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Excellence in Agricultural Research and Development

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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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

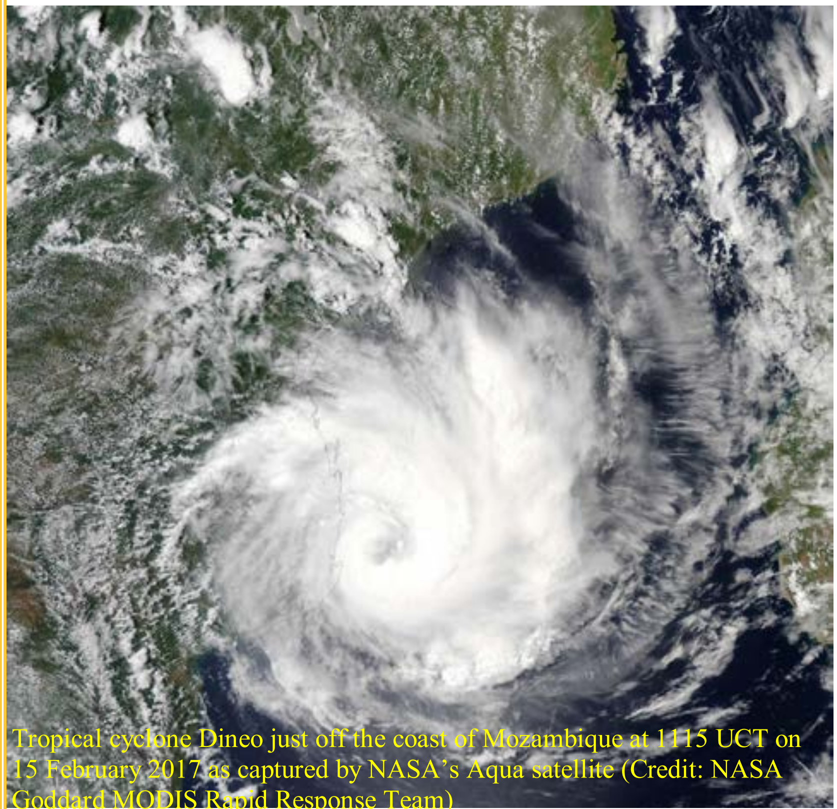
South African Weather Service

AMESD

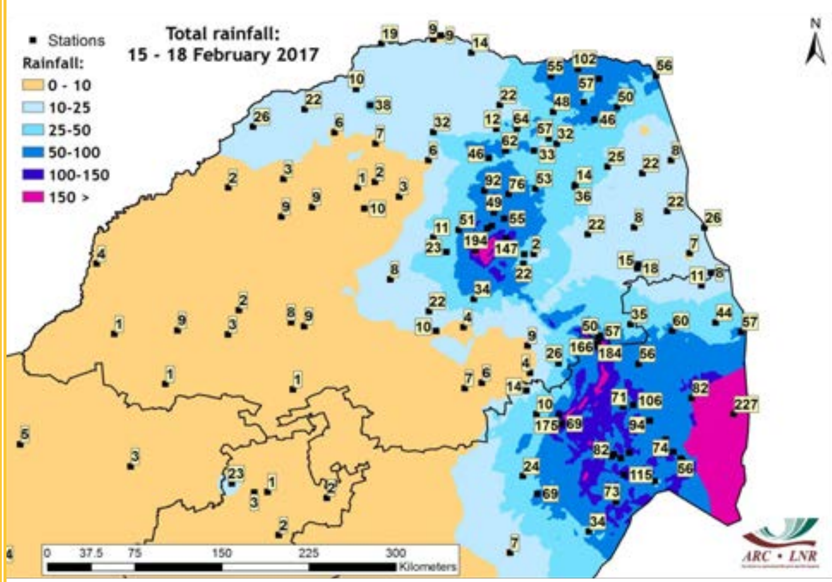
153rd Edition

Images of the Month

Dineo brings widespread rain in February



Tropical cyclone Dineo just off the coast of Mozambique at 1115 UCT on 15 February 2017 as captured by NASA's Aqua satellite (Credit: NASA Goddard MODIS Rapid Response Team)



February 2017 was an exceptionally good rainfall month with much of the country receiving above-normal rainfall. The rainfall event that contributed to most of the rain over the interior occurred from the 19th to the 21st. Over Gauteng and the surrounding areas of North West, Free State and Mpumalanga more than 60% of the month's rainfall occurred during this 3-day period. A few days prior to this rainfall event a tropical cyclone made landfall along the Mozambique coast (see image from 15 February). Tropical cyclone Dineo was the first tropical cyclone to make landfall since tropical cyclone Jokwe in 2008. Over South Africa, heavy rainfall directly associated with Dineo occurred prior to the rainfall event of 19-21 February and was confined to the eastern escarpment where up to 300 mm was recorded between the 15th and 18th. Dineo subsequently weakened to a tropical depression while moving westwards over the subcontinent and merged with an upper air trough, contributing indirectly to the rainfall experienced between the 19th and 21st.

The rainfall map shows accumulated rainfall totals recorded from 15-18 February at stations in northeastern South Africa, associated with Dineo.

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:

Almost the entire summer rainfall region received above-normal rainfall during the month of February. Exceptions were the central parts of Limpopo, the central Kruger National Park, the extreme northeastern parts of KwaZulu-Natal and the Eastern Cape coast. It was particularly the central parts of the country where rainfall was well above normal. Here, large areas received totals exceeding 150 mm. Some areas in North West, along the eastern escarpment and KwaZulu-Natal Drakensberg received more than 300 mm for the month. In stark contrast, over the far western parts of the country rainfall was below normal, and dam levels over these areas continued to drop to critically low levels. Below-normal rainfall also occurred over most of the southern coastal areas of the country.

February 2017 was characterized by high levels of moisture in circulation. As a result of the abundance of moisture, a high occurrence of cloud cover occurred over the interior in a northwest to southeast aligned band. On days with the absence of strong synoptic forcing, convective thundershowers developed in the region of the surface trough and further to its east. Well organized northwest to southeast aligned cloud bands developed on days when an upper air trough nearing the country facilitated an enhanced southward flow of tropically sourced moisture. Such events occurred from the 1^{st}-6^{th}, 11^{th}-14^{th} and 18^{th}-22^{nd}. These events contributed to the majority of the rainfall over the central parts of the country received during the month. February also saw a tropical cyclone making landfall on the 15^{th}, the first one to make landfall in the last few years. Tropical cyclone Dineo weakened considerably while moving westwards towards Namibia where the mid-level low associated with ex-tropical cyclone Dineo merged with an upper-air trough, giving rise to the rainfall event of the 18^{th}-22^{nd}.

The rainfall event from 1-6 February was characterized by the presence of an active Angola low in addition to the support provided by the upper-air trough. The combination of these weather systems resulted in rainfall totals for this 6-day period of 100-150 mm over the central parts of North West and the Free State. During the rainfall event of 11-14 February, the highest accumulated totals occurred over the western parts of the Free State, the Eastern Cape interior and the southwestern parts of KwaZulu-Natal with totals varying between 30-80 mm, reaching 100 mm at a few stations in the KZN Drakensberg region. The rainfall event of 18-22 February was the main event of the month over South Africa. This was the result of an upper-air trough that merged with the mid-level low pressure system associated with ex-tropical cyclone Dineo that was then located over Namibia. With the eastward advancement of the upper-air trough, the mid-level low moved briefly southeastwards in over South Africa. The bulk of the rain fell between the 19^{th} and 21^{st} and flooding occurred in some places (e.g. Wolmaransstad and Potchefstroom). The level of the Vaal Dam rose by more than 6% in a 24-hour period during this rainfall event.

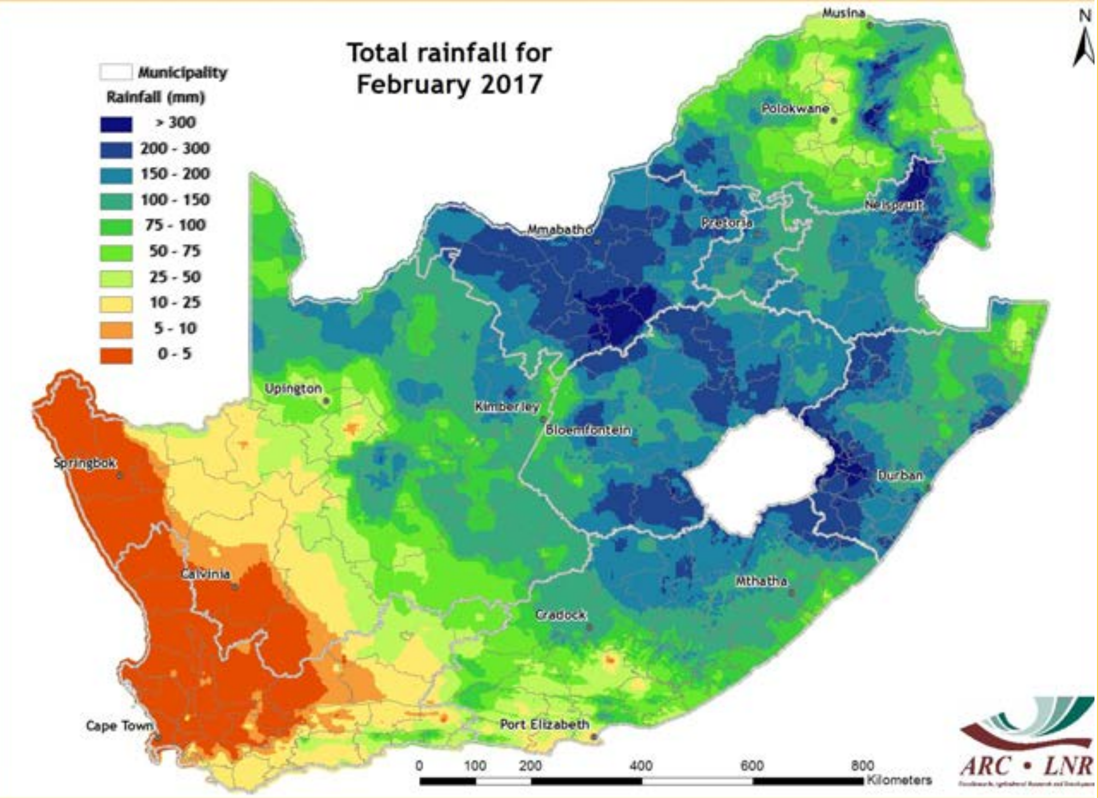


Figure 1

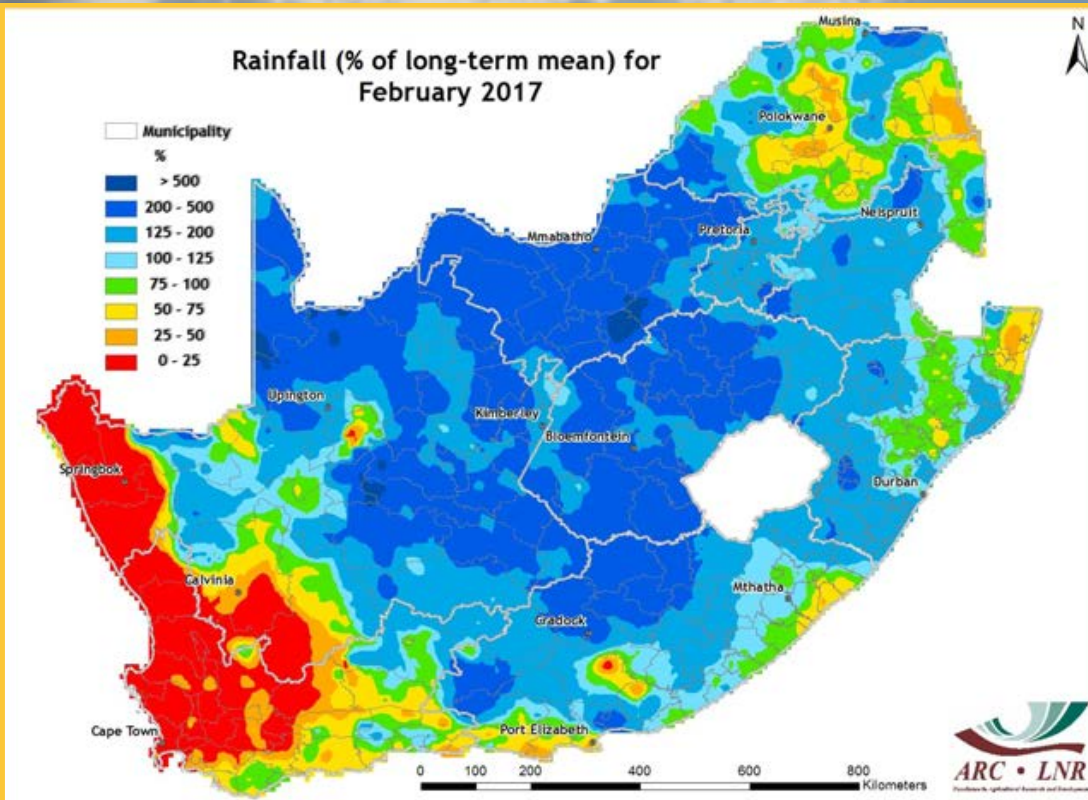


Figure 2

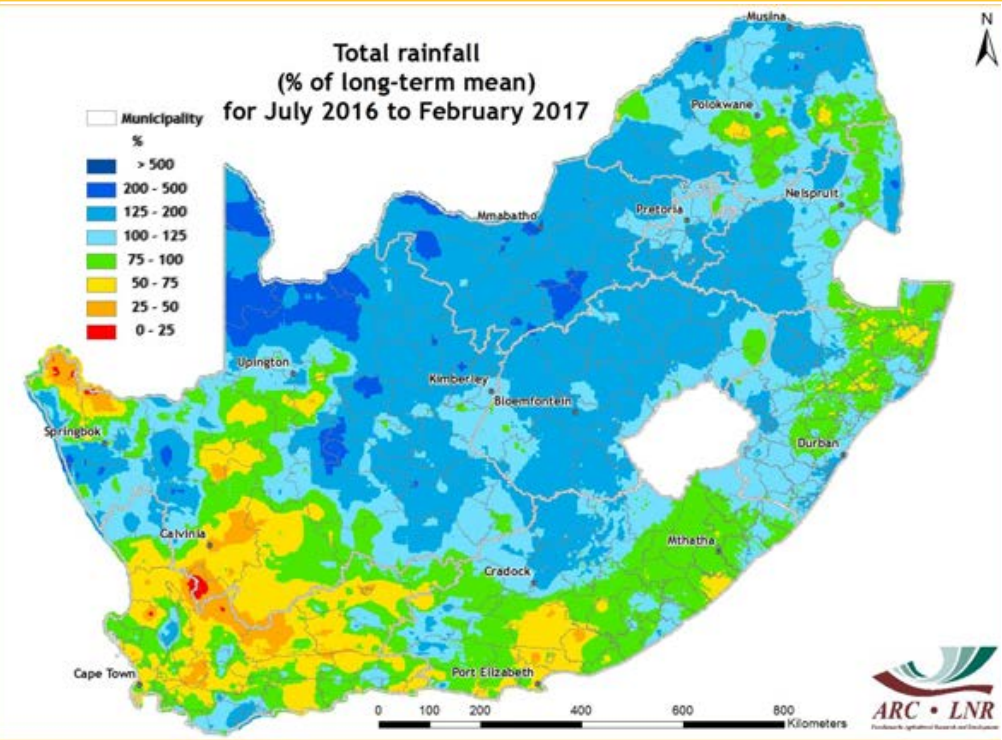


Figure 3

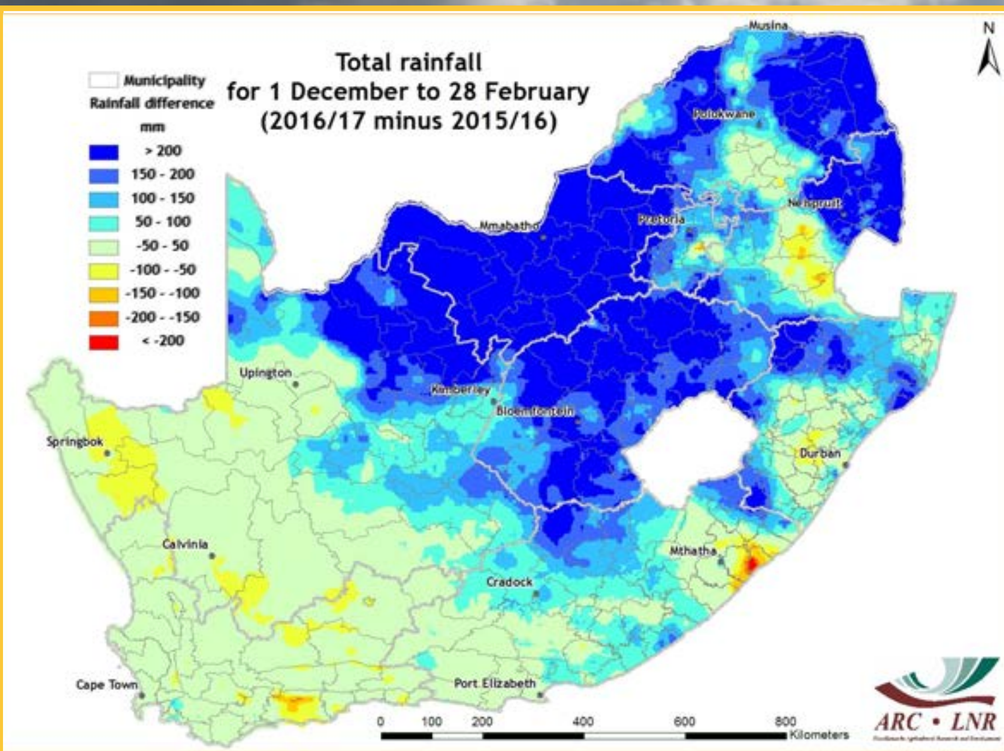


Figure 4

Tropical cyclone Dineo made landfall in the Beira region of Mozambique on 15 February. Excessive rainfall associated with Dineo occurred over our neighbouring countries. Over South Africa, heavy rainfall associated with the westward movement of Dineo was confined to the eastern escarpment where accumulated rainfall totals from the 15^{th}-18^{th} ranged mostly between 30-60 mm with some stations reporting in excess of 100 mm.

Maximum temperatures during February were below normal over the eastern parts of the country and especially over the central parts where there was a high occurrence of clouds. Here, maximum temperatures were 3-4 °C below normal, while minimum temperatures were above normal as the cloud cover reduced night-time long-wave radiation.

Figure 1:
Most of the country received rainfall totals in excess of 100 mm during February, with the exceptions located over the western to southwestern parts and some isolated areas in the far northeast of the country. Rainfall totals exceeded 200 mm over significant portions of North West and the Free State. As in January 2017, rainfall totals again exceeded 300 mm along the escarpment of Limpopo and Mpumalanga.

Figure 2:
Most of the country received above-normal rainfall during February, in particular over the eastern parts of the Northern Cape, North West, Free State and the adjacent northern interior of the Eastern Cape. The far western parts of the Northern Cape and the southwestern Cape received rainfall far below normal for the month of February.

Figure 3:
Since July, rainfall over the northern to central parts of the country was mostly normal to above normal. Below-normal rainfall occurred over the western interior. Some isolated areas over the far southern parts of the country also received above-normal rainfall during this 8-month period.

Figure 4:
Compared to the 2015/16 mid-summer season, the 2016/17 mid-summer season received 200 mm more rain over much of the summer rainfall region. The western interior was drier than during 2015/16.

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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.

At short and long time scales, the current SPI maps (Figures 5-8) show that severe to extreme drought conditions are present over the extreme southwestern parts of the country as well as over the eastern seaboard. Over the central to northeastern parts of the country, a recovery of the drought conditions visible on the longer time scales can be seen, in particular over the central interior.

Questions/Comments:
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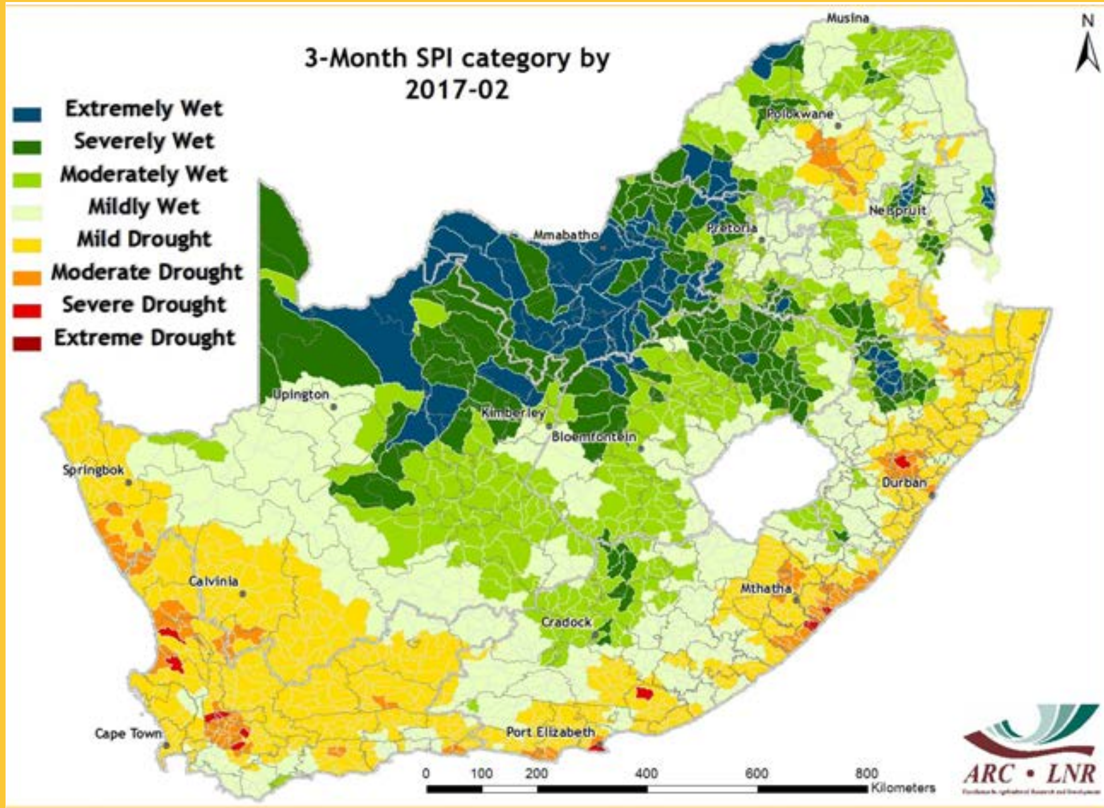

Figure 5

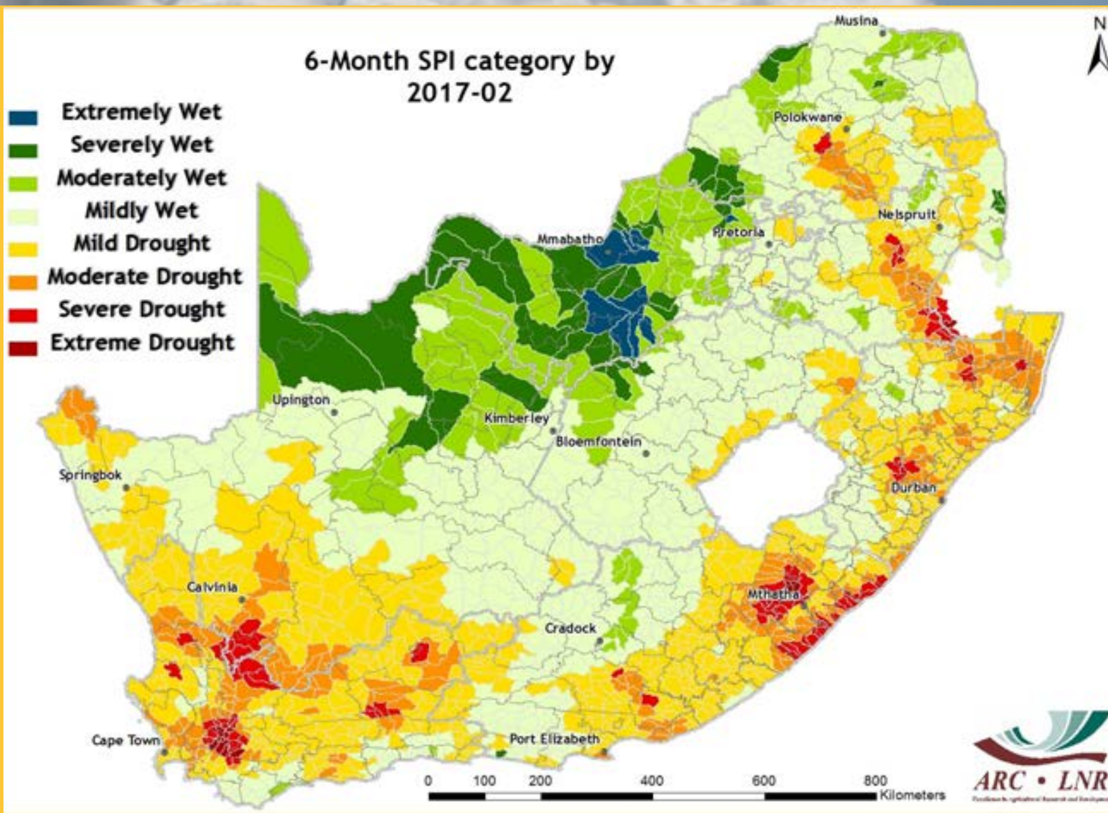

Figure 6

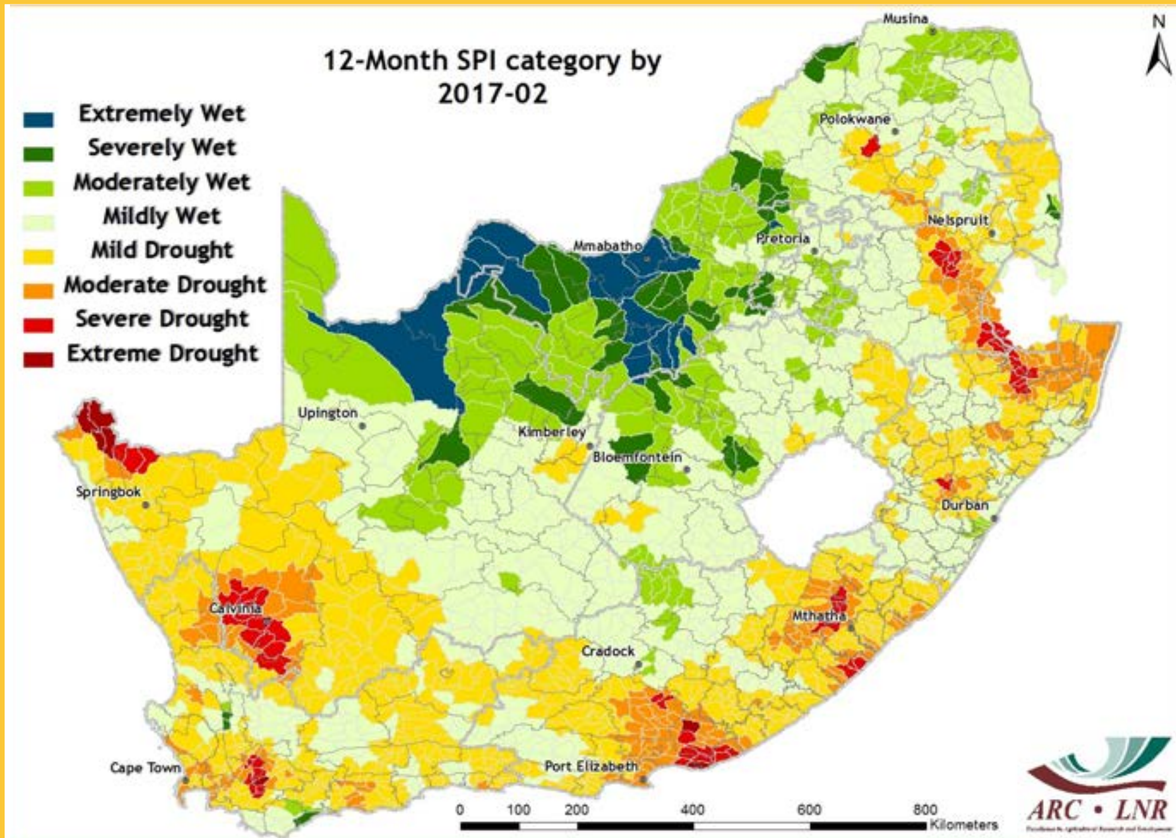

Figure 7

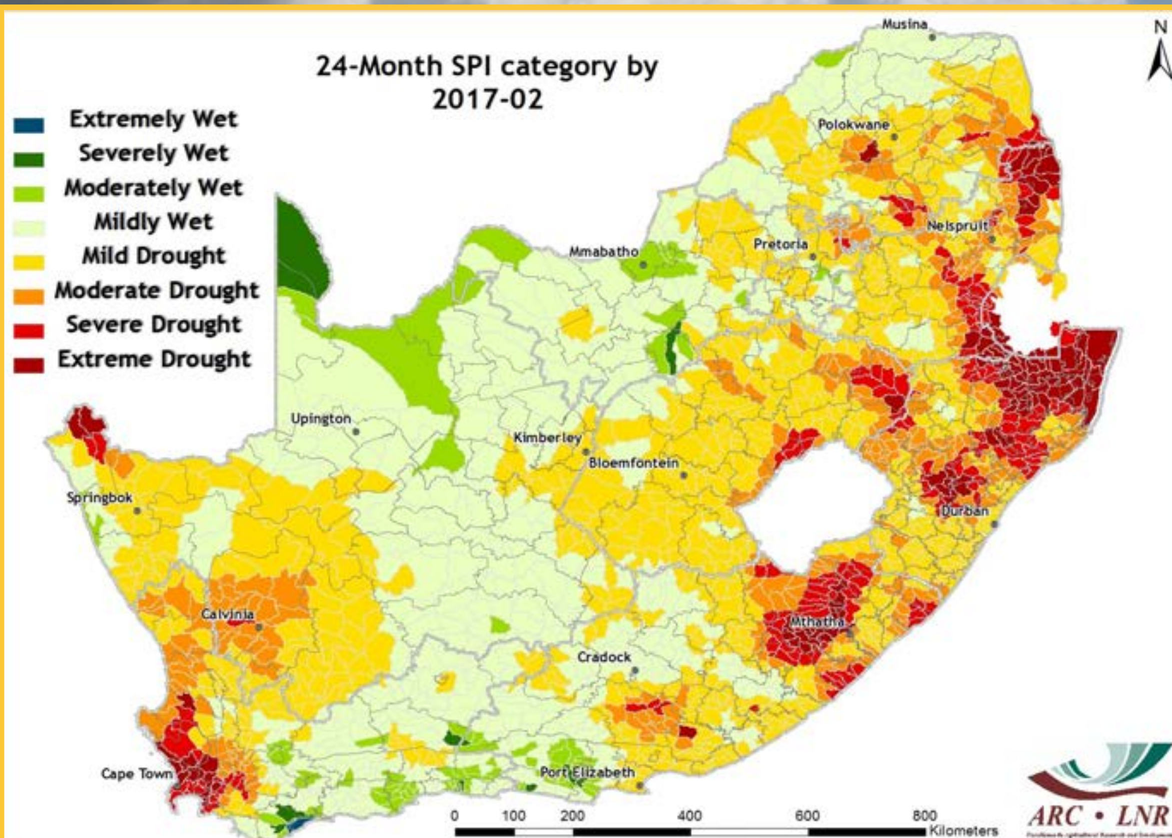

Figure 8

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.

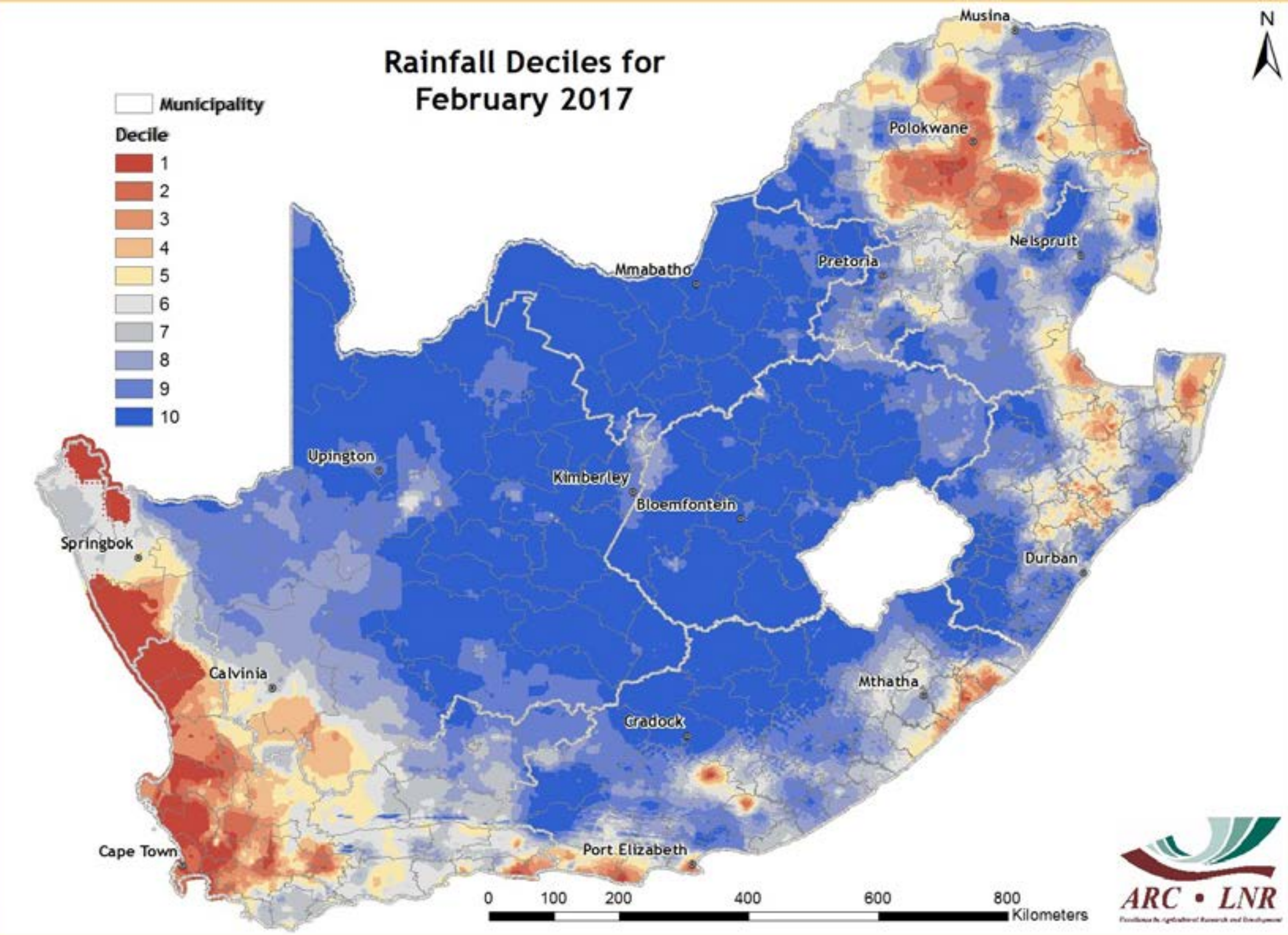

Figure 9

Figure 9:
Much of the interior was exceptionally wet in February. Areas in the northeast and the extreme west and southwest were exceptionally dry.

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4. Water Balance

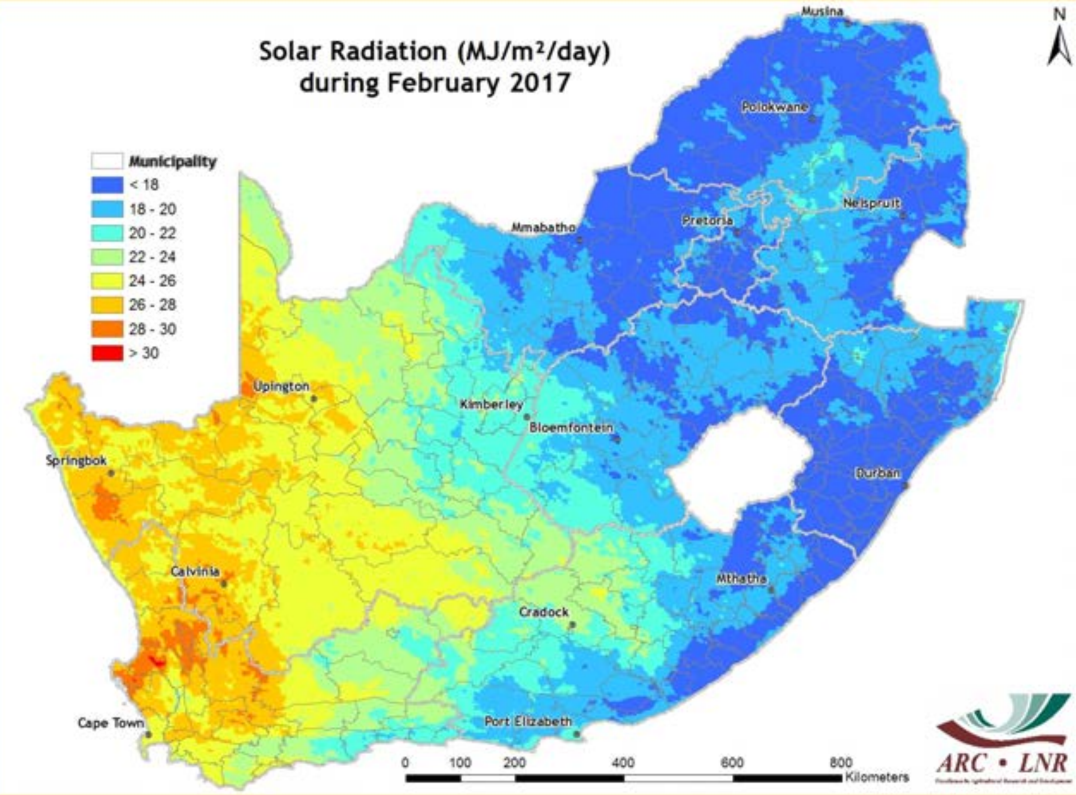

Figure 10

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 lowest solar radiation values occurred over the eastern parts of the country and the highest values over the extreme western interior.

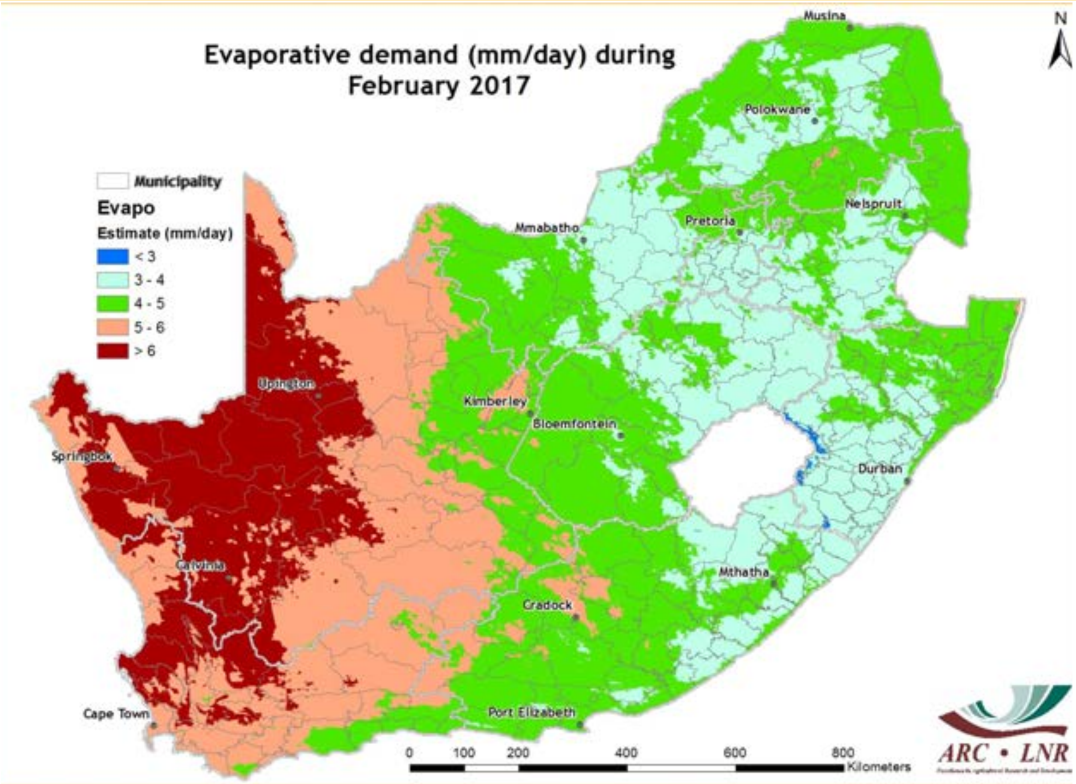

Figure 11

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:
Cloud cover and lower than normal maximum temperatures resulted in relatively low potential evaporation over the eastern areas while most of the western interior and west coast experienced high potential evaporation.

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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.

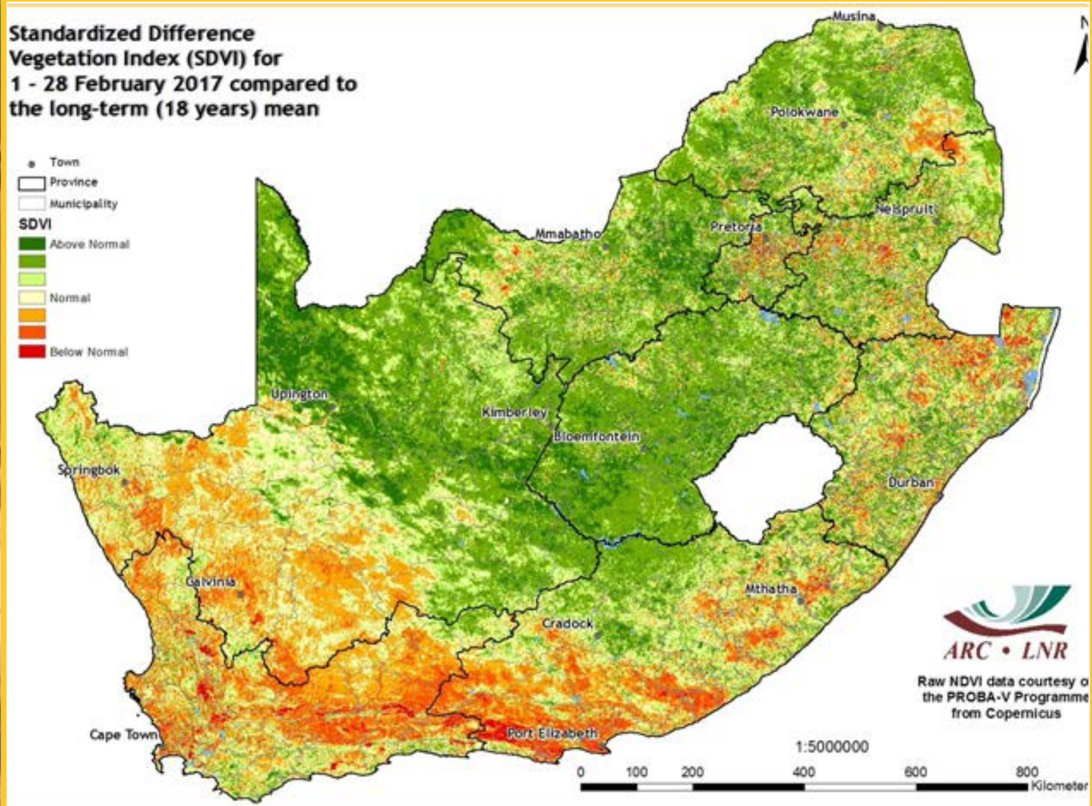

Figure 12

Figure 12:
The SDVI indicates drought stress over the western parts of the country, including most of the Karoo, as well the eastern parts. Over much of the interior and southern region vegetation activity was above normal during the month of February.

Figure 13:
Most of the summer rainfall region is experiencing above-normal vegetation activity compared to the situation in February 2016, due to the continued high rainfall received in the months of January and February this year.

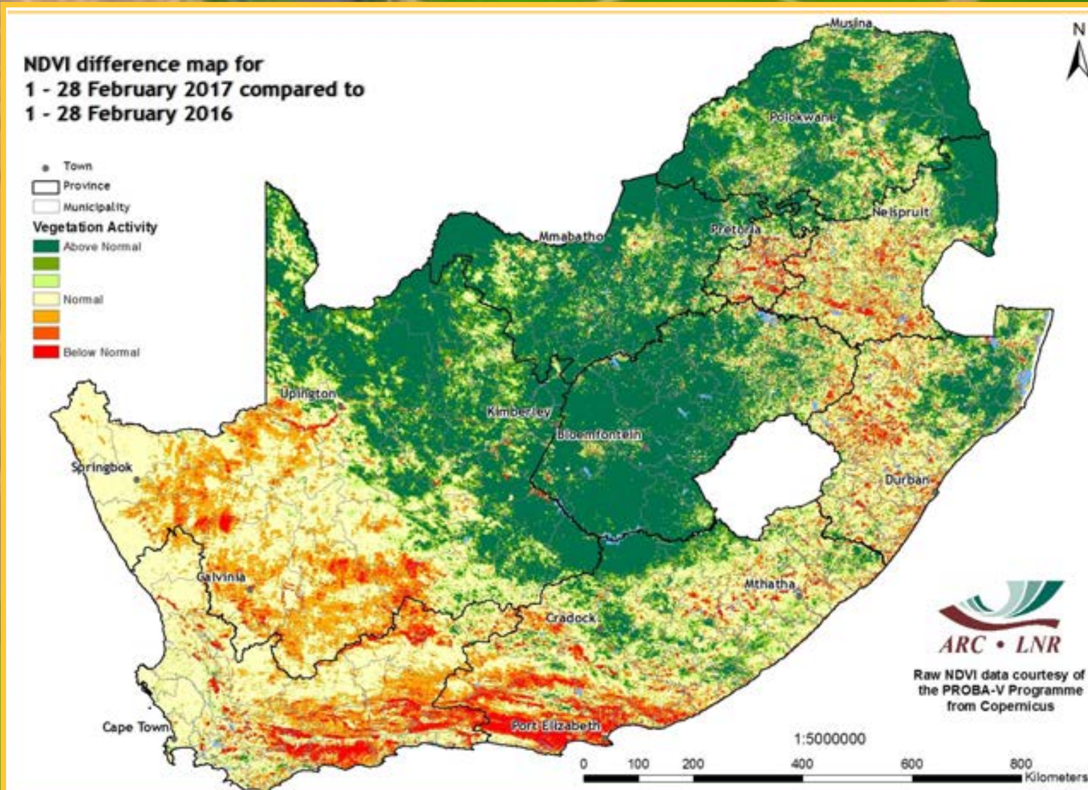

Figure 13

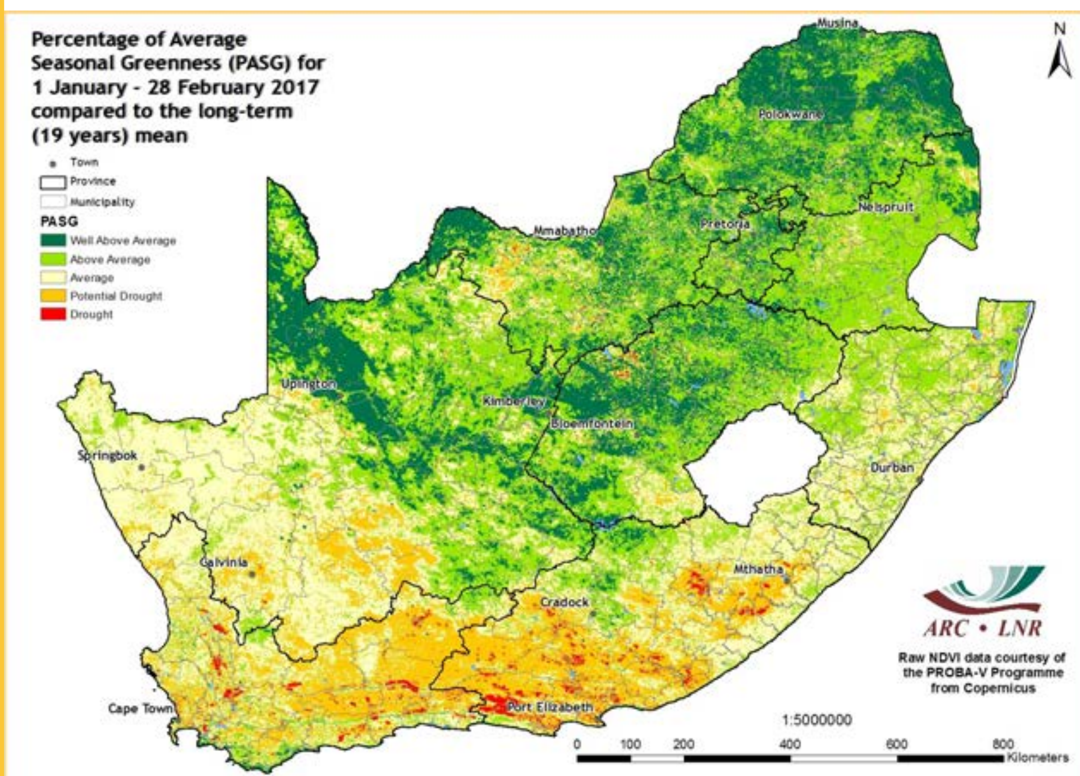

Figure 14

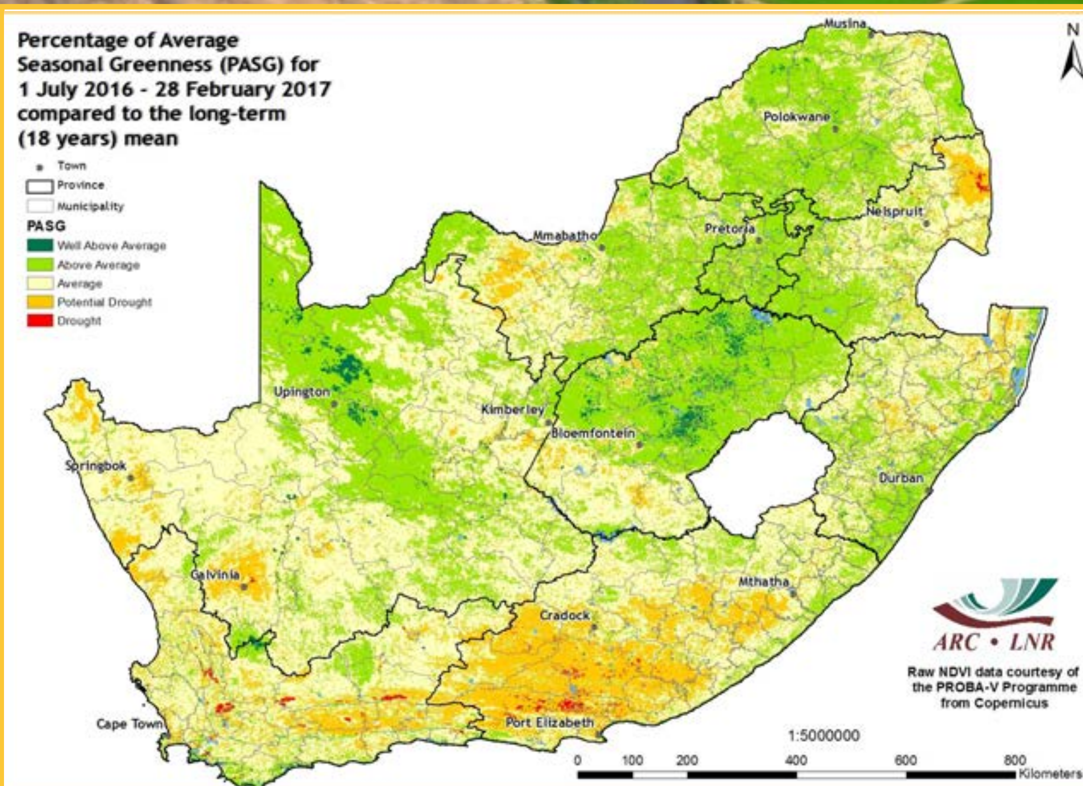

Figure 15

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:
Vegetation activity decreased over the southern parts of the country, including most of the Karoo, but increased over much of the central northern region.

Figure 15:
Cumulative vegetation activity anomalies indicate potential drought stress over the Eastern and Western Cape, the Lowveld of Mpumalanga, isolated areas in KwaZulu-Natal, Northern Cape, North West and the Free State.

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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.

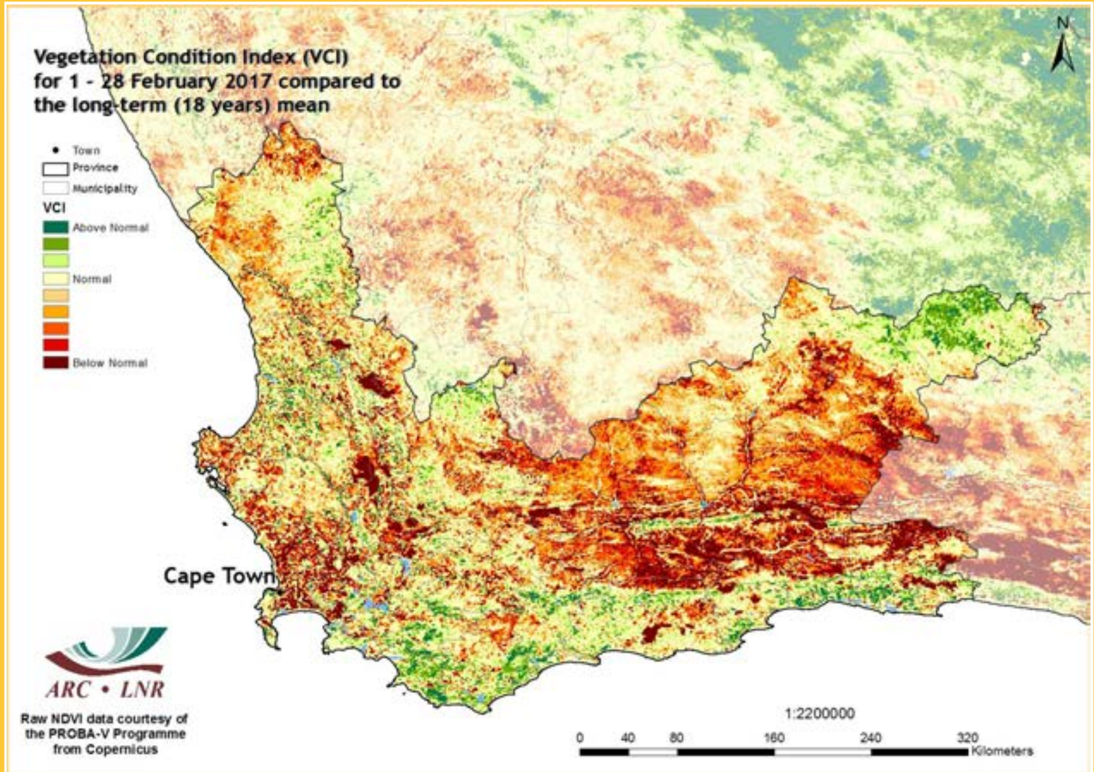

Figure 16

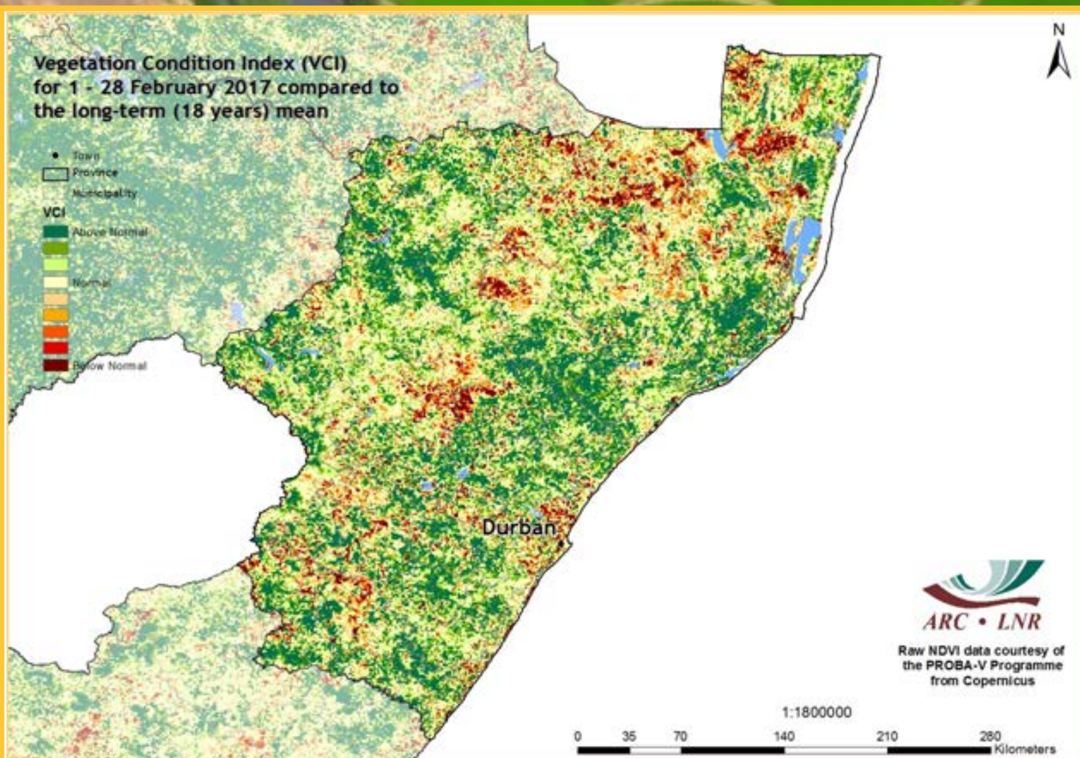

Figure 17

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

Figure 17:
The VCI map for February indicates both below-normal and above-normal vegetation activity over KwaZulu-Natal.

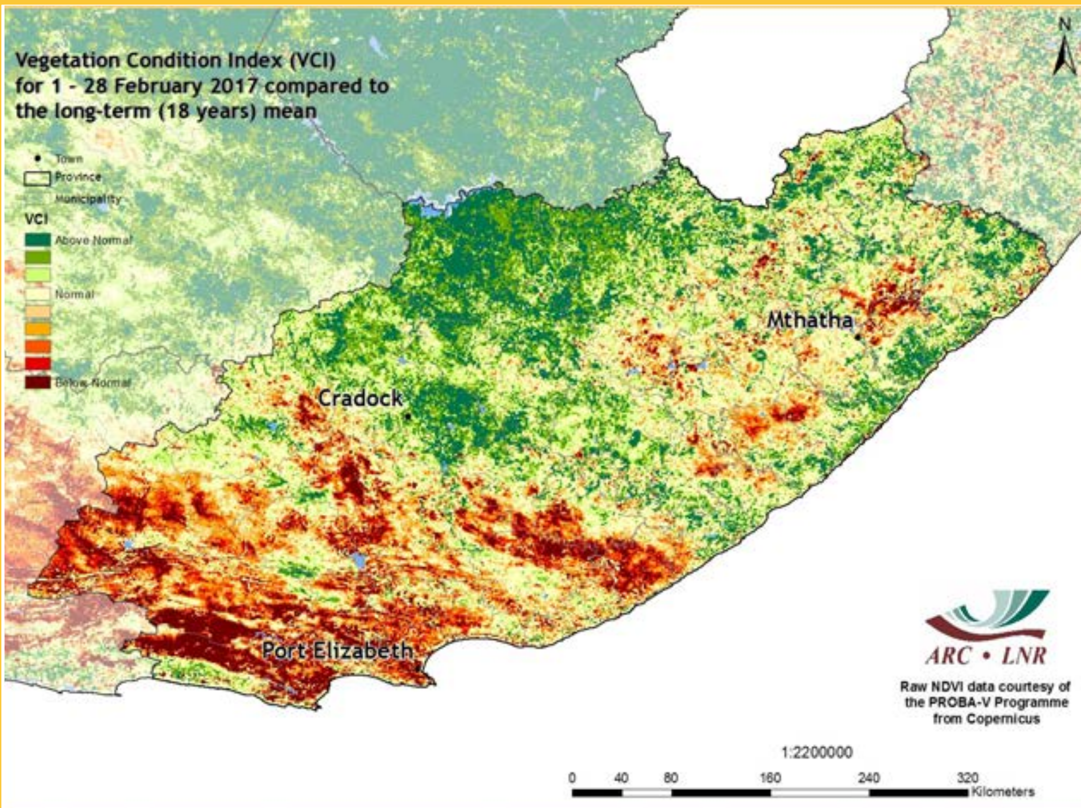

Figure 18

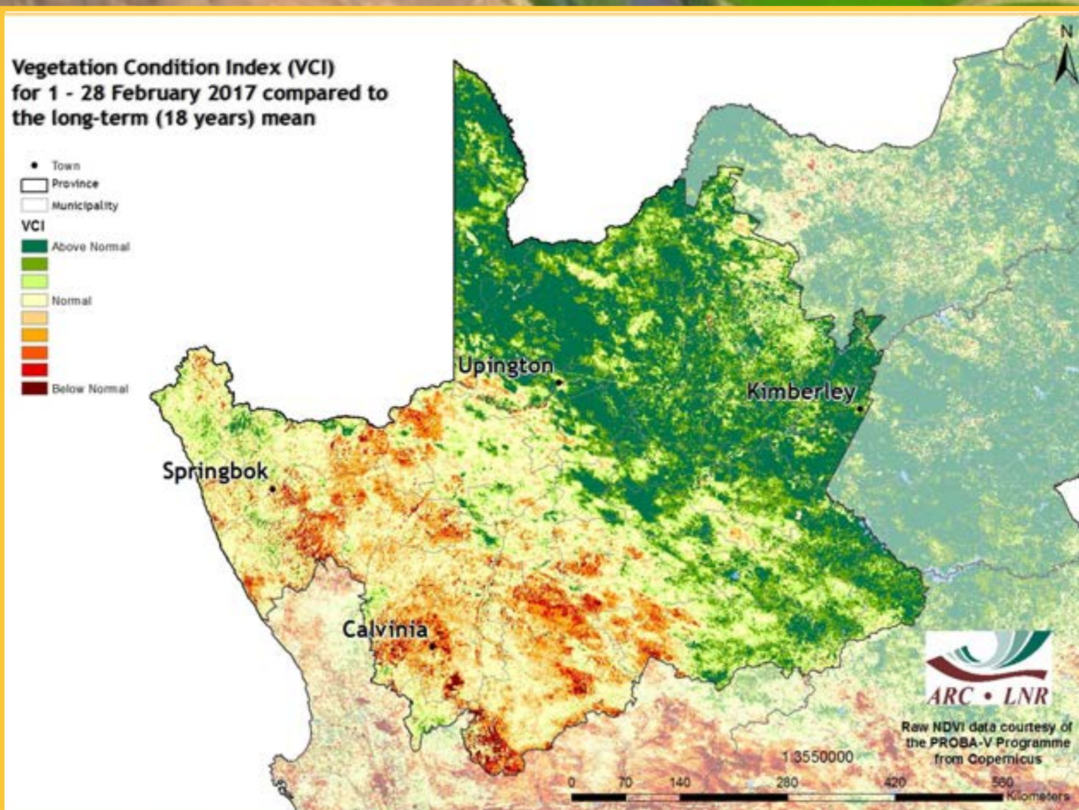

Figure 19

Figure 18:
The VCI map for February indicates below-normal vegetation activity over the western and eastern interior of the Eastern Cape.

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

Questions/Comments:
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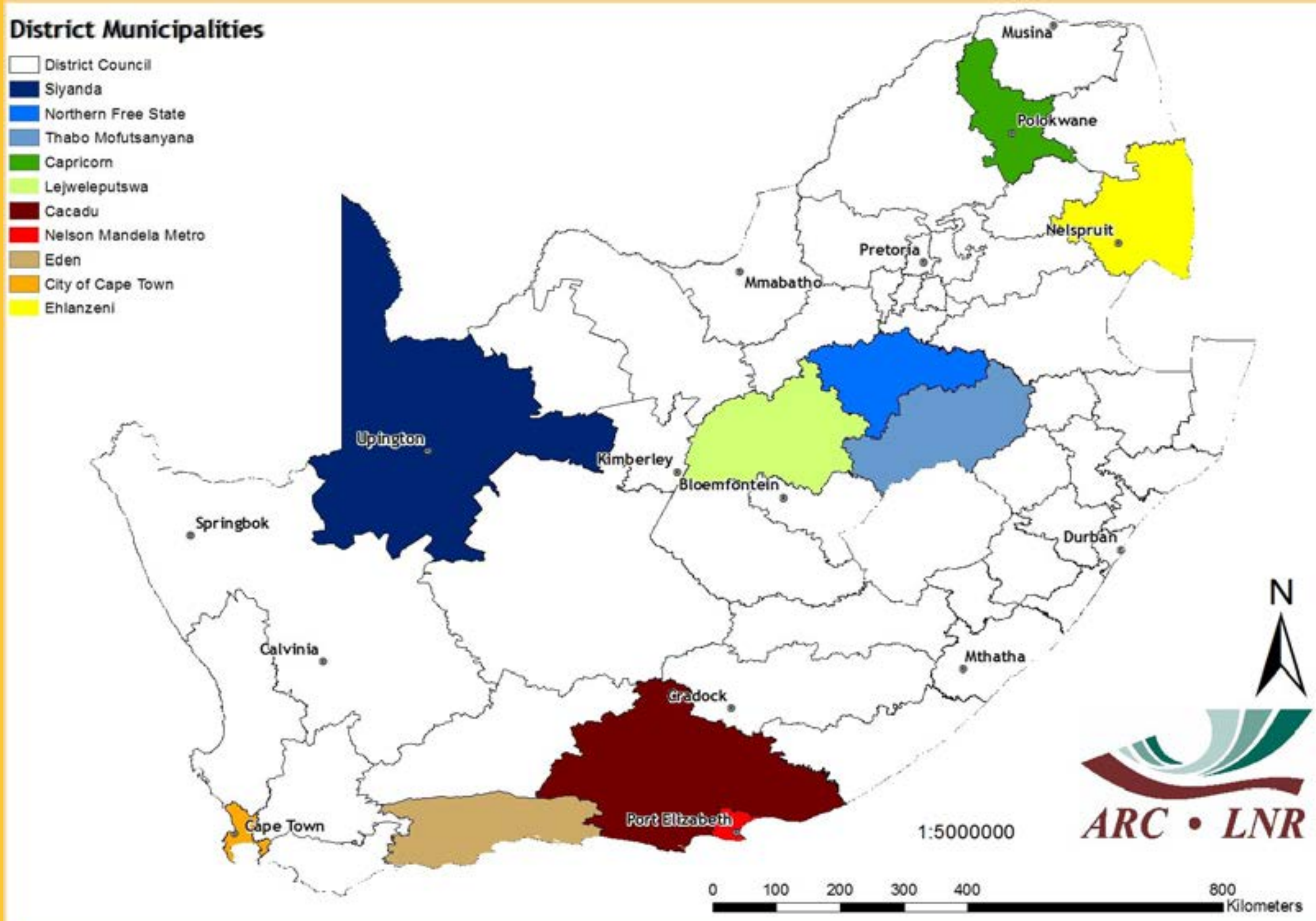
7. Vegetation Conditions & Rainfall



NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for February 2017. The district colour matches the border of the corresponding graph.

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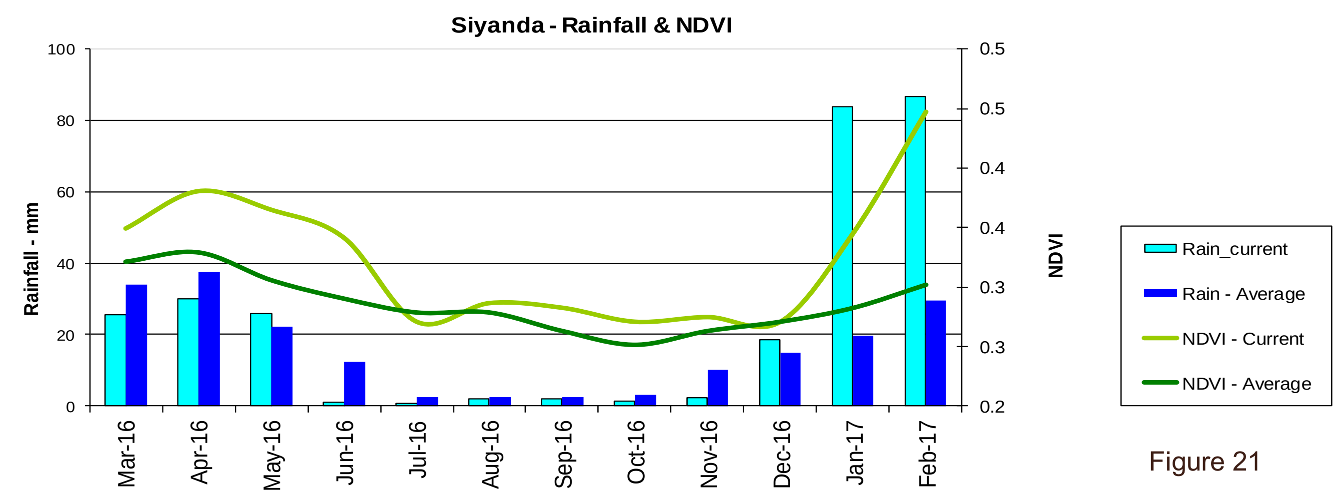
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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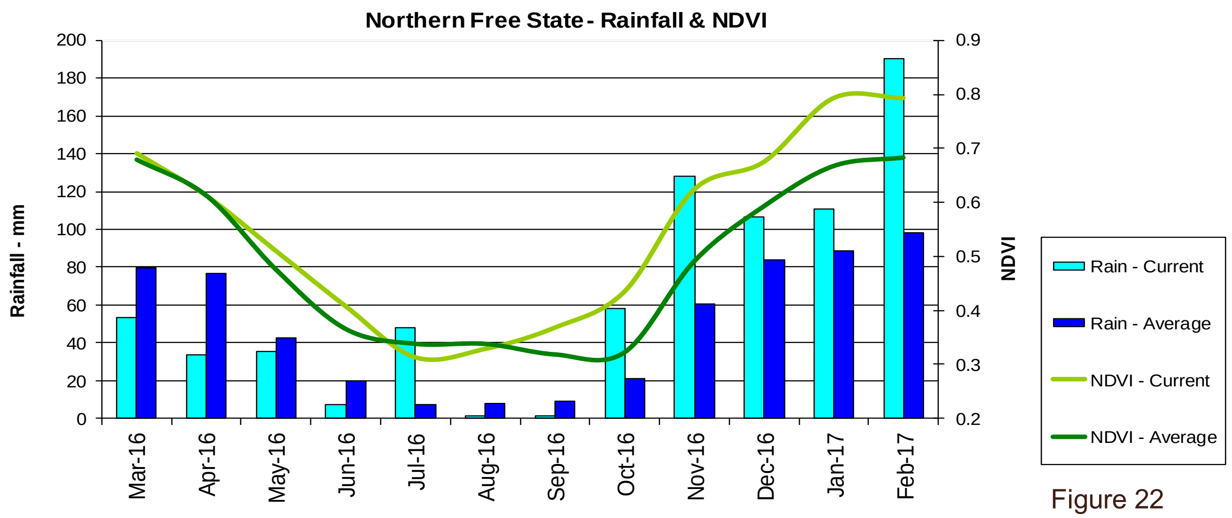

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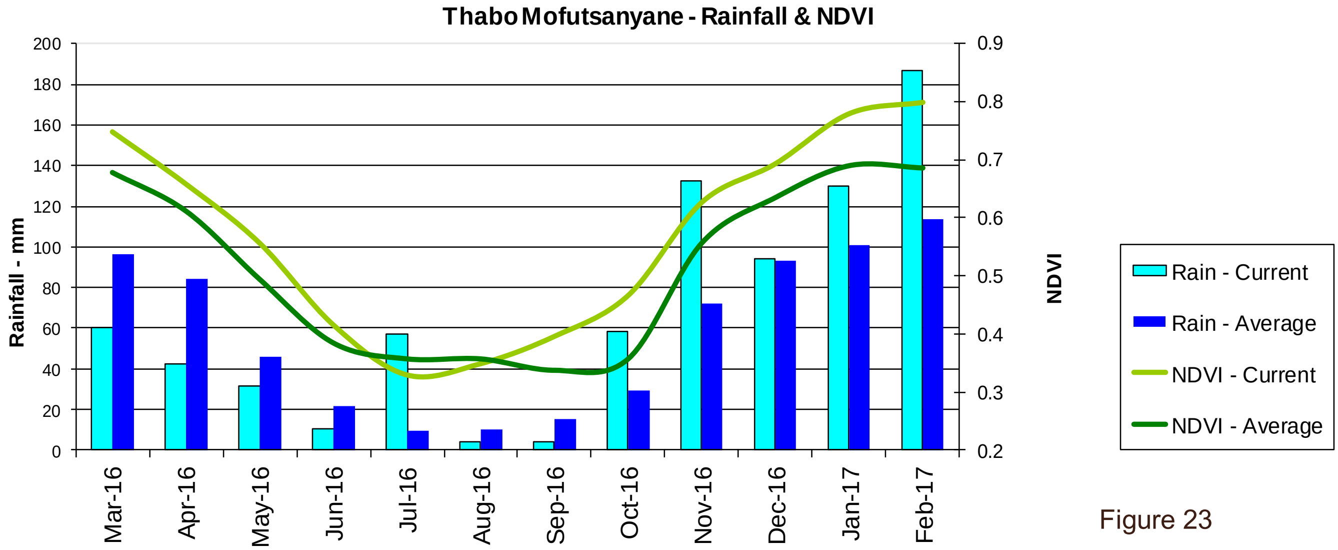

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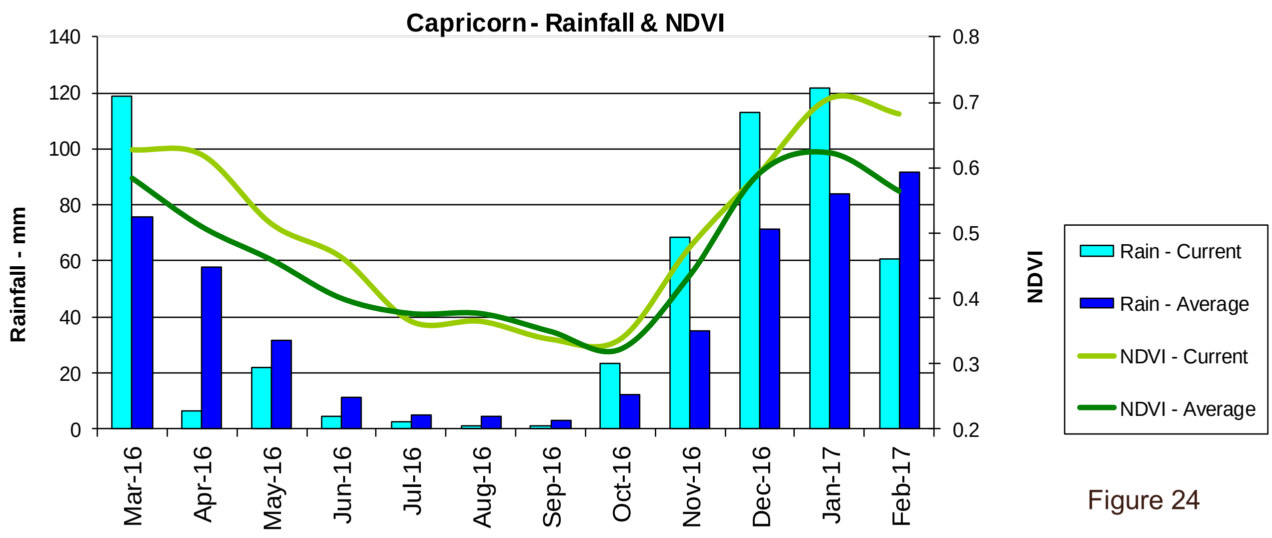
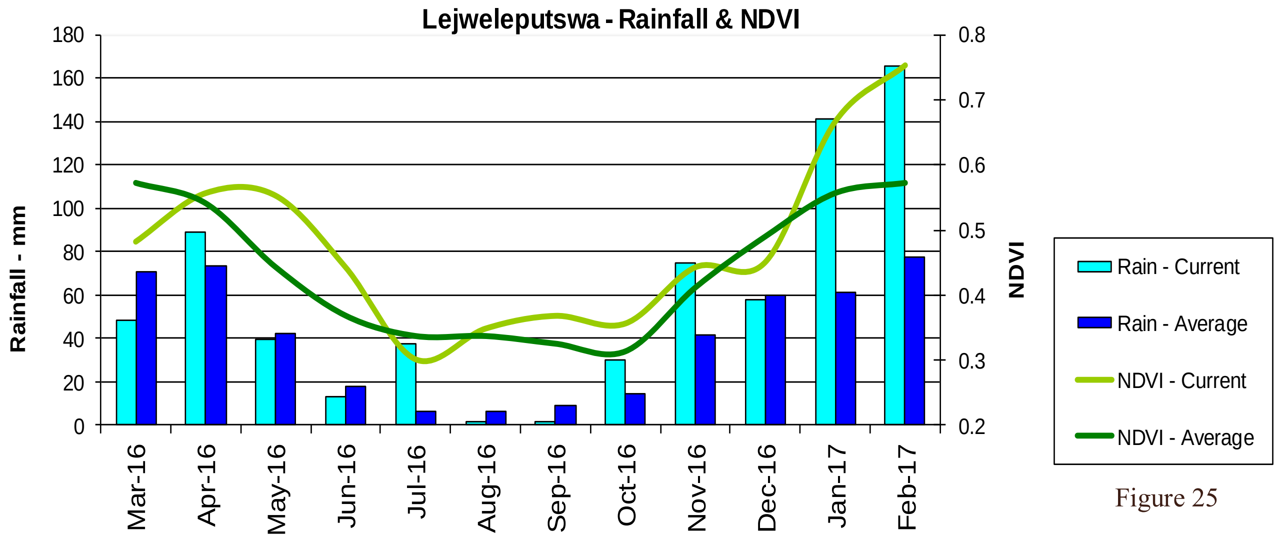


Figure 24



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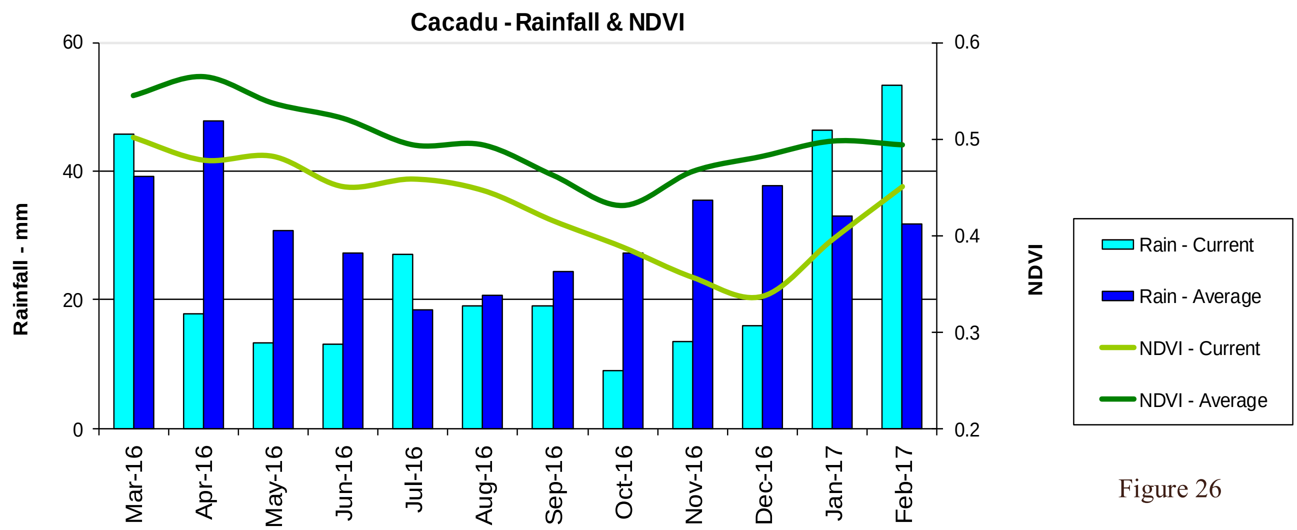

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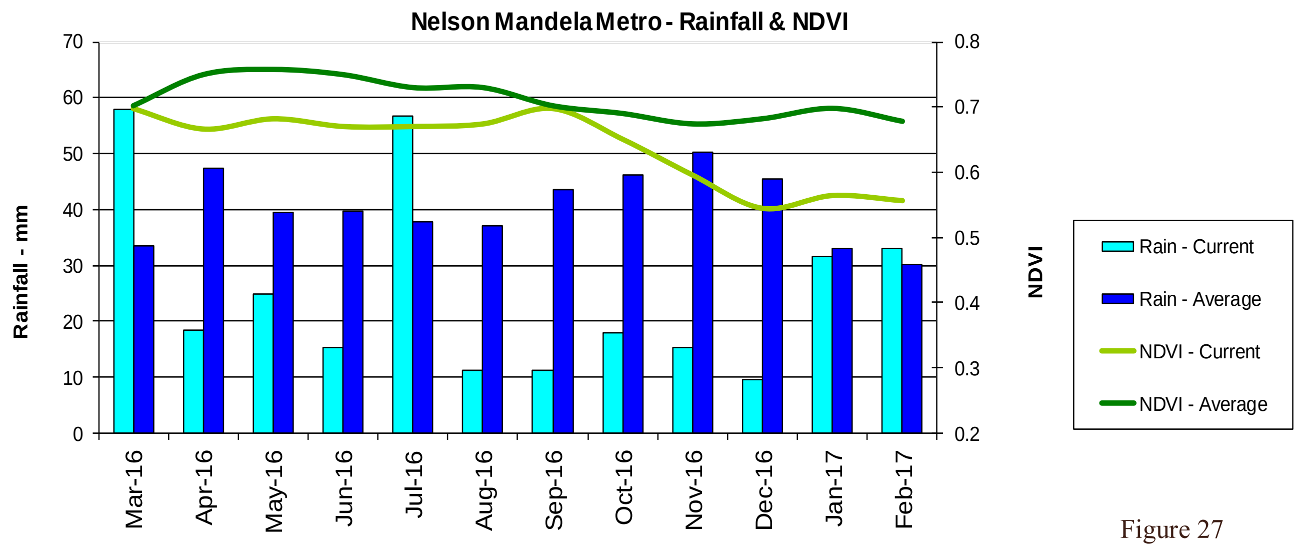
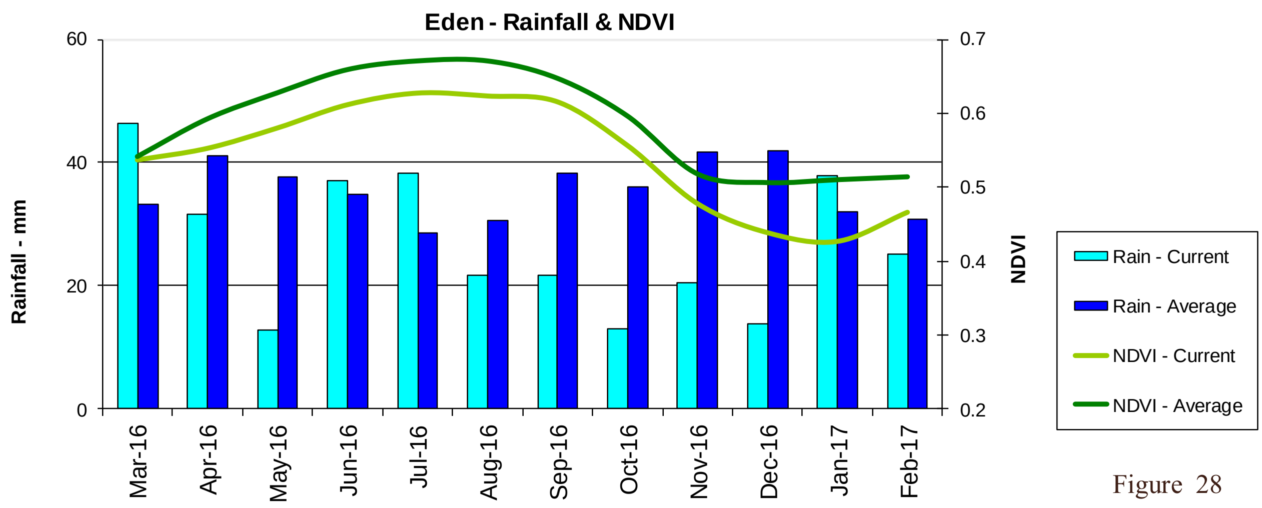


Figure 27



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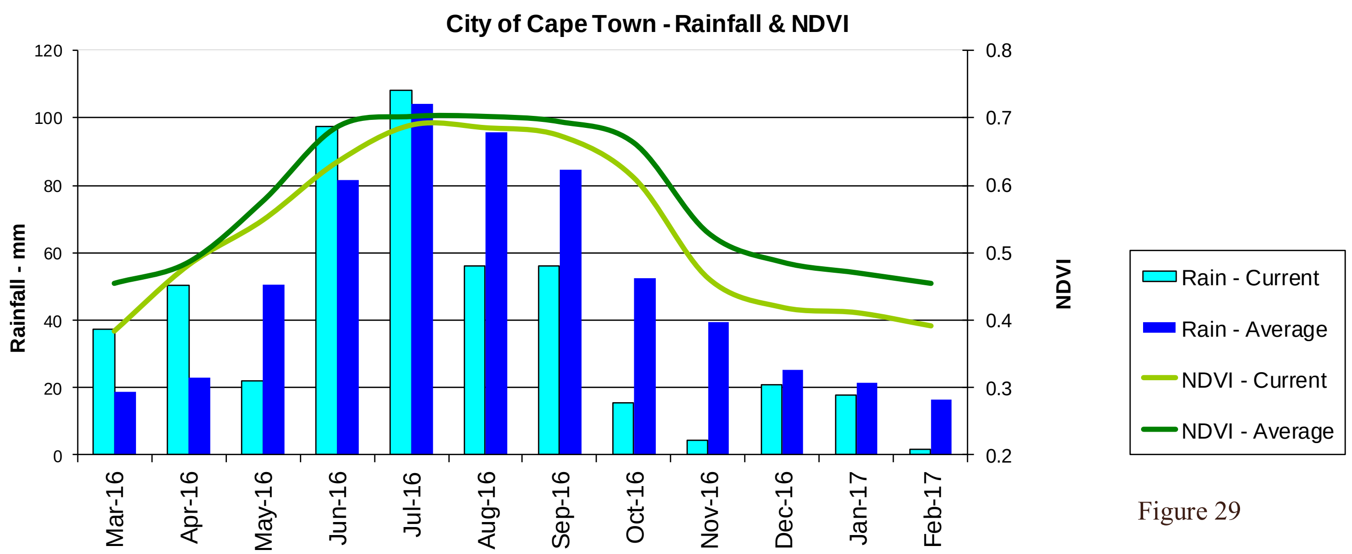

Figure 29

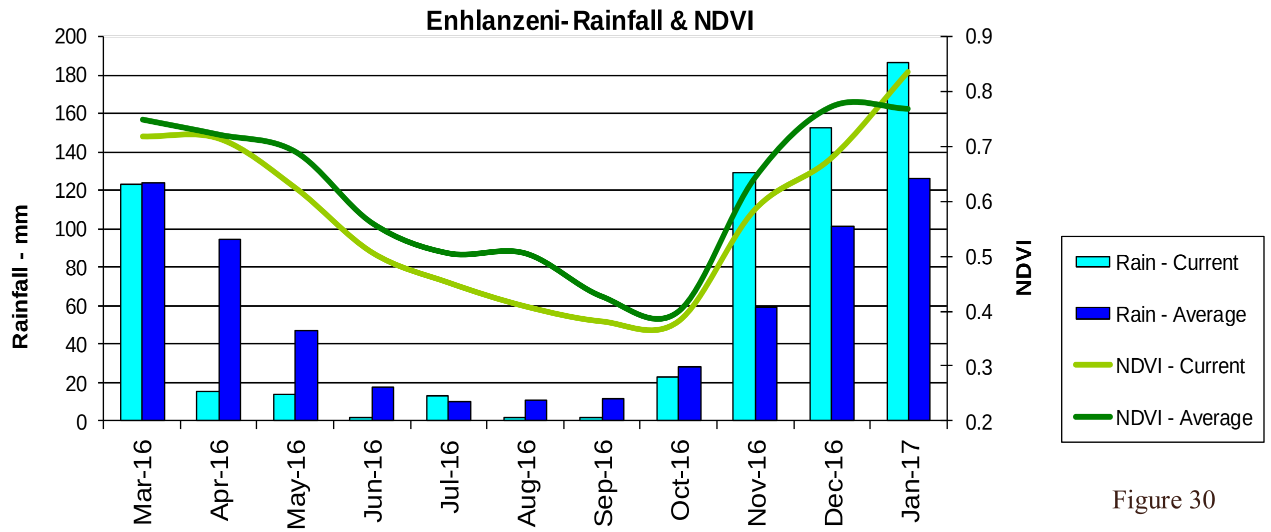

Figure 30

8. Soil Moisture

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Countywide soil moisture modelling by the University of KwaZulu-Natal Satellite Applications and Hydrology Group (SAHG)

Figure 31 shows the monthly averaged soil moisture conditions for February 2017. The colour scale ranging from brown to blue represents the Soil Saturation Index (SSI), defined as the percentage saturation of the soil store in the TOPKAPI hydrological model. The modelling is intended to represent the mean soil moisture state in the root zone. Figure 32 shows the SSI difference between February and January with brown colours showing the drier and the green colours the wetter areas. Similarly, the year-on-year SSI difference for February is shown in Figure 33.

The year-on-year and month-on-month SSI differences are in agreement with rainfall and vegetation trends observed elsewhere in the newsletter.

The SSI maps are produced at the ARC-ISCW in a collaborative effort with the University of KwaZulu-Natal Applications and Hydrology Group, made possible by the WMO.

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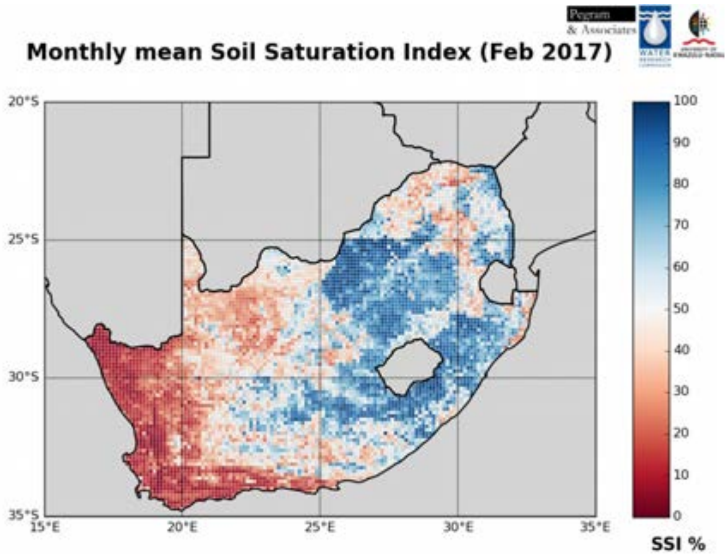

Figure 31

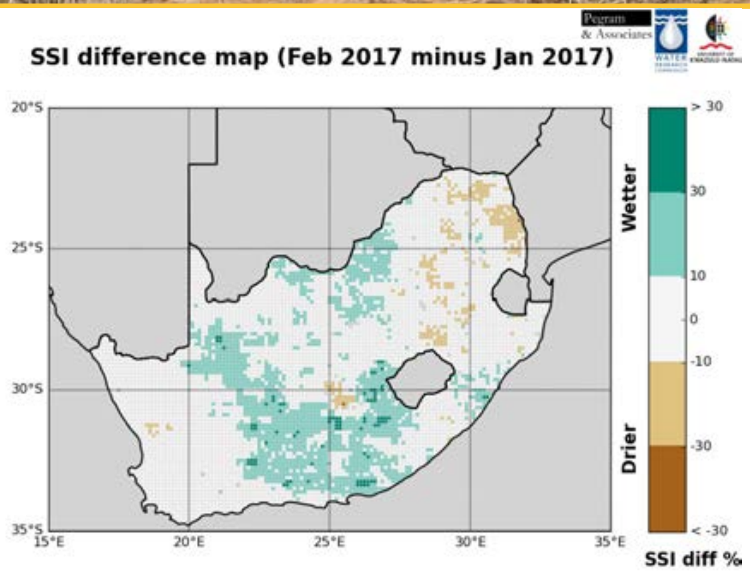

Figure 32

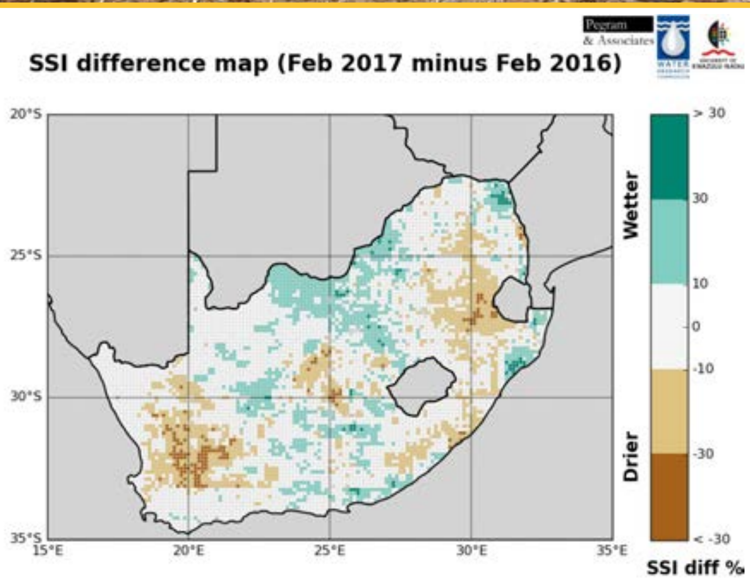

Figure 33

9. 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.

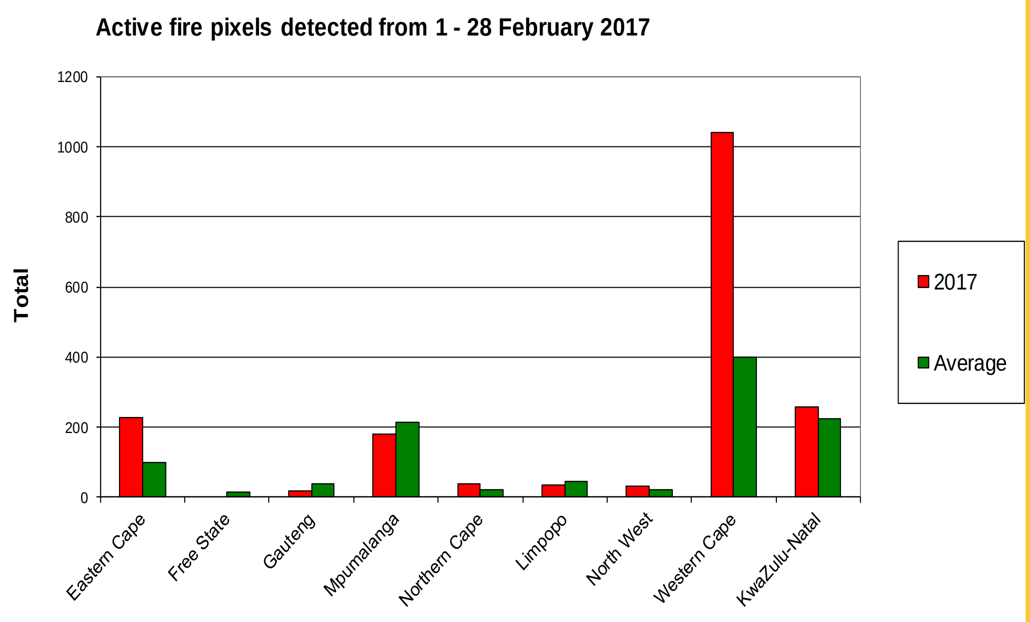

Figure 34

Figure 34:
The graph shows the total number of active fires detected during the month of February per province. Fire activity was higher in the Eastern Cape, Northern Cape, North West, Western Cape and KwaZulu-Natal compared to the average during the same period for the last 17 years

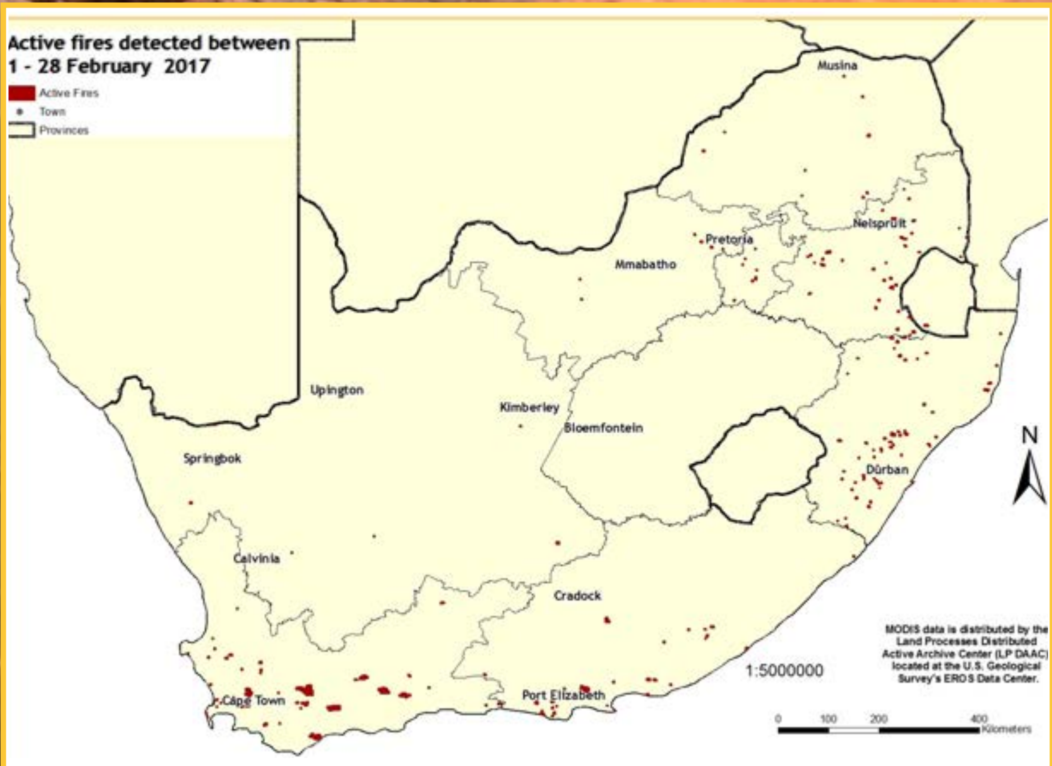

Figure 35

Figure 35:
The map shows the location of active fires detected between 1-28 February 2017.

PAGE 18

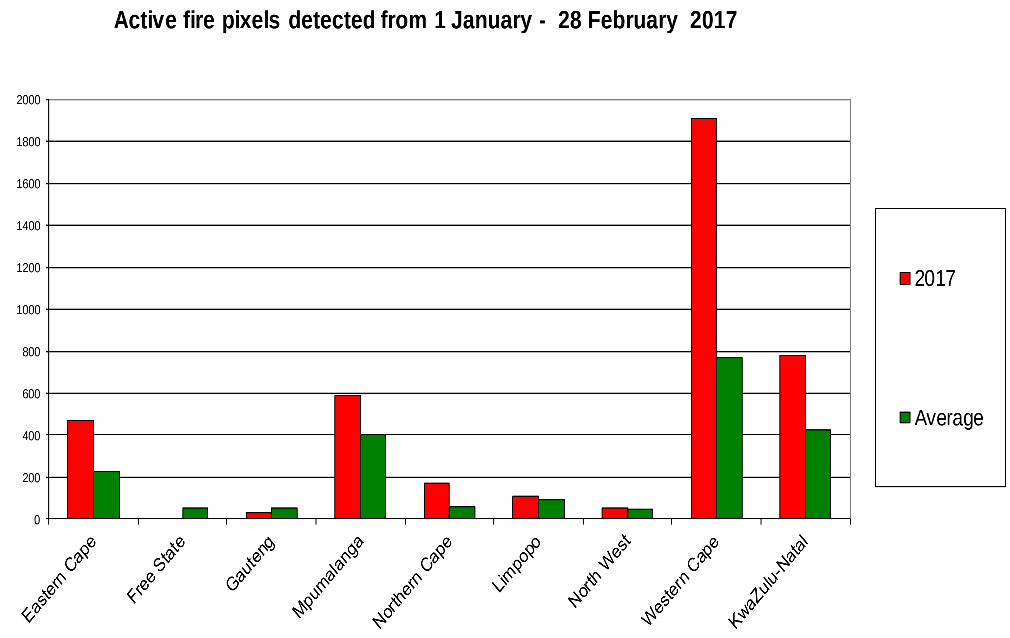

Figure 36

Figure 36:
The graph shows the total number of active fires detected from 1 January - 28 February 2017 per province. Fire activity was higher in all province except in the Free State and Gauteng compared to the average during the same period for the last 17 years.

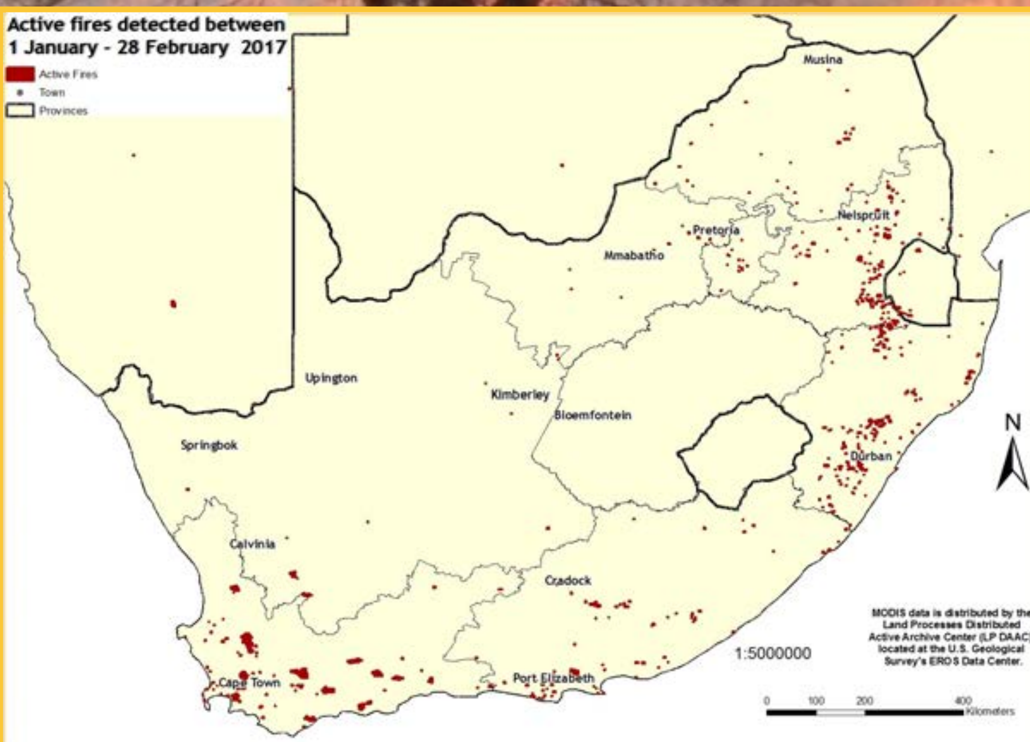

Figure 37

Figure 37:
The map shows the location of active fires detected between 1 January - 28 February 2017.

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Agrometeorology

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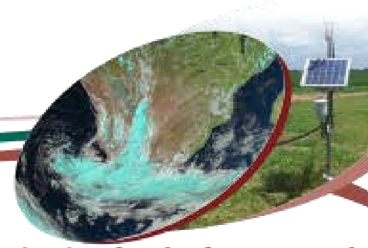

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national asset.

FOCUS AREAS

Climate Monitoring, Analysis & Modelling

- Analysis of climate variability and climate model simulation
- Use of crop modelling to assess the impact of climate on agriculture
- Development of decision support tools for farmers

Climate Change Adaptation & Mitigation

- National greenhouse gas inventory in the agricultural sector
- Improvement of agricultural production technologies under climate change
- Adaptation and mitigation initiatives, e.g. biogas production in small-scale farming communities

Climate Information Dissemination

- Communication to farmers for alleviating weather-related disasters such as droughts
- Dissemination of information collected from weather stations
- Climate change awareness campaigns in farming communities

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Geoinformation Science

ARC • LNR

The programme focuses on applied Geographical Information Systems (GIS) and Earth Observation (EO)/Remote Sensing research and provides leadership in applied GIS products, solutions, and decision support systems for agriculture and natural resources management. The Coarse Resolution Satellite Image Archive and Information Database is maintained as a national asset.

FOCUS AREAS

Decision Support Systems

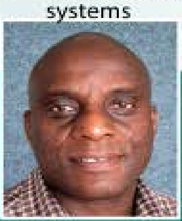
- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

Early Warning & Food Security

- Drought and vegetation production monitoring
- Crop estimates and yield modelling
- Animal biomass and grazing capacity mapping
- Global and local agricultural outlook forecasts
- Disaster monitoring for agricultural systems

Natural Resources Monitoring

- Land use/cover mapping
- Invasive species distribution
- Applications of GIS and EO on land degradation/erosion, desertification, hydrology and catchment areas
- Rangeland health assessments
- Carbon inventory monitoring



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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 at 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