ARC • LNR
Excellence in Agricultural Research and Development

UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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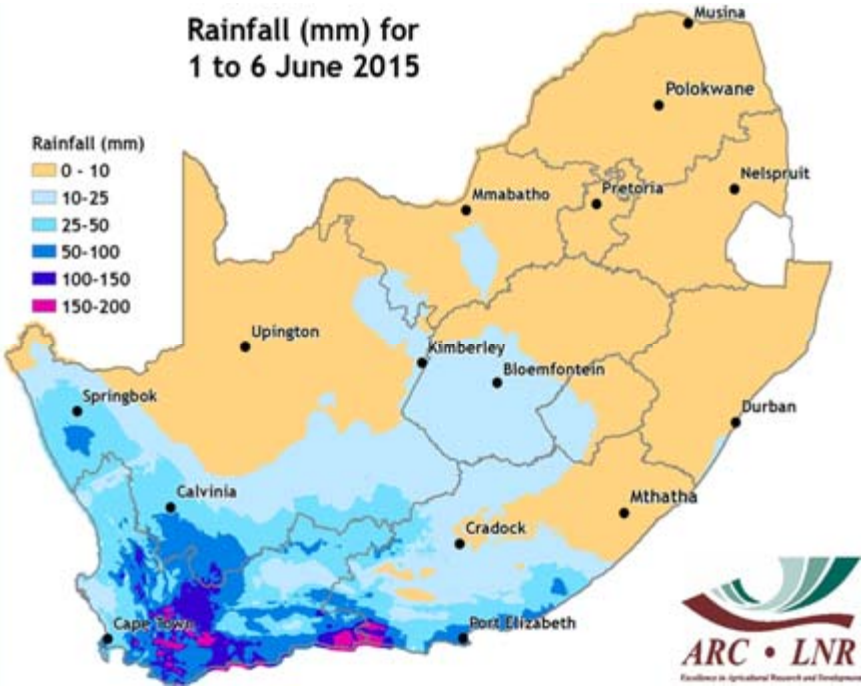
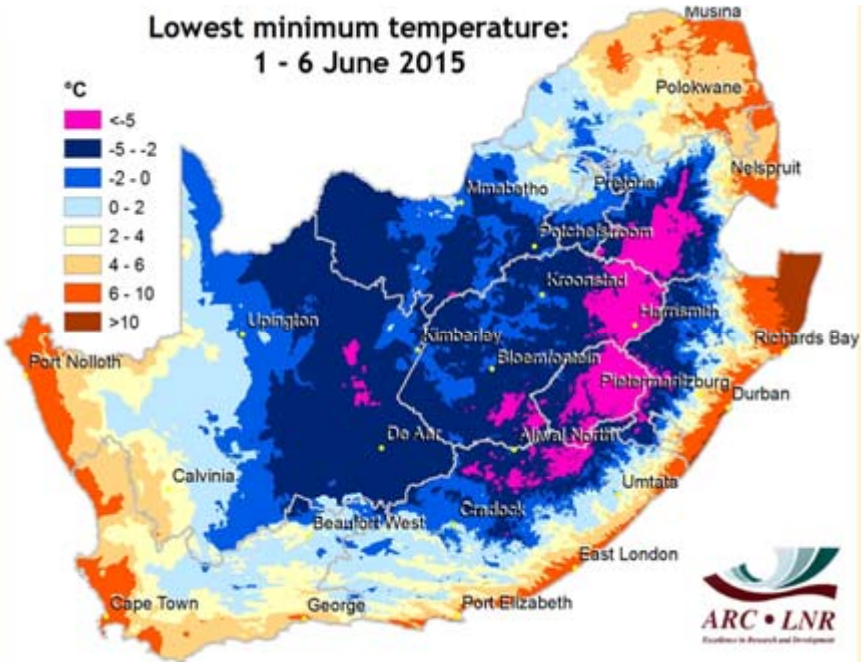
132nd Edition

Images of the Month





First widespread significant rain over winter rainfall region arrives by early June

The winter rainy season finally commenced by the end of May and more strongly in early June when widespread significant precipitation occurred over the entire winter rainfall region. Both the western and eastern wheat production areas benefitted from the rainfall event in early June. Due to dry conditions over the region during March to May, the rain was of critical importance for wheat production as planting had been completed to a large extent. While totals over the Swartland ranged between 25 and 50 mm (see top map), the Ruens recorded totals exceeding 50 mm in most places. This rain, together with more expected during early June, has improved expectations for a favourable growing season for winter grain production. An intense upper-air cut-off low and surface cold front with a strong surface onshore flow over the winter rainfall region were the main contributors to the rainfall event. Cold air associated with the southerly to westerly flow resulted in snow over the southern mountainous regions, as far north as the Drakensberg in KwaZulu-Natal. The system also resulted in widespread showers and thundershowers over the central to southern and southeastern interior, but totals remained below 25 mm. Temperatures over the interior plummeted due to the invasion of cold dry air from the west, leading to minimums below -5°C over the high-lying areas and the lowest minimum temperatures so far this winter over large parts (see second map) with frost in all nine provinces.

The rainfall and extreme minimum temperature maps are created from data recorded by the automatic weather station network of the ARC-ISCW, consisting of 450 operational stations across the country.

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

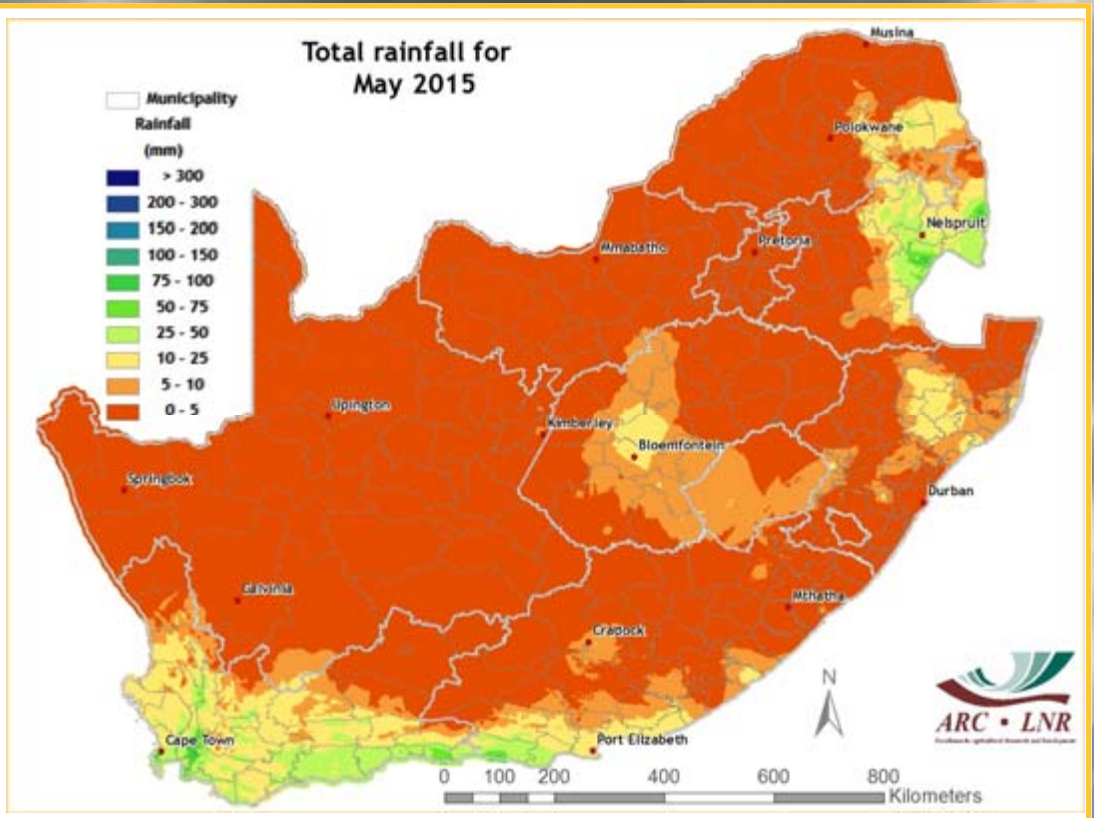
The Agricultural Research Council - Institute for Soil, Climate and Water (ARC-ISCW) collected the data, generated the products and compiled the information contained in this newsletter, as part of the Coarse Resolution Imagery Database (CRID) project that was funded by the Department of Agriculture 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:

May 2015 was dry and mild for the most part over both the summer and winter rainfall regions. Temperatures remained above normal as anticyclonic conditions resulted in clear skies. The summer rainfall region remained dry throughout most of the month, except for wetter conditions around the 10th. An upper-air trough moving across the country resulted in isolated to scattered thundershowers over the central to eastern parts from the 9th to the 11th with significant falls at some stations in the Lowveld of Mpumalanga. Isolated showers occurred over the northeastern parts from the 8th due to the ridging of an anticyclone around the country, resulting in the influx of moisture over the interior. As an upper air trough deepened over the country from the 9th, conditions became favourable for scattered thundershowers over the central parts, finally spreading to the east on the 10th to 11th. Conditions had cleared by the 13th, with a return to clear and stable conditions across the interior, lasting until the end of the month.

Cold fronts were confined to the southern parts during May, with the cold air never reaching the northeastern parts of the country. The most significant systems resulting in a drop in temperatures over the interior occurred at the beginning of the month (a system that made landfall in late April), by the 13th (following the rainfall event over the central parts) and again by the end of the month. The frontal activity by the 12th also resulted in rain over the winter rainfall region, but falls were light. Frontal systems resulted in more significant showers over the western and southern parts of the winter rainfall region during the last 5 days of the month, in a build-up towards the significant rainfall event of early June.



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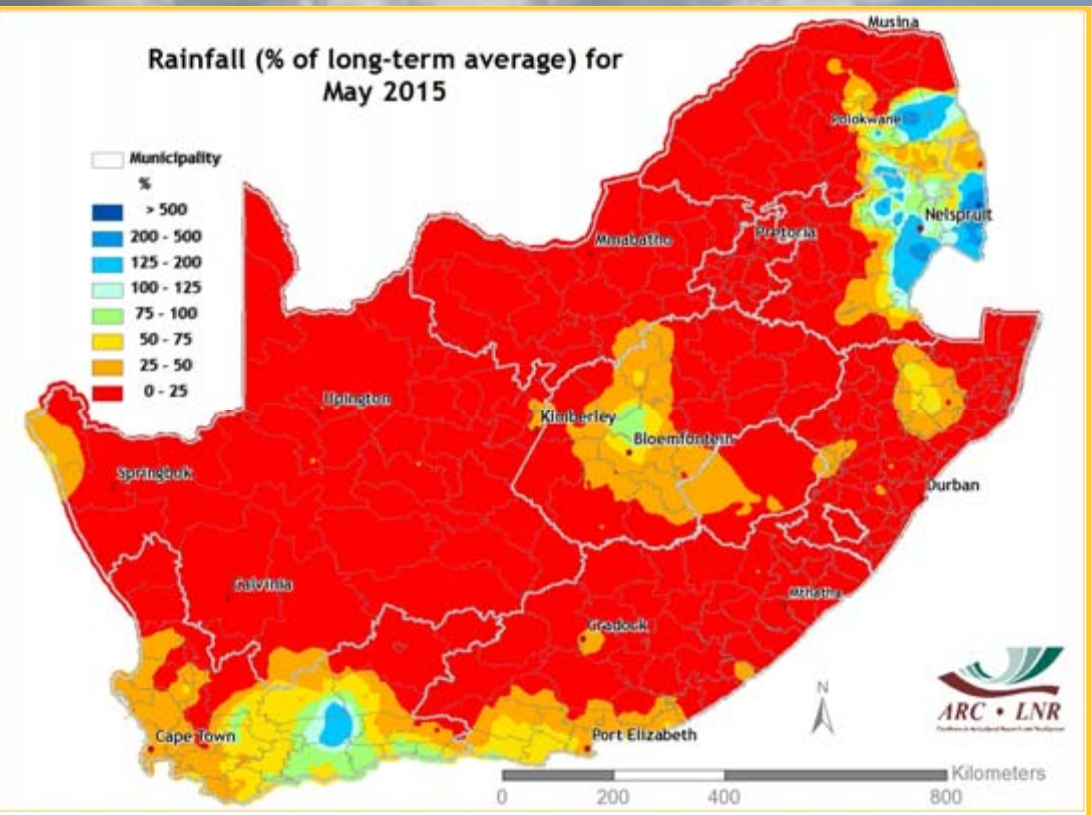

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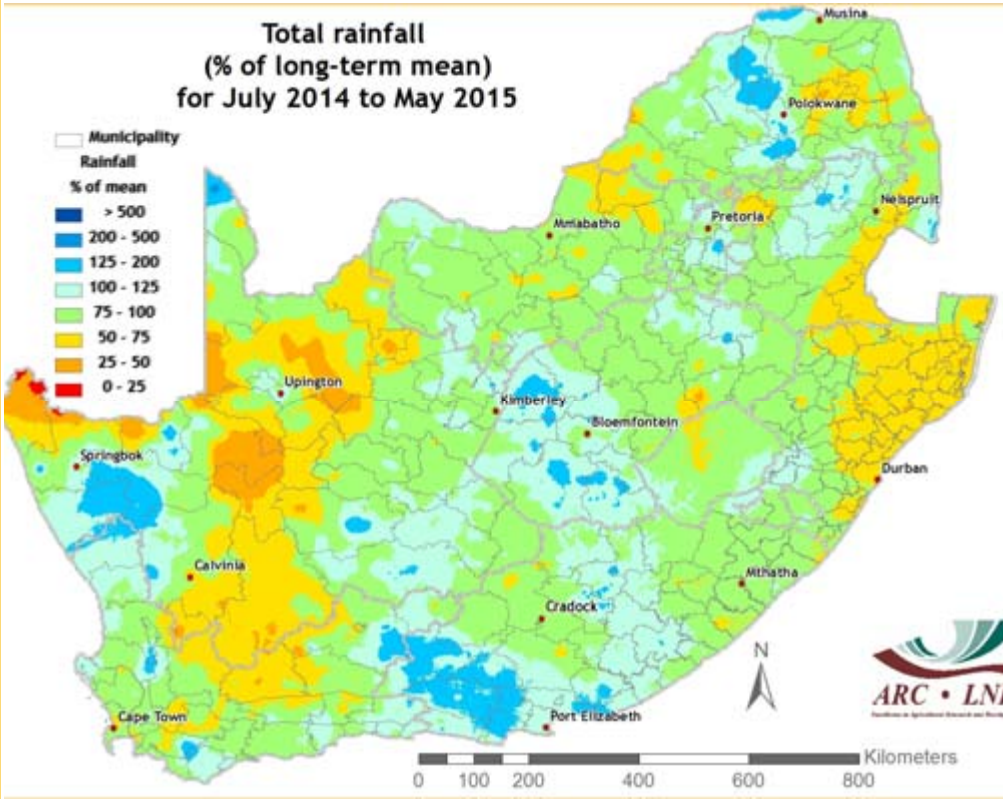

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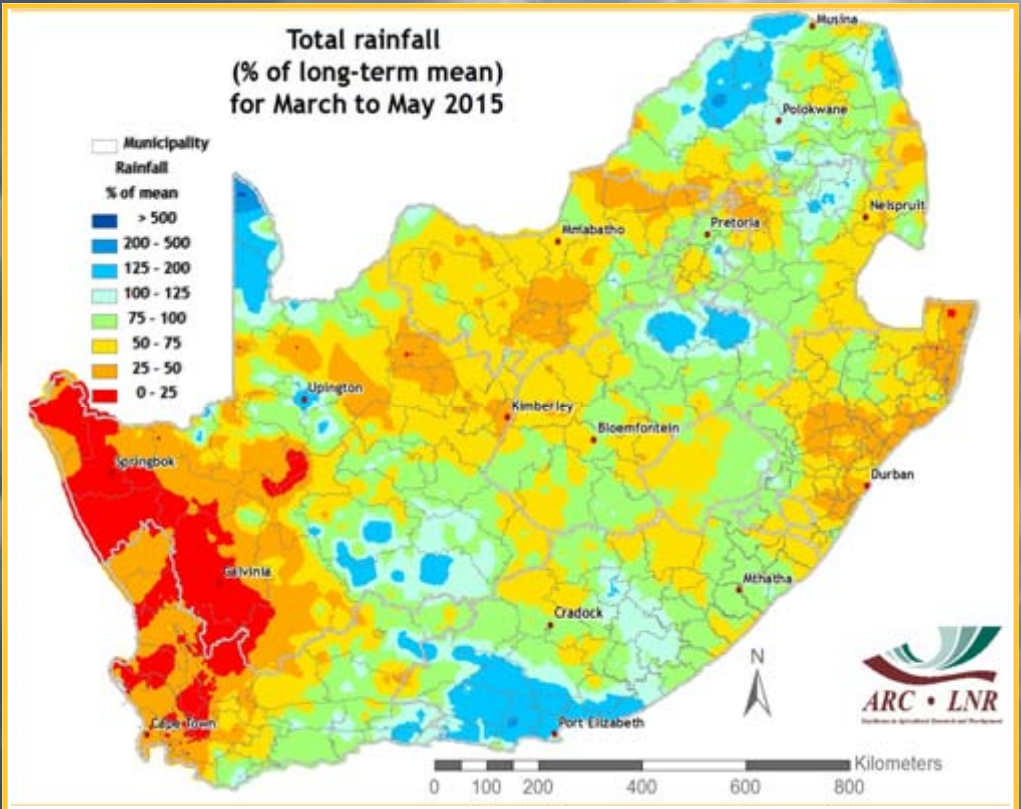

Figure 4

Figure 1:
The southwestern parts of the winter rainfall region and eastwards along the Garden Route received between 10 and 50 mm of rain during May. Parts of the Free State and KwaZulu-Natal received some rain while central to eastern Mpumalanga and southeastern Limpopo recorded totals ranging mostly between 5 and 50 mm, with larger totals towards the southeast.

Figure 2:
Rainfall during May was below normal over most parts, except for eastern Mpumalanga and southeastern Limpopo.

Figure 3:
Since July 2014, cumulative precipitation has been normal to above normal over the central interior, isolated areas in the northeast and the northern parts of the winter rainfall region. The eastern parts of KwaZulu-Natal, southeastern Mpumalanga and Limpopo and well as the central and southwestern parts of the Northern Cape received below-normal cumulative rainfall.

Figure 4:
Much of the north and northeast as well as the southwestern parts of the country received less rain in the 3-month period ending May 2015 than in 2014. The northeastern and northern Free State and isolated areas in the southern interior received more rain than in 2014 for the same 3-month period.

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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 dominate the northern parts of KwaZulu-Natal and southern Mpumalanga at the 12- and 24-month time scales, with wet conditions evident over the northeastern parts of the country at the longer time scale. The late start to the winter rainy season is clearly noticeable in the extreme drought conditions observed over the southwestern parts of the country at the 3- and 6-month time scales.

Questions/Comments:
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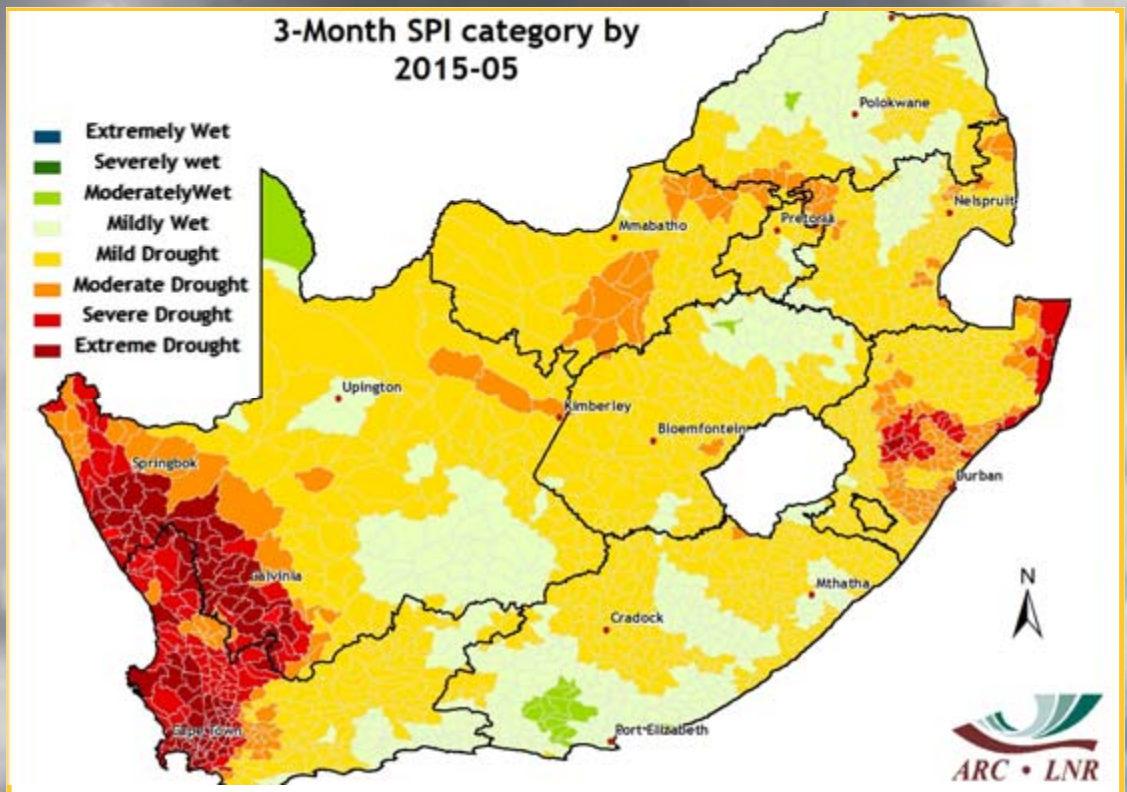

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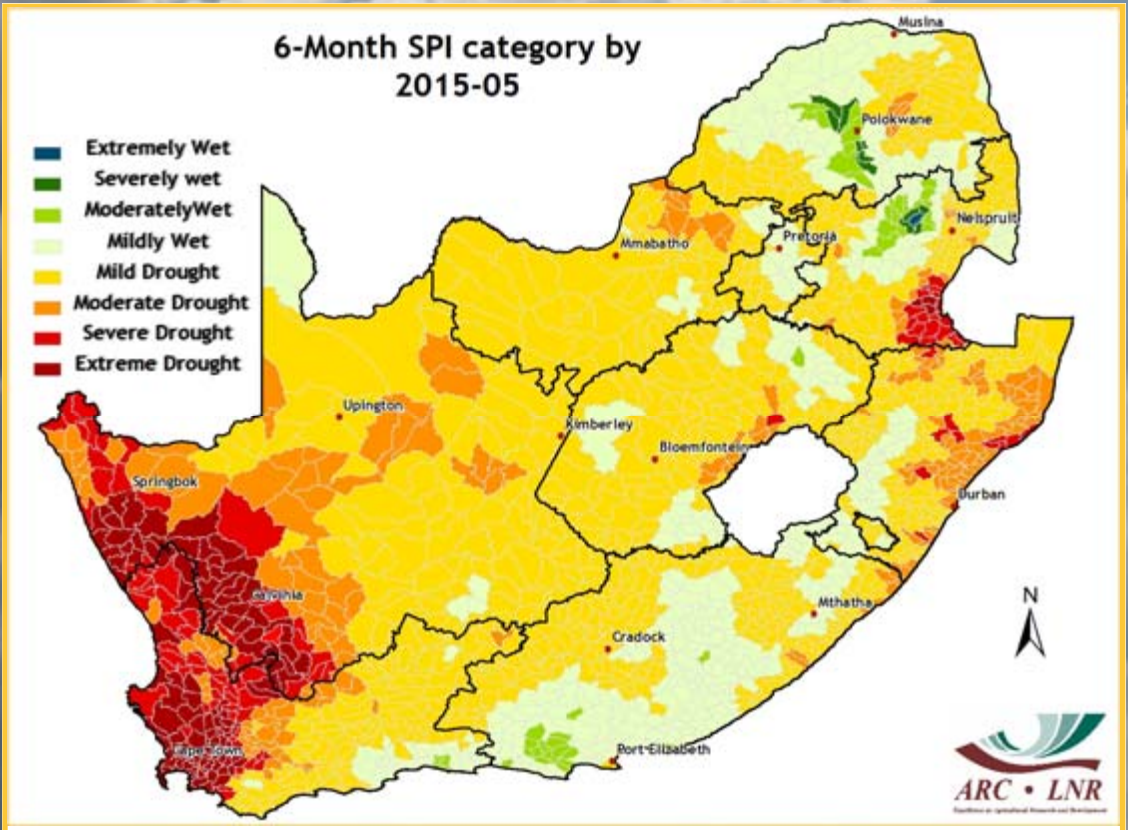

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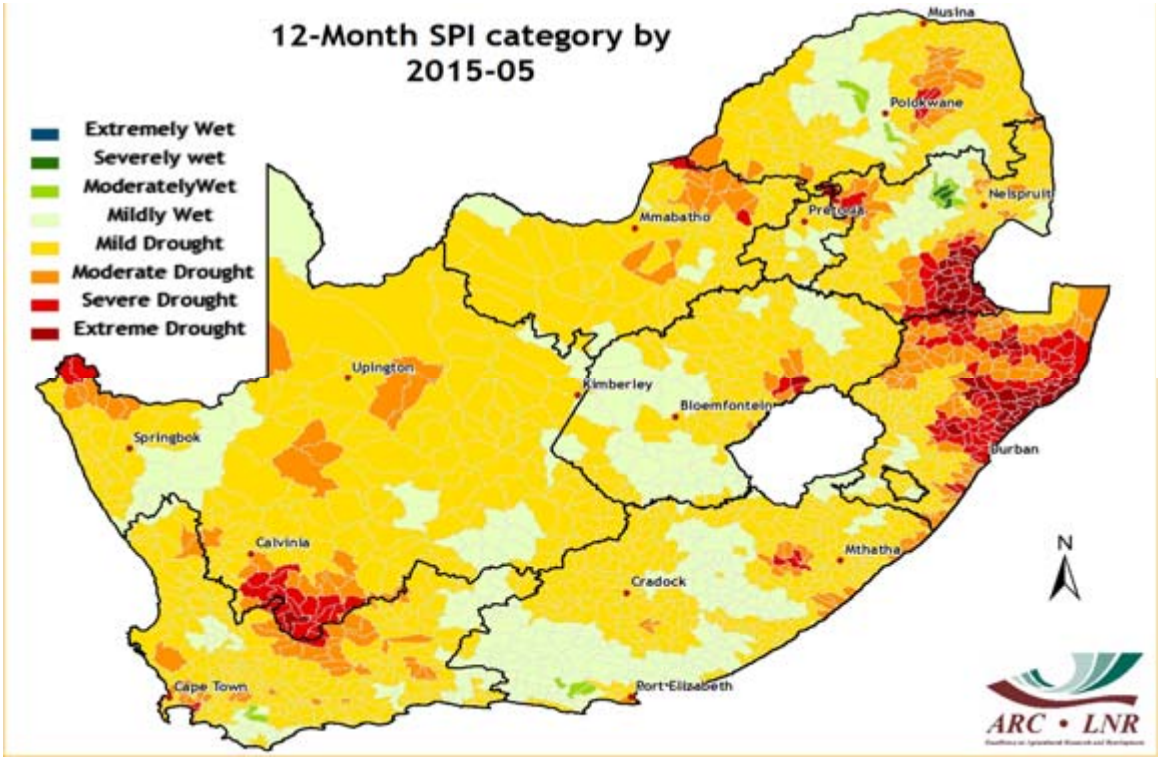

Figure 7

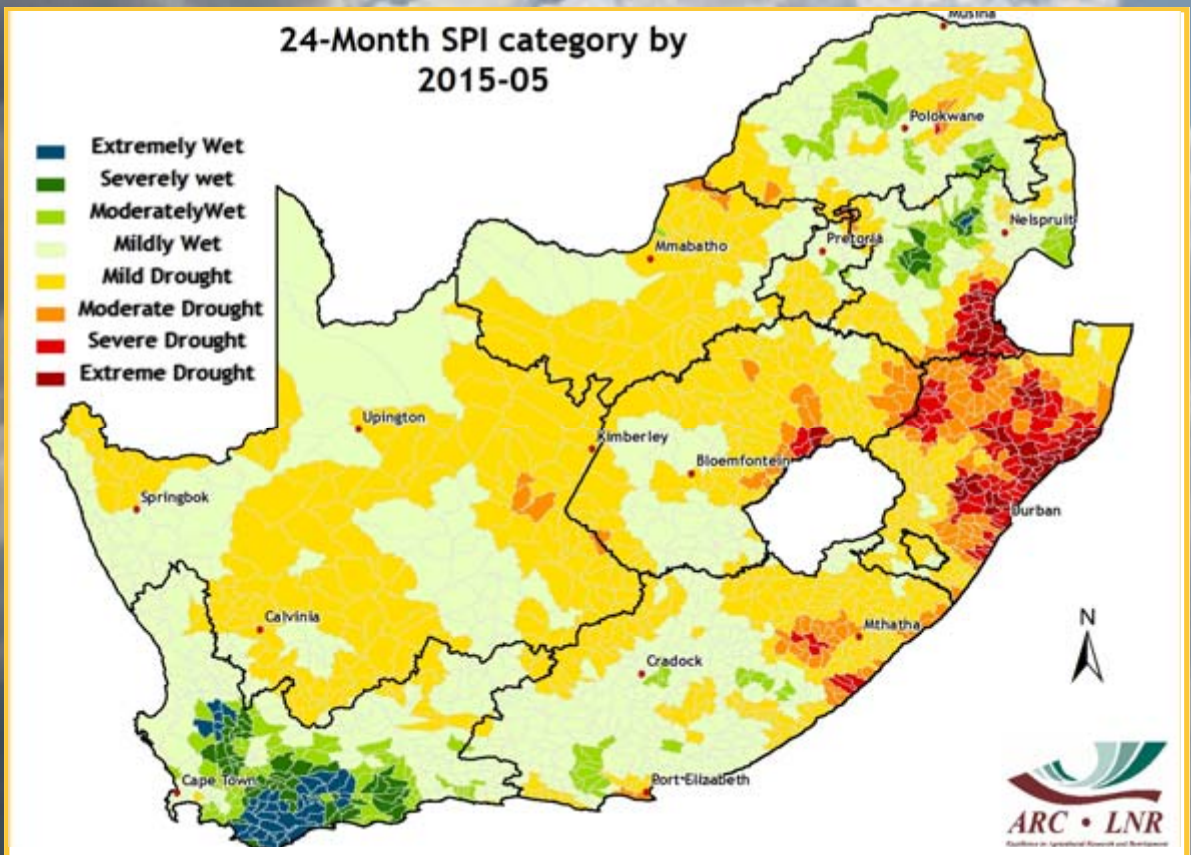

Figure 8

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.

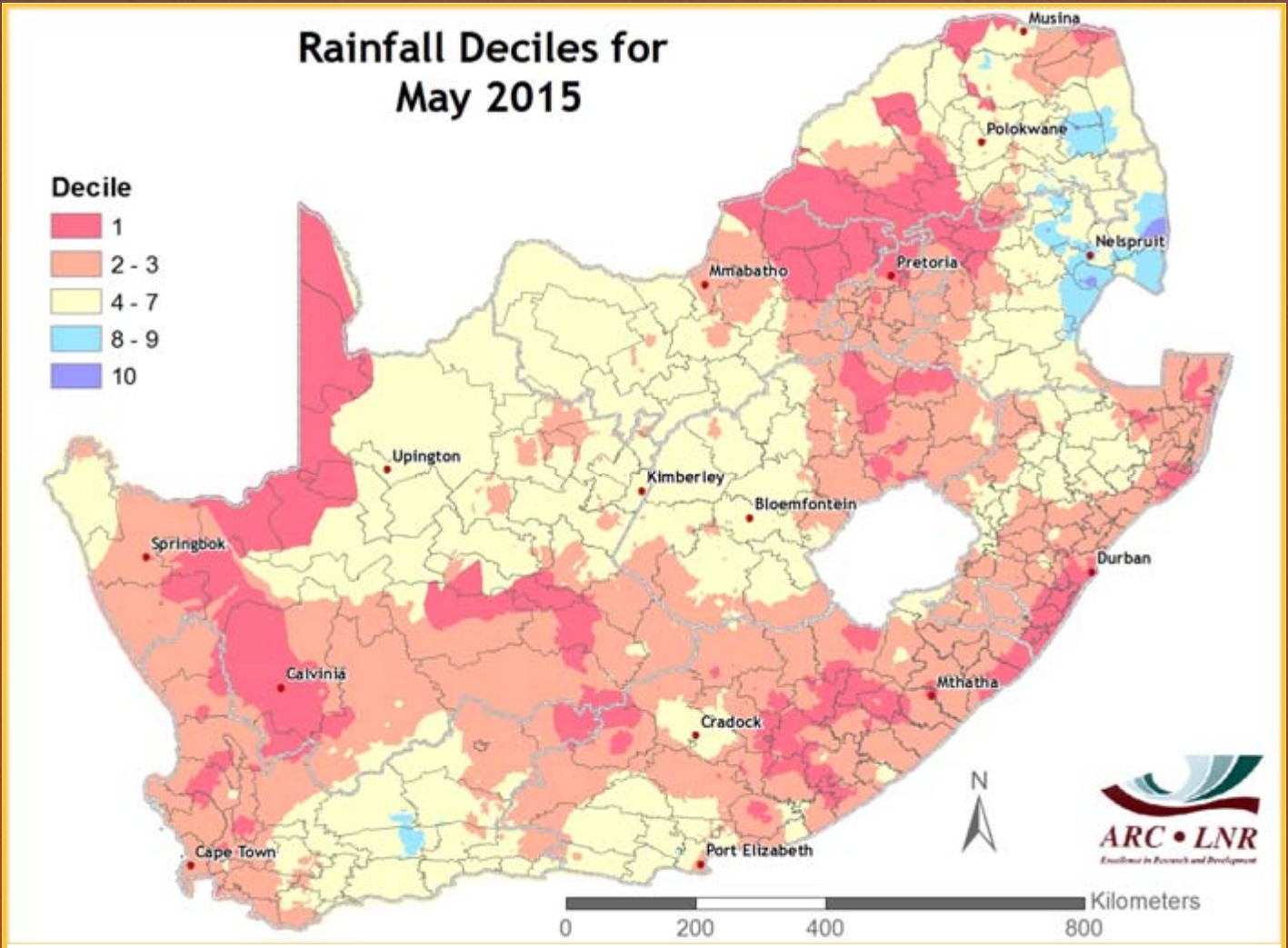

Figure 9

Figure 9:
The eastern parts of Mpumalanga recorded abnormally high rainfall totals in May while large parts of the southern interior including parts of the western winter rainfall region were exceptionally dry.

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

4. Water Balance

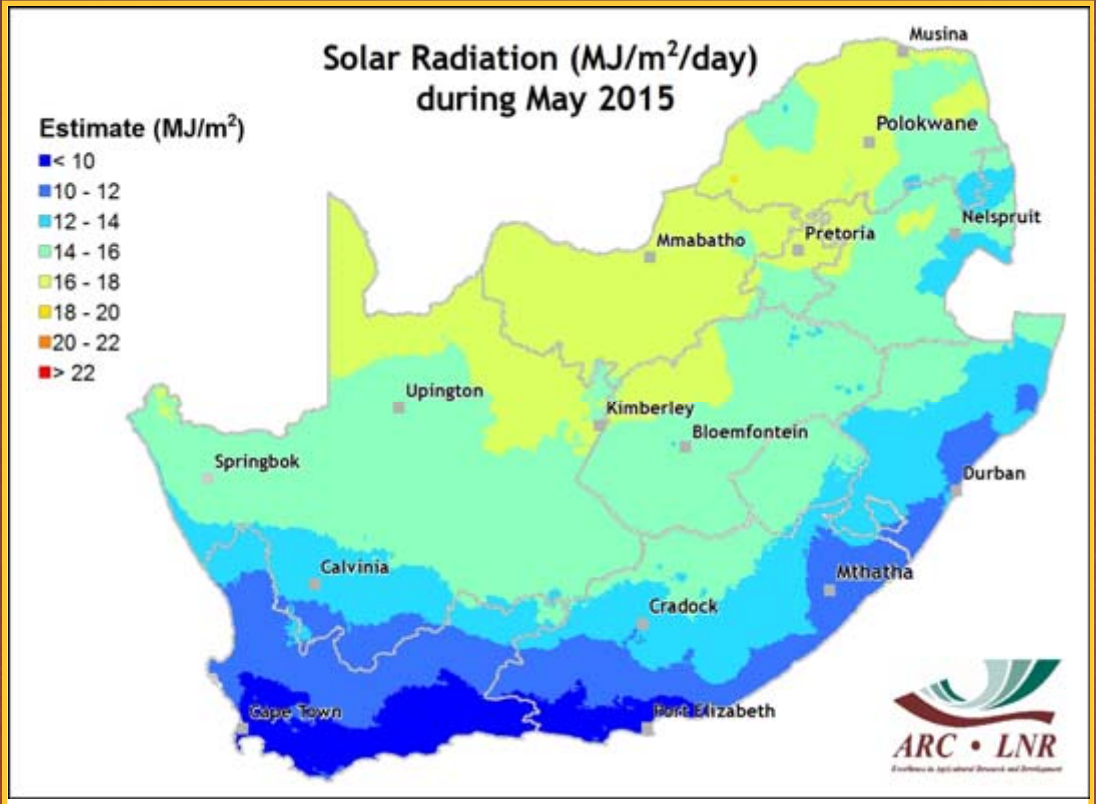

Figure 10

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:
Solar radiation values were high during May, especially over the northern parts of the country. Cloud cover resulted in low values along the southern and eastern coastal belts.

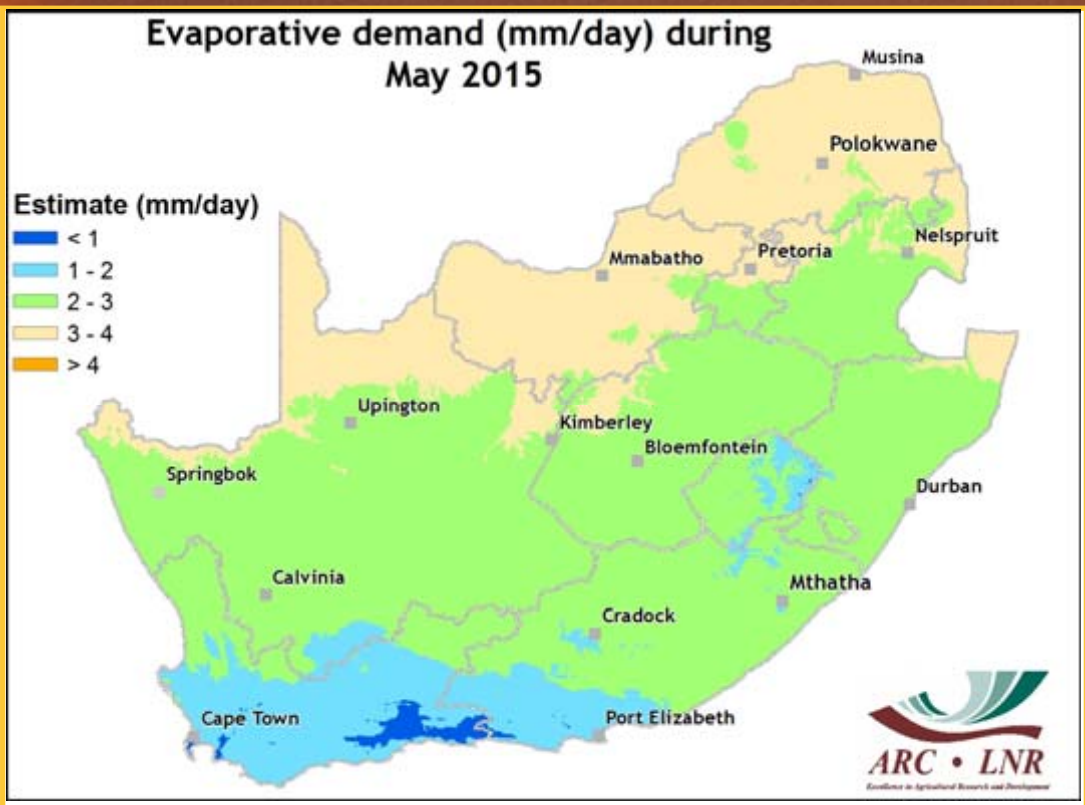

Figure 11

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 evapotranspiration ranged from less than 1 mm/day over parts of the Garden Route to between 3 and 4 mm/day in the northern parts of the country.

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.

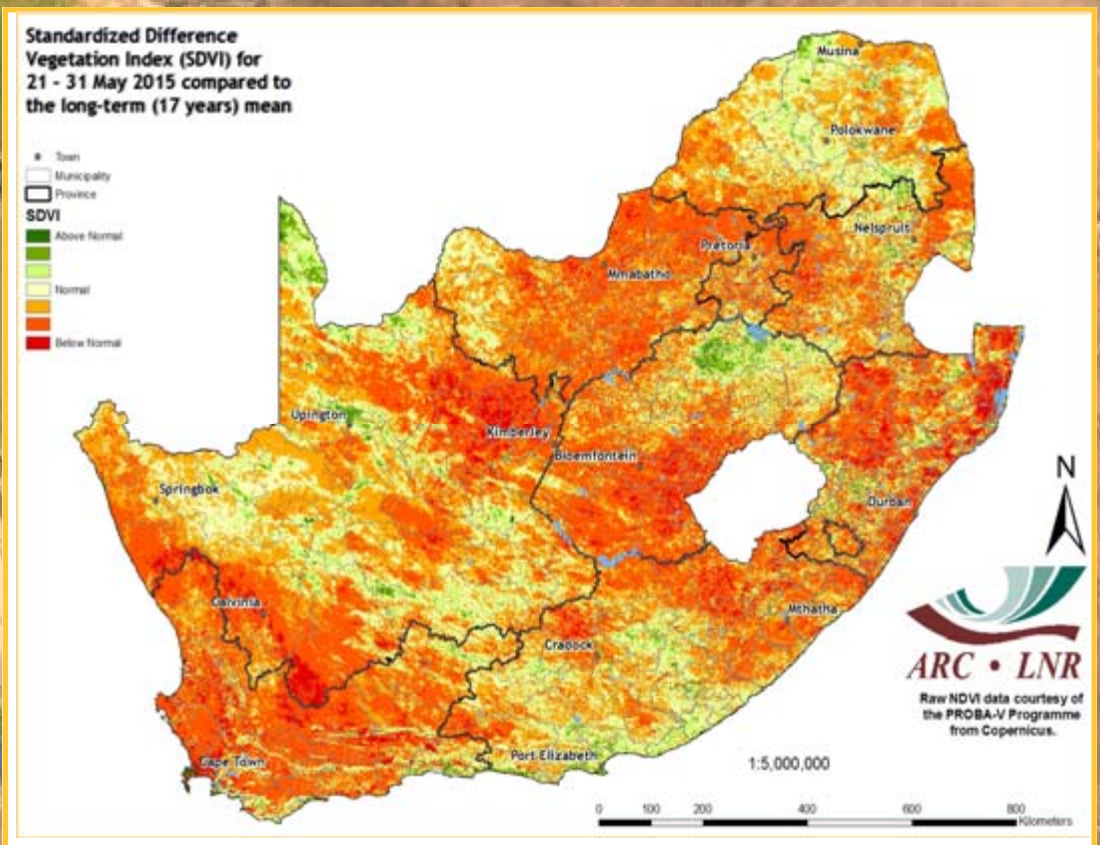

Figure 12

Figure 12:
The SDVI map shows drought stress over the winter rainfall region, western to central parts of the summer rainfall region (focussing on the northeastern parts of the Northern Cape), as well as a band stretching northwest-southeast from southwestern Limpopo to northern KwaZulu-Natal. Above-normal vegetation activity is indicated over much of the southeastern and northeastern parts as well as the northeastern Free State.

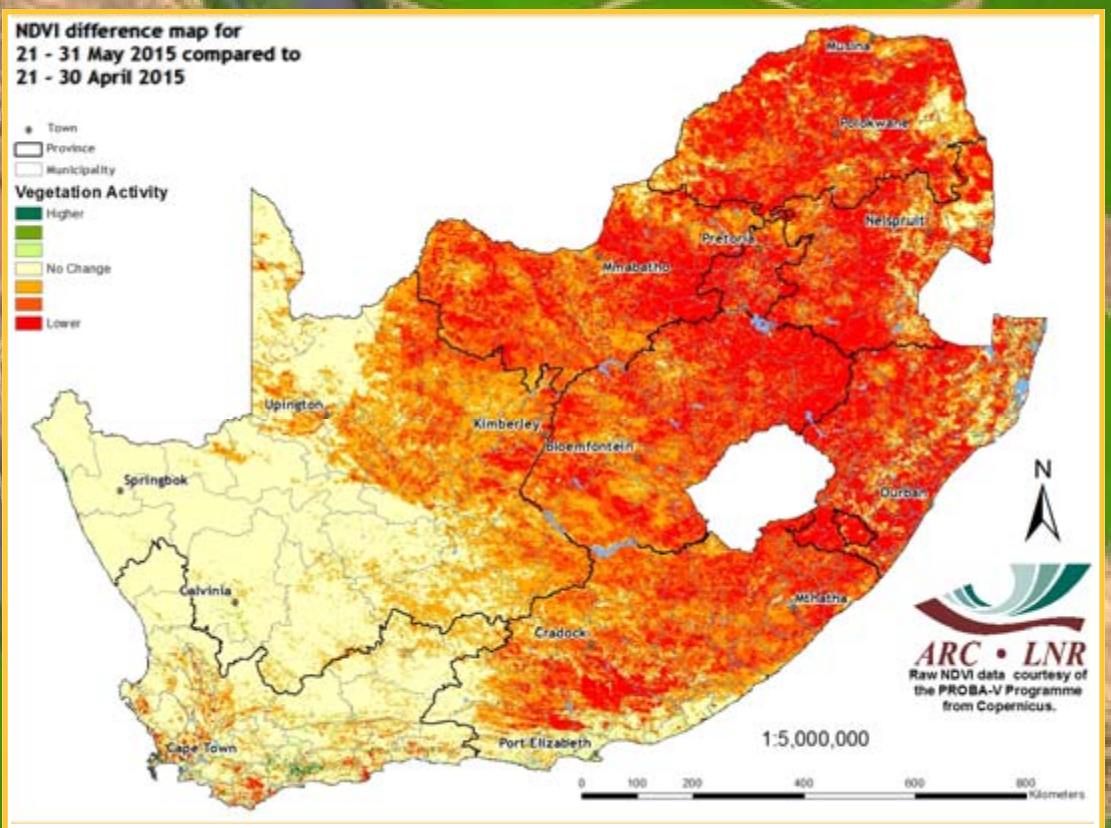

Figure 13

Figure 13:
Dry conditions and low minimum temperatures have resulted in large decreases in vegetation activity over the summer rainfall region. There has been little to no change over the winter rainfall region where the first significant rain only occurred by the end of May and early June.

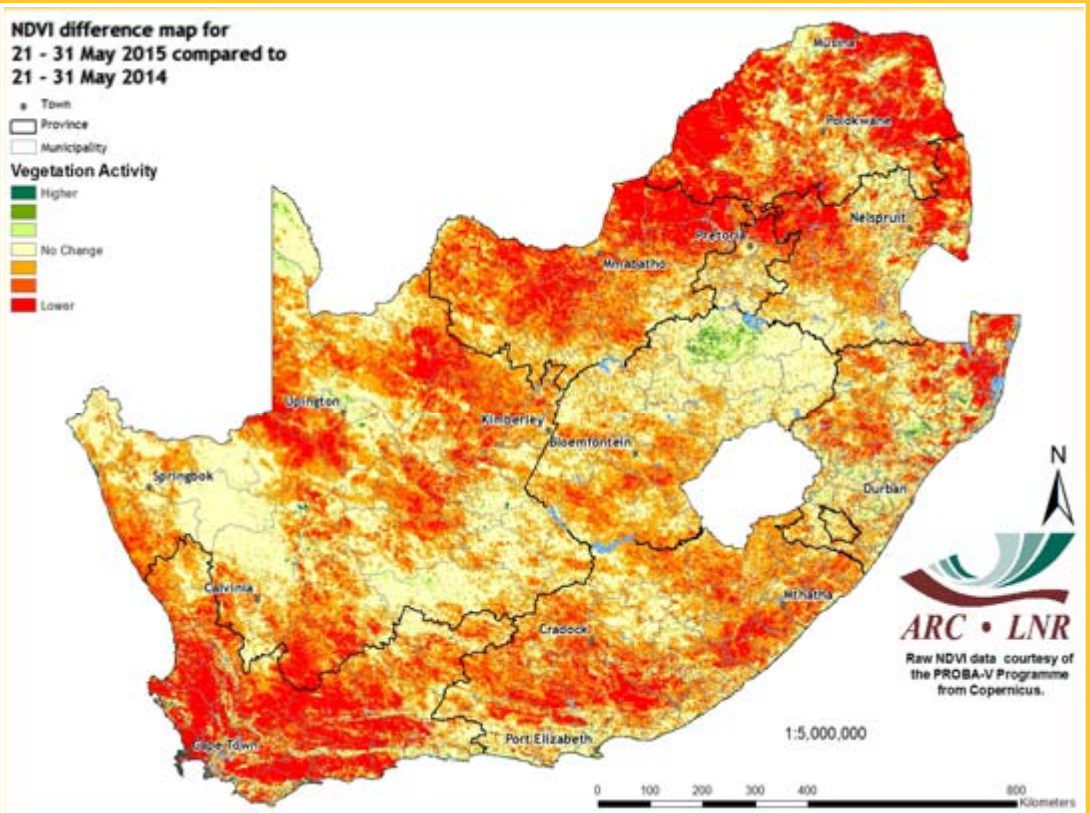

Figure 14

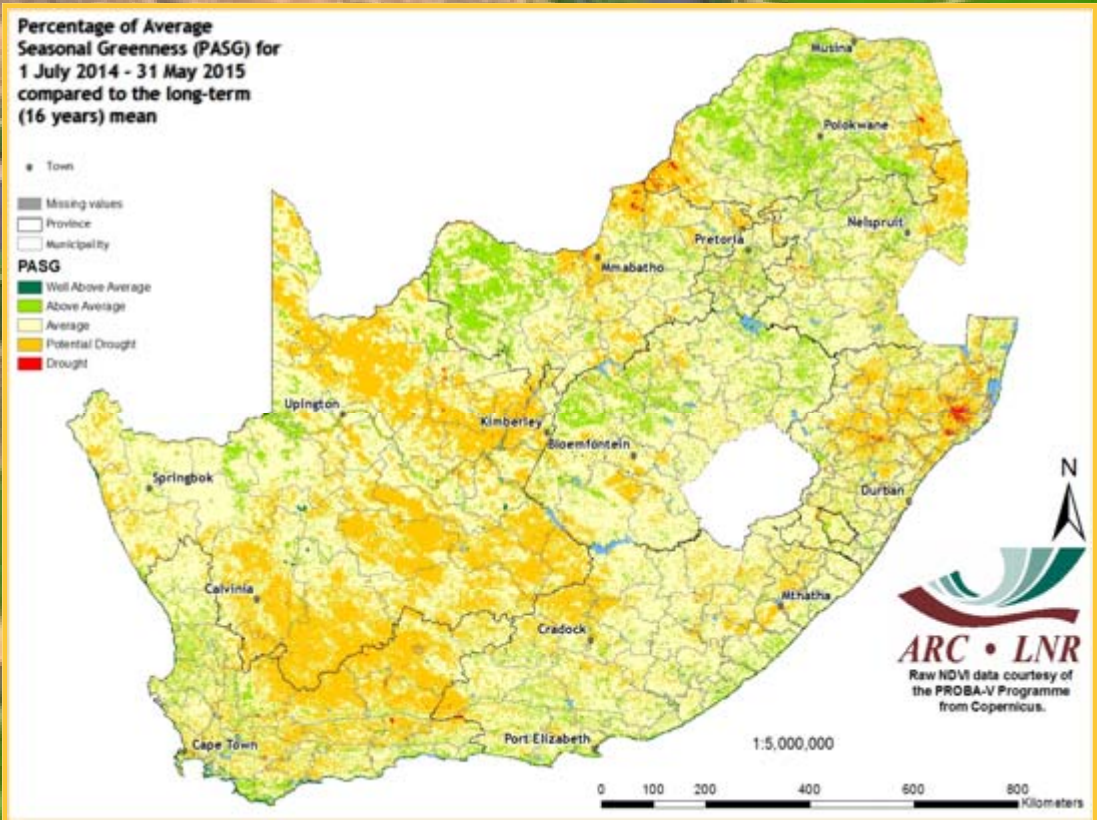

Figure 15

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:
With the exception of a few areas scattered throughout the country, most significantly the northern parts of the Free State, vegetation activity is lower than last year, especially over the winter rainfall region (due to the later start of the rainy season this year) and the northeastern parts (due to less rain during May 2015 compared to May 2014.)

Figure 15:
Cumulative vegetation activity is still normal to above normal over much of the interior (due to wet conditions during November and December and again by late February to April in some places.). Notable exceptions are the eastern parts of KwaZulu-Natal, eastern Mpumalanga, extreme southwestern and southeastern Limpopo and southern parts of the Northern Cape.

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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.

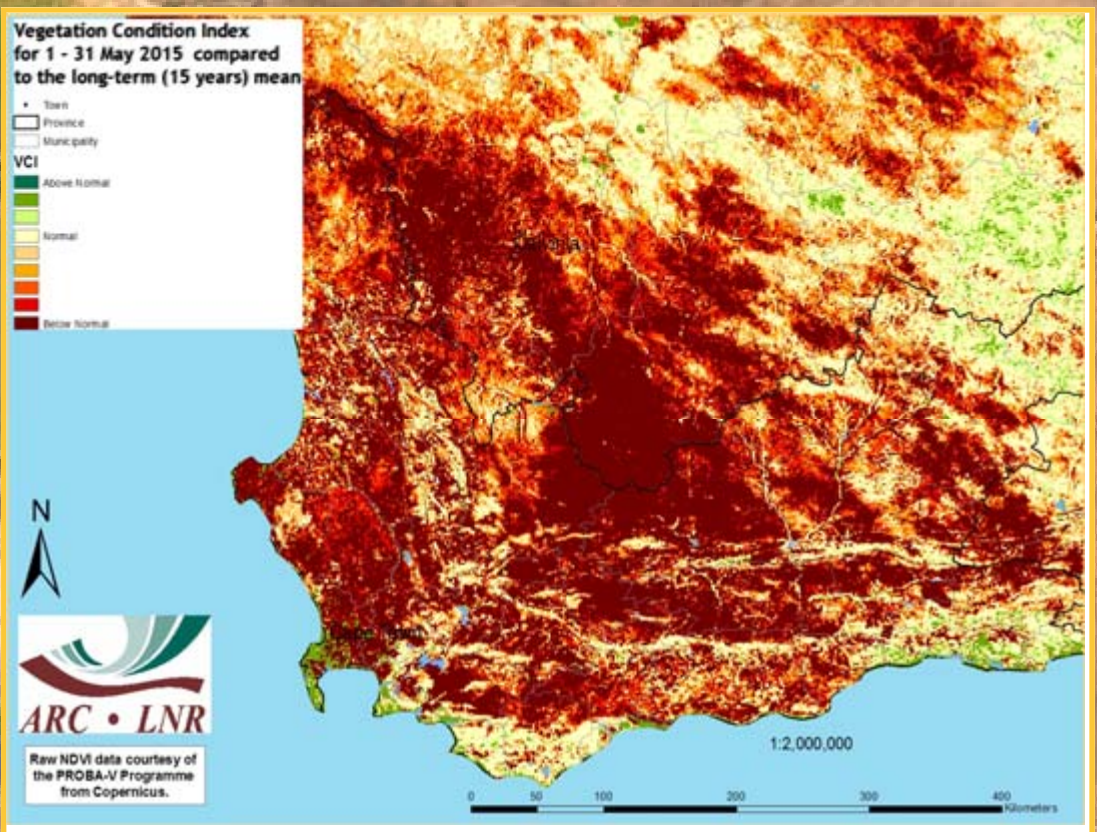


Figure 16

Figure 16:
The VCI map for May indicates below-normal vegetation activity over most parts of the Western Cape.

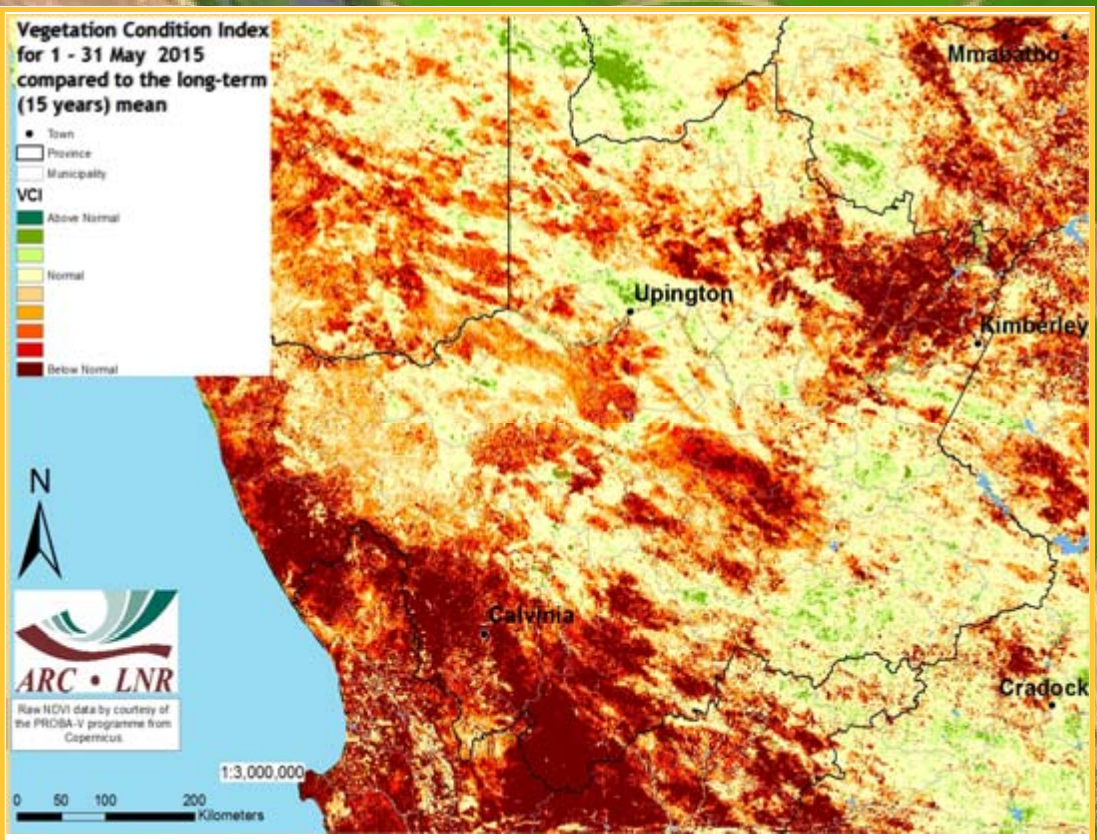
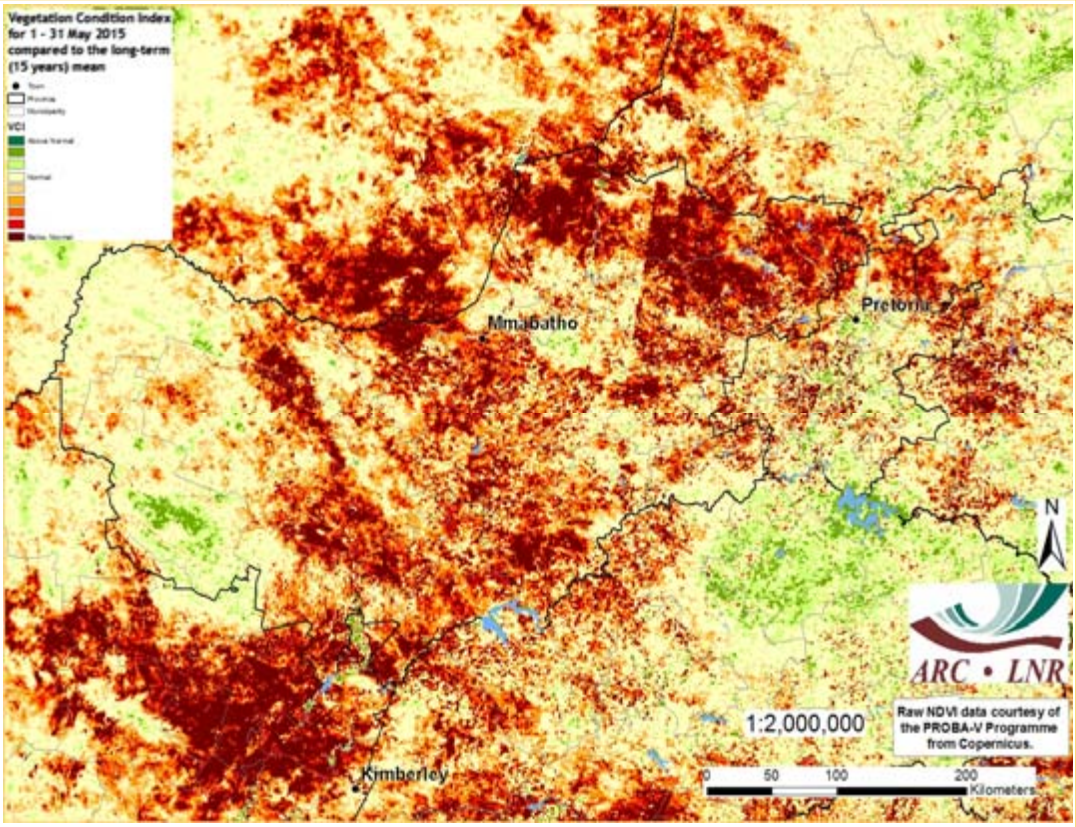


Figure 17

Figure 17:
The VCI map for May indicates below-normal vegetation activity over most parts of the Northern Cape.



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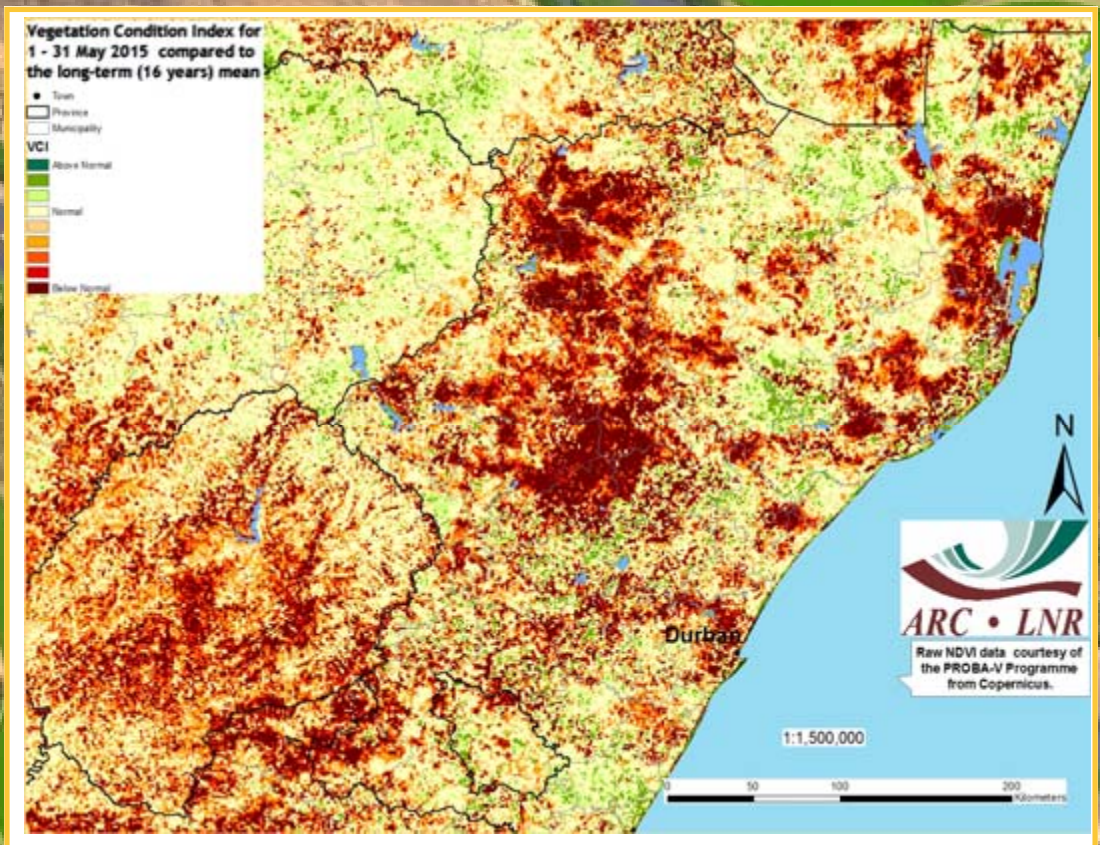


Figure 19

Figure 18:
The VCI map for May indicates above-normal vegetation activity over most parts of North West.

Figure 19:
The VCI map for May indicates below-normal vegetation activity over most parts of KwaZulu-Natal.

Questions/Comments:
NkambuleV@arc.agric.za

7. Vegetation Conditions & Rainfall

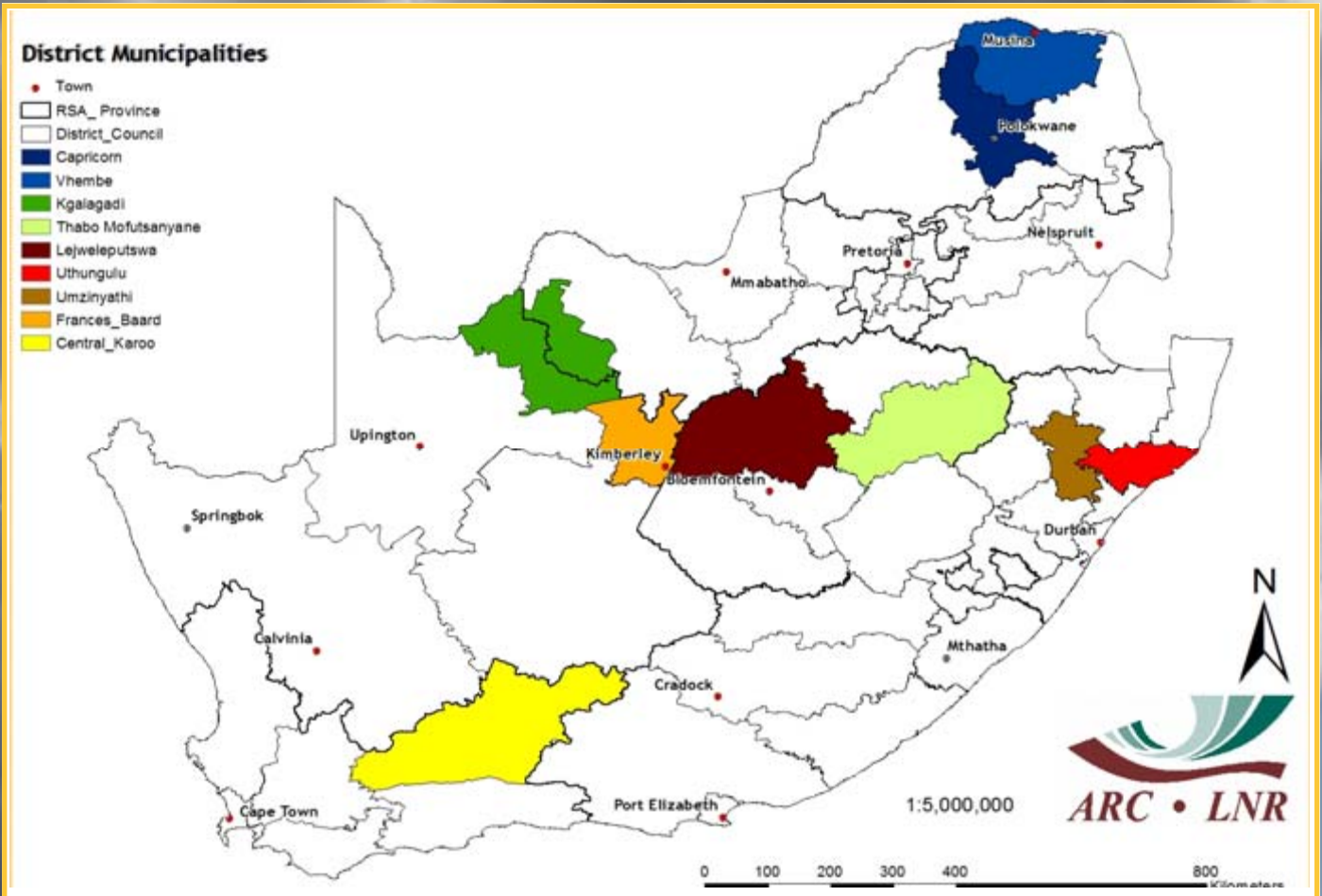


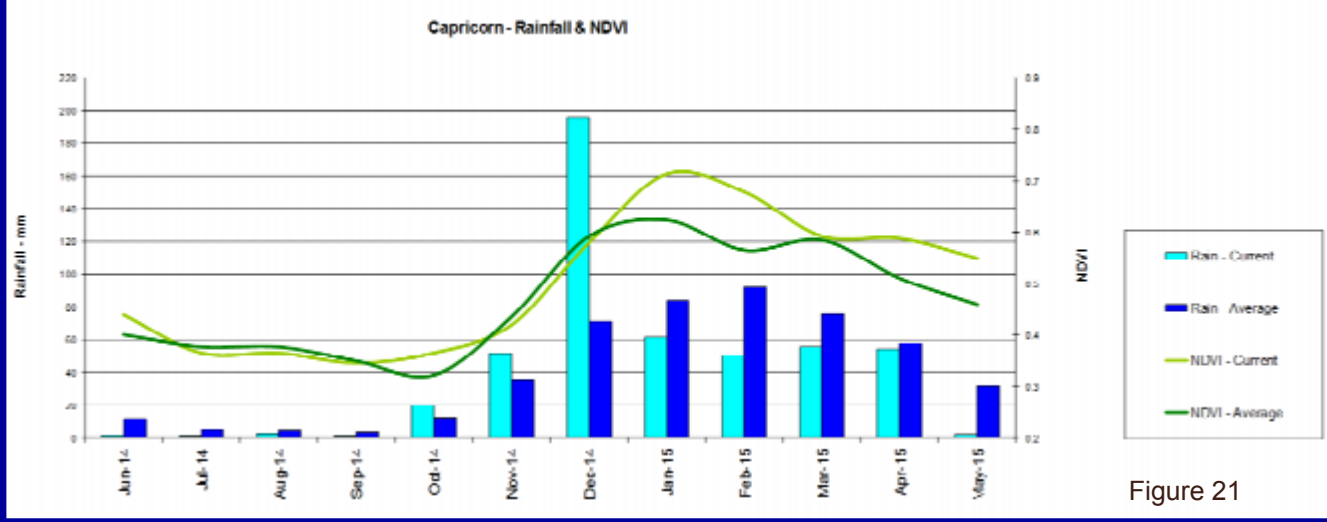
Figure 20

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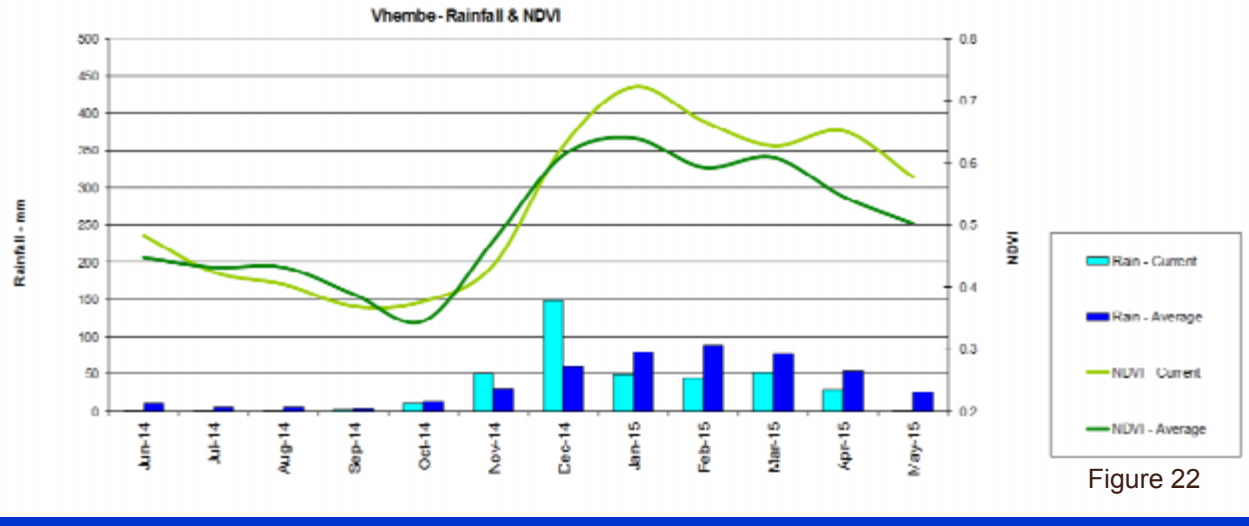

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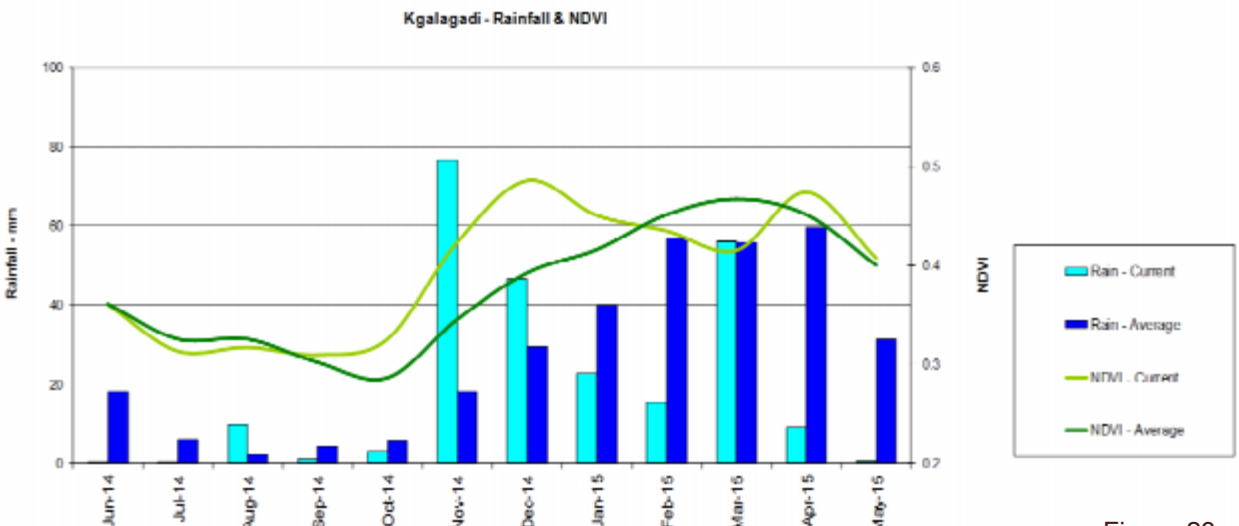

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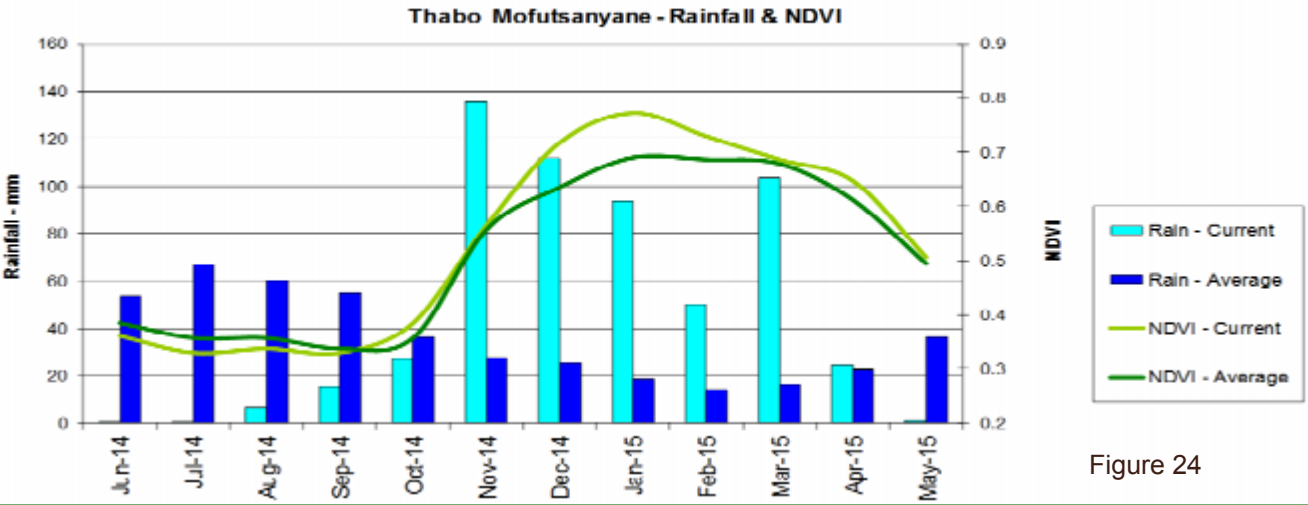

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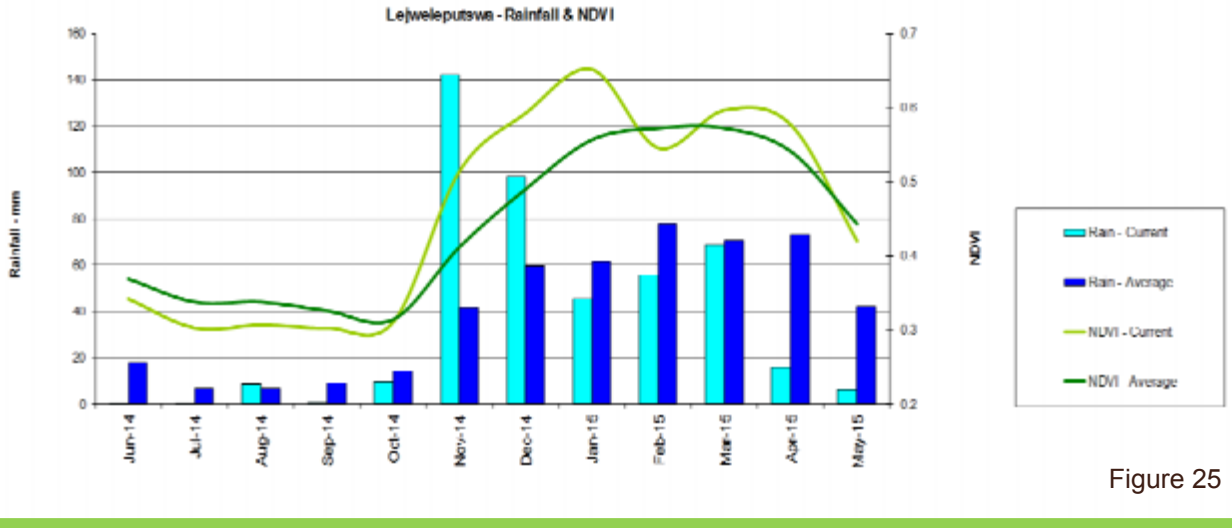

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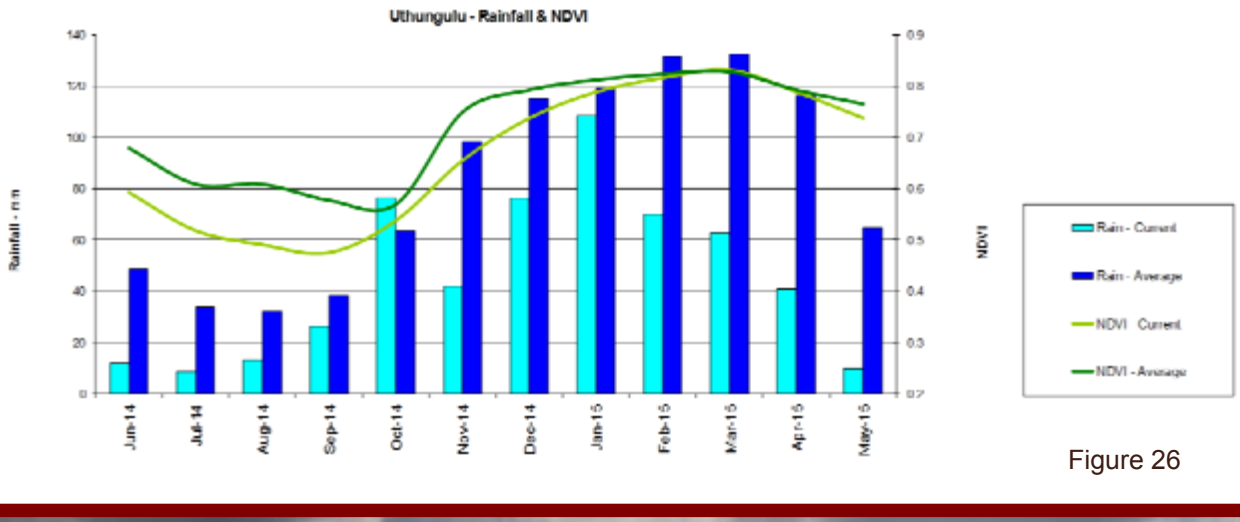

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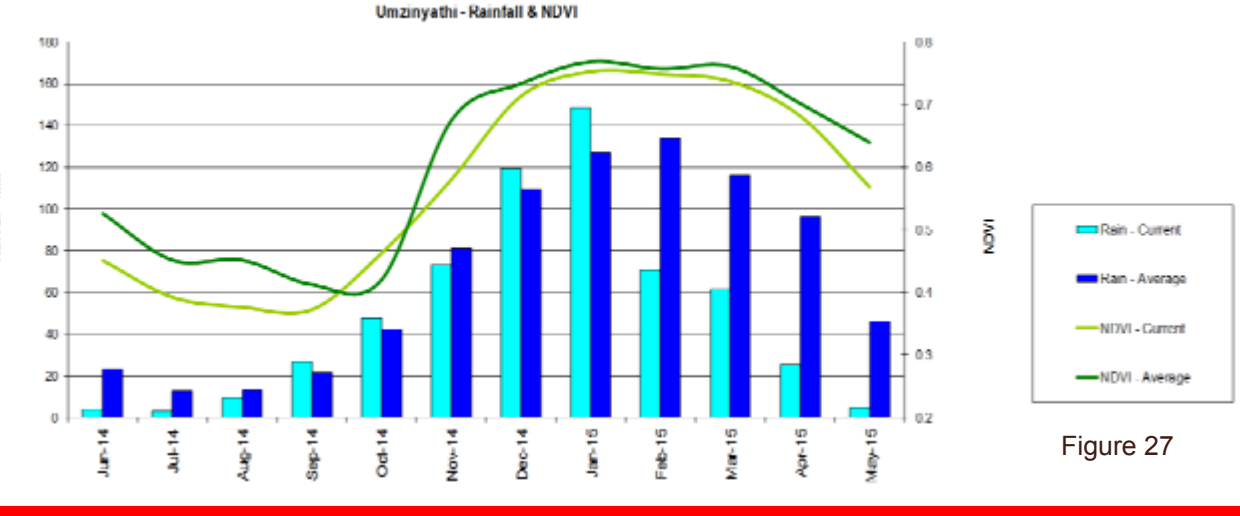

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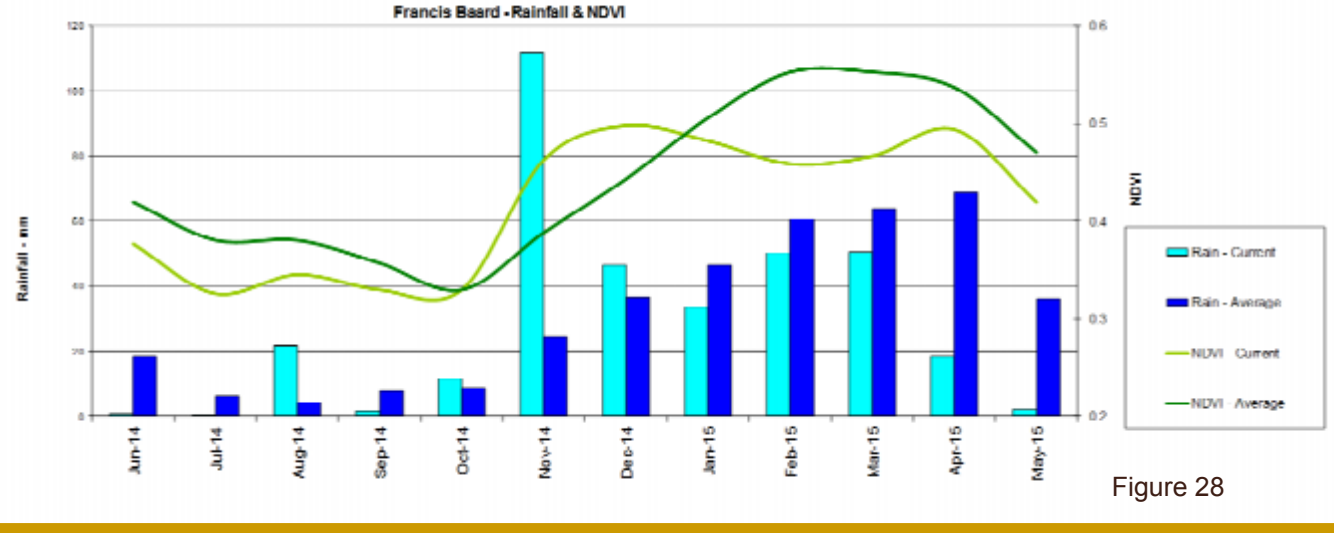

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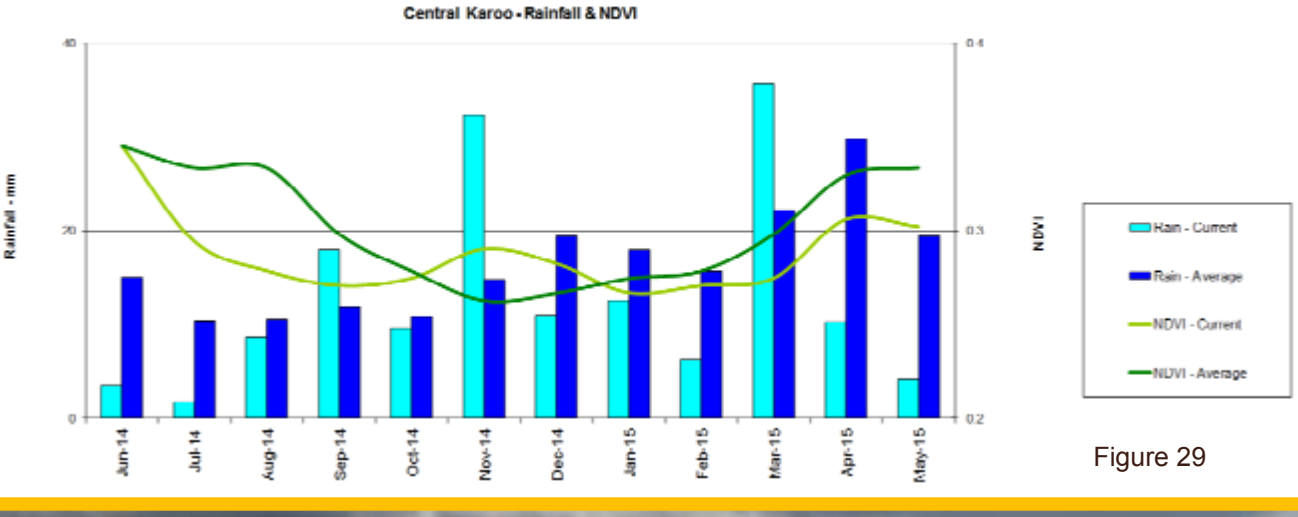

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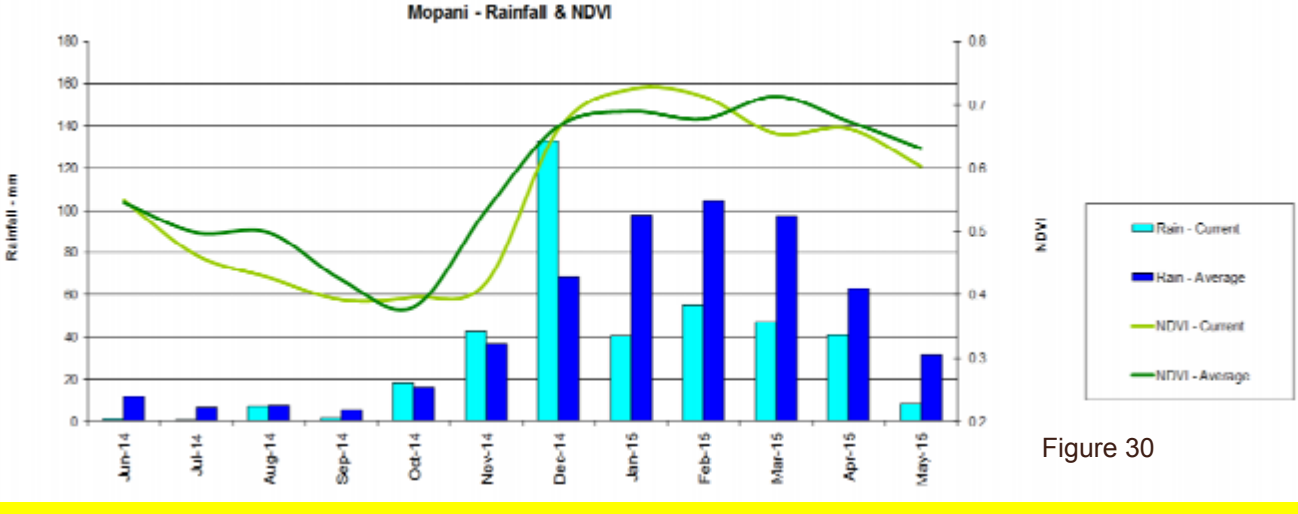

Figure 30

8. Soil Moisture

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

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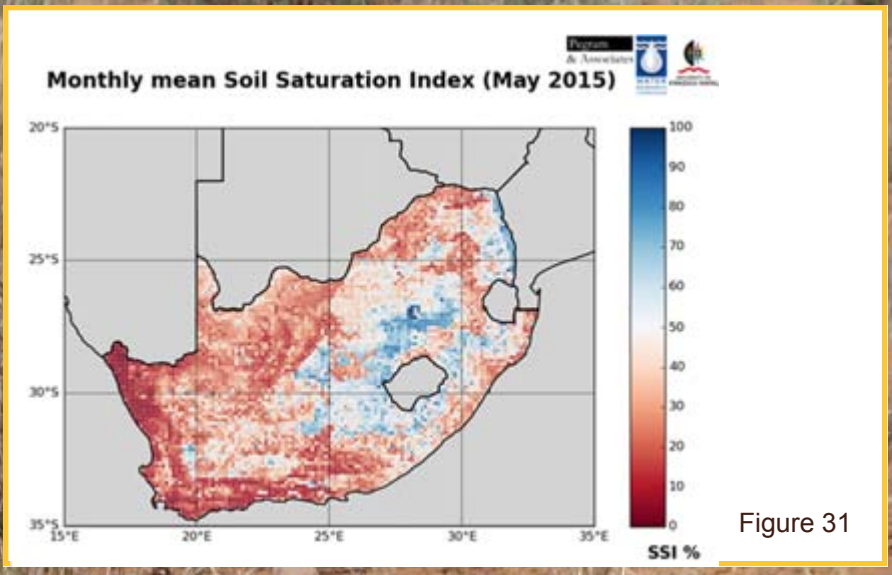

Figure 31

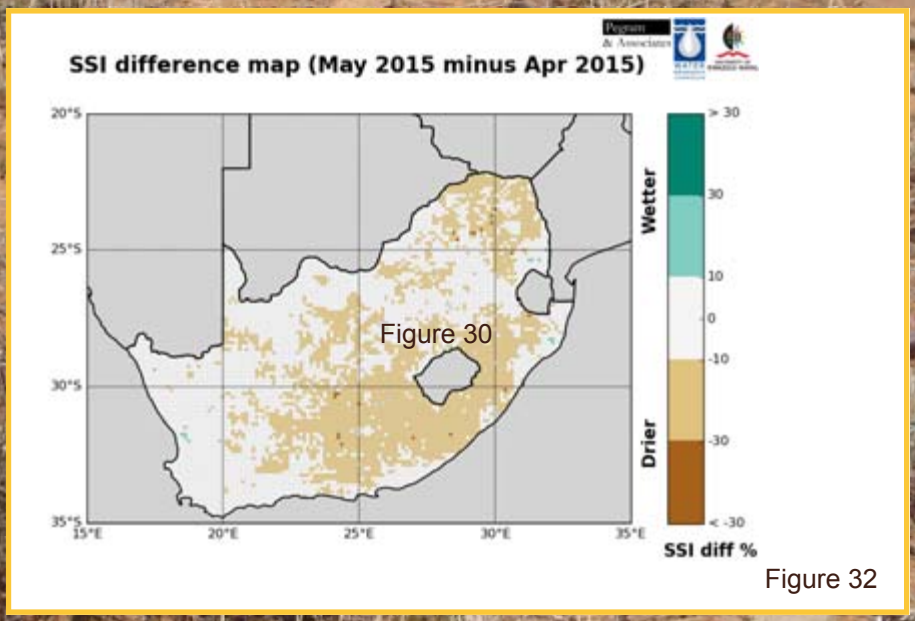

Figure 30

Figure 32

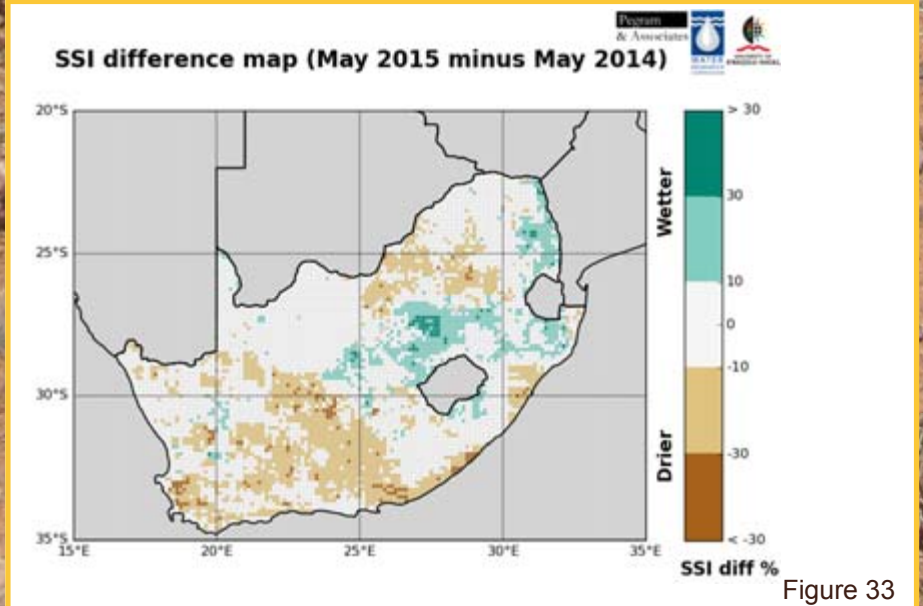

Figure 33

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 in the month of May per province. Fire activity was higher in all provinces except the Eastern Cape, Free State and KwaZulu-Natal compared to the average during the same period for the last 14 years.

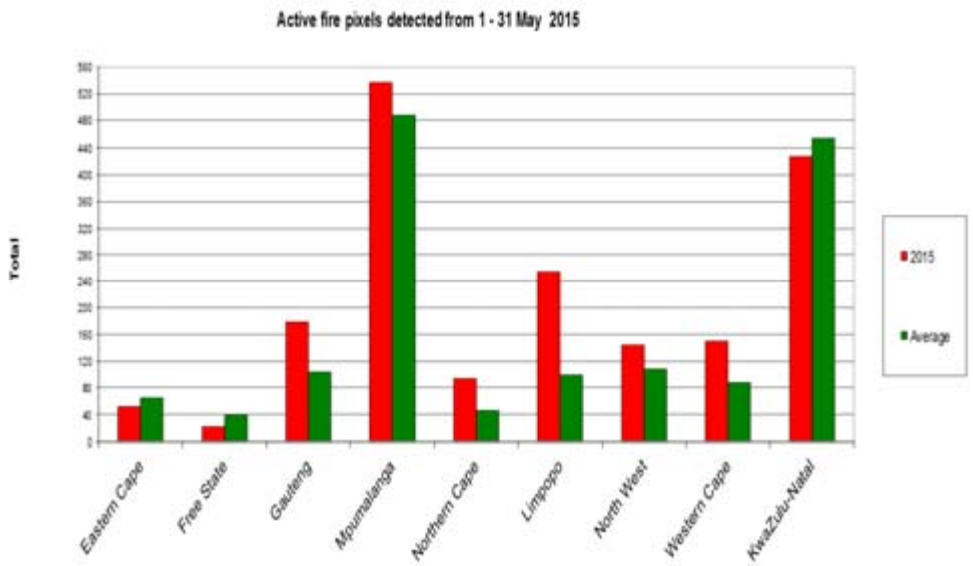

Figure 34

Figure 35:
The map shows the location of active fires detected between 1-31 May 2015.

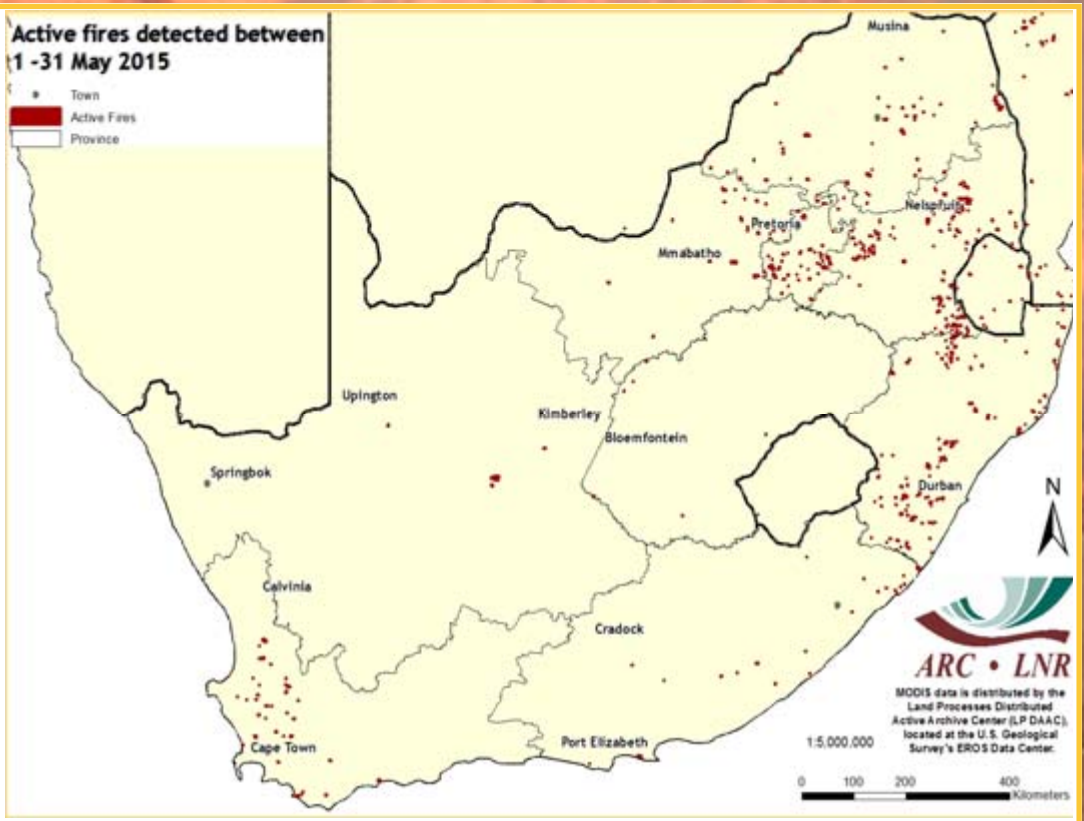

Figure 35

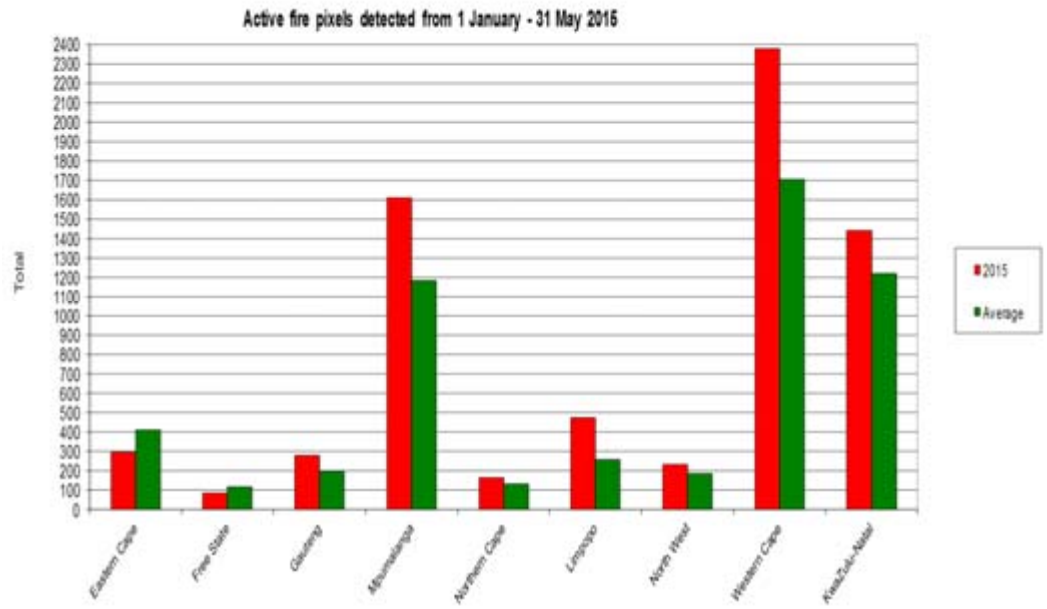

Figure 36

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

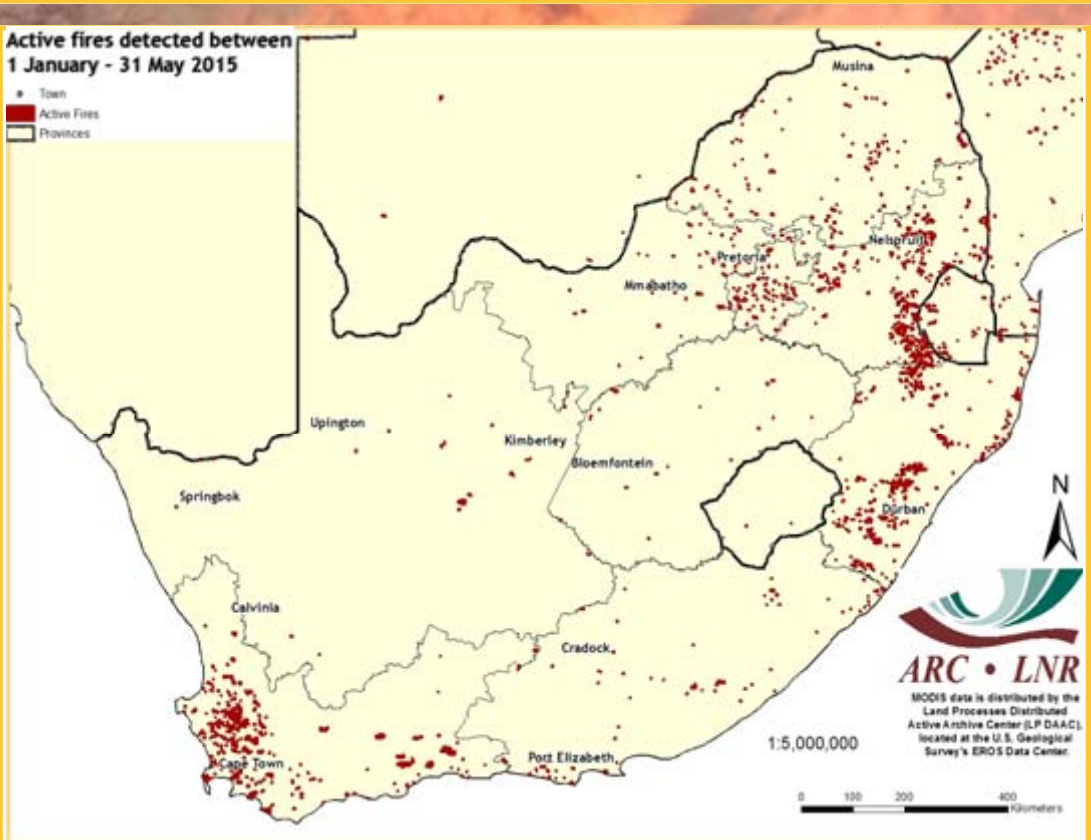

Figure 37

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

Questions/Comments:
NkambuleV@arc.agric.za

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:
Mr. Chris Kaempffer
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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 in its inception through LEAD funding from the Department of Science and Technology.

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

http://www.agis.agric.za