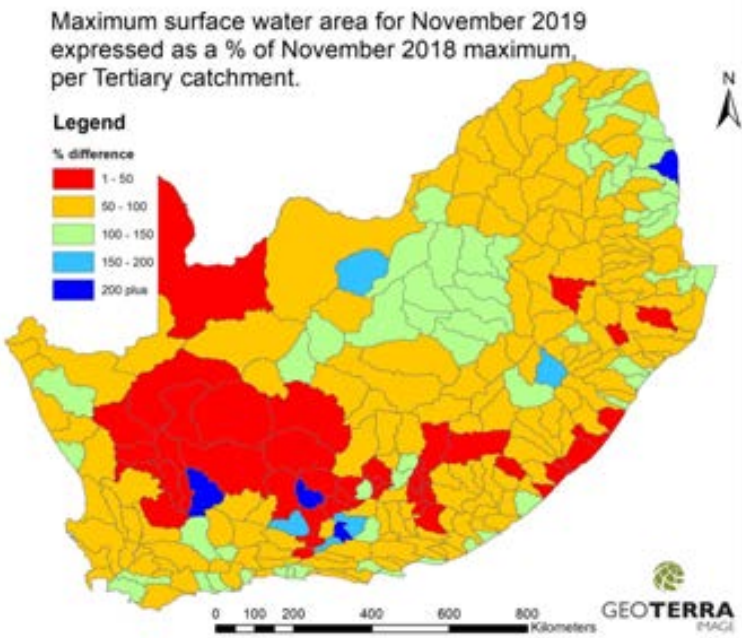

Figure 34

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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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".