ARC • LNR
Excellence in Research and Development

UMLINDI
The Watchman

ISSUE 2019-08 | 19 AUGUST 2019

INSTITUTE FOR SOIL, CLIMATE AND WATER

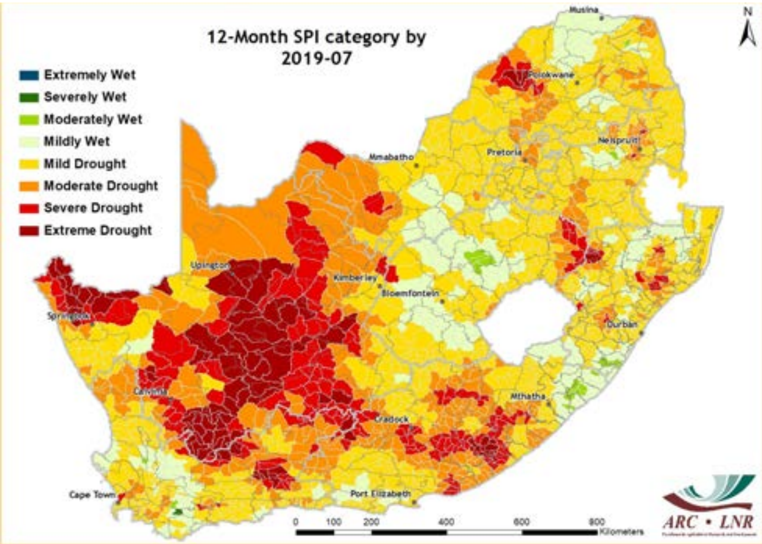
CONTENTS:

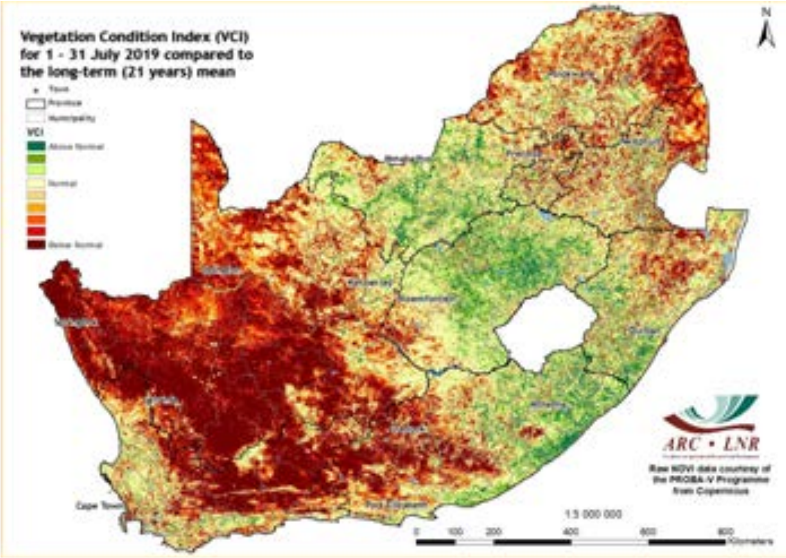
182nd Edition

Images of the Month

Drought conditions prevail in western South Africa

Greater parts of the Northern Cape and to a lesser extent the Western and Eastern Cape provinces have been suffering from drought conditions over the past 3-4 years. The 12-month Standardized Precipitation Index (SPI) map for July 2019 shows that rainfall totals have been below-normal over these areas, thus resulting in moderate to extreme drought. Consequently, the Vegetation Condition Index (VCI) map for July 2019 shows below-normal vegetation conditions when compared to the long-term mean for the same month during the past 21 years. This region is identified as one of the areas in South Africa that is prone to frequent drought occurrences with severe droughts observed at intervals of 10-20 years for more than a century. The Northern Cape especially has very low annual precipitation with climate characteristics closely reflecting that of a desert. This province is therefore unsuitable for conventional dryland agriculture, although through the use of proper and effective cropping systems and livestock management, desirable yields and production can be achieved. Promotion of production practices that can mitigate the effects of the crippling drought phenomenon needs to be determined per region and conveyed effectively to farmers.





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:

July 2019 experienced an improvement of rains over the winter rainfall region, as compared to the onset of the winter rainfall season in May and June. In contrast, rainfall was largely absent over the summer rainfall region, due to unfavourable upper air conditions and/or dry surface conditions, as expected. This included the northern KwaZulu-Natal and Eastern Cape coastlines which received slightly below-normal rainfall during the previous two months.

The month began with a large cold front over the southwestern parts of the country and received a fairly evenly spread number of above-normal rainfall days. However, with the frontal system moving towards the east, snow was experienced over the high-lying areas of the Eastern Cape. This system also resulted in low minimum temperatures over the Highveld and central parts of the country, causing widespread morning frost as night-time temperatures continued to drop below zero. Another cold front brought wet, windy and wintry weather during mid-July, with light snow falling at Sutherland and on the mountain peaks of the Western and Eastern Cape provinces. Furthermore, heavier snowfall was experienced over Lesotho and the southern Drakensberg (Barkly East and Elliot). These rainy conditions resulted in the Berg River Dam reaching full capacity and overflowing around 23 July. Similarly, other major dams responsible for supplying agricultural water to Cape Town and surrounding areas received good rains which improved the overall dam levels. The month ended with gale force winds and localized flooding, caused by heavy rainfall over the Western Cape.

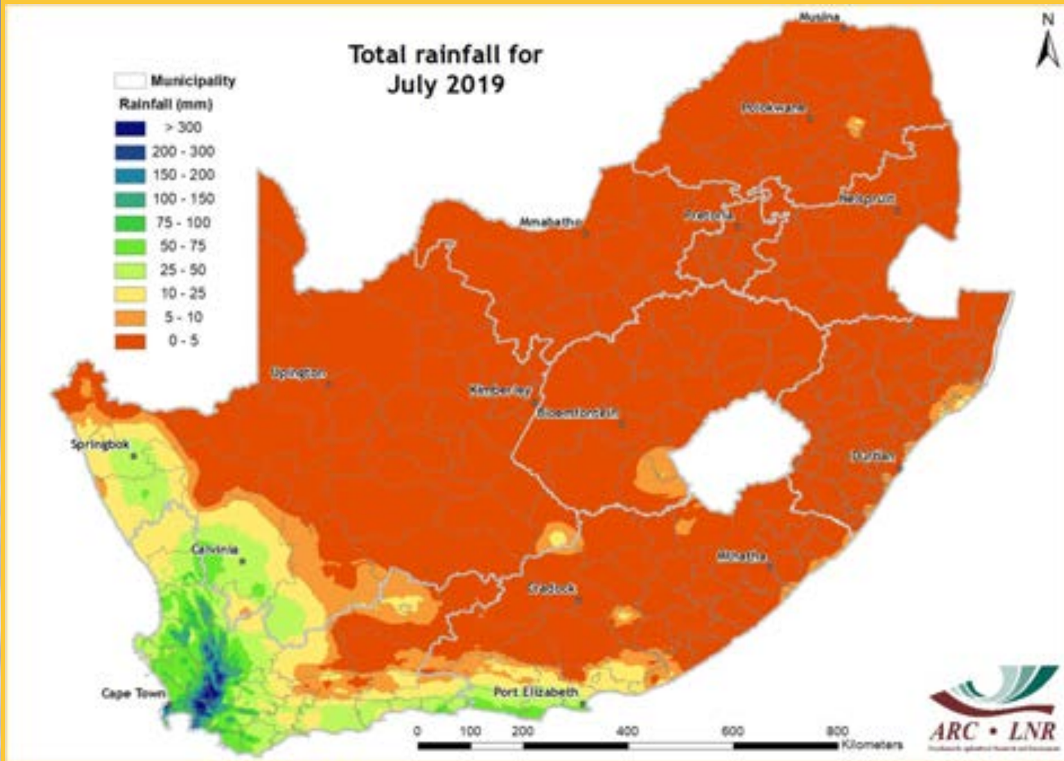


Figure 1

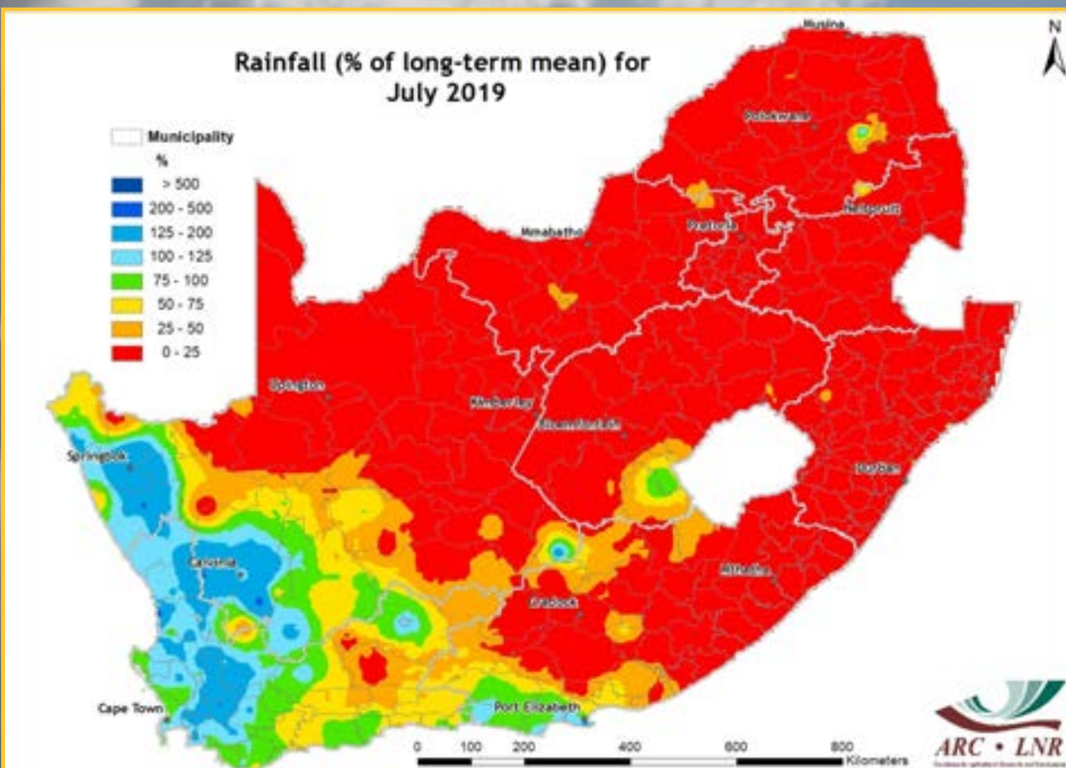


Figure 2

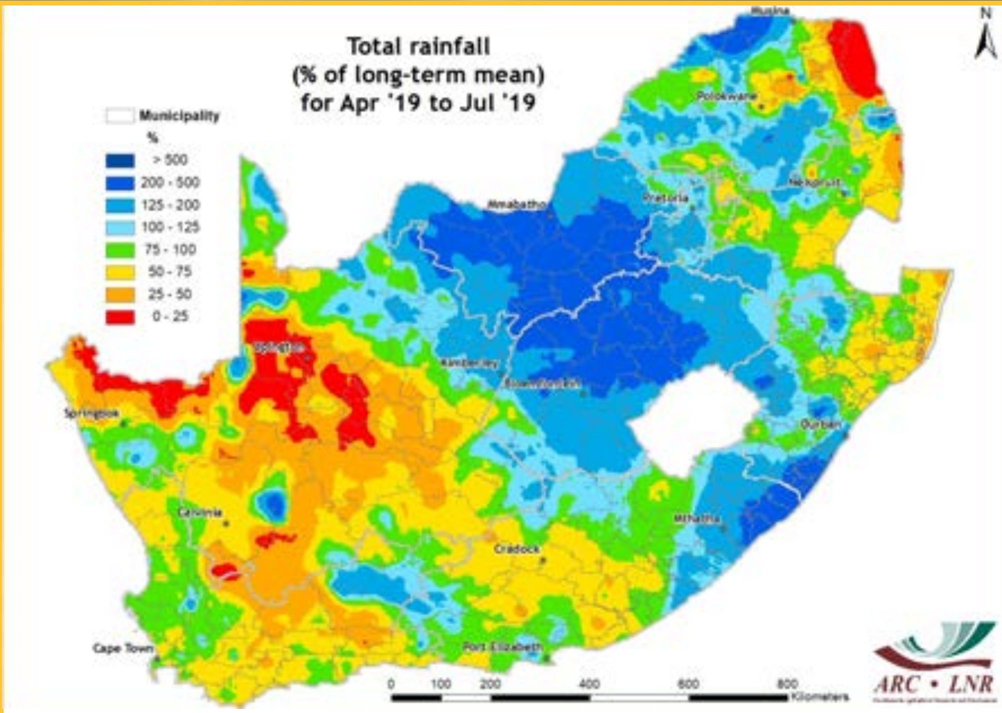


Figure 3

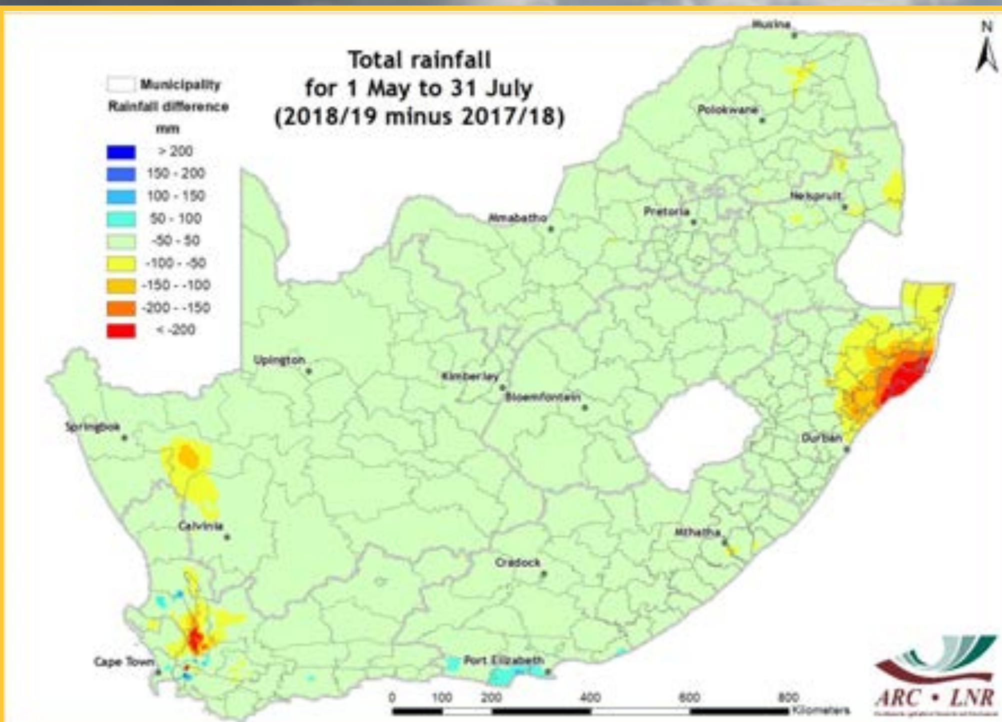


Figure 4

Figure 1:
Precipitation in July 2019 was concentrated over the winter rainfall region, with the interior being mostly dry. The high rainfall conditions resulted in better prospects for agriculture as dam levels increased considerably when compared to the past 4-5 years.

Figure 2:
Rainfall in July was above normal over the western parts of the winter rainfall region and near normal over the rest of the region. Below-normal rainfall occurred over the rest of the country.

Figure 3:
Rainfall conditions in the western half of the country and isolated areas of the summer rainfall region such as the coast of KwaZulu-Natal, Mpumalanga and Limpopo, were mostly between near- to below-normal since April 2019, when compared to the long-term mean for the same period. However, the central interior indicated above-normal rainfall.

Figure 4:
Parts of the western winter rainfall region and coastal belt of KwaZulu-Natal received significantly less rain during May-July 2019 compared to the same period last year, while the rest of the country experienced normal rainfall conditions.

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 current SPI maps (Figure 5-8) show that severe to extreme drought conditions are confined to the Northern Cape and parts of the Western and Eastern Cape provinces. Meanwhile, a fairly extensive area focussing on the northeastern parts of the country with severe to extreme drought is evident at the long-term time scales (24- and 36-month). Over the central interior, parts of the North West and southern KwaZulu-Natal, an improvement of rains was noted, with moderate to extreme wet conditions visible on the 6-month SPI. Moreover, relief from the extreme drought conditions (given by the 36-month SPI) over Cape Town and adjacent areas is evident on the short- to medium-term time scales.

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

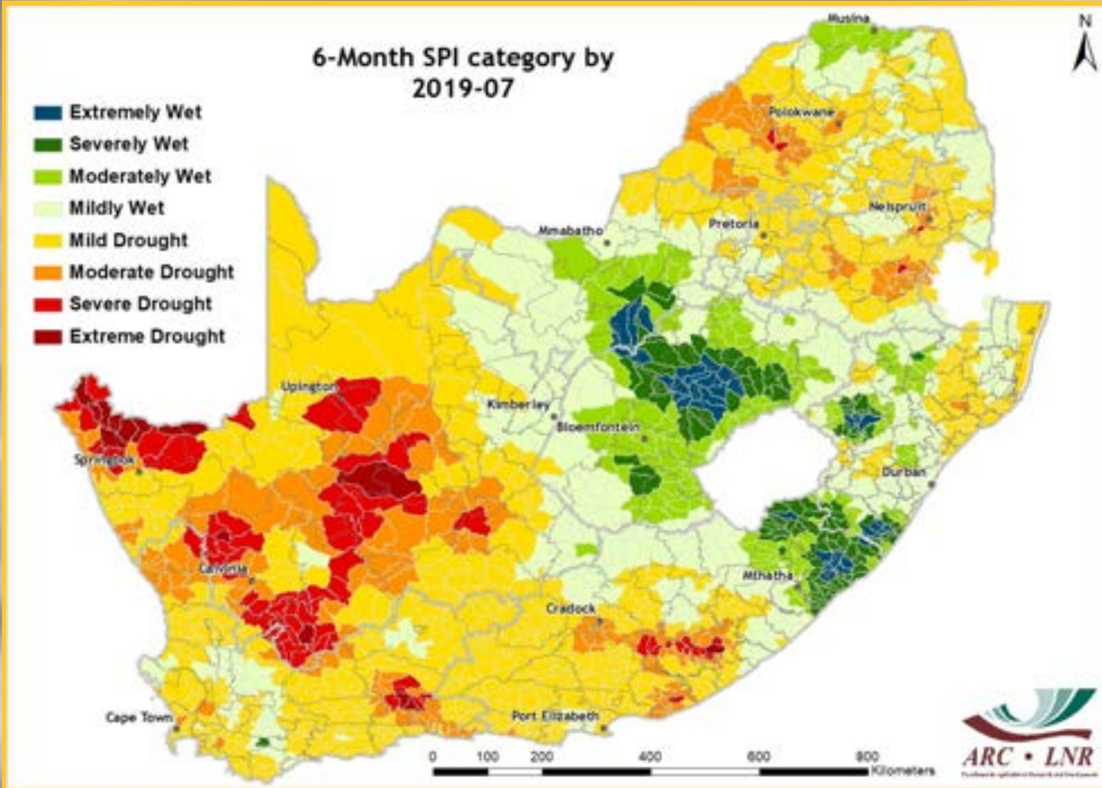


Figure 5

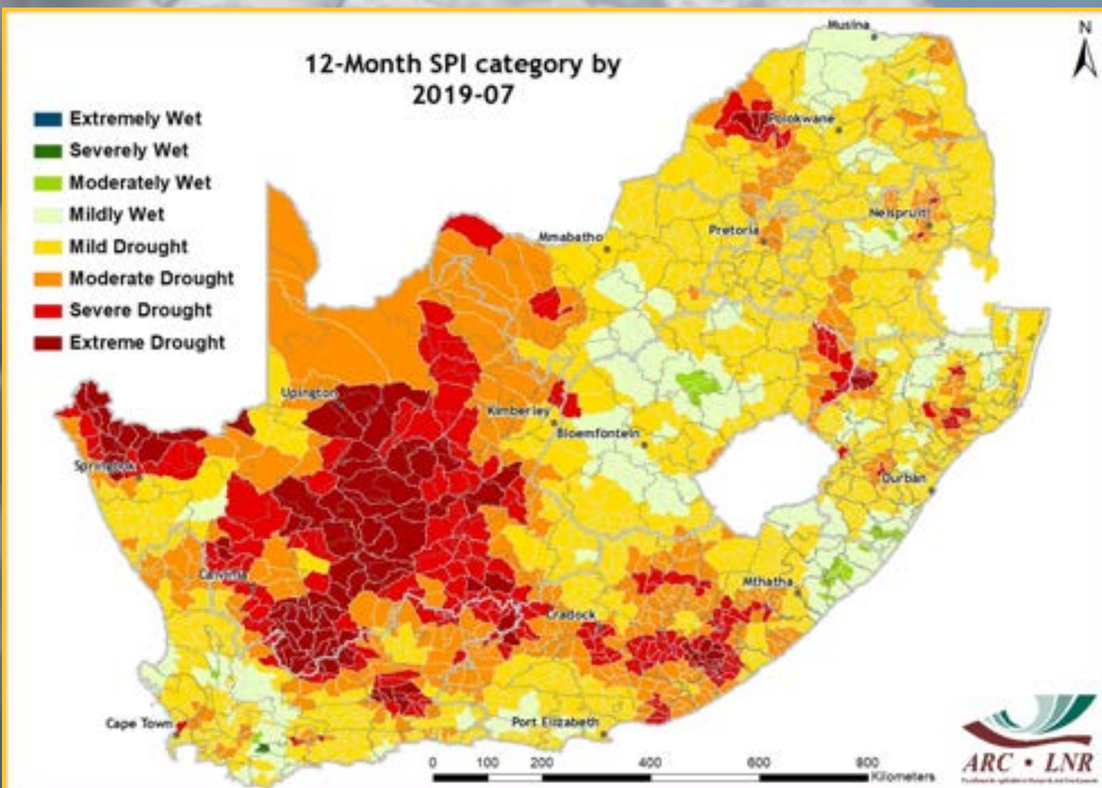


Figure 6

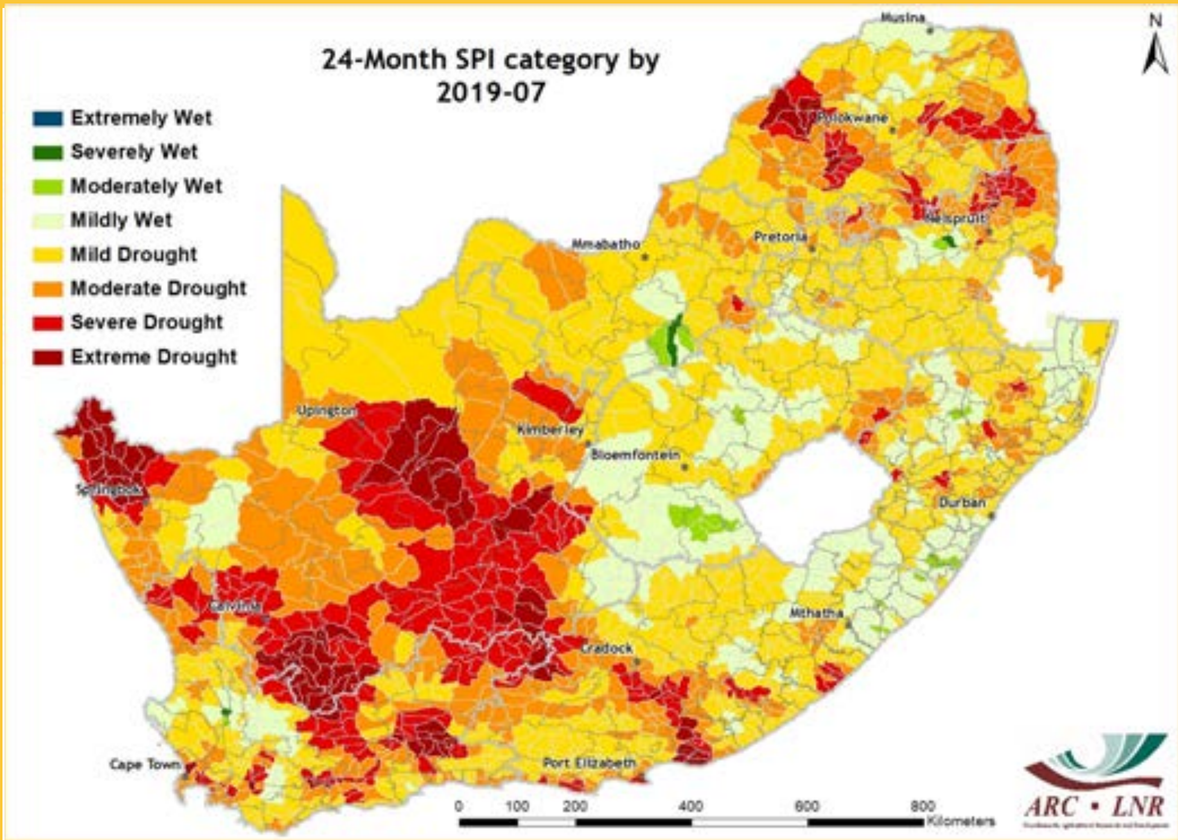


Figure 7

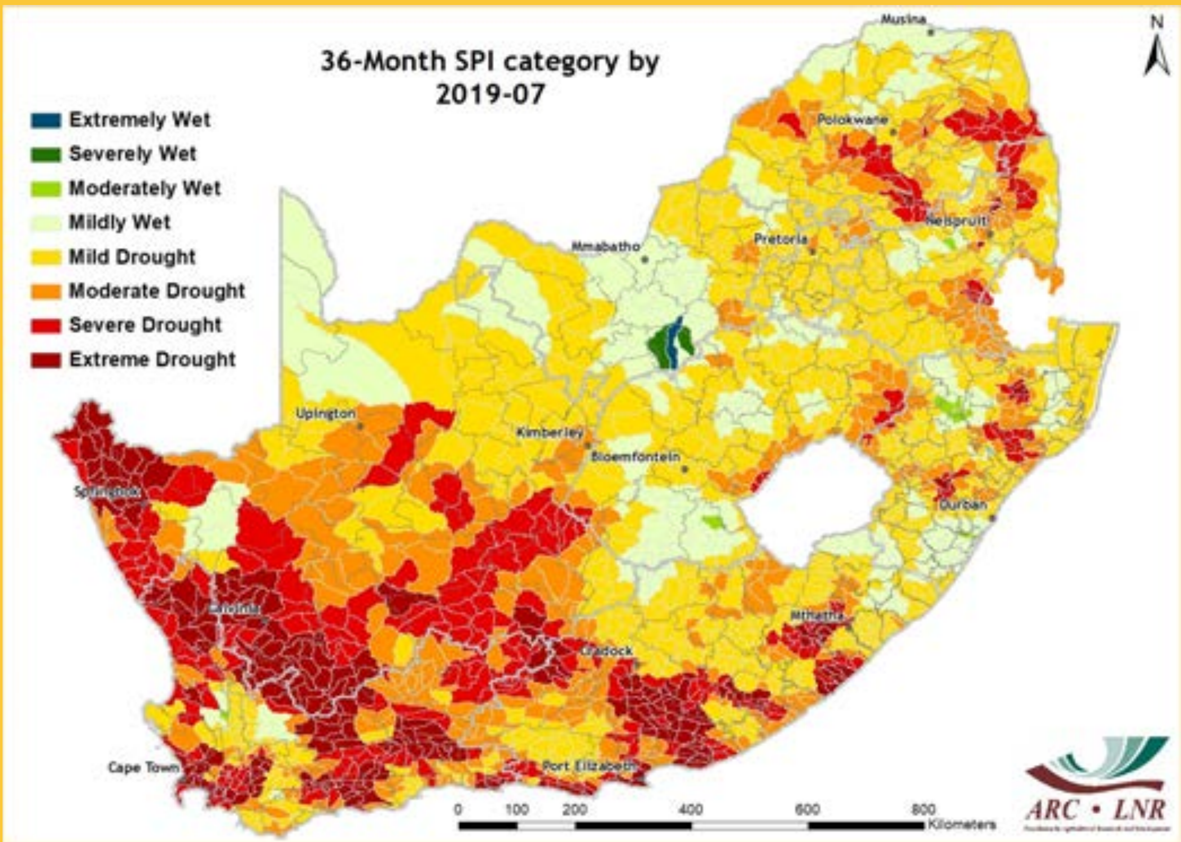


Figure 8

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.

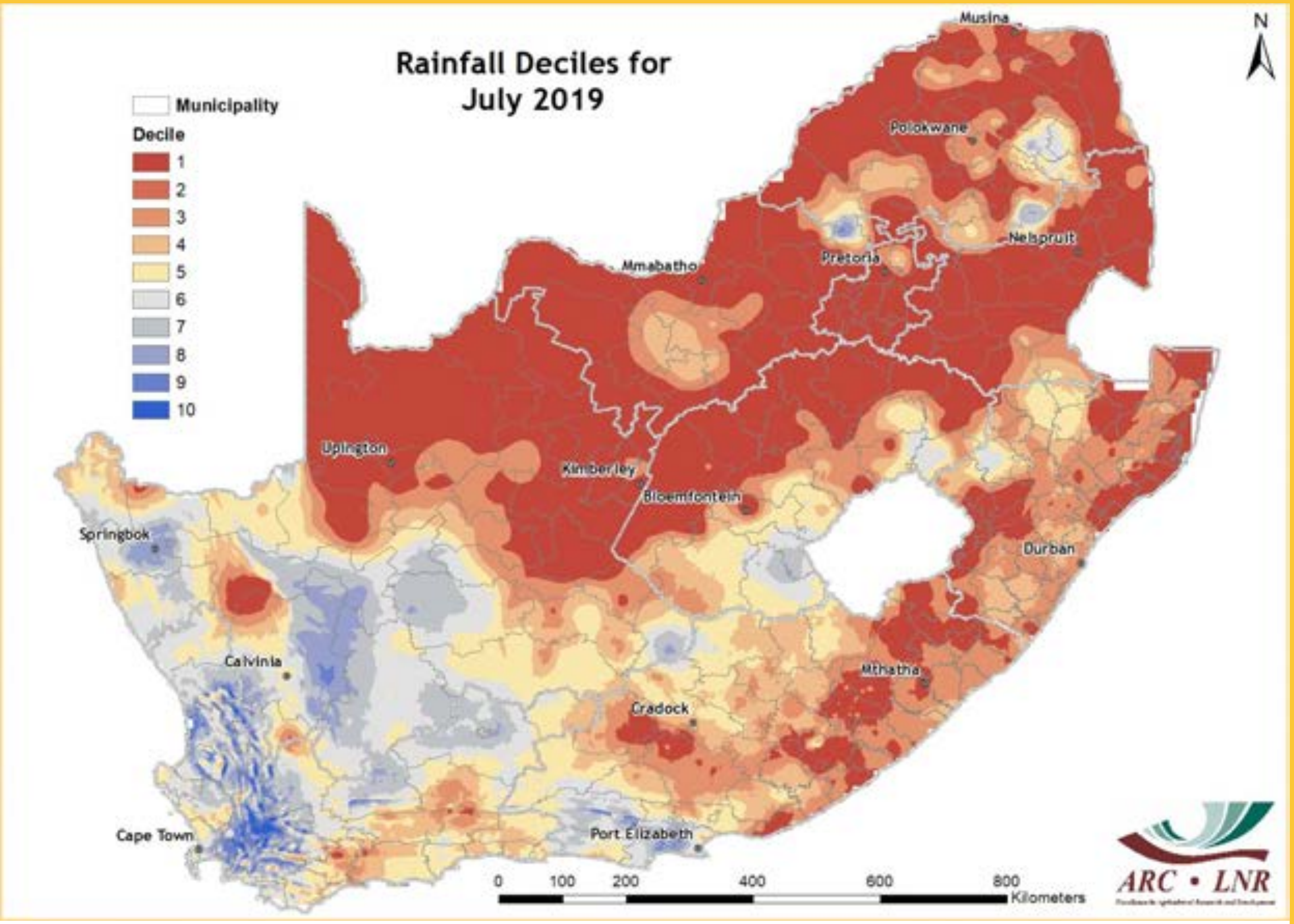


Figure 9

Figure 9:
Rainfall totals for July 2019 over the southwestern parts of the country fall within the historically wet July months, while the summer rainfall region experienced a drier than normal July.

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.

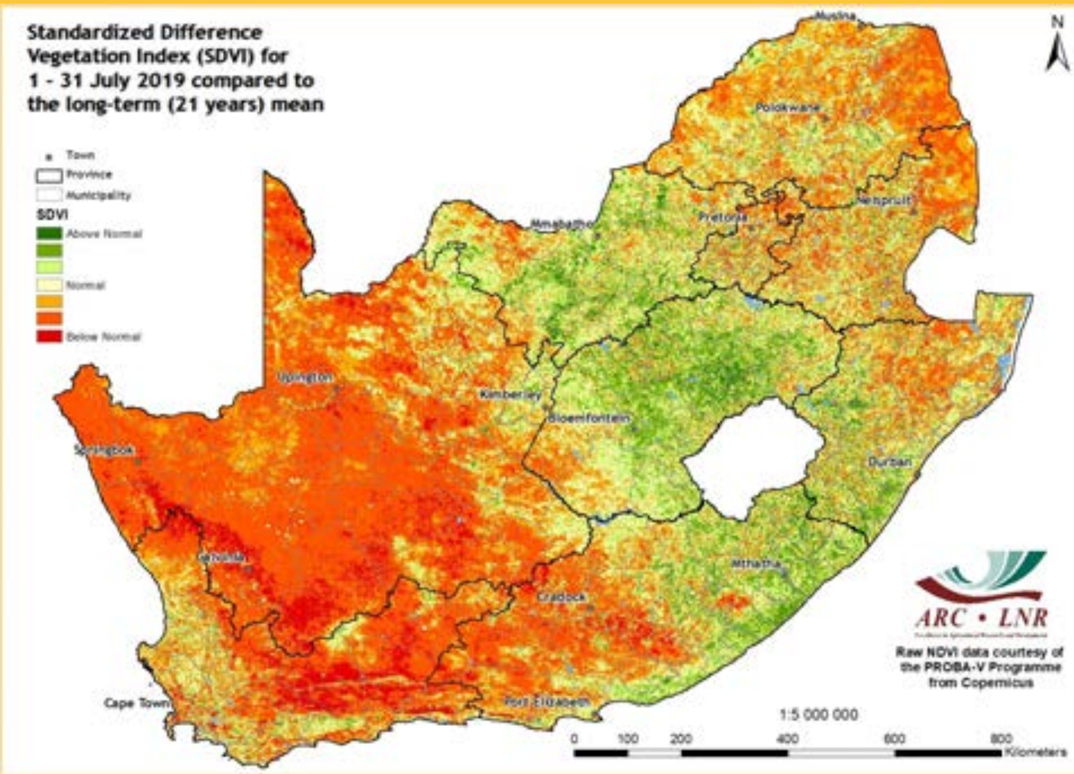


Figure 10

Figure 10:
The July 2019 SDVI map shows that the western as well as the northern parts of the country remain under conditions that are less favourable for vegetation. The central parts are an exception.

Figure 11:
Compared to the vegetation conditions calculated and averaged over the last 21 years, the NDVI difference map for the first 10 days of August 2019 shows that below-normal vegetation activity occurred in the western parts of the country and in some isolated areas in Limpopo, KZN and Mpumalanga. Meanwhile, the central parts experienced normal vegetation conditions.

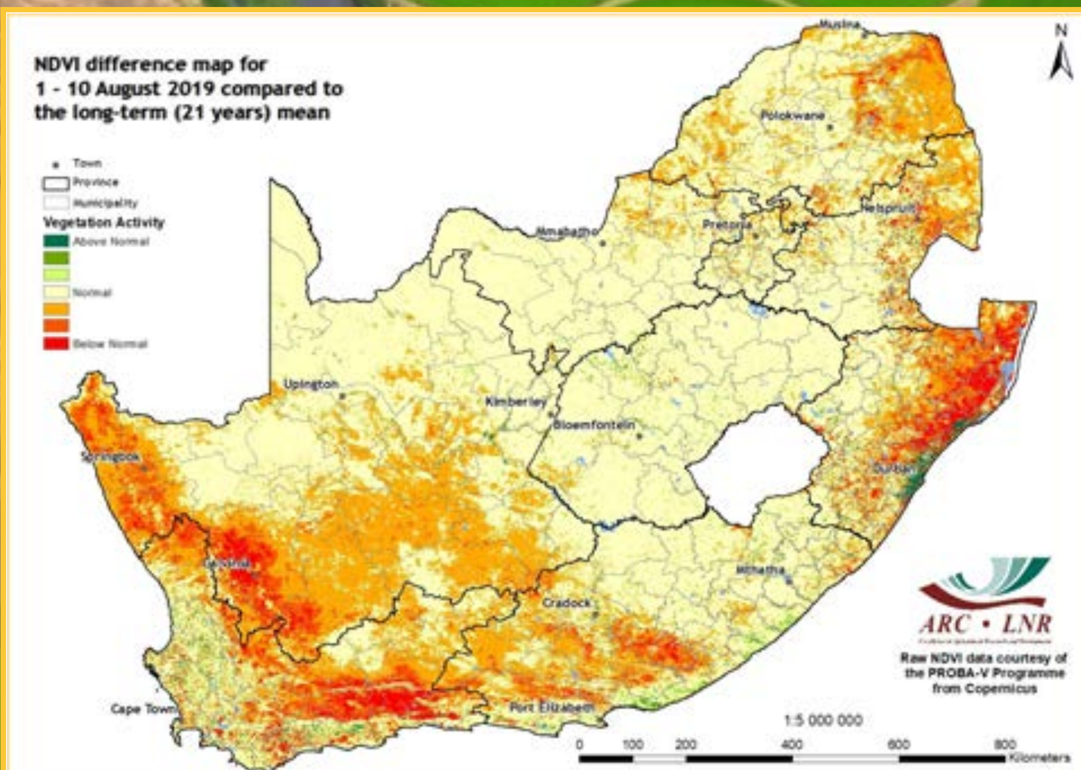


Figure 11

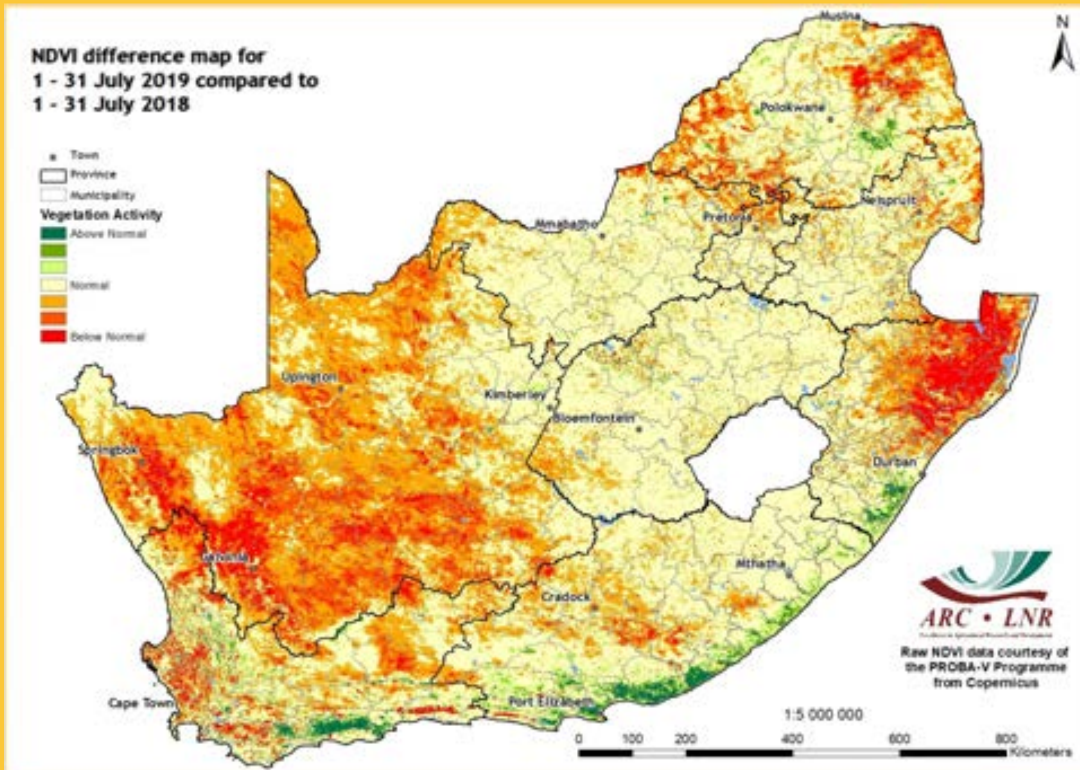


Figure 12

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

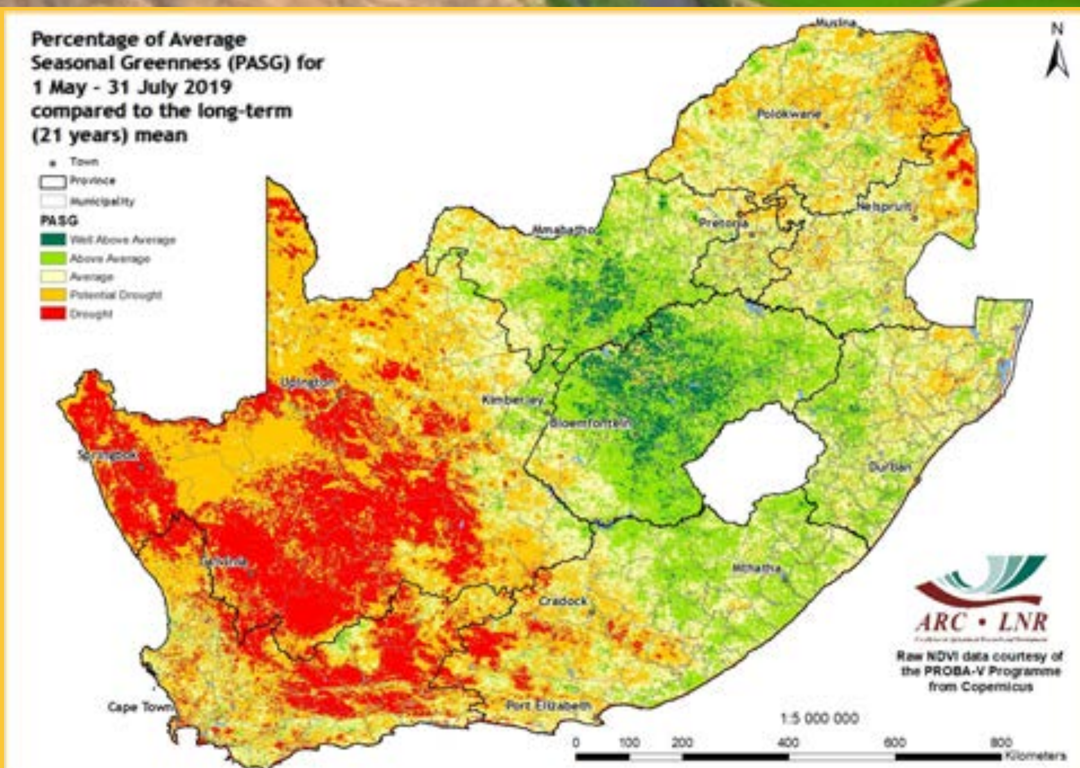


Figure 13

Figure 12:
Compared to the same month last year, the July 2019 NDVI map shows that below-normal vegetation activity continues to dominate in the Northern Cape, spreading over areas in Limpopo and the northern parts of KZN and Mpumalanga. Nevertheless, pockets of above-normal vegetation activity occurred in isolated coastal areas and the central parts of the Free State and North West provinces.

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

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.

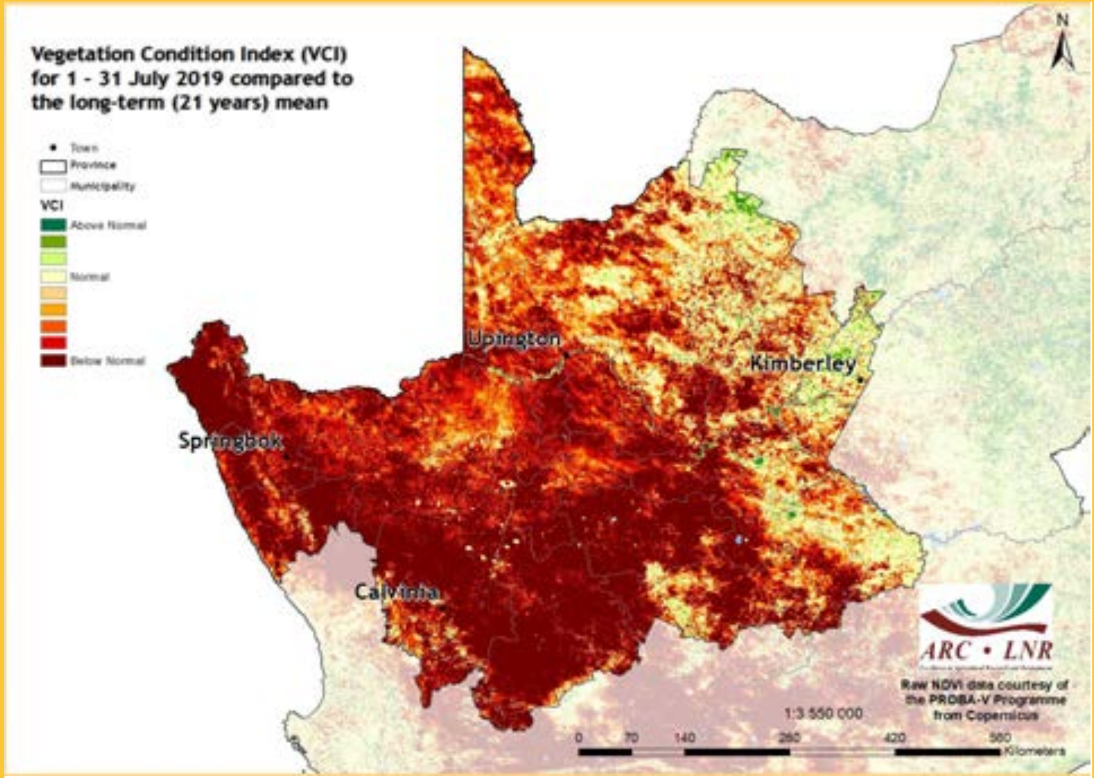


Figure 14

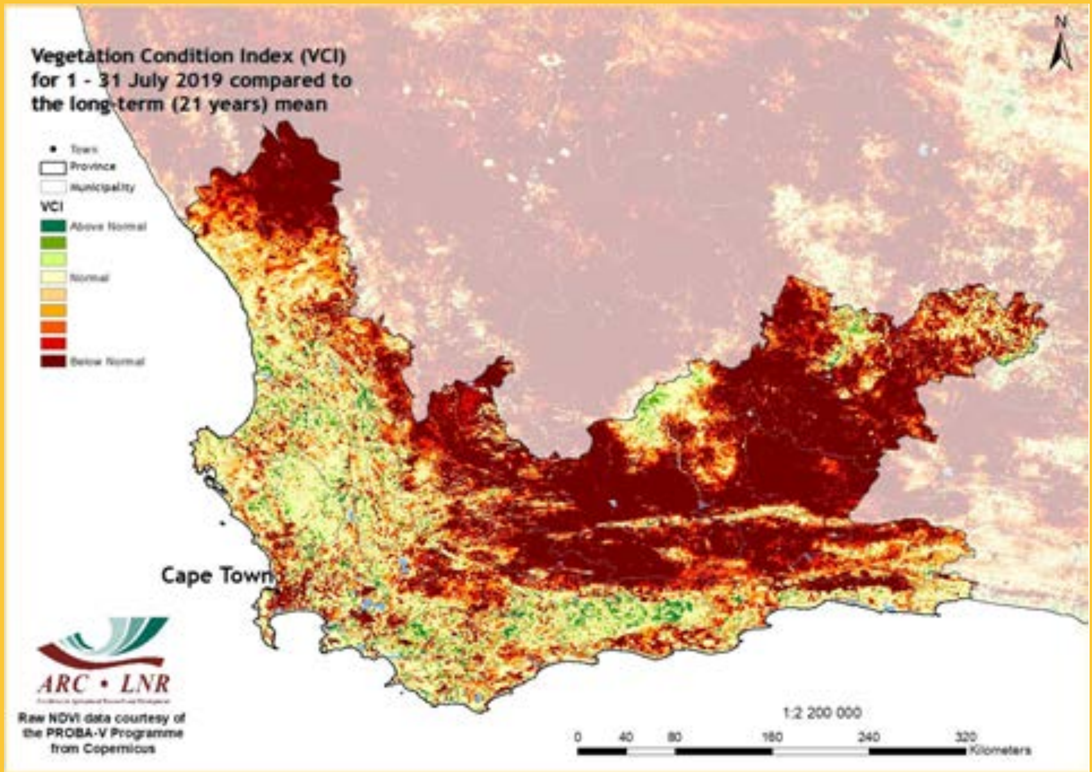


Figure 15

Figure 14:
The VCI map for July shows that major parts of the Northern Cape Province continue to experience poor vegetation conditions.

Figure 15:
The VCI map for July for the Western Cape Province indicates that northern parts of the Central Karoo and West Coast continue to experience very poor vegetation activity.

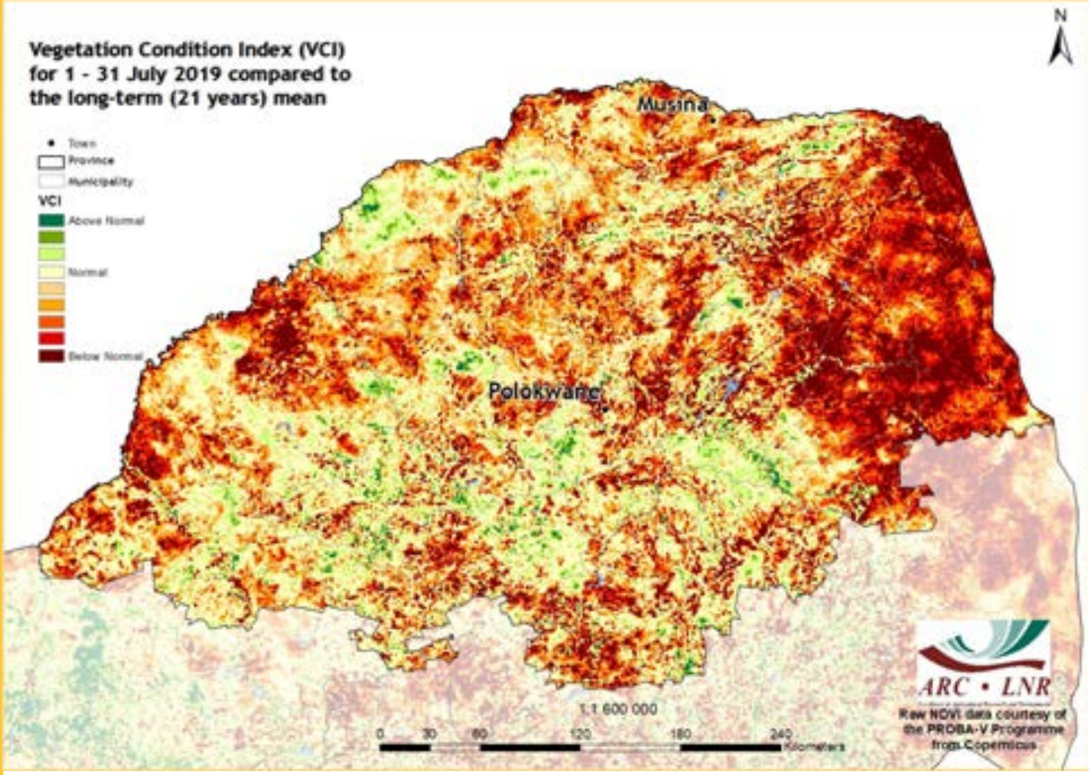


Figure 16

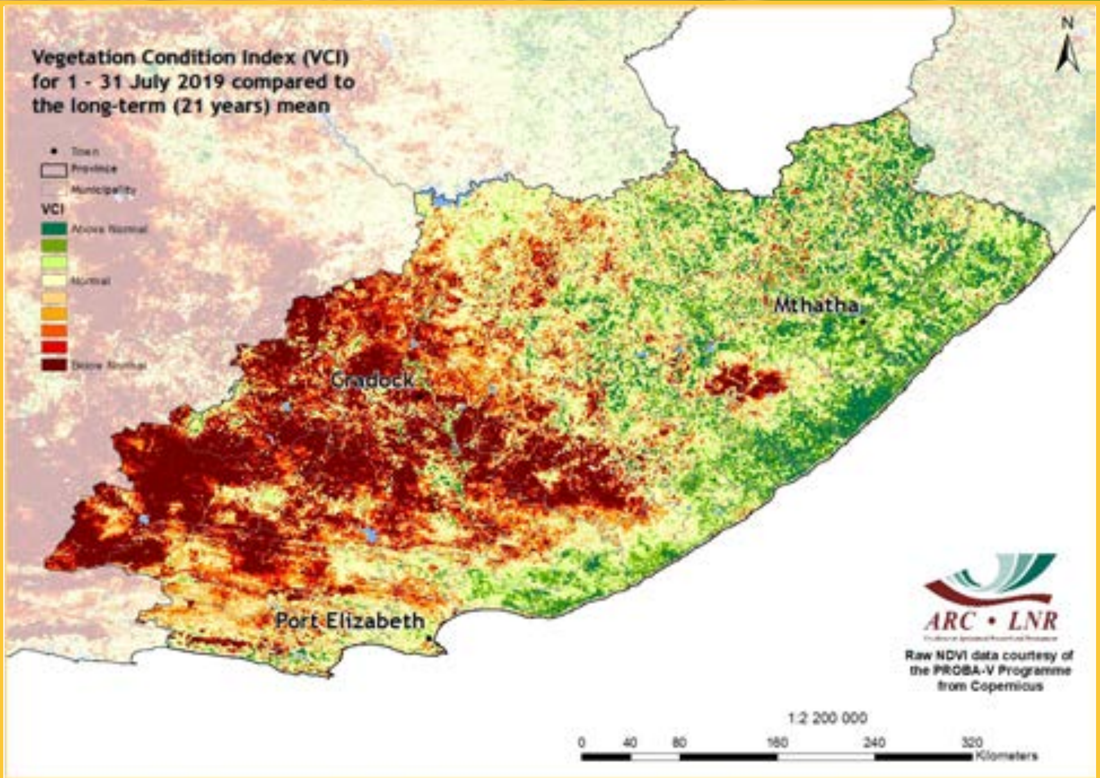


Figure 17

Figure 16:
The VCI map for July shows that poor vegetation activity has spread over many parts of the Limpopo Province.

Figure 17:
The VCI map for July for the Eastern Cape Province shows that many parts of the Sarah Baartman district municipality continue to experience poor vegetation activity but the area in the north of the province is experiencing above-normal vegetation activity.

Questions/Comments:
MaakeR@arc.agric.za

6. Vegetation Conditions & Rainfall

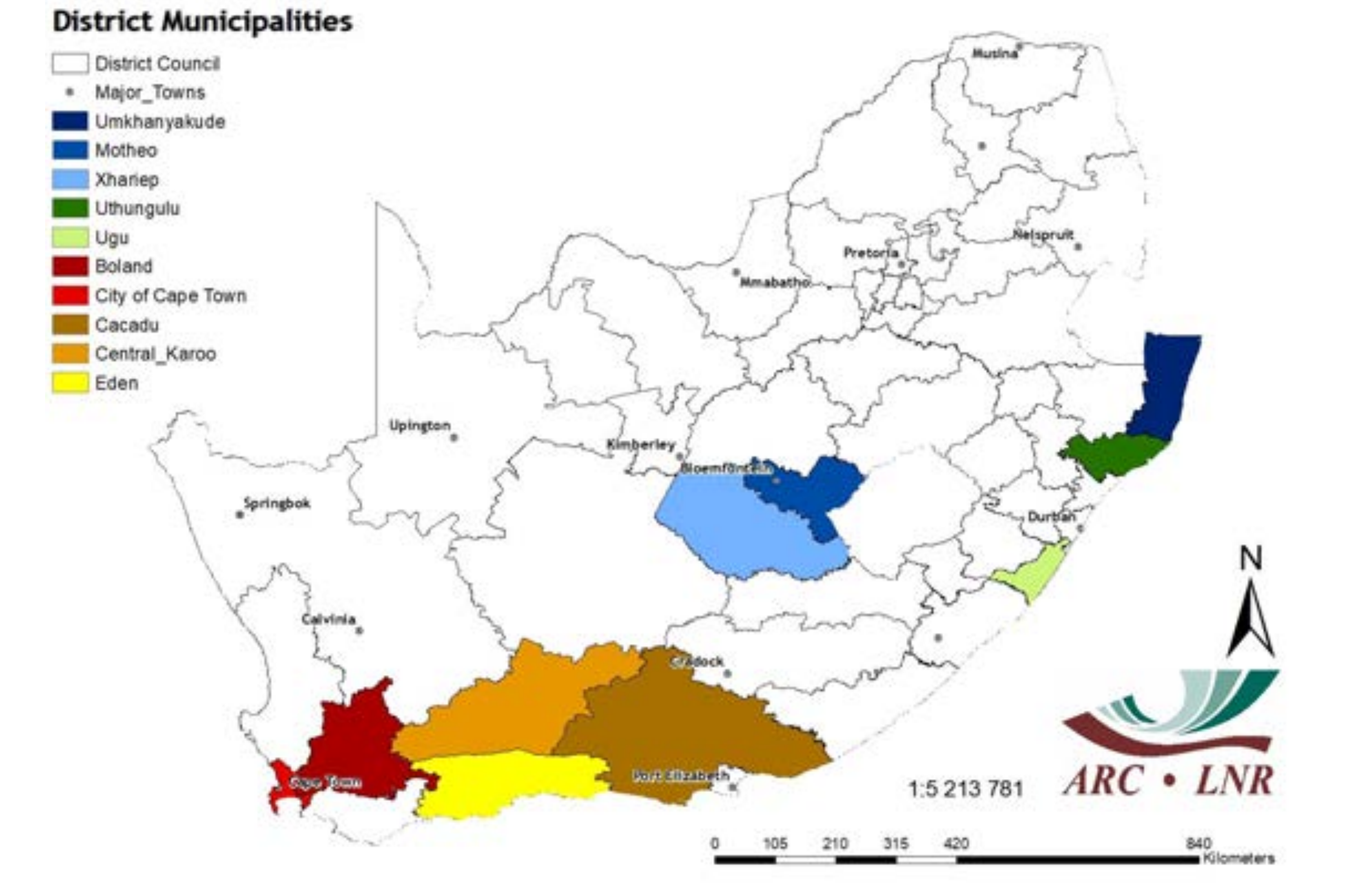


Figure 18

Rainfall and NDVI Graphs

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

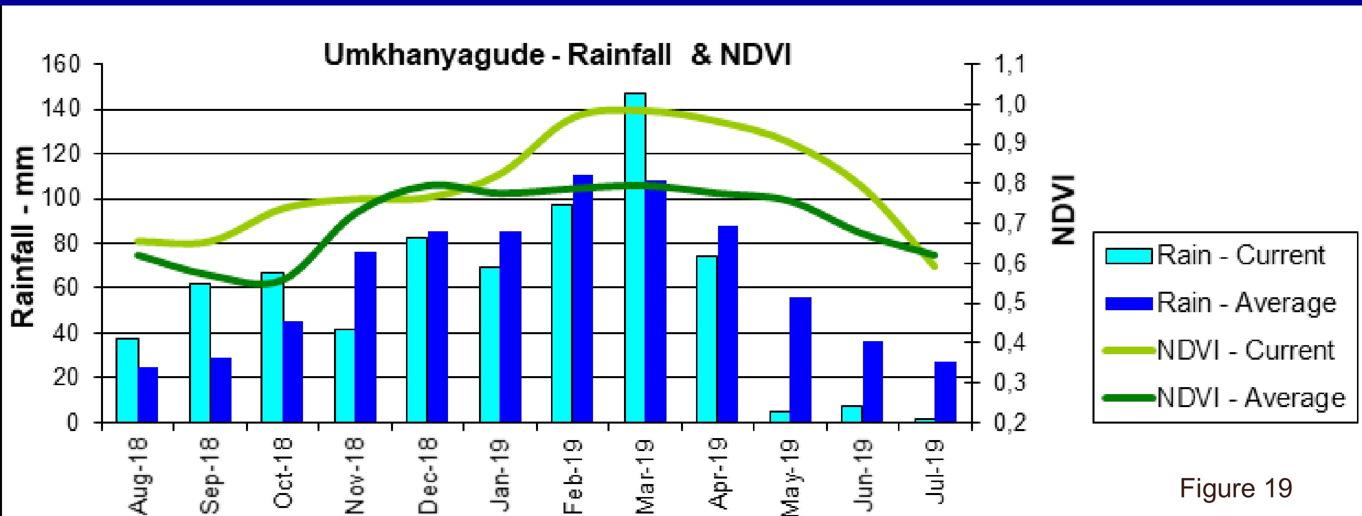


Figure 19

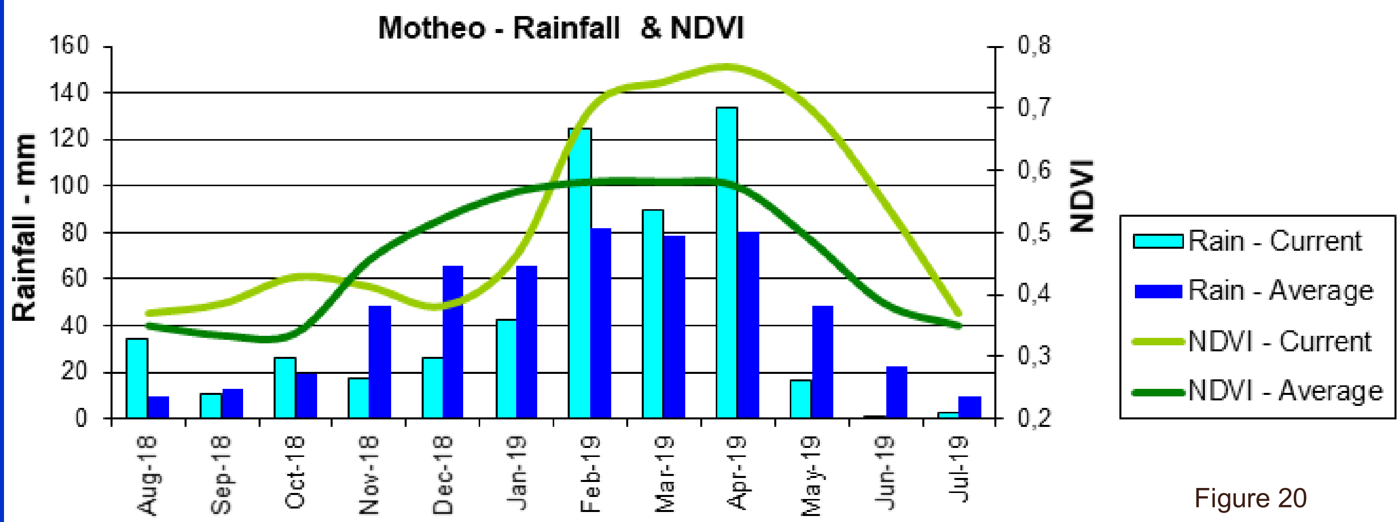


Figure 20

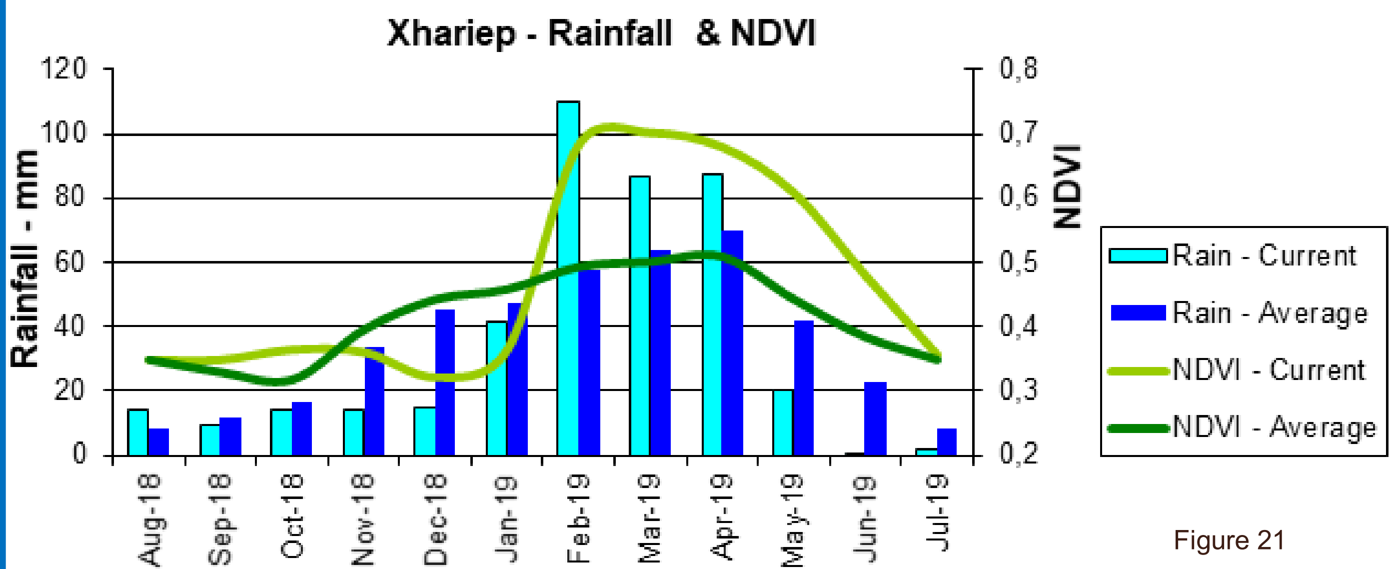


Figure 21

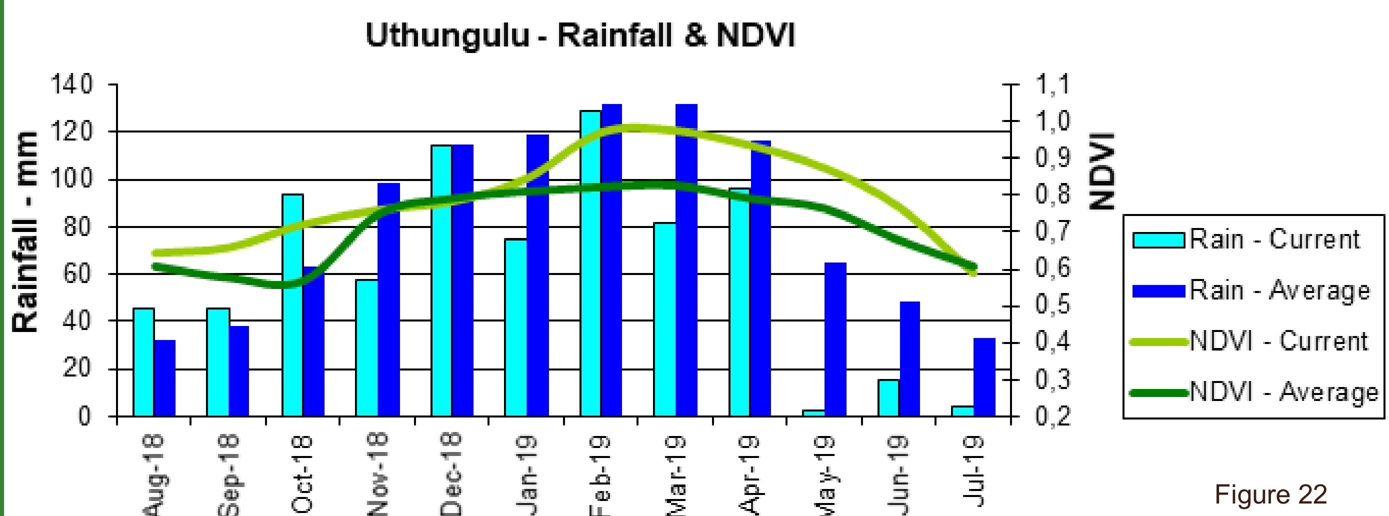


Figure 22

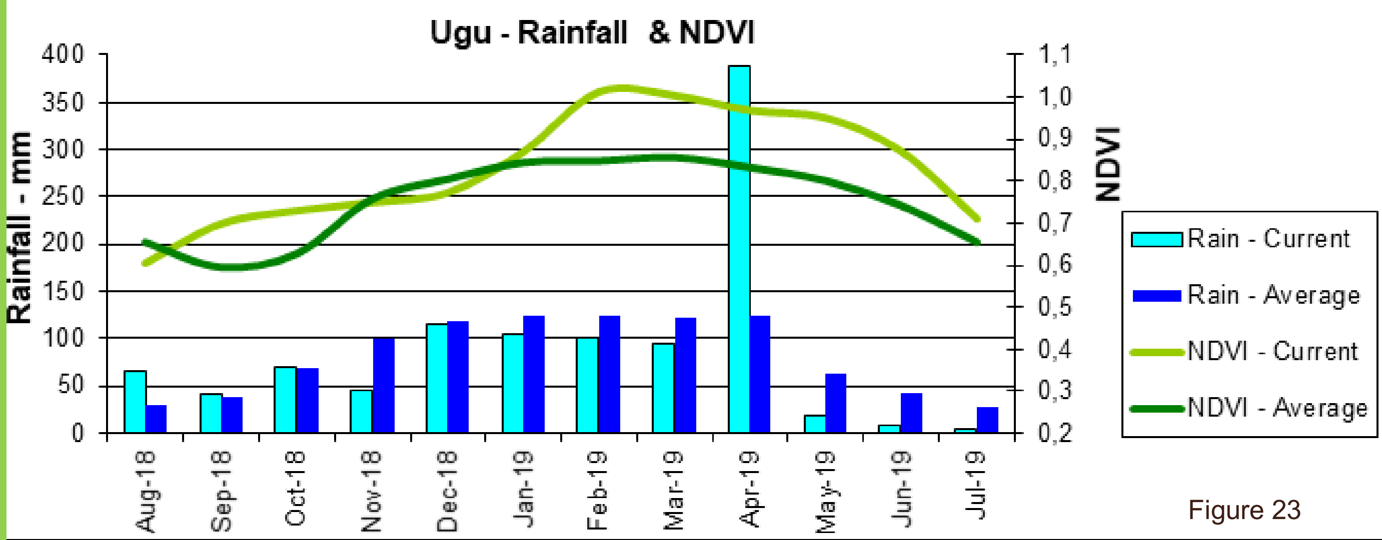


Figure 23

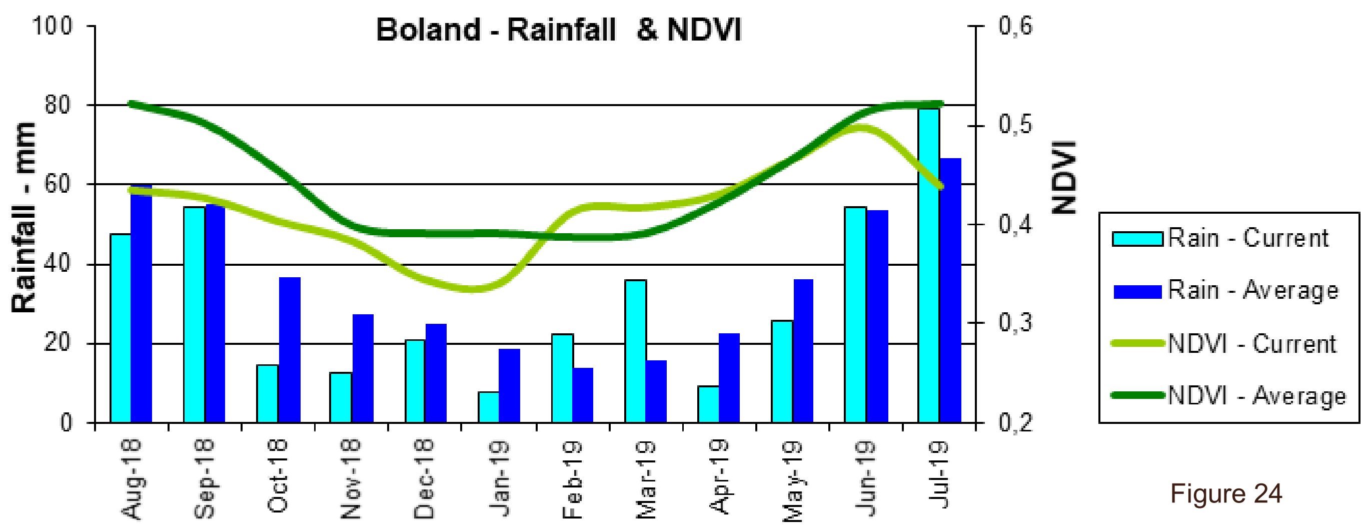


Figure 24

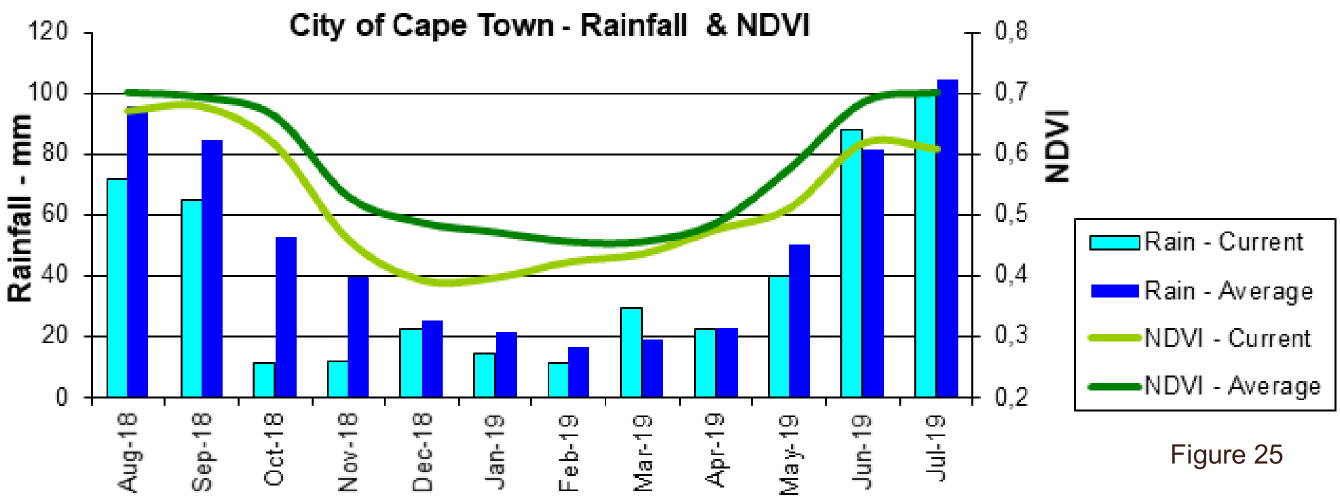


Figure 25

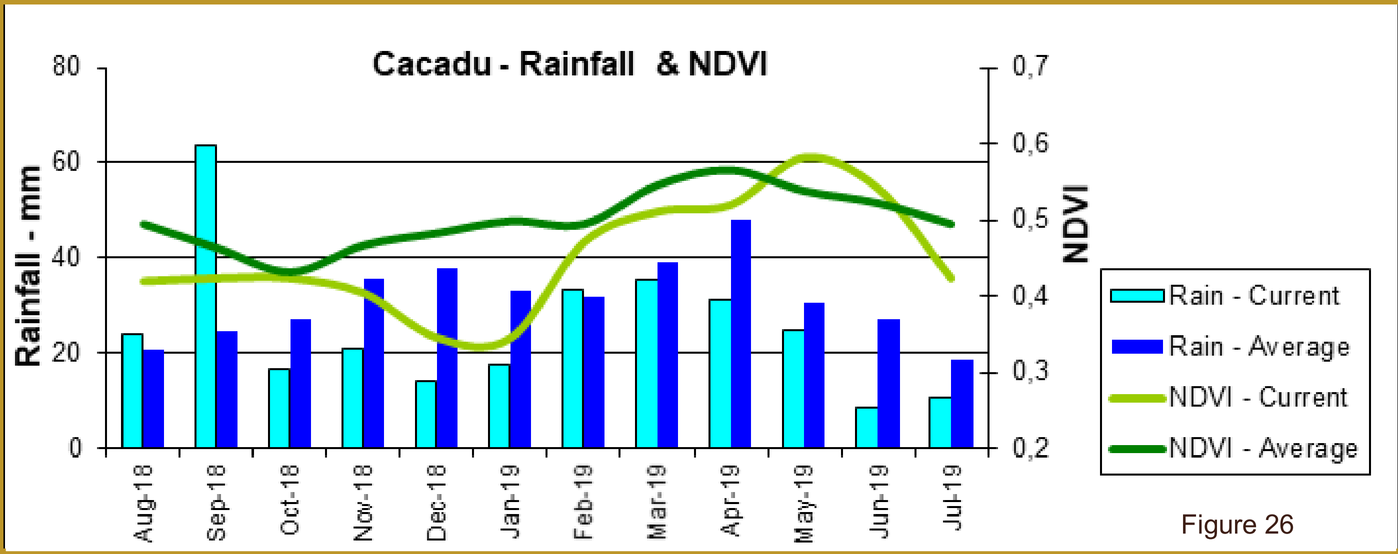


Figure 26

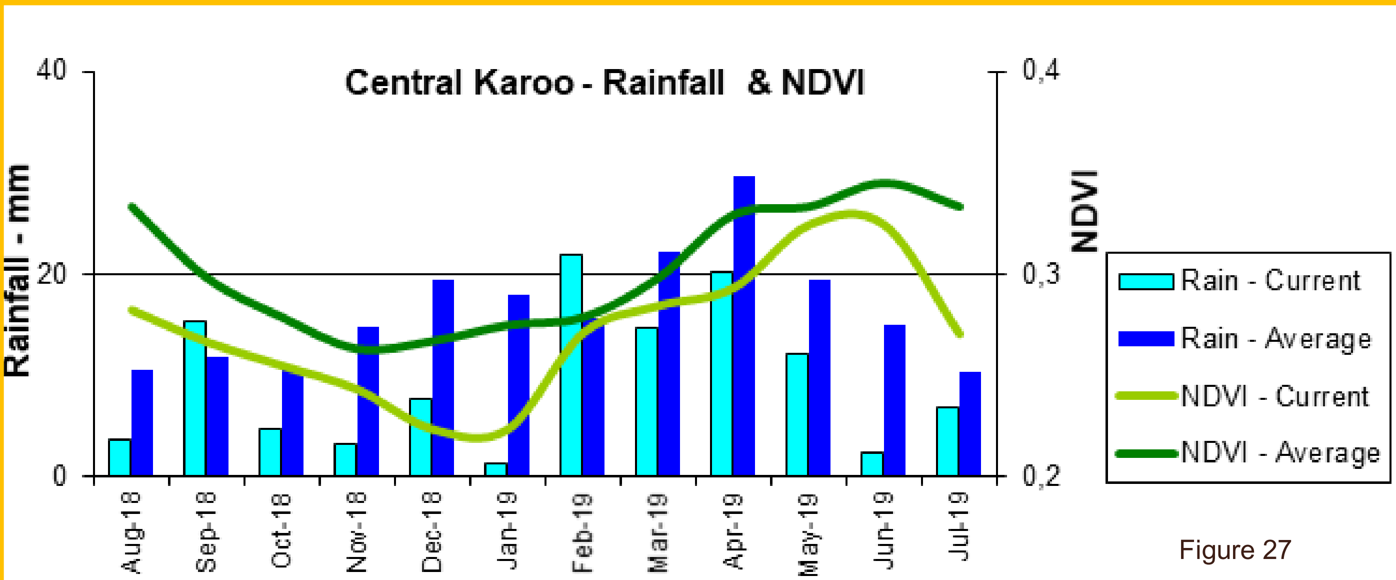


Figure 27

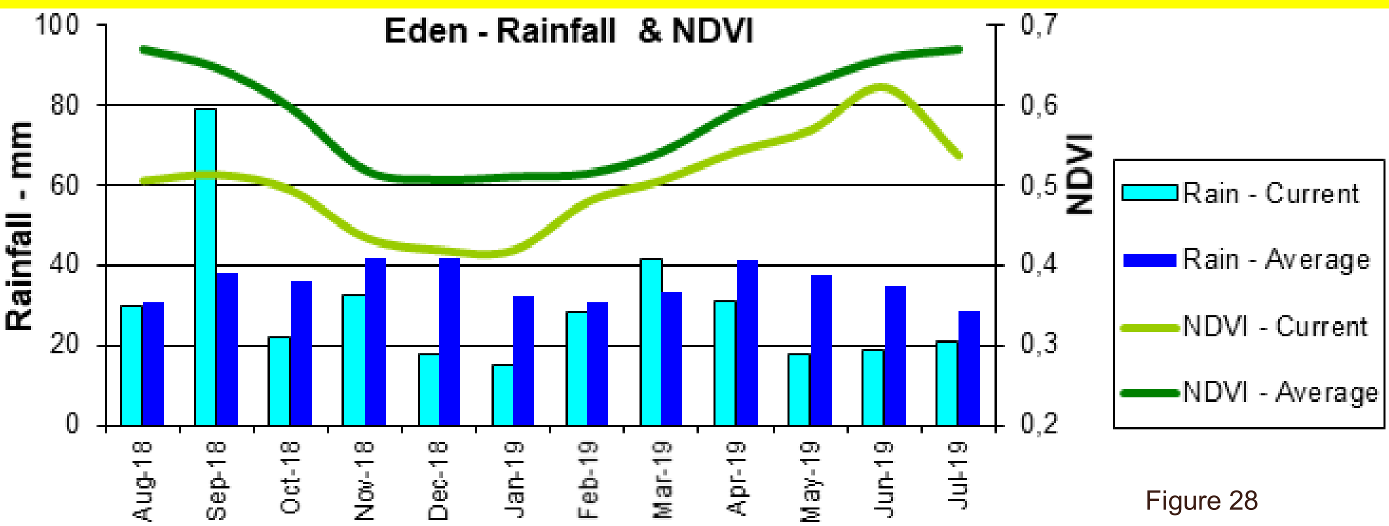


Figure 28

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 July 2019 per province. Fire activity was higher in all provinces compared to the long-term average.

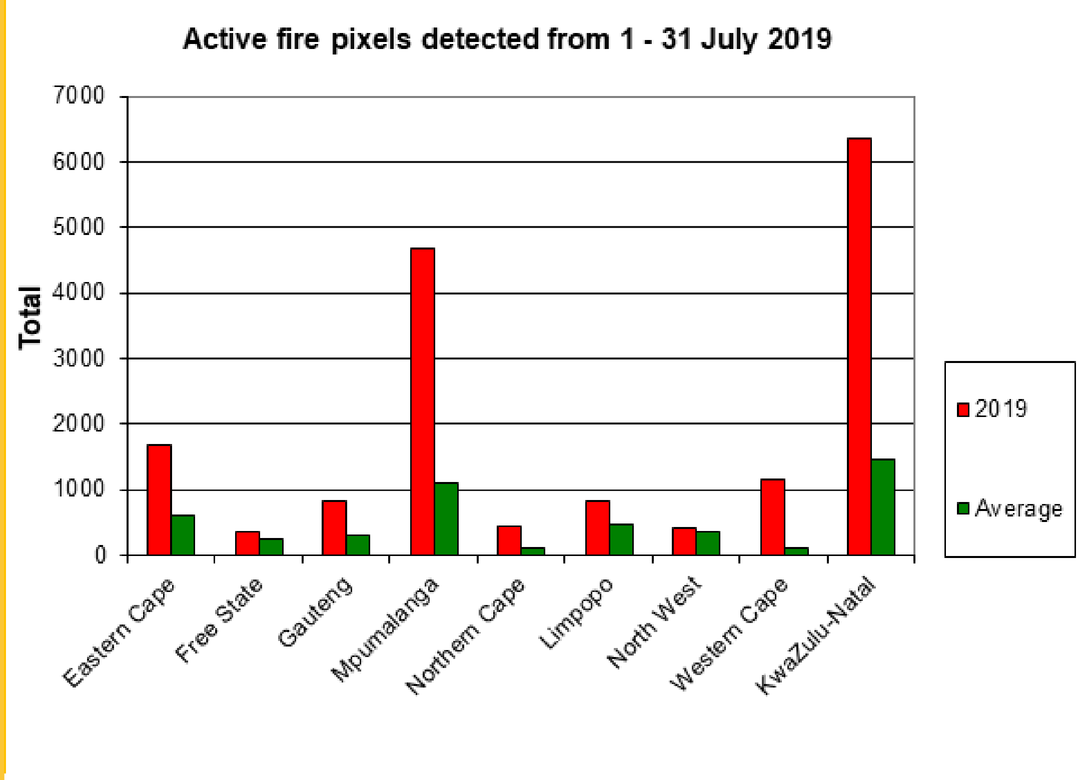


Figure 29

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

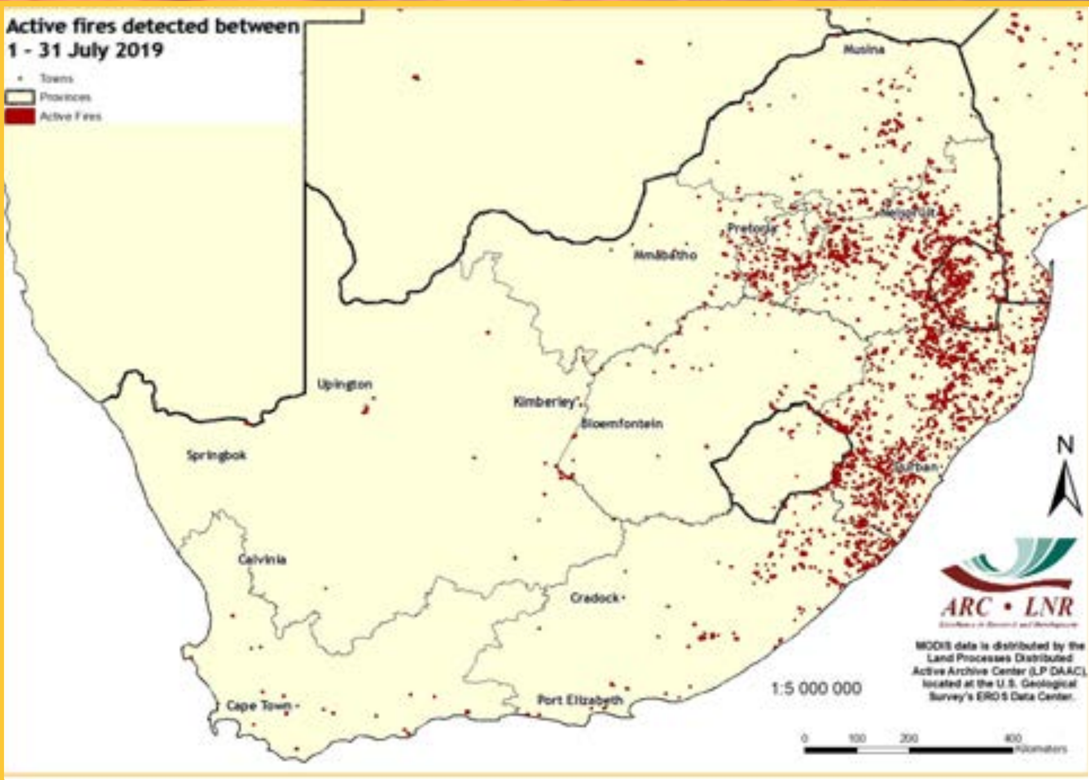


Figure 30

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

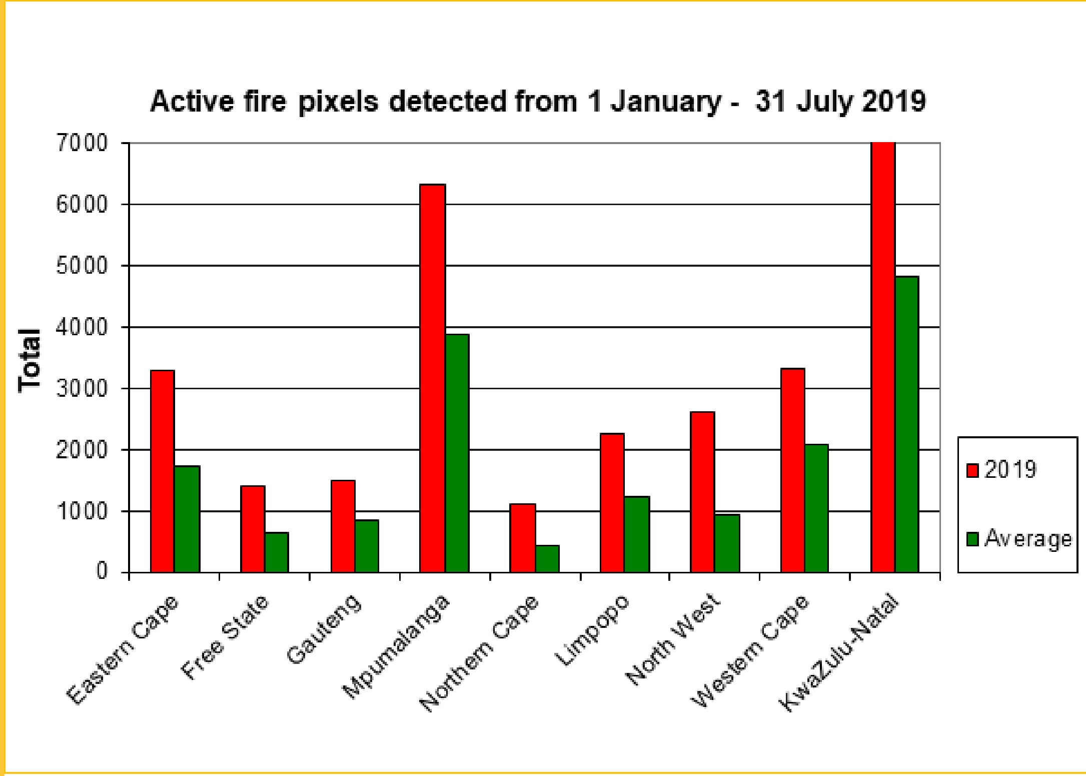


Figure 31

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

Questions/Comments:
MaakeR@arc.agric.za

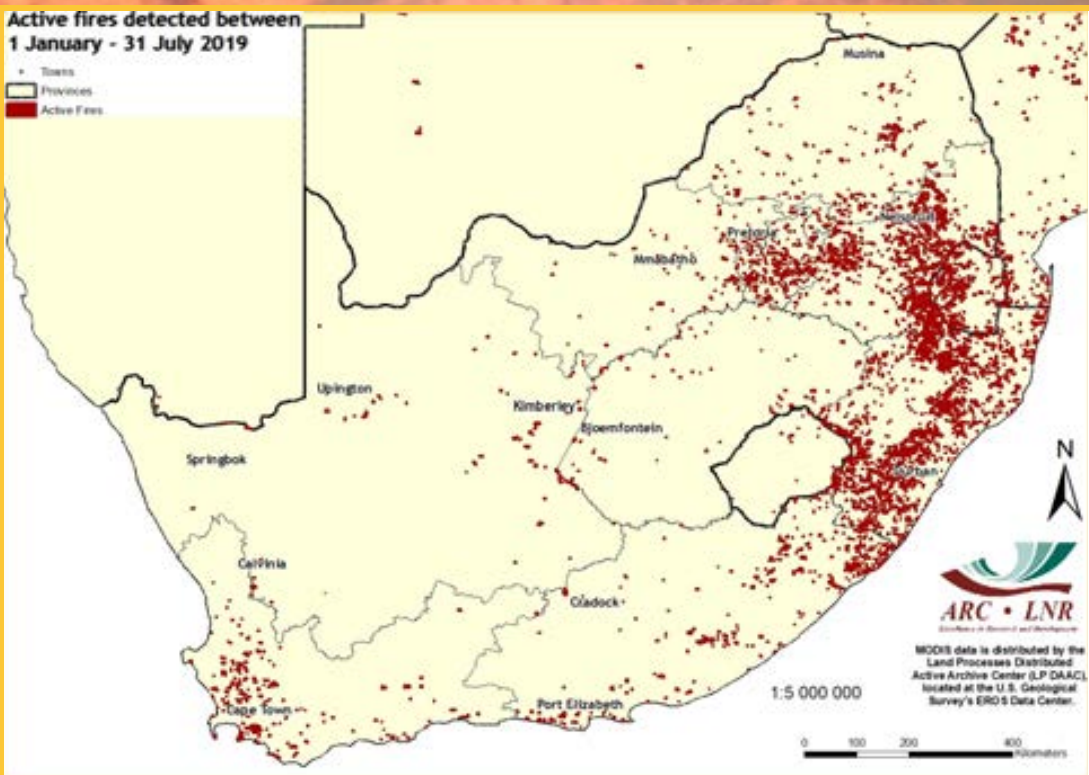


Figure 32

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 similar water areas to the maximum recorded in the 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 July 2019 and July 2018 shows that generally a major portion of the country has similar surface water extents to the same period in 2018. Notable exceptions occur in the Karoo, Kalahari and a few small local catchments in the Eastern Cape, KwaZulu-Natal and Mpumalanga, which show significantly lower water values. The Western Cape, however, shows significant increases in water extent in July 2019 compared 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

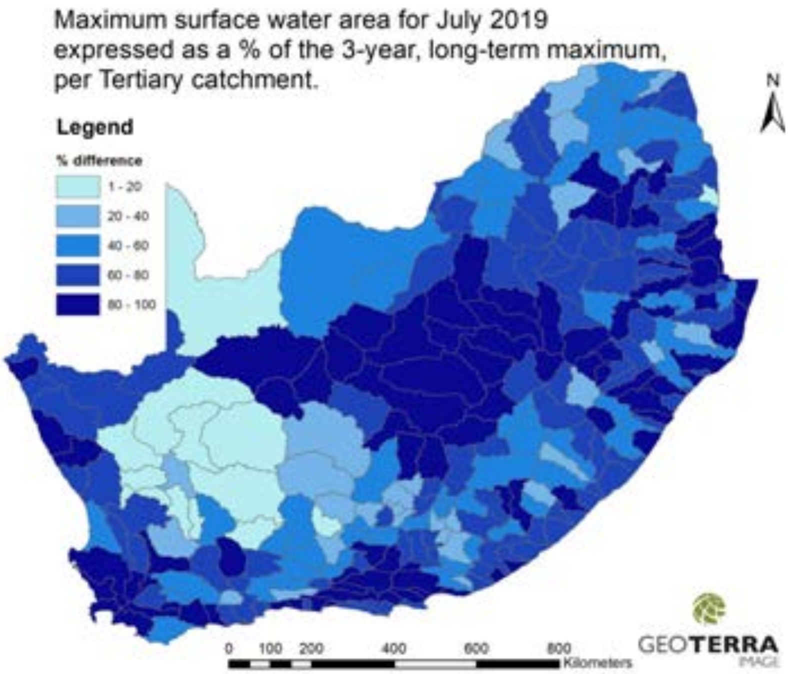


Figure 33

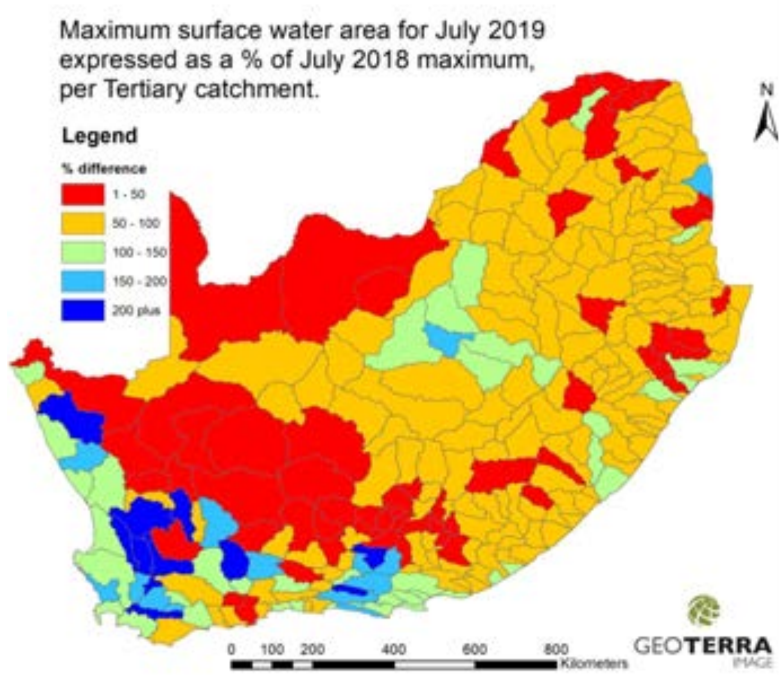
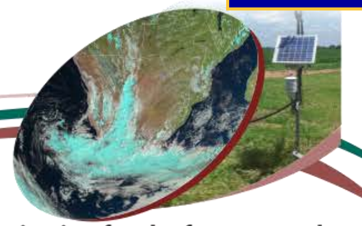


Figure 34

Agrometeorology



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

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".