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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

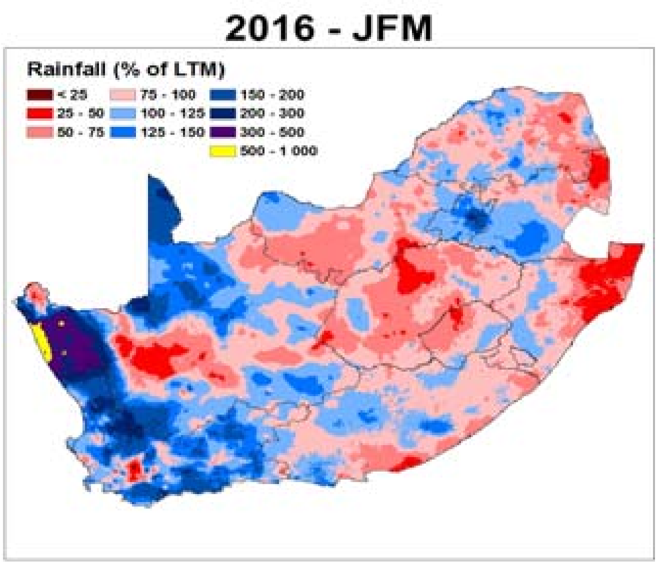
South African Weather Service

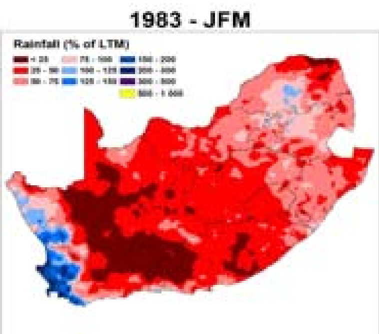
AMESD

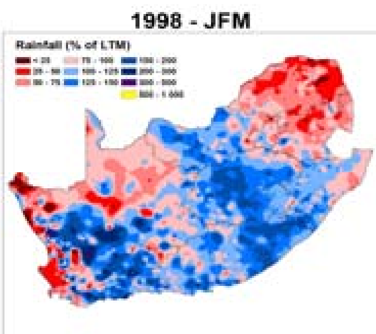
142nd Edition

Images of the Month

January-March rainfall during one of the three strongest El Niños since 1950





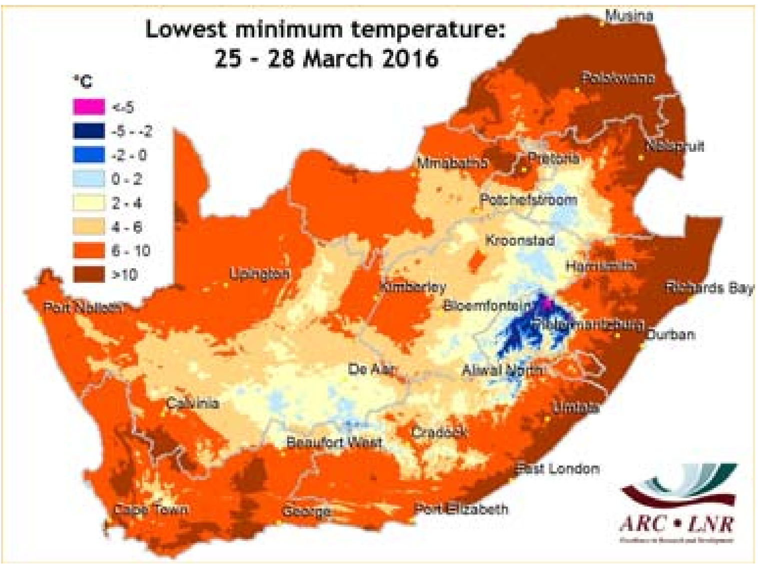


According to the Oceanic Niño Index (http://www.cpc.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.stm), the three strongest El Ninos since 1950 occurred during 1982/83, 1997/98 and the current summer (see rainfall maps, expressed as a percentage of the long-term mean). Drought associated with the current El Niño event reached its maximum extent and intensity during 2015. The January-March (JFM) period of the 2015/16 summer was somewhat wetter, with near-normal rainfall over much of the summer rainfall region, against the norm of intensifying drought during the second half of summer traditionally associated with El Niño. However, the damage done by hot and dry conditions in the early to middle part of the summer and dry conditions in the second half over the western summer grain production region cannot be overstated. Compared to the previous "super" El Niño (1997/98), the northeastern and western summer rainfall regions were wetter during January-March this year while the central parts were drier, resulting in larger negative impacts over the western maize production region. Almost the entire country was wetter during the current and 1998 events than in 1983.

The maps were derived from rainfall data from the ARC-ISCW National Climate Database containing data from the weather station networks of the South African Weather Service and the ARC-ISCW.

Low minimum temperatures at the end of March

A cold front moving across the country brought the first cold weather for the winter with minimum temperatures approaching 0°C in some places over the Highveld and around Lesotho by the 26th. Isolated areas experienced the first frost for the season, with damage possible especially in areas where crops were planted late. The frontal system was also responsible for the first widespread and significant rain since last winter over the winter rainfall region. The map is an interpolation of lowest minimum temperatures for the period 25-28 March as recorded by the ARC-ISCW network of 450 automatic weather stations.



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:

March 2016 was characterized by above-normal rainfall and localized flooding over the northeastern parts while the central to western interior continued to receive normal to below-normal rainfall. A significant cold front also brought above-normal rainfall to the western parts of the winter rainfall region whilst introducing low minimum temperatures by the latter part of the month over the Highveld with isolated occurrences of early frost.

Hot and dry weather occurred over the interior and southern coastal areas at the beginning of the month, with a heatwave in the south. Due to a frontal system brushing the southern parts, extreme heat in the south was displaced to the northeast from the 2nd. Hot conditions once again occurred over the southern to southeastern parts as the flow became offshore by the 5th, ahead of a frontal system to the southwest. The cold front made landfall in the southwest by the 6th, resulting in some showers over the winter rainfall region,. The associated upper-air trough deepened over the southwestern parts, facilitating the transport of large amounts of tropical moisture from the north across the interior, aided by an onshore flow from the Indian Ocean with a large anticyclonic circulation pattern. As the Atlantic Ocean anticyclone ridged strongly around the country, moisture from the east enhanced the rainfall intensity and distribution over the northeastern parts, specifically where upper-air condtions were favourable. Heavy falls with flash flooding occurred over Gauteng and in some areas in the Lowveld during the period 7-9 March. More widespread rain and thundershowers occurred over the northeastern parts as a second trough developed in the southwest, with upper-air perturbations and tropical moisture moving from Botswana over the northeastern parts by 10-11 March. Conditions cleared somewhat by the 12th. The rainfall pattern repeated again between the 16th and 19th as another similar sequence of events resulted in widespread rain, focussing mainly over the northeastern parts of the country which were closer to the position of a tropical low over northern Botswana during this period.

Due to a strong Atlantic Ocean anticyclone ridging to the southwest of the country and over the western interior and a low pressure area towards the southeast, the flow over the western parts became southwesterly, with cool, dry air (following a cold front) spreading over much of the central to western interior from the 19th. This resulted in clear and cool conditions setting in over the interior, with light frost over the southeastern high-lying areas.

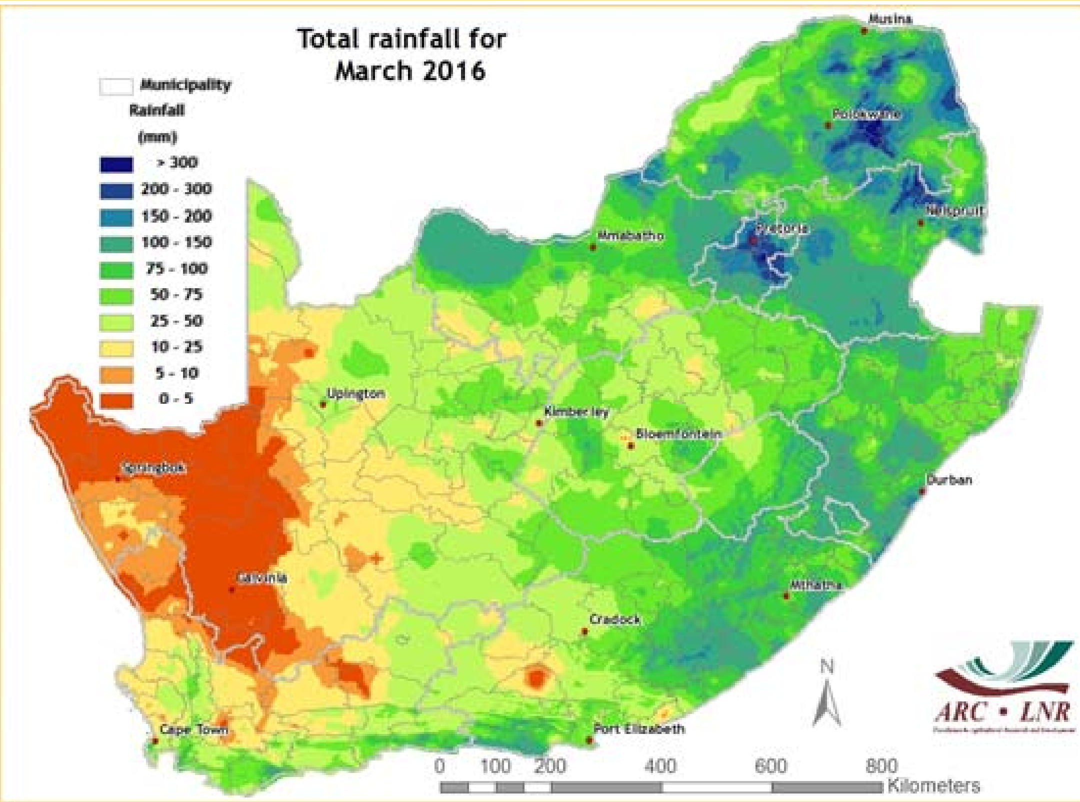


Figure 1

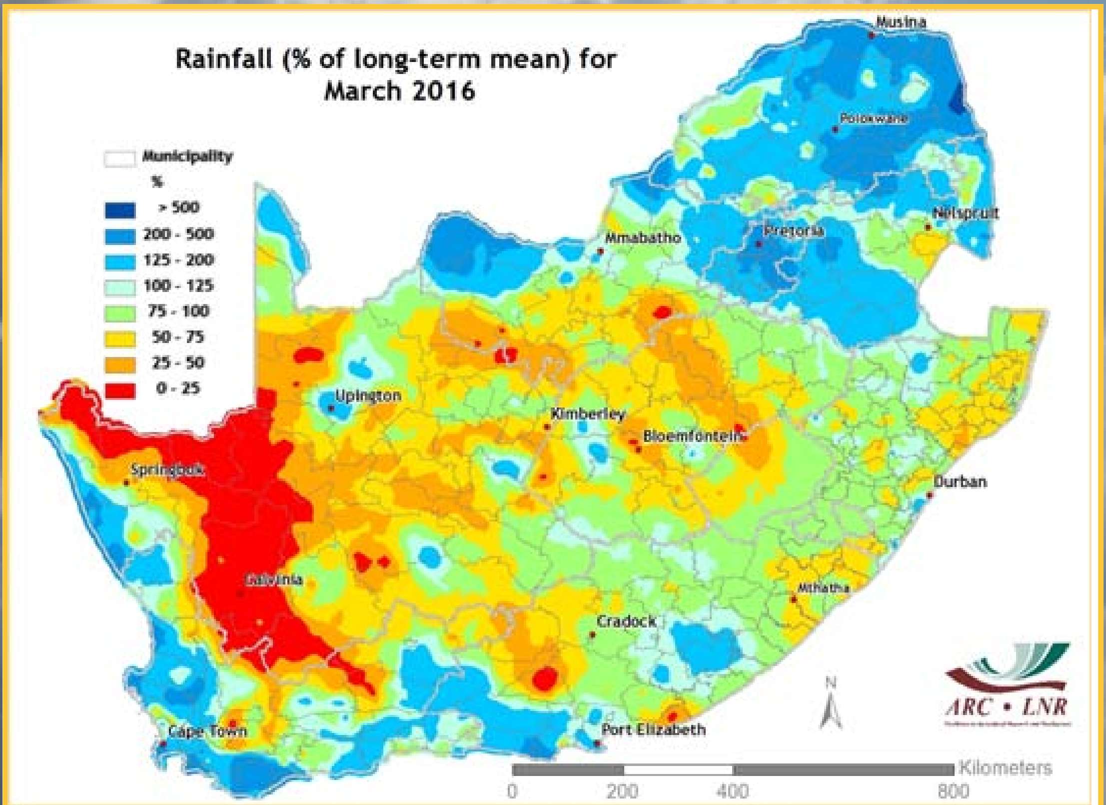
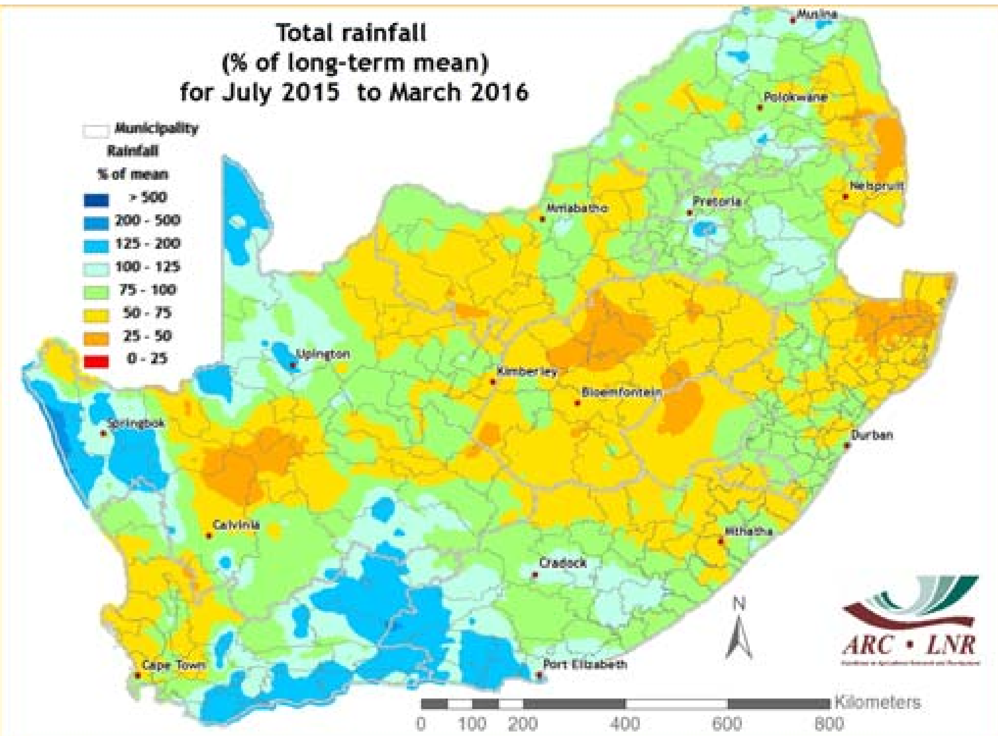


Figure 2



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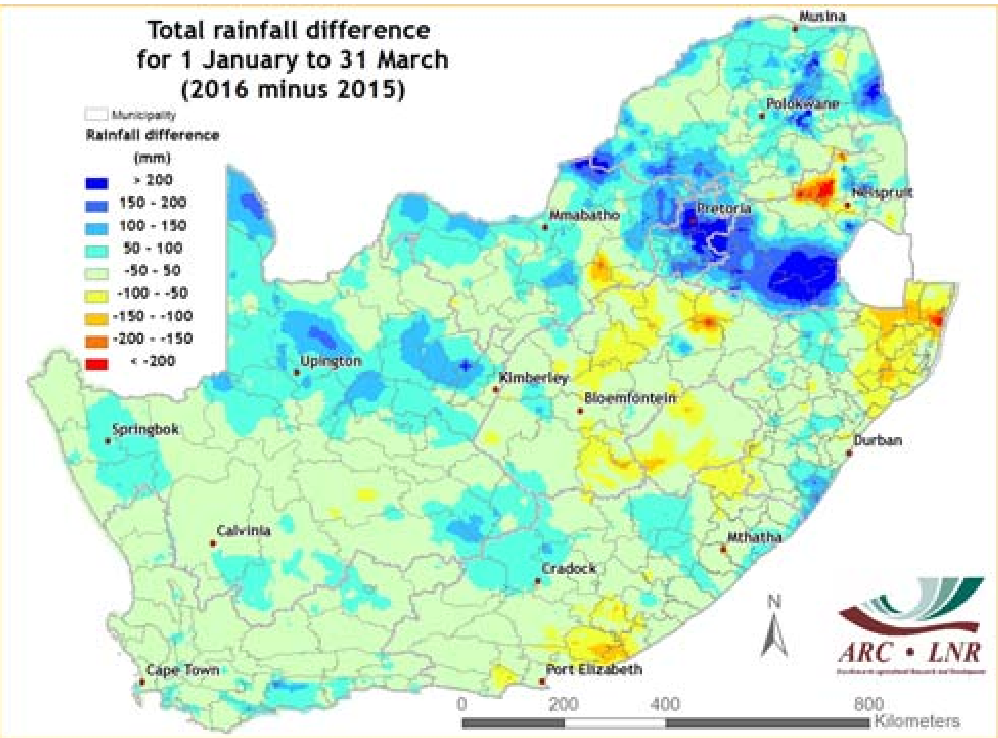

Figure 4

As another cold front invaded the southwest on the 24th, an upper-air cut-off low developed over the southwestern interior. The frontal system resulted in widespread rain over the western winter rainfall region, with some areas receiving their first significant rainfall since the previous winter. The upper-air cut-off low resulted in widespread rain and thundershowers over the central parts, with some stations in the western Free State and parts of the Northern Cape receiving in excess of 25 mm from 24-26 March. As the surface flow once again became southwesterly to westerly, conditions cleared rapidly, with no rain over the northeastern parts. The southwesterly flow over the interior advected cold air over many parts, with minimum temperatures over the high-lying eastern and southeastern parts again approaching freezing point, and frost occurring in isolate areas.

Figure 1:
The entire country except for the western parts of the Northern Cape received some rain during March. Much of the northeastern and eastern parts received in excess of 100 mm, with totals even exceeding 200 mm in some places over the northeastern provinces.

Figure 2:
Rainfall was largely above normal in the northeast and over the winter rainfall region, but below normal over the central parts and towards the eastern seaboard.

Figure 3:
Rainfall over the southern parts of the country, into the central parts of the Northern Cape and also the northwestern parts of the Northern Cape has been above normal since July 2015. Normal rainfall occurred over parts of Limpopo, Mpumalanga and central North West. Rainfall was below normal over the central parts, northern KwaZulu-Natal, Lowveld in the far northeast and east and western winter rainfall region.

Figure 4:
The northern parts of the country were generally wetter than in 2015 during January to March. In contrast, parts of the Free State, northern KwaZulu-Natal and southern parts of the Eastern Cape were drier than in 2015.

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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 (Figures 5-8) show that severe to extreme drought conditions occur at the 3-month time scale only over isolated parts of northern KwaZulu-Natal and northwestern Free State. From the 6- to the 24-month time scales, a more extensive area of severe drought concentrates over the northern half of KwaZulu-Natal and the Free State, related mostly to the very dry conditions during the 2015 calendar year.

Questions/Comments:
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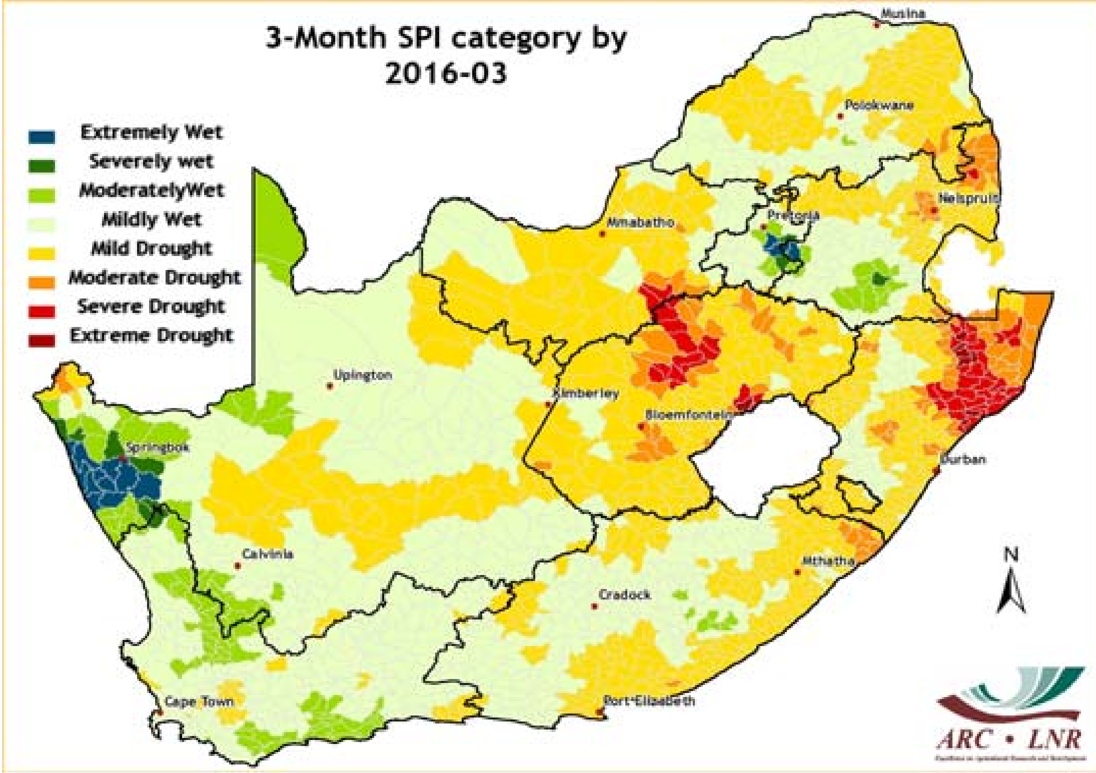

Figure 5

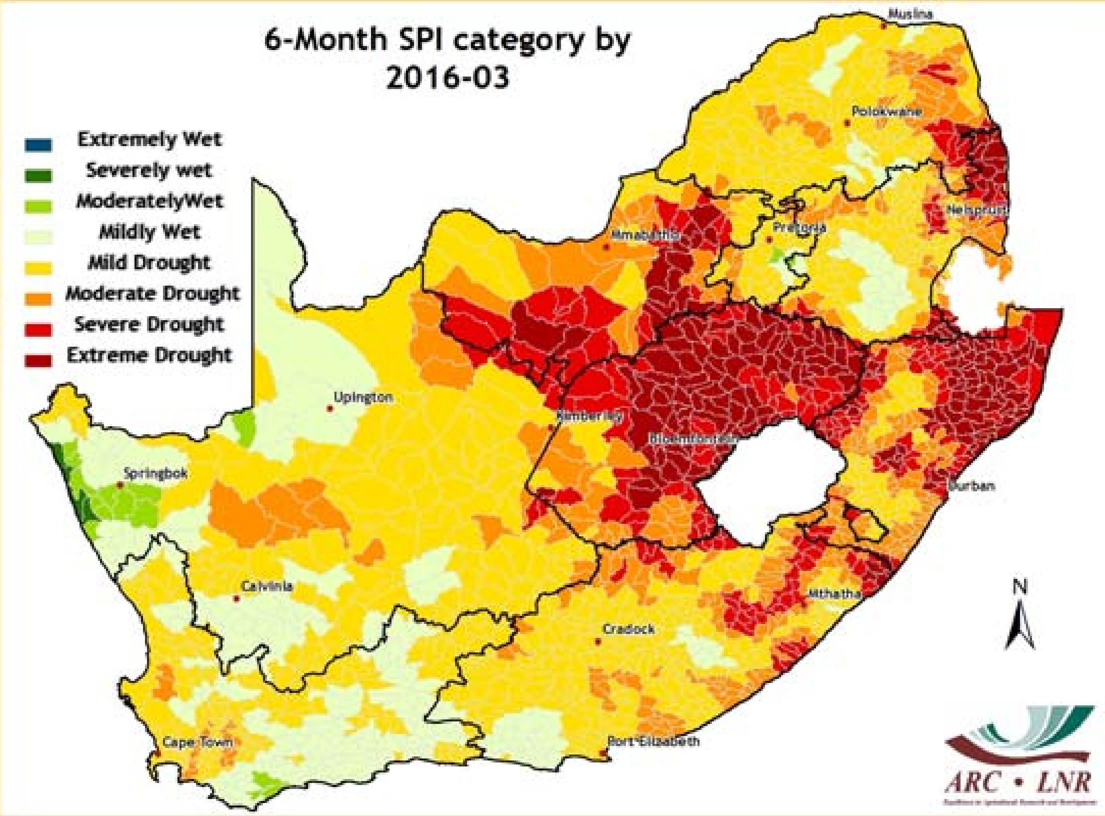

Figure 6

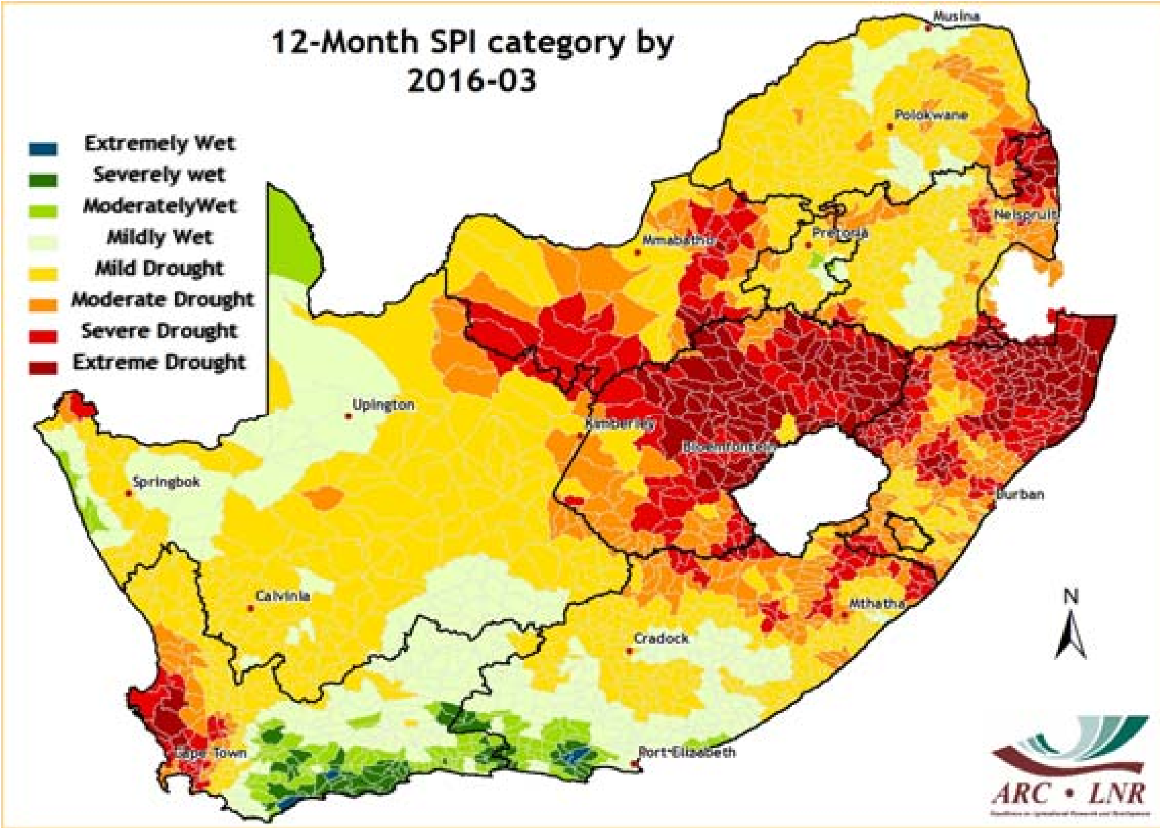

Figure 7

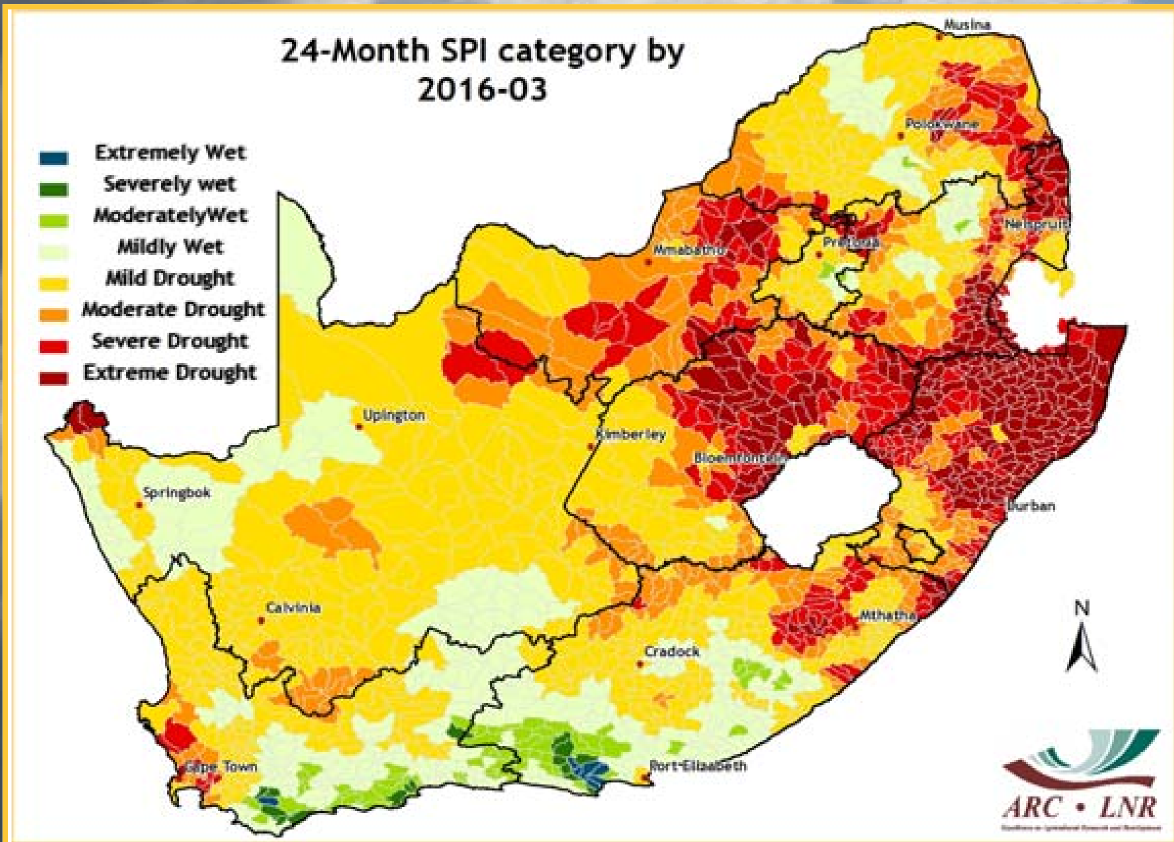

Figure 8

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.

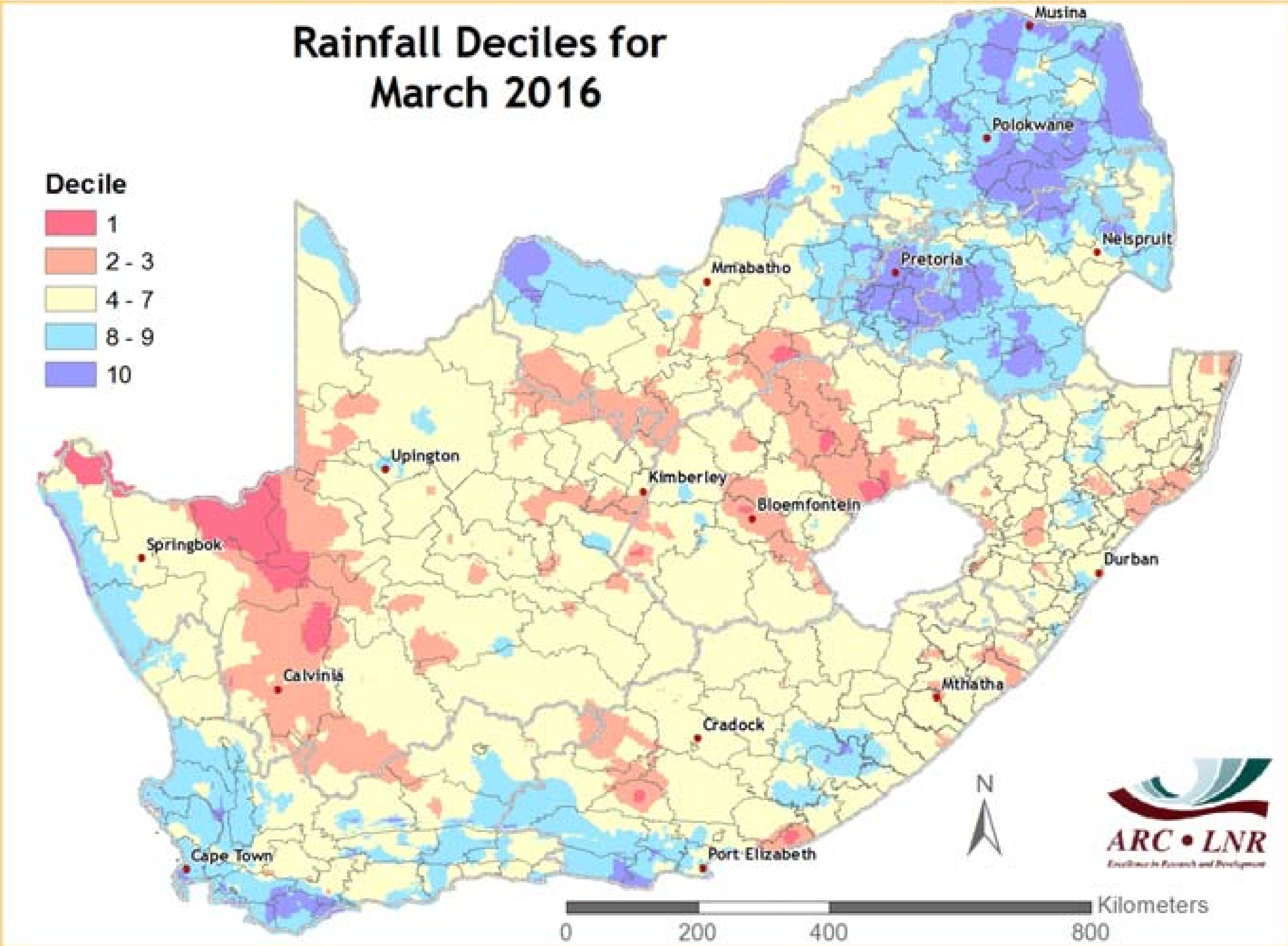

Figure 9

Figure 9:
The central Free State and western interior of the Northern Cape received exceptionally little rainfall during March. However, parts of the northeastern interior and isolated areas along the Garden Route were exceptionally wet.

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

4. Water Balance

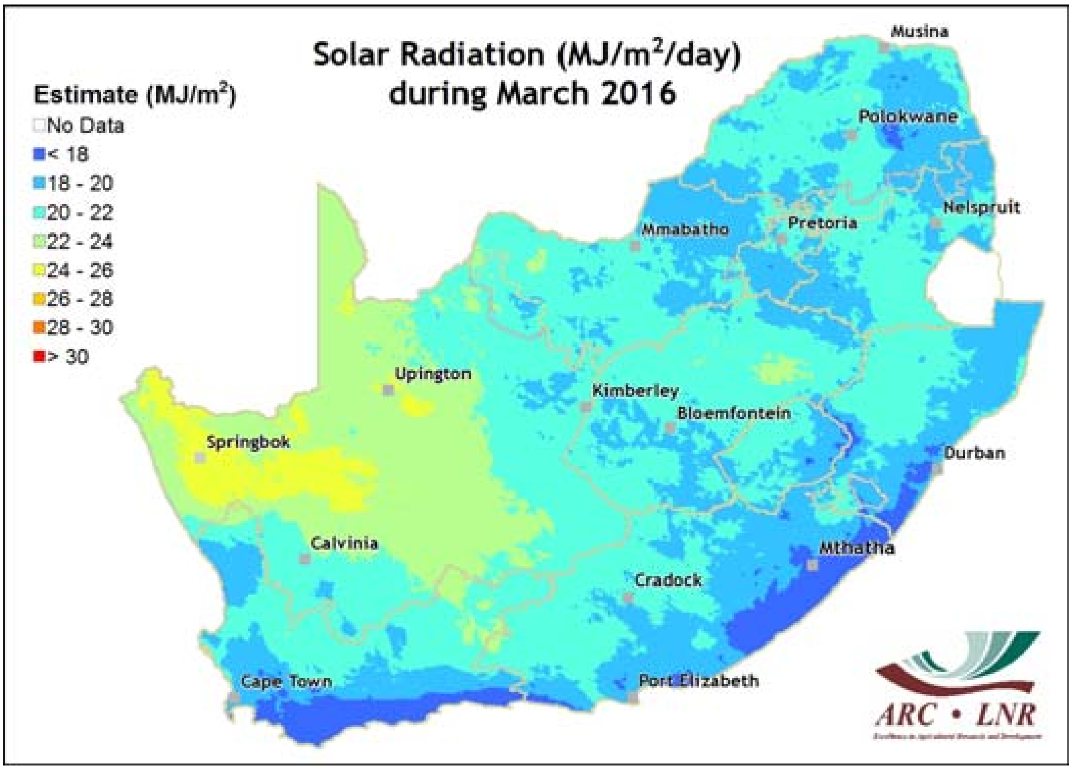

Figure 10

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:
Large amounts of cloud had a negative effect on solar radiation, with totals generally much reduced compared to February. Lowest values were recorded along the Escarpment and eastern to southern coastal areas.

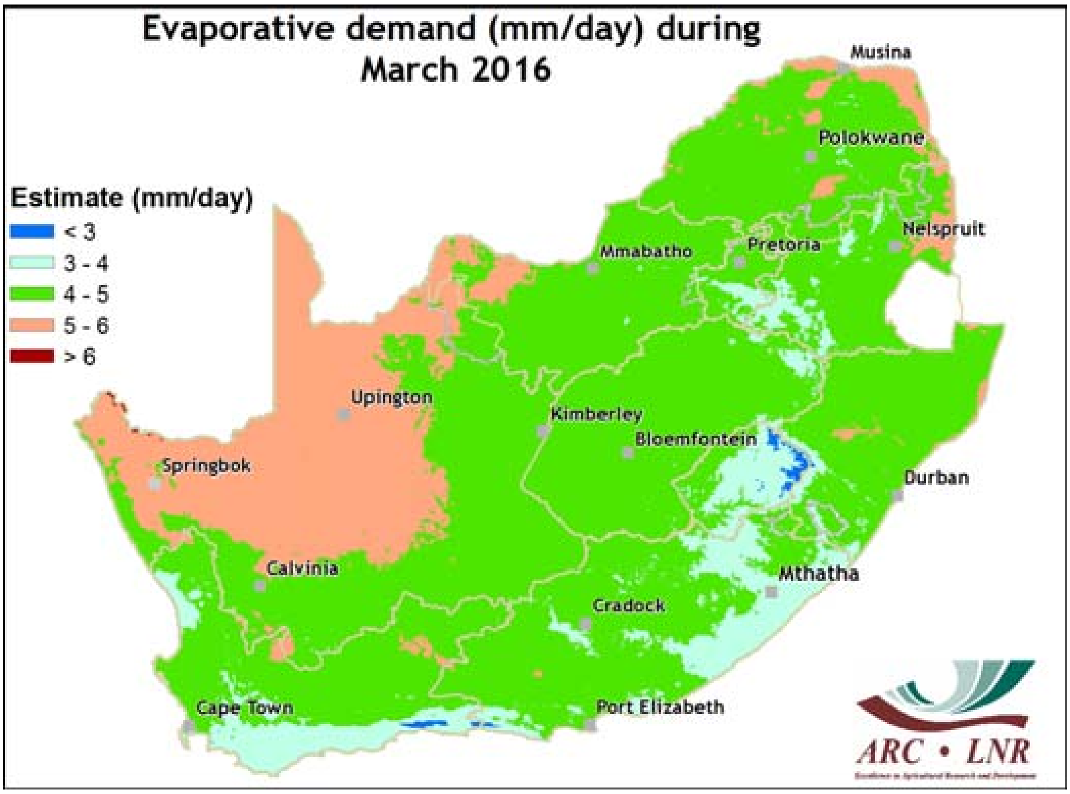

Figure 11

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 3 and 5 mm/day, with lowest values towards the east and south. These were also much reduced due to cloud cover, lower temperatures and rain.

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.

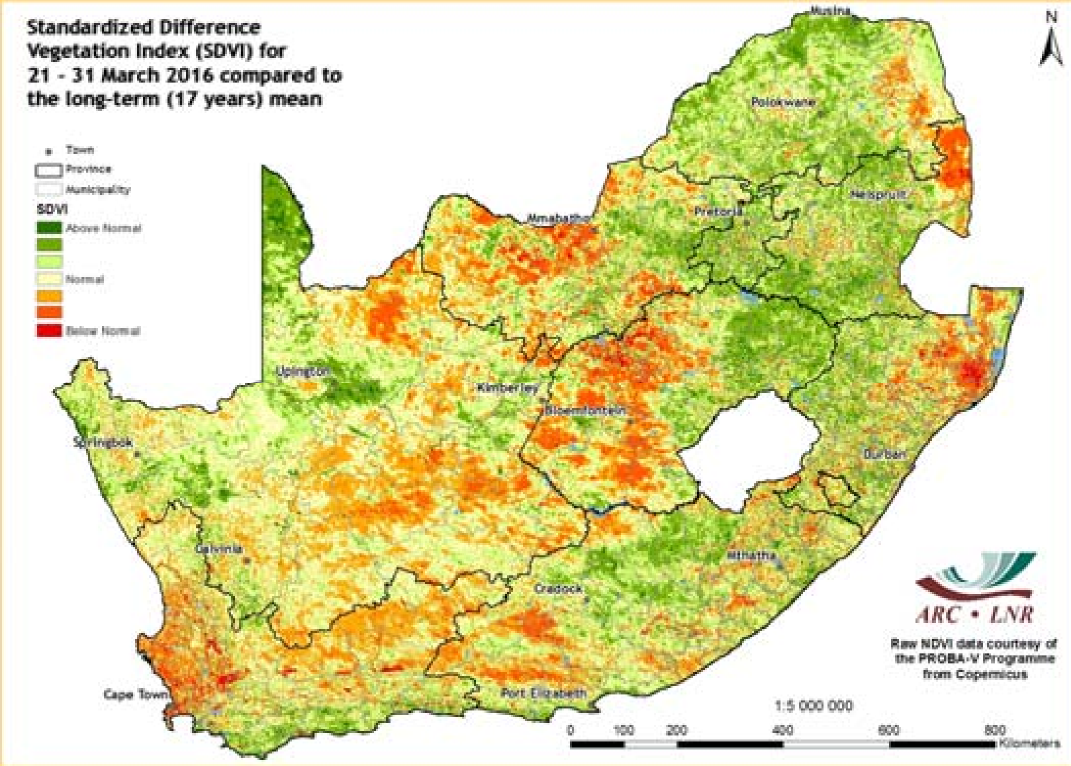

Figure 12

Figure 12:
The SDVI by late March indicates drought stress over the western parts of the Free State and North West, the Lowveld of Mpumalanga, northern KwaZulu-Natal and the western parts of the Eastern Cape.

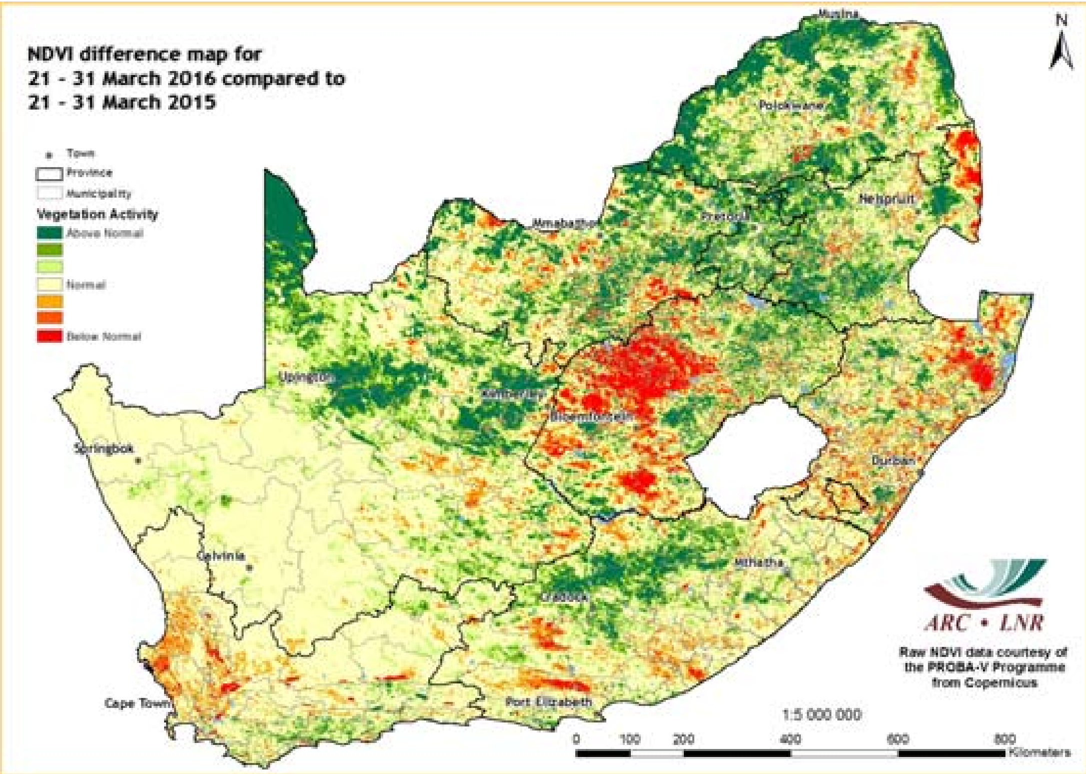

Figure 13

Figure 13:
Vegetation activity is higher over most parts compared to a year ago, except for the central to western Free State, northern KwaZulu-Natal and the Lowveld of Mpumalanga.

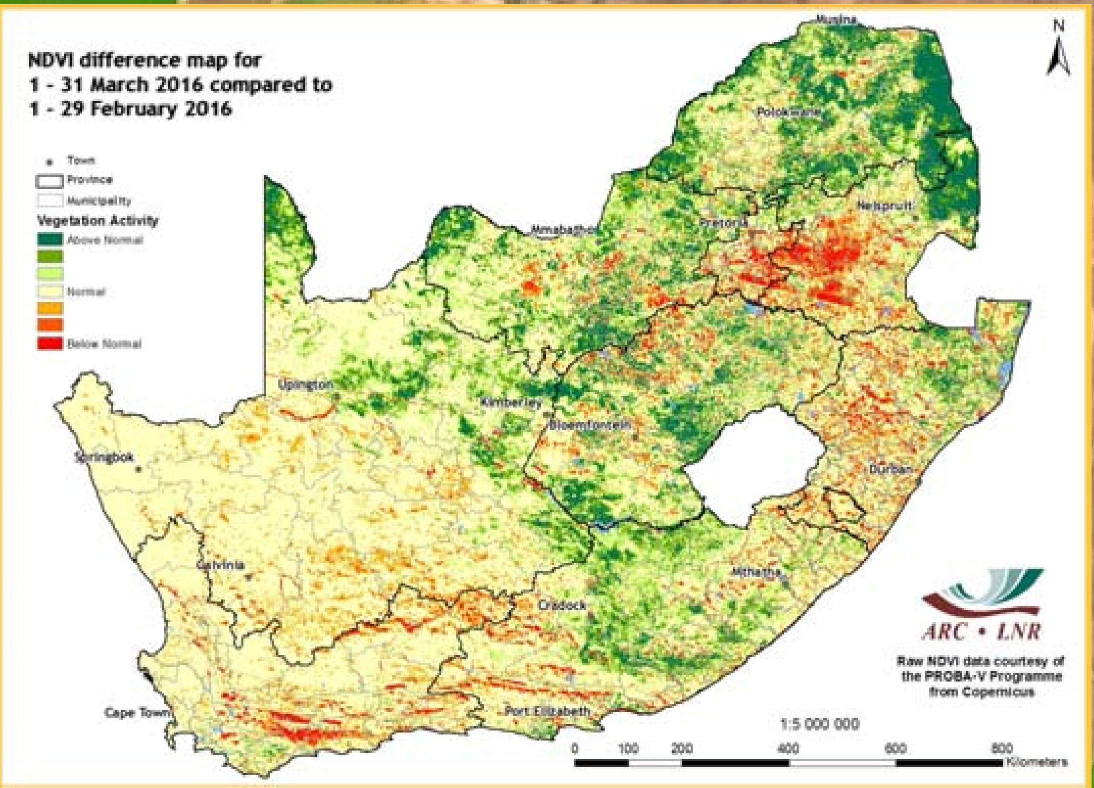

Figure 14

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

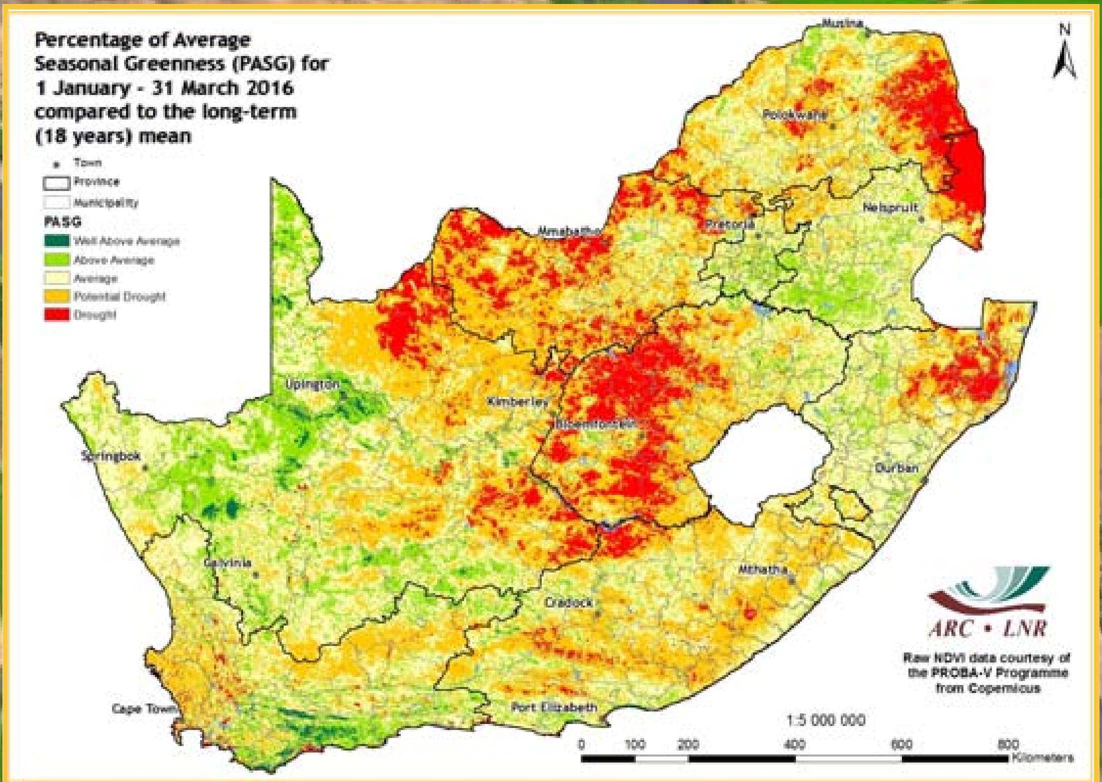

Figure 15

Figure 14:
Vegetation activity increased over most of the summer rainfall region due to more favourable conditions during March compared to the situation during February.

Figure 15:
Cumulative vegetation activity anomalies indicate drought stress over the Free State and North West, the Lowveld of Mpumalanga, northern KwaZulu-Natal and the western parts of the Eastern Cape.

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.

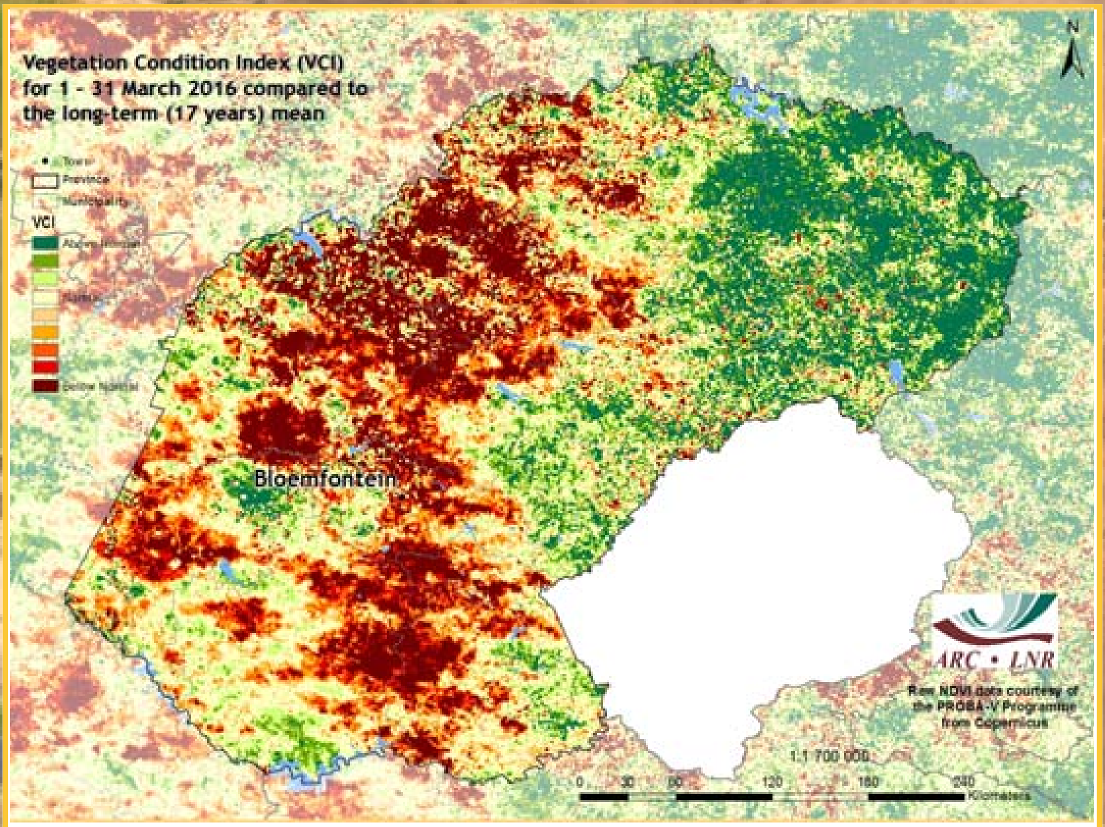


Figure 16

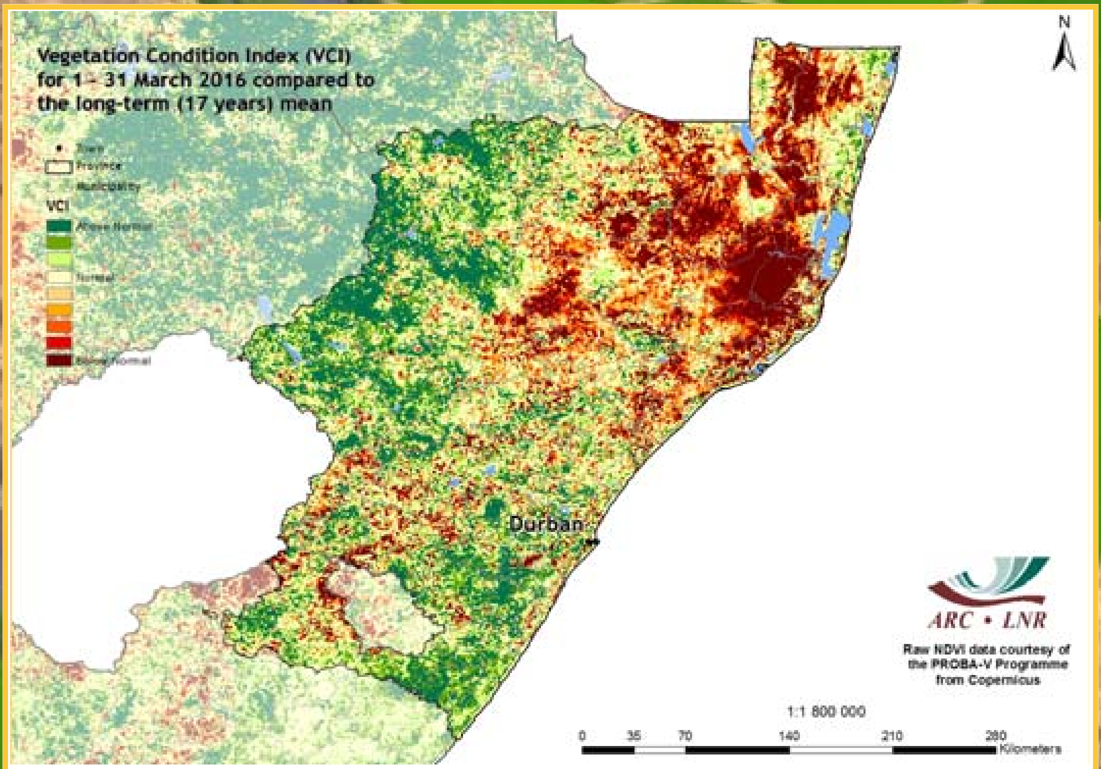
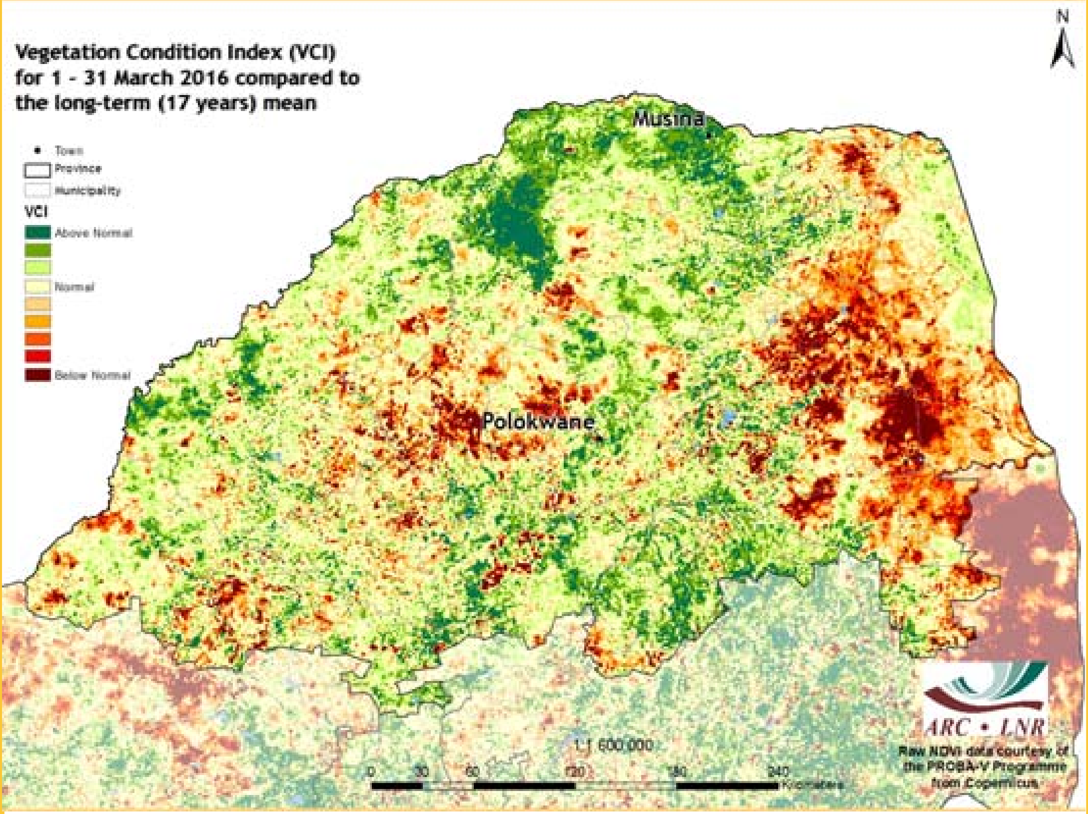


Figure 17

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

Figure 17:
The VCI map for March indicates below-normal vegetation activity over the northern and eastern parts of KwaZulu-Natal province.



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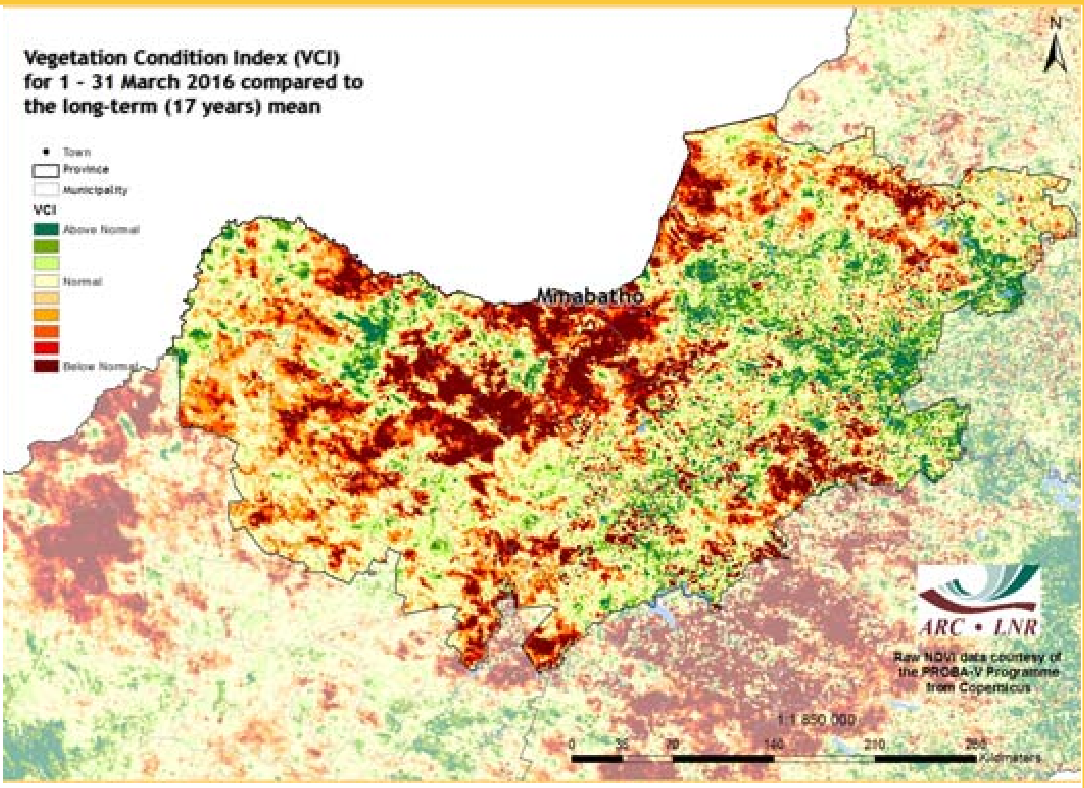

Figure 19

Figure 18:
The VCI map for March indicates below-normal vegetation activity over the western and eastern parts of Limpopo province.

Figure 19:
The VCI map for March indicates below-normal vegetation activity over most of North West province, except in the east.

Questions/Comments:
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7. Vegetation Conditions & Rainfall

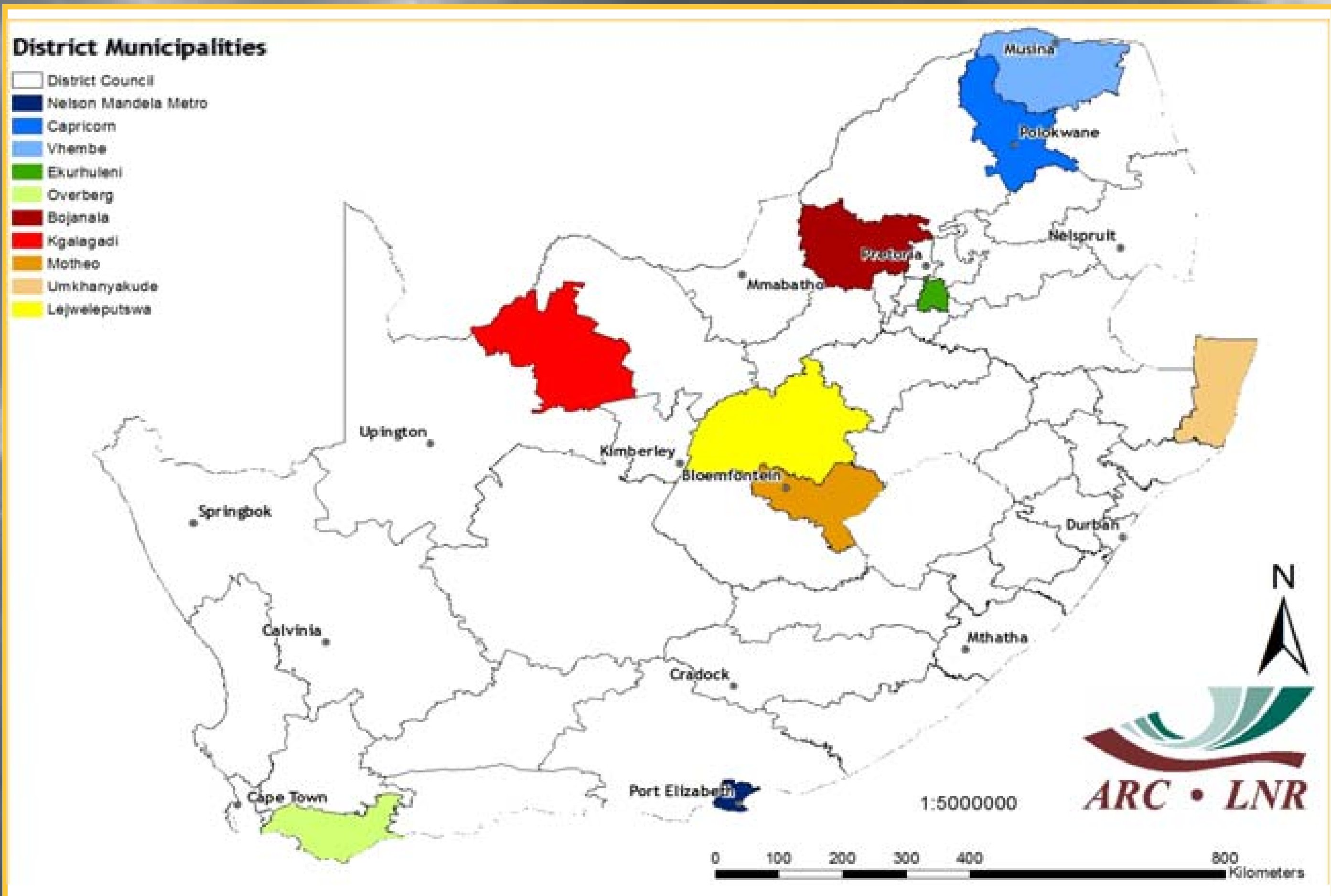


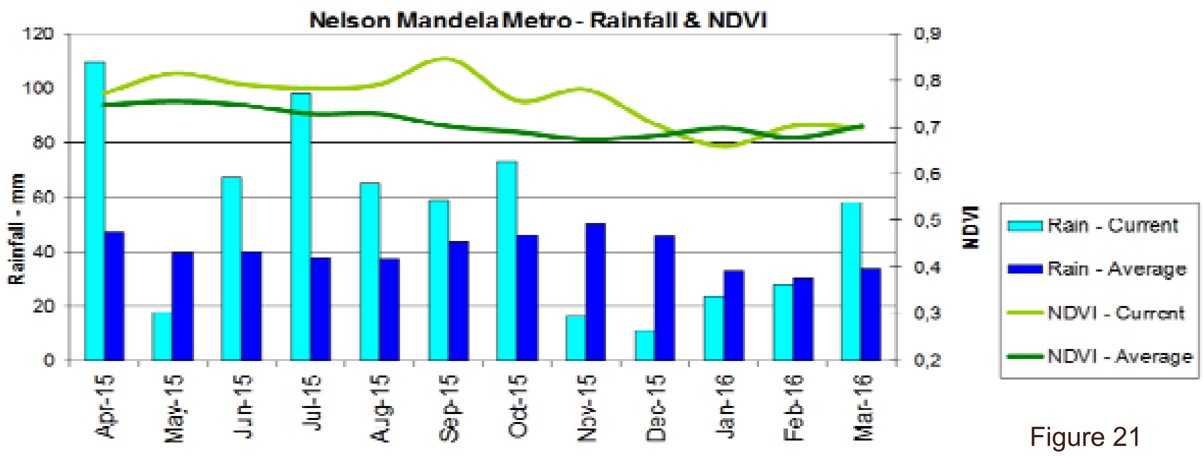
Figure 20

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

Questions/Comments:
Johan@arc.agric.za; NkambuleV@arc.agric.za

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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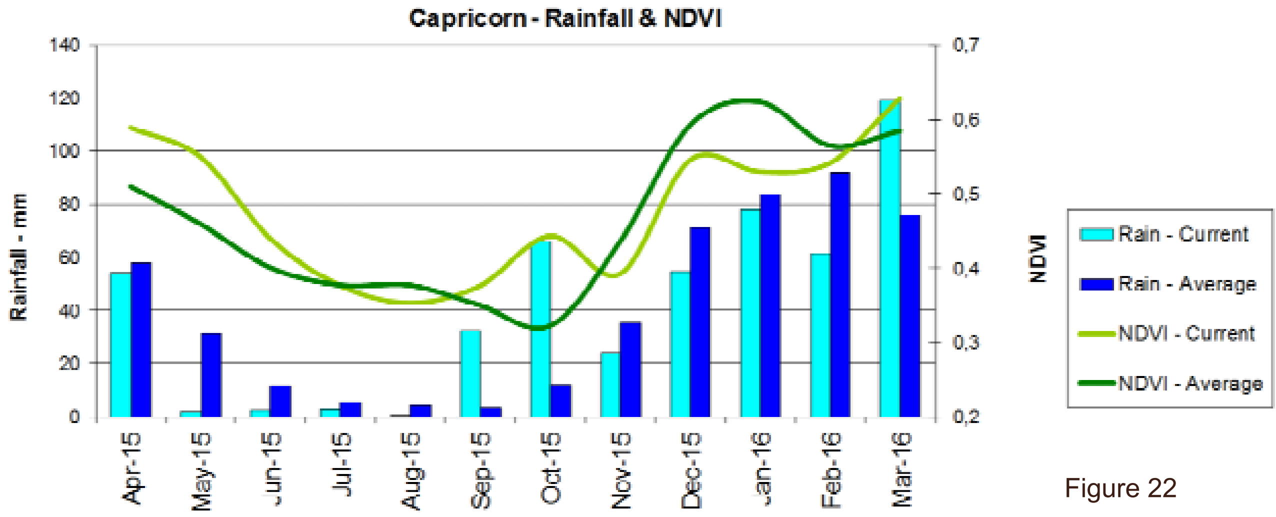

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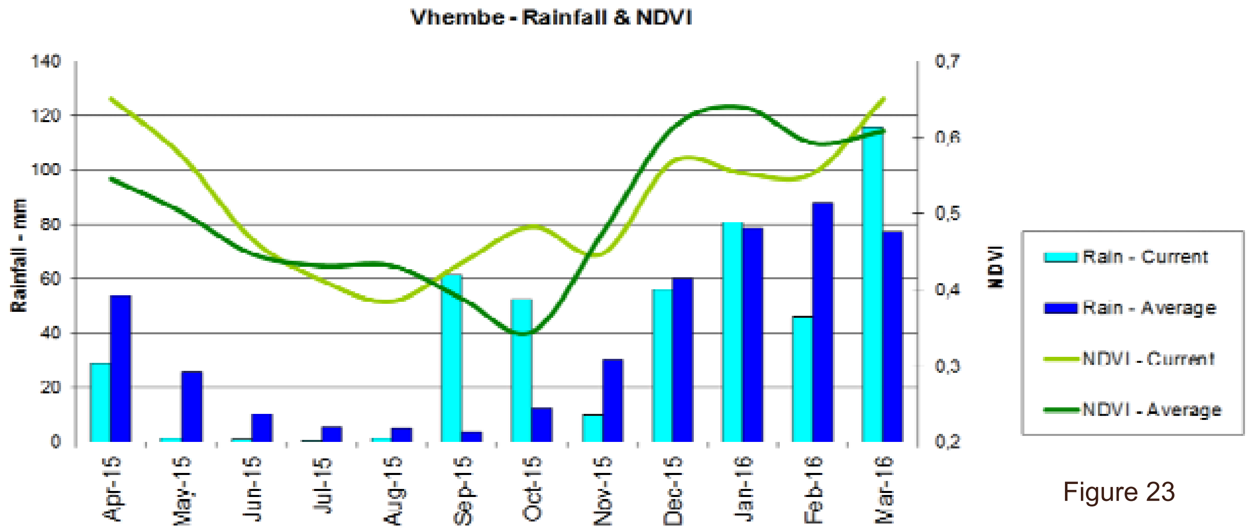

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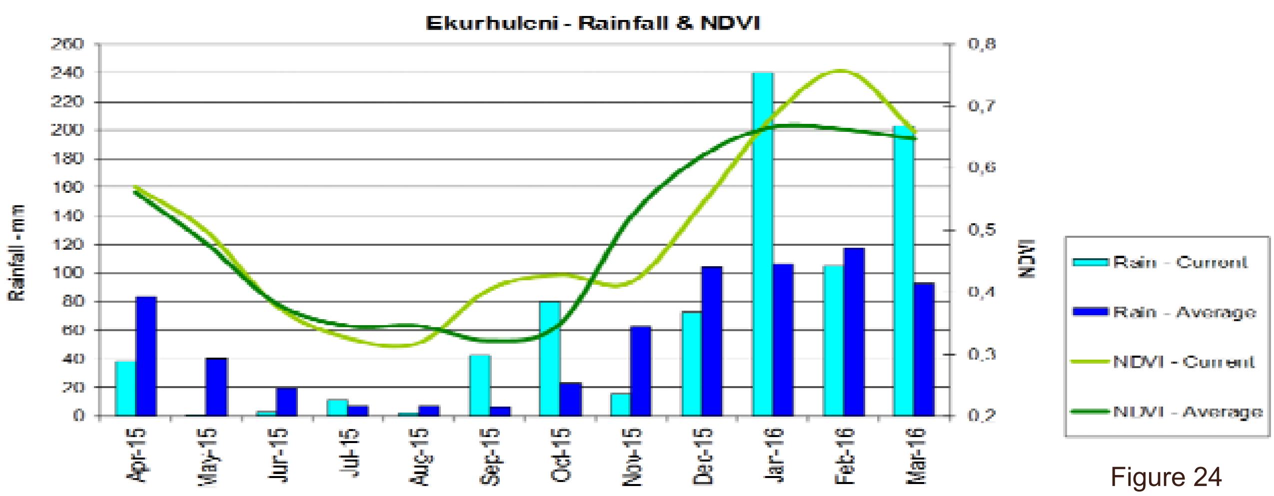
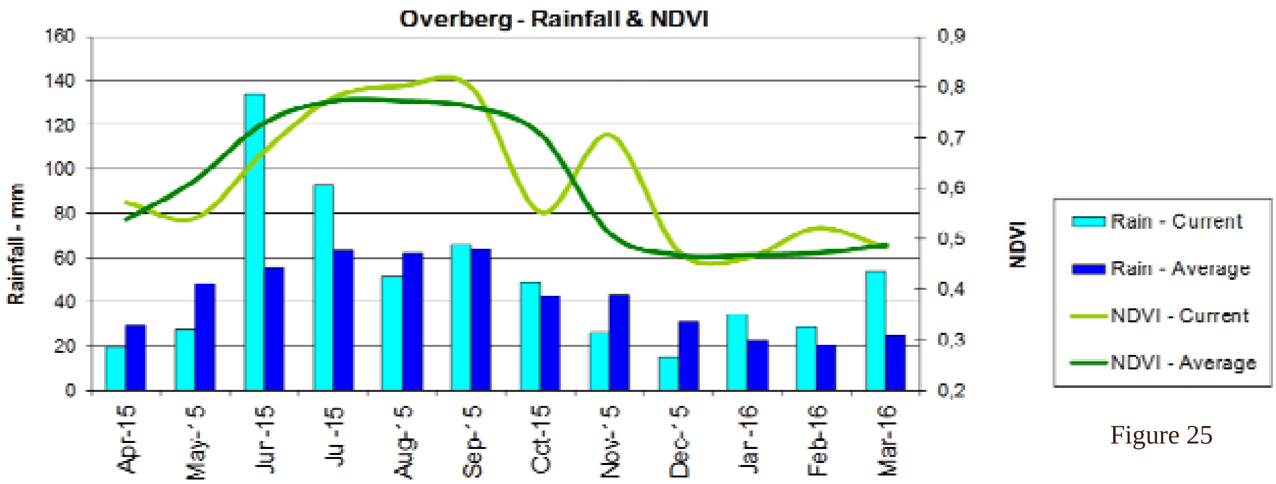


Figure 24

Figure 24



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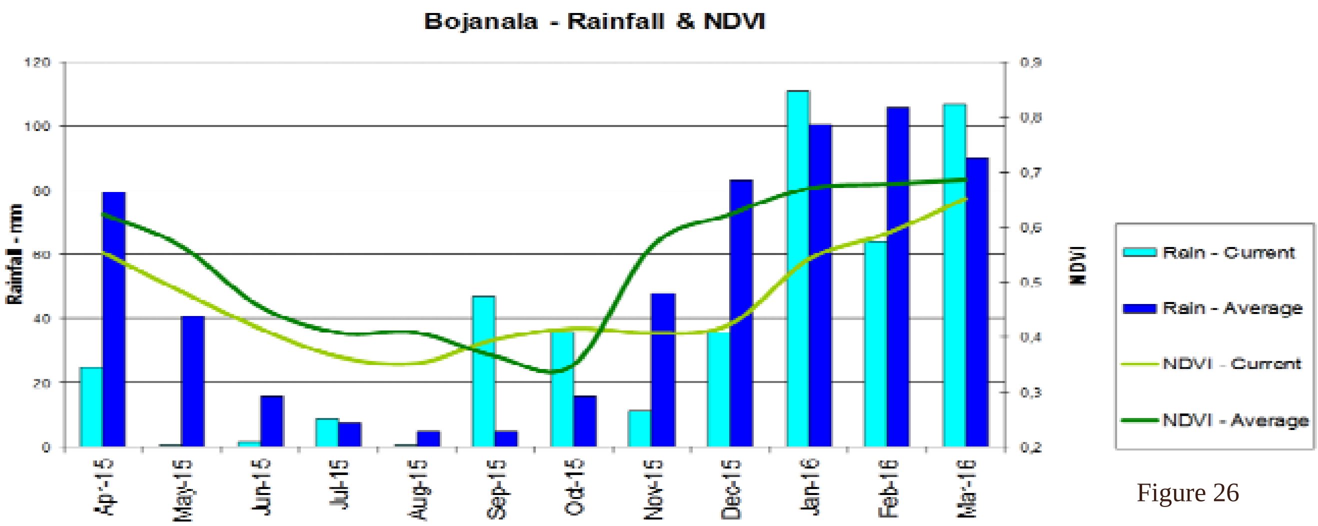

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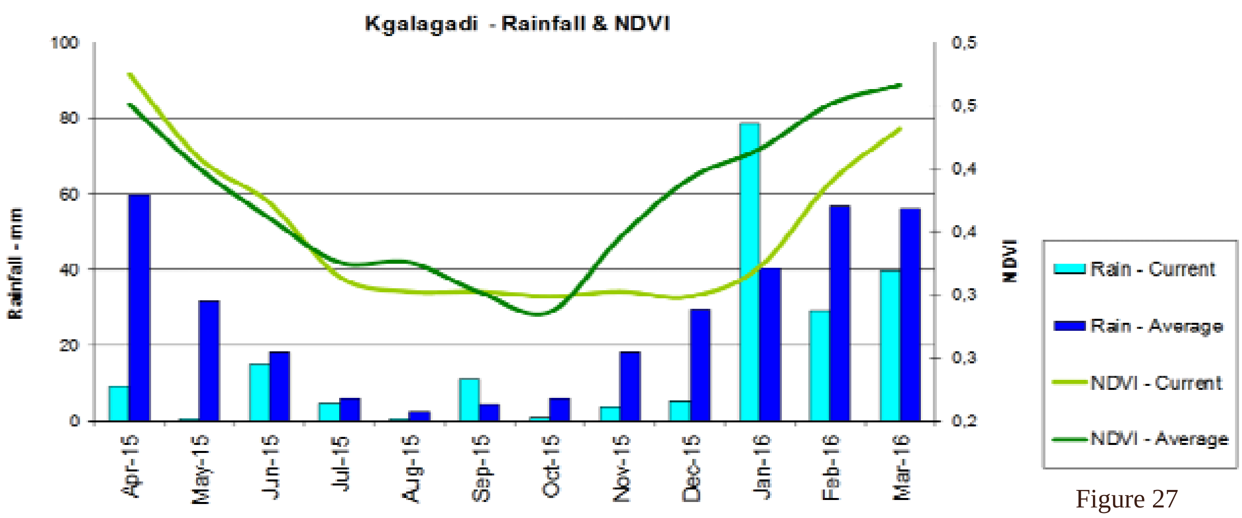

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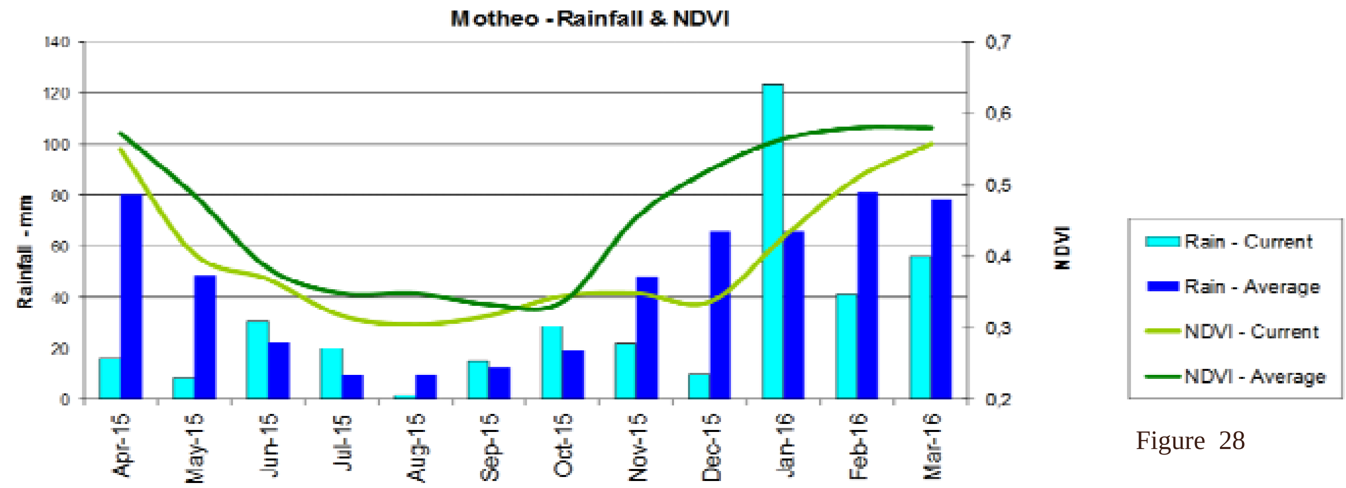

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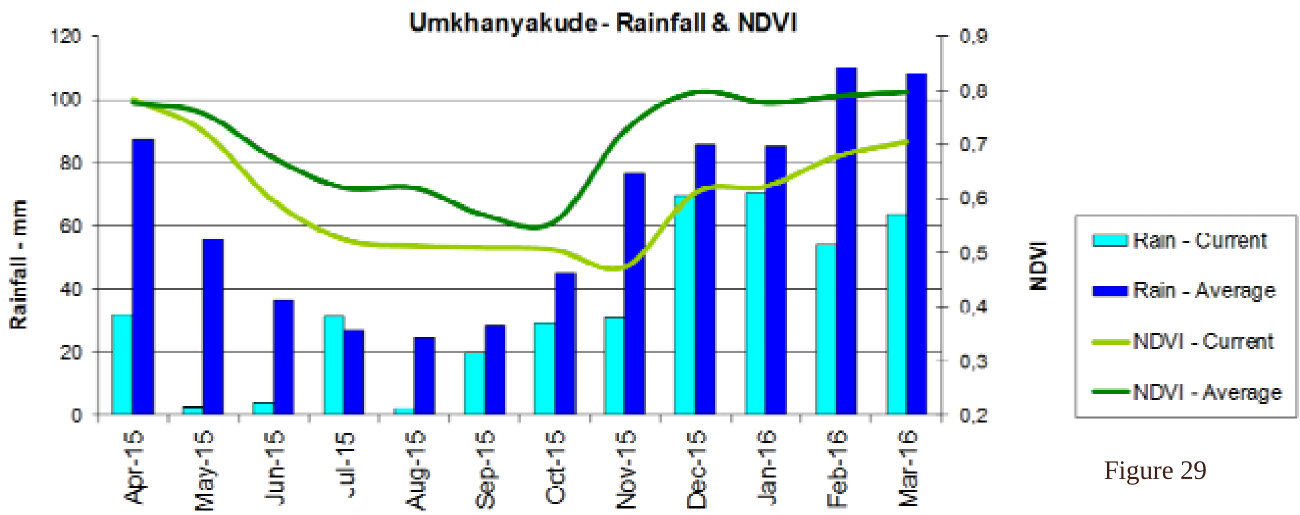

Figure 29

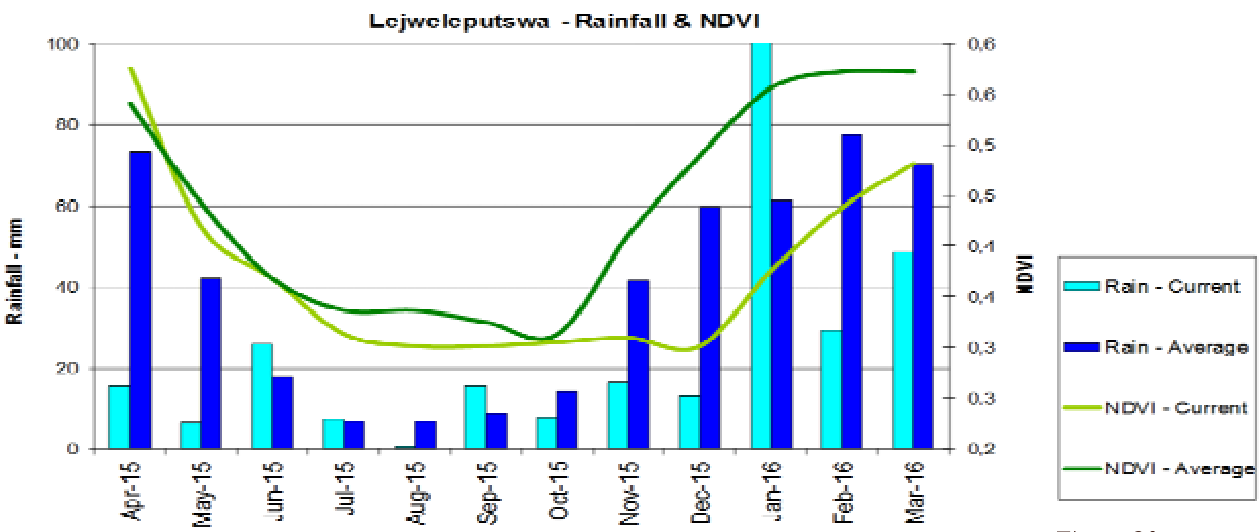

Figure 30

PAGE 16

8. Soil Moisture

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 March 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 March and February 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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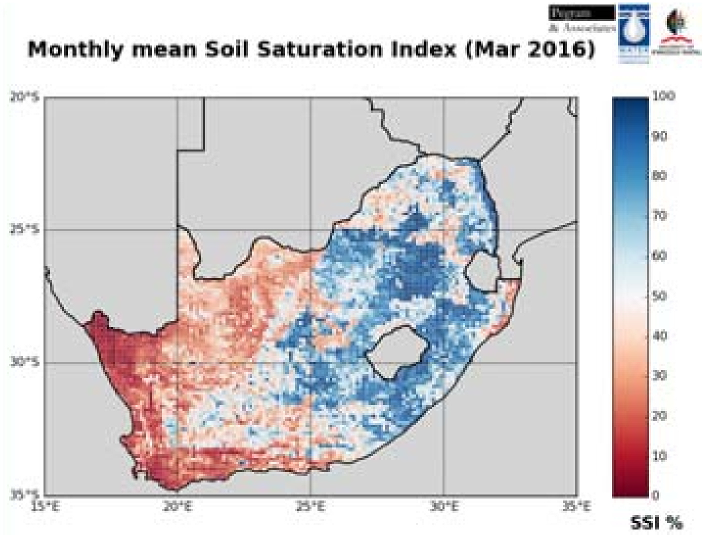

Figure 31

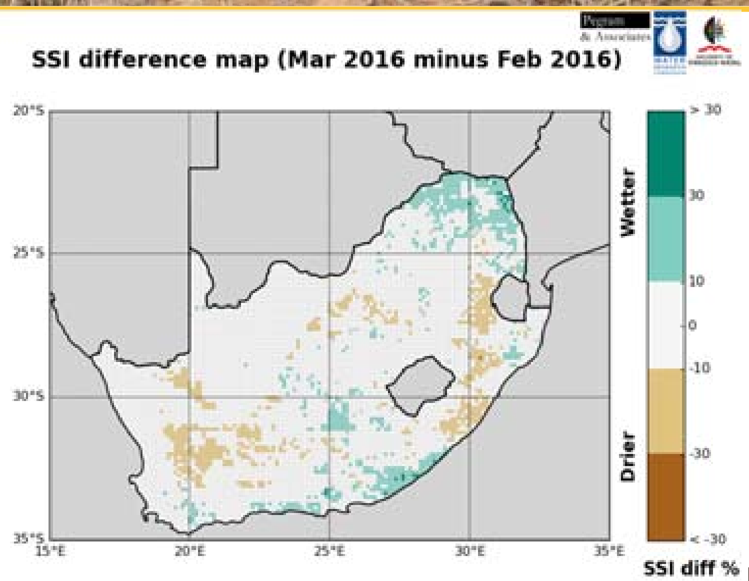

Figure 32

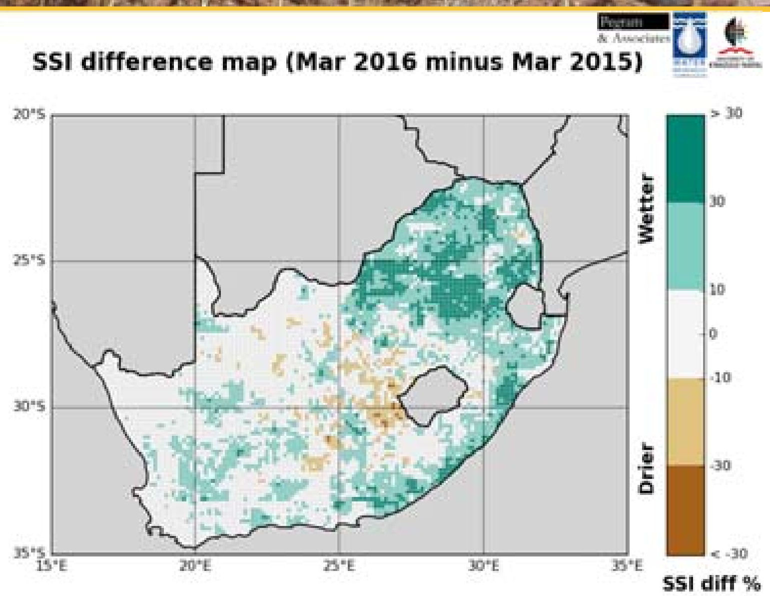

Figure 33

UNIVERSITY OF KWAZULU-NATAL

9. Fire Watch

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 March per province. Fire activity was lower in all provinces compared to the average during the same period for the last 16 years.

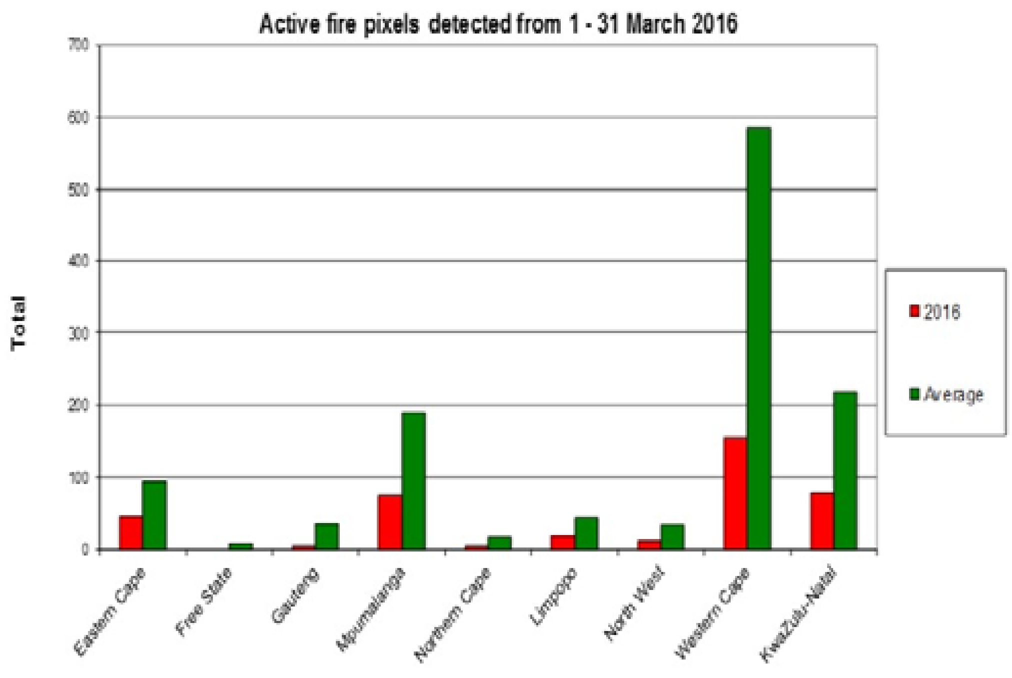

Figure 34

Figure 35:
The map shows the location of active fires detected between 1-31 March 2016.

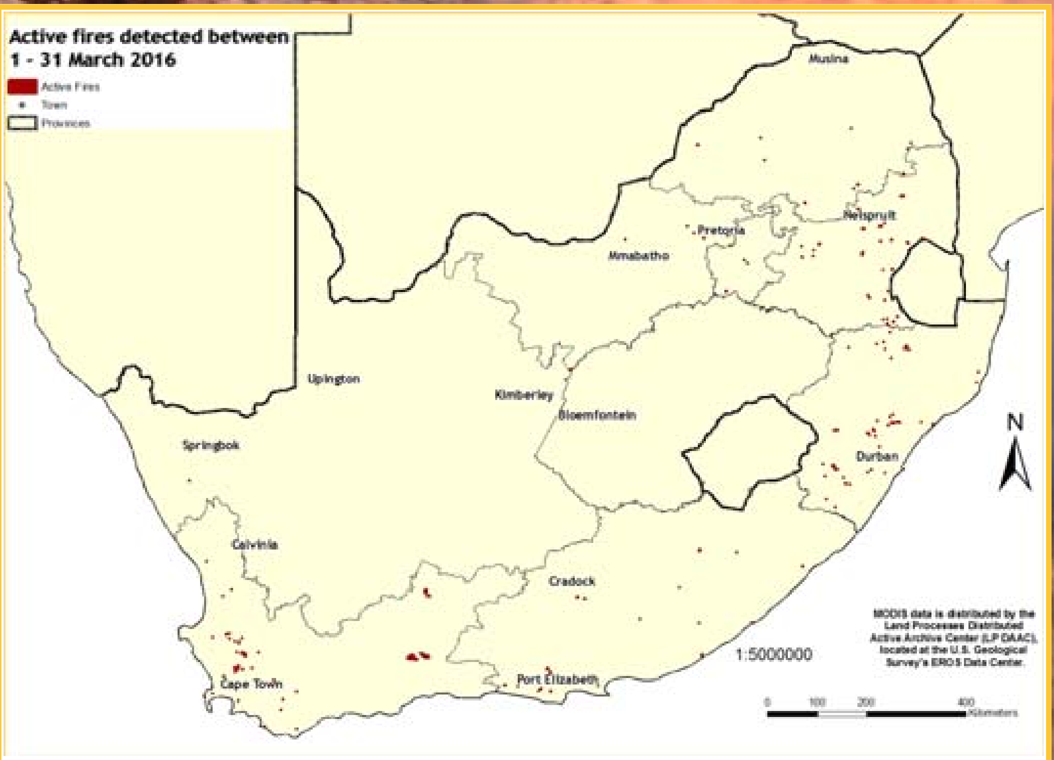

Figure 35

Questions/Comments:
NkambuleV@arc.agric.za

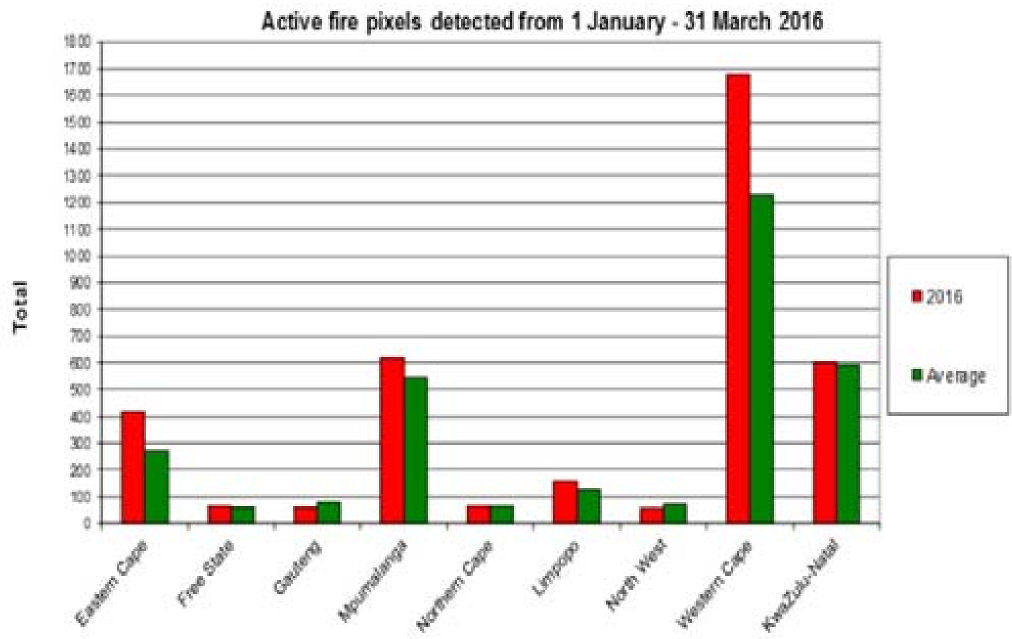

Figure 36

Figure 36:
The graph shows the total number of active fires detected from 1 January - 31 March 2016 per province. Fire activity was higher in the Eastern Cape, Mpumalanga, Limpopo and Western Cape compared to the average during the same period for the last 16 years.

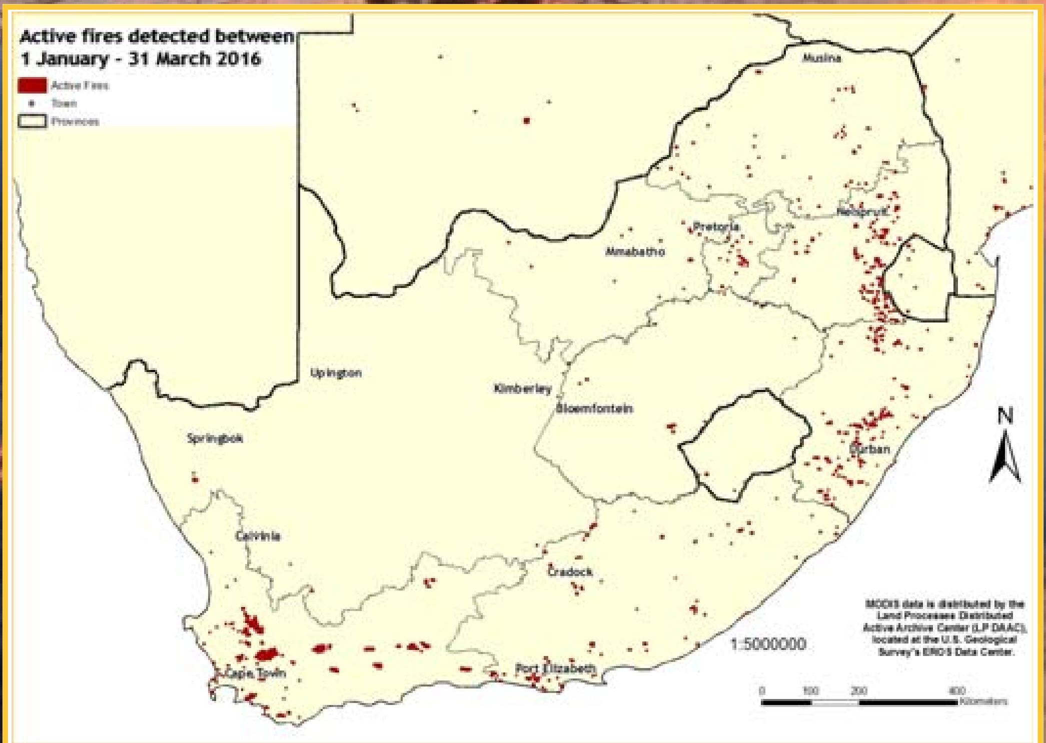

Figure 37

Figure 37:
The map shows the location of active fires detected between 1 January - 31 March 2016.

Questions/Comments:
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ARC-INSTITUTE FOR SOIL, CLIMATE AND WATER

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Excellence in Research and Development

Your Partner in Natural Resources Research and Information

AgroClimatology

The AgroClimatology Programme of the ARC-Institute for Soil, Climate and Water monitors South Africa's weather and supports the country's agricultural sector through timely provision of weather and climate information.

Since its inception at Bien Donné in the Western Cape in 1940, the Programme has evolved to become a leading arm of the ARC and currently has the capacity to maintain a large country-wide weather station network comprising over 500 automatic weather stations and a small number of mechanical weather stations. The data from all the stations is loaded onto a web-enabled databank from which various climate information products can be derived.

The weather station network and databank constitute a National Asset whose maintenance is largely funded by government through a parliamentary grant that is annually disbursed for this purpose.

Products and Services

Climate-related services and information are available from the Institute's offices in Pretoria (Tel: 012 310 2500), Potchefstroom (Tel: 018 299 6349) and Stellenbosch (Tel: 021 809 3100).

From the web-enabled databank, hourly, daily, monthly, yearly or long-term data can be requested for the following measured elements:

- Temperature
- Rainfall
- Wind speed (including gusts) and direction
- Radiation
- Humidity

Value-added information on evapotranspiration, cold and heat units, and Powdery and Downy Mildew disease indicators is available and various spatial interpretations can be conducted for interested users upon request.

For more information contact:
Mr. Chris Kaempffer
E-mail: ChrisK@arc.agric.za
Tel: 012 310 2560

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