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Excellence in Research and Development

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

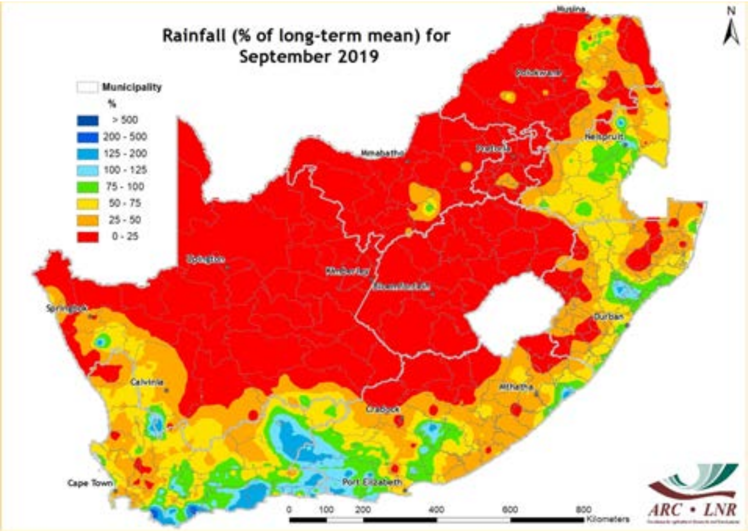
AMESD

184th Edition

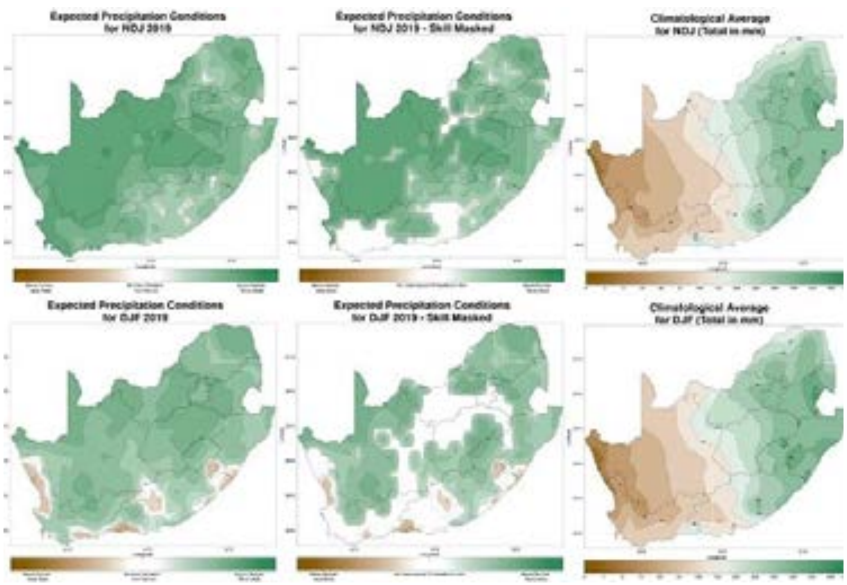
Images of the Month

Delayed onset of rains & seasonal outlook for summer 2019/20

A dry start to the summer rainfall season was observed during September 2019, with below-normal rainfall over the central interior and Limpopo (see rainfall map). These dry conditions imply late planting for maize and could also place livestock production under pressure. The only regions that received significant rainfall were isolated parts of Mpumalanga, KwaZulu-Natal and the Eastern Cape.



The latest seasonal forecast (September) issued by the South African Weather Service (see figure below), indicates that these below-normal rainfall conditions are likely to persist during the late spring (OND) period. However, above-normal rainfall conditions, accompanied by high temperatures for the central and eastern parts, are expected during early summer (NDJ) and predicted to continue into mid-summer (DJF). Thus, promotion of production practices that can mitigate the effects of agroclimatic risks during the summer rainfall season need to be determined per region and conveyed effectively to farmers. These include proper grazing and livestock management practices, as well as efficient water management technologies (e.g. rainwater harvesting) for dryland crop producers.



Source: South African Weather Service (SAWS), September 2019

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 during September 2019 occurred mainly along the southern and eastern coastal belts of South Africa. A cold front made landfall along the southwestern and western parts during the morning hours of the 12th, with scattered rain showers producing totals of up to 25 mm in Jonkershoek and surrounding areas. Towards the end of September, above-normal rainfall occurred, causing strong winds and localized flooding over the drought stricken Little Karoo and western parts of the Eastern Cape province. Thus, the winter rainfall region had a good end to its rainy season with above-normal rainfall occurring at both the beginning and end of the month. However, the month started with dry and warm to hot weather over the central and eastern parts of the country. On the 18th of September, significant amounts of rainfall (≥ 5 mm) were observed along the KwaZulu-Natal coast. Then at the end of the month, cloudy conditions with isolated light showers were observed along the escarpment and Lowveld of Limpopo and Mpumalanga on the afternoon of the 30th.

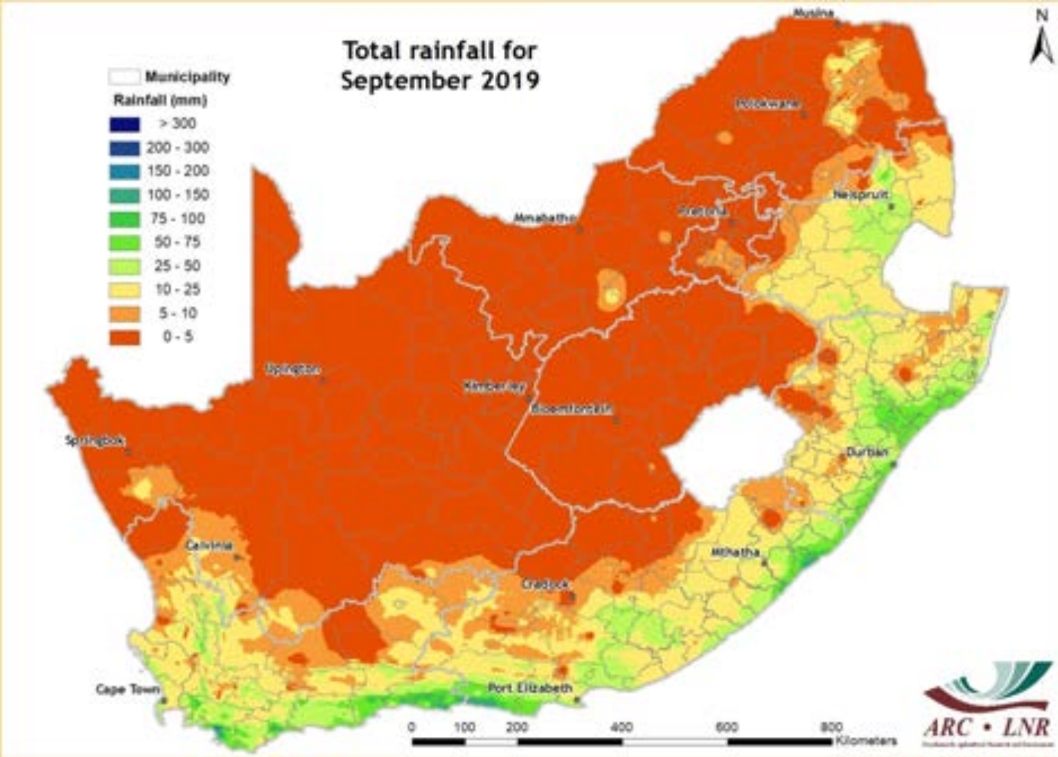


Figure 1

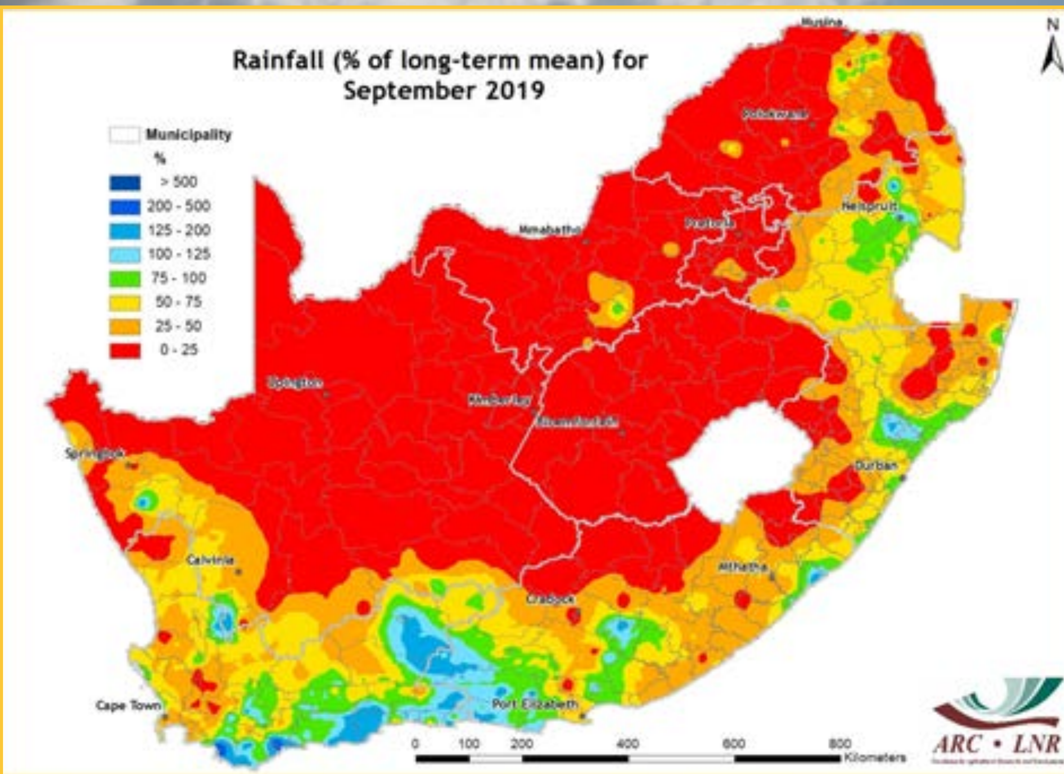


Figure 2

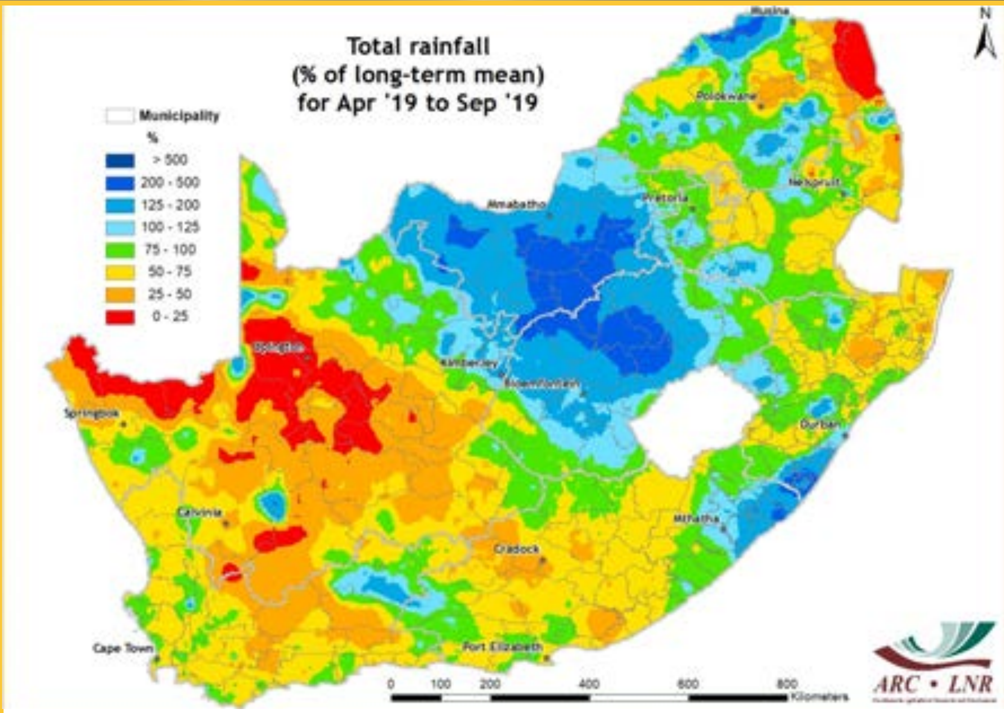


Figure 3

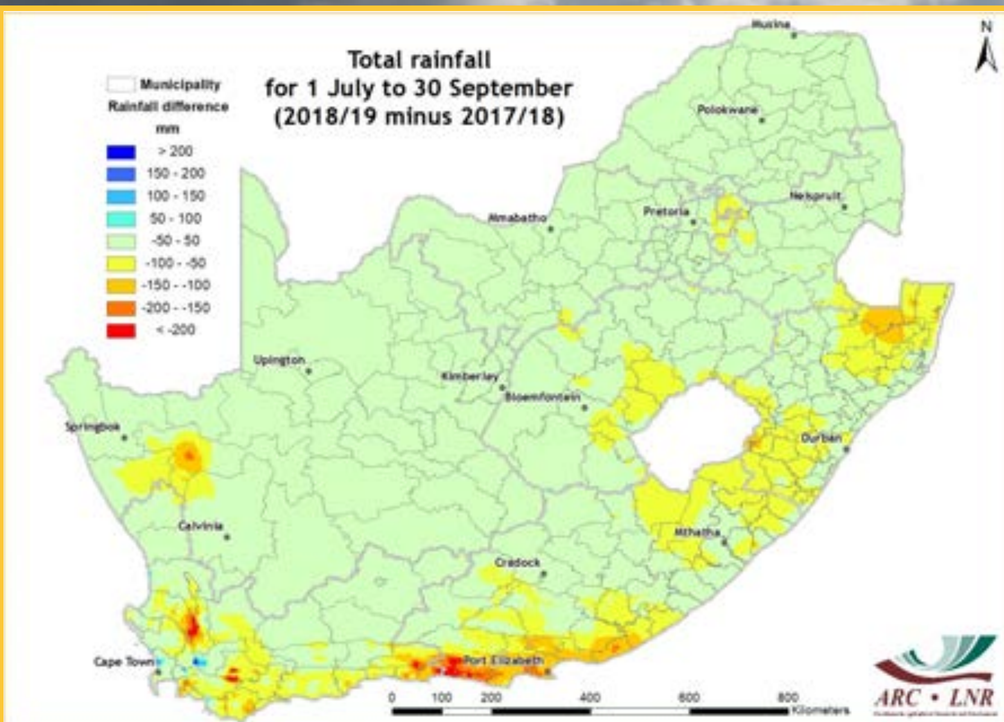


Figure 4

Figure 1:
Rainfall totals in September 2019 over the winter rainfall region ranged between 5 and 75 mm, while the central interior was mostly dry. Higher totals were recorded along the Garden Route, as well as parts of the coastal belts of the Eastern Cape and KwaZulu-Natal.

Figure 2:
Below-normal rainfall was observed over the central interior and towards the Northern Cape in September. Above-normal rainfall occurred along the Cape south coast, in the Little Karoo and western parts of the Eastern Cape province.

Figure 3:
Rainfall totals since April to September 2019 indicate below-normal conditions over the Northern Cape and eastern corner of Limpopo when compared to the long-term for the same period. Near- to above-normal rainfall conditions can be seen over the summer rainfall region, due to the high rainfall amounts that were recorded in April 2019.

Figure 4:
When comparing July-September in the 2018/19 season with the corresponding 3-month period in 2017/18, it can be seen that the southwestern area of the Eastern Cape recorded much less (≤ 200 mm) rainfall. Isolated parts of Gauteng, KZNl, Western and Northern Cape also showed a decrease in rainfall during this period, while the rest of the country was somewhat comparable.

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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 (Figures 5-8) for the month of September 2019 show the 6-month accumulation of mild to extreme drought over the Cape provinces as well as northeastern Limpopo. Meanwhile the interior and parts of the western coastline show wetter conditions. The 12-month time scale depicts the prevalence of extreme drought even after good rains occurred during the month of September. Longer time scales (12- to 24-month) indicate widespread drought conditions, ranging from mild in the interior to extreme in the western half of the country.

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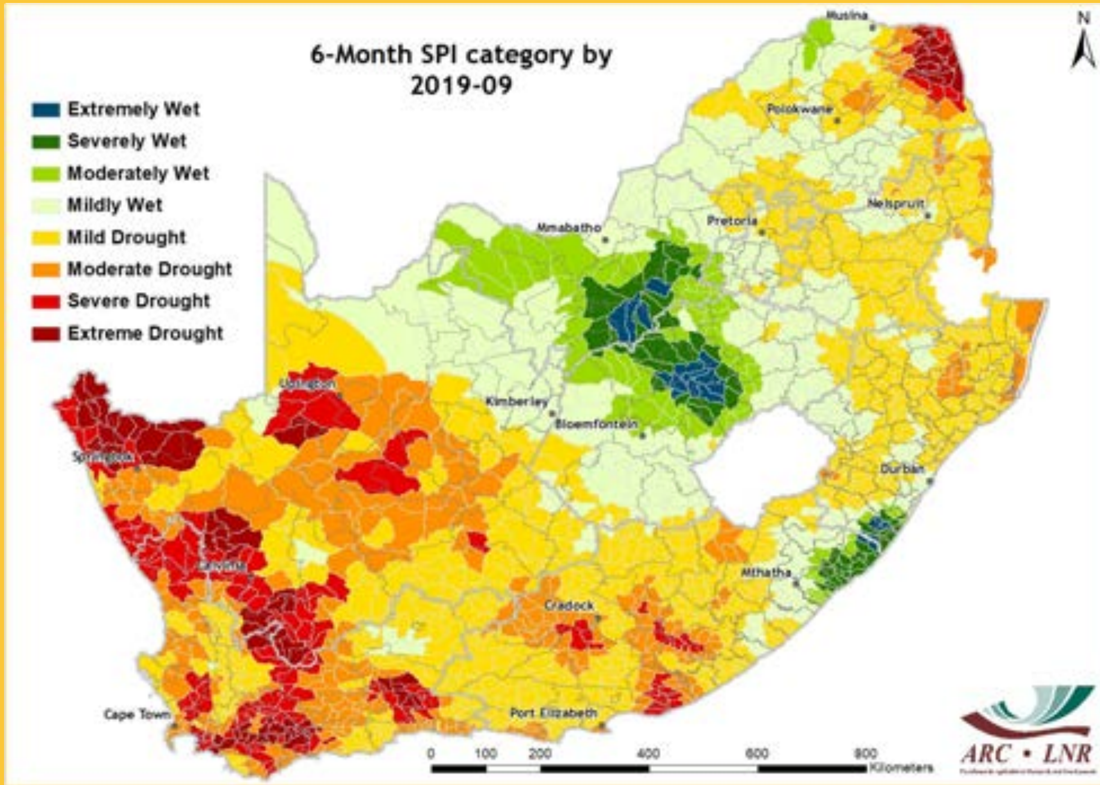
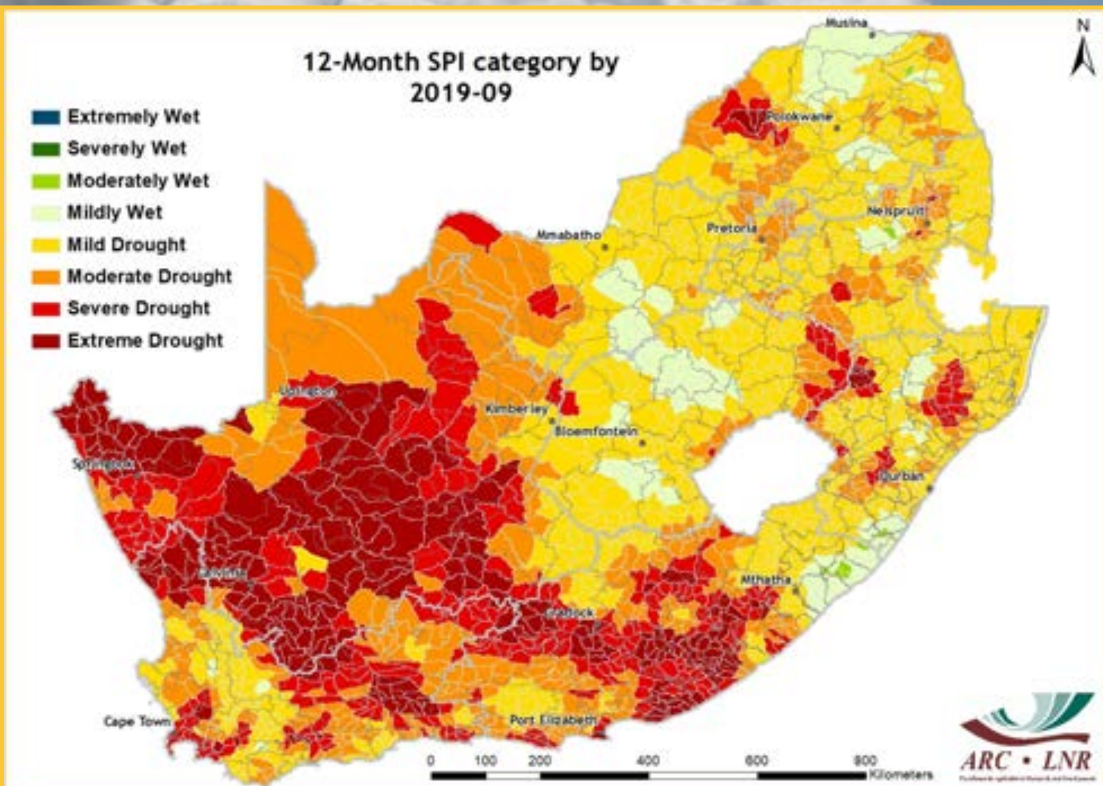


Figure 5



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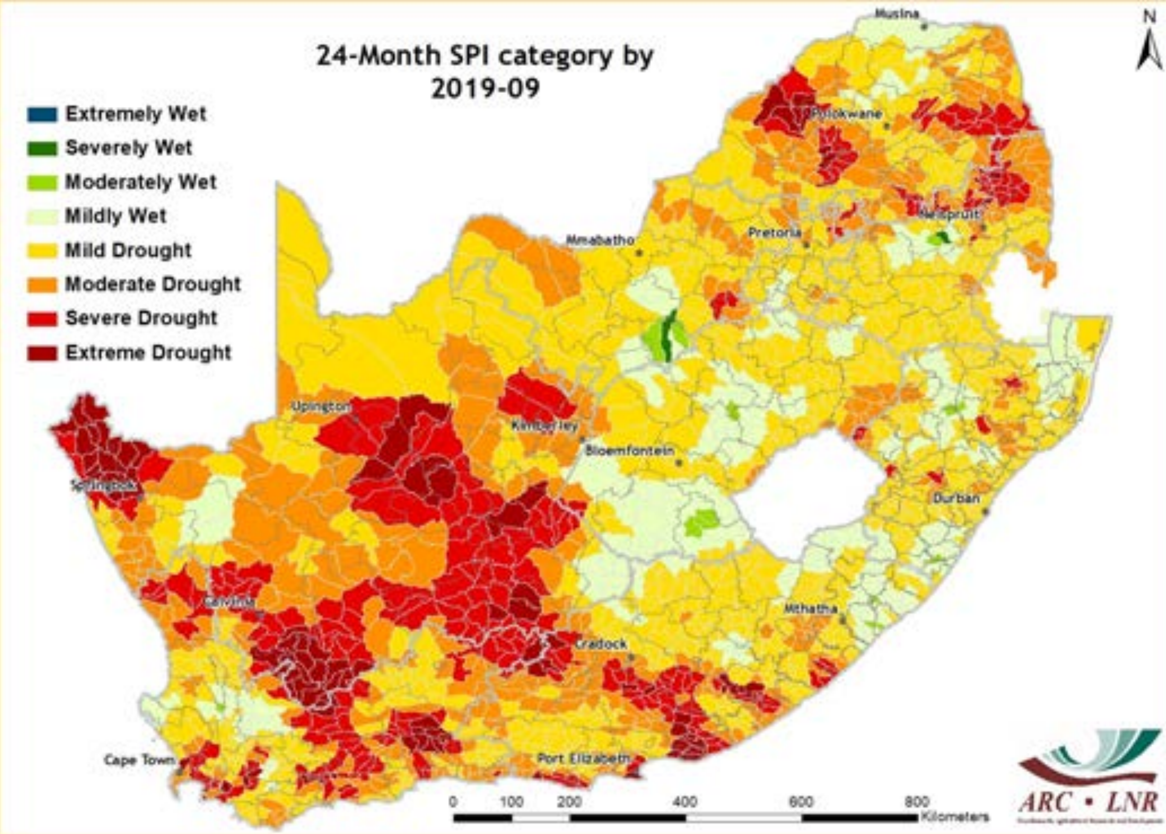

Figure 7

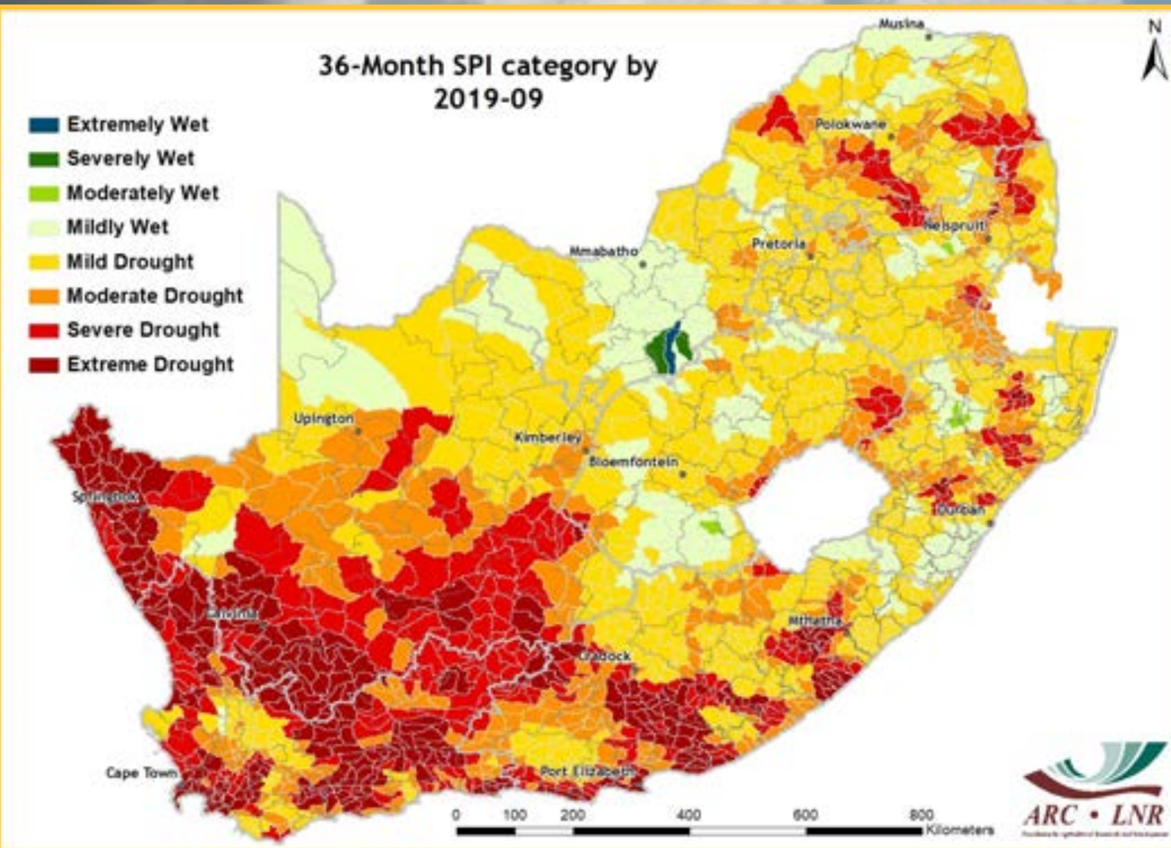

Figure 8

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.

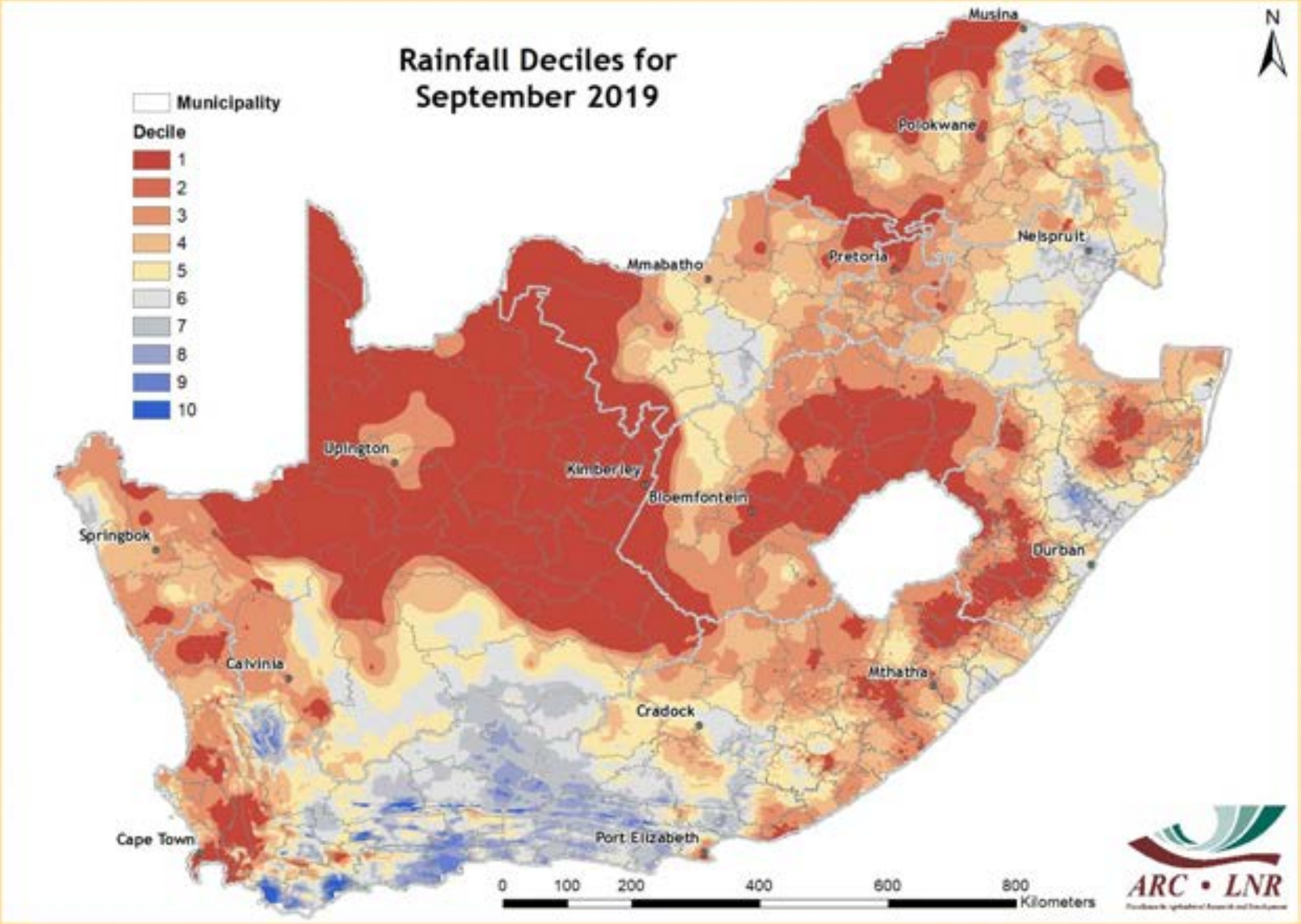

Figure 9

Figure 9:
An improvement of rains over the southwestern and northeastern areas of the country is depicted on the decile map, whereby most of these areas compare well with the historically wetter September months. However, the interior remains 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.

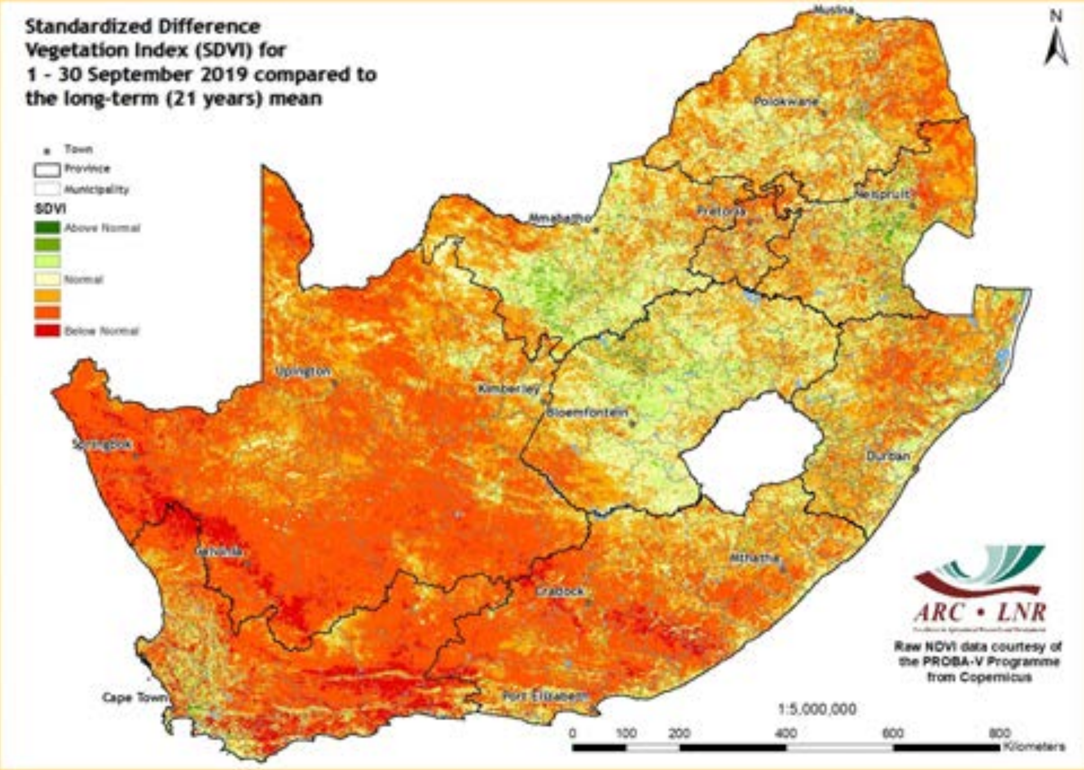

Figure 10

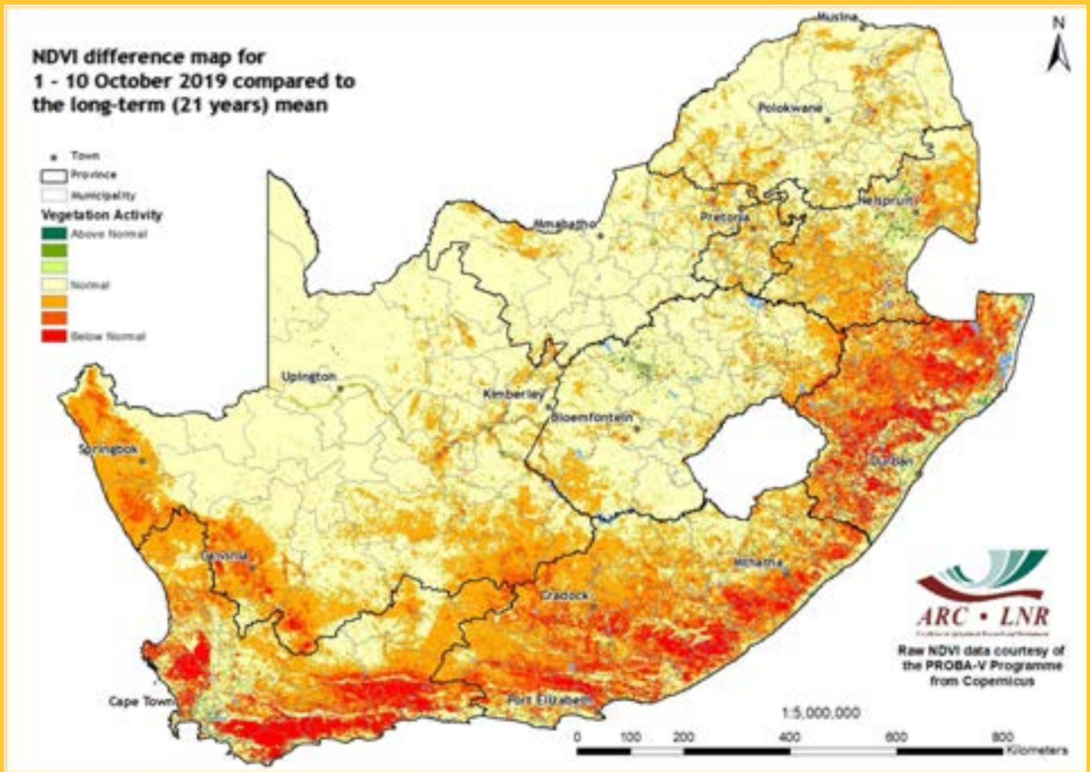

Figure 11

Figure 10:
The SDVI map for September 2019 shows that, relative to the vegetation condition trends computed over 21 years, the western parts of the country continue to experience poor vegetation activity.

Figure 11:
The NDVI difference map for the first 10 days of October 2019 shows that below-normal vegetation activity occurred in KwaZulu-Natal, Eastern Cape, Western Cape and the southern parts of the Northern Cape province. Meanwhile, the northern parts experienced normal vegetation conditions.

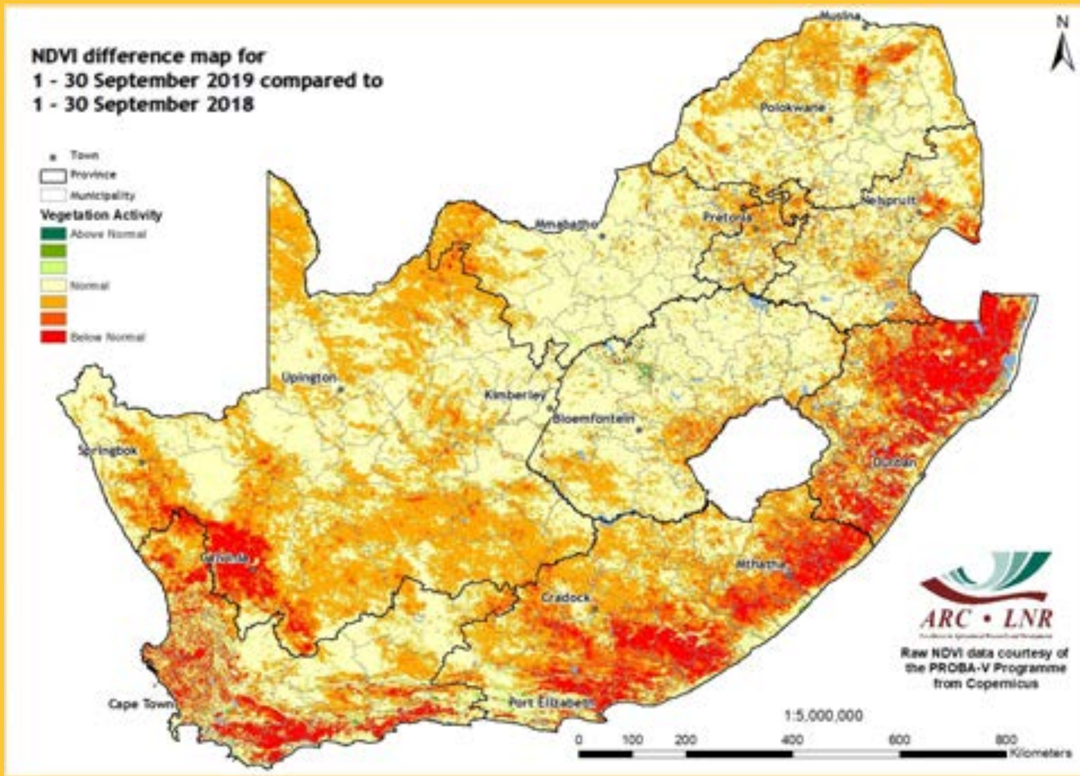

Figure 12

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

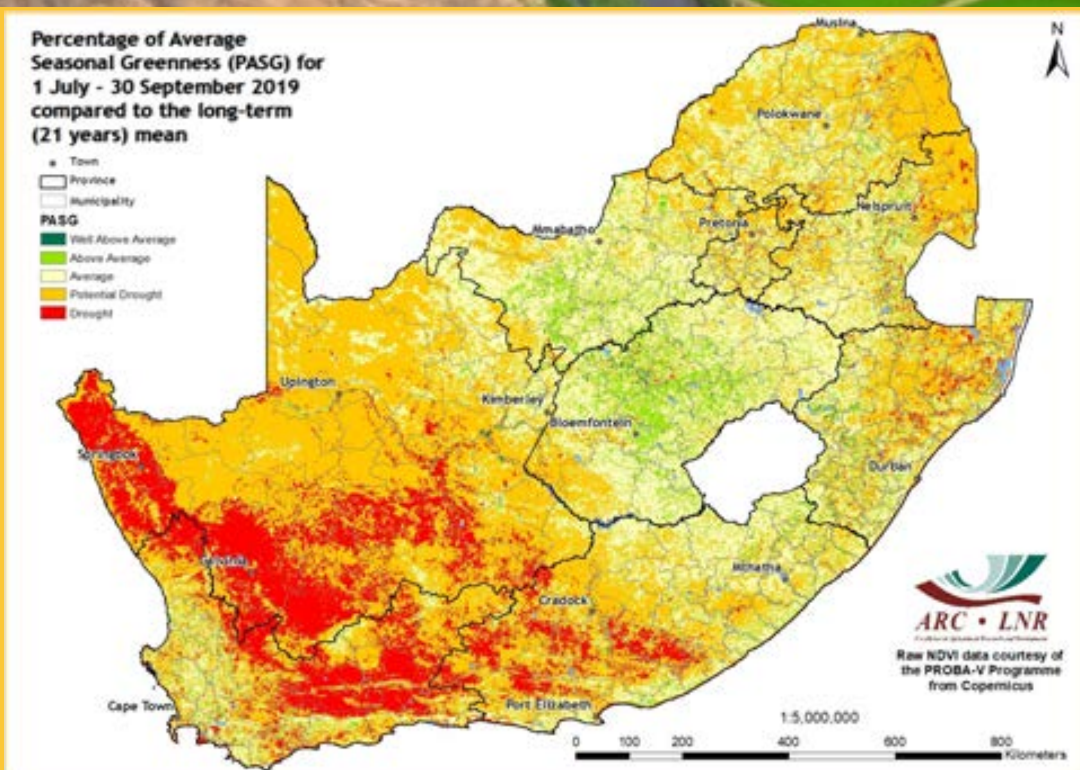

Figure 13

Figure 12:
Compared to the same month last year, the September 2019 NDVI map shows that below-normal vegetation activity occurred mostly in the KZN, Eastern Cape, Western Cape and Northern Cape provinces. Nevertheless, normal vegetation activity occurred in the Free State, Northern Cape and some isolated areas in Limpopo, Northern Cape and Mpumalanga.

Figure 13:
The PASG over a 3-month period remains lower over the western parts of the country but average in the central parts compared to the long-term mean.

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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.

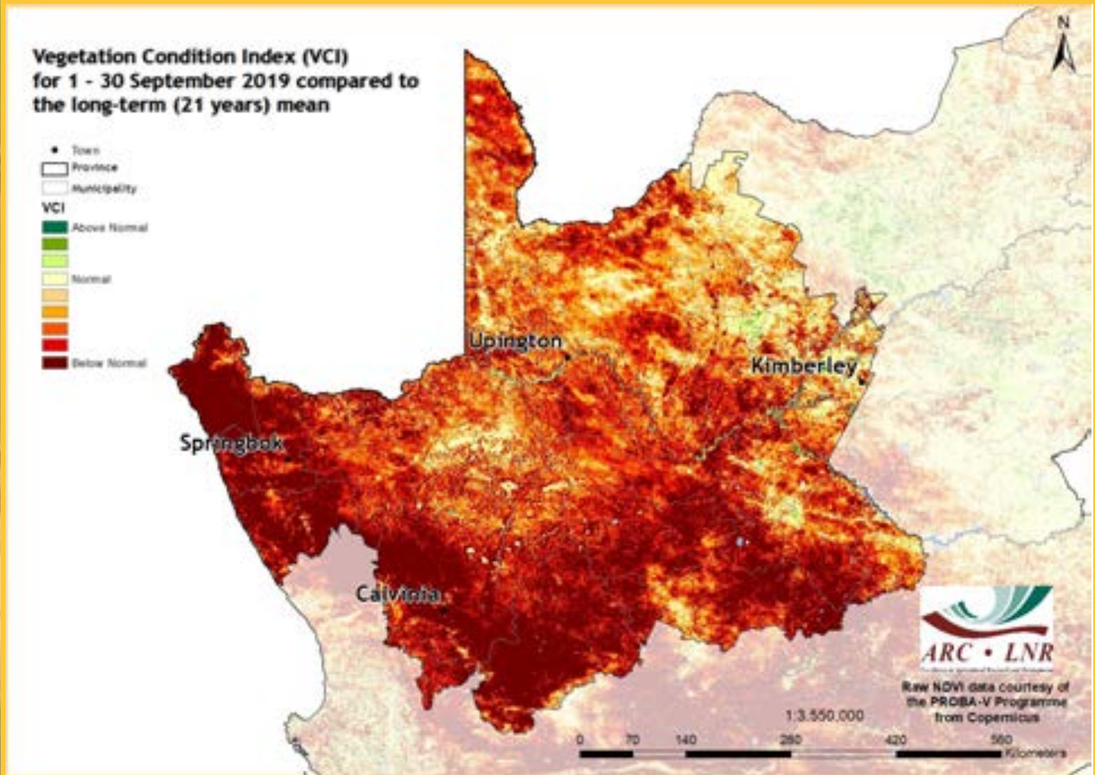


Figure 14

Figure 14:
The VCI map for September 2019 show that the Northern Cape remains under severe drought conditions, as shown by the poor levels of vegetation activity.

Figure 15:
Poor vegetation conditions remain dominant in the Western Cape. Minor exceptions are some isolated areas on the West Coast which experienced normal vegetation activity.

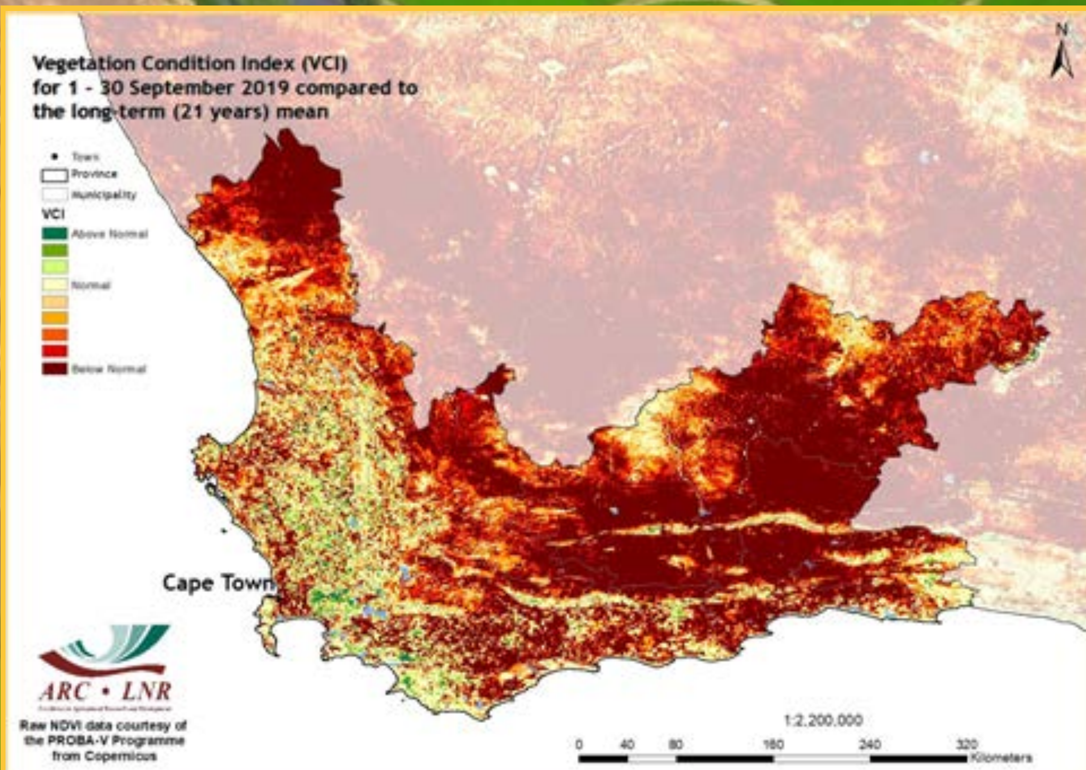
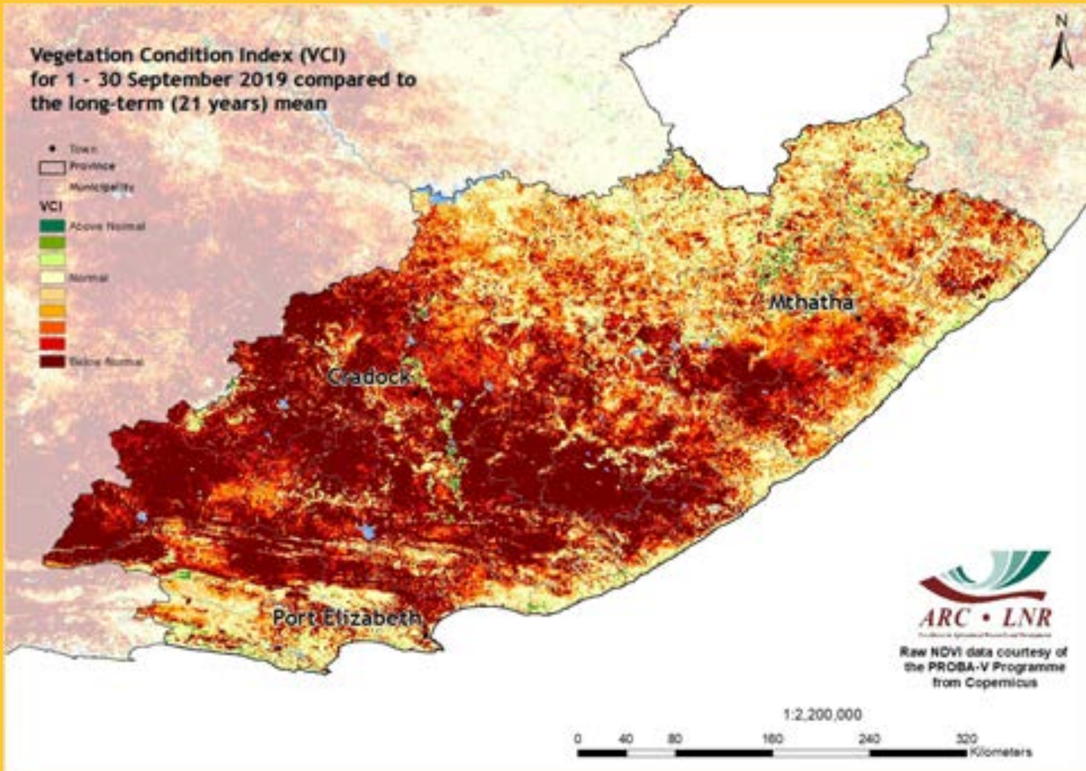


Figure 15



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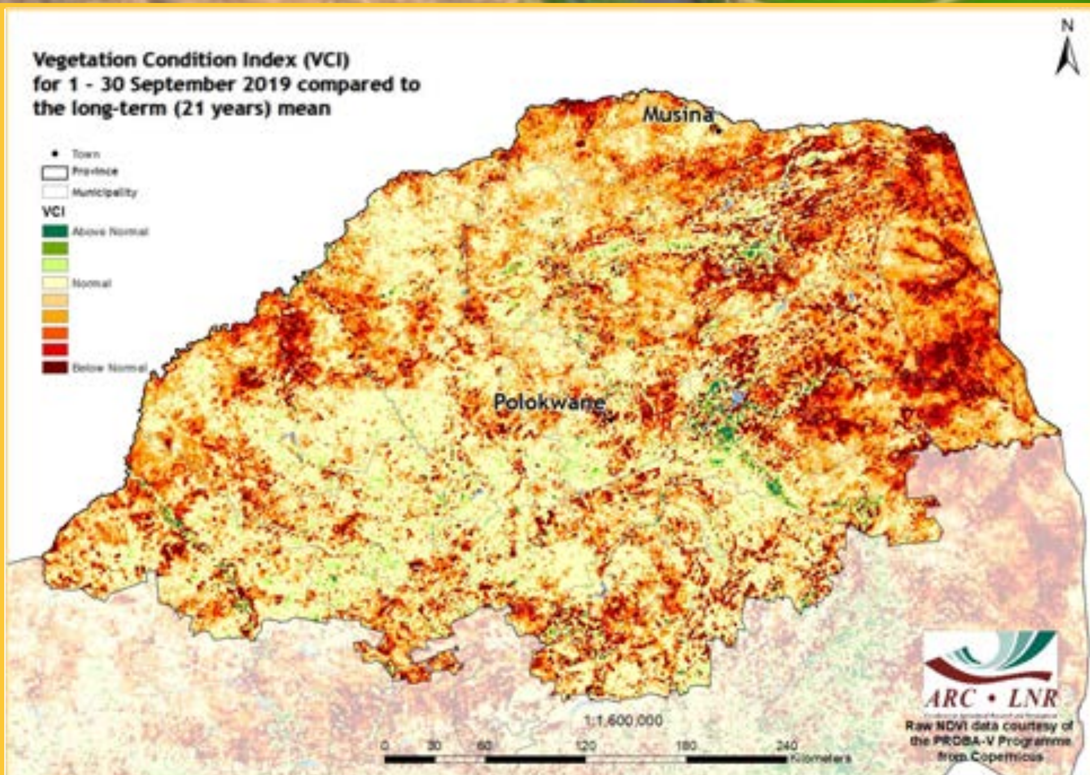

Figure 17

Figure 16:
The VCI map for the Eastern Cape shows that many parts of the Sarah Baartman district municipality continue to experience poor vegetation activity while some areas in the north of the province experienced pockets of above-normal vegetation activity.

Figure 17:
The September VCI map for Limpopo shows that many parts of the province continue to experience poor vegetation conditions.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

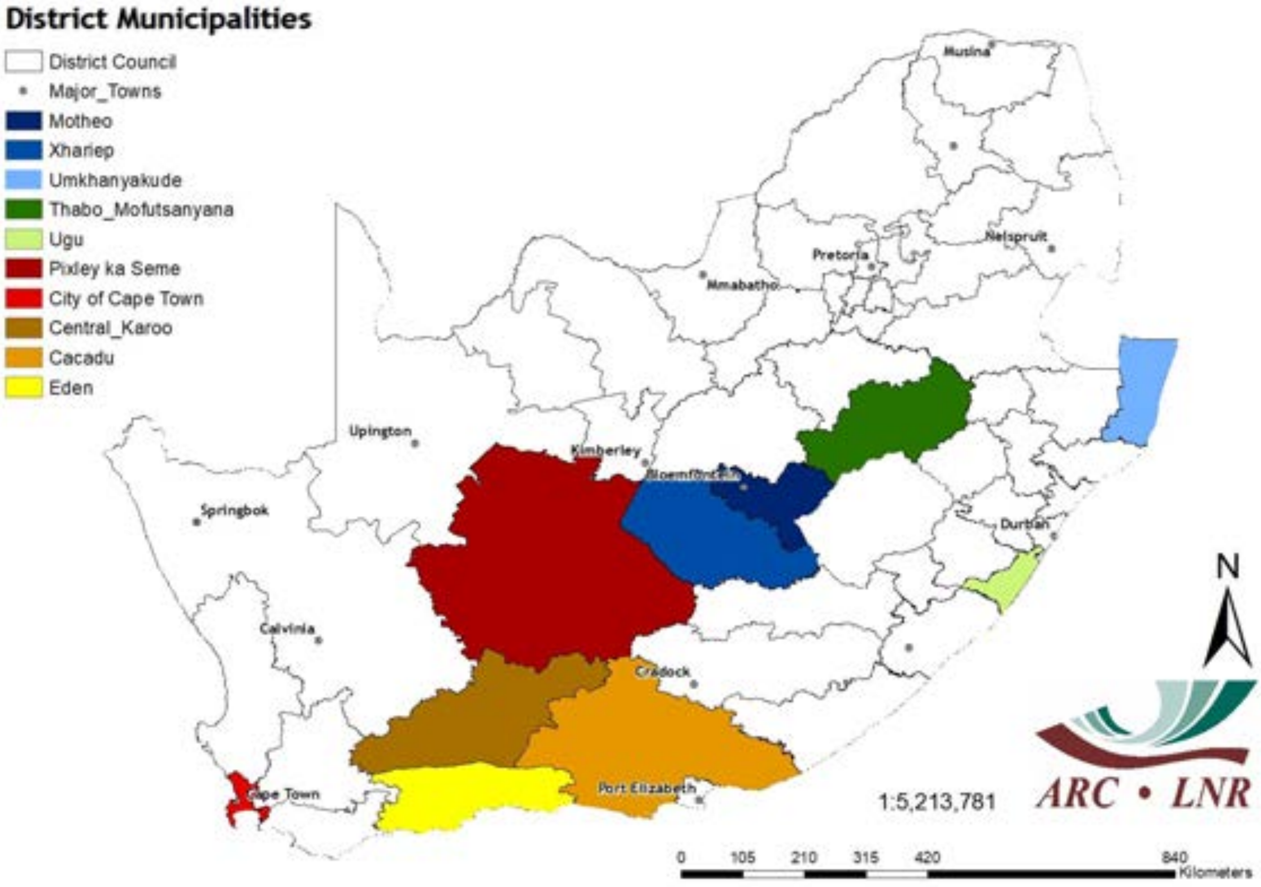

Figure 18

Rainfall and NDVI Graphs

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

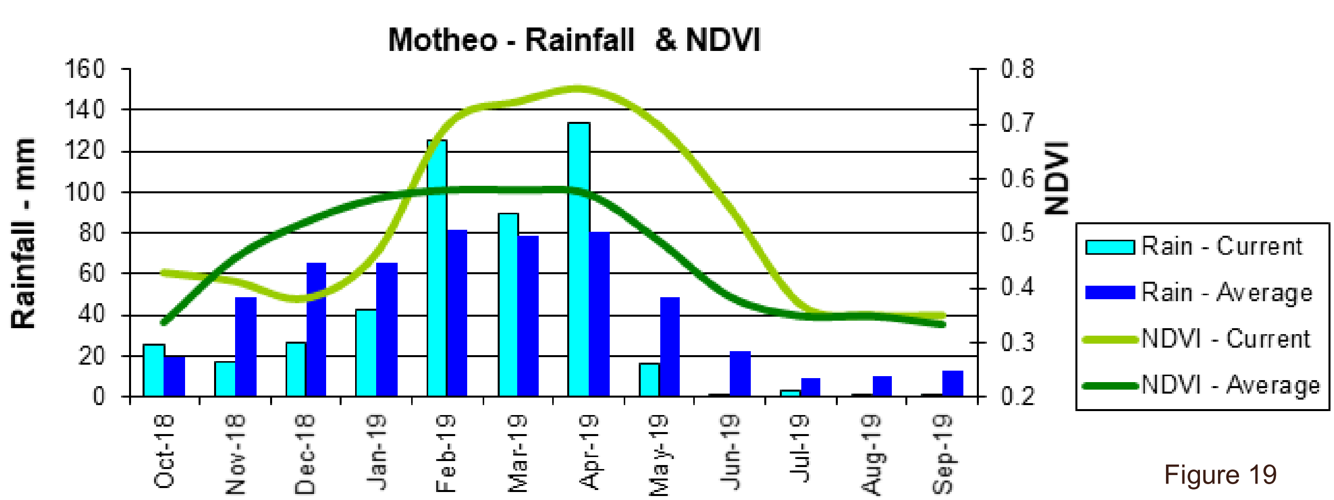


Figure 19

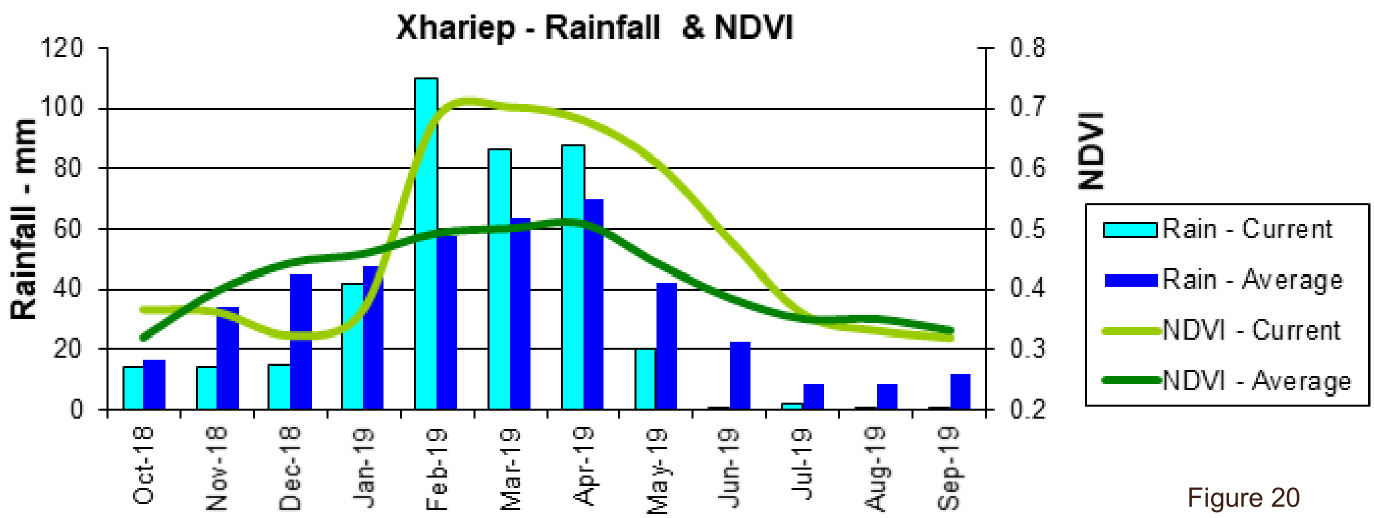


Figure 20

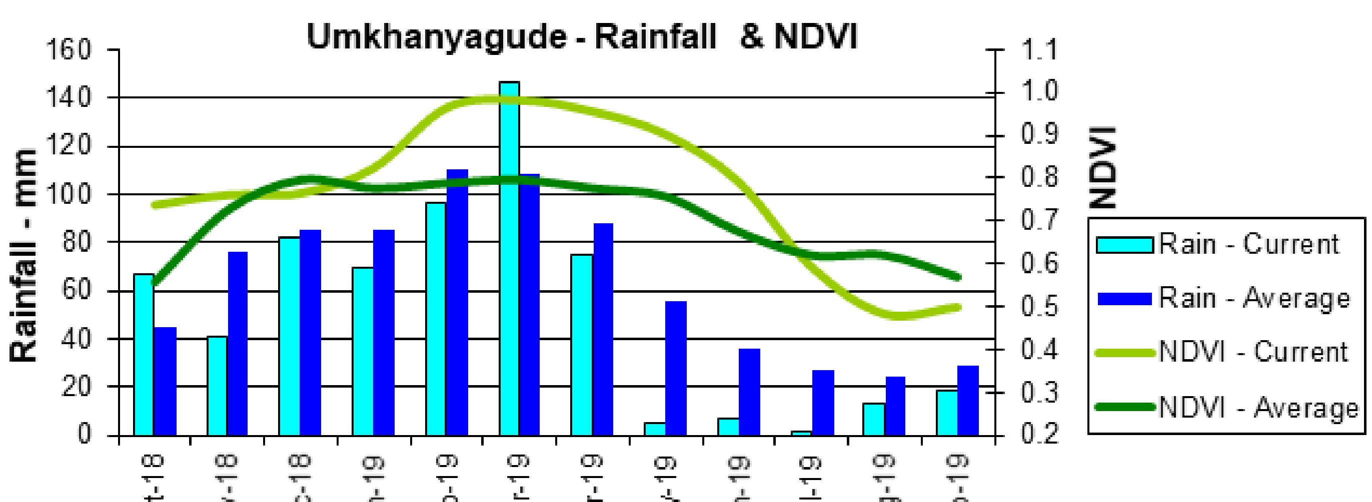


Figure 21

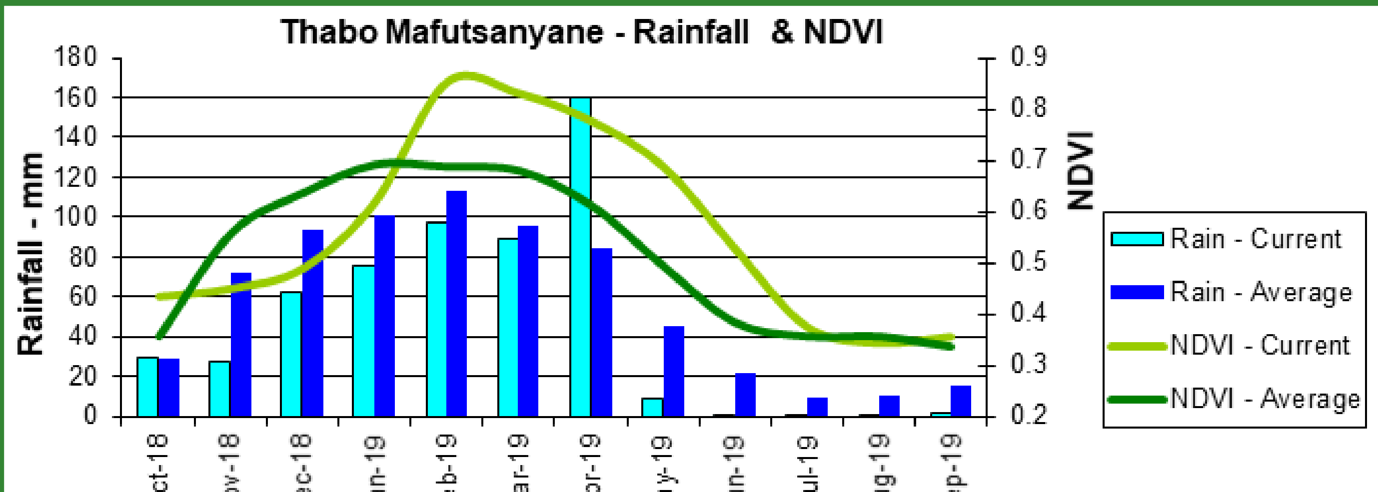


Figure 22

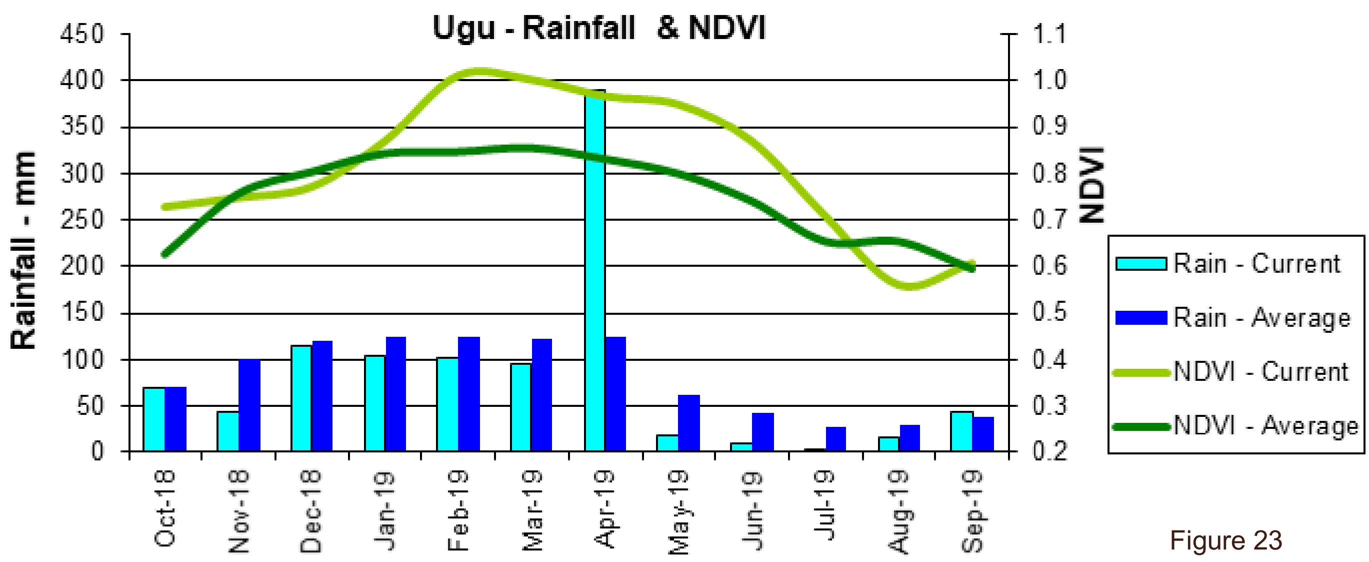
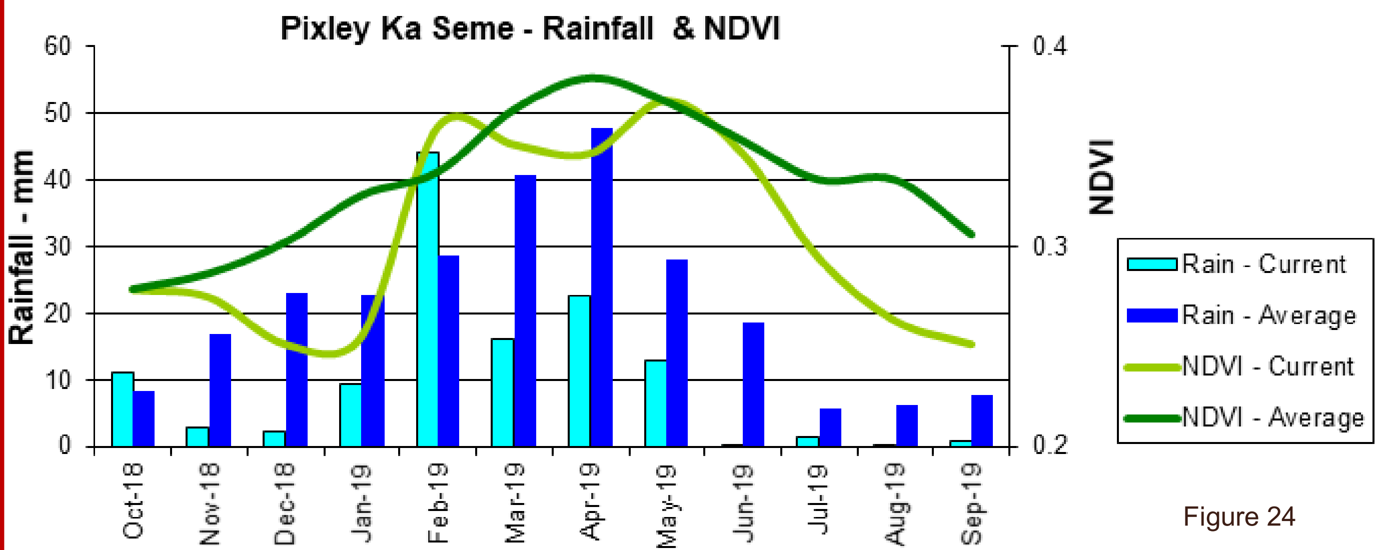


Figure 23



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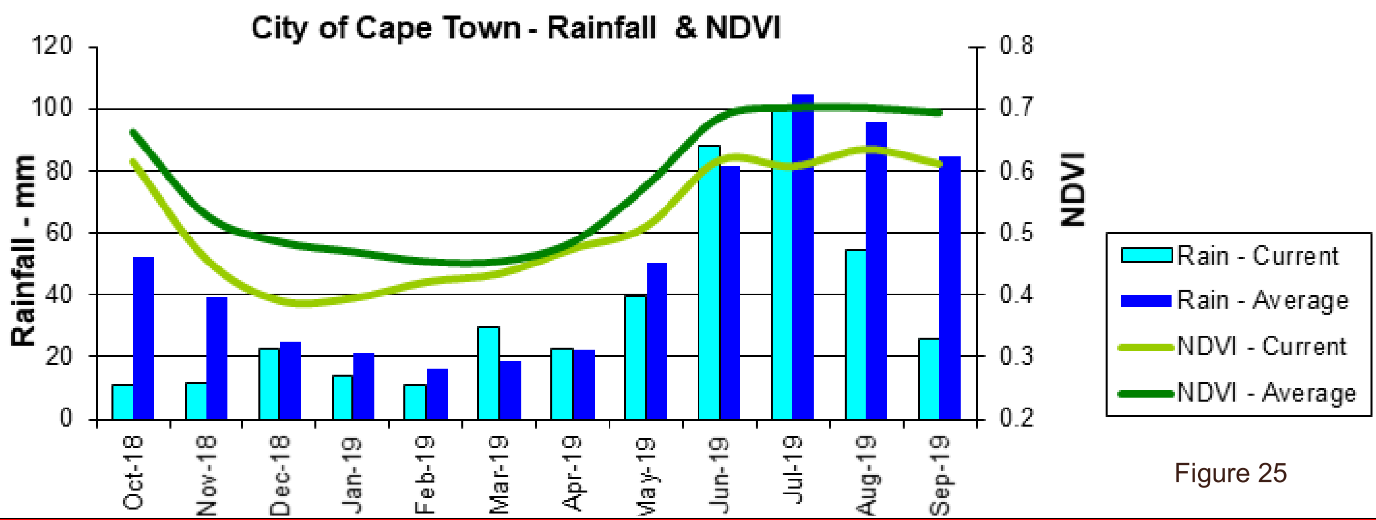

Figure 25

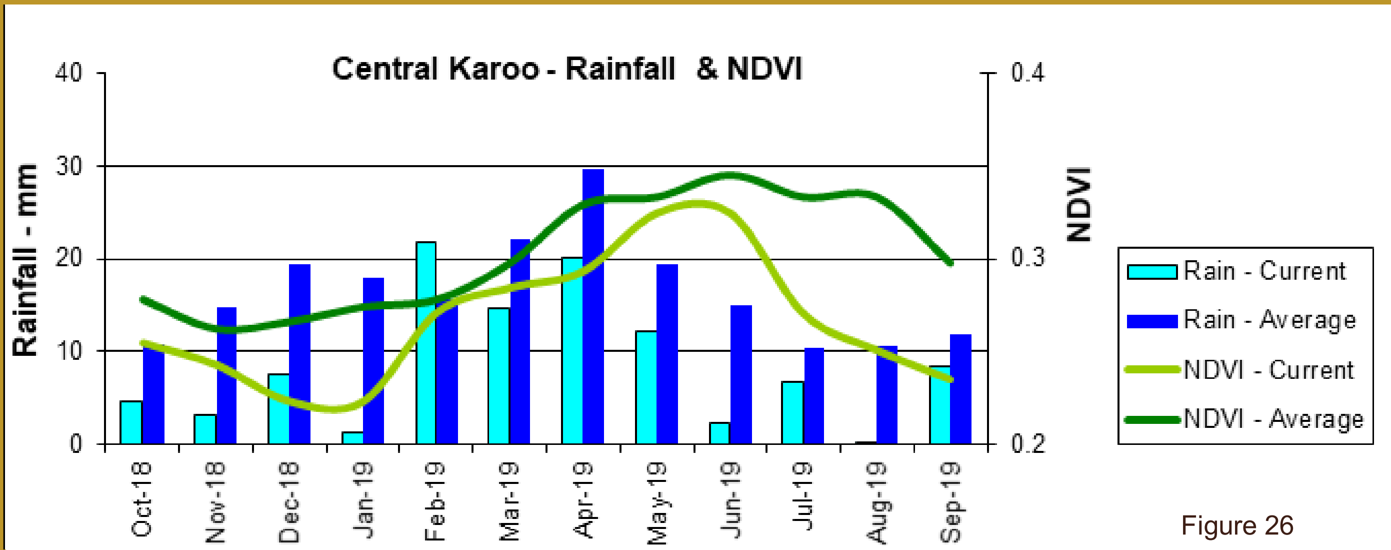

Figure 26

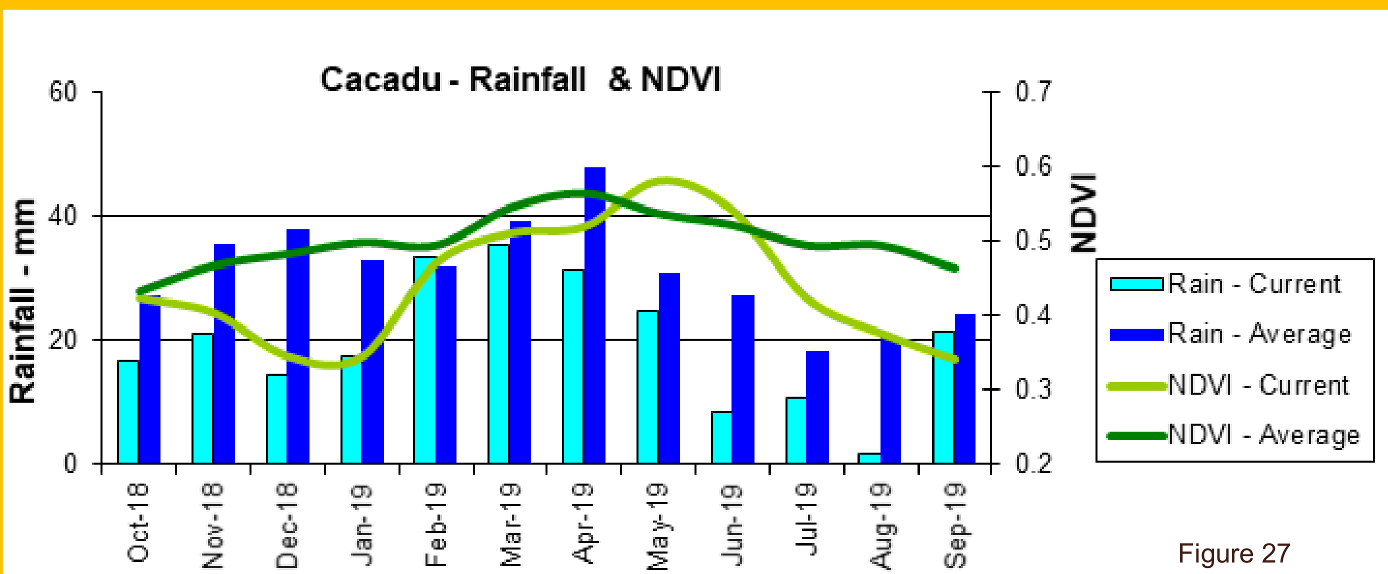

Figure 27

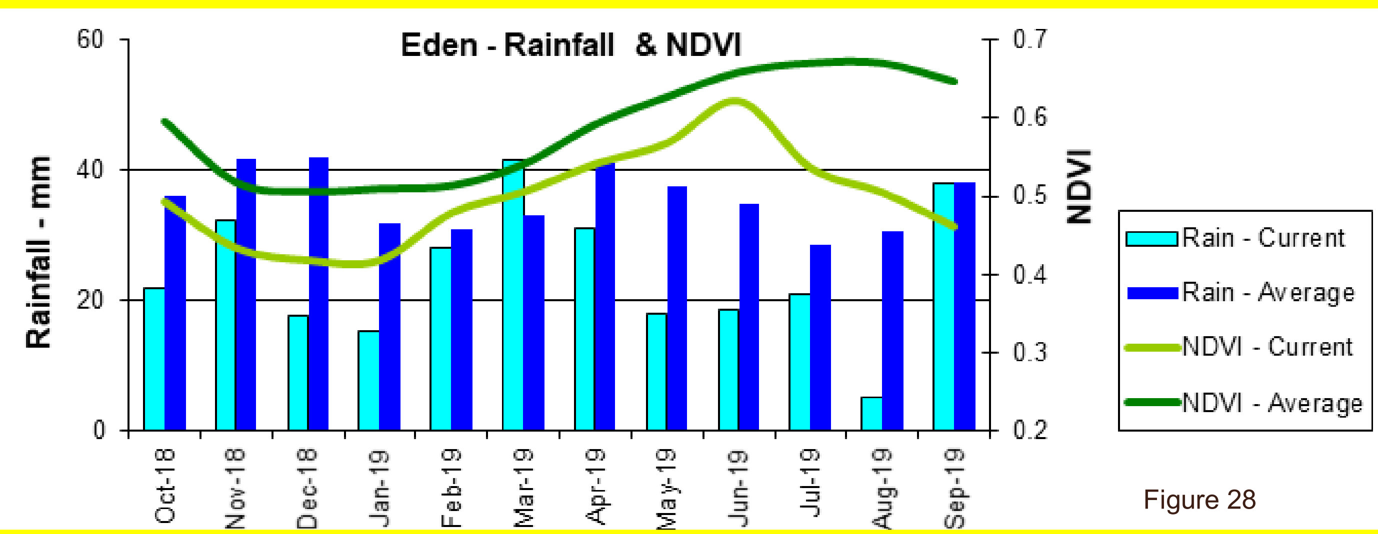

Figure 28

7. Fire Watch

Active Fires *(Provided when data is available)*

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

Figure 29:
The graph shows the total number of active fires detected between 1-30 September 2019 per province. Fire activity was higher in KZN, Western Cape, Mpumalanga, Gauteng and the Free State compared to the long-term average.

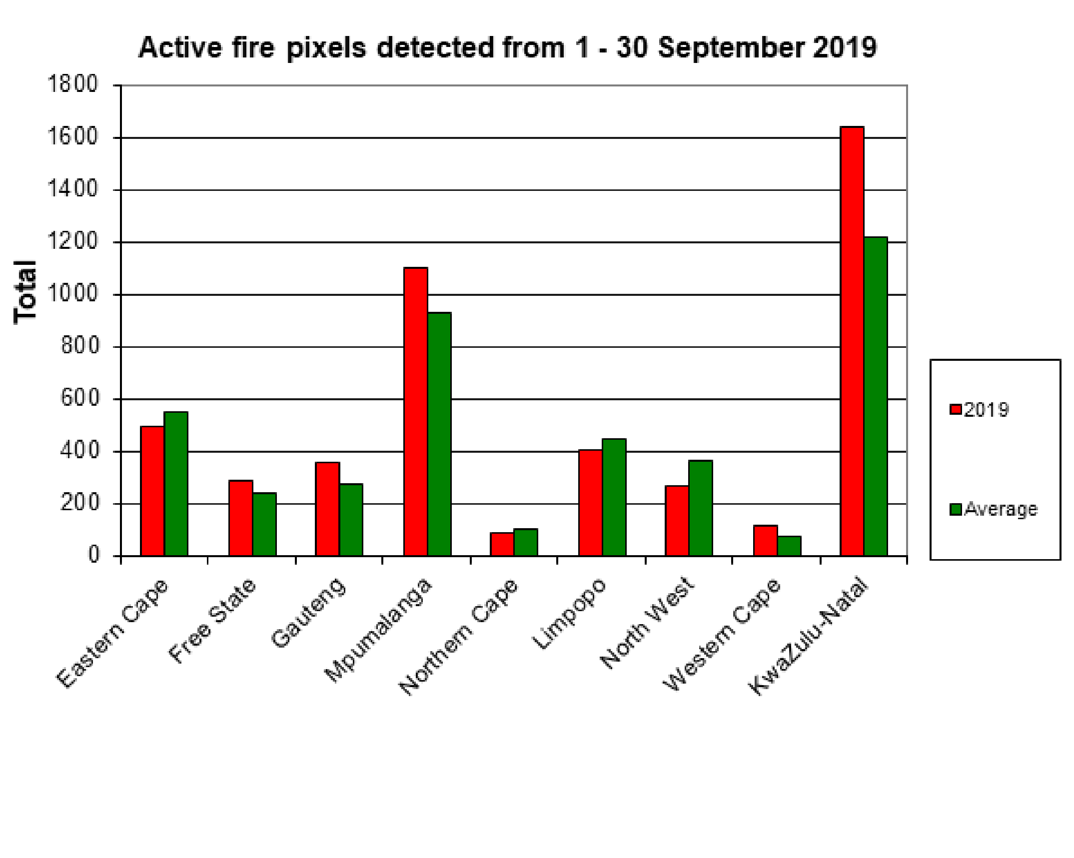

Figure 29

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

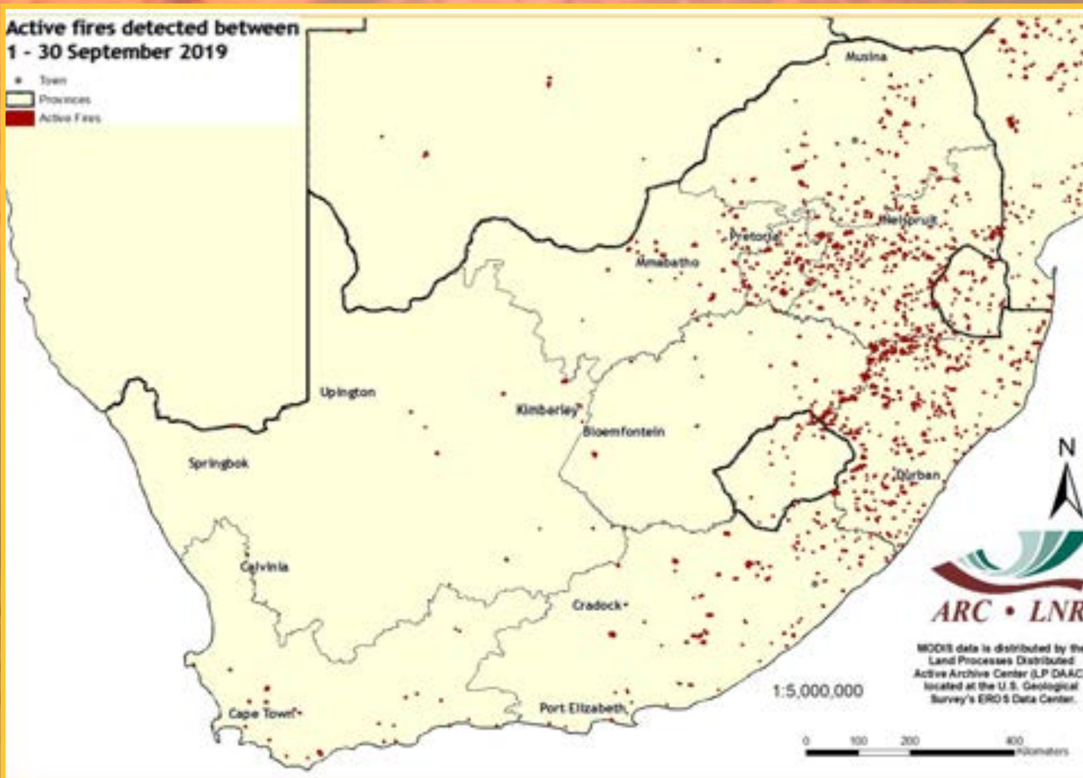

Figure 30

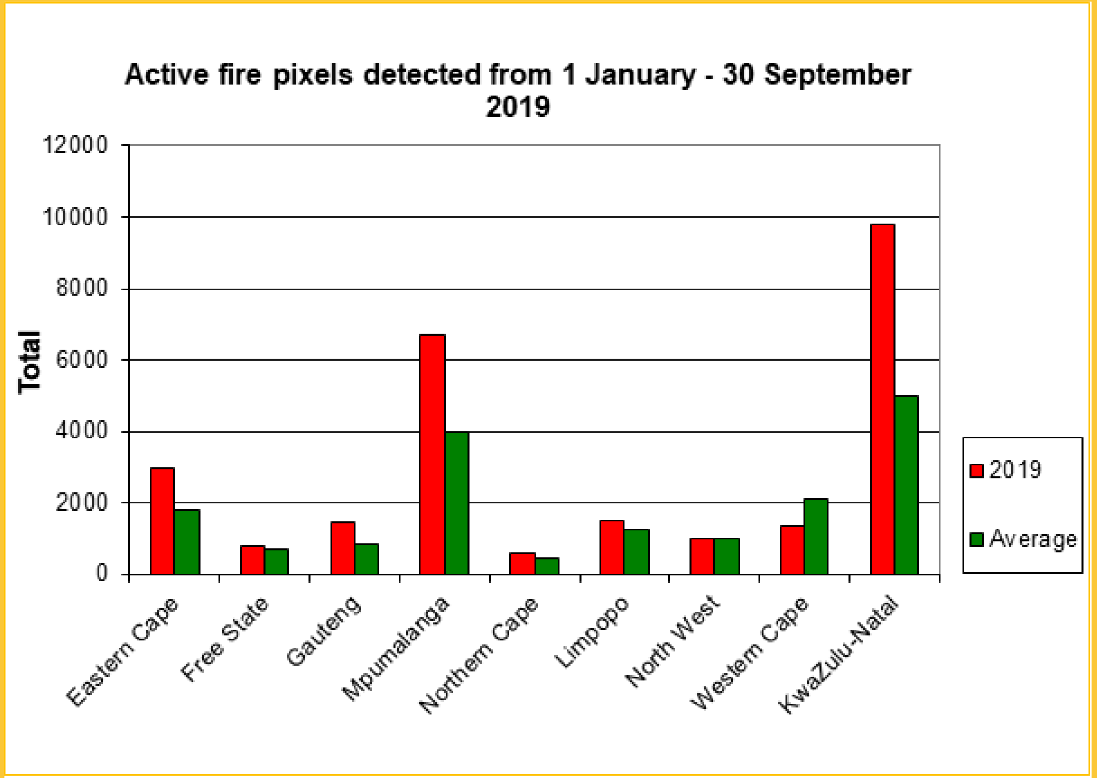

Figure 31

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

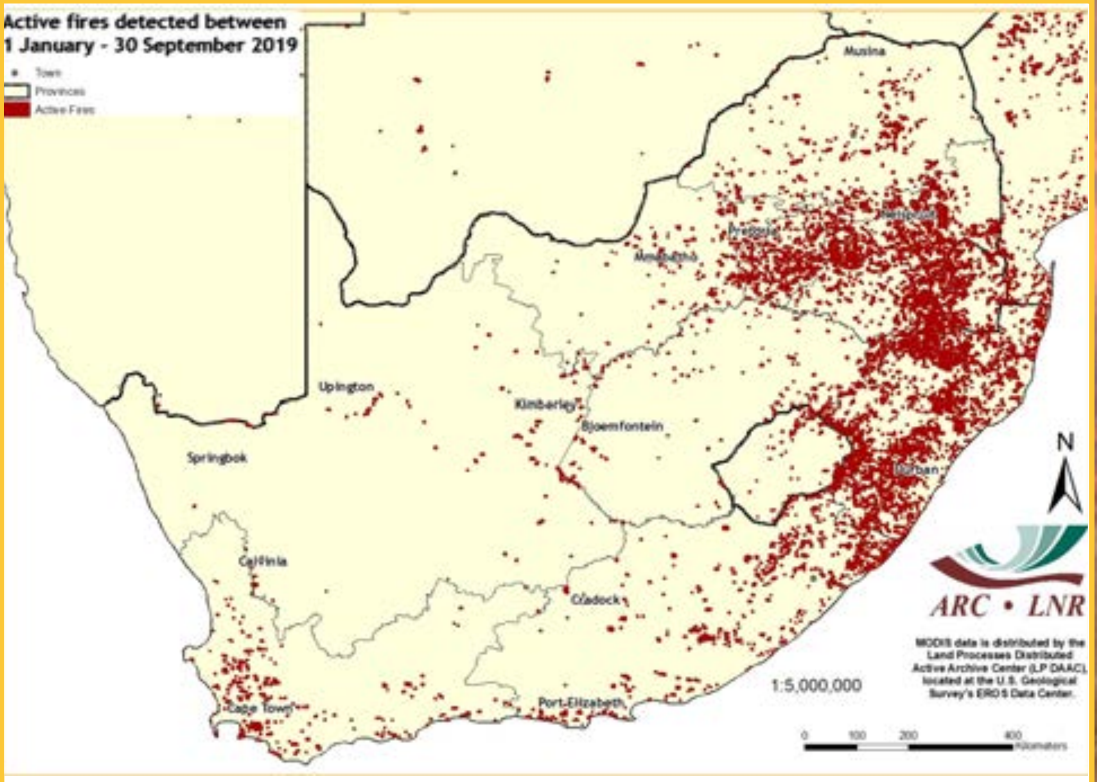

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January to 30 September 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 shows that the majority of water catchments across the country currently contain similar water areas to the maximum recorded in those same catchments since the end of 2015, with the exception of the continuing water reductions in the Karoo, Kalahari and some areas in Limpopo province.

Comparison between September 2019 and September 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.

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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mark.thompson@geoterraimage.com

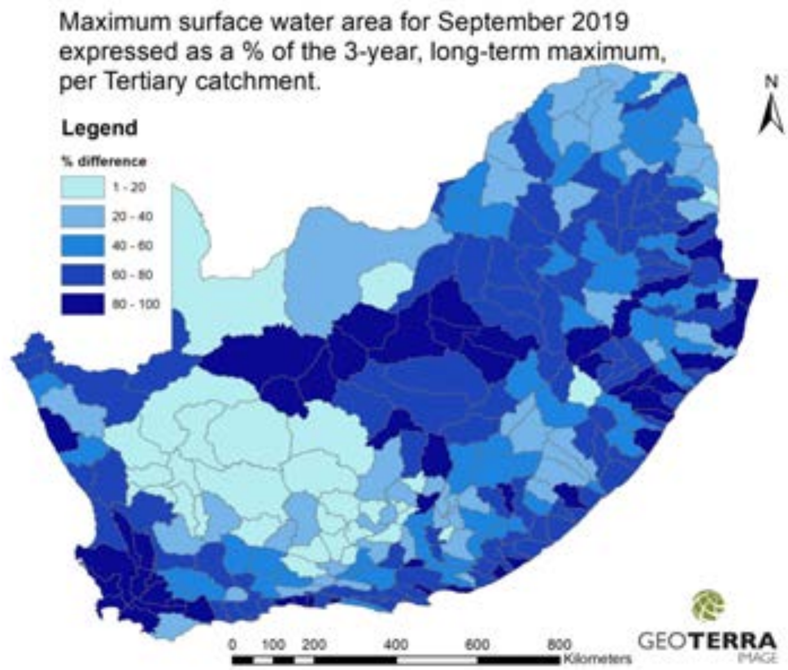

Figure 33

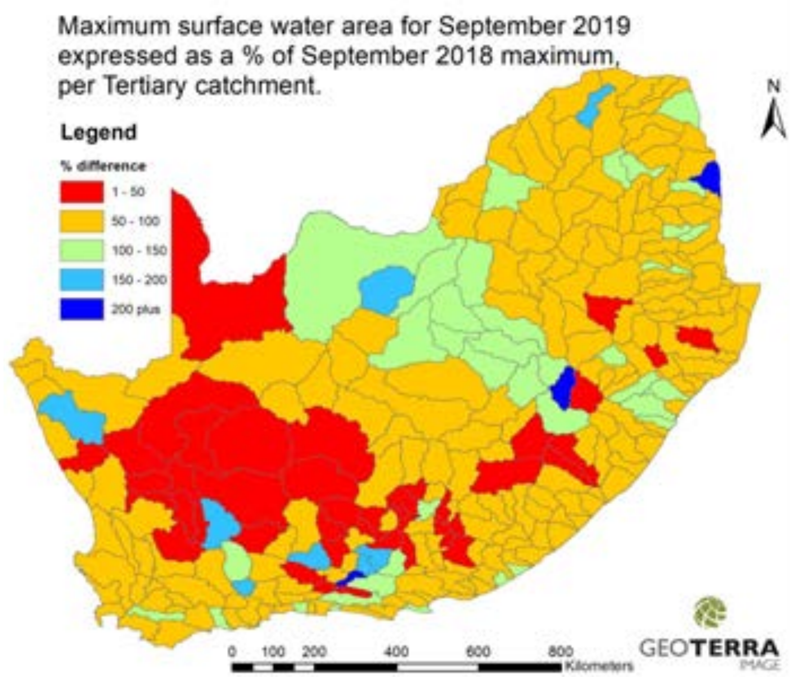

Figure 34

Agrometeorology

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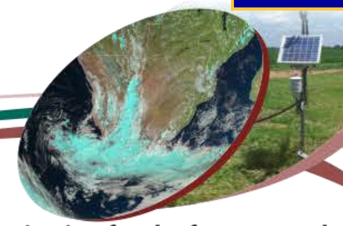

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national 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

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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".