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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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REPUBLIC OF SOUTH AFRICA

South African Weather Service

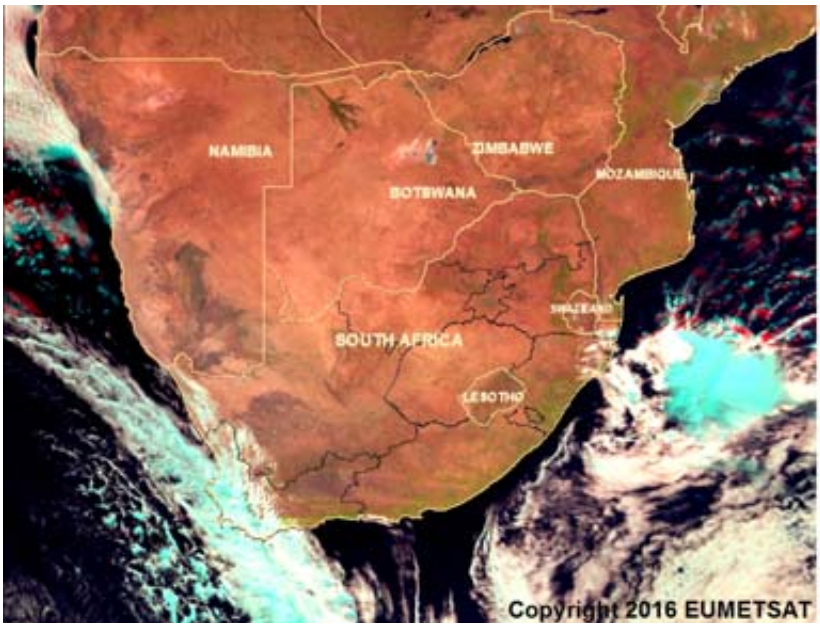
AMESD

147th Edition

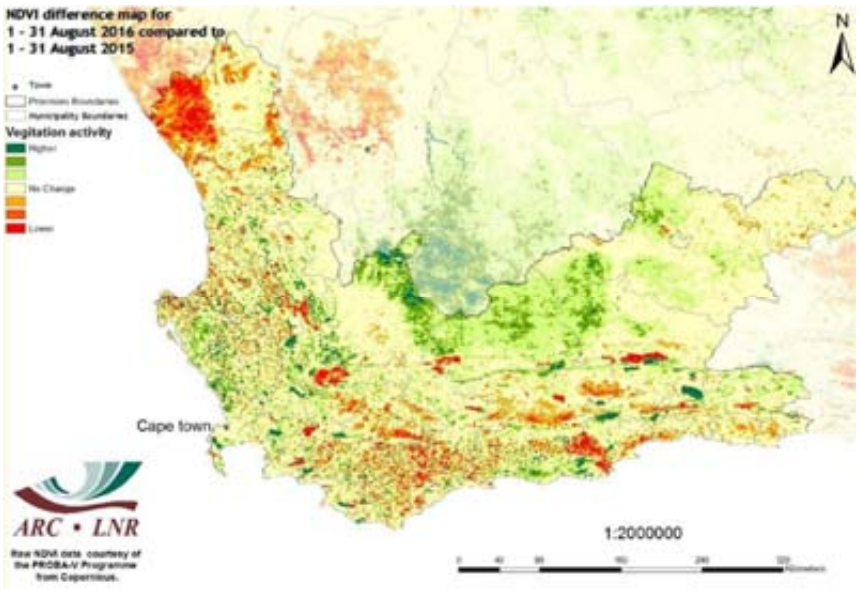
Images of the Month

Improved conditions over the western winter rainfall region

Low dam levels in the Western Cape are an indication of 2 years of normal to below-normal rainfall, focussing especially over the Swartland and Boland. The failure of the second half of the 2015 winter rainfall season in particular, resulted in large crop losses over the Swartland, the main wheat production area of the Western Cape. Following the dry winter of 2015, rainfall has returned to near normal levels in 2016. Except for May, rainfall totals have been near normal for each month of the 2016 winter. While rainfall during August 2016 was near normal to below normal, several cold fronts resulted in regular rainfall events, albeit light most of the time, keeping conditions relatively favourable for crop production.



The false-colour composite from the MSG-3 SEVIRI sensor for 12:00 SAST on the 21st of August shows the landfall of a cold front over the southwestern parts of the country. The system was the most intense cold front for the month and contributed a large part of the rain that fell over the winter rainfall region. With rainfall totals over the main crop production areas ranging from 15-40 mm, the system played an important role in supporting production in an otherwise rather dry month. The frontal system in the southwest swept across the country during the following few days, resulting in low minimum temperatures and widespread occurrence of frost during a month in which the general trend in temperatures was upward. The cool and dry weather associated with the frontal system over the interior also brought an end to a week of unstable conditions with scattered thundershowers over much of the southern parts and KwaZulu-Natal. Improved rainfall relative to last year has resulted in higher vegetation activity over much of the Swartland this year, as shown in the NDVI difference map for August.



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:

Near-normal to above-normal precipitation occurred over the southern half of the country during August 2016, while showers of an isolated nature resulted in most of the north receiving normal to below-normal rainfall. Over the southern to eastern interior, most of the rain occurred during the week of the 14th to 20th, following dry conditions during the first half of the month. During that week a high pressure system ridged to the south and east of the country, with a surface trough in the west, coupled with a weak upper air trough over the southwestern parts. The combination of these systems resulted in scattered thundershowers over much of the Northern Cape, Eastern Cape and interior of the Western Cape, including the Karoo. As the upper-air trough moved eastwards, with the high-pressure system strengthening towards the south, widespread rain occurred over much of KwaZulu-Natal, especially along the coast where totals exceeded 40 mm. During this time, a frontal system also moved into the western parts of the country, with a westerly to southwesterly flow advecting cold and dry air into much of the southern and central parts, resulting in a return to dry and anticyclonic conditions. The colder dry air resulted in the last widespread frost over the interior, occurring on the mornings of the 20th to 23rd. The rest of the month was relatively warm and dry, as anticyclonic upper-air circulation patterns dominated. Overall, temperatures during the month were on an upward trend, with the cold episode around the 22nd being an exception. A frontal system moving across the country at the beginning of the month resulted in widespread frost around the 3rd, followed by a slow and elongated recovery. While rainfall totals were normal to below normal over the winter rainfall region, rainfall events were fairly evenly distributed during the month, even though only light falls occurred during most of these events. Frontal systems resulted in rainfall focussing on the following periods: 2, 5 (light falls only), 13, 19-21 and 31 August. The event from the 19th to 21st was the most significant, with some areas receiving significant totals during this period. This was associated with a stronger frontal system with a strong westerly flow, which subsequently resulted in cold and dry conditions over the interior following a week of unstable conditions there. The last frontal system resulting in some precipitation over the southwestern parts occurred on the very last day of the month.

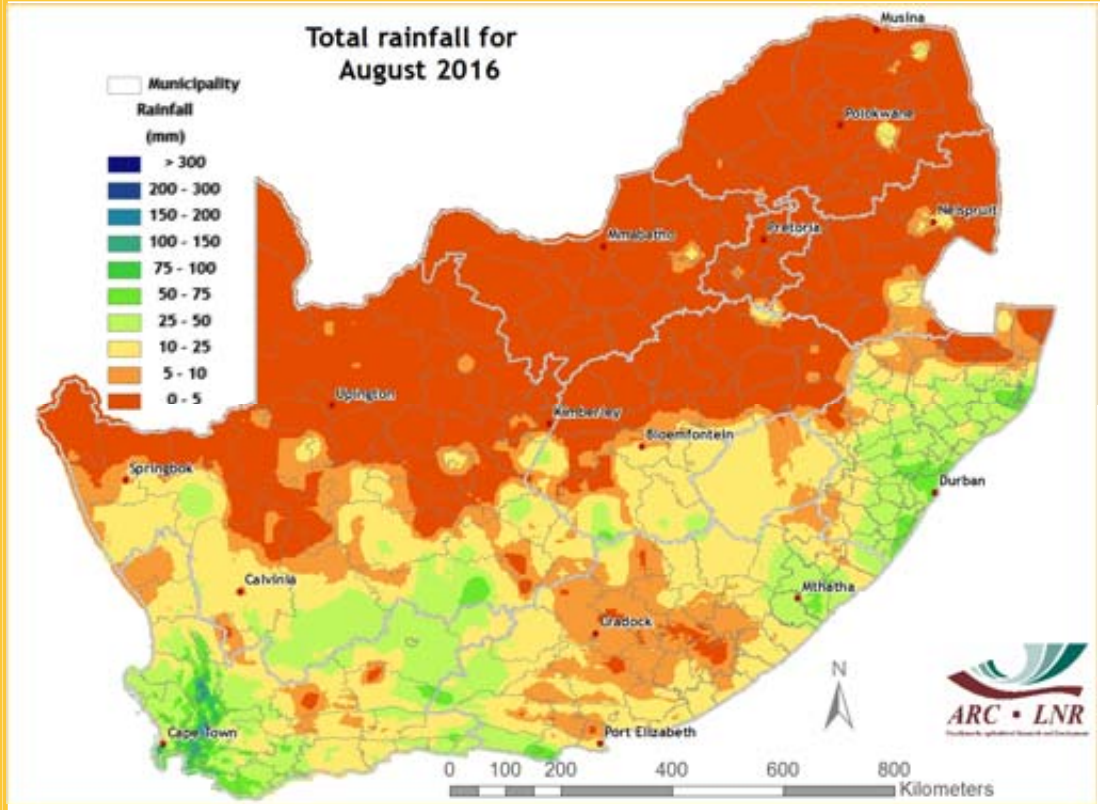


Figure 1

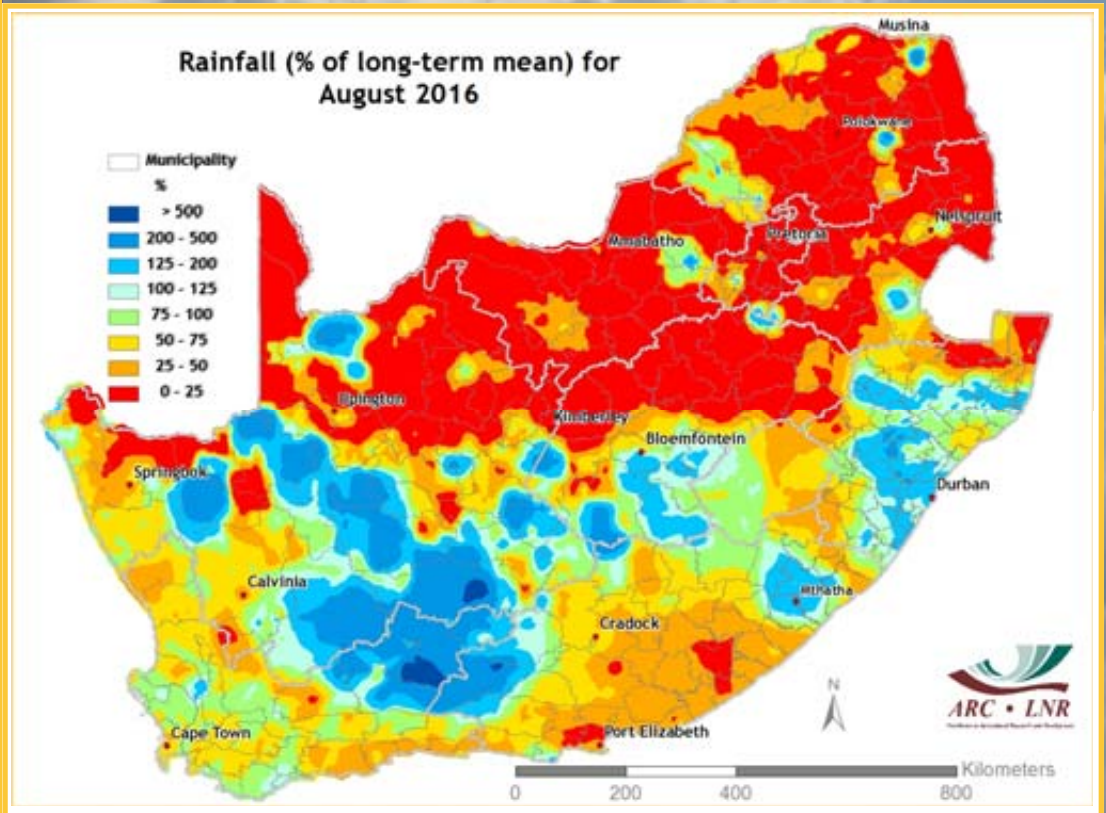


Figure 2

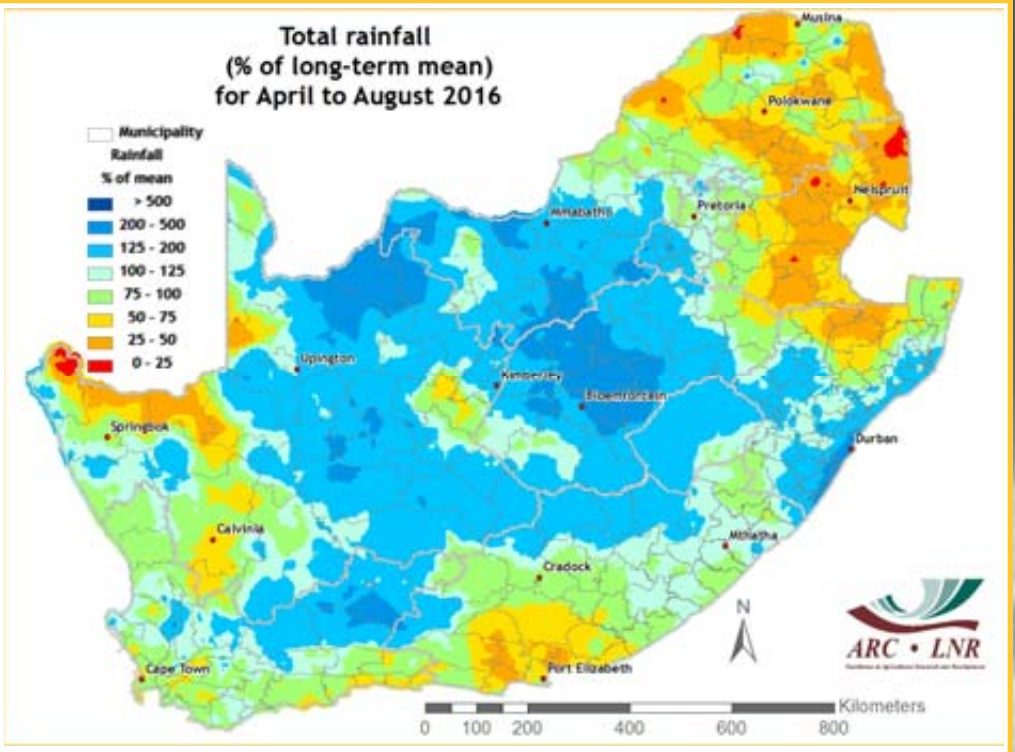


Figure 3

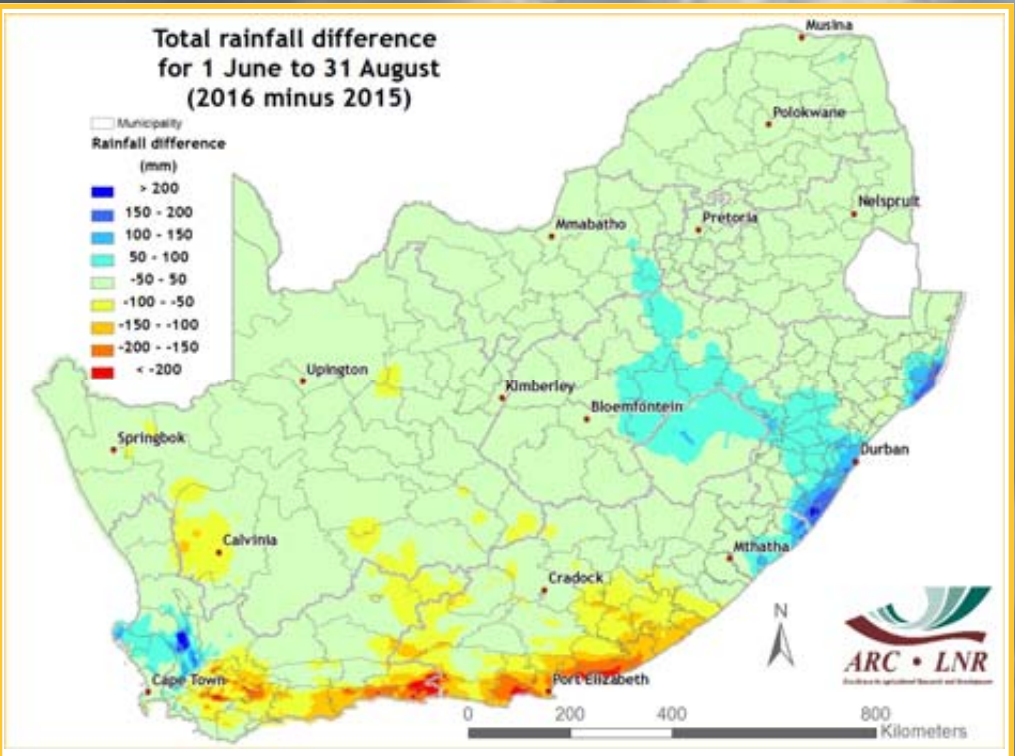


Figure 4

Figure 1:
Most of the southern half of the country, including the winter rainfall region, received rain during August. Grain-producing areas in the winter rainfall region received between 25 and 75 mm of rain, with totals over the mountainous areas exceeding 100 mm. Totals along the coast of KwaZulu-Natal also exceeded 50 mm.

Figure 2:
Large parts of the southern interior, including much of central to southern KwaZulu-Natal as well as the coast, received above-normal rainfall. Rainfall was predominantly normal to below normal over the winter rainfall region while below-normal rainfall occurred over the northern interior.

Figure 3:
Much of the central interior experienced above-normal rainfall since April, with the coast of KwaZulu-Natal and some parts of the winter rainfall region also experiencing above-normal rainfall. Rainfall in the northeast, adjacent to Namibia and over the western parts of the Eastern Cape was normal to below normal.

Figure 4:
The southern parts of the country (focussing on the Garden Route) received significantly less rain during June to August this year than in the same period last year. In contrast, the western parts of the winter rainfall region (focussing on the Swartland), coastal KwaZulu-Natal into the eastern Free State, received more rain during this period than last year.

Questions/Comments:
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2. Standardized Precipitation Index

Standardized Precipitation Index

The Standardized Precipitation Index (SPI - McKee *et al*., 1993) was developed to monitor the occurrence of droughts from rainfall data. The index quantifies precipitation deficits on different time scales and therefore also drought severity. It provides an indication of rainfall conditions per quaternary catchment (in this case) based on the historical distribution of rainfall.

REFERENCE:
McKee TB, Doesken NJ and Kliest J (1993) The relationship of drought frequency and duration to time scales. In: Proceedings of the 8th Conference on Applied Climatology, 17-22 January, Anaheim, CA. American Meteorological Society: Boston, MA; 179-184.

The current SPI maps (Figures 5-8) show that wet conditions dominate at the shorter time scales over the central interior and towards the coast of KwaZulu-Natal. At the longer time scales (12 and especially 24-month time scale), severe to extreme drought conditions still dominate over the far eastern parts as well as the western winter rainfall region.

Questions/Comments:
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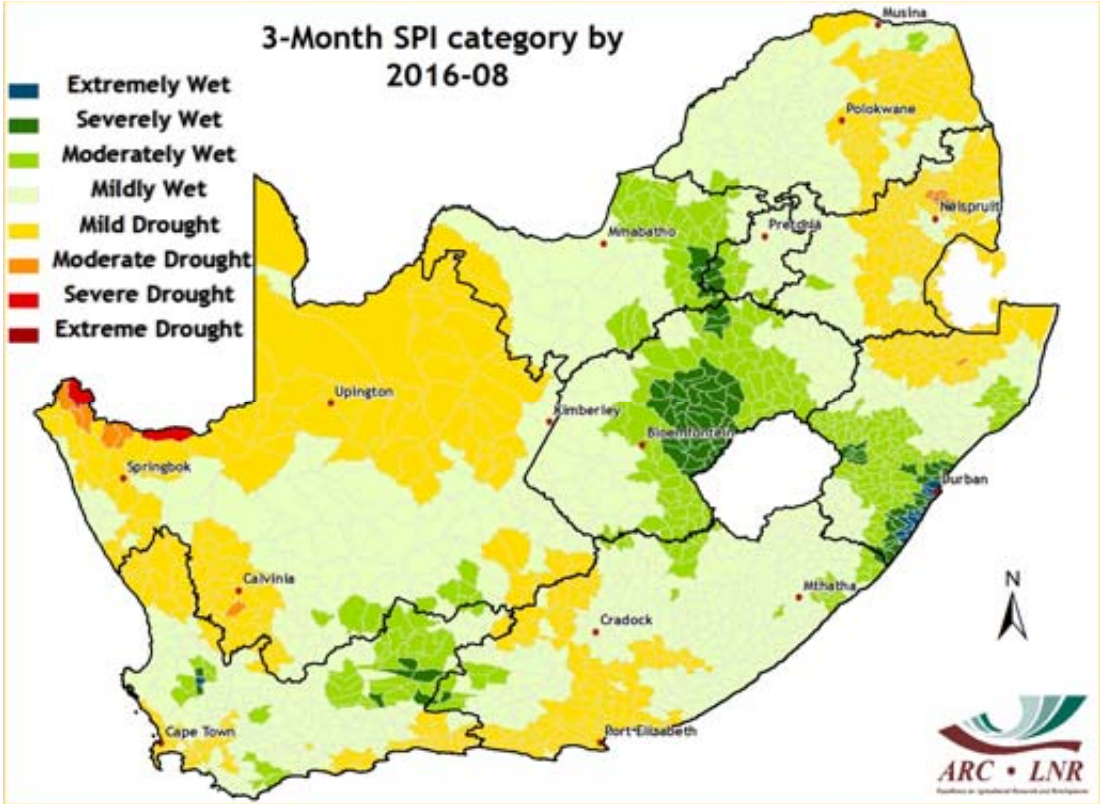

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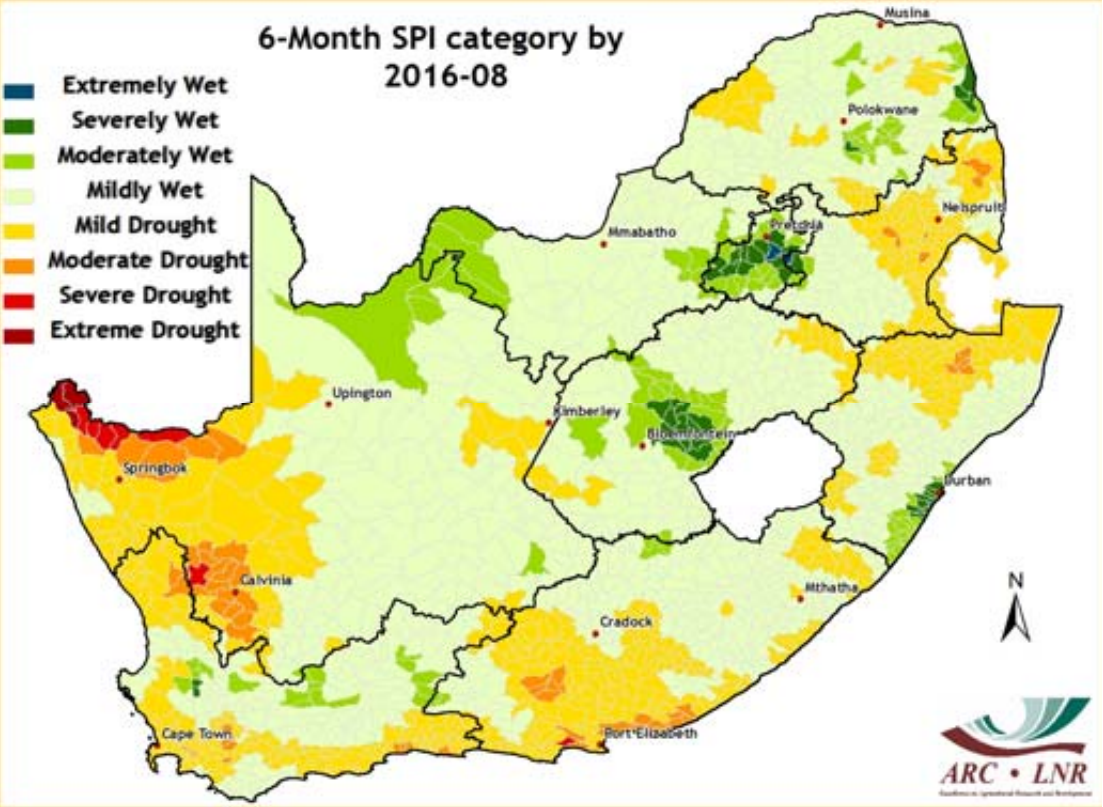

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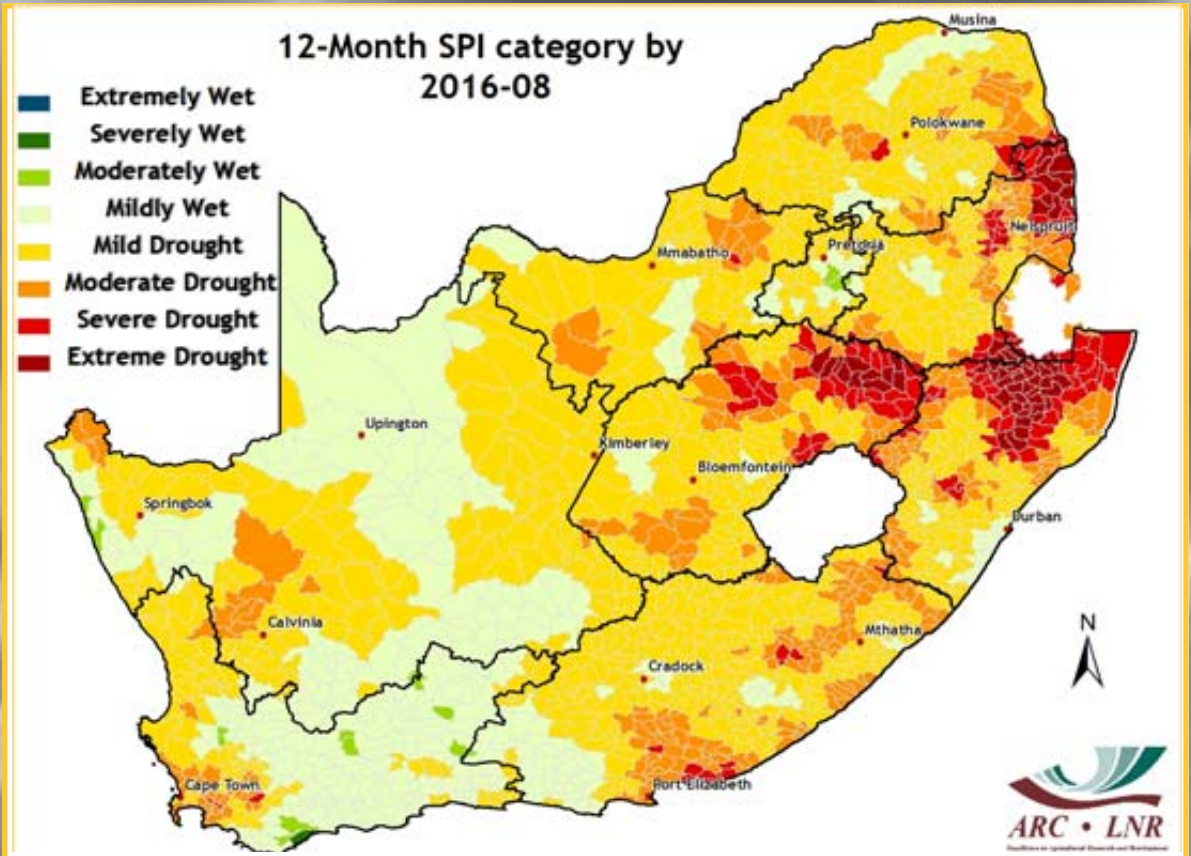

Figure 7

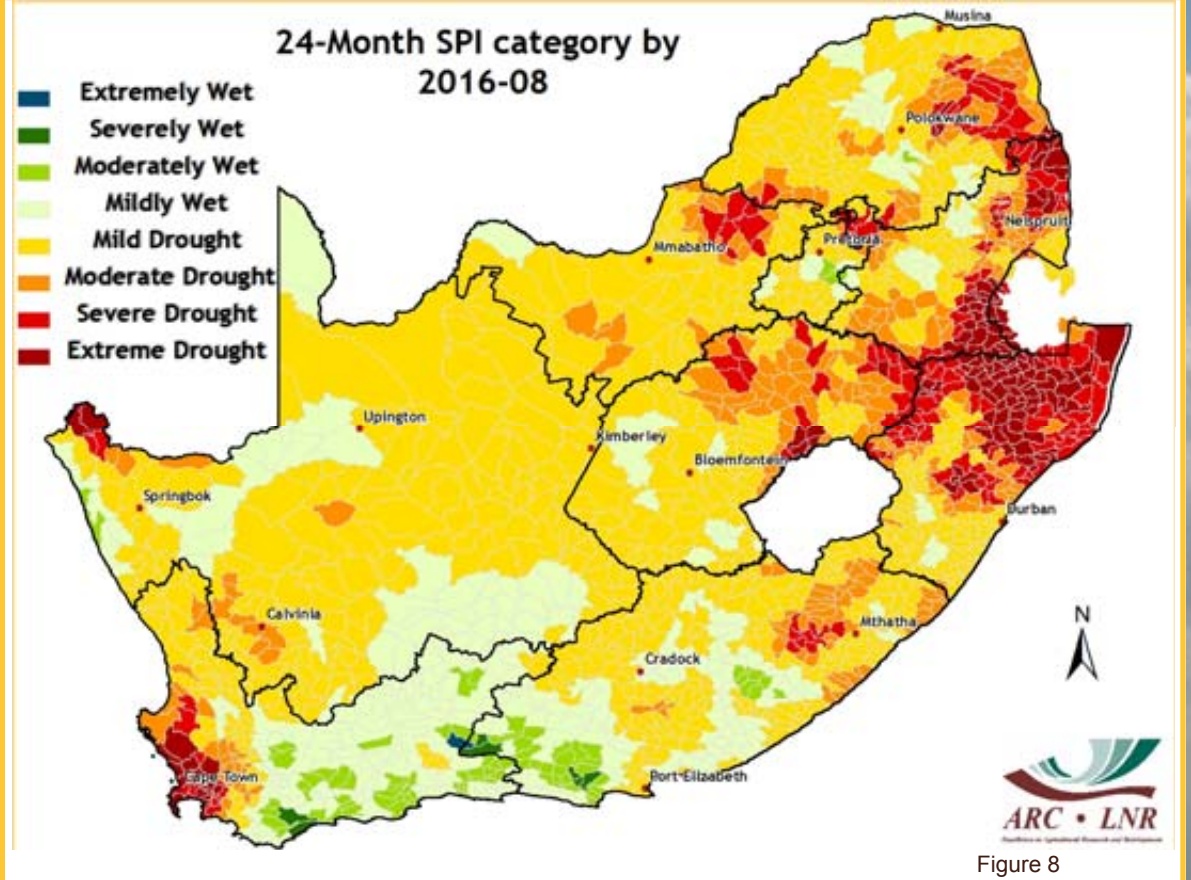

Figure 8

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.

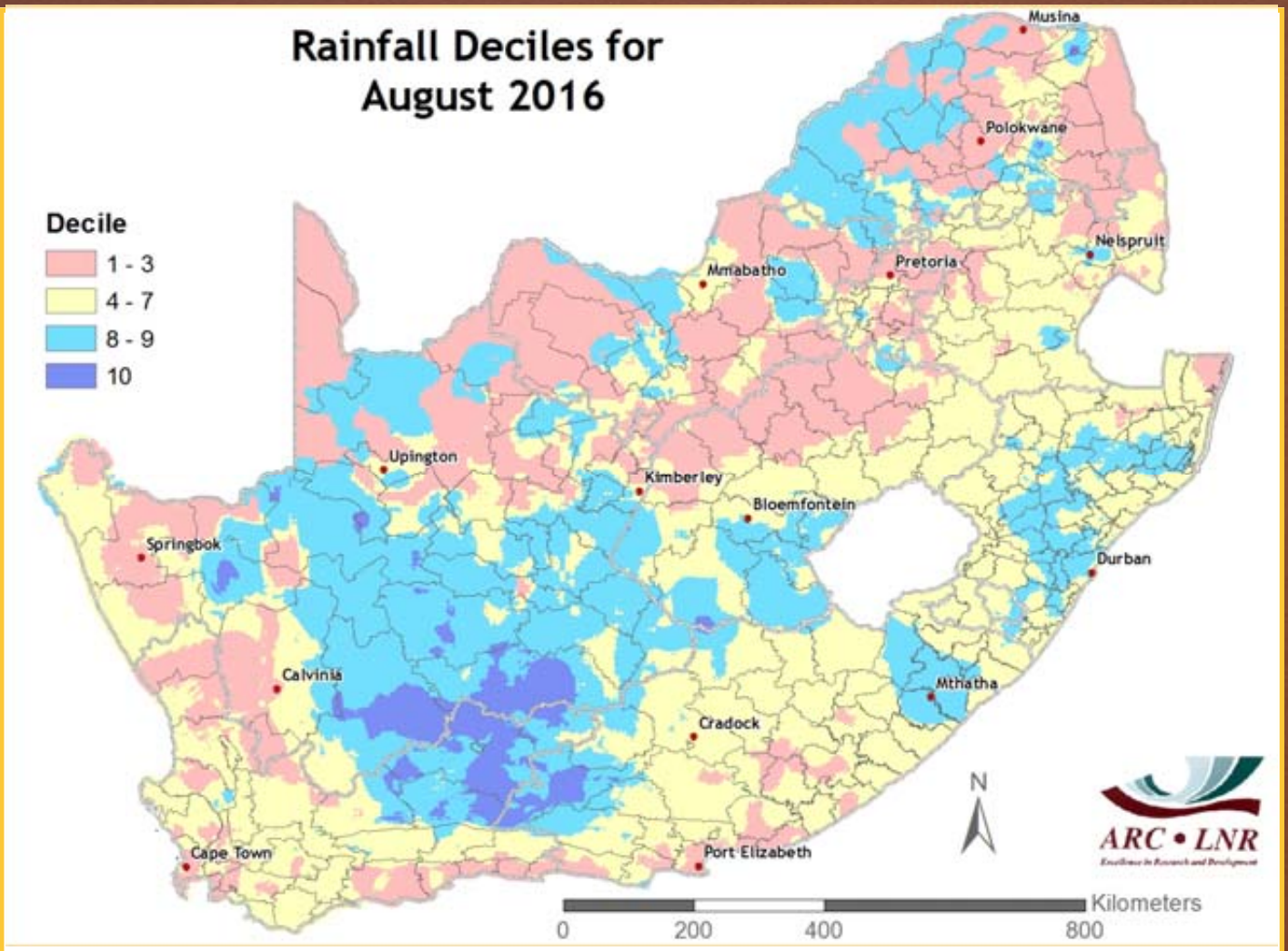

Figure 9

Figure 9:
Large parts of the Karoo were exceptionally wet during August.

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

4. Water Balance

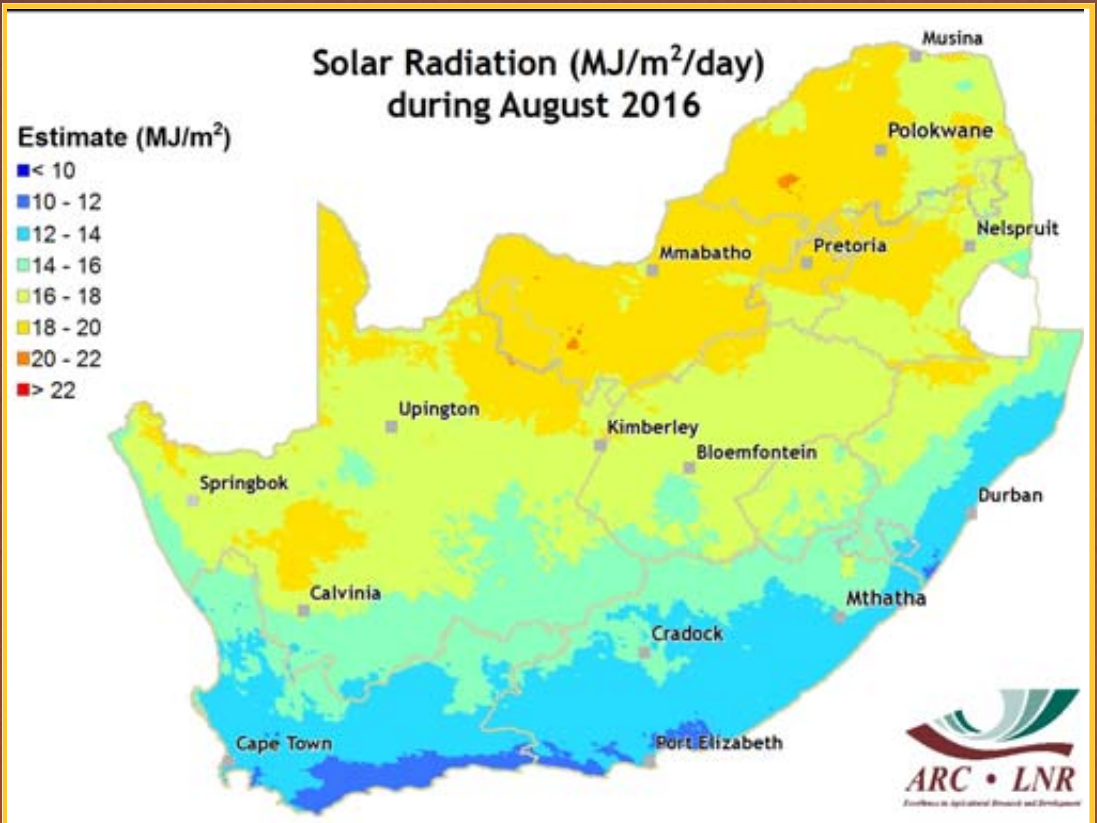

Figure 10

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:
Daily solar radiation totals are increasing as the spring Equinox approaches. Frequent cloudy conditions over the southern coastal areas exacerbated the effect of larger solar angles, keeping average daily totals below 12 MJ/m^2.

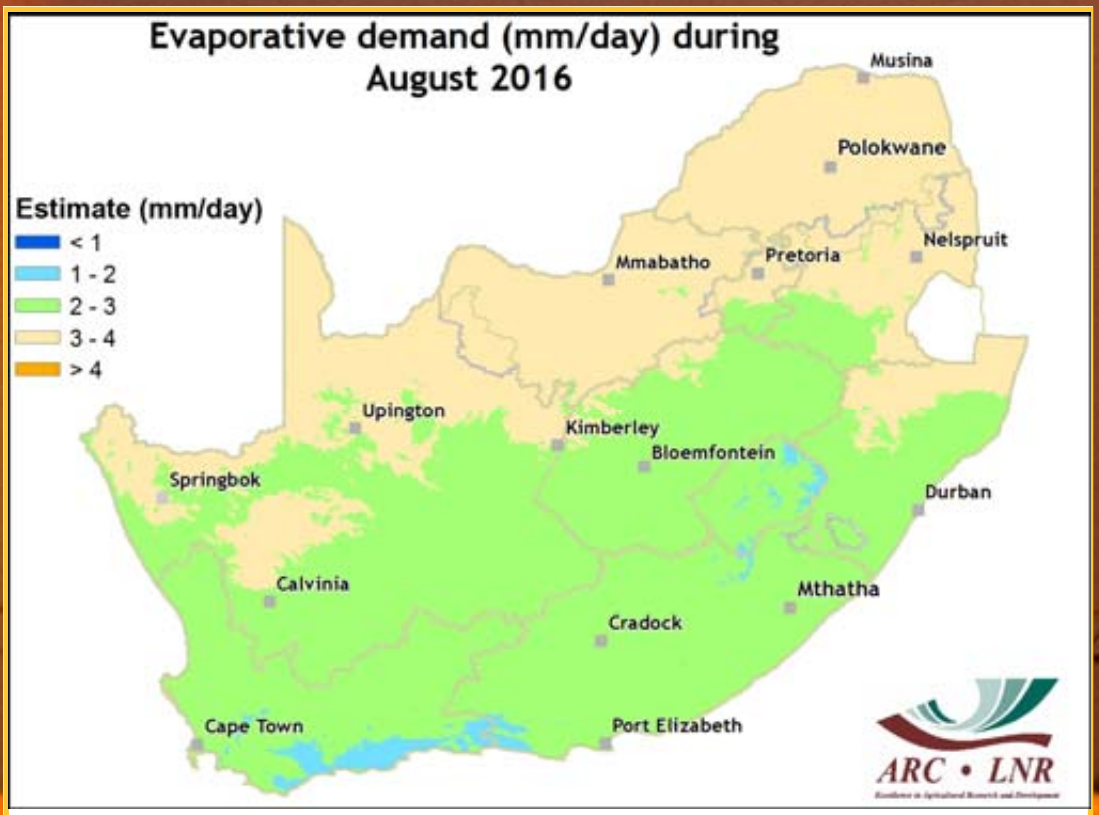

Figure 11

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:
Daily potential evapotranspiration values also increased, related to more solar energy and higher maximum temperatures.

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.

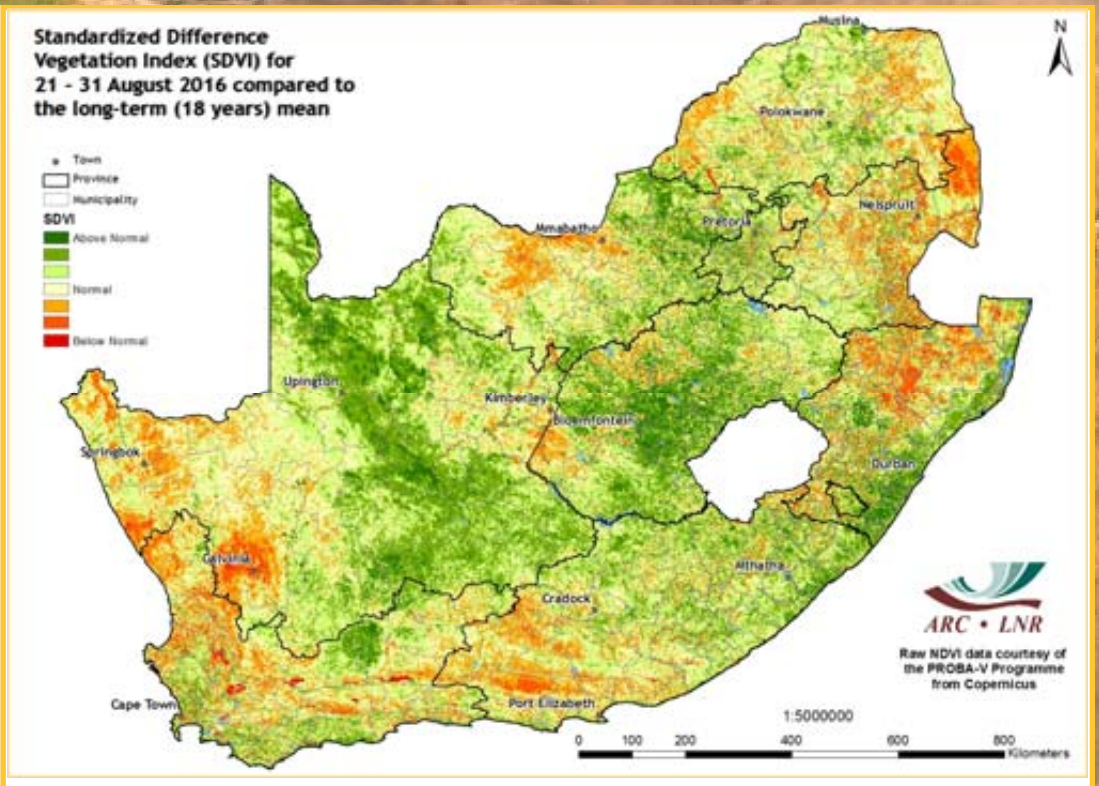

Figure 12

Figure 12:
The SDVI by late August reflected recent above-normal rainfall over much of the interior and the coast of KwaZulu-Natal. Vegetation activity was near normal over the crop production areas of the winter rainfall region, where rainfall has been near normal. Vegetation activity is below normal over the northern parts of the winter rainfall region as well as the eastern low-lying areas.

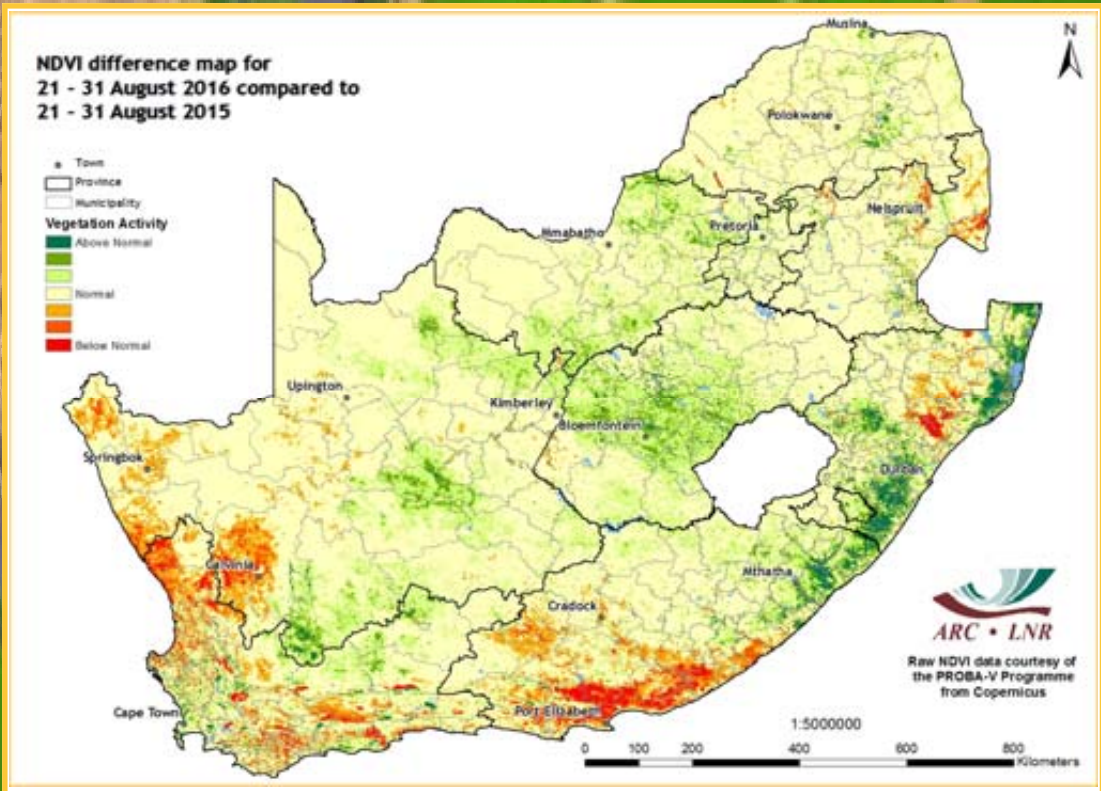

Figure 13

Figure 13:
Vegetation activity is much lower over the northern parts of the winter rainfall region as well as the eastern Garden Route into the southern parts of the Eastern Cape, compared to the previous year. Vegetation activity is higher over much of southern and coastal KwaZulu-Natal as well as, to a lesser extent, much of the interior.

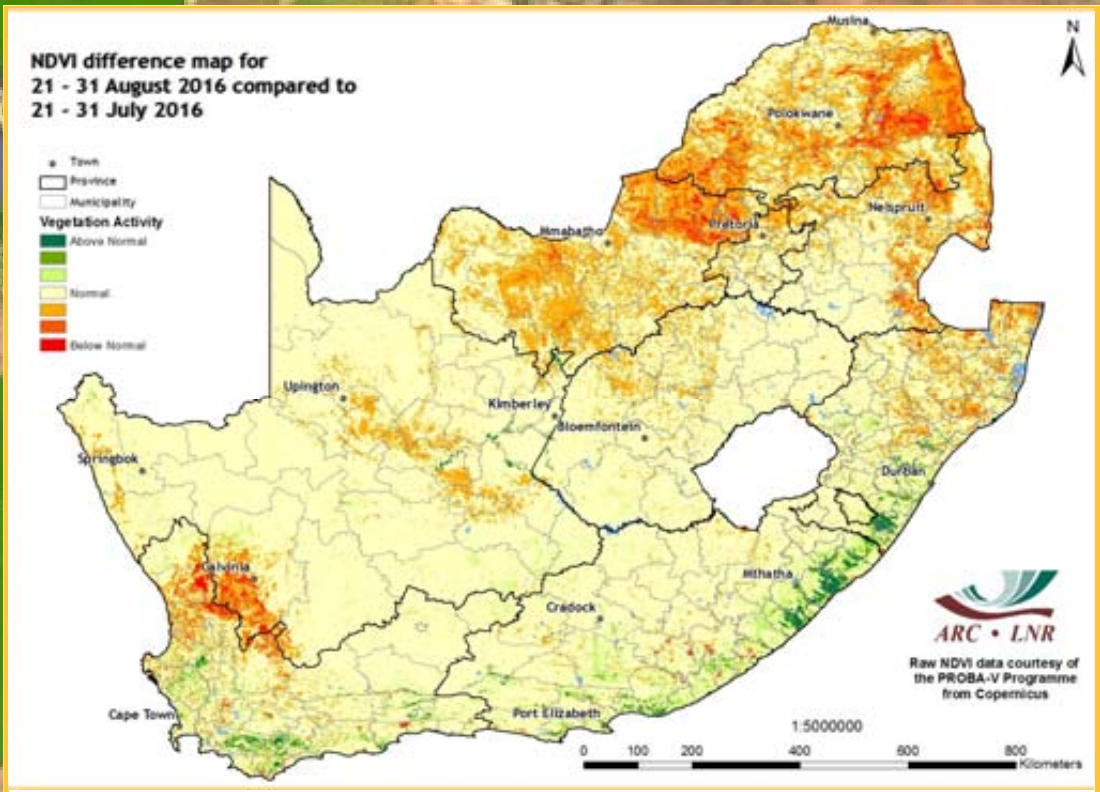

Figure 14

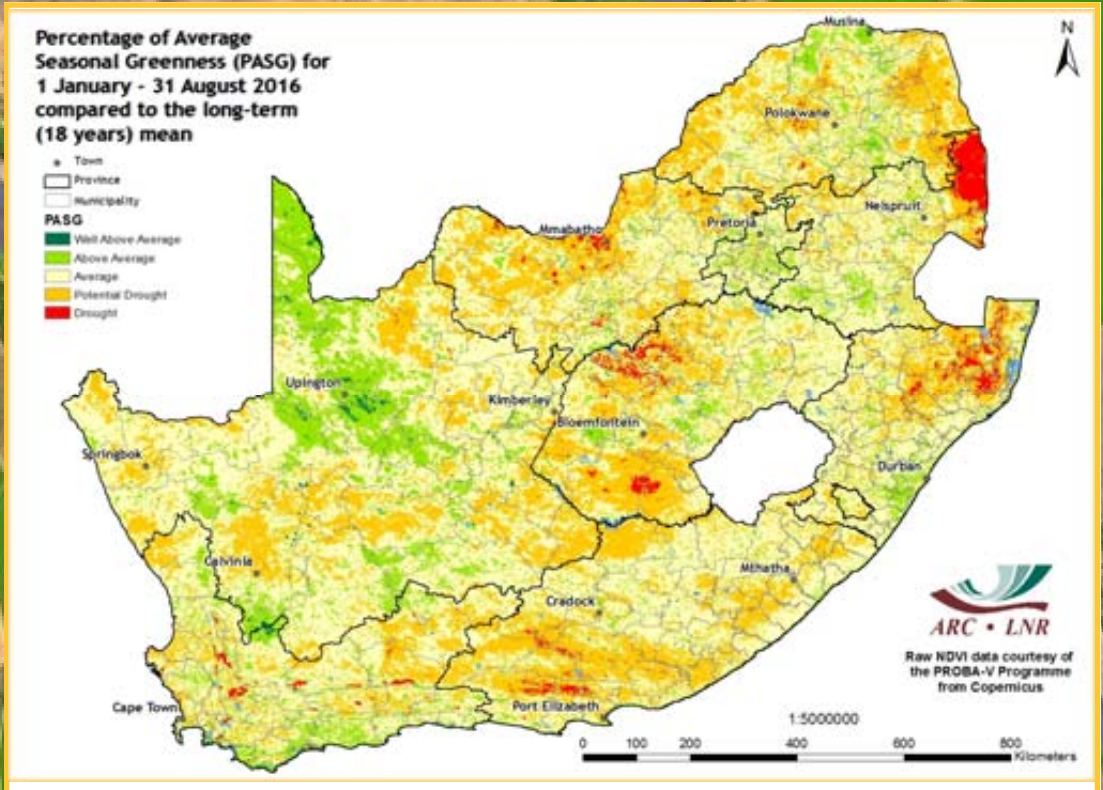

Figure 15

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 and rainfall patterns, together with cultivation, resulted in some increases in vegetation activity over the southwestern parts of the country together with the eastern coastal areas, while vegetation activity decreased over the southwestern parts of the Northern Cape due to weaker frontal activity, as well as the northern parts of the country.

Figure 15:
The effects of earlier drought conditions are still clear over the central to northwestern parts of the Free State, northern KwaZulu-Natal and Lowveld of Mpumalanga. Conditions seem close to the norm over much of the winter rainfall region.

Questions/Comments:
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6. Vegetation Condition Index

Vegetation Condition Index (VCI)

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

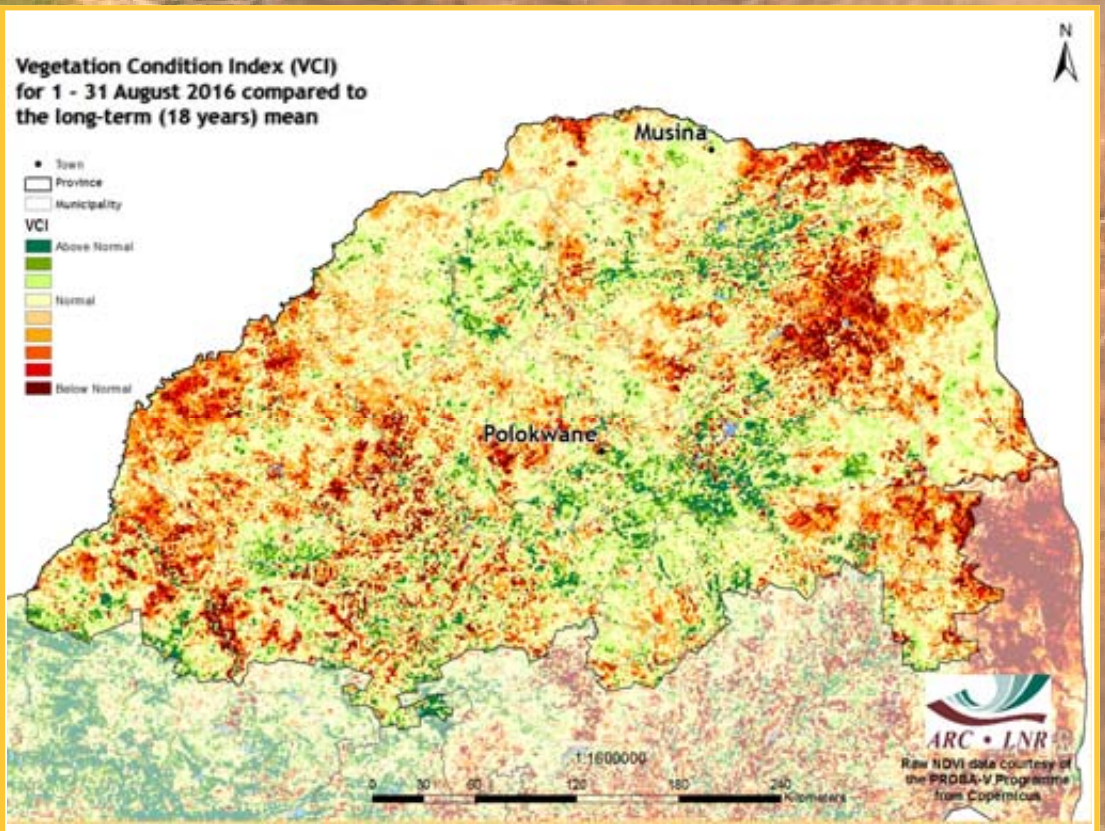


Figure 16

Figure 16:
The VCI map for August indicates below-normal vegetation activity over most parts of Limpopo.

Figure 17:
The VCI map for August indicates below-normal vegetation activity over the northern and northeastern parts of North West.

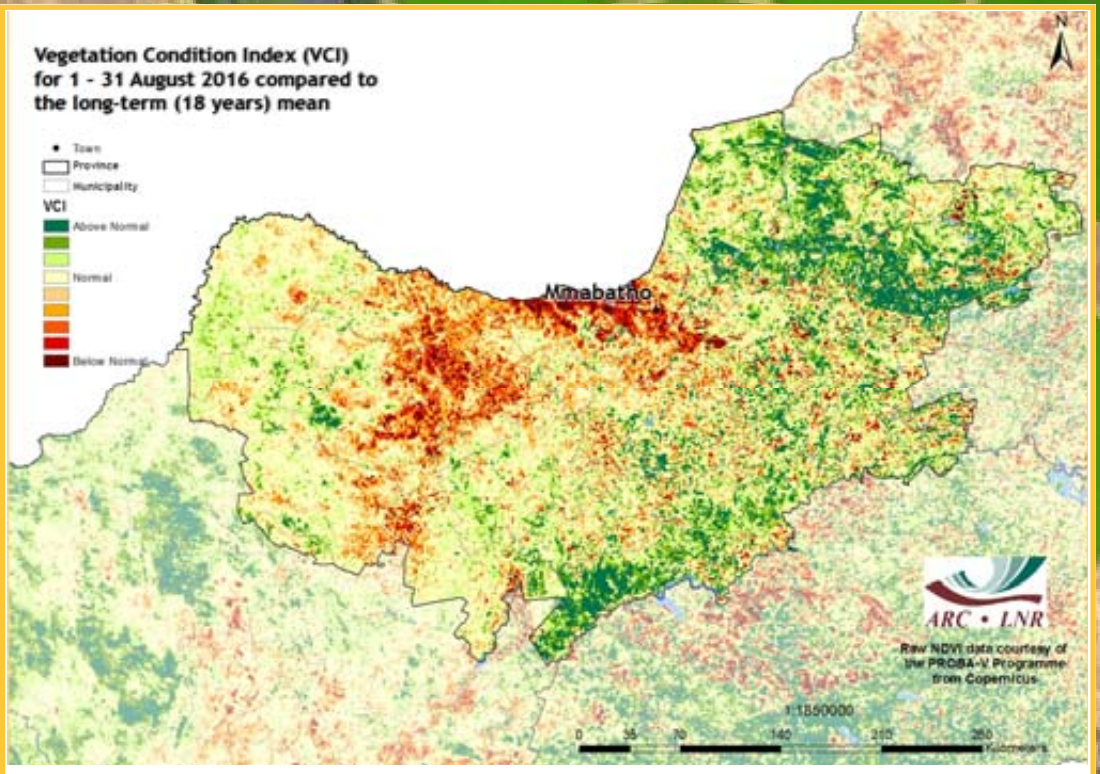
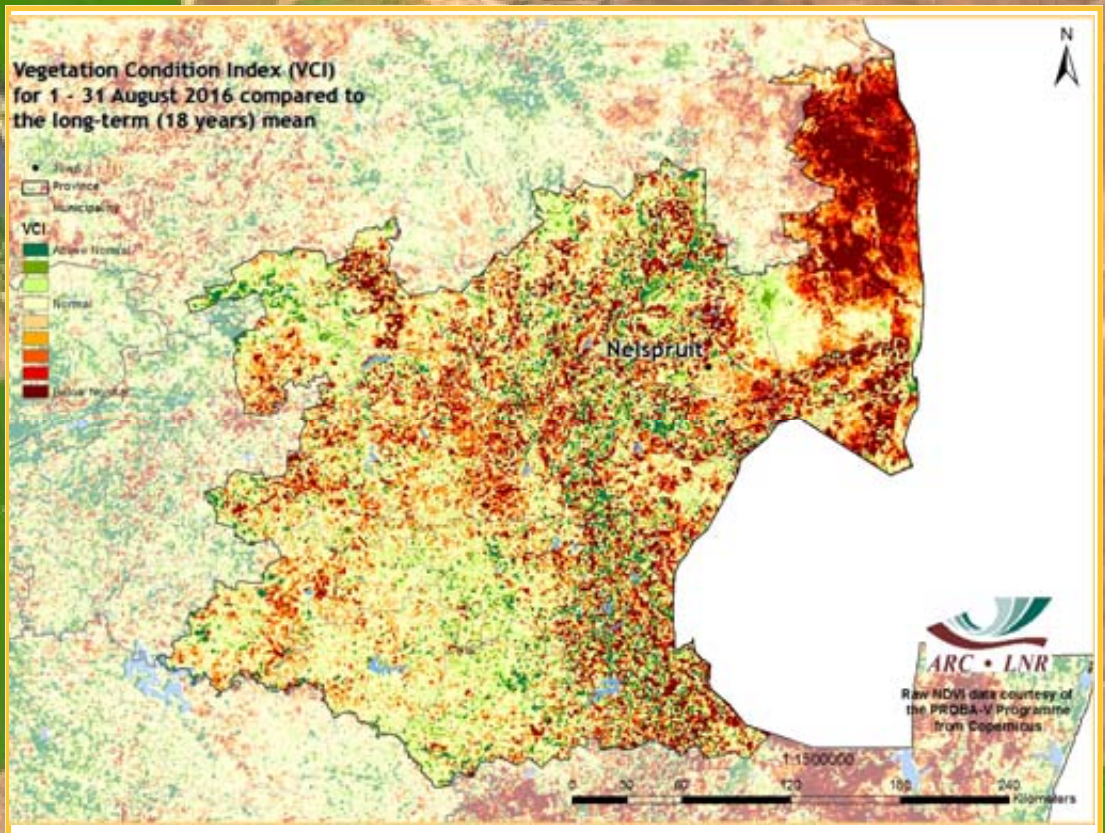


Figure 17



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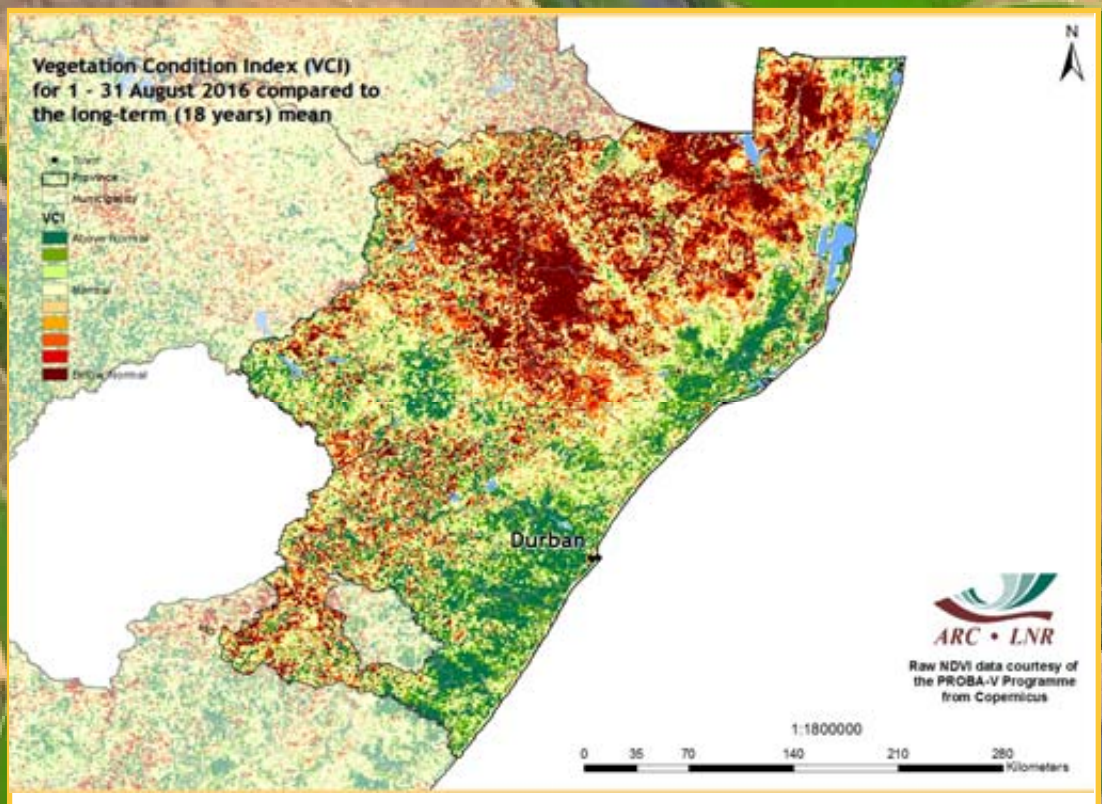


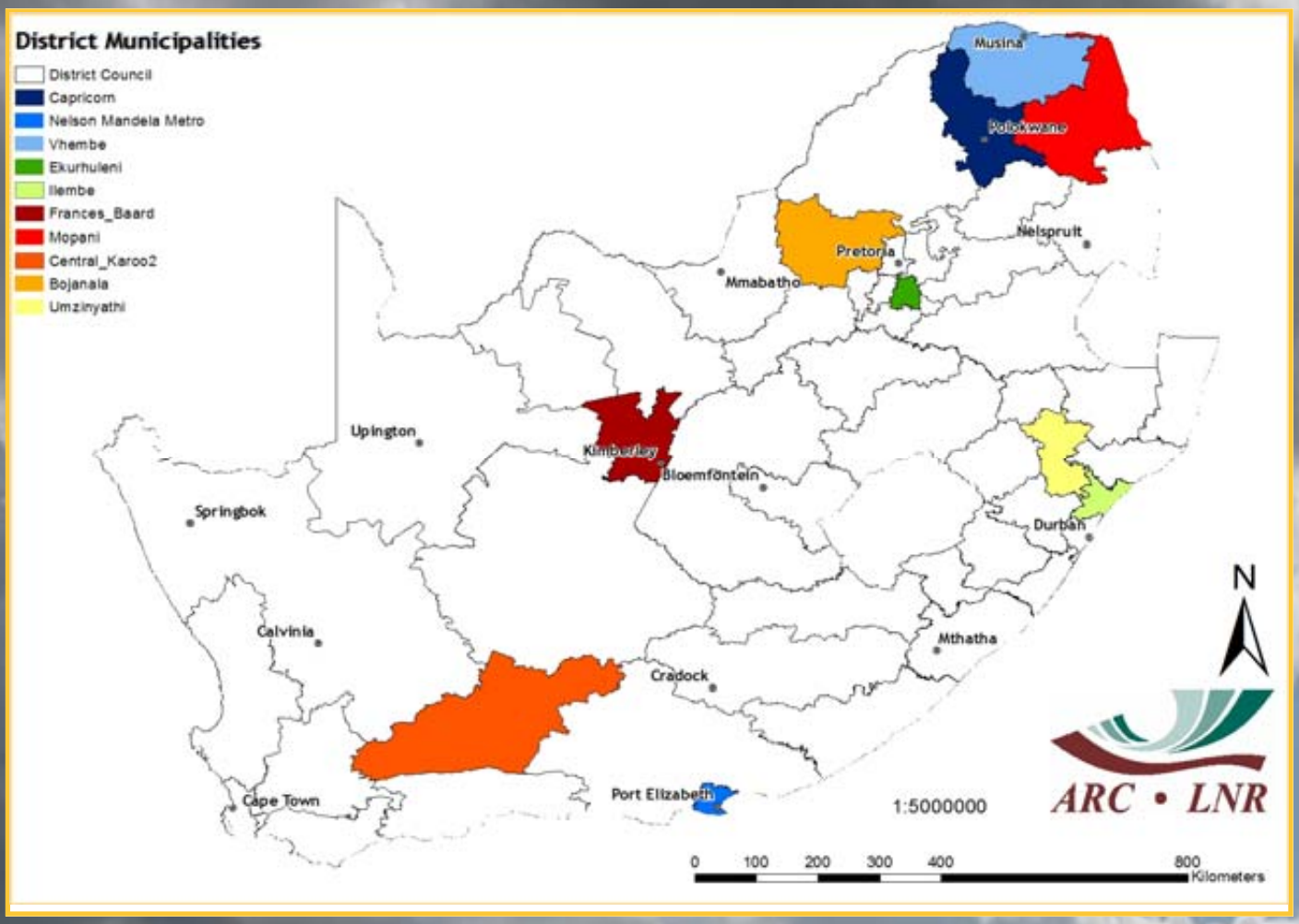
Figure 19

Figure 18:
The VCI map for August indicates below-normal vegetation activity over most parts of Mpumalanga, especially the Lowveld.

Figure 19:
The VCI map for August indicates below-normal vegetation activity over most parts of KwaZulu-Natal, with the exception of the coastal areas and south.

Questions/Comments:
NkambuleV@arc.agric.za

7. Vegetation Conditions & Rainfall



NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for August 2016. The district colour matches the border of the corresponding graph.

Questions/Comments:
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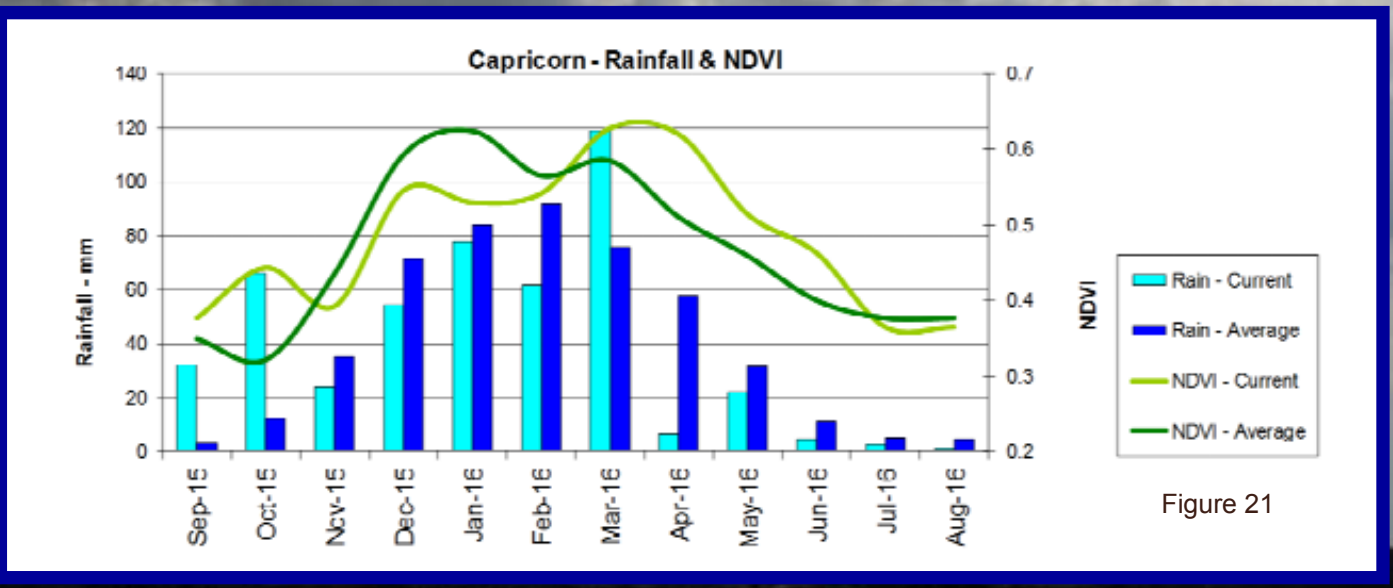
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

Figures 26-30:
Indicate areas with lower cumulative vegetation activity for the last year.



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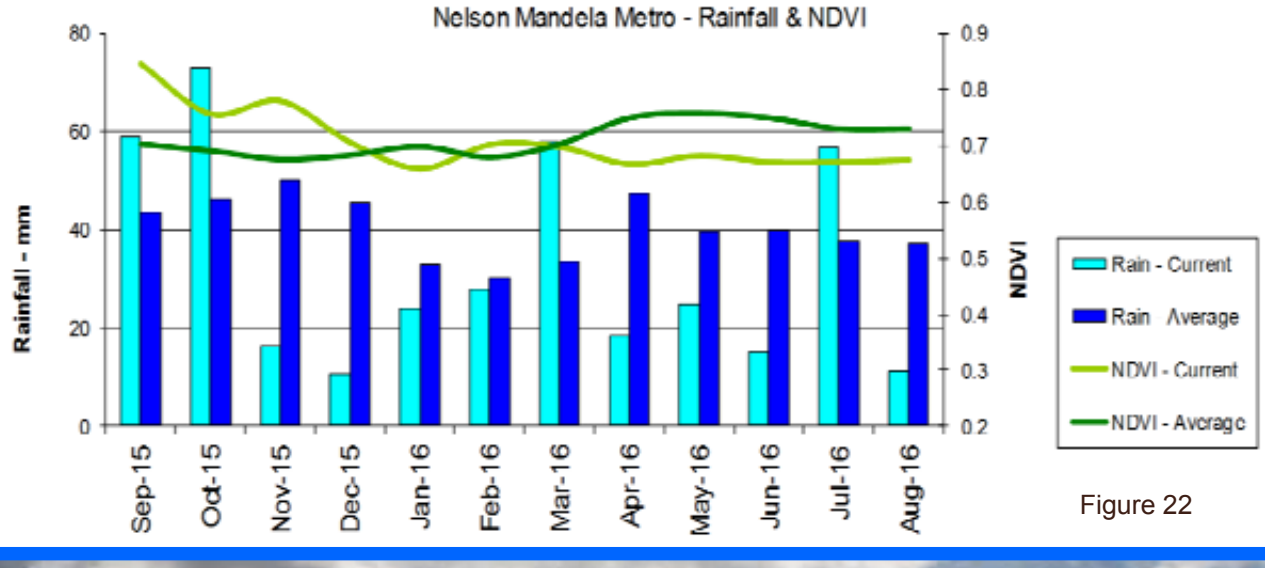

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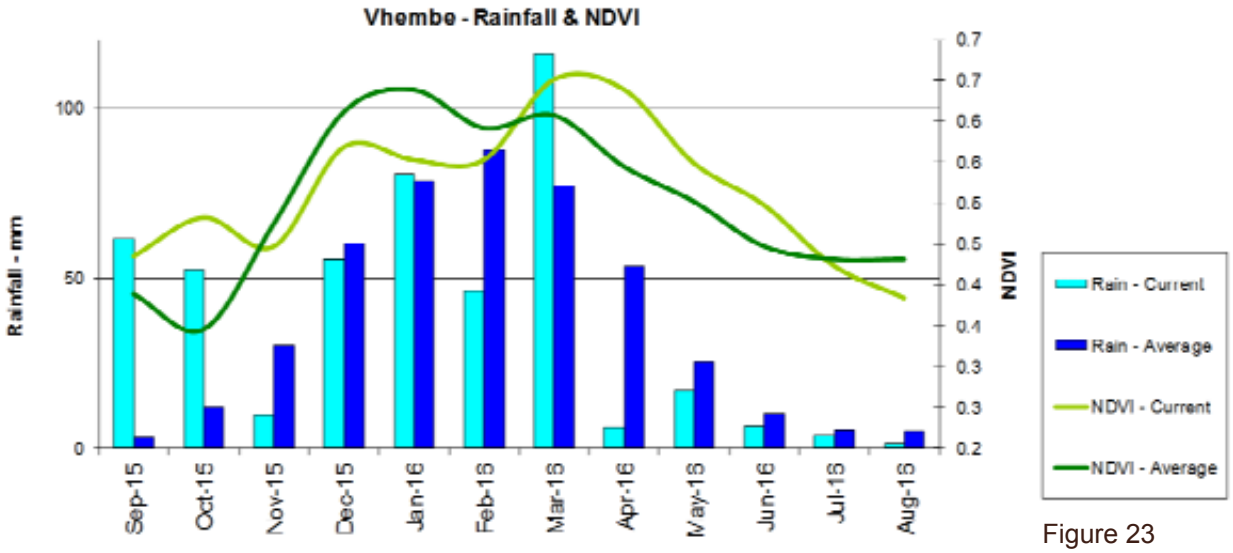

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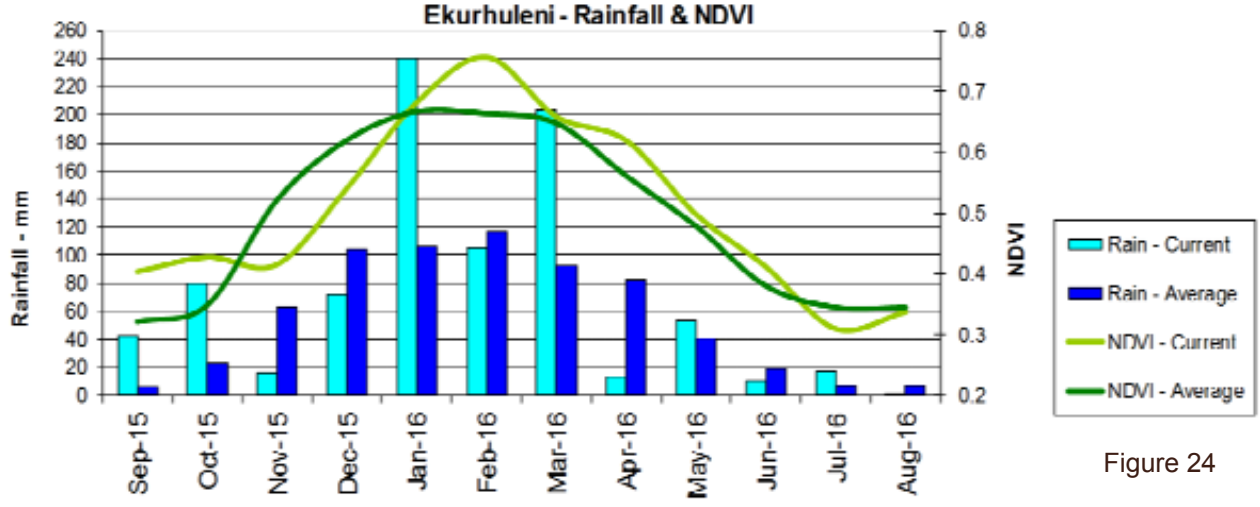

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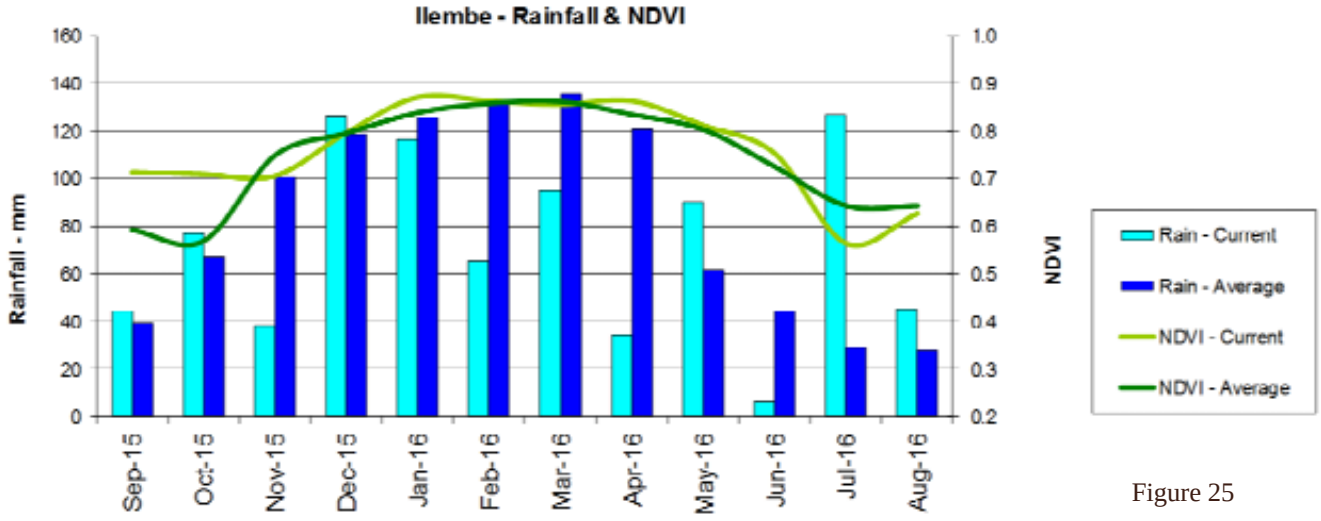

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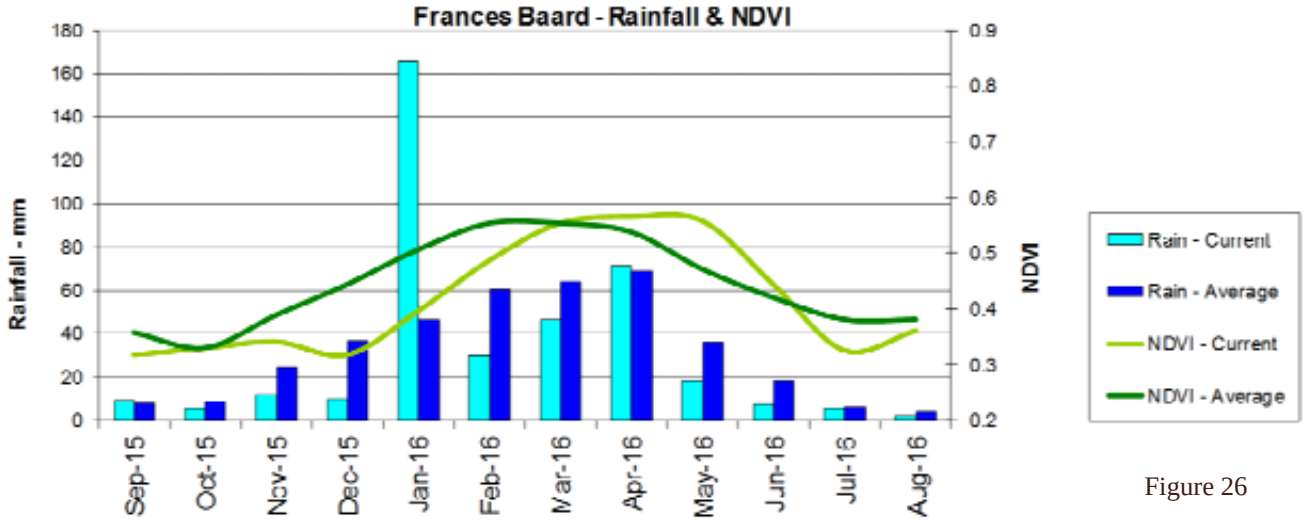

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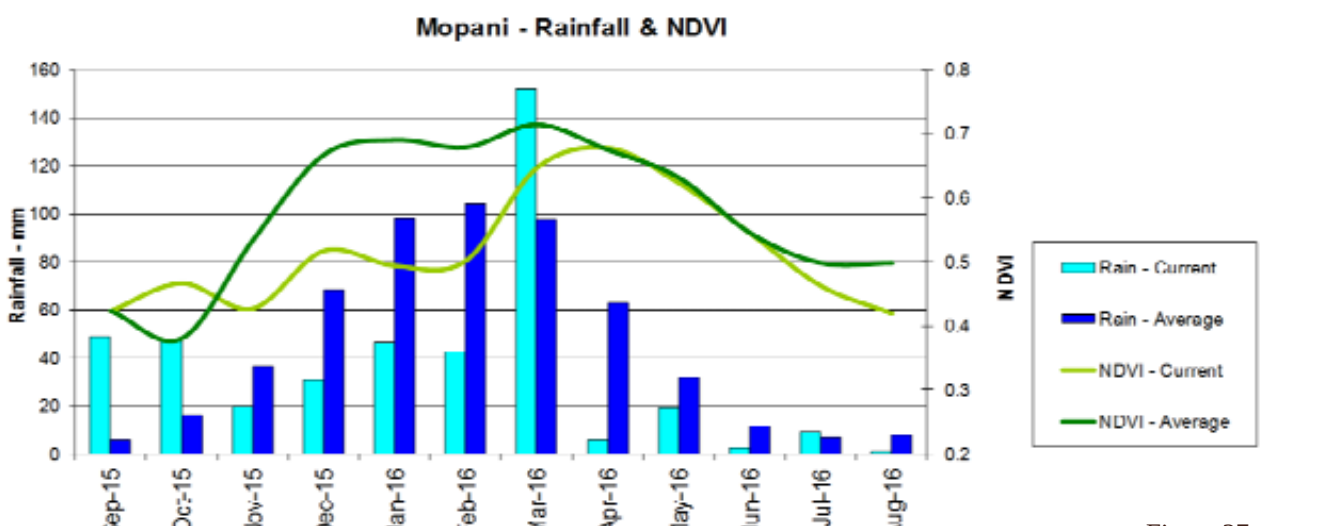

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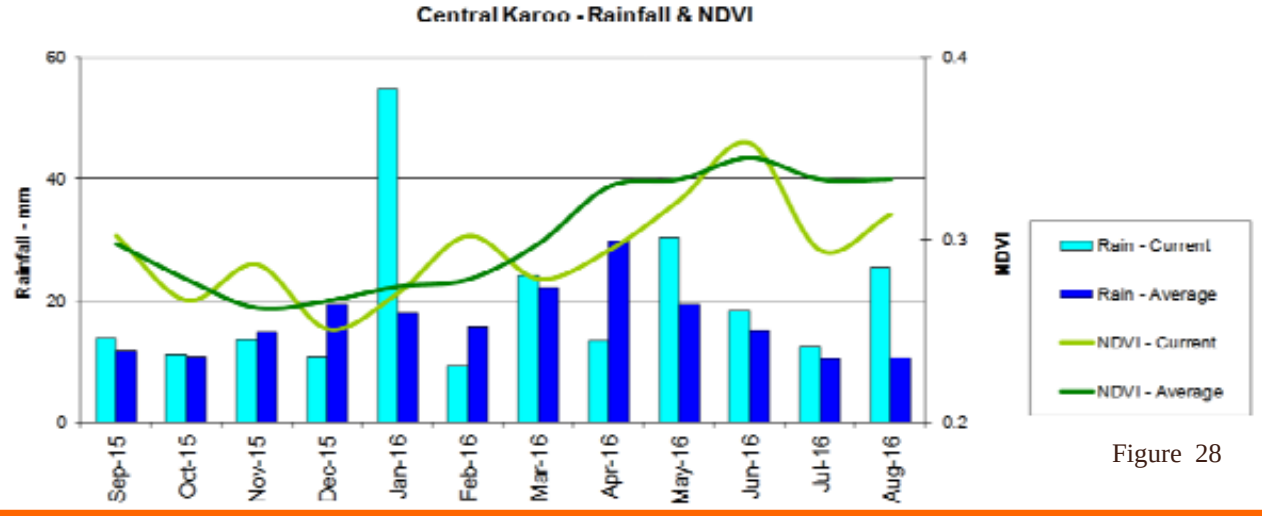

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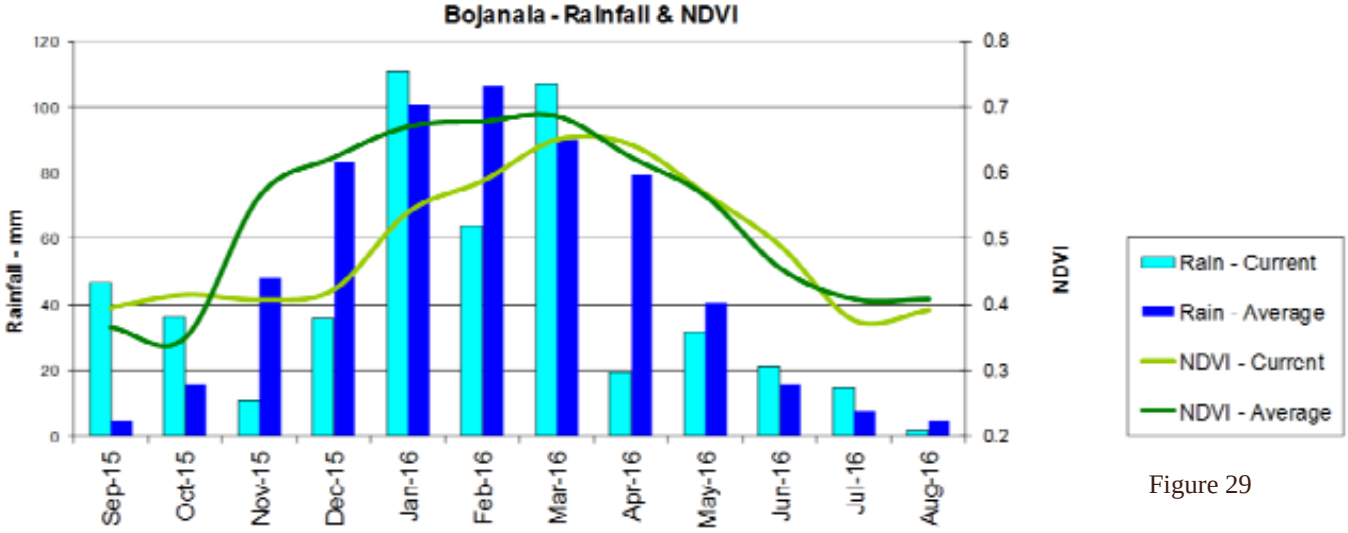

Figure 29

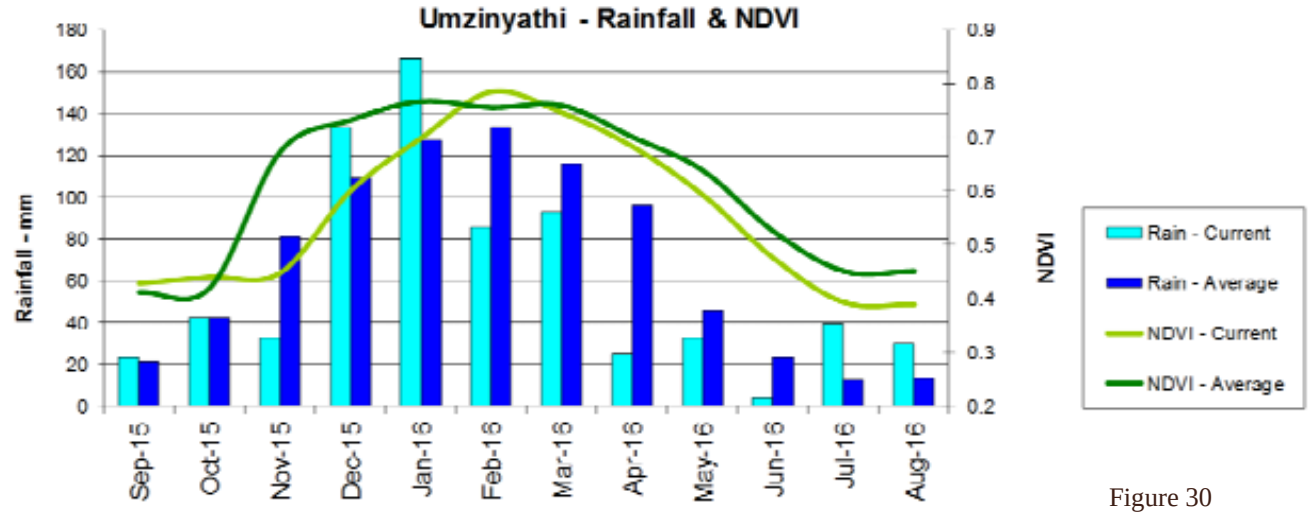

Figure 30

8. Soil Moisture

PAGE 16

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

Figure 31 shows the monthly averaged soil moisture conditions for August 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 August and July 2016, with the brown colours showing the drier and the green colours the wetter areas. Similarly, the year-on-year SSI difference for August is shown in Figure 33.

The year-on-year and month-on-month SSI differences are in agreement with rainfall and vegetation trends observed elsewhere in the newsletter.

The SSI maps are produced at the ARC-ISCW in a collaborative effort with the University of KwaZulu-Natal Applications and Hydrology Group, made possible by the WMO.

Questions/Comments:
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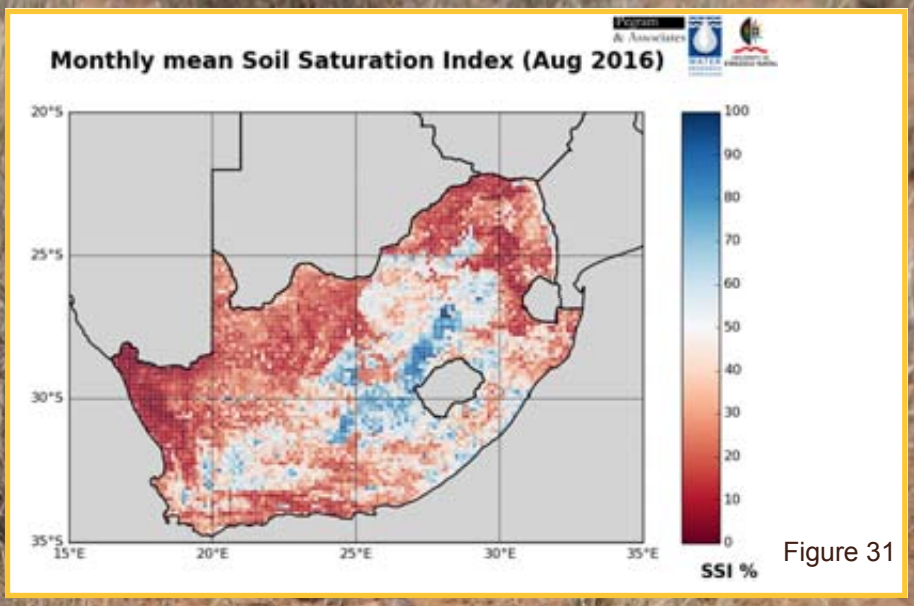

Figure 31

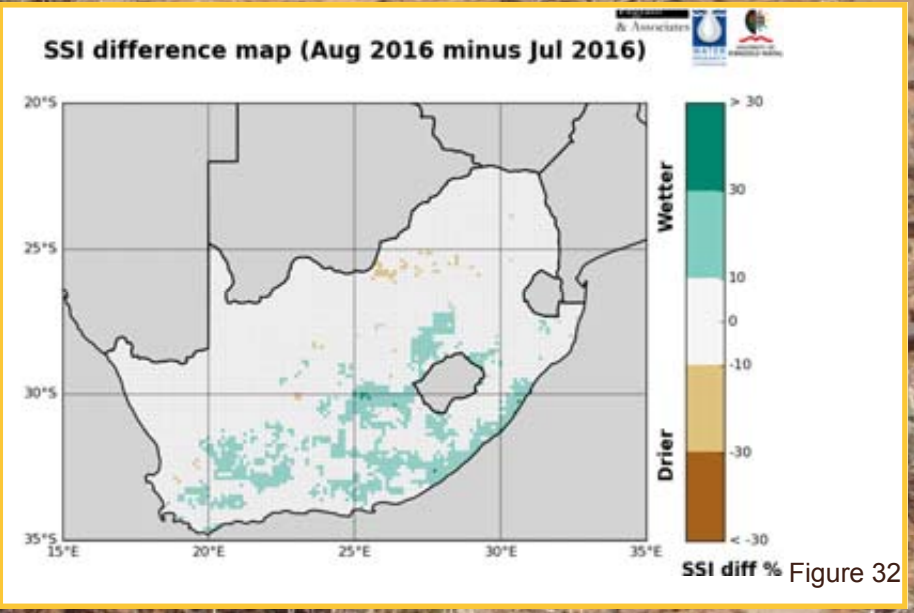

Figure 32

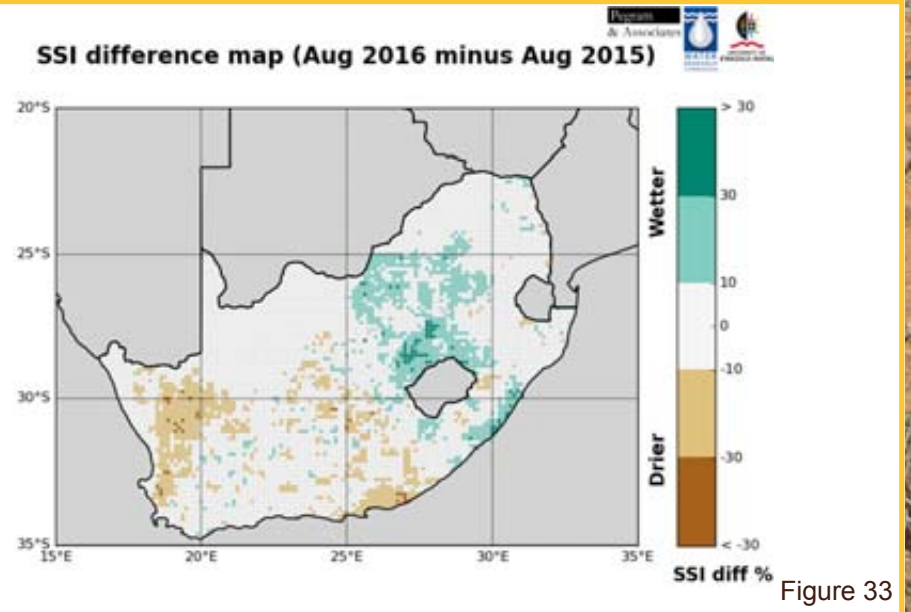

Figure 33

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

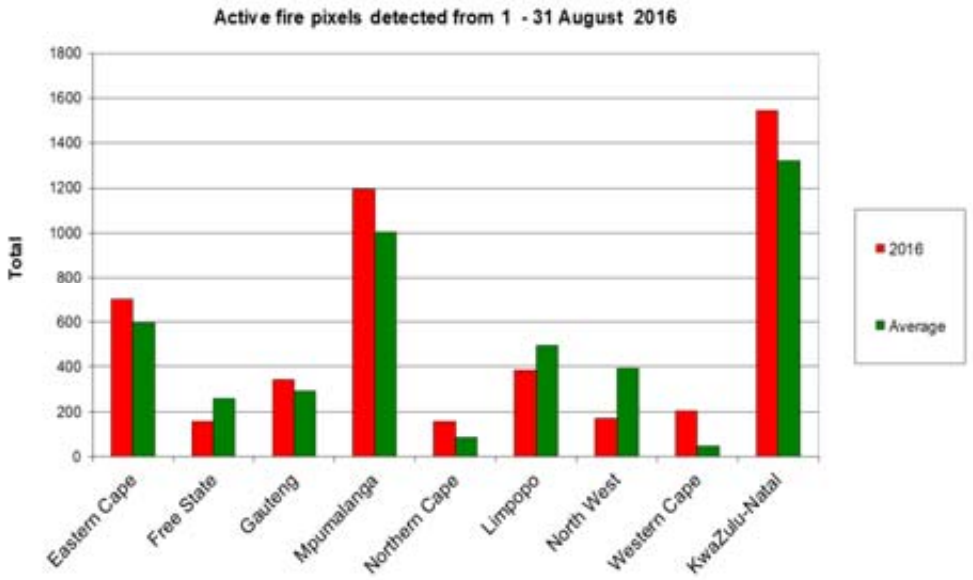

Figure 34

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

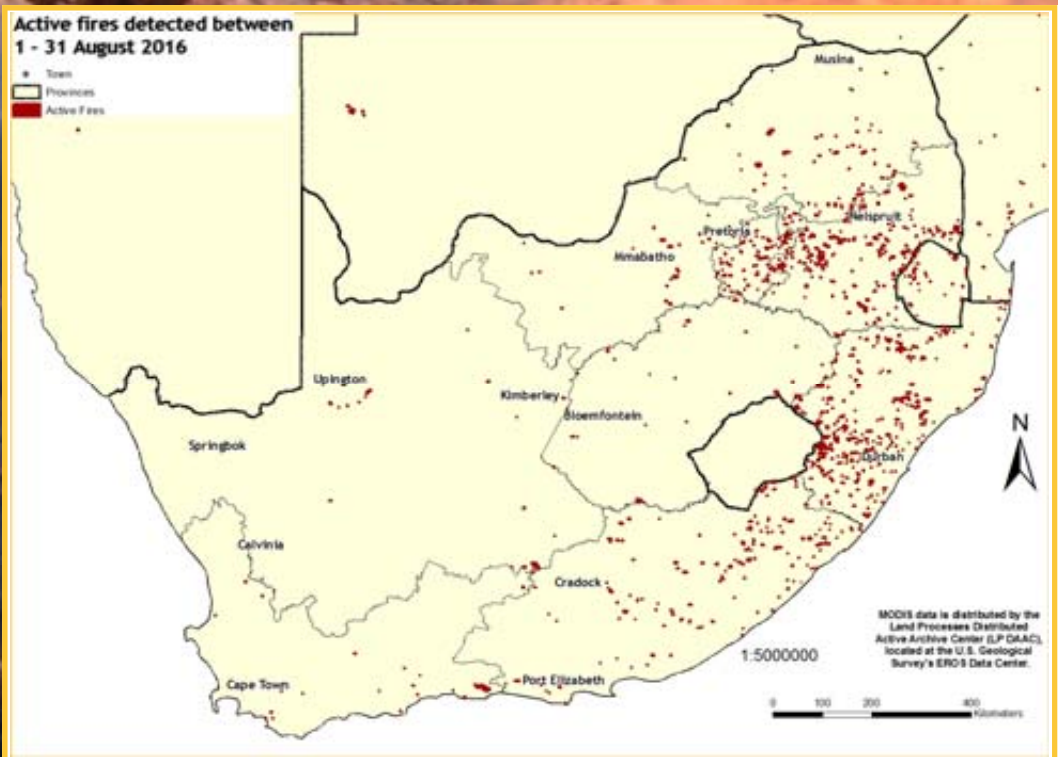

Figure 35

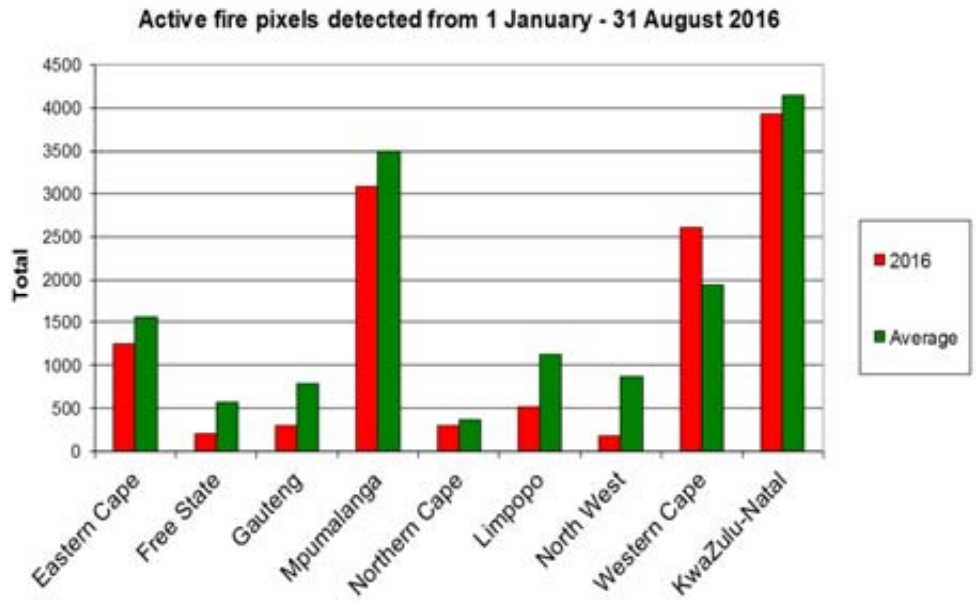

Figure 36

Figure 36:
The graph shows the total number of active fires detected from 1 January - 31 August 2016 per province. Fire activity was lower in all provinces except the Western Cape compared to the average during the same period for the last 16 years.

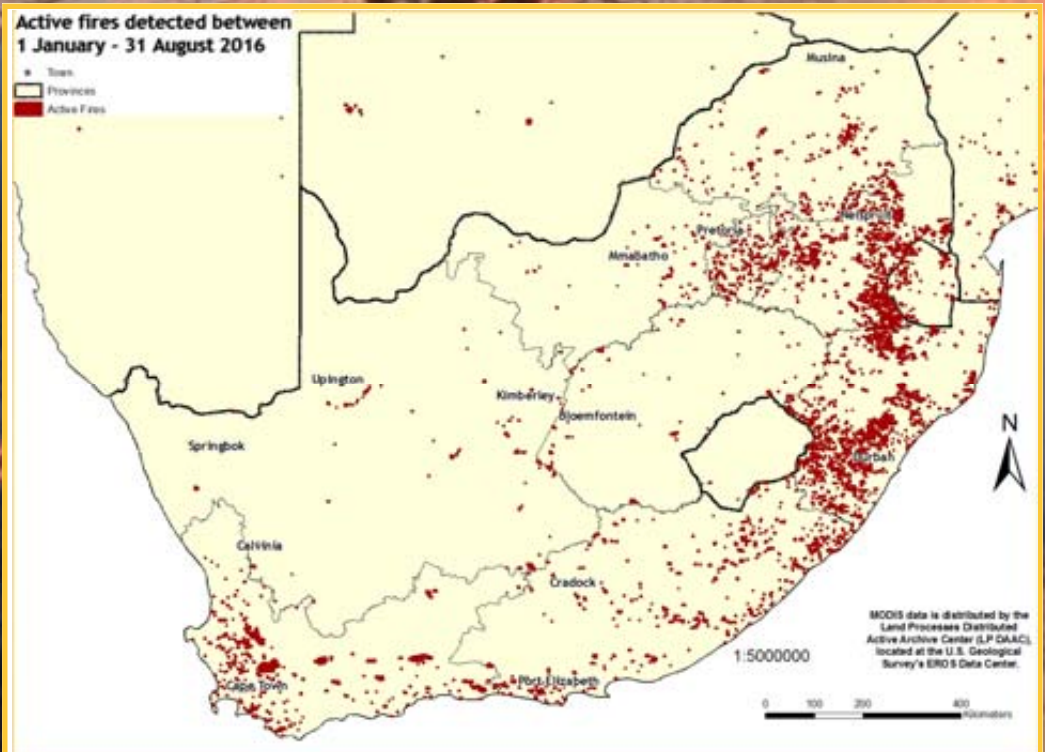

Figure 37

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

Questions/Comments:
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Geoinformation Science

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The programme focuses on applied Geographical Information Systems (GIS) and Earth Observation (EO)/Remote Sensing research and provides leadership in applied GIS products, solutions, and decision support systems for agriculture and natural resources management. The Coarse Resolution Satellite Image Archive and Information Database is maintained as a national asset.

FOCUS AREAS

Decision Support Systems

- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

Early Warning & Food Security

- Drought and vegetation production monitoring
- Crop estimates and yield modelling
- Animal biomass and grazing capacity mapping
- Global and local agricultural outlook forecasts
- Disaster monitoring for agricultural systems

Natural Resources Monitoring

- Land use/cover mapping
- Invasive species distribution
- Applications of GIS and EO on land degradation/erosion, desertification, hydrology and catchment areas
- Rangeland health assessments
- Carbon inventory monitoring

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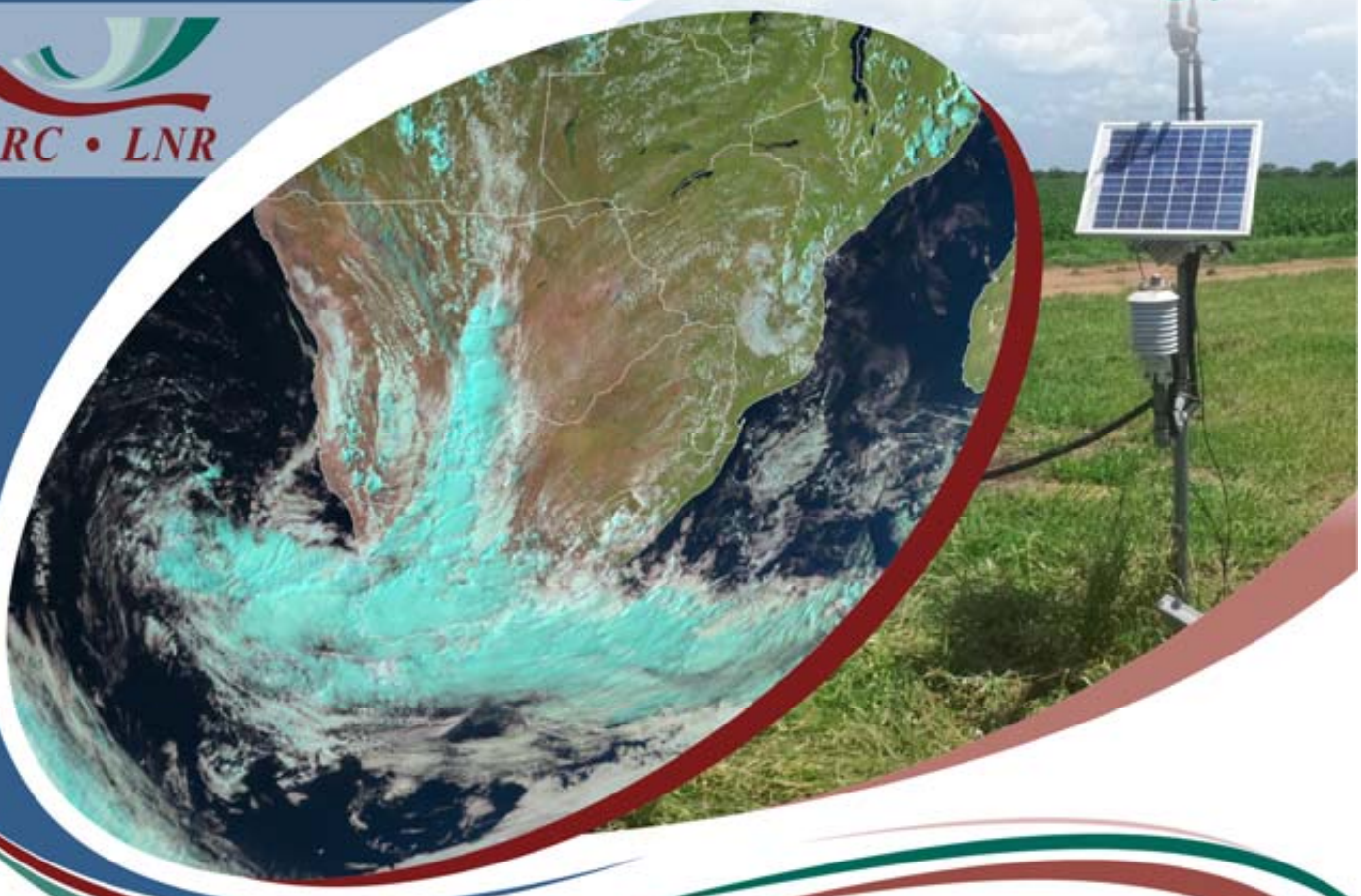
Agrometeorology

ARC • LNR



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