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Excellence in Agricultural Research and Development

UMLINDI

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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

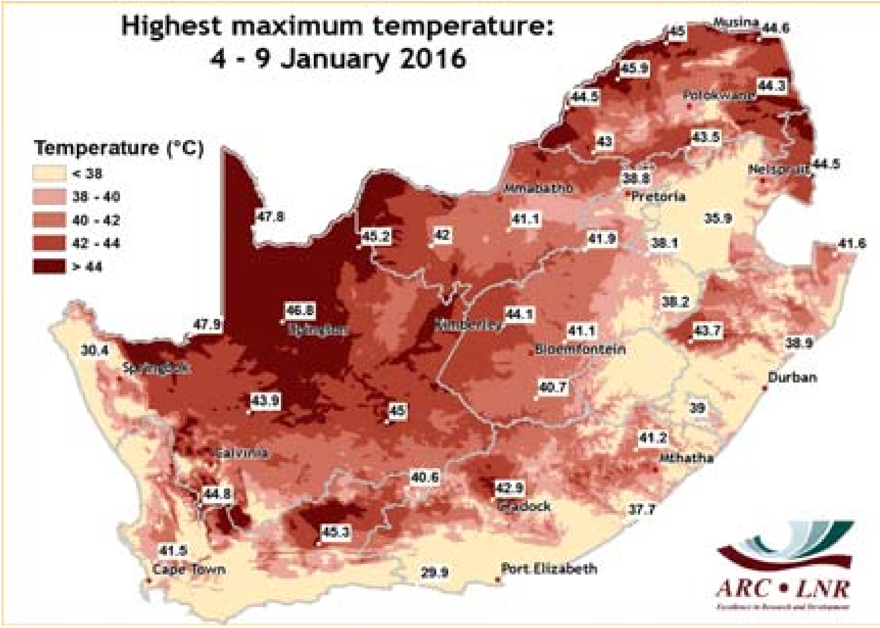
agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

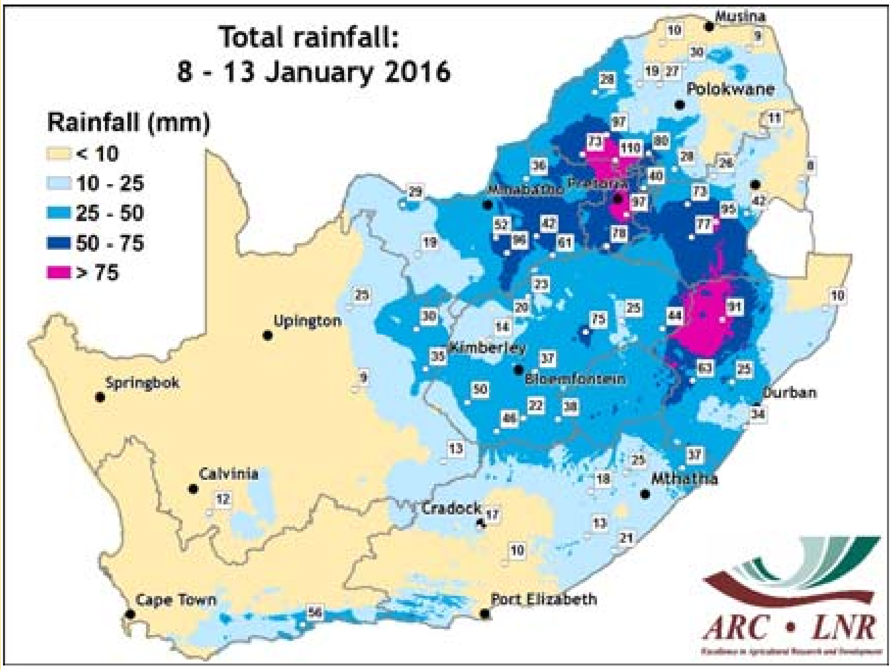
South African Weather Service

AMESD

139th Edition

Images of the Month





Extreme weather conditions in early January 2016

Another heat wave occurred over much of the country during early January 2016, following several such events during October to December 2015. Record-breaking maximum temperatures were recorded as the mercury rose above 40°C on several days over many areas, placing additional strain on drought-stressed crops. A strong upper-air anticyclone dominated especially between the 4th and 8th, resulting in sunny and hot conditions lasting for about a week. The map above shows the highest recorded maximum temperature during the period with the actual value indicated for a number of station locations.

The extreme heat and dry conditions were replaced by a much more favourable situation since the 8th, as the upper-air anticyclone was replaced by perturbations resulting in instability while a large high-pressure system ridged around the country, feeding cooler moist air into the interior, resulting in scattered to widespread thundershowers over much of the interior. Large parts of the Free State and eastern Northern Cape received more rain than the total for November and December 2015. The map below shows the total rainfall for the period 8 to 13 January 2016.

The maps are interpolations of temperature and rainfall data collected through the ARC-ISCW automatic weather station network, consisting of 450 operational stations across the country.

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).

Overview:

December was another dry month over much of the interior, excluding parts of KwaZulu-Natal and Mpumalanga. Not only was it dry, but several heat-waves occurred during the month. Temperatures regularly exceeded 40°C over many areas. The hottest periods were during the 5th to 10th as well as from the 18th to the 23rd with the Northern Cape, North west, western Free State, parts of Gauteng and Limpopo experiencing exceptional maximum temperatures.

The southwestern winter rainfall regions received some showers but monthly totals generally remained below 25 mm. Showers were mainly associated with frontal activity, resulting in cooler conditions over the southwestern parts of the country. These occurred around the 12th, 15th and 21st.

Isolated to scattered thundershowers occurred from time to time over the interior. Weak upper-air troughs together with ridging anticyclones to the south of the country at the surface resulted in some moderate to heavy storms at times, with the preferred areas for development over Mpumalanga and KwaZulu-Natal with less frequent activity into Limpopo, eastern North West and the northern Free State. Most of the precipitation, in the form of isolated to scattered thundershowers, occurred around the 2nd, from the 11th to the 16th and again from the 20th reaching a maximum around Christmas. A rather deep upper-air trough and surface low over the southwestern and central interior respectively resulted in fairly widespread significant thundershowers with most of the rain over parts of Mpumalanga and Limpopo occurring between the 10th and 16th. The frontal systems responsible for some rain over the winter rainfall region were in accordance to unfavourable atmospheric conditions in the southern African area, the anticyclones locating somewhat too far north towards the southwest of the subcontinent, pushing frontal systems into the southwestern parts, advecting dry air over much of the central, western and southern parts.

1. Rainfall

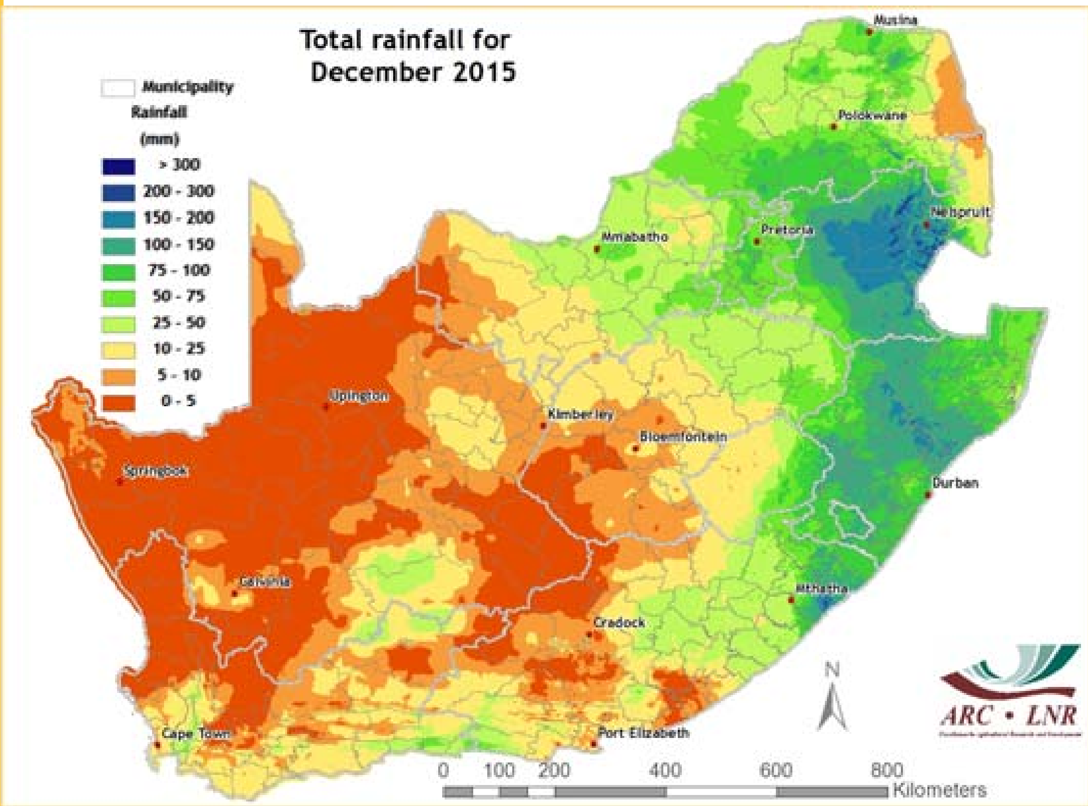


Figure 1

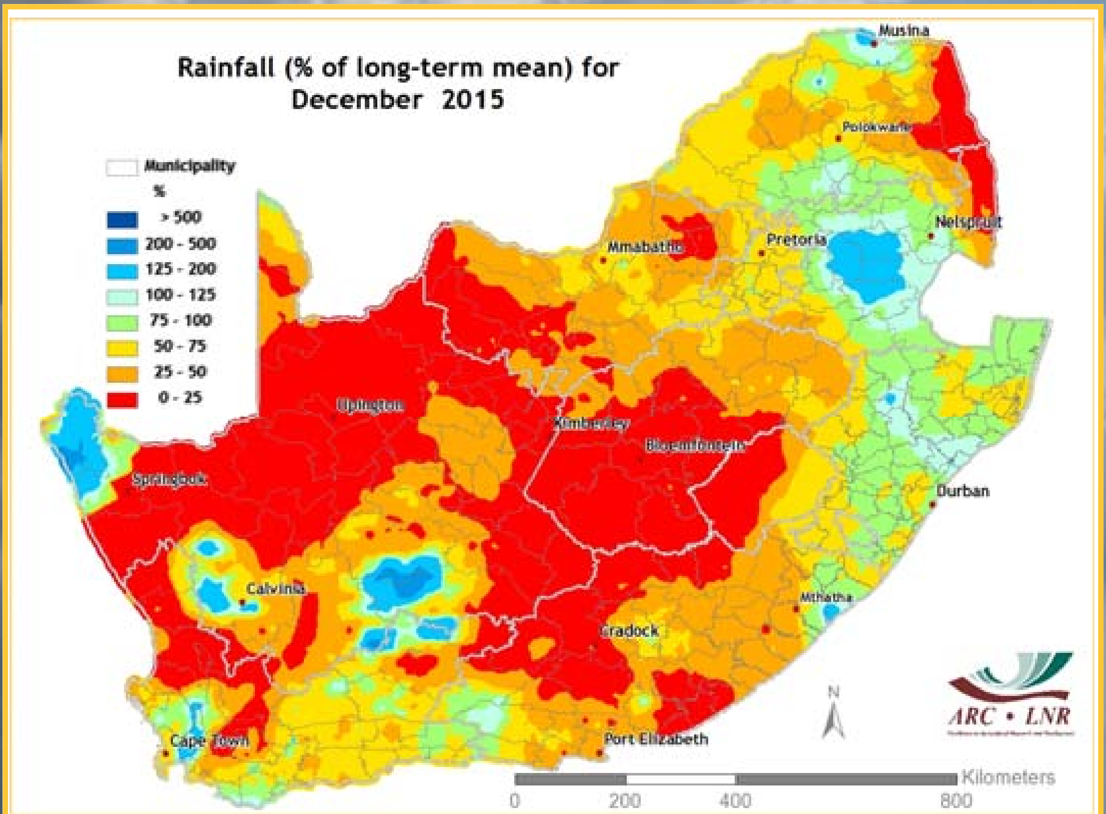


Figure 2

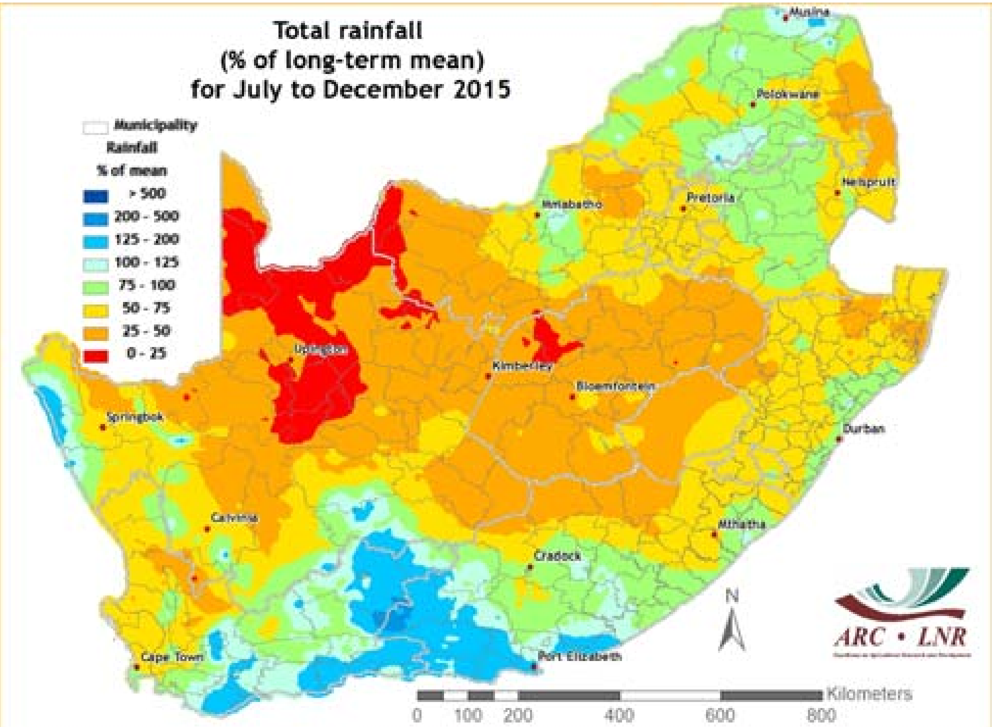


Figure 3

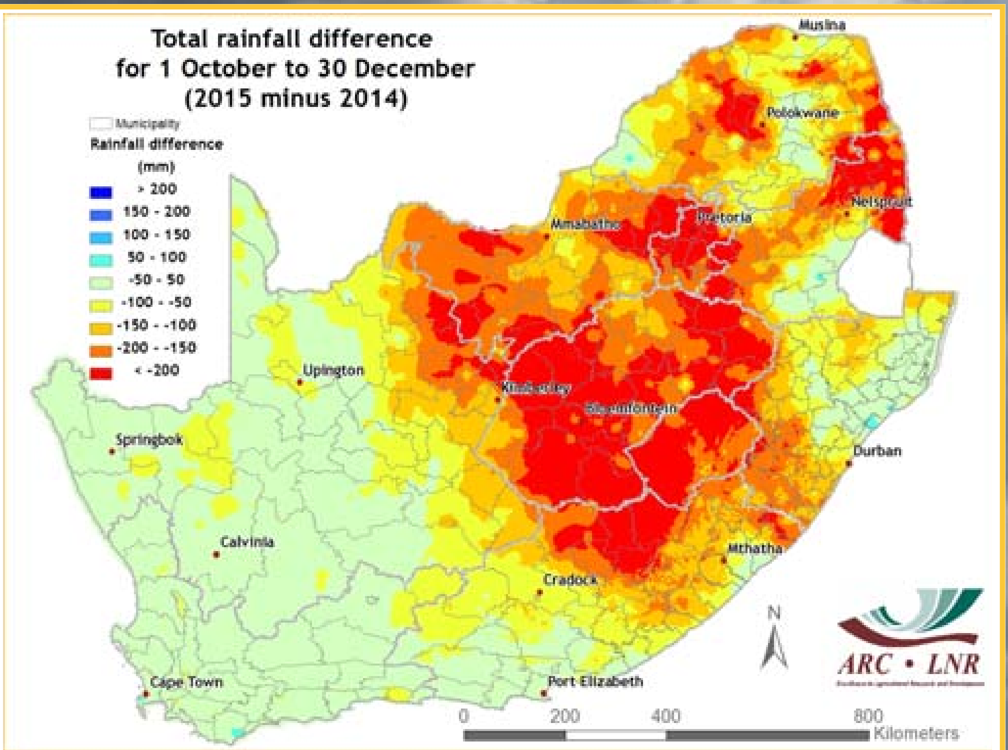


Figure 4

The repetition of such events played a large role in keeping the western to central interior dry, while thundershowers were mainly confined to the northeast and east. Conditions changed somewhat from the 25th, with a large area of rain and thundershower activity over the northern to central parts of Namibia into Angola, in the region of a tropical low. Moisture drifted southwards around and within a strengthening upper-air high over the interior. Large amounts of mid-level clouds developed over the central to western parts, bringing some relief in the wake of high temperatures. Some showers and thundershowers also developed over the western to central parts during this period until the end of the month.

Figure 1:
The central to western interior and western winter rainfall region received very little rain during December. The Lowveld of Mpumalanga and Limpopo was very dry also. Part of the eastern half of the summer rainfall region received between 50 and 180 mm of rain. Highest totals were recorded over central Mpumalanga and central KwaZulu-Natal together with the extreme northeastern Eastern Cape

Figure 2:
Rainfall was below normal over most of the central to western interior and the Eastern Cape as well as the Lowveld in the northeast. Normal to above-normal rainfall occurred over much of KwaZulu-Natal and Mpumalanga.

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 northeastern parts of KwaZulu-Natal, through the Free State and Northern Cape towards the western parts of the winter rainfall region.

Figure 4:
A northwest-southeast stretching band covering western Northwest, the Free State and southern KwaZulu-Natal received much less rain in 2015 during October-December than during 2014.

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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 especially the central parts, shifting towards KwaZulu-Natal at the 24month time scale. The northeastern and southern parts are relatively wet at the longer time scales.

Questions/Comments:
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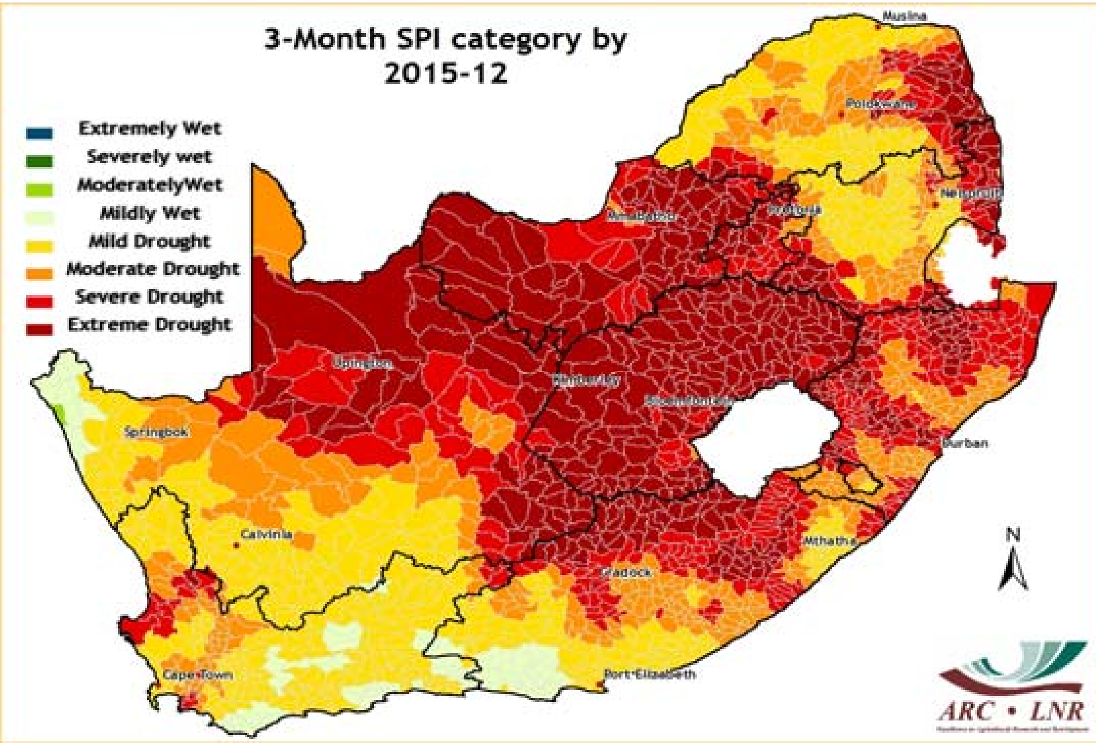

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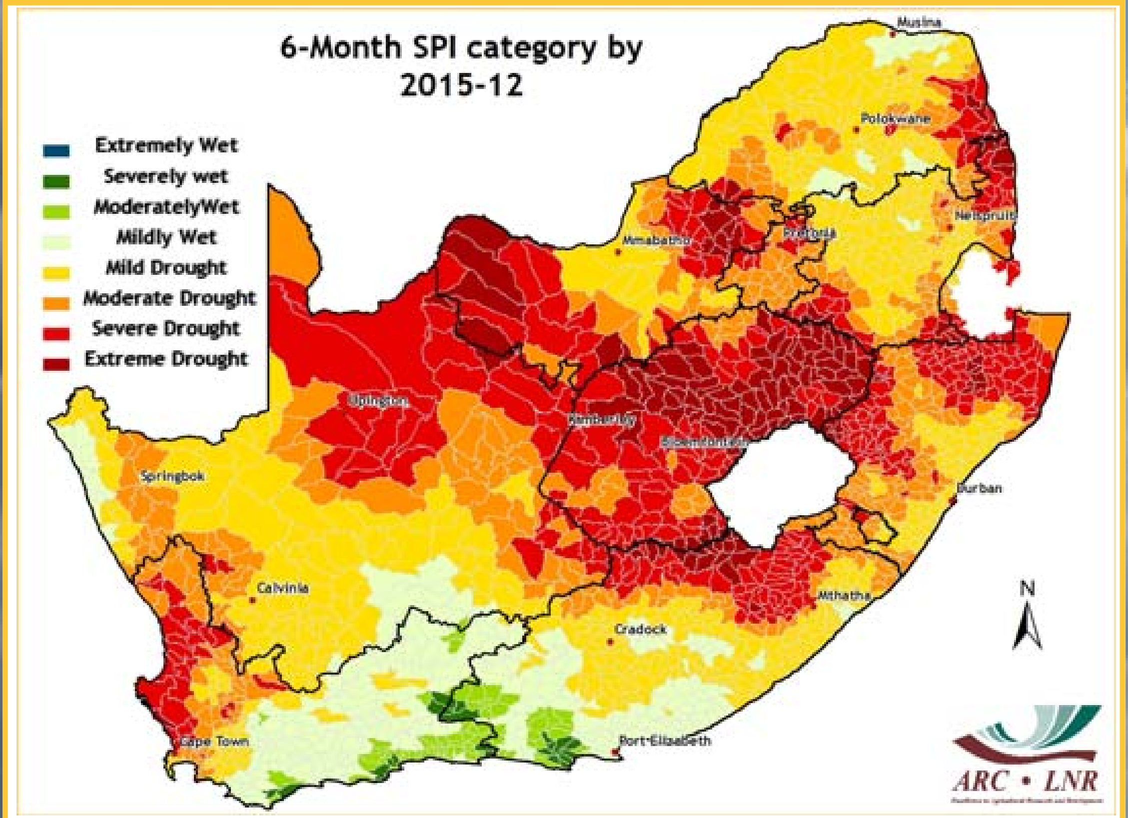

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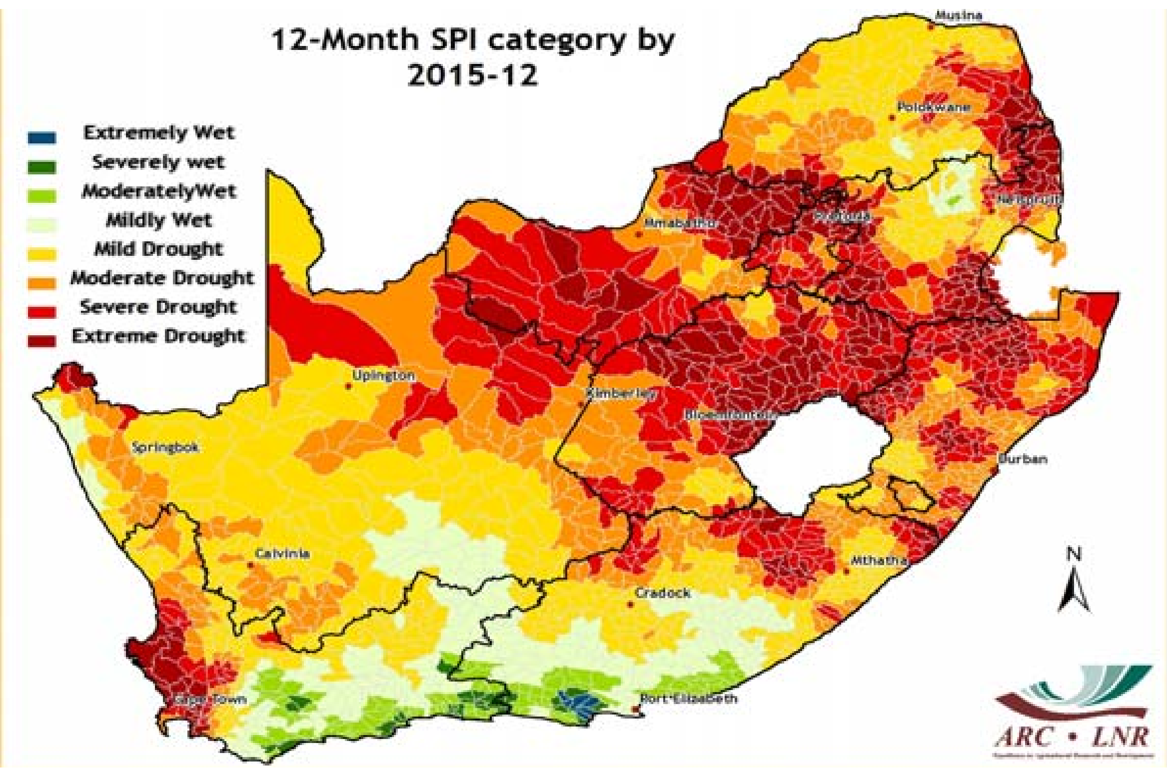

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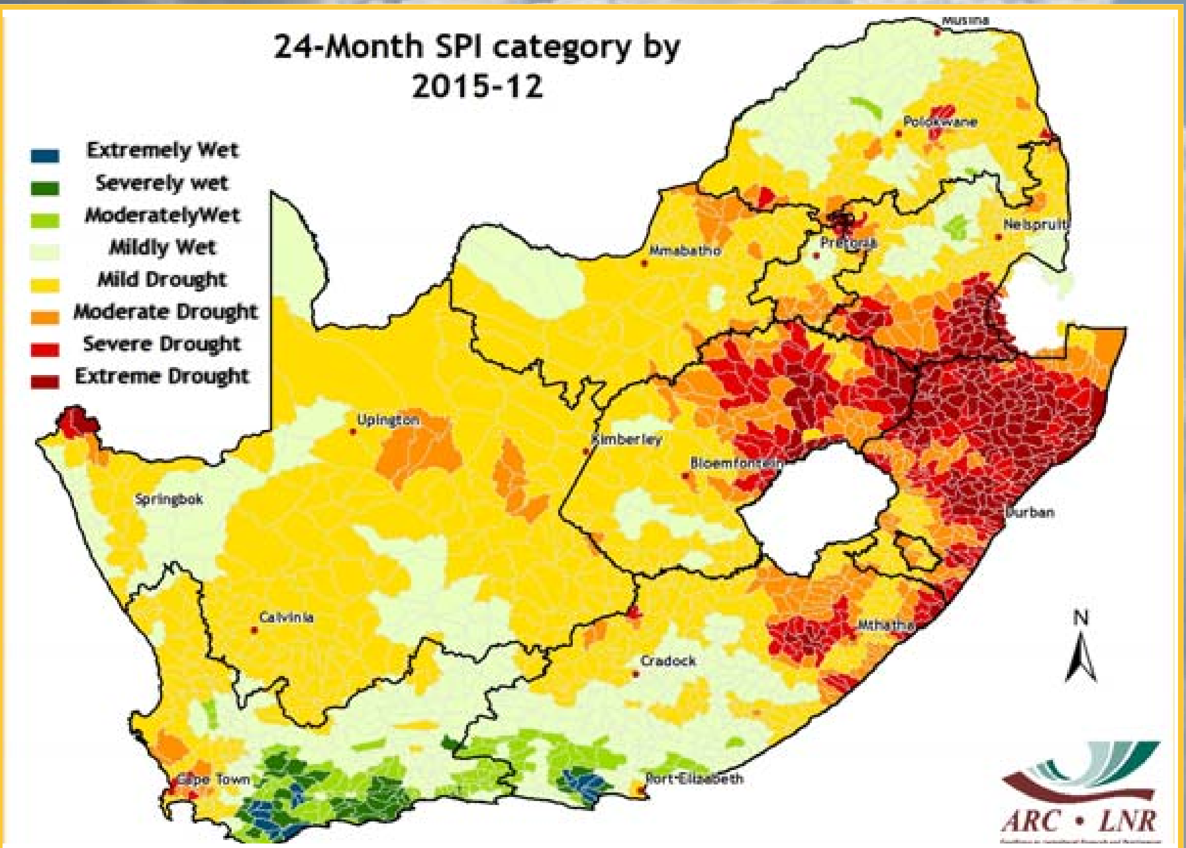

Figure 8

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.

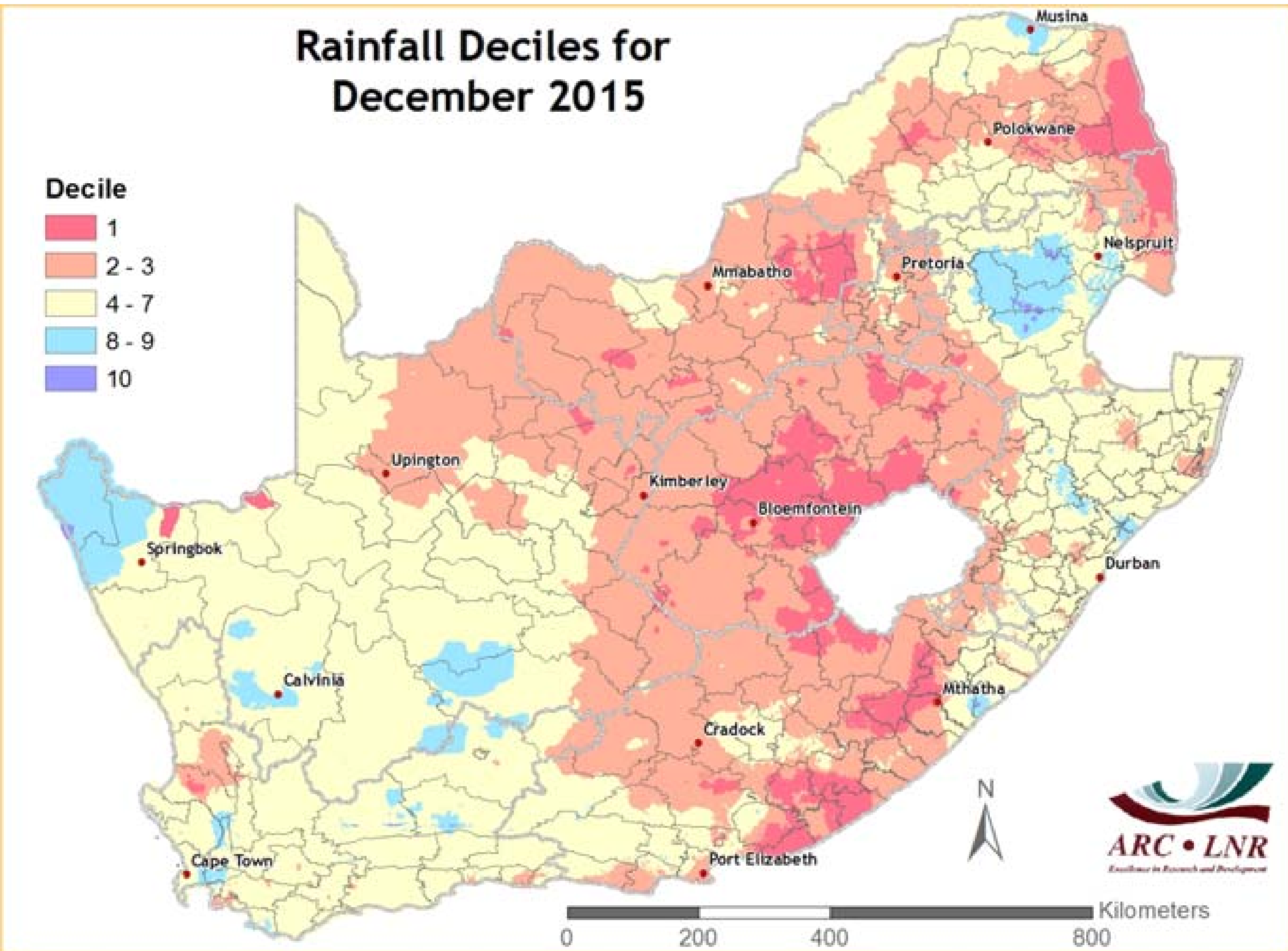

Figure 9

Figure 9:
The central to southeastern parts together with the Lowveld in the northeast were exceptionally dry during December while he northeastern interior and the winter rainfall region and southern parts received near-normal to above-normal rainfall.

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

4. Water Balance

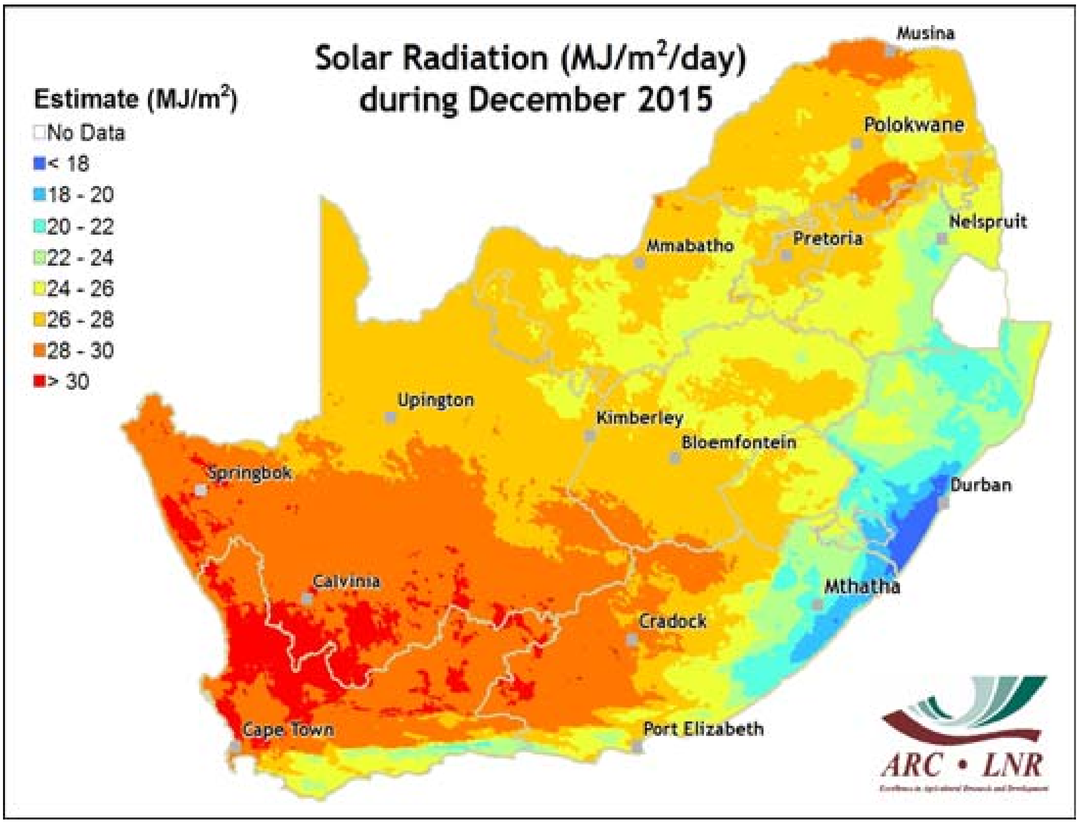

Figure 10

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:
Solar radiation estimates remained low over the southern to eastern coastal areas. Very high values are indicative of sunny conditions dominating the south-western interior.

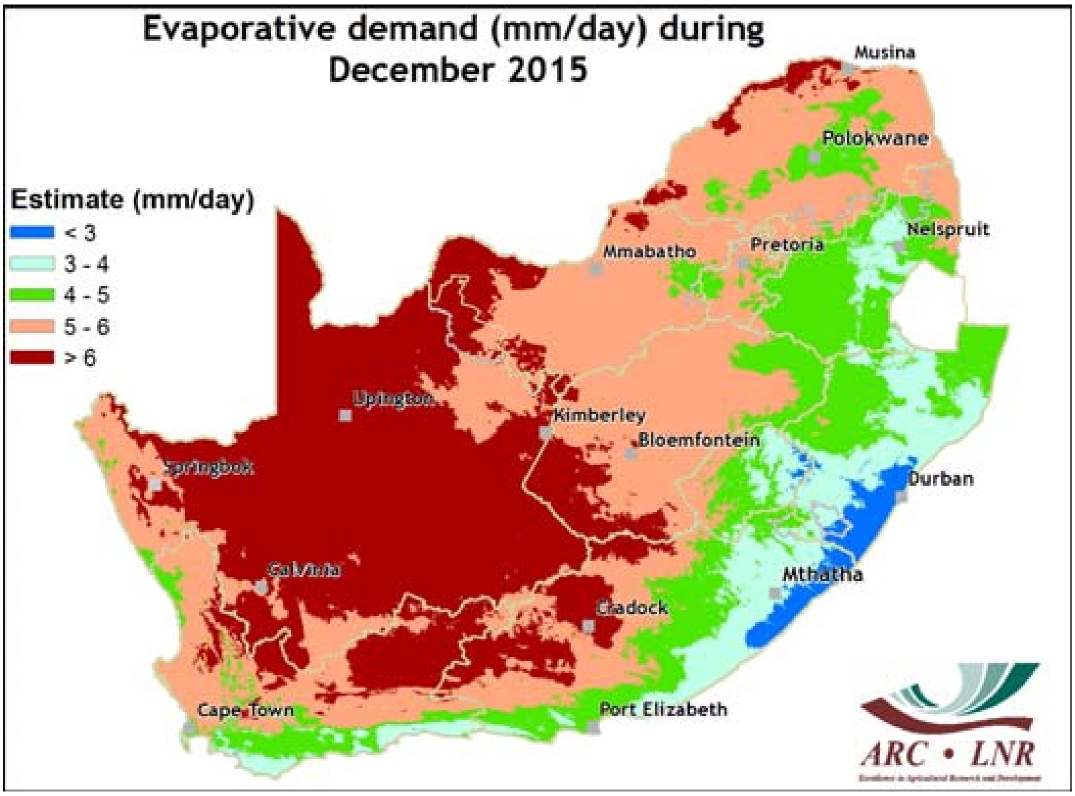

Figure 11

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:
Potential evapotranspiration remained low from the Escarpment towards the coast in the south and east, but exceeded 6 mm/day over the central to northern interior.

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:
The VCI indicates drought stress over much of the central interior including the western parts of the maize production region following hot and dry conditions during much of October to December 2015. Vegetation activity is also negatively affected over the Lowveld of Mpumalanga and Limpopo. Vegetation activity is near normal to above normal along the southern to eastern coastal belt as well as parts of Mpumalanga and Limpopo.

Figure 13:
Normal to above-normal rainfall over parts of KwaZulu-Natal, Mpumalanga and Limpopo resulted in increasing vegetation activity over those areas while drought stress resulted in diminishing activity over much of the central interior and the eastern parts of the Eastern Cape.

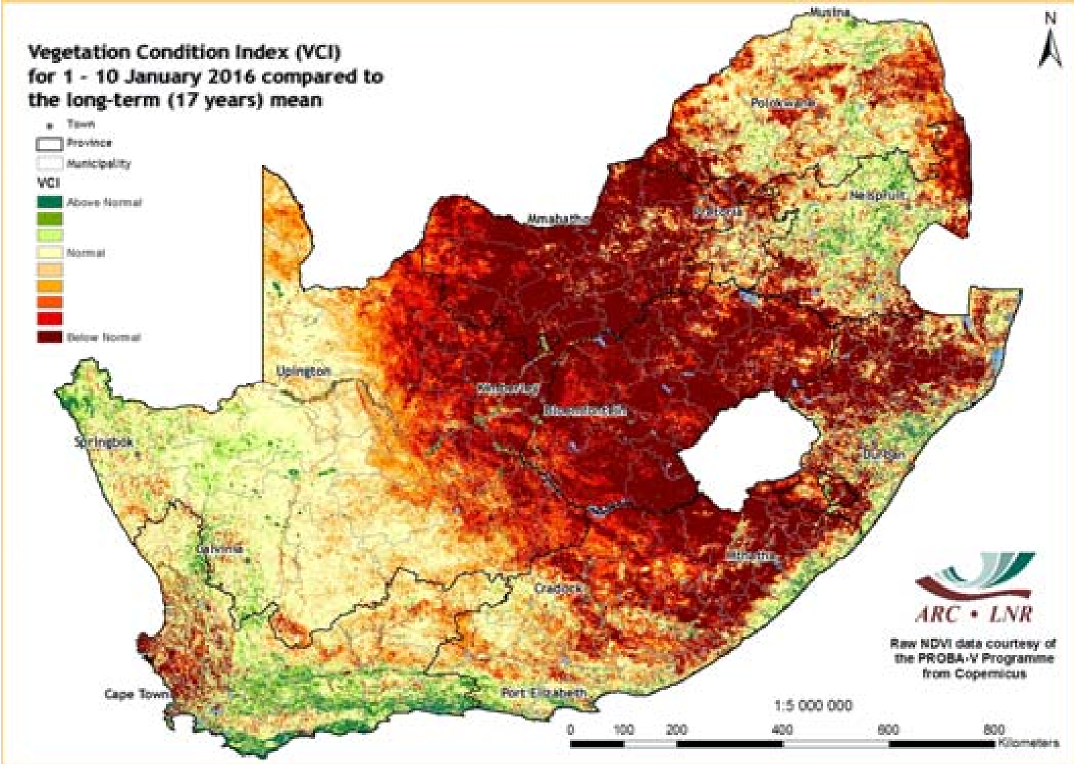

Figure 12

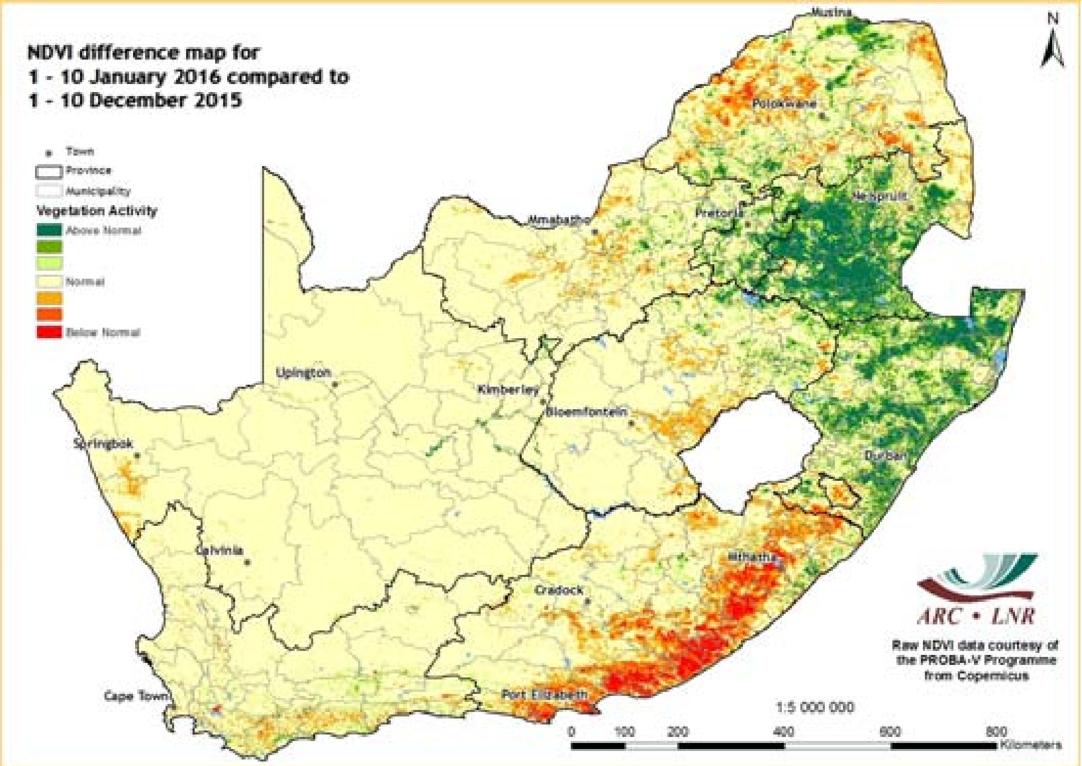

Figure 13

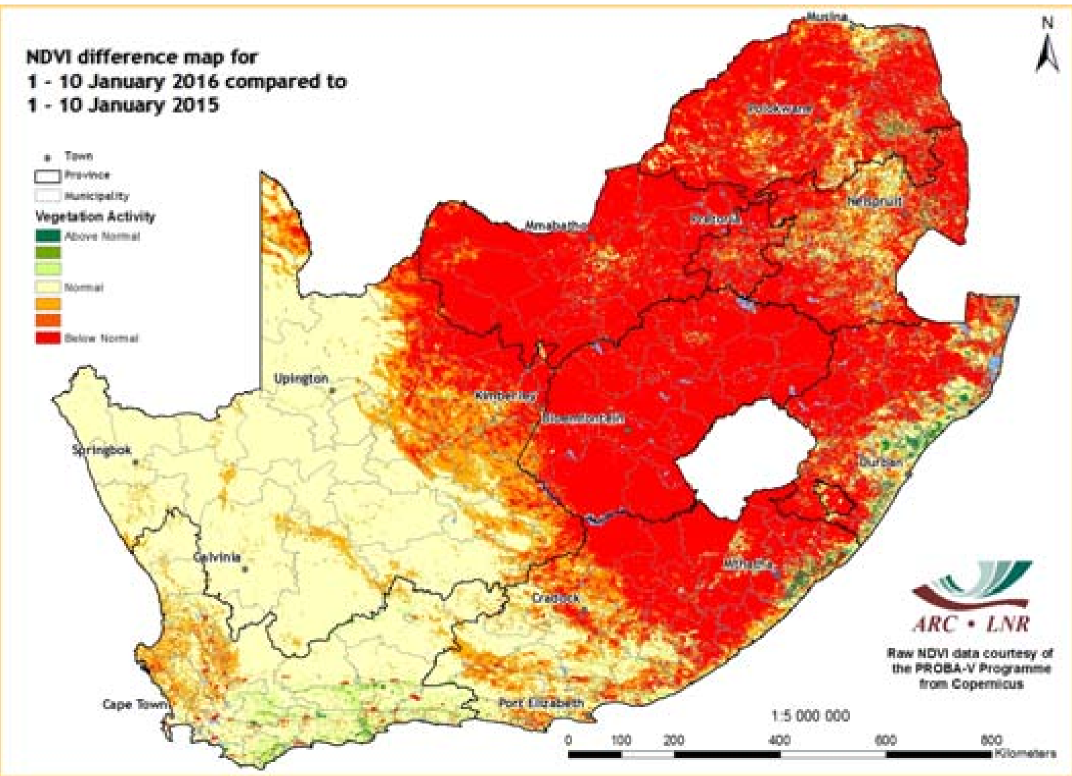

Figure 14

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

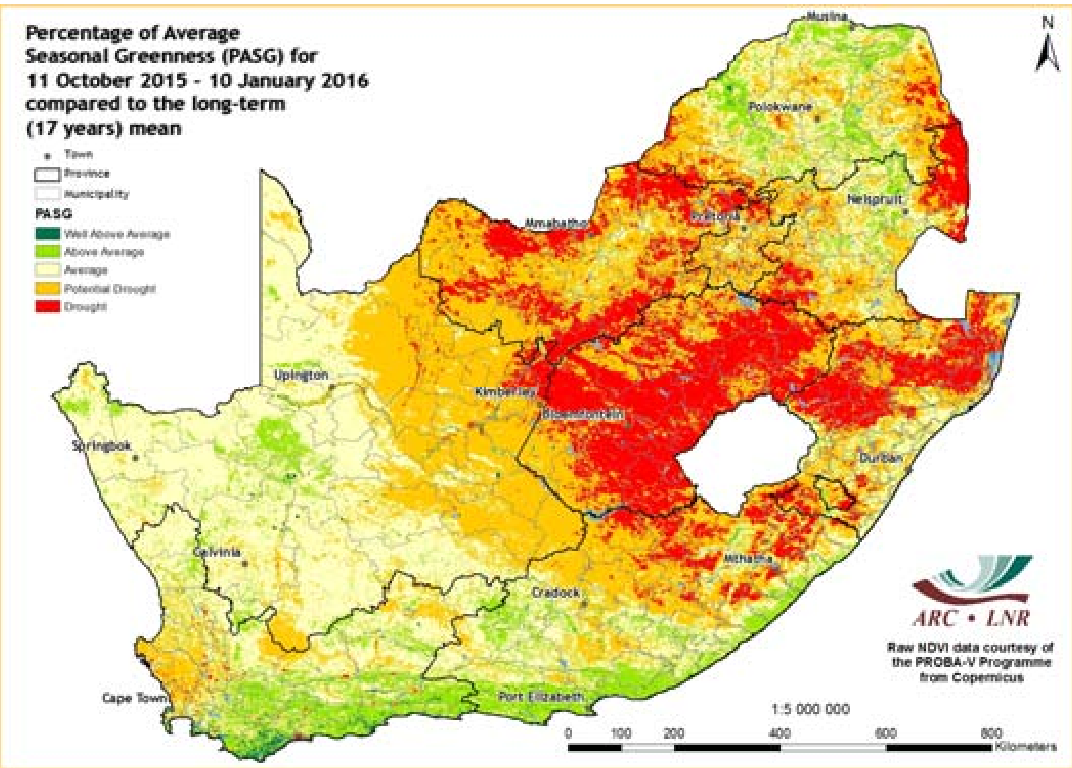

Figure 15

Figure 14:
Very hot and dry conditions during October-November 2015, in contrast to above-normal rainfall over much of the same area during October-December 2014, have resulted in much lower vegetation activity by January 2016 compared to the same time last year.

Figure 15:
Cumulative vegetation activity anomalies indicate drought stress over much of the central parts of the country while the southern and northeastern parts of the country experienced much more favourable conditions.

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6. Vegetation Condition Index

Vegetation Condition Index (VCI)

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

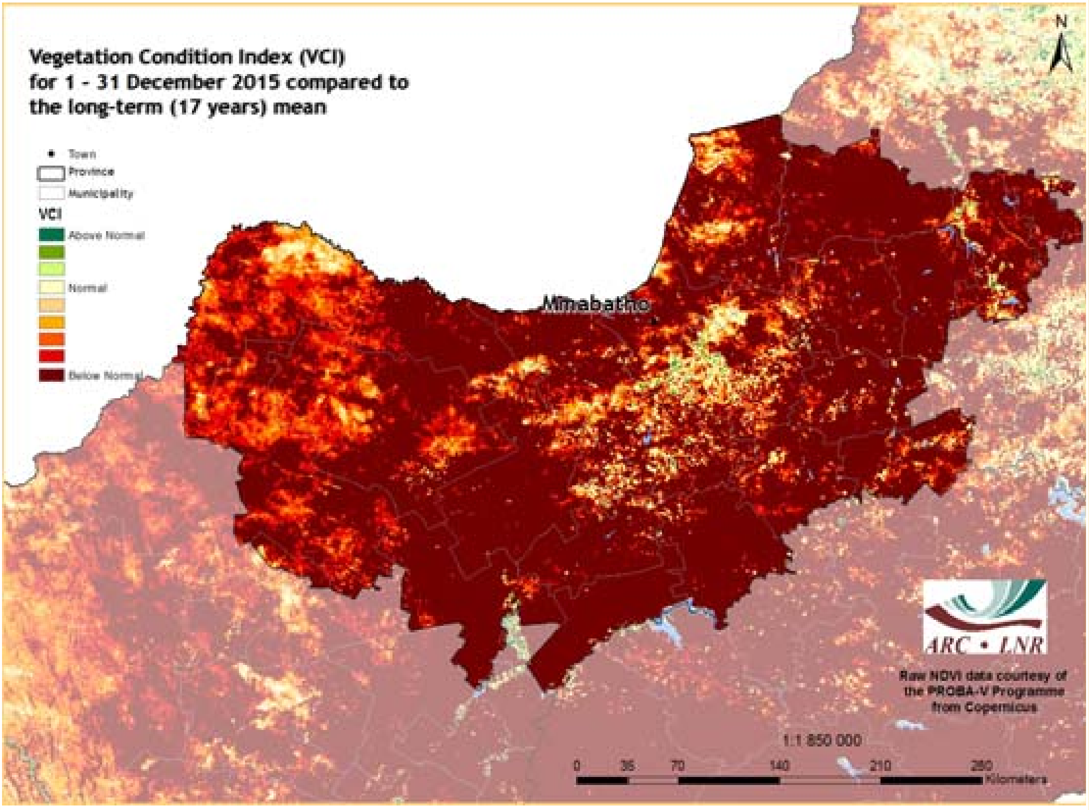
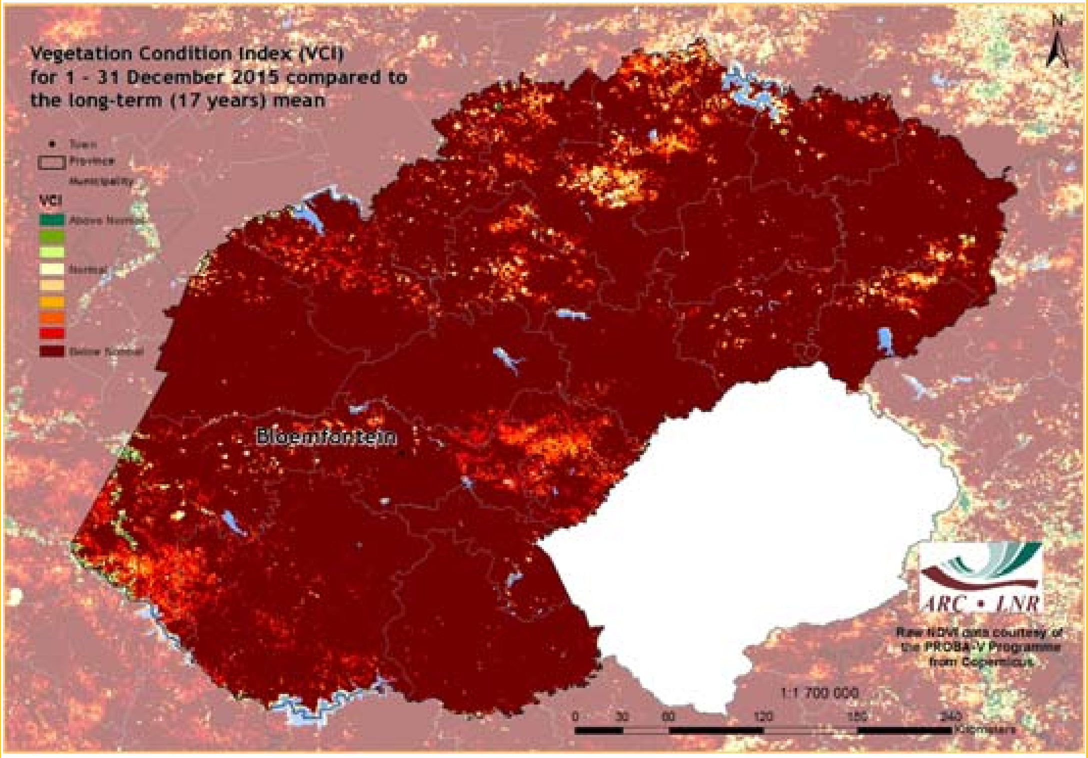


Figure 16

Figure 16:
The VCI map for December indicates below-normal vegetation activity over most of North West.

Figure 17:
The VCI map for December indicates below-normal vegetation activity over the whole of the Free State.



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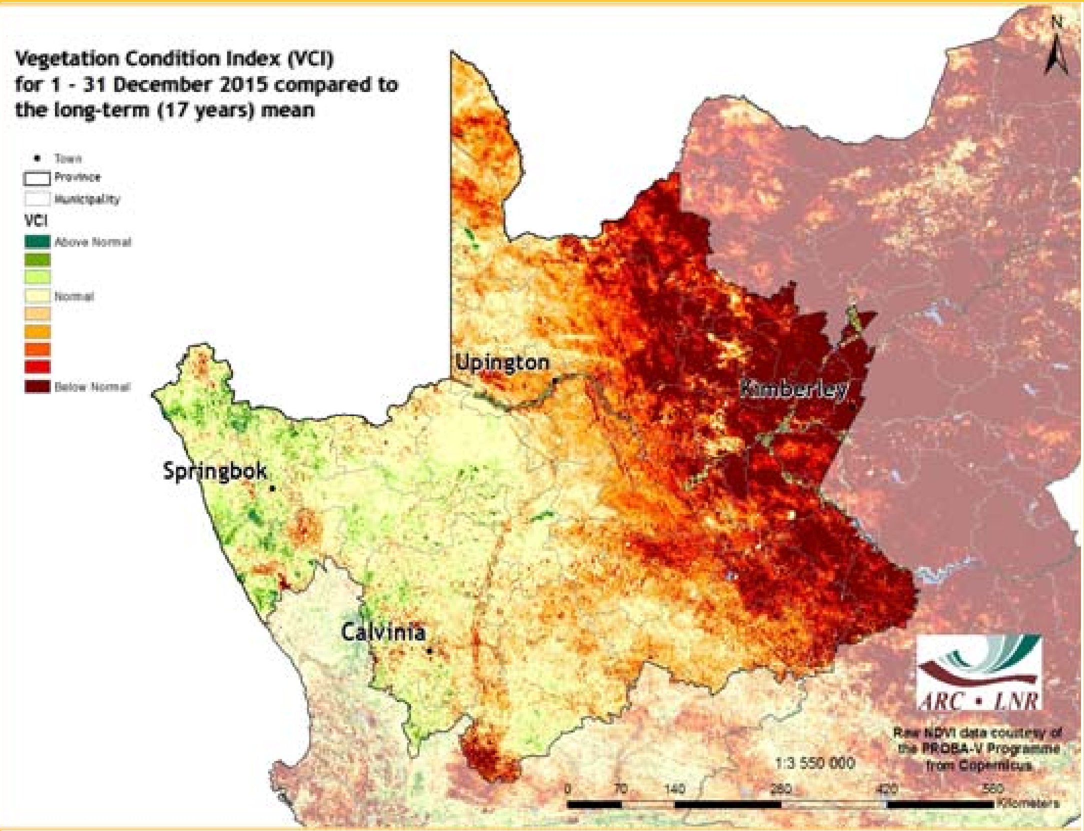

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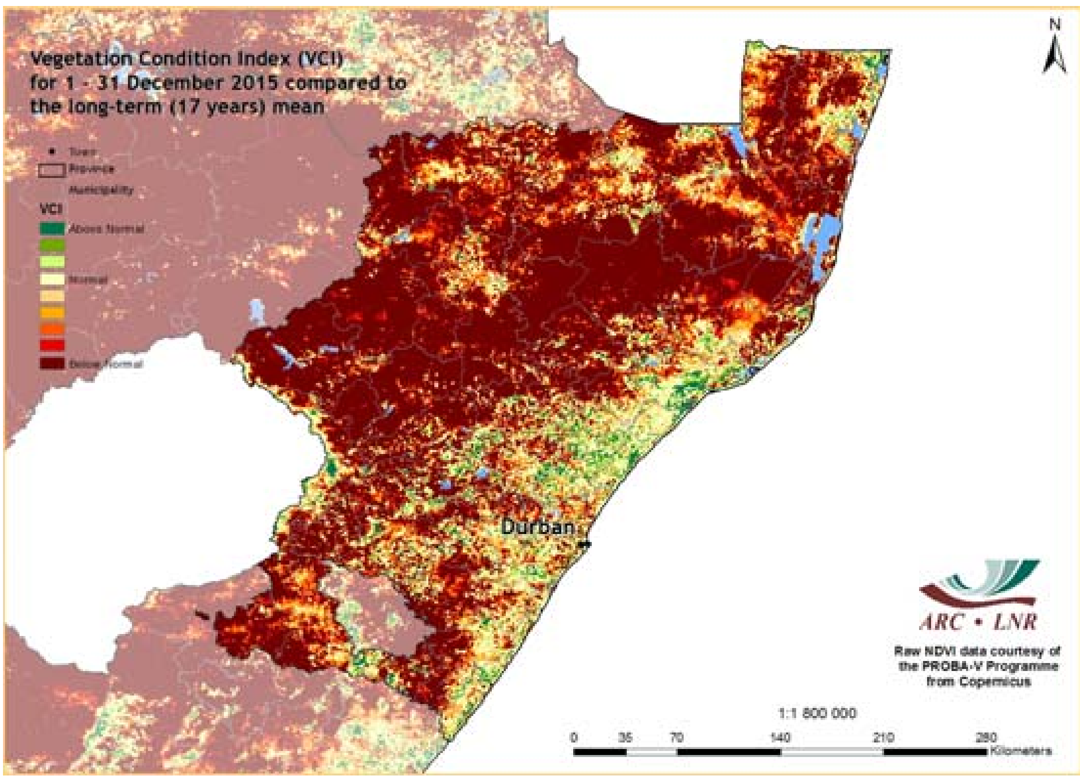

Figure 19

Figure 18:
The VCI map for December indicates below-normal vegetation activity over the northern and eastern parts of Northern Cape and above–normal vegetation activity in the western areas of the province.

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

Questions/Comments:
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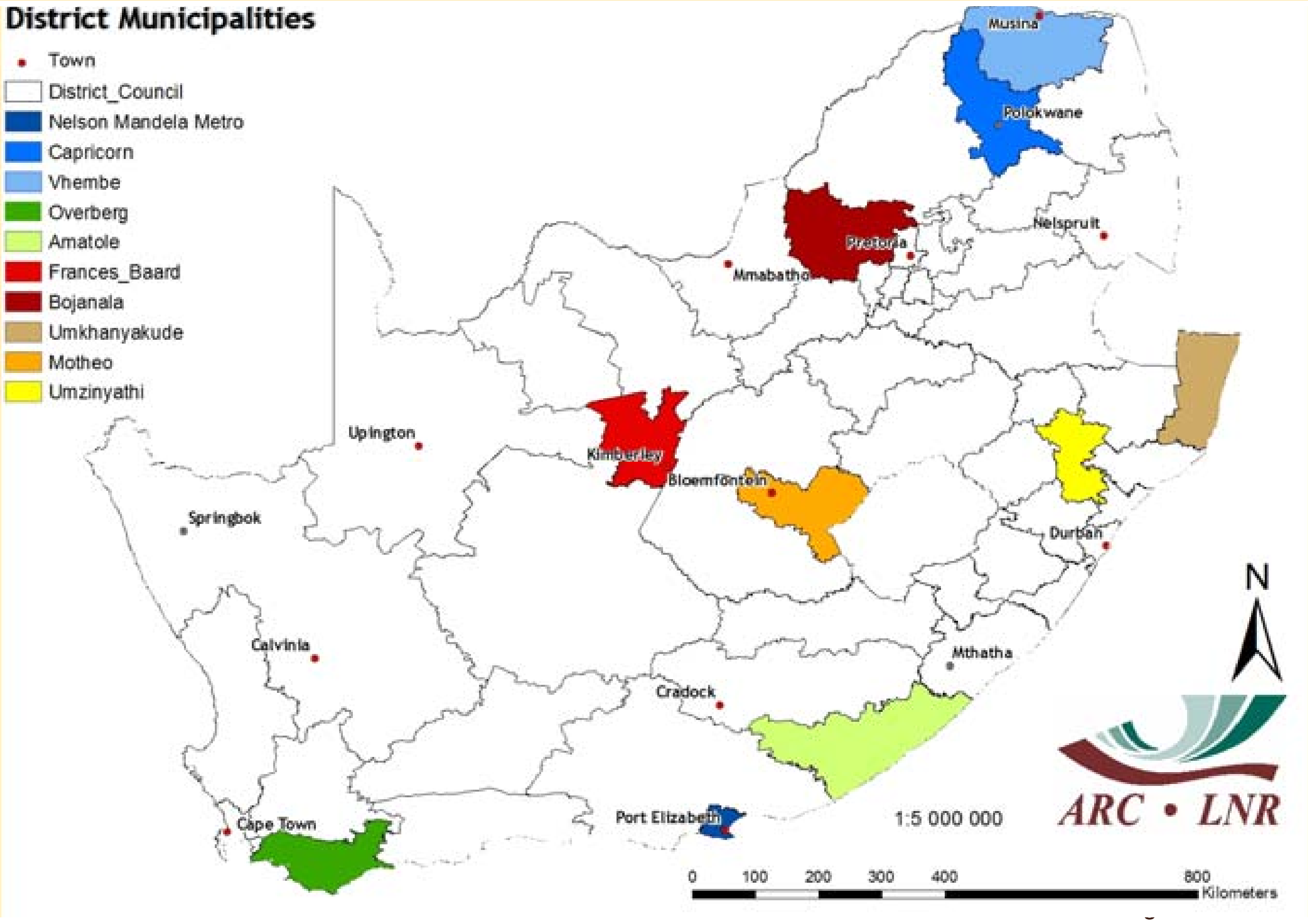
7. Vegetation Conditions & Rainfall

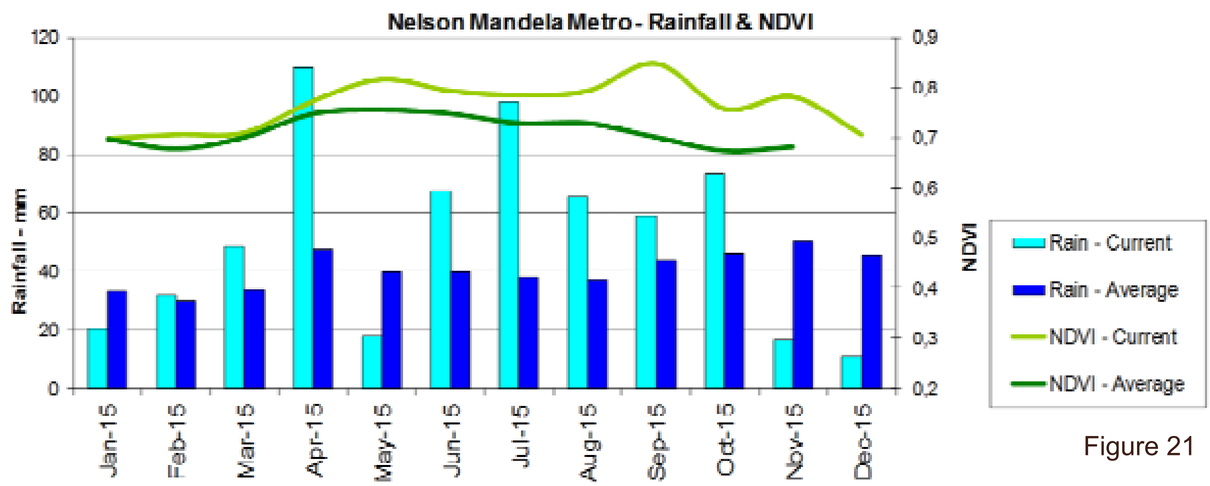


NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for December 2015. The district colour matches the border of the corresponding graph.

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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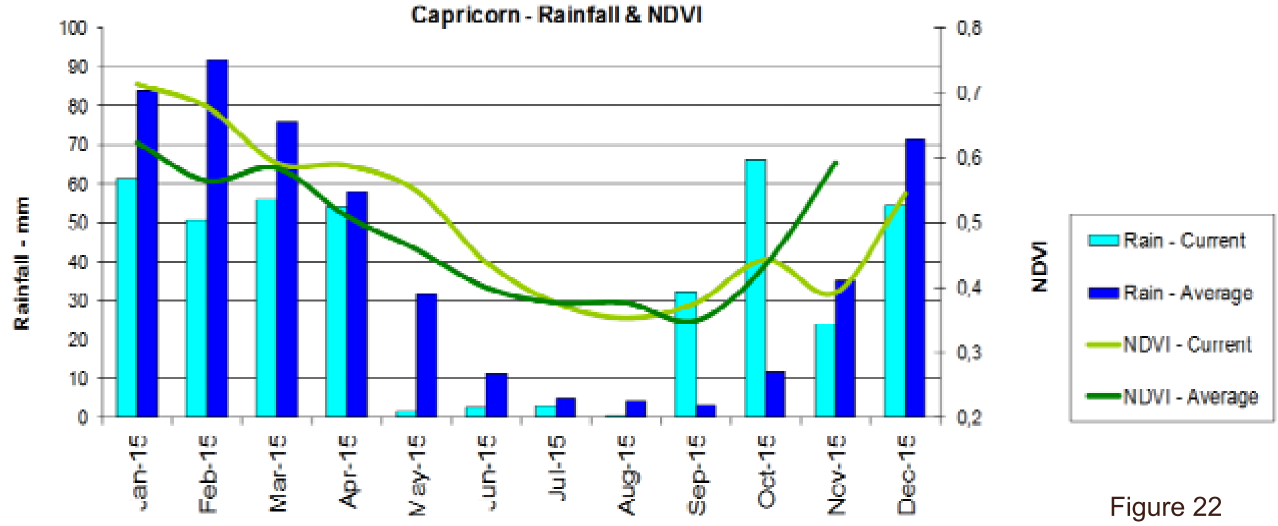

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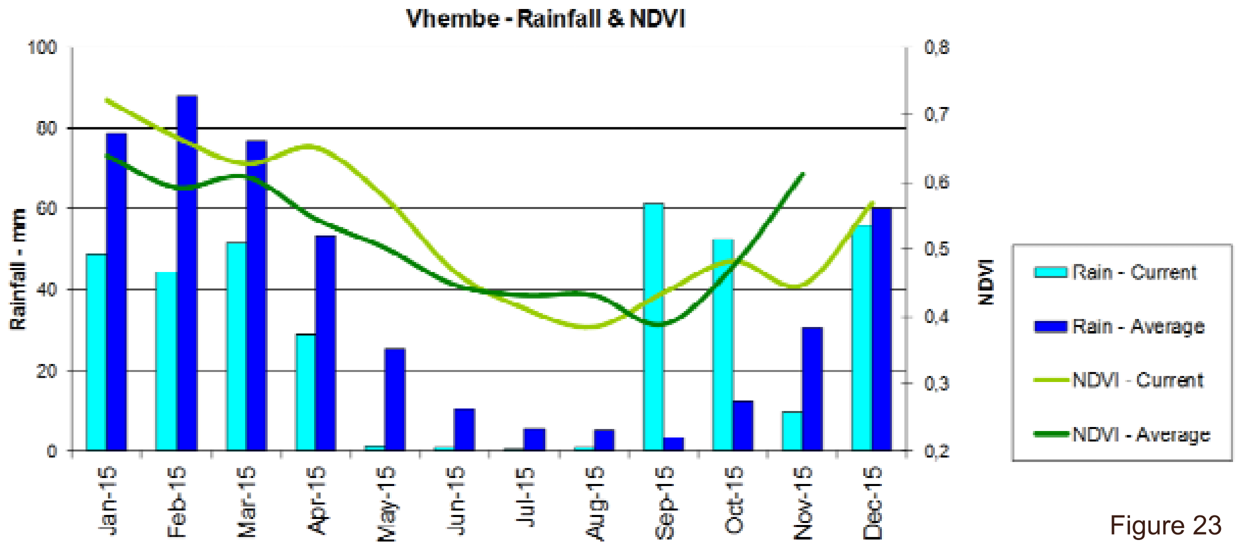

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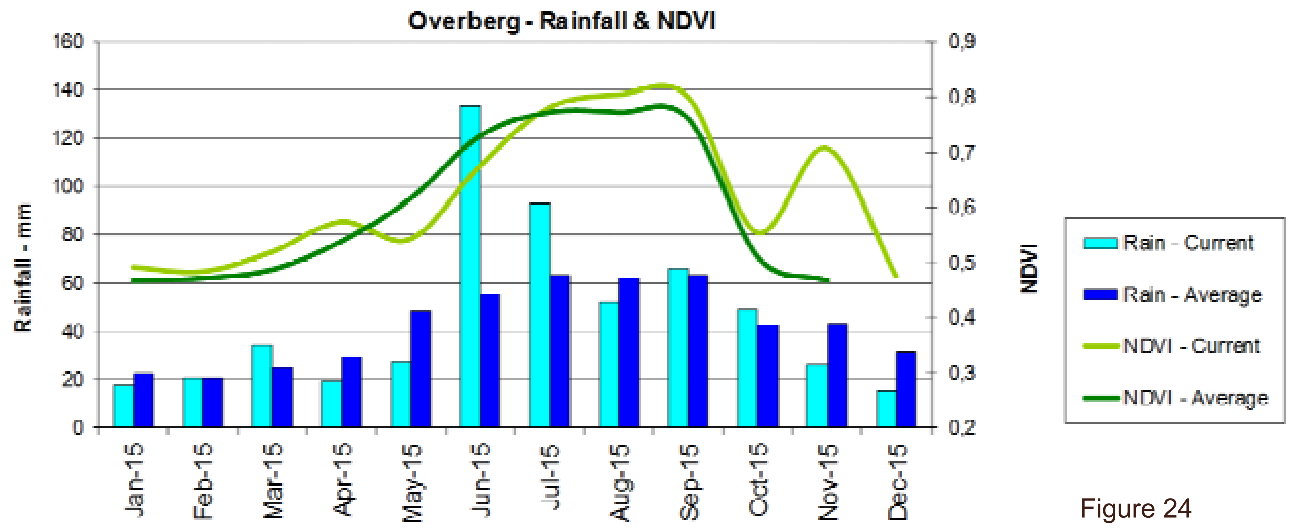
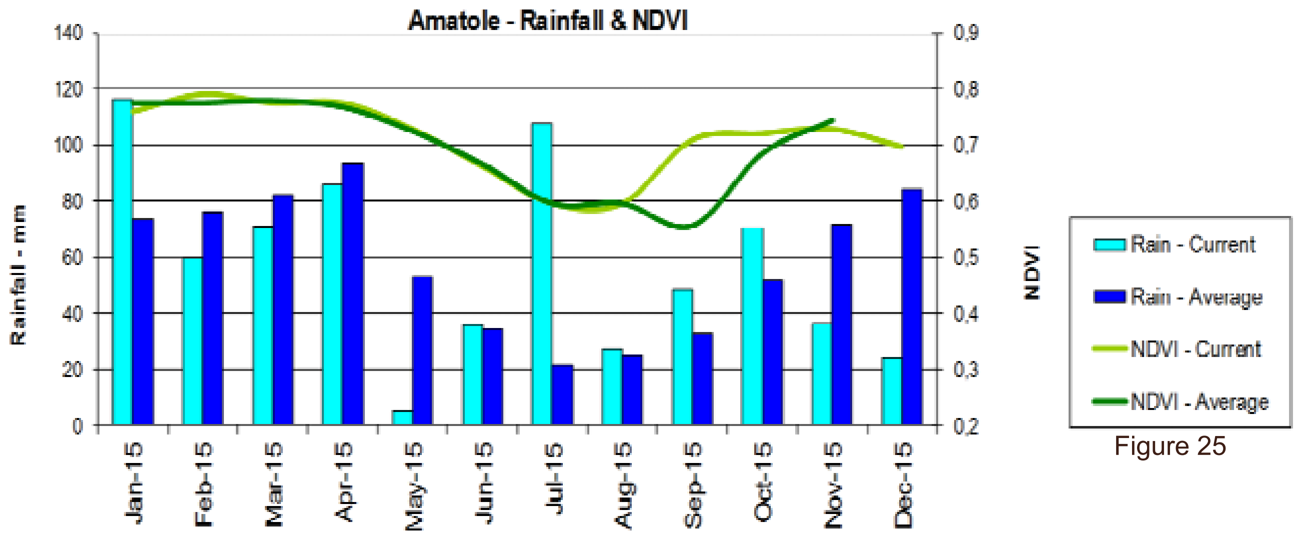


Figure 24

Figure 24



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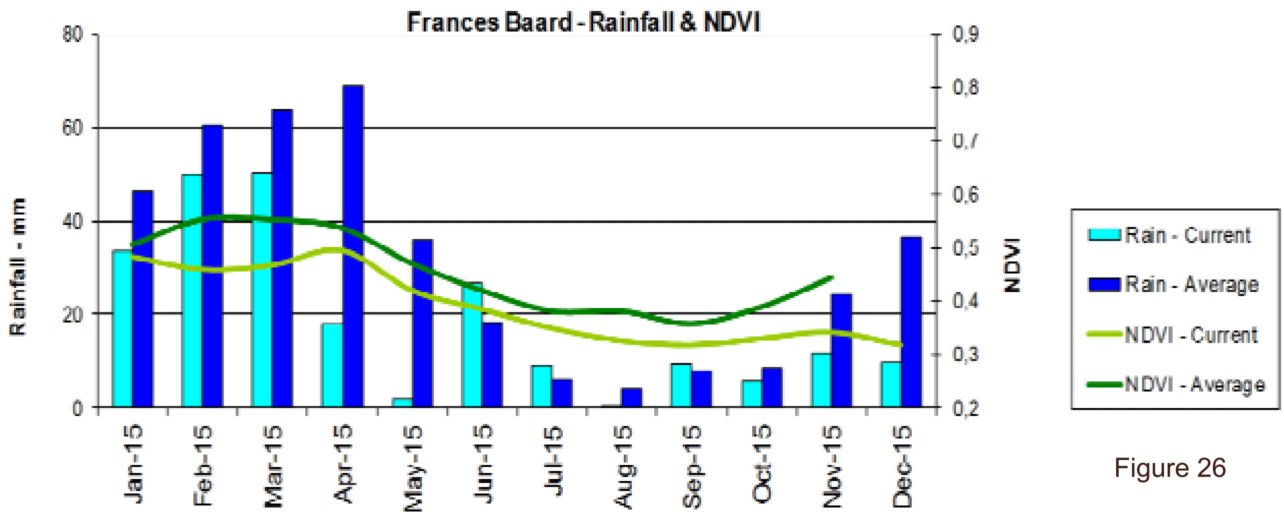
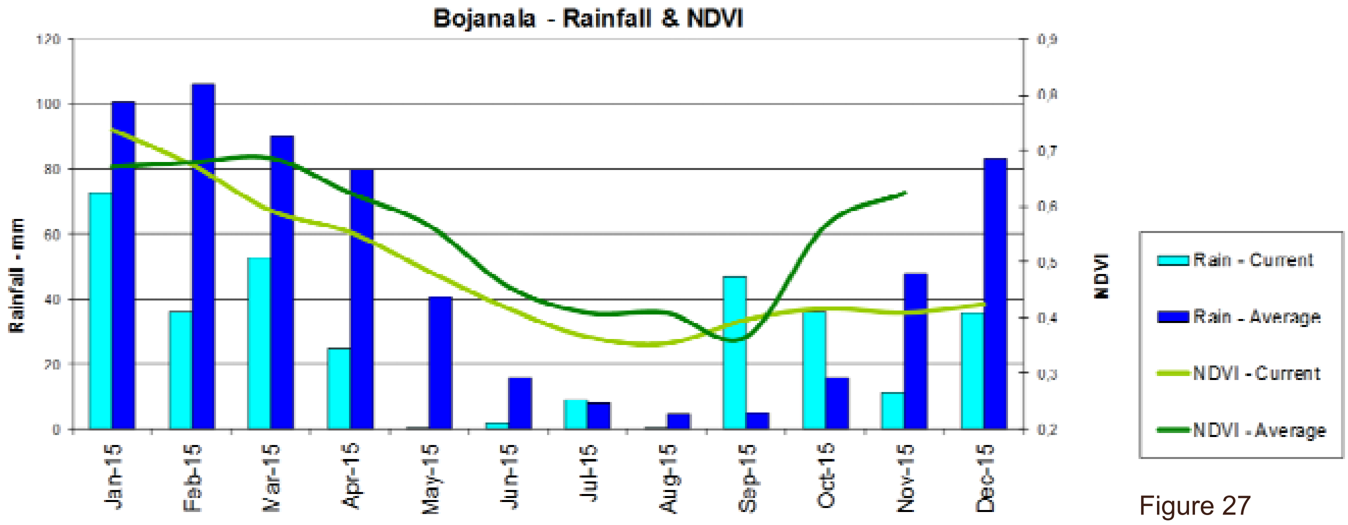


Figure 26



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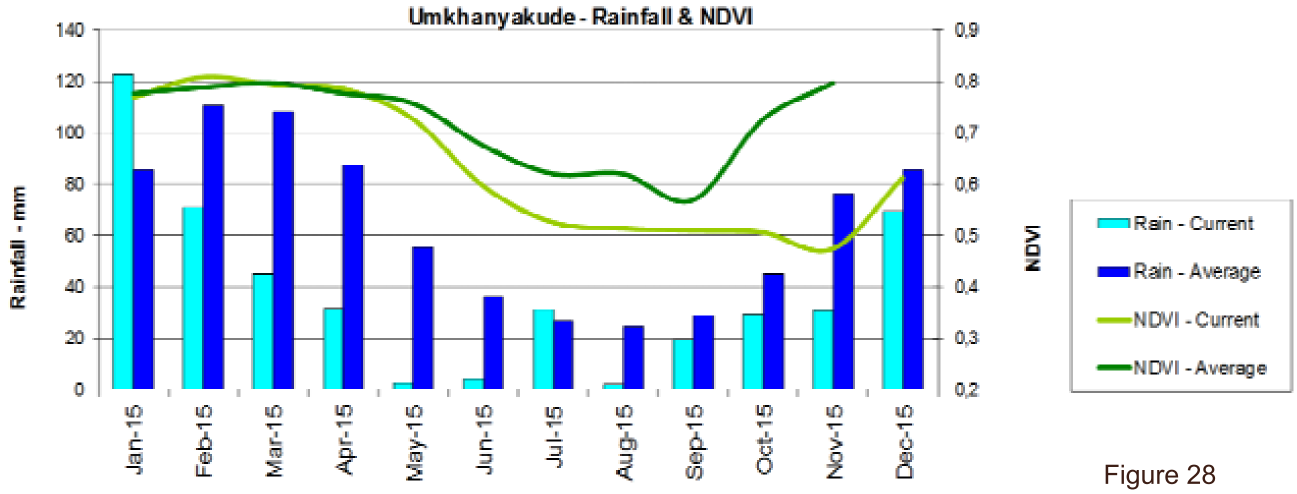

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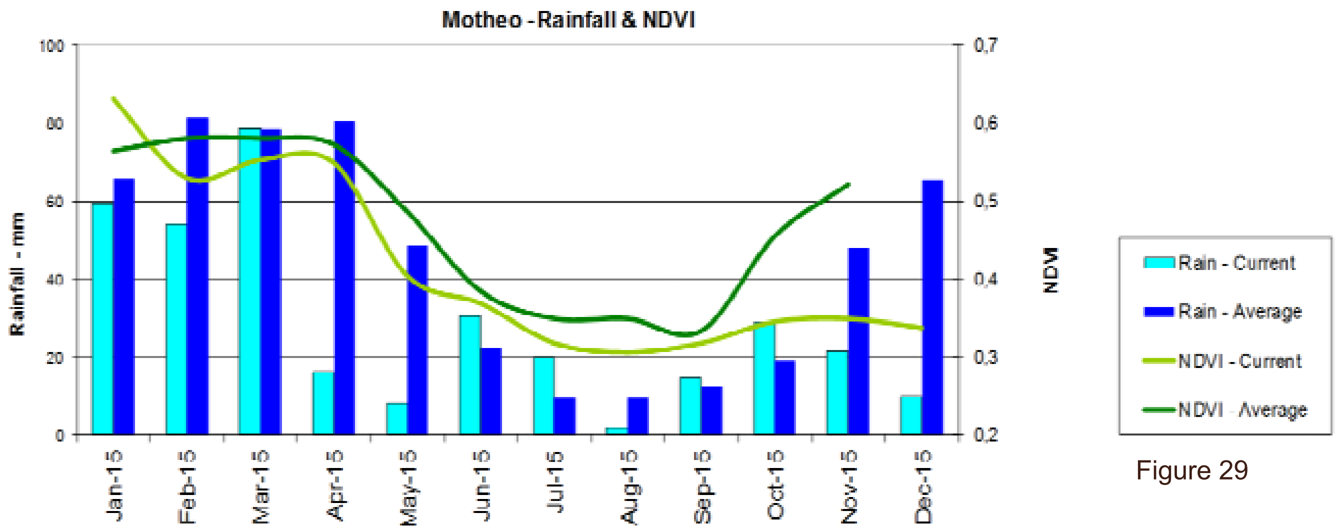

Figure 29

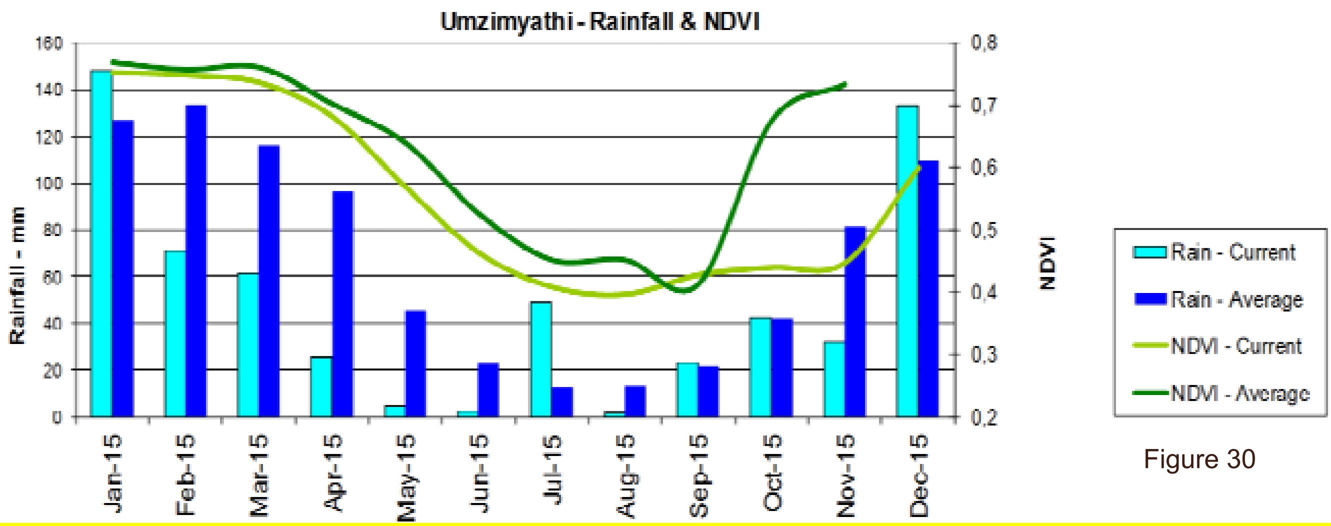

Figure 30

8. Soil Moisture

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

Figure 31 shows the monthly averaged soil moisture conditions for December 2015. 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 December and November 2015, with the brown colours showing the drier and the green colours the wetter areas. Similarly, the year-on-year SSI difference for December 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.

UNIVERSITY OF KWAZULU-NATAL

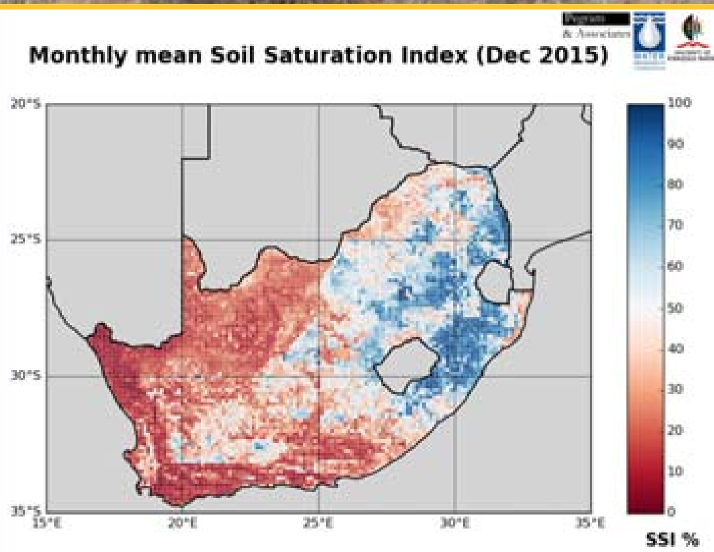

Figure 31

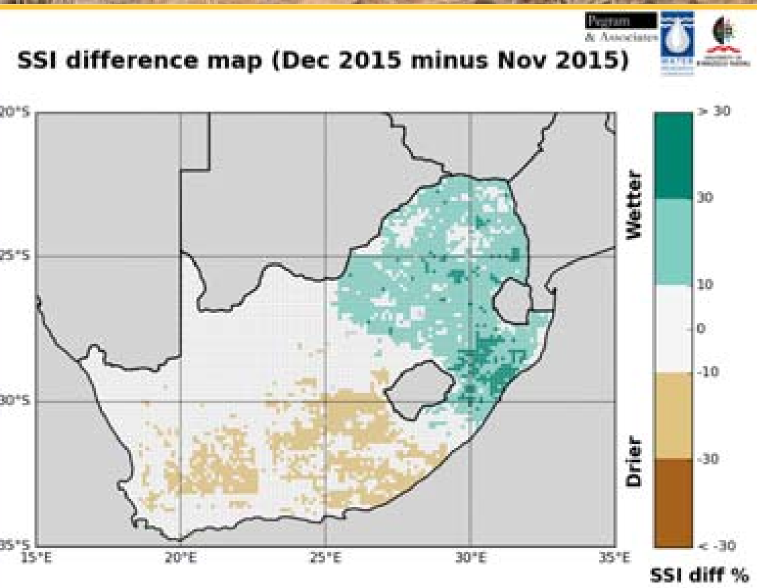

Figure 32

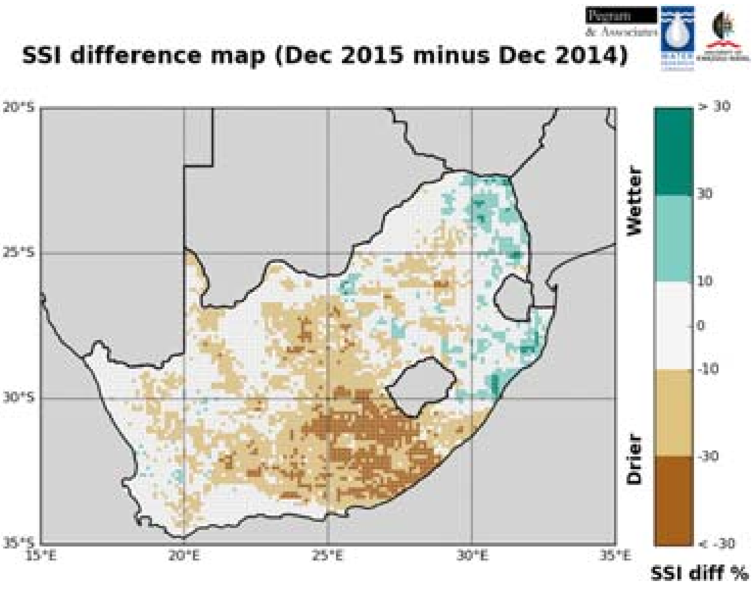

Figure 33

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 December per province. Fire activity was higher in the Eastern Cape, Free State, Mpumalanga, Limpopo and Western Cape, KwaZulu-Natal compared to the average during the same period for the last 14

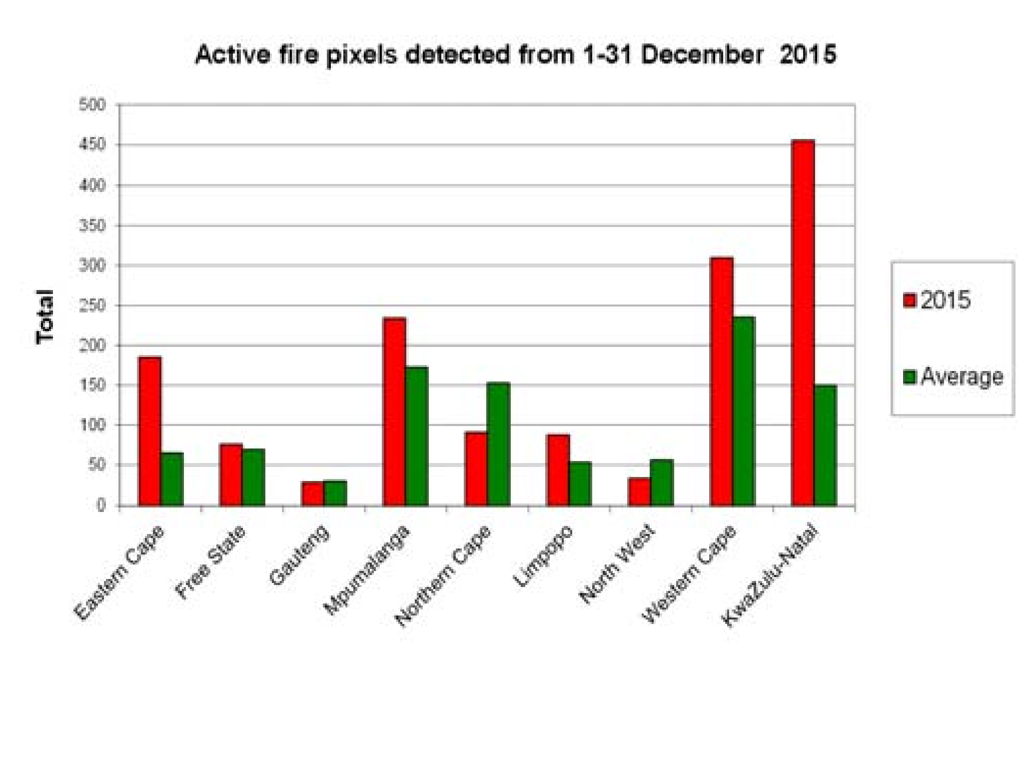

Figure 34

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

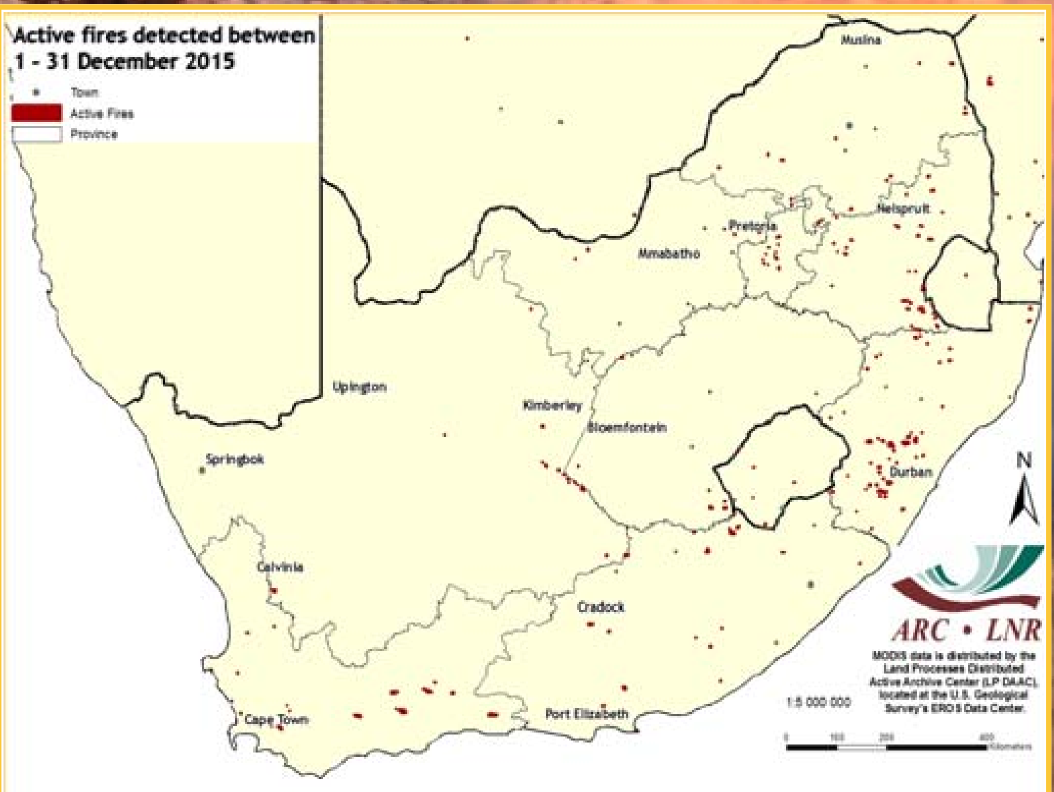

Figure 35

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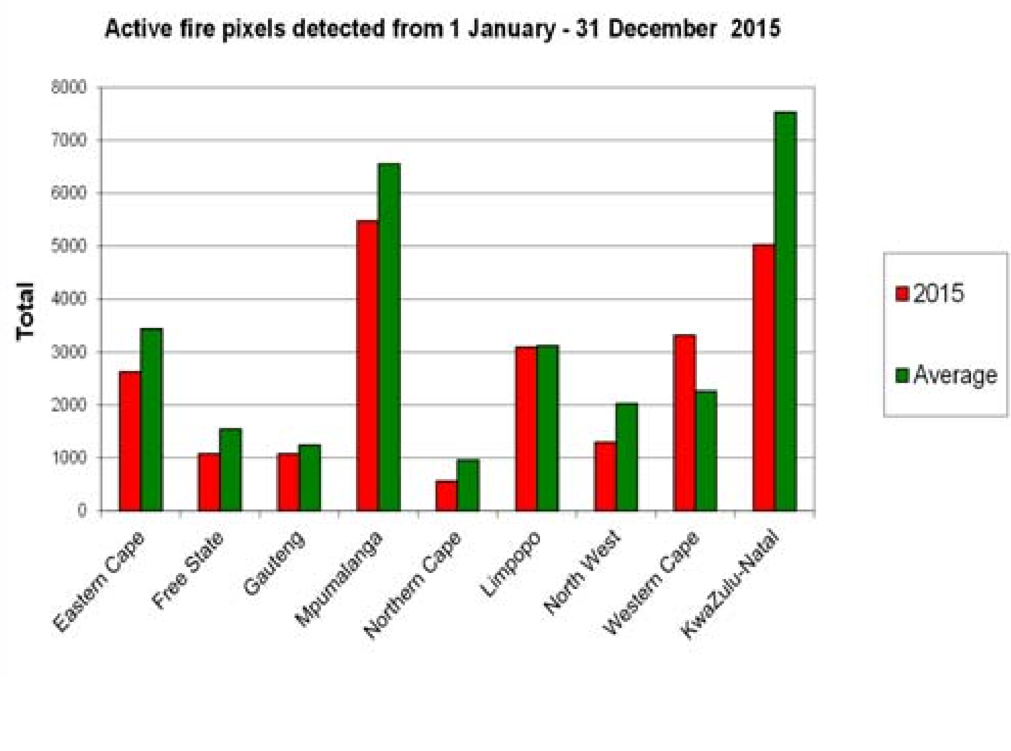

Figure 36

Figure 36:
The graph shows the total number of active fires detected between 1 January to 31 December 2015 per province. Fire activity was lower in all provinces except the Western Cape compared to the average during the same period for the last 14 years.

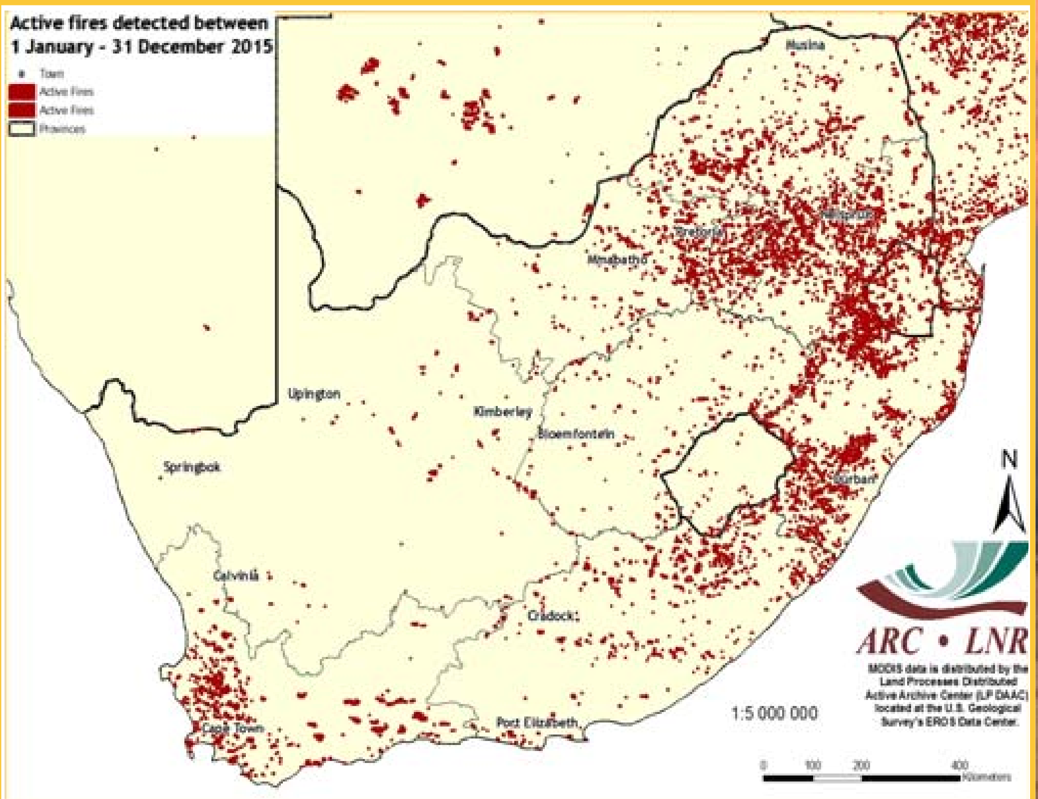

Figure 37

Figure 37:
The map shows the location of active fires detected between 1 January to 31 December 2015.

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ARC-INSTITUTE FOR SOIL, CLIMATE AND WATER

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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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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