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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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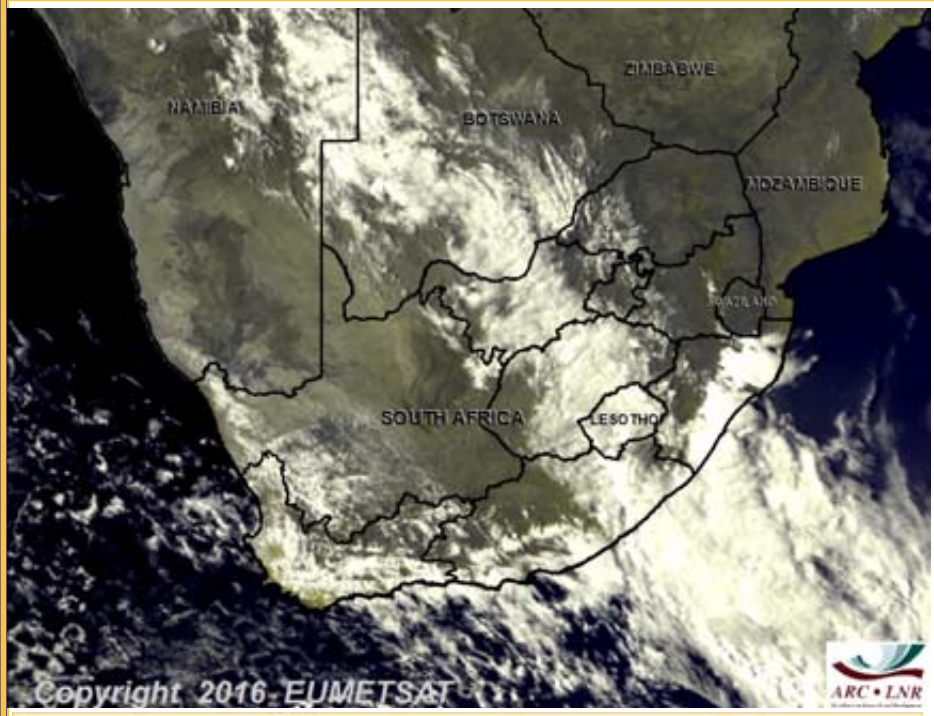
REPUBLIC OF SOUTH AFRICA

South African Weather Service

AMESD

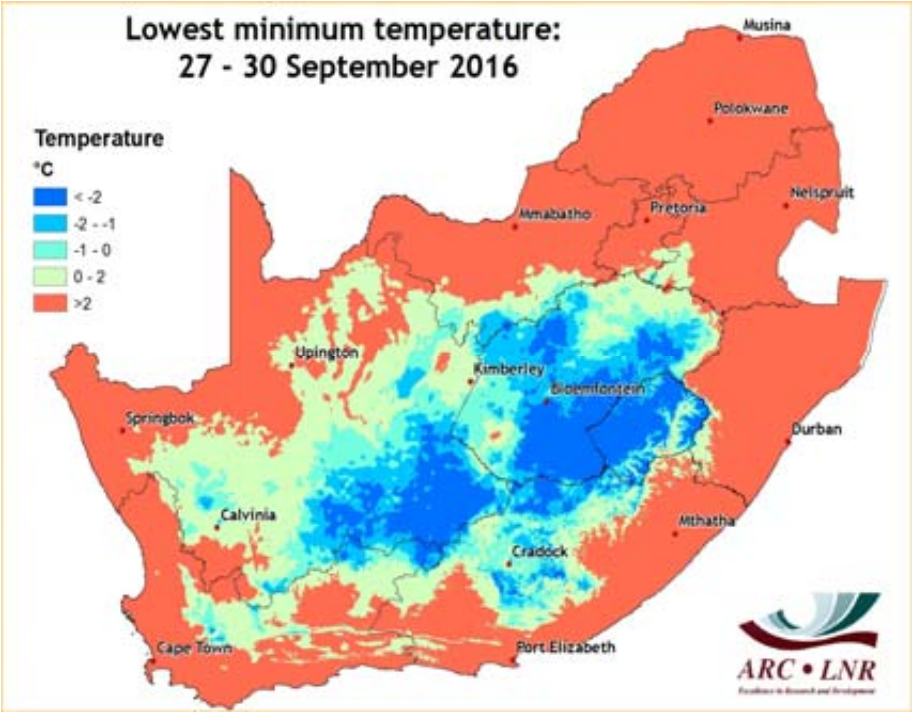
148th Edition

Images of the Month



Cold conditions at the end of September

While some weather events during September, such as the development of cloud bands and rain over the eastern interior, indicated the onset of spring, several cold fronts moving far north over the country resulted in the lowest temperatures over the central to southern parts being reached during the last few days of the month, in many places only by the 29th.



The MSG-3 SEVIRI false colour composite for 12:00 SAST on the 27th shows the development of a cloud band, with some thundershowers over the interior. To the west, broken clouds indicate the progress of a cold front over the western parts. These features were associated with an upper-air trough to the west, moving into the country and supporting precipitation. While the system resulted in some thundershowers over the interior and widespread rain over the winter rainfall region including the northern parts of the West Coast and adjacent interior, the cold air that spread into the interior behind the front was responsible for widespread light to moderate frost over the interior. The map shows the lowest minimum temperatures recorded from 27-30 September over the country. This map is an interpolation of minimum temperatures recorded by the ARC-ISCW automatic weather station network, consisting of 450 operational weather stations across the country.

The Agricultural Research Council - Institute for Soil, Climate and Water (ARC-ISCW) collected the data, generated the products and compiled the information contained in this newsletter, as part of the Coarse Resolution Imagery Database (CRID) project that was funded by the Department of Agriculture and Department of Science and Technology at its inception and is currently funded by the Department of Agriculture, Forestry and Fisheries (DAFF).

1. Rainfall

Overview:
Rainfall during September 2016 occurred mainly over the winter rainfall region and the eastern parts of the country. The central parts were predominantly dry. Maximum and minimum temperatures over the northern interior showed an increasing trend throughout the month, except for a cold snap around the 19th associated with a cold front and upper-air system responsible for most of the rain over the interior. Temperatures over the southern half of the country showed no specific trend, with cold periods and the lowest minimum temperatures in some areas recorded by the end of the month when a cold front crossed the interior and widespread frost occurred.

Over the winter rainfall region, rainfall was above normal over the northern parts of the West Coast as well as along the Garden Route while near-normal to below-normal totals were recorded over the south-western parts. The regular passage of frontal systems resulted in well-distributed rainfall events throughout the month, even though most of the events were insignificant. Precipitation occurred over some parts of the winter rainfall region on the 2nd, 4th-5th, 8th, 12th-16th, 19th-21st and 26th-27th. Two major frontal systems with upper-air support were responsible for widespread rain over the northern parts of the West Coast and western escarpment by the 15th and 26th. The subsequent movement of these systems over the interior resulted in the lowest minimum temperatures over most of the interior being recorded by the 17th and 29th.

Widespread significant rain occurred along the Garden Route into the southern and eastern parts of the Eastern Cape during the first few days of the month as an upper-air and surface low moved over the area with a strong ridge to the south. Precipitation during this event was confined to the southern parts of the country. Another ridging event with slight upper-air support resulted in more rainfall along the eastern seaboard and isolated thundershowers over the central interior between the 11th and 15th. An upper-air trough moving over the southern parts and deepening into a cut-off low by the 17th resulted in the most significant rainfall of the month over the eastern parts on the 17th and 18th. A strong surface ridge to the south of the country caused an influx of cold moist air into the east. Overcast and rainy conditions occurred from southern Limpopo across the north-eastern and eastern provinces. Significant falls were recorded in some places over Mpumalanga and KwaZulu-Natal. Relatively warm and dry conditions developed during the next few days as anticyclonic circulation patterns dominated until the 25th.

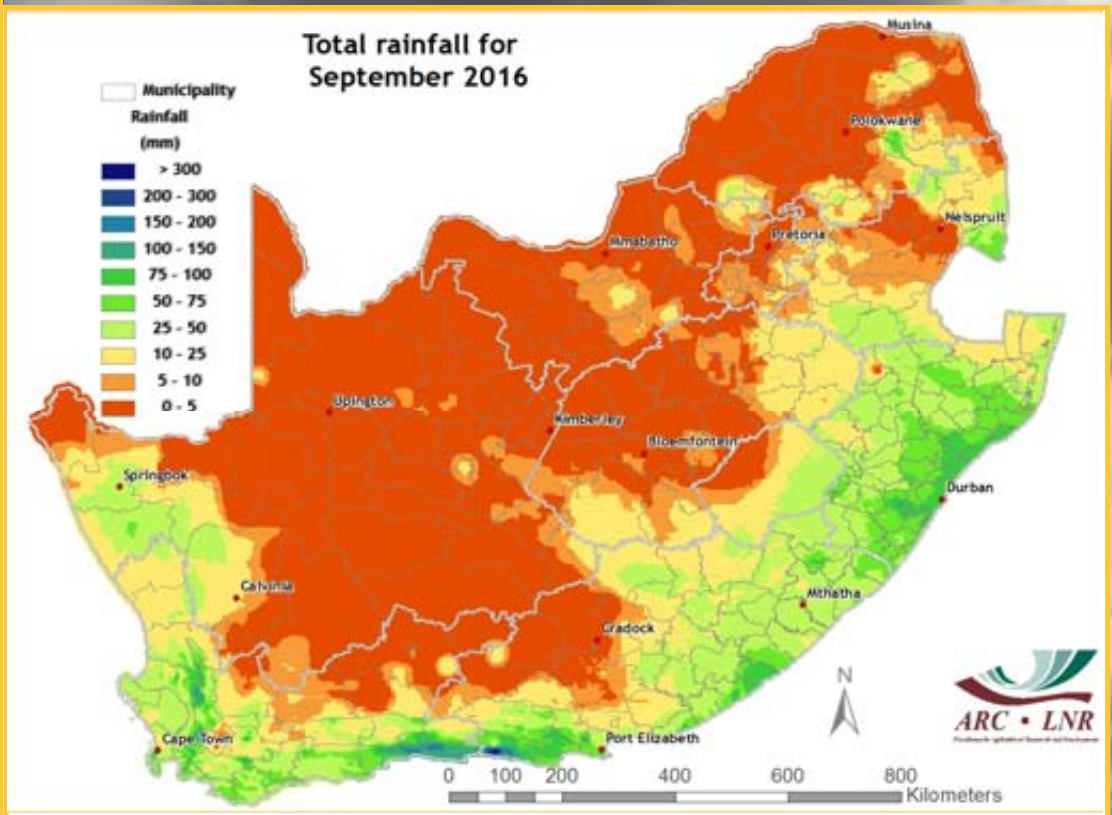
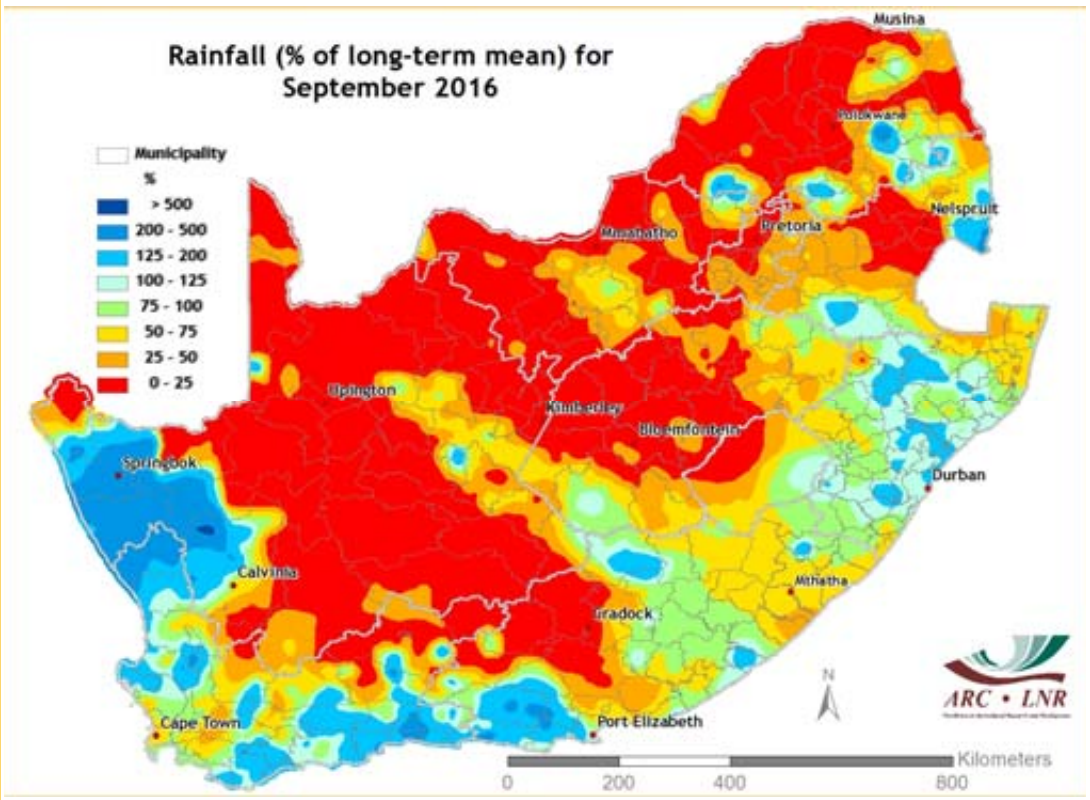


Figure 1



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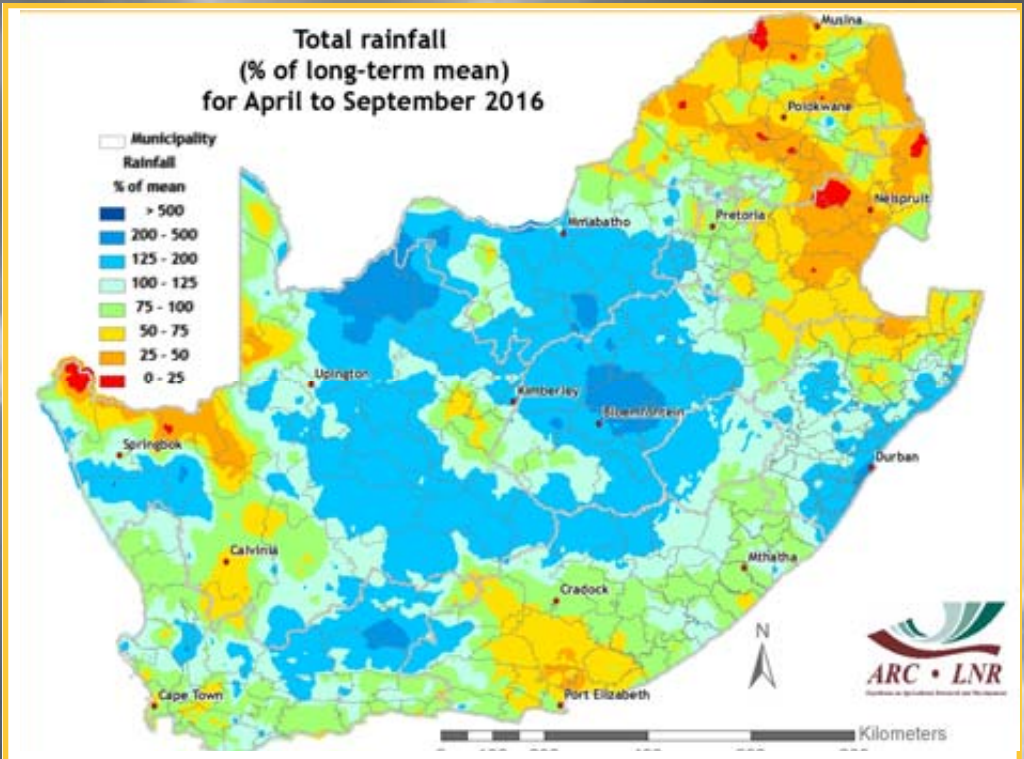

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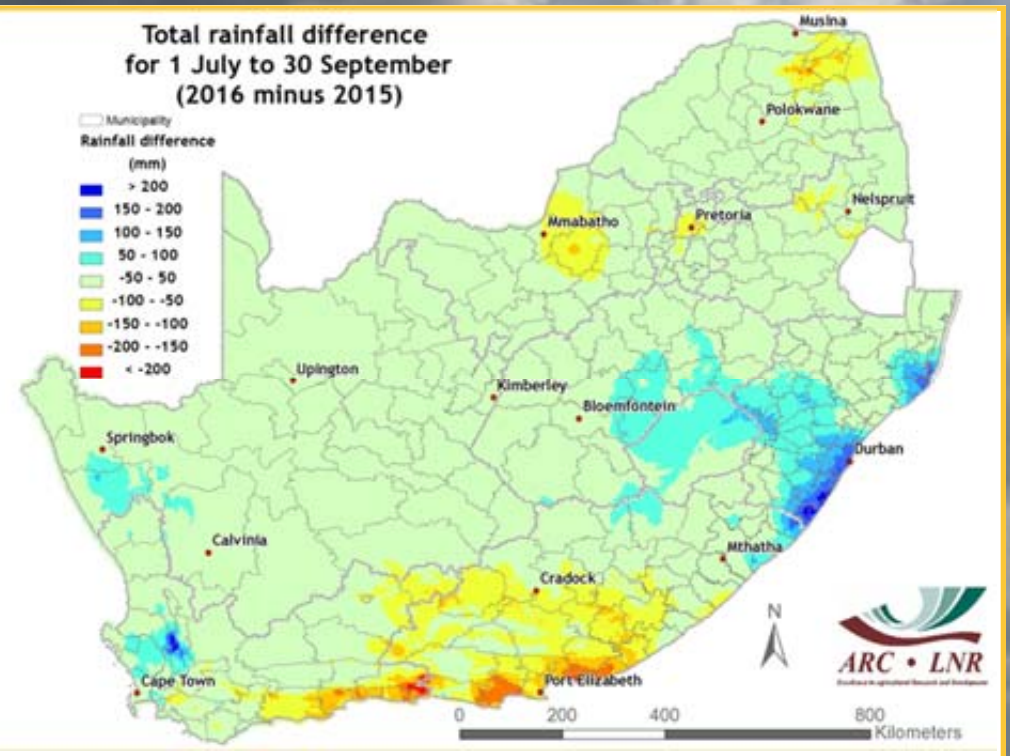

Figure 4

From the 26th, the last strong frontal system for the month moved into the western interior with precipitation all the way along the West Coast and western escarpment. An upper-air trough and yet another ridge to the south resulted firstly in some thundershowers over the northeastern parts, moving to the central interior by the 27th. As the cold, dry air invaded the interior from the west during the next few days, dry weather set in with frost over many areas by the 29th. With some upper-air support and surface moisture, isolated thundershowers continued over the northeastern parts until the end of the month.

Figure 1:
While the central interior was mostly dry, rainfall totals over the winter rainfall region and eastern to southern parts of the summer rainfall region ranged between 5 and 75 mm for the most part. Higher totals were recorded along the Garden Route as well as parts of the coastal belts of the Eastern Cape and KwaZulu-Natal.

Figure 2:
Compared the long-term mean, the northern parts of the winter rainfall region and the Garden Route were relatively wet. Parts of the eastern summer rainfall region also received above-normal rainfall. Rainfall over the central to northern interior was mostly below normal.

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 (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 during July to September this year than last year . The western parts of the winter rainfall region (focussing on the Swartland and northern parts of the West Coast), coastal KwaZulu-Natal into the eastern Free State, received more rain than during the same period 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 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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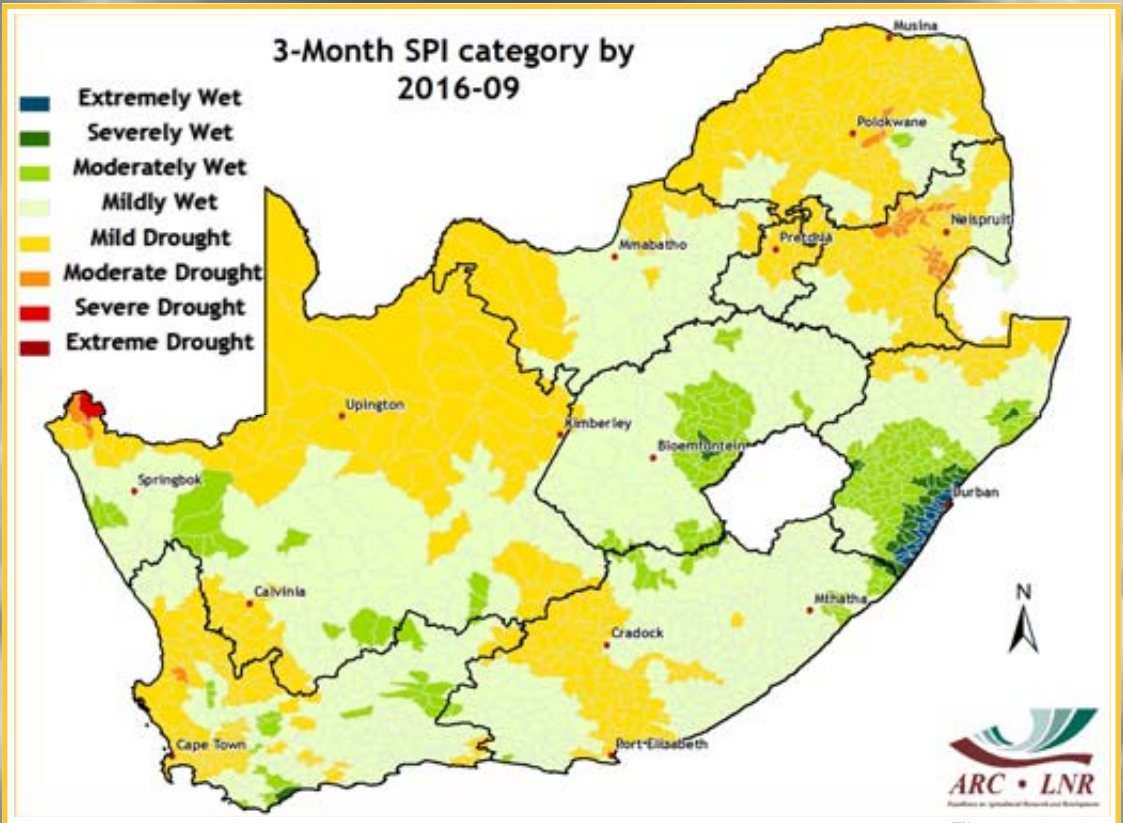

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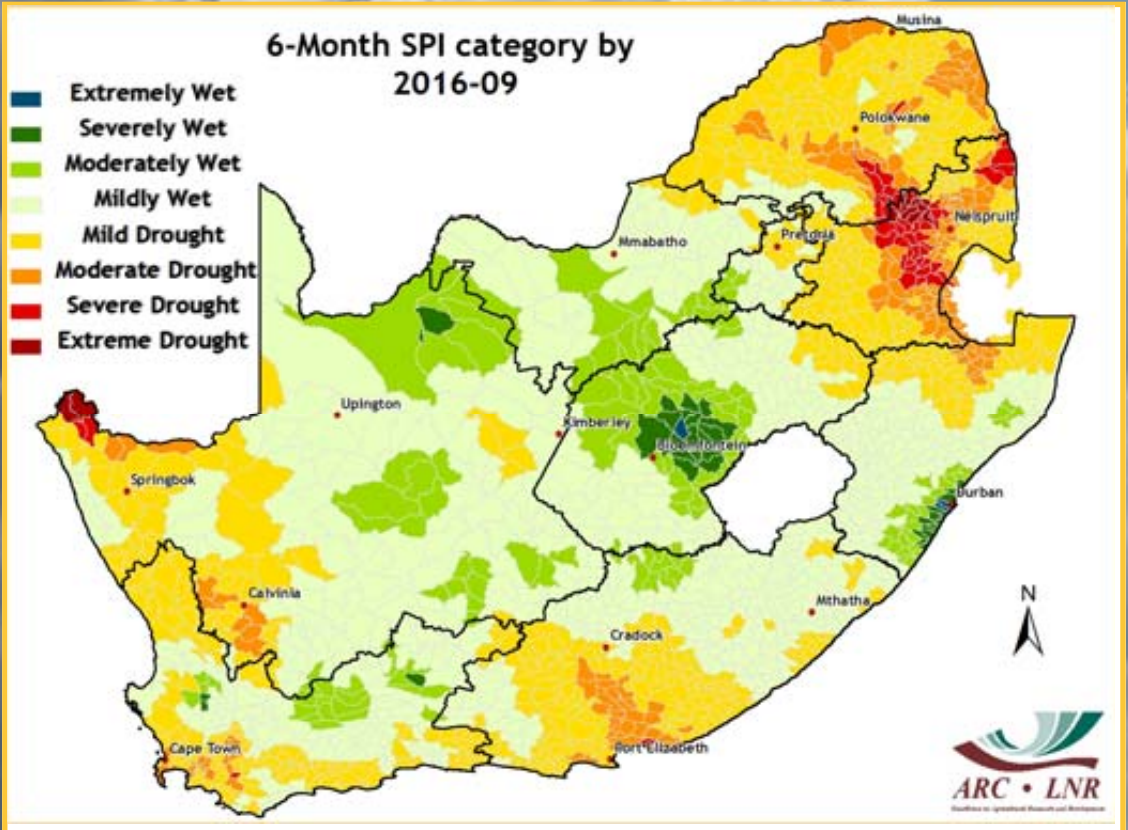

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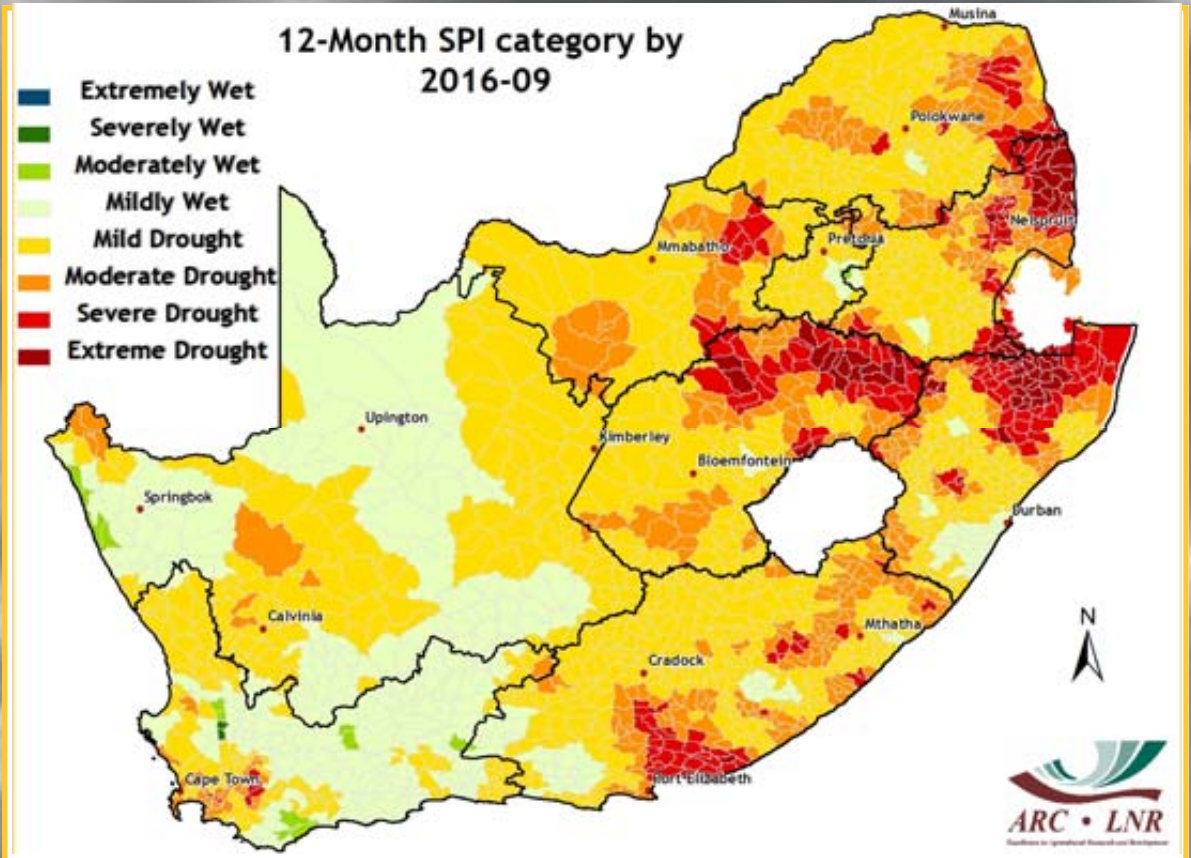

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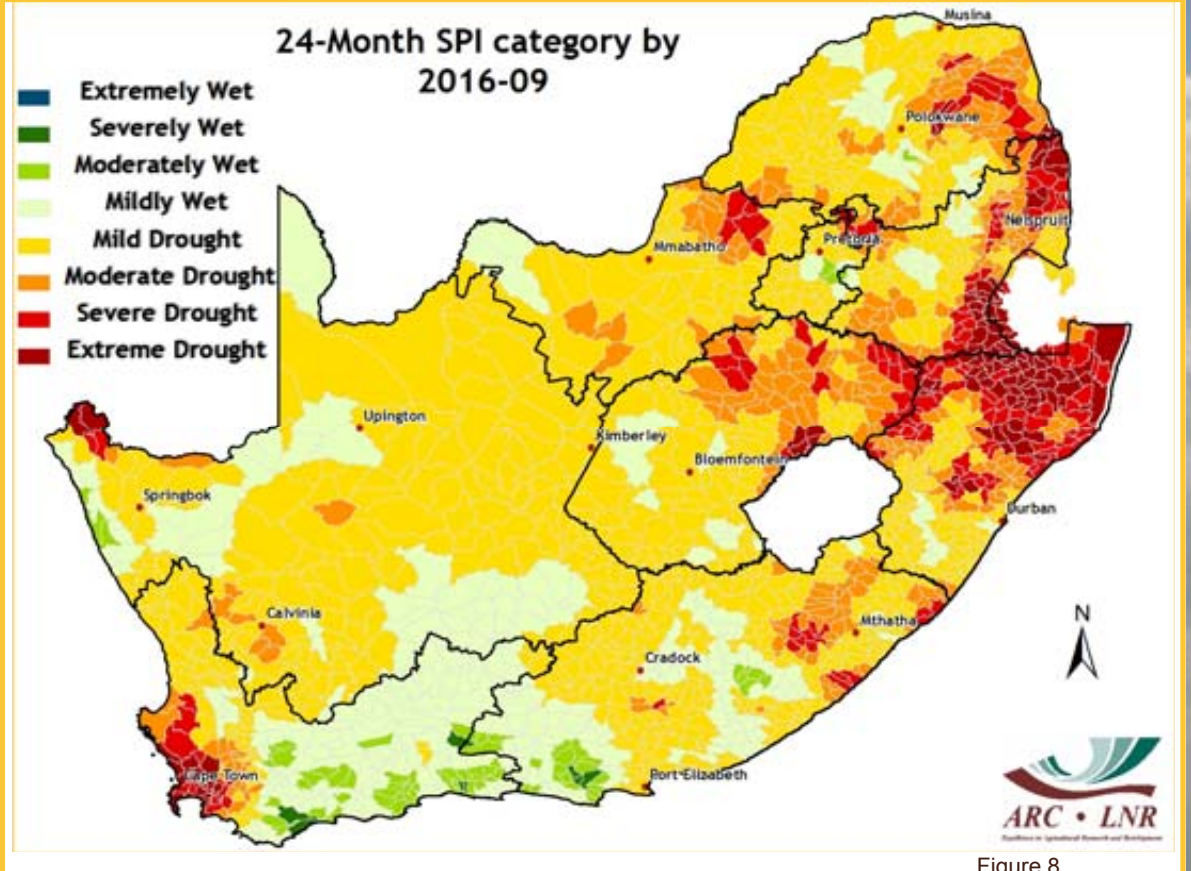

Figure 8

3. Rainfall Deciles

Deciles are used to express the ranking of rainfall for a specific period in terms of the historical time series. In the map, a value of 5 represents the median value for the time series. A value of 1 refers to the rainfall being as low or lower than experienced in the driest 10% of a particular month historically (even possibly the lowest on record for some areas), while a value of 10 represents rainfall as high as the value recorded only in the wettest 10% of the same period in the past (or even the highest on record). It therefore adds a measure of significance to the rainfall deviation.

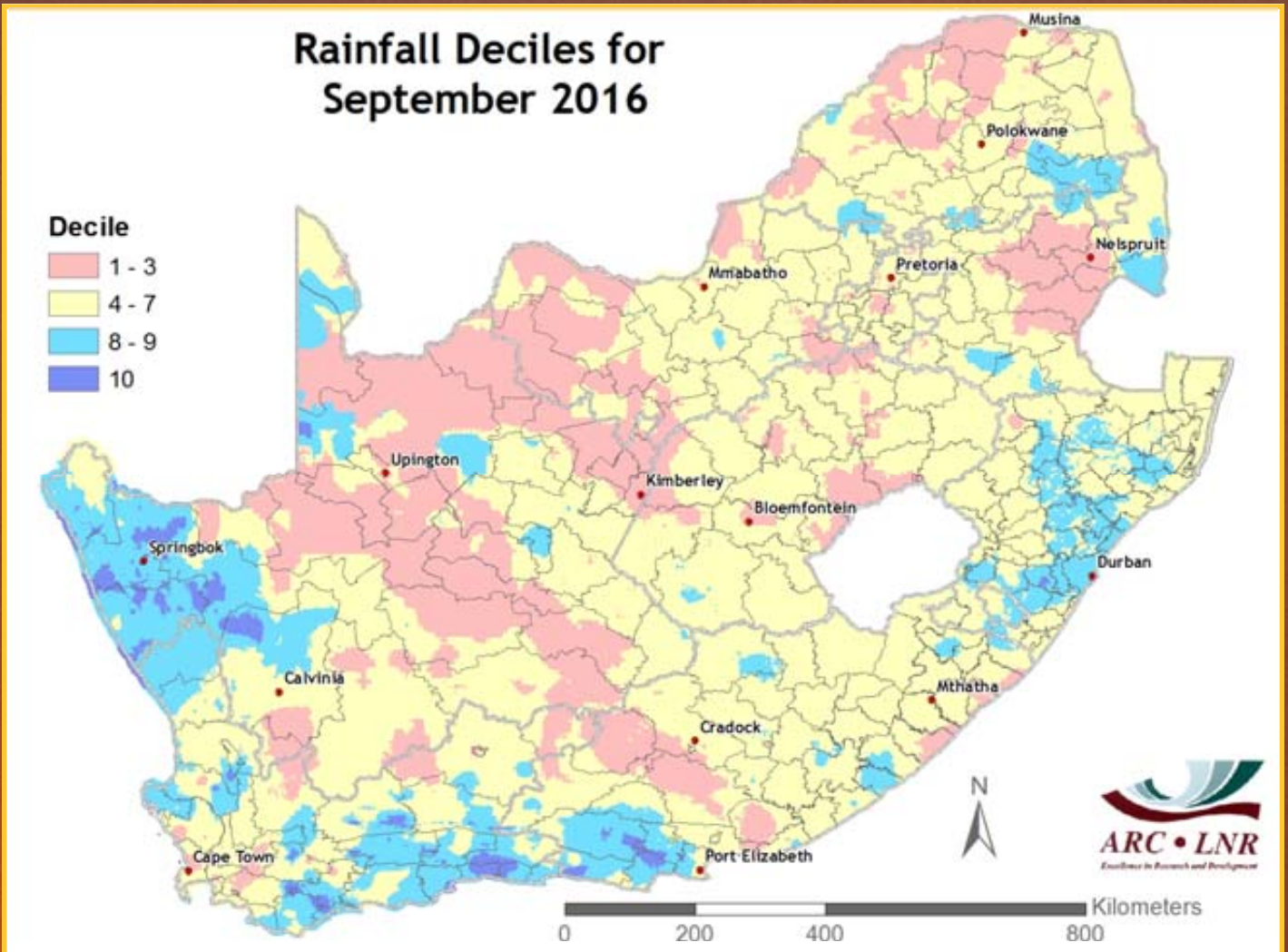

Figure 9

Figure 9:
The northern parts of the winter rainfall region and parts of the Garden Route were exceptionally wet during September.

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

4. Water Balance

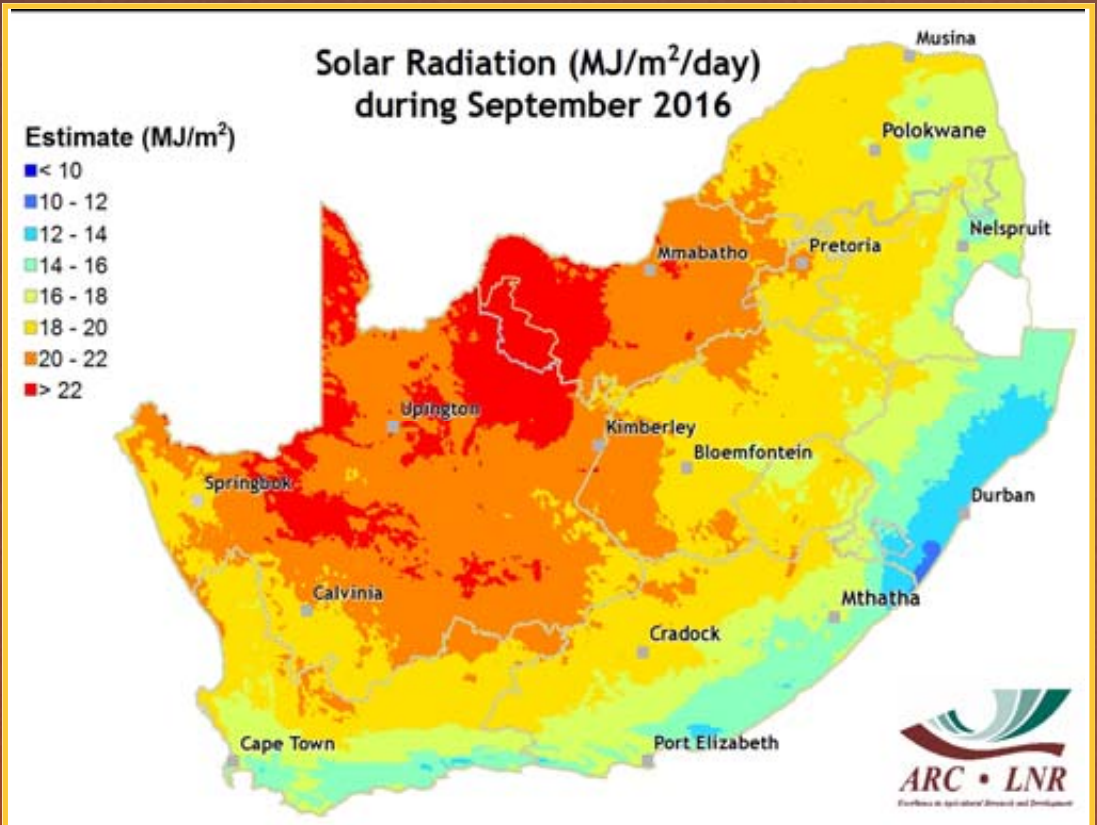

Figure 10

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.

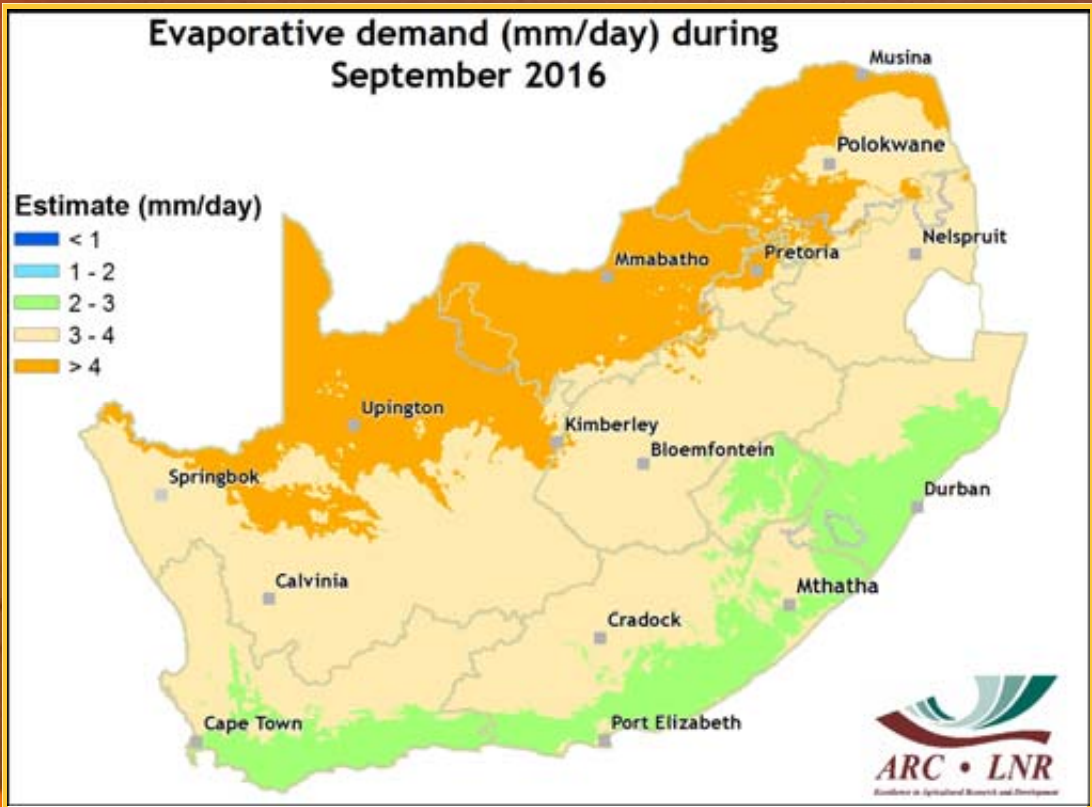

Figure 11

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 September.

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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.

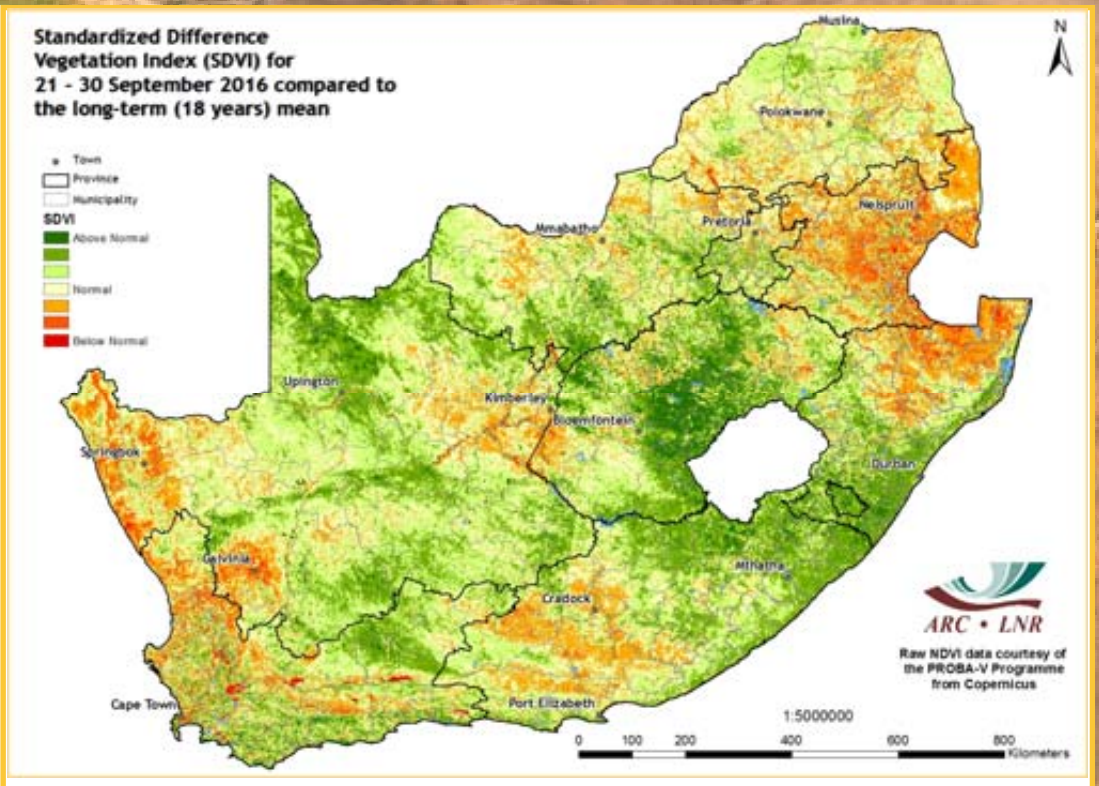

Figure 12

Figure 12:
The SDVI by late September concurs with the cumulative rainfall anomalies during the April-September period, showing above-normal activity over much of the central interior and towards the coast of KwaZulu-Natal whilst activity is below normal over much of the northeast and western parts of the Eastern Cape.

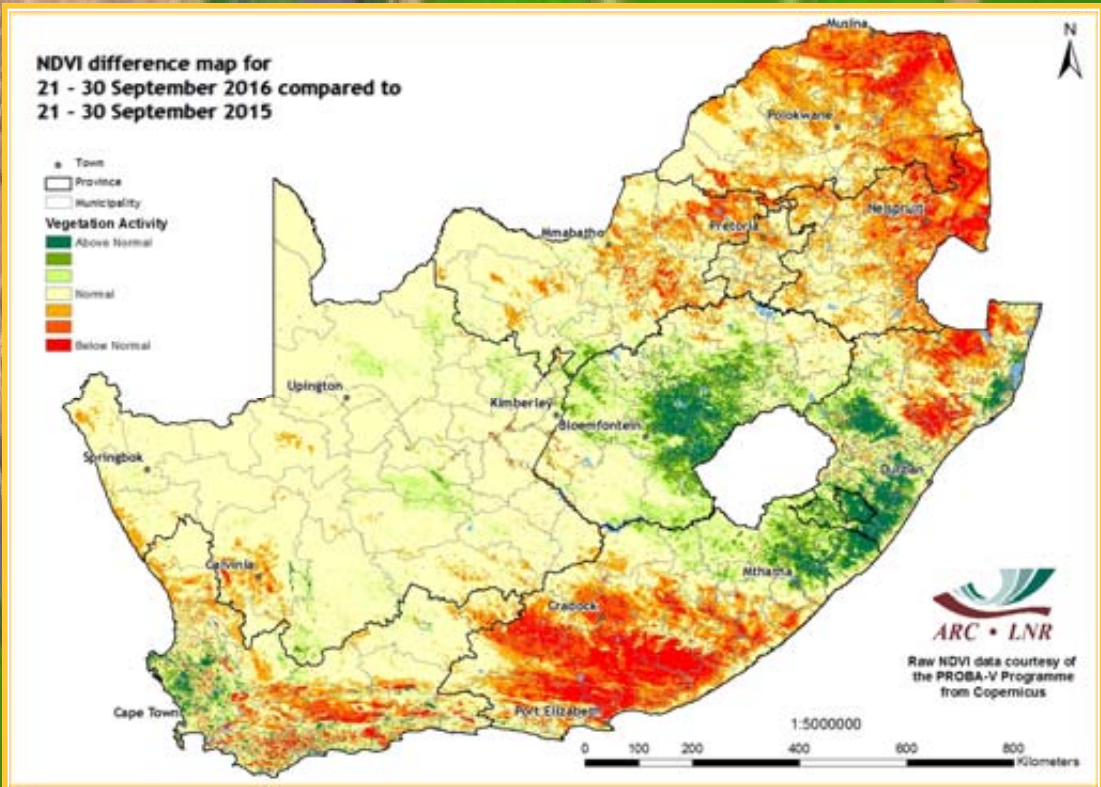

Figure 13

Figure 13:
Vegetation activity is much lower over the southern parts of the country and the northeast compared to a year ago. More favourable conditions during the winter this year have resulted in comparatively higher activity over much of the Free State, southern KwaZulu-Natal as well as the Swartland.

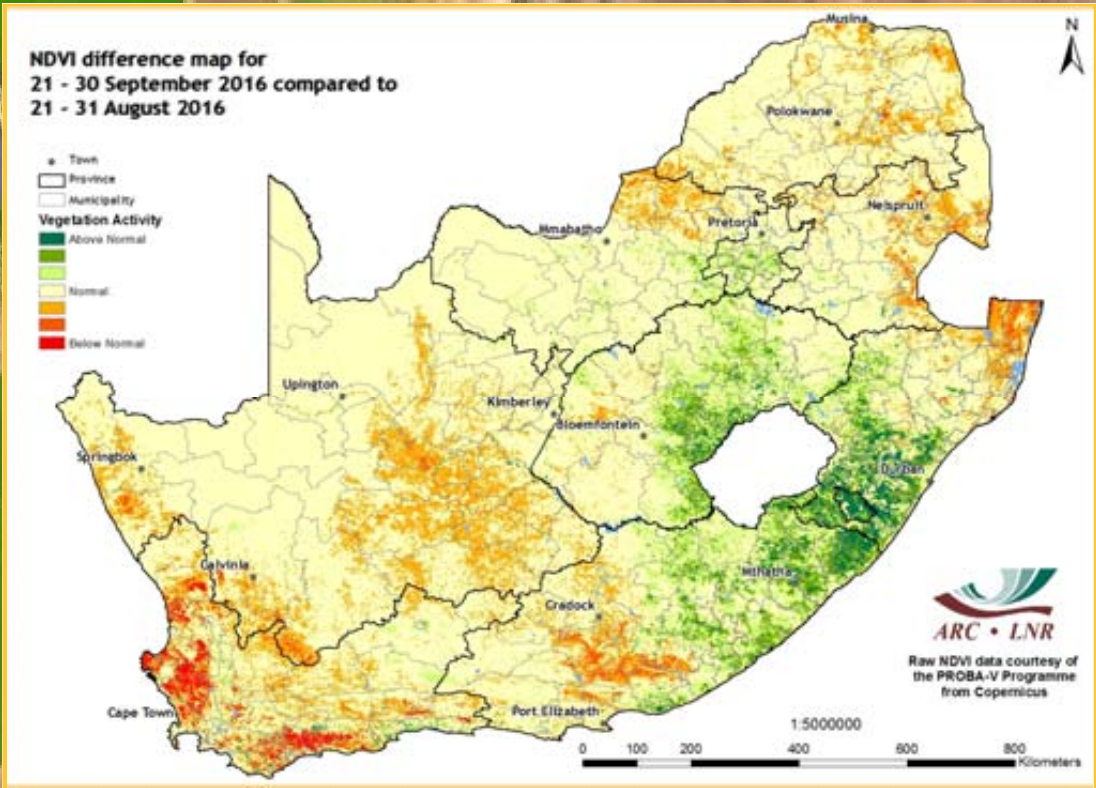

Figure 14

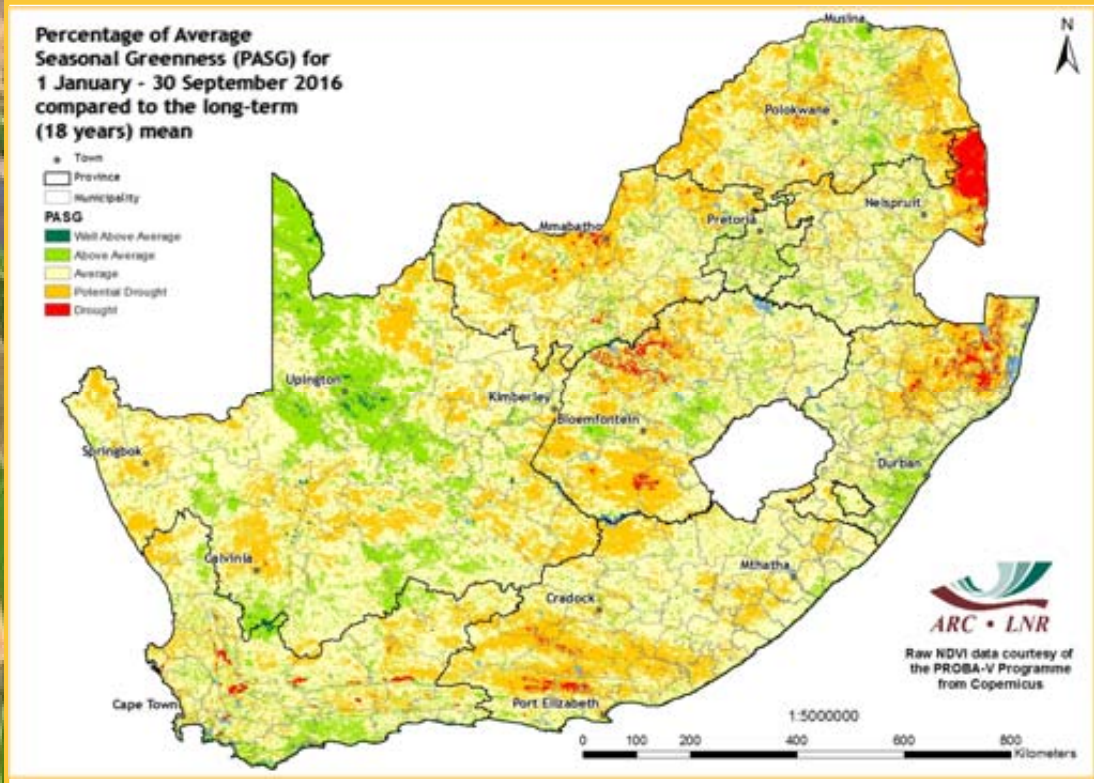

Figure 15

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.

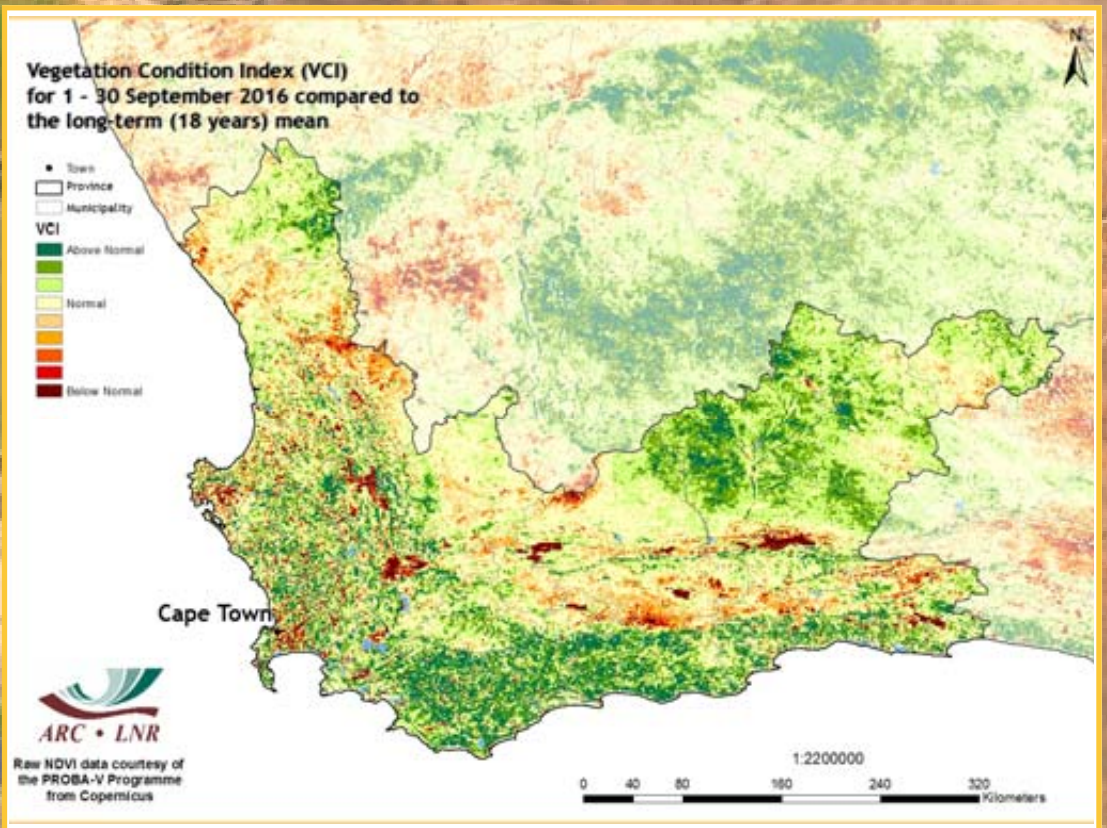
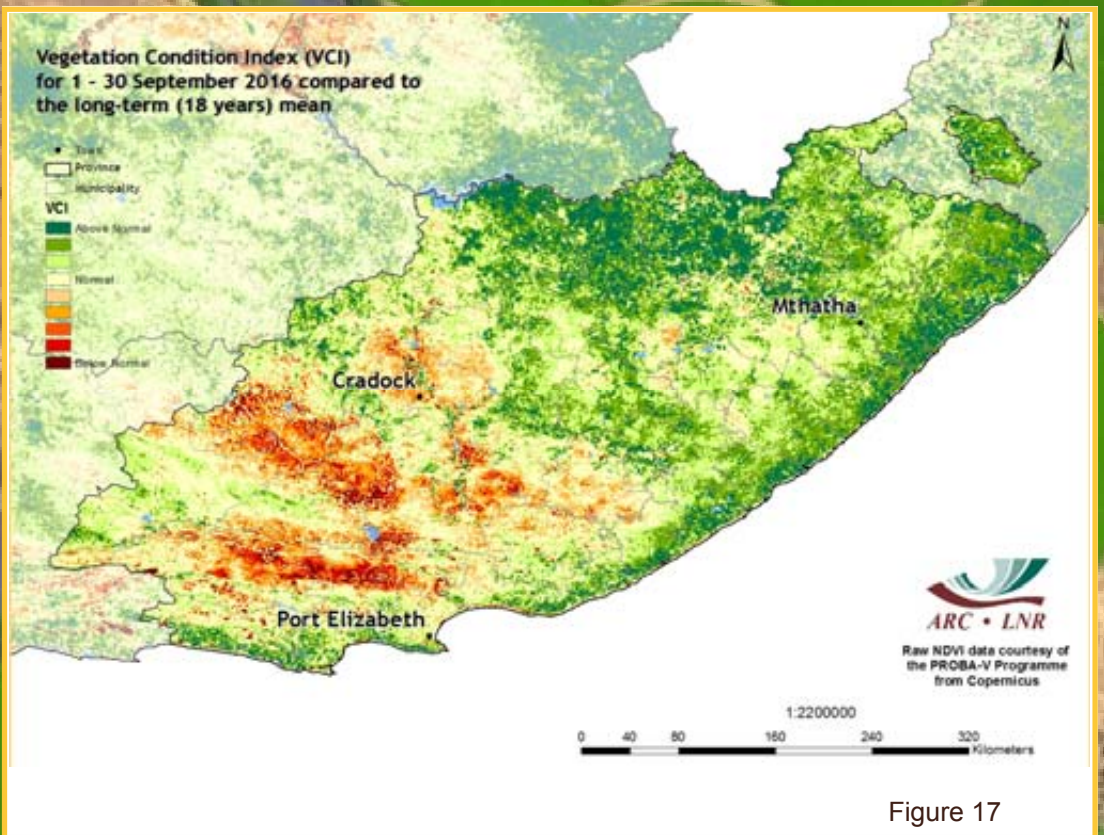


Figure 16

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

Figure 17:
The VCI map for September indicates below-normal vegetation activity over the southwestern interior of the Eastern Cape.



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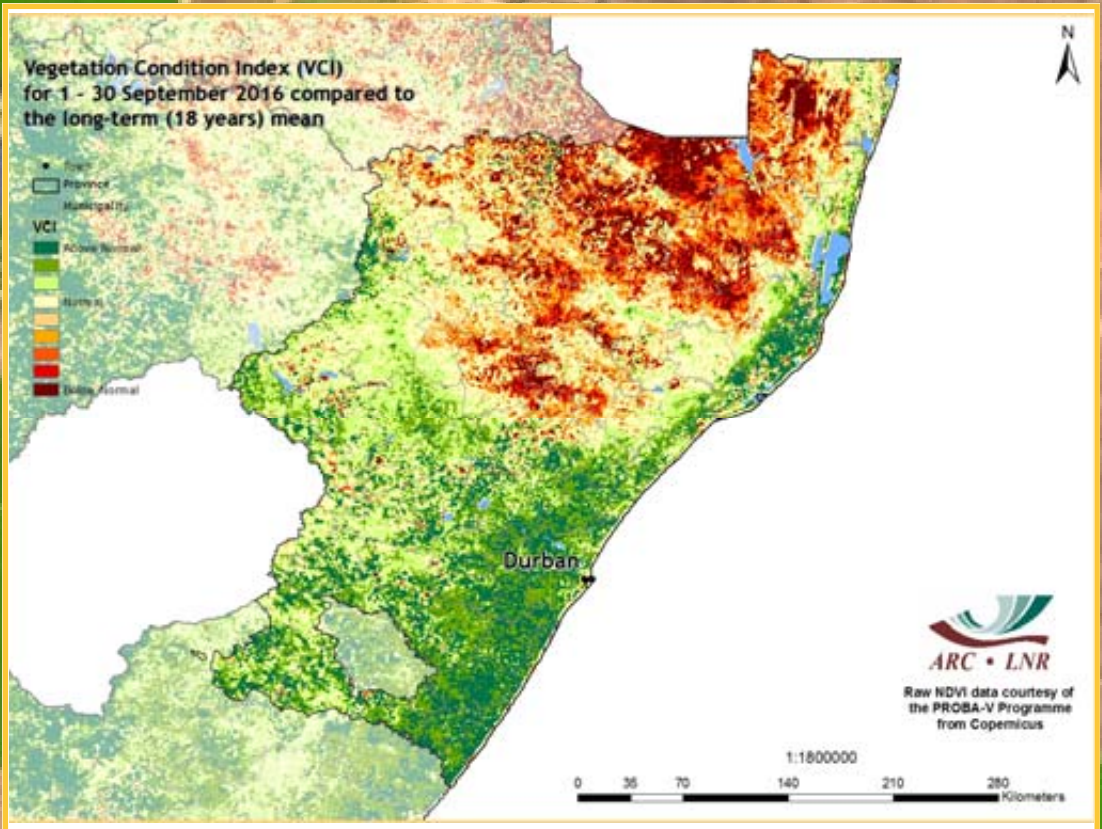

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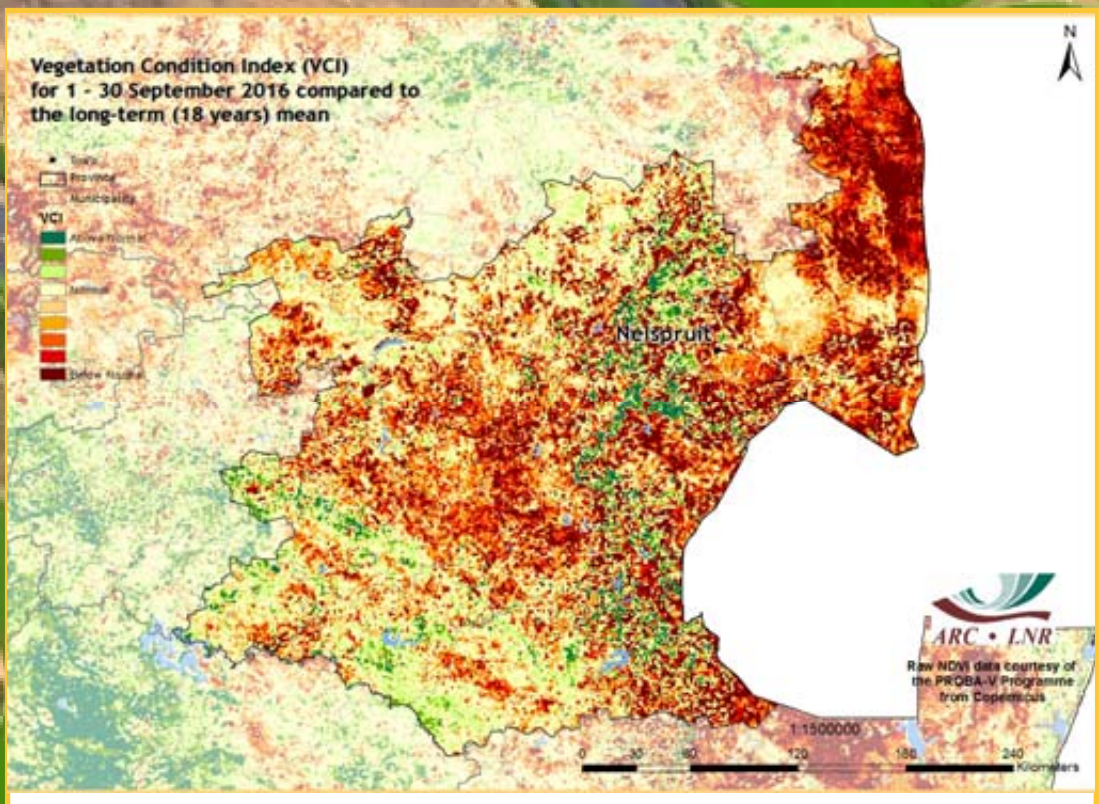

Figure 19

Figure 18:
The VCI map for September indicates below-normal vegetation activity over the northern parts of KwaZulu-Natal, with the exception of the coastal belt.

Figure 19:
The VCI map for September indicates below-normal vegetation activity over most parts of Mpumalanga.

Questions/Comments:
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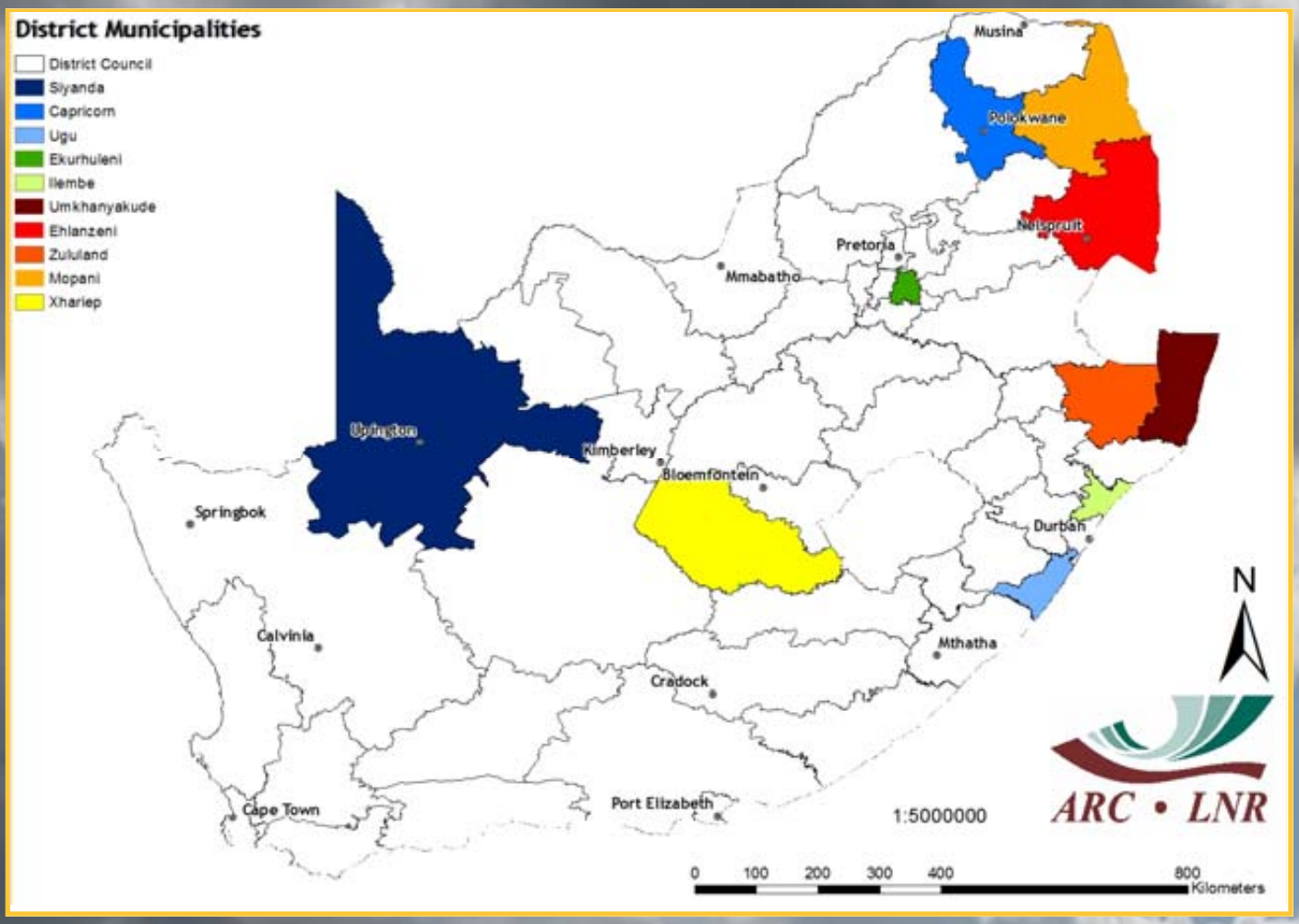
7. Vegetation Conditions & Rainfall

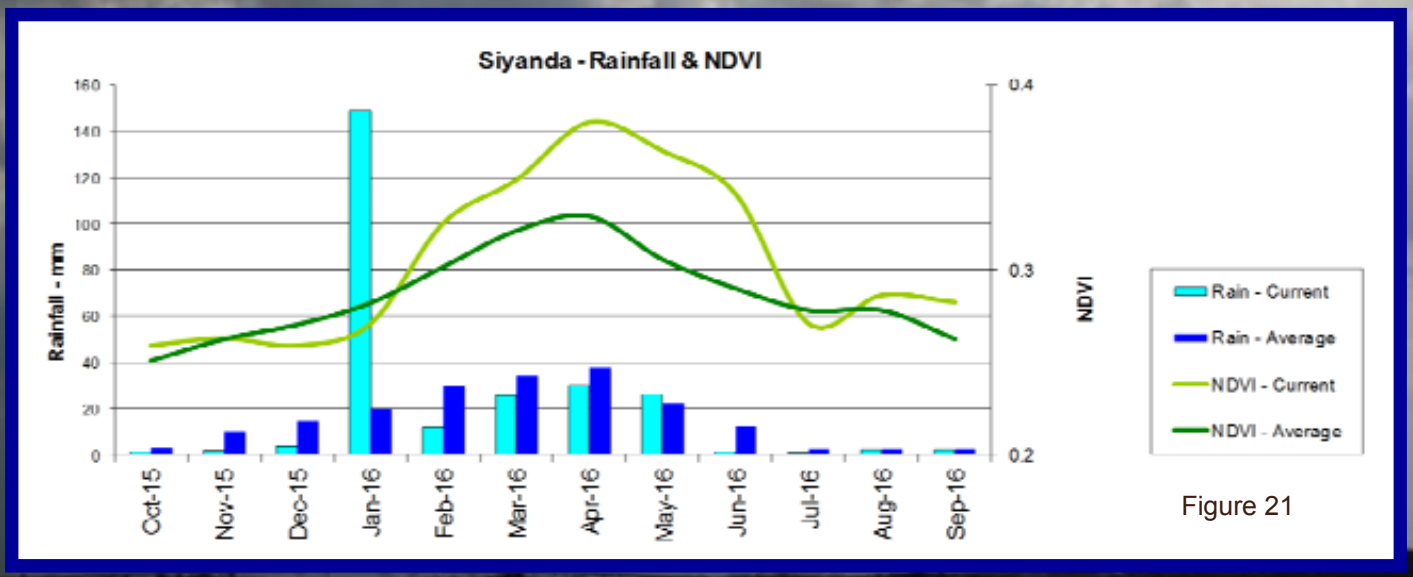


NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for September 2016. The district colour matches the border of the corresponding graph.

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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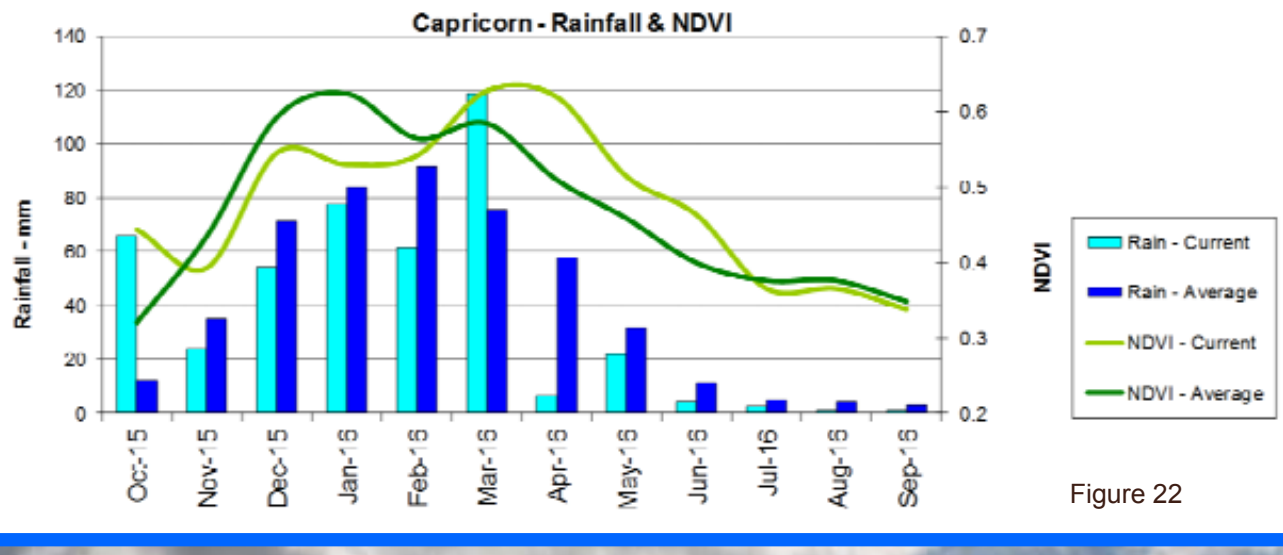

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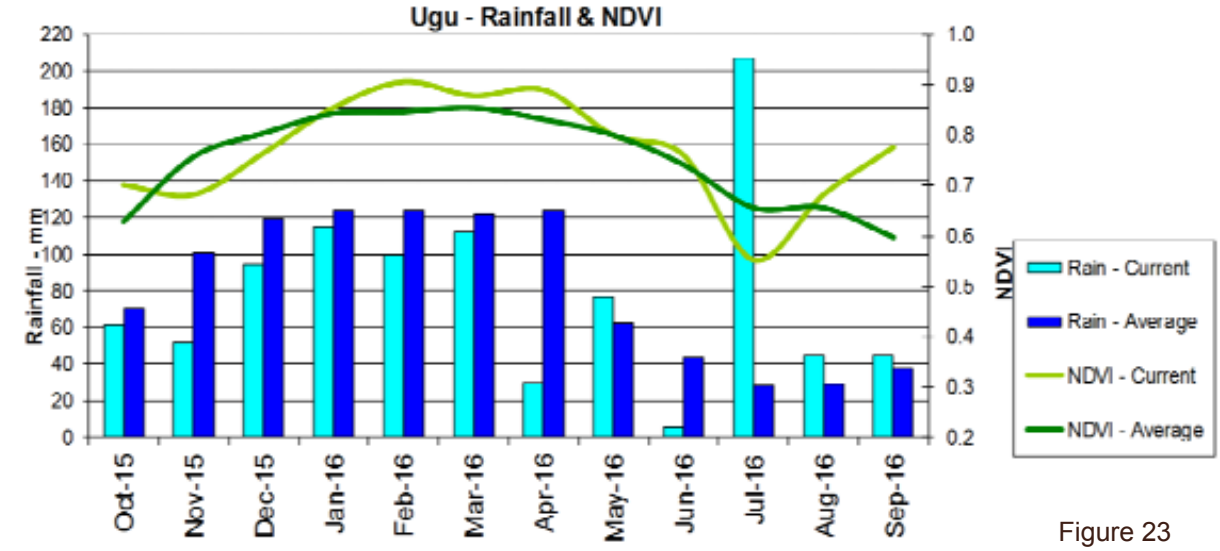

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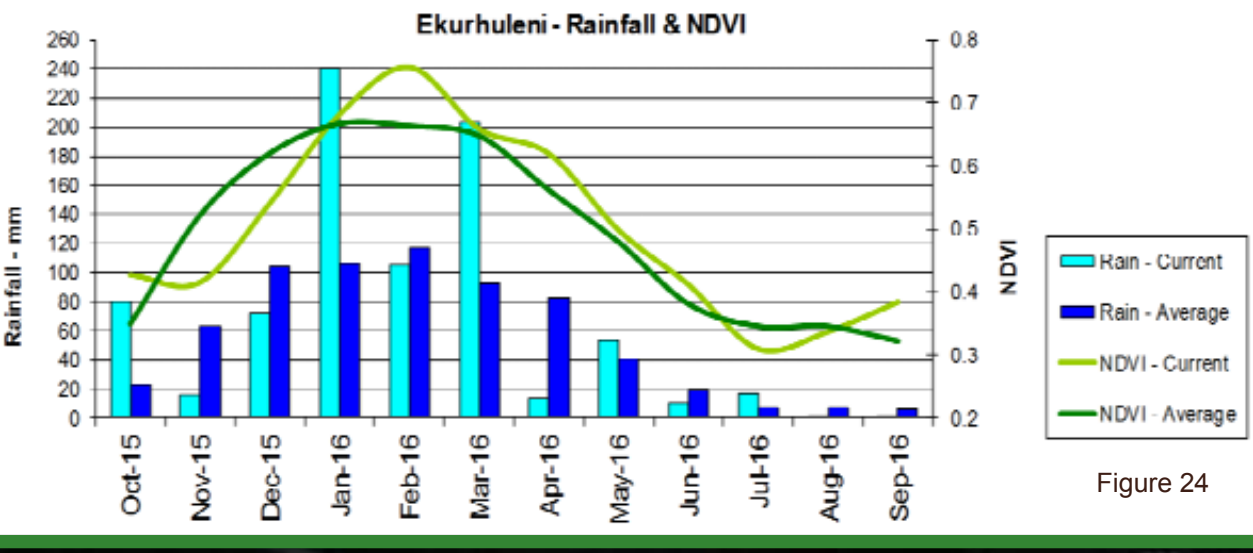

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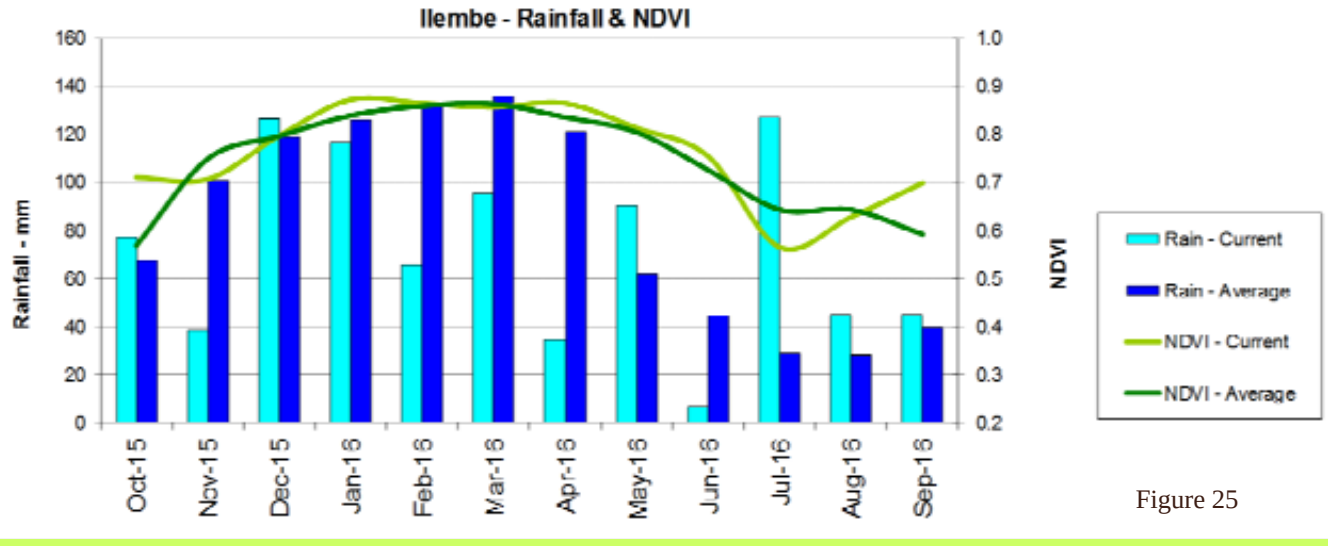

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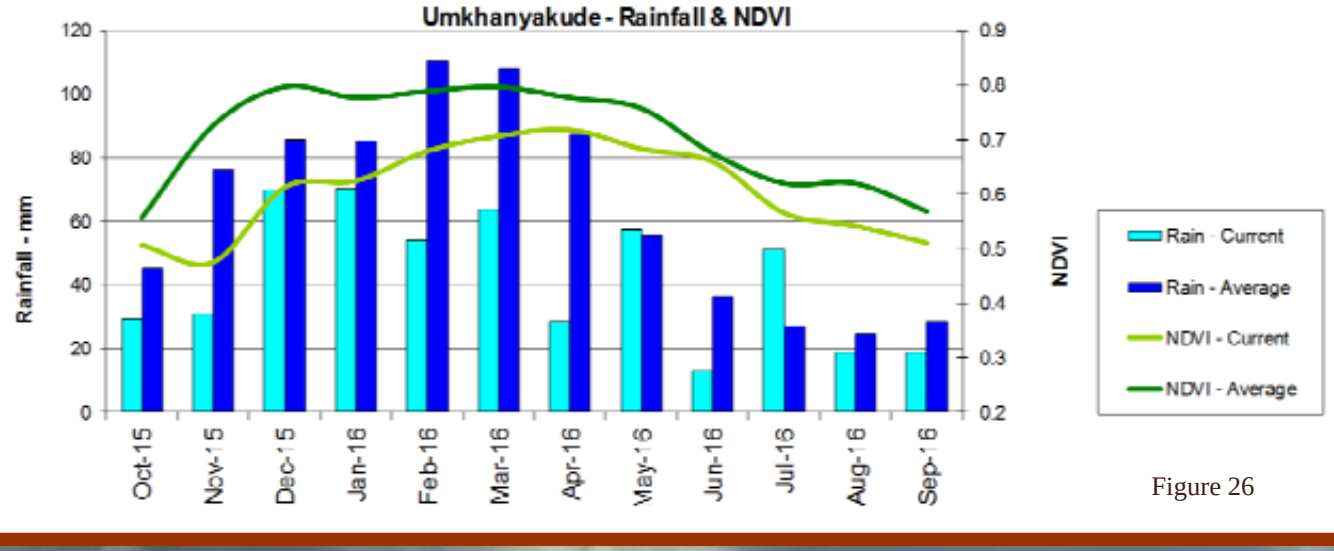

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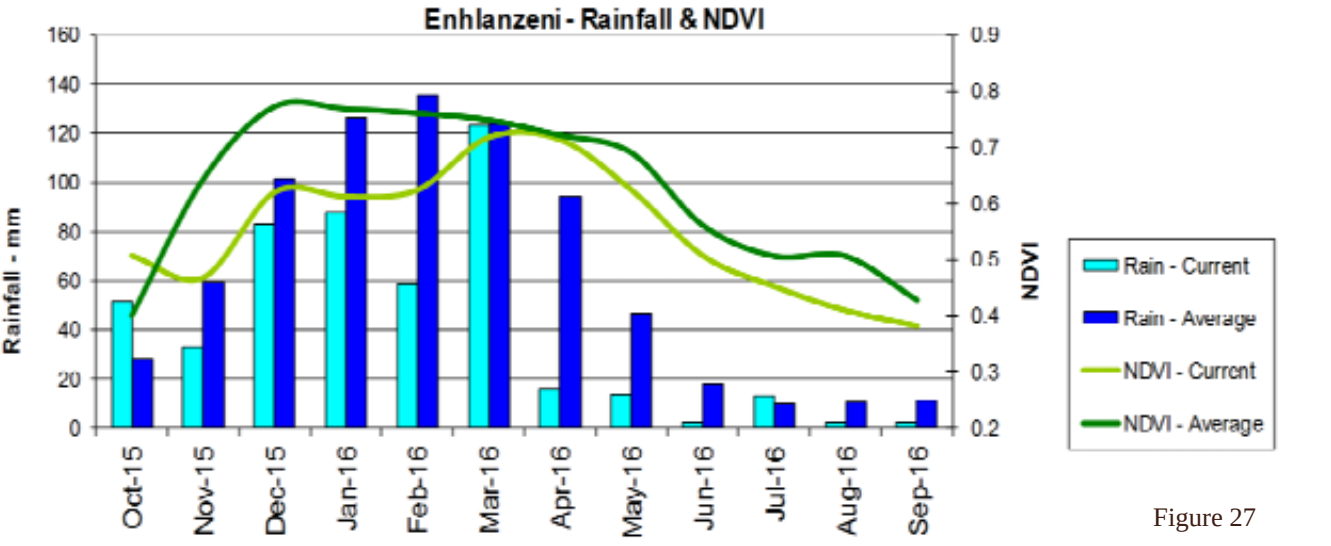

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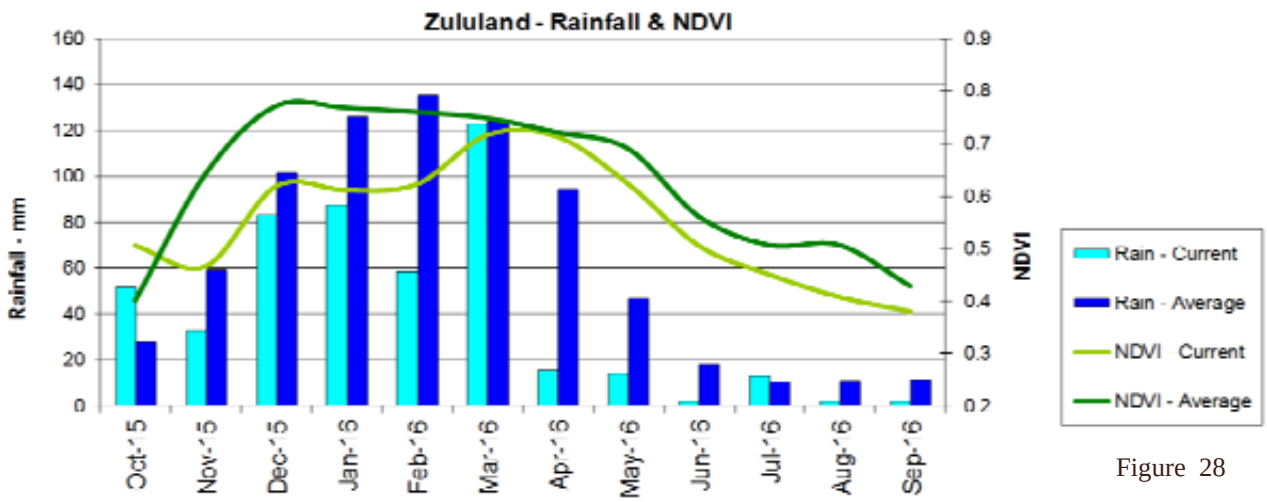

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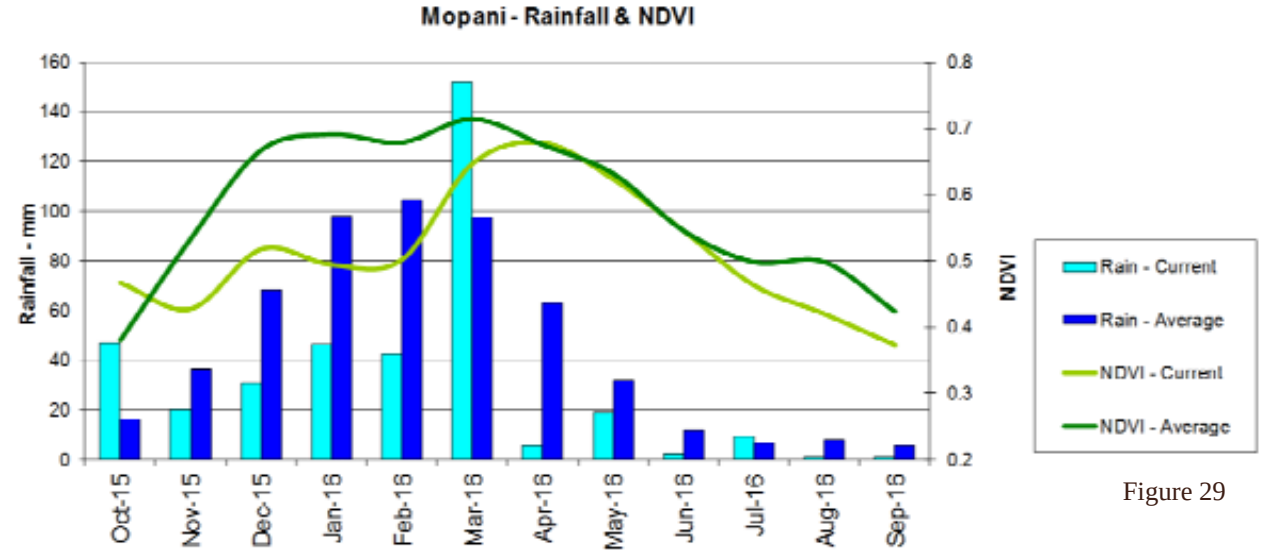

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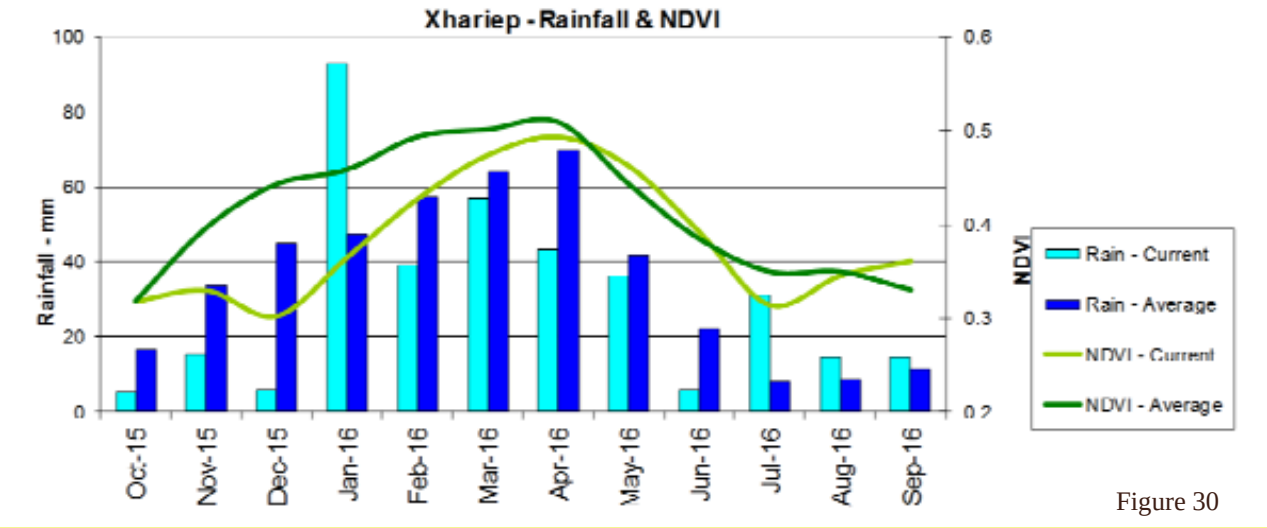

Figure 30

8. Soil Moisture

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

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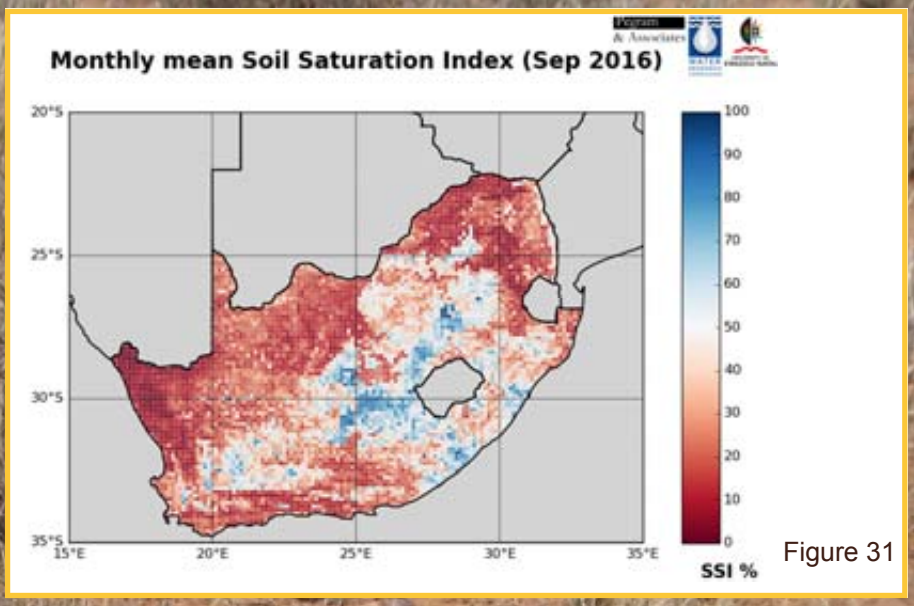

Figure 31

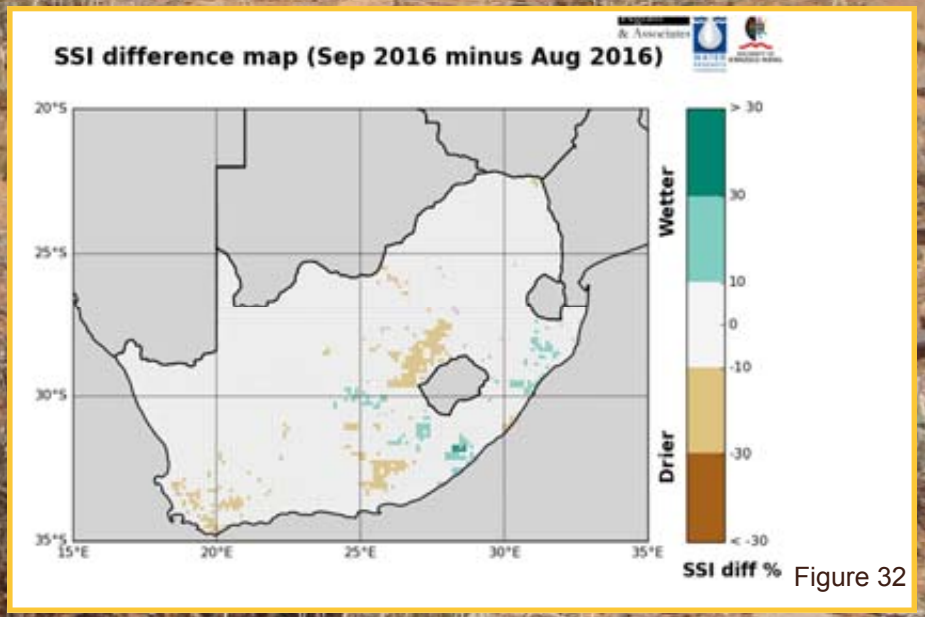

Figure 32

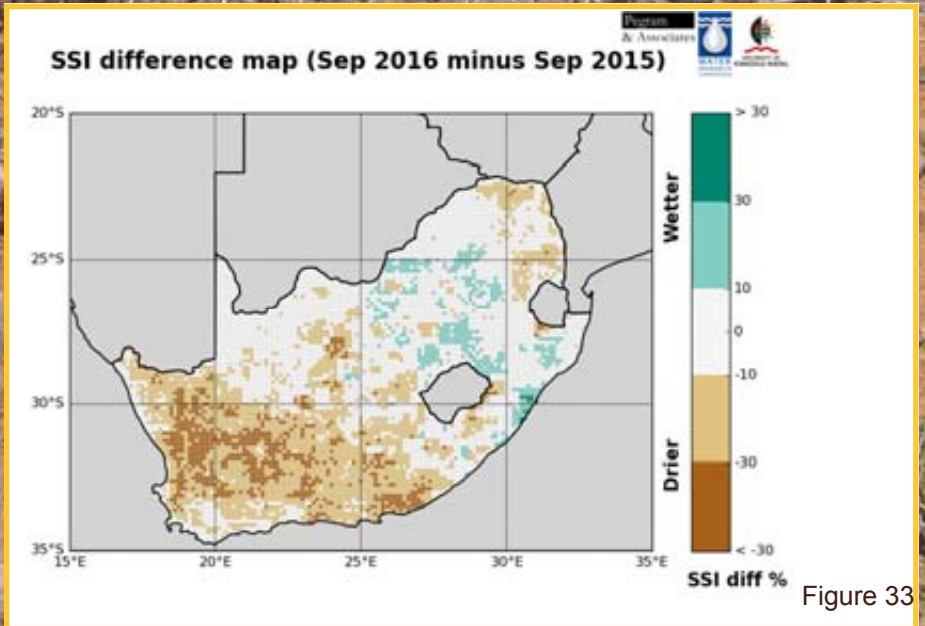

Figure 33

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 September 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.

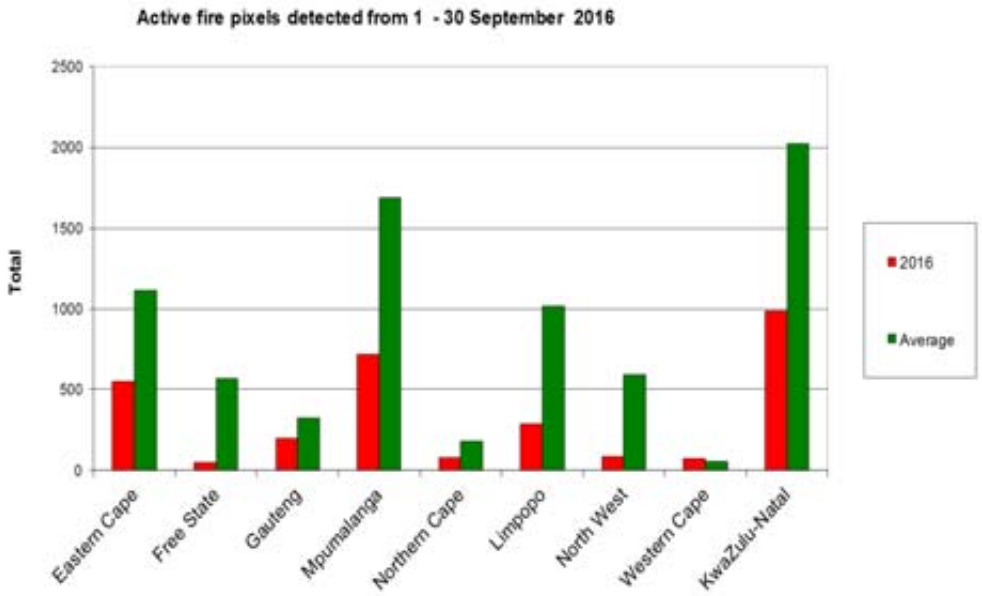

Figure 34

Figure 35:
The map shows the location of active fires detected between 1-30 September 2016.

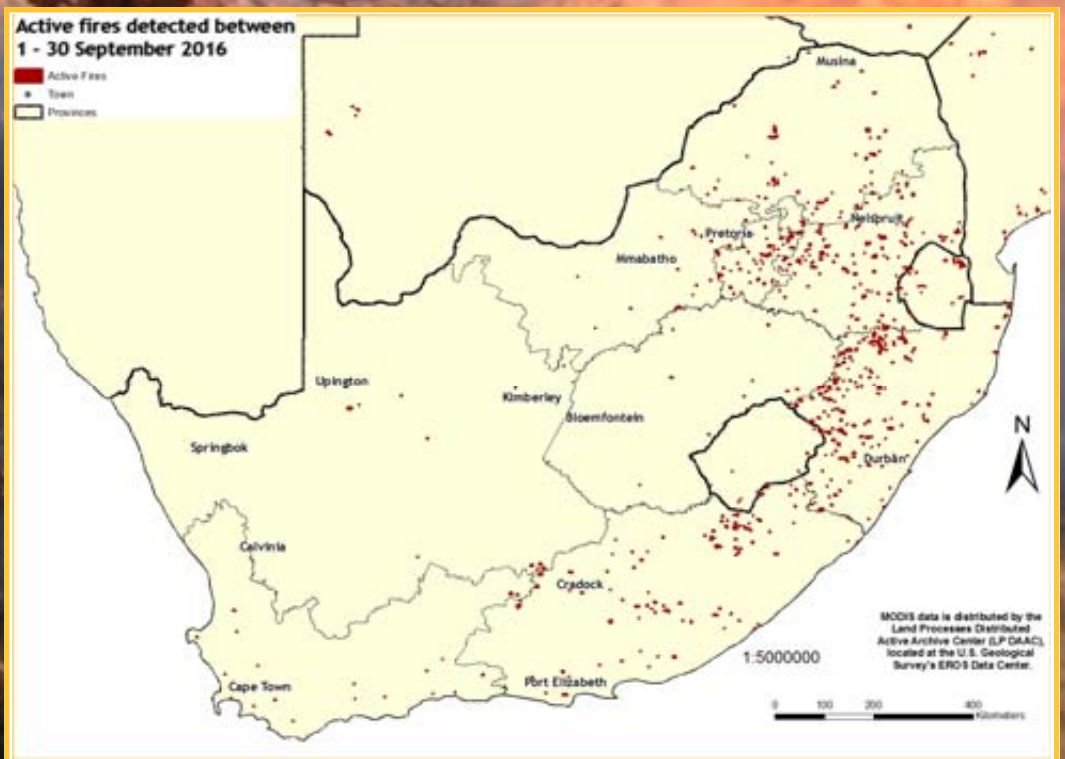

Figure 35

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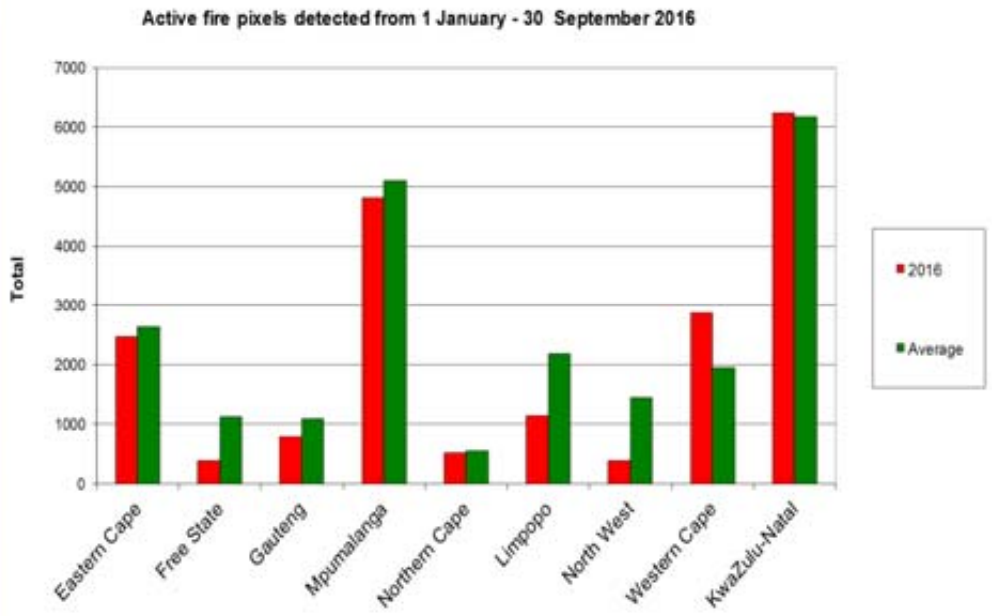

Figure 36

Figure 36:
The graph shows the total number of active fires detected from 1 January - 30 September 2016 per province. Fire activity was lower in all provinces except the Western Cape and KwaZulu -Natal compared to the average during the same period for the last 16 years.

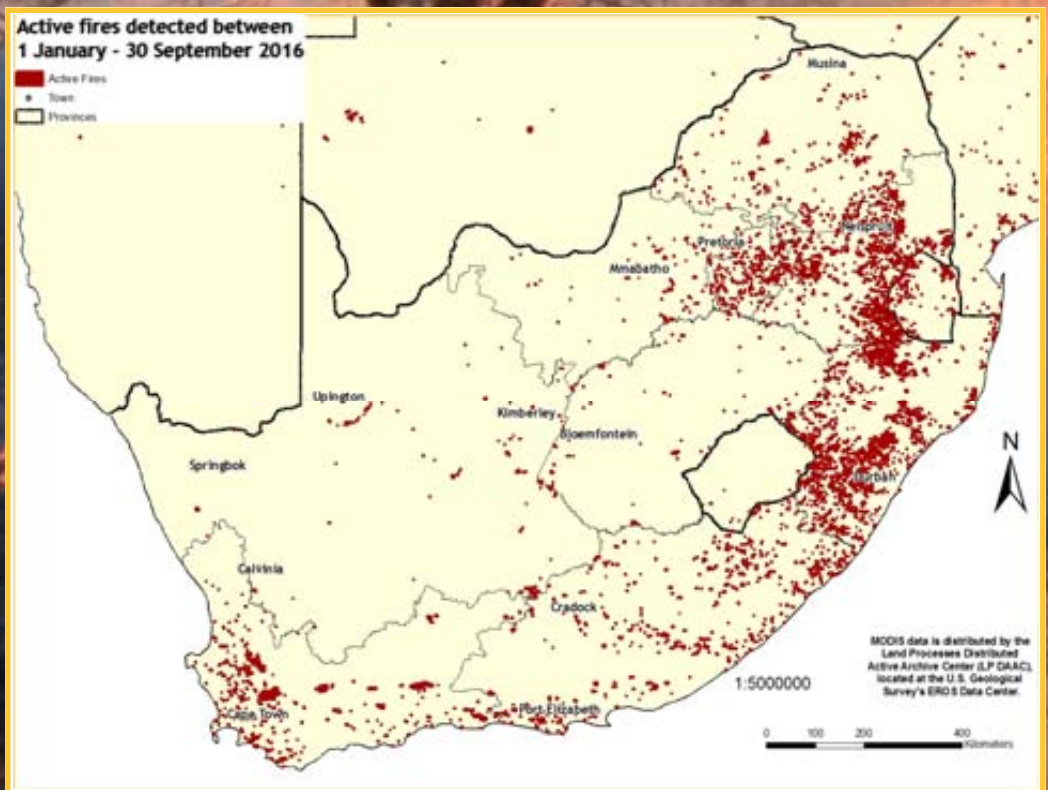

Figure 37

Figure 37:
The map shows the location of active fires detected between 1 January - 30 September 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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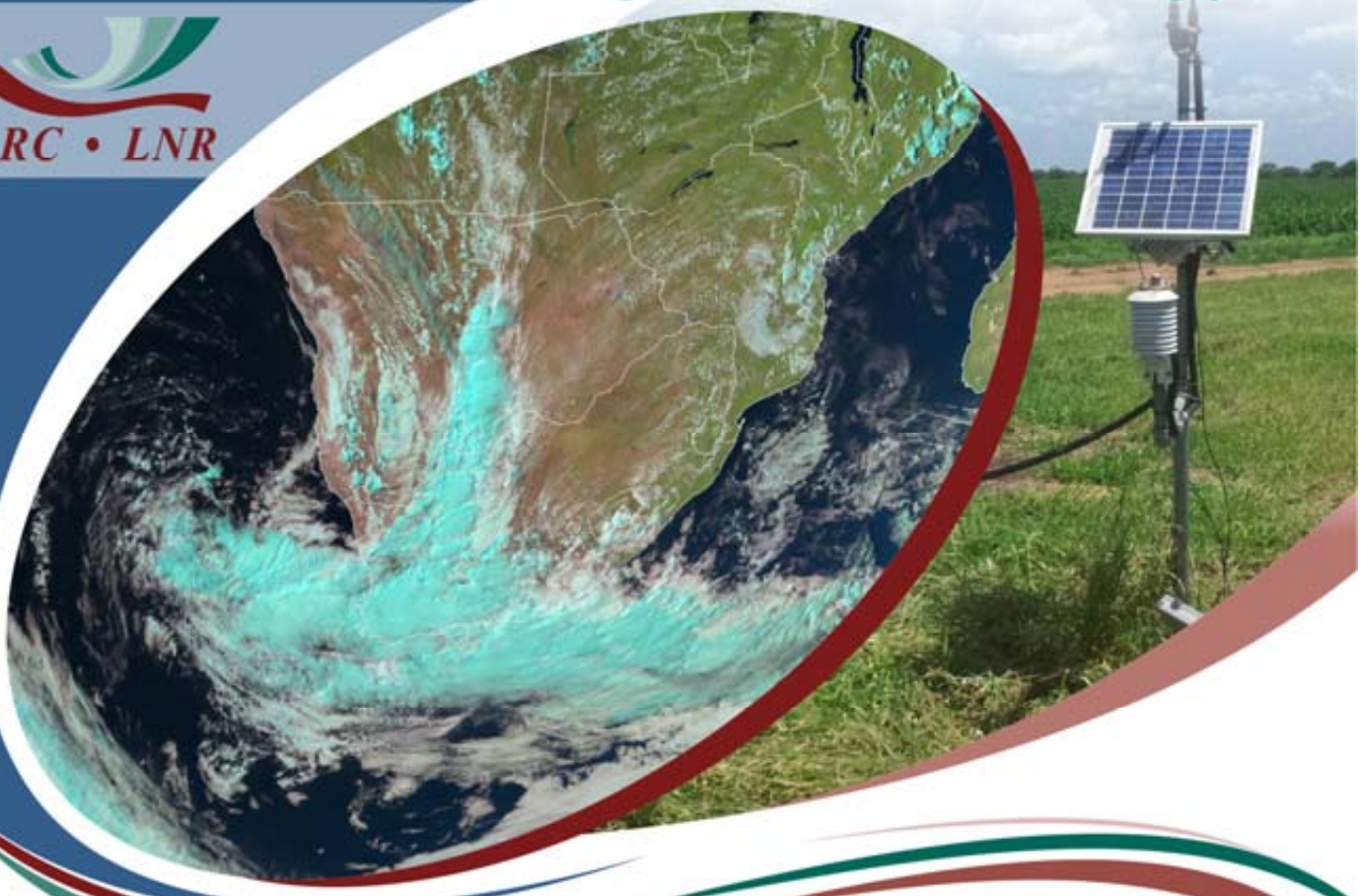
Agrometeorology

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