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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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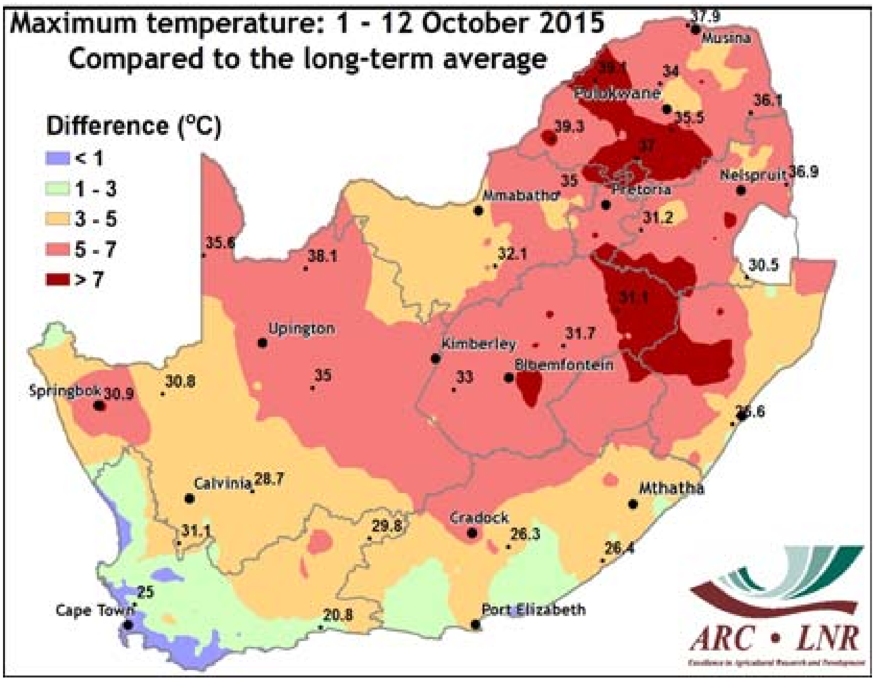
136th Edition

Images of the Month

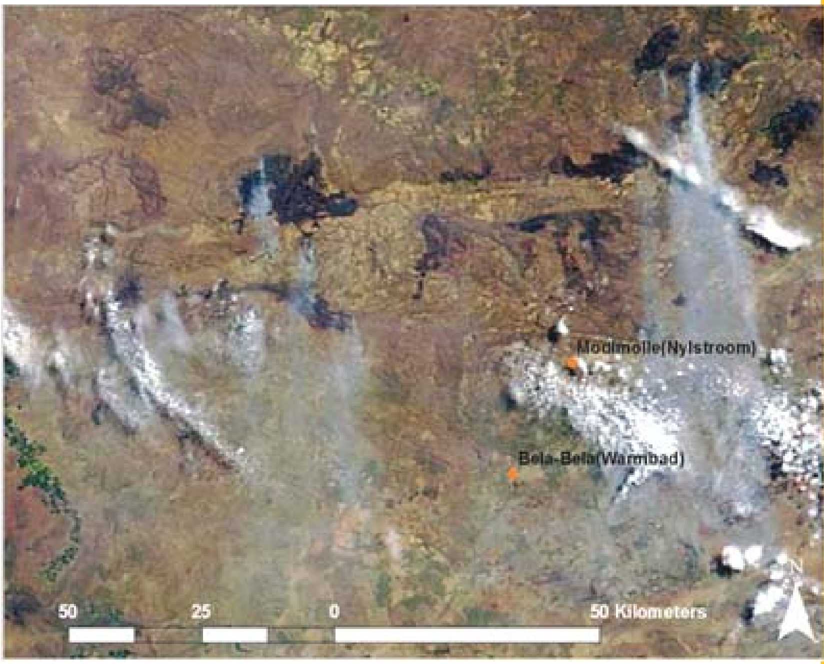


Heatwave conditions in early October

Hot conditions dominated across the interior during the first few days of October 2015. Temperatures over most of the interior exceeded the long-term average maximum temperature for October by at least 5 °C on average during the first 12 days. The map is an interpolation of maximum temperature data collected through the ARC-ISCW automatic weather station network, comprising 400 operational stations across the country. Average maximum temperatures for the period are indicated at selected stations on the map.

Anticyclonic circulation patterns over southern Africa resulted in the high temperatures over the interior with northerly to northwesterly winds dominating. Such extremely hot and dry conditions during October are not necessarily an indication of a hot and dry summer to follow. The hot conditions with little to no precipitation have, however, resulted in unfavourable conditions over the eastern maize production region where the planting window is nearing its end. Temperatures have decreased significantly since the 12th with some thundershowers over the interior.

The heatwave conditions in early October with fairly strong northerly winds resulted in the development and spread of wild fires over some parts of the summer rainfall region, despite earlier above-normal rainfall during September. Some of the fires were ignited by lightning. The Terra/MODIS true-colour composite for the 11th shows large burn scars (dark areas) and the smoke plumes (fuzzy north/south aligned plumes, not to be confused with the bright white clouds) from the active fires over the southern parts of the Waterberg in southern Limpopo. Thousands of hectares of vegetation were burnt during this event.



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:

Early spring rain occurred over large parts of the summer rainfall region, particularly during the first few days of September in the northeast and later over the central interior. Rainfall over the Swartland was disappointingly low again as circulation patterns favoured above-normal rain over the southern to southeastern parts of the country while the southwestern and western winter rainfall region remained largely dry. Temperatures across the interior were mostly above normal, but lower over the southern and southewestern parts due to frequent influences from frontal systems and strong ridges to the south, feeding colder air into the southern parts from time to time.

Widespread heavy rain occurred over the southern parts on the first day of the month, in association with an upper-air trough and a strong onshore flow from the south. As during previous months, most of the activity in the south was to the east of the western winter rainfall region. As the strong anticyclone ridged around the country, a secondary upper-air development took place over southern Namibia, where a cut-off low developed. The system was responsible for most of the month's rainfall over the northeastern parts, resulting in widespread rain and thundershowers, with low temperatures from the 3rd to the 5th. Many stations in the northeast recorded totals in excess of 50 mm, surpassing the long-term monthly mean for September several times in some areas. The cold influx from the south during the beginning of the event resulted in light frost in some areas of central South Africa by the 3rd before warmer air from the east replaced the cold air mass.

Conditions over the interior had cleared by the 6th and somewhat more stable conditions followed. By the 11th, a strong ridge to the south resulted in another influx of cold air over the southern parts while widespread rain occurred along the coastal belt and adjacent interiors of KwaZulu-Natal and the Eastern Cape.

The deepening of an upper air trough over the western parts, together with large amount of moisture from the east, resulted in scattered thundershowers over many central to southeastern parts from the 17th to the 22nd.

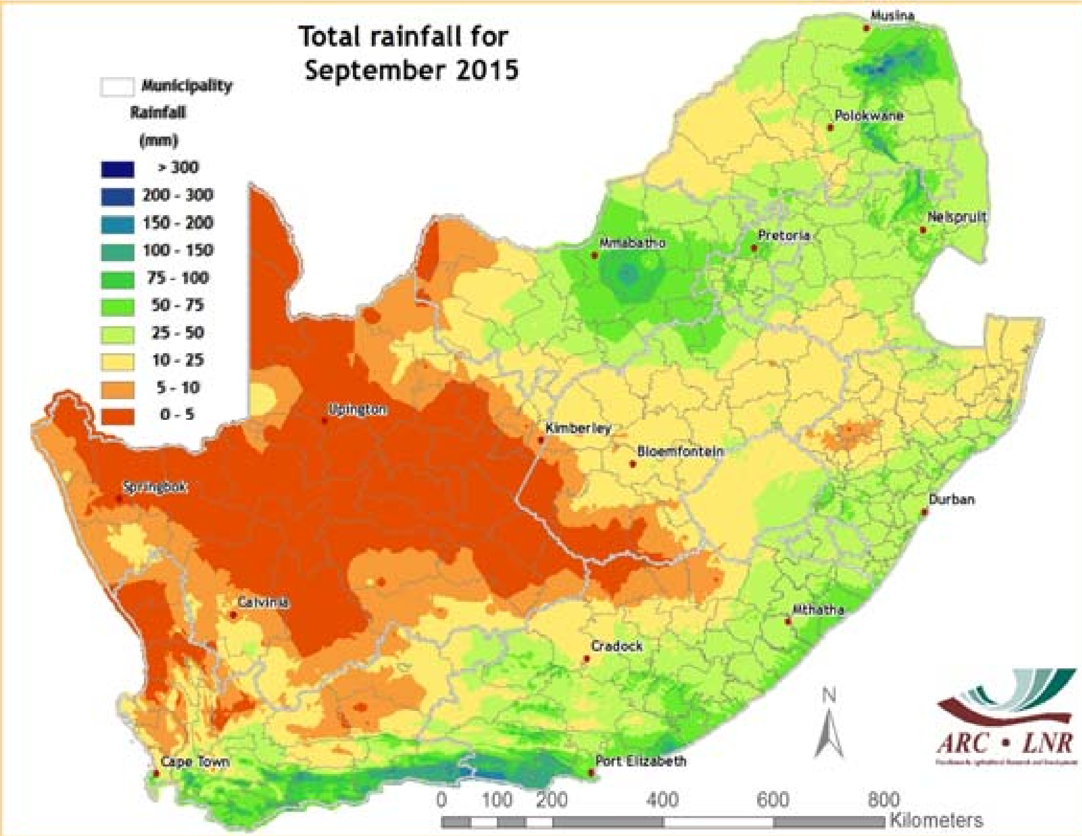


Figure 1

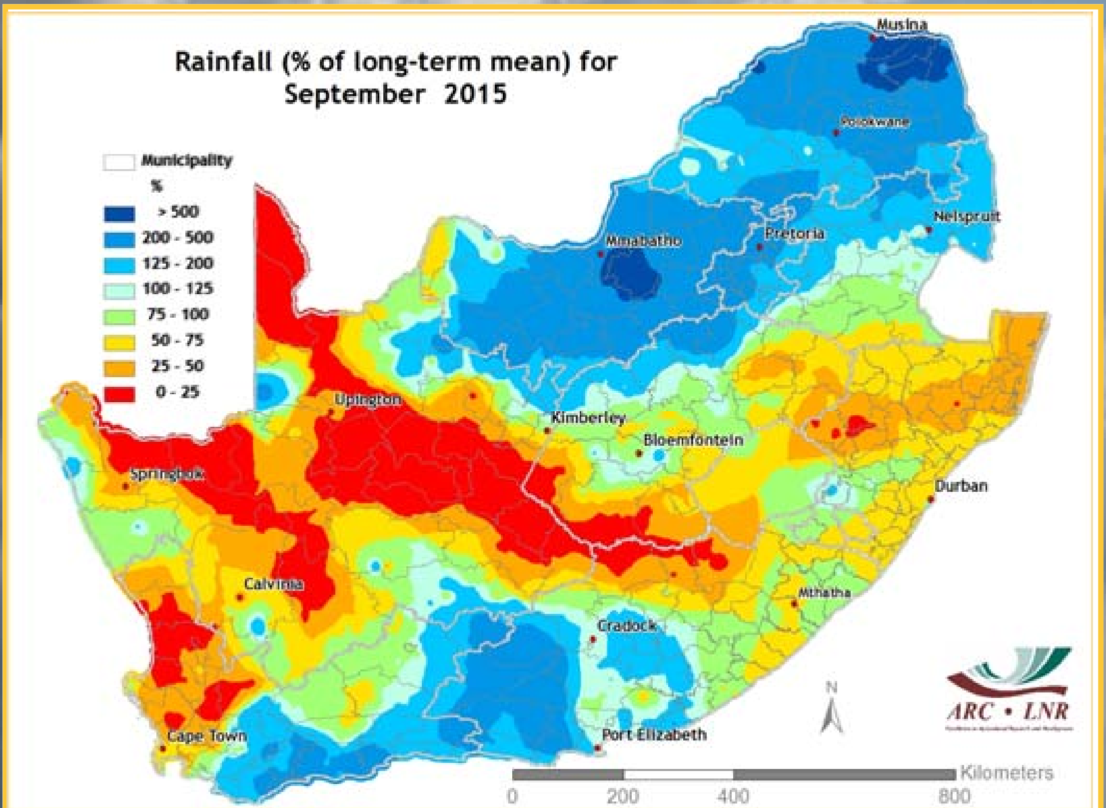


Figure 2

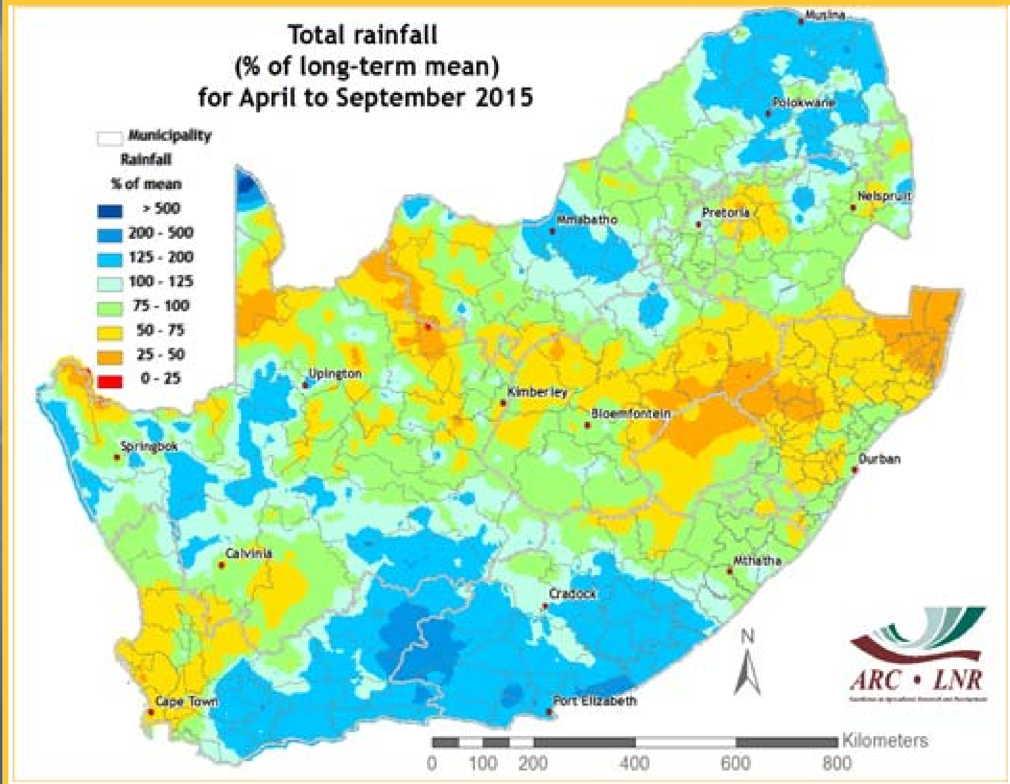


Figure 3

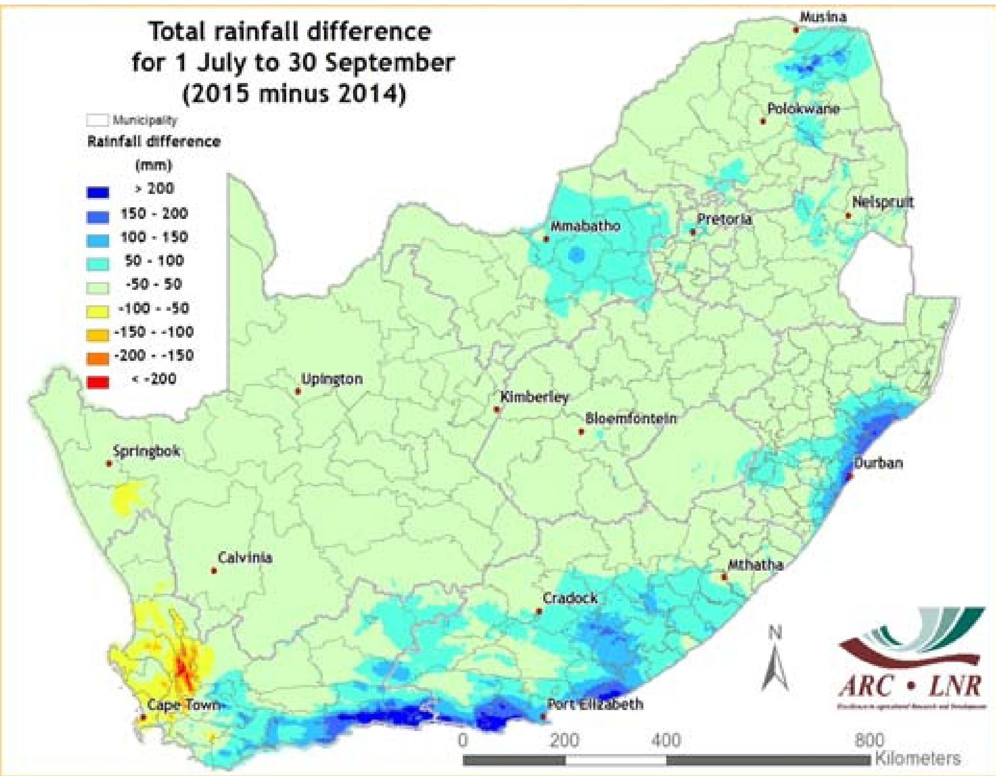


Figure 4

Some light showers also occurred over the western winter rainfall region, due to frontal activity, but falls were light. Widespread rain occurred along the southern to eastern coastal belts also due to strong ridging by the Atlantic Ocean anticyclone. Low-level moisture resulted in widespread rain and showers over much of the Eastern Cape and KwaZulu-Natal. Rainfall totals over parts of the Free State and North West exceeded 20 mm over many areas, in association with the system. Drier conditions followed.
During the last few days of the month a frontal system again resulted in lower temperatures in the south with rain mostly over the southern parts. An onshore flow together with an upper air trough associated with the cold front again resulted in significant showers and thundershowers towards the south of the country while falls in the west were light. As the upper air trough moved across the country, isolated to scattered thundershowers occurred over the central to northeastern parts during the last few days of September into early October.

Figure 1:
Most of the country received some rain during September. In the summer rainfall region the highest falls occurred over central North West and northeastern Limpopo, where totals exceeded 75 mm at several locations and even 100 mm in some places The western parts of the winter rainfall region were mostly dry while the eastern parts (from the Boland eastwards) received between 25 and 75 mm. The highest falls occurred along the Garden Route where some places recorded in excess of 150 mm.

Figure 2:
The northern and northeastern interior as well as the southern parts of the country received above-normal rainfall, with some places in North West and Limpopo receiving more the 500% of the long-term mean.

Figure 3:
Rainfall over the southern parts of the country, into the central parts of the Northern Cape, has been above normal since April. This also applies to the northern to northeastern parts. Rainfall was below normal over the northern parts of KwaZulu-Natal and the western parts of the winter rainfall region, particularly the Swartland.

Figure 4:
The western parts of the winter rainfall region experienced much less rain during July to September this year than for the same period last year while the southern to eastern coastal areas, adjacent interior and the northeastern parts received significantly more rain.

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2. Standardized Precipitation Index

Standardized Precipitation Index

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

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

The current SPI maps (Figures 5-8) show that severe to extreme drought conditions occur over the southwestern parts of the winter rainfall region and northeastern KwaZulu-Natal while much of the southern parts of the country experiences moderately to severely or extremely wet conditions. At the 12-month time scale, severe drought occurs over a large part of northern KwaZulu-Natal and southeastern Mpumalanga as well as the southwestern parts of the winter rainfall region. At the 24-month time scale, moderately to severely wet conditions occur over the southern and northeastern parts of the country.

Questions/Comments:
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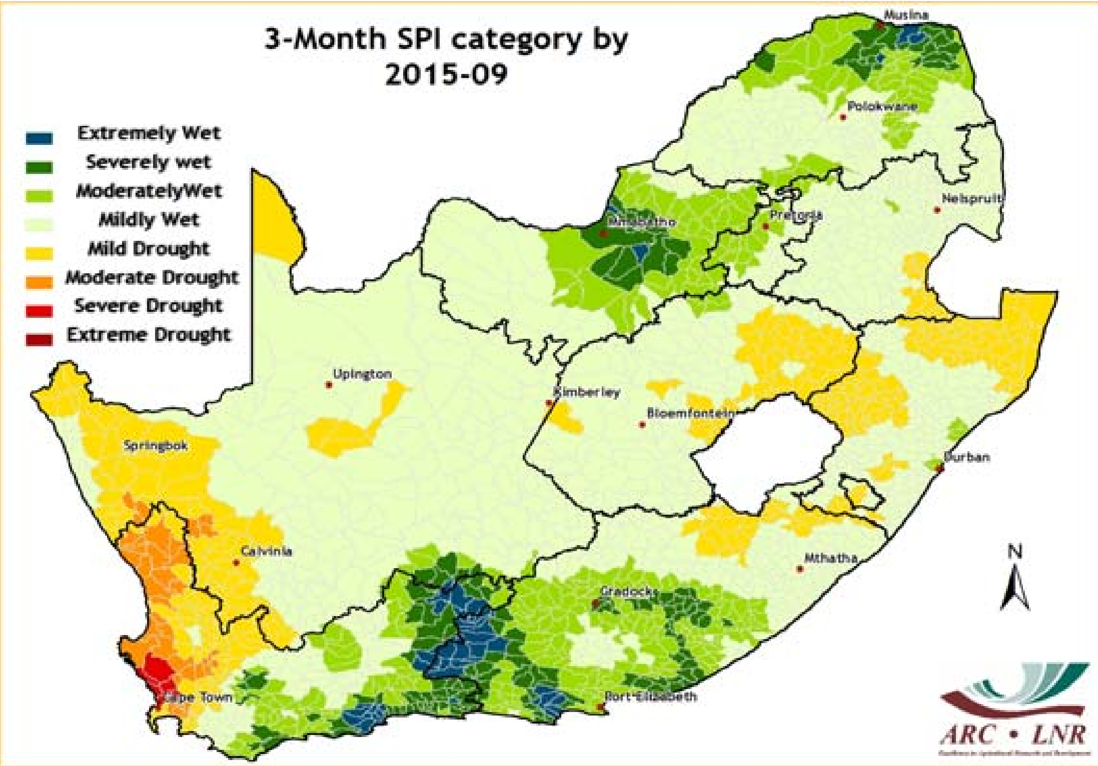

Figure 5

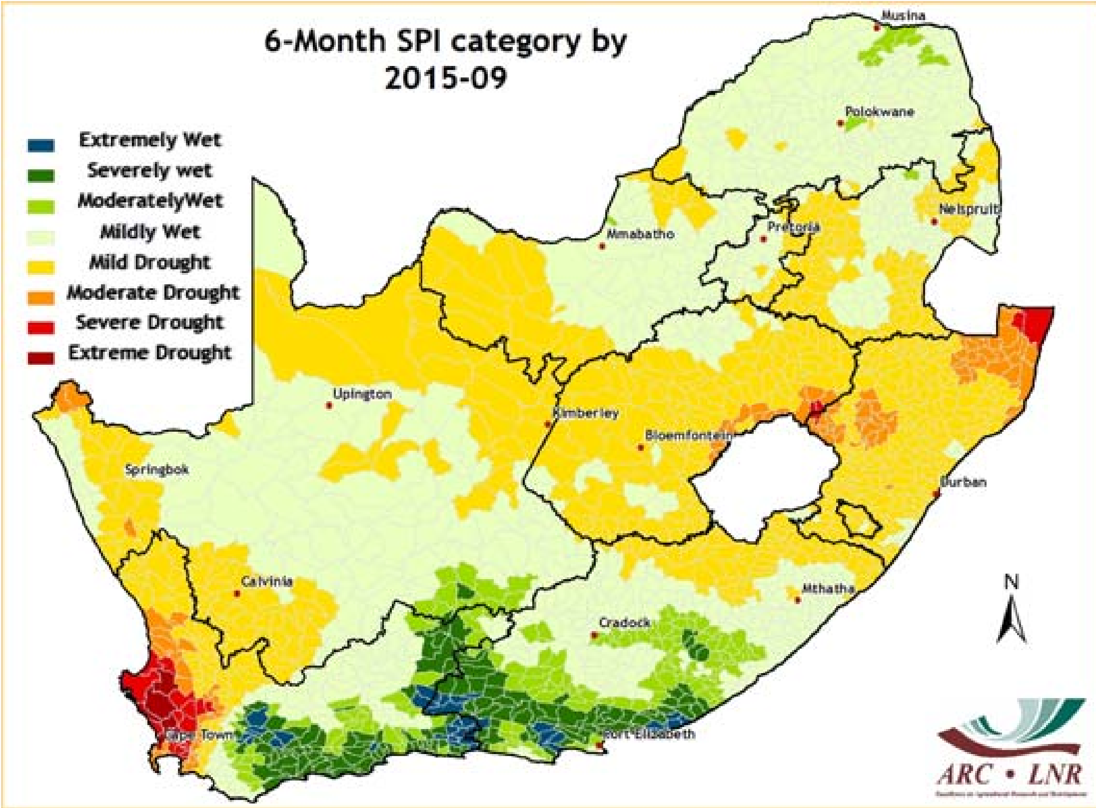

Figure 6

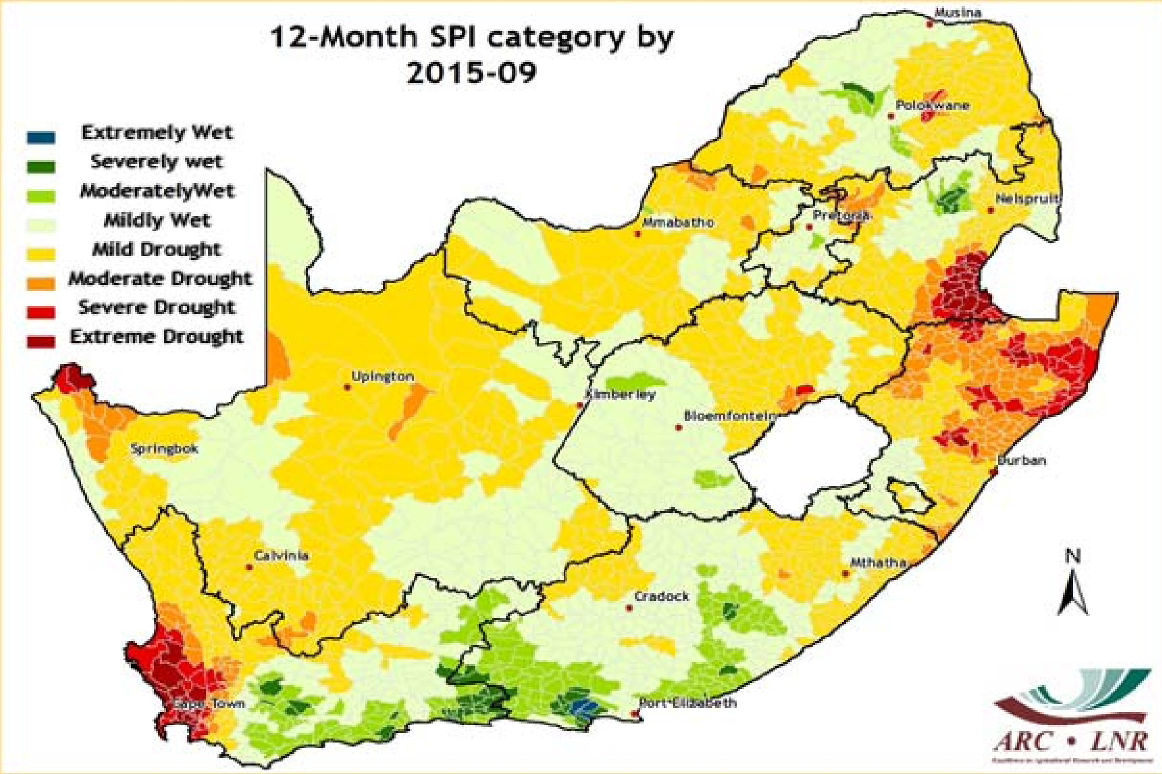

Figure 7

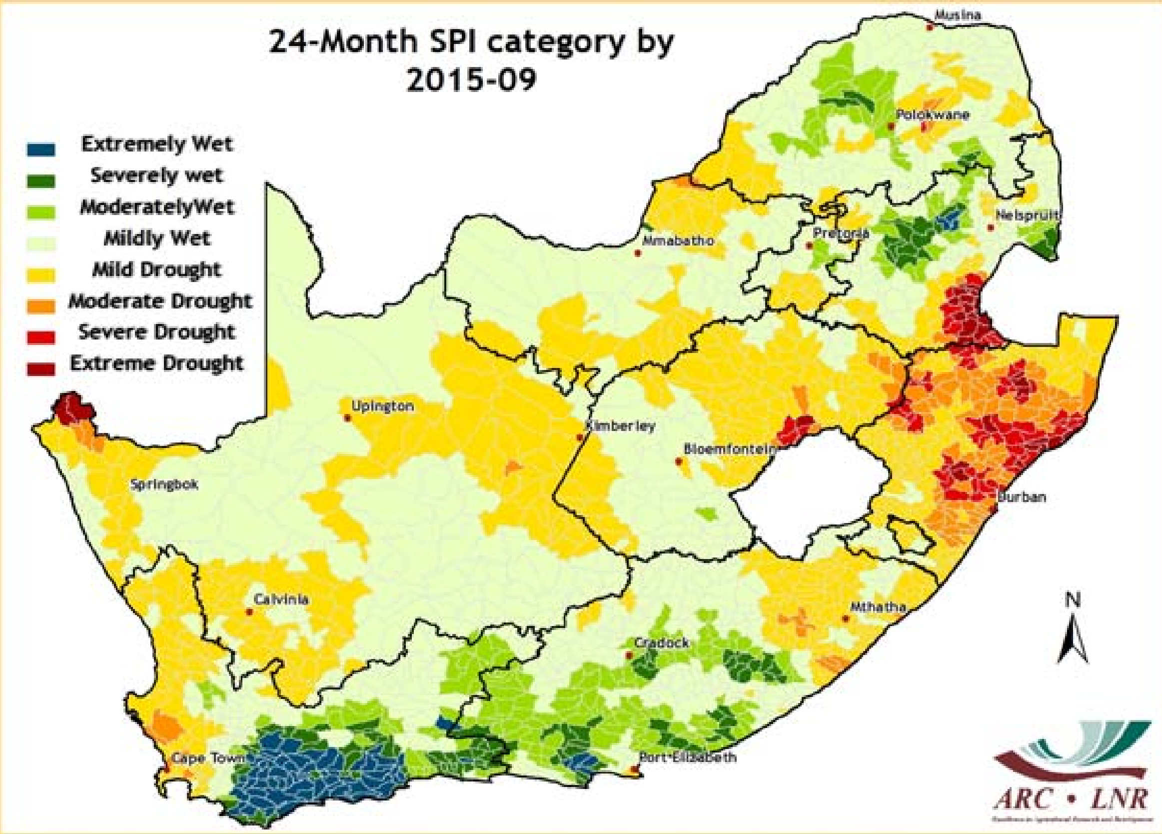

Figure 8

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.

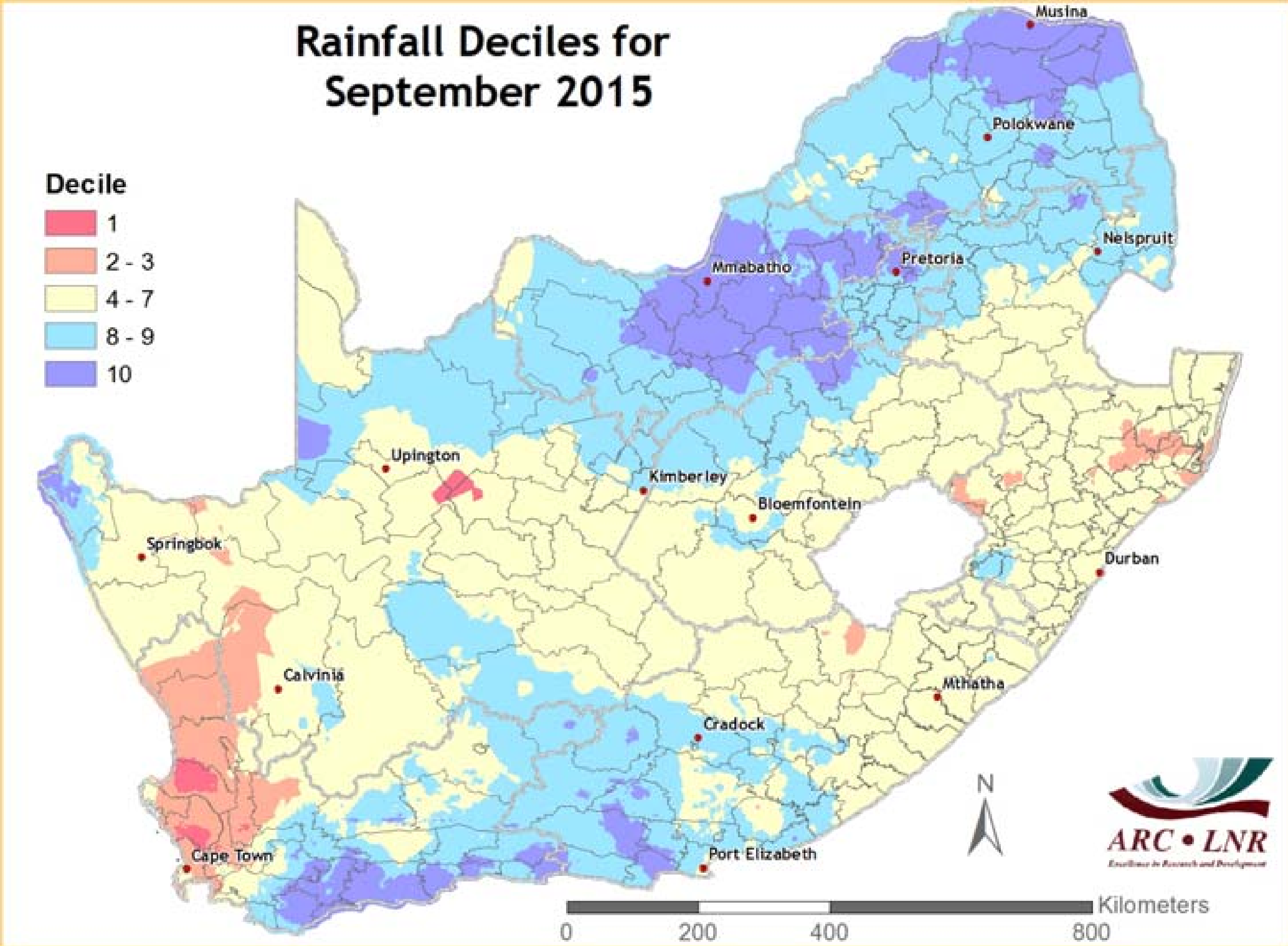

Figure 9

Figure 9:
Rainfall during September was significantly above normal over the northeastern parts as well as along the Garden Route and in the Karoo. The western winter rainfall region, including the Swartland, was exceptionally dry.

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4. Water Balance

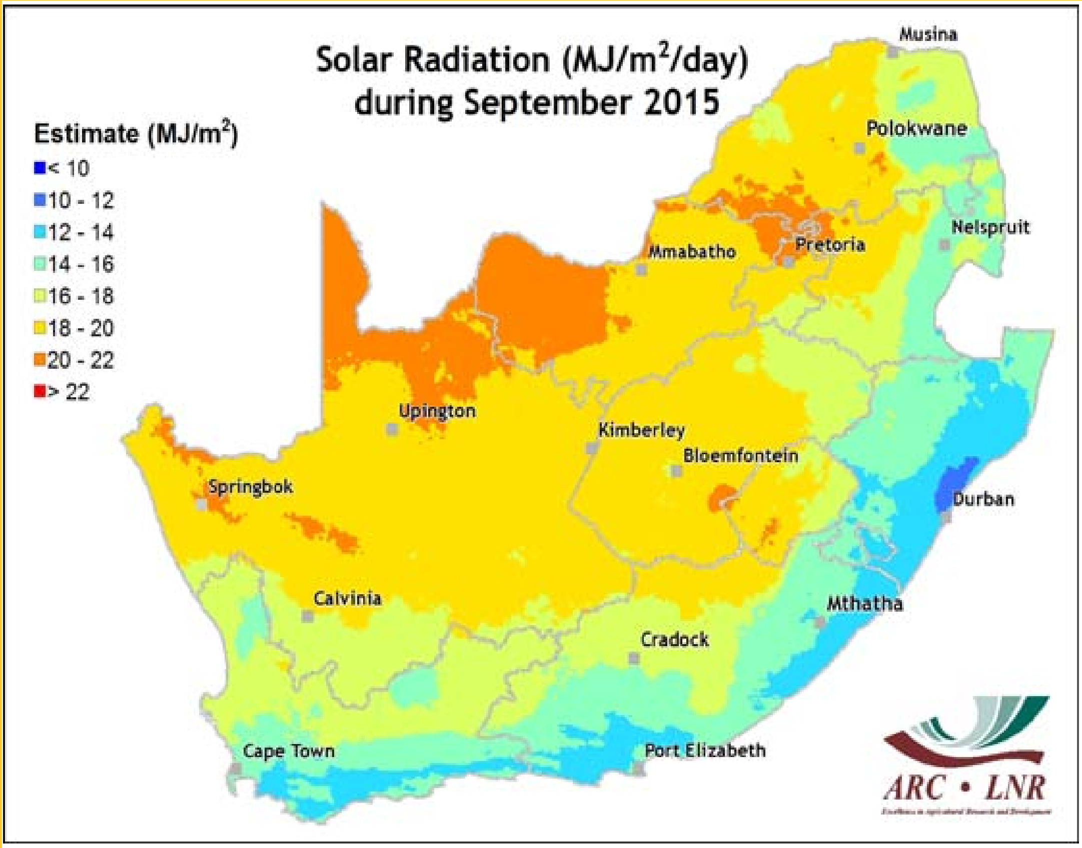

Figure 10

Solar Radiation

Daily solar radiation surfaces are created for South Africa by combining *in situ* measurements from the ARC-ISCW automatic weather station network with 15-minute data from the Meteosat Second Generation satellite.

Figure 10:
Solar radiation estimates remained low over the southern parts, but increased markedly over the northern parts in September.

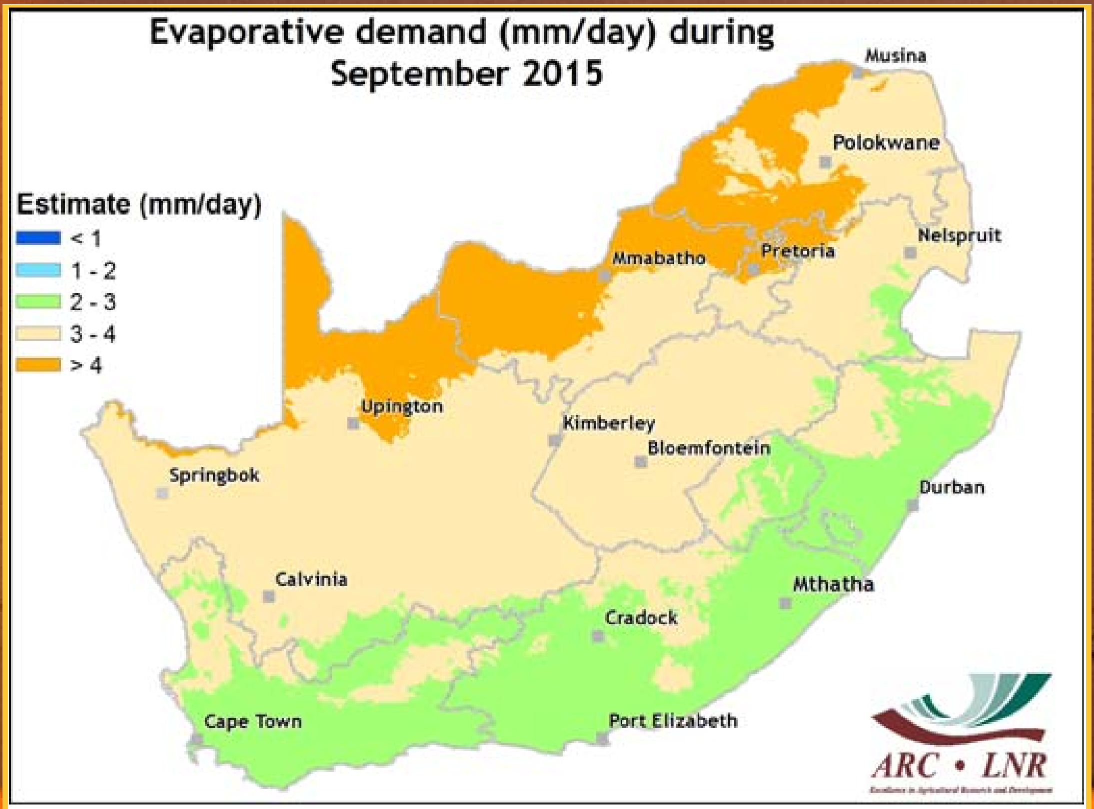

Figure 11

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:
Potential evapotranspiration remained low in the south but exceeded 4 mm/day over the northern interior in 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

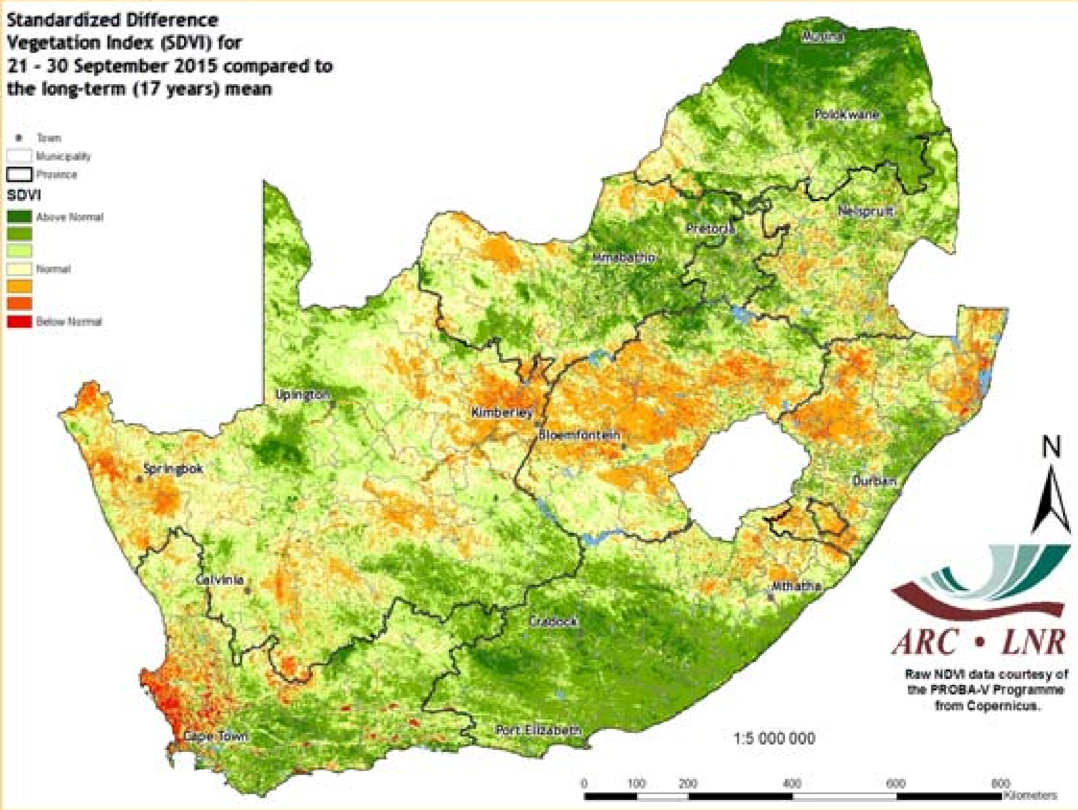
NDVI images describe the vegetation activity. A decadal NDVI image shows the highest possible "greenness" values that have been measured during a 10-day period.

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:
The SDVI indicates drought stress over the northern parts of KwaZulu-Natal, central Free State and western parts of the winter rainfall region, focusing on the Swartland.

Figure 13:
Vegetation activity increased over much of the summer rainfall region during September, related to higher temperatures and widespread rain. Large decreases in activity occurred over the winter rainfall region, associated with the ripening of grains (especially towards the south) or drought (especially towards the west).



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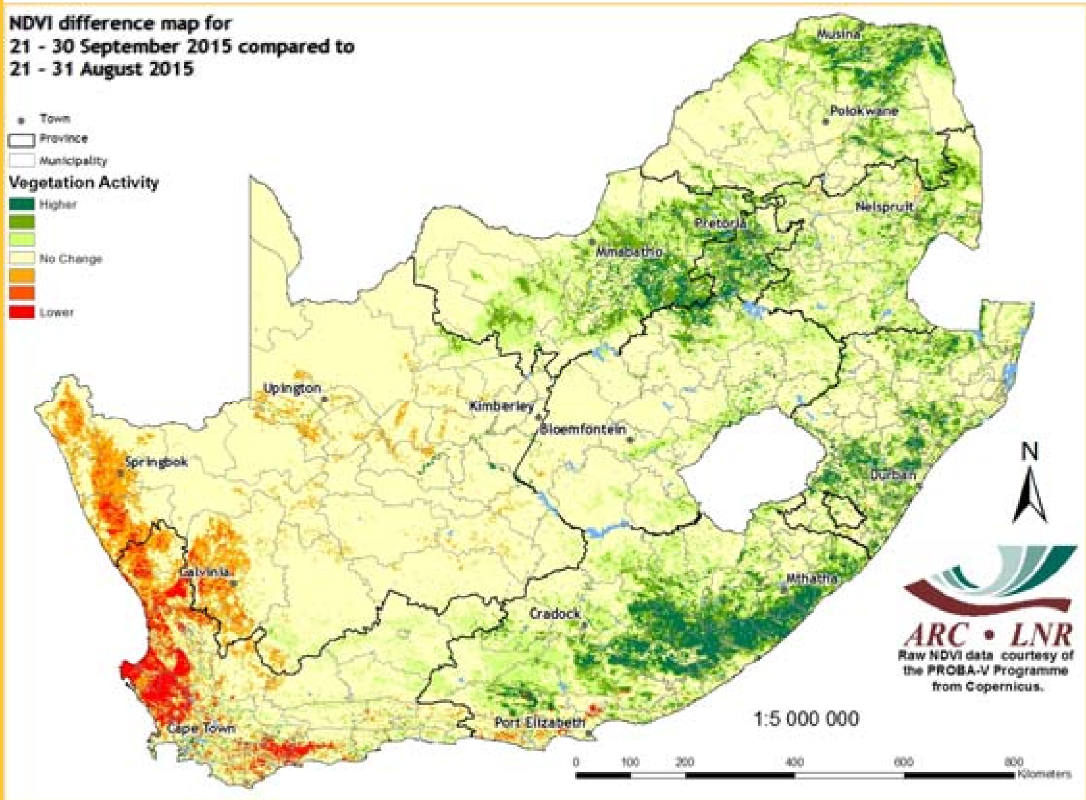

Figure 13

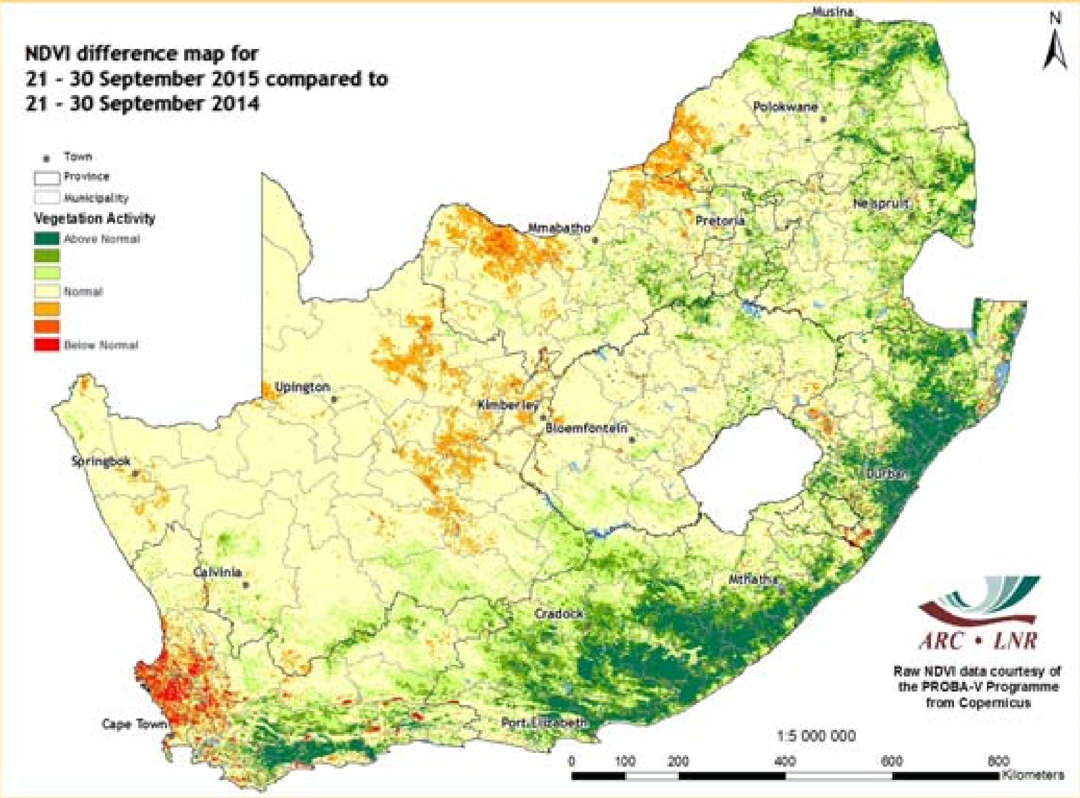

Figure 14

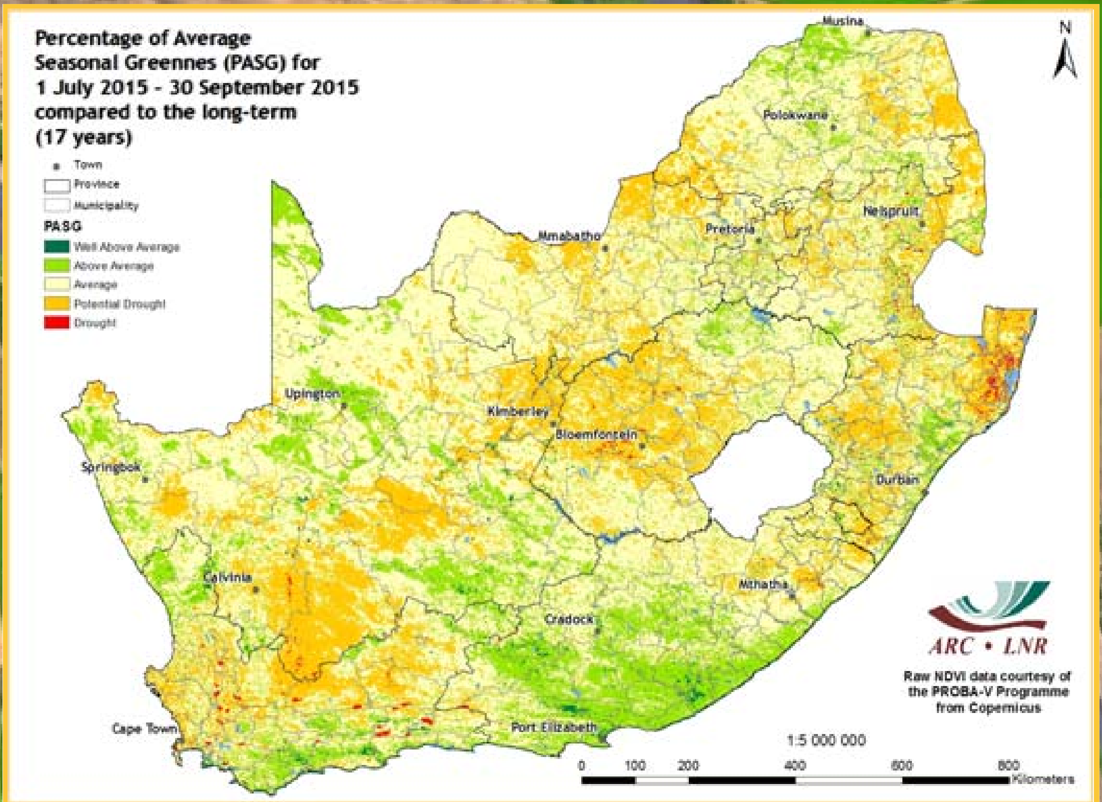

Figure 15

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:
Vegetation activity this year is higher over the southern and eastern parts relative to last year but lower over the western parts of the winter rainfall region as well as isolated areas in central South Africa.

Figure 15:
Cumulative vegetation activity is above normal over the southern and southeastern parts as well as parts of central to northern and northwestern Northern Cape and central Limpopo, Cumulative vegetation activity over the northern parts of the Western Cape into the western parts of the Northern Cape is below normal.

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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.

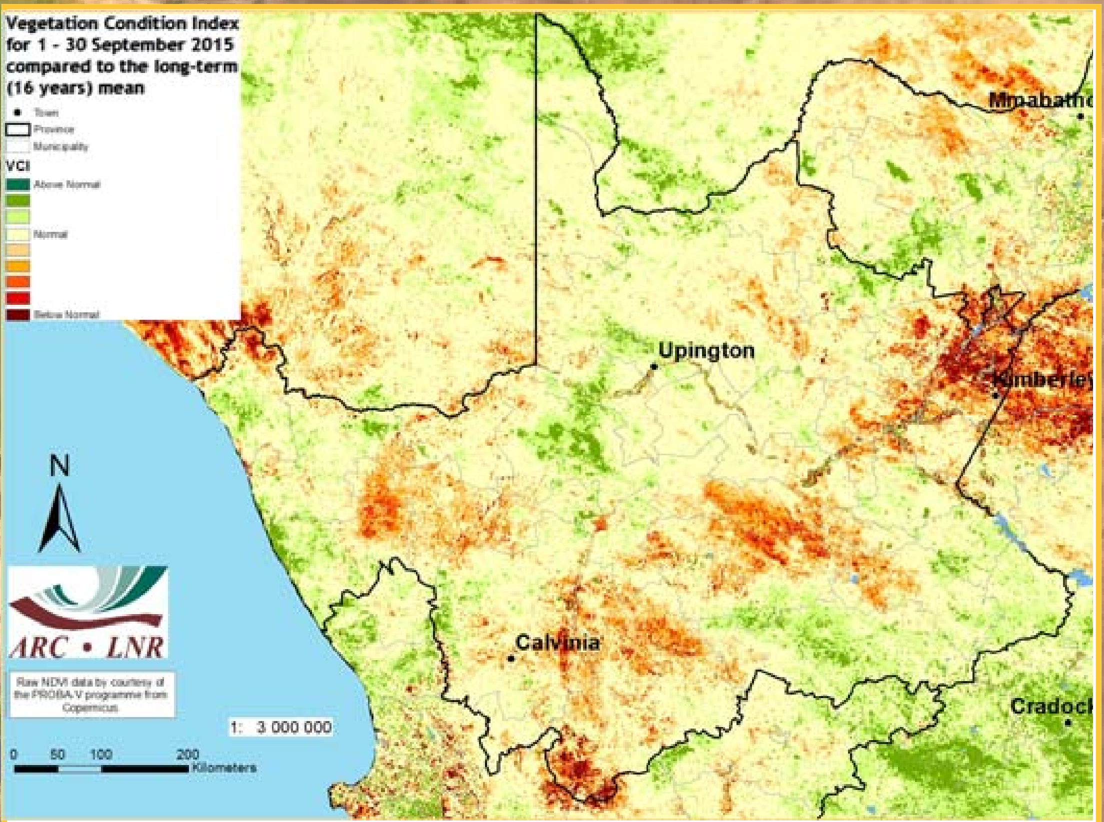
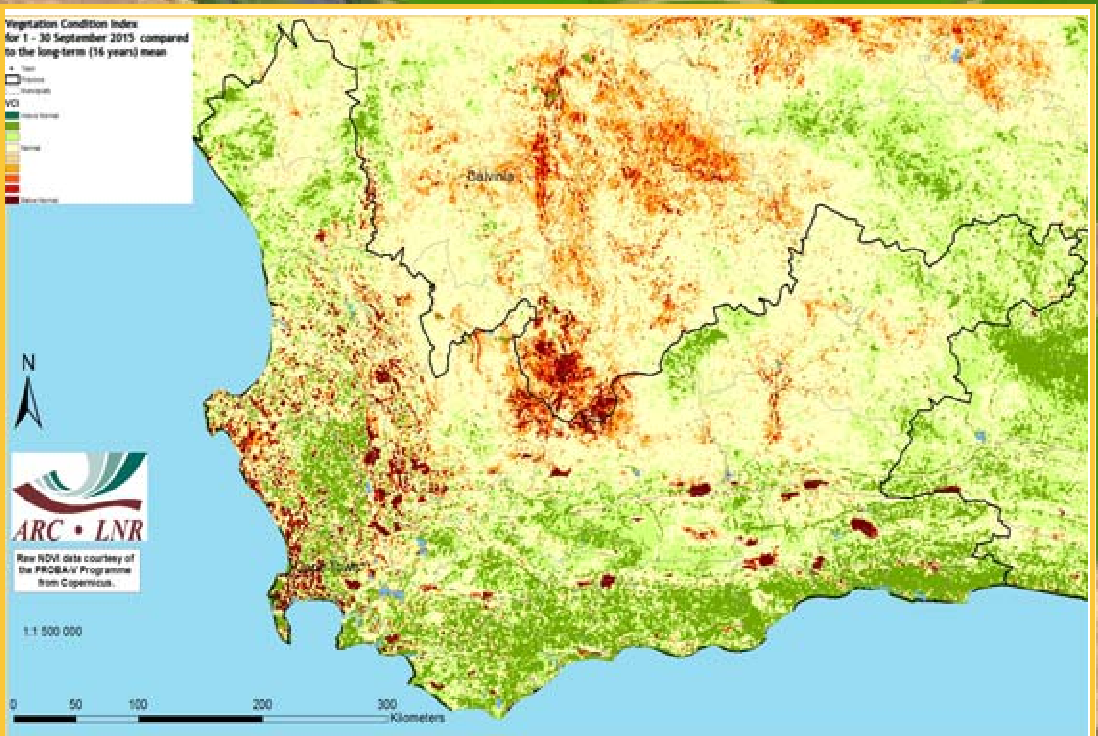


Figure 16

Figure 16:
The VCI map for September Indicates below-normal vegetation activity over the southern to eastern parts of the Northern Cape.

Figure 17:
The VCI map for September indicates below-normal vegetation activity over the western and northern parts of the Western Cape.



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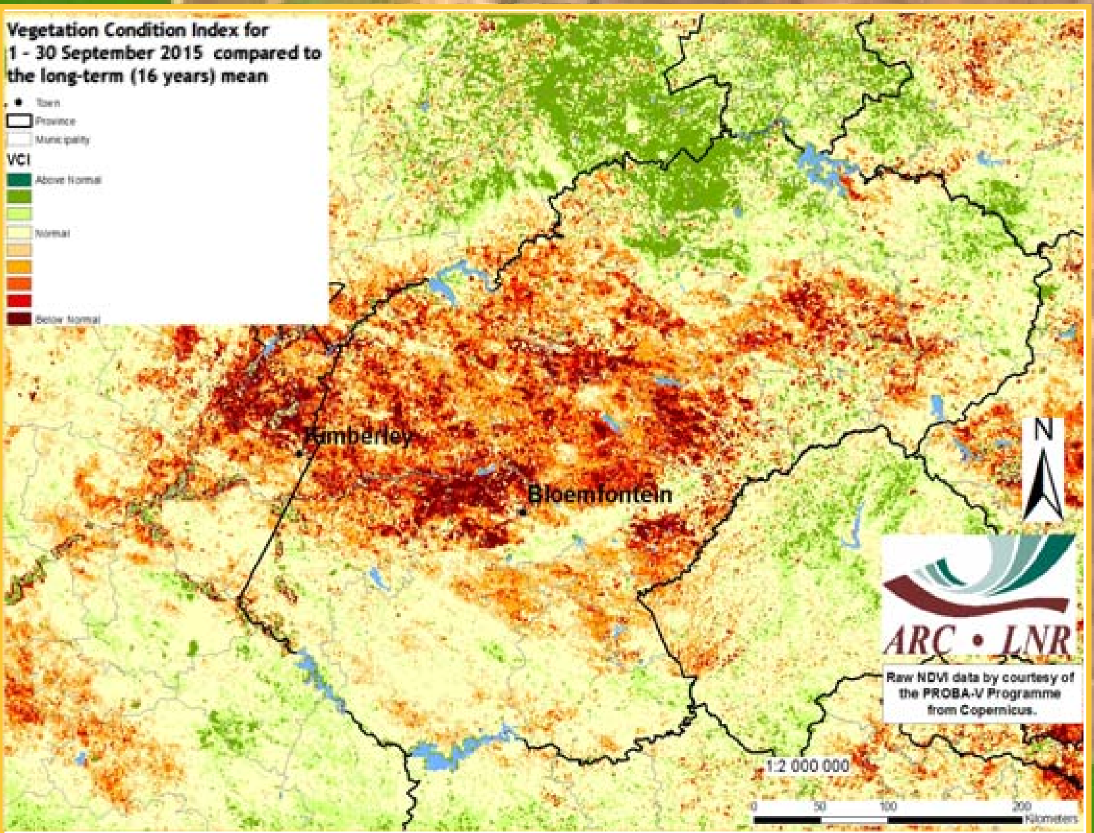

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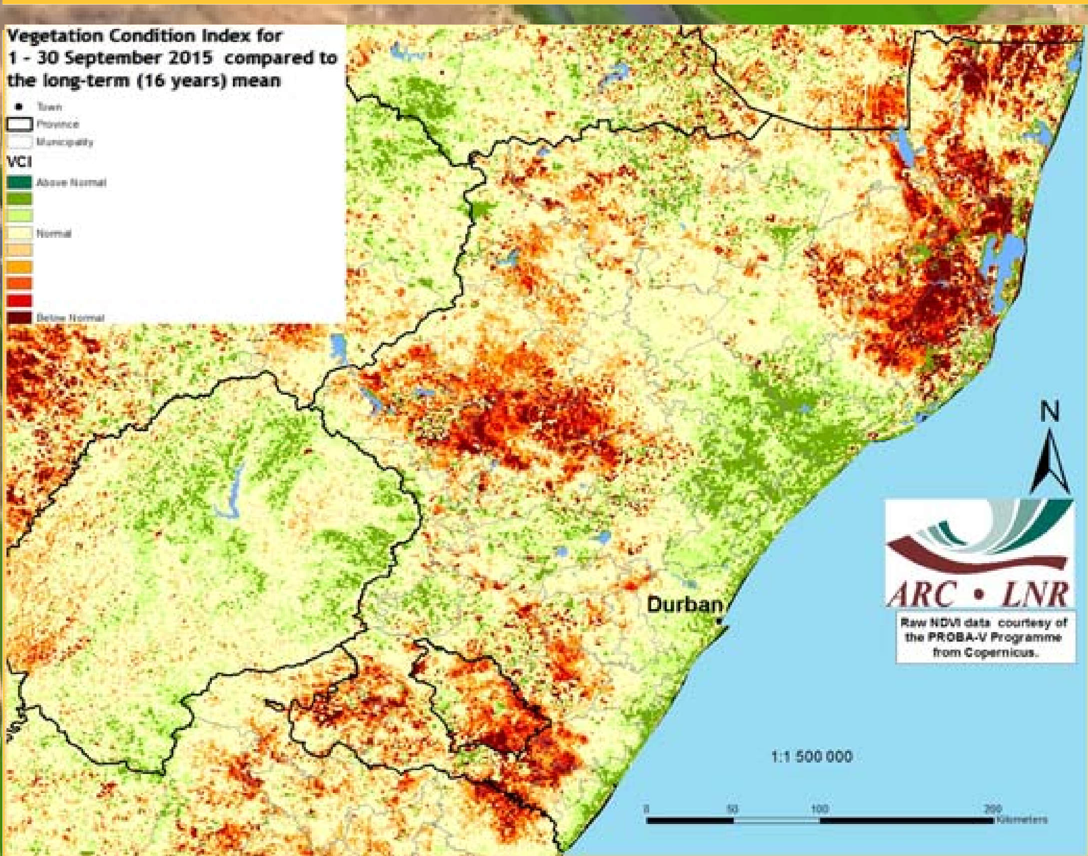

Figure 19

Figure 18:
The VCI map for September indicates below-normal vegetation activity over the central parts and above-normal activity over the northeastern parts of the Free State.

Figure 19:
The VCI map for September indicates below-normal vegetation activity except over the central to southern coastal area and adjacent interior of KwaZulu-Natal.

Questions/Comments:
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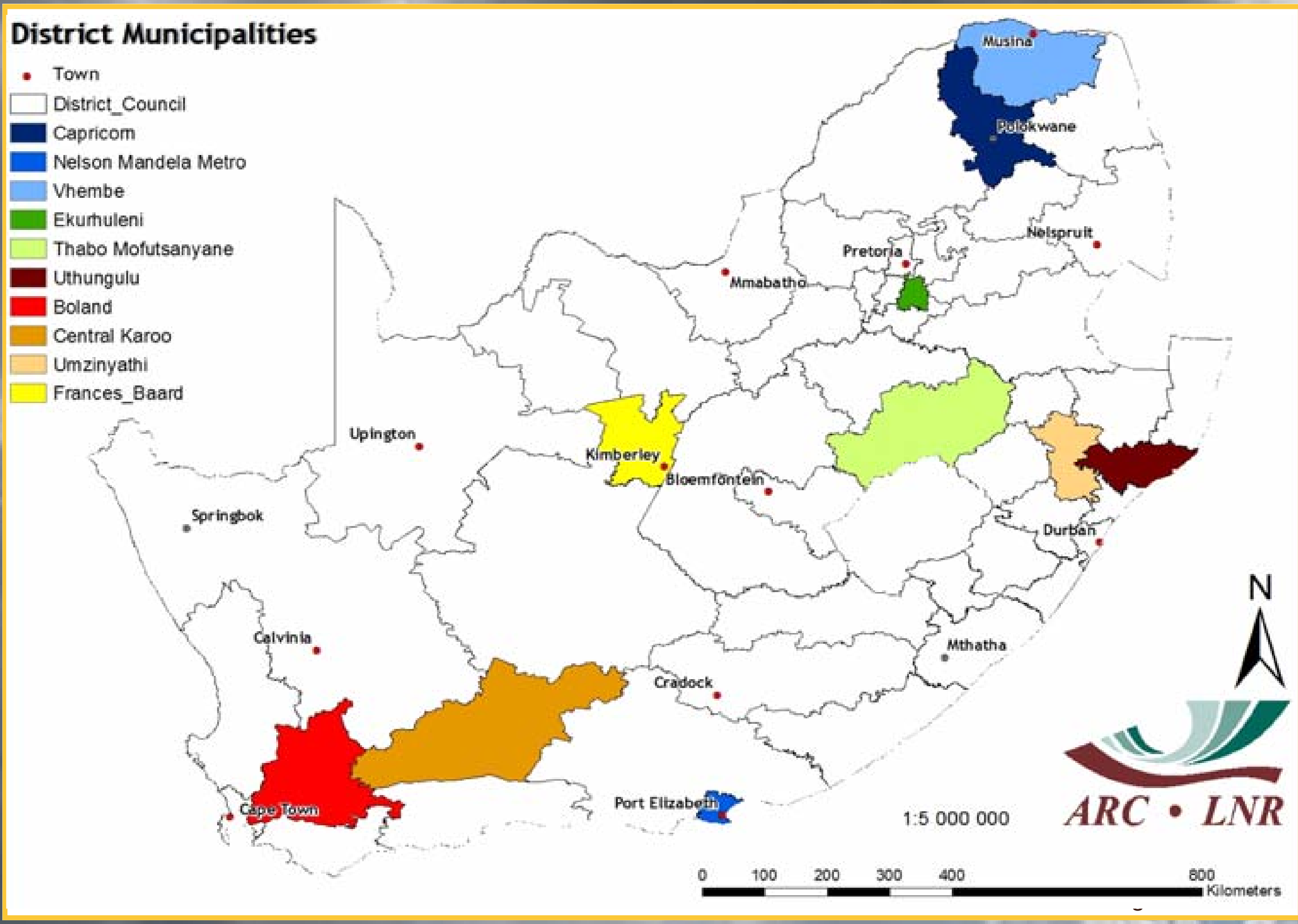
7. Vegetation Conditions & Rainfall



NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for September 2015. The district colour matches the border of the corresponding graph.

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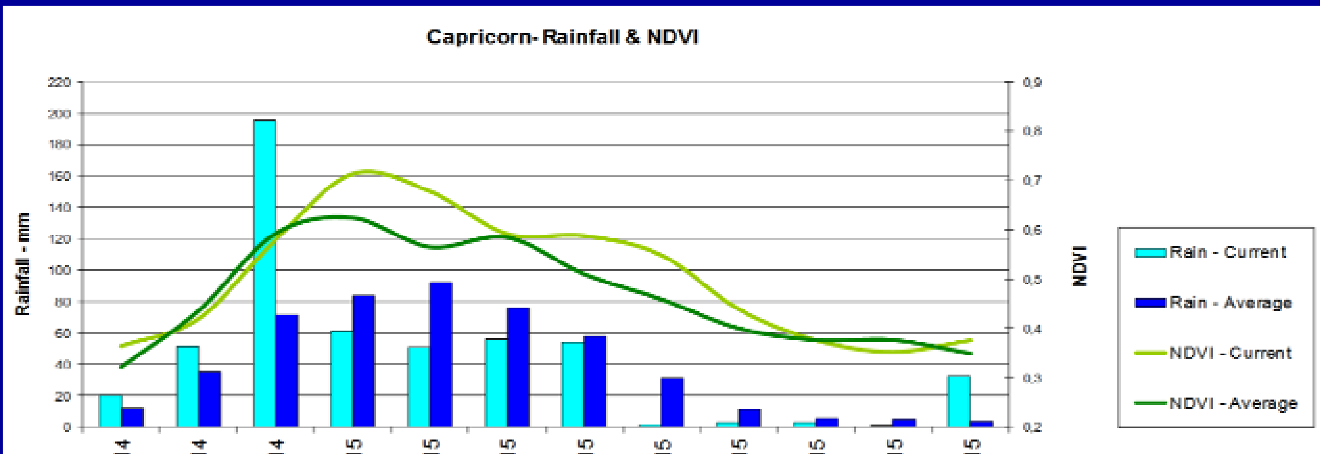
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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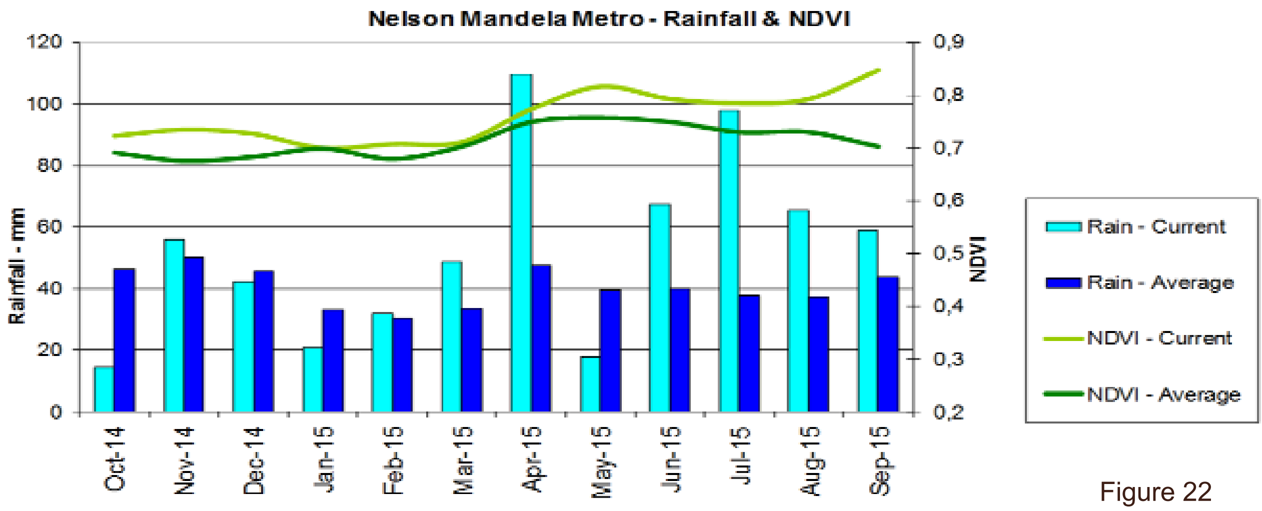

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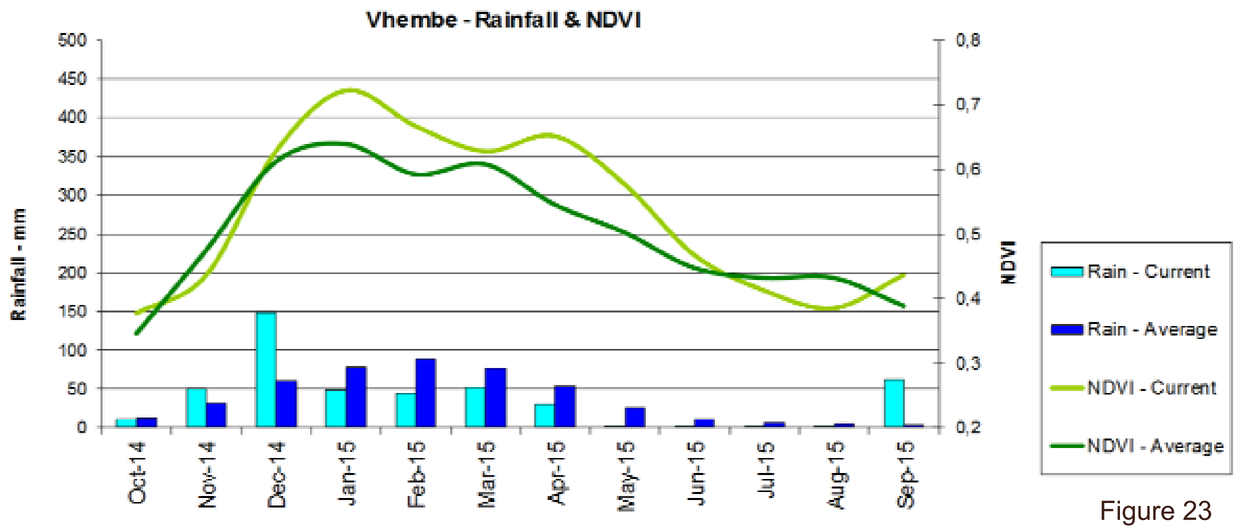

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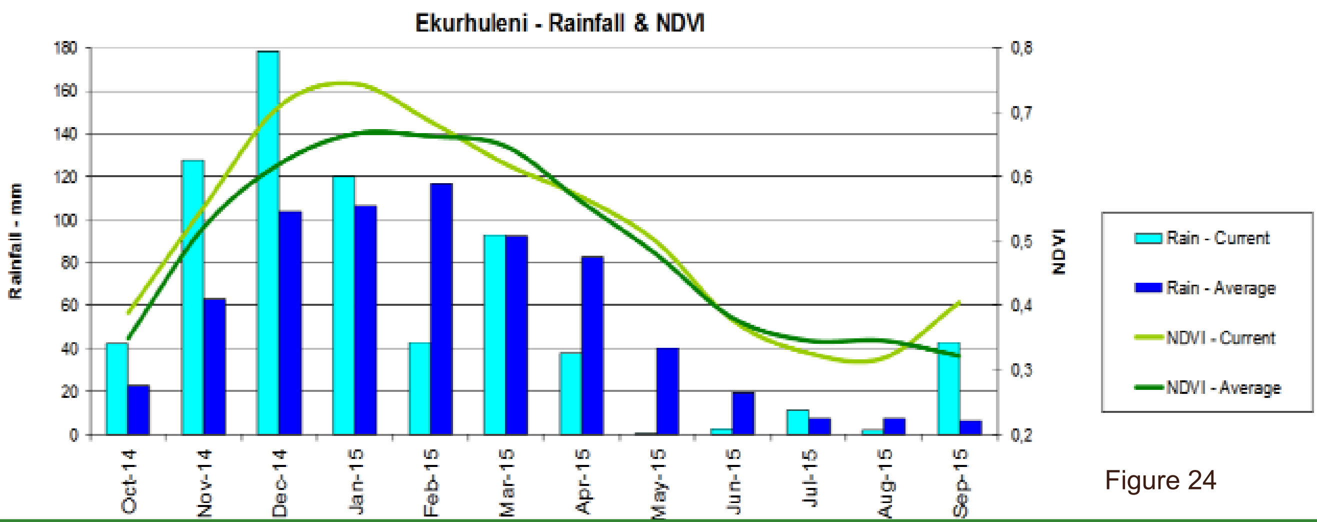

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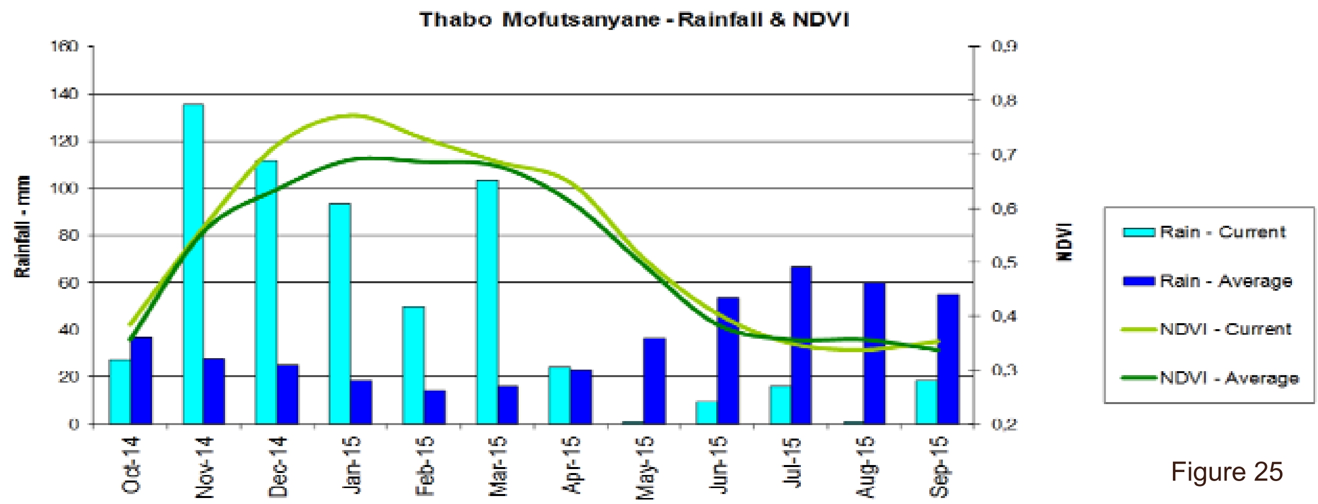

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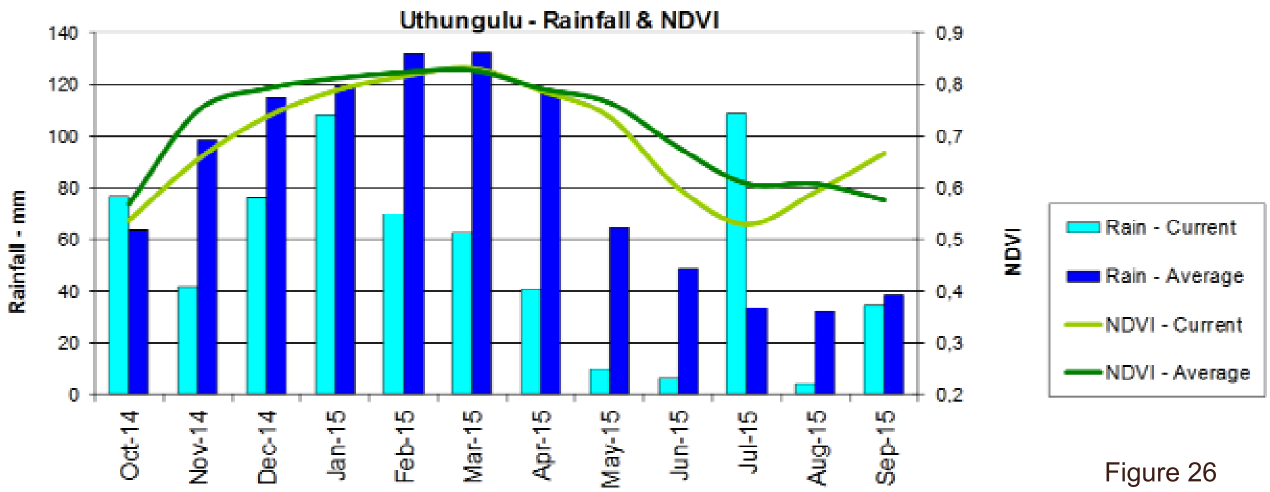
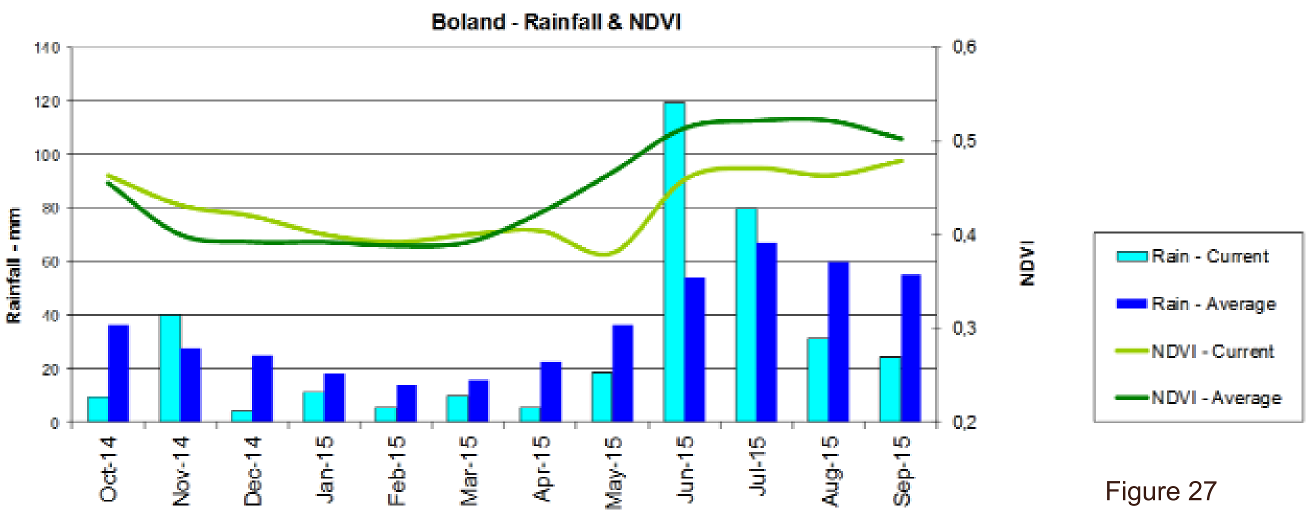


Figure 26



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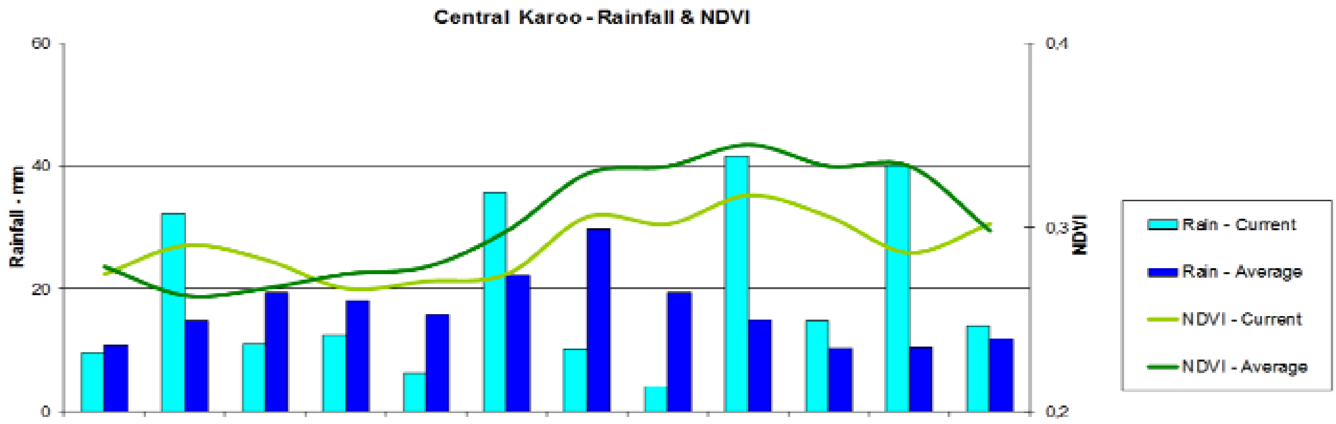

Figure 28

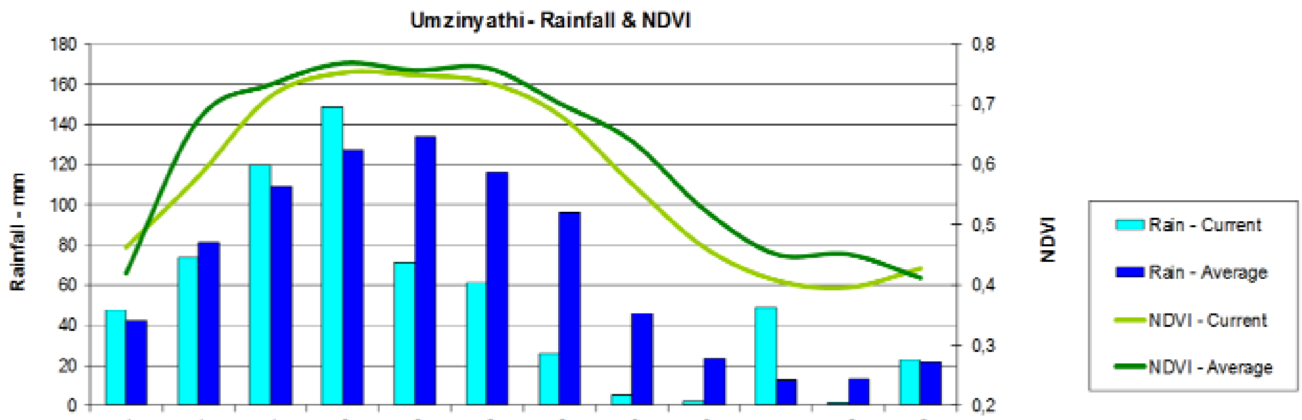

Figure 29

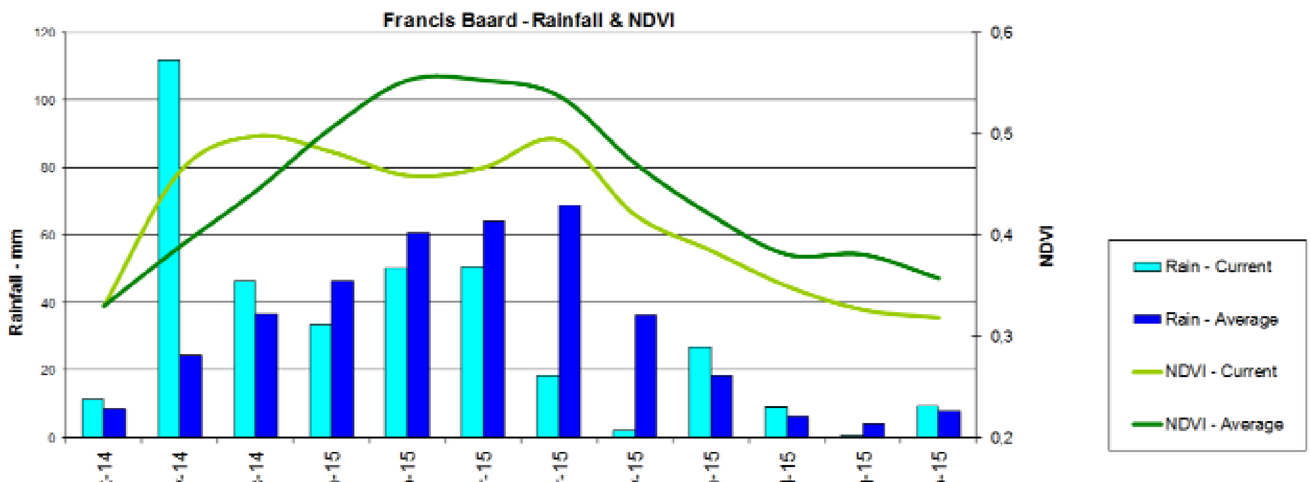

Figure 30

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 September 2015. The colour scale ranging from brown to blue represents the Soil Saturation Index (SSI), defined as the percentage saturation of the soil store in the TOPKAPI hydrological model. The modelling is intended to represent the mean soil moisture state in the root zone. Figure 32 shows the SSI difference between September and August 2015, 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 SSI maps are produced at the ARC-ISCW in a collaborative effort with the University of KwaZulu-Natal Applications and Hydrology Group, made possible by the WMO.

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UNIVERSITY OF KWAZULU-NATAL

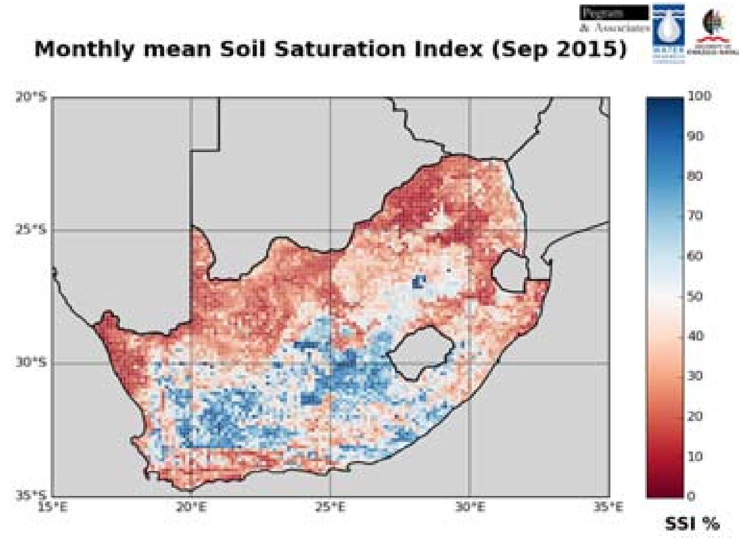

Figure 31

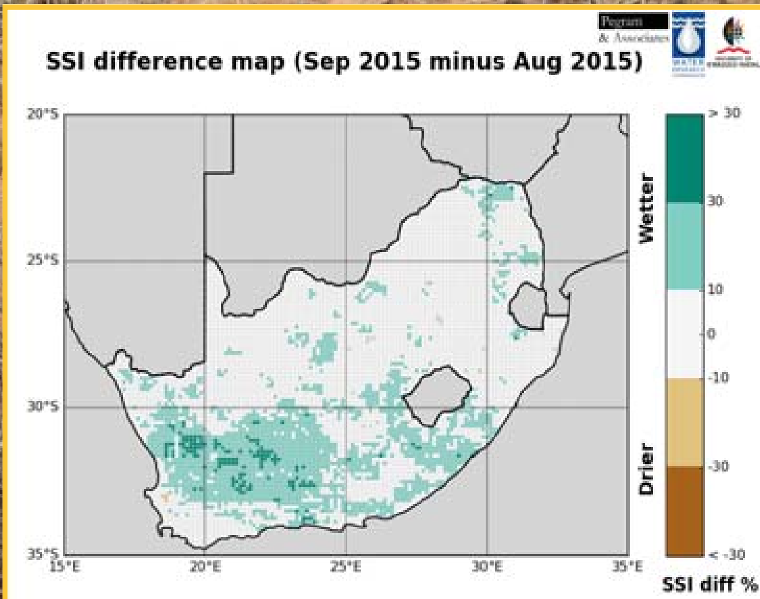

Figure 32

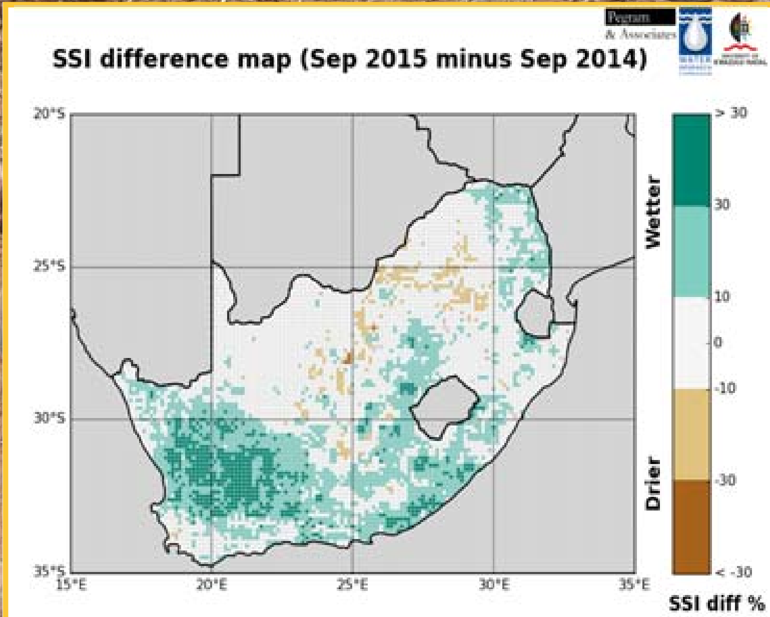

Figure 33

9. Fire Watch

Active Fires *(Provided when data is available)*

Forest and vegetation fires have temperatures in the range of 500 K (Kelvin) to 1000 K. According to Wien's Displacement Law, the peak emission of radiance for blackbody surfaces of such temperatures is at around 4 µm. For an ambient temperature of 290 K, the peak of radiance emission is located at approximately 11 µm. Active fire detection algorithms from remote sensing use this behaviour to detect "hot spot" fires.

Figure 34:
The graph shows the total number of active fires detected during the month of September per province. Fire activity was lower in all the provinces except the Western Cape compared to the average during the same period for the last 14 years.

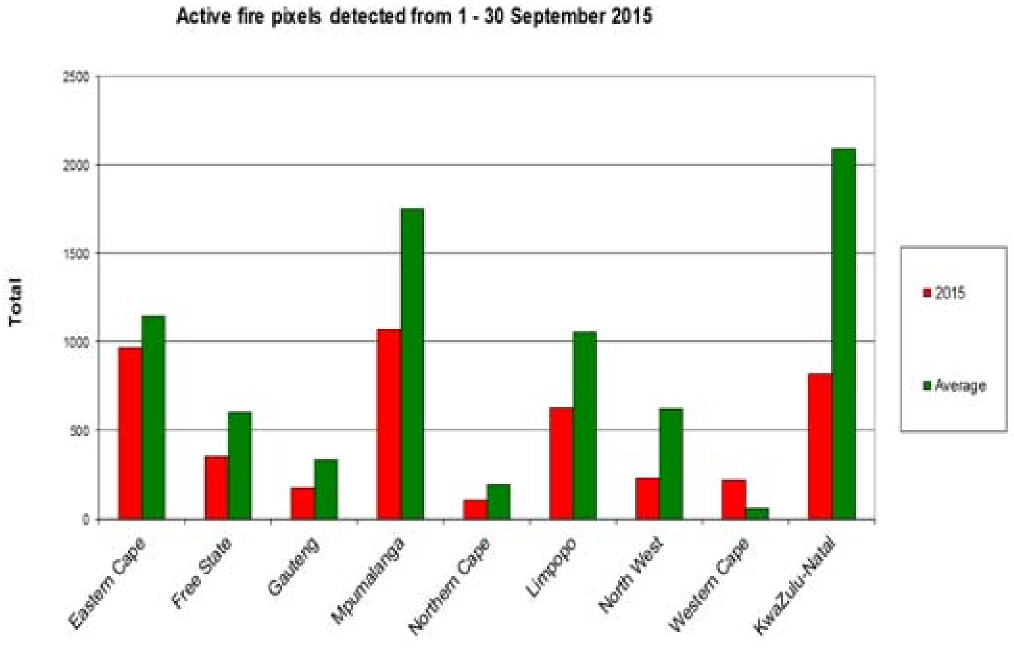

Figure 34

Figure 35:
The map shows the location of active fires detected between 1-30 September 2015.

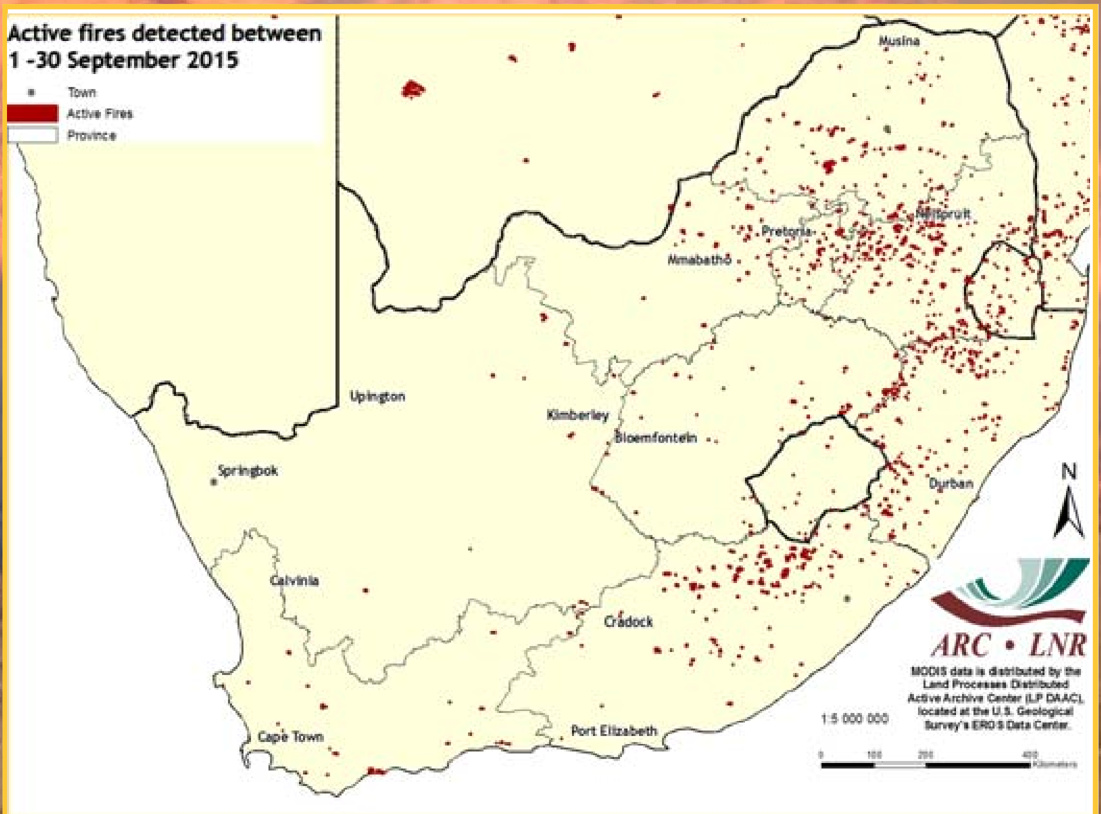

Figure 35

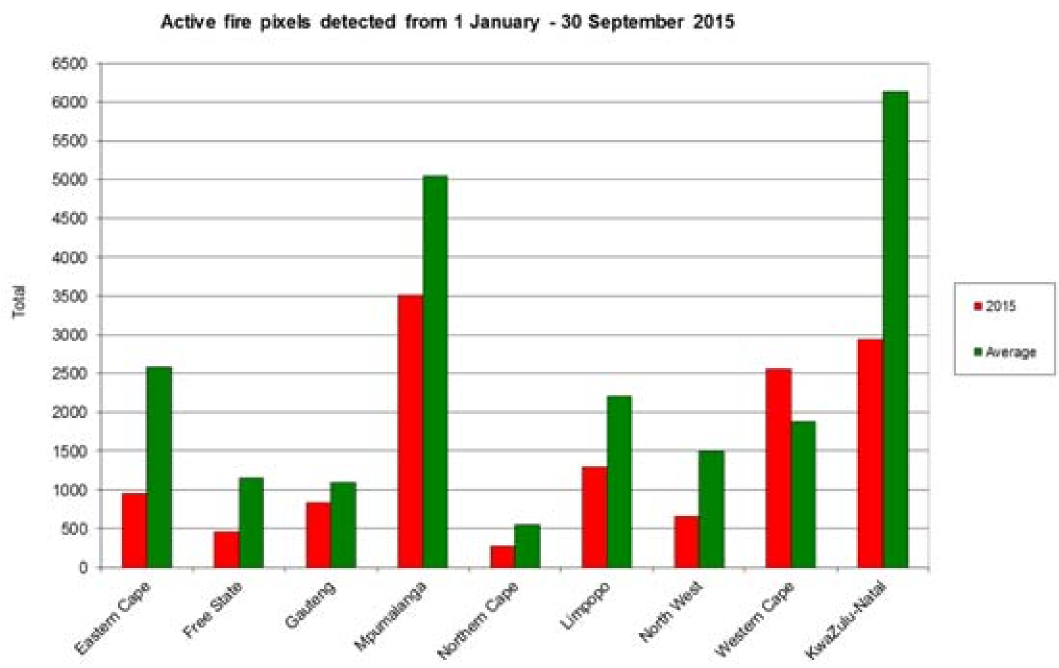

Figure 36

Figure 36:
The graph shows the total number of active fires detected between 1 January to 30 September 2015 per province. Fire activity was lower in all the provinces except the Western Cape compared to the average during the same period for the last 14 years.

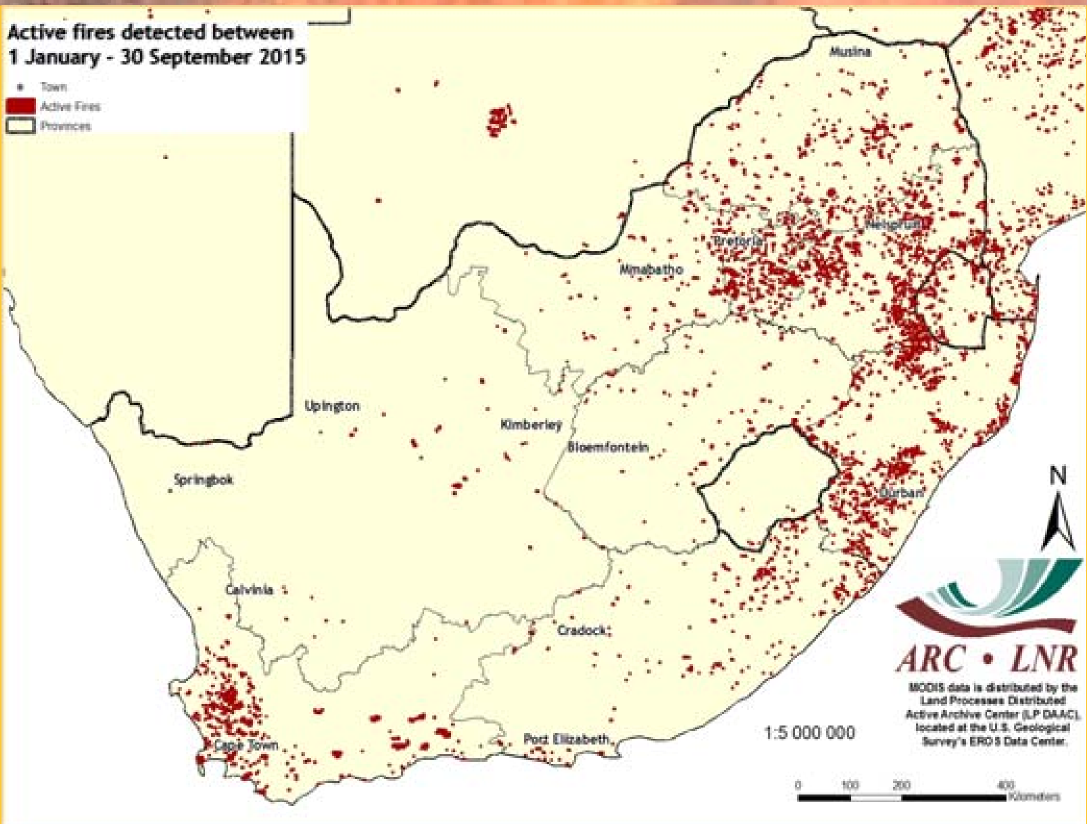

Figure 37

Figure 37:
The map shows the location of active fires detected between 1 January to 30 September 2015.

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ARC-INSTITUTE FOR SOIL, CLIMATE AND WATER

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AgroClimatology

The AgroClimatology Programme of the ARC-Institute for Soil, Climate and Water monitors South Africa's weather and supports the country's agricultural sector through timely provision of weather and climate information.

Since its inception at Bien Donné in the Western Cape in 1940, the Programme has evolved to become a leading arm of the ARC and currently has the capacity to maintain a large country-wide weather station network comprising over 500 automatic weather stations and a small number of mechanical weather stations. The data from all the stations is loaded onto a web-enabled databank from which various climate information products can be derived.

The weather station network and databank constitute a National Asset whose maintenance is largely funded by government through a parliamentary grant that is annually disbursed for this purpose.

Products and Services

Climate-related services and information are available from the Institute's offices in Pretoria (Tel: 012 310 2500), Potchefstroom (Tel: 018 299 6349) and Stellenbosch (Tel: 021 809 3100).

From the web-enabled databank, hourly, daily, monthly, yearly or long-term data can be requested for the following measured elements:

- Temperature
- Rainfall
- Wind speed (including gusts) and direction
- Radiation
- Humidity

Value-added information on evapotranspiration, cold and heat units, and Powdery and Downy Mildew disease indicators is available and various spatial interpretations can be conducted for interested users upon request.

For more information contact:
Mr. Chris Kaempffer
E-mail: ChrisK@arc.agric.za
Tel: 012 310 2560

The Coarse Resolution Imagery Database (CRID)

NOAA AVHRR

The ARC-ISCW has an archive of daily NOAA AVHRR data dating from 1985 to 2004. This database includes all 5 bands as well as the Normalized Difference Vegetation Index (NDVI), Active Fire and Land Surface Temperature (LST) images. The NOAA data are used, for example, for crop production and grazing capacity estimation.

MODIS

MODIS data is distributed by the Land Processes Distributed Active Archive Center (LP DAAC), located at the U.S. Geological Survey's EROS Data Center. The MODIS sensor is more advanced than NOAA with regard to its high spatial (250 m^2 to 1 km^2) and spectral resolution. The ARC-ISCW has an archive of MODIS (version 4 and 5) data.

- MODIS v4 from 2000 to 2006
- MODIS v5 from 2000 to present

Datasets include:

- MOD09 (Surface Reflectance)
- MOD11 (Land Surface Temperature)
- MOD13 (Vegetation Products)
- MOD14 (Active Fire)
- MOD15 (Leaf Area Index & Fraction of Photosynthetically Active Radiation
- MOD17 (Gross Primary Productivity)
- MCD43 (Albedo & Nadir Reflectance)
- MCD45 (Burn Scar)

Coverage for version 5 includes South Africa, Namibia, Botswana, Zimbabwe and Mozambique.
More information:
http://modis.gsfc.nasa.gov

VGT4AFRICA and GEOSUCCESS

SPOT NDVI data is provided courtesy of the VEGETATION Programme and the VGT4AFRICA project. The European Commission jointly developed the VEGETATION Programme. The VGT4AFRICA project disseminates VEGETATION products in Africa through GEONETCast.

ARC-ISCW has an archive of VEGETATION data dating from 1998 to the present. Other products distributed through VGT4AFRICA and GEOSUCCESS include Net Primary Productivity, Normalized Difference Wetness Index and Dry Matter Productivity data.

Meteosat Second Generation (MSG)

The ARC-ISCW has an operational MSG receiving station. Data from April 2005 to the present have been archived. MSG produces data with a 15-minute temporal resolution for the entire African continent. Over South Africa the spatial resolution of the data is in the order of 3 km. The ARC-ISCW investigated the potential for the development of products for application in agriculture. NDVI, LST and cloud cover products were some of the initial products derived from the MSG SEVIRI data. Other products derived from MSG used weather station data, including air temperature, humidity and solar radiation.

Rainfall maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network, 270 automatic rainfall recording stations from the SAWS, satellite rainfall estimates from the Famine Early Warning System Network: **http://earlywarning.usgs.gov** and long-term average climate surfaces developed at the ARC-ISCW.

Solar Radiation and Evapotranspiration maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network.
- Data from the METEOSAT Second Generation (MSG) 3 satellite via GEONETCAST: **http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast/GEONETCast/index.html**.

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The operational Coarse Resolution Imagery Database (CRID) project of ARC-ISCW is funded by the National Department of Agriculture, Forestry and Fisheries. Development of the monitoring system was made possible in its inception through LEAD funding from the Department of Science and Technology.

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Johan@arc.agric.za

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

http://www.agis.agric.za

Disclaimer:
The ARC-ISCW and its collaborators have obtained data from sources believed to be reliable and have made every reasonable effort to ensure accuracy of the data. The ARC-ISCW and its collaborators cannot assume responsibility for errors and omissions in the data nor in the documentation accompanying them. The ARC-ISCW and its collaborators will not be held responsible for any consequence from the use or misuse of the data by any organization or individual.