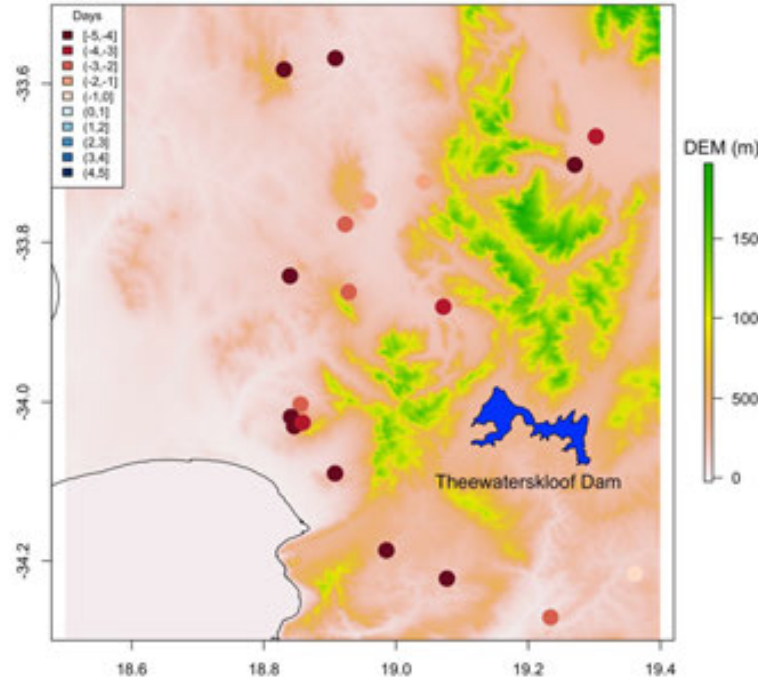


**INSTITUTE FOR SOIL, CLIMATE AND WATER**

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### Images of the Month

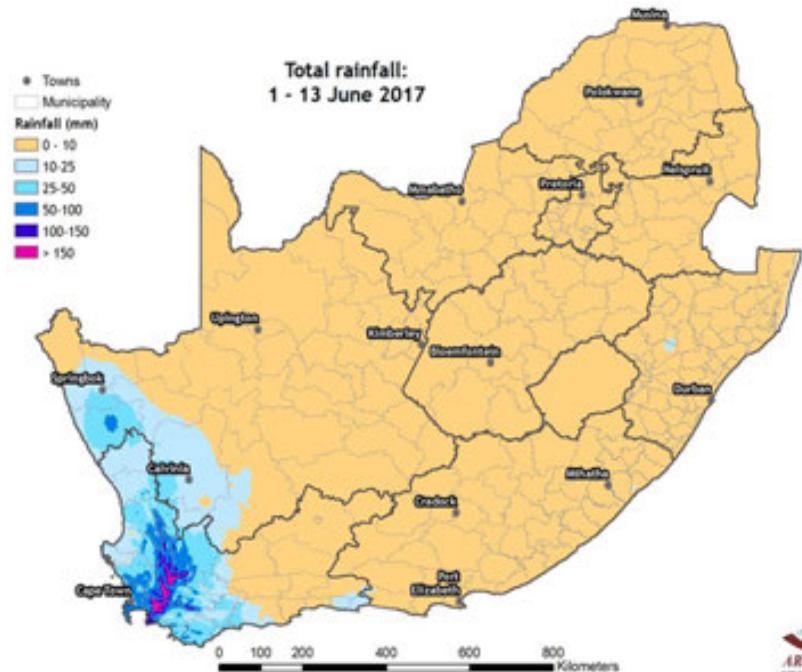


### Welcome early June rains after a very dry autumn in the Western Cape

Above-normal temperatures and below-normal rainfall conditions continued over the drought stricken Western Cape during May 2017. The top image shows the rainy day anomaly during May this year relative to the average number of rainy days for the month of May over the period 2006-2015. The number of rainy days during May 2017 is below-

average over the entire immediate water catchment area (the Theewaterskloof Dam is indicated in blue).

Some relief came in early June as a strong frontal system made landfall, with some follow-up rains. The map shows the accumulated rainfall for the period 1-13 June 2017 when up to 150 mm fell in the water catchment area. Unfortunately, the main storm during this period also caused severe wind damage over the southwestern Cape.



# 1. Rainfall

**Overview:**  
 As during April 2017, cold fronts making landfall over the southwestern parts of the country were very limited during the month of May. Rainfall associated with the passage of weak frontal systems occurred on only two occasions during approximately the first 10 days of the month and again during the last 10-day period. However, the accumulated rainfall during these two periods did not exceed 30 mm, except in the mountainous areas. The absence of regular frontal activity and upper-air support during this activity resulted in yet another month of rainfall well below average over the winter rainfall region, whilst maximum temperatures were up to 2 °C above normal along the coast and up to 4 °C above normal over the Western Cape interior. The fact that frontal systems only brushed along the coast in passing is reflected in the below-normal rainfall that extended eastwards to the Cape south coast region which was so severely affected by fires during early June 2017.

Eastwards of Port Elizabeth, above-normal rainfall occurred along the coast and adjacent interior, extending northwards over KwaZulu-Natal to the northeastern parts of the country. On the 3<sup>rd</sup> of May, a ridging high pressure system caused falls of rain of up to 50 mm in the areas located between Port Elizabeth and East London. Between the 12<sup>th</sup> and 15<sup>th</sup>, the strongest ridging high pressure system in weeks caused widespread rainfall along the KwaZulu-Natal coast, reaching 200-300 mm in some areas. A sharp upper-air trough in combination with the strong ridging high also resulted in the above-normal rainfall that occurred over large parts of the northeastern interior. Along the eastern escarpment, rainfall totals of up to 150 mm occurred during this single event.

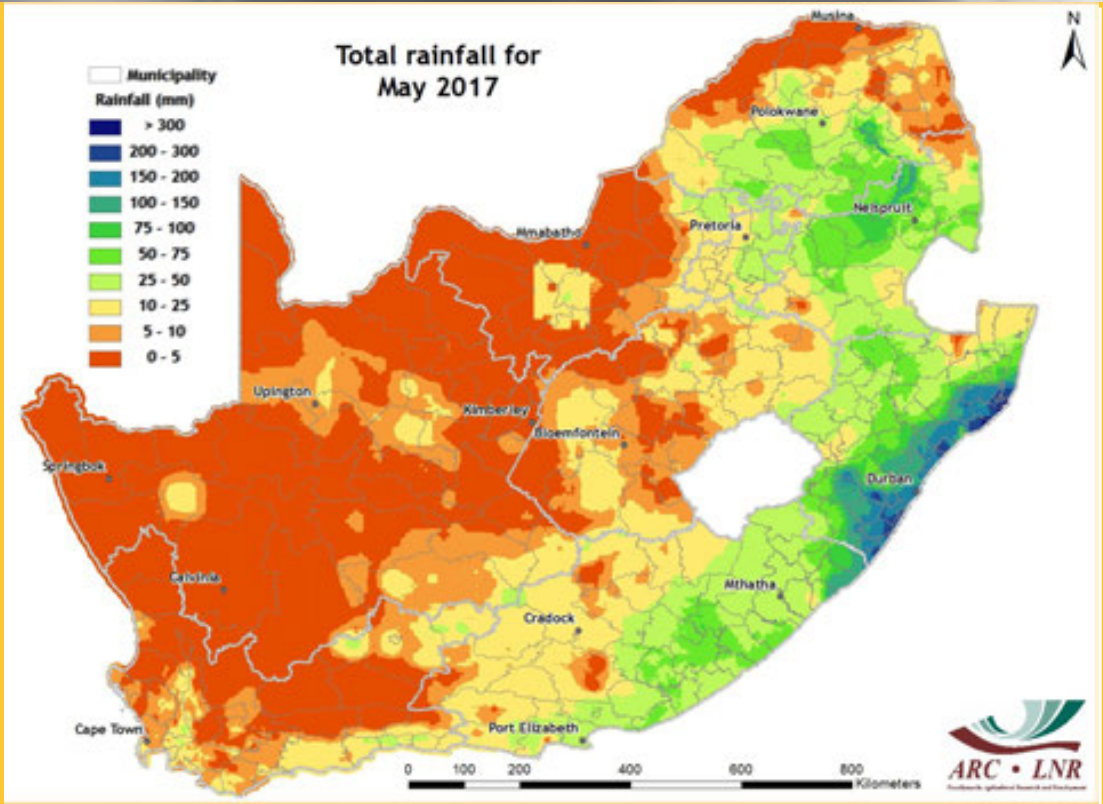


Figure 1

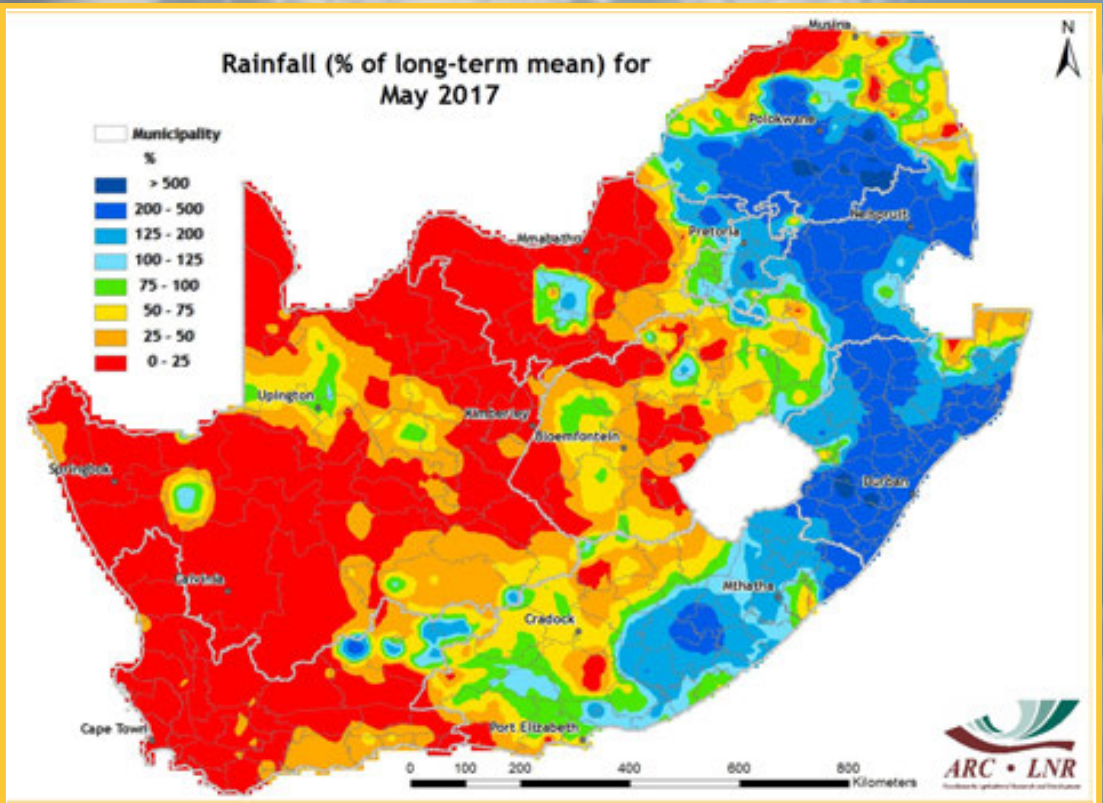


Figure 2

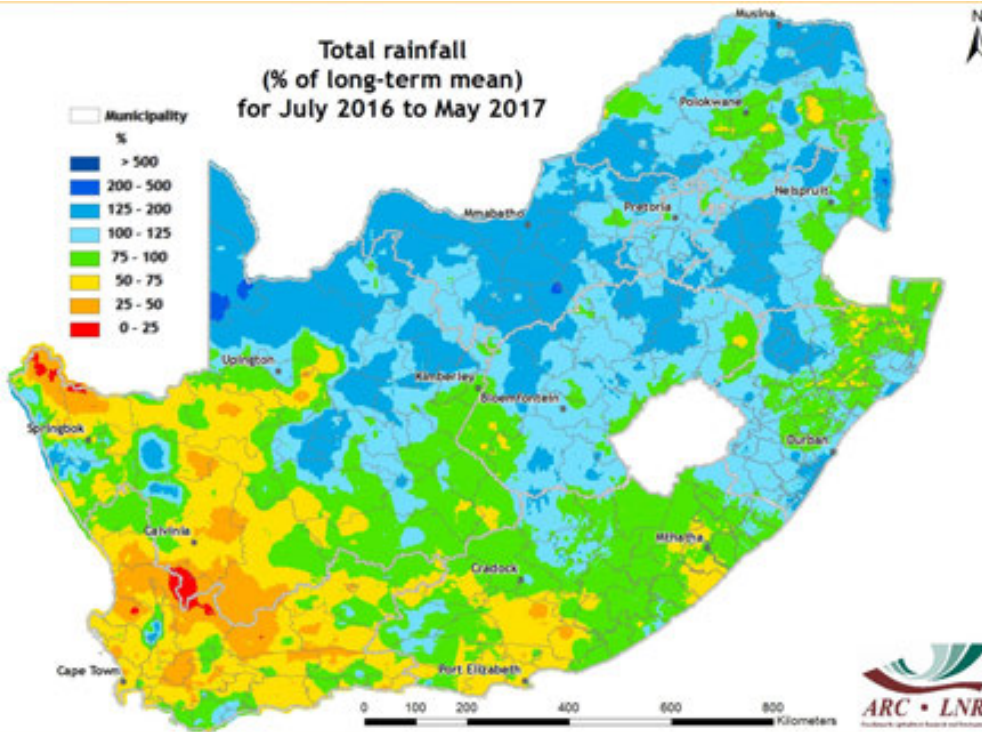


Figure 3

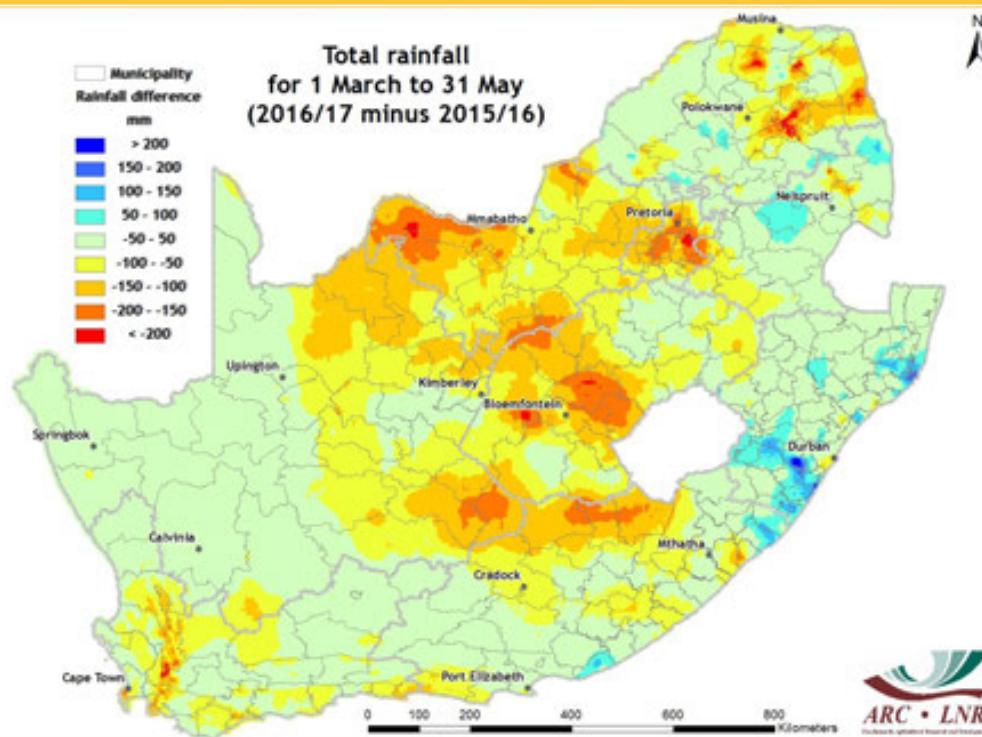


Figure 4

**Figure 1:**

Large parts of northeastern South Africa received rainfall totals in excess of 50 mm during May, reaching monthly totals in excess of 100 mm along the eastern escarpment and 300 mm along the KwaZulu-Natal coast. Over the Cape south coast falls were limited, with some areas over the drought stricken southwestern Cape receiving no more than 10 mm during May.

**Figure 2:**

Above-normal rainfall occurred over the northeastern parts as well as over KwaZulu-Natal and the eastern parts of the Eastern Cape. Below-normal rainfall continued over the drought stricken southwestern Cape.

**Figure 3:**

Since July 2016, rainfall over the northern to central parts of the country was mostly normal to above normal. Some isolated areas over the western and southern interior also received normal to above-normal rainfall during this 11-month period.

**Figure 4:**

Compared to 2015/16, the southwestern, central and far northeastern parts of the country received 50-100 mm less rainfall and in some isolated areas up to 150 mm less rainfall during the corresponding period in 2016/17. In contrast, some areas in KwaZulu-Natal received more rainfall during 2016/17 compared to the corresponding period in 2015/16.

**Questions/Comments:**

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## 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 8<sup>th</sup> Conference on Applied Climatology, 17-22 January, Anaheim, CA. American Meteorological Society: Boston, MA; 179-184.

At short and long time scales, the current SPI maps (Figures 5-8) show that severe to extreme drought conditions are present over the extreme southwestern parts of the country. At the longer time scales, severe to extreme drought conditions are present over the eastern seaboard, gradually recovering towards the shorter time scale.

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[Philip@arc.agric.za](mailto:Philip@arc.agric.za)

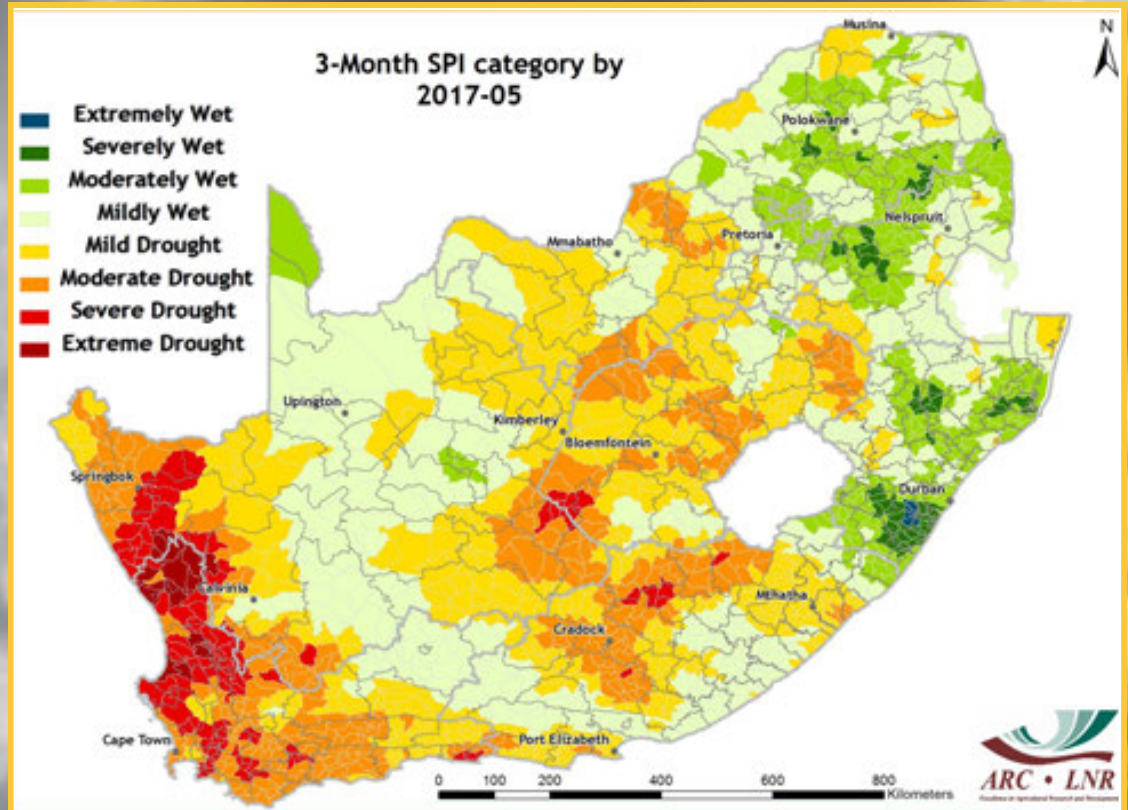


Figure 5

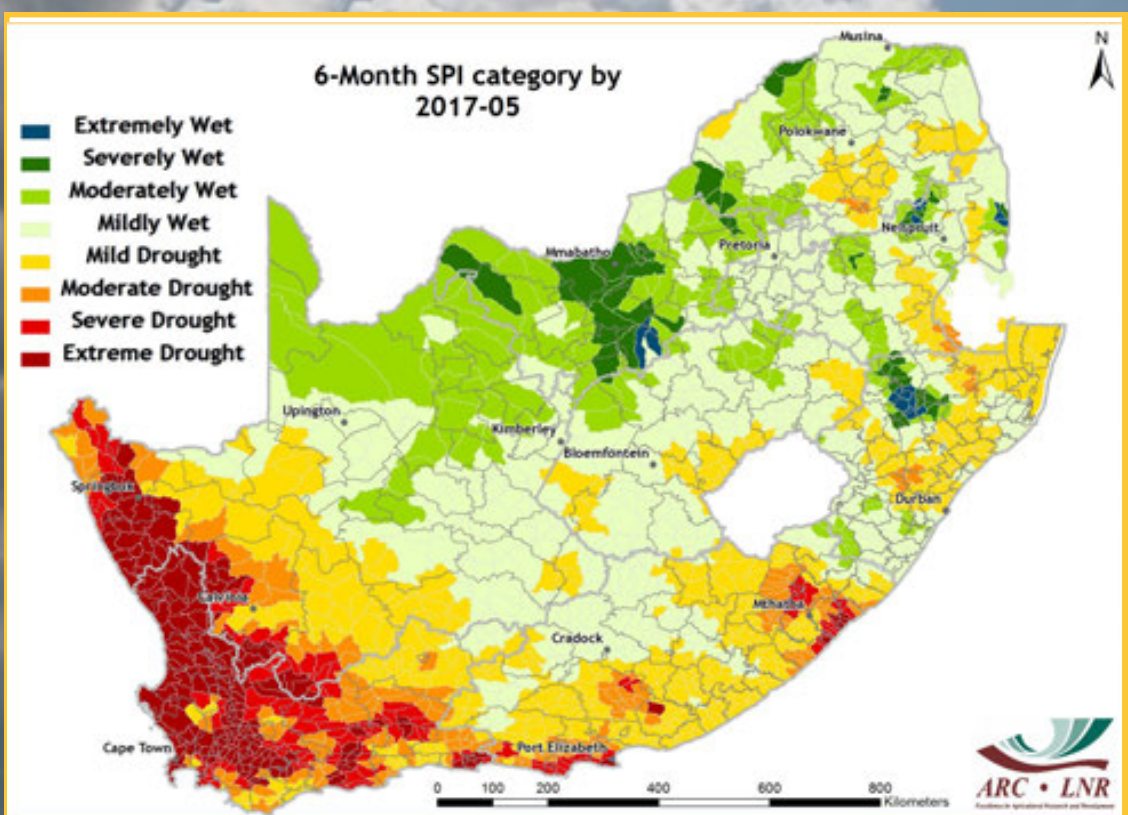


Figure 6

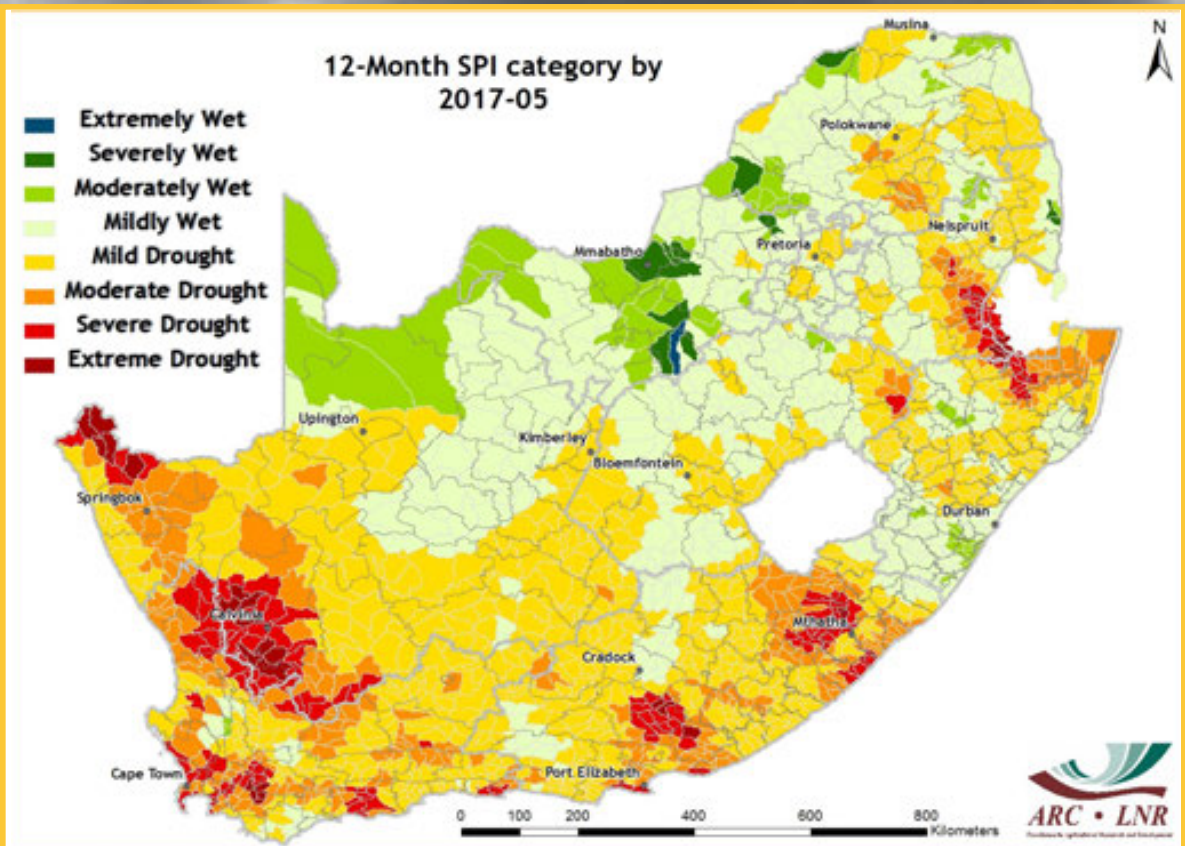


Figure 7

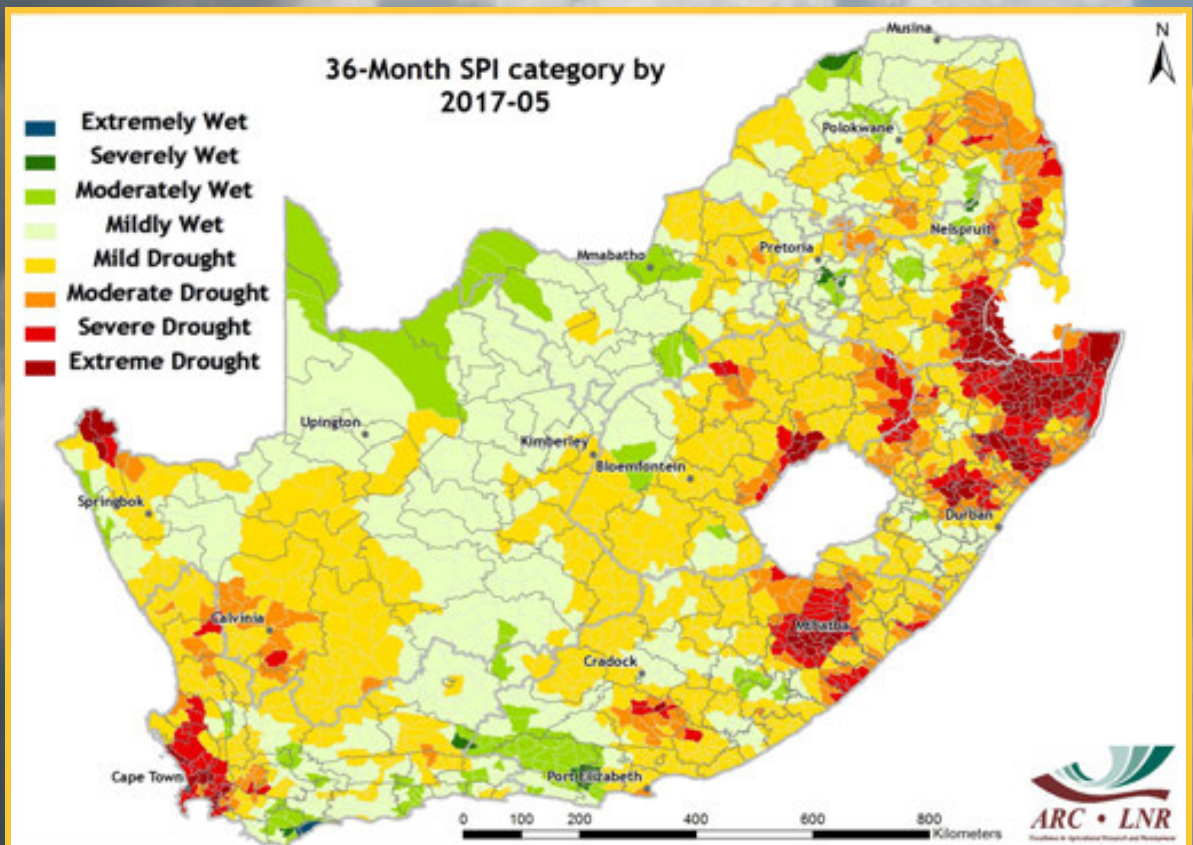


Figure 8

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.

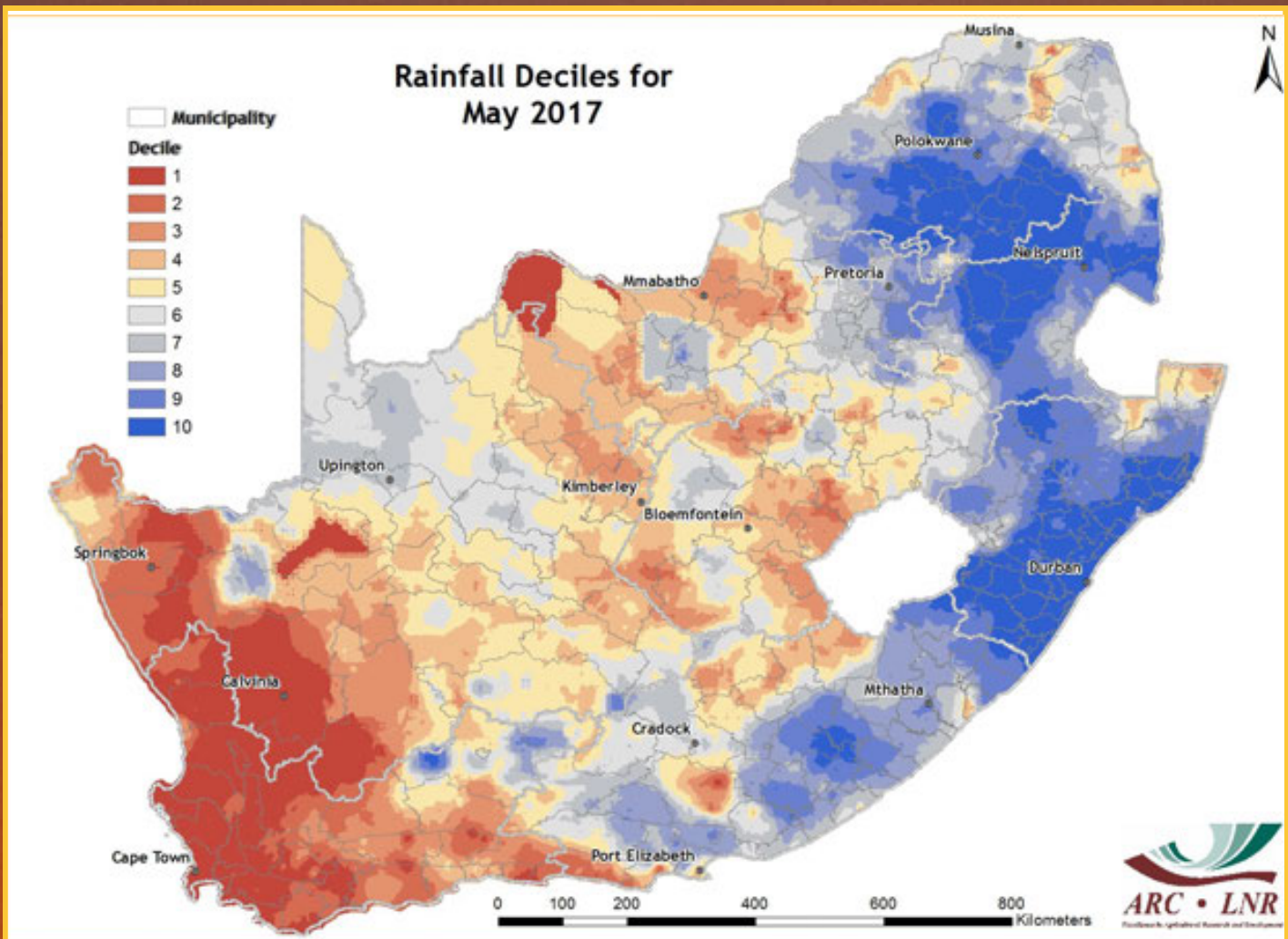


Figure 9

**Figure 9:**

Areas over the northeastern and eastern parts of the country were wet during May, while extremely dry conditions occurred over the western and southwestern parts.

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[Philip@arc.agric.za](mailto:Philip@arc.agric.za)

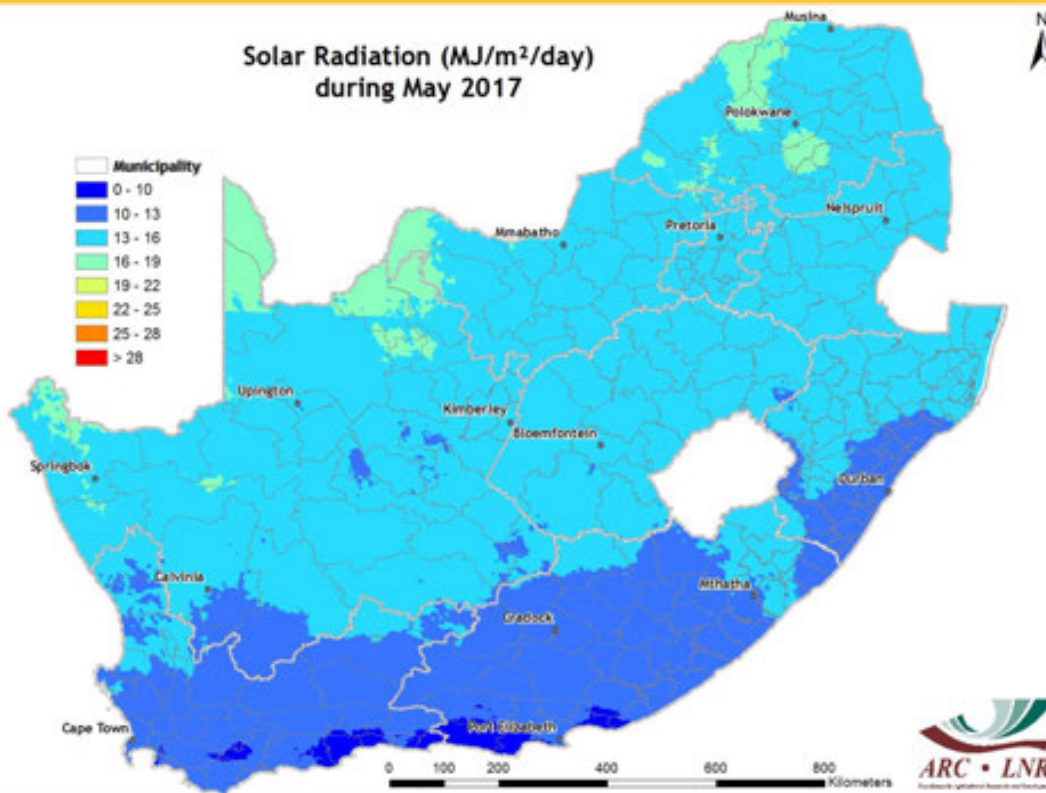


Figure 10

## Solar Radiation

Daily solar radiation surfaces are created for South Africa by combining *in situ* measurements from the ARC-ISCW automatic weather station network with 15-minute data from the Meteosat Second Generation satellite.

**Figure 10:**

The lowest solar radiation values occurred over the southern and eastern coastal belts and adjacent interior regions with higher values further northwards.

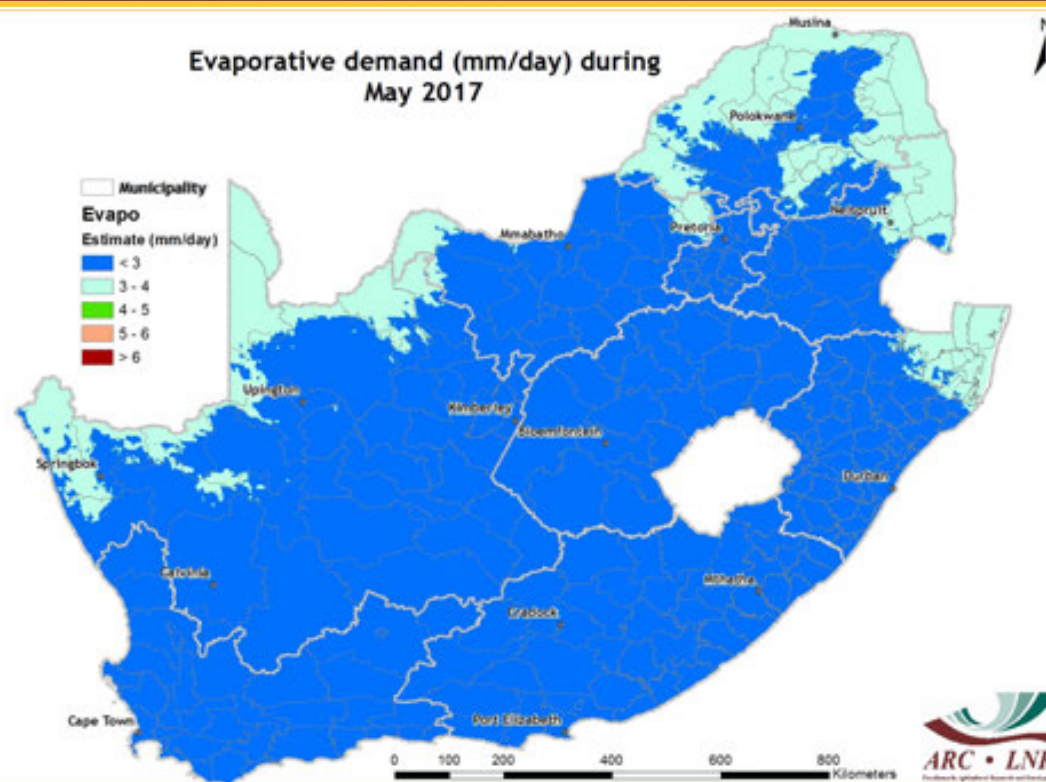


Figure 11

## Potential Evapotranspiration

Potential evapotranspiration (PET) for a reference crop is calculated at about 450 automatic weather stations of the ARC-ISCW located across South Africa. At these stations hourly measured temperature, humidity, wind and solar radiation values are combined to estimate the PET.

**Figure 11:**

The evaporative demand follows a similar pattern to the solar radiation values, with the lowest demand occurring over the southern to southeastern coast and adjacent interior and the highest demand over the northwestern parts of the country.

### Questions/Comments:

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## Vegetation Mapping

The Normalized Difference Vegetation Index (NDVI) is computed from the equation:

$$NDVI = \frac{(IR - R)}{(IR + R)}$$

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.

# 5. Vegetation Conditions

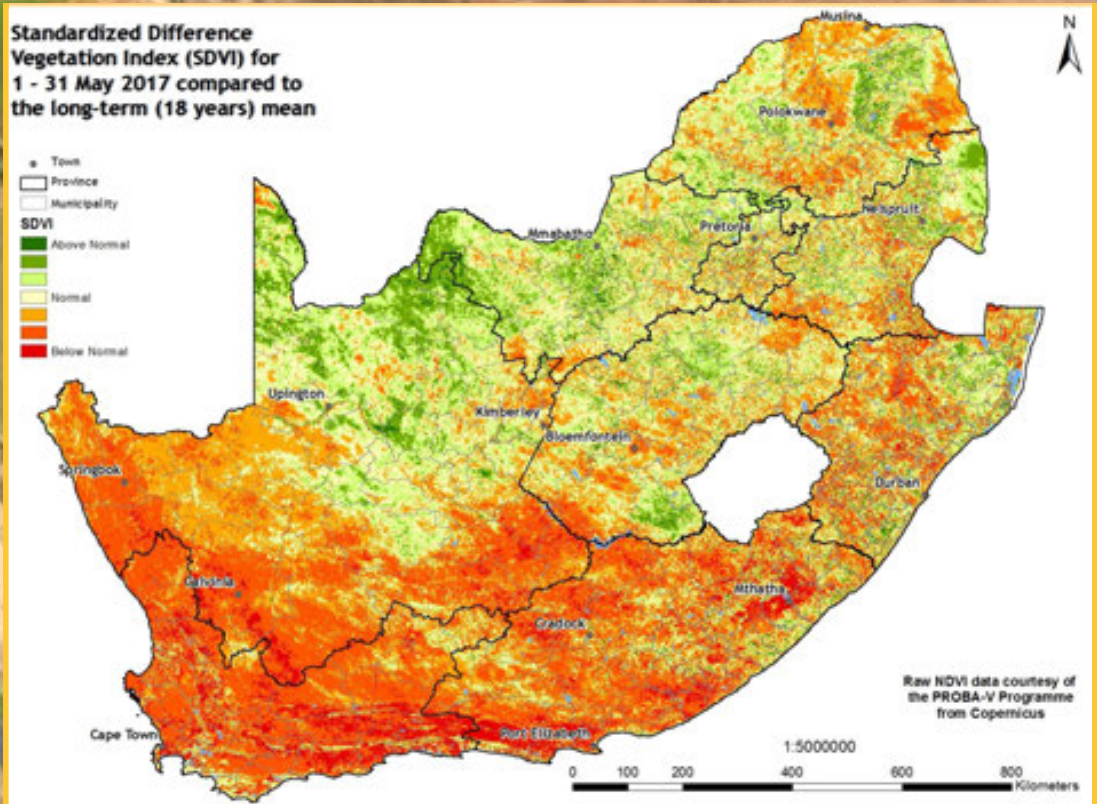


Figure 12

**Figure 12:**

The SDVI by late May indicates drought stress over the Western Cape, Eastern Cape and the western part of the Northern Cape, including the Highveld and Lowveld regions of Limpopo. The northwestern and central parts experienced above-normal vegetation activity in the month of May.

**Figure 13:**

The onset of winter resulted in a large decrease in vegetation activity over much of the central to northeastern interior due to dry conditions and low minimum temperatures.

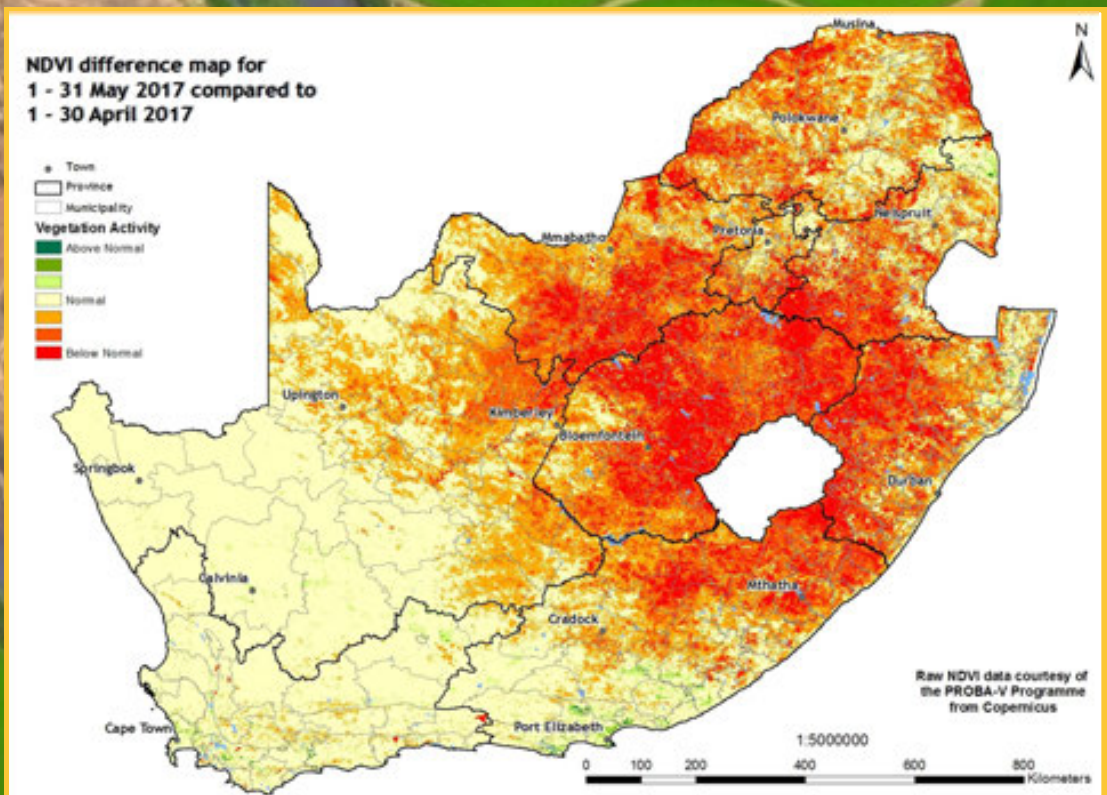


Figure 13



**Percentage of Average Seasonal Greenness (PASG) for 1 January - 31 May 2017 compared to the long-term (19 years) mean**

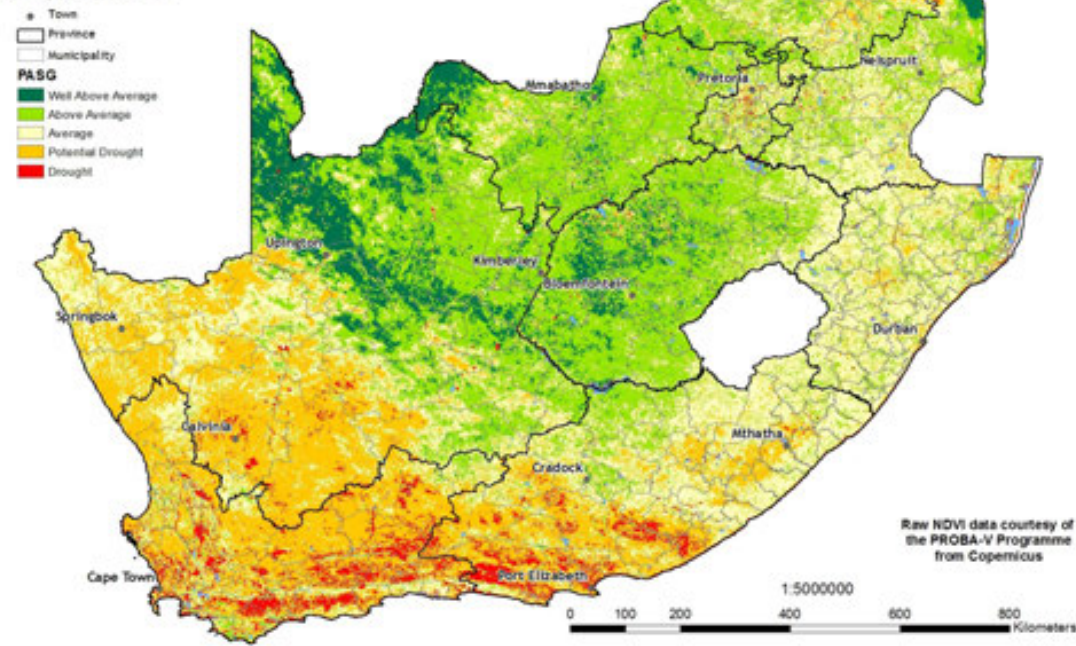


Figure 14

**Vegetation Mapping (continued from p. 8)**

**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

**Percentage of Average Seasonal Greenness (PASG) for 1 July - 31 May 2017 compared to the long-term (19 years) mean**

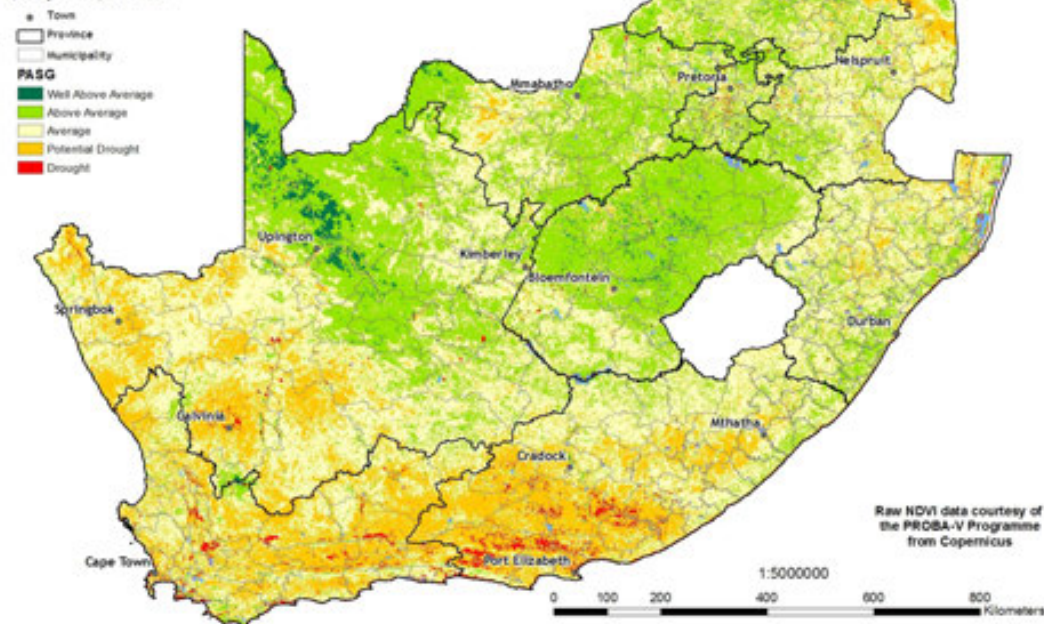


Figure 15

**Figure 14:**

The central and northern parts of the country experienced higher vegetation activity, while drought conditions dominated much of the winter rainfall region.

**Figure 15:**

Cumulative vegetation activity anomalies indicate drought stress over the extreme western and southern parts of the country, as well as the northern parts of Mpumalanga.

**Questions/Comments:**  
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# 6. 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.

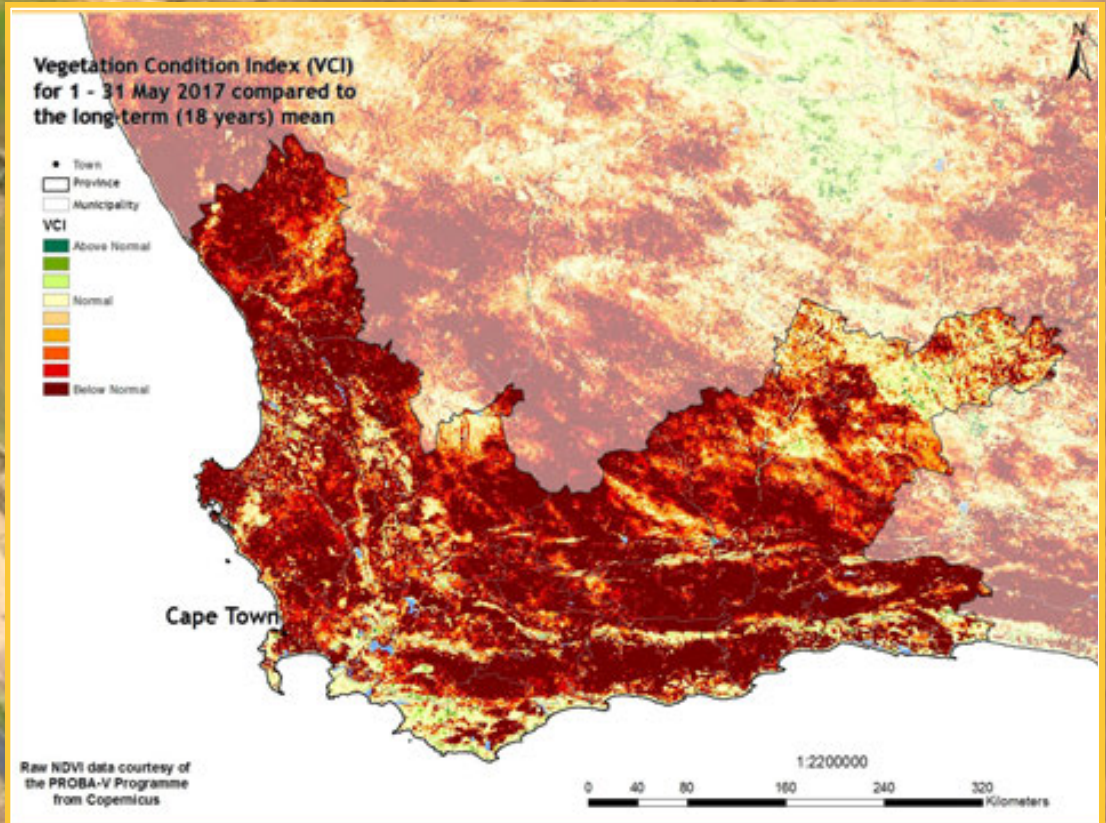


Figure 16

### Figure 16:

The VCI map for May indicates increased below-normal vegetation activity over most parts of the Western Cape since February this year.

### Figure 17:

The VCI map for May indicates below-normal vegetation activity over most parts of the Eastern Cape.

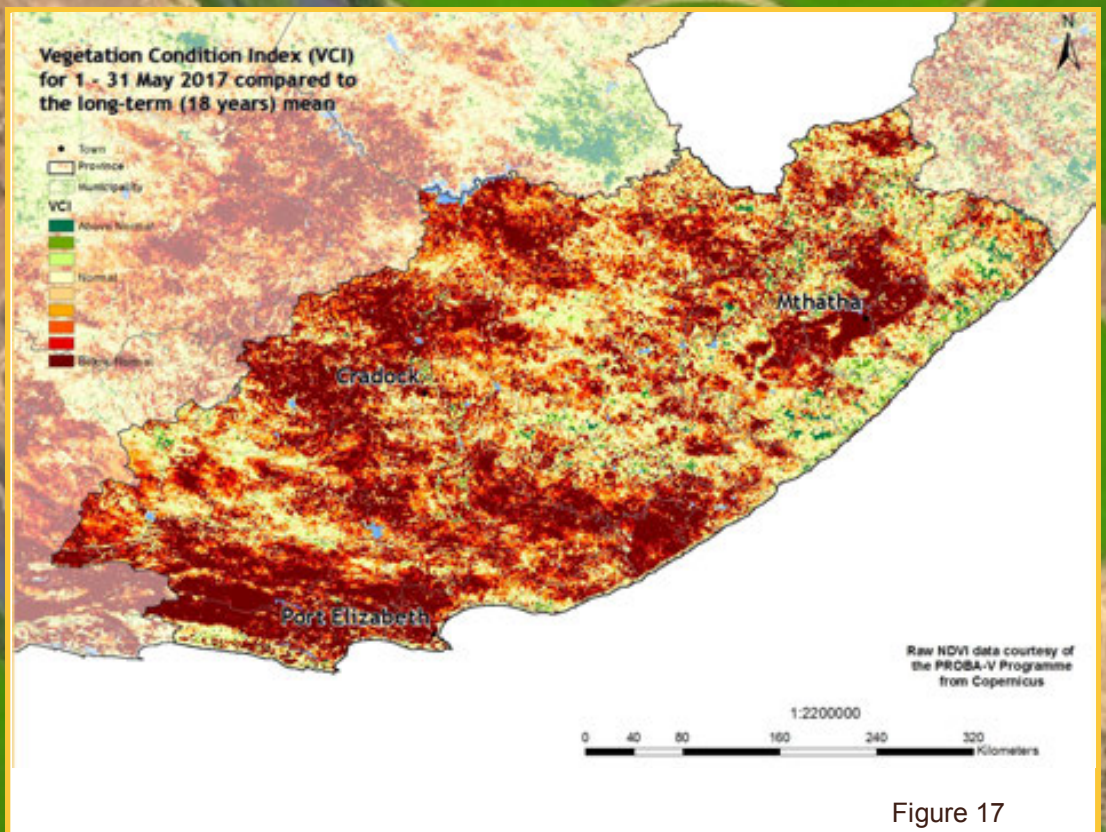


Figure 17

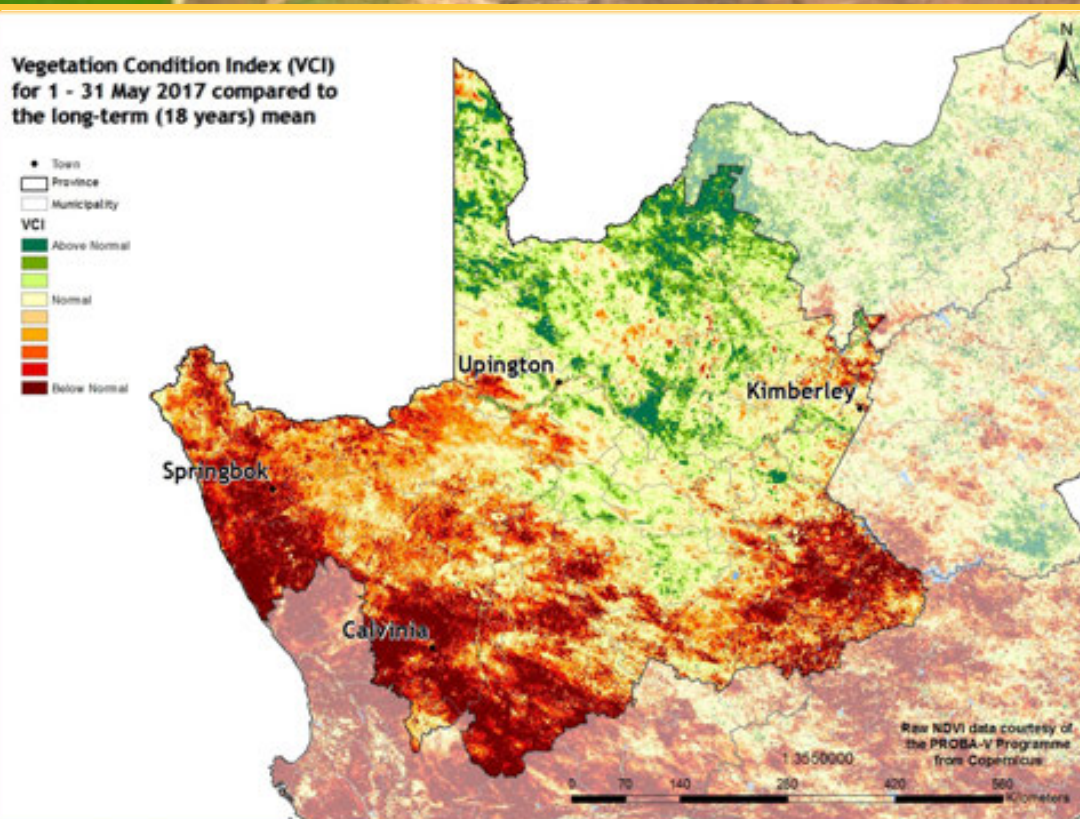


Figure 18

**Figure 18:**  
The VCI map for May indicates below-normal vegetation activity over the western and southern parts of the Northern Cape.

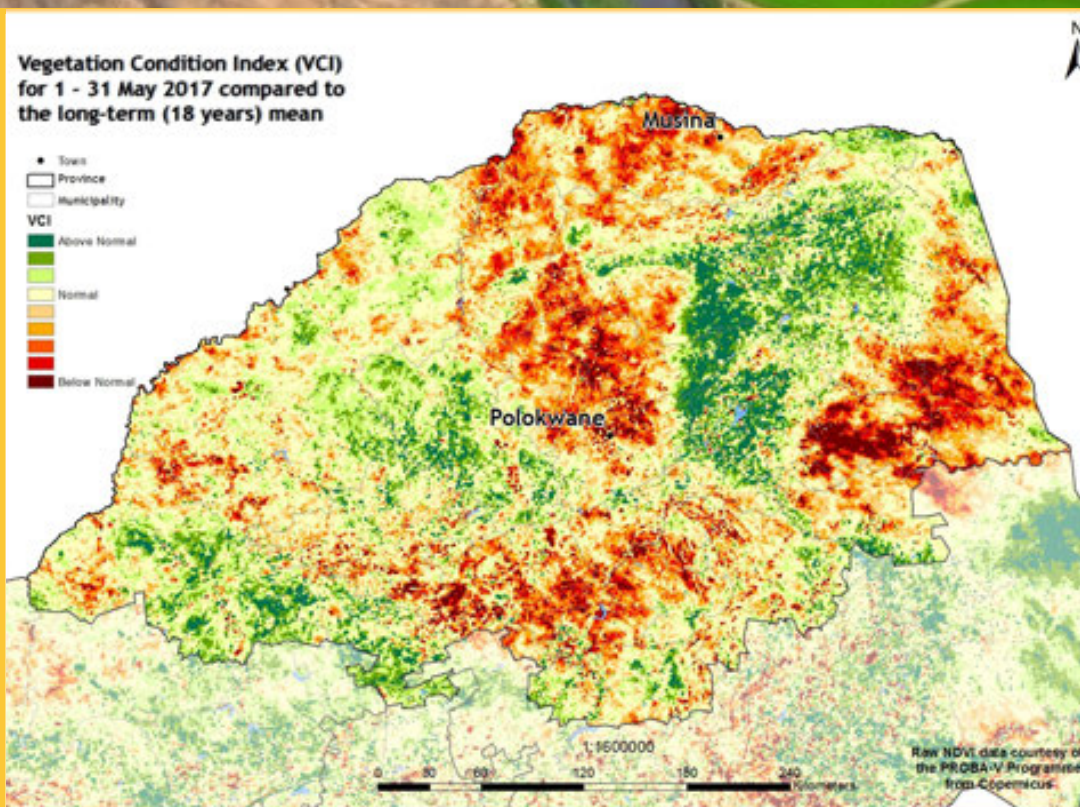


Figure 19

**Figure 19:**  
The VCI map for May indicates above-normal vegetation activity over the Lowveld region extending to the southern and western parts of Limpopo.

**Questions/Comments:**  
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# 7. Vegetation Conditions & Rainfall

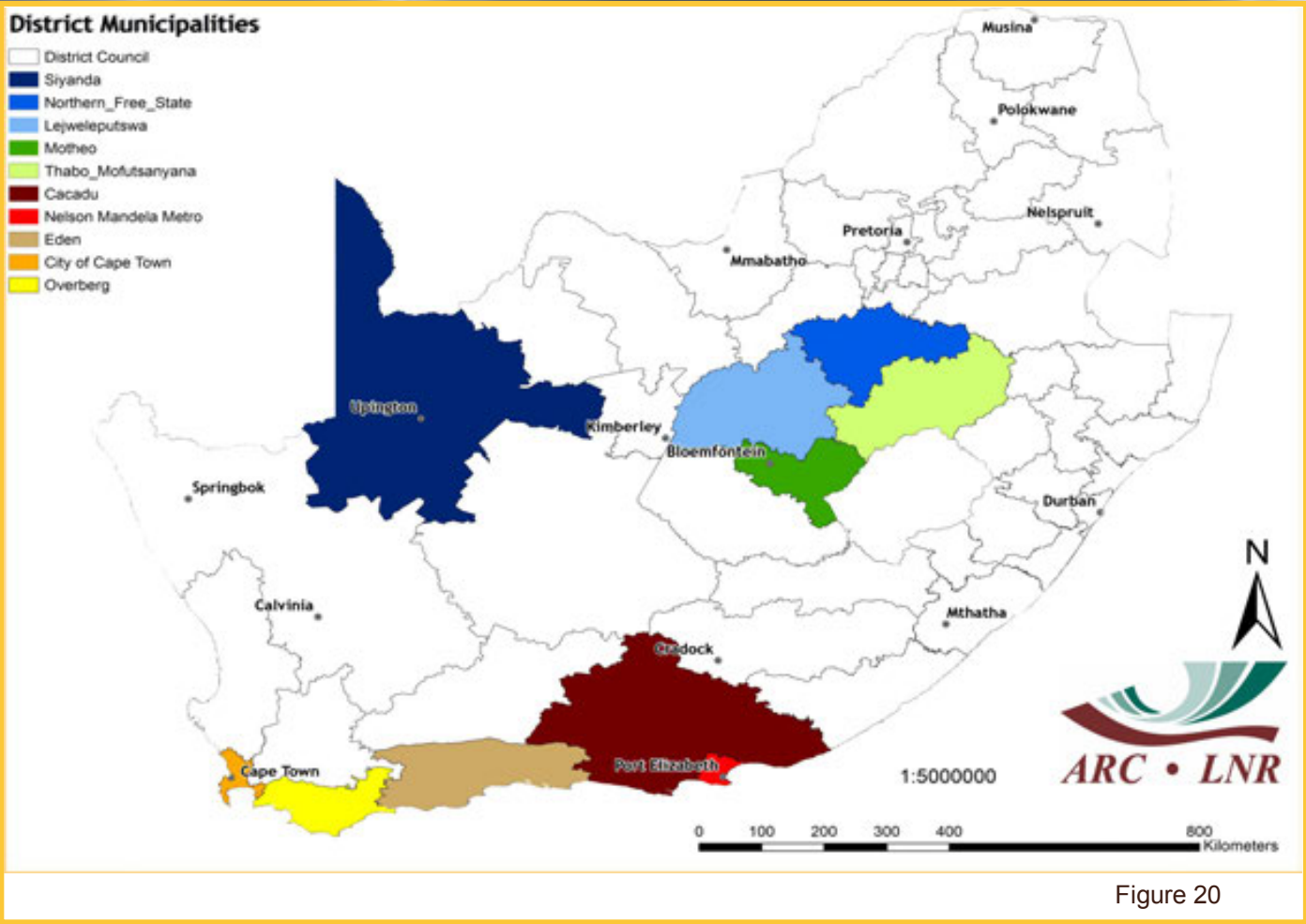


Figure 20

**NDVI and Rainfall Graphs**  
**Figure 20:**  
 Orientation map showing the areas of interest for May 2017. The district colour matches the border of the corresponding graph.

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**Figures 21-25:**  
 Indicate areas with higher cumulative vegetation activity for the last year.

**Figures 26-30:**  
 Indicate areas with lower cumulative vegetation activity for the last year.

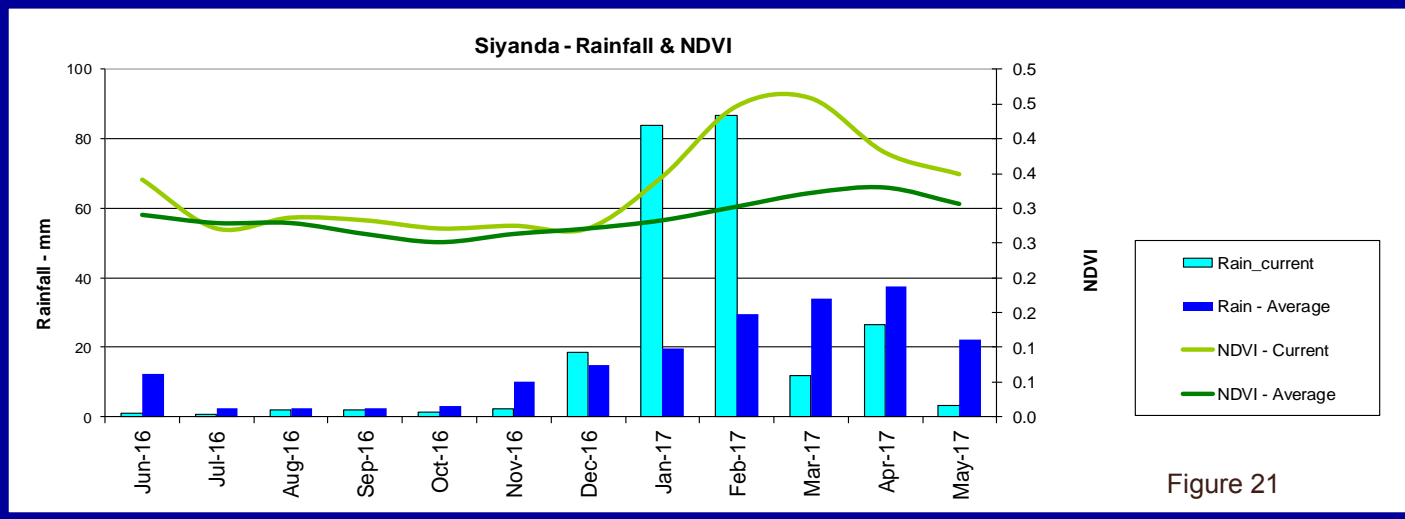


Figure 21

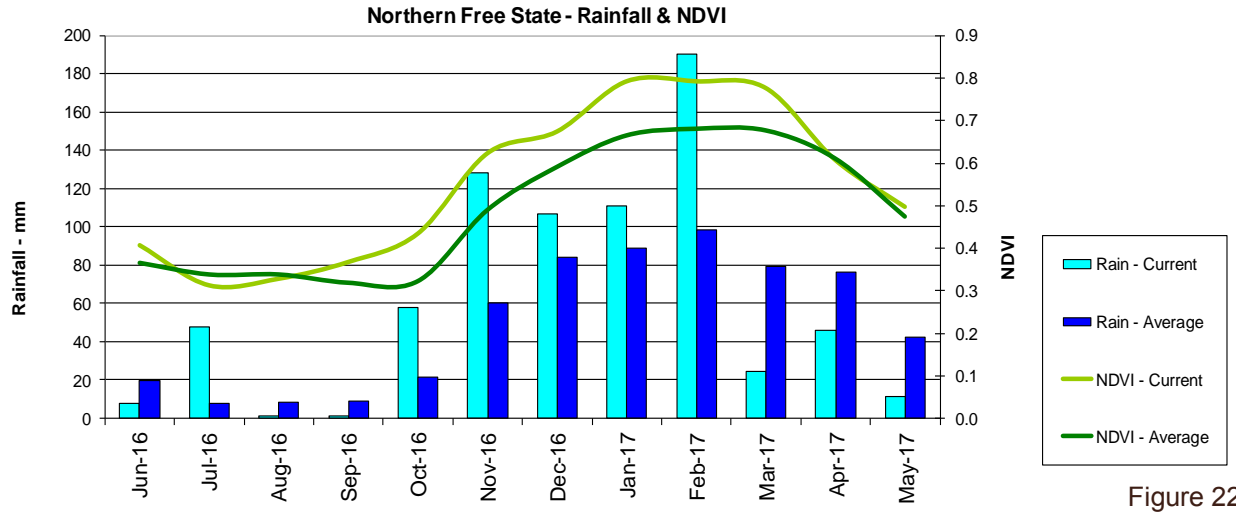


Figure 22

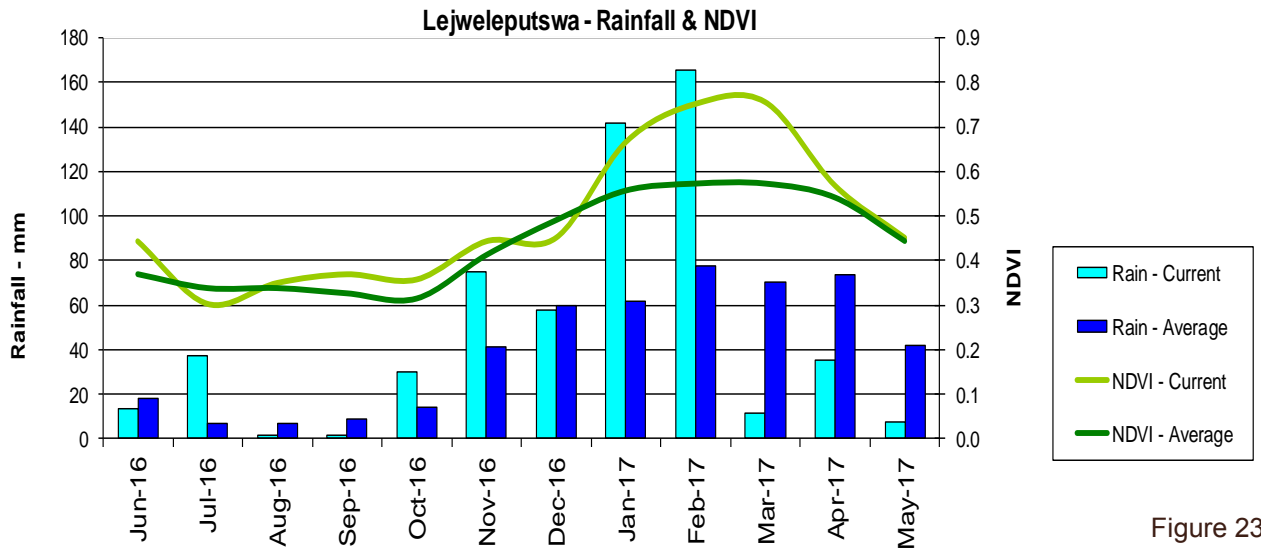


Figure 23

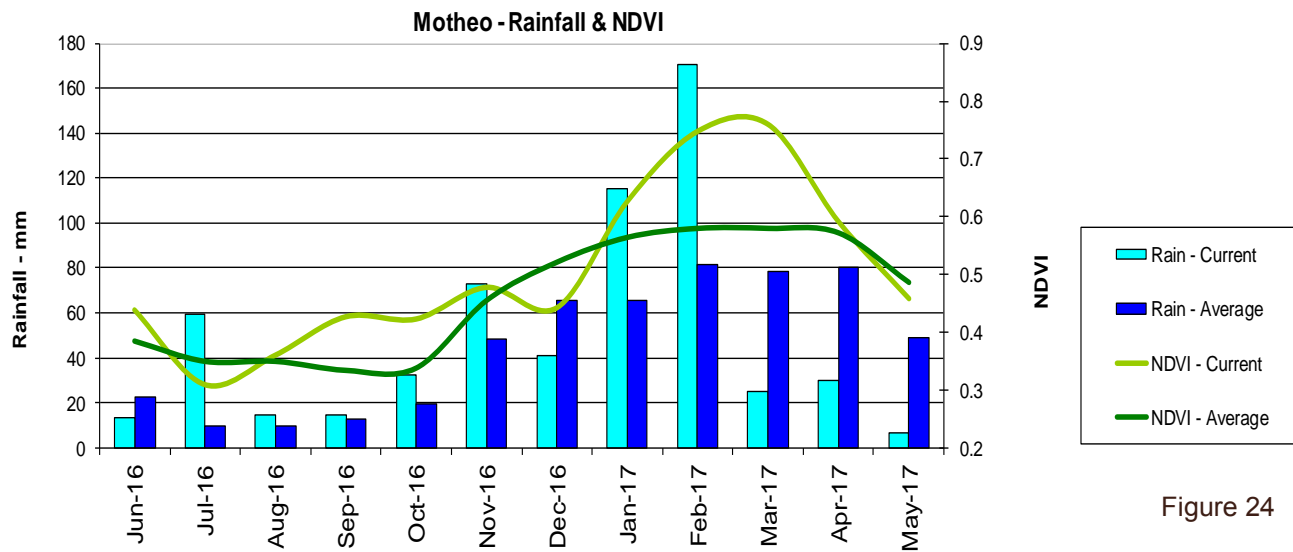


Figure 24

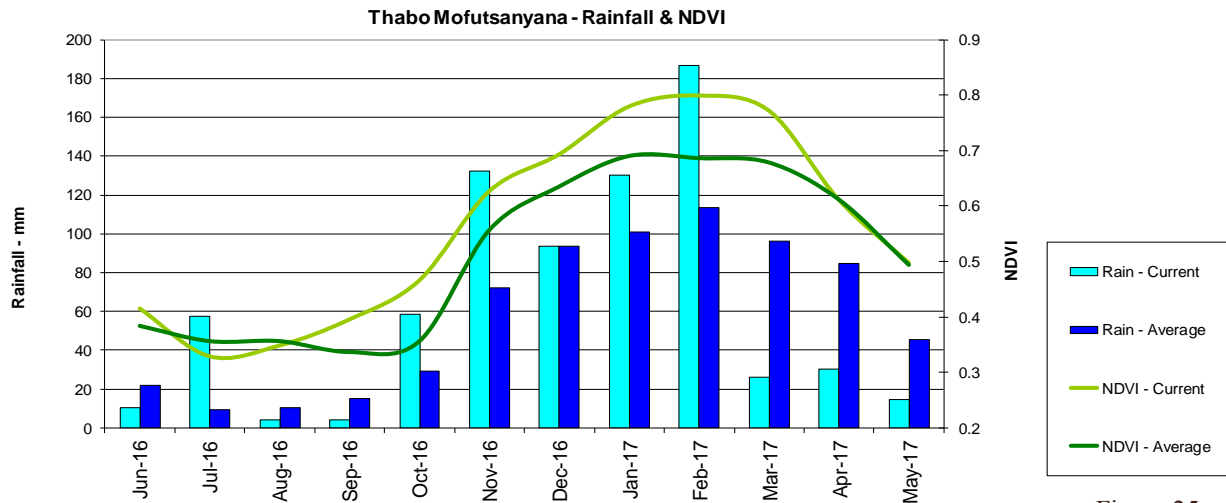


Figure 25

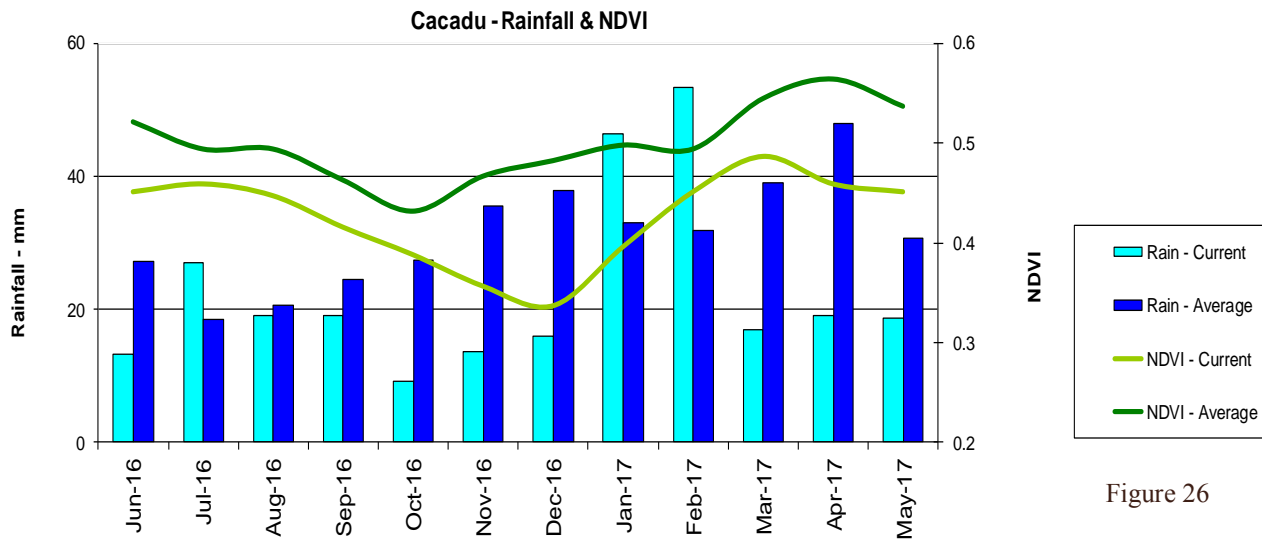


Figure 26

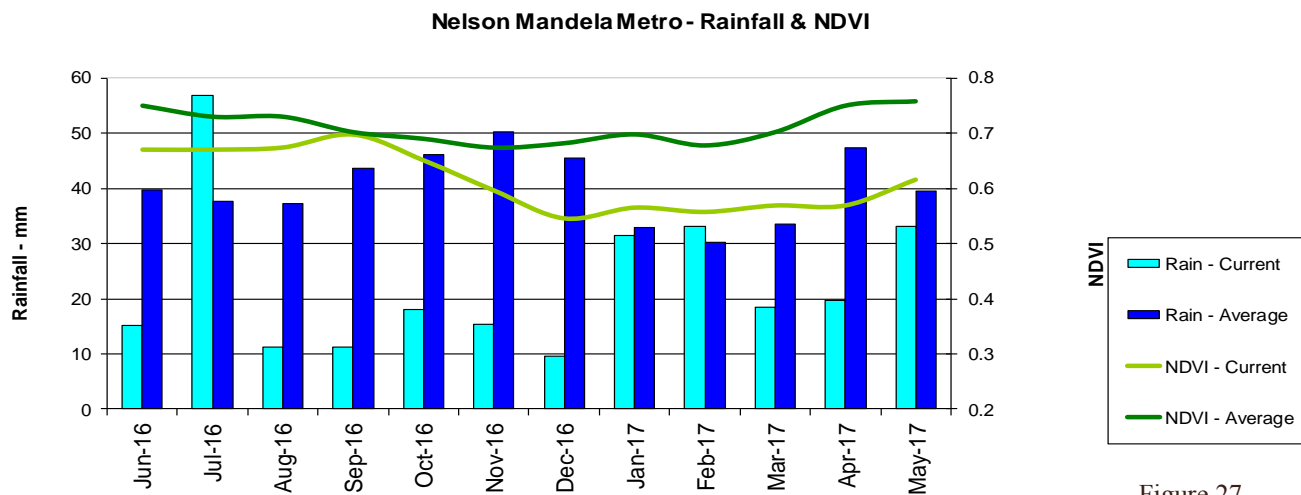


Figure 27

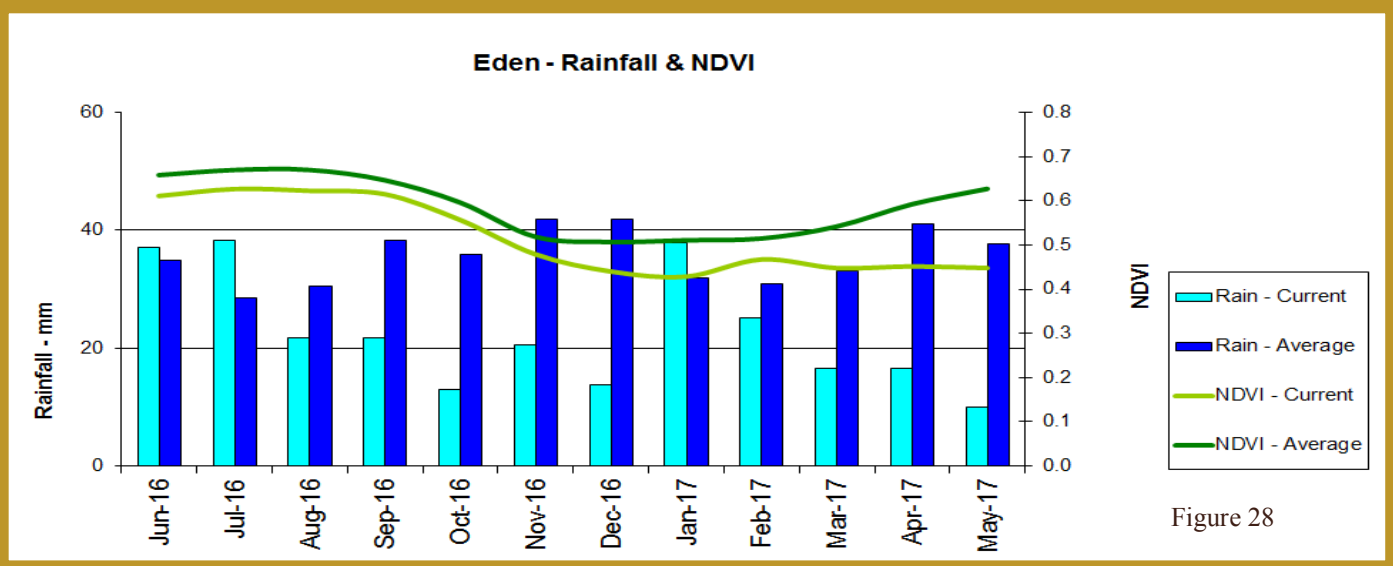


Figure 28

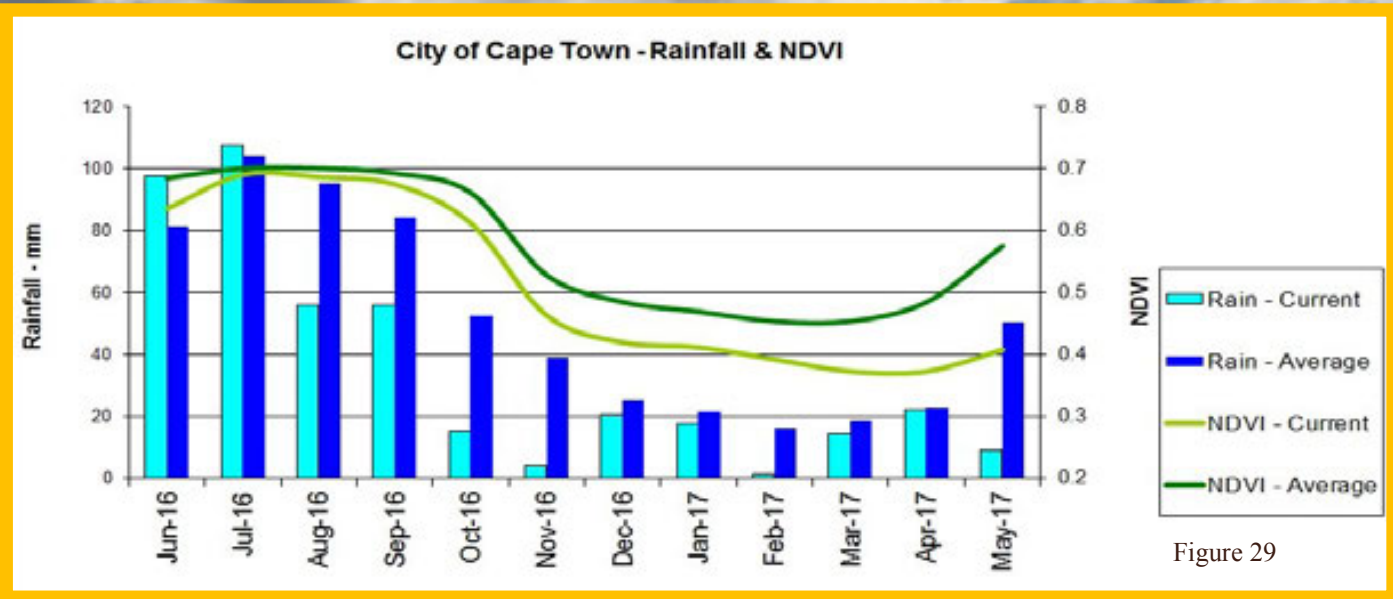


Figure 29

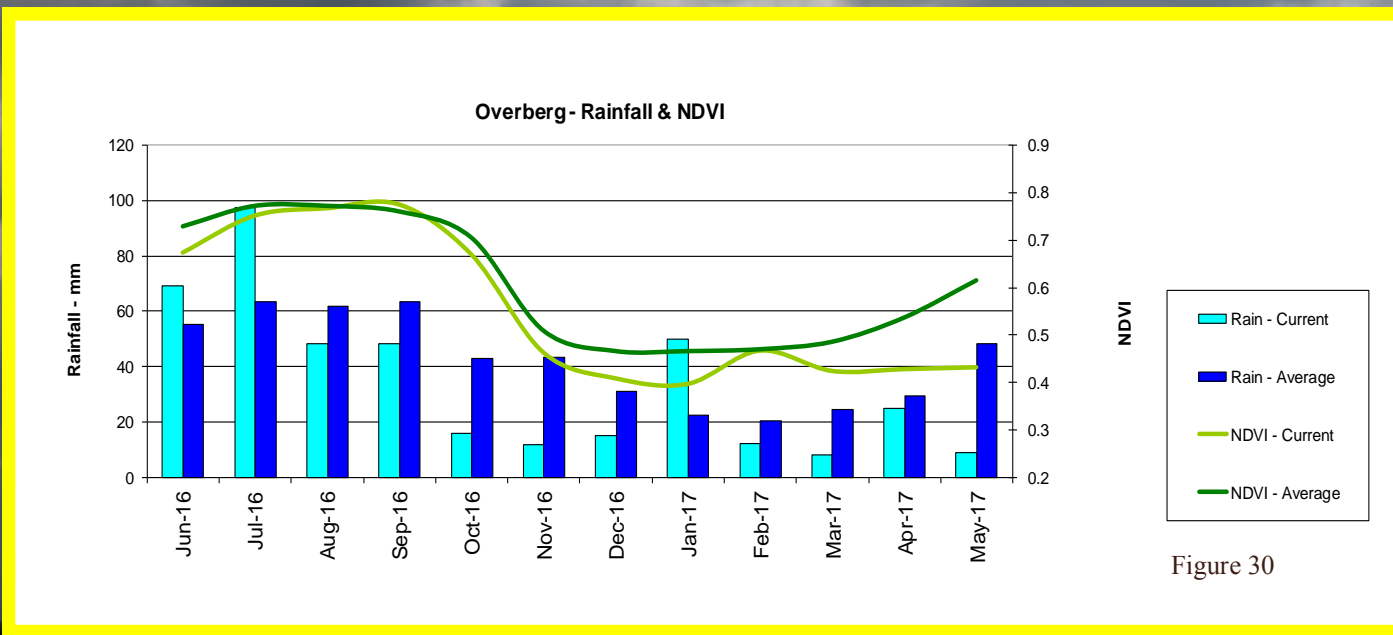


Figure 30

# 8. 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 31:**

The graph shows the total number of active fires detected during the month of May per province. Fire activity was higher in all provinces except North West compared to the average during the same period for the last 17 years.

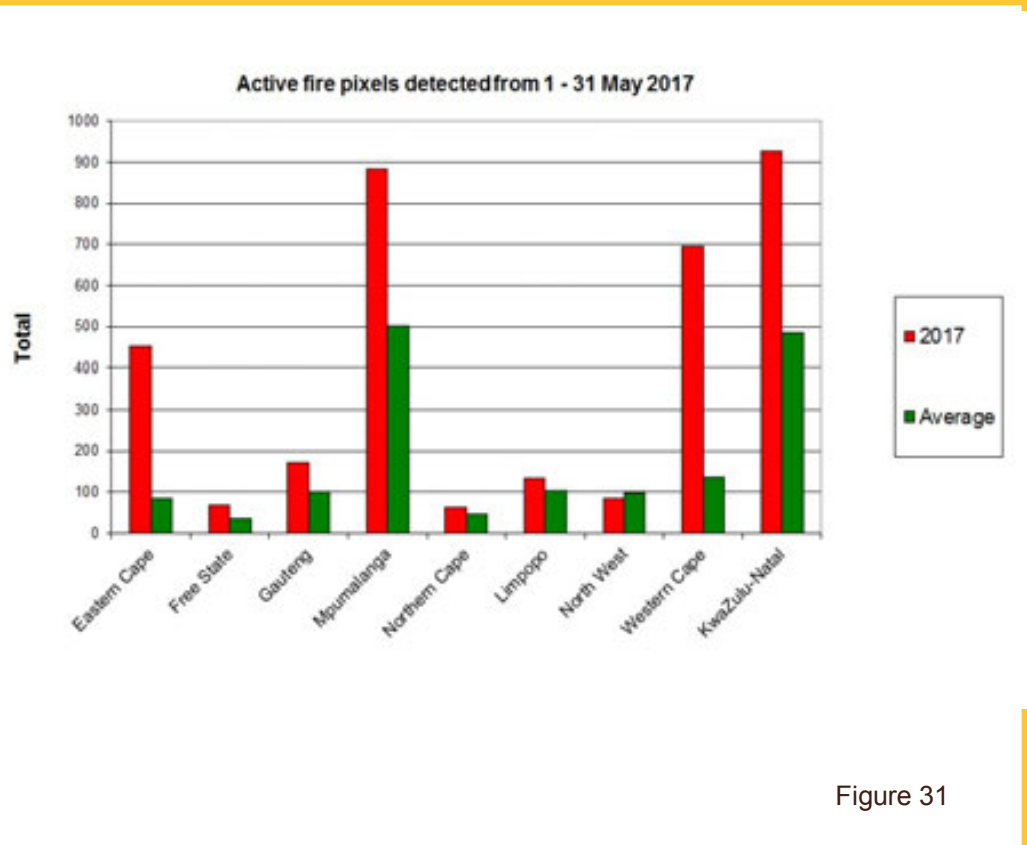
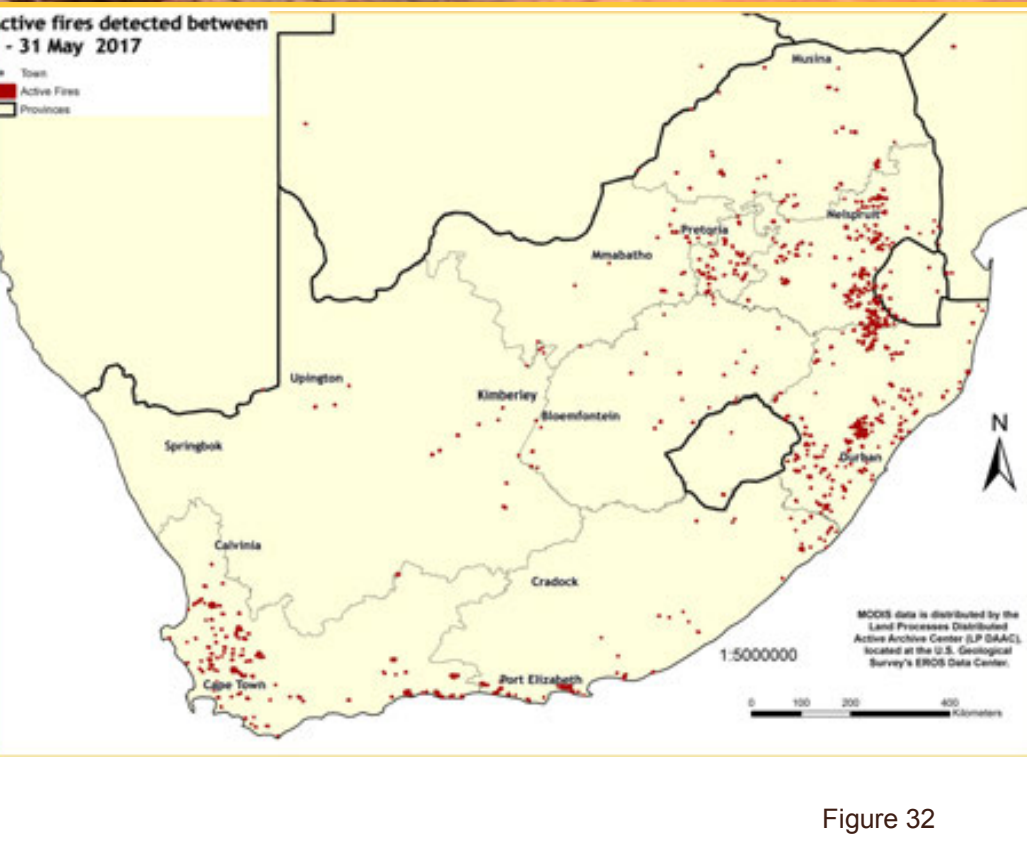


Figure 31



**Figure 32:**

The map shows the location of active fires detected between 1-31 May 2017.

Figure 32



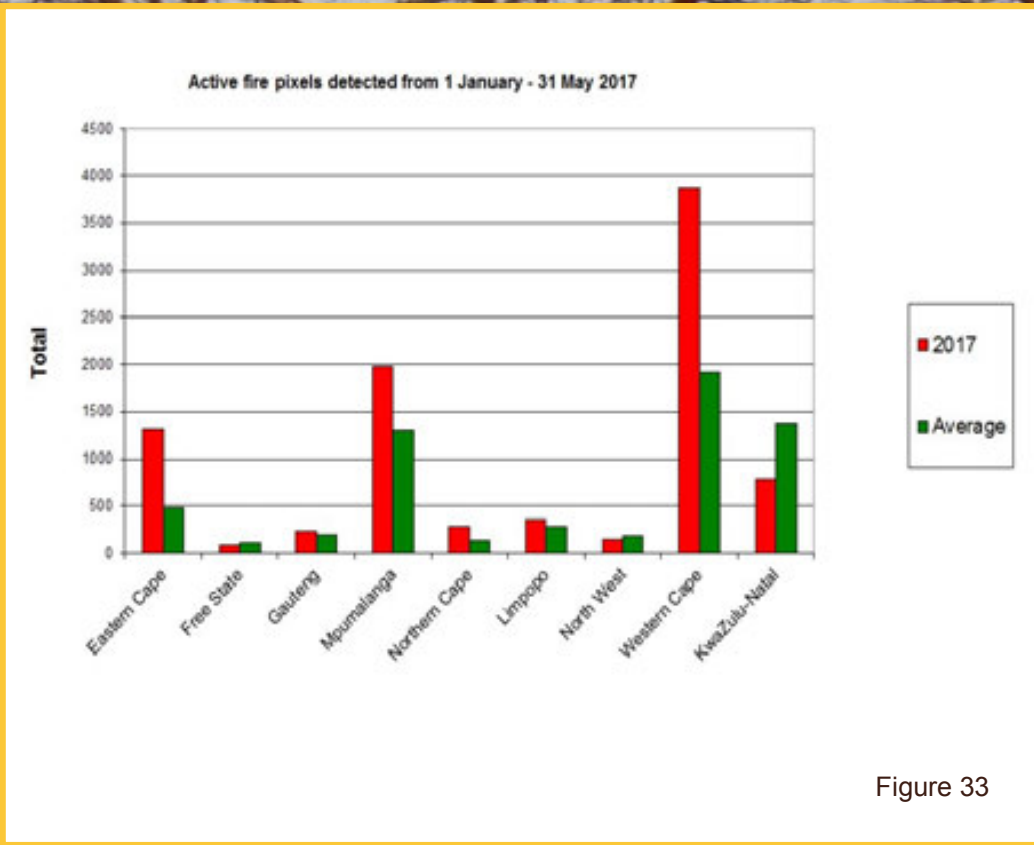


Figure 33

**Figure 33:**  
 The graph shows the total number of active fires detected from 1 January - 31 May 2017 per province. Fire activity was higher in all provinces except the Free State, North West and KwaZulu-Natal compared to the average during the same period for the last 17 years.

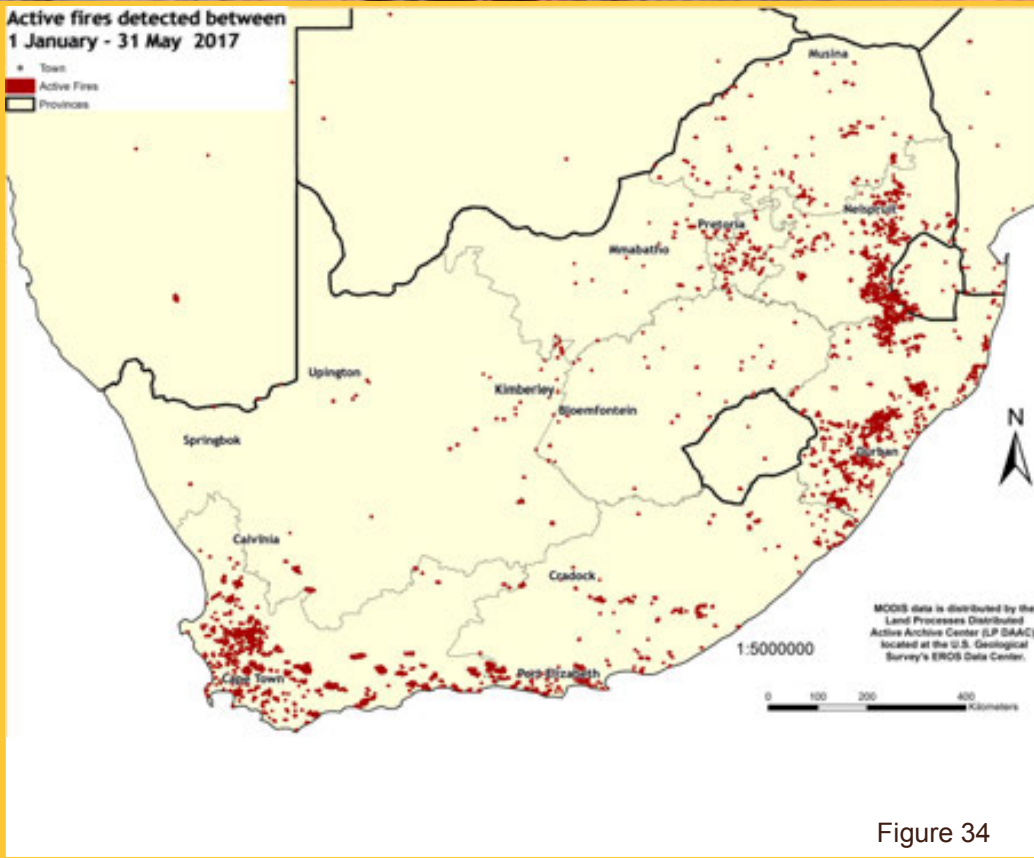
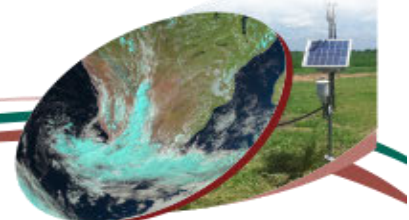


Figure 34

**Figure 34:**  
 The map shows the location of active fires detected between 1 January - 31 May 2017.

**Questions/Comments:**  
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# 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



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### Climate Change Adaptation & Mitigation

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

### Climate Information Dissemination

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

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# Geoinformation Science



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



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### Early Warning & Food Security

- Drought and vegetation production monitoring
- Crop estimates and yield modelling
- Animal biomass and grazing capacity mapping
- Global and local agricultural outlook forecasts
- Disaster monitoring for agricultural systems

### Natural Resources Monitoring

- Land use/cover mapping
- Invasive species distribution
- Applications of GIS and EO on land degradation/erosion, desertification, hydrology and catchment areas
- Rangeland health assessments
- Carbon inventory monitoring

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# The Coarse Resolution Imagery Database (CRID)

## NOAA AVHRR

The ARC-ISCW has an archive of daily NOAA AVHRR data dating from 1985 to 2004. This database includes all 5 bands as well as the Normalized Difference Vegetation Index (NDVI), Active Fire and Land Surface Temperature (LST) images. The NOAA data are used, for example, for crop production and grazing capacity estimation.

## MODIS

MODIS data is distributed by the Land Processes Distributed Active Archive Center (LP DAAC), located at the U.S. Geological Survey's EROS Data Center. The MODIS sensor is more advanced than NOAA with regard to its high spatial (250 m<sup>2</sup> to 1 km<sup>2</sup>) 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>.



*Excellence in Research and Development*

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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.

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What does Umlindi mean?

UMLINDI is the Zulu word for "the watchman".

<http://www.agis.agric.za>

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