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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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

South African Weather Service

AMESD

157th Edition

Image of the Month

The Knysna fires viewed from space

The strong winter storm that brought extreme wind and some rain to the drought stricken Western Cape at the beginning of June was associated with an exceptional deep low pressure system. This system migrated eastwards while being relatively close to the country, inducing strong northerly winds and hot conditions along the Garden Route. These weather conditions in combination with the current drought were conducive to the spread of wildfires. The fires that occurred near Knysna and Plettenberg Bay were one of the most severe fire events ever experienced in this region. Sustained strong winds averaging 70 km/h made fire extinguishing operations by air too dangerous, and rainfall associated with the storm was too limited over the region to aid in naturally containing the multiple wildfires. Ten thousand residents from the town of Knysna had to be evacuated overnight on 7 June as the fire threatened the town. The image was taken by an astronaut from the Expedition 52 Crew on the International Space Station on 14 June, a week after the fires started. Smoke from smouldering fires can still be seen in this image. Smoke is visible over Knysna, as well as an approximate west-east orientated smoke "front" over the sea south of Knysna. The southward extension of the smoke over the sea is an indication of the intensity of the bergwind conditions that fanned the flames of the fires. This image was taken as local government requested assistance through the International Charter: Space and Major Disasters.

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:

After months of below-normal rainfall over the Western Cape, the month of June 2017 received normal to above-normal rainfall with the more frequent arrival of frontal systems that brought rainfall to the region. The largest contribution to rainfall over the Western Cape occurred during the first 10 days of the month in association with the strong cold front that moved over the south-western parts of the country on the 7th of June, followed by another frontal system on the 9th to 10th. During this same period, bergwind conditions occurred ahead of the frontal systems over the Garden Route region and in combination with the prevailing dry conditions created the ingredients for veld fires. The deep low pressure system of the 7th was located relatively close to the subcontinent as it moved eastwards. This caused a tight pressure gradient orientated in such a way that it promoted the occurrence of strong winds and unfavourable conditions for rainfall to aid in extinguishing the veld fires naturally. From the map showing the total rainfall for June (Figure 1), it is evident that the Garden Route region received less than 25 mm during the entire month. This is the result of the frontal systems (although more frequent than during the preceding months) not properly invading the country to allow ridging high pressure systems to bring rainfall to those areas. The effect of this process can be clearly seen on the map showing the percentage of normal rainfall over the country for June (Figure 2), where the areas of above-normal rainfall are confined to the far western parts of the country.

The middle 10 days of the month were characterized by the quick succession of weak frontal systems, with rainfall limited to the Western Cape with only the more mountainous areas that received decent rainfall totals during this period. During the last 10-day period, better developed frontal systems made landfall again that brought rainfall of up to 20 mm over some areas in the Western Cape. In general, the upper-air support that accompanied the frontal systems was weak, explaining the patchy nature of the areas that did receive above-normal rainfall.

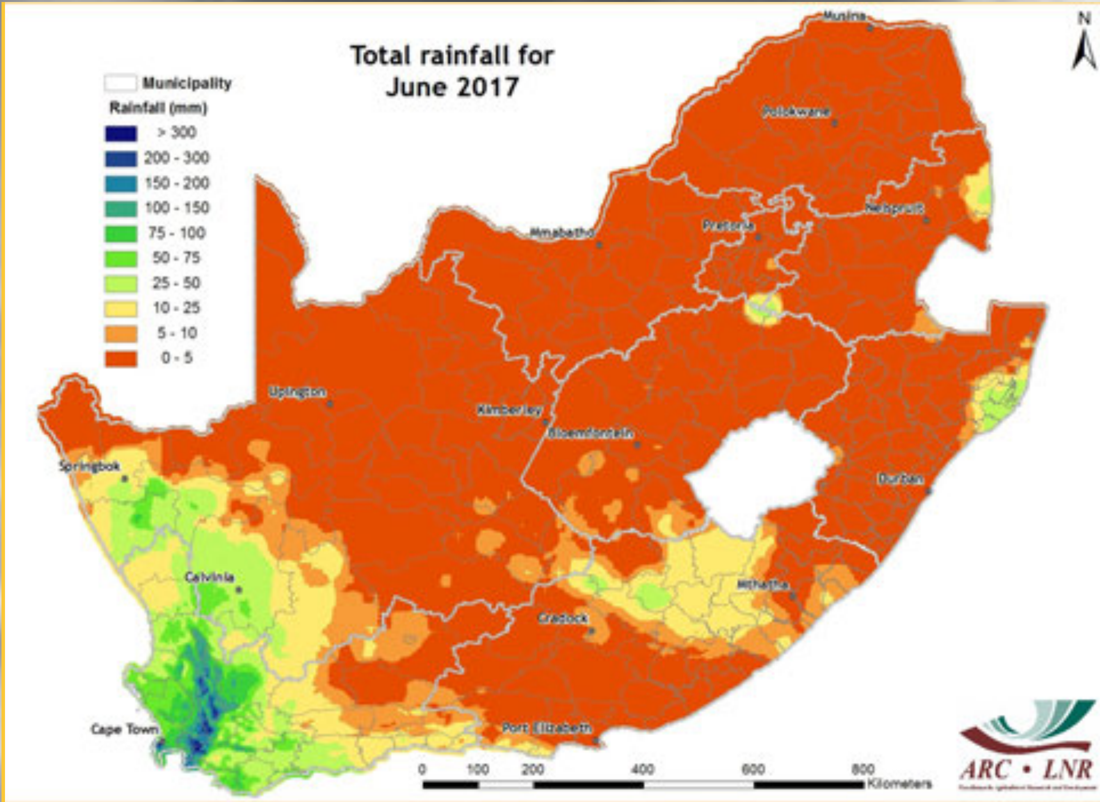

Figure 1

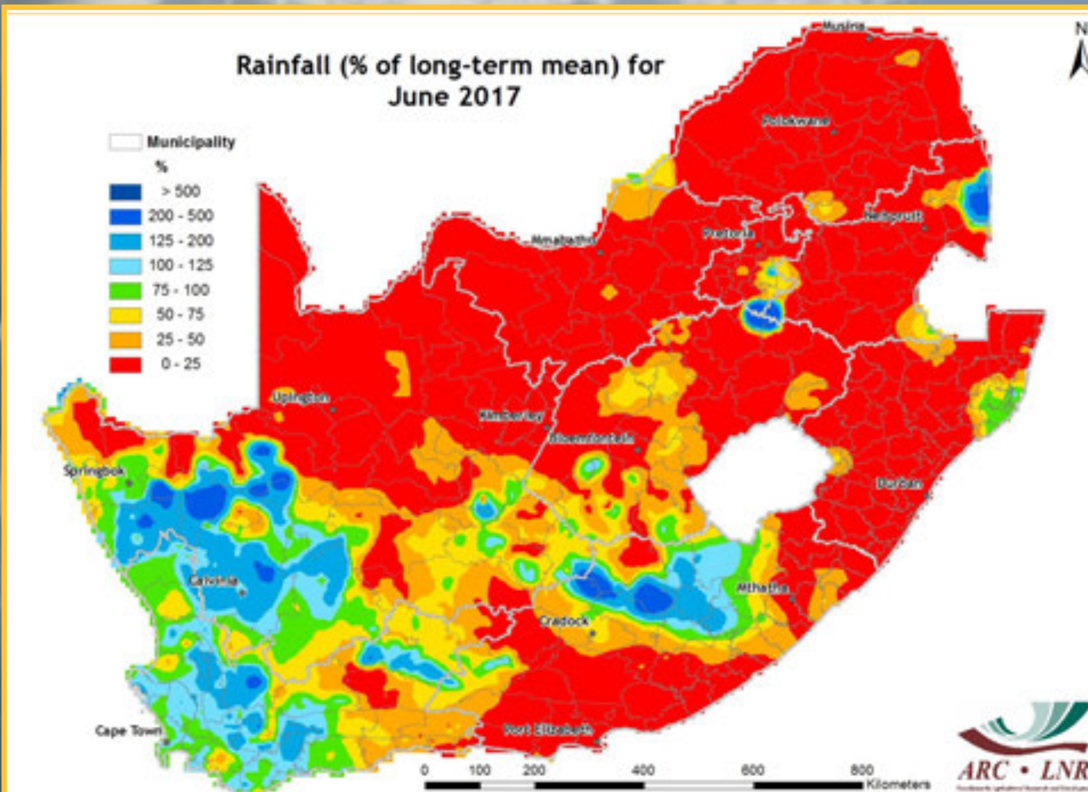

Figure 2

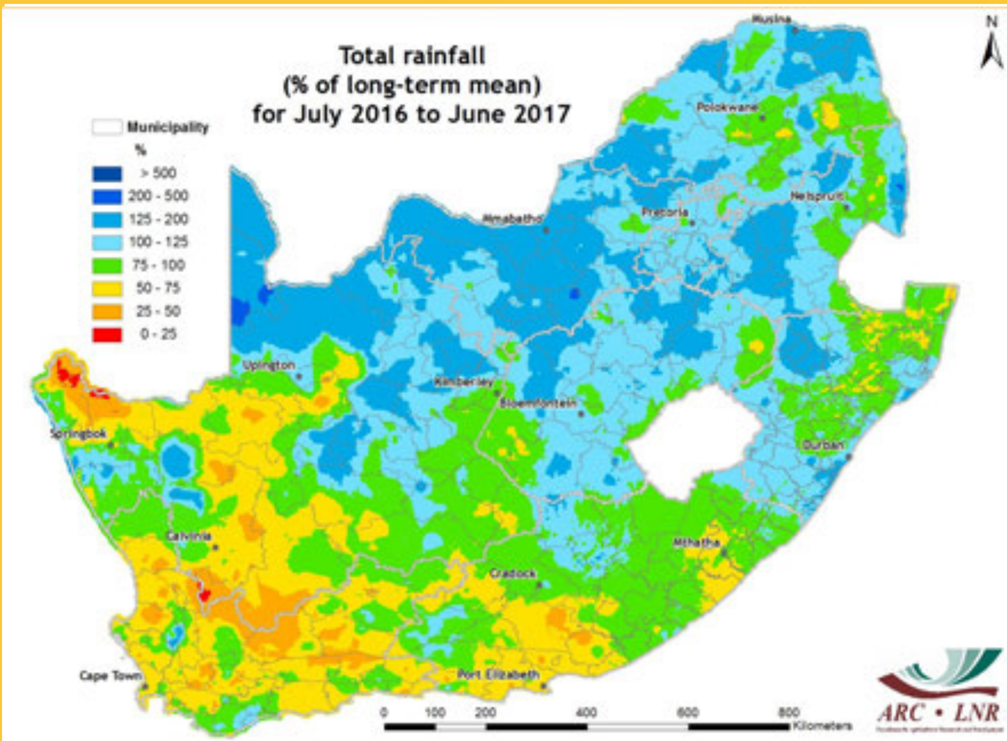

Figure 3

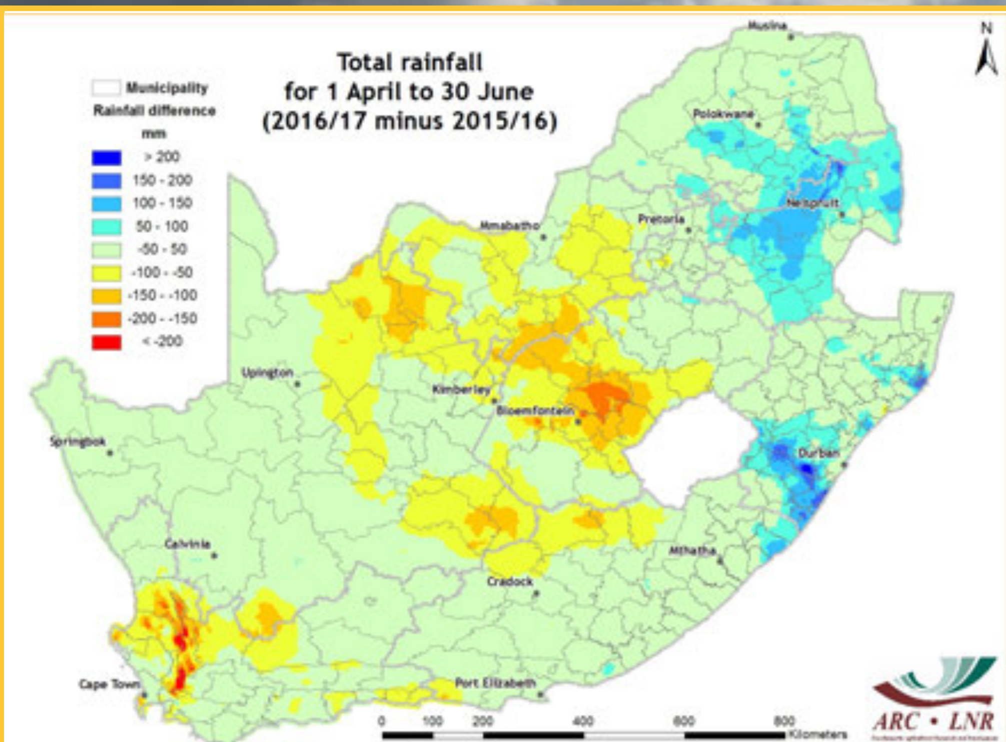

Figure 4

Figure 1:
Rainfall during the month of June was mostly confined to the far western parts of the country where the largest totals occurred over the mountainous areas. Rainfall totals exceeding 10 mm also occurred in isolated areas over the summer rainfall region.

Figure 2:
Above-normal rainfall occurred over parts of the Western Cape and the Northern Cape as well as over isolated areas of the summer rainfall region. The all-year rainfall region along the Cape south coast received rainfall far below normal for this time of the year.

Figure 3:
In the 12-month period since July 2016, rainfall over the northern to central parts of the country was mostly normal to above normal. The remainder of the country received mostly below-normal rainfall during this period.

Figure 4:
Compared to April-June 2015/16, the corresponding 3-month period during 2016/17 received 50-150 mm more rainfall over parts of Limpopo, Mpumalanga and KwaZulu-Natal. Up to 200 mm less occurred during 2016/17 over the mountainous areas of the Western Cape compared to 2015/16.

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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.

Severe drought is present over the southwestern parts of the country at both the long to short time scales. At the longer time scales, severe to extreme drought is present over the eastern seaboard and adjacent interior regions, gradually recovering towards the shorter time scale, whilst increased drought conditions become evident along the Cape south coast.

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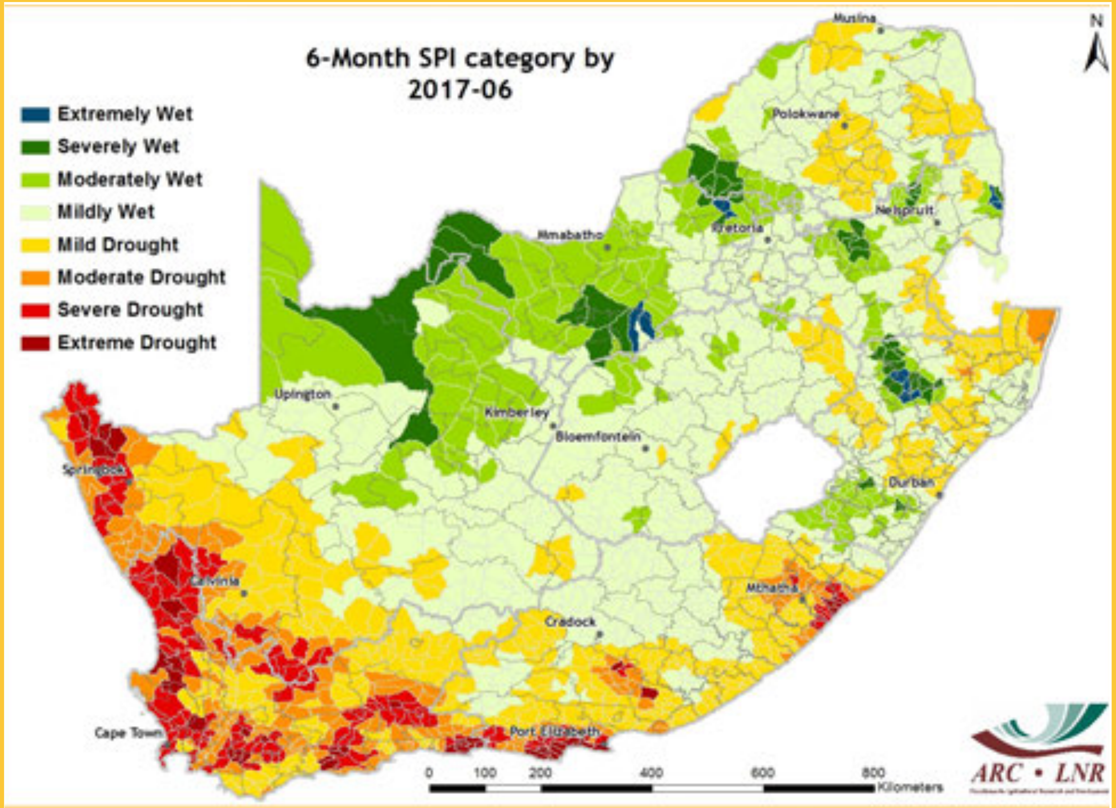
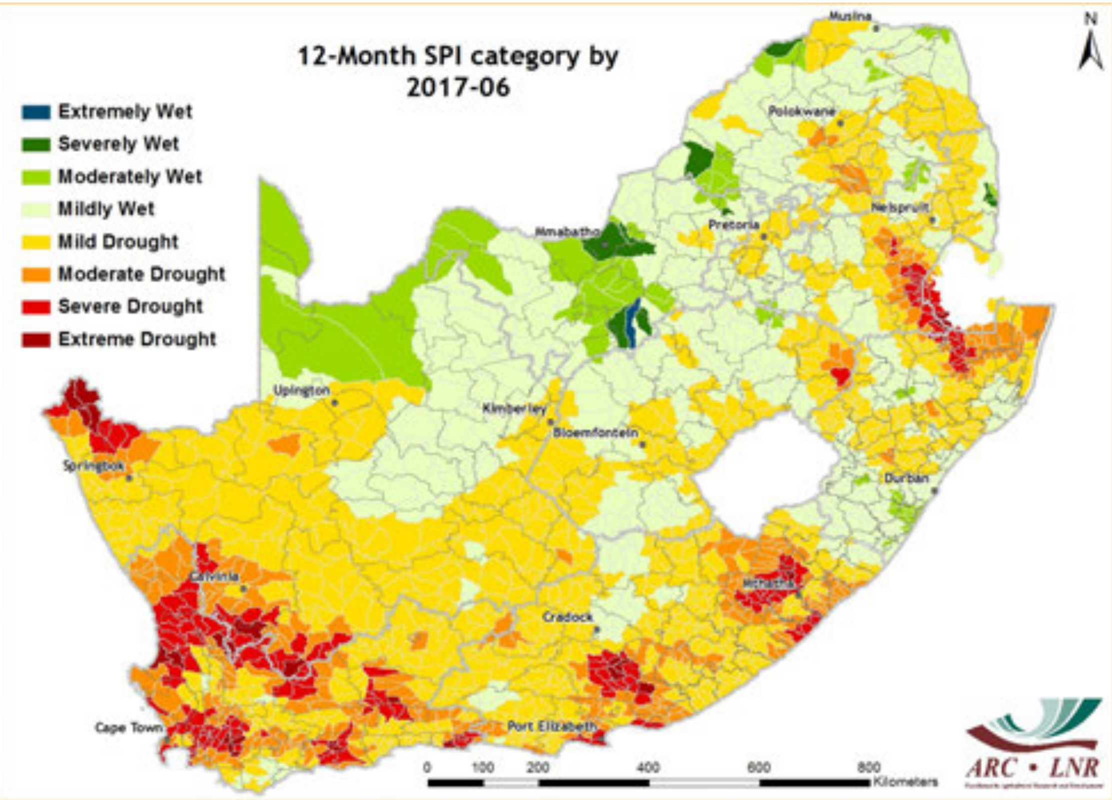


Figure 5



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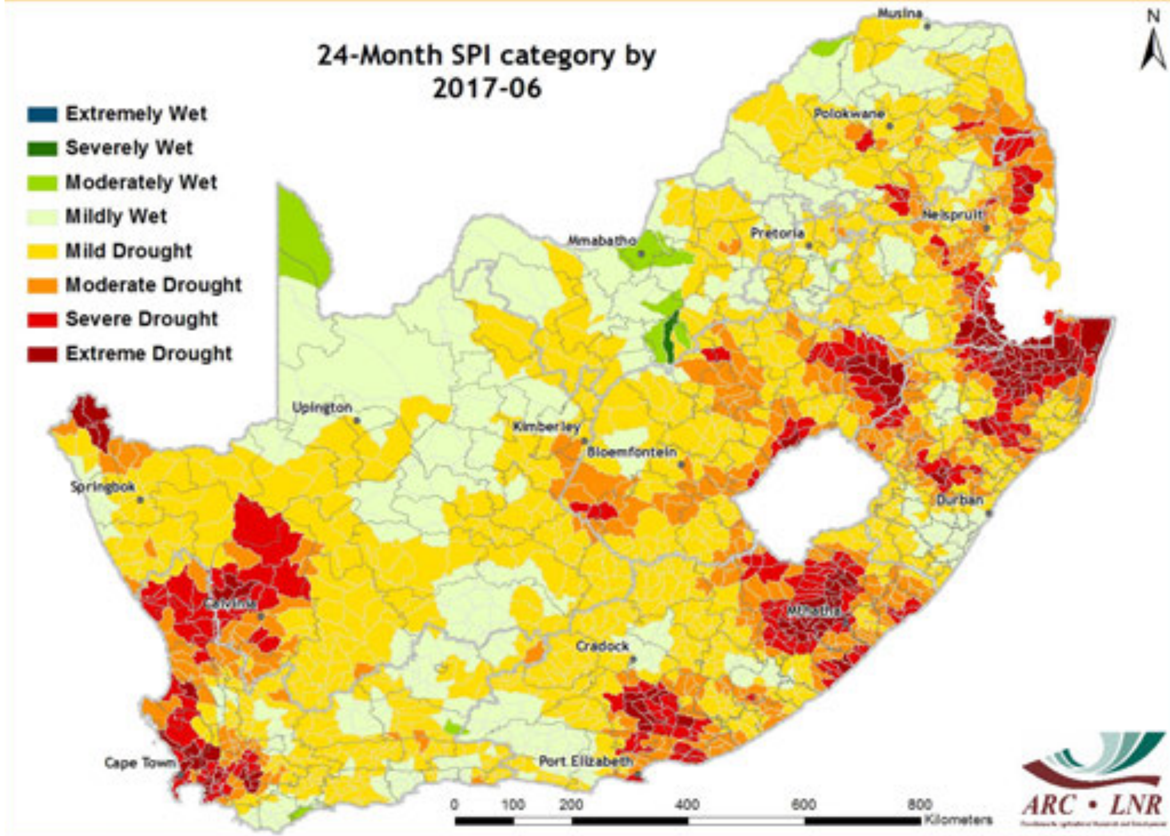

Figure 7

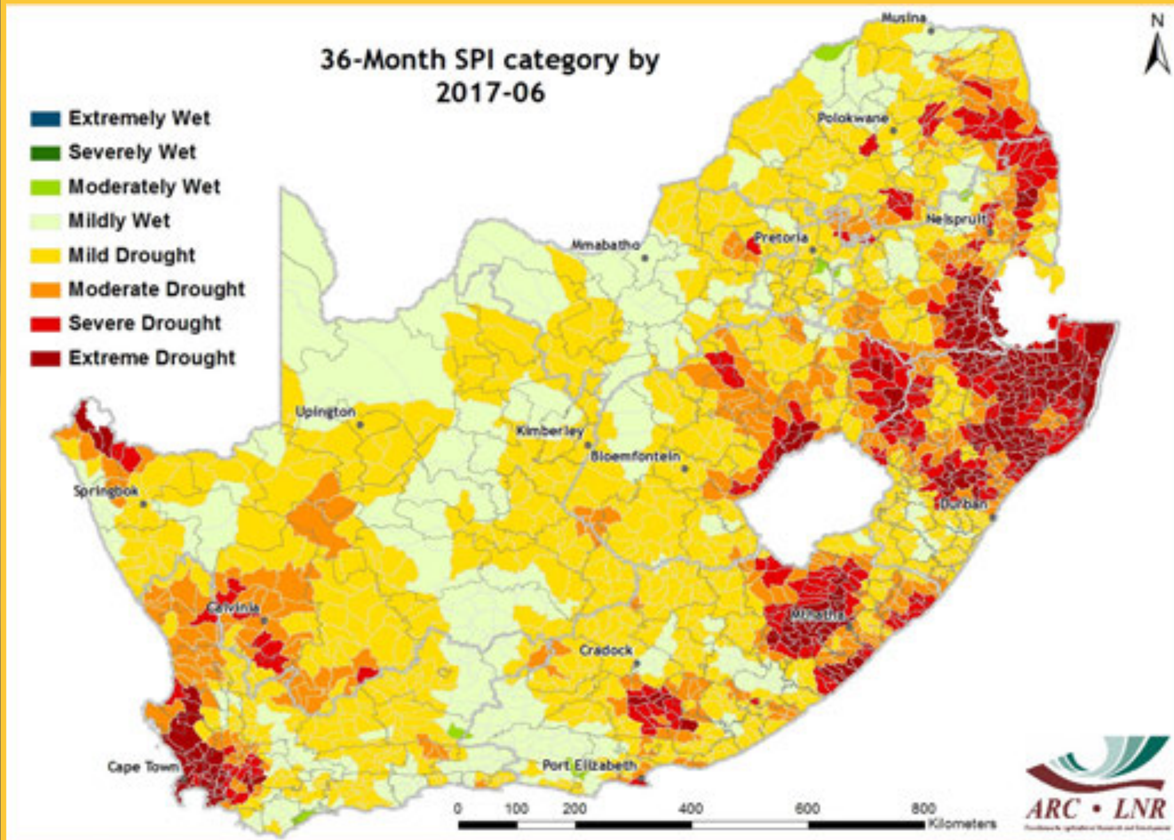

Figure 8

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.

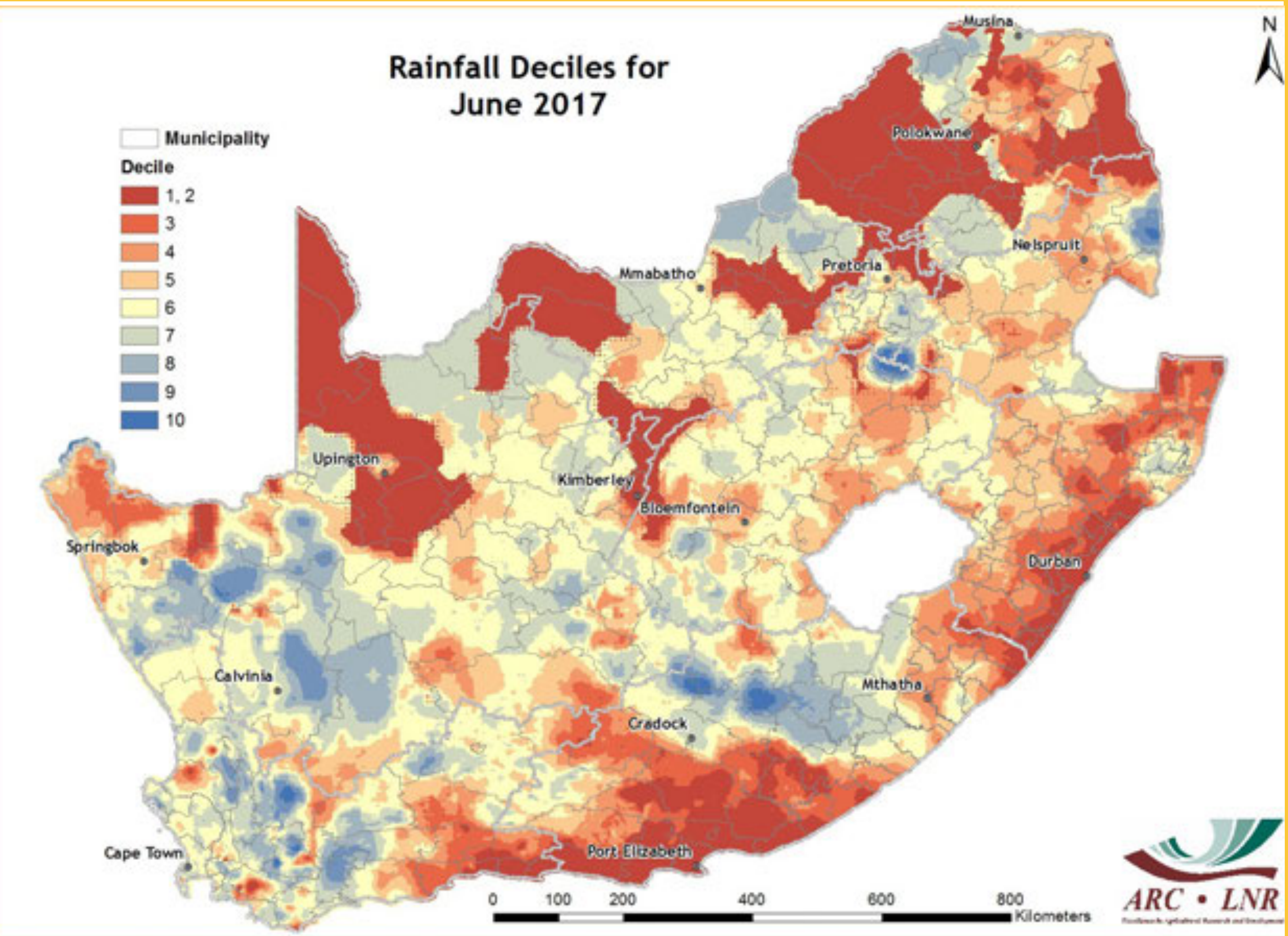

Figure 9

Figure 9:
Areas over the Western Cape and Northern Cape were wet during June 2017 compared to historical June months. In contrast the Cape south coast region was very dry.

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4. Water Balance

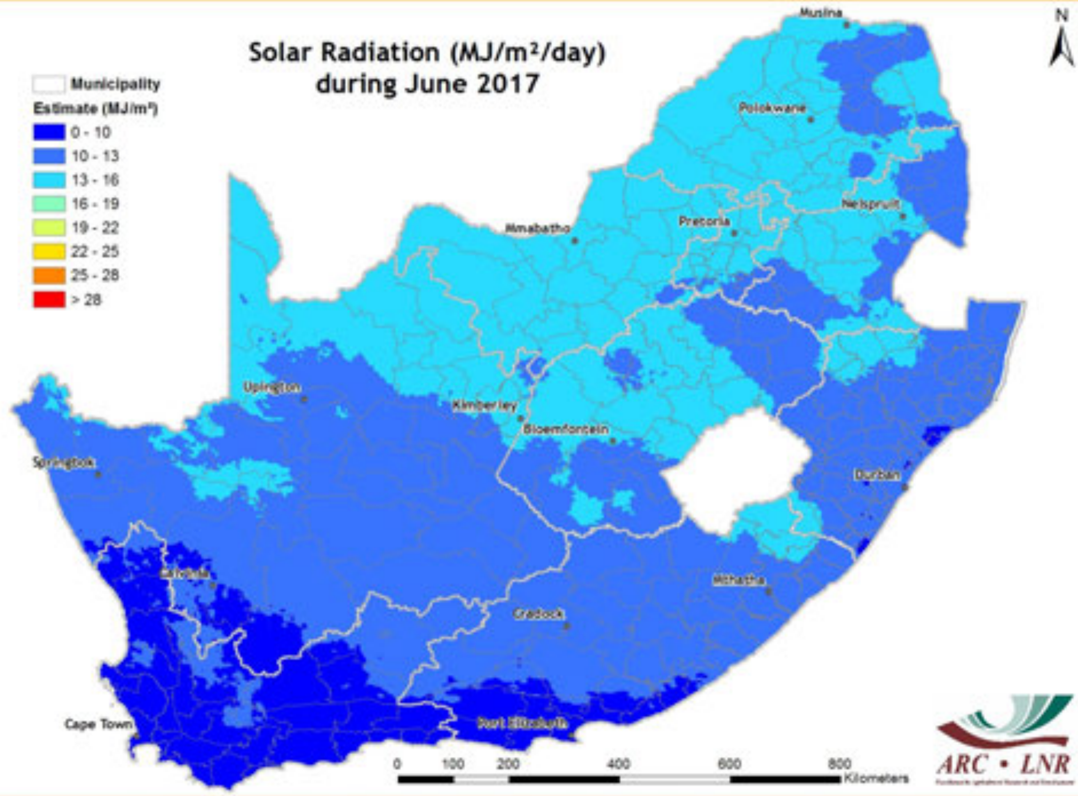

Figure 10

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 south-western parts of the country and along the Cape south coast with higher values further northwards.

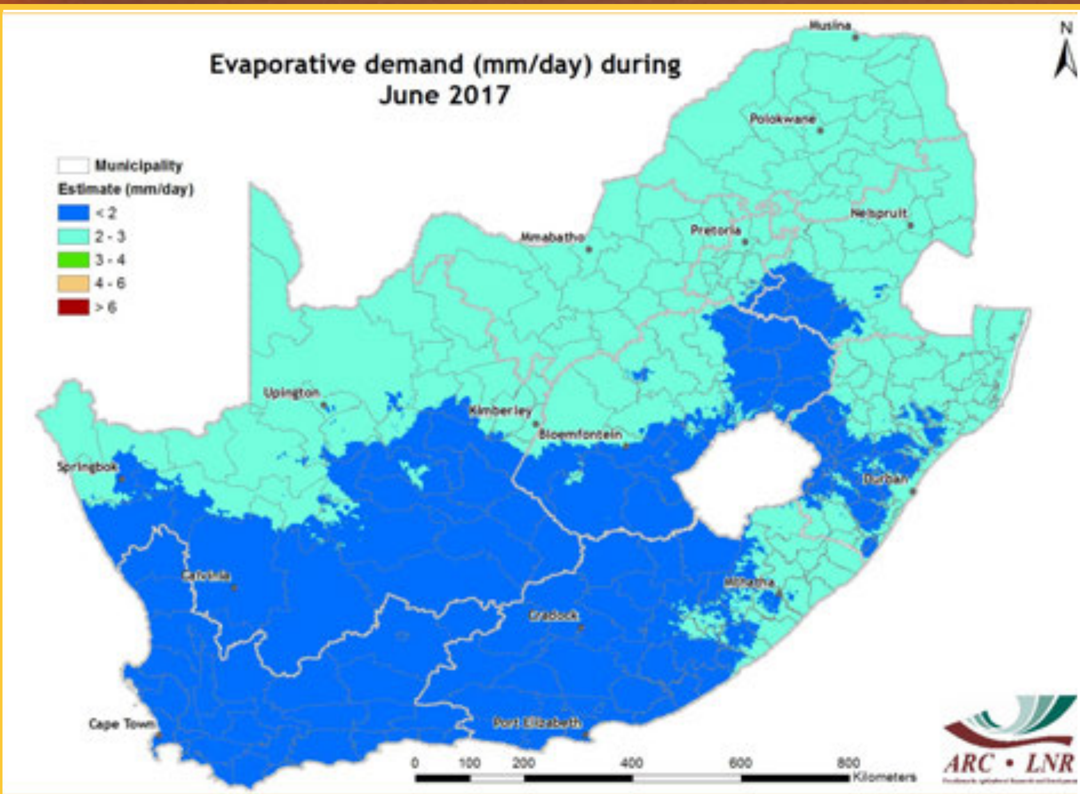

Figure 11

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 was less than 3 mm/day over the entire country, with the lowest demand over the southern parts of the country.

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5. 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.

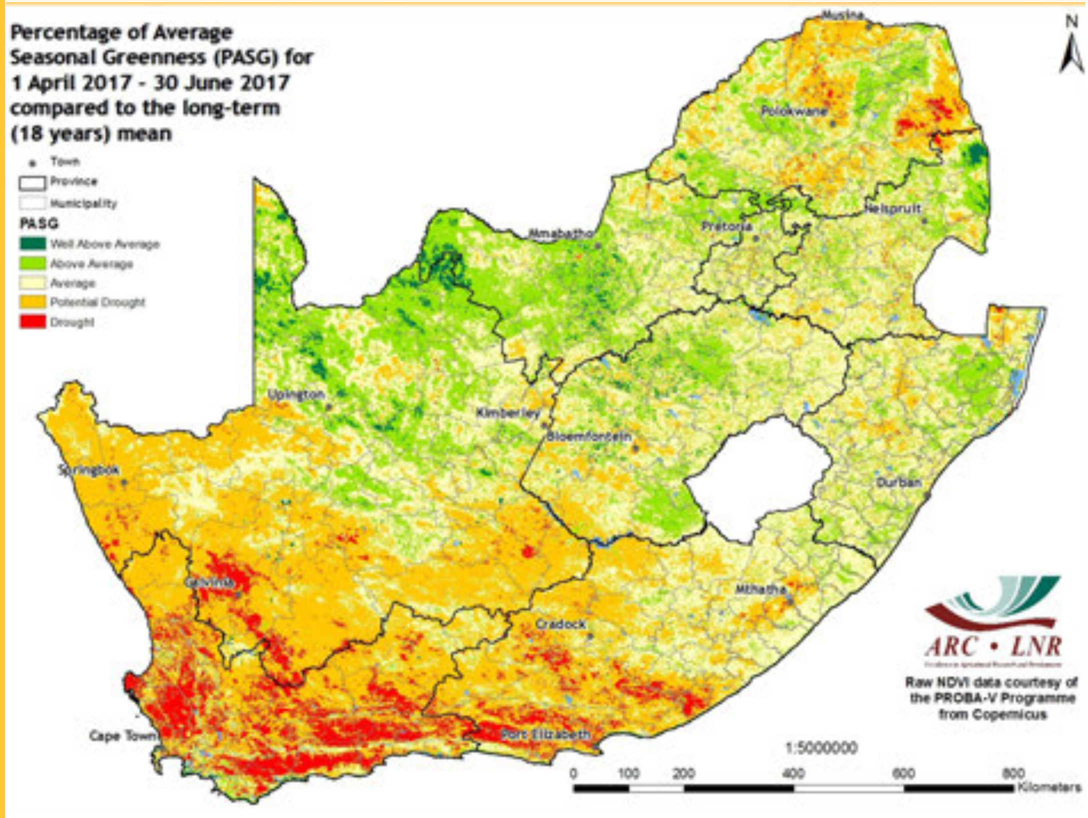

Figure 12

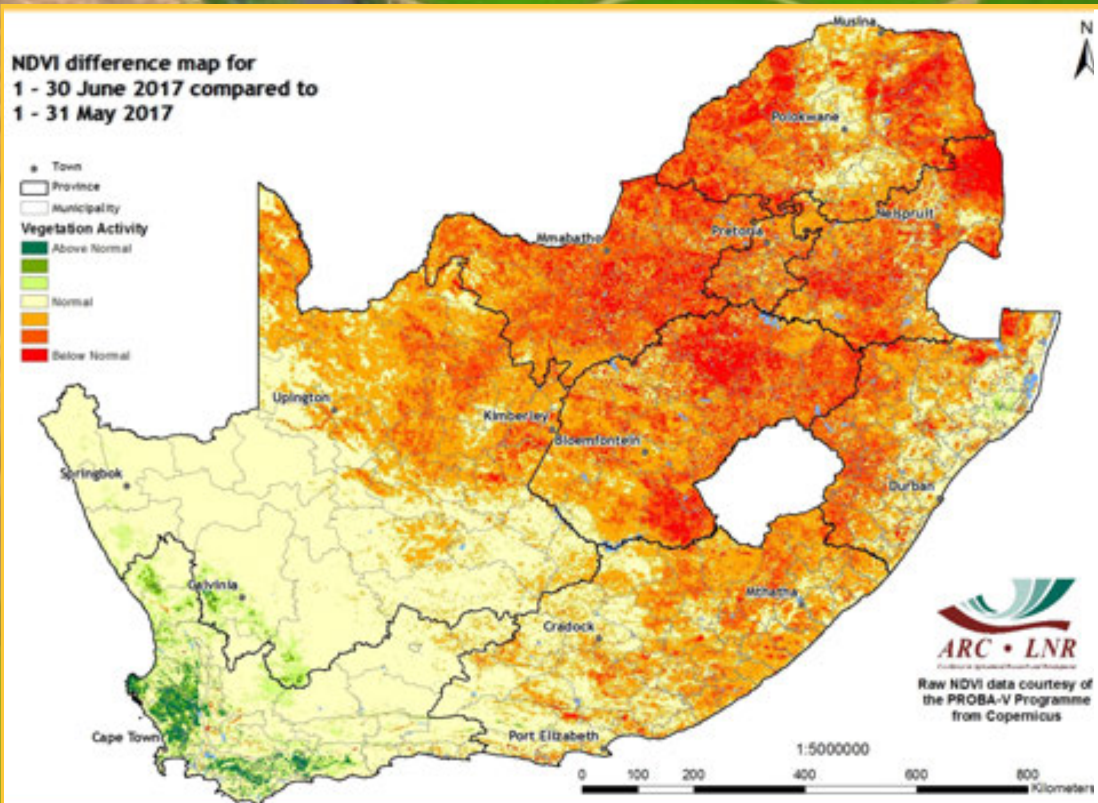

Figure 13

Figure 12:
The 3-month moving cumulative PASG indicates drought conditions over the winter rainfall region and the Highveld areas of Limpopo. The map also indicates average to above-average PASG in the central parts of the country.

Figure 13:
Widespread rain in the southwest and west resulted in a large increase in vegetation activity over the winter rainfall region while low rainfall and frost resulted in further decreases in vegetation activity over the interior, the eastern and northern parts.

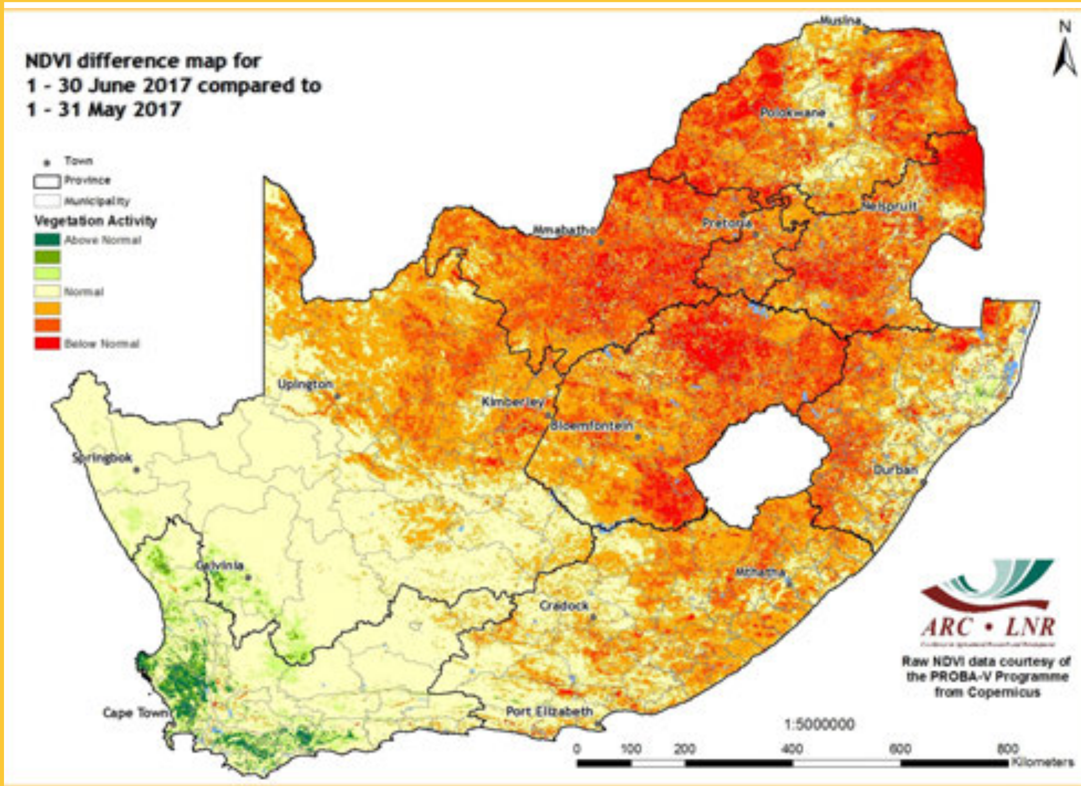

Figure 14

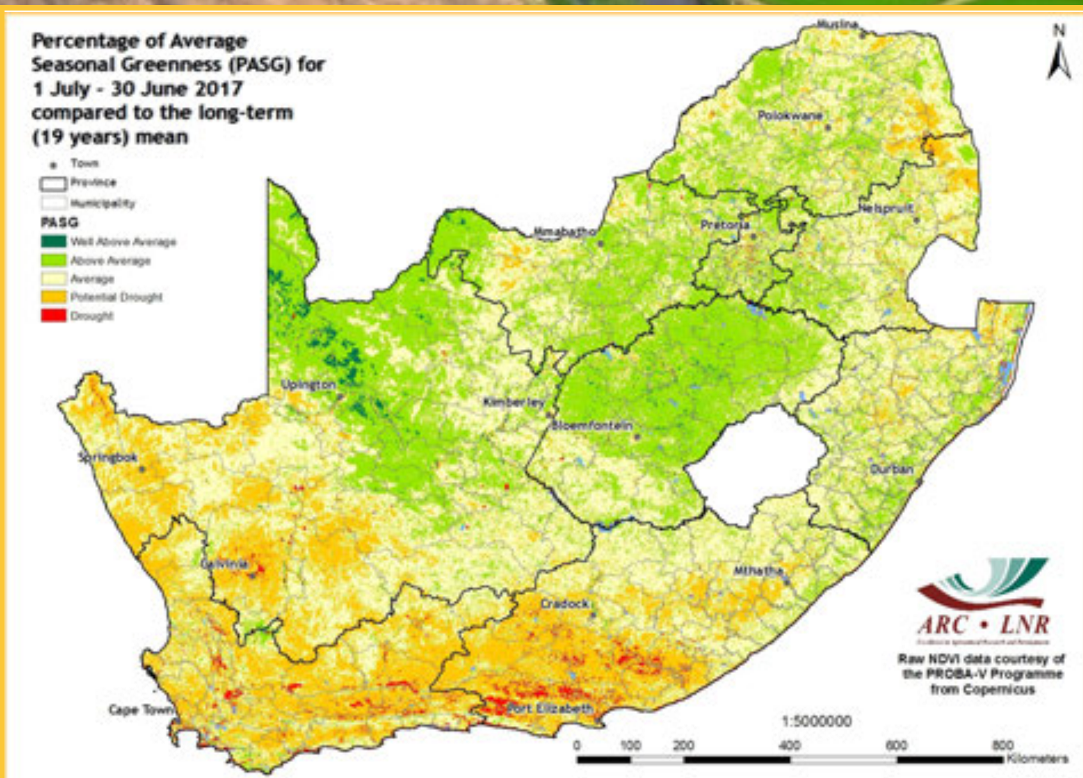

Figure 15

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

Figure 14:
Vegetation activity was higher than last year over the winter rainfall region and several isolated areas in the extreme east of KwaZulu-Natal.

Figure 15:
Cumulative vegetation activity is still normal to above normal over much of the interior. Notable exceptions are the northern parts of KwaZulu-Natal, eastern Mpumalanga and Limpopo, western parts of the Northern Cape and Eastern Cape, and most parts of the Western Cape.

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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.

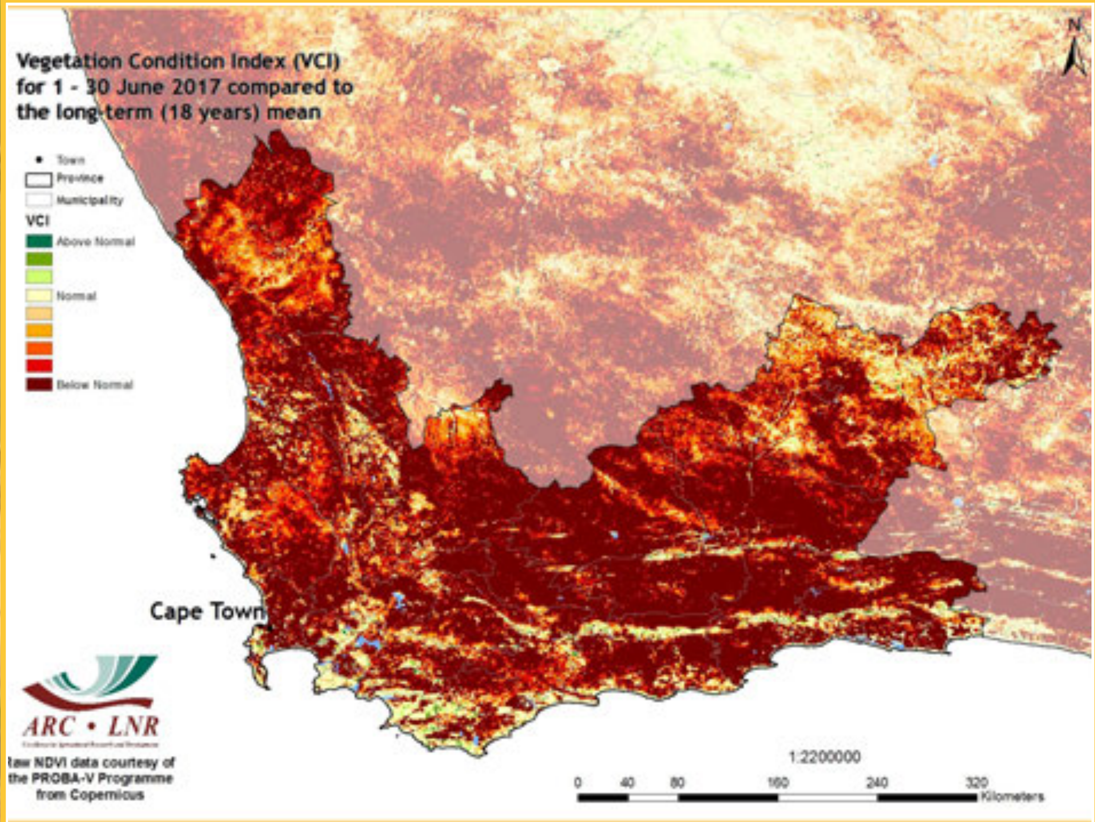


Figure 16

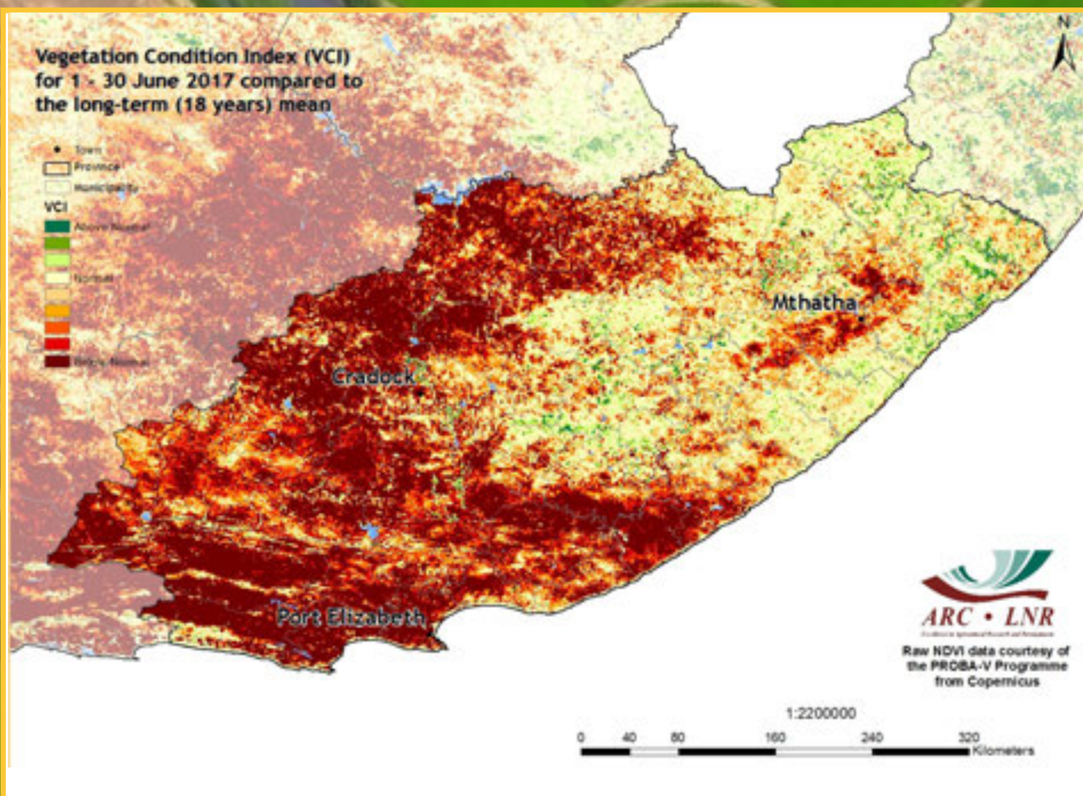
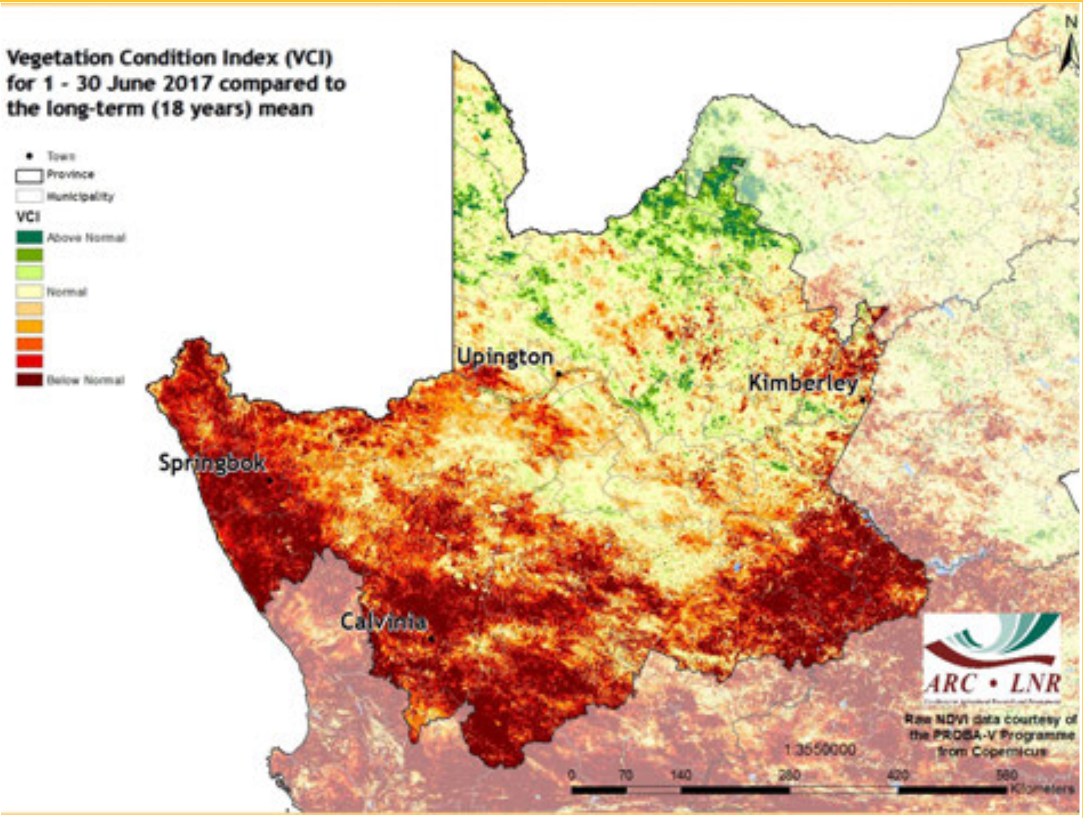


Figure 17

Figure 16:
The VCI map for June indicates below-normal vegetation activity over most parts of the Western Cape.

Figure 17:
The VCI map for June indicates below-normal vegetation activity over the western parts of the Eastern Cape, as well as the Mthatha region.



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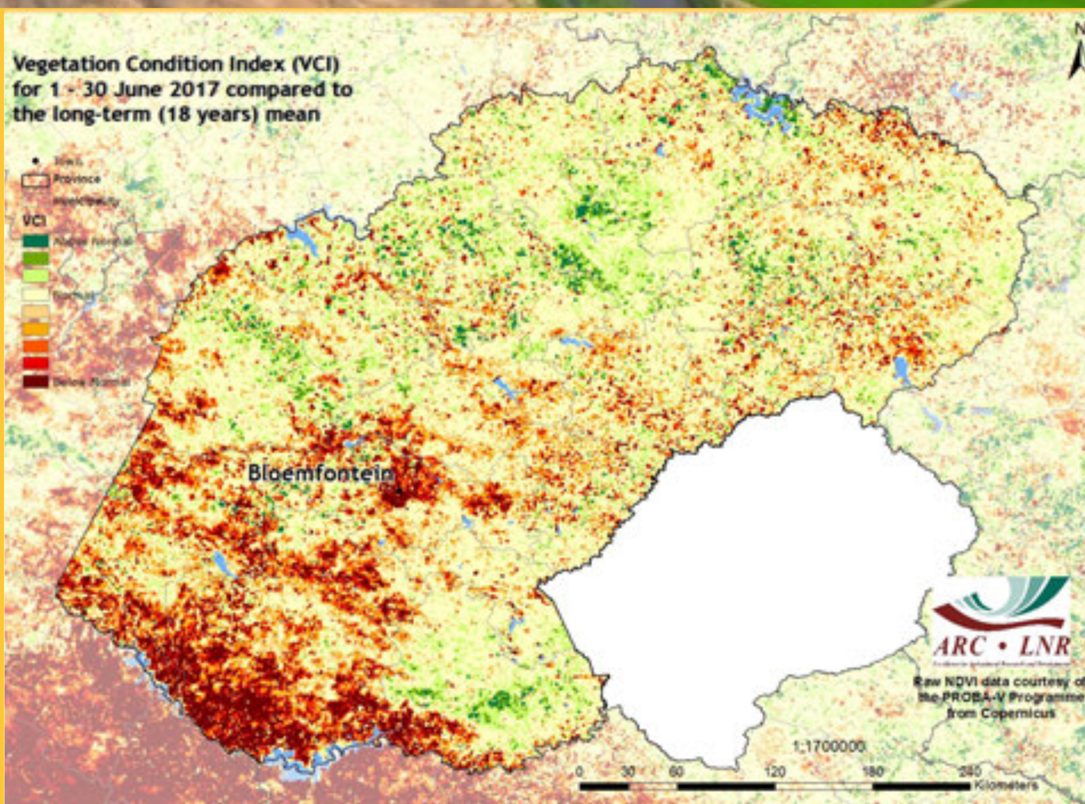

Figure 19

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

Figure 19:
The VCI map for June indicates below-normal vegetation activity over southwestern parts as well as other isolated areas of the Free State.

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7. Vegetation Conditions & Rainfall

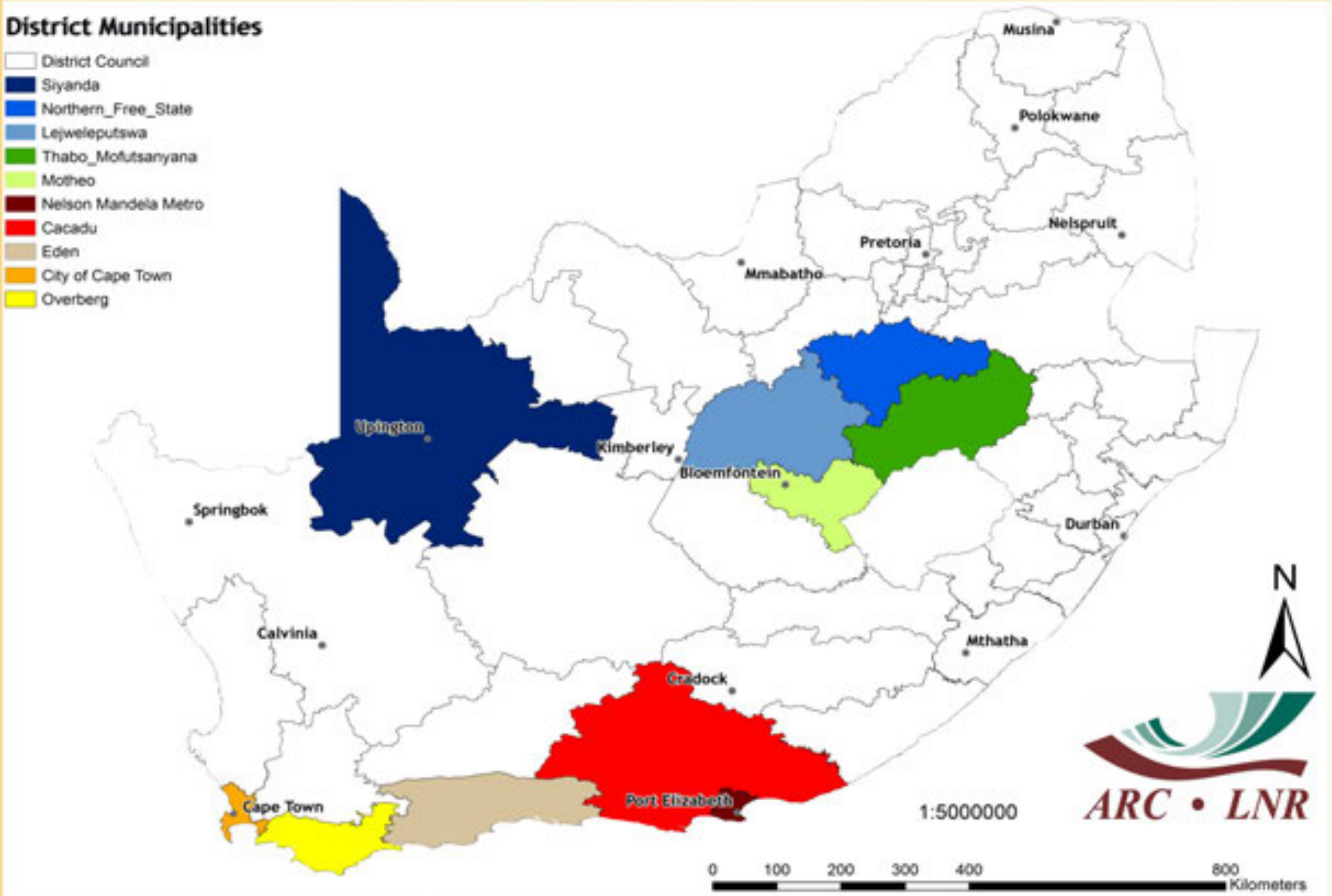

Figure 20

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

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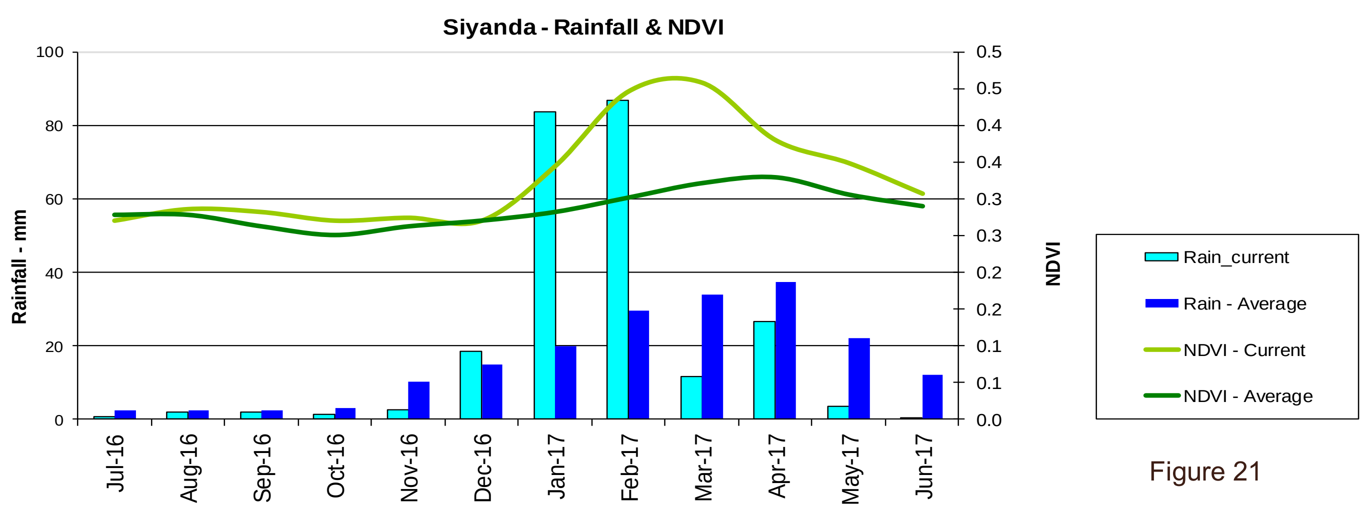
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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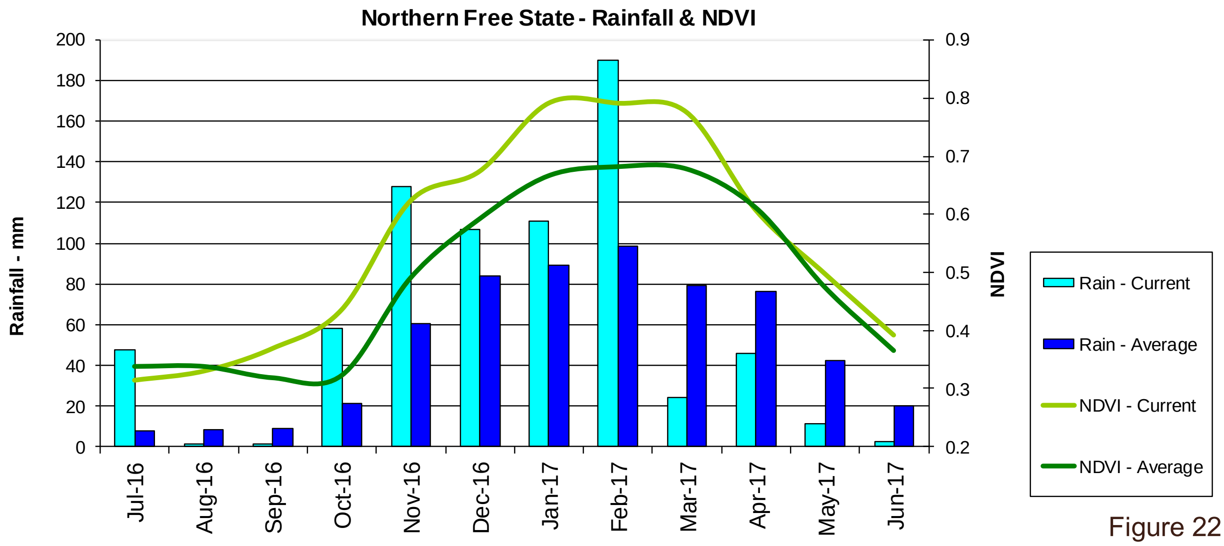

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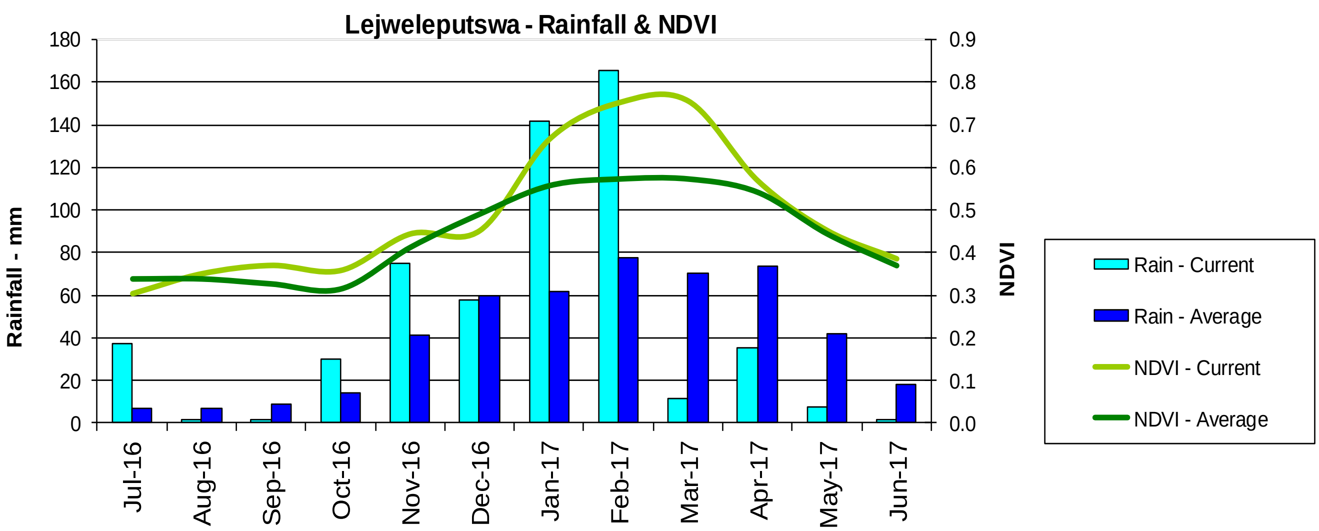

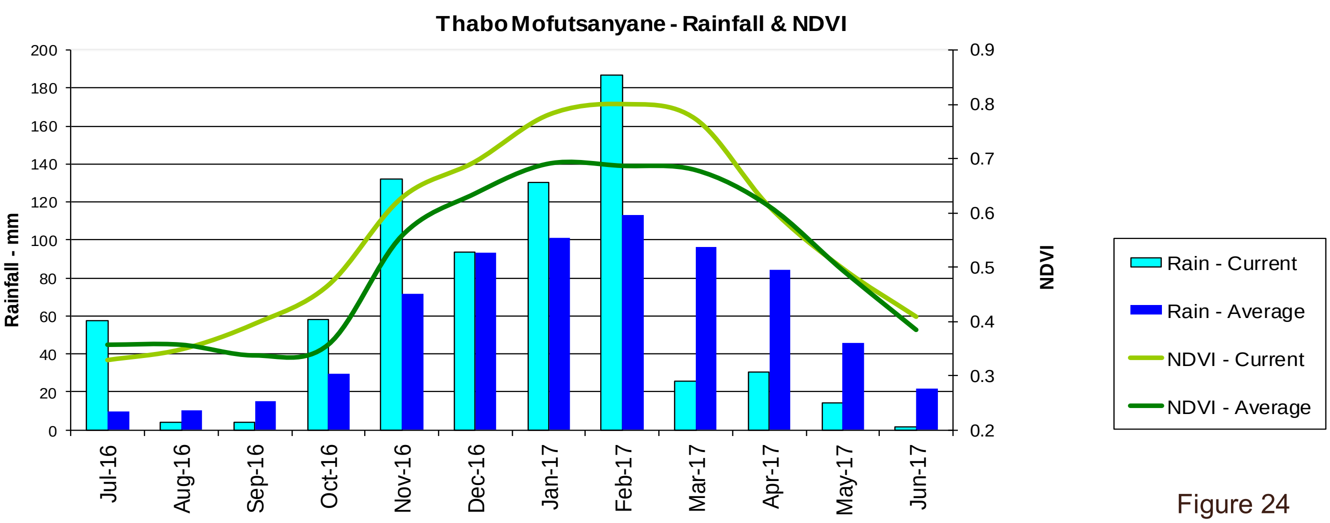

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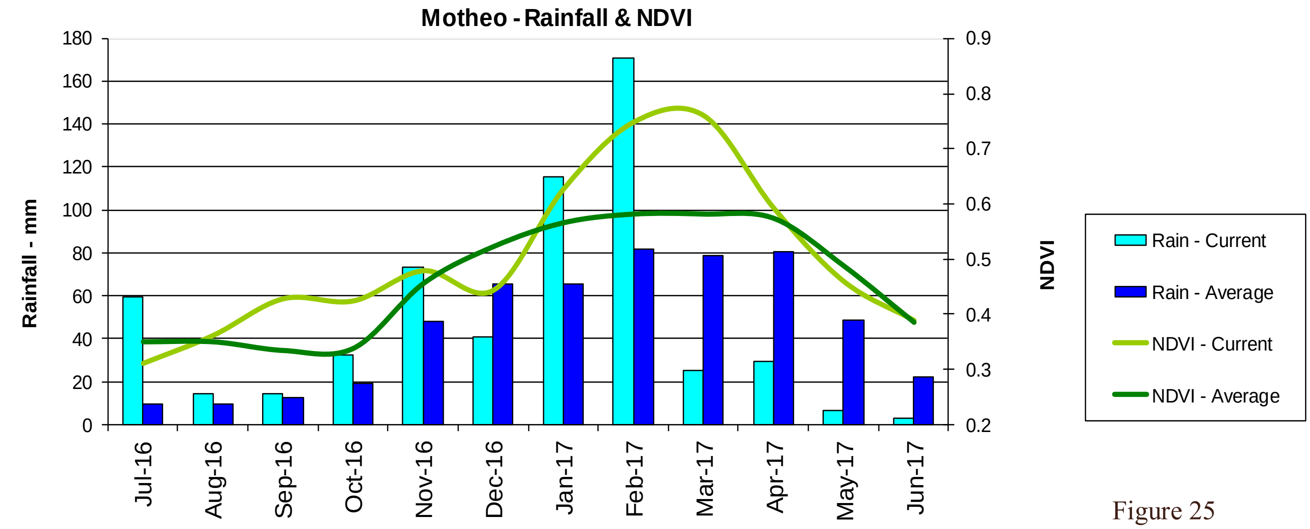

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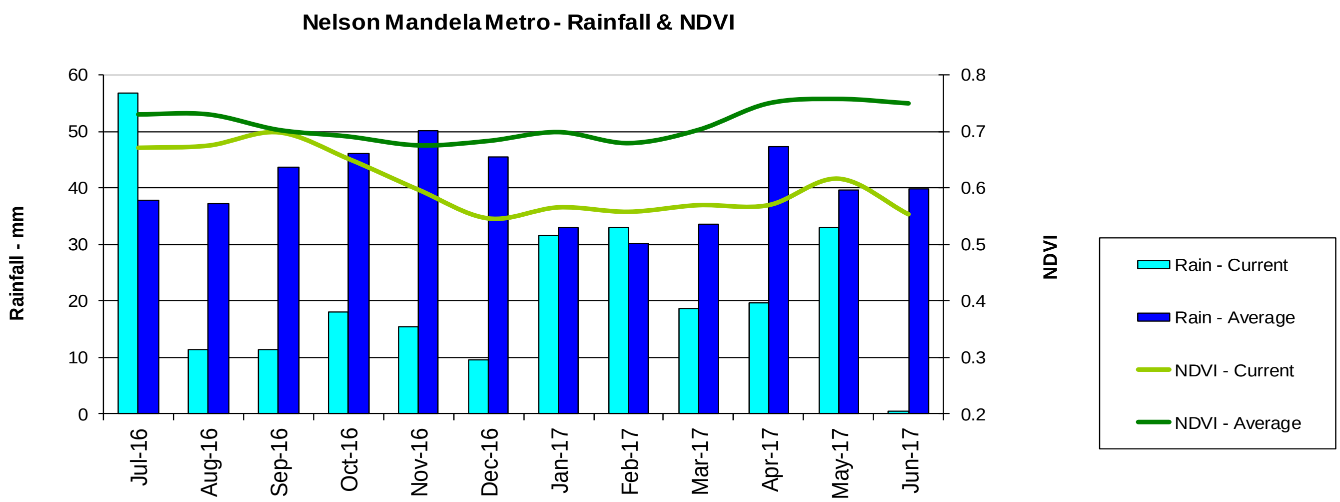

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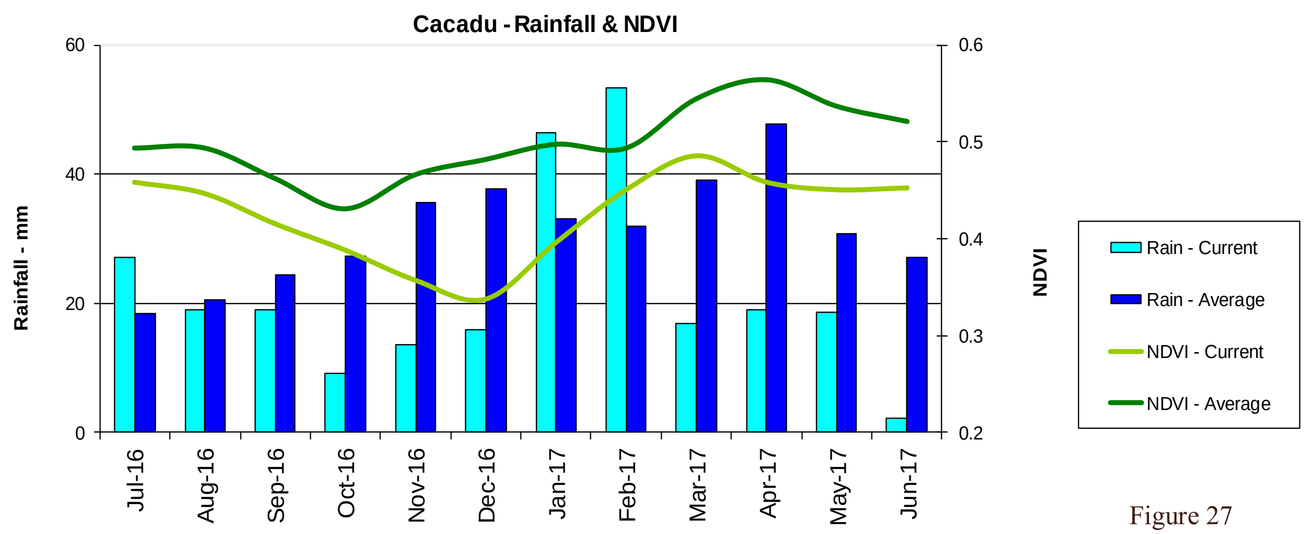

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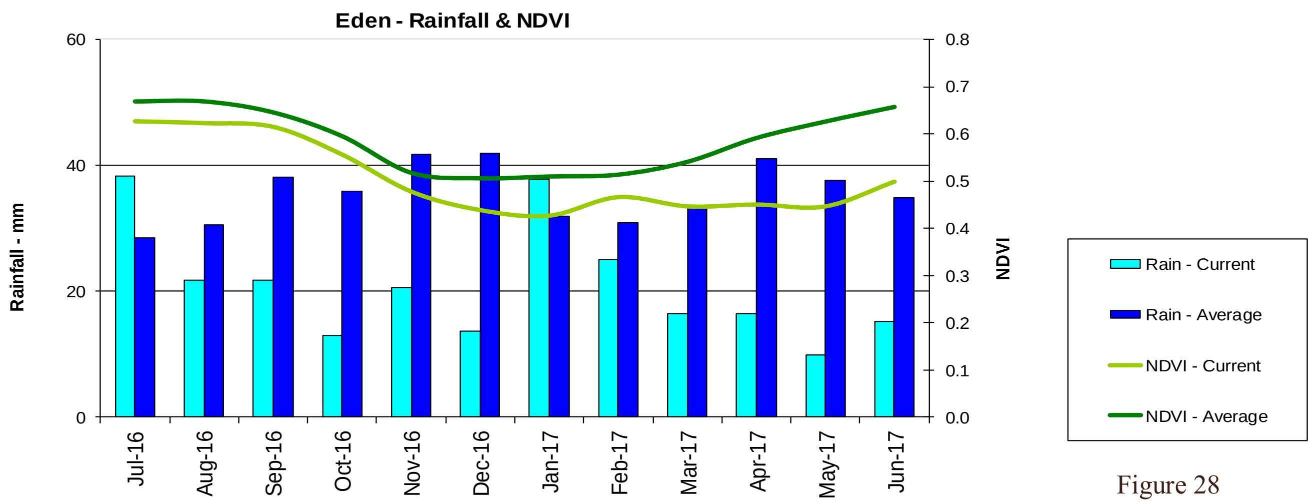

Figure 28

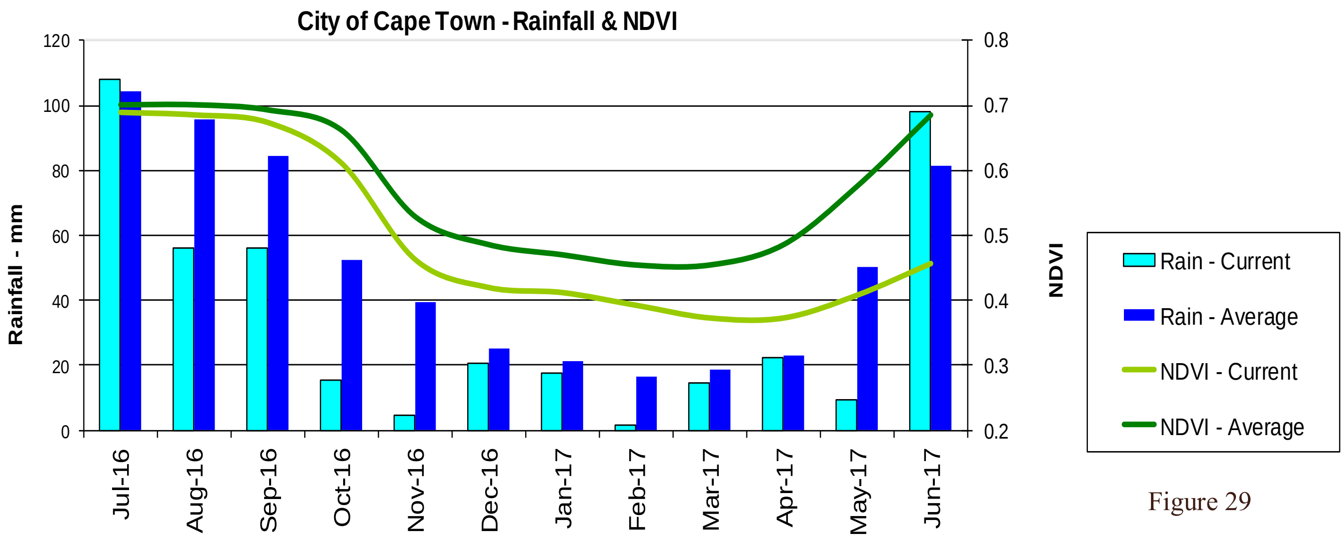

Figure 29

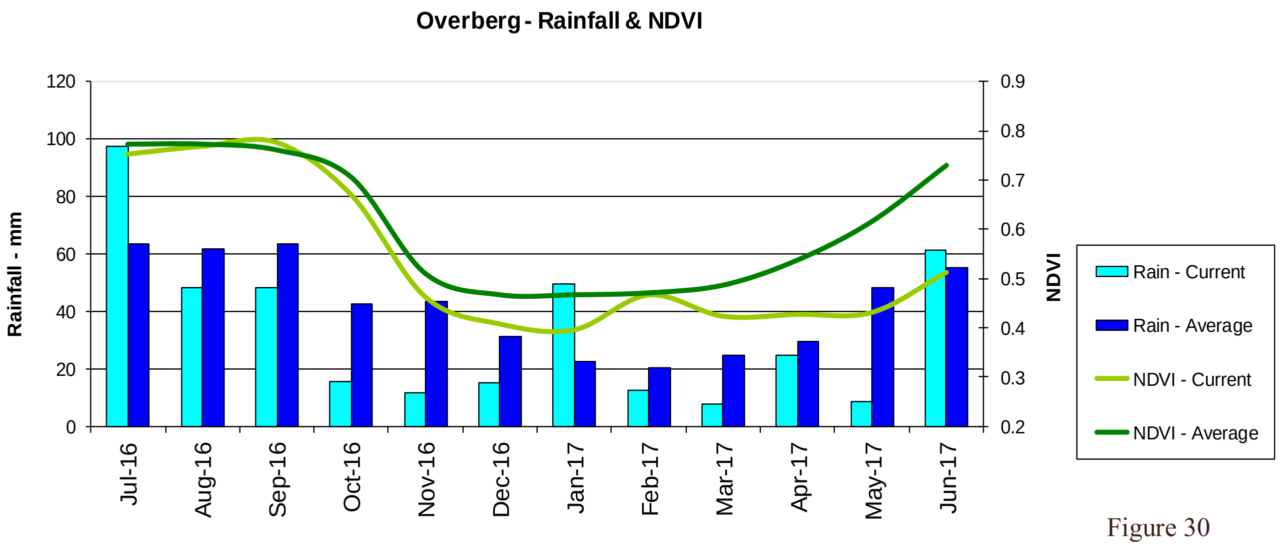

Figure 30

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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 June per province. Fire activity was higher in all provinces compared to the average during the same period for the last 17 years.

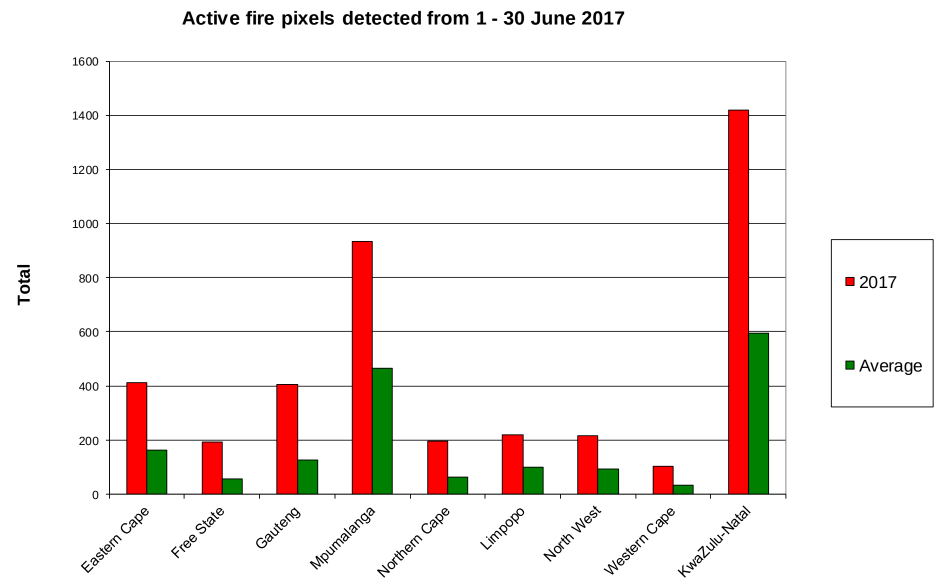

Figure 31

Figure 32:
The map shows the location of active fires detected between 1-30 June 2017.

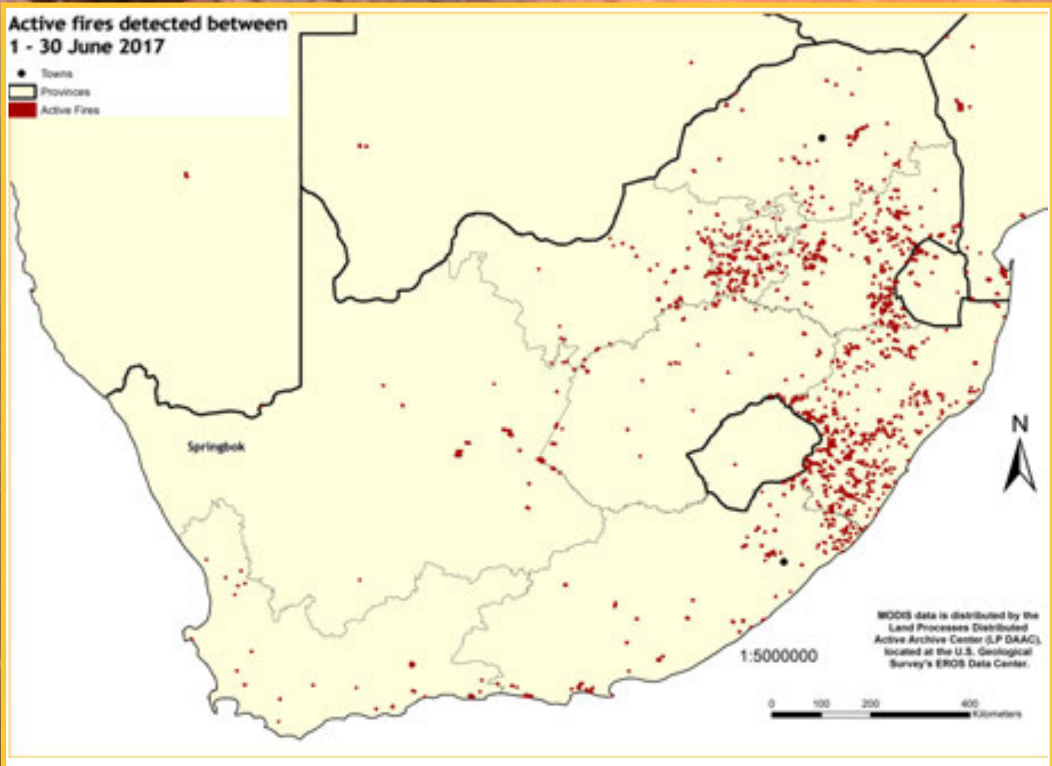

Figure 32

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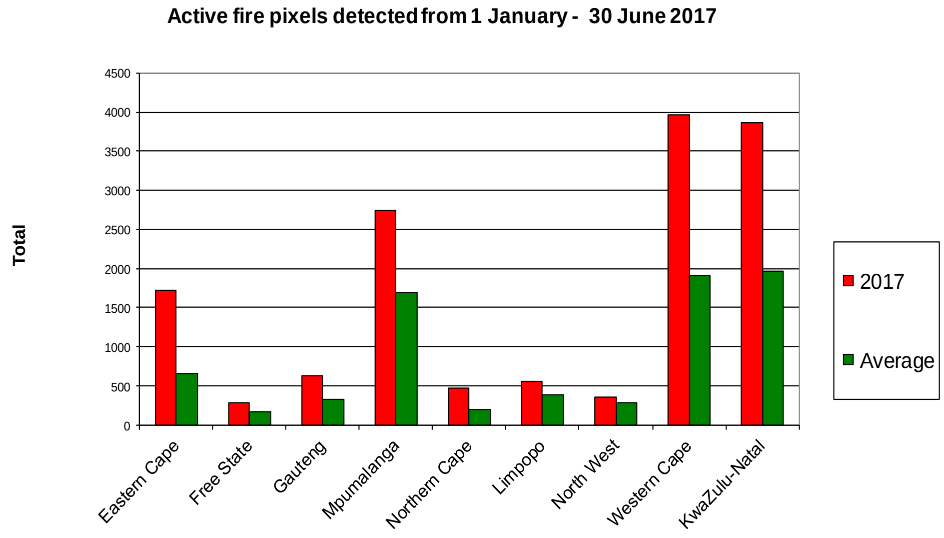

Figure 33

Figure 33:
The graph shows the total number of active fires detected from 1 January - 30 June 2017 per province. Fire activity was higher in all provinces compared to the average during the same period for the last 17 years.

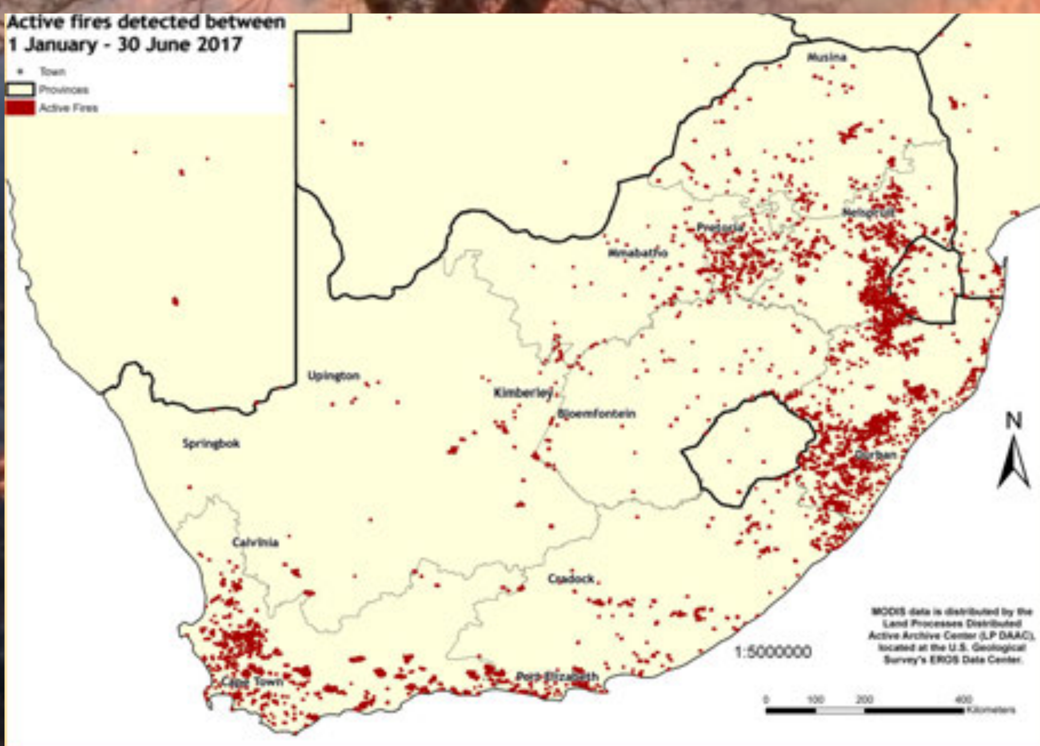

Figure 34

Figure 34:
The map shows the location of active fires detected between 1 January - 30 June 2017.

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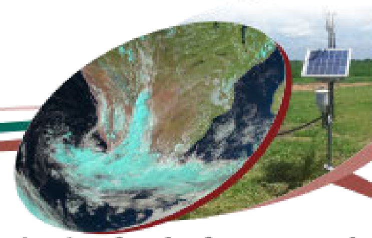
Agrometeorology



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

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

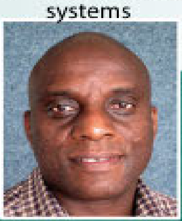
- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

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

http://www.agis.agric.za