ARC • LNR
Excellence in Research and Development

UMLINDI
The Watchman

ISSUE 2019-09 | 18 SEPTEMBER 2019

INSTITUTE FOR SOIL, CLIMATE AND WATER

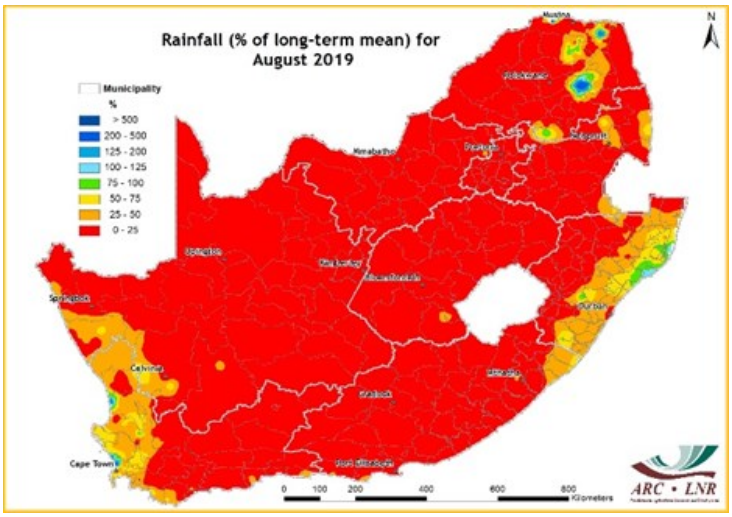
CONTENTS:

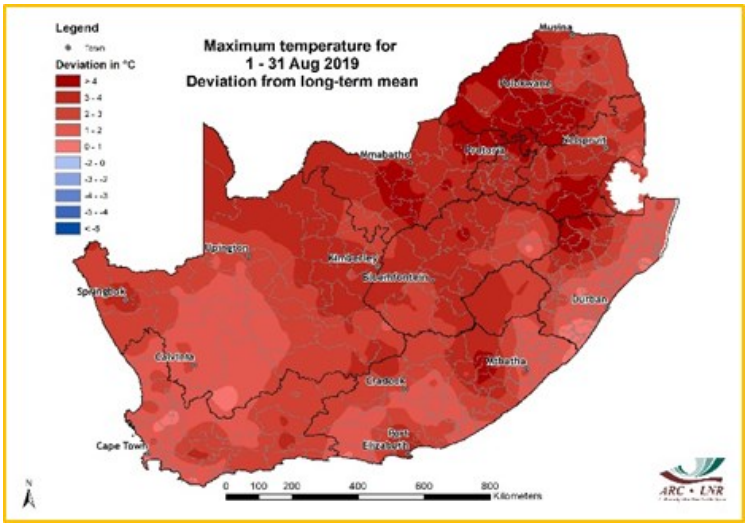
183rd Edition

Images of the Month

Dry and warm conditions characterized the month of August

A prominent feature of South Africa's climate during August 2019 was the widespread dry and warm conditions over the greater part of the country. The only areas that recorded several rainfall events which resulted in above-normal totals were the southwestern parts of the winter rainfall region, the KwaZulu-Natal coastal belt and isolated areas of Limpopo Province (see map left), thus keeping conditions relatively favourable for crop production. Maximum temperatures were high throughout the month due to evident anticyclonic circulation patterns over the interior, with positive anomalies exceeding 4°C in the northern half of the country (see map below). This unseasonably warm weather poses an alarm for the approaching summer rainfall season as extreme drought has already started to cripple agriculture and water resources in the Eastern Cape Province and adjacent areas. However, farmers in the affected areas can be advised that it is important to sell mature livestock and to continue assessing the grazing and available feed for proper planning, as overgrazing can lead to reduced capacity for coping with adverse drought conditions. Moreover, sustainable water management strategies (such as conservation agriculture) should be planned in order to mitigate the possible drought effects.





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, Forestry and Fisheries (DAFF).

1. Rainfall

Overview:

Circulation patterns during August 2019 were such that rainfall was largely absent over the greater part of the country. However, several areas experienced above-normal rainfall, including parts of the Western Cape and KwaZulu-Natal which recorded up to 50 mm, and isolated parts of Limpopo and the Eastern Cape south coast which received monthly rainfall totals of up to 25 mm.

The first few days of the month were characterized by dry westerlies with isolated showers over the Western Cape. A cold front made landfall around the 11th which resulted in good rainfall the following day in Paarl, Ceres and Wellington. Following the cold front, temperatures started to increase over the country. Although the southwestern parts experienced the passage of regular frontal systems, parts of the Eastern, Western and Northern Cape provinces received below-normal rainfall, contributing to the occurrence of drought over those areas. Around the 15th a ridging high pressure system caused rainfall over the eastern parts of Limpopo, with above-normal rainfall subsequently occurring along the escarpment area. As the month of August came to an end, several frontal systems brought in some rain and showers over the southwestern parts of the country, while anticyclonic circulation patterns kept the rest of the country warm and dry.

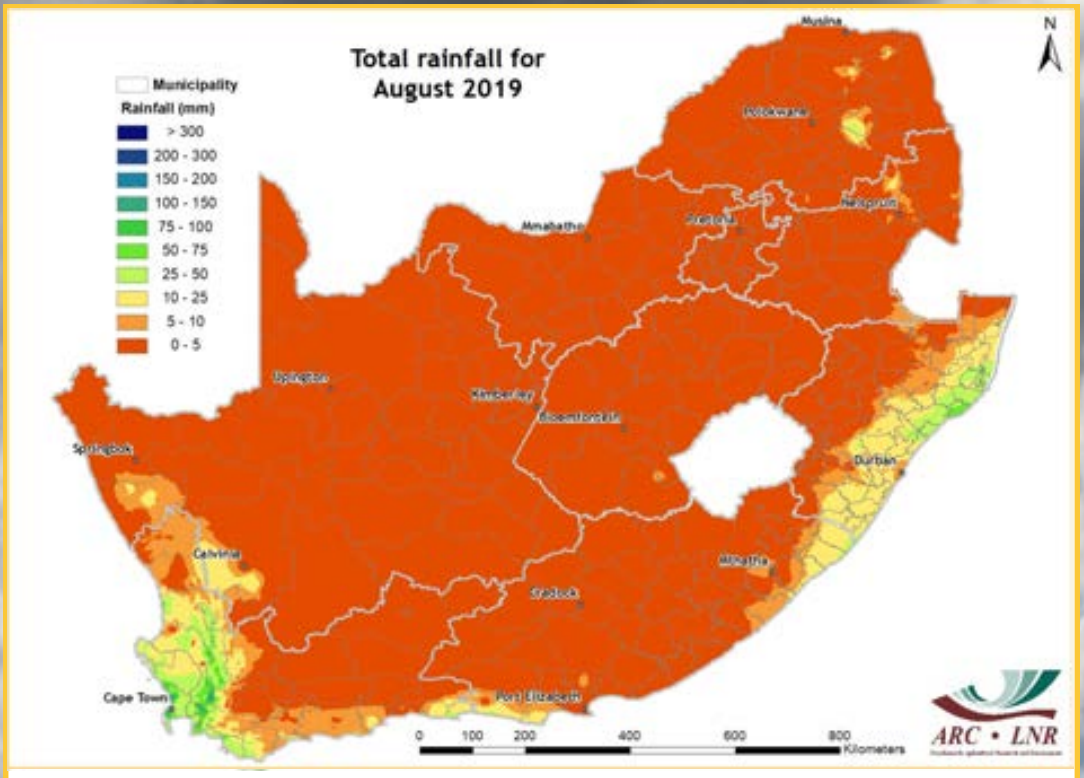


Figure 1

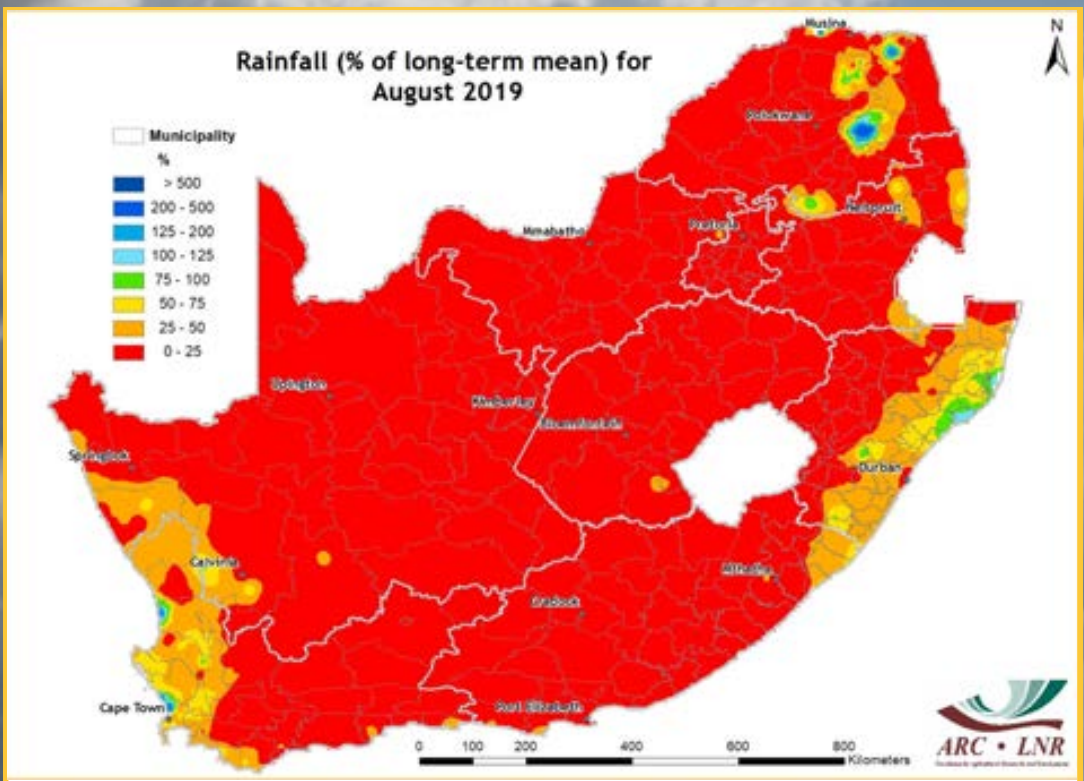


Figure 2

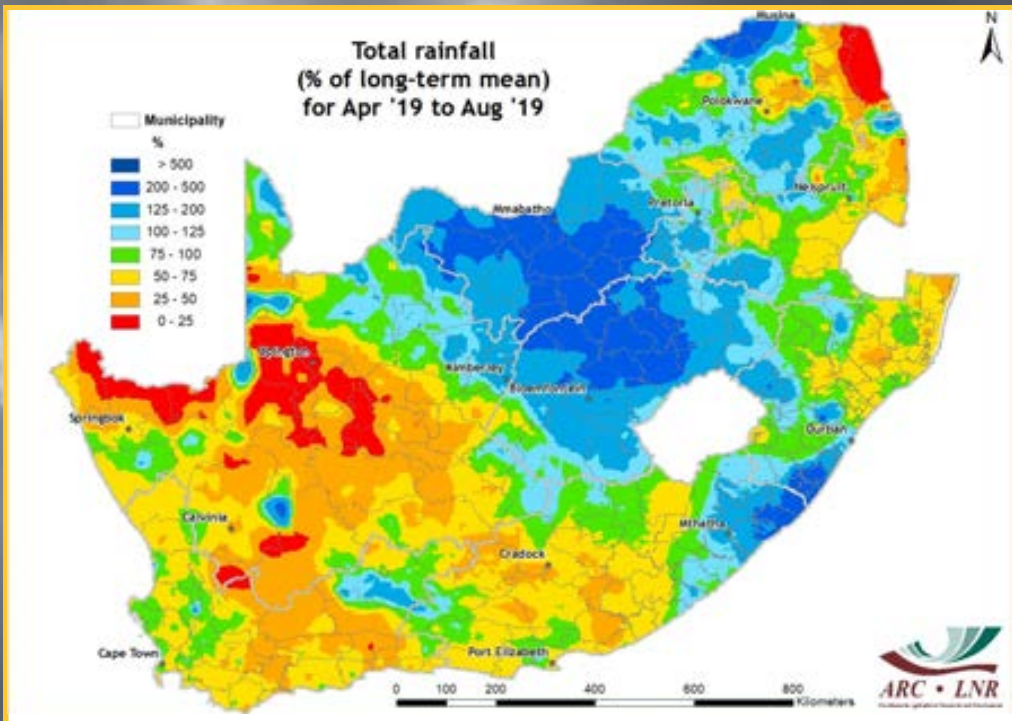


Figure 3

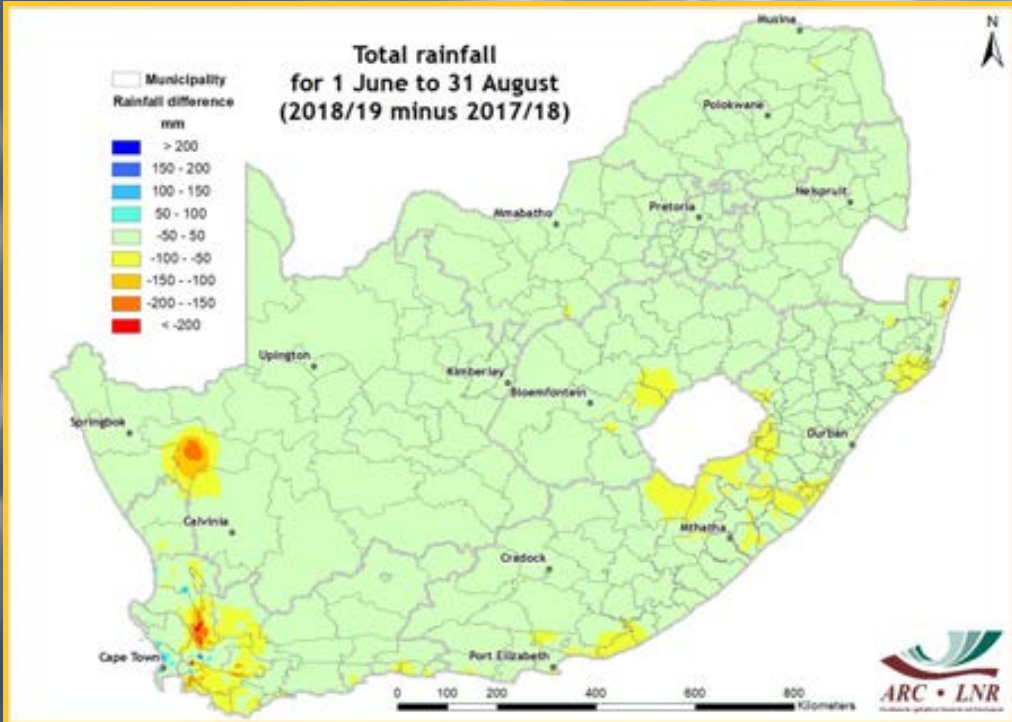


Figure 4

Figure 1:
The month of August was generally dry but the coastal areas of the Western Cape and KwaZulu-Natal received high rainfall totals for the month.

Figure 2:
Near- to above-normal rainfall occurred along the Cape south coast, KwaZulu-Natal coastline and the eastern parts of Limpopo.

Figure 3:
Rainfall totals since April to August 2019 indicate below-normal conditions over the Northern Cape and the eastern corner of Limpopo, when compared to the long-term mean for the same period. Near- to above-normal rains were experienced over the summer rainfall region.

Figure 4:
The 3-month period from June to August in the 2018/19 season received comparable amounts of rainfall to the corresponding period in 2017/18. However, the western parts of the Western Cape and Northern Cape received up to 200 mm less rainfall while isolated areas of the Eastern Cape, Free State and KwaZulu-Natal received up to 100 mm less rainfall.

Questions/Comments:
MasuphaE@arc.agric.za
Philip@arc.agric.za

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 August 2019 show the 3-month accumulation of mild to extreme drought over the country. Also at the short time scale an intensification of drought over the Eastern Cape Province and adjacent areas is notable. Wet conditions dominate at the 6-month time scale over the central interior and towards the southern coast of KwaZulu-Natal. At the longer time scales (12- to 24-month), severe to extreme drought conditions still dominate over the Northern Cape and other parts of the Western and Eastern Cape provinces.

Questions/Comments:
MasuphaE@arc.agric.za
Philip@arc.agric.za

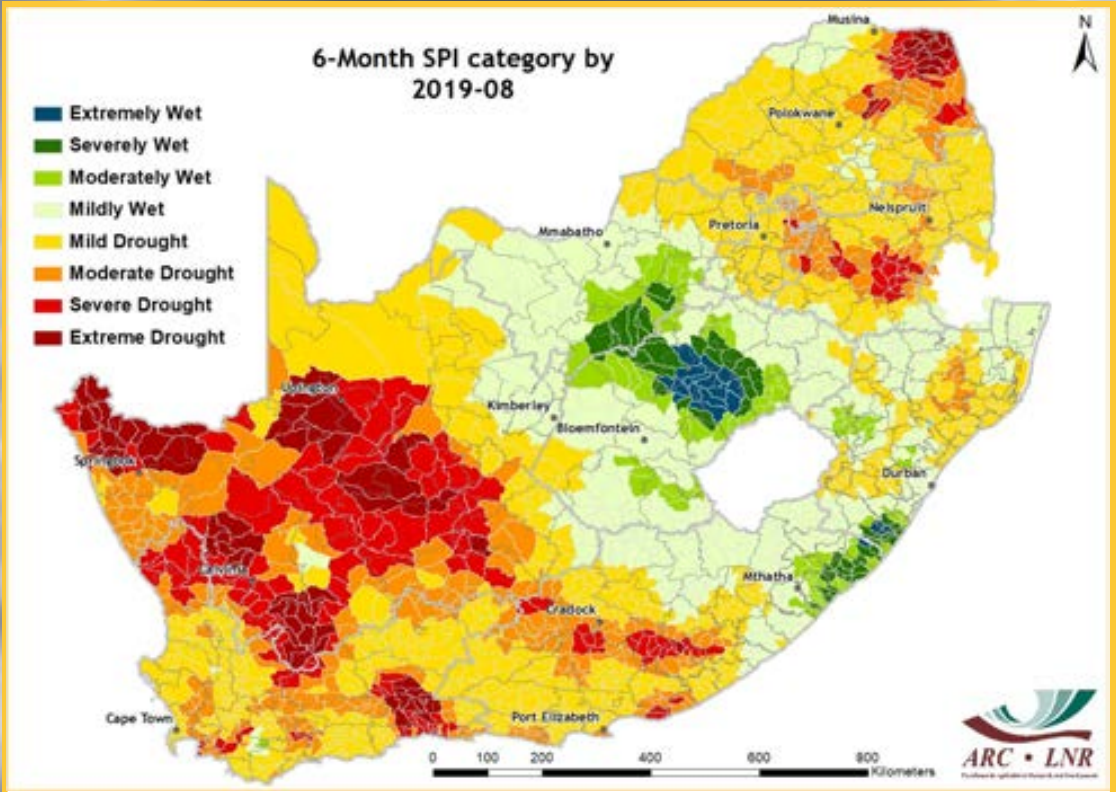


Figure 5

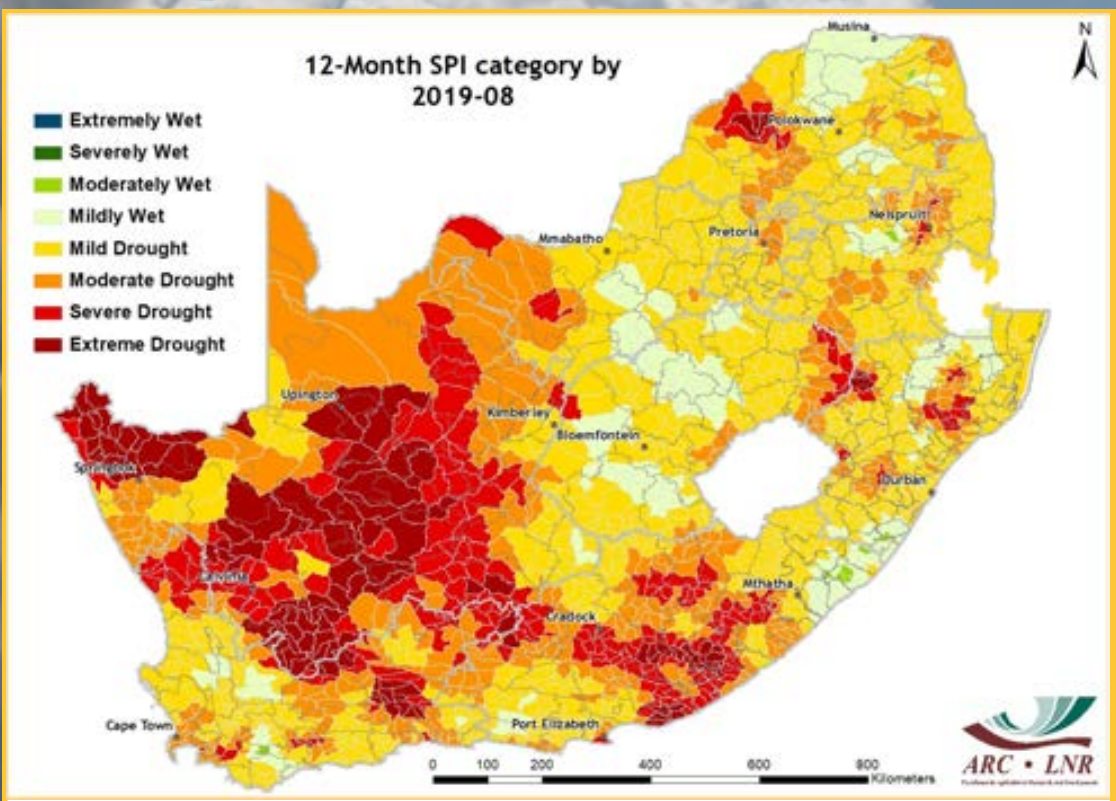


Figure 6

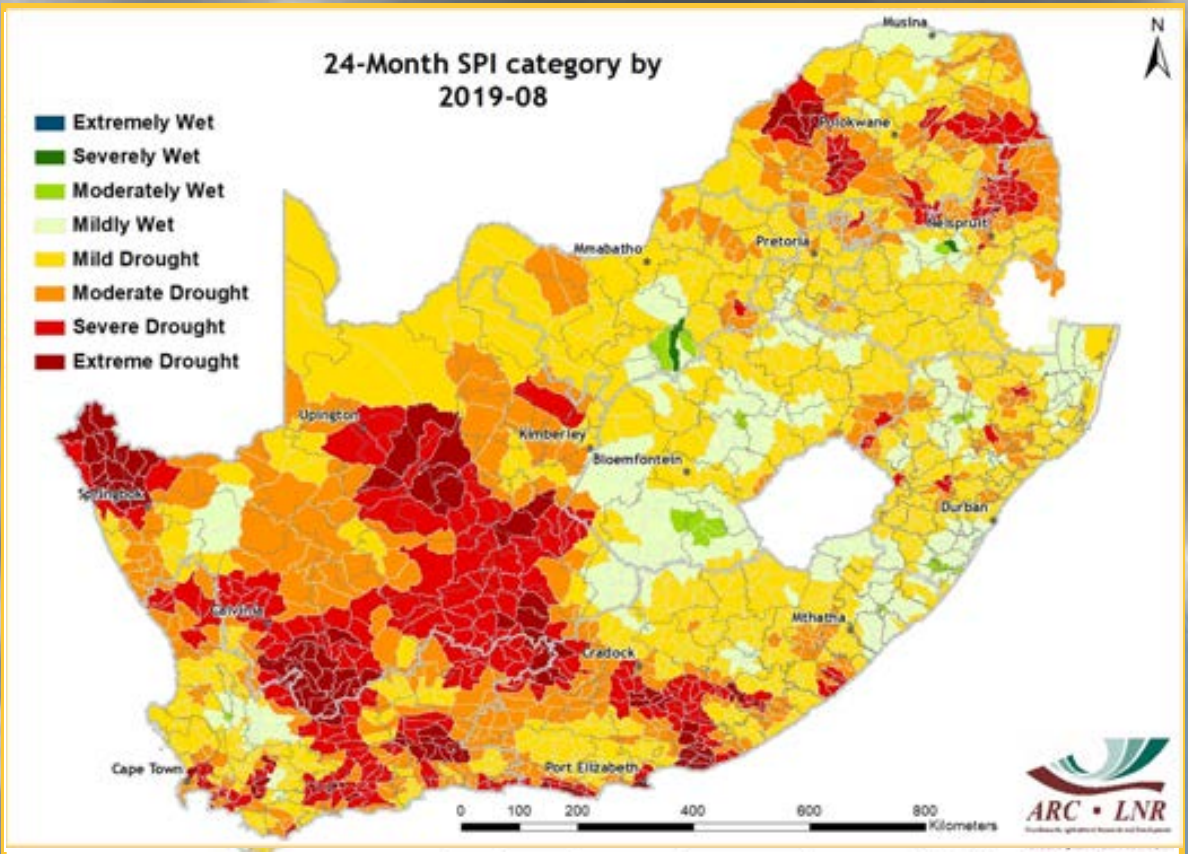


Figure 7

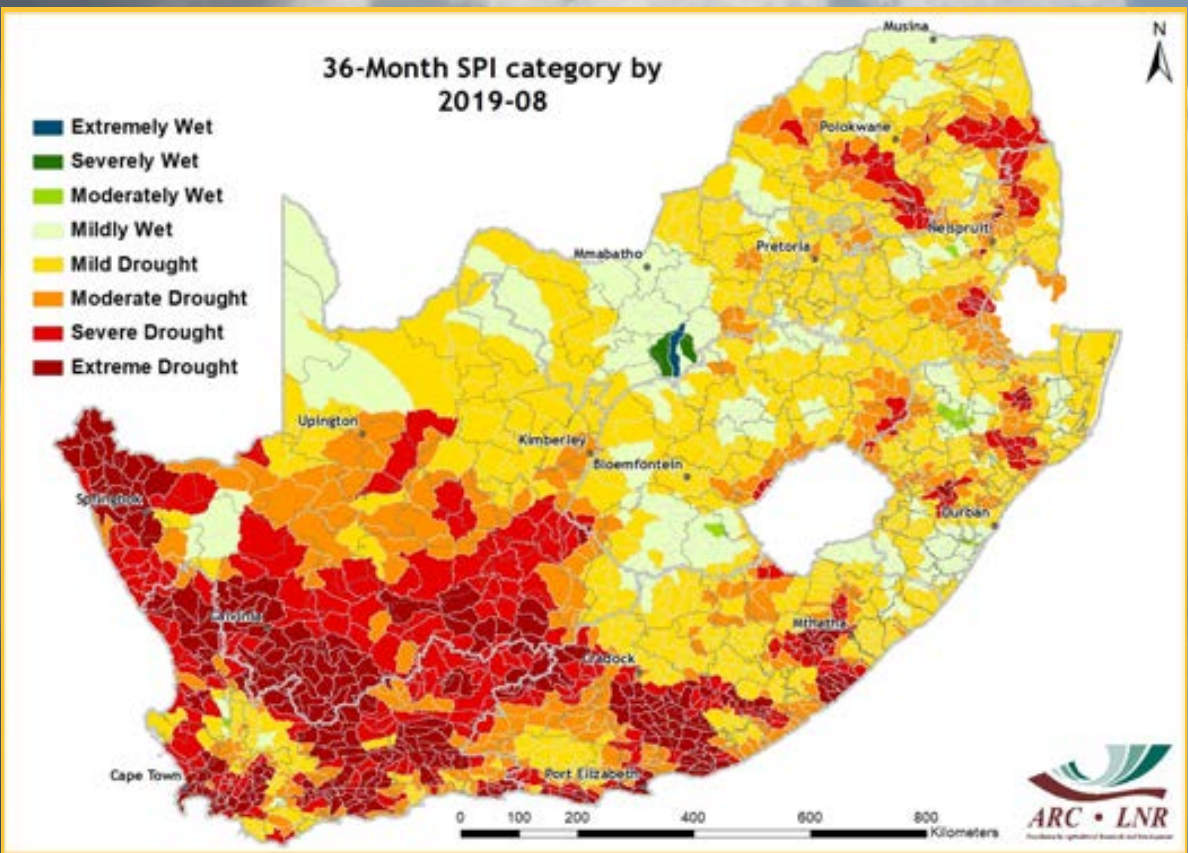


Figure 8

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.

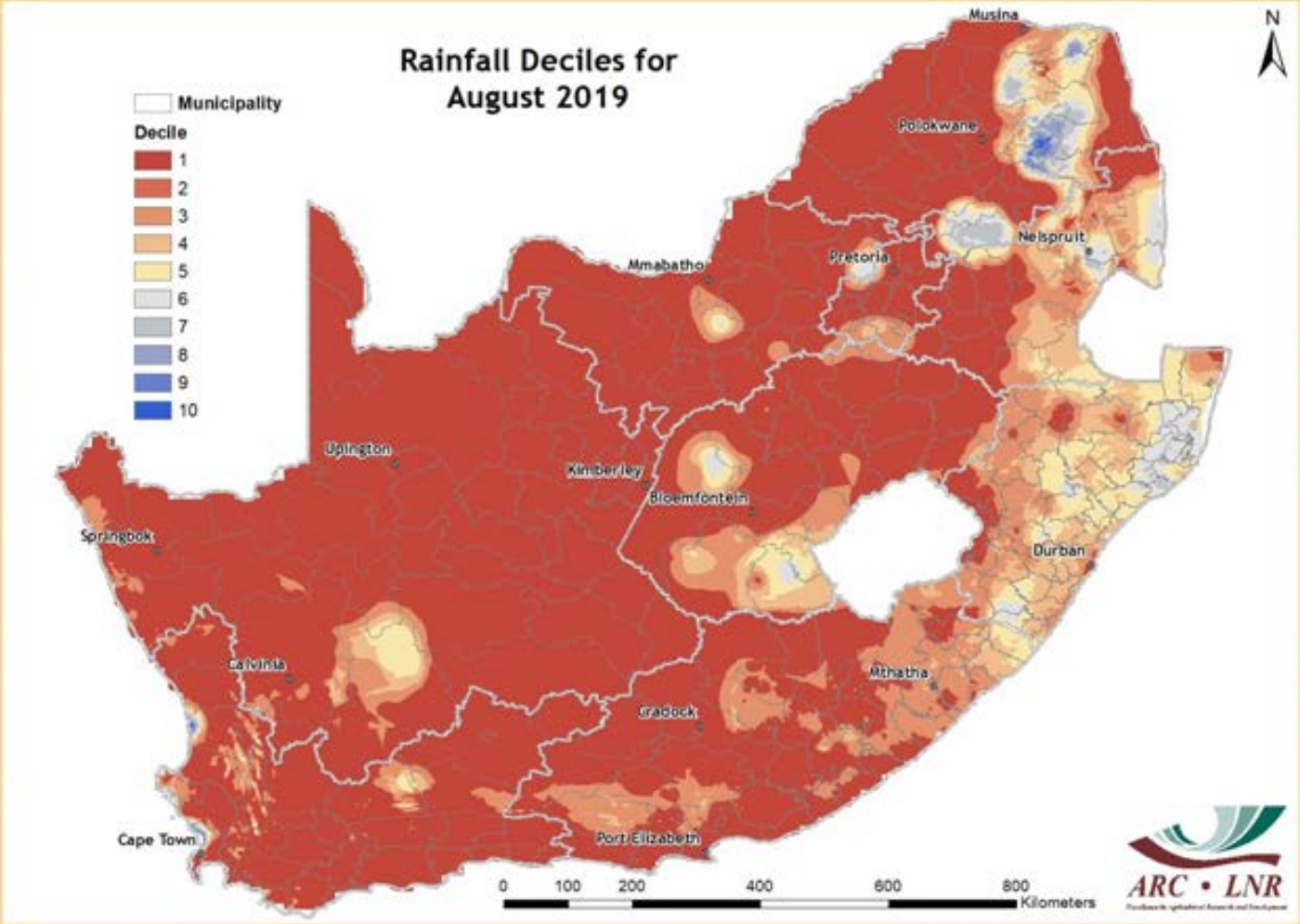


Figure 9

Figure 9:
August 2019 over most parts of the country compares well with the historically drier August months. The northeastern areas of Limpopo, Mpumalanga and KwaZulu-Natal fall within the wetter August months.

Questions / Comments:
MasuphaE@arc.agric.za
Philip@arc.agric.za

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.

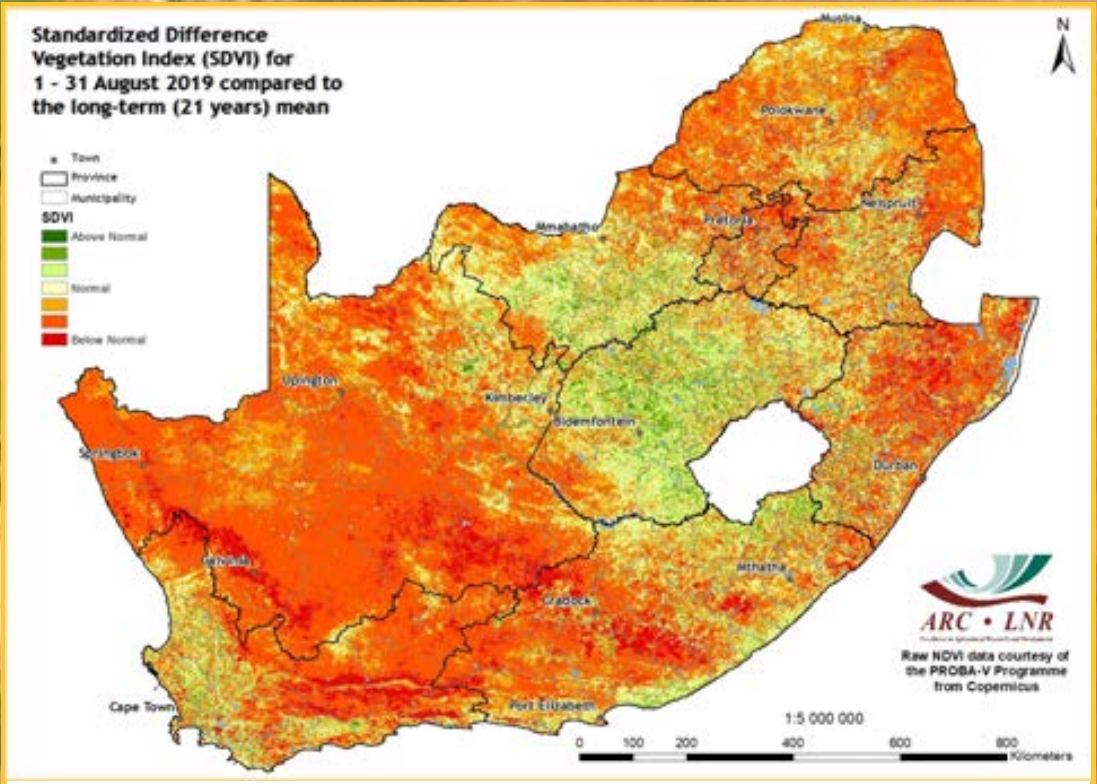


Figure 10

Figure 10:
The August 2019 SDVI map shows that the western parts as well as the northern parts of the country continue to experience less and less vegetation activity.

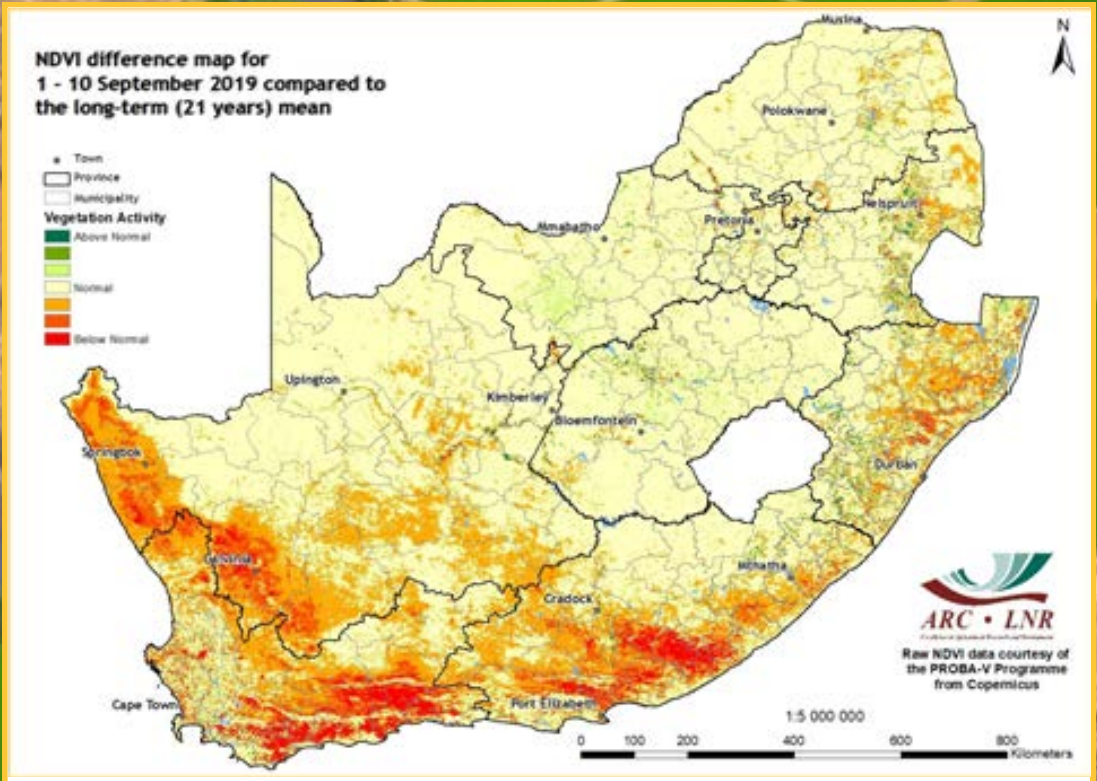


Figure 11

Figure 11:
The NDVI difference map for the first 10 days of September 2019 shows that below-normal vegetation activity occurred in the lower parts of the Northern Cape, the Western Cape, Eastern Cape and some isolated areas in KwaZulu-Natal and Mpumalanga. Meanwhile, the remaining parts of the country experienced normal vegetation conditions.

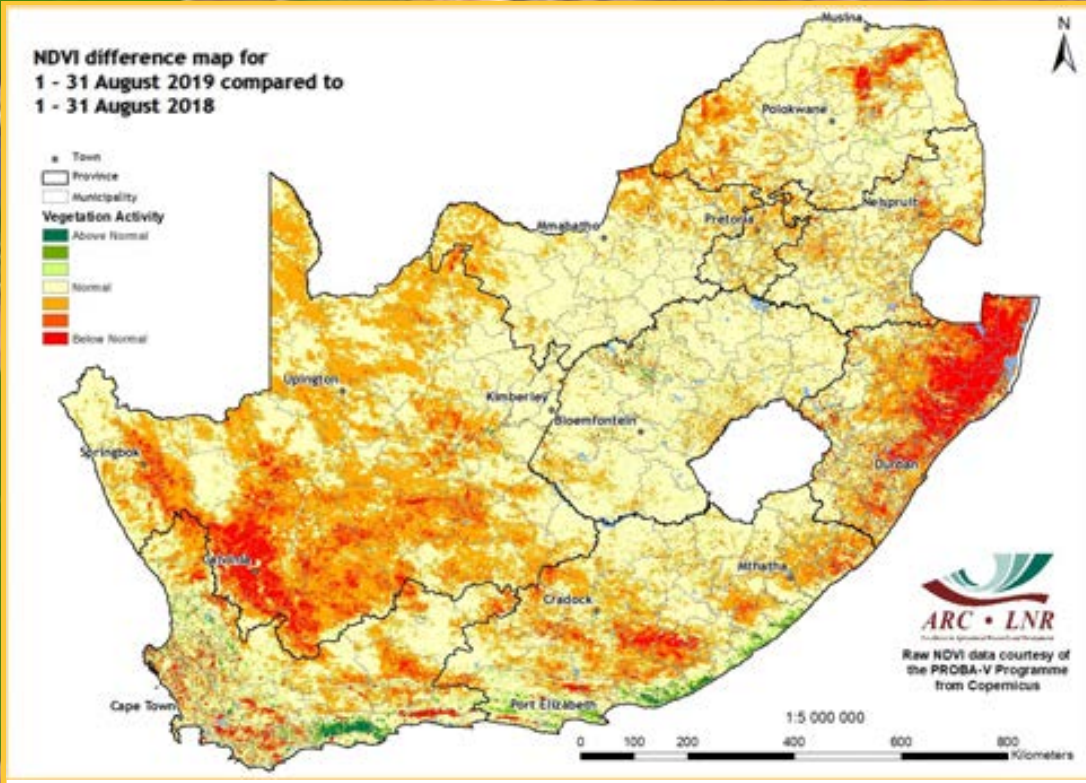


Figure 12

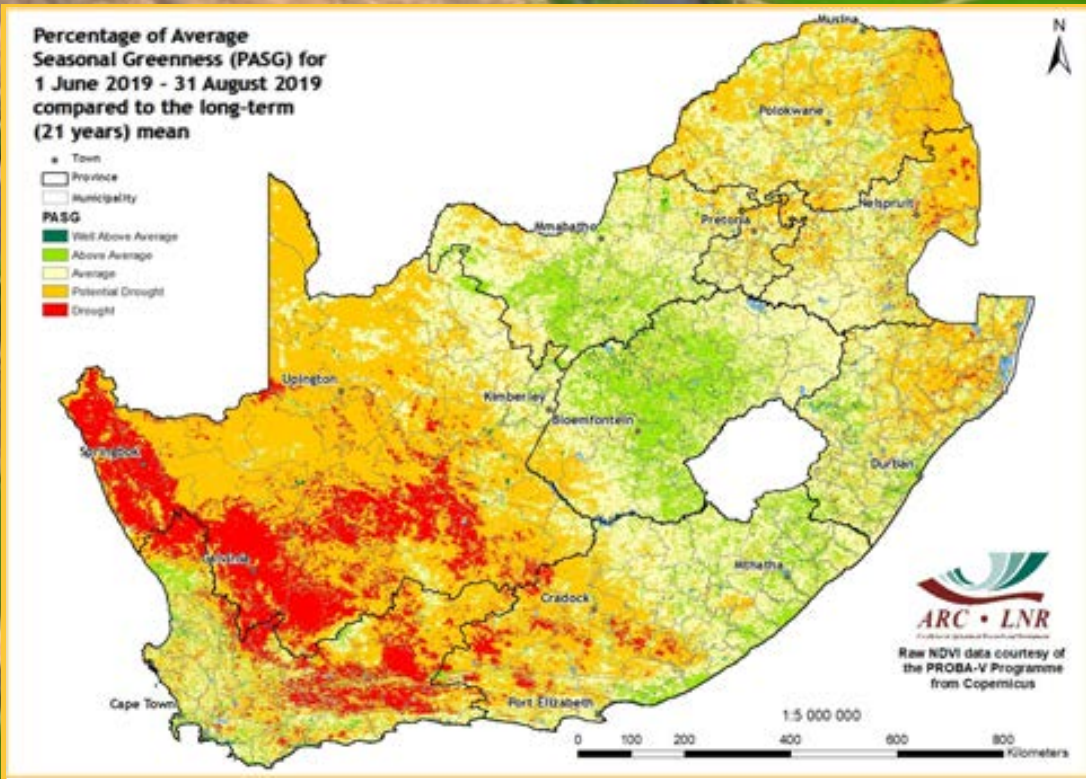


Figure 13

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 same month last year, the August 2019 NDVI map shows that the Northern Cape continues to experience below-normal vegetation activity. The same conditions were observed in northern parts of KZN as well as remote areas of Limpopo and Mpumalanga. However, pockets of above-normal vegetation activity remained in isolated coastal areas.

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

Questions/Comments:
MaakeR@arc.agric.za

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.

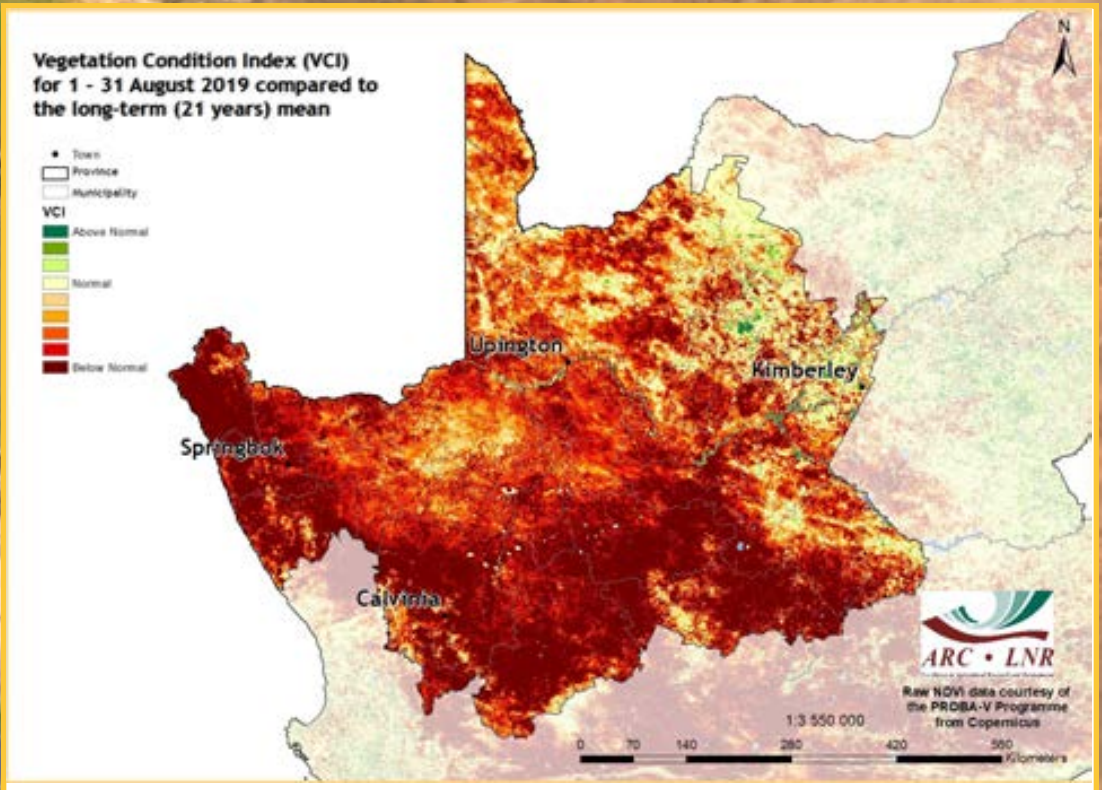


Figure 14

Figure 14:
The VCI map for August 2019 shows that the Northern Cape Province remains under severe poor vegetation conditions.

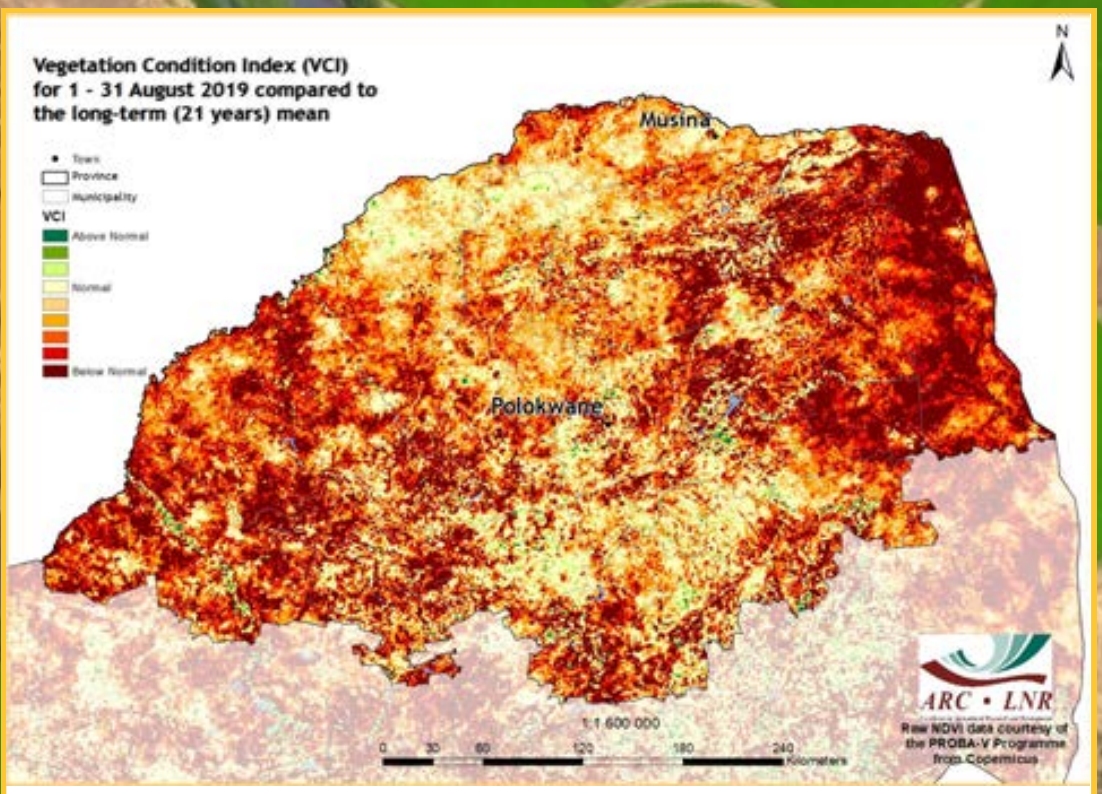


Figure 15

Figure 15:
The VCI map for Limpopo indicates that almost the entire province experienced very poor vegetation activity in August.

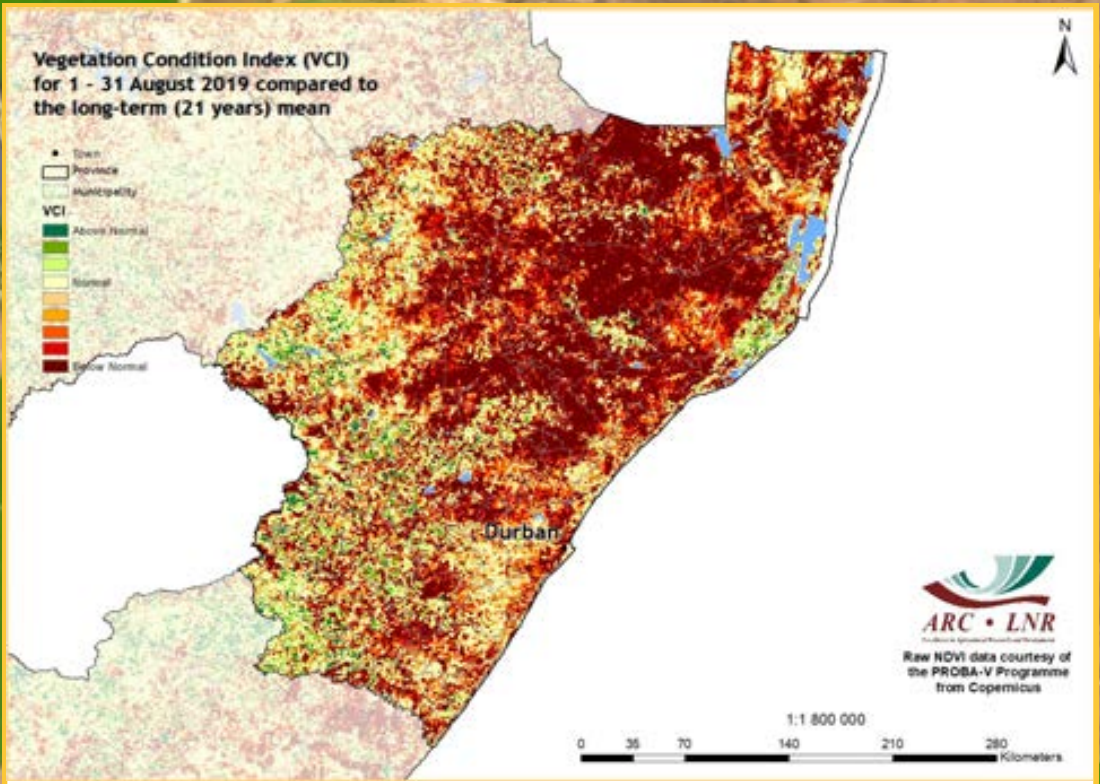


Figure 16

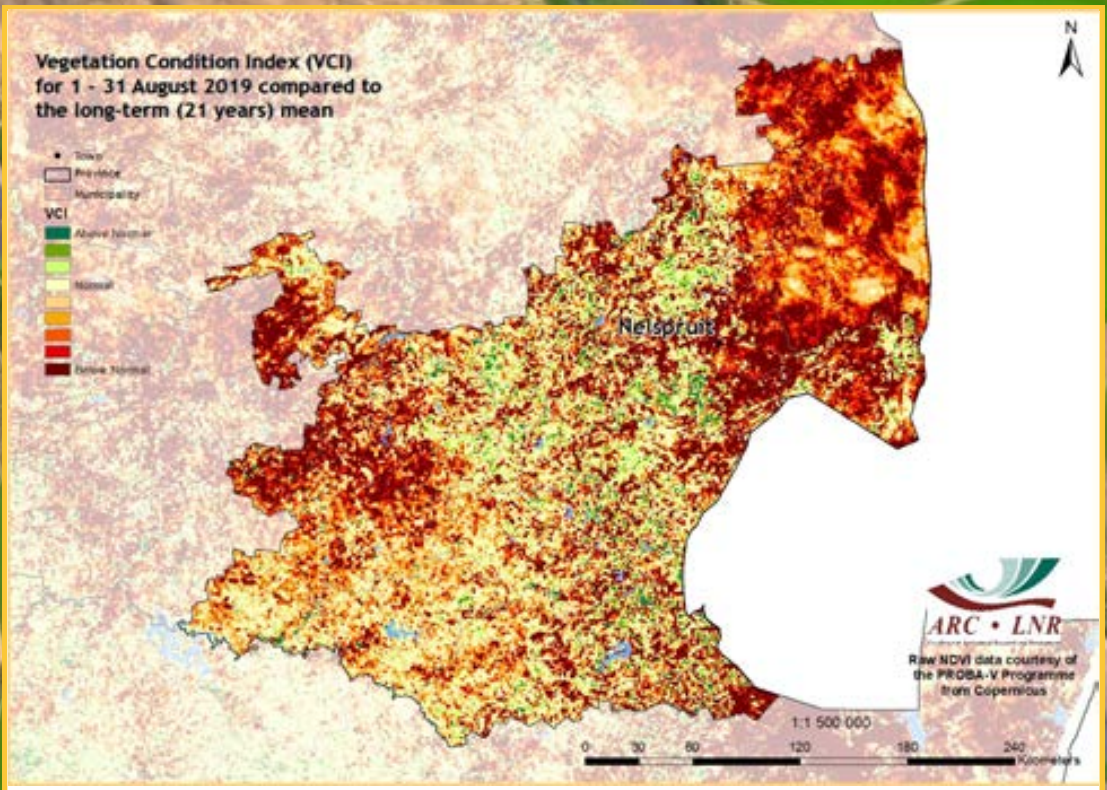


Figure 17

Figure 16:
While KwaZulu-Natal has been experiencing poor vegetation conditions in isolated areas, the August VCI map shows that the condition has spread over many parts of the province.

Figure 17:
The VCI map for Mpumalanga shows that many parts experienced poor vegetation conditions activity in August with the Kruger National Park being the most affected part of the province.

Questions/Comments:
MaakeR@arc.agric.za

6. Vegetation Conditions & Rainfall

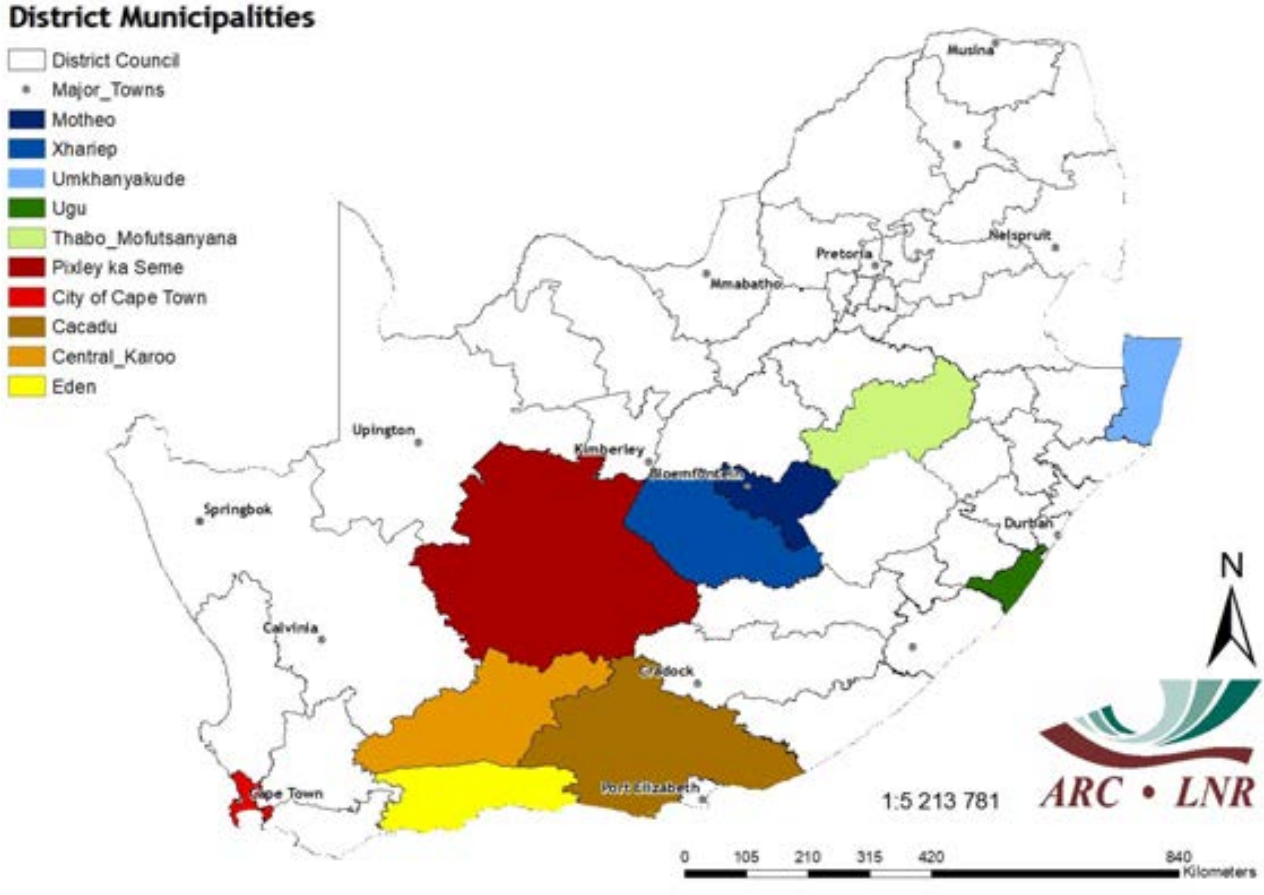


Figure 18

Rainfall and NDVI Graphs

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

Questions/Comments:
MaakeR@arc.agric.za

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.

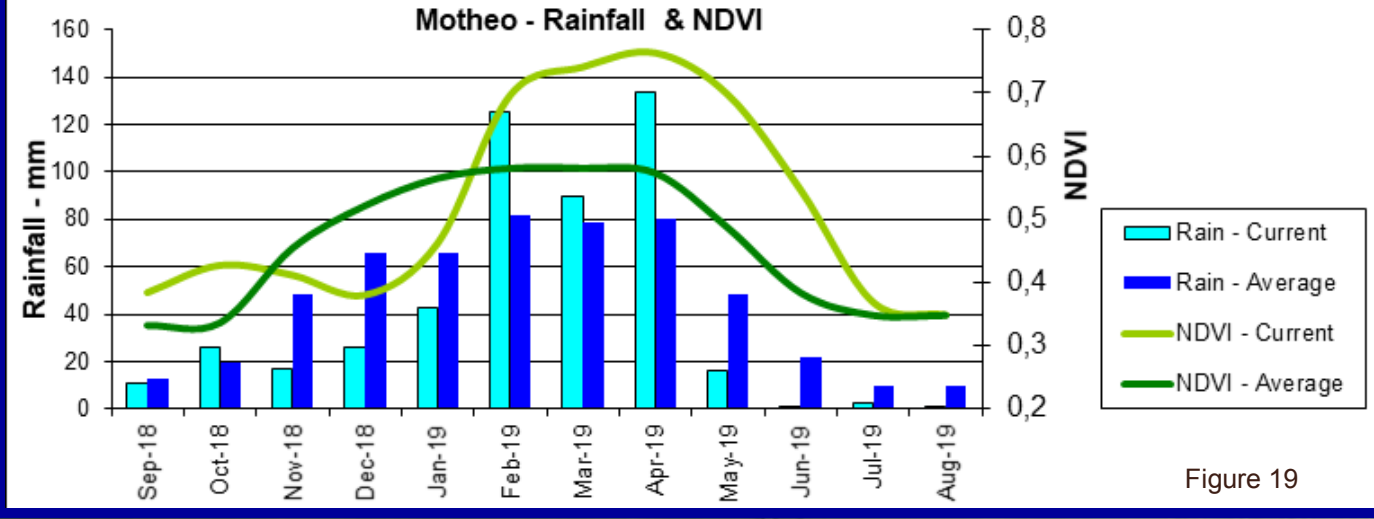


Figure 19

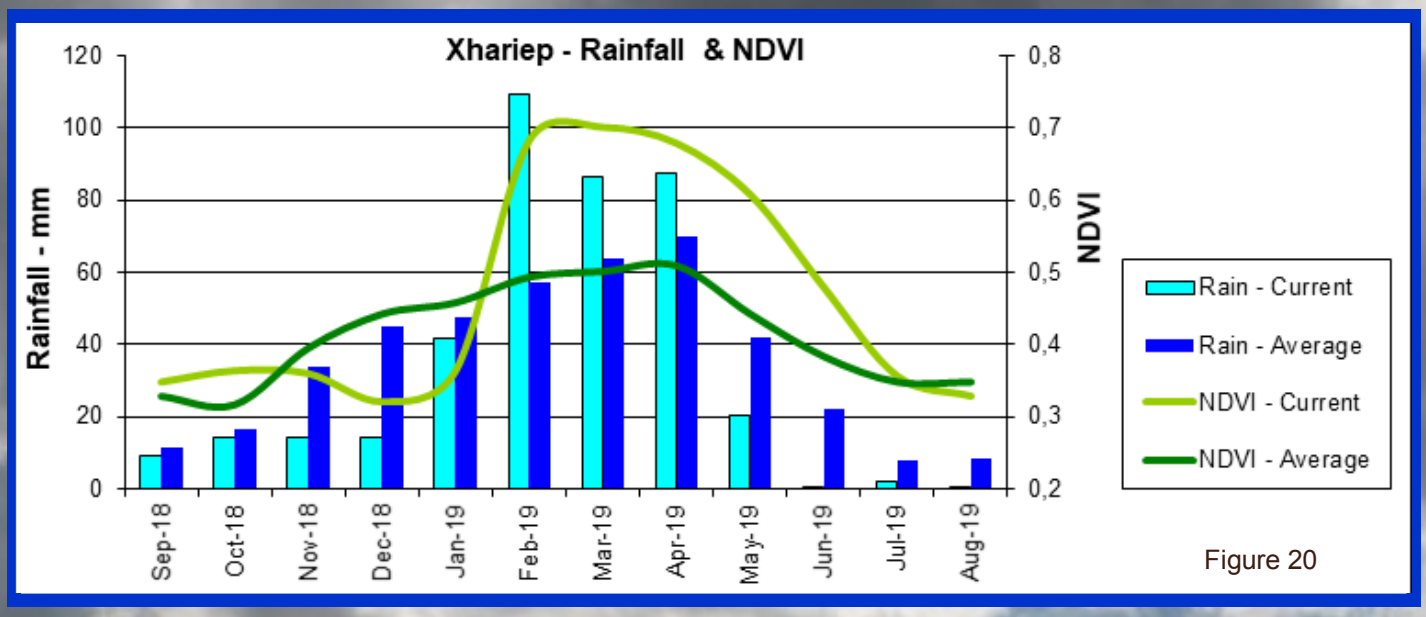


Figure 20

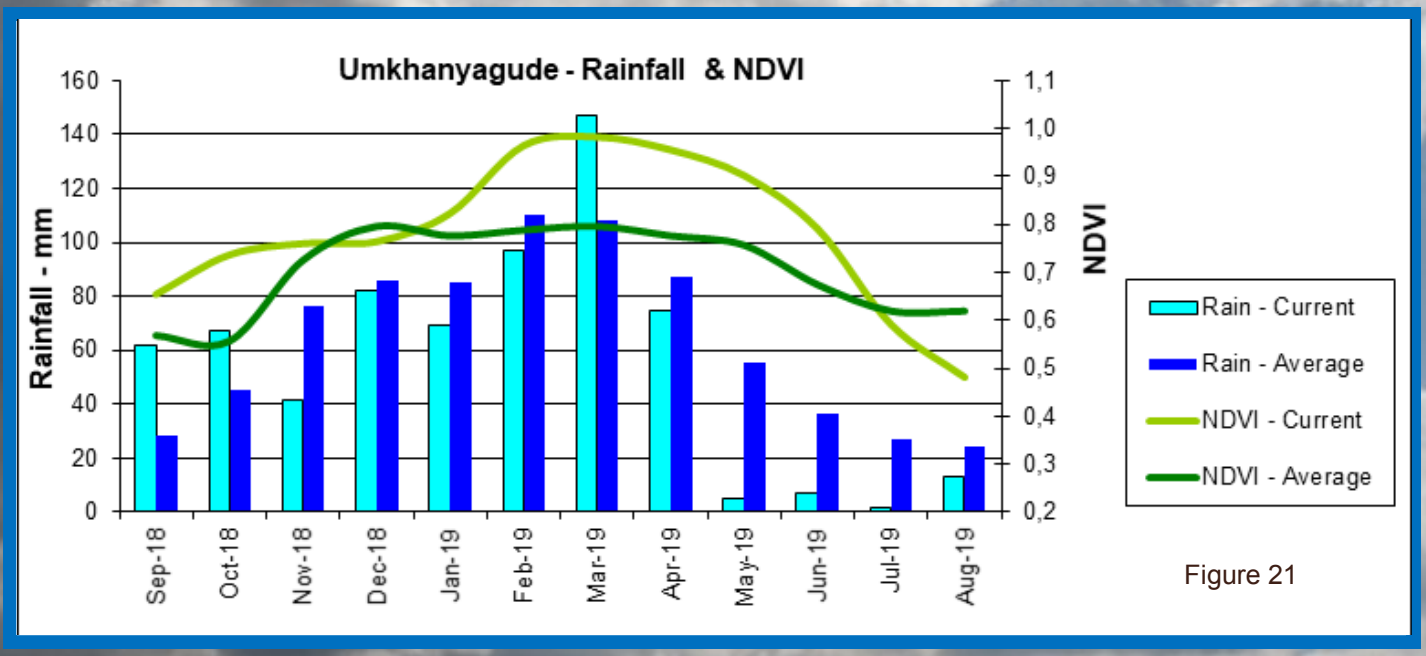


Figure 21

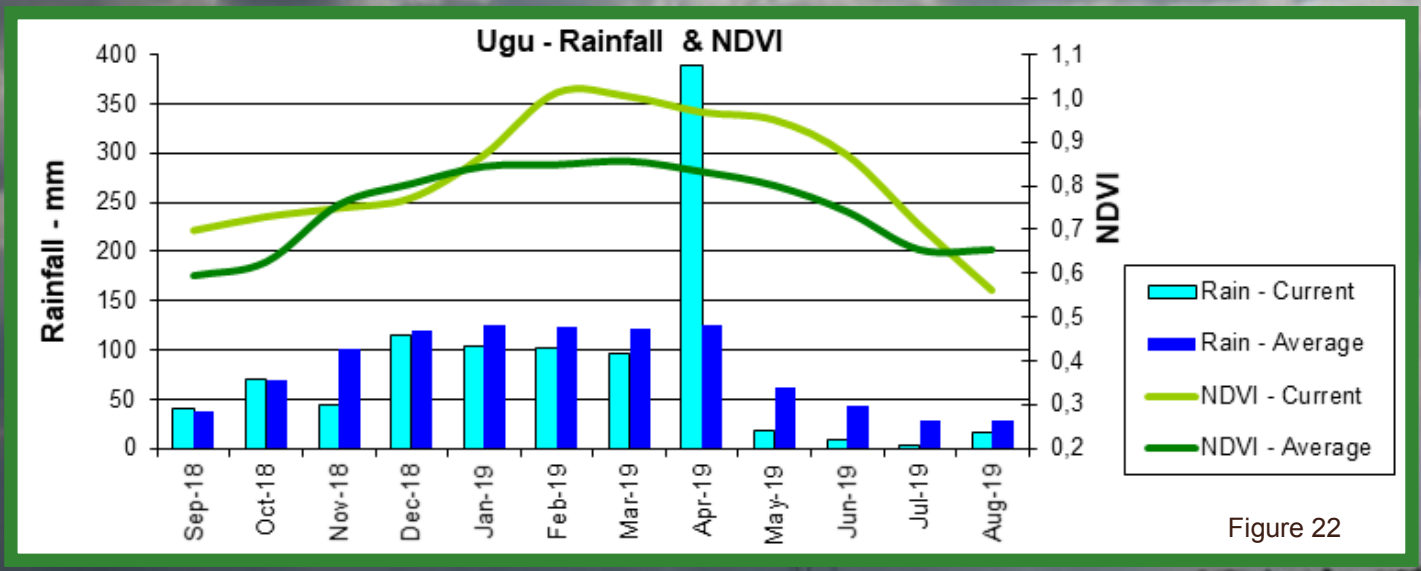


Figure 22

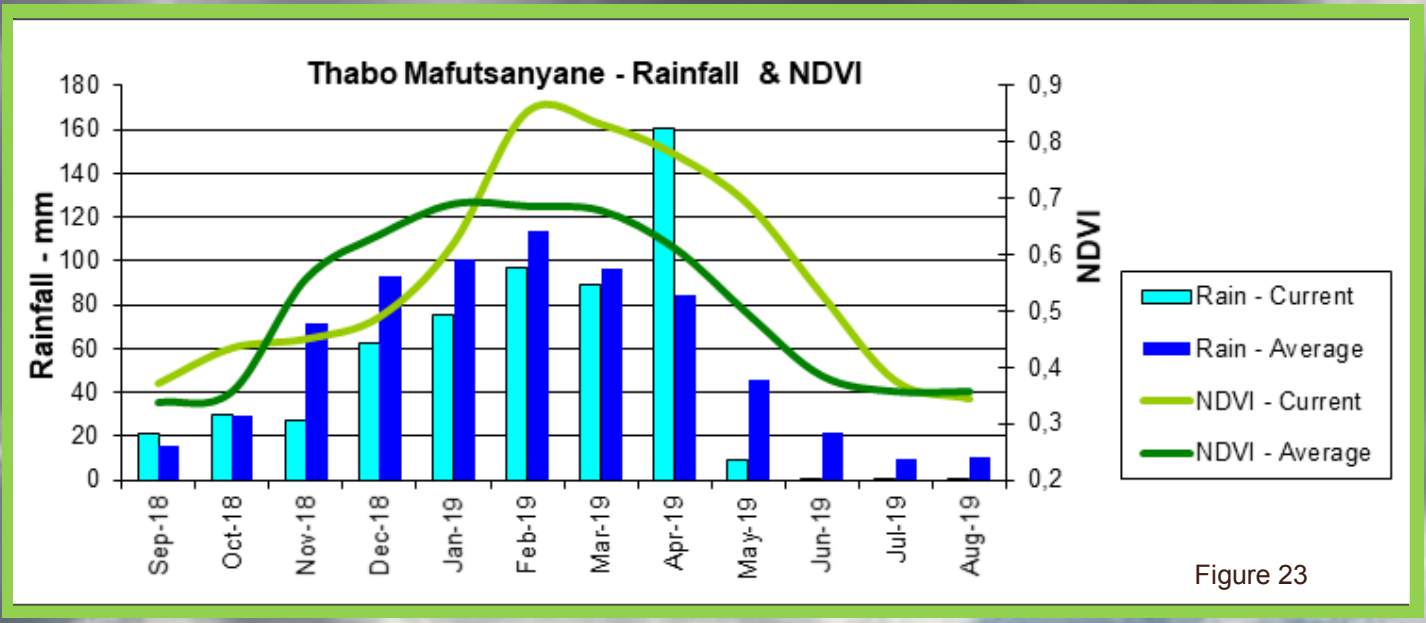


Figure 23

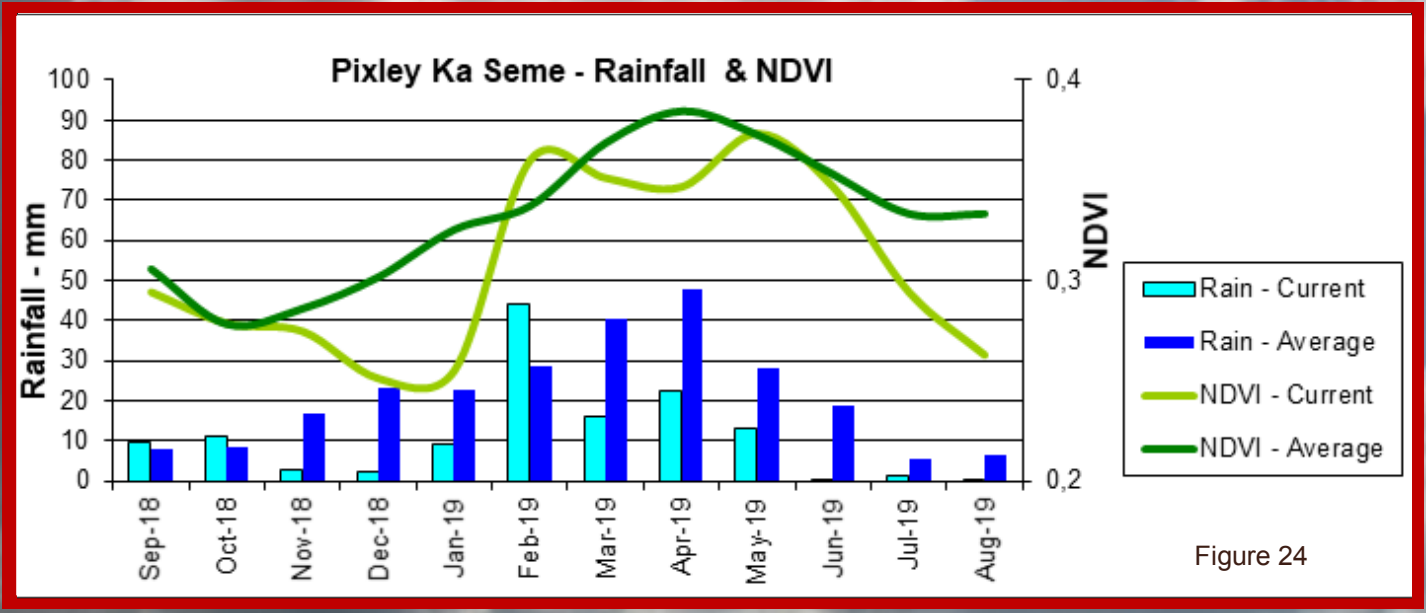


Figure 24

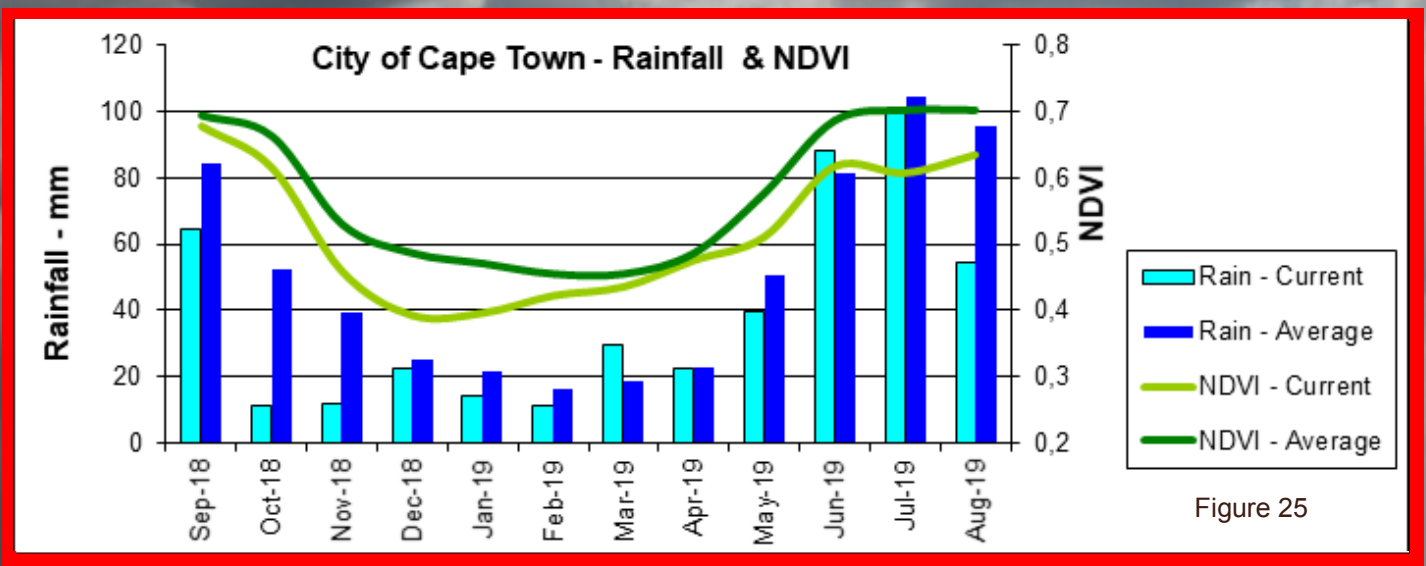


Figure 25

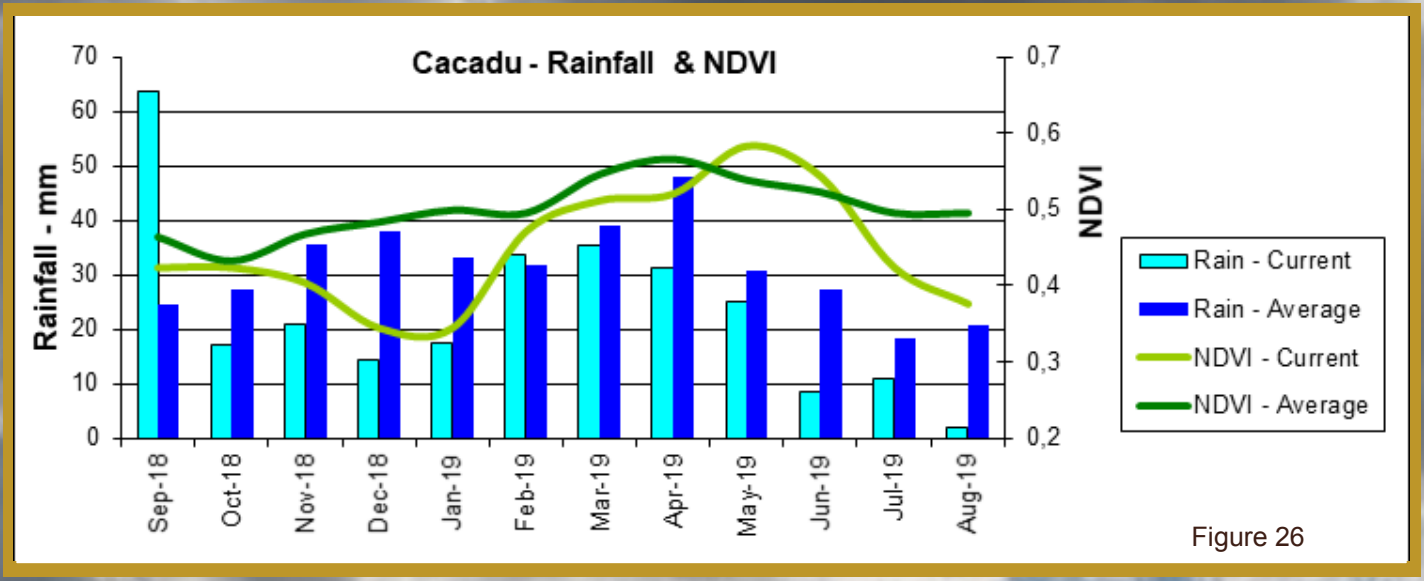


Figure 26

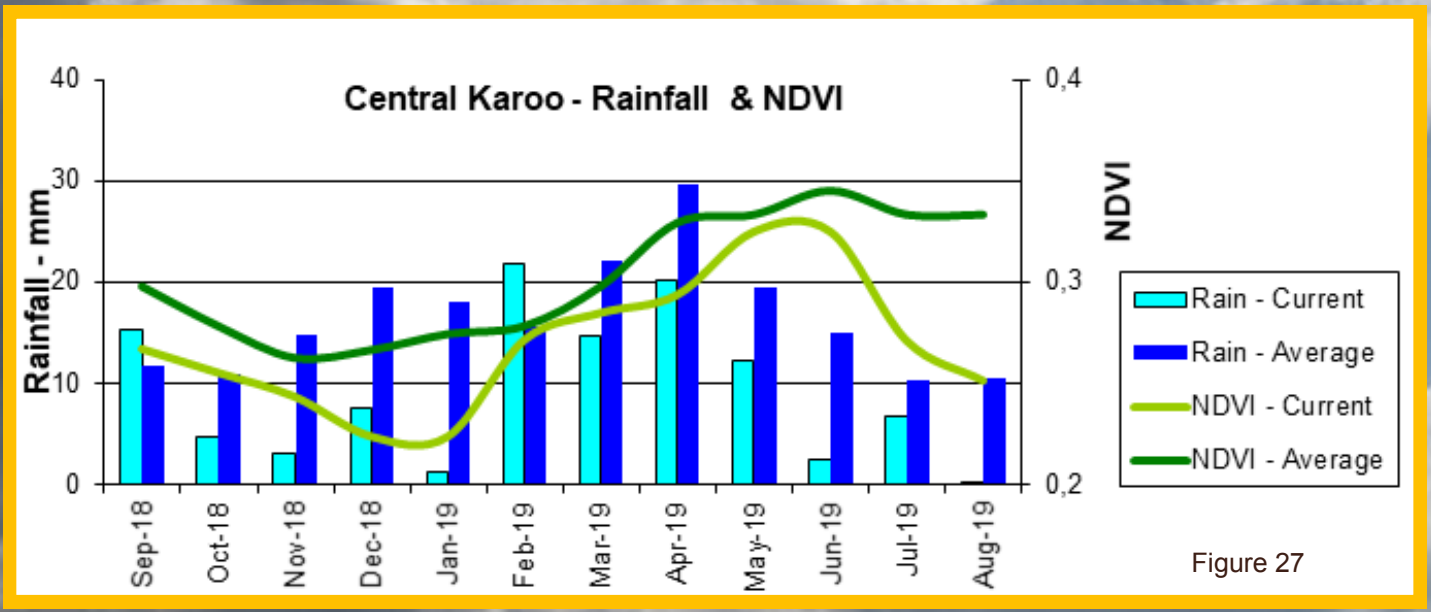


Figure 27

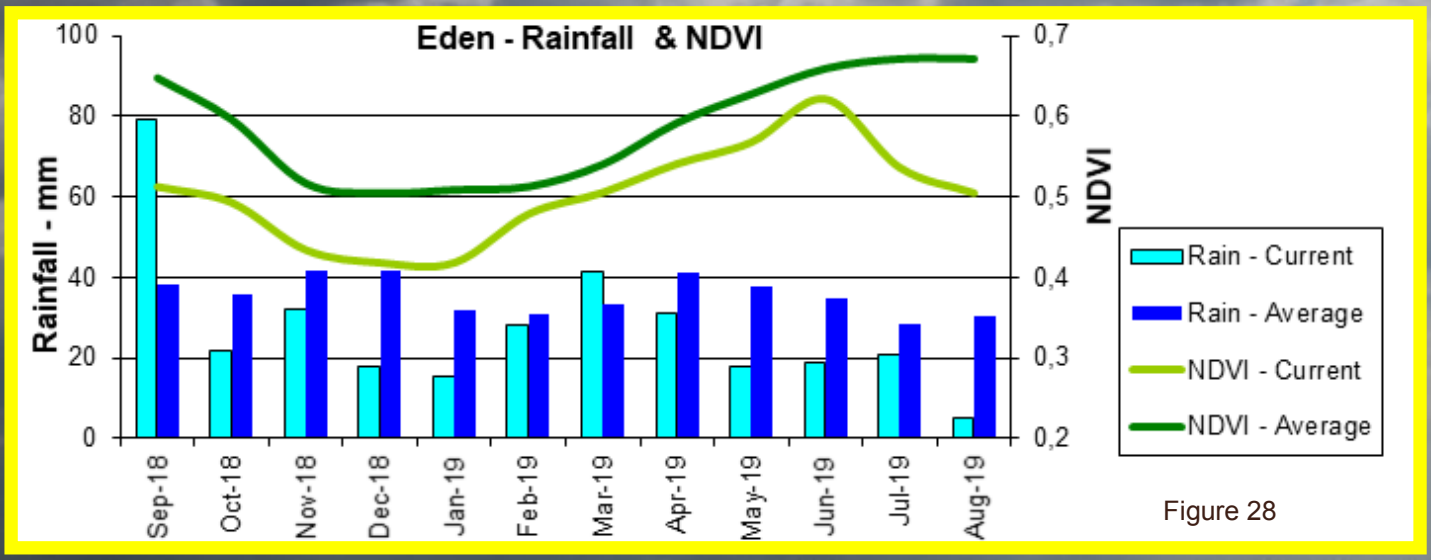


Figure 28

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 1-31 August 2019 per province. Fire activity was higher in KZN, Mpumalanga, Eastern Cape, Gauteng and Western Cape compared to the long-term average.

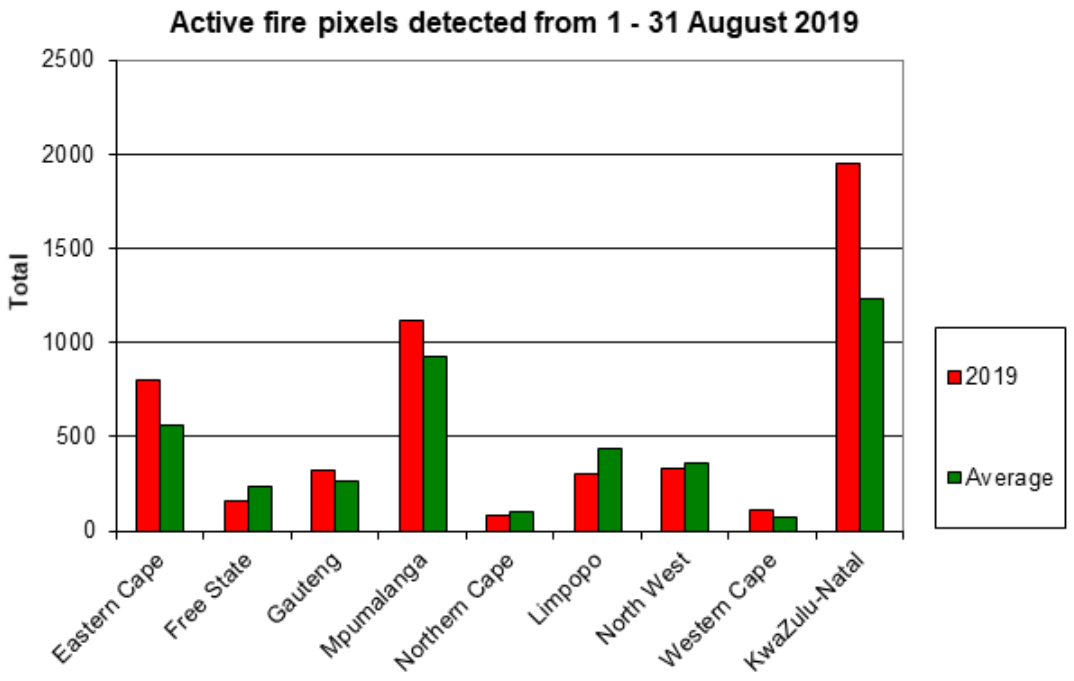


Figure 29

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

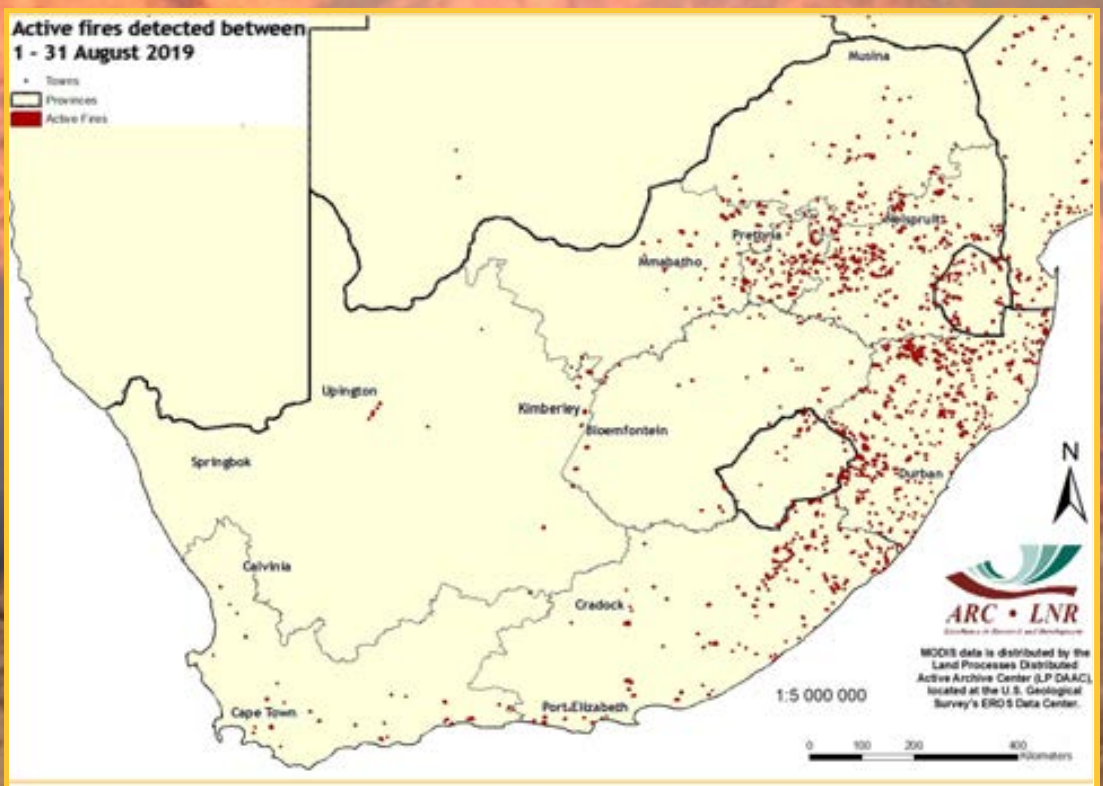


Figure 30

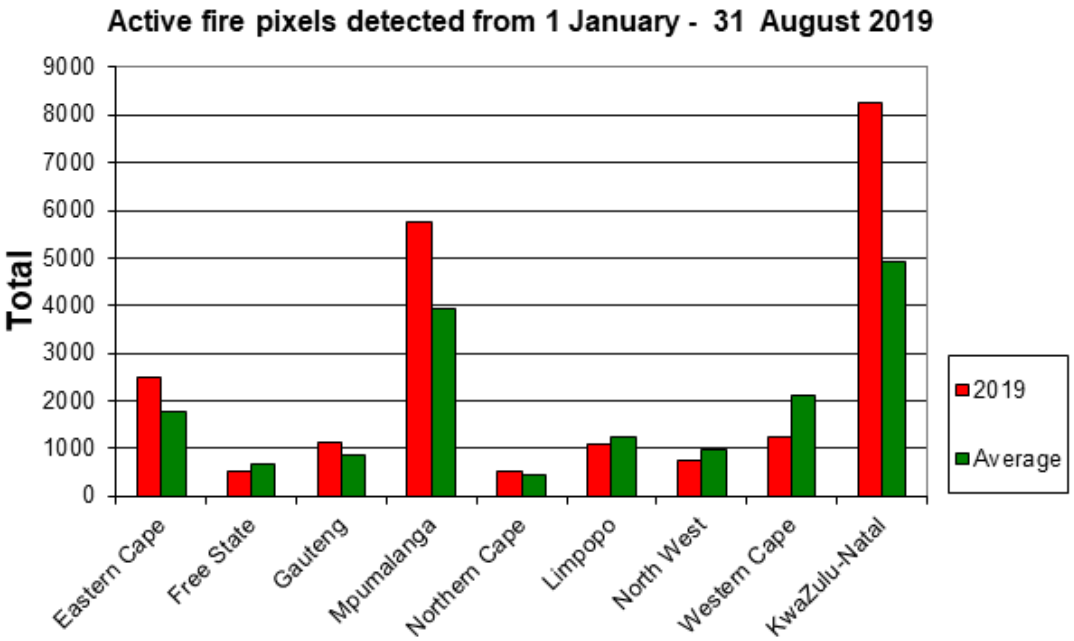


Figure 31:
The graph shows the total number of active fires detected between 1 January to 31 August 2019 per province. Fire activity was higher in KZN, Mpumalanga, Eastern Cape, Gauteng and Northern Cape compared to the long-term average.

Figure 31

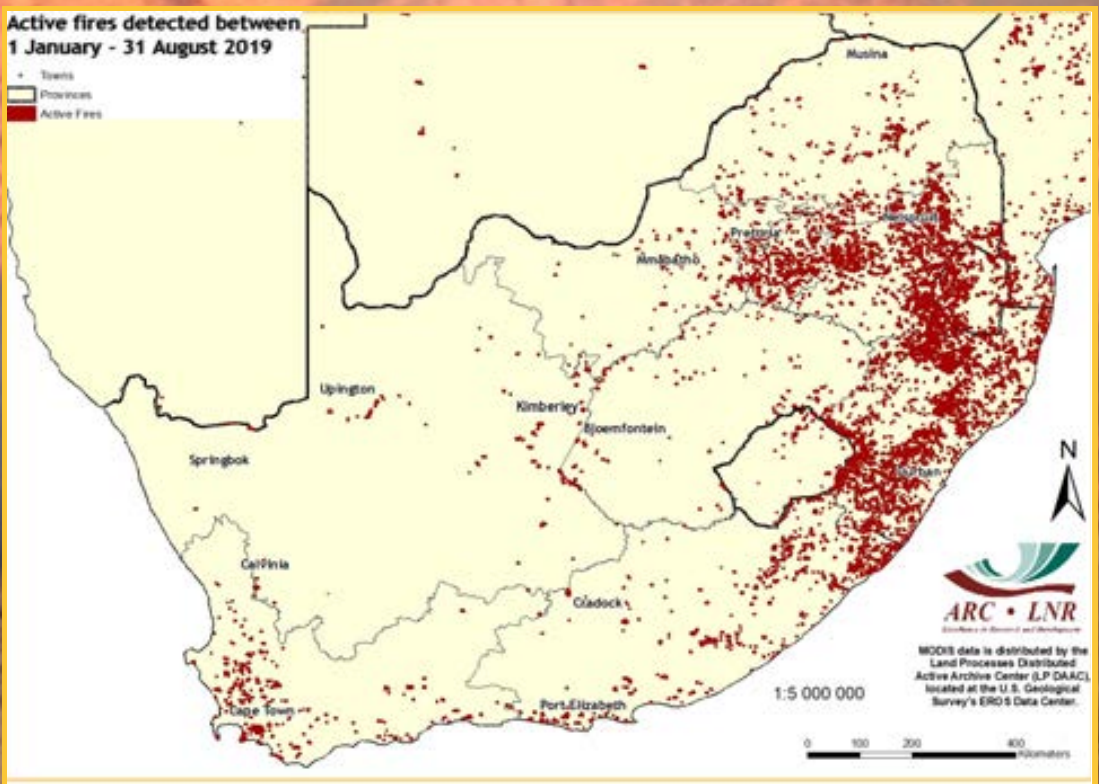


Figure 32:
The map shows the location of active fires detected between 1 January to 31 August 2019.

Questions/Comments:
MaakeR@arc.agric.za

Figure 32

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 either similar or slightly reduced water areas to the maximum recorded in that 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 August 2019 and August 2018 shows that generally a major portion of the country has similar surface water extents to the same period in 2018, with notable exceptions in the Karoo, Kalahari and an increasing number of small local catchments in the Eastern Cape, KZN and Mpumalanga, which are continuing to show significantly lower water values. The Western Cape, however, is now starting to exhibit similar water extents to the same month last year.

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

Questions/Comments:
mark.thompson@geoterraimage.com

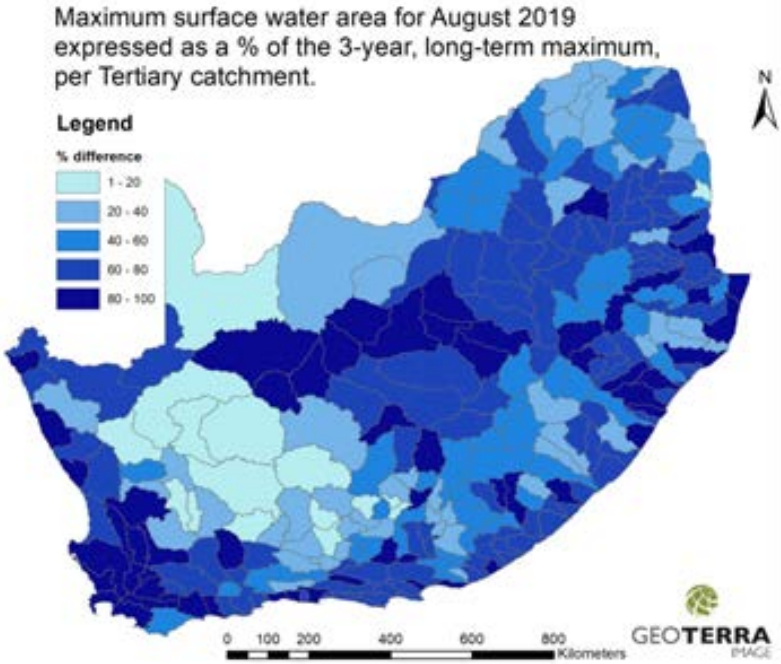


Figure 33

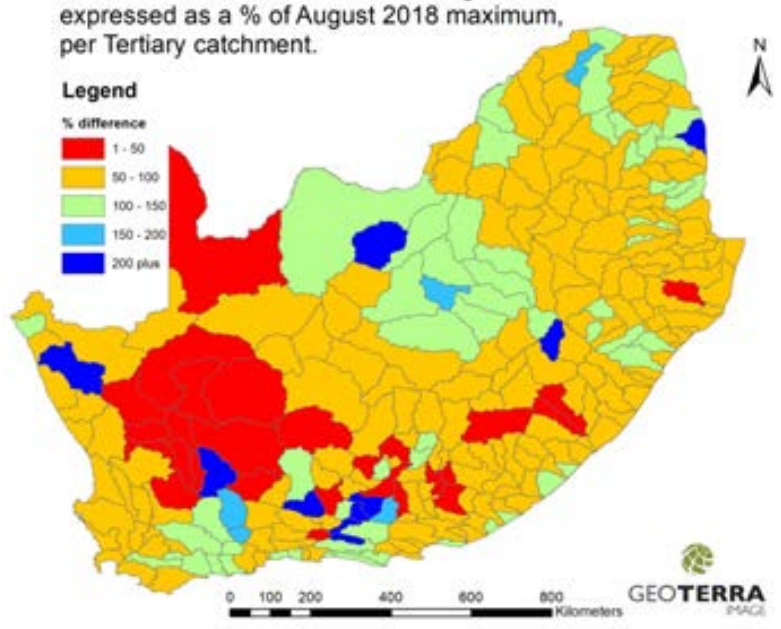


Figure 34

Agrometeorology

ARC • LNR

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

FOCUS AREAS

Climate Monitoring, Analysis & Modelling

- Analysis of climate variability and climate model simulation
- Use of crop modelling to assess the impact of climate on agriculture
- Development of decision support tools for farmers

Climate Change Adaptation & Mitigation

- National greenhouse gas inventory in the agricultural sector
- Improvement of agricultural production technologies under climate change
- Adaptation and mitigation initiatives, e.g. biogas production in small-scale farming communities

Climate Information Dissemination

- Communication to farmers for alleviating weather-related disasters such as droughts
- Dissemination of information collected from weather stations
- Climate change awareness campaigns in farming communities

Contact Person:
Dr Mokhele Moeletsi
Tel: 012 310 2537
E-mail: moeletsim@arc.agric.za

ARC-Institute for Soil, Climate and Water
600 Belvedere Street, Arcadia • Private Bag X79, Pretoria 0001
Tel: 012 310 2500 • Fax: 012 323 1157 • Website: www.arc.agric.za
For more information contact:
Adri Laas - Public Relations Officer • E-mail: adril@arc.agric.za

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

Contact Person:
Dr George Chirima
Tel: 012 310 2672
E-mail: chirimaj@arc.agric.za

ARC-Institute for Soil, Climate and Water
600 Belvedere Street, Arcadia • Private Bag X79, Pretoria 0001
Tel: 012 310 2500 • Fax: 012 323 1157 • Website: www.arc.agric.za
For more information contact:
Adri Laas - Public Relations Officer • E-mail: adril@arc.agric.za

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**.

ARC • LNR
Excellence in Research and Development

Institute for Soil, Climate and Water

Private Bag X79, Pretoria 0001,
South Africa
600 Belvedere Street, Arcadia, Pretoria, South Africa

Reneilwe Maake
Project Leader: Coarse Resolution Imagery Database (CRID)
Phone: +27(0) 12 310 2533
Fax: +27(0) 12 323 1157
E-mail: MaakeR@arc.agric.za

The operational Coarse Resolution Imagery Database (CRID) project of ARC-ISCW is funded by the National Department of Agriculture, Forestry and Fisheries. Development of the monitoring system was made possible at its inception through LEAD funding from the Department of Science and Technology.

For further information please contact the following:
Reneilwe Maake – 012 310 2533, MaakeR@arc.agric.za
Adri Laas – 012 310 2518, AdriL@arc.agric.za

To subscribe to the newsletter, please submit a request to:
MaakeR@arc.agric.za

What does Umlindi mean?
UMLINDI is the Zulu word for "the watchman".