ARC • LNR
Excellence in Agricultural Research and Development

UMLINDI
The Watchman

ISSUE 2016-07 | 14 JULY 2016

INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

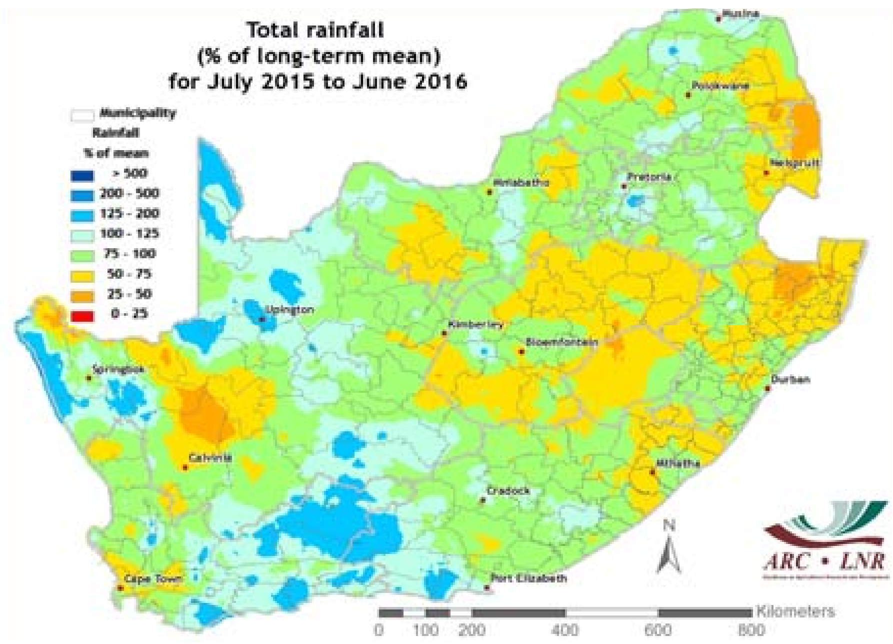
agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

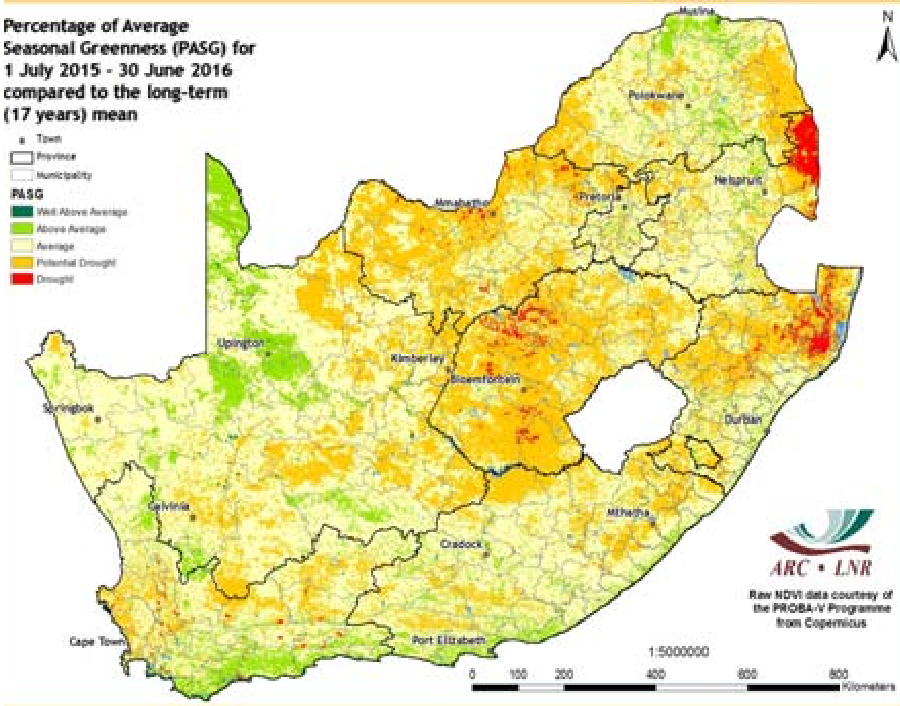
South African Weather Service

AMESD

145th Edition

Images of the Month





Rainfall and vegetation response: summer 2015/16

The Austral summer year (July-June) 2015/16 has concluded. While rainfall was below normal over large parts of the summer rainfall region (see rainfall map), deficits were smaller than during most other summers associated with strong El Niños. Extremely dry conditions with several heatwaves during early to mid-summer were somewhat offset by wetter conditions since January. Dry conditions during the previous summer together with very high maximum temperatures were some of the exacerbating effects on the drought impact. The rainfall map and Percentage of Average Seasonal Greenness (PASG) map both highlight, in terms of dominant weather conditions and vegetation response, areas where the largest drought impacts were observed. These include the Lowveld of Mpumalanga, northern KwaZulu-Natal, and the southern and northwestern Free State. Areas where both rainfall and cumulative vegetation activity were above normal include large parts of Gauteng, central to western Mpumalanga, central to northern Limpopo, northwestern Northern Cape and the Garden Route.

The rainfall map is derived from interpolated rainfall data collected by the automatic weather station networks of the ARC-ISCW and South African Weather Service.

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:

Most importantly, normal to above-normal rainfall returned to the winter rainfall region during June 2016, after a lull during May. Rainfall events associated with frontal activity over the southwestern areas occurred regularly from the 9th. The strongest systems resulted in widespread rain over the winter rainfall region around the 9th, 14th, 19th, 26th and 30th. Significant falls occurred especially in association with the first three of these events. Low temperatures associated with the frontal systems resulted in snow over the southwestern Cape mountains by the 20th and 26th. The movement of some of the cold fronts into the southern interior resulted in more widespread snow along the southern high-lying areas by the 10th.

In much the same vain as the situation during the April-May period, yet another upper-air cut-off low developed over the country in association with the frontal system by the 9th. The low resulted in widespread cloudy and rainy conditions over the northern to southeastern interior. Significant snow occurred over especially the northwestern parts of Lesotho and adjacent South Africa in association with this system. Large parts of the summer rainfall region received between 10 and 20 mm between the 12th and 14th. This low pressure system was the last in a series of such systems responsible for a relatively wet autumn over much of the interior. Circulation patterns up to this point favoured the development of strong surface high pressure systems around the country, feeding moisture into the interior and supporting rainfall development in association with developing systems over the interior.

While some ridging still resulted in periods with clouds and mist over the northeastern parts later in the month, a more zonal circulation pattern developed during the remainder of June, with frontal systems moving into the interior, spreading cold air associated with westerly winds over many areas, and confining wet conditions mostly to the winter rainfall region and southern extremes, except for the odd shower along the eastern coastal region or northeastern Escarpment. This drier tendency over the interior was reflected in a gradual decline in minimum temperatures from the middle of the month, with widespread frost occurring towards the end of the month.

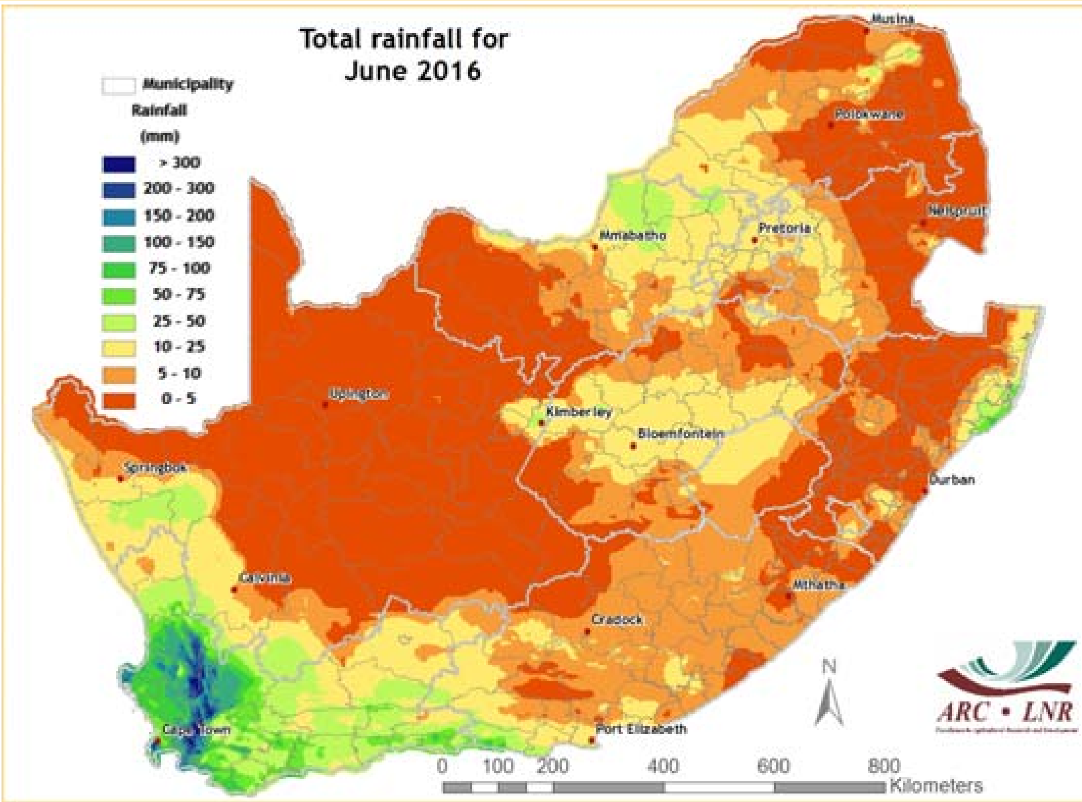


Figure 1

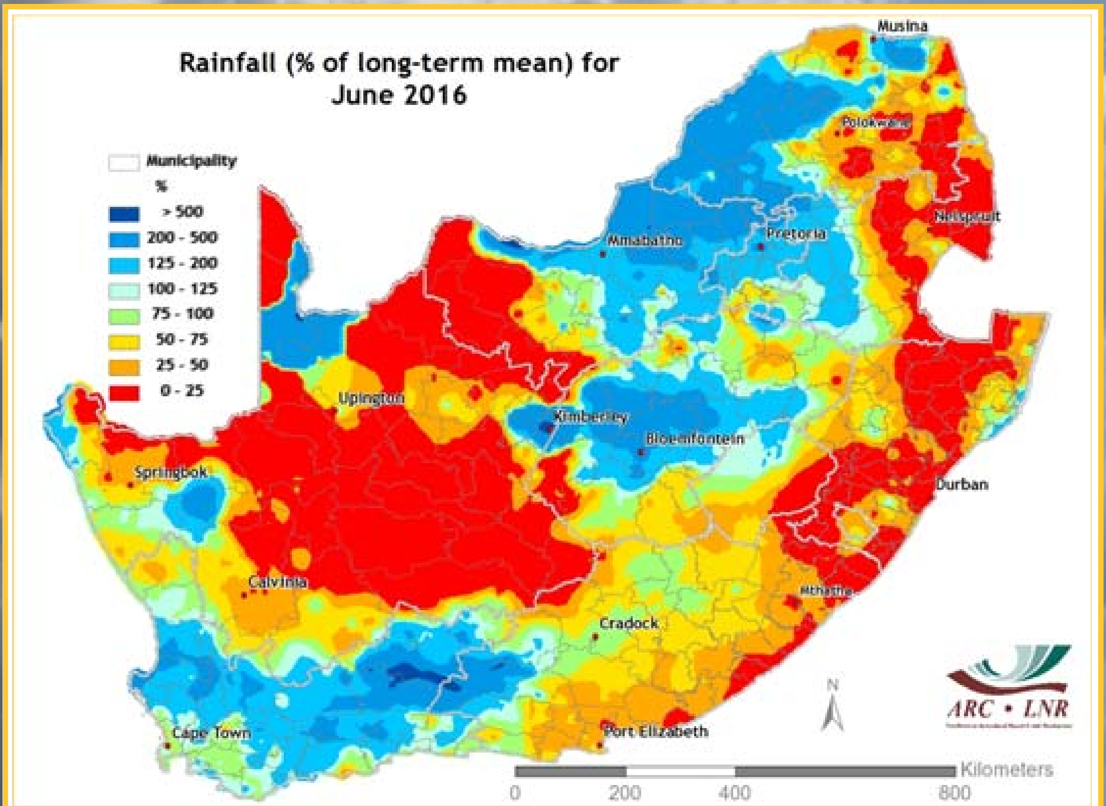


Figure 2

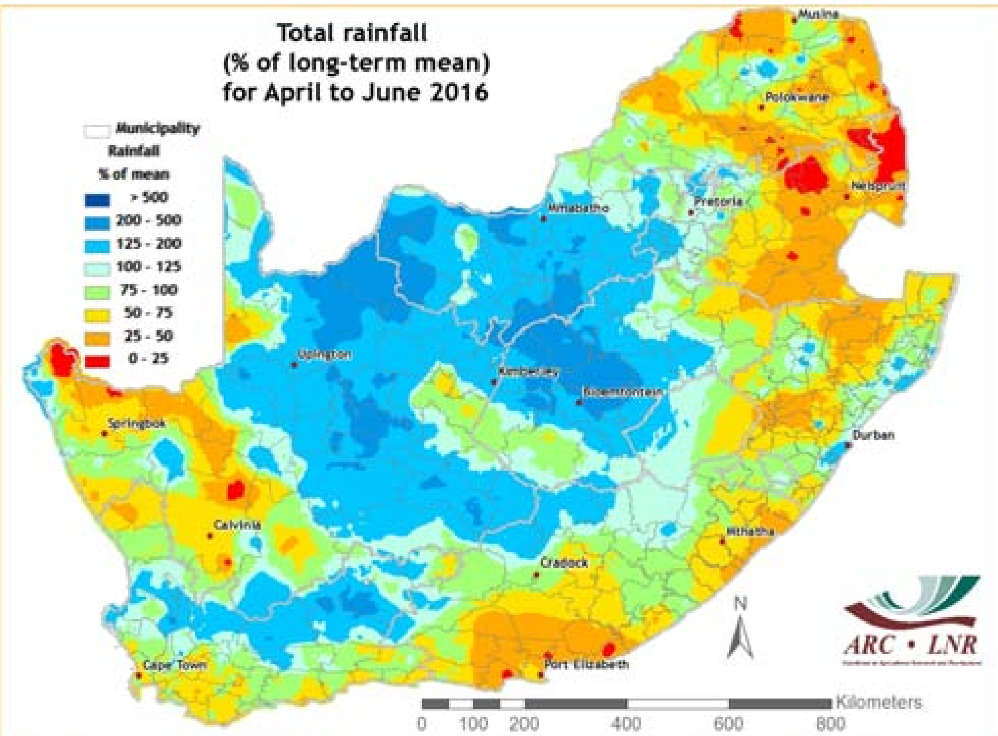


Figure 3

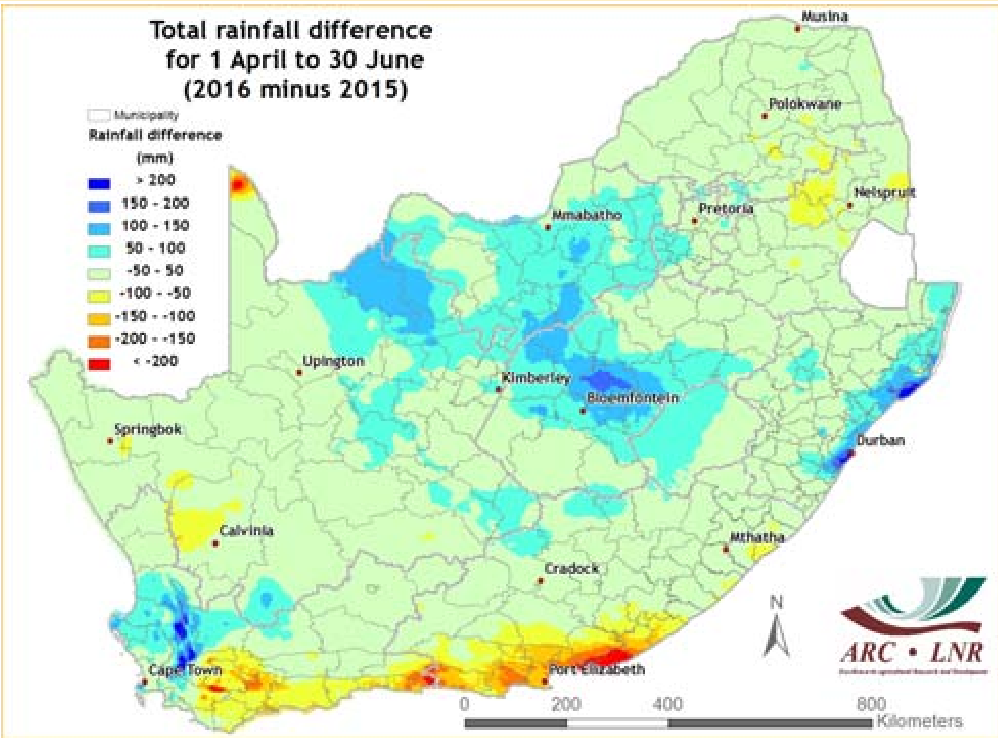


Figure 4

Figure 1:
Most of the rain during June was confined, as climatologically expected, to the winter rainfall region. Rainfall totals over the mountainous Boland exceeded 200 mm while ranging between 70 mm and 150 mm over the Swartland. Totals were somewhat lower along the Garden Route. A single rainfall event also resulted in widespread rain over the central to northern summer rainfall region, but totals over these areas remained below 25 mm for the most part. The coastal areas of KwaZulu-Natal received in excess of 100 mm. Most of the winter rainfall region received less than 25 mm in total.

Figure 2:
Most of the winter rainfall region received normal to above-normal rainfall. Rainfall was also above normal over much of the central to northern interior. The rest of the country experienced below-normal rainfall.

Figure 3:
Much of the central interior experienced above-normal rainfall since April, with smaller areas along the coast of KwaZulu-Natal and within the winter rainfall region also experiencing above-normal rainfall. Rainfall over the remainder of the country ranged mostly between normal and below normal.

Figure 4:
Much of the central interior, the western winter rainfall region and coastal belt of KwaZulu-Natal received significantly more rain than in 2015 during April-June. However, the southern parts of the country received much less rain than last year.

Questions/Comments:
Johan@arc.agric.za

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 are confined to the southern parts of the Eastern Cape and parts of Mpumalanga at the shorter time scales, but a fairly extensive area focussing on the north-eastern Free State, northern KwaZulu-Natal and Mpumalanga with severe to extreme drought at the longer time scales. The drought resulting in lower dam levels over the Western Cape is also visible at the longer time scales, but is barely visible at shorter time scales due to above-normal rainfall in that region during April and June.

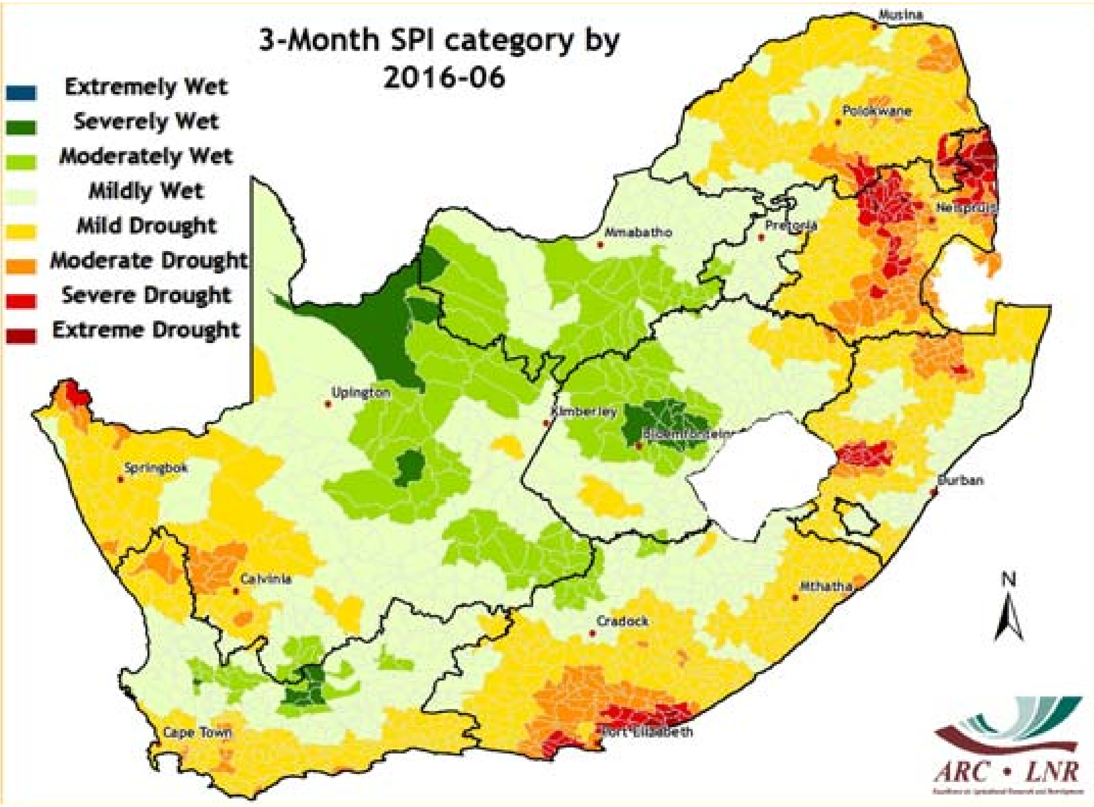


Figure 5

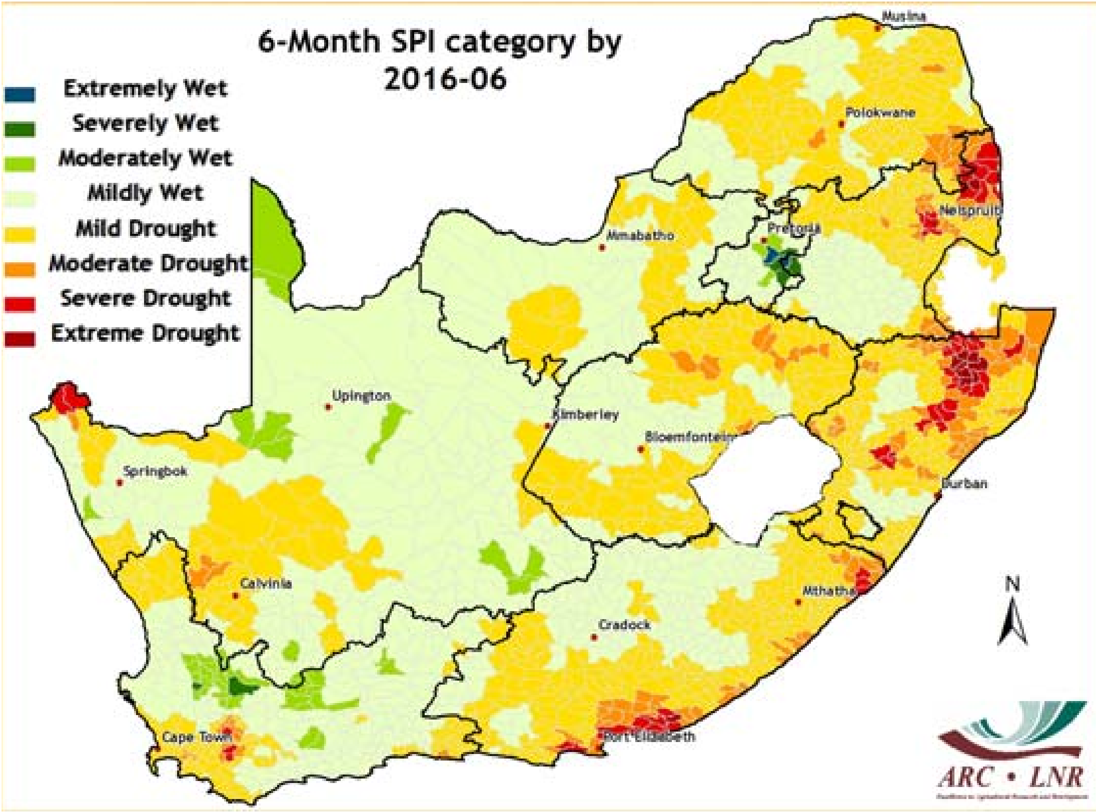


Figure 6

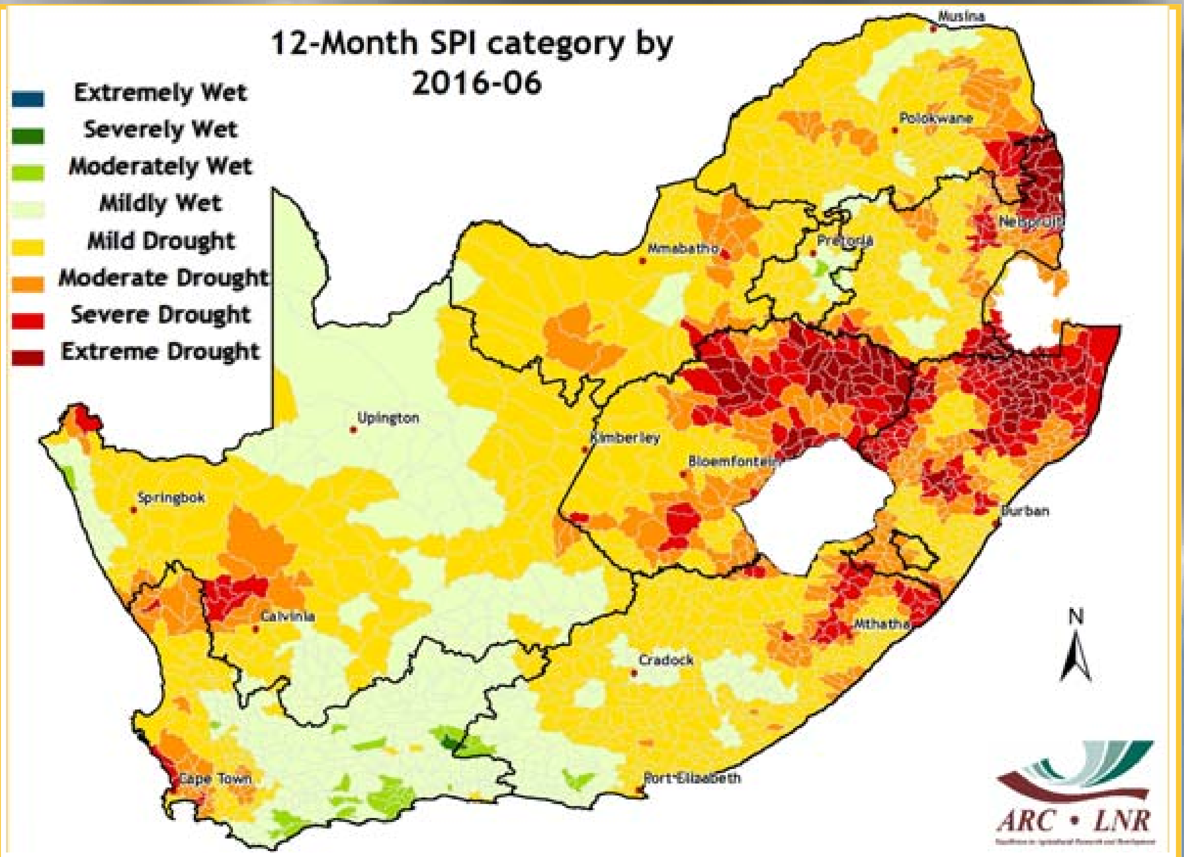


Figure 7

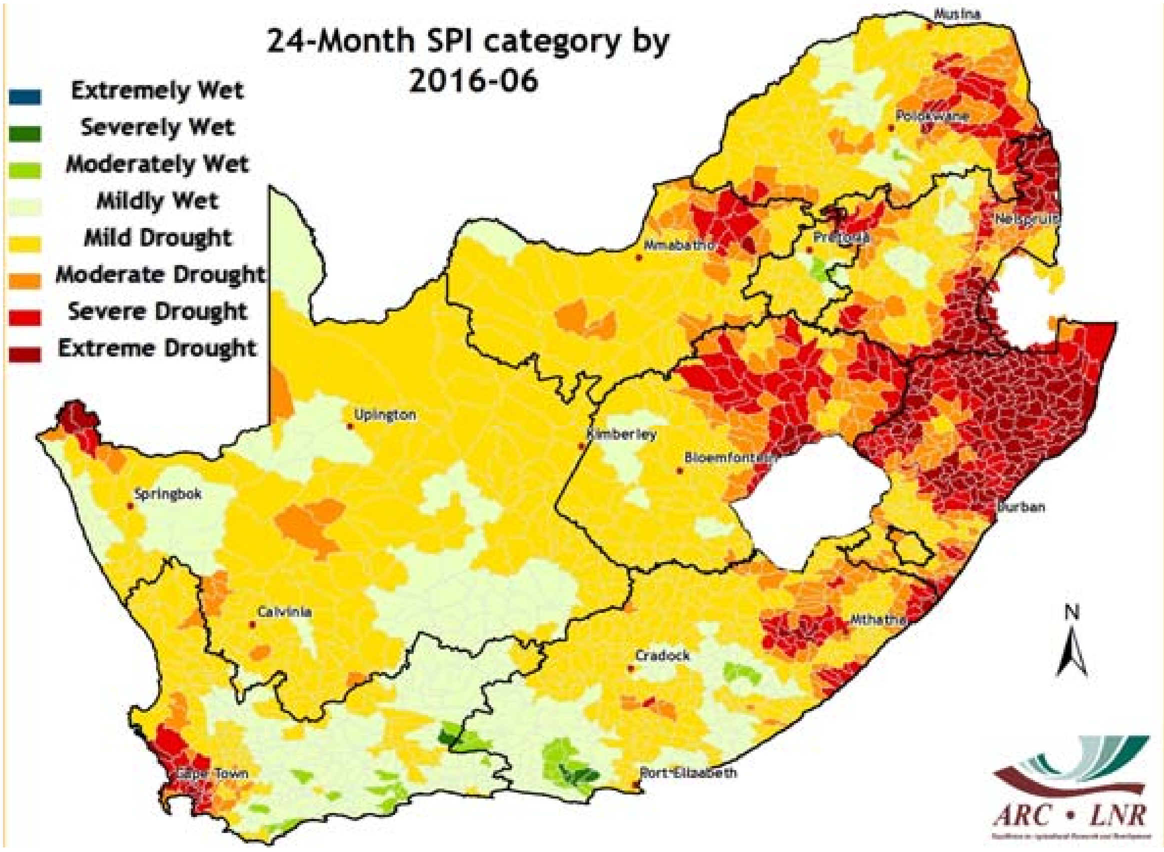


Figure 8

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.

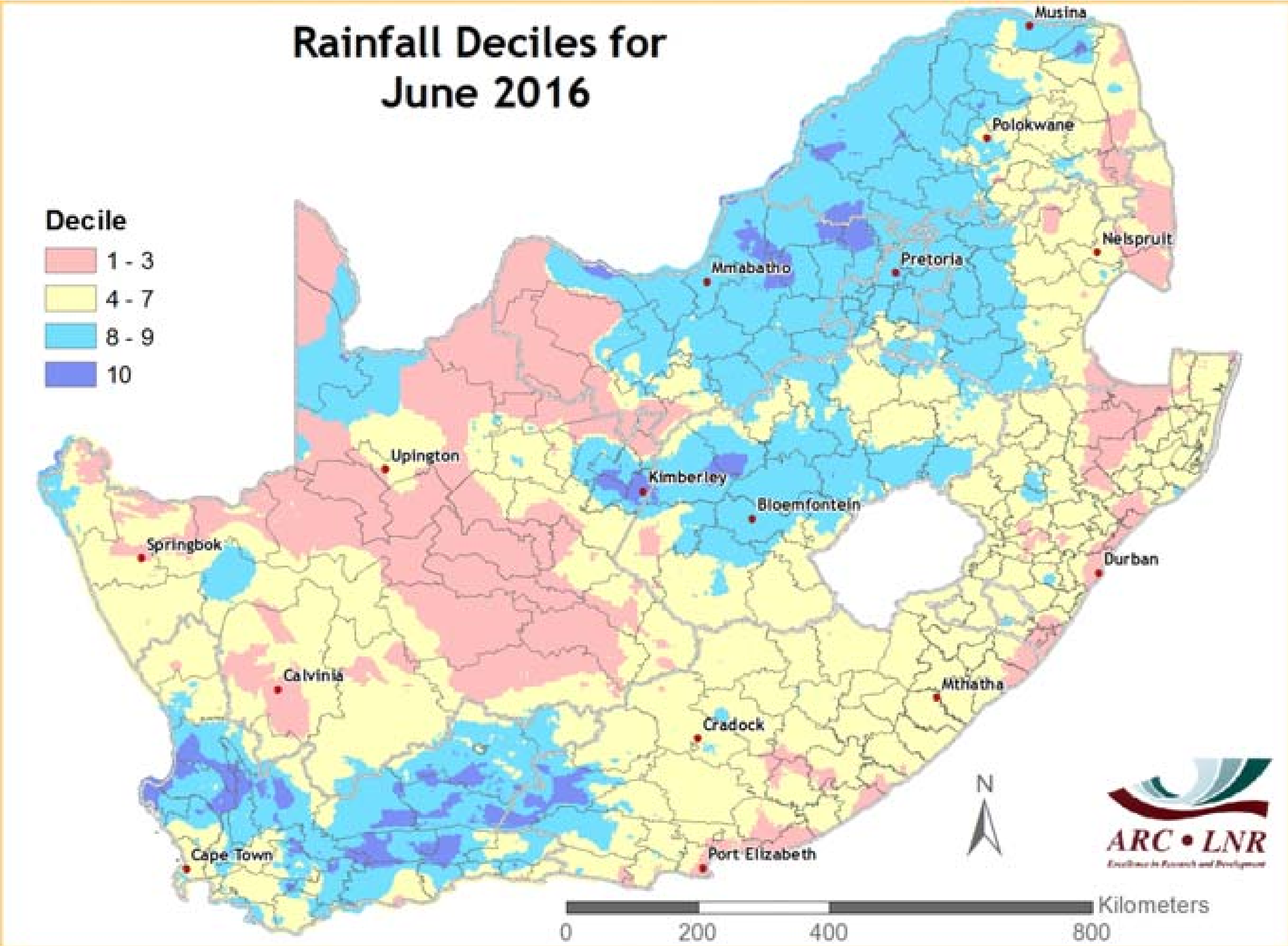


Figure 9

Figure 9:
Isolated parts of the Karoo and western winter rainfall region together with small areas in North West were exceptionally wet during June. In contrast, the southeastern to eastern low-lying peripheries were exceptionally dry.

4. Water Balance

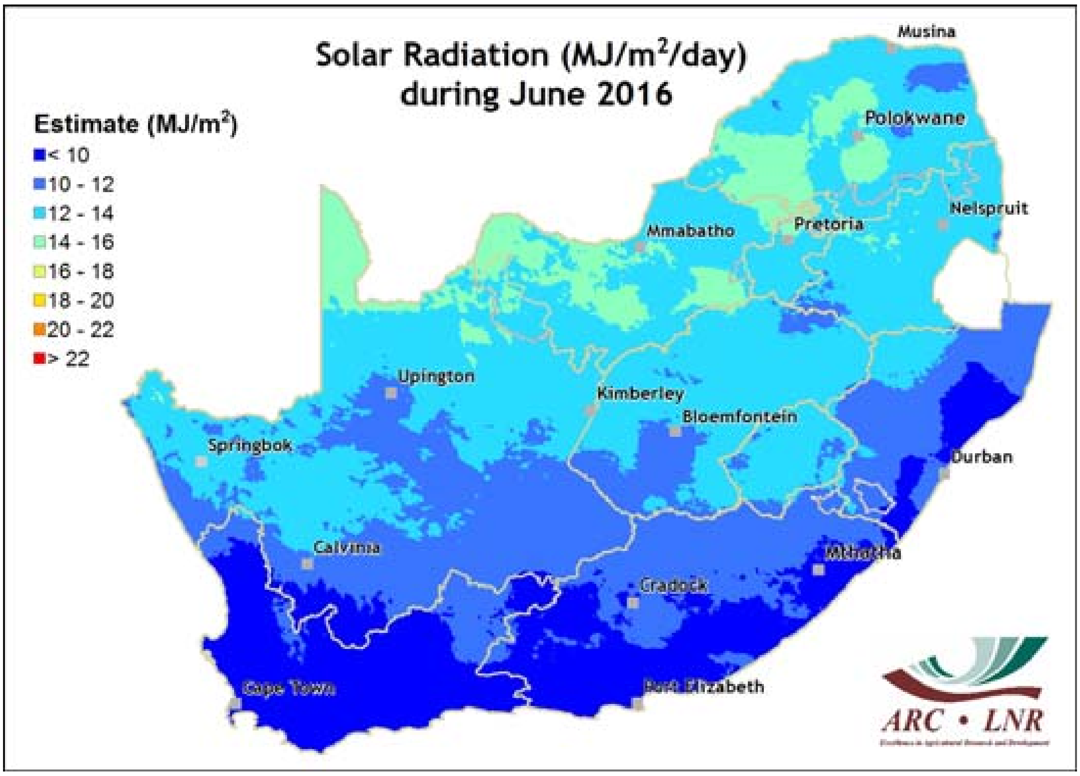


Figure 10

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:
With the winter solstice at hand, the average daily solar radiation totals diminished further, ranging from less than 10 MJ/m^2 in the south to about 15 MJ/m^2 in the north. Clouds associated with cold fronts further resulted in lower values along the coasts and over the winter rainfall region. Clouds associated with moisture advection from the east also had a negative effect over the eastern parts of Limpopo.

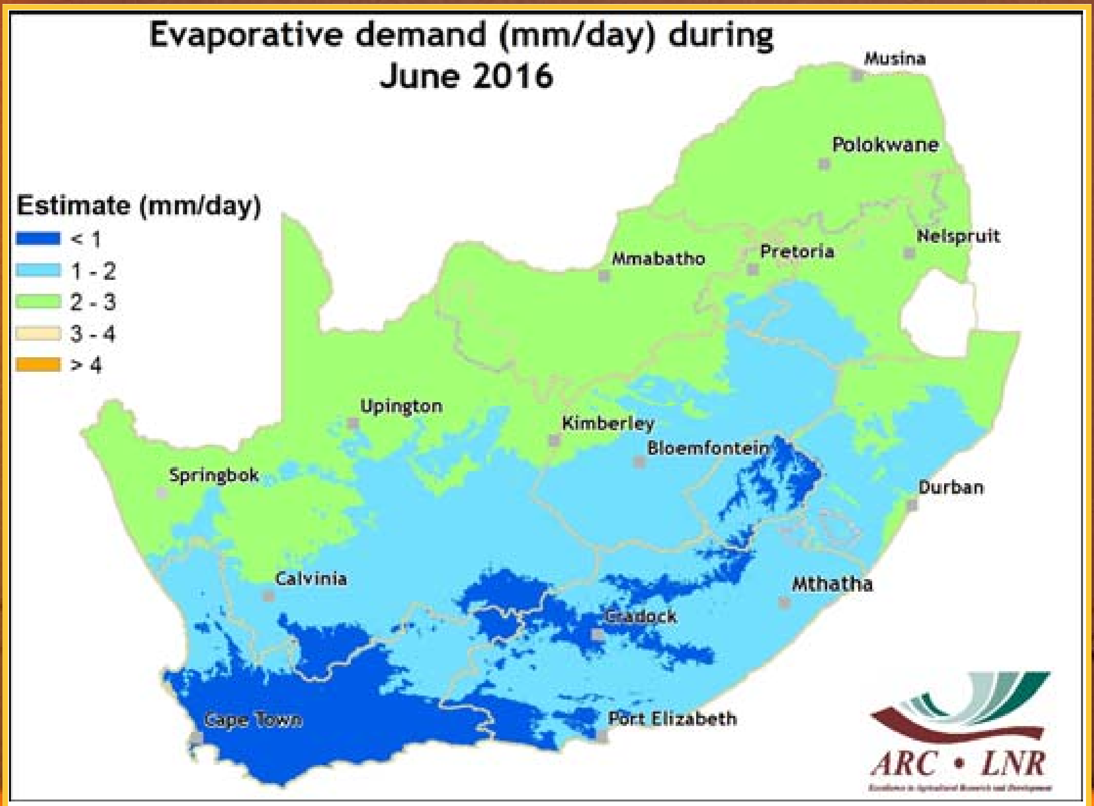


Figure 11

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:
The decreasing trend in mean daily potential evapotranspiration continued with values not exceeding 1 mm/day in the south-west, where cloud cover and rainfall events had an additional negative effect over and above lower solar radiation totals.

Questions/Comments:
Johan@arc.agric.za

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.

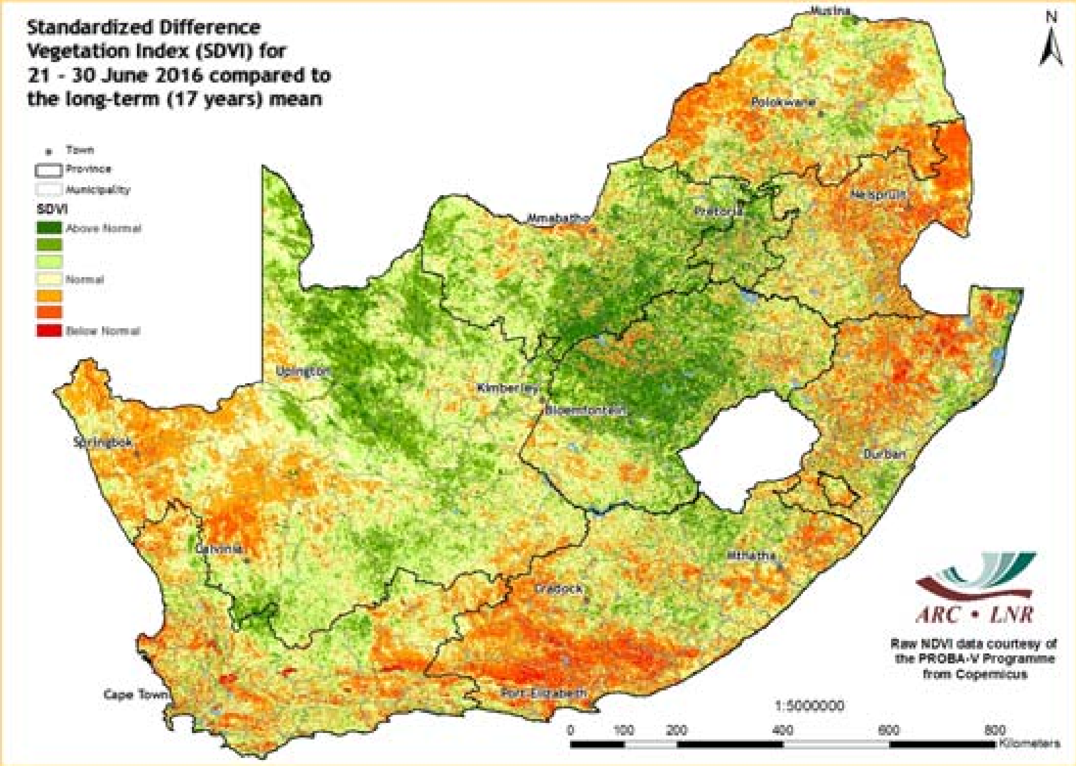


Figure 12

Figure 12:
The SDVI by late June reflected recent above-normal rainfall over much of the interior, the coast of KwaZulu-Natal and northern parts of the winter rainfall region (West Coast and western Escarpment) as well as dry conditions over the southeastern and eastern low-lying areas.

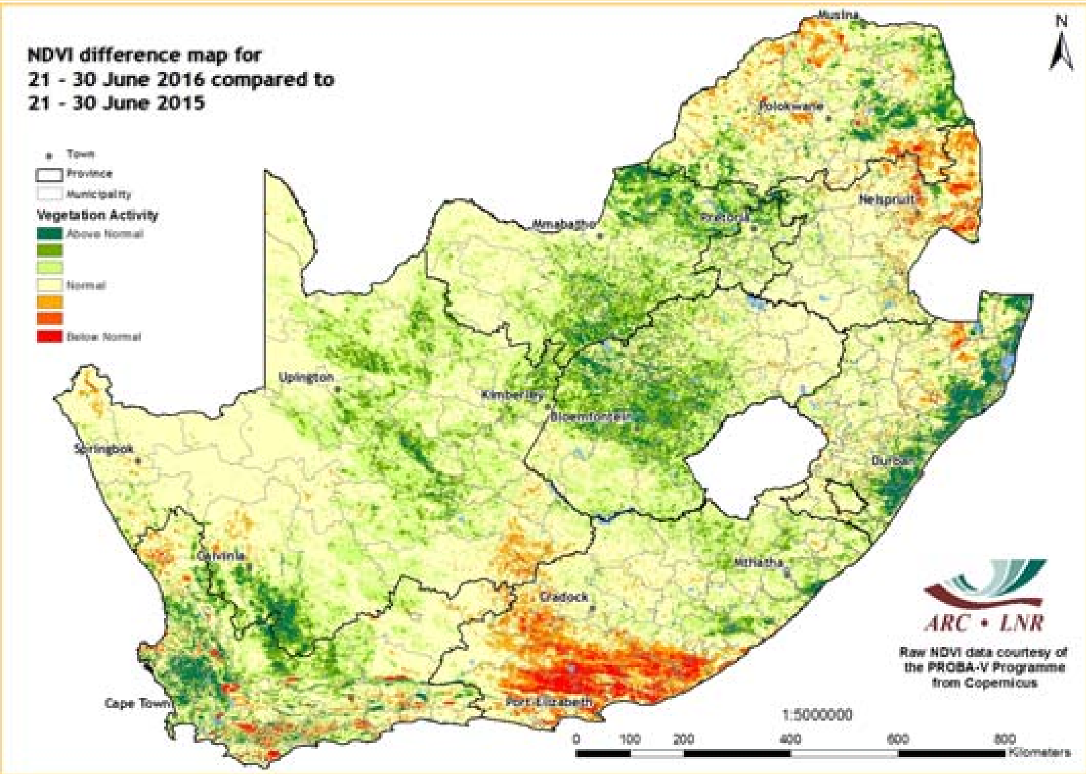


Figure 13

Figure 13:
Vegetation actrivity over much of the winter rainfall region is higher than a year ago due to an earlier start to the winter rainy season there. More rain over much of the interior and KwaZulu-Natal coast is also reflected in higher vegetation activity relative to the conditions last year by late June. Vegetation activity over the southeastern parts is lower than a year ago.

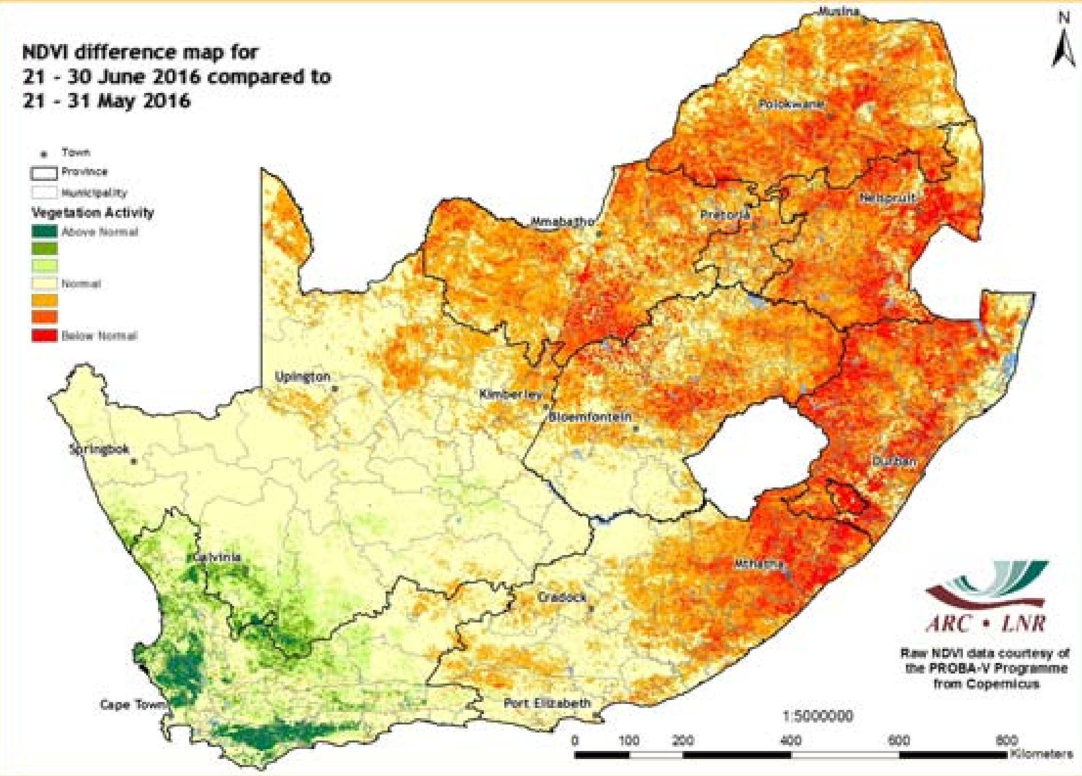


Figure 14

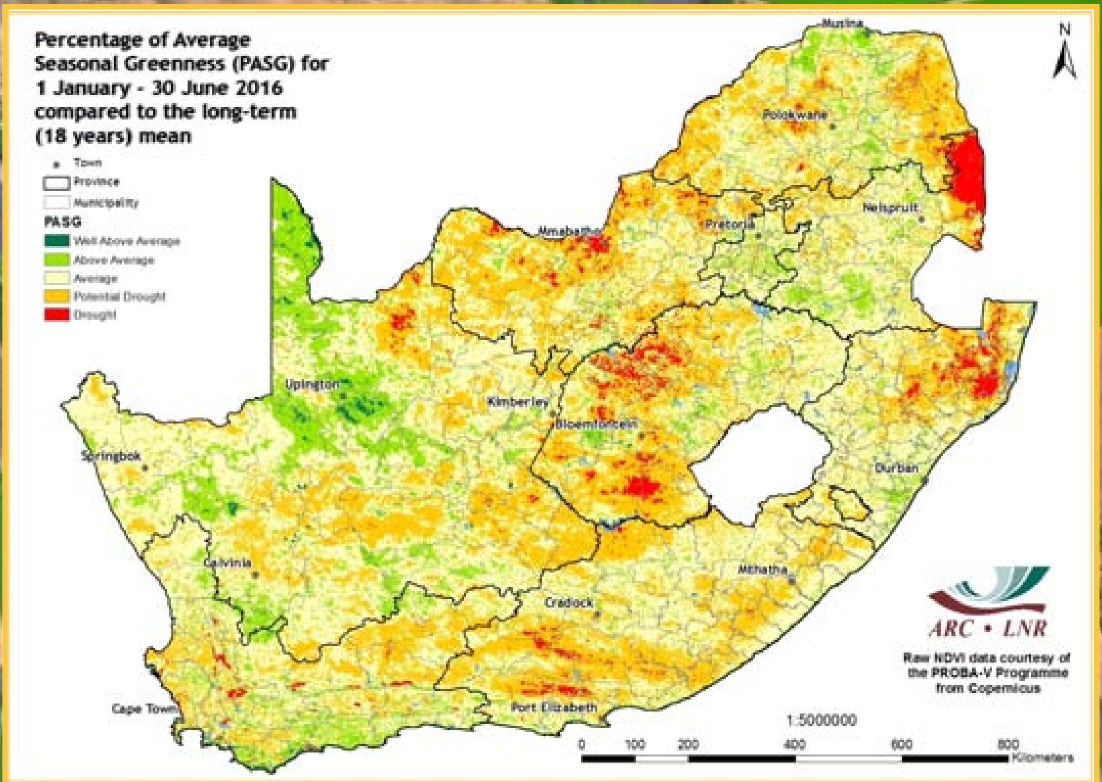


Figure 15

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:
Temperature and rainfall trends are the main drivers of the vegetation activity showing a decreasing tendency over the northeastern parts whilst increasing over the winter rainfall region, particularly the grain production areas.

Figure 15:
Cumulative vegetation activity anomalies still indicate earlier drought stress over much of the central parts of the country as well as the northern parts of KwaZulu-Natal and Lowveld of Mpumalanga. Conditions appear close to the norm over much of the winter rainfall region.

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

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.

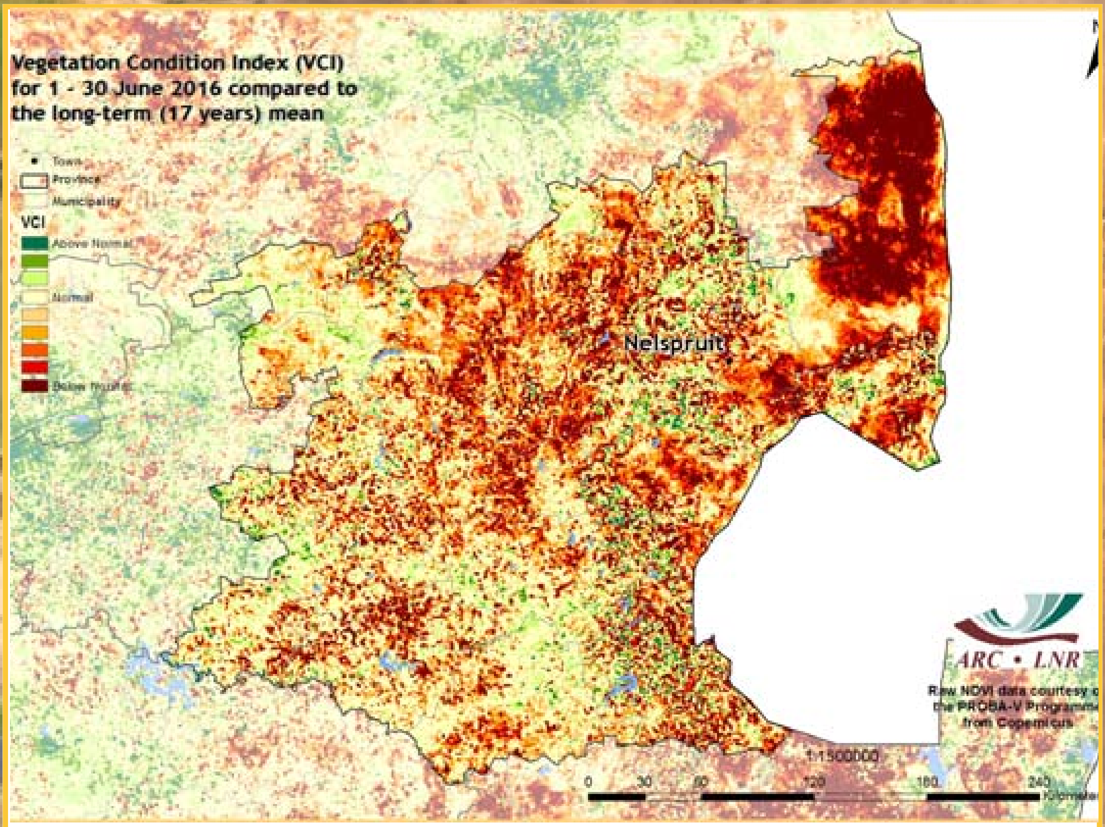


Figure 16

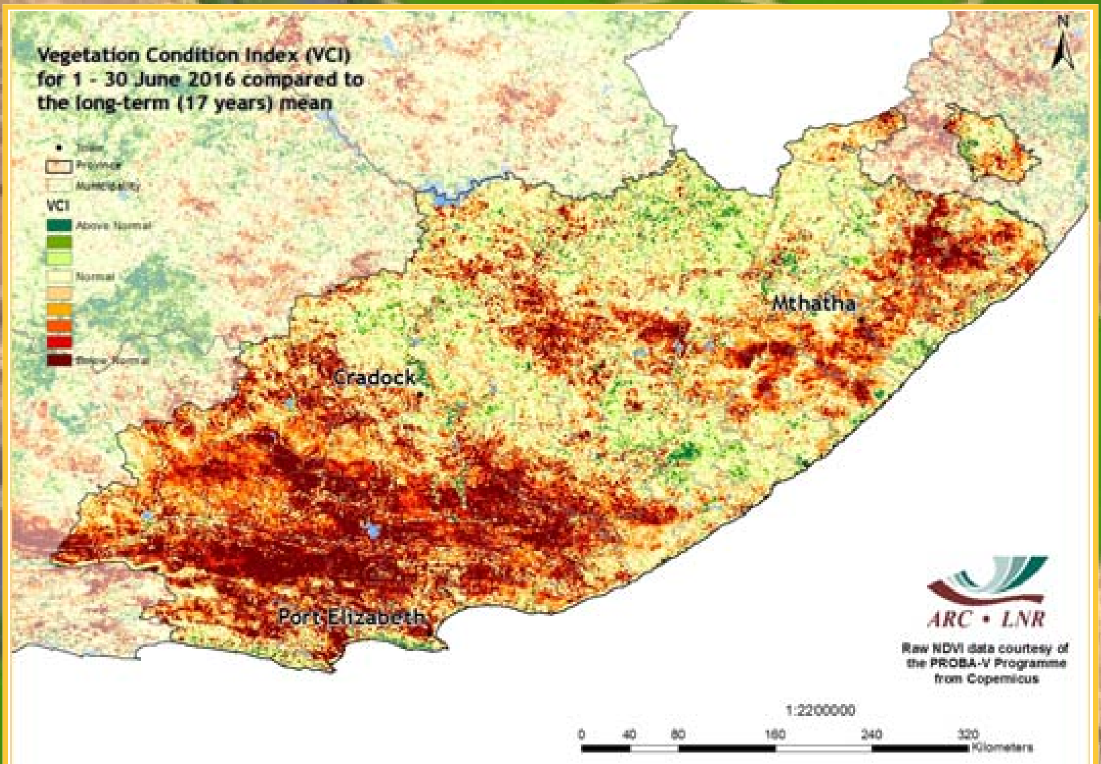


Figure 17

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

Figure 17:
The VCI map for June indicates below-normal vegetation activity over most parts of the Eastern Cape.

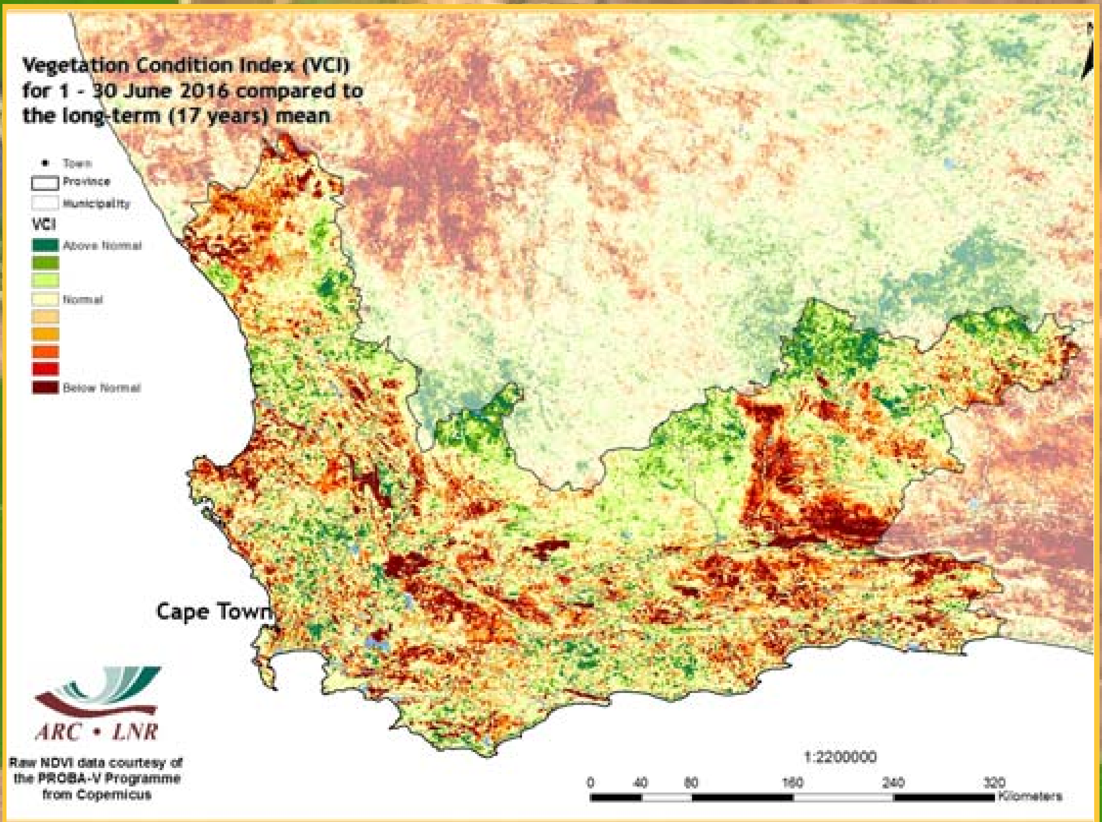


Figure 18

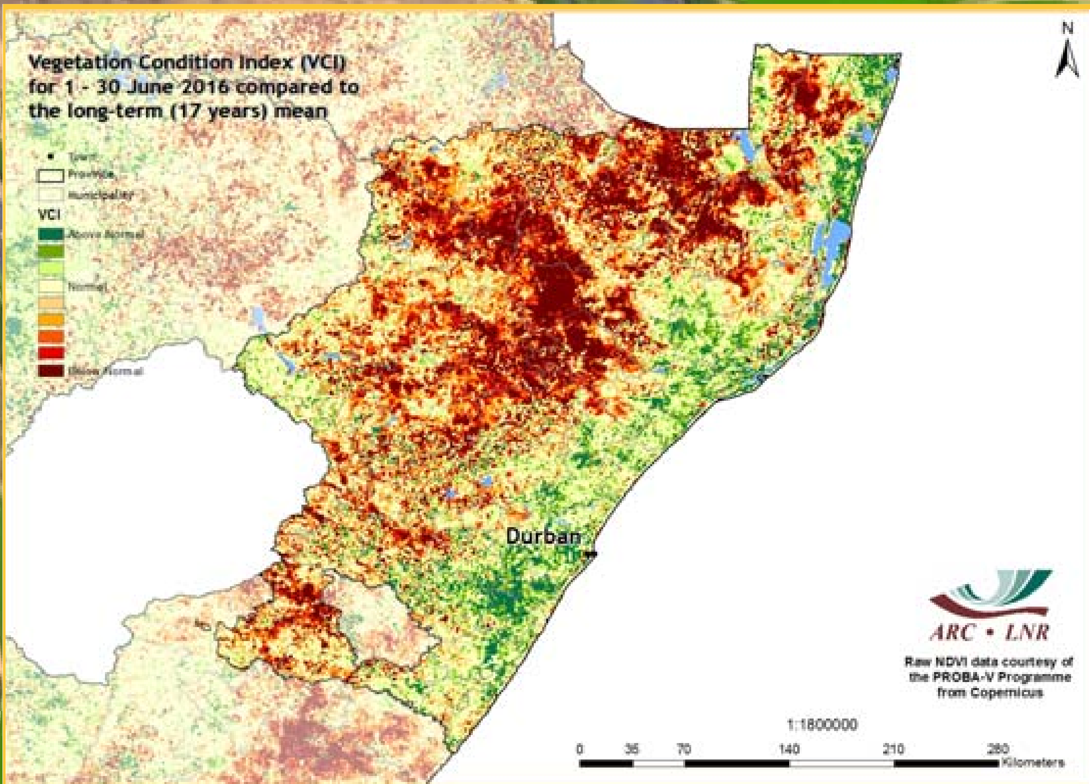


Figure 19

Figure 18:
The VCI map for June indicates below-normal vegetation activity over most parts of the Western Cape.

Figure 19:
The VCI map for June indicates below-normal vegetation activity over most parts of KwaZulu-Natal except in the costal areas of the province.

Questions/Comments:
NkambuleV@arc.agric.za

7. Vegetation Conditions & Rainfall

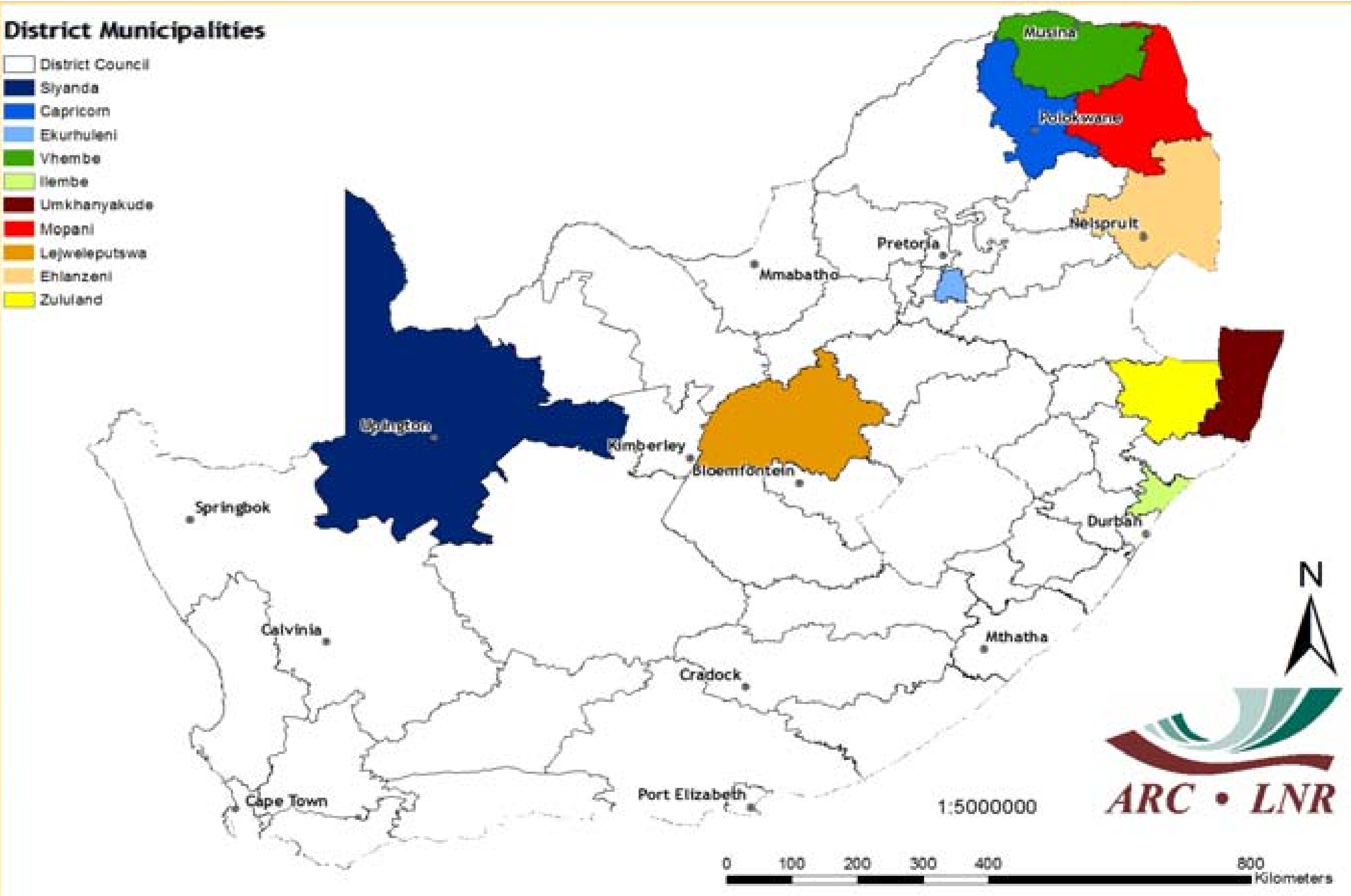


Figure 20

NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for June 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.

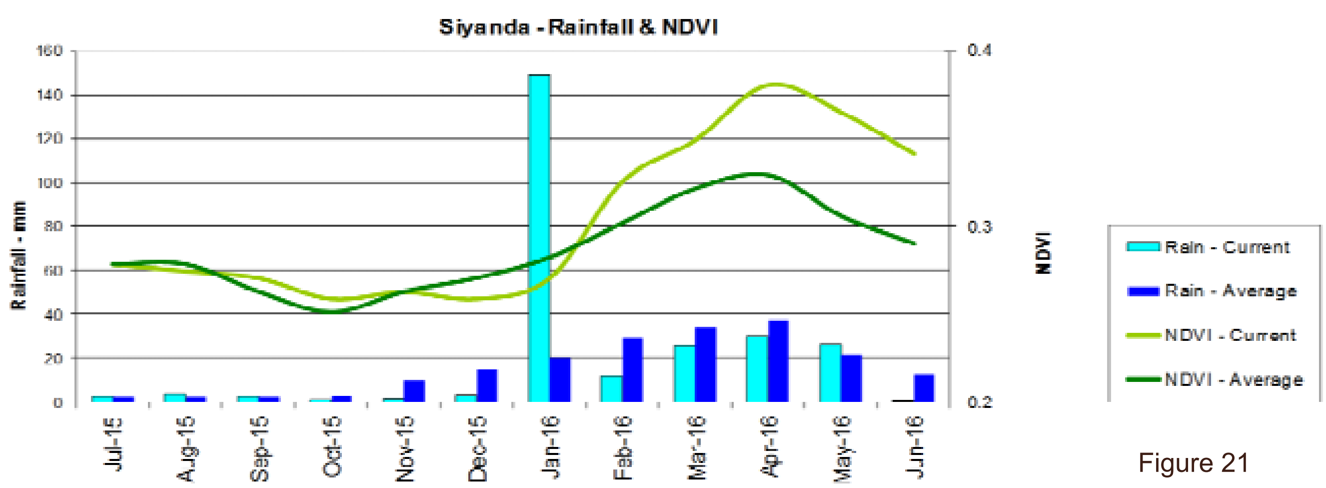


Figure 21

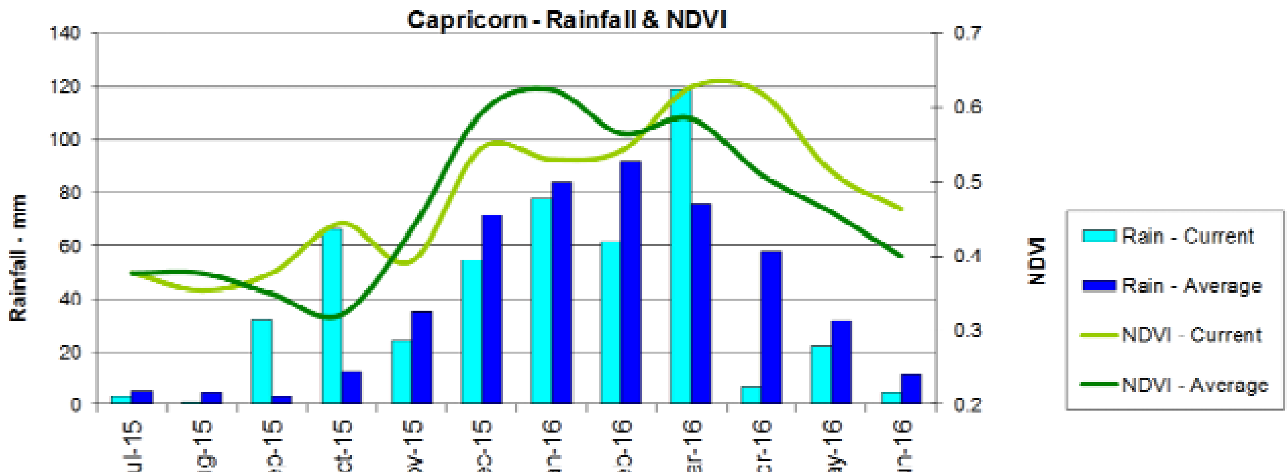


Figure 22

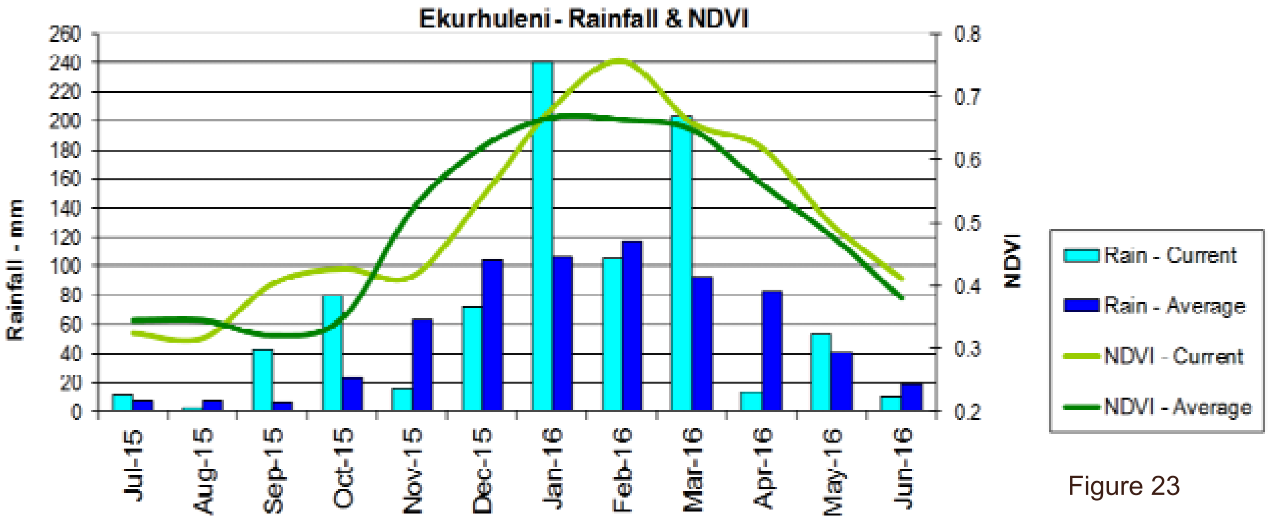


Figure 23

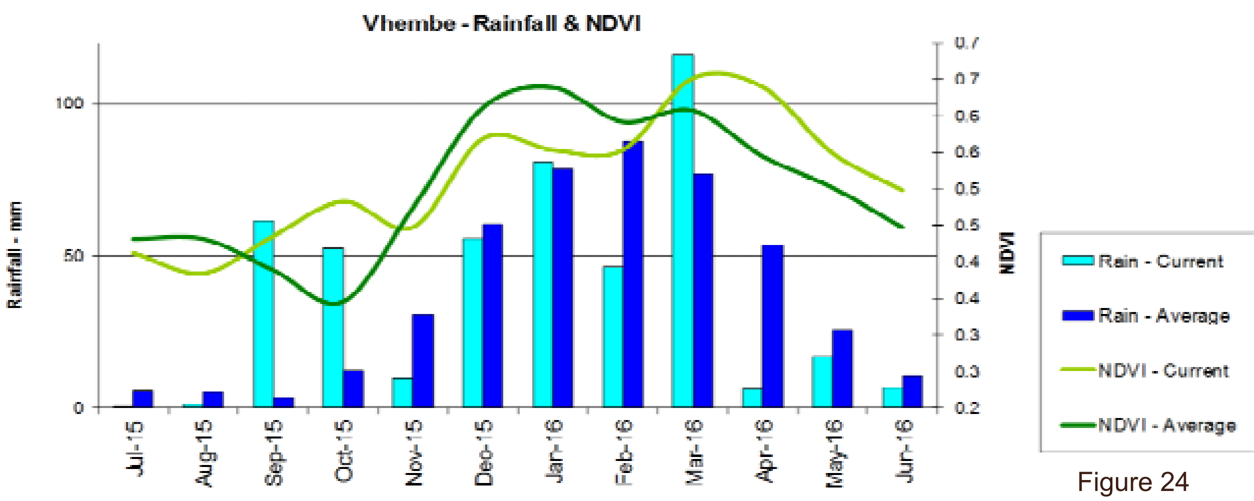


Figure 24

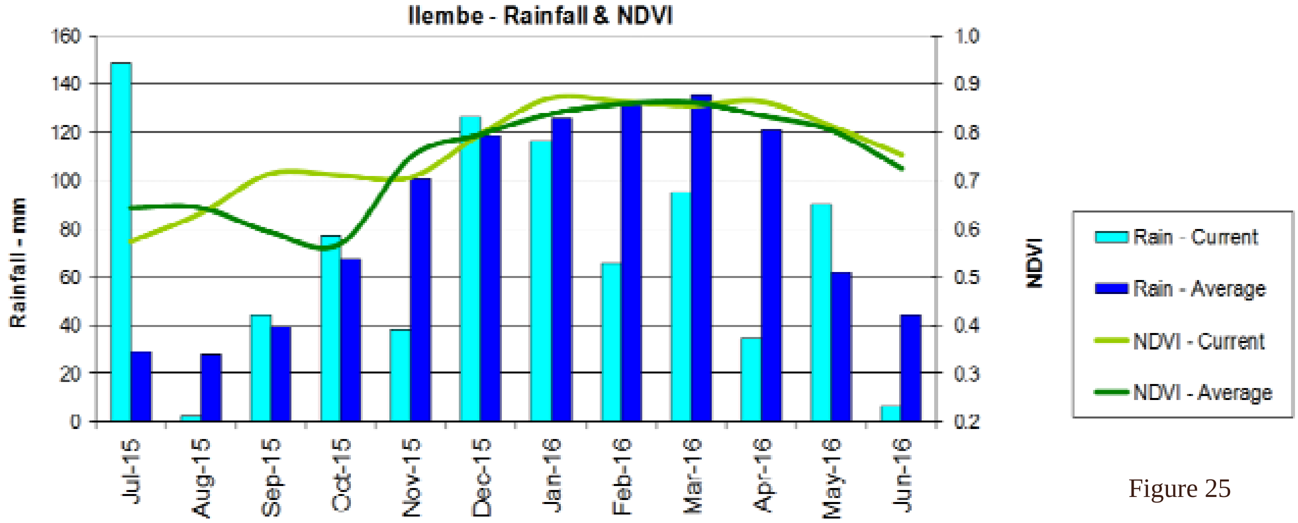


Figure 25

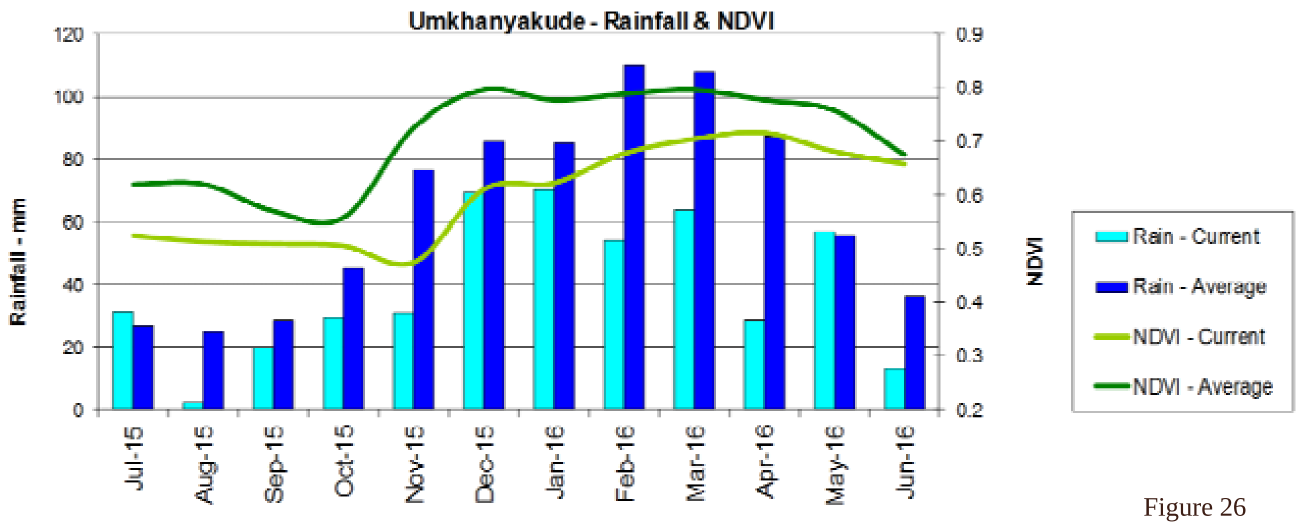


Figure 26

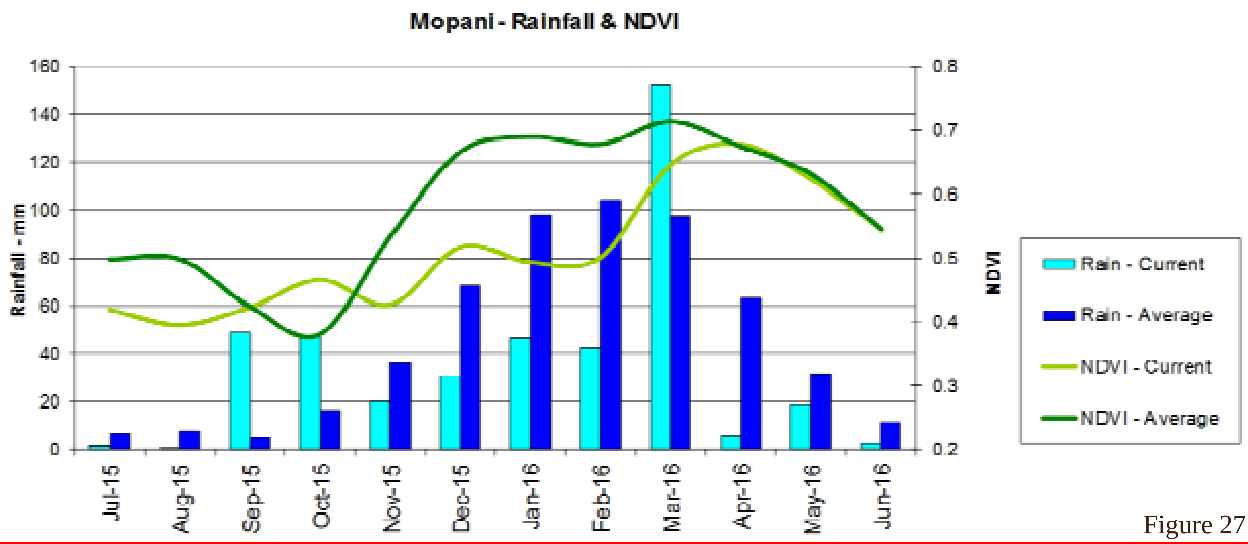


Figure 27

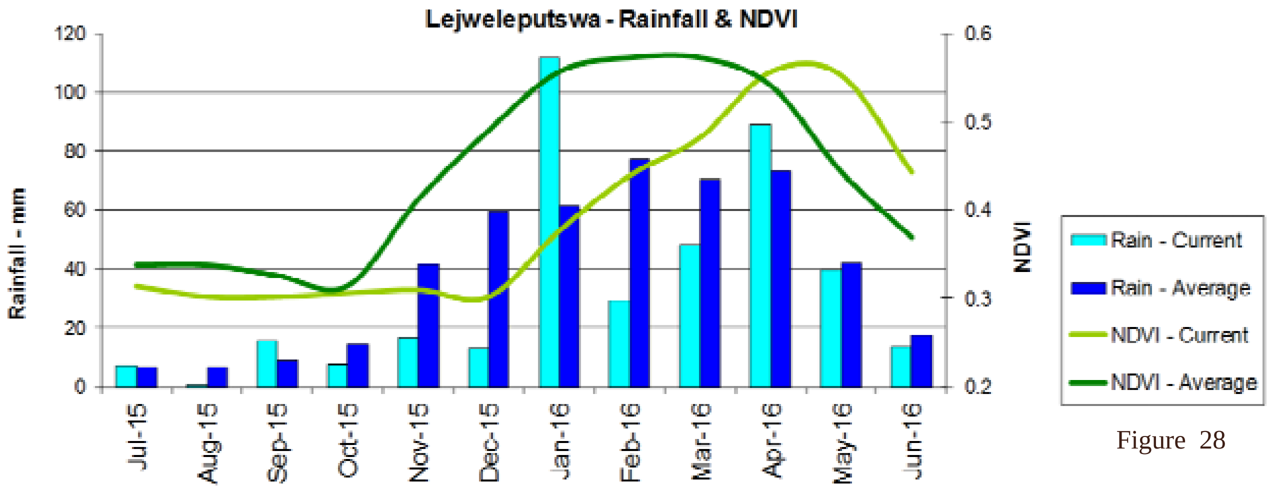


Figure 28

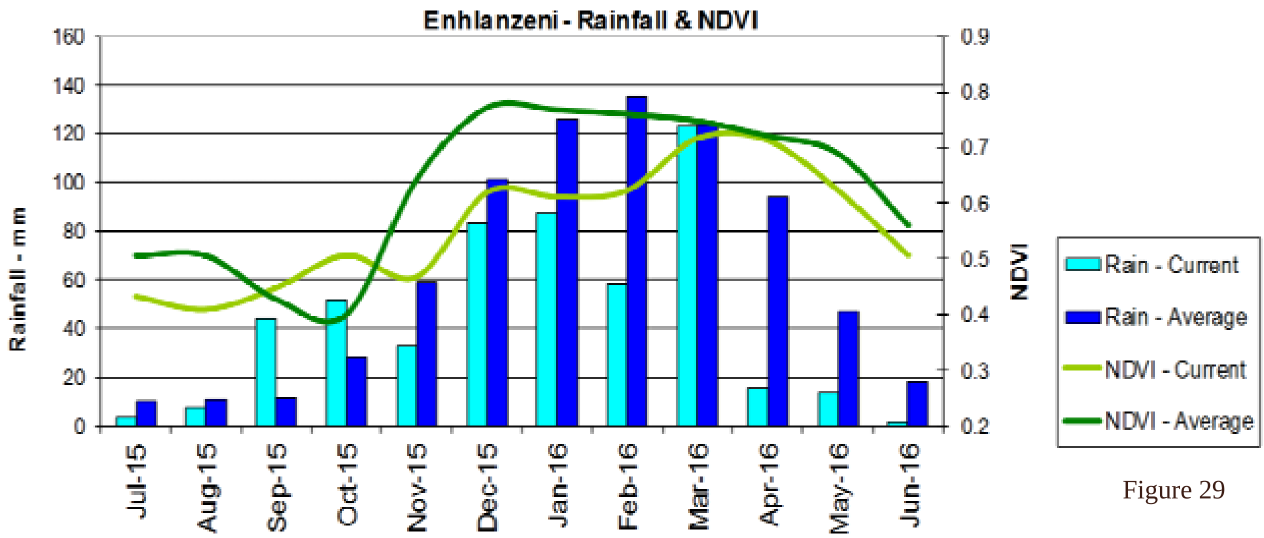


Figure 29

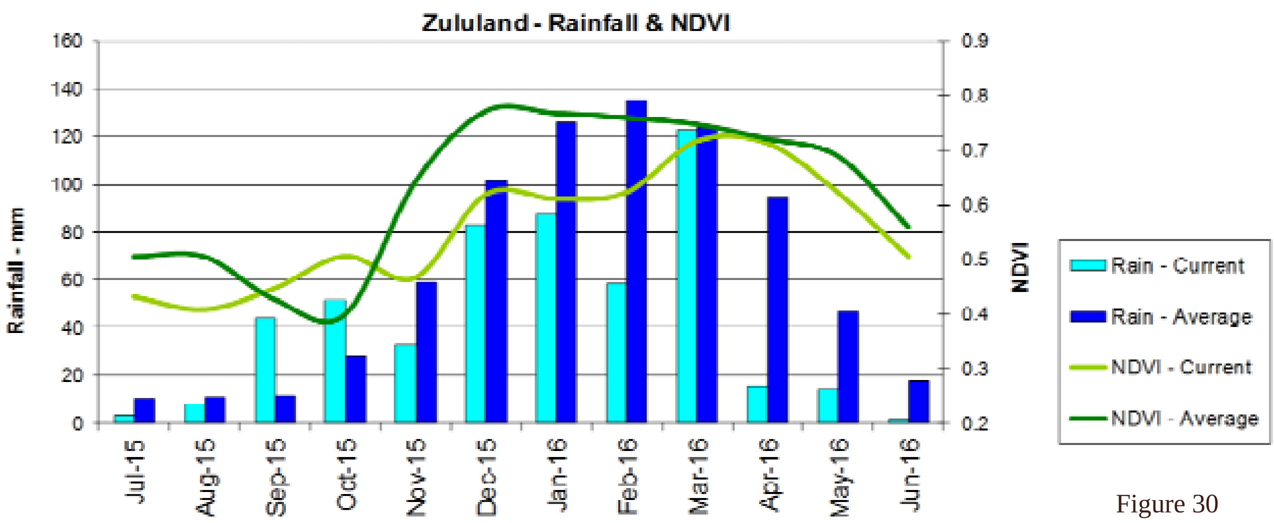


Figure 30

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 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 June and May 2016, 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:
sinclaird@ukzn.ac.za

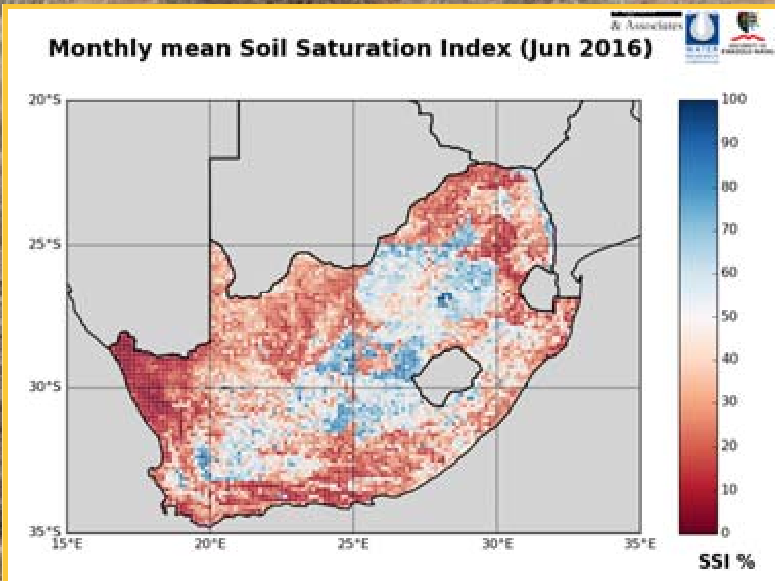


Figure 31

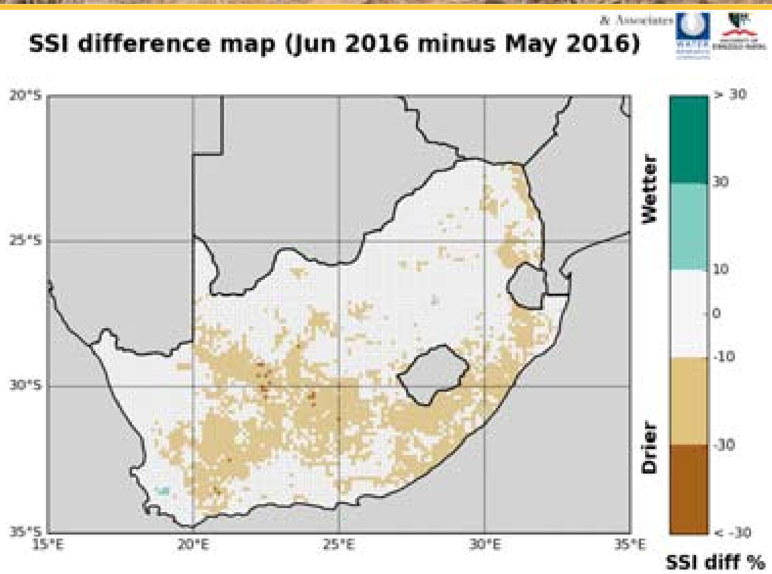


Figure 32

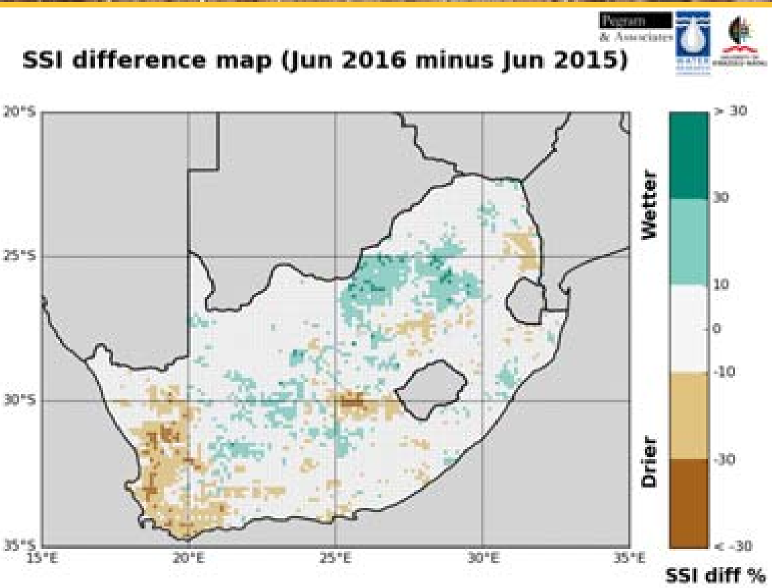


Figure 33

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:
The graph shows the total number of active fires detected during the month of June per province. Fire activity was lower in all provinces except the Eastern Cape compared to the average during the same period for the last 16 years.

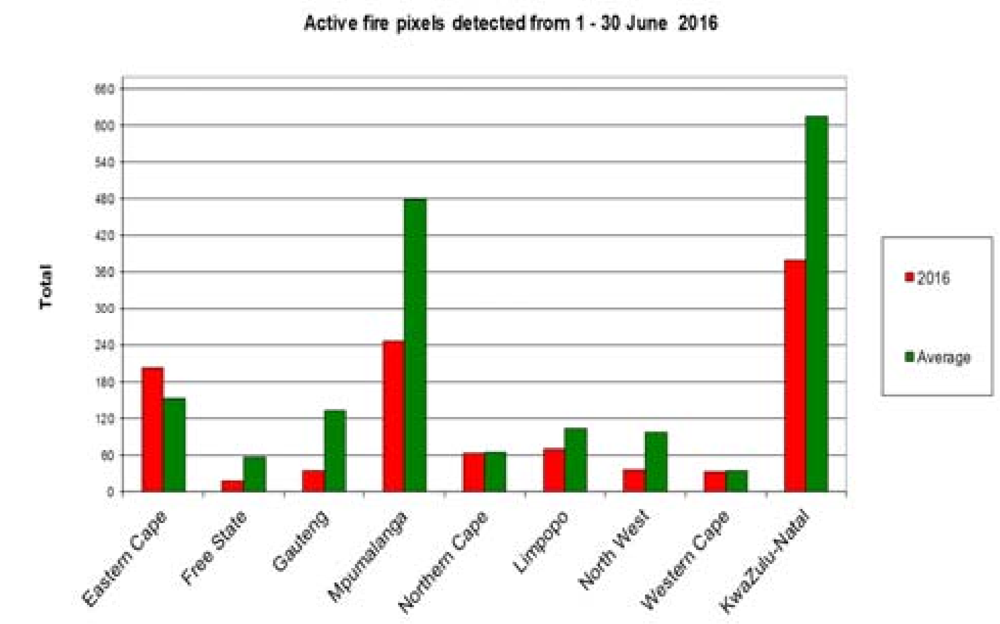


Figure 34

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

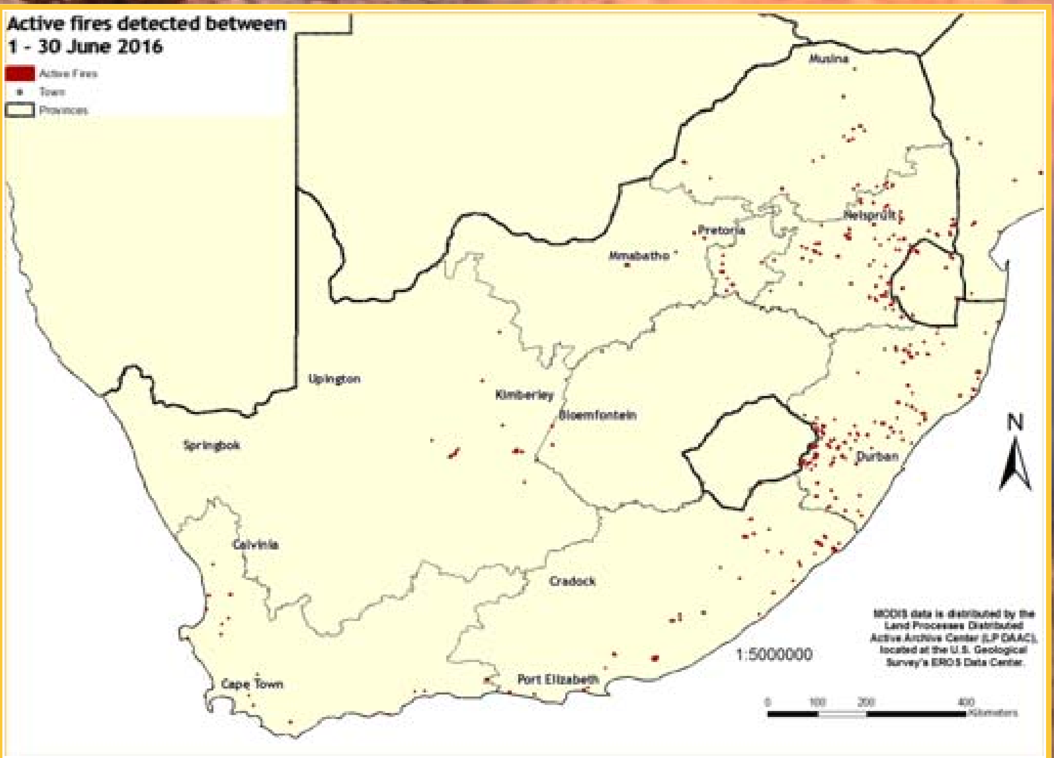


Figure 35

Questions/Comments:
NkambuleV@arc.agric.za

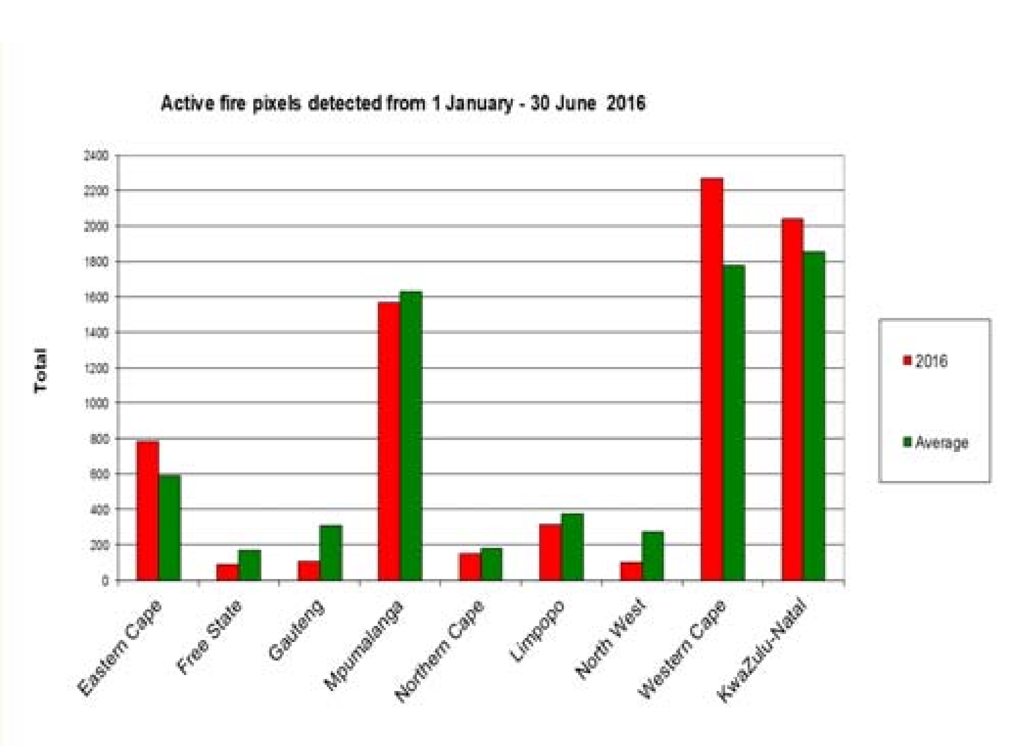


Figure 36

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

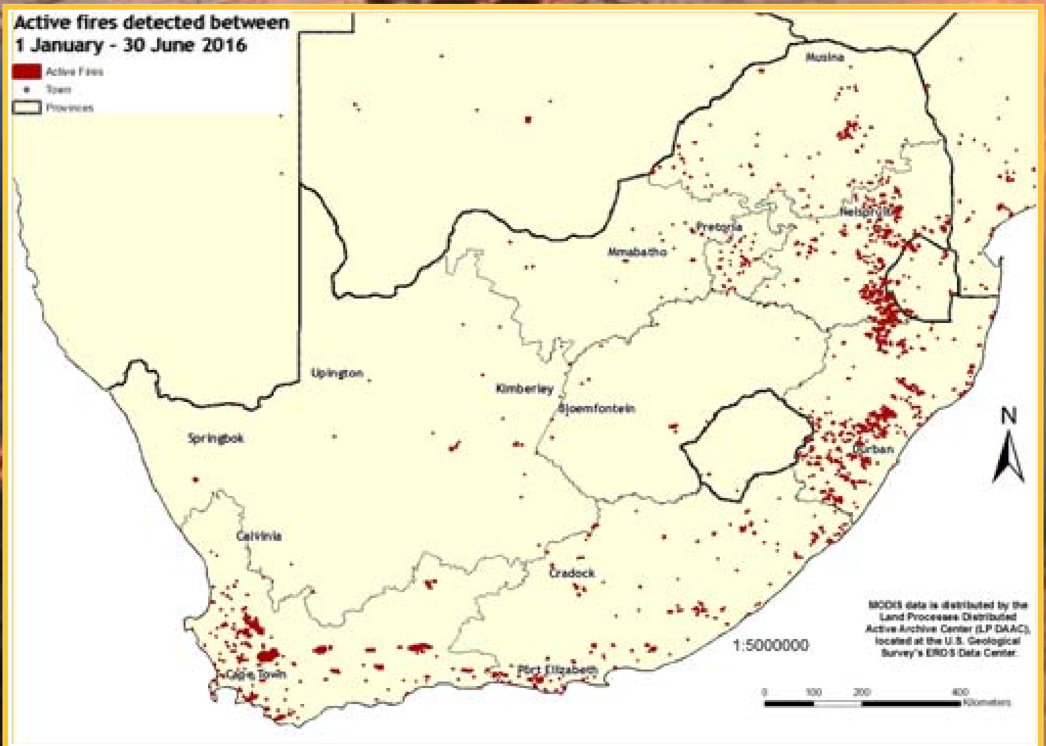
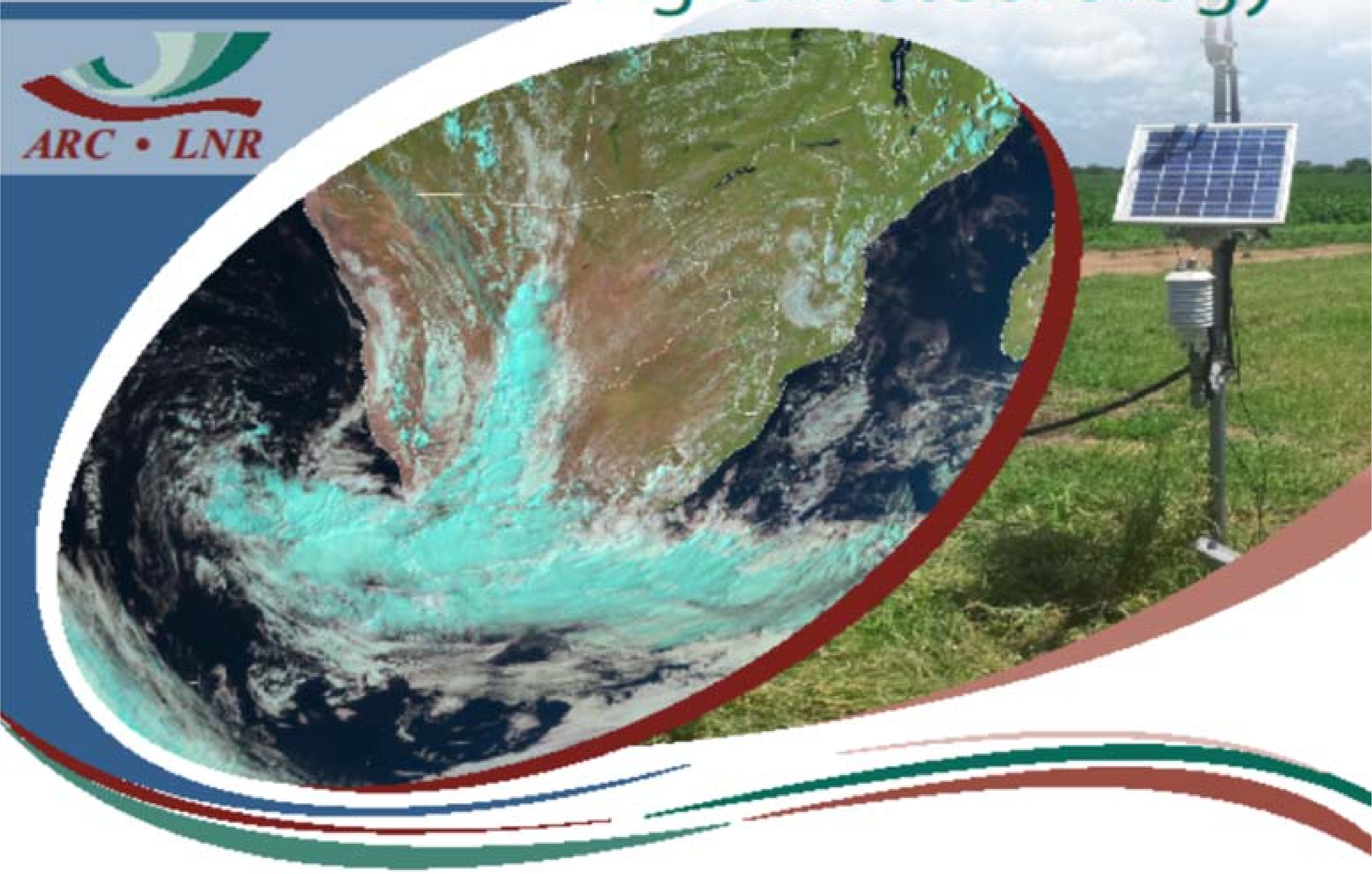


Figure 37

Figure 37:
The map shows the location of active fires detected between 1 January - 30 June 2016.

Questions/Comments:
NkambuleV@arc.agric.za

Agrometeorology



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

Contact Person:
Dr Mitsuru Tsubo
Tel: 012 310 2502
E-mail: tsubom@arc.agric.za

ARC-Institute for Soil, Climate and Water
600 Belvedere Street, Arcadia • Private Bag X79, Pretoria 0001
Tel: 012 310 2500 • Fax: 012 323 1157 • Website: www.arc.agric.za
For more information contact:
Adri Laas - Public Relations Officer • E-mail: adril@arc.agric.za

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**.

ARC • LNR

Excellence in Agricultural Research and Development

Institute for Soil, Climate and Water

Private Bag X79, Pretoria 0001,
South Africa
600 Belvedere Street, Arcadia, Pretoria, South Africa

Victoria Nkambule
Project leader: Coarse Resolution Imagery Database (CRID)
Phone: +27(0) 12 310 2533
Fax: +27 (0) 12 323 1157
E-mail: NkambuleV@arc.agric.za

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.

For further information please contact the following:
Dr Johan Malherbe – 012 310 2577, Johan@arc.agric.za
Adri Laas – 012 310 2518, AdriL@arc.agric.za

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