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The Watchman

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INSTITUTE FOR SOIL, CLIMATE ANDWATER

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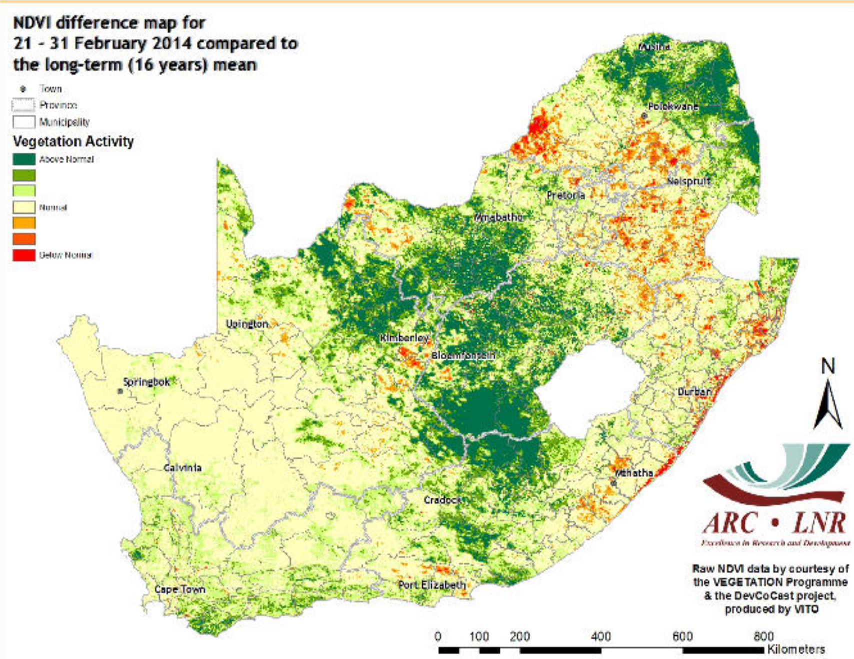
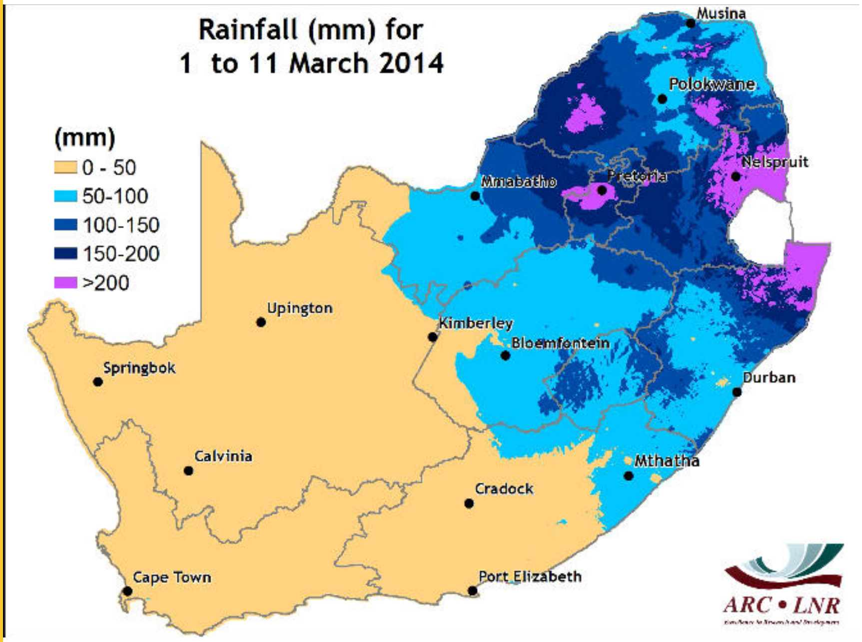
117th Edition

Images of the Month





Above-normal rainfall in February has a positive influence on vegetation

Widespread and heavy rain over much of the recently drought stricken central interior resulted in a large northwest-southeast band of above-normal vegetation activity by the end of February. The cloudy and rainy weather during early February together with above-normal rainfall during December have benefitted most of the drought stricken North West. Areas to the east of the North West, outside the influence of the tropical low over Botswana responsible for much of the precipitation during February, showed indications of stress due to the low rainfall there. Further to the northeast, however, the movement of tropical systems once again resulted in above-normal vegetation activity.

Widespread heavy rain over northeastern parts during early March

Since the beginning of March, atmospheric circulation anomalies in the southern African region became very favourable for rainfall over the northeastern parts of South Africa. The rainfall map for this period shows very high cumulative rainfall amounts over an extensive area due to the persistent rainy conditions. The highest falls were recorded over the area where below-normal rainfall during February resulted in below-normal vegetation activity (as indicated in the NDVI map). Persistent cloud and general rain and thundershowers dominated during much of this period resulting in floods in many places and also had a negative impact on some crops. The extent of the flooding exceeded that of the massive floods that occurred during February 1996 over much of northeastern South Africa and is consistent with the well-known 18-20-year Dyer-Tyson rainfall cycle. **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:

Wet conditions that developed over the central parts of South Africa and much of Botswana due to a dominant tropical low pressure system over central Botswana since late January continued up to about the 8th of February. Most of the rain occurred over North West and further north into Botswana, in the direct vicinity of the low. Tropical moisture from the north-east also resulted in widespread rain over the northeastern Escarpment during this period, while showers occurred over almost the entire country due to large amounts of moisture available. The tropical low over Botswana then moved further north-west, with rainfall over South Africa abating. Another tropical disturbance resulted in some thundershowers over the north-eastern interior around the 13th. Some showers also occurred during this period towards the southern parts of the country, as an easterly flow due to the strengthening of the Indian Ocean high pressure system became more dominant throughout the month. The easterly flow further resulted in cloudy conditions during much of the month over the northern and eastern parts while high temperatures occurred in the far western and southern parts. A tropical storm moved southwards towards the east of South Africa over the Mozambique Channel while scattered thunderstorms occurred over much of the interior until the 22nd. Thundershowers concentrated mostly over the northeastern areas by the 25th while the system over the Indian Ocean moved out towards the south and an upper air trough moved over the southern parts. The last few days of the month were drier over South Africa while the tropical low that dominated weather patterns during the early part of the month deepened over Namibia where widespread rain occurred. This system started moving towards the east and, together with the high pressure system to the east of the country, would play an important role in the widespread rain that followed during early March.

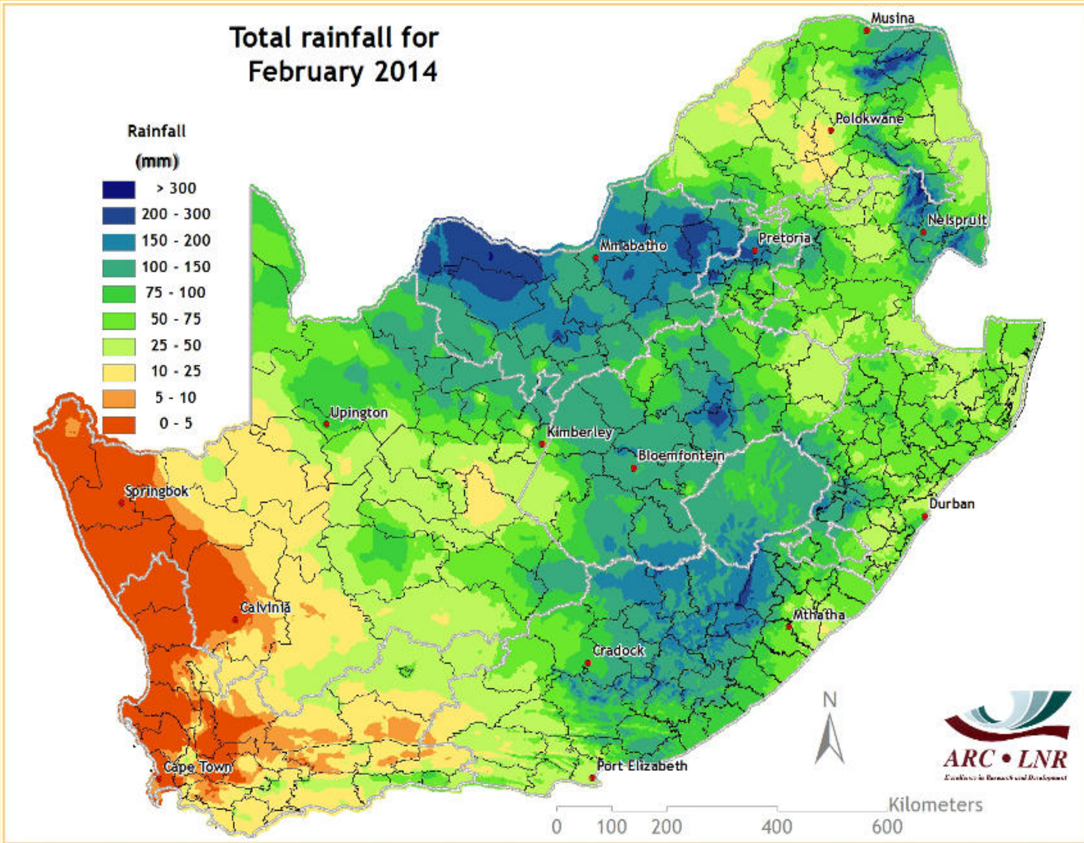
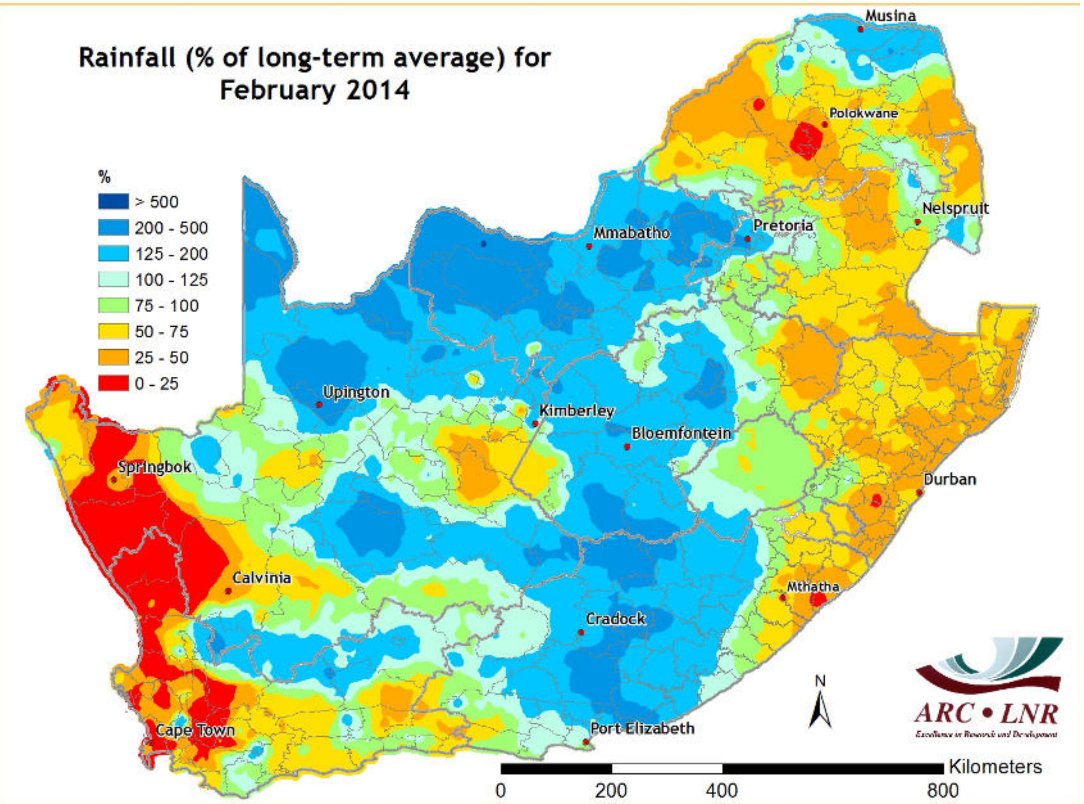


Figure 1



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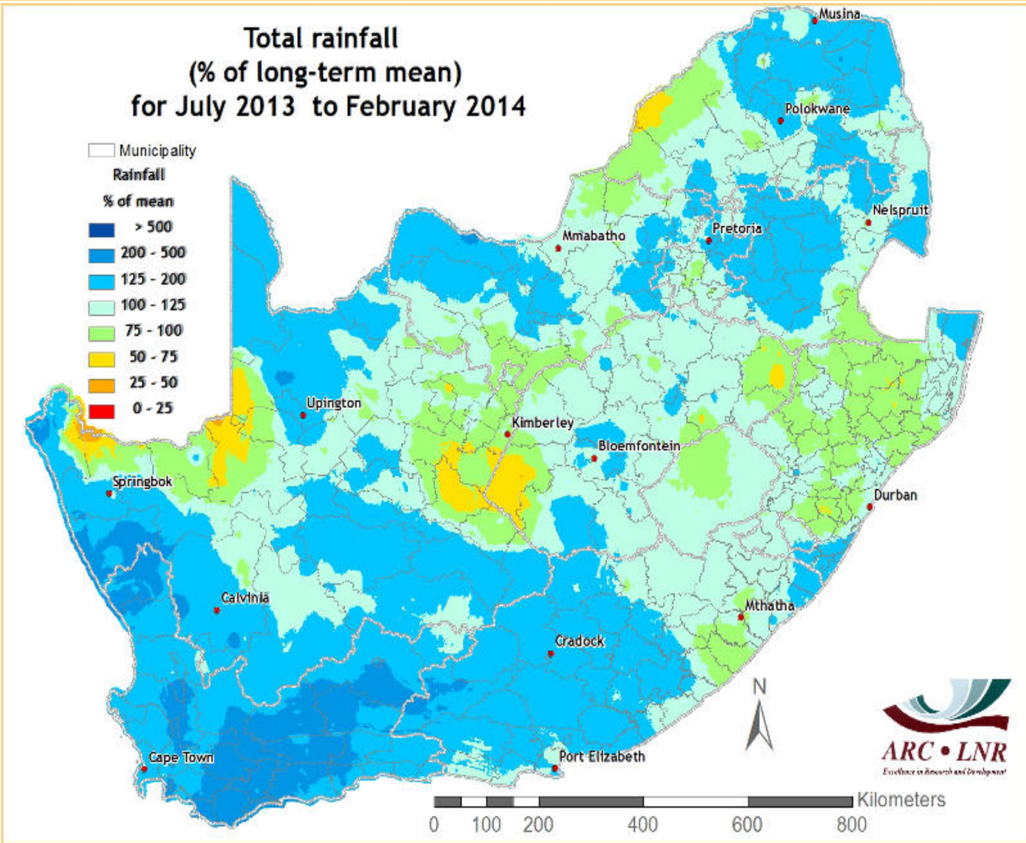

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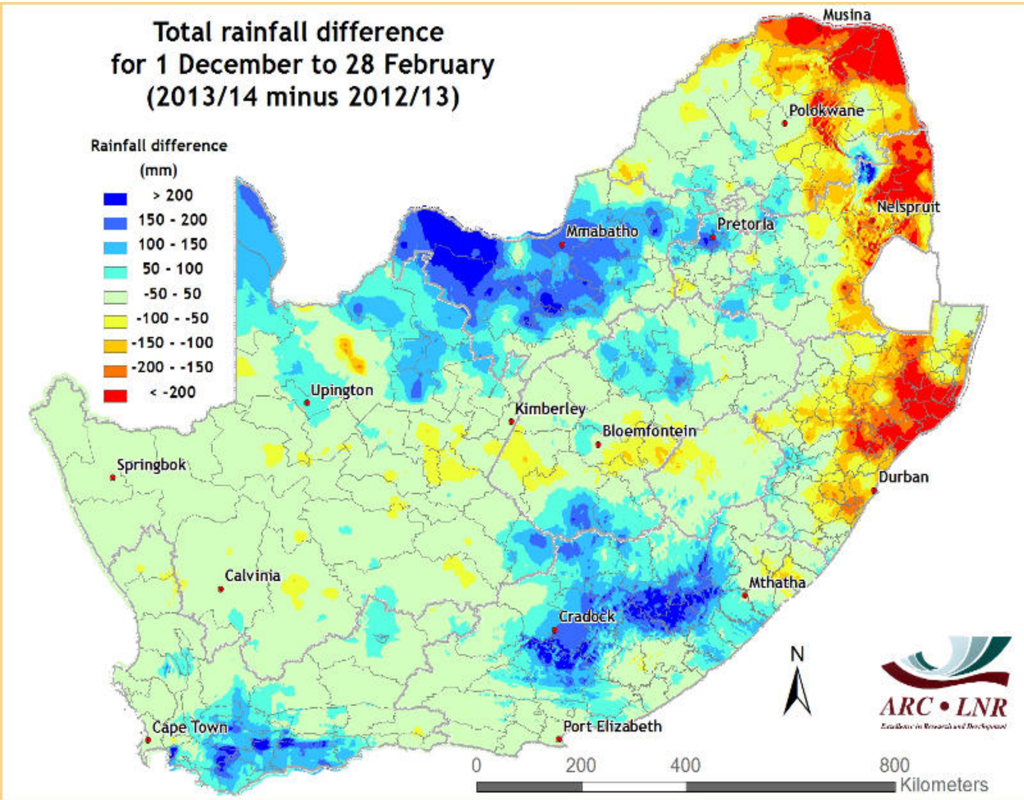

Figure 4

Figure 1:
Most of the interior received some rain during February, with much of the winter rainfall area remaining dry. Large parts of North West, the Free State, Eastern Cape and the northeastern Escarpment received in excess of 100mm of rain. Rainfall exceeded 200 mm over large parts of North West and the northeastern Escarpment.

Figure 2:
Monthly rainfall was above normal over much of central South Africa and the extreme northeast. Large areas received more than 200% of the long-term average for the month. Rainfall was below normal from the northeastern Eastern Cape, through KwaZulu-Natal and northwards towards much of Limpopo as well as over the winter rainfall area.

Figure 3:
Normal to above-normal cumulative rainfall occurred over most of South Africa since July 2013, especially over the southwestern parts.

Figure 4:
While the extreme eastern parts received less rain than a year ago during the December-to-February 3-month period, much of the central and southern parts received more rain. This is mostly the result of above-normal rainfall over the central parts during December and February of the current summer and above-normal rainfall over the extreme eastern parts during the December-to-February period in 2012/13.

Questions/Comments:
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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 have been replaced by wet conditions at the short time scale (3-6 months) due to widespread rain during December and late January into February. However, at a longer time scale the effect of a long dry period since 2012 is clearly visible with the SPI in some catchments being in the severe to extreme drought range, especially towards western North West. Due to two wet winters and unseasonal rain during January over the winter rainfall area, the extremely wet category dominates there at all time scales.

Questions/Comments:
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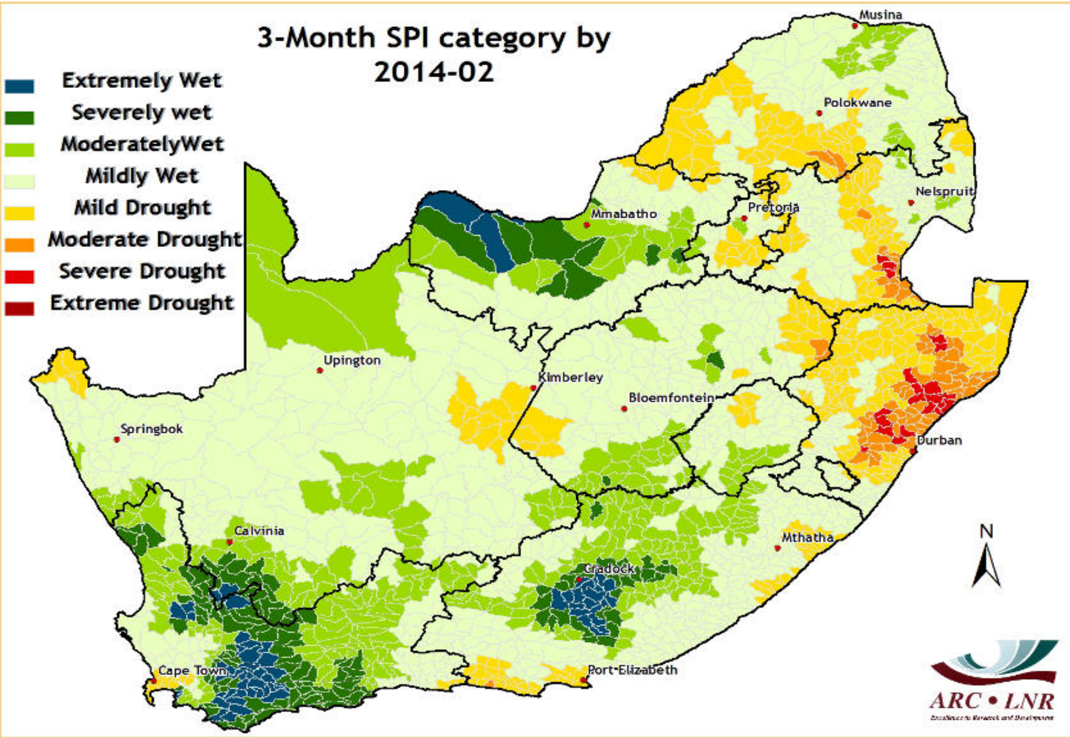
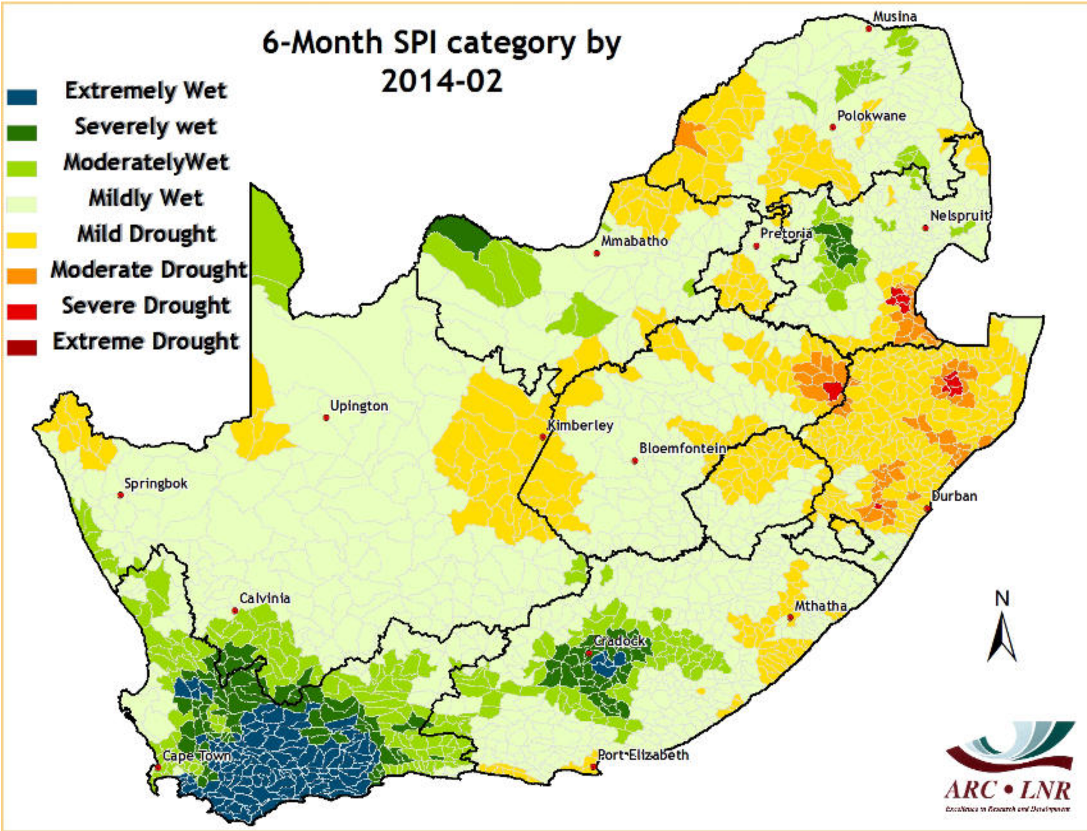


Figure 5



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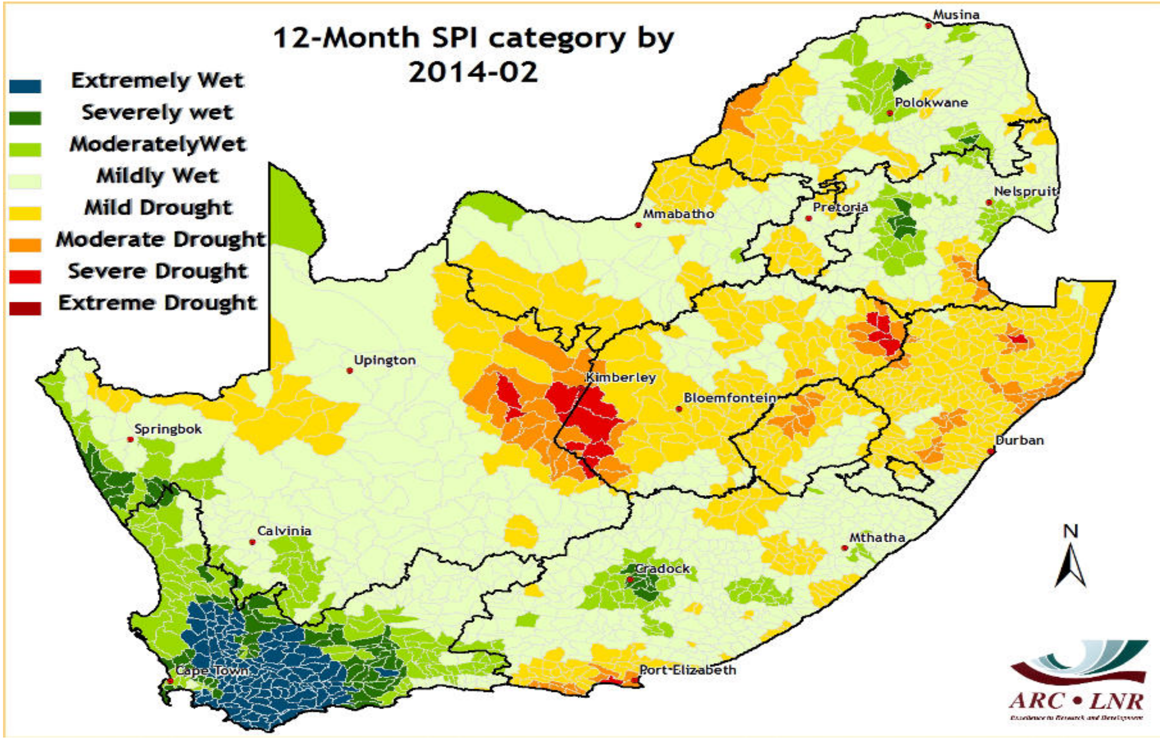

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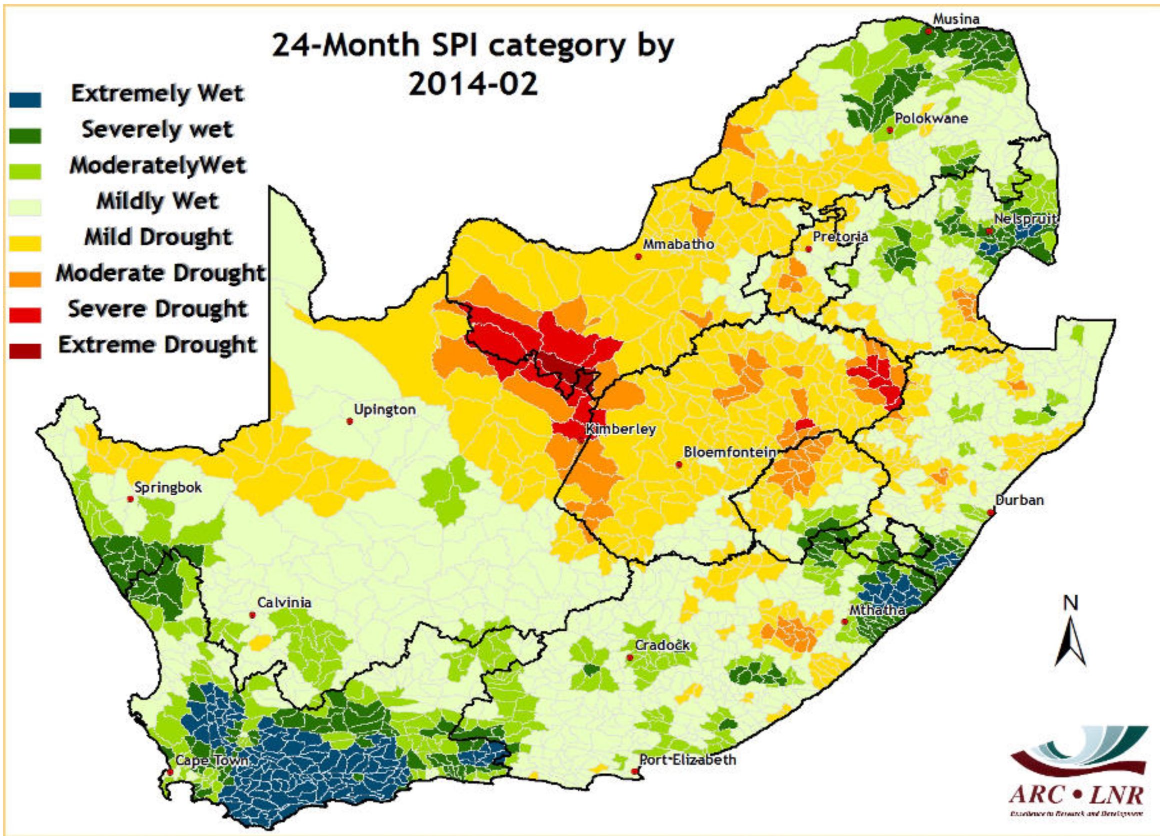

Figure 8

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.

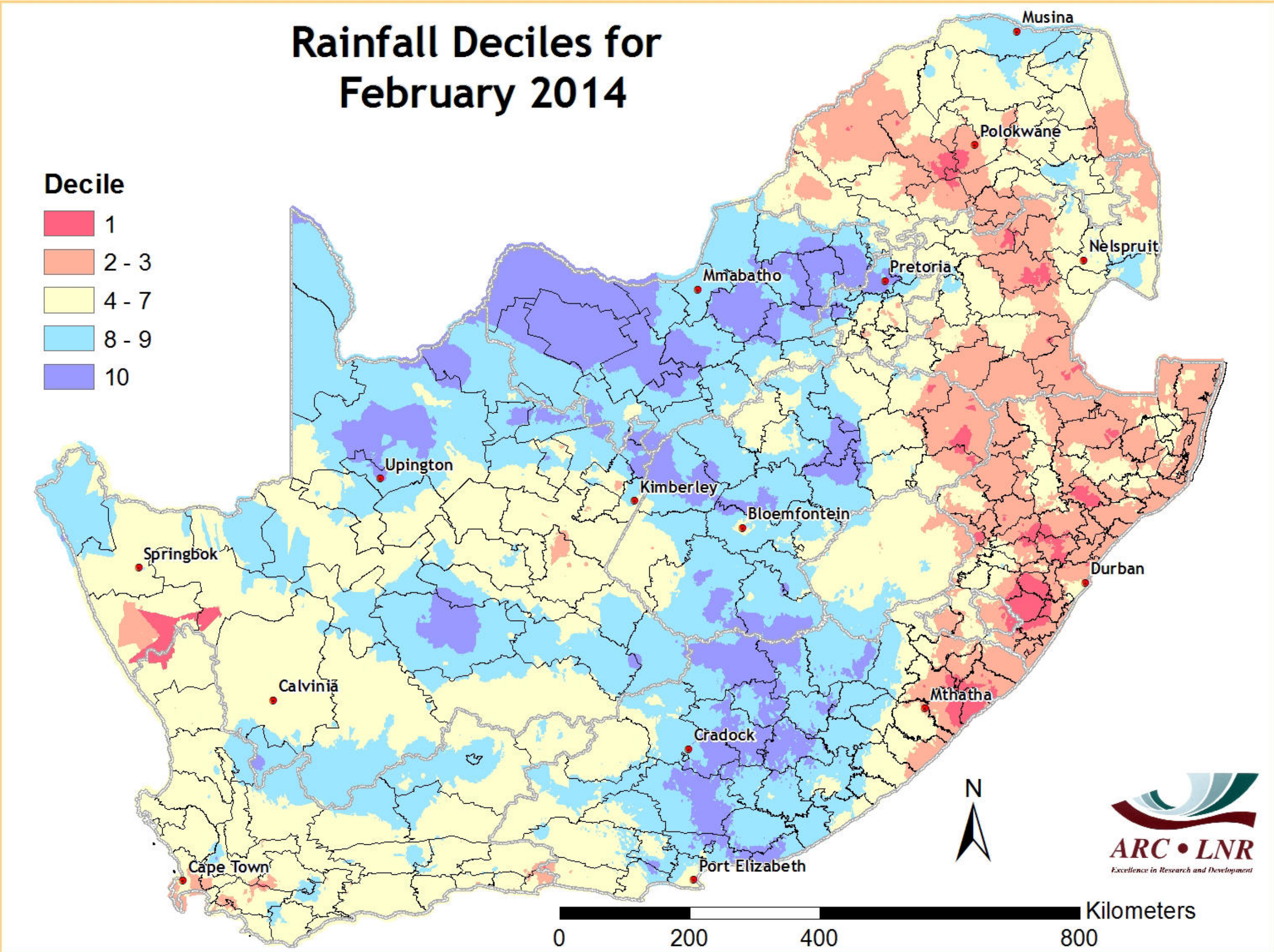

Figure 9

Figure 9:
The decile map indicates that February was exceptionally wet over much of central South Africa but exceptionally dry over much of KwaZulu-Natal, eastern Mpumalanga and southern Limpopo.

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

4. Water Balance

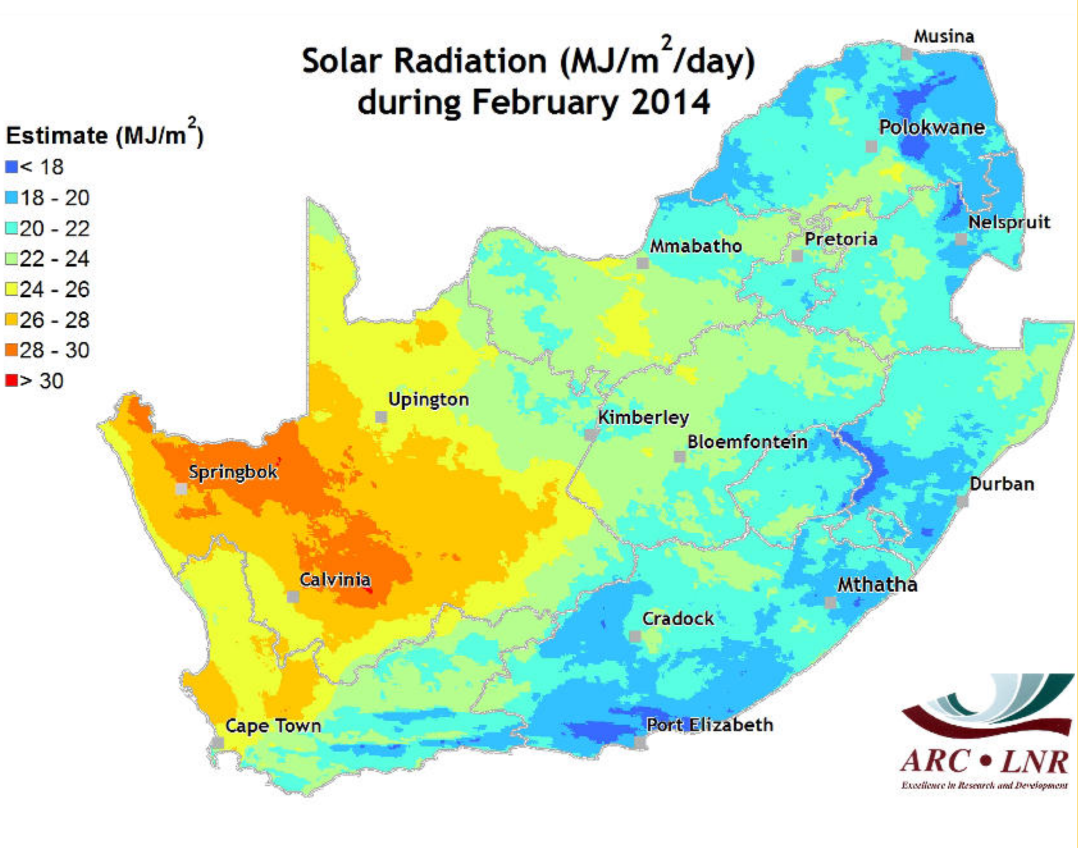

Figure 10

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:
The dominance of cloudy conditions across much of South Africa during February had a negative impact on average daily solar radiation values especially over the central and northeastern parts.

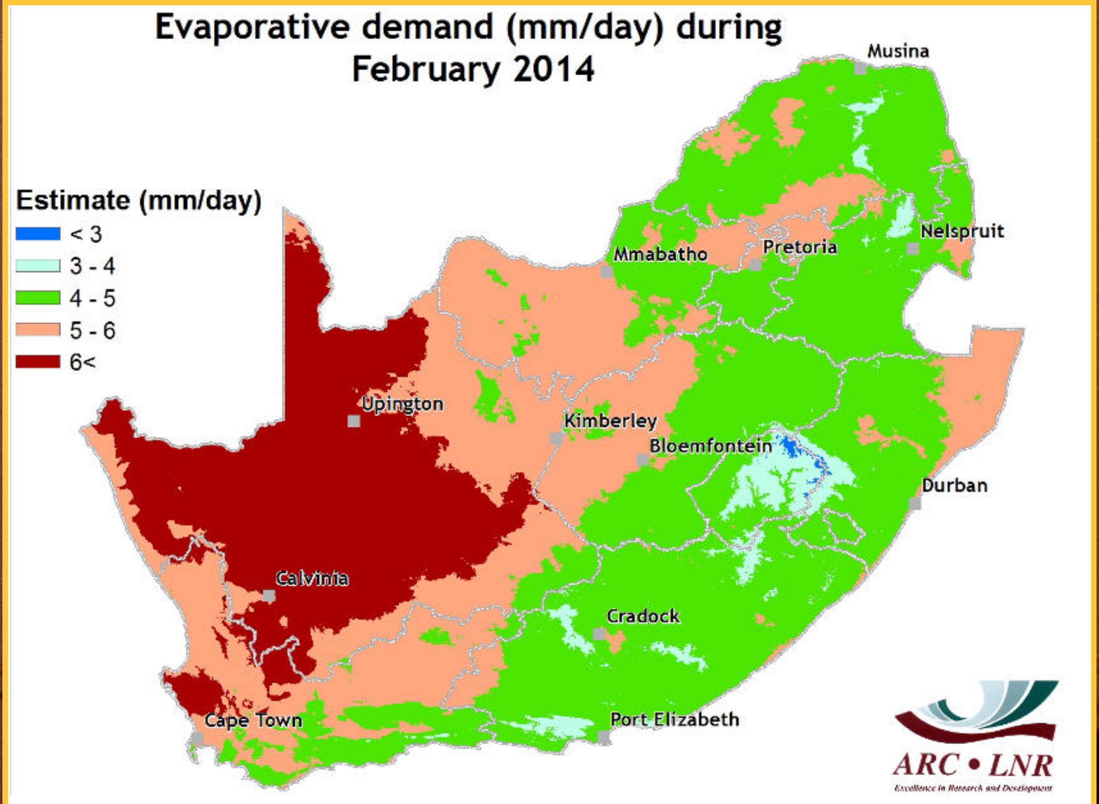

Figure 11

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:
As expected with cooler conditions and cloud cover dominating for most of the month over the central and eastern parts, as opposed to hot and dry conditions in the west, low potential evapotranspiration values dominated there.

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.

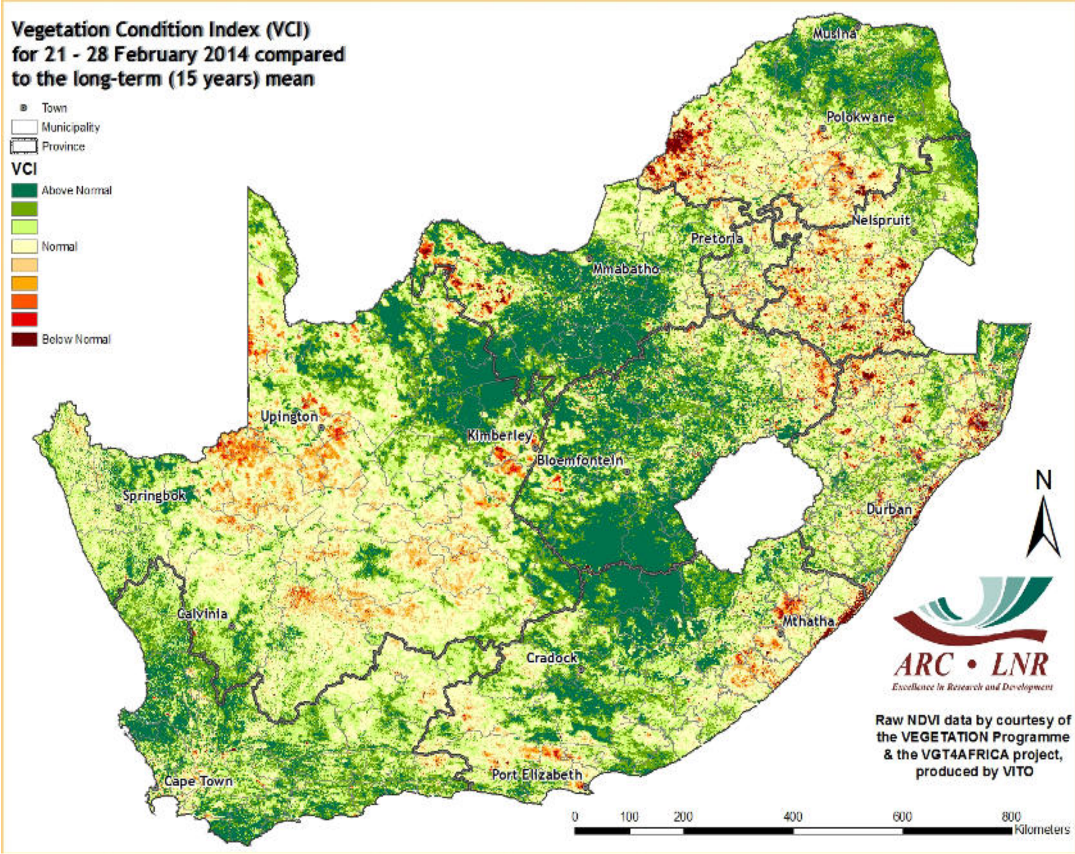

Figure 12

Figure 12:
Vegetation activity during late February was above normal over most of the interior due to wet conditions during December, late January and much of February. It is somewhat below normal over parts of the northeast and central Northern Cape where less rain occurred during February.

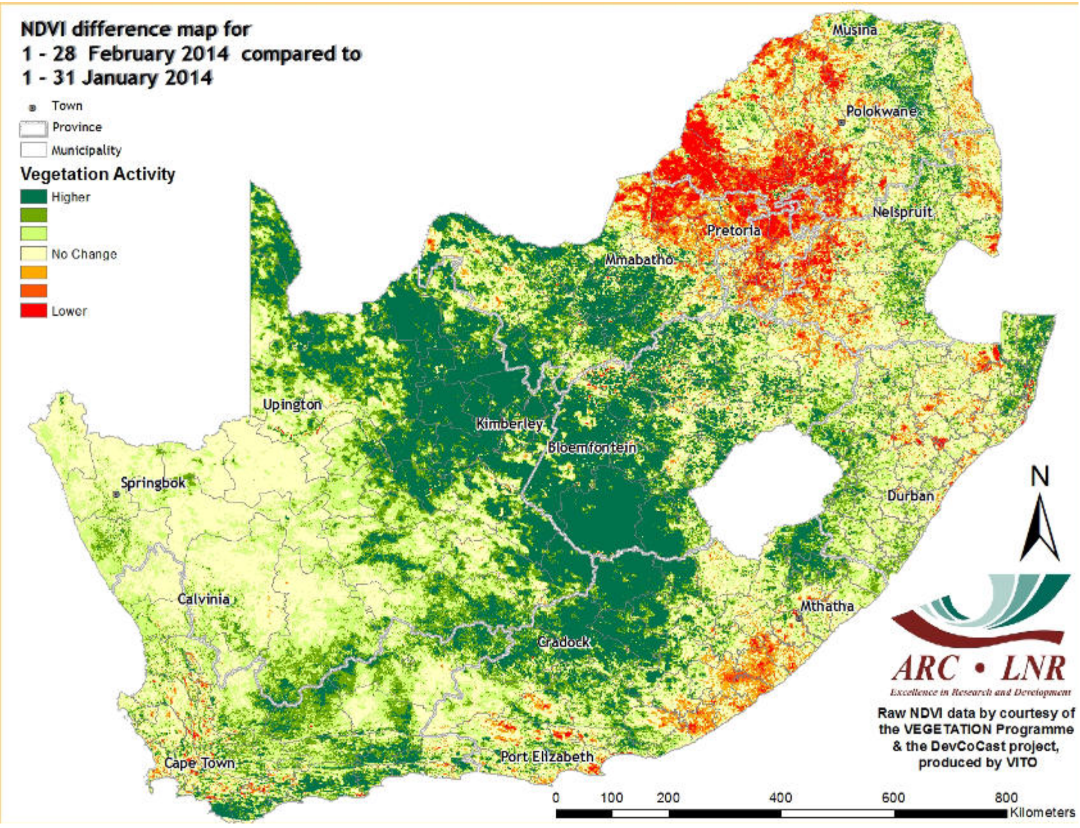

Figure 13

Figure 13:
Vegetation activity has improved over much of the central parts since late January. Activity has decreased over the western parts of Limpopo.

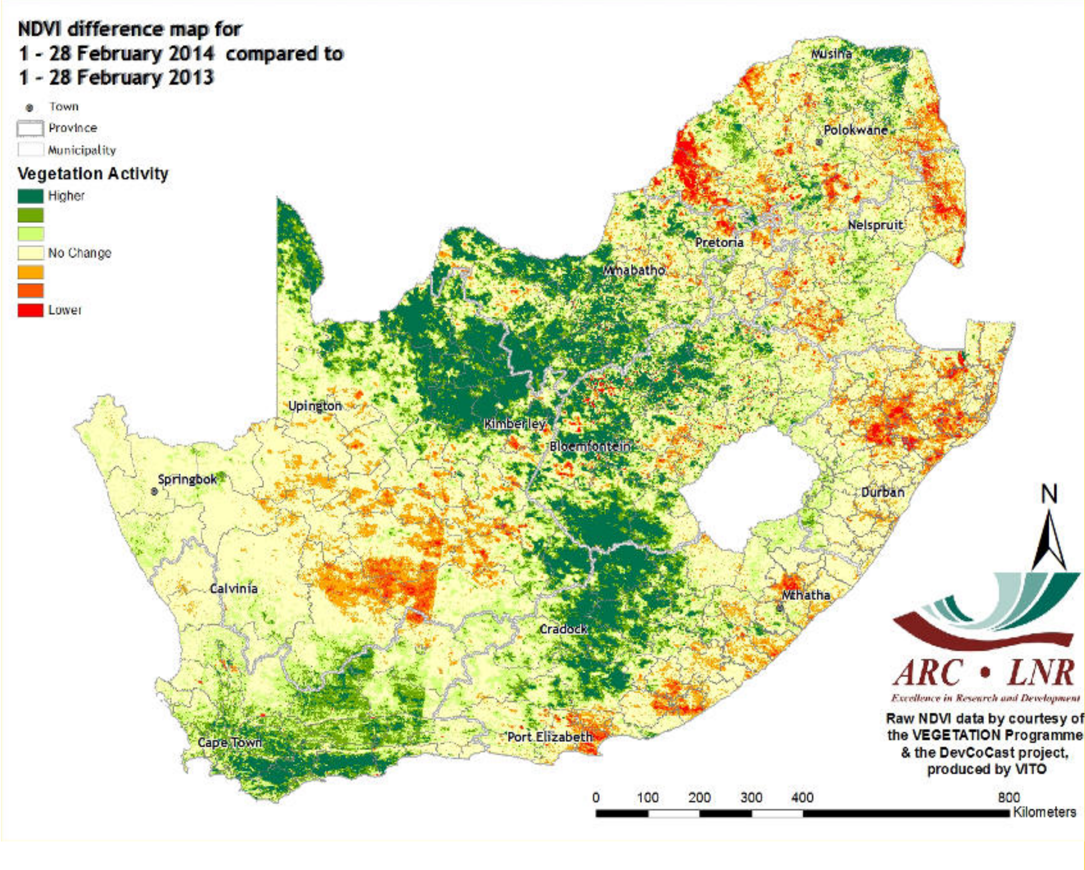

Figure 14

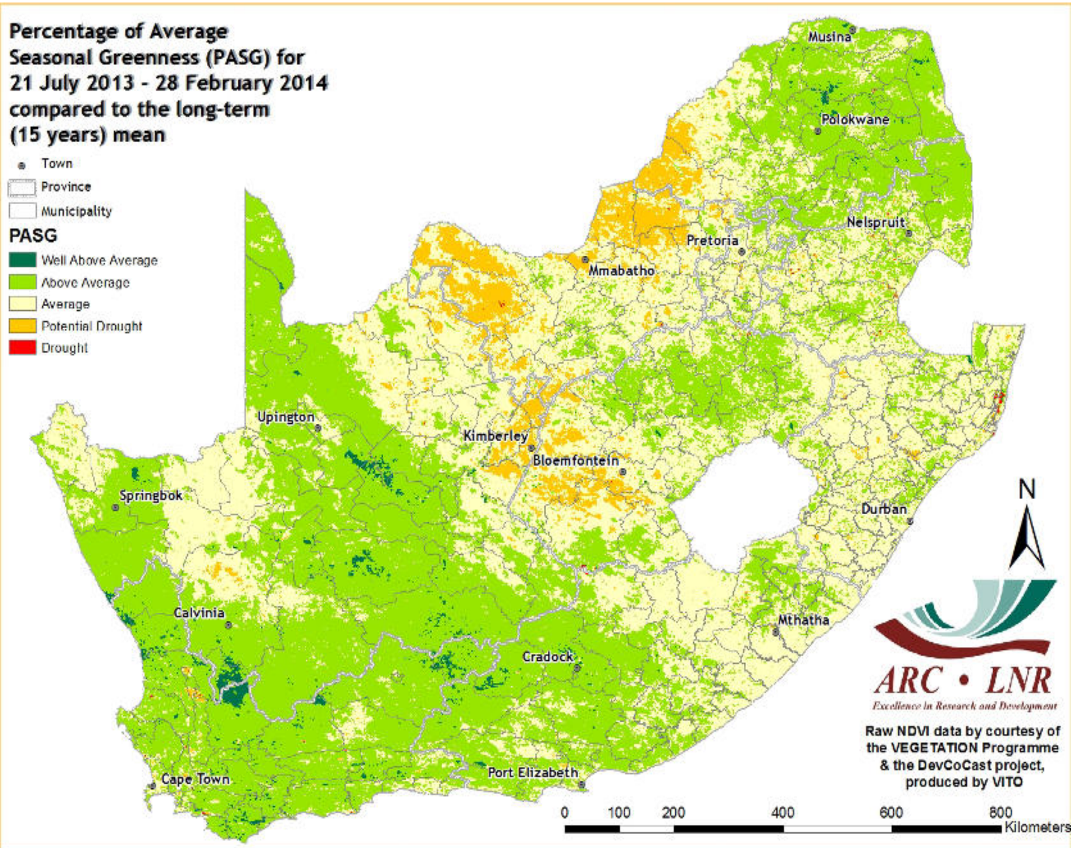

Figure 15

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 which earlier were drought stricken are experiencing higher vegetation activity than during February 2013.

Figure 15:
Considering the entire summer season so far, the effect of drought conditions over much of the central parts on cumulative vegetation activity is still evident in the relatively low PASG values over that region, especially the western North West and southwestern Free State. This is a result of a relatively late start to the rainy season there during the current summer.

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.

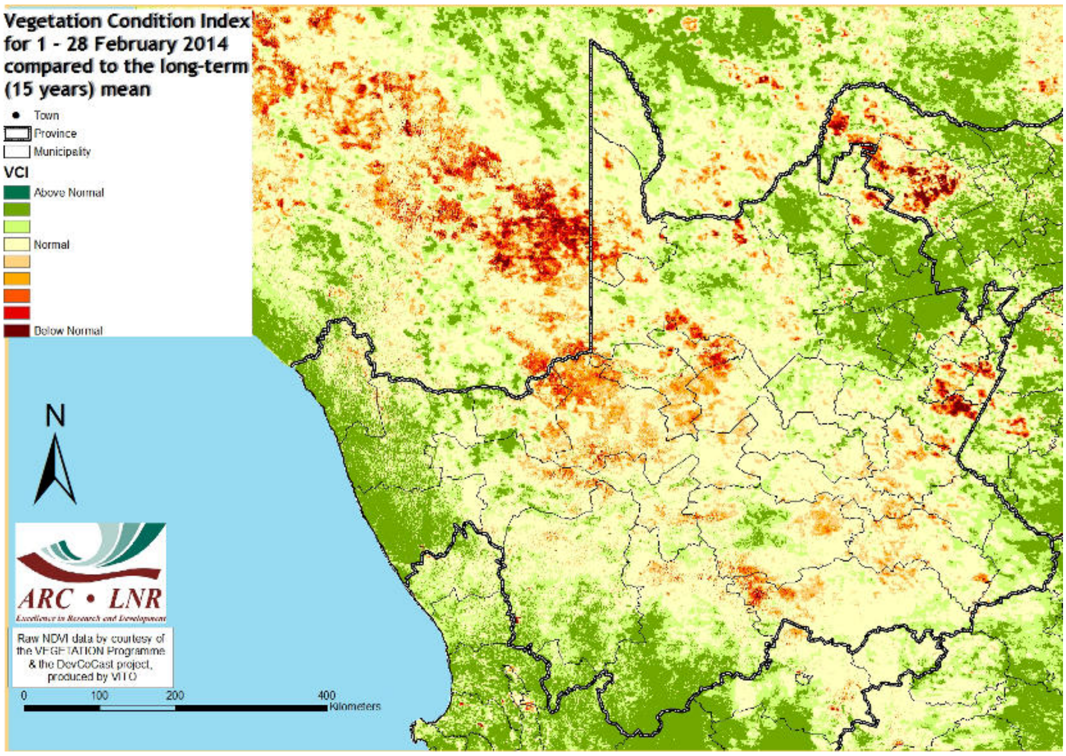


Figure 16

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

Figure 17:
The VCI map for February 2014 indicates below-normal vegetation activity over western parts of the Mpumalanga Province.

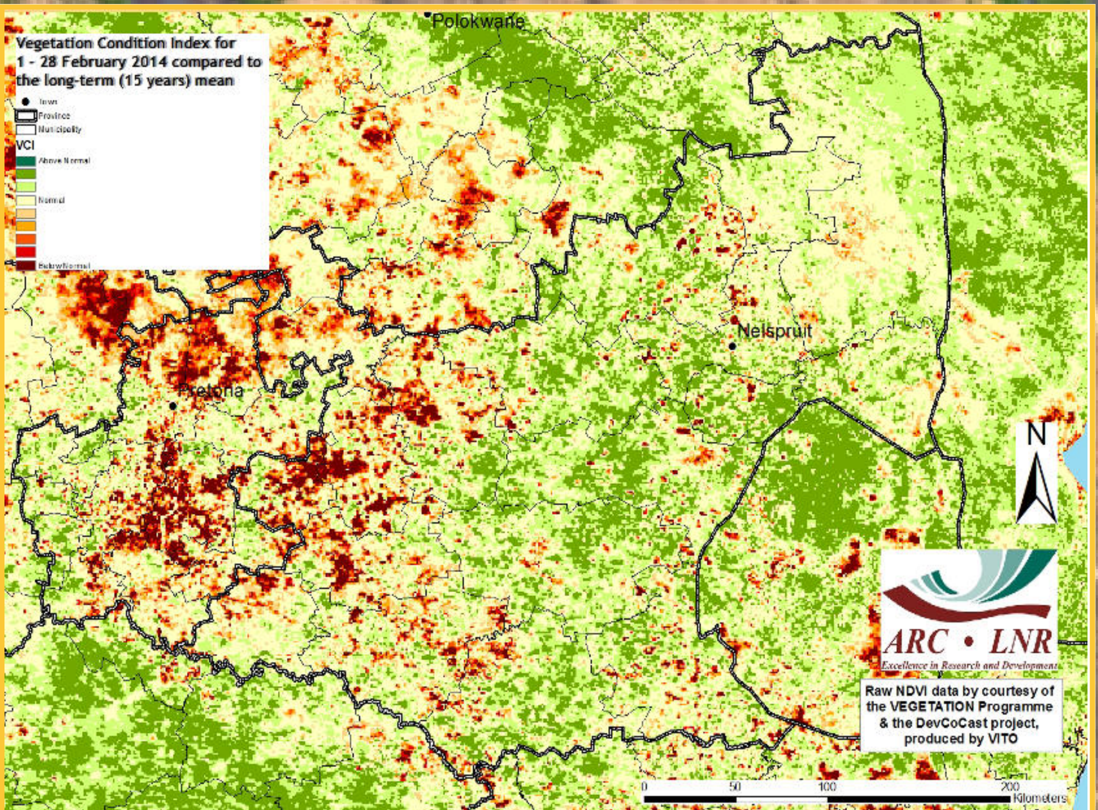
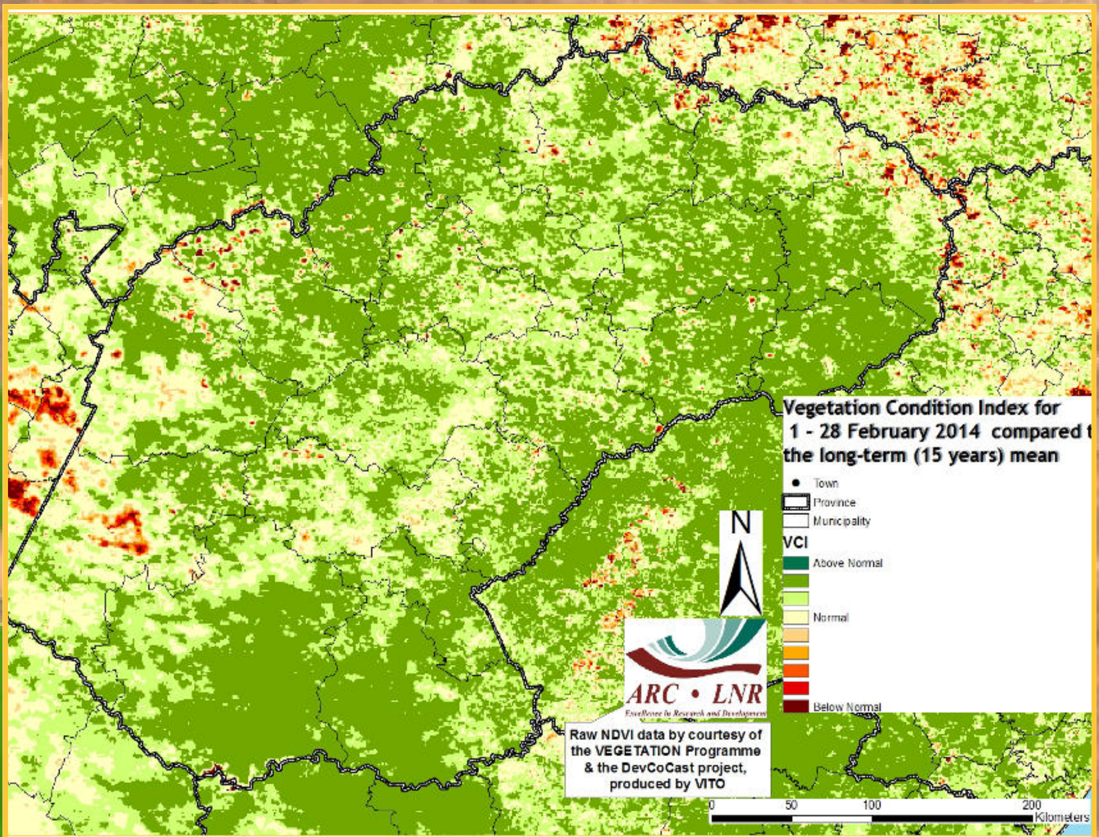


Figure 17



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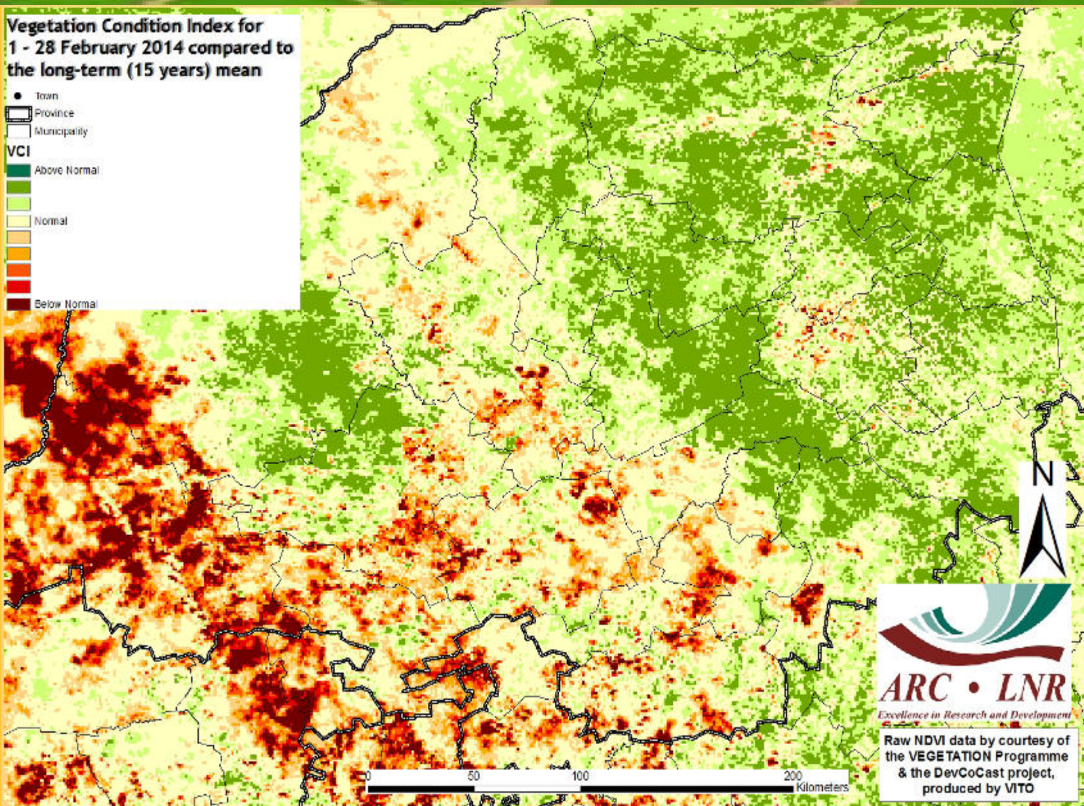

Figure 19

Figure 18:
The VCI map for February 2014 indicates above-normal vegetation activity over most of the Free State Province.

Figure 19:
The VCI map for February 2014 indicates below-normal vegetation activity over the western parts of the Limpopo Province.

Questions/Comments:
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7. Vegetation Conditions & Rainfall

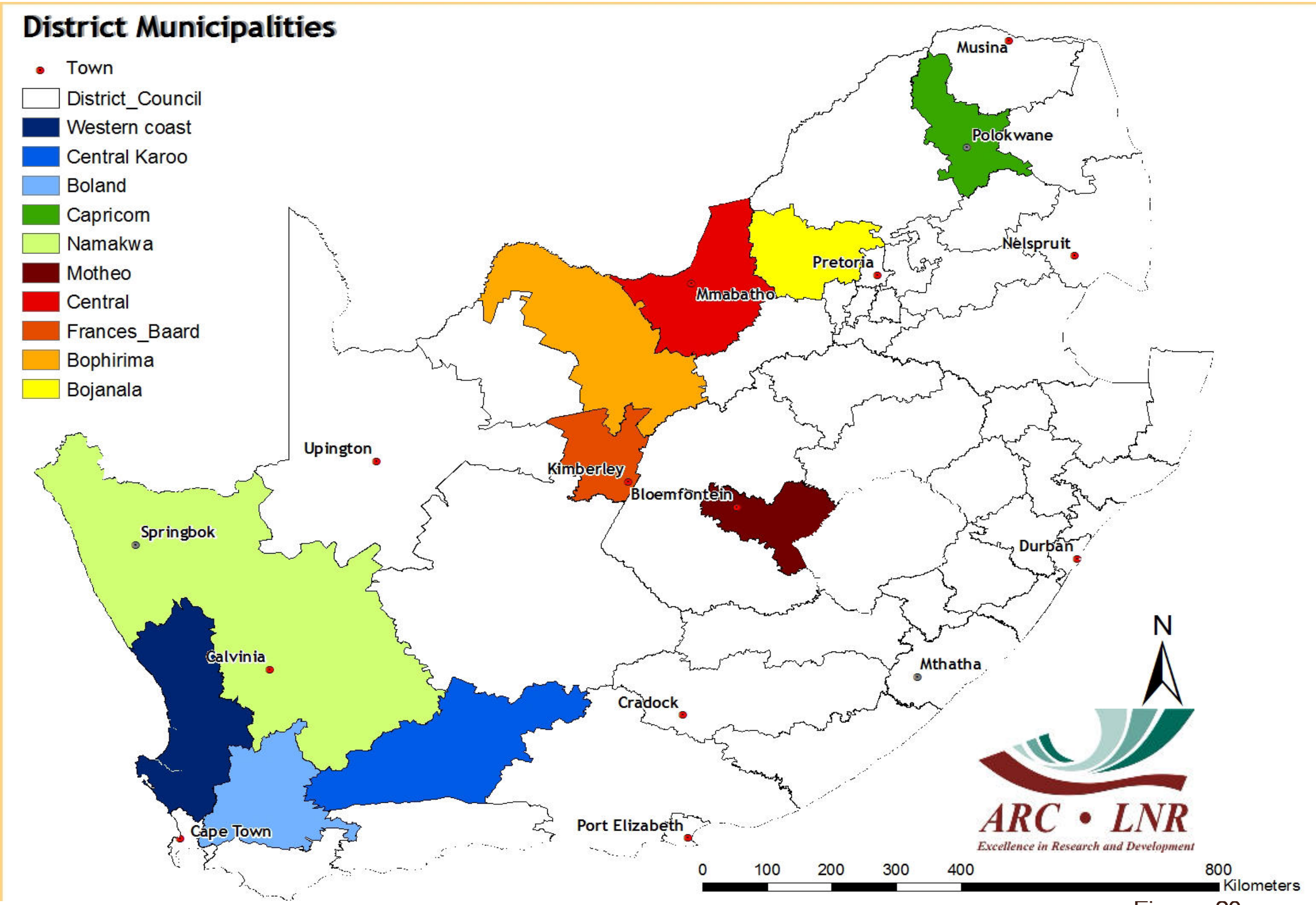


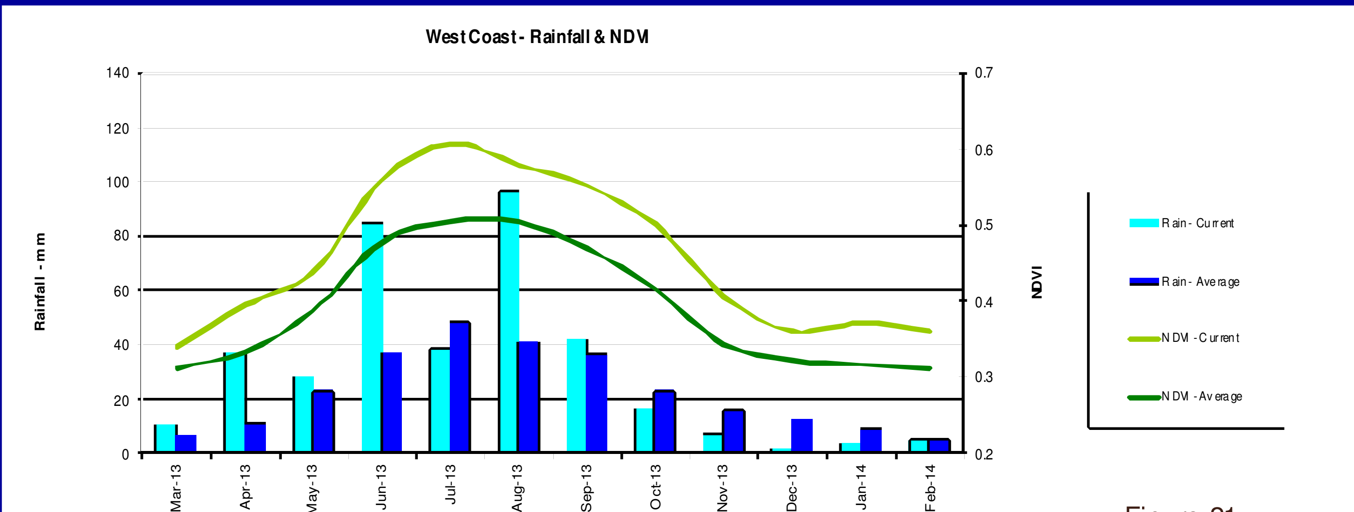
Figure 20

NDVI and Rainfall Graphs
Figure 17:
Orientation map showing the areas of interest for February 2014. 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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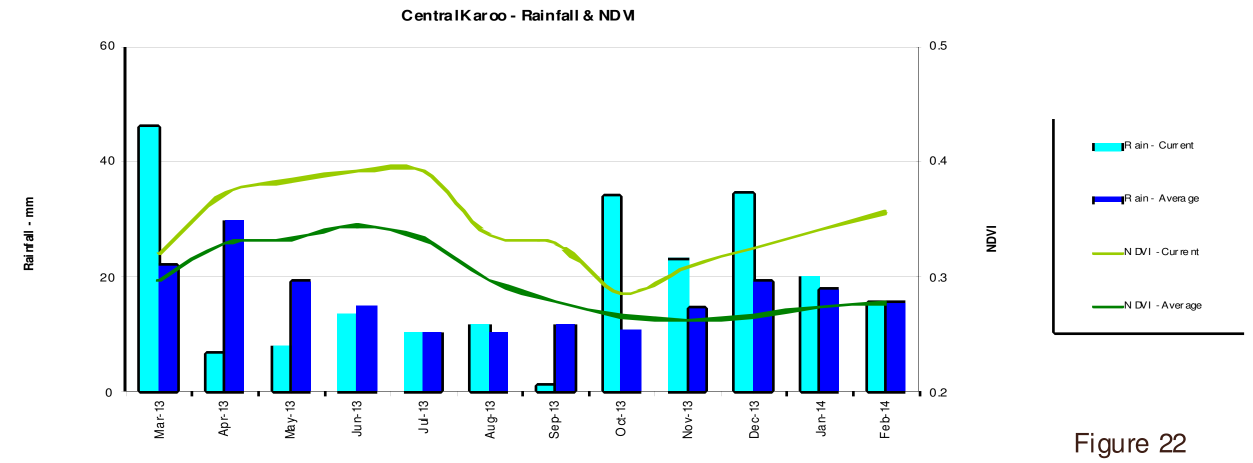

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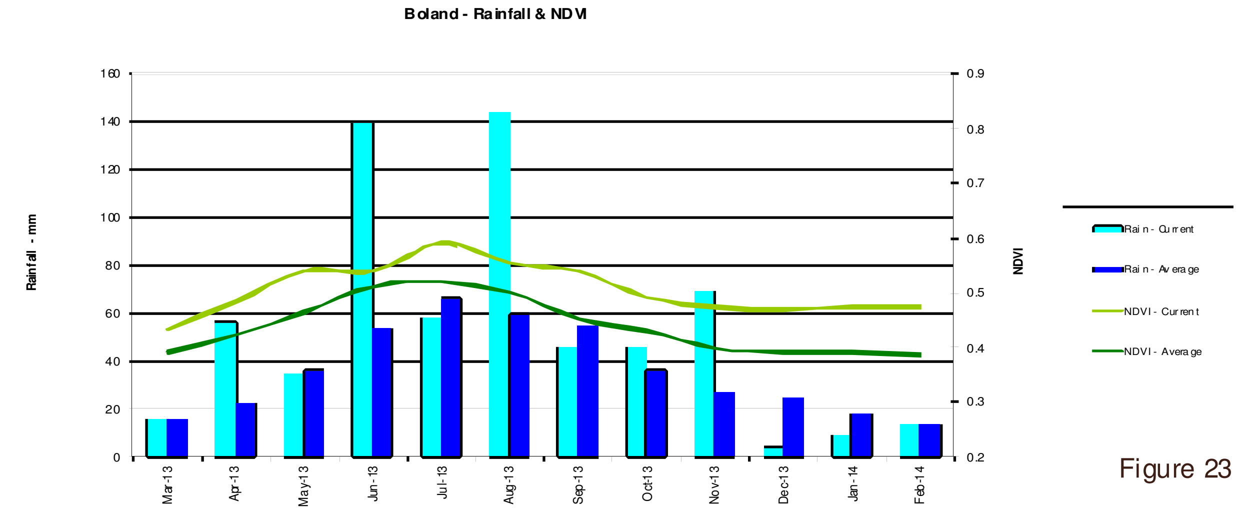

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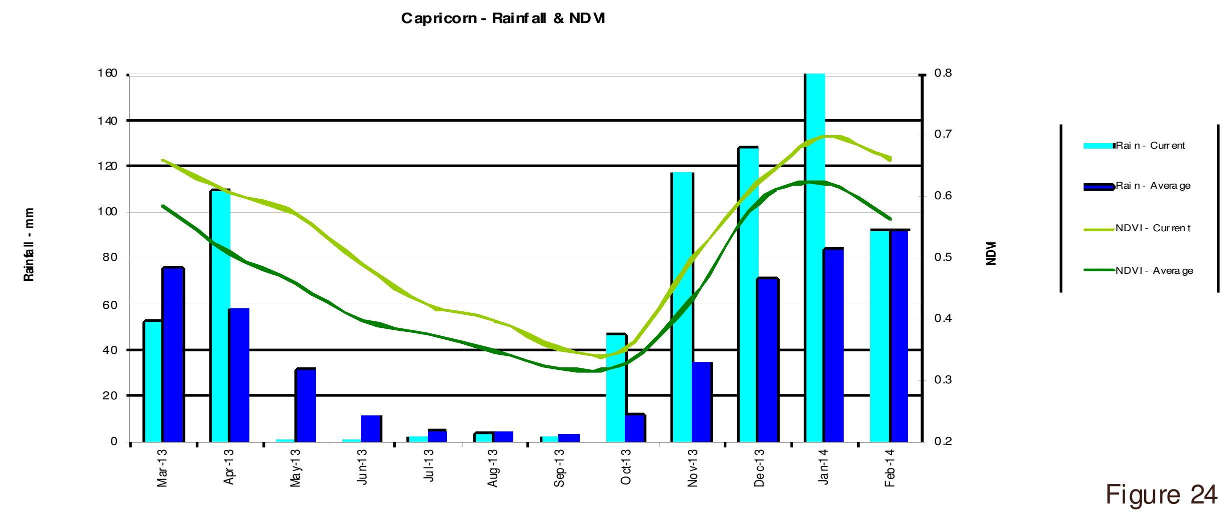

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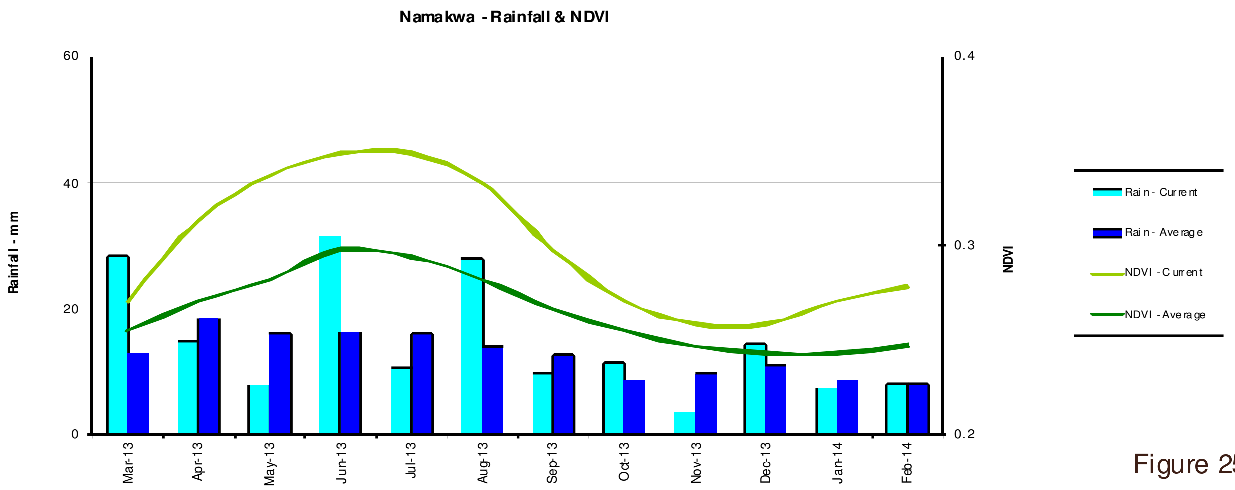

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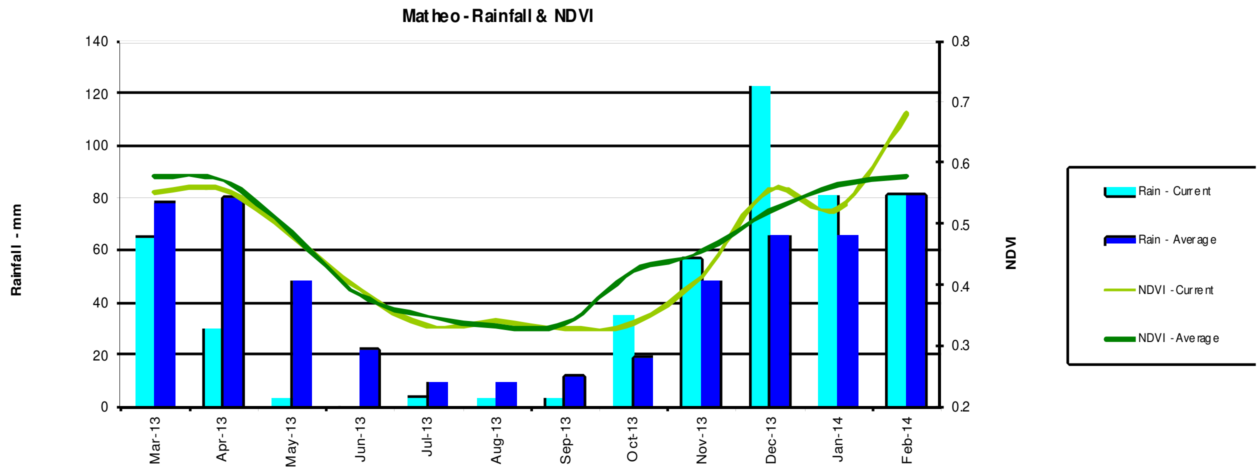

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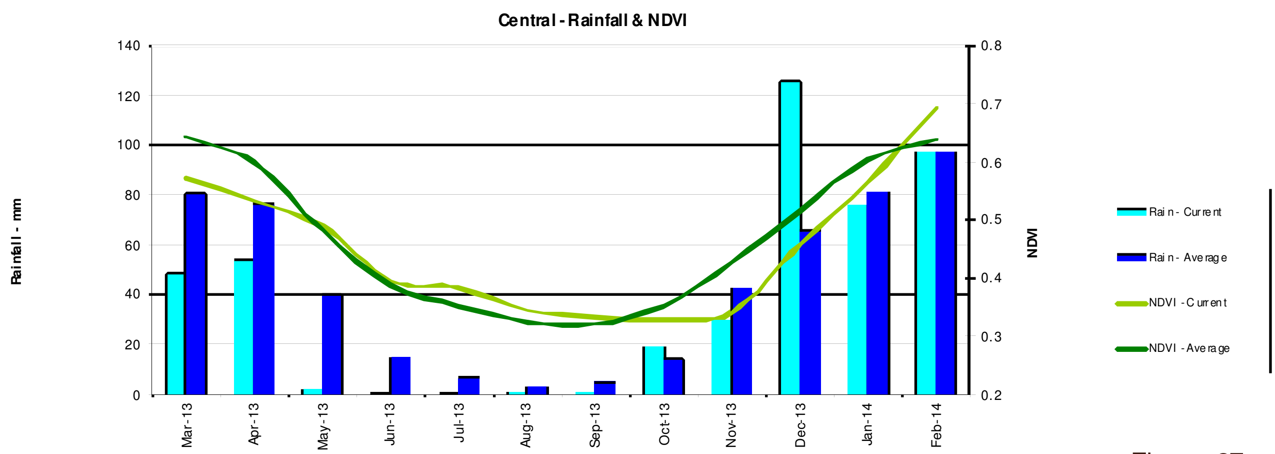

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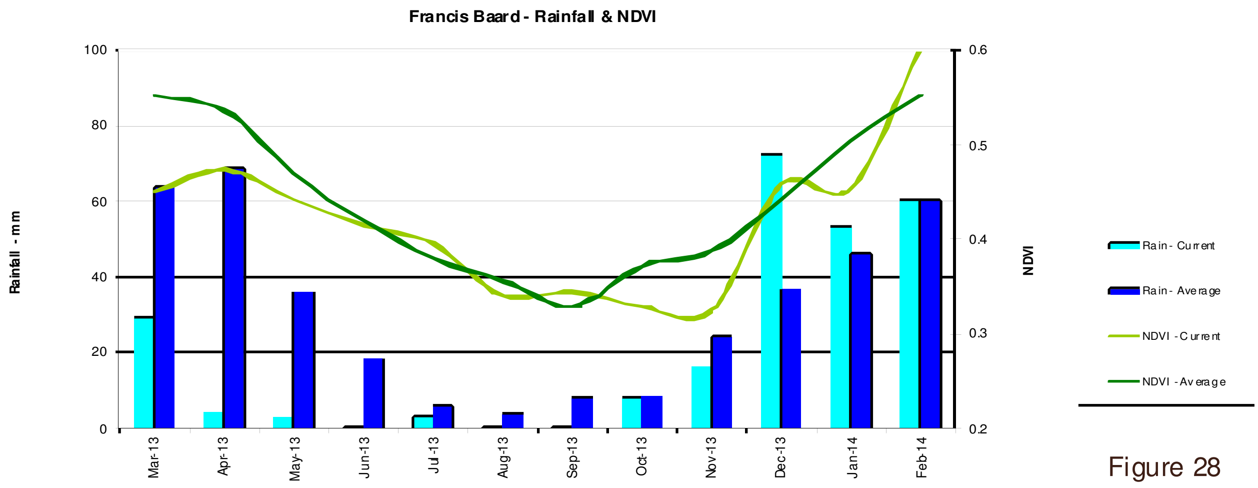

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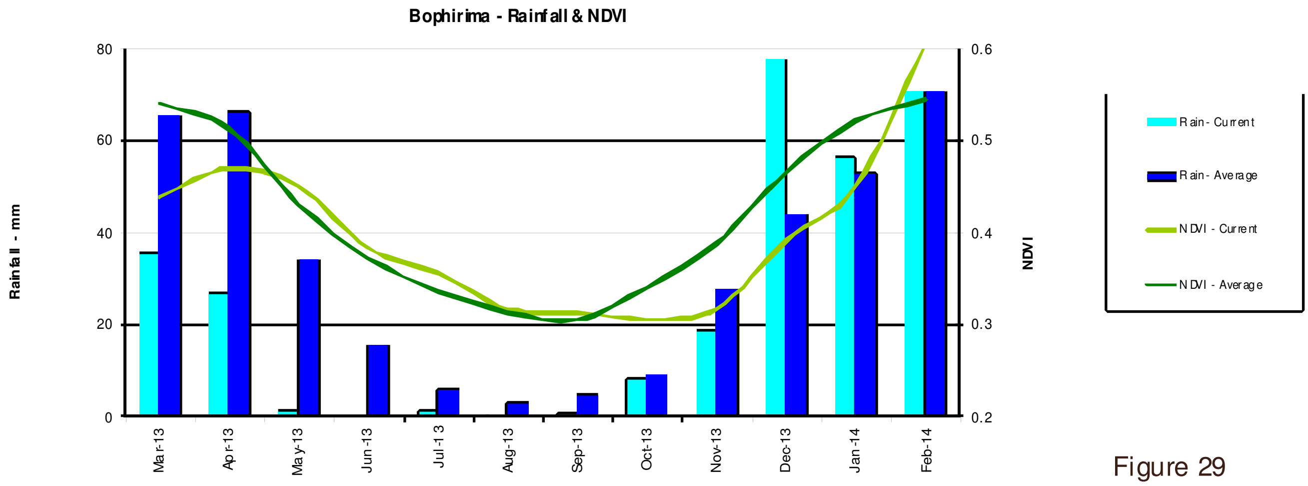

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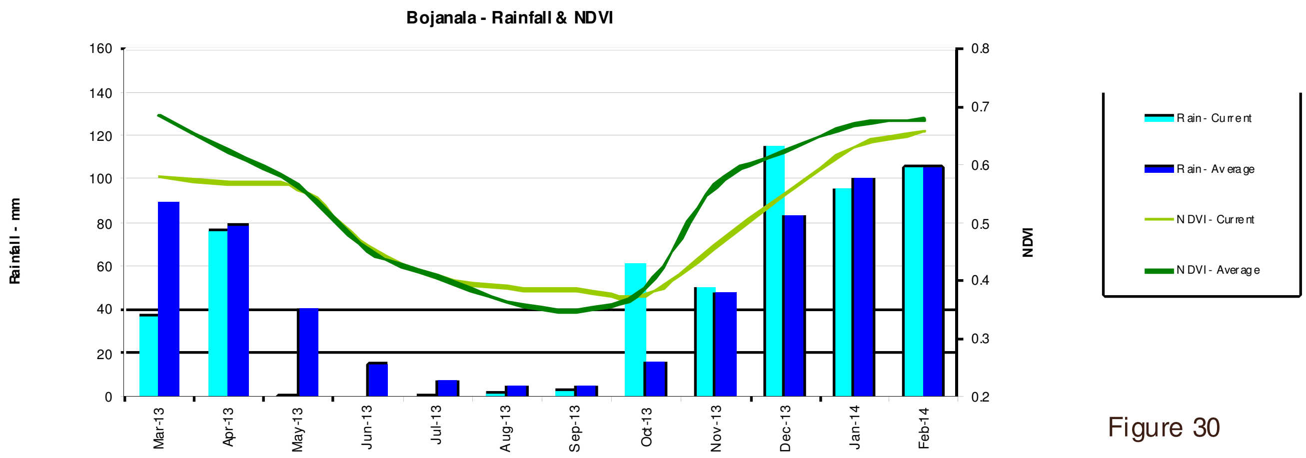

Figure 30

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 between 1-28 February 2014 per province. Fire activity was higher in Mpumalanga and KwaZulu-Natal compared to the average for the same period for the last 13 years.

Figure 32:
The map shows the location of active fires detected between 1-28 February 2014.

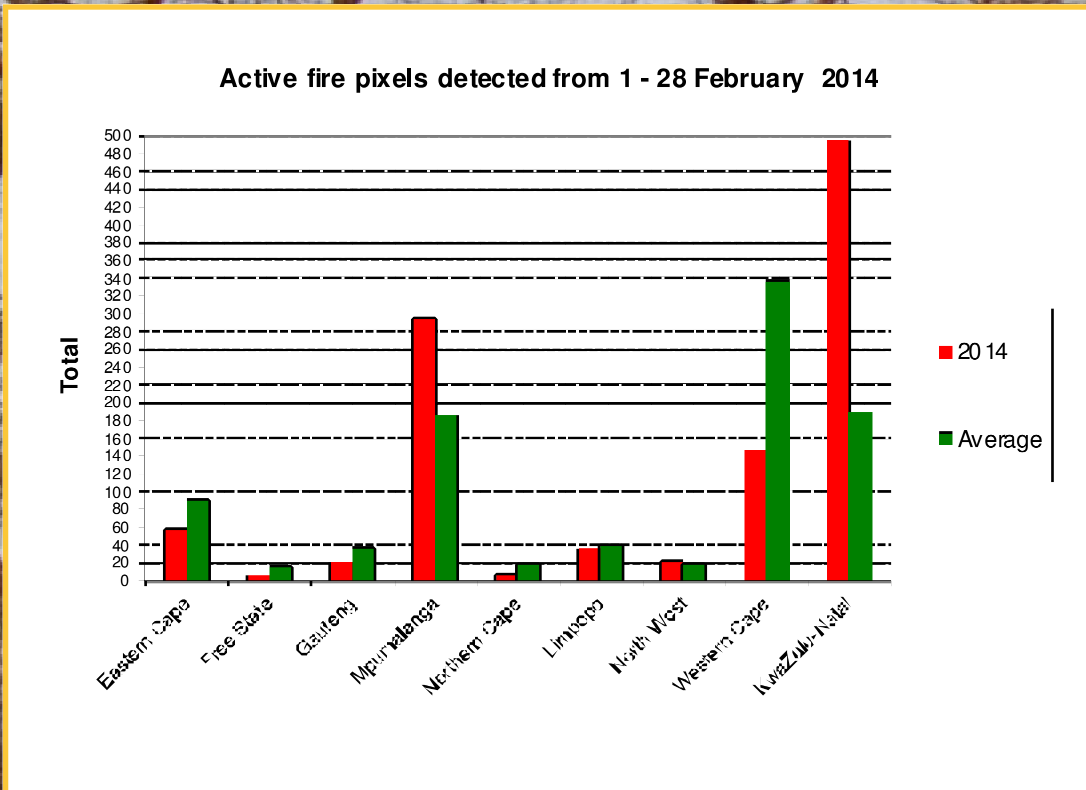

Figure 31

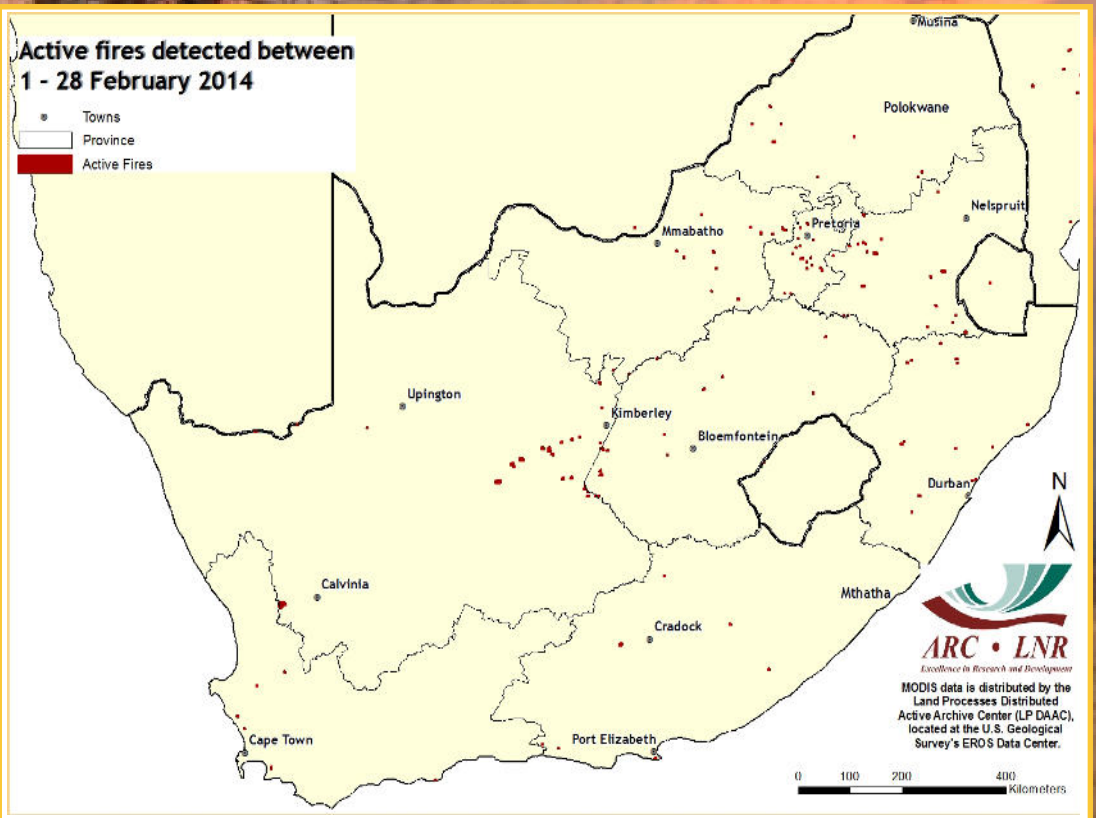

Figure 32

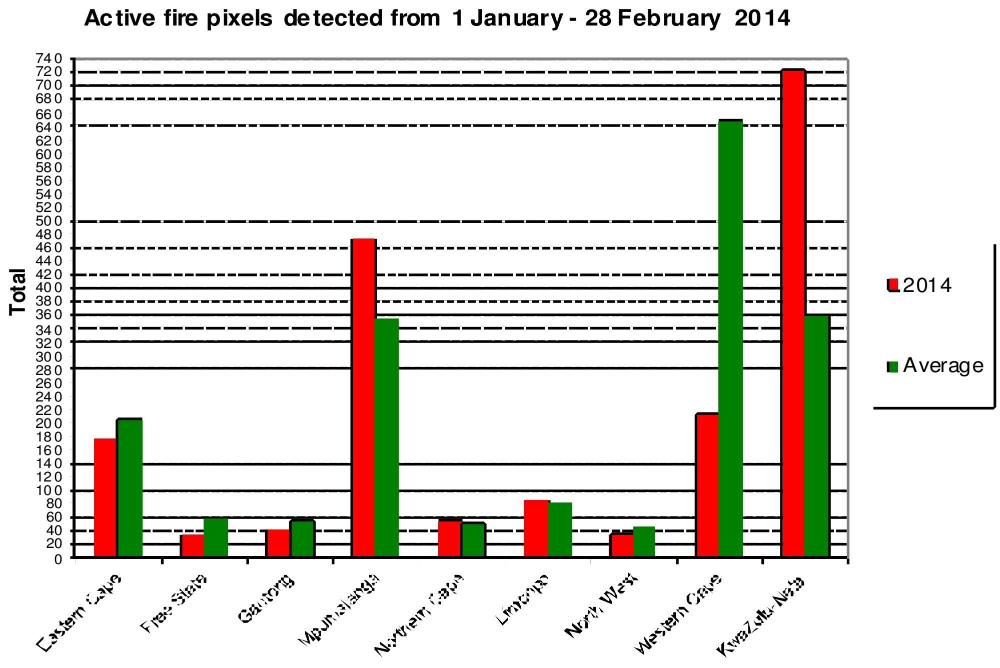

Figure 33

Figure 33:
The graph shows the total number of active fires detected between 1 January to 28 February 2014 per province. Fire activity was higher in Mpumalanga, Northern Cape, Limpopo and KwaZulu-Natal compared to the average for the same period for the last 13 years.

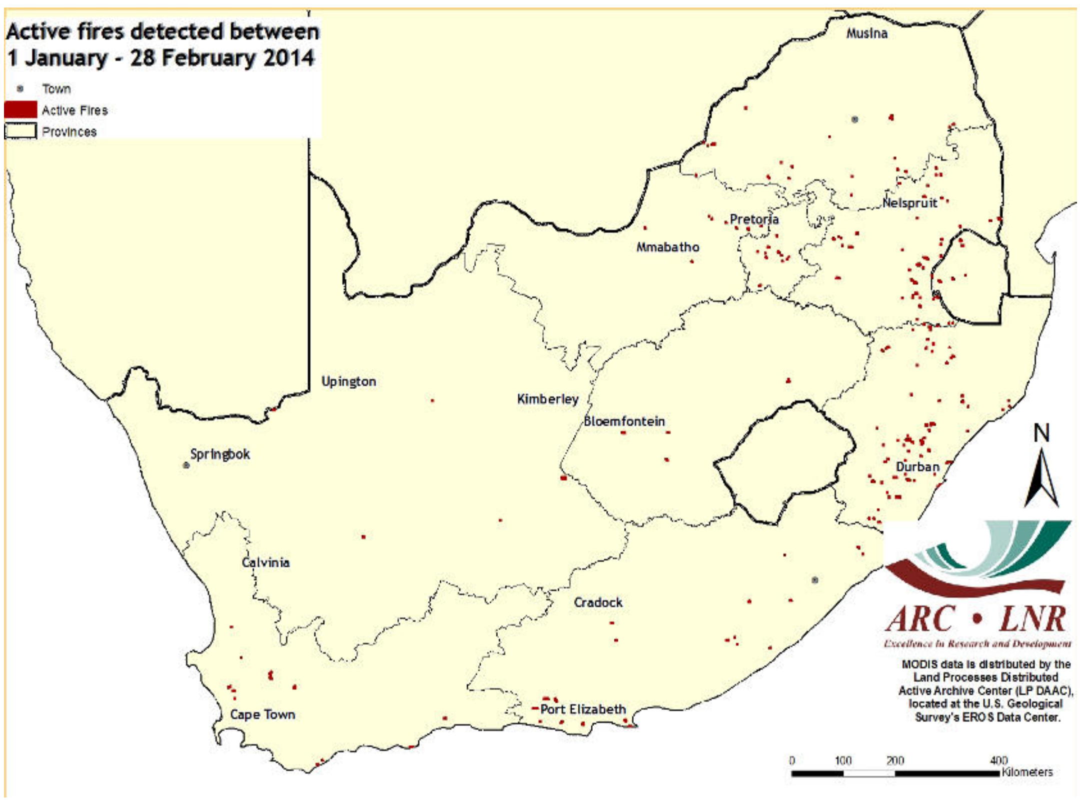

Figure 34

Figure 34:
The map shows the location of active fires detected between 1 January to 28 February 2014.

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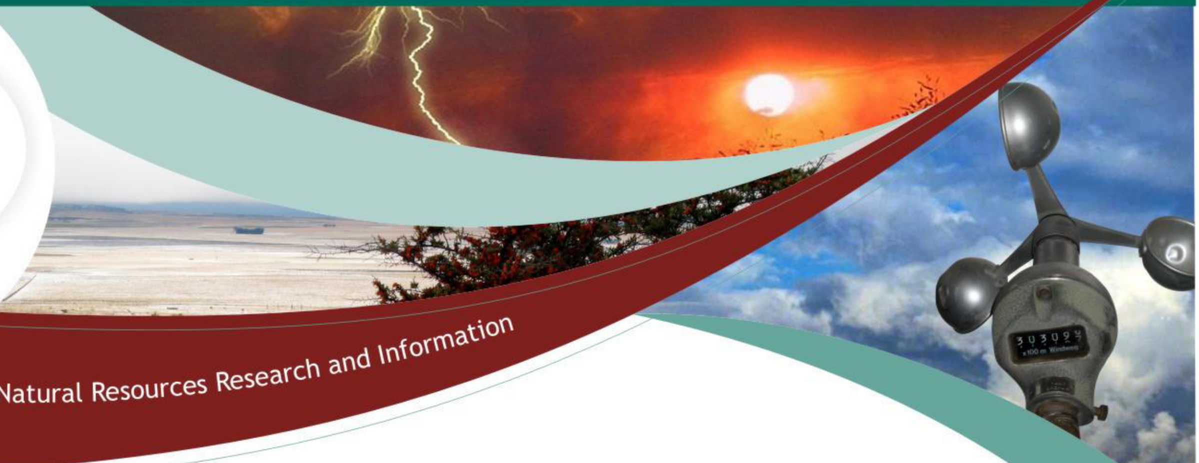

Your Partner in Natural Resources Research and Information

AgroClimatology

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

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

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

Products and Services

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

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

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

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

For more information contact:
Mr. Chris Kaempffer
E-mail: ChrisK@arc.agric.za
Tel: 012 310 2560

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 is 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 m² to 1 km²) 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 v5 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 South African Weather Service (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