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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

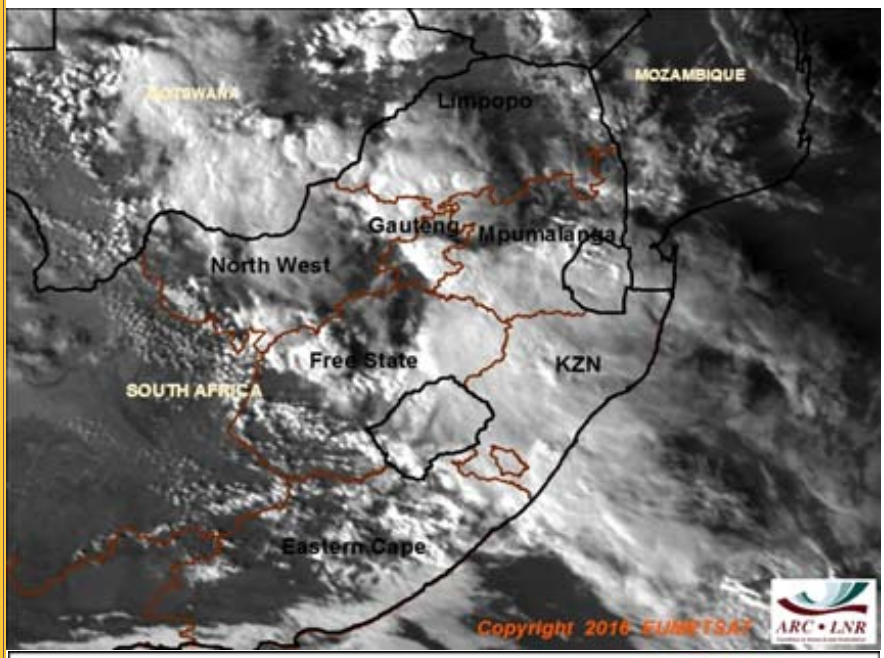
South African Weather Service

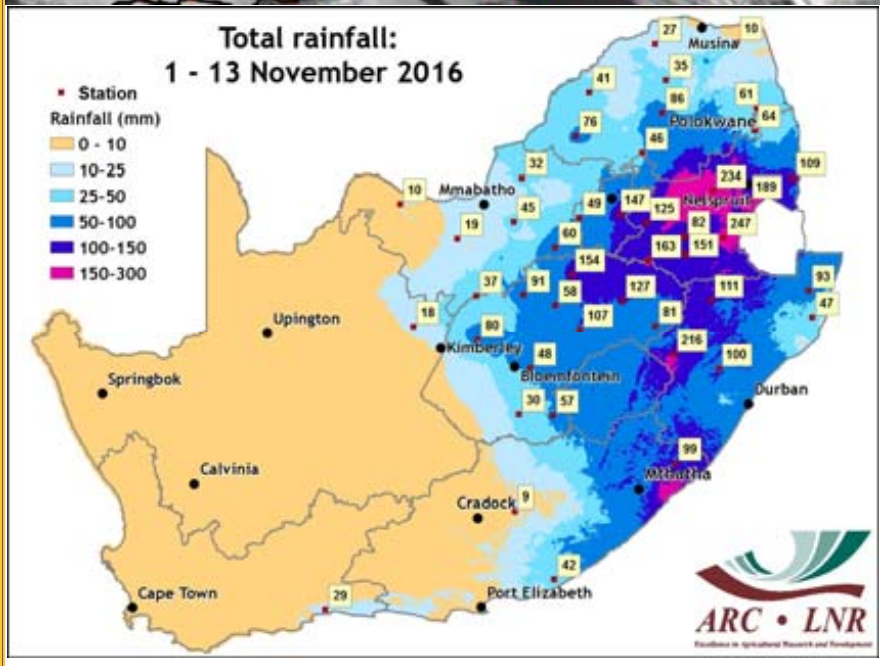
AMESD

149th Edition

Images of the Month

Widespread heavy thunderstorms during early November





Following hot and dry conditions by the end of October, widespread thundershowers occurred over the central to eastern and northeastern parts of the country during the first few days of November. High moisture content and favourable upper-air conditions resulted in particularly widespread and heavy thundershowers over much of the summer rainfall region from 8-12 November. Several flash floods occurred, due to the slow movement of the storms and high rainfall volumes. These floods occurred especially over the Highveld, causing structural damage and in some cases leading to the loss of life. Rainfall totals were particularly high over parts of Mpumalanga, the Free State and Gauteng, encompassing the eastern maize production region where the rainfall came just in time for planting within the normal planting window. The Visible Red band from the SEVIRI sensor on board the MSG-3 satellite shows the extent of massive thunderstorms over the summer rainfall region on the afternoon of the 9th of November, when flooding negatively affected operations in and around OR Tambo International Airport near Johannesburg.

The map shows the rainfall totals for the first 13 days of November, exceeding 100 mm over much of the eastern maize production region. It is an interpolation of rainfall recorded by the ARC-ISCW automatic weather station network, consisting of 450 operational weather stations across the country. Rainfall totals for selected stations are indicated.

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:

October 2016 saw the usual outbreak of thunderstorms over the eastern to central interior, concentrated to a large degree around the middle of the month. Typical early-summer atmospheric conditions resulted in several of the storms becoming severe, most noteworthy that which resulted in large amounts of hail over parts of Bloemfontein on the 19th.

Temperatures showed an increasing trend over the interior during the month, with a hiatus around the middle of the month during the period of more widespread thundershowers. A heatwave over large parts of the central to northern and northeastern interior was associated with maximum temperatures exceeding 40°C at many stations. These high temperatures came to an end in early November when the rainfall situation improved once again.

Over the winter rainfall region, little rainfall was recorded, with totals mostly in the below-normal to normal ranges. Regular frontal activity, albeit weak for the most part, kept temperatures fairly low through most of the month over this region. Precipitation associated with fronts occurred around the 6th, 10th, 16th and 22nd.

For the most part, upper-air and surface atmospheric conditions were fairly unfavourable for widespread rain during October. While cool dry air invaded the southwestern and western parts often during the first half of the month, the associated low moisture levels in the atmosphere lessened the potential for rainfall events over the interior, a result also of the weakness of the Indian Ocean Anticyclone early in the month. There were sporadic outbreaks of mostly isolated thunderstorms over the central to northern parts, often associated with weak upper-air troughs and marginally sufficient surface moisture. The eastern parts of KwaZulu-Natal did experience some higher falls during this period, mostly associated with some ridging around the southern parts and upper-air troughs moving through over the southeastern parts. The mostly unfavourable circulation patterns culminated by the end of the month in a heatwave associated with very high temperatures over most of the interior. One notable exception to these conditions was the period 17-23 October. During this time, an upper-air trough was positioned over the southwestern parts while a fairly strong anticyclonic circulation to the east of the country advected moisture into the interior, starting by the 17th with a strong ridge of the Atlantic Anticyclone to the south of the country. Scattered to widespread thundershowers occurred over most of the summer rainfall region until the 22nd, with some significant falls in places, but also, as is typical of early summer, some severe storms with hail in places.

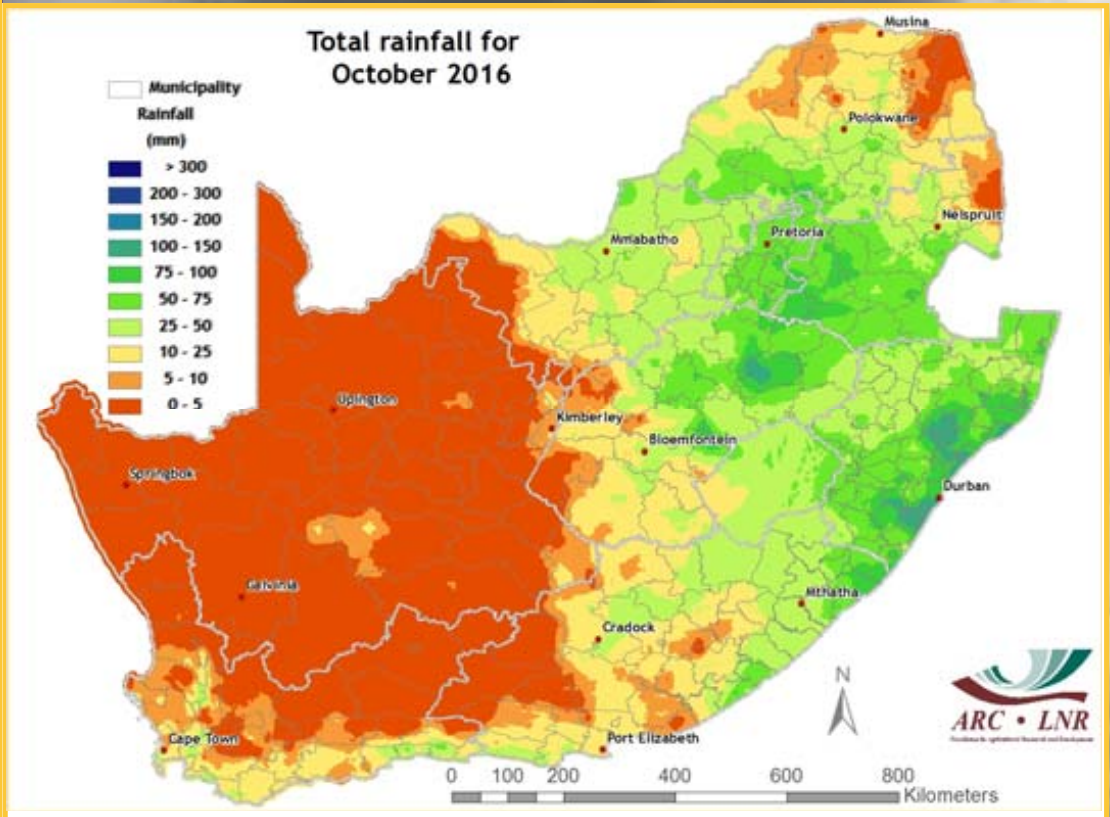


Figure 1

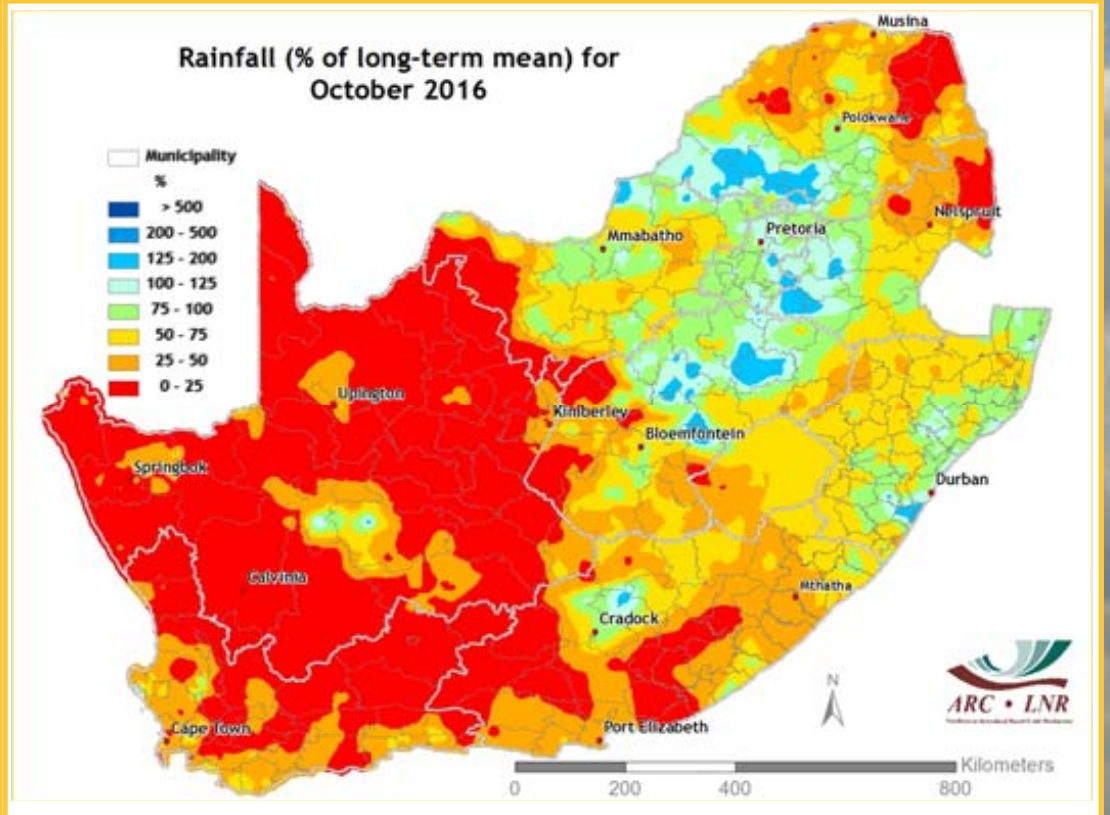
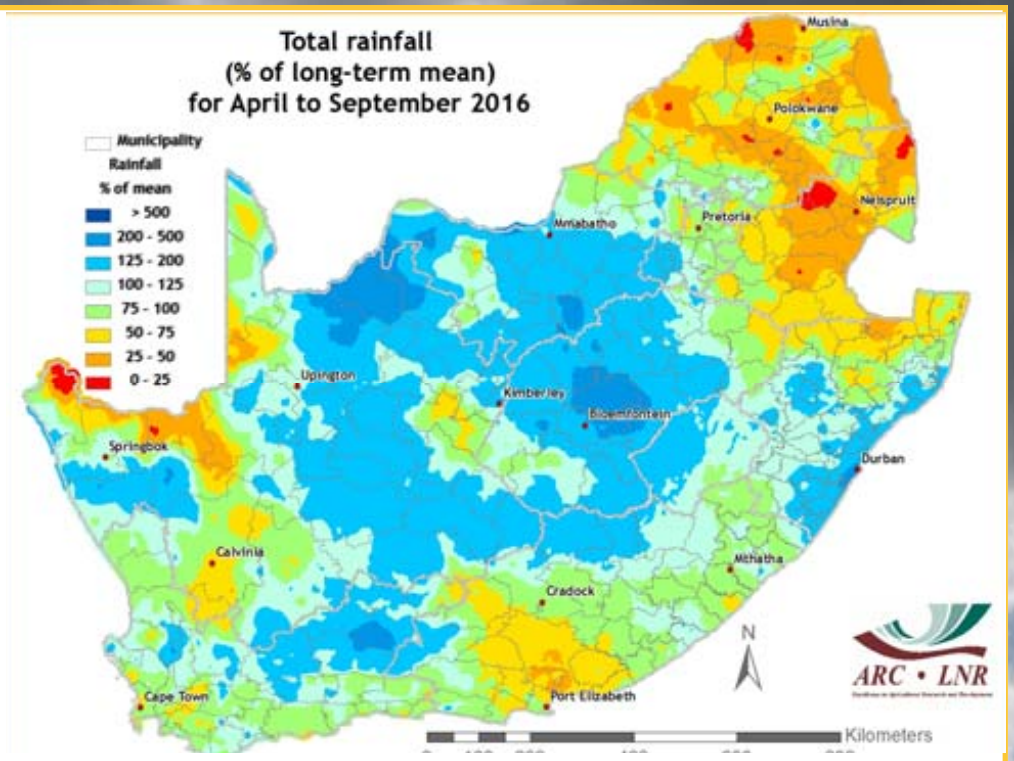


Figure 2



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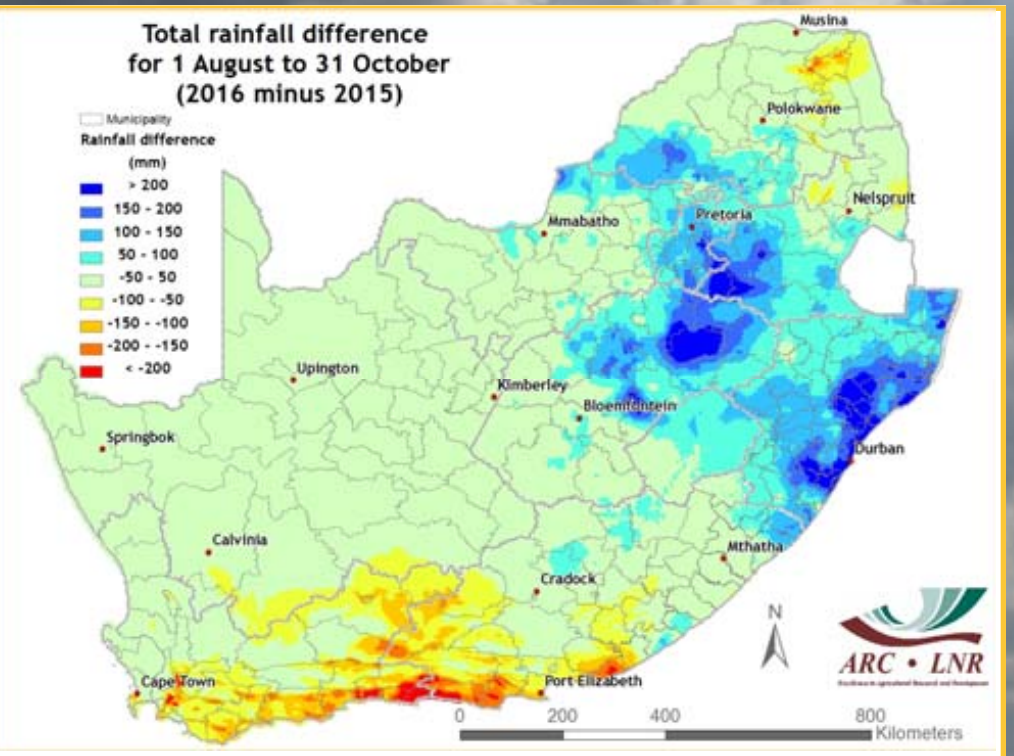

Figure 4

Figure 1:
Rainfall was mostly confined to the central to eastern summer rainfall region during October, with highest falls over the Highveld and along the eastern coastal belt and adjacent interior.

Figure 2:
The western parts were relatively dry, while normal to above-normal rainfall centred around Gauteng and towards the coast of KwaZulu-Natal.

Figure 3:
Much of the eastern interior experienced normal to above-normal rainfall since July, with the coast of KwaZulu-Natal and some parts of the winter rainfall region (particularly the northern parts of the West Coast and western escarpment) also experiencing above-normal rainfall. Rainfall in the northeast, parts of the Northern Cape 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 this year than last year during the period August to October. The western parts of the winter rainfall region (focussing on the Swartland and northern parts of the West Coast) and a band stretching northwestwards from the coast of KwaZulu-Natal into eastern North West and southern Limpopo, 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 dry conditions focus at the shorter time scales over the western parts of North West and northeastern Northern Cape as well as the western interior to southern parts of the Eastern Cape. At the longer time scales (12- and especially 24-month time scales), 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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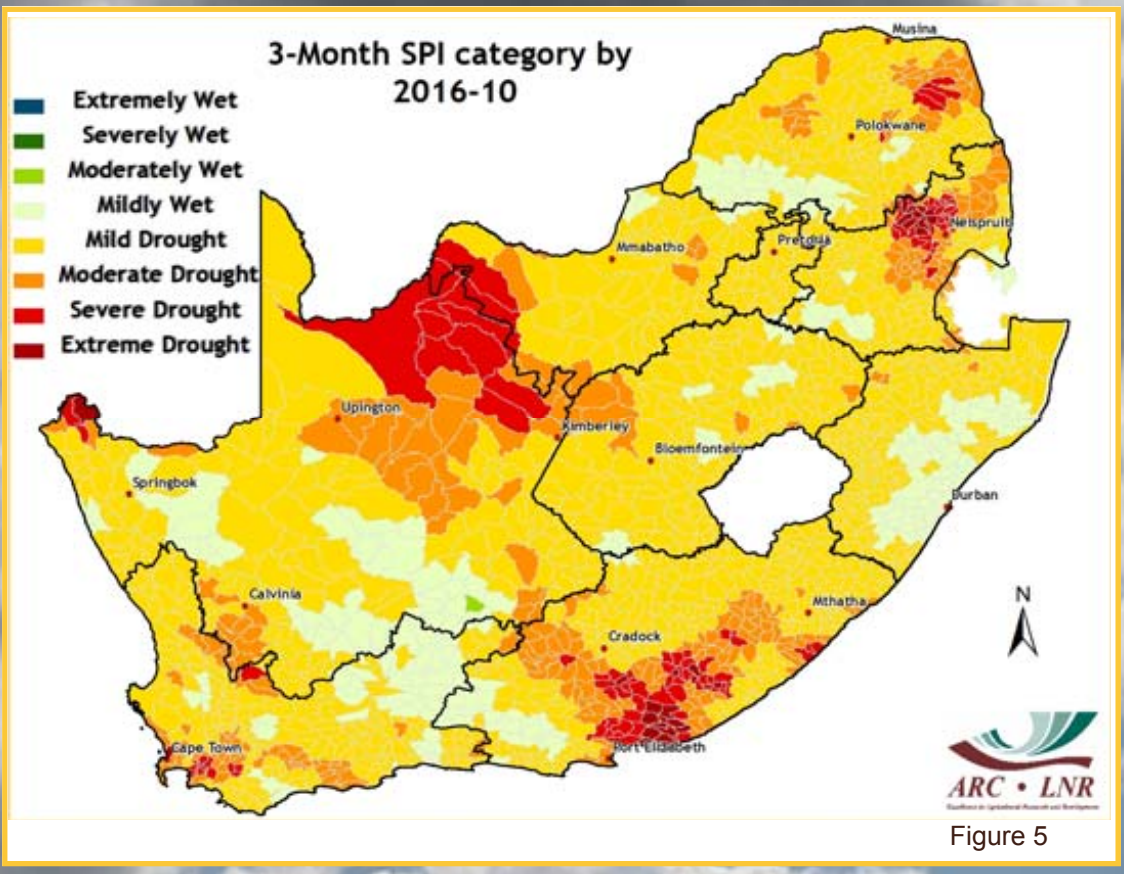

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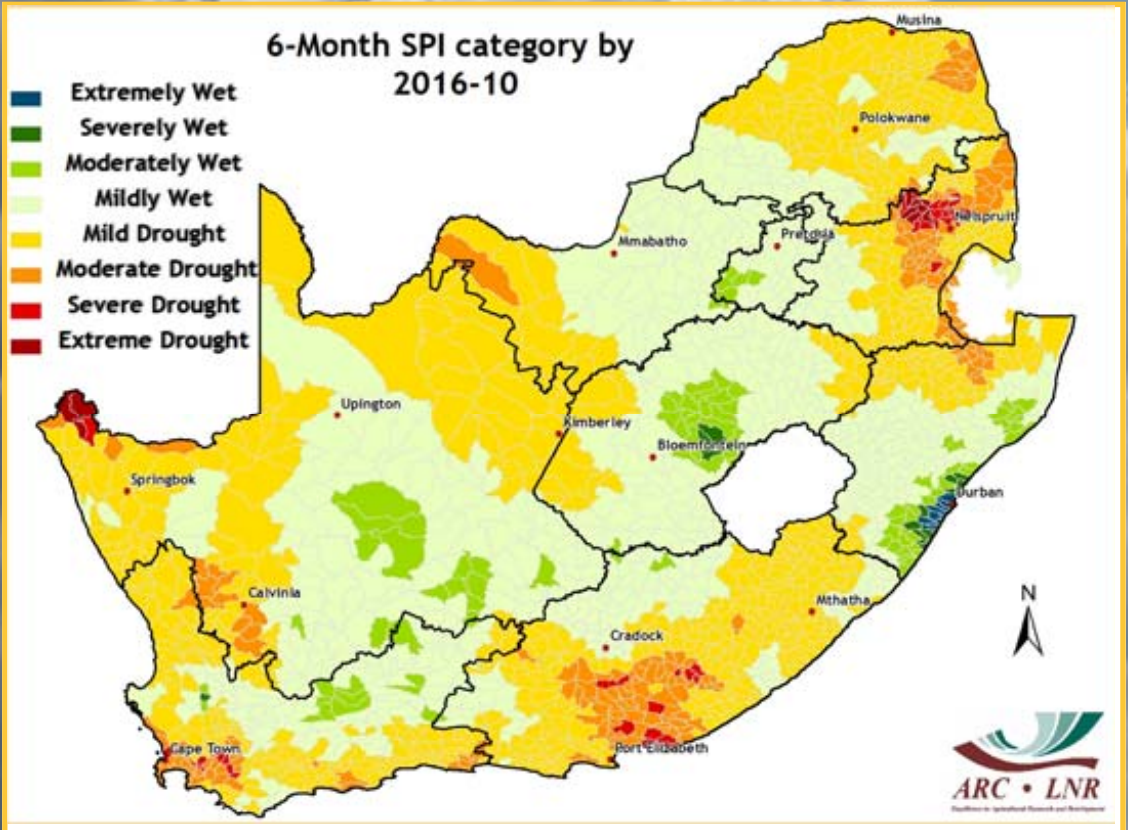

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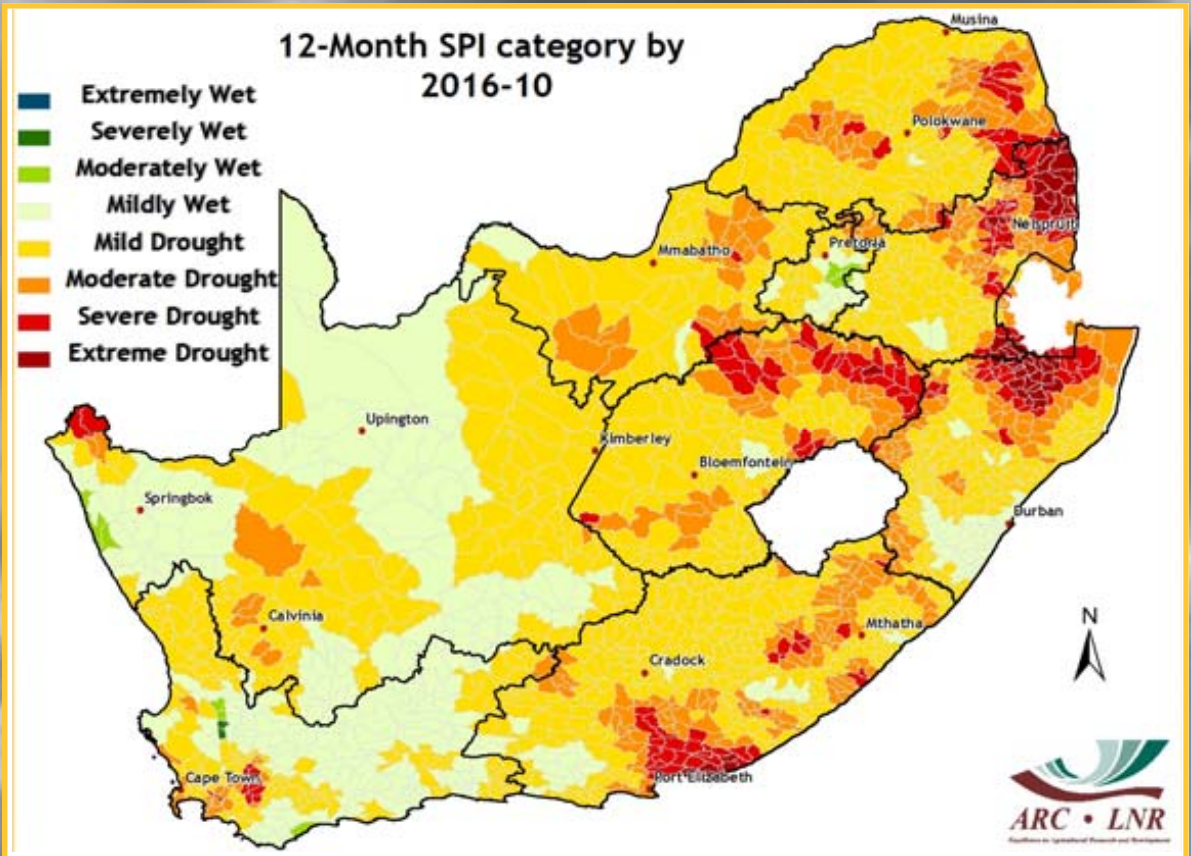

Figure 7

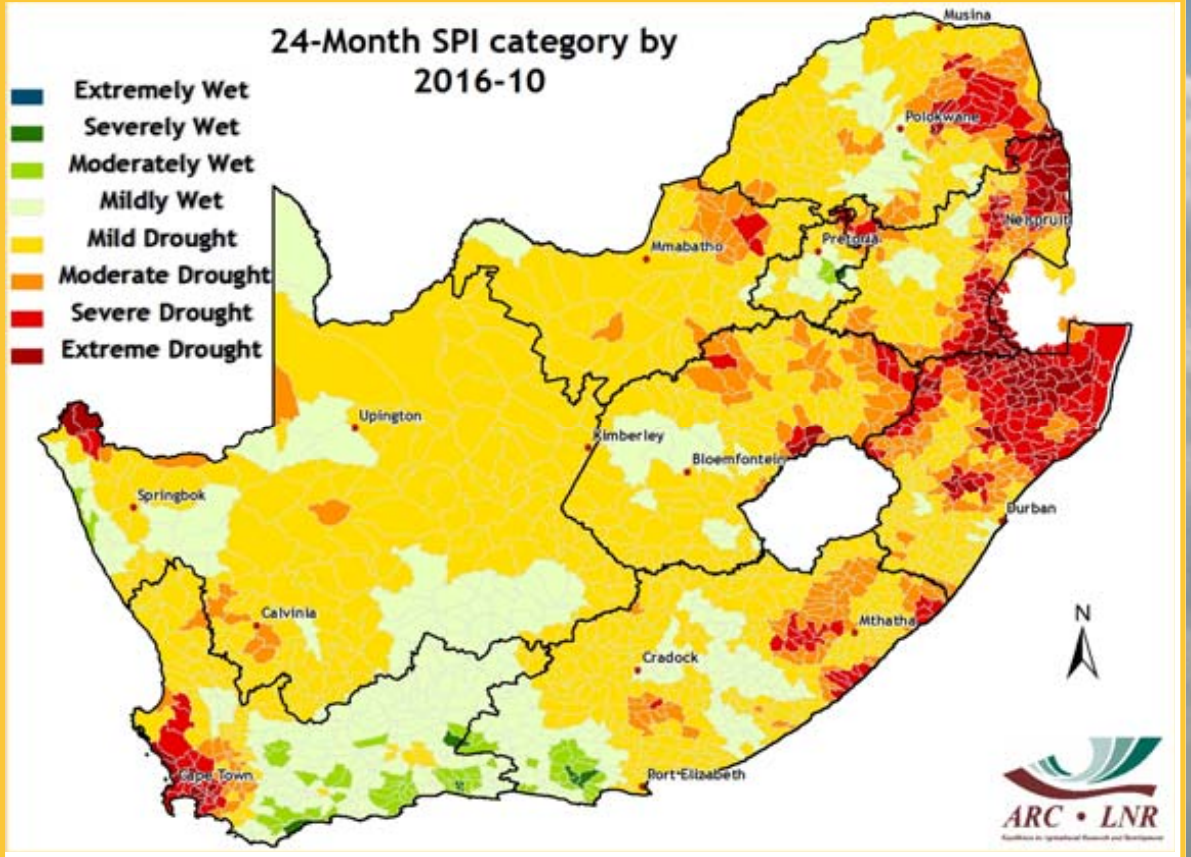

Figure 8

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.

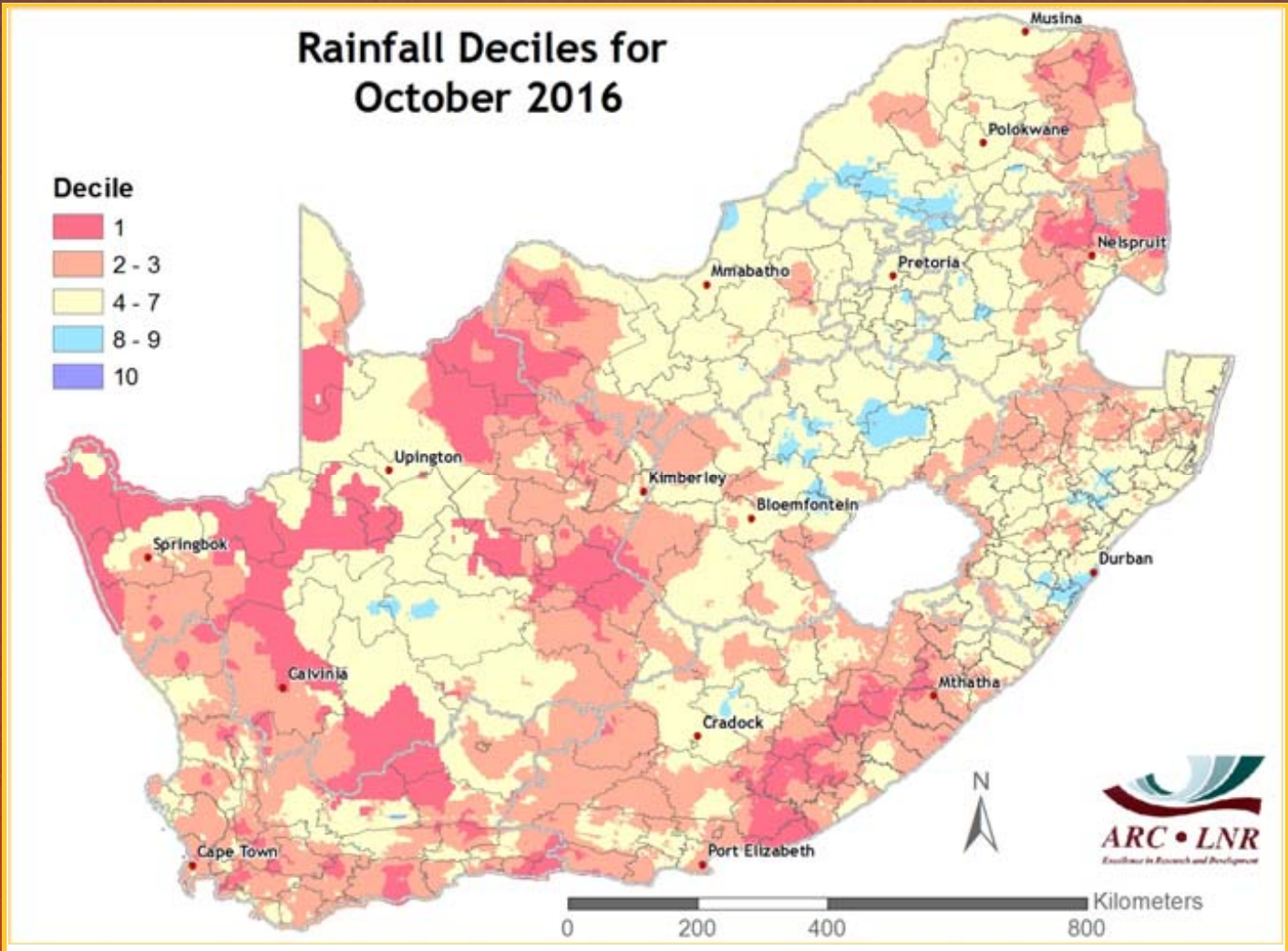

Figure 9

Figure 9:
Parts of the Northern and Eastern Cape were exceptionally dry during October while the northeastern parts experienced rainfall in the near-normal category.

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

4. Water Balance

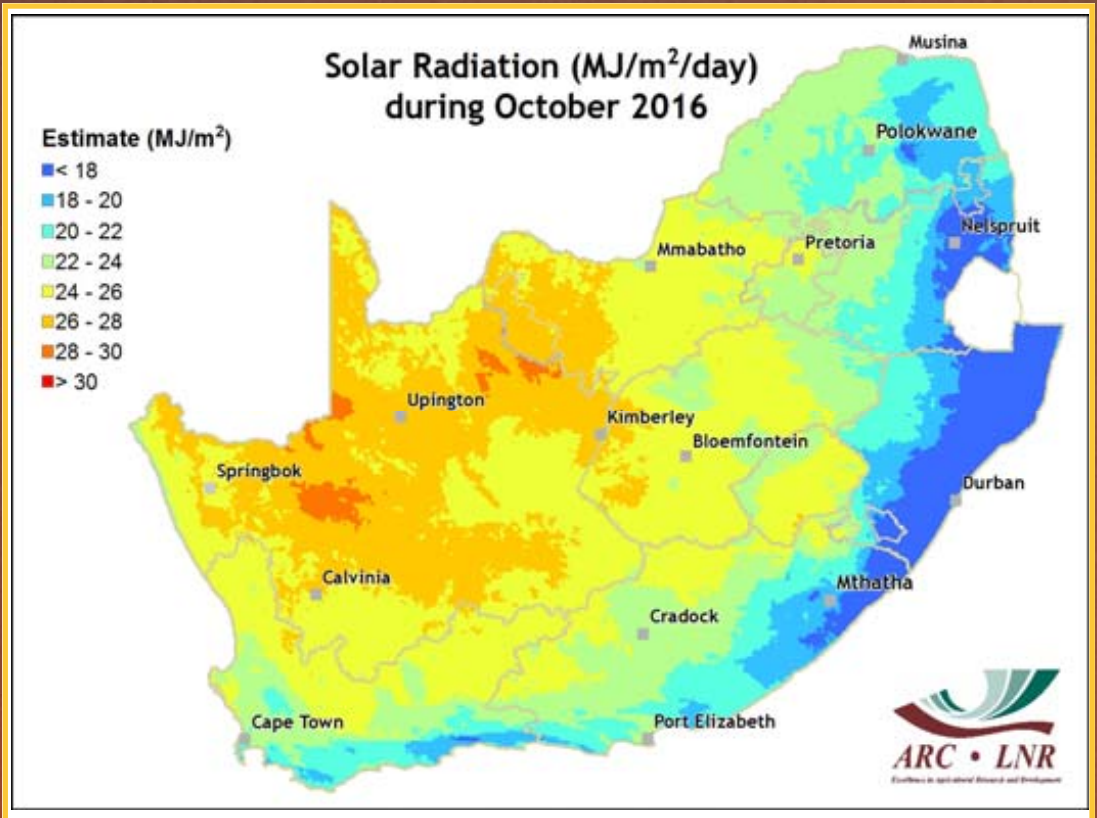

Figure 10

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 continue to increase, with lower values towards the south and eastern coastal belt and eastern interior.

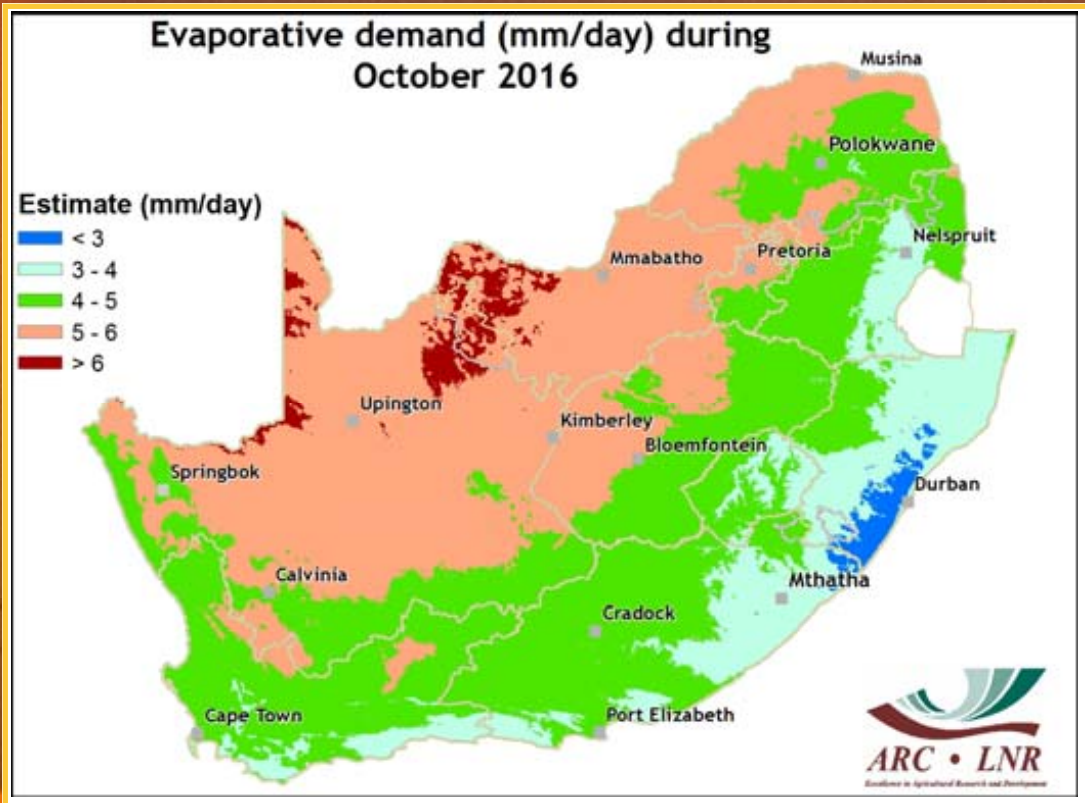

Figure 11

Potential Evapotranspiration

Potential evapotranspiration (PET) for a reference crop is calculated at about 450 automatic weather stations of the ARC-ISCW located across South Africa. At these stations hourly measured temperature, humidity, wind and solar radiation values are combined to estimate the PET.

Figure 11:
Daily potential evapotranspiration values also increased further during October.

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.

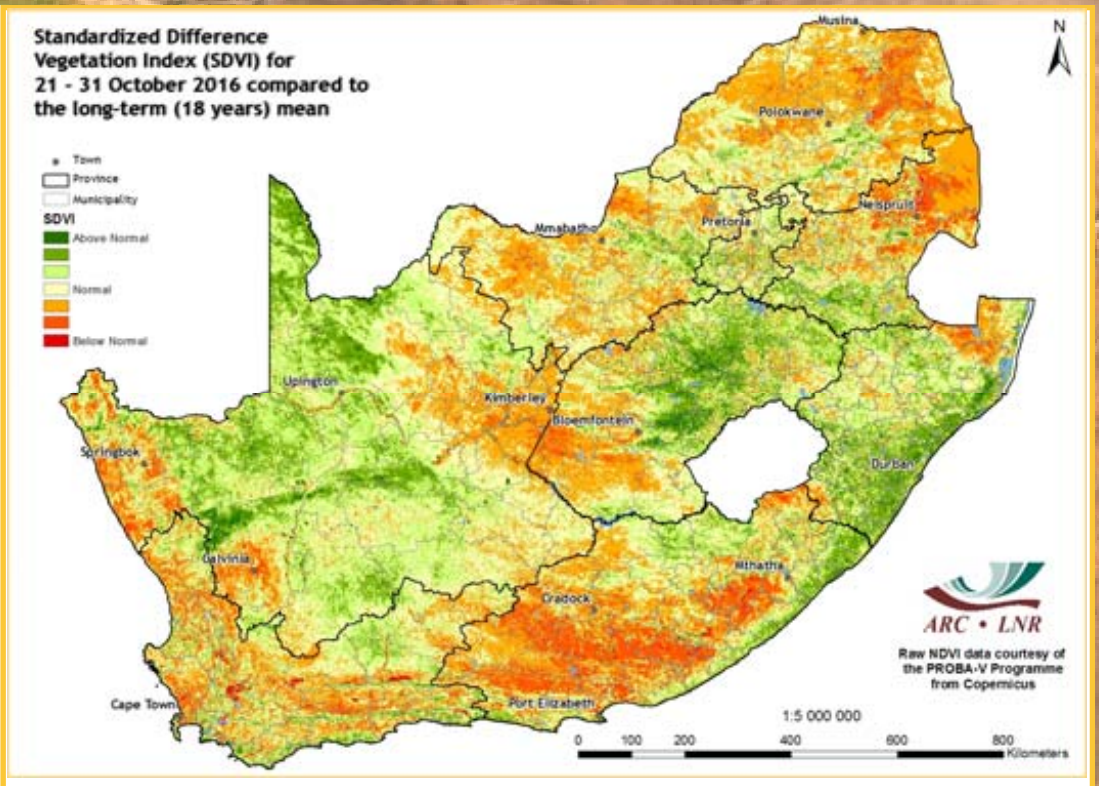

Figure 12

Figure 12:
The SDVI by late October shows the positive effect of rain during especially October over the eastern interior and coastal belt. Large negative anomalies are present over the western interior of the Eastern Cape and the Lowveld in the northeast.

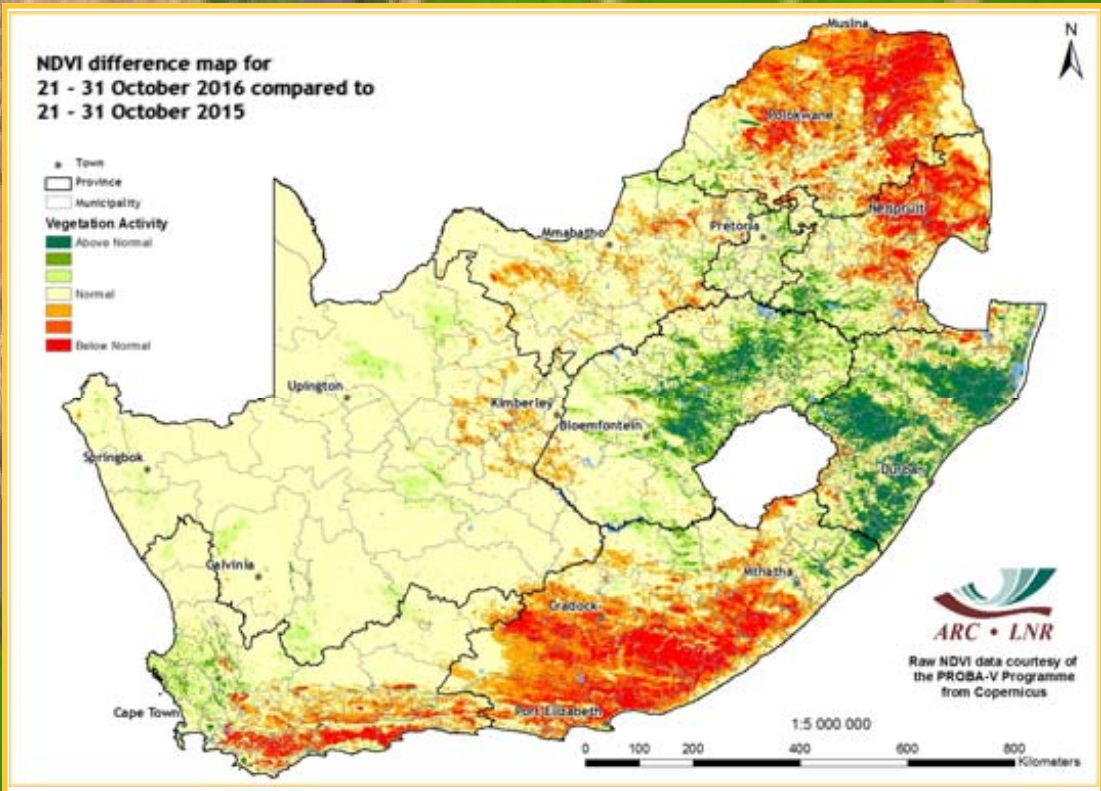

Figure 13

Figure 13:
Vegetation activity is much lower over the Garden Route and Eastern Cape and the northeast compared to a year ago. Due to more favourable conditions especially in October and July, Kwa-Zulu-Natal, the Free State, Gauteng and western Mpumalanga are experiencing higher vegetation activity than a year ago. In the southwest, the western parts of the wheat production region experience higher vegetation activity while the eastern parts show predominantly lower activity than a year ago, a reflection of the difference in rainfall patterns between the two years.

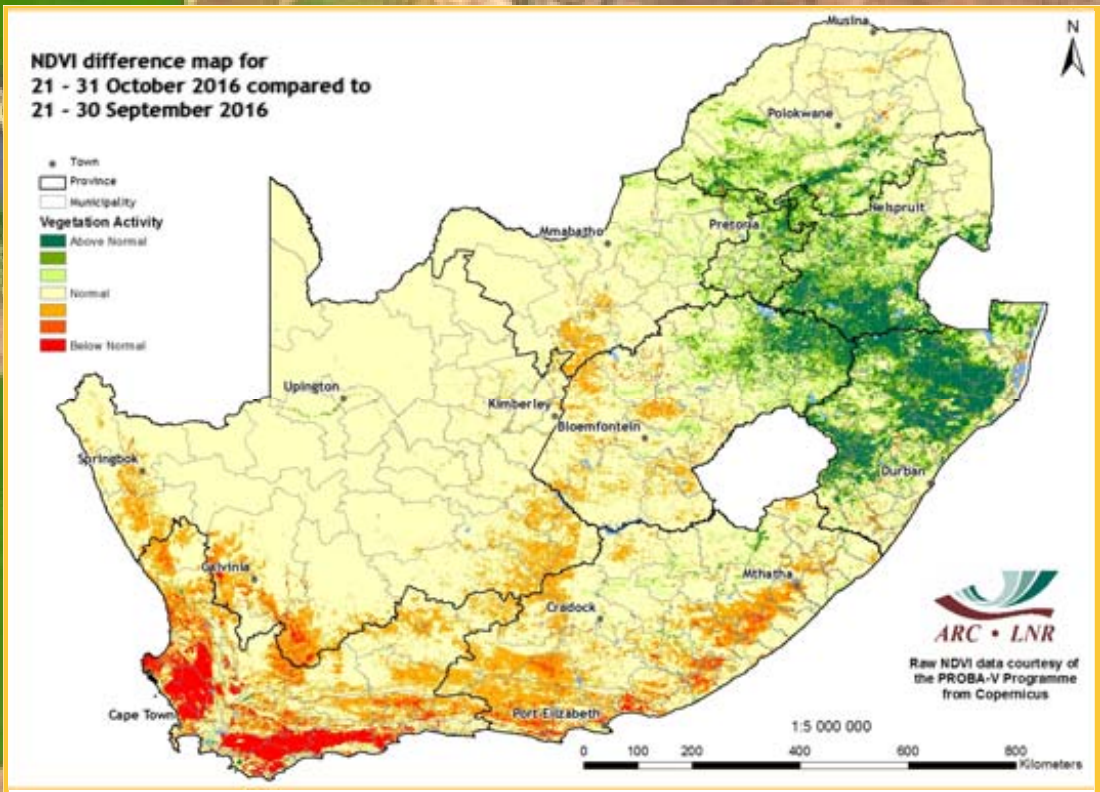

Figure 14

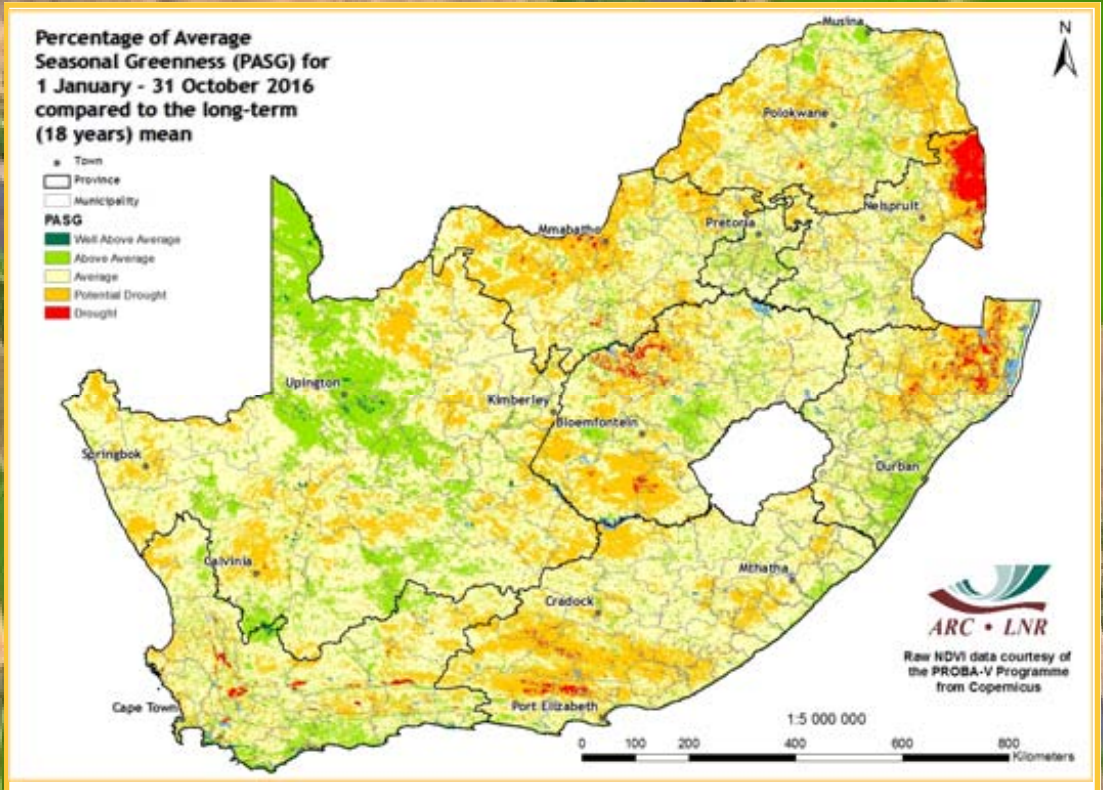

Figure 15

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:
Decreasing vegetation activity over the grain production areas of the Western Cape shows ripening of the crop. Winter and spring rain together with the increase in temperatures have resulted in increasing vegetation activity over the Free State and southeastwards since August.

Figure 15:
The effect of earlier drought conditions is still evident over the central to northwestern parts of the Free State, northern KwaZulu-Natal and Lowveld of Mpumalanga. Recent drought conditions have also impacted negatively over much of the western Eastern Cape. 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.

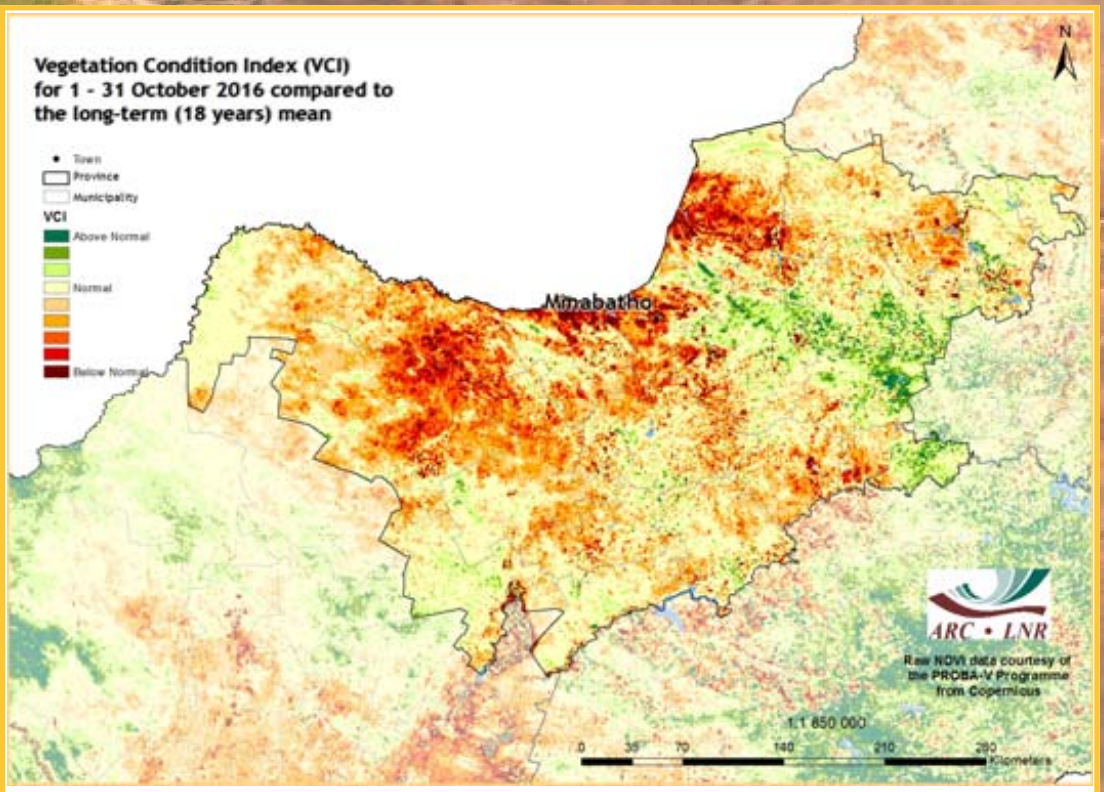


Figure 16

Figure 16:
The VCI map for October indicates below-normal vegetation activity over most of North West except over some of the eastern parts.

Figure 17:
The VCI map for October indicates below-normal vegetation activity over the central to western interior of the Eastern Cape.

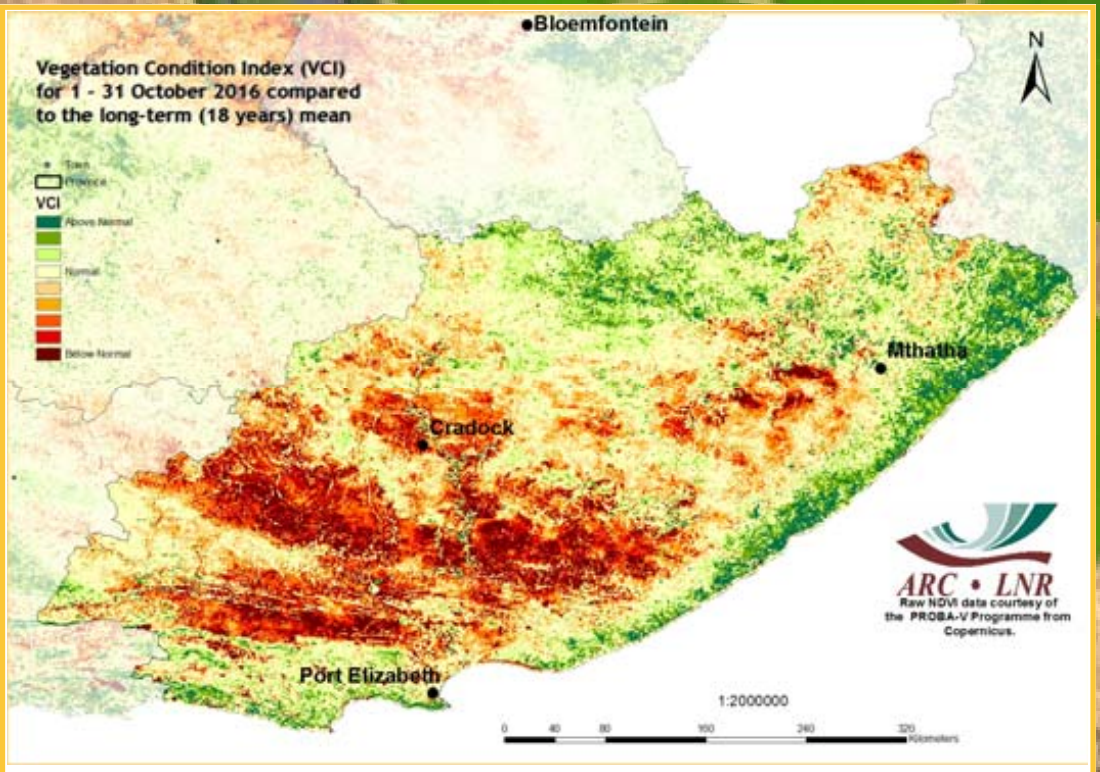
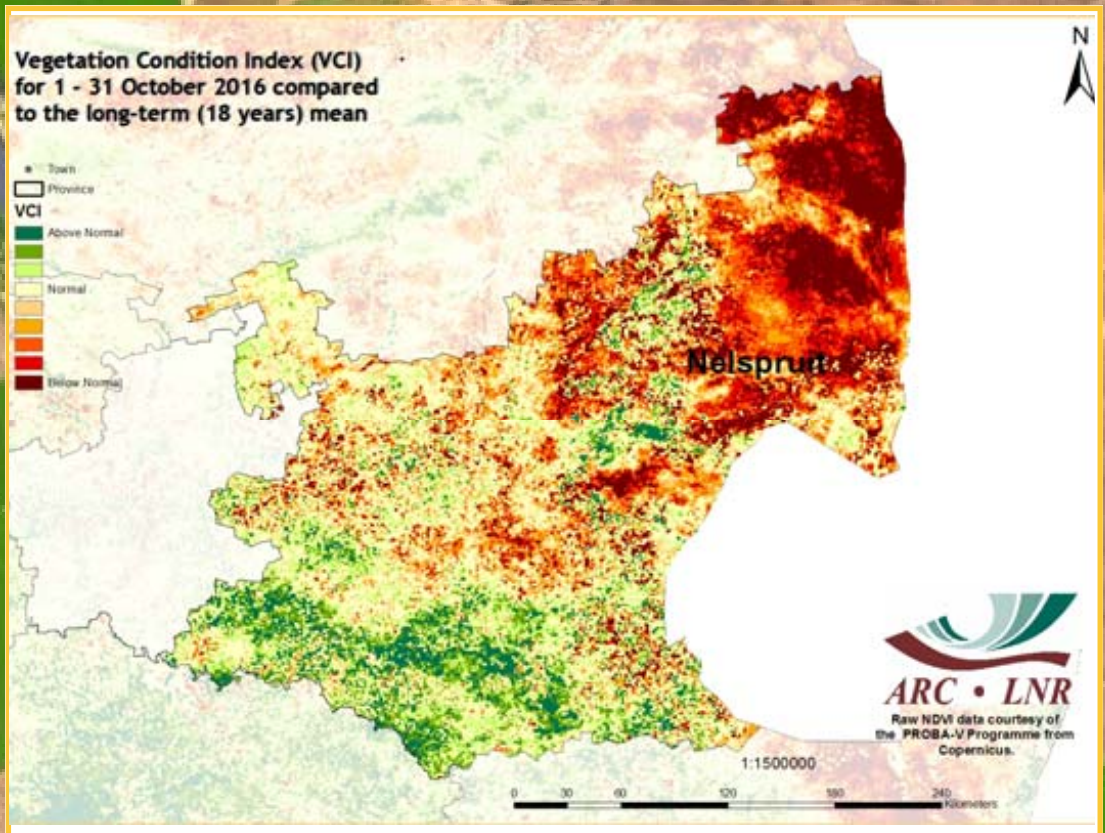


Figure 17



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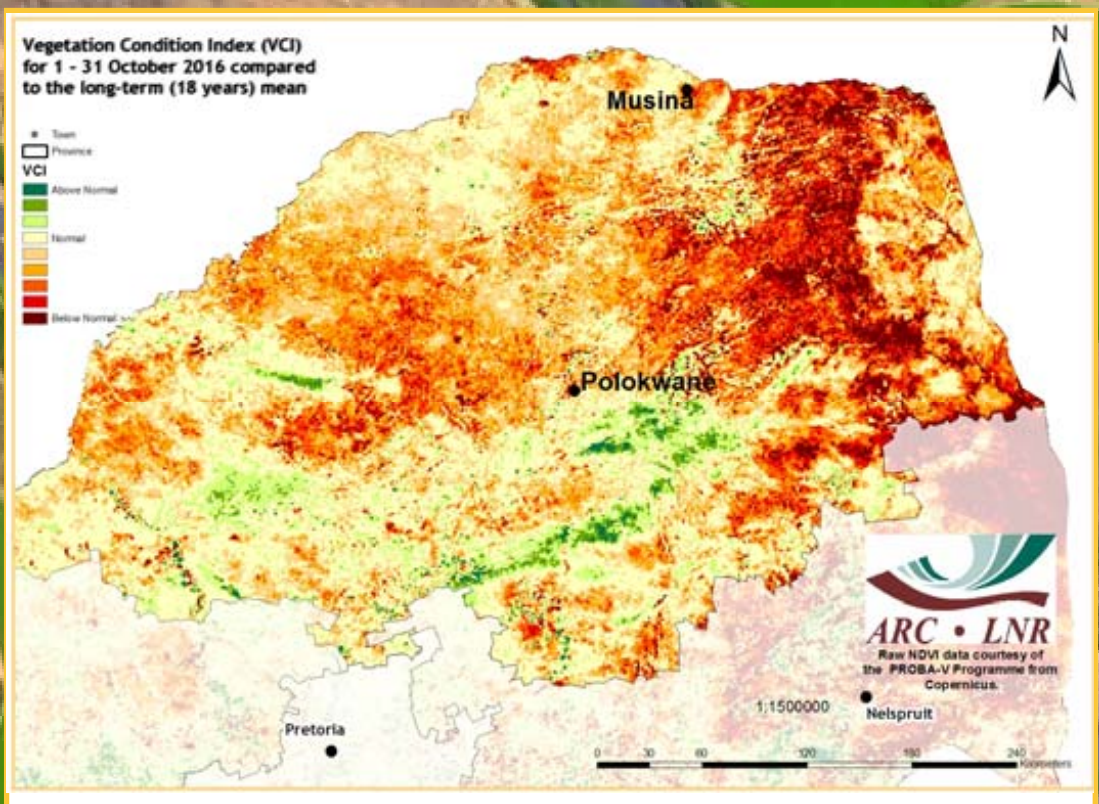


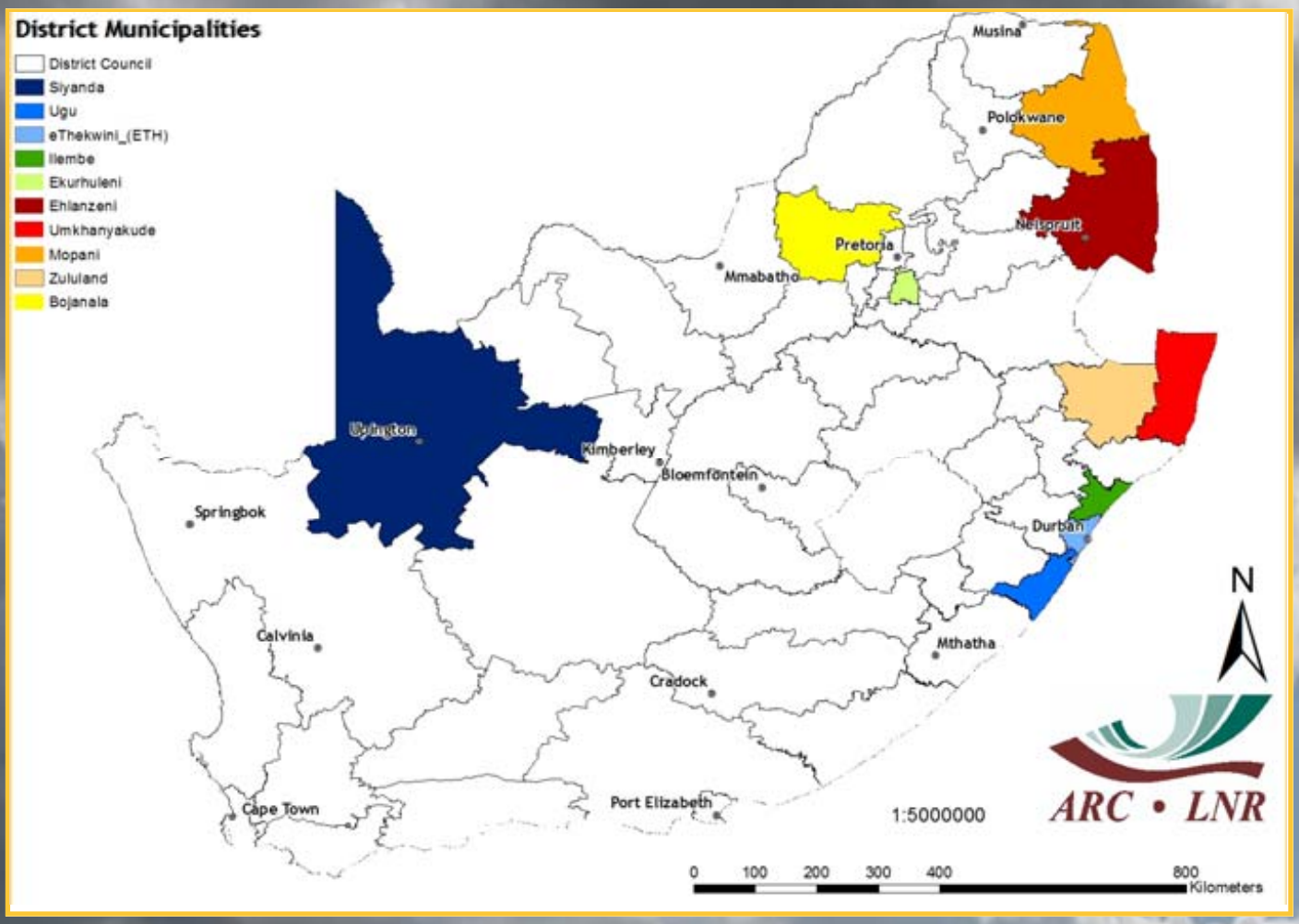
Figure 19

Figure 18:
The VCI map for October indicates below-normal vegetation activity over the Lowveld of Mpumalanga.

Figure 19:
The VCI map for October indicates below-normal vegetation activity over most of Limpopo, especially over the northern parts including the Lowveld.

Questions/Comments:
NkambuleV@arc.agric.za

7. Vegetation Conditions & Rainfall



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

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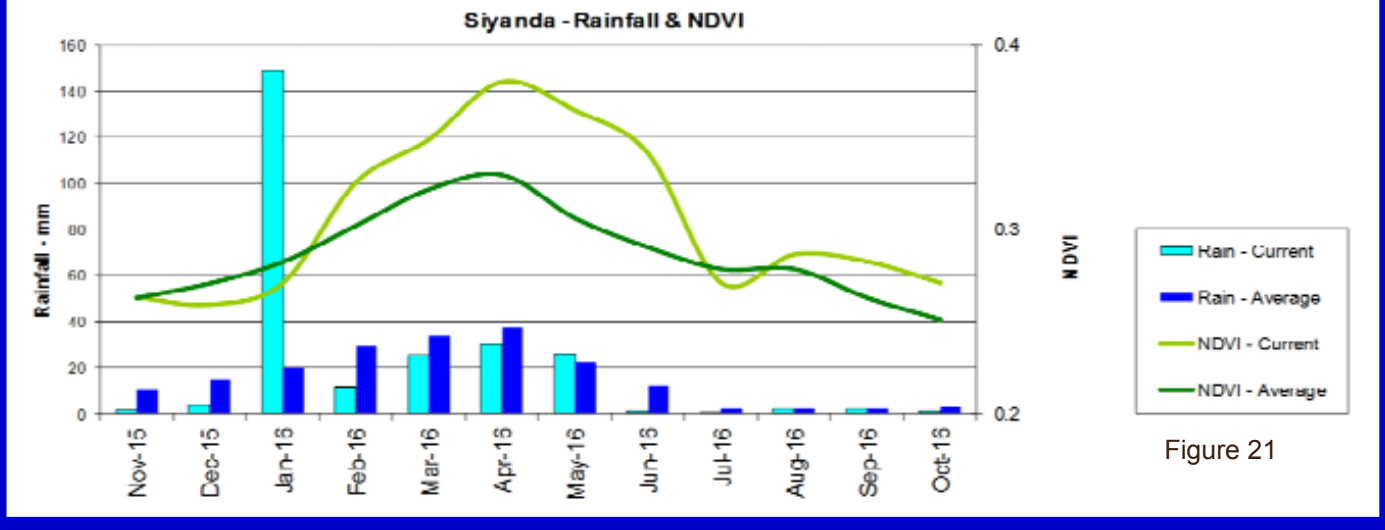
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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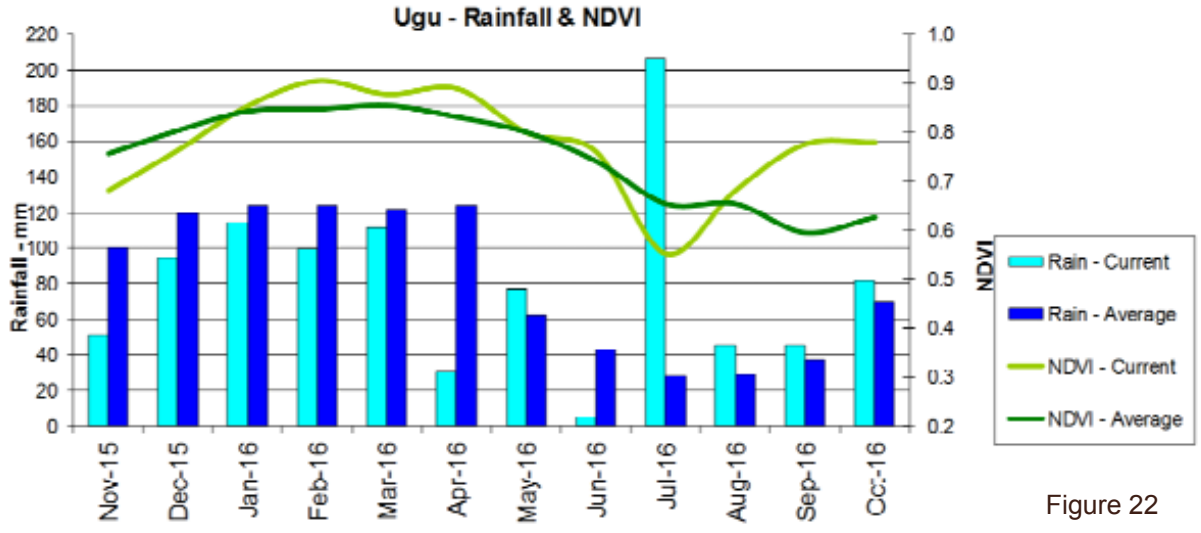

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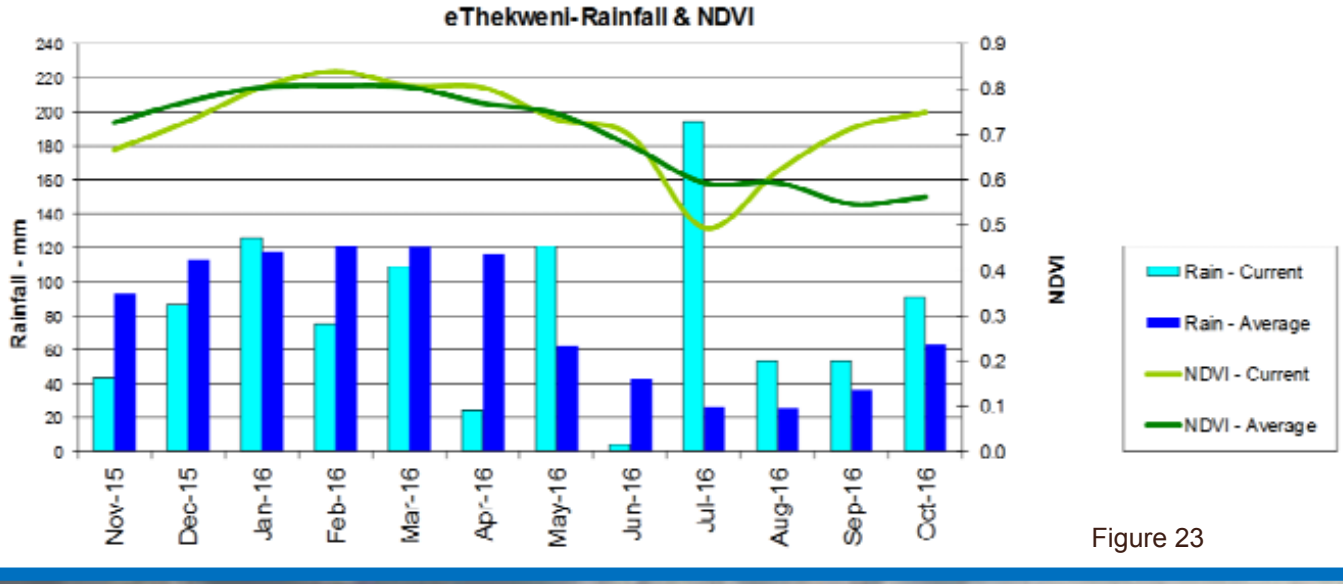

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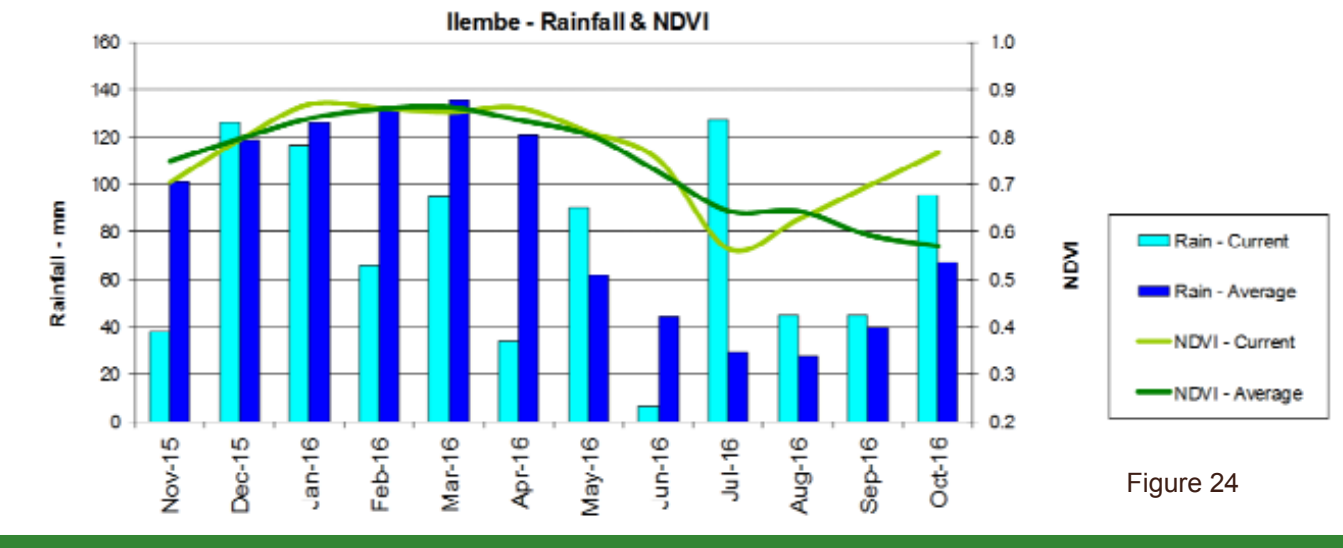

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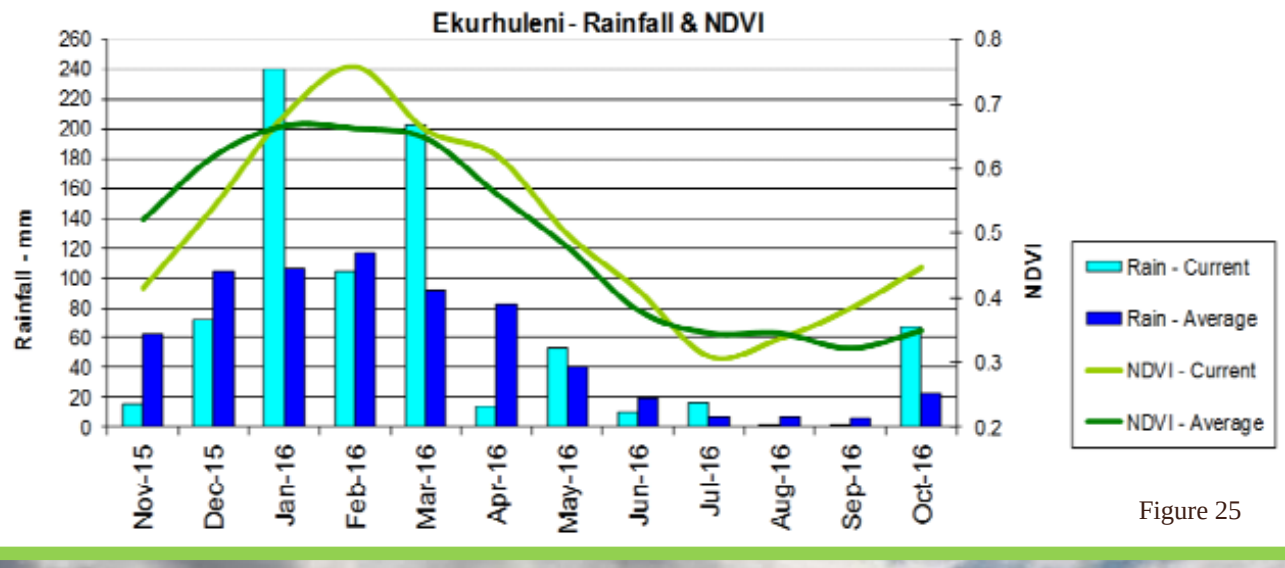
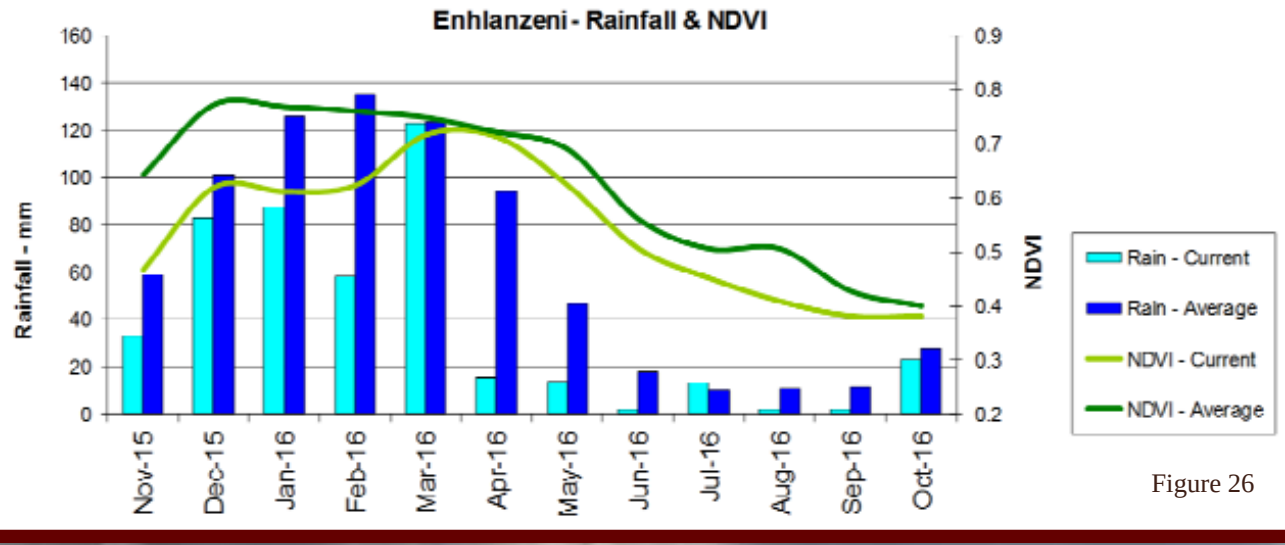


Figure 25



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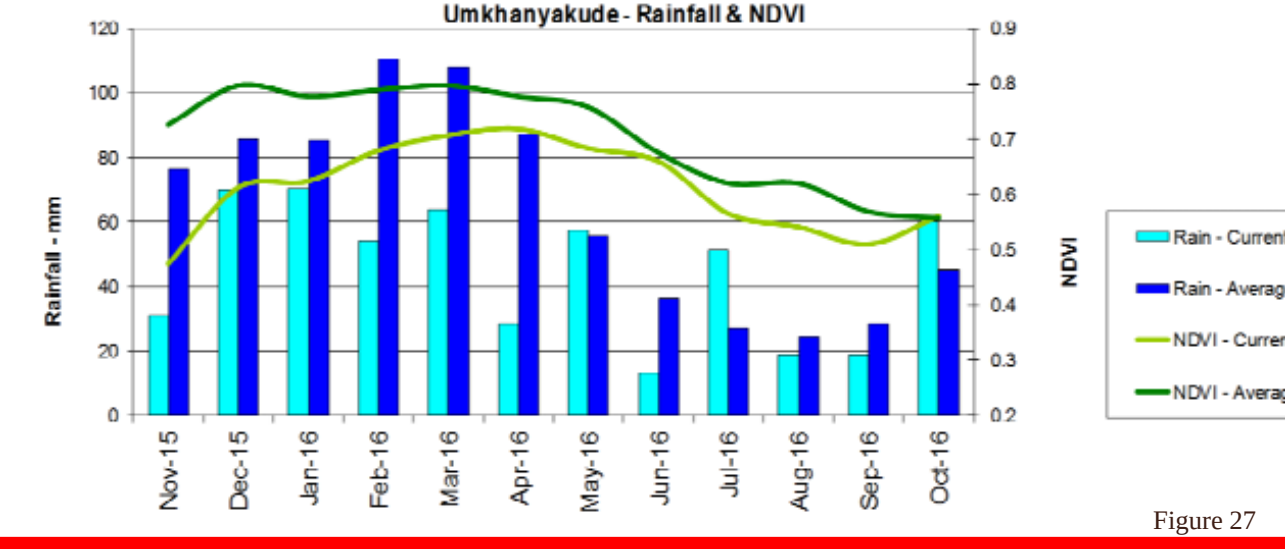

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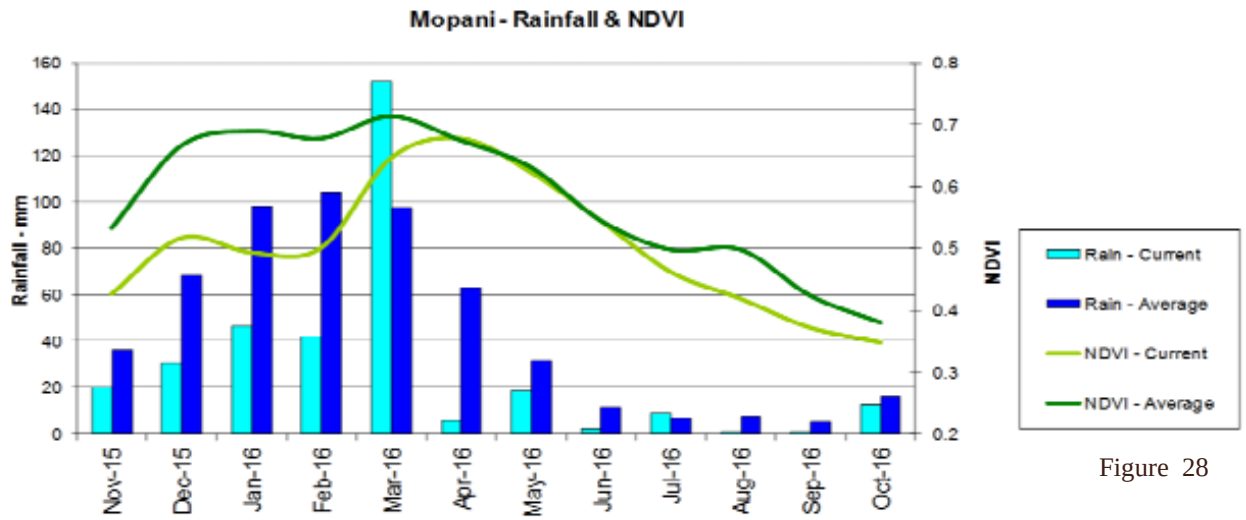

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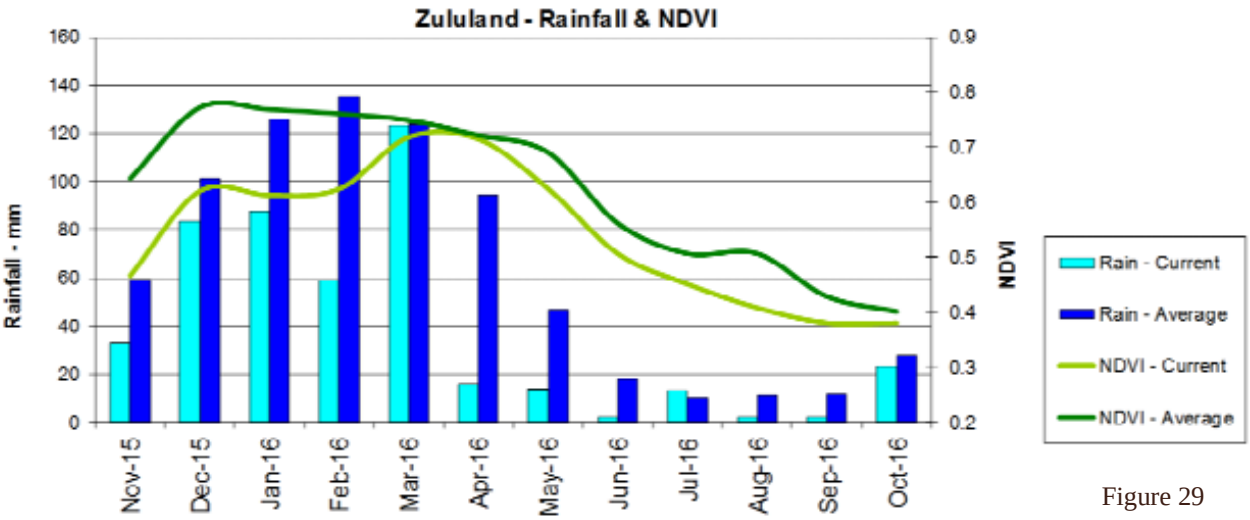

Figure 29

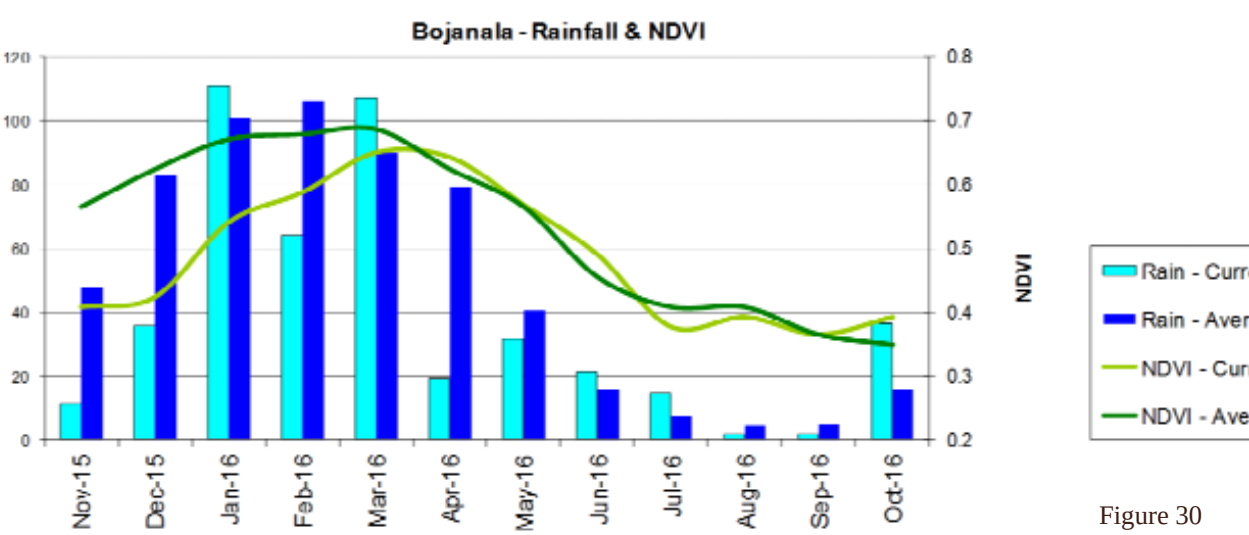

Figure 30

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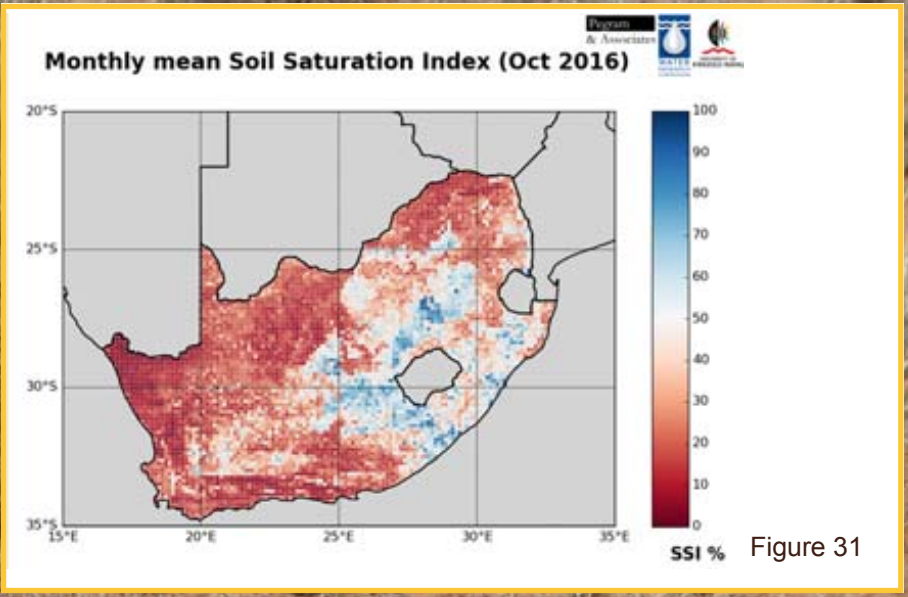

Figure 31

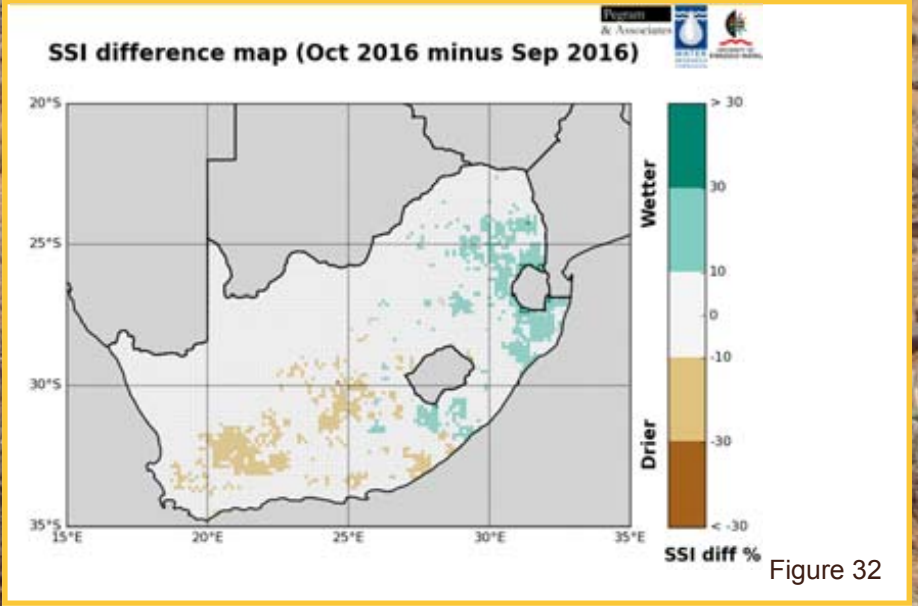

Figure 32

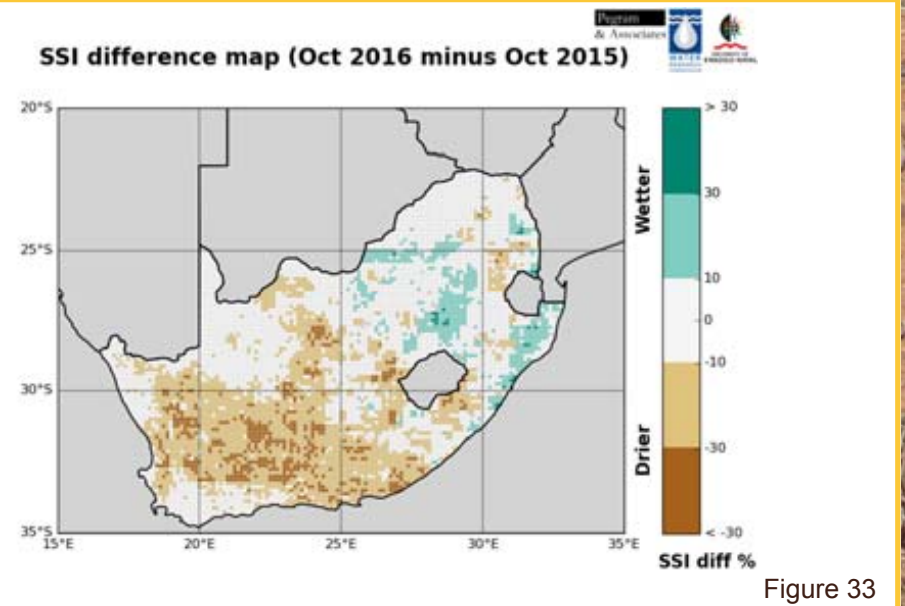

Figure 33

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 October per province. Fire activity was lower in all provinces compared to the average during the same period for the last 16 years.

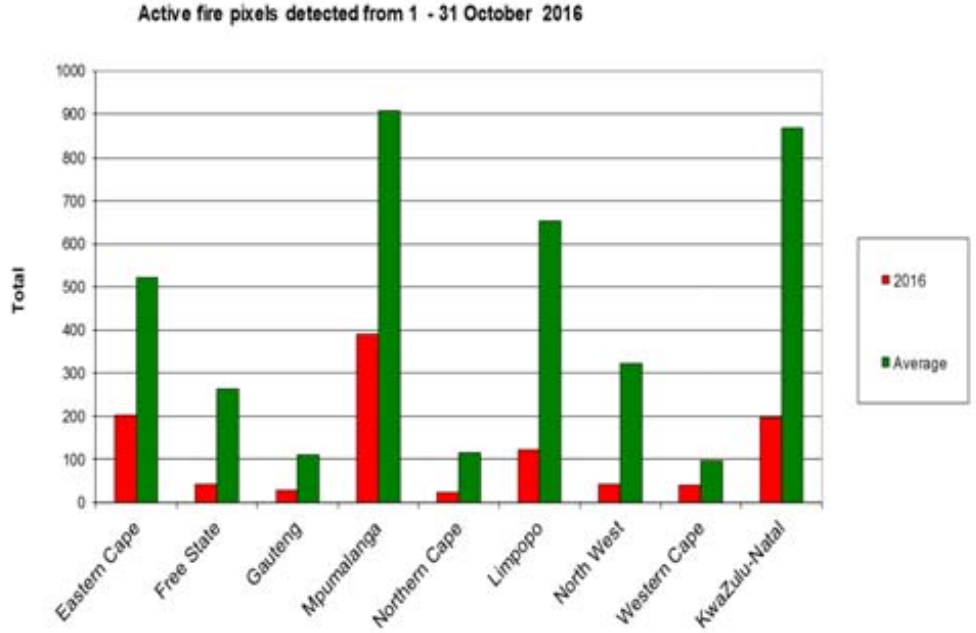

Figure 34

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

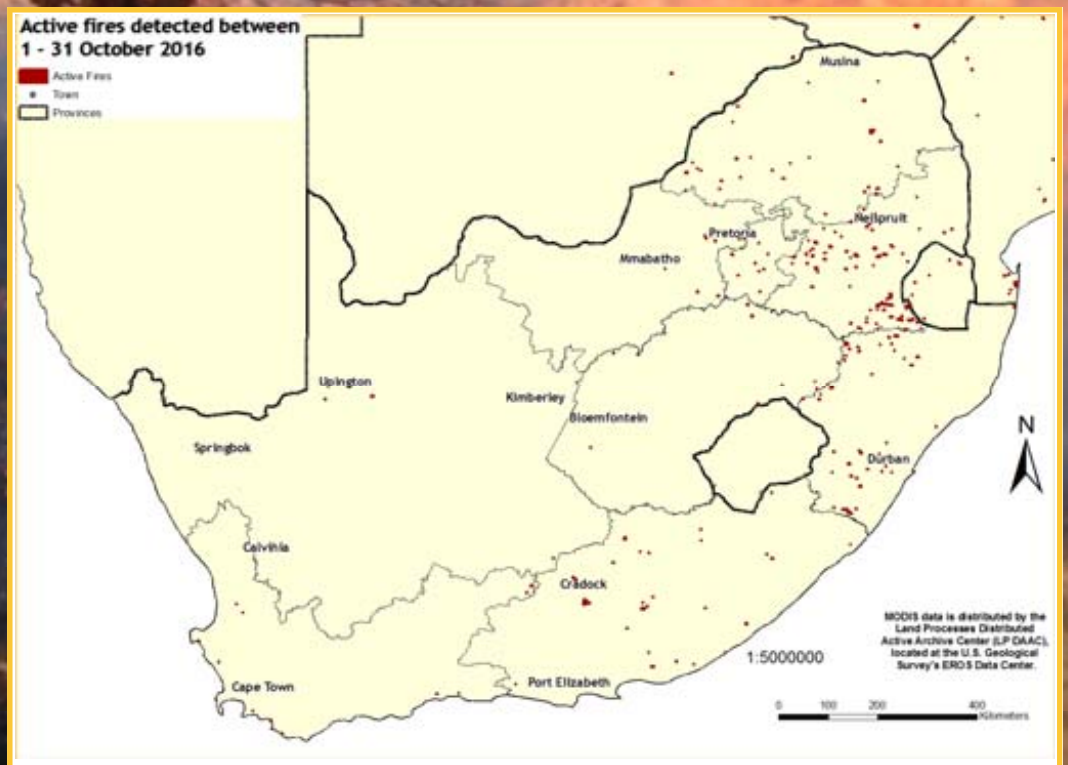

Figure 35

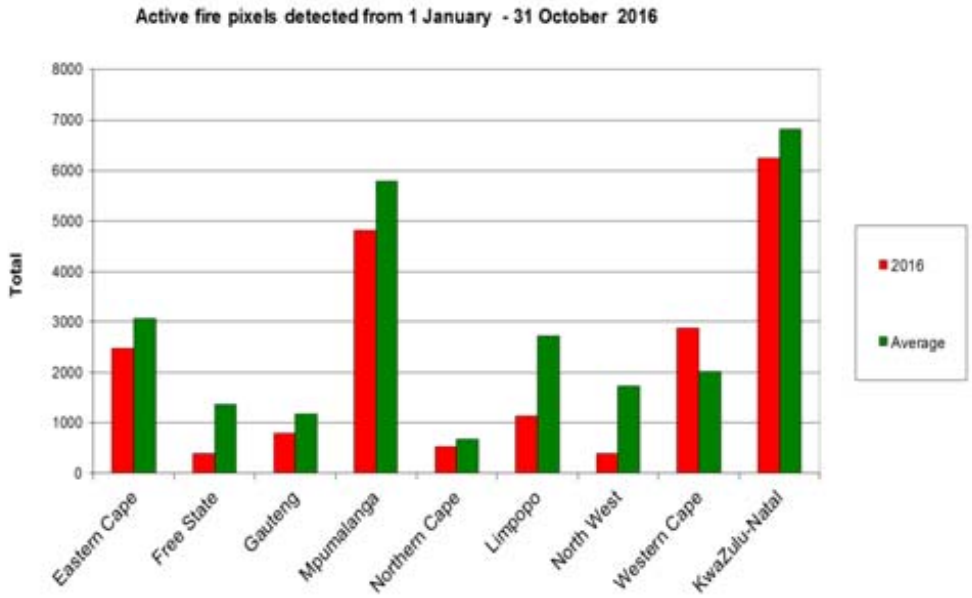

Figure 36

Figure 36:
The graph shows the total number of active fires detected from 1 January - 31 October 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.

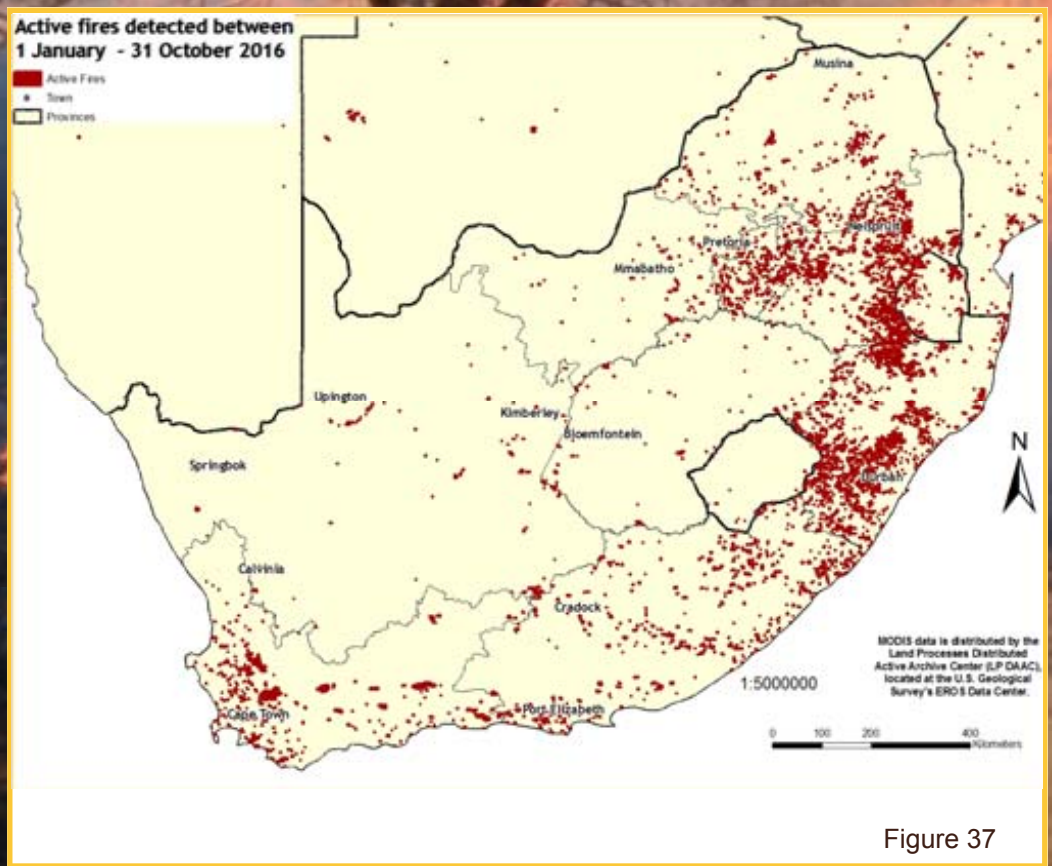

Figure 37

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

Questions/Comments:
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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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Geoinformation Science

ARC • LNR

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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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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Johan@arc.agric.za

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

http://www.agis.agric.za