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

# UMLINDI
## The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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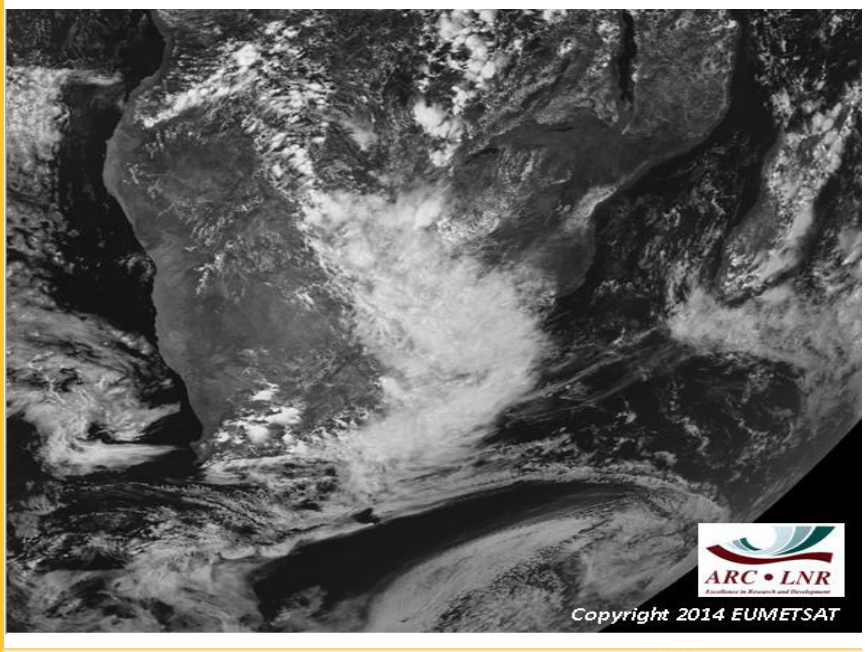
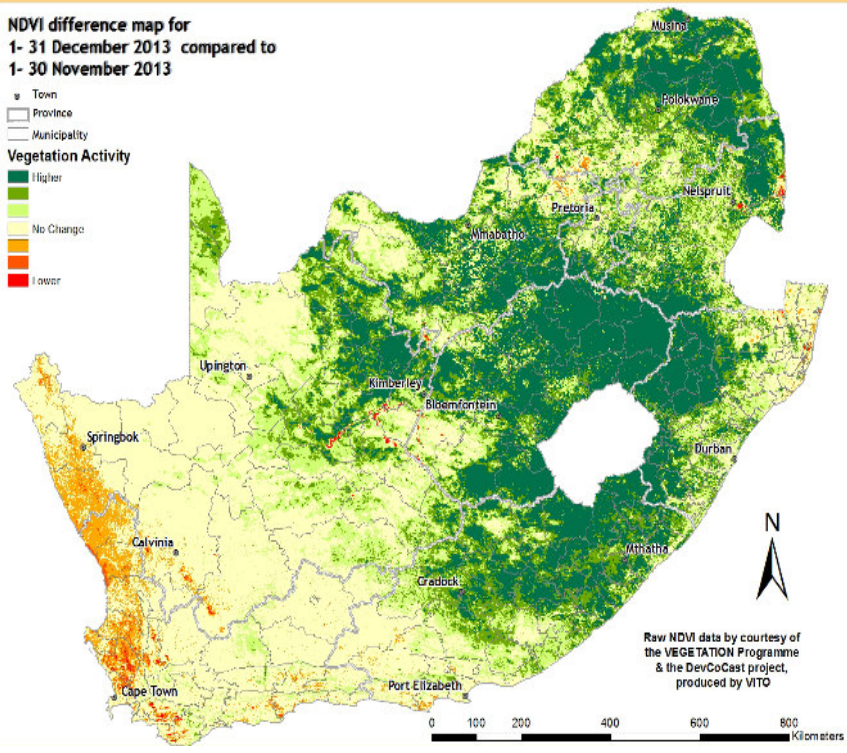
# Image of the Month

## Widespread rain during December brings some relief to the central interior




Widespread rainfall over the central interior in December brought welcome relief to the drought stricken central parts of the country. The most widespread rainfall events occurred around the 10th and again during the last few days of the month. The satellite image is from MSG 3 for the visible (red) band at 14:00 SAST on the 10th. On this day and the day before, overcast conditions and general rain occurred over most of the central and eastern parts as large amounts of tropical moist air were in circulation.

Much of the North West Province and surrounding areas received 100-200% of the long-term average rainfall for December, with some stations in the central parts of the province recording up to 180 mm. Vegetation responded very positively to the rainfall during December, as indicated on the map by the difference in vegetation activity according to the change in NDVI between November and December 2013. The rainfall pattern is, however, still very much a repetition of the situation during 2012/13, when dry conditions were also followed by a wet December, to be replaced by dry conditions settling in from early January over the central parts. At this stage, the same pattern is also emerging with mid-summer drought conditions developing in some areas over the interior. The rainfall situation towards the end of January and into February will be of critical importance in the central parts, where the agricultural sector is under severe pressure due to two consecutive drought years. **Questions/Comments:** *Johan@arc.agric.za*

# 1. Rainfall



***Overview:***

Widespread rain occurred over much of the country during December, also spreading over the central parts where the drought conditions is a source of major concern.

The main rainfall periods were from the 6th to the 13th and again from the 24th to the 30th. During both these periods, large amounts of tropical moist air were present over much of the country, moving in from the north in the region of a tropical low, and drawn southwards by upper air troughs moving across the country. Rainfall over especially the northeastern parts was sometimes the direct result of the interaction between a tropical low over northeastern Botswana and an upper air trough over the central parts of South Africa. Cloudy conditions with general rain occurred during some of the rainy periods over the central to northeastern parts around the 10th and 30th, but most of the precipitation was the result of thunderstorms typical of mid-summer.

While the persistence of cloud cover over the eastern parts of the country kept temperatures normal to below-normal in that region, maximum temperatures soared to above 40°C during the early part and again by the end of the month over the northwestern interior.

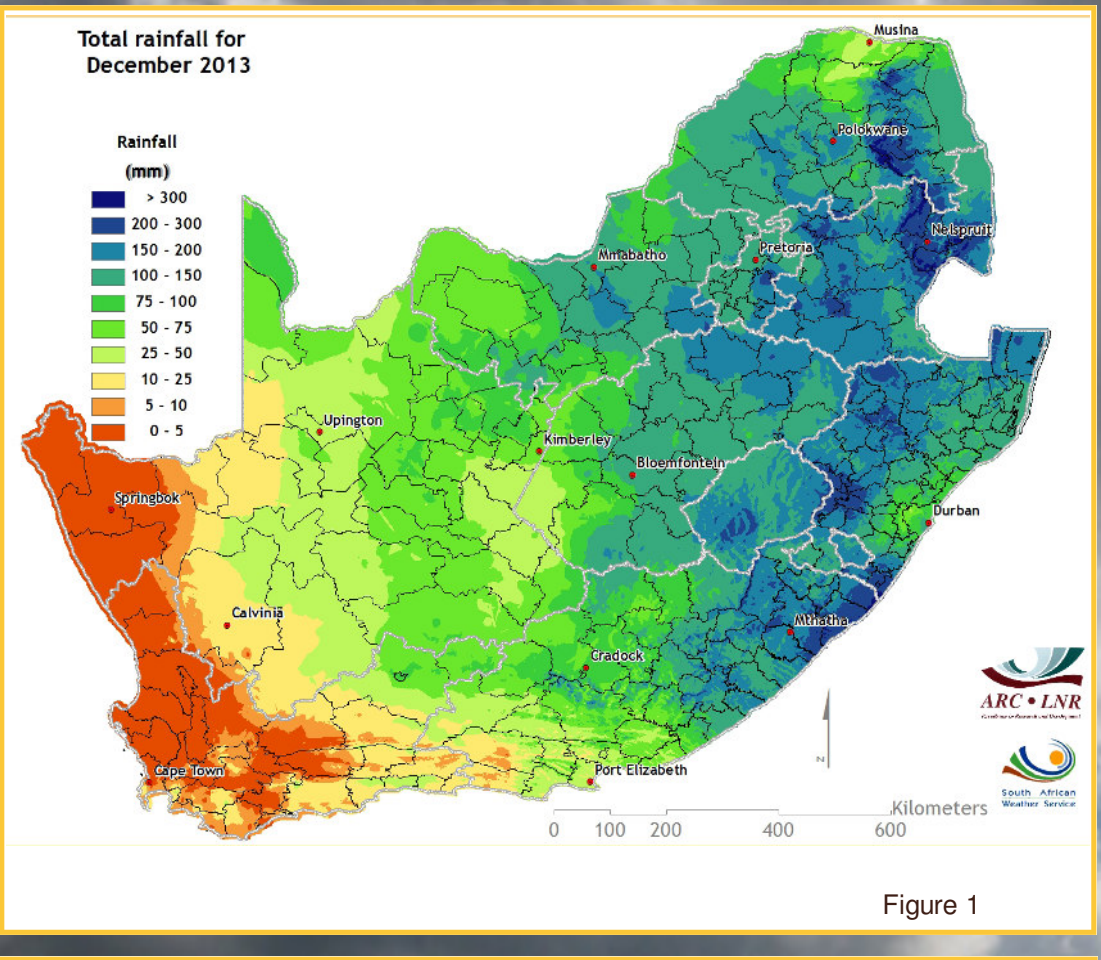



Figure 1

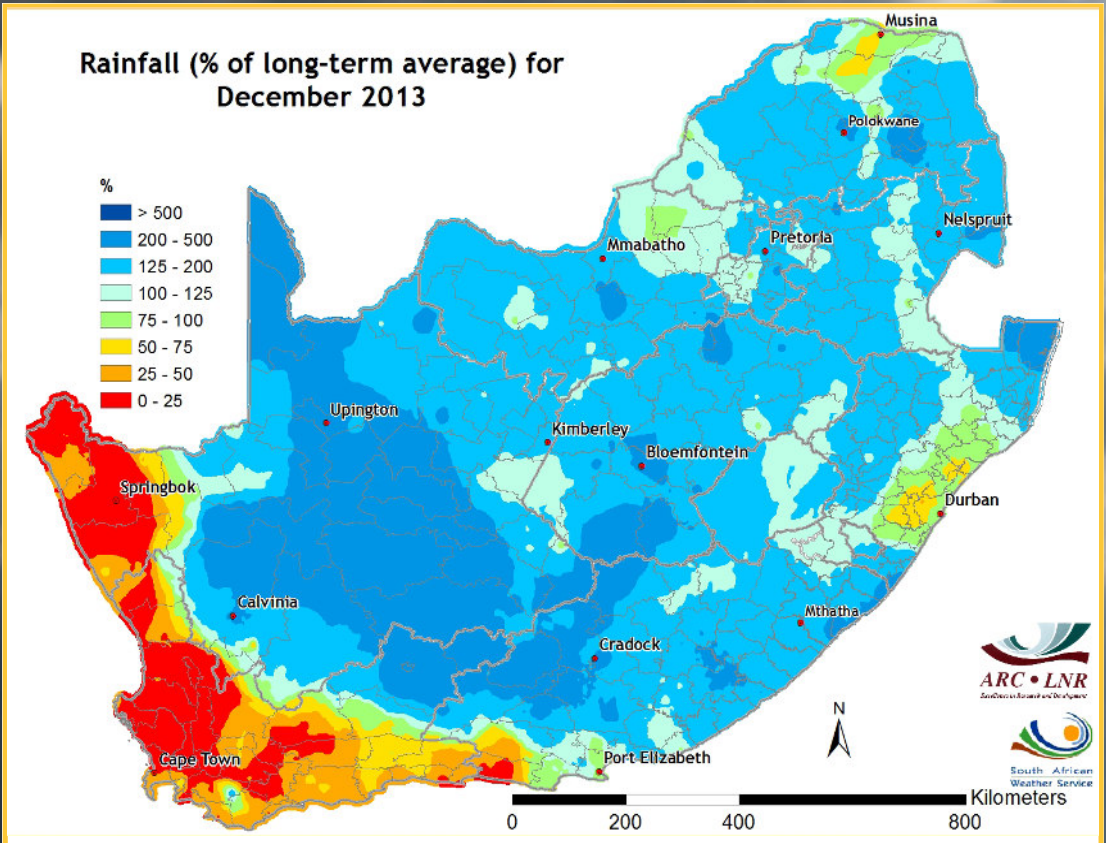



Figure 2

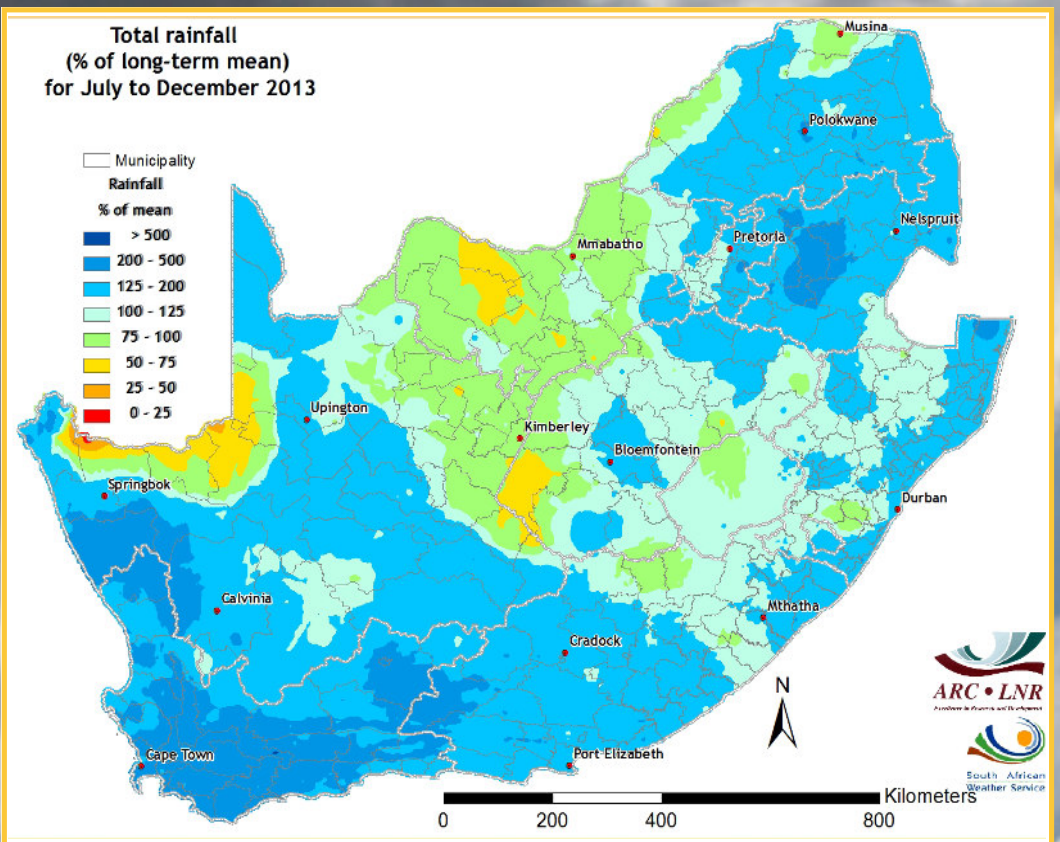



Figure 3

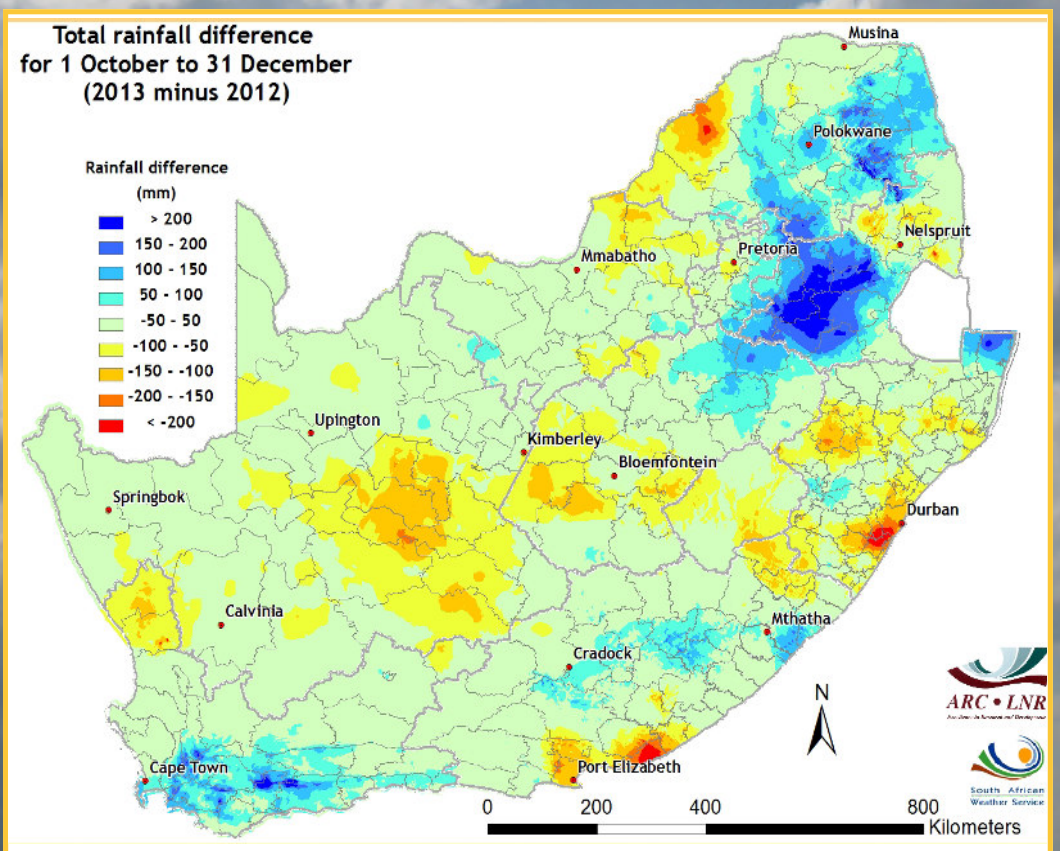



Figure 4

***Figure 1:***
The entire country, except for the western coastal regions and adjacent interior, received rain during December, indicating that rain producing cloud bands developed quite far west for December. Most of the eastern summer rainfall area received in excess of 100 mm in total, with falls exceeding 200 mm over many parts of the escarpment and into the eastern parts of the Eastern Cape. Most of the central areas received between 50 mm and 100 mm.

***Figure 2:***
As expected from the wide distribution of rainfall during the month, rainfall was above normal over almost the entire summer rainfall area and exceeded 200% of the average over the western parts of the region. Below-normal rainfall occurred over the winter rainfall area.

***Figure 3:***
Rainfall since July has been above normal over the western, eastern and northeastern parts of the country, but remains below normal over much of North West and the surrounding area and normal over the central parts despite above-normal rainfall during December.

***Figure 4:***
The southern parts of the winter rainfall area and the northeastern parts of the summer rainfall area received more rain during October-December in 2013 than in 2012. Some areas over the central interior and coastal regions of KwaZulu-Natal and the Eastern Cape received less rain than in 2012.

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

# 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 & 6) indicate that above-normal rainfall during December resulted in higher short-term SPI values with very weak indication of drought conditions. However, on the 12 and 24-month time scale, the extreme drought conditions are still very much in place over parts of the North West Province and surroundings.

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

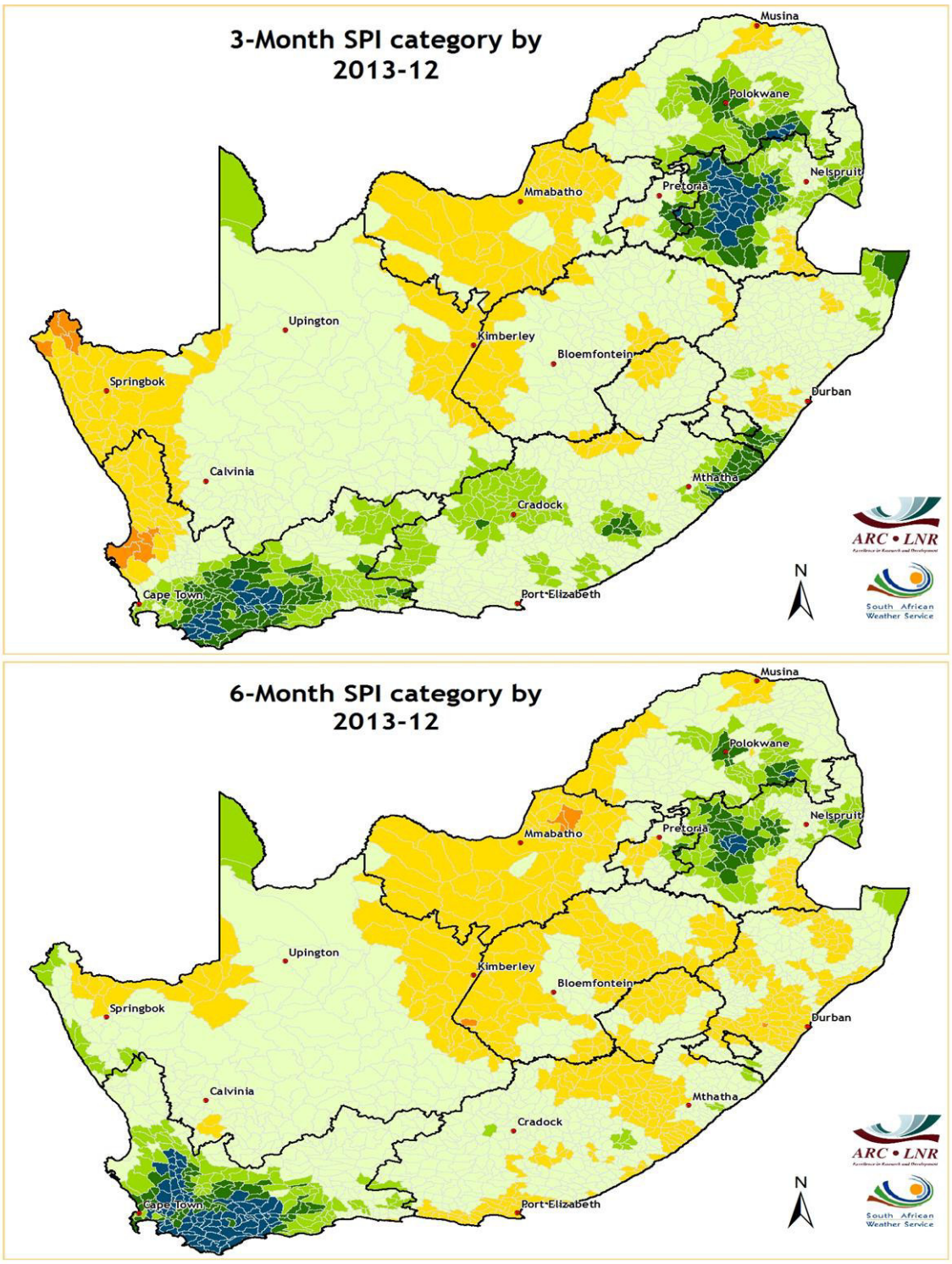
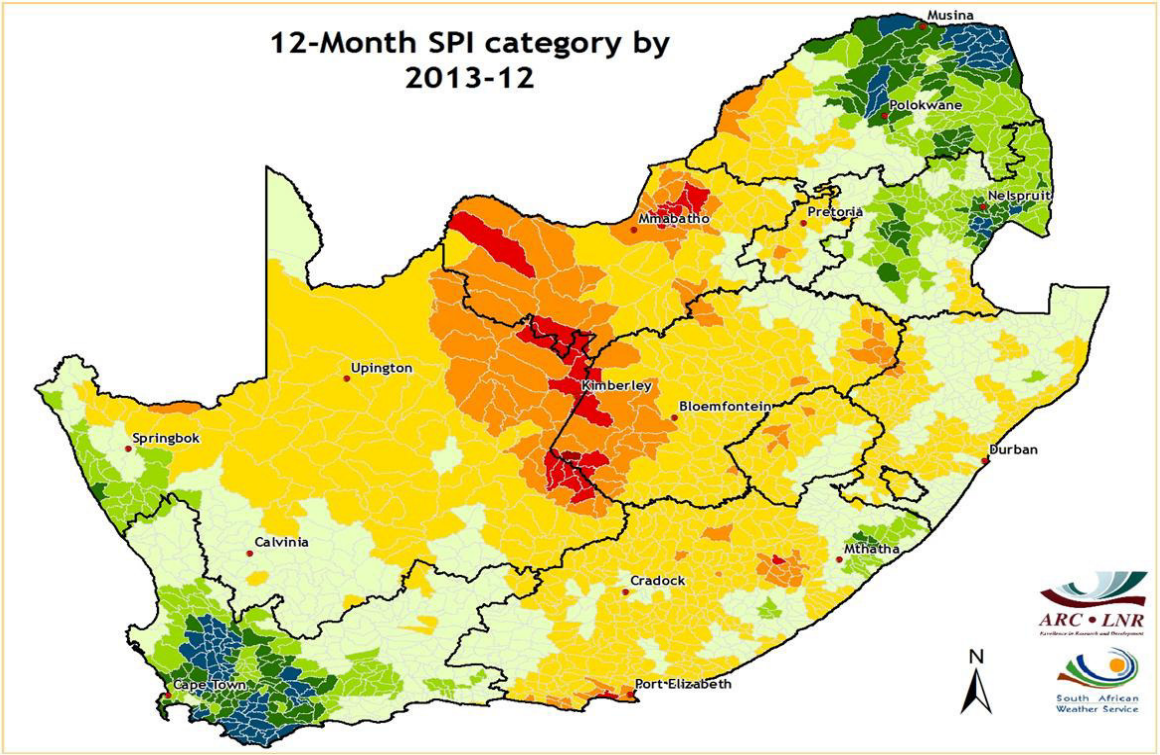
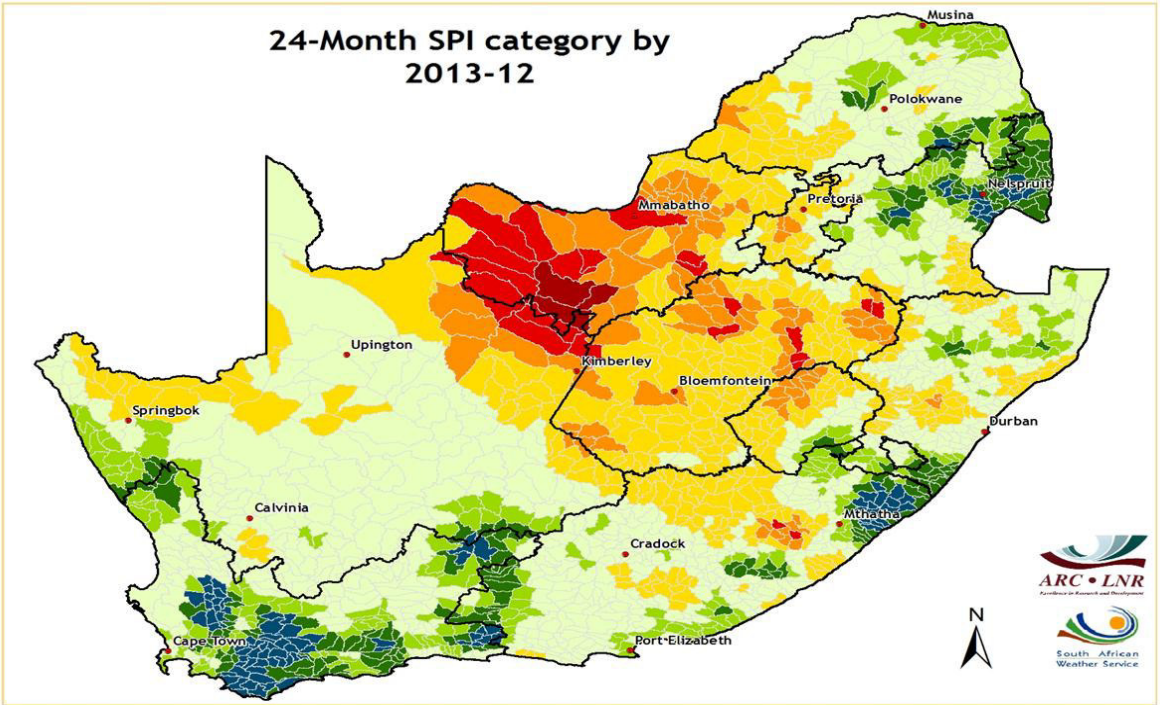



Figure 5


12-Month SPI category by
2013-12
Musina
Polokwane
Nelspruit
Pretoria
Mmabatho
Upington
Kimberley
Bloemfontein
Springbok
Durban
Calvinia
Mthatha
Cradock
Cape Town
Port Elizabeth
N
ARC • LNR
South African Weather Service


24-Month SPI category by
2013-12
Musina
Polokwane
Nelspruit
Pretoria
Mmabatho
Upington
Kimberley
Bloemfontein
Springbok
Durban
Calvinia
Mthatha
Cradock
Cape Town
Port Elizabeth
N
ARC • LNR
South African Weather Service


Legend
Extremely Wet
Moderately Wet
Mild Drought
Severe Drought
Severely Wet
Mildly Wet
Moderate Drought
Extreme Drought

Figure 6

# 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.

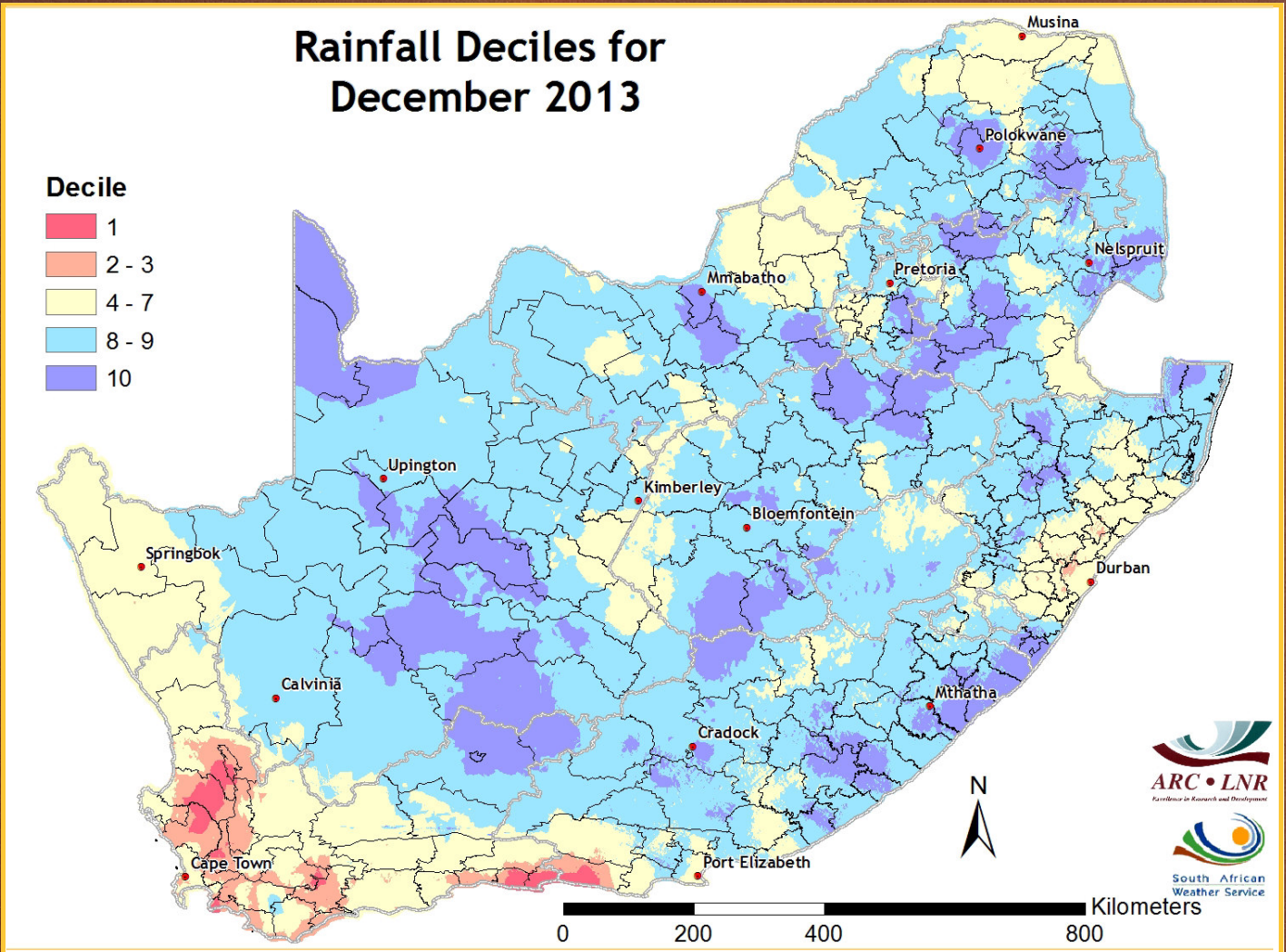



Figure 7

***Figure 7:***
The decile map indicates that December was much wetter over large parts of the summer rainfall area than experienced during most years.

# 4. Water Balance



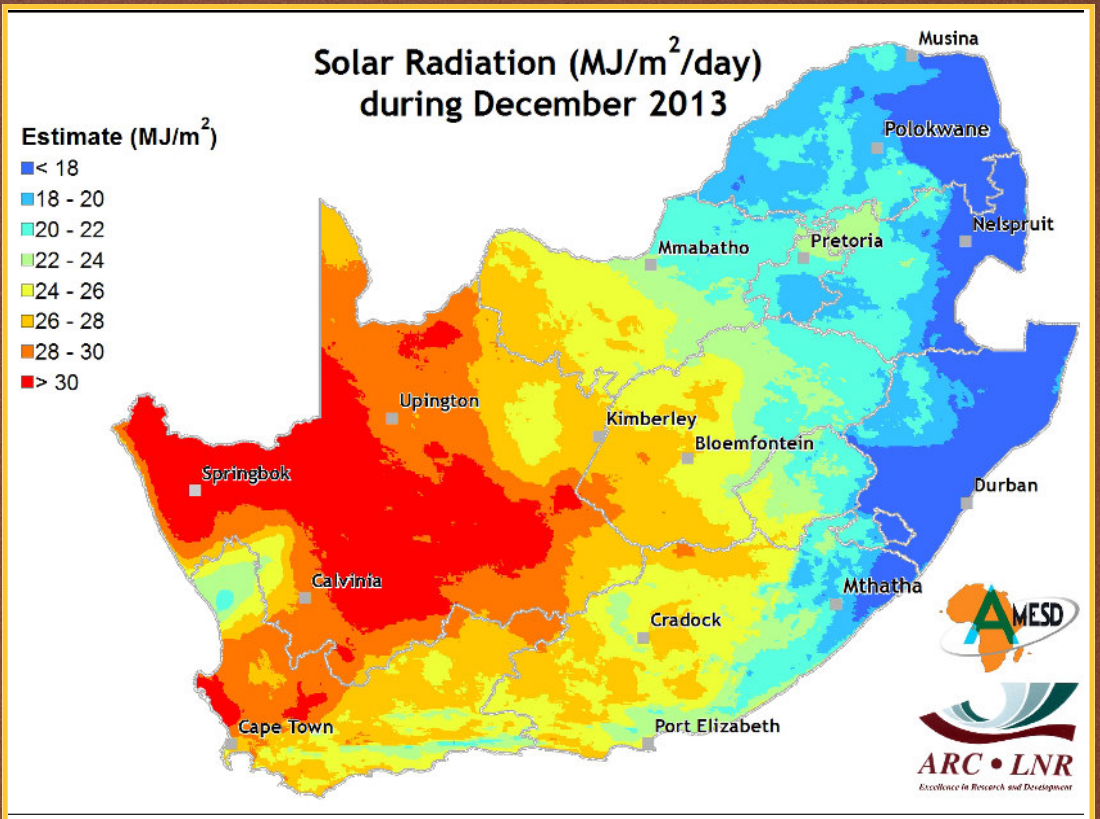



Figure 8a

## 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 8a:***
The persistence of cloudy to partly cloudy weather through much of December kept solar radiation relatively low over the central to eastern parts.

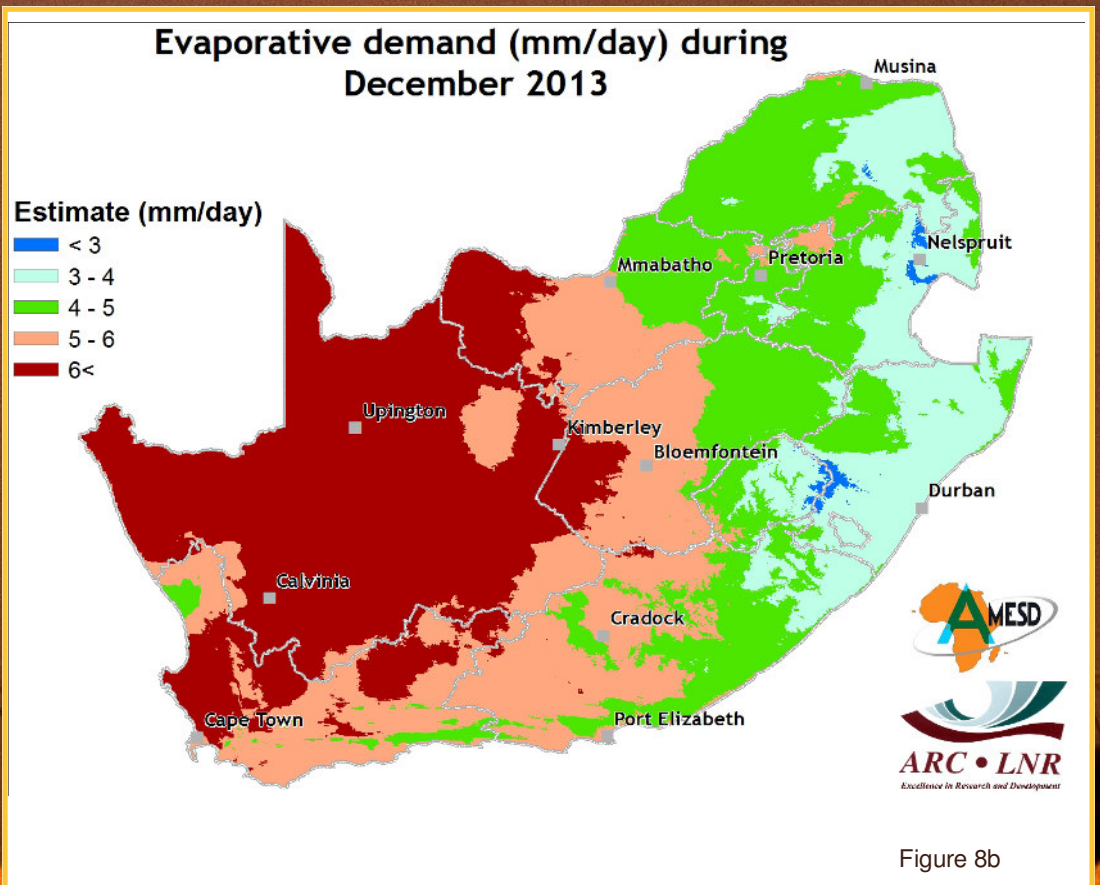



Figure 8b

## 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 8b:***
A lack of sunshine coupled with lower maximum temperatures and high humidity resulted in relatively low potential evapotranspiration over the eastern parts of the country.

**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.

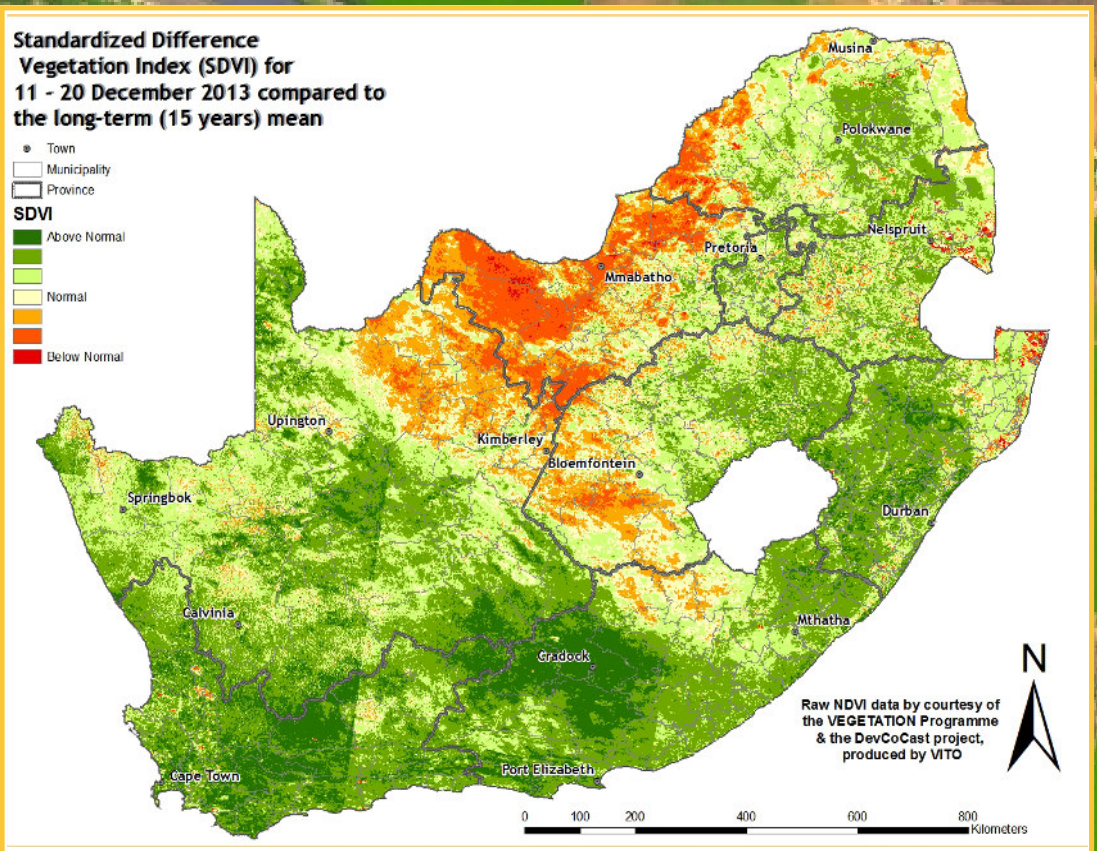



Figure 9

***Figure 9:***
Vegetation activity during December was above normal over the western and northeastern parts of the country, but remained below normal over the central areas.

***Figure 10:***
Vegetation activity over much of the southern parts of the country is higher than in December 2012. Activity over much of the central and northern interior is lower than a year ago.

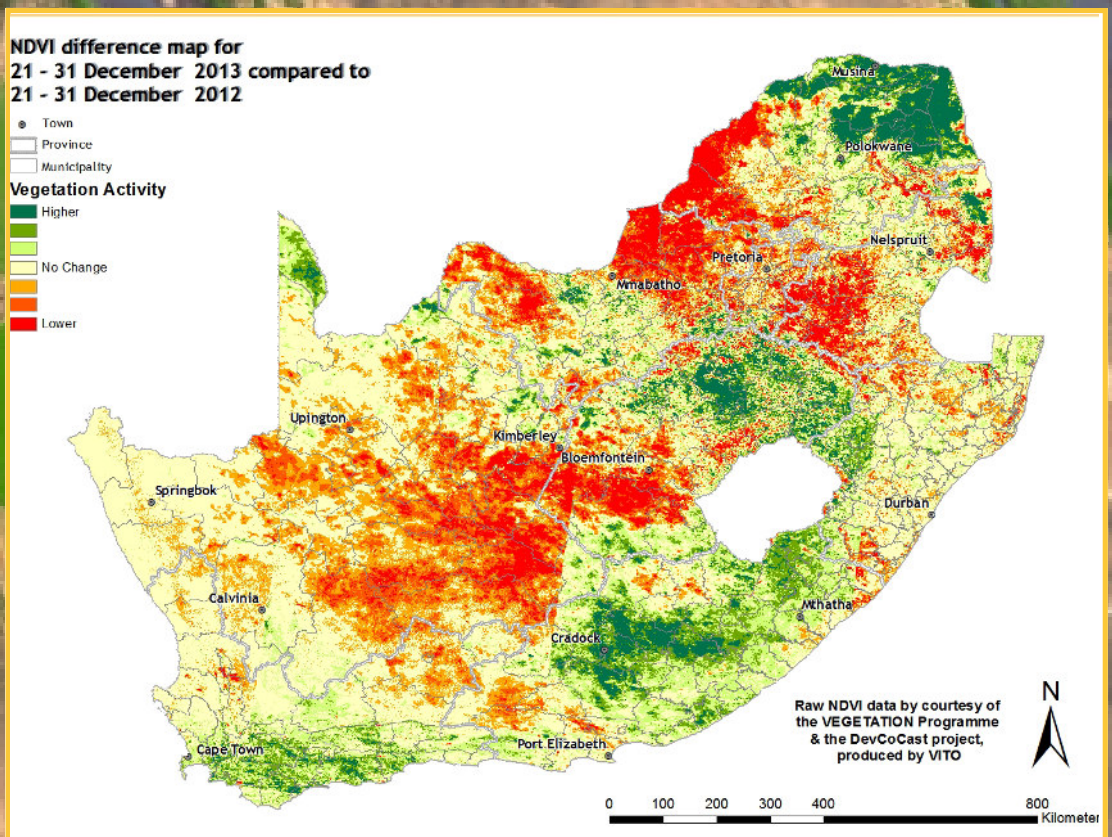



Figure 10

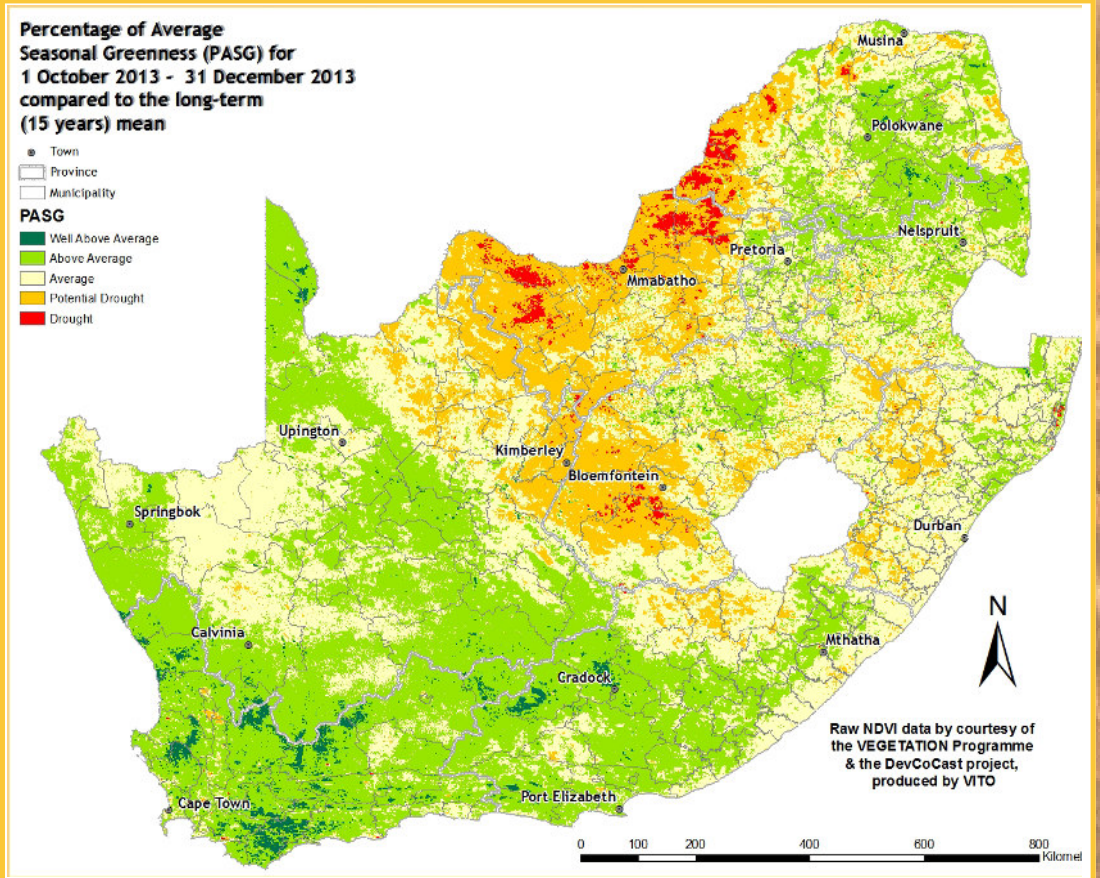



Figure 11

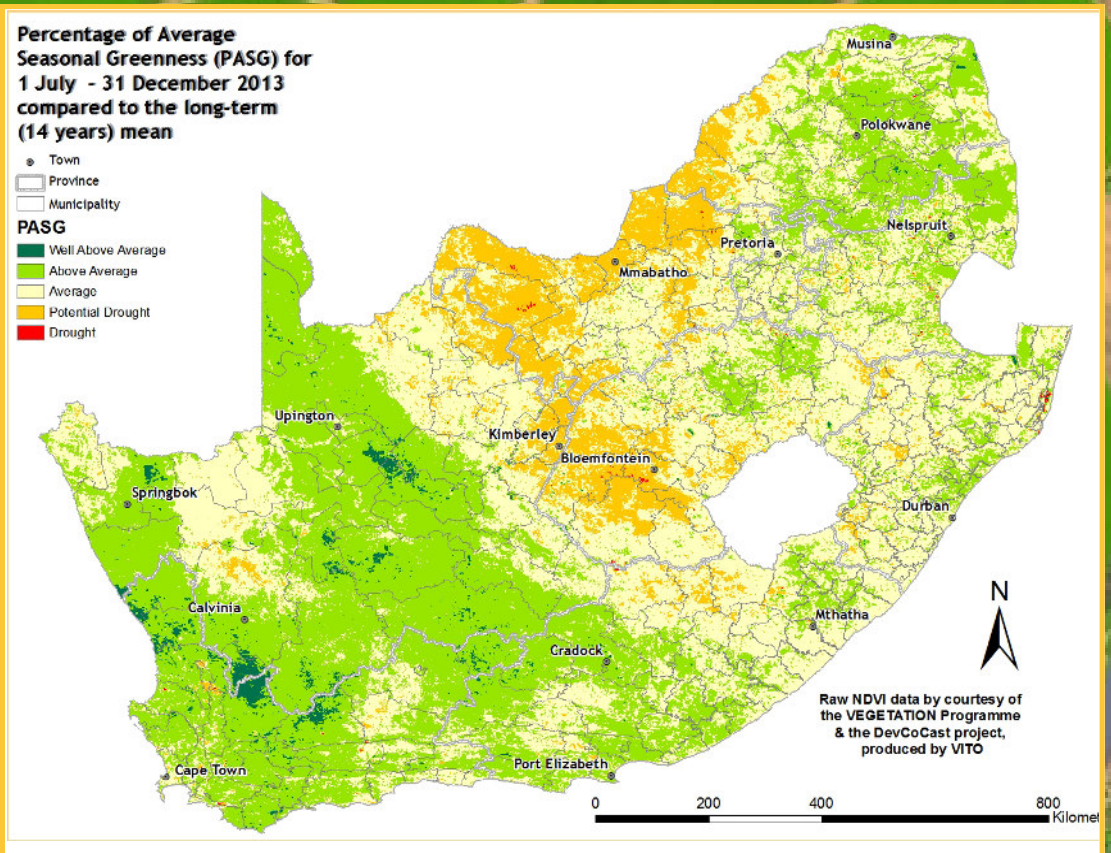



Figure 12

**Vegetation Mapping**
*(continued from p. 6)*

**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 11:***
Persistent below-normal rainfall during the past few months over parts of the central to northern interior resulted in below-average cumulative vegetation activity as seen in the lower than average PASG for the October-December period.

***Figure 12:***
Considering the entire summer season so far, the effect of drought conditions over much of the central parts on cumulative vegetation activity is evident in the relatively low PASG values over that region. Cumulative vegetation activity is higher than average over the southwestern and eastern parts where rainfall during the preceding months was above normal.

**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.

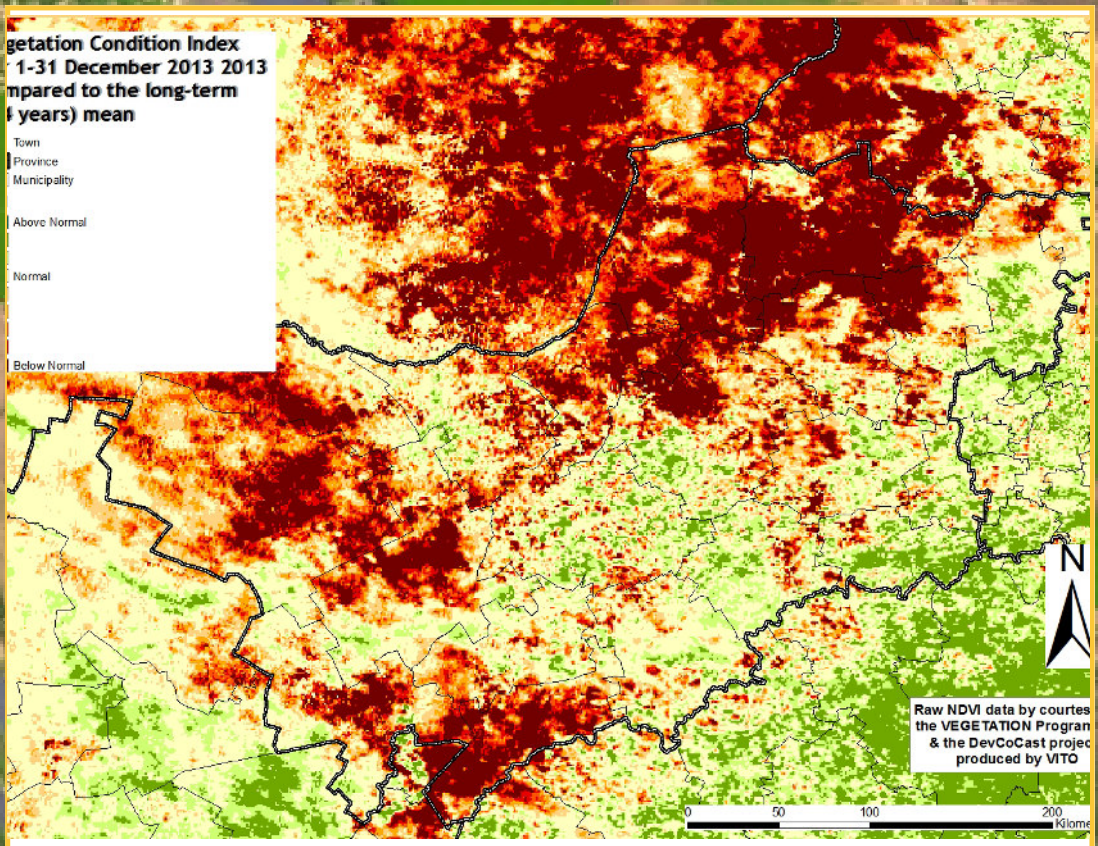



Figure 13

***Figure 13:***
The VCI map for December 2013 indicates below-normal vegetation activity over most parts of the North West Province.

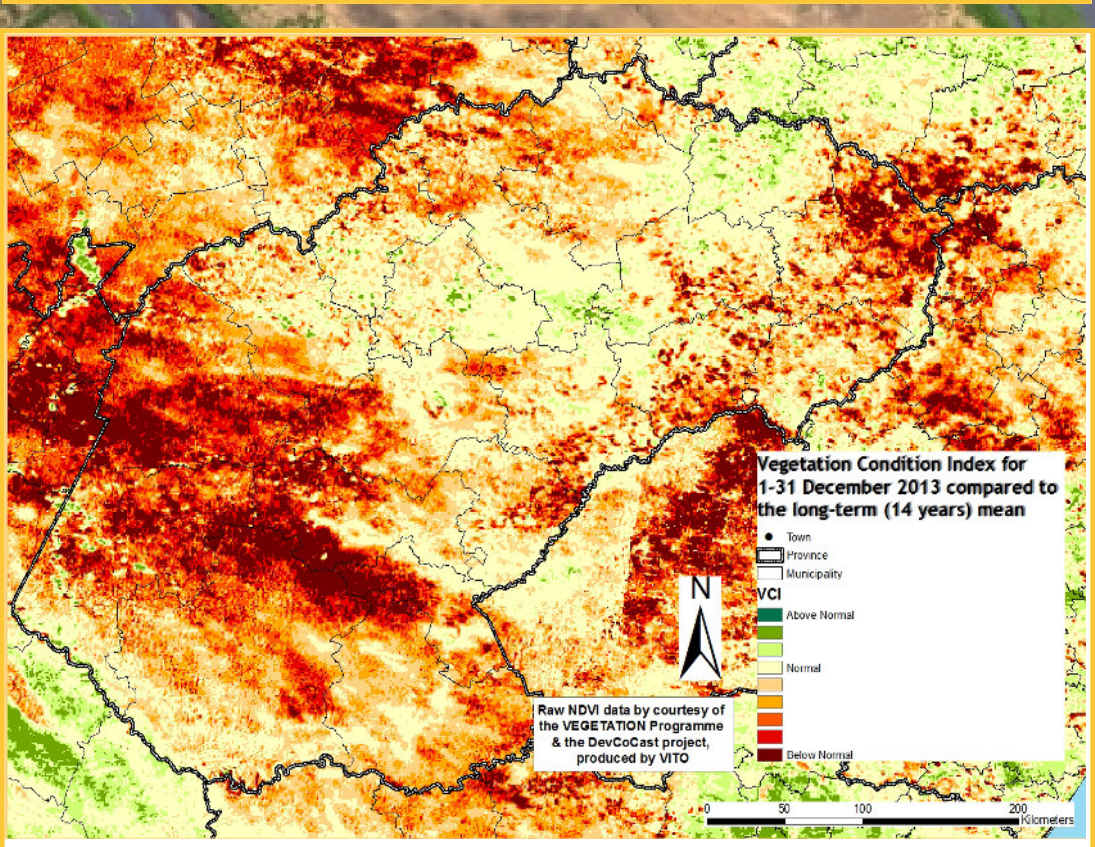



Figure 14

***Figure 14:***
The VCI map for December 2013 indicates below-normal vegetation activity over most parts of the Free State Province.

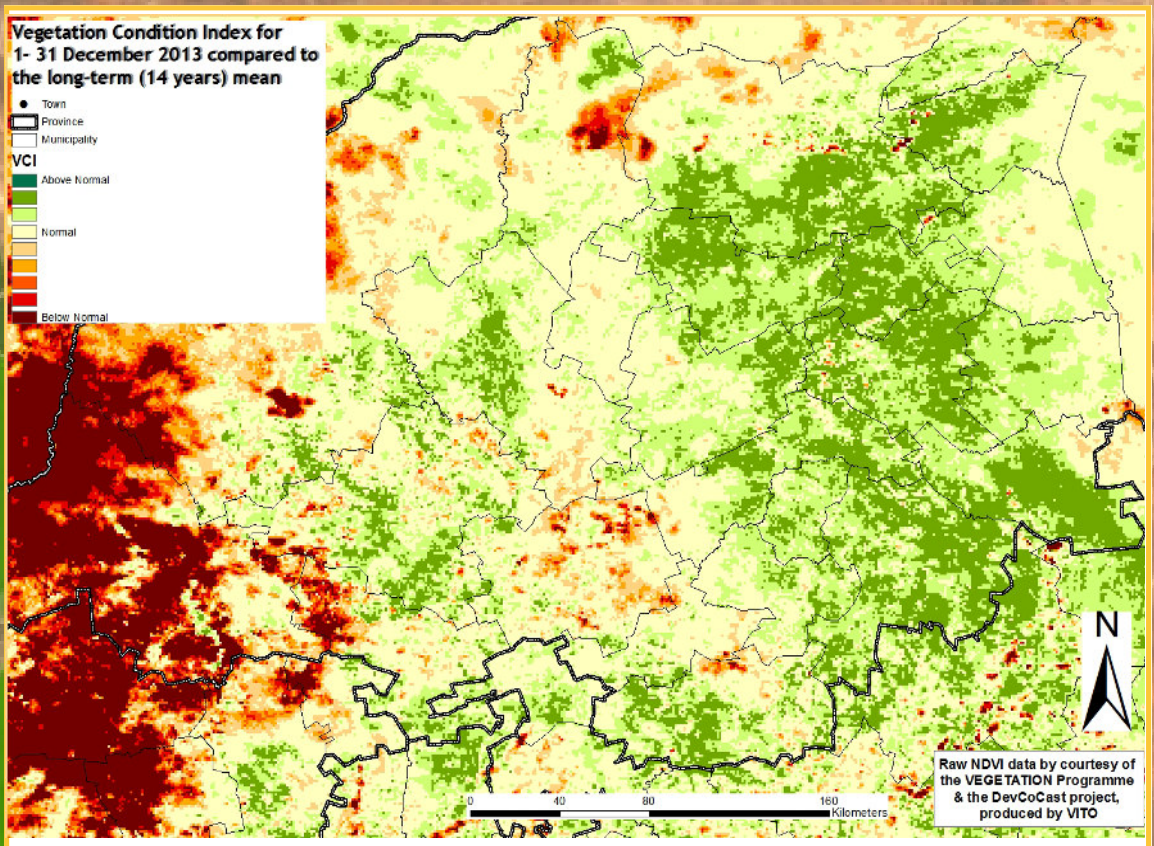



Figure 15

***Figure 15:***
The VCI map for December 2013 indicates below-normal vegetation activity over the western parts of Limpopo Province.

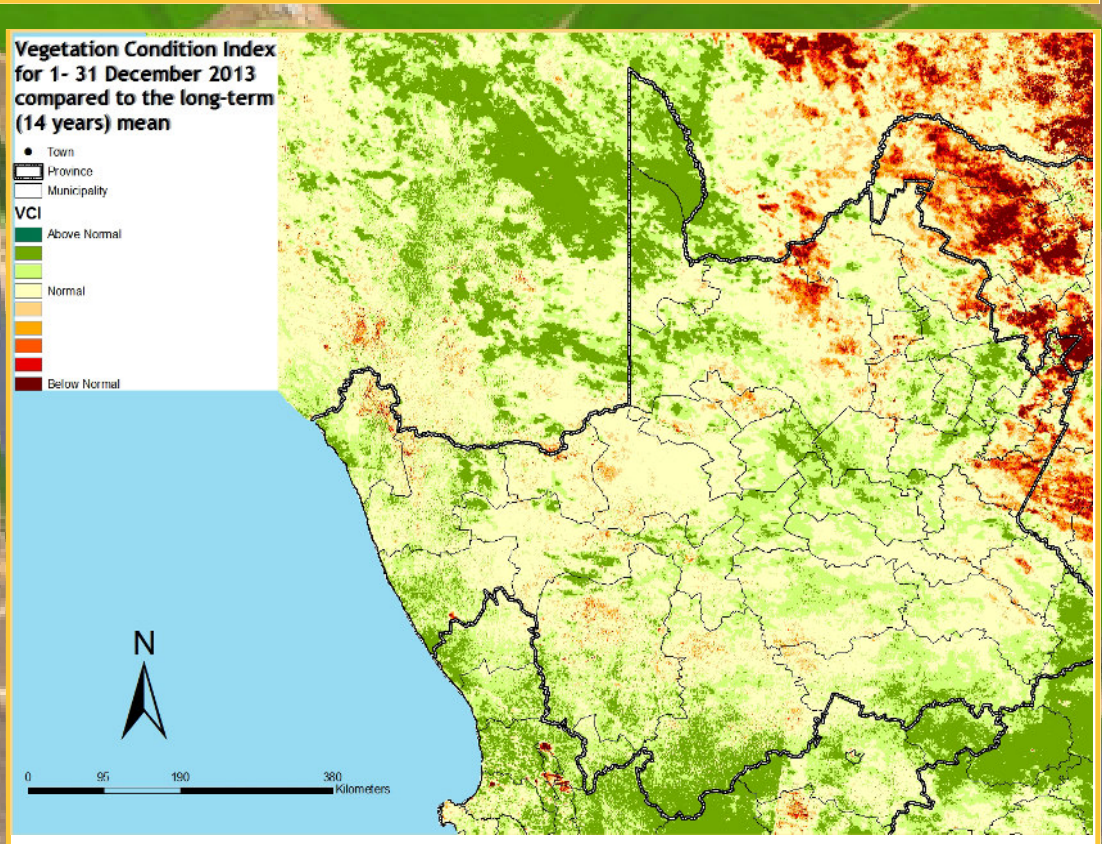



Figure 16

***Figure 16:***
The VCI map for December 2013 indicates normal vegetation activity over most parts of the Northern Cape Province.

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

# 7. Vegetation Conditions & Rainfall



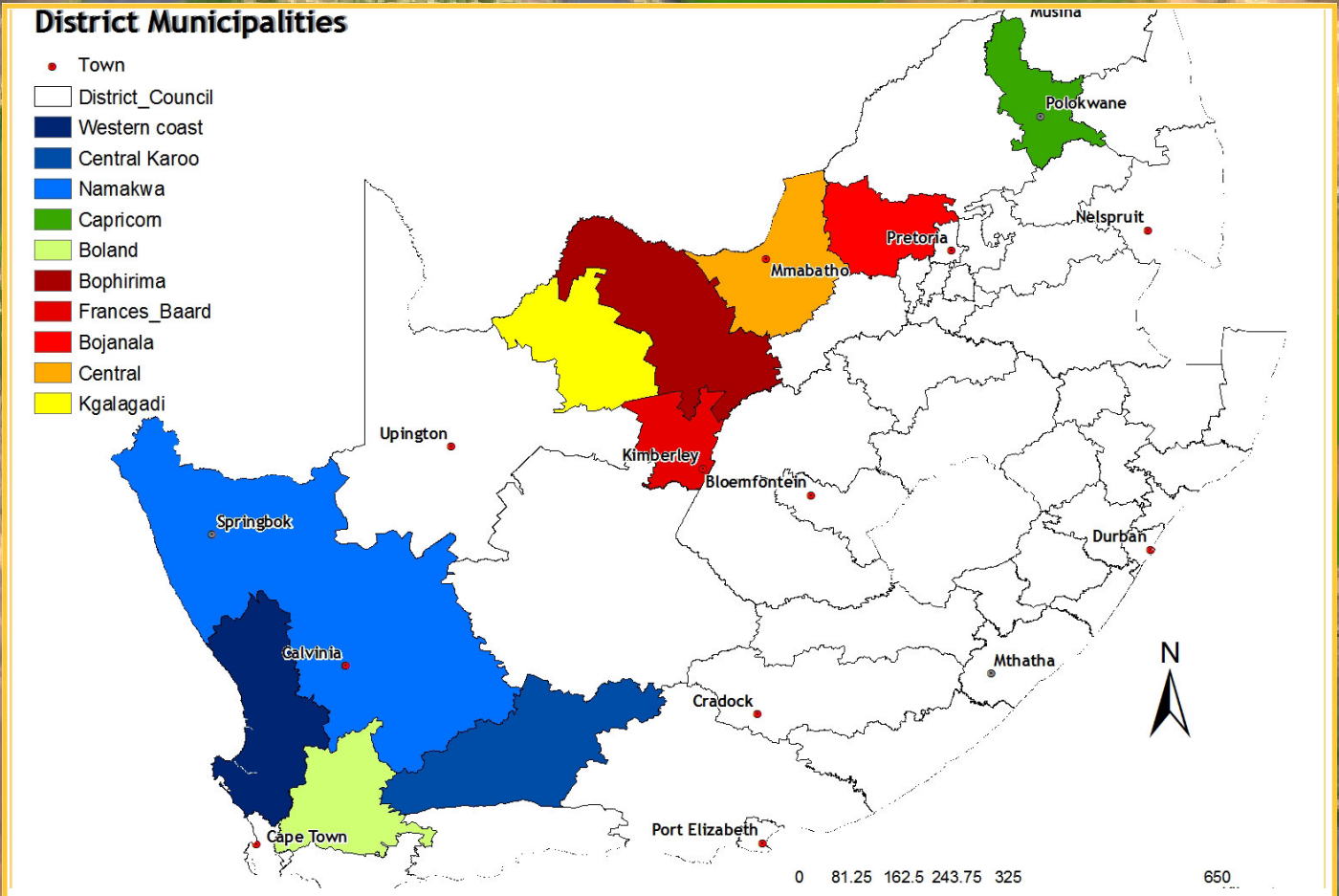



Figure 17

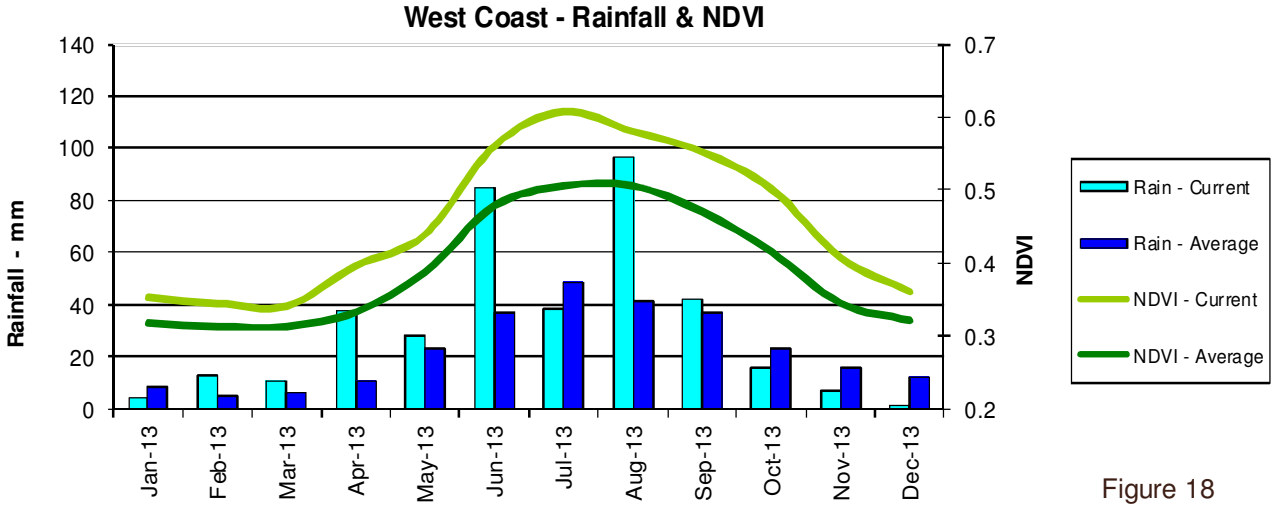
**NDVI and Rainfall Graphs**

***Figure 17:***
Orientation map showing the areas of interest for December 2013. The district colour matches the border of the corresponding graph.

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

***Figures 18-22:***
Indicate areas with higher cumulative vegetation activity for the last year.

***Figures 23-27:***
Indicate areas with lower cumulative vegetation activity for the last year.

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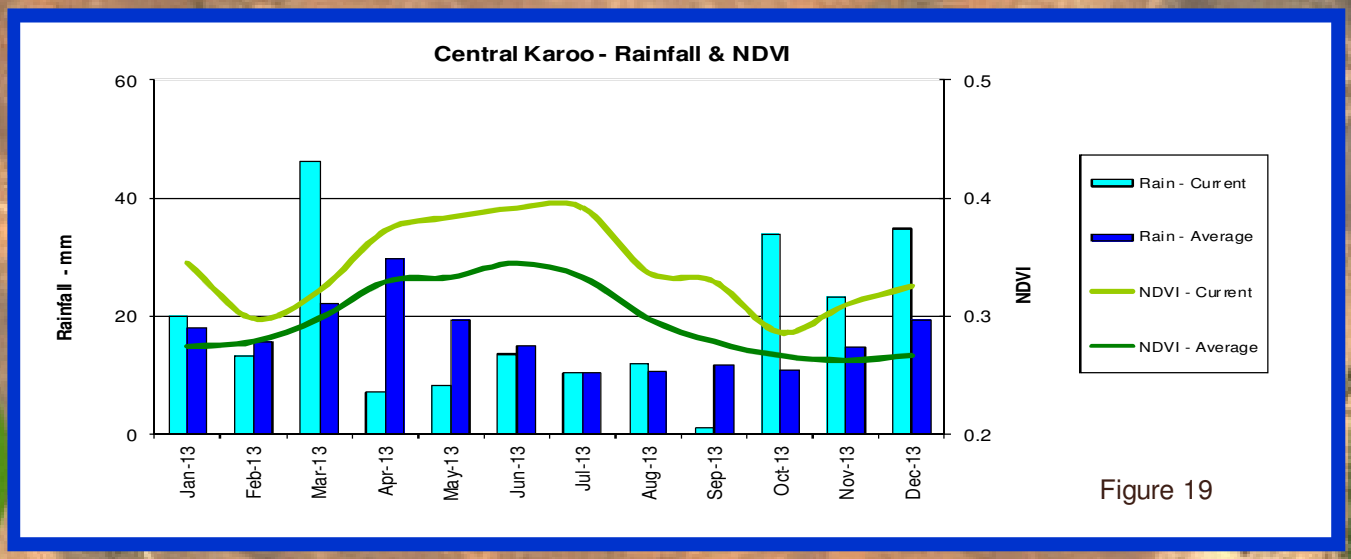


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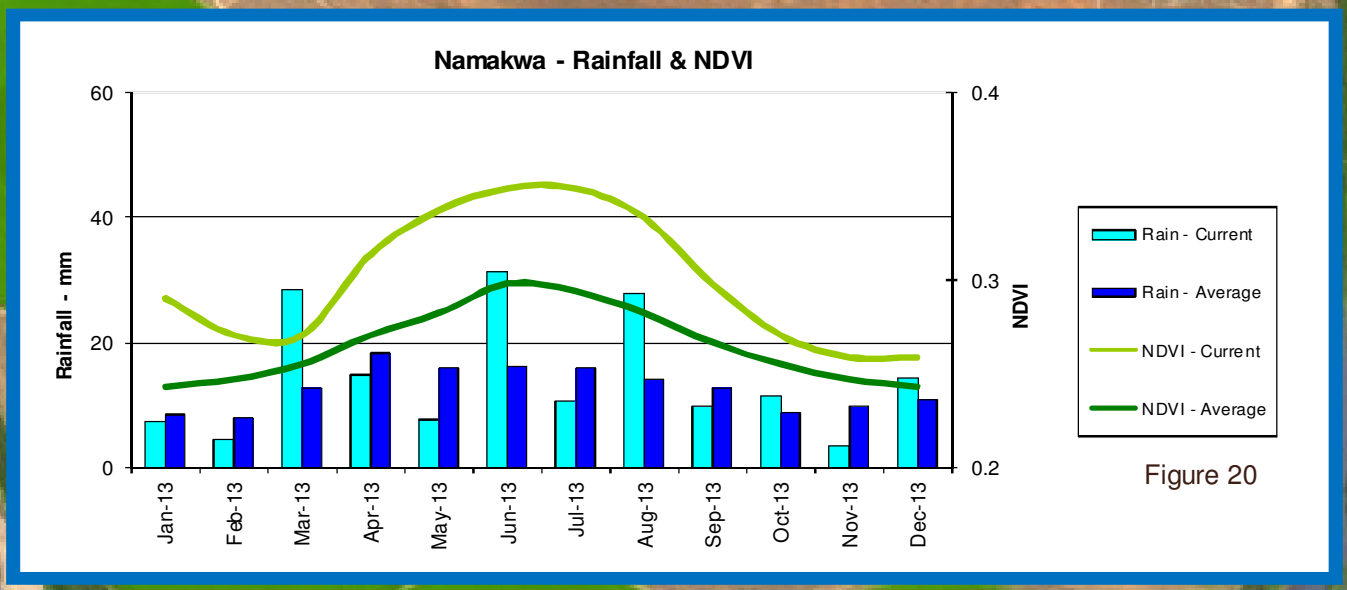


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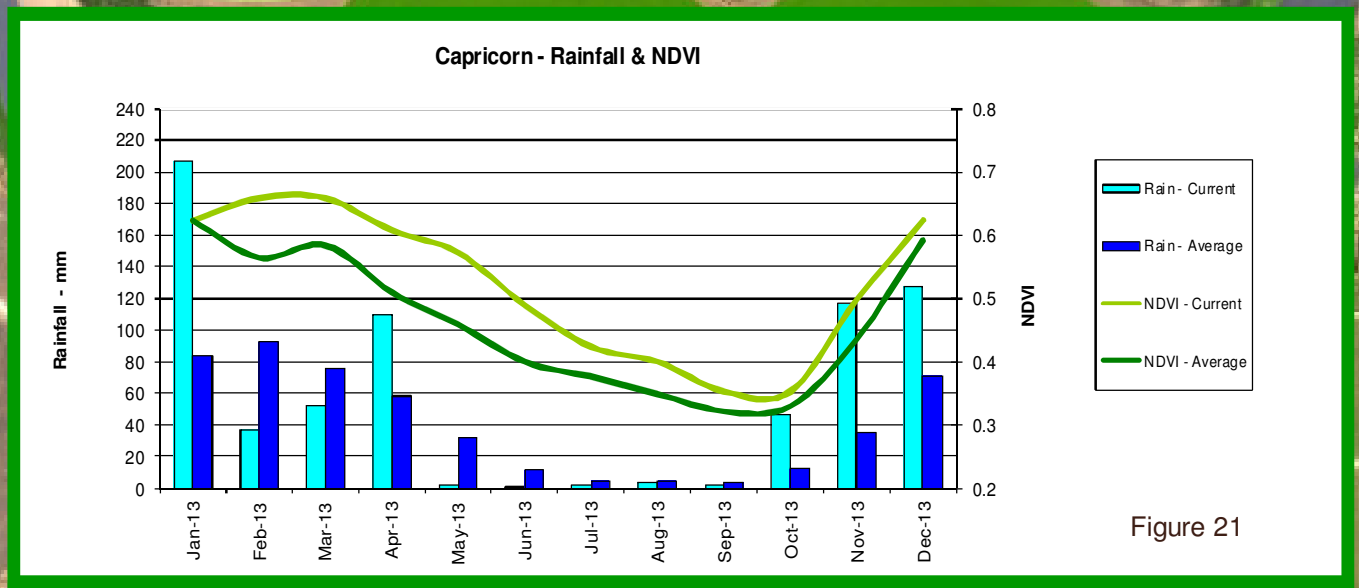


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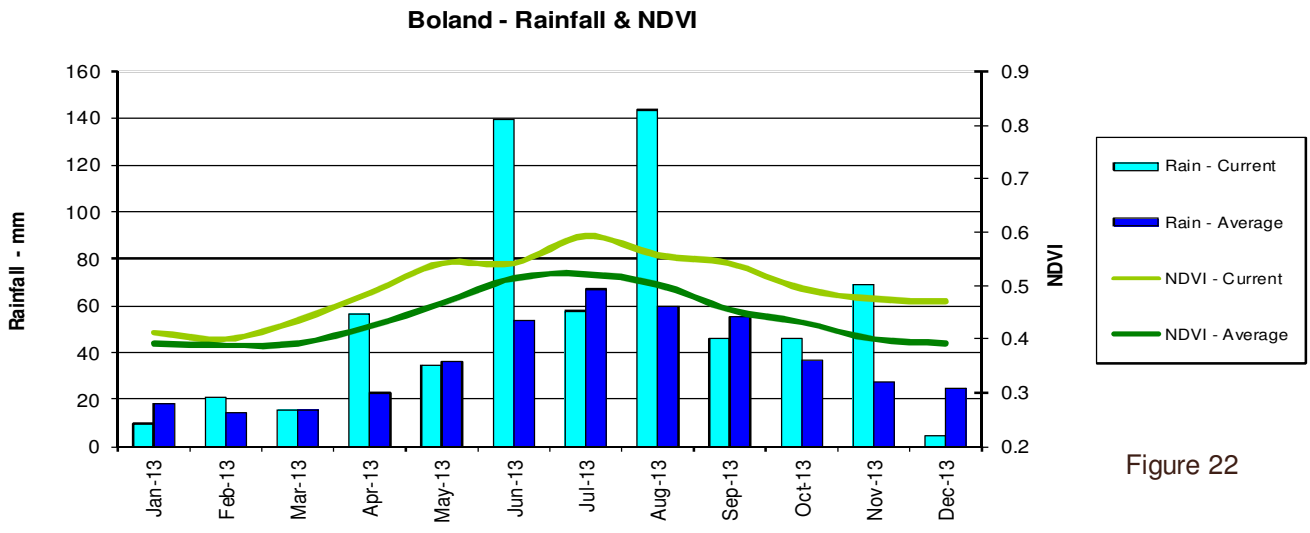


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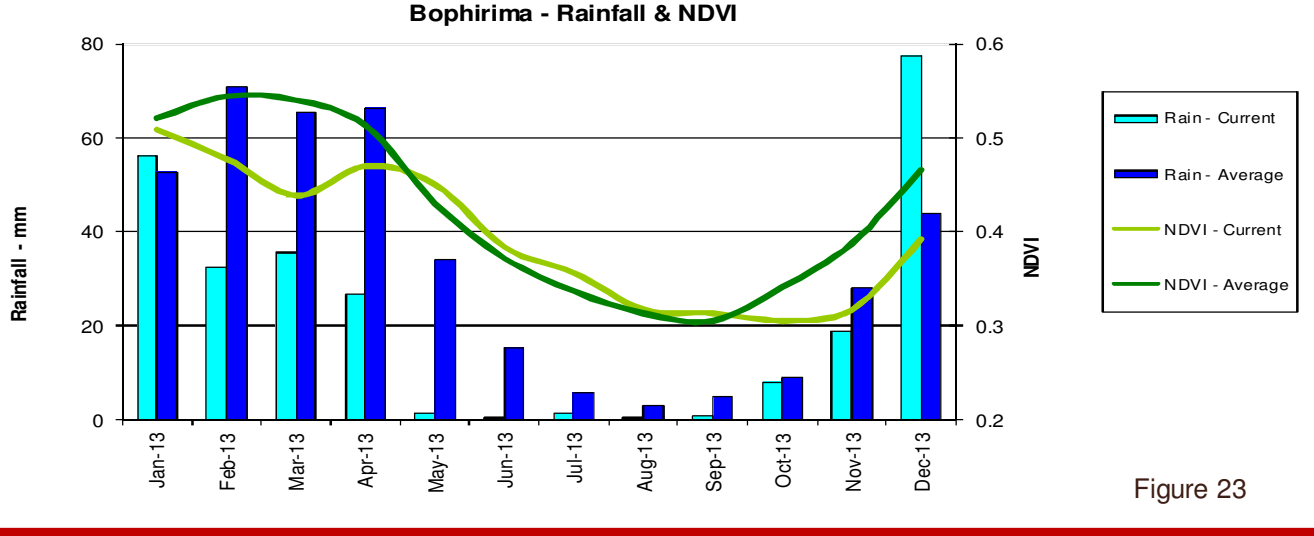


Figure 23

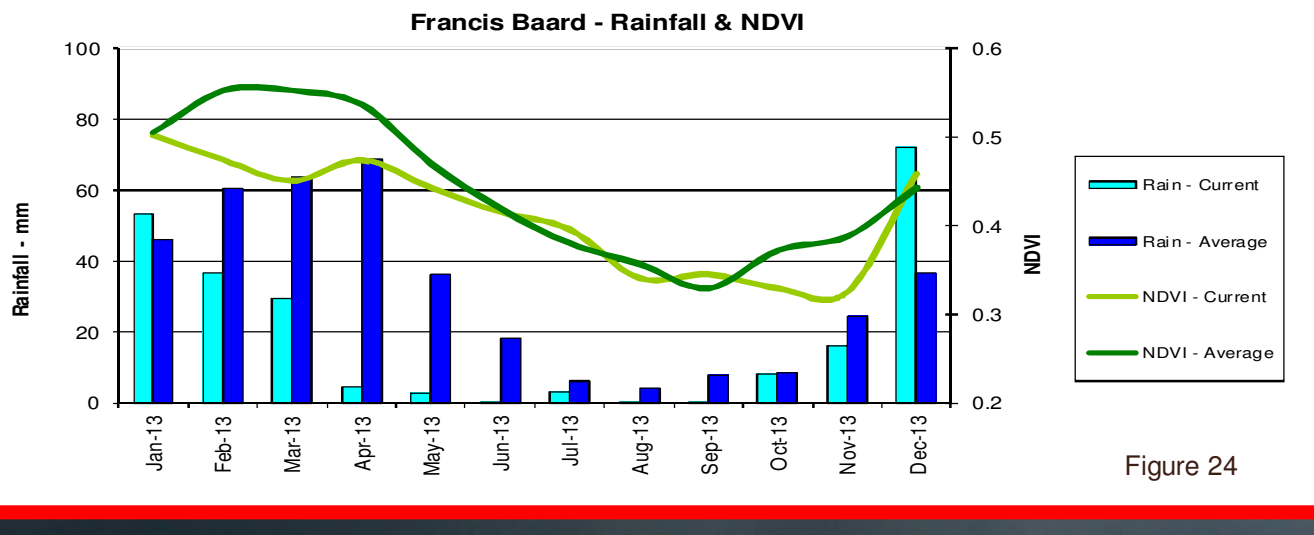


Figure 24

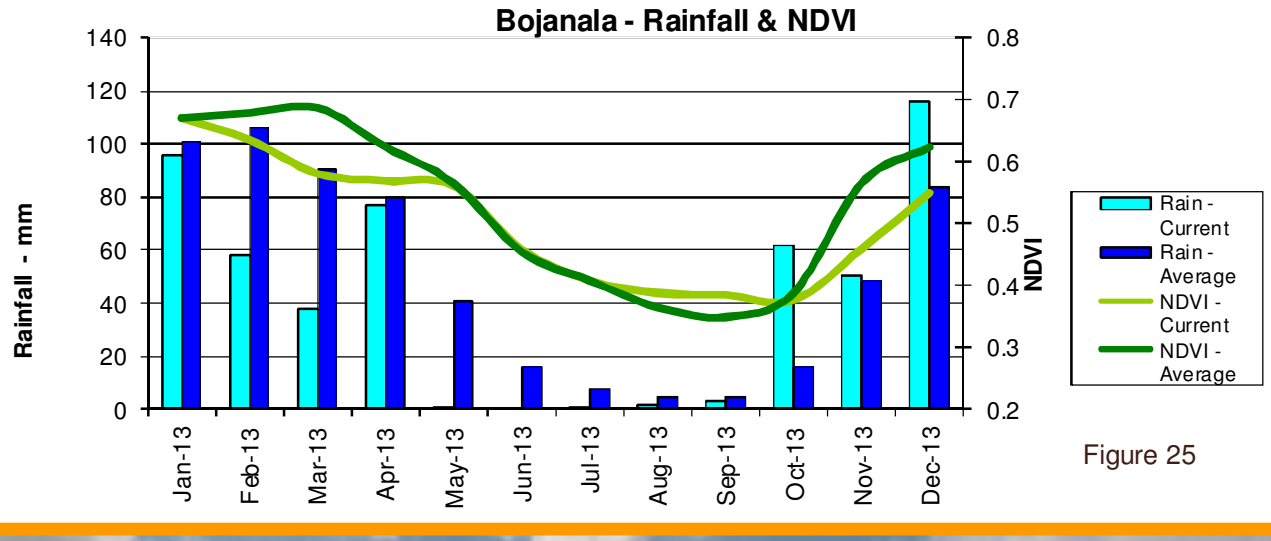


Figure 25

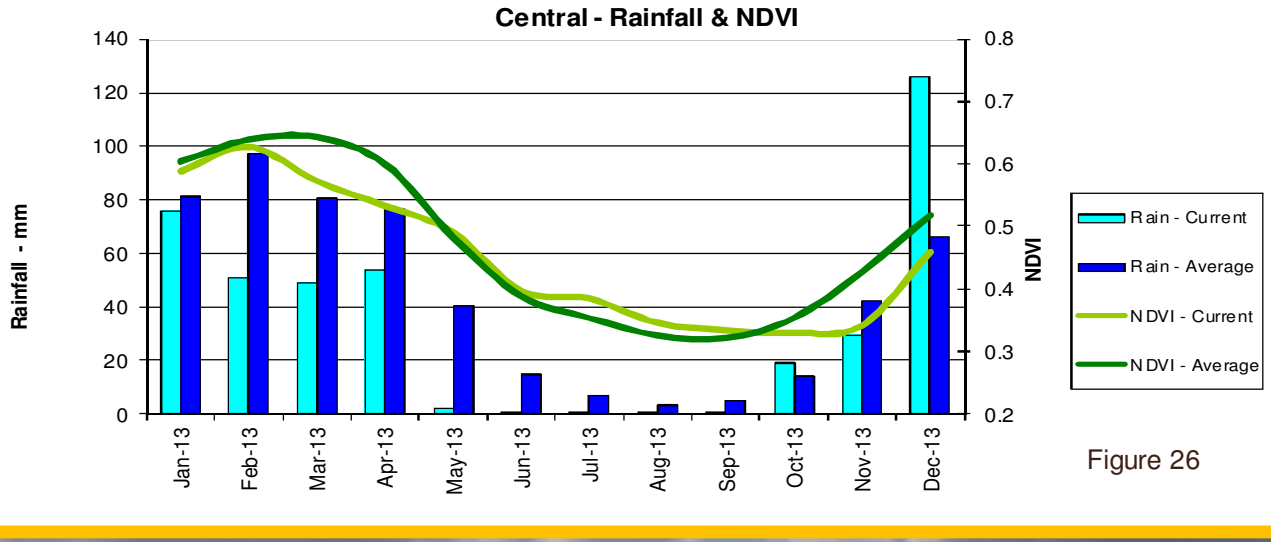


Figure 26

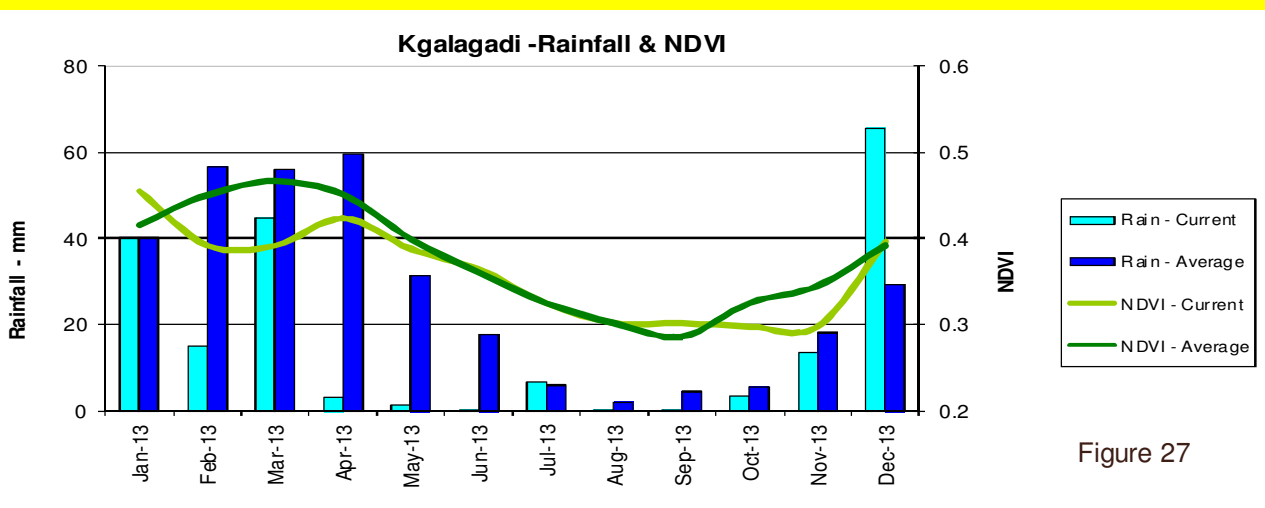


Figure 27

# 7. 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 28:***
The graph shows the total number of active fires detected between 1-31 December 2013 per province. Fire activity was higher in Gauteng and the Northern Cape compered to the average for the same period for the last 12 years.

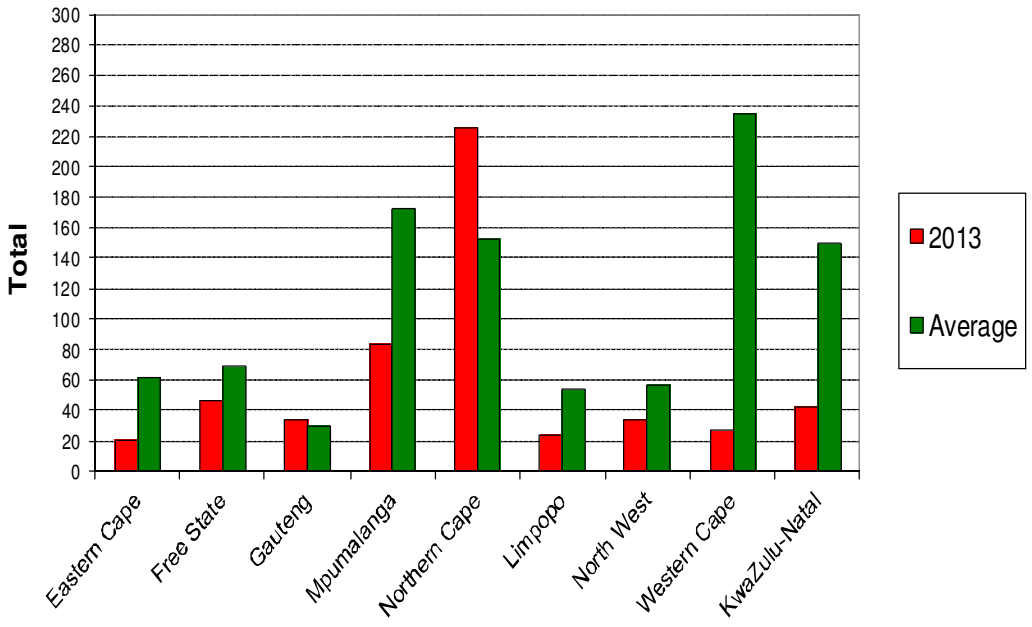


Figure 28

***Figure 29:***
The map shows the location of active fires detected between 1-31 December 2013.

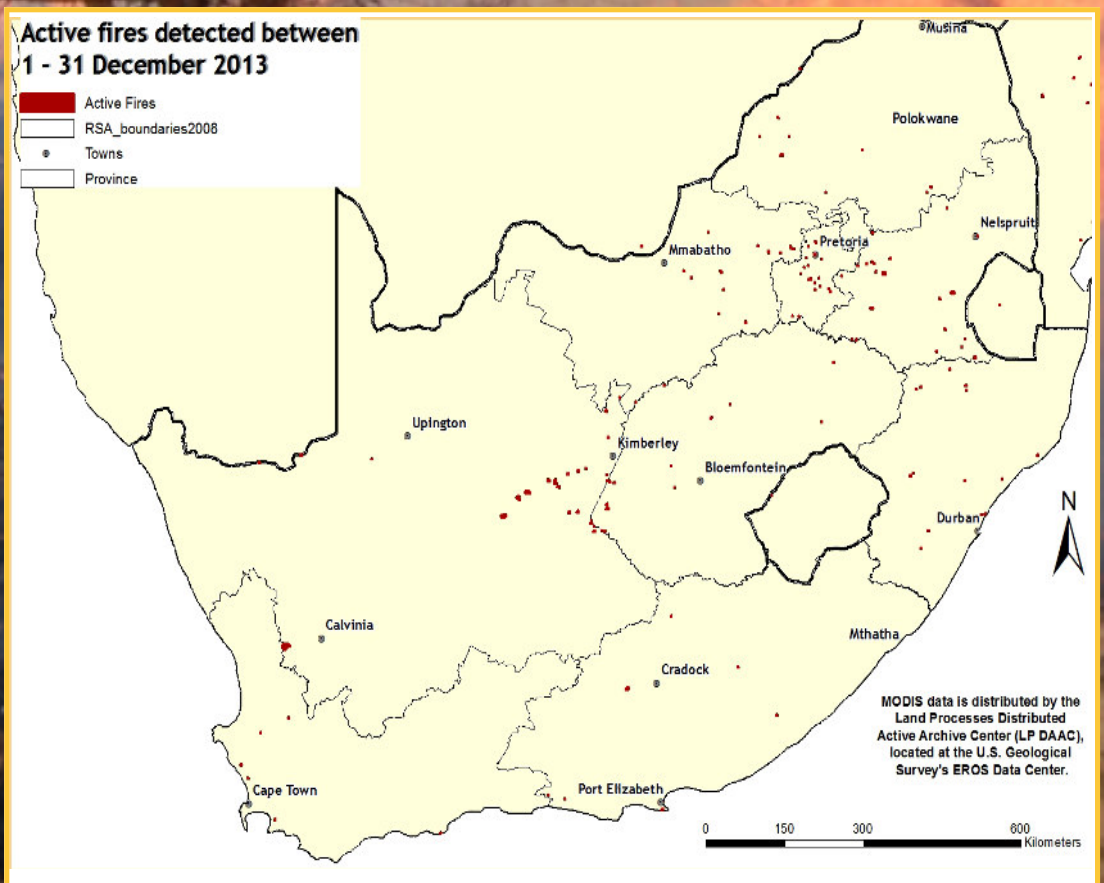


Figure 29

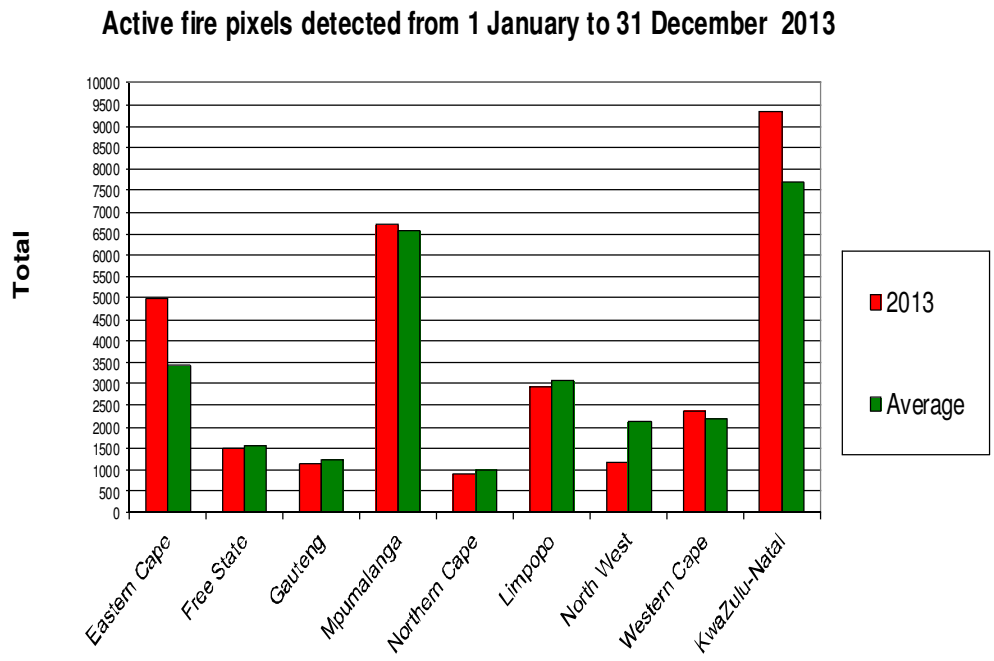


Figure 30

***Figure 30:***
The graph shows the total number of active fires detected between 1 January and 31 December 2013 per province. The fire activity was higher in the Eastern Cape, Mpumalanga, the Western Cape and KwaZulu -Natal compared to the average for the same period for the last 12 years.

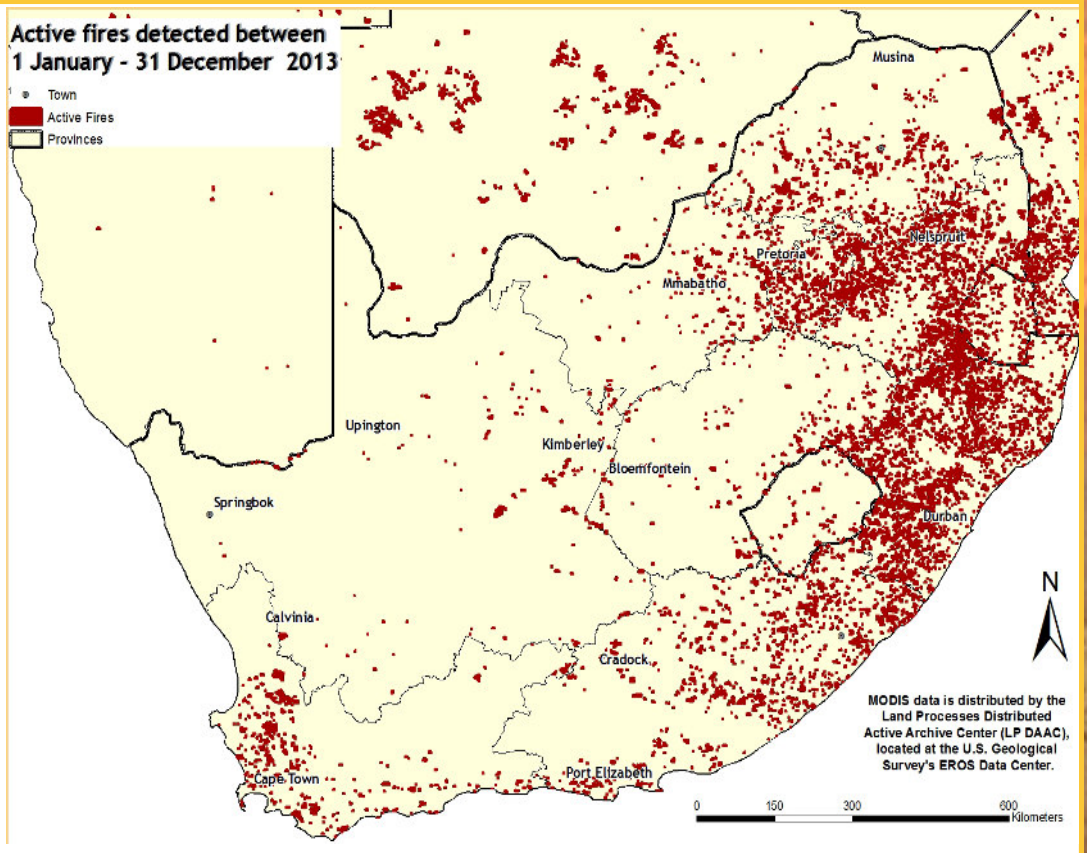


Figure 31

***Figure 31:***
The map shows the location of active fires detected between 1 January and 31 December 2013.

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

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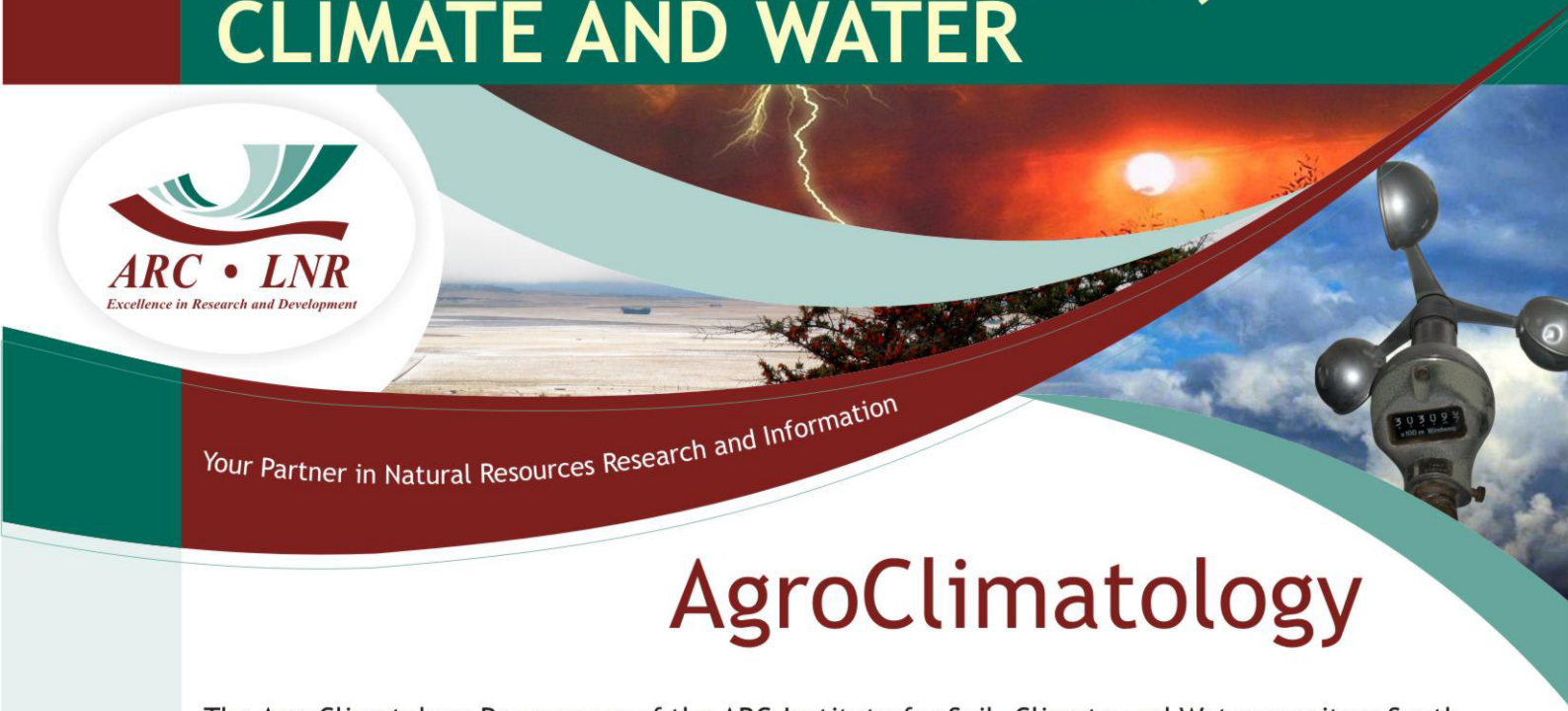

# AgroClimatology

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.

**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 Normalised 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, Normalised 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.

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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 through LEAD funding from the Department of Science and Technology.**



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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**