ARC • LNR
Excellence in Agricultural Research and Development

UMLINDI
The Watchman

ISSUE 2015-01 | 15 JANUARY 2015

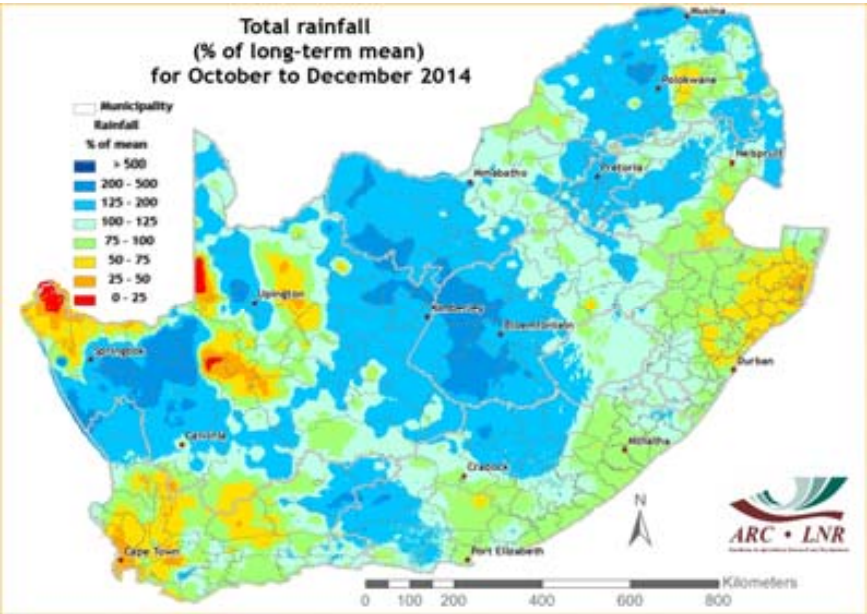
INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

127th Edition

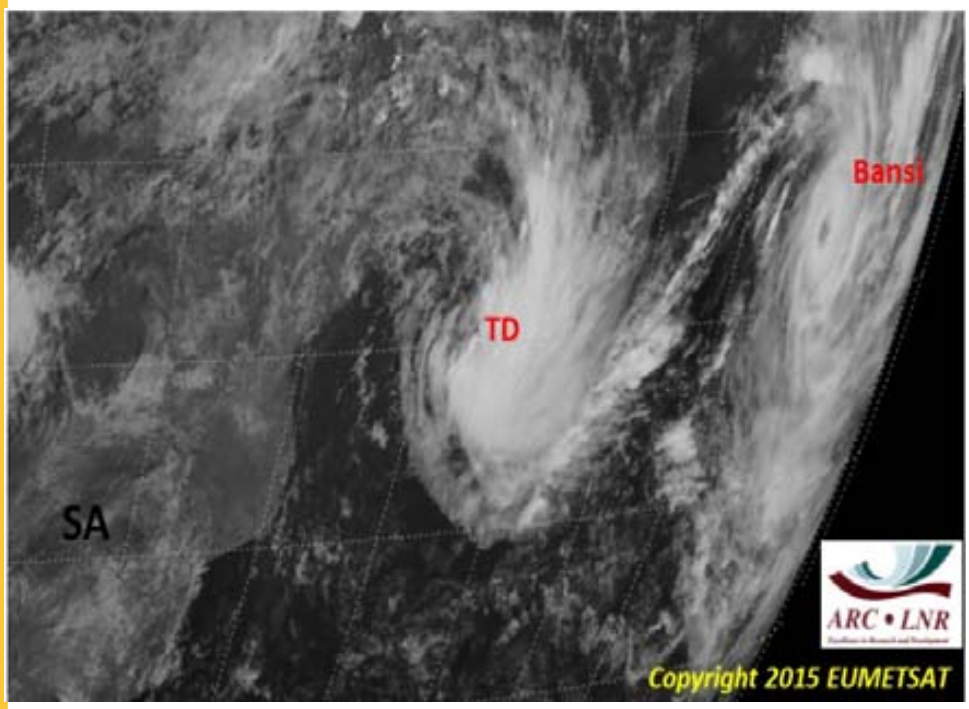
Images of the Month

Above-normal rainfall during early to mid-summer



Rainfall over the summer rainfall area for the early to mid-summer period of October to December 2014 was largely above normal (see map). While October was dry over most parts, most of the rain occurred during November and December. Important exceptions were the southern and northwestern parts of Mpumalanga and north-eastern parts of North West, where maize production may be negatively impacted, as well as the eastern parts of KwaZulu-Natal, where relatively dry conditions have been present for up to 2 years. These anomalies are also visible in the vegetation monitoring products presented later in this newsletter.

Conditions have dried out somewhat across much of South Africa since the end of December, with a mid-summer drought-type pattern resulting in only isolated to scattered thundershowers. One of the main reasons for the drier conditions is the presence of active tropical systems over the southwest Indian Ocean. The MSG-3 visible image for the morning of 15 January 2015 shows a tropical depression (TD) over the Mozambique Channel as well as Category 2 Tropical Cyclone Bansi further east, to the north of Mauritius. Both systems are currently projected to move away from the subcontinent. While these two systems represent the main area of activity, drier subsident conditions to the west over the subcontinent are typical during this situation. This type of pattern is not unusual for early January, and conditions may improve towards the last 10 days of January and possibly again in February.



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:

December 2014 was wet over the central to northeastern parts of the country. While isolated to scattered thundershowers occurred almost every day over large parts of the country, rain of a more widespread nature occurred between the 9th and 12th and from the 25th to the 28th. Due to an easterly to northeasterly flow dominating throughout most of the month, the eastern parts were relatively cool while hot conditions developed towards the central and northwestern interior on several occasions. Hot conditions with maximum temperatures exceeding 40°C also developed over the far eastern parts by the 25th.

The month started off with relatively dry conditions after the rains by the end of November. Conditions slowly became more favourable for precipitation from the 5th as atmospheric moisture increased over the interior due to the ridging of high pressure systems to the south of the country and an anticyclonic circulation to the east over the Indian Ocean. From the 9th to the 12th, upper air troughs in the southwest facilitated the advection of large amounts of tropical moisture from the north while several high pressure systems ridging around the country resulted in increased moisture. Widespread showers and thundershowers occurred over the central to northeastern parts. Relatively favourable conditions continued during the middle of the month, with moisture from the Indian Ocean and some upper air perturbations moving across the interior being the main reason for the development of scattered thundershowers in many places. Throughout this period there was also an active tropical low over Angola and northern Botswana, providing tropical moisture to the interior. A fast moving upper air trough by the 17th also resulted in the movement of the tropical low in the north to regions northeast of South Africa, heralding a period during which thunderstorms of a more isolated nature dominated, with a few large storm systems in the northeast due to upper air perturbations in that region. Rainfall extent decreased towards the 24th and hot conditions developed over many parts, including KwaZulu-Natal where maximum temperatures exceeded 40°C by the 25th. Thereafter, a deep tropical low developed over eastern Botswana and western Zimbabwe. With an upper air trough moving into the country from the west, large amounts of moisture were introduced together with instability over the interior.

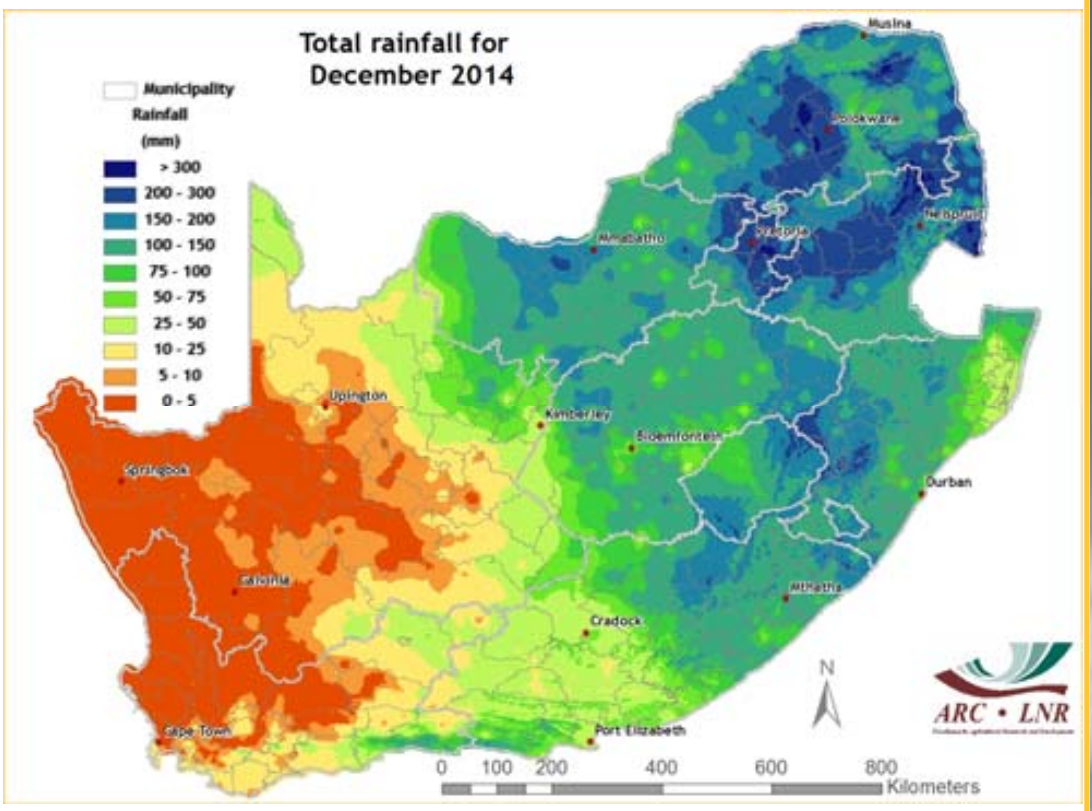


Figure 1

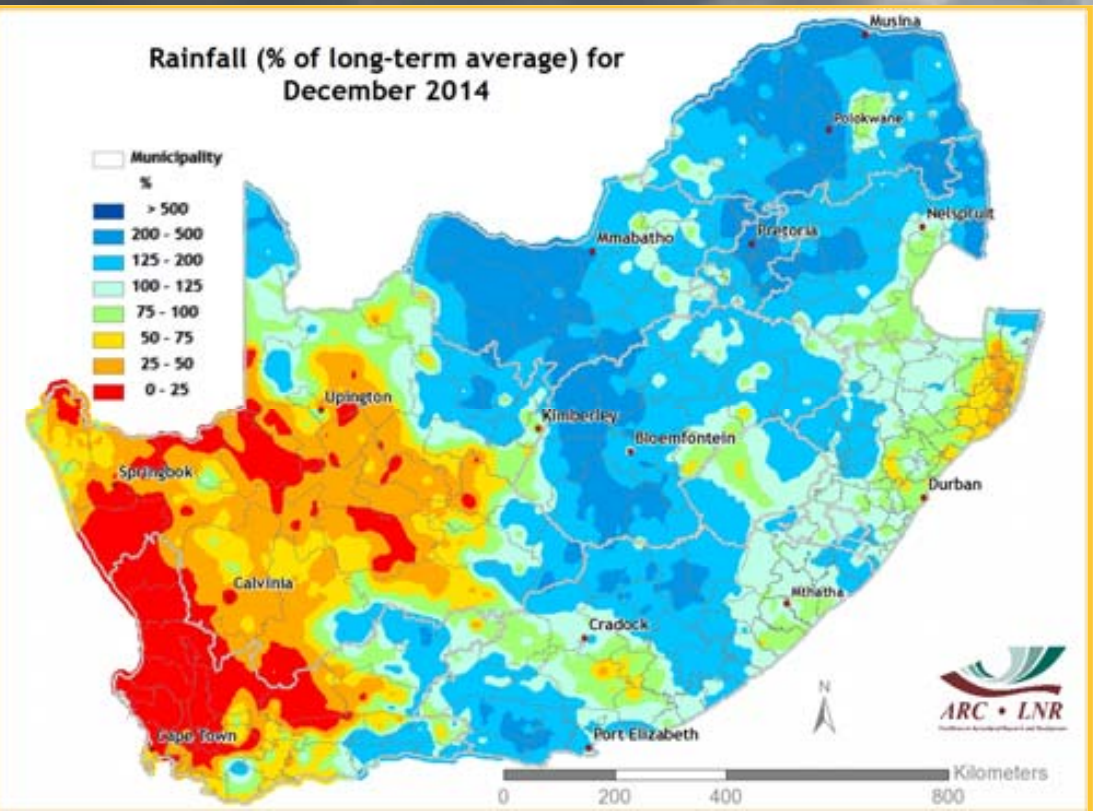


Figure 2

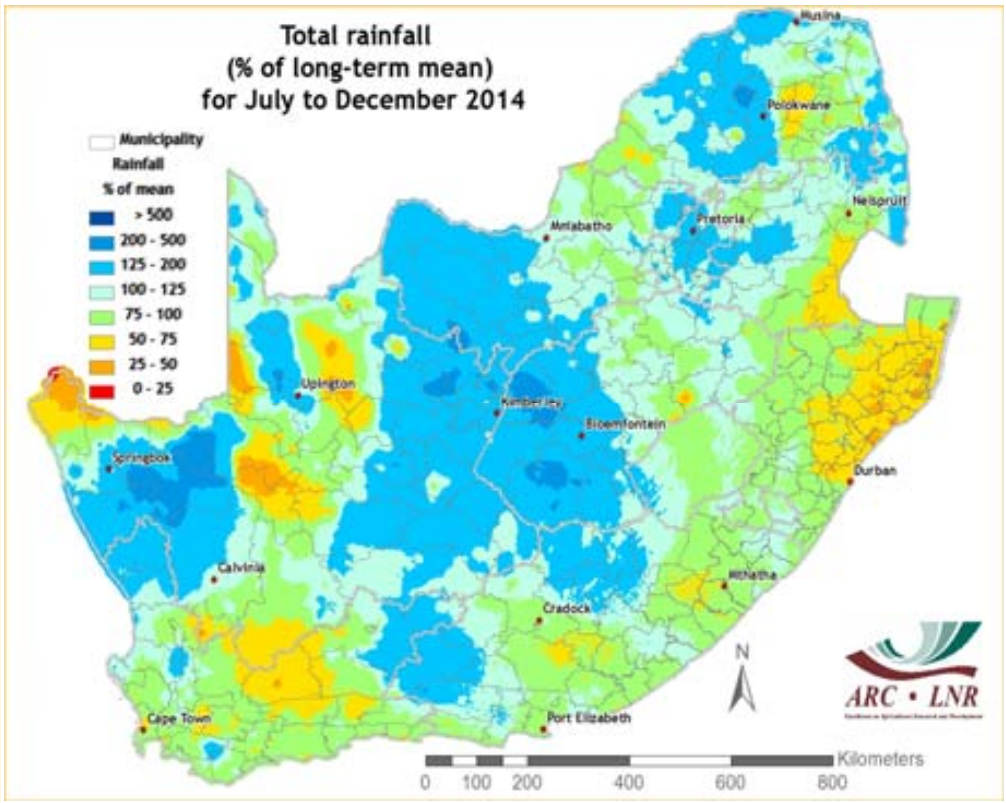


Figure 3

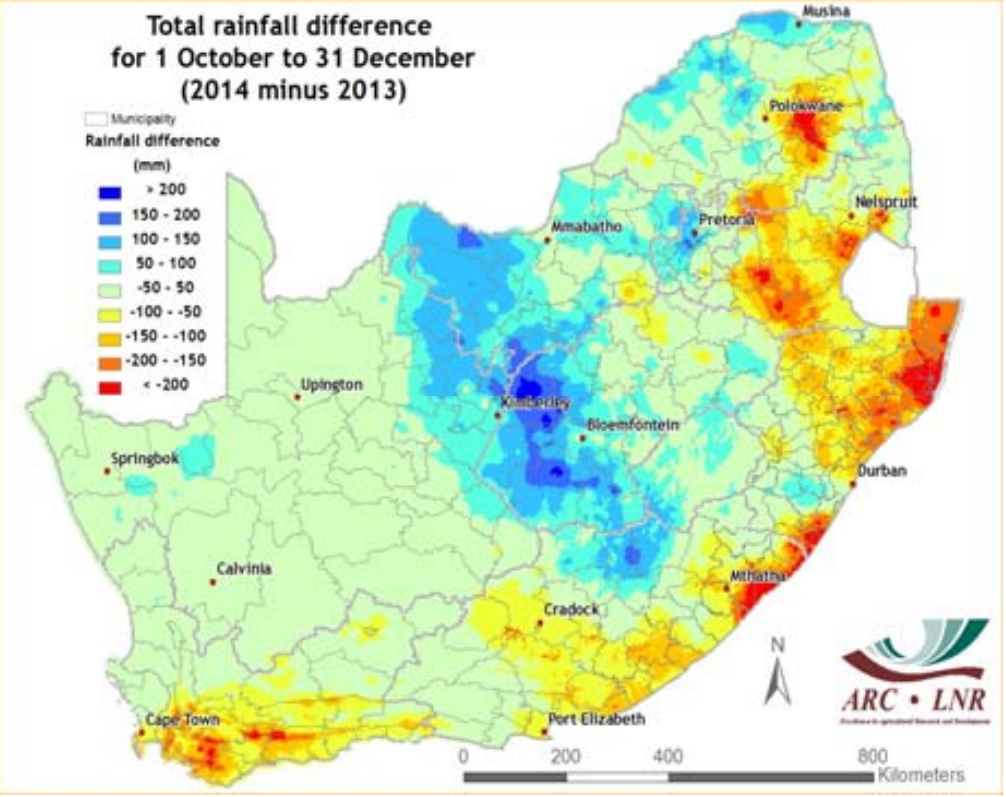


Figure 4

Some rain also occurred over the winter rainfall area due to frontal activity associated with the upper air trough. Moisture from east was also available over the interior due to an anticyclonic circulation over the Indian Ocean. Many stations in the north and east recorded in excess of 50 mm per day while daily totals exceeded 100 mm at several stations in Gauteng, Mpumalanga and Limpopo from the 26th to the 28th. The tropical low relocated to the northeast of South Africa by the end of the month, with only isolated to scattered thundershowers over the Highveld and surrounding regions, while drier conditions began to dominate over the rest of the country.

Questions/Comments:
Johan@arc.agric.za

Figure 1:
Most of the eastern two-thirds of the country received in excess of 100 mm during December. A notable exception was the northern coast and adjacent interior of KwaZulu-Natal. Large parts of Gauteng, Mpumalanga and Limpopo received in excess of 200 mm. Some stations along the Escarpment recorded higher totals, exceeding 300 mm.

Figure 2:
Most of the central to northeastern interior received above-normal rainfall with large areas receiving more than 200% of the long-term average. Total rainfall was below normal over the western region, excluding parts of the Karoo and the Garden Route, and was also below normal over the eastern parts of KwaZulu-Natal.

Figure 3:
Since July, precipitation has been normal to above normal over much of the central, western and northern interior and near normal over the winter rainfall area. Below-normal rainfall occurred over the southwestern parts of the Northern Cape and eastern KwaZulu-Natal and Mpumalanga.

Figure 4:
Early to mid-summer rainfall was much higher this year over the central to northern interior than in 2013 and much lower along the southern and eastern coastal regions and adjacent interior as well as the eastern interior.

Questions/Comments:
Johan@arc.agric.za

2. Standardized Precipitation Index

Standardized Precipitation Index

The Standardized Precipitation Index (SPI - McKee *et al*., 1993) was developed to monitor the occurrence of droughts from rainfall data. The index quantifies precipitation deficits on different time scales and therefore also drought severity. It provides an indication of rainfall conditions per quaternary catchment (in this case) based on the historical distribution of rainfall.

REFERENCE:
McKee TB, Doesken NJ and Kliest J (1993) The relationship of drought frequency and duration to time scales. In: Proceedings of the 8th Conference on Applied Climatology, 17-22 January, Anaheim, CA. American Meteorological Society: Boston, MA; 179-184.

The current SPI maps (Figures 5-8) show that wet conditions dominate over the central to northern and northeastern parts at the 3 to 12-month time scales. At the 24-month time scale, the southwestern parts and northeast are wet, while mild to moderate drought conditions are indicated in pockets over the central to southeastern parts. Towards eastern KwaZulu-Natal, severe drought conditions are indicated at both the longer and shorter time scales.

Questions/Comments:
Johan@arc.agric.za

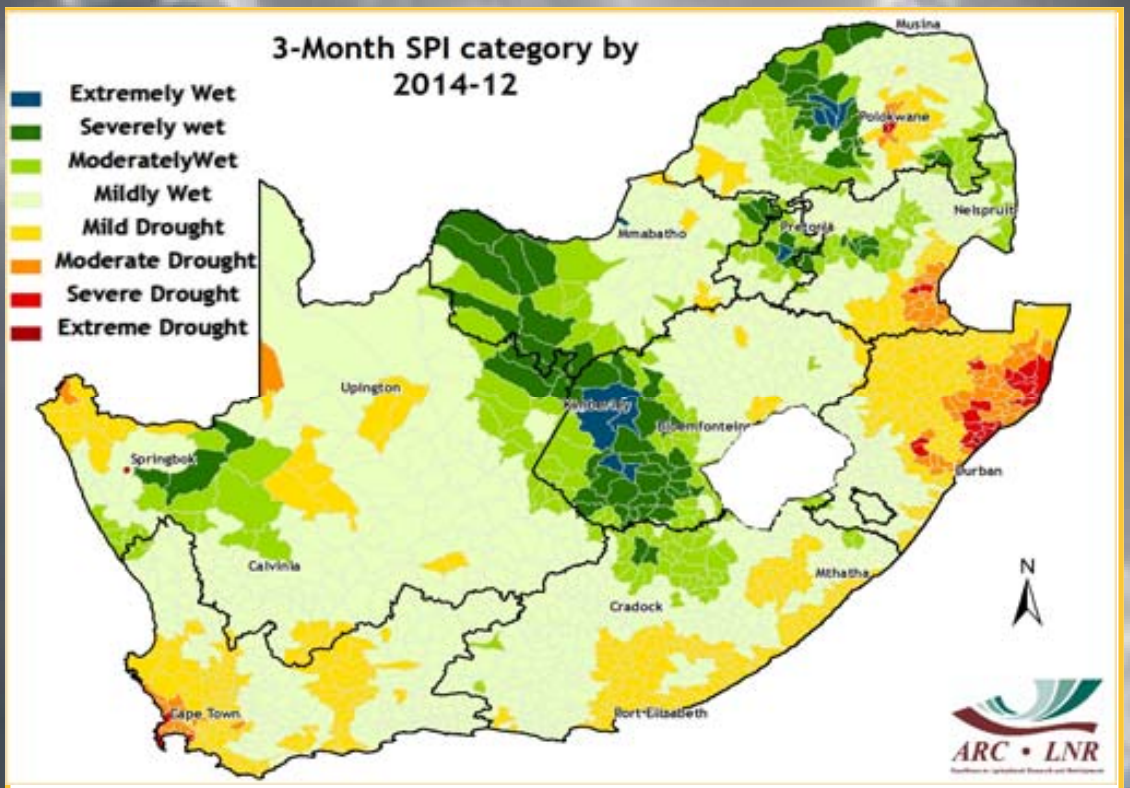


Figure 5

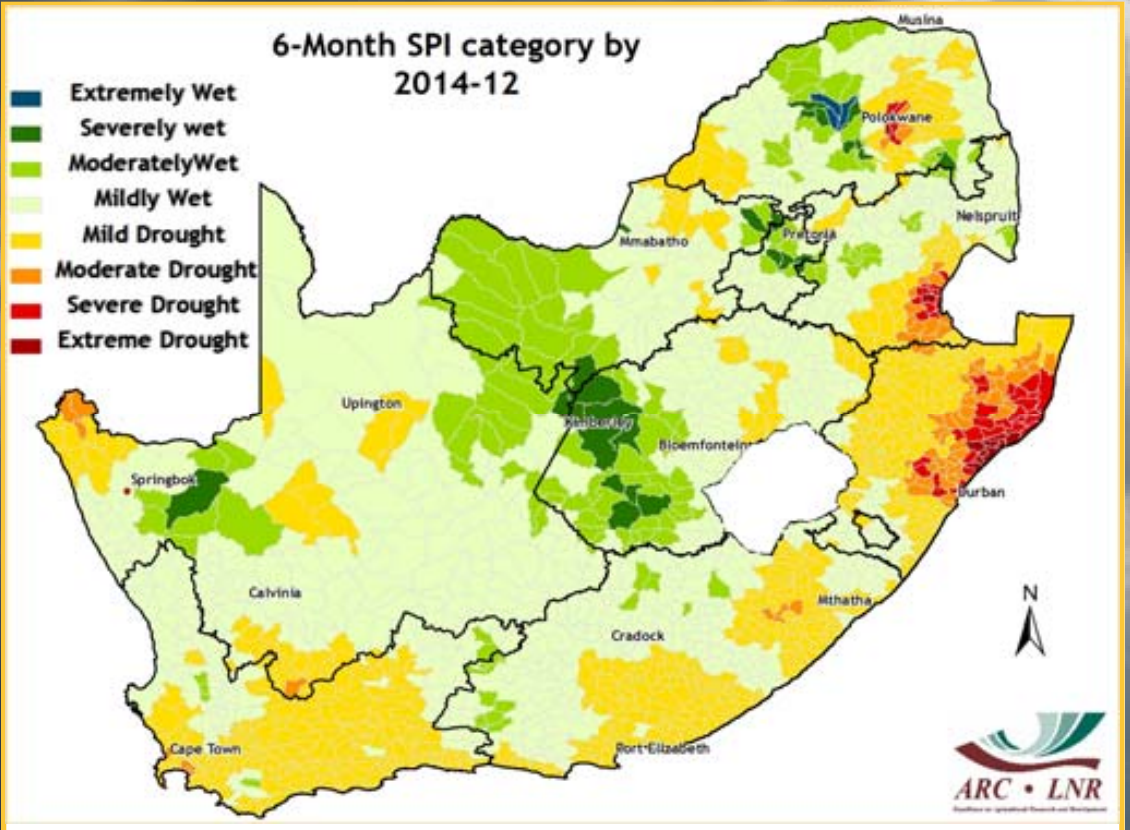


Figure 6

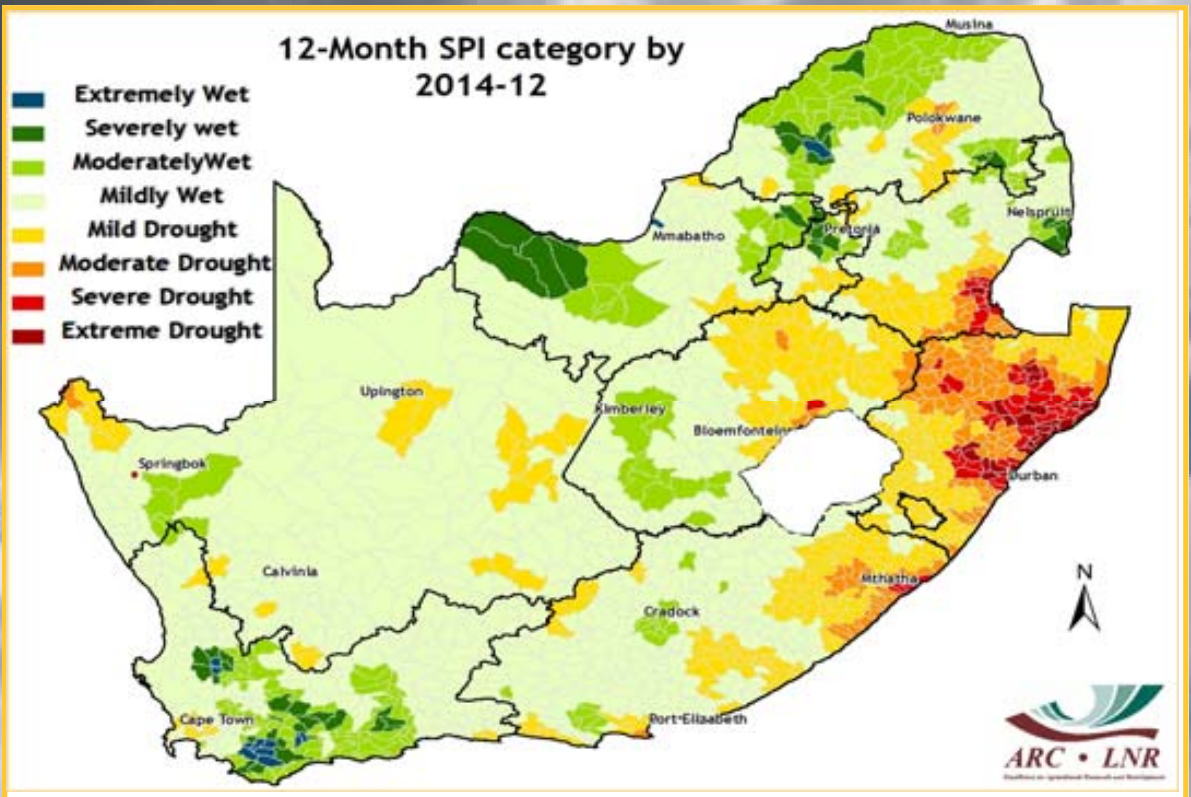


Figure 7

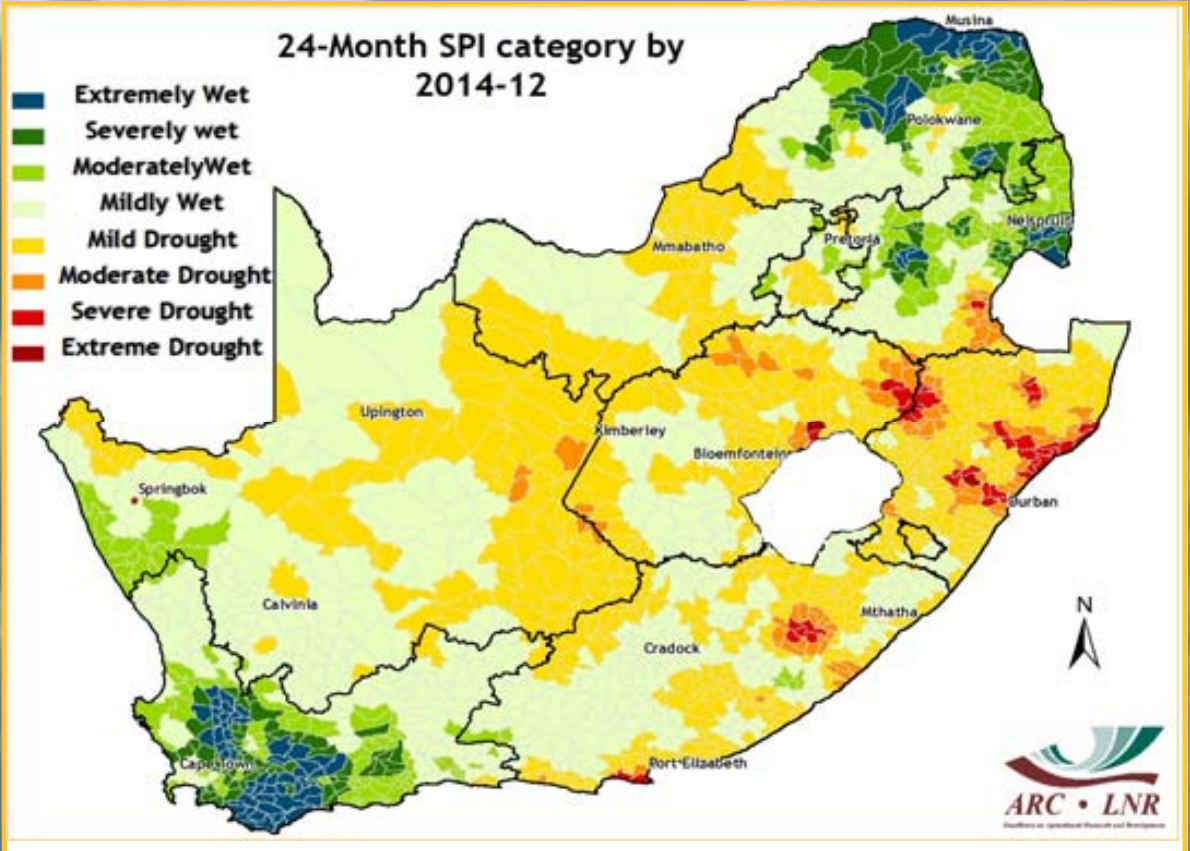


Figure 8

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.

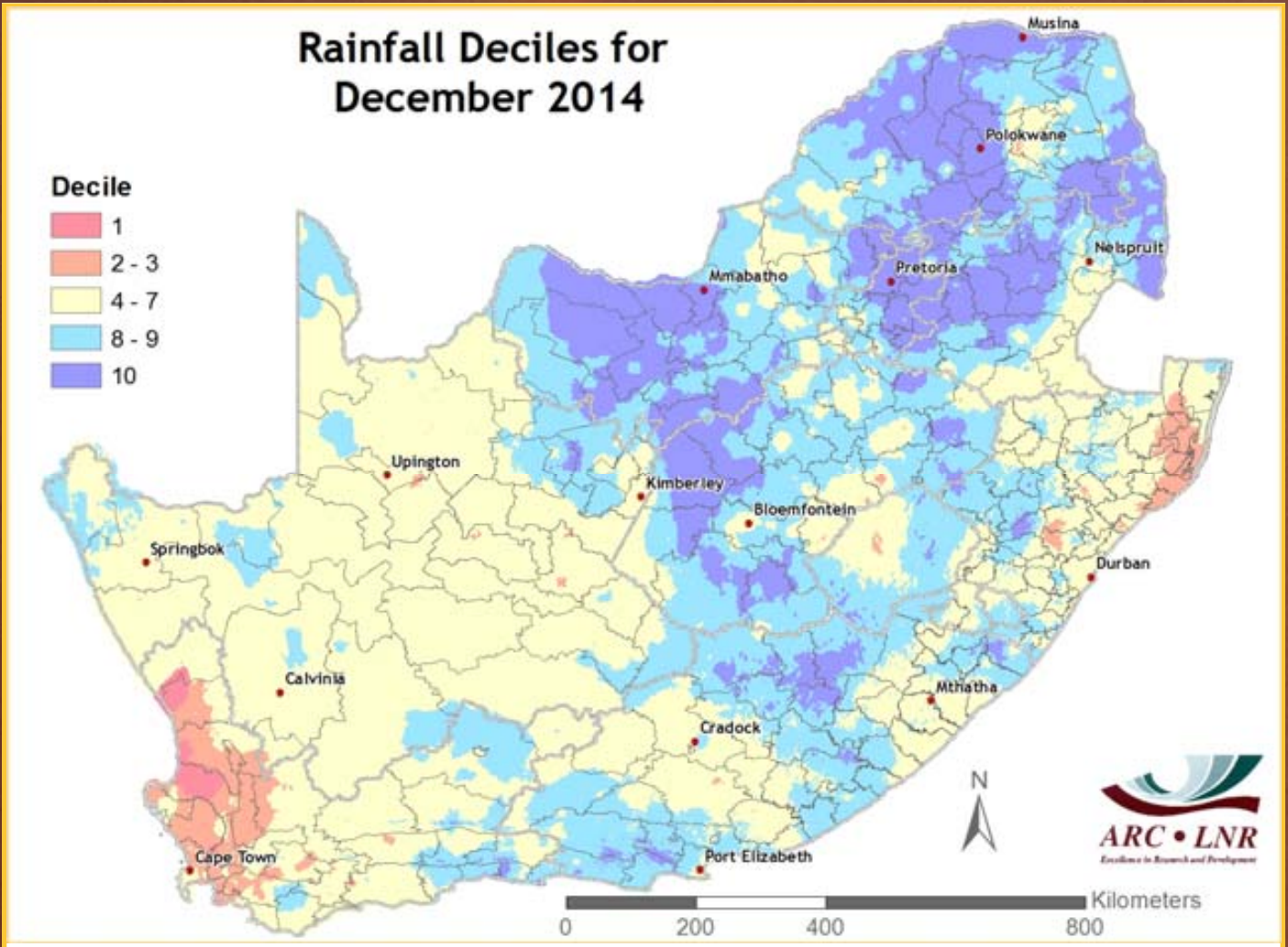


Figure 9

Figure 9:
Rainfall during December was abnormally high over parts of North West, Gauteng, Mpumalanga, Limpopo and the Free State. The northwestern parts of the Western Cape experienced drier than normal conditions, possibly only indicating the absence of a single rain-bearing system that may occur in other years.

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

4. Water Balance

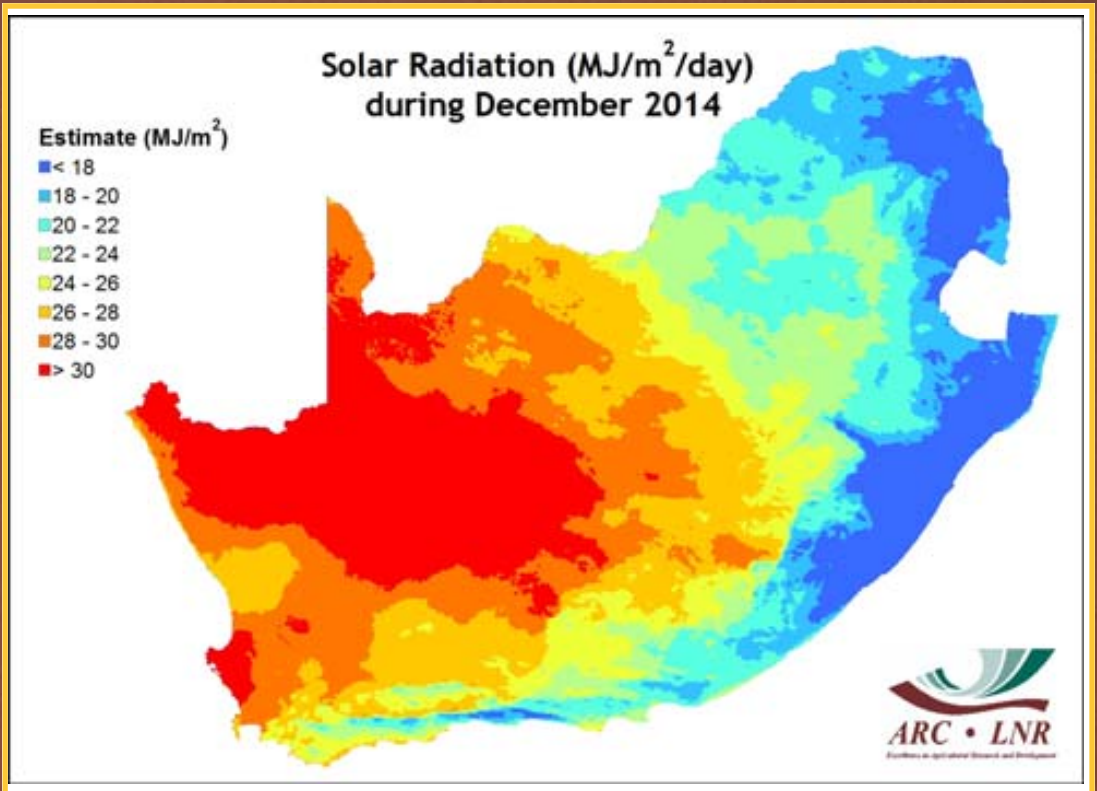


Figure 10

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 highest average daily solar radiation values were recorded over the northwestern interior with relatively low values over much of the central to eastern interior. The lowest values were recorded along the southern coastal areas and east of the eastern Escarpment.

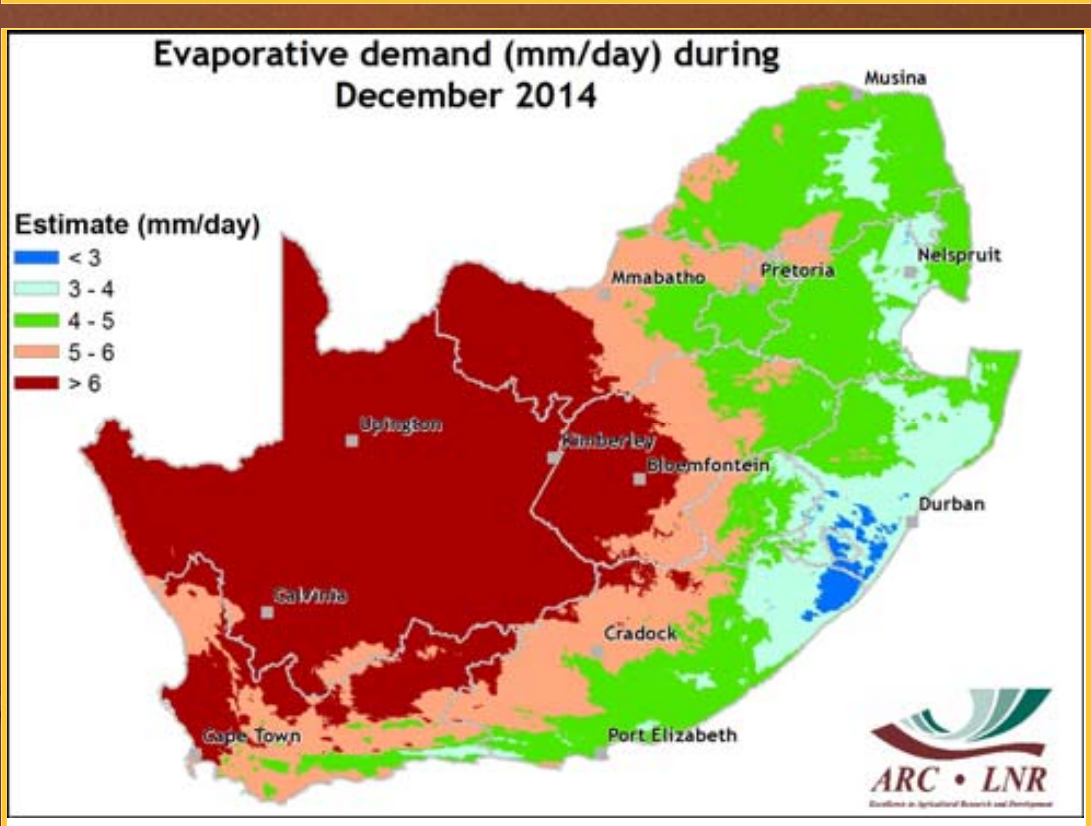


Figure 11

Potential Evapotranspiration

Potential evapotranspiration (PET) for a reference crop is calculated at about 450 automatic weather stations of the ARC-ISCW located across South Africa. At these stations hourly measured temperature, humidity, wind and solar radiation values are combined to estimate the PET.

Figure 11:
Average daily evapotranspiration ranged from 2-3 mm/day over the eastern Escarpment and the southern parts of KwaZulu-Natal to more than 6 mm/day over the northwestern interior.

Questions/Comments:
Johan@arc.agric.za

5. Vegetation Conditions

Vegetation Mapping

The Normalized Difference Vegetation Index (NDVI) is computed from the equation:

NDVI=(IR-R)/(IR+R)

where:
IR = Infrared reflectance &
R = Red band

NDVI images describe the vegetation activity. A decadal NDVI image shows the highest possible "greenness" values that have been measured during a 10-day period.

Vegetated areas will generally yield high values because of their relatively high near infrared reflectance and low visible reflectance. For better interpretation and understanding of the NDVI images, a temporal image difference approach for change detection is used.

The Standardized Difference Vegetation Index (SDVI) is the standardized anomaly (according to the specific time of the year) of the NDVI.

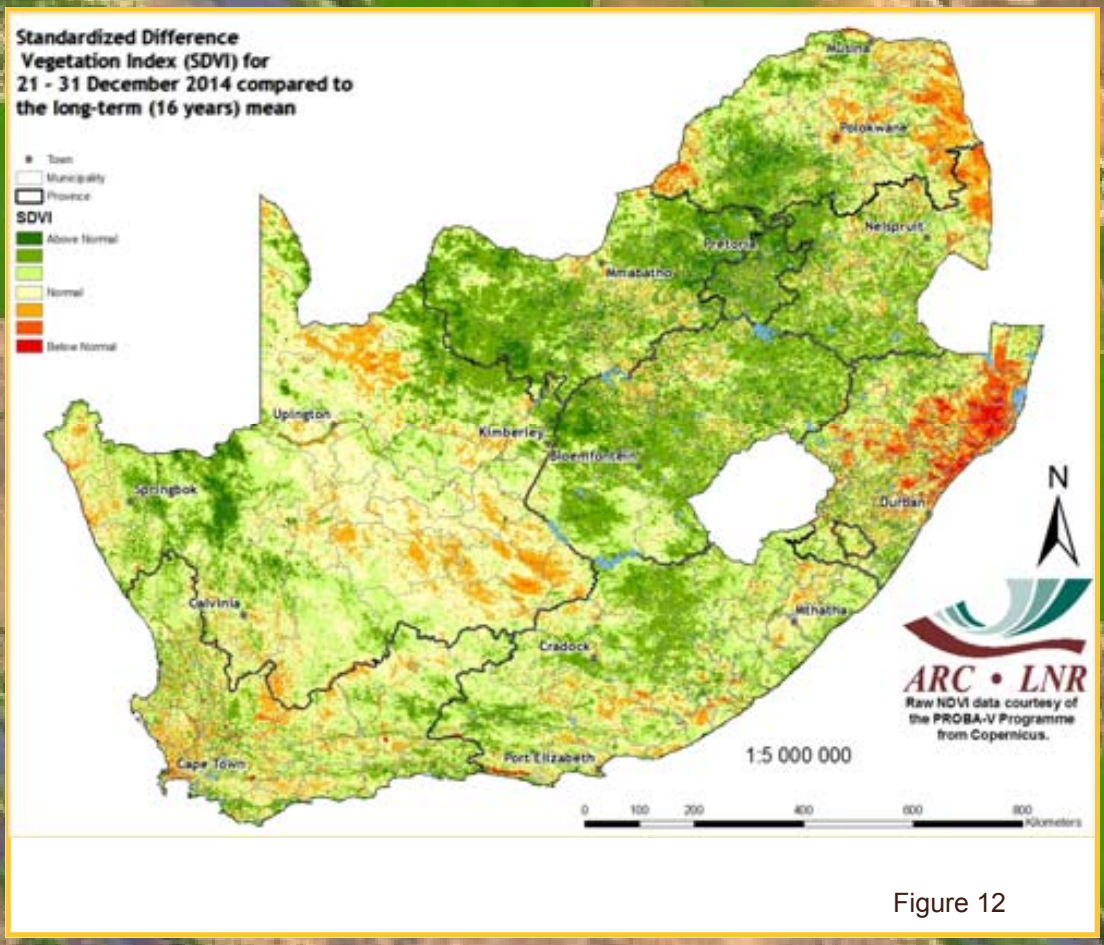


Figure 12

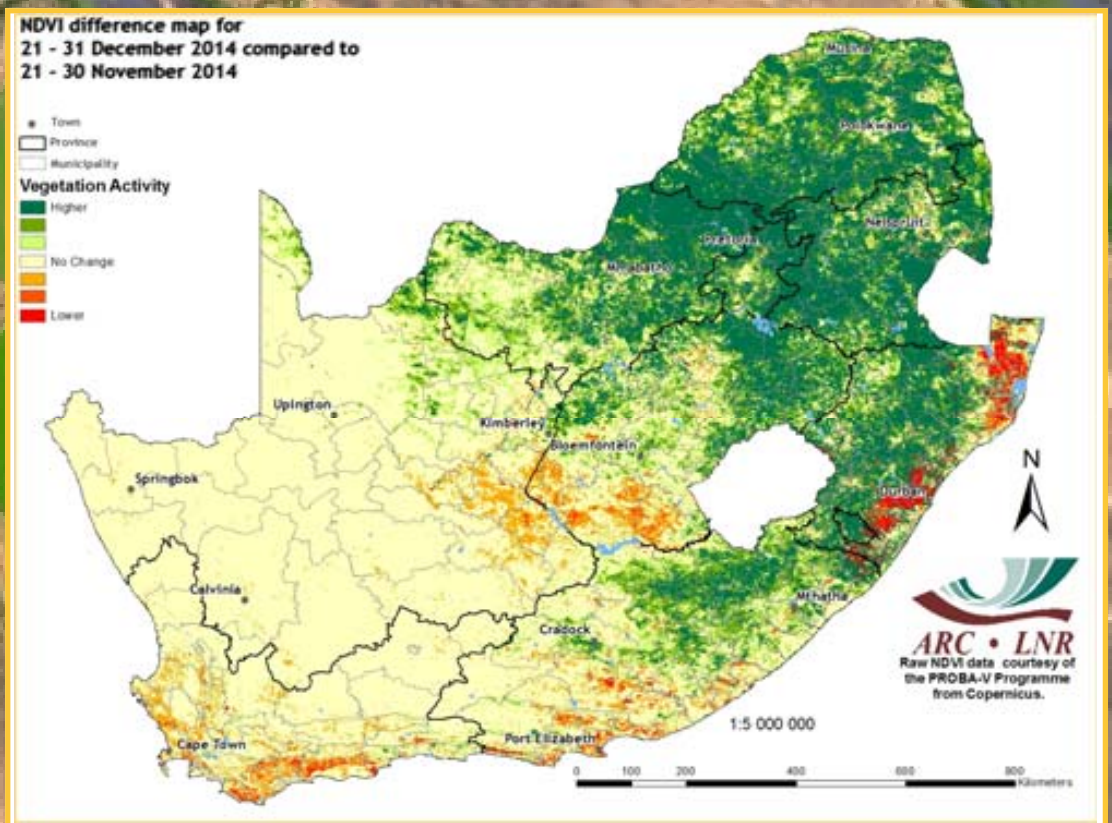


Figure 13

Figure 12:
The SDVI is increasing over much of the central to northeastern interior after widespread rain. High rainfall over the southwestern parts during November is also reflected. Relatively dry conditions over eastern Mpumalanga and northeastern North West had a negative effect on vegetation activity.

Figure 13:
Rainfall over the central to northeastern interior during the past month had a very positive impact on vegetation activity there. The southwesten parts of the Free State and far eastern Northern Cape experienced some decreases in activity due to drier conditions during December relative to November.

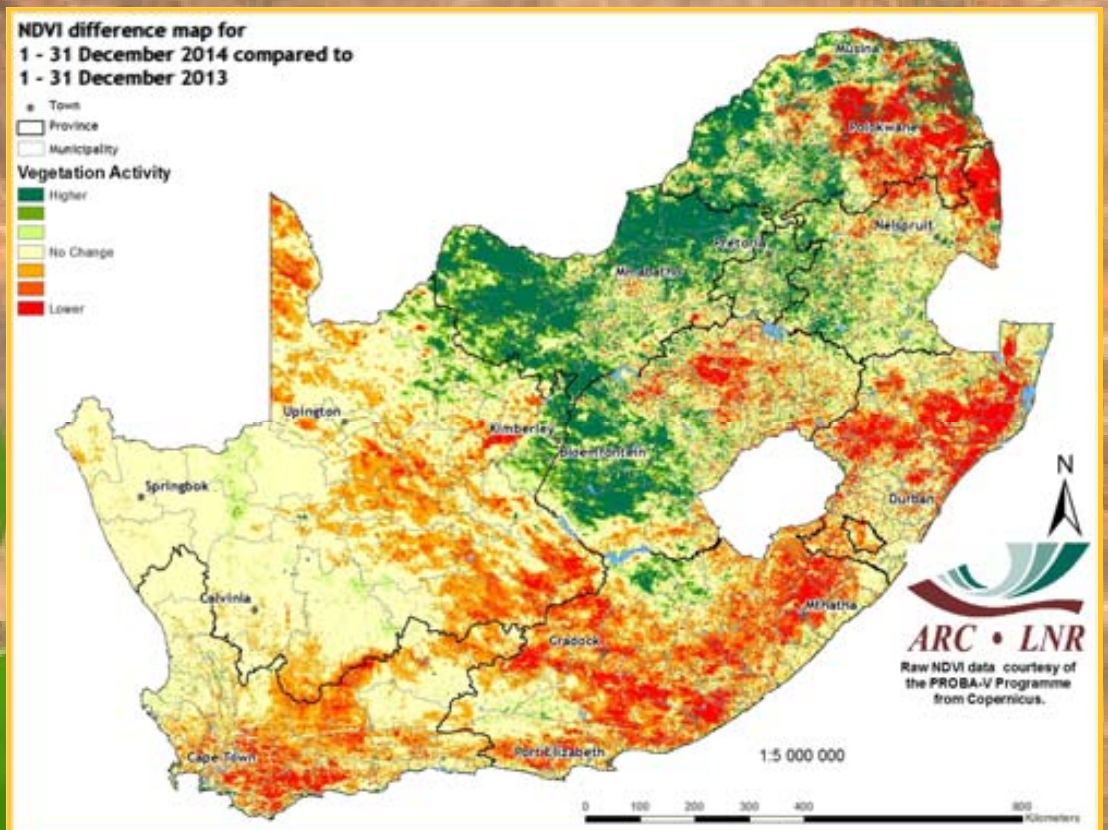


Figure 14

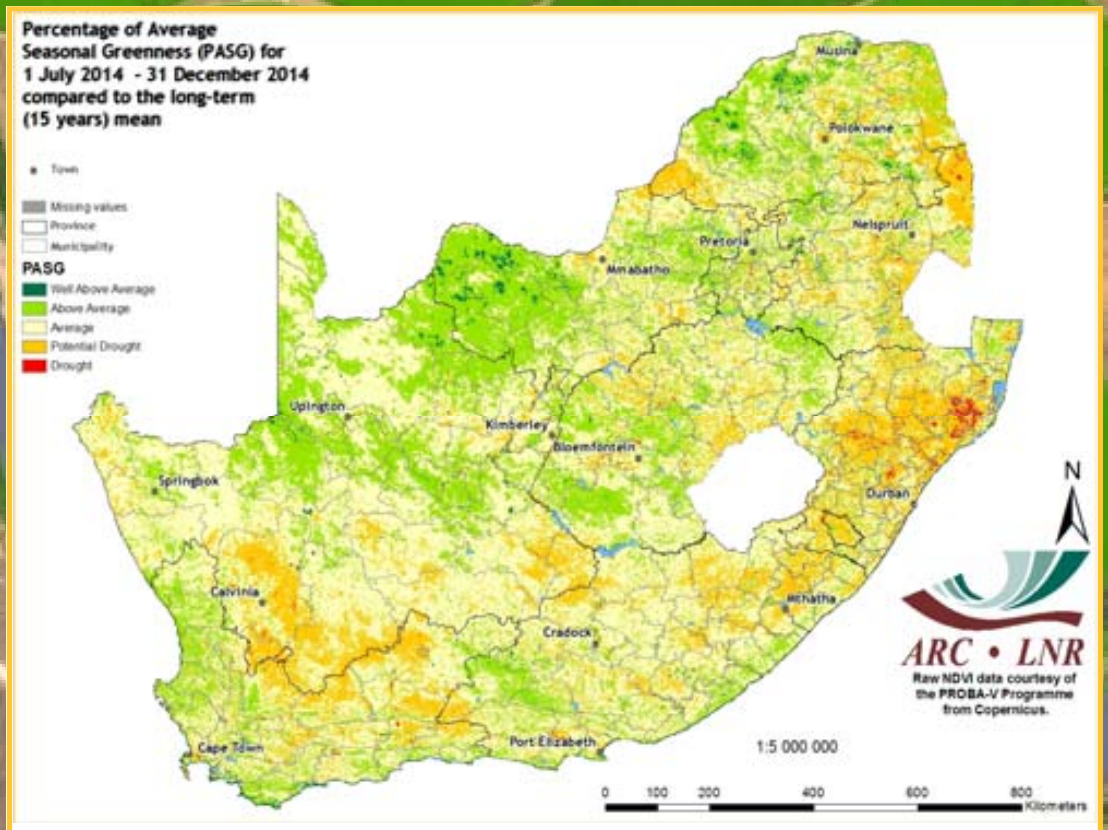


Figure 15

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:
Much of the central to northern interior experienced higher vegetation activity during December 2014 than in the same month last year. Some areas along and near the southern and eastern coastal belt and extreme northeastern parts, however, experienced decreased vegetation activity compared to the previous year.

Figure 15:
Cumulative vegetation activity since July reflects a relatively wet January-March 2014 and also wet conditions since November over the northern parts of the country. Cumulative vegetation activity is also above normal over the winter rainfall area. Cumulative vegetation activity over the southern parts of the Northern Cape as well as much of the southeastern Free State, KwaZulu-Natal, Lowveld of Mpumalanga and the interior of the Eastern Cape reflects recent dry conditions.

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.

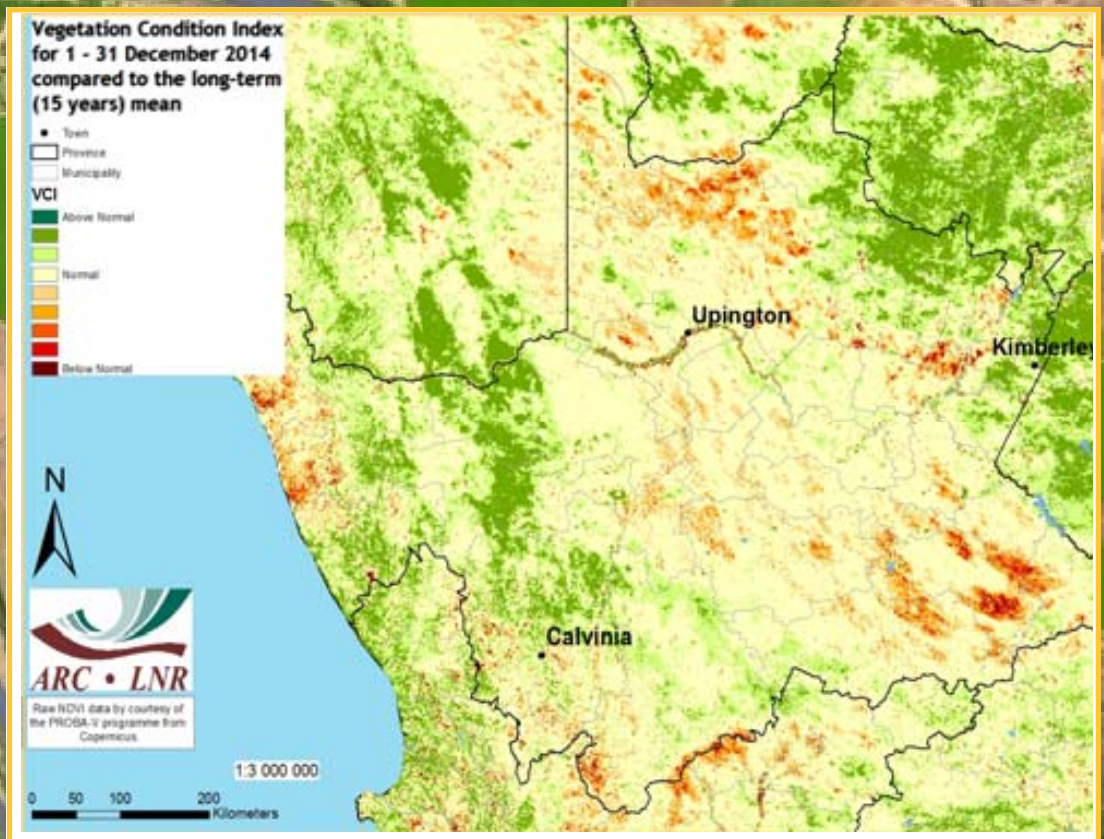


Figure 16

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

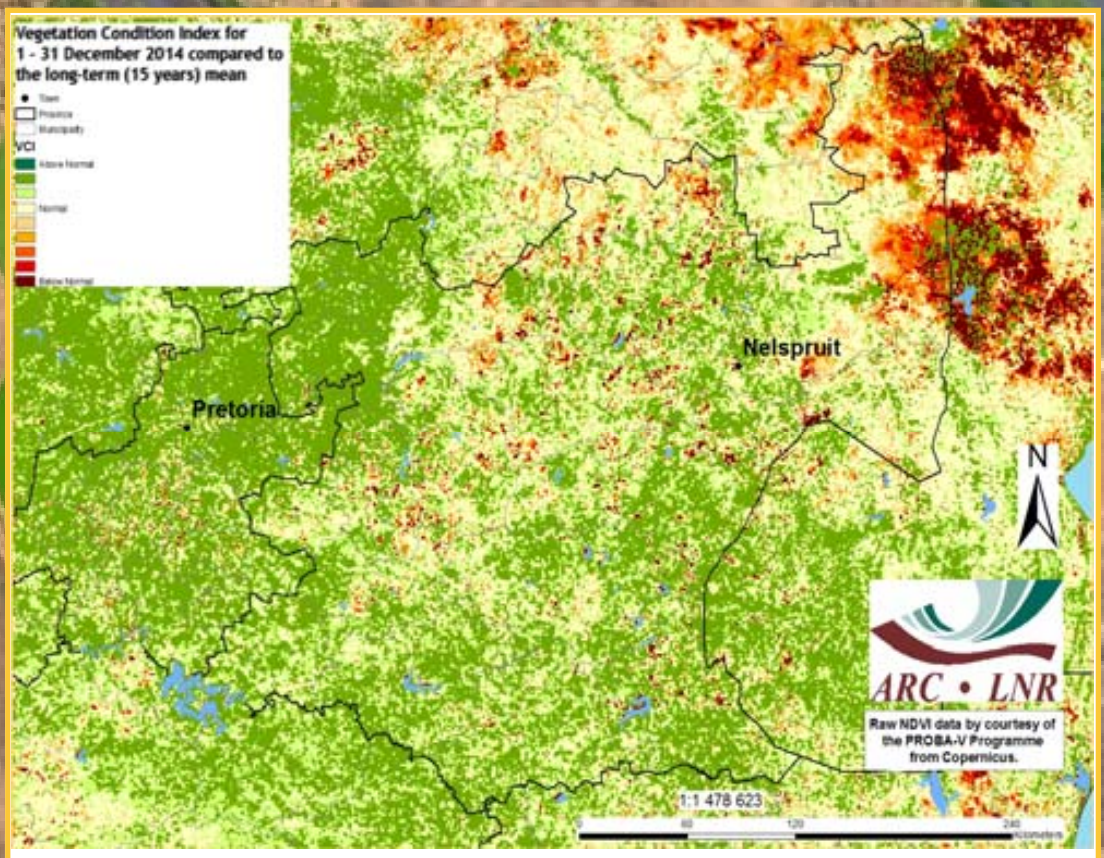


Figure 17

Figure 17:
The VCI map for December indicates below-normal vegetation activity over the Lowveld of Mpumalanga, where the rainfall this summer only started during December.

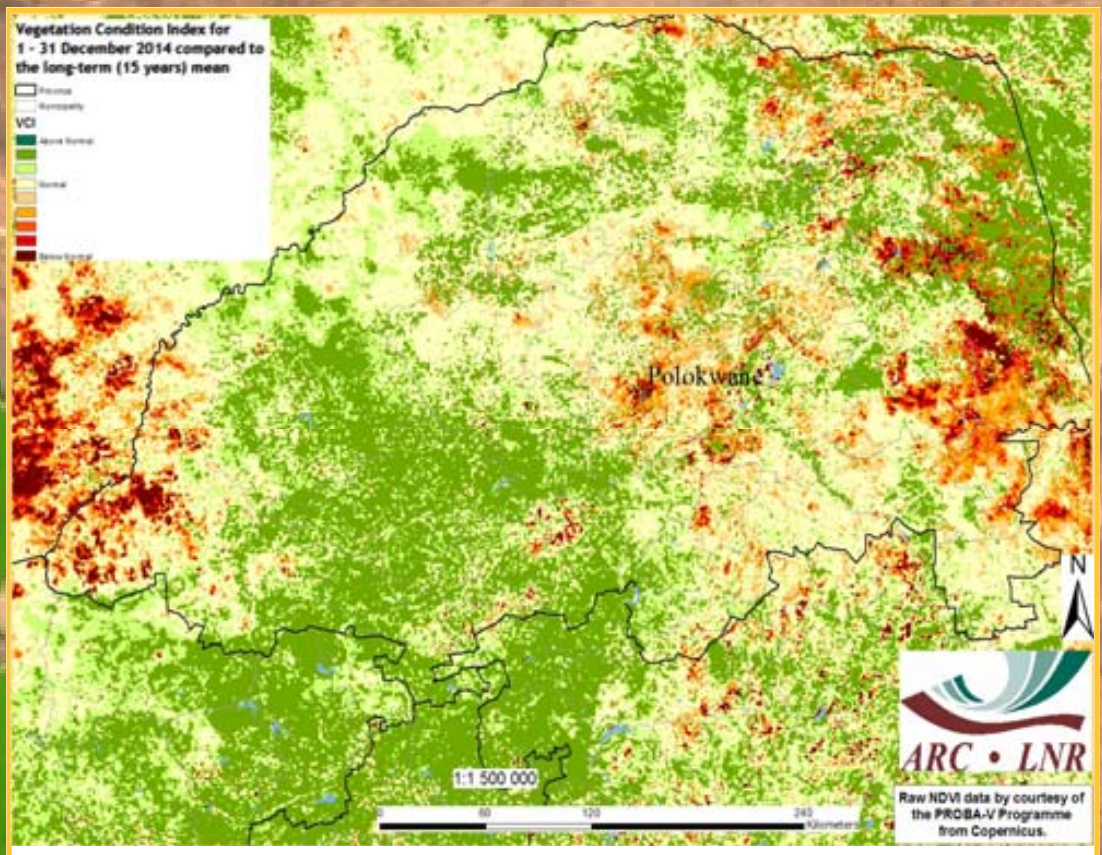


Figure 18

Figure 18:
The VCI map for December indicates below-normal vegetation activity over the southwestern parts and the Lowveld of Limpopo.

Figure 19:
The VCI map for December indicates below-normal vegetation activity over the eastern parts of KwaZulu-Natal.

Questions/Comments:
NkambuleV@arc.agric.za

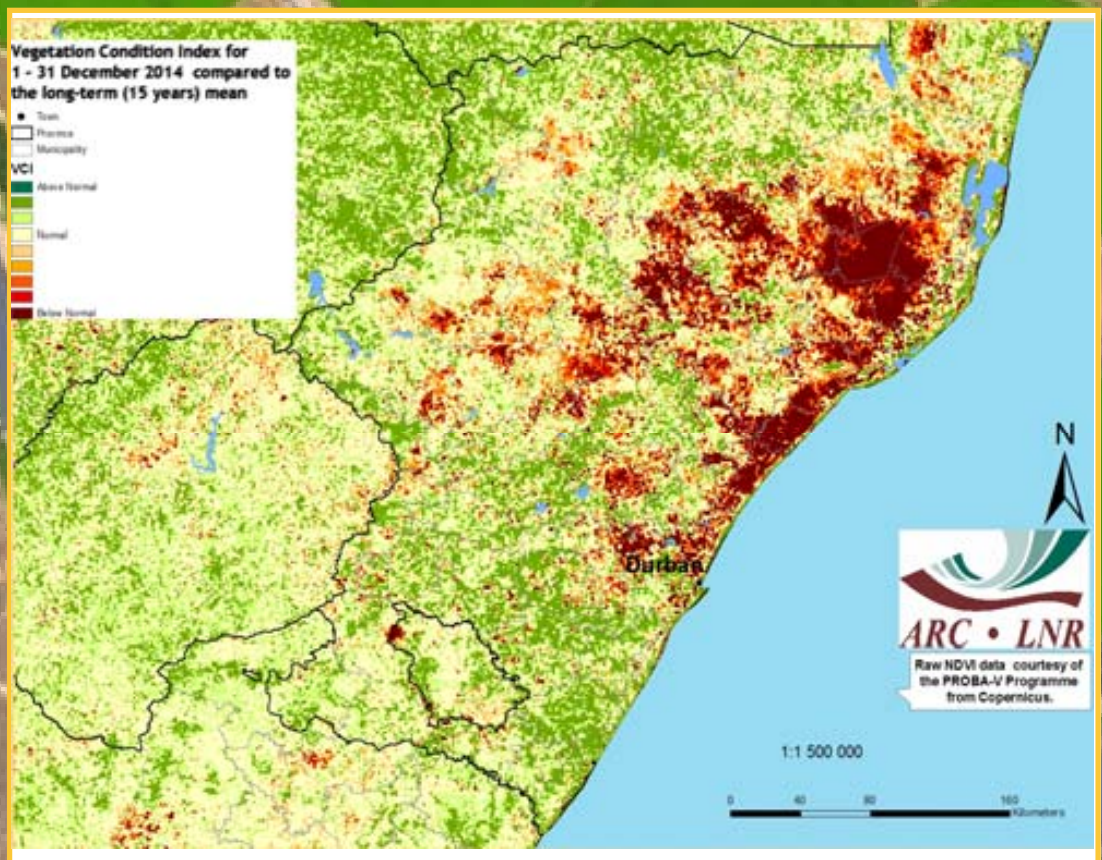


Figure 19

7. Vegetation Conditions & Rainfall

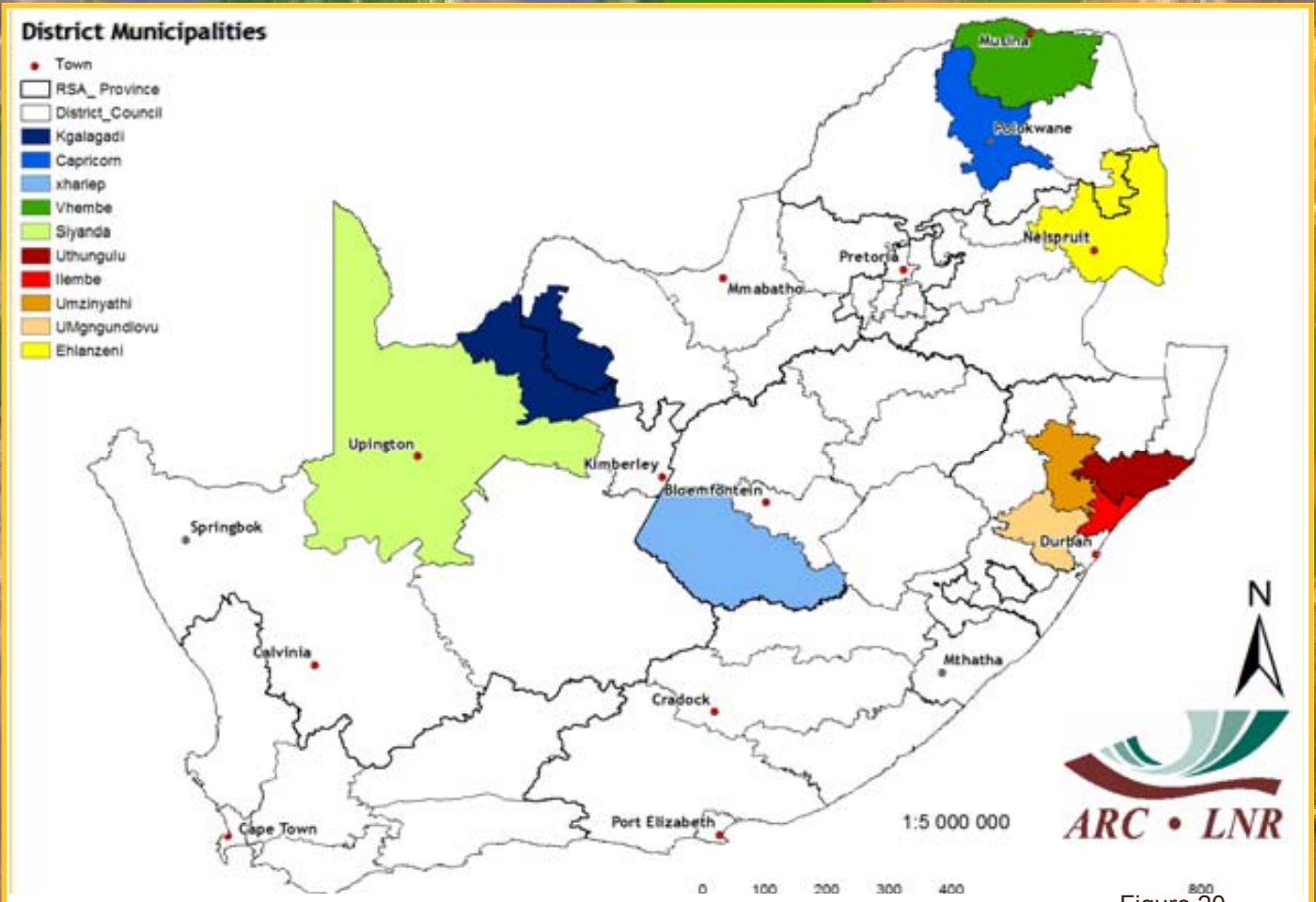


Figure 20

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

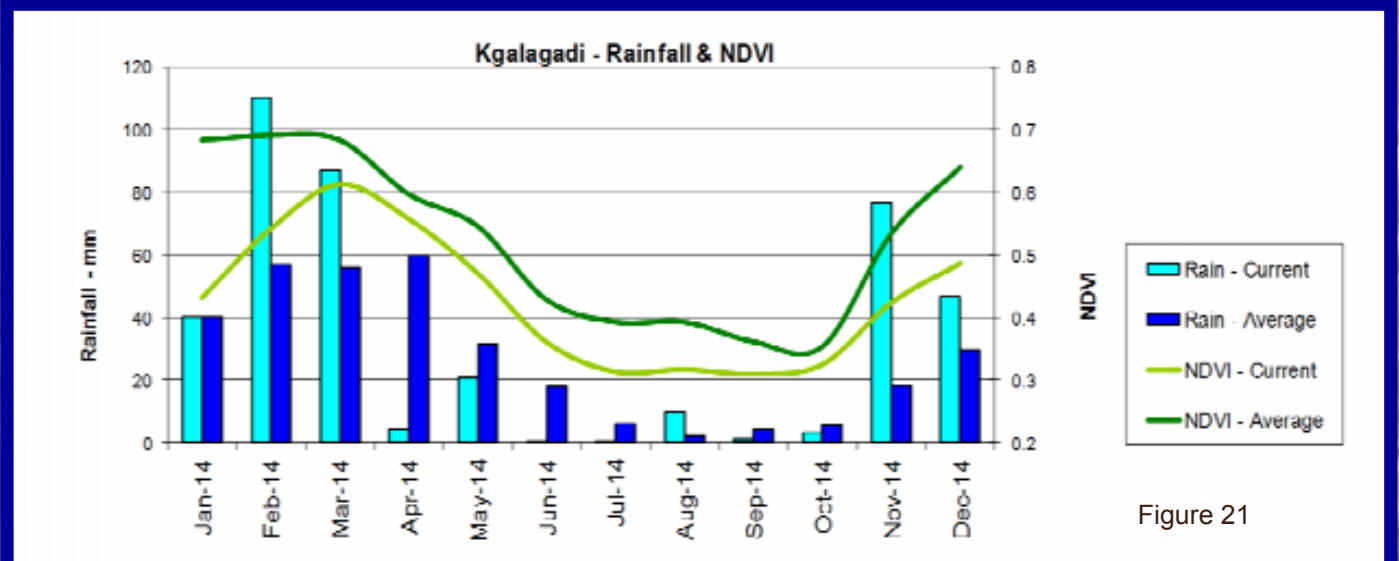


Figure 21

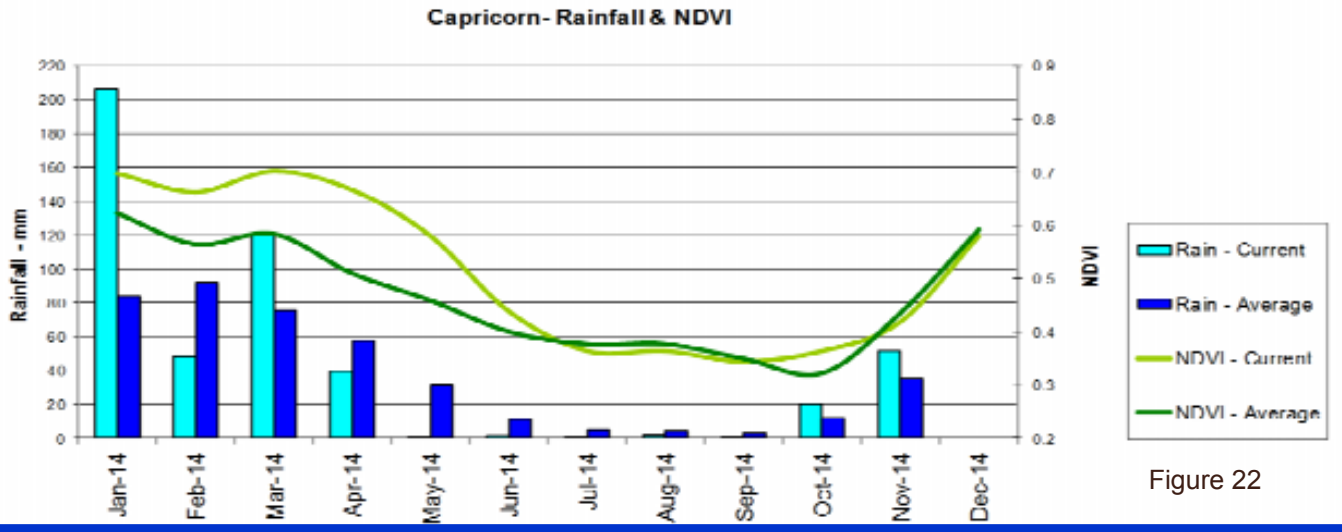


Figure 22

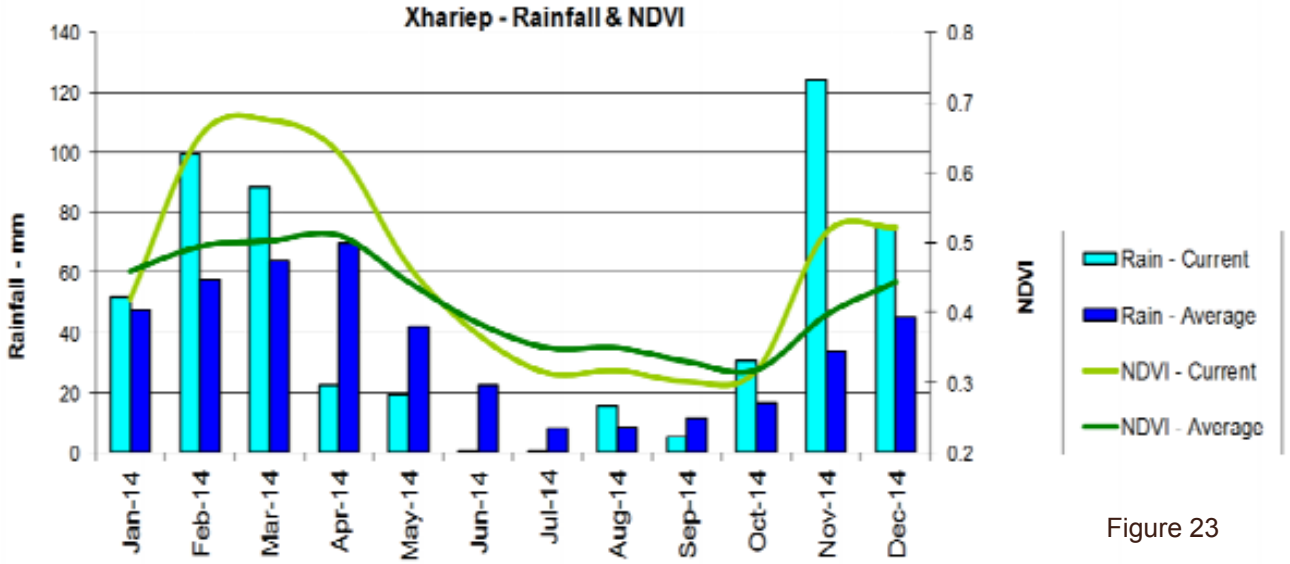


Figure 23

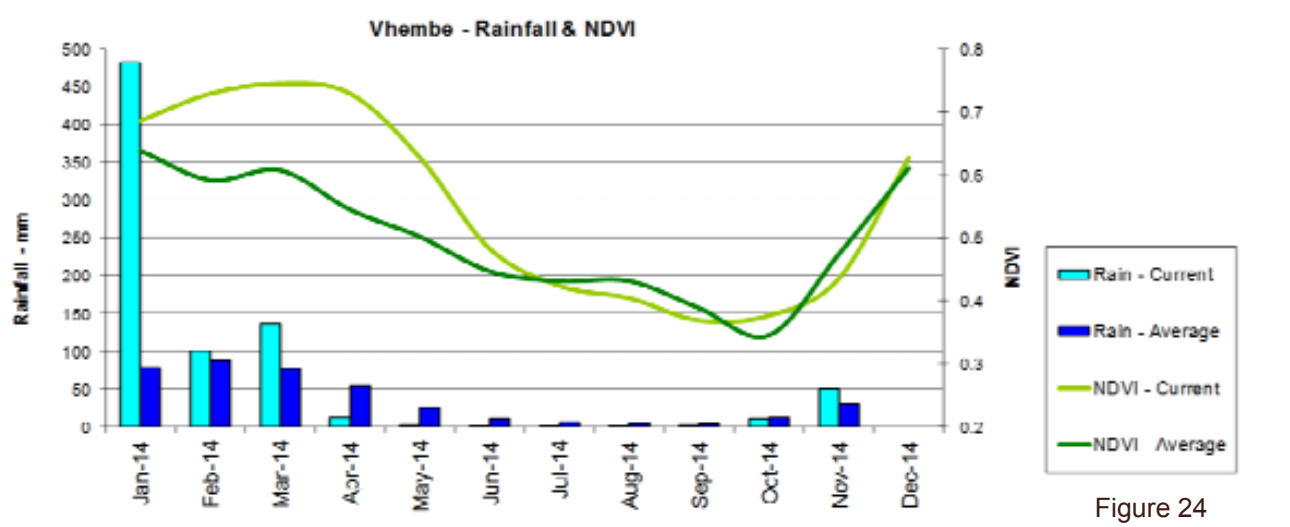


Figure 24

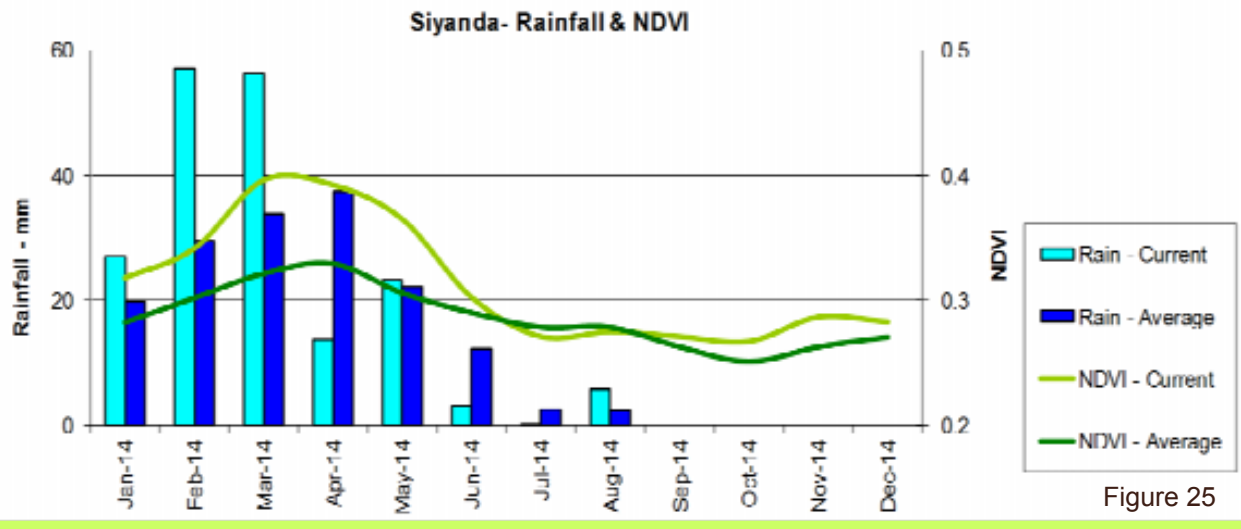


Figure 25

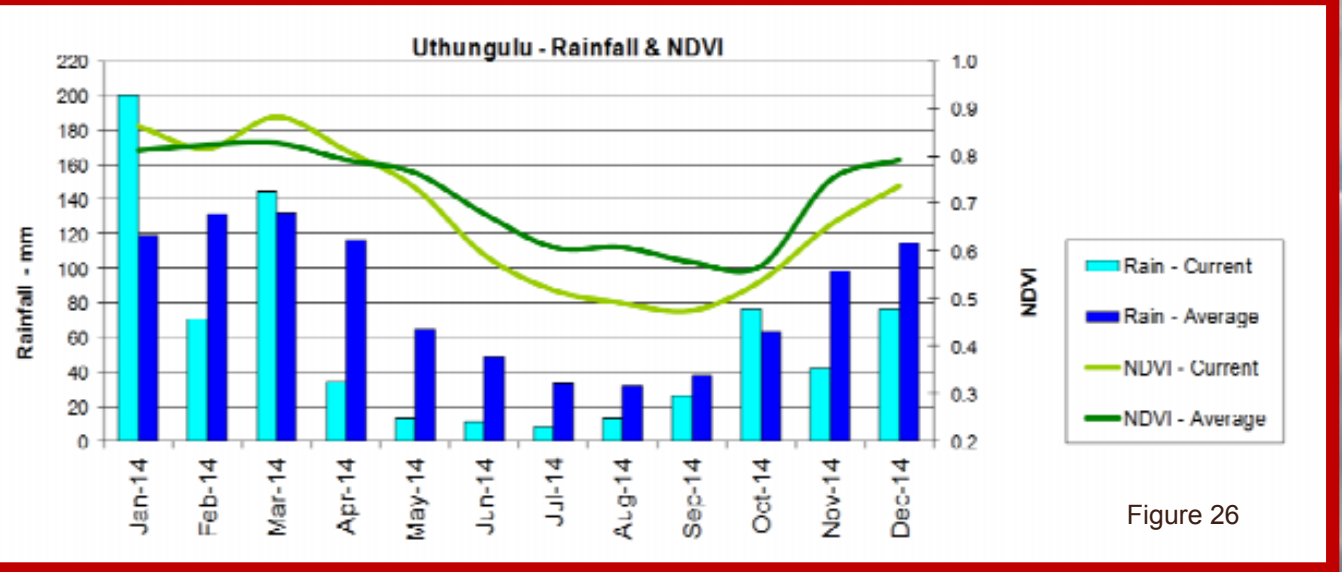


Figure 26

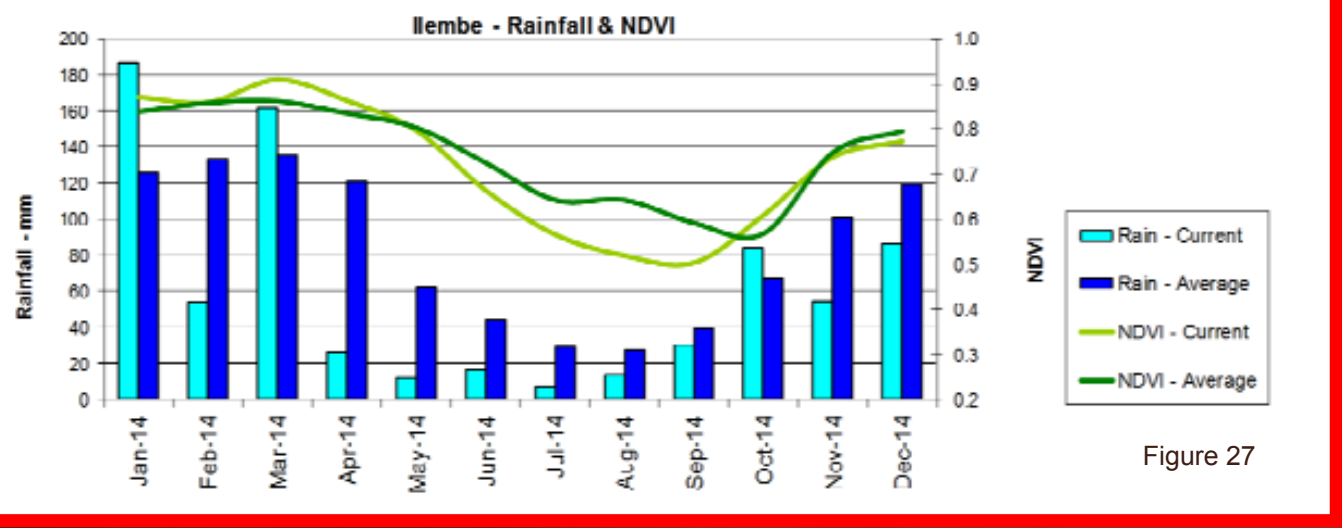


Figure 27

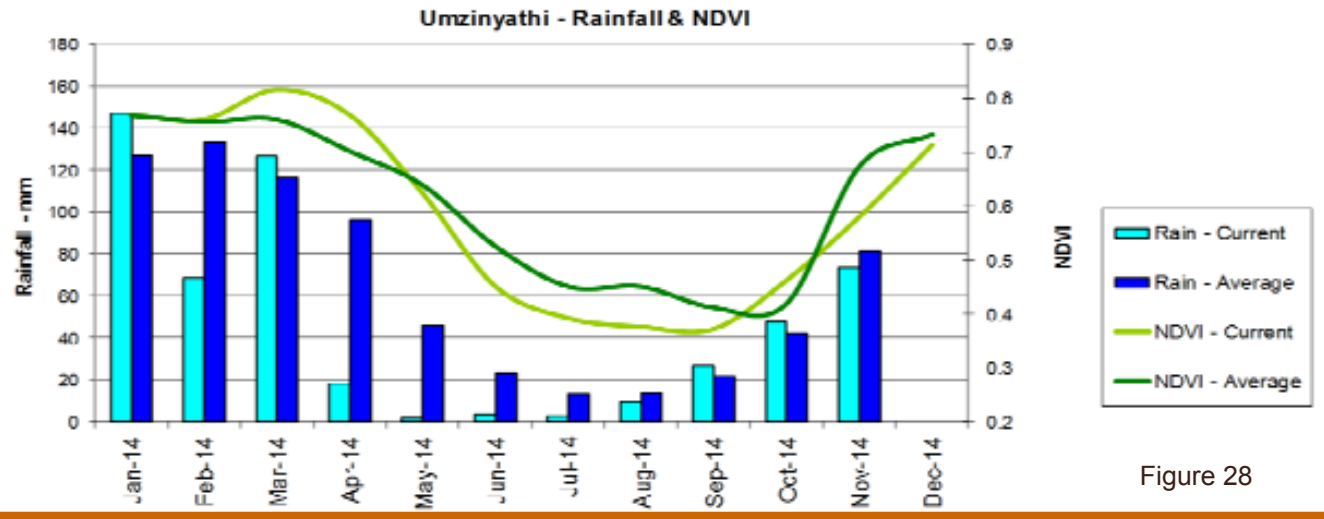


Figure 28

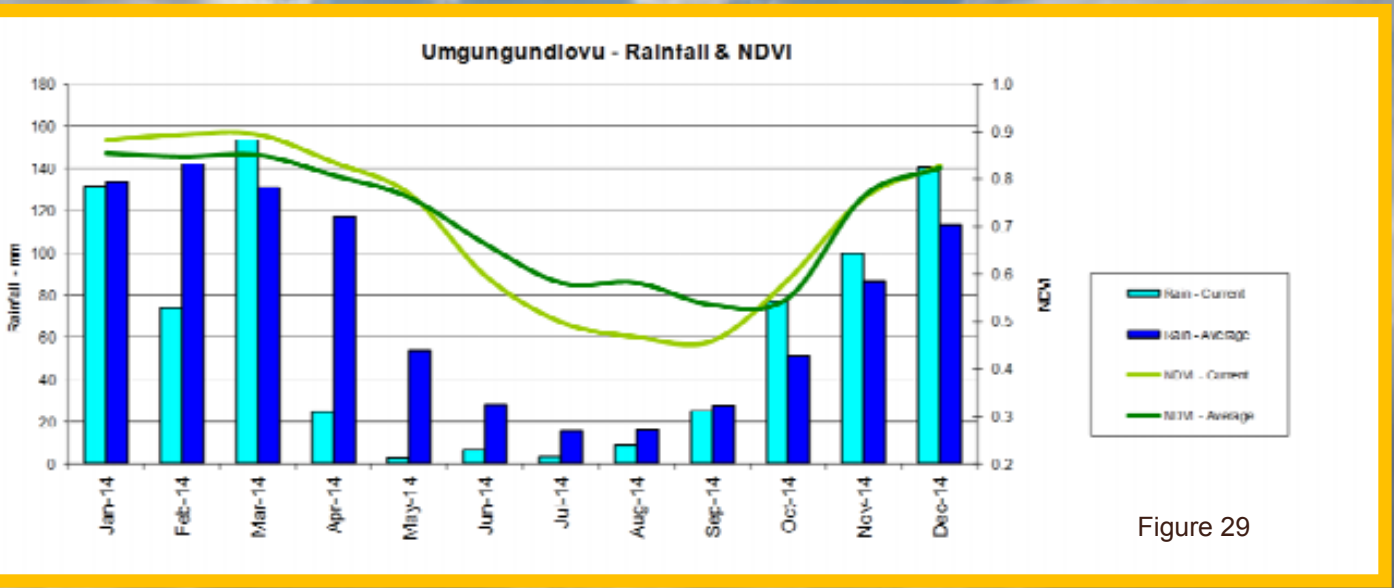


Figure 29

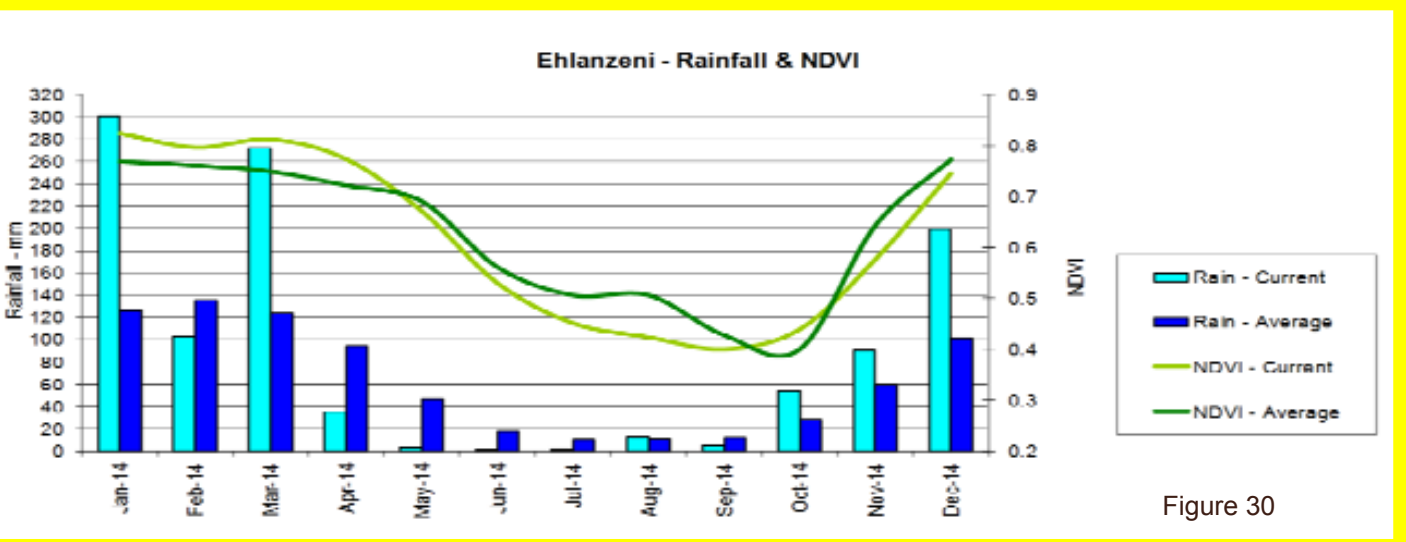


Figure 30

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 December per province. Fire activity was higher in the Eastern Cape, Gauteng, Mpumalanga, Northern Cape, Limpopo and KwaZulu-Natal compared to the average during the same period for the last 13 years.

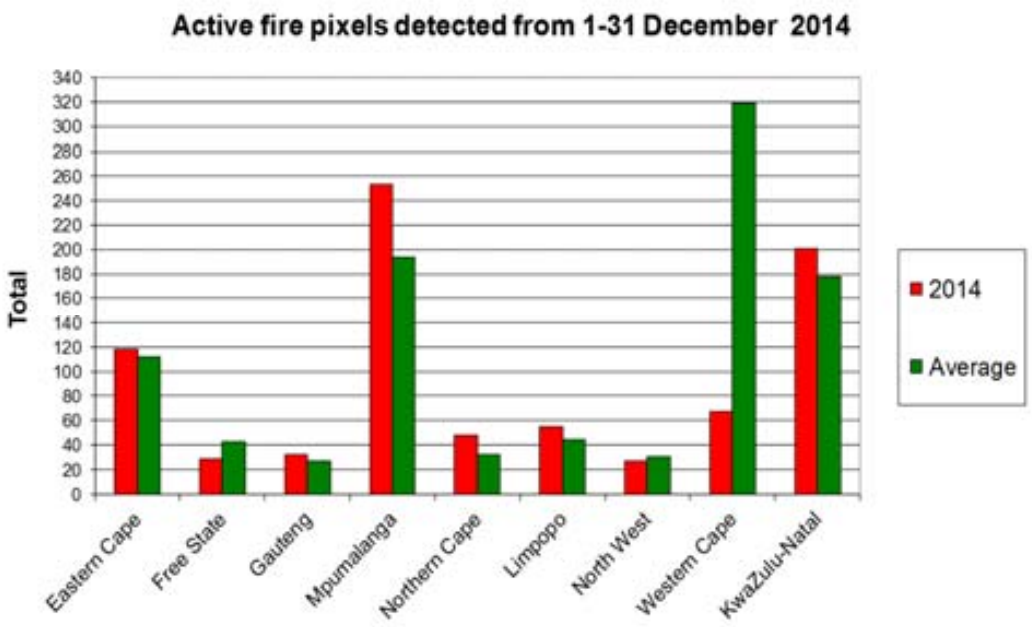


Figure 31

Figure 32:
The map shows the location of active fires detected between 1-31 December 2014.

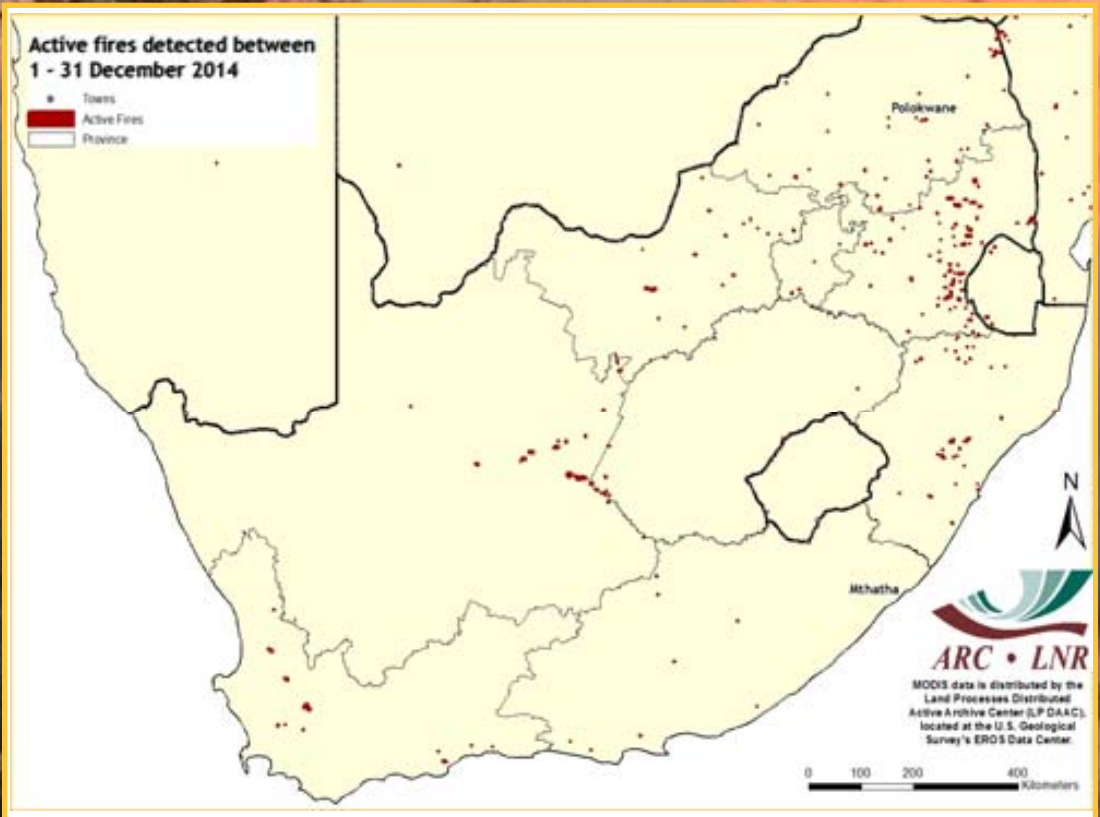


Figure 32

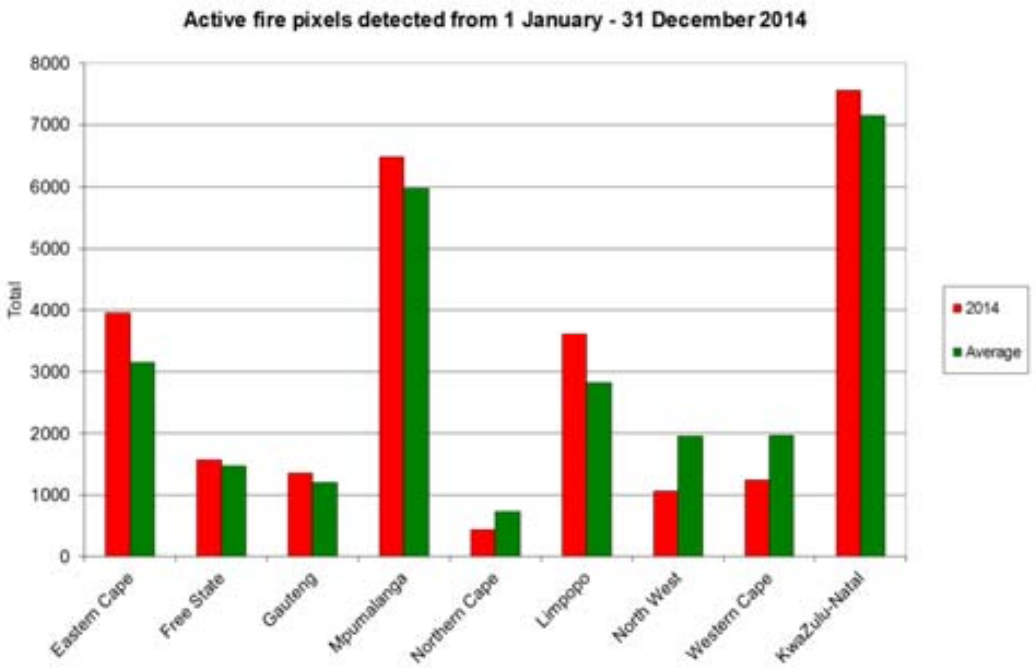


Figure 33

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

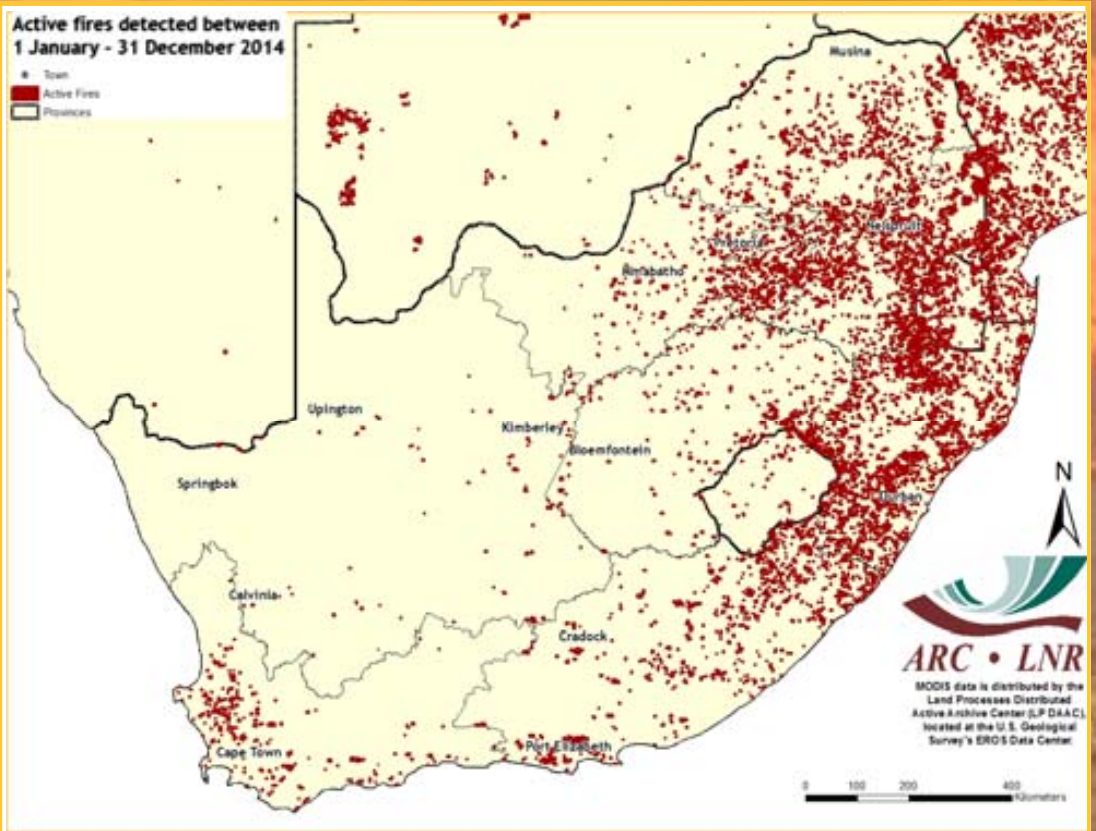


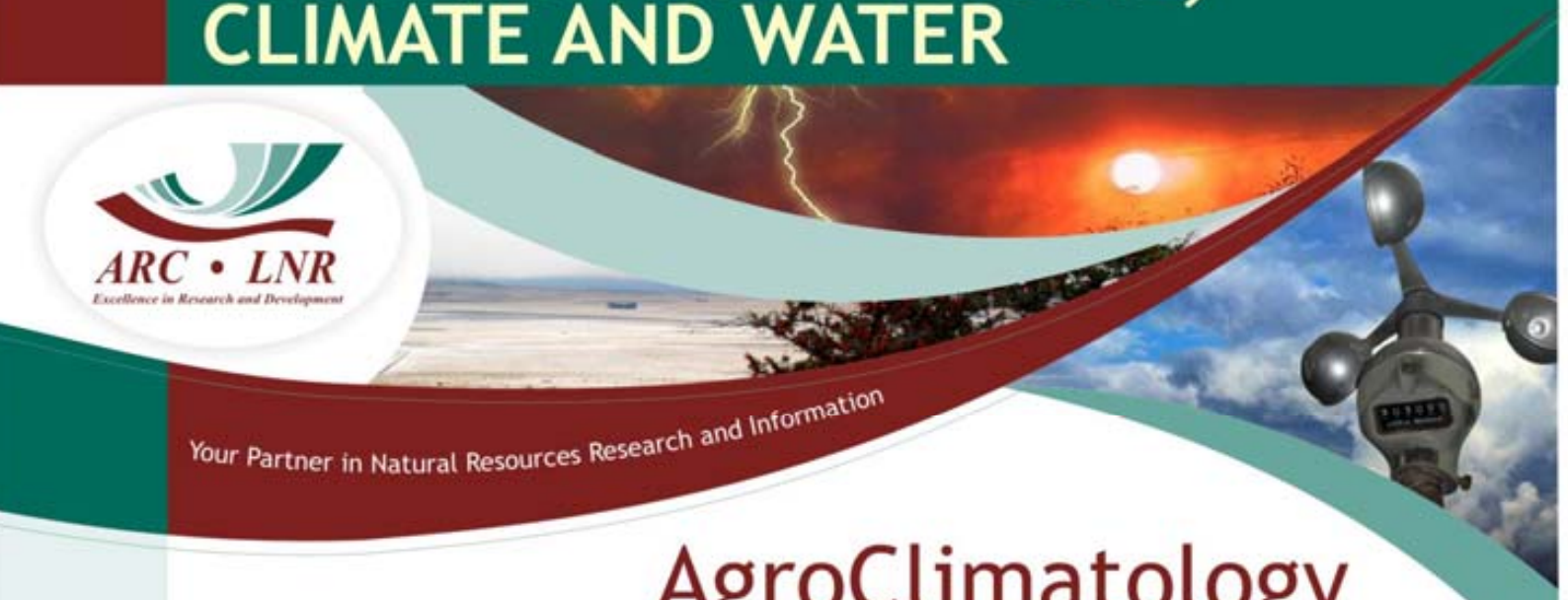
Figure 34

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

Questions/Comments:
Nkambulev@arc.agric.za

ARC-INSTITUTE FOR SOIL, CLIMATE AND WATER

ARC • LNR
Excellence in Research and Development



Your Partner in Natural Resources Research and Information

AgroClimatology

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

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

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

Products and Services

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

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

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

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

For more information contact:
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 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**.

ARC • LNR
Excellence in Agricultural Research and Development

Institute for Soil, Climate and Water

Private Bag X79, Pretoria 0001,
South Africa
600 Belvedere Street, Arcadia, Pretoria, South Africa

Victoria Nkambule
Project Leader: Coarse Resolution Imagery Database (CRID)
Tel: +27 (0) 12 310 2533
Fax: +27 (0) 12 323 1157

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.

For further information please contact the following:
Dr Johan Malherbe – 012 310 2577, Johan@arc.agric.za
Adri Laas – 012 310 2518, iscwinfo@arc.agric.za

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