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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

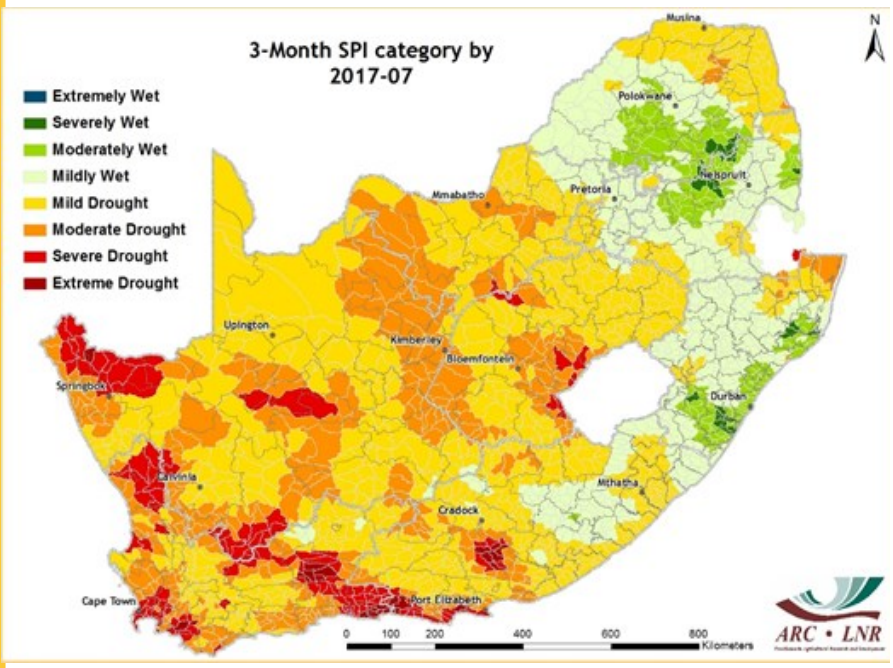
CONTENTS:

158th Edition

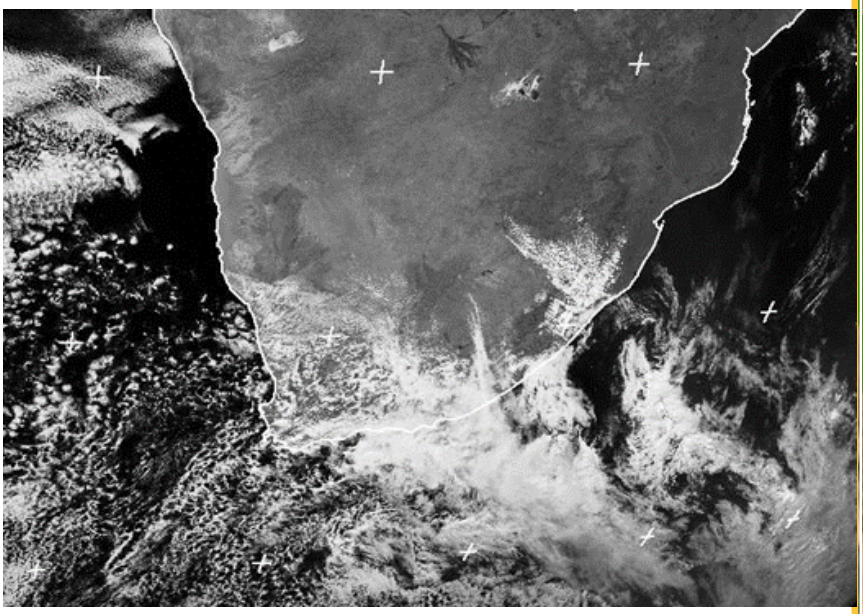
Images of the Month

Improved winter rainfall prospects in August

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. The Western Cape and the Cape south coast to a slightly lesser extent has been suffering from drought conditions over the past 2-3 years. The expected winter rainfall during 2017 has been very disappointing so far, with most cold fronts failing to invade the country. Rainfall totals have been below-normal over these areas, with the result that the general drought conditions have persisted, being severe and even extreme in some areas as shown in the SPI map. On the other hand, the summer rainfall region has experienced moderate to mildly wet conditions during the winter so far, with widespread rainfall occurring in May.



There are better prospects for winter rainfall during the month of August. The satellite image, taken on 16 August 2017 at 14h00 SAST, shows a strong frontal system. Earlier in August good rainfall occurred, in particular along some areas of the Cape south coast, with up to 100 mm being measured in Port Elizabeth.



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 better rainfall during June over the very dry Western Cape, below-normal rainfall returned to most of this region in July 2017. Over the important water catchment areas, only 25-50% of the normal July rainfall occurred. Some isolated areas over the central to eastern parts of the Western Cape (the little Karoo), received normal to slightly above -normal rainfall. Further east over the Cape south coast (an all -year rainfall region), July was also dry, particularly in the Port Elizabeth area which received less than 25 mm for the month. Rainfall occurred over some areas of the summer rainfall region during July, being above-normal over parts of the KwaZulu-Natal coast, North West and Limpopo. Maximum temperatures were above-normal over most of the country during July.

Numerous frontal systems occurred in July, four of which were associated with rainfall and a decrease in maximum temperatures, and were not just confined to the coastal regions but extended in over the southwestern interior. The first of these frontal systems made landfall on the 9th followed by the second frontal system that was accompanied by a well developed frontal cloud band that moved in over the country on the 15th. This frontal system advanced far over the interior as it moved eastwards, causing snow over the mountains of the southern and southeastern interior and widespread frost on the morning of the 17th over the southeastern and central interior. A third frontal system, although not as strong as the previous two systems, moved over the far southern parts of the country on the 20th with the fourth frontal system moving over the southwestern parts on the 25th.

The unseasonal rainfall over North West and Limpopo occurred during the first week of the month as result of a cut-off low that was located just to the north of the country and lingered there for a few days. Rainfall totals of up to 25 mm were measured at several weather stations during that event. The rainfall along the KwaZulu-Natal coast, which is a summer rainfall region, occurred on the 30th of July in the wake of a frontal system.

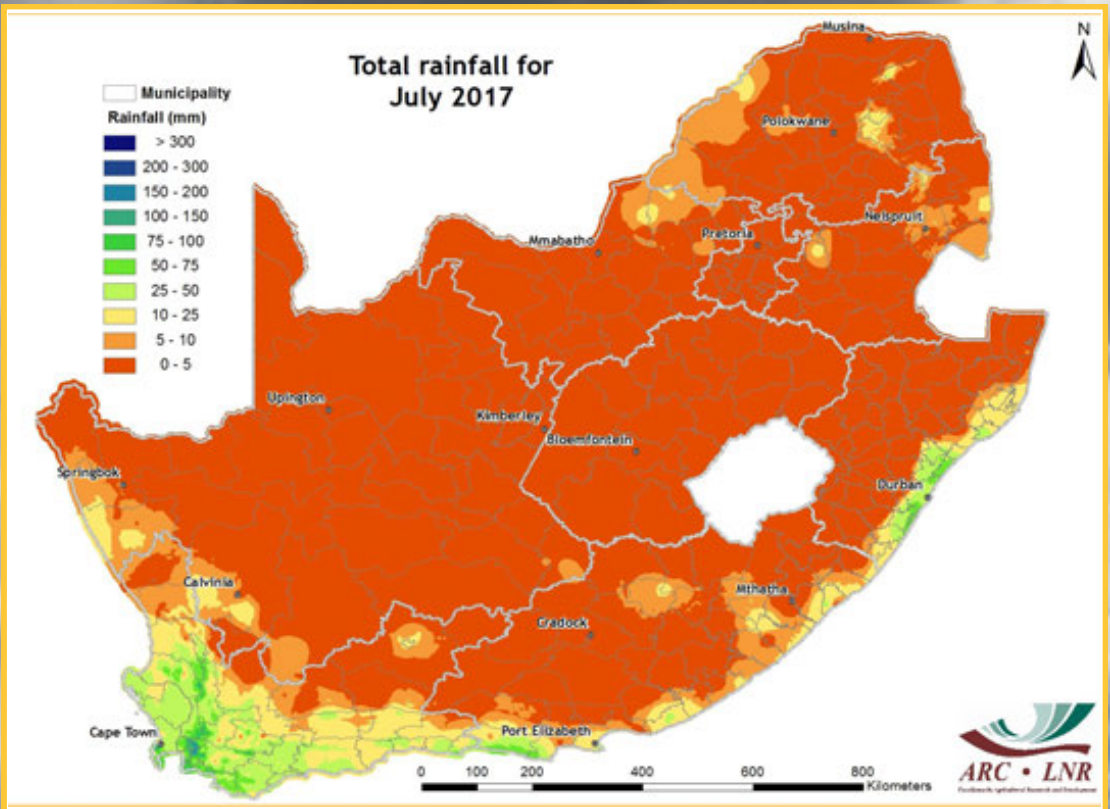


Figure 1

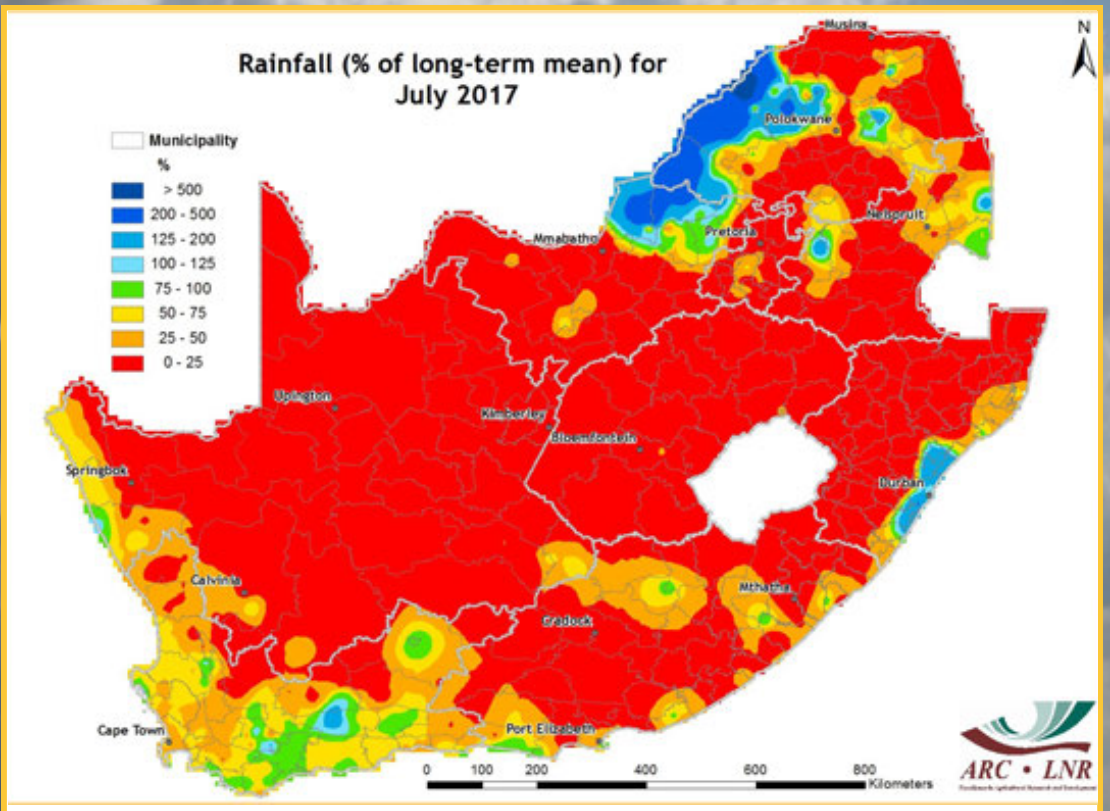


Figure 2

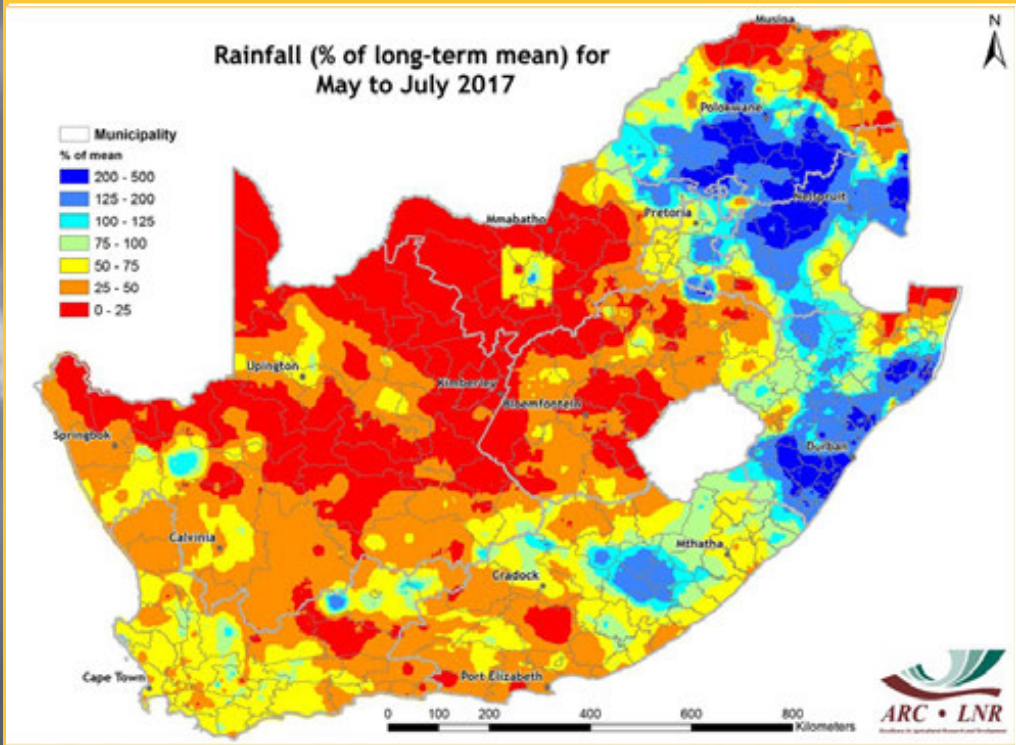


Figure 3

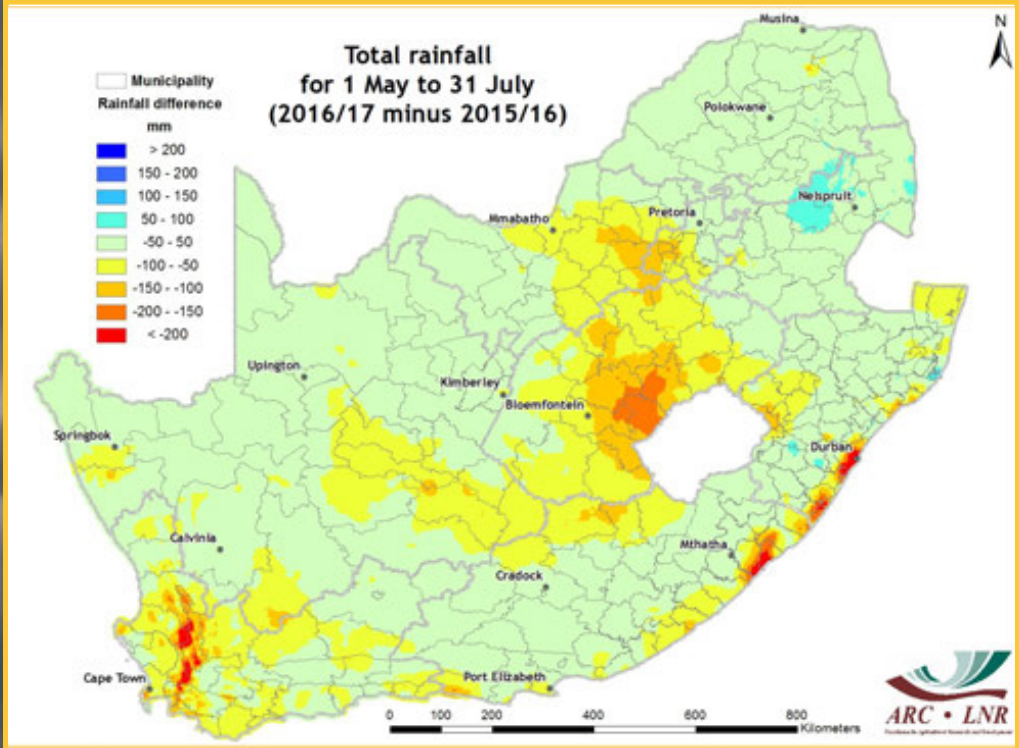


Figure 4

Figure 1:
Rainfall totals for the month of July were generally below 50 mm over the Western Cape, but reaching 150-200 mm over the mountainous areas. Further to the east along the coast and adjacent interior, below-normal rainfall occurred over the largest part. Over the summer rainfall region, rainfall exceeding 50 mm occurred along the KwaZulu-Natal coast, whilst amounts of 5-25 mm occurred over the northeastern parts of the country.

Figure 2:
Below-normal rainfall occurred over most parts of the Western Cape and along the Cape south coast, whilst above-normal rainfall occurred over some areas of the summer rainfall region along the KwaZulu-Natal coast and over the northeastern parts of the country.

Figure 3:
Over the past three months, above-normal rainfall occurred over the summer rainfall region in the northeast of the country as well as in some isolated areas over the southern interior. Over the winter rainfall region, 50-75% of the normal May to July rainfall occurred, whilst most of the all-year rainfall region received less than half of the normal rainfall during this period.

Figure 4:
Compared to 2016, the corresponding 3-month period during 2017 received less rainfall. Over the central interior, this can be explained by good rainfall during 2015/16 over that area. Over the winter rainfall region as well as over the all-year rainfall region, the 2016 period received below-normal rainfall with even less rainfall during the corresponding 2017 period.

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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.

At the longer time scales, severe to extreme drought conditions are present over the eastern seaboard and adjacent interior regions, gradually recovering towards the shorter time scale. Over the western parts of the Western Cape and Northern Cape, as well as over parts of the Eastern Cape interior, severe drought conditions persist from the longer to shorter time scales. The severe drought conditions expand eastwards over the southwestern parts of the country and over the Cape south coast from the longer to shorter time scales.

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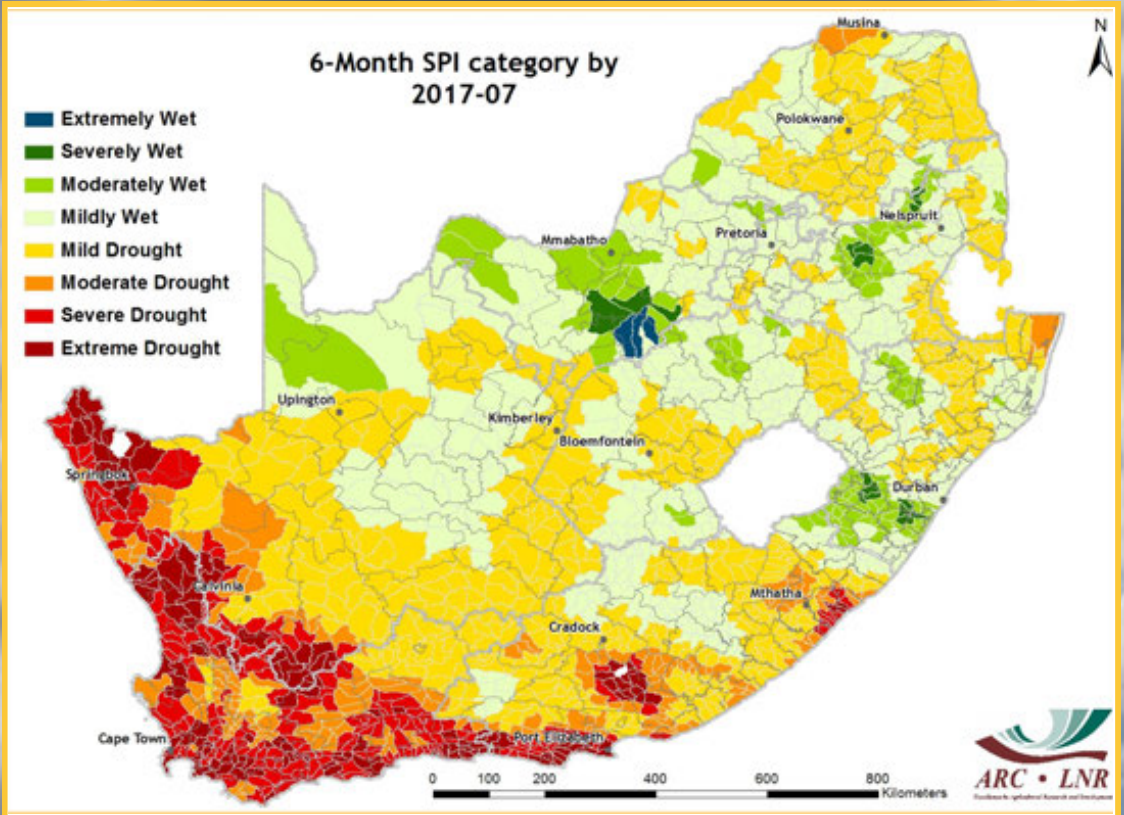

Figure 5

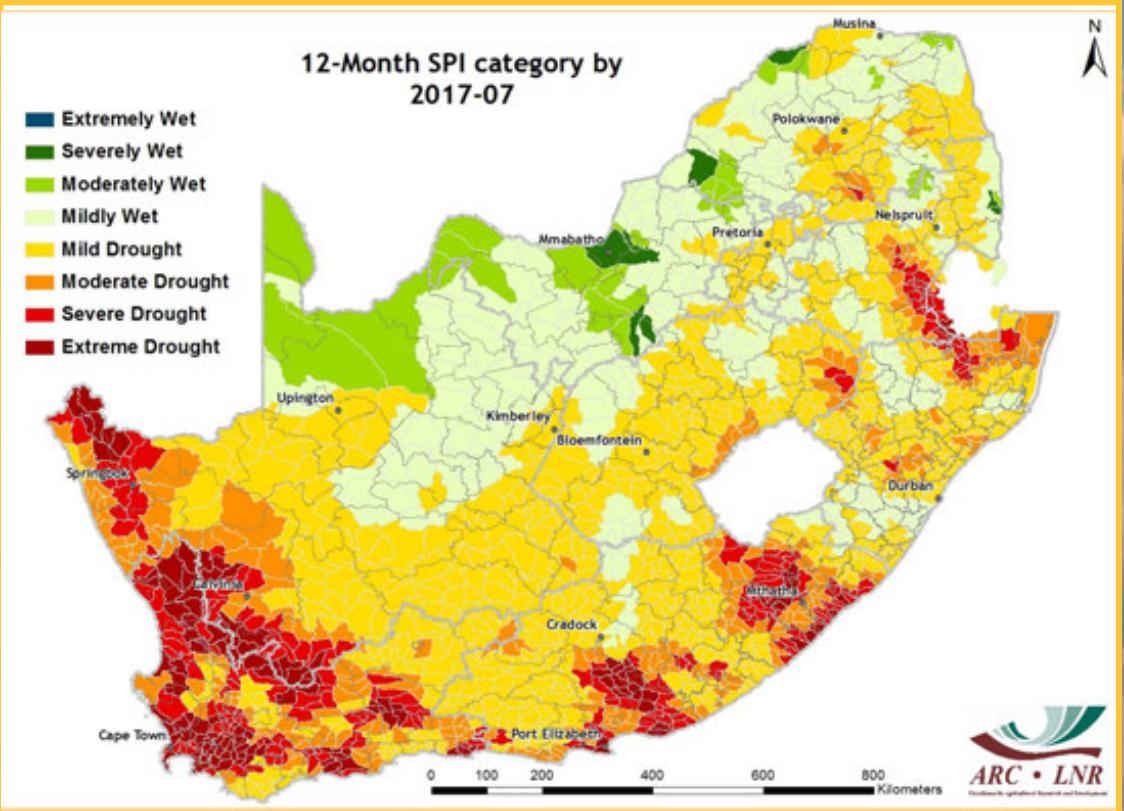

Figure 6

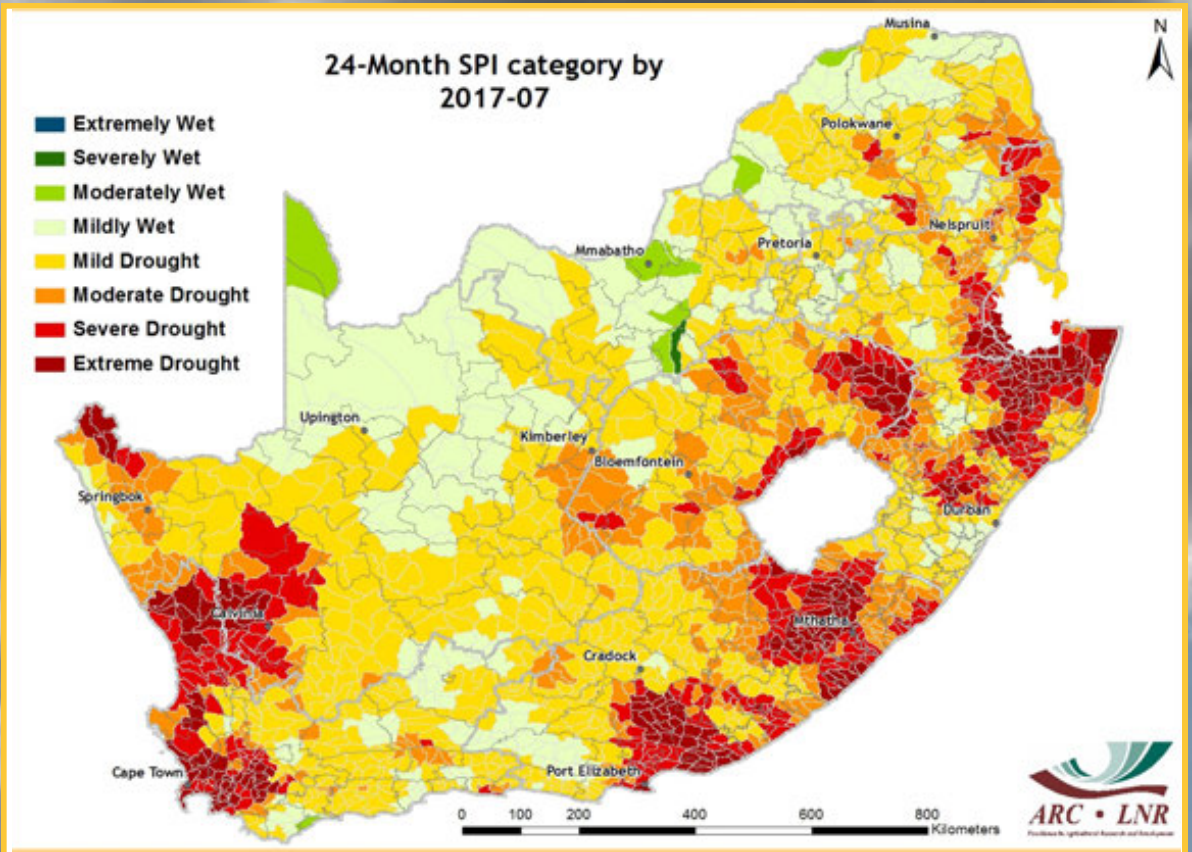

Figure 7

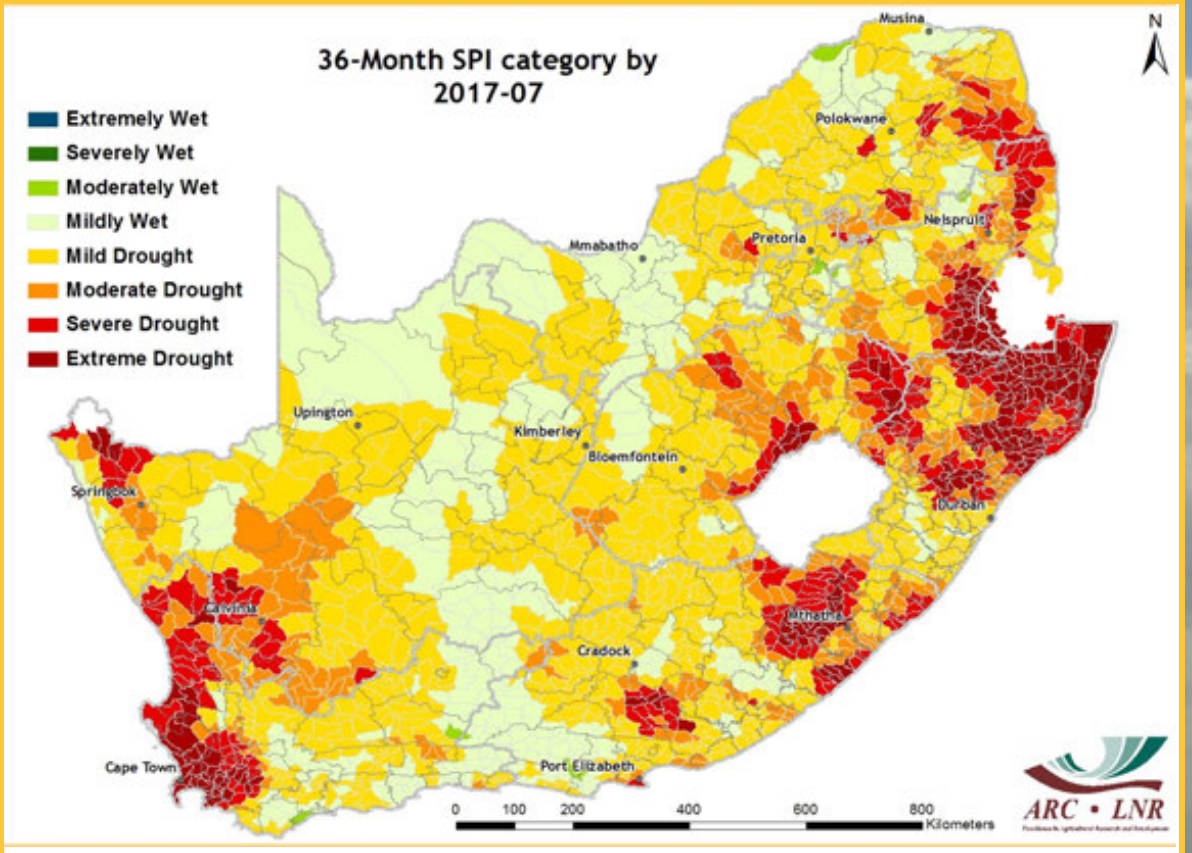

Figure 8

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.

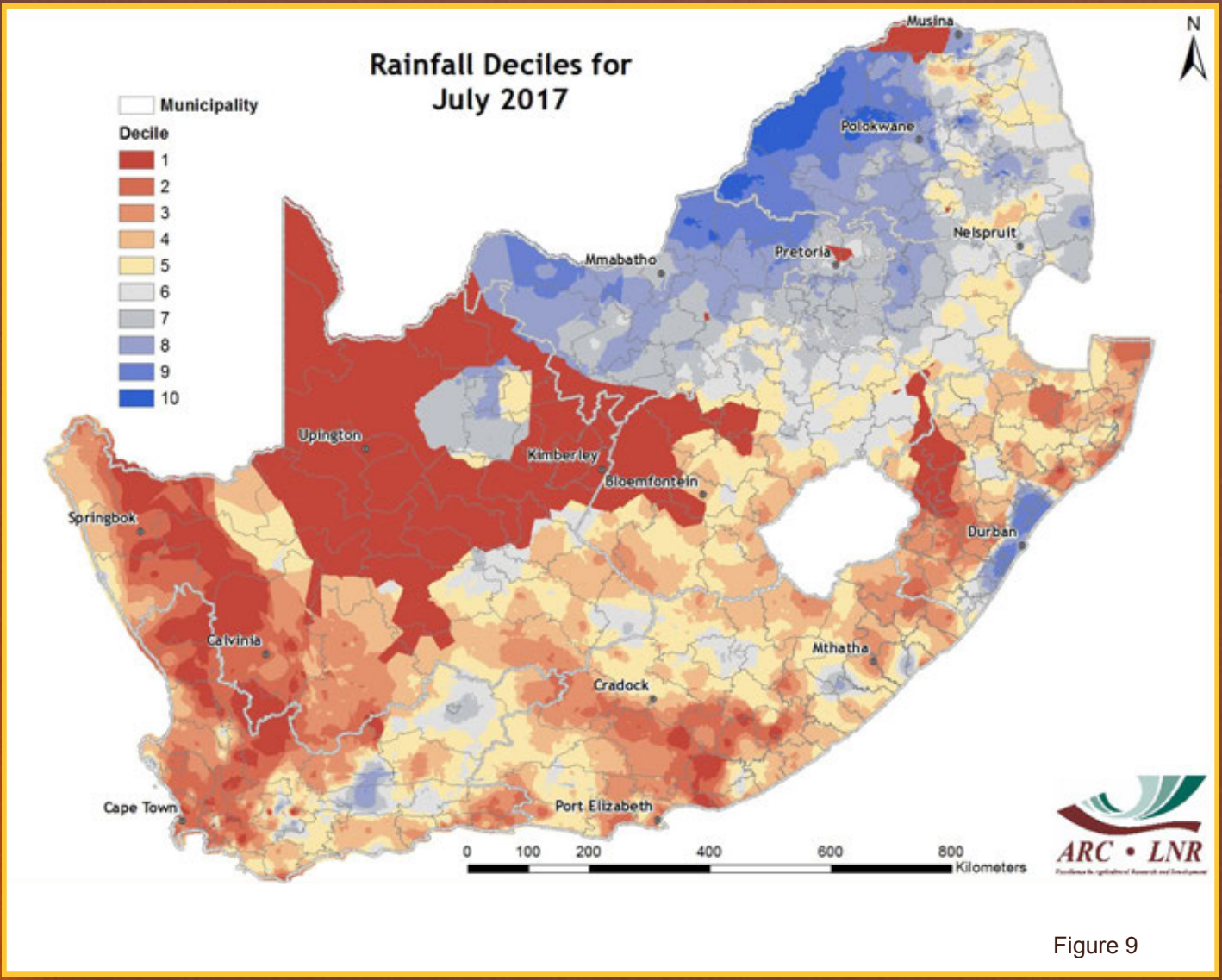

Figure 9

Figure 9:
Some areas over the summer rainfall region experienced a wetter than normal July, but the parts of the country that should receive winter rainfall remained mostly dry.

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4. Water Balance

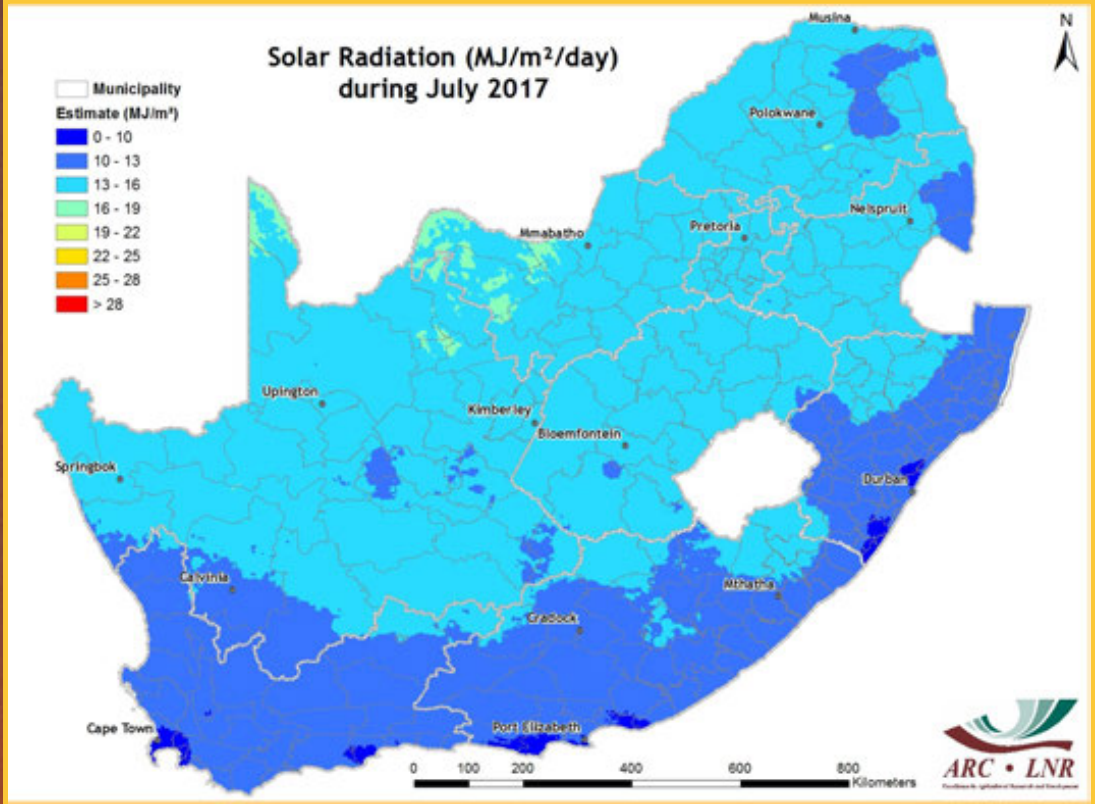

Figure 10

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 southern parts of the country and along the east coast with higher values further northwards.

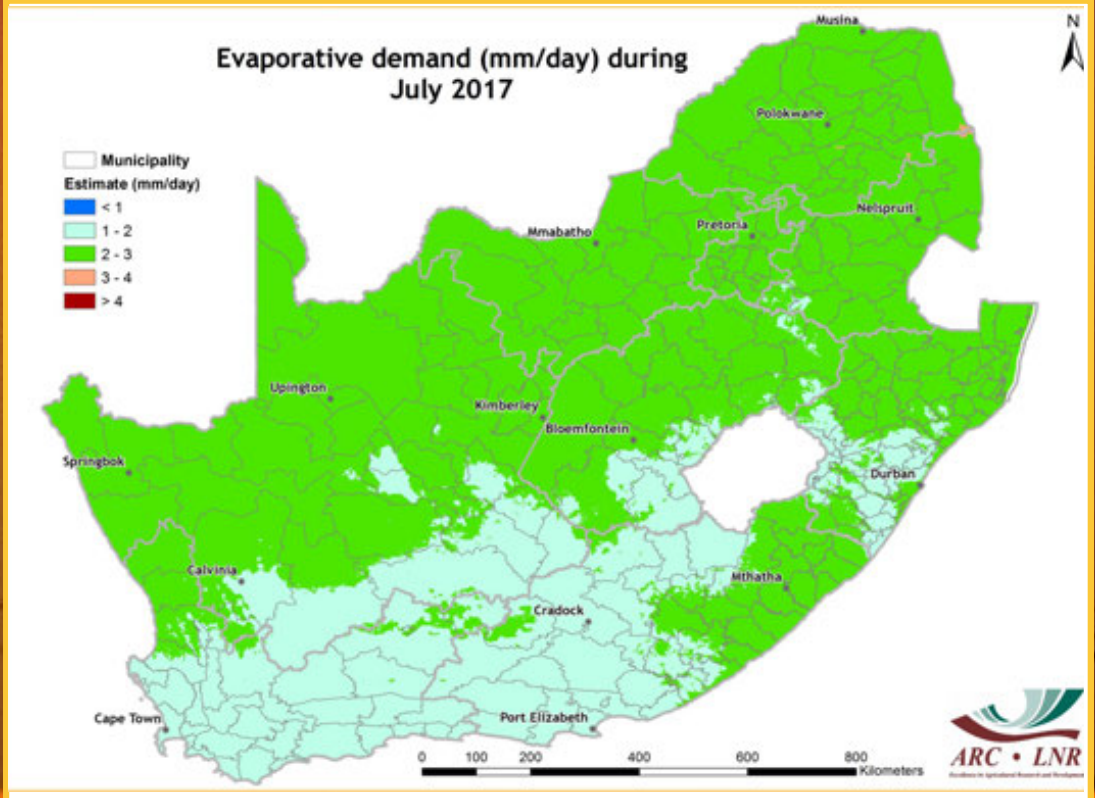

Figure 11

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.

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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.

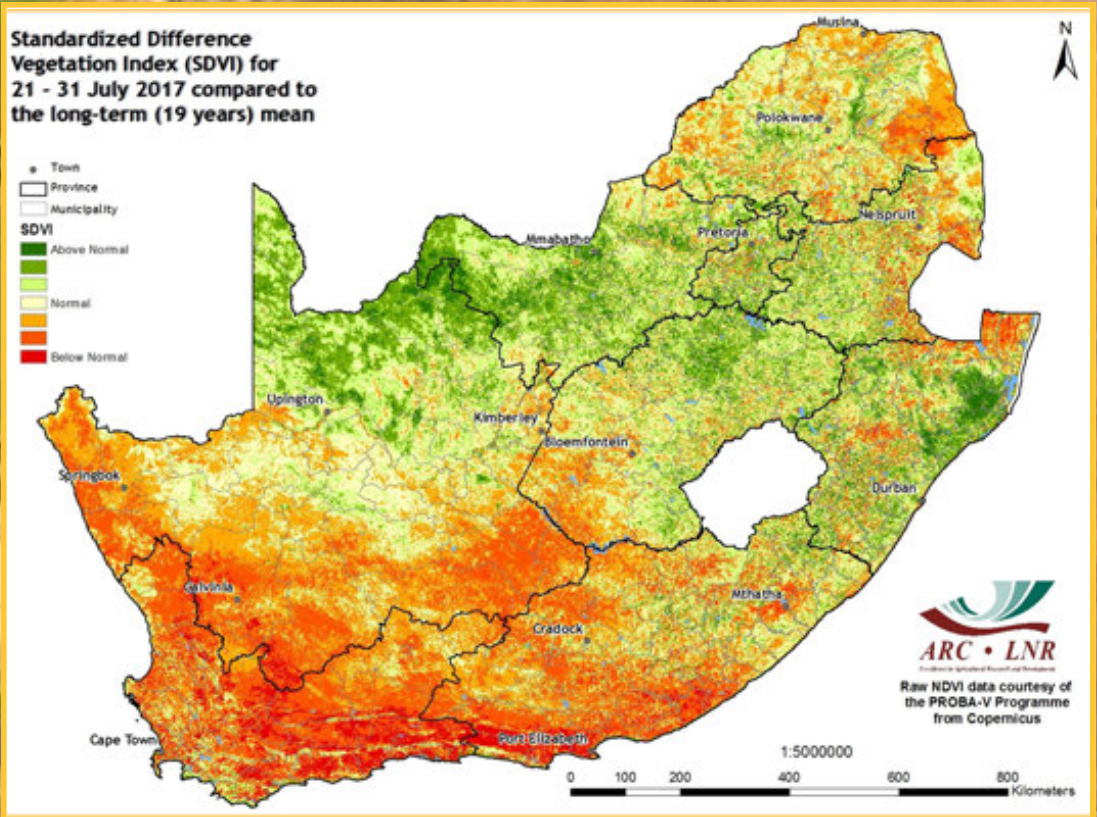

Figure 12

Figure 12:
The SDVI by late July indicates above-normal vegetation activity over much of the interior and KwaZulu-Natal region, as well as dry conditions over much of the Northern Cape, Eastern Cape and Western Cape winter rainfall region.

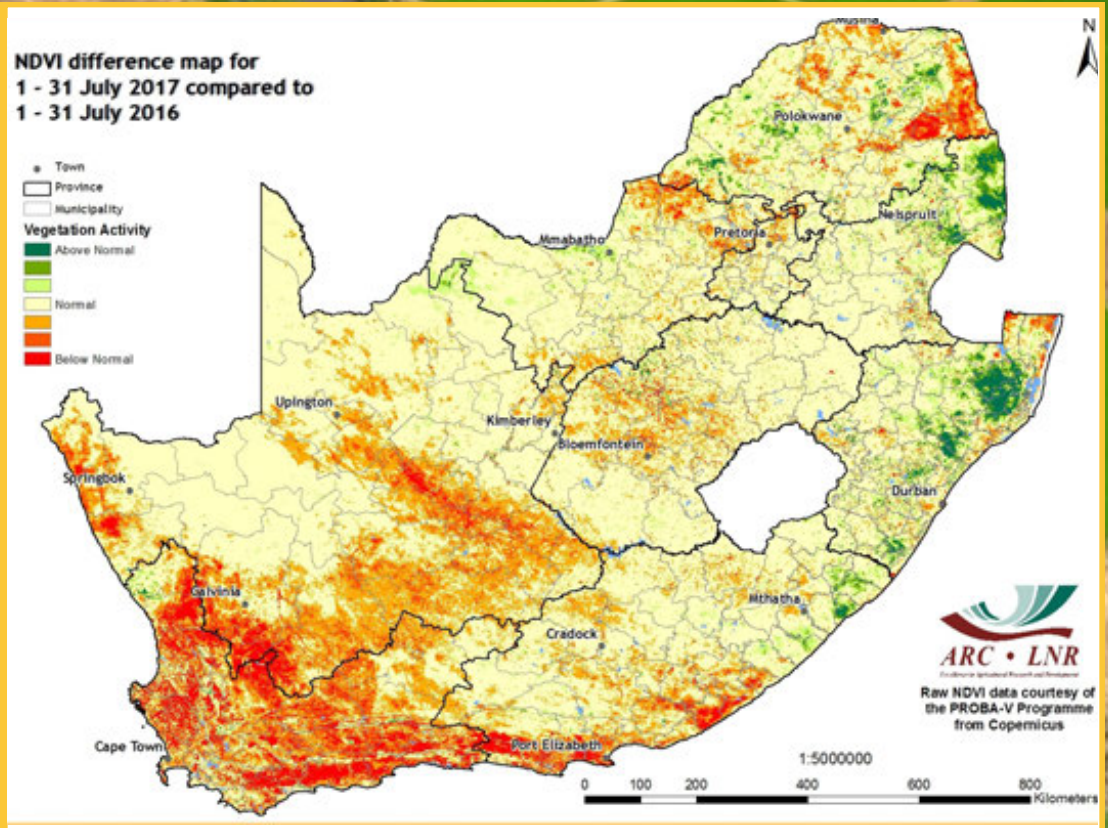

Figure 13

Figure 13:
Vegetation activity over much of the western parts of the winter rainfall region is lower than a year ago. Vegetation activity is also lower over the upper Karoo regions, central Free State, lowveld regions of Limpopo and isolated areas in the Eastern Cape and North West. Much of the eastern parts of KwaZulu-Natal and Mpumalanga reflected higher vegetation activity relative to the conditions last year by late July.

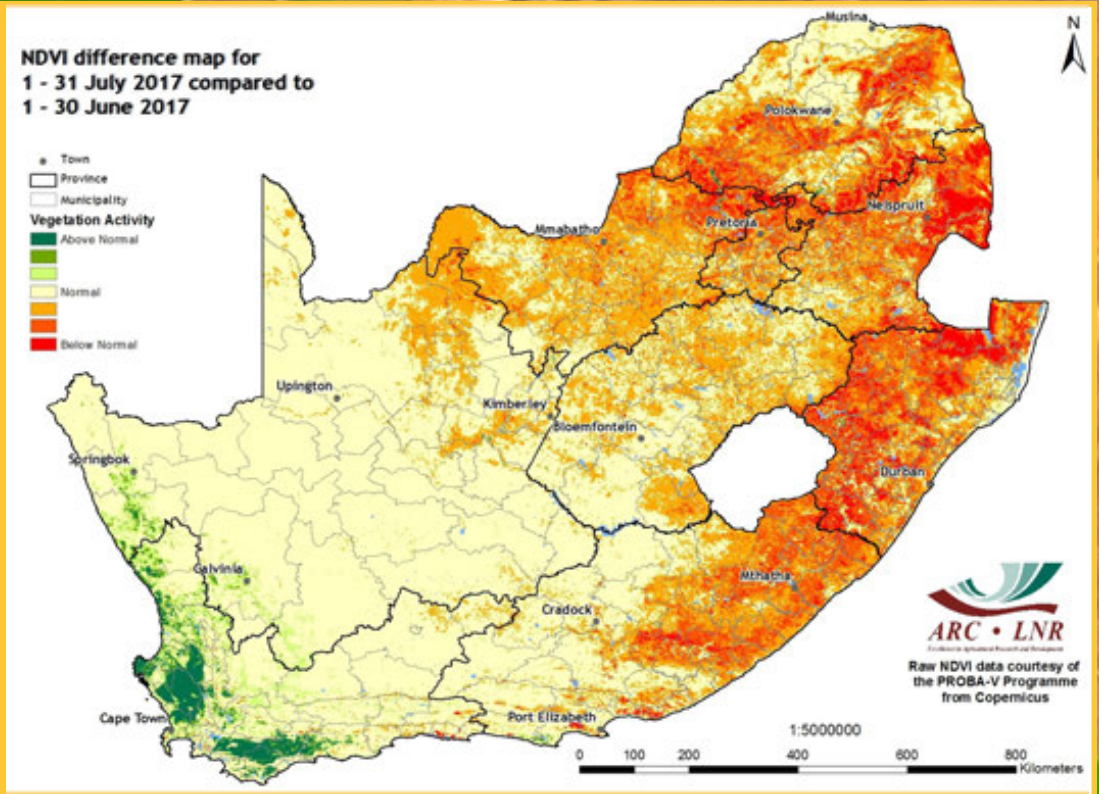

Figure 14

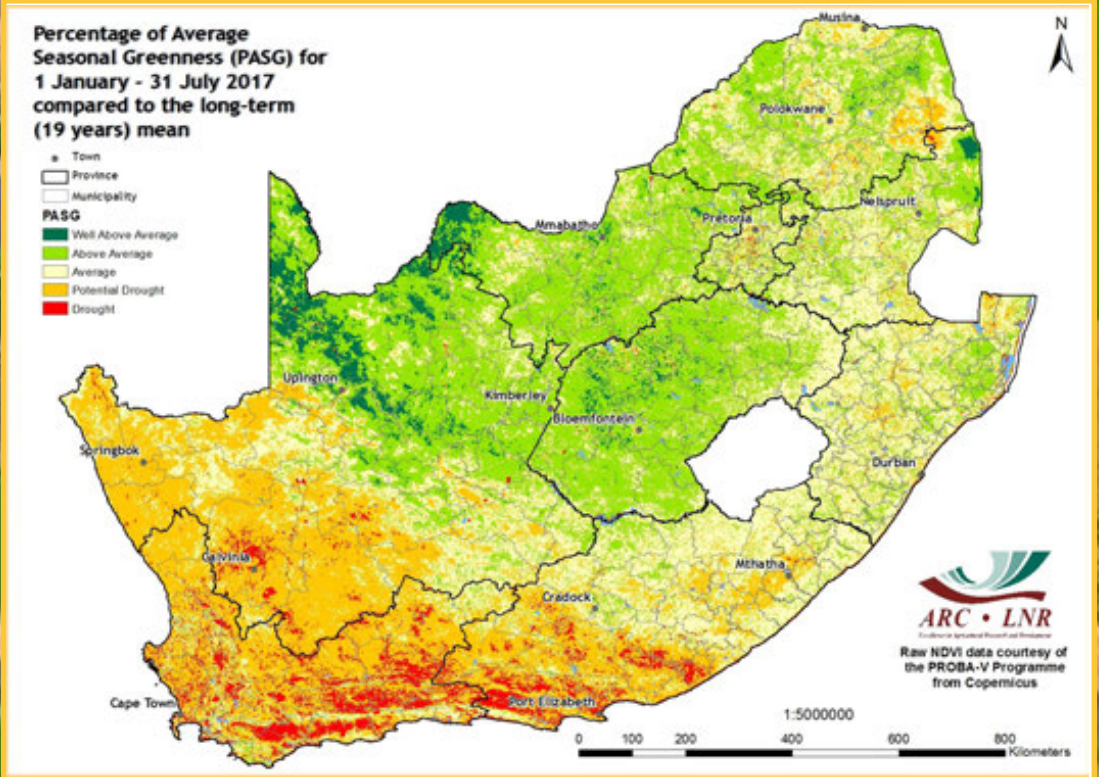

Figure 15

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 lower in the eastern interior, eastern and northern parts of the country. However, the south western region and further north along the coast and adjacent interior experienced an increase in vegetation activity in July.

Figure 15:
Cumulative vegetation activity is well above average in the western interior, northeastern parts of the Northern Cape and the extreme north-western parts of Mpumalanga. In contrast, the winter rainfall region continues to experience potential drought conditions.

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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.

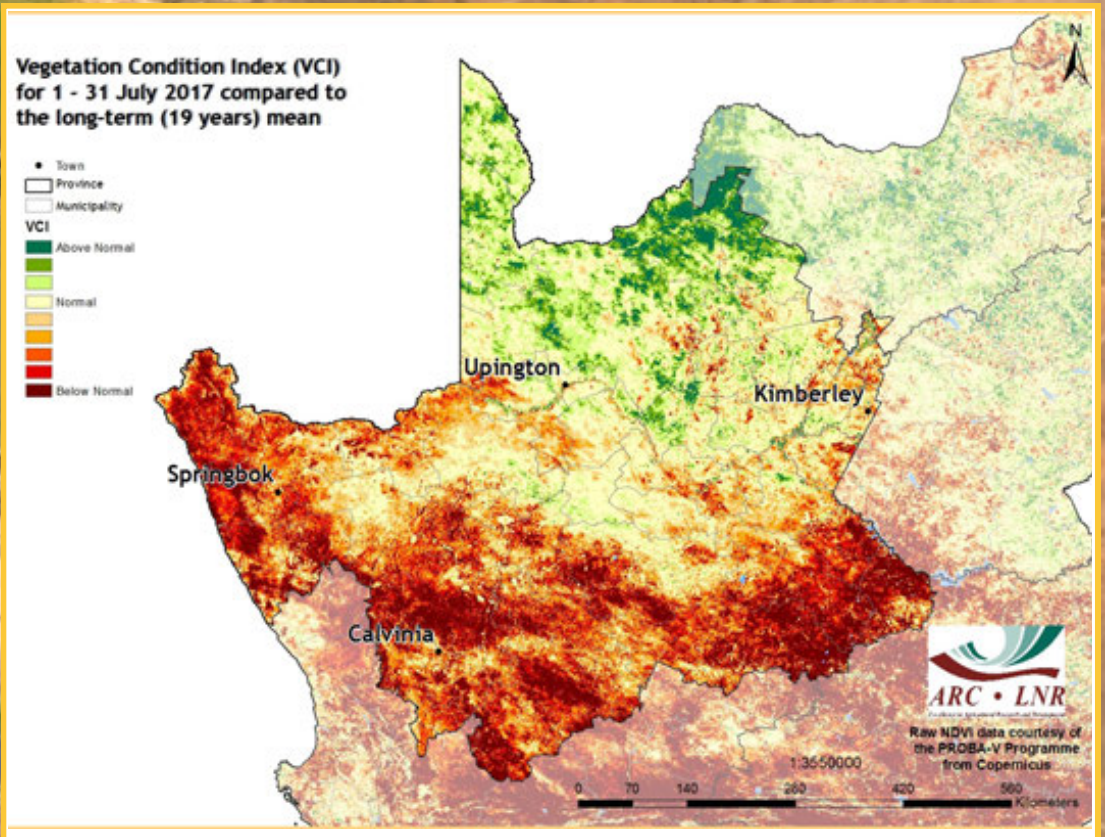

Figure 16

Figure 16:
The VCI map for July indicates below-normal vegetation activity over the western and southern parts of the Northern Cape.

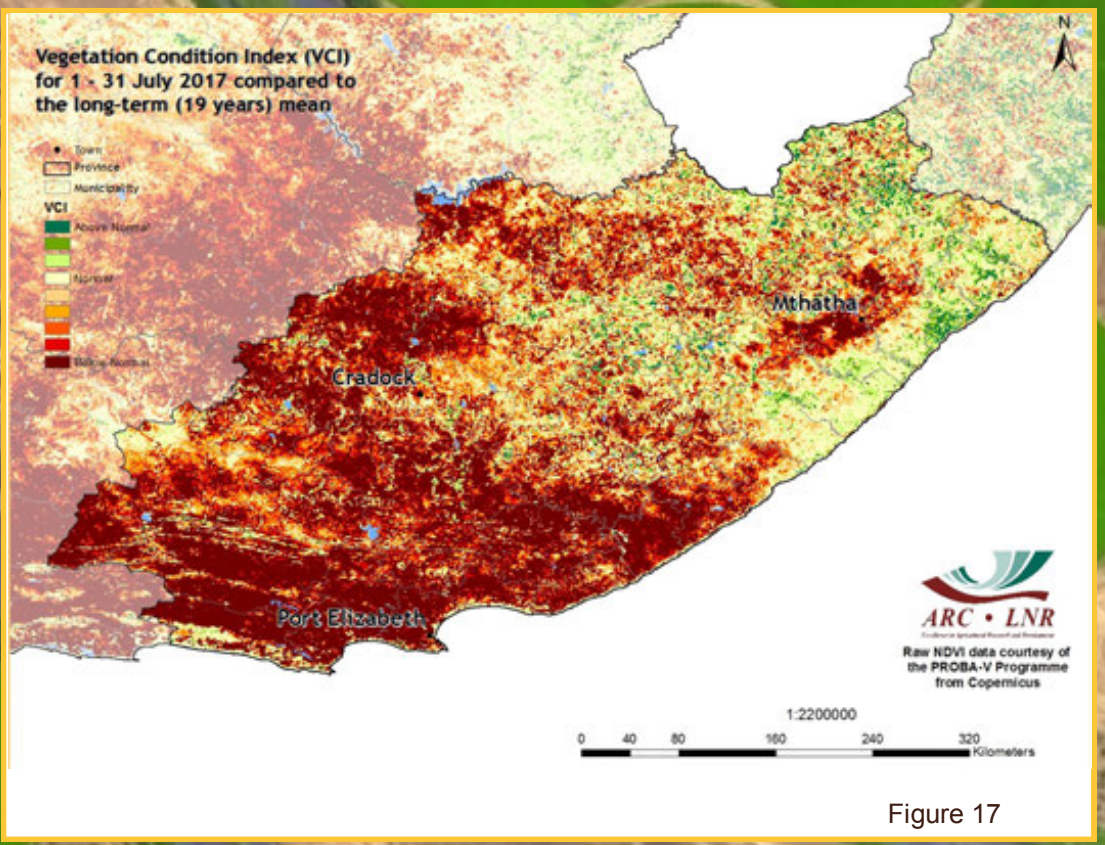

Figure 17

Figure 17:
The VCI map for July indicates below-normal vegetation activity over most parts of the Eastern Cape.

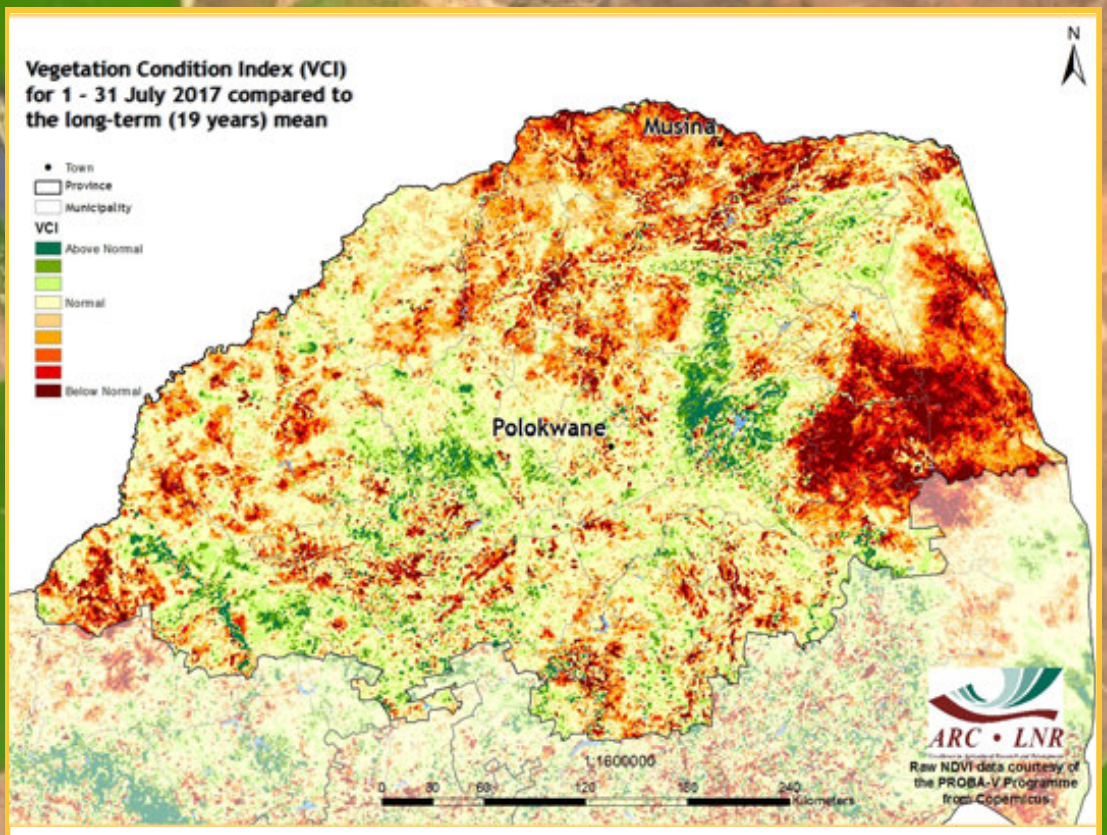

Figure 18

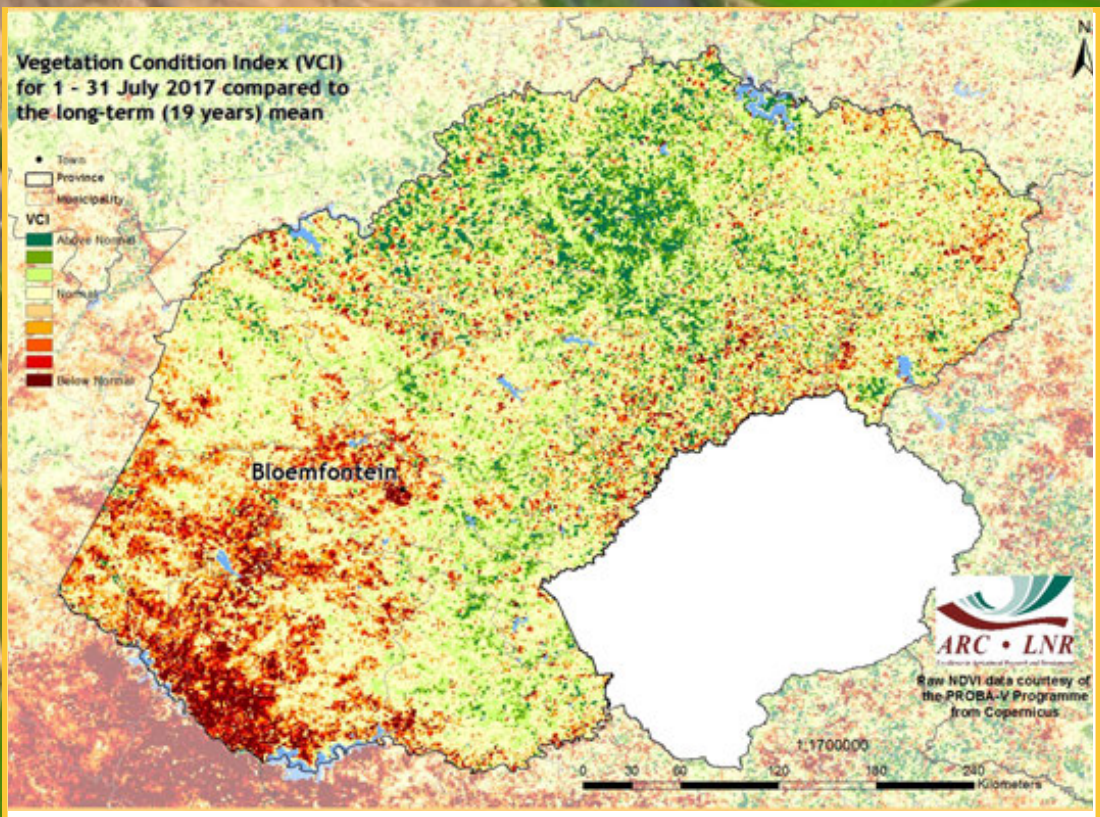

Figure 19

Figure 18:
The VCI map for July indicates below-normal vegetation activity over the lowveld regions stretching towards the southwest and southern parts of Limpopo.

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

Questions/Comments:
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7. Vegetation Conditions & Rainfall

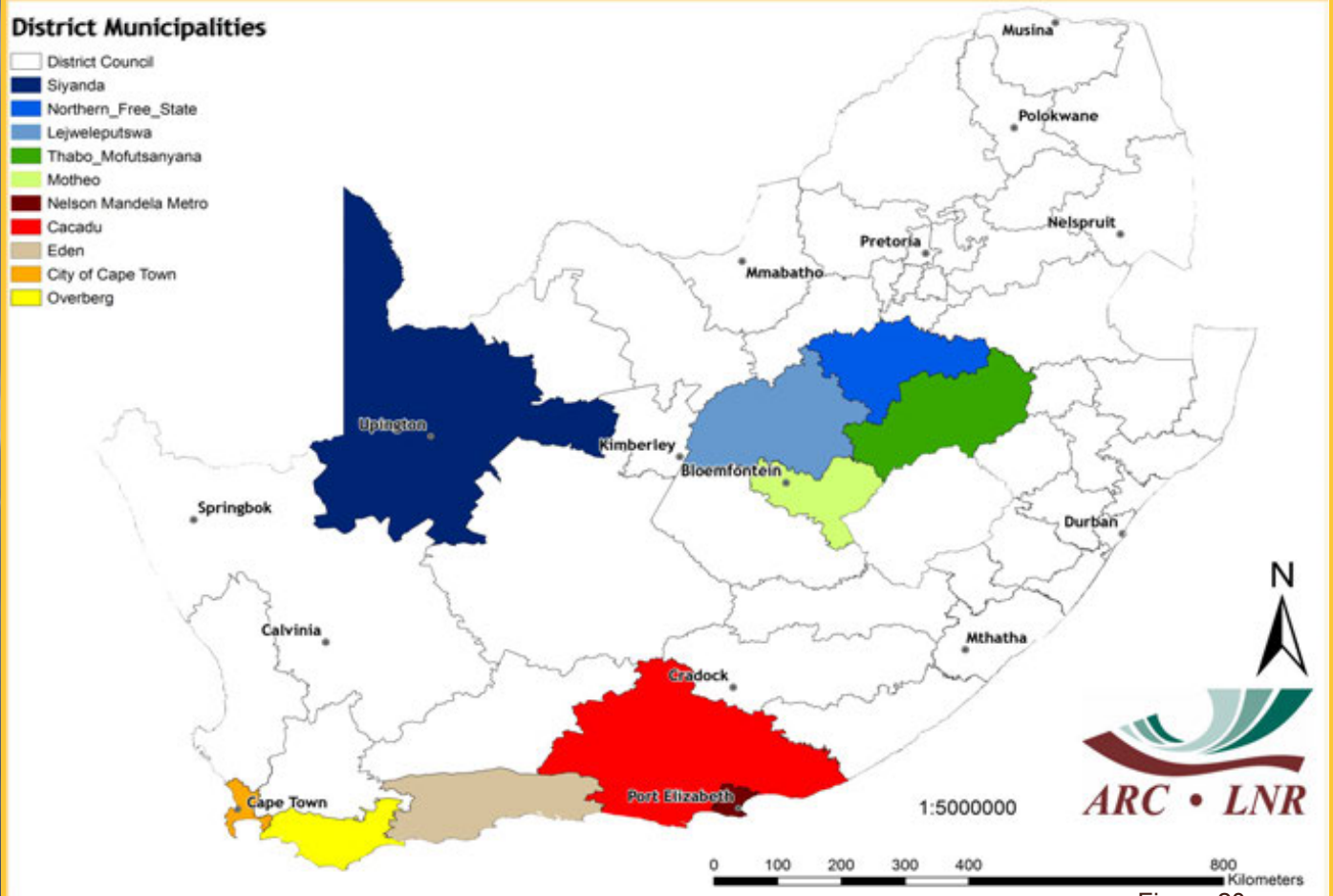

Figure 20

NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for July 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.

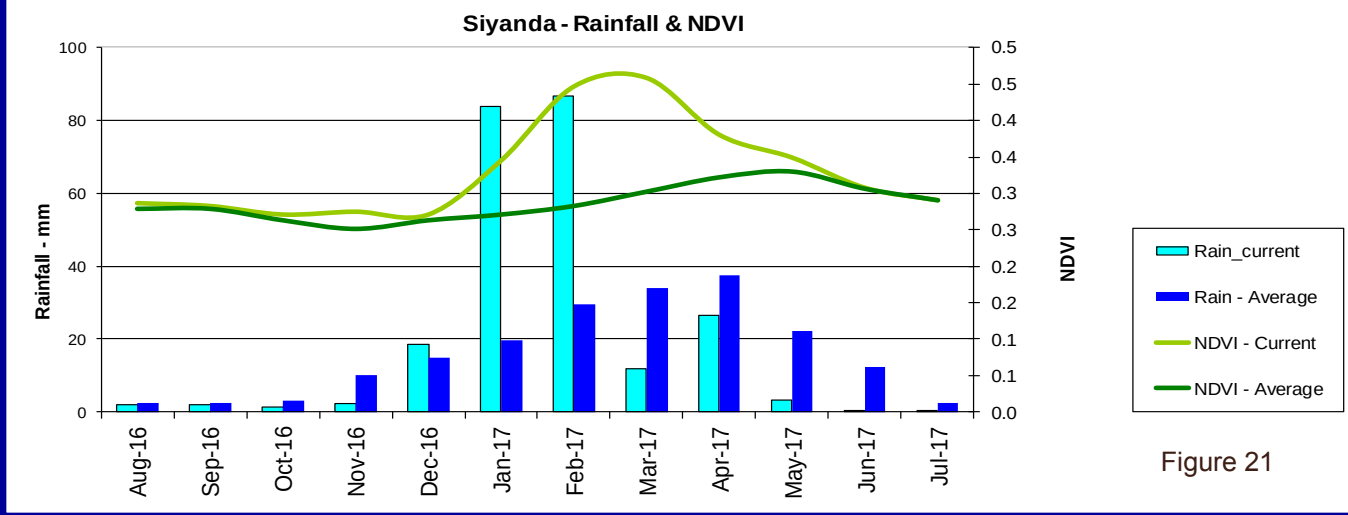


Figure 21

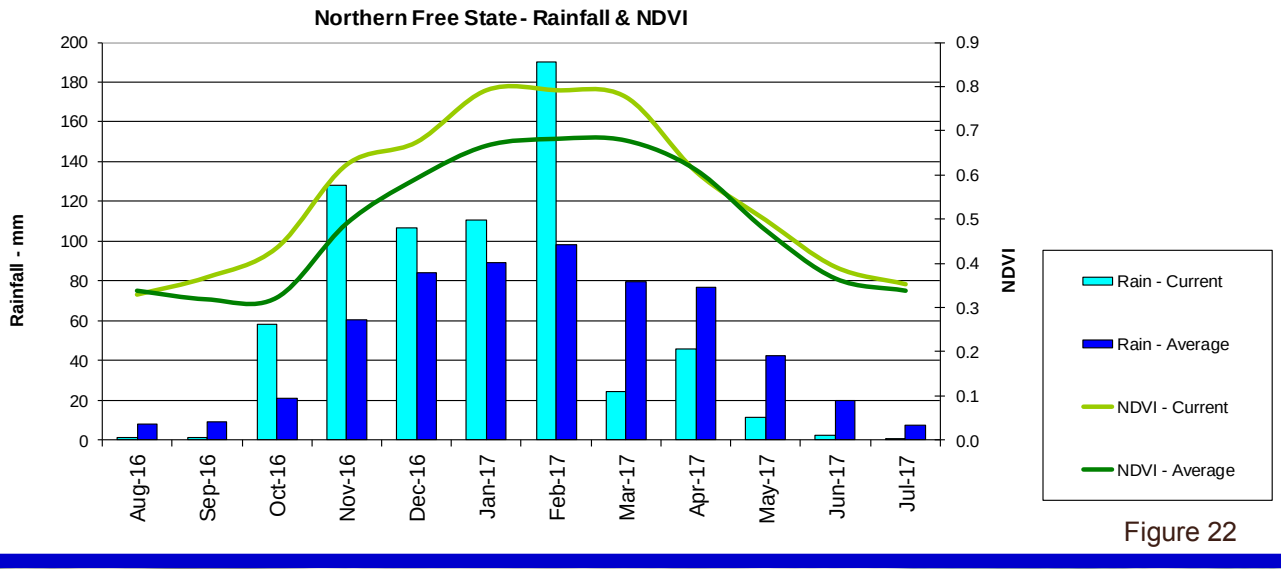
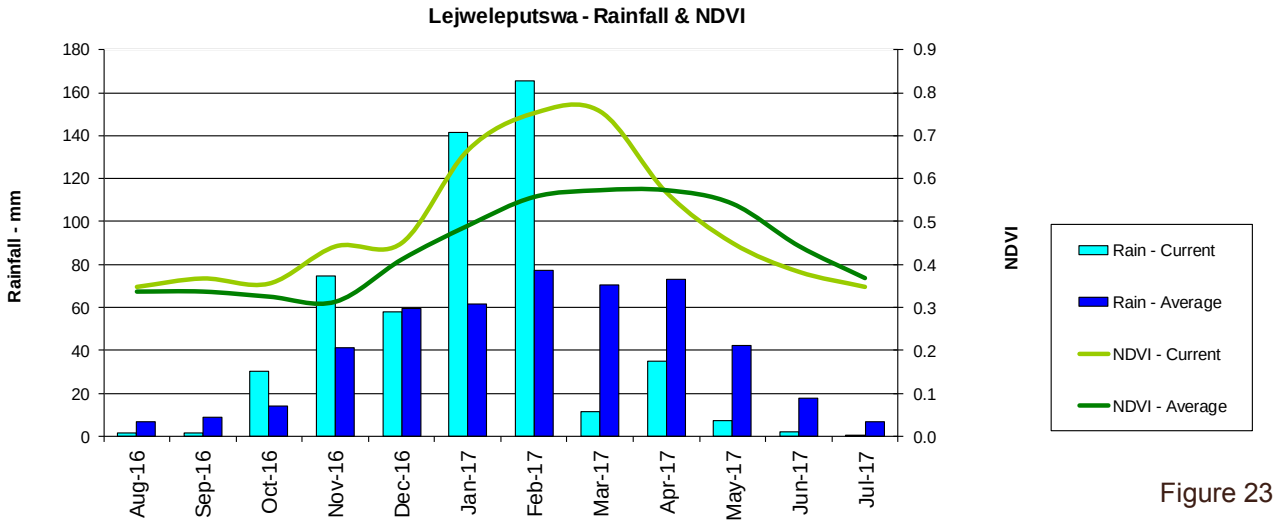


Figure 22



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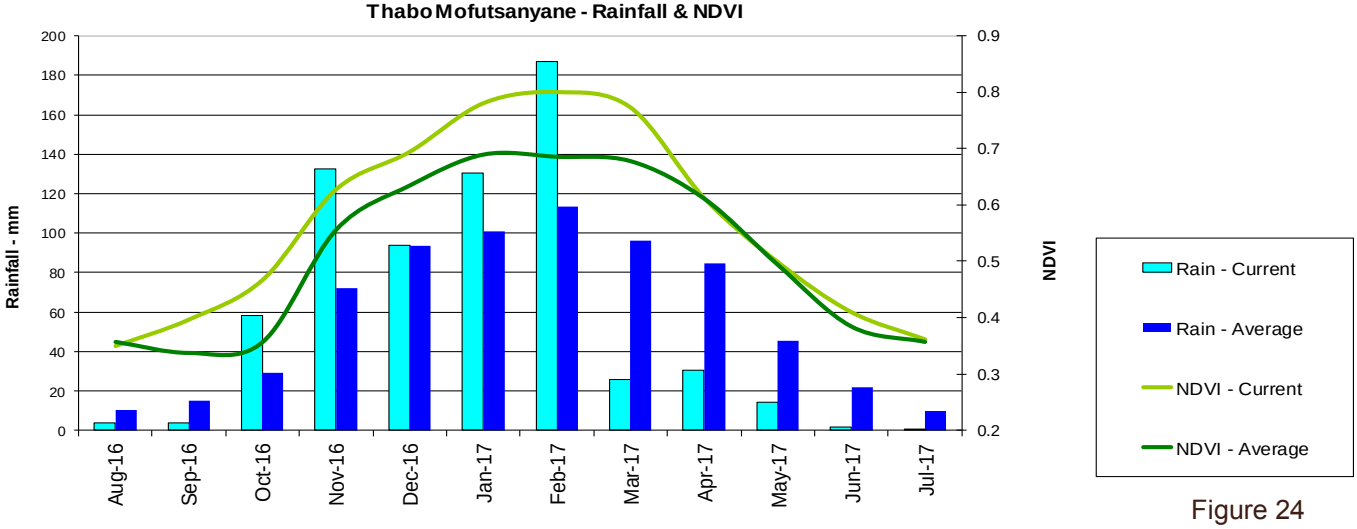

Figure 24

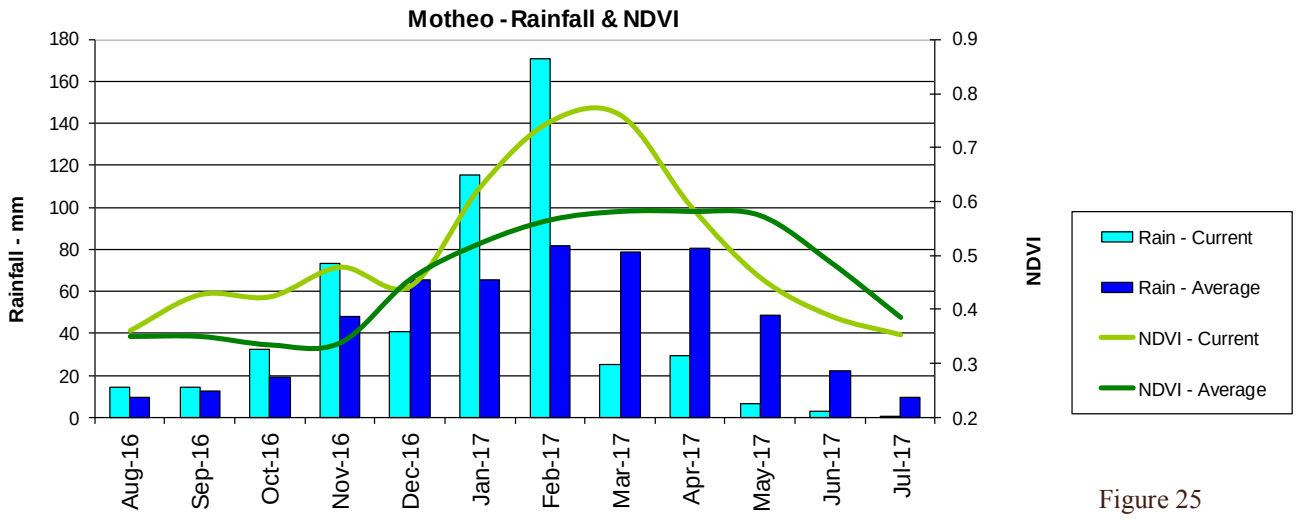

Figure 25

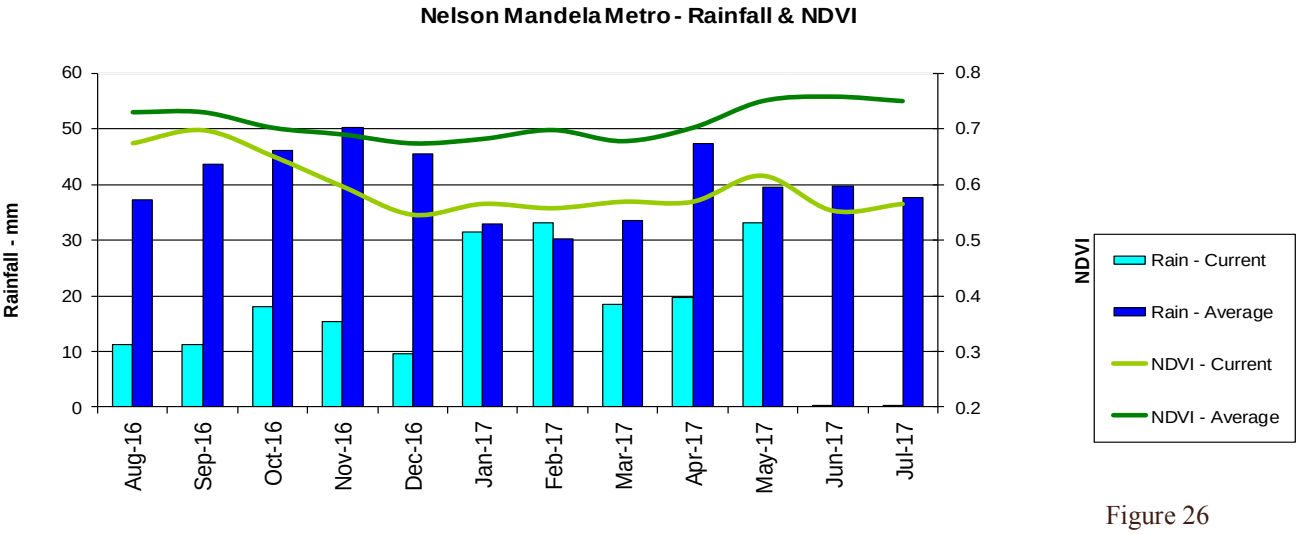

Figure 26

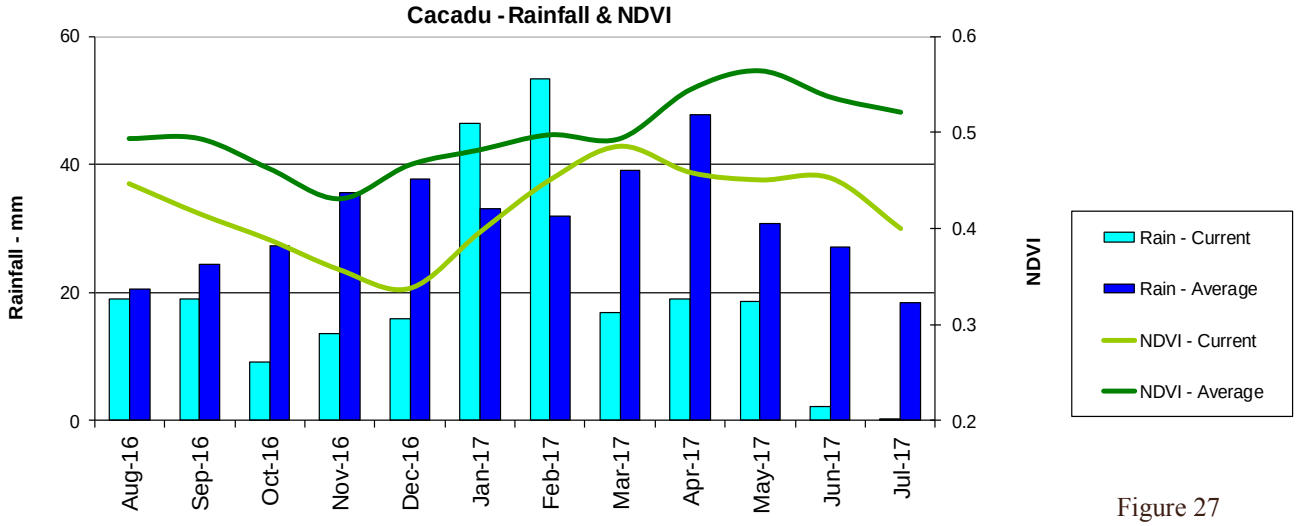

Figure 27

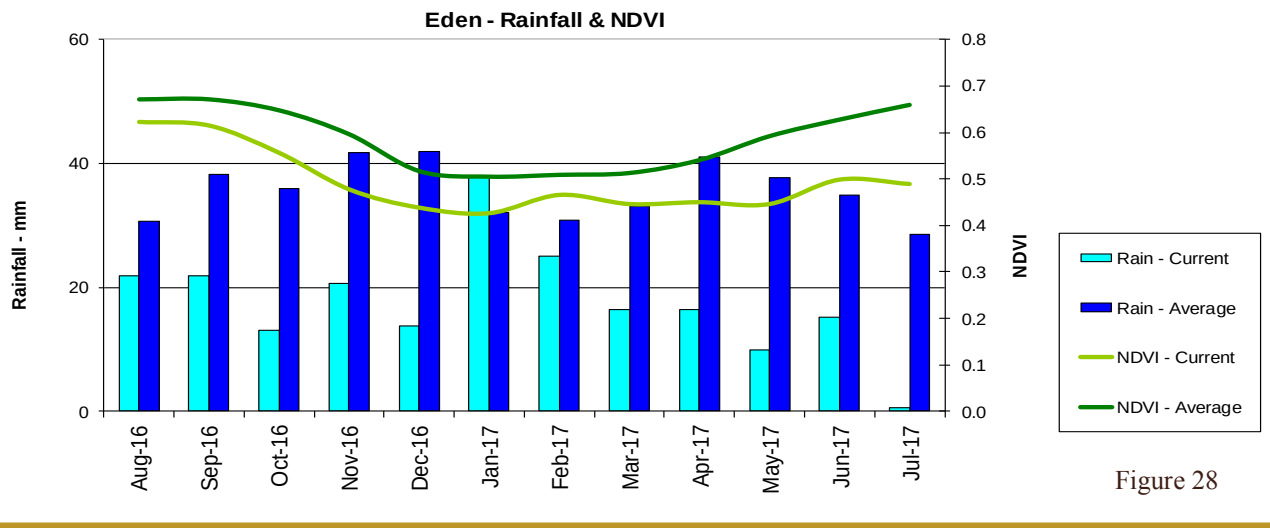

Figure 28

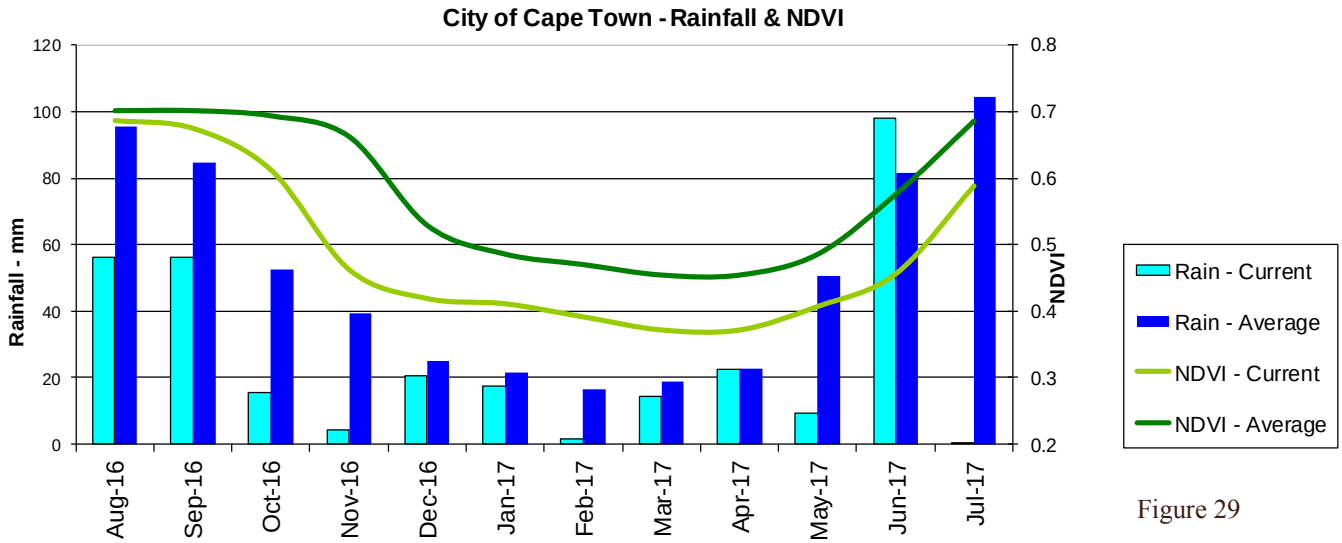

Figure 29

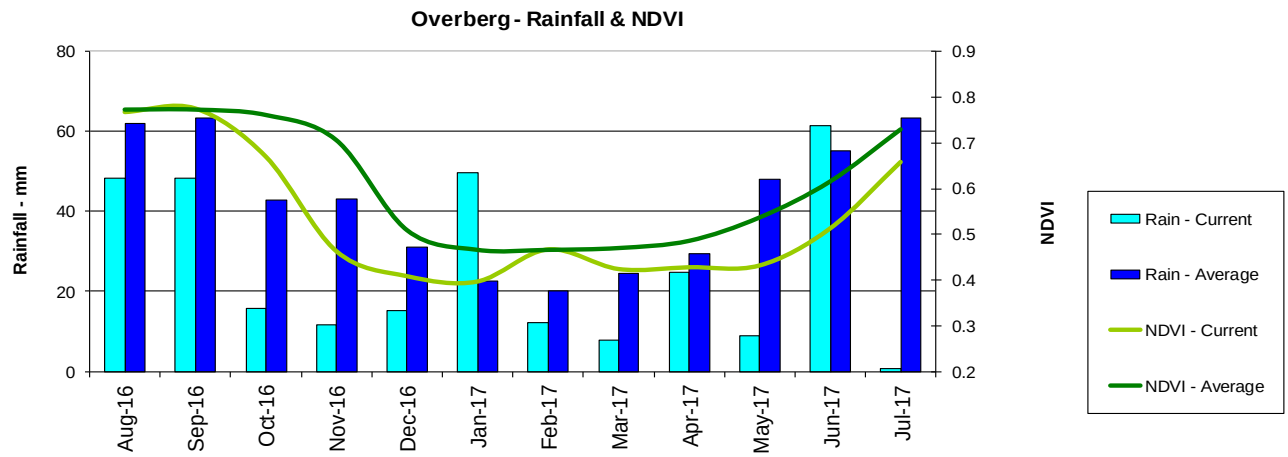

Figure 30

8. Fire Watch

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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 July per province. Fire activity was higher in all provinces except the Northern Cape and Limpopo compared to the average during the same period for the last 17 years.

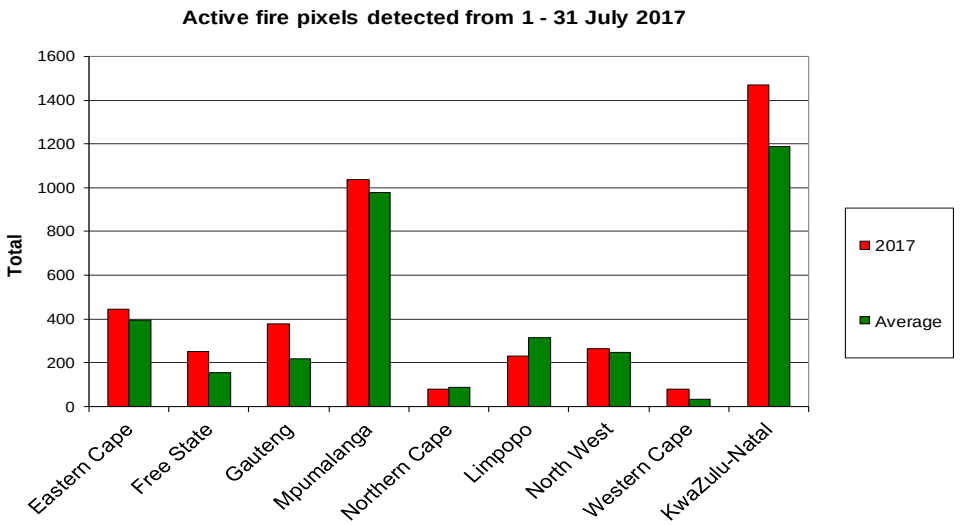

Figure 31

Figure 32:
The map shows the location of active fires detected between 1-31 July 2017.

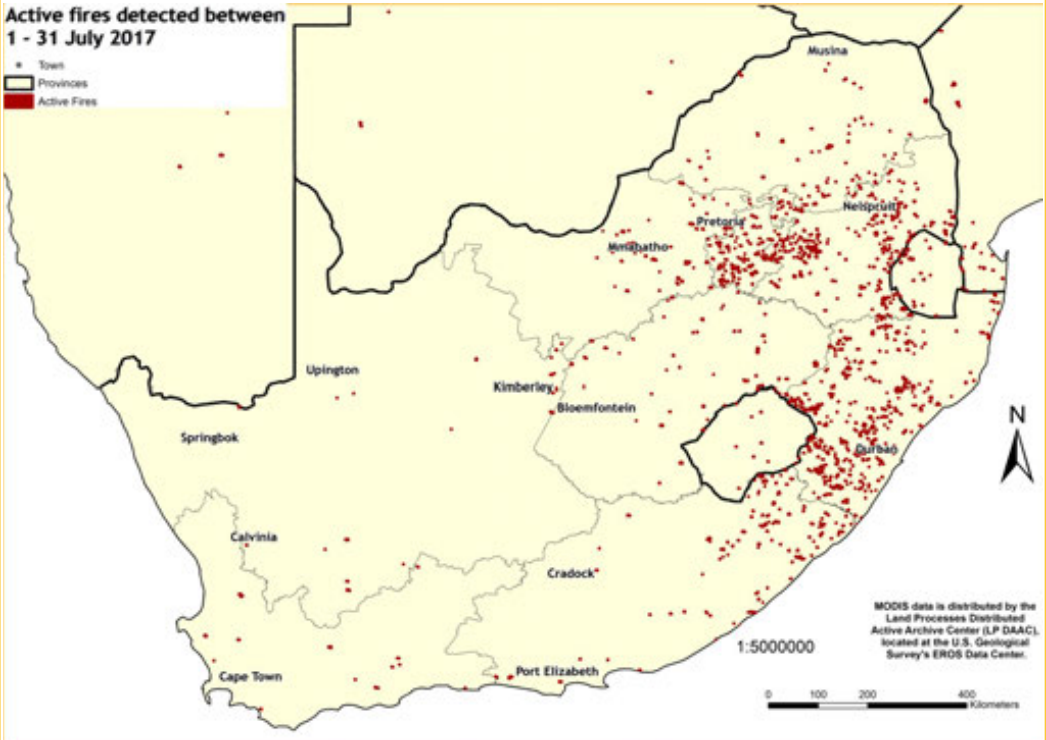

Figure 32

PAGE 17

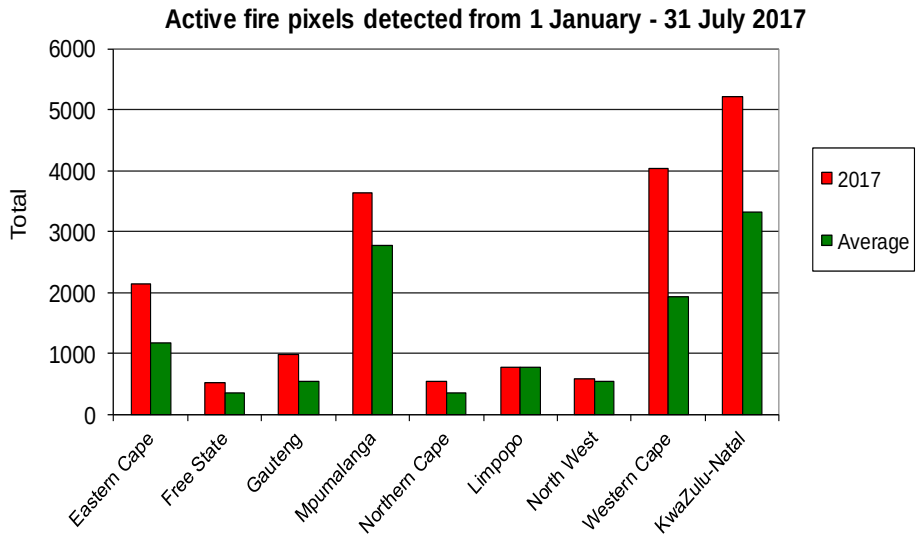

Figure 33

Figure 33:
The graph shows the total number of active fires detected from 1 January - 31 July 2017 per province. Fire activity was higher in all provinces compared to the average during the same period for the last 17 years.

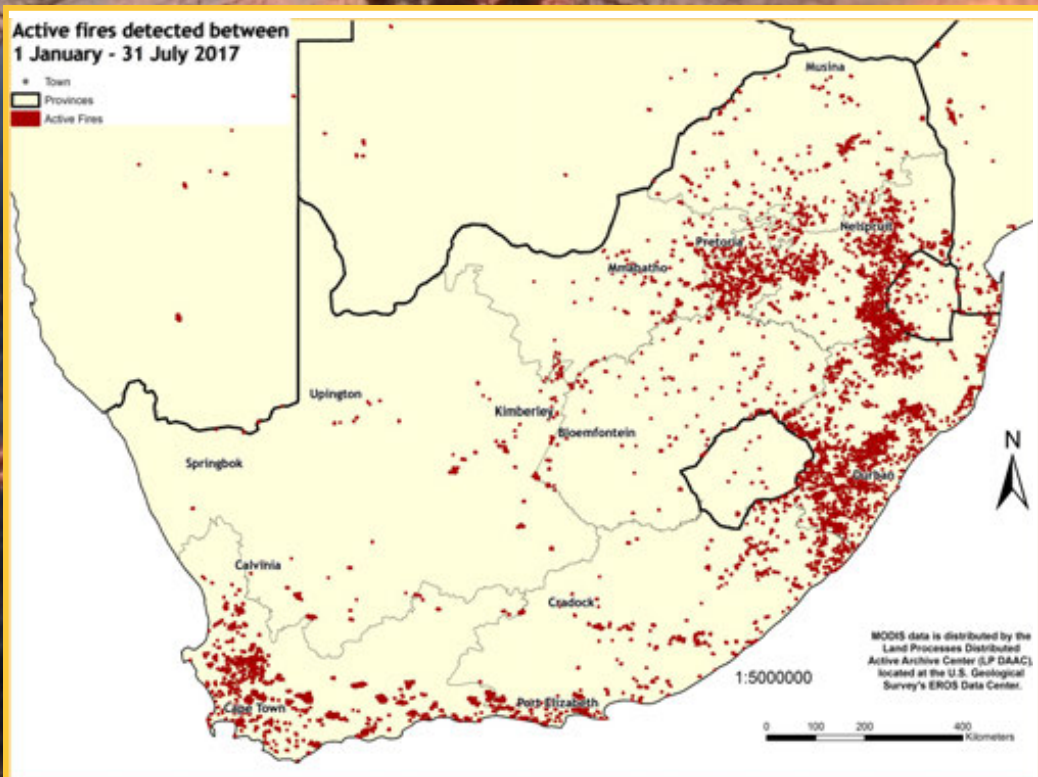

Figure 34

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

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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

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Geoinformation Science

ARC • LNR

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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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