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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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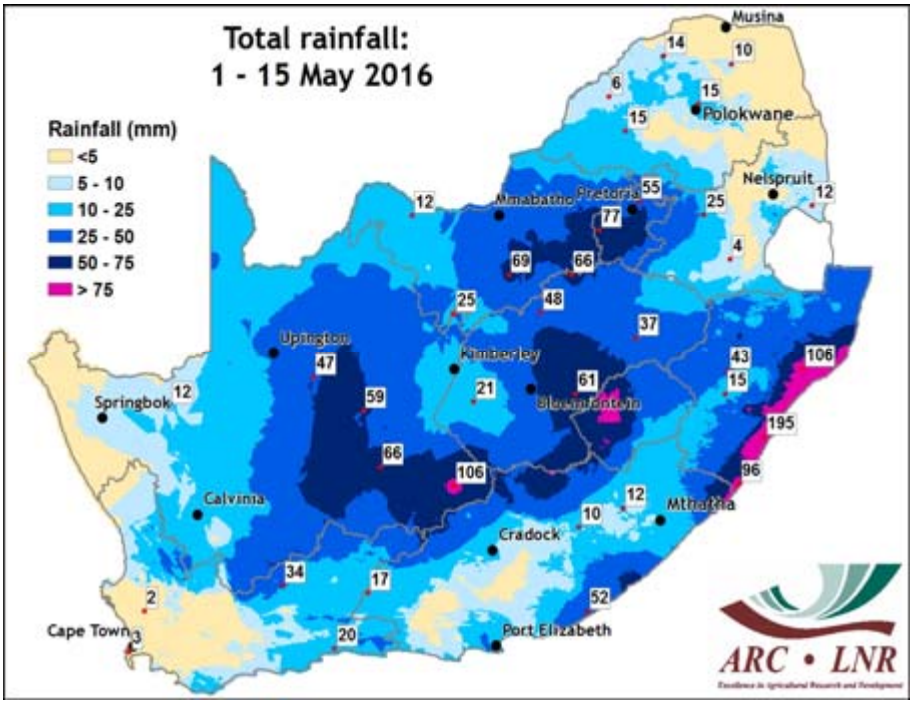
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

South African Weather Service

AMESD

143rd Edition

Images of the Month

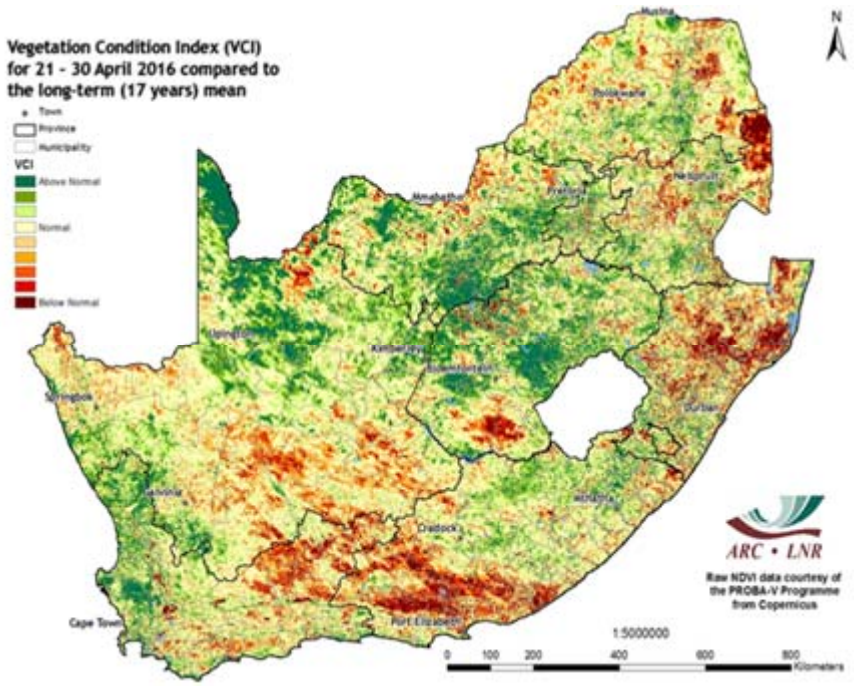


Summer-like conditions in first half of May

Widespread rain occurred over the central parts of the country since late March. This tendency continued into May with two deep cut-off low pressure systems resulting in widespread rain and thundershowers. Heavy falls occurred along the coast of KwaZulu-Natal in association with the first system as a strong high pressure system ridged around the country. Associated with the low pressure systems over the interior, large parts of the central interior and east received above-normal rainfall totals ranging between 25 and 100 mm. The rainfall map for 1-15 May is an interpolation of rainfall data from 450 stations of the ARC-ISCW automatic weather station network. Rainfall totals are indicated for selected stations.

While circulation patterns were conducive to the development of low pressure systems over the interior, frontal systems largely remained south of the country. The effect was above-normal minimum temperatures over the interior while very little rain occurred over the winter rainfall region, where follow-up rain after showers during April is urgently needed.

The above-normal temperatures and rainfall over the central parts resulted in positive anomalies in vegetation activity, associated with relatively summer-like conditions dominating. These tendencies are visible in the latest Vegetation Condition Index (VCI) map.



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:

April 2016 was characterized by above-normal rainfall over the central interior and the western parts of the winter rainfall region. While the early rain over the winter rainfall region represents a better start to conditions than last year, follow-up rain during May, which started out relatively dry over the region, is urgently needed. Since late March, circulation patterns have favoured the development of cut-off low pressure systems over the western interior. No less than six such systems developed over the central parts between the beginning of April and the middle of May. Temperatures over the interior remained above normal. Small areas did experience frost due to frontal systems by late March and early April. Otherwise, mild conditions prevailed over most areas.

Rainfall events over the interior mainly occurred between the 4th and 9th as well as from the 19th to 21st with more showers in the east by the 26th and 29th. Frontal systems resulting in rainfall over the winter rainfall region moved over the region by the 11th and 12th (light rain), 21st to 23rd (significant showers) and the 29th (significant showers). Colder air associated with the frontal systems invaded mostly the southern high-lying areas with the frontal systems of the 21st and 29th. However, the cold air did not spread as far north as Limpopo.

The largest rainfall totals over the interior were associated with the cut-off low between the 4th and 9th. A very strong high pressure system to the southeast also aided in rainfall over the eastern parts, while heavier falls occurred in the vicinity of the low over the central interior. Anticyclonic conditions dominated after the first rainfall event over the interior, but another upper-air trough moved over the interior between the 21st and 23rd, resulting in widespread rain and showers again over the central provinces. Following this event, a high pressure system ridging around the country with some upper-air instability due to a perturbation over the northern parts resulted in scattered thundershowers over the northeastern interior by the 26th, with rain over the coastal areas and far east due to the influx of moisture associated with the ridging high pressure system. The last rain-producing system occurred by the 29th. A strong frontal system and deep upper-air trough resulted in widespread rain over the winter rainfall region. The upper-air trough supported scattered showers over the south-eastern to eastern interior and coastal areas as another high pressure system ridged around the country. Cold air invaded most parts except the far north. Anticyclonic conditions followed, with temperatures increasing gradually by the end of the month.

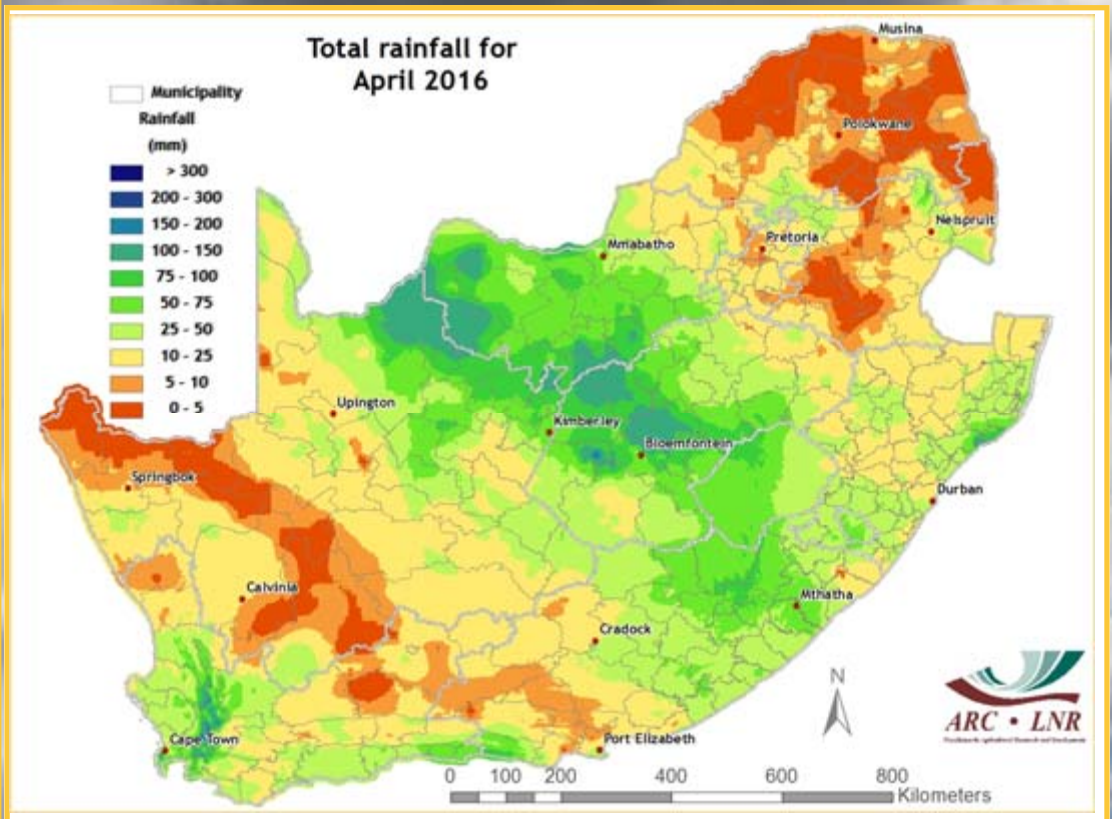
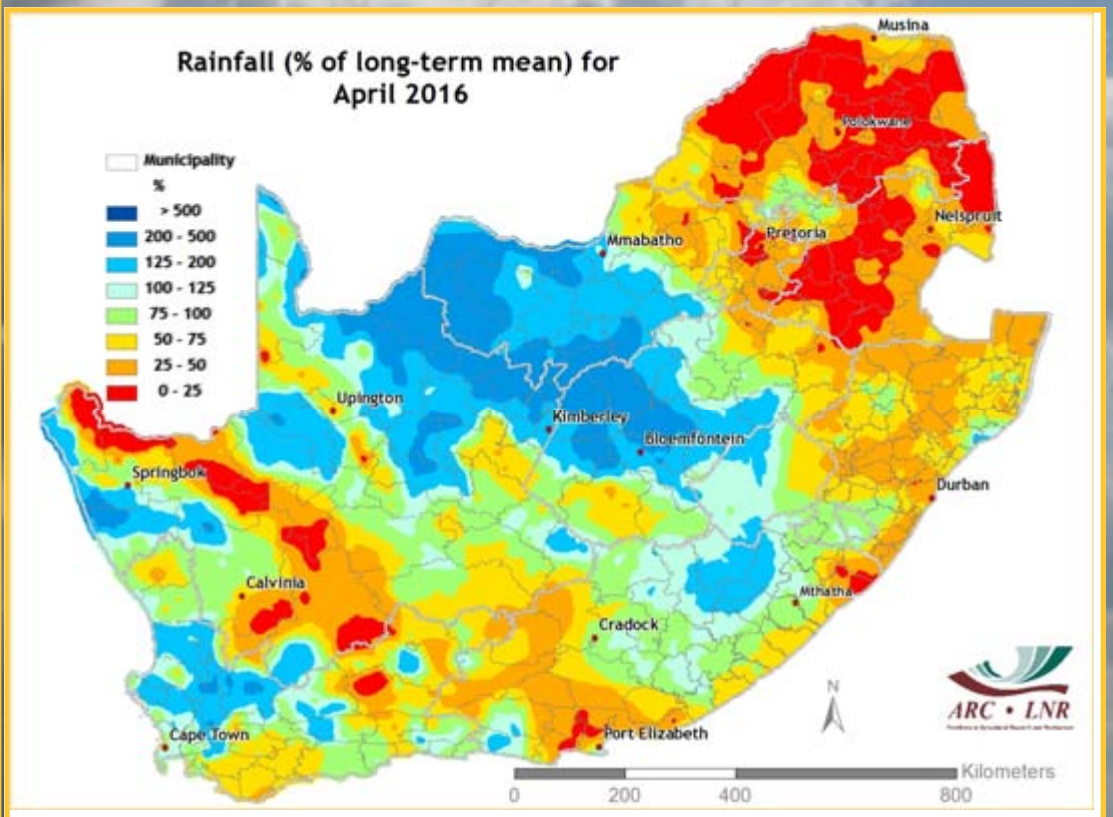


Figure 1



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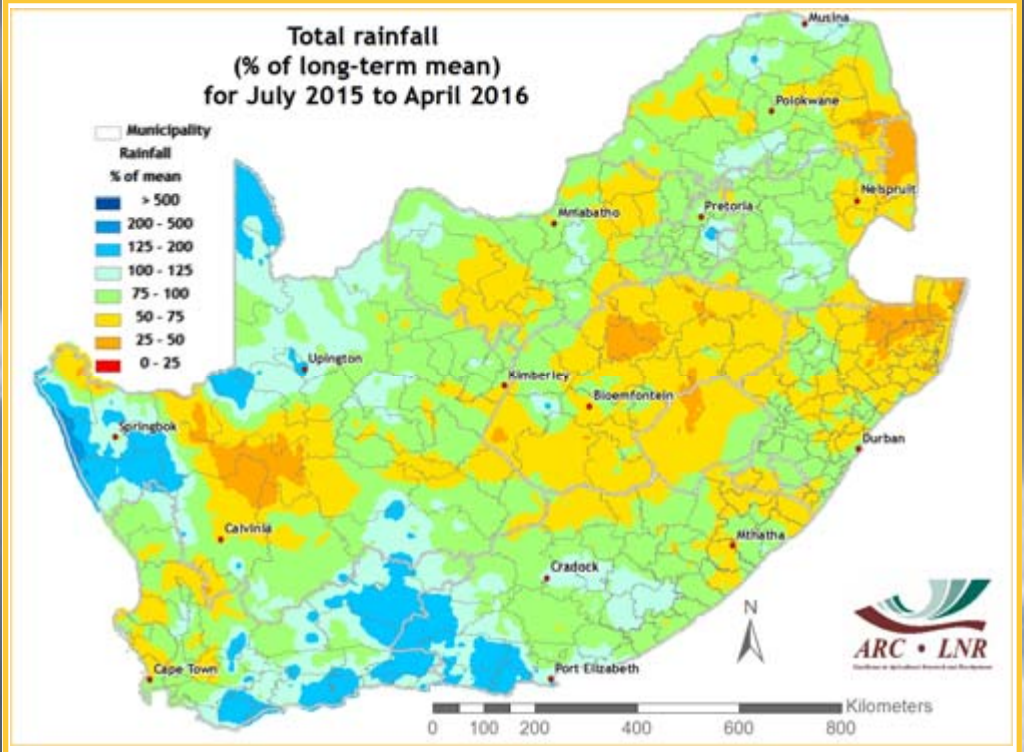

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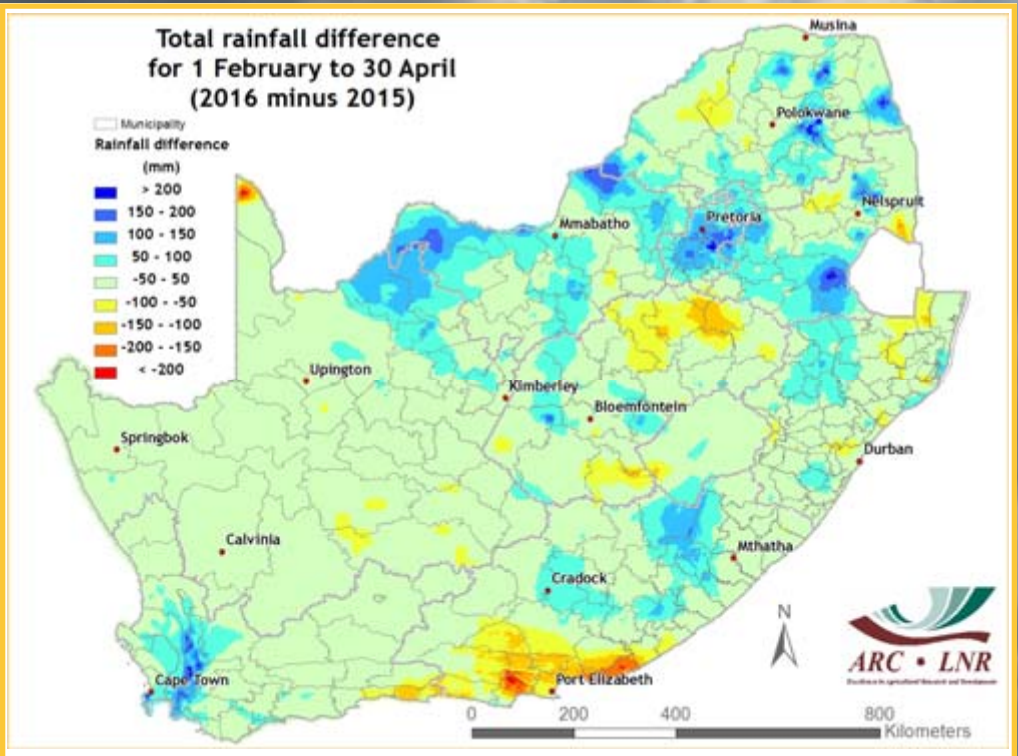

Figure 4

Figure 1:
A northwest-southeast stretching band over the central interior received in excess of 50 mm of rain in total for April, with some areas receiving more than 100 mm. Other areas receiving significant rainfall included the Boland and a small area along the north coast of KwaZulu-Natal. The western parts of the Northern Cape together with Limpopo were mostly dry.

Figure 2:
Above-normal precipitation occurred over the central interior as well as the northern parts of the winter rainfall region. Most of the rest of the country received below-normal totals.

Figure 3:
Most of the country received near normal rainfall for the summer since July 2015 in total, reflecting a balance between very dry conditions in early summer and wetter conditions in late summer. However, areas that received below-normal rainfall are still present including the central Free State, northern KwaZulu-Natal and the Lowveld of Mpumalanga.

Figure 4:
Most of the summer and winter rainfall regions received more rain this year during the period February to April. A notable exception is the southeastern parts, specifically the southern parts and coastal area of the Eastern Cape.

Questions/Comments:
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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.

The current SPI maps (Figure 5-8) show that severe to extreme drought conditions are very limited at the shorter time scales. At the longer time scales, severe to extreme drought occurs over parts of KwaZulu-Natal, northeastern Free State and the Lowveld.

Questions/Comments:
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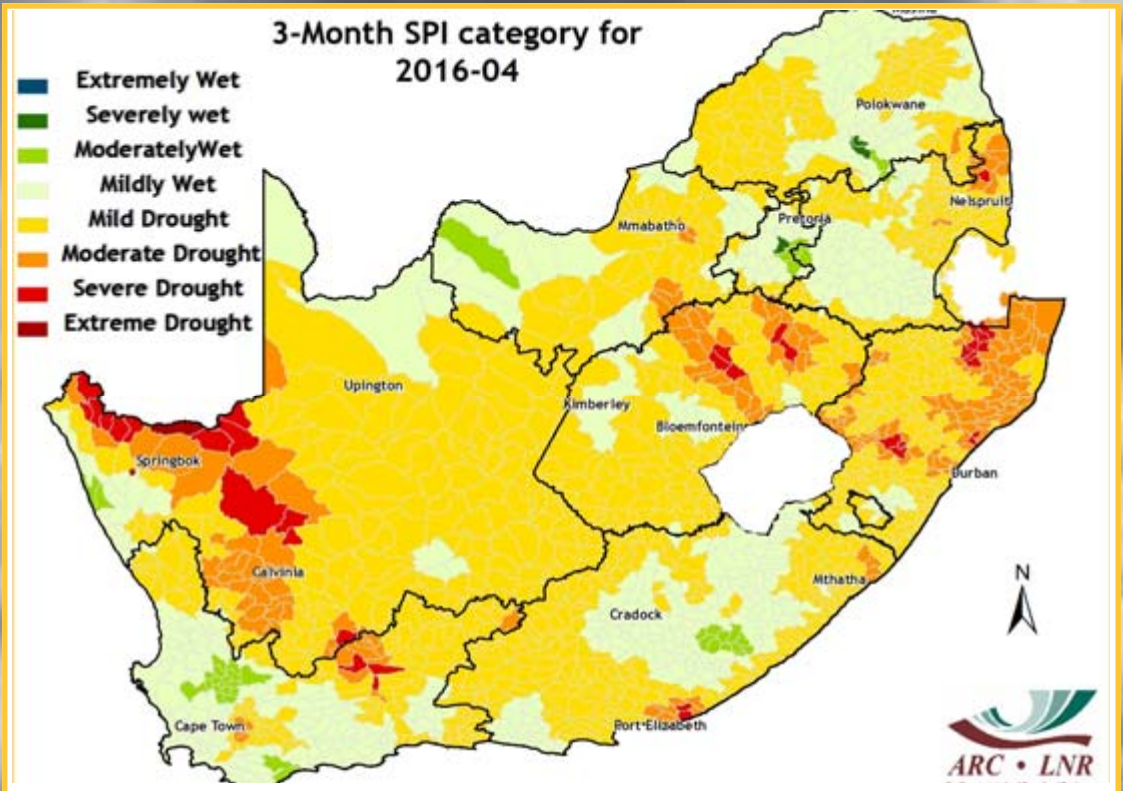

Figure 5

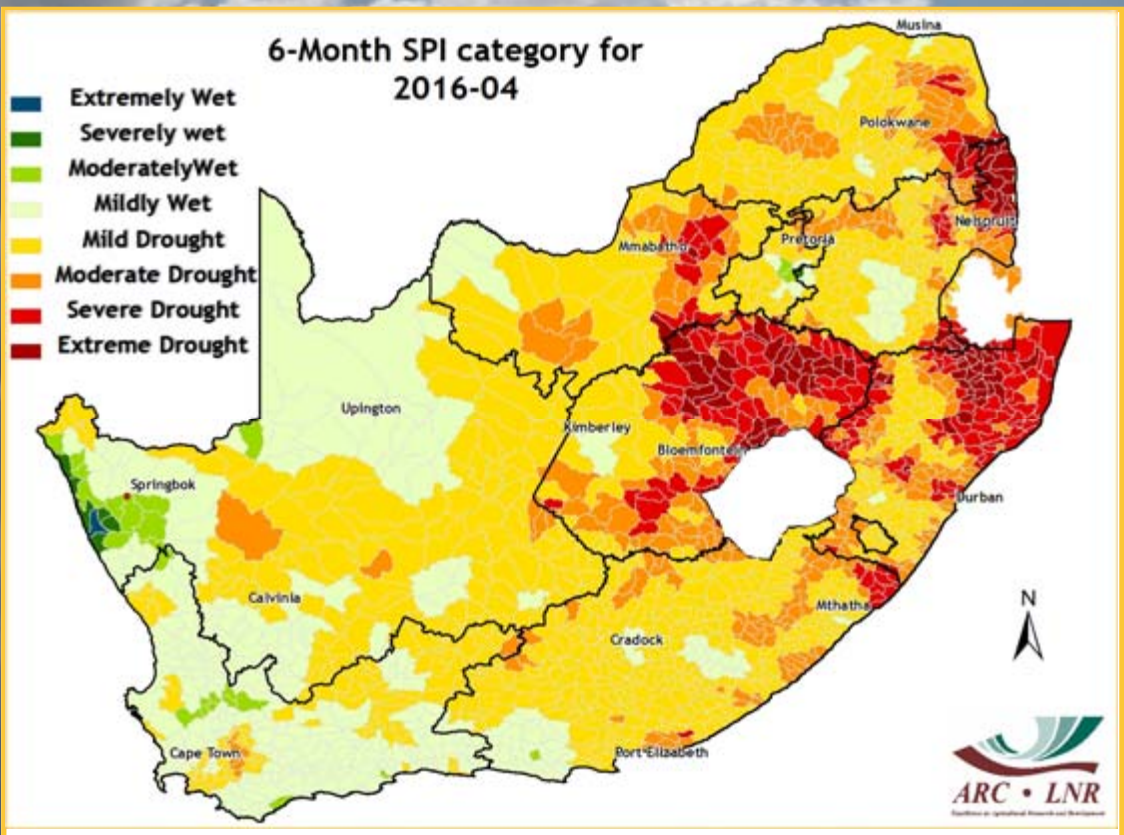

Figure 6

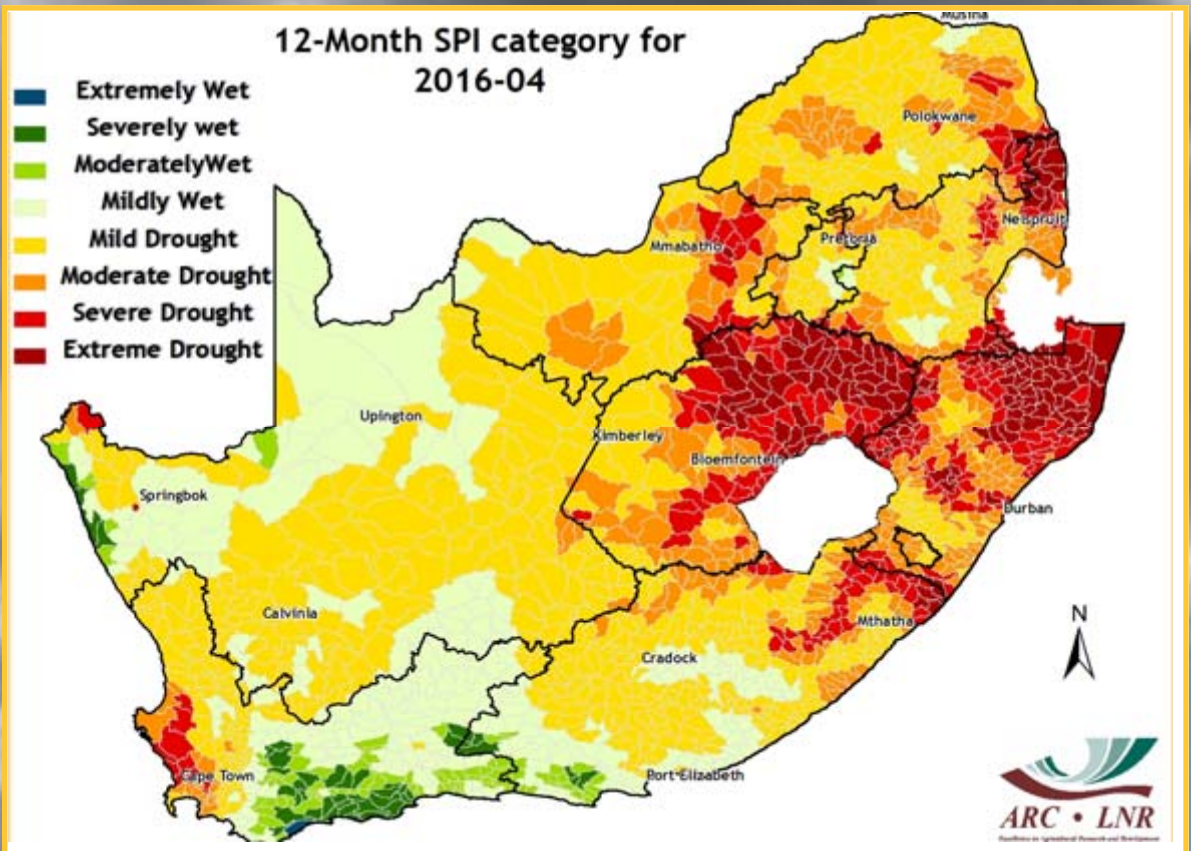

Figure 7

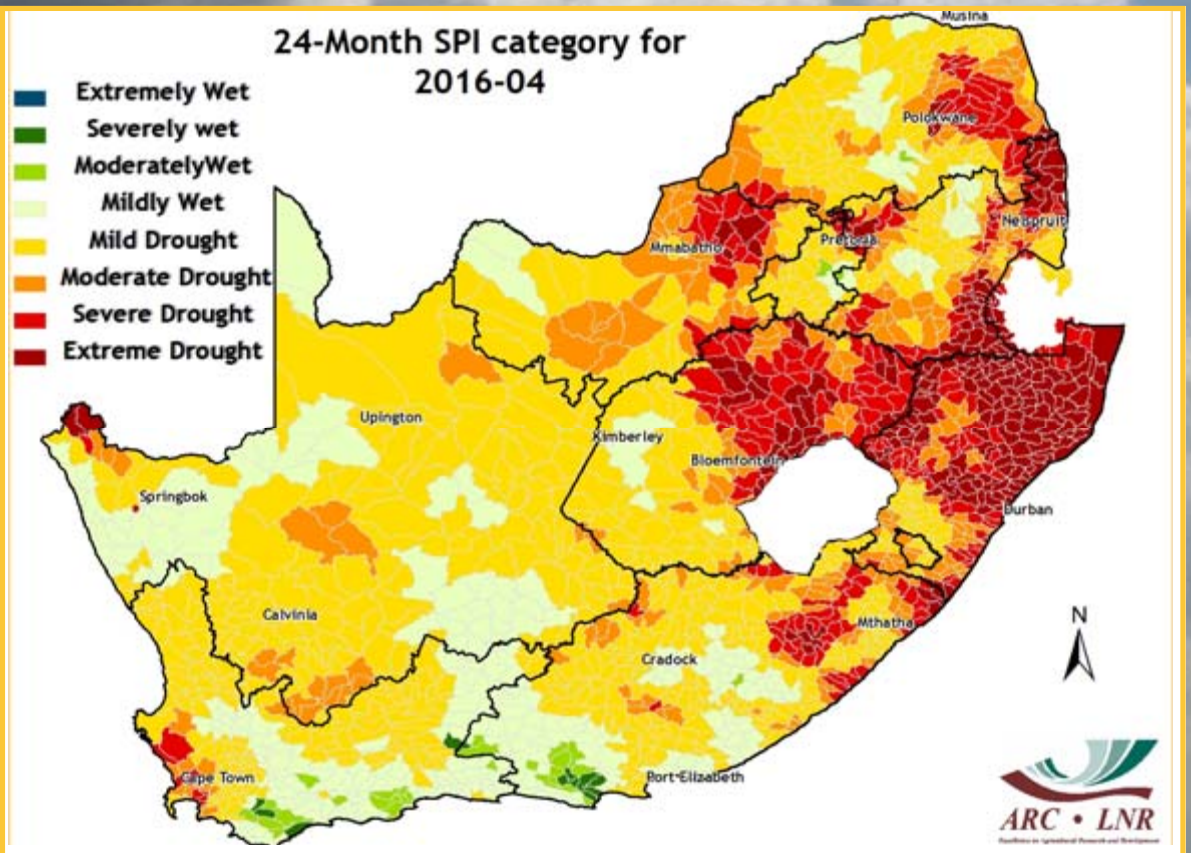

Figure 8

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.

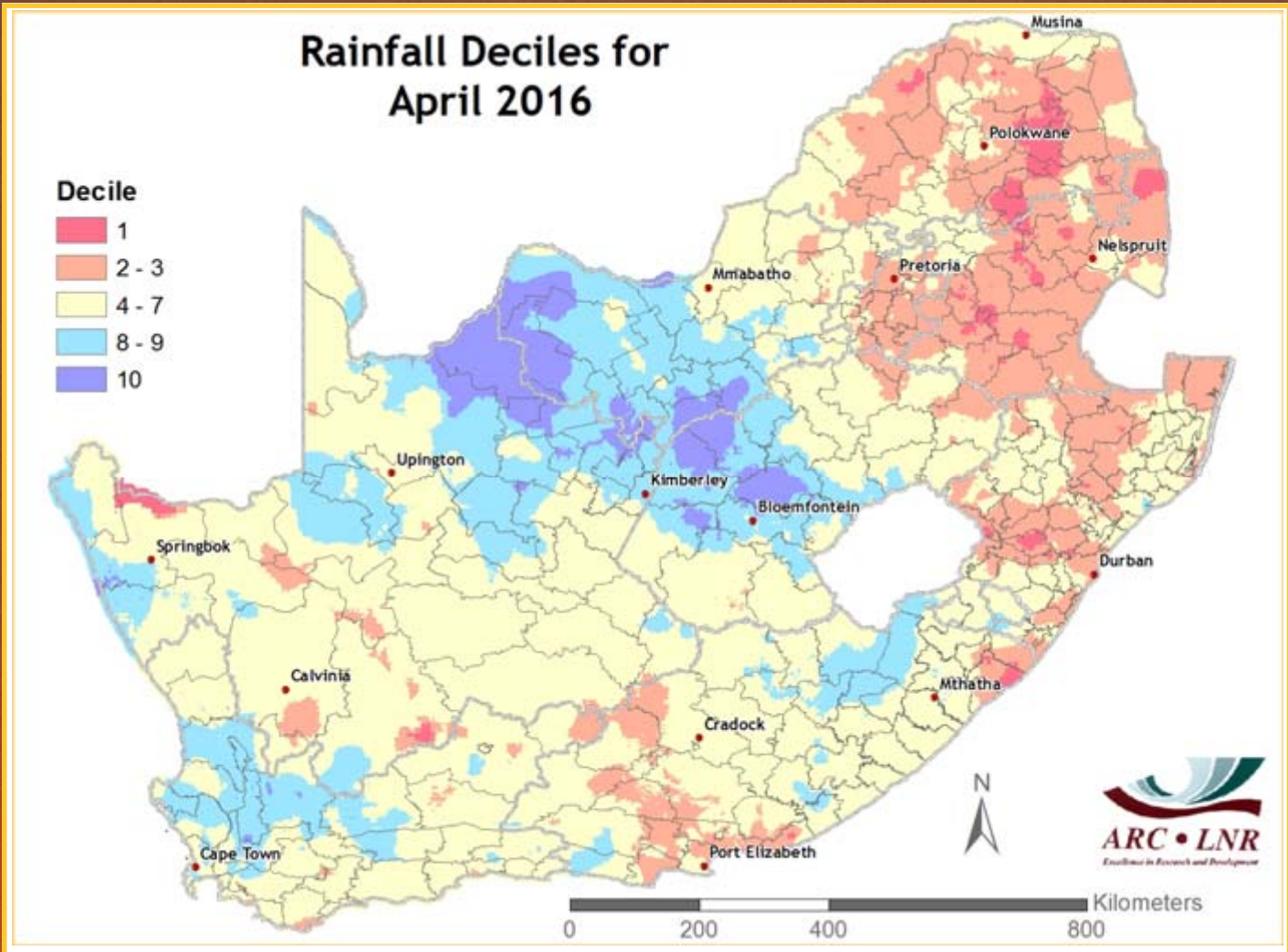

Figure 9

Figure 9:
Parts of the central interior were exceptionally wet during April while large parts of the northeast were exceptionally dry.

Questions/Comments: *Johan@arc.agric.za*

4. Water Balance

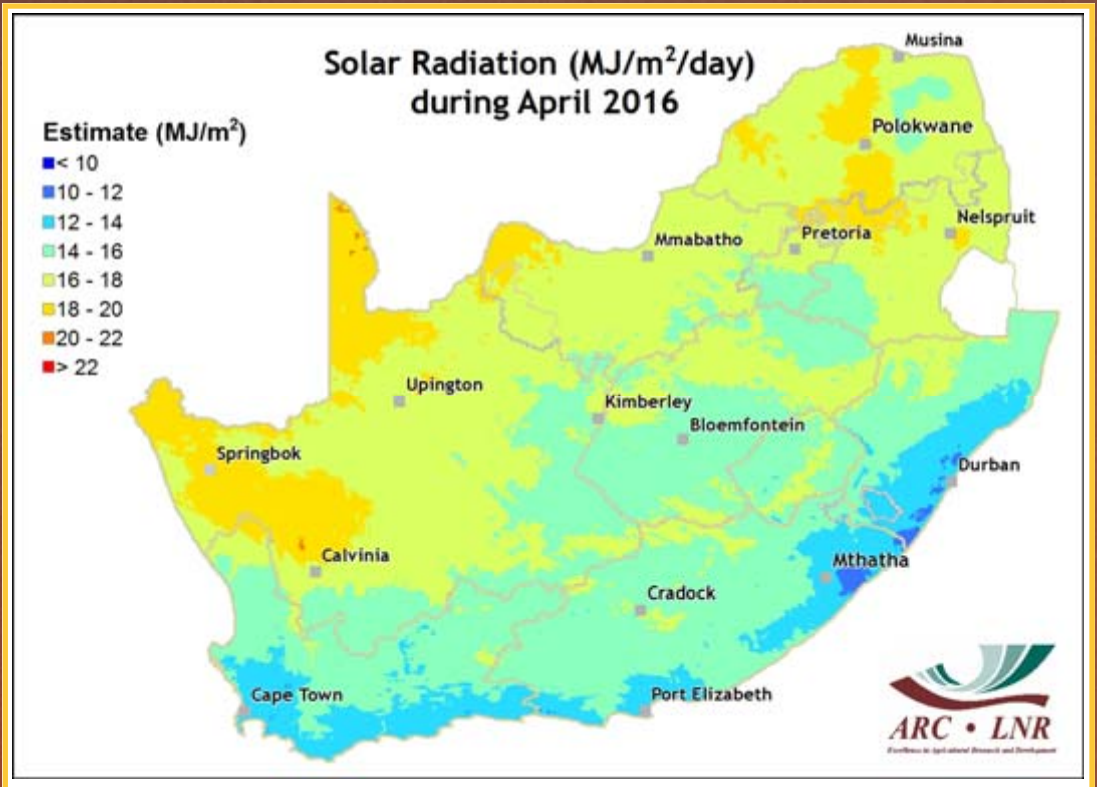

Figure 10

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:
While the general trend of increasing solar radiation towards the west remained during April, it is clear that large amounts of clouds had a negative impact over some of the eastern and northeastern parts.

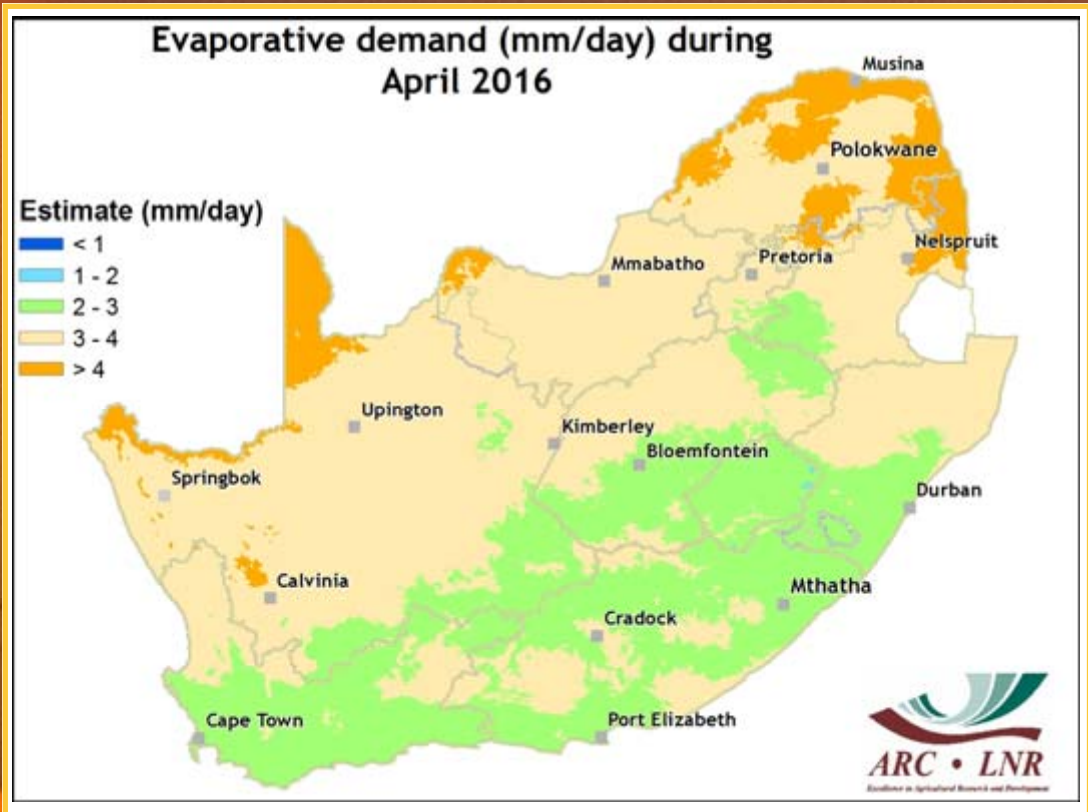

Figure 11

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:
Average daily potential evapotranspiration ranged between 2 mm/day in the southwest to more than 4 mm/day over the Northern Cape and Limpopo.

Questions/Comments:
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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.

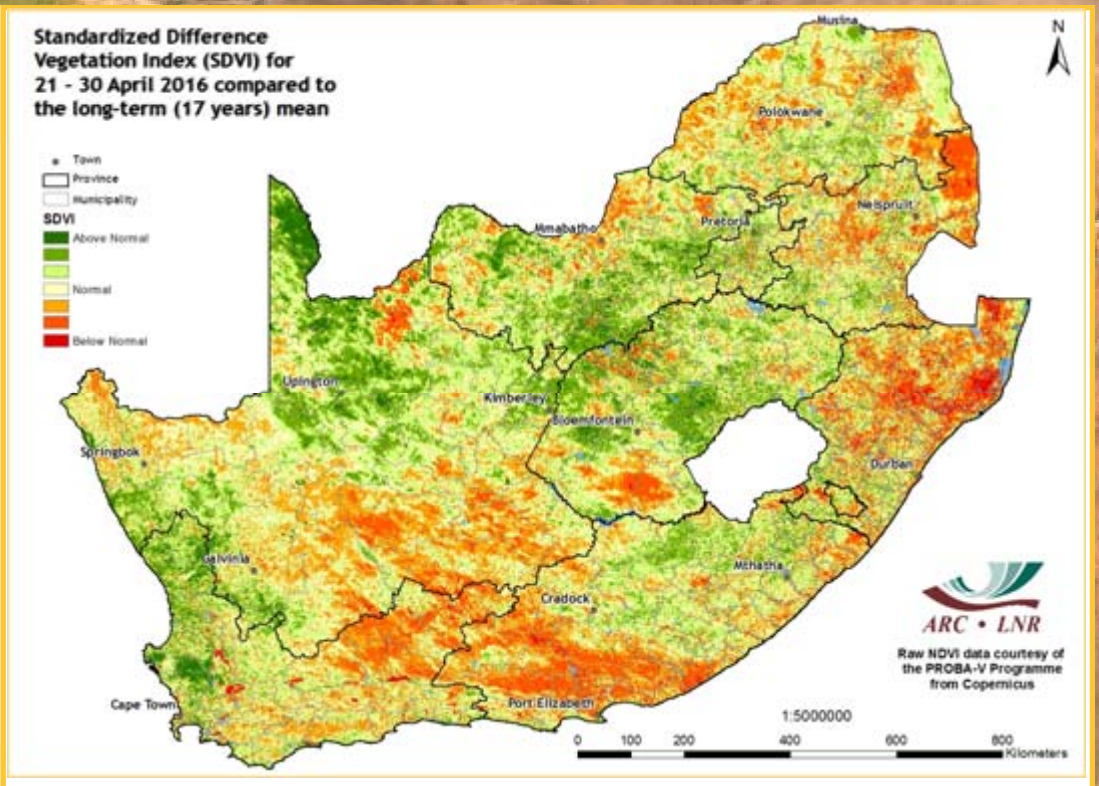

Figure 12

Figure 12:
The SDVI by late April reflected recent above-normal rainfall over the central to western interior and northern parts of the winter rainfall region (West Coast and western Escarpment) as well as dry conditions over the southeastern and eastern low-lying areas.

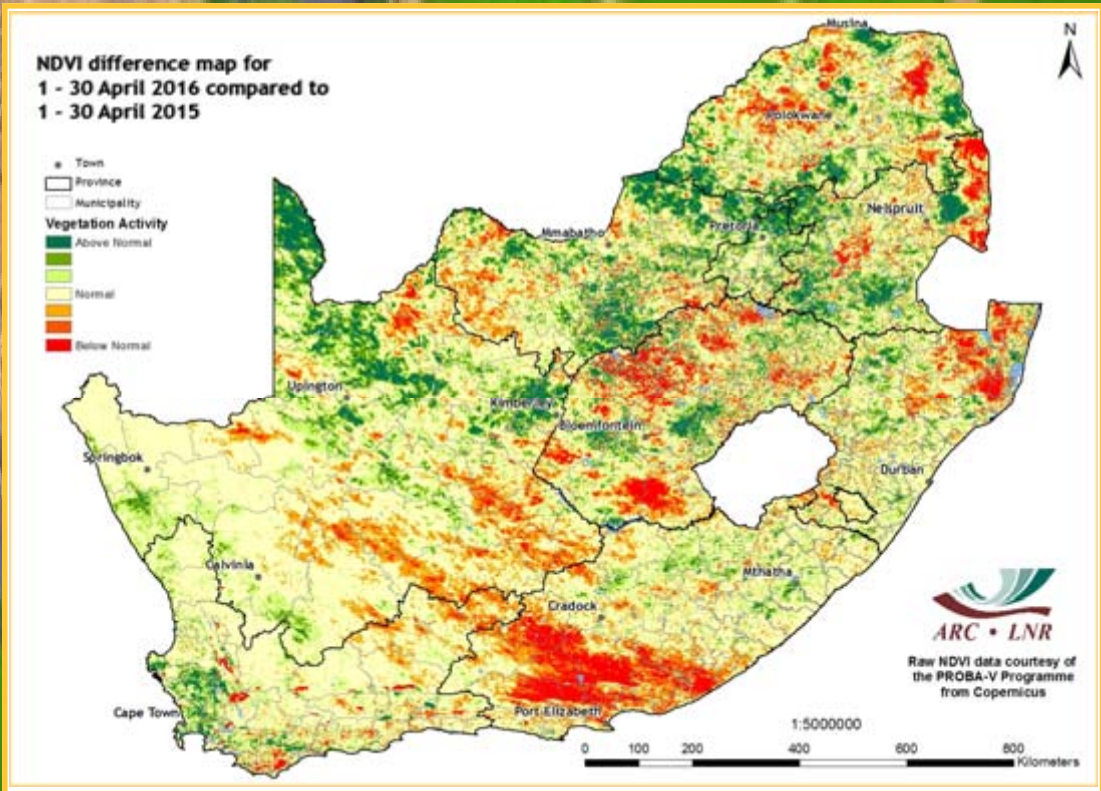

Figure 13

Figure 13:
An earlier start to the winter rainy season and more rain over the western and central areas are reflected in vegetation activity relative to the conditions last year by late April. Vegetation activity over the southeastern parts is lower than a year ago.

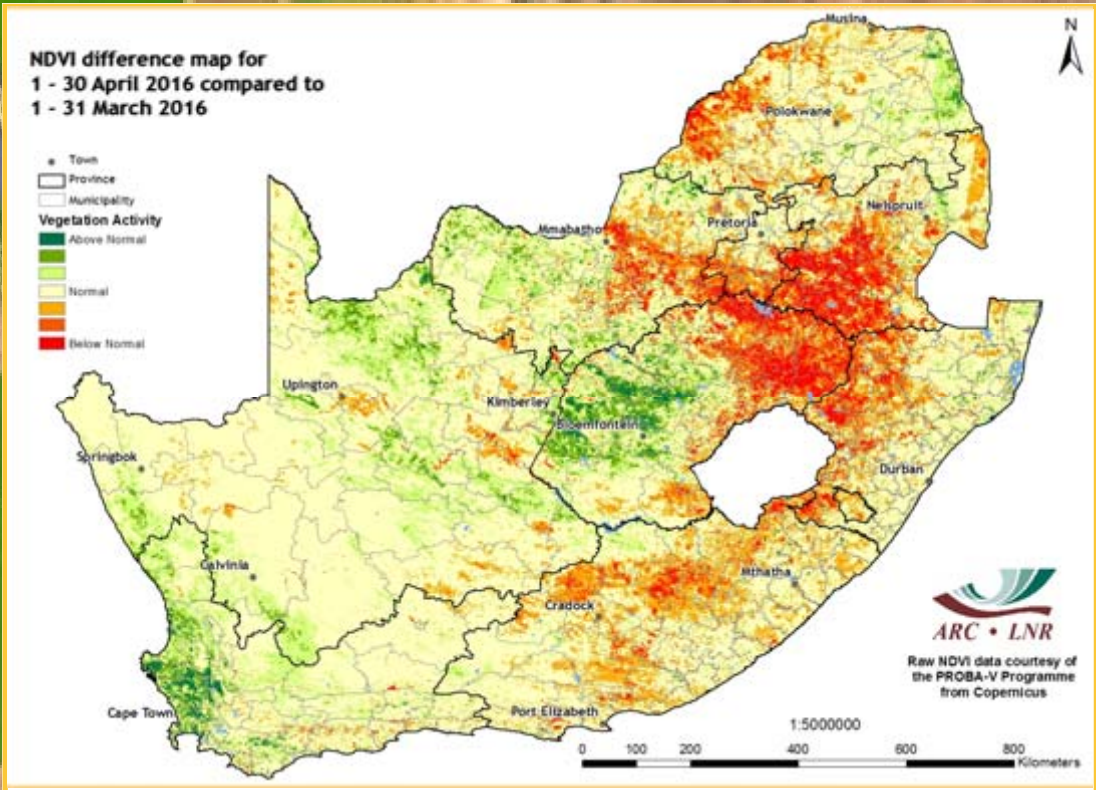

Figure 14

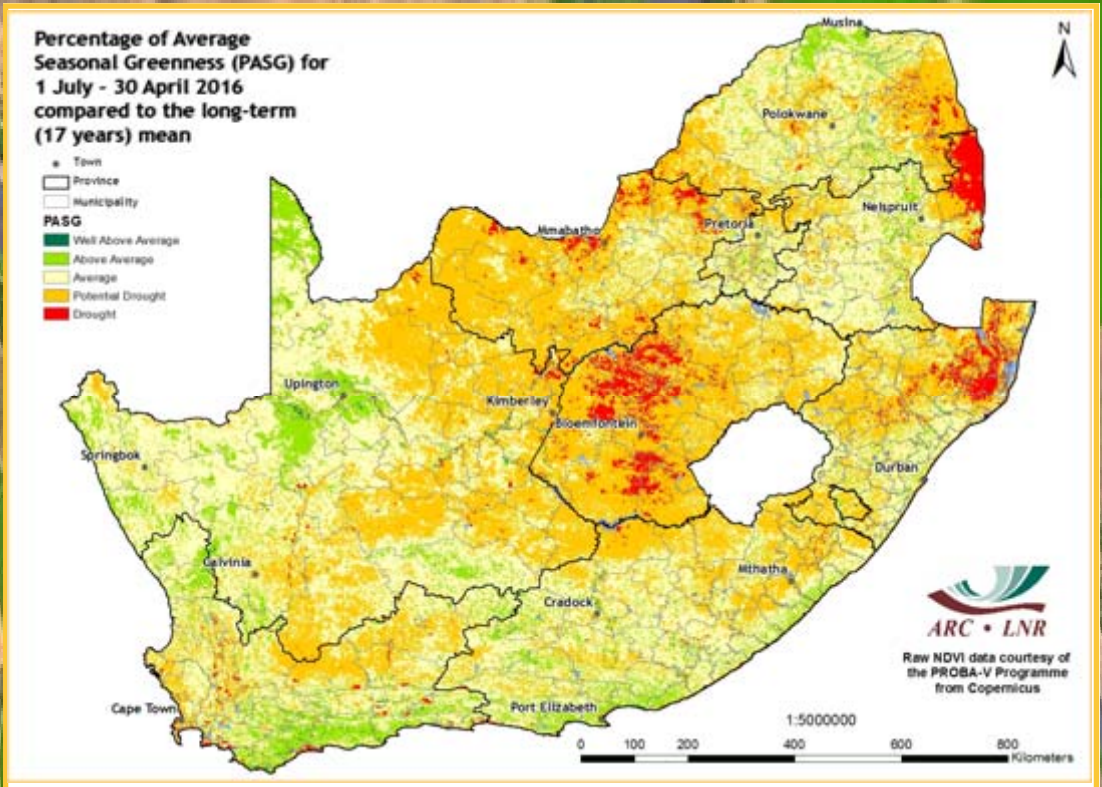

Figure 15

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:
Due to relatively warm and wet conditions, vegetation activity over the central parts increased during April. Widespread rain over the western parts of the winter rainfall region also had a positive effect on vegetation activity. Recent colder, drier conditions, following normal to above-normal rain in late summer, resulted in large decreases in vegetation activity over the Highveld.

Figure 15:
Cumulative vegetation activity anomalies still indicate earlier drought stress over much of the central parts of the country as well as the eastern coastal areas and the Lowveld. The southern parts of the country, together with parts of Limpopo and Mpumalanga, experienced above-normal cumulative vegetation activity during the past summer.

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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.

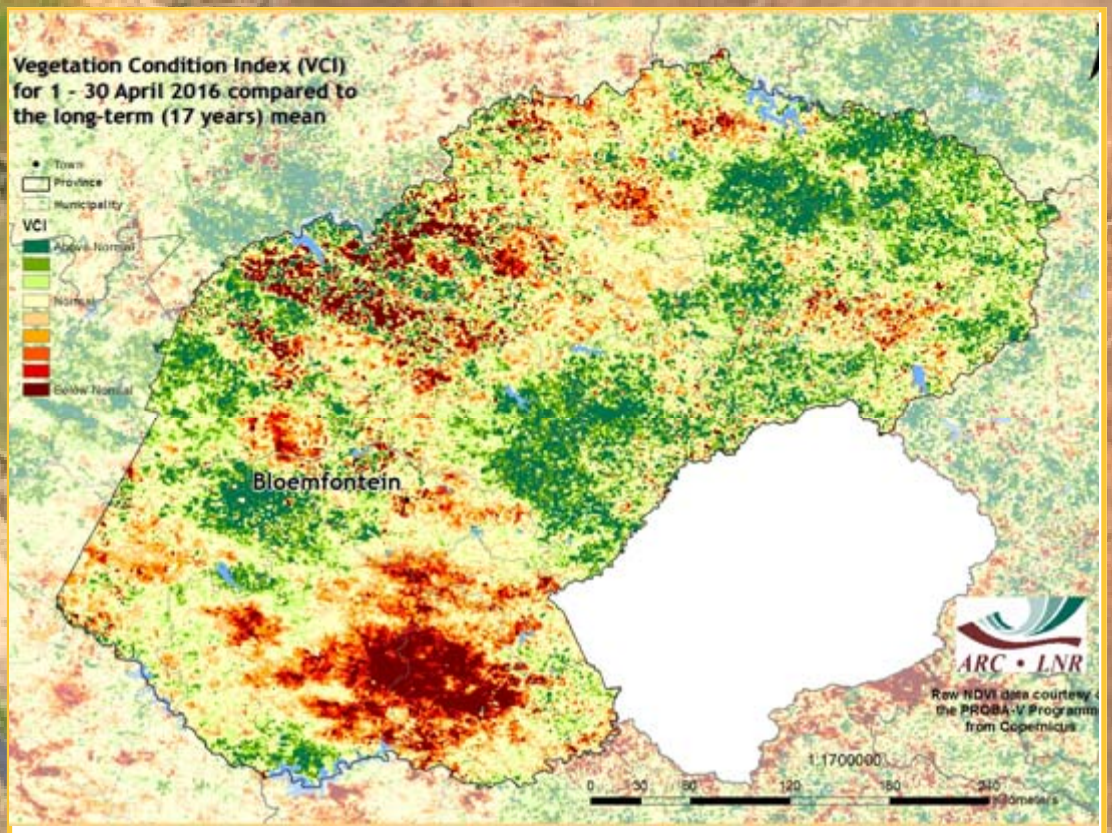

Figure 16

Figure 16:
The VCI map for April indicates below-normal vegetation activity mainly over the southern parts of the Free State province.

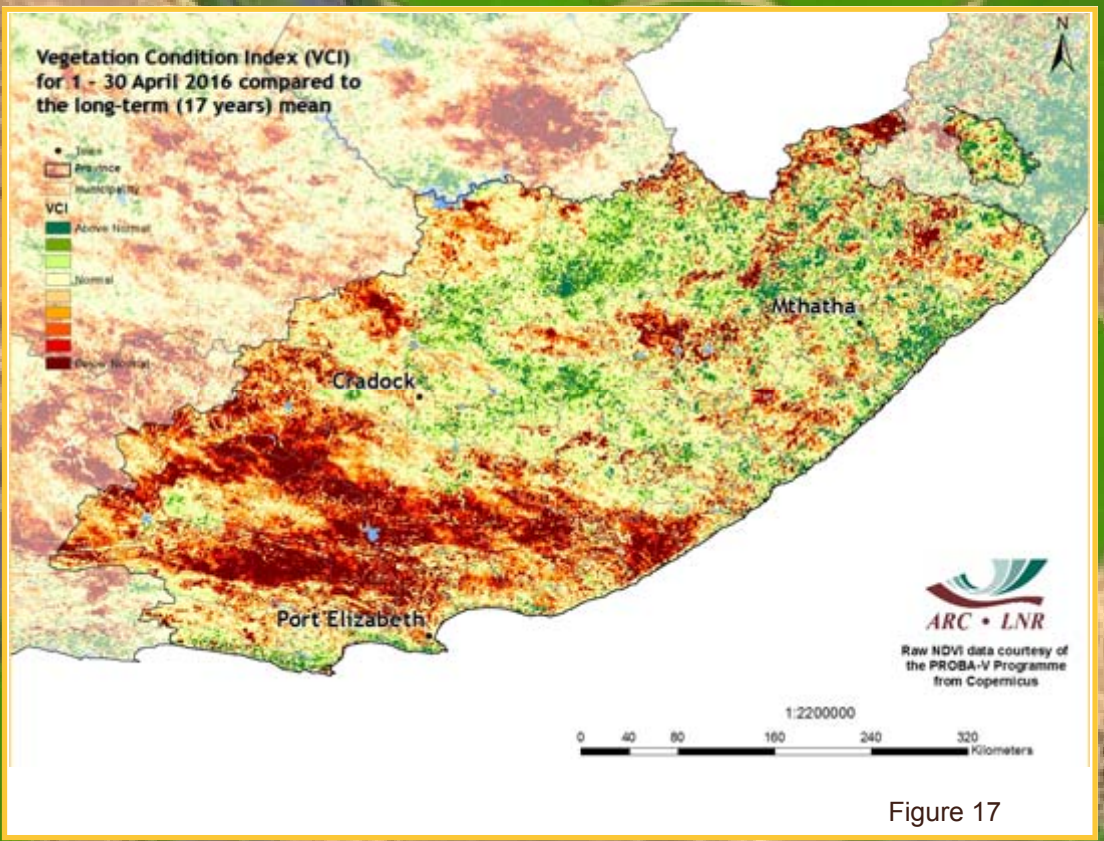

Figure 17

Figure 17:
The VCI map for April indicates below-normal vegetation activity mainly over the southern parts of the Eastern Cape province.

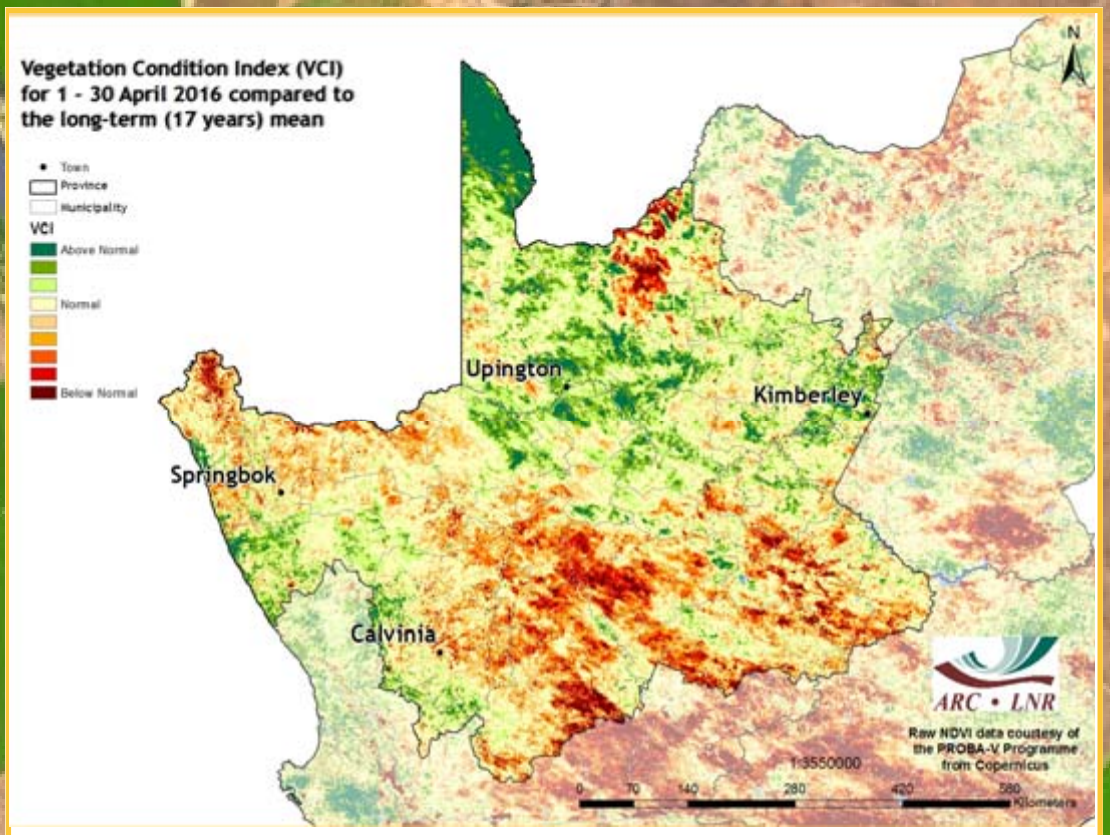

Figure 18

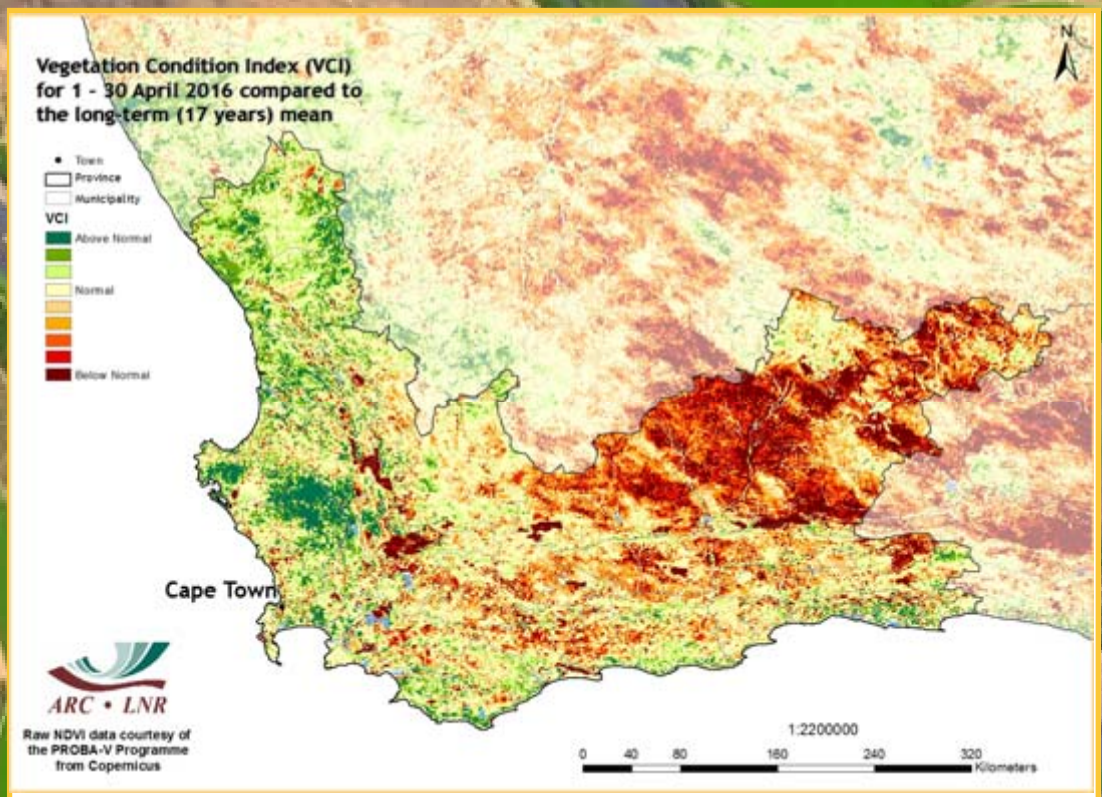

Figure 19

Figure 18:
The VCI map for April indicates below-normal vegetation activity over the southern and western interior of the Northern Cape province, excluding the winter rainfall region.

Figure 19:
The VCI map for April indicates below-normal vegetation activity over the northeastern parts of the Western Cape province.

Questions/Comments:
NkambuleV@arc.agric.za

7. Vegetation Conditions & Rainfall

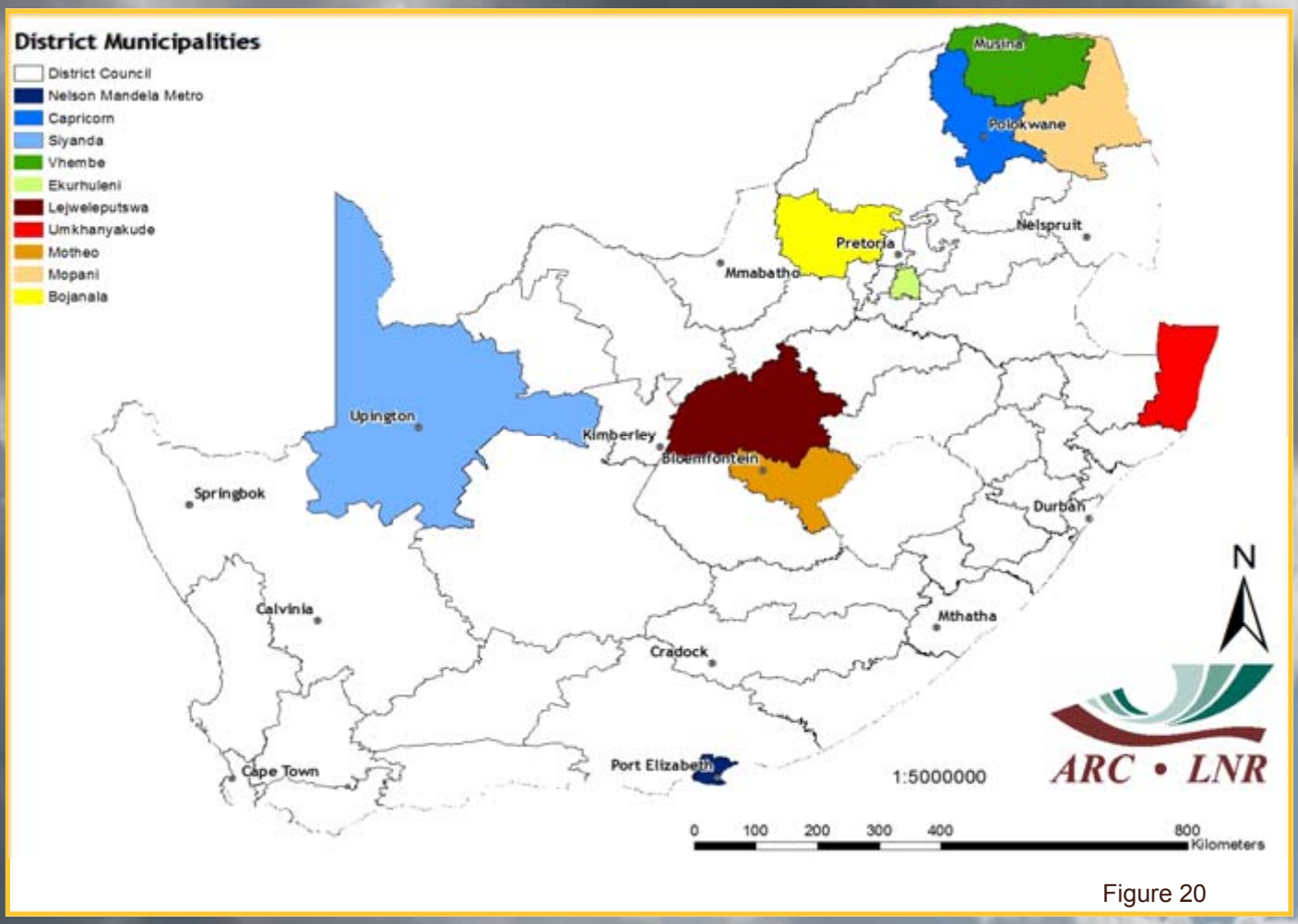

Figure 20

NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for April 2016. The district colour matches the border of the corresponding graph.

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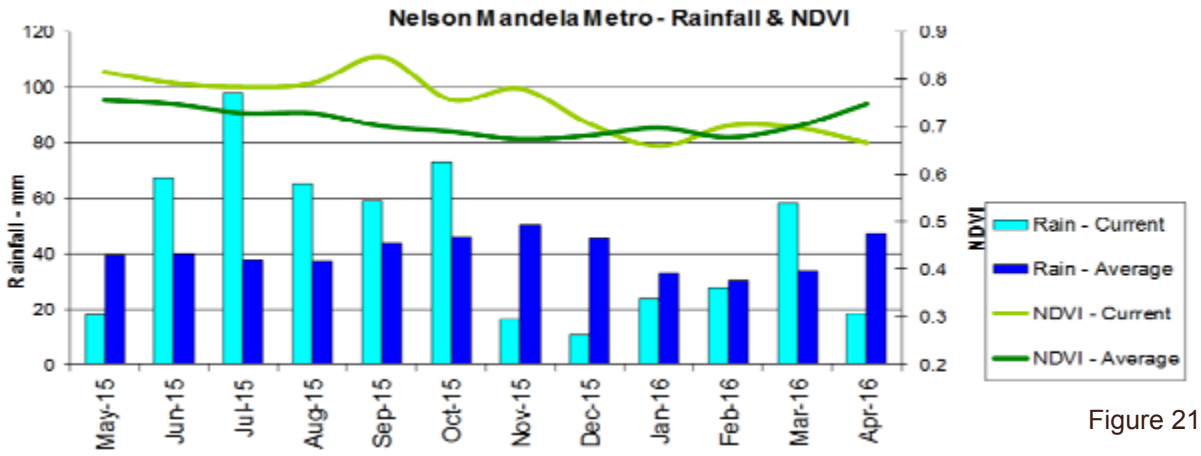
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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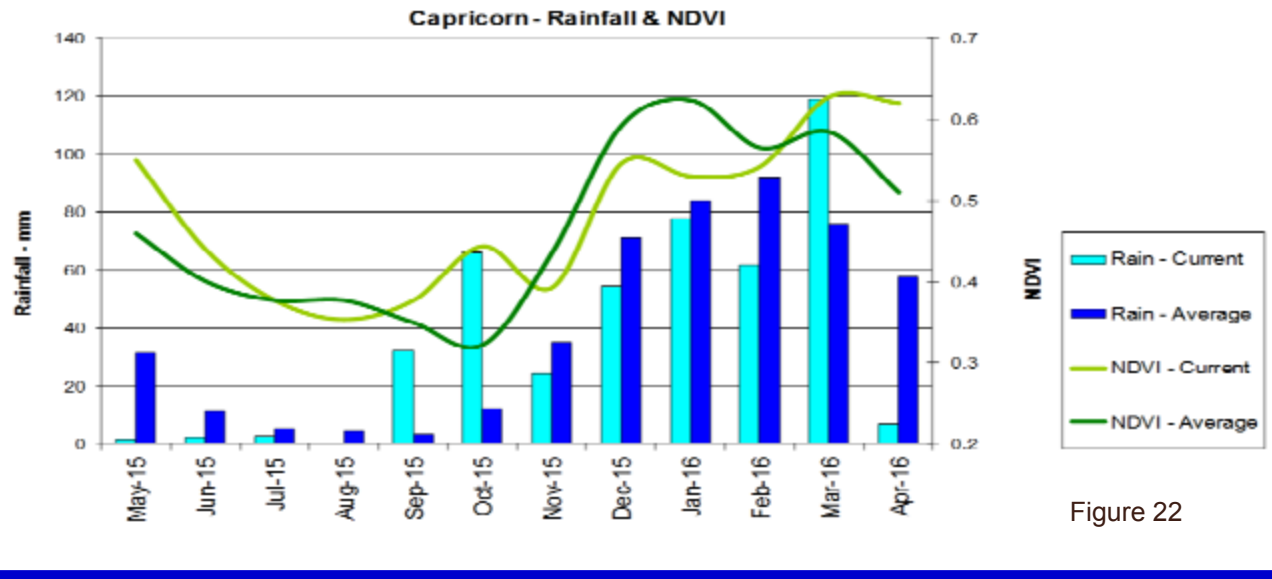

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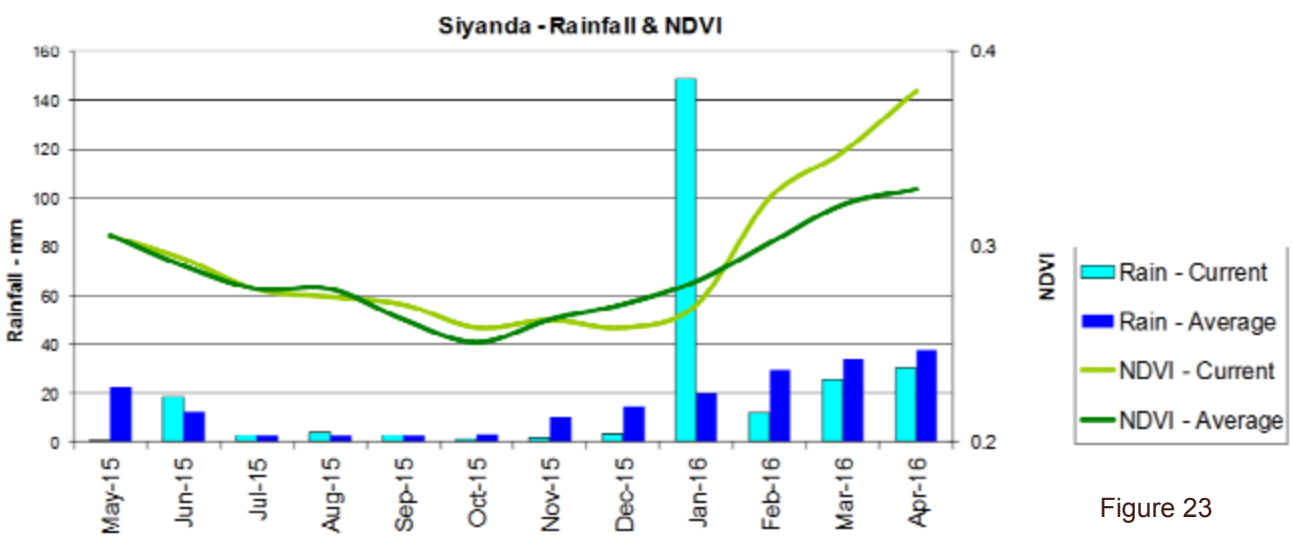

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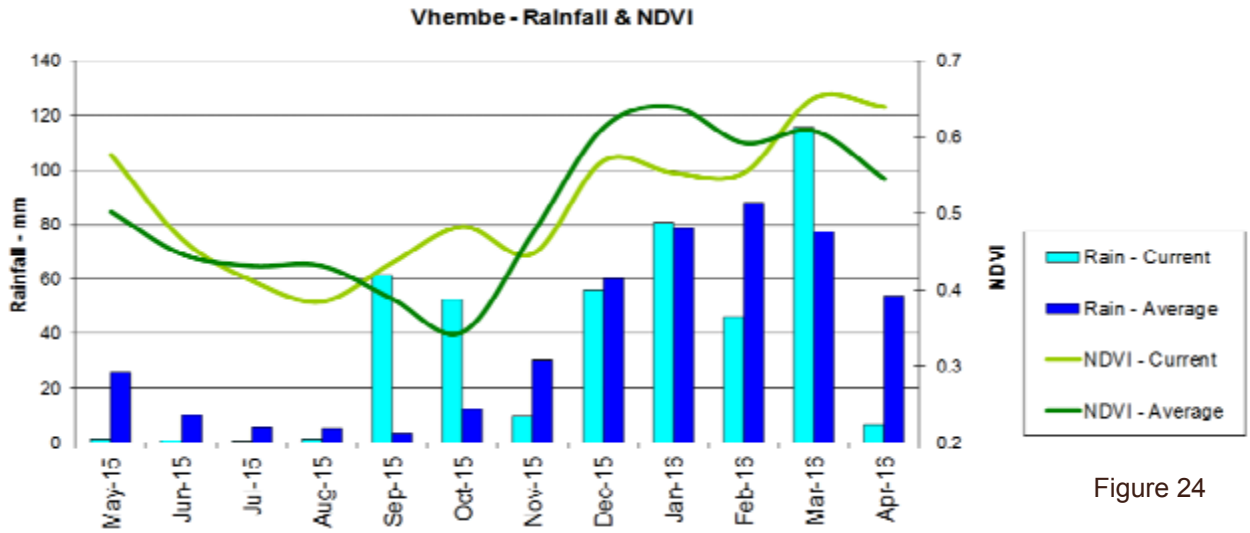

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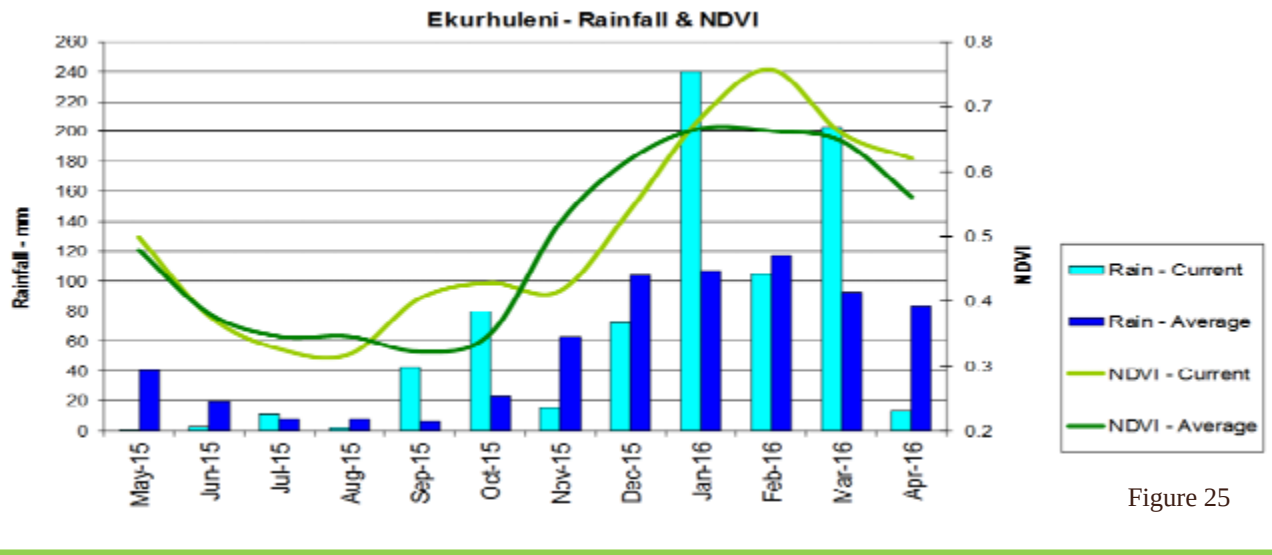

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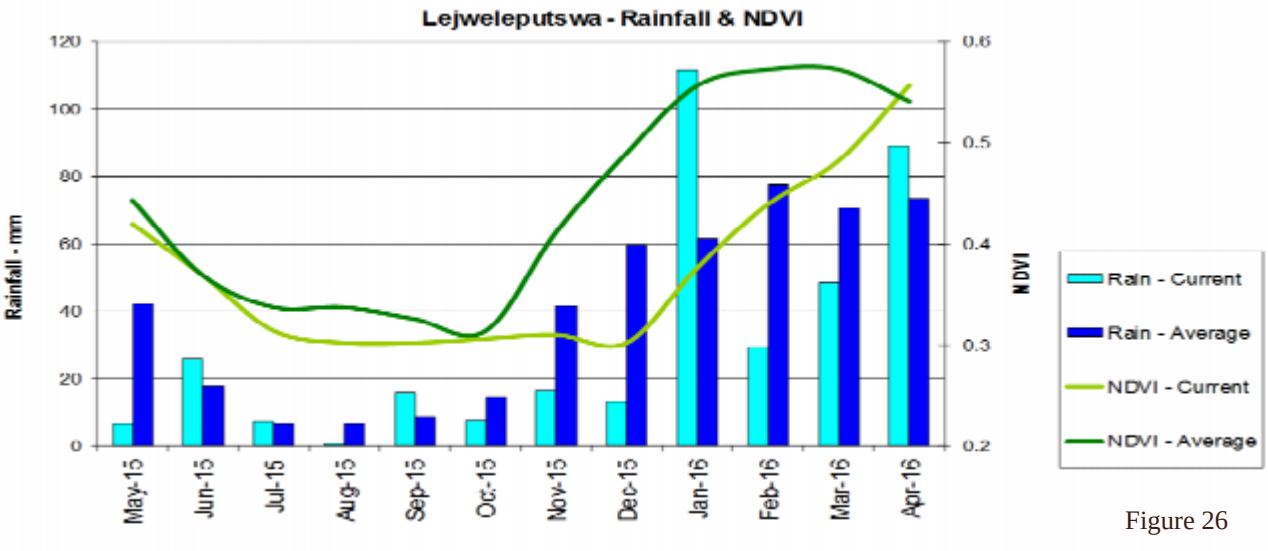
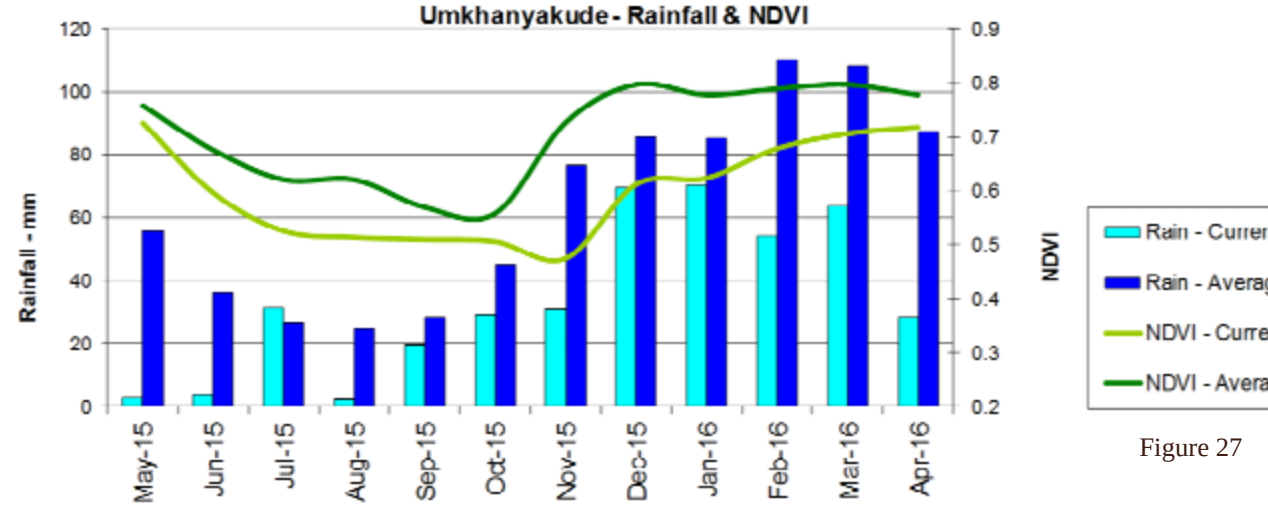


Figure 26



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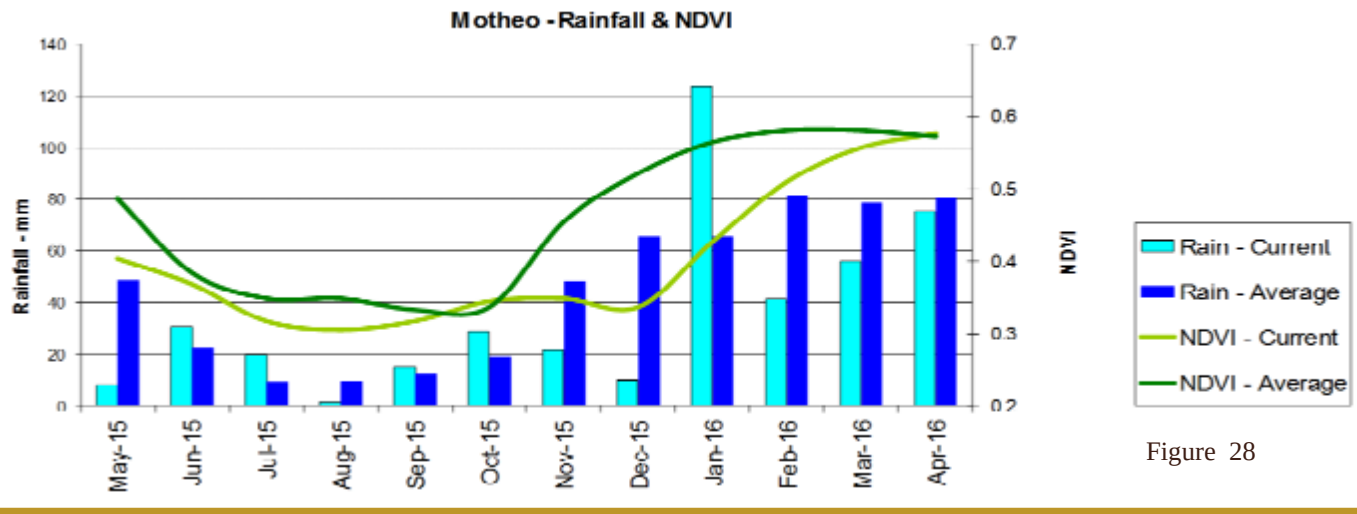

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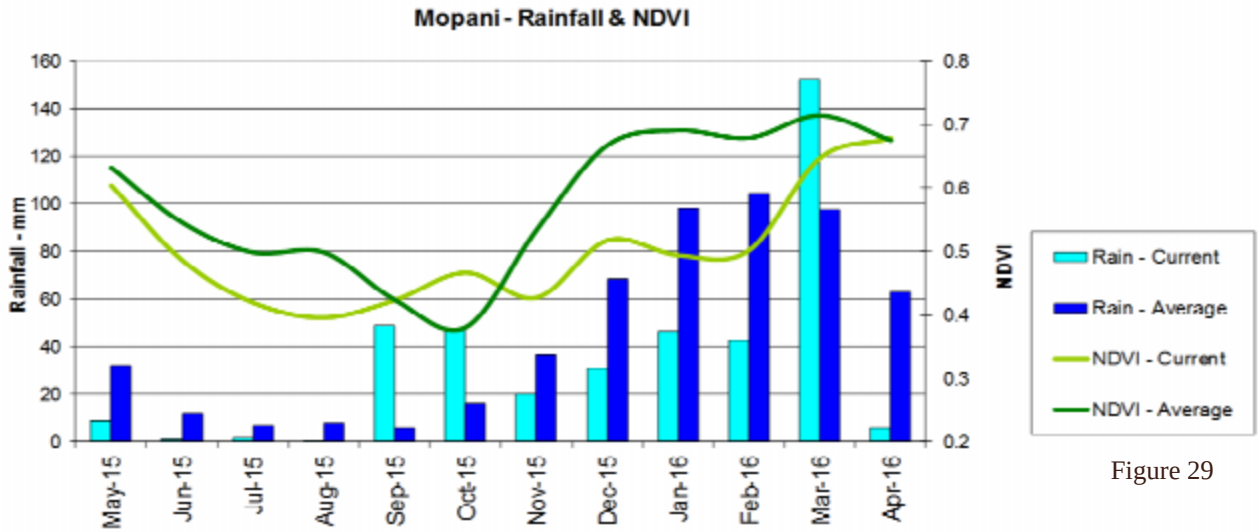

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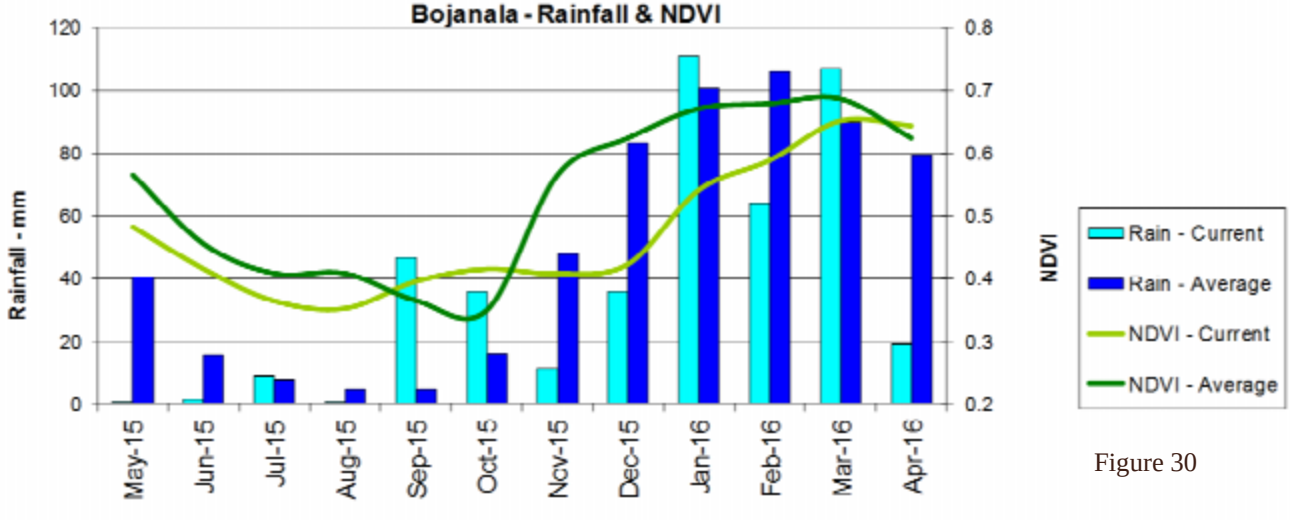

Figure 30

8. Soil Moisture

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Countywide soil moisture modelling by the University of KwaZulu-Natal Satellite Applications and Hydrology Group (SAHG)

Figure 31 shows the monthly averaged soil moisture conditions for April 2016. The colour scale ranging from brown to blue represents the Soil Saturation Index (SSI), defined as the percentage saturation of the soil store in the TOPKAPI hydrological model. The modelling is intended to represent the mean soil moisture state in the root zone. Figure 32 shows the SSI difference between April and March 2016, with the brown colours showing the drier and the green colours the wetter areas. Similarly, the year-on-year SSI difference for March is shown in Figure 33.

The year-on-year and month-on-month SSI differences are in agreement with rainfall and vegetation trends observed elsewhere in the newsletter.

The SSI maps are produced at the ARC-ISCW in a collaborative effort with the University of KwaZulu-Natal Applications and Hydrology Group, made possible by the WMO.

Questions/Comments:
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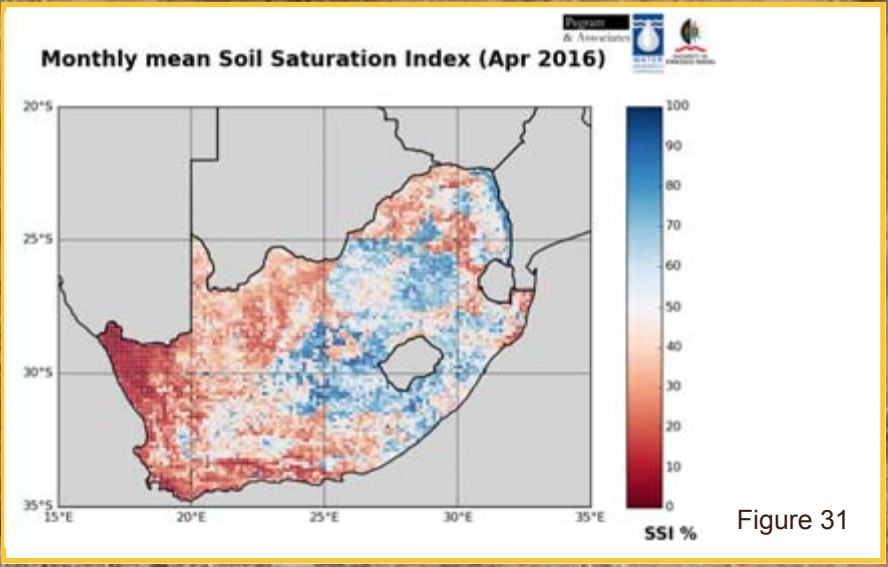

Figure 31

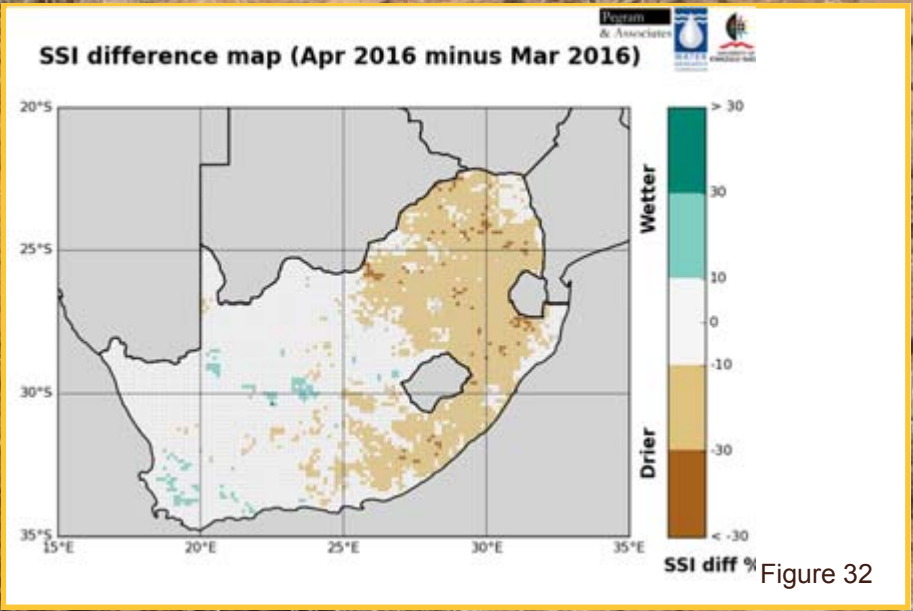

Figure 32

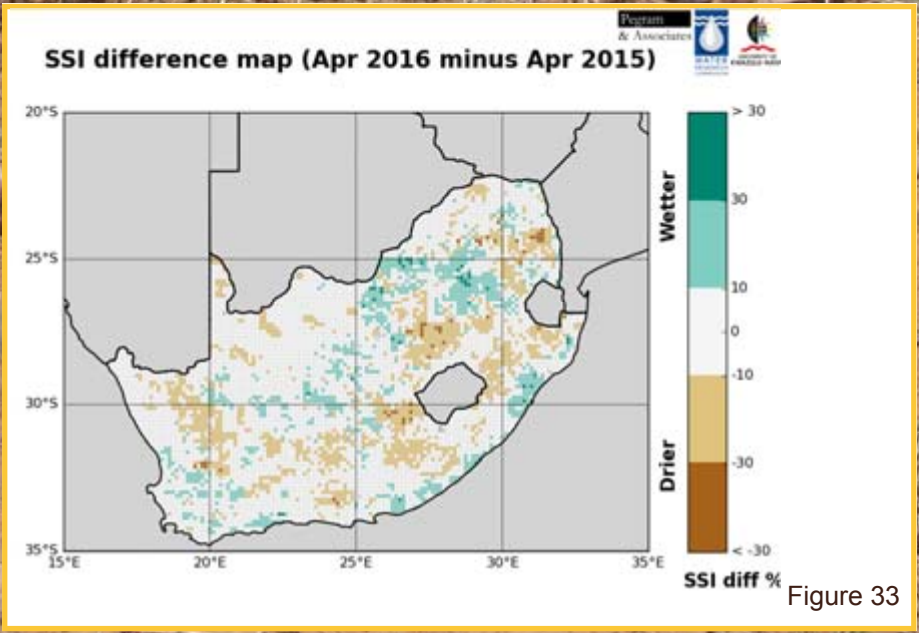

Figure 33

UNIVERSITY OF KWAZULU-NATAL

9. Fire Watch

PAGE 17

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 34:
The graph shows the total number of active fires detected during the month of April per province. Fire activity was higher in the Eastern Cape, Free State, Mpumalanga, Northern Cape, Limpopo and KwaZulu-Natal compared to the average during the same period for the last 16 years.

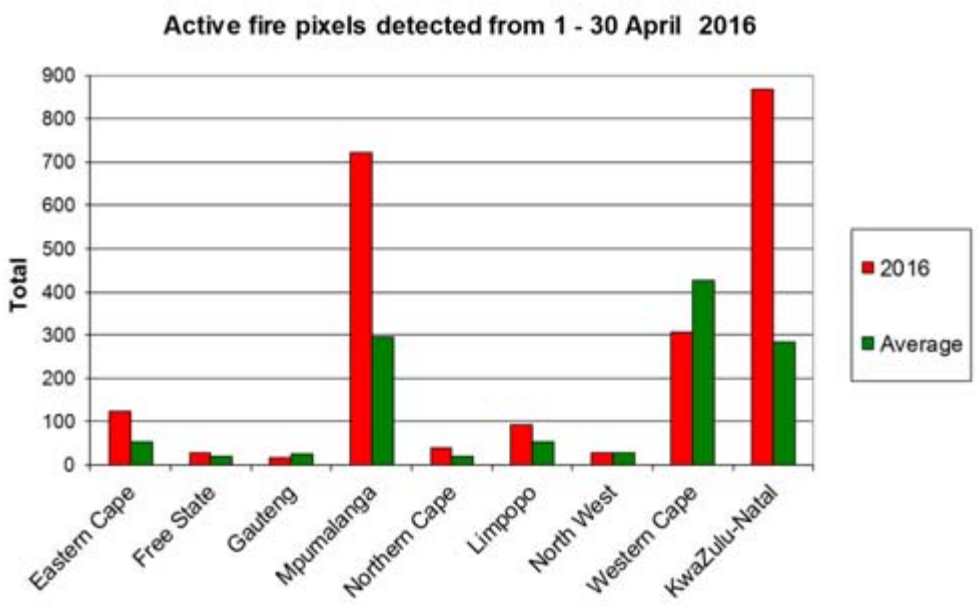

Figure 34

Figure 35:
The map shows the location of active fires detected between 1-30 April 2016.

Questions/Comments:
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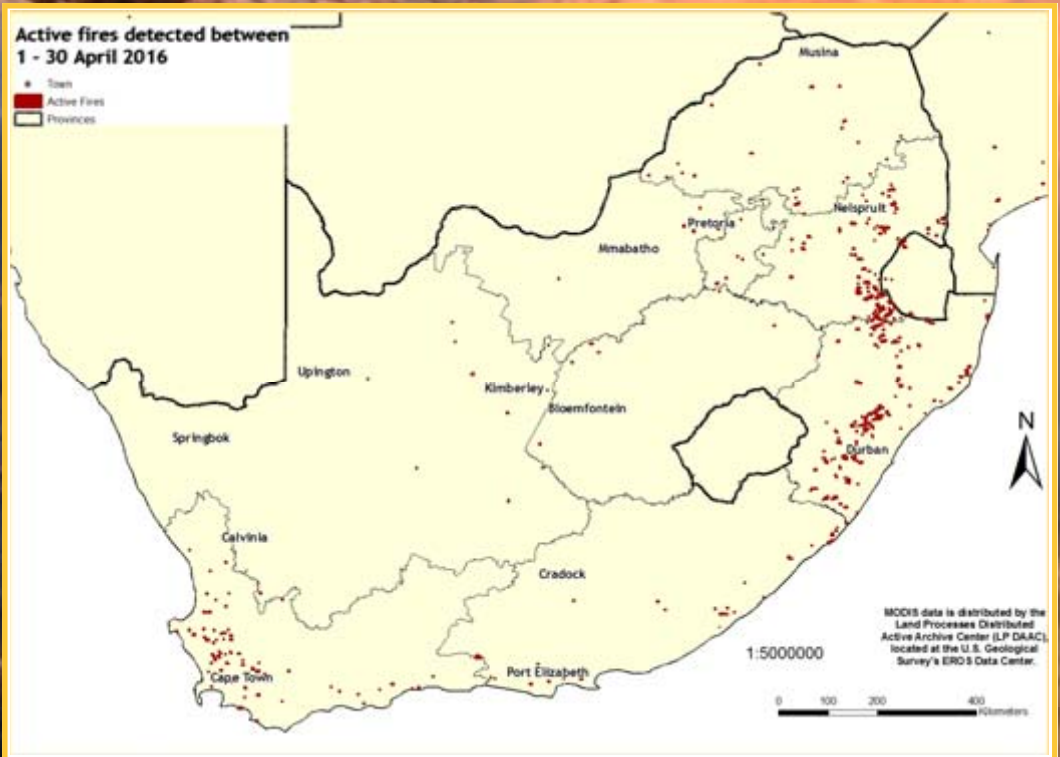

Figure 35

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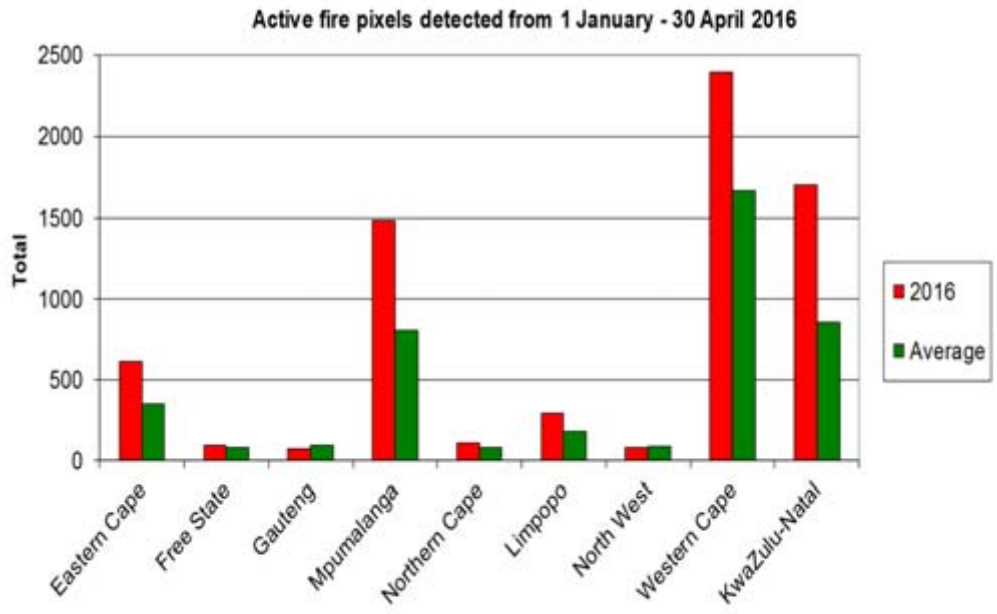

Figure 36

Figure 36:
The graph shows the total number of active fires detected from 1 January - 30 April 2016 per province. Fire activity was higher in the Eastern Cape, Free State, Mpumalanga, Northern Cape, Limpopo, Western Cape and KwaZulu-Natal compared to the average during the same period for the last 16 years.

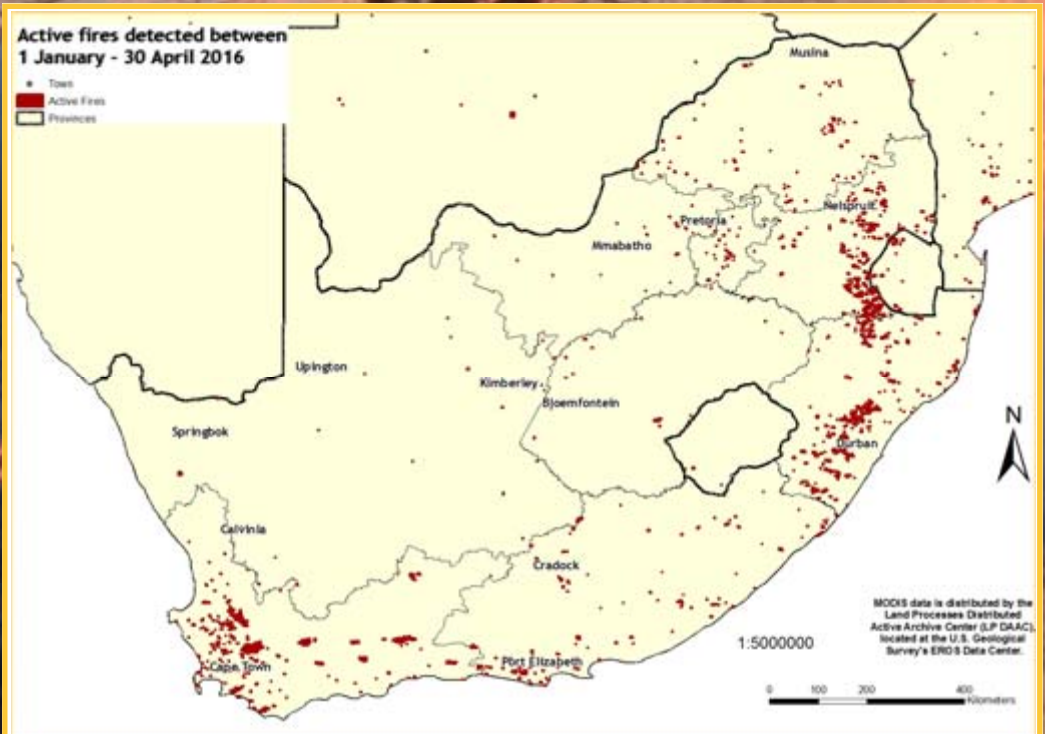

Figure 37

Figure 37:
The map shows the location of active fires detected between 1 January - 30 April 2016.

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Agrometeorology

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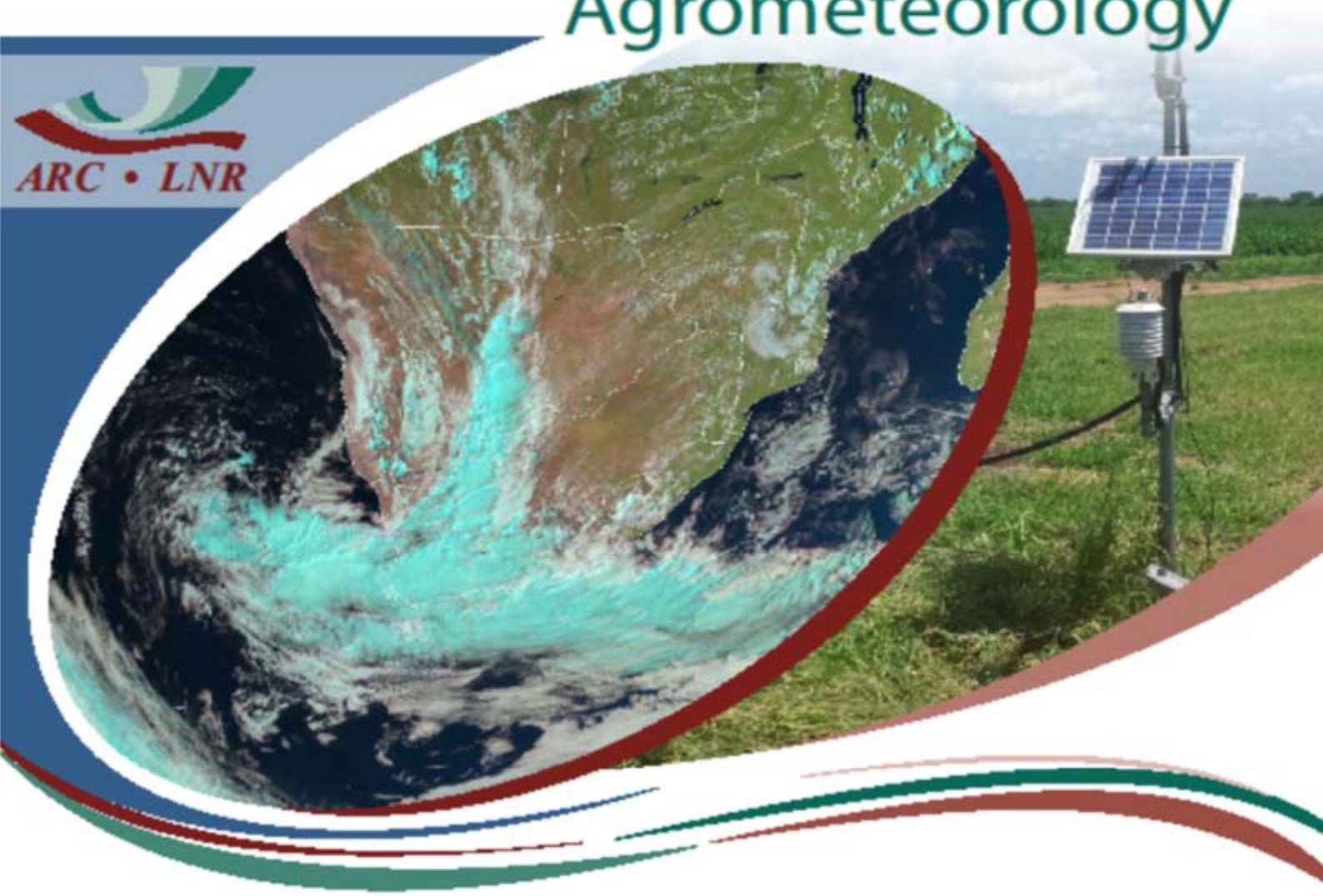

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national 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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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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To subscribe to the newsletter, please submit a request to:
Johan@arc.agric.za

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

http://www.agis.agric.za