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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

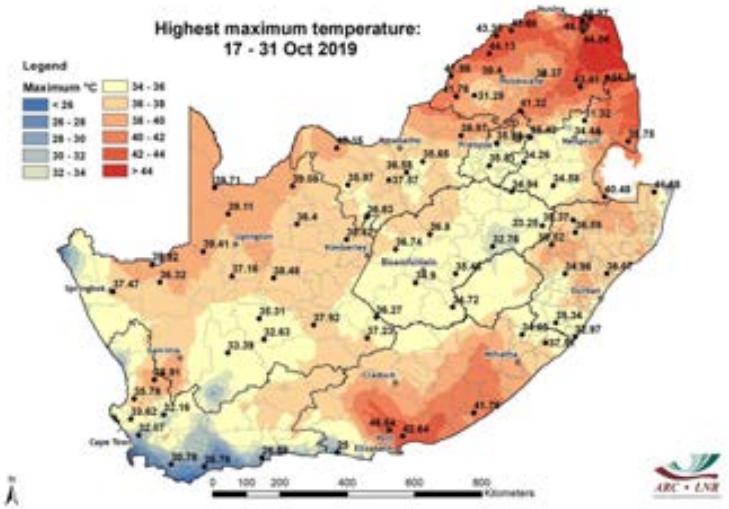
CONTENTS:

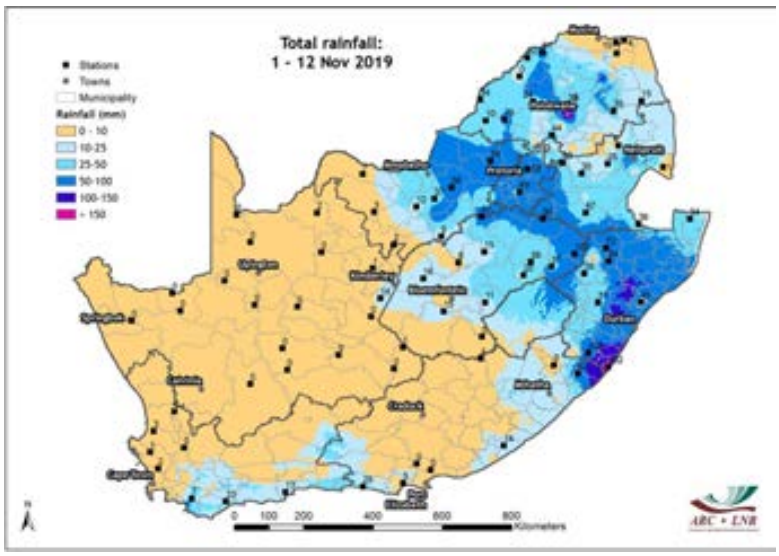
185th Edition

Images of the Month

Hot weather followed by good rains over northeastern South Africa

October 2019 was characterized by a series of unseasonably hot days over most parts of the country. This scorching weather was experienced across the summer rainfall region, particularly in parts of Gauteng, Limpopo, Mpumalanga, Northern Cape, Eastern Cape and KwaZulu-Natal. The month ended with exceptional heat, recording maximums of >44°C in the northern provinces of the country as well as in the Eastern Cape (see temperature map). However, the heat broke fairly quickly after a cut-off low caused stormy weather over the summer rainfall region during the beginning of November. Scattered to widespread severe thunderstorms with strong damaging winds and large hail were observed over the eastern half of the country. The total rainfall map for the period 1-12 November below shows that large areas of KwaZulu-Natal, North West, Gauteng, Free State and Mpumalanga recorded between 50 and 100 mm, with even higher amounts (>150 mm) along the Wild Coast and in Zebediela, south of Polokwane. These were the first significant rains for the summer rainfall region, bringing some relief to drought affected areas. On the 12th and 14th of November, severe thunderstorms formed tornados near both New Hanover and Bergville. According to the South African Weather Service (SAWS), these resulted in damage to property and loss of life. It is therefore advisable to keep track of extreme weather warnings. Farmers should also be alert for signs of potential fires, especially during strong windy days. Periodic checks for pests, diseases and ticks on livestock are also essential as high insect activity is likely to become widespread, particularly if preceding seasons have been dry.





The Agricultural Research Council - Institute for Soil, Climate and Water (ARC-ISCW) collected the data, generated the products and compiled the information contained in this newsletter, as part of the Coarse Resolution Imagery Database (CRID) project that was funded by the Department of Agriculture and Department of Science and Technology at its inception and is currently funded by the Department of Agriculture, Land Reform and Rural Development.

1. Rainfall

Overview:

Rainfall conditions in October 2019 were fairly similar to the previous month. Rainfall was largely absent over much of the summer rainfall region. Below-normal rainfall was observed over the Northern Cape, Eastern Cape, North West, Free State, southern parts of Gauteng and the Lowveld of Limpopo. Areas that recorded totals of between 25 and 100 mm for the whole month include the coastlines of the Northern Cape, Eastern Cape and KwaZulu-Natal, as well as Mpumalanga and central parts of Limpopo. The month started with thunderstorms accompanied by hail over the Eastern Cape south coast, KwaZulu-Natal Midlands and southern Gauteng. However, most rainfall occurred towards the end of the month, bringing relief from the very hot and dry conditions in Limpopo, Gauteng, KZN and Mpumalanga. In the winter rainfall region, a cold front made landfall in the latter part of the month, causing heavy rainfall with destructive winds, resulting in localized flooding over the southwestern parts of the country.

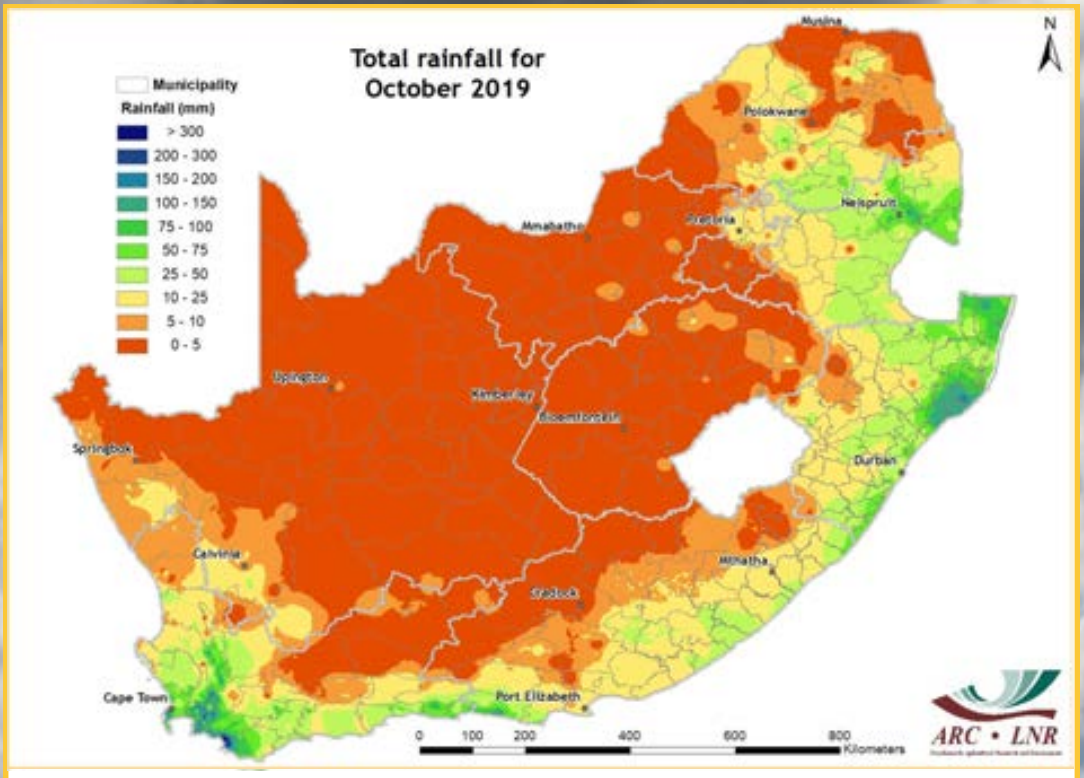


Figure 1

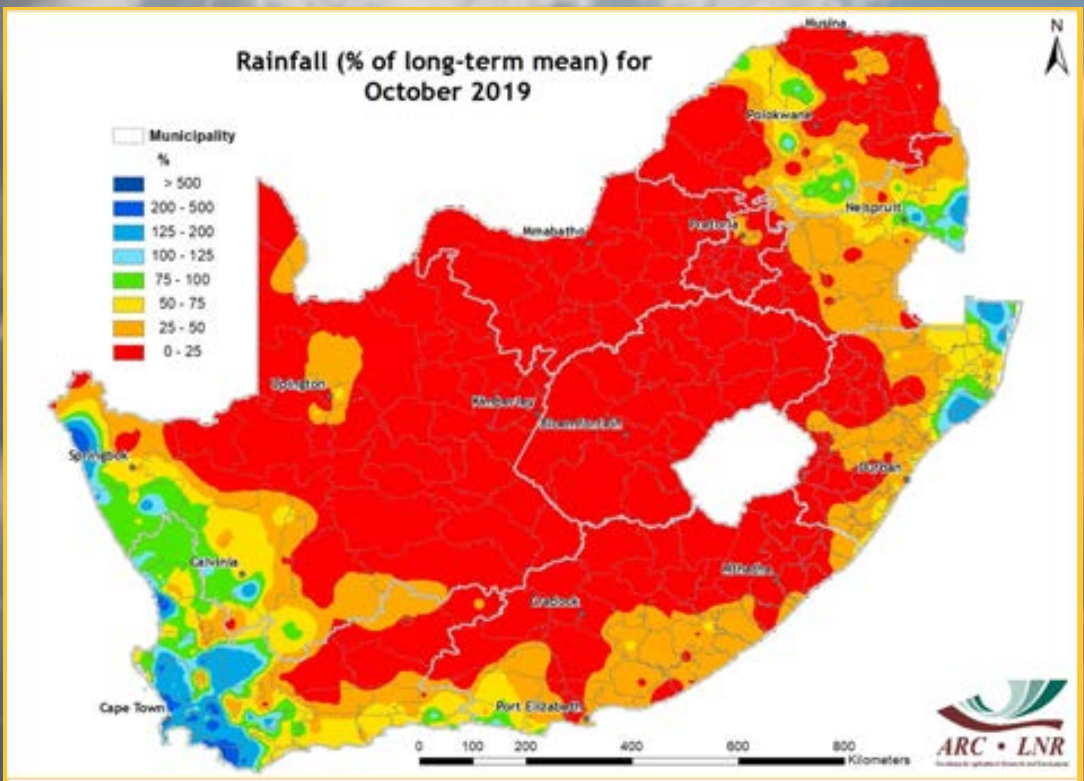
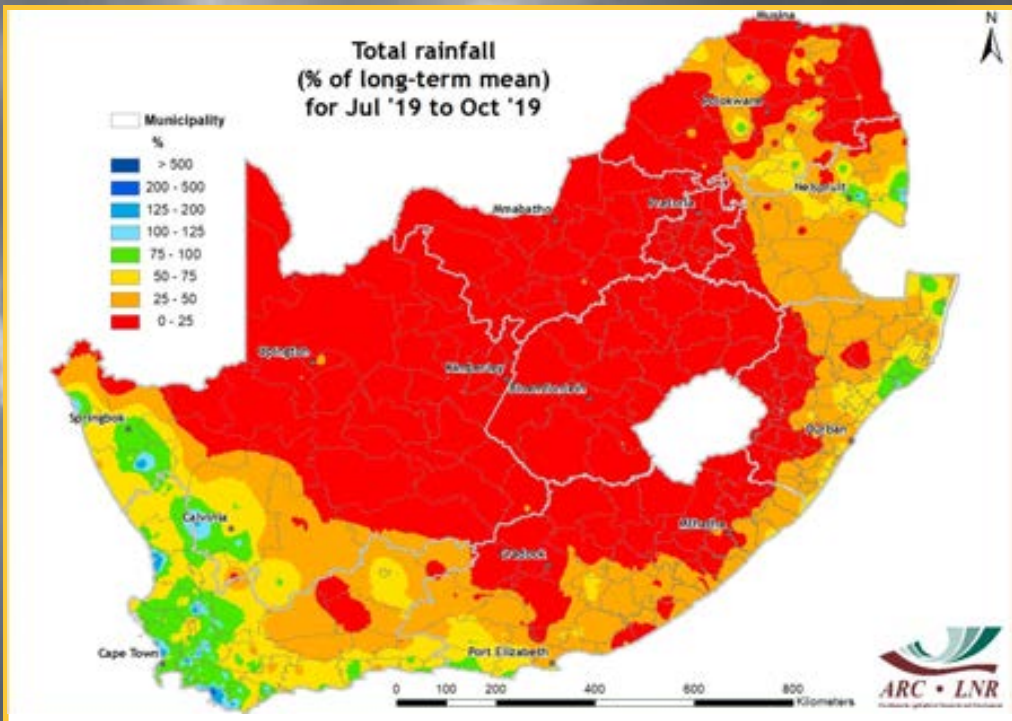


Figure 2



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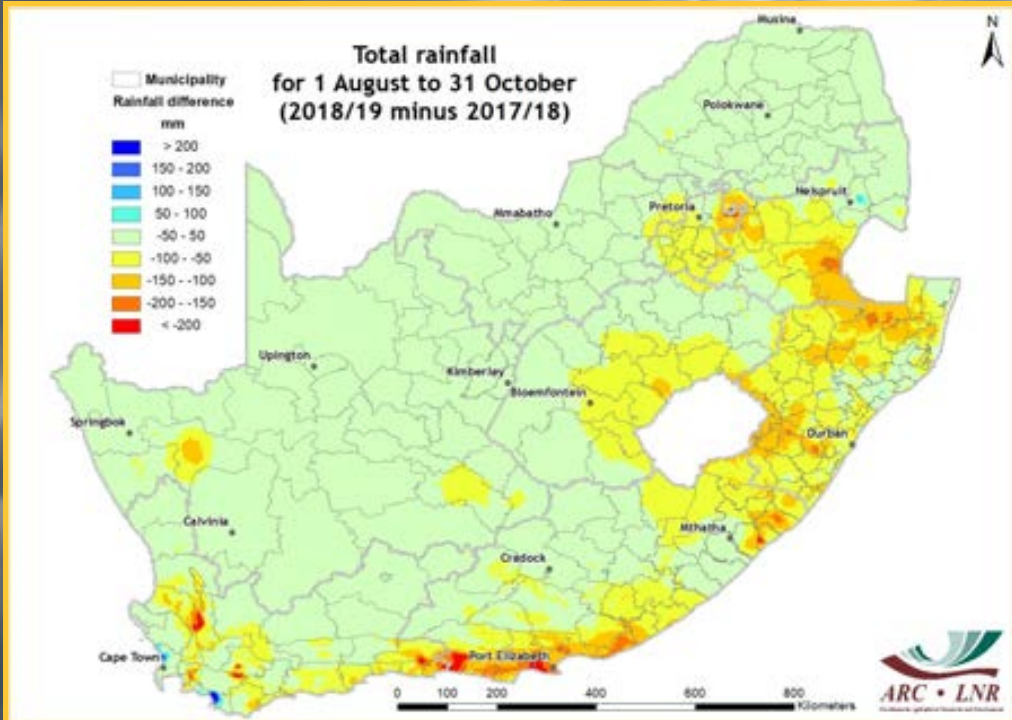

Figure 4

Figure 1:
The central interior and the Limpopo Lowveld were mostly dry during October 2019, while the western Northern Cape received a small amount of rainfall. Considerable amounts of rainfall were recorded along the coastal belts of Western Cape, Eastern Cape and KwaZulu-Natal, as well as Mpumalanga and central areas of Limpopo.

Figure 2:
Rainfall was below normal over most parts of the summer rainfall region, including the central to southern interior and towards the Northern Cape. Above-normal rainfall occurred along the coasts of the Northern Cape and Western Cape, as well as parts of KZN and Mpumalanga.

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

Figure 4:
Greater parts of Gauteng, Mpumalanga, KwaZulu-Natal, Free State and some parts of the Cape provinces received much less rain during August-October 2019 as compared to the same period 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 October 2019. The short-term (6-month) accumulation of drought indicates widespread extreme drought over the Lowveld, central interior and towards the eastern parts of the country. Meanwhile, patches of mild to extreme drought are depicted over the rest of the country. The 12-month SPI shows the prevalence of extreme drought over much of the Northern Cape, Eastern Cape, parts of the Western Cape and the north-eastern provinces. Long-term time scales (24- to 36-month) indicate no prospects of rainfall over the Northern Cape, with widespread moderate to extreme drought conditions observed over the western half of the country. Farmers in the drought stricken areas can be advised that it is important to sell mature livestock and to continue assessing the grazing and available feed for proper planning.

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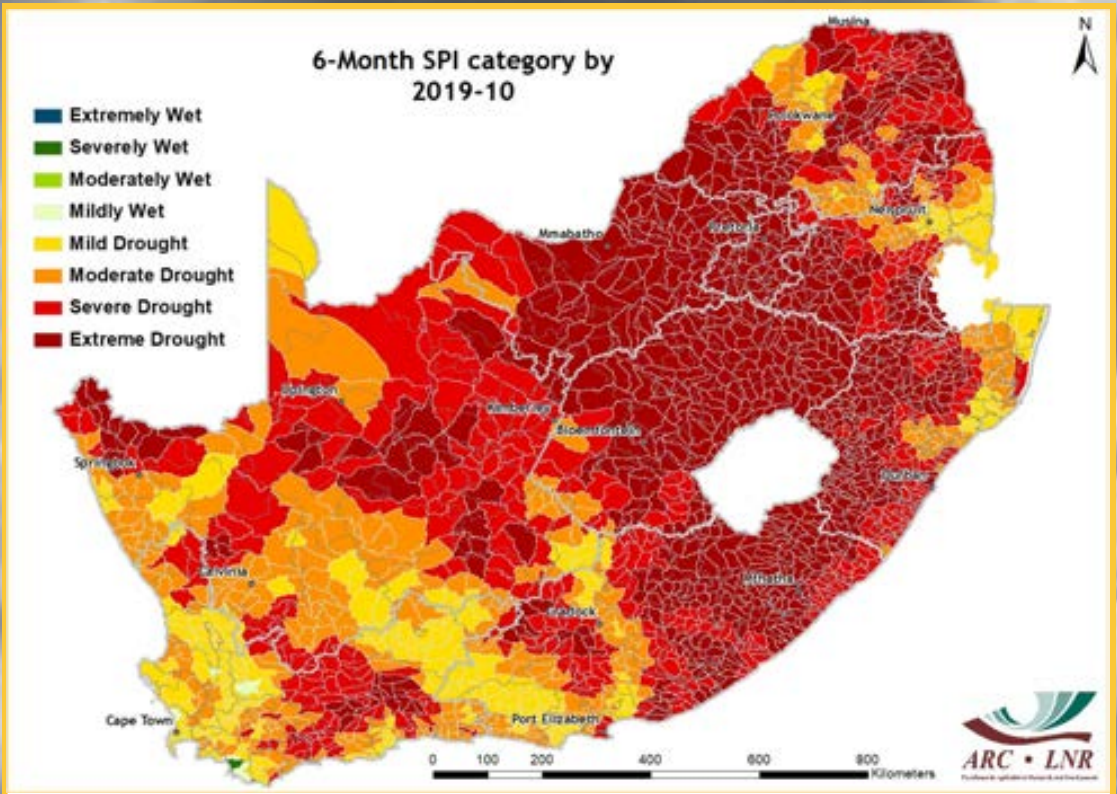

Figure 5

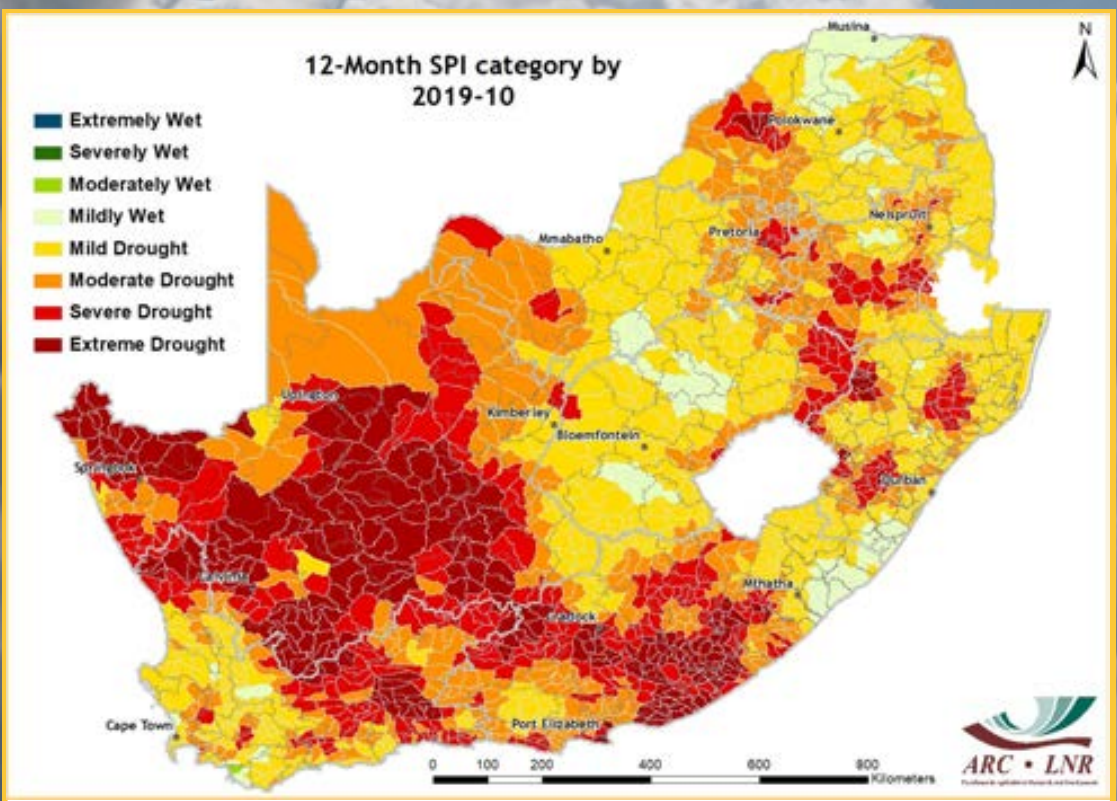

Figure 6

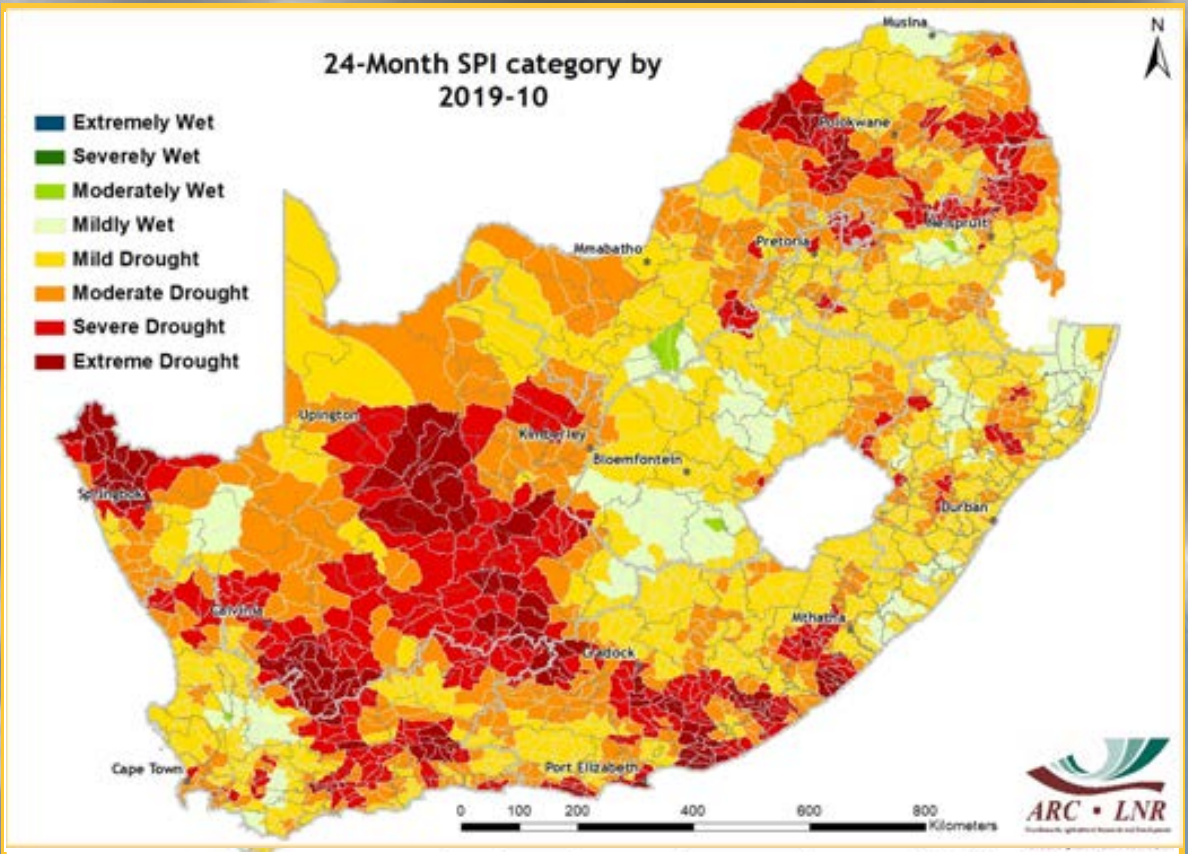

Figure 7

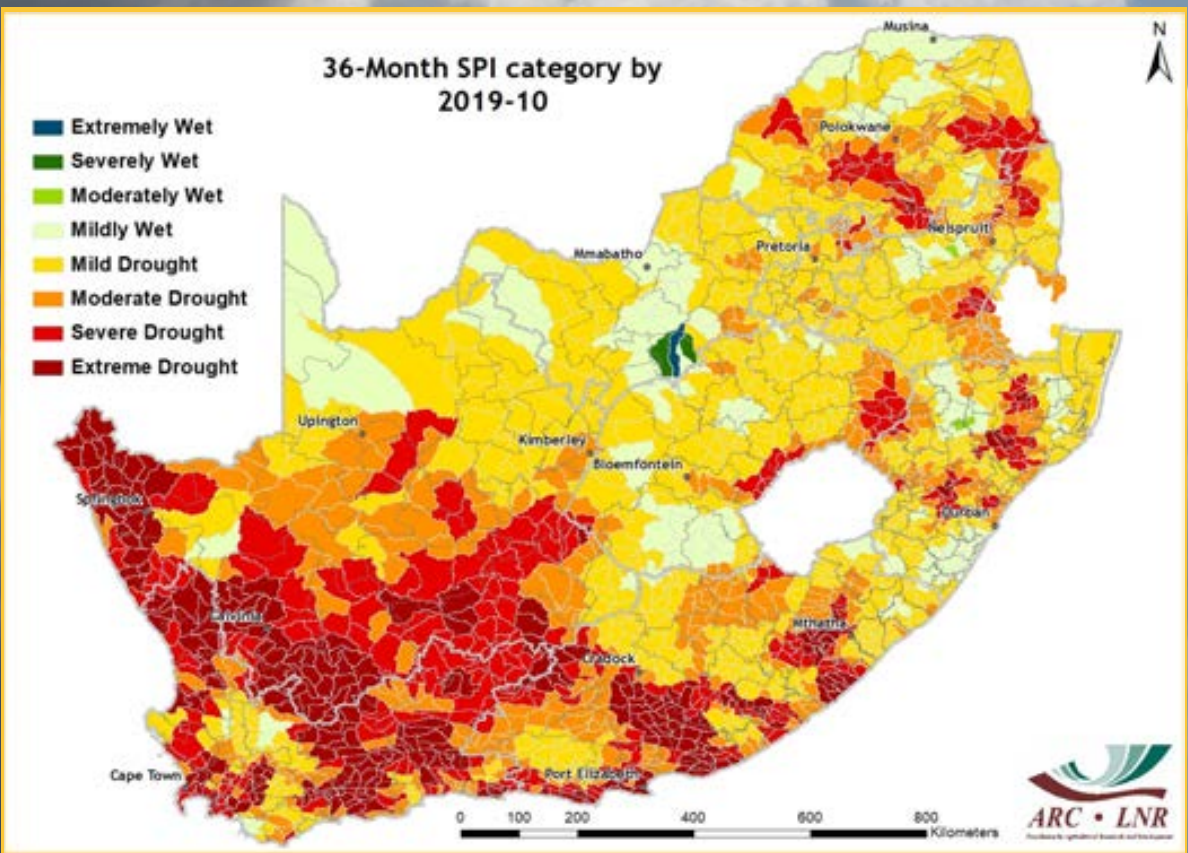

Figure 8

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.

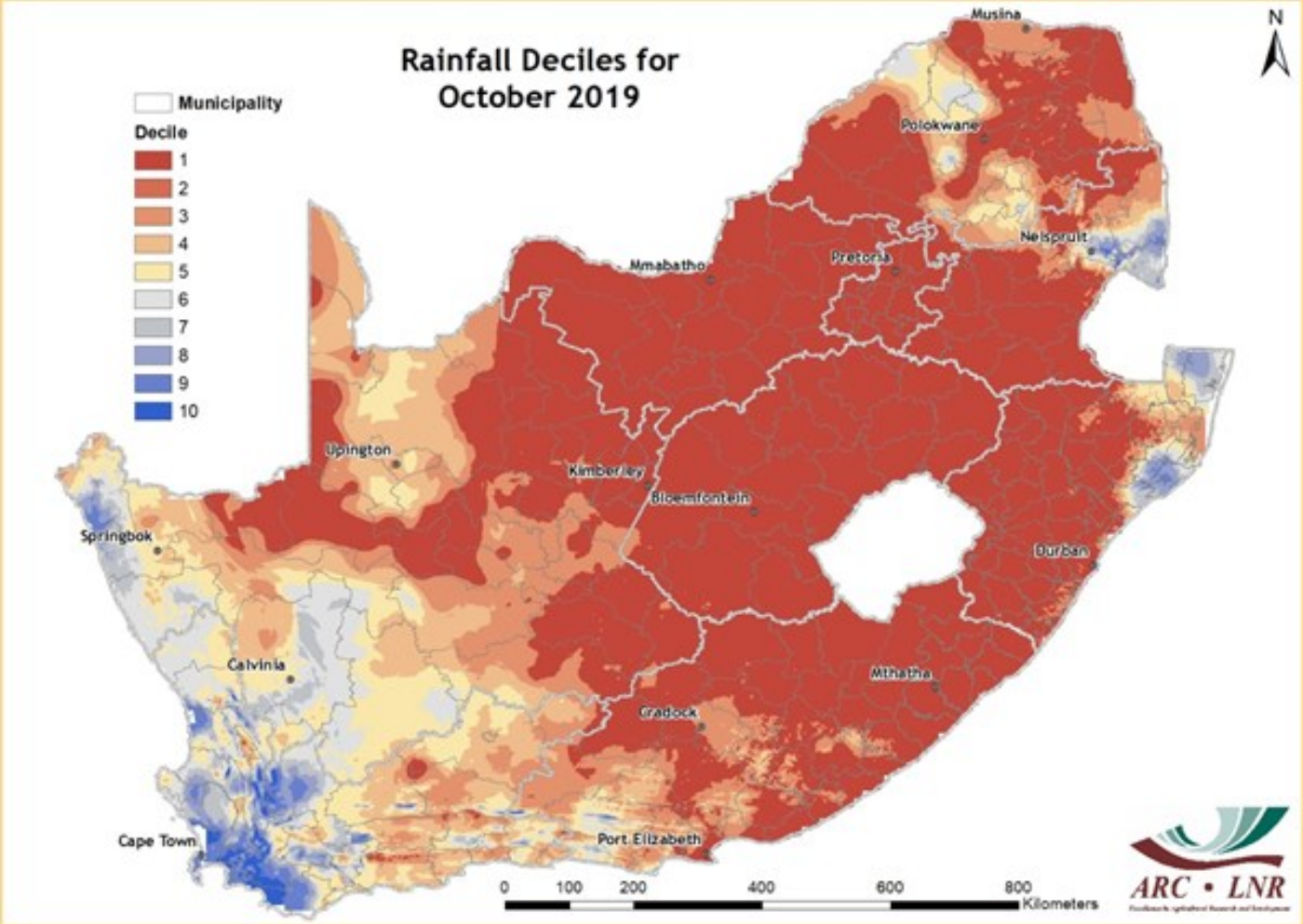

Figure 9

Figure 9:
The western parts of the Northern Cape to the winter rainfall region, as well as northeastern parts of the country and northern Kwa-Zulu-Natal, compare well with historically wetter October months, while the interior to southeastern parts remain dry.

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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.

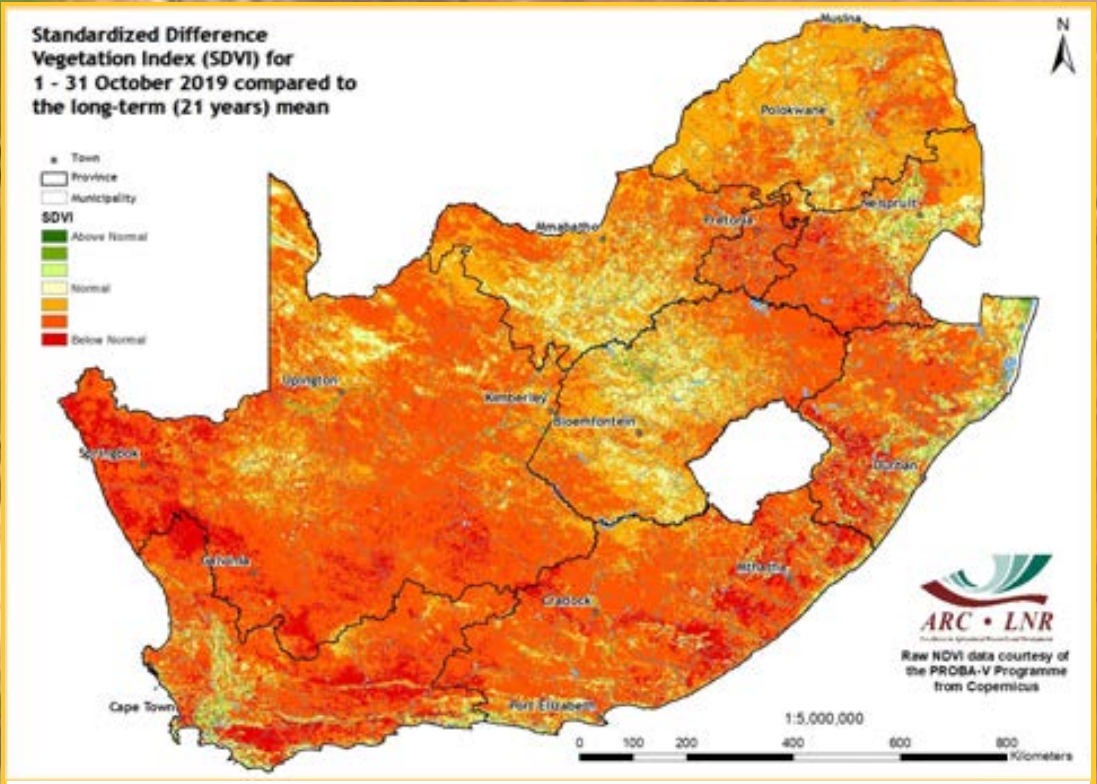

Figure 10

Figure 10:
The SDVI map for October 2019 shows that, relative to the vegetation condition trends computed over 21 years, poor vegetation activity spread over many parts of the country.

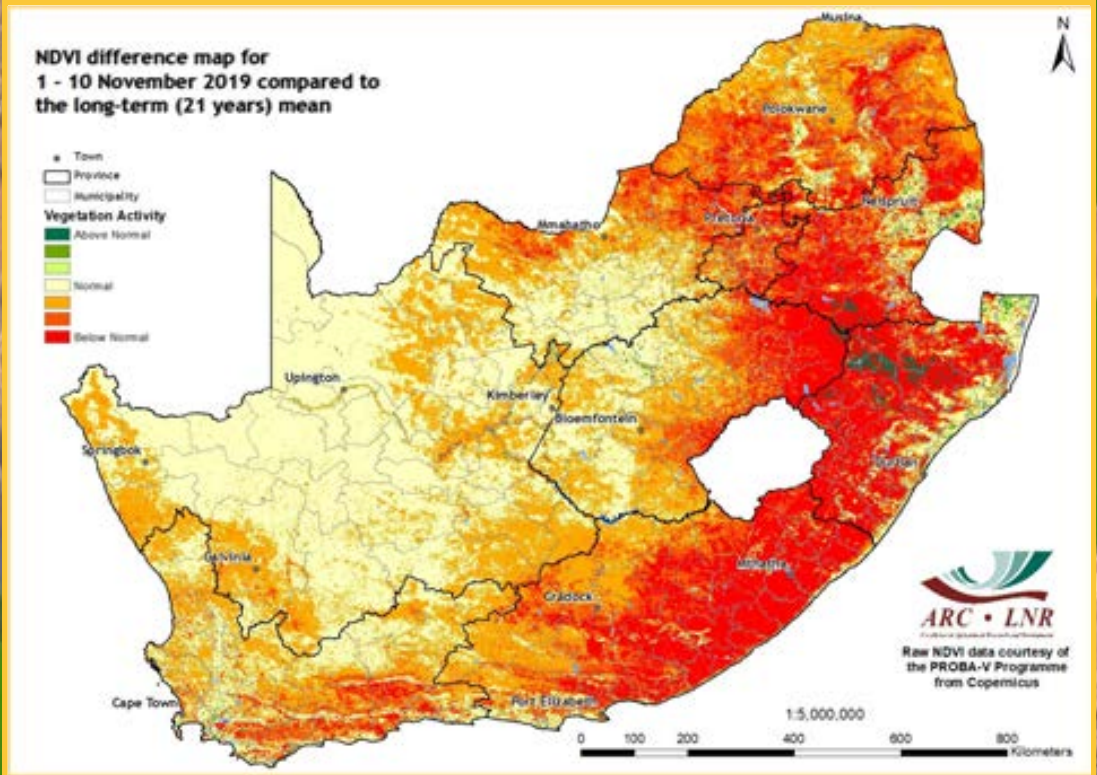

Figure 11

Figure 11:
The NDVI difference map for the first 10 days of November 2019 shows a shift in vegetation conditions, with below-normal vegetation being concentrated in the eastern parts of the country, while the western parts - particularly the Northern Cape Province - experienced normal vegetation conditions.

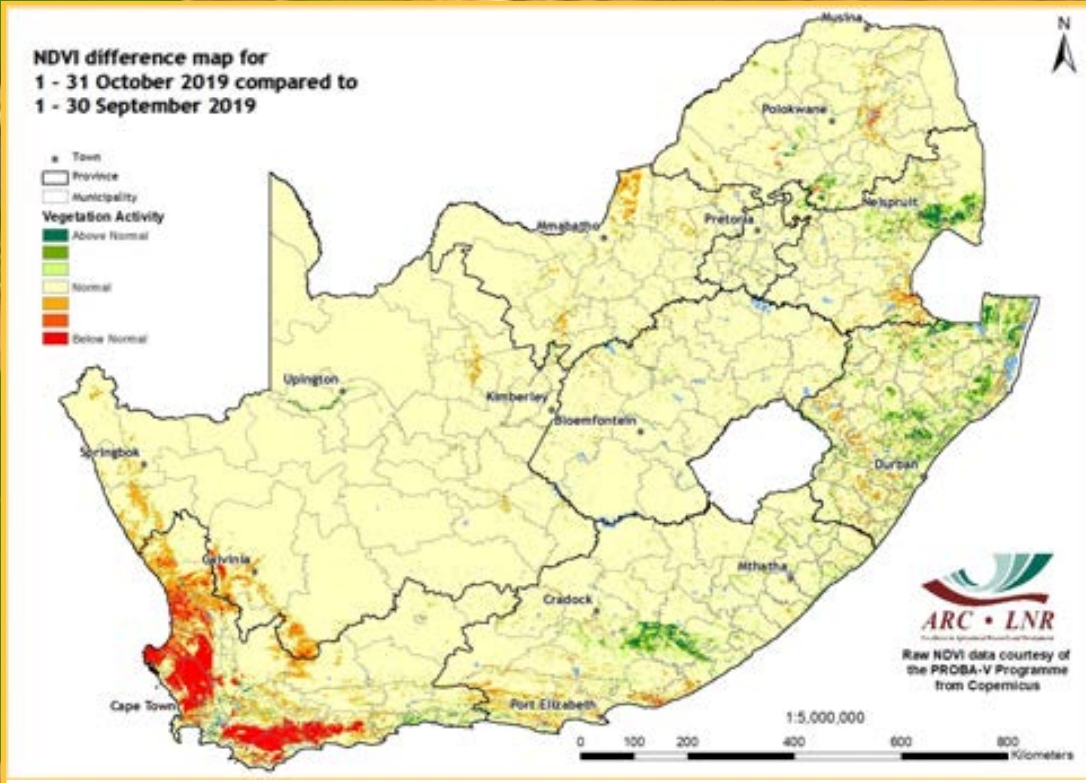

Figure 12

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

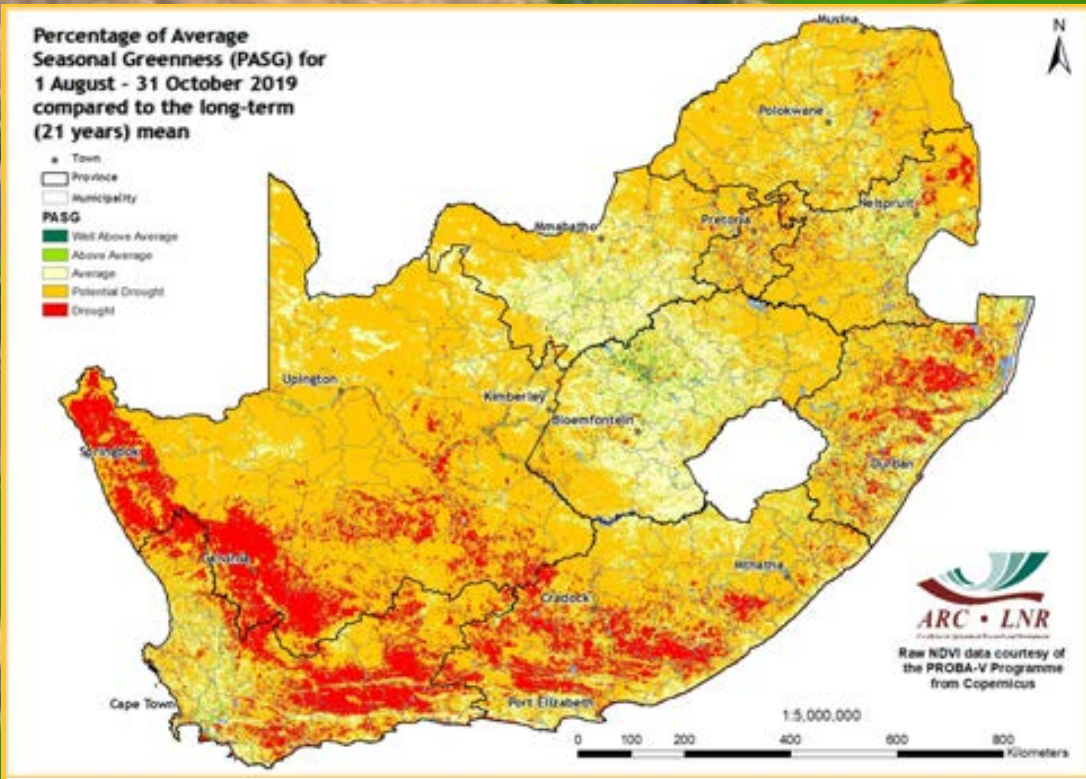

Figure 13

Figure 12:
Compared to the previous month, the October 2019 NDVI map shows that many parts of the country experienced normal vegetation activity. However, the far western parts of the Western Cape 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 alarmingly low vegetation greenness while with isolated areas in the Free State and North West experienced 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.

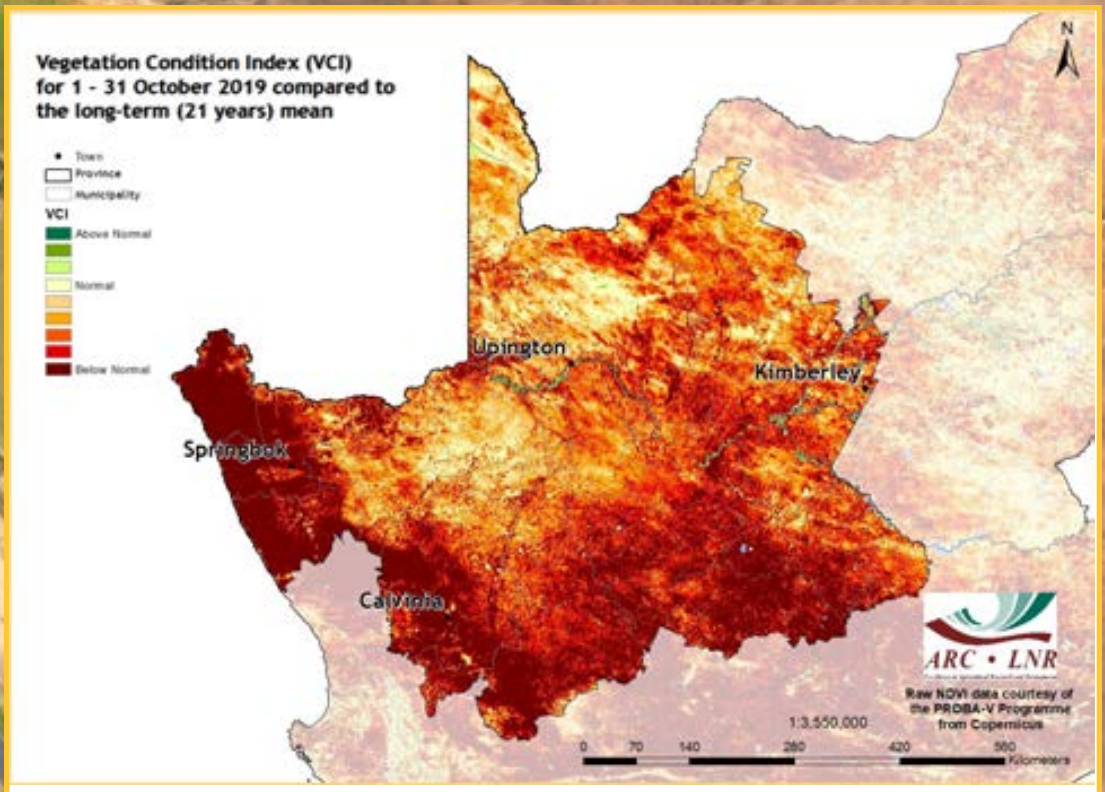


Figure 14

Figure 14:
The VCI map for October 2019 shows that severe drought conditions prevail in the Northern Cape as shown by the poor levels of vegetation activity.

Figure 15:
While Gauteng Province has in previous months experienced only minor effects of drought, the opposite was observed during the month of October, as shown on the VCI map where many parts of the province experienced poor vegetation conditions.

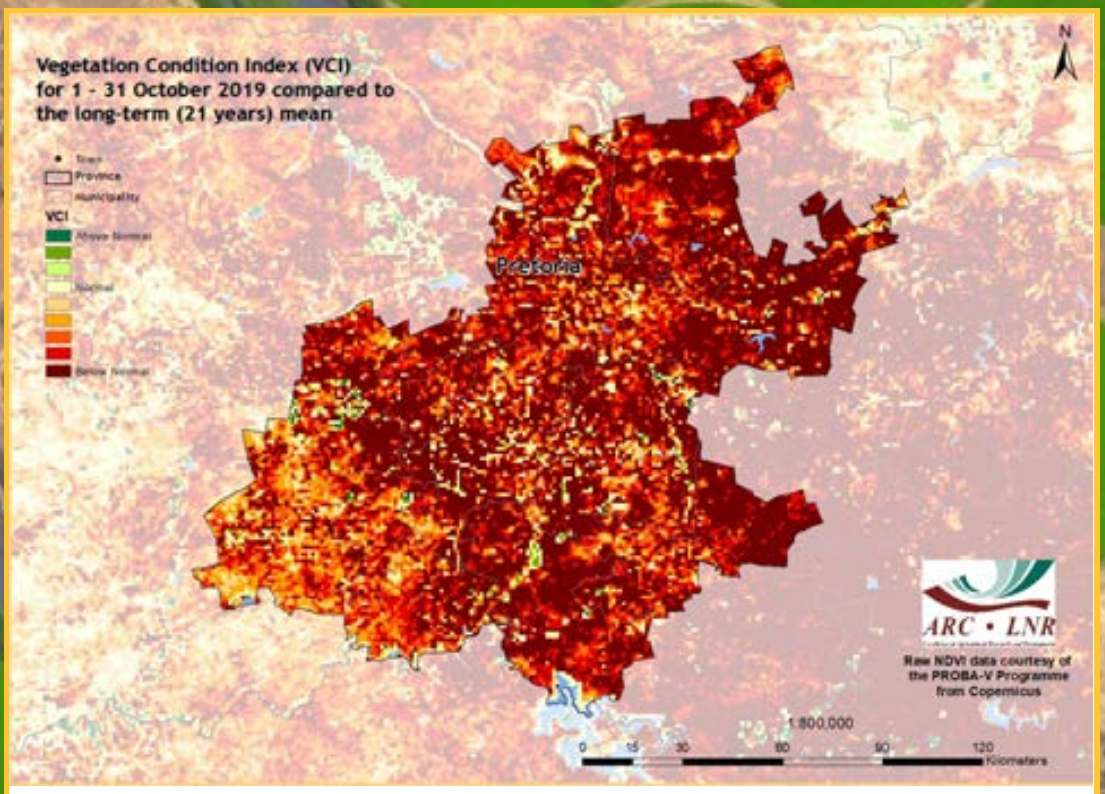
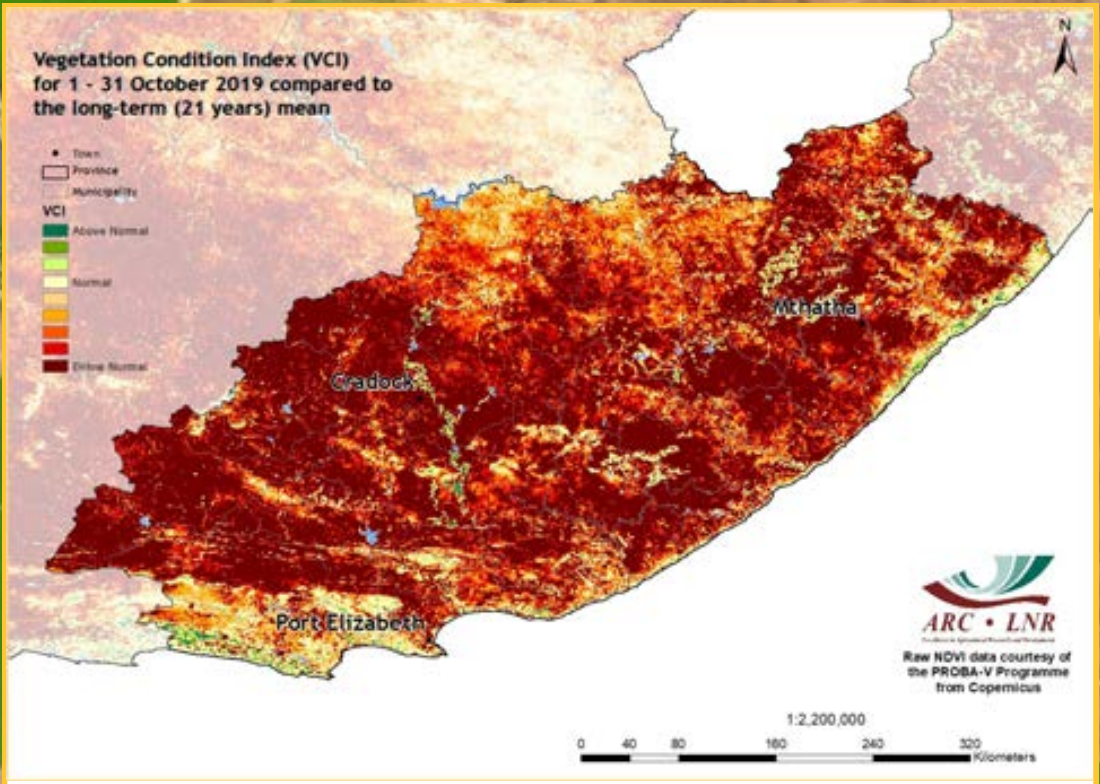


Figure 15



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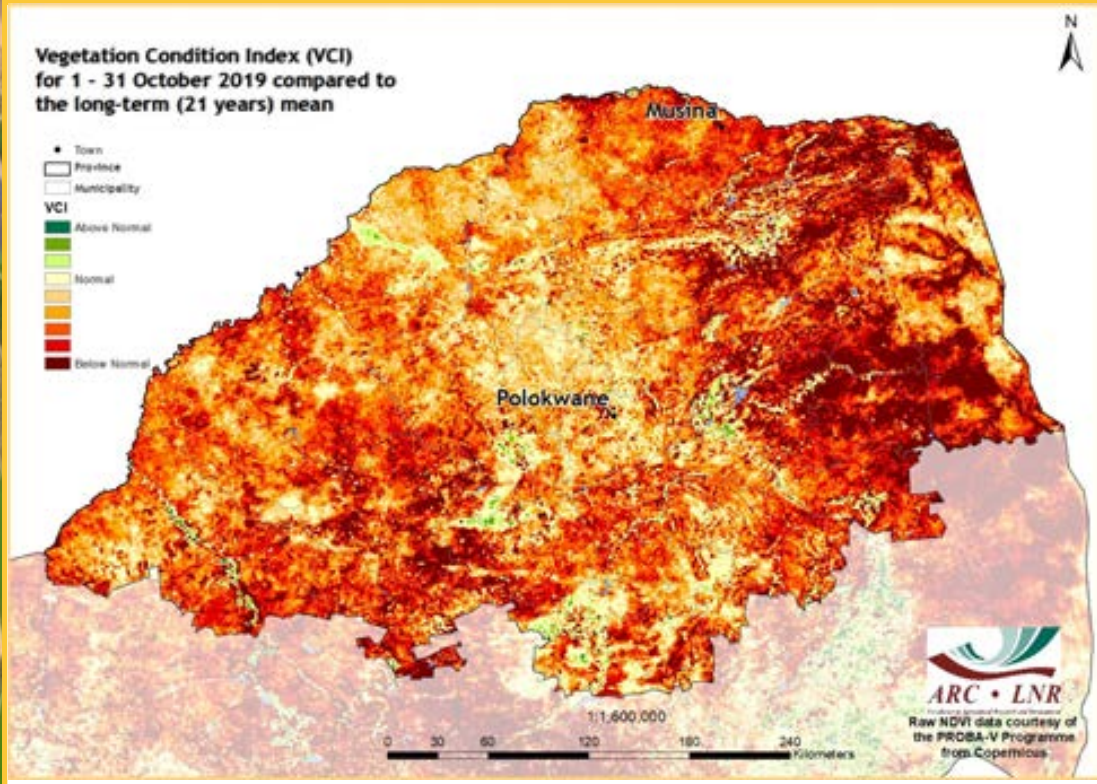

Figure 17

Figure 16:
The VCI map for the Eastern Cape shows that compared to the long-term average, many parts of the province continue to experience poor vegetation activity. Minor exceptions were observed in some isolated areas, particularly in the Kau-Kamma, Kouga local municipality and the coastal belt of the OR Tambo district.

Figure 17:
Many parts of Limpopo Province continue to experience poor vegetation conditions as evidenced by the VCI map for October.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

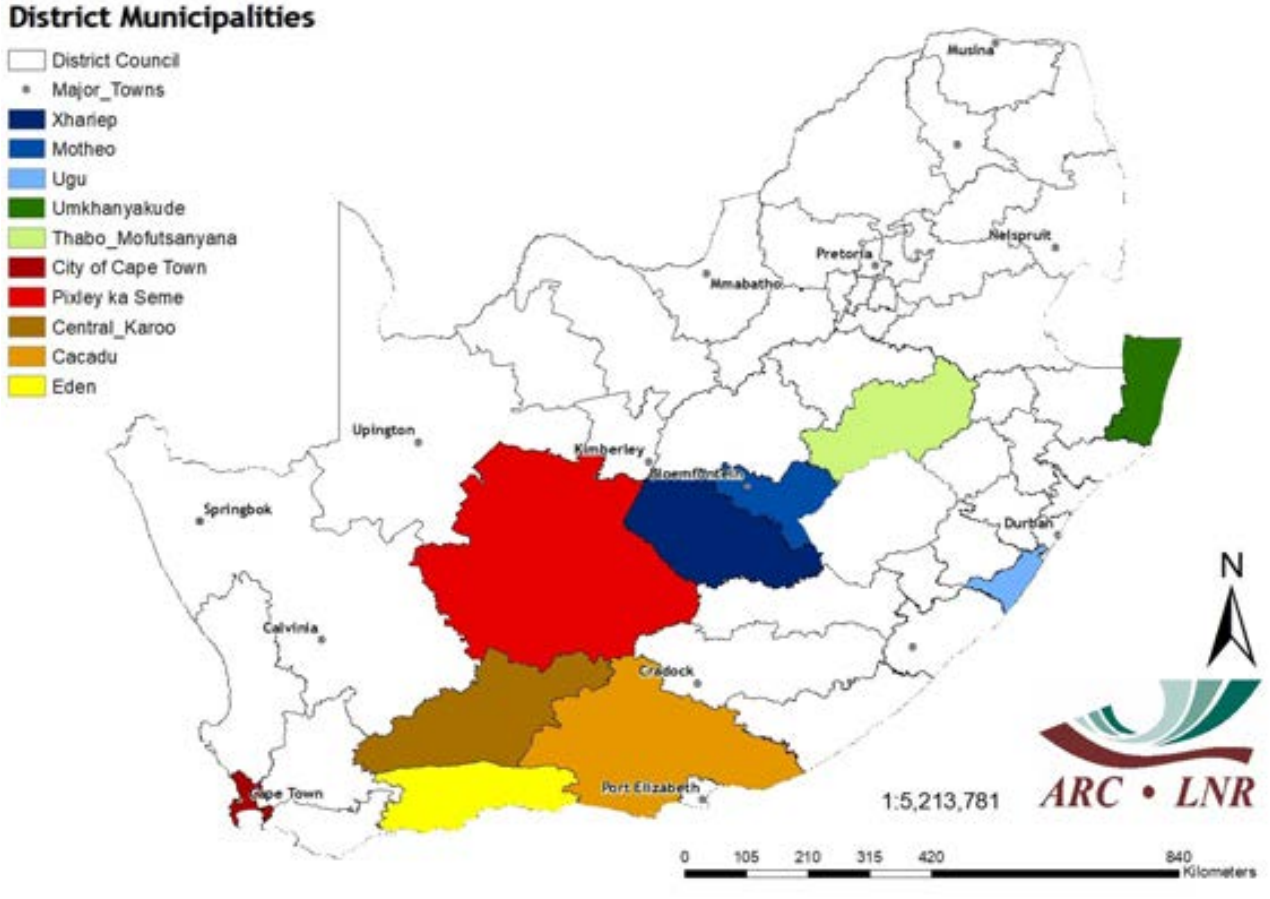

Figure 18

Rainfall and NDVI Graphs

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

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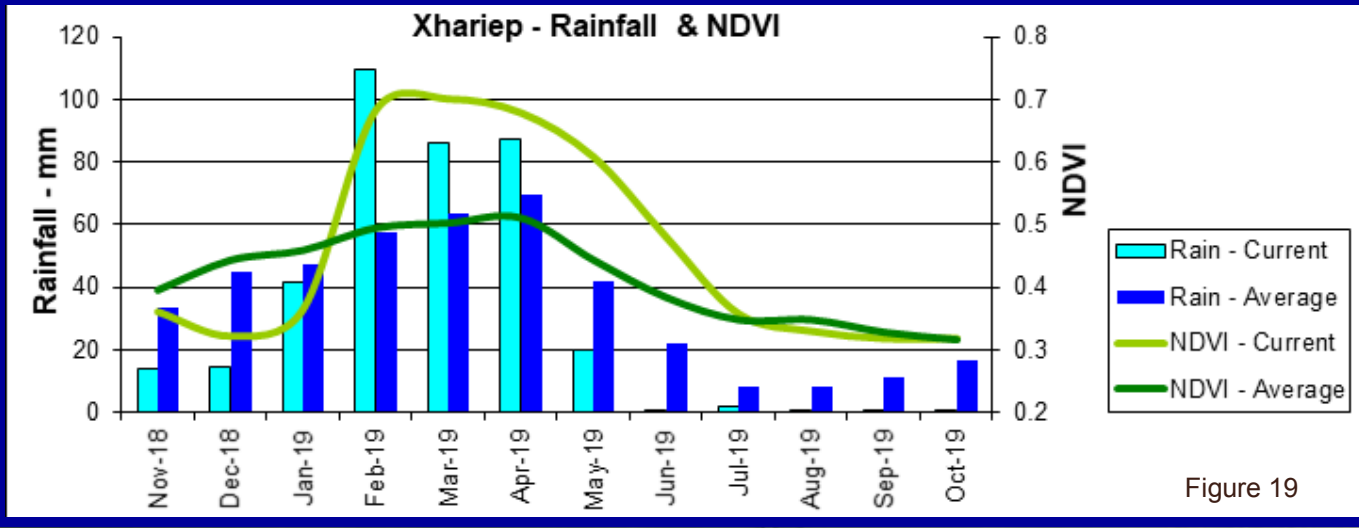
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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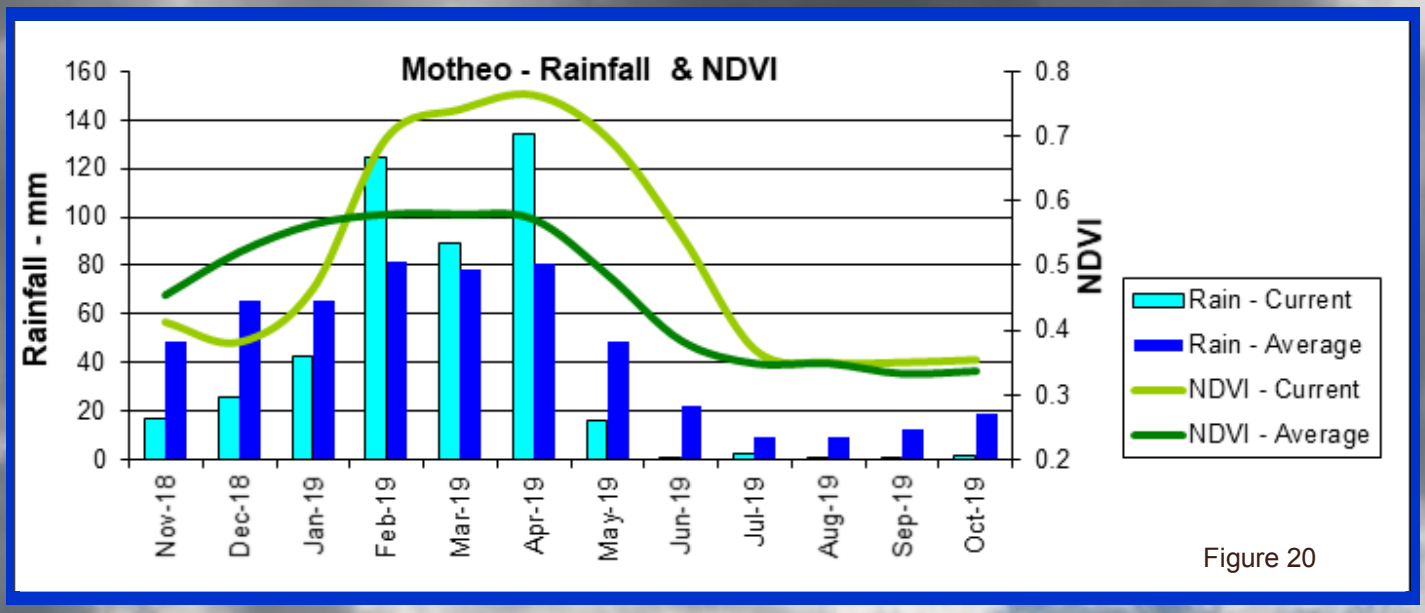

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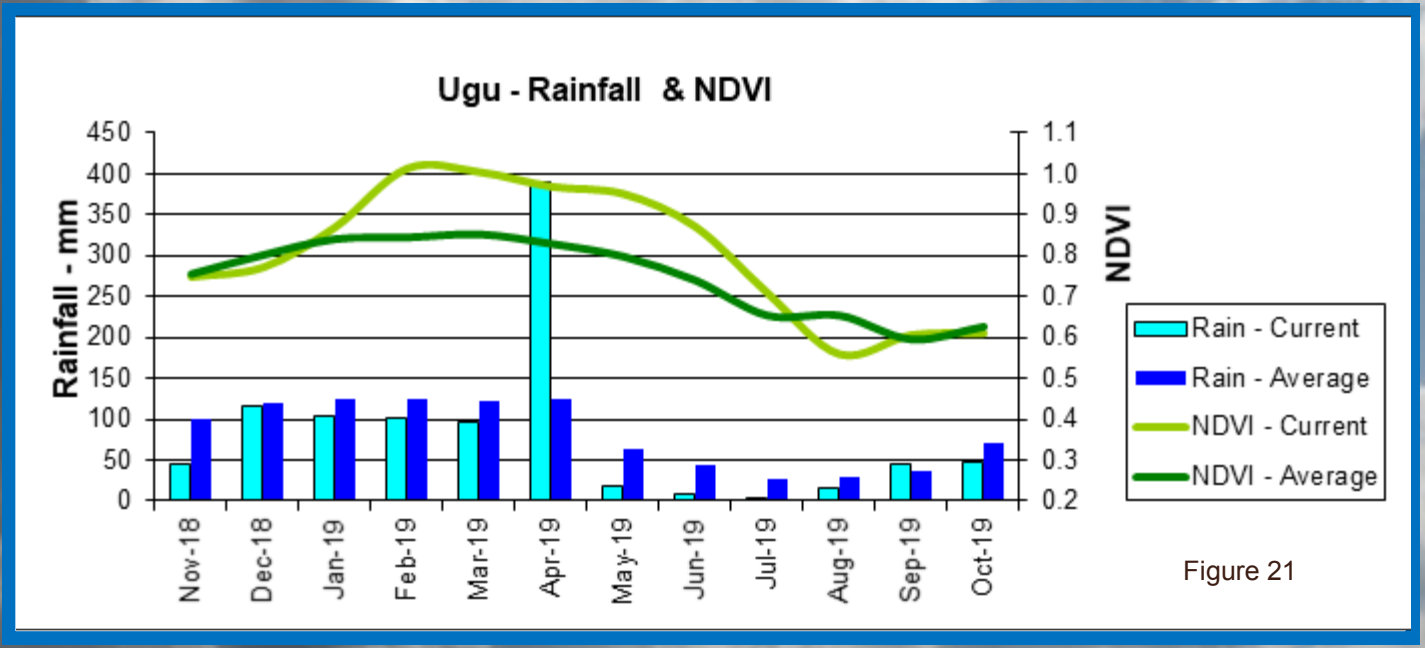

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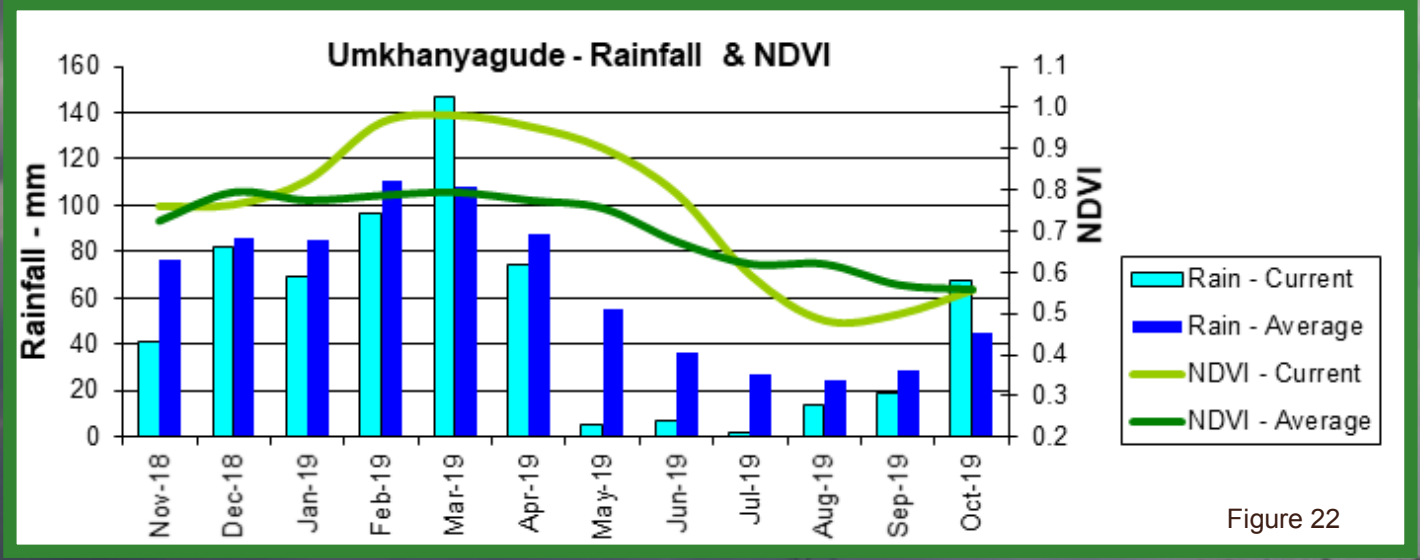

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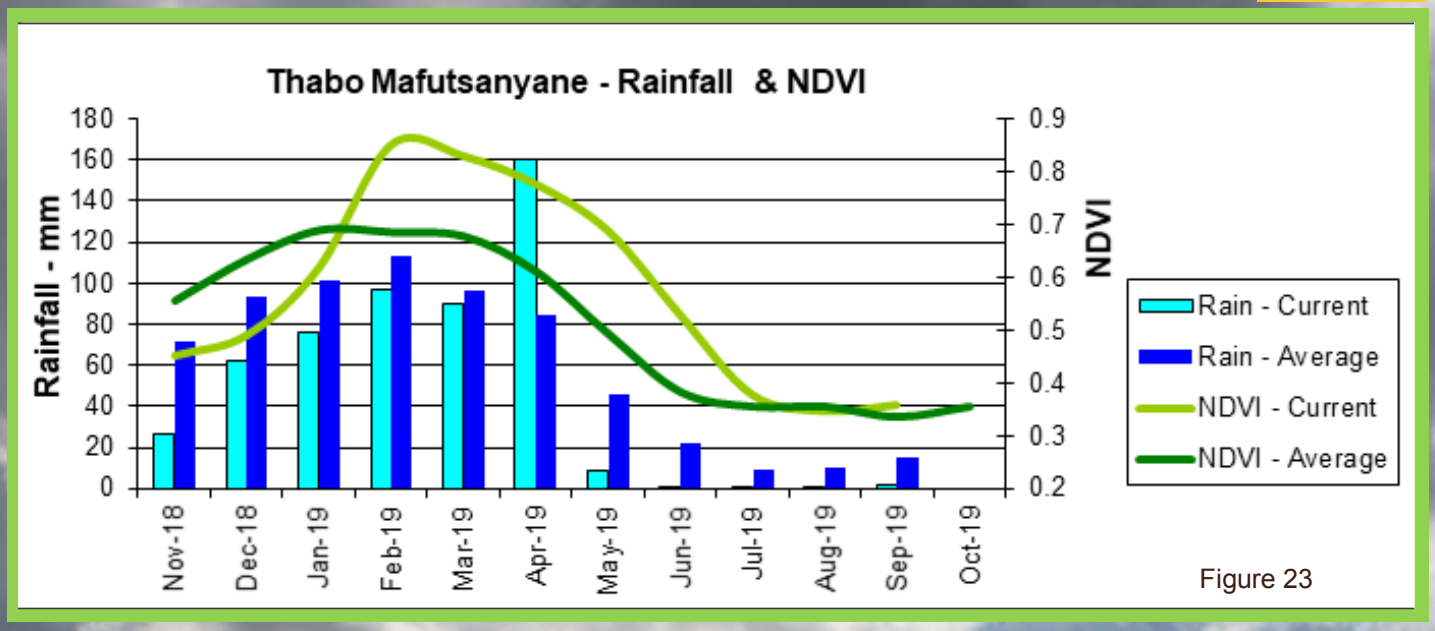

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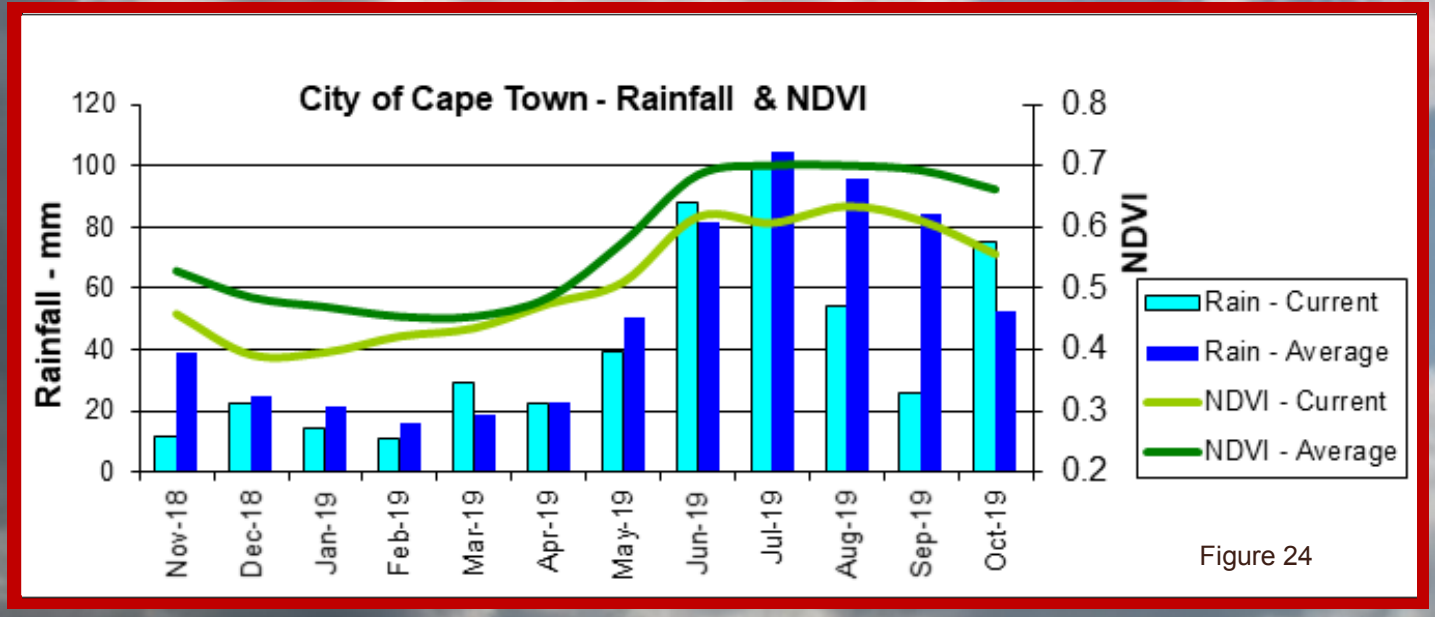

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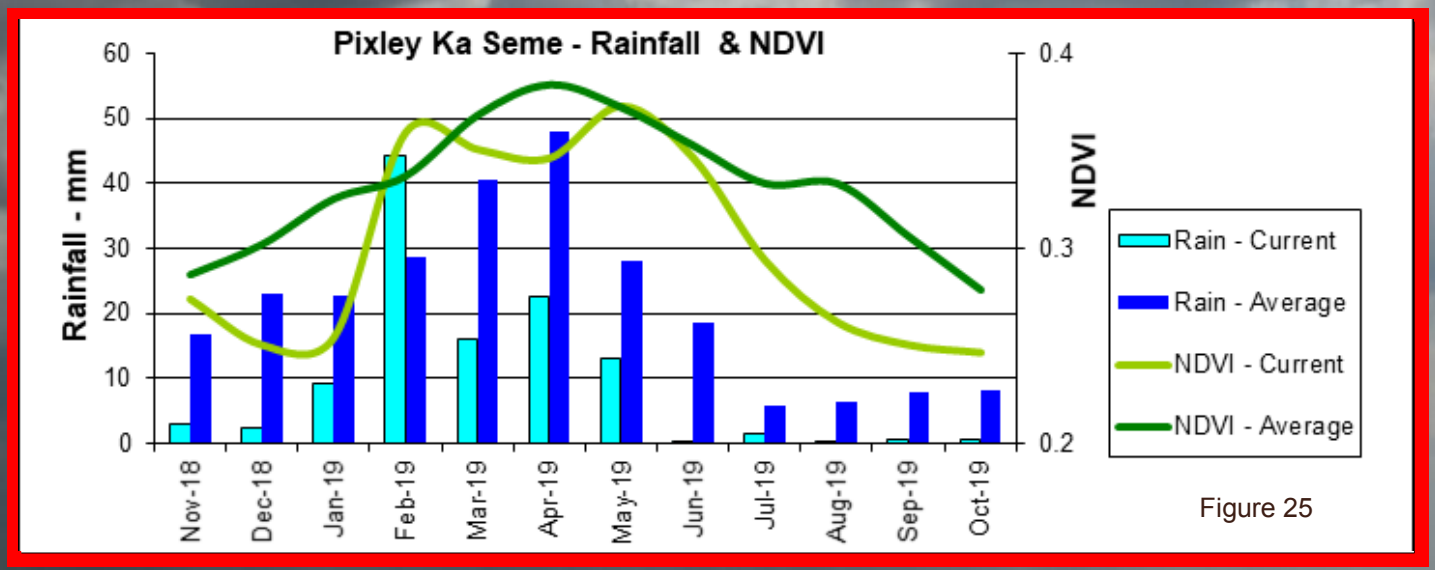

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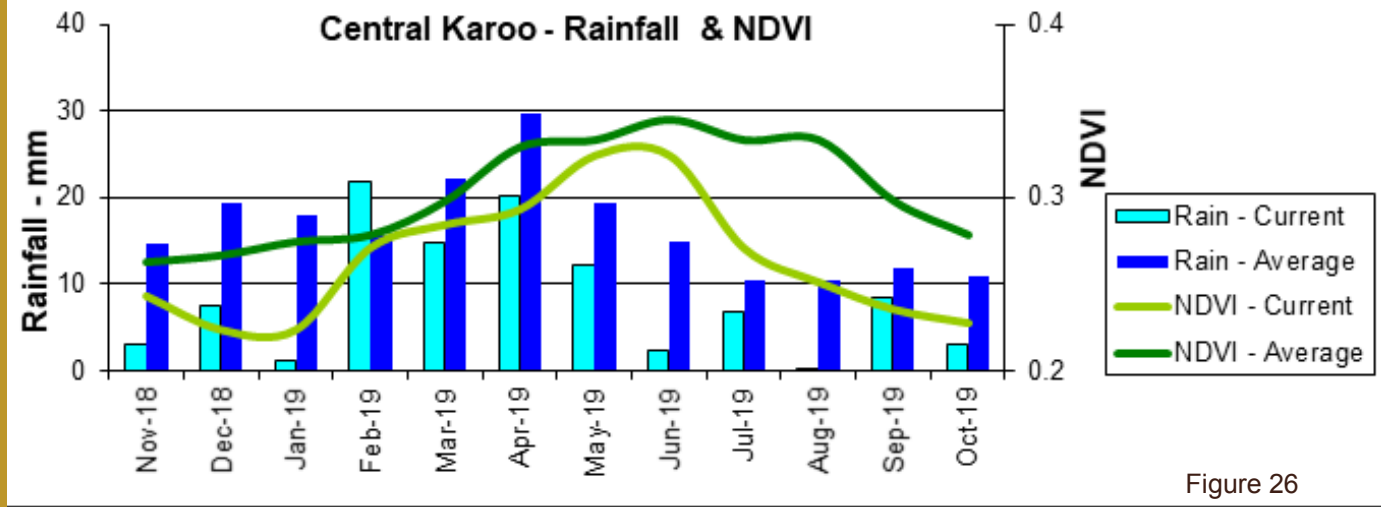
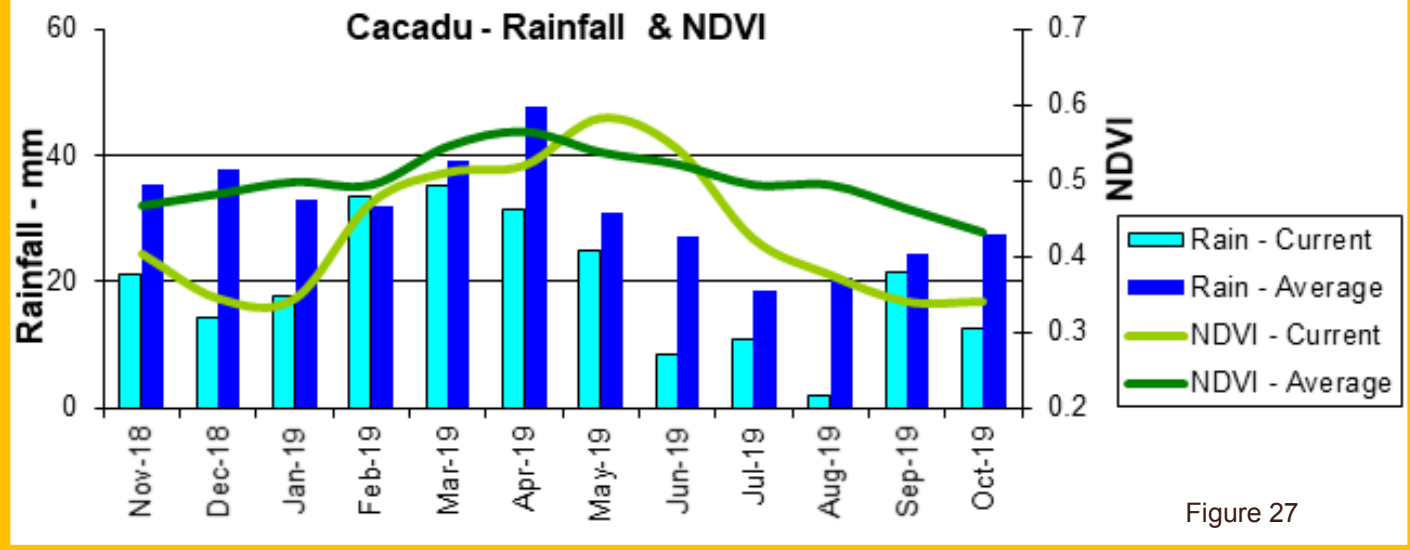


Figure 26



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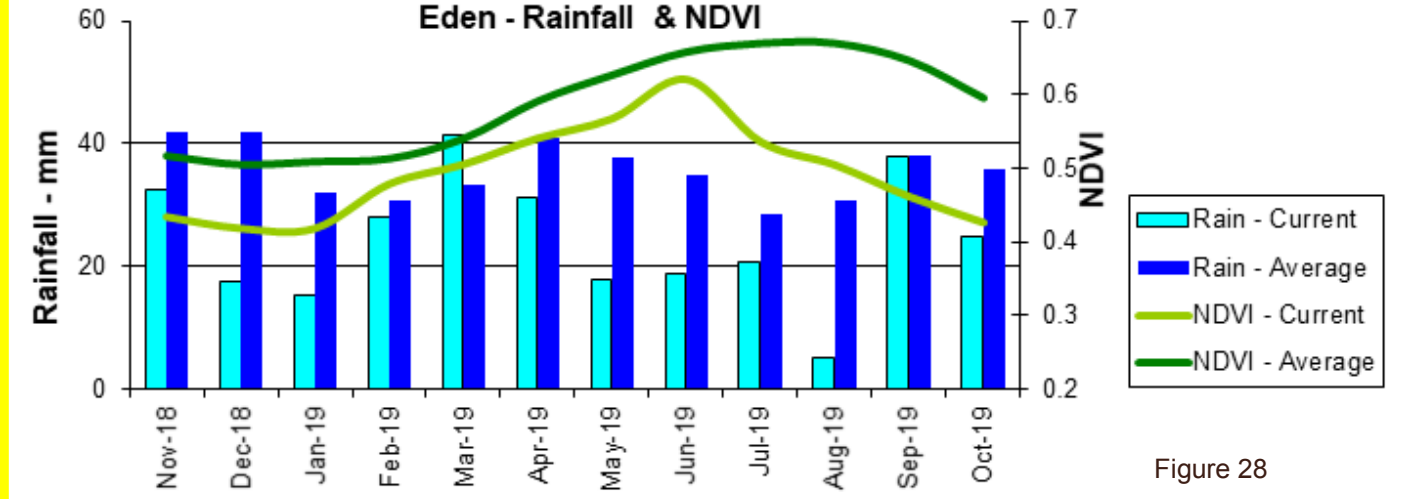

Figure 28

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

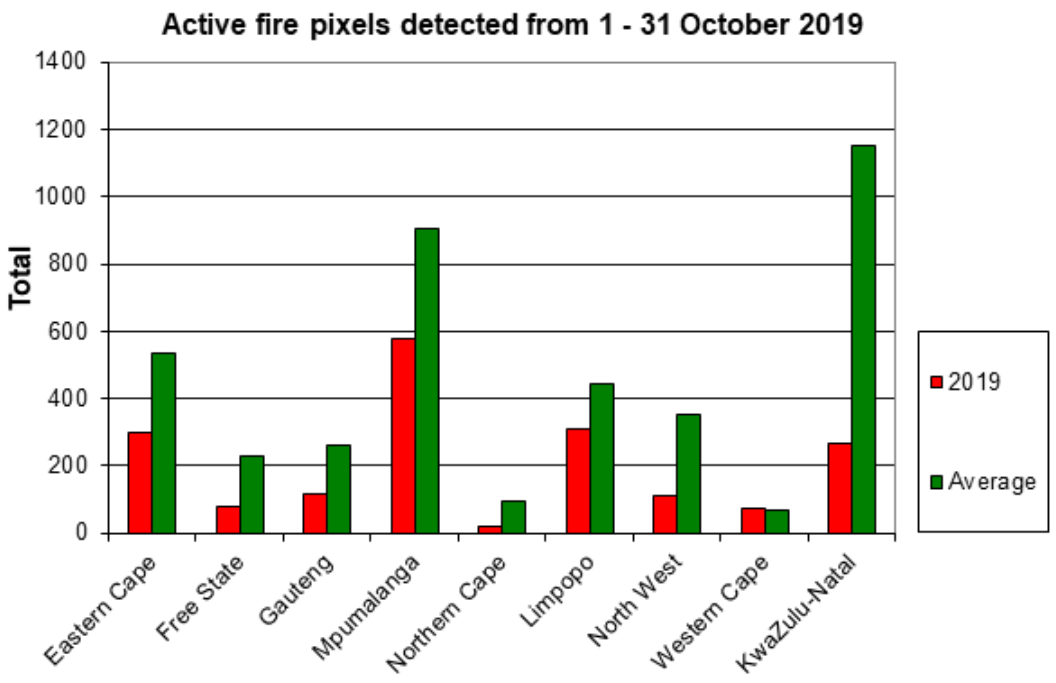

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-31 October 2019.

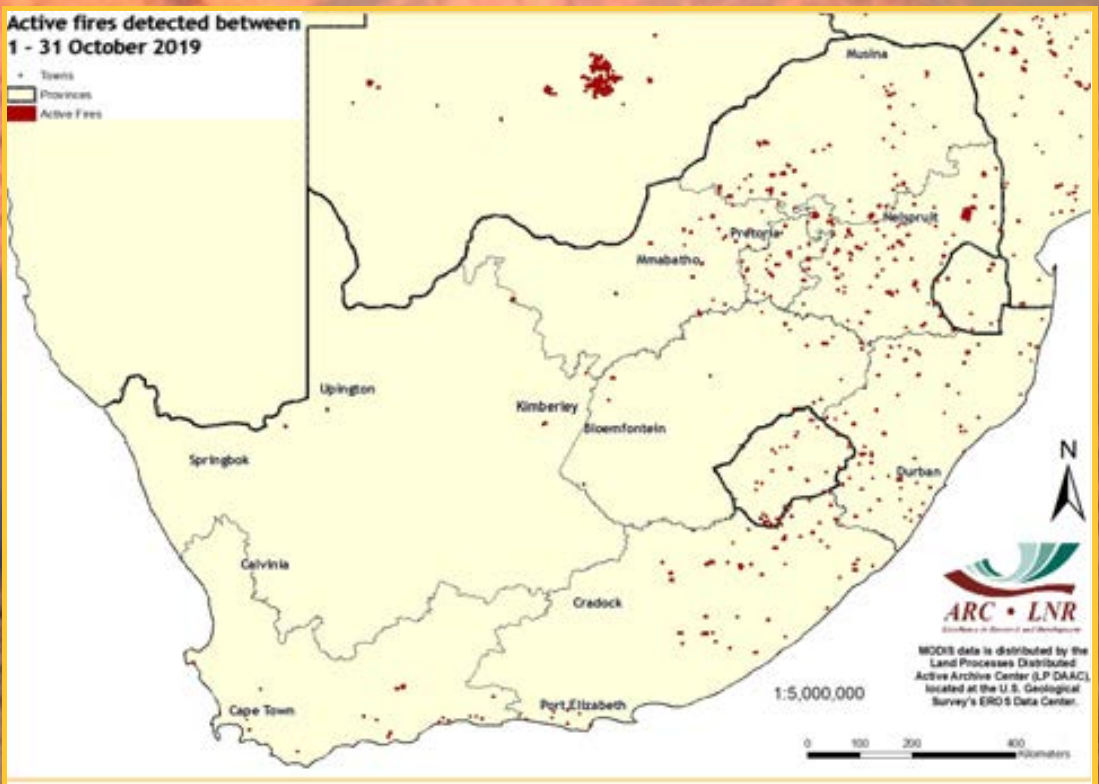

Figure 30

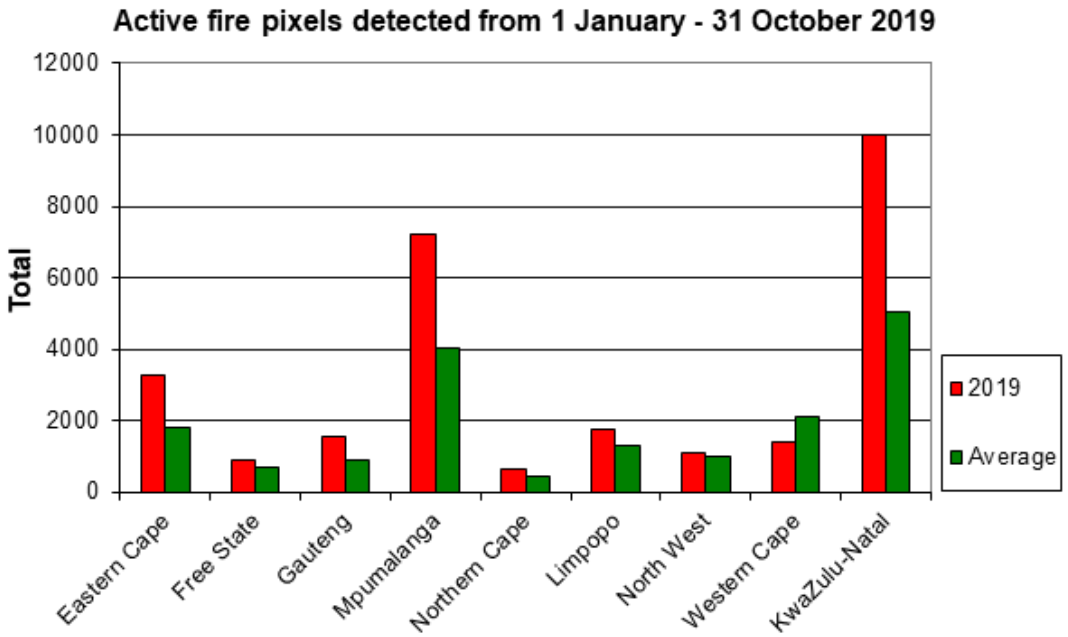

Figure 31

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

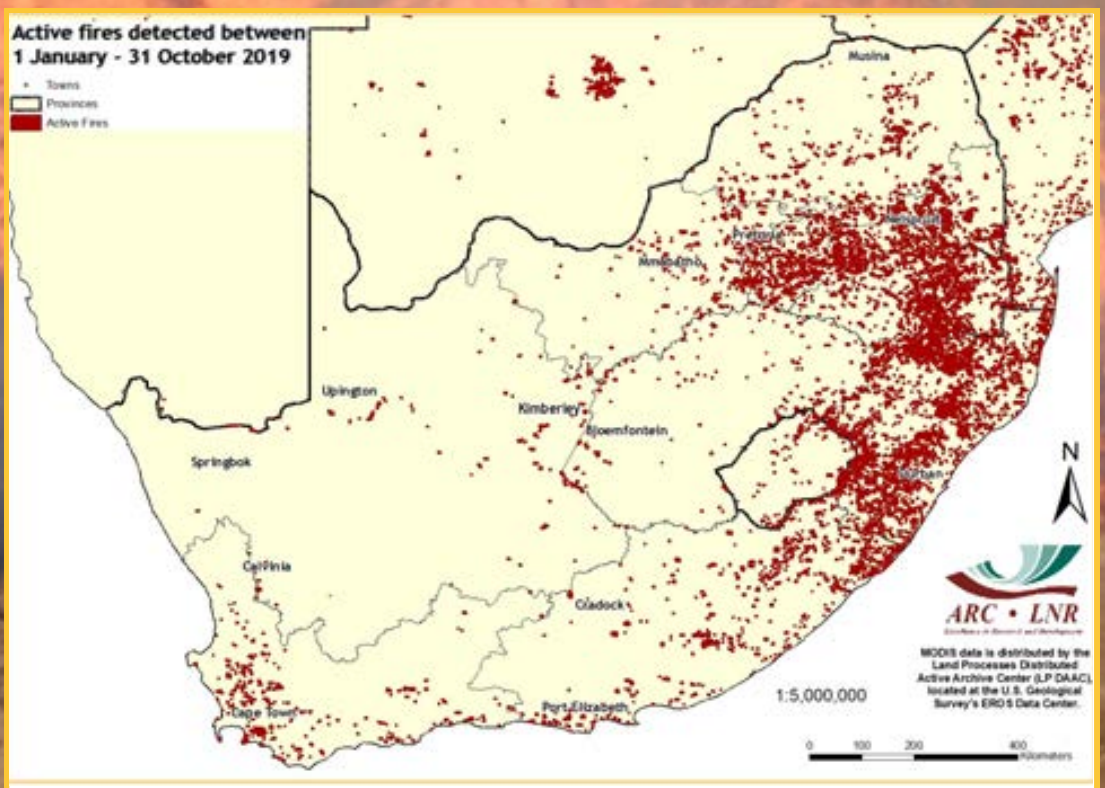

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January to 31 October 2019.

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 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 October shows little change to the previous September map, and again shows that the majority of water catchments across the country currently contain either similar or slightly reduced water areas to the maximum recorded in the same catchments since the end of 2015, with the exception of the continuing significant water reductions in the Karoo, Kalahari and some areas in Limpopo Province.

Comparison between October 2019 and October 2018 shows that generally a major portion of the country has similar or slightly less surface water extents to the same period last year, with notable significant reductions in the Karoo, Kalahari and an increasing number of small local catchments in the Eastern Cape and KZN, which is the same as that reported for the September 2019 / 2018 comparison.

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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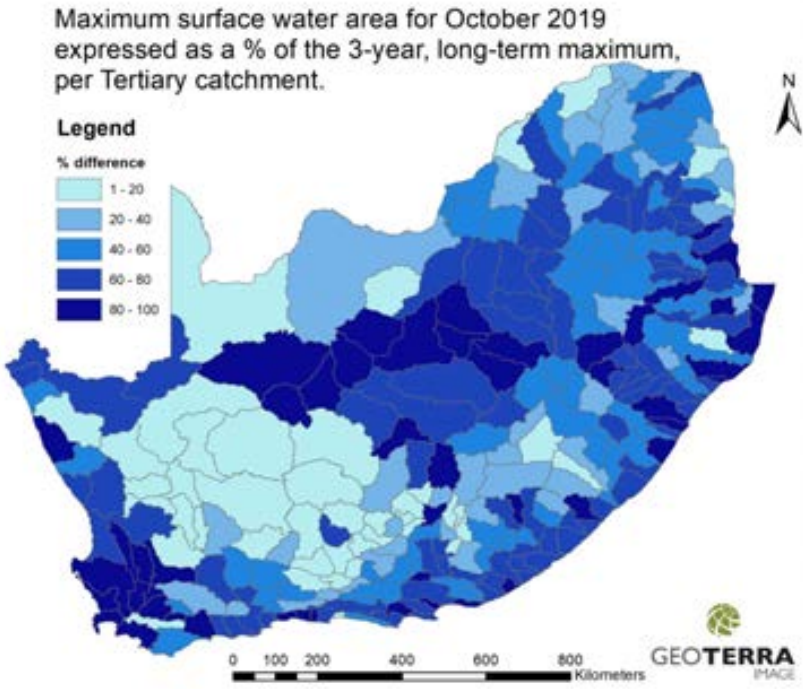

Figure 33

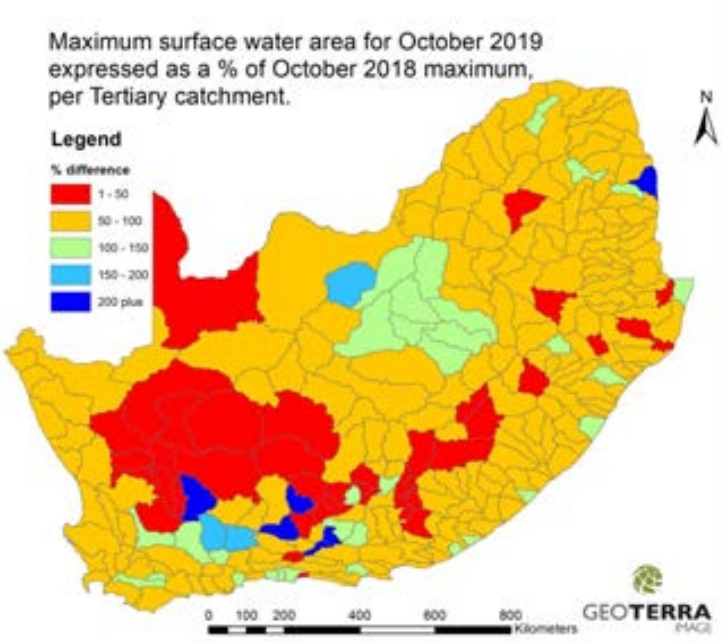

Figure 34

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".