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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE ANDWATER

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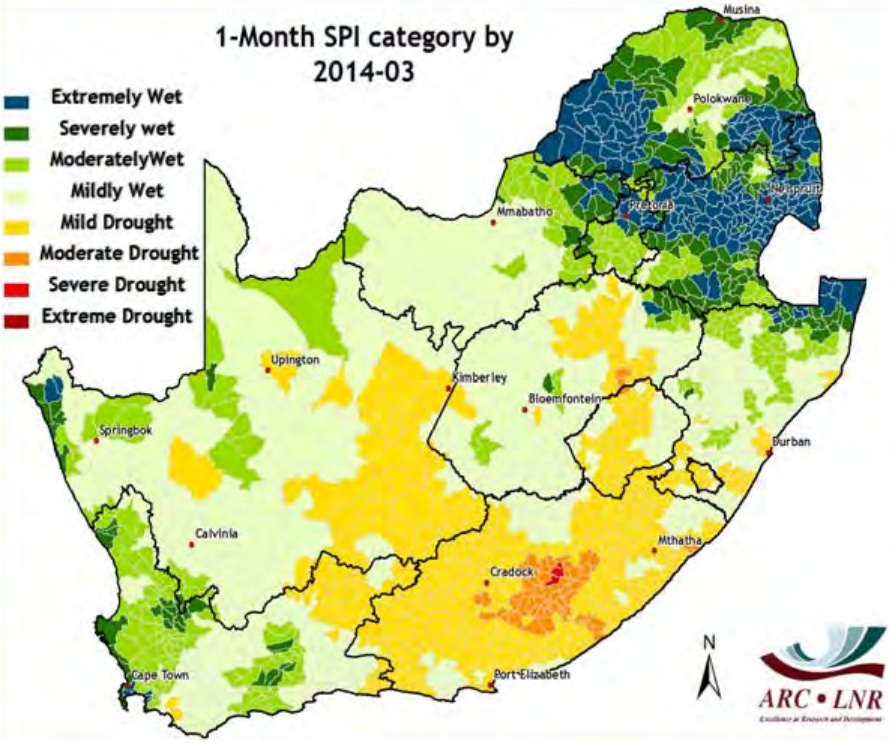
118th Edition

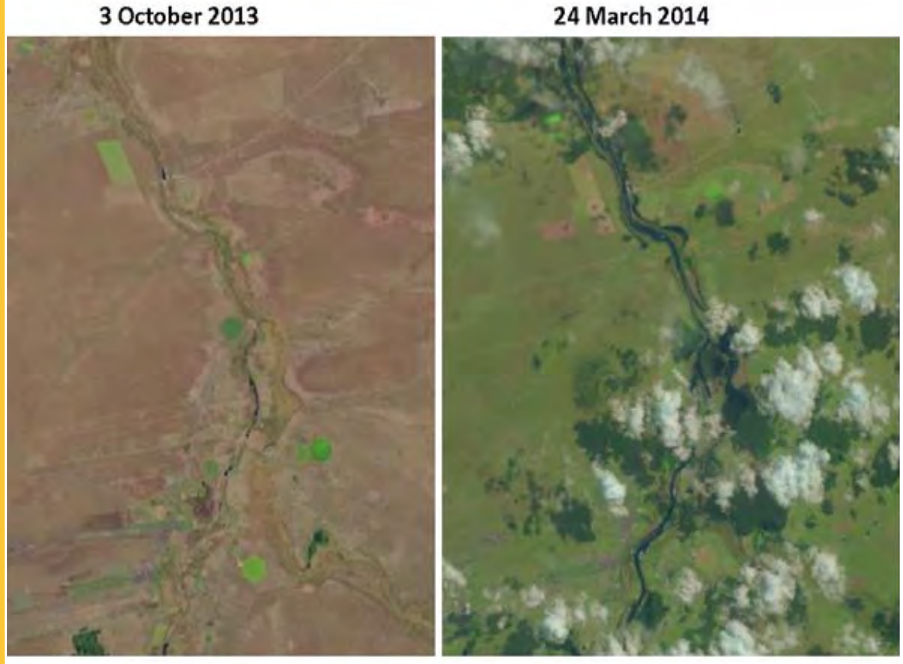
Images of the Month



A very wet March in the northeast

March 2014 was exceptionally wet over much of northeastern South Africa. The Standardized Precipitation Index (SPI) category for the month, calculated using 95 years of data, indicates extremely wet conditions over much of Limpopo, Gauteng and Mpumalanga. According to the classification, the extremely wet class is only obtained roughly in 2.5% of cases comprising the time series.

Most of the rain fell within the first 2 weeks of the month. The intensity and persistence of rainfall resulted in several rivers bursting their banks, causing widespread flood damage. The two LANDSAT 8 (USGS, 2014) images give an indication of the positive effect that the rainfall during early March had on the levels of rivers and dams in the northeast. It shows the Mogol River in western Limpopo with basically no water on 3 October 2013 and in a flooded state on 24 March 2014. Floods in the area were comparable with those last experienced in 1996.



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:

Three main rainfall periods occurred during March over different parts of the country. Rainfall maxima over the interior progressed westward with each consecutive multiday rainfall event. Temperatures during the month remained near normal to below normal over the eastern parts of the country, but above normal over the western and southern parts during certain periods due to the persistence of an easterly flow across the country. There were no incidences of early cold outbreaks during late March (or early April), a significant positive contribution by the temperature regime during early autumn towards a potentially good maize harvest irrespective of late plantings over much of the western maize production area.

By far the most significant sequence of events was the rainfall over the northeastern parts of the country which occurred mainly from the 1st to the 13th. Total rainfall over some areas in the northeast, during this period only, already exceeded 200% or even 500% of the long-term average for March. A tropical system located earlier over Namibia moved eastwards by the beginning of the month to over eastern Botswana. The system, together with an upper air trough towards the southwest and a large high pressure system towards the east, feeding large amounts of moisture into the country, resulted in widespread rain with daily totals in some places exceeding 50 mm or even 100 mm.

By the 15th, most of the rain shifted to the central parts with scattered to widespread thundershowers over much of the Free State, eastern Northern Cape and Eastern Cape. Maximum temperatures exceeding 40°C occurred on several days during this period over the far western and southern parts due to a persistent easterly flow associated with the high towards the east. During the last week of the month, a cut-off low developed over the extreme southwestern parts. With large amounts of moisture flowing southwards into the Northern Cape, much of the western parts of the country including the winter rainfall area received widespread showers with heavy rainfall in places. As the system weakened and moved northeastward, the area of precipitation shifted towards the northeast again. The month therefore ended with scattered light to moderate showers in the northeast and dry conditions in the west.

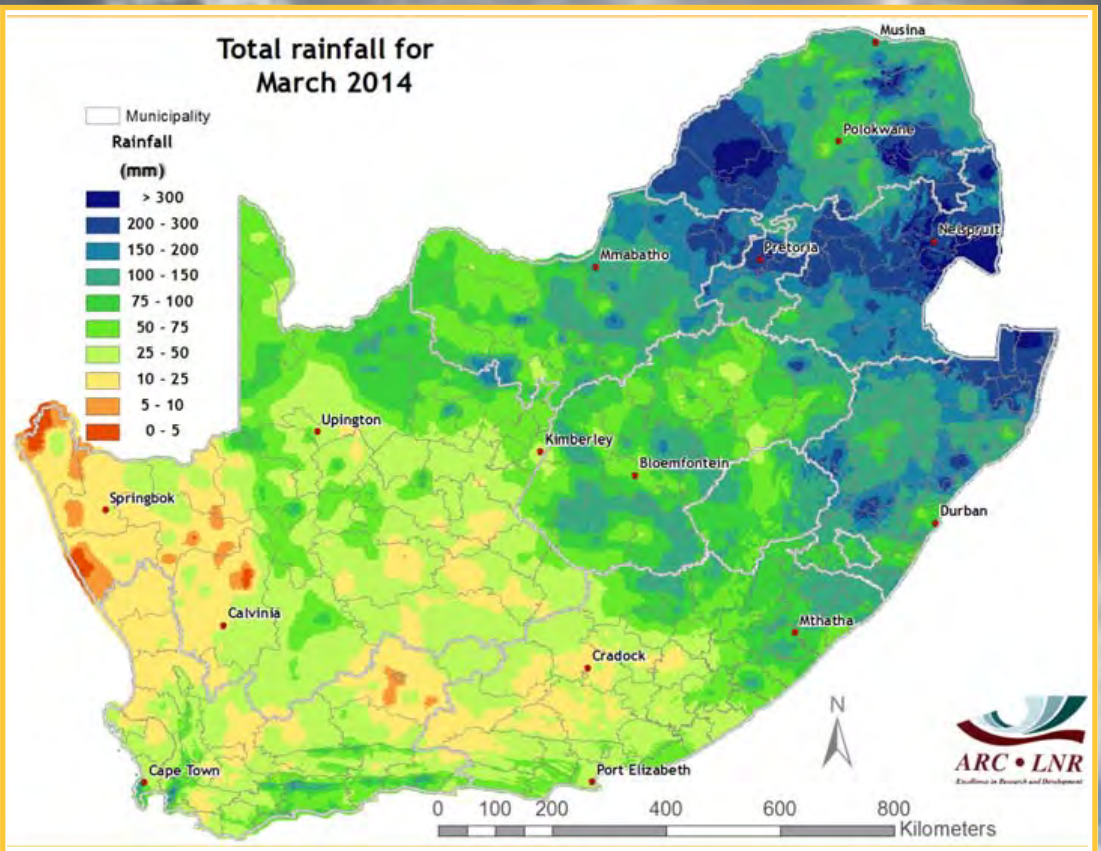


Figure 1

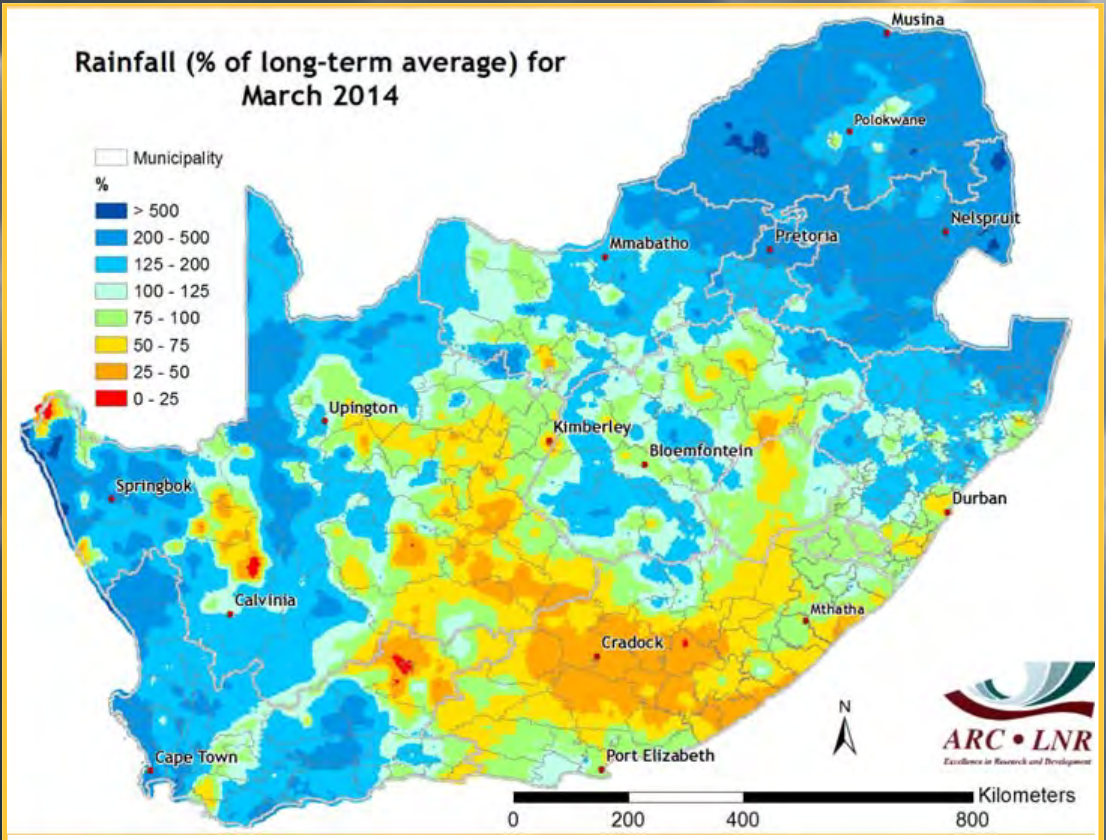
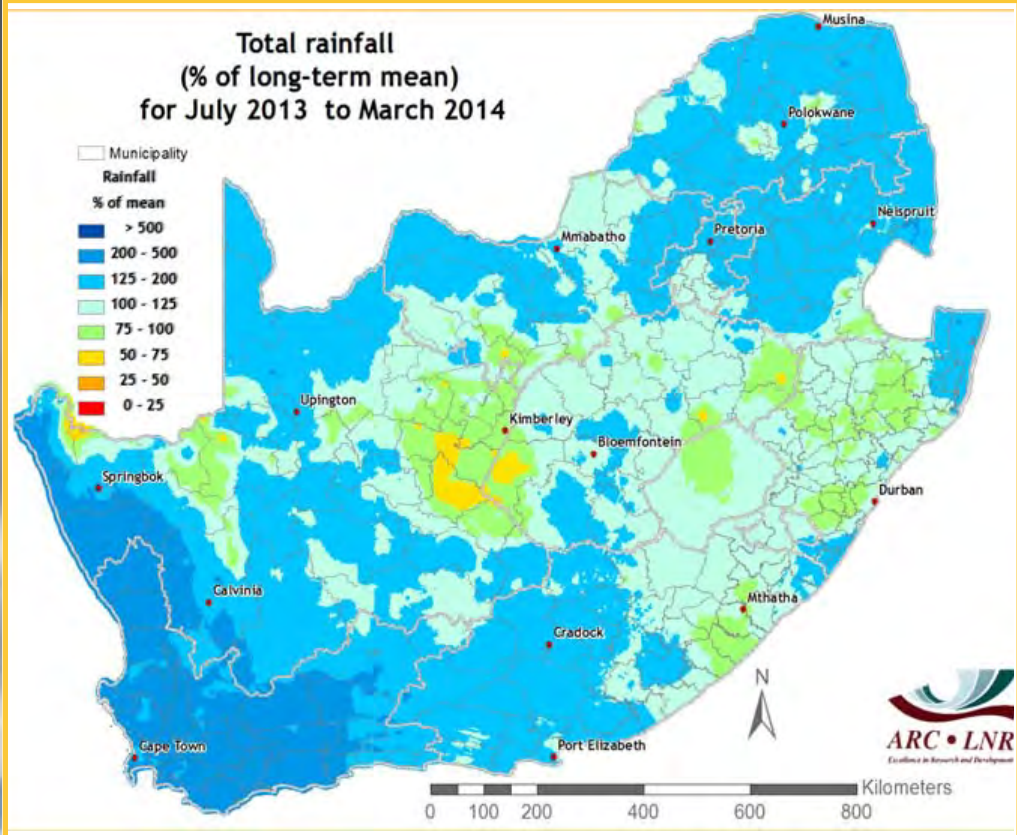


Figure 2



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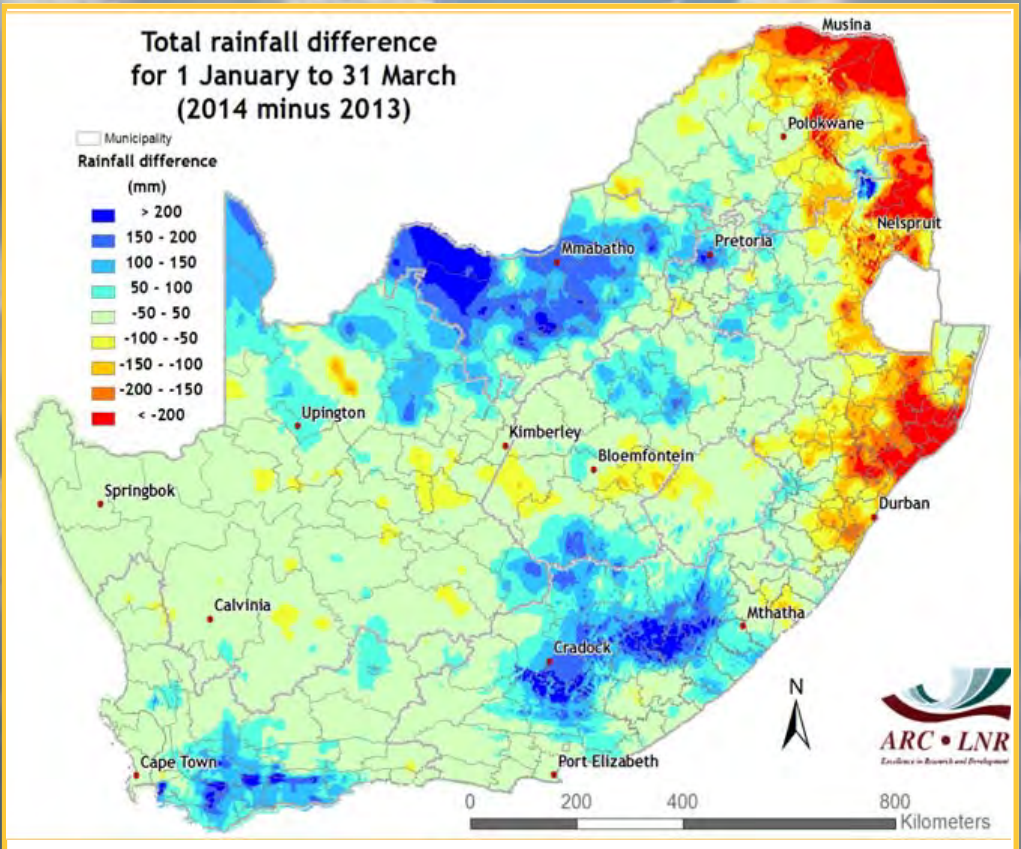

Figure 4

Figure 1:
Precipitation occurred across the entire country during March 2014 with the highest falls in the northeast where large parts of Limpopo, Mpumalanga, Gauteng and northern KwaZulu-Natal received in excess of 200 mm or even more than 300 mm. Rainfall totals decreased gradually towards the western parts of the country where rainfall for the month did not exceed 50 mm in most places.

Figure 2:
The northeastern parts of the country received more than 200% of the average rainfall for March, with isolated areas receiving more than 500% of the monthly average. Rainfall was also above normal over much of the western parts of the country, including the winter rainfall area, but below normal towards the southeast, including much of the Eastern Cape where large parts received less than 50% of the long-term average.

Figure 3:
The 2013/14 summer rainfall season is emerging as one where above-normal rainfall has been recorded over most of South Africa. Two exceptions are central KwaZulu-Natal and surroundings where most parts still received in excess of 75% of the long-term average, and the extreme western Free State and eastern Northern Cape where some areas received less than 75% of the long-term average. Almost the entire winter rainfall area received in excess of 200% of the long-term average.

Figure 4:
Much of the central parts of the country together with the southern winter rainfall area received more rain during January-March 2014 than during 2013. Parts of KwaZulu-Natal, the eastern escarpment, the Lowveld and eastern Limpopo River Valley received less rain than during 2013 for the 3-month period.

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2. Standardized Precipitation Index

Standardized Precipitation Index (SPI)

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) indicate that drought conditions over the central parts of the country and especially towards the north have eased at the short time scale (3-6 months) due to widespread rain since late January over many parts. At longer time scales (12-24 months), drought conditions are still in place over much of the central interior due to the earlier extended dry period while much of the northeastern parts of the country and the winter rainfall area are exceptionally wet.

Questions/Comments:
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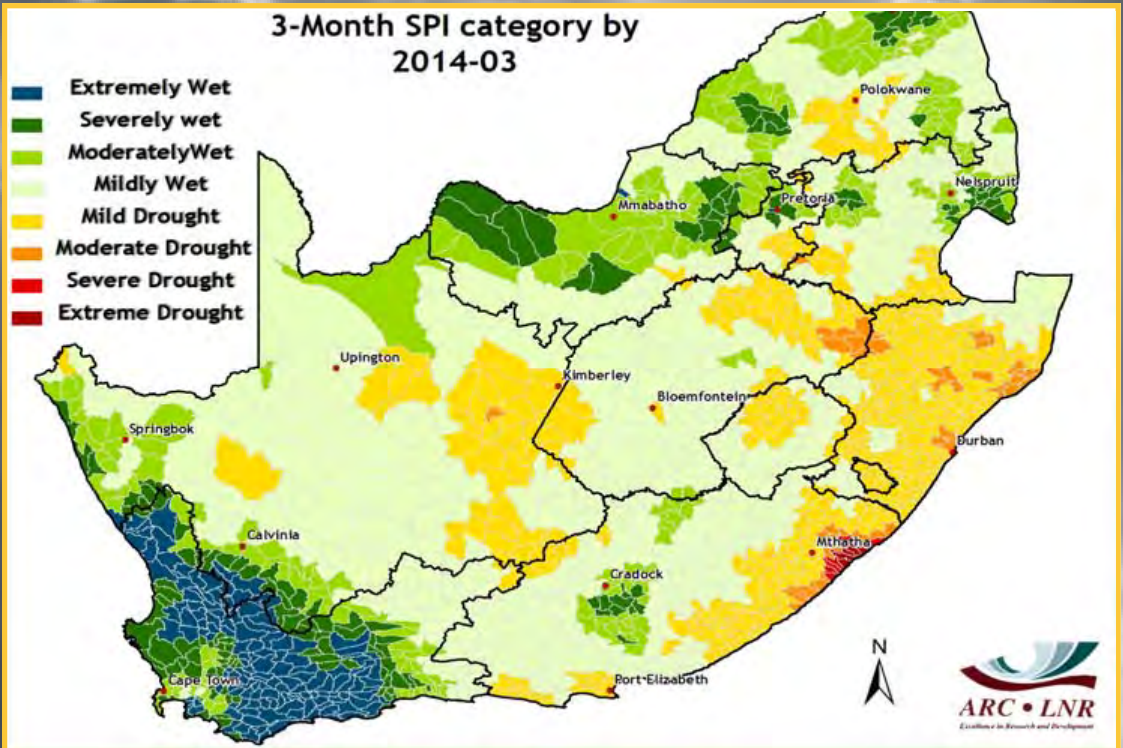

Figure 5

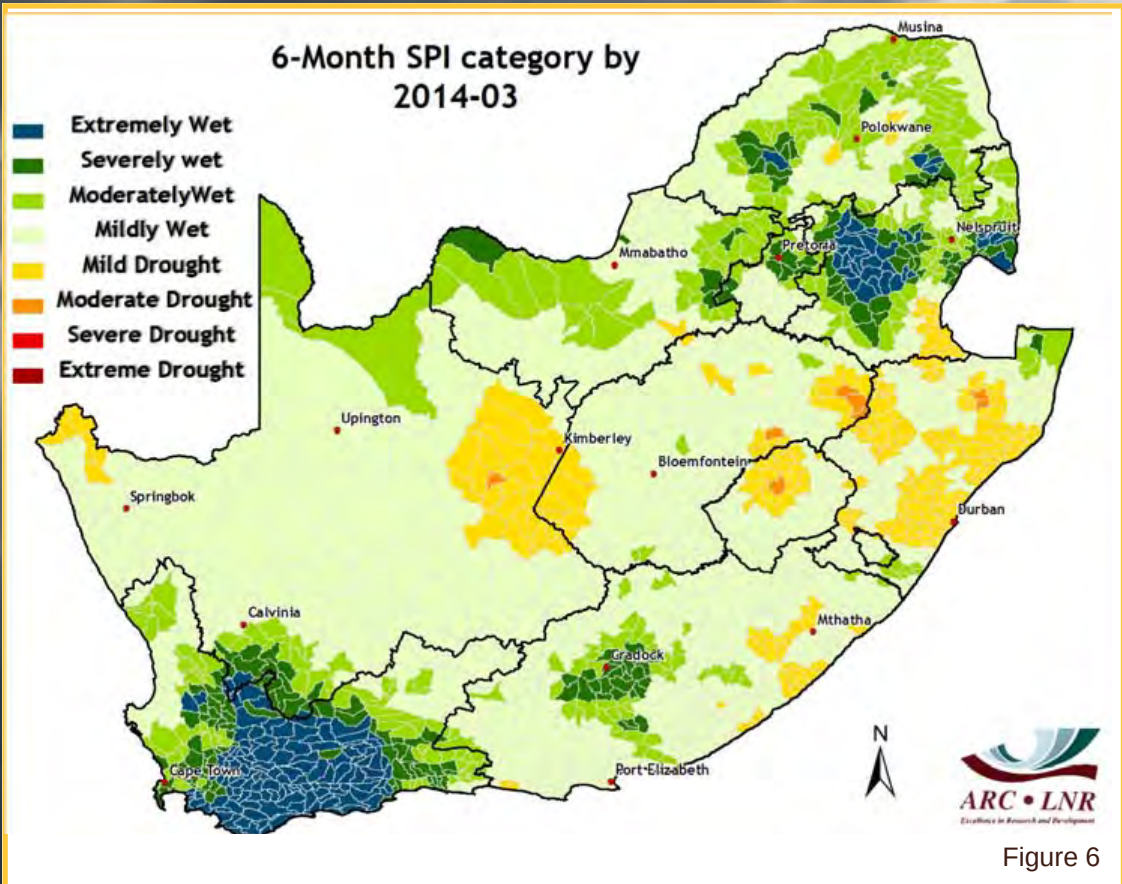

Figure 6

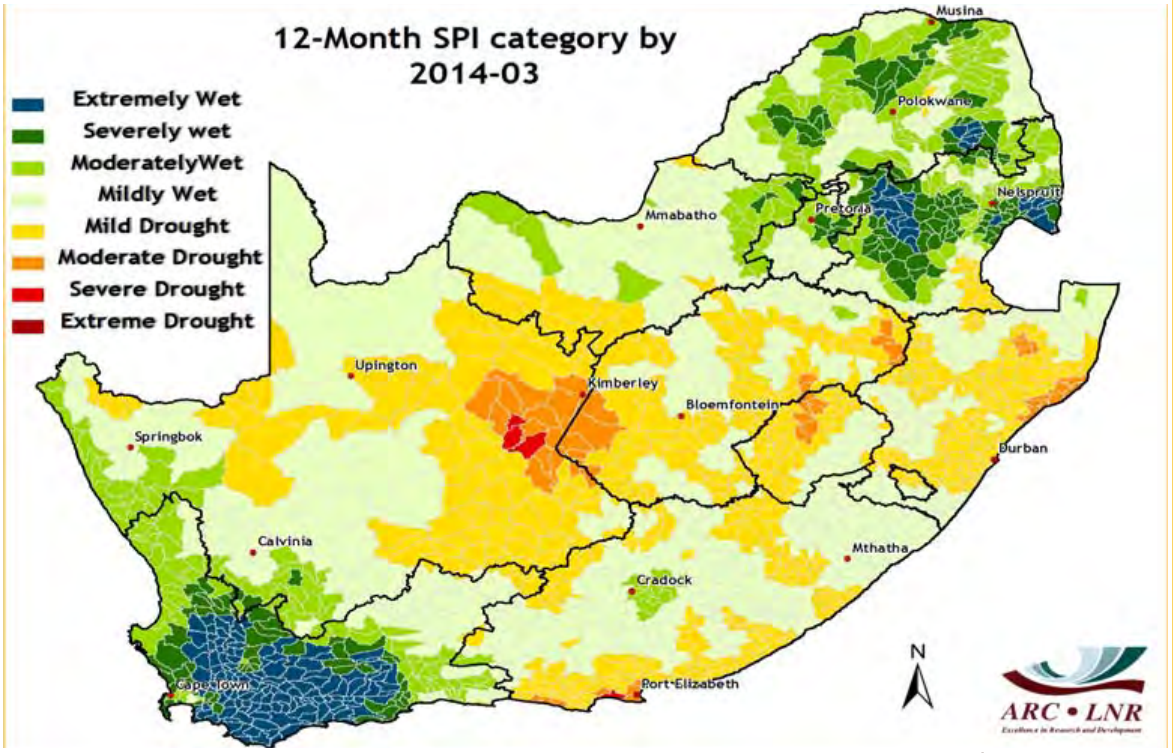

Figure 7

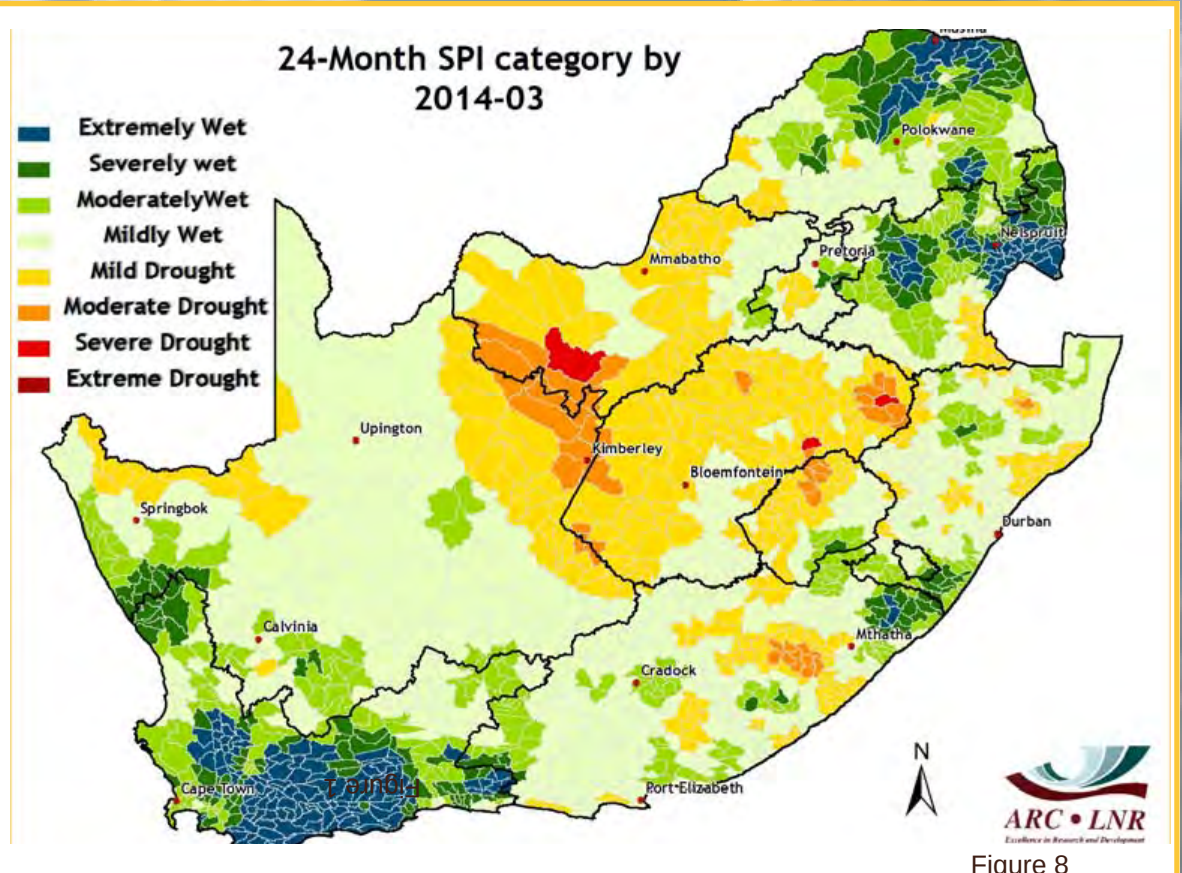

Figure 8

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.

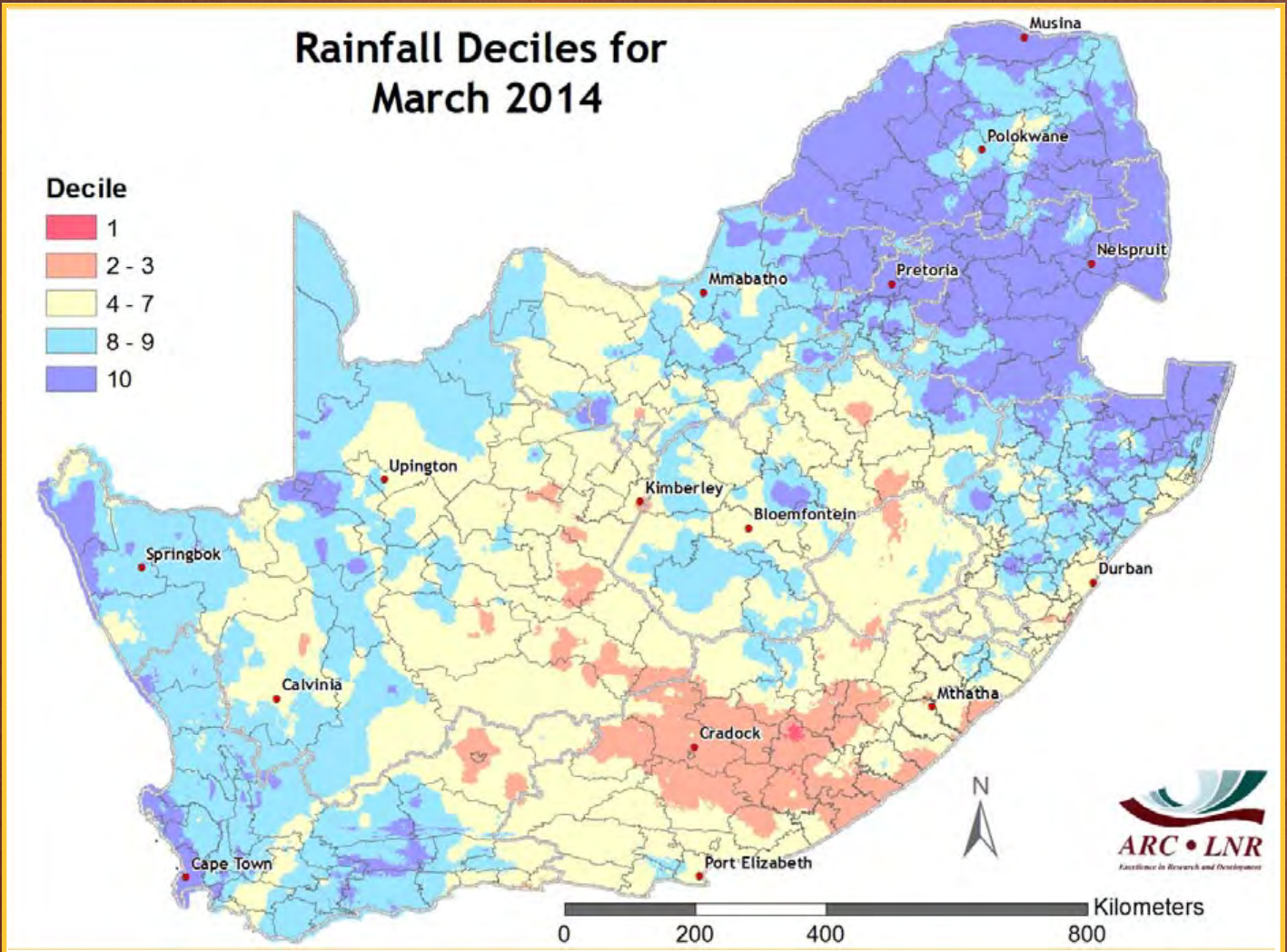

Figure 9

Figure 9:
The decile map indicates that March was exceptionally wet over much of the northeast. The value of 10 indicates that rainfall was equal to or exceeded that only experienced during the 10% wettest of March months, and possibly the highest on record in some places.

4. Water Balance

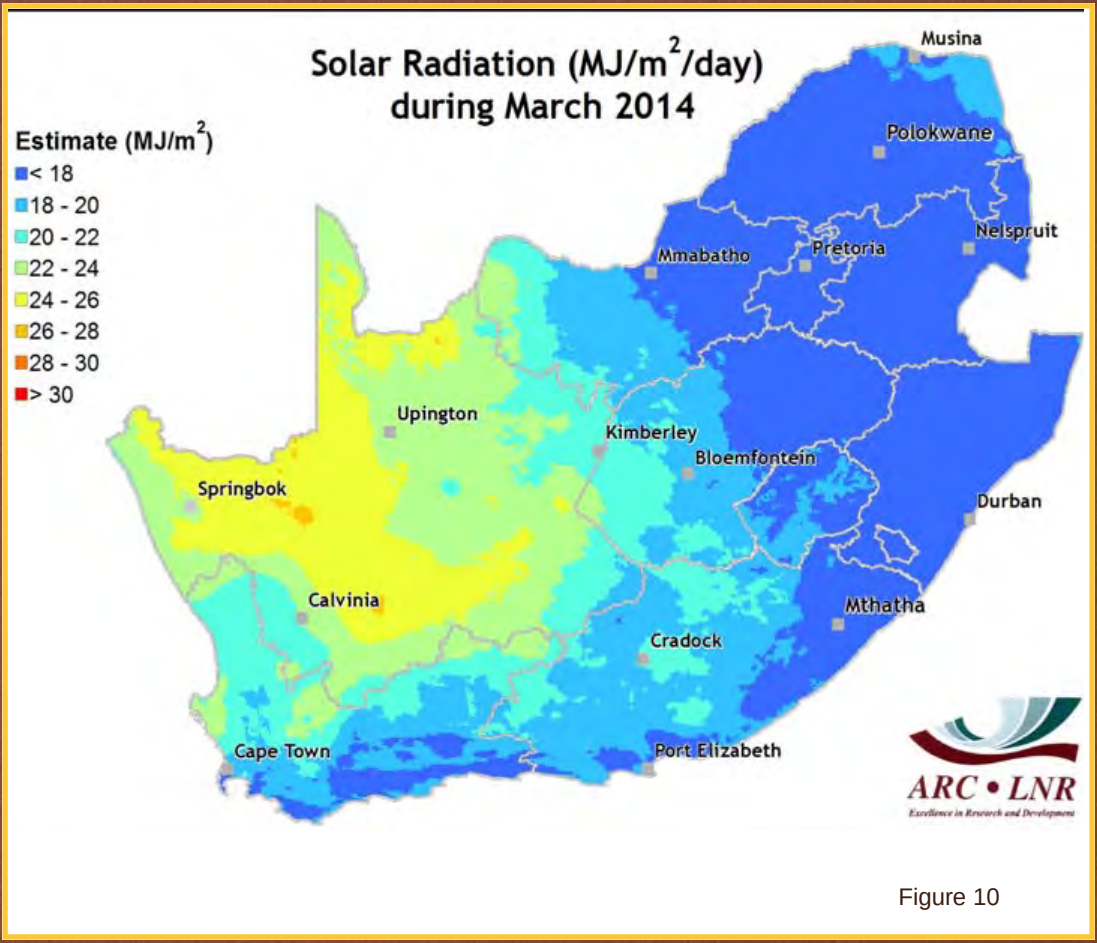

Figure 10

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:
Persistent cloud cover during much of March over the north-eastern parts resulted in very low solar radiation estimates there.

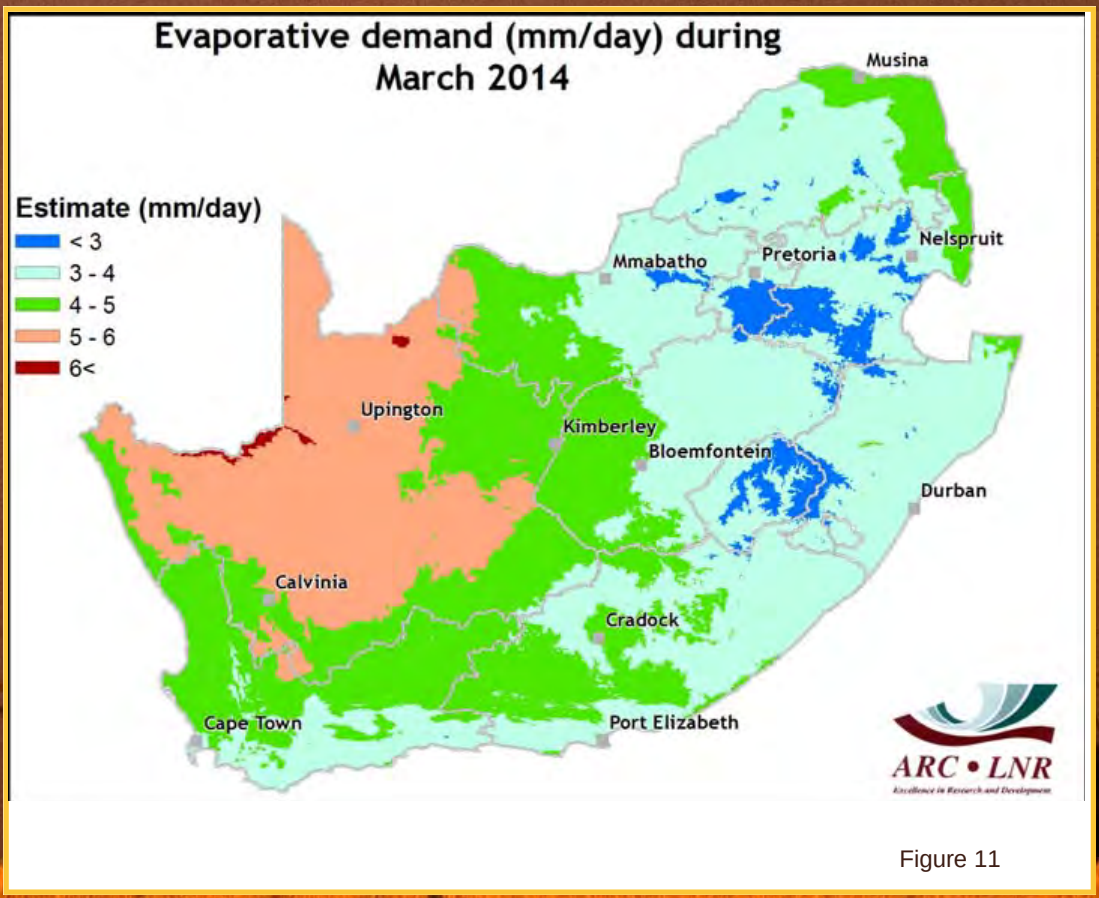

Figure 11

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:
A lack of sunshine, low maximum temperatures and high humidity during much of the month were all contributing factors to the very low potential evaporation estimates over the eastern and north-eastern areas.

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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.

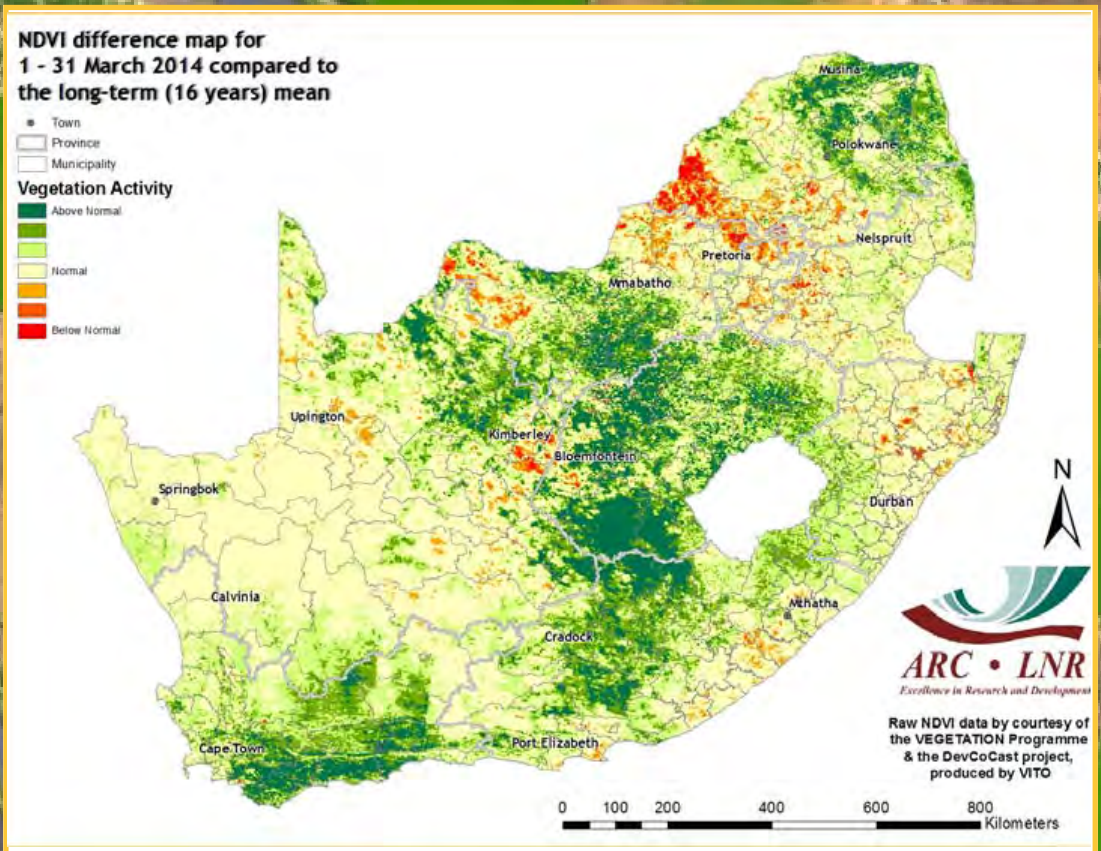

Figure 12

Figure 12:
Vegetation activity is above normal over most of the country except for much of the interior of the Northern Cape as well as the western parts of Limpopo where the high rainfall during March will have a larger positive contribution towards early April.

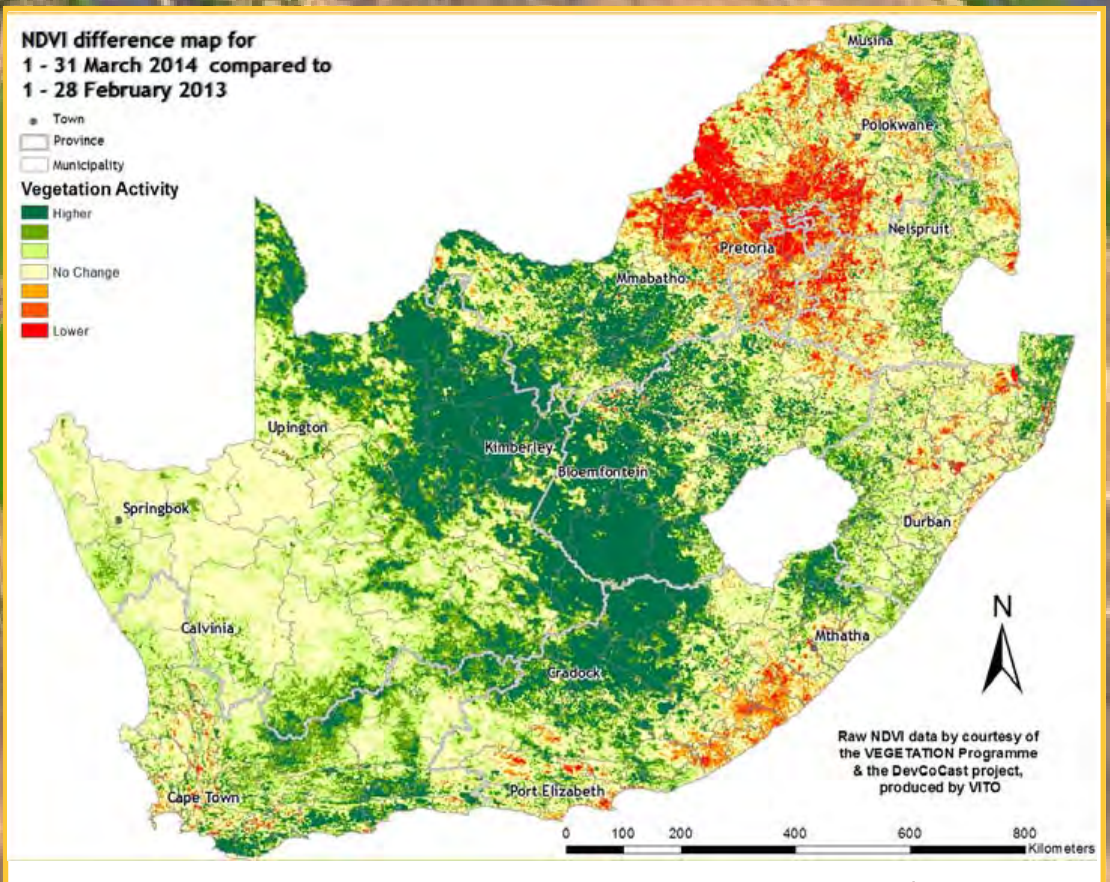

Figure 13

Figure 13:
Vegetation activity during March continued to improve across much of the country following high rainfall during February and March over much of the country.

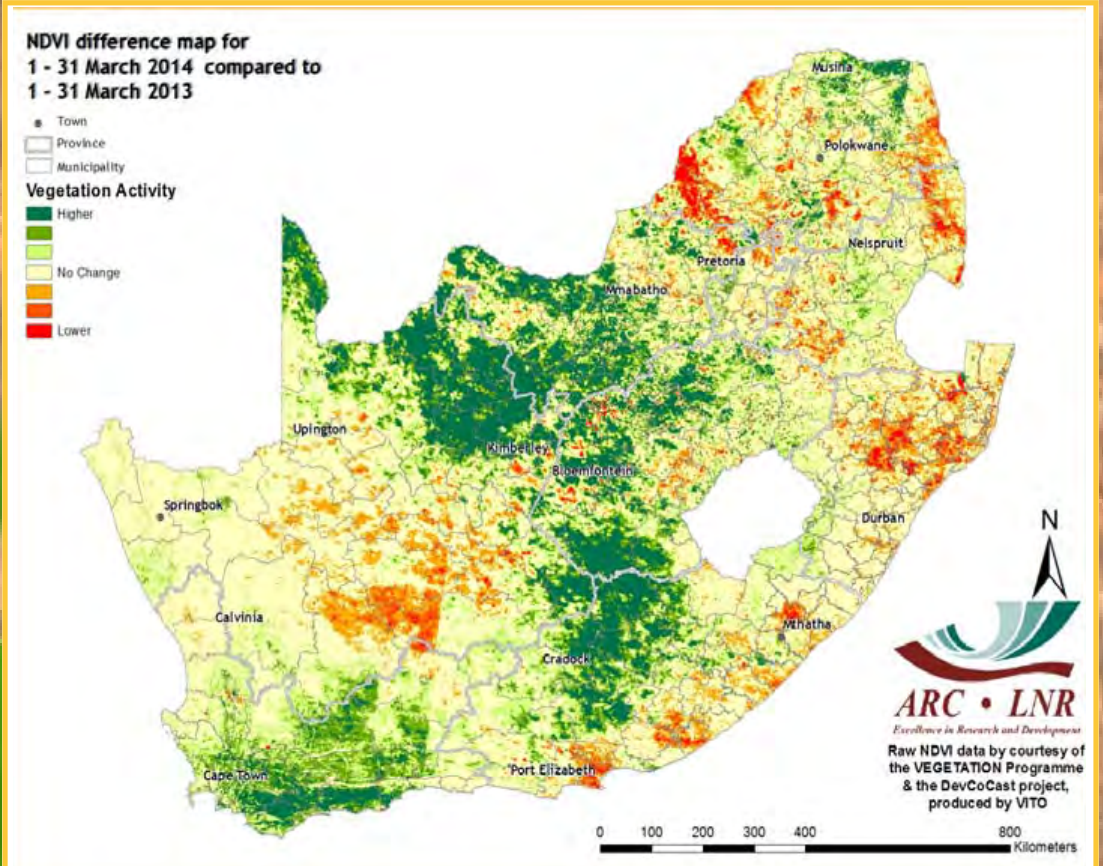

Figure 14

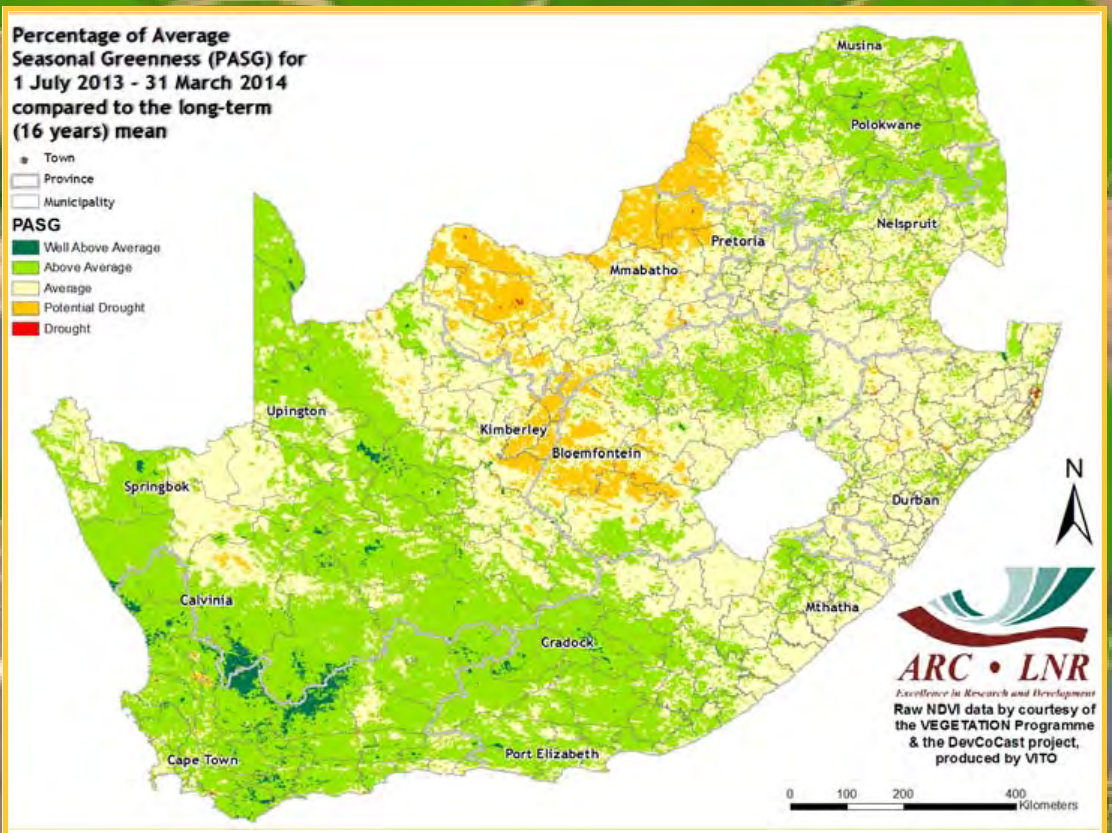

Figure 15

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:
The central parts of the country are experiencing much higher vegetation activity than in March 2013 when drought conditions dominated there. Vegetation activity is somewhat lower over parts of the northeast where very high rainfall totals occurred during January 2013.

Figure 15:
Due to the late start of the current summer rainfall season and dry conditions over isolated areas of central South Africa, the cumulative vegetation activity there is still somewhat below normal. Due to wet conditions during much of early 2014 and late 2013 over the southwestern and northeastern parts of the country, cumulative vegetation activity is above-normal over much of those areas.

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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.

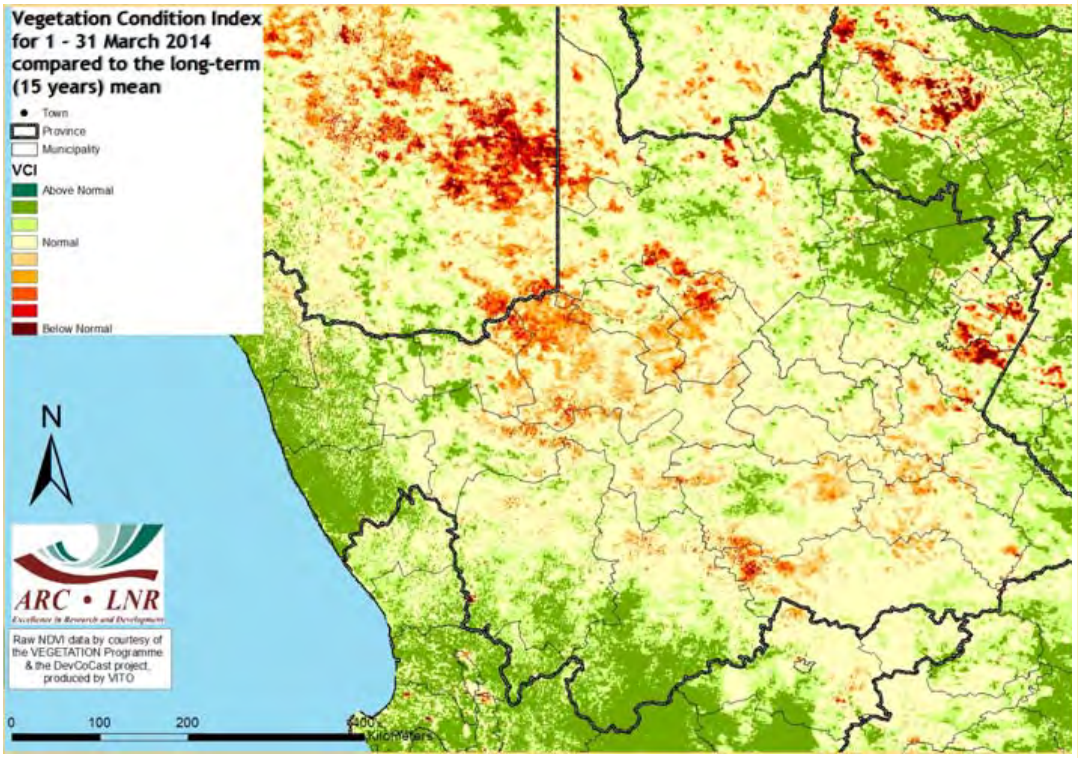


Figure 16

Figure 16:
The VCI map for March 2014 indicates normal to below-normal vegetation activity over the central parts of the Northern Cape Province.

Figure 17:
The VCI map for March 2014 indicates both normal and below-normal vegetation activity over the northern, central and western parts of the KwaZulu-Natal Province.

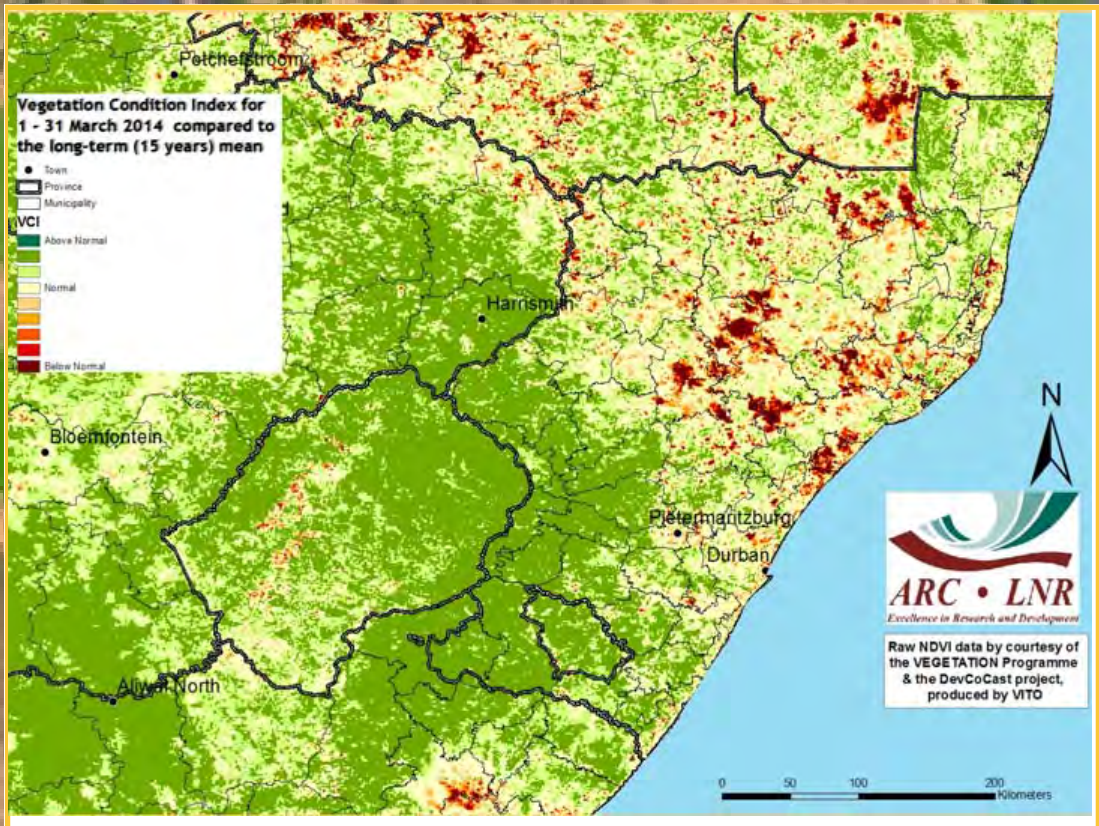
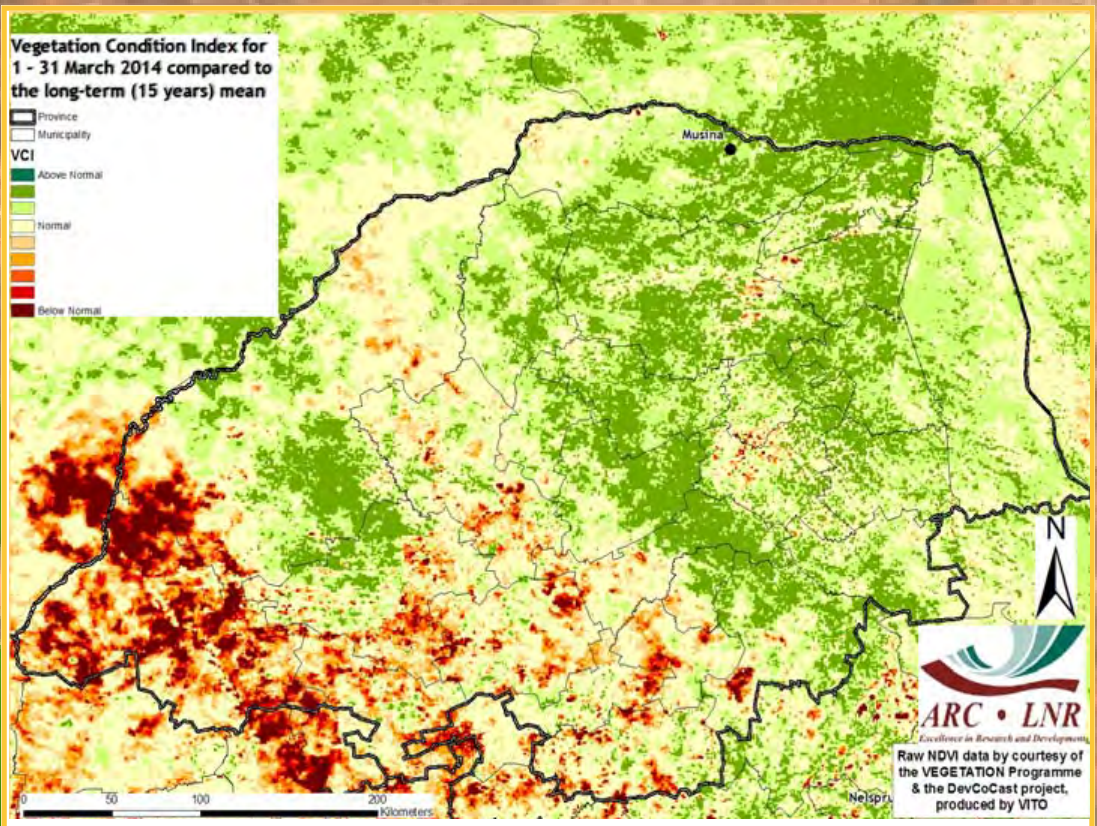


Figure 17



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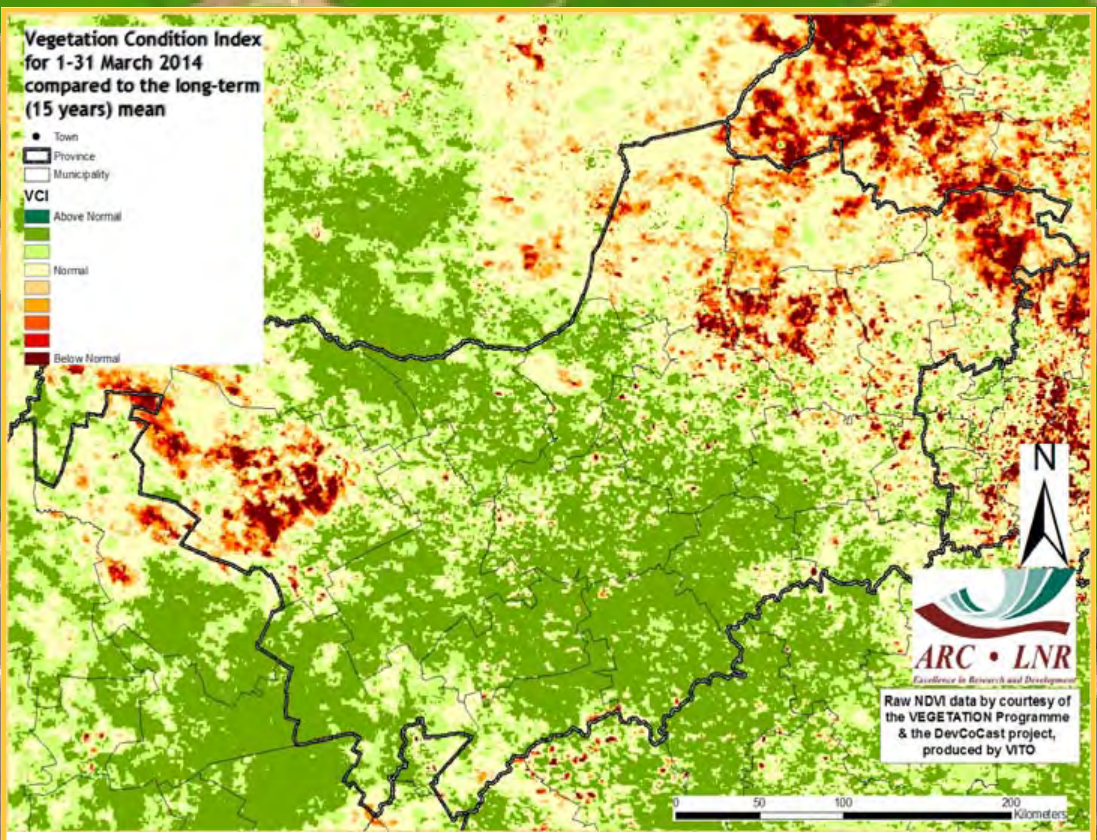

Figure 19

Figure 18:
The VCI map for March 2014 indicates below-normal vegetation activity over the southwestern parts of the Limpopo Province.

Figure 19:
The VCI map for March 2014 indicates below-normal vegetation activity over the northeastern and far western parts of the North West Province.

Questions/Comments:
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7. Vegetation Conditions & Rainfall

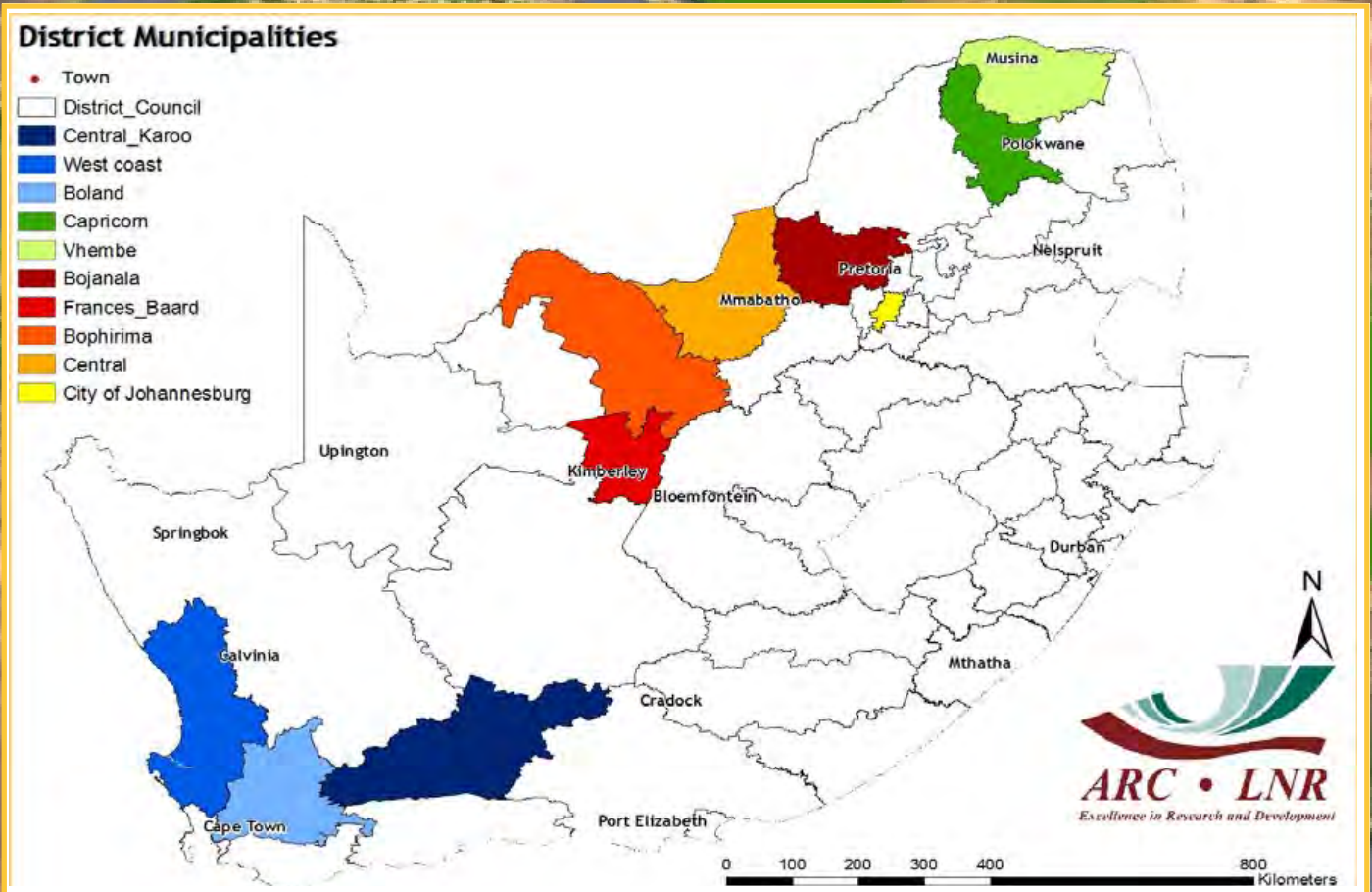

Figure 20

NDVI and Rainfall Graphs

Figure 20:
Orientation map showing the areas of interest for March 2014. The district colour matches the border of the corresponding graph.

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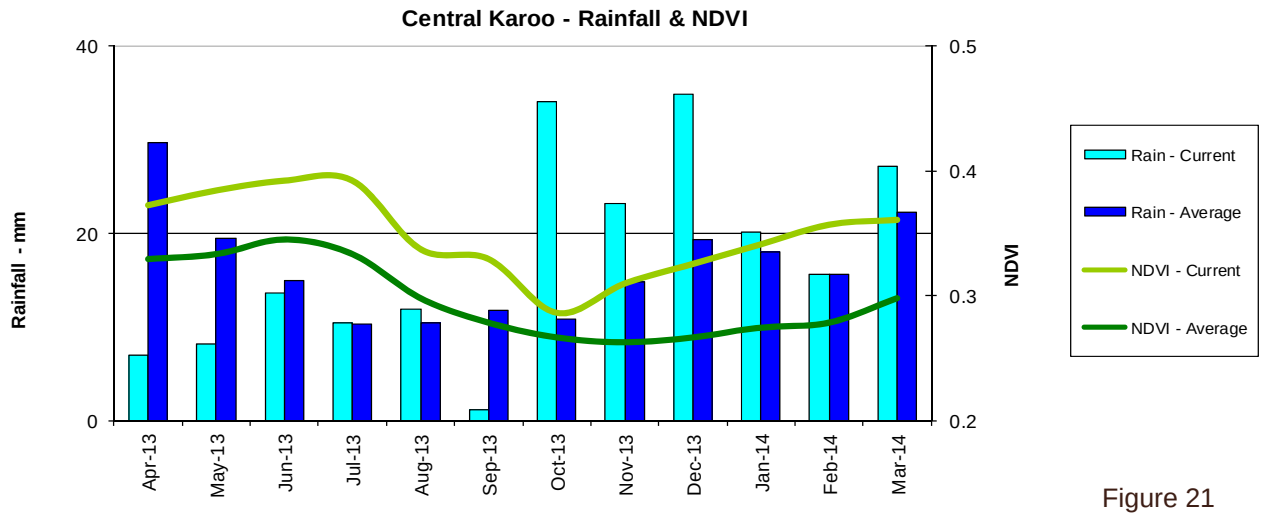
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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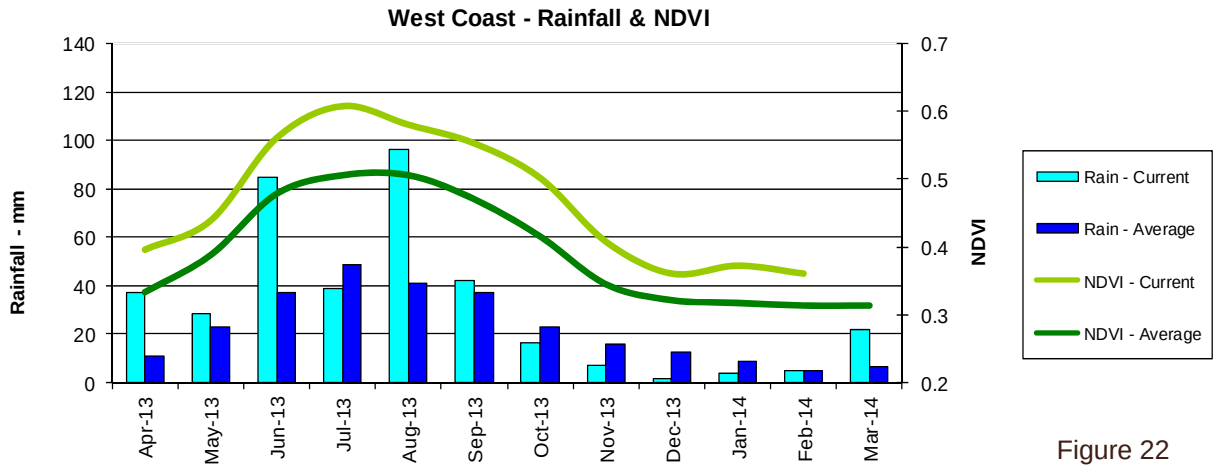

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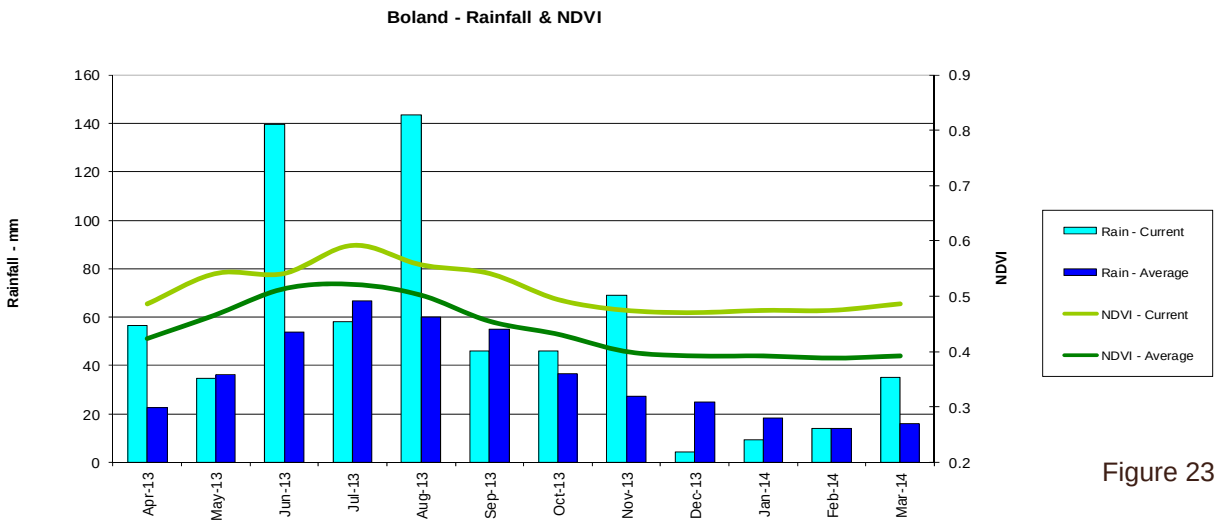

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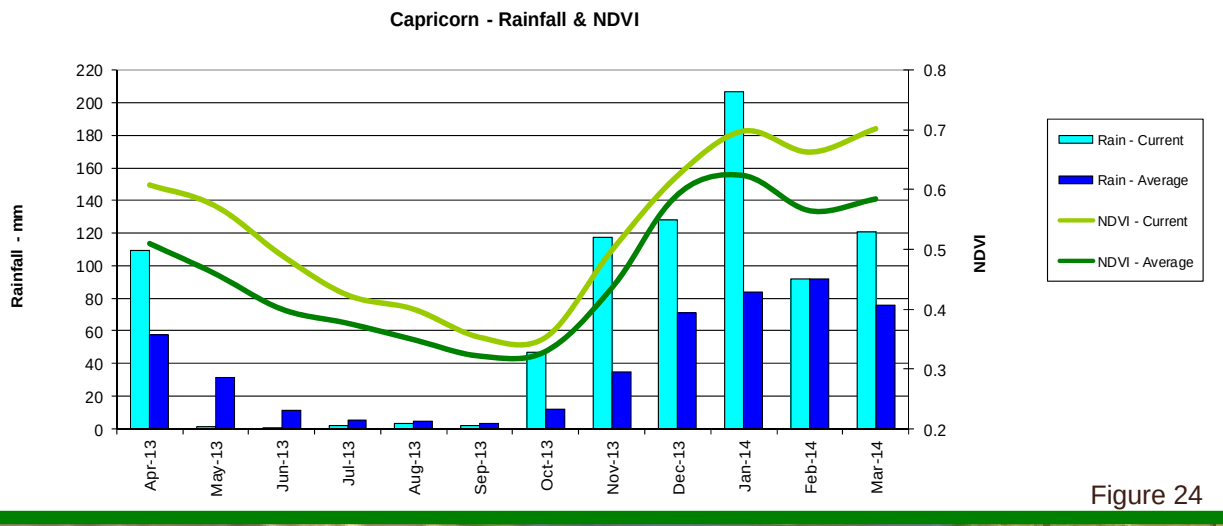

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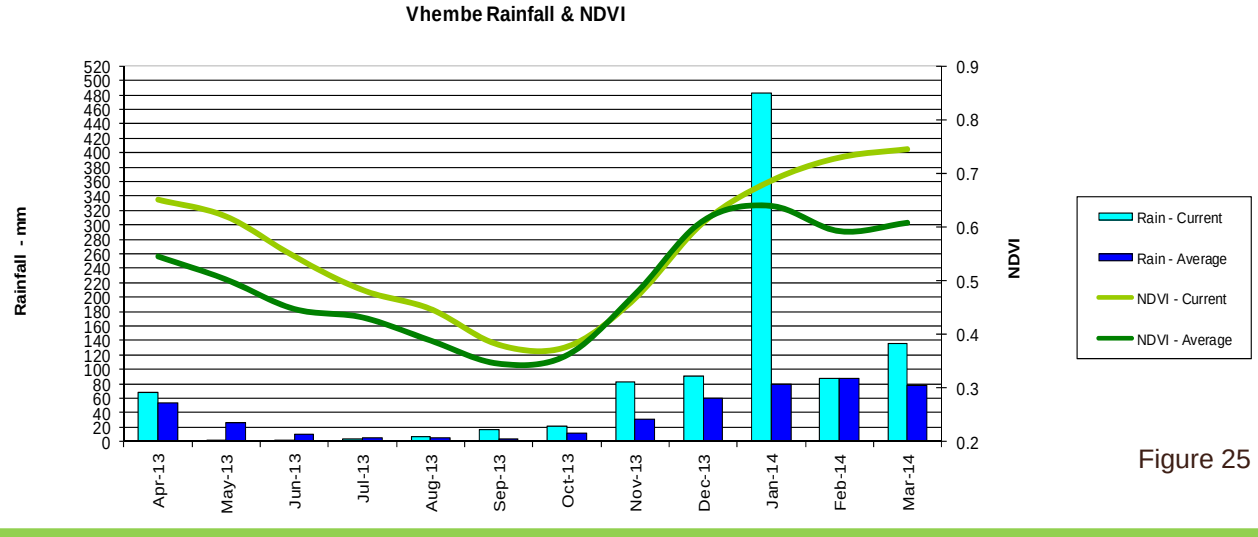


Figure 25

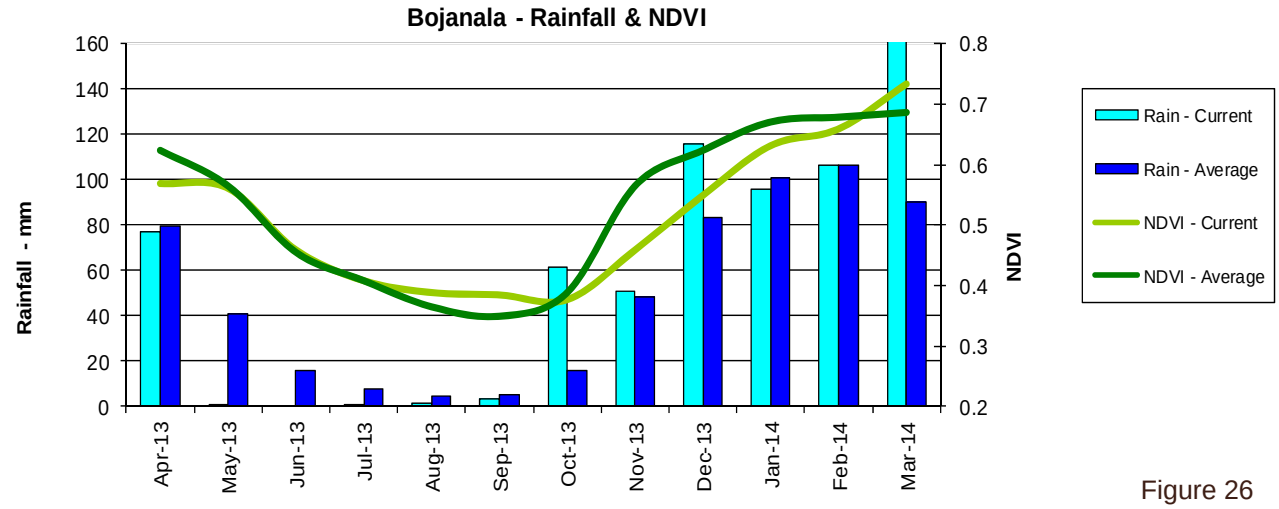
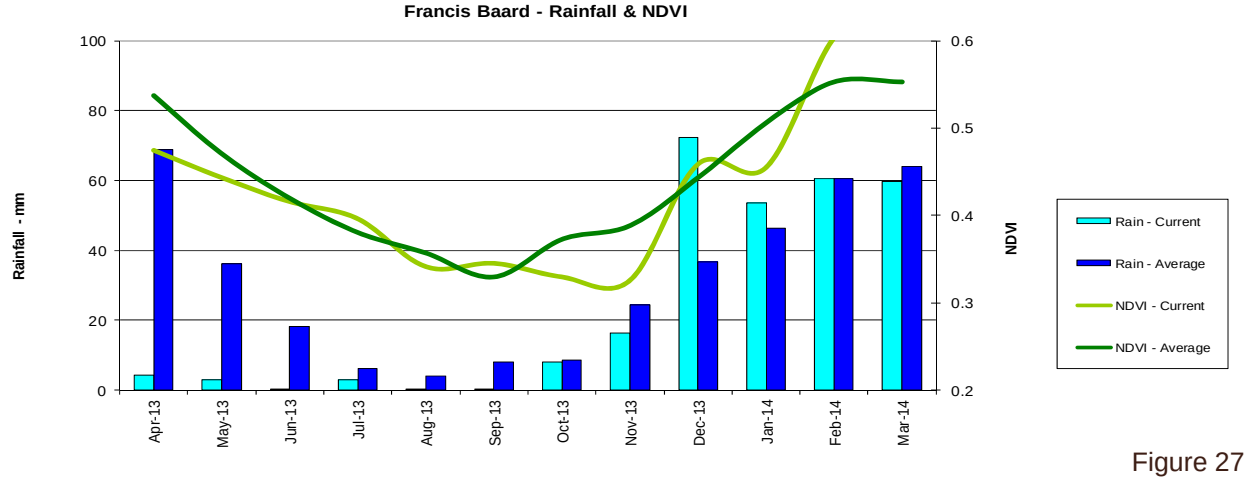


Figure 26



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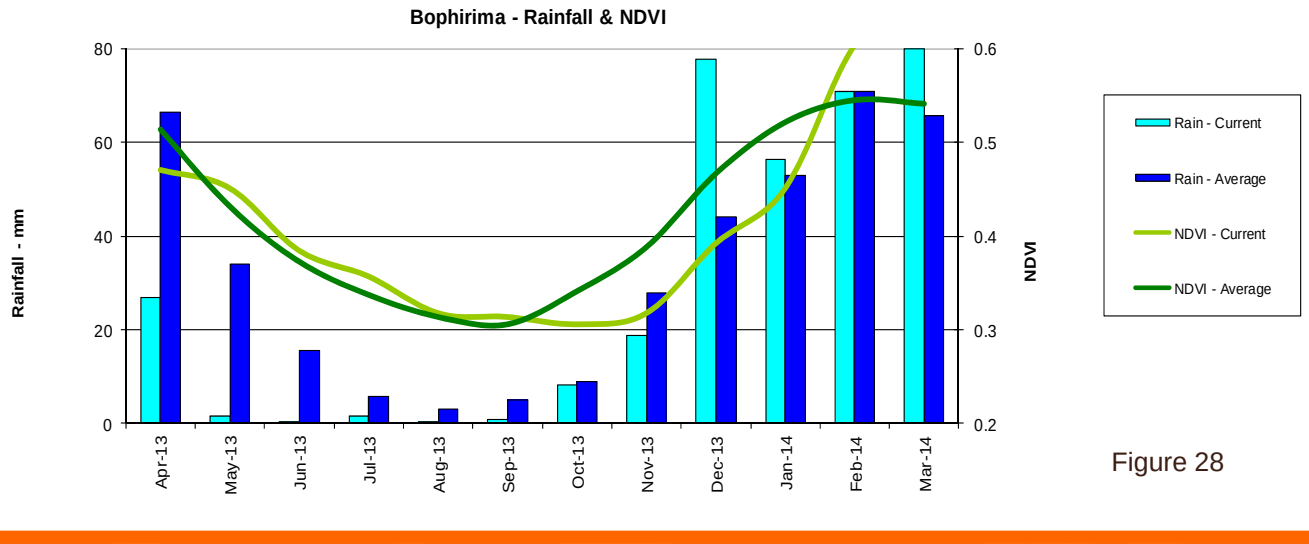

Figure 28

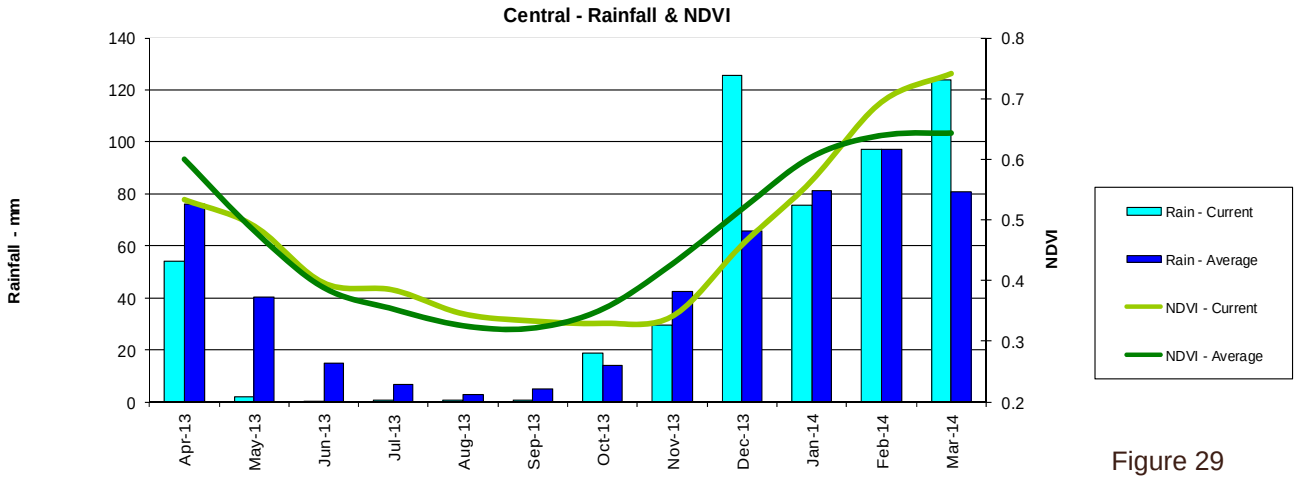

Figure 29

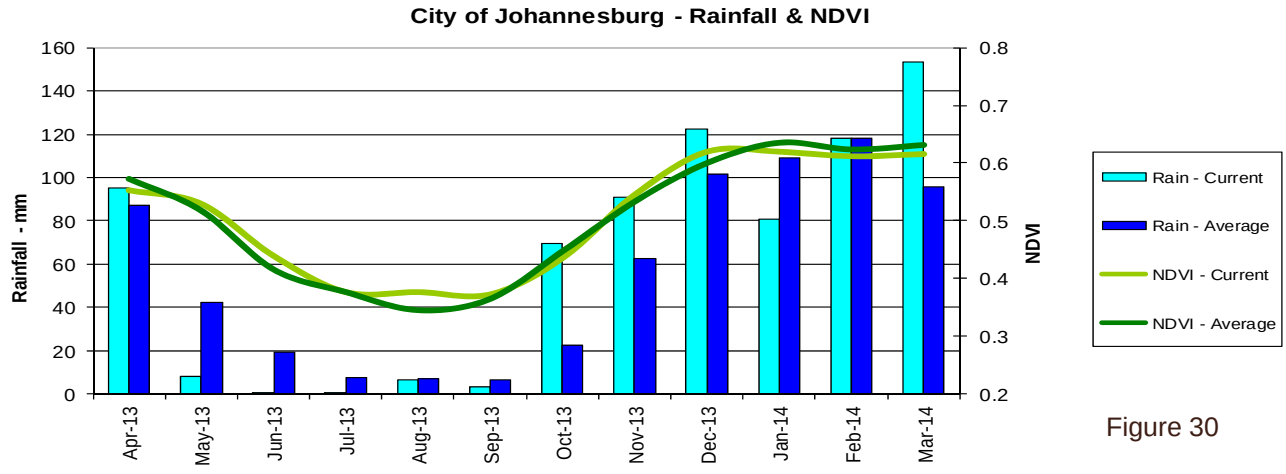

Figure 30

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 2014 per province. Fire activity was only higher in KwaZulu-Natal compared to the average for the same period for the last 13 years.

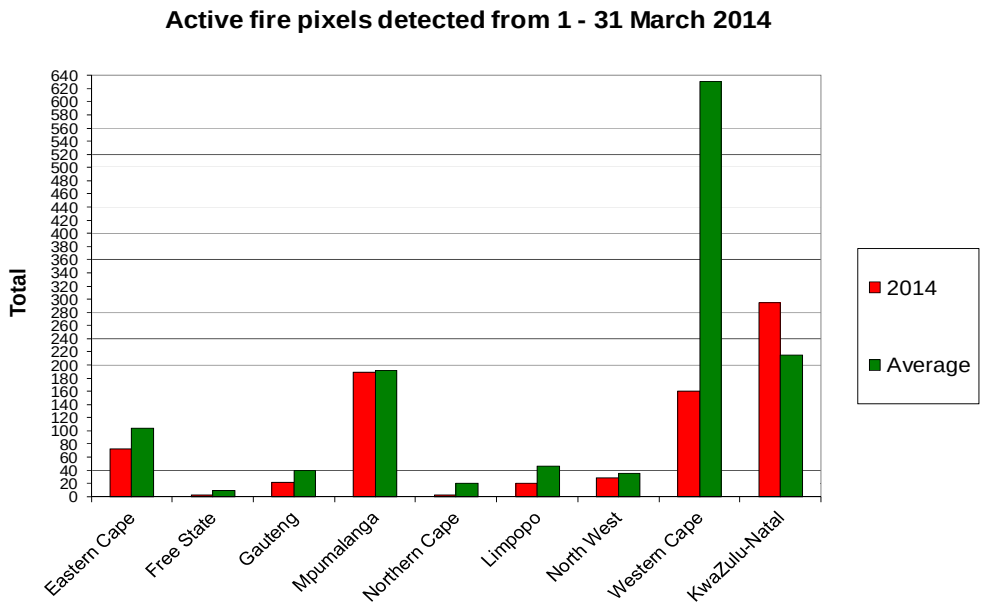

Figure 31

Figure 32:
The map shows the location of active fires detected in month of March 2014.

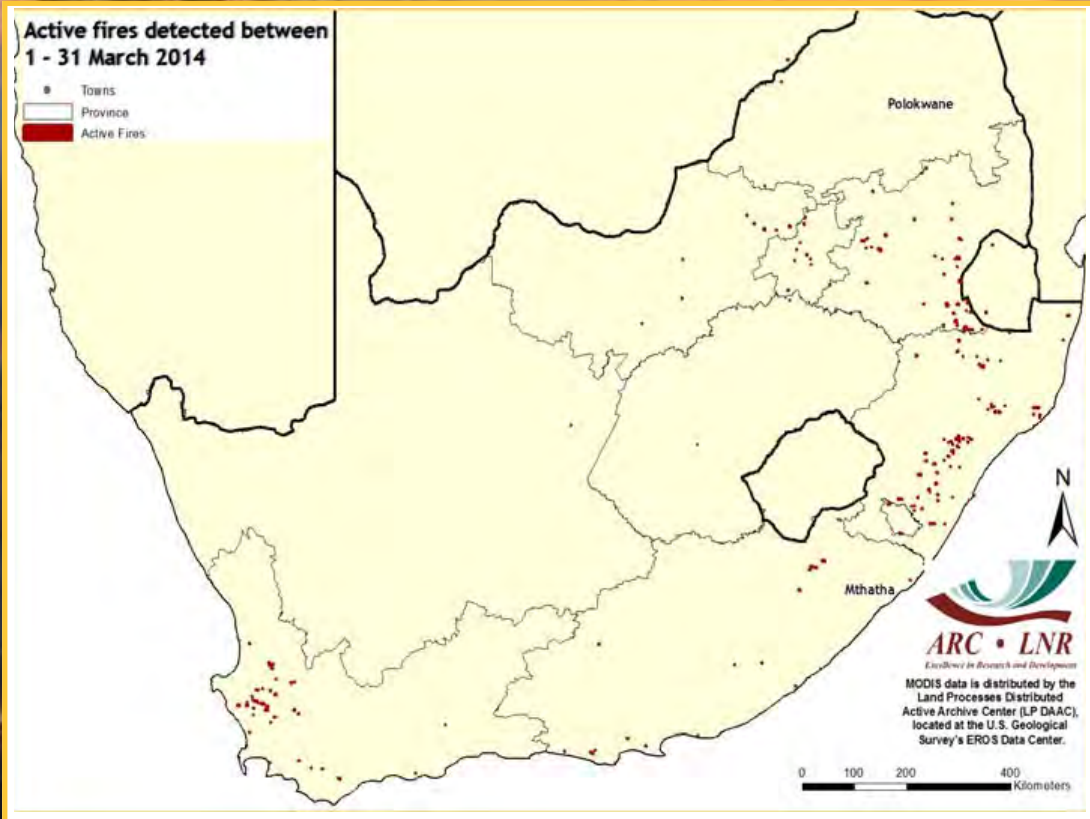

Figure 32

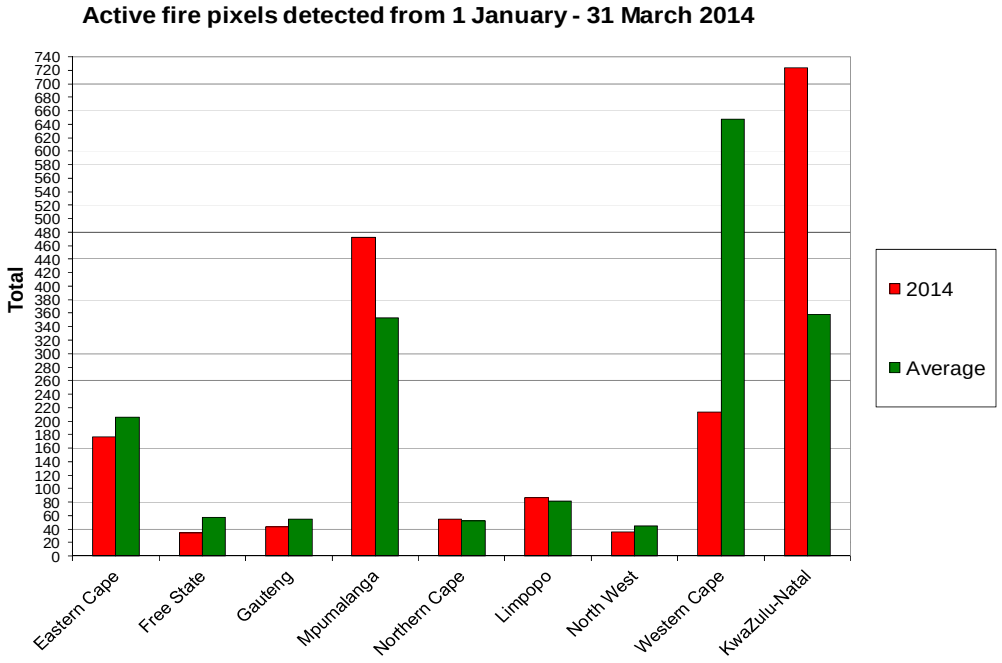

Figure 33

Figure 33:
The graph shows the total number of active fires detected from 1 January to 31 March 2014 per province. Fire activity was higher in Mpumalanga, Limpopo and KwaZulu-Natal compared to the average for the same period for the last 13 years.

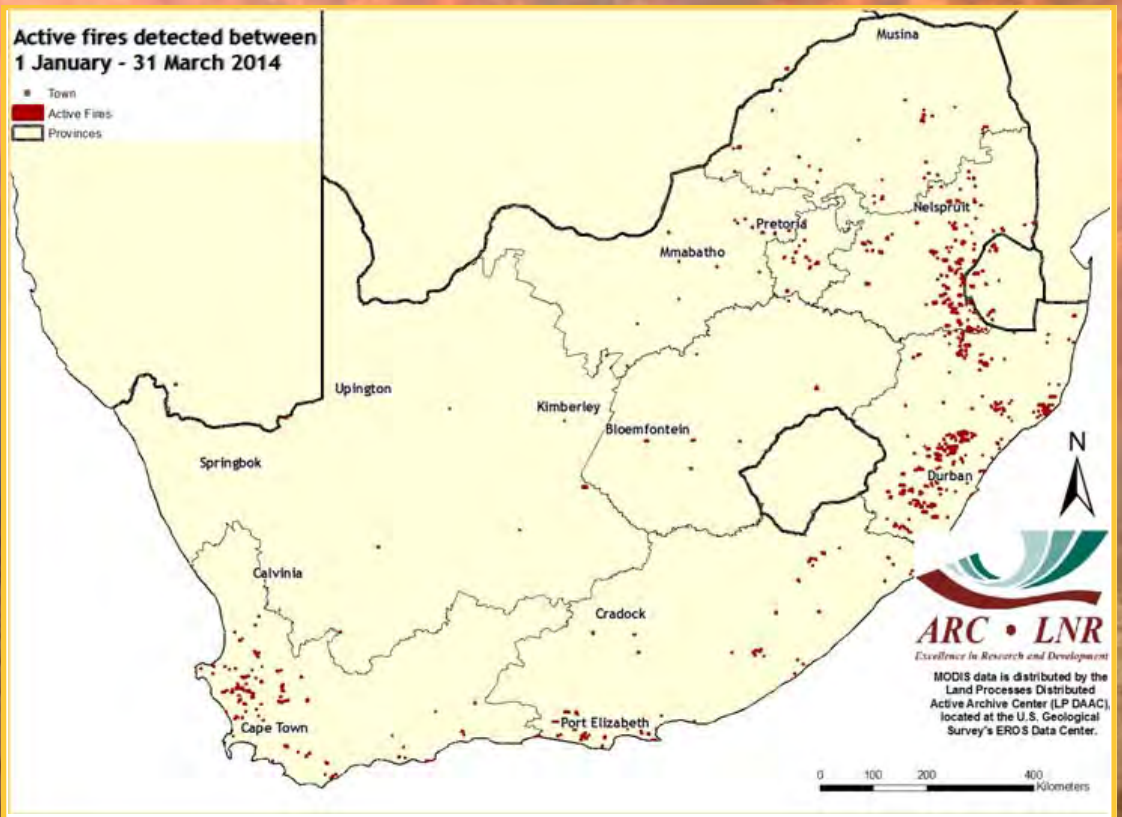

Figure 34

Figure 34:
The map shows the location of active fires detected from 1 January to 31 March 2014.

ARC-INSTITUTE FOR SOIL, CLIMATE AND WATER

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AgroClimatology

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

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

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

Products and Services

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

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

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

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

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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