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Excellence in Agricultural Research and Development

UMLINDI
The Watchman

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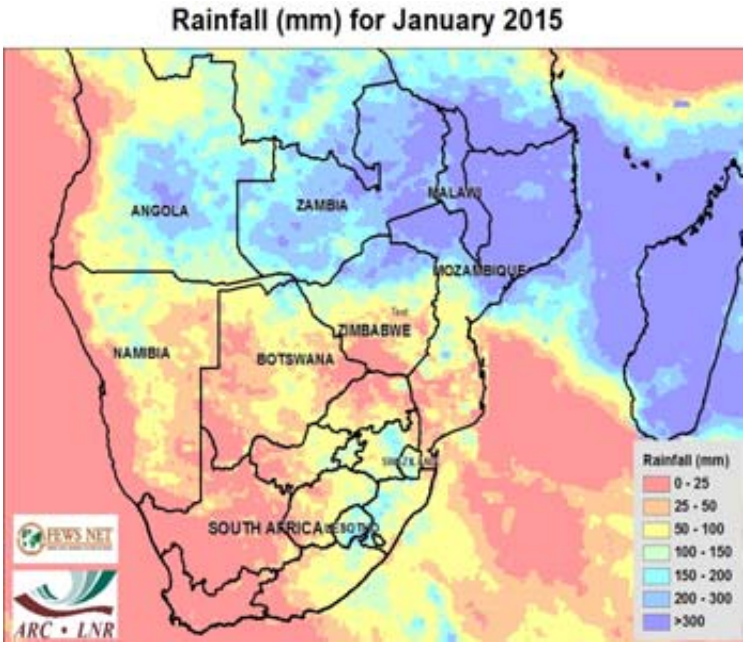
INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

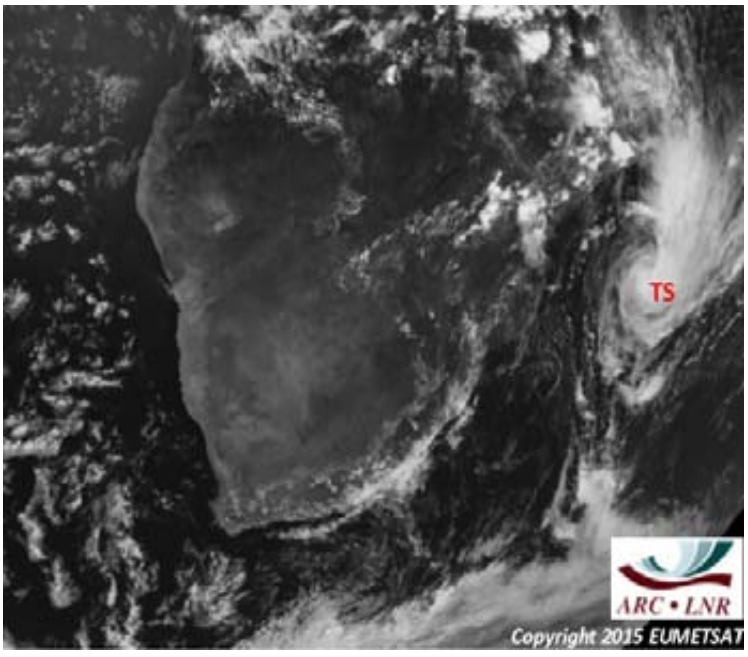
128th Edition

Images of the Month

Dry conditions during January and early February



The summer rainfall area received much less rain in January 2015 than during the two preceding months. The total rainfall estimate (available from the Famine Early Warning Systems Network (FEWSNET) Africa Data Portal) for the SADC region shows that most of South Africa received less than 100 mm during January, whilst areas to the northeast experienced heavy rainfall. The Inter-Tropical Convergence Zone (ITCZ), defined by a semi-stationary east-west cloud band located over the subcontinent during summer, was relatively far north, with the main latitudes of activity around 15°S. Tropical depressions and storms located in the eastern flank of the ITCZ over the subcontinent resulted in heavy rain and flooding over parts of Malawi and northern Mozambique during the first part of the month. The absence of large amounts of tropical moisture, as associated with the ITCZ, resulted in more isolated to scattered thundershowers over South Africa. The absence of more general rainfall created a salt-and-pepper effect of good versus bad crop conditions over the summer maize production region.



The first few days of February have been characterized by hot and dry conditions over most of South Africa. While thundershowers occurred in the northeast on a daily basis, the central to western parts were characterized by a complete absence of cloud, coupled with high temperatures, leading to crop failure over some of the western maize production areas. The visible (red) band image of the Spinning Enhanced Visible and InfraRed Imager (SEVIRI) onboard the METEOSAT Second Generation 3 (MSG-3) satellite for 13:00 SAST on the 7th of February shows an almost winter-like absence of clouds over the central to western parts of the subcontinent (including central to western South Africa). While isolated to scattered thundershowers are visible on the image over the eastern and northeastern parts of the country, the main area of activity is located towards the far northeast, with a tropical storm (TS) close to Madagascar. Conditions have since improved somewhat, but real relief will only arrive if widespread rain occurs later in February, albeit too late for some of the maize crop.

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:

After two relatively wet months over the summer rainfall area, dry conditions started to dominate from early January. Much of the rainfall was in the form of isolated to scattered thundershowers, resulting in an uneven distribution across the country. With frequent invasions of dry air from the west, very little rain was recorded over the western to central parts of the summer rainfall area, whilst frontal activity resulted in some rain over the winter rainfall area. Due to upper air anticyclonic conditions and a surface flow from north to west, maximum temperatures frequently exceeded 40°C in some northwestern parts.

During early January, a tropical depression strengthening into a tropical storm was present over the northern parts of Mozambique and the Mozambique Channel. This area experienced the main activity in terms of rainfall producing weather while isolated to scattered thundershowers developed over the summer rainfall area, aided by upper air perturbations as well as a large anticyclonic circulation to the east feeding moisture into the subcontinent. These conditions remained in place for the first 2 weeks of the month. The easterly to northerly flow also resulted in above-normal temperatures over the western parts while the east remained relatively cool.

By the 16th, a cold front invaded the western parts of the country, resulting in some rain over the winter rainfall area, while the influx of Atlantic air resulted in dry conditions starting to dominate in much of the interior. However, from the 22nd a tropical low moving from the east towards northern Namibia and an upper air trough building in the southwest, facilitated the transport of moisture across central and eastern South Africa, with isolated to scattered thundershowers over the central to northeastern parts. Some parts of KwaZulu-Natal and Mpumalanga received heavy falls during the period towards the end of the month. Then another sharp upper air trough and surface cold front moved over the western and southern interior, resulting in some rain over the winter rainfall area, before an invasion of dry air from the west heralded the dry conditions that lasted into early February.

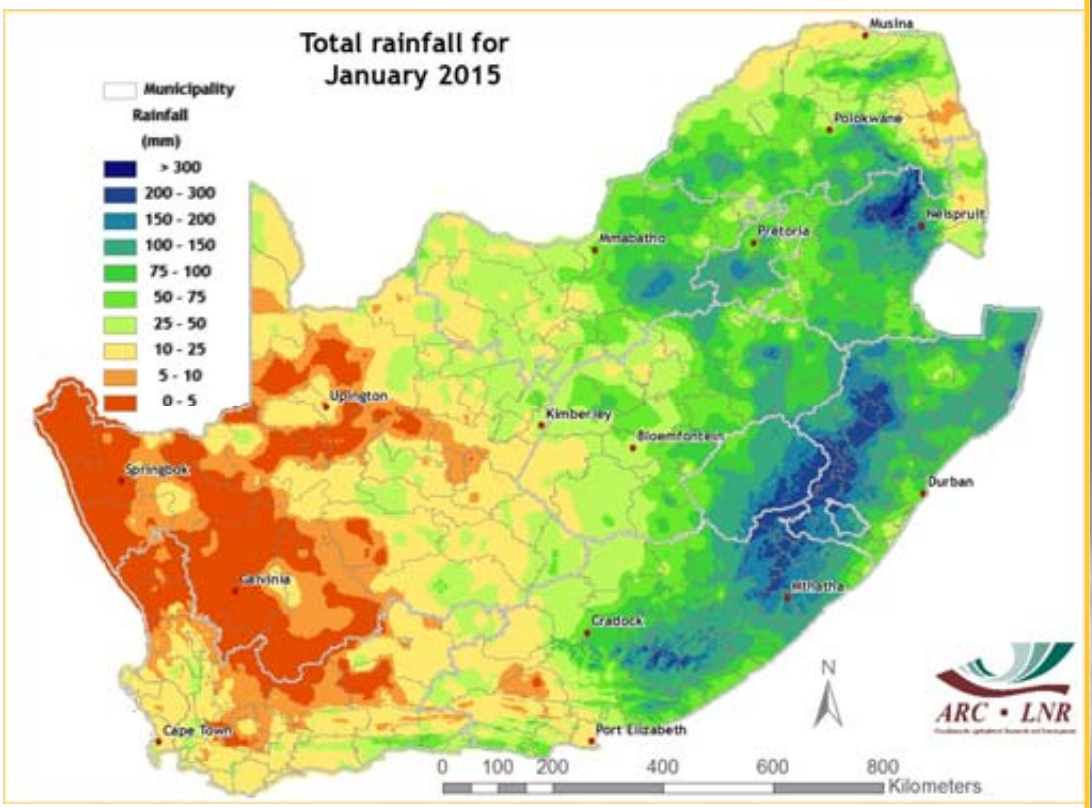


Figure 1

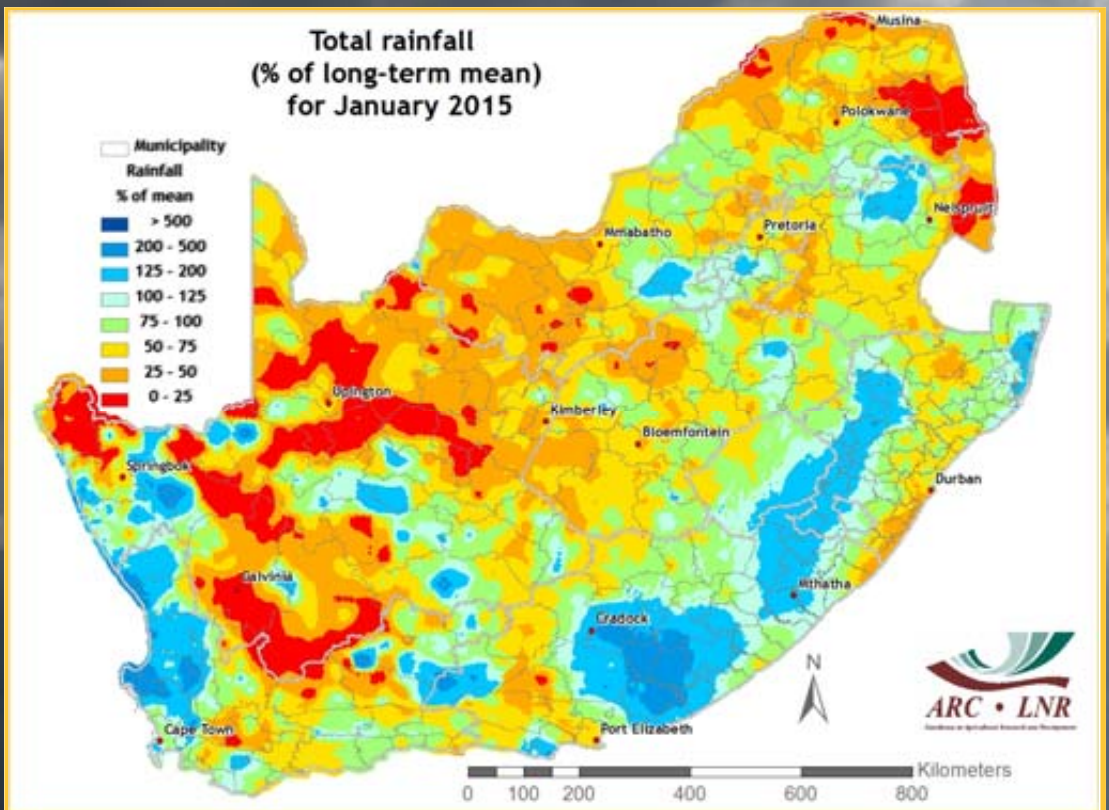
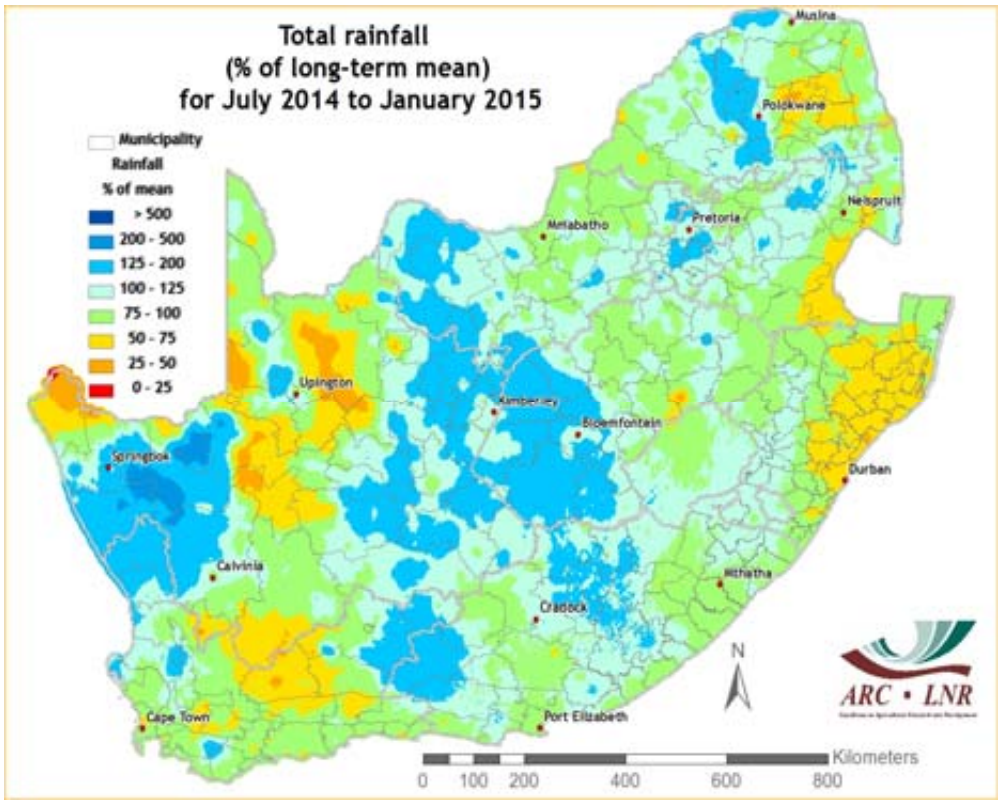


Figure 2



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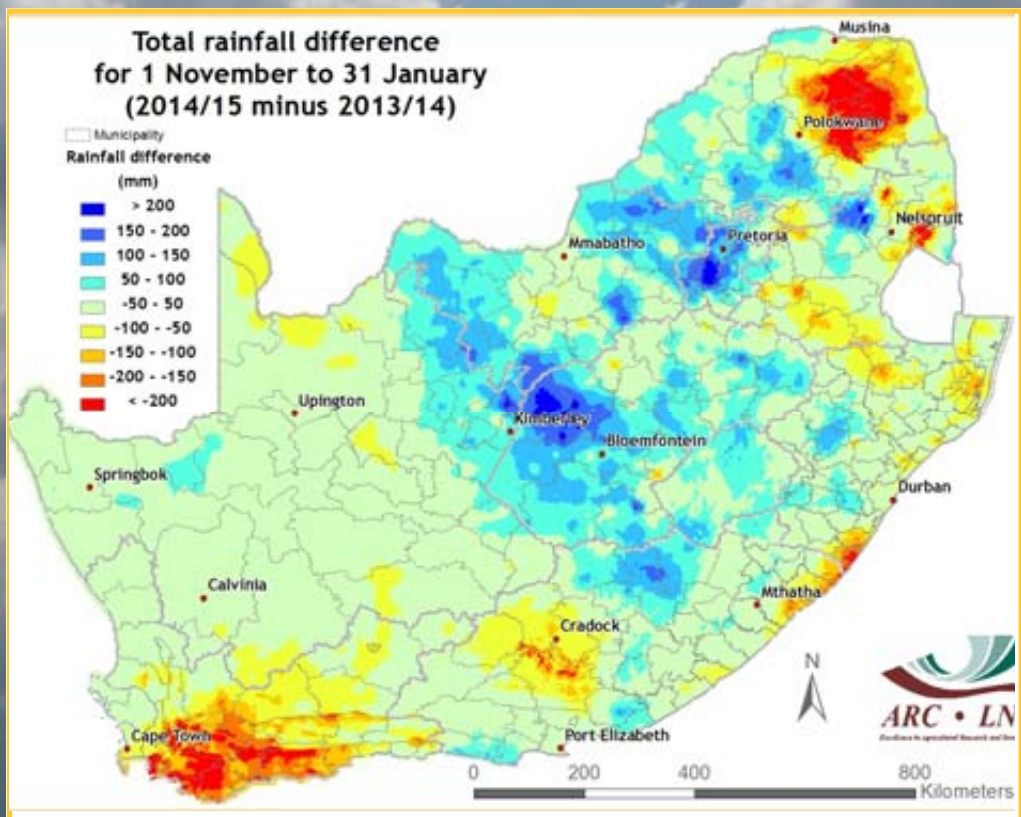

Figure 4

Figure 1:
Rainfall totals over the eastern parts of the summer rainfall area ranged between 50 mm and 250 mm, with the highest falls along the eastern Escarpment and into parts of western KwaZulu-Natal. The western half of the Free State and western North West received less than 50 mm whilst very little precipitation (less than 5 mm) was recorded over the western parts of the Northern Cape and the northern parts of the winter rainfall area.

Figure 2:
Most of the summer rainfall area received below-normal rain during January, except for the interior of the Eastern Cape, western KwaZulu-Natal, northern Mpumalanga and parts of northeastern Free State and eastern North West. In contrast, the western parts of the winter rainfall area received above-normal rainfall.

Figure 3:
Since July, cumulative precipitation has been above normal over the central interior, isolated areas in the northeast and the northern parts of the winter rainfall area. The eastern parts of KwaZulu-Natal, eastern Mpumalanga and Limpopo and well as the central and southwestern parts of the Northern Cape received below-normal rainfall.

Figure 4:
Much of the central to northeastern interior received more rain during the 3 months ending in January 2015 than in 2013/14. The extreme northeastern and southwestern parts of the country received much less rain.

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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) show that wet conditions dominate over some of the central to northern and northeastern parts at the 3- to 12-month time scales. The eastern parts of KwaZulu-Natal experience drought conditions at all time scales indicated

Questions/Comments:
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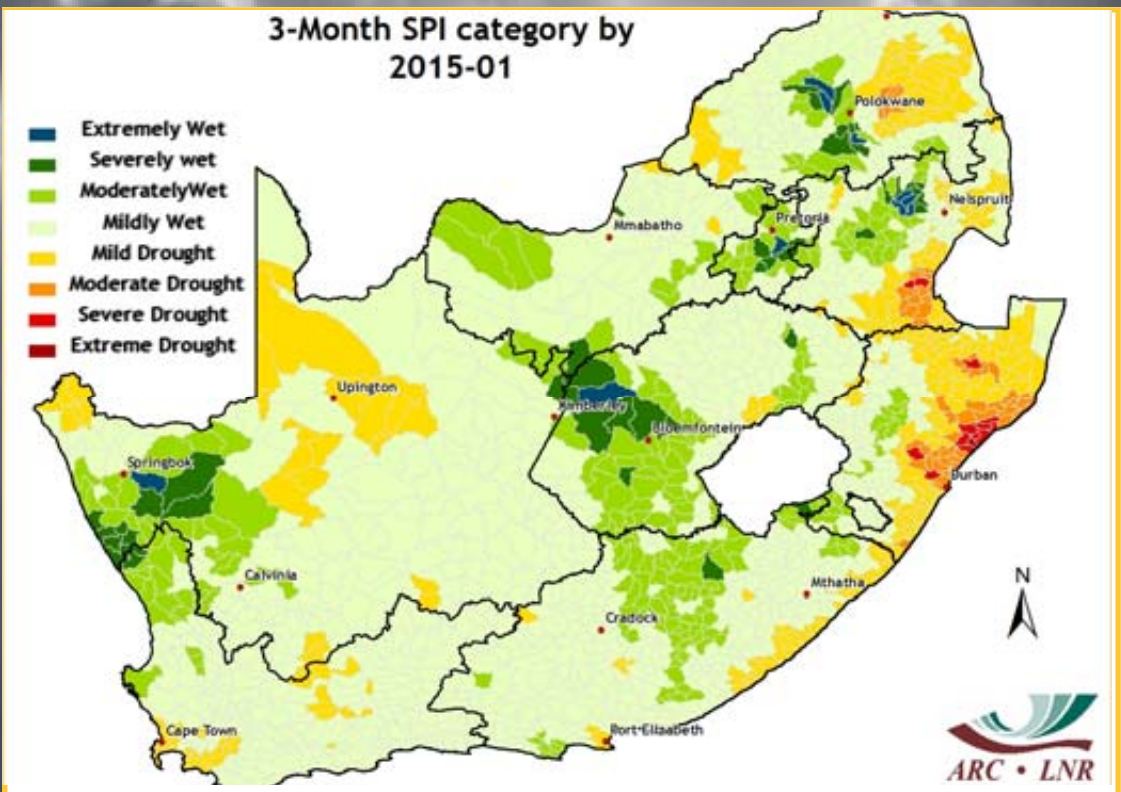

Figure 5

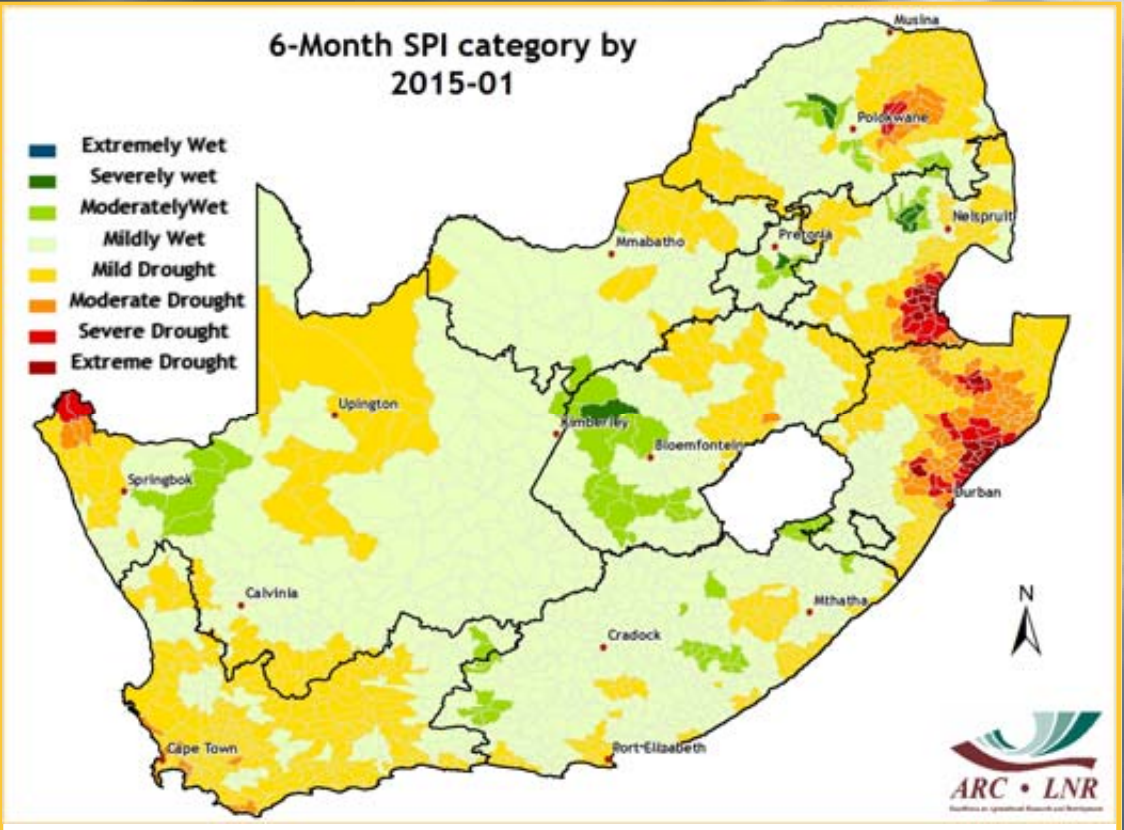

Figure 6

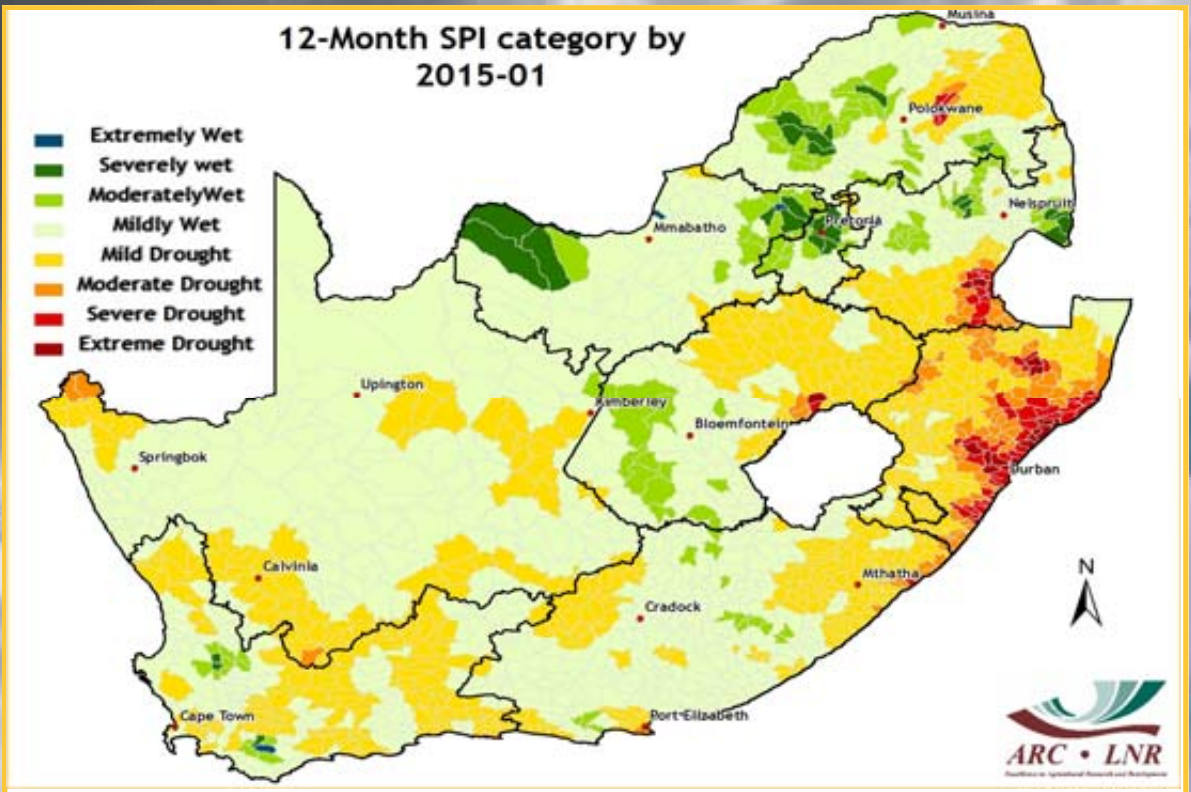

Figure 7

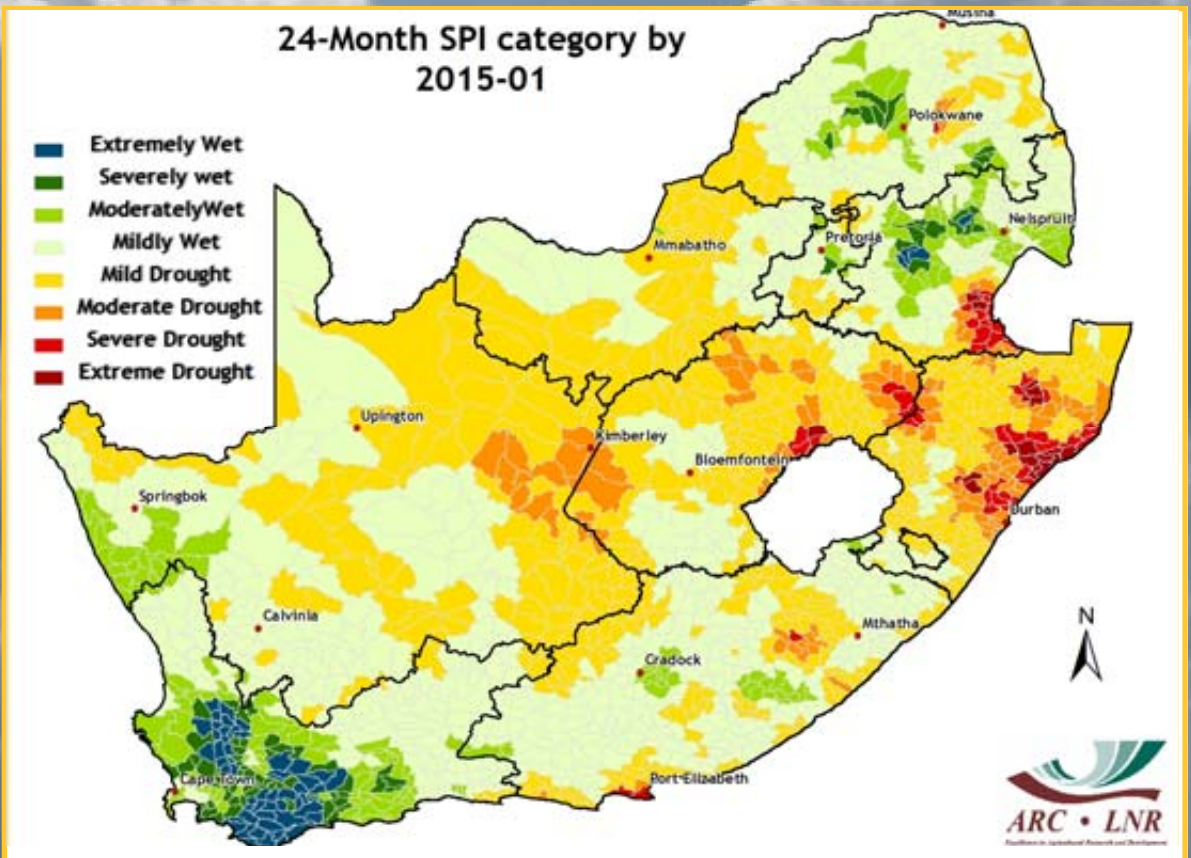

Figure 8

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.

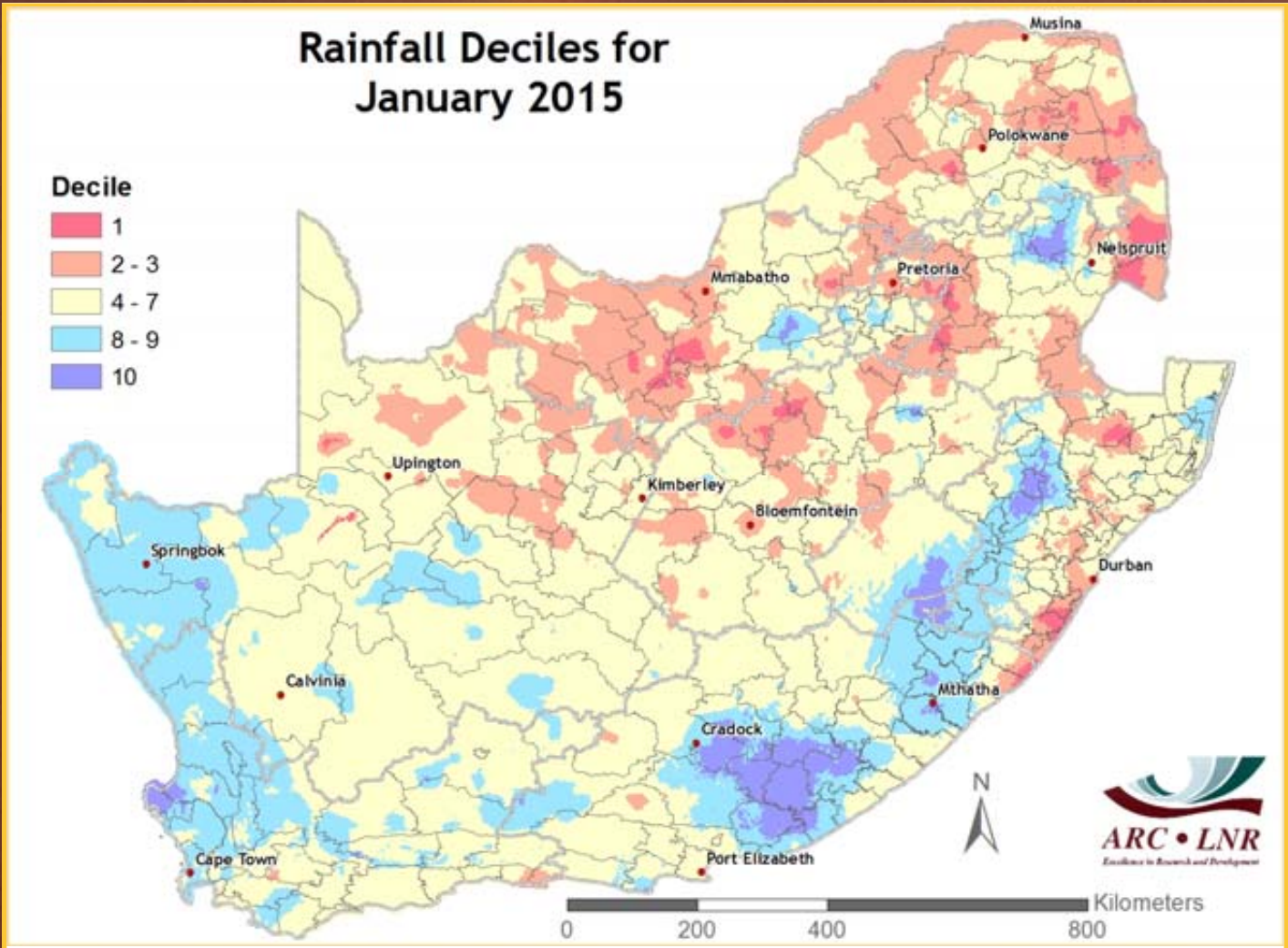

Figure 9

Figure 9:
Rainfall during January was abnormally high over parts of the Eastern Cape and western KwaZulu-Natal but abnormally low over parts of central North West and northwest Free State and large parts of the Lowveld of Mpumalanga. However, the above-normal rainfall over the northern parts of the winter rainfall area was not exceptional.

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

4. Water Balance

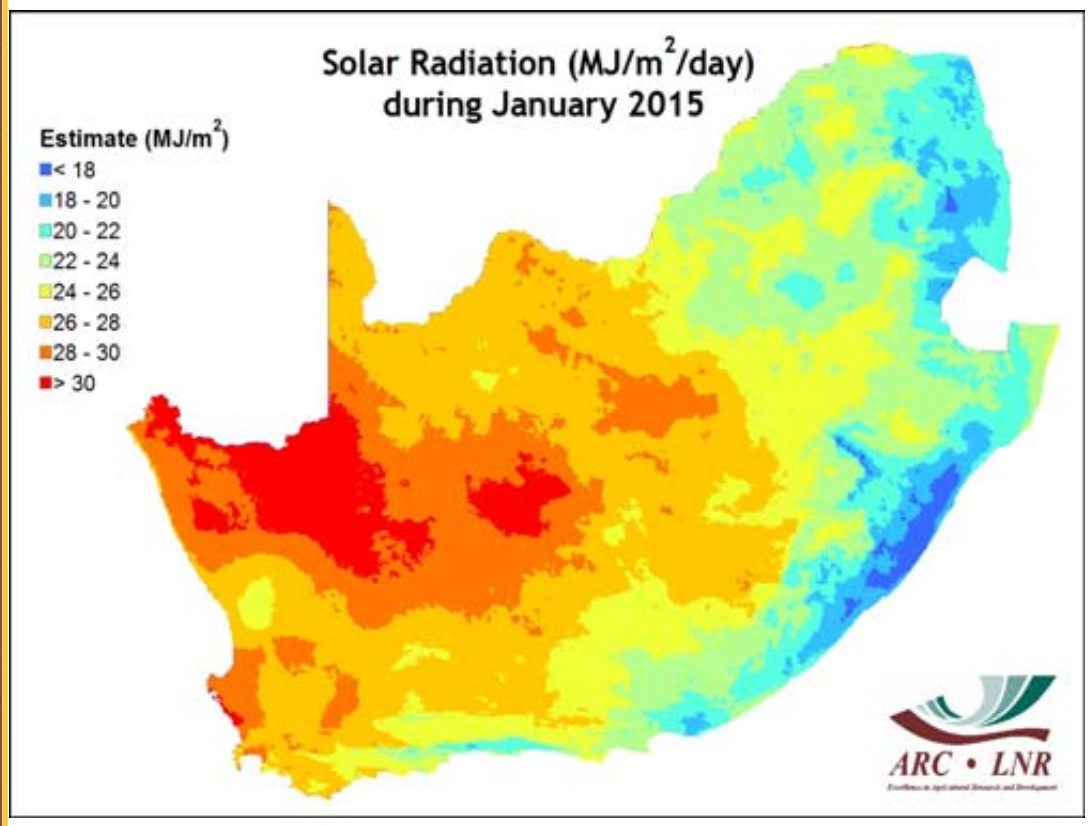

Figure 10

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:
Solar radiation values were high over especially the northwestern and western parts of the country, even more so because of the dominating dry and clear conditions there during January.

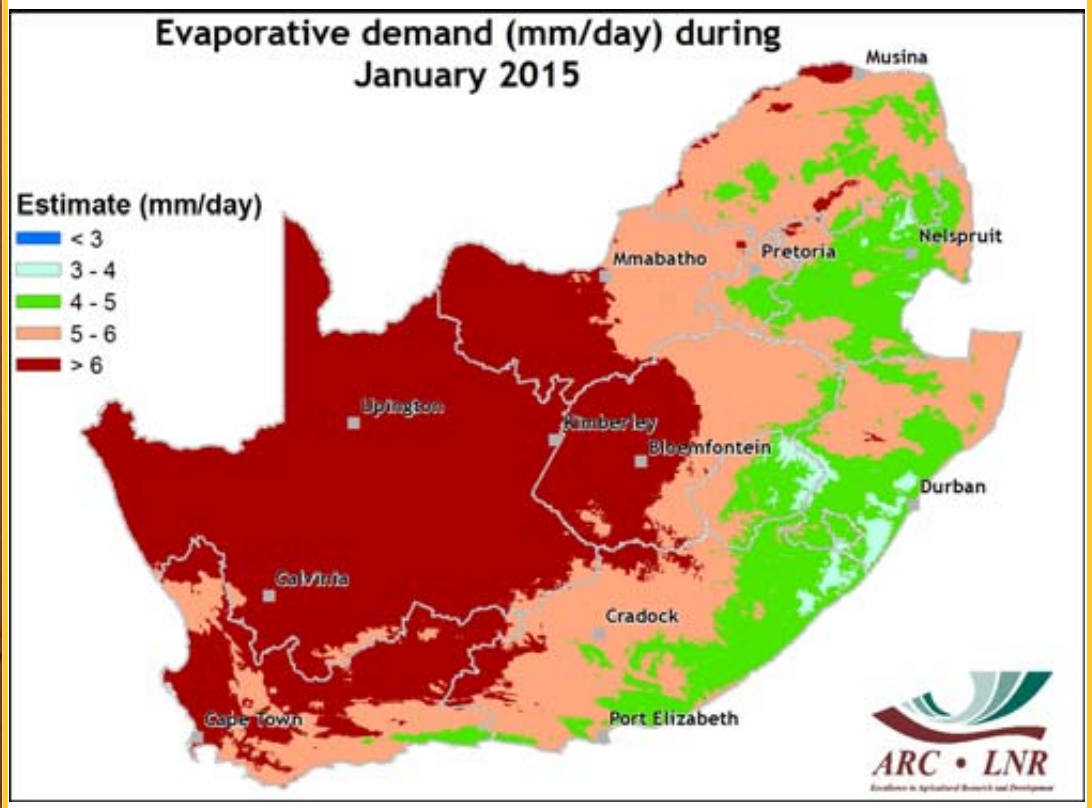

Figure 11

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 3-4 mm/day over the southeastern coastal areas to more than 6 mm/day over the northwestern interior.

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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.

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

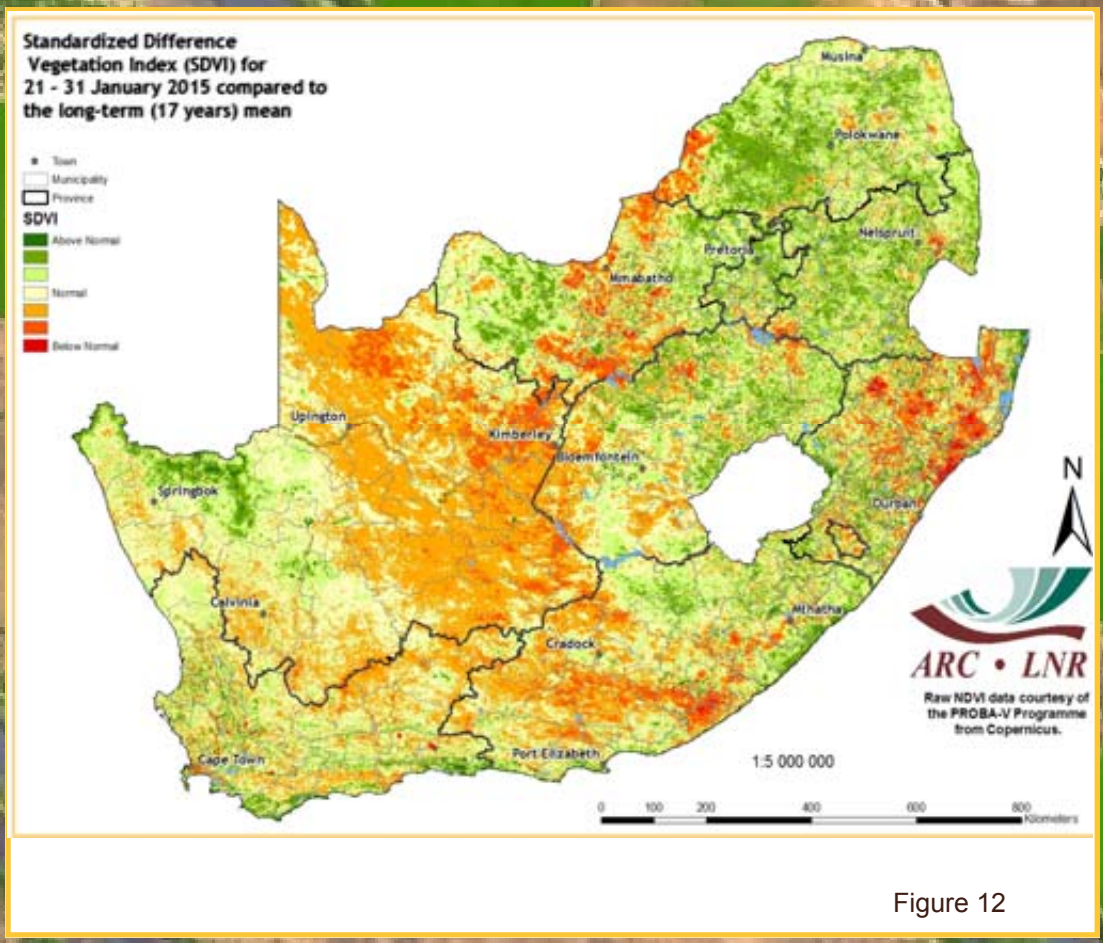

Figure 12

Figure 12:
The SDVI shows drought stress over the western parts of the summer rainfall area, extreme western Limpopo, central parts of North West and parts of northeastern KwaZulu-Natal.

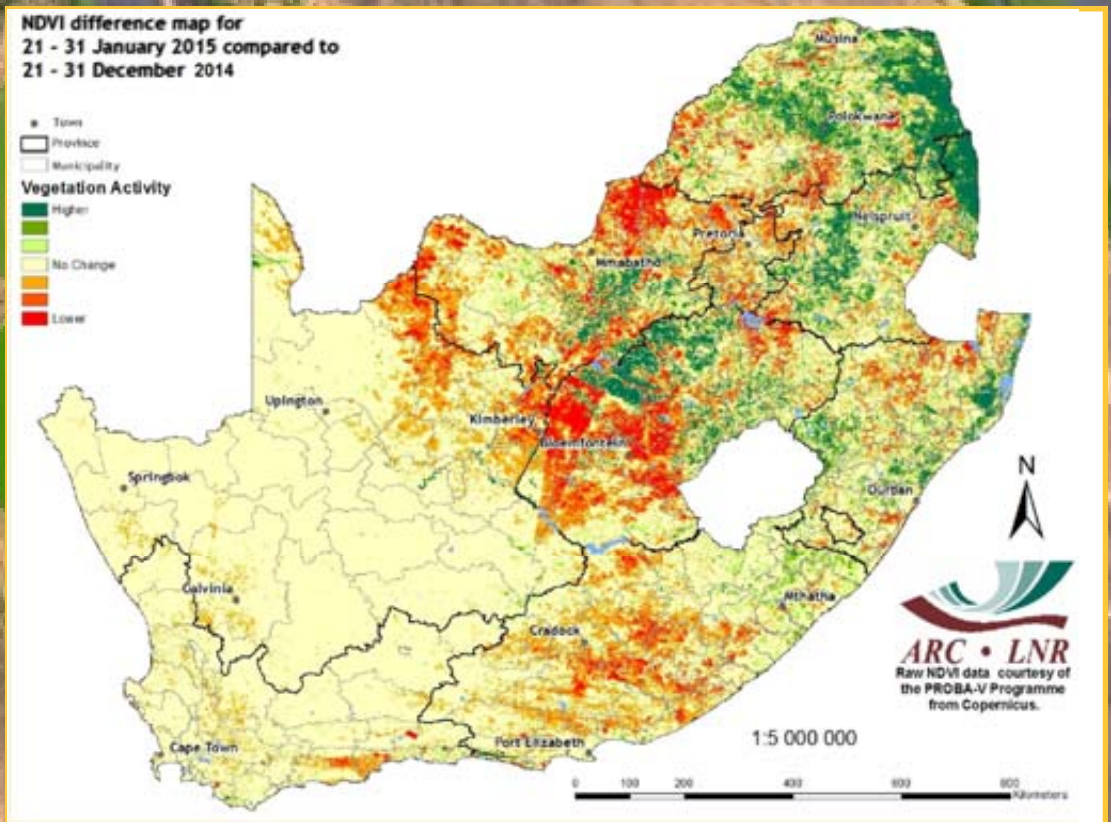

Figure 13

Figure 13:
Vegetation activity decreased over most parts since December due to drier and hot conditions that dominated much of the western and central interior during January.

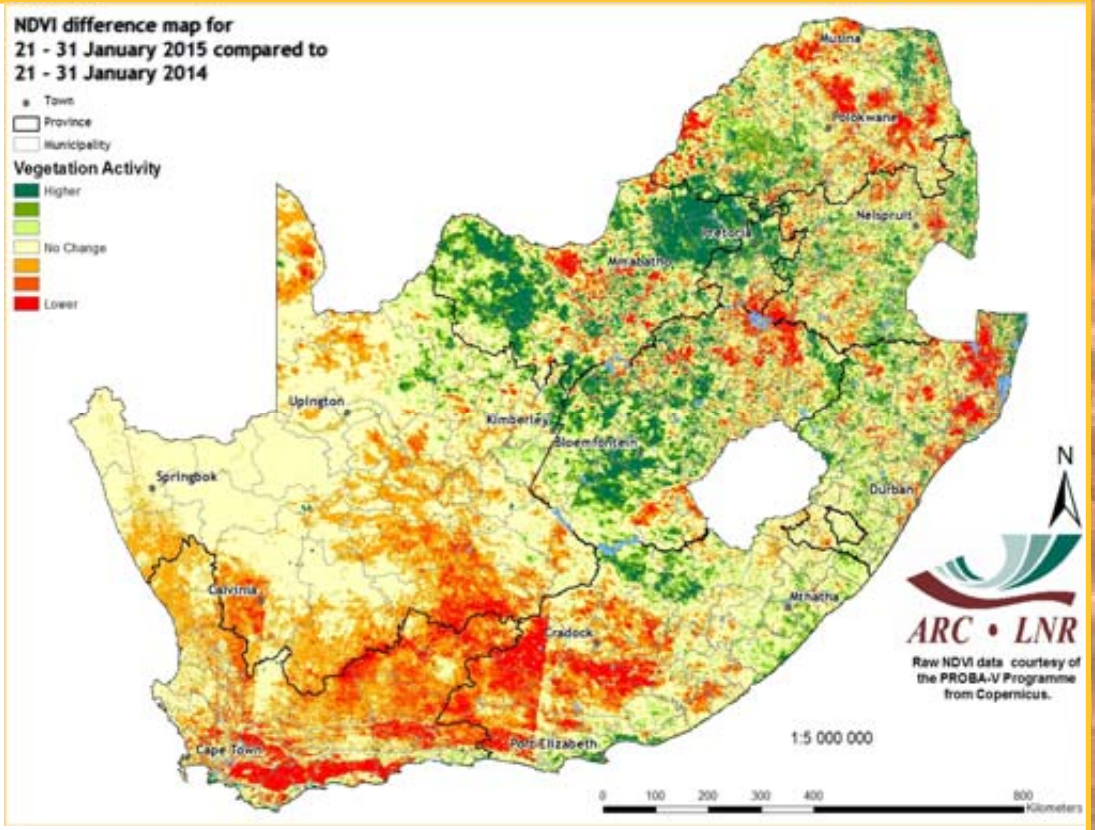

Figure 14

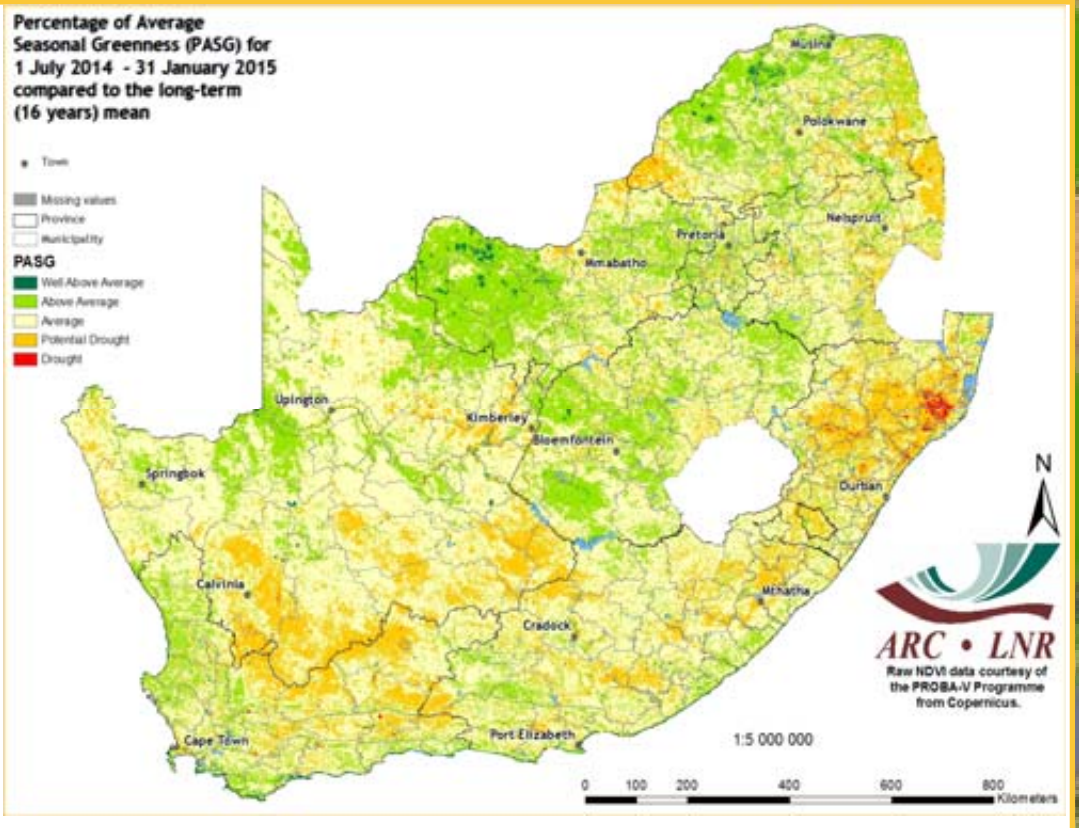

Figure 15

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:
Most of the central parts still experience higher vegetation activity than in January 2014 while the southwestern and northeastern extremes experience lower activity. This is in accordance with the rainfall difference between the two years for November to January.

Figure 15:
Cumulative vegetation activity is still above normal over much of the interior due to wet conditions during November and December. One notable exception is the eastern parts of KwaZulu-Natal where drought conditions dominate at several time scales.

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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.

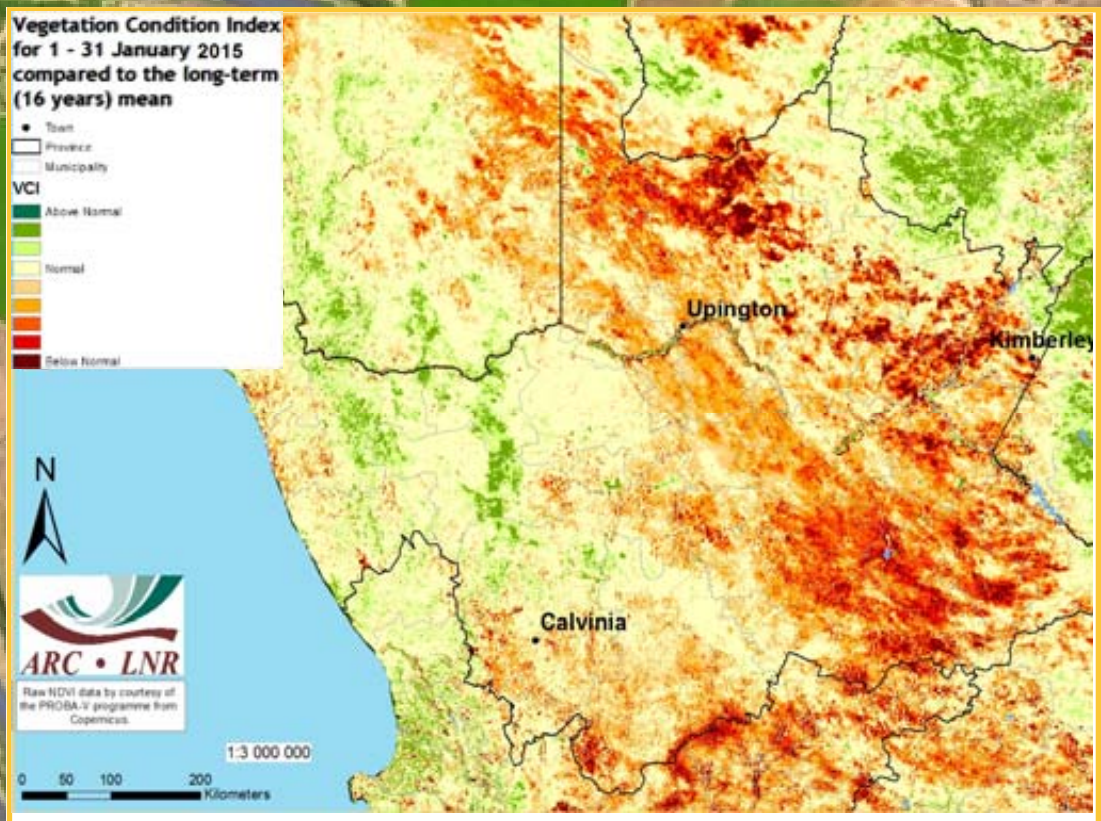

Figure 16

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

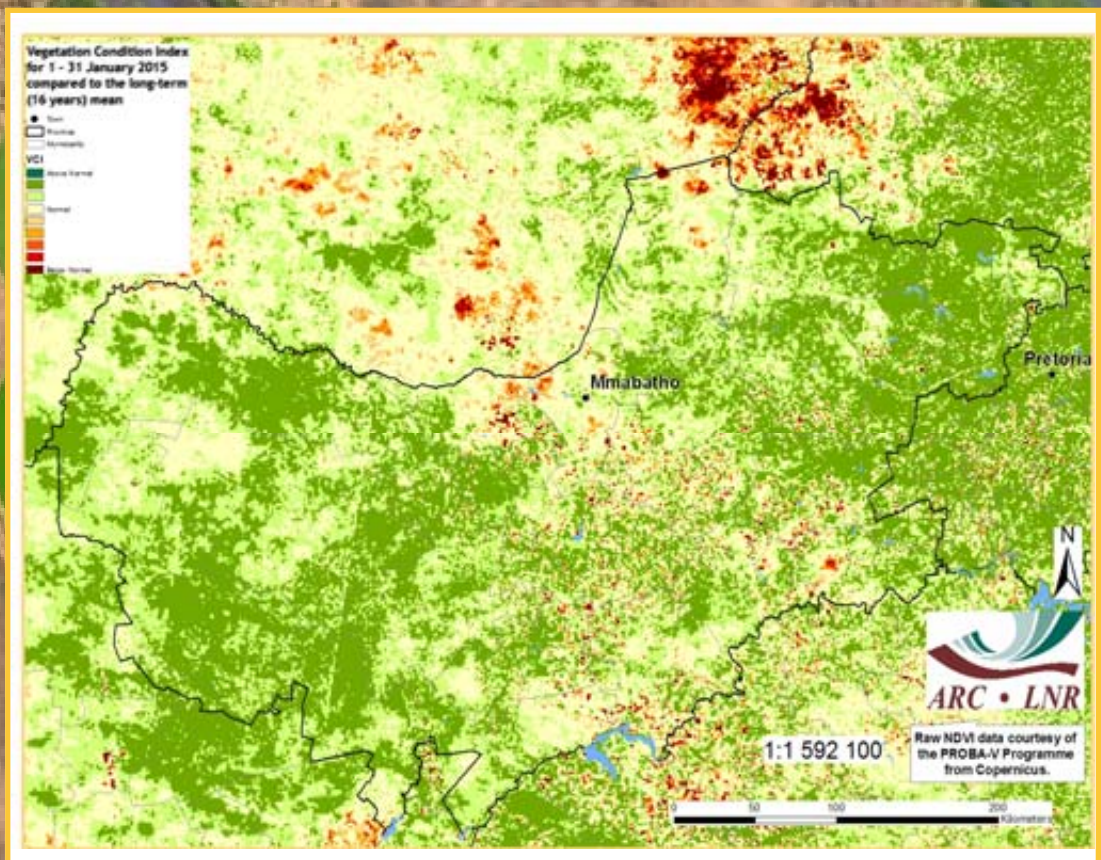

Figure 17

Figure 17:
The VCI map for January indicates below-normal vegetation activity starting to appear over the central parts of North West, southeast Botswana and southwest Limpopo.

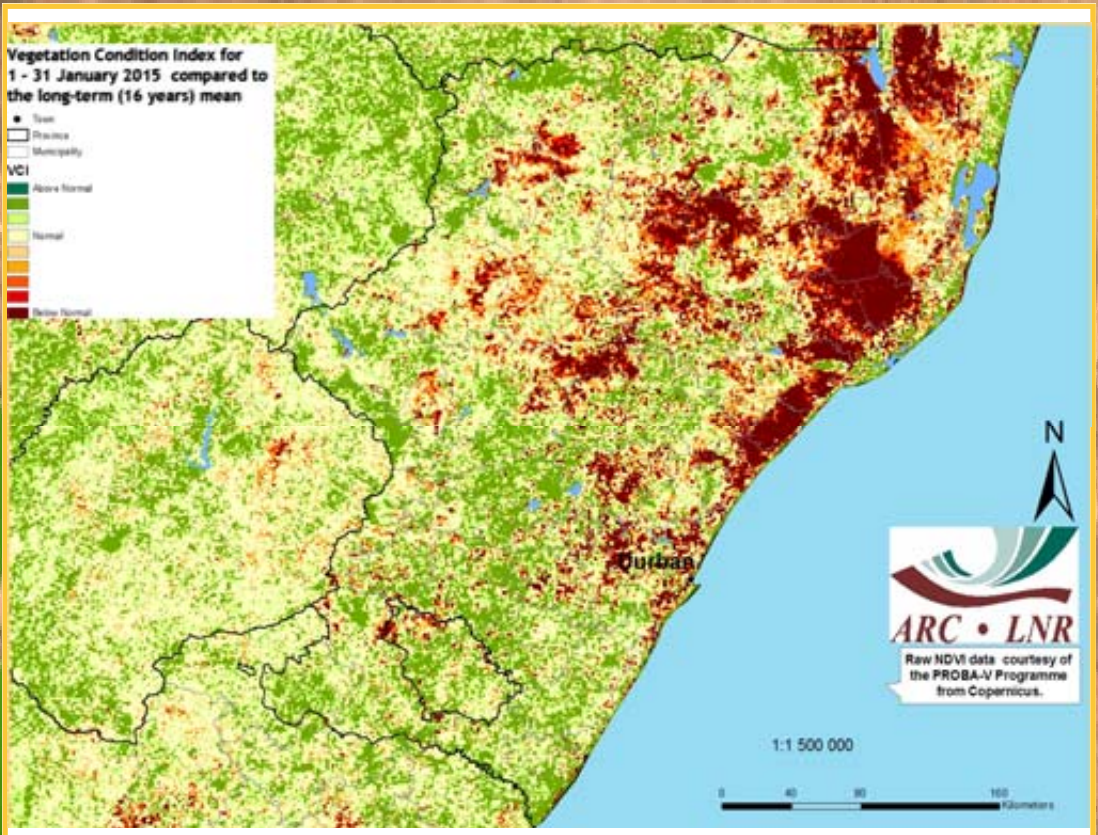

Figure 18

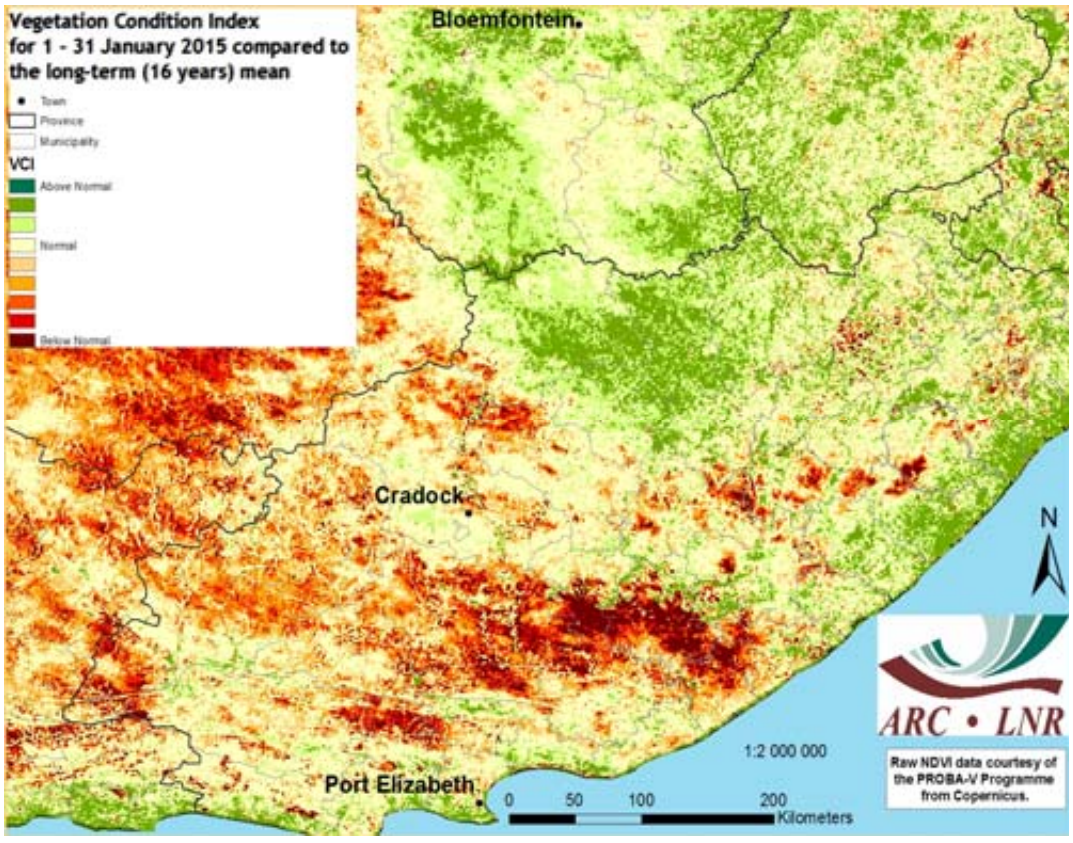

Figure 19

Figure 18:
The VCI map for January indicates below-normal vegetation activity over the central and eastern parts of KwaZulu-Natal.

Figure 19:
The VCI map for January indicates below-normal vegetation activity over the western parts of Eastern Cape province.

Questions/Comments:
NkambuleV@arc.agric.za

7. Vegetation Conditions & Rainfall

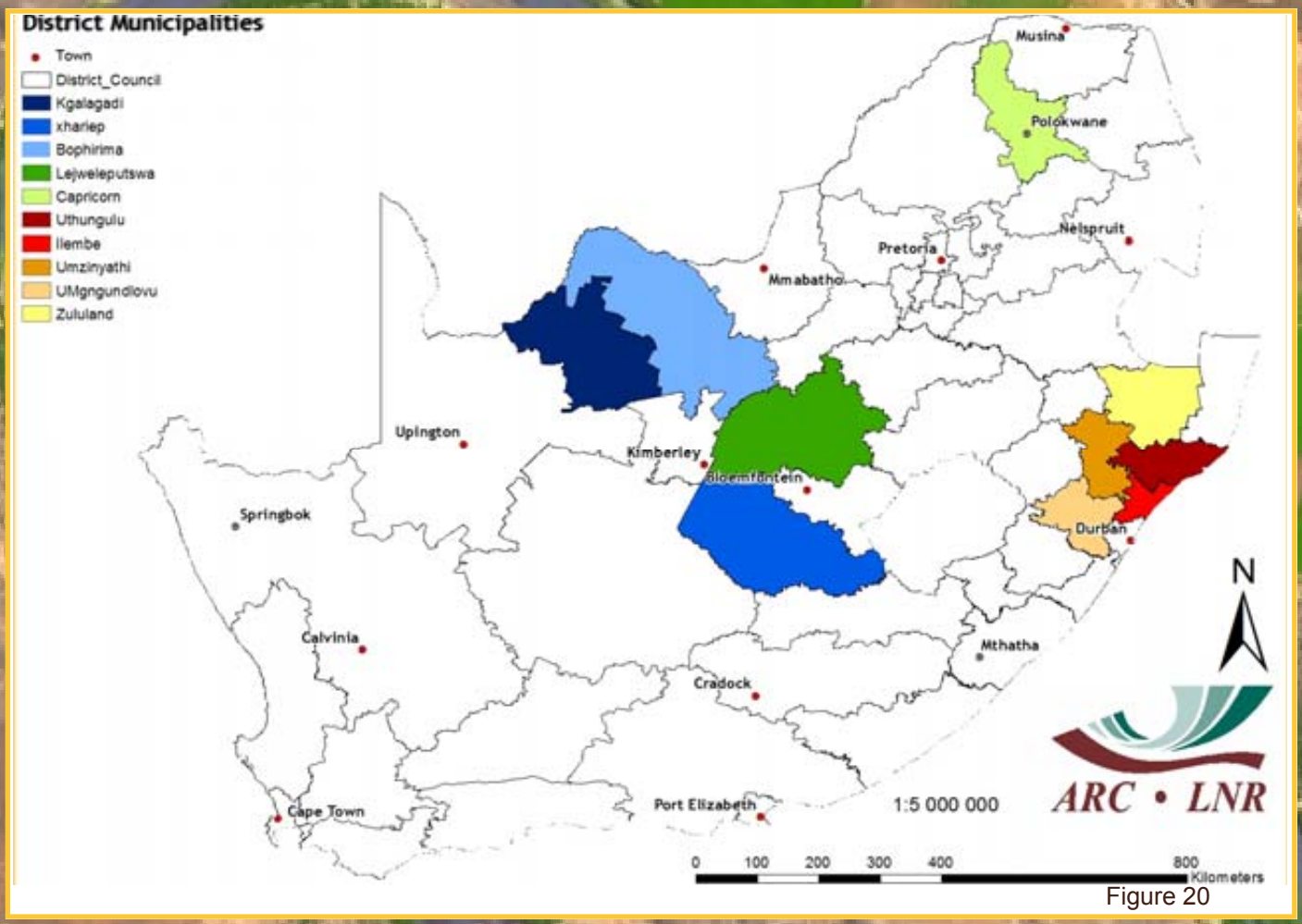

Figure 20

NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for January 2015. The district colour matches the border of the corresponding graph.

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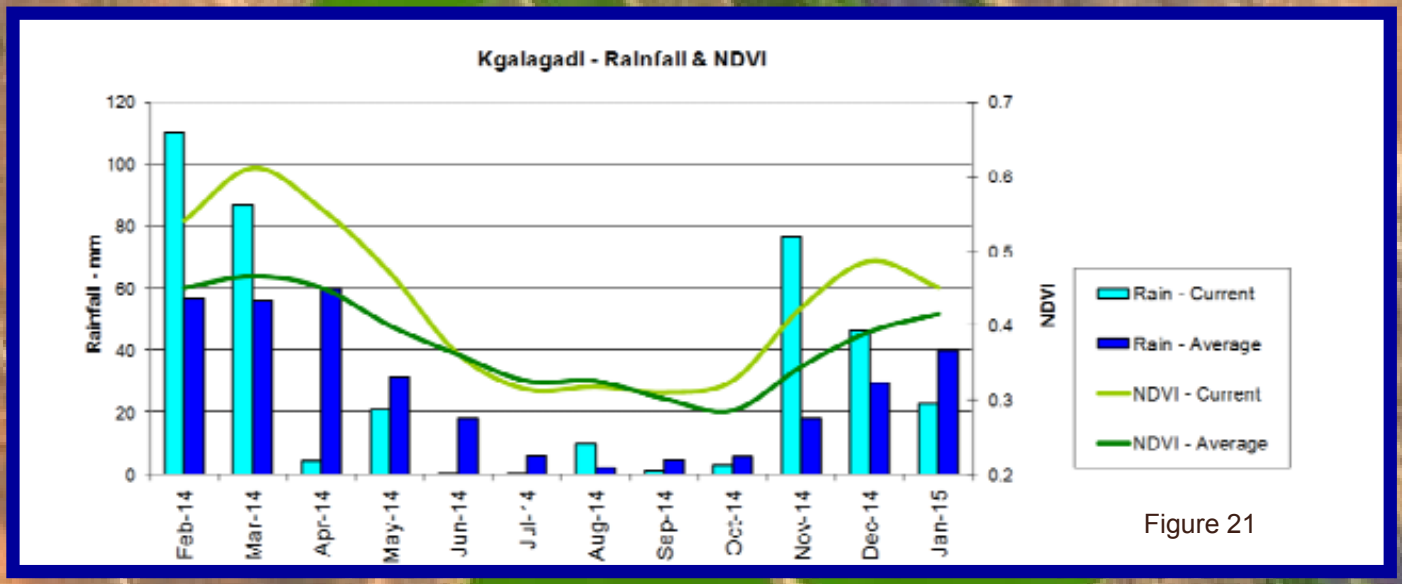
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

Figures 26-29:
Indicate areas with lower cumulative vegetation activity for the last year.



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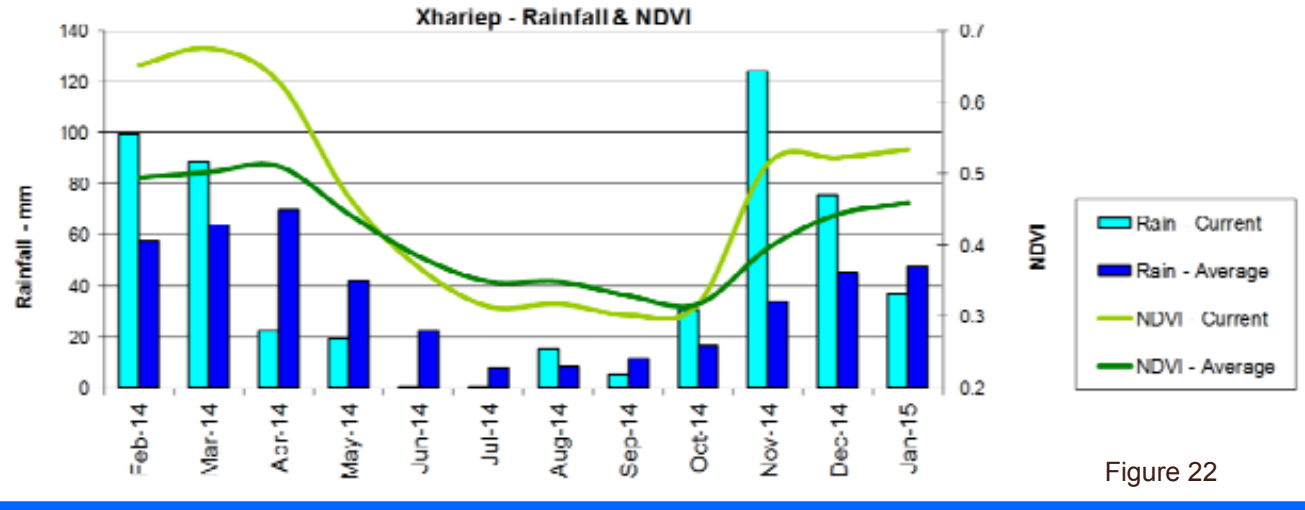

Figure 22

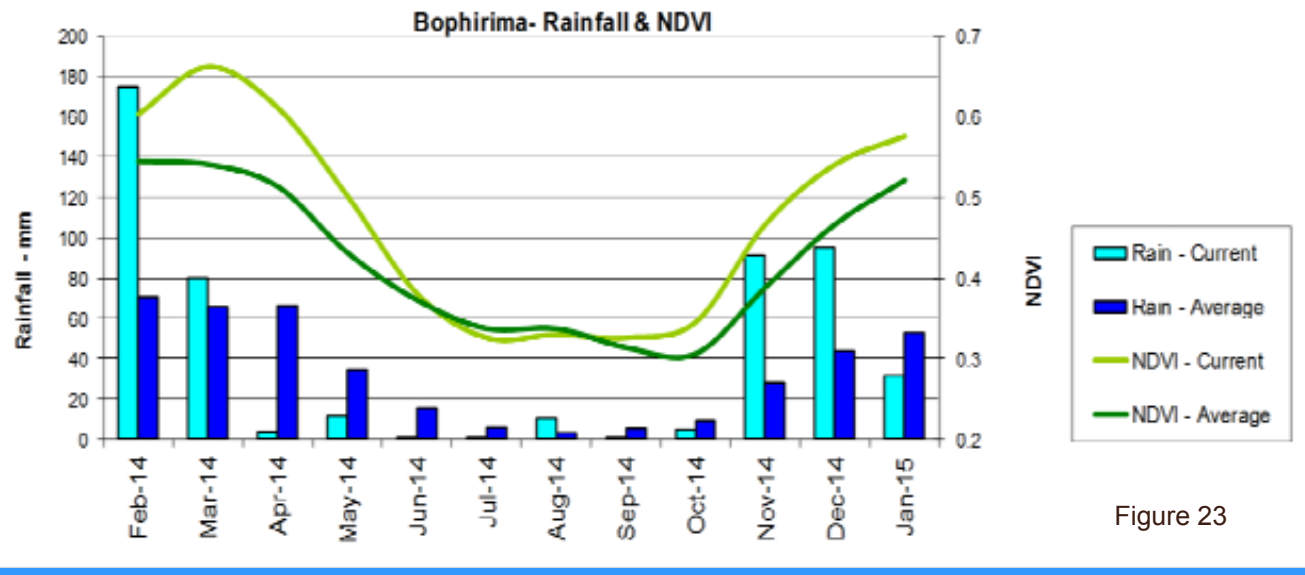

Figure 23

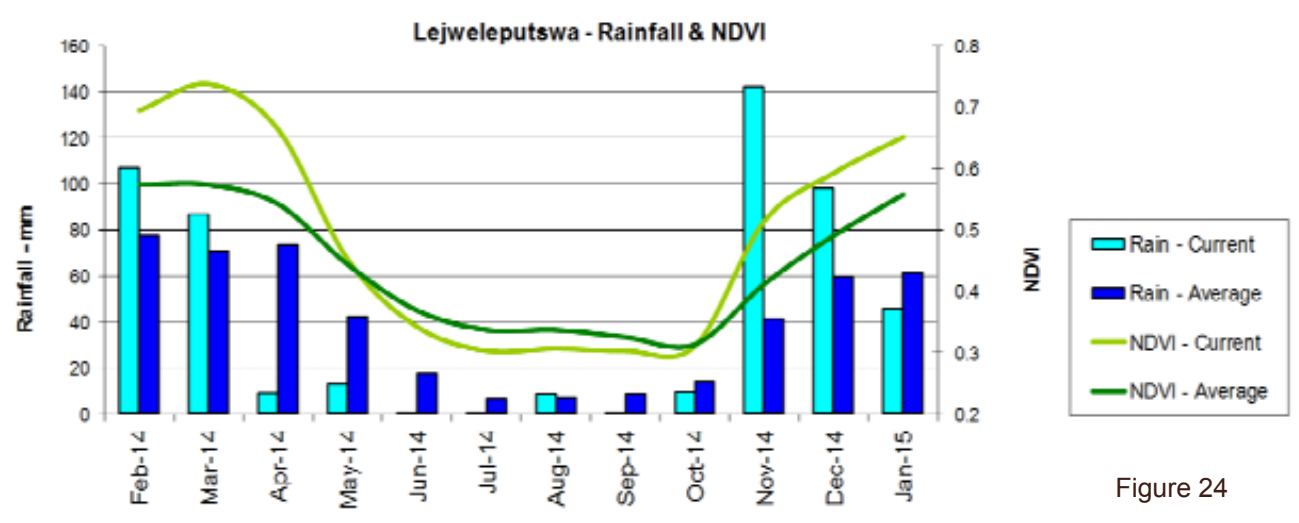

Figure 24

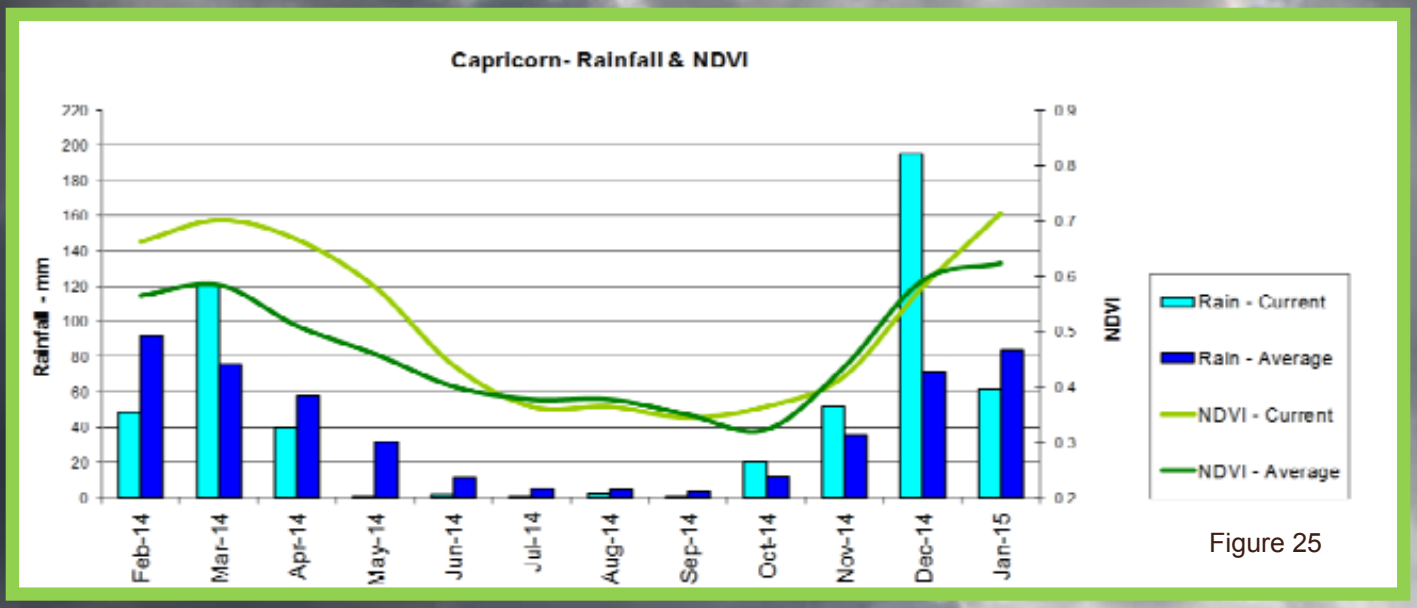

Figure 25

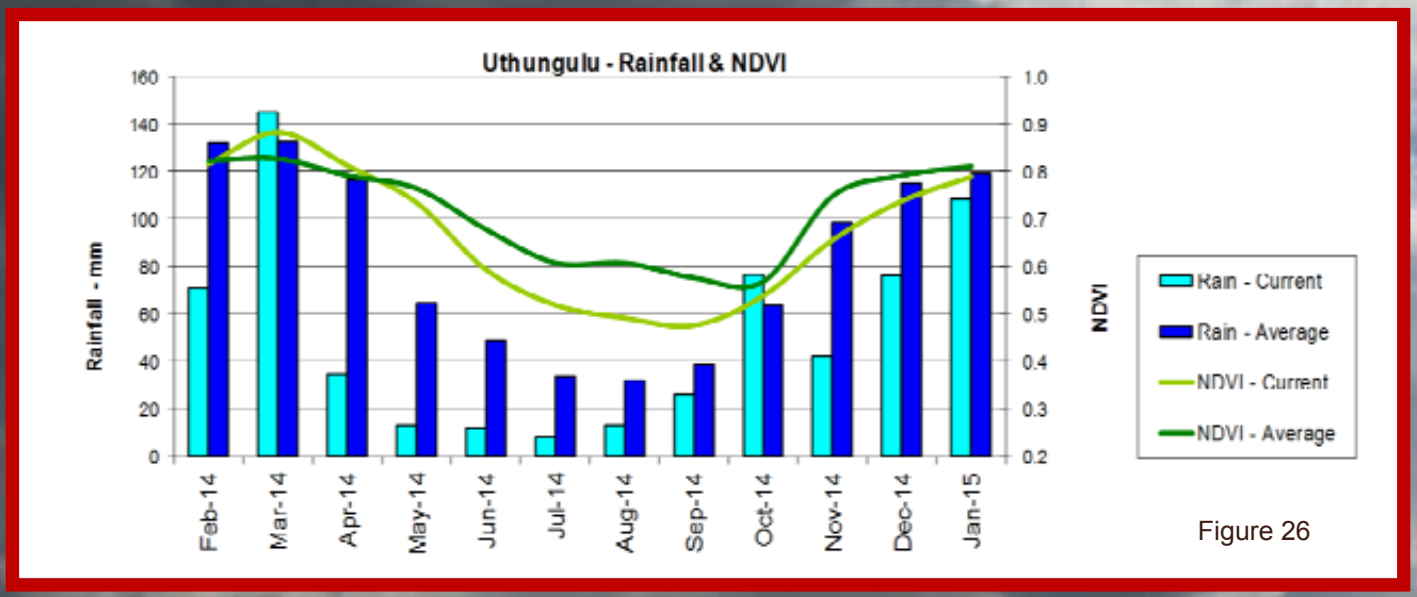

Figure 26

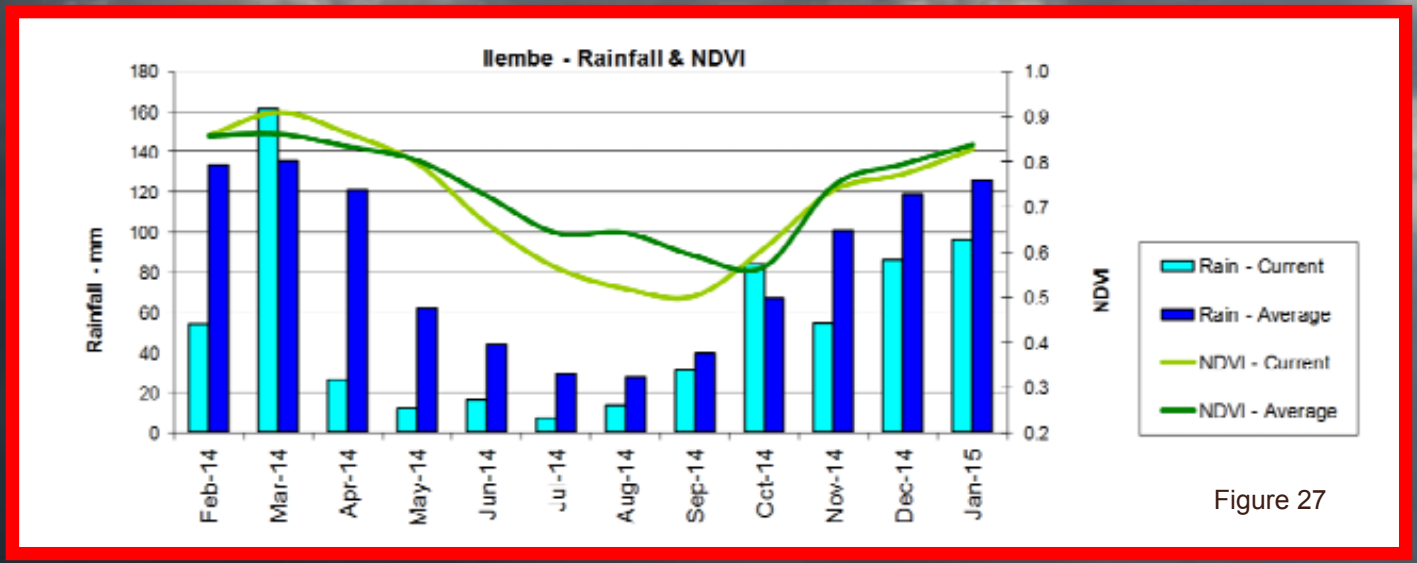

Figure 27

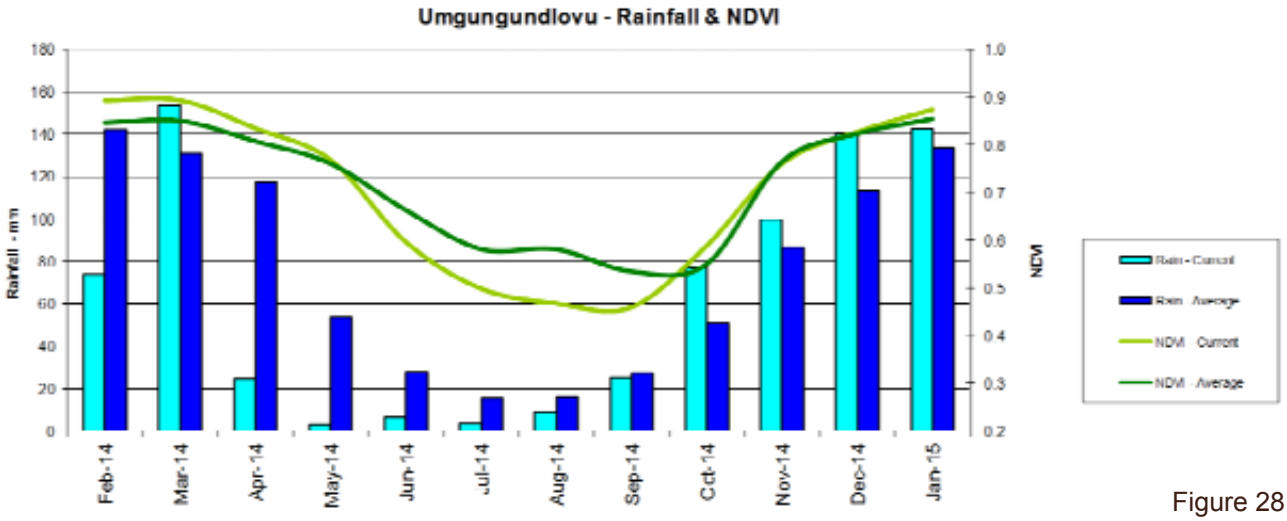

Figure 28

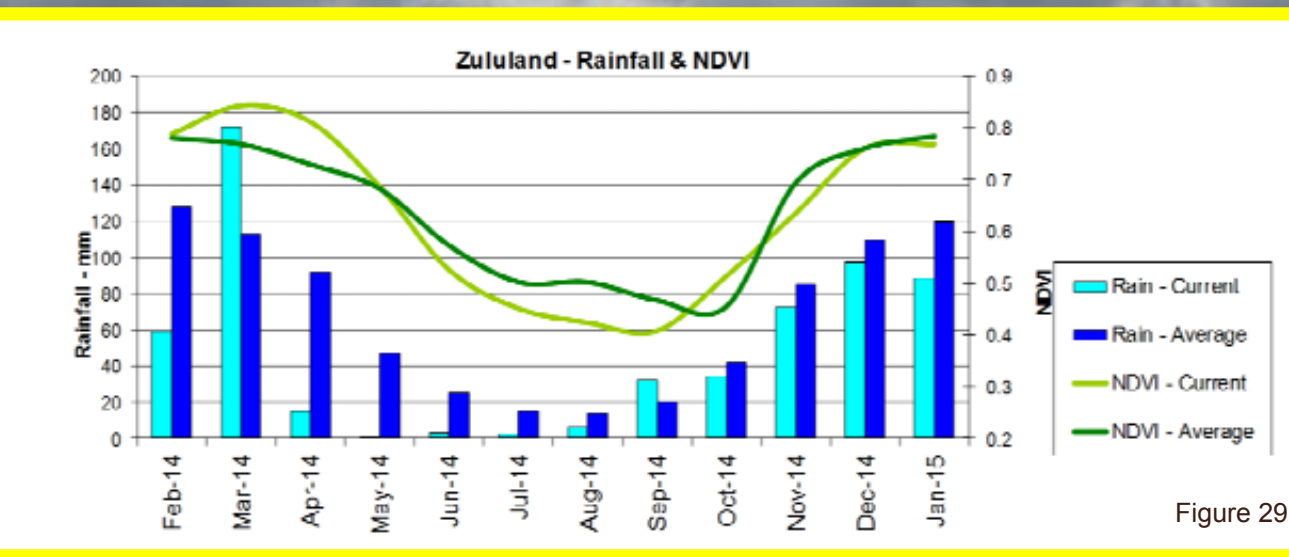

Figure 29

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 30:
The graph shows the total number of active fires detected in the month of January per province. Fire activity was higher in Gauteng, Mpumalanga, Limpopo, North West, Western Cape and KwaZulu-Natal compared to the average during the same period for the last 14 years.

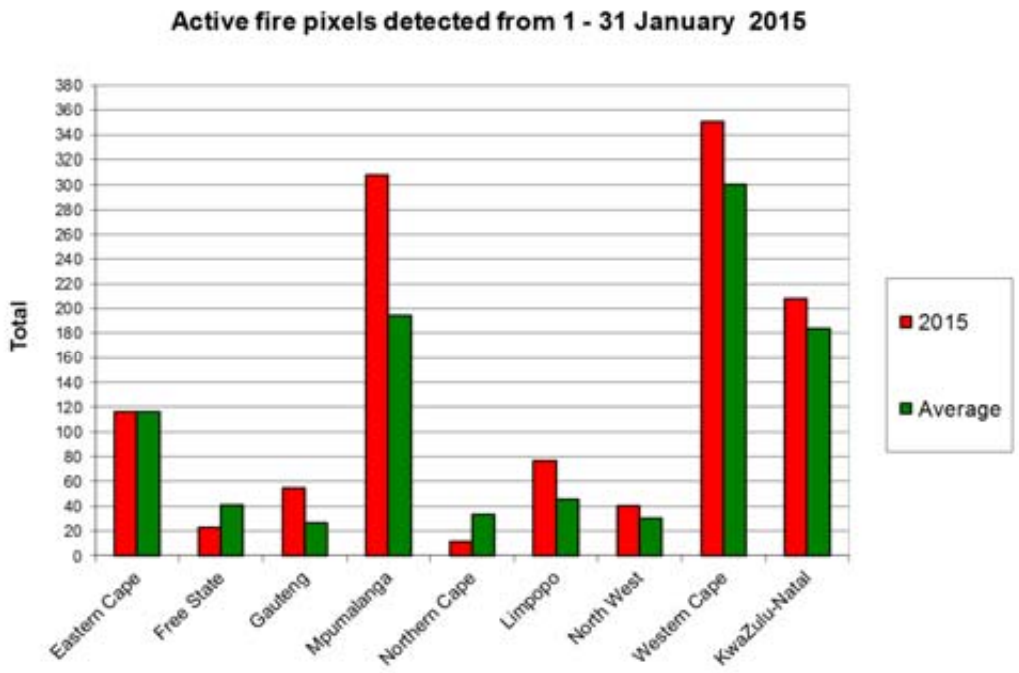

Figure 30

Figure 31:
The map shows the location of active fires detected between 1-31 January 2015.

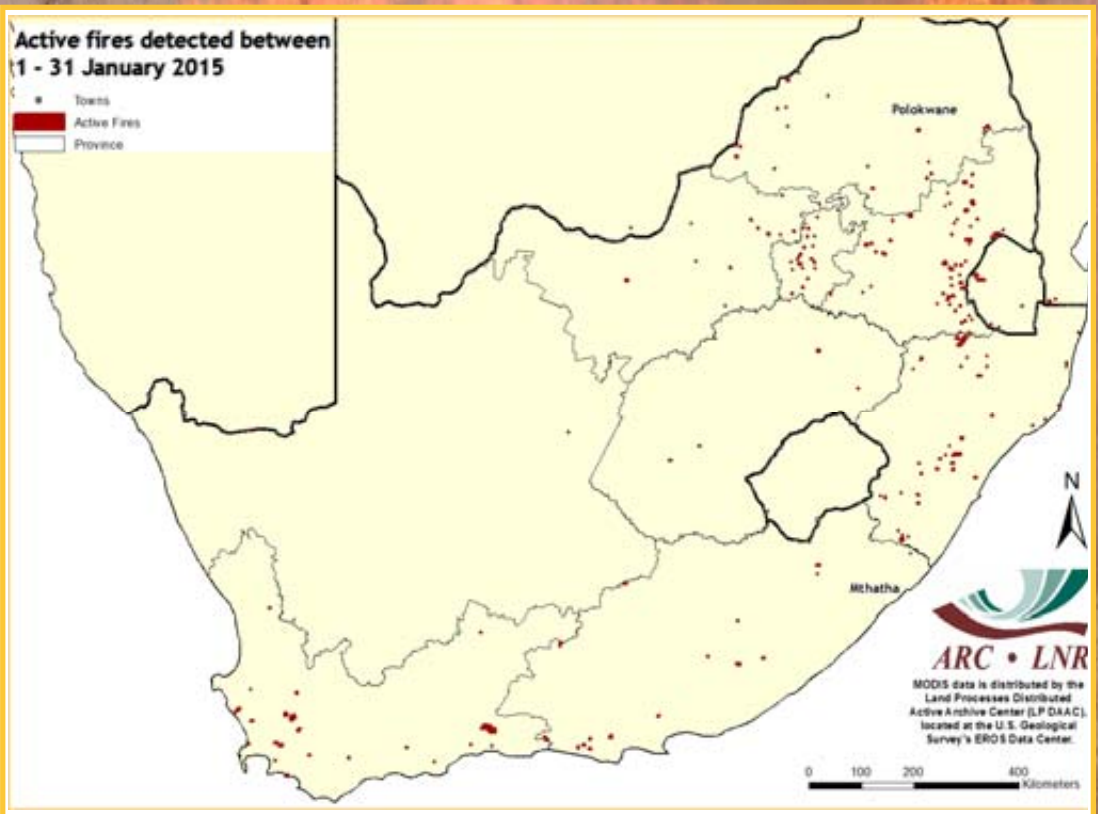

Figure 31

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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E-mail: ChrisK@arc.agric.za
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Private Bag X79, Pretoria 0001
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Website: www.arc.agric.za

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 Spot VEGETATION and ProbaV 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

Rainfall maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network, 270 automatic rainfall recording stations from the SAWS, satellite rainfall estimates from the Famine Early Warning System Network: **http://earlywarning.usgs.gov** and long-term average climate surfaces developed at the ARC-ISCW.

Solar Radiation and Evapotranspiration maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network.
- Data from the METEOSAT Second Generation (MSG) 3 satellite via GEONETCAST: **http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast/GEONETCast/index.html**.

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What does Umlindi mean?
UMLINDI is the Zulu word for "the watchman".

http://www.agis.agric.za