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UMLINDI
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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

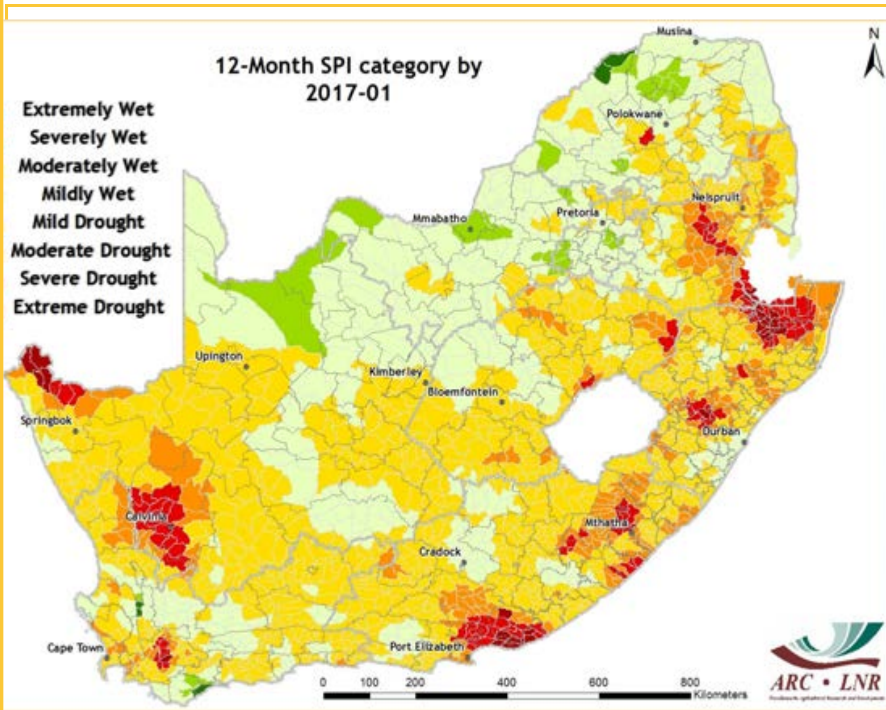
agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

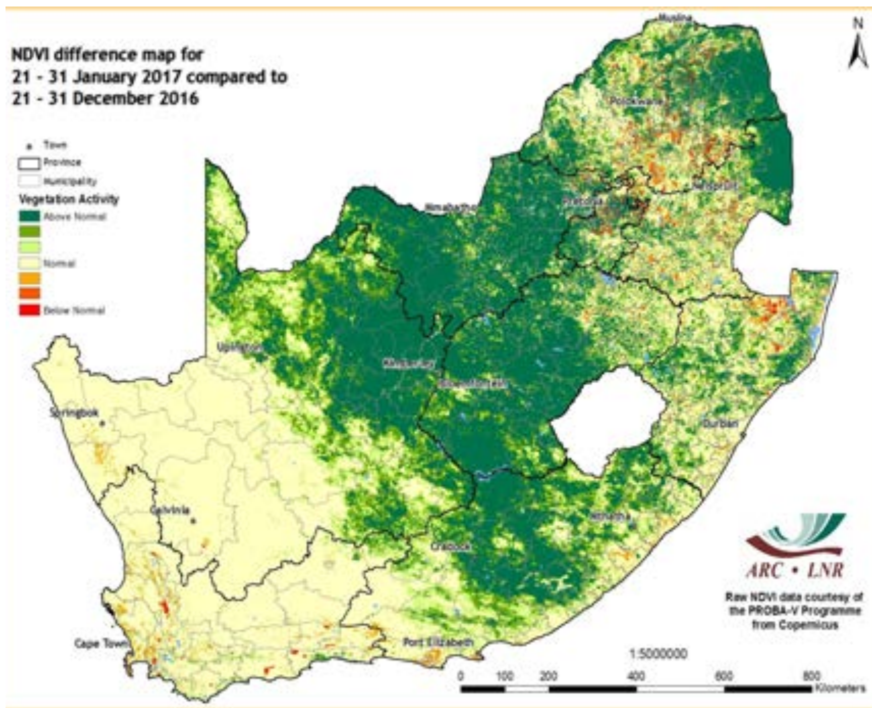
South African Weather Service

AMESD

152nd Edition

Images of the Month





Above-normal rainfall and vegetation recovery over much of the summer rainfall region in January

Widespread above-normal rainfall over the central to northeastern summer rainfall region during January 2017 is shown in the Standardized Precipitation Index (SPI) map. Parts of the northeastern Northern Cape, northeastern North West and southwestern Limpopo can be categorized as extremely wet according to the index at the 1-month time scale.

The pattern of relatively high rainfall is also reflected in the vegetation activity trend. The Normalized Difference Vegetation Index (NDVI) map indicates that large increases in vegetation activity occurred between late December and late January over much of the anomalously wet areas according to the change in the NDVI. The wet conditions were especially welcome over especially the western parts of the maize production area where some parts had received below-normal rainfall earlier in the summer.

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:
Most of South Africa received normal to above-normal rainfall during January 2017. The persistent presence of a tropical low pressure system over Botswana played an important role in maintaining high levels of atmospheric moisture throughout much of the month, with widespread thundershowers and even some periods of persistent cloud and rain over especially the central and northeastern interior. The rainfall anomaly pattern is reminiscent of the persistent moisture source over Botswana together with a southward to southeastward flow of moisture over the interior, facilitated by a tendency for upper-air troughs to develop over the south-western parts. Furthermore, an anticyclonic circulation anomaly existed over most of the Indian Ocean to the east of South Africa, further aiding the large-scale transport of moisture into the subcontinent. Extensive cloud cover kept most of the country relatively mild during the month. Hot periods still occurred over the western interior, but temperatures were somewhat lower than earlier this summer over these areas. Highest maximum temperatures over the central to western interior were reached on the 1st, from the 17th to 20th and again by the end of the month. In most areas, maximum temperatures seldom exceeded 40°C. Rainfall over the central to eastern parts was well distributed in time, with the two most extensive rainfall events centred around the 5th and again by the 27th. In both these events, the movement of the tropical low to the north to a position close to South Africa's borders enhanced moisture levels and instability, with favourable upper-air conditions providing the necessary dynamics. Over the western interior, rainfall was mostly confined to the first week of the month, while over the Garden Route it was concentrated mostly during the last week. Since the beginning of the month, scattered to widespread thundershowers occurred over the central parts ahead of an upper-air trough while the tropical low was situated over northwest Botswana. Widespread rain and thundershowers occurred over the central to western interior by the 2nd, including much of the Eastern Cape interior and coastal region. As the tropical low moved towards southeastern Botswana by the 6th, rain shifted to northeastern South Africa. Several stations recorded daily totals exceeding 50 mm. Dam levels over the summer rainfall region generally increased during and following the wet spell. The atmosphere over South Africa dried out considerably during the middle of the month, with most of the action replaced to the north and over Mozambique. Until then, the tropical low that had been responsible for much of the rain earlier in the month remained quasi-stationary over northwestern Botswana. The presence of the system with some moisture flowing across South Africa kept the situation favourable for scattered thundershowers over many areas until the 15th. By the 16th, a cold front swept across the eastern parts with a strong high pressure system to the south and southeast, advecting cooler air over the interior while the upper-air conditions became largely anticyclonic. While scattered thundershowers occurred as cooler air undercut the tropical moisture, the cool air also resulted in clearance over the country while the tropical low over northwestern Botswana weakened and moved further away from the country. Meanwhile, another tropical depression moved from the coast into central Mozambique and resulted in some significant showers over the escarpment and parts of the Lowveld in the northeast. The de-

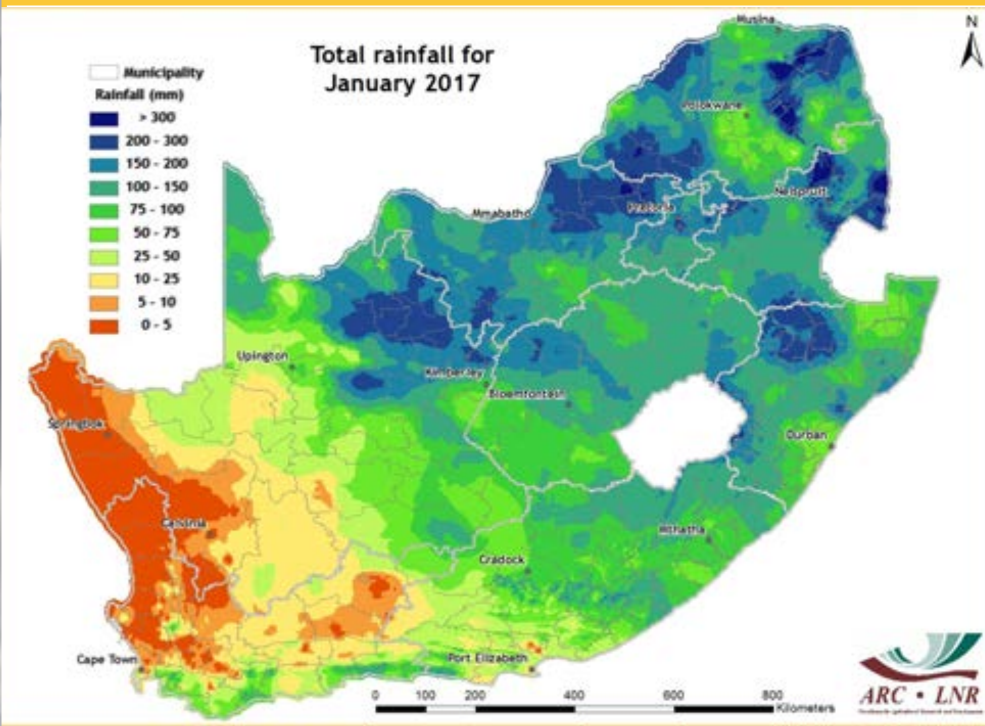
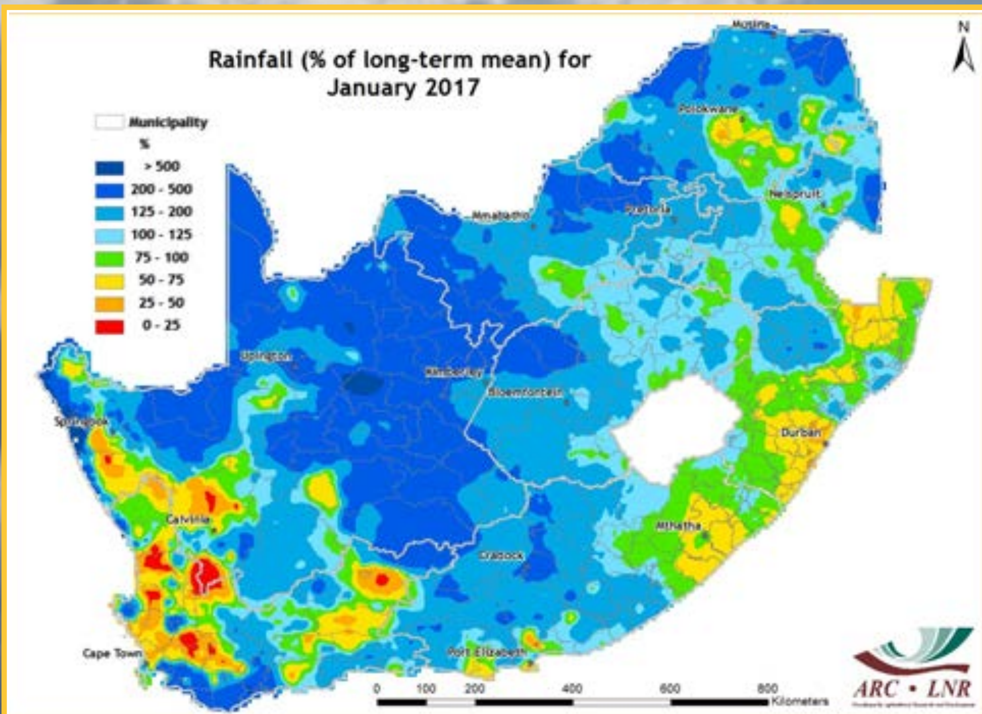


Figure 1



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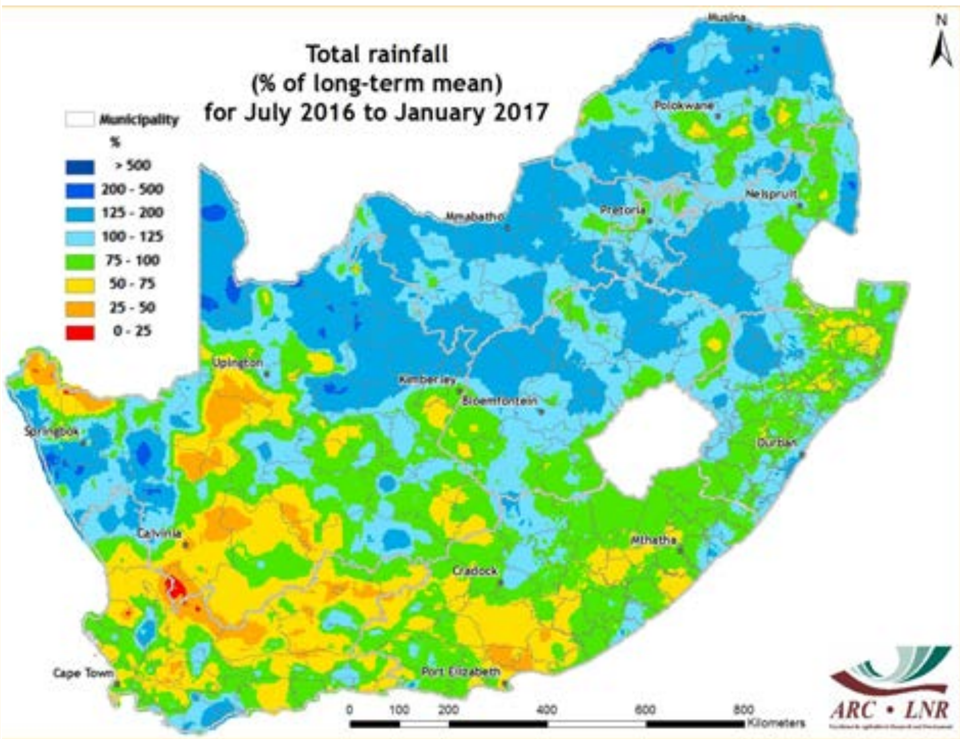

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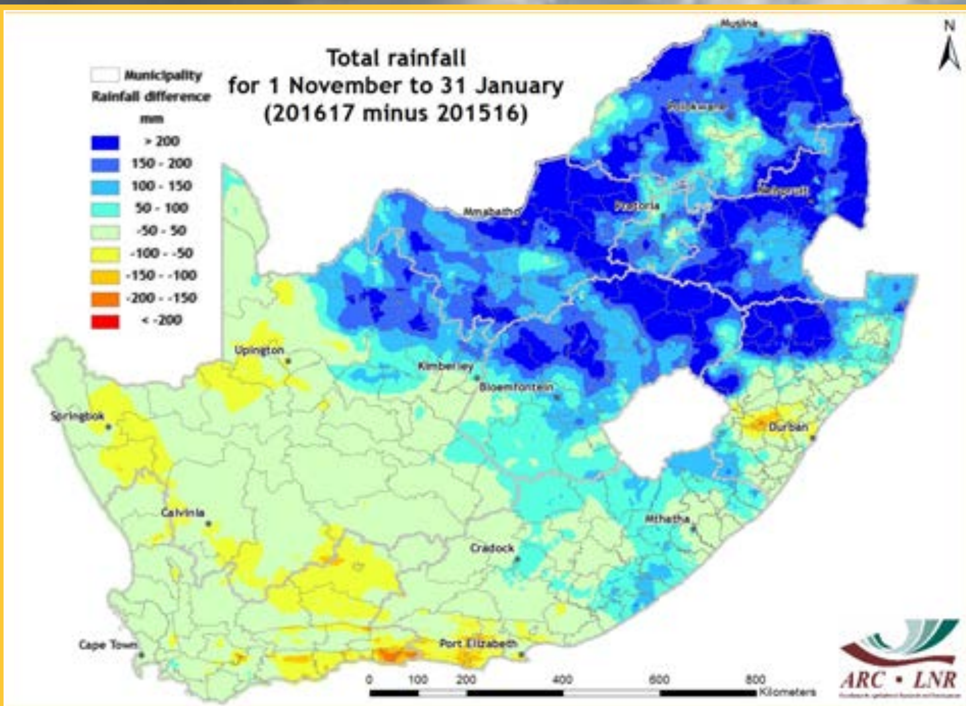

Figure 4

From the 21st, the tropical low towards the north moved somewhat closer again and moisture levels increased over much of the interior. Frontal systems in the south and west, a cut-off low in the south and the tropical low over Botswana drove rainfall and temperature anomalies across the country during the last few days. The cut-off low moving along the southern parts together with a strong on-shore flow from the south supported a widespread rain event over the southern extremes, which were relatively dry prior to this event. Widespread rain occurred especially along the Garden Route but also some light showers into the interiors of the Western and Eastern Cape provinces. Some significant falls occurred especially in the mountainous areas along the coast. During the same time, an influx of tropical moisture from the north and northeast together with upper-air instability resulted in scattered to widespread thundershowers starting at first over the central to western parts, but moving to the eastern and northeastern areas during the following days. While rainfall totals over the central to western parts of the interior remained mainly below 25 mm, the northern parts of North West, western Mpumalanga, Gauteng and large parts of Limpopo received between 50 and 150 mm of rain. Westerlies to southwesterlies over the southern to western interior, however, prevented wet conditions in the northeast and central interior to spread as far west and south as earlier in the month, while keeping the minimum temperatures somewhat lower too. By the end of the month, the tropical low was situated over northeastern Botswana, with cloud and residual showers over the northeastern parts of South Africa and dry conditions over the rest of the country.

Figure 1:
The central to northeastern interior received mostly in excess of 100 mm of rain during January. Rainfall totals exceeded 200 mm in the northeastern Northern Cape, northeastern North West, southwestern Limpopo and northwestern KwaZulu-Natal. Totals exceeded 300 mm along the escarpment of Limpopo and Mpumalanga.

Figure 2:
Much of the central, southeastern and northeastern summer rainfall region and the southern parts of the winter rainfall region received above-normal rainfall during January. The extreme western interior and much of the northern winter rainfall region received below-normal rainfall. Below-normal rainfall occurred over much of central Mpumalanga, KwaZulu-Natal and northeastern Cape.

Figure 3:
Since July, rainfall over the northern parts of the country was mostly normal to above normal. Below-normal rainfall occurred over the western interior. Much of the winter rainfall region, especially along the West Coast, also received above-normal rainfall.

Figure 4:
Much of the northern summer rainfall region received significantly more rain during the November -January period. The western interior was drier than during 2015/16.

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 exist over the lower-lying eastern to southeastern parts, including the eastern seaboard, while the north-eastern to central interior experienced relatively wet conditions.

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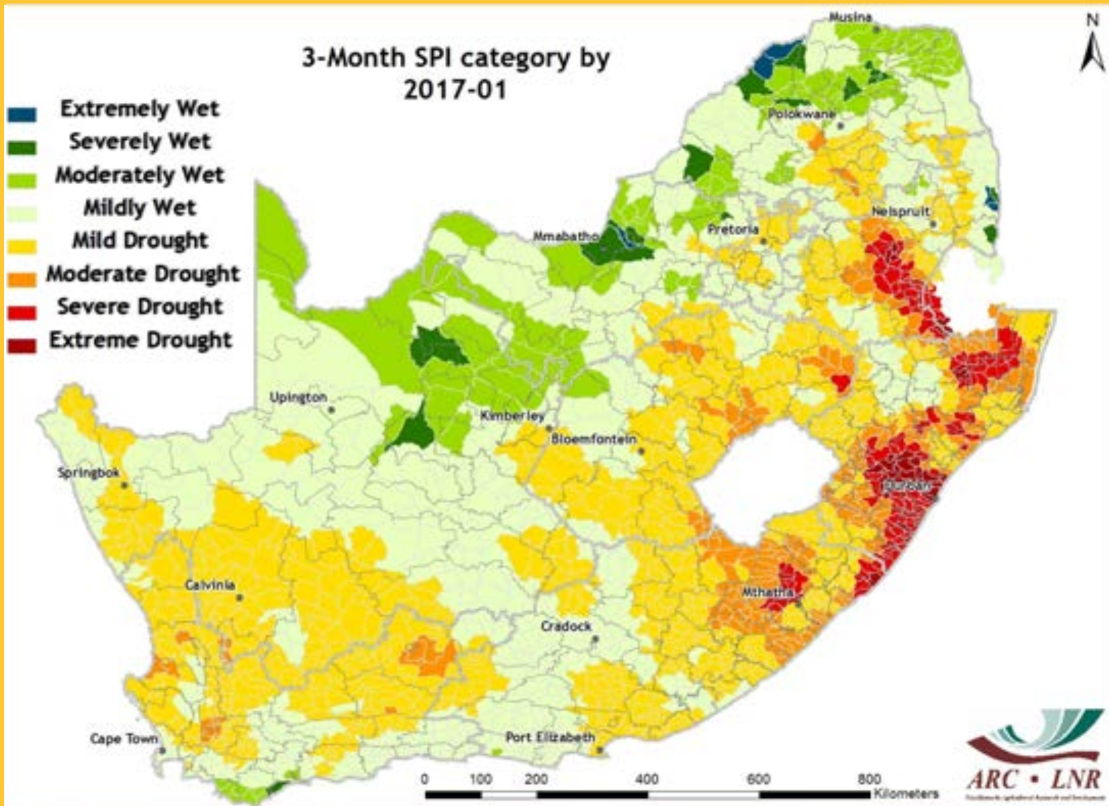

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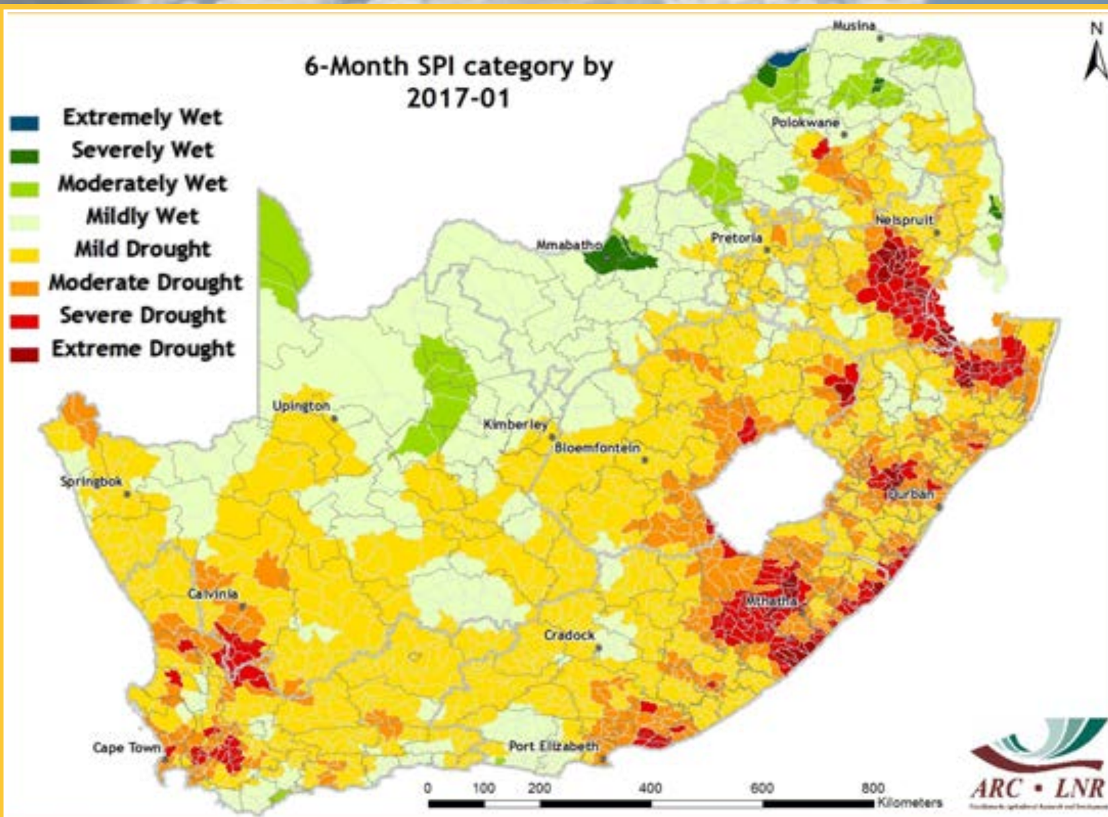

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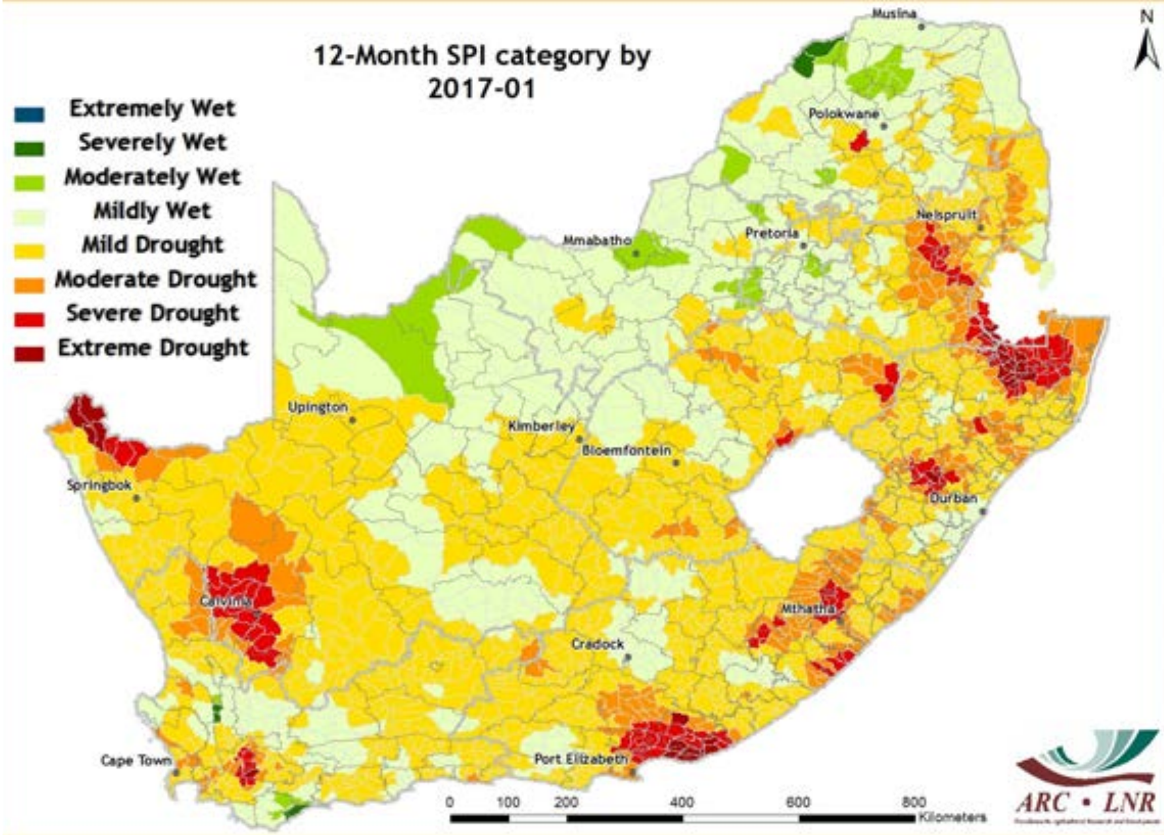

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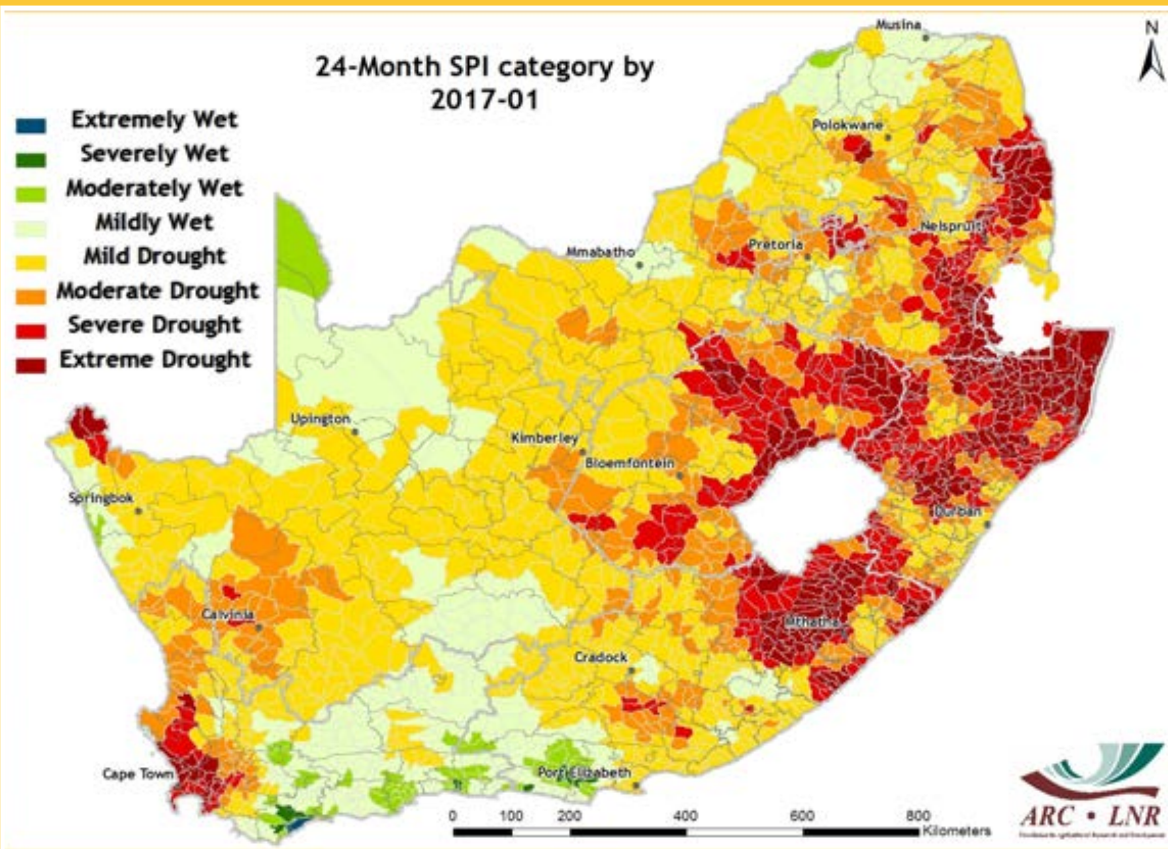

Figure 8

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.

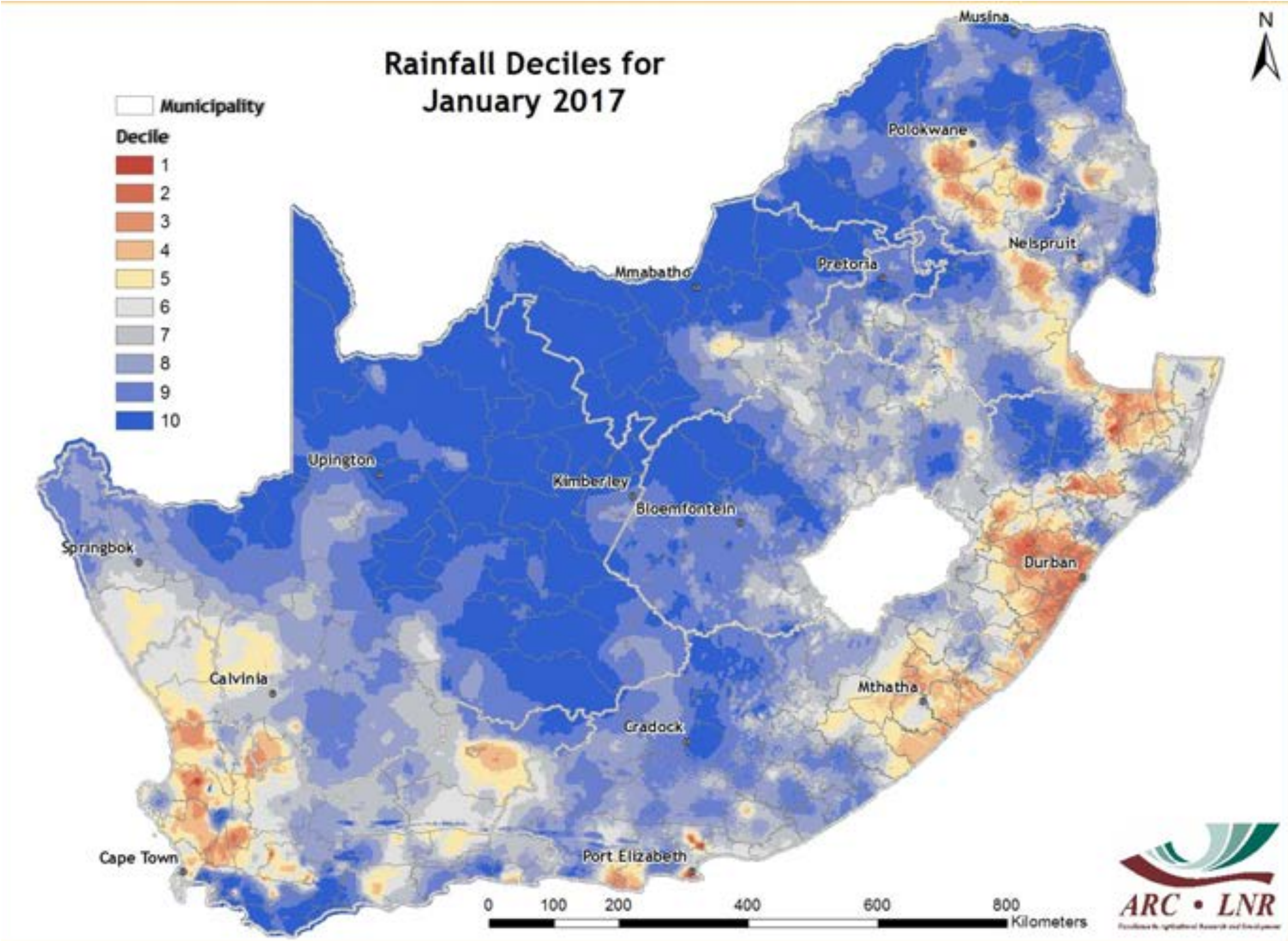

Figure 9

Figure 9:
Much of the northern interior was exceptionally wet in January. Large areas in the extreme east and southeast were exceptionally dry.

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4. Water Balance

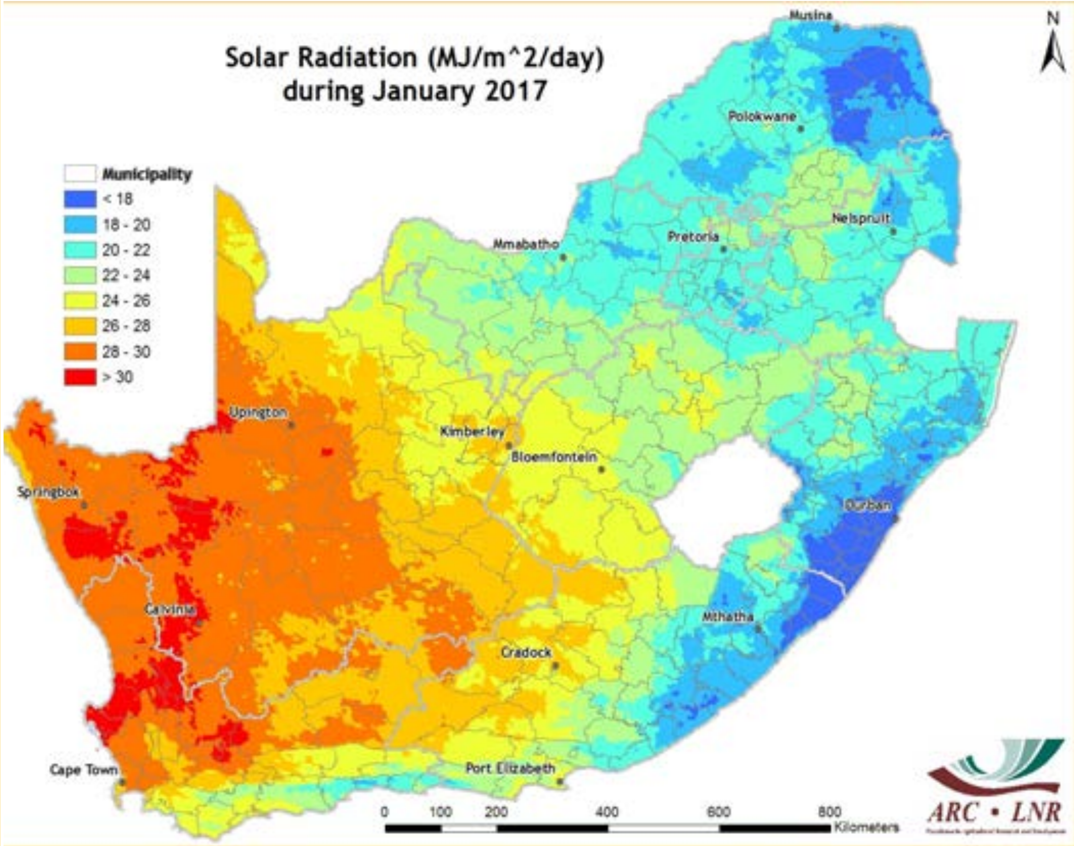

Figure 10

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:
Solar radiation during the month reflected the patterns of cloud cover, with lowest values on the seaward side of and along the escarpment, and highest values over the western interior.

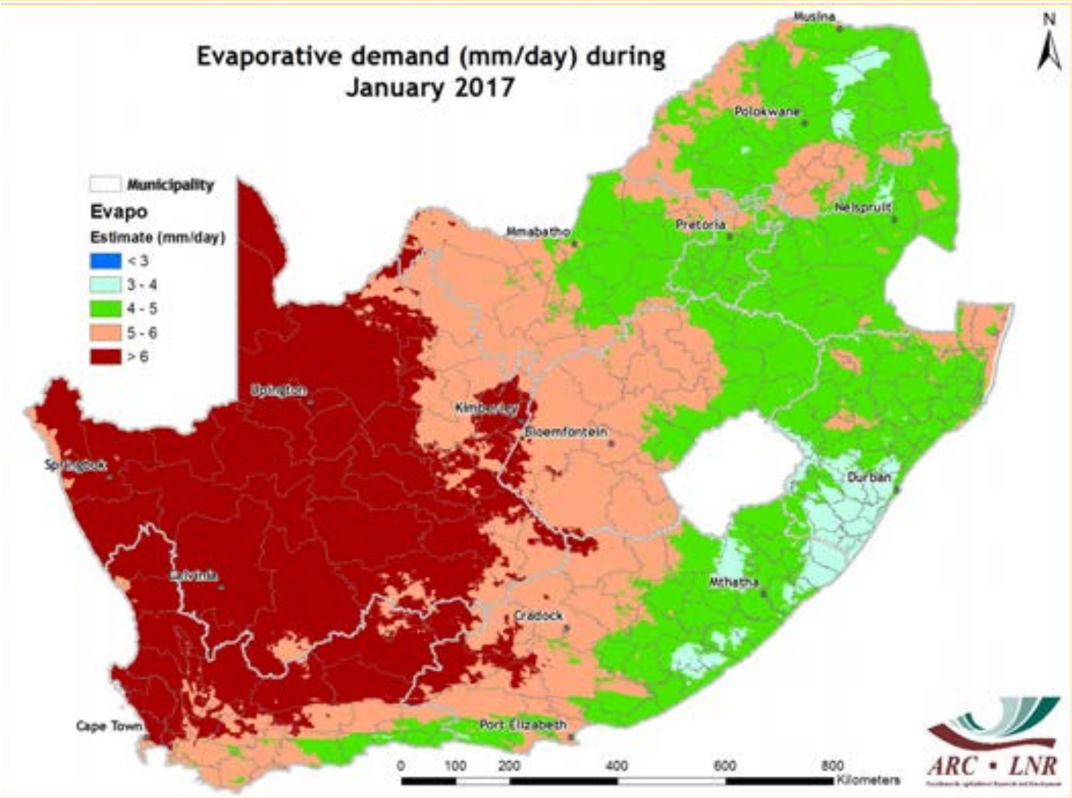

Figure 11

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 low temperatures resulted in relatively low potential evaporation over the far 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.

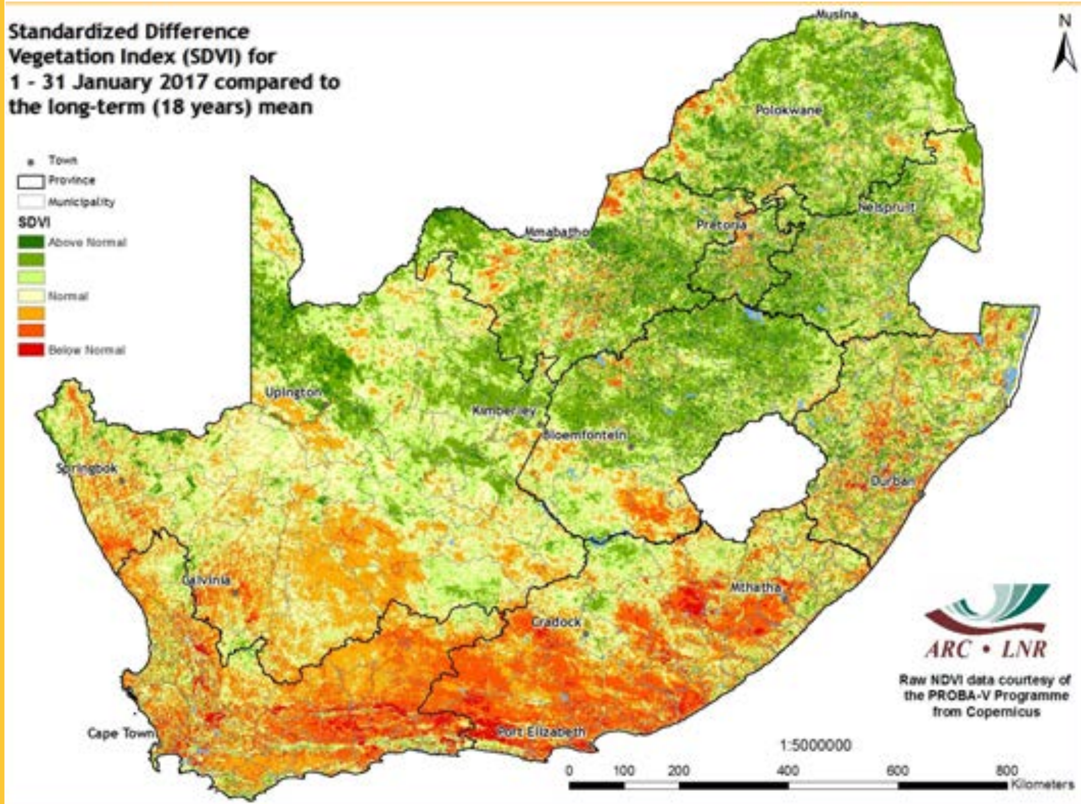

Figure 12

Figure 12:
The VCI indicates drought stress over the southern parts of the country, including most of the Karoo. Vegetation activity over the northern parts reflects favourable climate conditions.

Figure 13:
The year-on-year NDVI difference in January shows the complete change in rainfall situation between the two years, with the southern parts becoming drier while the central to northern parts experienced much wetter conditions.

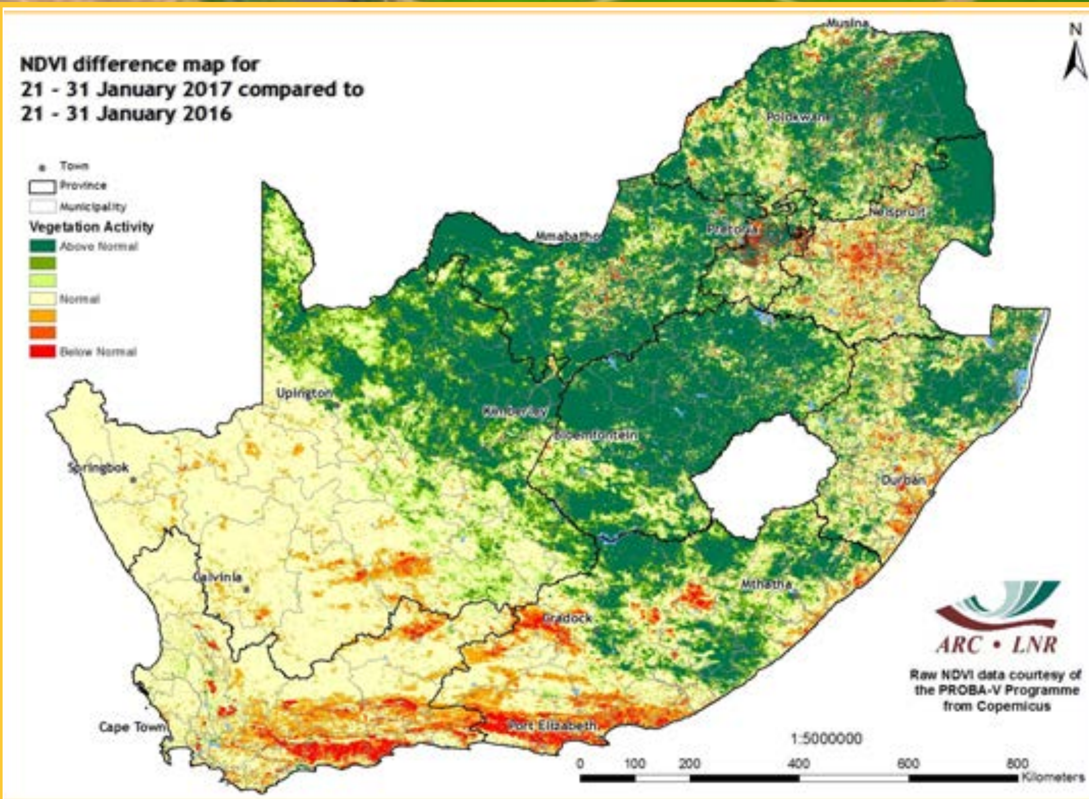

Figure 13

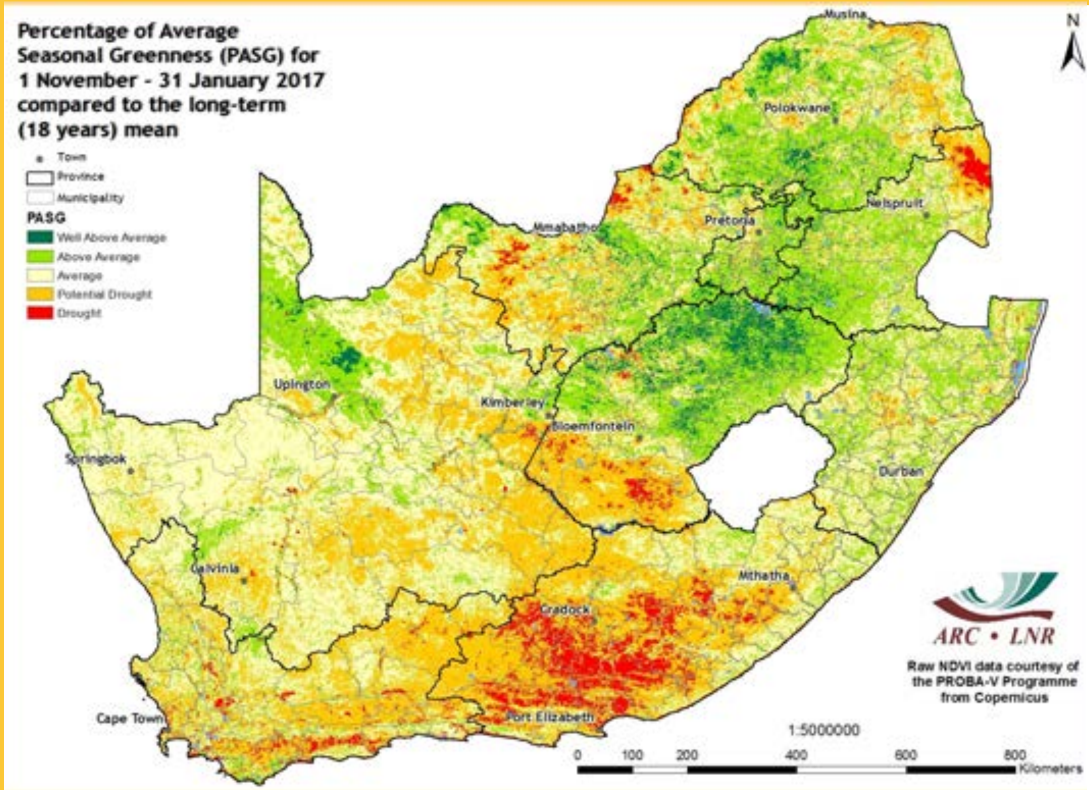

Figure 14

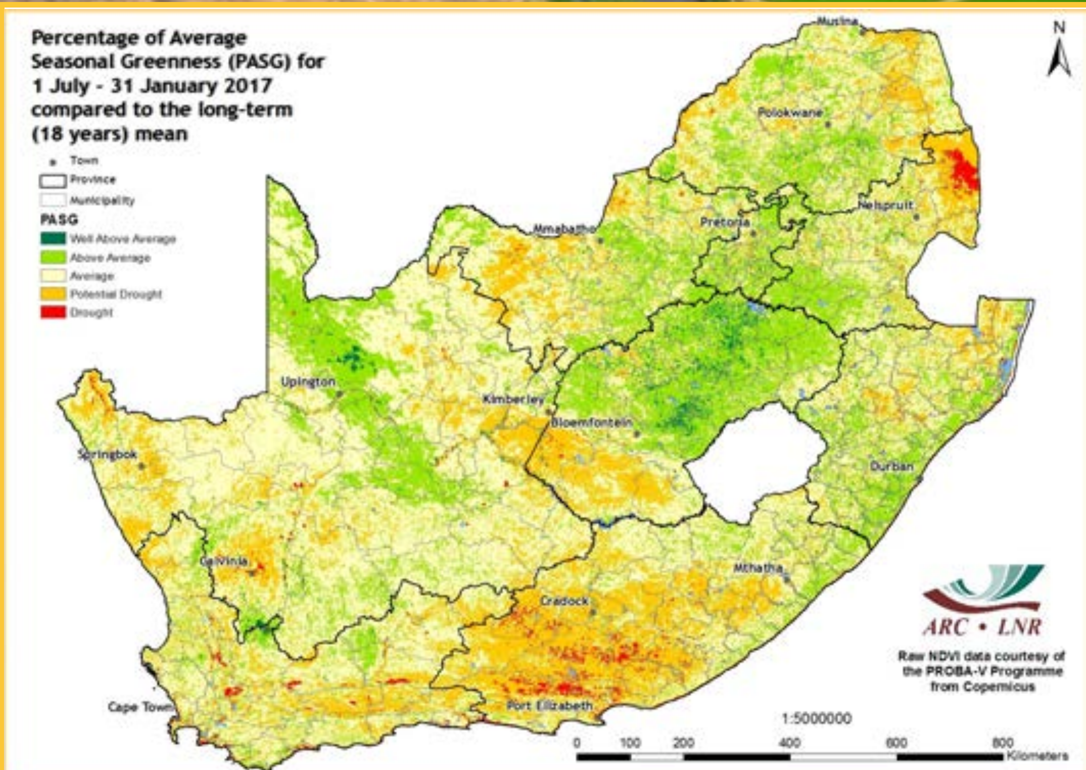

Figure 15

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:
While the cumulative vegetation activity indicates dry conditions over much of the southern interior and coastal areas, most of the rest of the country experienced above-normal vegetation activity during mid-summer.

Figure 15:
At a longer time scale, since July 2016, cumulative vegetation activity shows the negative effect of drought over the central to western Eastern Cape as well as the Lowveld of Mpumalanga.

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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.

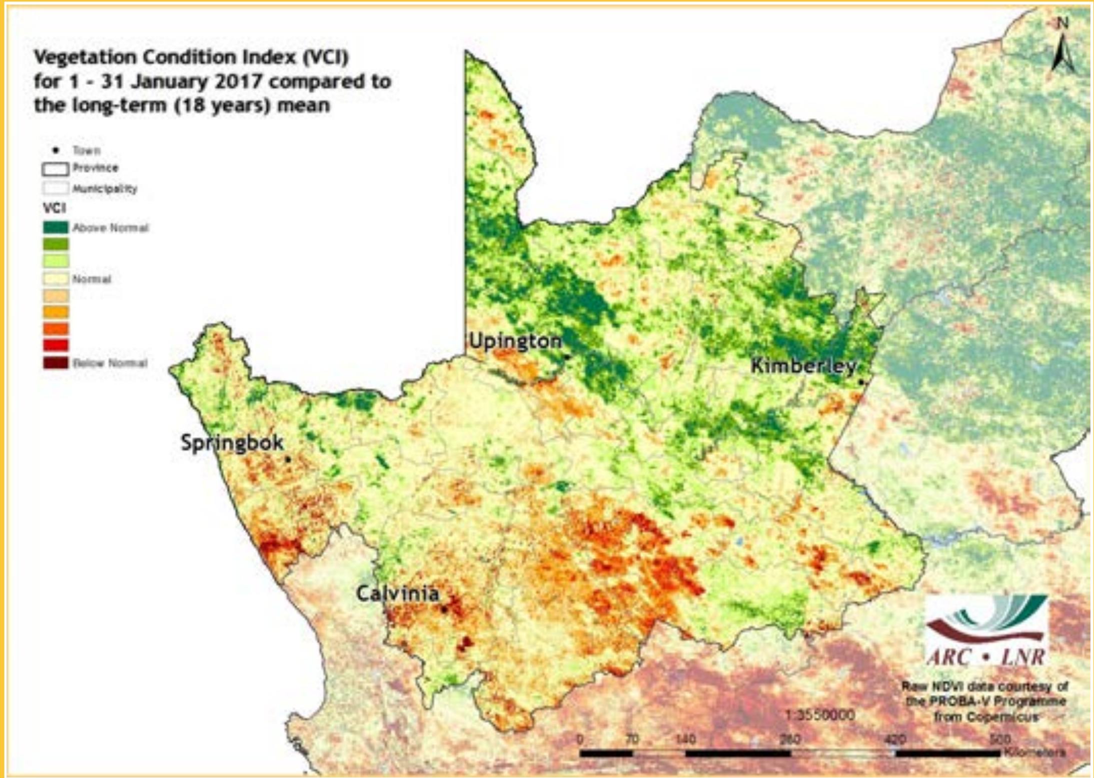


Figure 16

Figure 16:
The VCI map for January indicates below-normal vegetation activity over the southern and western parts of the Northern Cape.

Figure 17:
The VCI map for January indicates below-normal vegetation activity over most parts of the Western Cape.

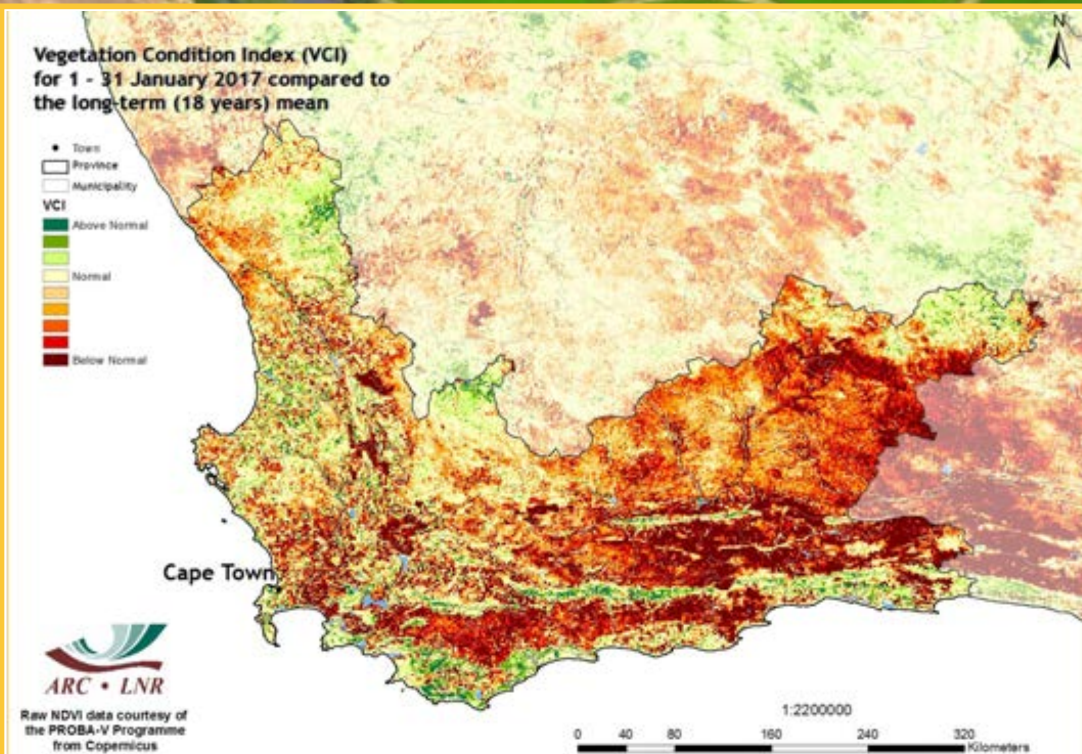
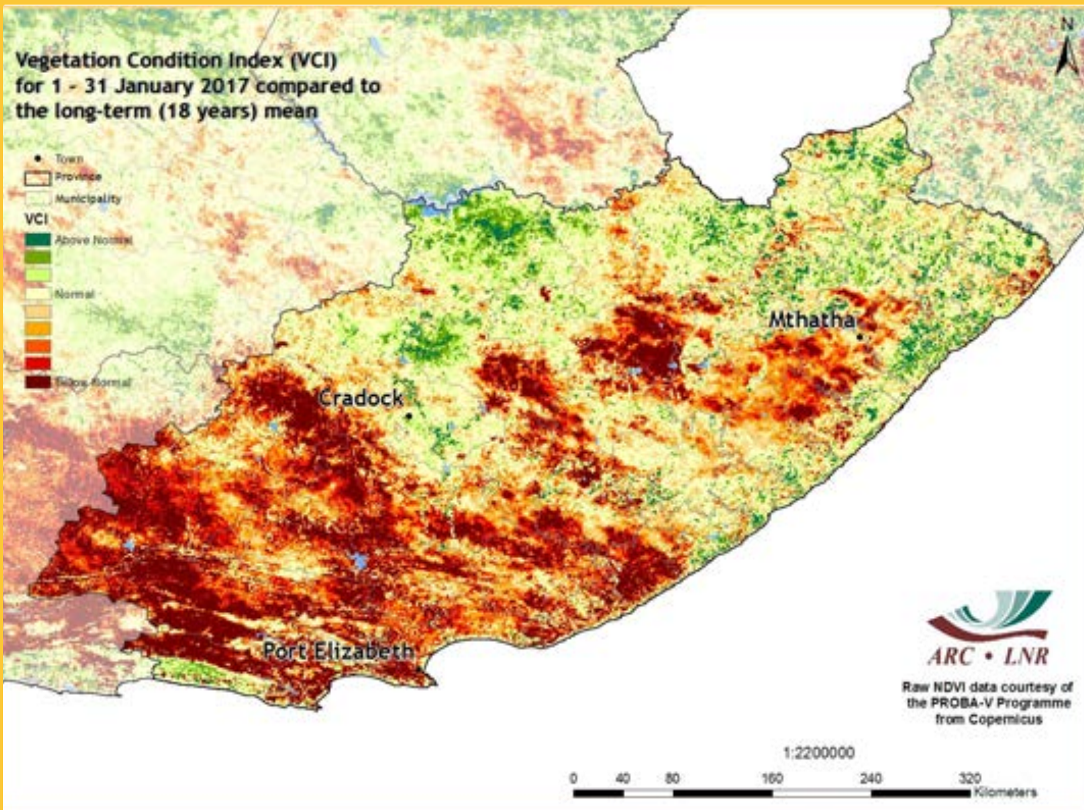


Figure 17



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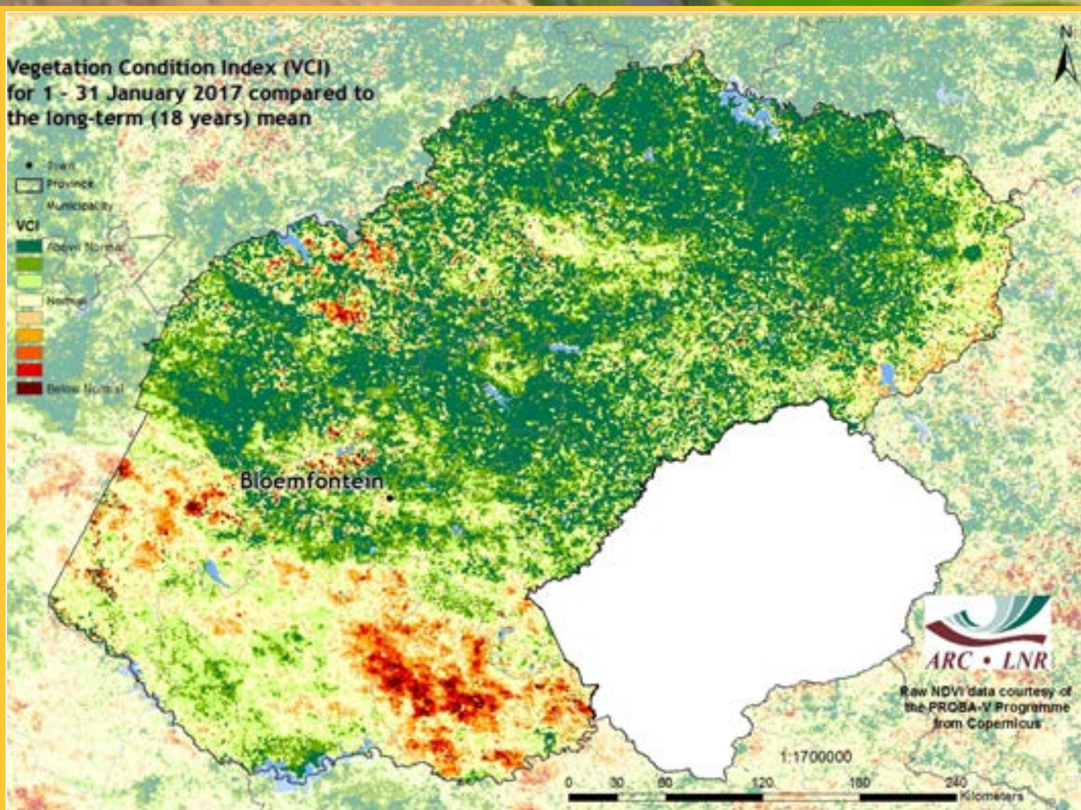

Figure 19

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

Figure 19:
The VCI map for January indicates below-normal vegetation activity over the southeastern parts of the Free State.

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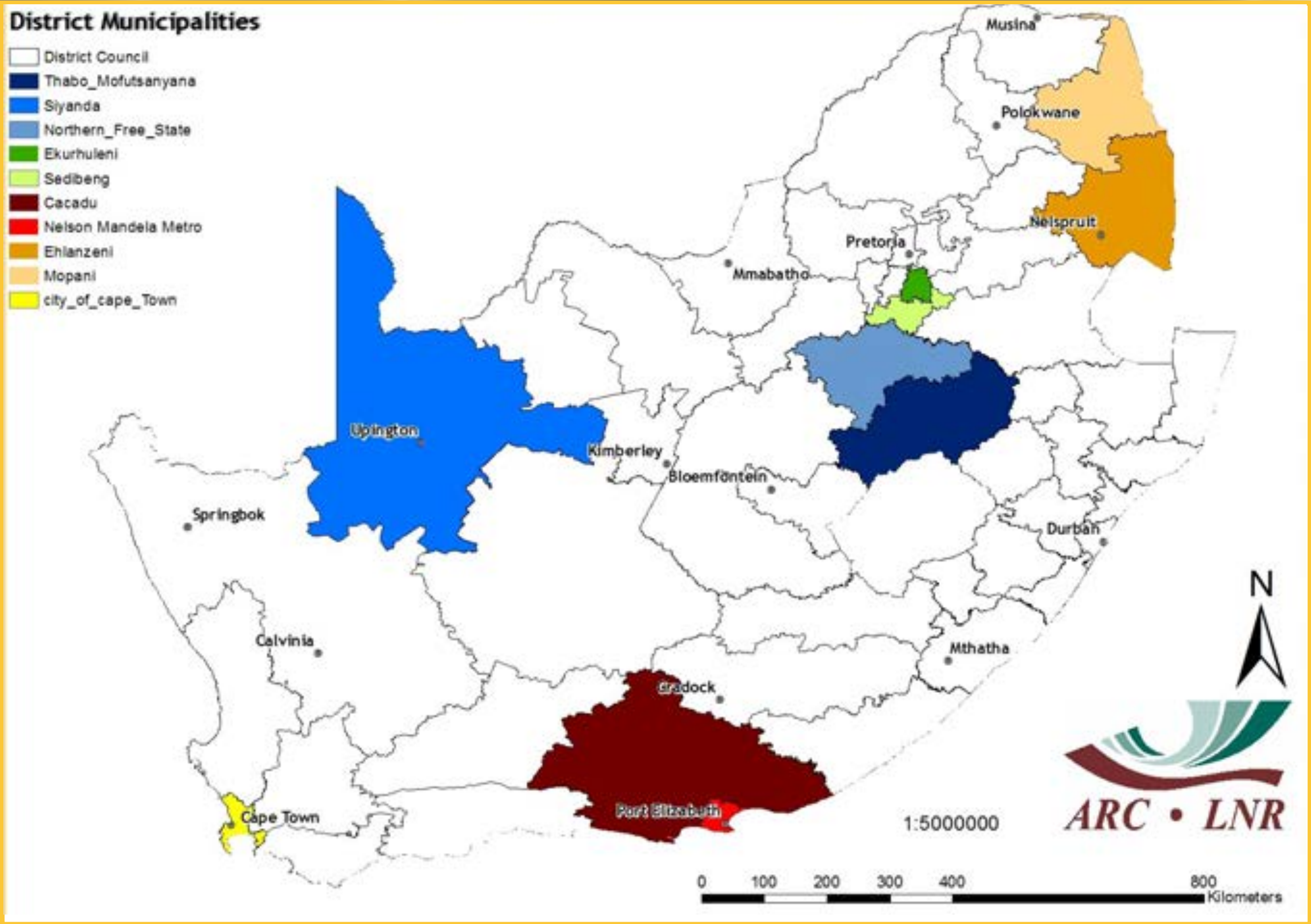
7. Vegetation Conditions & Rainfall



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

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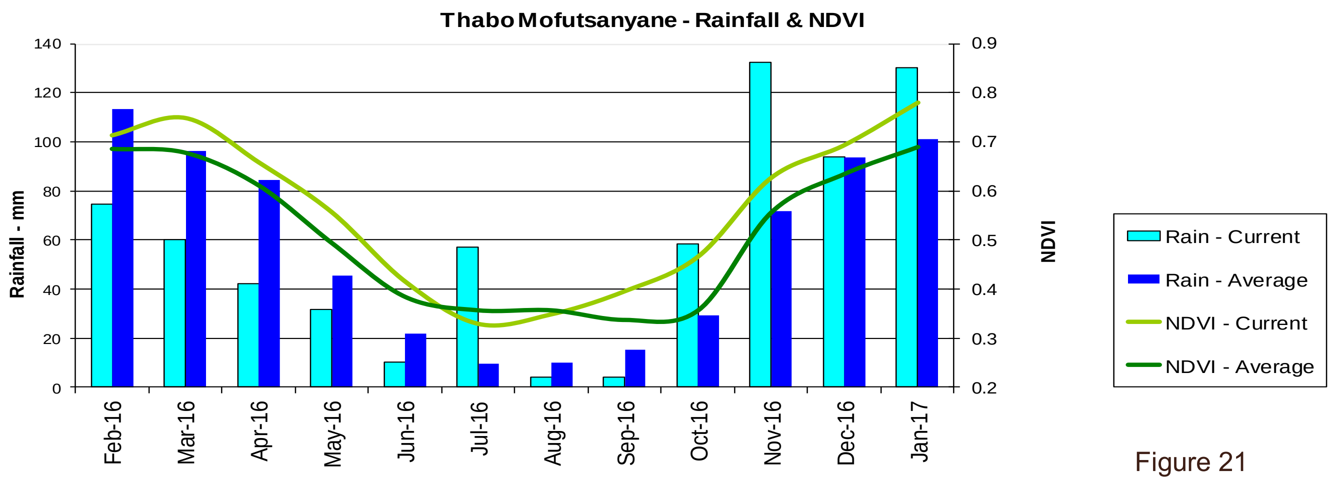
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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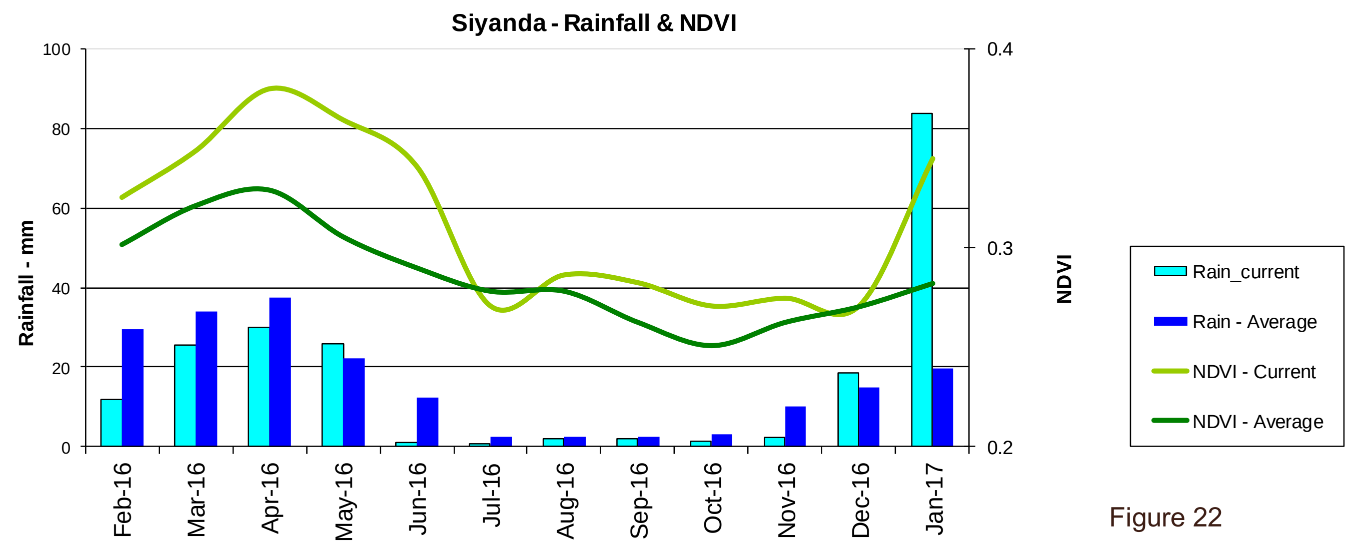

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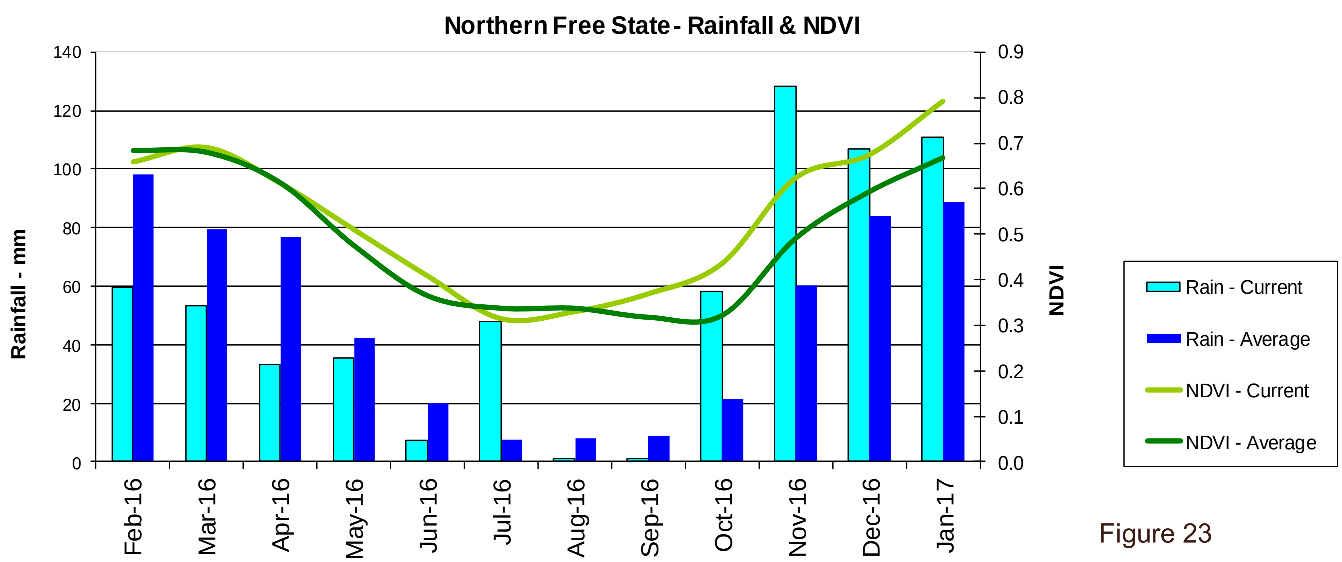

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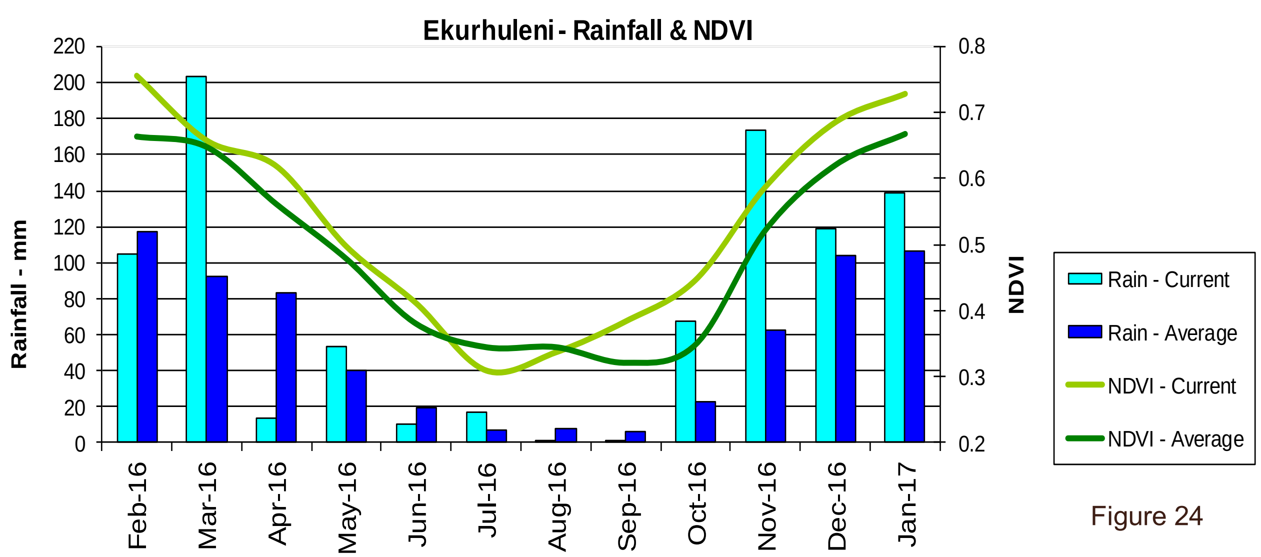

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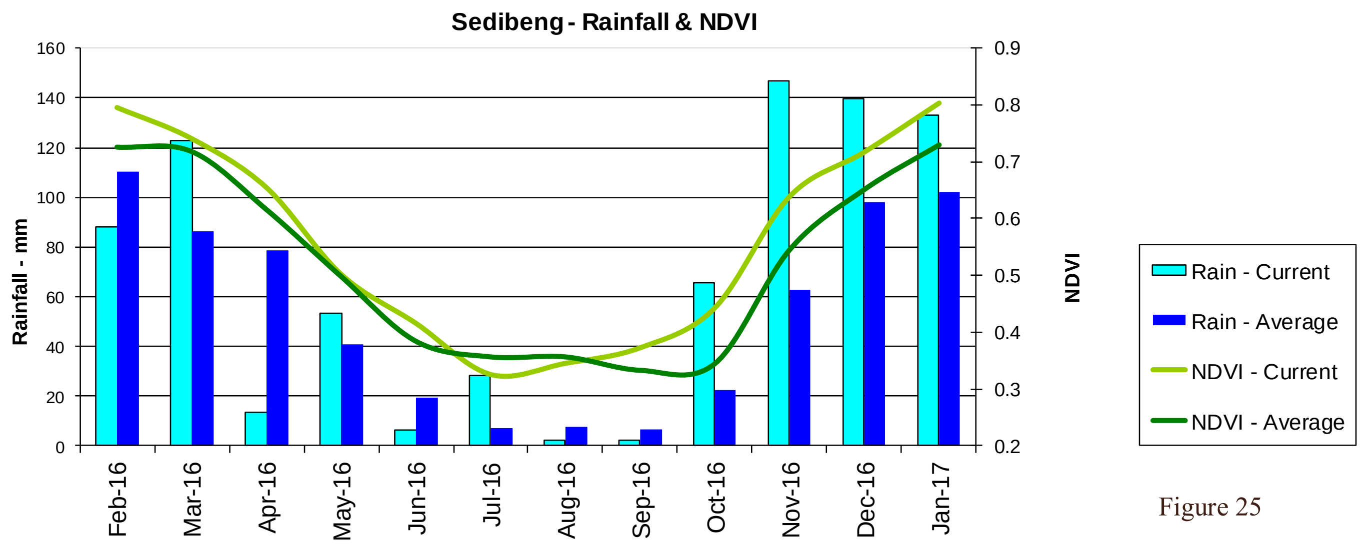

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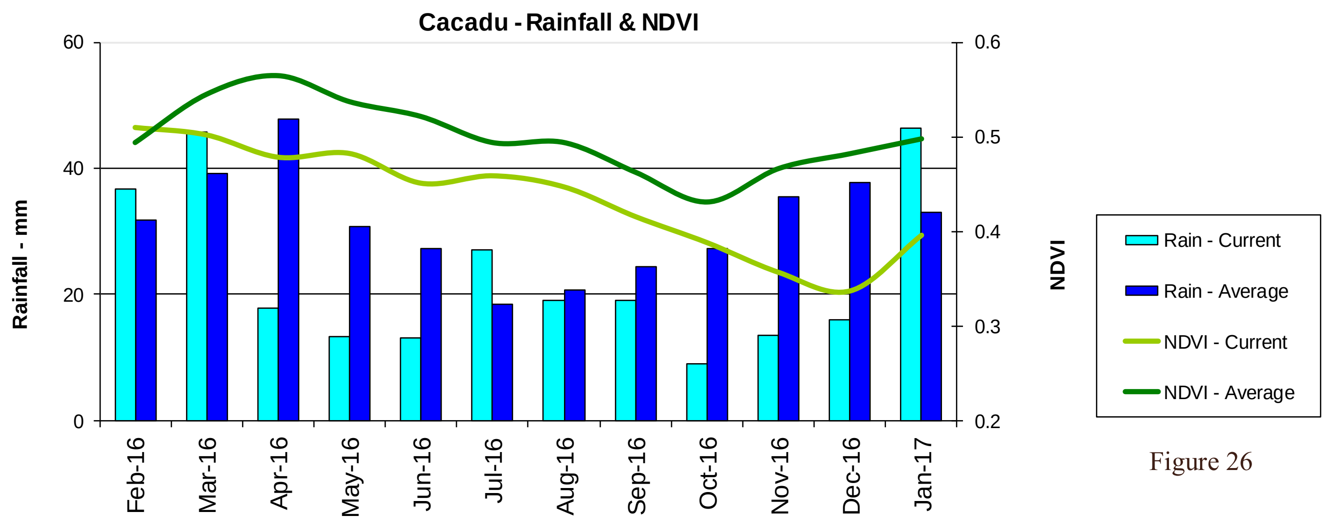

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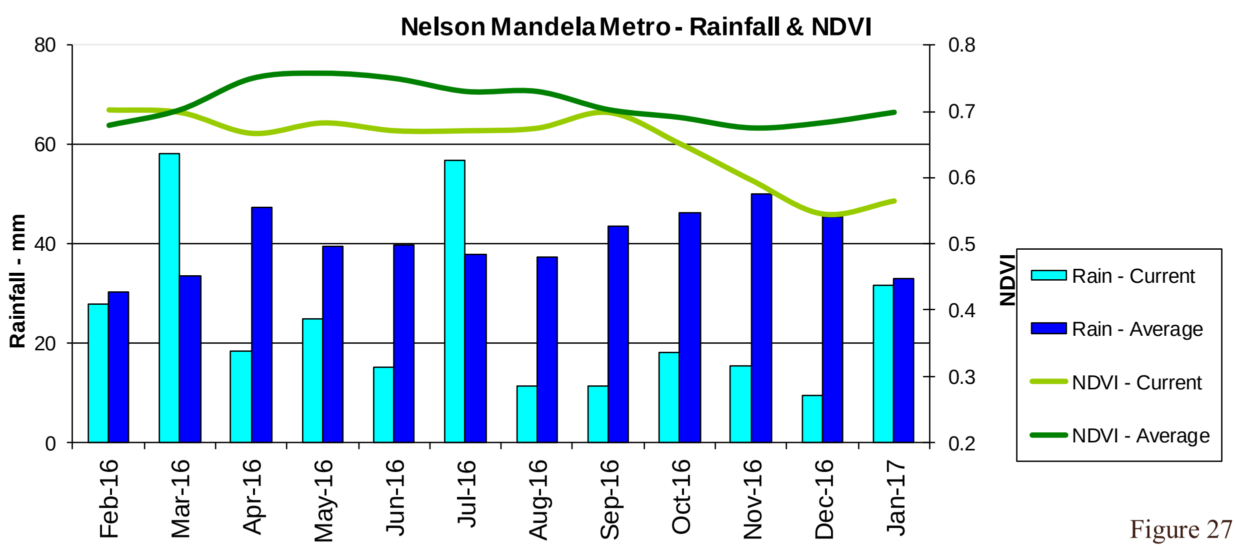

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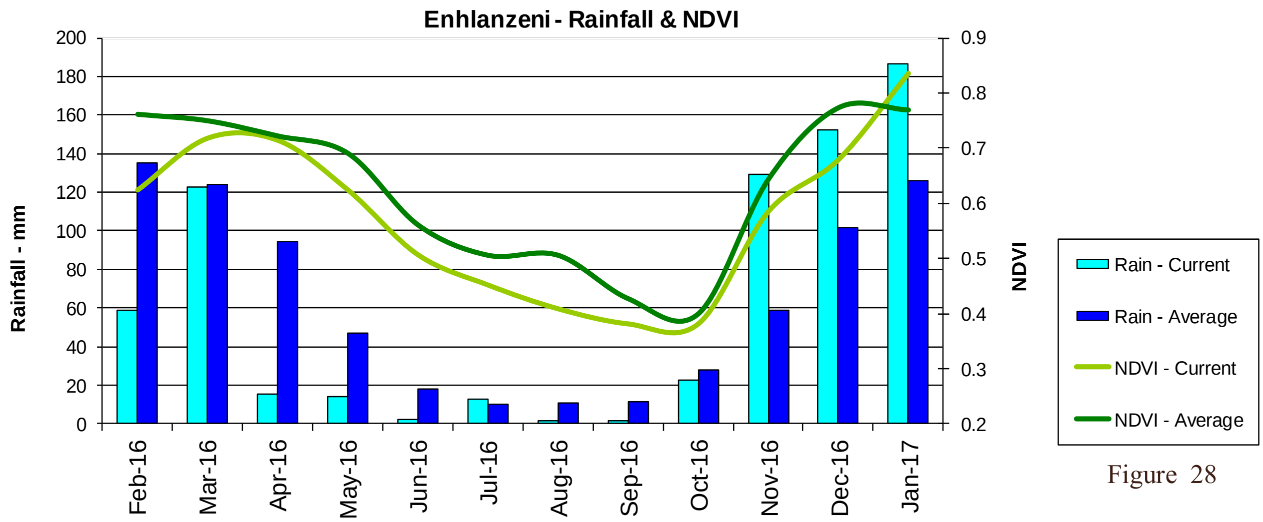

Figure 28

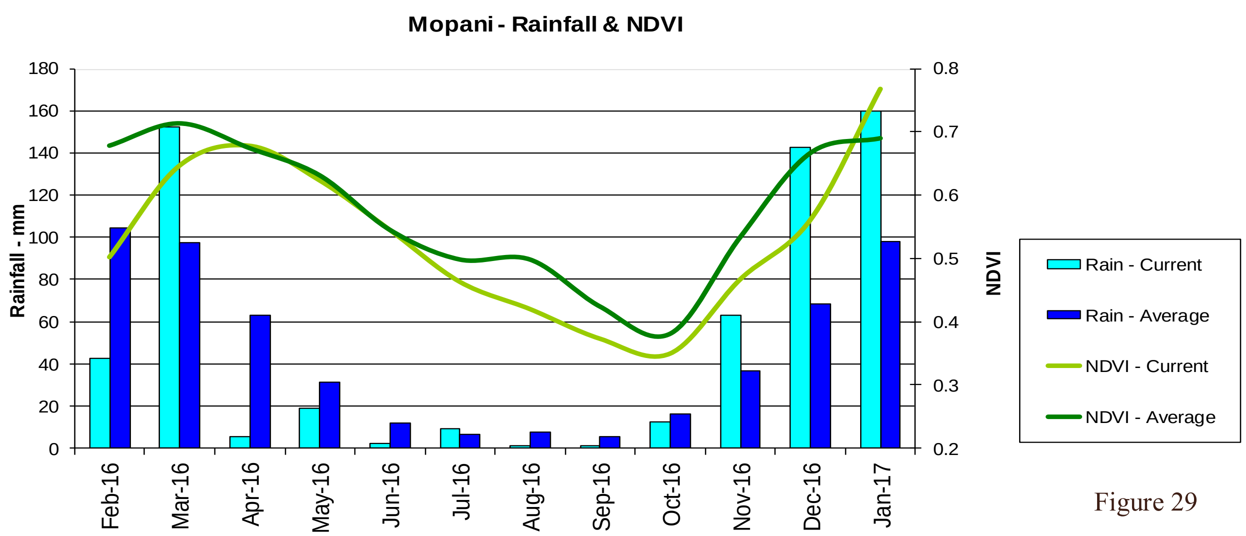

Figure 29

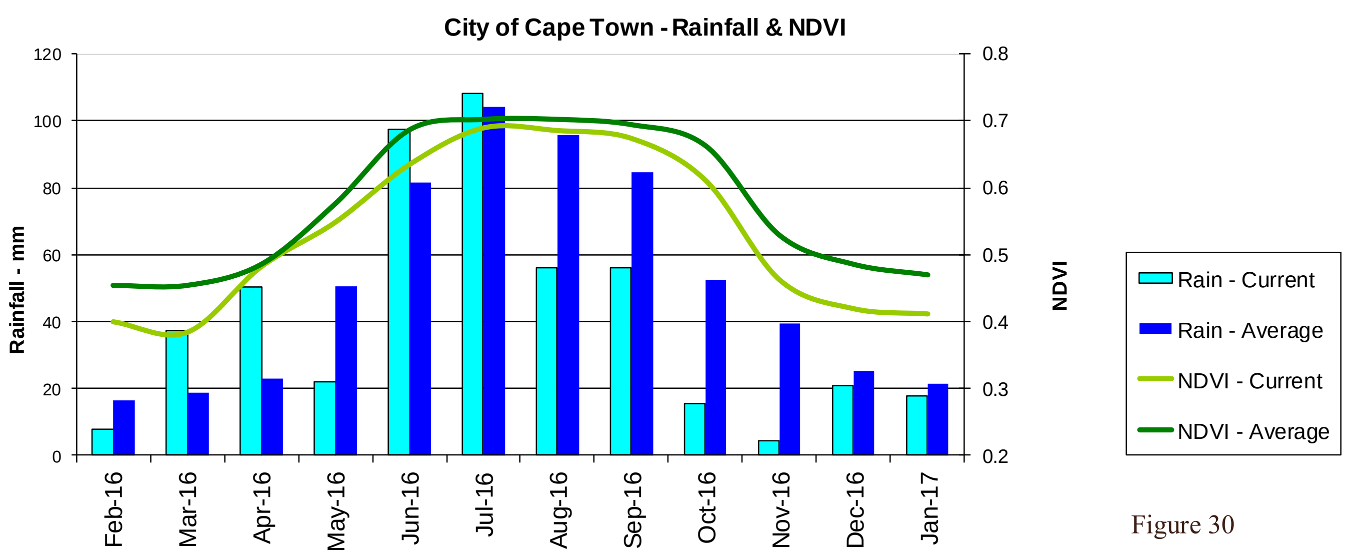

Figure 30

8. Fire Watch

Active Fires *(Provided when data is available)*

Forest and vegetation fires have temperatures in the range of 500 K (Kelvin) to 1000 K. According to Wien's Displacement Law, the peak emission of radiance for blackbody surfaces of such temperatures is at around 4 µm. For an ambient temperature of 290 K, the peak of radiance emission is located at approximately 11 µm. Active fire detection algorithms from remote sensing use this behaviour to detect "hot spot" fires.

Figure 31:
The graph shows the total number of active fires detected during the month of January per province. Fire activity was higher in the Eastern Cape, Mpumalanga, Northern Cape, Limpopo, North West, the Western Cape and KwaZulu-Natal compared to the average during the same period for the last 17 years

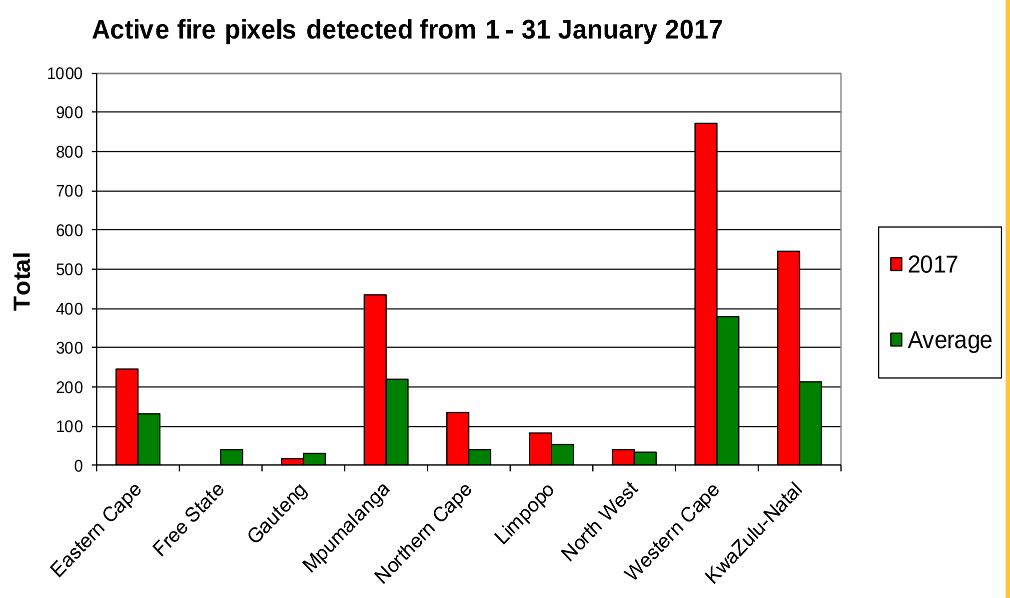

Figure 31

Figure 32:
The map shows the location of active fires detected between 1- 31 January 2017.

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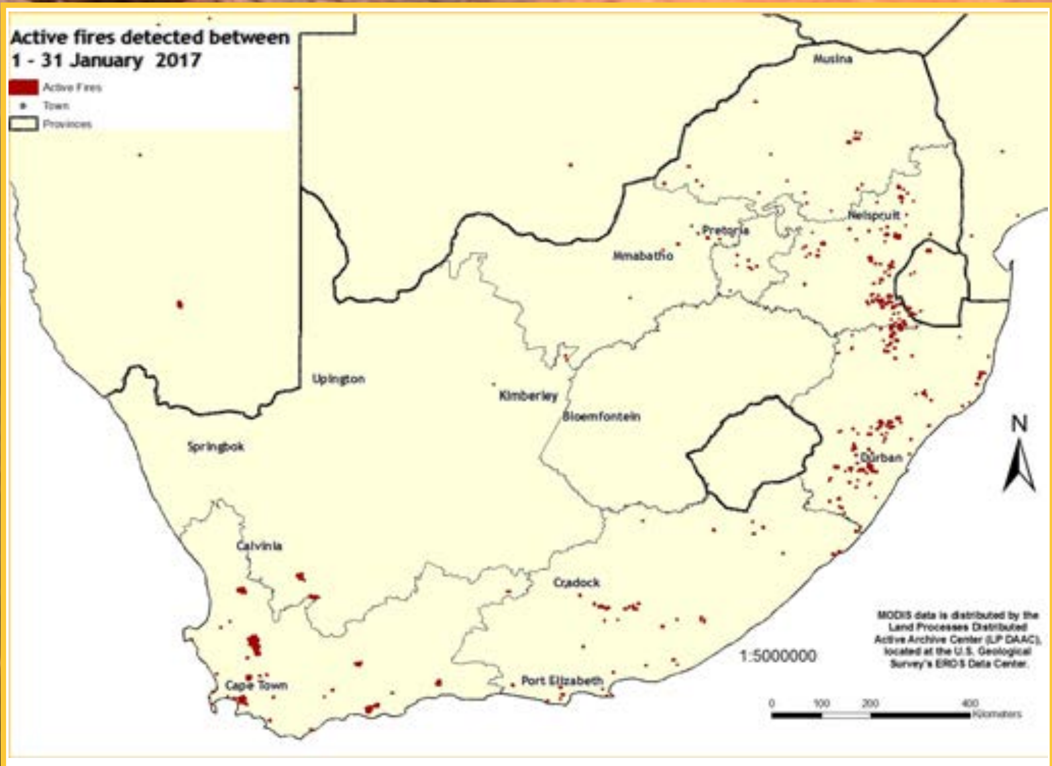

Figure 32

Agrometeorology

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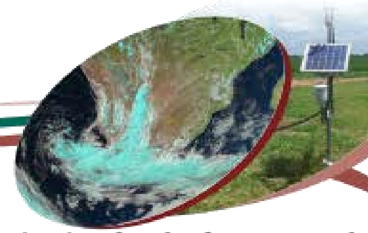

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national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

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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

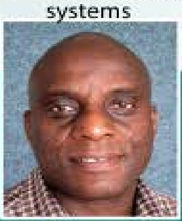
- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

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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Excellence in Agricultural Research and Development

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