UMLINDI

The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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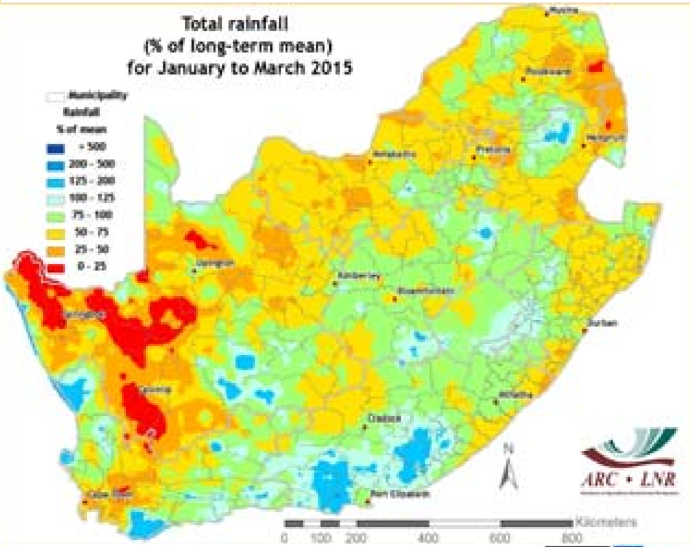
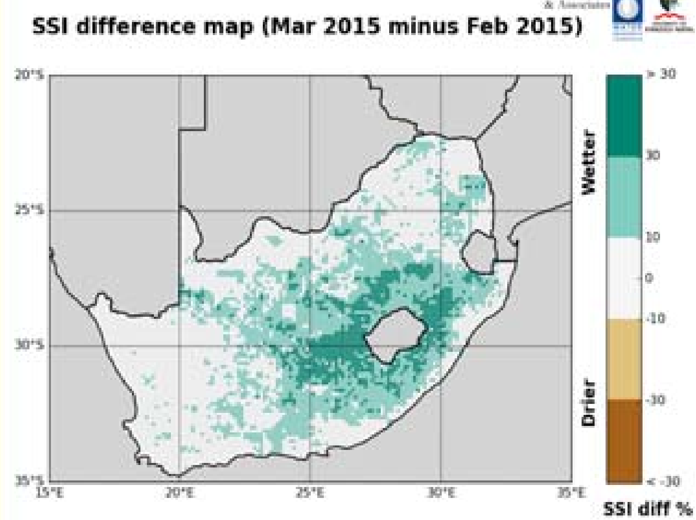
130th Edition

Images of the Month





Normal to below-normal rainfall during January-March 2015

Low rainfall, especially during early to mid-February, had a negative impact on maize production. Even though rainfall was below normal during the January-March (JFM) period this year, the situation still is better than that experienced in the previous two summers with record low maize yields, namely 1992 and 2007, when most of the Free State and North West received less than 50% of the long-term average rainfall and some areas even less than 25% during JFM. The rainfall map shows that most areas received between 50-100% during this year's JFM period. Two important maize producing areas, namely southern Mpumalanga and central to northeastern North West, received less than 75% of the long-term average. Near-normal to above-normal rainfall occurred over the Eastern Cape, parts of the Free State and northern Mpumalanga during this period. Widespread rain by mid- to late March was in most cases too late to significantly improve the situation for crops in areas affected by drought earlier. However, soil moisture status has improved markedly since February, as shown by the Soil Saturation Index (SSI) difference map produced by the University of KwaZulu-Natal Applications and Hydrology Group.

Fires in the Cape Peninsula during early March

During the first few days of March 2015, an easterly off-shore flow over the Western Cape resulted in hot, dry and windy conditions in that region, conducive to the development and spread of wild fires. A particularly devastating fire occurred over the Cape Peninsula, covering an area of about 4 000 ha and causing damage to property. The City of Cape Town spent millions of rand in an effort to contain the fires, which were to some extent alleviated by a change in the weather in terms of lower temperatures and light showers by the 4th. The fires were finally extinguished by the 8th. The MODIS visible bands true-colour composite for 3 March shows the smoke plume, driven from the Peninsula westwards over the Atlantic Ocean, by the strong easterlies that day. Fire pixels, as derived from the MODIS Fire product, are indicated in red, showing the large area influenced by two extensive fires that occurred during the first few days of the month.

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:

Welcome rains occurred over large parts of the summer rainfall area during March 2015, following a very hot and dry February. Temperatures over the interior were also lower than during much of February, owing to abundant cloud cover especially towards the second half of the month. An easterly surface flow dominated, keeping temperatures near normal over the eastern parts but above normal towards the southwest. Despite a tendency for wetter conditions during March, the northern parts of North West, eastern Mpumalanga and parts of KwaZulu-Natal remained dry.

Early in the month, several upper air systems developed over the southwestern parts, keeping conditions over the western to central interior relatively favourable for the development of thundershowers. An easterly surface flow dominated most parts, and resulted in hot and windy conditions over the southwestern parts by the 2nd and 3rd, during which time a large wild fire occurred over the Cape Peninsula. A tropical depression over the Mozambique Channel and anticyclonic upper air conditions kept the northeast dry during the first few days of the month.

By the 6th, favourable upper air conditions together with the influx of moisture from the east resulted in fairly widespread thundershowers over the central to eastern parts until the 8th. During the following few days, an upper air anticyclone towards the northwest with troughs moving across the southern and eastern parts kept conditions fairly favourable for thundershowers over the central to southeastern and eastern parts.

The development of three upper air low pressure systems to the west of and over southwestern South Africa, together with large amounts of tropical moisture from Angola and advection of moisture from the Indian Ocean due to a large anticyclonic circulation there, were responsible for very favourable conditions experienced from about the middle of the month for rain over the interior. The eastern extremes did not benefit much as the preferred area of precipitation has remained somewhat to the west during the period 17-25 March.

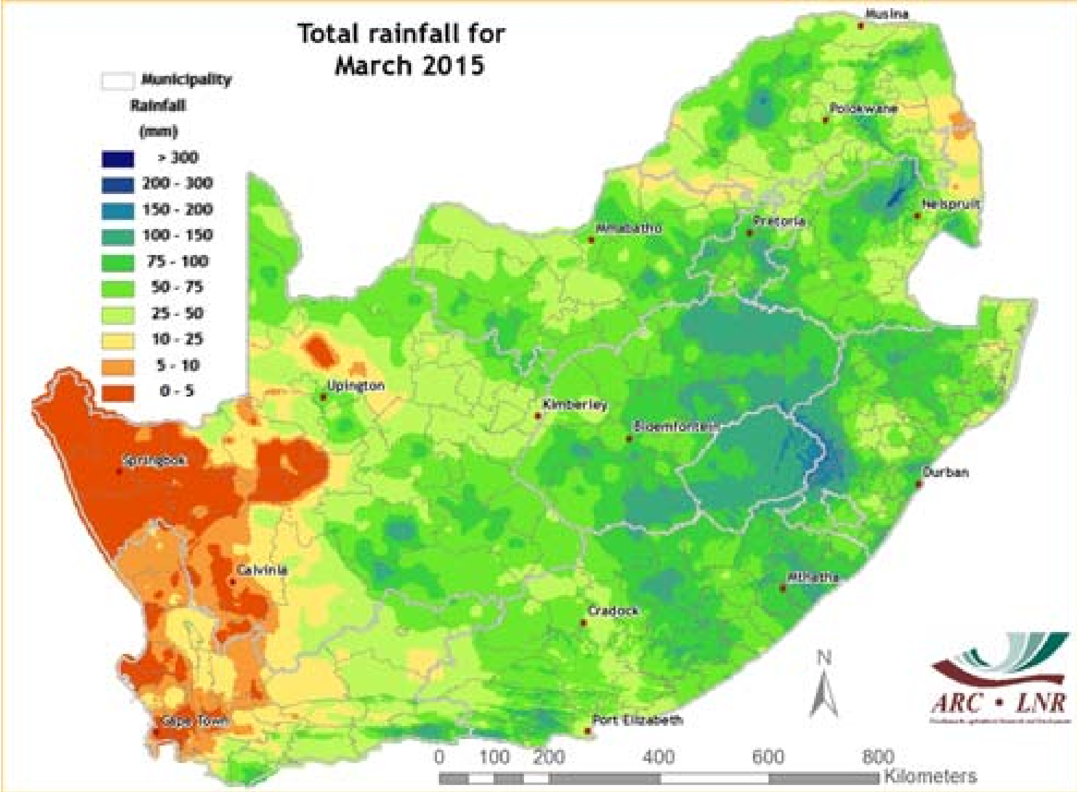


Figure 1

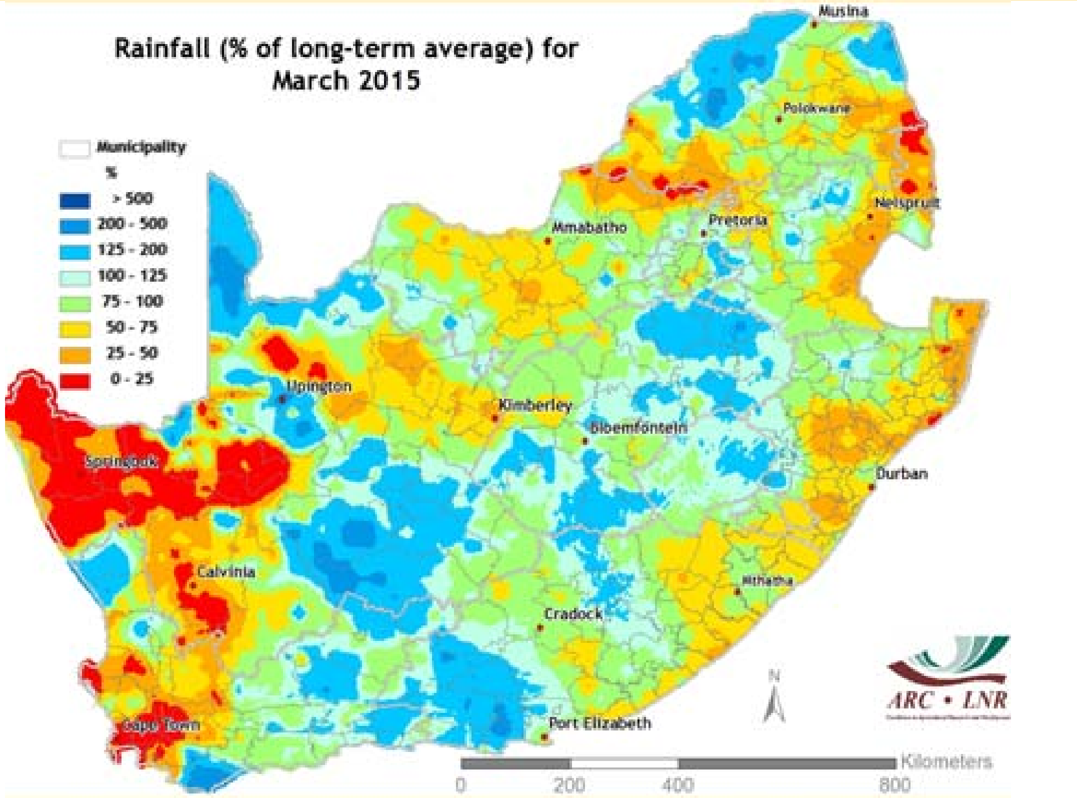


Figure 2

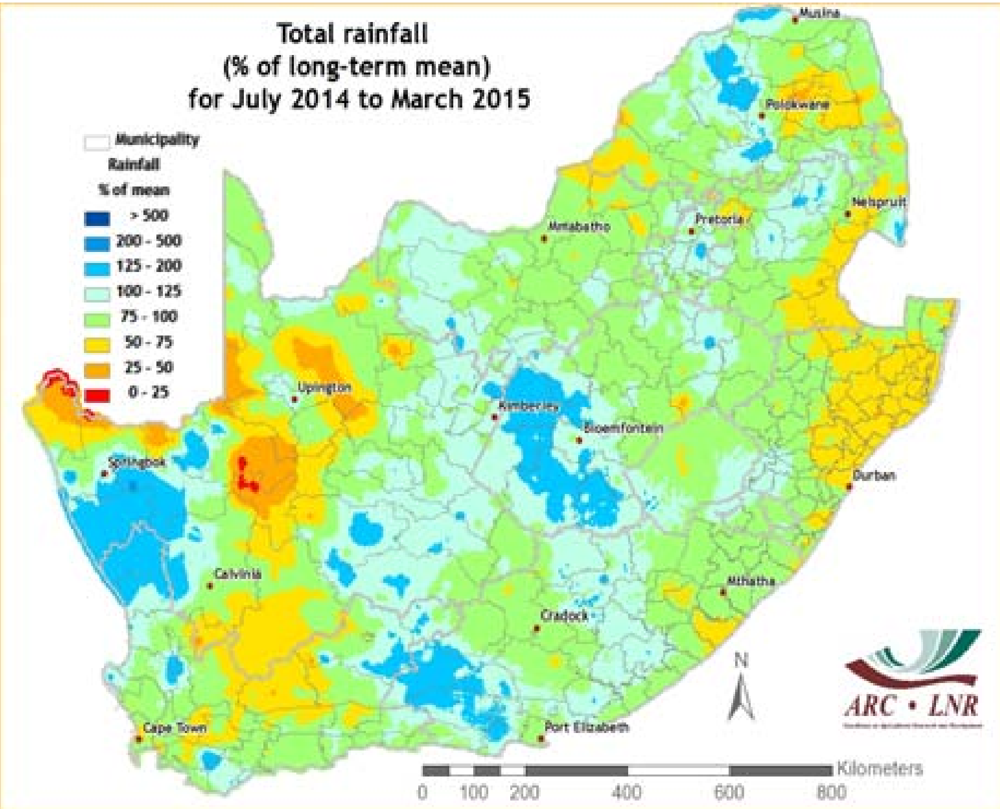


Figure 3

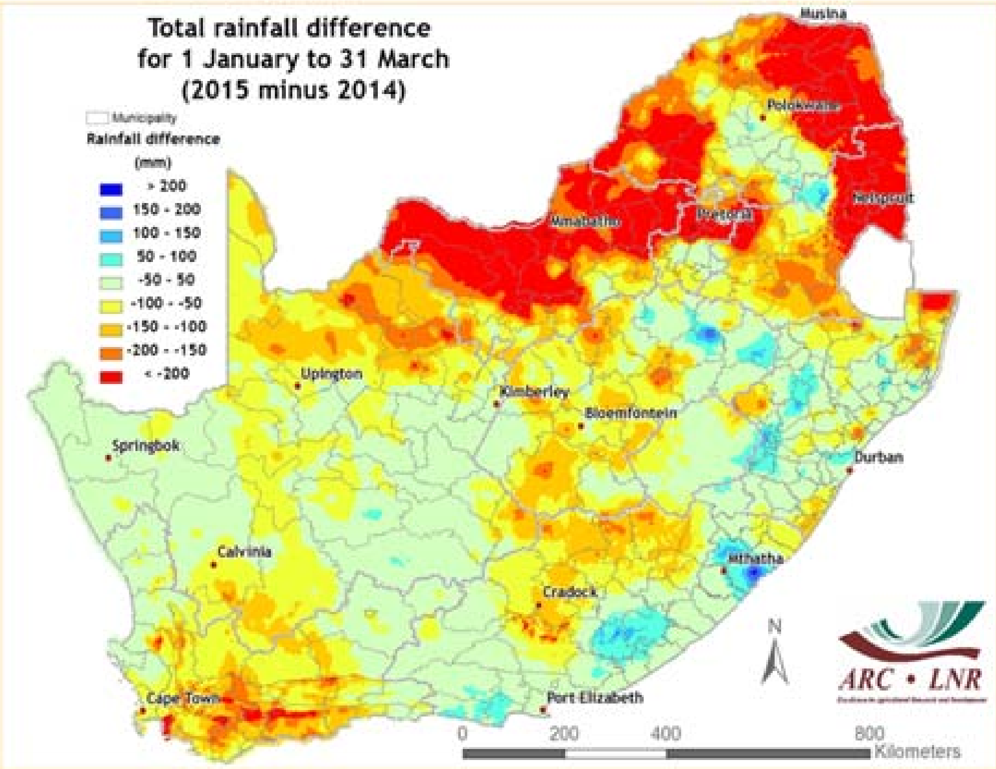


Figure 4

The main area of precipitation relocated to the northeast where fairly widespread rain and thundershowers occurred by the 27th and 28th due to upper air perturbations there to the north of a developing low over the southeast, together with large amounts of moisture advected from the east and north. Yet another upper air low developed over western Botswana by the end of the month, resulting in widespread rain and thundershowers over large parts of Botswana and Namibia, with some thundershowers also over adjacent parts of South Africa.

Figure 1:
Most of the interior received between 50-150 mm of rain in March with the highest falls from the eastern parts of the Eastern Cape across the Escarpment of KwaZulu-Natal into the eastern and northern Free State and southern Gauteng. Higher totals were also recorded along the northeastern Escarpment and parts of western Limpopo.

Figure 2:
Large parts of the central to northeastern interior received above-normal rainfall during March. Below-normal rainfall occurred over much of eastern Mpumalanga and central to northeastern KwaZulu-Natal as well as the extreme southwestern parts of Limpopo and northern North West.

Figure 3:
Since July 2014, cumulative precipitation has been above normal over the central interior, isolated areas in the northeast and the northern parts of the winter rainfall area. The eastern parts of KwaZulu-Natal, eastern Mpumalanga and Limpopo as well as the central and southwestern parts of the Northern Cape received below-normal cumulative rainfall.

Figure 4:
Much of the north and northeast as well as the southwestern parts of the country received less rain in the 3-month period ending March 2015 than in 2014, whilst parts of the southeastern interior and coastal area received more rain this 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 all time scales, with wet conditions indicated over the northeastern and southwestern parts of the country at the 12-24-month time scales.

Questions/Comments:
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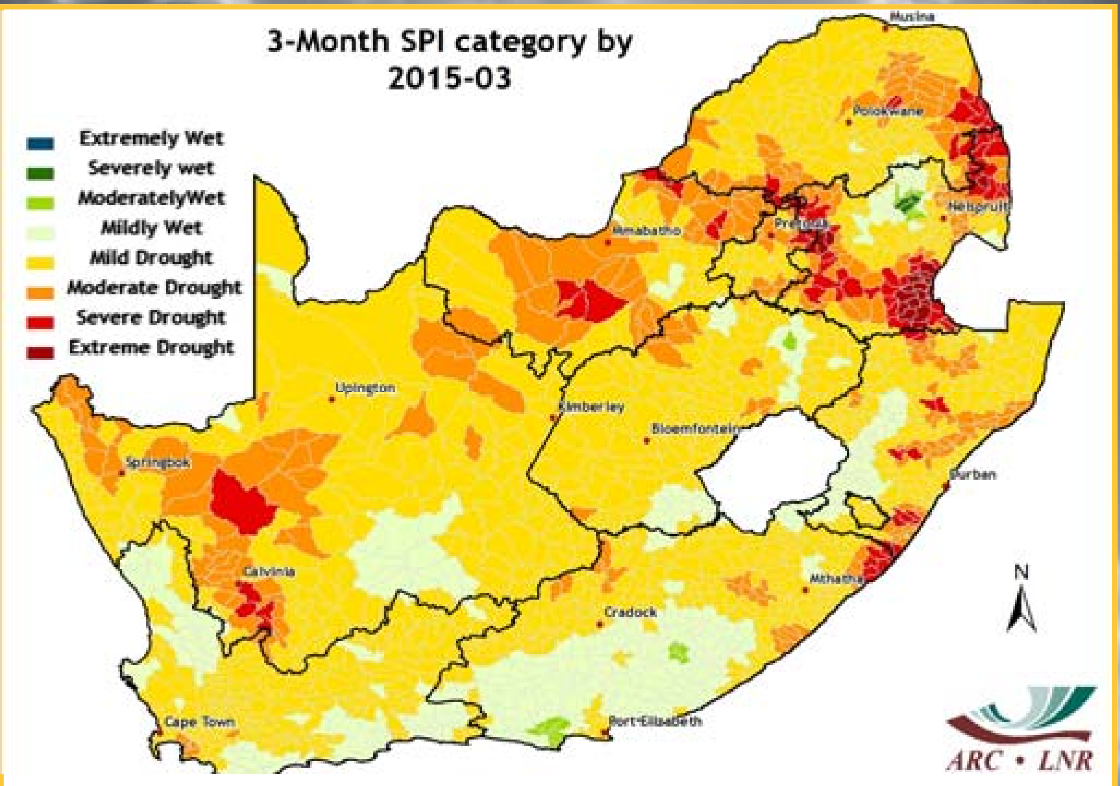
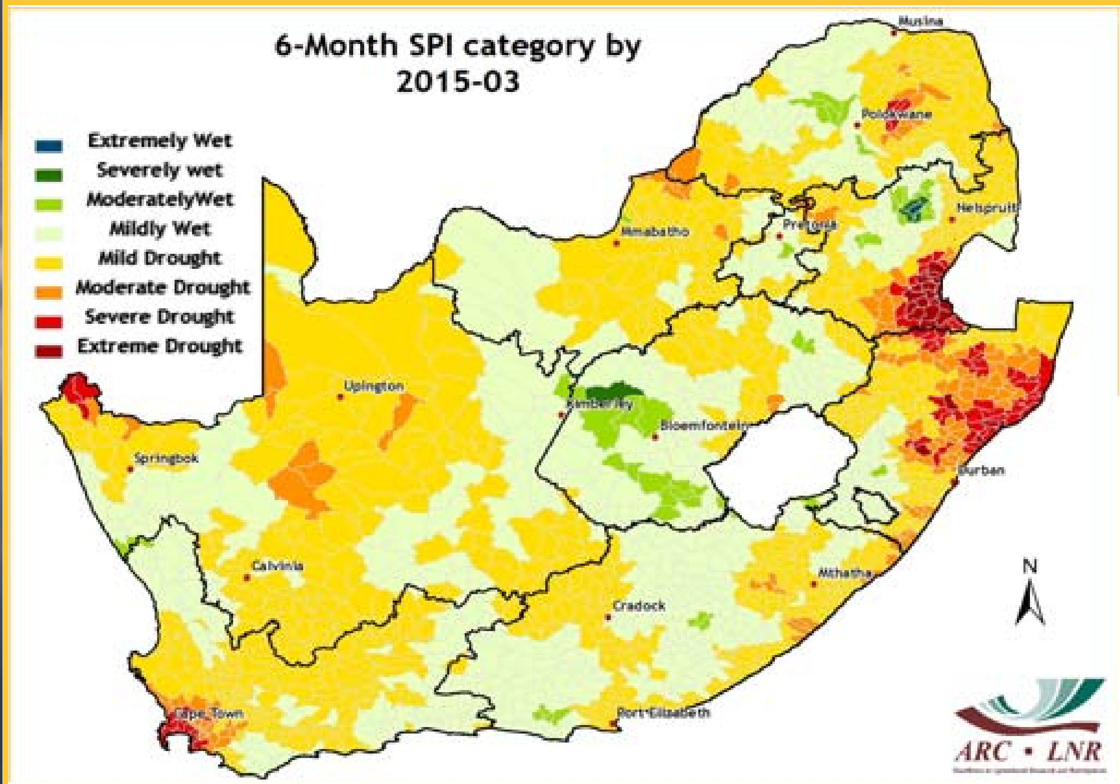


Figure 5



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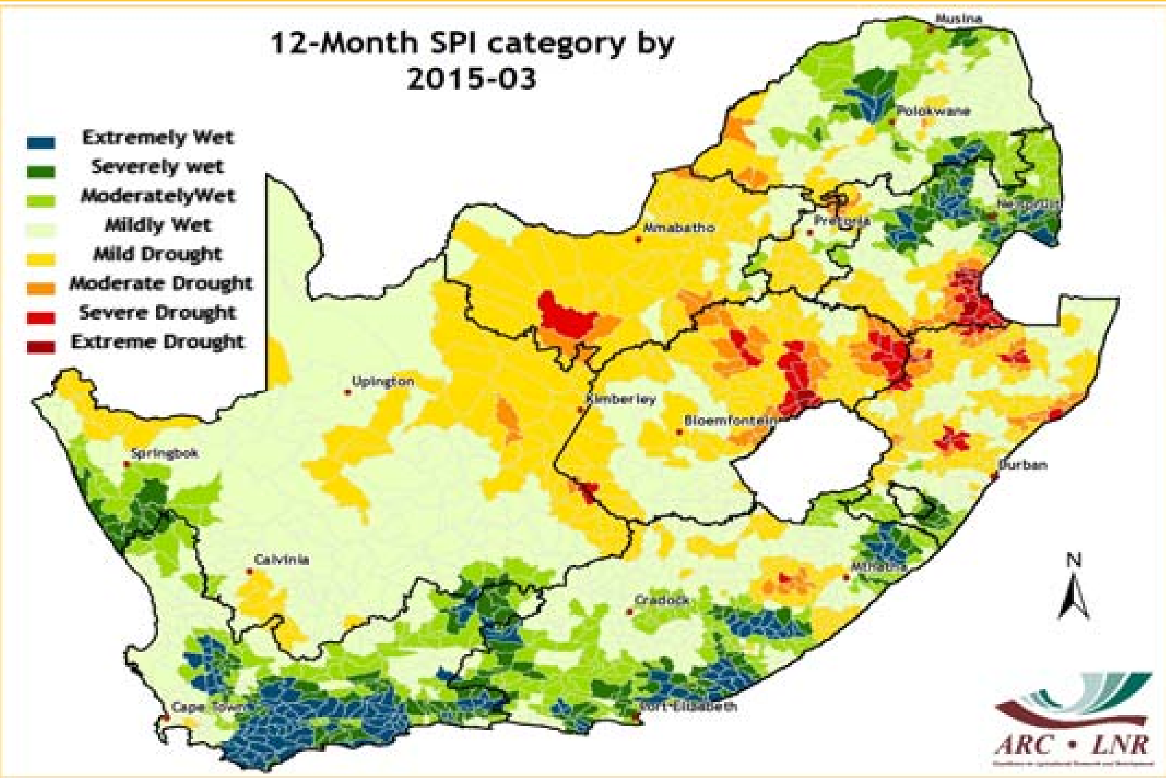

Figure 7

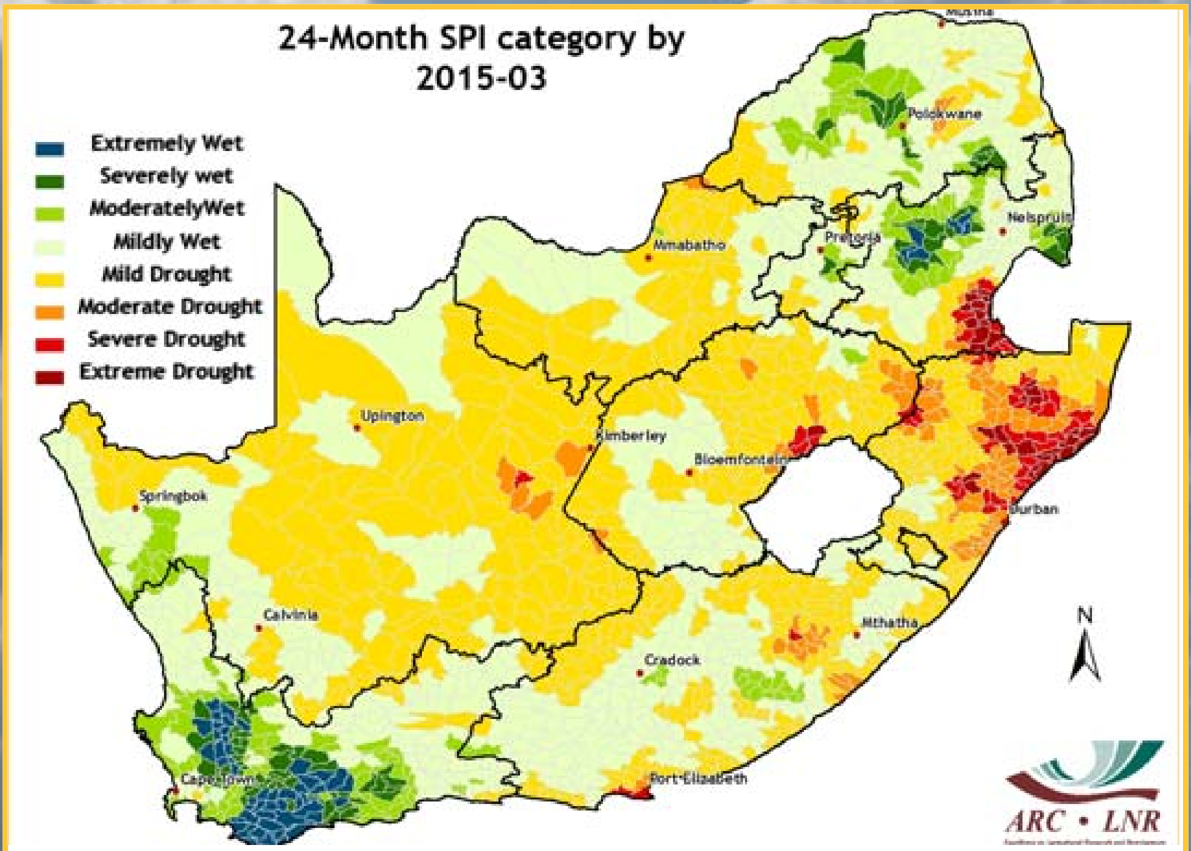

Figure 8

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.

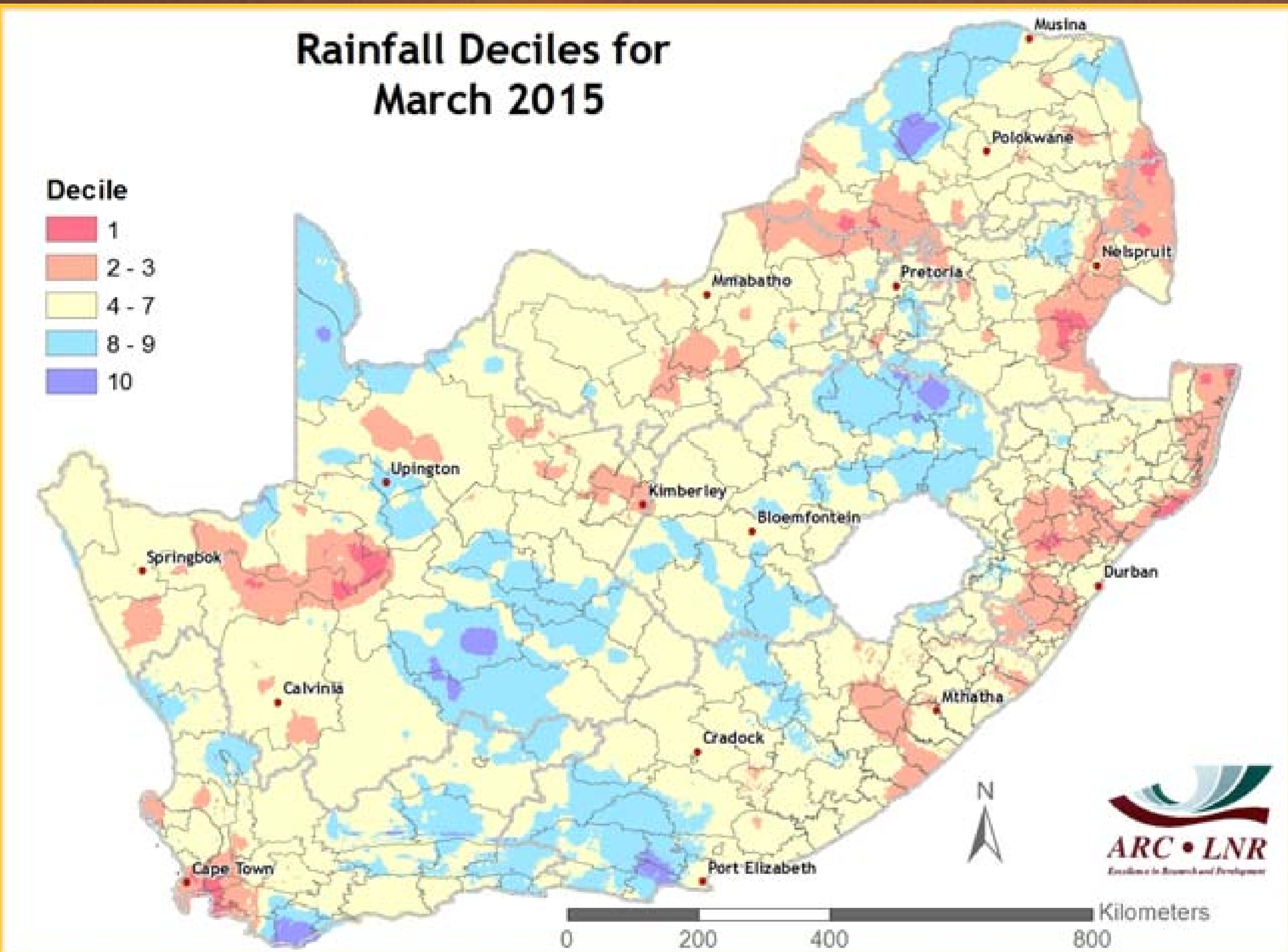

Figure 9

Figure 9:
Rainfall during March was abnormally high over parts of western Limpopo, the northeastern Free State and central parts of the Northern Cape. In contrast, the southwestern extremes of Limpopo as well as eastern Mpumalanga and eastern KwaZulu-Natal were exceptionally dry.

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

4. Water Balance

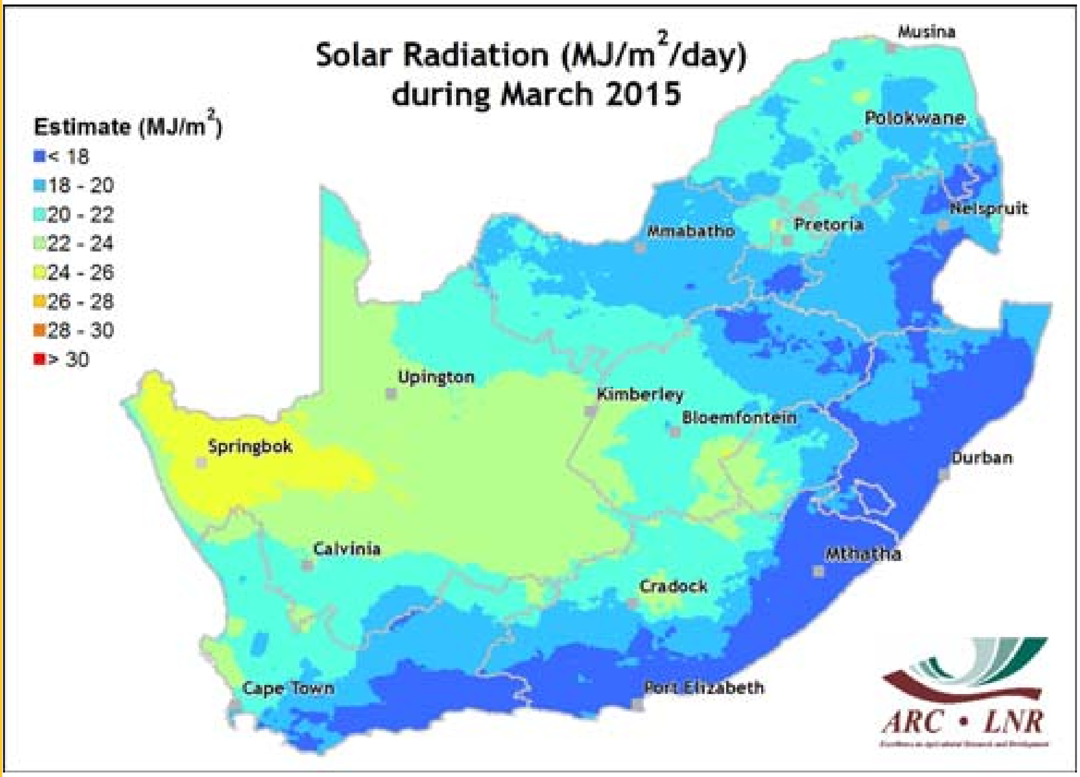

Figure 10

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 relatively low from central North West to KwaZulu-Natal, due to extensive cloud cover especially during the second half of the month. Solar radiation values remained low to the south and east of the Escarpment.

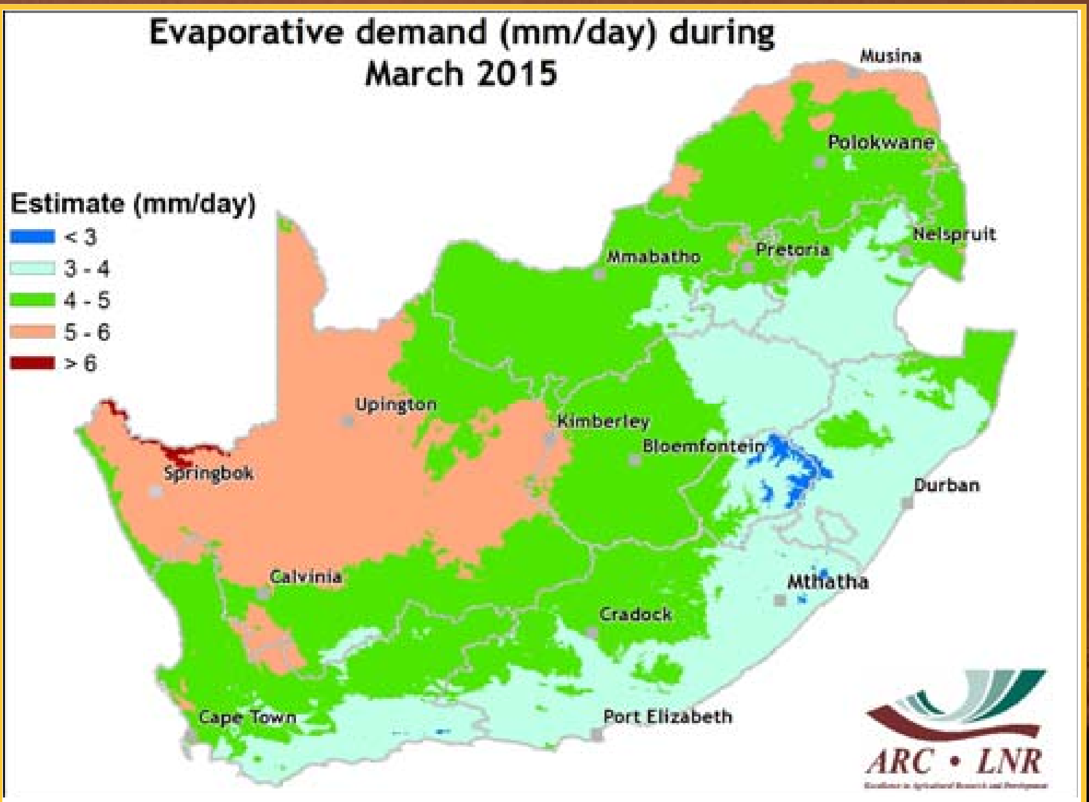

Figure 11

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:
Average daily evapotranspiration ranged from 3-4 mm/day over the southern and eastern areas to 5 mm/day over the central to northwestern parts of the Northern Cape.

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.

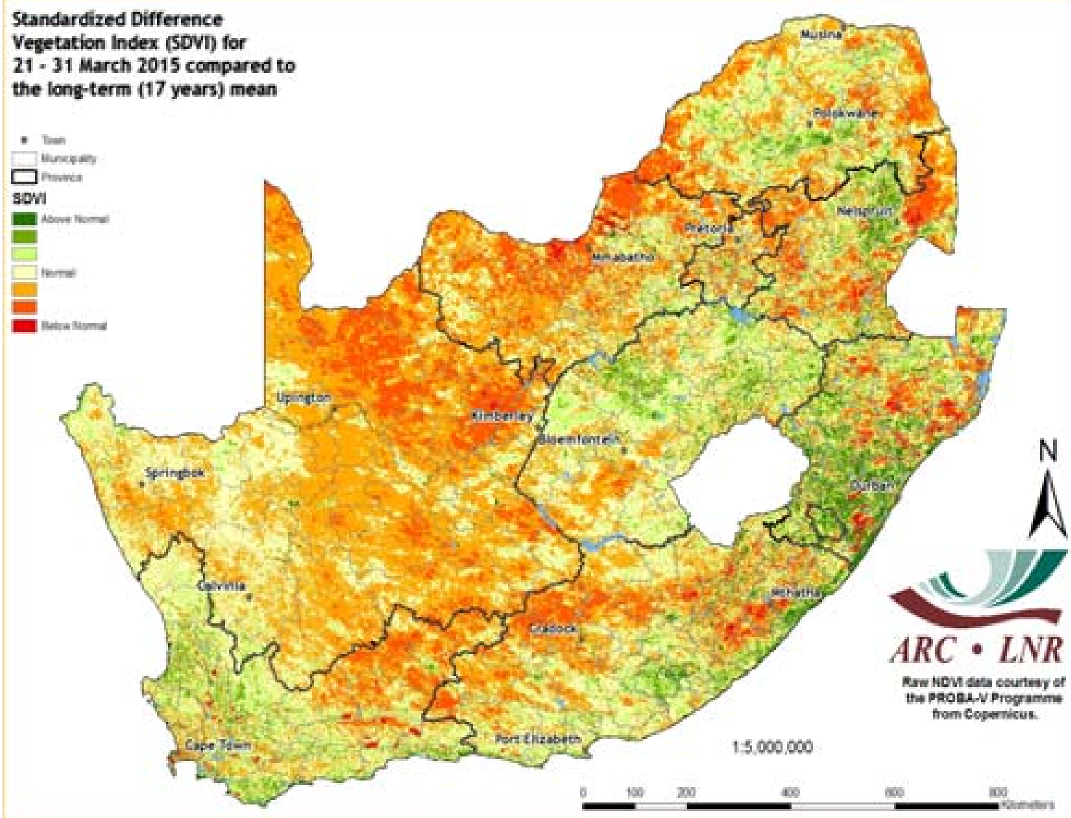

Figure 12

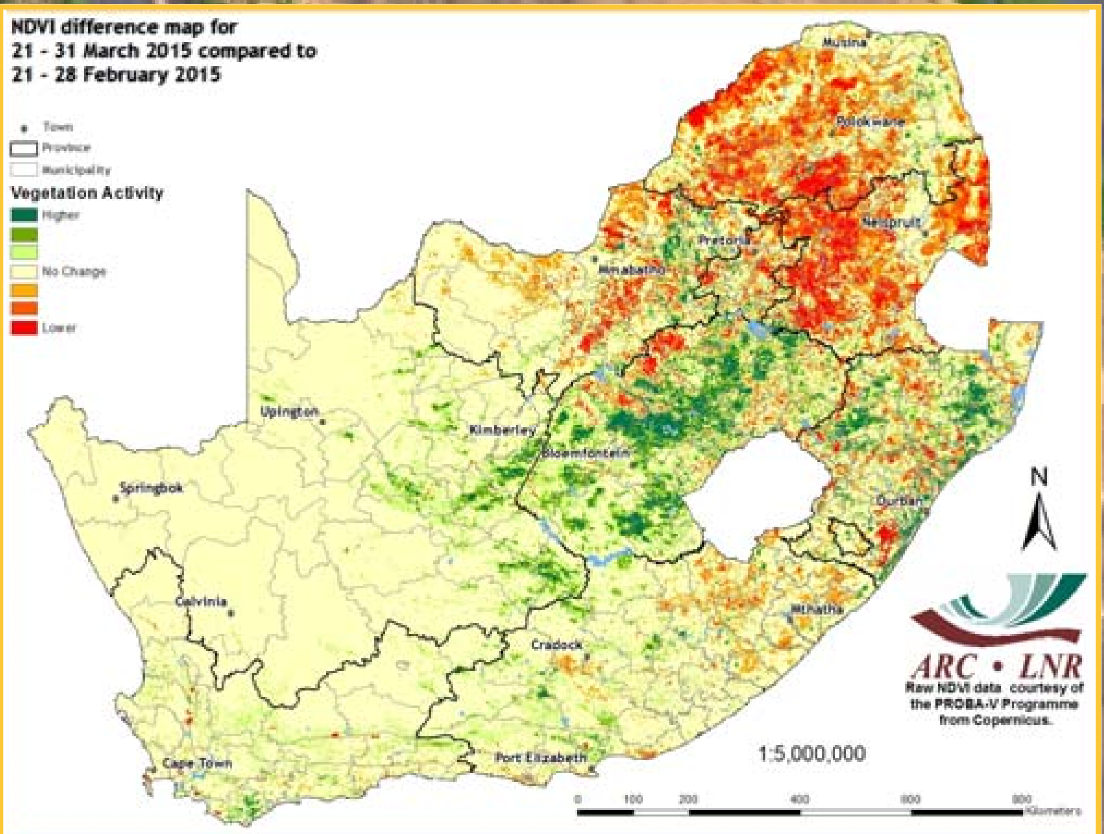

Figure 13

Figure 12:
The SDVI shows drought stress over the western parts of the summer rainfall area, as well as a band stretching northwest-southeast from southwestern Limpopo to northern KwaZulu-Natal and eastern Mpumalanga where rainfall was extremely deficient.

Figure 13:
Due to widespread thundershowers and rain over the central parts since late February, some areas experienced large increases in vegetation activity. Vegetation activity over the northeast has decreased since February, with most of the rain during March over that area only occurring by the end of the month.

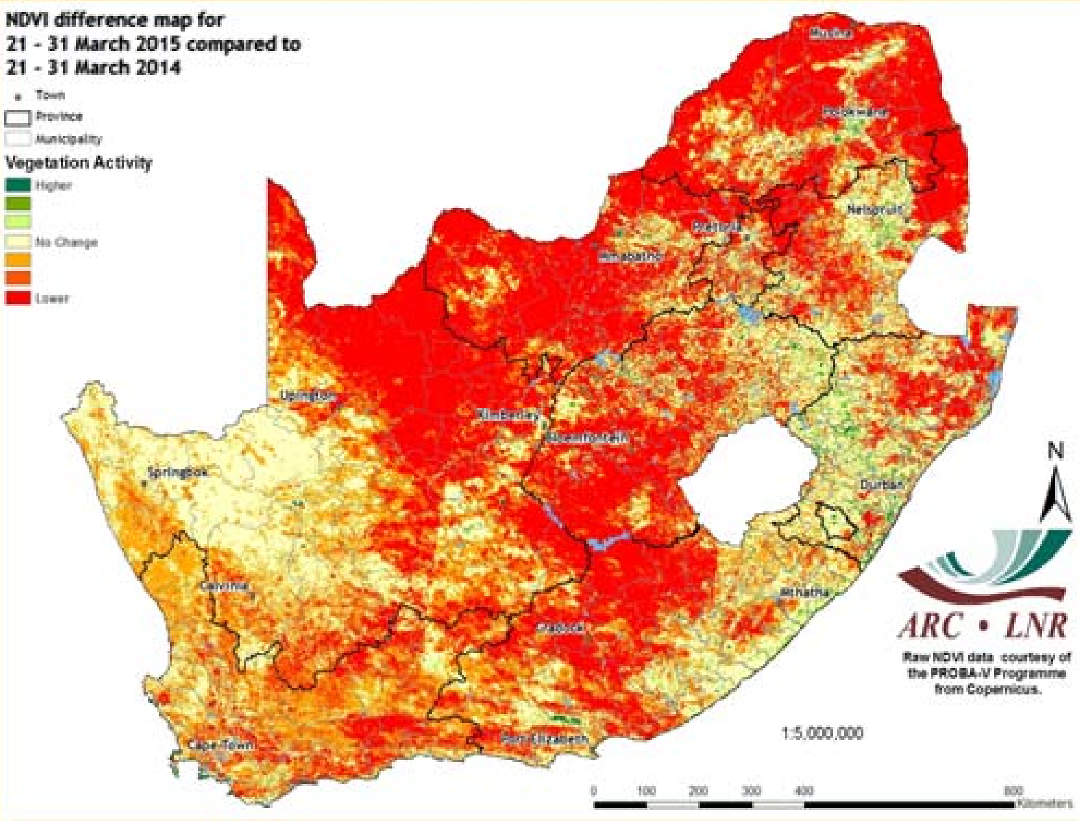

Figure 14

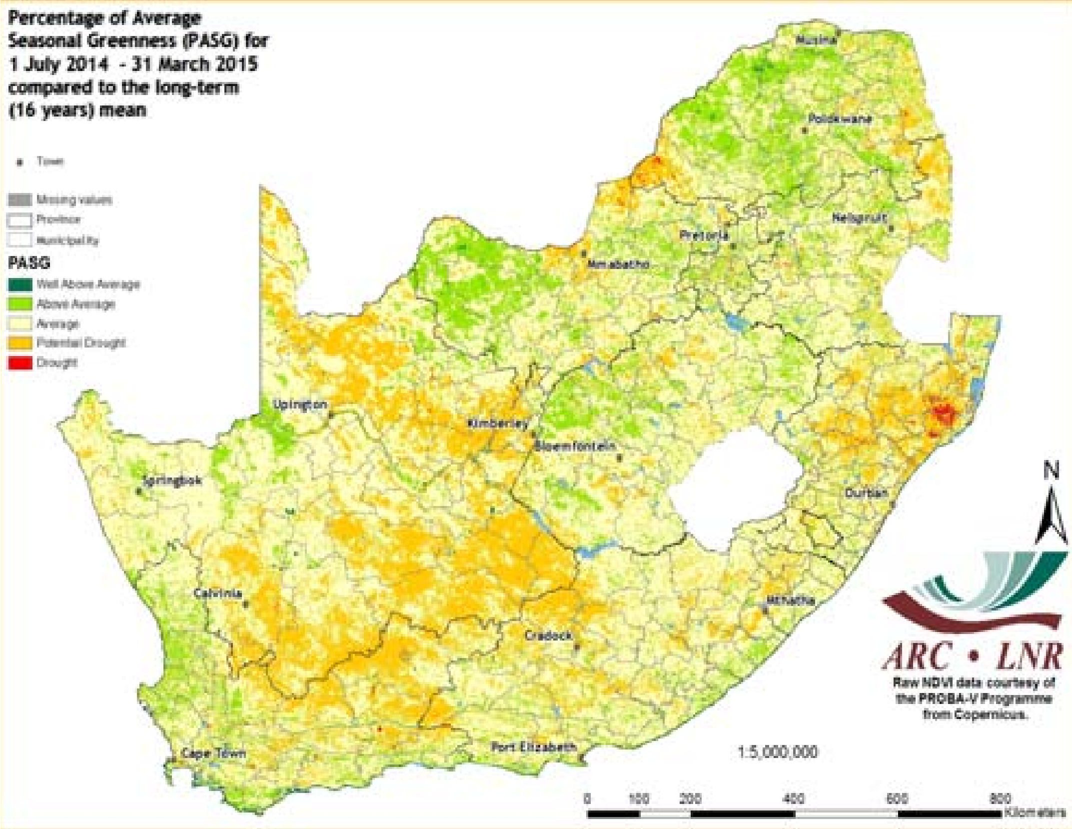

Figure 15

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:
Reflecting the rainfall difference between this summer and the previous one during the January-March period, vegetation activity is much lower over the central parts and northeastern extremes by the end of March this year compared to last, while higher activity is noted over some of the eastern to southeastern parts.

Figure 15:
Cumulative vegetation activity is still above normal over much of the interior due to wet conditions during November and December and again by late February and March. Notable exceptions are the eastern parts of KwaZulu-Natal, eastern Mpumalanga and extreme southwestern Limpopo.

Questions/Comments:
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6. Vegetation Condition Index

Vegetation Condition Index (VCI)

The VCI is an indicator of the vigour of the vegetation cover as a function of the NDVI minimum and maximum encountered for a specific pixel and for a specific period, calculated over many years.

The VCI normalizes the NDVI according to its changeability over many years and results in a consistent index for various land cover types. It is an effort to split the short-term weather-related signal from the long-term climatological signal as reflected by the vegetation. The VCI is a better indicator of water stress than the NDVI.

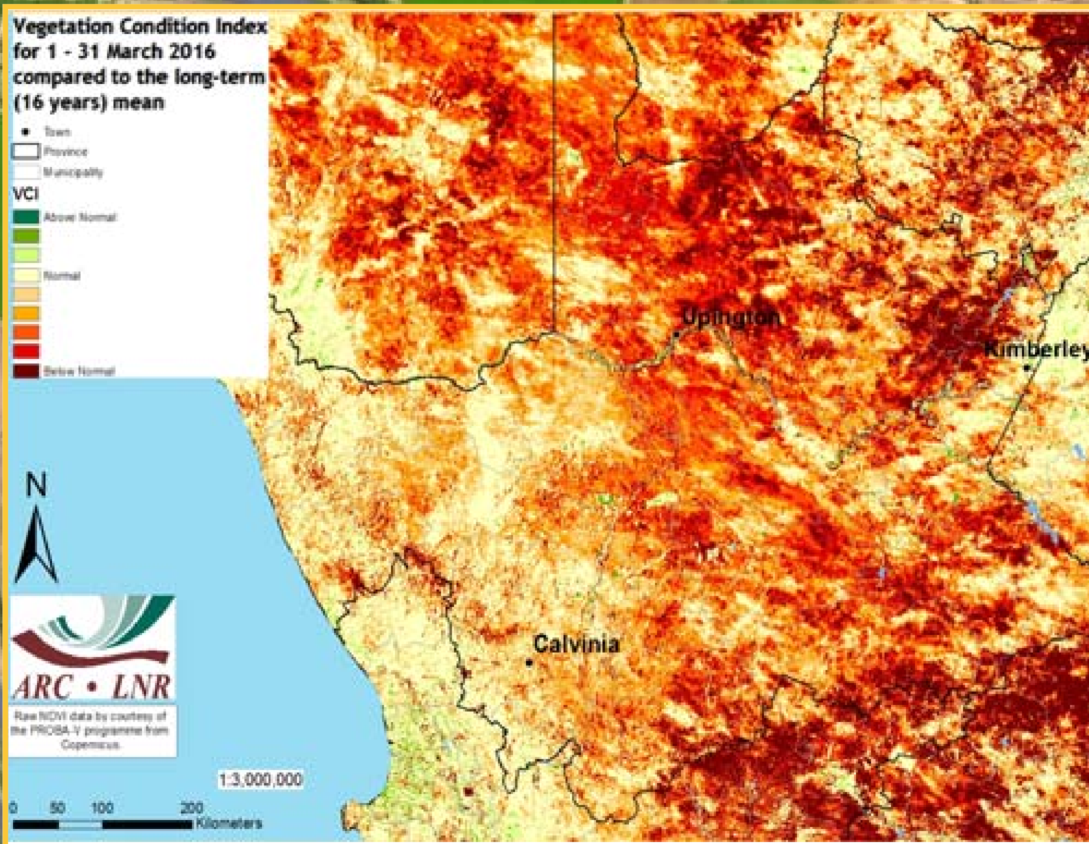


Figure 16

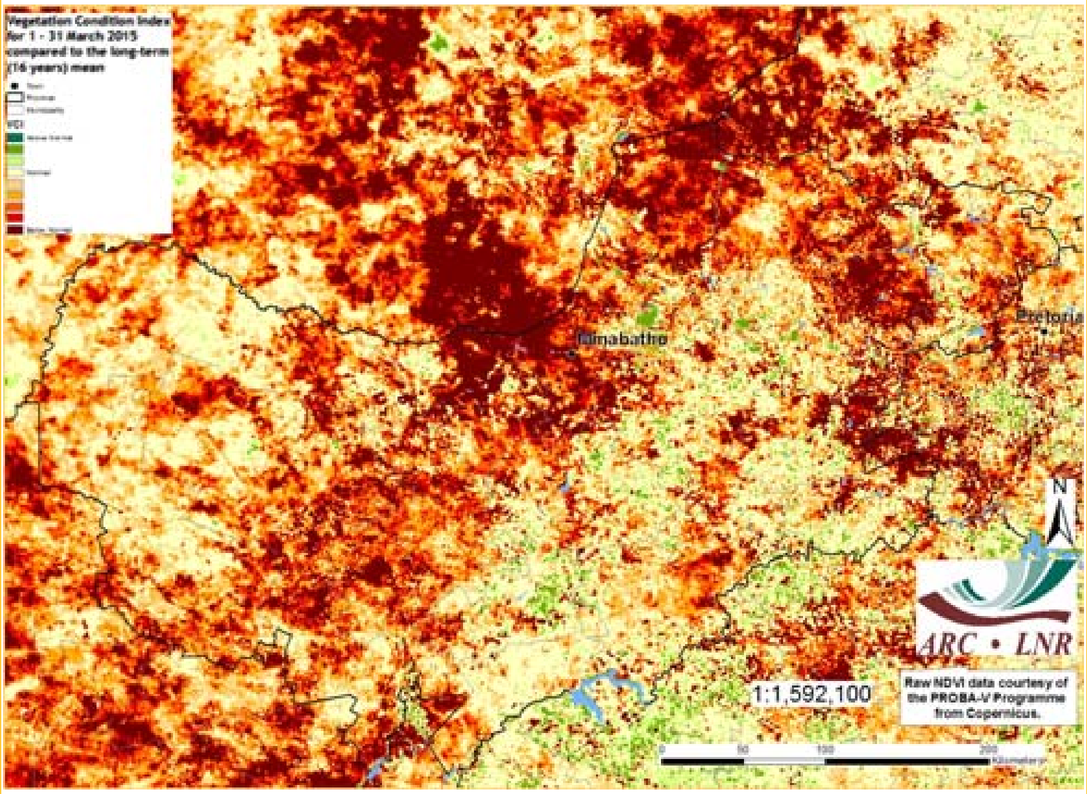
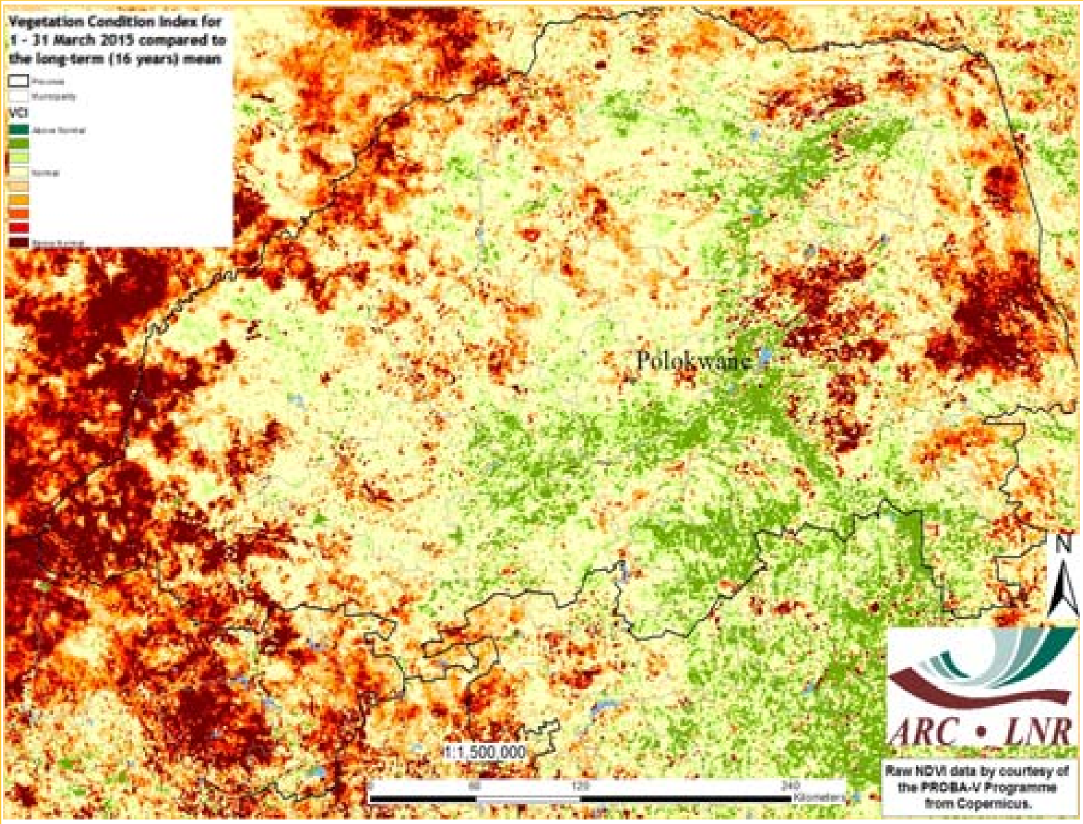


Figure 17

Figure 16:
The VCI map for March indicates below-normal vegetation activity over most parts of the Northern Cape.

Figure 17:
The VCI map for March indicates below-normal vegetation activity over northern and western North West.



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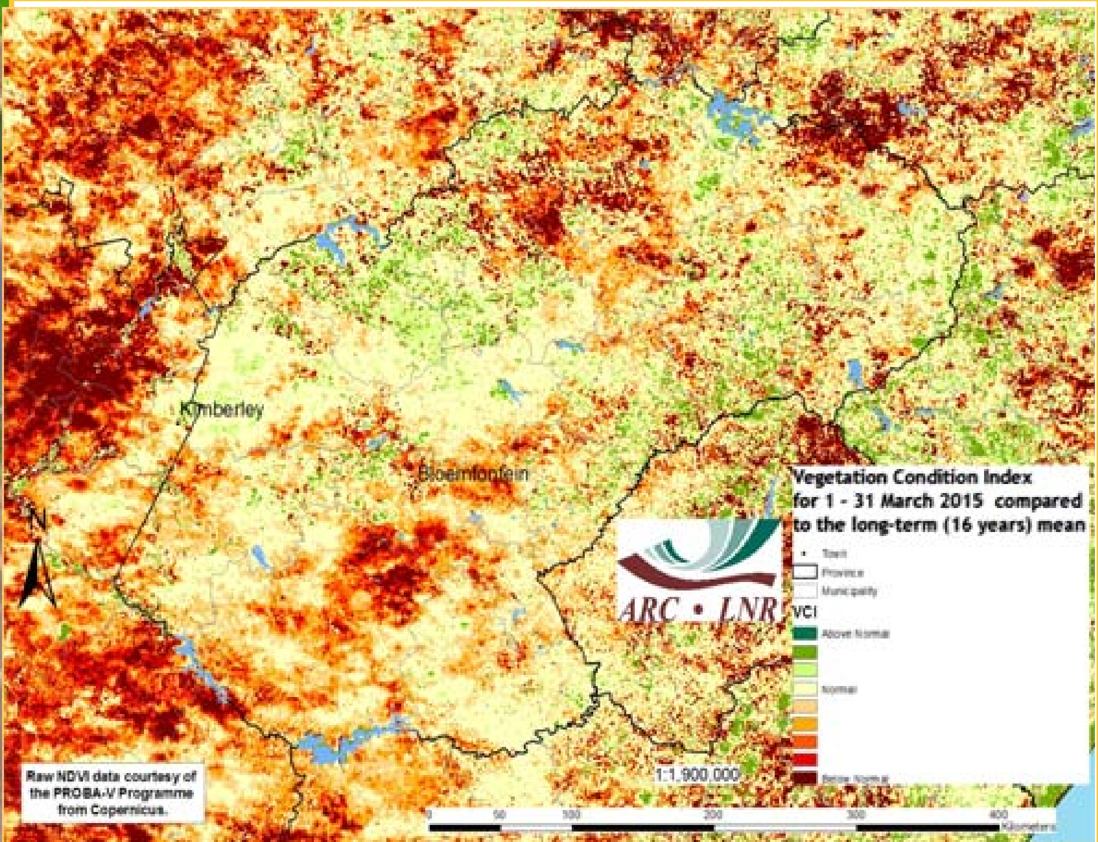

Figure 19

Figure 18:
The VCI map for March indicates below-normal vegetation activity over the southwestern extremes and Lowveld area but normal to above-normal activity over the rest of Limpopo.

Figure 19:
The VCI map for March indicates below-normal vegetation activity over parts of the northern and southern Free State.

Questions/Comments:
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7. Vegetation Conditions & Rainfall

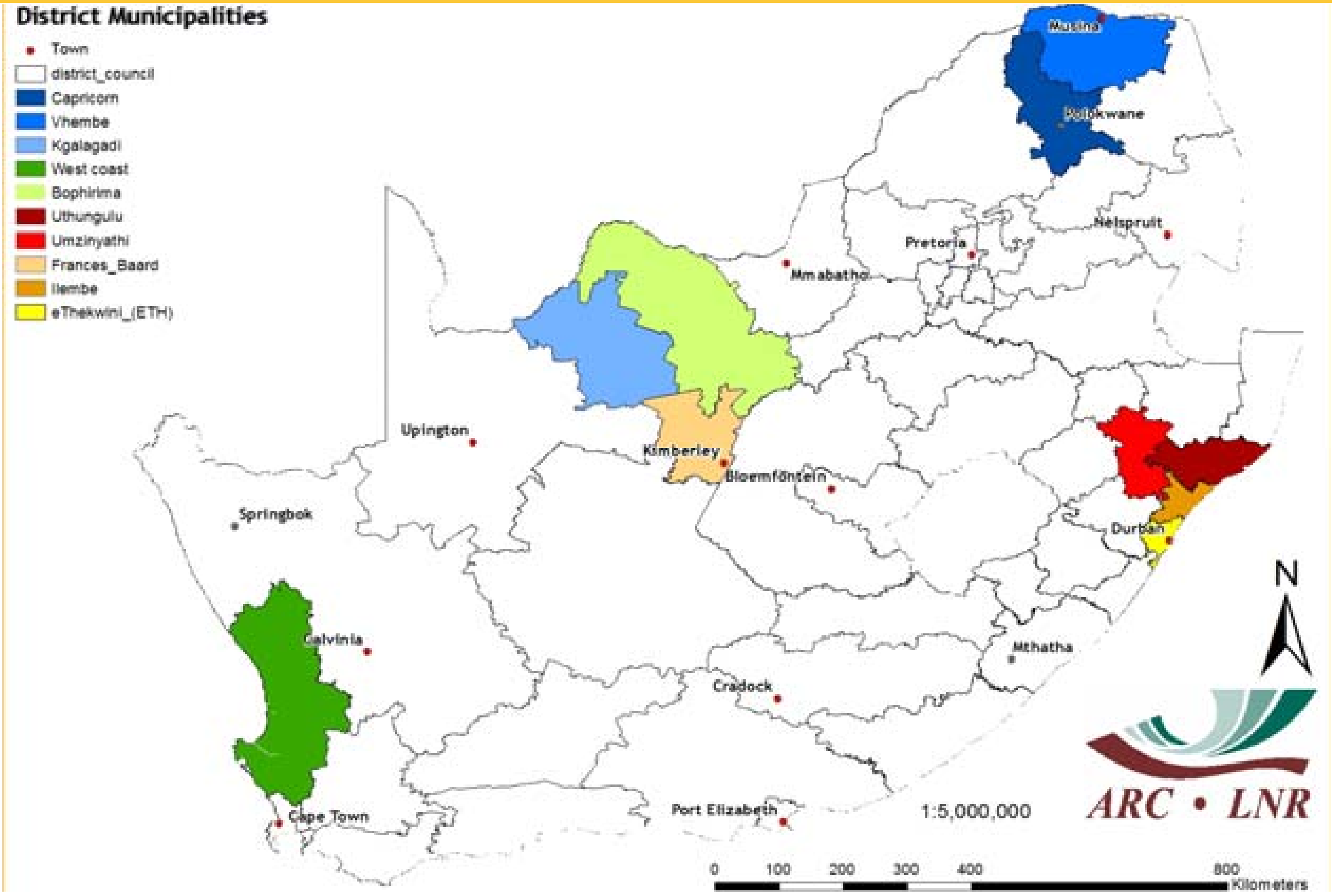

Figure 20

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

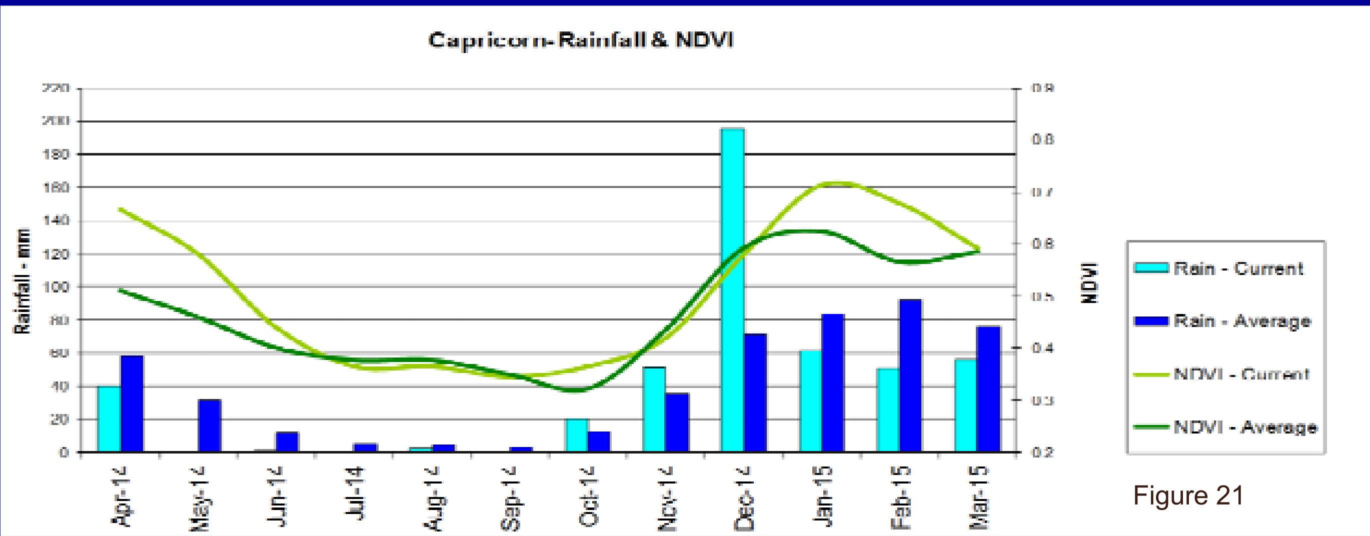
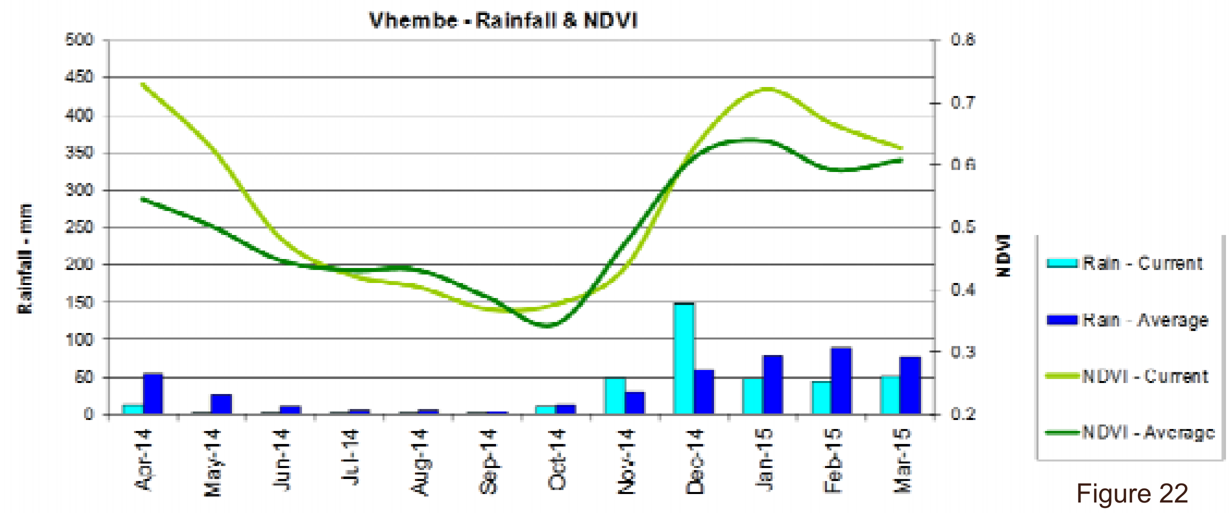


Figure 21



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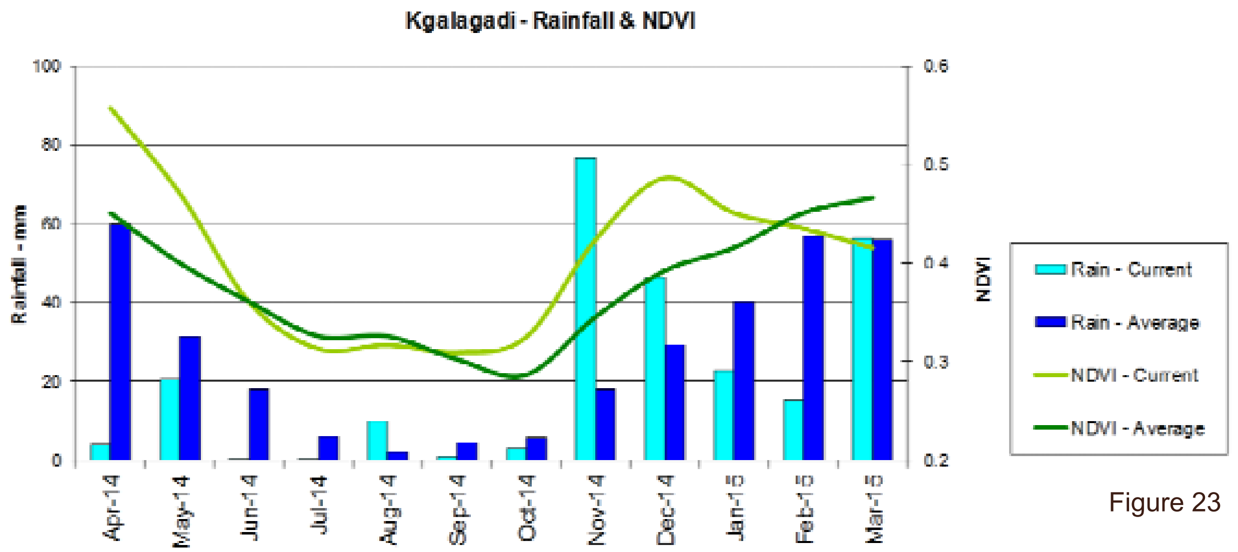

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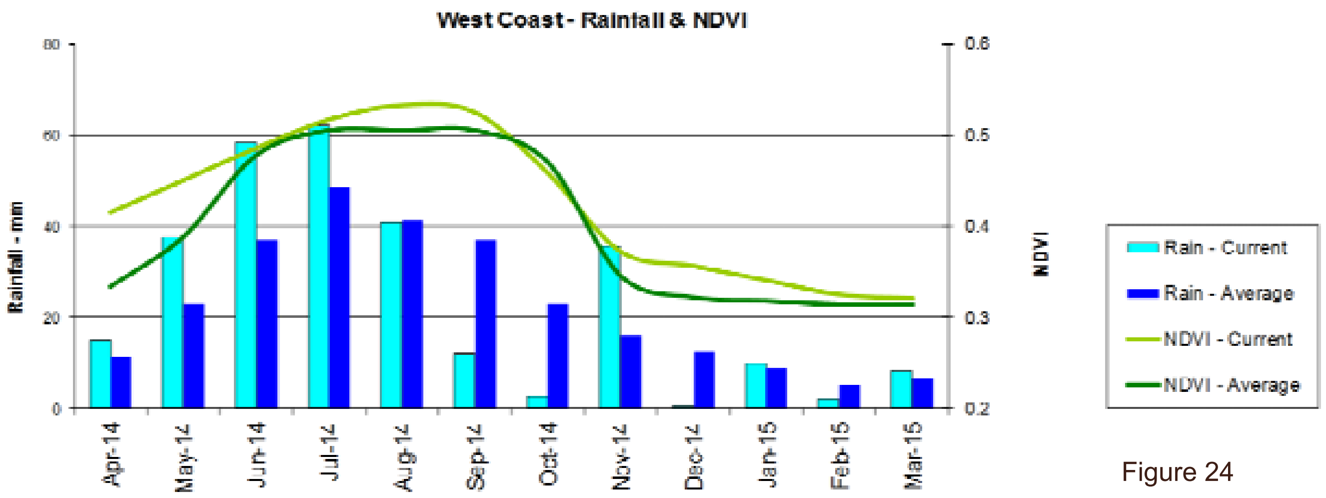

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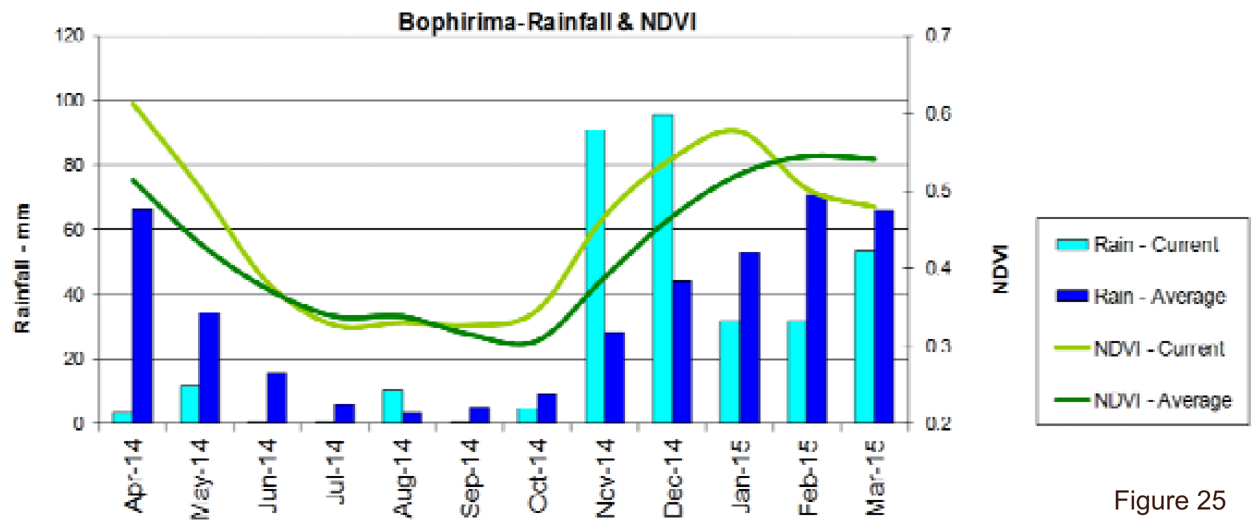

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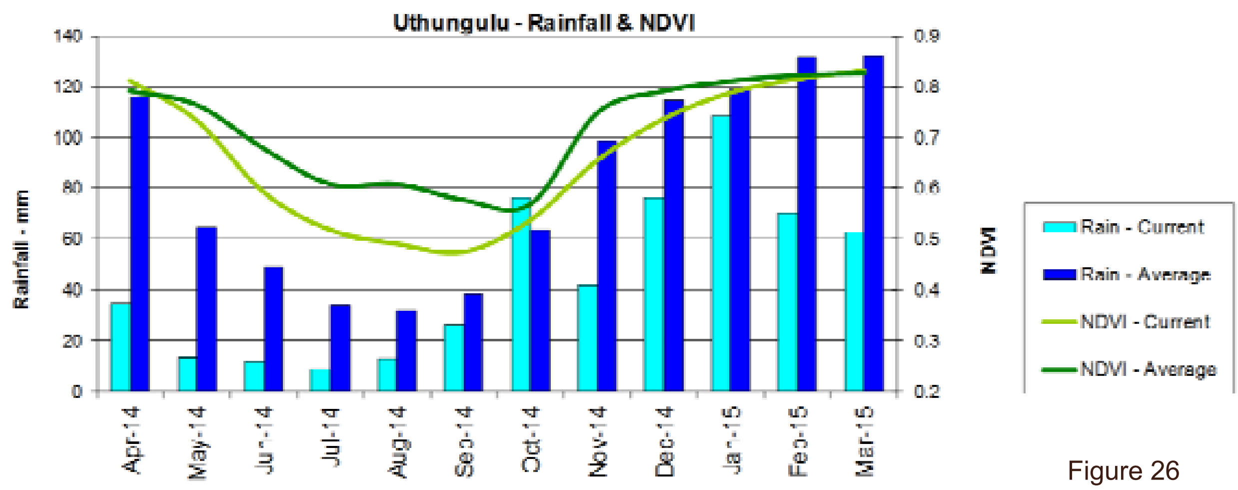

Figure 26

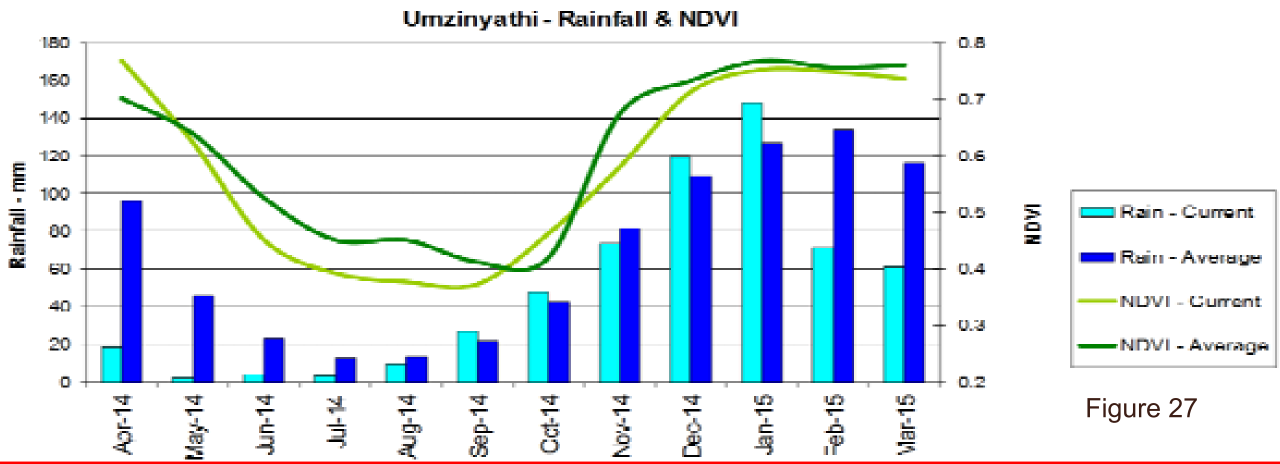

Figure 27

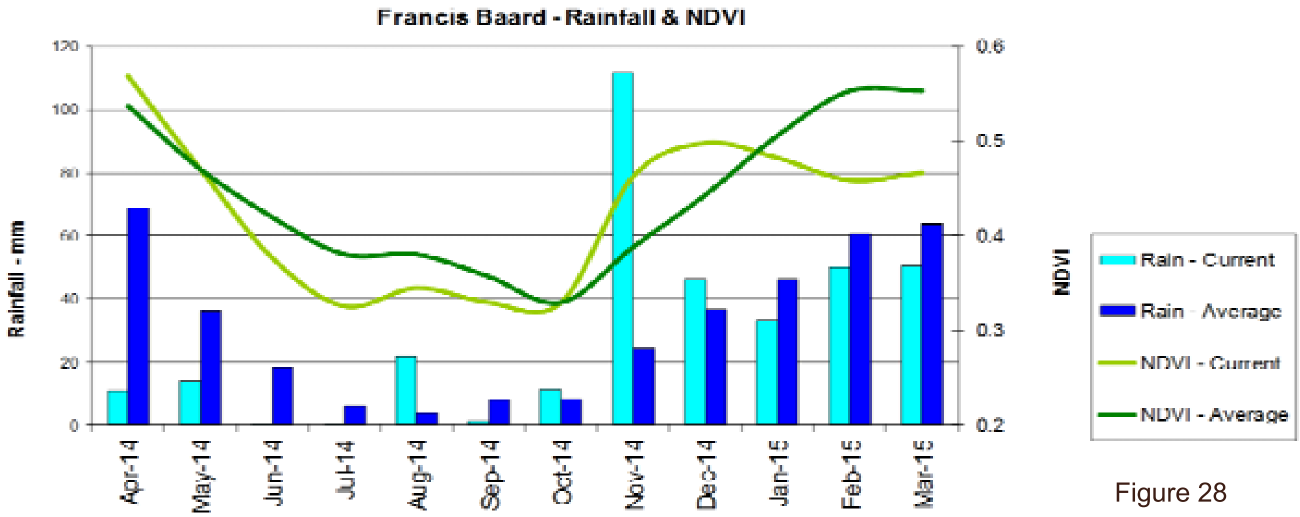

Figure 28

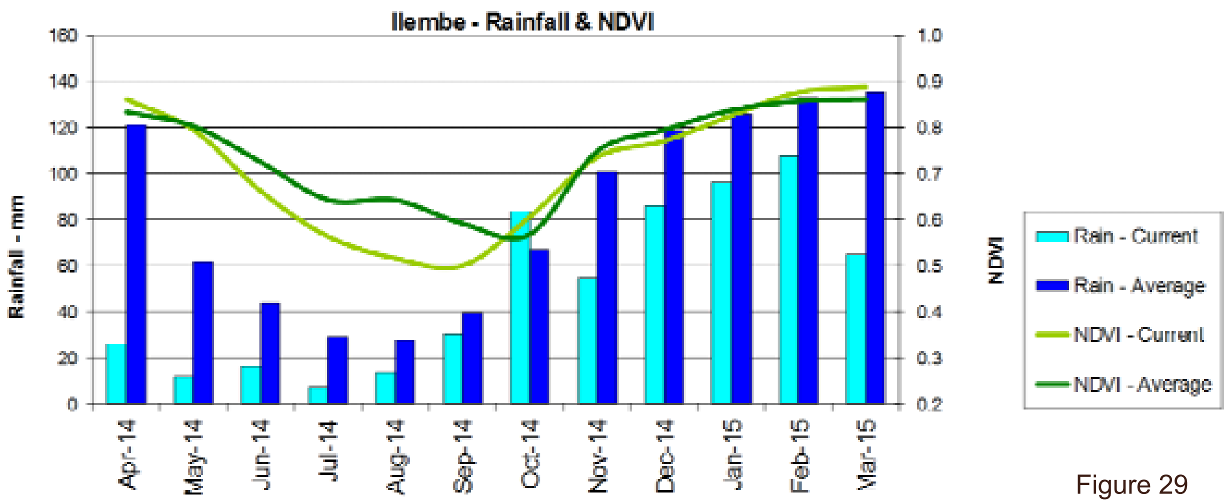

Figure 29

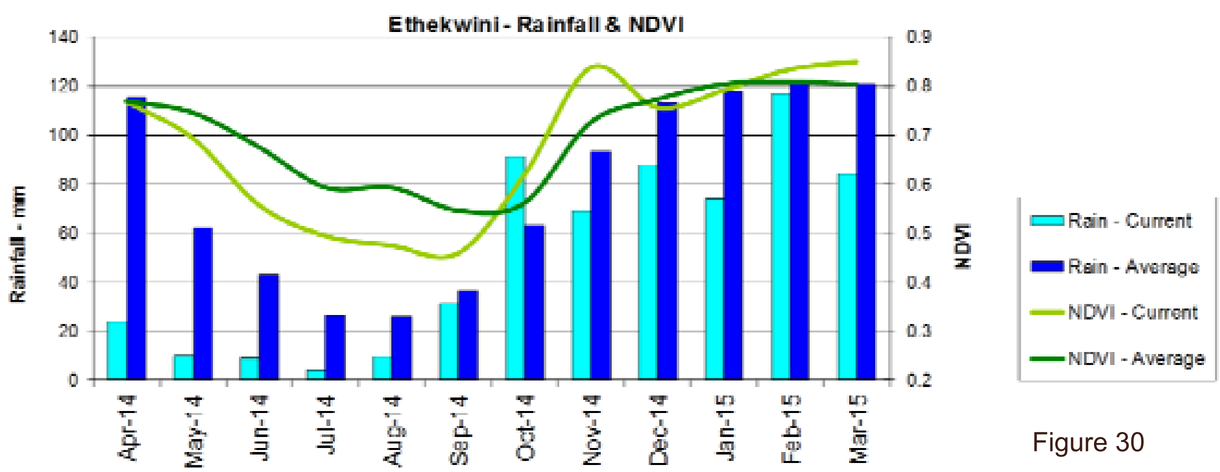

Figure 30

8. 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 31:
The graph shows the total number of active fires detected in the month of March per province. Fire activity was higher in Mpumalanga, Limpopo, North West, Western Cape and KwaZulu-Natal compared to the average during the same period for the last 14 years.

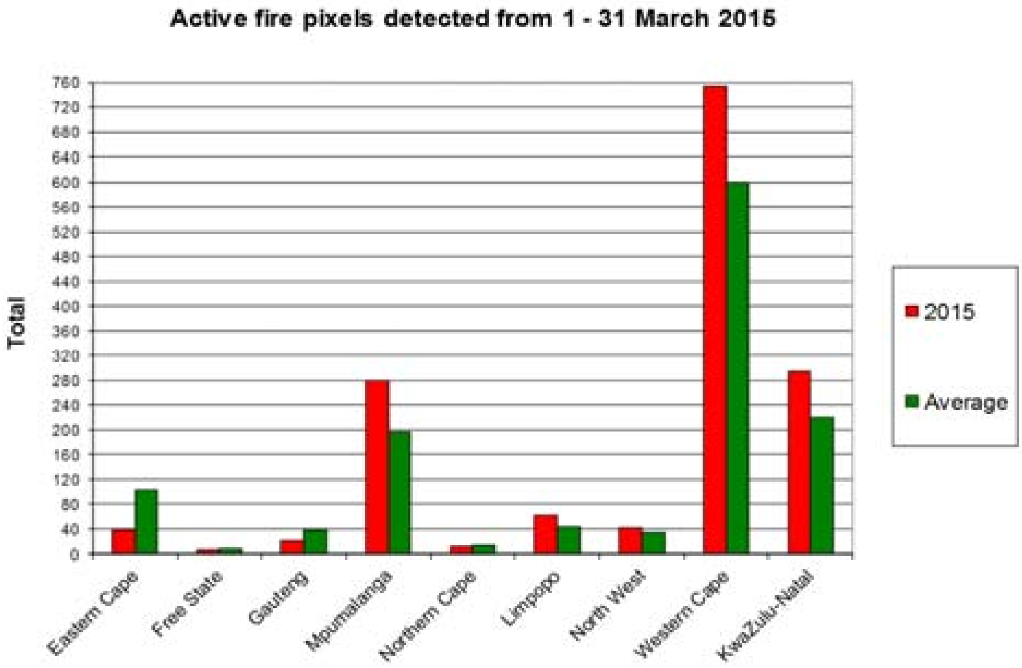

Figure 31

Figure 32:
The map shows the location of active fires detected between 1-31 March 2015.

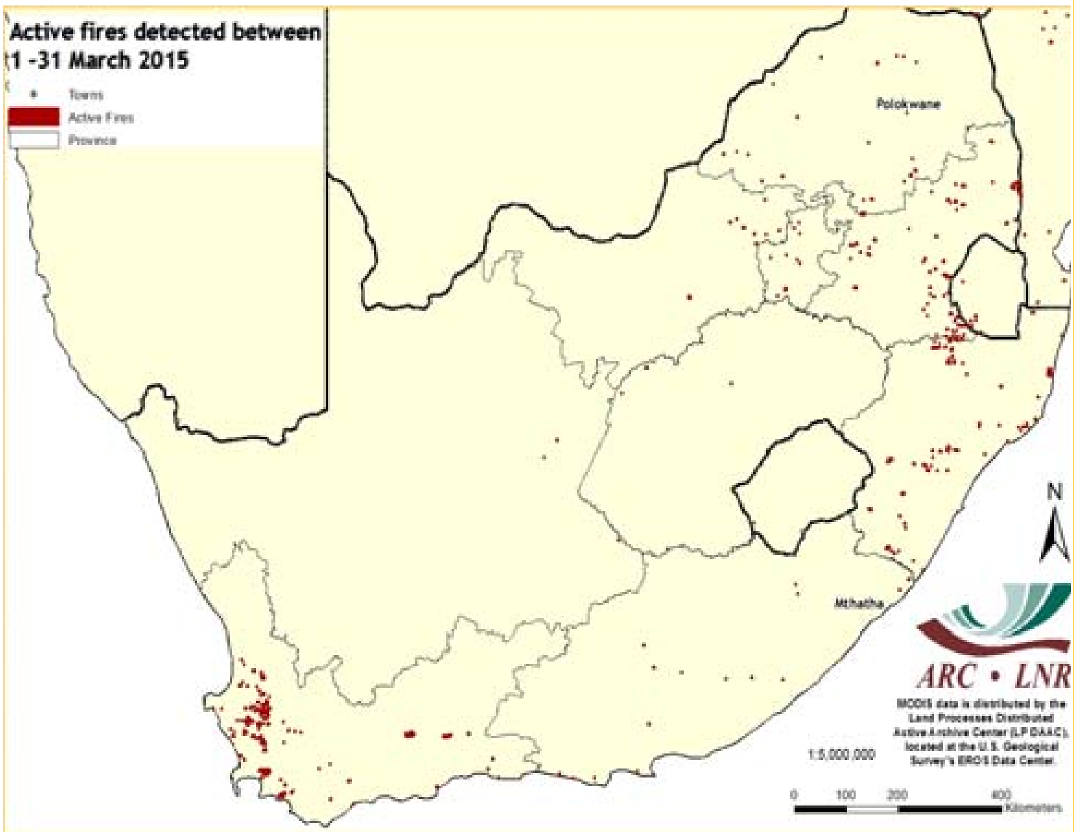

Figure 32

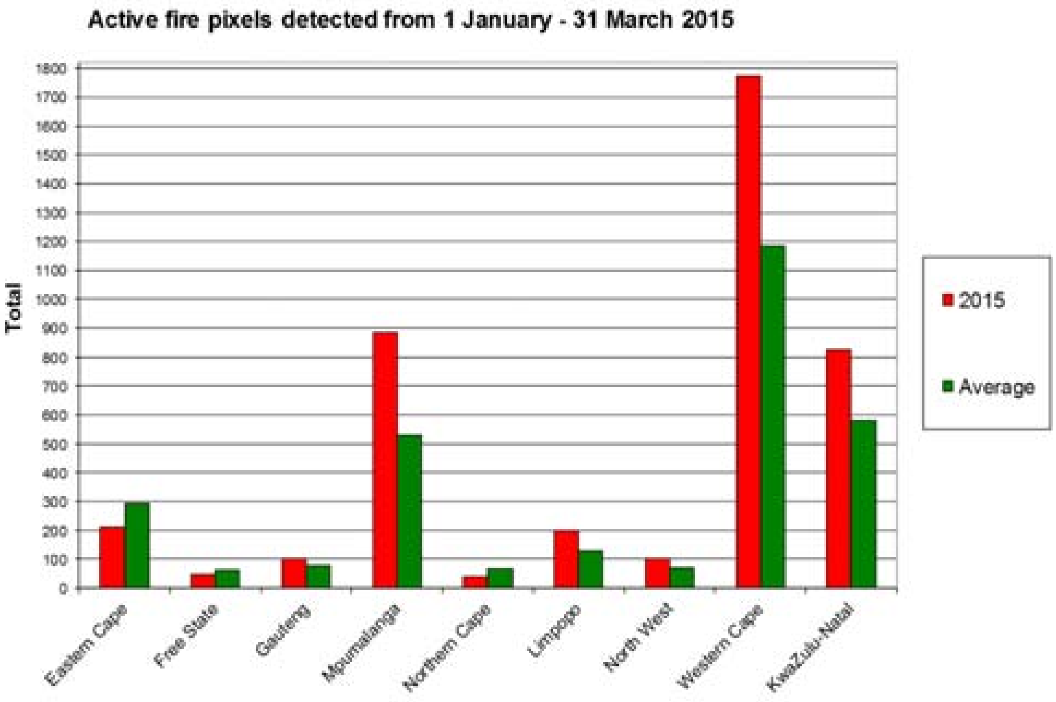

Figure 33

Figure 33:
The graph shows the total number of active fires detected between 1 January to 31 March 2015 per province. Fire activity was higher in Gauteng, Mpumalanga, Limpopo, North West, Western Cape, and KwaZulu-Natal compared to the average during the same period for the last 14 years.

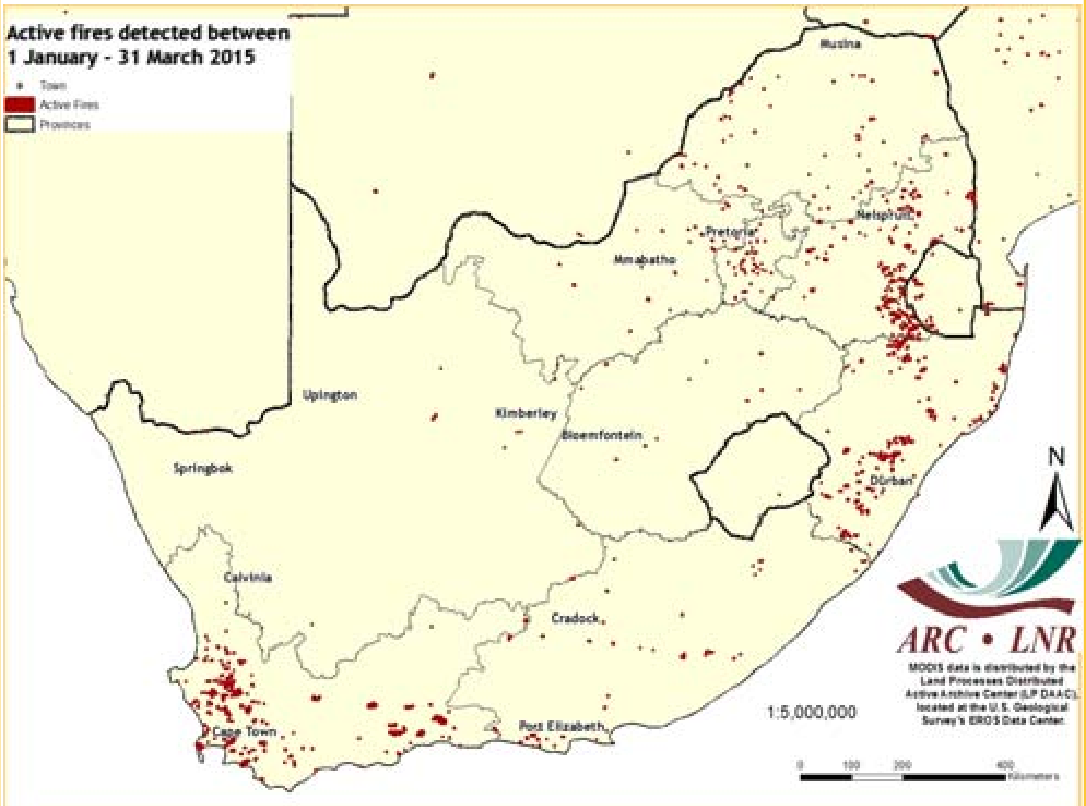

Figure 34

Figure 34:
The map shows the location of active fires detected between 1 January to 31 March 2015.

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

ARC • LNR

Excellence in Research and Development

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

http://www.agis.agric.za