ARC • LNR
Excellence in Research and Development

UMLINDI
The Watchman

ISSUE 2019-07 | 15 JULY 2019

INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

South African Weather Service

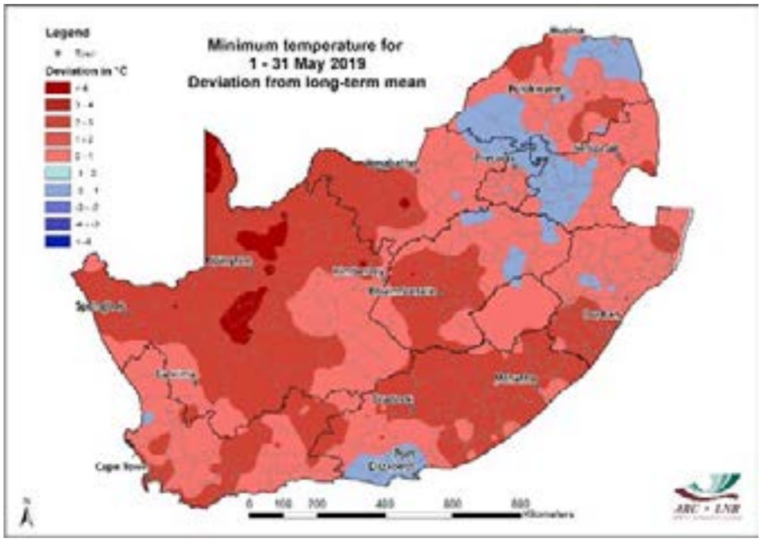
AMESD

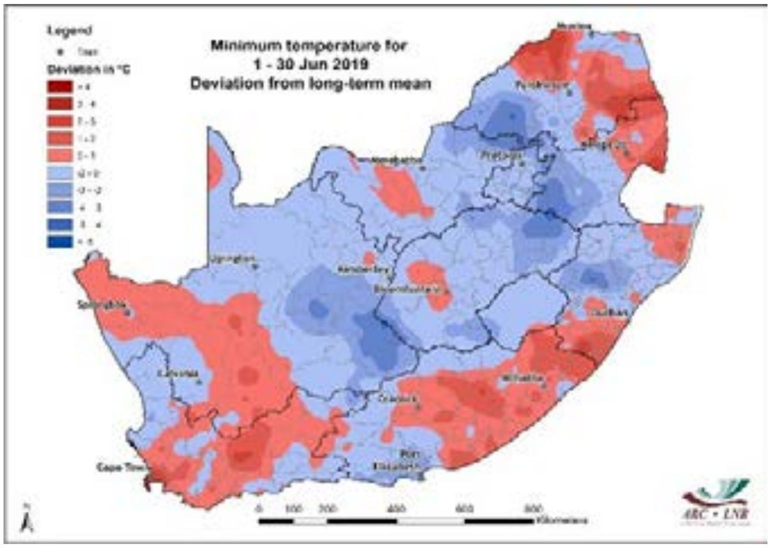
181st Edition

Images of the Month

Warm weather in May followed by a cold June

The maps show how the weather situations, including extremes, can vary over South Africa. A very late start to the frost season supported very late planting of maize over the western production region (North West and Free State provinces). Extensive areas of this region saw planting happening much later than the normal planting window. However, following above-normal rainfall during the latter part of summer 2018/19 and significantly above-normal minimum (as well as maximum) temperatures during May (see top map), successful late development of the crops occurred. By the end of May, very dry conditions resulted in a drop in minimum temperatures, with more severe cold conditions setting in through the month of June – reinforced by a strong cold front that moved across the interior late in the month. These colder conditions resulted in average monthly minimum temperatures during June being mostly below the long-term mean (see bottom map), in contrast to the mild conditions in May.





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).

Overview:

With the winter season in full swing, an evident decrease in total rainfall in June 2019 was notable over the southern interior – which was the only area that received above-normal rainfall in May. Although dry conditions with total rainfall of 0 to 5 mm continued over larger parts of the summer rainfall region, the northern KwaZulu-Natal coast experienced an improvement in June, receiving total rainfall ranging from 25 to 50 mm at Eshowe and adjacent areas. The northeastern parts of Mpumalanga followed a similar pattern, with thick bands of clouds bringing in isolated showers and recording up to 25 mm total rainfall as compared to 0 to 5 mm that was received during the month of May.

Considering the southwestern parts of the country, the above-normal rainfall conditions that occurred during May continued throughout June. This was driven by a series of cold fronts developing and pushing in a northeasterly direction over the area. The cold temperatures associated with these frontal systems imply optimal conditions for chill unit accumulation in the Cape Winelands. Furthermore, following the moderate and mild drought conditions that were experienced during April and May respectively, the rainfall activity that started in the second week of June indicates a slow recovery from the drought, and thus could be favourable for dryland wheat production in the Cape southern and western coastal areas. It is important to note that such conditions – characterized by low temperatures, isolated showers and thundershowers – are to be expected in these areas at this time of the year.

1. Rainfall

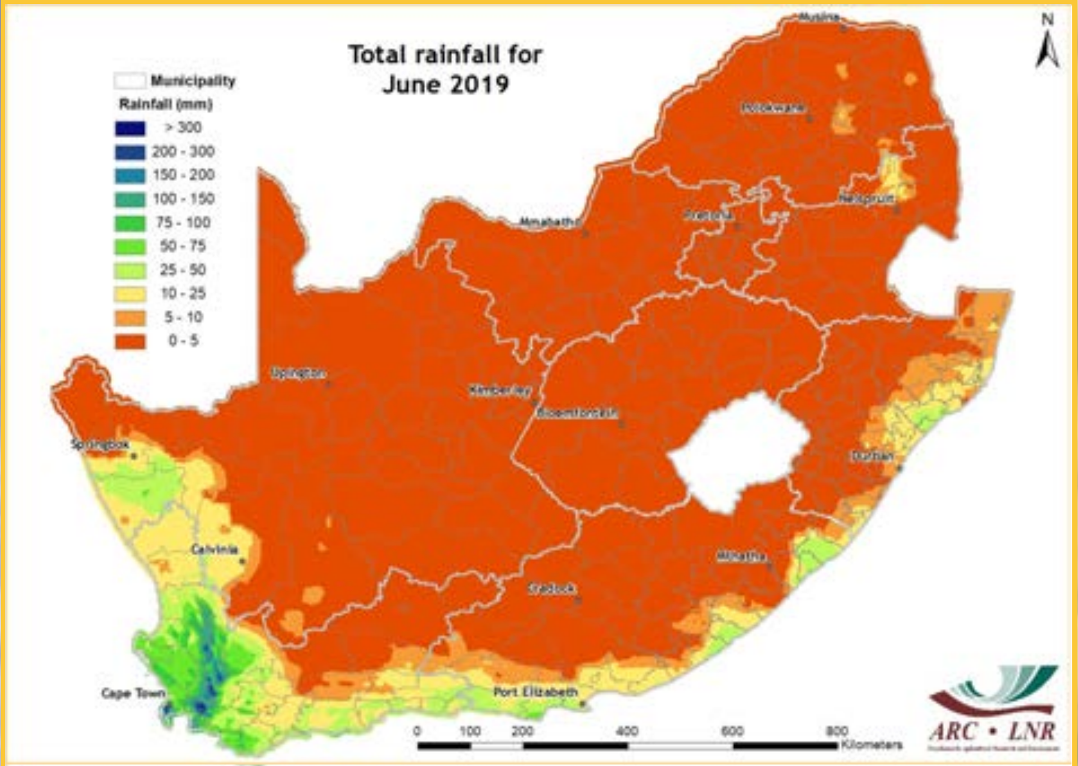


Figure 1

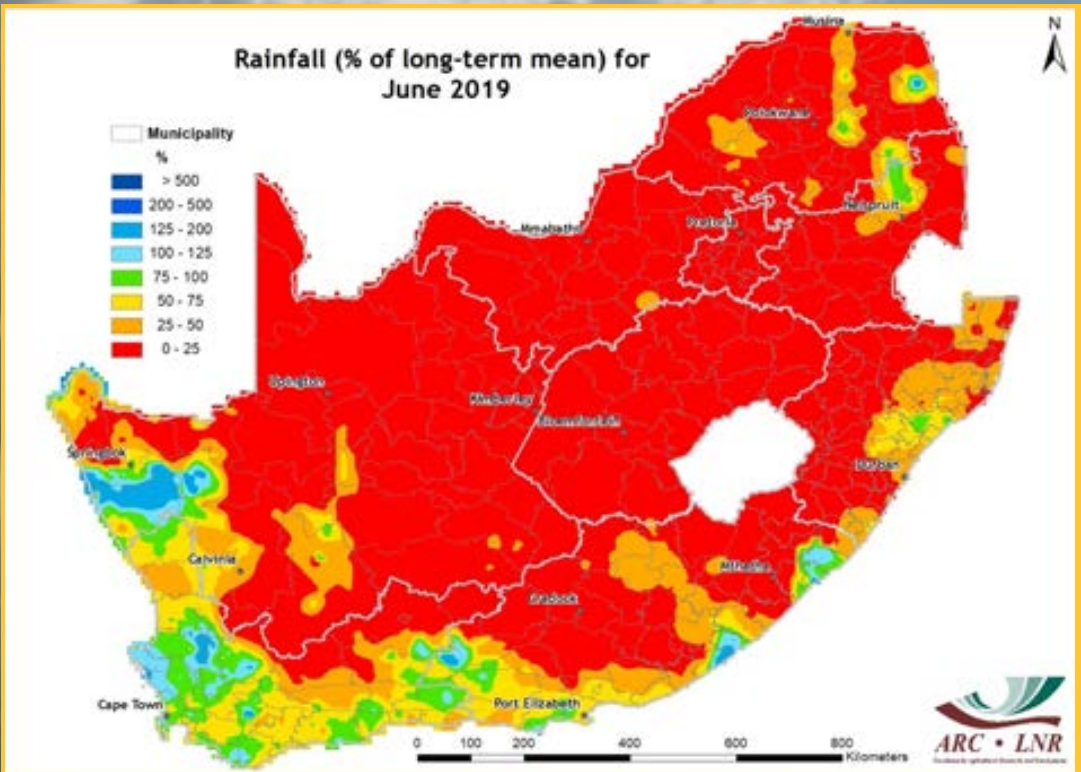


Figure 2

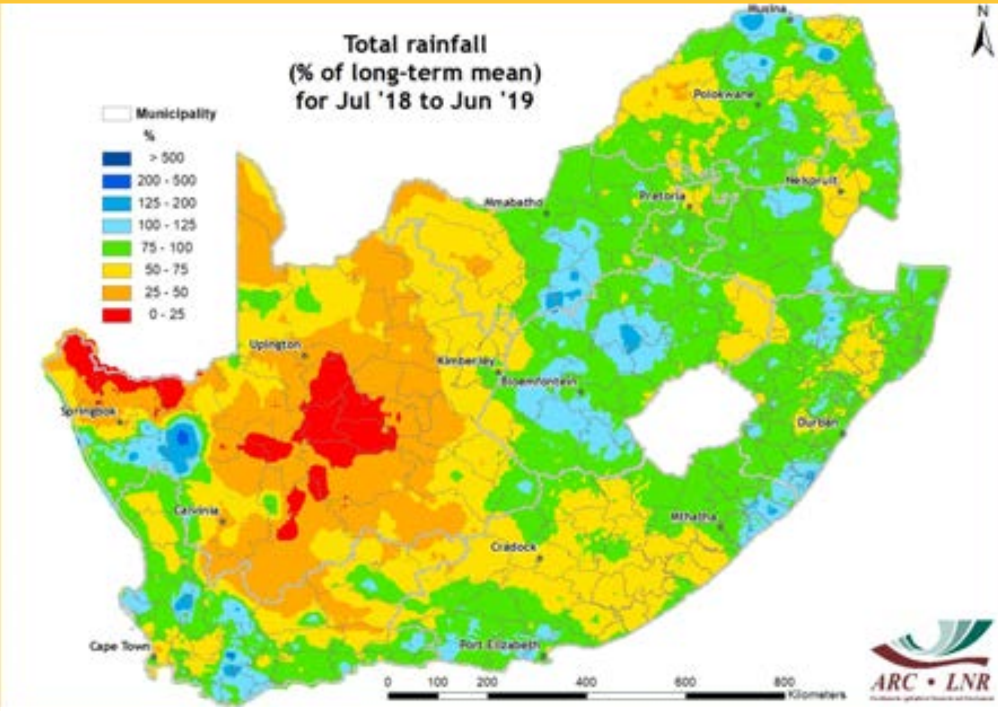


Figure 3

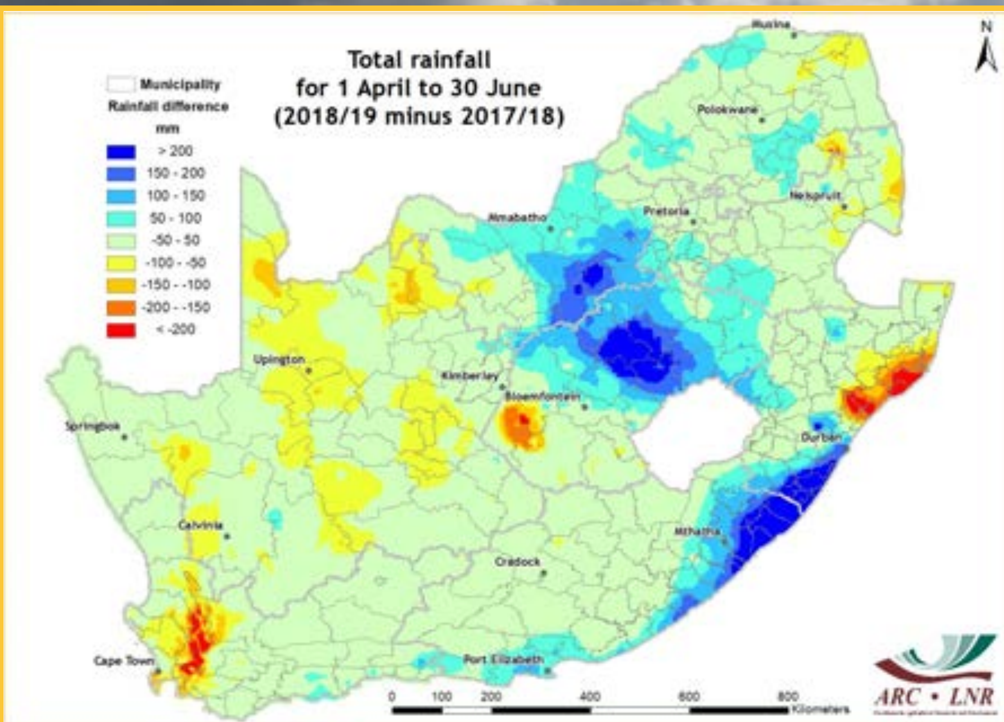


Figure 4

Figure 1:
Rainfall totals continued to drop in June as winter weather patterns gripped most of the interior of the country. As expected climatologically, the most significant rainfall activity was produced by a series of cold fronts experienced over the southwest of the Western Cape. KwaZulu-Natal and isolated areas in northeastern Mpumalanga also received light showers.

Figure 2:
The southwestern coast and isolated areas of the summer rainfall region experienced above-normal rainfall conditions when expressed as a percentage of the long-term mean for the month of June. This indicates positive implications for agricultural productivity in the winter rainfall region. The rest of the country experienced below-normal rainfall as expected.

Figure 3:
This map shows cumulative total rainfall from July 2018 to June 2019 expressed as a percentage of the long-term mean. It was observed that the Northern Cape and isolated parts of the summer rainfall region experienced below-normal rainfall during this period. However, similar to the month of May, near- to above-normal rainfall conditions were noted along the Cape south coast, Eastern Cape coast, northern Limpopo and parts of the central interior (Free State and North West provinces).

Figure 4:
Much of the central interior, the lower coastal belt of KwaZulu-Natal and the Eastern Cape received significantly more rain in April-June 2019 as compared to the same period last year. However, further to the south, much less rainfall was received as compared to the same 3-month period last year, with a difference of -200 to -150 mm.

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.

Standardized Precipitation Index (SPI) maps revealing drought conditions for short-term (6-month SPI), medium-term (12-month SPI) and long-term (24-month and 36-month SPI) are shown in this section. Given the short to medium drought conditions for the month of June, it is evident that mild to severe drought (SPI 0 to -2) had been frequent in the north and western parts of the country. Areas of concern include parts of the Western Cape, Northern Cape and northeastern Limpopo. The central to southern interior experienced mild to extreme wet conditions during this month. When considering the long-term drought conditions, SPI values corresponding to wet conditions were noted over the central parts of the country, northern Limpopo and coastal areas on the KwaZulu-Natal / Eastern Cape border. Long-term severe to extreme droughts were noted, particularly in the Northern Cape, implying significantly low dam levels. The drought conditions varying from mild to severe over Limpopo are prevalent at the longer time scales but not visible at the shorter time scales due to near- to above-normal rainfall that was received in the region during April-June 2019.

Questions/Comments:
MasuphaE@arc.agric.za

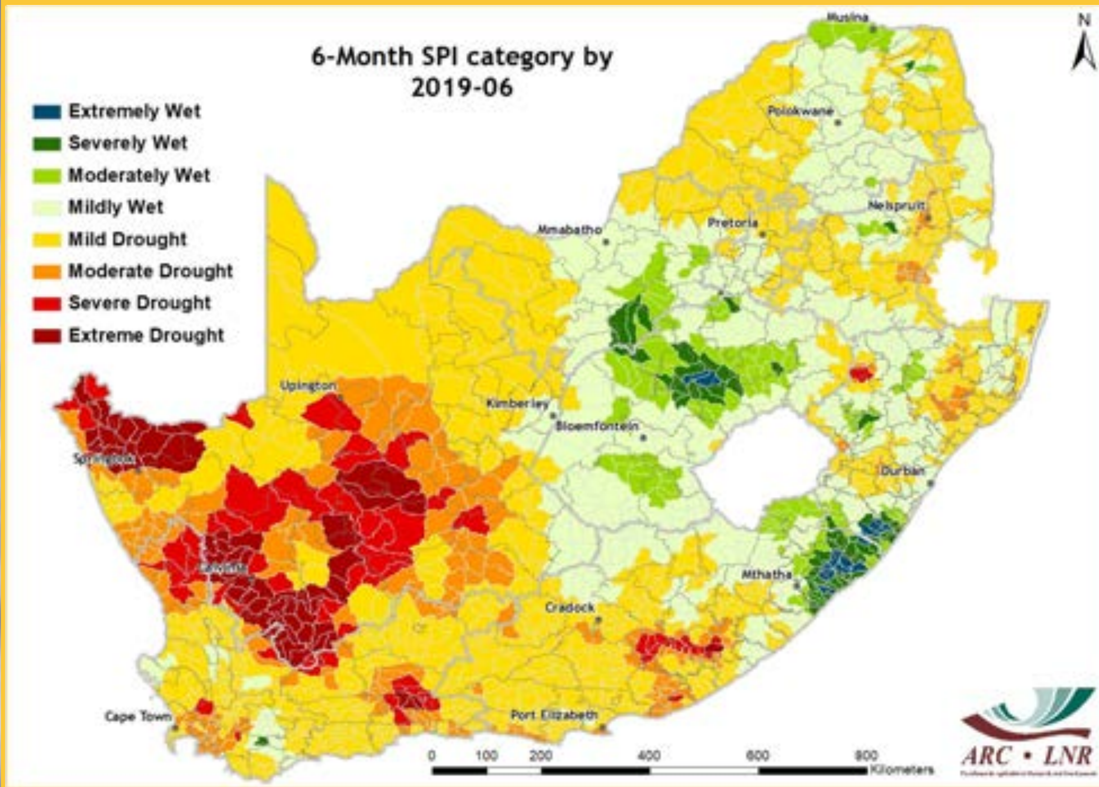


Figure 5

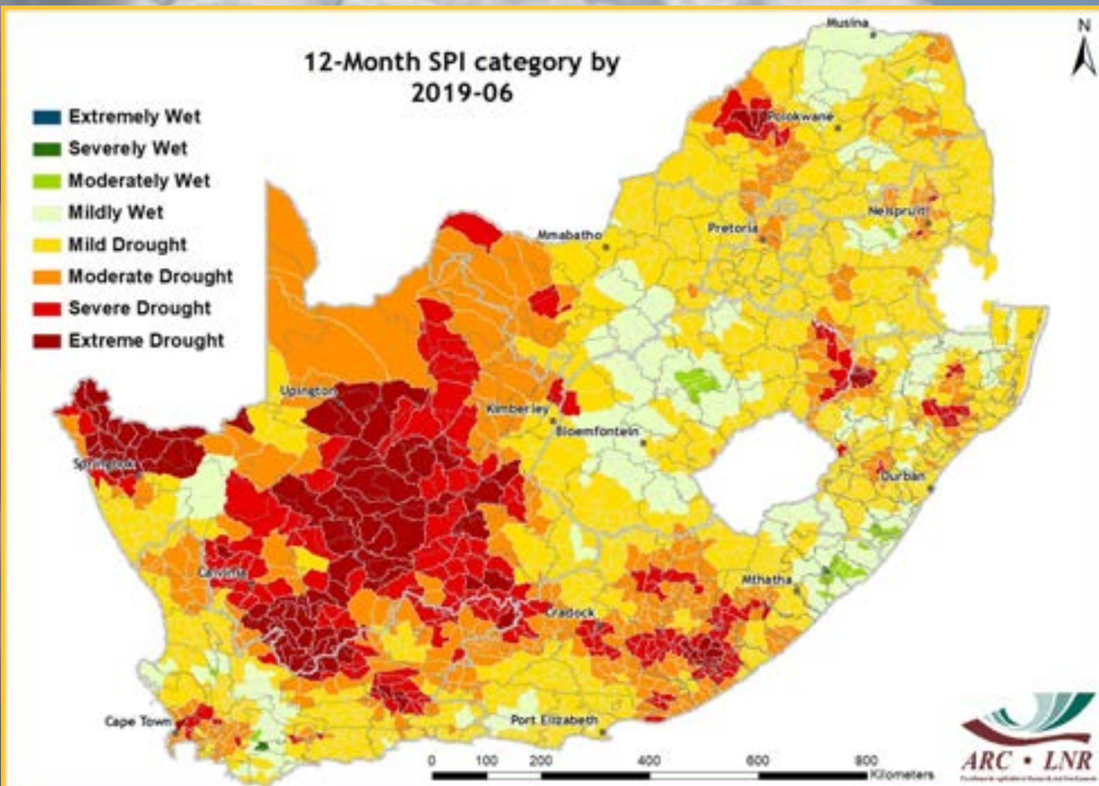


Figure 6

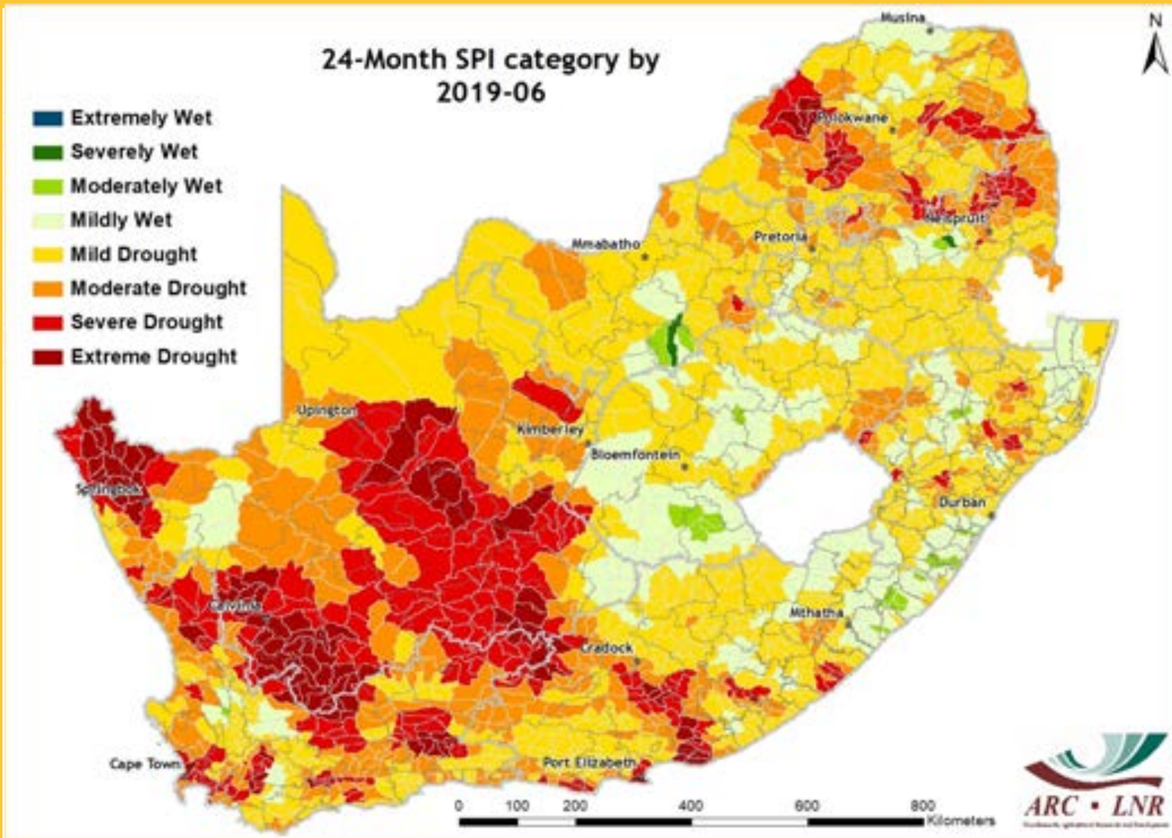


Figure 7

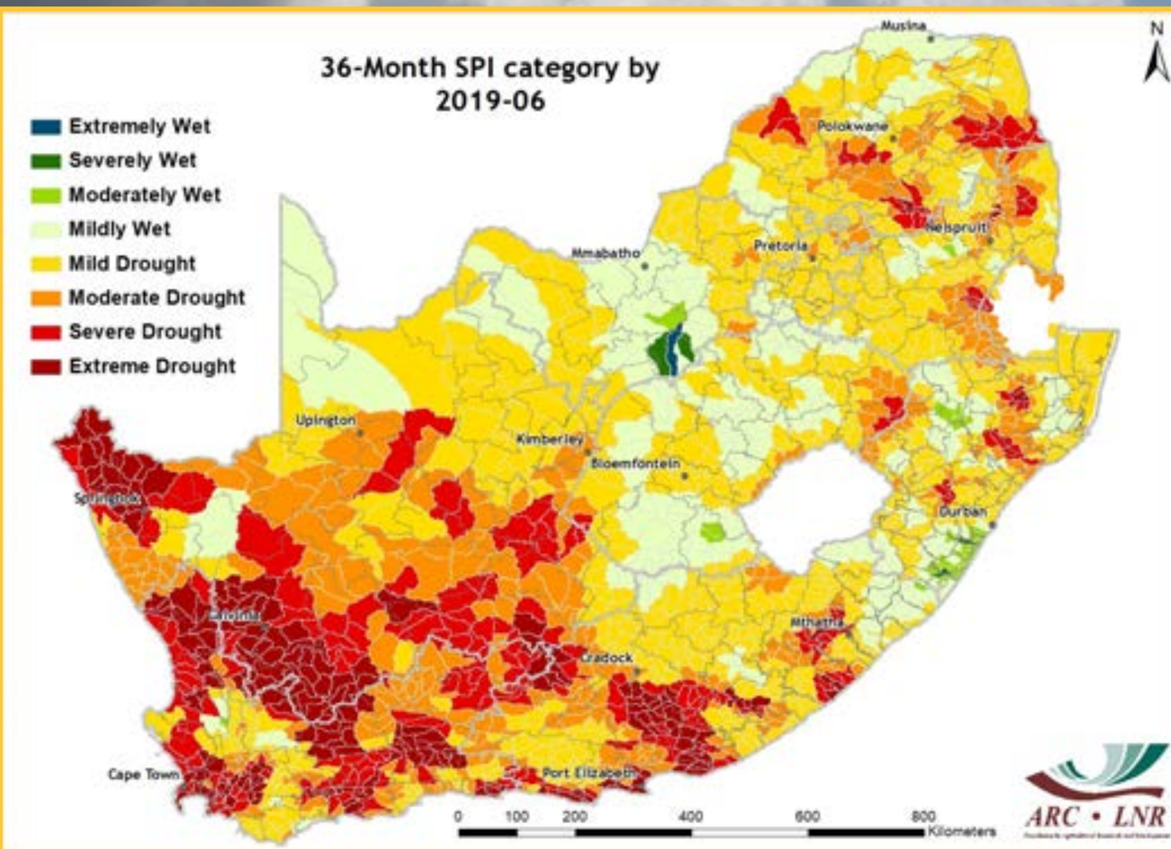


Figure 8

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.

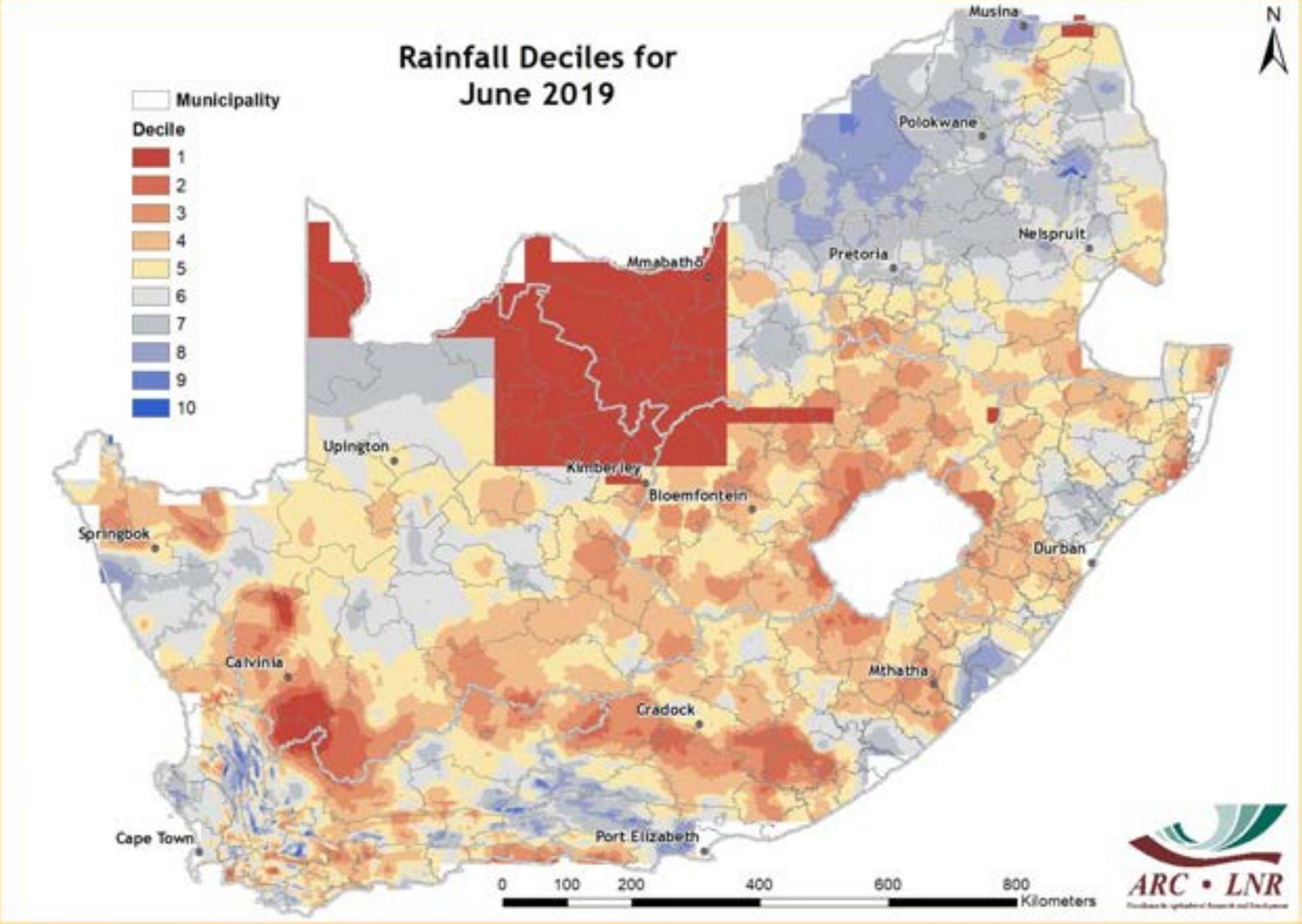


Figure 9

Figure 9:
Greater parts of the Limpopo, North West and Mpumalanga provinces received exceptionally high rainfall totals in June 2019, as compared to the historical observations of the same month. In contrast, the central interior, parts of the Western Cape, Northern Cape and the eastern low-lying peripheries were exceptionally dry.

[Note: The “1 decile” block over the North West and Northern Cape provinces may be erratic and will be investigated.]

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.

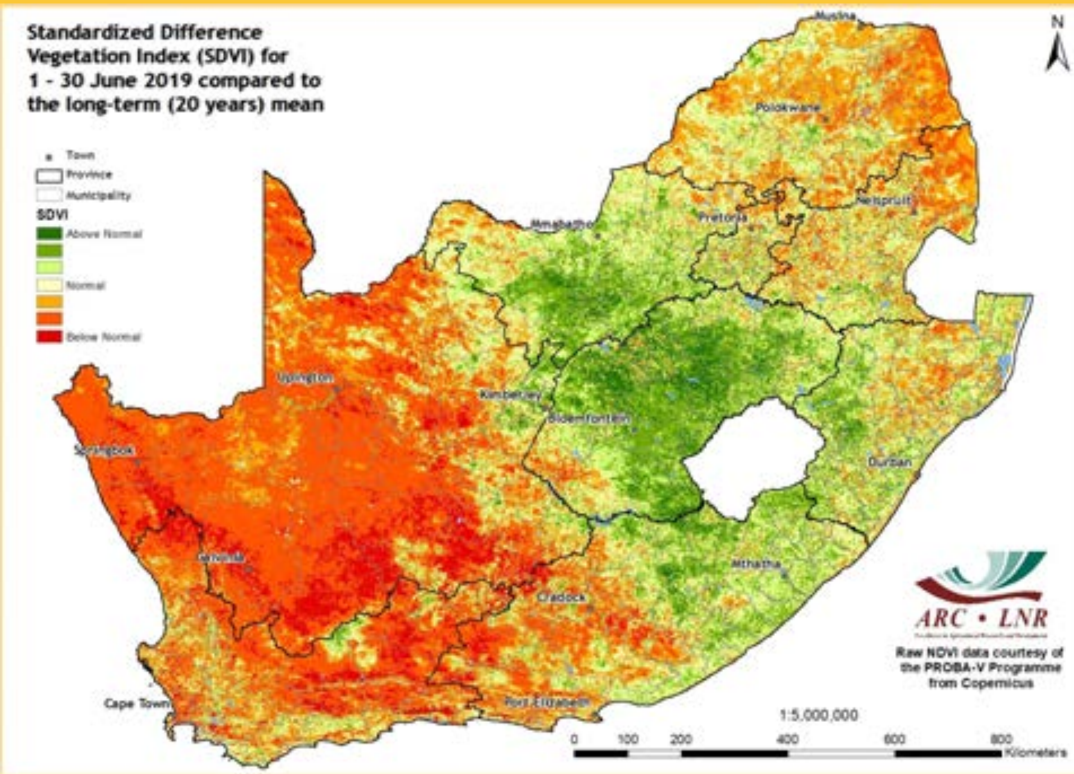


Figure 10

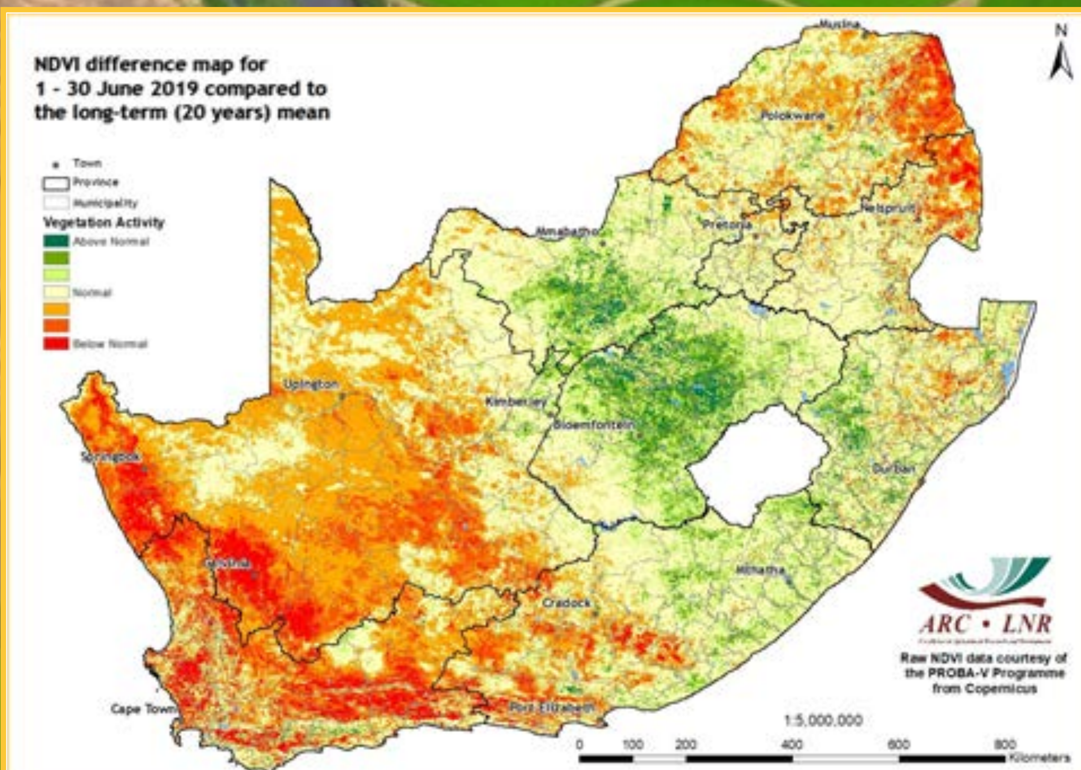


Figure 11

Figure 10:
The June 2019 SDVI map shows that less favourable vegetation conditions not only occurred in the western parts of the country, but also in the far northern parts. The central parts are an exception.

Figure 11:
Compared to the vegetation conditions calculated and averaged over 20 years, the NDVI difference map for June 2019 shows that below-normal vegetation activity occurred mainly in the western parts of the country and some isolated areas in Limpopo and Mpumalanga. Meanwhile, the central parts experienced above-normal vegetation activity.

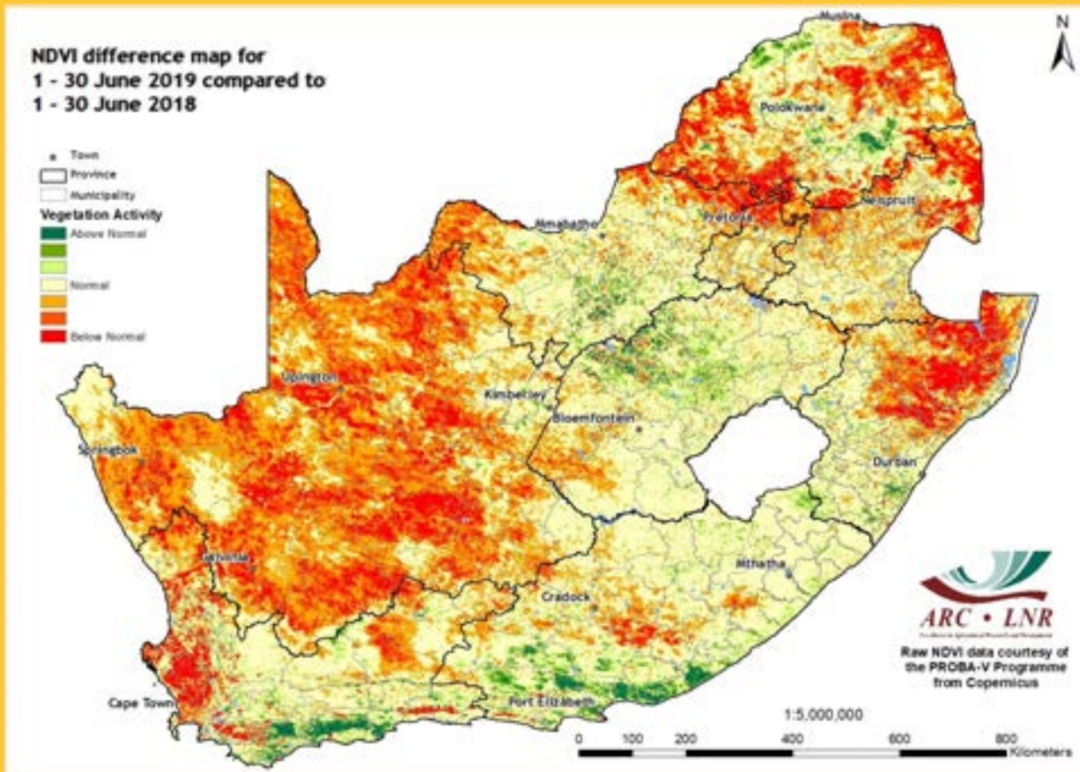


Figure 12

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

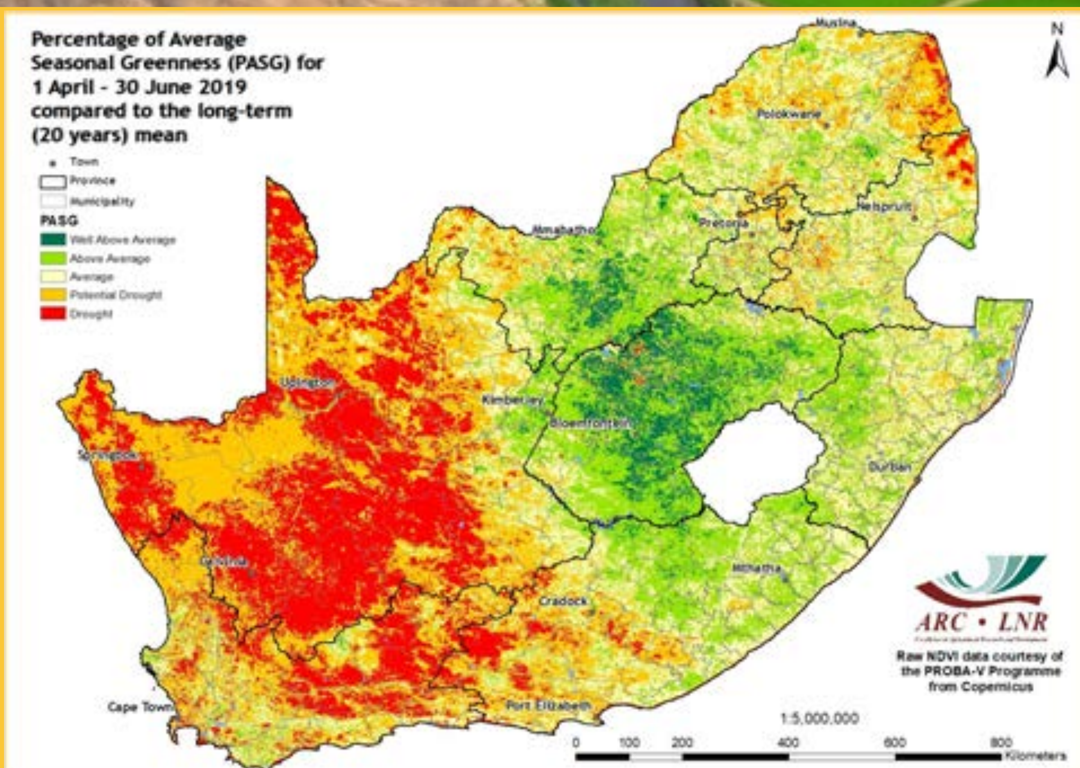


Figure 13

Figure 12:
When comparing the NDVI map for June 2019 to that for June 2018, it shows that below-normal vegetation activity continues to dominate in the Northern Cape, spreading over areas in Limpopo and the northern parts of Mpumalanga and KZN. Nevertheless, pockets of above-normal vegetation activity occurred in isolated coastal areas and the central parts of the Free State and North West.

Figure 13:
The PASG map over a 3-month period shows that the percentage of average seasonal greenness was lower over the western parts of the country but higher in the eastern 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.

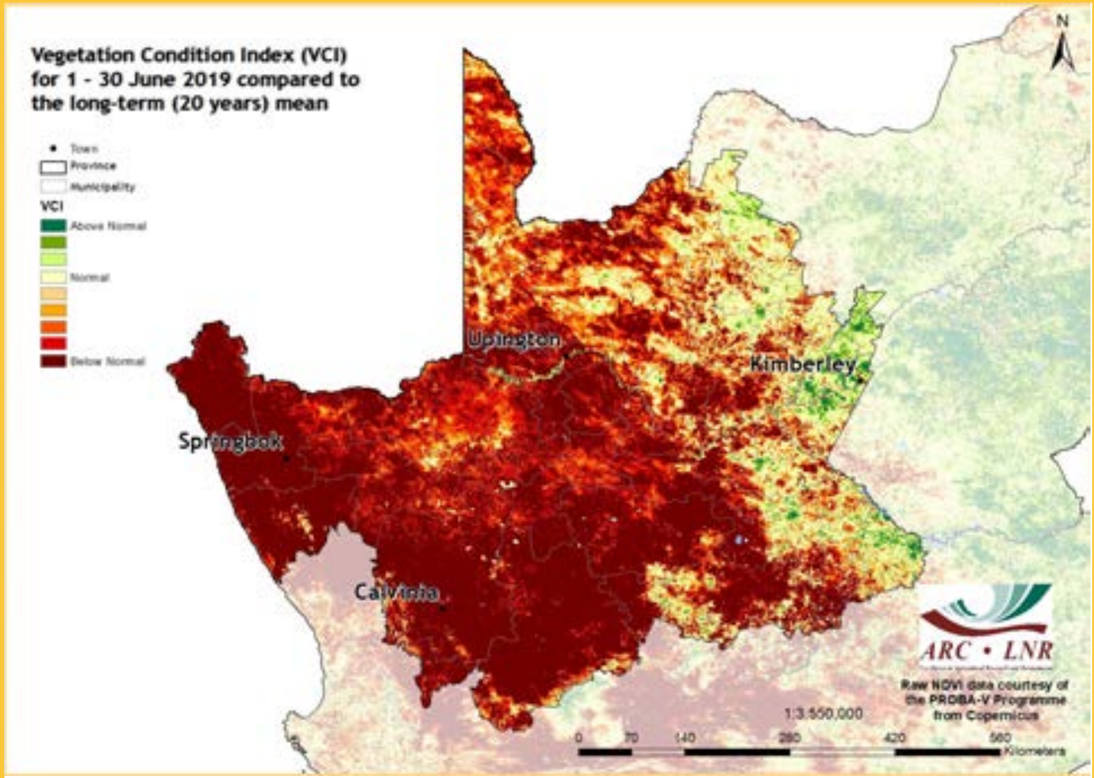


Figure 14

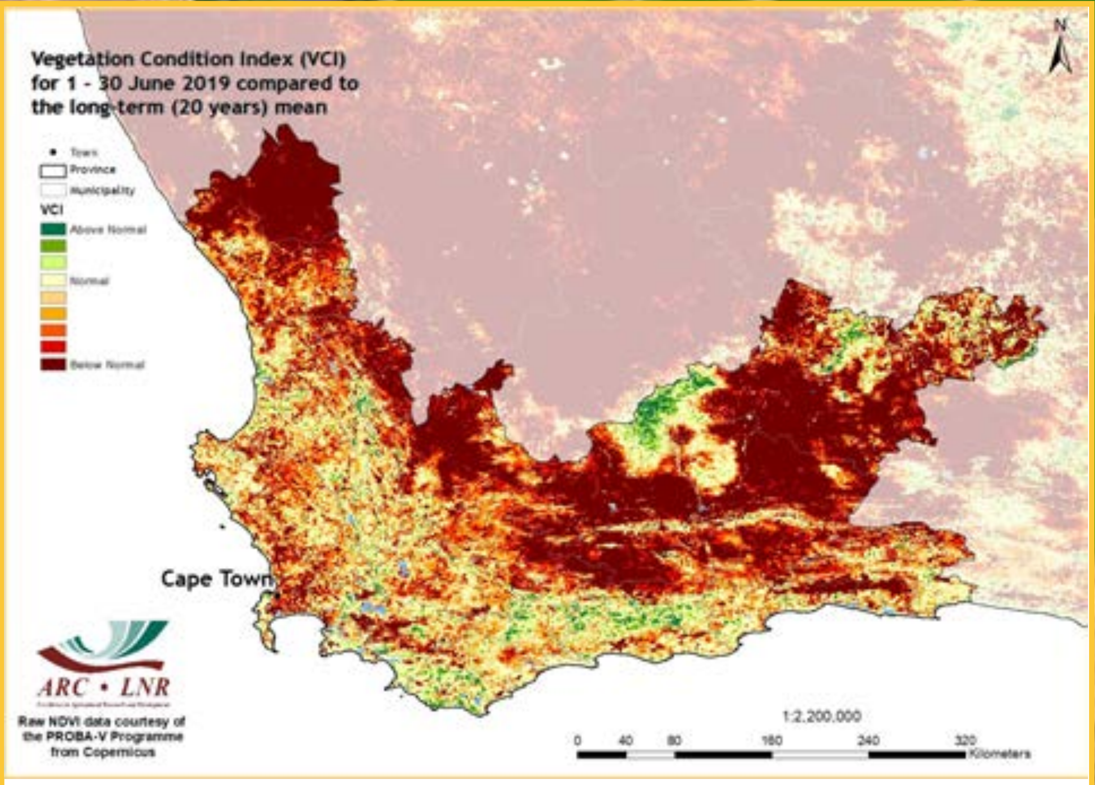


Figure 15

Figure 14:
The VCI map for the Northern Cape shows that entire province remains threatened by alarmingly poor vegetation conditions.

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

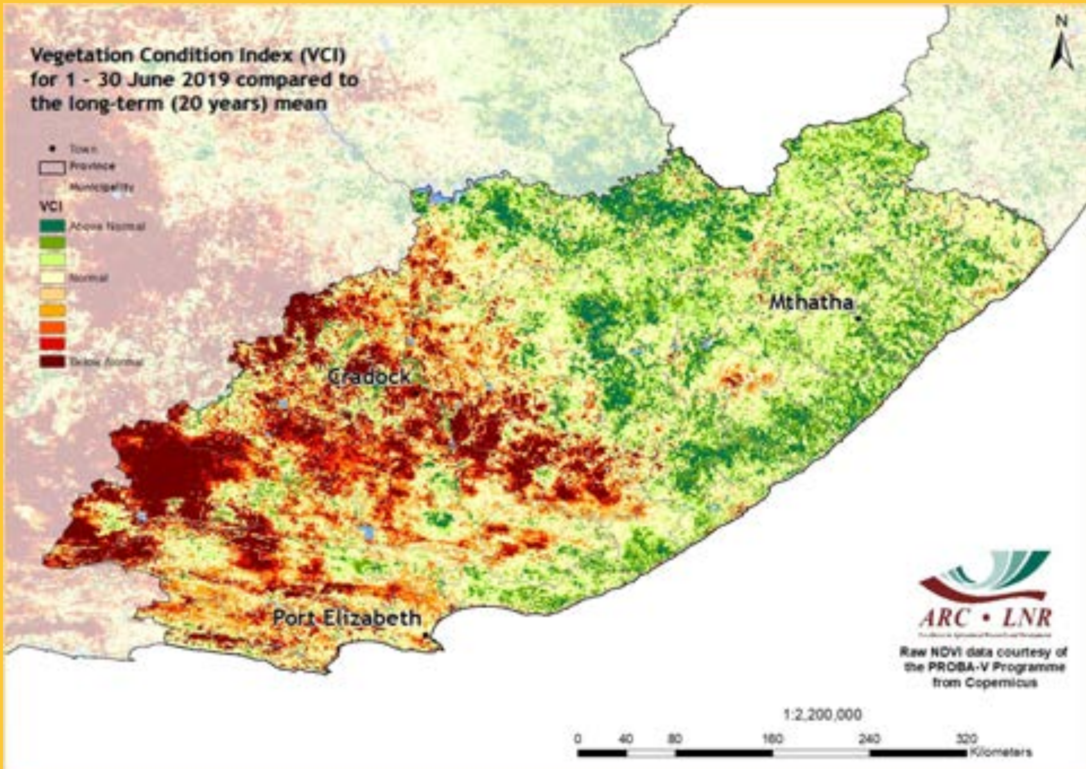


Figure 16

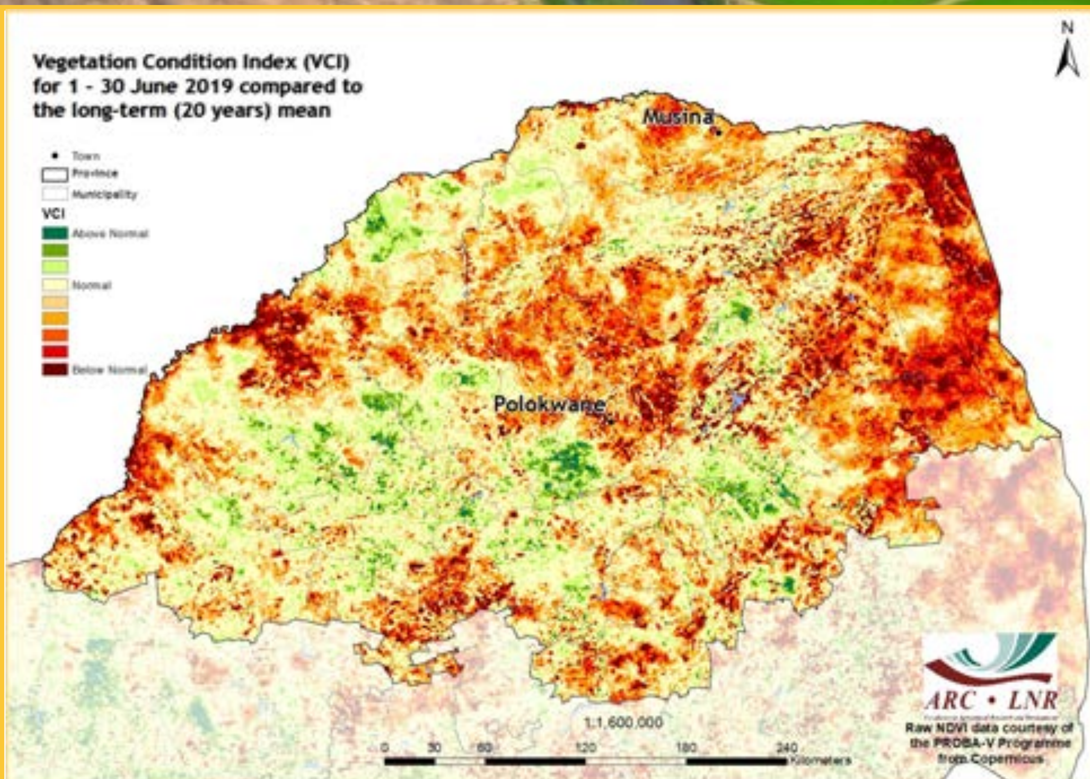


Figure 17

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

Figure 17:
The VCI map for Limpopo shows that poor vegetation activity occurred over much of the Kruger National Park, spreading to many other parts of the province.

Questions/Comments:
MaakeR@arc.agric.za

6. Vegetation Conditions & Rainfall

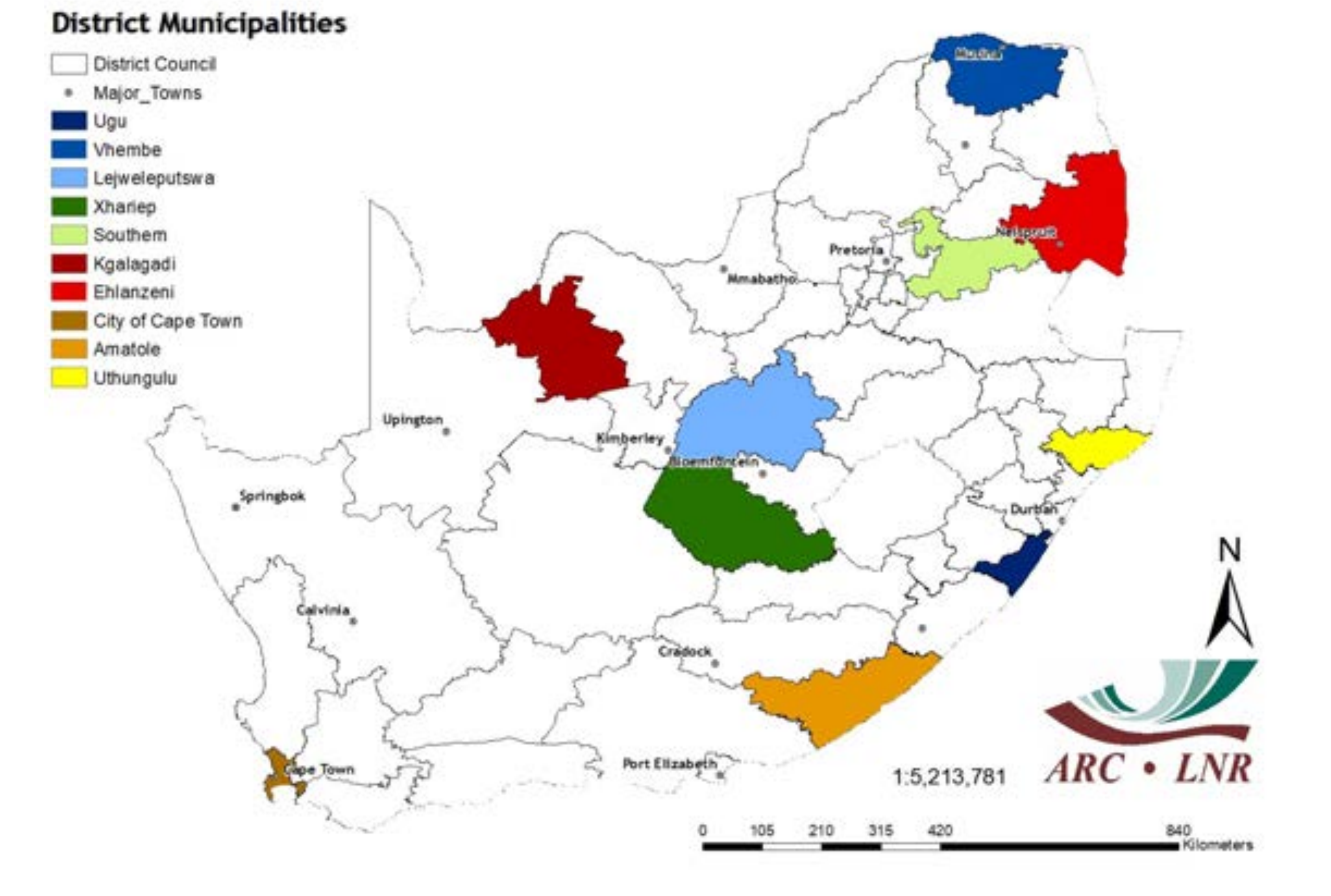


Figure 18

Rainfall and NDVI Graphs

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

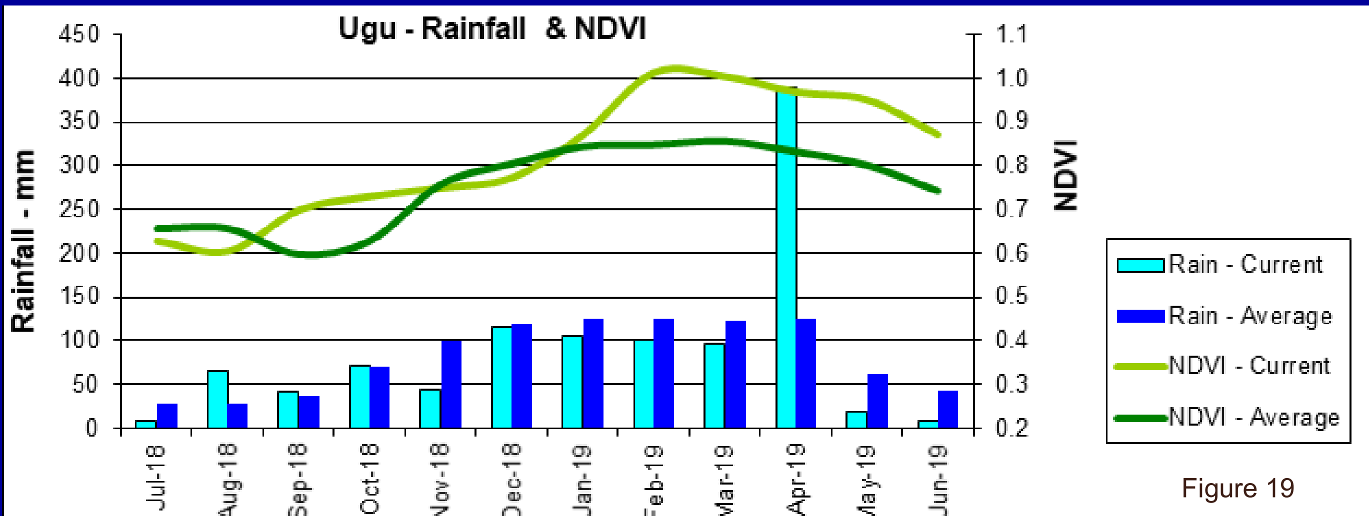


Figure 19

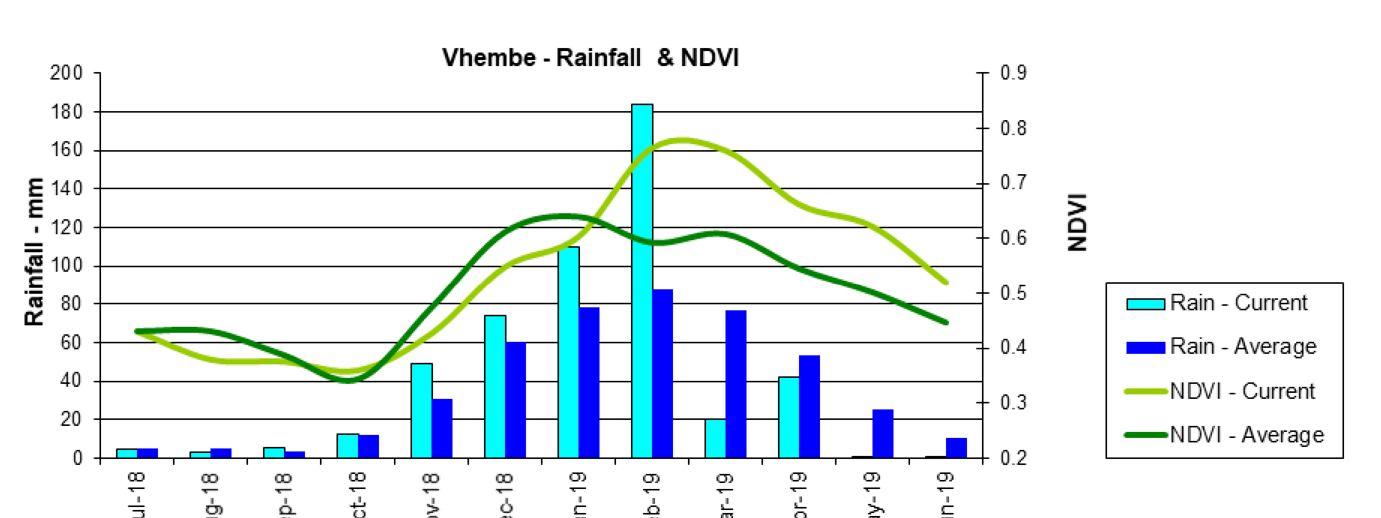


Figure 20

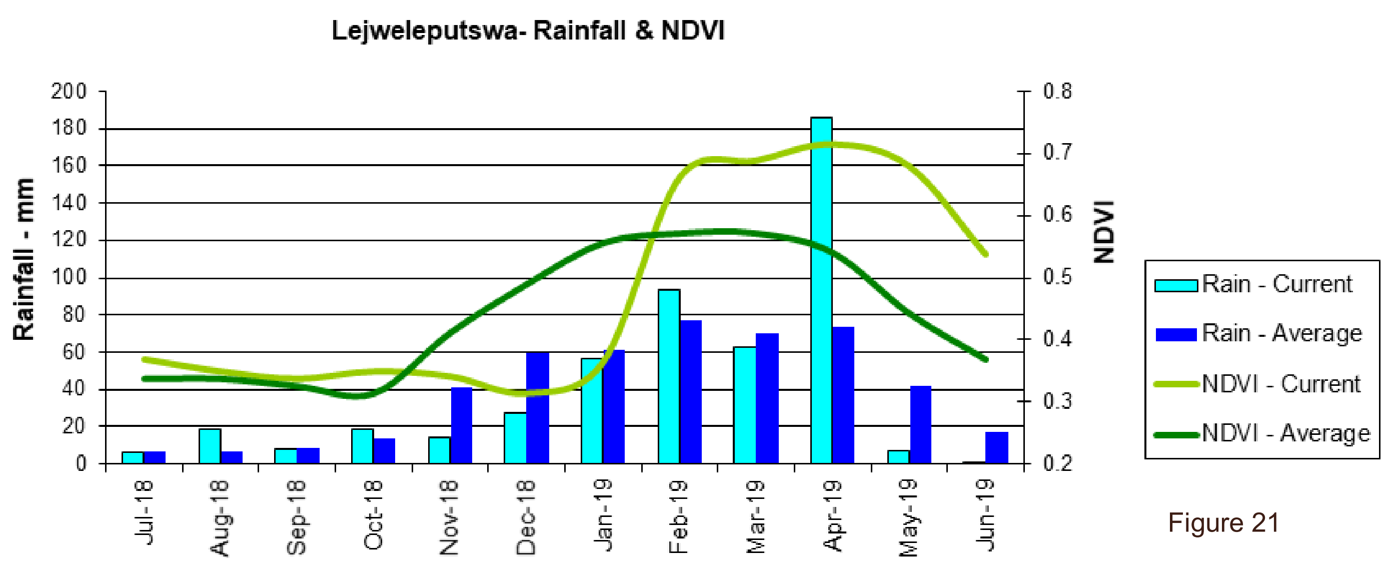


Figure 21

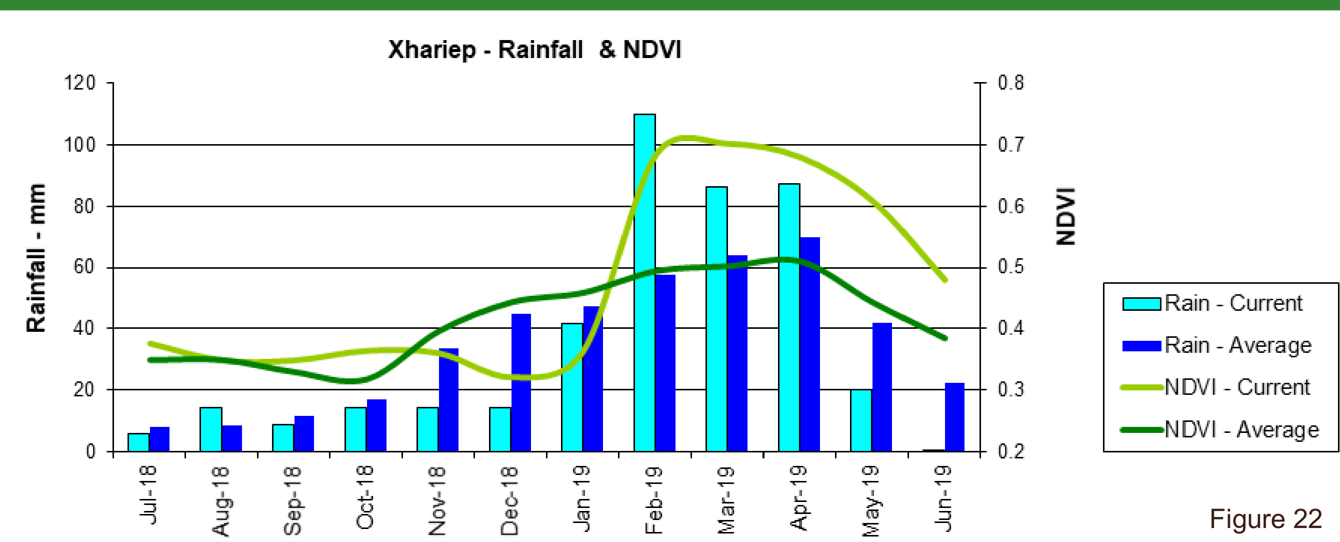


Figure 22

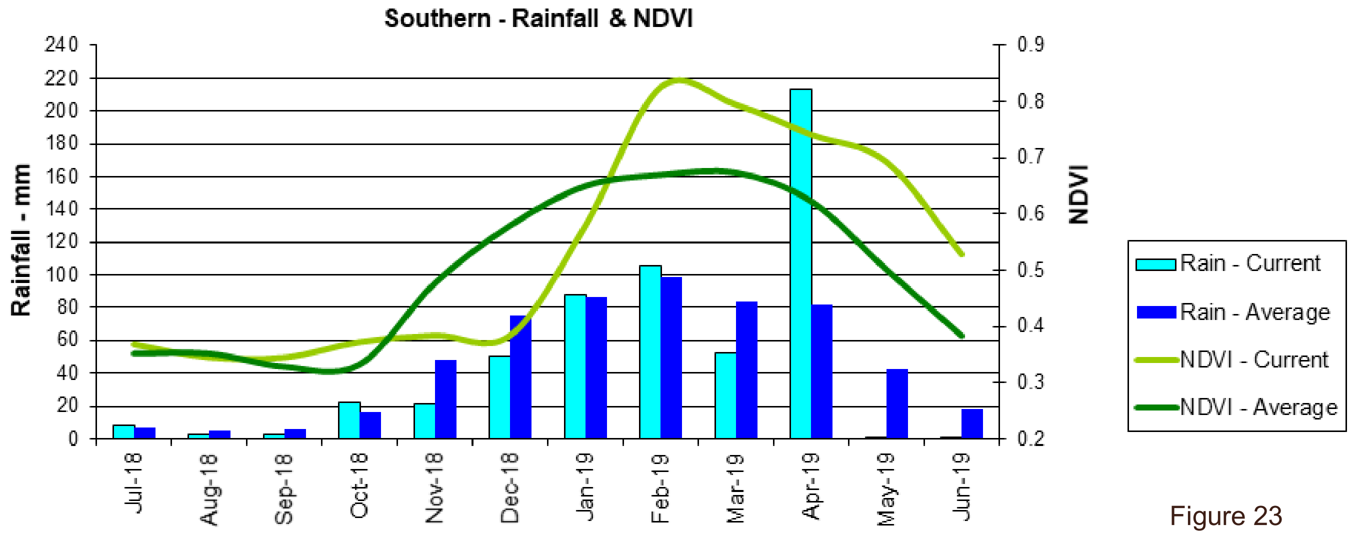


Figure 23

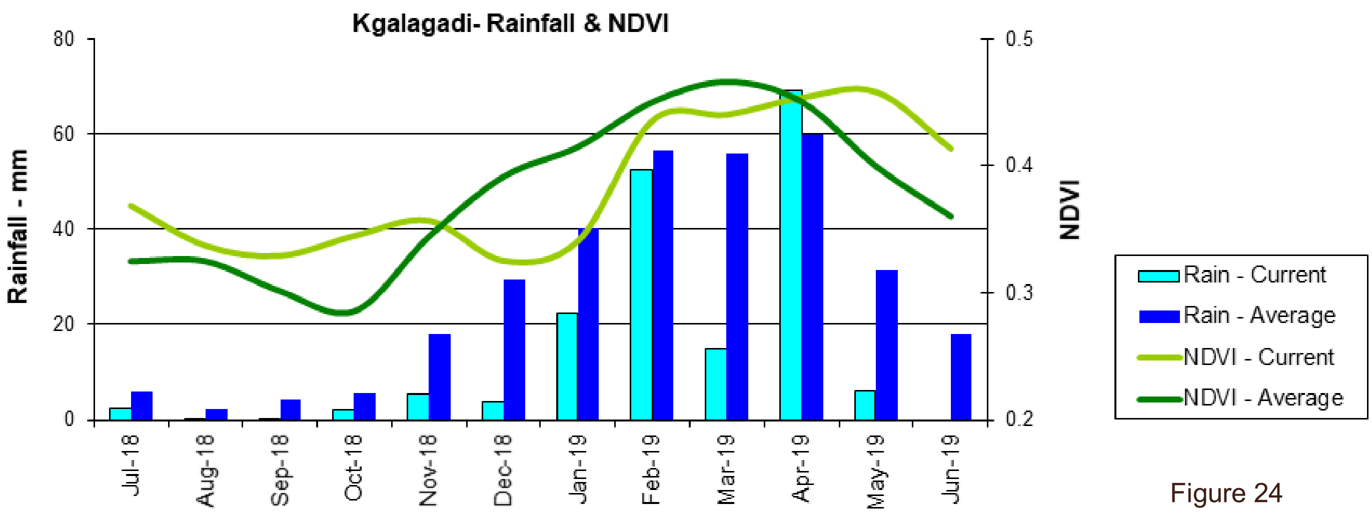


Figure 24

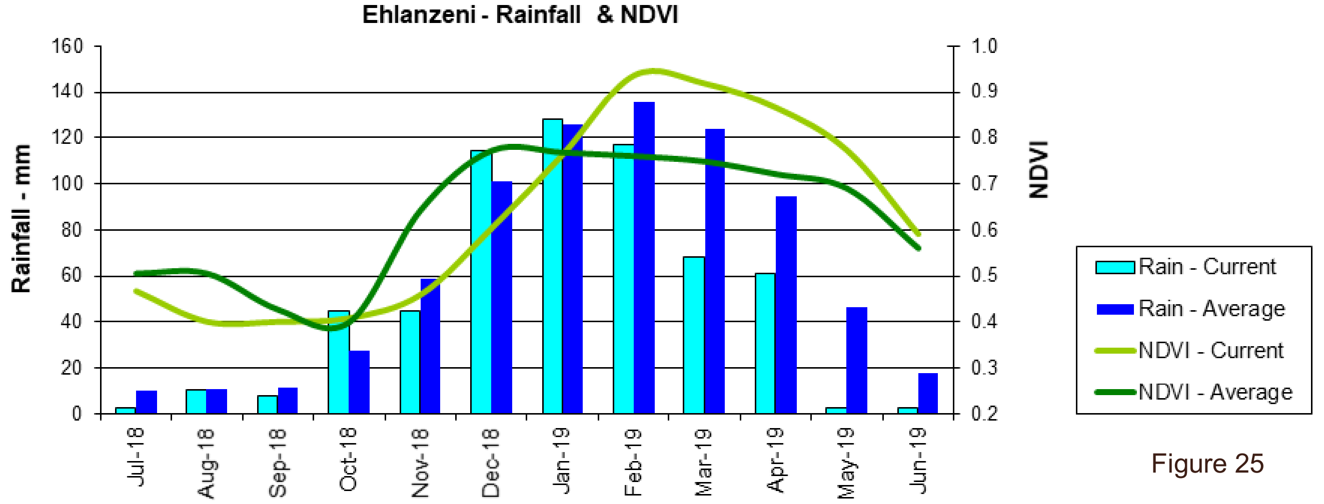


Figure 25

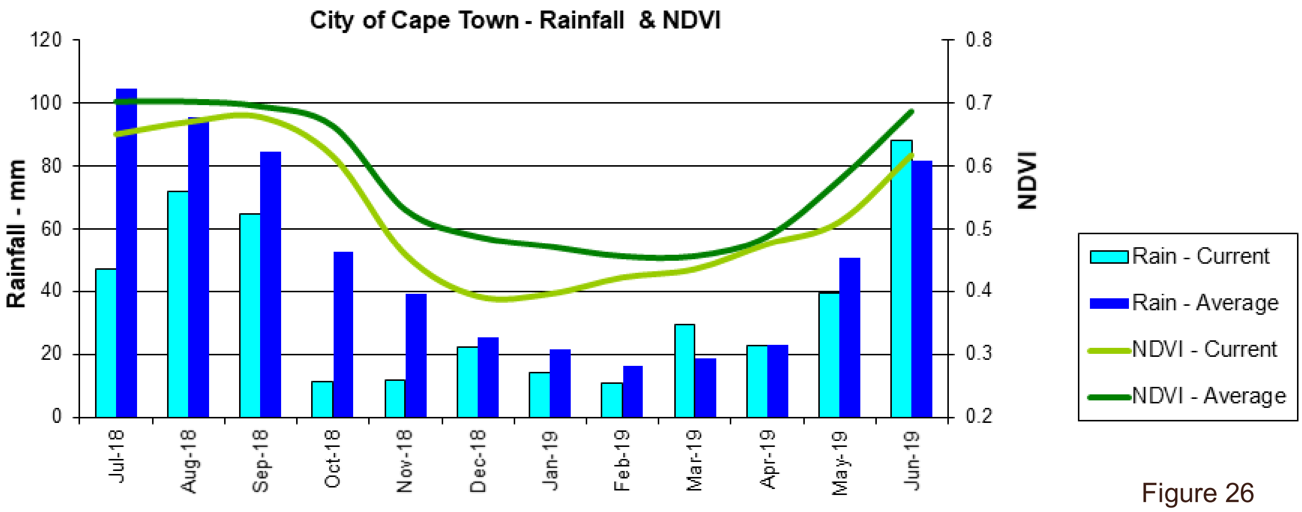


Figure 26

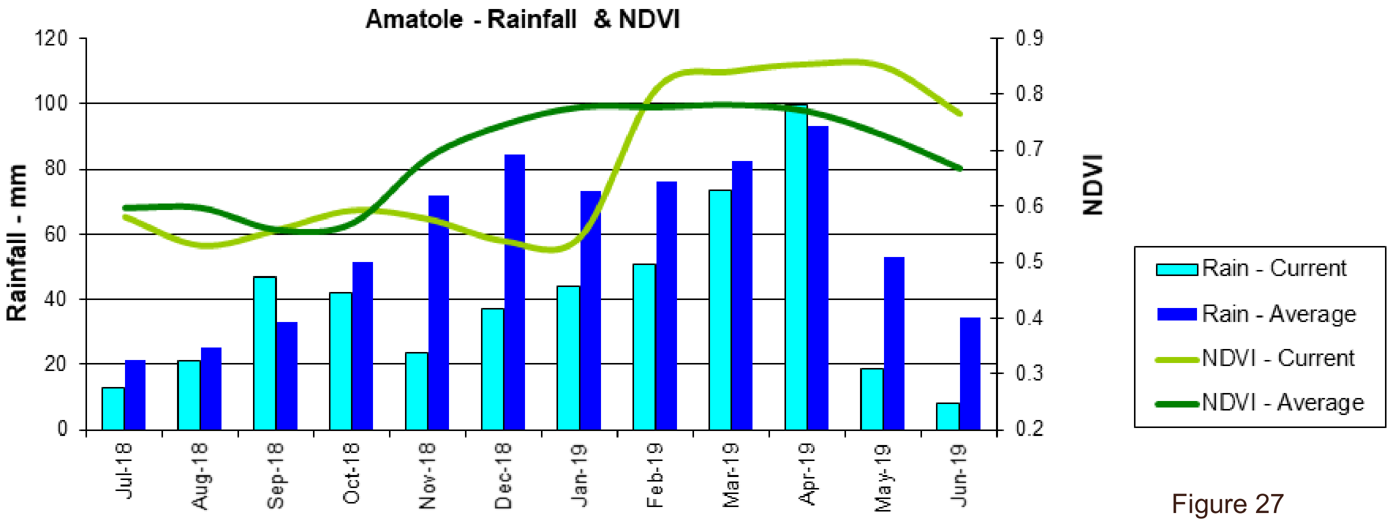


Figure 27

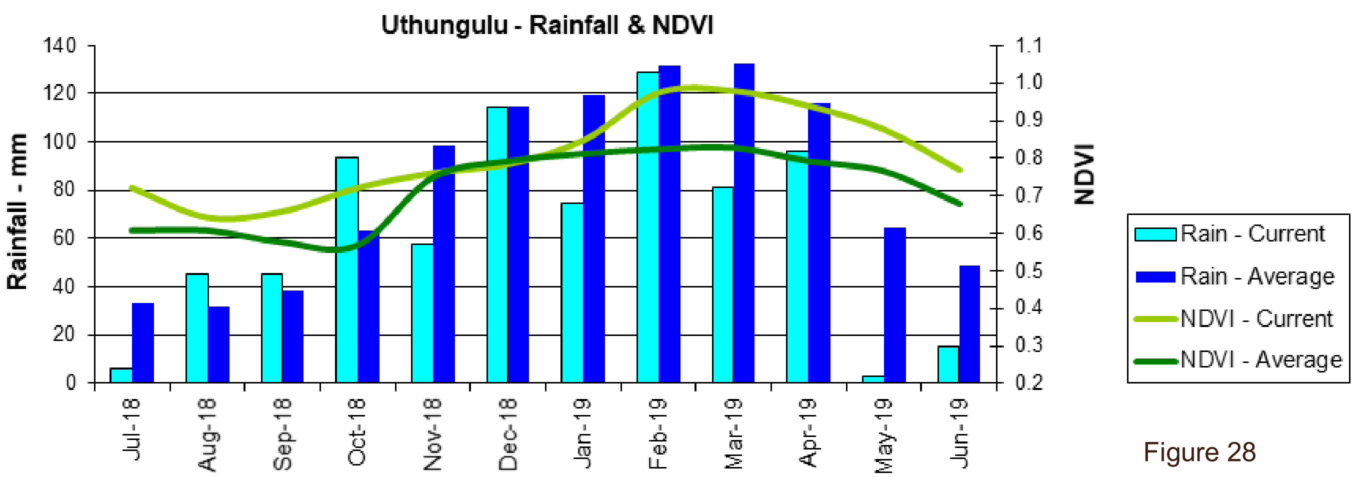


Figure 28

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 1-30 June 2019 per province. Fire activity was higher in KwaZulu-Natal, Mpumalanga, Northern Cape and Gauteng compared to the long-term average.

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

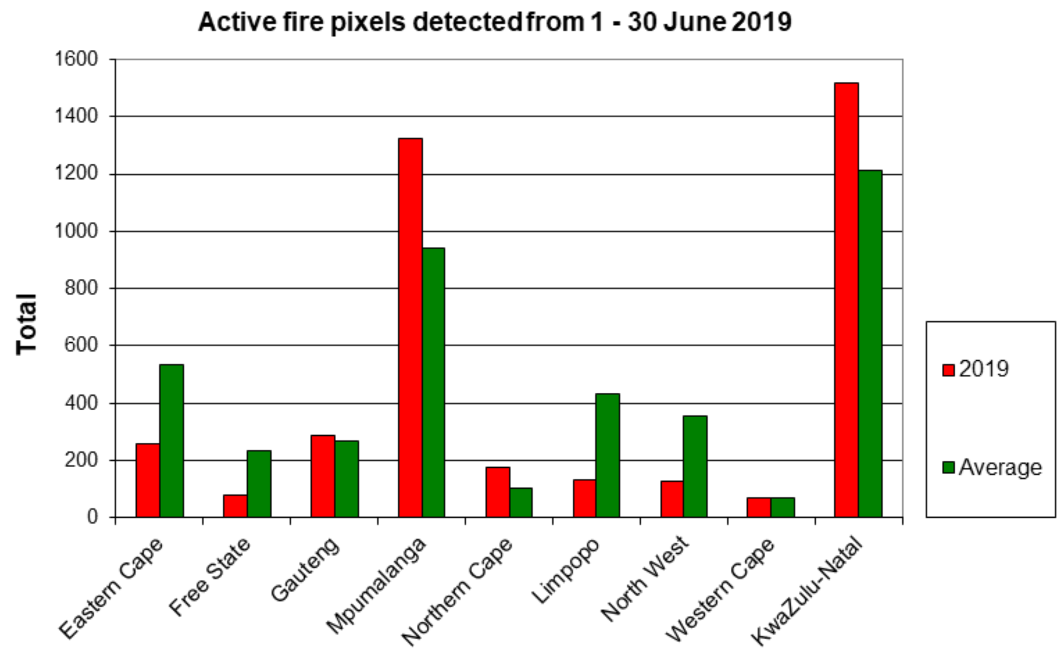


Figure 29

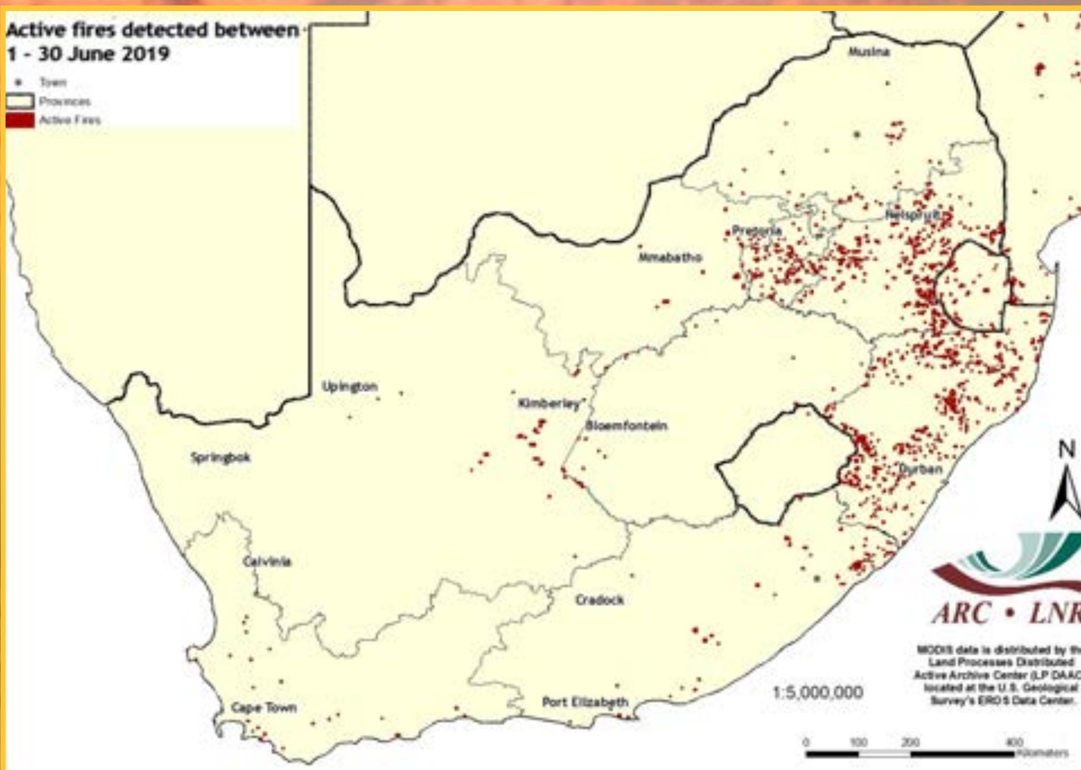


Figure 30

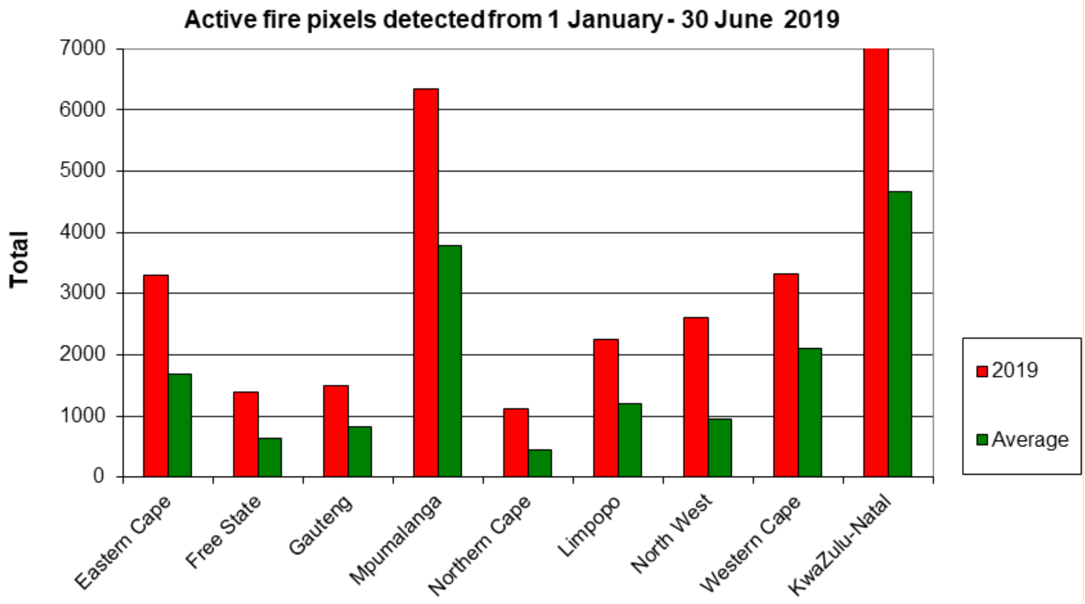


Figure 31

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

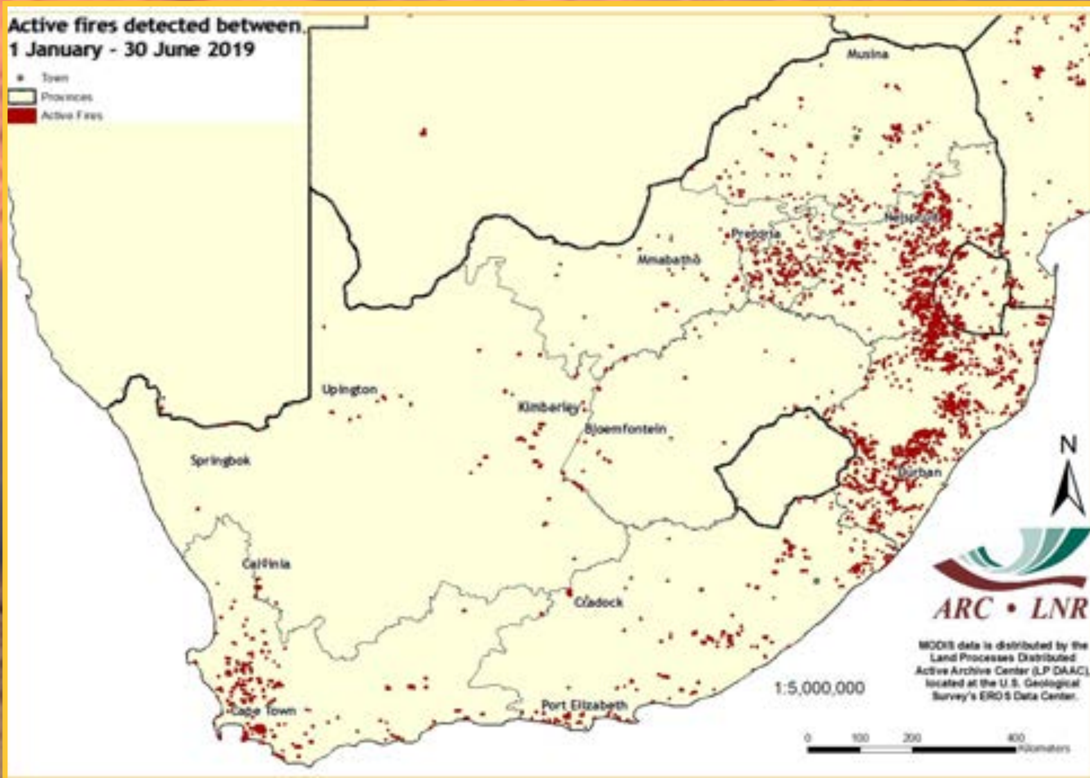


Figure 32

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

Questions/Comments:
MaakeR@arc.agric.za

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 SWAs to the maximum recorded in those same catchments since the end of 2015, with the exception of the severe water reductions in the Karoo and Kalahari and some areas in Limpopo Province.

Comparison between June 2019 and June 2018 shows that generally the entire country has either equal or more water extents than the same period in 2018, with the exception of the Karoo, Kalahari and a few small local catchments in the Eastern Cape, KwaZulu-Natal and Mpumalanga provinces, which are showing significantly lower water values.

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

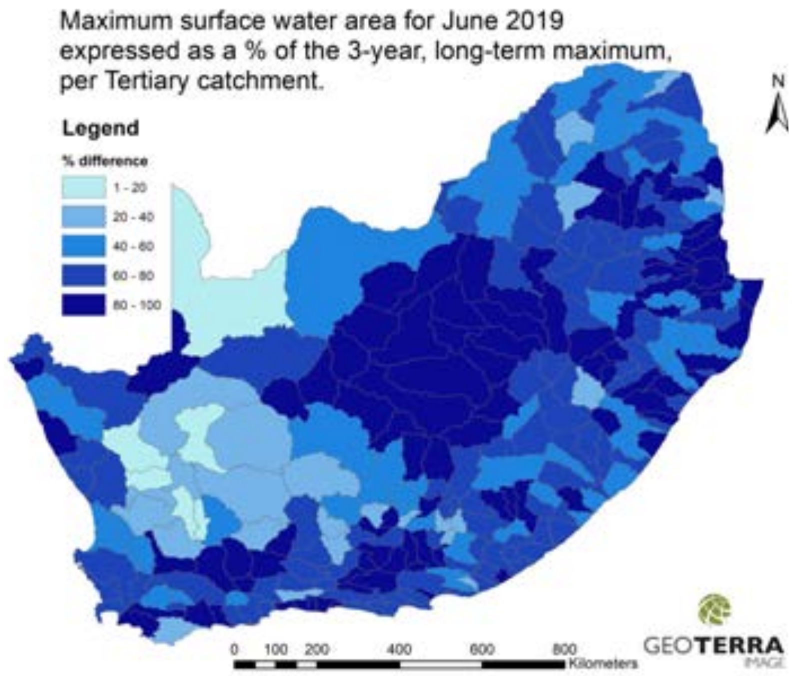


Figure 33

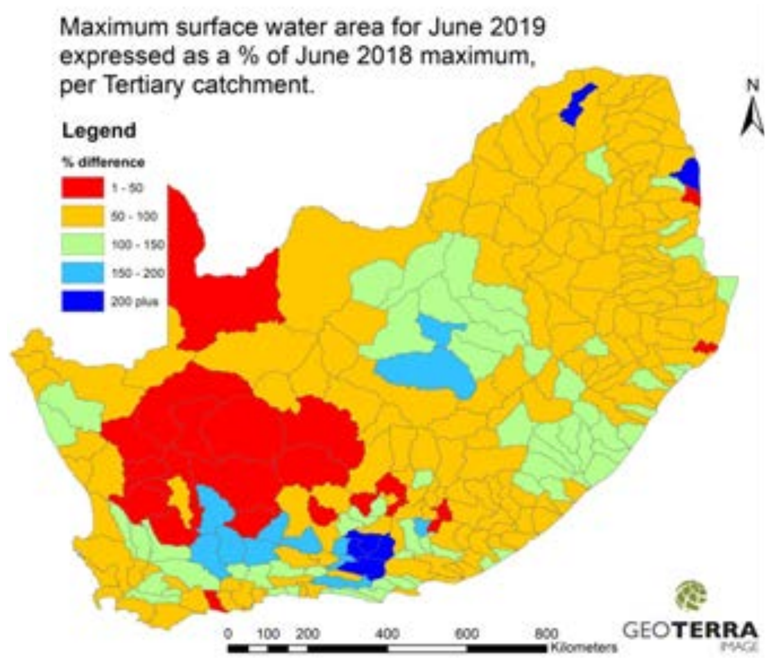
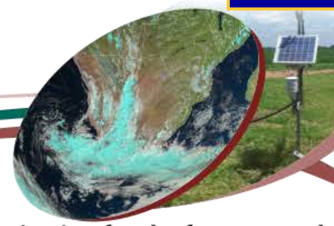


Figure 34

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".