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Excellence in Agricultural Research and Development

UMLINDI
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INSTITUTE FOR SOIL, CLIMATE AND WATER

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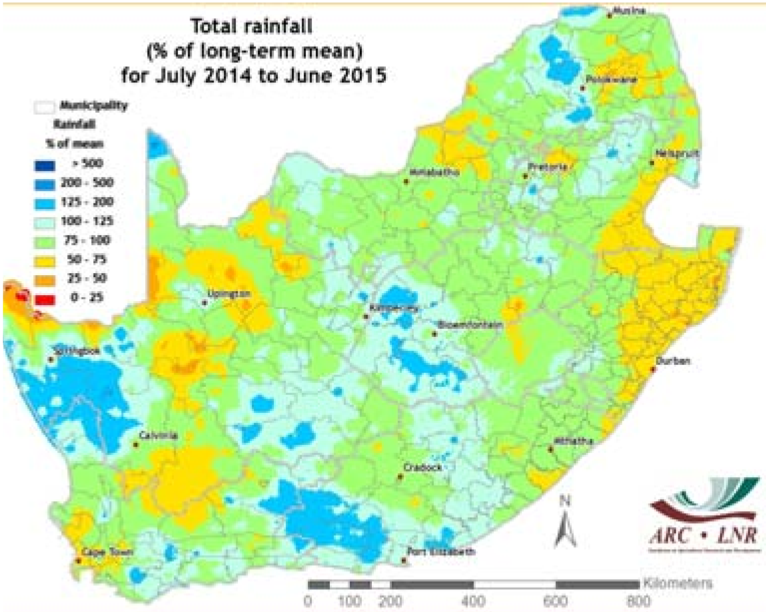
agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

South African Weather Service

AMESD

133rd Edition

Images of the Month



Above- and below-normal rainfall during the 2014/15 summer season

Considered in totality, rainfall during the 2014/15 summer season was near normal (between 75% and 125%) over most of South Africa. However, the map shows that over parts of Limpopo, the western Free State, southeastern parts of the Northern Cape and western parts of the Eastern Cape, seasonal totals were above normal. Areas that received less than 75% of the long-term mean, and can be considered as experiencing drought at this time scale, include northern KwaZulu-Natal, southeastern Mpumalanga and central to southern Northern Cape. Even though seasonal totals over most of the maize production region were near normal, much of this was contributed by wet conditions during November and December. A particularly dry spell over the central interior during the first half of February, coupled with extremely high maximum temperatures, resulted in crop failures scattered over both production regions. Near-normal rainfall during January and March had little positive effect owing to the sensitive period for maize during which the extreme conditions occurred.

Widespread above-normal rainfall over the interior and winter rainfall region

The MSG-3 SEVIRI colour composite for 10:00 SAST on 11 June shows a cloud mass over the interior, associated with a cut-off low moving across the central parts. This was the second of three major rain-producing lows resulting in above-normal totals over most of the central to western and southern parts and light snow over the high-lying southern interior. Cold air invaded the country on each occasion, resulting in sharp temperature decreases following these systems. The winter rainfall region also benefitted from the rainfall associated with the surface cold fronts with these systems even though rainfall over the Swartland was slightly below normal. The eastern and northeastern parts of the country, including the drought-stricken northern KwaZulu-Natal, received very little precipitation as wind direction was mostly offshore while upper air lows weakened or veered towards the southeast after reaching the central parts.

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:

The central to western interior received exceptionally high rainfall during June 2015 due to no less than three upper-air cut-off lows making their way across the interior during the month, while another moved over the southern extremes. Each system was associated with a surface cold front, resulting in cold conditions sweeping from west to east across the country with each system. The cold fronts and onshore flow also resulted in wet conditions over much of the winter rainfall region, although totals were somewhat lower over the western grain production region (Swartland) of the Western Cape. Major precipitation events over the interior, associated with cut-off lows, were concentrated around the 2nd, 10th ,15th (only in the south) and 25th. Associated frontal activity also resulted in the highest falls across the winter rainfall region during the same periods. Temperatures on average were near normal to above normal over the central interior, but near normal over the southwestern parts. With cold air invading the country with each low pressure system, the lowest minimum temperatures were recorded between the 5th and 7th, around the 12th, 16th to 19th and again by the 24th. Temperatures increased somewhat towards the end of the month, especially over the central parts, with an anticyclonic circulation pattern dominating. A high pressure system towards the east also advected some moisture into the northeast, with light showers especially along the Escarpment during the last few days of the month.

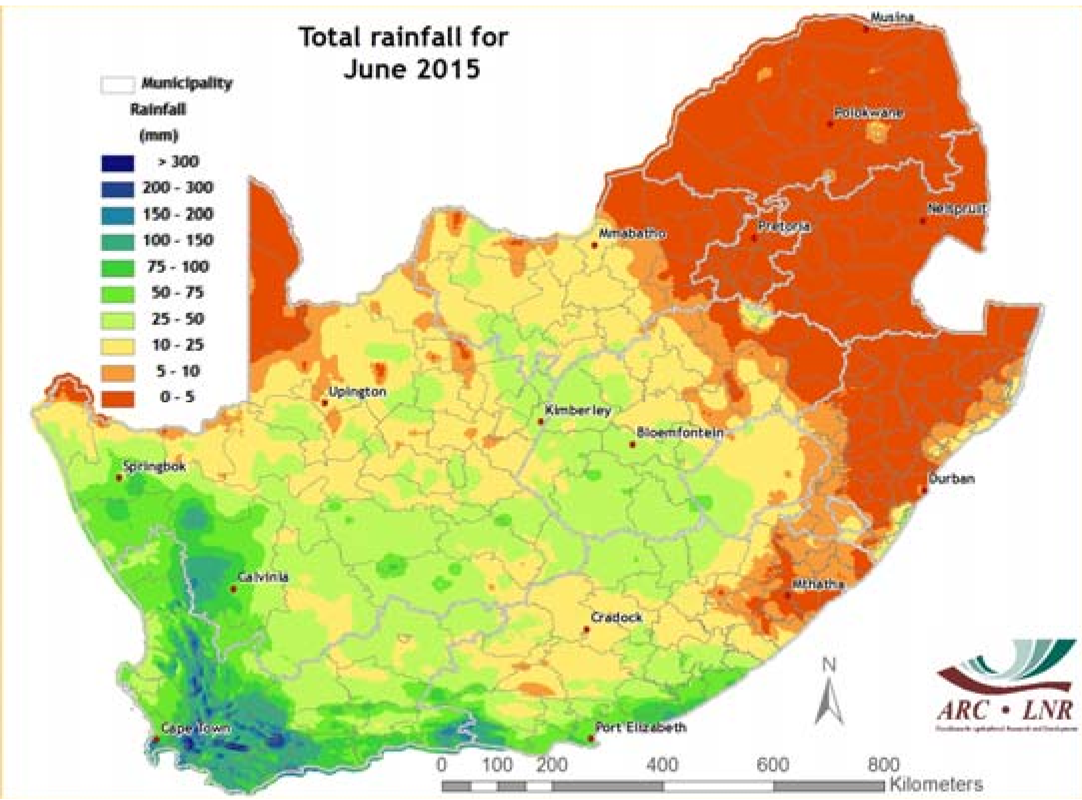


Figure 1

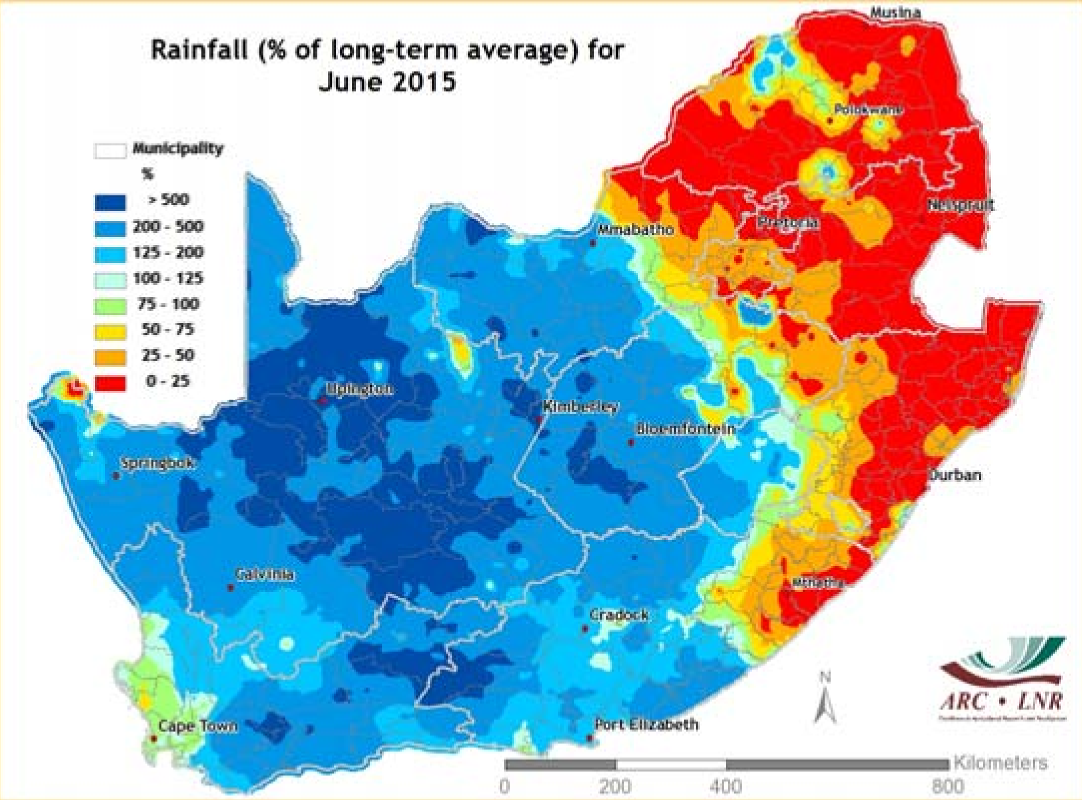
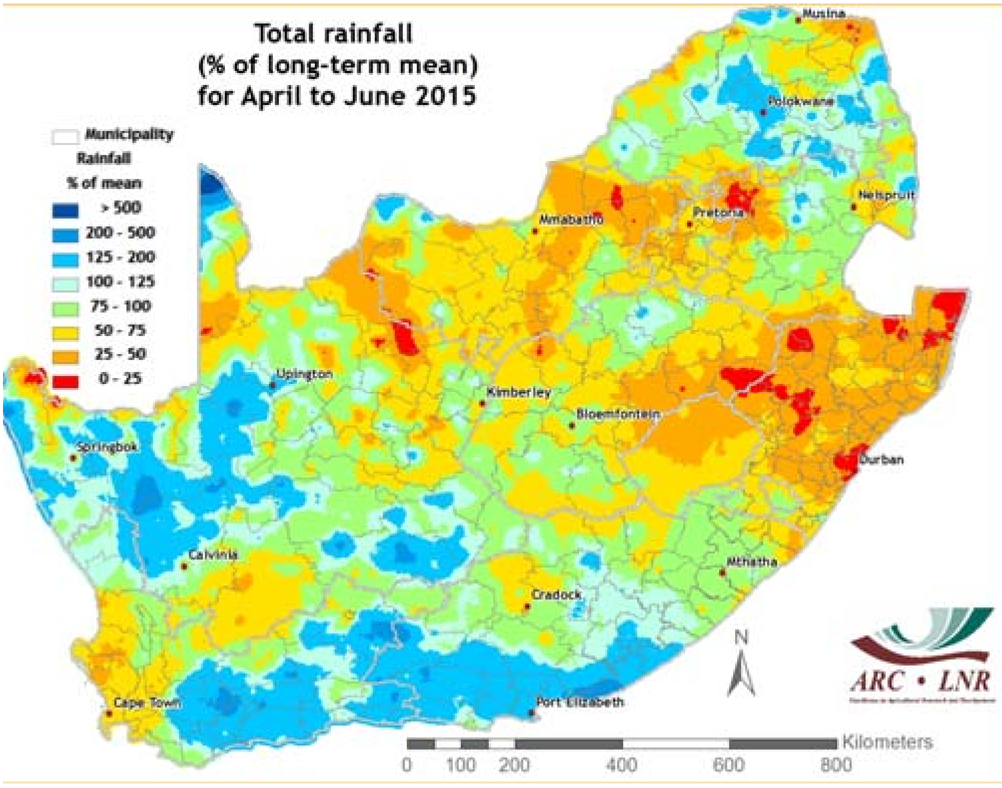


Figure 2



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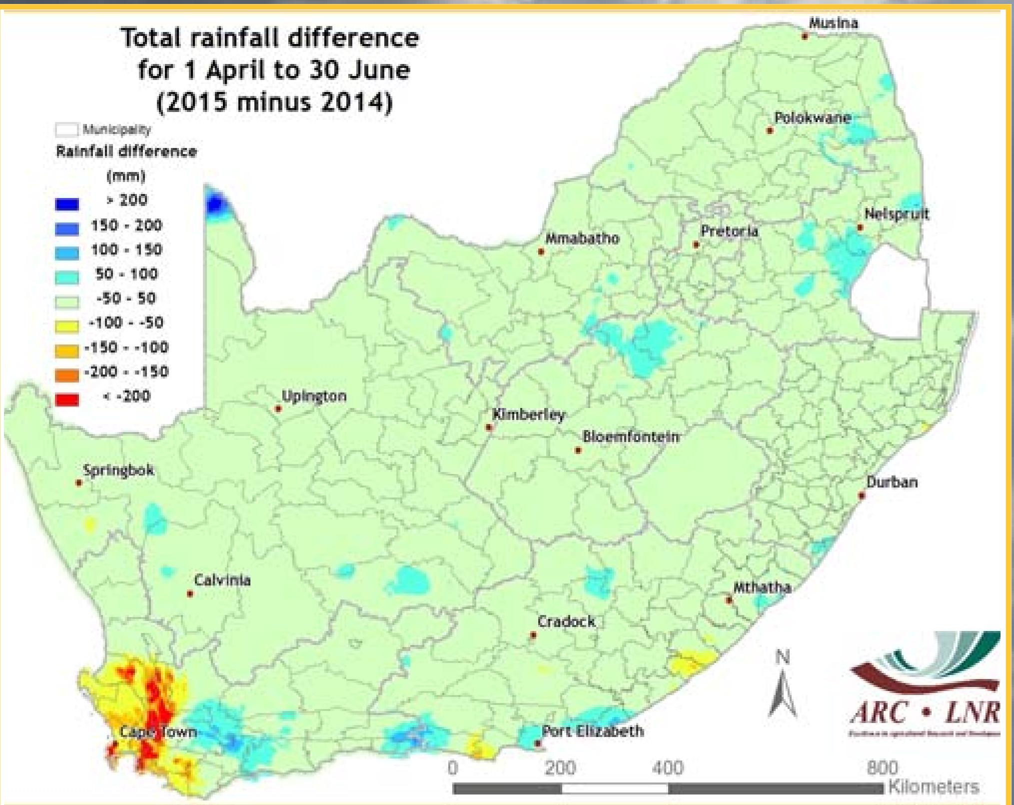

Figure 4

Figure 1:
Most of the central to western interior received between 10 and 50 mm of rain during June. Totals exceeded 50 mm over much of the winter rainfall region, with higher falls (in some cases more than 200 mm) over the Boland, western Escarpment and along the Garden Route.

Figure 2:
The western two thirds of the country (except for the western parts of the winter rainfall region) received above-normal precipitation during June while the eastern and northeastern parts received below-normal precipitation.

Figure 3:
Cumulative rainfall since April is above normal over the southwestern and northeastern parts of the country and below normal over the central parts to KwaZulu-Natal. Precipitation over the western winter rainfall region was below normal during this period, but above normal over the eastern winter rainfall region.

Figure 4:
The western parts of the winter rainfall region experienced much less rain during April-to-June this year than for 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 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. Welcome rain during June has reduced the area experiencing severe to extreme drought at the shorter time scales over the winter rainfall region substantially.

Questions/Comments:
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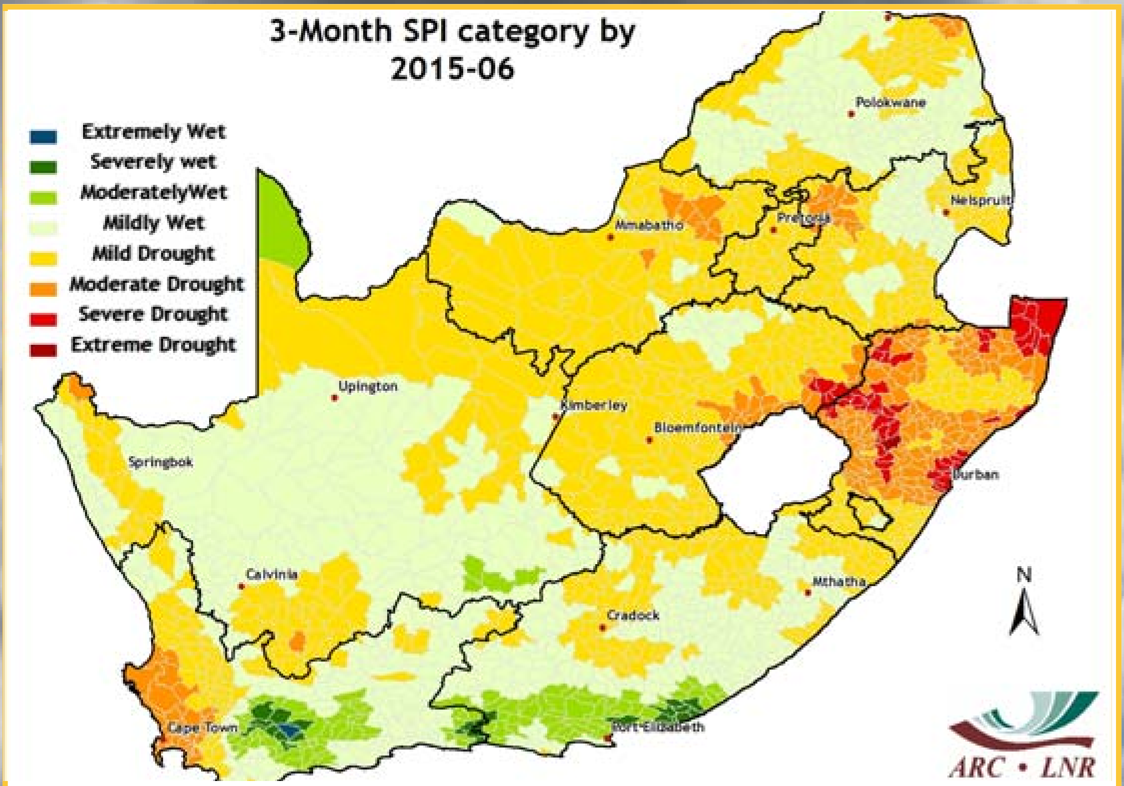


Figure 5

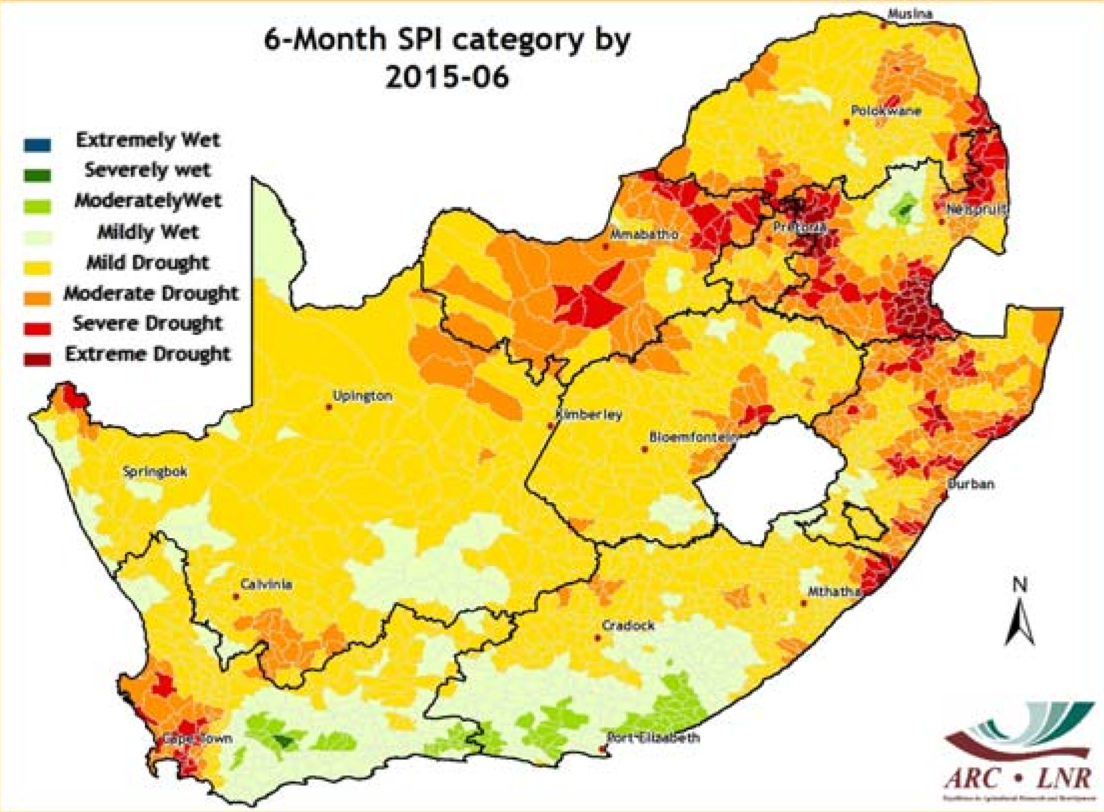
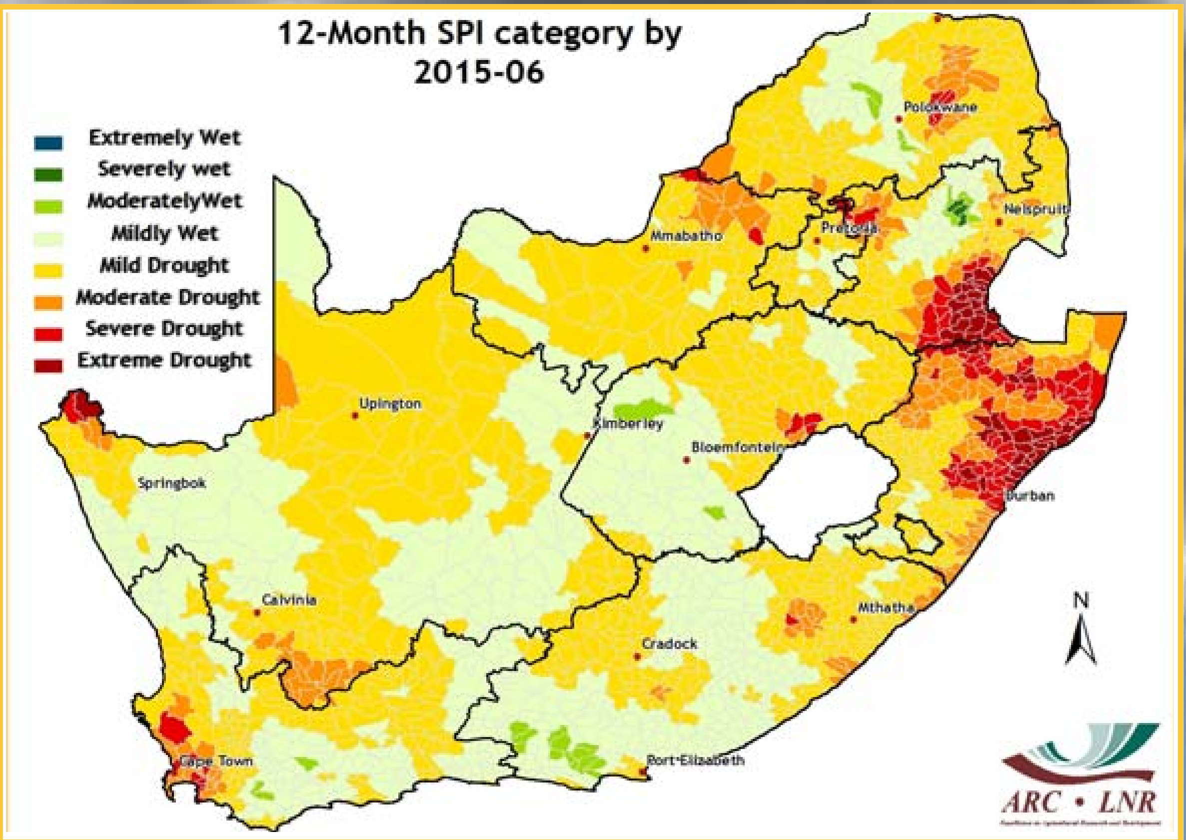


Figure 6


12-Month SPI category by
2015-06
Extremely Wet
Severely wet
ModeratelyWet
Mildly Wet
Mild Drought
Moderate Drought
Severe Drought
Extreme Drought
Polokwane
Nelspruit
Mmabatho
Pretoria
Upington
Kimberley
Bloemfontein
Springbok
Durban
Calvinia
Mthatha
Cradock
Cape Town
Port Elizabeth
N
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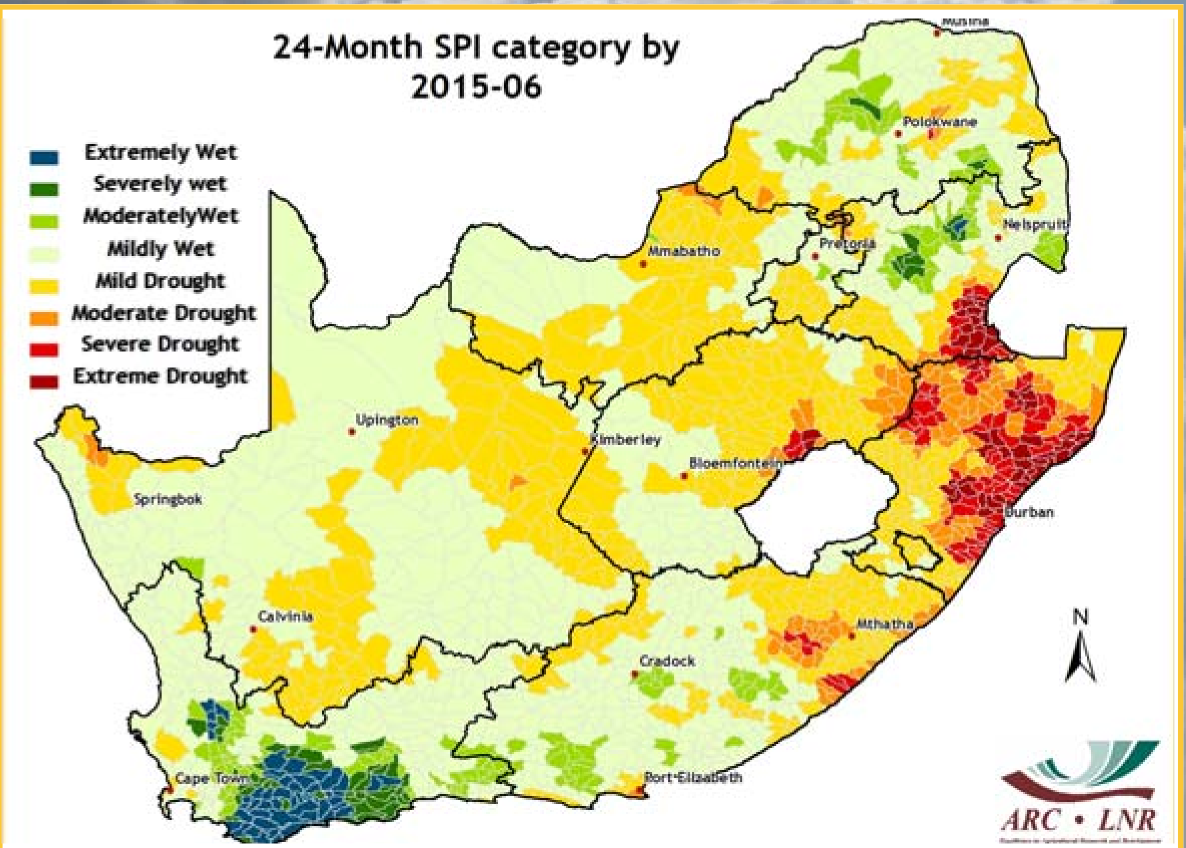
24-Month SPI category by
2015-06
Extremely Wet
Severely wet
ModeratelyWet
Mildly Wet
Mild Drought
Moderate Drought
Severe Drought
Extreme Drought
Polokwane
Nelspruit
Mmabatho
Pretoria
Upington
Kimberley
Bloemfontein
Springbok
Durban
Calvinia
Mthatha
Cradock
Cape Town
Port Elizabeth
N
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Figure 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.

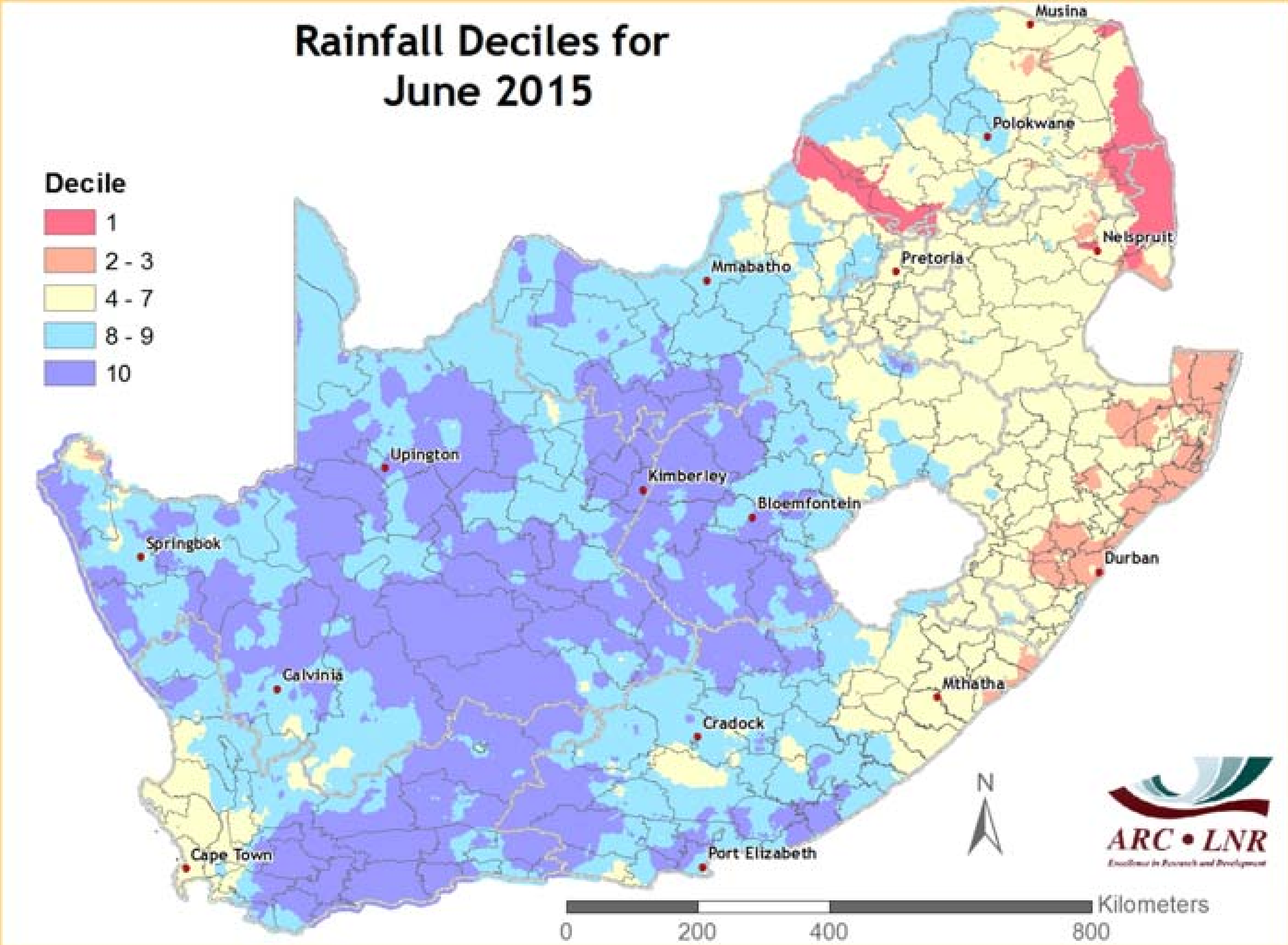

Figure 9

Figure 9:
The central to western and southern parts of the country were exceptionally wet during June.

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

4. Water Balance

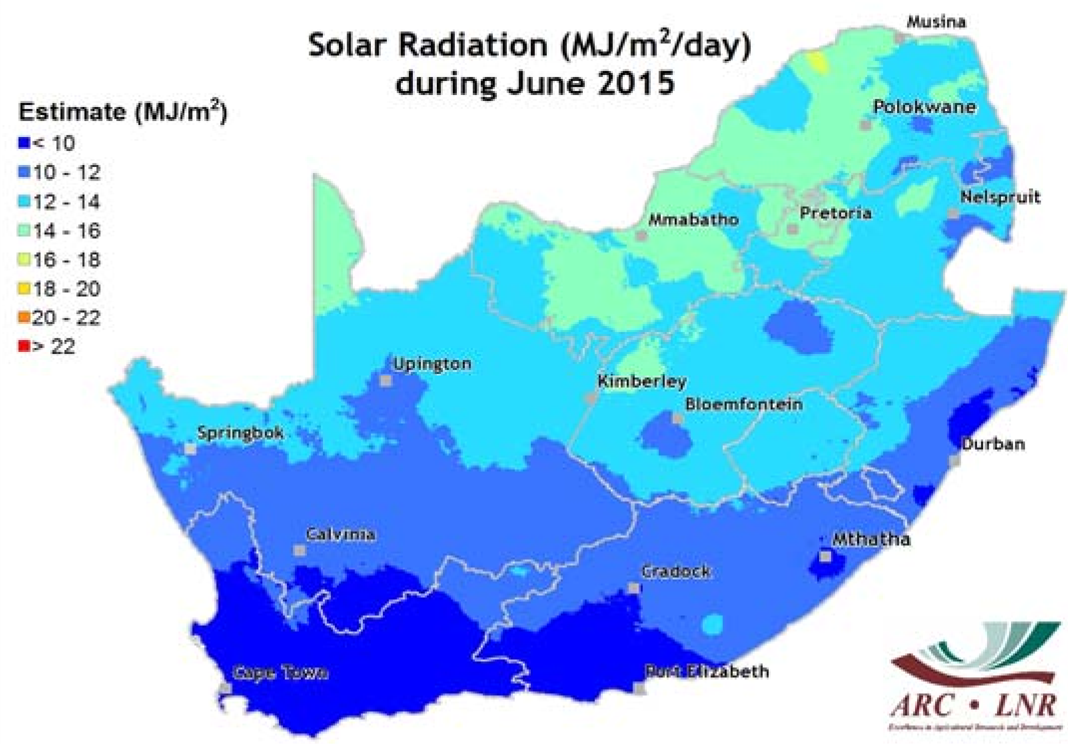

Figure 10

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 values were low during June, especially over the southern parts.

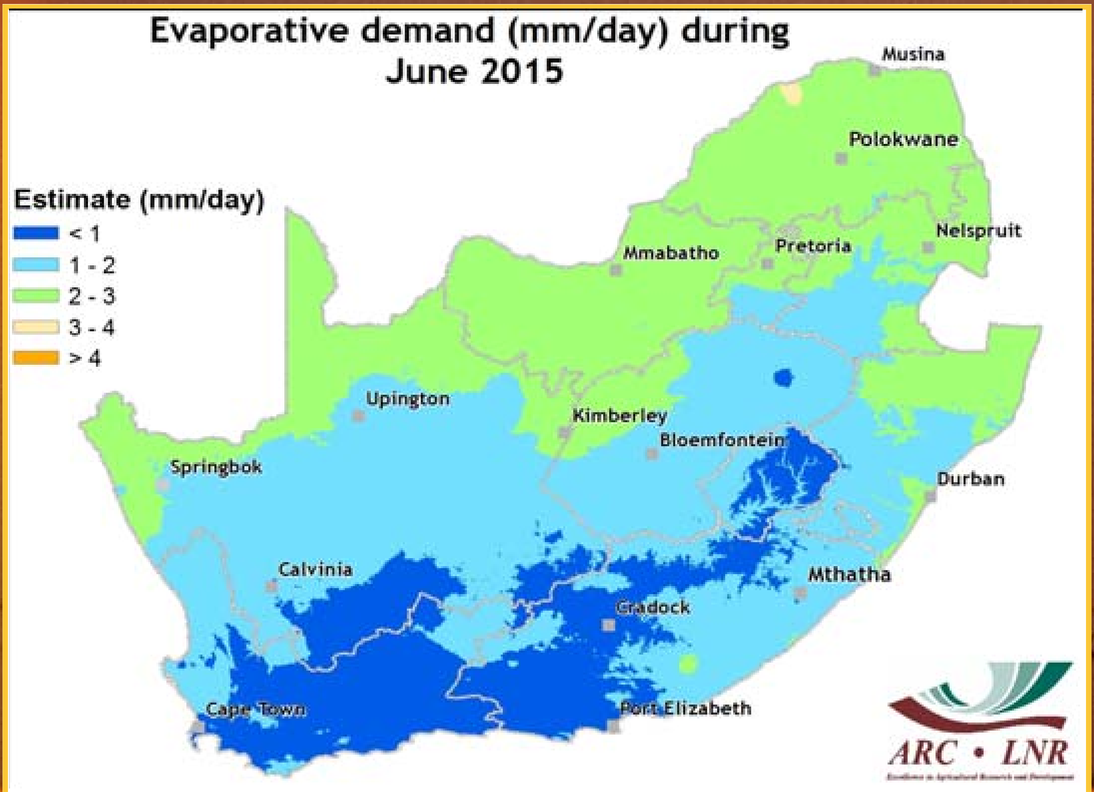

Figure 11

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 in June, 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.

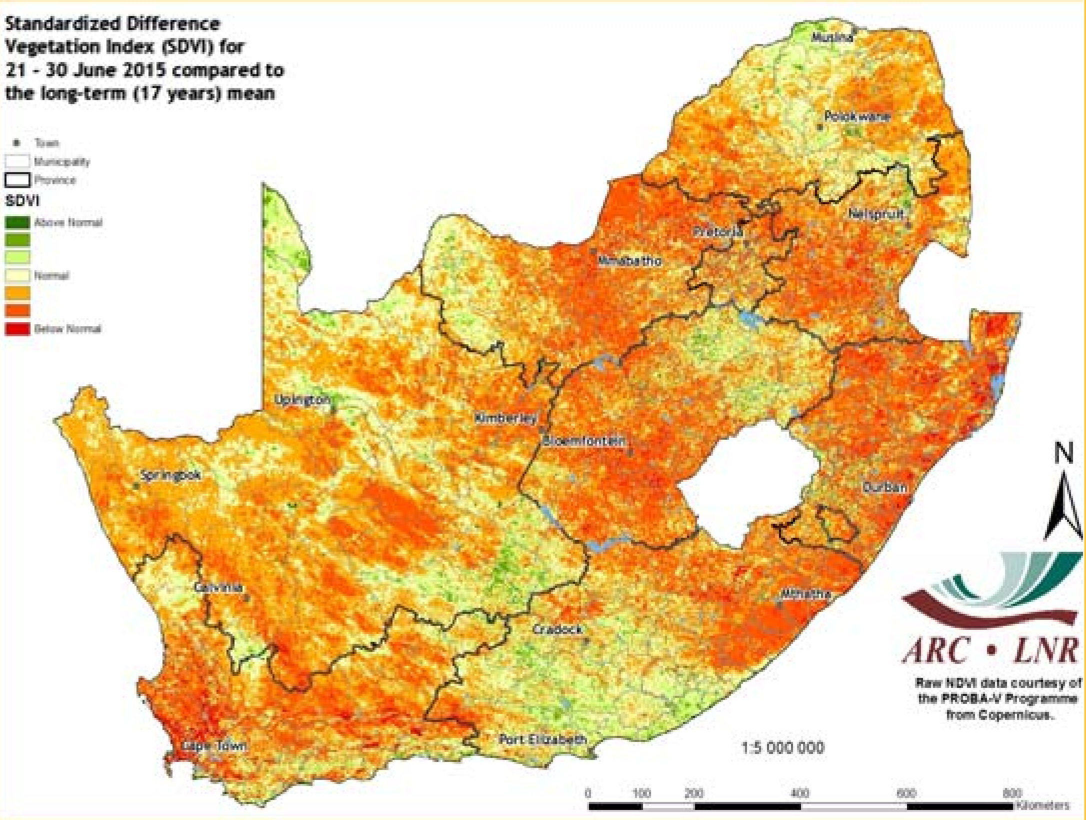

Figure 12

Figure 12:
The SDVI still indicates drought stress over the western parts of the winter rainfall region, as well as much of KwaZulu-Natal and the eastern parts of the Eastern Cape.

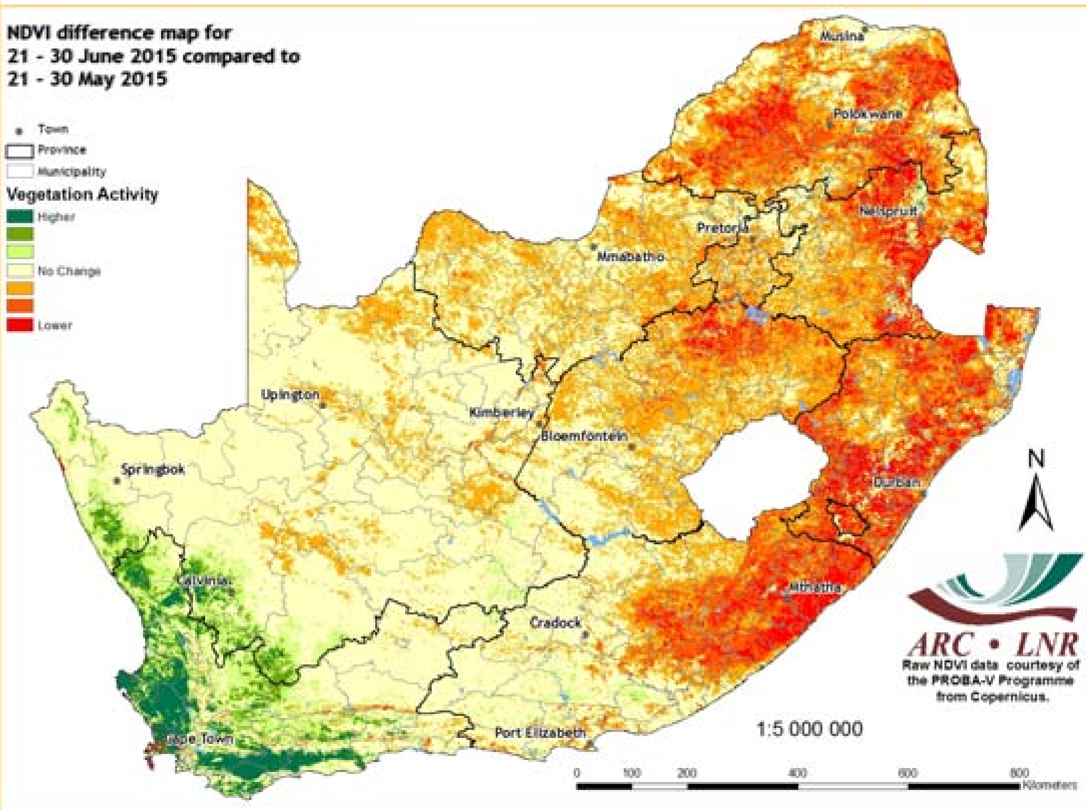

Figure 13

Figure 13:
Widespread rain in the southwest and west resulted in a large increase in vegetation activity over the winter rainfall region while low rainfall and frost resulted in further decreases in vegetation activity over the eastern and northeastern parts.

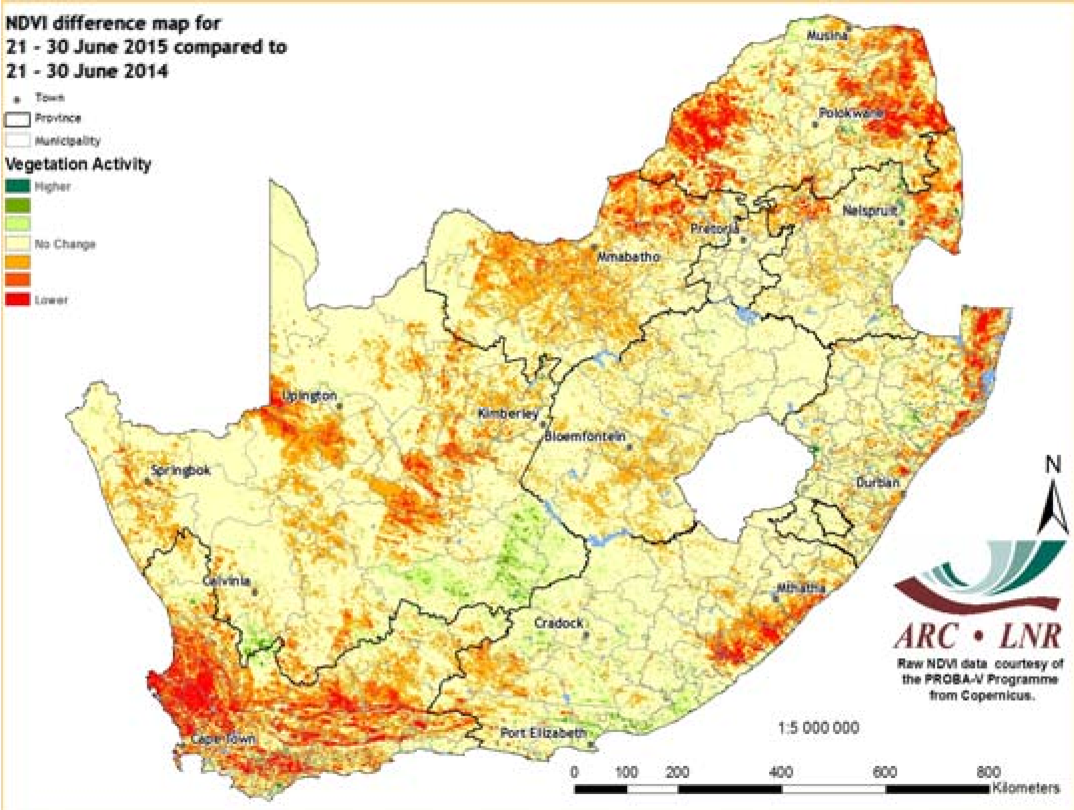

Figure 14

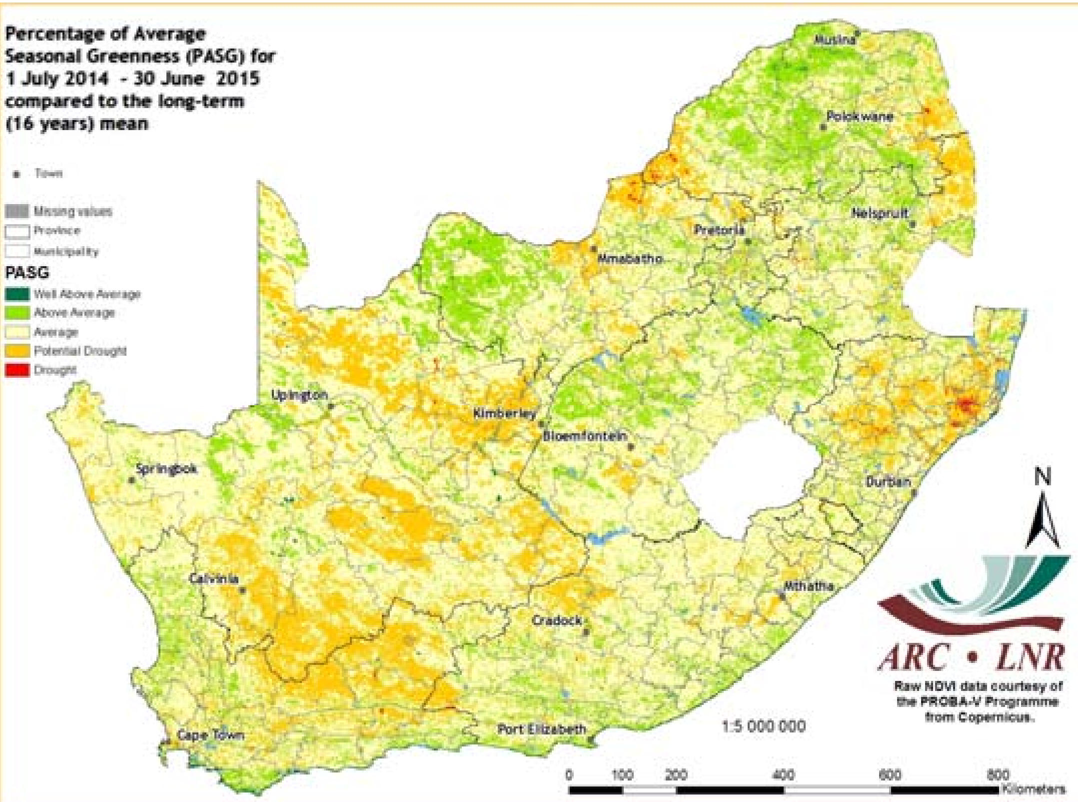

Figure 15

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 June, vegetation activity was lower than last year over the winter rainfall region and several separate areas in the east and northeast, compared to last year.

Figure 15:
Cumulative vegetation activity is still 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 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.

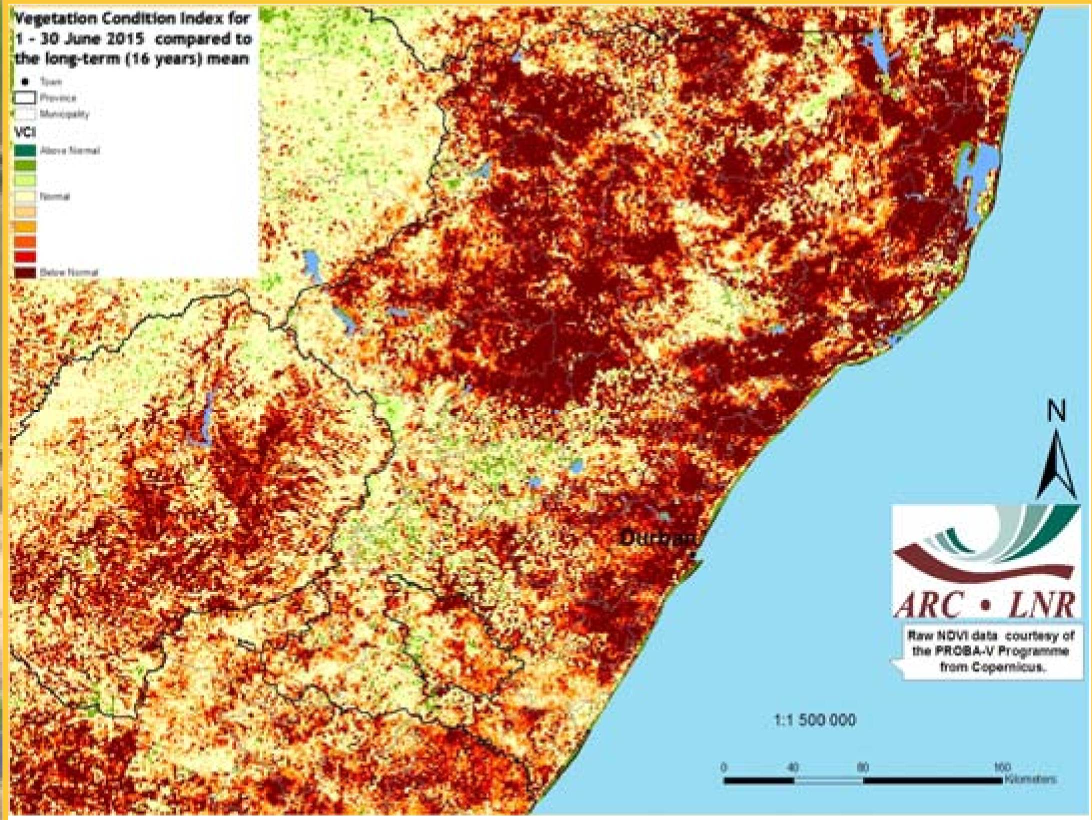


Figure 16

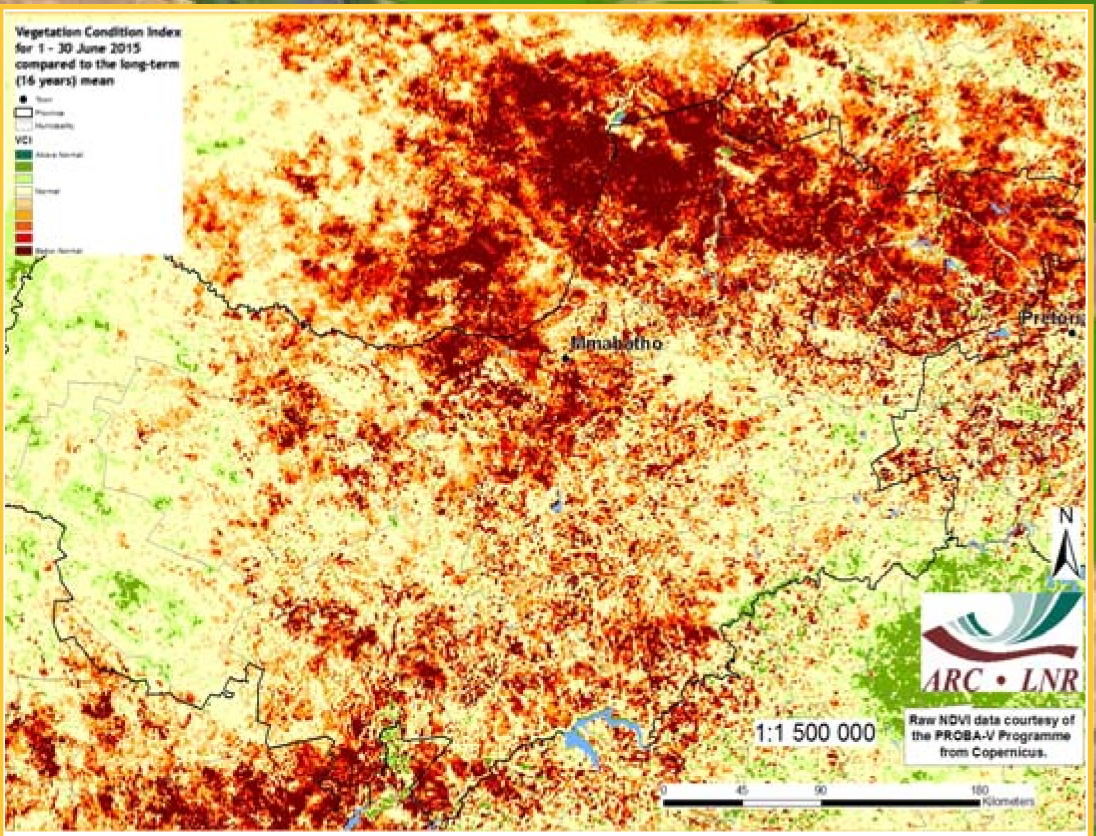
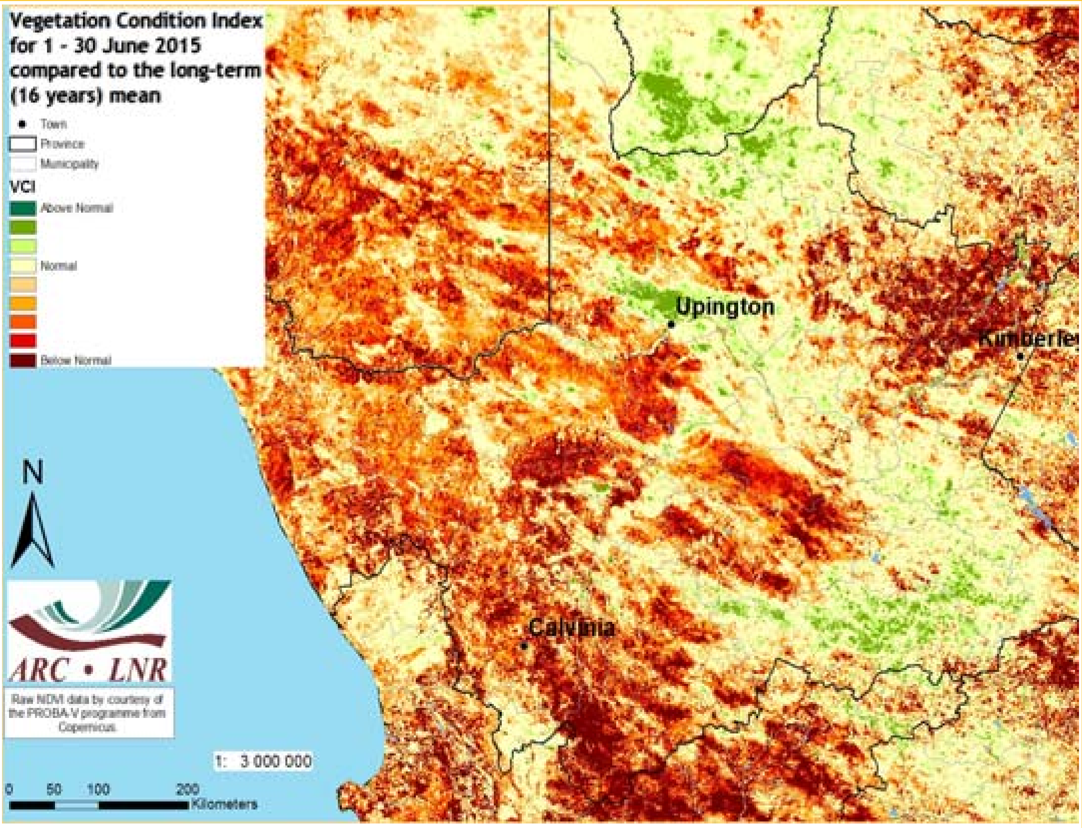


Figure 17

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

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



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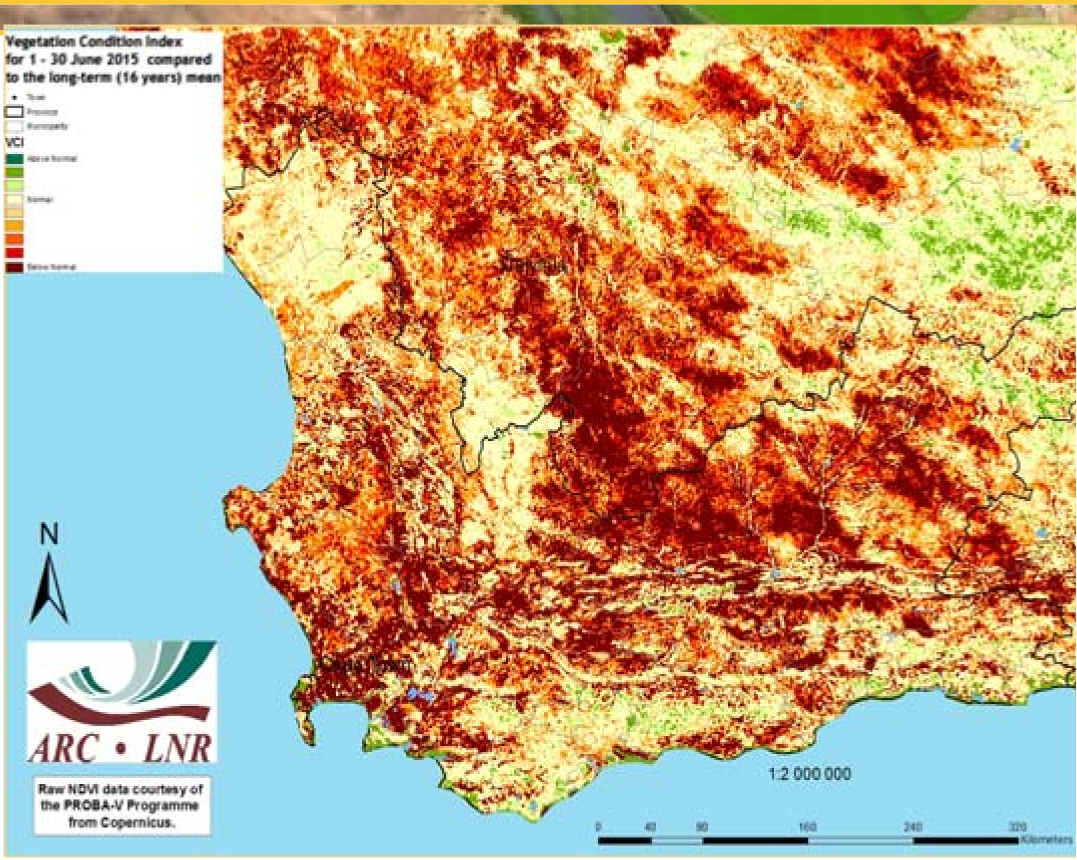


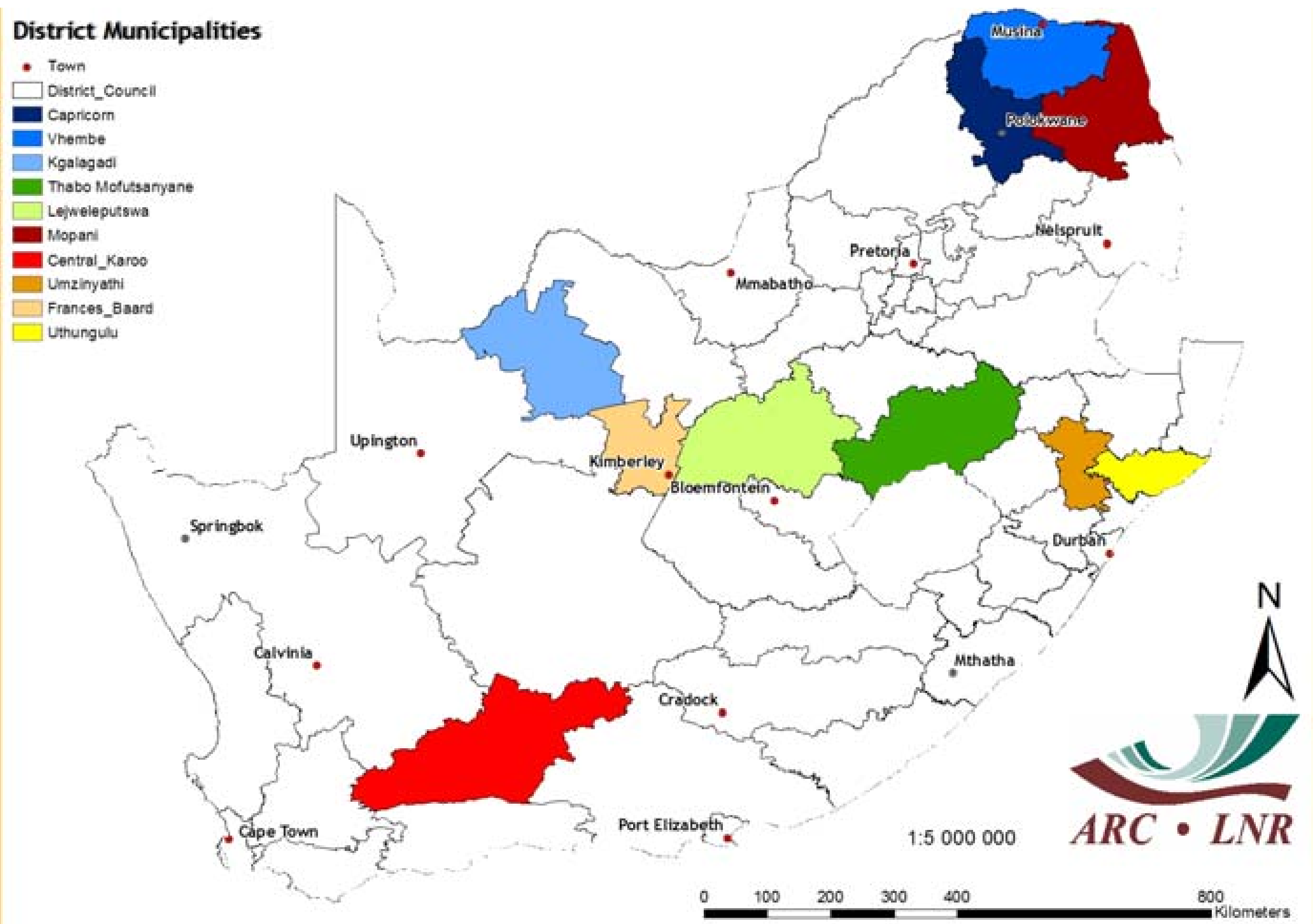
Figure 19

Figure 18:
The VCI map for June indicates below-normal vegetation activity over the western parts of the Northern Cape as well the area to the north of Kimberley.

Figure 19:
The VCI map for June indicates below-normal vegetation activity over the Swartland and the Karoo areas of the Western Cape.

Questions/Comments:
NkambuleV@arc.agric.za

7. Vegetation Conditions & Rainfall

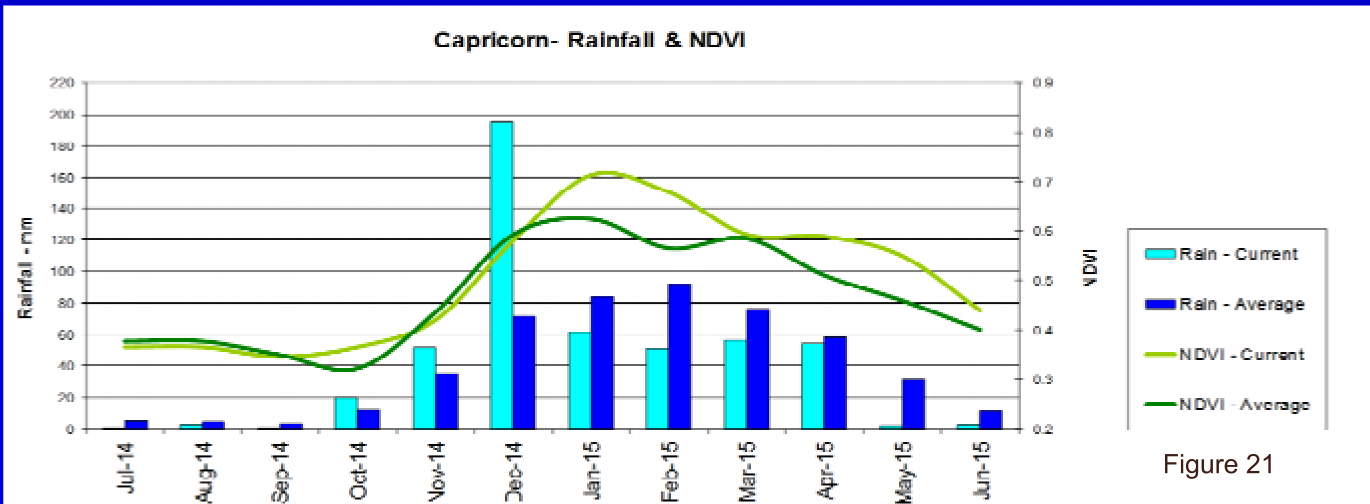


NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for June 2015. The district colour matches the border of the corresponding graph.

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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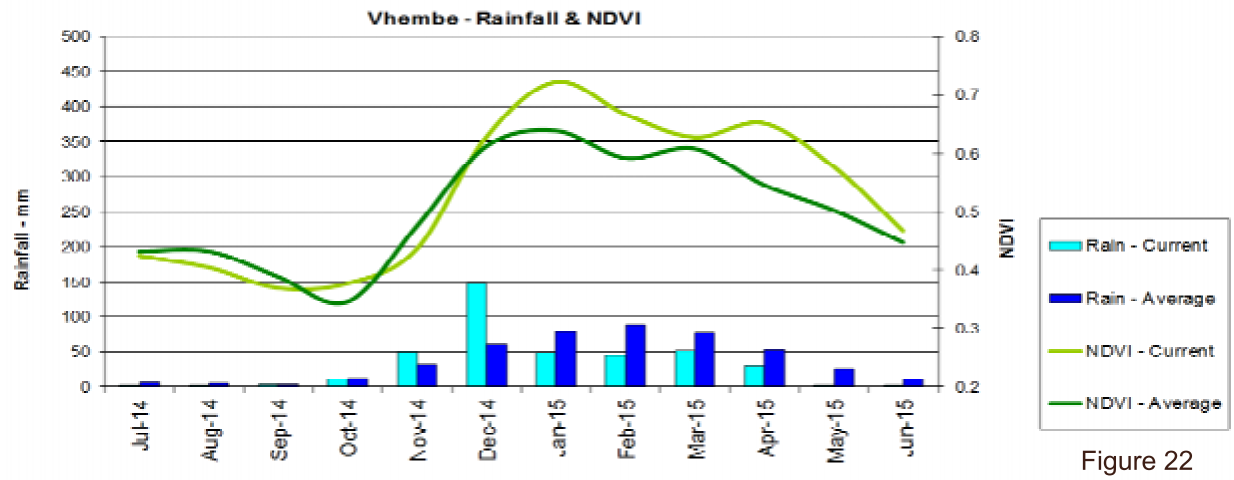

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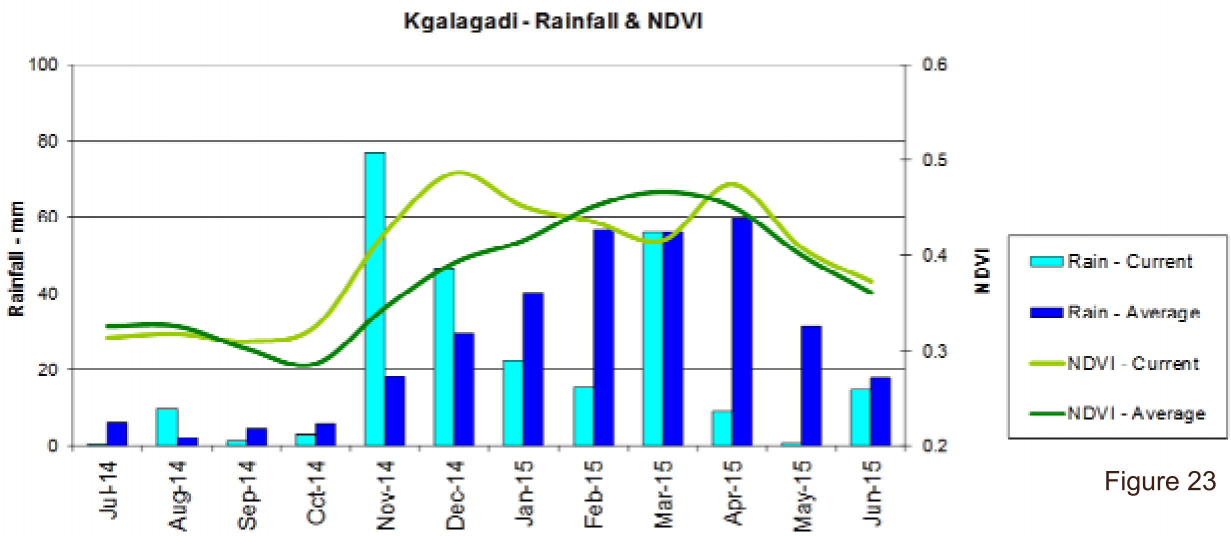

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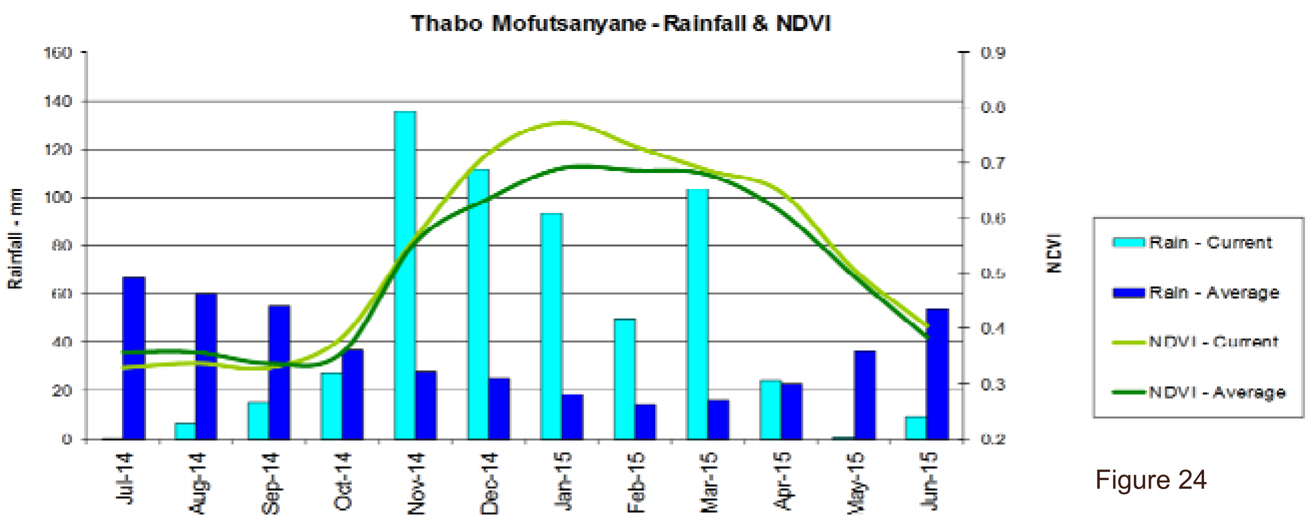

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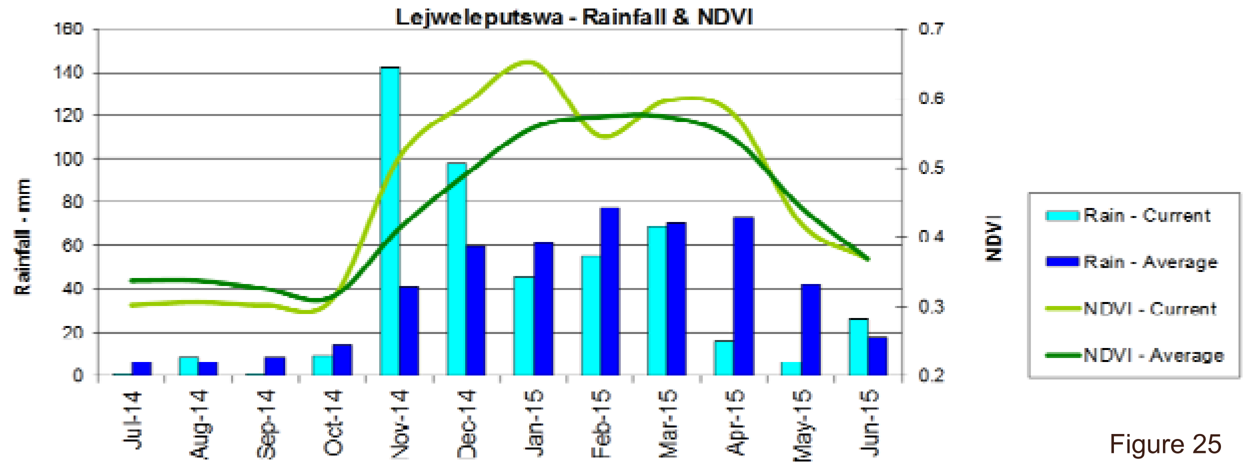

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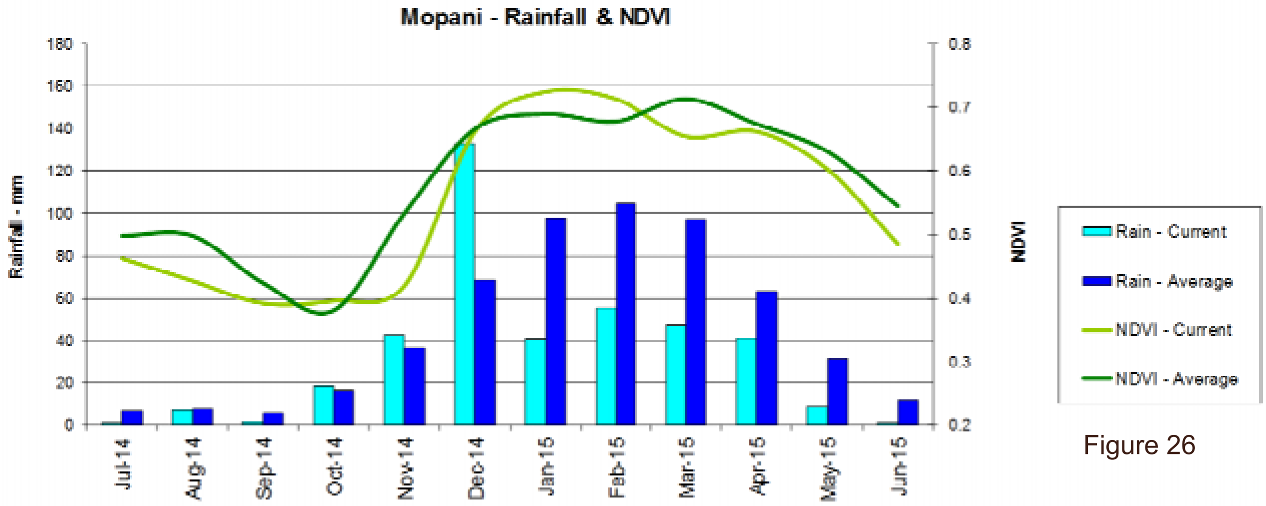

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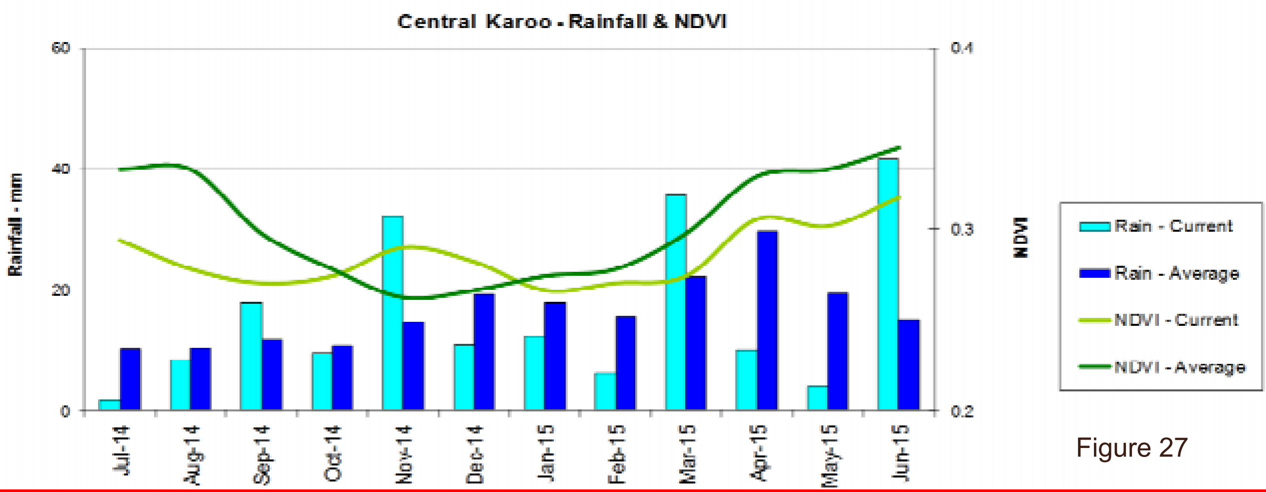

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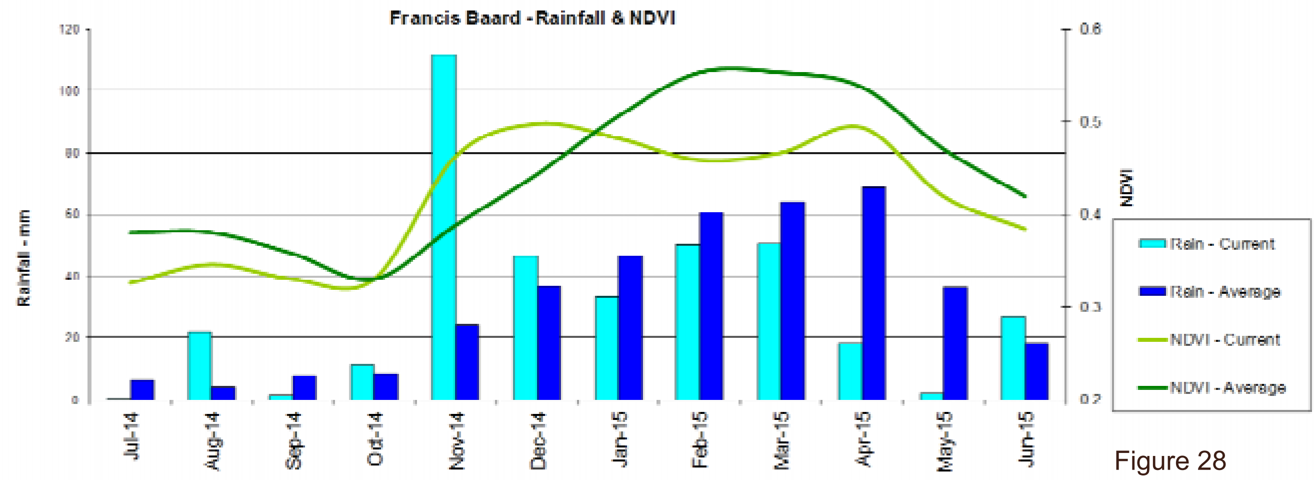

Figure 28

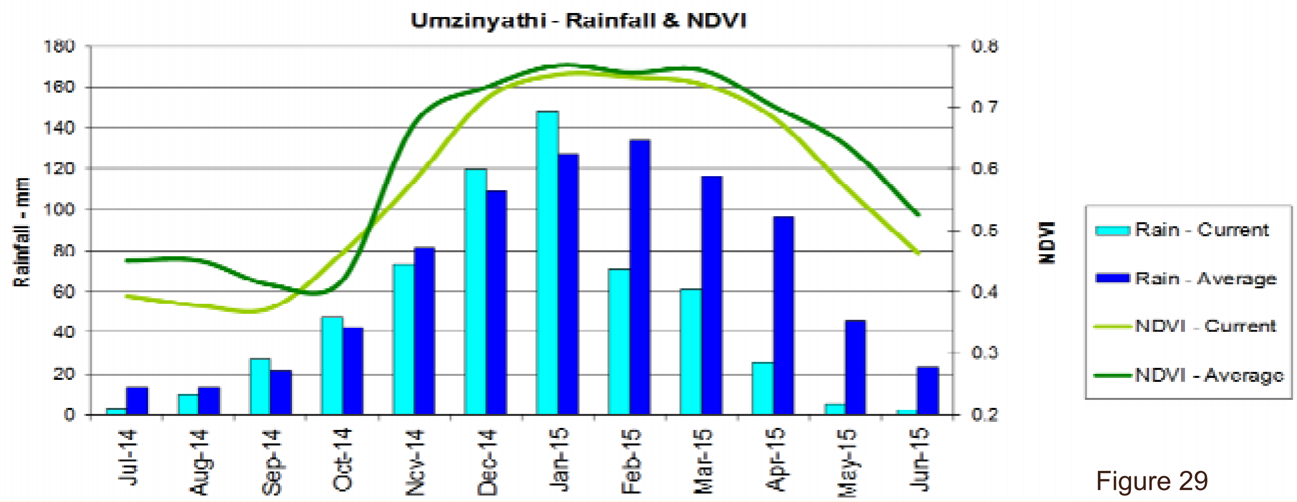

Figure 29

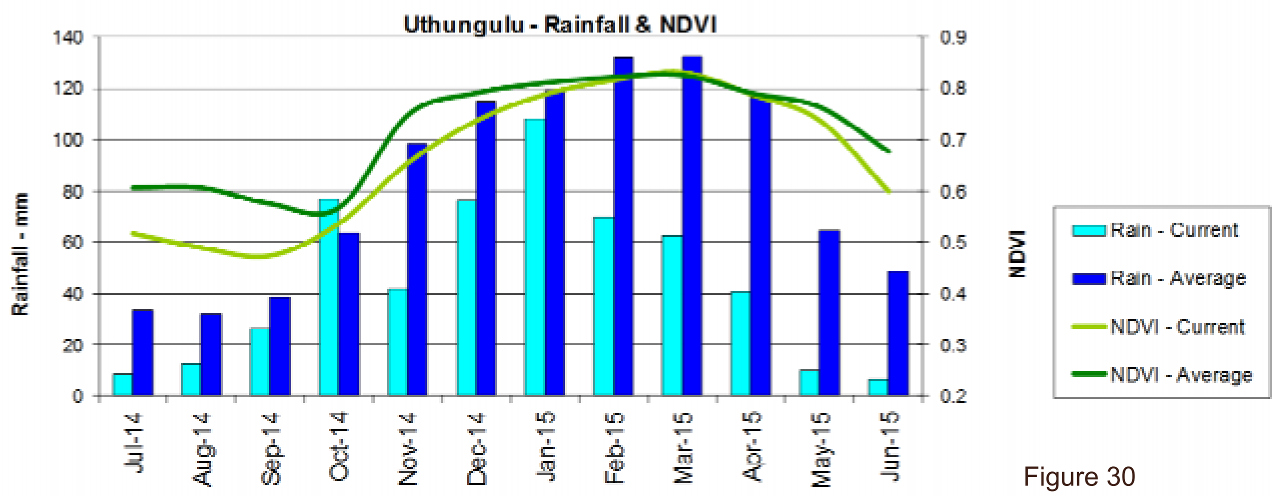

Figure 30

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 June 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 June and May 2015, with the brown colours showing the drier and the green colours the wetter areas. Similarly, the year-on-year SSI difference for June is shown in Figure 33.

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

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

Questions/Comments:
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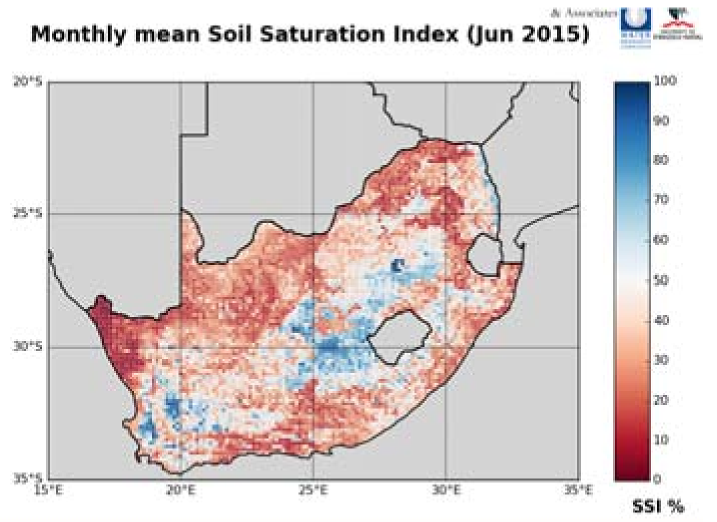

Figure 31

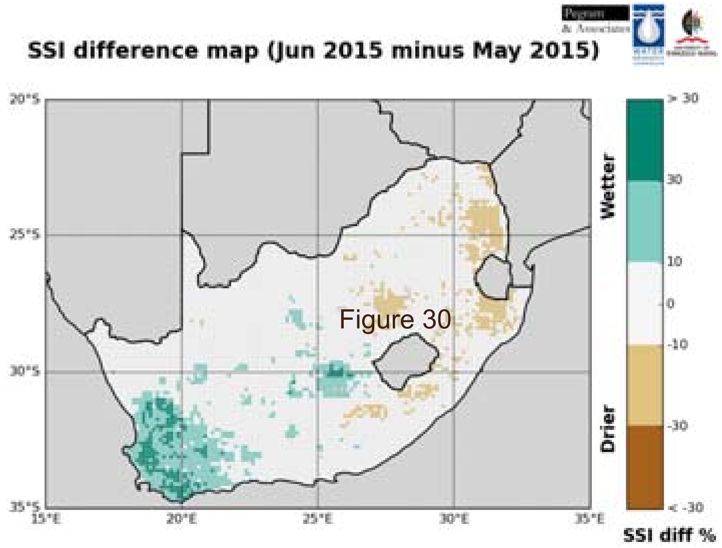

Figure 32

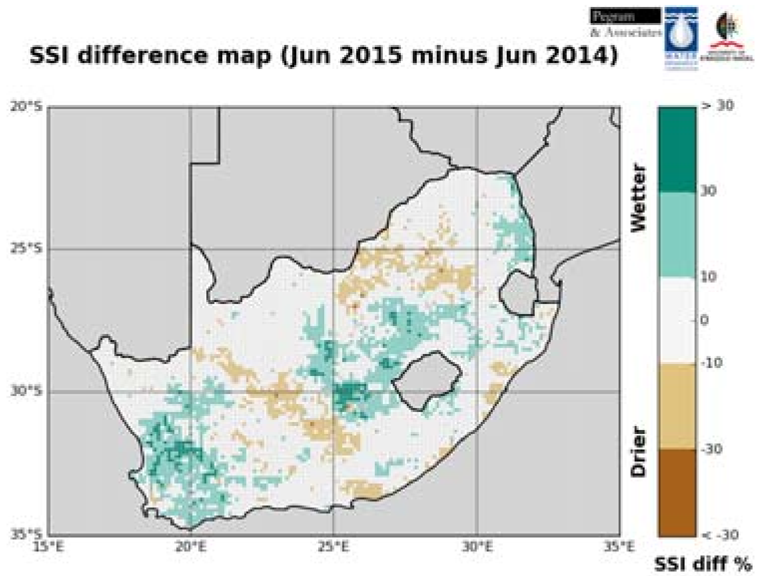

Figure 33

9. Fire Watch

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 in the month of June 2015 per province. Fire activity was higher in Gauteng, Mpumalanga, Limpopo and the Western Cape compared to the average during the same period for the last 14 years.

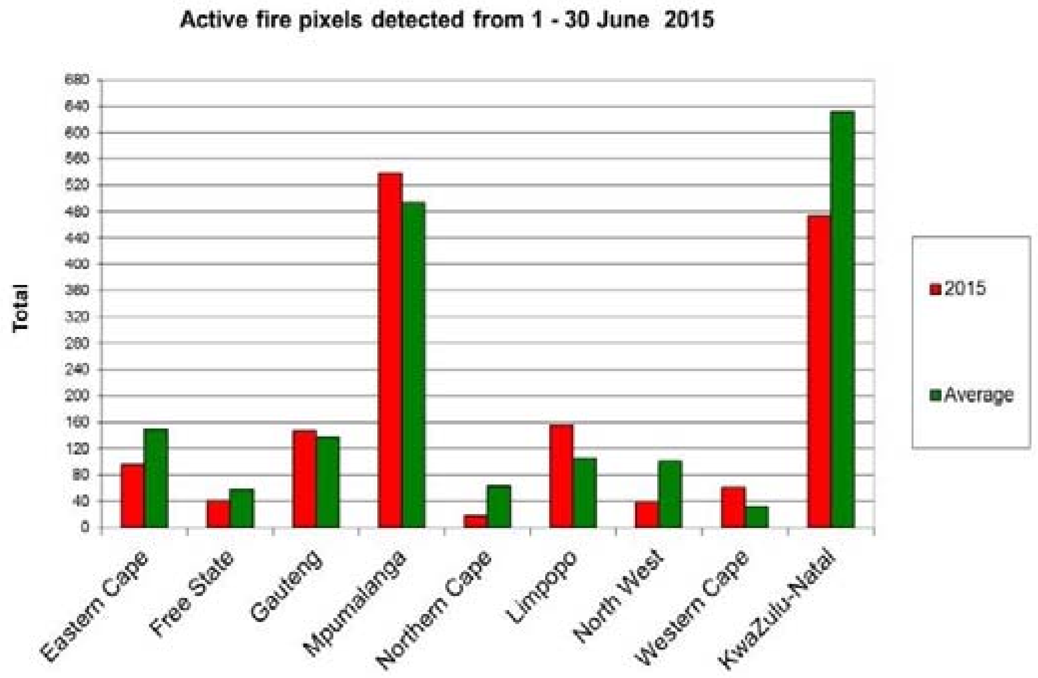

Figure 34

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

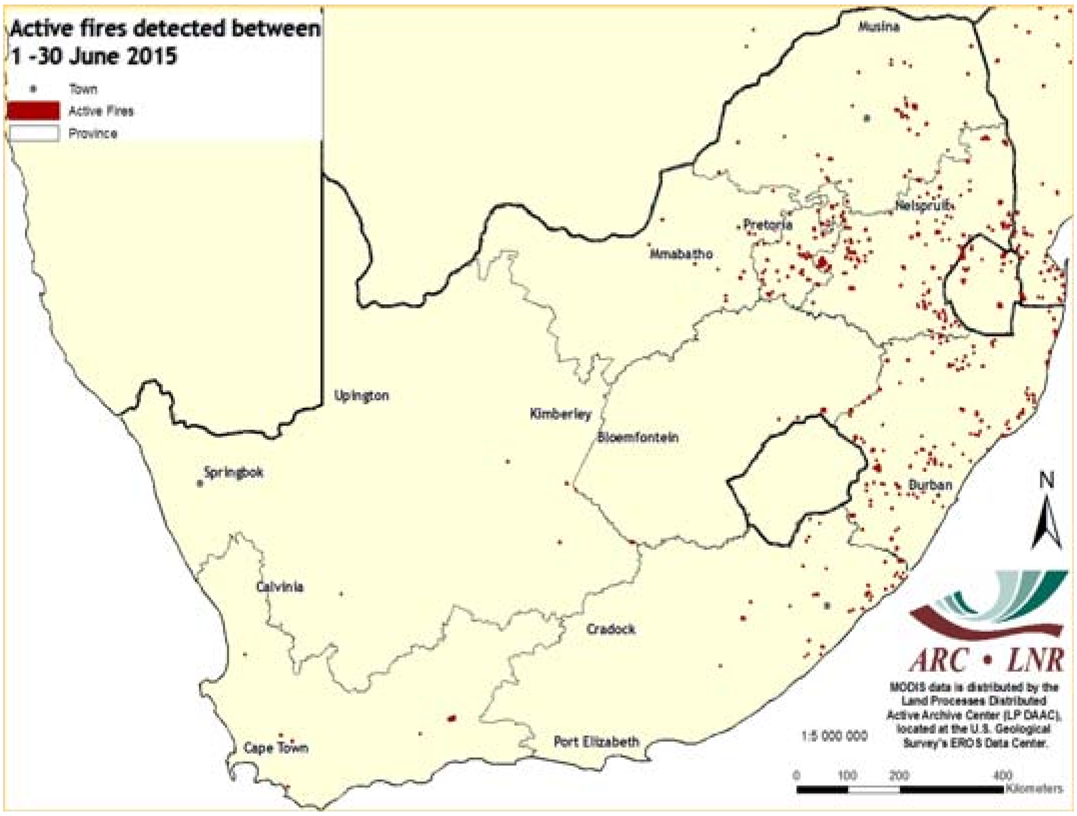

Figure 35

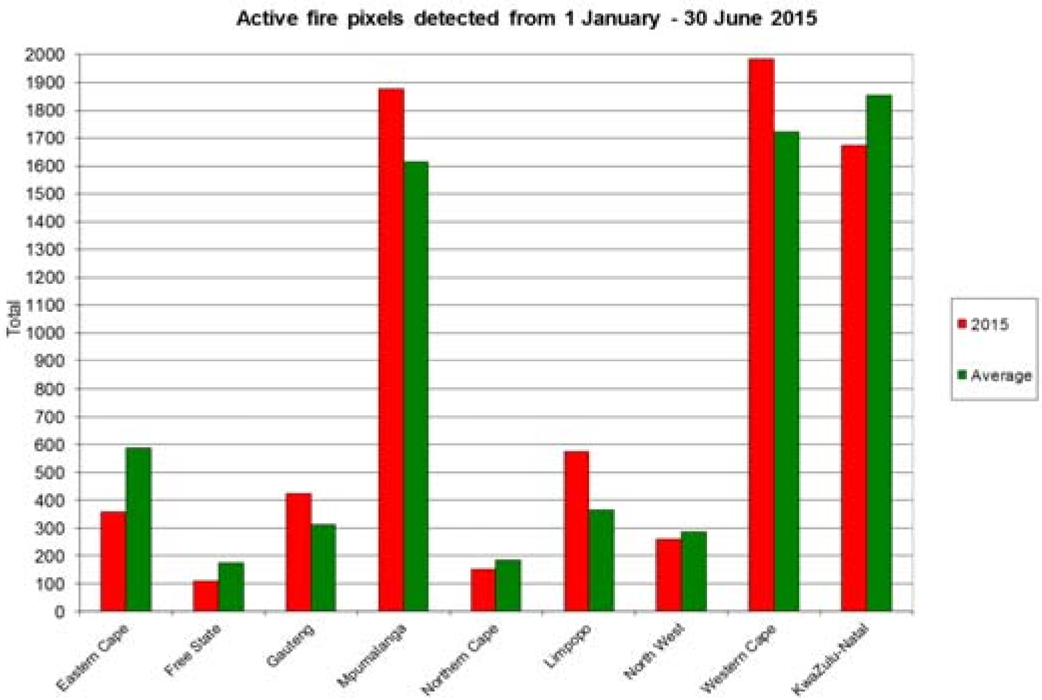

Figure 36

Figure 36:
The graph shows the total number of active fires detected between 1 January to 30 June 2015 per province. Fire activity was higher in Gauteng, Mpumalanga, Limpopo and the Western Cape compared to the average during the same period for the last 14 years.

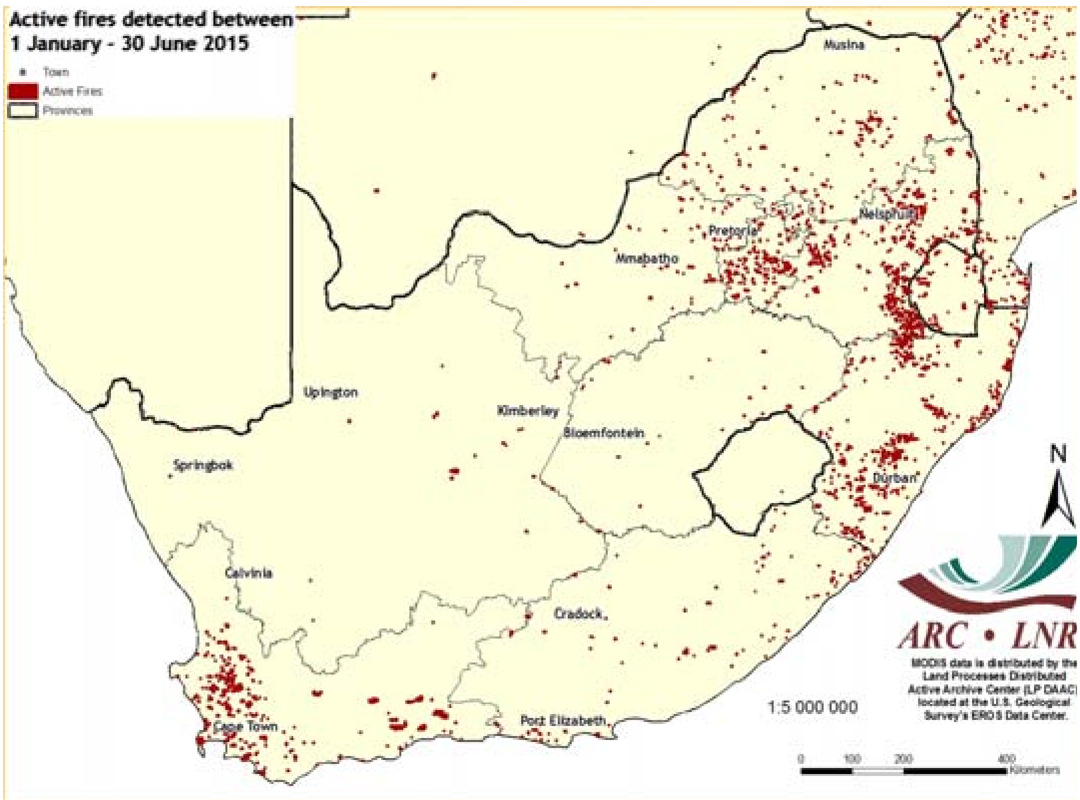

Figure 37

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

Questions/Comments:
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ARC-INSTITUTE FOR SOIL, CLIMATE AND WATER

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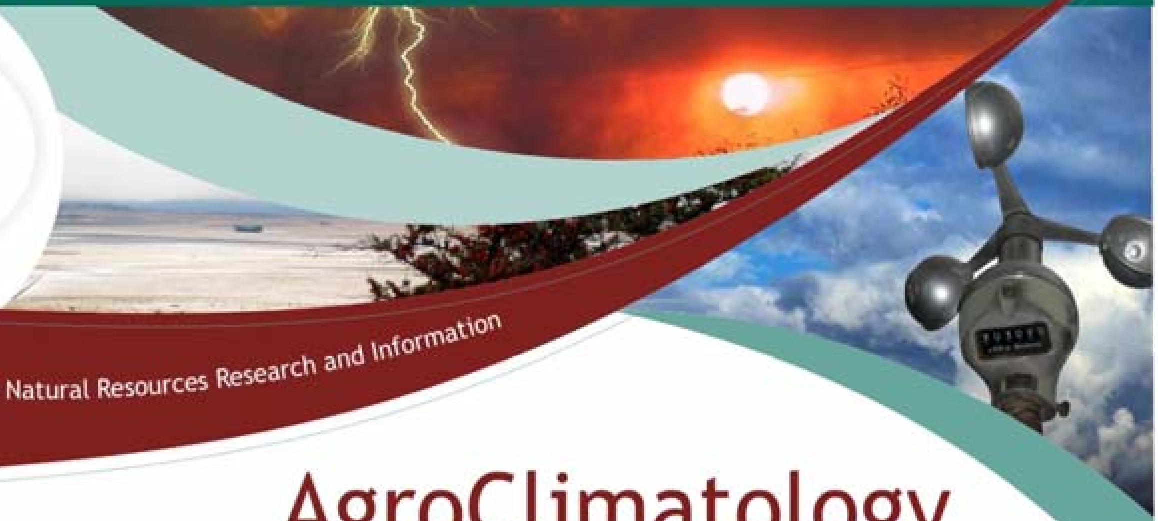

Your Partner in Natural Resources Research and Information

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.

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

http://www.agis.agric.za