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UMLINDI
The Watchman

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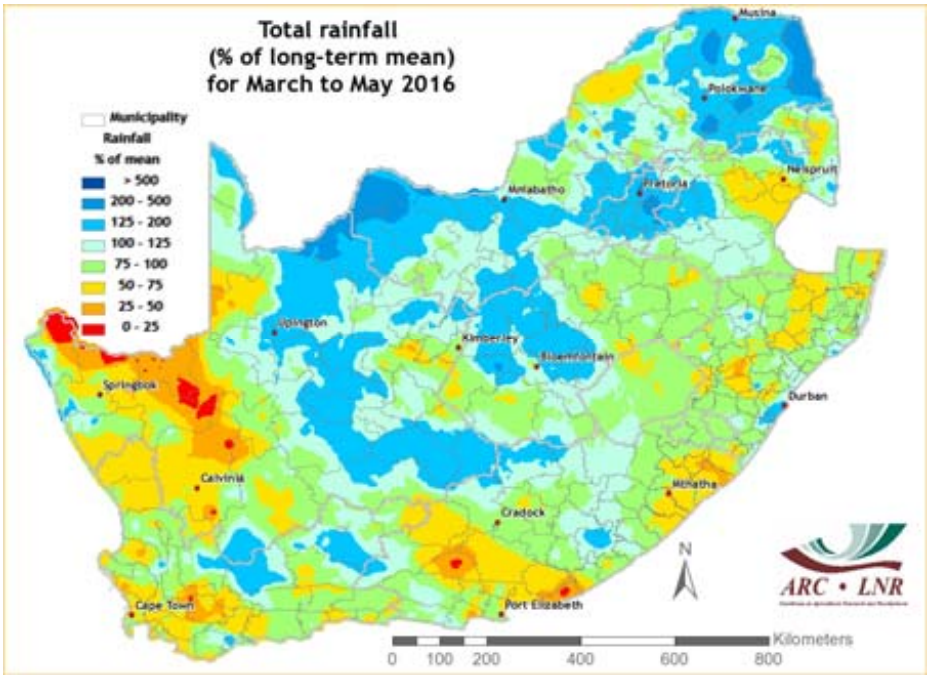
INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

144th Edition

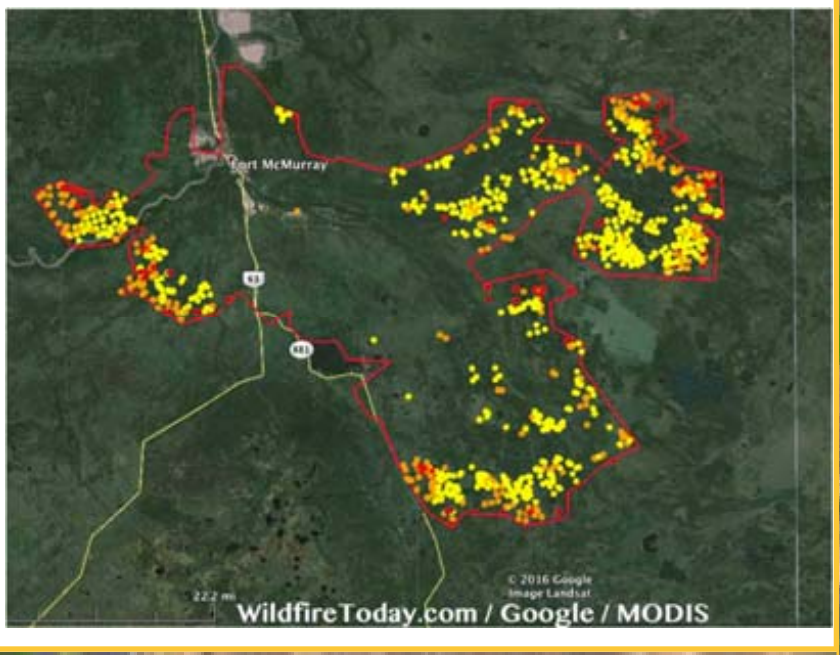
Images of the Month

Wet autumn over the summer rainfall region



The second half of the 2015/16 summer saw some appreciable improvements in rainfall conditions over the summer rainfall region compared with the first half. Continuing this trend, autumn brought further welcome above-normal rainfall over much of the interior of South Africa. Circulation patterns were such that a multitude of upper-air cut-off low pressure systems and deep troughs traversing the country resulted in several periods of widespread rain and thundershowers since March, continuing even into early June. Vegetation activity has responded positively, and it can be expected that grazing, especially towards the northern parts of the country, may have benefitted. The rainfall map shows the rainfall for autumn expressed as a percentage of the long-term average. It is derived from an interpolation of rainfall data from 450 stations of the ARC-ISCW automatic weather station network. Much of the central to northern parts of the country received above-normal rain during the period. Areas that remained somewhat drier than average are still present though, mostly located over the eastern low-lying parts of the country. The winter rainfall region received very little rain during May and is therefore also indicated as a region with below-normal rainfall during autumn. Since early June, however, widespread rain has occurred over the western winter rainfall region, bringing much needed relief to a region that also received below-normal rainfall during winter 2015. Rainfall totals recorded over the western parts of the winter rainfall region by some ARC-ISCW stations varied between 30 and 50 mm in the Swartland and approached 100 mm in the Boland during the first 13 days of June 2016.

Massive wild fire in Canada



The image shows the Fort McMurray fire extent with hotspots as of May 16th. The region affected by the fire at that time was truly vast — stretching nearly 80 km long and 50 km wide. (*Image source: WildfireToday.com*)

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:

In terms of rainfall patterns and temperatures, May 2016 was anomalously summery for the time of the year. No less than three upper-air lows resulted in rainfall over the interior during the course of the month. Elevated moisture levels and cloud cover resulted in anomalously high minimum temperatures while keeping maximum temperatures at bay, overall making for pleasant autumn conditions and little to no frost over the interior.

Maximum and minimum temperatures showed only very slight downward trends during the month. In fact, maximum temperatures reached the lowest values around the middle of the month, during which time minimum temperatures reached their highest values.

Two upper-air cut-off lows developing in quick succession resulted in most of the rain over the summer rainfall region. The first developed over the southwestern parts by the 7th and resulted in widespread rain, especially over the Northern Cape and southern Free State from the 8th to 10th. A very strong ridge around the southern parts resulted is heavy rainfall also along the KwaZulu-Natal coast with flooding in some areas. The second system developed by the 12th and caused widespread rain over the central parts and into the northeast by the 13th and 14th. Totals around Gauteng and eastern North West exceeded 60 mm in 24 hours due to the persistent nature of the rainfall while much of the Free State received in excess of 30 mm.

By the 24th, yet another upper-air low developed over the central parts and moved towards the northeast. With a fairly strong high to the east of the country and influx of moisture into the area, more showers developed, but this time mostly confined to the northeast (mostly Limpopo and Mpumalanga).

Partly cloudy to sunny and mild conditions occurred for the most part between the rainy periods, when upper-air anticyclonic conditions dominated. Frontal systems tracked further south than the norm in the southern African region, with the winter rainfall region remaining largely dry – and receiving much below-normal rainfall. Frontal systems that did reach the winter rainfall region, causing some rain there, were active in that area around the 6th, 18th and 23rd. Falls associated with these were, however, mostly light.

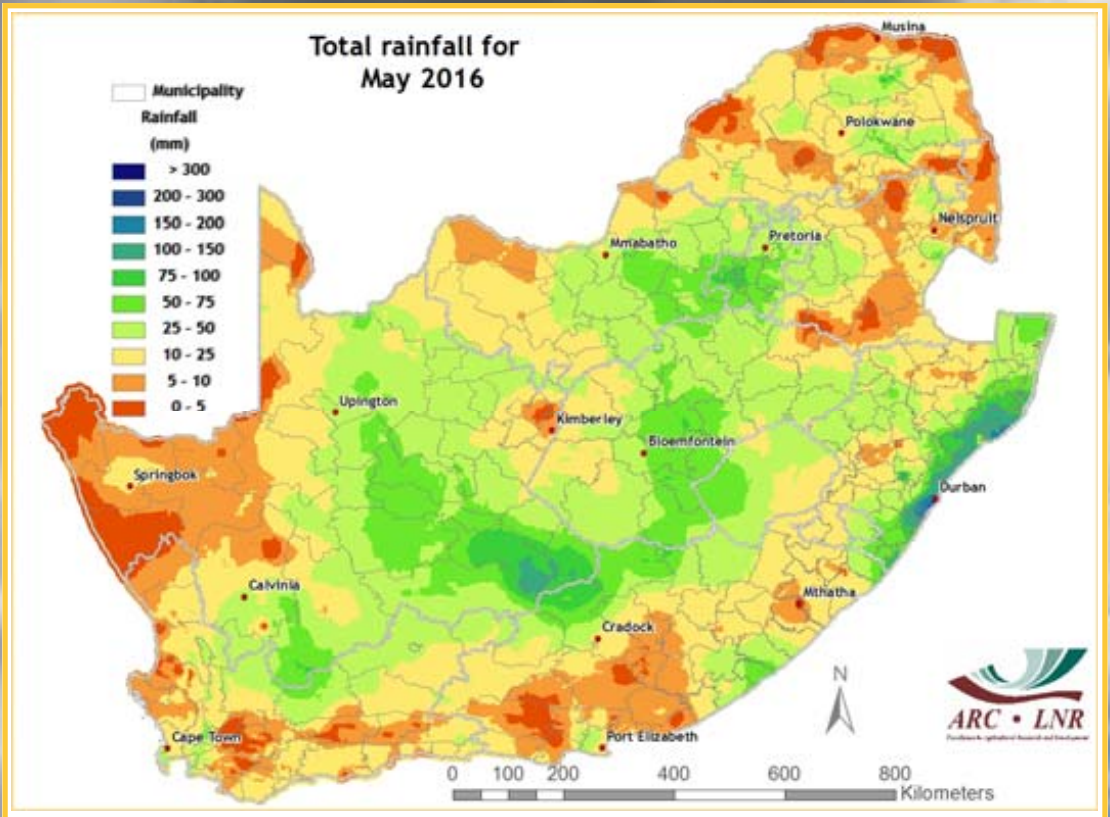


Figure 1

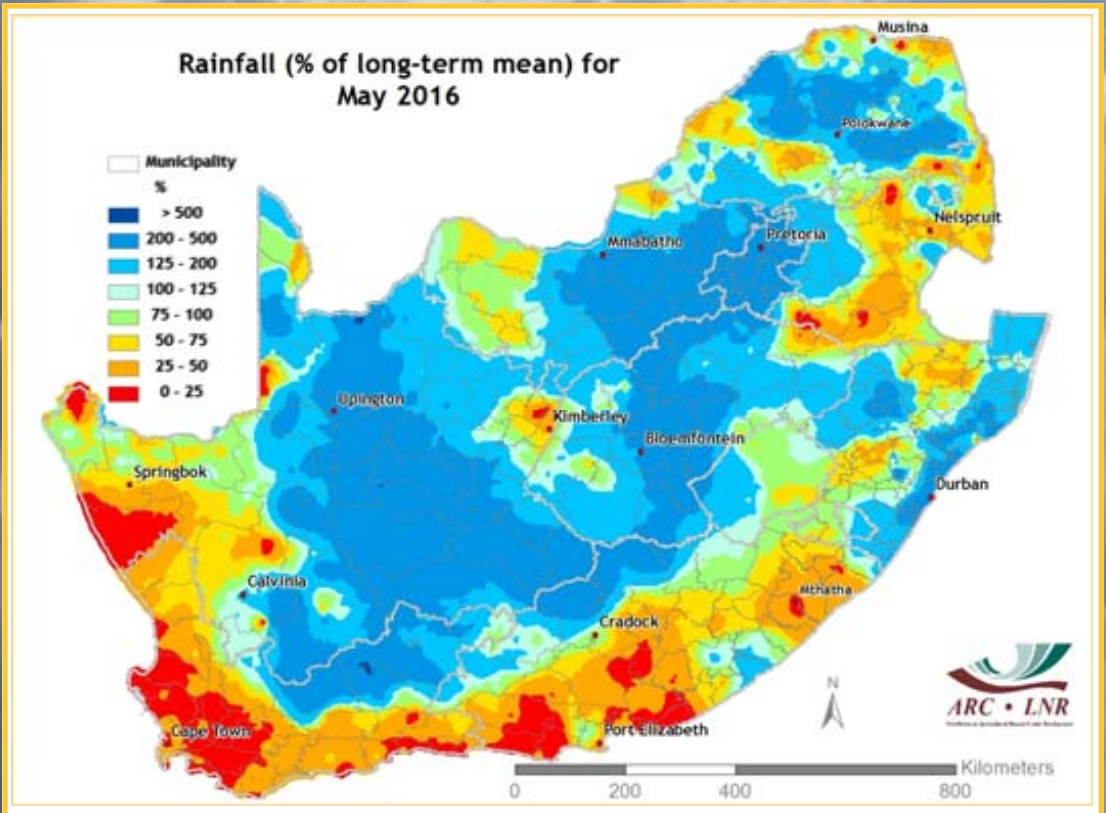
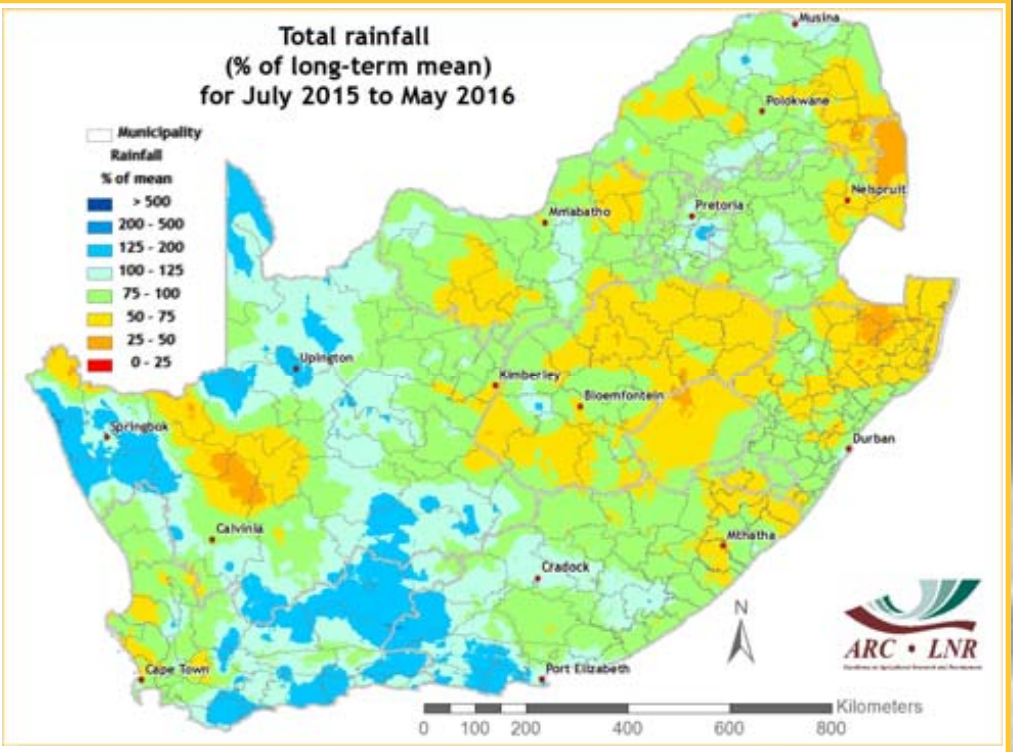


Figure 2



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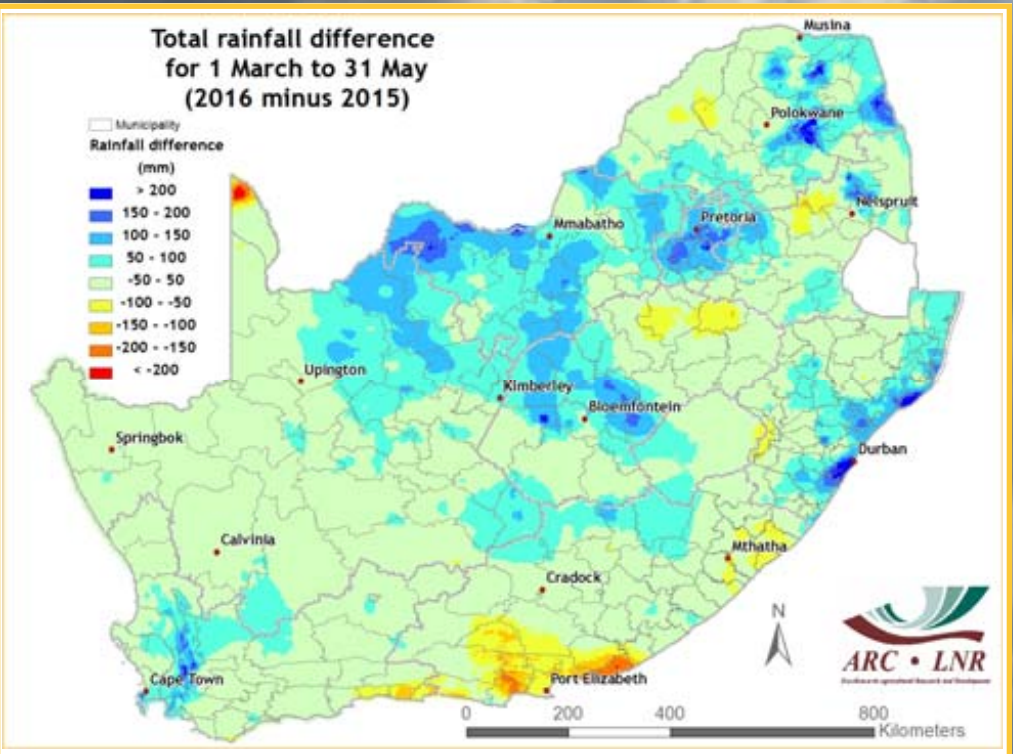

Figure 4

Figure 1:
Most of the interior received at least some rain, with totals exceeding 75 mm over the southeastern Northern Cape, southern to central Free State and eastern North West into southwestern Gauteng. The coastal parts of KwaZulu-Natal received in excess of 100 mm. Most of the winter rainfall region received less than 25 mm in total.

Figure 2:
Most of the interior and the coastal areas of KwaZulu-Natal received above-normal rain while the winter rainfall region received less than 50% of the long-term average for the most part.

Figure 3:
Most of the country received near normal rainfall for the period since July 2015 in total, reflecting a balance between very dry conditions in early summer and wetter conditions in late summer. Areas that received much below-normal rainfall are still present though: central Free State, northern KwaZulu-Natal and the Lowveld of Mpumalanga.

Figure 4:
Most of the summer and winter rainfall regions received more rain during March to May this year than in 2015. A notable exception is the southeastern parts, specifically the coast and adjacent interior of the eastern Western Cape and the western Eastern Cape.

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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 are very limited at the shorter time scales, but as the period of interest increases to 24 months, drought extent and intensity also increase, indicating areas where the potential effect of earlier drought conditions may still be present.

Questions/Comments:
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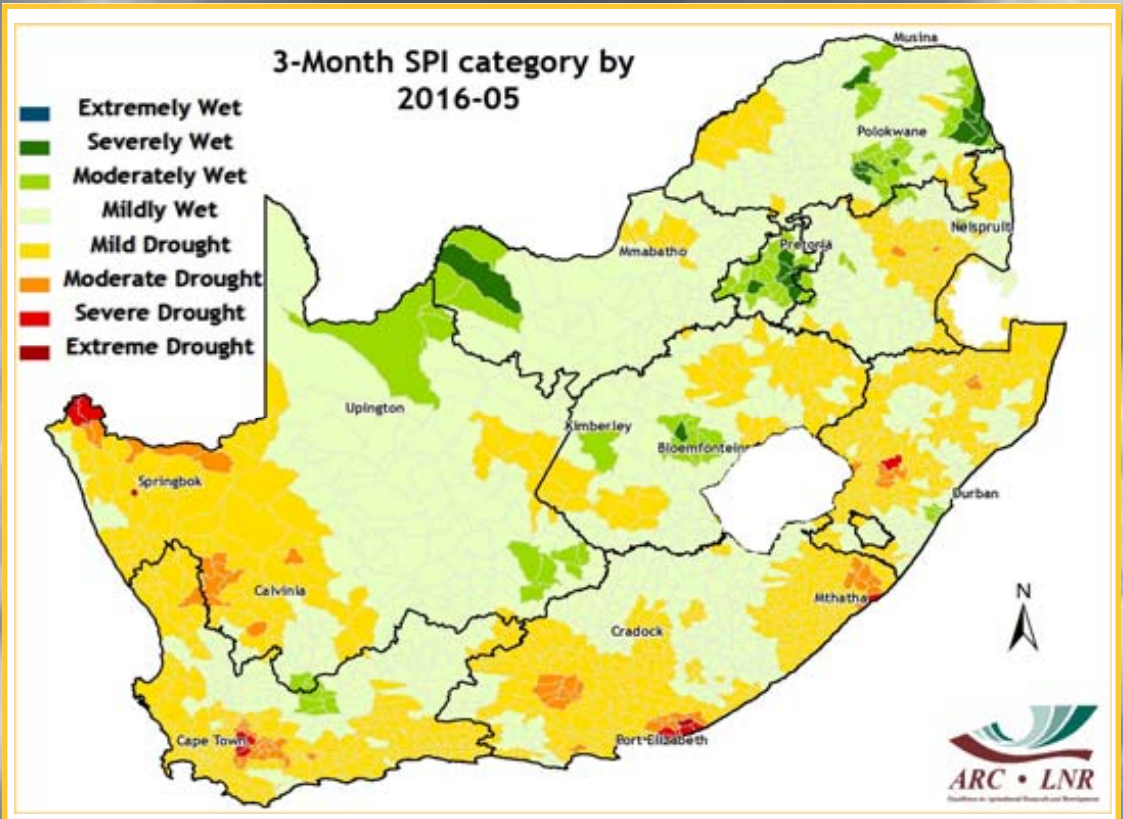

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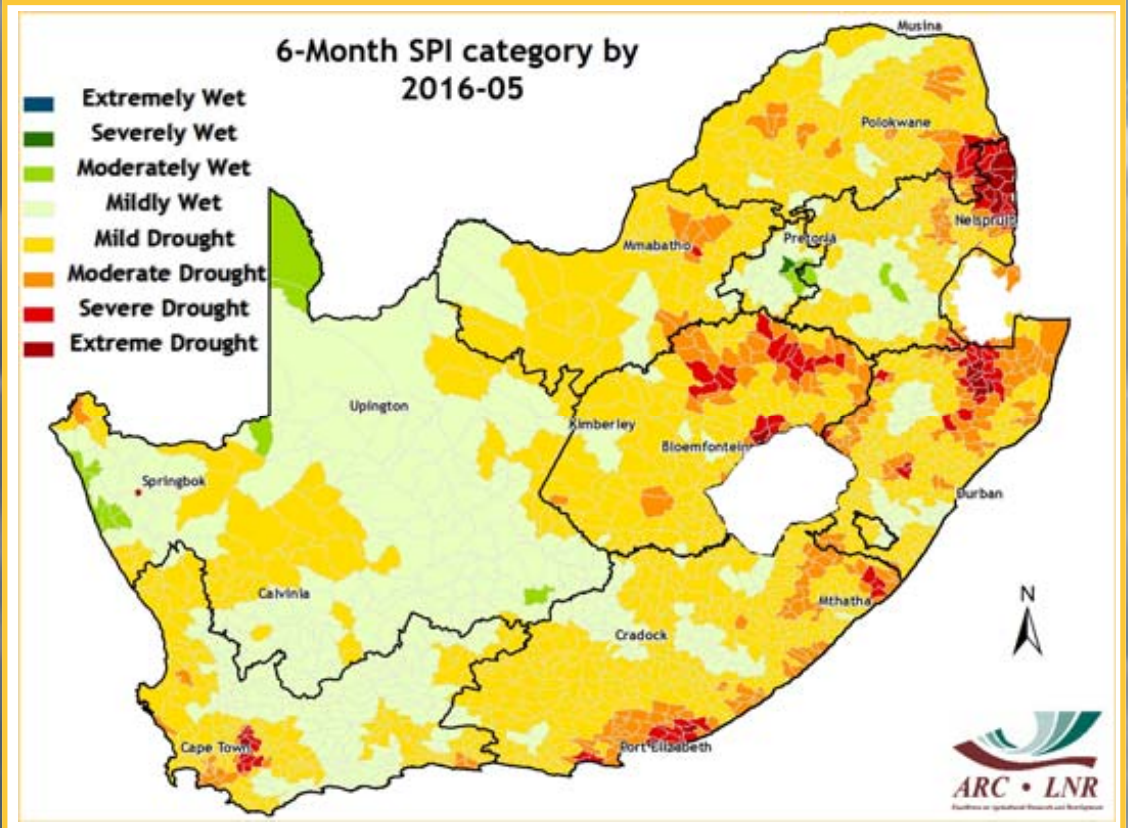

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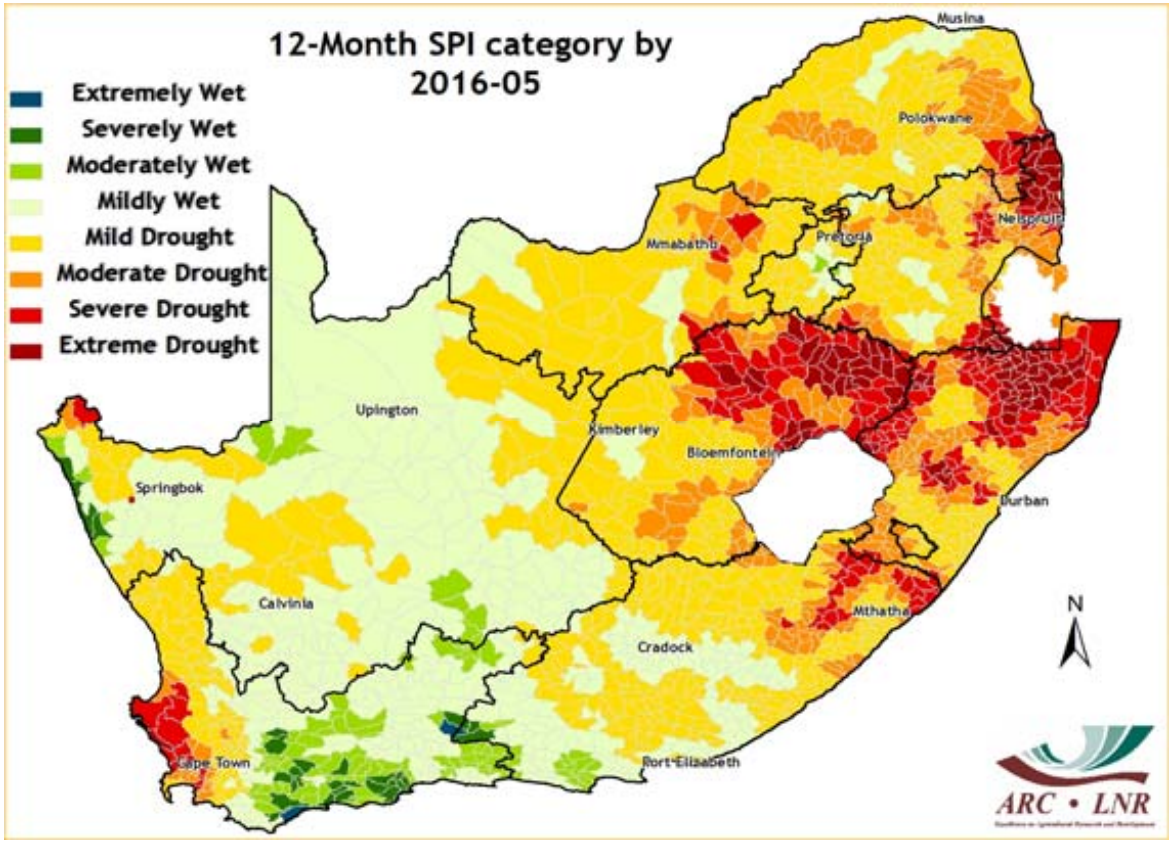

Figure 7

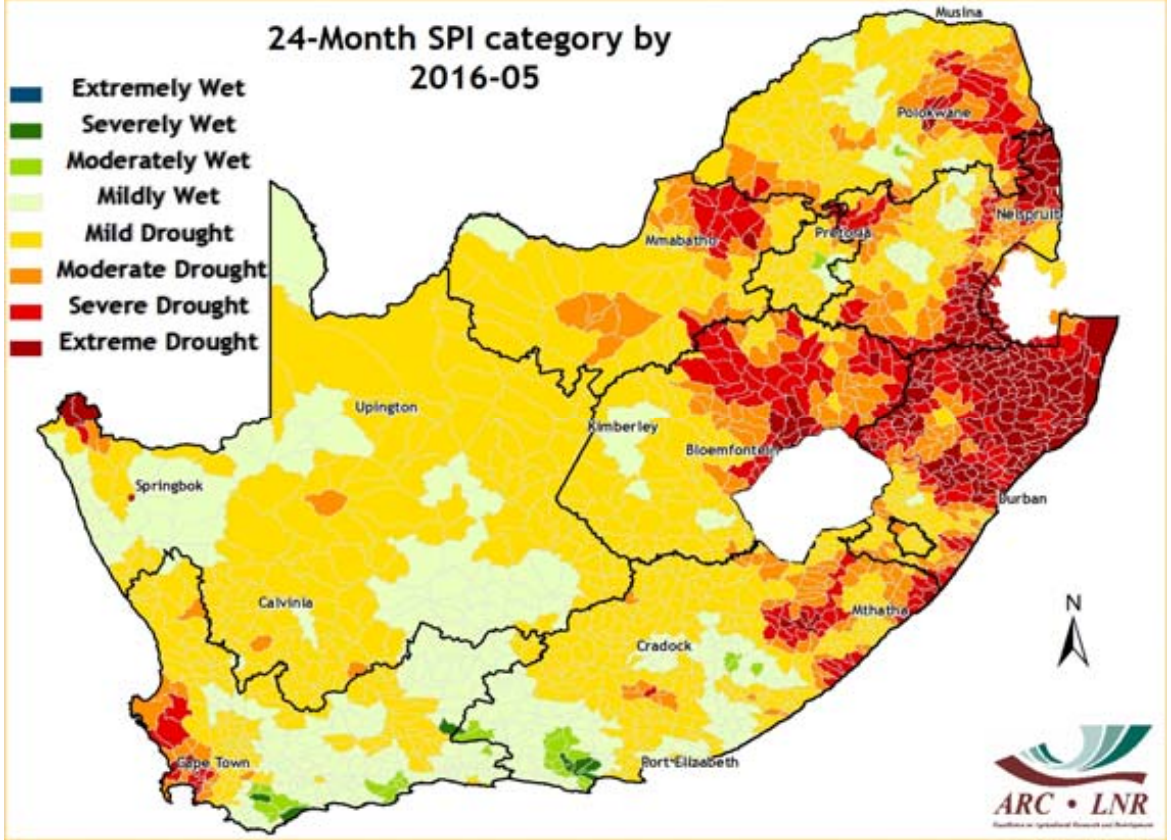

Figure 8

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.

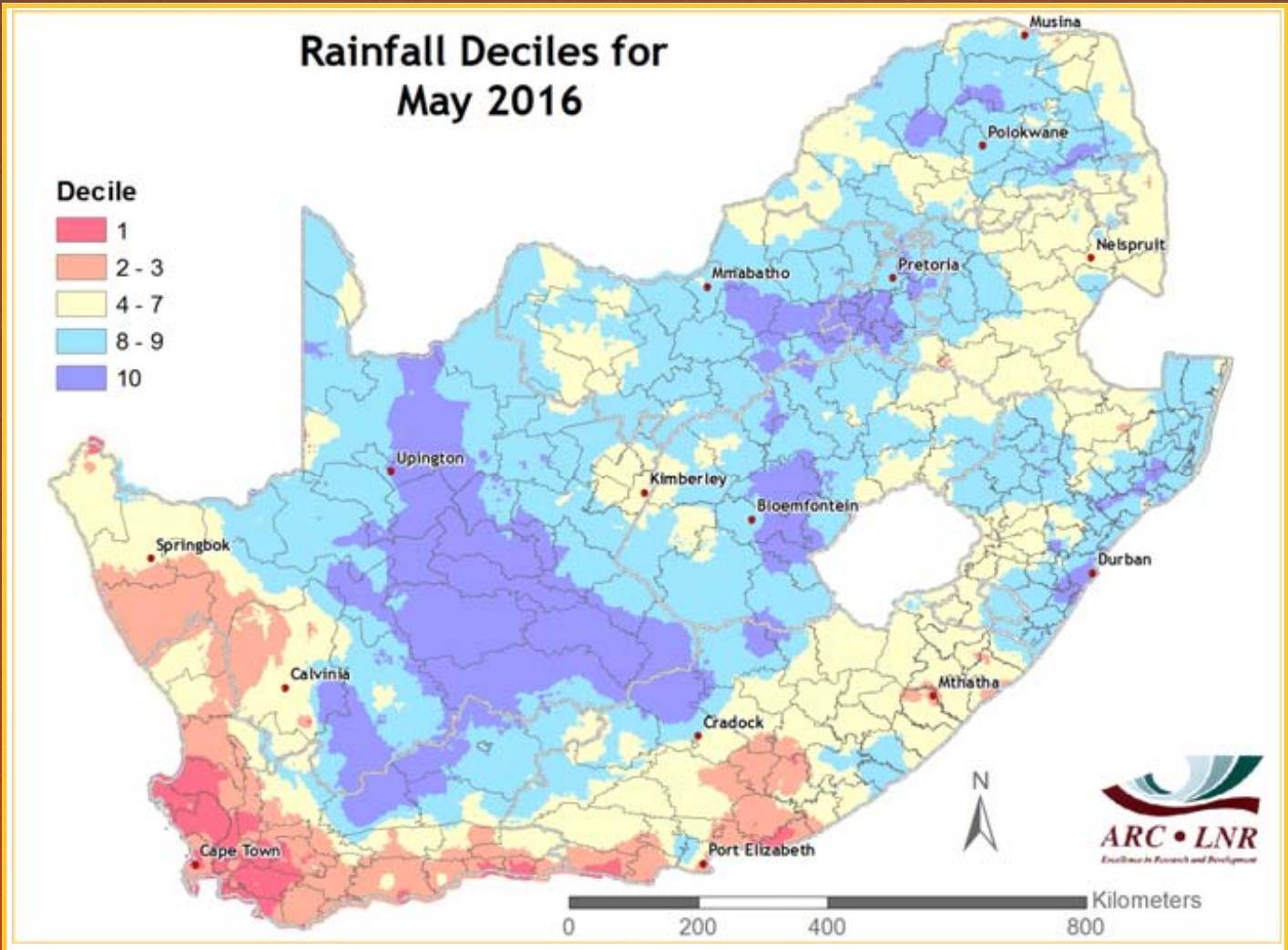

Figure 9

Figure 9:
Parts of the central to northeastern interior and the coast of KwaZulu-Natal were exceptionally wet during May while much of the winter rainfall region was exceptionally dry.

4. Water Balance

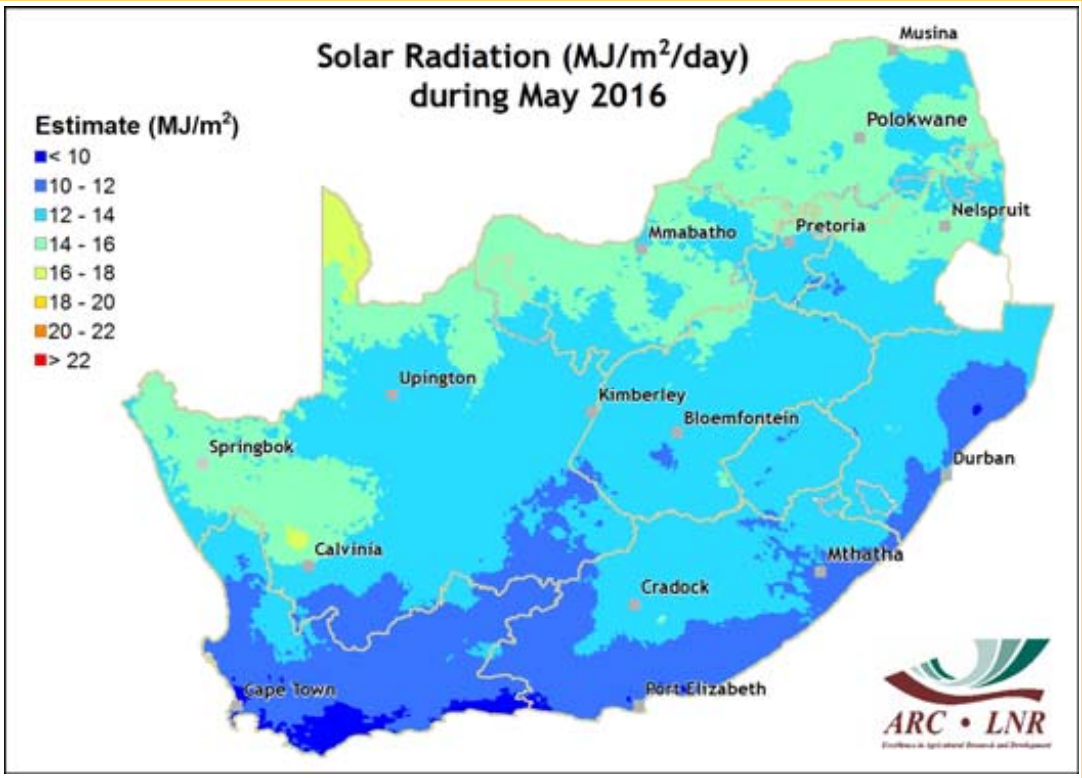

Figure 10

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:
Mean daily solar radiation values ranged from less than 10 MJ/m^2 in the south to about 15 MJ/m^2 in the north.

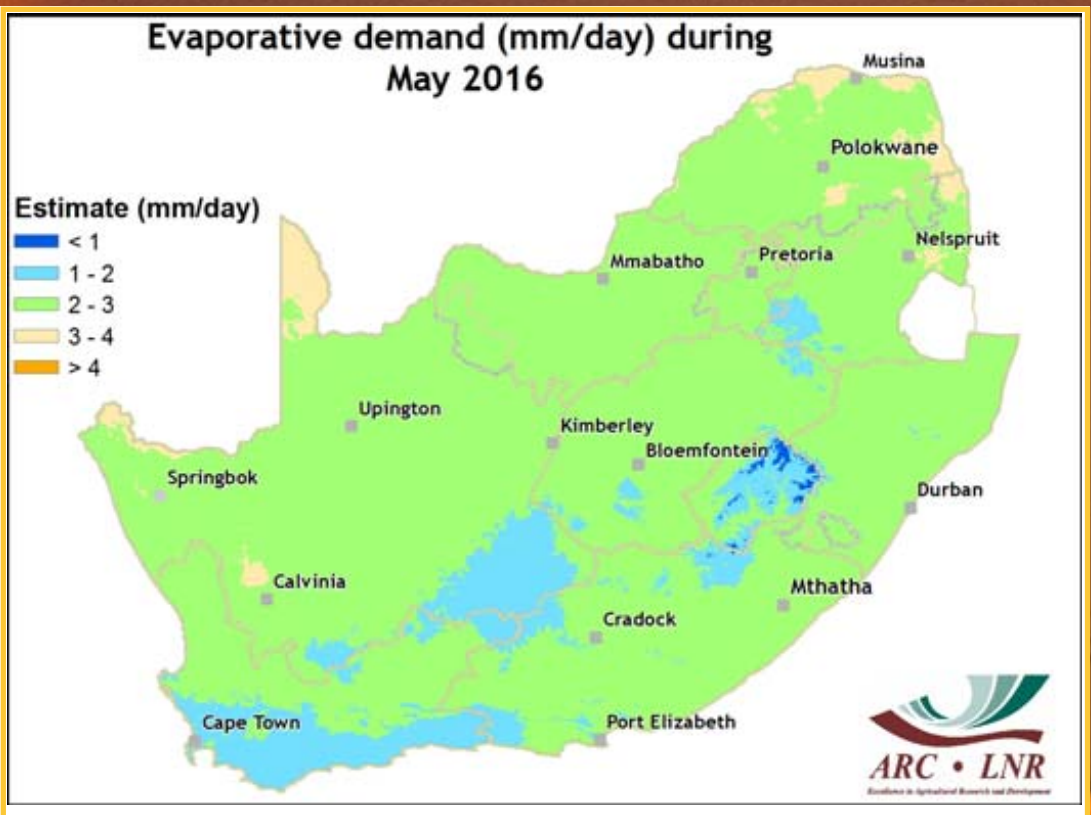

Figure 11

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:
The decreasing trend in mean daily potential evapotranspiration continued as the winter solstice approaches and temperatures decrease, with mean values rarely exceeding 3 mm/day.

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5. Vegetation Conditions

Vegetation Mapping

The Normalized Difference Vegetation Index (NDVI) is computed from the equation:

NDVI=(IR-R)/(IR+R)

where:
IR = Infrared reflectance &
R = Red band

NDVI images describe the vegetation activity. A decadal NDVI image shows the highest possible "greenness" values that have been measured during a 10-day period.

Vegetated areas will generally yield high values because of their relatively high near infrared reflectance and low visible reflectance. For better interpretation and understanding of the NDVI images, a temporal image difference approach for change detection is used.

The Standardized Difference Vegetation Index (SDVI) is the standardized anomaly (according to the specific time of the year) of the NDVI.

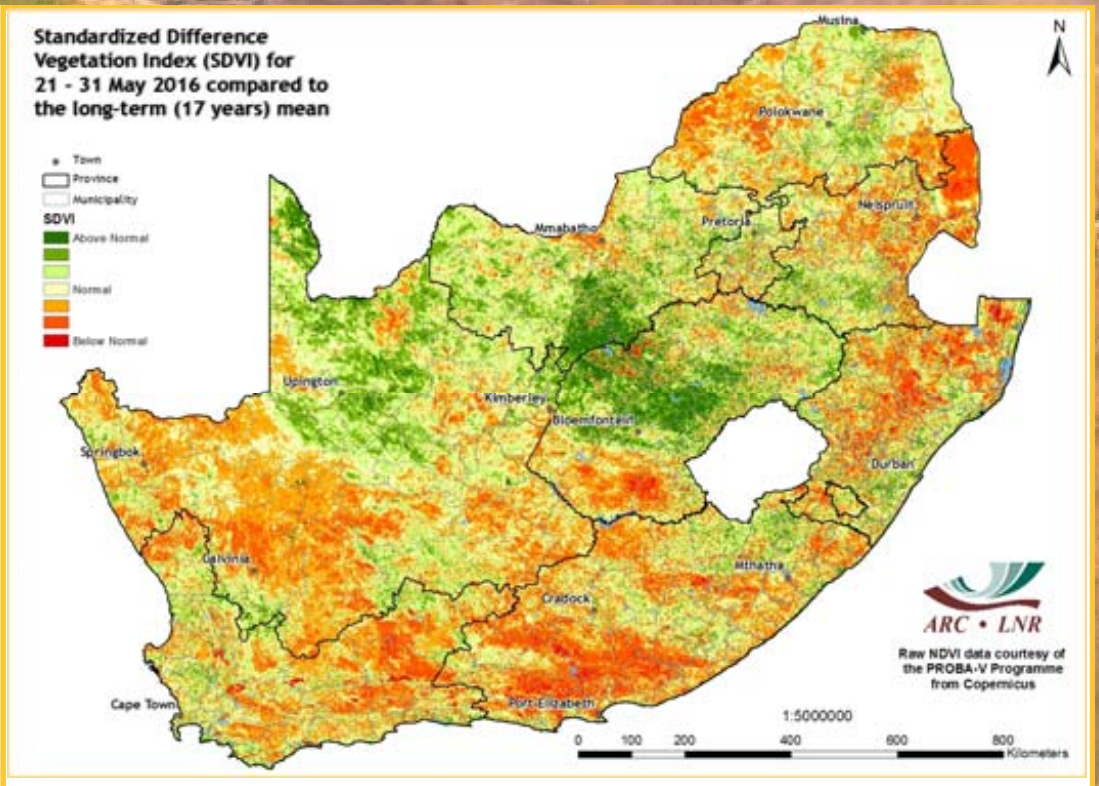

Figure 12

Figure 12:
The SDVI by late May reflected recent above-normal rainfall over much of the interior, the coast of KwaZulu-Natal and northern parts of the winter rainfall region (West Coast and western Escarpment), as well as dry conditions over the southeastern and eastern low-lying areas.

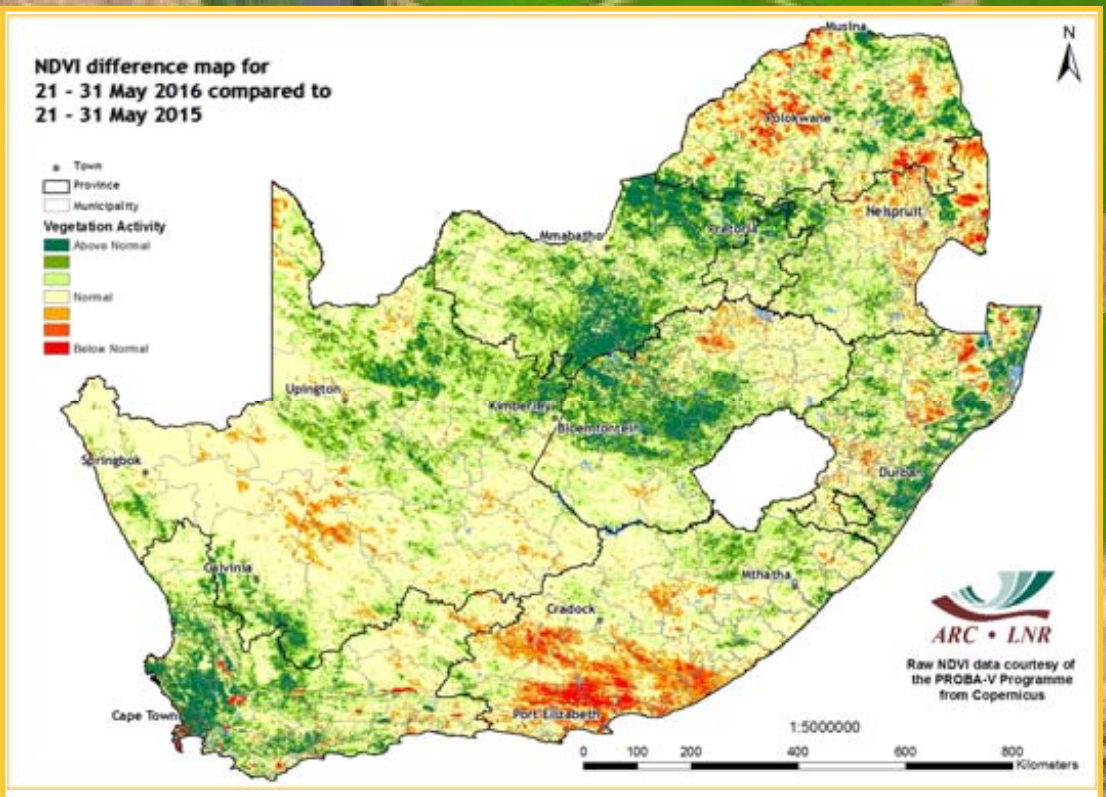

Figure 13

Figure 13:
An earlier start to the winter rainy season and more rain over much of the interior are reflected in vegetation activity relative to the conditions last year by late May. Vegetation activity over the southeastern parts and western interior of the Northern Cape are lower than a year ago.

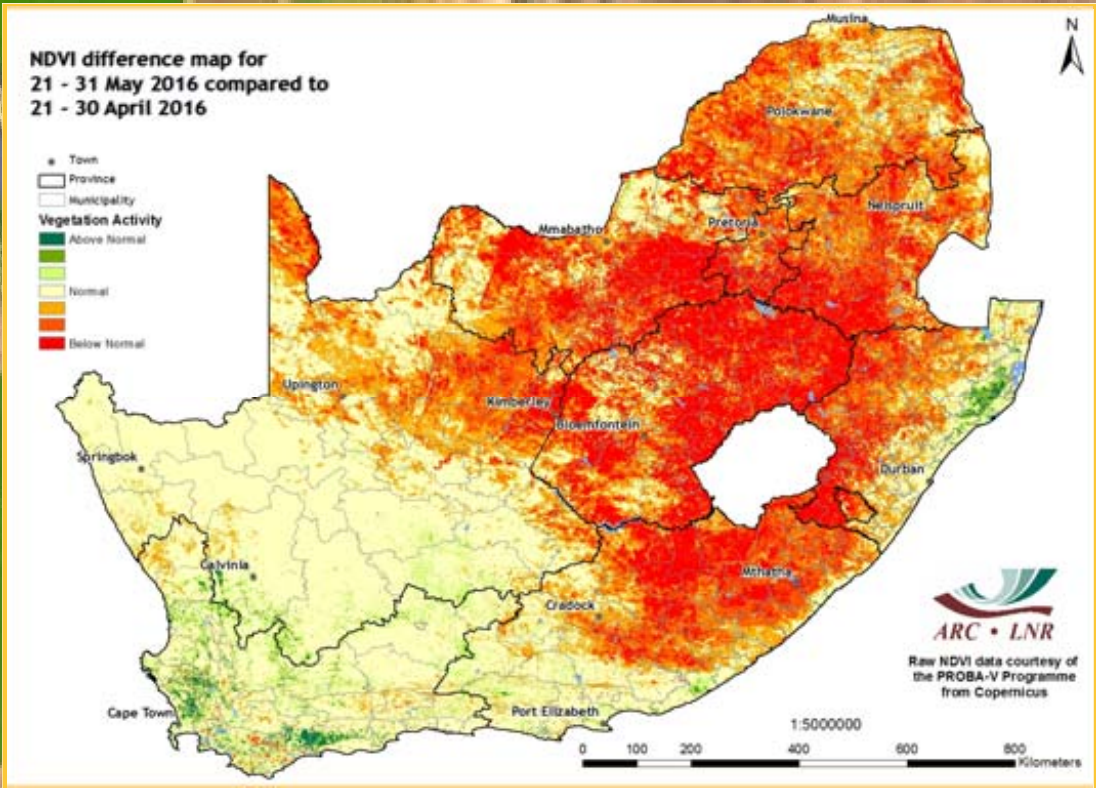

Figure 14

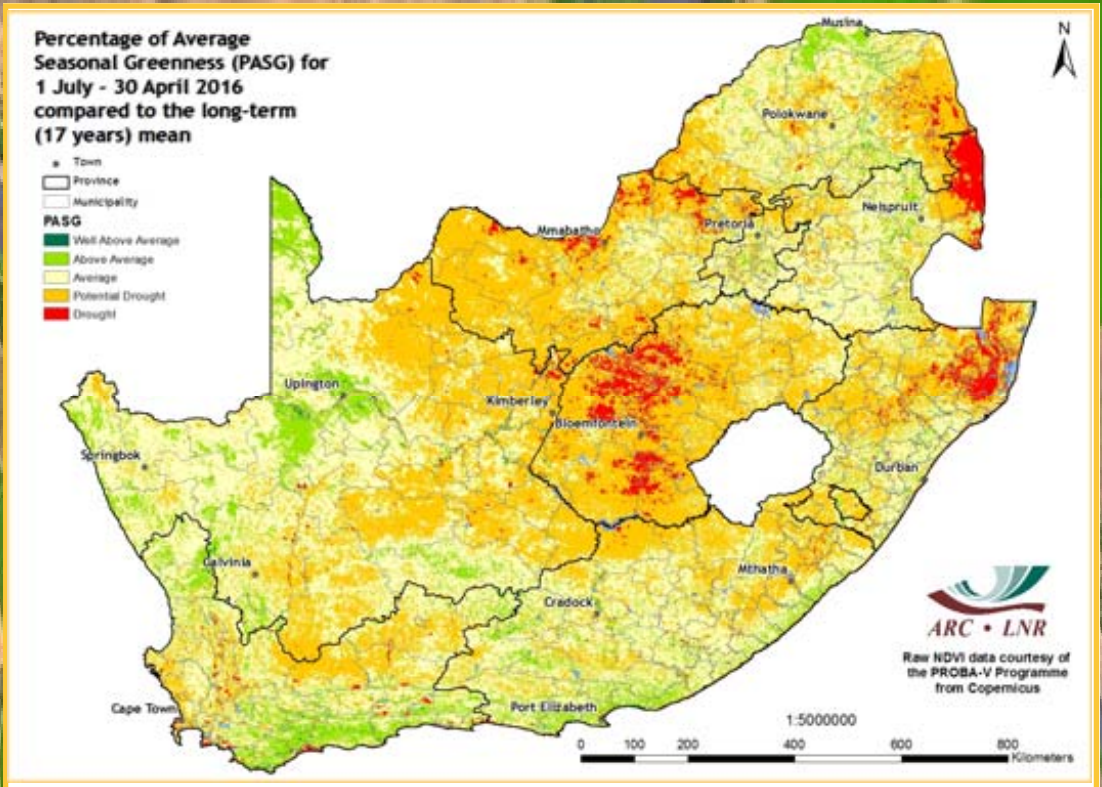

Figure 15

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:
Temperature trends are the main driver of the vegetation activity changes observed over the interior, with low minimum temperatures resulting in decreased activity. Increases in activity are noted over coastal KwaZulu-Natal (due to heavy rain in May) and the winter rainfall region (due to heavy rain during April).

Figure 15:
Cumulative vegetation activity anomalies still indicate earlier drought stress over much of the central parts of the country as well as the coastal areas in the east and the Lowveld. The southern parts of the country, together with parts of Limpopo and Mpumalanga and the northern parts of the Northern Cape, experienced above-normal cumulative vegetation activity during the past summer.

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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.

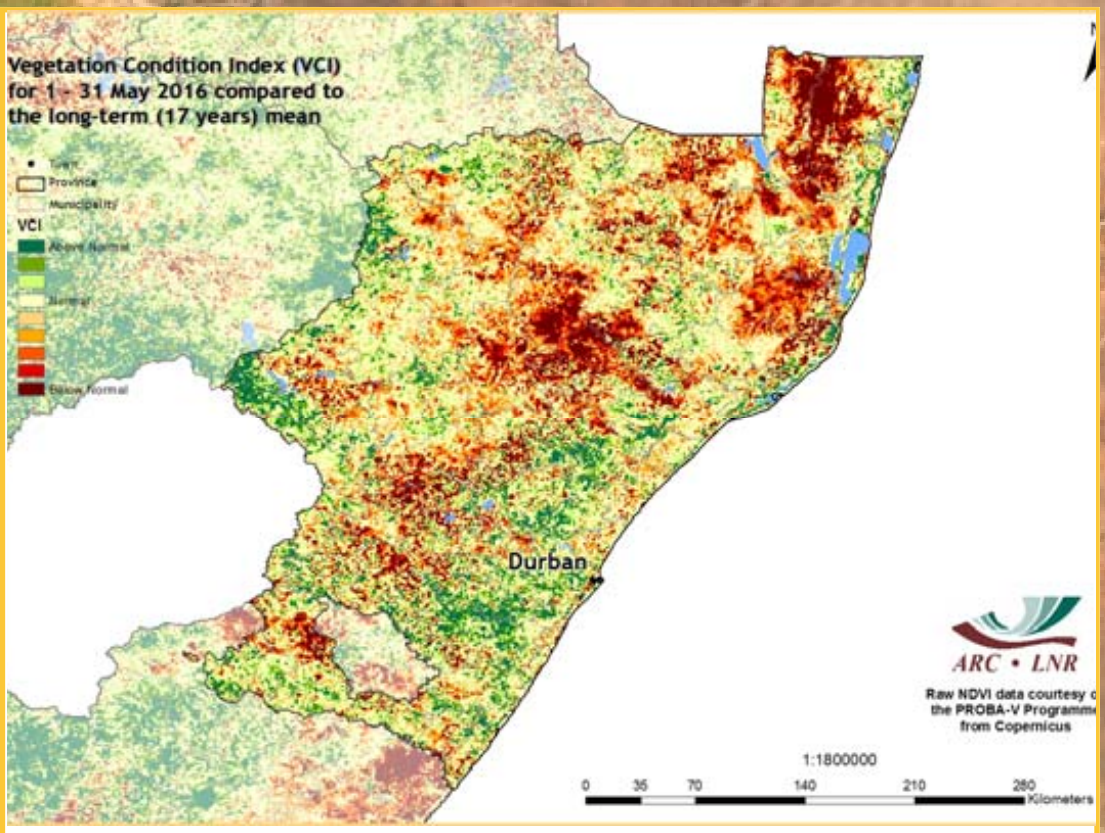


Figure 16

Figure 16:
The VCI map for May indicates below-normal vegetation activity over most parts of KwaZulu-Natal.

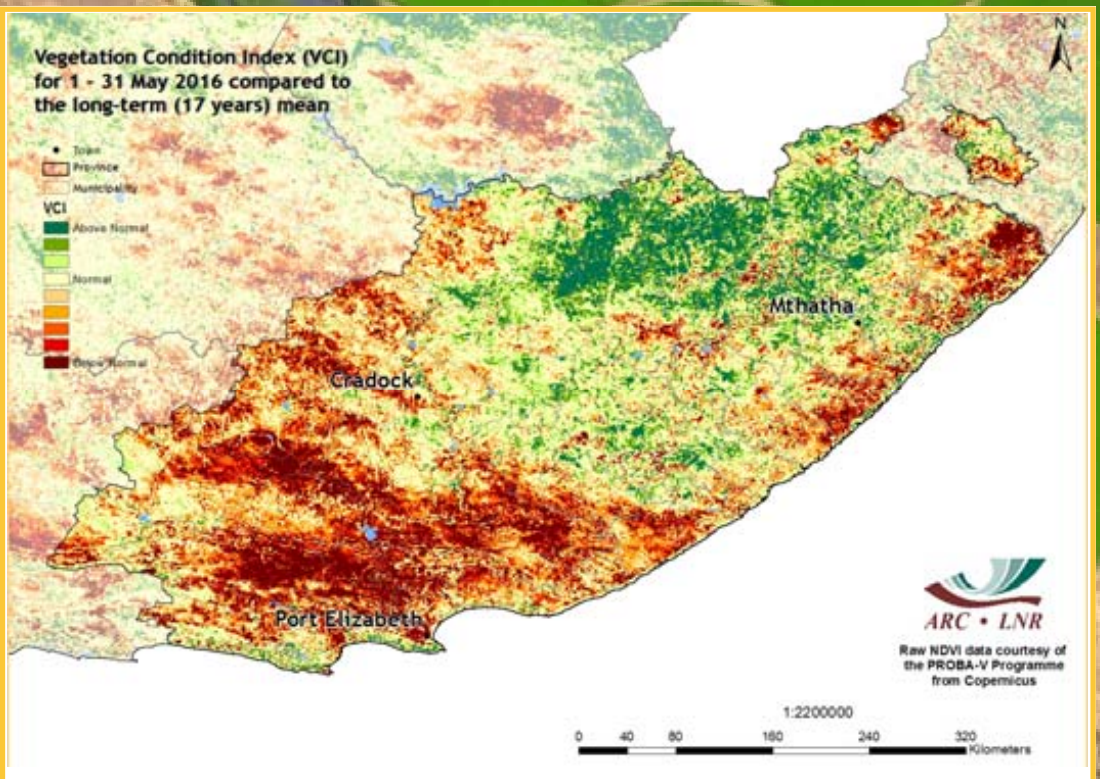


Figure 17

Figure 17:
The VCI map for May indicates below-normal vegetation activity over the western, southern and coastal areas of the Eastern Cape.

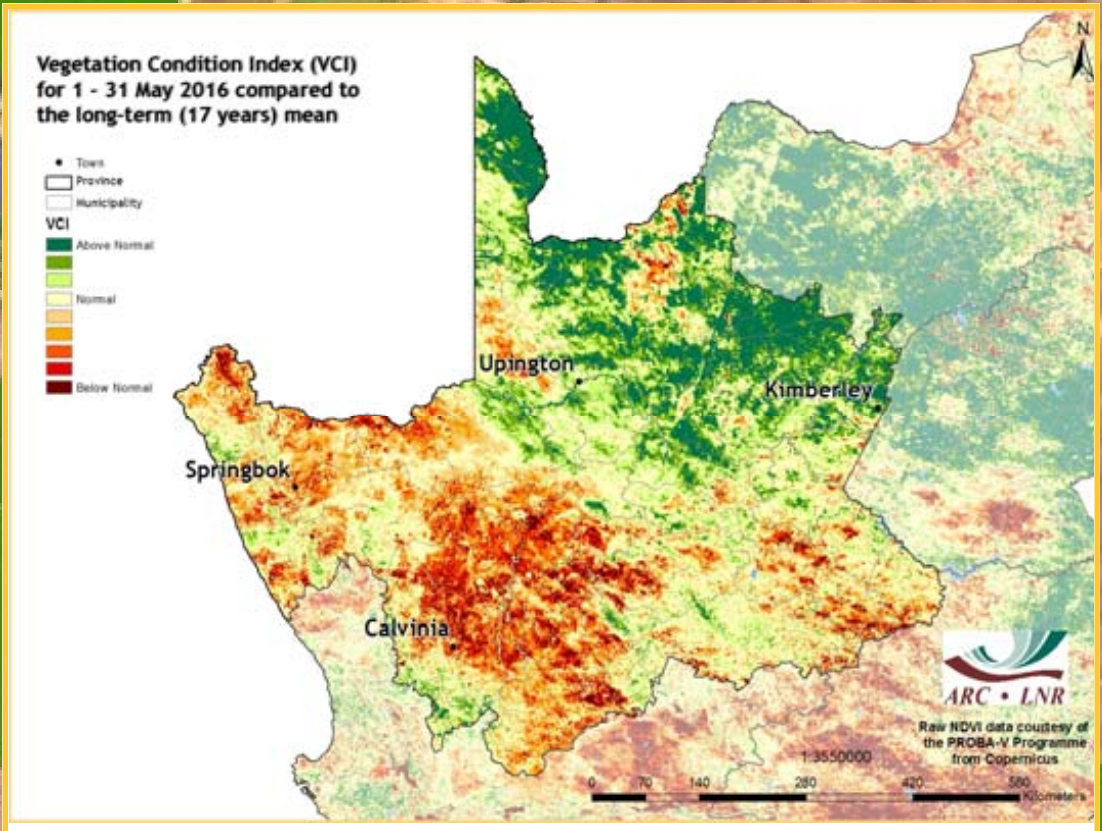


Figure 18

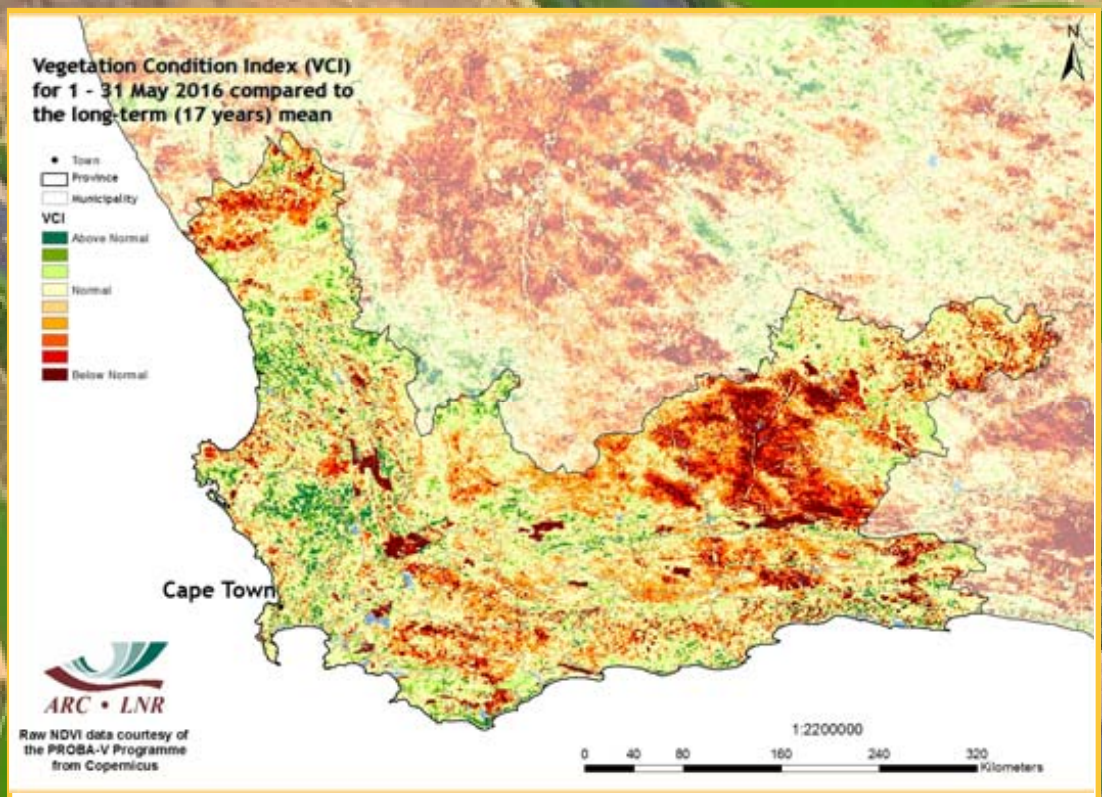


Figure 19

Figure 18:
The VCI map for May indicates below-normal vegetation activity over the western interior, southern and southwestern parts of the Northern Cape.

Figure 19:
The VCI map for May indicates below-normal vegetation activity over the northeastern parts of the Western Cape.

Questions/Comments:
NkambuleV@arc.agric.za

7. Vegetation Conditions & Rainfall

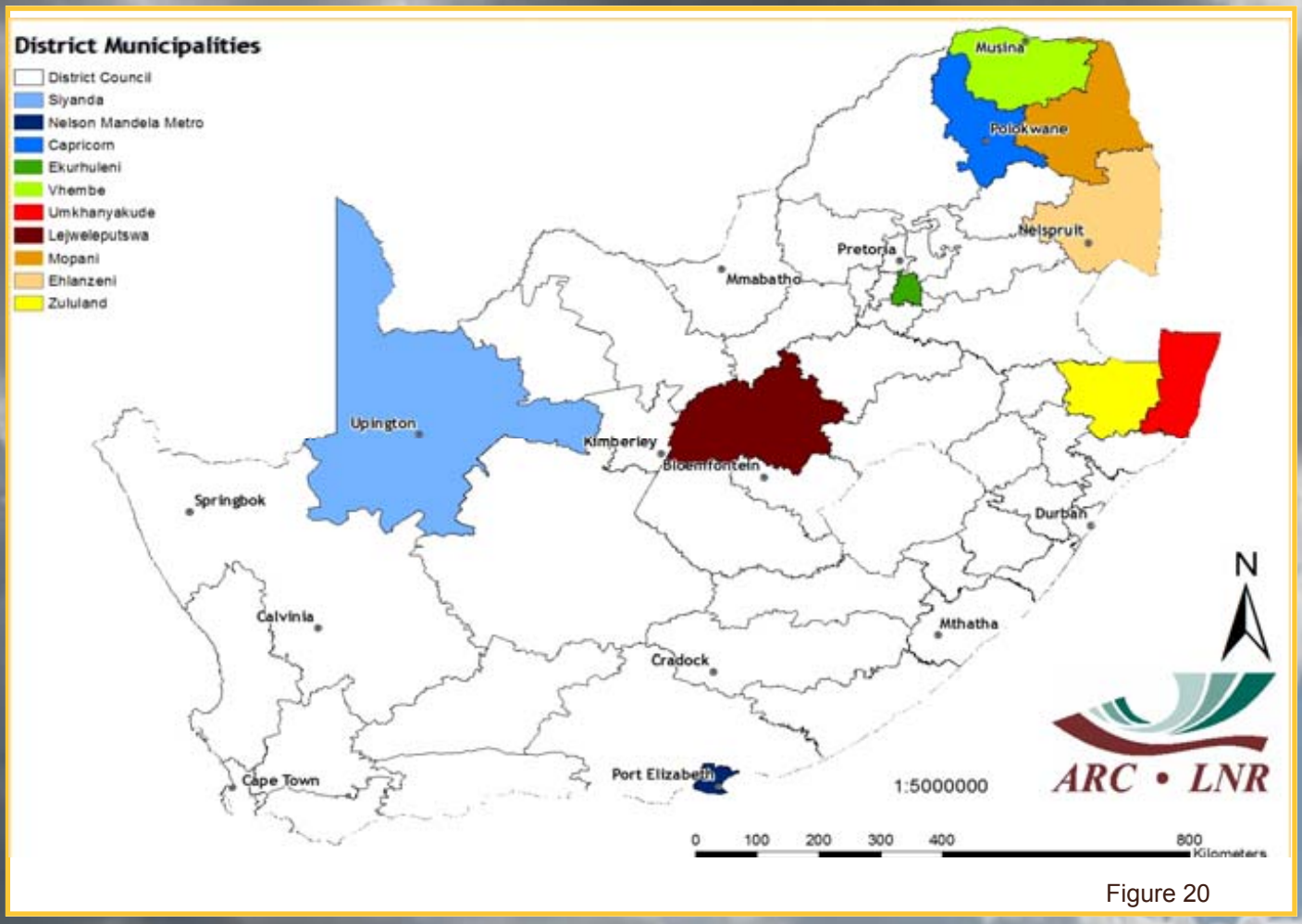


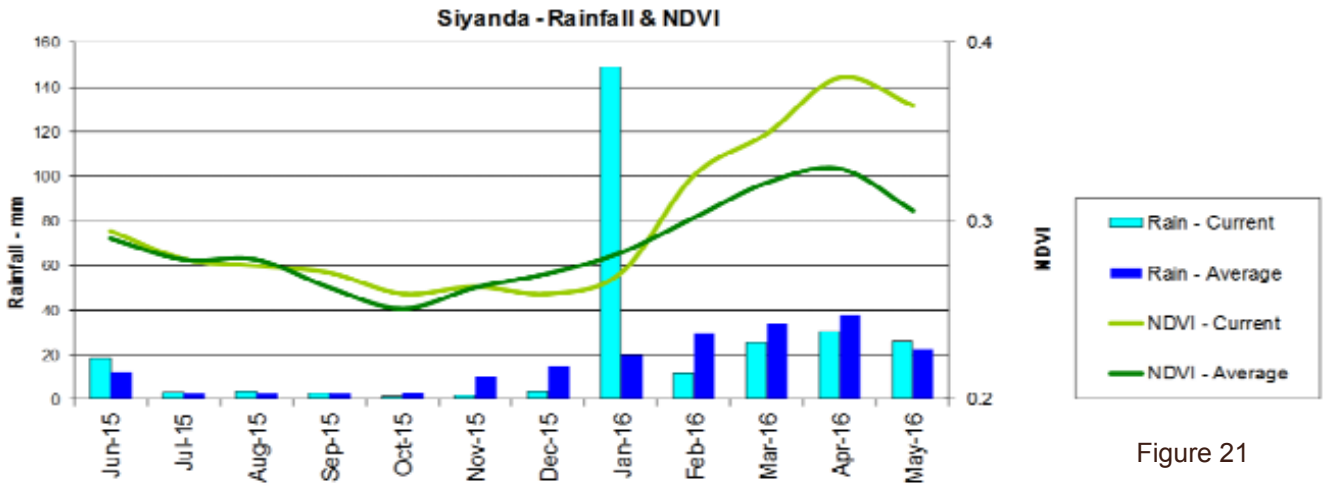
Figure 20

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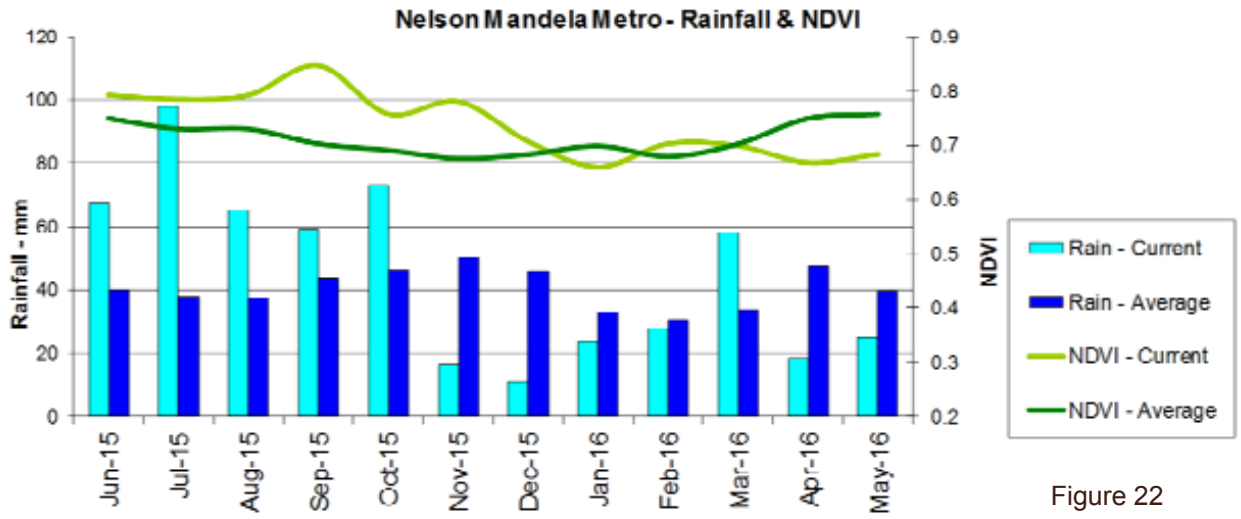

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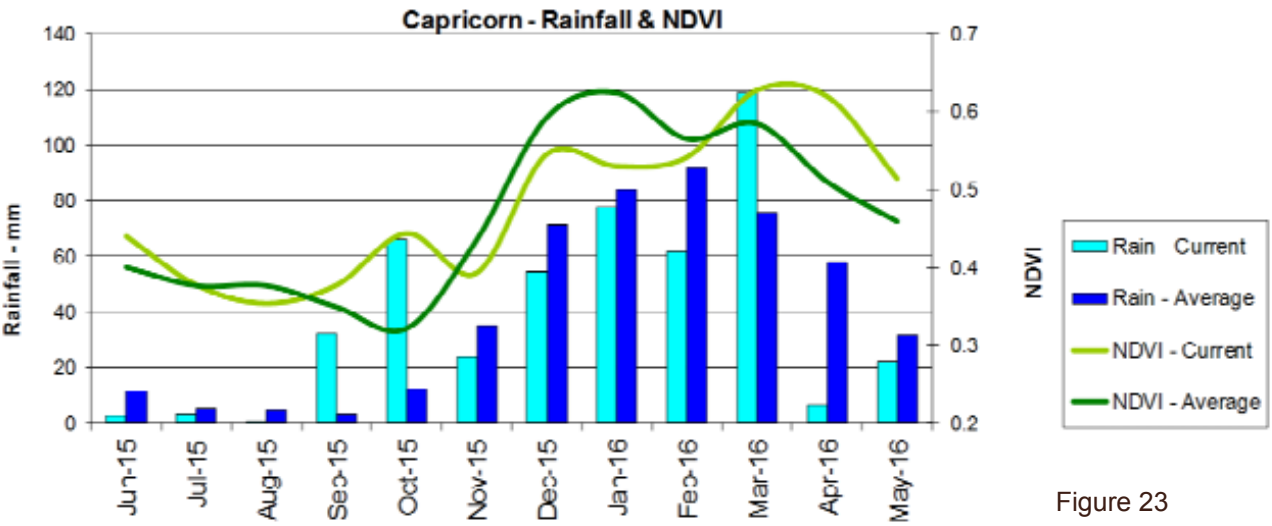

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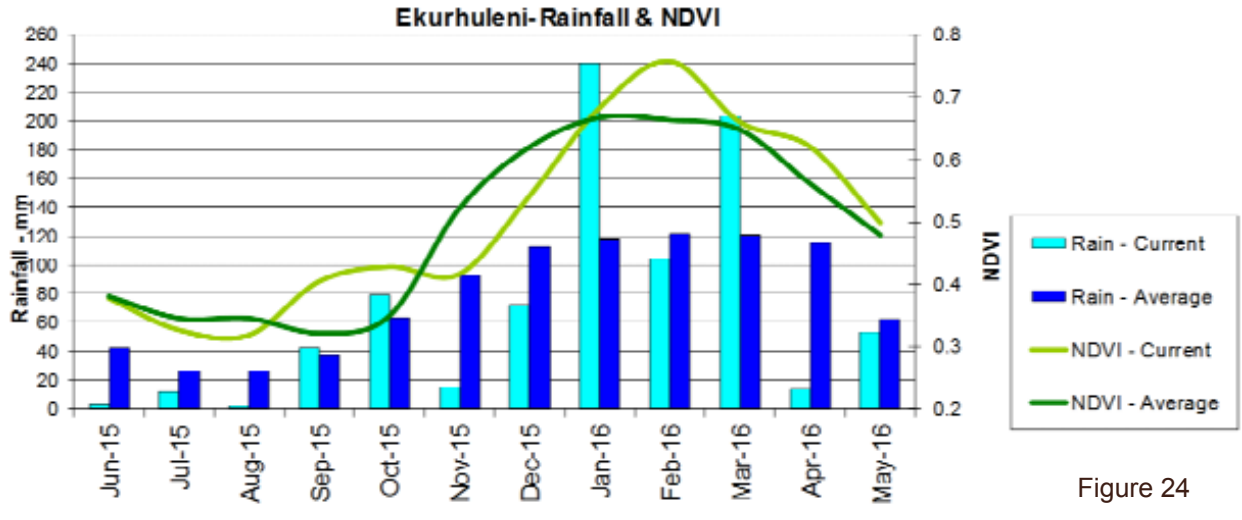

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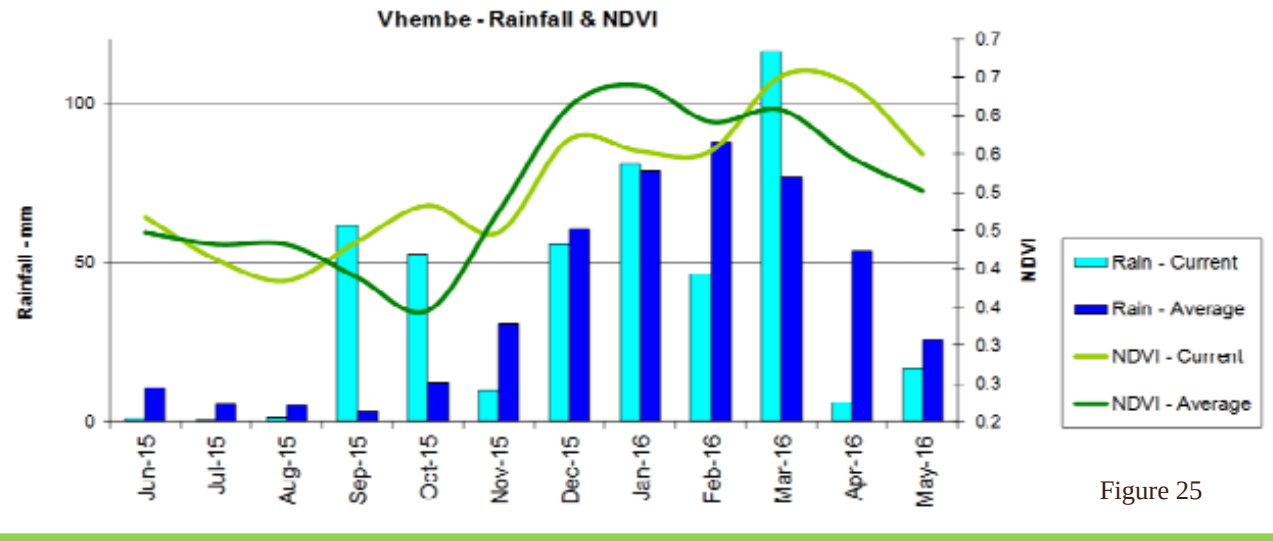


Figure 25

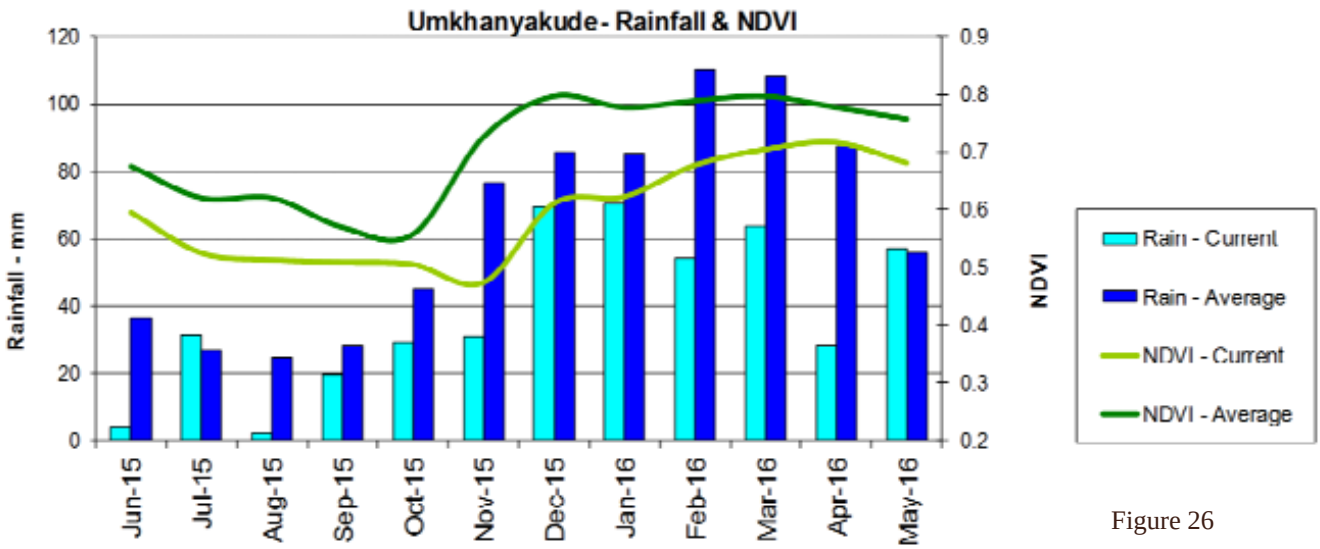
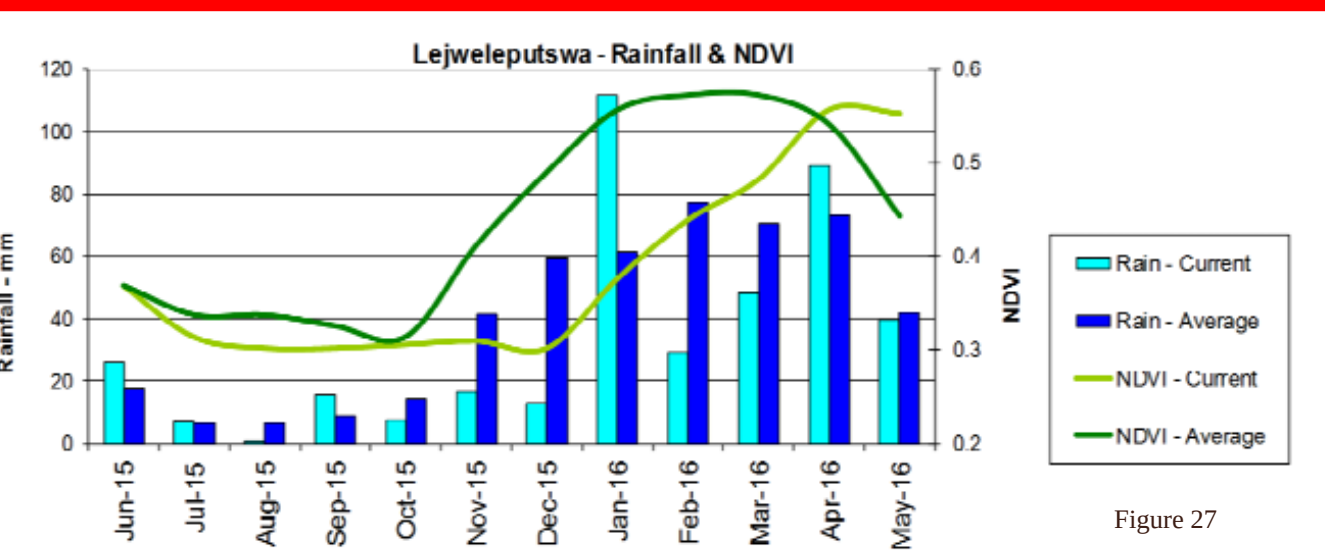


Figure 26



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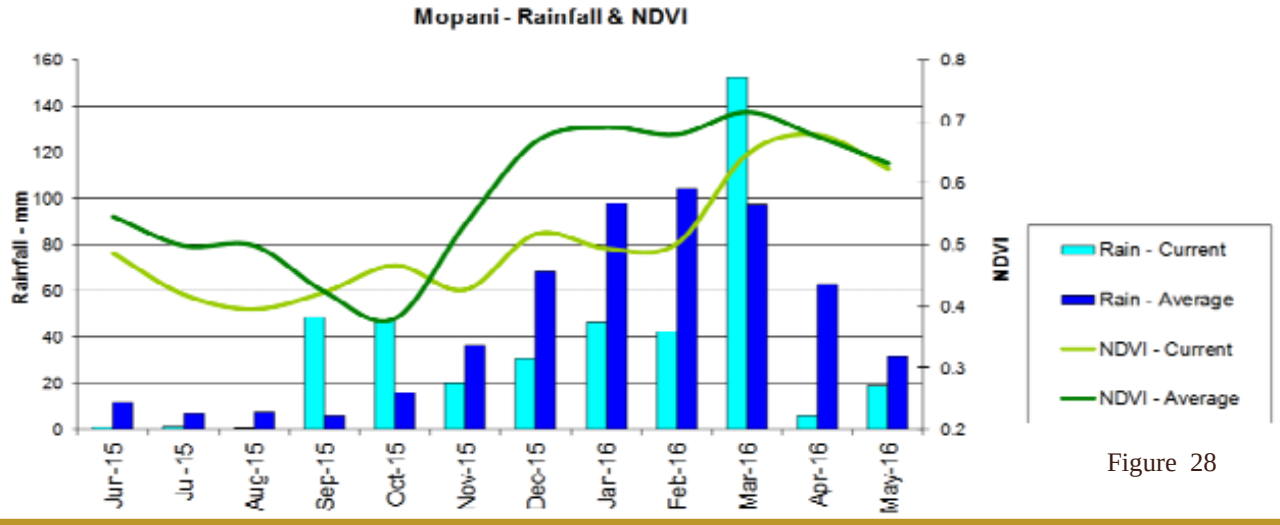

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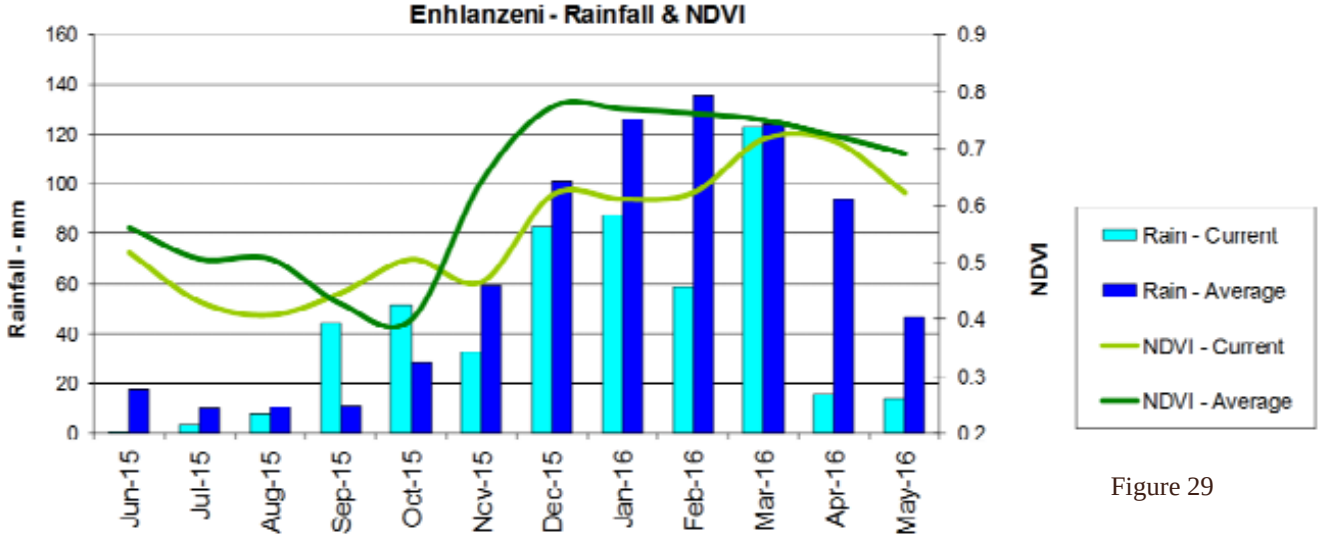

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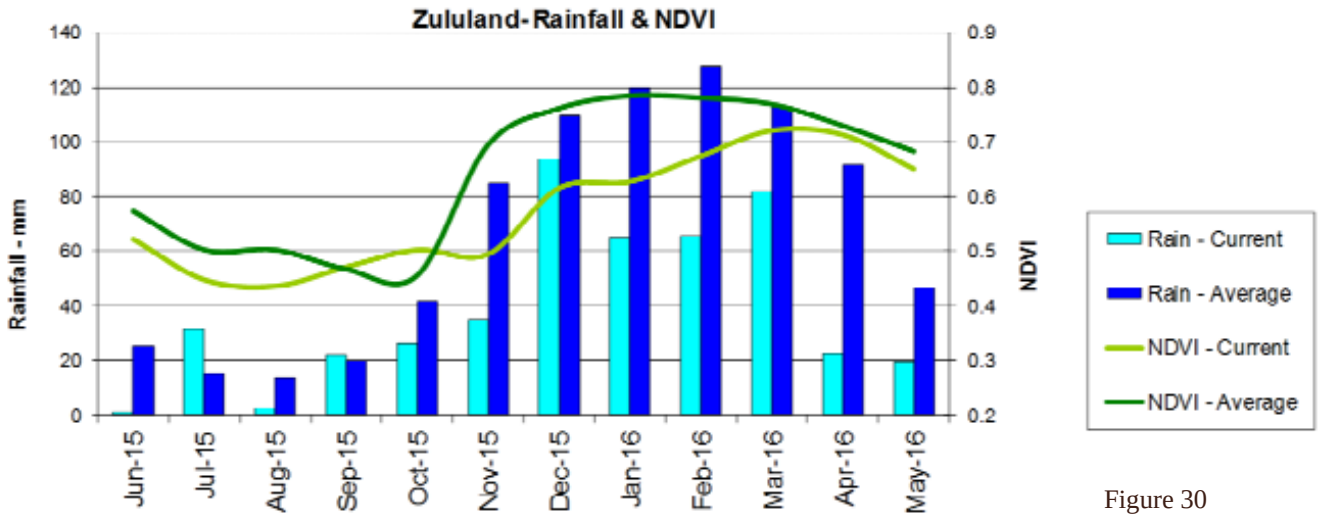

Figure 30

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 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 May and April 2016, 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 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.

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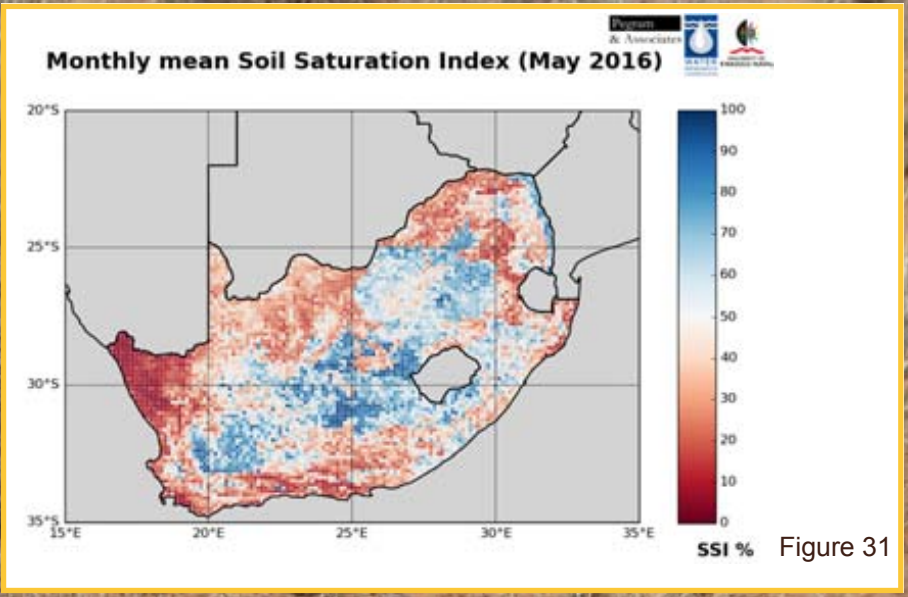

Figure 31

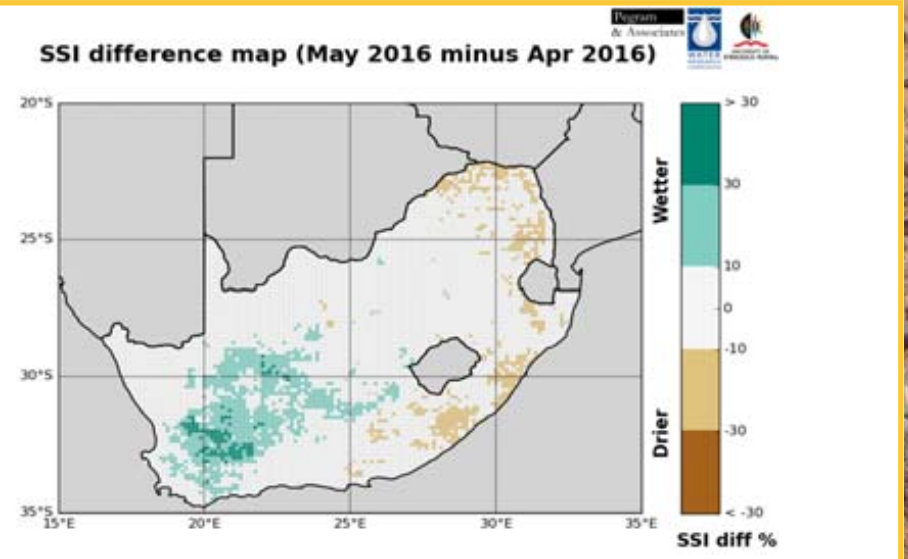

Figure 32

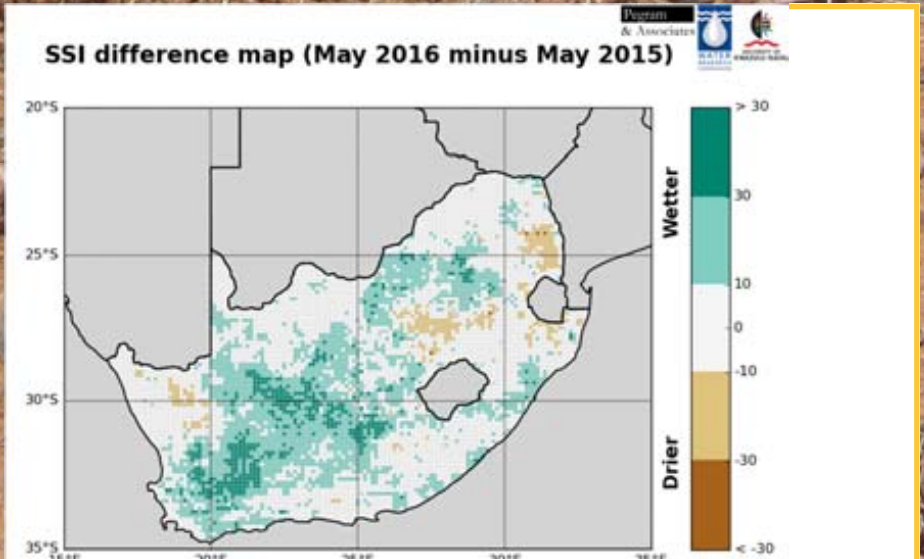

Figure 33

UNIVERSITY OF KWAZULU-NATAL

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

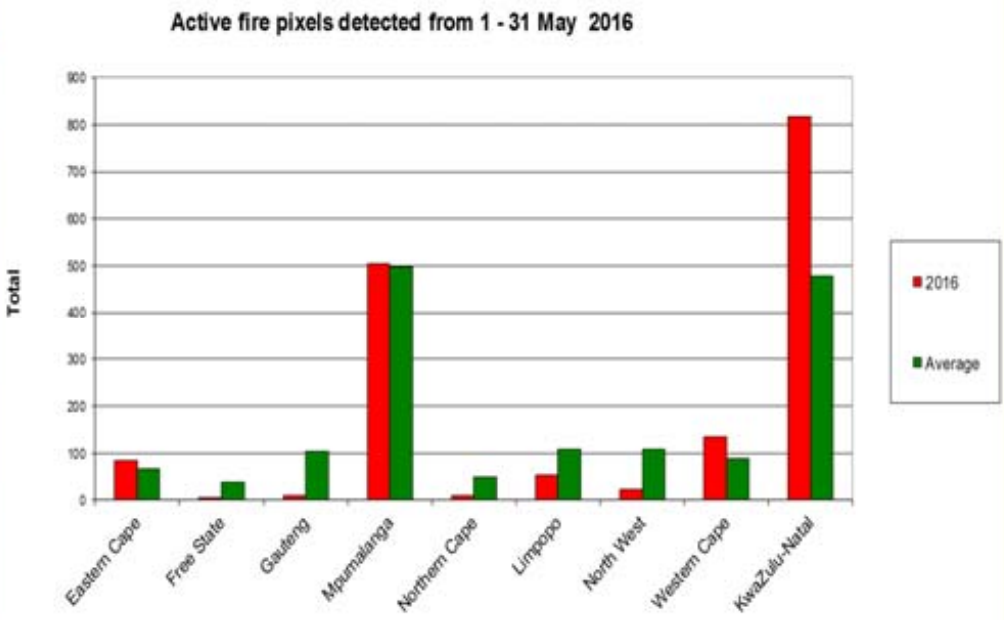

Figure 34

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

Questions/Comments:
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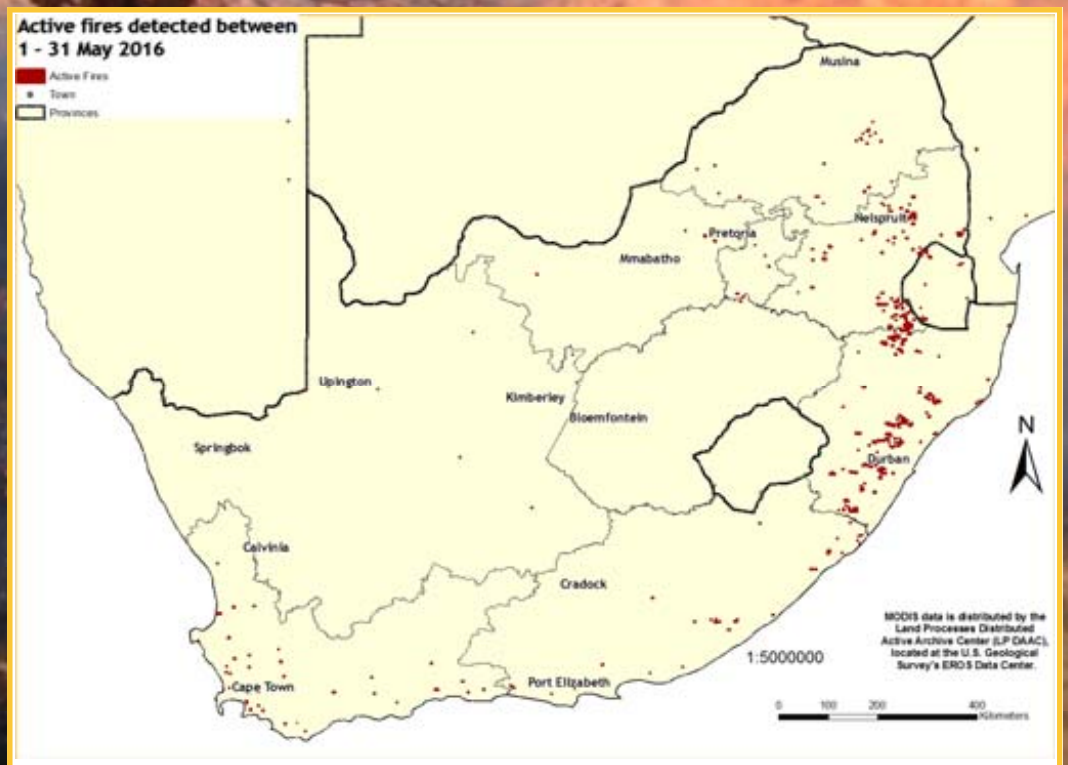

Figure 35

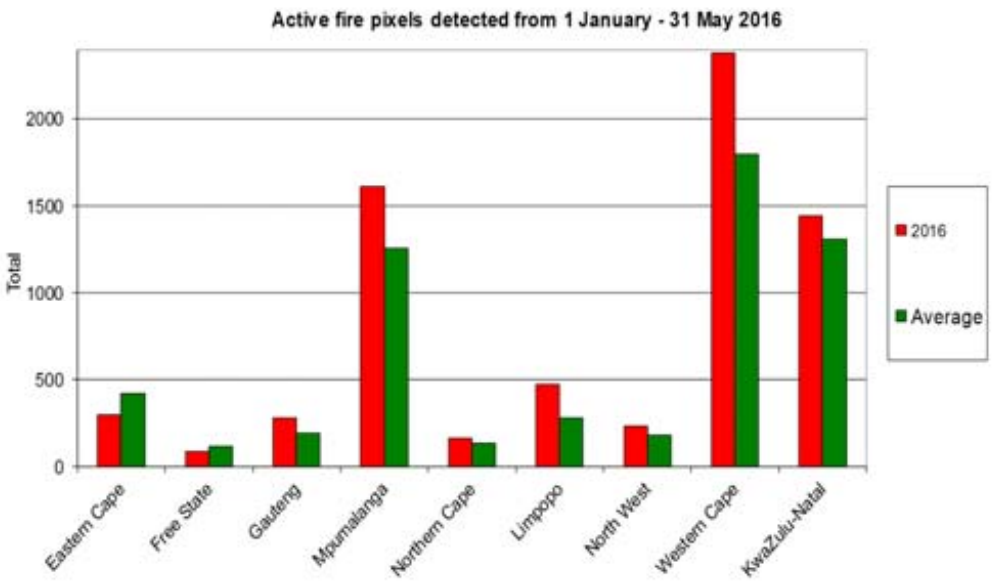

Figure 36

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

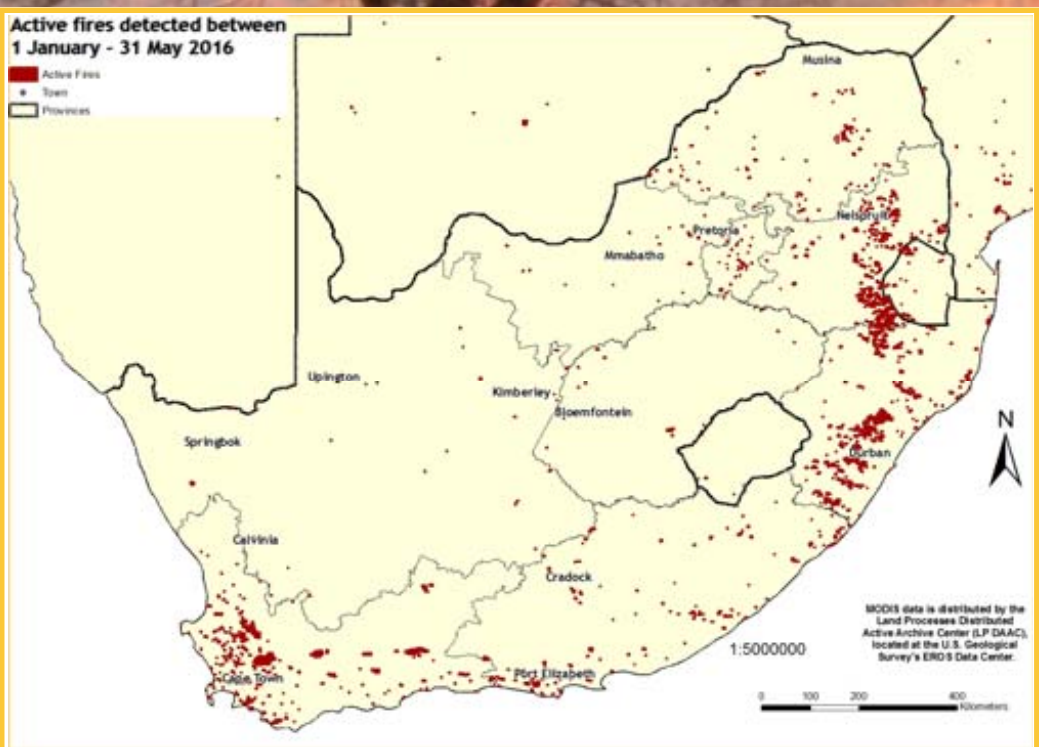

Figure 37

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

Questions/Comments:
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Agrometeorology

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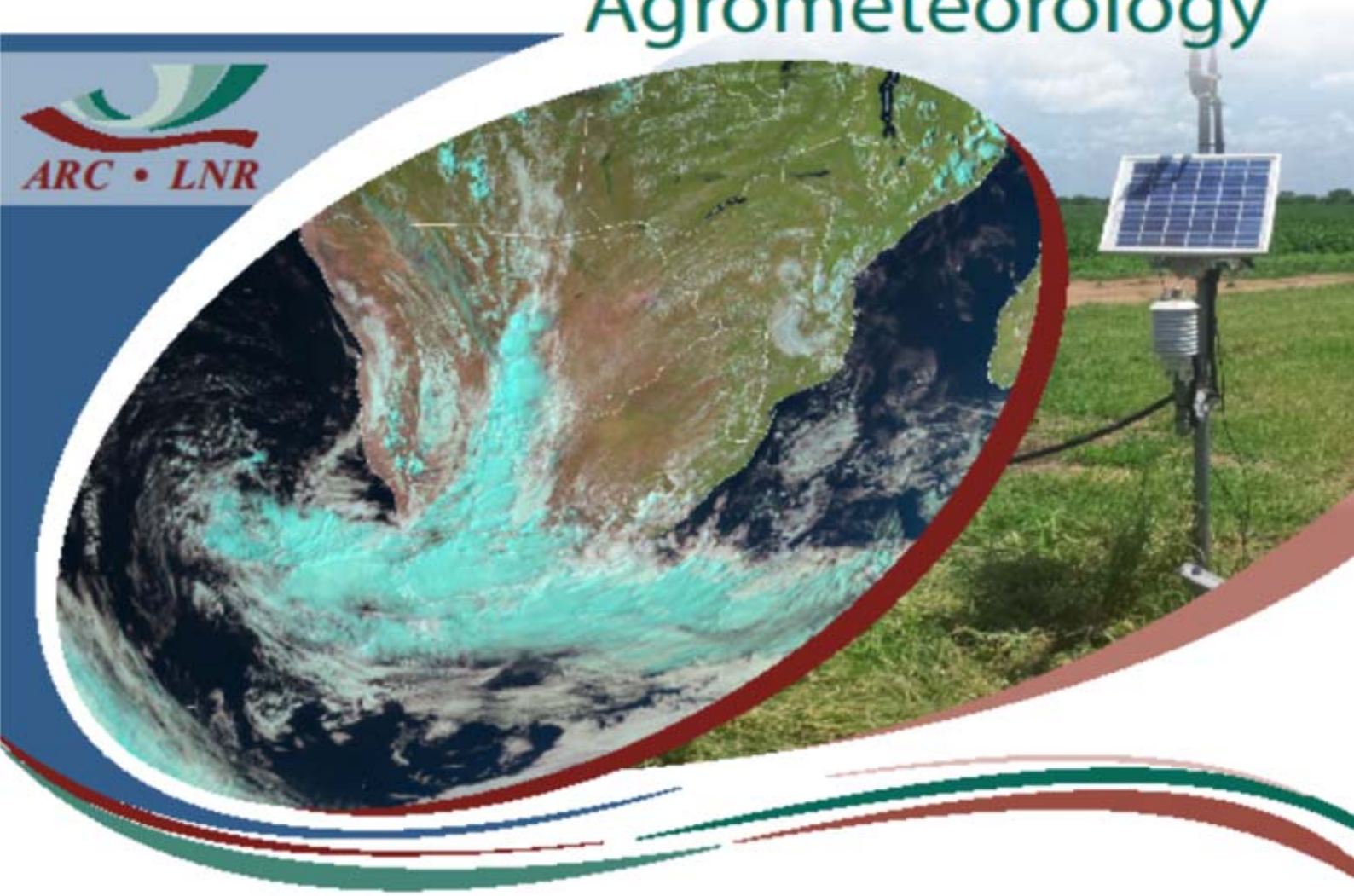

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national asset.

FOCUS AREAS

Climate Monitoring, Analysis & Modelling

- Analysis of climate variability and climate model simulation
- Use of crop modelling to assess the impact of climate on agriculture
- Development of decision support tools for farmers

Climate Change Adaptation & Mitigation

- National greenhouse gas inventory in the agricultural sector
- Improvement of agricultural production technologies under climate change
- Adaptation and mitigation initiatives, e.g. biogas production in small-scale farming communities

Climate Information Dissemination

- Communication to farmers for alleviating weather-related disasters such as droughts
- Dissemination of information collected from weather stations
- Climate change awareness campaigns in farming communities

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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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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