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Excellence in Research and Development

UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

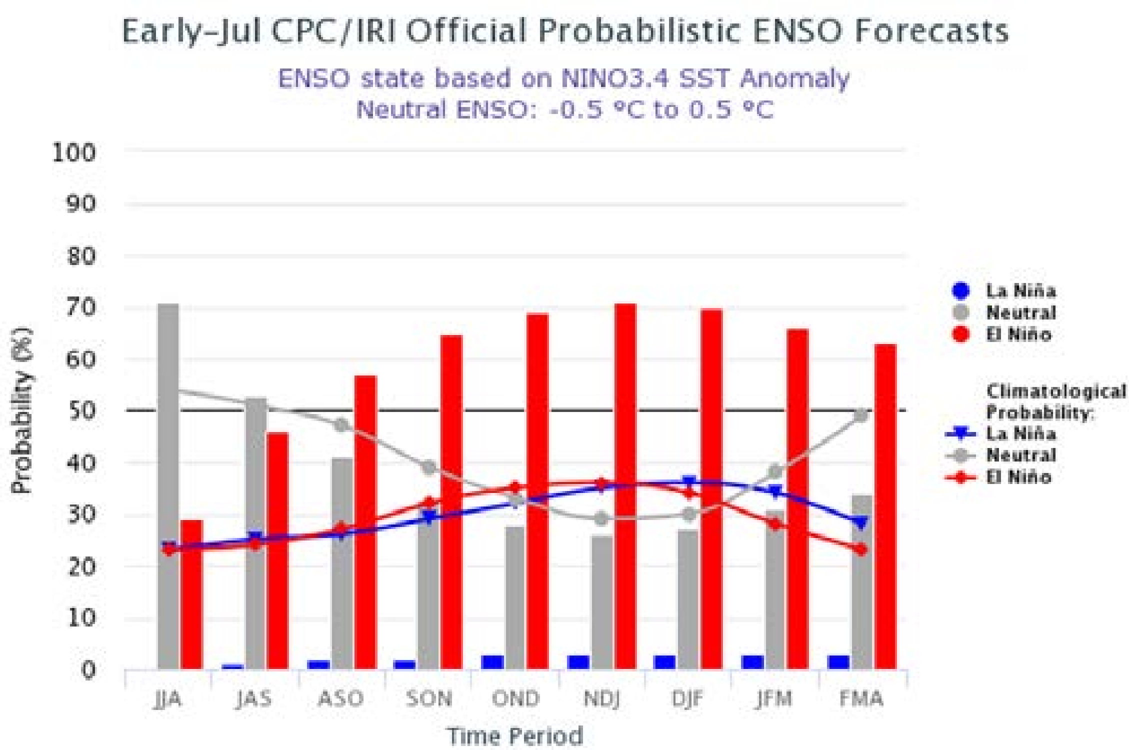
CONTENTS:

169th Edition

Image of the Month

El Niño event likely during the summer of 2018/19

Sea surface temperatures in the central Pacific Ocean are currently close to normal and in some locations only slightly above normal. However, most international seasonal forecasting centres, including the multi-model prediction systems of the International Research Institute for Climate and Society (IRI) in the USA and the European Centre for Medium-Range Weather Forecasts (ECMWF) are predicting the onset of an El Niño event during the spring of 2018. In fact, the probability is about 60% that a weak El Niño event will have manifested itself by then, with a 70% chance of it strengthening into a moderate event by the mid-summer of 2018/19 (as seen in the official probabilistic ENSO forecast below, issued by CPC/ IRI). Nationally, the South African Weather Service as well as the University of Pretoria issue ENSO forecasts, the latest of which both predict the likelihood of an El Niño to develop. Typically, when the central Pacific Ocean is above-normally warm (El Niño), southern Africa experiences below-normal rainfall or even drought. Consistently, most international modelling centres are predicting high probabilities of a dry period over southern Africa during the mid-summer of 2018/19.



(Source: https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/)

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:

The above-normal rainfall conditions that occurred during April and May over the western parts of the winter rainfall region continued during June 2018. A total of nine frontal systems moved in over the far southwestern parts of the country, causing good rainfall over this area. The dams important for supplying water to Cape Town and surrounds received good runoff and the overall dam levels improved considerably compared to this time last year. However, the area that received good rainfall over the past few months is actually limited to the far southwestern parts of the country, with other areas of the winter rainfall region and the all-year rainfall region still being in the grip of drought despite the regular passage of frontal systems. During June, positive pressure anomalies occurred over the country and resulted in the trajectory of the frontal systems to be of such a nature that rainfall was confined to the far southwestern parts of the country. Sufficient ridging following in the wake of the frontal systems was absent, resulting in very limited rainfall along the coast of the all-year rainfall region. Also, upper-air support was lacking, contributing to the confined rainfall distribution. Instead, the anomalous higher pressure over the interior of the country relative to that found to the south, in combination with the regular passage of frontal systems, caused winds with a northerly component over the far southern parts of the country and resulted in warm conditions. One such event occurred on the 14th ahead of the strongest frontal system that moved over the Cape and surrounding areas when maximum temperatures of up to 30˚C occurred in the Port Elizabeth area.

The anomalously higher pressure over the interior also influenced the circulation over the west coast region where easterly winds were associated with anomalously warm conditions. For example, on 6 June, maximum temperatures of up to 34˚C occurred along the west coast. The remainder of the country, with the exception of some areas east of the eastern escarpment, also experienced anomalously high maximum temperatures, although not as extreme as those over the far southern parts of the country or the west coast. Despite the anomalously warm maximum temperatures that occurred during June, about three of the frontal systems that made landfall caused a drop in temperatures over the interior, reaching the eastern interior. This was most evident in the minimum temperatures on mornings that followed the passage of the frontal air, and resulted in frost occurring over large parts of the interior of the country.

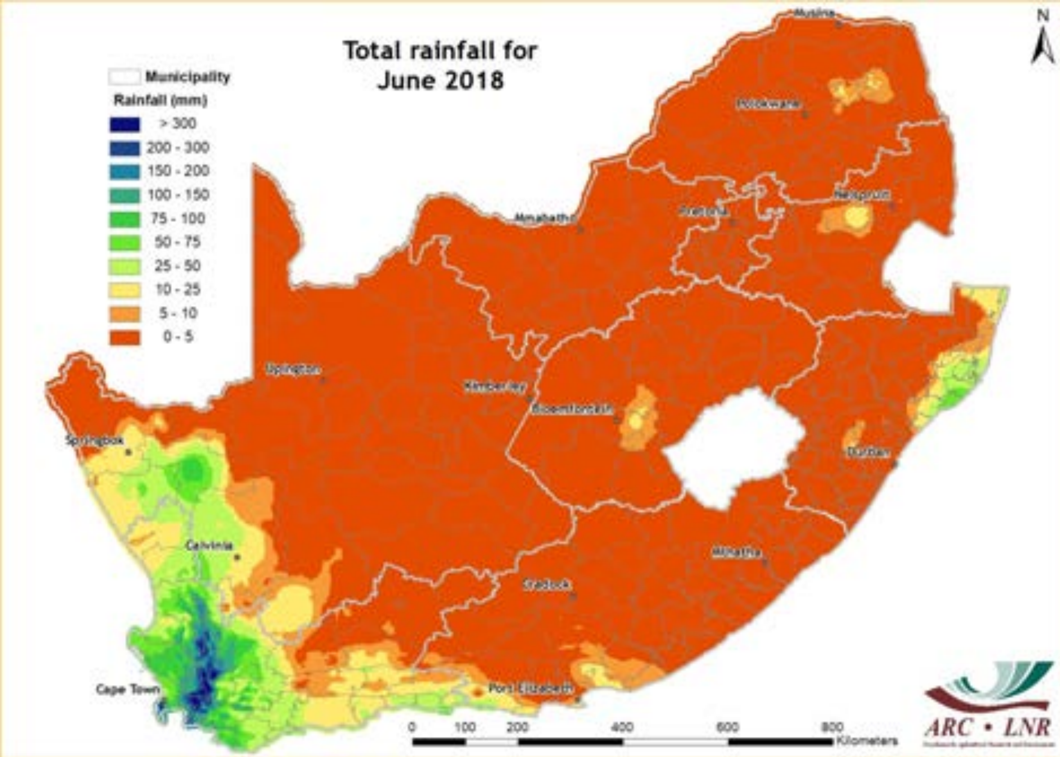


Figure 1

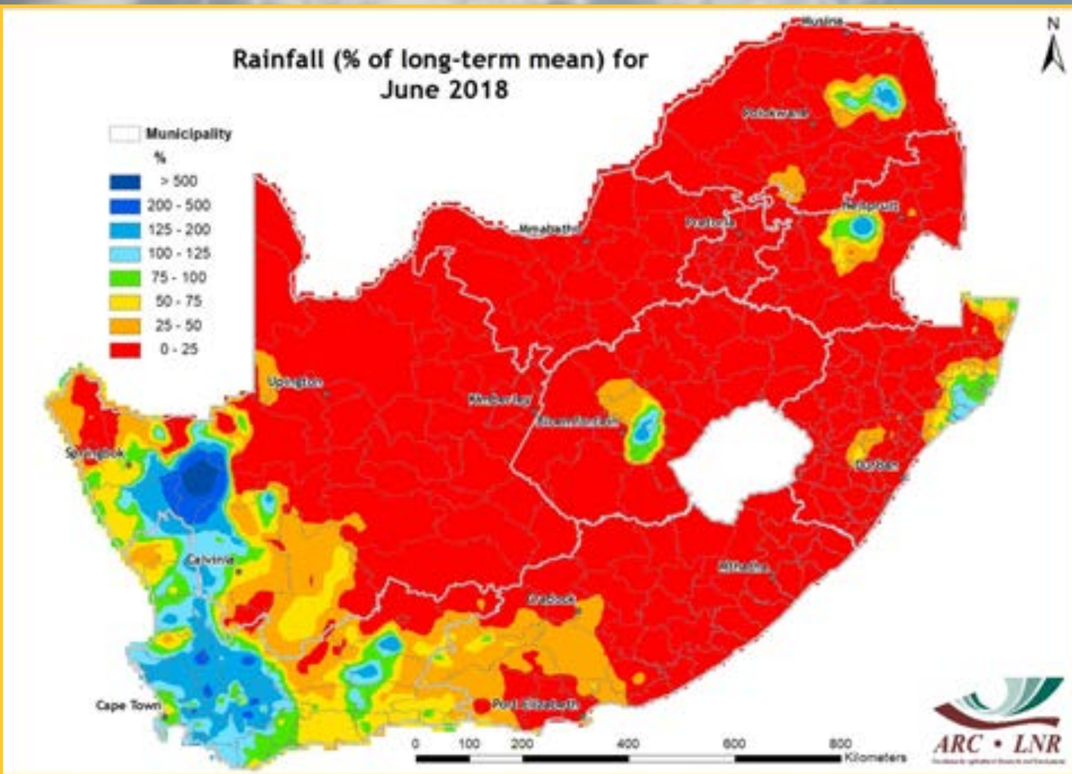


Figure 2

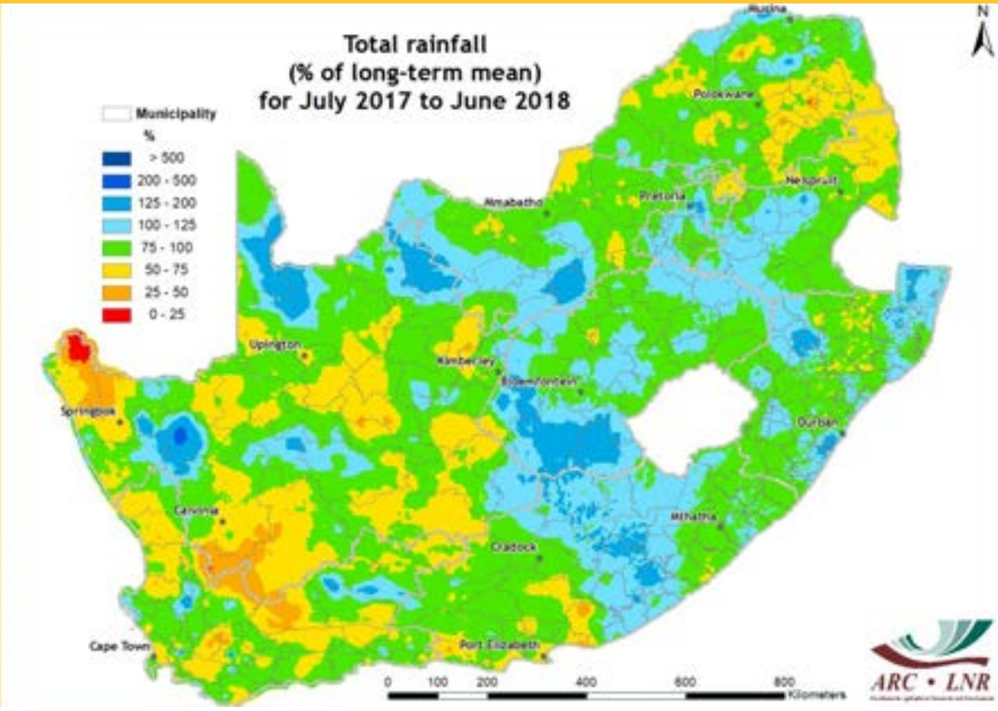


Figure 3

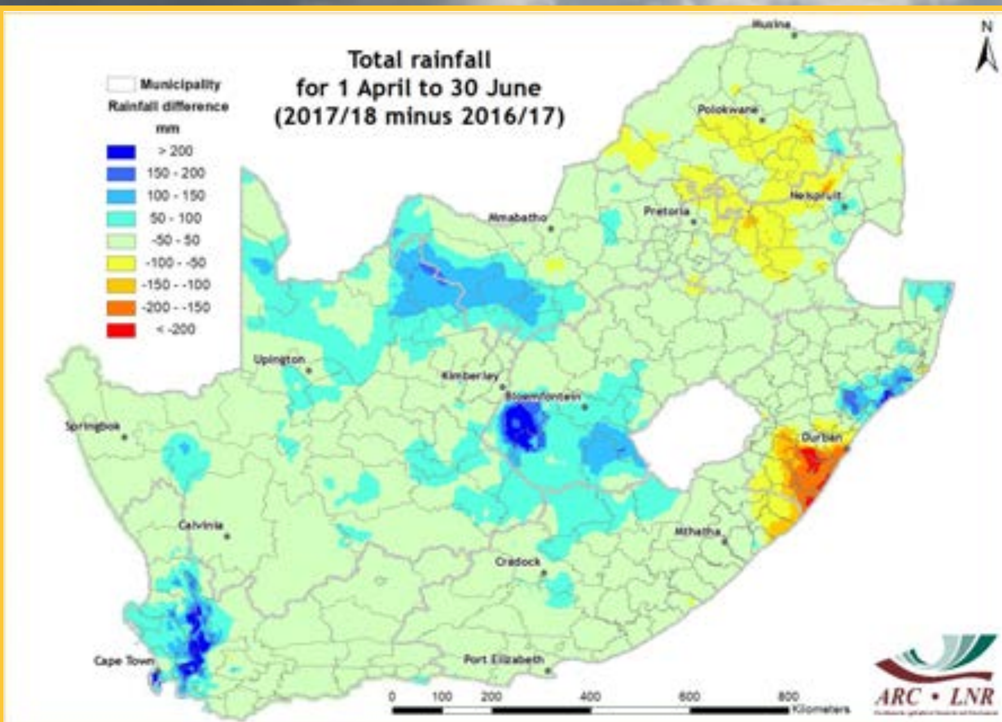


Figure 4

Figure 1:
Good rainfall totals, exceeding 200 mm in places, occurred in June over the far southwestern parts of the country as a result of cold fronts that made landfall. The good rains also extended further northwards over the far western areas where the accumulated rainfall exceeded 50 mm in places. However, rainfall totals along the Cape south coast were low. Good rainfall totals occurred in places east of the eastern escarpment.

Figure 2:
Over the winter rainfall region, above-normal rainfall occurred over large areas with a sudden transition to below-normal rainfall at about 20˚E. This rainfall pattern is indicative of a lack of ridging behind the frontal systems that made landfall. A few isolated areas over the summer rainfall region received above-normal rainfall – due to single rainfall events associated with the passage of an upper air trough and surface ridging over the eastern parts of the country.

Figure 3:
Over the 12 months from July 2017 to June 2018, near-normal rainfall occurred over large parts of the summer rainfall region, with above-normal rainfall in a relatively narrow band over the central to southeastern parts of the country as well as over isolated areas over the western interior. Over the all-year rainfall region, below- to near-normal rainfall occurred during this period, of which the last few months have been extremely dry. Below- to near-normal rainfall also occurred over the winter rainfall region. The influence of improved rainfall experienced over the past 3 months is visible over some parts of the winter rainfall region.

Figure 4:
Compared to the corresponding 3-month period in 2017, improved rainfall conditions occurred during 2018 over the far southwestern and central parts of the country. The relatively small area over the far southwest which received more rain in 2018 than the corresponding period last year, is indicative of the confined nature of the better rainfall conditions that were experienced over the past 3 months.

Questions/Comments:
EngelbrechtC@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.

At the 36-month time scale, drought conditions occurred over many parts of the country, but in particular over the winter rainfall region, Port Elizabeth area, and the eastern parts of the country where severe to extreme drought conditions occurred. Relief from the severe drought occurred over areas of the central to southeastern parts of the country on the 24-month time scale. At the same time, the severe drought conditions over the southwestern parts extended eastwards along the Cape south coast region. On the 12-month time scale, drought conditions deteriorated slightly over the northeastern parts of the country compared to the 24-month time scale. The 6-month SPI indicates mildly to moderately wet conditions over the central to southeastern parts. An improvement from the drought conditions over the far western parts is also visible on the 6-month time scale, but drought conditions along the southern Cape coast experienced no improvement.

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

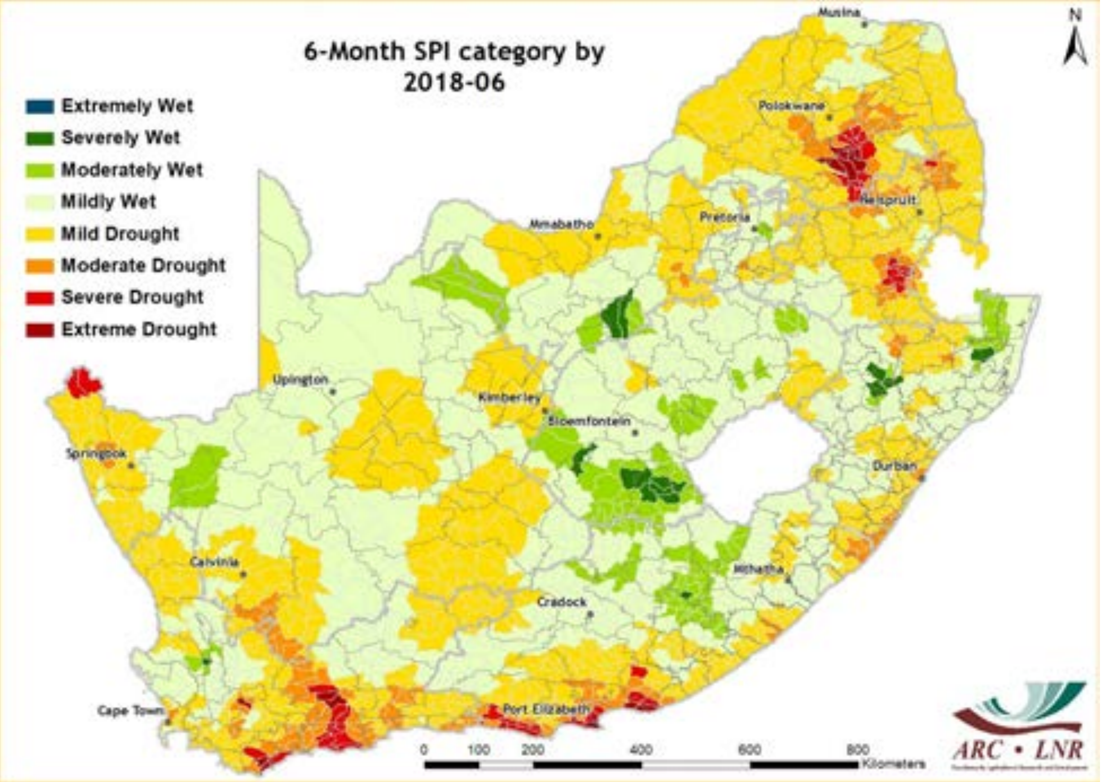


Figure 5

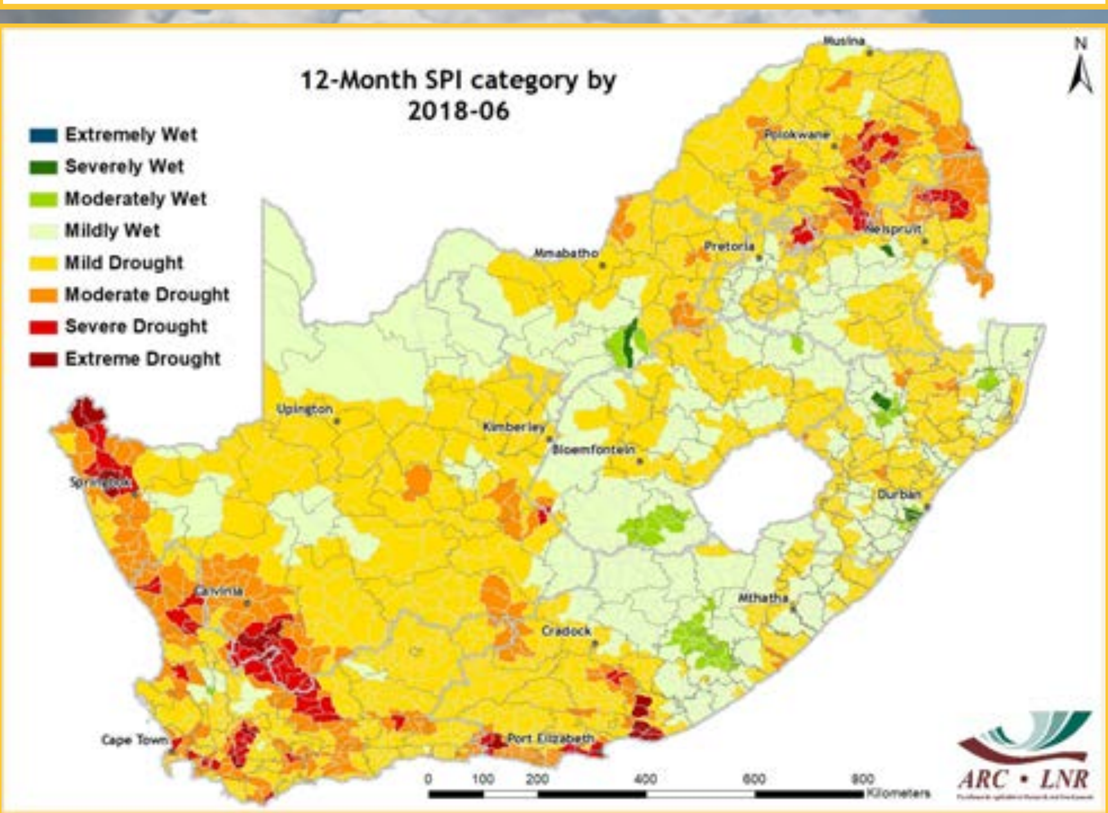


Figure 6

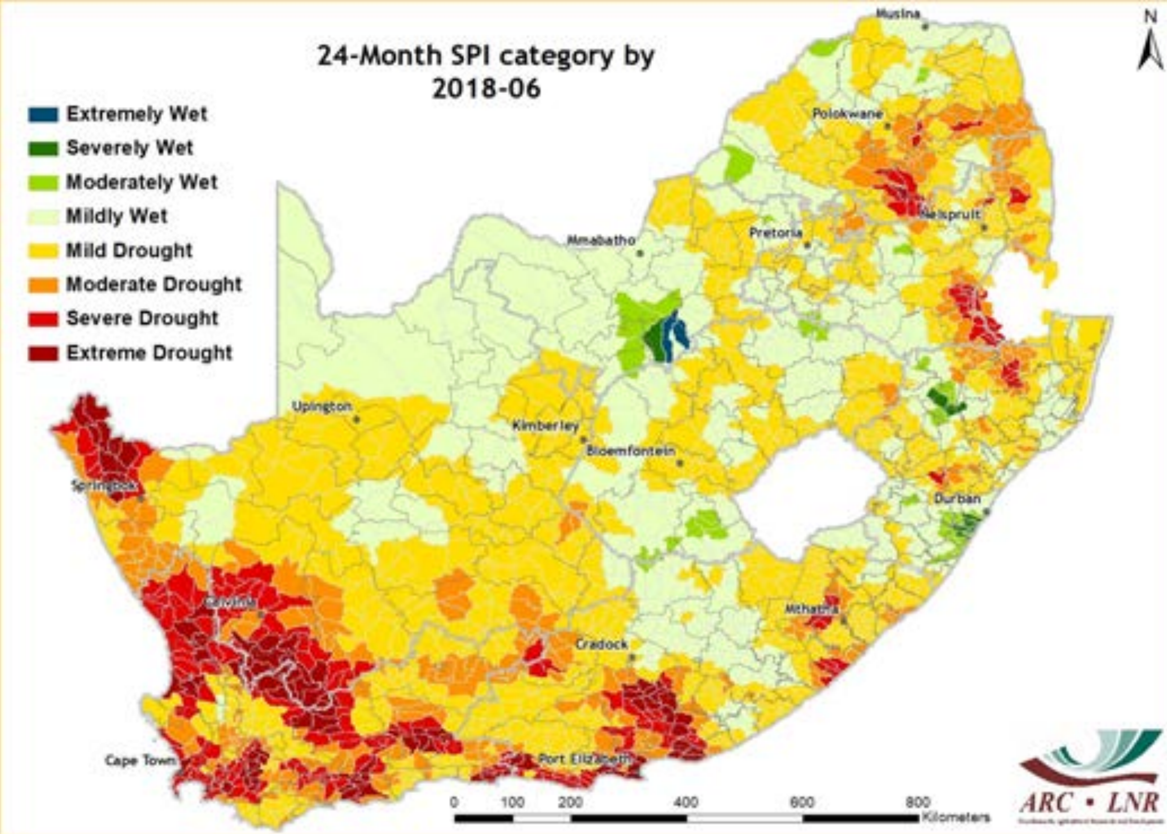


Figure 7

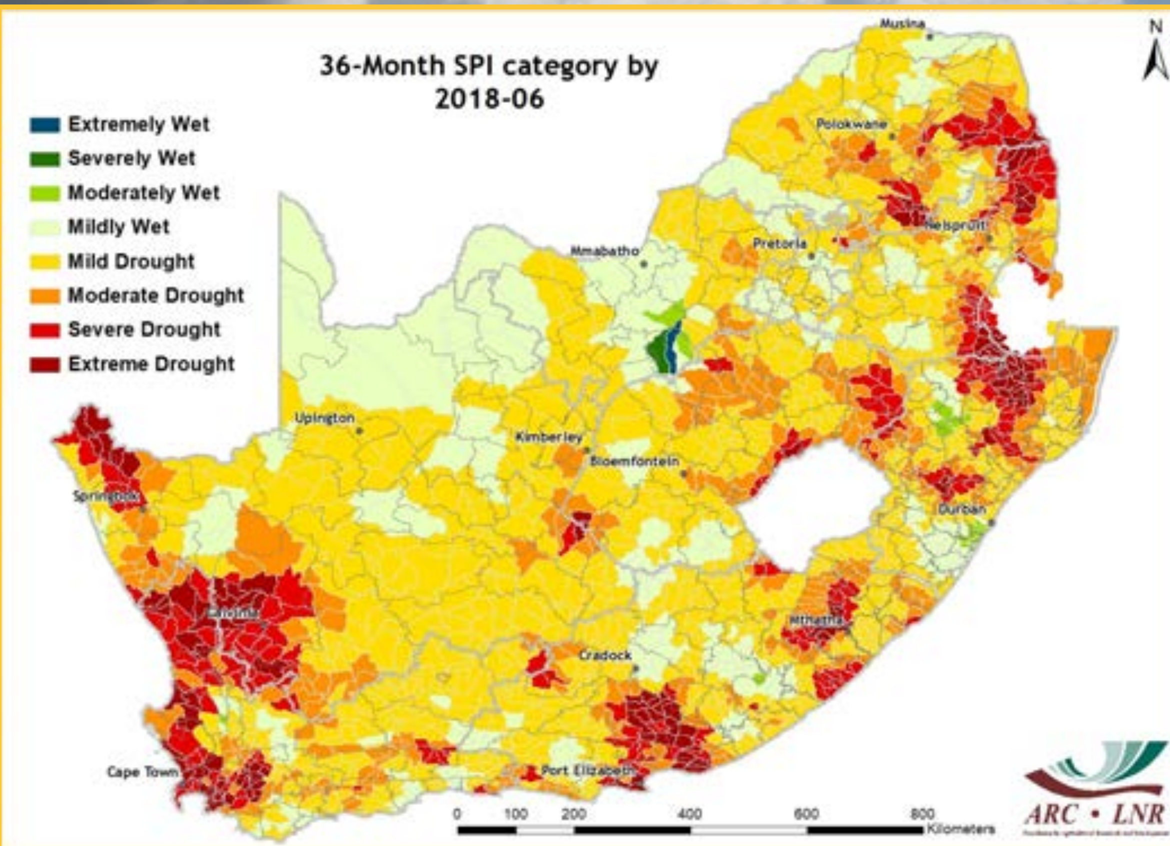


Figure 8

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.

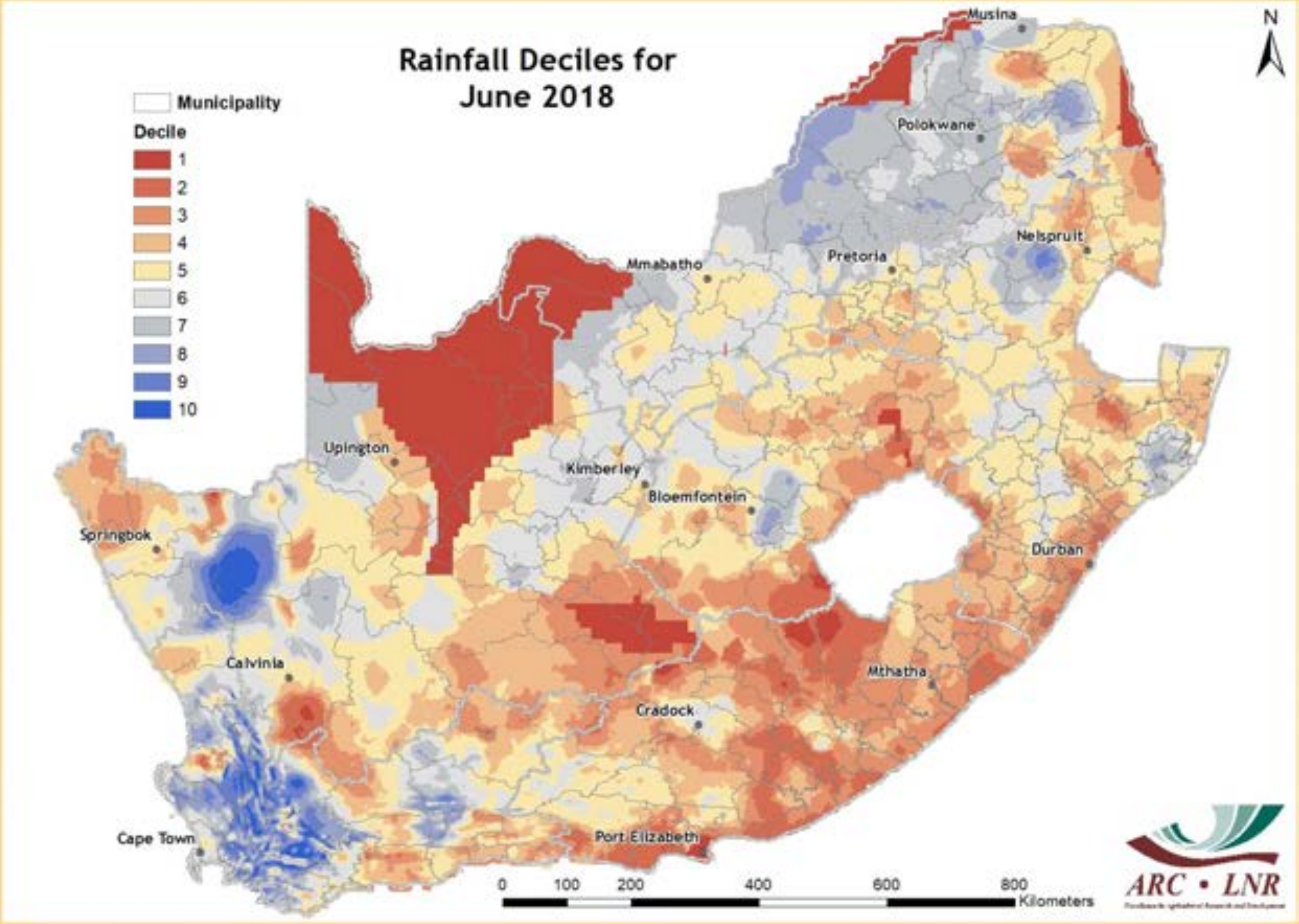


Figure 9

Figure 9:
Rainfall totals during June 2018 over the far southwestern parts of the country fall within the wet June rainfall totals compared to historical June rainfall totals. The all-year rainfall region experienced a very dry month compared to previous rainfall totals during the month of June. This pattern extended further northwards up along the eastern coastal belt and over the southeastern interior.

Questions/Comments:
EngelbrechtC@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.

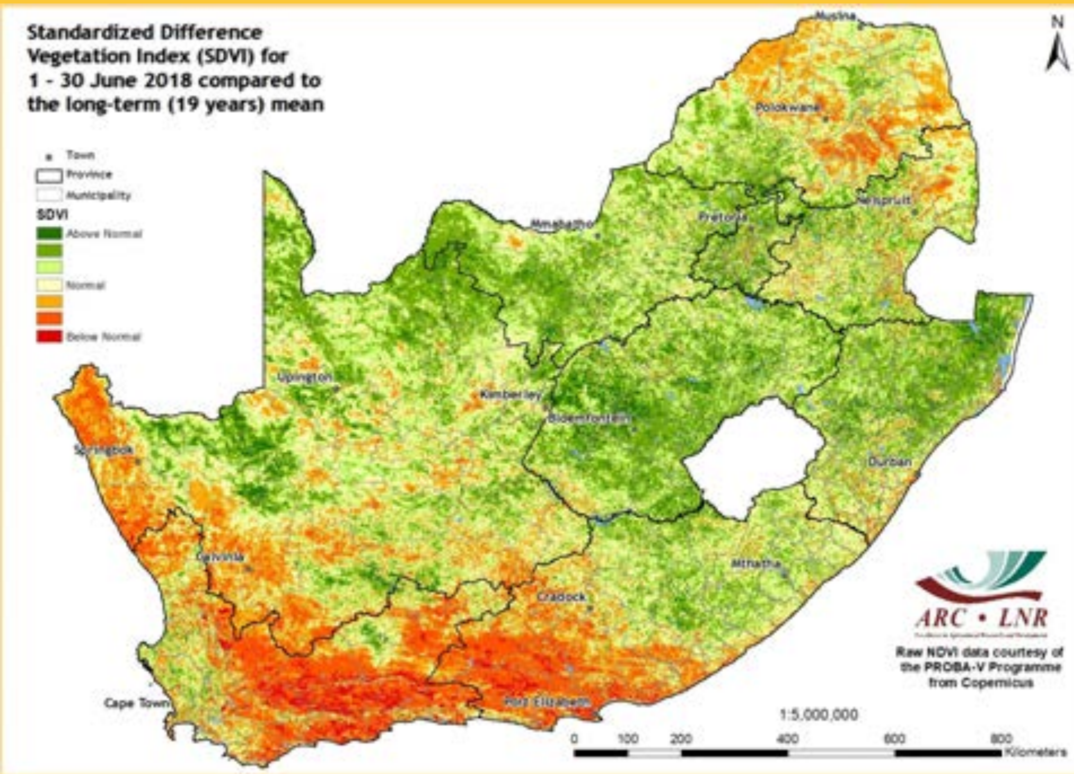


Figure 10

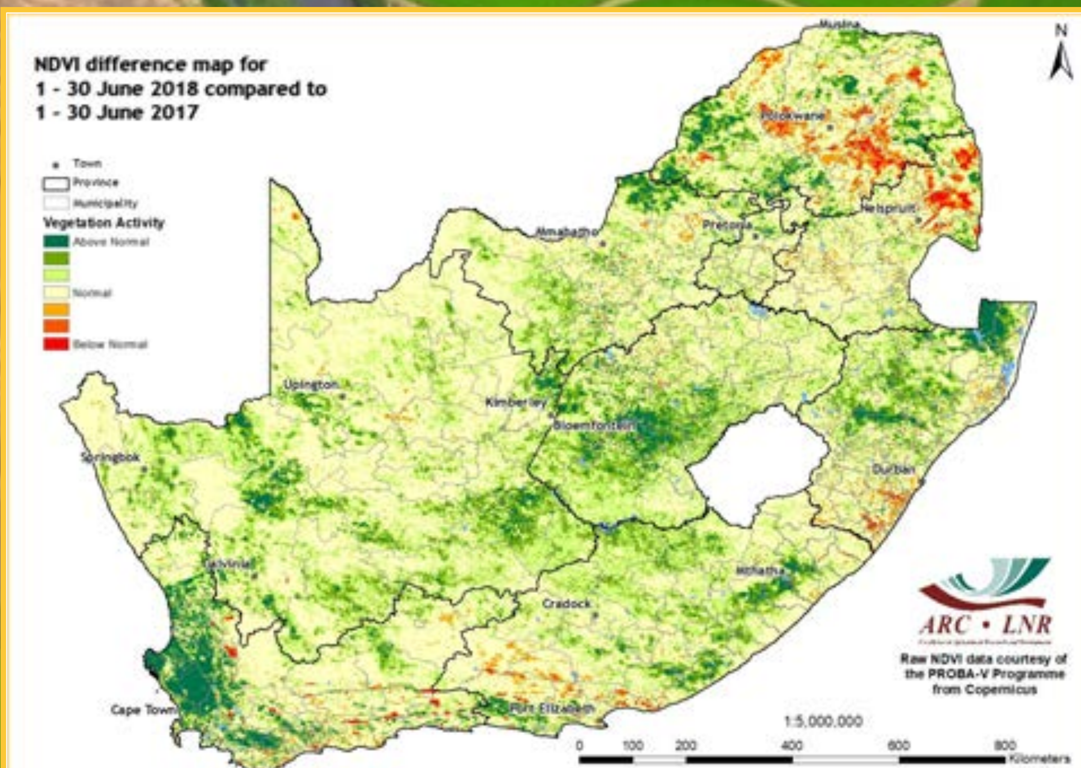


Figure 11

Figure 10:
Above-normal vegetation activity remains prevalent in the country's interior, while in the Western Cape, south-western Eastern Cape and some distinct areas in Limpopo, Northern Cape and Mpumalanga, vegetation remains below-normal compared to the long-term mean.

Figure 11:
Above-normal to normal vegetation activity occurred over majority of the country in June 2018 compared to the same month last year. Meanwhile, pockets of below-normal vegetation activity remain in some distinct parts of Limpopo, Mpumalanga, and the Western and Eastern Cape compared to June 2017.

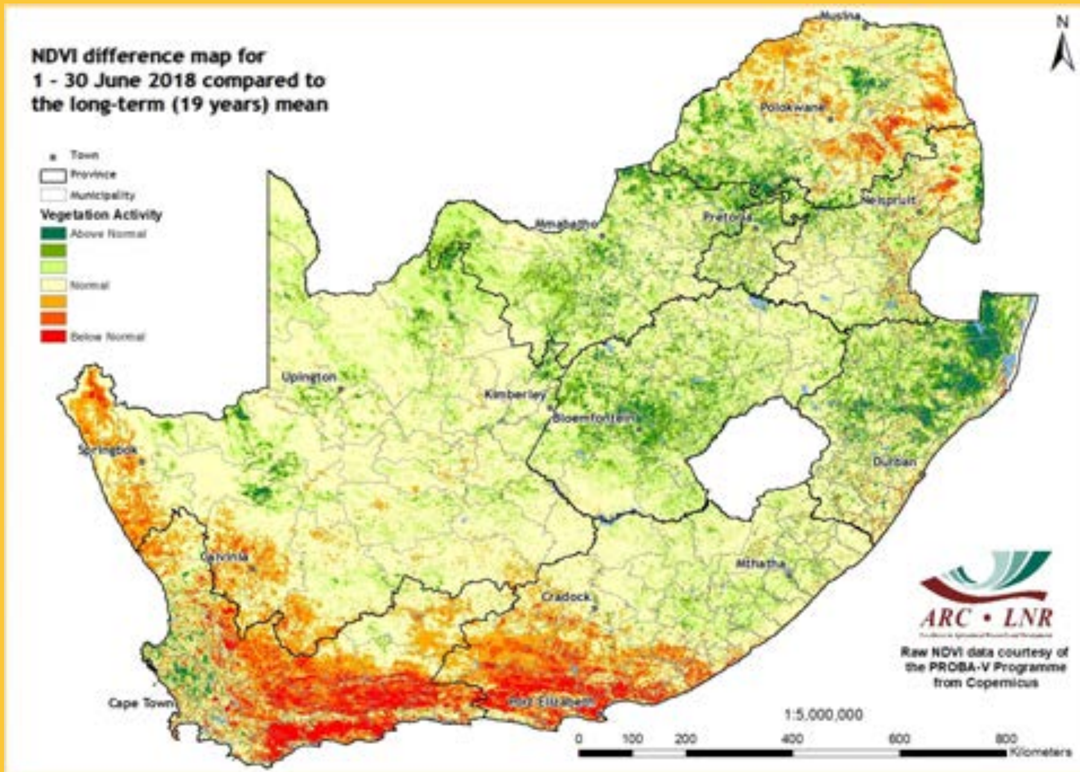


Figure 12

Vegetation Mapping
(continued from p. 7)

Interpretation of map legend

NDVI 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

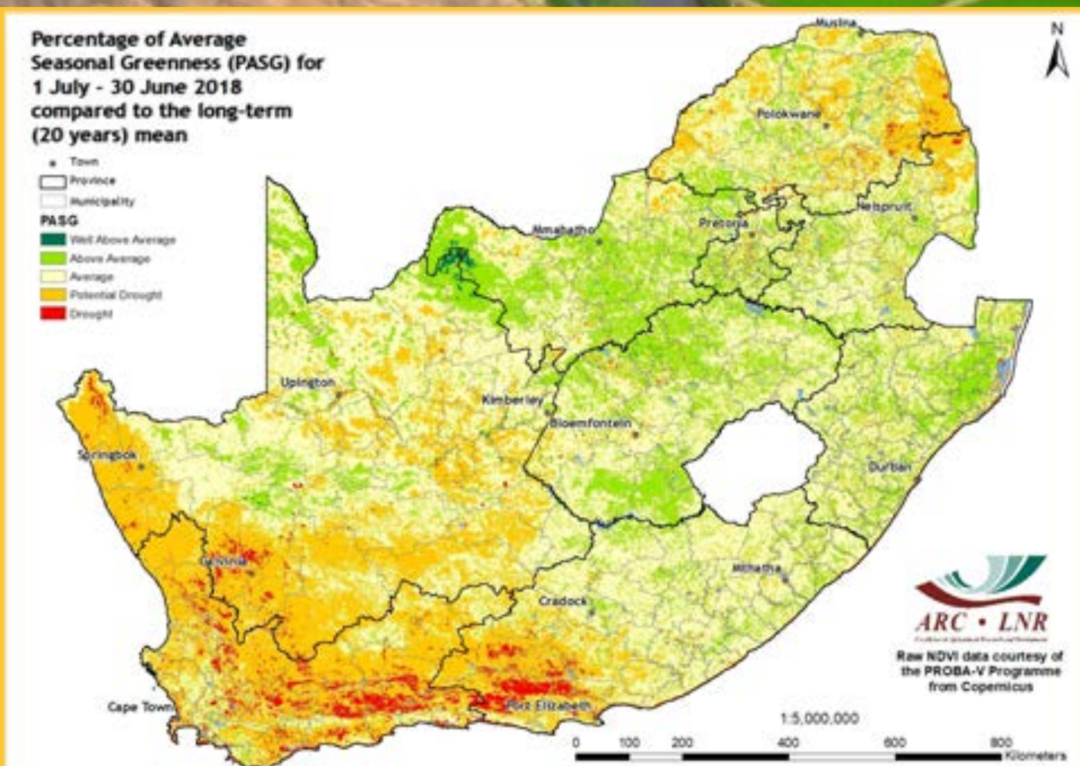


Figure 13

Figure 12:
The NDVI difference map for June shows that above-normal vegetation occurred over much of the country's interior and while the coastal regions and some isolated areas in Limpopo and Mpumalanga had below-normal vegetation activity compared to the long-term mean.

Figure 13:
Cumulative vegetation activity remains stressed over much of the southwestern parts of the country. Meanwhile, pockets of above-average cumulative vegetation activity remain in isolated areas of the interior.

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.

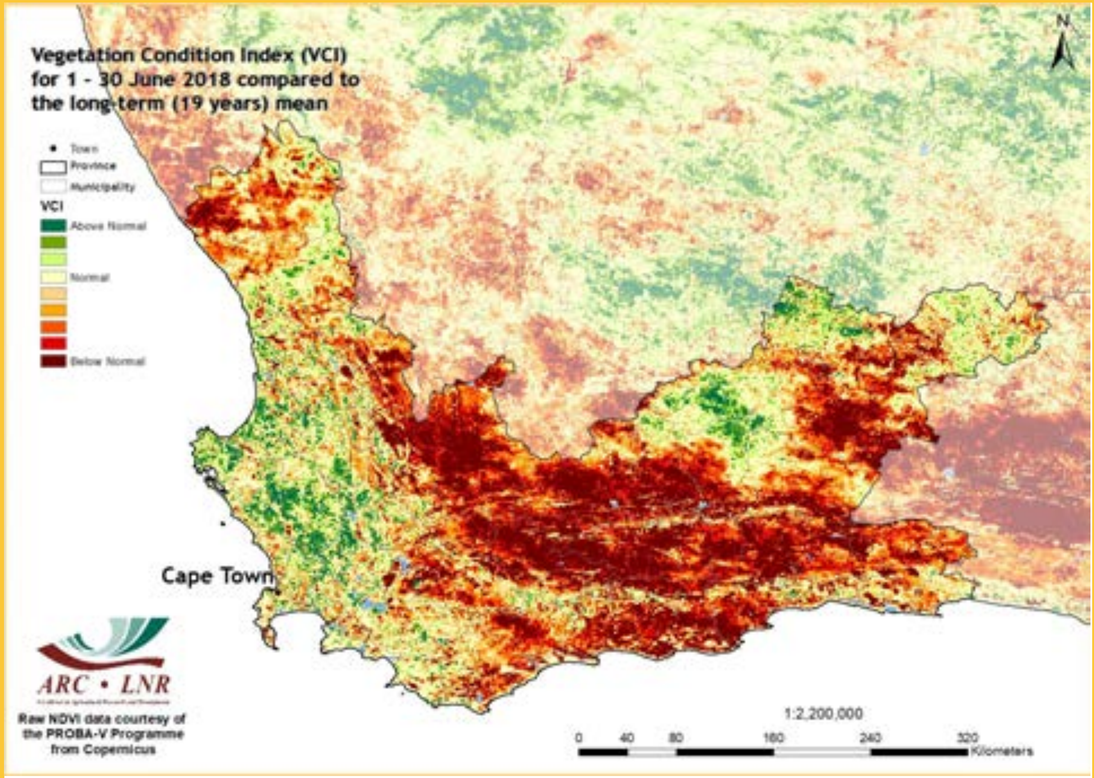


Figure 14

Figure 14:
Drought conditions which continue to reduce vegetation activity to below normal remain persistent in the Western Cape, particularly over much of Eden and the lower parts of the Central Karoo district. Nevertheless, vegetation activity is in a good state in isolated areas of the west coast, as well as the northern and far northeastern parts of the Beaufort West municipality.

Figure 15:
The western region of the Eastern Cape continues to experience below-normal vegetation. Meanwhile, vegetation activity remains above normal in the Amatola and Stormberg areas as well as the Wild Coast and Berg regions of the province.

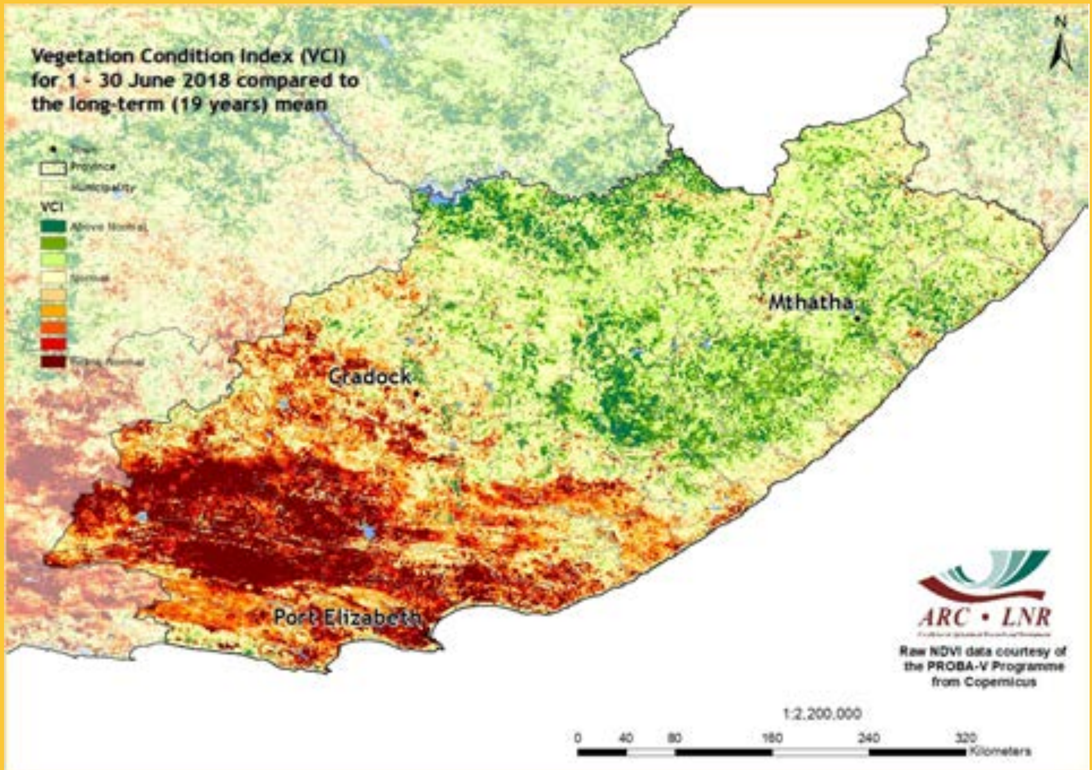


Figure 15

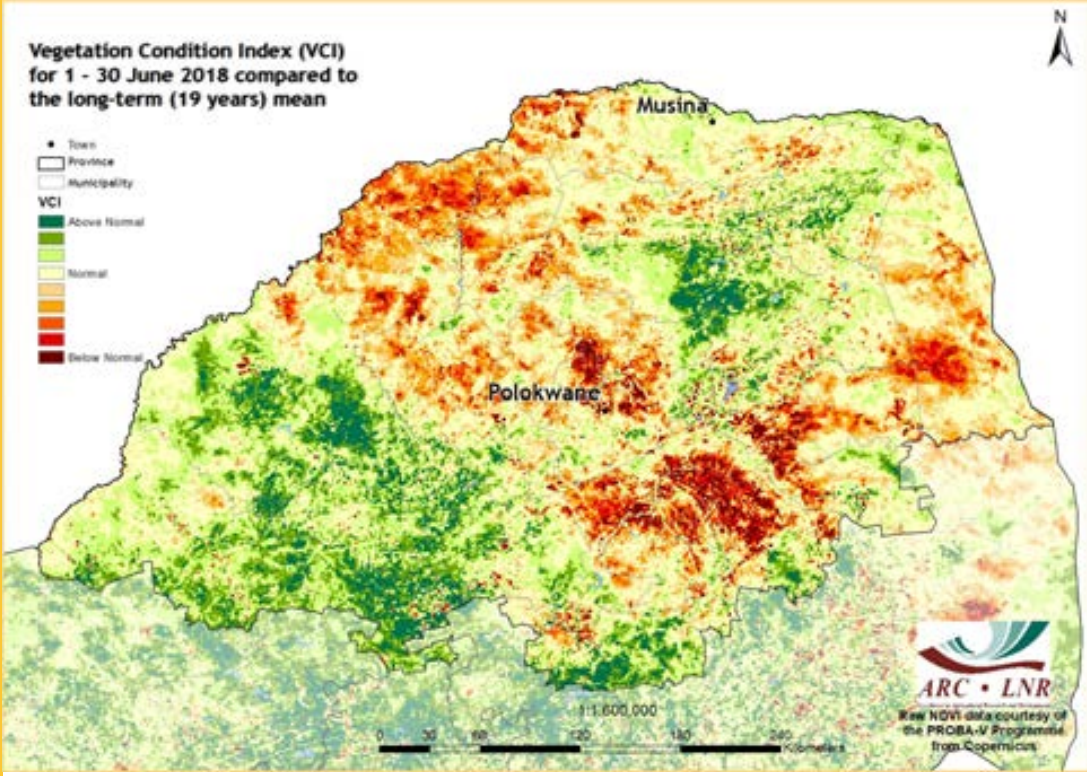


Figure 16

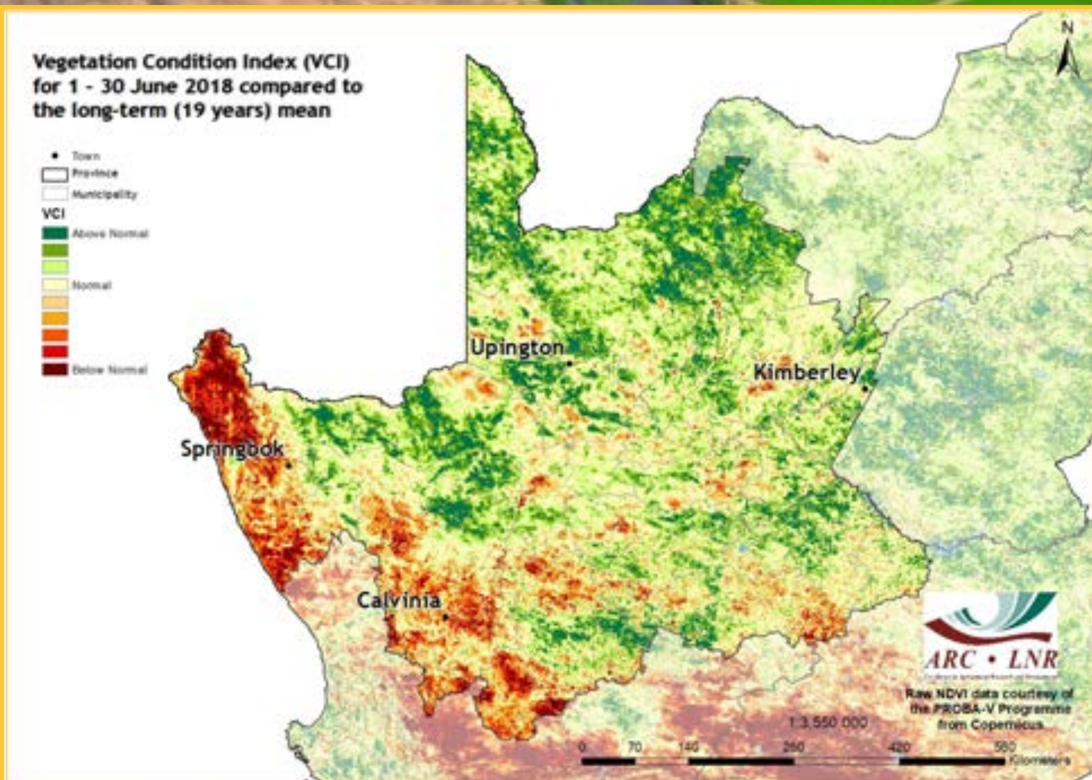


Figure 17

Figure 16:
The northwestern and far southeastern parts of Limpopo continue to experienced below -normal vegetation conditions. Meanwhile, improved vegetation conditions remain in the southwestern and northeastern portions of the province.

Figure 17:
Vegetation conditions remain good over much of the Green Kalahari, Kalahari and the Diamond region of the Northern Cape while below-normal vegetation conditions persist in the Namaqua region.

Questions/Comments:
MaakeR@arc.agric.za

6. Vegetation Conditions & Rainfall

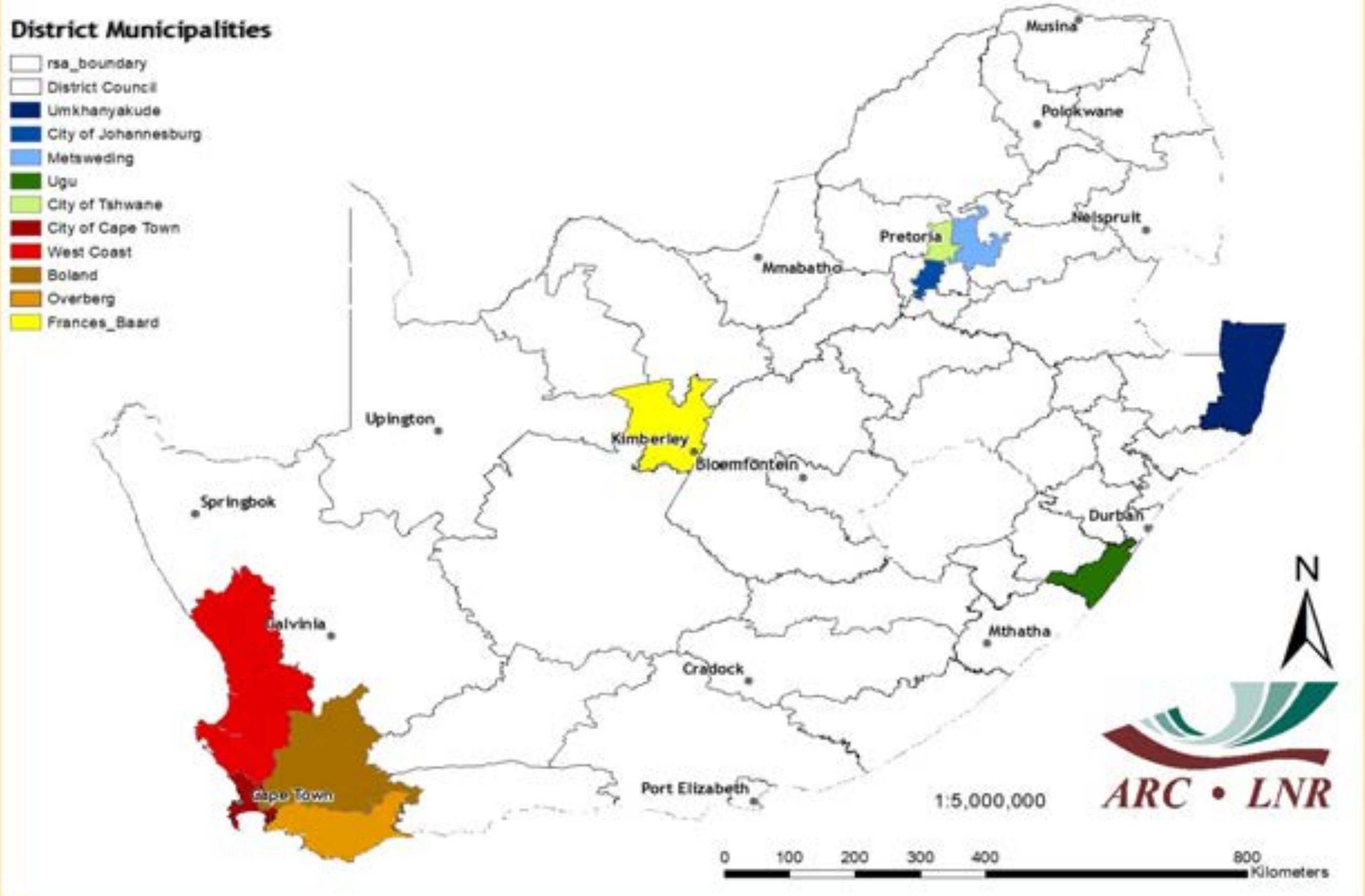


Figure 18

NDVI and Rainfall Graphs
Figure 18:
Orientation map showing the areas of interest for June 2018. The district colour matches the border of the corresponding graph.

Questions/Comments:
MaakeR@arc.agric.za / FergusonJ@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.

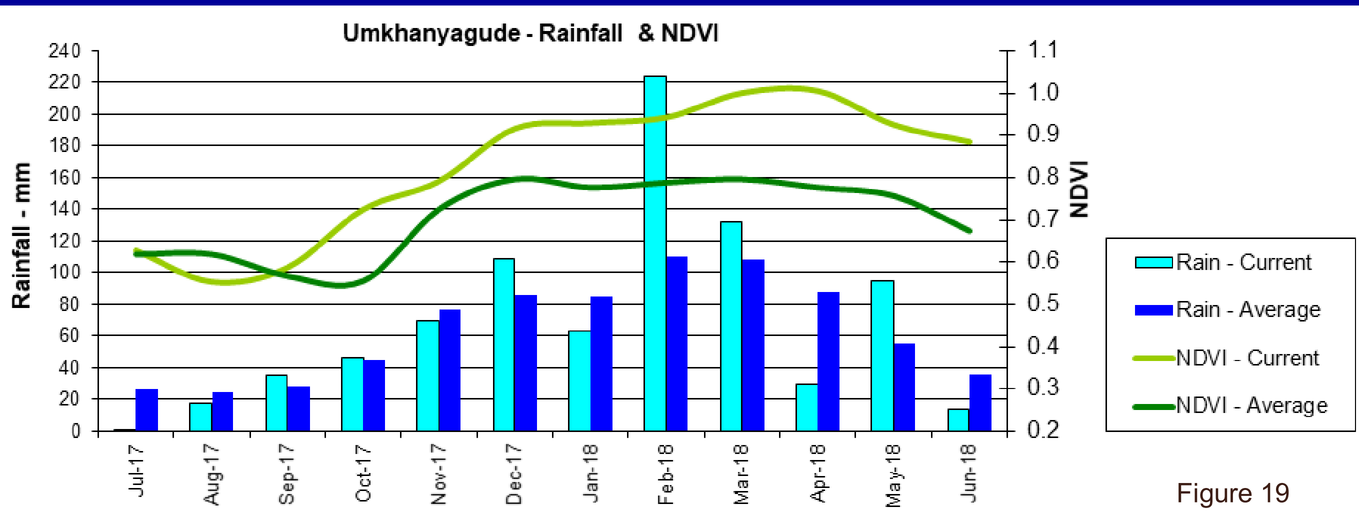
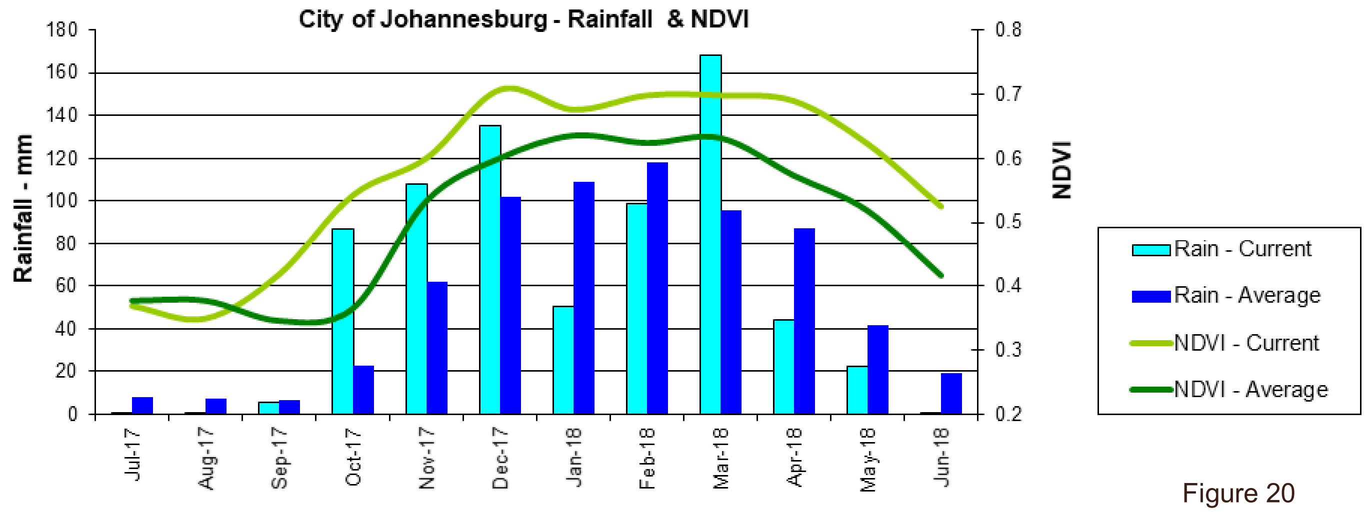


Figure 19



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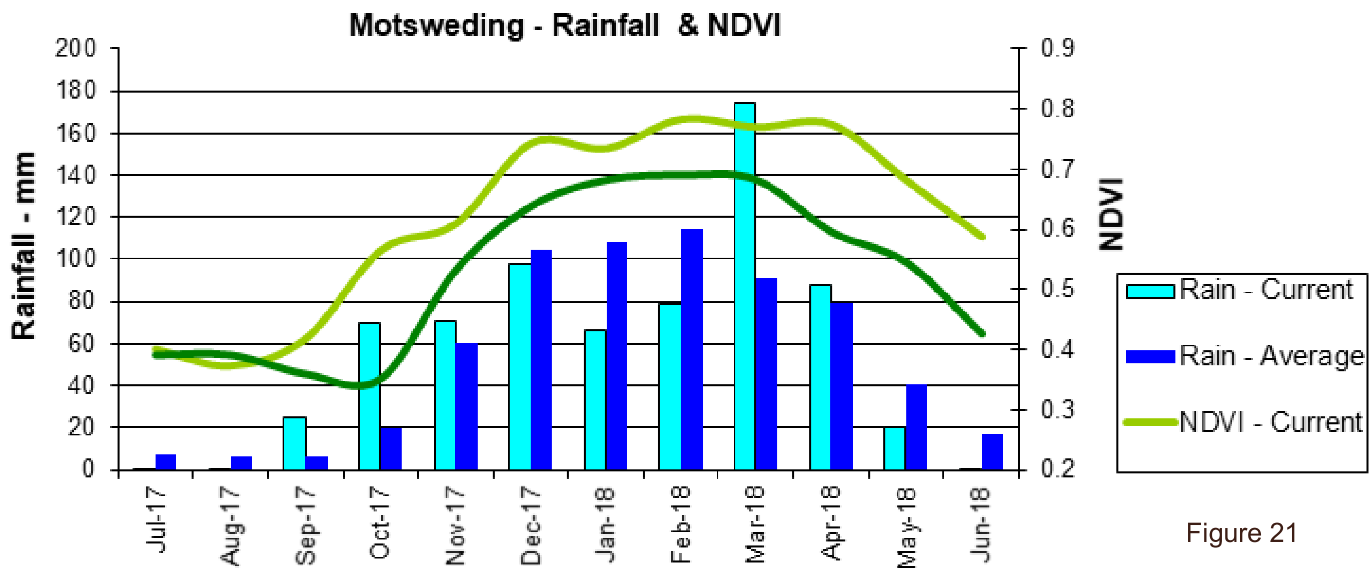

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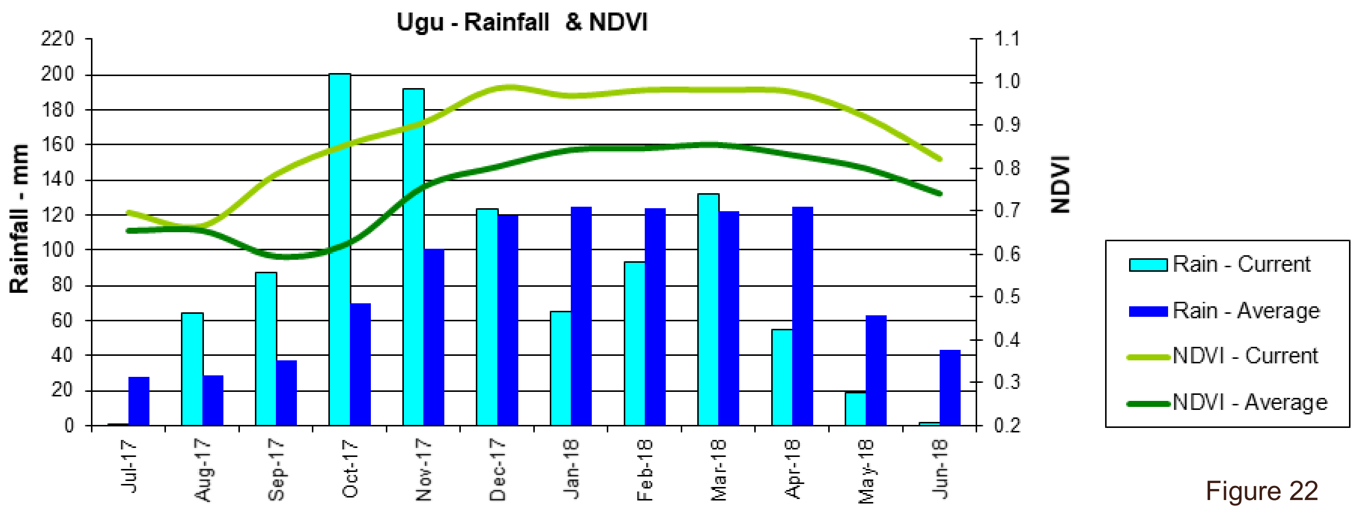

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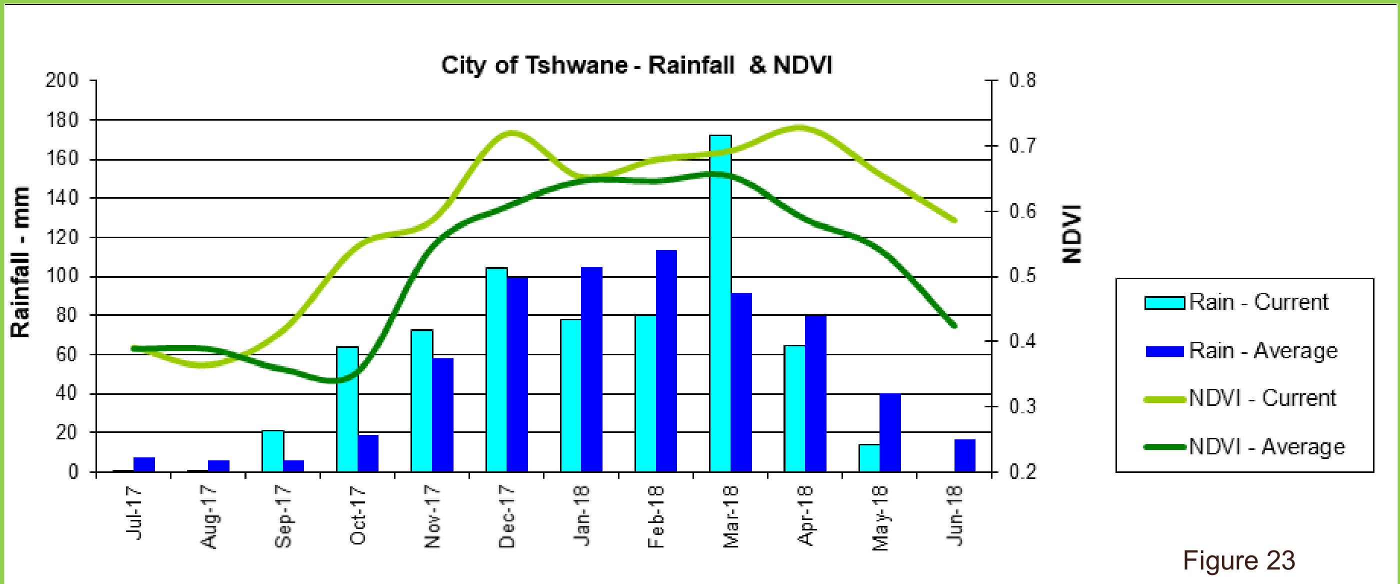

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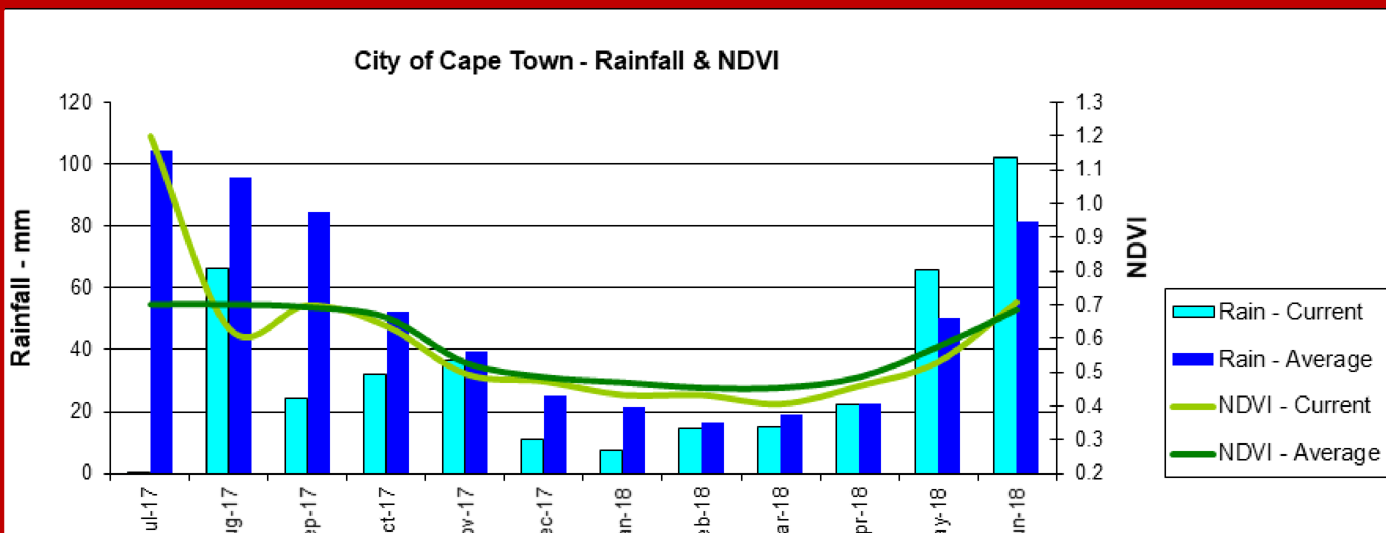

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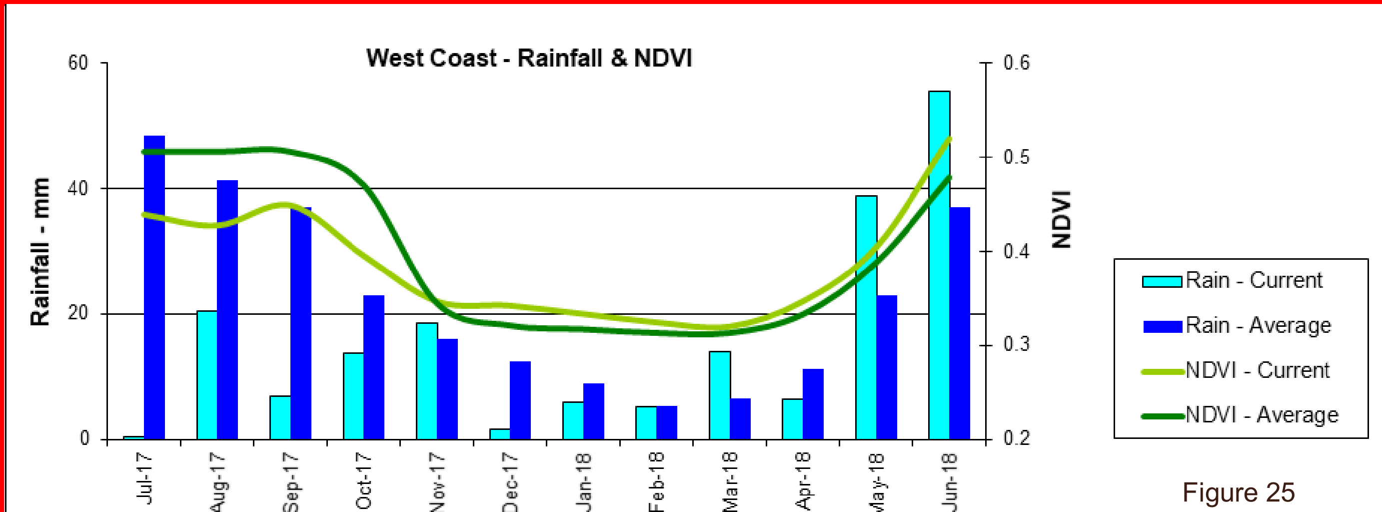

Figure 25

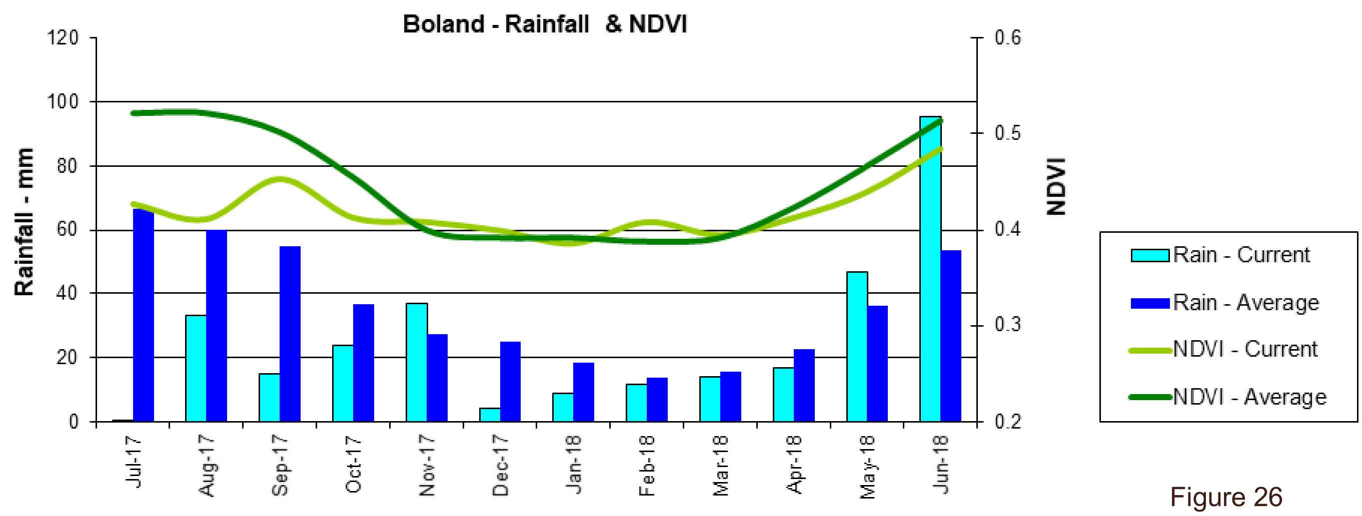

Figure 26

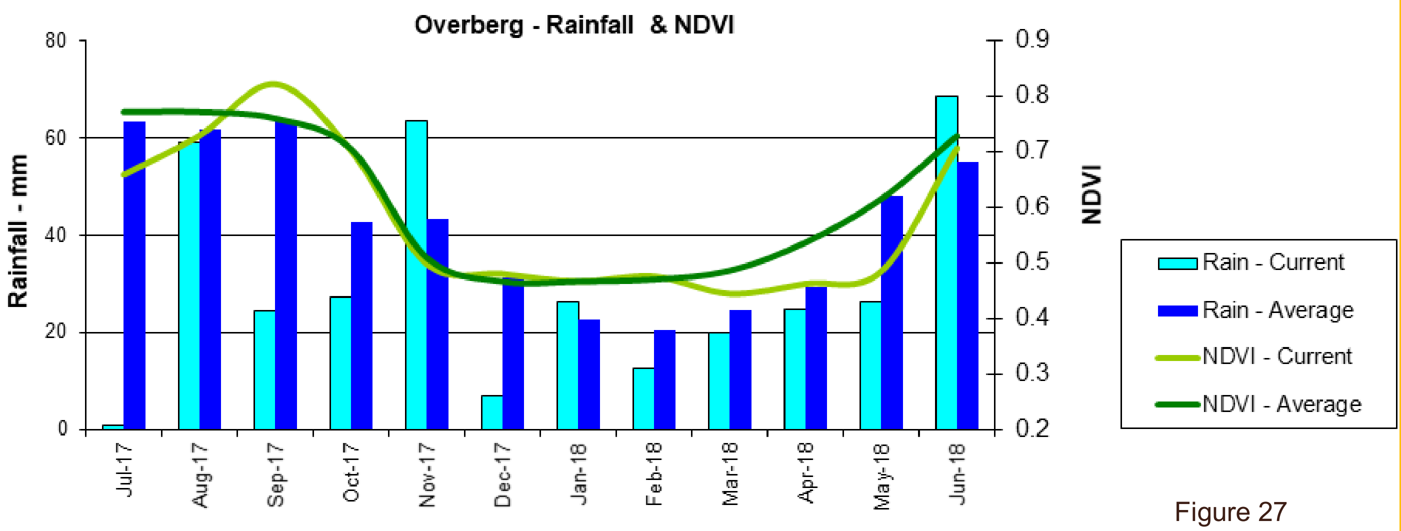

Figure 27

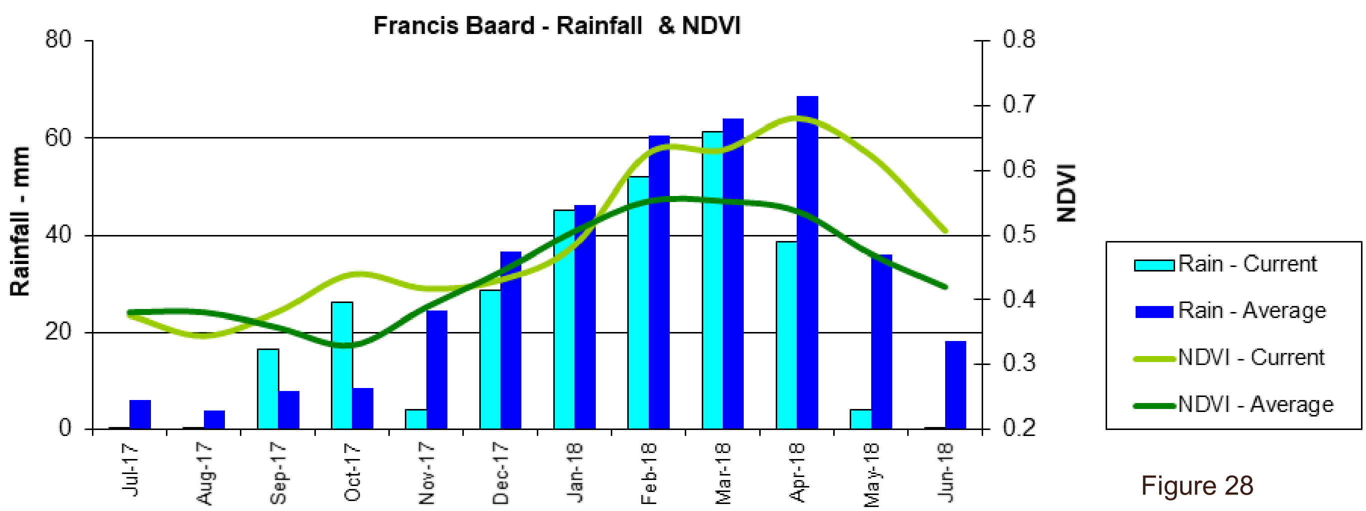

Figure 28

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 during June 2018 per province. Fire activity was higher in the Northern Cape and Western Cape compared to the average during the same period for the last 18 years.

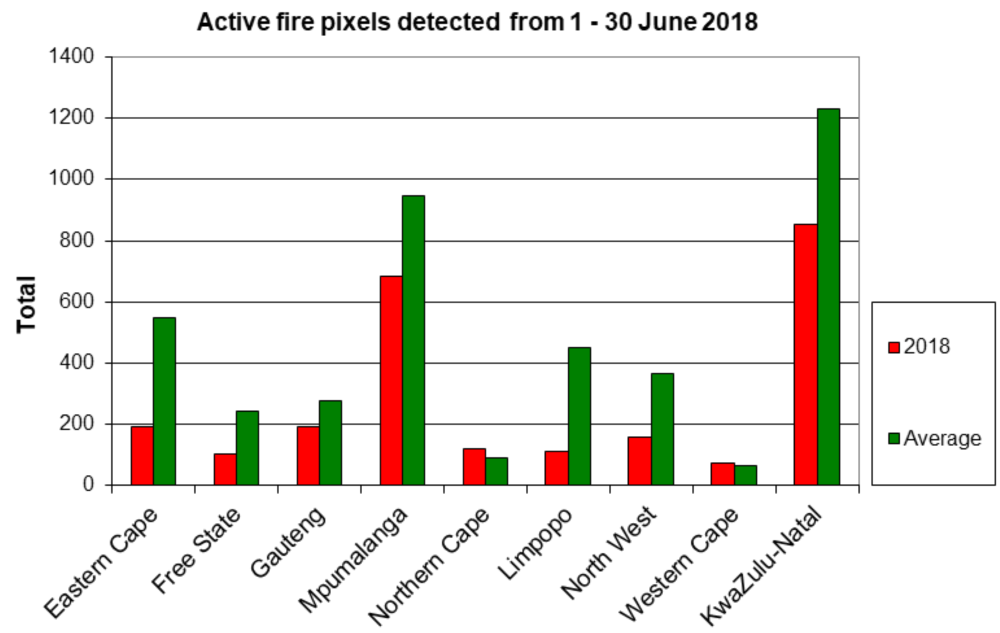

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-30 June 2018.

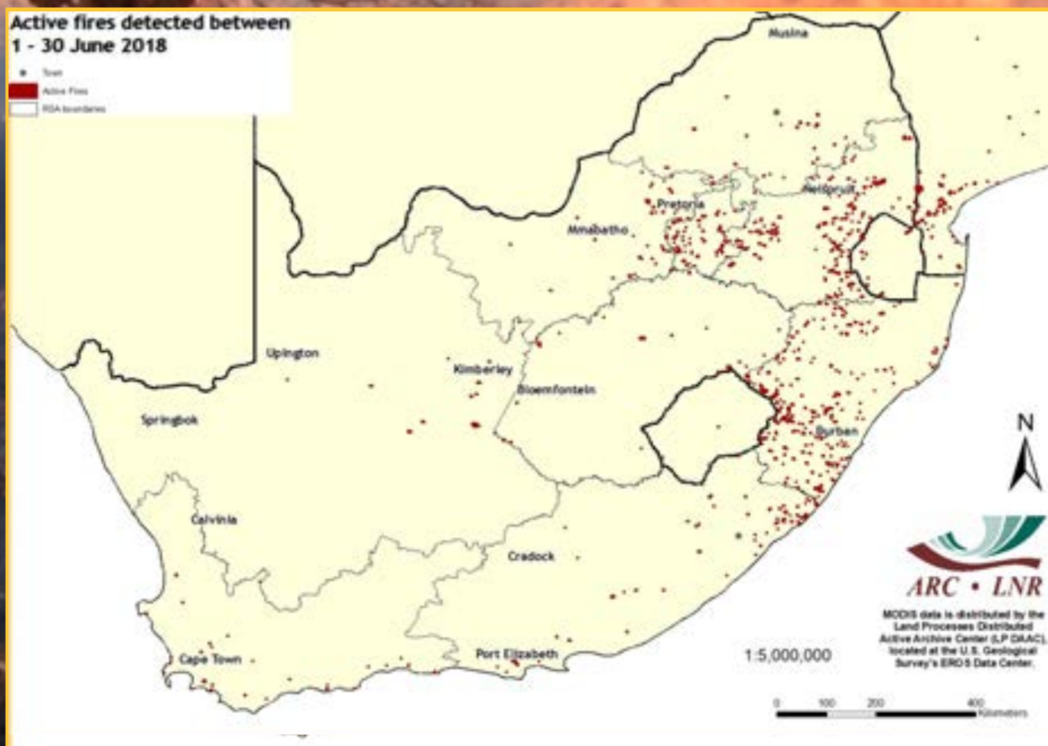

Figure 30

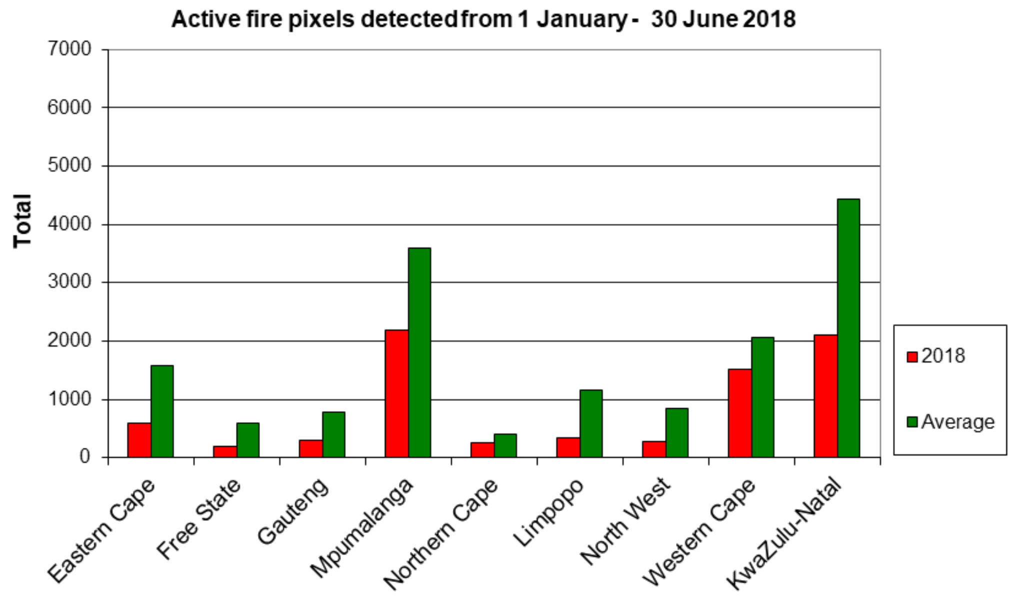

Figure 31

Figure 31:
The graph shows the total number of active fires detected from 1 January - 30 June 2018 per province. Fire activity was lower in all provinces compared to the average during the same period for the last 18 years.

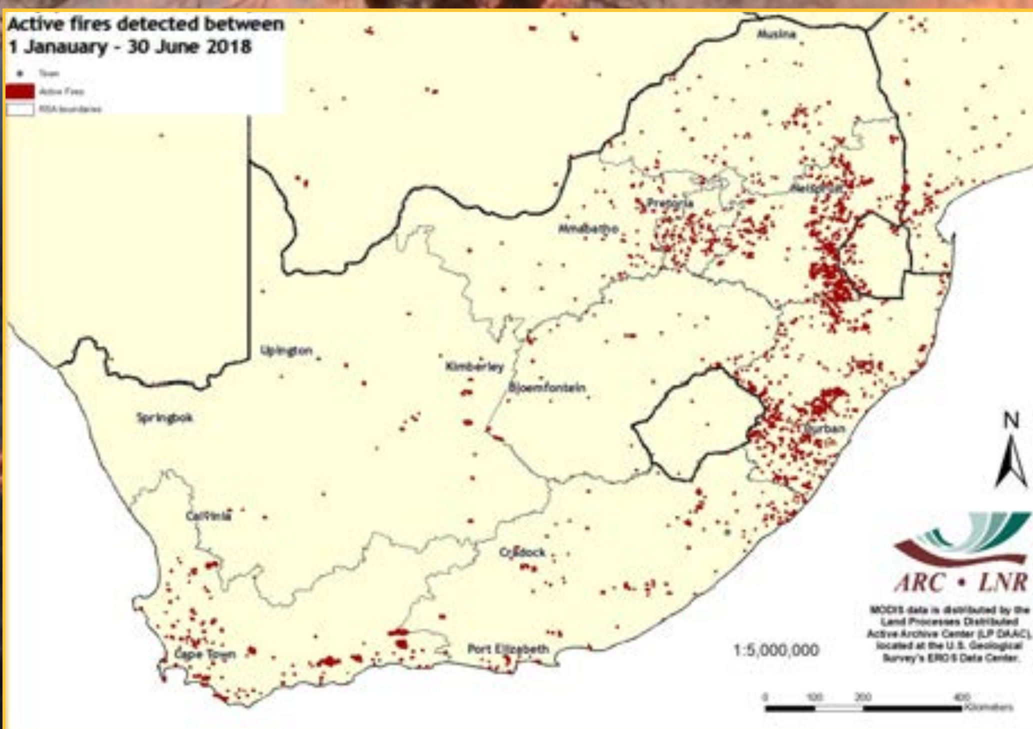

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January - 30 June 2018.

Questions/Comments:
MaakeR@arc.agric.za

Agrometeorology

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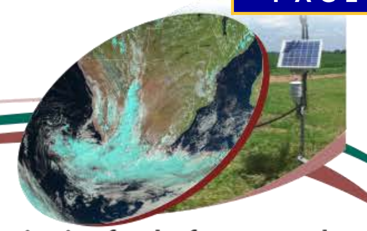

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national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

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

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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

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**.

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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

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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".