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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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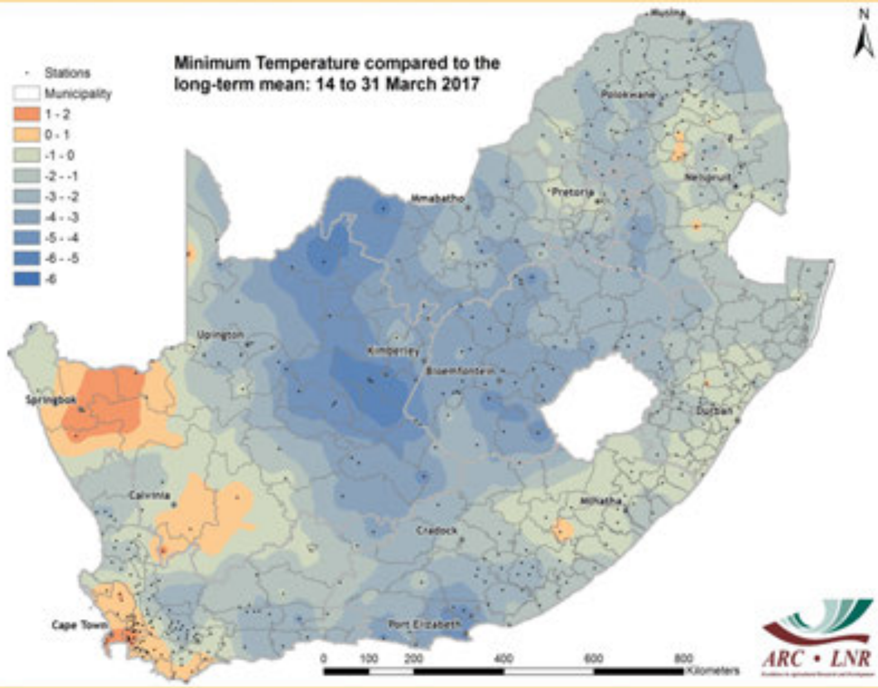
agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

South African Weather Service

AMESD

154th Edition

Images of the Month

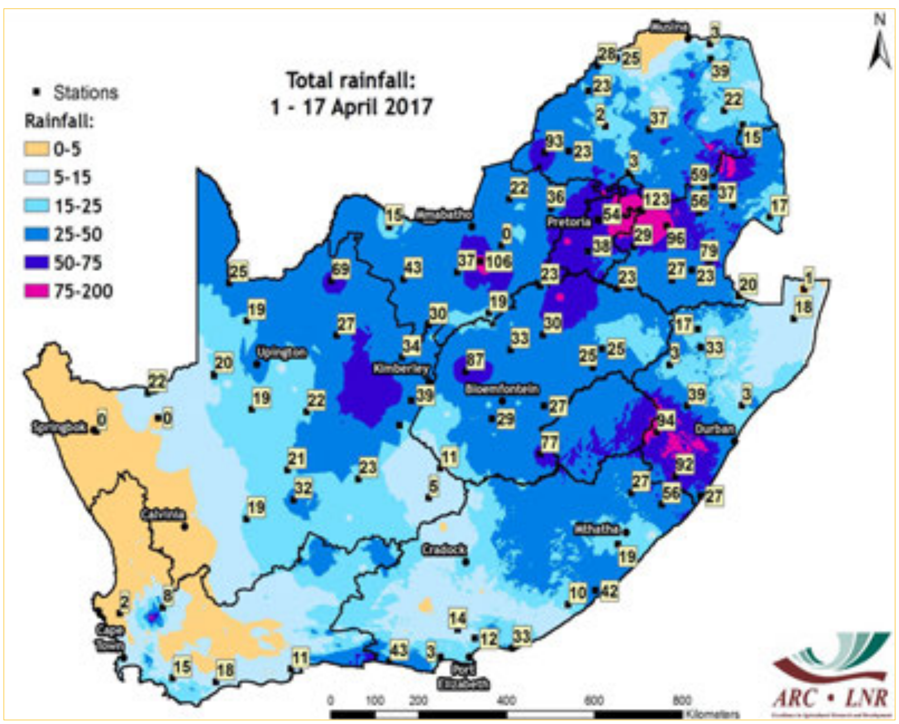


March relatively cool at night over the central parts

Following wet conditions during December to February over large parts of the summer rainfall region, March 2017 was dry for the most part. The same atmospheric circulation patterns responsible for the dry conditions also resulted in anomalously low minimum temperatures over especially the central parts. During the second half of the month, minimum temperatures were on average more than 5°C lower than the long-term average over parts of the central interior. However, a lack of intense, cold-bearing systems resulted in frost being confined to the high-lying southern parts of the country, sparing the maize production areas.

Return of wet conditions to the interior

Widespread rain occurred over the entire summer rainfall region since early April. Rain and thundershowers were associated with much more favourable upper-air conditions, specifically upper-air troughs and lows over the southwestern parts, supporting precipitation over most of the interior. Totals recorded over the summer rainfall region ranged from 25 to 100 mm. However, the winter rainfall region, still in the grip of a 2-year drought, received very little rainfall.



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:

Below-normal rainfall occurred over almost the entire country during March 2017, although there were exceptions over some areas in Limpopo, Mpumalanga, KwaZulu-Natal and the central parts of the Eastern Cape. Maximum and minimum temperatures generally trended downwards during the month. This was especially the case with minimum temperatures, while maximum temperatures remained fairly unchanged over most parts.

The below-normal rainfall conditions can largely be attributed to the atmospheric circulation in the mid to upper troposphere that was not favourable for the transport of sufficient moisture over the country to aid in the development of well organized cloud bands. During the times when NW/SW orientated cloud bands did develop it was mostly heat-driven without good mid to upper level tropospheric dynamic support. The nature of rainfall over the summer rainfall region was therefore for thundershowers to be isolated. In such an event on the 2nd of the month, localized flooding occurred in Alberton (Gauteng). The severely drought-stricken areas over the southwestern parts of the country received no relief from the dry conditions. Over these areas, rainfall recorded during March 2017 was only 20-40% of that which usually occurs during the month of March.

Tropical systems in the vicinity of Madagascar marked a large area of tropical convergence and convection, leaving southern Africa to the west under the influence of anticyclonic upper-air circulation for most of the middle part of the month. Intense Tropical Cyclone Enawo developed northeast of Madagascar during the first week of March. This system reached the island's northeast coast on the 7th then tracked slowly southwards during the next few days. It was followed by similar less intense systems in the same general region over the next 2 weeks. Enawo, together with more tropical systems to the east and south of Madagascar, maintained relatively dry conditions across the southern African subcontinent for a large part of the month.

Precipitation, mostly in the form of isolated to scattered thundershowers over the central and southern to eastern parts, was associated with upper-air troughs in the westerlies and ridging high pressure systems. These systems were also responsible for spreading cold air into the interior behind cold fronts. Over the northeastern parts, isolated to scattered thundershowers occurred between the 6th and 9th as well as between the 17th and 21st in association with easterly waves passing from Mozambique over the northern parts of the country. Rainfall in these instances was also supported by large high-pressure systems to the east of the country, especially during the second of these events – as the large-scale circulation towards the east of the country became more anticyclonic towards the latter part of the month.

In association with the atmospheric circulation that was mostly associated with widespread subsidence of the air over the country and subsequent below-normal rainfall, maximum temperatures were above normal over most of the country. As with the rainfall, exceptions were found over some areas over the northeastern parts. Over most of the western area of the country, maximum temperatures were 2-3 °C higher than usual. Over some areas of the southwestern interior of the Western Cape, maximum temperatures were 3-4 °C warmer than usual. The lack of moisture in circulation over the country in the absence of clouds, particularly the early morning hours, as well as the influence of frontal systems resulted in lower than normal minimum temperatures over most of the country. This was especially the case over the central parts where the minimum temperatures were on average 1-2 °C, and in some places 3 °C, lower than usual during March 2017.

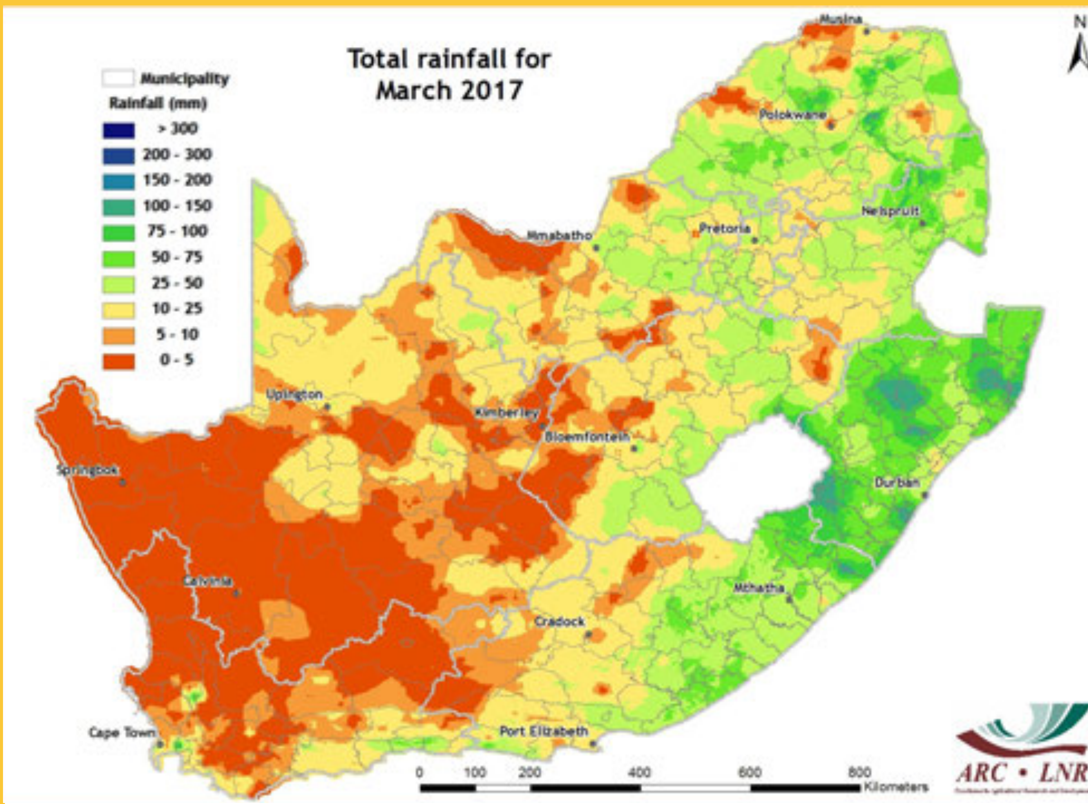


Figure 1

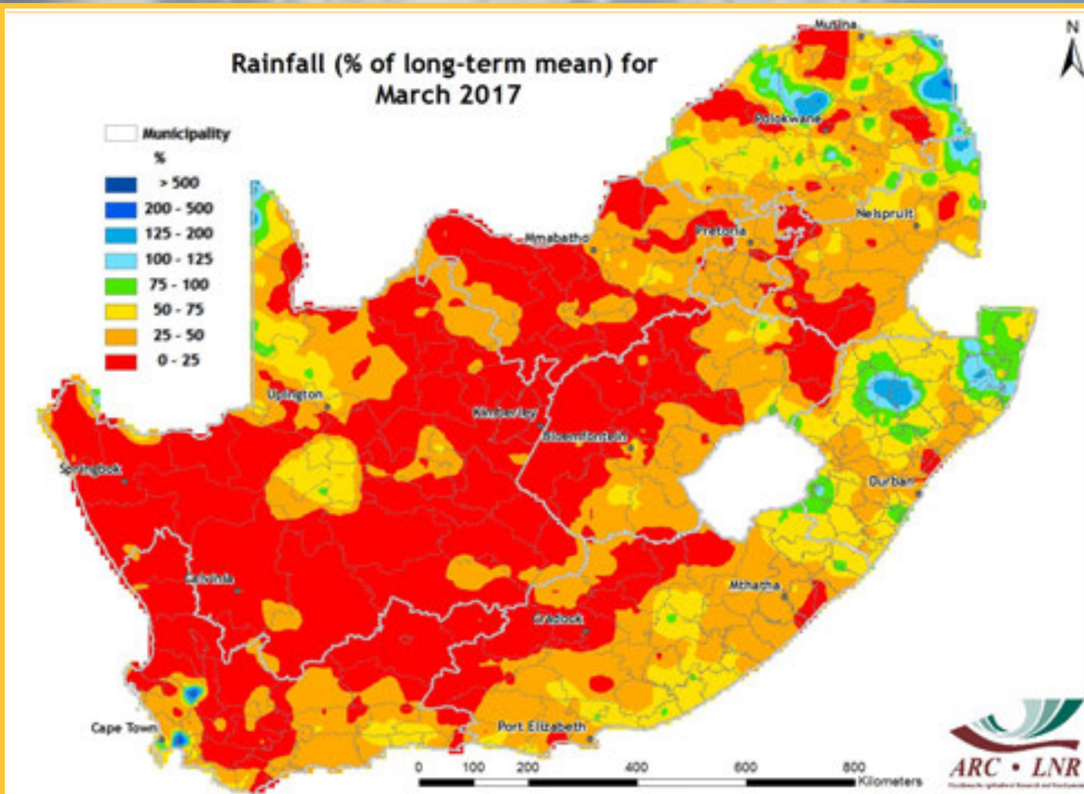
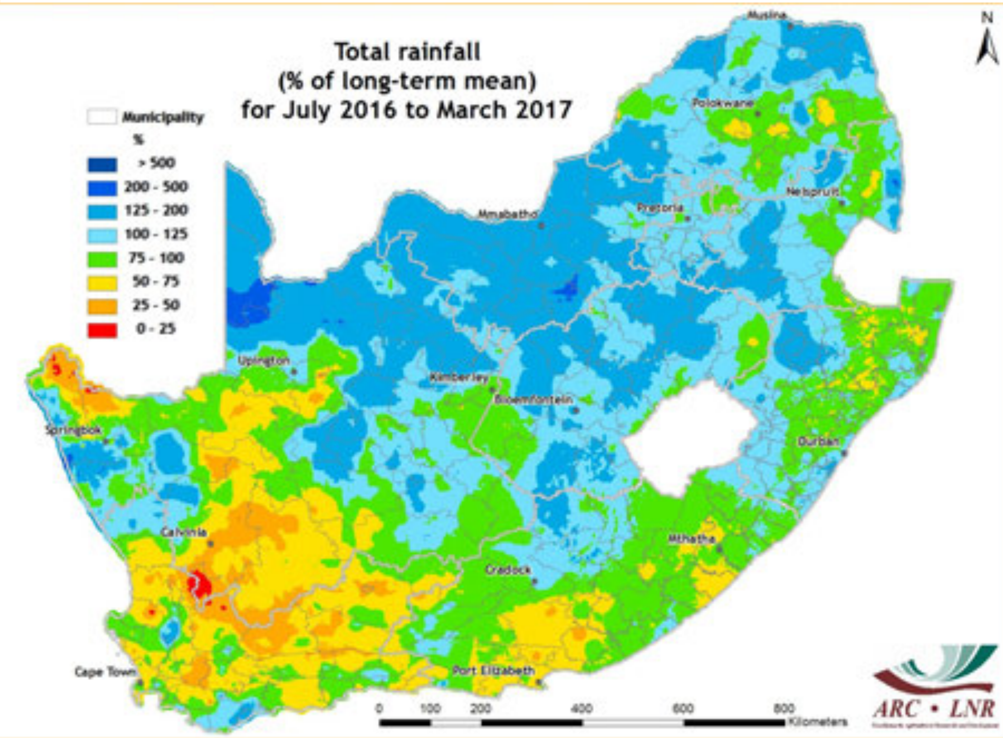


Figure 2



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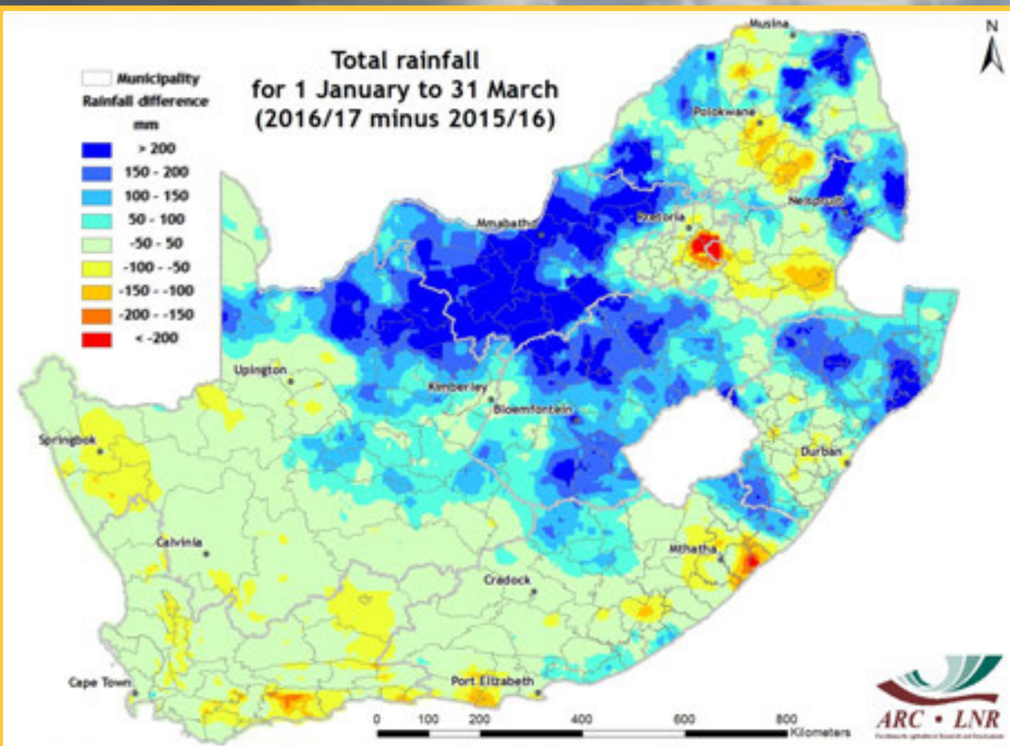

Figure 4

With the start of autumn, frontal systems approached and moved eastwards just to the south of the country or over the extreme southern parts on a regular basis during the month, but without any significant rainfall over the drought-stricken winter rainfall region. Of these frontal systems, two events stand out in terms of the influence they had on minimum temperatures. The first event occurred during the second week of March. On the 8th a relatively fast-moving frontal system moved in over the southwestern parts and exited the country the next day. Minimum temperatures dropped notably after the passage of the frontal system – an indication that winter is on its way. The second event was stronger and lasted longer. The cold front approached the country on the 22nd and moved eastwards to the exit the country on the 24/25th. The lowest minimum temperature recorded at any of the ARC-ISCW weather stations during this event (and the month) was measured at Colesberg on the 26th when the temperature dropped to 0.8 °C. In contrast to the low early morning temperatures over the interior with the passage of the cold front, some parts of the coast and adjacent interior in and around Port Elizabeth experienced record high maximum temperatures towards the end of the month. Temperatures as high as 43°C were recorded on the 30th. A strong high pressure system established itself over the interior and towards the east in the wake of the frontal system and caused air to flow from the interior to the coast, introducing adiabatic warming as it descended to the lower-lying coastal areas.

Figure 1:
Rainfall totals were generally low over the country. These ranged mostly between 5 and 25 mm over the central and western interior and between 10 and 50 mm over most of the eastern parts. Parts of KwaZulu-Natal and along the eastern escarpment received more rain, with totals reaching 100 mm in some areas. The western interior and most of the winter rainfall region received little or no rain.

Figure 2:
Rainfall was predominantly much below normal, with most of the country receiving less than 50% of the long-term mean for March. Small areas in the east (parts of KwaZulu-Natal, Mpumalanga and Limpopo) received above-normal rainfall.

Figure 3:
For the summer, since July 2016, rainfall was mostly above normal, with most of the central to northern parts receiving in excess of 125% of the long-term mean. Areas where below-normal rainfall occurred include the western and southern interior, northern parts of the winter rainfall region and, to a lesser extent, parts of KwaZulu-Natal as well as small areas in eastern Limpopo and Mpumalanga.

Figure 4:
During January to March, most of the summer rainfall region (except for a small area focusing on eastern Gauteng) received significantly more rain than during the same time last year. The southwestern half of the country was drier than last year.

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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 SPI maps (Figures 5-8) show very wet conditions over the central parts with drought over the southern and southwestern parts of the country at the short to medium time scales (3-12 months). At the longer time scale (24 months), severe to extreme drought is still present over the far eastern parts, especially KwaZulu-Natal, eastern Mpumalanga, and eastern parts of the Eastern Cape. Extreme drought is also present over the western parts of the winter rainfall region. This is also reflected in the levels of dams over affected areas.

Questions/Comments:
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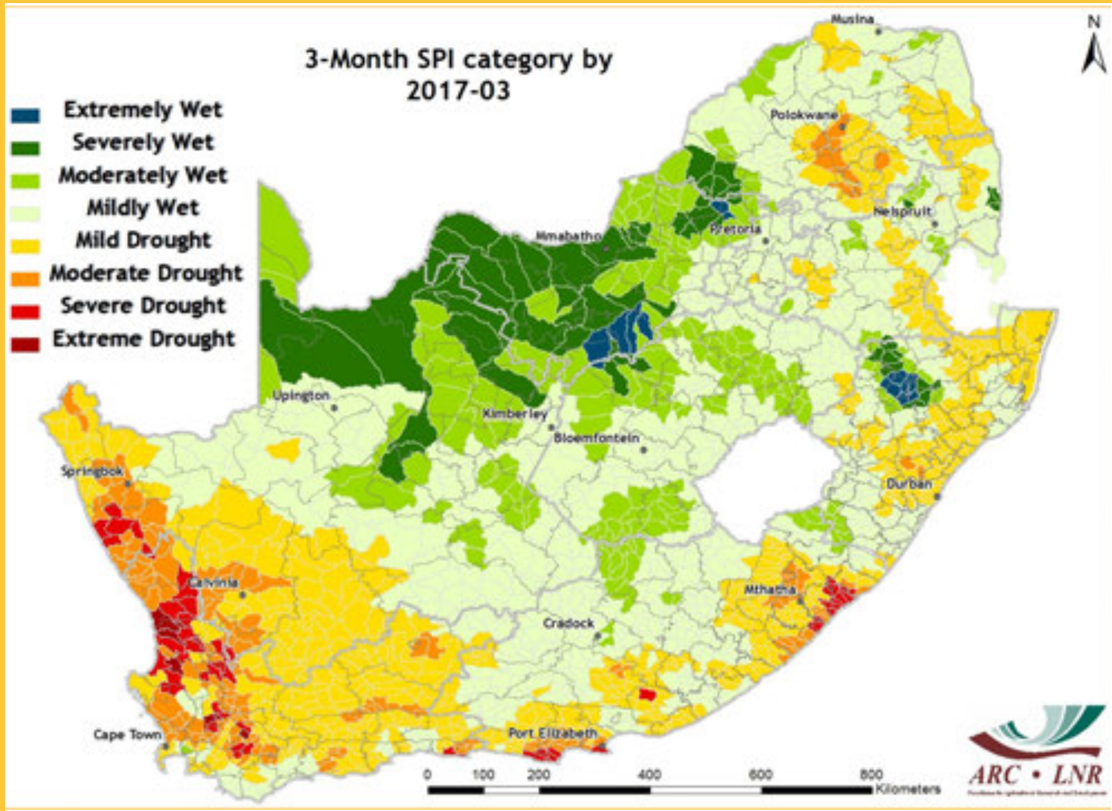

Figure 5

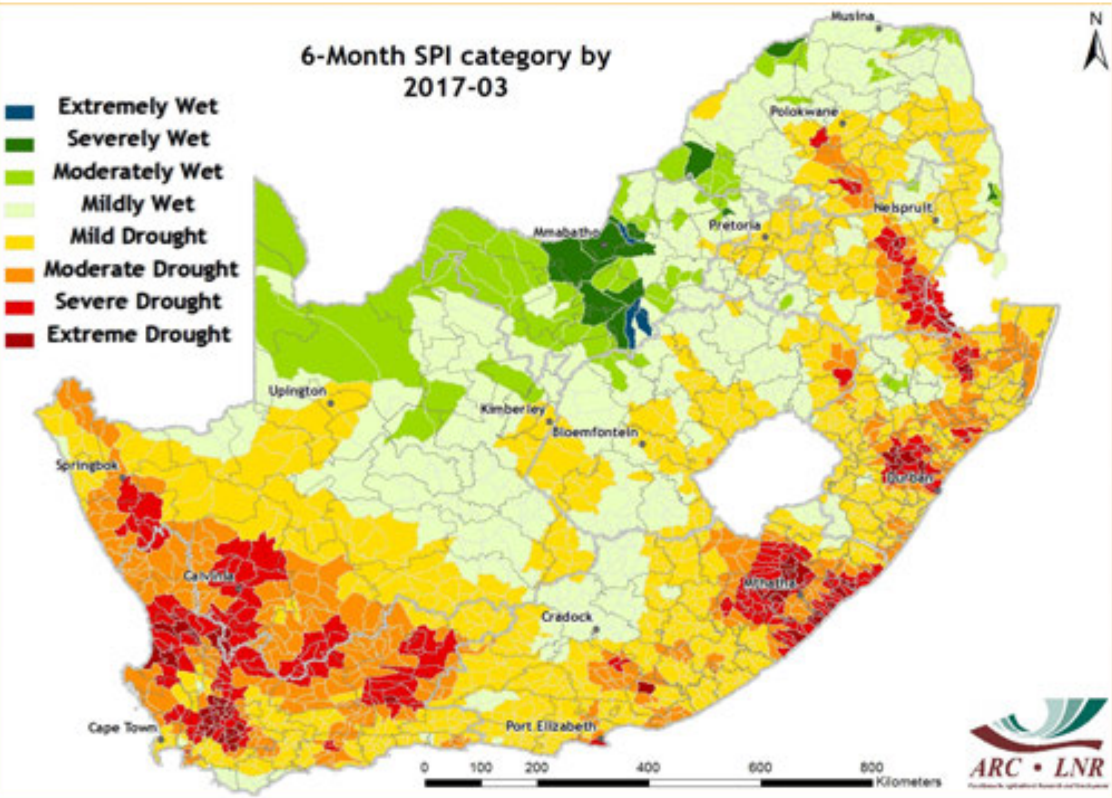

Figure 6

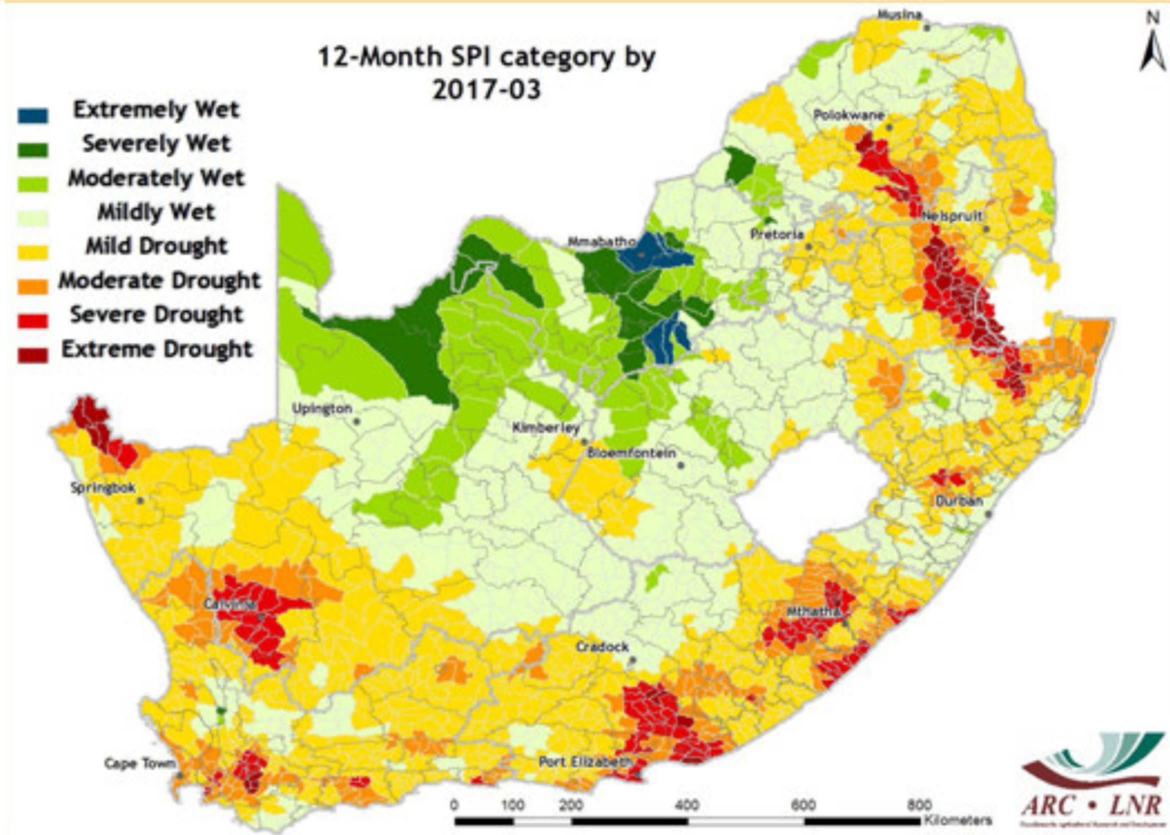

Figure 7

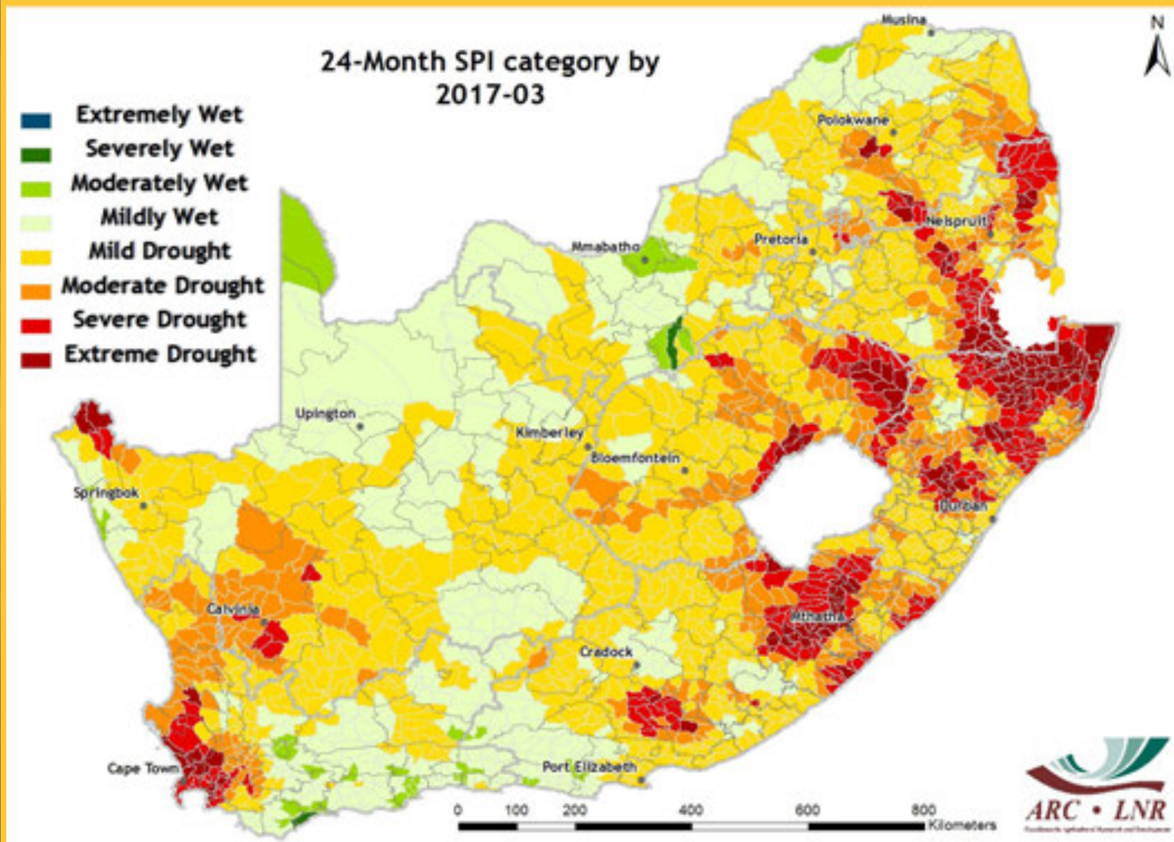

Figure 8

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.

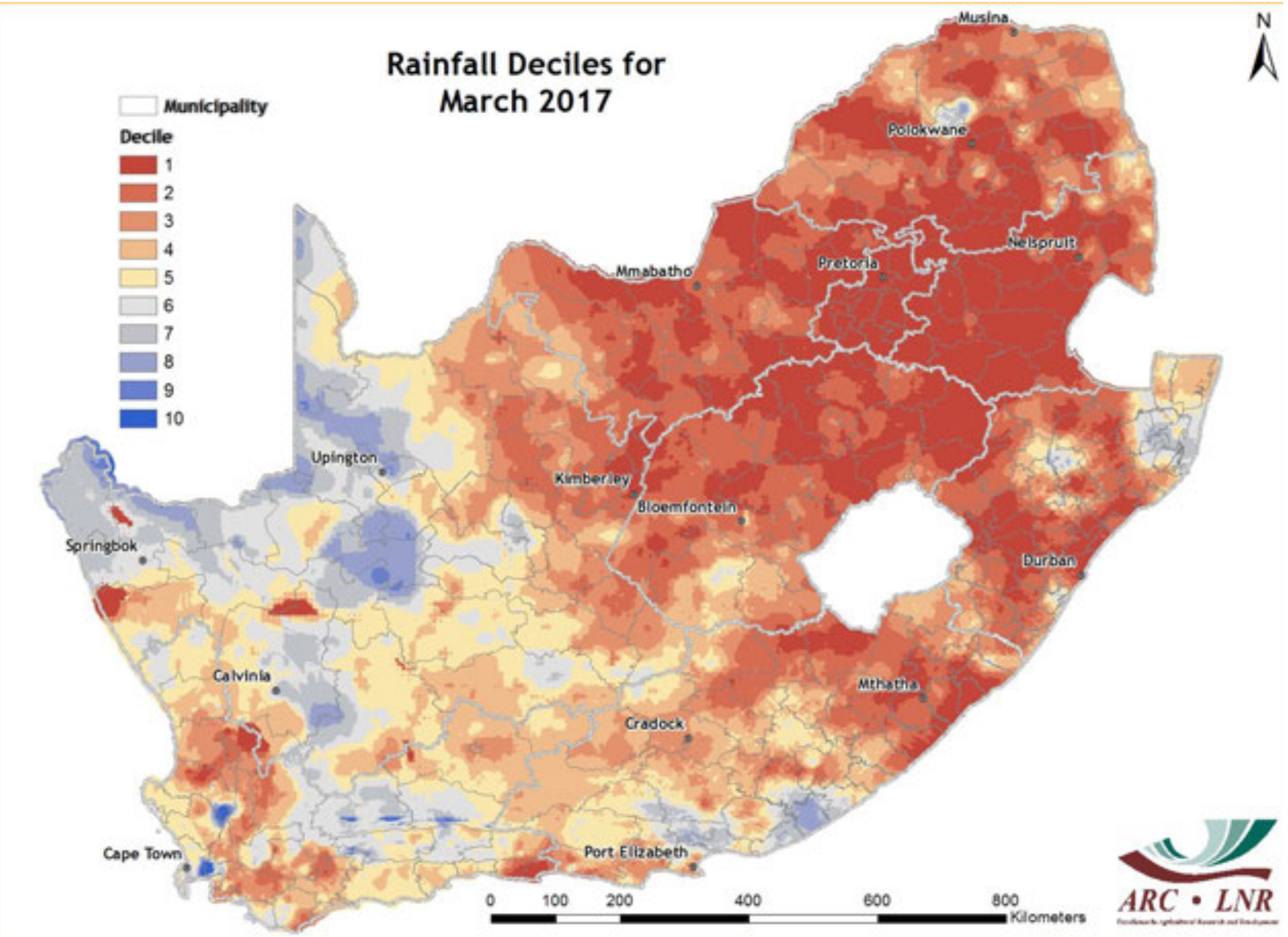

Figure 9

Figure 9:
The decile map for March shows exceptionally dry conditions over the eastern parts of the country.

Questions/Comments:
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4. Water Balance

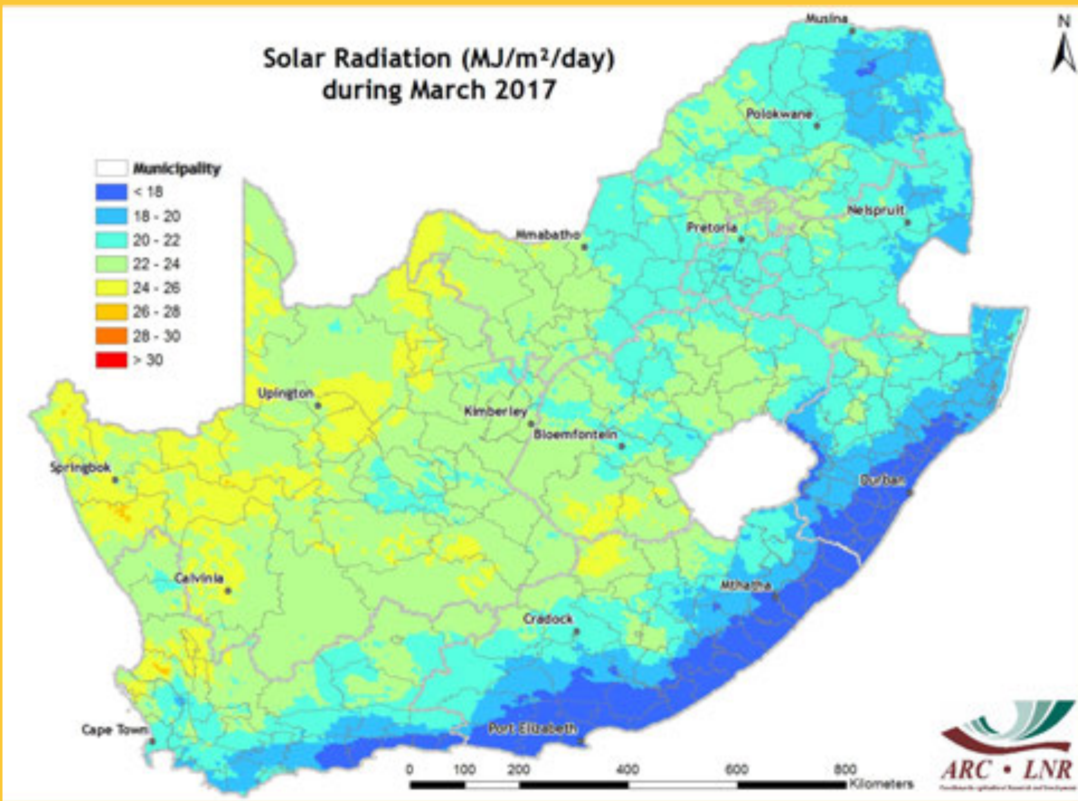

Figure 10

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 northeastern and coastal areas and the highest values over the interior to the western part of the country.

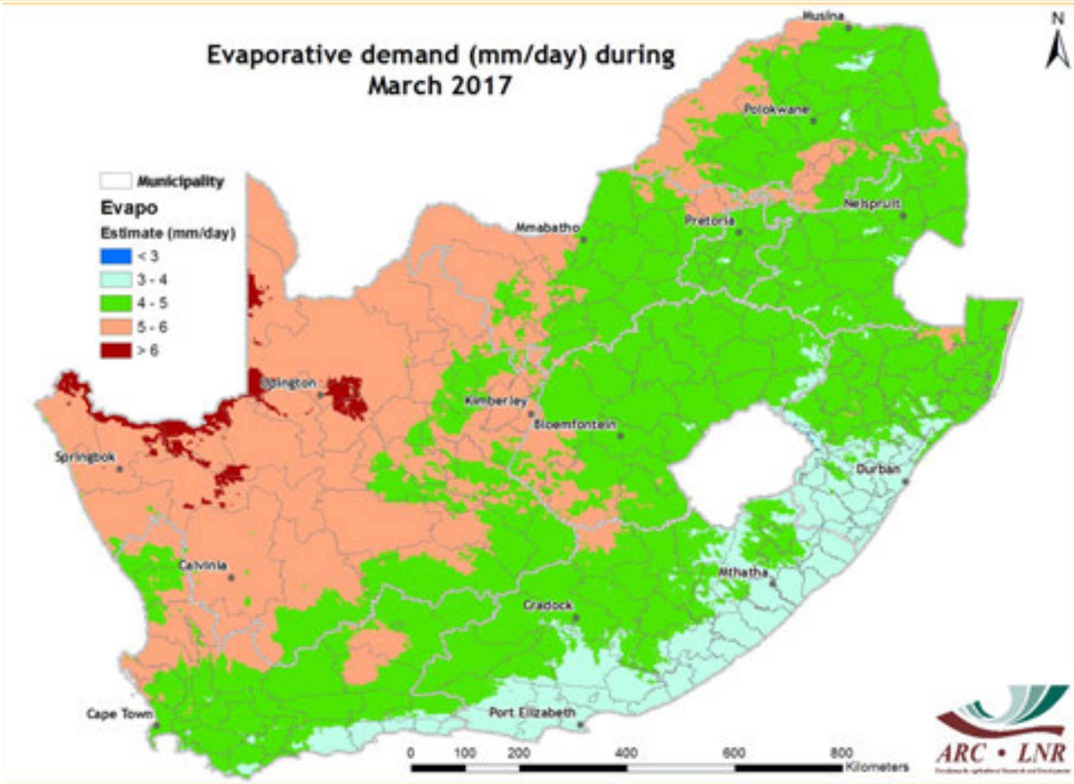

Figure 11

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 potential evapotranspiration ranged from 3 mm/day over the southwest of KwaZulu-Natal and Eastern Cape coastal areas to 6 mm/day over the southwestern parts of the Northern Cape.

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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.

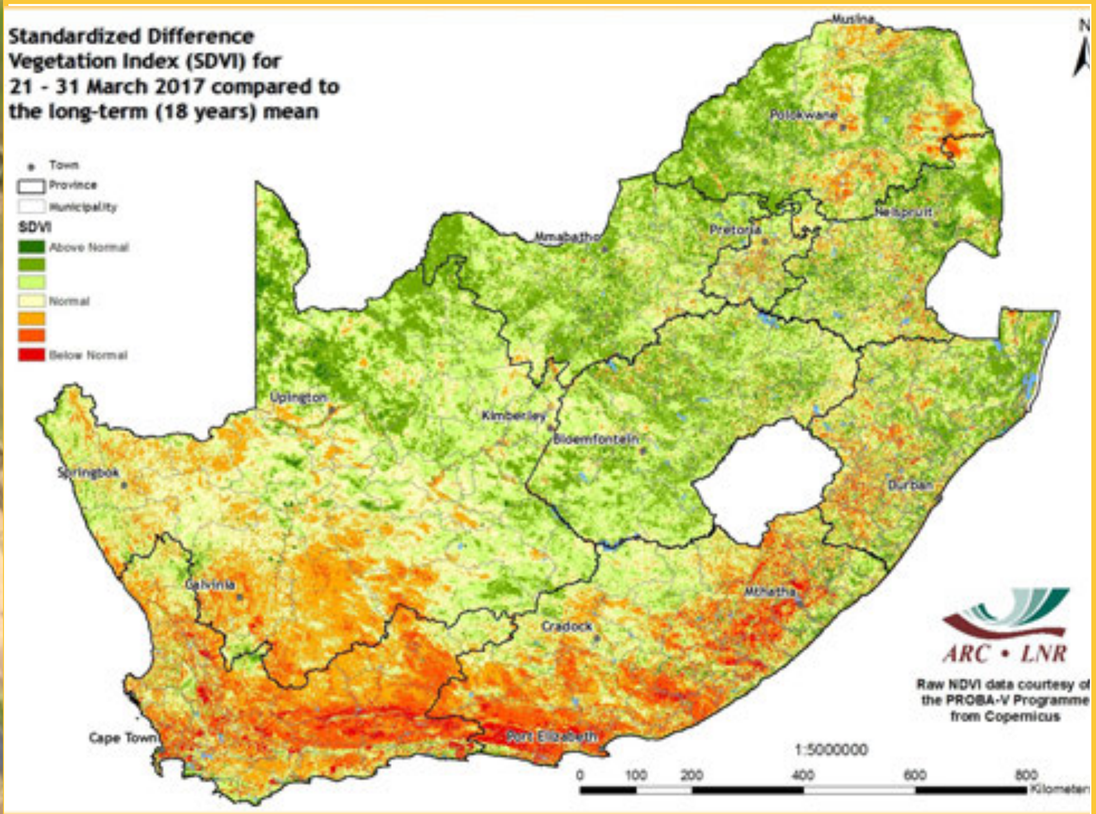

Figure 12

Figure 12:
The SDVI by late March indicates drought stress over the interior and southeastern parts of Limpopo, southern KwaZulu-Natal, Eastern Cape, Western Cape and the western parts of the Northern Cape.

Figure 13:
Vegetation activity is lower over most parts compared to a year ago, except for the central to western Free State, northern KwaZulu-Natal, the Lowveld area of Mpumalanga and North West.

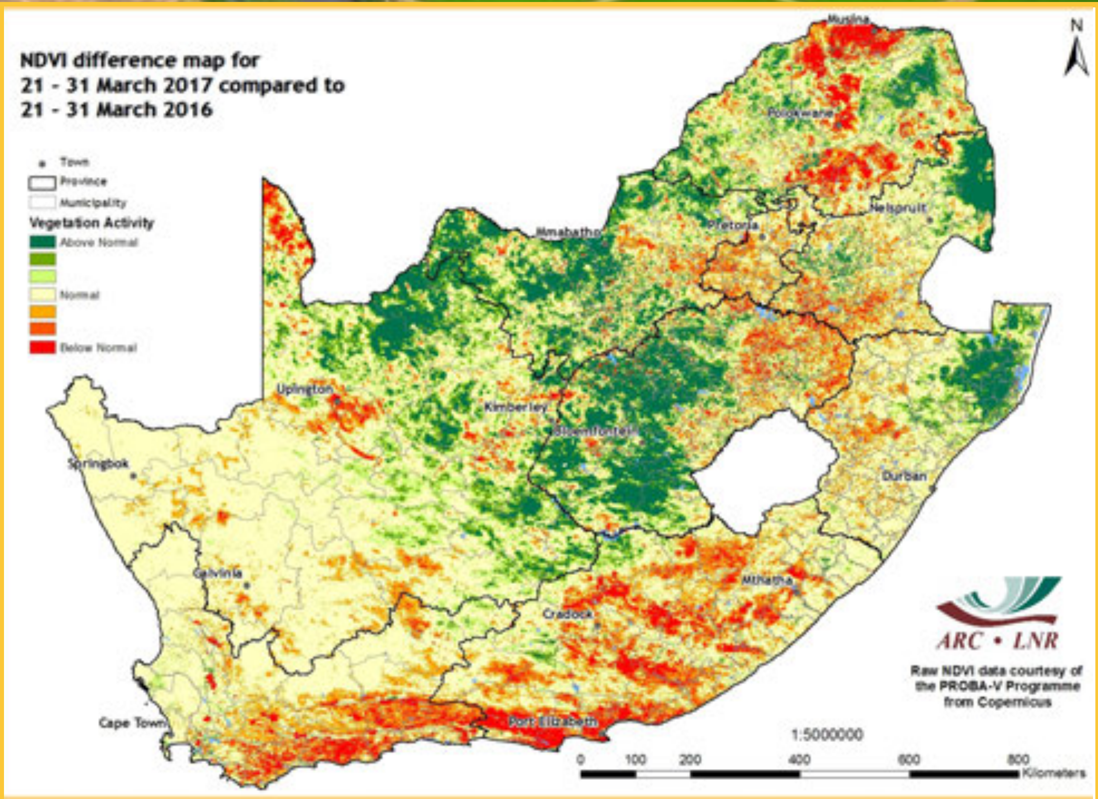

Figure 13

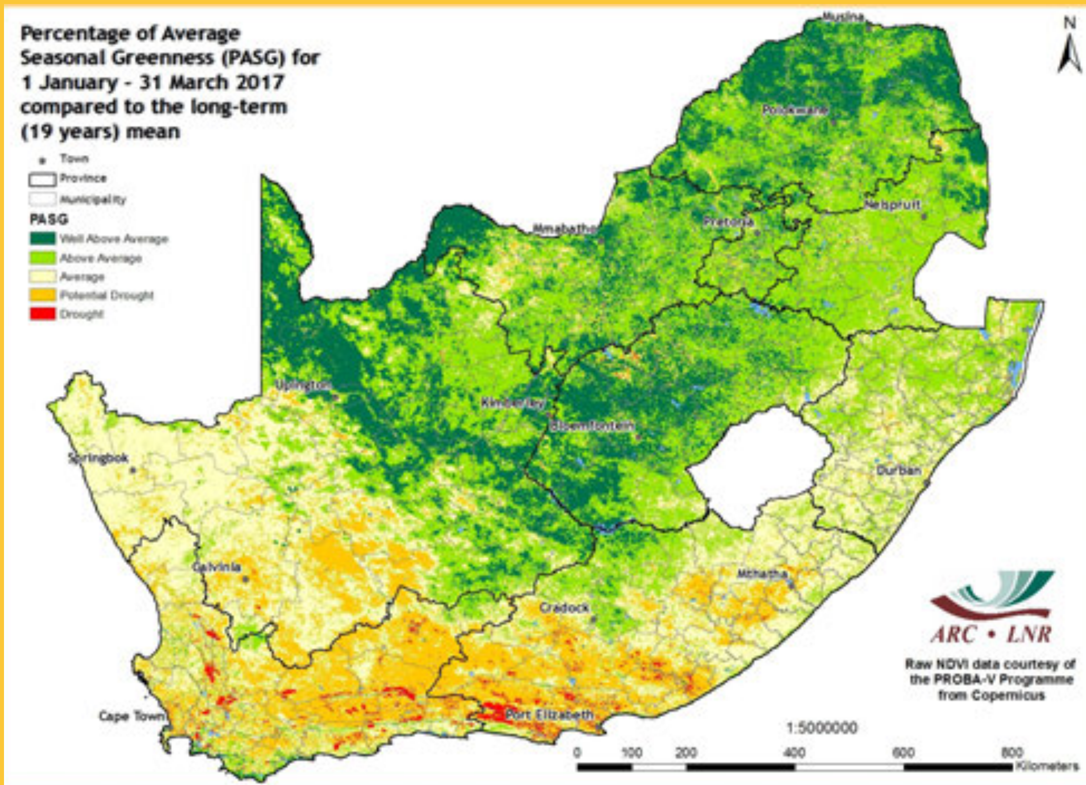

Figure 14

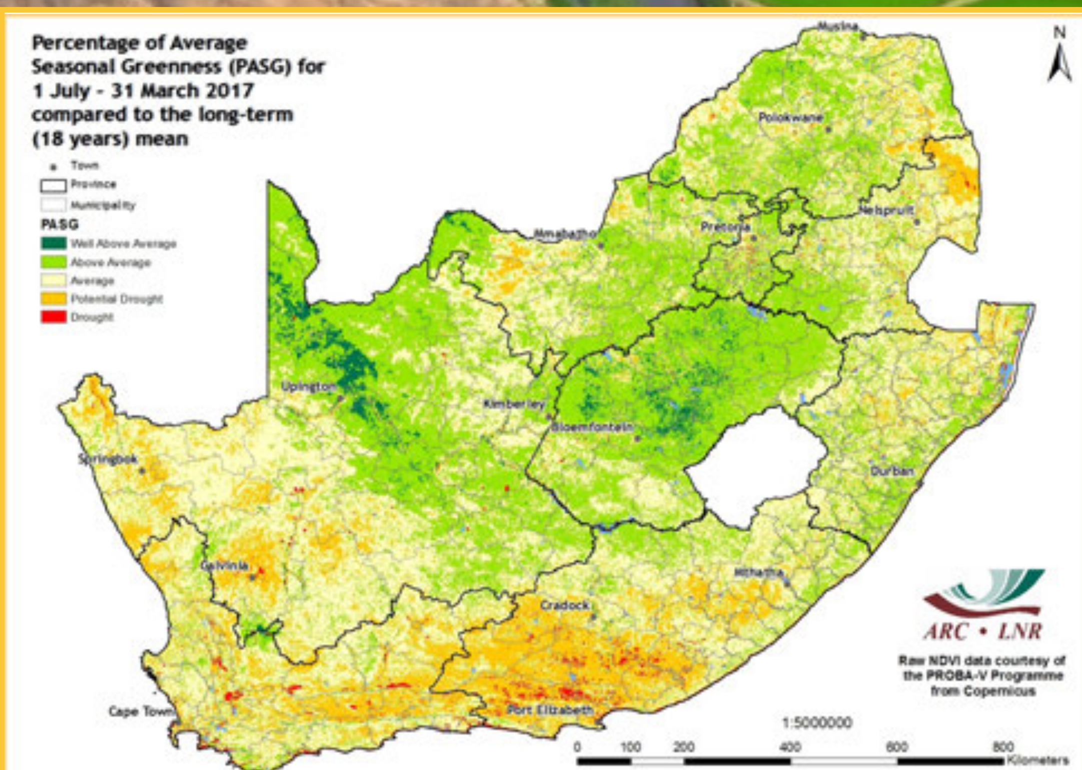

Figure 15

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 is higher over the eastern interior to the northern parts of the country, and lower over the southern and western regions.

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

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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.

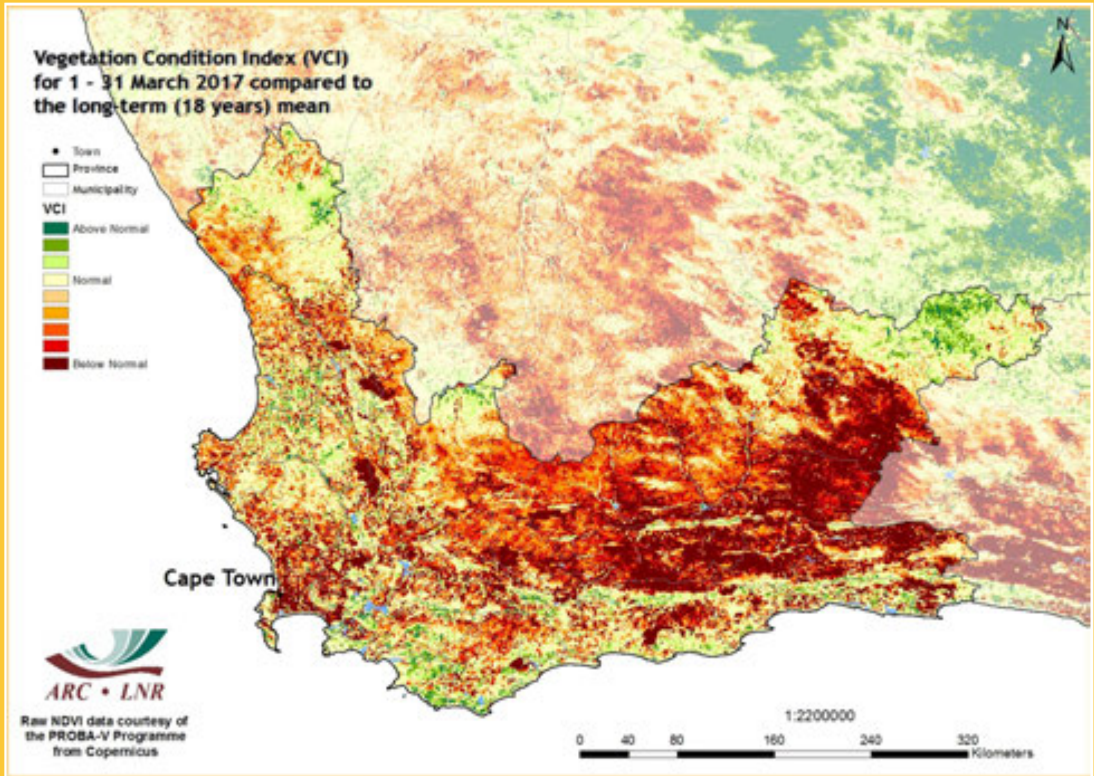


Figure 16

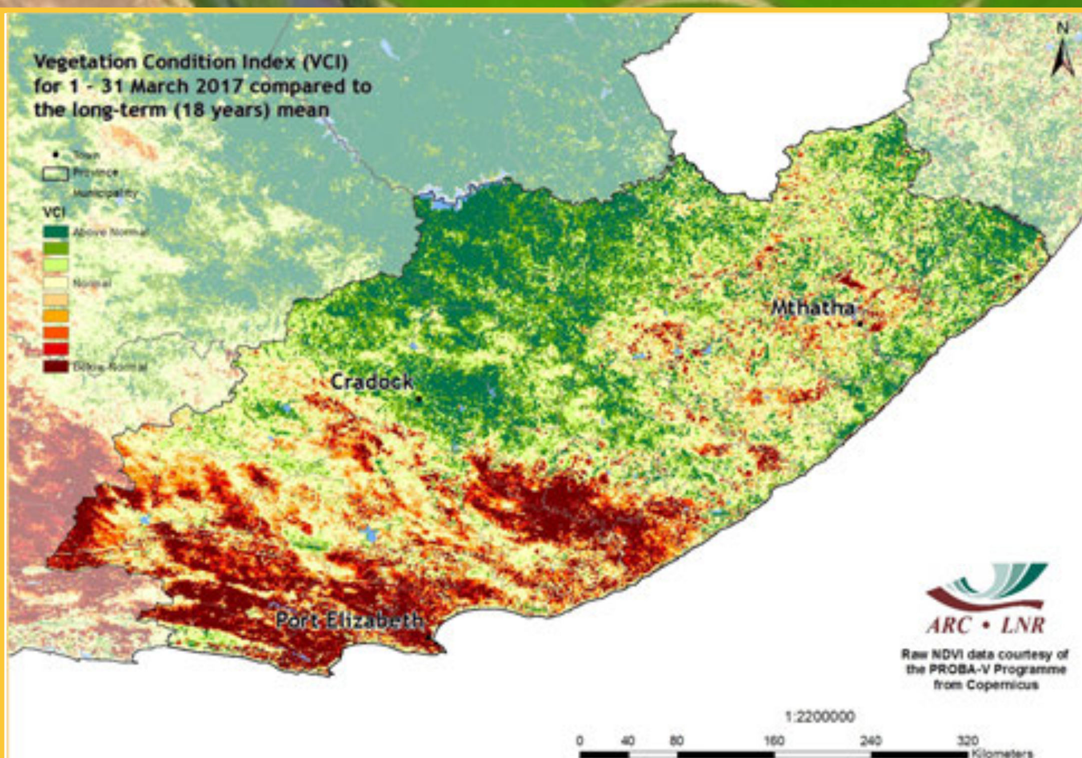
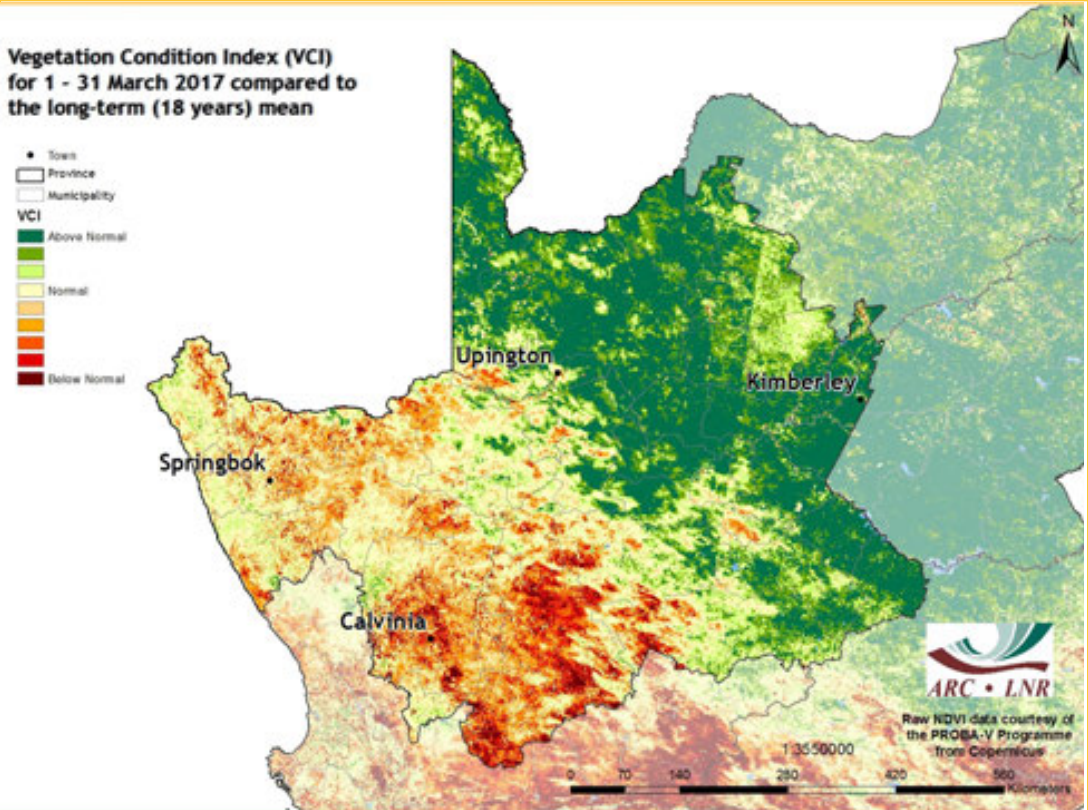


Figure 17

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

Figure 17:
The VCI map for March indicates below-normal vegetation activity over the eastern interior and the western parts of the Eastern Cape.



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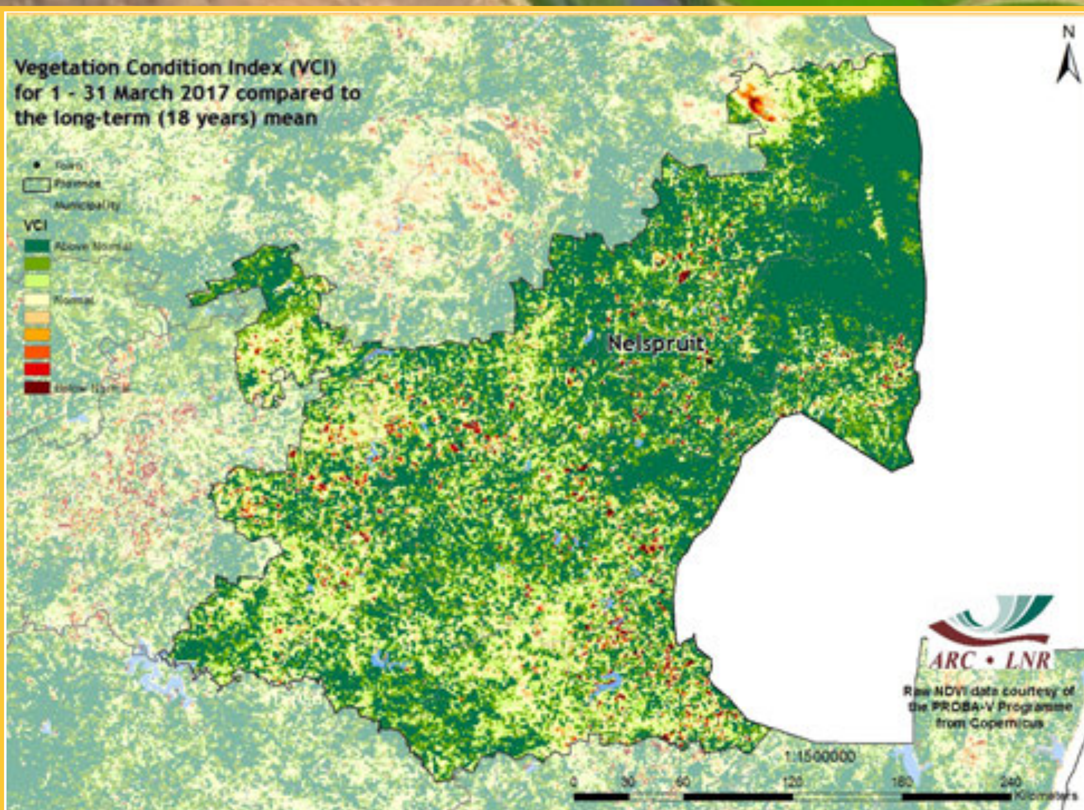

Figure 19

Figure 18:
The VCI map for March indicates below-normal vegetation activity over the western parts of the Northern Cape.

Figure 19:
The VCI map for March indicates above-normal vegetation activity over most parts of Mpumalanga.

Questions/Comments:
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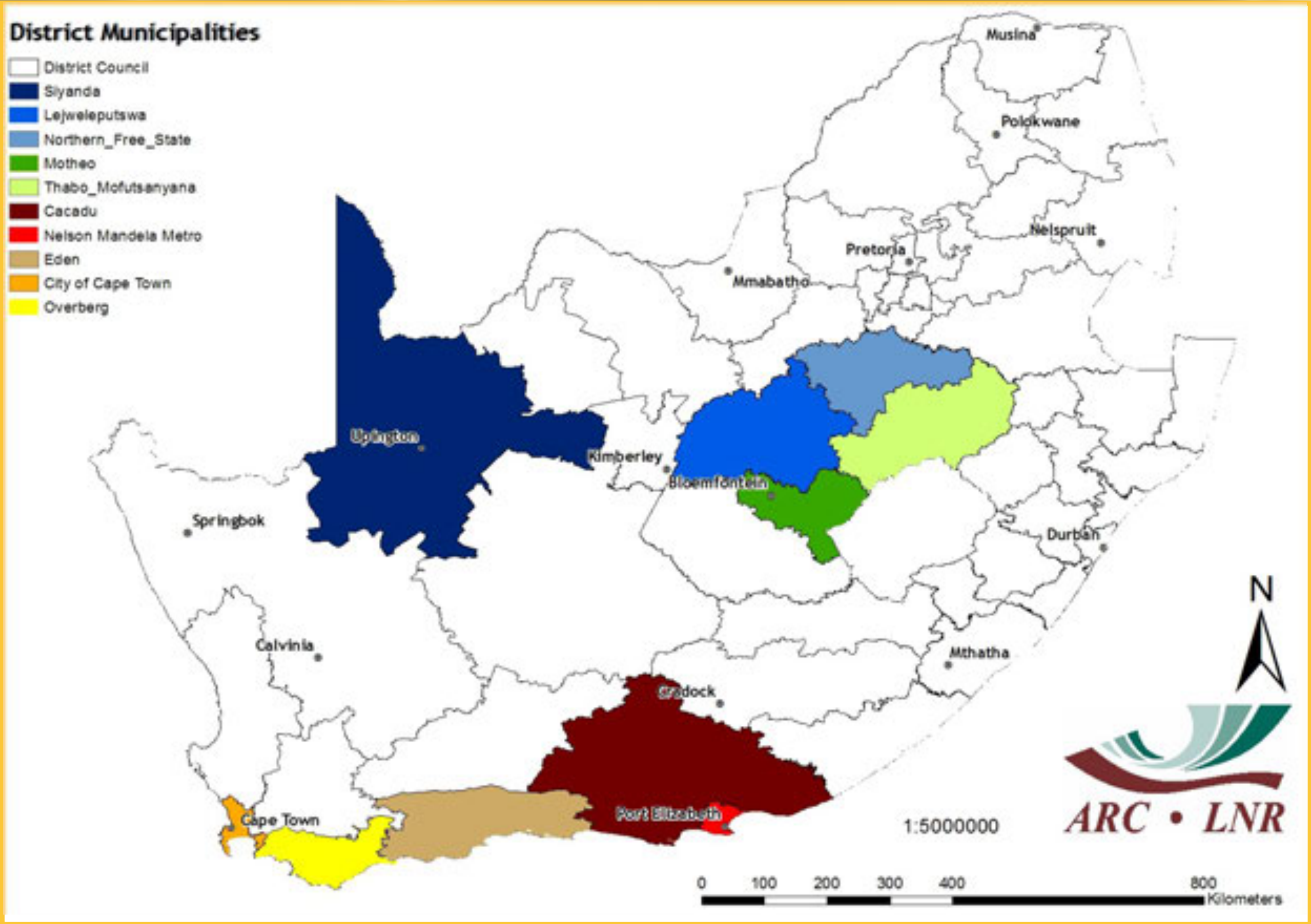
7. Vegetation Conditions & Rainfall



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

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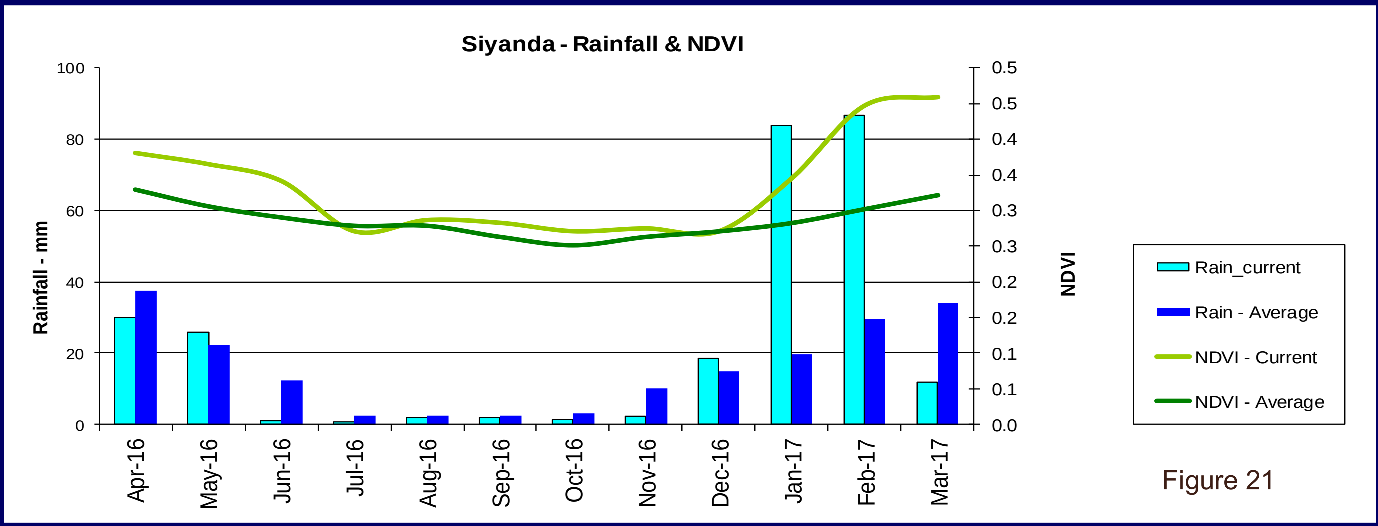
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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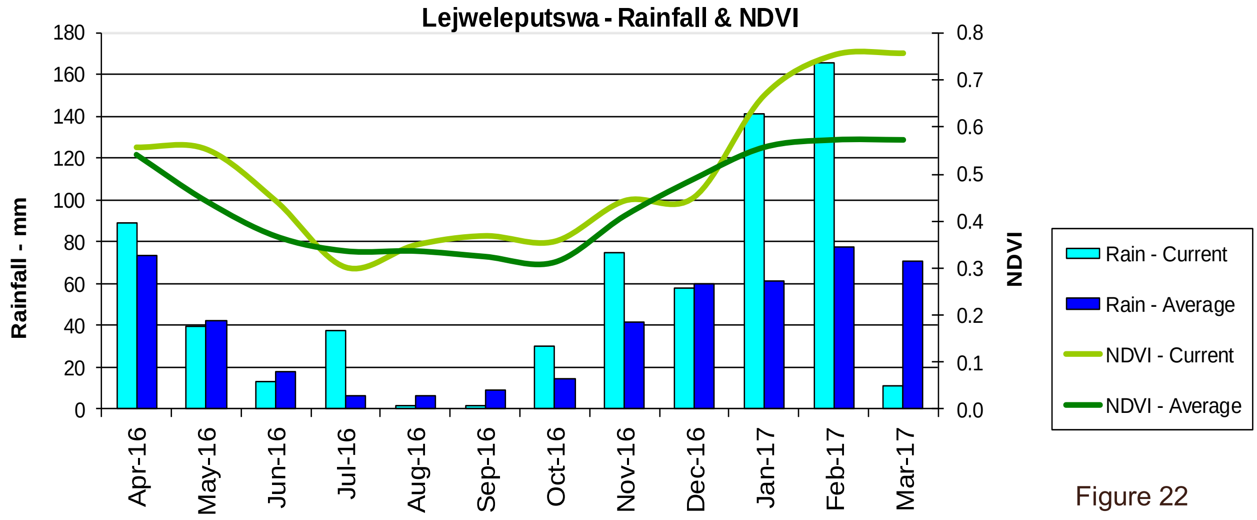

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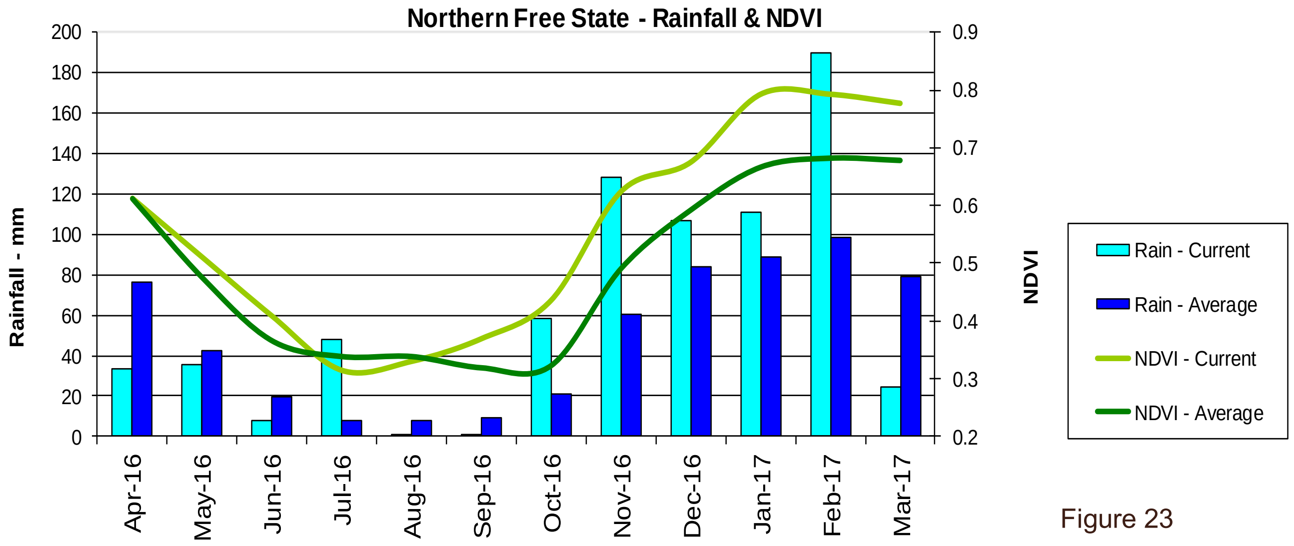

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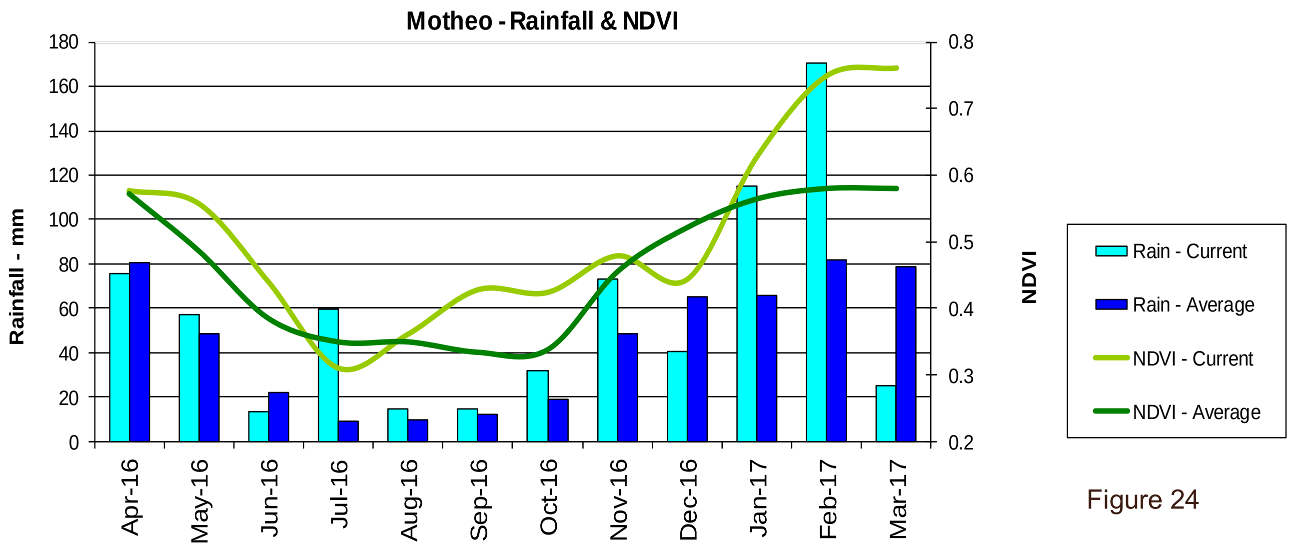

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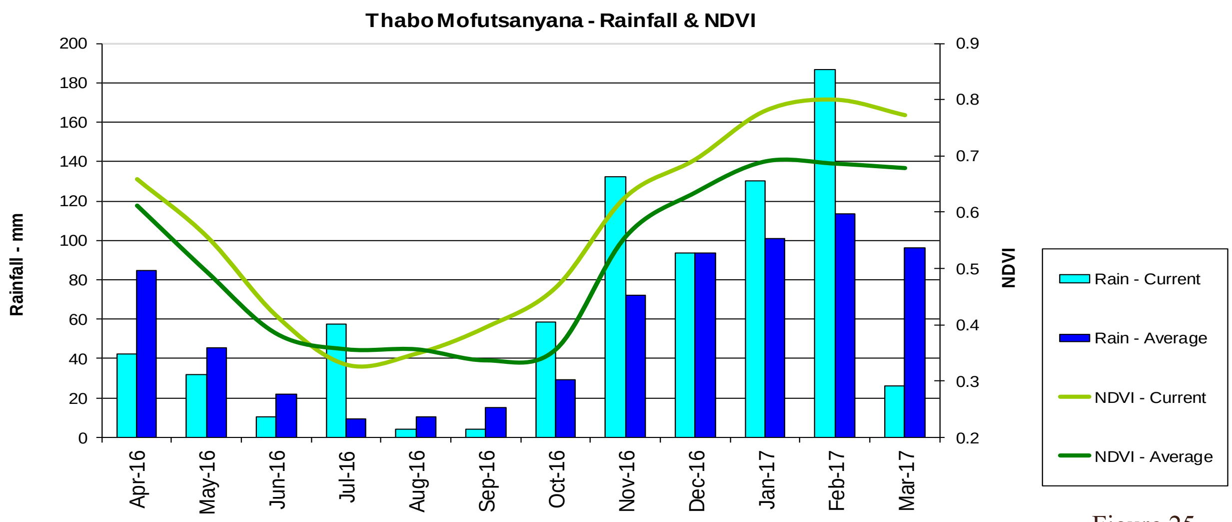

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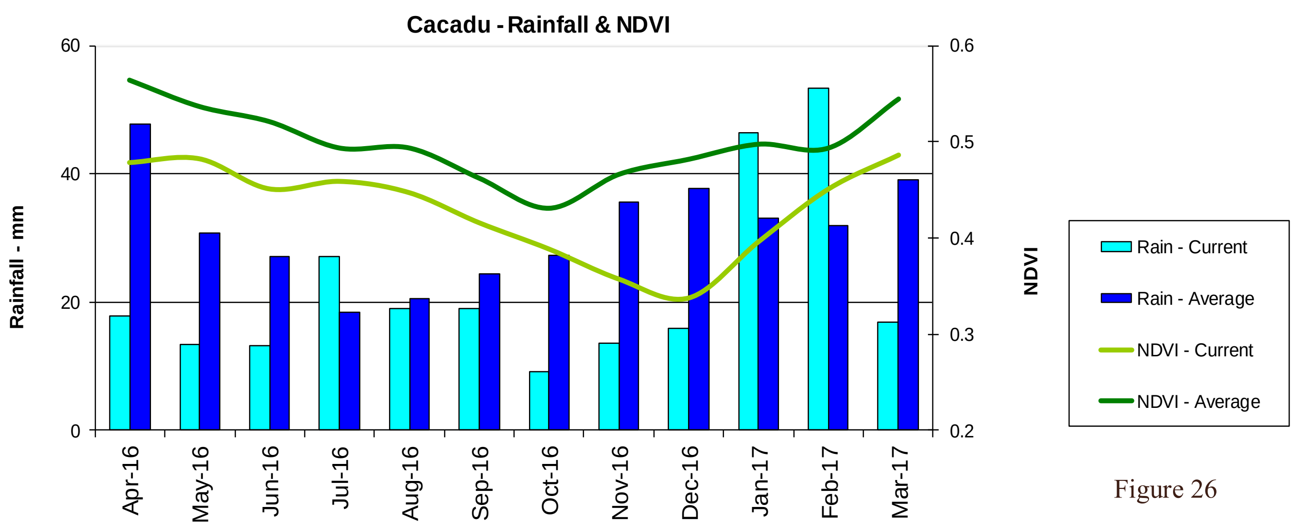

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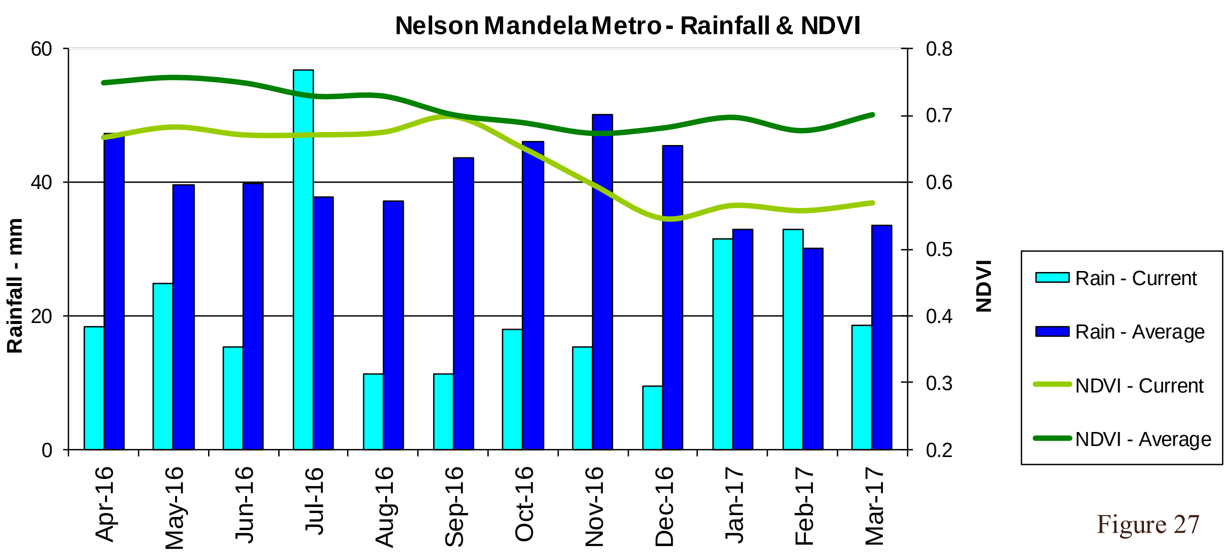

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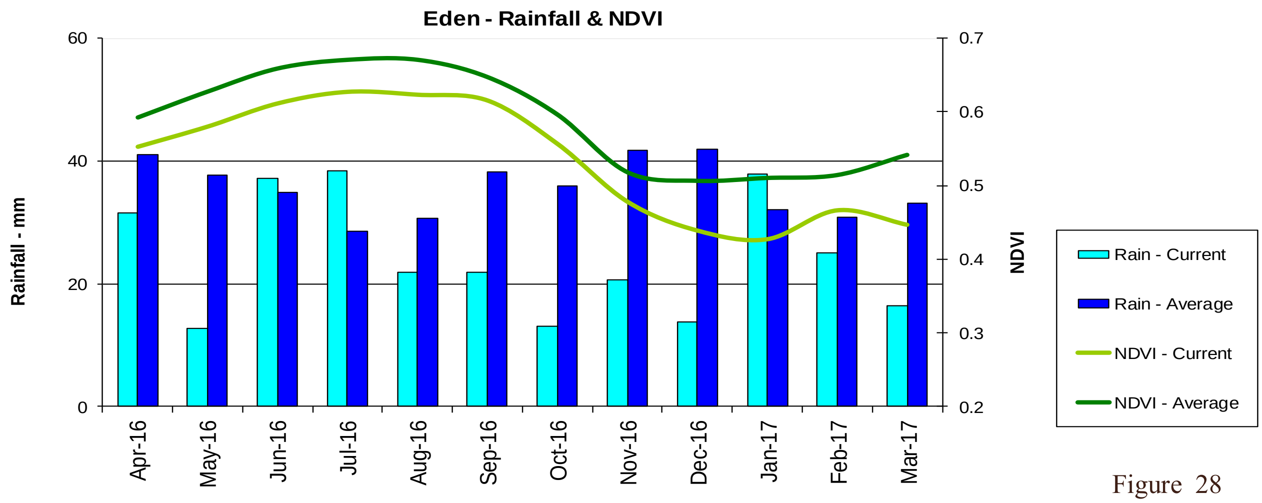

Figure 28

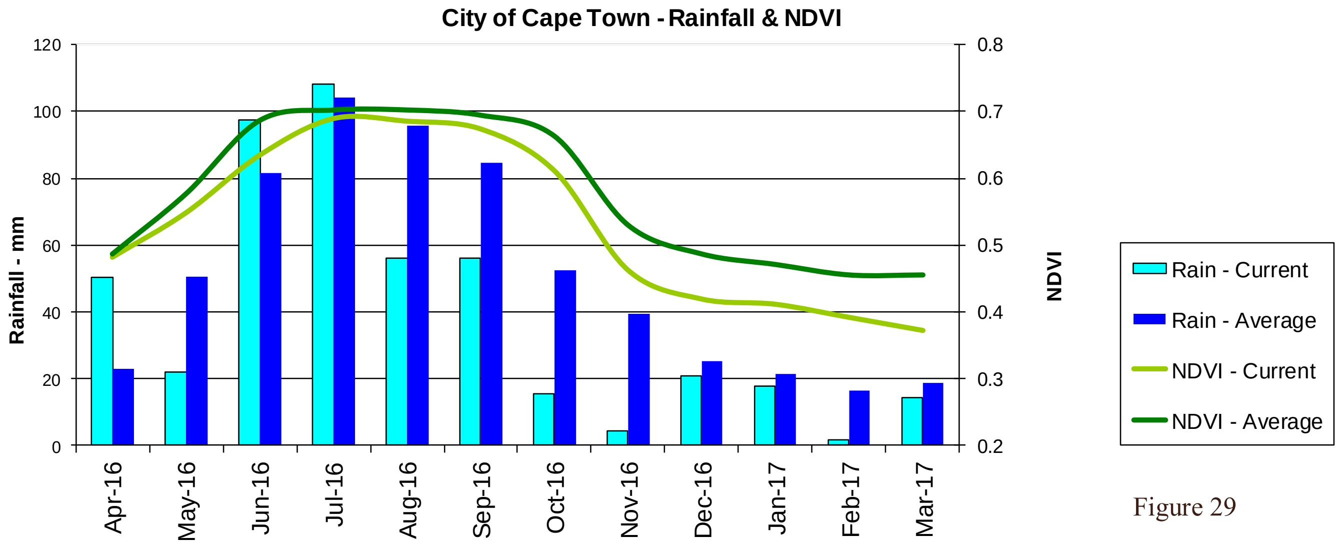

Figure 29

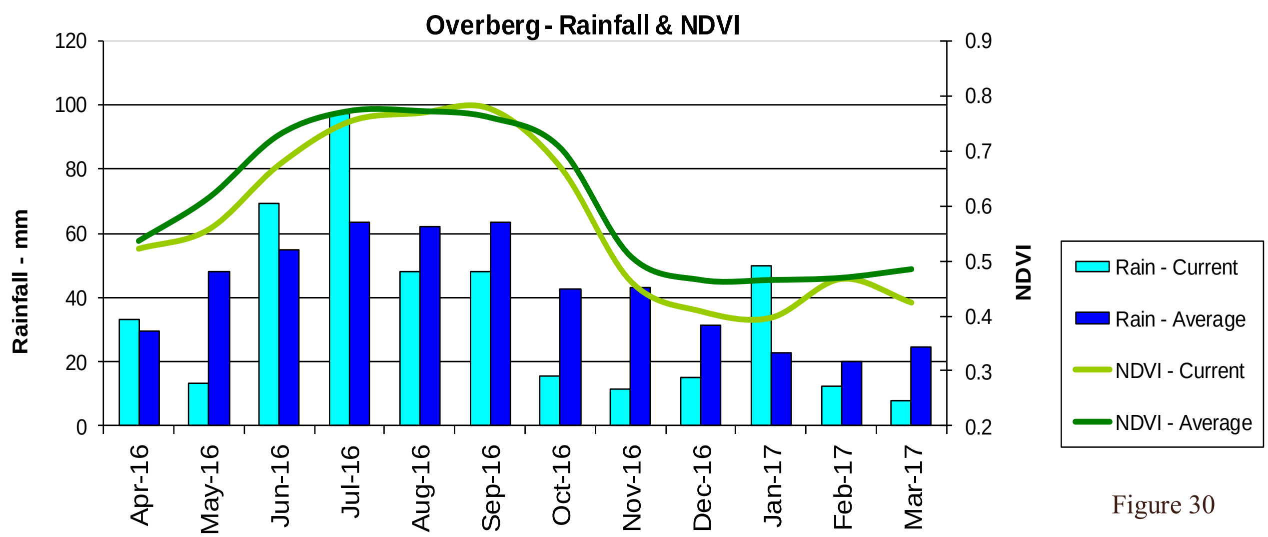

Figure 30

PAGE 16

8. Soil Moisture

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 March 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 March and February with brown colours showing the drier and the green colours the wetter areas. Similarly, the year-on-year SSI difference for March 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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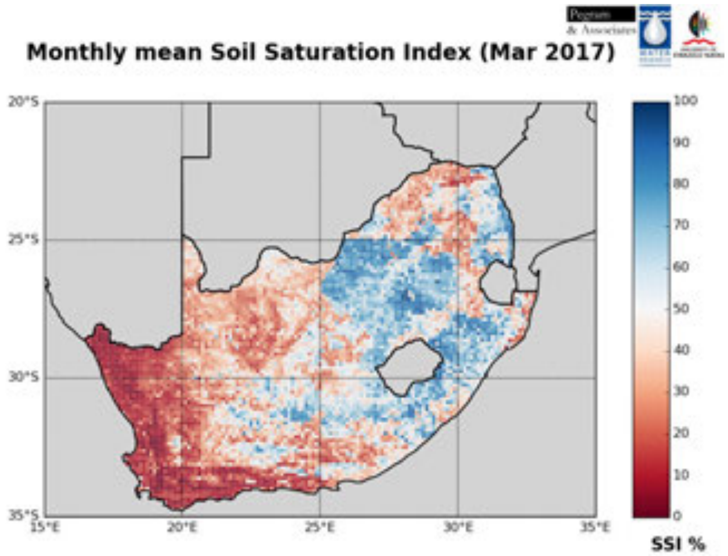


Figure 31

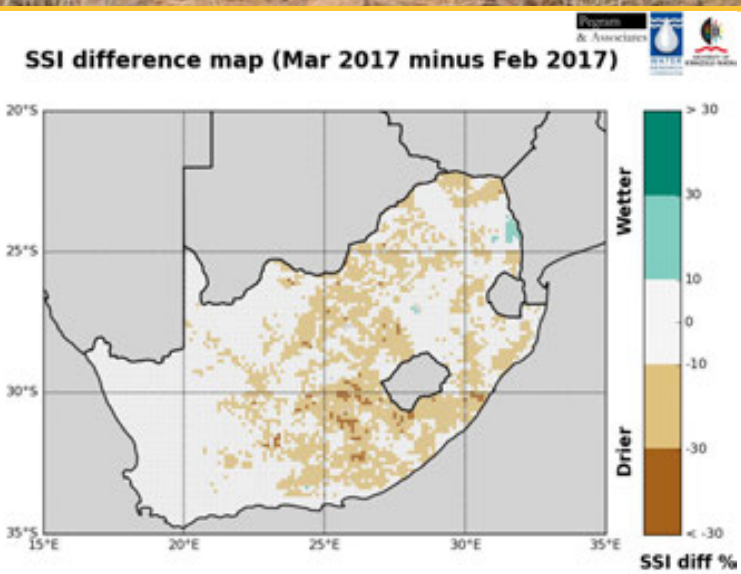


Figure 32

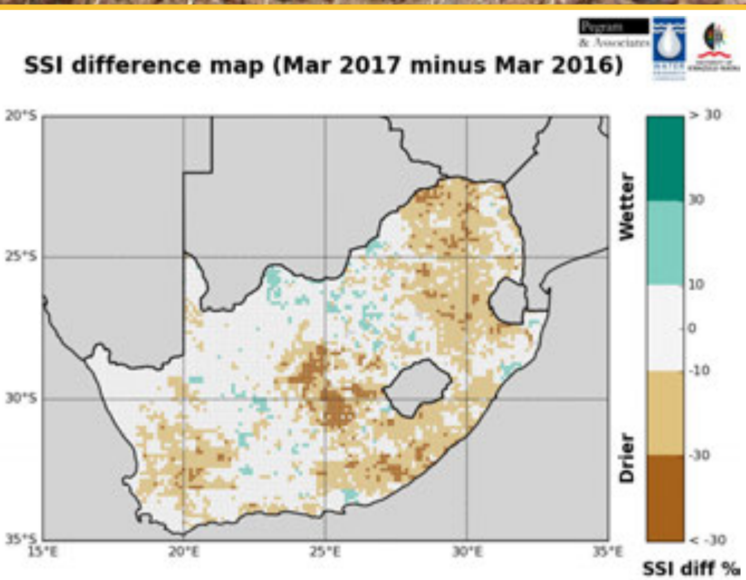


Figure 33

9. Fire Watch

PAGE 17

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:
The graph shows the total number of active fires detected during the month of March per province. Fire activity was higher in all provinces except Gauteng compared to the average during the same period for the last 17 years.

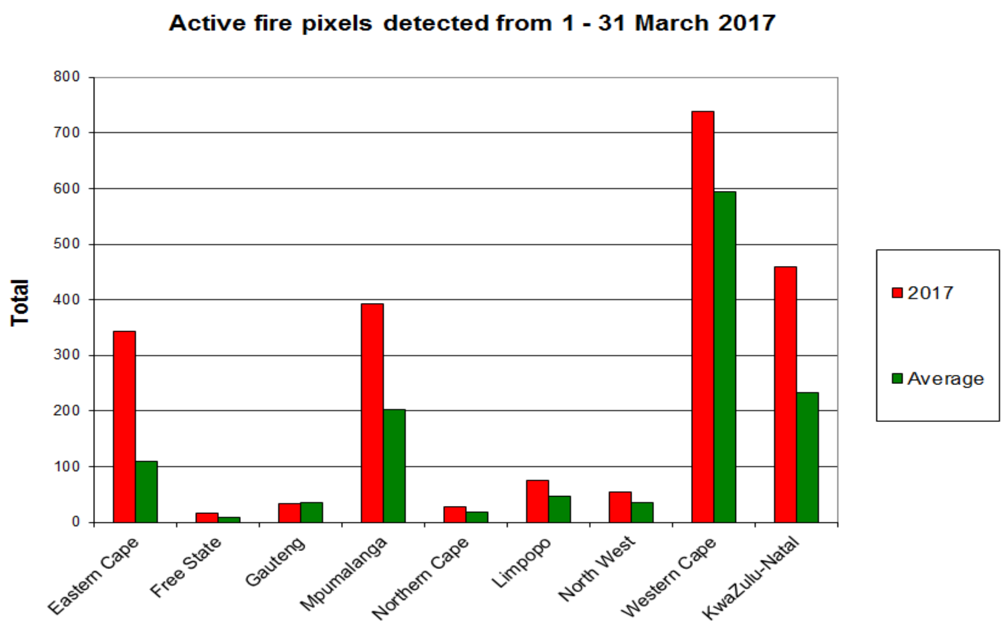


Figure 34

Figure 35:
The map shows the location of active fires detected between 1-31 March 2017.

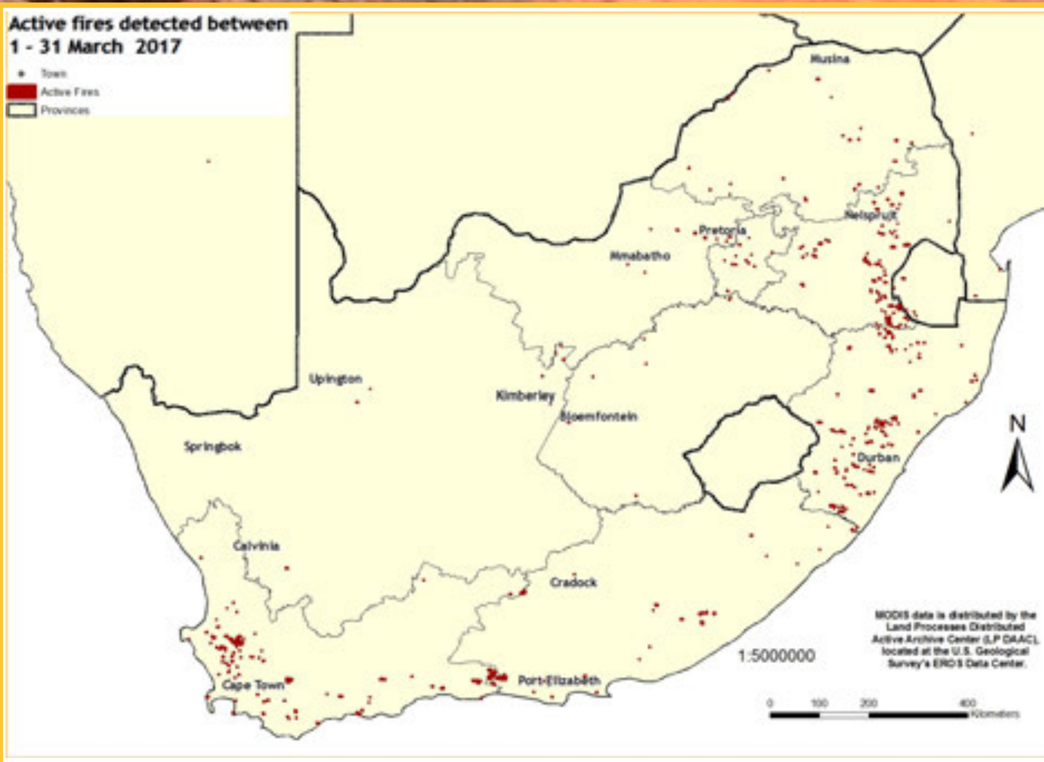


Figure 35

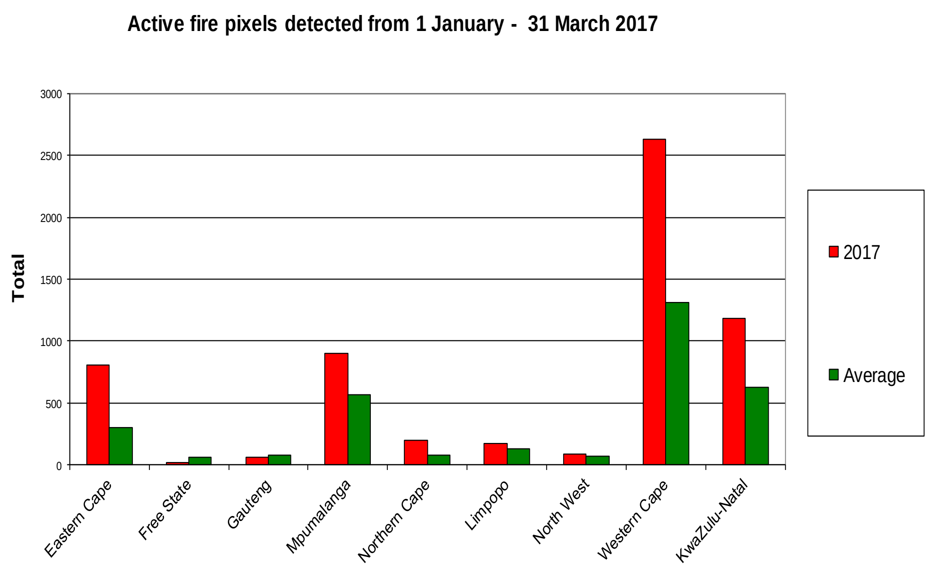


Figure 36

Figure 36:
The graph shows the total number of active fires detected from 1 January - 31 March 2017 per province. Fire activity was higher in all provinces except the Free State and Gauteng compared to the average during the same period for the last 17 years.

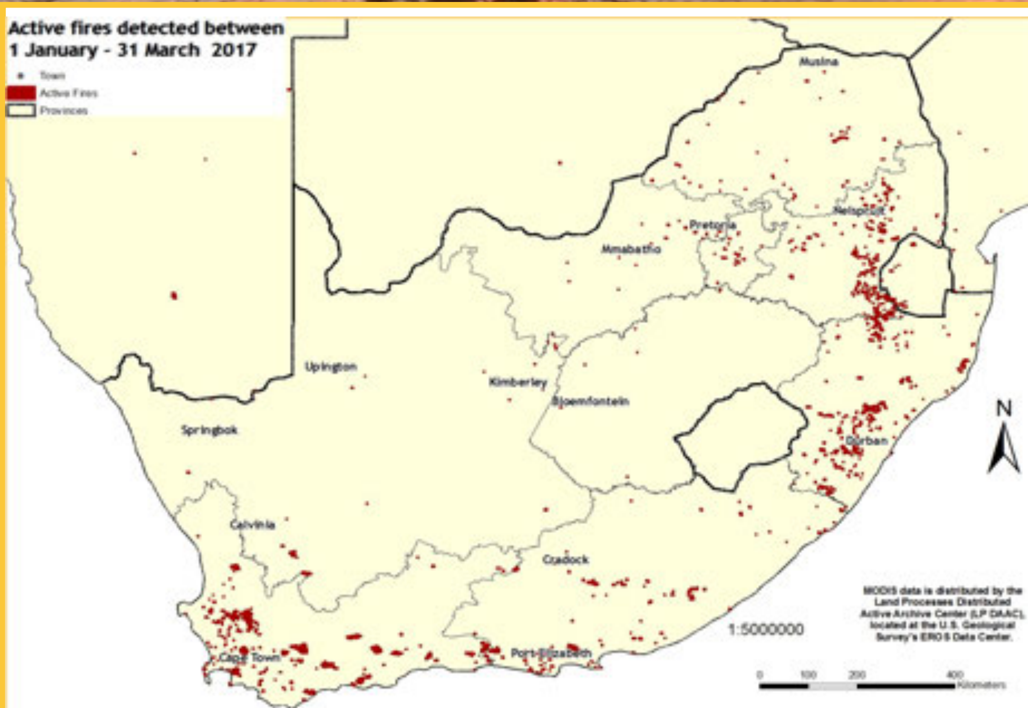
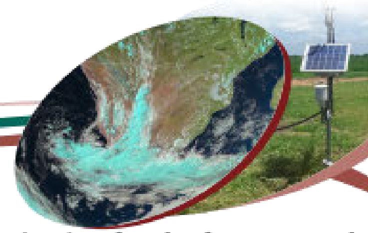


Figure 37

Figure 37:
The map shows the location of active fires detected between 1 January - 31 March 2017.

Questions/Comments:
NkambuleV@arc.agric.za

Agrometeorology



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

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

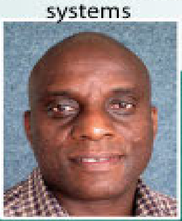
- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

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**.

ARC • LNR

Excellence in Agricultural Research and Development

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”.

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