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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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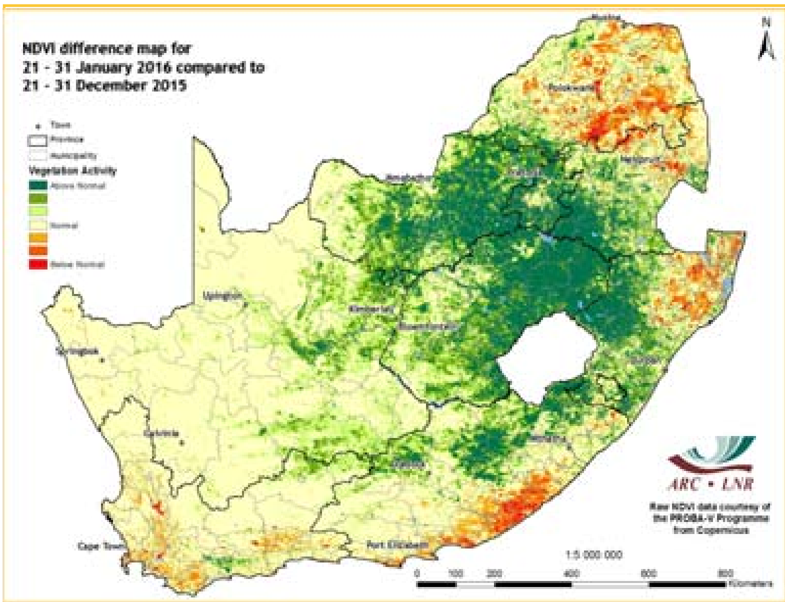
agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

South African Weather Service

AMESD

140th Edition

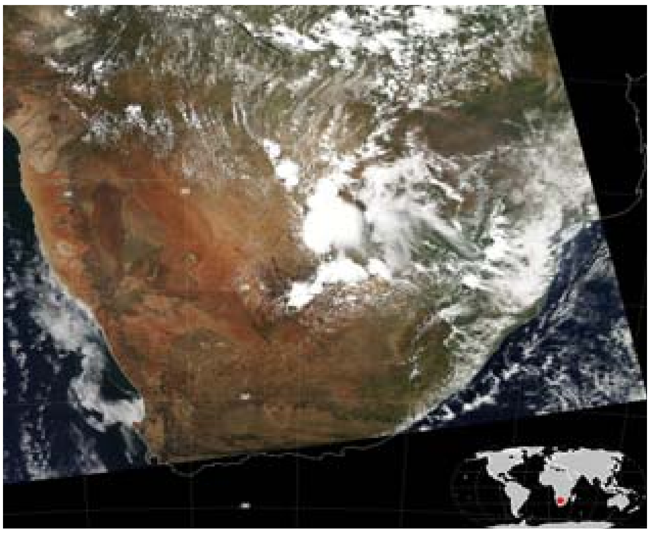
Images of the Month



Positive impact of recent rainfall on vegetation activity

Widespread rain, distributed fairly evenly since the 8th of January 2016, had a dramatic positive impact on vegetation activity during the month (see map showing the change in vegetation activity between late December 2015 and late January 2016). The above-normal rainfall over much of the summer rainfall region further improved outlooks for maize production over the eastern production region where near-normal rainfall during November and December supported planting and emergence. Desperately needed moisture also had a positive impact over the western production region, even though the planting window for white maize in that region had already expired. Of critical importance now is follow-up rain during February.

Drier conditions in early February



Drier conditions set in by late January after 3 weeks of fairly widespread rain over the summer rainfall region. Apart from a widespread rainfall event in the south, 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. Major convective activity in the region of Madagascar was associated with largely subsident conditions across southern Africa. Still, a number of thunderstorm clusters brought some relief over the northern parts, especially since the 6th.
The true-colour Aqua MODIS composite (http://modis-atmos.gsfc.nasa.gov/IMAGES/index.htm) on the afternoon of the 10th shows several large thunderstorm systems over parts of northern South Africa and eastern Botswana, while dry conditions dominate the central to western interior. *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 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:

The weather during January 2016 took a drastic turn from the conditions experienced earlier over the summer rainfall region. After yet another heatwave, in some areas more intense than the heatwaves experienced during October to December, scattered to widespread thundershowers started to occur from the 8th, with wetter conditions lasting until the last week of the month while temperatures remained in the normal ranges, except for the West Coast where heatwave conditions occurred from time to time. Large-scale atmospheric circulation anomalies changed such that high pressure systems strengthened and ridged to the south of the subcontinent, maintaining an influx of moisture and enhancing the development of low pressure systems over the interior. The associated off-shore flow in the southwest resulted in several heatwaves over the southwestern parts of the country, including the winter rainfall region where windy conditions also caused favourable conditions for wild fires. Of note too was a fairly strong tropical circulation towards the north over southern Angola, together with favourable upper-air conditions resulting in above-normal rainfall over much of Namibia and the western half of South Africa.

Large parts of the interior received above-normal rain during January, starting around the 8th and continuing until the 25th. Widespread showers occurred over the central to eastern parts from the 8th to the 15th, with heavy falls in places on some days. These falls were associated with a strong ridge of the Atlantic Ocean Anticyclone around the country and an upper-air trough over the southwestern parts, with several redevelopments in the south. A continuation of ridging to the south of the country together with the development of a semi-stationary upper-air cut-off low off the West Coast from the 15th resulted in an influx of large amounts of moisture from the north and east, with a tropical low over northern Namibia also contributing. Fairly widespread rain and showers occurred over especially the western to central parts until the 24th with daily rainfall and cloudy conditions, resulting in large improvements in agricultural conditions.

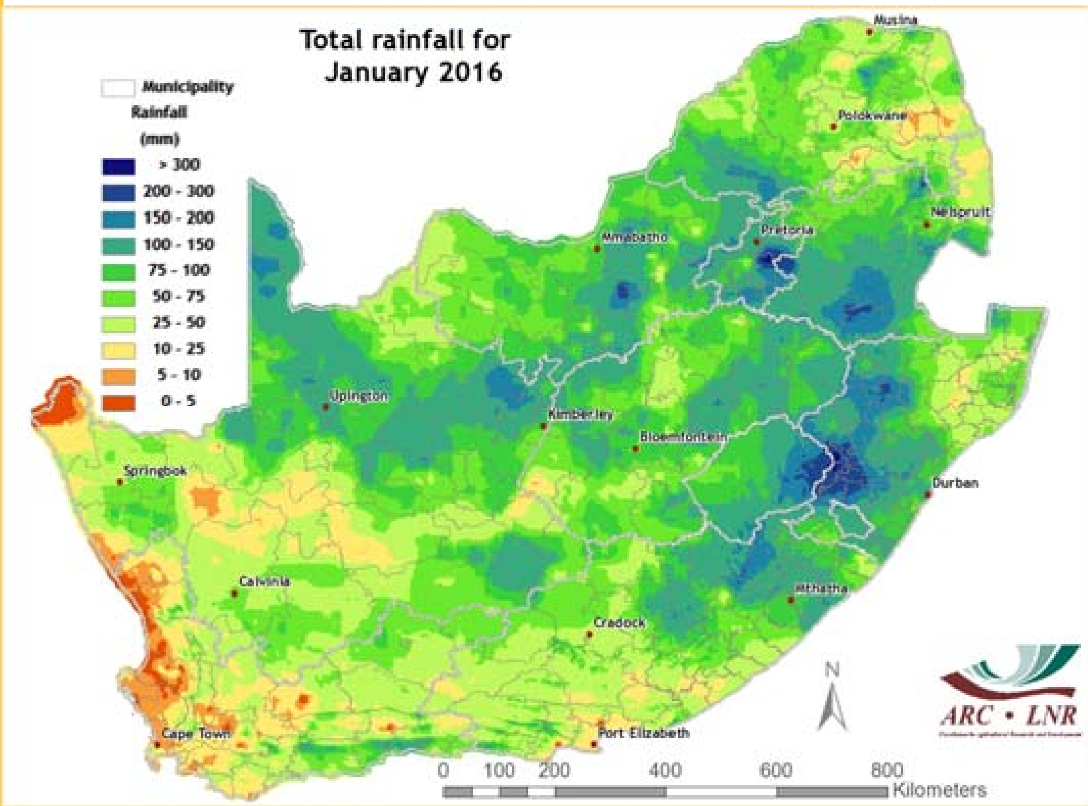


Figure 1

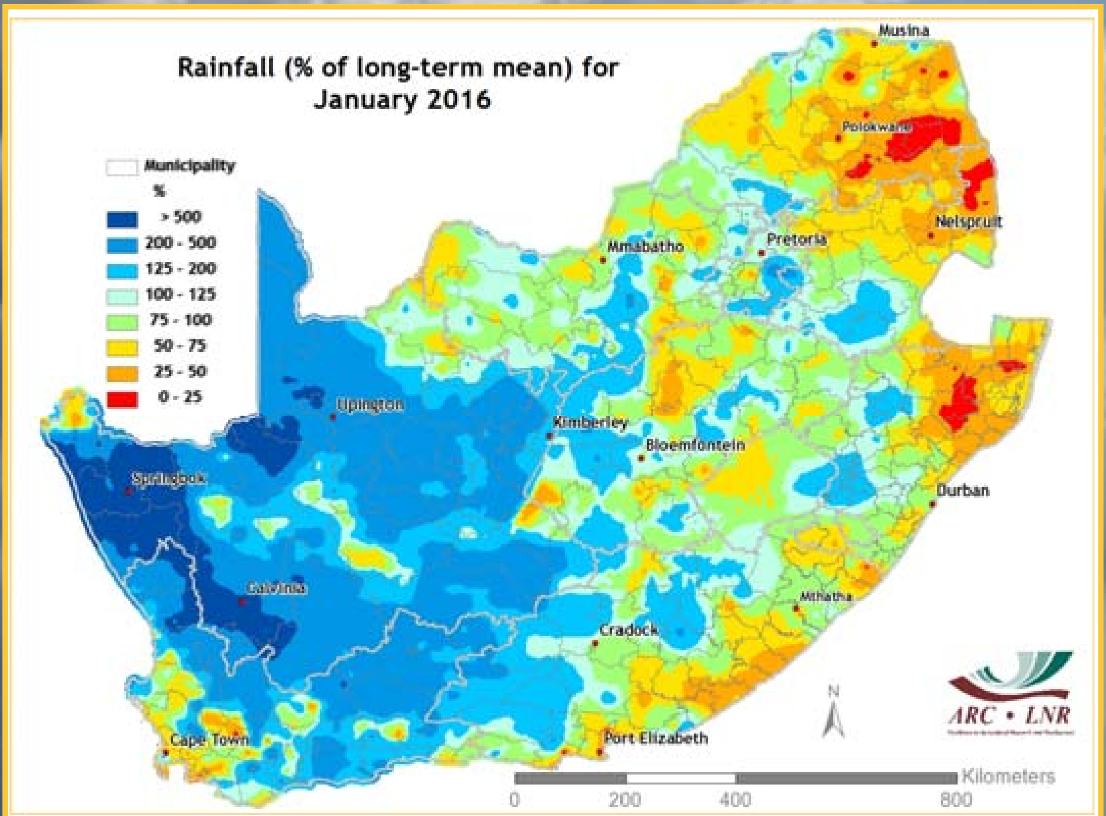


Figure 2

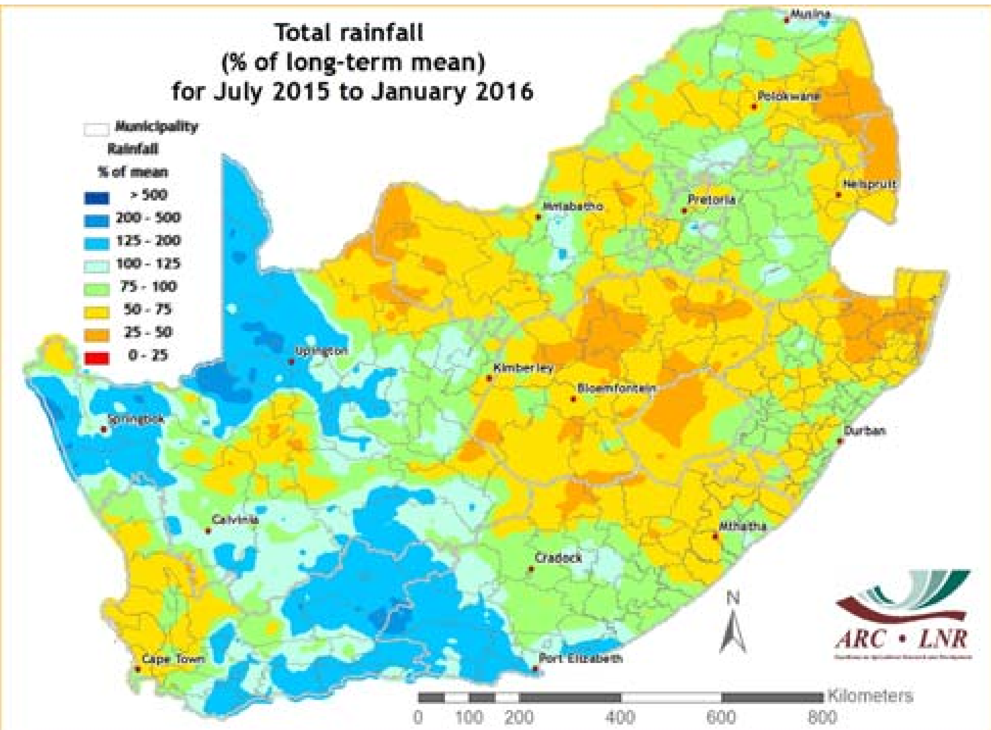


Figure 3

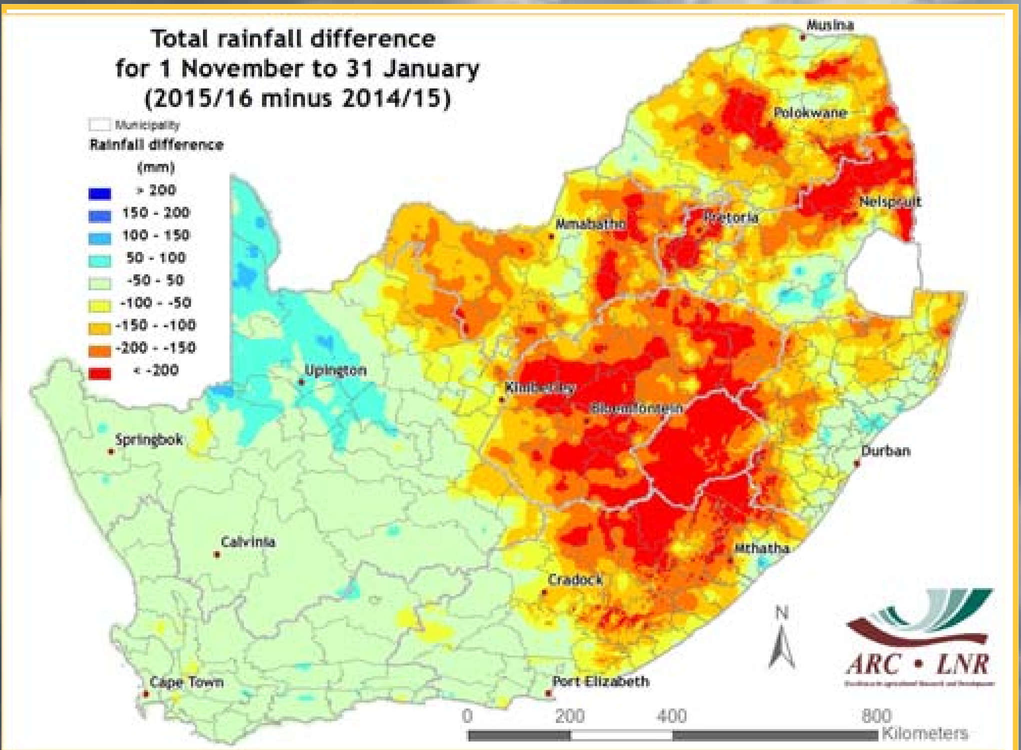


Figure 4

During this period, several hot and windy days occurred over the southwestern parts, associated with the flow from the east and northeast dominating the interior. The system weakened and moved eastwards across the country from the 25th, resulting in scattered thundershowers over the northeastern areas until the 26th. Light showers continued in the far northeast until the 30th with a tropical wave situated over Zimbabwe while the surface trough over the interior resulted in thundershowers over some parts during the last few days of the month. The southwestern winter rainfall region received some showers but monthly totals generally remained below 25 mm due to weakness or southward location of frontal systems in the region. The southwestern interior did, however, benefit from the presence of the upper-air cut-off low to the north of the region from the 17th to the 24th.

Figure 1:
The entire country received some precipitation during January. Large parts of the maize production regions and westwards into the northern parts of the Northern Cape received in excess of 100 mm. The western parts of KwaZulu-Natal and southern Mpumalanga received more than 200 mm. The northern parts of the Northern Cape also received in excess of 100 mm in total.

Figure 2:
Most of the western to central parts of the country received above-normal rain, while the eastern parts of KwaZulu-Natal, eastern Mpumalanga and eastern Limpopo received below-normal rainfall.

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 Lowveld, northeastern parts of KwaZulu-Natal, through the Free State and into western North West as well as over the southwestern parts of the winter rainfall region.

Figure 4:
The northeastern parts of the country received significantly less rain this summer during November to January than during summer 2014/15. This is tied to much more rain during November and December 2014 than in 2015. KwaZulu-Natal received much less rain this year during October-December than in 2014.

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 (Figures 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, contracting to KwaZulu-Natal and parts of the northeastern Free State at the 24-month time scale.

Questions/Comments:

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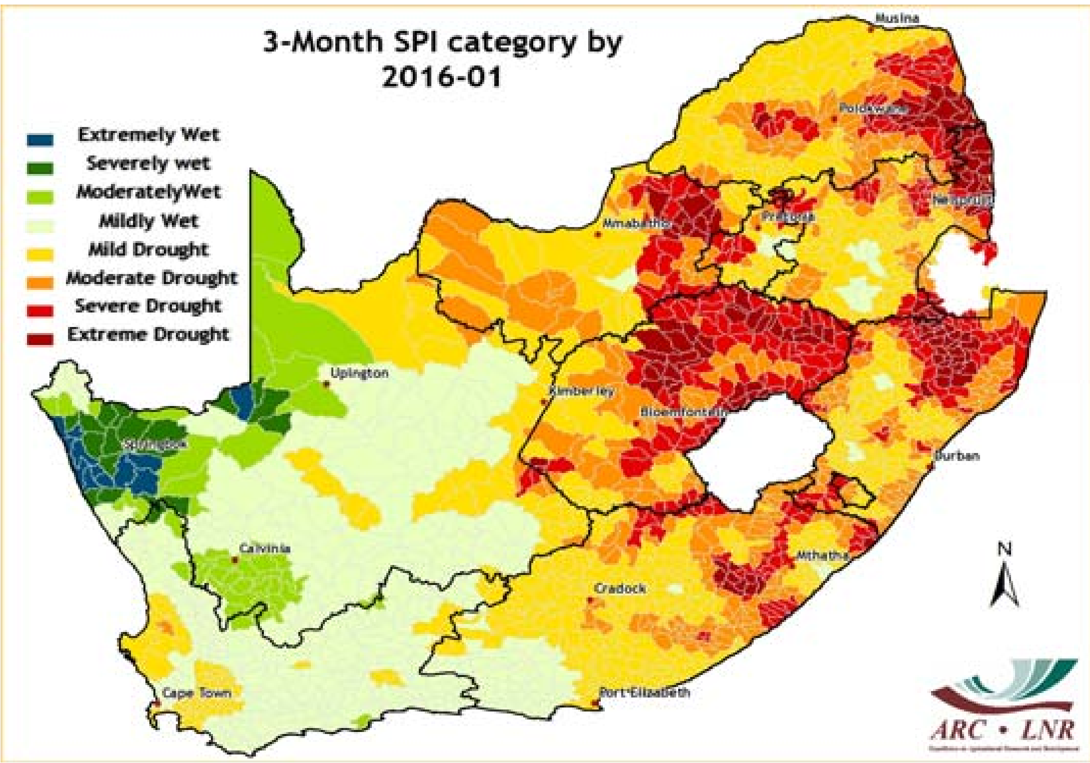

Figure 5

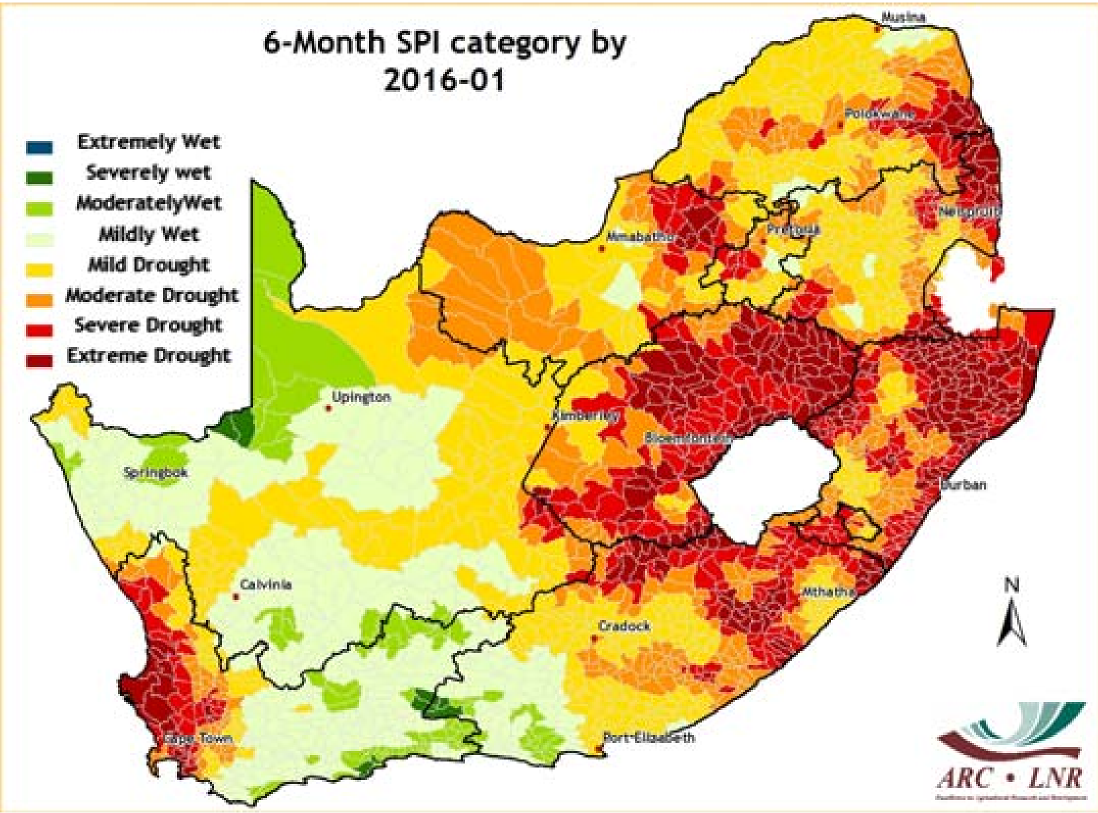

Figure 6

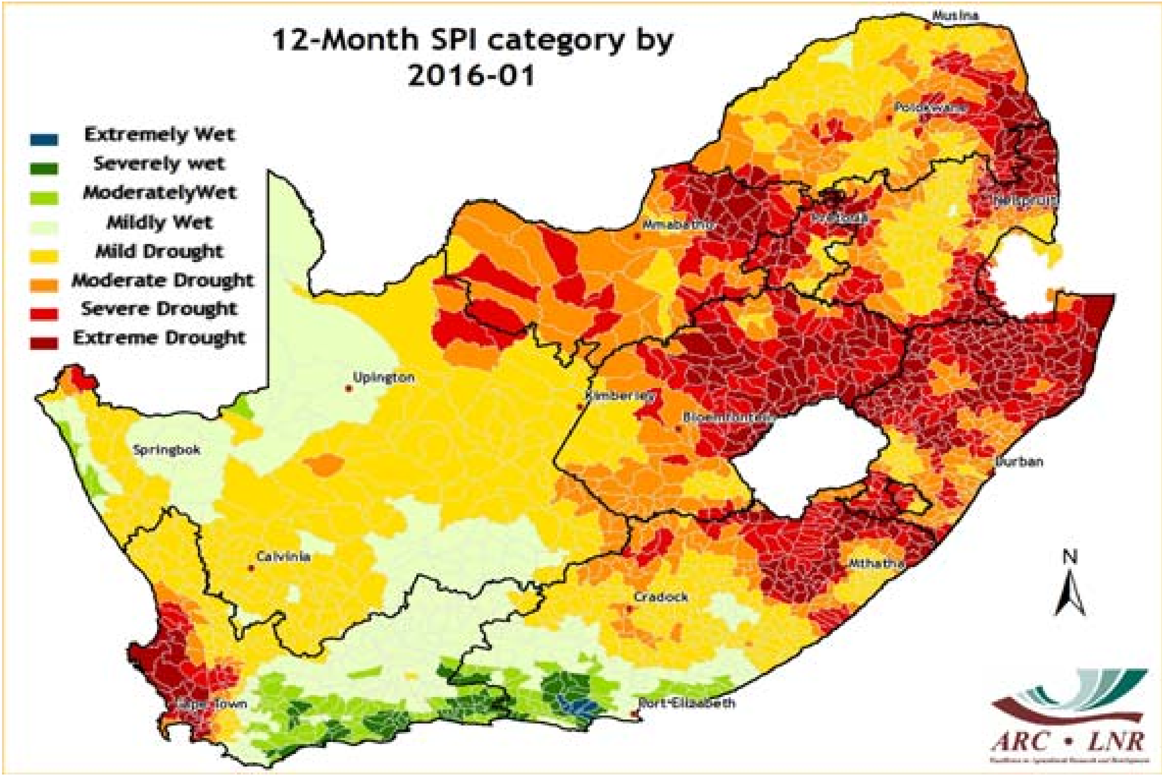

Figure 7

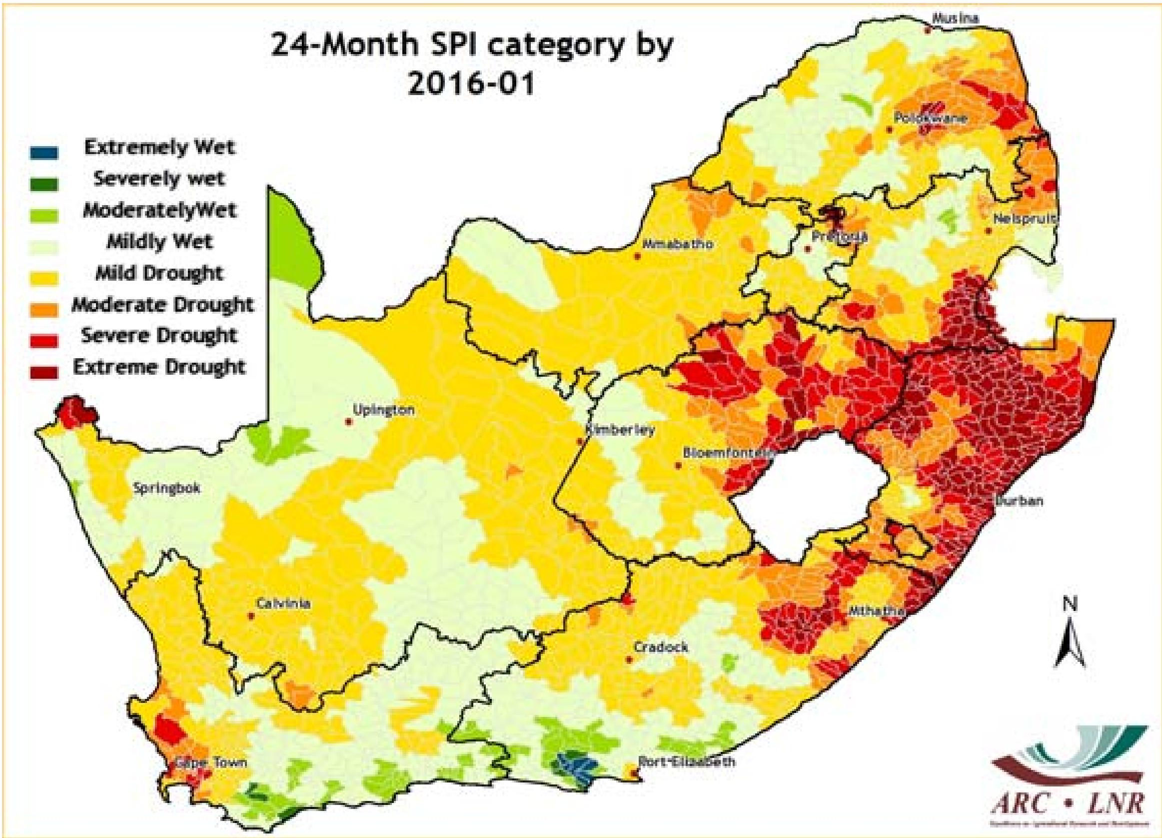

Figure 8

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.

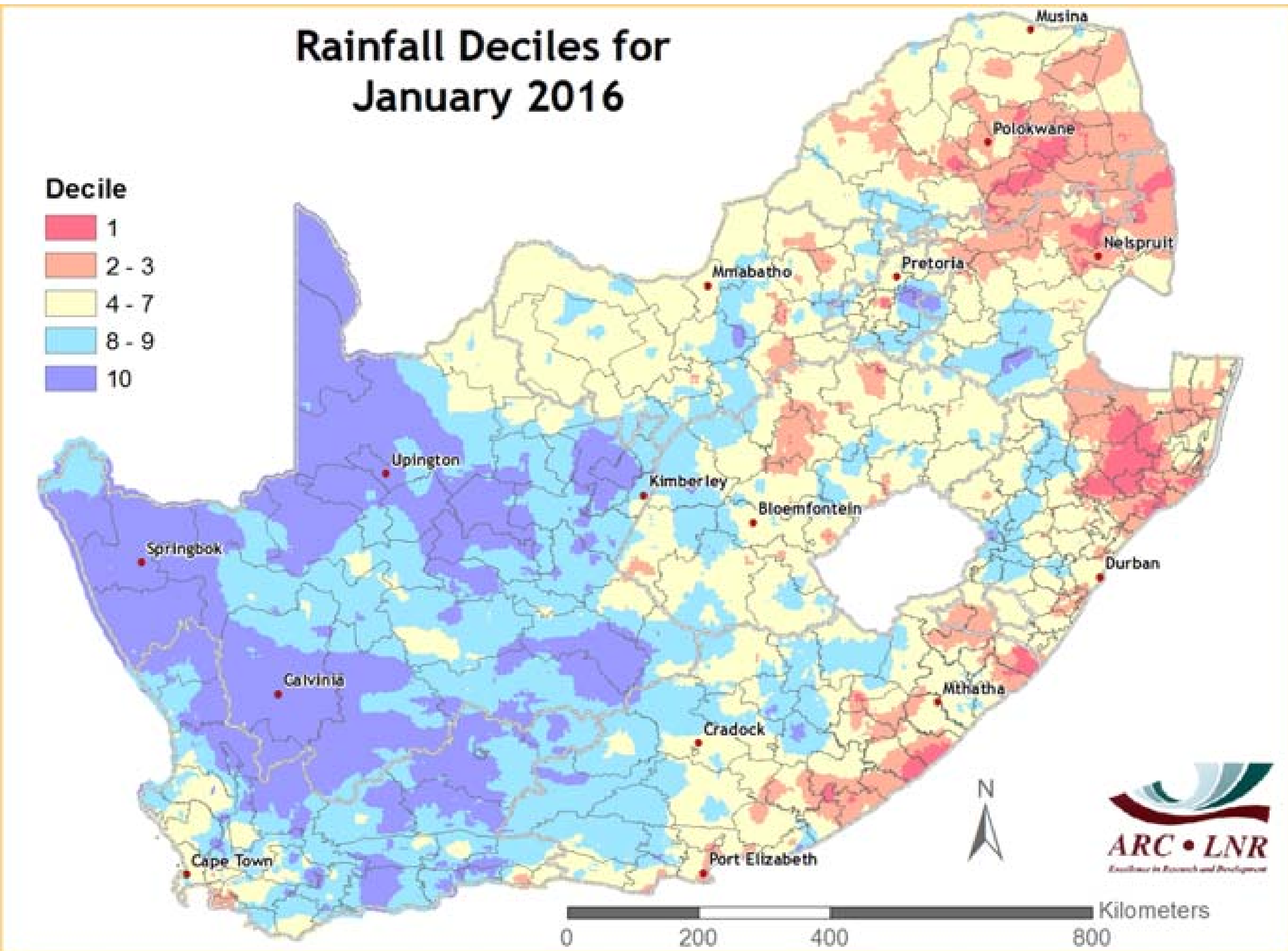

Figure 9

Figure 9:
The western parts of the country were exceptionally wet during January 2016 while northeastern KwaZulu-Natal and the Lowveld were exceptionally dry.

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

4. Water Balance

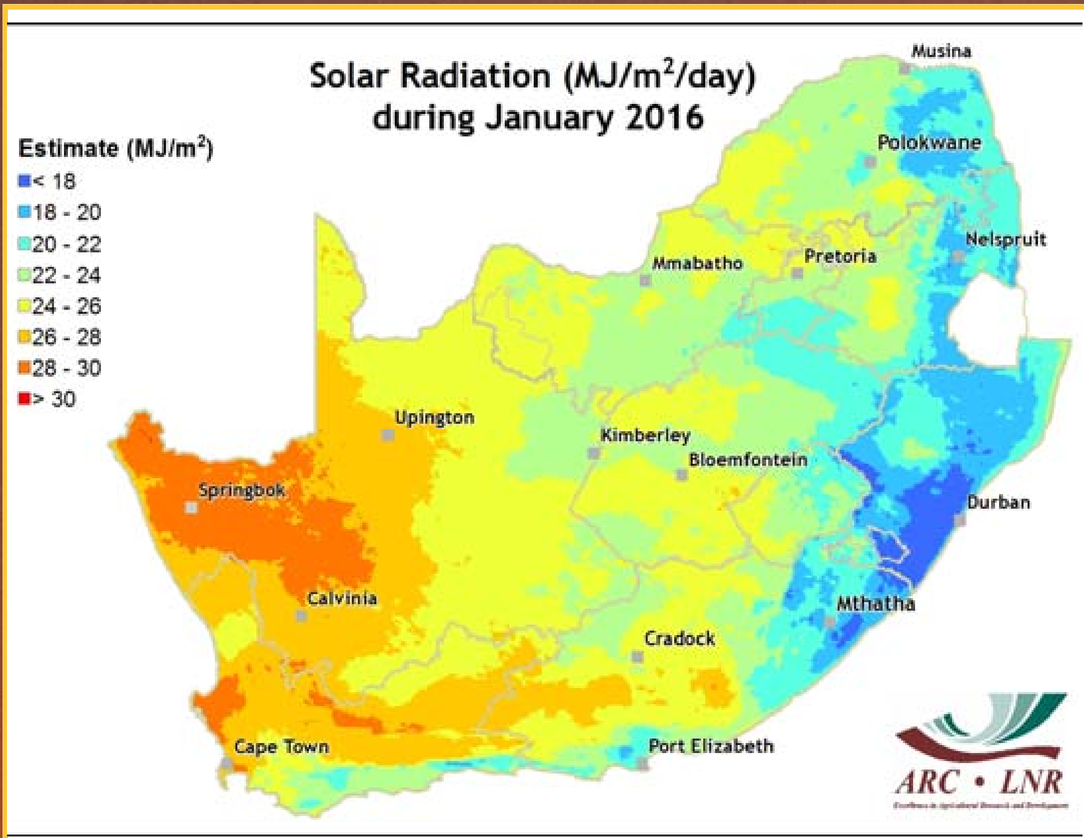

Figure 10

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 January, it is clear that large amounts of clouds had a negative impact across the entire country.

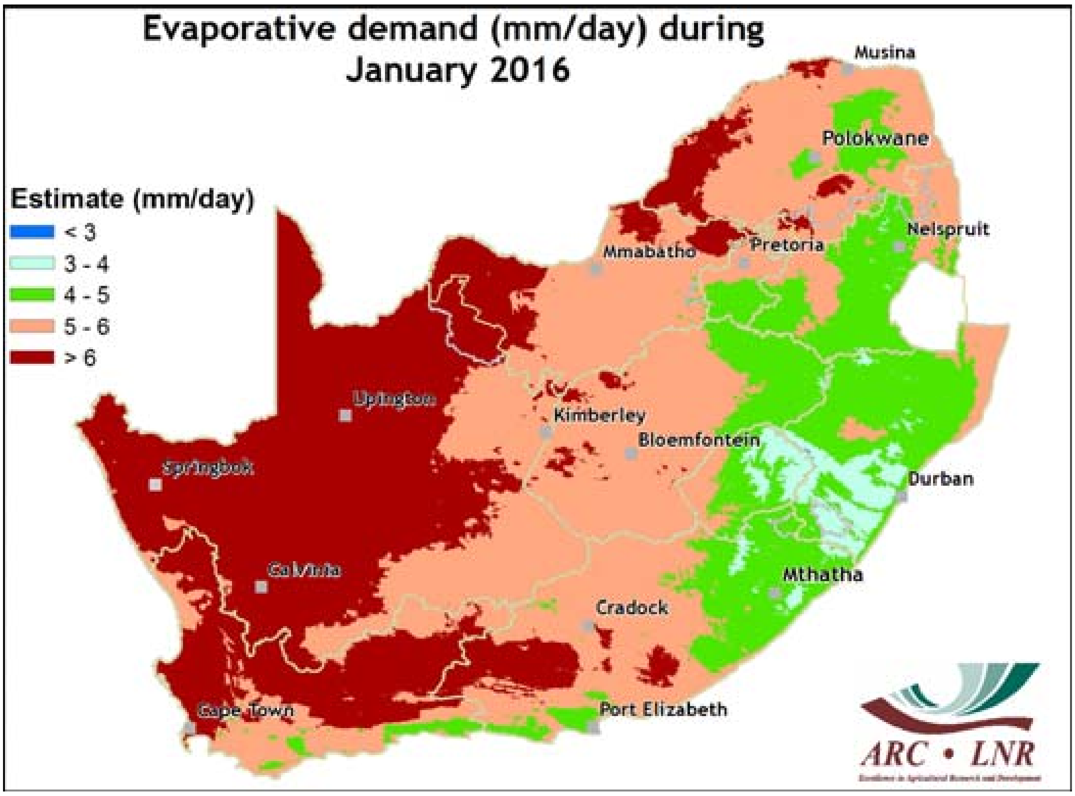

Figure 11

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 from 3 mm/day over southern KwaZulu-Natal to more than 6 mm/day over the western and northern parts of the Northern Cape.

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.

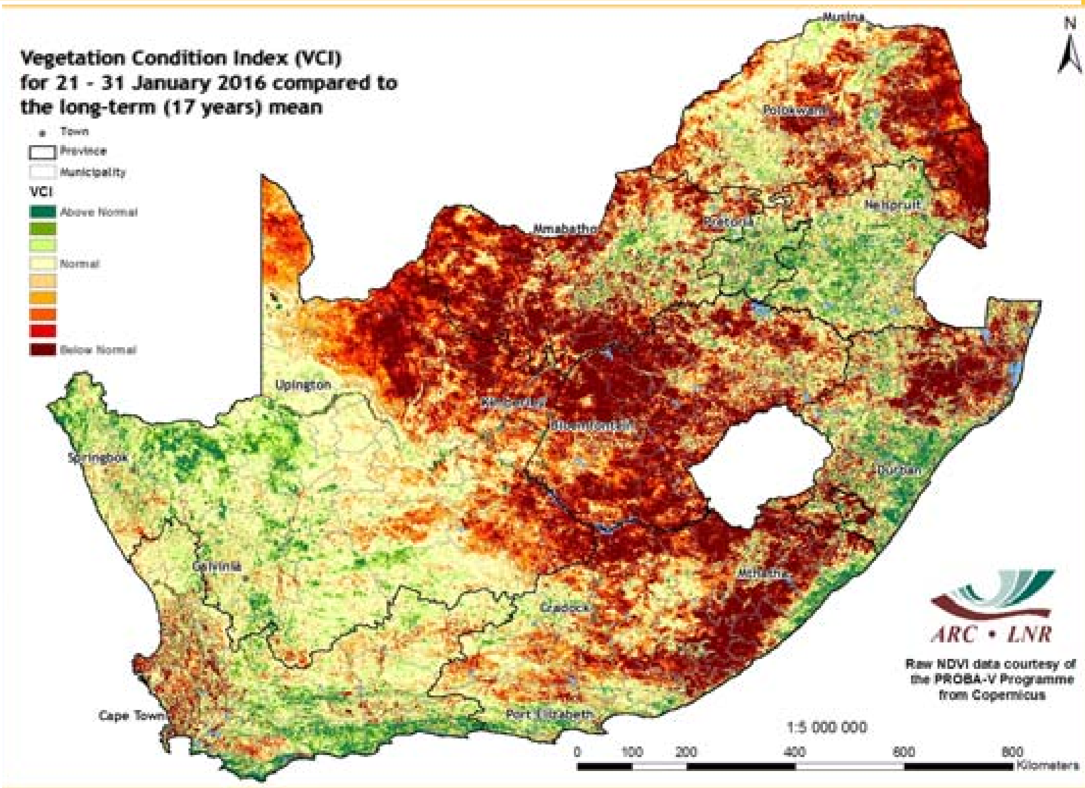

Figure 12

Figure 12:
The VCI by late January 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 half of the western maize production region.

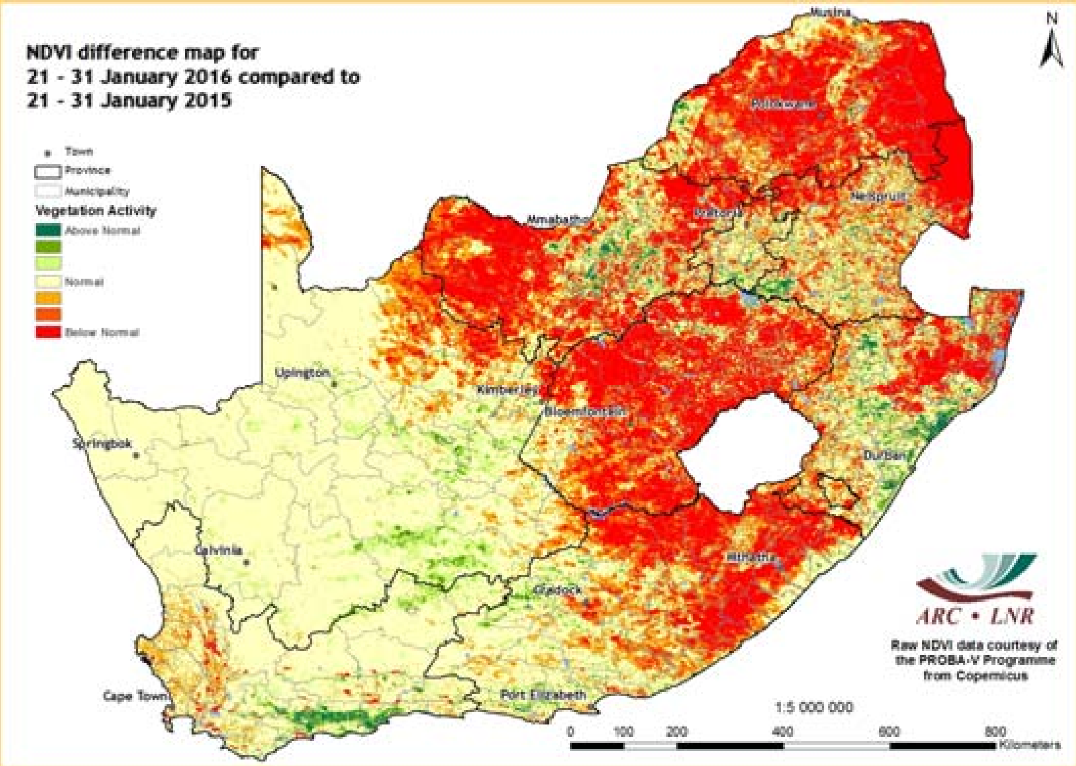

Figure 13

Figure 13:
Most of the summer rainfall region is drought stressed compared to the situation in January 2015, due mainly to higher rainfall across those areas during November-December 2014 than in November-December 2015.

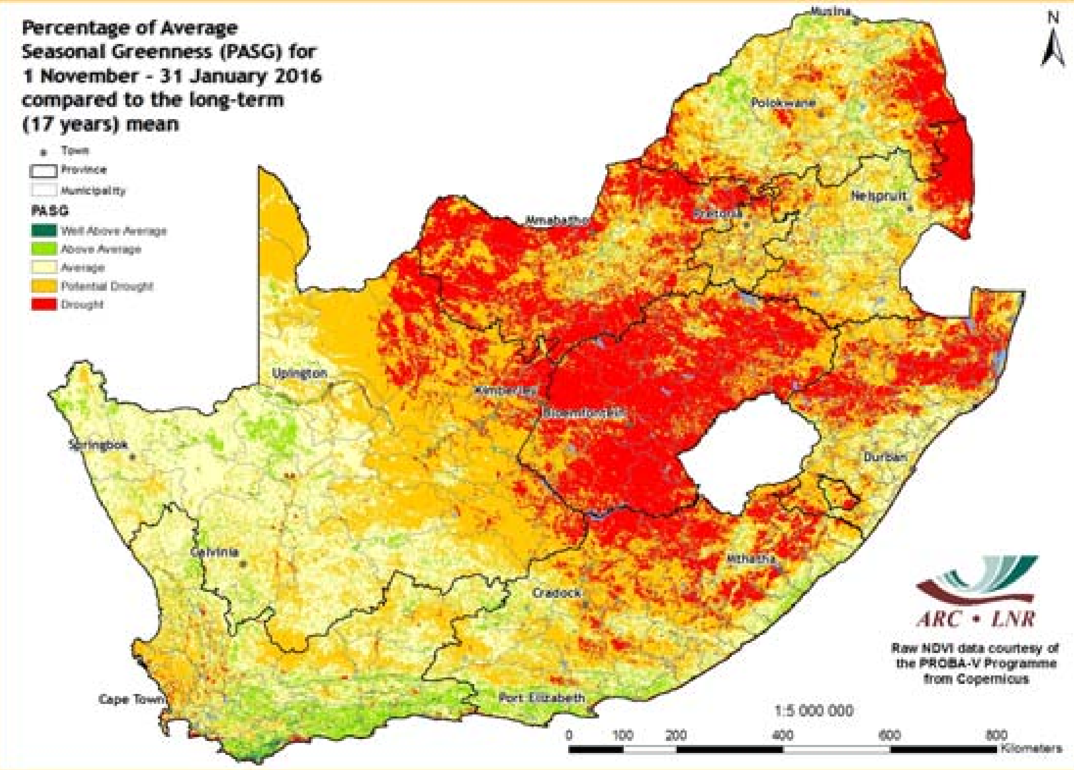

Figure 14

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

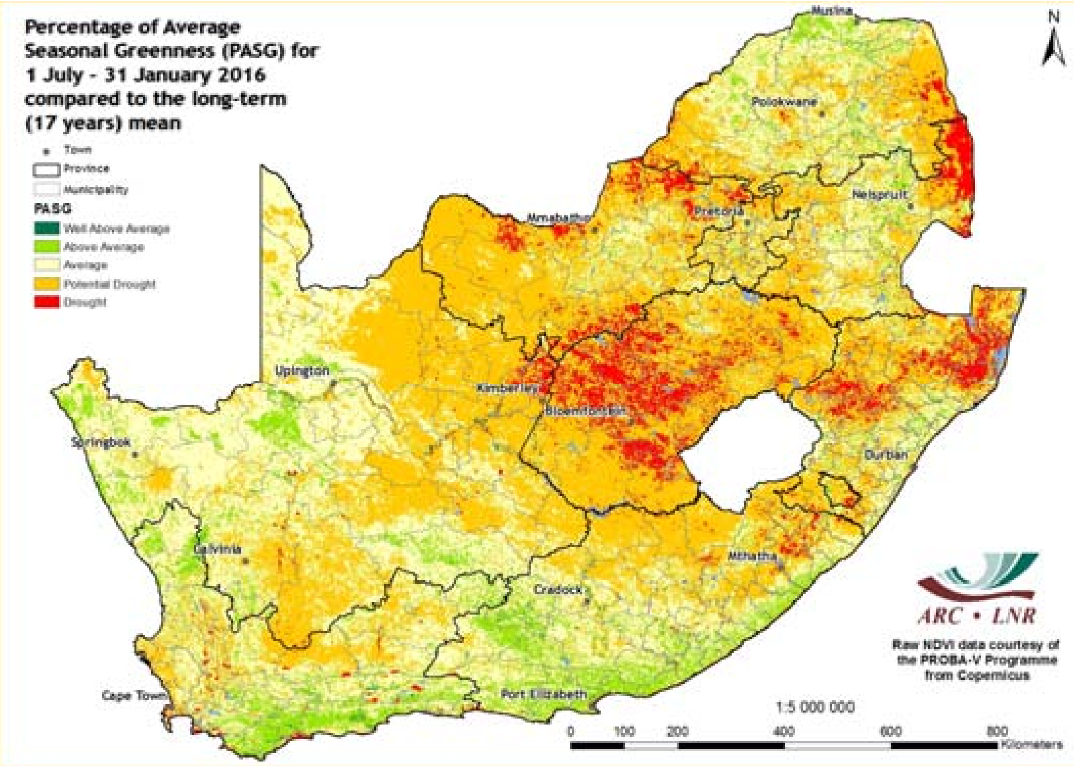

Figure 15

Figure 14:
Very hot and dry conditions during October-November 2015 are apparent in the low PASG values observed over much of the central summer rainfall region, into northern KwaZulu-Natal and the Lowveld further north.

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-January 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.

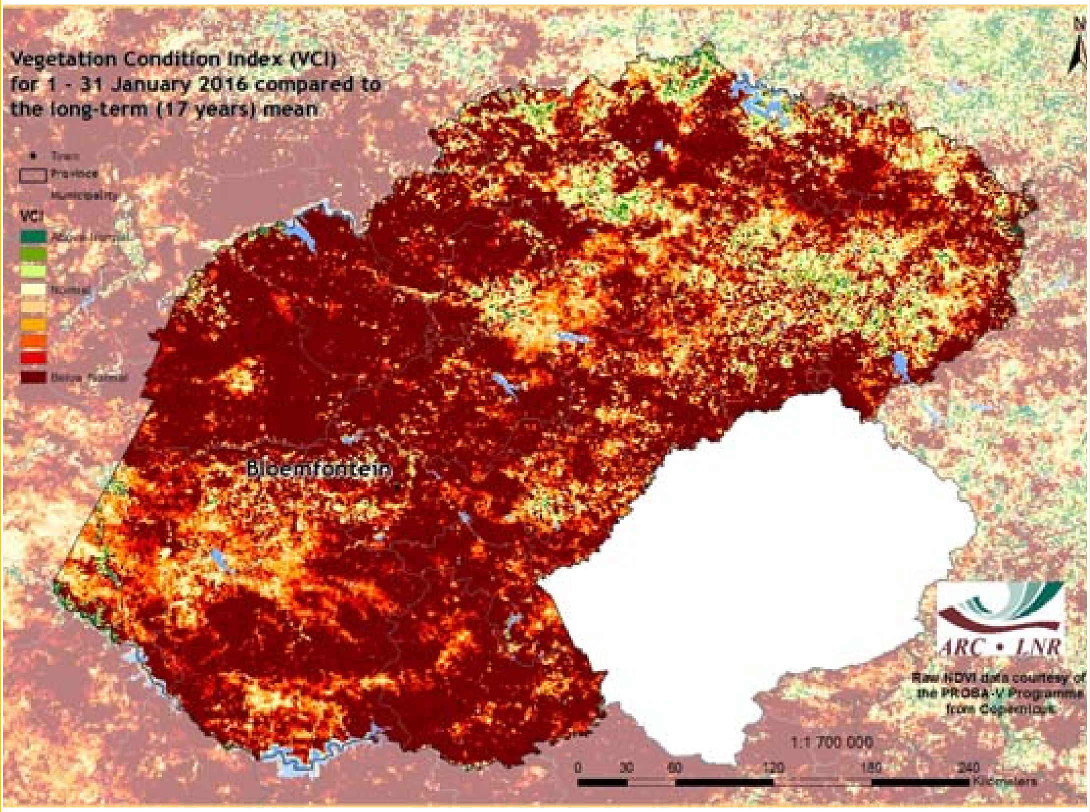

Figure 16

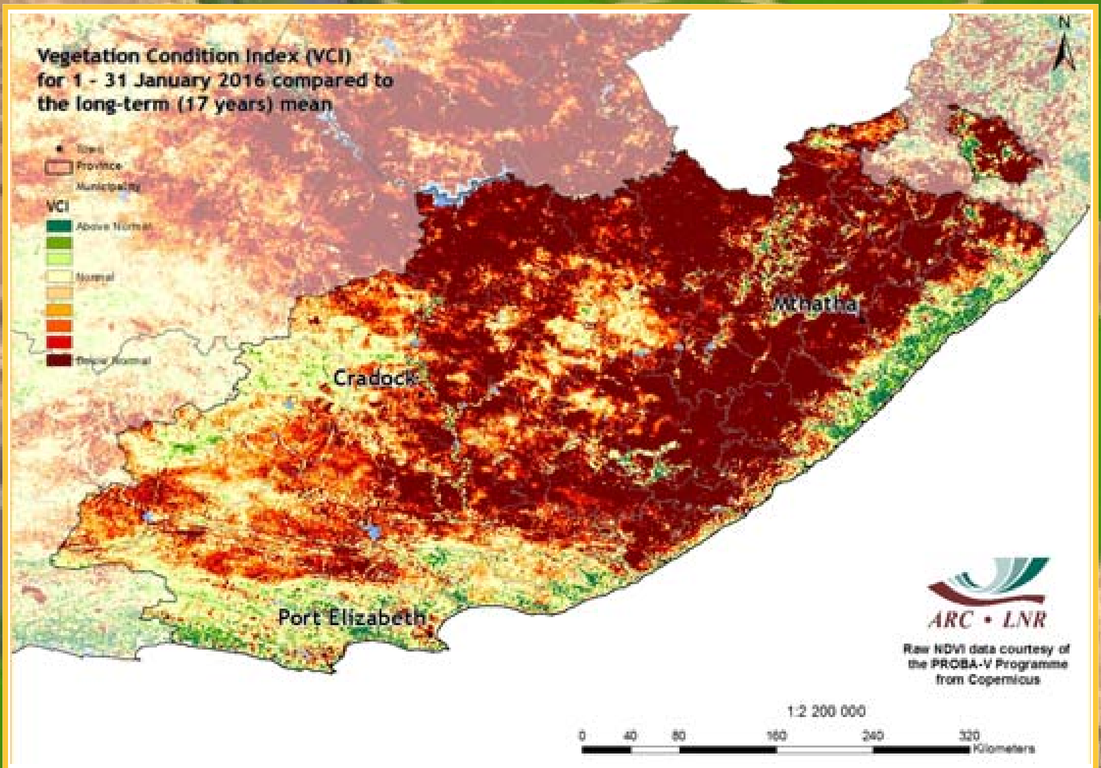

Figure 17

Figure 16:
The VCI map for January indicates below-normal vegetation activity over most of the Free State province.

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

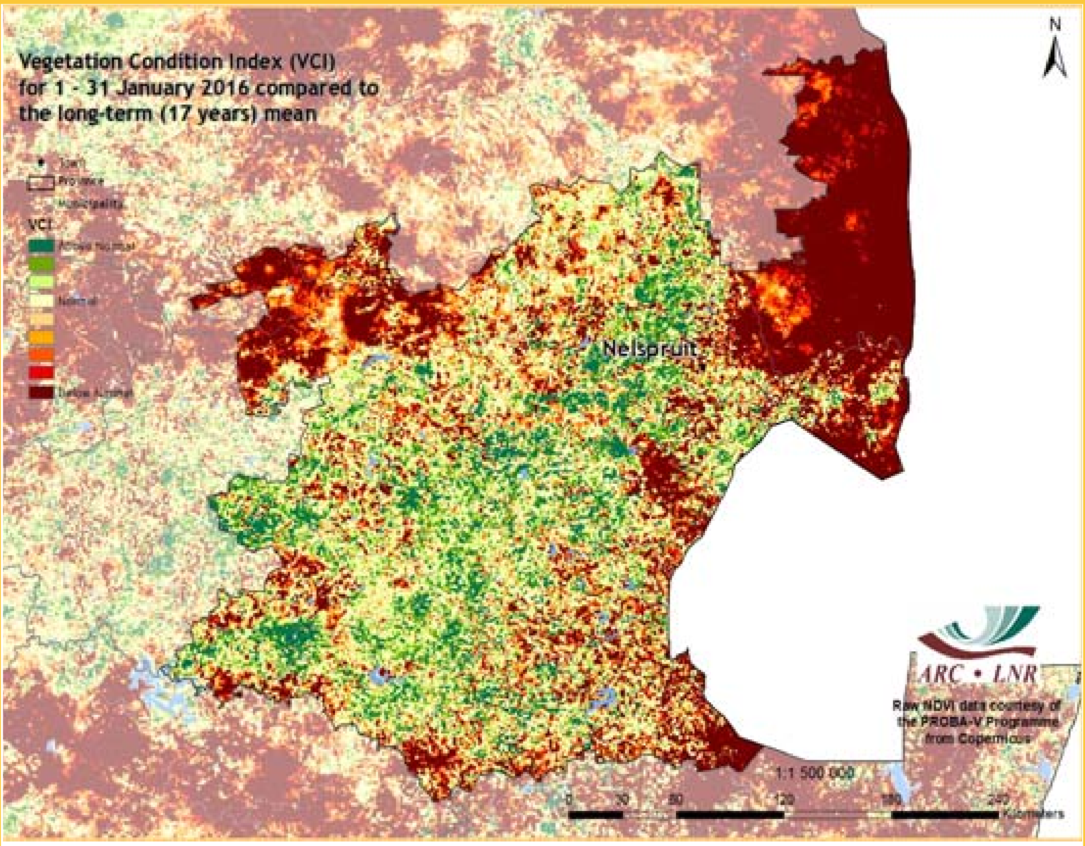

Figure 18

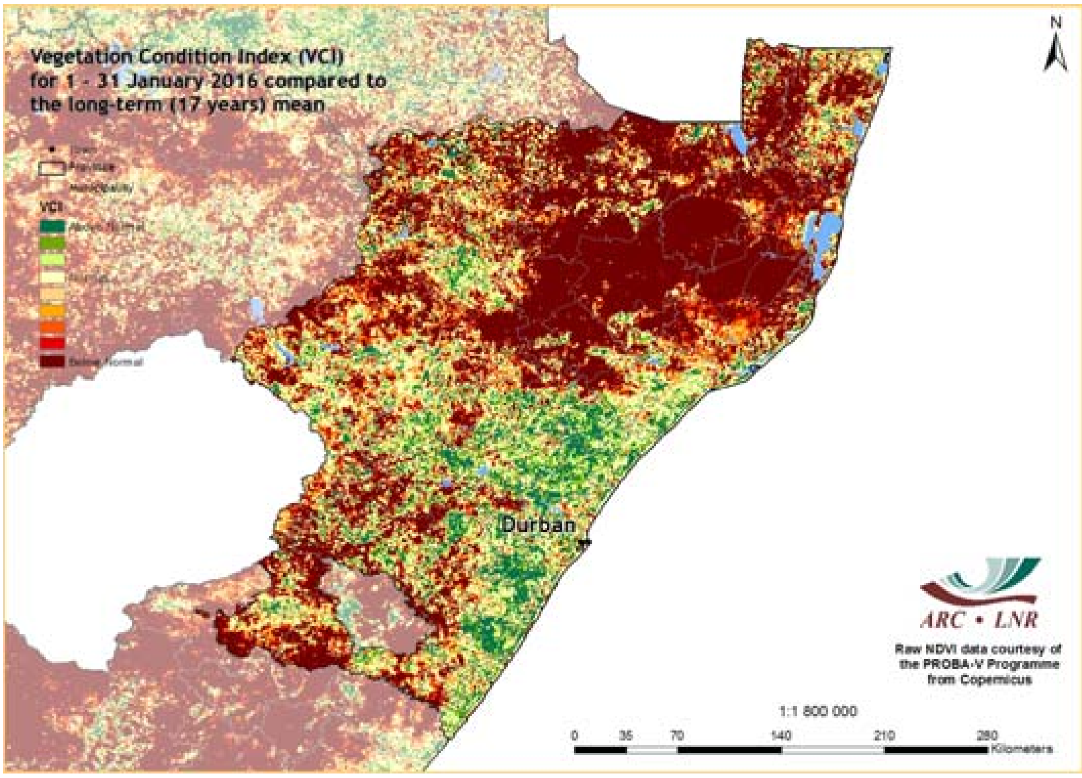

Figure 19

Figure 18:
The VCI map for January indicates below-normal vegetation activity over the northeastern and above–normal vegetation activity in the central areas of the Mpumalanga province.

Figure 19:
The VCI map for January indicates below-normal vegetation activity over most of KwaZulu-Natal except for south-eastern coastal area.

Questions/Comments:
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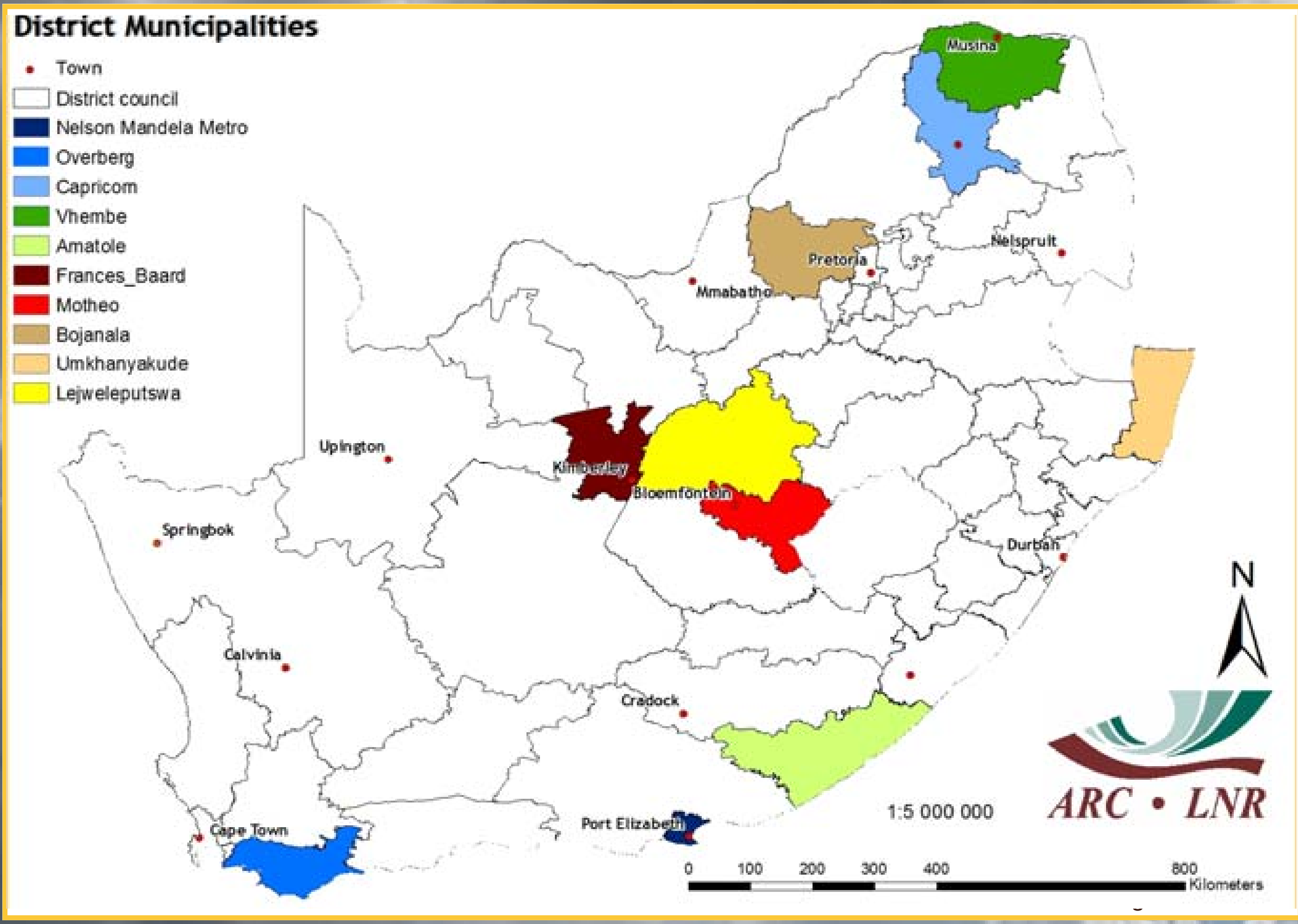
7. Vegetation Conditions & Rainfall



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

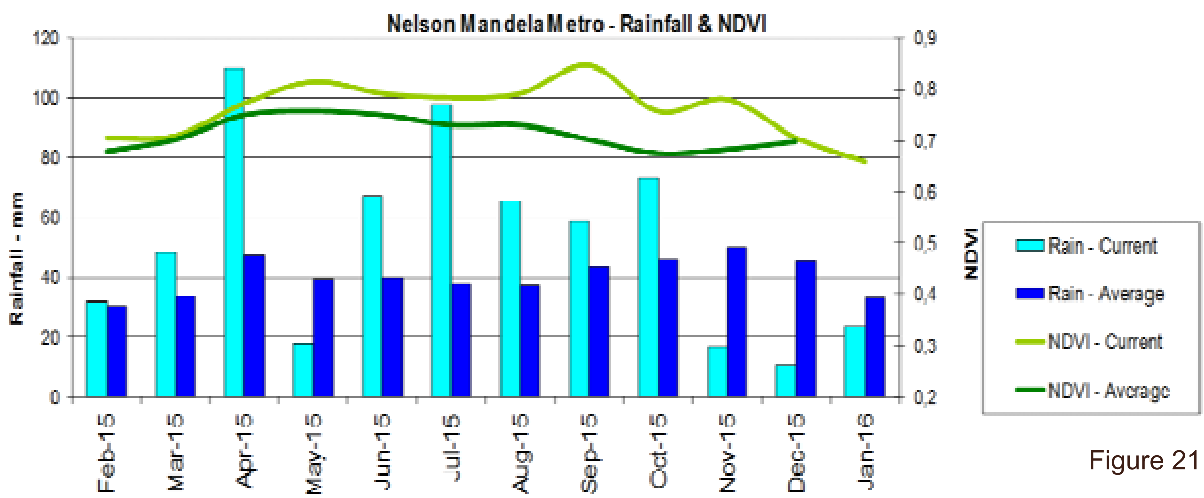


Figure 21

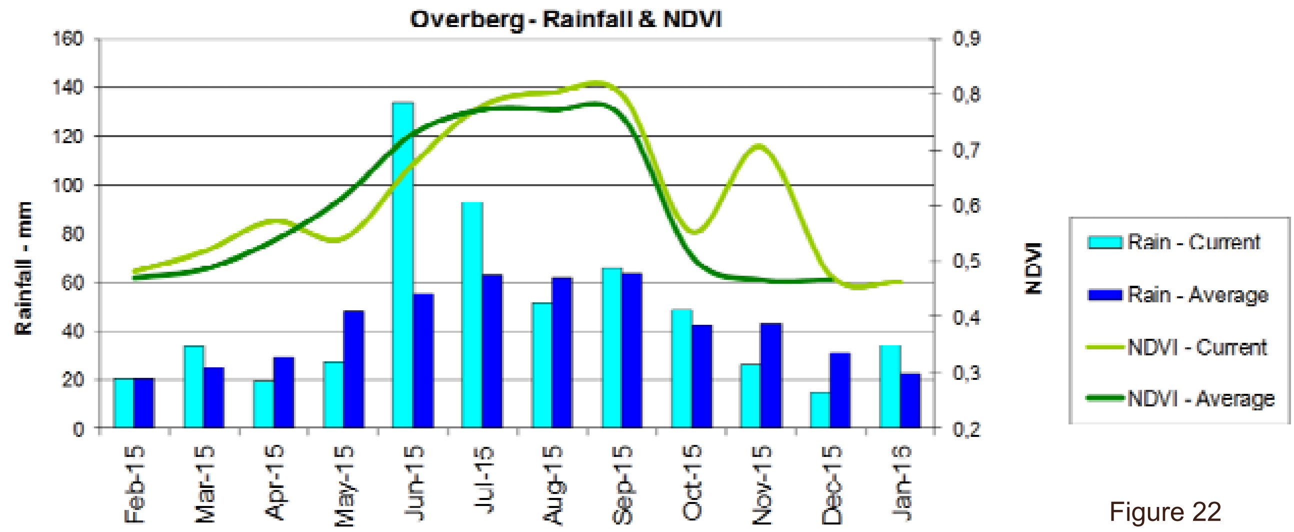


Figure 22

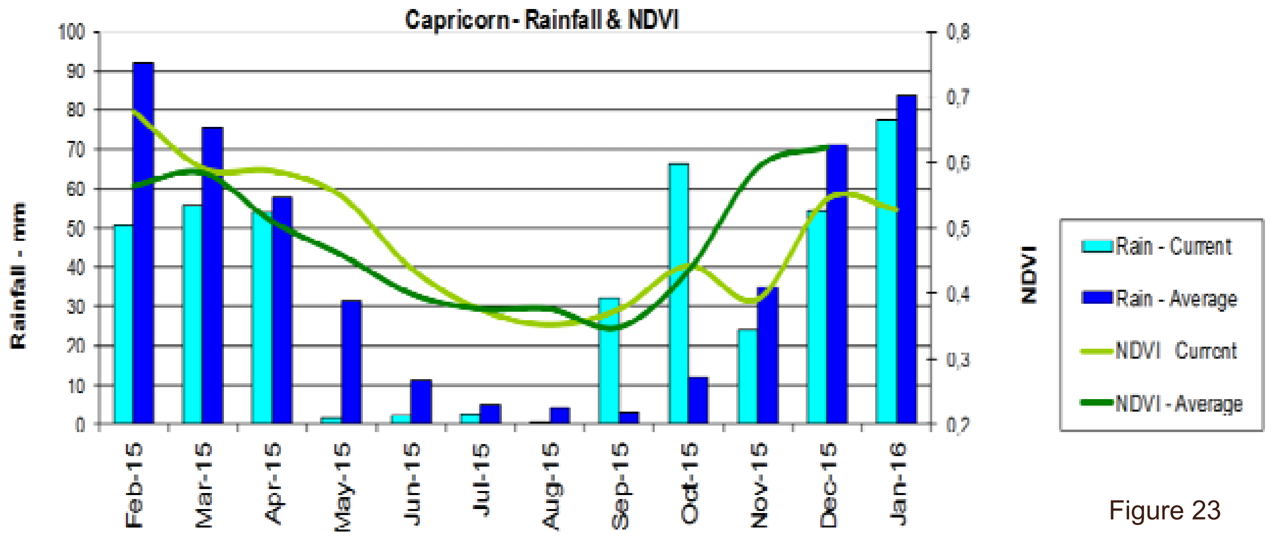


Figure 23

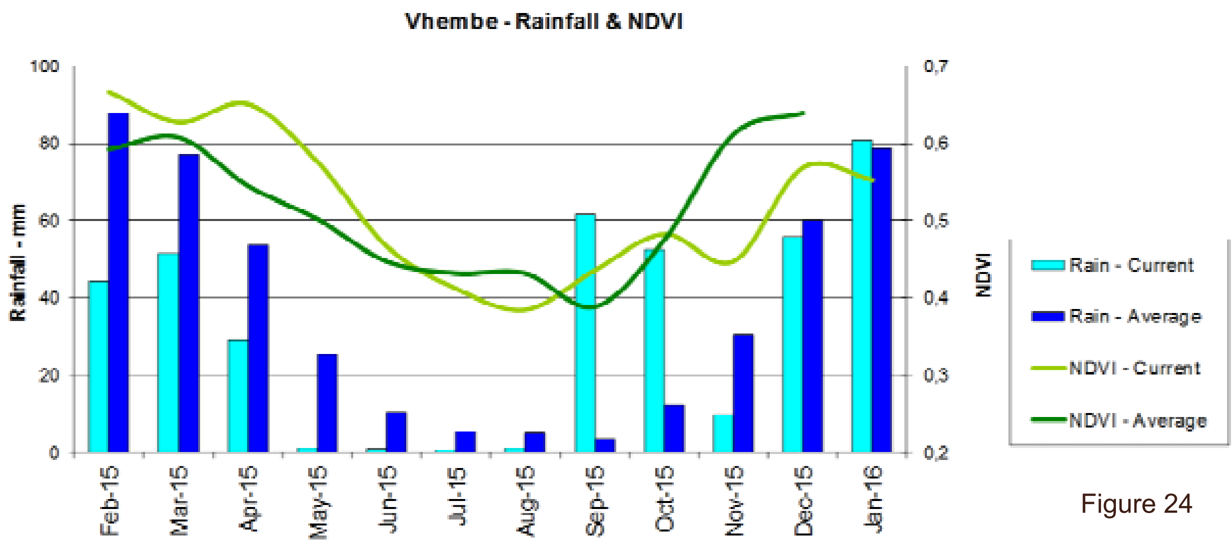


Figure 24

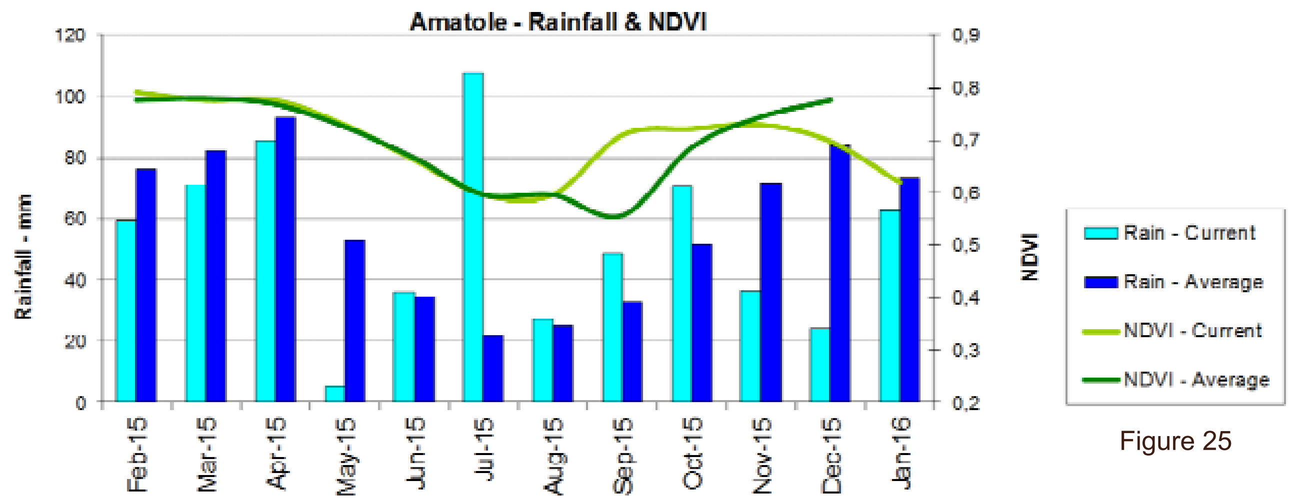


Figure 25

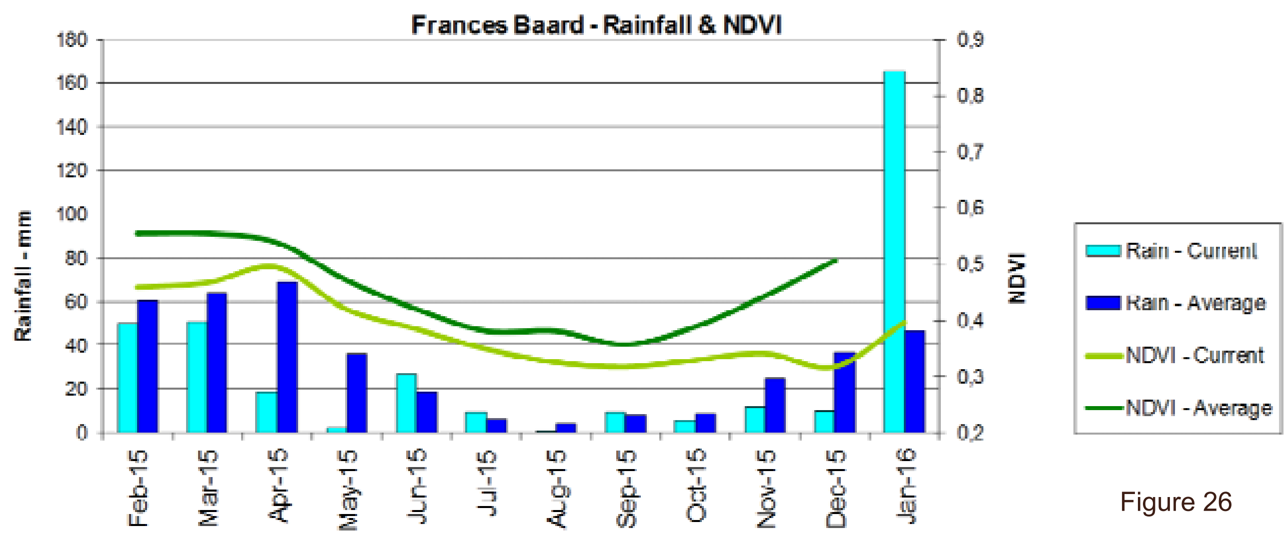


Figure 26

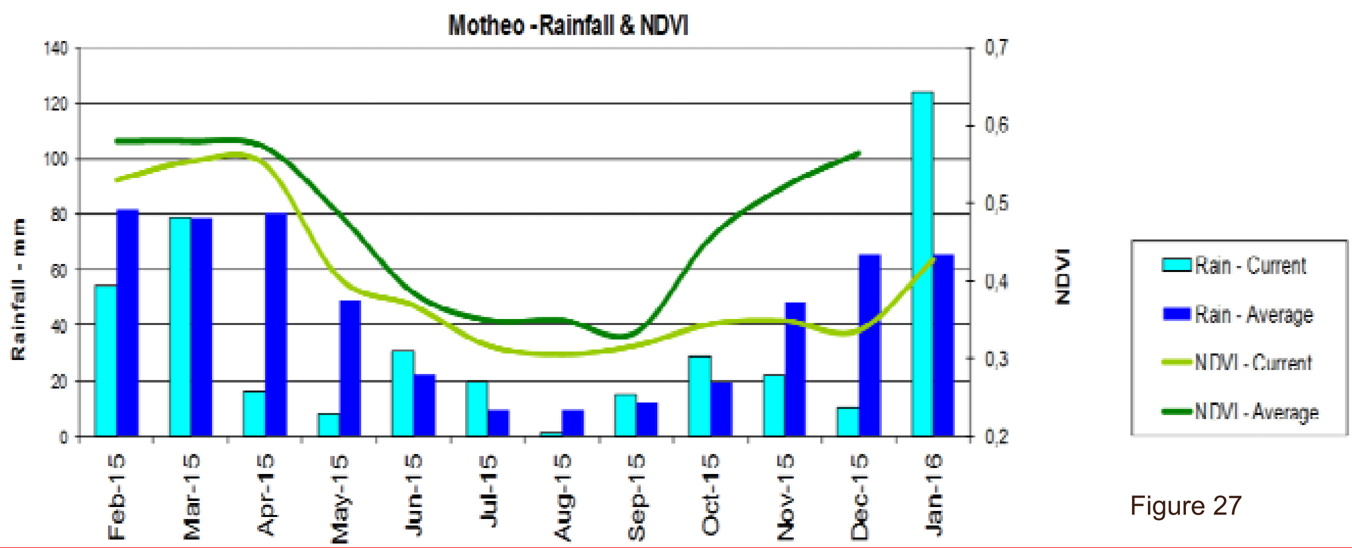
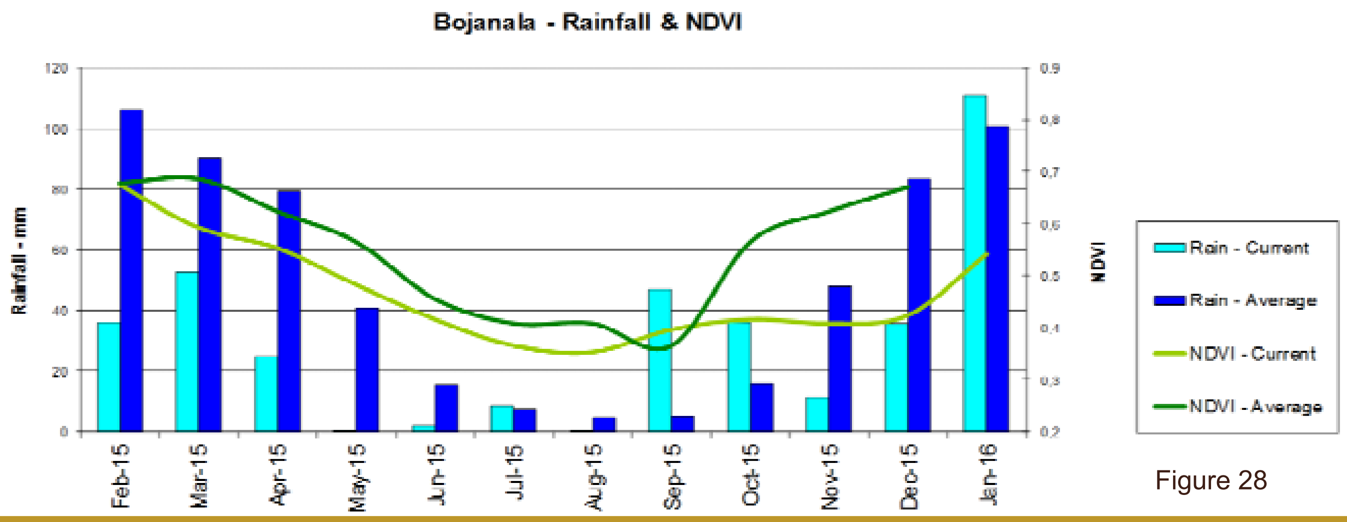


Figure 27



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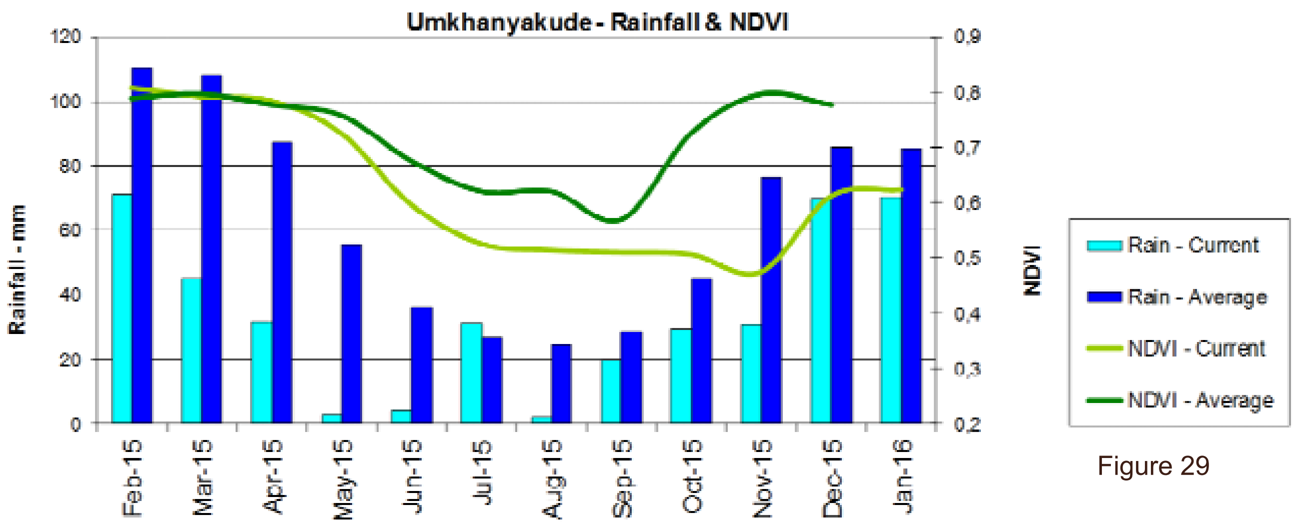

Figure 29

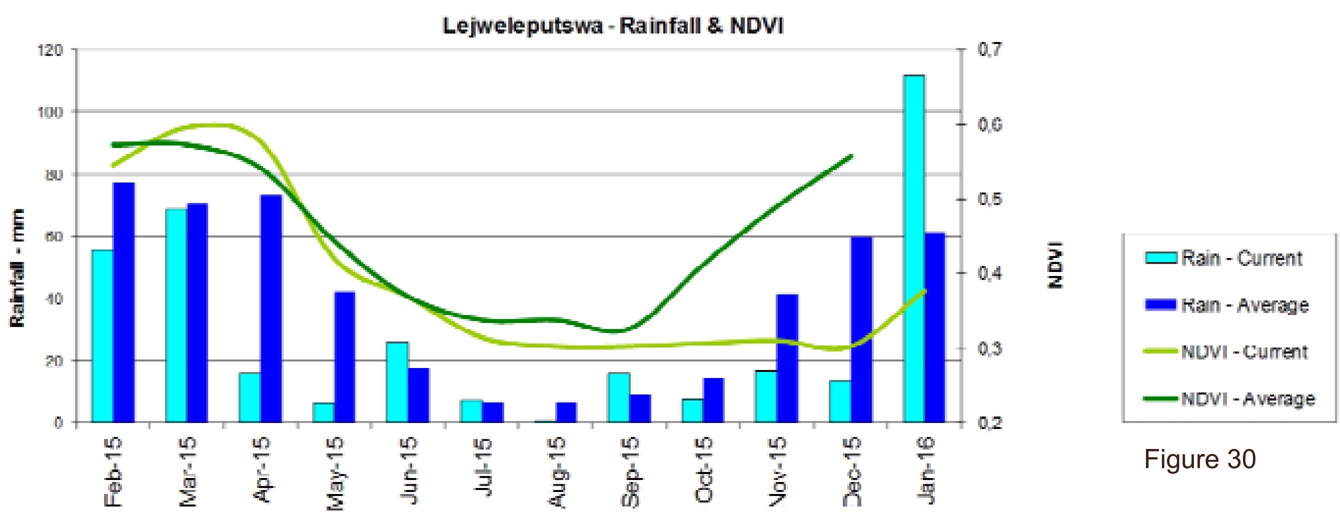

Figure 30

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 January 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 January 2016 and December 2015, with the brown colours showing the drier and the green colours the wetter areas. Similarly, the year-on-year SSI difference for January 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.

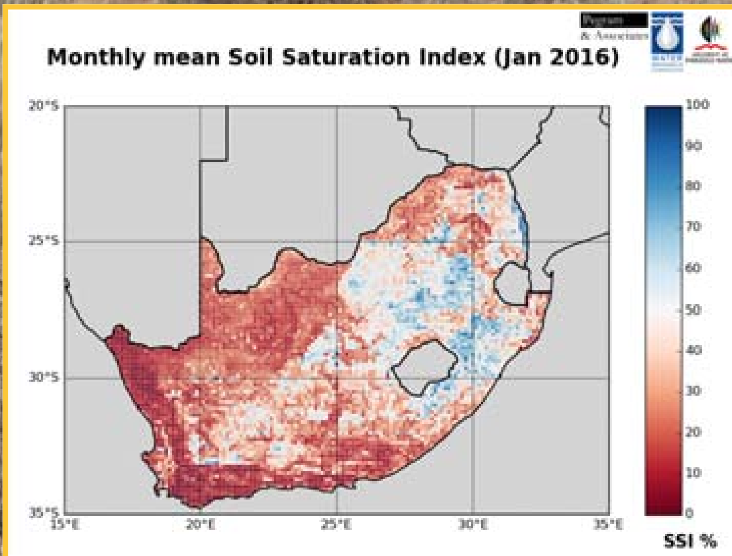

Figure 31

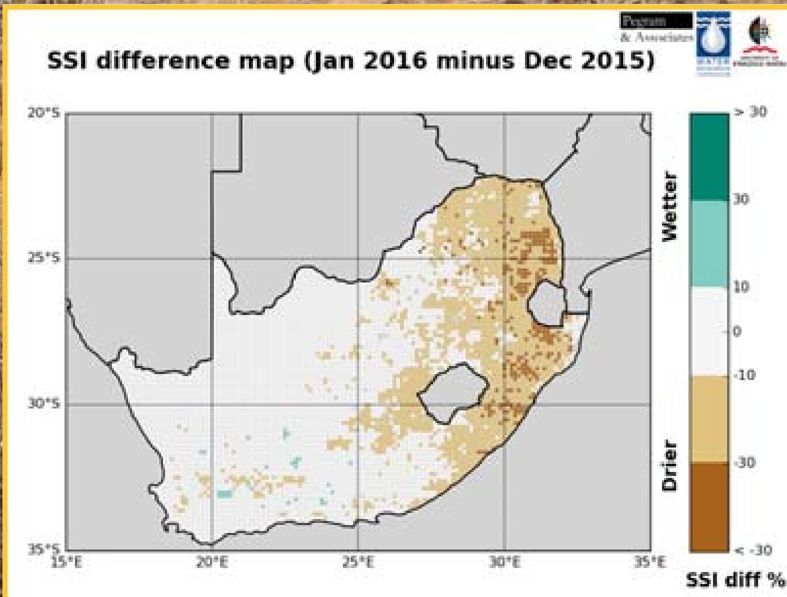

Figure 32

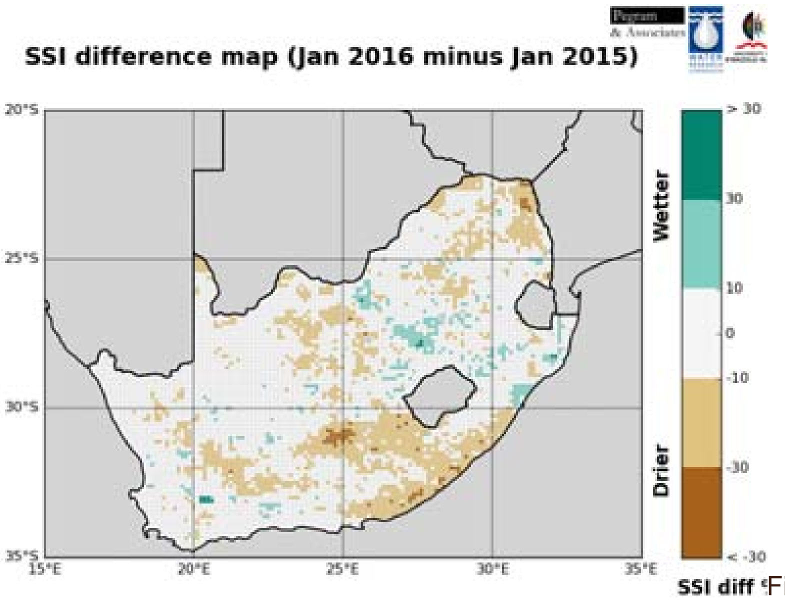

Figure 33

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 January per province. Fire activity was higher in all provinces compared to the average during the same period for the last 15 years.

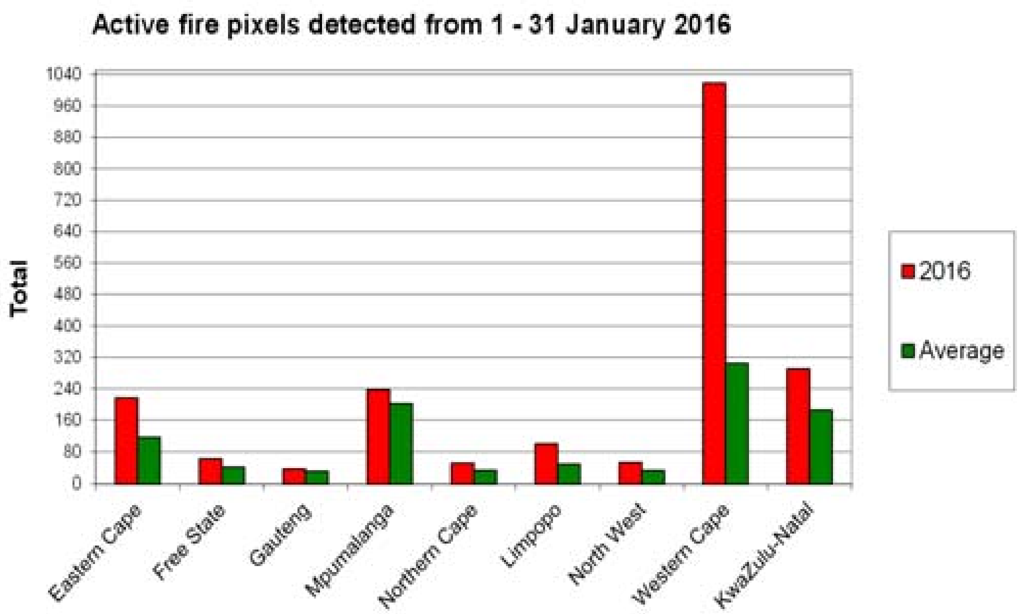

Figure 34

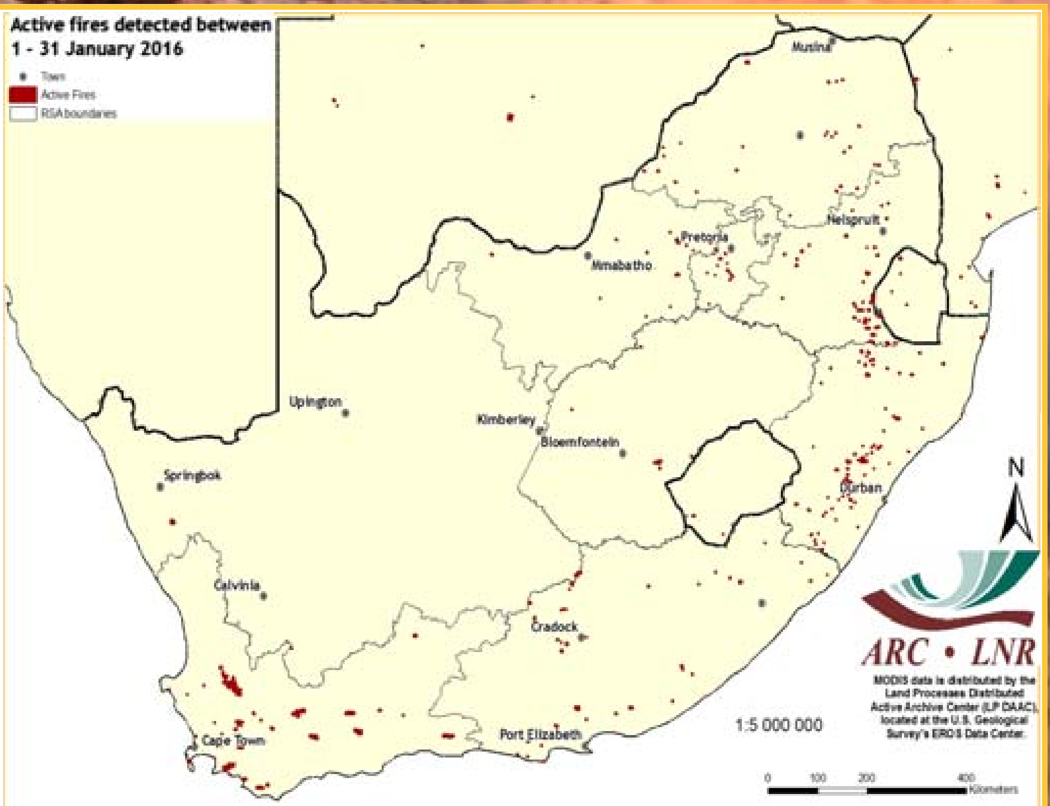

Figure 35

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

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

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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:
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E-mail: ChrisK@arc.agric.za
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Private Bag X79, Pretoria 0001
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E-mail: ISCWinfo@arc.agric.za
Website: www.arc.agric.za

The Coarse Resolution Imagery Database (CRID)

NOAA AVHRR

The ARC-ISCW has an archive of daily NOAA AVHRR data dating from 1985 to 2004. This database includes all 5 bands as well as the Normalized Difference Vegetation Index (NDVI), Active Fire and Land Surface Temperature (LST) images. The NOAA data are used, for example, for crop production and grazing capacity estimation.

MODIS

MODIS data is distributed by the Land Processes Distributed Active Archive Center (LP DAAC), located at the U.S. Geological Survey's EROS Data Center. The MODIS sensor is more advanced than NOAA with regard to its high spatial (250 m^2 to 1 km^2) and spectral resolution. The ARC-ISCW has an archive of MODIS (version 4 and 5) data.

- MODIS v4 from 2000 to 2006
- MODIS v5 from 2000 to present

Datasets include:

- MOD09 (Surface Reflectance)
- MOD11 (Land Surface Temperature)
- MOD13 (Vegetation Products)
- MOD14 (Active Fire)
- MOD15 (Leaf Area Index & Fraction of Photosynthetically Active Radiation
- MOD17 (Gross Primary Productivity)
- MCD43 (Albedo & Nadir Reflectance)
- MCD45 (Burn Scar)

Coverage for version 5 includes South Africa, Namibia, Botswana, Zimbabwe and Mozambique.
More information:
http://modis.gsfc.nasa.gov

VGT4AFRICA and GEOSUCCESS

SPOT NDVI data is provided courtesy of the VEGETATION Programme and the VGT4AFRICA project. The European Commission jointly developed the VEGETATION Programme. The VGT4AFRICA project disseminates VEGETATION products in Africa through GEONETCast.

ARC-ISCW has an archive of VEGETATION data dating from 1998 to the present. Other products distributed through VGT4AFRICA and GEOSUCCESS include Net Primary Productivity, Normalized Difference Wetness Index and Dry Matter Productivity data.

Meteosat Second Generation (MSG)

The ARC-ISCW has an operational MSG receiving station. Data from April 2005 to the present have been archived. MSG produces data with a 15-minute temporal resolution for the entire African continent. Over South Africa the spatial resolution of the data is in the order of 3 km. The ARC-ISCW investigated the potential for the development of products for application in agriculture. NDVI, LST and cloud cover products were some of the initial products derived from the MSG SEVIRI data. Other products derived from MSG used weather station data, including air temperature, humidity and solar radiation.

Rainfall maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network, 270 automatic rainfall recording stations from the SAWS, satellite rainfall estimates from the Famine Early Warning System Network: **http://earlywarning.usgs.gov** and long-term average climate surfaces developed at the ARC-ISCW.

Solar Radiation and Evapotranspiration maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network.
- Data from the METEOSAT Second Generation (MSG) 3 satellite via GEONETCAST: **http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast/GEONETCast/index.html**.

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

http://www.agis.agric.za