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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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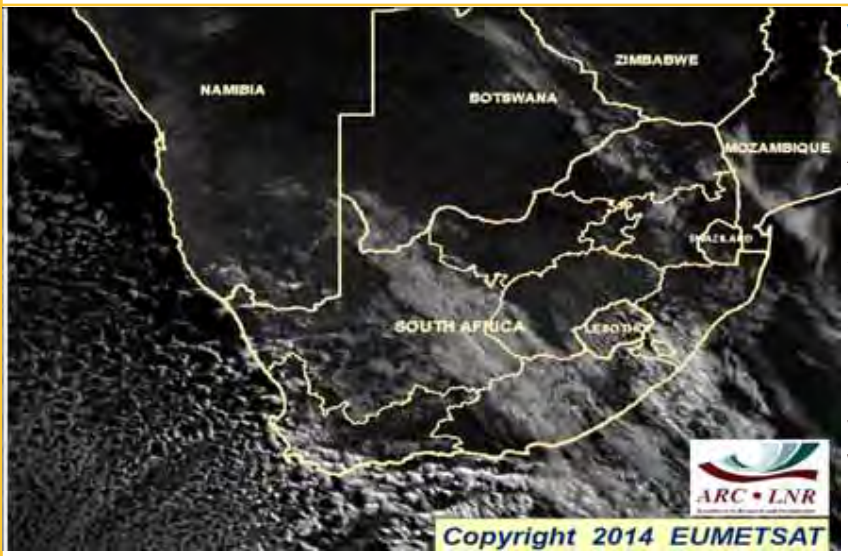
agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

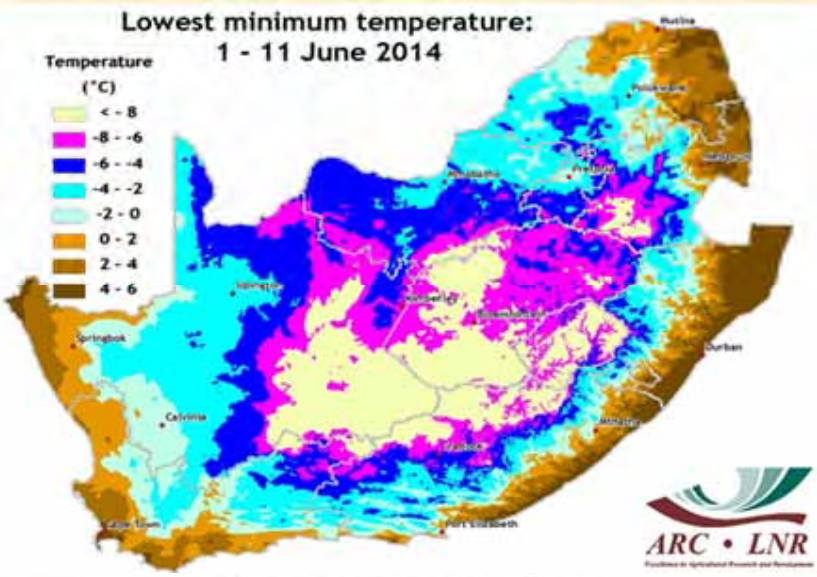
South African Weather Service

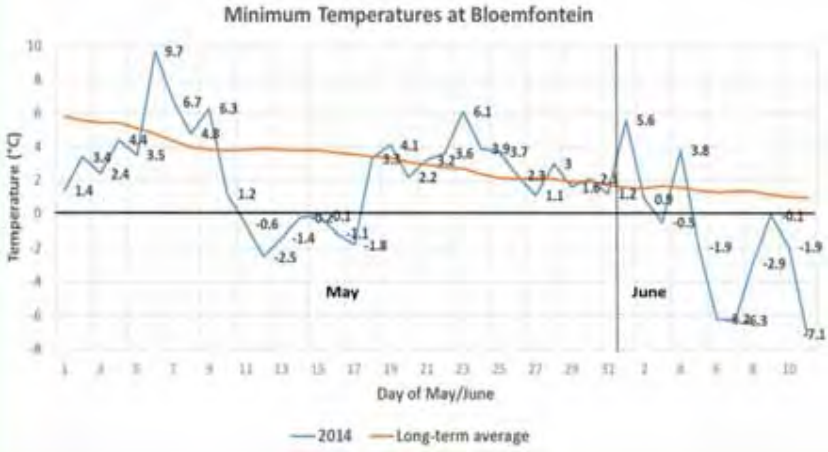
AMESD

120th Edition

Images of the Month







Winter's Icy Grip Felt in Early June

After a relatively mild May, temperatures plummeted in early June due to a very strong cold front that moved across the country. The MSG-3 visible band image for 9:00 SAST on 4 June shows the cold air as broken clouds invading the country from the west. The front, together with a deep upper air low, was responsible for snow over mountainous areas of the Western and Eastern Cape, Northern Cape and Lesotho. The lowest temperatures so far this winter were recorded since the front swept over the interior with minimum temperatures below -8°C over large parts on some mornings, intensified by a follow-on cold front that moved across the interior by the 9th. The map shows the lowest minimum temperatures recorded so far during June. It is a map interpolated from data from the ARC-ISCW automatic weather station network, consisting of about 450 stations across South Africa. For one of the stations, located near Bloemfontein, the graph shows how minimum temperatures over the interior have plummeted since 4 June to about 8°C below the average minimum temperature calculated over the last 15 years.

Questions/Comments:
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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:

Except for one significant rain-bearing system over the central and western interior, May 2014 was mostly dry over the summer rainfall area. Only some light rainfall occurred along the eastern coastal region early in the month. Winter rain did, however, occur over the western and southern winter rainfall area, indicting normal conditions, favourable for the planting of winter wheat.

Minimum temperatures over the interior decreased gradually through the month, but remained relatively high due to the lack of extreme cold outbreaks as would have been associated with strong cold fronts moving across the country. The lack of significant inland penetration by frontal systems was also evident in the relatively high maximum temperatures that occurred until the end of the month, exceeding 30°C over much of the eastern and northern interior.

Frontal systems, sometimes with upper-air support, were responsible for widespread and sometimes significant precipitation events over the winter rainfall area, spread fairly evenly throughout the month. The most significant of these events were concentrated around the 8th, 15th and again from the 27th to the end of the month.

The development of a cut-off low in the upper air over the southwestern parts of the country resulted in general rain and showers over the western interior and towards the southern and southeastern coastal areas by the 19th, moving across the central parts by the 20th. With an onshore flow over the eastern parts, some showers also occurred mostly over the Escarpment during this period. As the system in the southwest weakened, very little precipitation occurred in association with it over the eastern parts. In fact, the eastern and northeastern interior remained dry through most of the month.

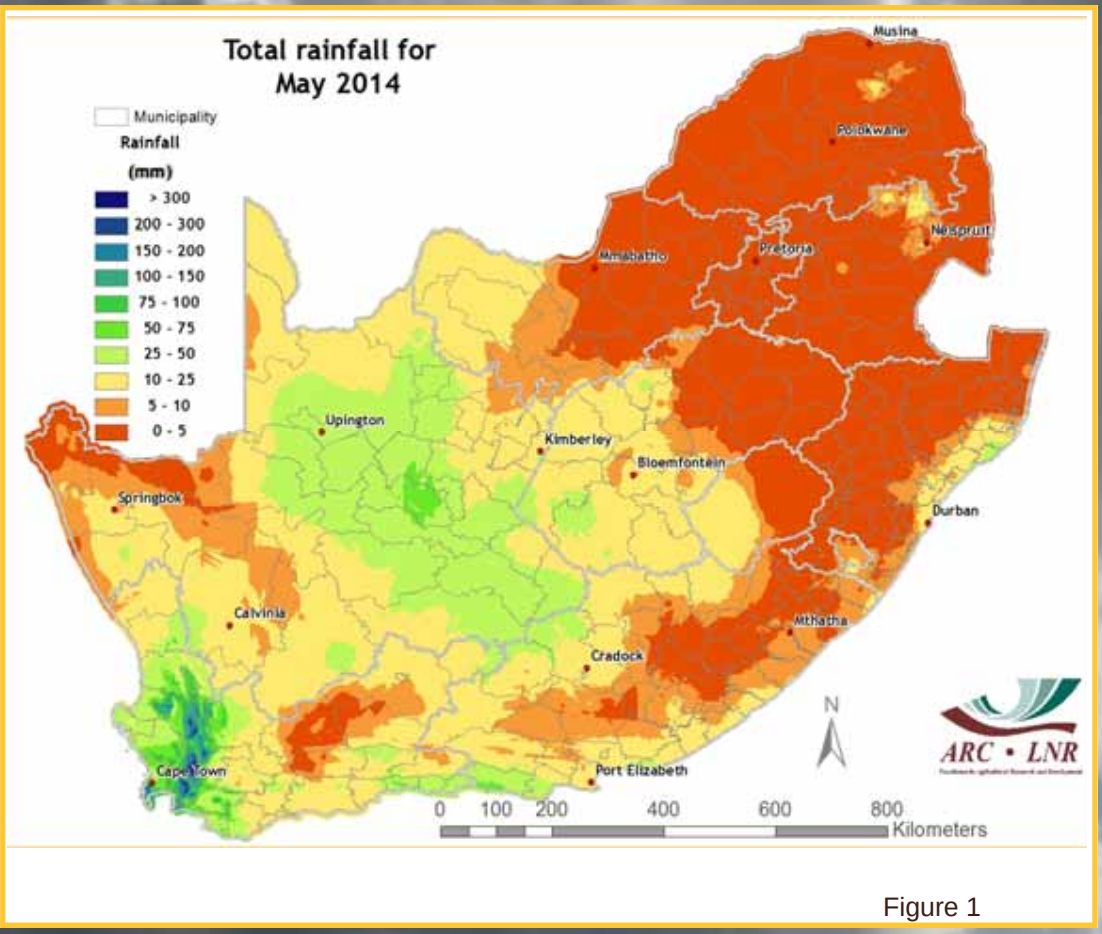


Figure 1

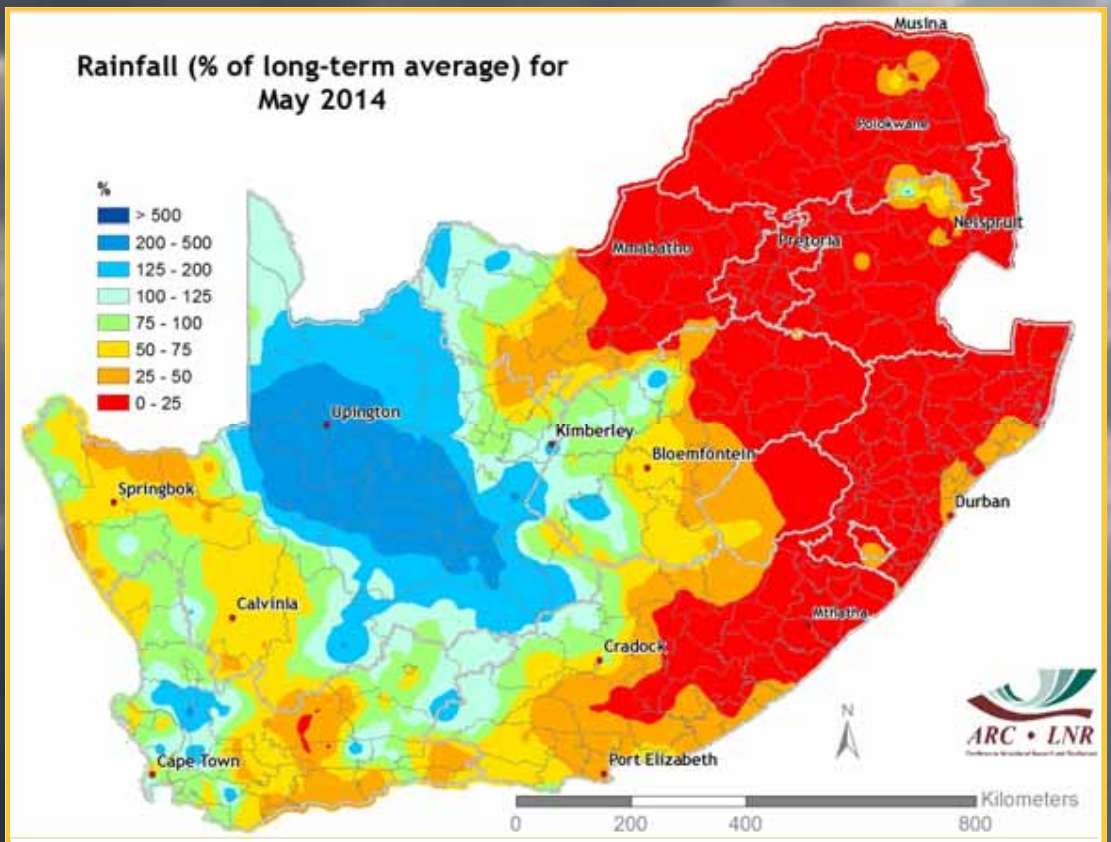
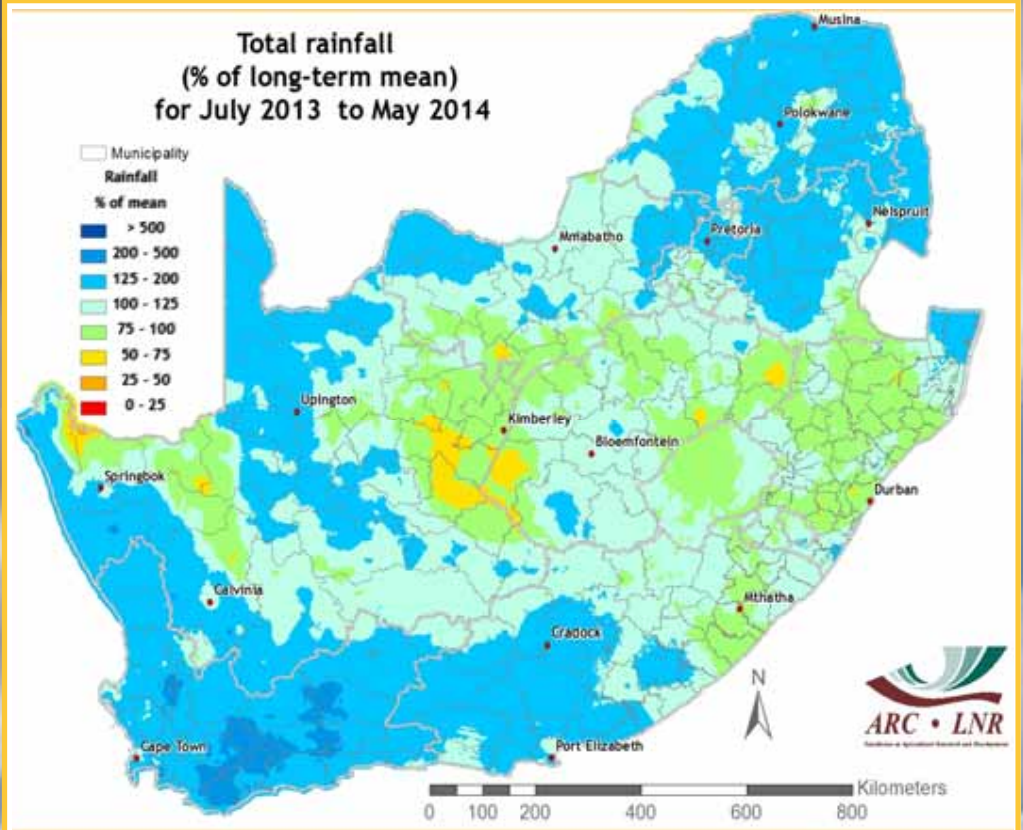


Figure 2



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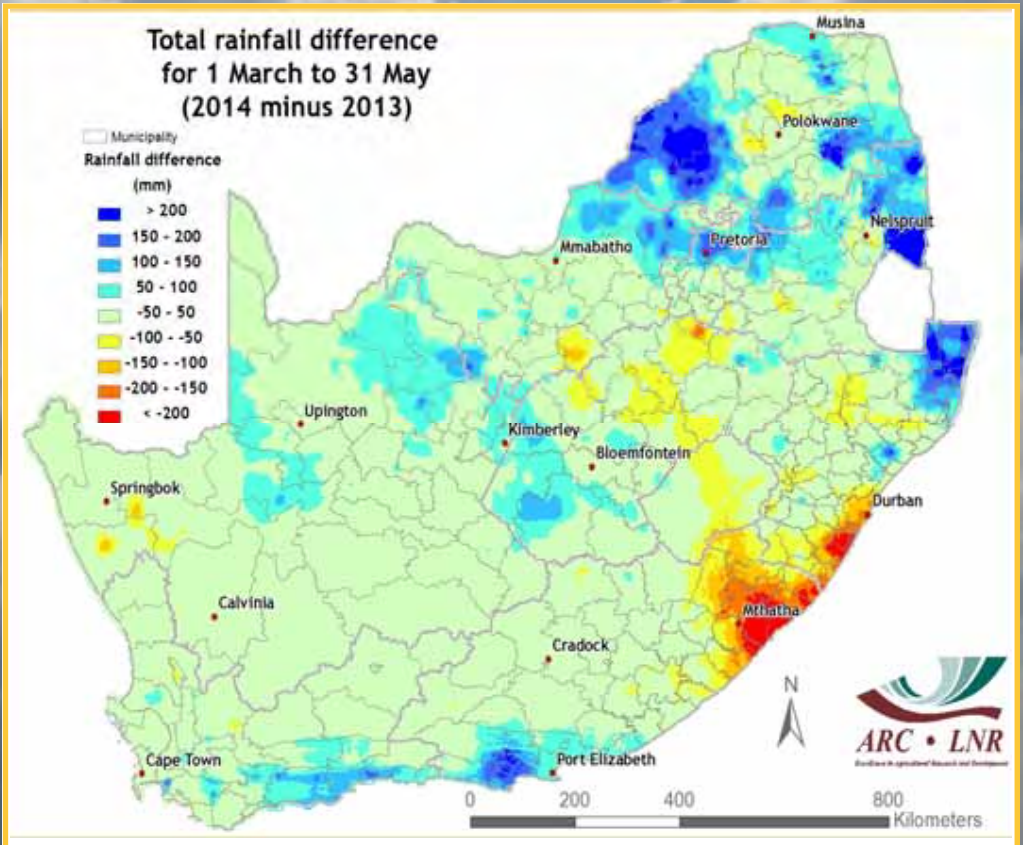

Figure 4

Figure 1:
While the northeastern areas were dry during May, large parts over the central and western interior received between 10 and 50 mm of rain. The entire winter rainfall area also received rain, with falls exceeding 25 and 50 mm over some parts and higher totals, exceeding 150 mm, over the mountainous region in the southwest.

Figure 2:
Rainfall was below normal over the northeastern and eastern South Africa, above normal over much of the interior of the Northern Cape, and near normal over most of the winter rainfall area in the southwest.

Figure 3:
Above-normal rainfall occurred over most of the country during the period July 2013 to May 2014. The largest positive deviations occurred over the southwestern parts of the country. A west-east stretching band, covering much of the eastern Northern Cape across the northern Free State and into central KwaZulu-Natal received normal to below-normal rainfall.

Figure 4:
Much of the northern and extreme southern parts received more rain during the March-May period this year than during 2013. A NW-SE-stretching band from the northern Free State towards southern KwaZulu-Natal and the northeastern Eastern Cape received less rain than during 2013, with the largest deficits towards the coastal areas in this band.

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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) indicate that the northeastern parts remain wet according to the SPI class at all time scales and the southwestern parts also especially towards the longer timescales. Indications of drought do exist over parts of the Free State into KwaZulu-Natal at the 6 to 12-month time scale, and are replaced towards the west at the 24-month time scale, still indicating drought conditions over the extreme western Free State, extreme northeastern Northern Cape and southwestern North West at that time scale.

Questions/Comments:
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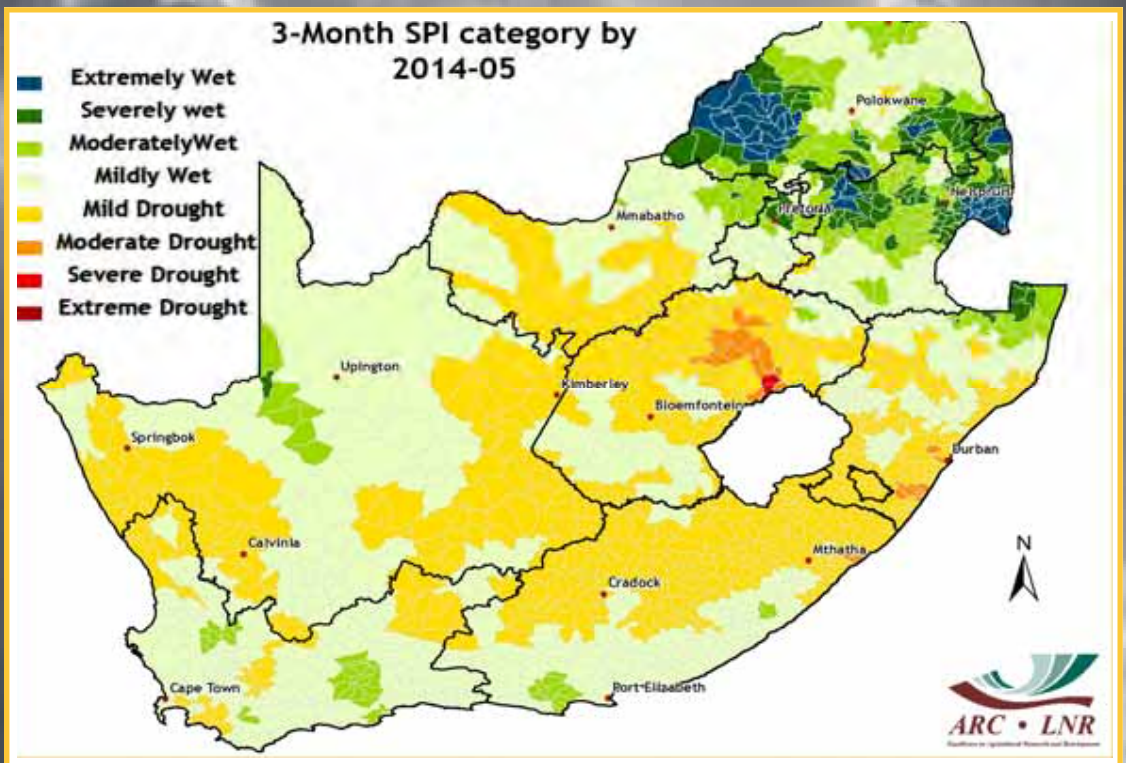

Figure 5

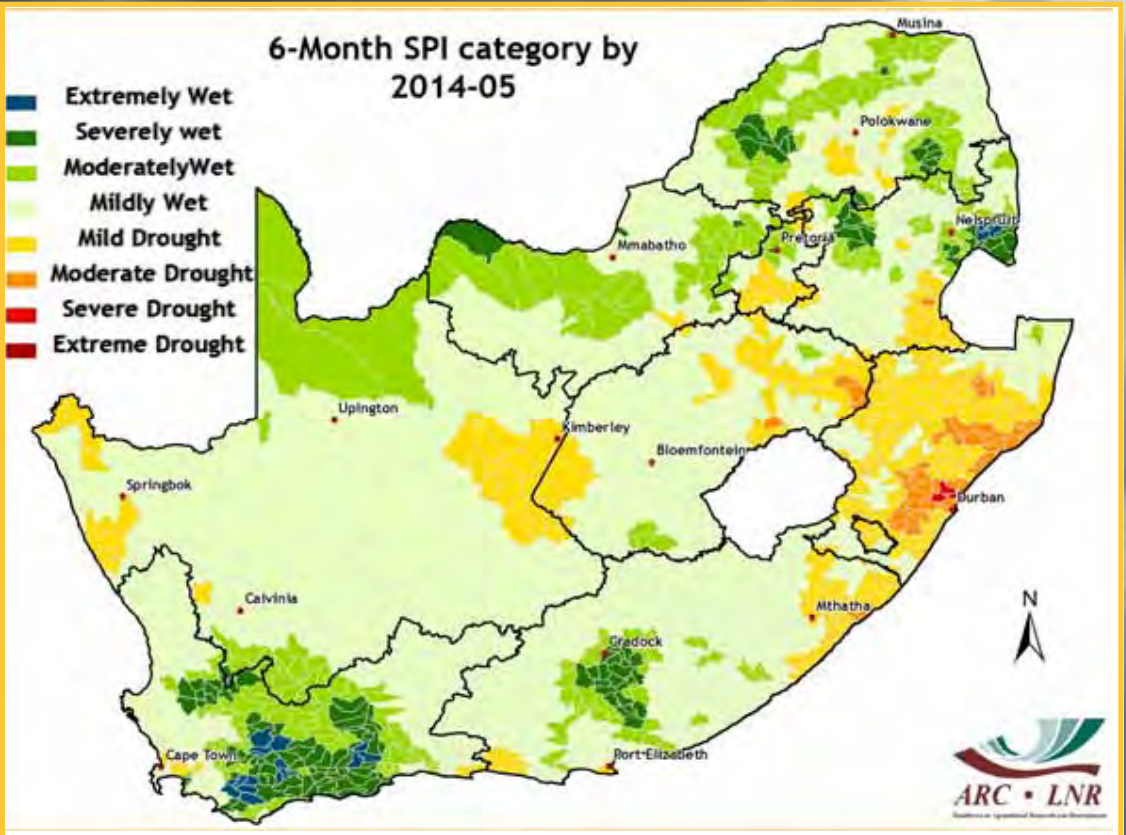

Figure 6

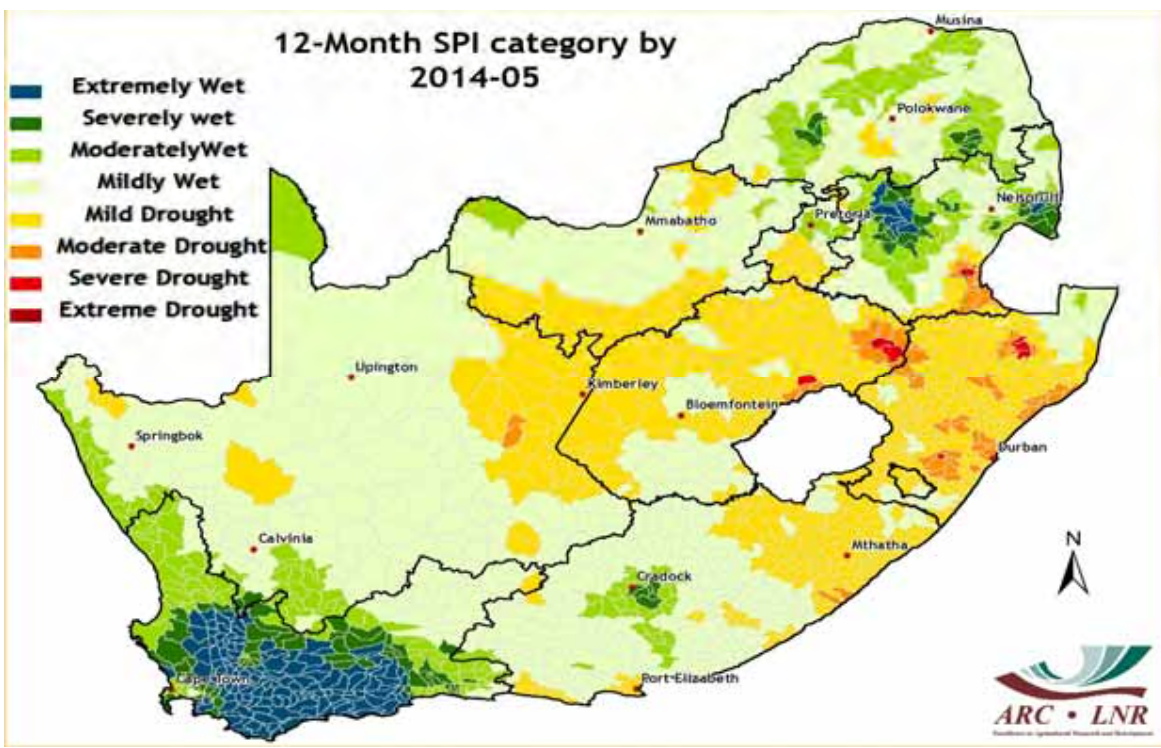

Figure 7

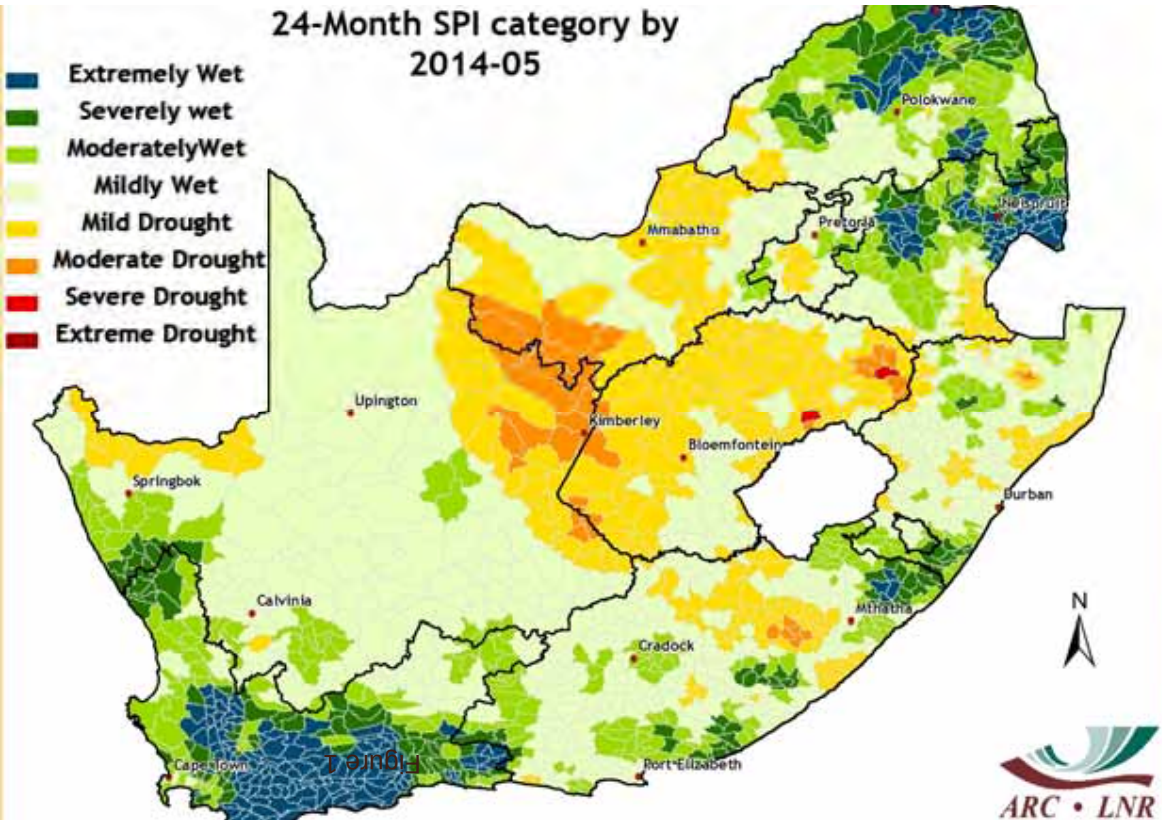

Figure 8

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.

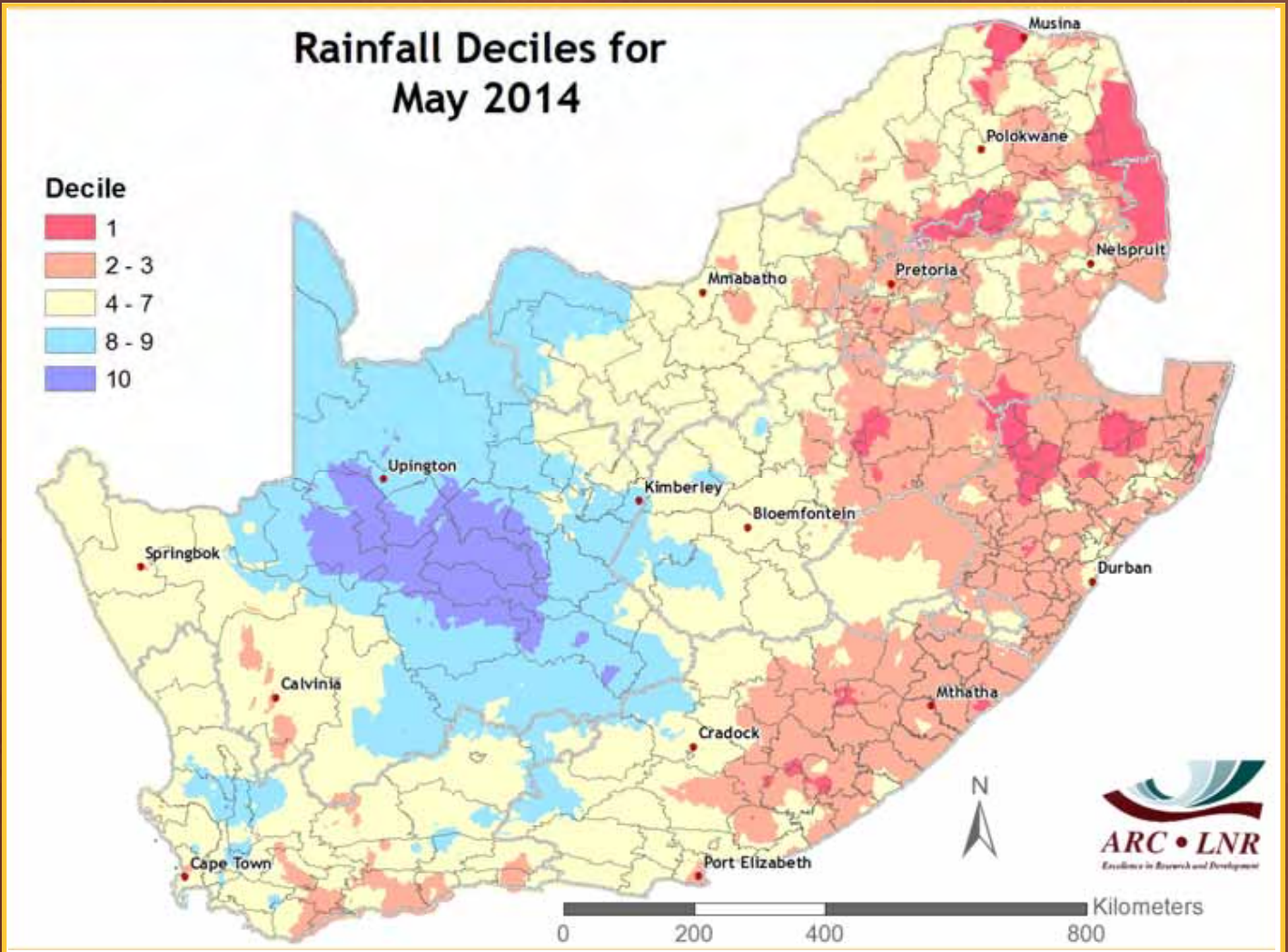

Figure 9

Figure 9:
The decile map indicates that May was exceptionally dry over much of eastern South Africa whilst exceptionally wet over large parts of the western interior, especially the central Northern Cape.

4. Water Balance

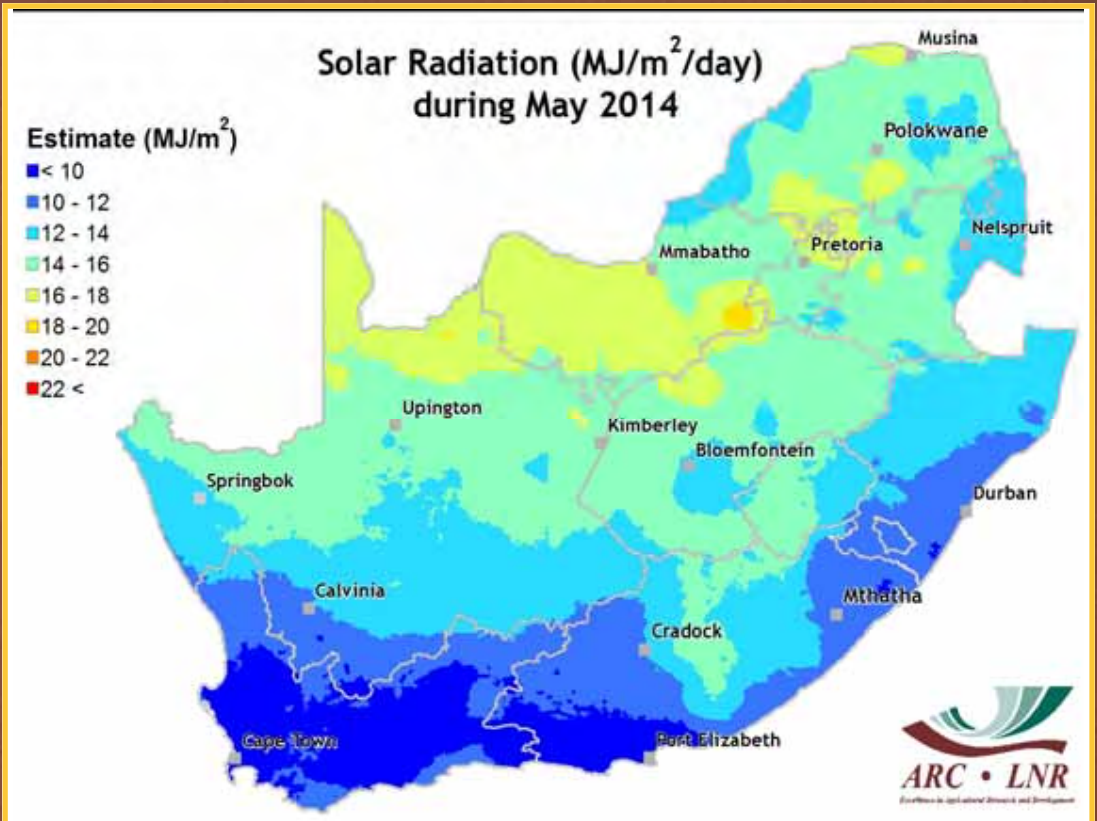

Figure 10

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 expected south-north gradient of increasing daily average solar radiation dominated during May, with the lowest values over the southwestern parts where regular frontal activity kept values even lower as well as the eastern coastal regions where low cloud periodically occurred due to an onshore flow over the region.

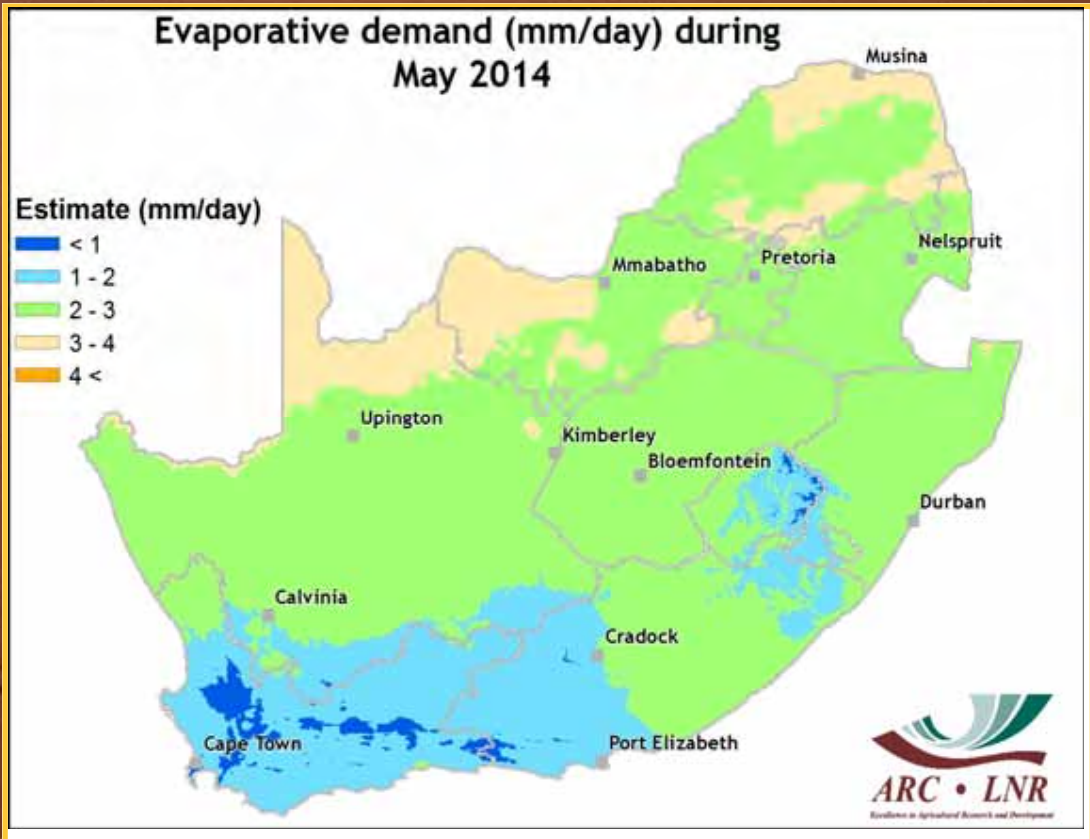

Figure 11

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:
Evaporative demand was lower than during the previous month, as expected with winter approaching. The lowest values occurred over the southwestern parts, where lower temperatures, cloudy periods and higher relative humidity due to frontal systems moving across the area resulted in lower PET values.

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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.

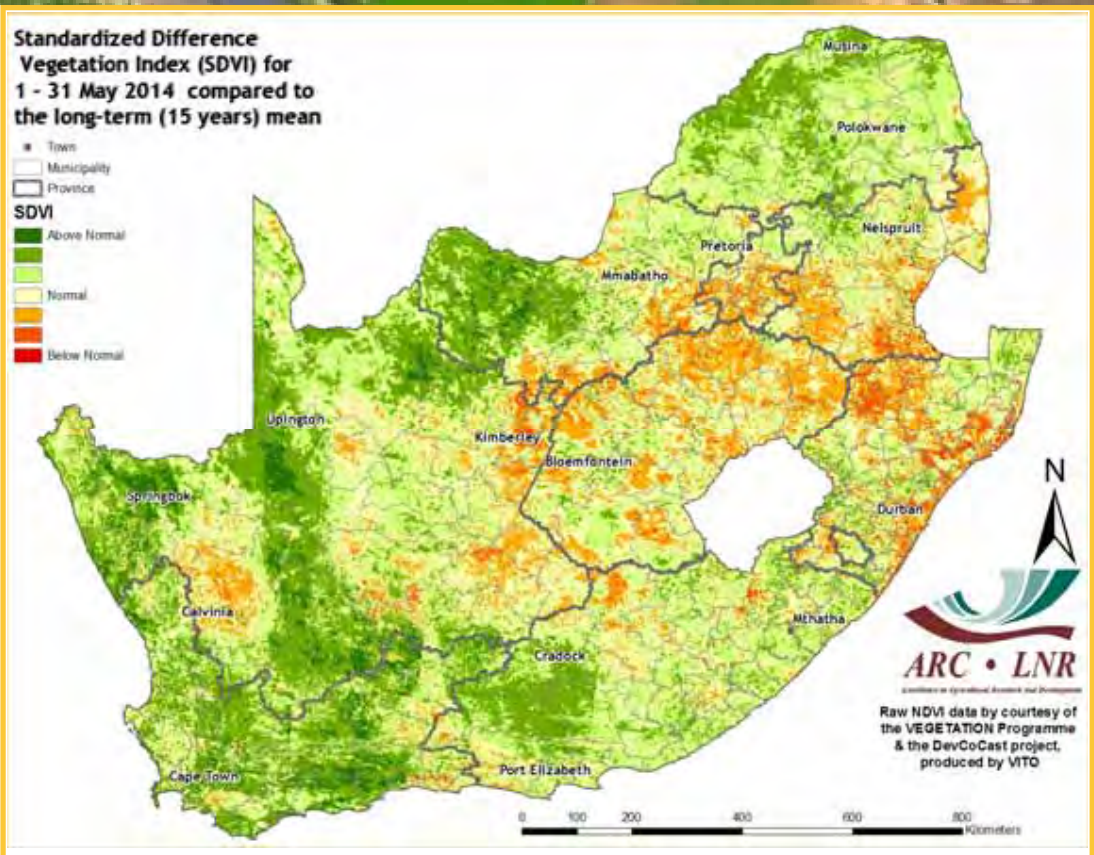

Figure 12

Figure 12:
Relatively dry conditions at the 3-monthly to 12-monthly time scale indicated in the rainfall maps are also reflected in relatively low vegetation activity over especially some parts of KwaZulu-Natal and isolated areas in the Free State. Vegetation activity is above normal over much of the northern and southern thirds of the country, including most of the winter rainfall area in the southwest.

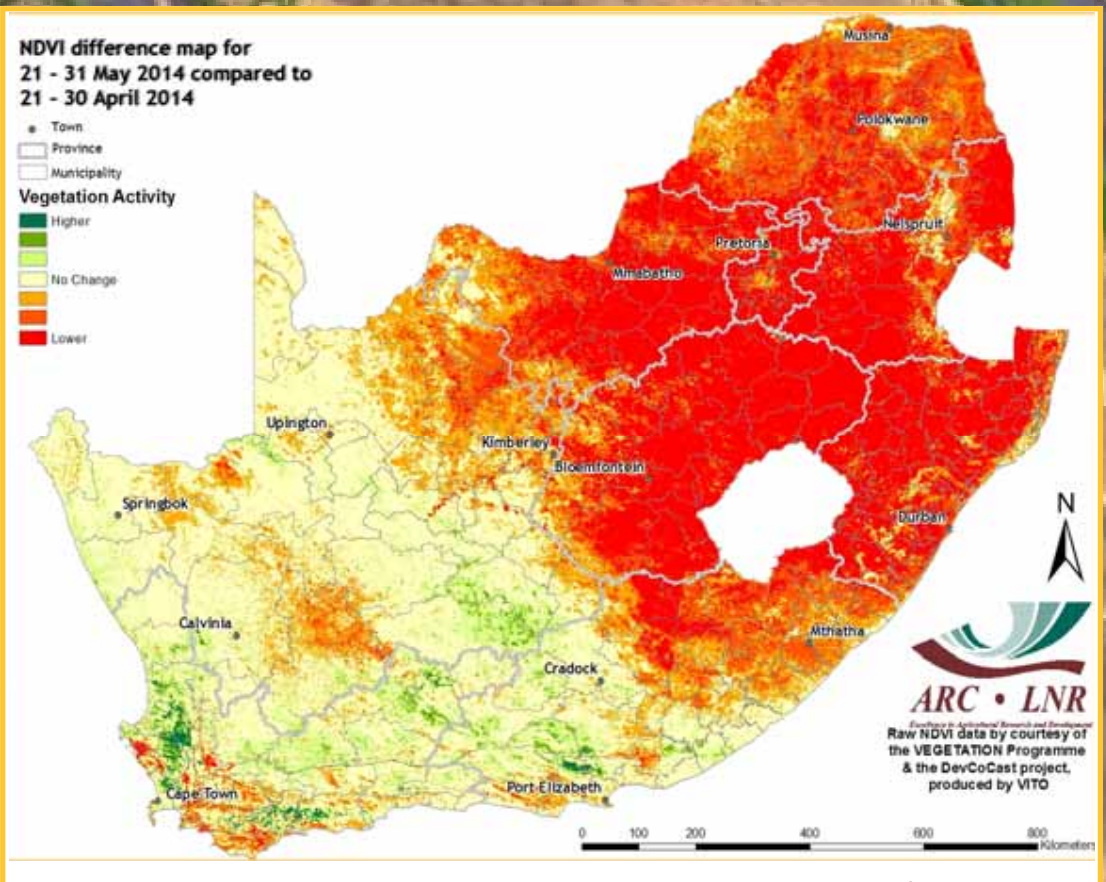

Figure 13

Figure 13:
The onset of winter resulted in a large decrease in vegetation activity over much of the central to northeastern interior due to dry conditions and low minimum temperatures, while wet conditions over the winter rainfall region and western interior resulted in an increase of vegetation activity over those parts. Part of the important grain production region in the southwest shows a large increase in activity, partially attributed to the emergence of crops.

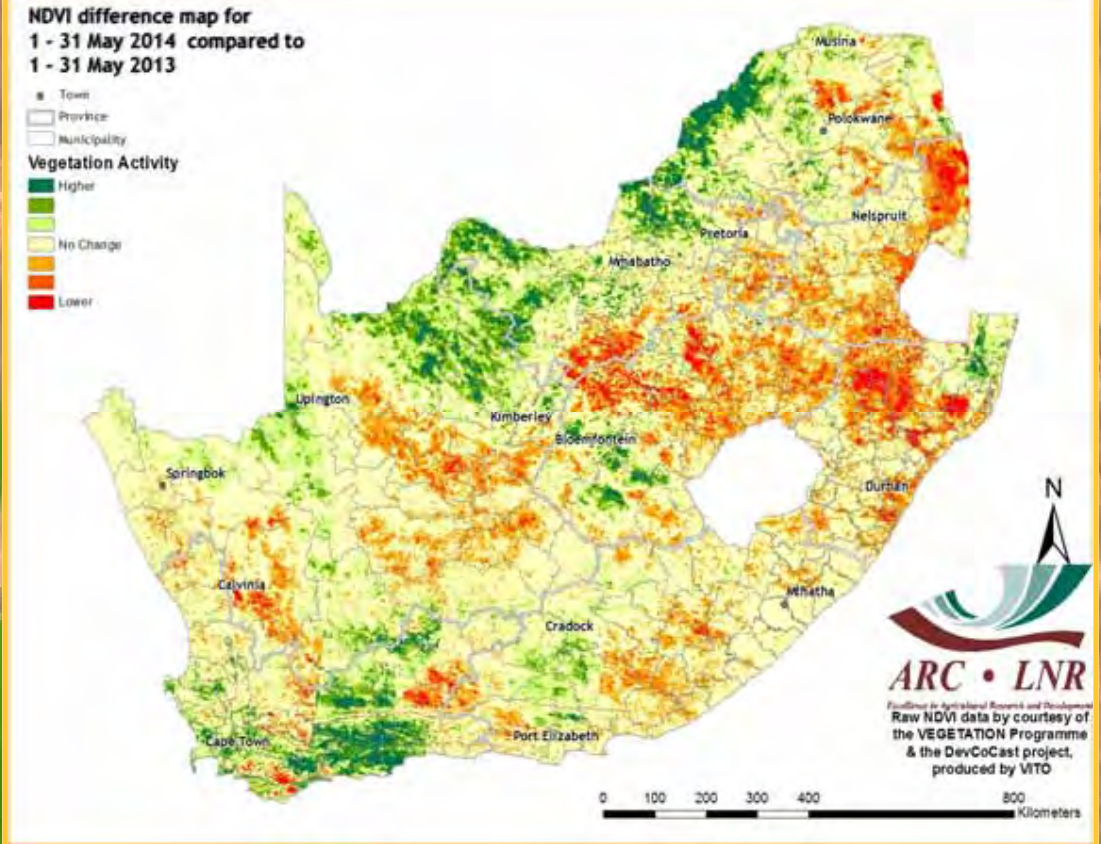

Figure 14

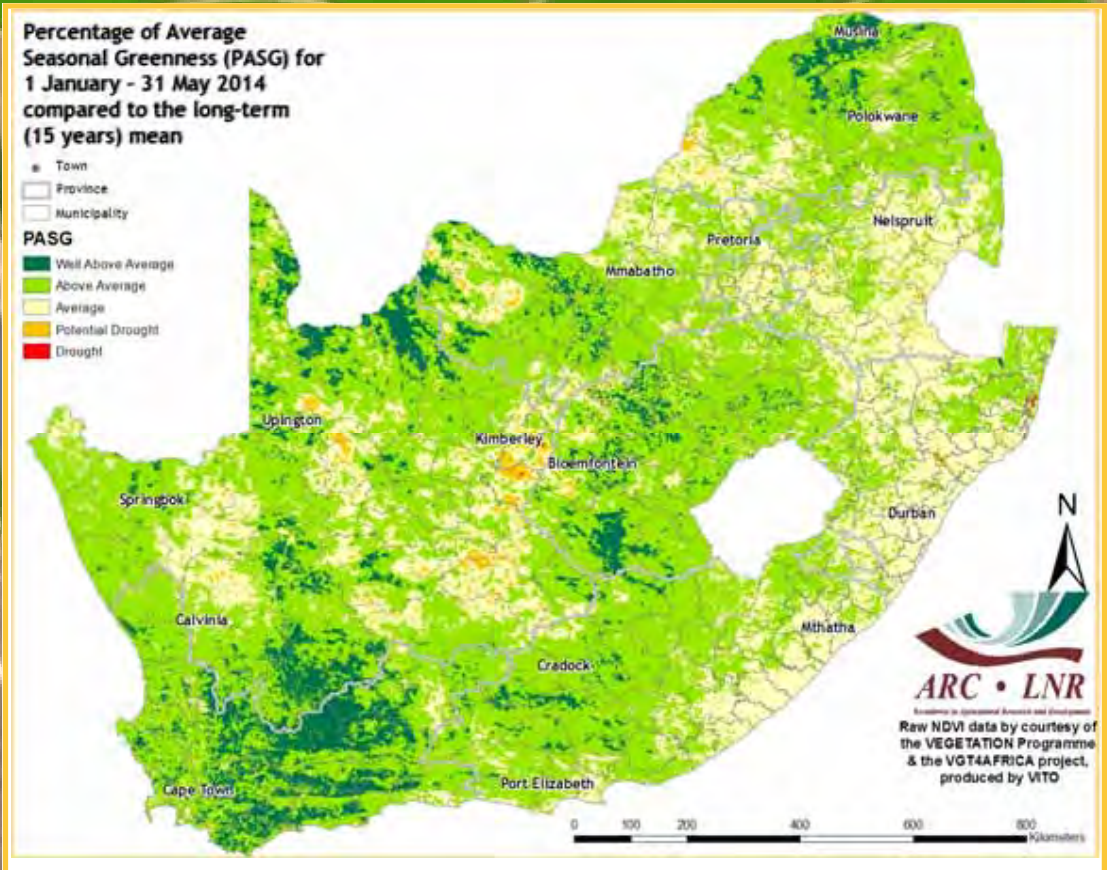

Figure 15

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:
While vegetation activity exceeds that of a year ago over the northwestern interior and parts of the winter rainfall area, parts of KwaZulu-Natal, Mpumalanga and the Free State experienced much lower vegetation activity than during 2013 in May.

Figure 15:
Cumulative vegetation activity since January has been above normal over the majority of South Africa. Exceptions are small areas over the extreme eastern Northern Cape where activity is below normal and the southern parts of Mpumalanga, large parts of KwaZulu-Natal and the eastern parts of the Eastern Cape where cumulative activity has been near normal.

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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.

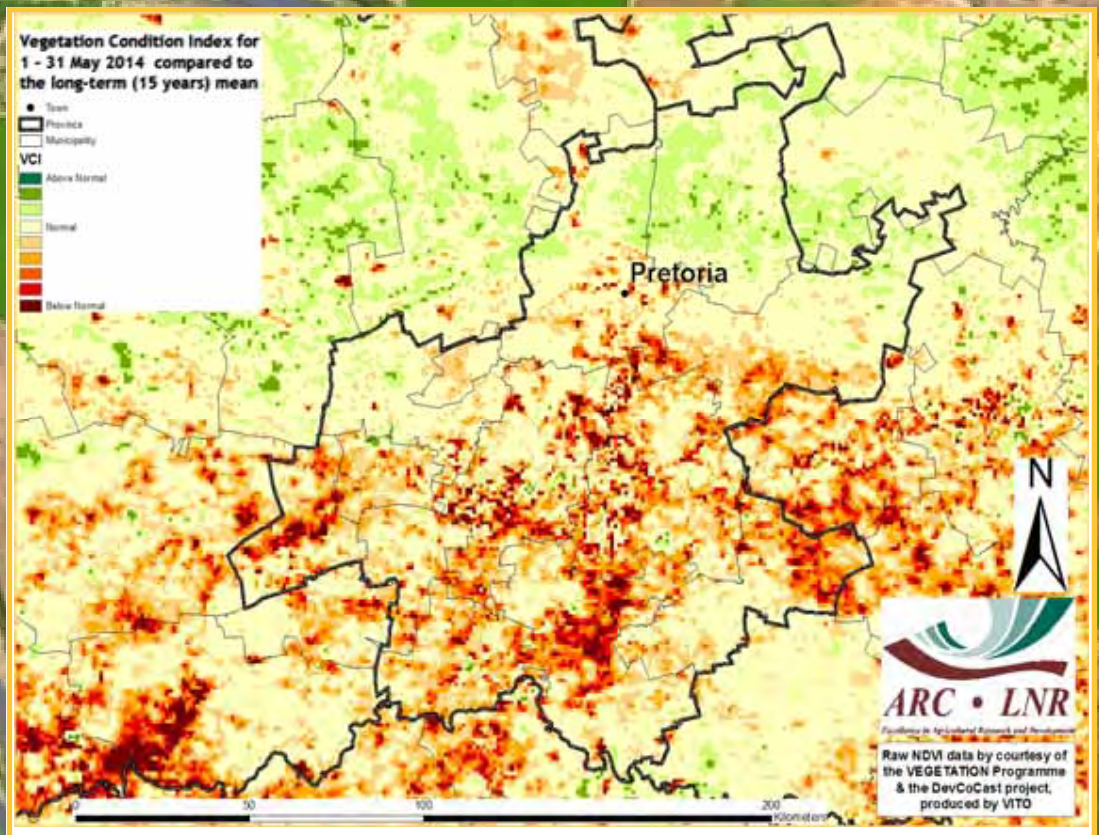

Figure 16

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

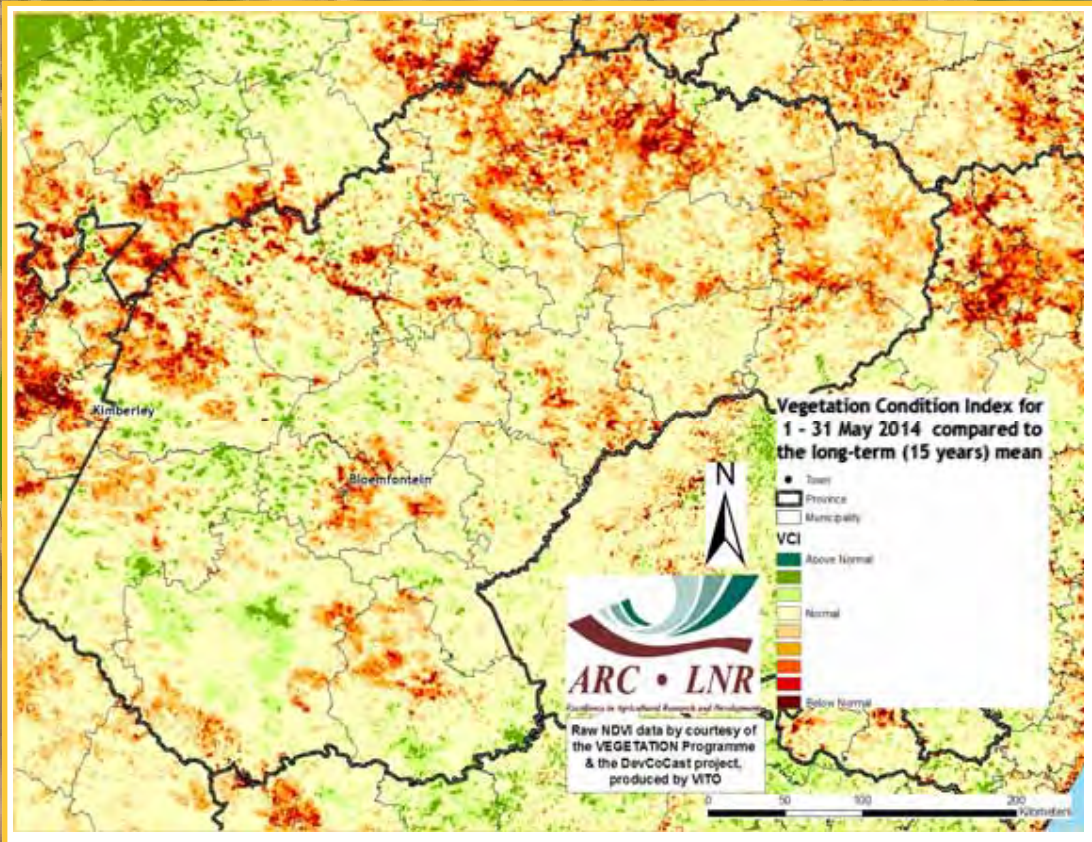

Figure 17

Figure 17:
The VCI map for May indicates below-normal vegetation activity over most parts of the Free State.

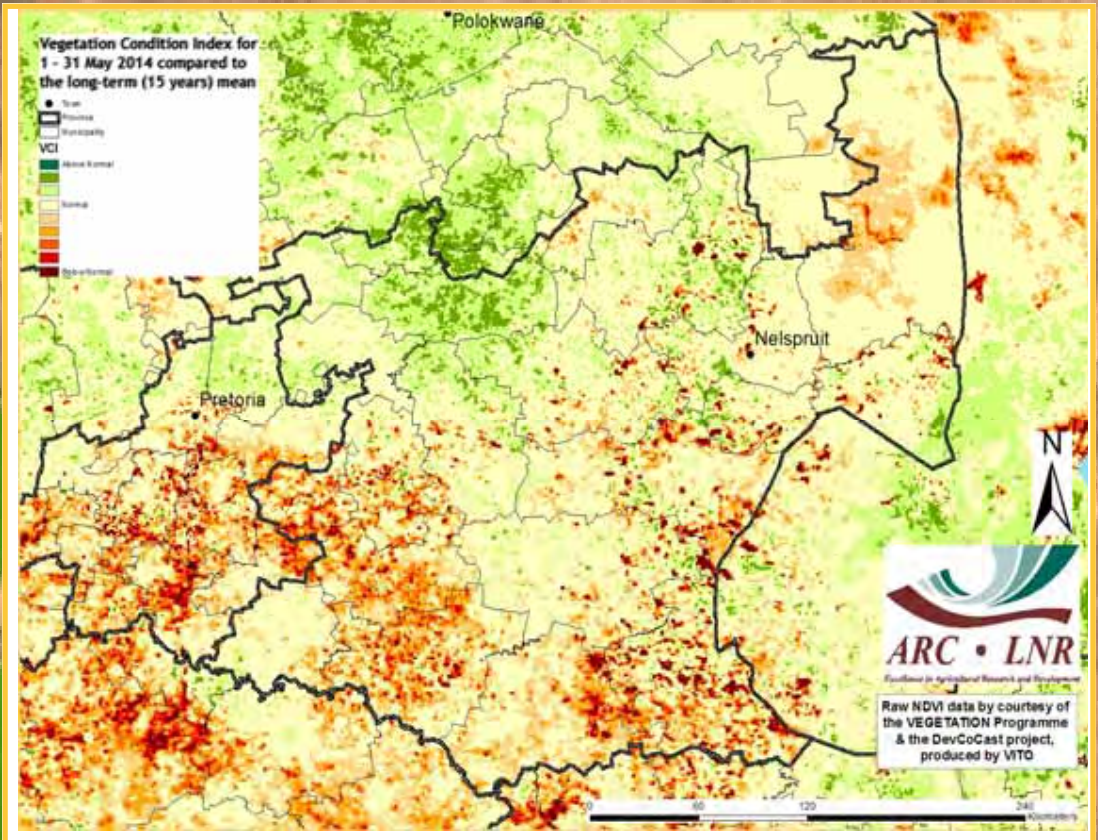

Figure 18

Figure 18:
The VCI map for May indicates below-normal vegetation activity over most parts of Mpumalanga.

Figure 19:
The VCI map for May indicates below-normal vegetation activity over most parts of KwaZulu-Natal.

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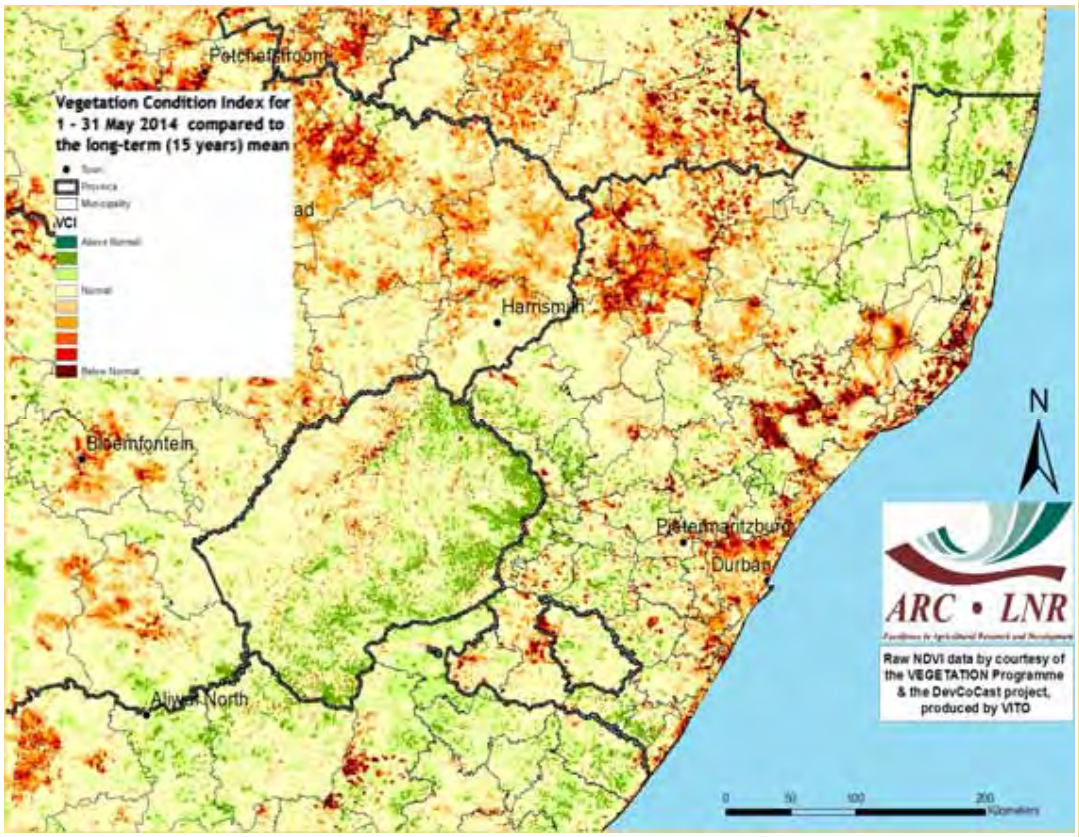

Figure 19

7. Vegetation Conditions & Rainfall

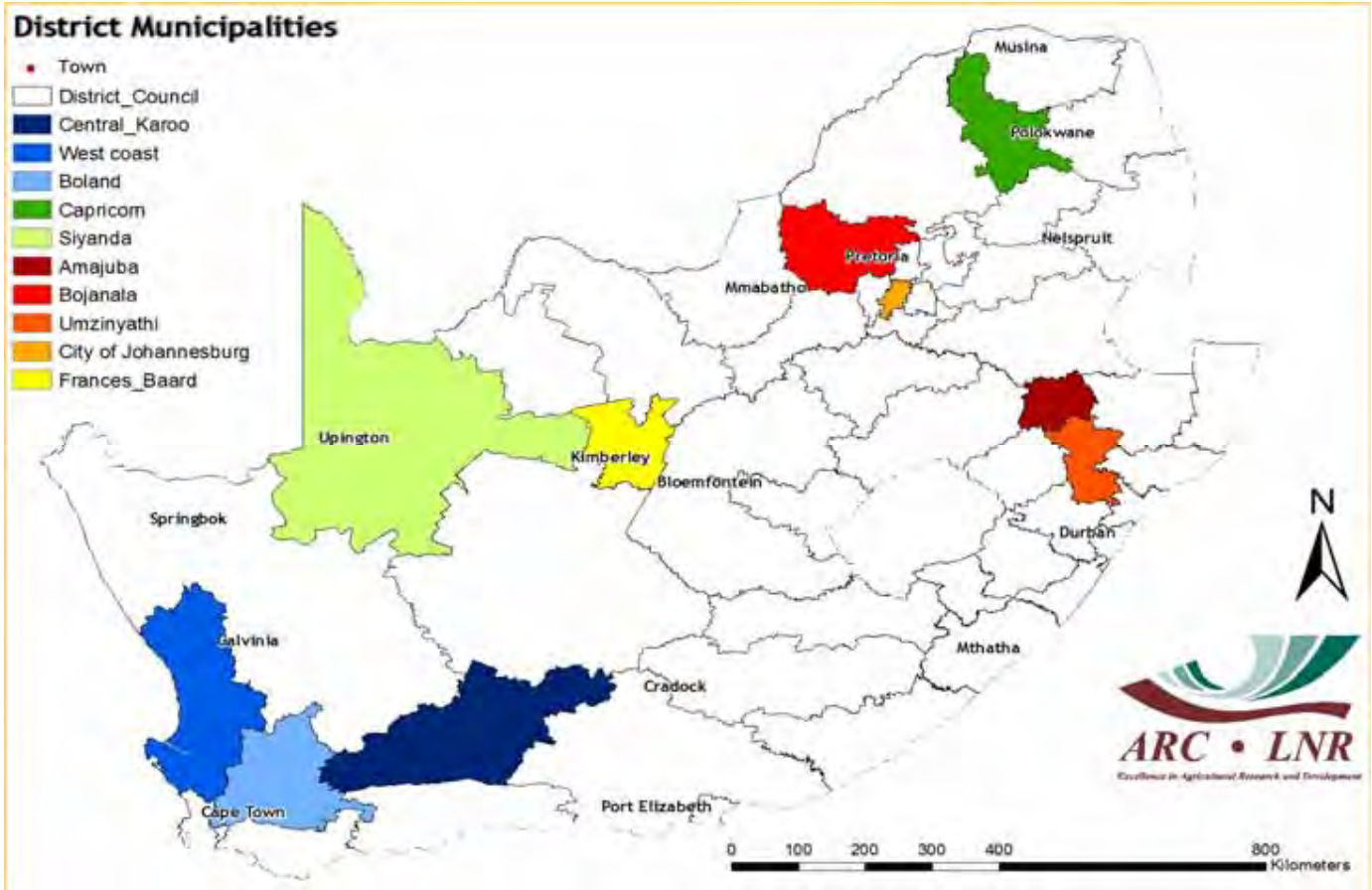

Figure 20

NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for May 2014. The district colour matches the border of the corresponding graph.

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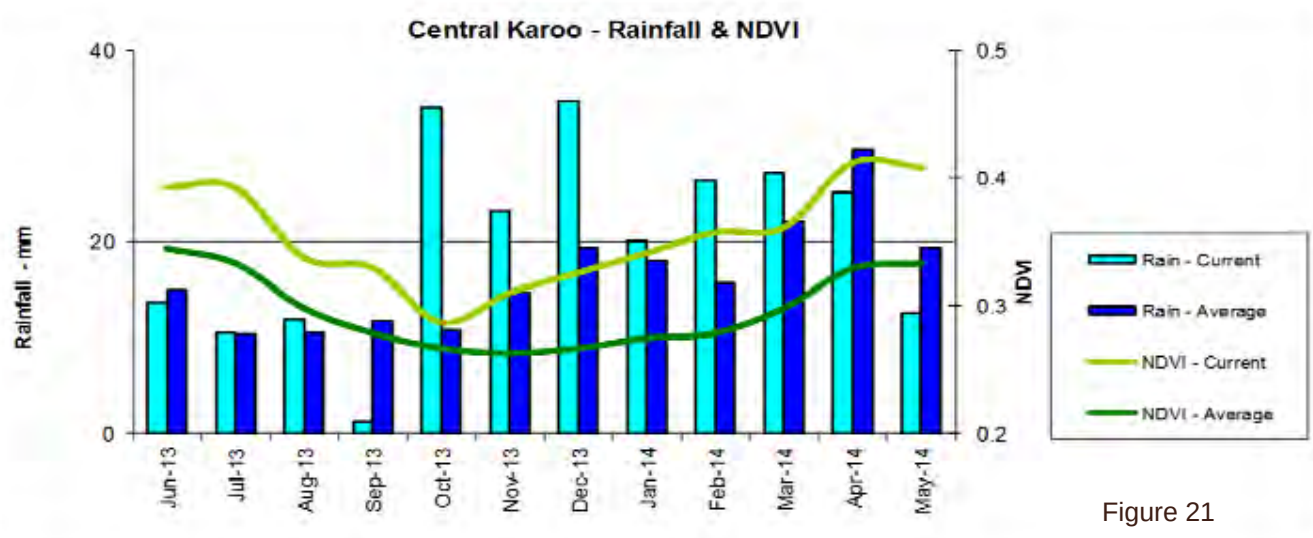
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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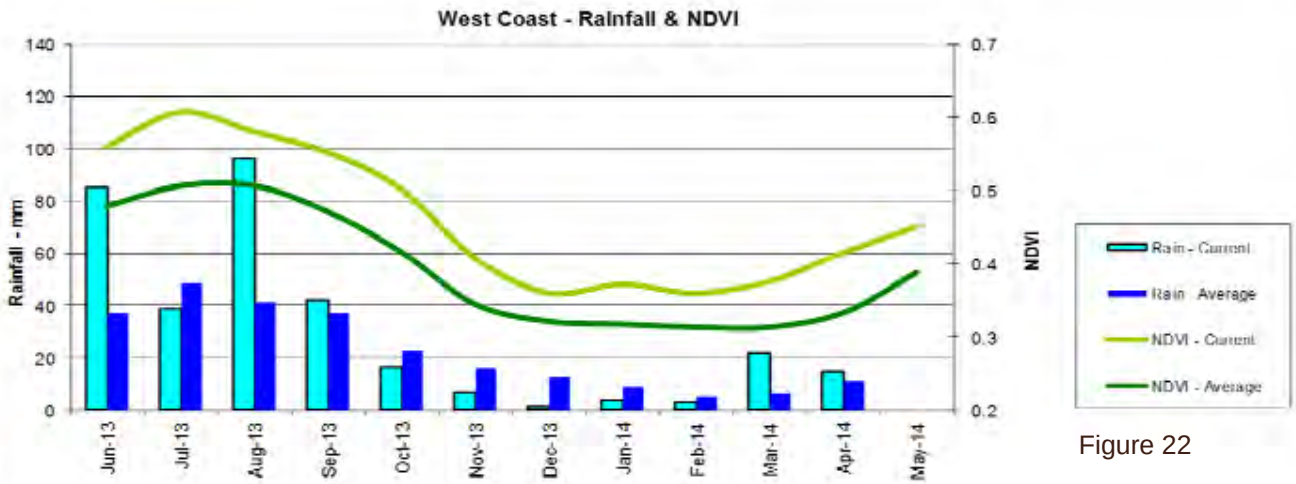

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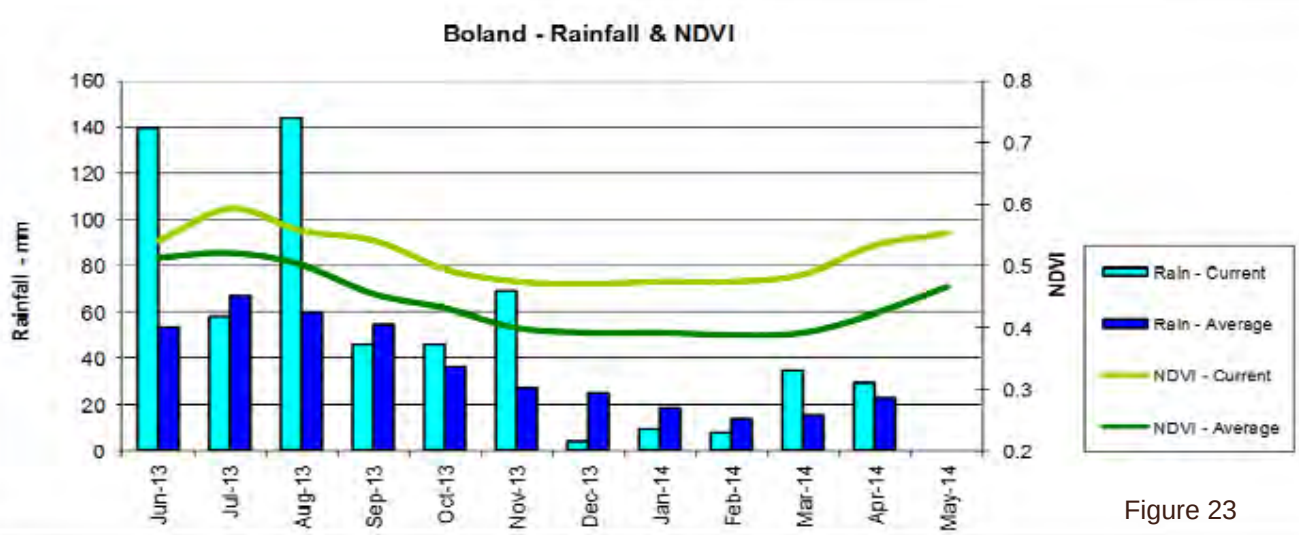

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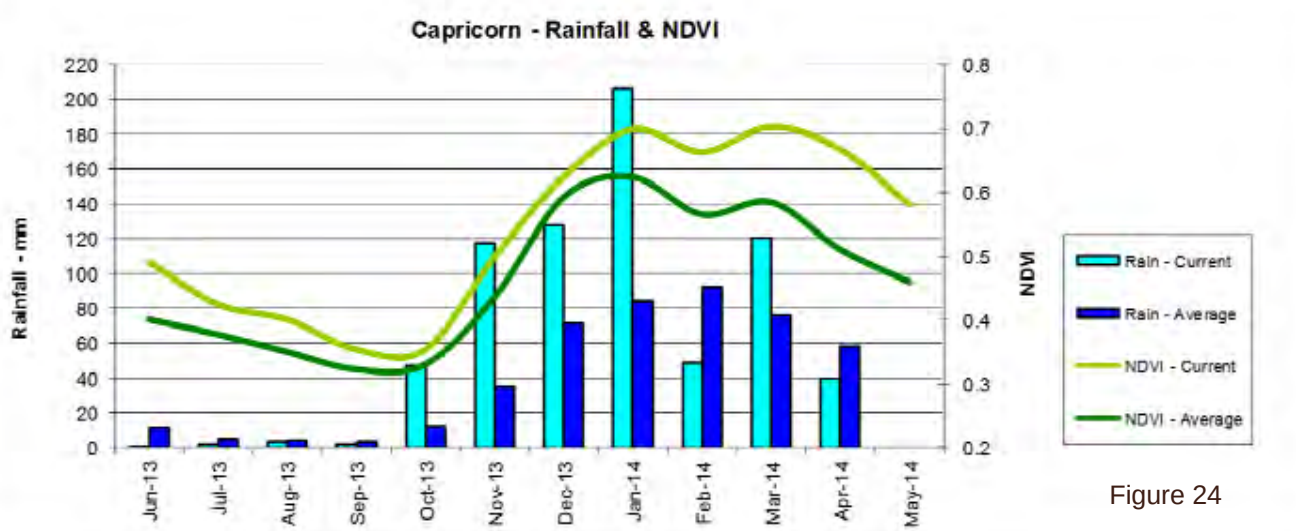

Figure 24

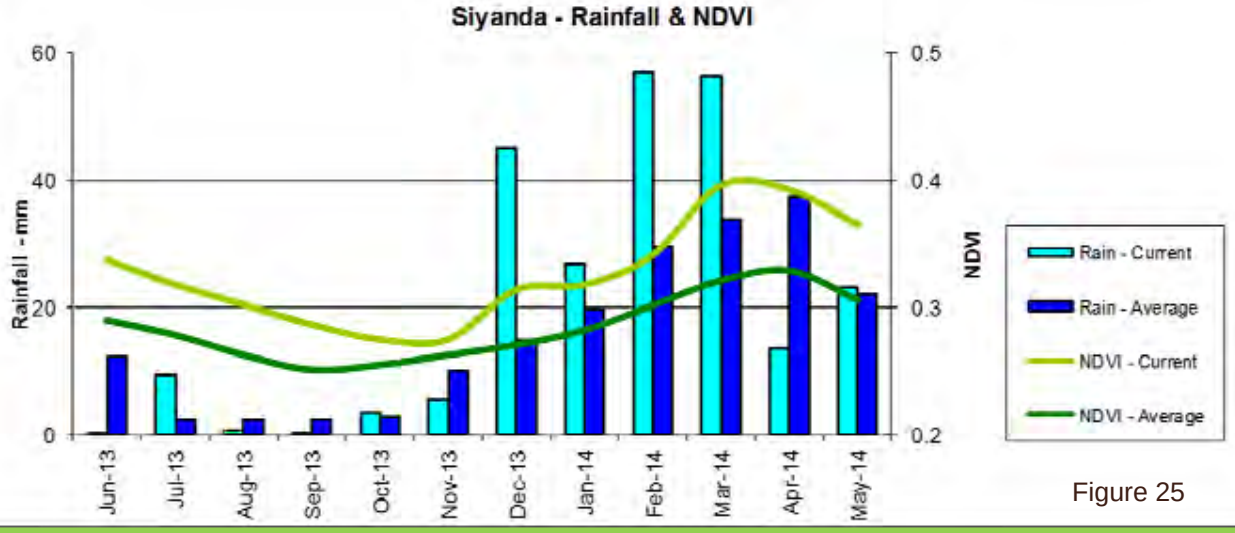

Figure 25

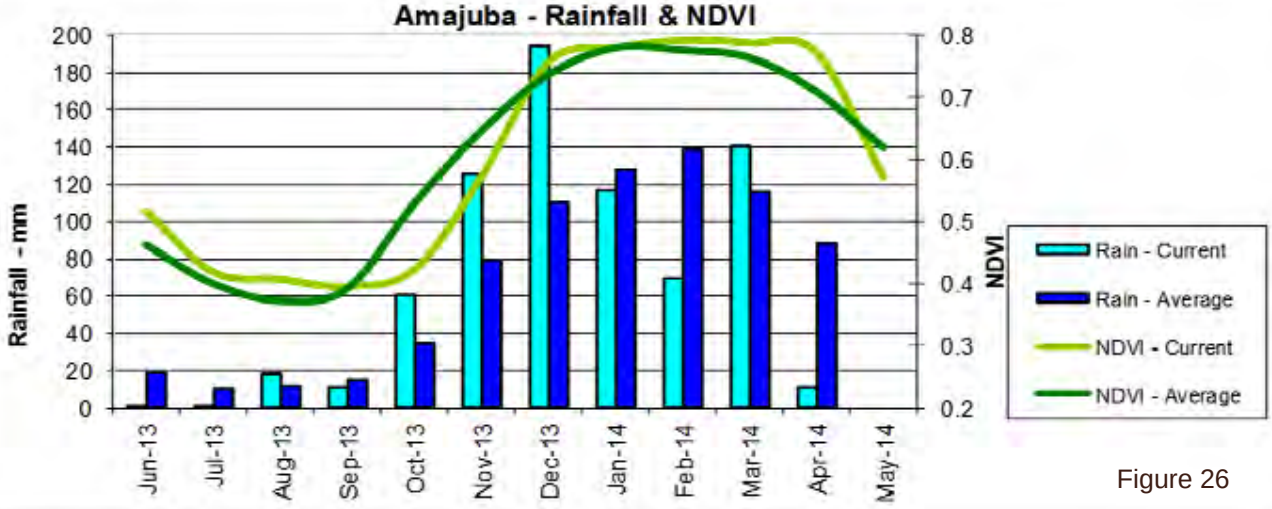

Figure 26

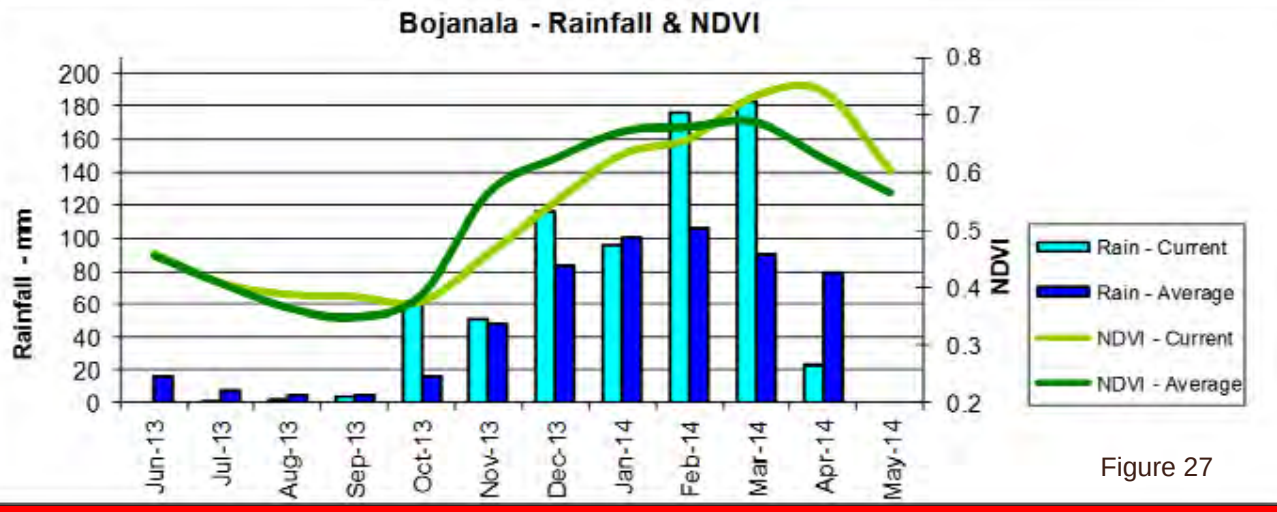

Figure 27

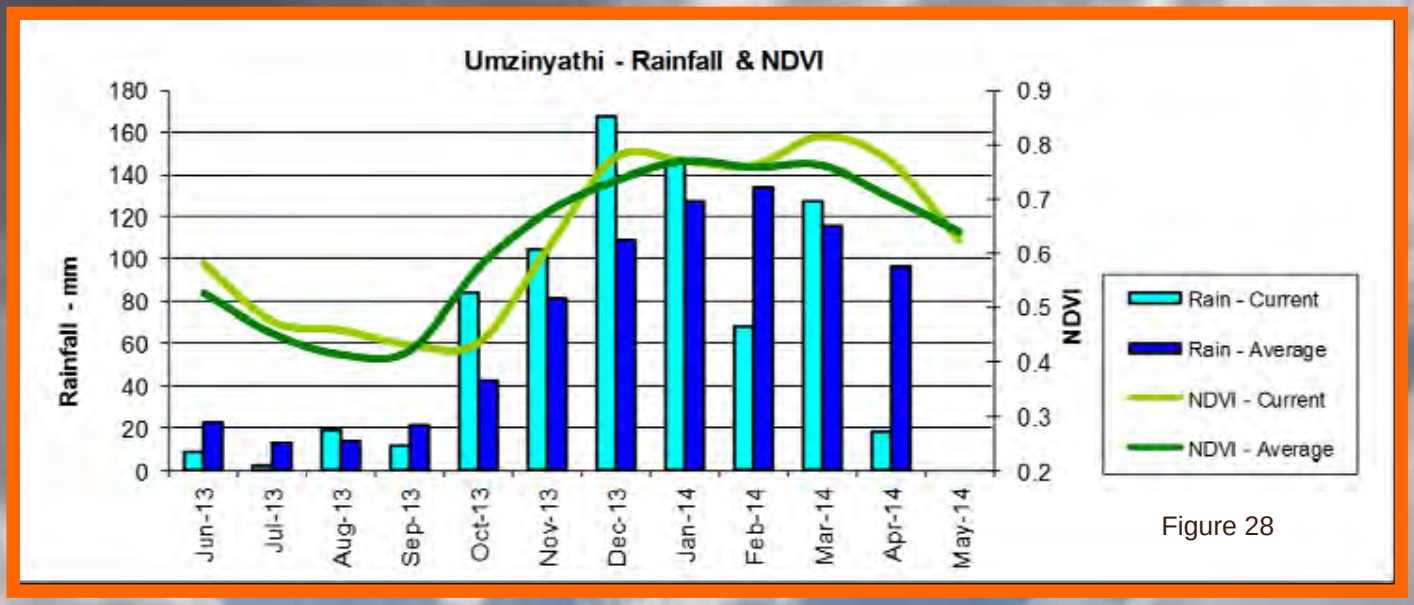

Figure 28

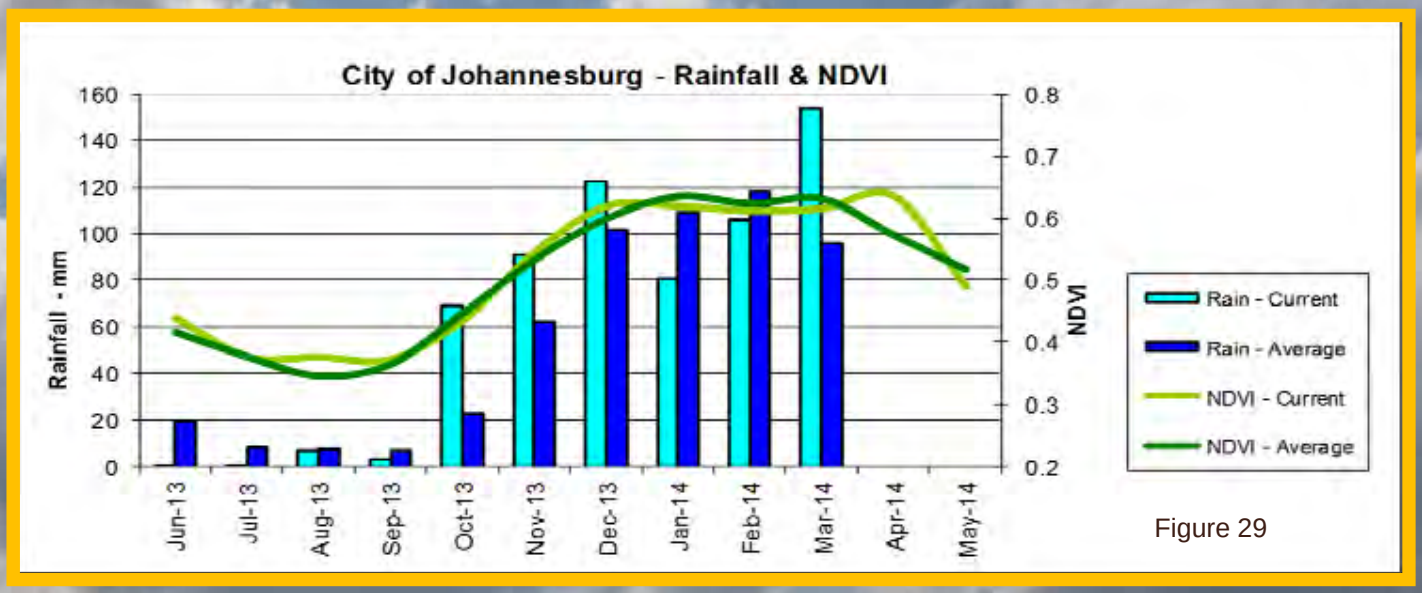

Figure 29

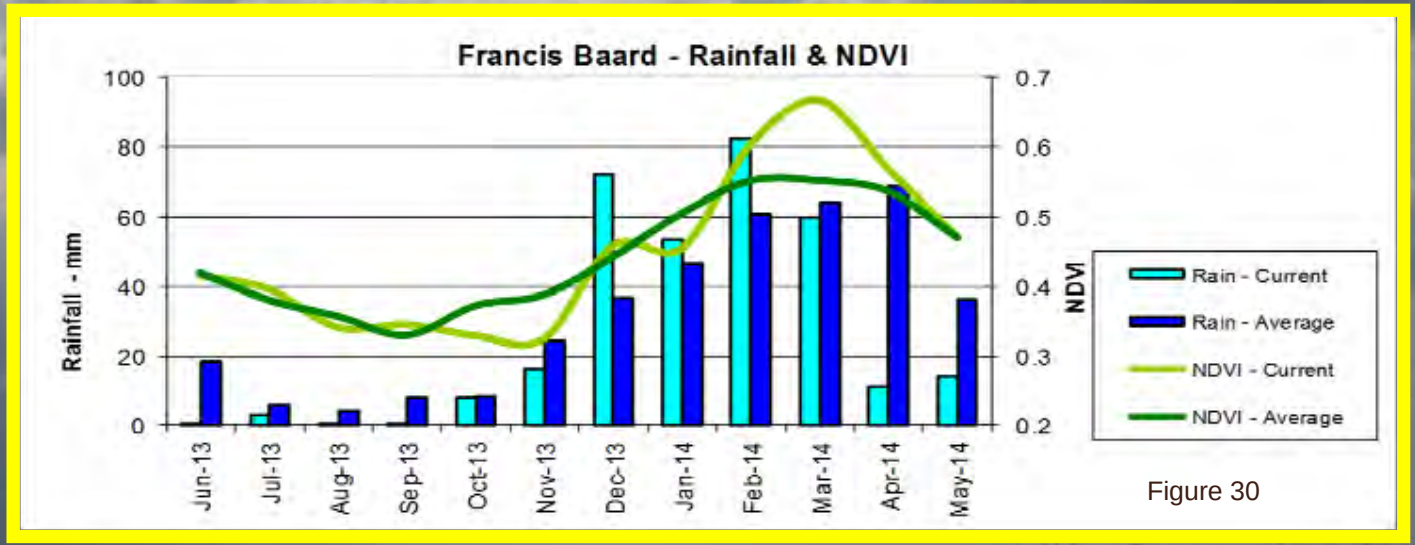

Figure 30

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 May per province. Fire activity was significantly higher in Gauteng, Mpumalanga and KwaZulu-Natal compared to the average for the same period for the last 13 years.

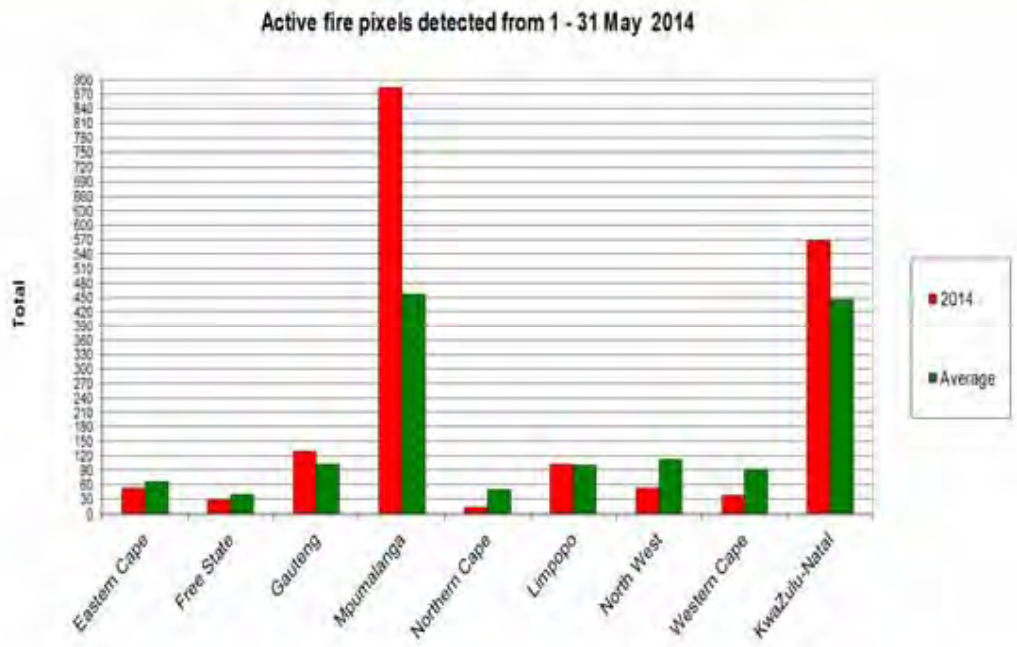

Figure 31

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

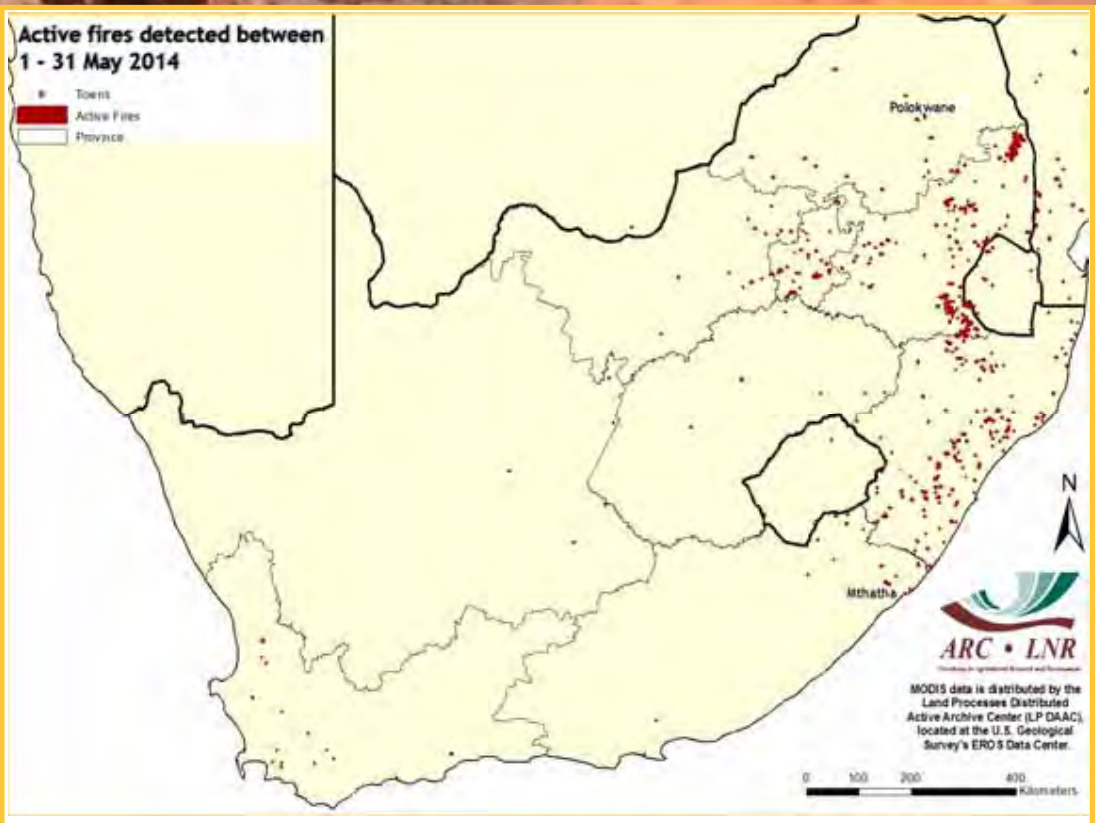

Figure 32

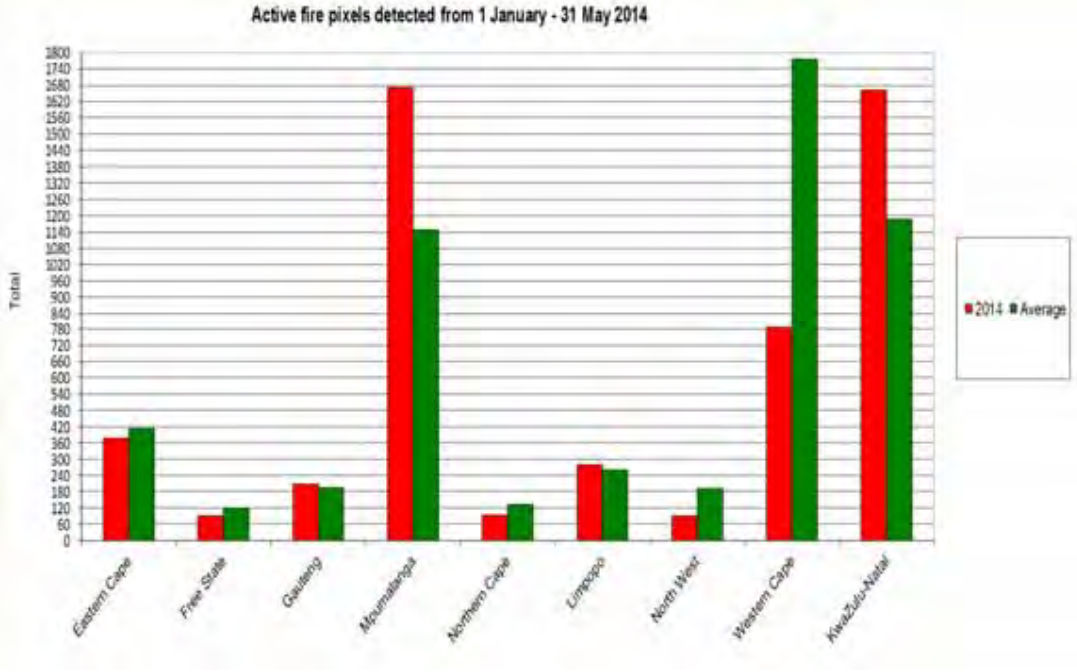

Figure 33

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

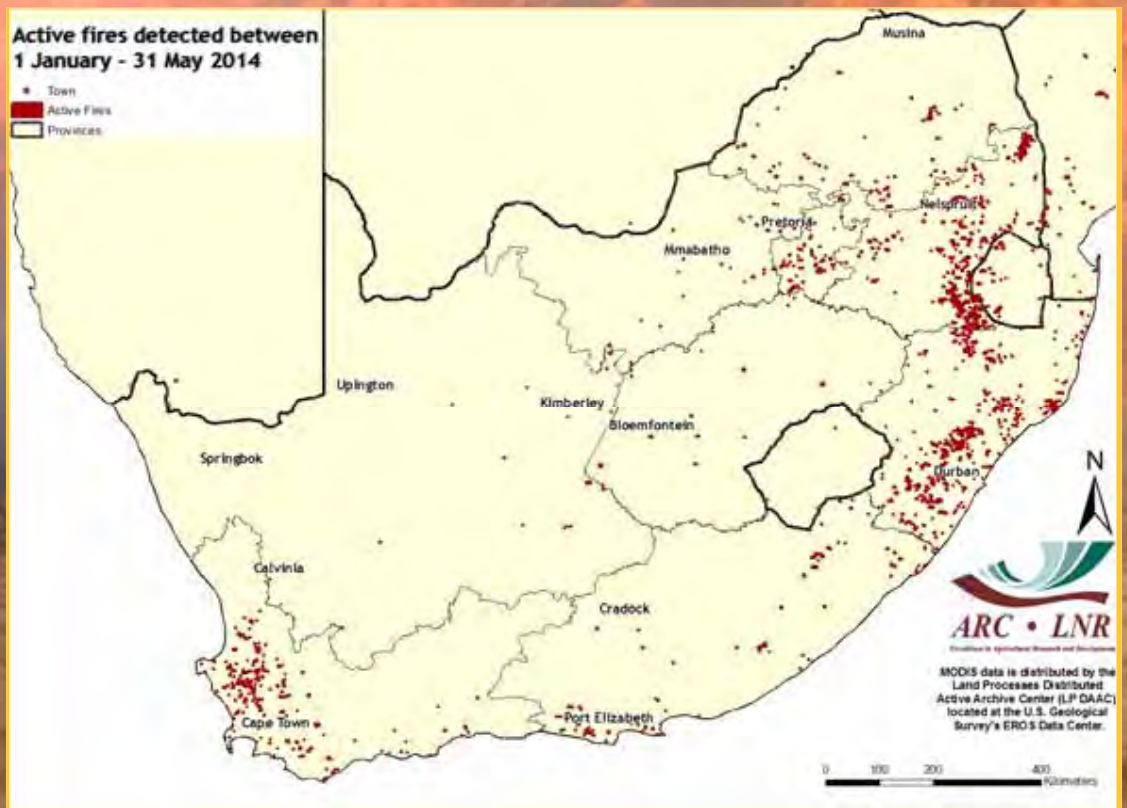

Figure 34

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

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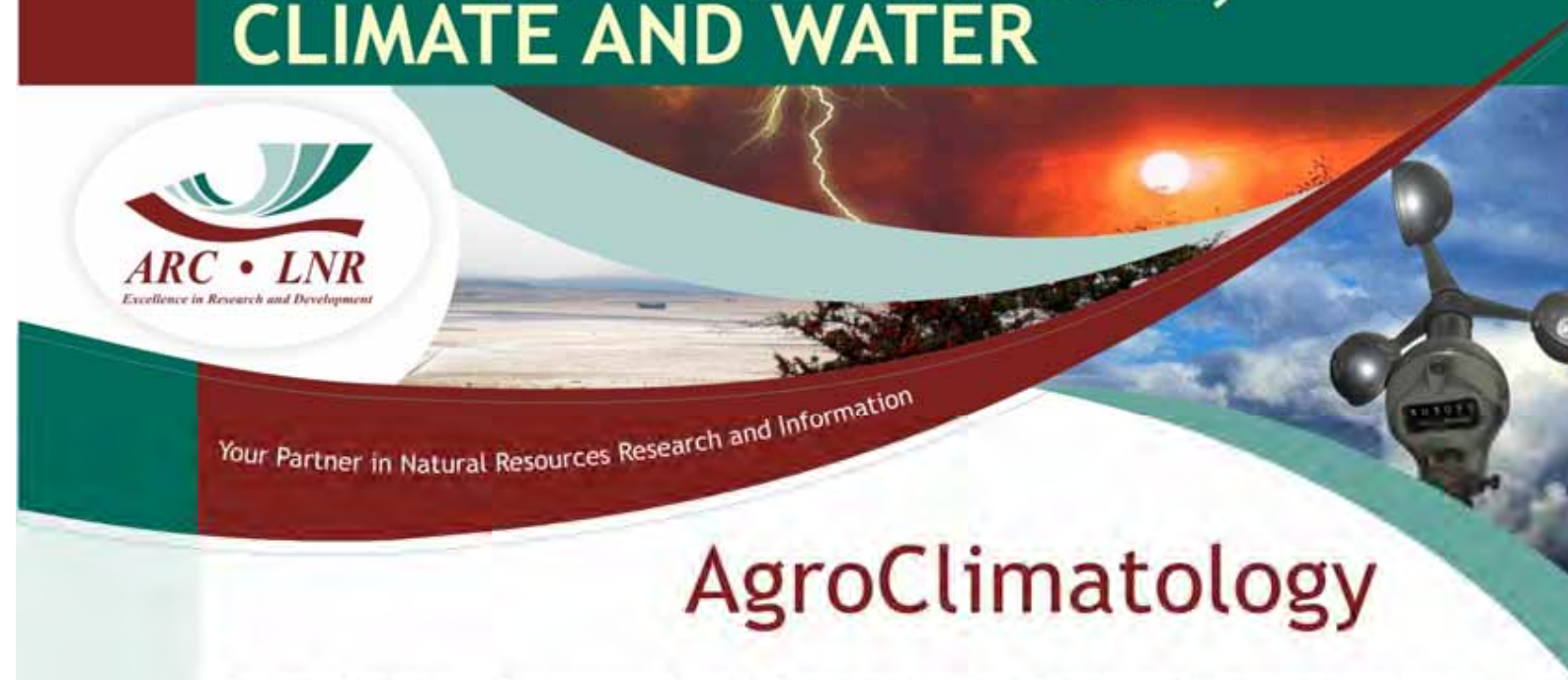

Your Partner in Natural Resources Research and Information

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.

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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