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Excellence in Agricultural Research and Development

UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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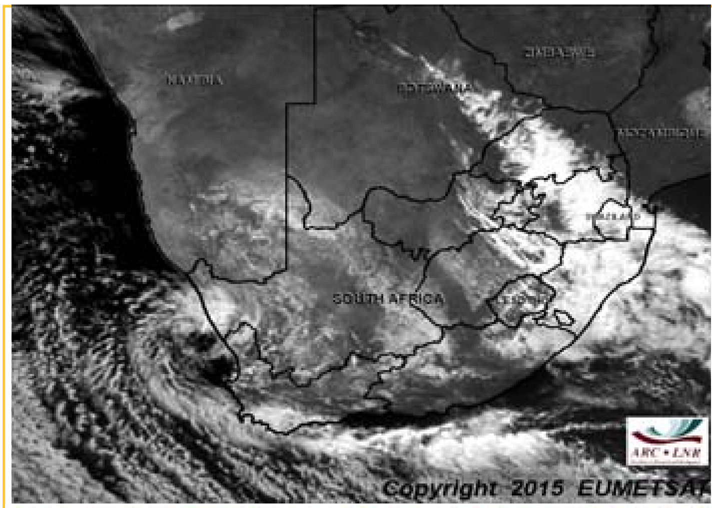
agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

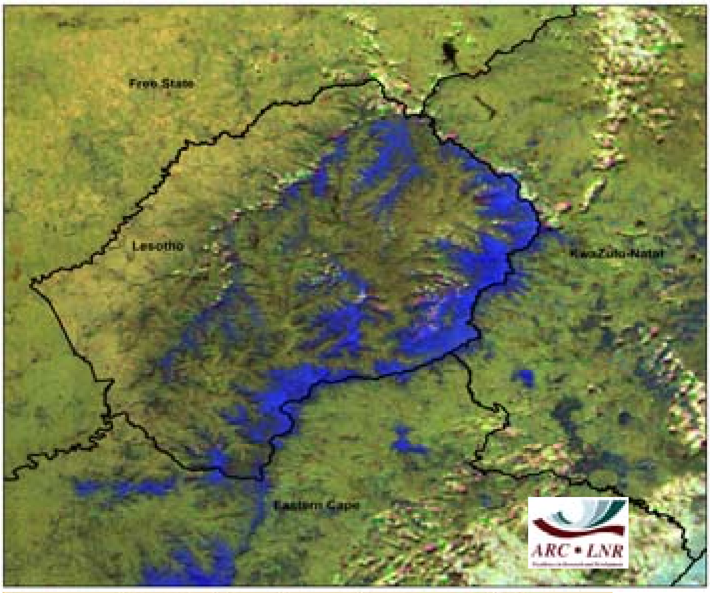
South African Weather Service

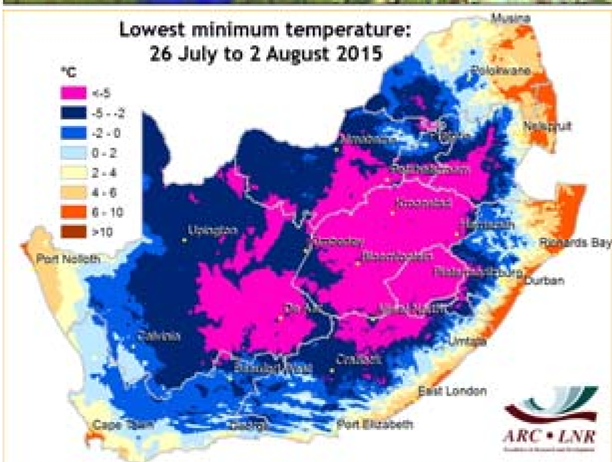
AMESD

134th Edition

Images of the Month







Widespread rain over the interior continues in July

Following anomalously wet conditions during June over much of the central to western interior, further above-normal rain occurred over the central to southern and eastern parts during July. Two rainfall events, occurring during the period 17 to 25 July, resulted in widespread rain over the summer rainfall region, together with the most significant snow thus far this winter over the Drakensberg. Heavy rain occurred over drought-stricken KwaZulu-Natal, especially along the coast and adjacent interior. Rainfall totals further inland were somewhat lower and not sufficient to bring an end to the drought situation over the province.

The MSG-3 SEVIRI Visible Red band for 12:00 SAST on 24 July (top image) shows the second of the main rain producing systems, a cut-off low, depicted as the spiralling cloud mass over the West Coast. Large amounts of moisture fed into the eastern parts combined with the instability provided by the low pressure system to the west to cause widespread thundershowers over the interior and more significant widespread rain with heavy falls towards the southern and eastern coastal areas. Broken cloud over the interior is an indication of very cold air that invaded the country during this event.

Widespread snow occurred over the Drakensberg as can be seen in blue on the Aqua MODIS colour composite (second image). The cold air that invaded the country resulted in widespread frost as minimum temperatures plummeted to below freezing in the days that followed. The map shows the lowest minimum temperature recorded during the period 26 July to 2 August. It is an interpolation of temperature data collected through the ARC-ISCW automatic weather station network, consisting of 450 operational stations across the country.

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

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:

July 2015 was characterized by normal to above-normal rainfall over the winter rainfall region while large parts of the summer rainfall region once again experienced some winter rain. The first significant rain in a long time occurred over parts of the drought-stricken central to northern KwaZulu-Natal. The month evolved from an uneventful relatively dry first half through a very unstable middle part, with the most significant precipitation events over both summer and winter rainfall regions, to end with relatively cold conditions with circulation patterns winding down to relatively stable conditions.

Cold fronts regularly influenced the winter rainfall region, but only light falls, confined to the southwestern parts of the winter rainfall region, occurred in association with weaker/ more southerly cold fronts during the first half of the month. Rainfall events over the winter rainfall region, associated with frontal activity, were spread fairly evenly from the 10th, concentrated specifically around the 11th, 17th, 22nd and 29th. Low temperatures, associated with some of the cold fronts, occurred over large parts of the interior by the 17th to 19th and again by the 25th to the 29th.

Mild and dry conditions dominated during the early part of the month. Frontal activity towards the south and upper-air lows towards the southwest resulted in light showers in the southwest from time to time. Light showers also occurred from time to time over the Escarpment and coastal zone in the east in association with the Indian Ocean Anticyclone. A fairly strong cold front made its presence felt over the southern parts of the country by the 10th with fairly significant showers and rain over the winter rainfall region. Cold air invaded especially the southern parts. An upper-air trough, together with a surface flow from the north and northeast, resulted in isolated showers and thundershowers over parts of the central to western interior from the 12th. Conditions changed further with a sharp upper air trough moving over the interior resulting in scattered thundershowers over the interior on the 16th and 17th, even though falls were mainly on the light side. More significant precipitation occurred towards the southeast and also over the winter rainfall region where a cold front resulted in widespread and significant precipitation. The cold front moved across the interior with the upper air trough, bringing a particularly cold snap to most of the interior, reaching the northern extremes by the 17th causing some of the lowest minimum temperatures so far this winter. Another cold front reached the southwest on that day, resulting in heavy falls over parts of the winter rainfall region.

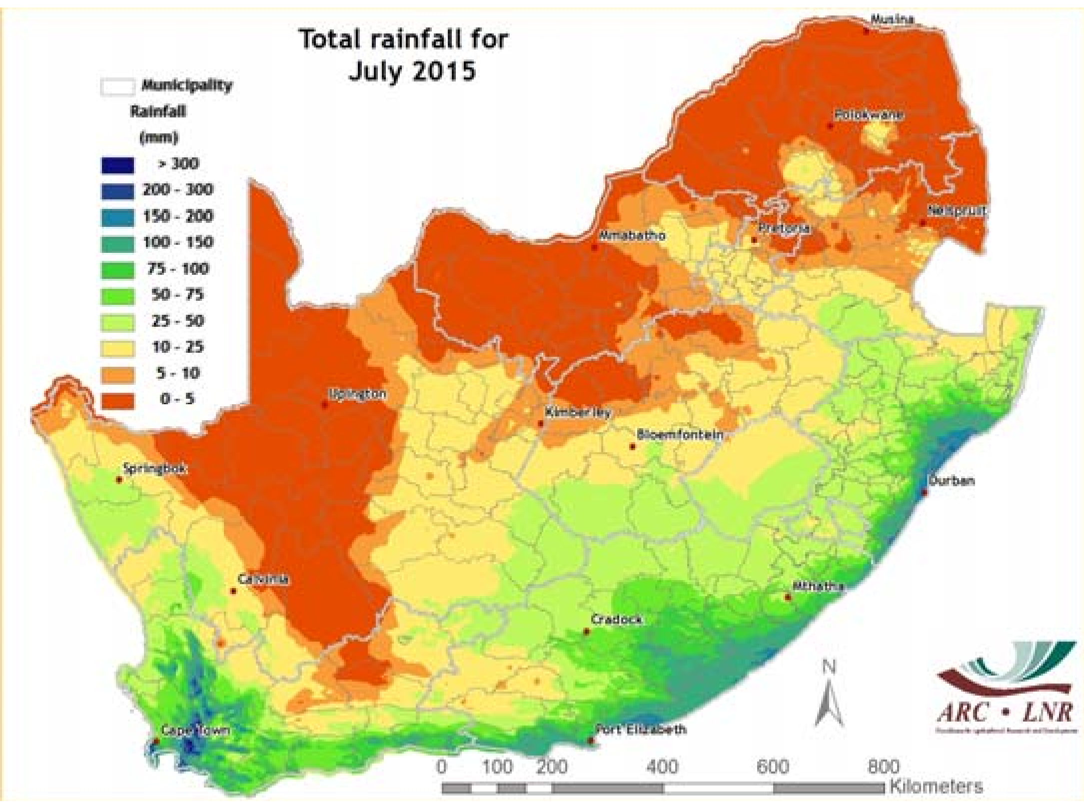


Figure 1

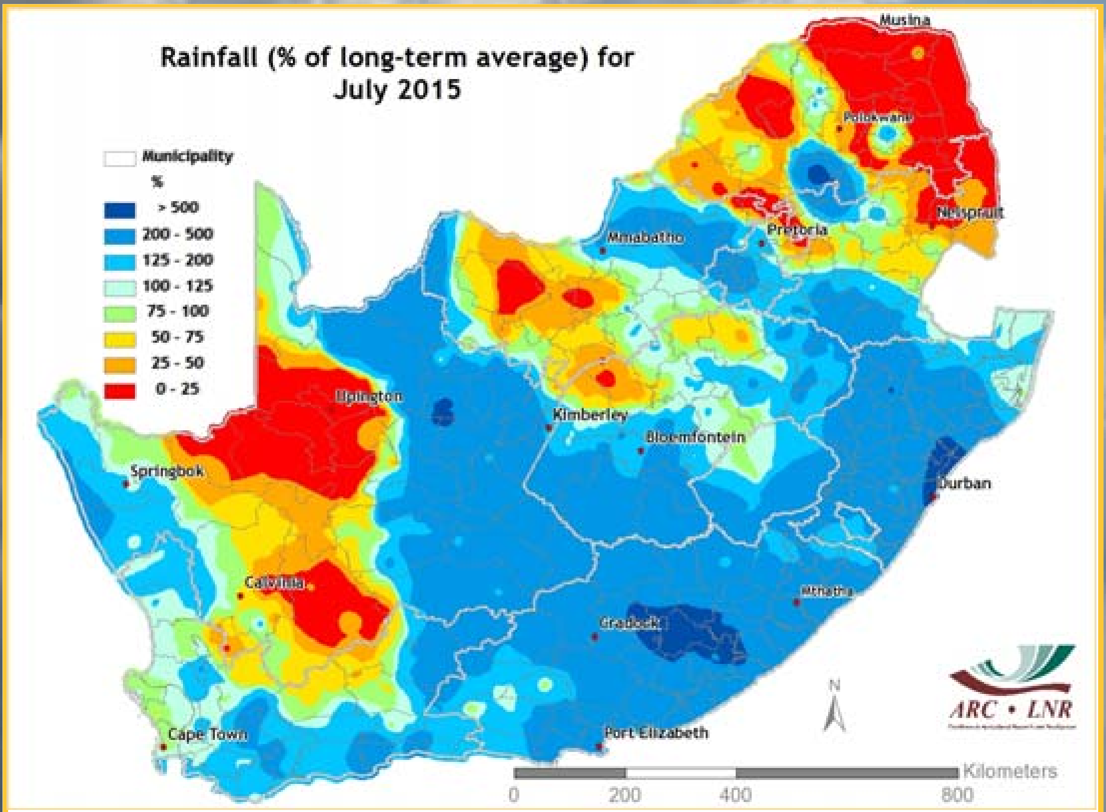


Figure 2

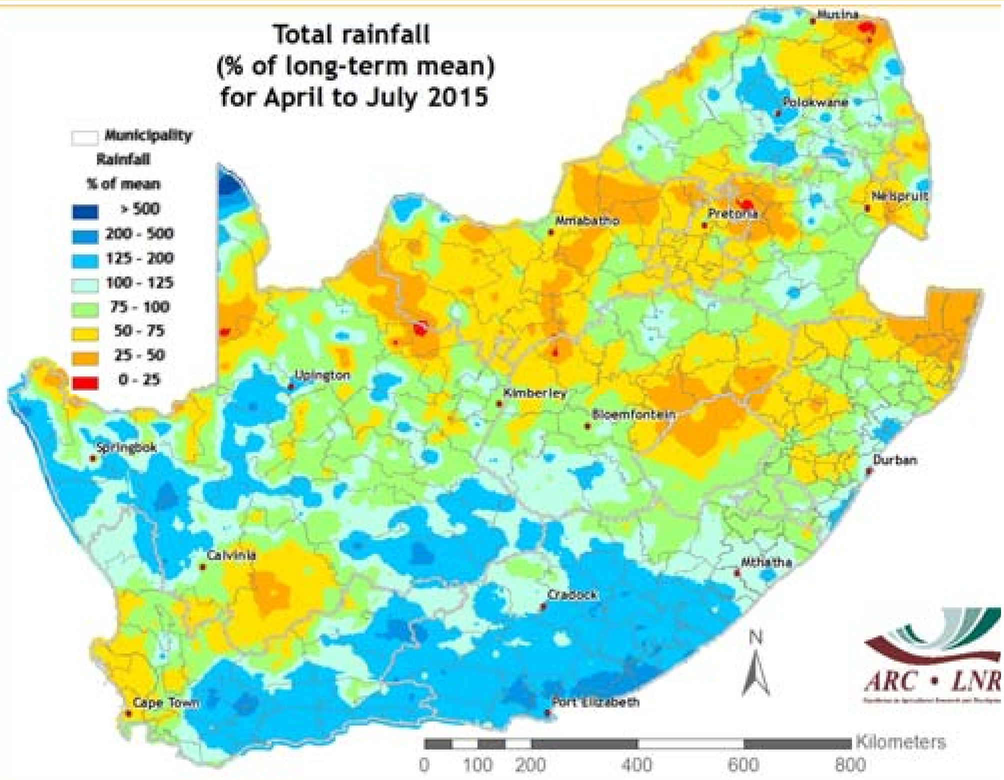


Figure 3

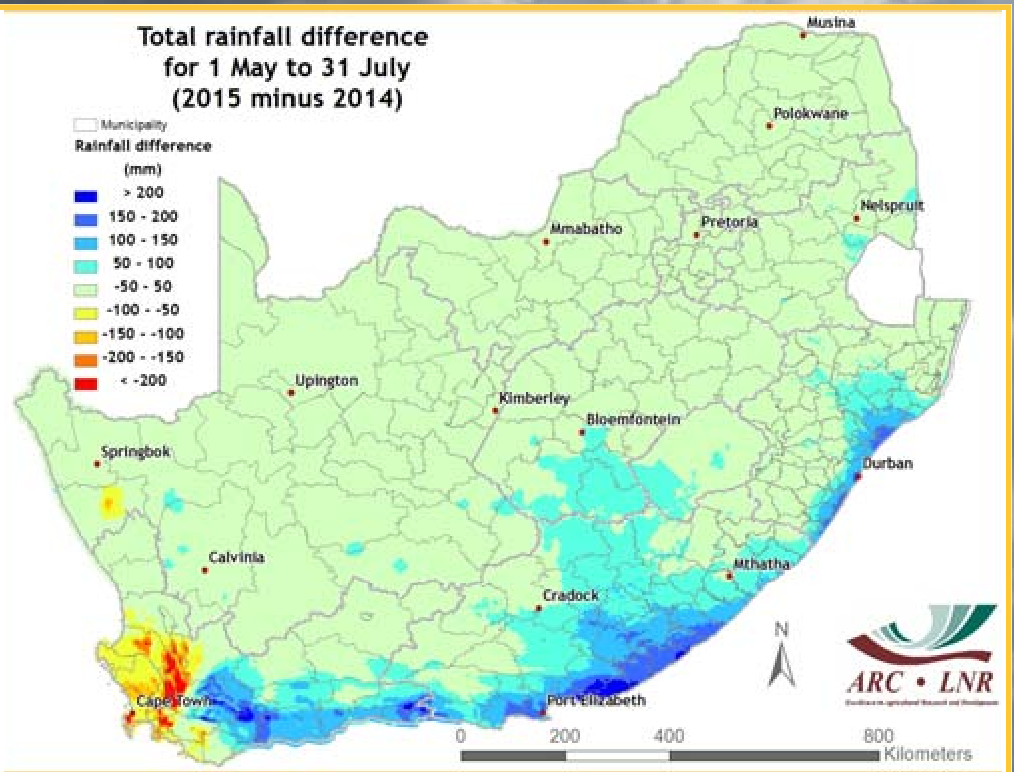


Figure 4

Unstable conditions continued over the country until the 25th after which settled cool conditions started dominating. After being semi-stationary over the south-western parts of the country since the 20th, a deep cut-off low started moving eastwards from the 23rd, resulting in widespread thundershowers with small hail in places over the central to eastern and southern parts. Heavy falls were recorded in places along the southern and eastern coastal belt due to a strong ridging high-pressure system to the south. The ridge also resulted in strong southeasterlies over the southwestern parts of the winter rainfall region. Wide-spread rain along the eastern coastal belt brought some relief to drought-stricken areas in KZN, but totals further inland were relatively low, lessening the potential positive impact on water resources. During the last few days of the month another cold front moved into the winter rainfall region, resulting in precipitation mostly over the western parts of that region, while dry and cool to cold conditions predominated over the interior with widespread frost.

Figure 1:
The winter rainfall region as well as the southern to eastern interior and coastal belt received rain during July. Highest falls occurred over the Boland and the southern to eastern coastal regions where totals exceeded 100 mm in many places.

Figure 2:
The winter rainfall region, except for the western parts of the Swartland, received above-normal rainfall during July. Much of the central to southeastern interior and the southern to eastern coastal areas also received above-normal rainfall.

Figure 3:
Cumulative rainfall since April is above normal over many of the southern and western parts, excluding the southwestern part of the winter rainfall region. Below-normal rainfall occurred over most of North West, northwestern and eastern Free State and northern KwaZulu-Natal.

Figure 4:
The western parts of the winter rainfall region experienced much less rain during May-to-July this year than for the same period last year, while the southern to eastern coastal areas and adjacent interior 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 dominate the northern parts of KwaZulu-Natal and southern Mpumalanga at the 12-month and 24-month time scales, with wet conditions evident over the northeastern and southern parts of the country at the longer time scale. At shorter time scales, the southern parts of the country, including the south-eastern parts of the winter rainfall region, are experiencing extremely wet conditions.

Questions/Comments:
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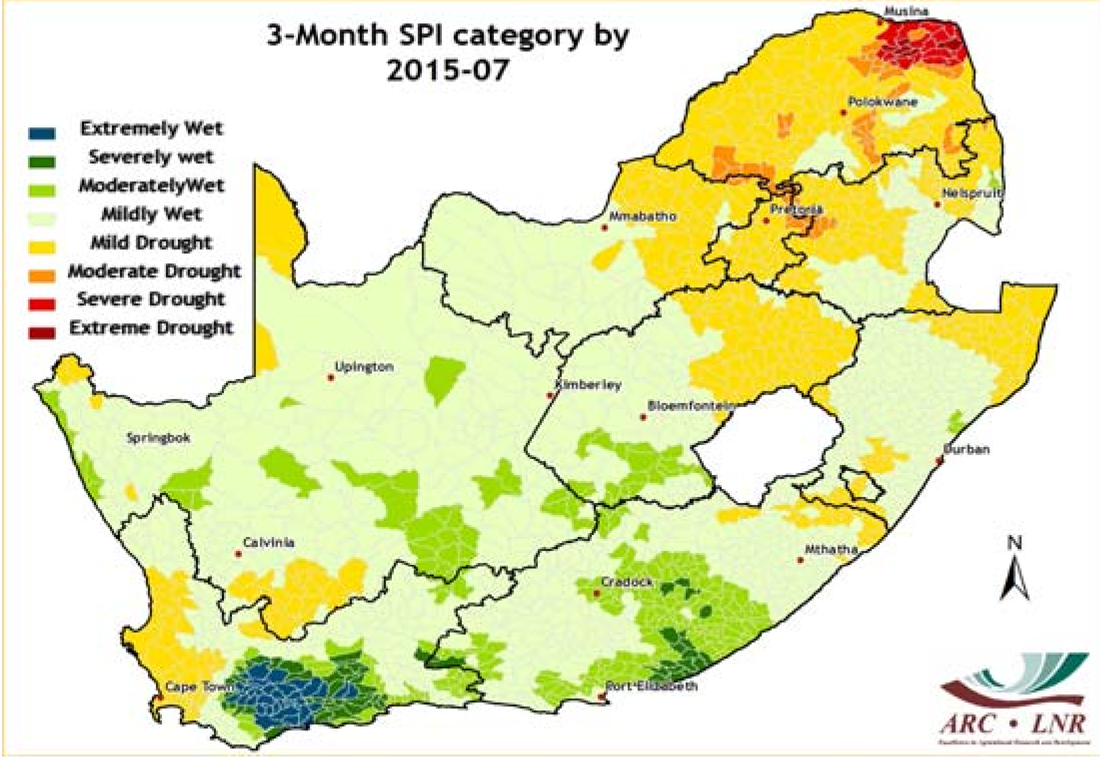

Figure 5

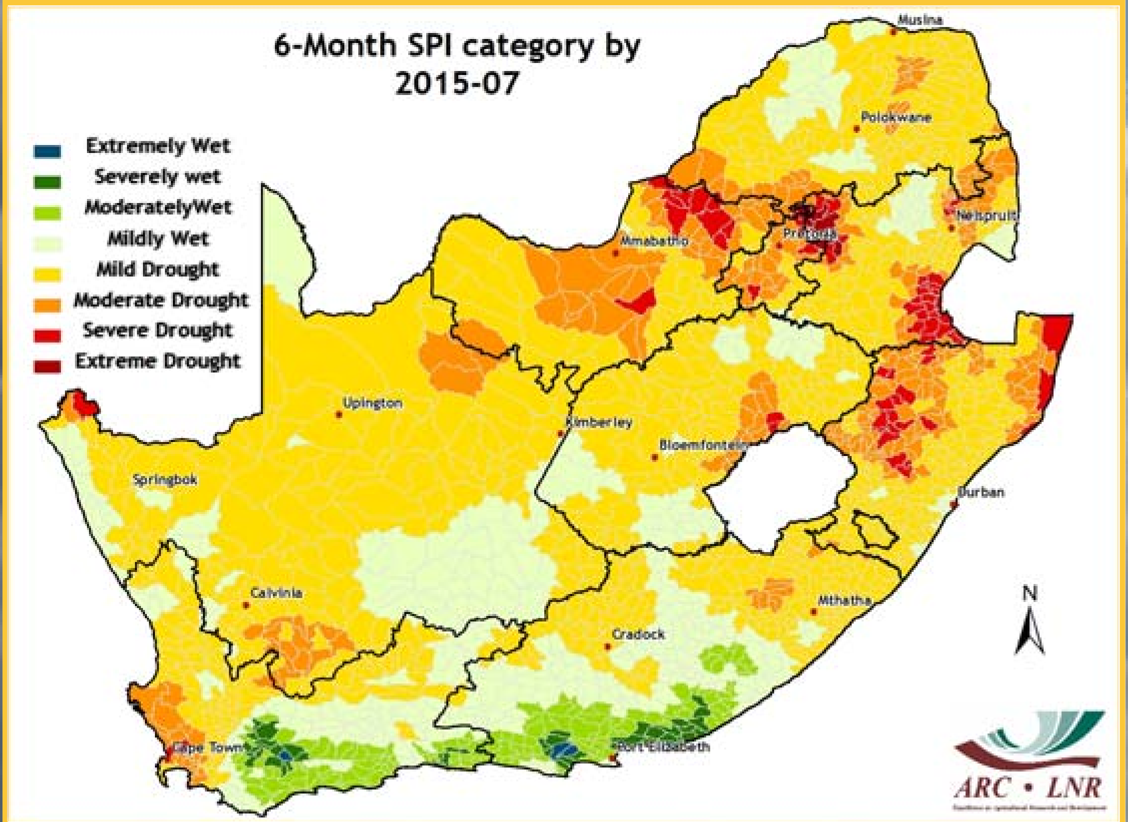

Figure 6

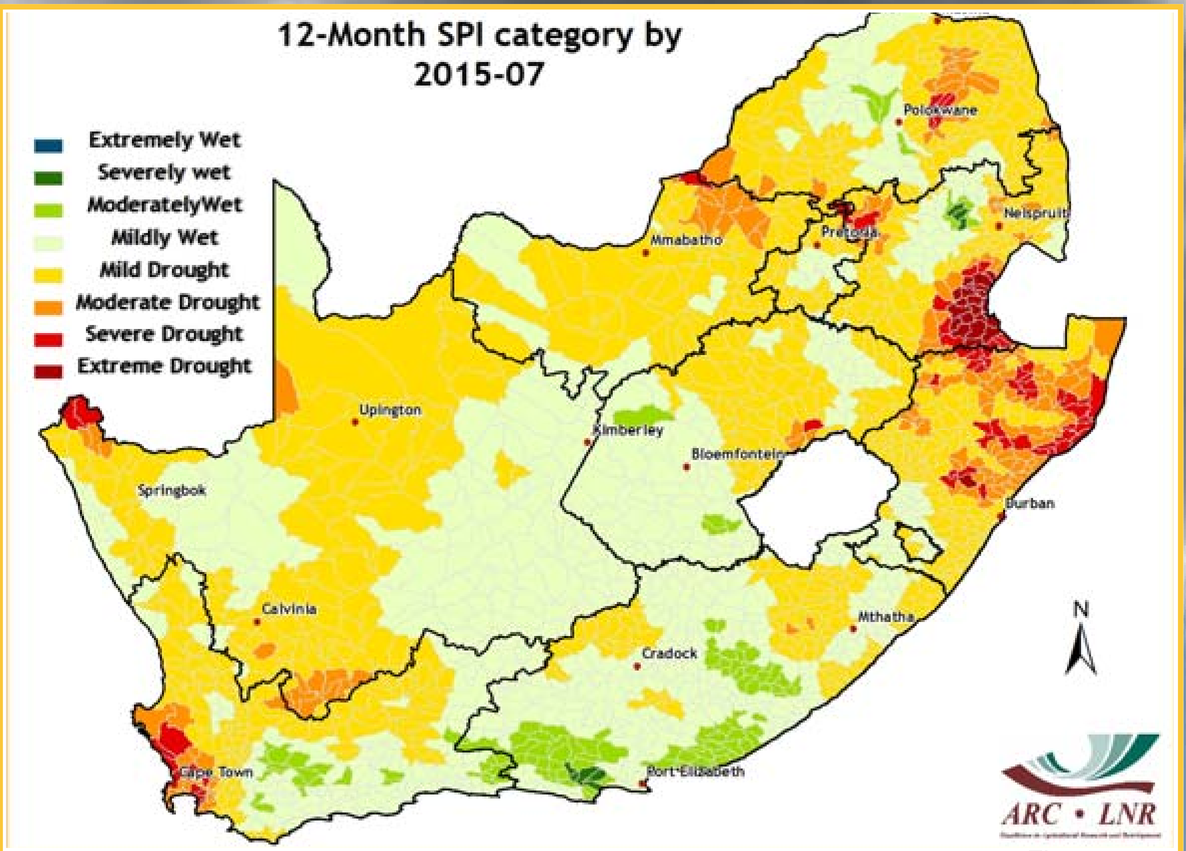

Figure 7

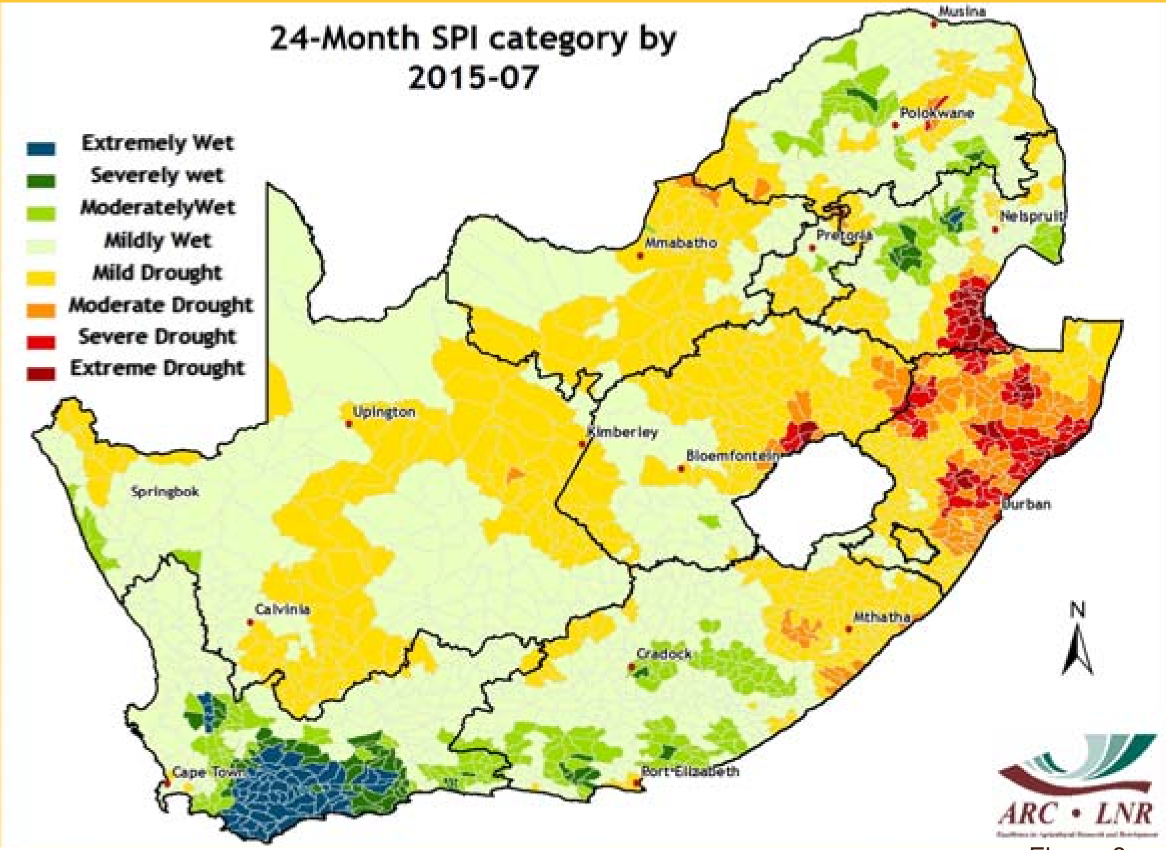

Figure 8

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.

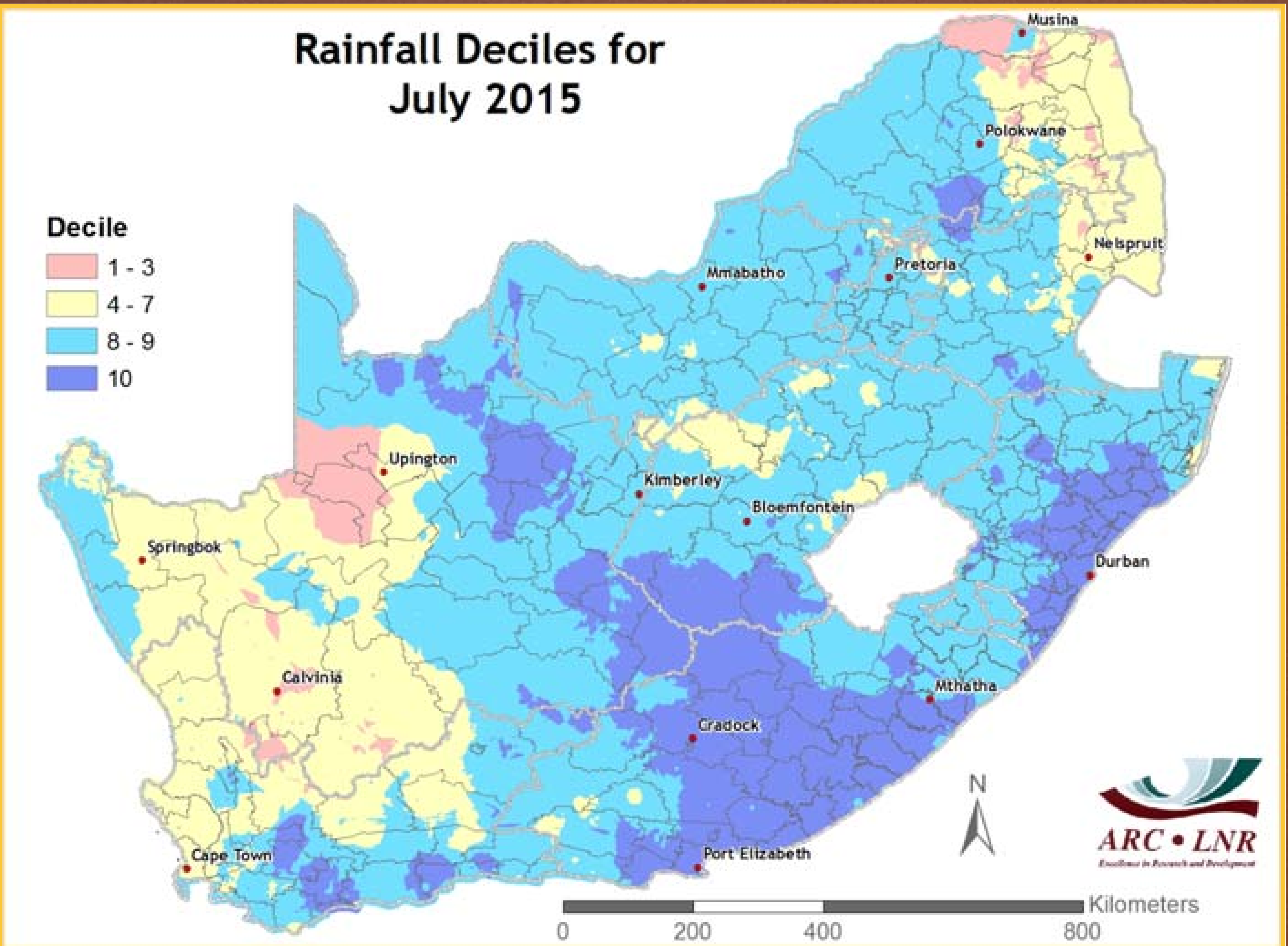

Figure 9

Figure 9:
The central to southern and eastern parts of the country were exceptionally wet during July. The southeastern parts of the winter rainfall region, including the Ruens, also received exceptional rainfall.

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

4. Water Balance

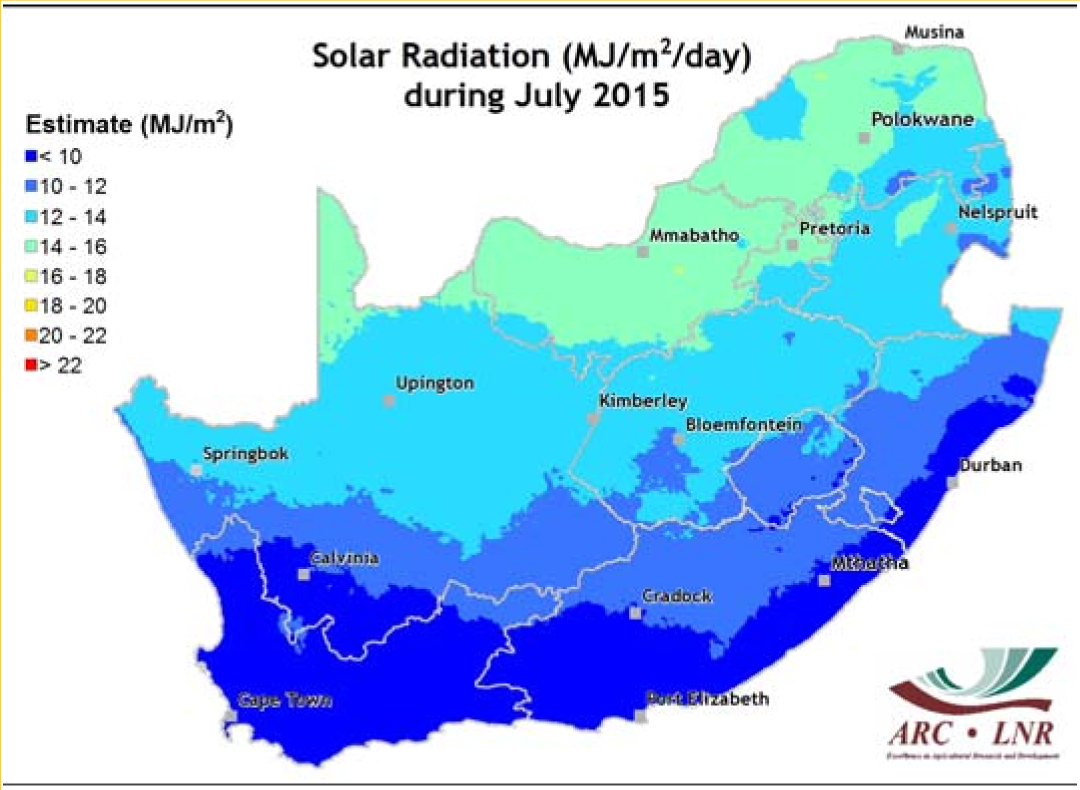

Figure 10

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:
Solar radiation measurements and estimates remained low during July, especially over the southern parts.

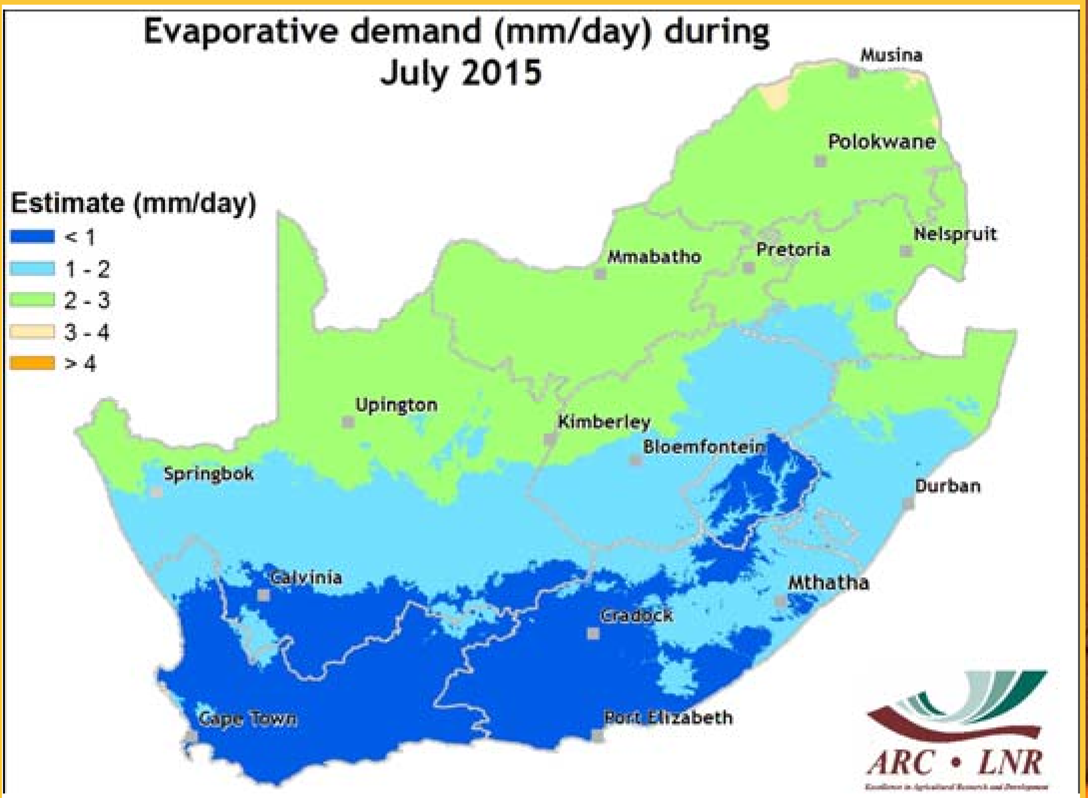

Figure 11

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 was low as expected during winter and ranged from less than 1 mm/day in the south to 3 mm/day in the north.

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.

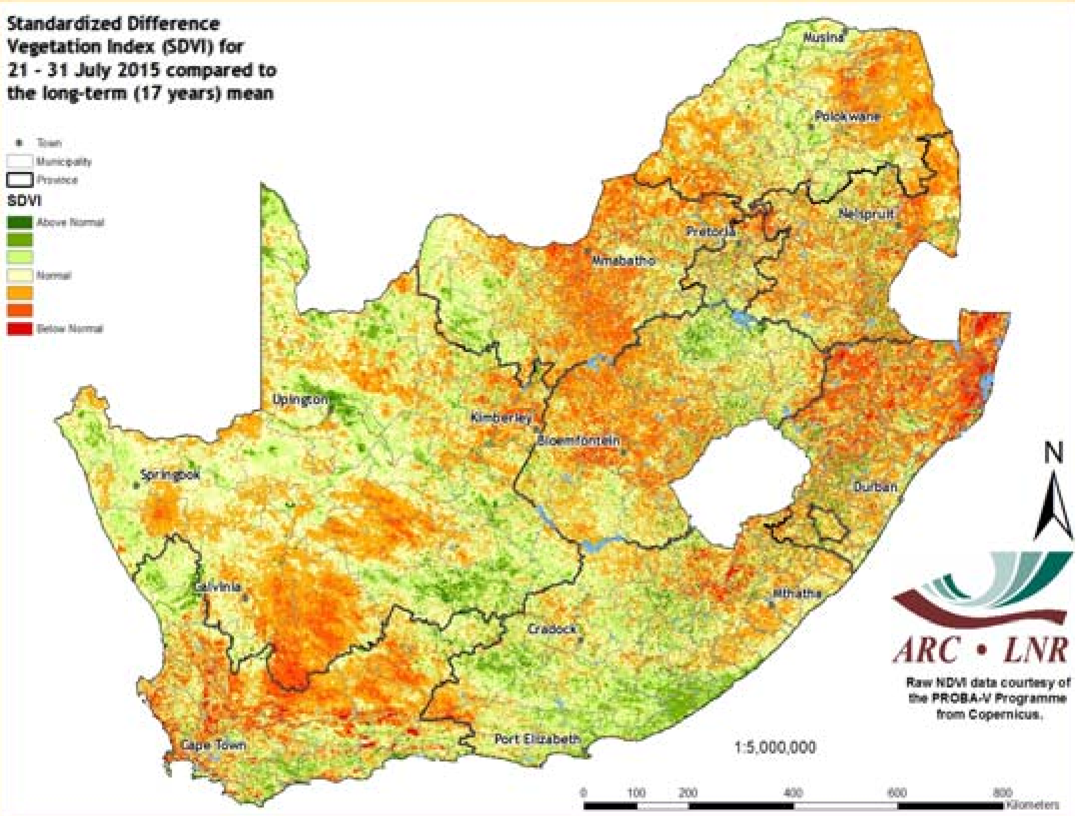

Figure 12

Figure 12:
The SDVI indicates drought stress over the northern parts of KwaZulu-Natal and some of the southwestern parts of the Northern Cape. The southern to southeastern parts of the country are experiencing above-normal vegetation activity.

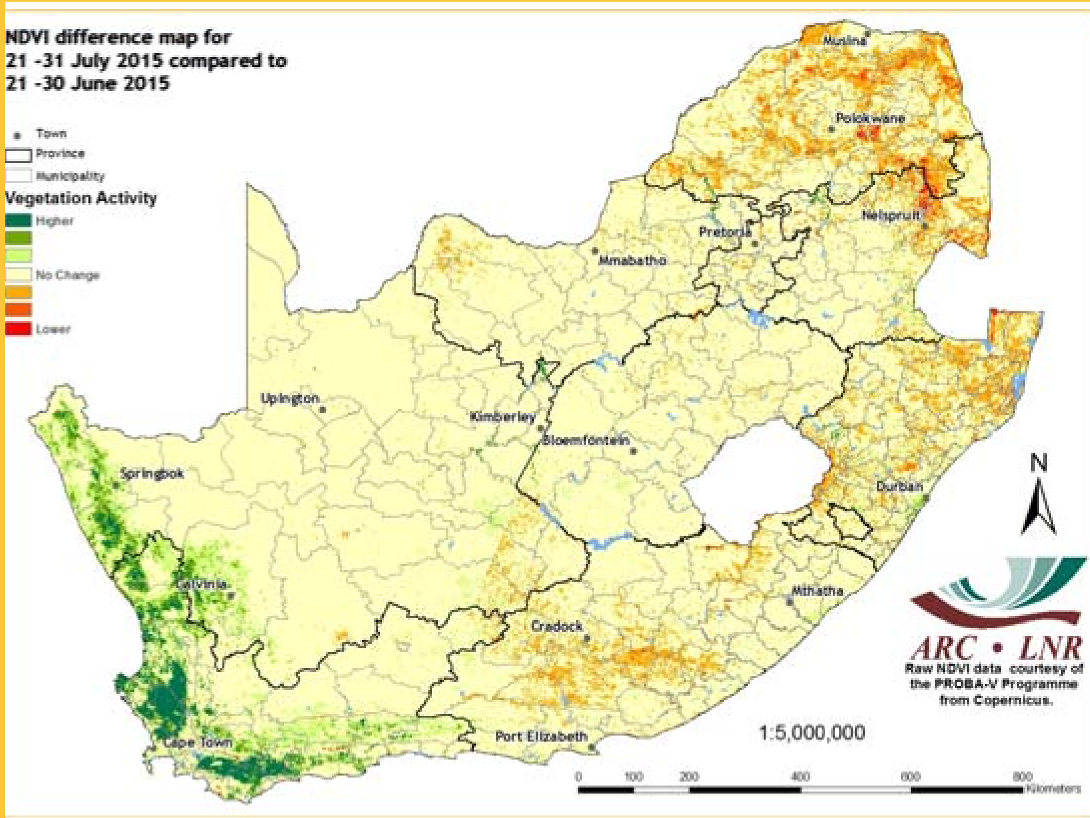

Figure 13

Figure 13:
Widespread rain over the winter rainfall region resulted in a large increase in vegetation activity over this region, particularly the main crop production areas.

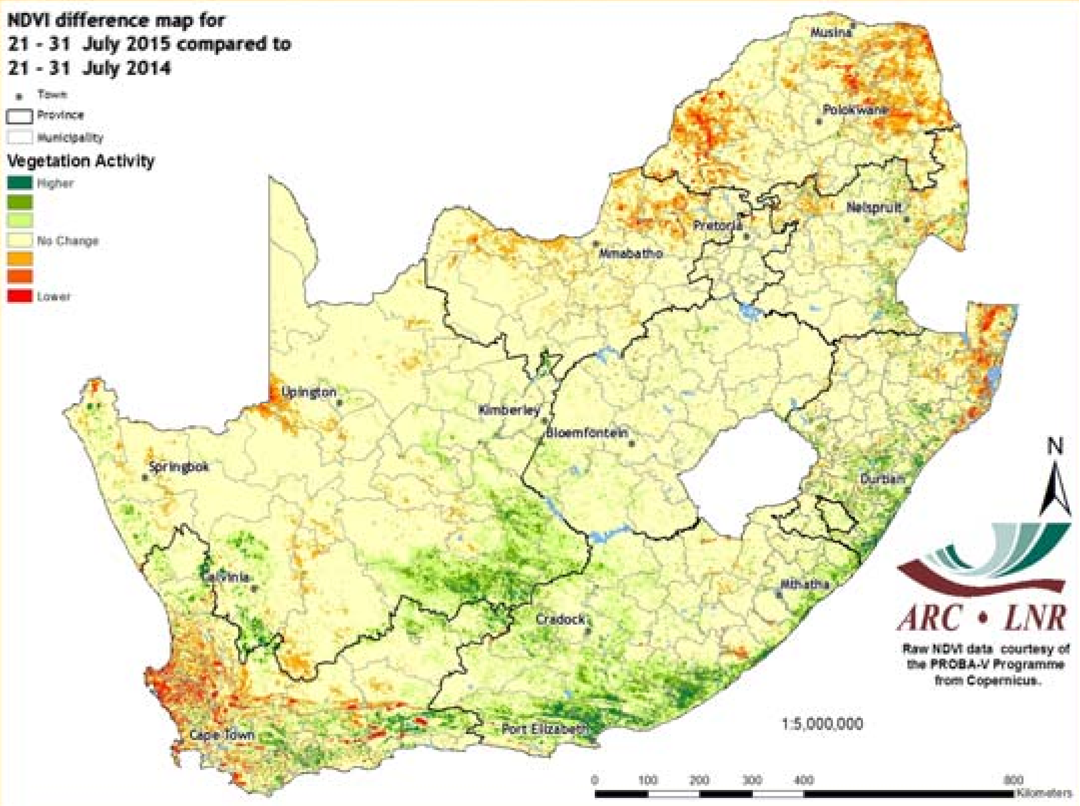

Figure 14

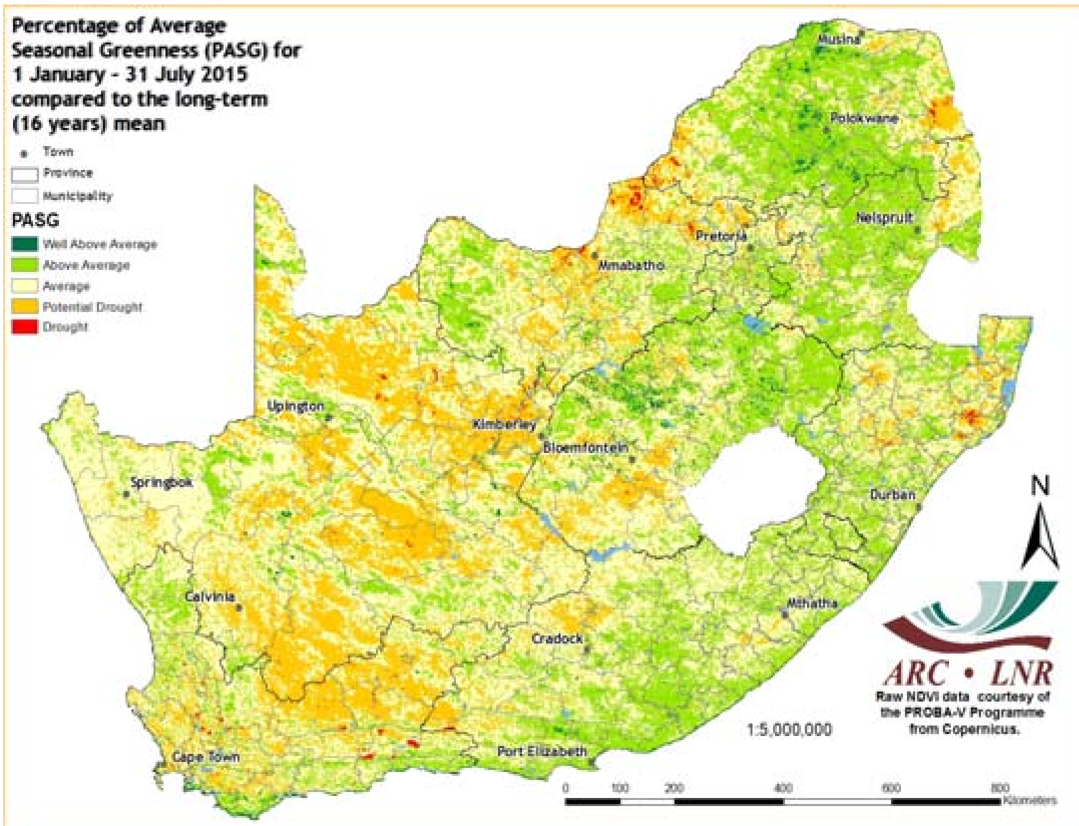

Figure 15

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:
By the end of July, vegetation activity was lower than last year over the western parts of the winter rainfall region (Swartland) and several separate areas in the east and northeast, but higher over the central to southern and southeastern parts.

Figure 15:
Cumulative vegetation activity since January is normal to above normal over much of the interior due to wet conditions during November and December and again by late February to April in some places. Notable exceptions are the eastern parts of KwaZulu-Natal, eastern Mpumalanga, extreme southwestern and southeastern Limpopo, northeastern North West and southern parts of the Northern Cape.

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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.

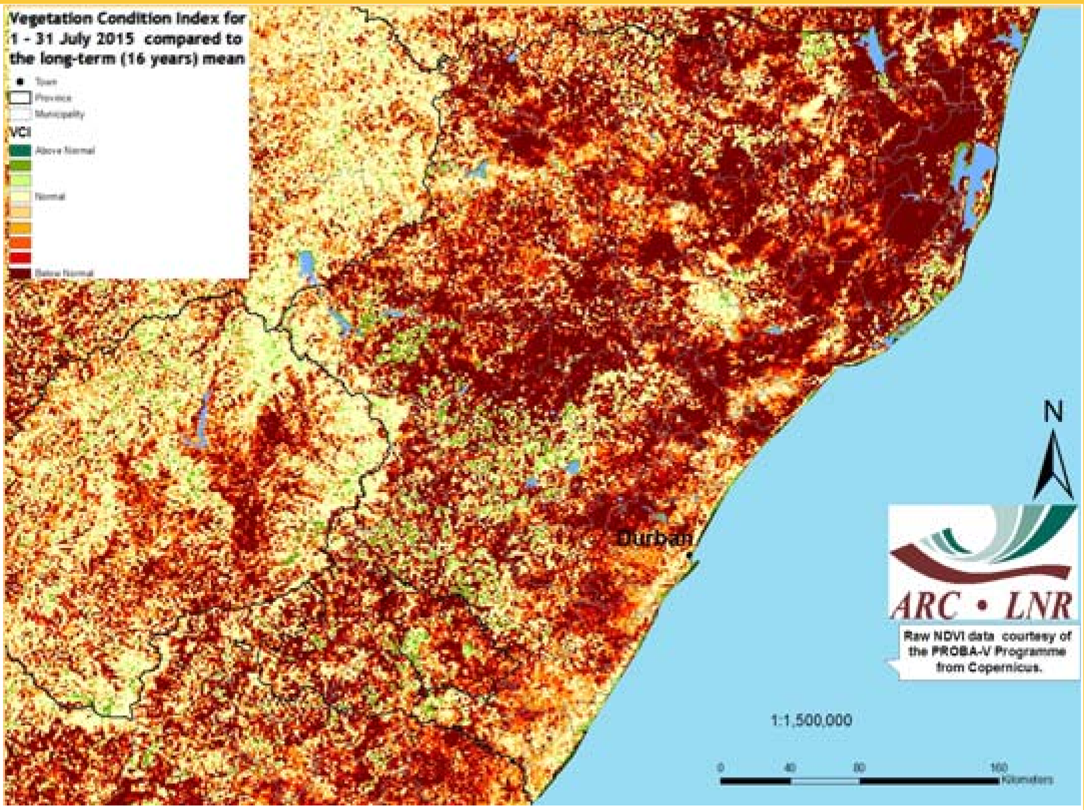


Figure 16

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

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

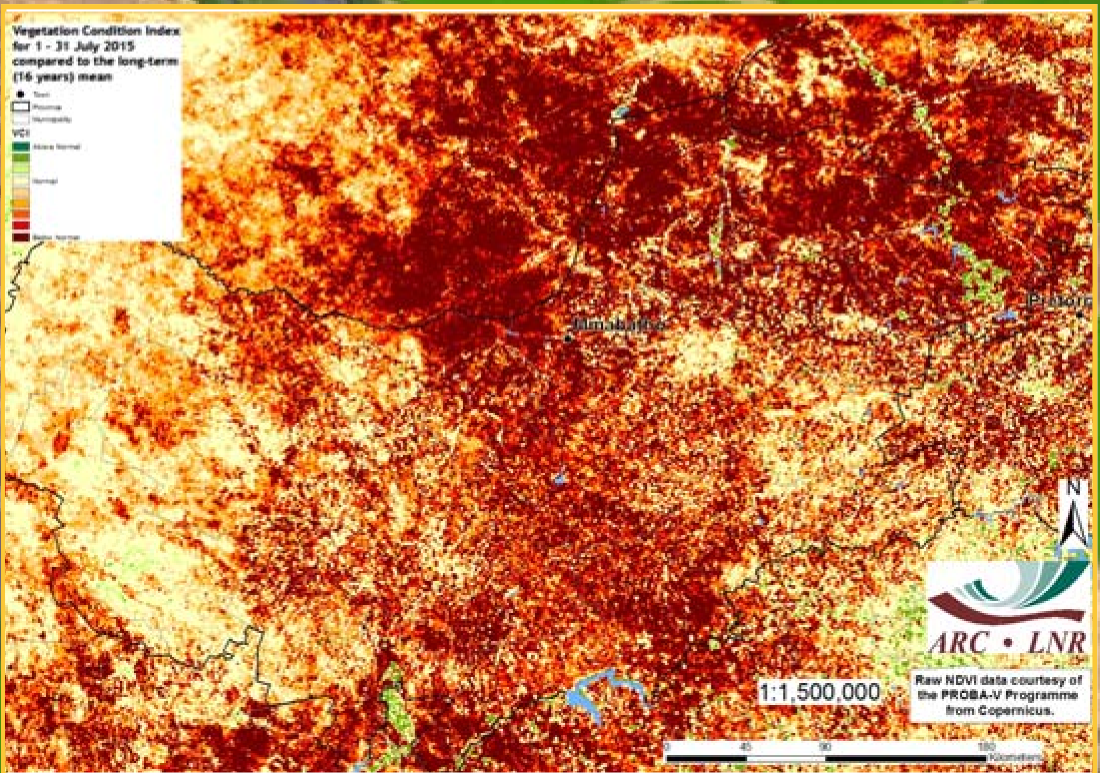
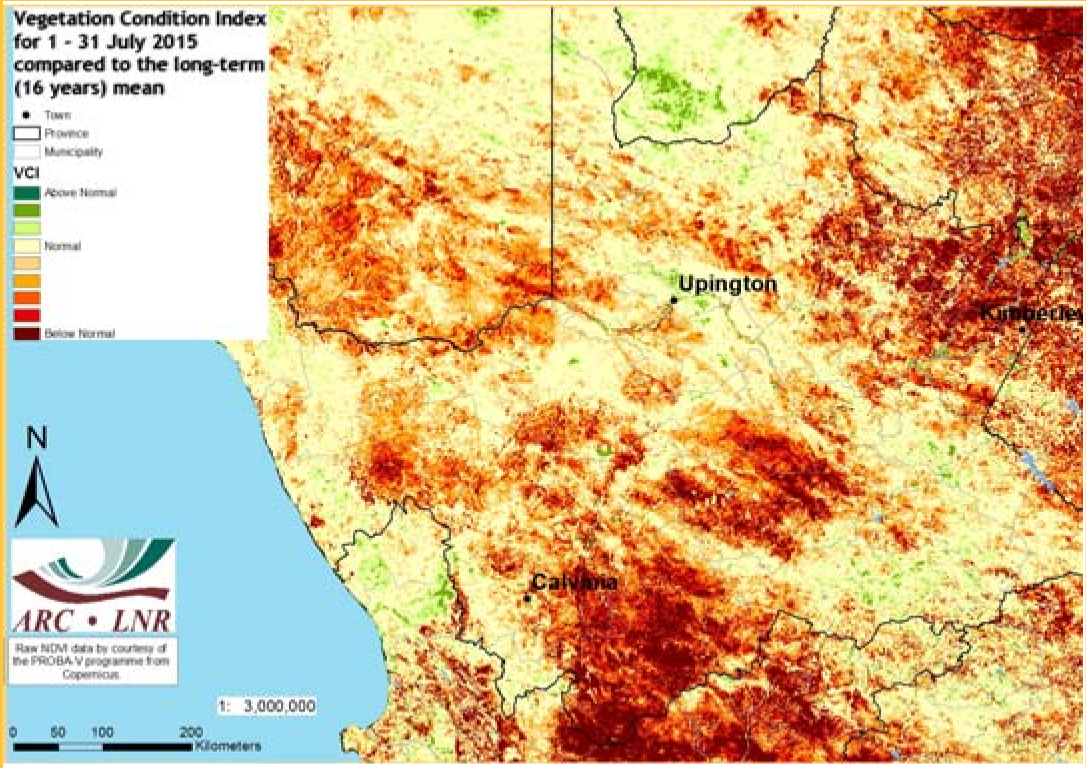


Figure 17



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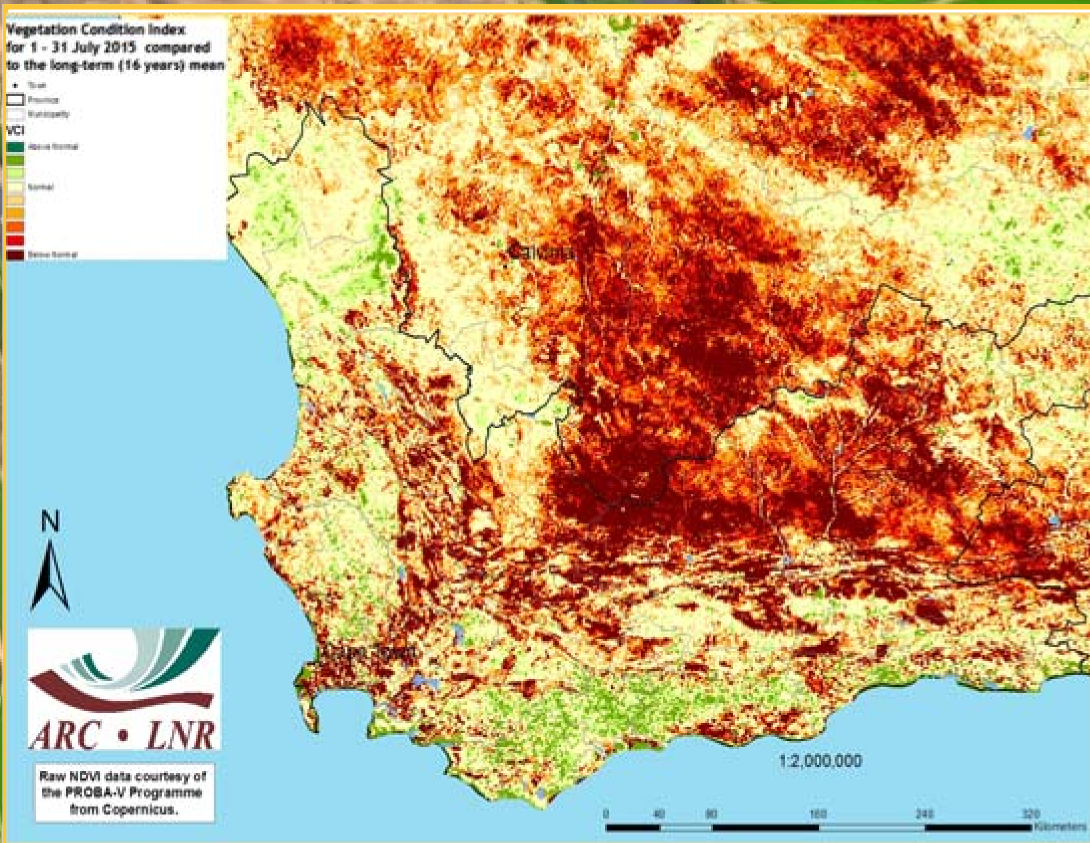

Figure 19

Figure 18:
The VCI map for July indicates below-normal vegetation activity over the central to southern parts of the Northern Cape.

Figure 19:
The VCI map for July indicates above-normal vegetation activity over the northwestern and southern parts and below-normal vegetation activity over the central parts of the Western Cape.

Questions/Comments:
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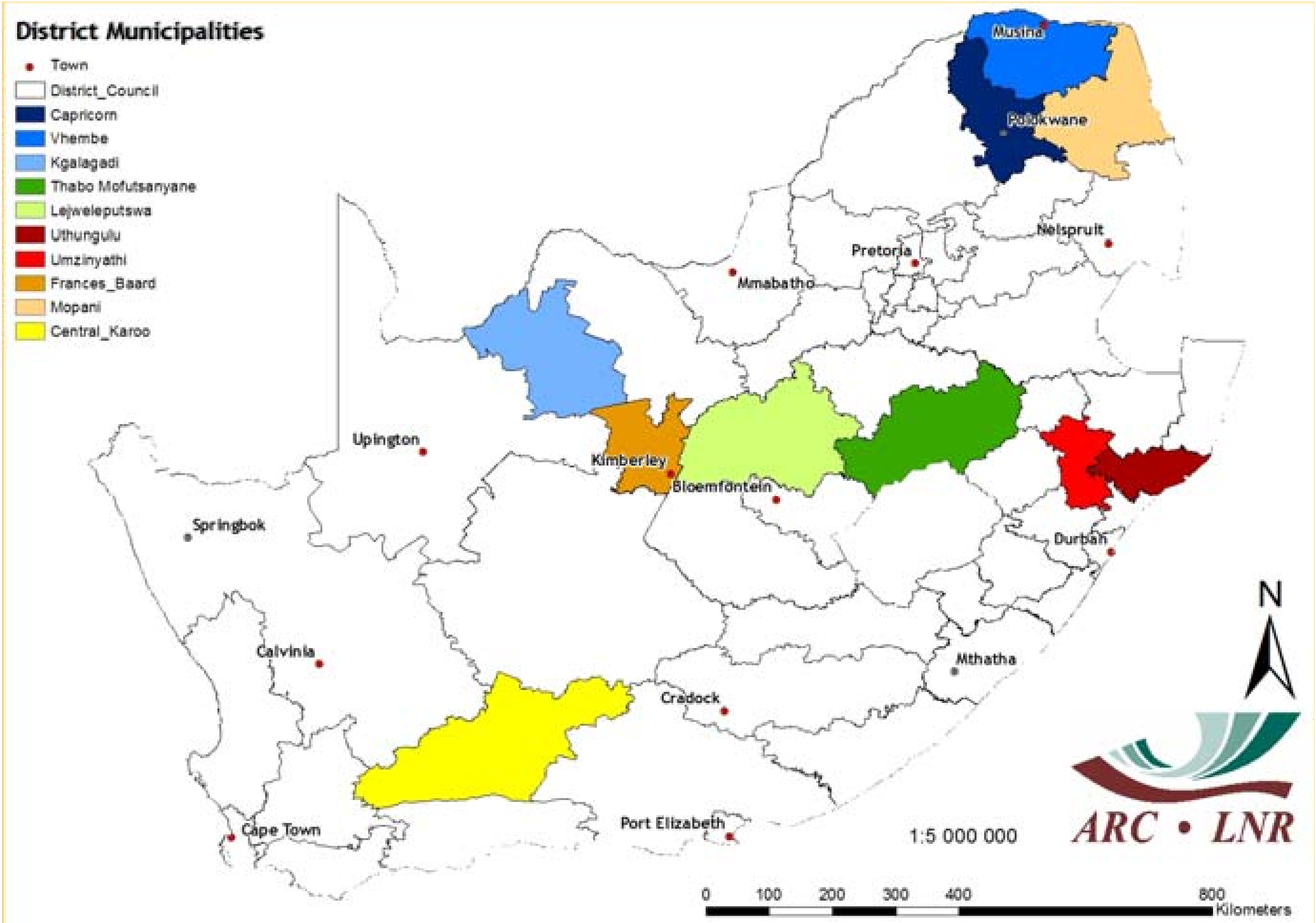
7. Vegetation Conditions & Rainfall



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

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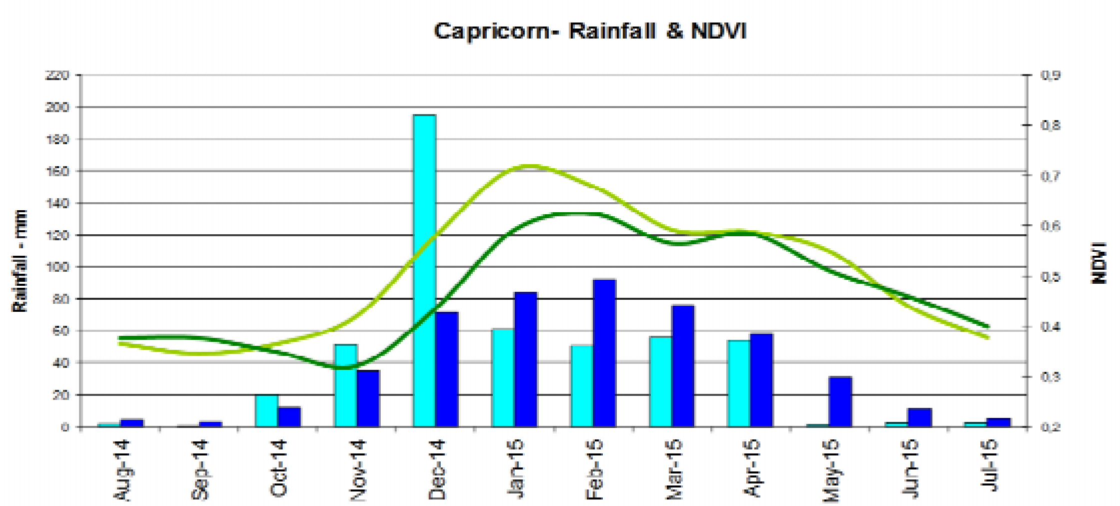
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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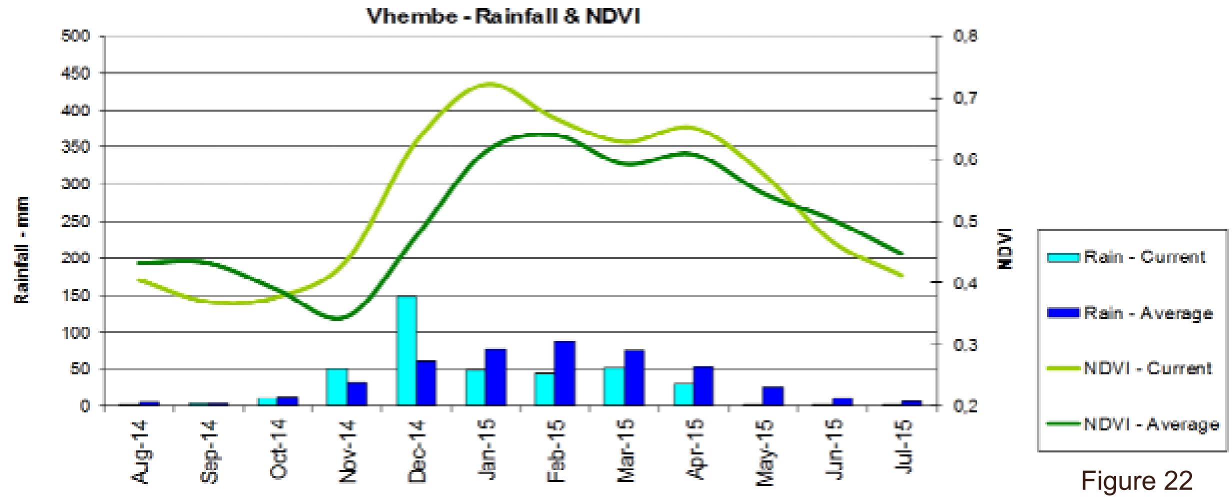

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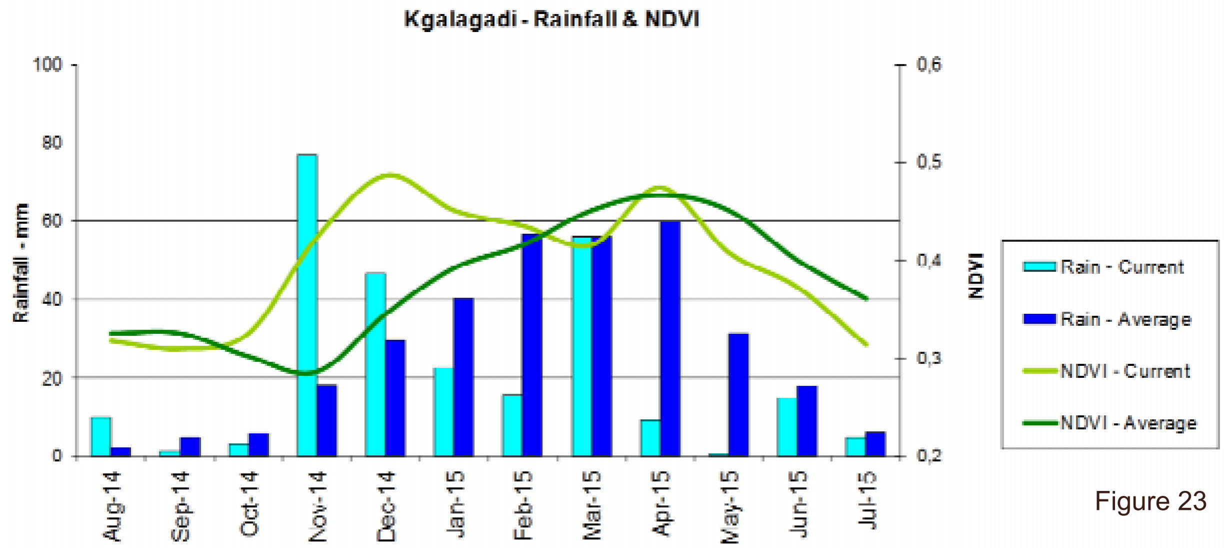

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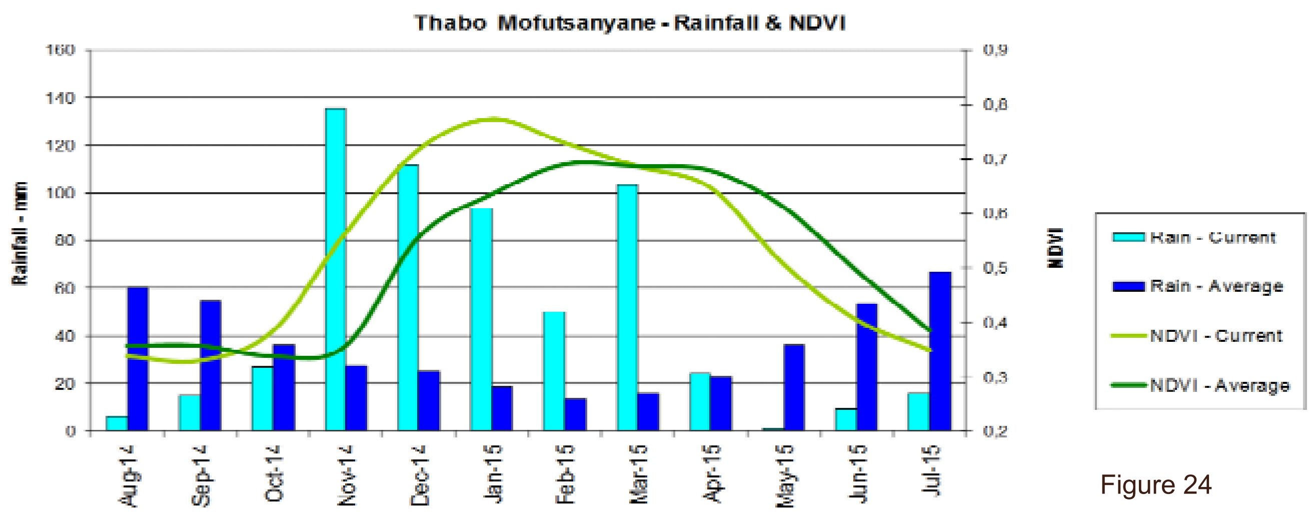
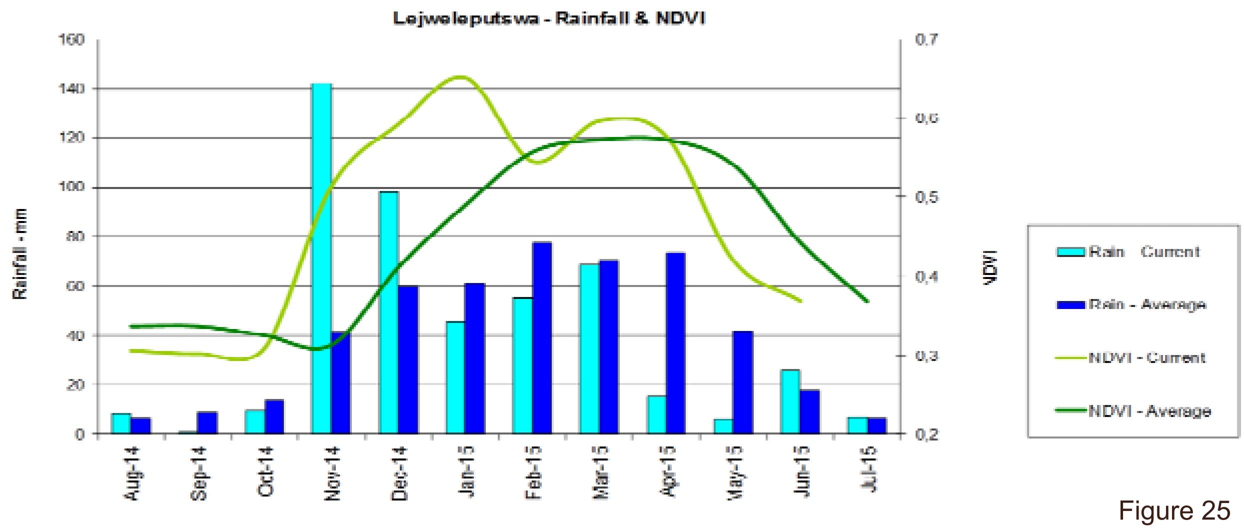


Figure 24

Figure 24



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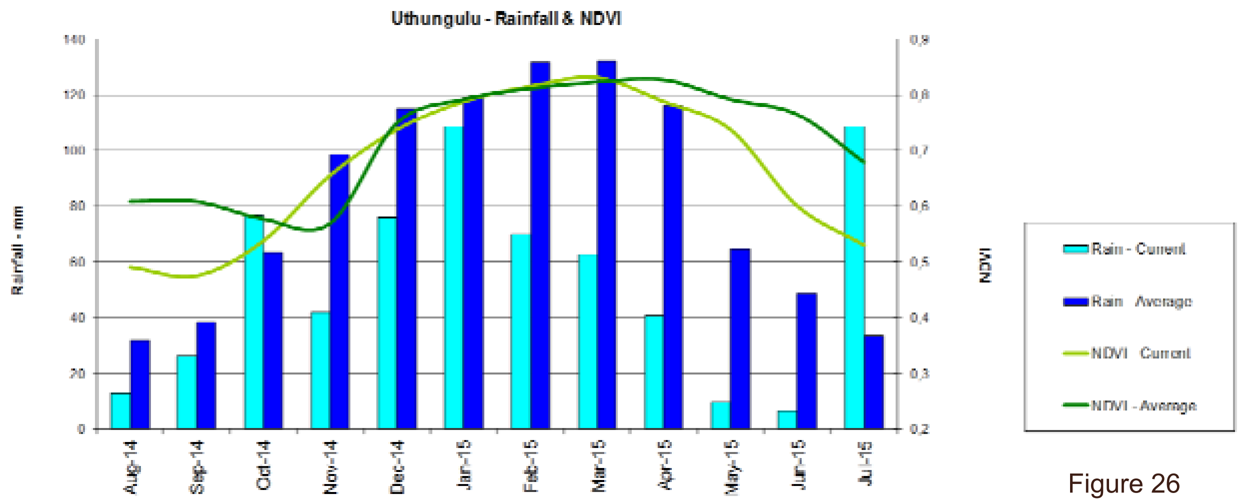
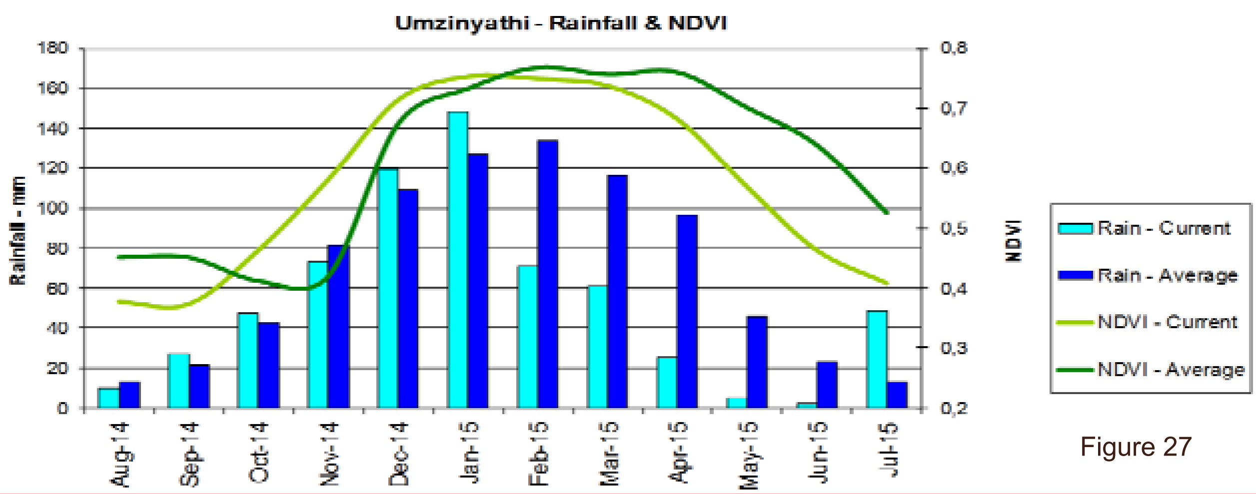


Figure 26



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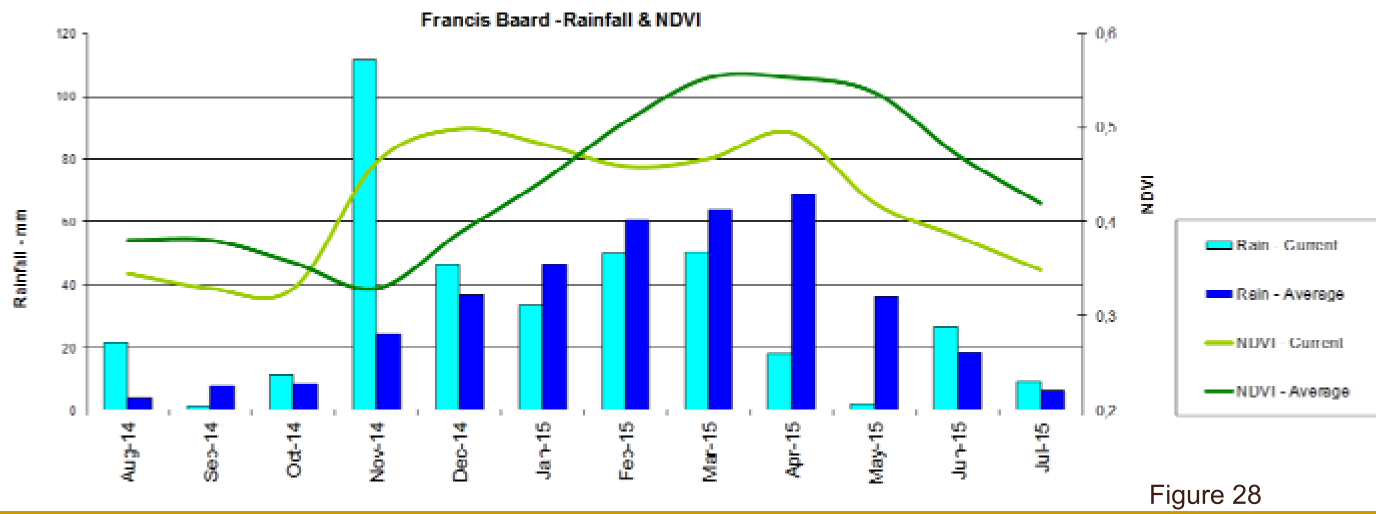

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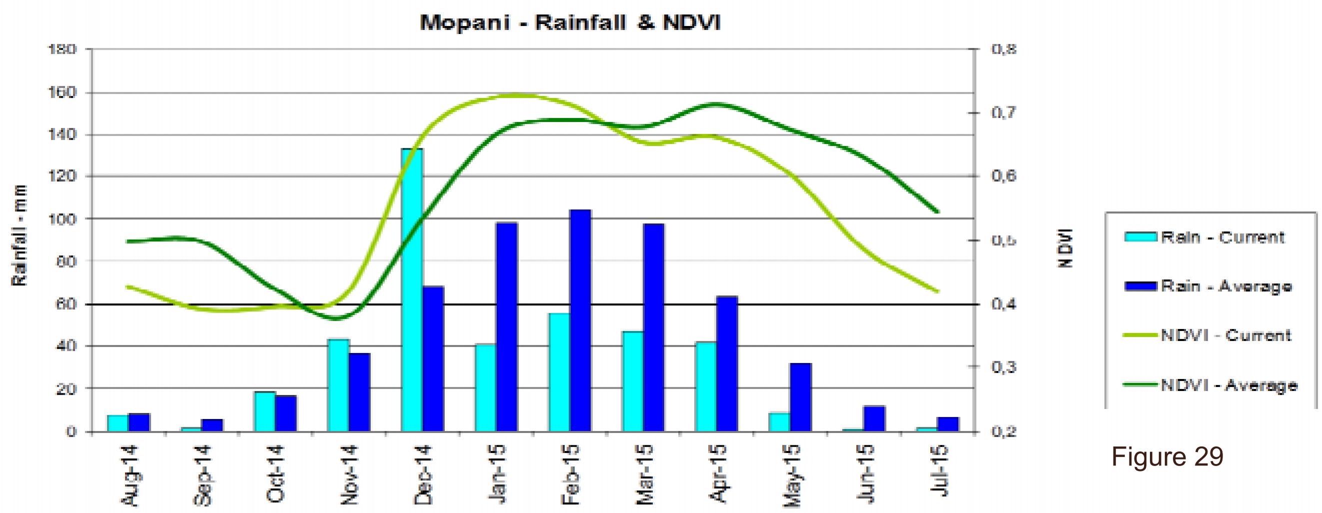

Figure 29

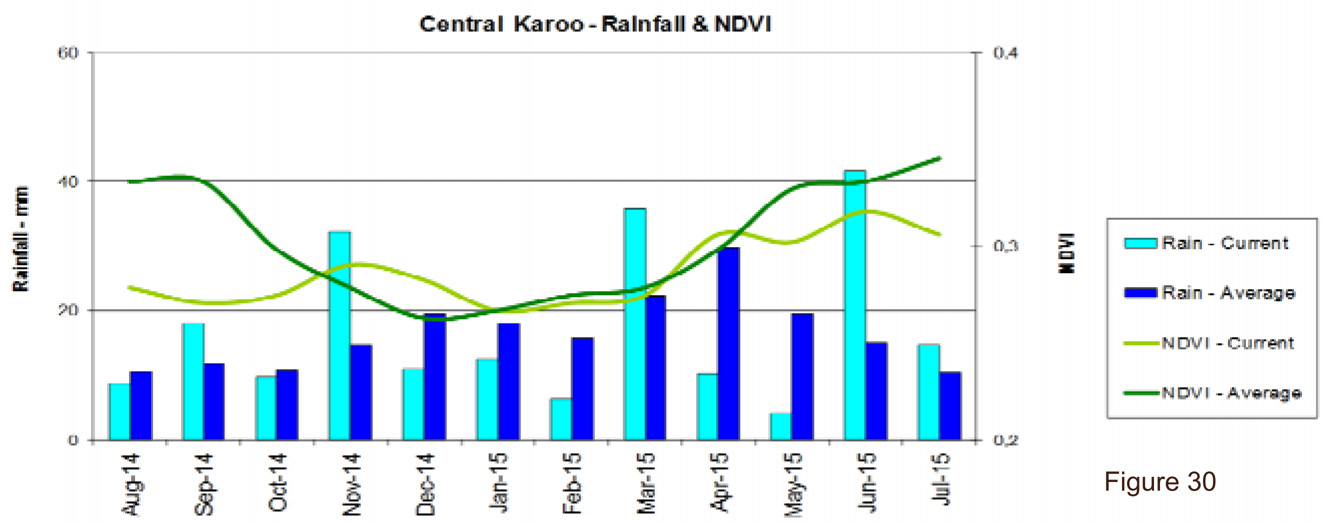

Figure 30

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 July 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 July and June 2015, with the brown colours showing the drier and the green colours the wetter areas. Similarly, the year-on-year SSI difference for July 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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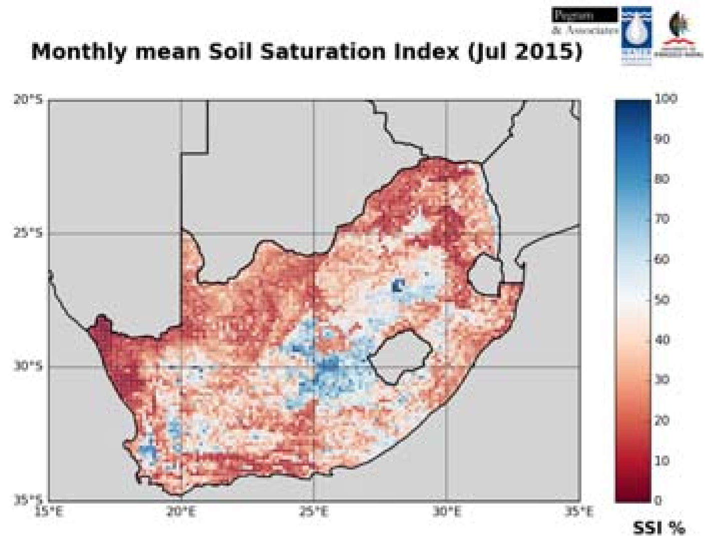

Figure 31

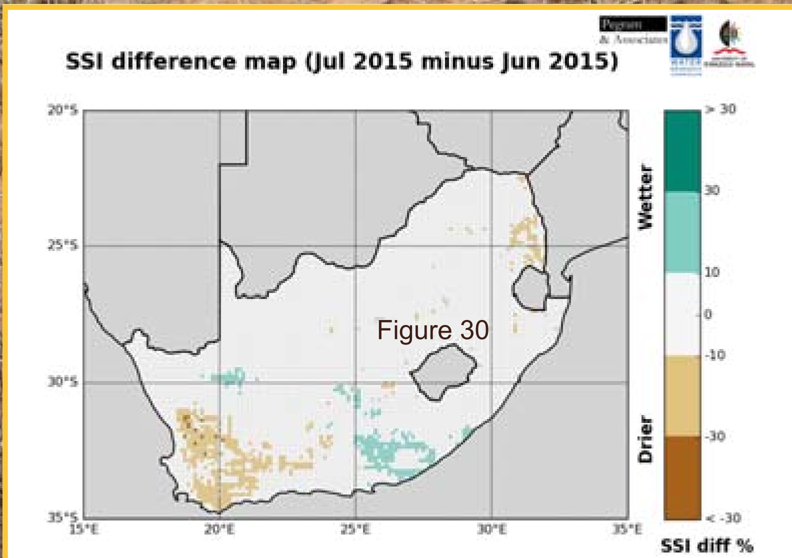

Figure 32

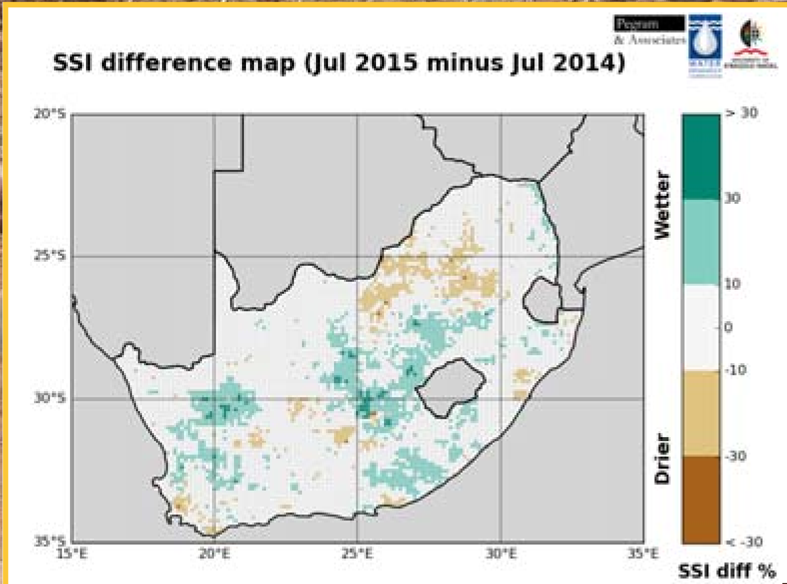

Figure 33

UNIVERSITY OF KWAZULU-NATAL

9. Fire Watch

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.

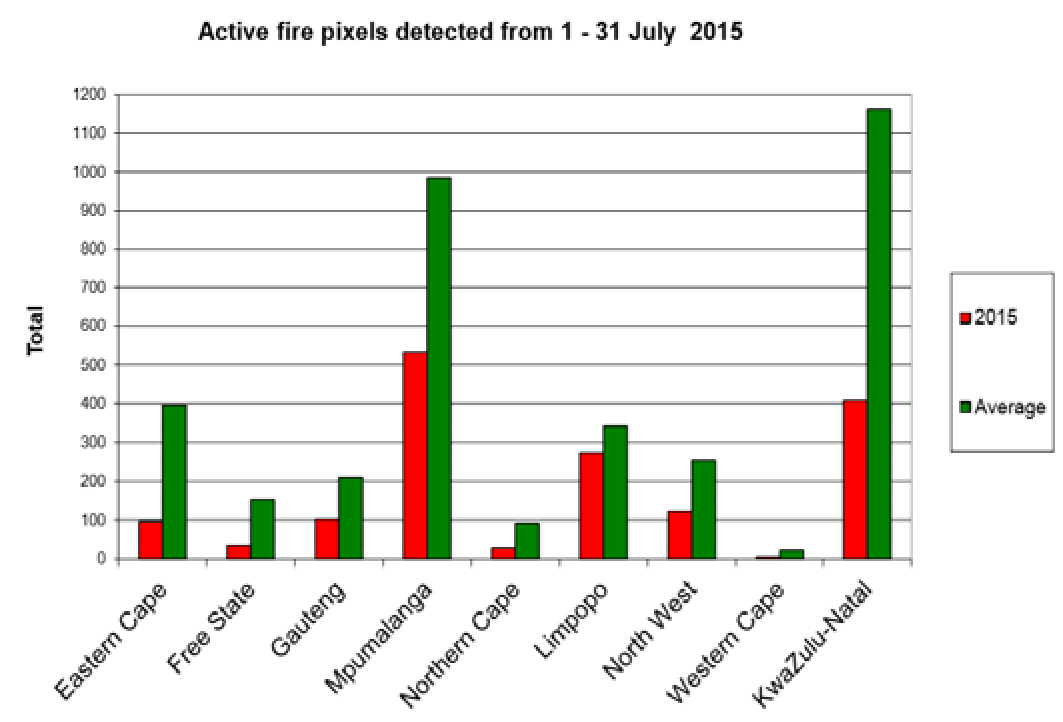

Figure 34

Figure 34:
The graph shows the total number of active fires detected in the month of July 2015 per province. Fire activity was lower than normal in all provinces compared to the average during the same period for the last 14 years.

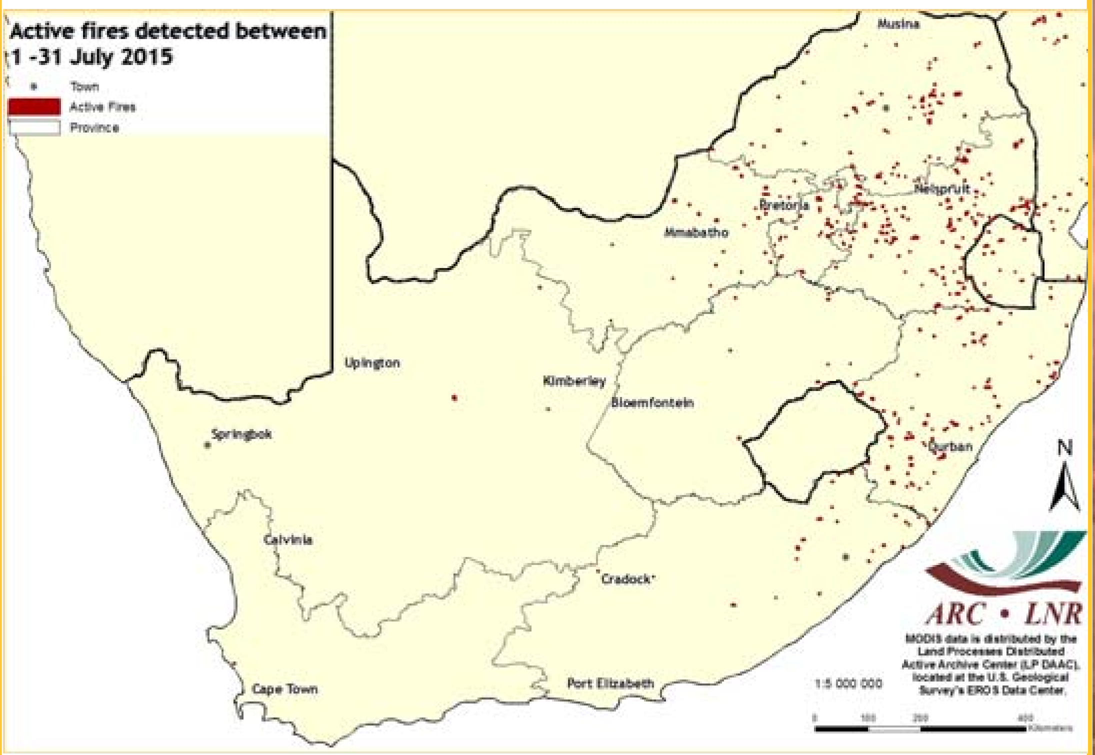

Figure 35

Figure 35:
The map shows the location of active fires detected between 1-31 July 2015.

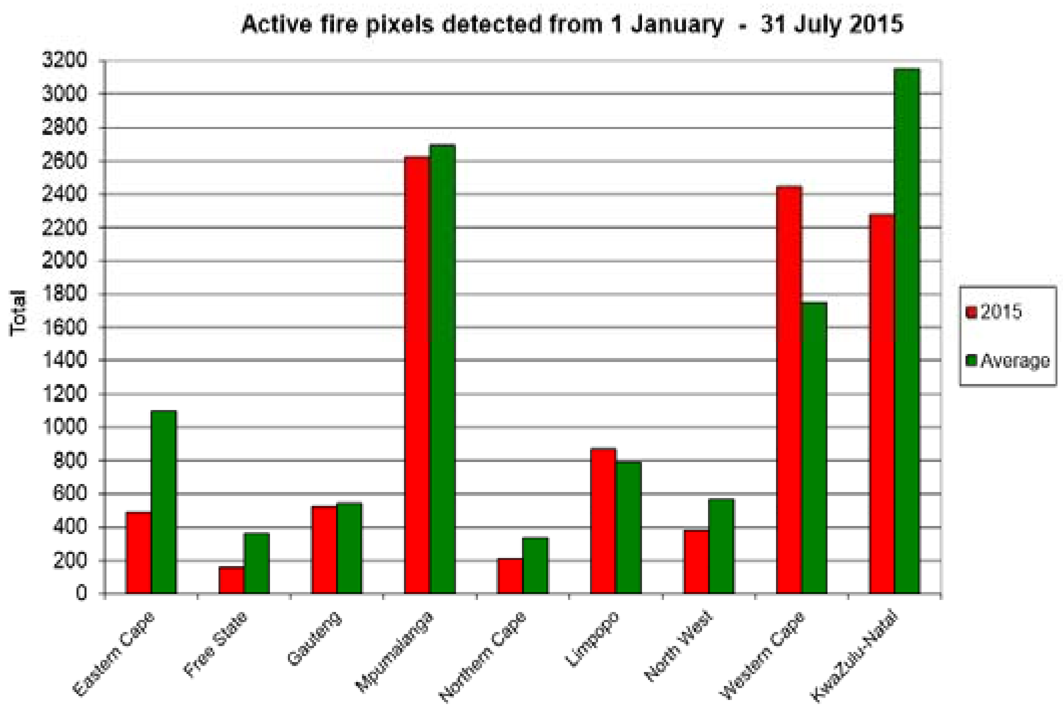

Figure 36

Figure 36:
The graph shows the total number of active fires detected between 1 January to 31 July 2015 per province. Fire activity was lower in all provinces except Limpopo and the Western Cape compared to the average during the same period for the last 14 years.

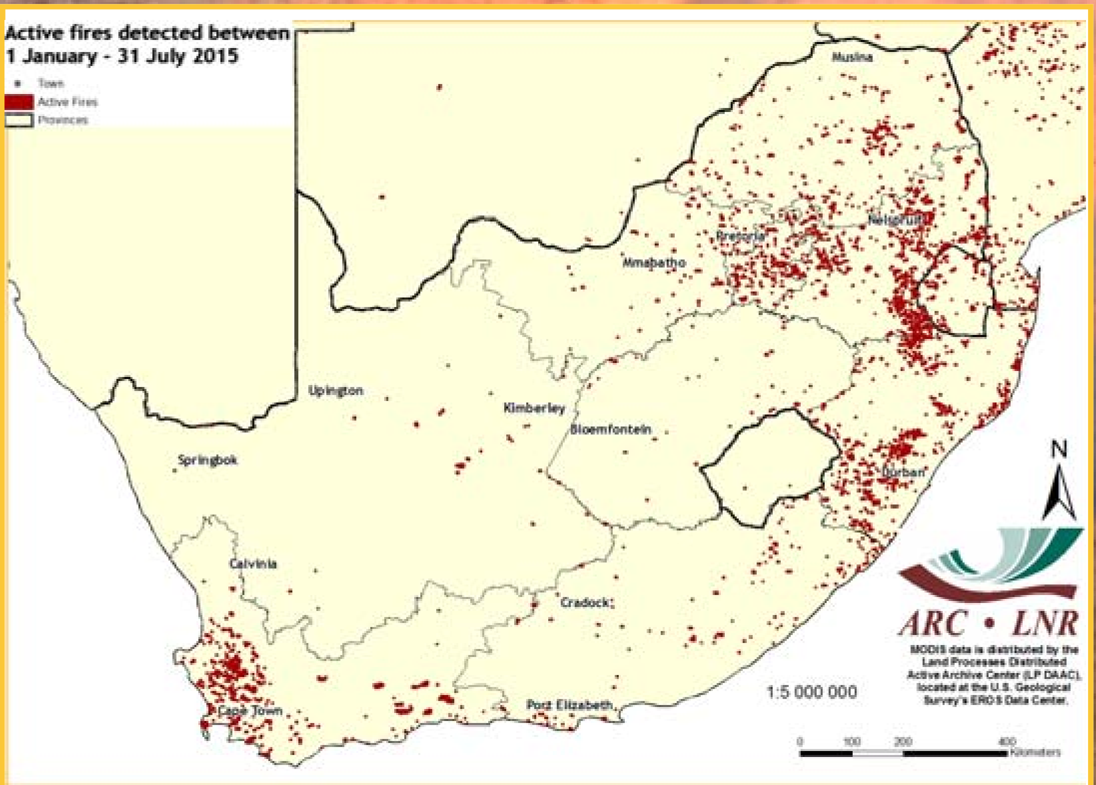

Figure 37

Figure 37:
The map shows the location of active fires detected between 1 January to 31 July 2015.

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Your Partner in Natural Resources Research and Information

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:
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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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Institute for Soil, Climate and Water

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To subscribe to the newsletter, please submit a request to:
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What does Umlindi mean?
UMLINDI is the Zulu word for "the watchman".

http://www.agis.agric.za