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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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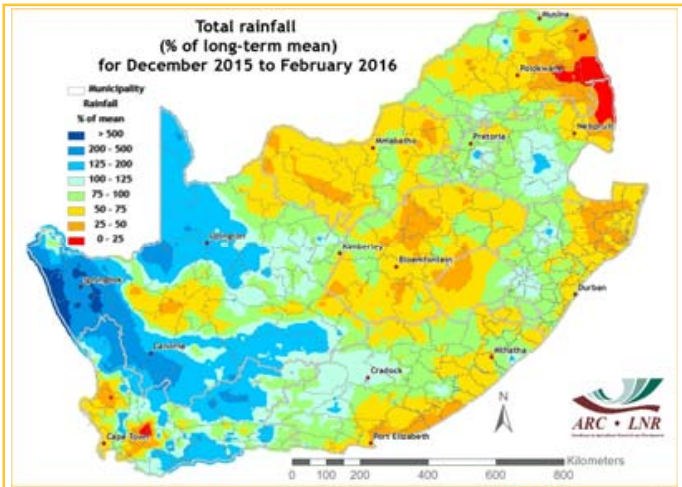
agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

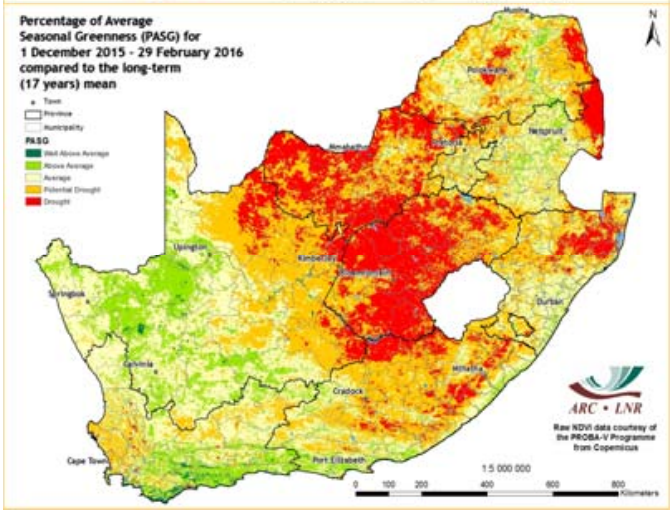
South African Weather Service

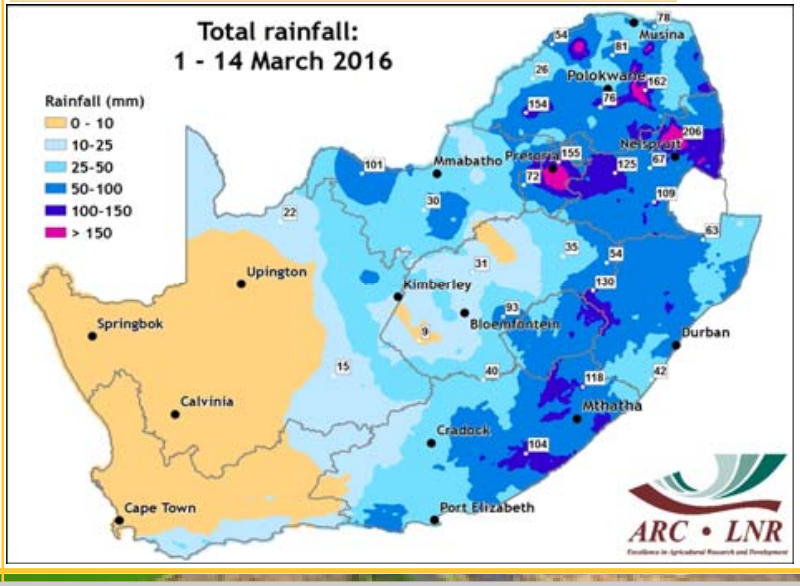
AMESD

141st Edition

Images of the Month







Rainfall and cumulative vegetation anomalies highlight areas worst affected by drought

The percentage-of-average rainfall and Percentage of Average Seasonal Greenness (PASG) maps for the December-to-February period of summer 2015/16 (left) indicate in warmer hues the more severely drought-affected areas. These include the western grain production regions, eastern parts of the Eastern Cape, northern KwaZulu-Natal and the Lowveld in the northeast.

Widespread rain in early March

Hot conditions during early March were followed by very favourable conditions for widespread rain over the summer rainfall region since the 7th. Heavy falls resulted in flash flooding in some areas, particularly parts of the Lowveld and Gauteng. The rainfall situation developed as large-scale atmospheric circulation patterns caused tropical moisture to move south over the country, ahead of an upper air trough that developed over the southwestern parts. The combination of tropical moisture and upper-air instability resulted in widespread significant showers and thundershowers over most parts in the east. The map (bottom left) is an interpolation of data from the automatic weather station network of the ARC-ISCW consisting of more than 400 operational stations. Rainfall totals from 1-14 March for a few of these stations are indicated.

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:

While conditions remained fairly favourable for rainfall over the eastern areas during February, the overall situation was less rainy than in January. Especially the western and central interior experienced hot and dry conditions, resulting in an unfavourable situation for crop production over much of the central interior while conditions remained more conducive to normal production over the eastern areas. Dry conditions were also associated with above-normal maximum temperatures, putting further strain on agricultural activities. The interior experienced especially hot weather with heatwave conditions during the first few days and again at the end of the month, with a somewhat cooler middle part during which the central interior received some thundershowers. The winter rainfall region experienced above-normal temperatures with several heatwaves, while little to no rain occurred over the western parts of this region.

An upper-air trough moving into southwestern South Africa deepened during the first few days over the southeastern parts into a cut-off low that became almost stationary to the east of the country. The system accompanied a fairly strong high pressure system ridging around the south of the country, feeding moisture into the southern to eastern parts. It resulted in unstable conditions over the southern parts firstly, spreading to the eastern parts with fairly widespread thundershowers and significant falls in places over the eastern provinces. Severe weather in the form of a tornado near Belfast and several hail storms were associated with the system. Precipitation over the rest of the summer rainfall region during early February was in the form of isolated to scattered thundershowers, with many areas receiving below-normal rainfall totals. Major convective activity in the region of Madagascar was associated with largely subsident conditions across southern Africa.

However, a number of large thunderstorms brought some relief over the northern parts especially from the 6th to 11th. Still, large-scale subsidence resulted in a steady rise in maximum temperatures over much of the interior, with heatwave conditions setting in over some areas. Surface moisture and some upper-air instability due to troughs moving over the southern parts resulted in scattered thundershowers over the central to eastern parts from the 16th to the 22nd. Large amounts of tropical moisture flowed southwards over the eastern parts under relatively weak upper-air conditions. Due to moisture convergence and position of the troughs, the eastern parts were favoured above the central interior for significant falls

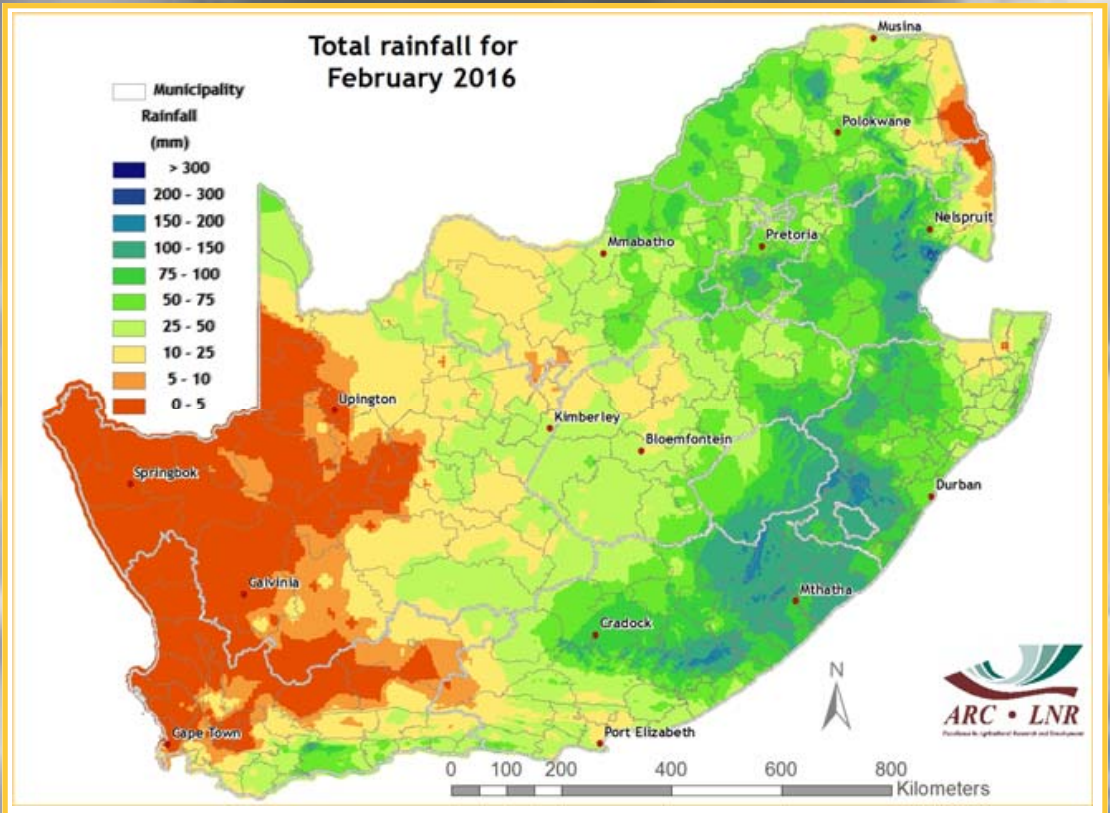


Figure 1

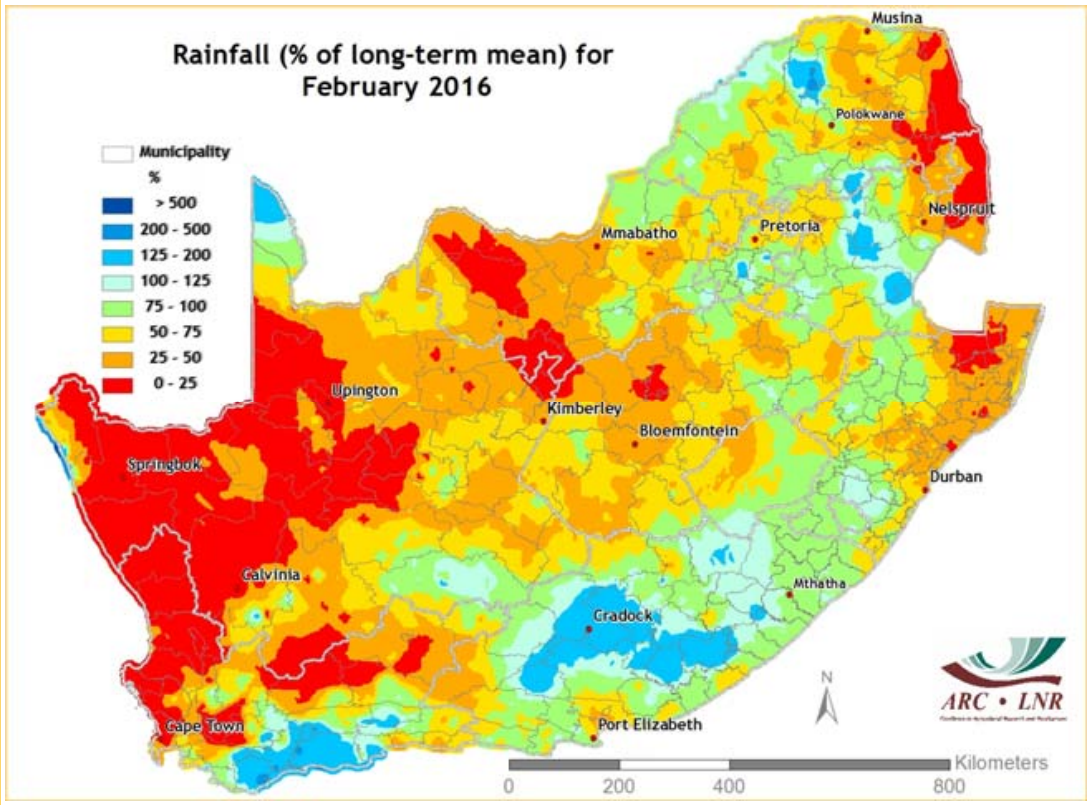


Figure 2

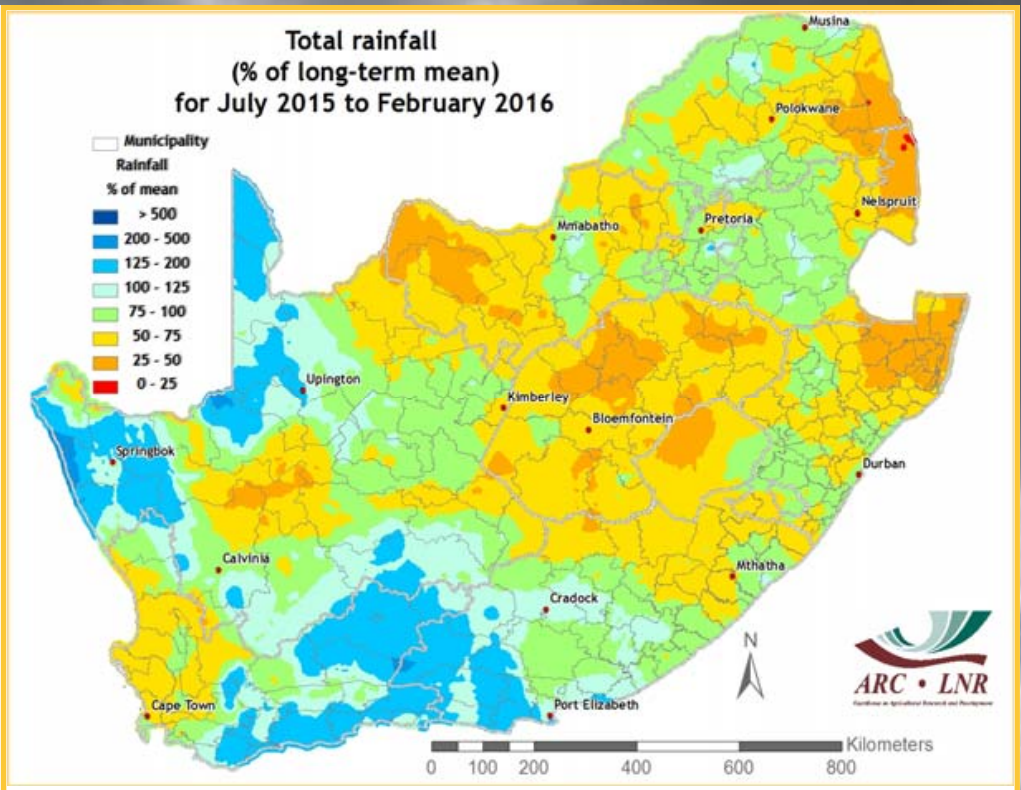


Figure 3

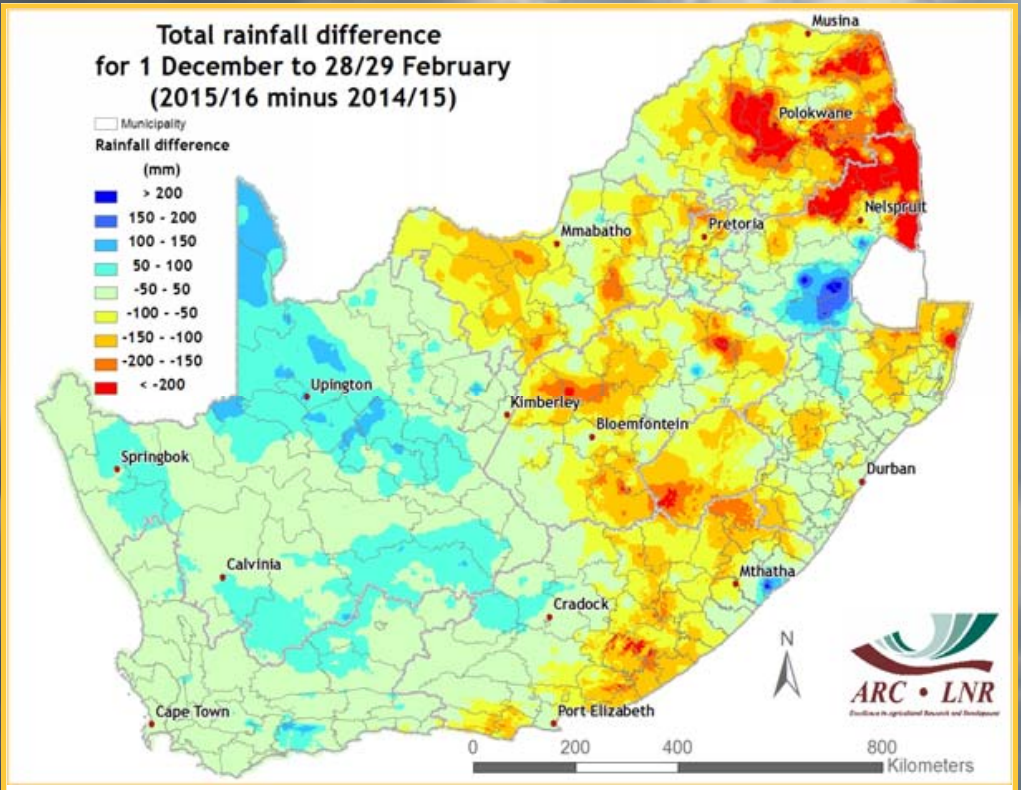


Figure 4

Towards the end of the month, upper-air perturbations situated over the central to northern parts of the country, as well as a large anticyclonic circulation towards the east of the country advecting moisture into the subcontinent, with the availability also of moisture from the north, favoured scattered showers and thunderstorms over the northern and northeastern parts of the country, including the eastern maize production region. An upper-air trough moving through between the 26th and 27th supported more significant thundershowers over the northeastern parts. A strong ridge around the south of the country resulted in a cooler easterly flow over the eastern parts from the 27th, leading to some significant falls in the northeast. The month ended with somewhat cooler conditions with isolated thundershowers over the eastern parts while a tropical low was developing towards the north of Botswana, indicating a trend towards the widespread rainfall experienced in early March.

Figure 1:
The southeastern parts, eastern interior and northeast received totals in excess of 75 or even 100 mm during February while it was dry over the western parts and the Lowveld.

Figure 2:
Rainfall was below normal over the central to western parts as well as the Lowveld and northeastern coastal areas. Near-normal to above-normal rainfall was observed over the eastern summer rainfall region as well as some of the southern areas.

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

Figure 4:
The northeastern parts of the country received significantly less rain during the December to February period this summer than in summer 2014/15. This is tied to much more rain during December 2014 than in 2015. The Northern Cape and parts of Mpumalanga received significantly more rain this summer than last.

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 occur at the shorter time scales over large areas over the central and eastern parts of the country. At the 24-month time scale, severe to extreme drought occurs over parts of KwaZulu-Natal, northeastern Free State and the Lowveld.

Questions/Comments:
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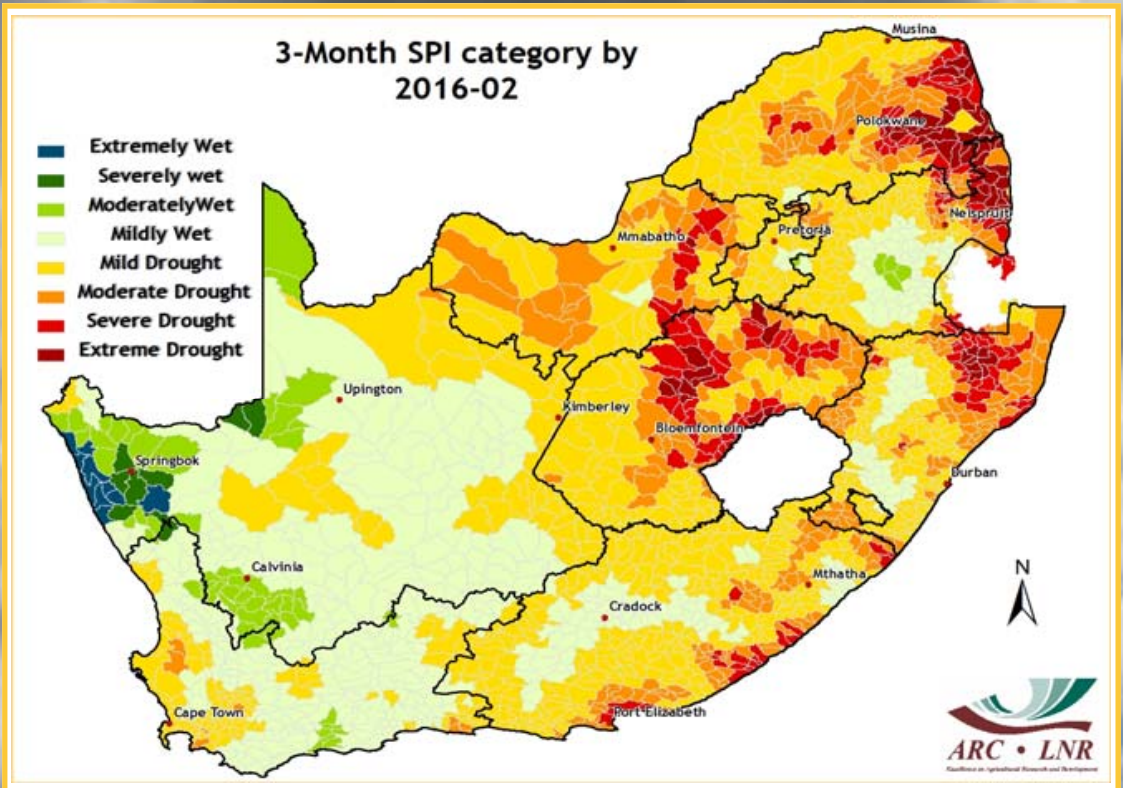

Figure 5

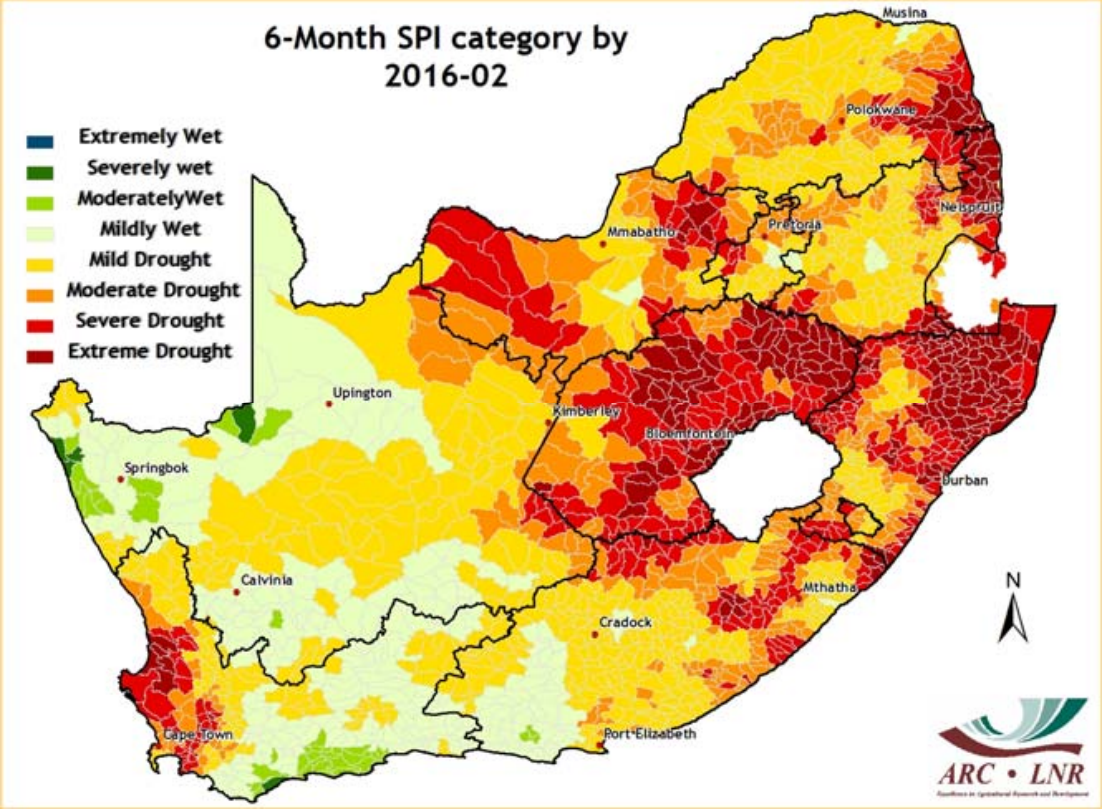

Figure 6

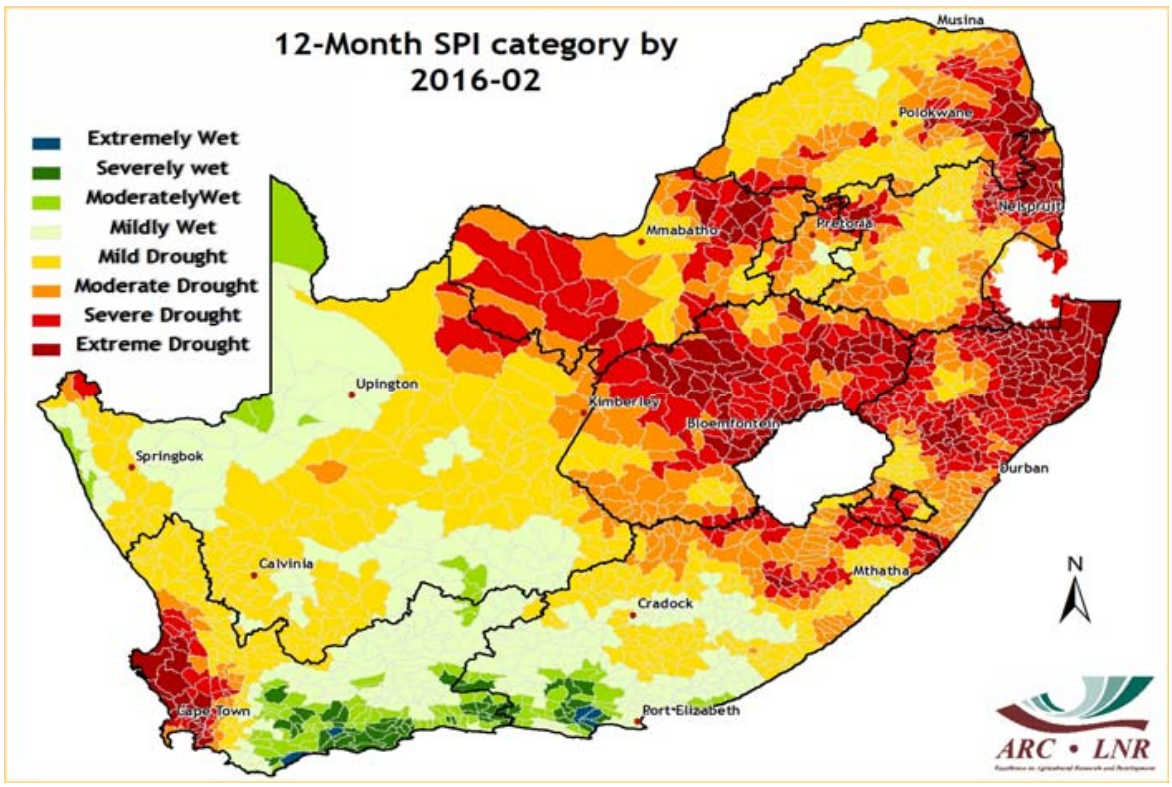

Figure 7

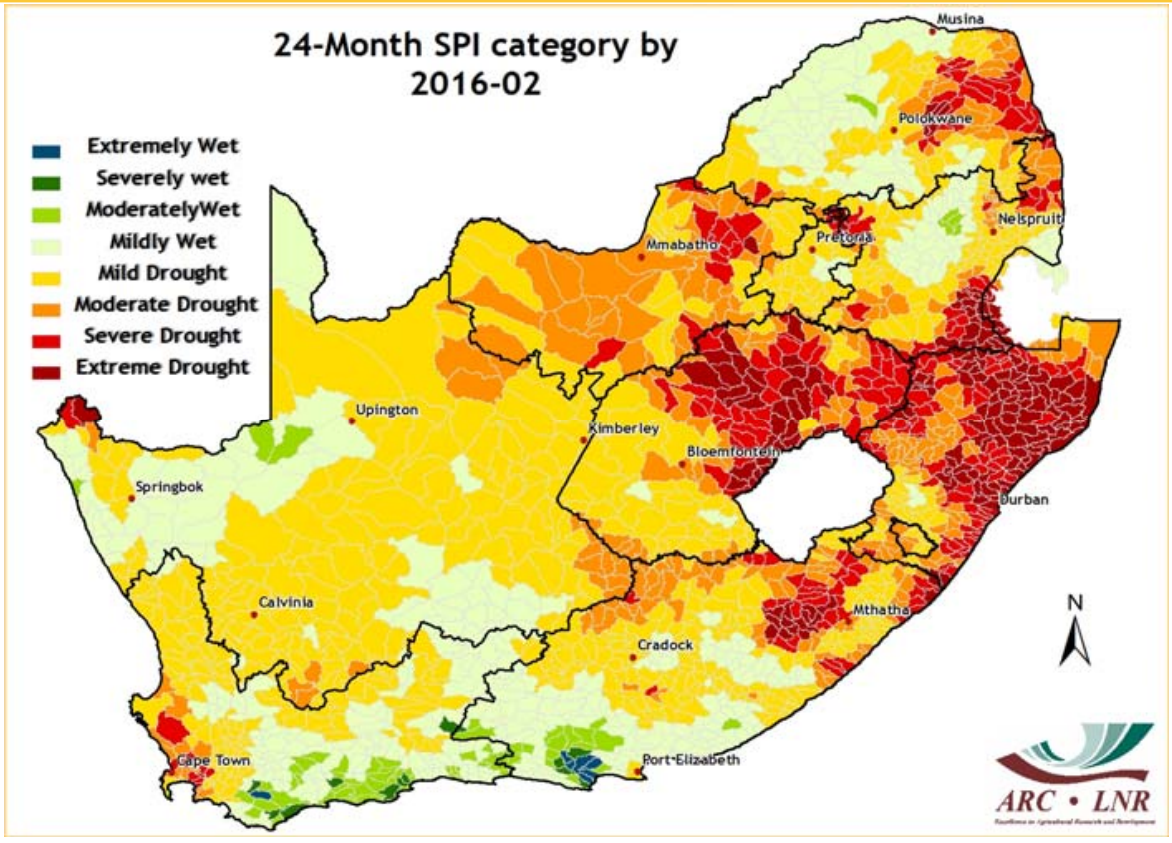

Figure 8

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.

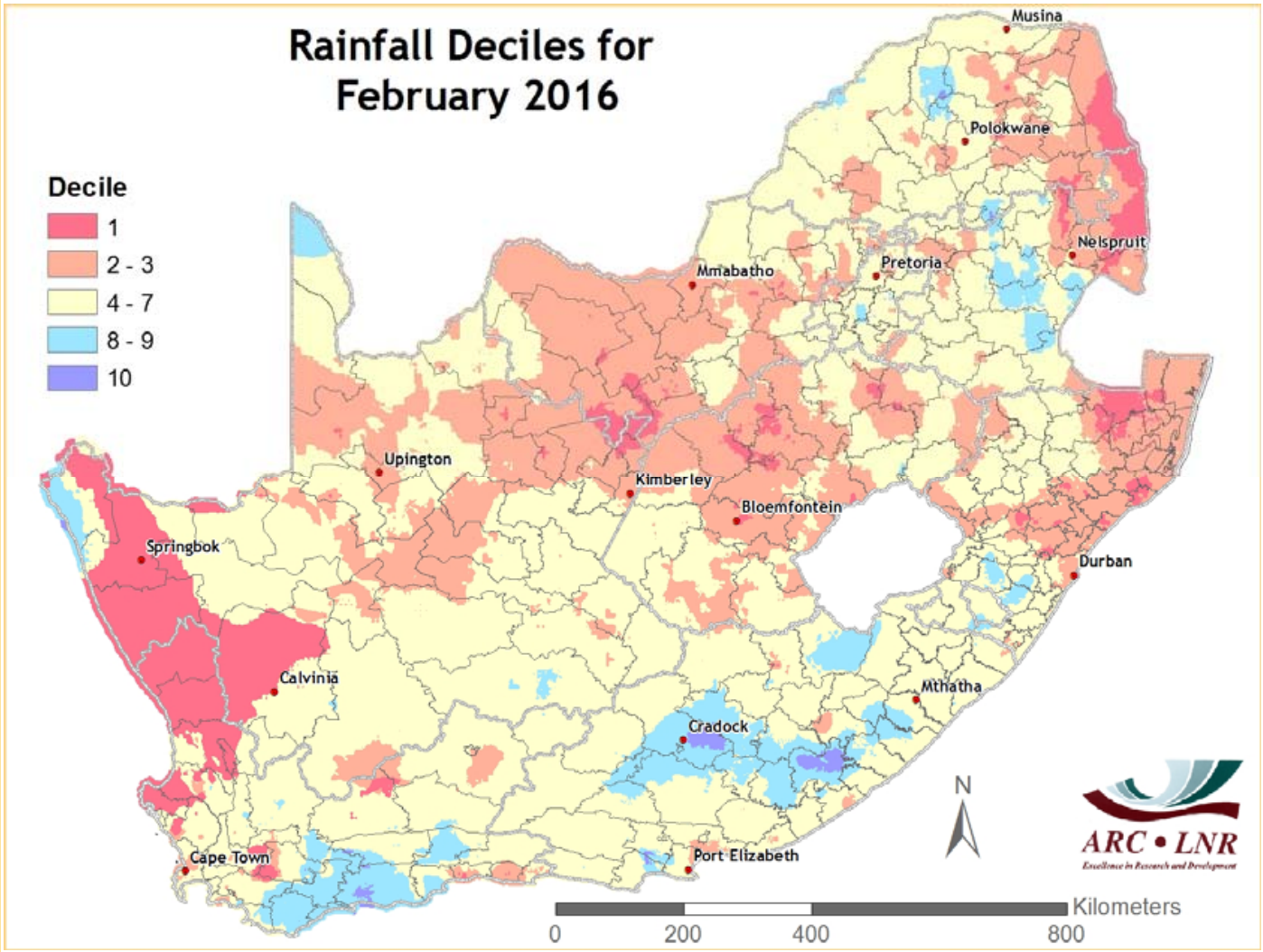

Figure 9

Figure 9:
Western North West, northwestern Free State, northern KwaZulu-Natal and the Lowveld are summer rainfall areas that received exceptionally little rainfall during February. In contrast, parts of the central Eastern Cape and small areas in the northeast were exceptionally wet.

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

4. Water Balance

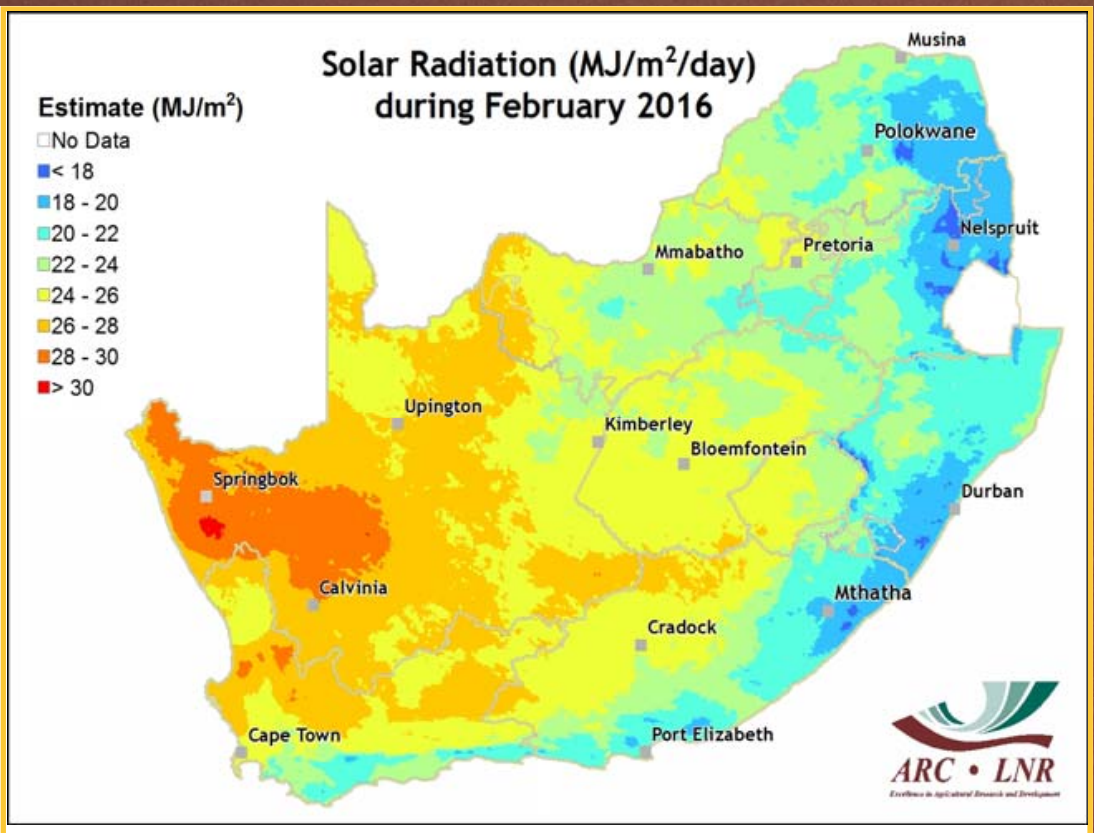

Figure 10

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

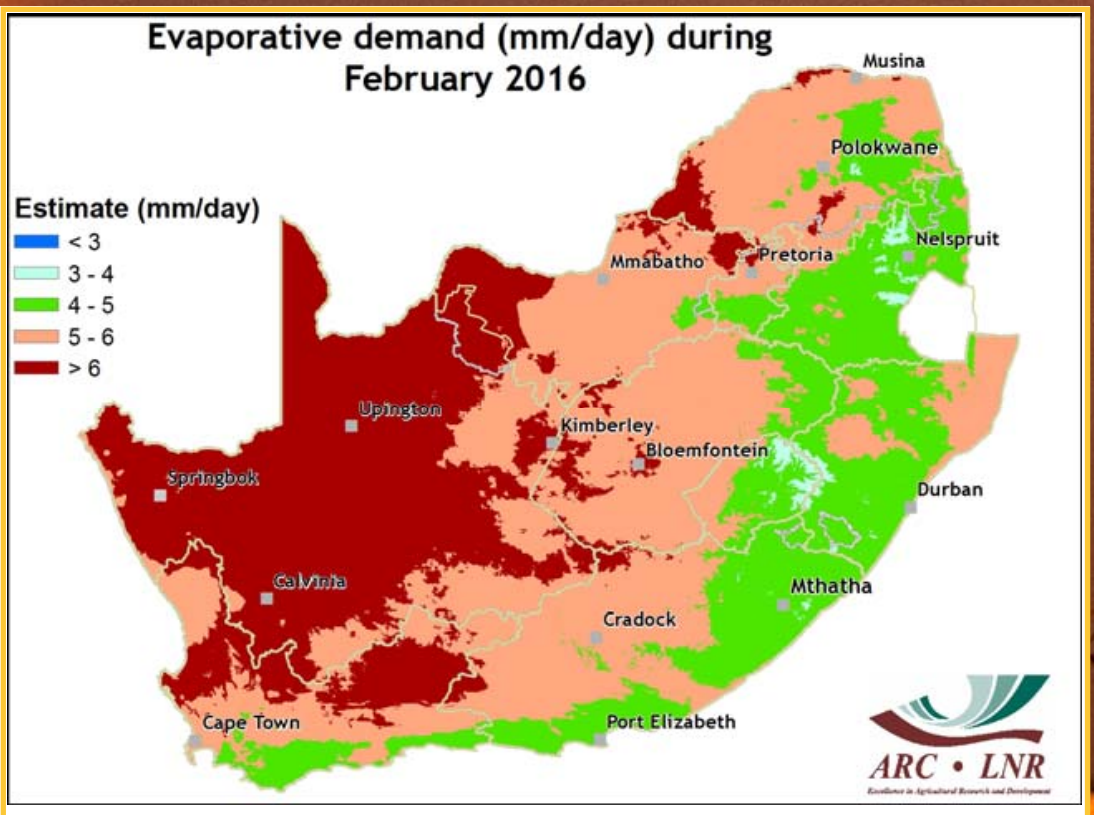

Figure 11

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 4 and 5 mm/day over southern KwaZulu-Natal and the Garden Route to more than 6 mm/day over the western and northern parts of 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.

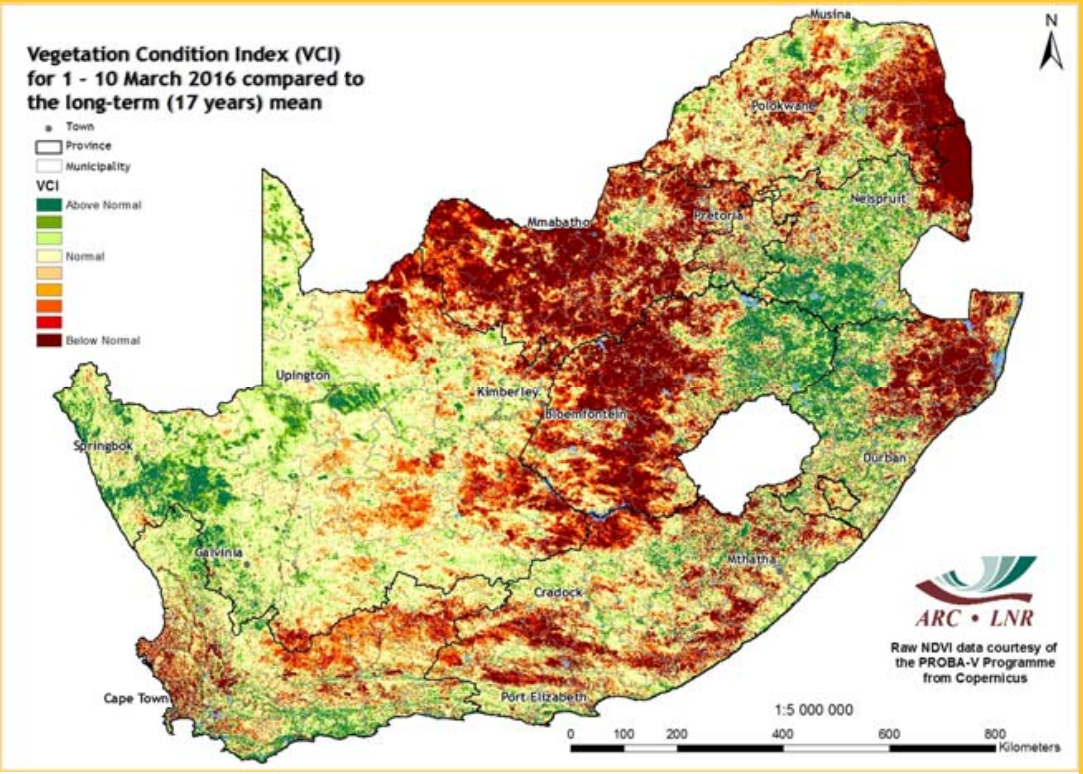

Figure 12

Figure 12:
The VCI by early March indicates drought stress over much of the central interior southeastwards into the eastern parts of the Eastern Cape as well as the northeastern parts of KwaZulu-Natal and the Lowveld. Above-normal activity dominates across the eastern maize production region and Northern Cape.

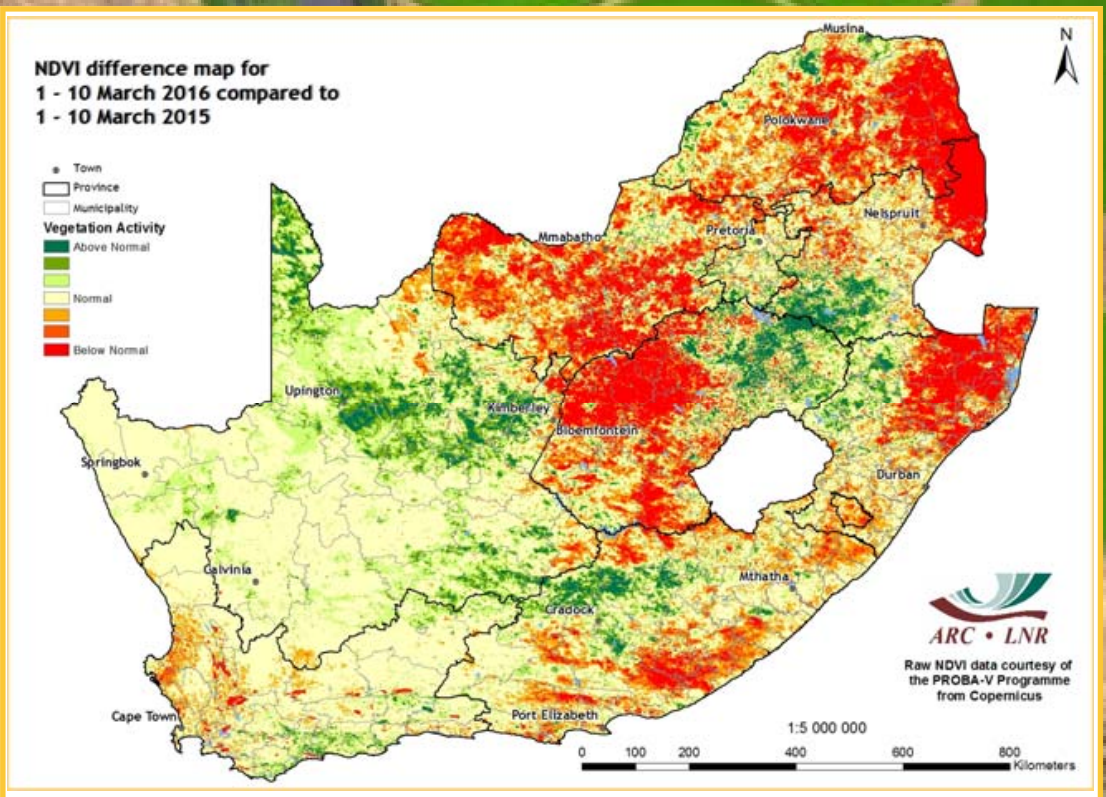

Figure 13

Figure 13:
Most of the summer rainfall region is drought stressed compared to the situation in early March 2015 except for the eastern maize production region and the Northern Cape.

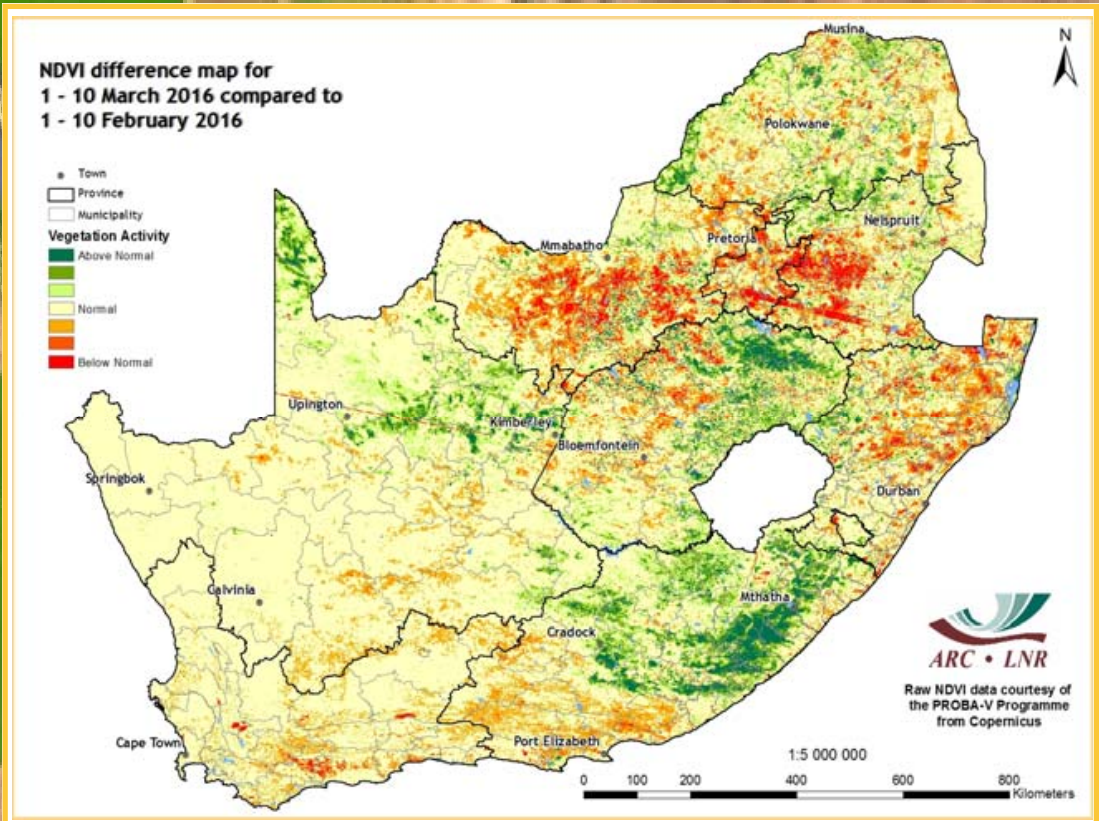

Figure 14

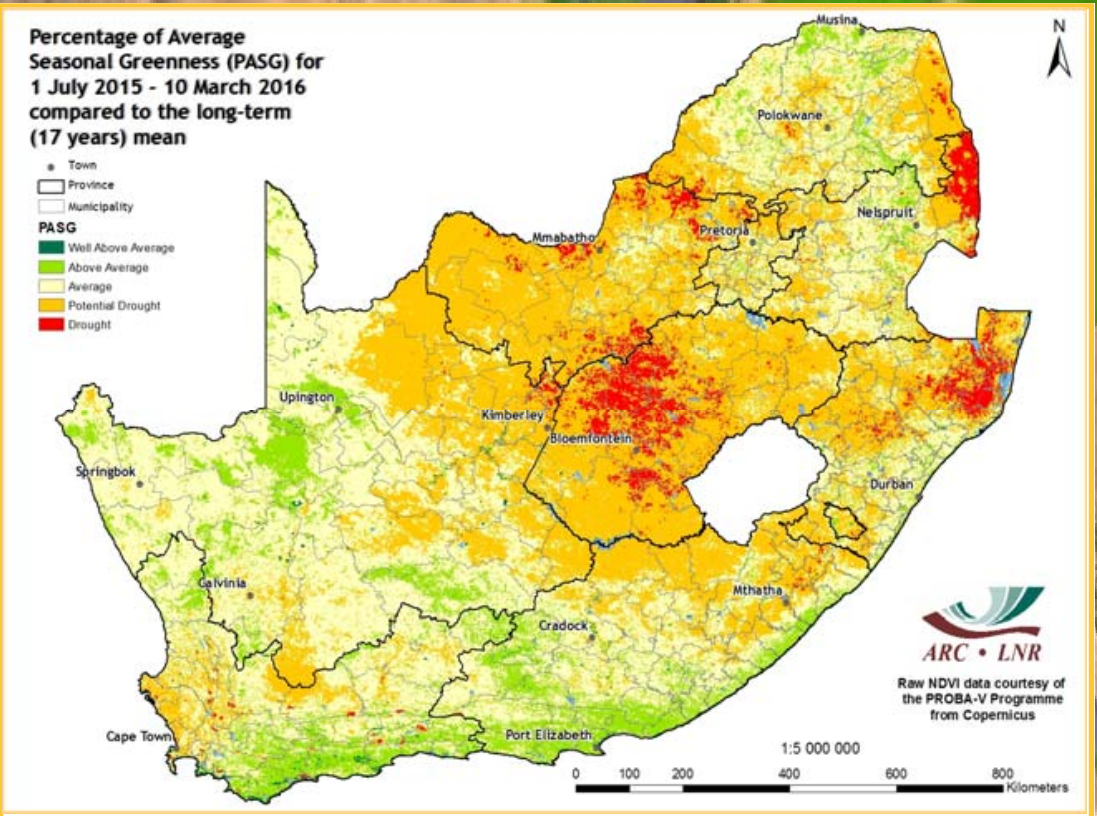

Figure 15

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 hot conditions with below-normal precipitation over some areas, vegetation activity has decreased in some parts of the summer rainfall region since early February.

Figure 15:
Cumulative vegetation activity anomalies indicate drought stress over much of the central parts of the country while the southern and northeastern parts experienced much more favourable conditions considering the July-early March period as a whole.

Questions/Comments:
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6. Vegetation Condition Index

Vegetation Condition Index (VCI)

The VCI is an indicator of the vigour of the vegetation cover as a function of the NDVI minimum and maximum encountered for a specific pixel and for a specific period, calculated over many years.
The VCI normalizes the NDVI according to its changeability over many years and results in a consistent index for various land cover types. It is an effort to split the short-term weather-related signal from the long-term climatological signal as reflected by the vegetation. The VCI is a better indicator of water stress than the NDVI.

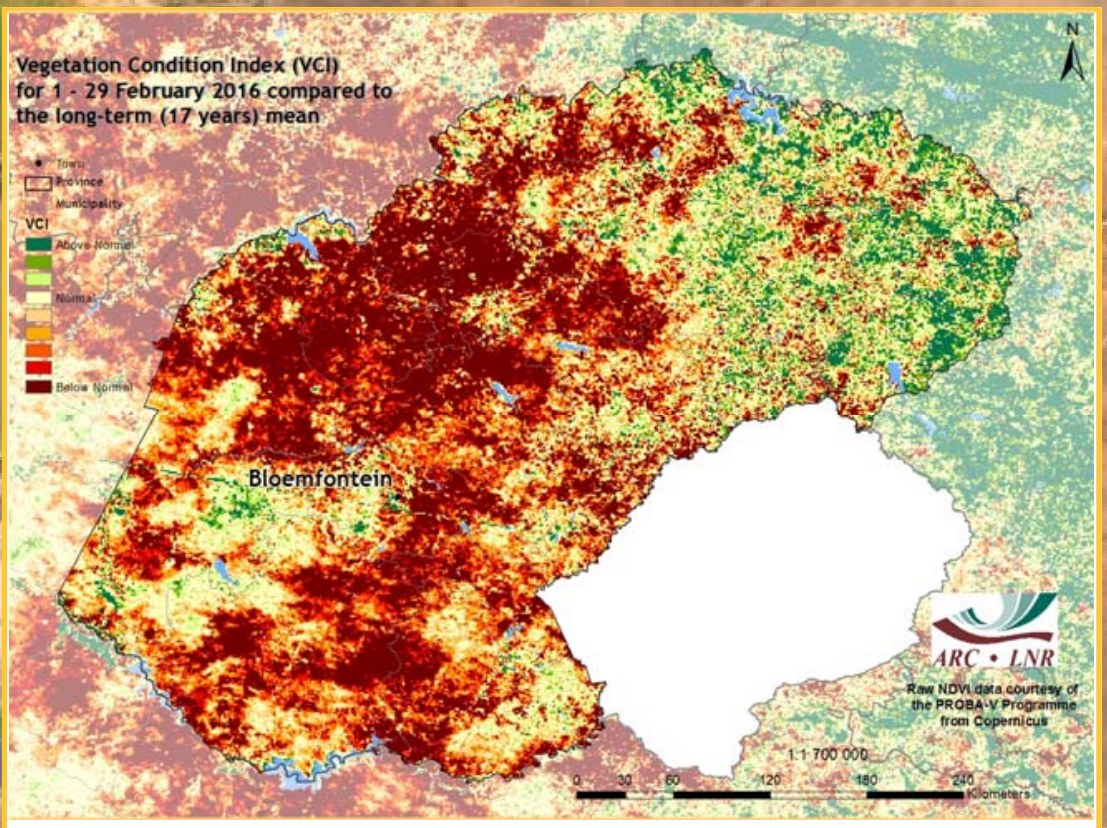


Figure 16

Figure 16:
The VCI map for February indicates below-normal vegetation activity over the central to western parts of the Free State province.

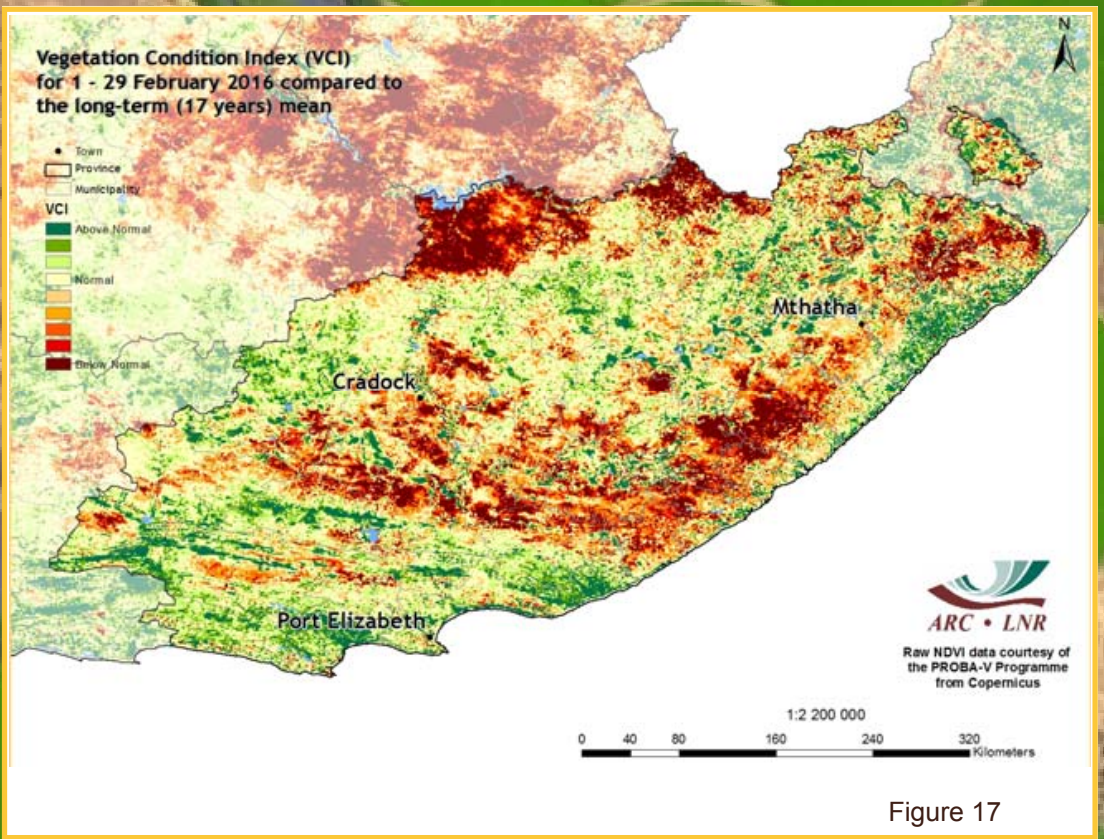
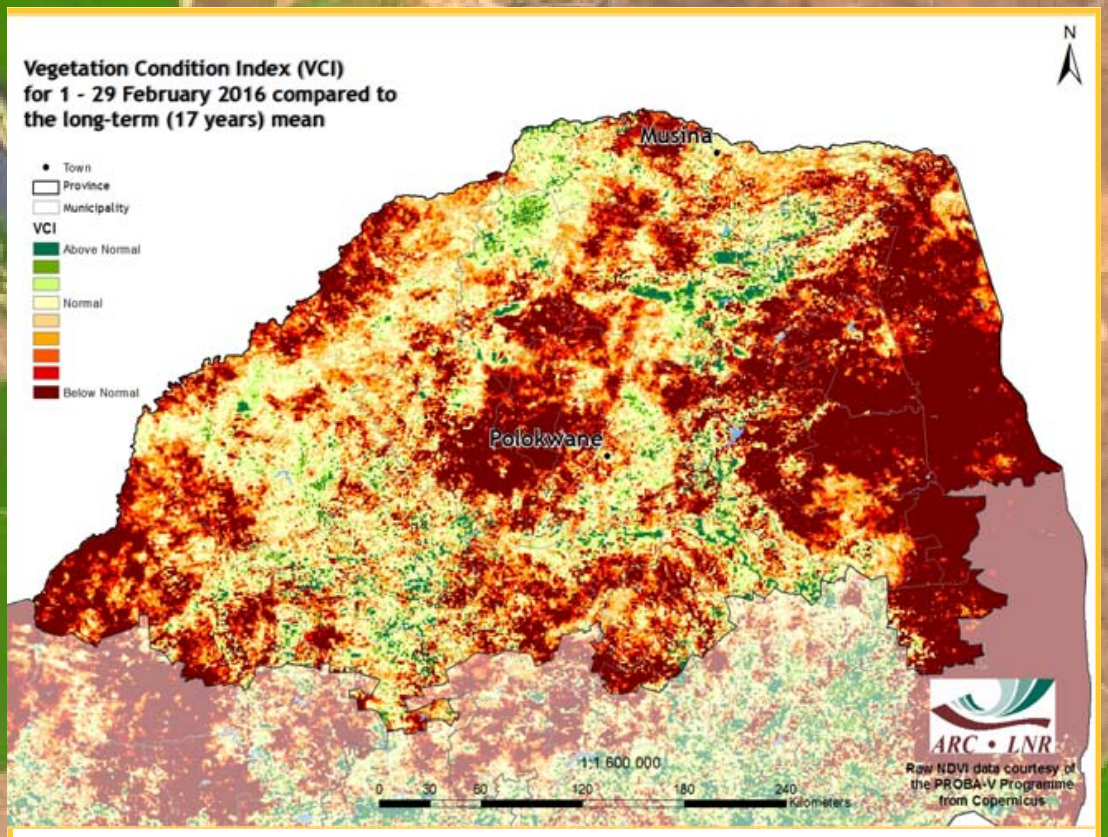


Figure 17

Figure 17:
The VCI map for February indicates below-normal vegetation activity over the eastern to southeastern and central parts of the Eastern Cape province as well as in the extreme north.



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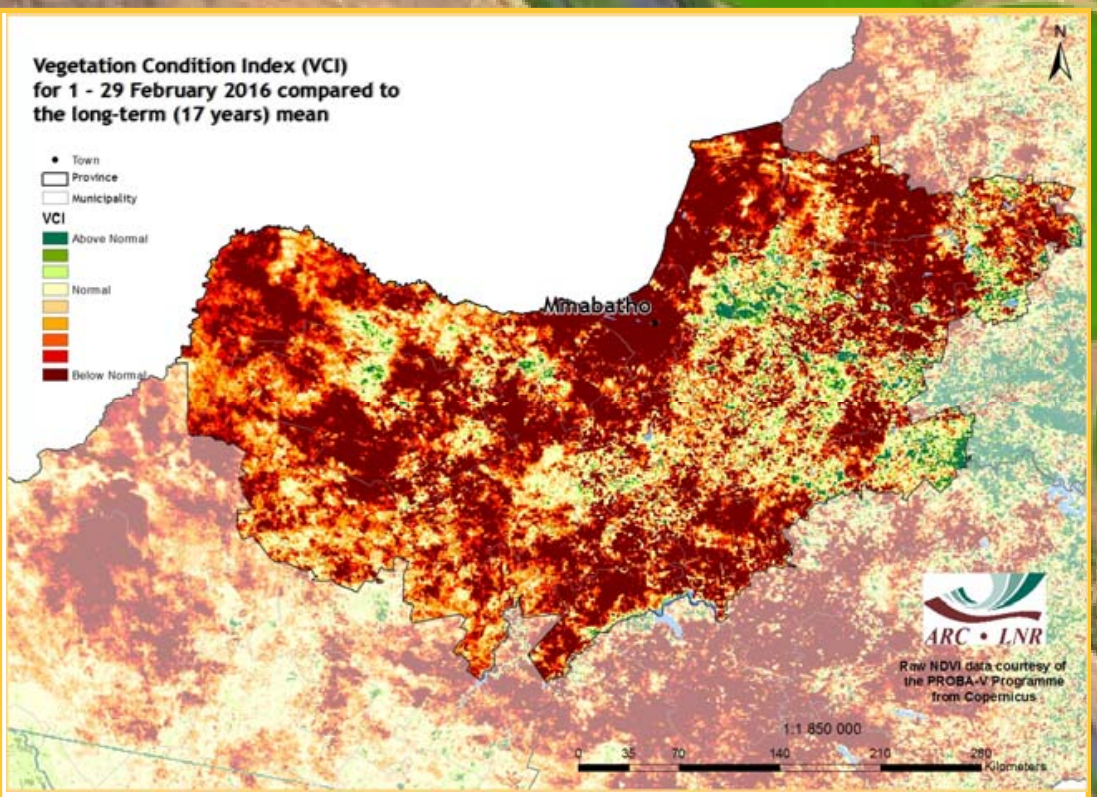


Figure 19

Figure 18:
The VCI map for February indicates below-normal vegetation activity over especially the Lowveld of Limpopo province.

Figure 19:
The VCI map for February indicates below-normal vegetation activity over most of North West province.

Questions/Comments:
NkambuleV@arc.agric.za

7. Vegetation Conditions & Rainfall

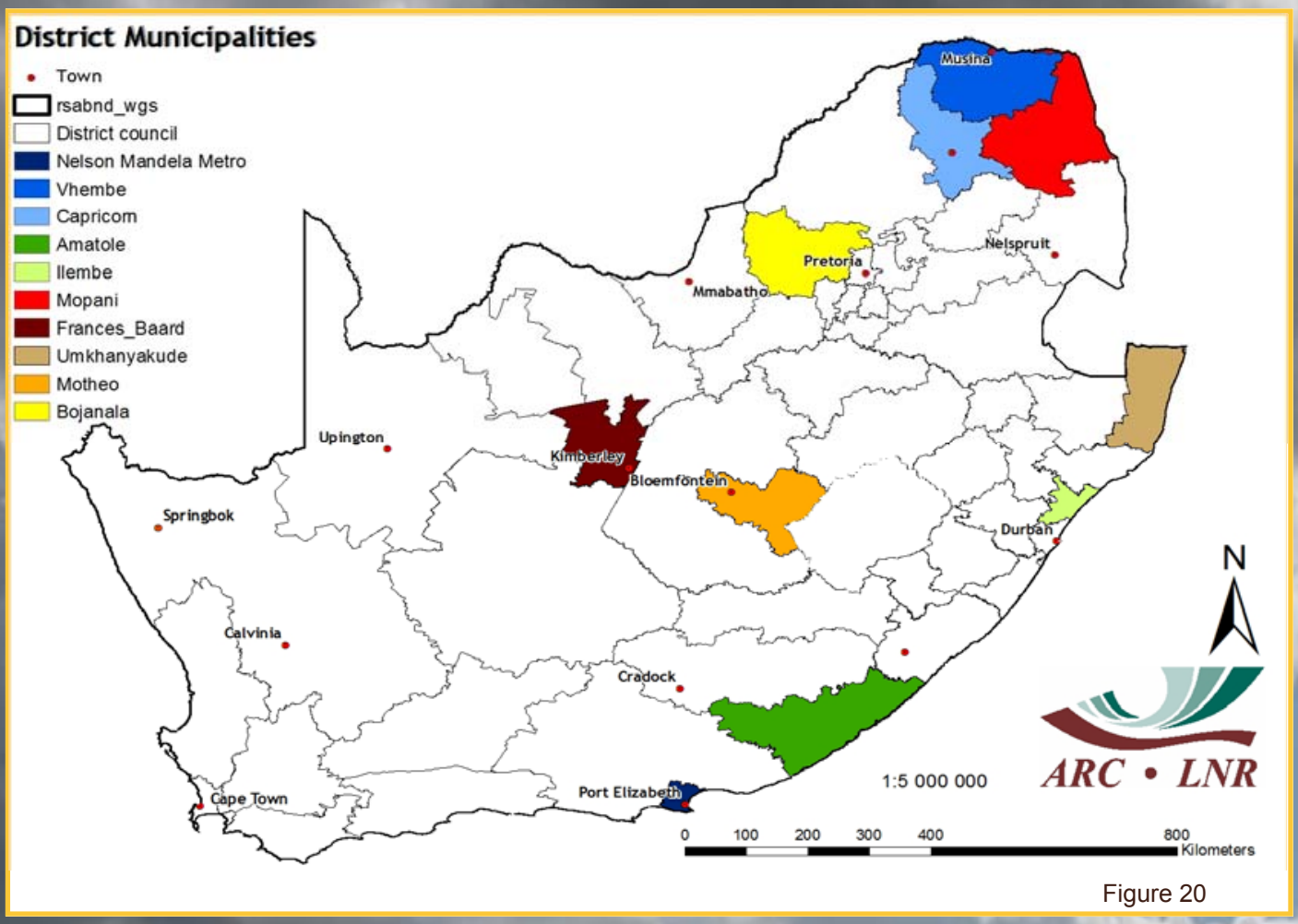


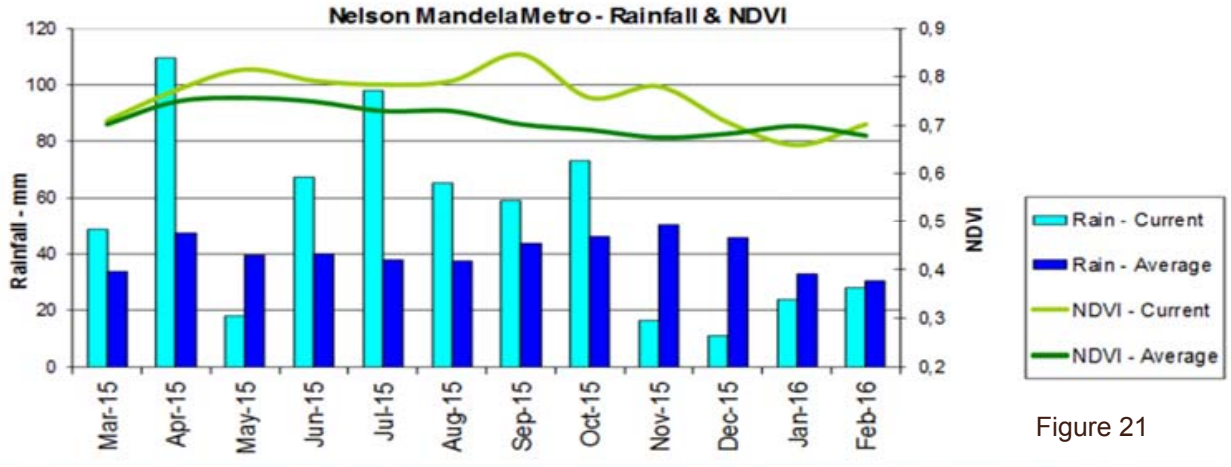
Figure 20

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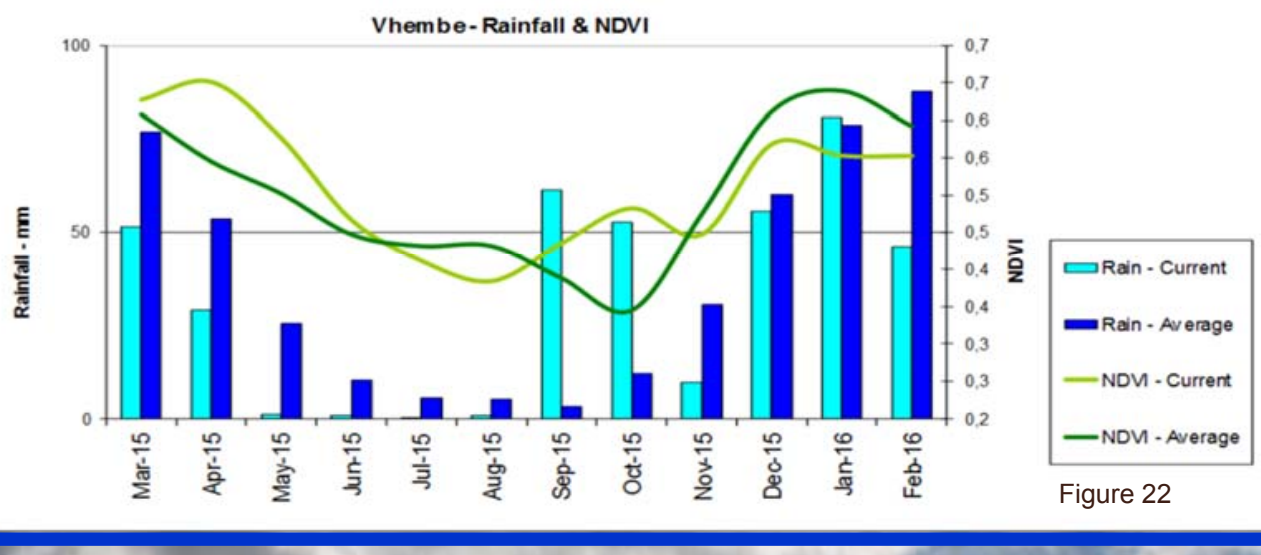

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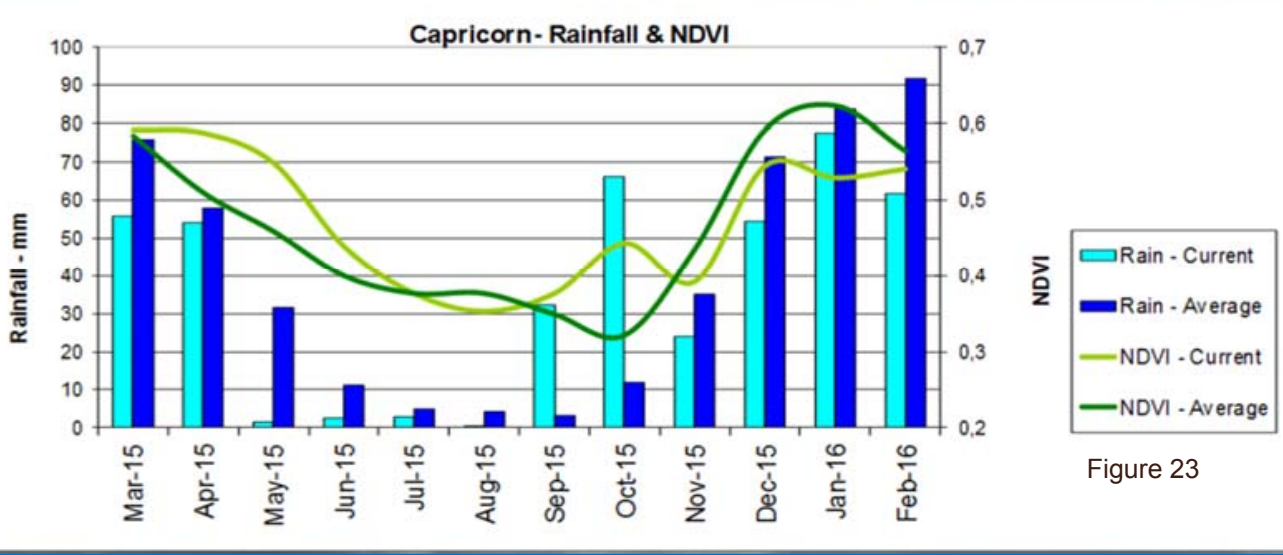

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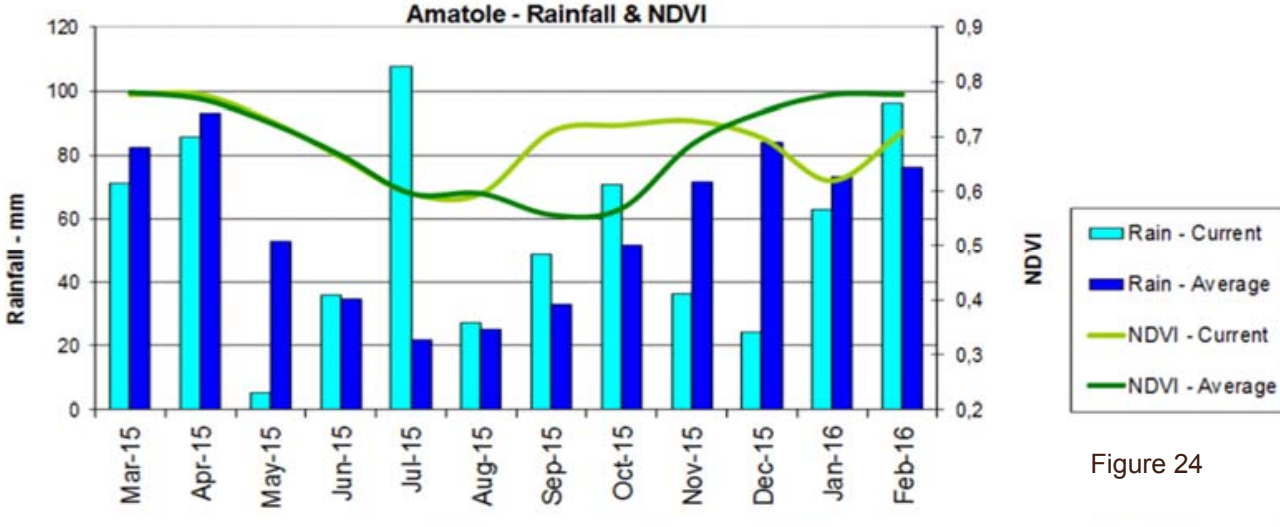


Figure 24

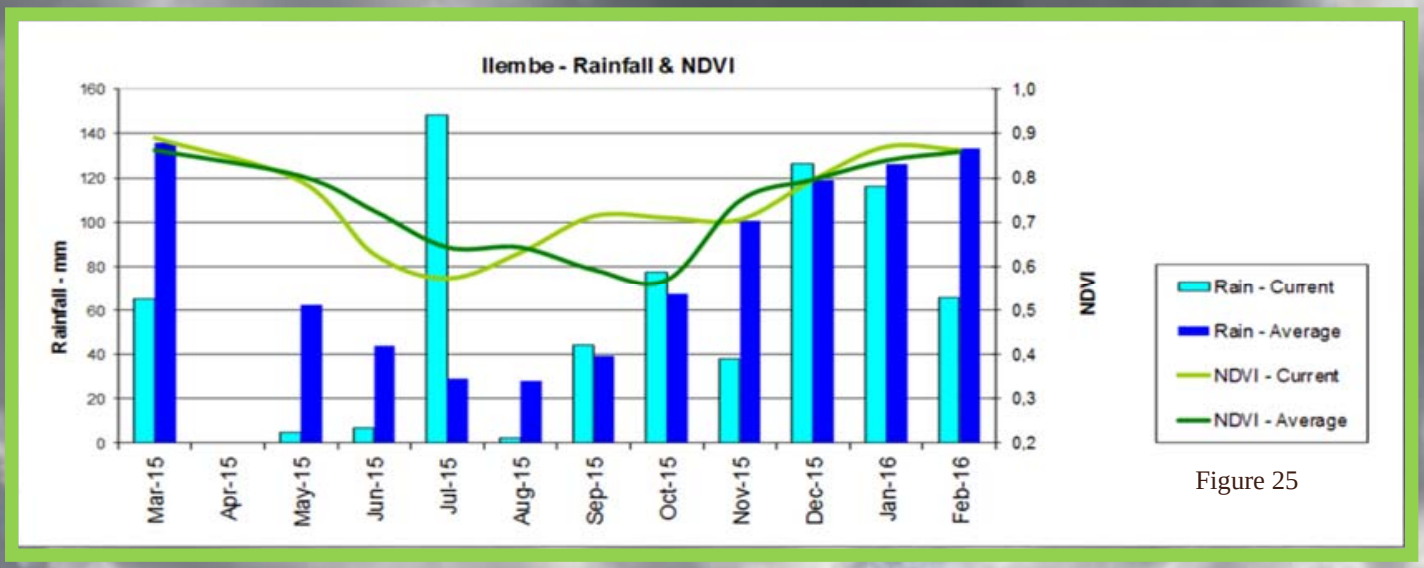
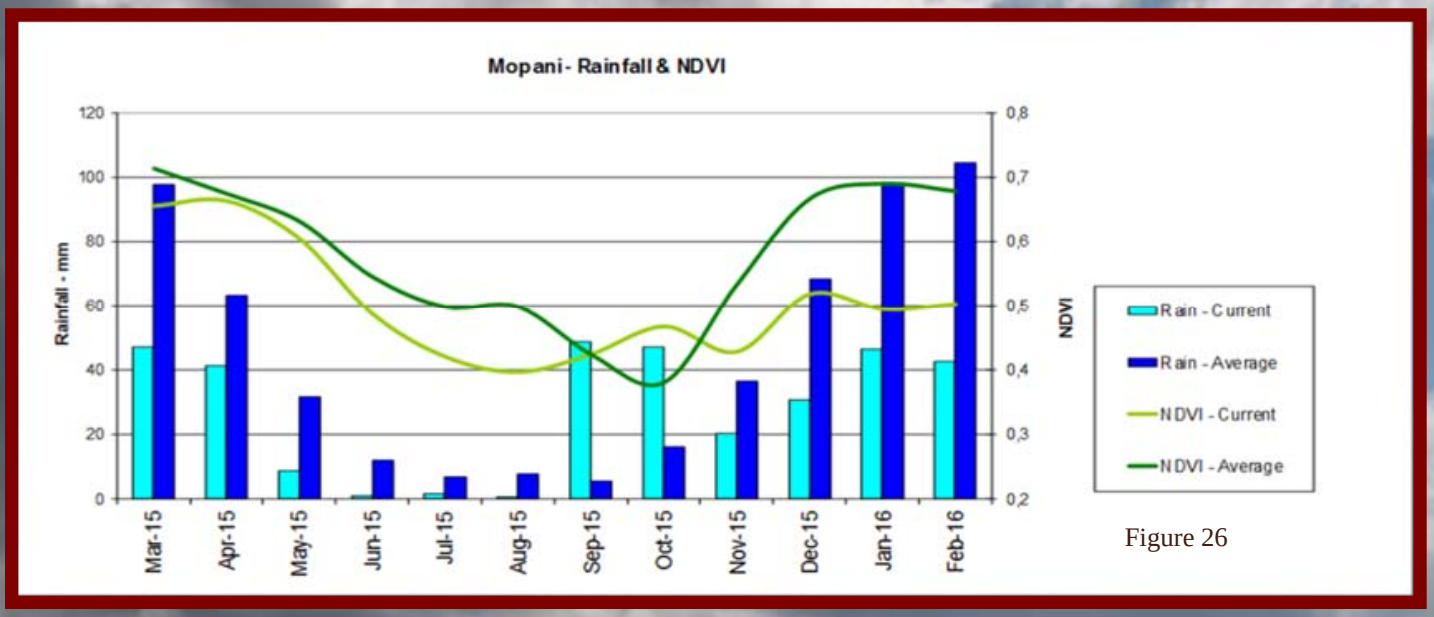


Figure 25



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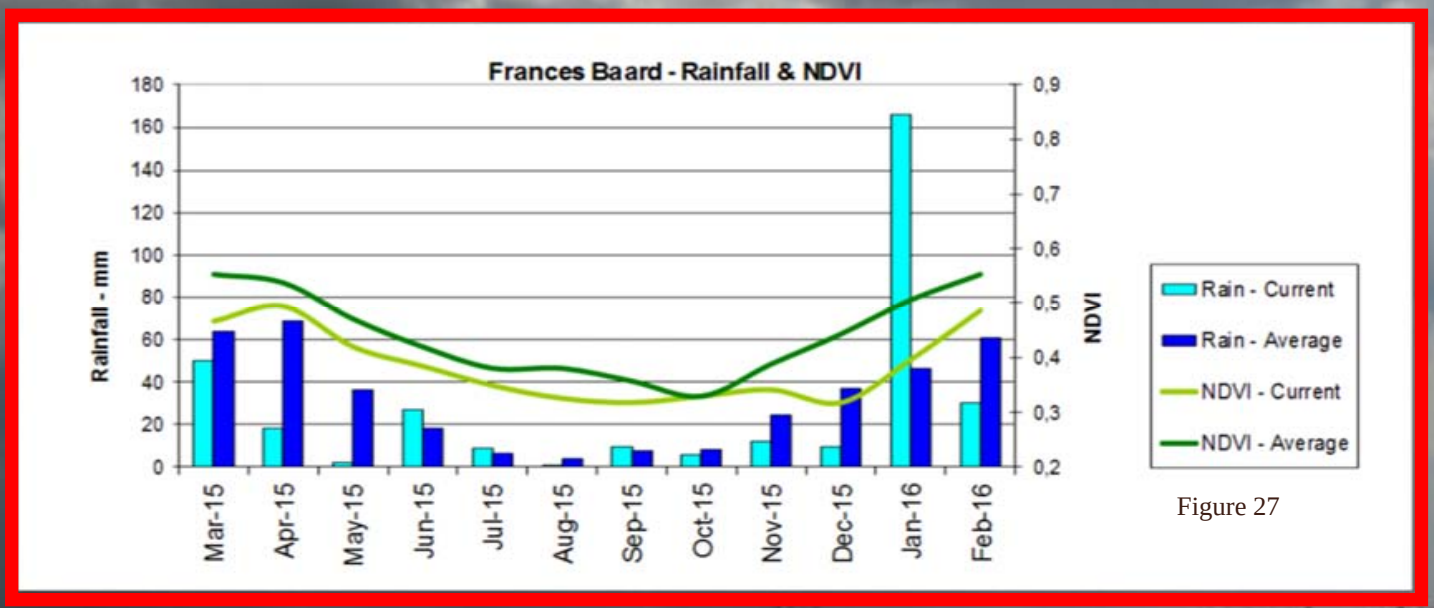

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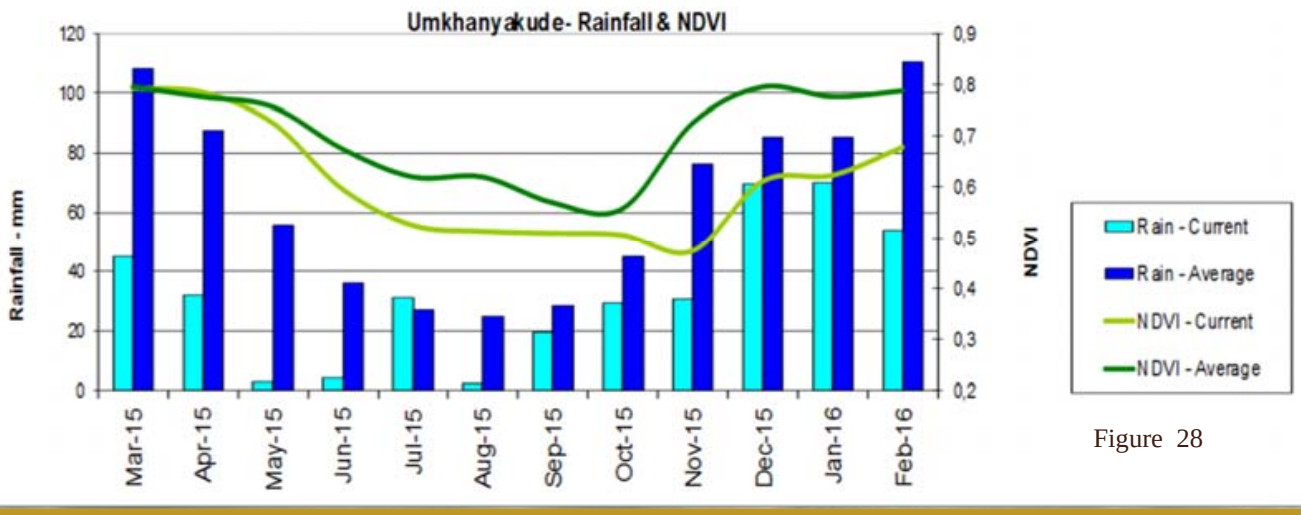

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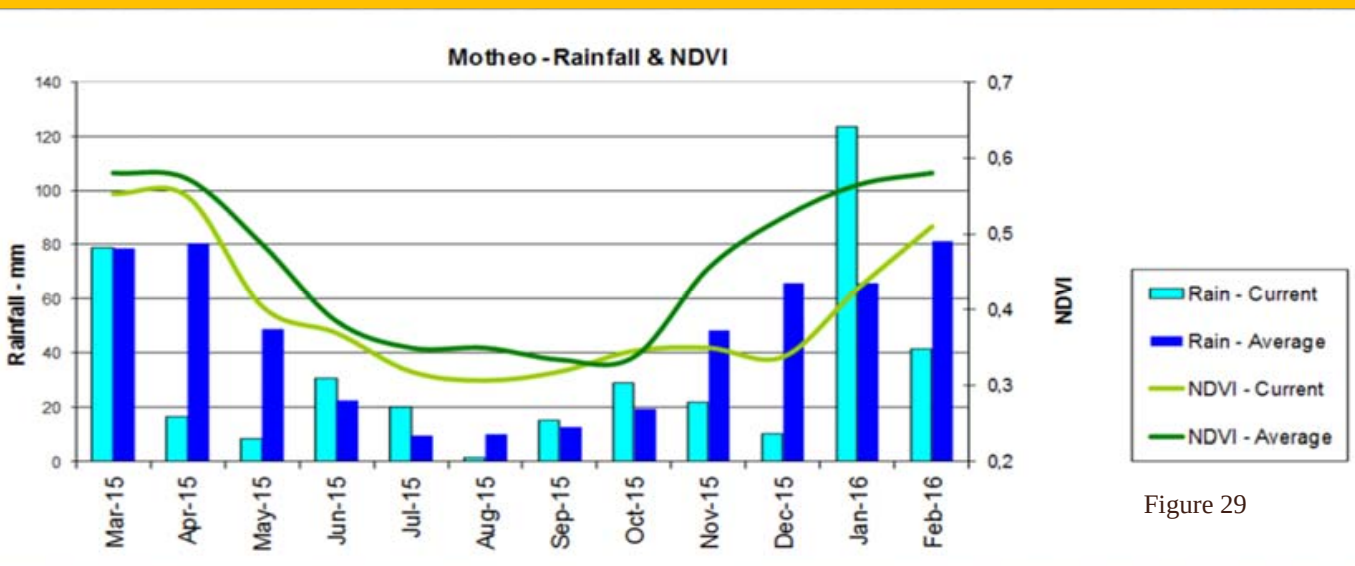

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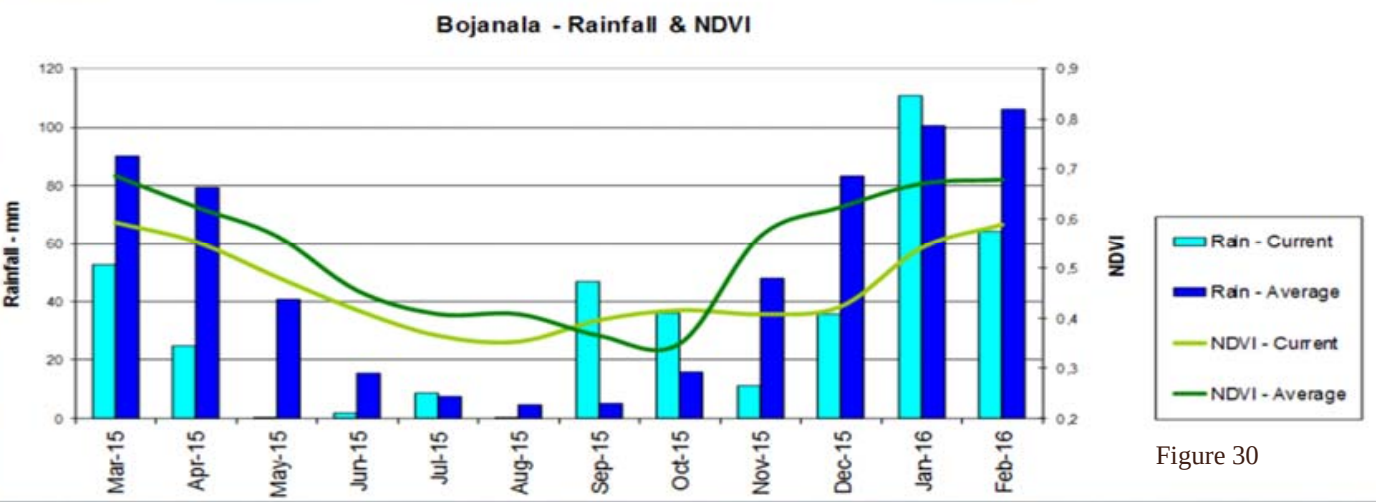

Figure 30

8. Soil Moisture

PAGE 16

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 February 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 February and January 2016, with the brown colours showing the drier and the green colours the wetter areas. Similarly, the year-on-year SSI difference for February 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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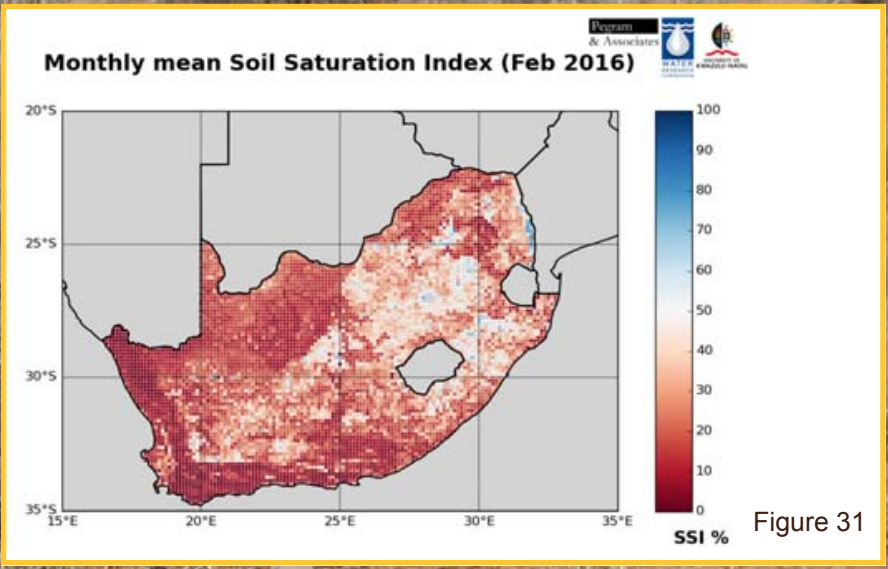

Figure 31

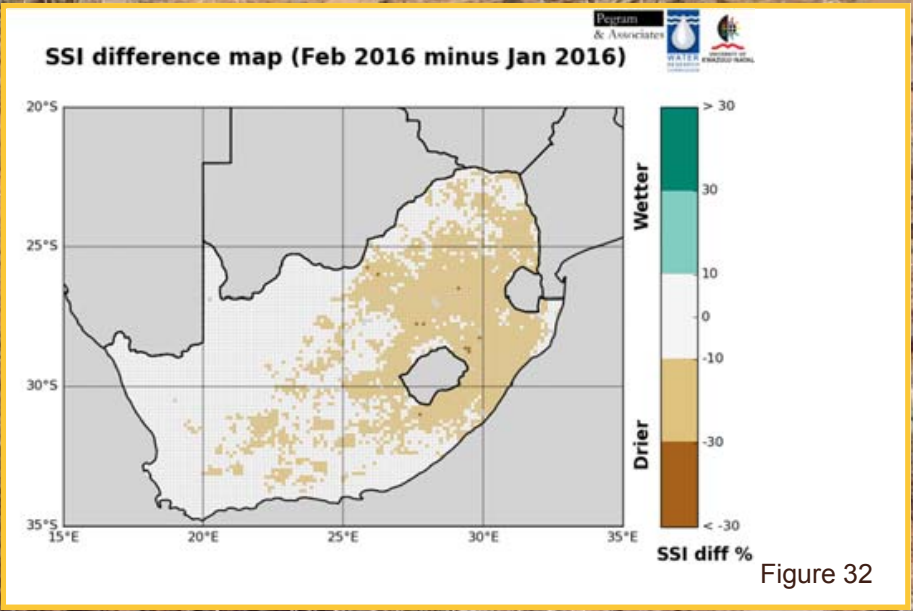

Figure 32

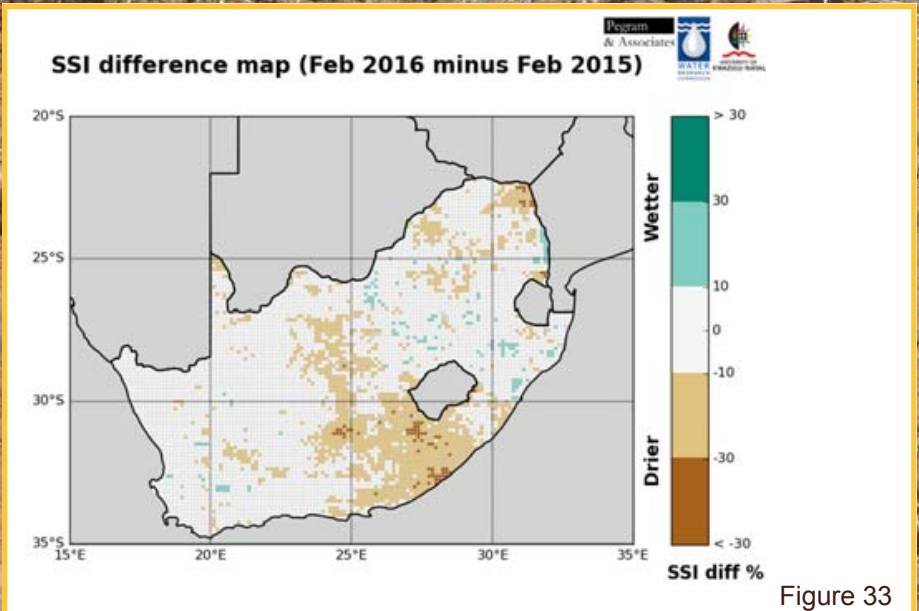

Figure 33

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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 February per province. Fire activity was higher in the Eastern Cape, Mpumalanga, Limpopo, Western Cape and KwaZulu-Natal compared to the average during the same period for the last 16 years.

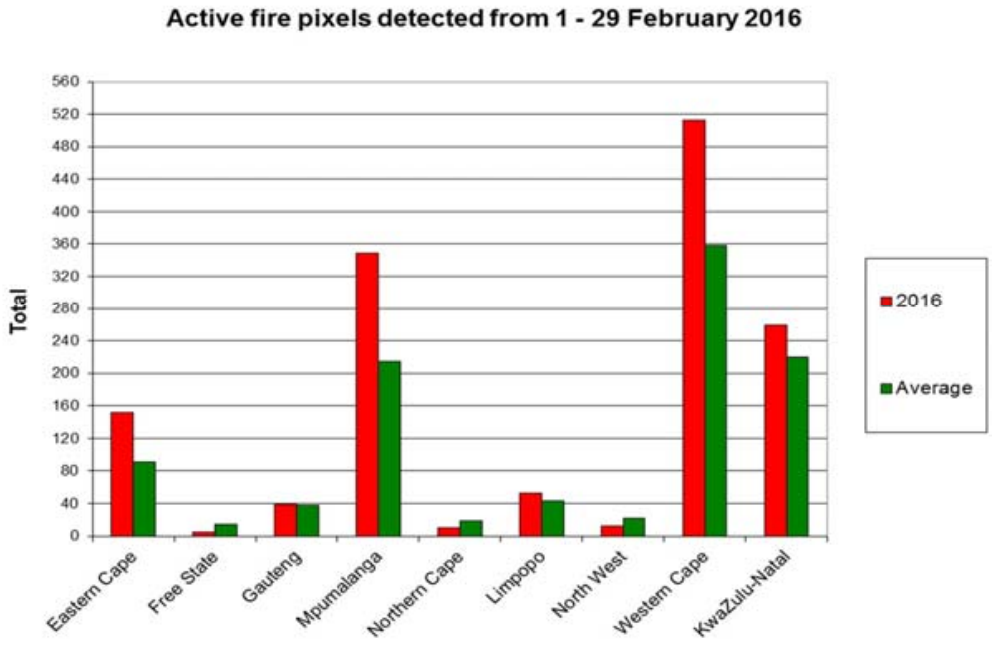

Figure 34

Figure 35:
The map shows the location of active fires detected between 1-29 February 2016.

Questions/Comments:
NkambuleV@arc.agric.za

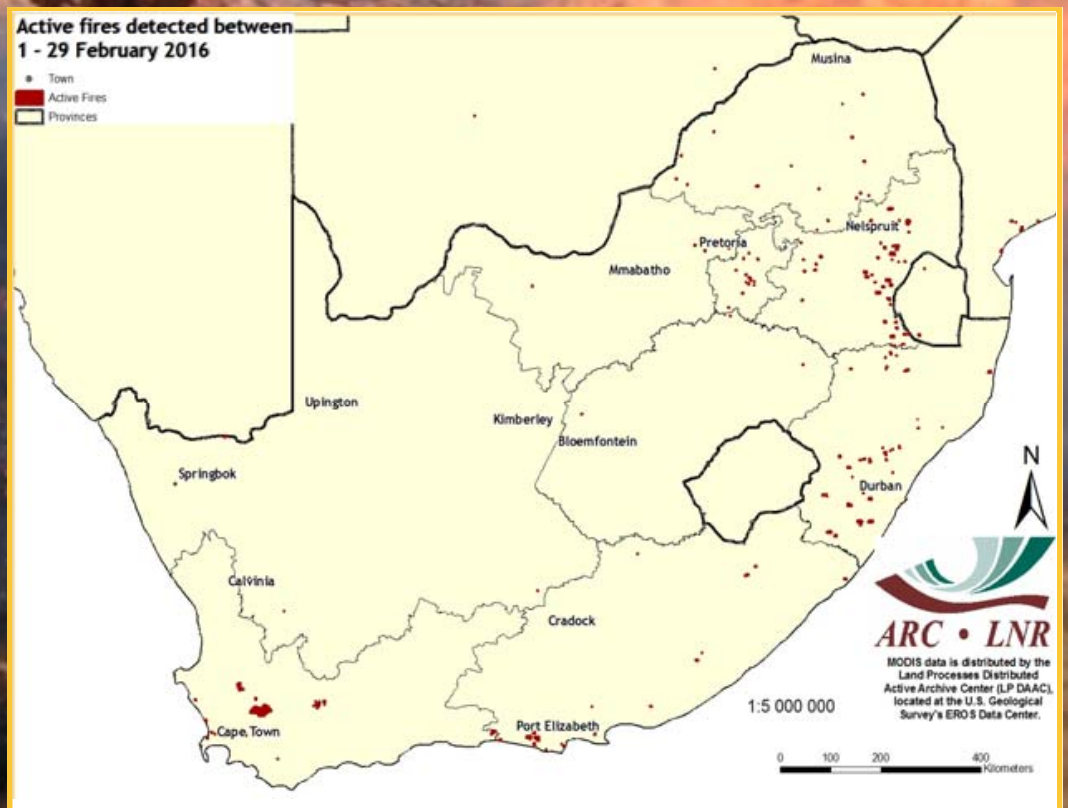

Figure 35

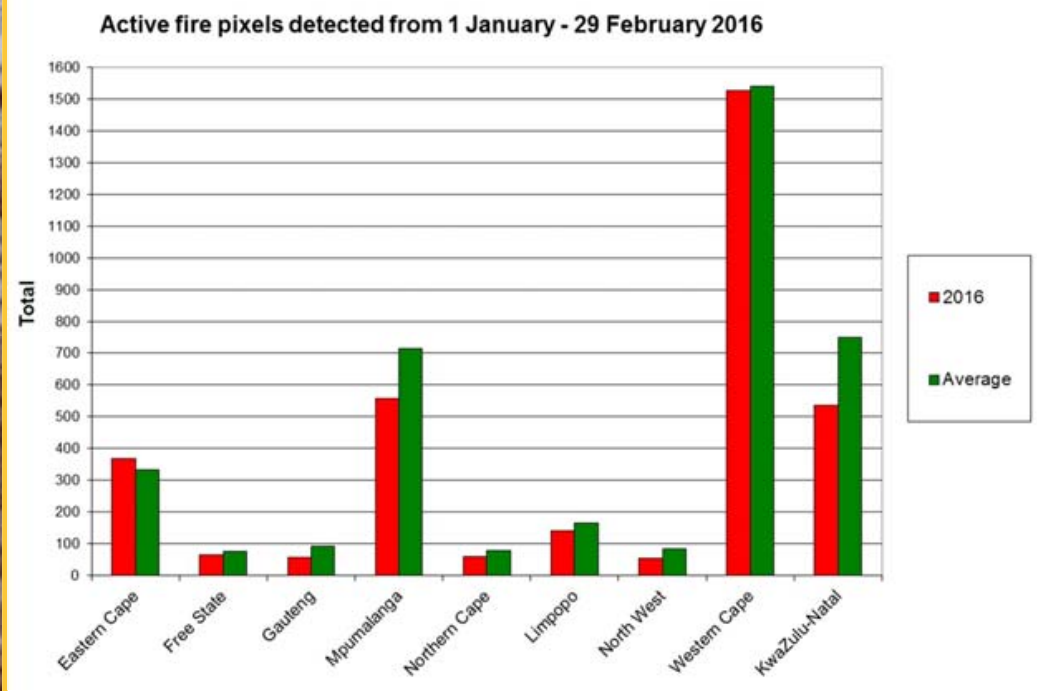

Figure 36

Figure 36:
The graph shows the total number of active fires detected during from 1 January - 29 February 2016 per province. Fire activity was lower in all provinces except the Eastern Cape compared to the average during the same period for the last 16 years.

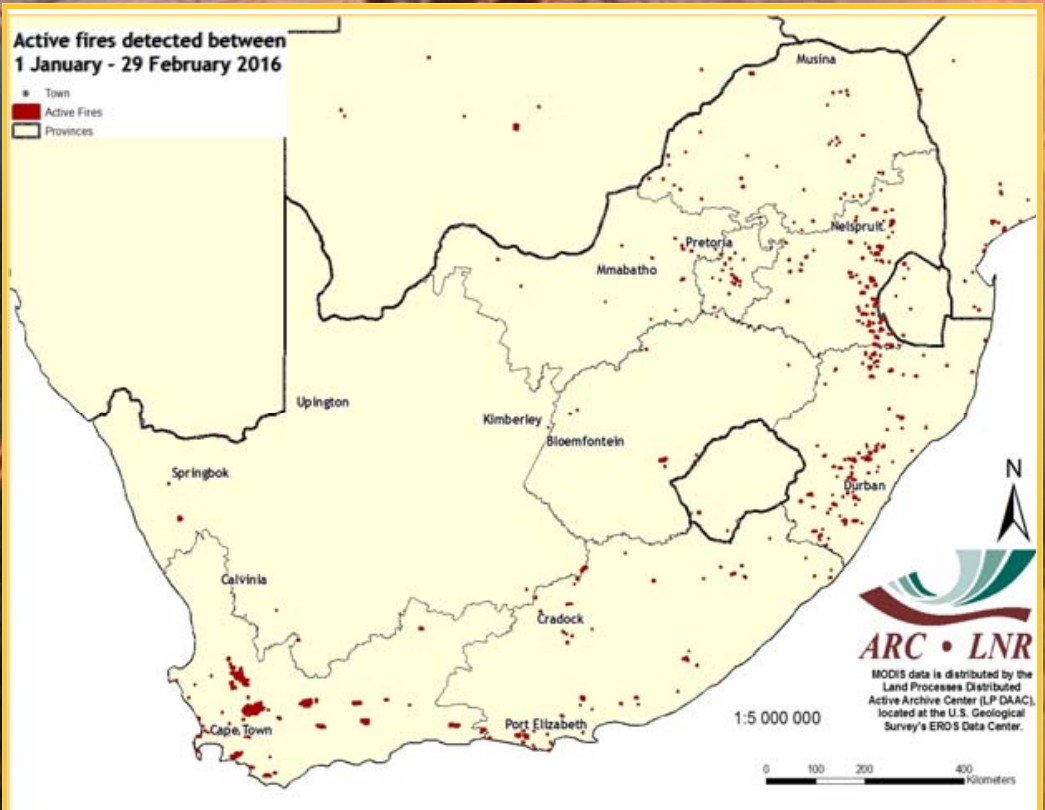

Figure 37

Figure 37:
The map shows the location of active fires detected between 1 January - 29 February 2016.

Questions/Comments:
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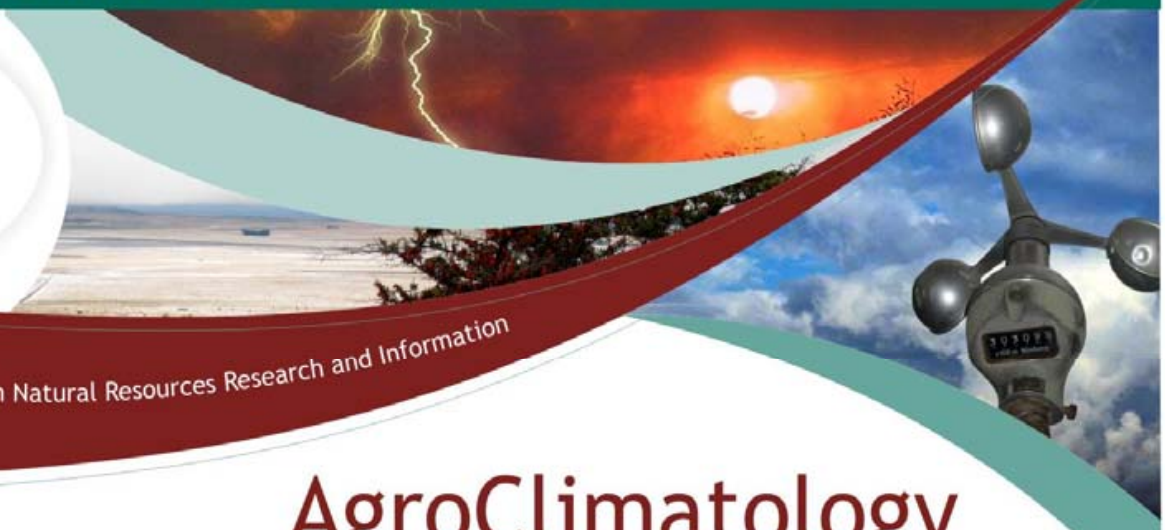

Your Partner in Natural Resources Research and Information

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