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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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

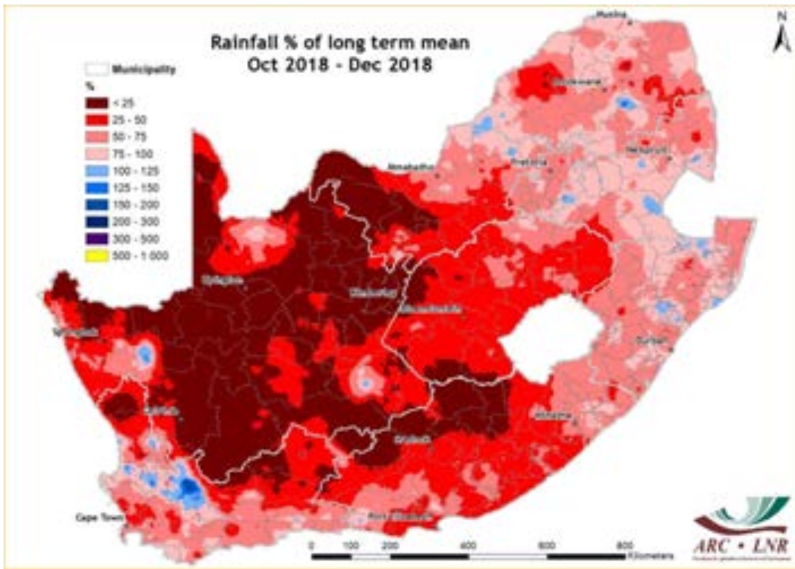
South African Weather Service

AMESD

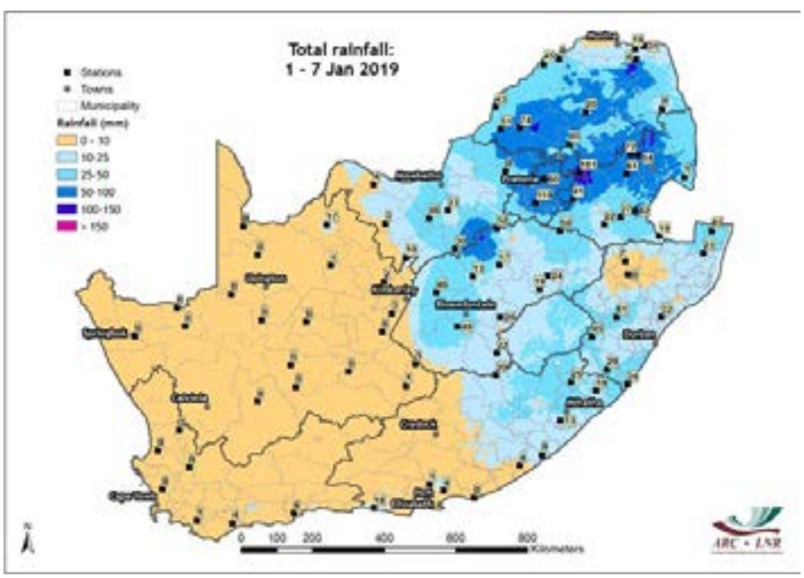
175th Edition

Images of the Month

Good rainfall after a dry start to the summer



The first three months of the summer half-year (considered as October to March the following year) have been dry over the largest part of the country, in particular over the western interior (see top map). The lack of rain in combination with high temperatures resulted in a delayed onset of the planting season. The western parts of the maize producing region suffered more than the eastern parts, where the rainfall was near normal as good rains fell during the last few days of December and continued into January. This rain brought an end to the extensive heatwave that peaked around the 25th of December 2018.



Rain occurred over a widespread area in the eastern half of the country during the first week of January 2019 (see bottom map), including the western part of the maize producing region where some stations recorded 30-40 mm. Higher rainfall totals were recorded further northeast, with large parts of Mpumalanga and Limpopo receiving more than 50 mm and as much as 180 mm along the Gauteng-Limpopo-Mpumalanga border.

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:

Parts of the winter rainfall region as well as areas over the eastern to northeastern parts of the country received above-normal rainfall during December 2018, whilst the remainder of the country received mostly below-normal rainfall. Over the winter rainfall region, relatively frequent rainfall events resulted in totals reaching 50 mm in places, which is very good considering that it is currently that region's dry season. In association with the relatively frequent passage of frontal systems, maximum temperatures over the far southwestern parts of the country were 1-3 ˚C cooler than normal over those areas.

December was hot and dry over most of the country. The rain that resulted in near-normal to above-normal rainfall conditions over the eastern to northeastern parts occurred during the last few days of the month, with a good proportion falling on the 31st when up to 80 mm was recorded within a 24-hour period. Before that, rainfall development was generally weak and isolated over the larger part of the summer rainfall region. Maximum temperatures were higher than normal over most of the country, except in the far southwest. Over the maize producing regions the maximum temperatures were generally 3 ˚C above normal, and as much as 5 ˚C in some places. As in the preceding months of the summer season, heatwaves continued to occur, with an exceptional heatwave occurring around Christmas time, just before the arrival of welcome rains which continued into early January 2019.

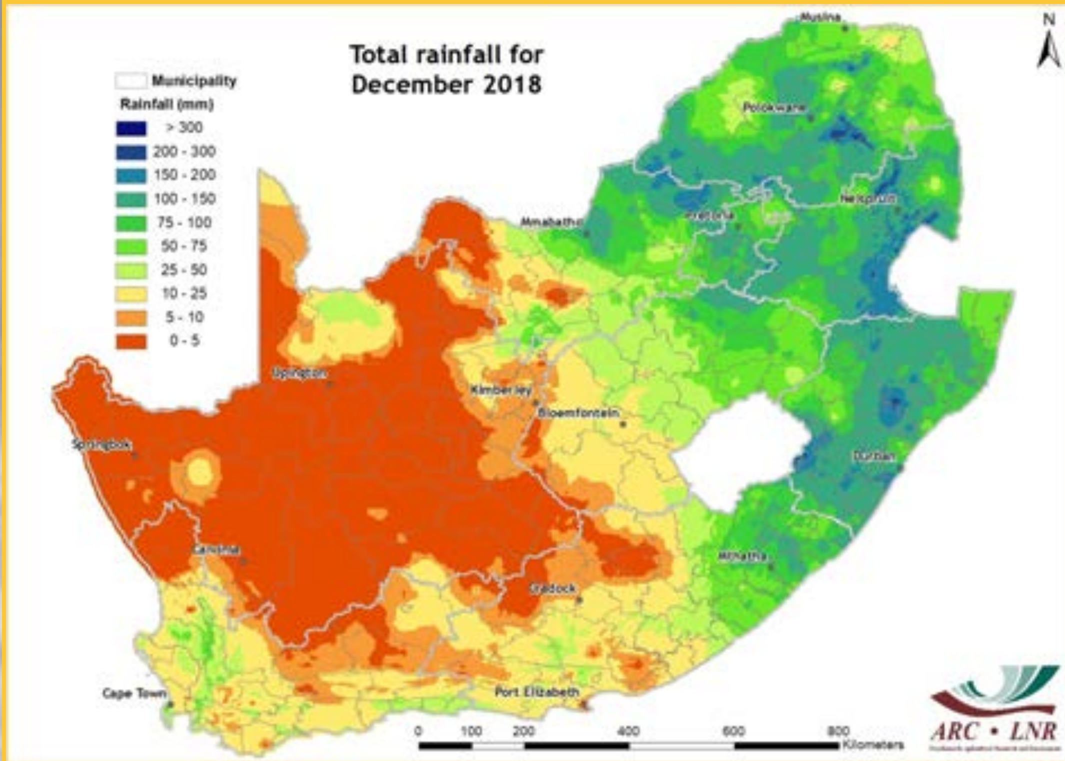


Figure 1

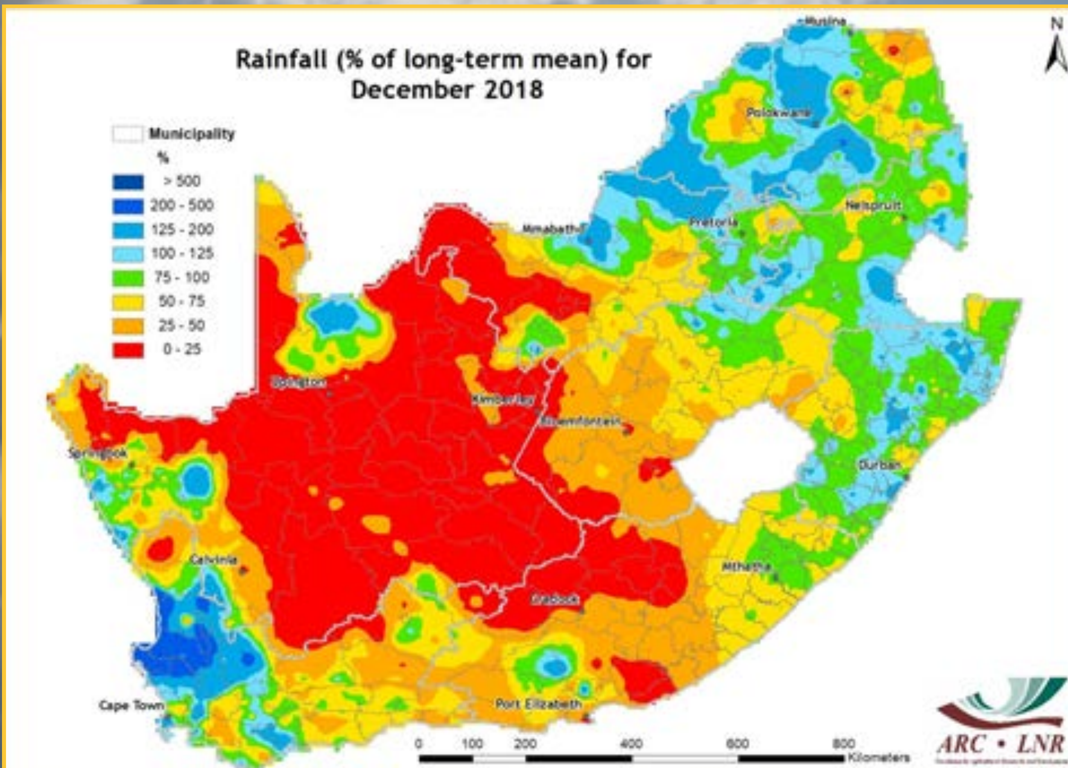


Figure 2

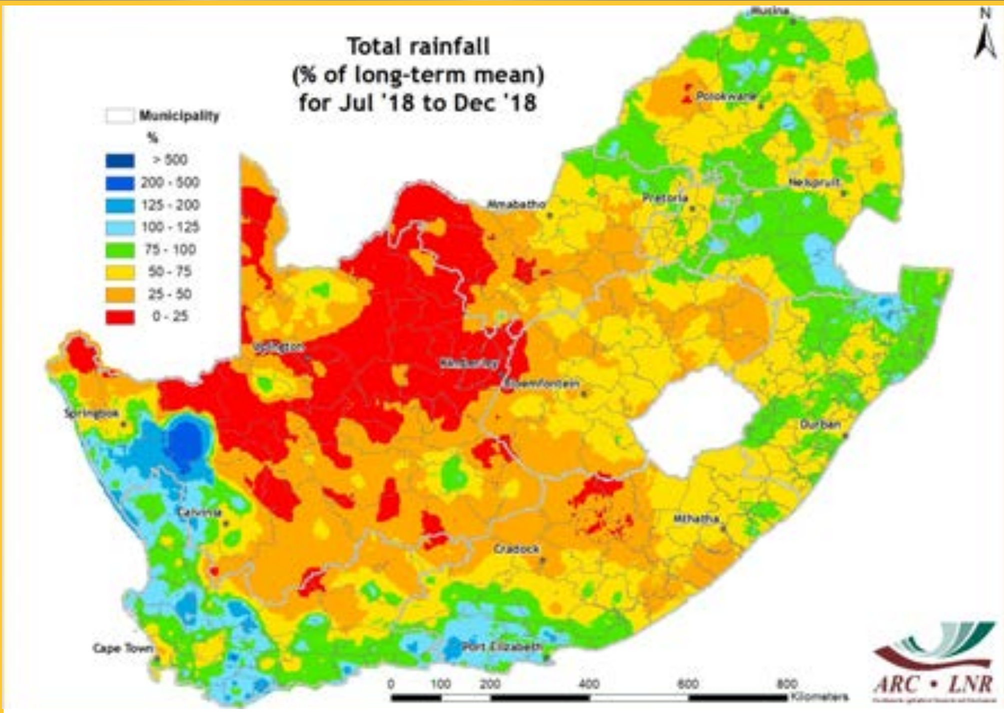


Figure 3

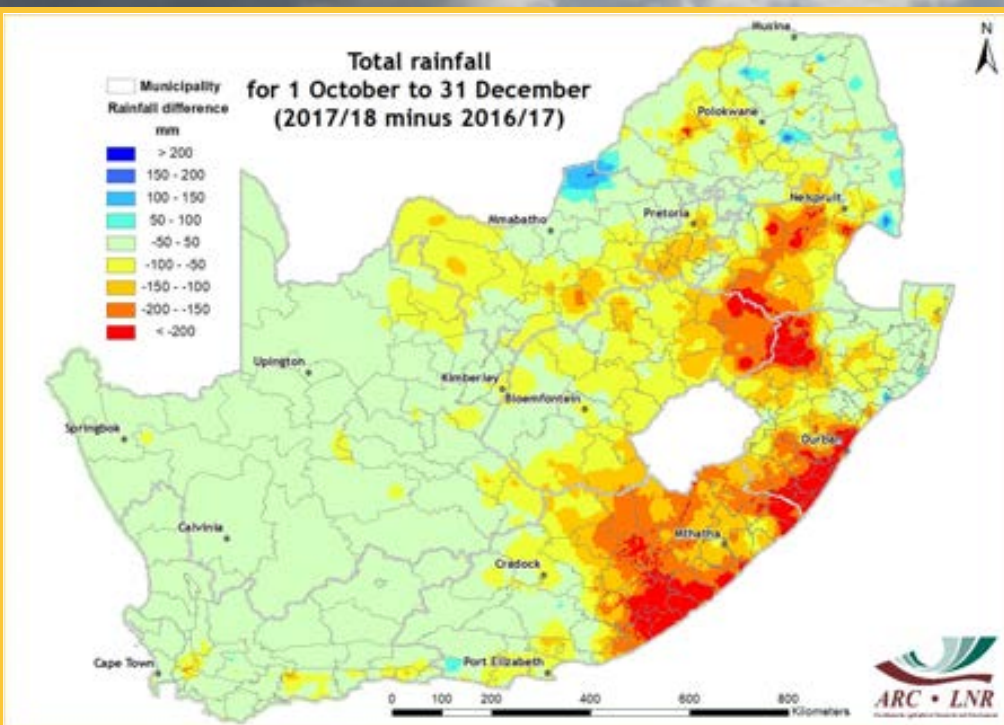


Figure 4

Figure 1:
Rainfall totals of up to 50 mm occurred over some areas in the far southwest of the country in December. This was the result of about five rainfall events during the month. Good rainfall totals occurred over areas in the east of the country where up to 200 mm was recorded. However, most of this rain fell during the last few days of the month.

Figure 2:
Above-normal rainfall occurred over the far southwest of the country as well as over areas in the east and northeast. The central to western interior received below-normal rainfall during the month of December.

Figure 3:
During the period from July to December above-normal rainfall occurred over the larger part of the winter rainfall region. Further to the east along the Cape south coast, near-normal rainfall occurred with above-normal rainfall in places. However, most months during this 6-month period were actually very dry in this region. Over the summer rainfall region, most areas received below-normal rainfall during this period. Some areas in the eastern parts received near-normal rainfall with isolated areas receiving above-normal rainfall.

Figure 4:
Compared to the corresponding period in 2017, the largest part of the summer rainfall region over the eastern parts of the country experienced a much drier October to December period this year. Over areas of Mpumalanga, KwaZulu-Natal and the Eastern Cape up to 200 mm less rain was received during 2018 compared to last year. Considering that this 3-month period comprises about half of the summer rainfall season for these areas, that is quite a change from the same period in 2017.

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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 severe drought over the southwestern parts of the country visible on the 24 and 36-month time scales shows signs of relief on the 6 and 12-month SPI maps. The good rains at the end of August into beginning of September 2018 that occurred along the Cape south coast brought relief to those areas as seen on the 6-month SPI map. However, the past 2 months has been dry again over those areas. Over the northeastern interior of the country, some areas that have been consistently under the influence of severe drought conditions received good rains during January 2019. On the 6-month SPI map it can be seen that the central parts of the country are suffering from drought or severe drought conditions. On this time scale, the SPI is representative of soil moisture conditions. The excessive heat over those areas during the summer season so far is contributing to these drought conditions.

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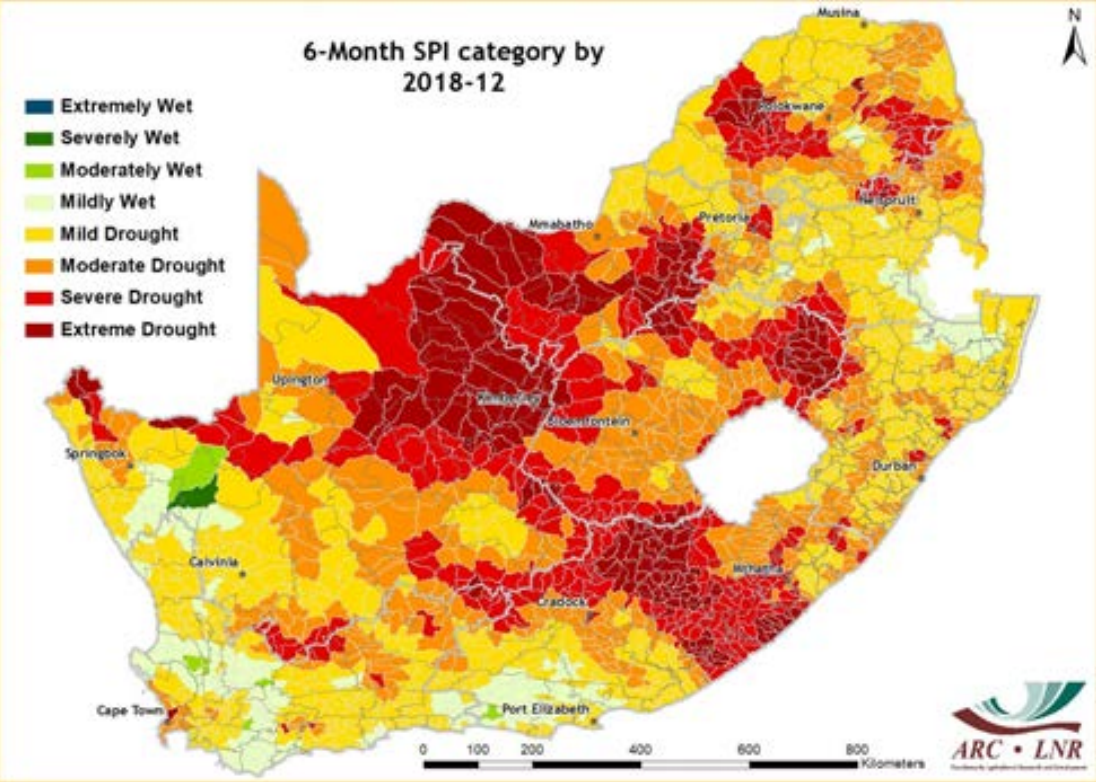

Figure 5

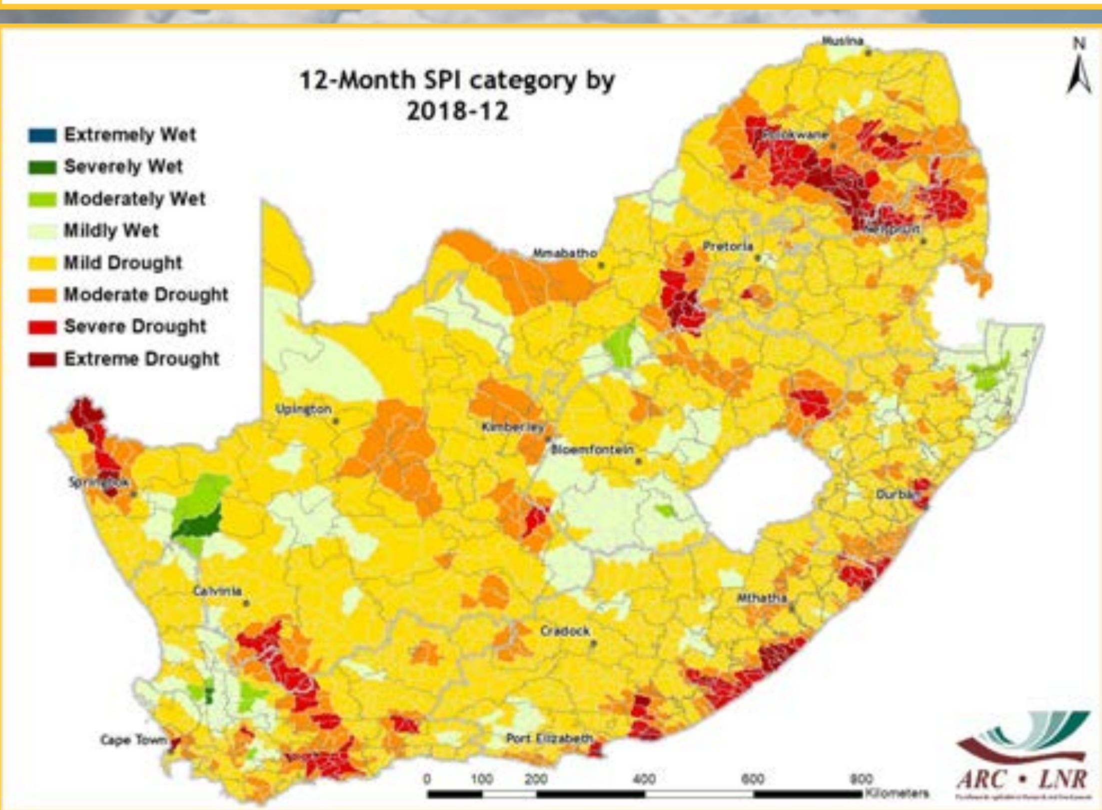

Figure 6

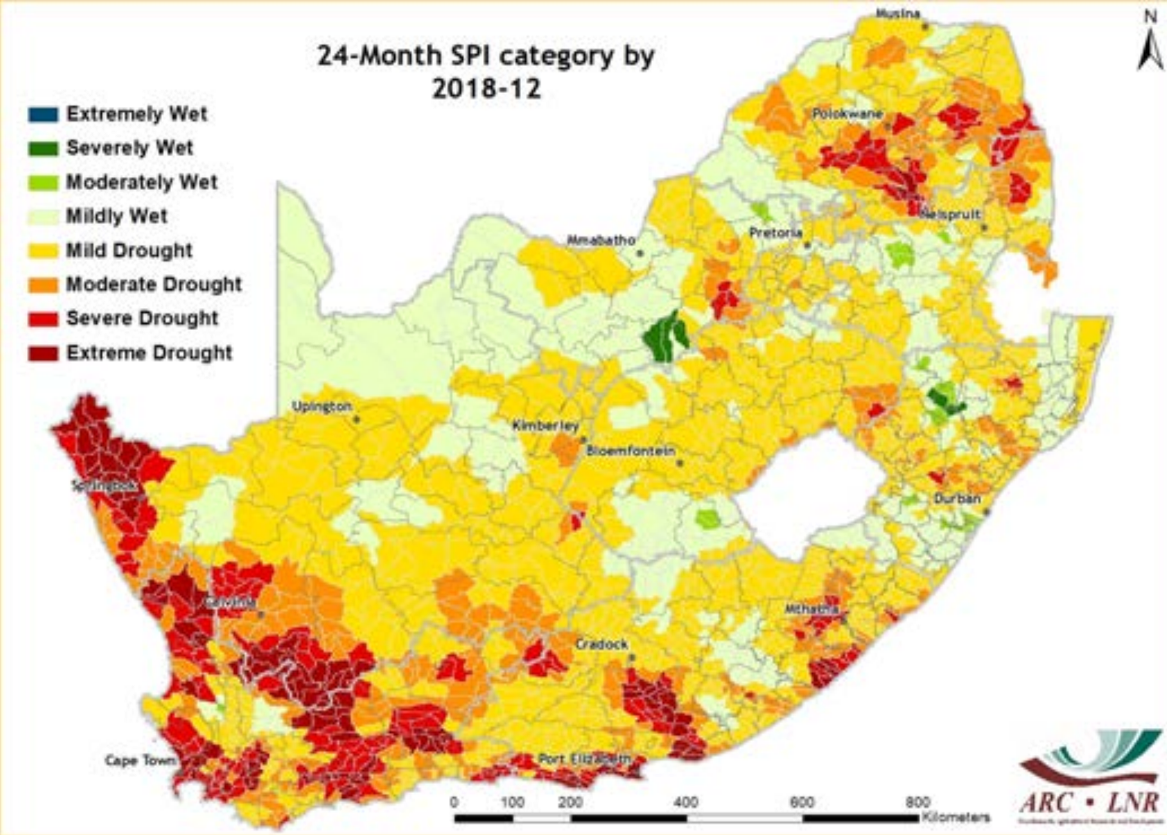

Figure 7

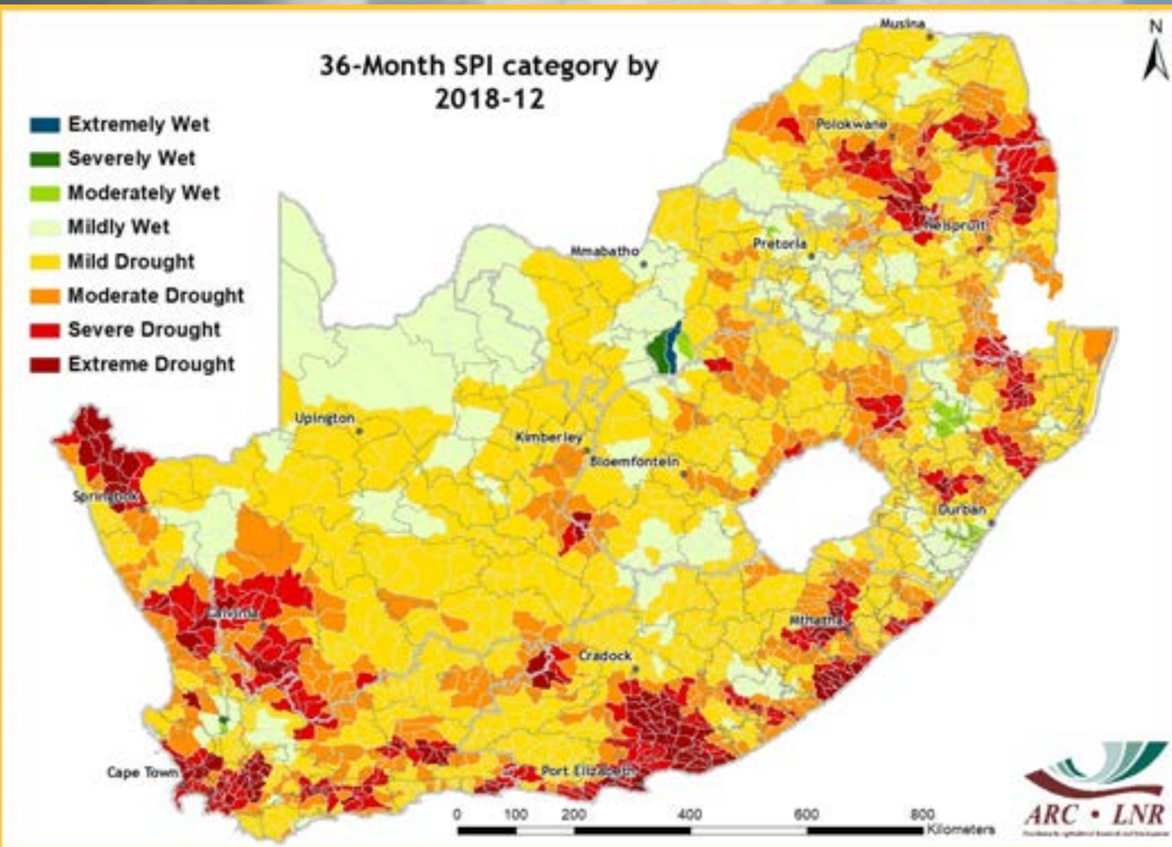

Figure 8

3. Rainfall Deciles

Deciles are used to express the ranking of rainfall for a specific period in terms of the historical time series. In the map, a value of 5 represents the median value for the time series. A value of 1 refers to the rainfall being as low or lower than experienced in the driest 10% of a particular month historically (even possibly the lowest on record for some areas), while a value of 10 represents rainfall as high as the value recorded only in the wettest 10% of the same period in the past (or even the highest on record). It therefore adds a measure of significance to the rainfall deviation.

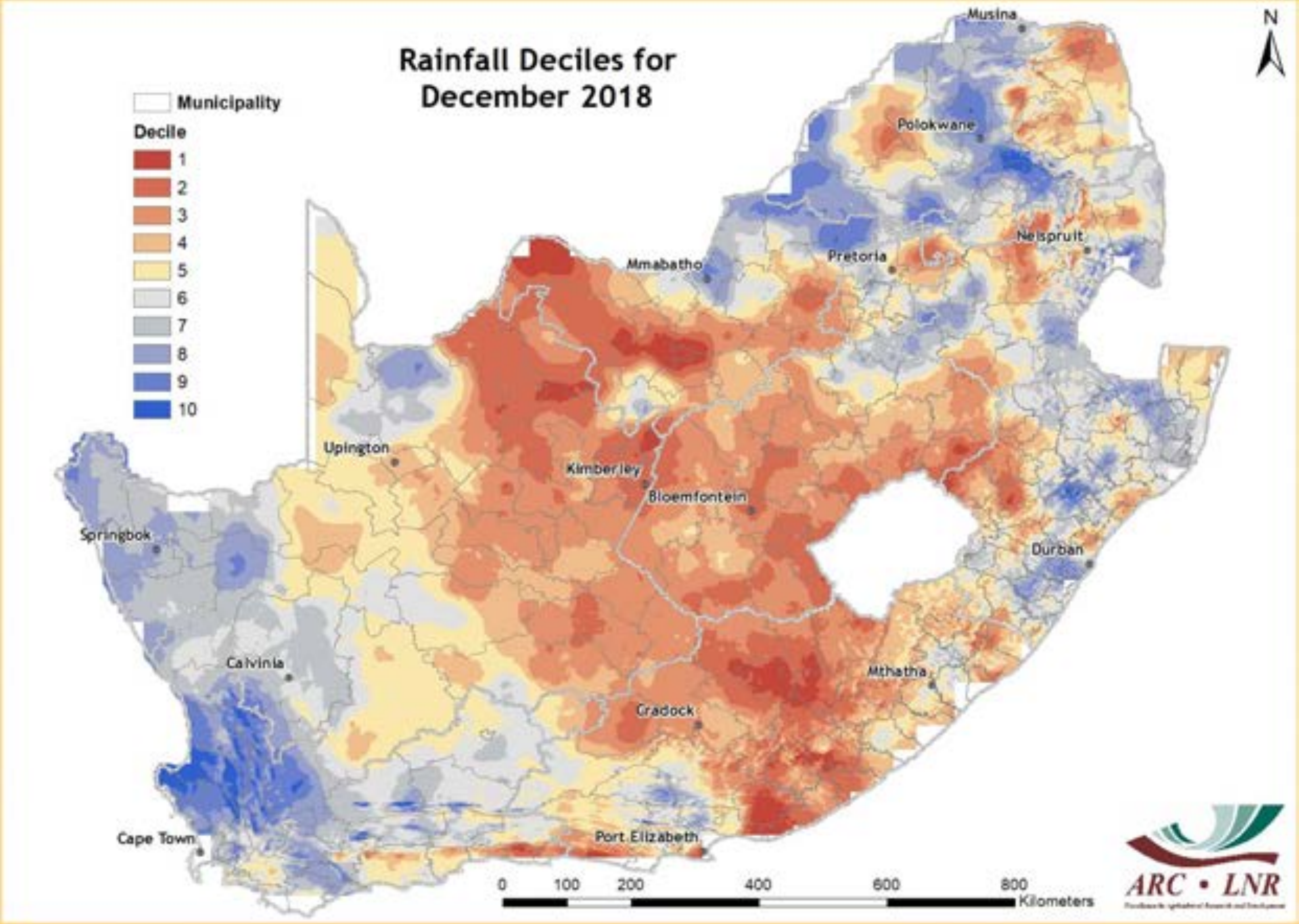

Figure 9

Figure 9:
Rainfall totals during December 2018 over the southwestern and northeastern parts of the country fell within the wetter December months compared to historical December rainfall totals. The remainder of the country experienced a dry month compared to historical December rainfall totals.

Questions / Comments:
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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.

4. Vegetation Conditions

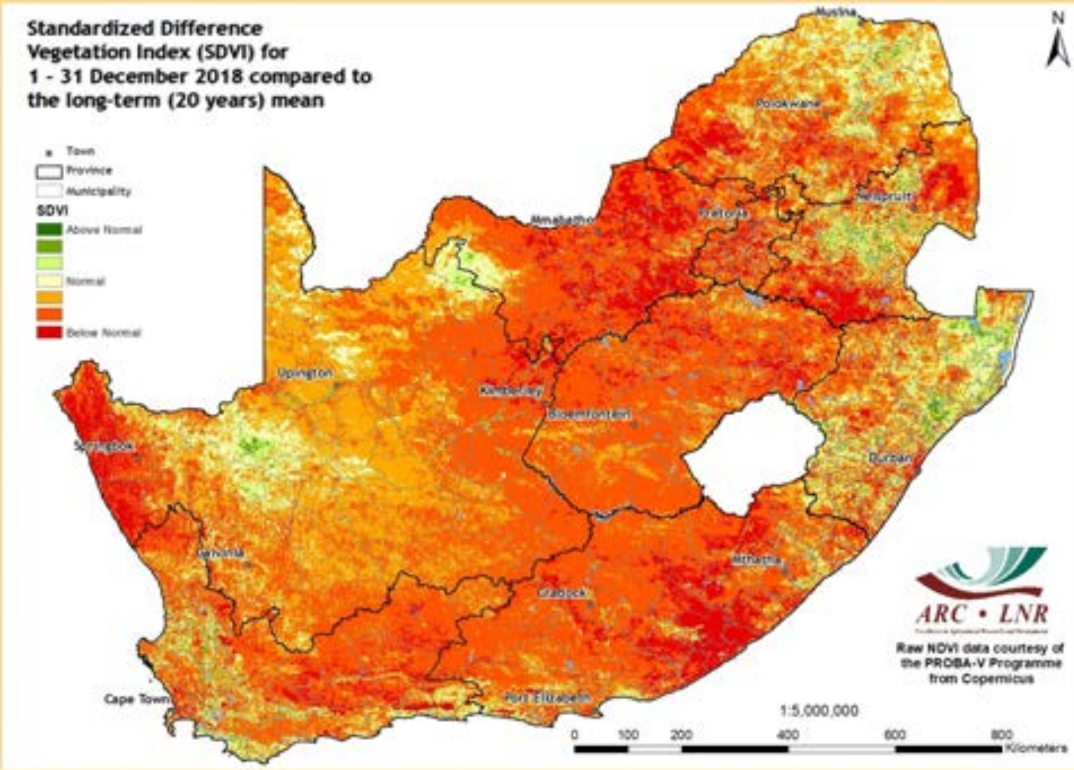

Figure 10

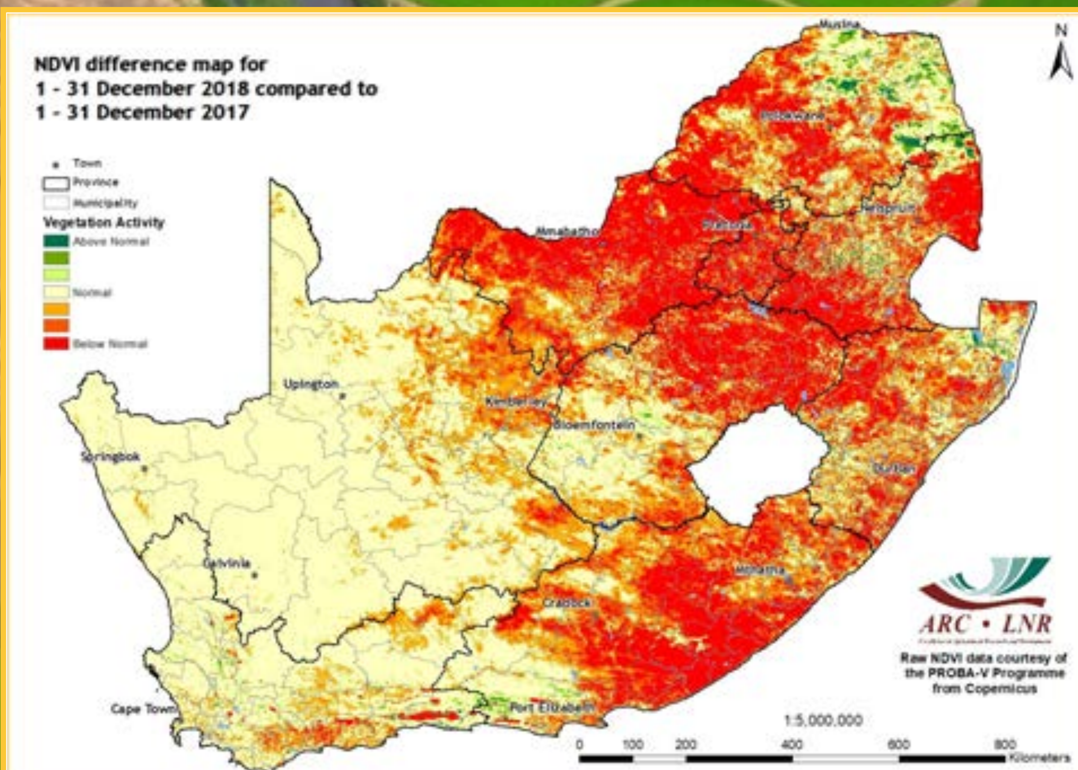

Figure 11

Figure 10:
The SDVI map shows that conditions that are unfavourable for promoting healthy vegetation growth continue to spread over many parts of the country, including areas which normally experienced good vegetation activity at this time of the year.

Figure 11:
Compared to the previous year, the NDVI map for December 2018 shows that improved vegetation conditions continue to dominate in the western parts of the country while there are poor vegetation conditions over much of the eastern parts.

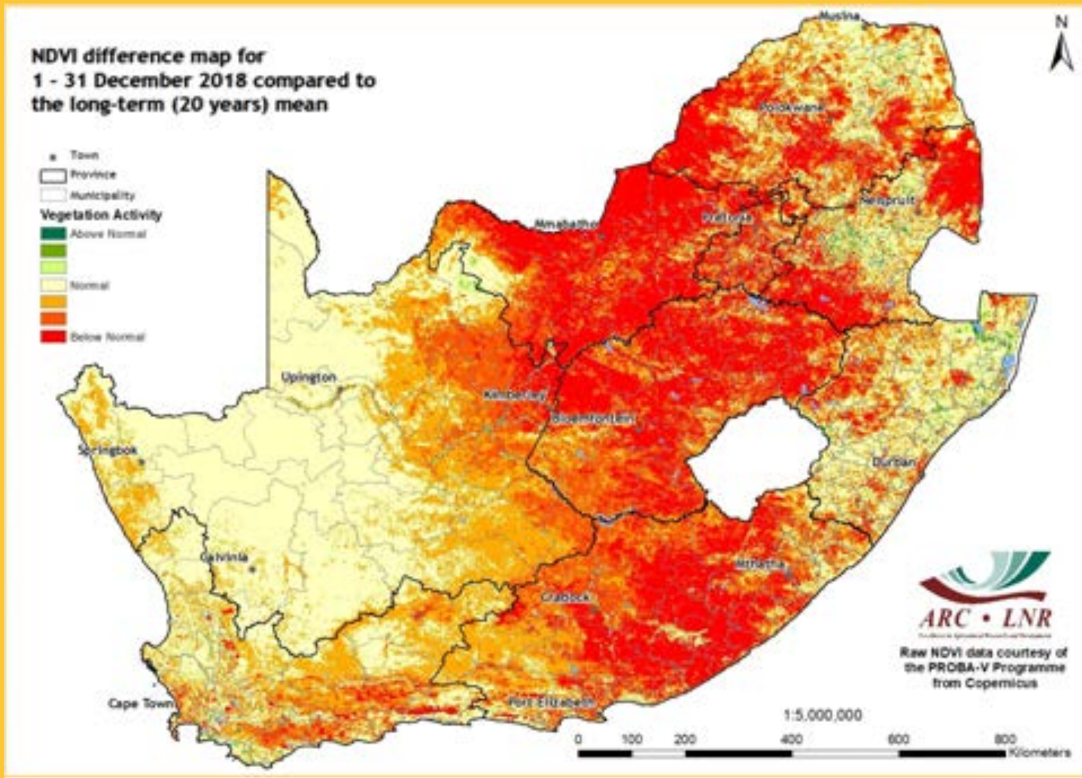

Figure 12

Vegetation Mapping
(continued from p. 7)

Interpretation of map legend

NDVI-based 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

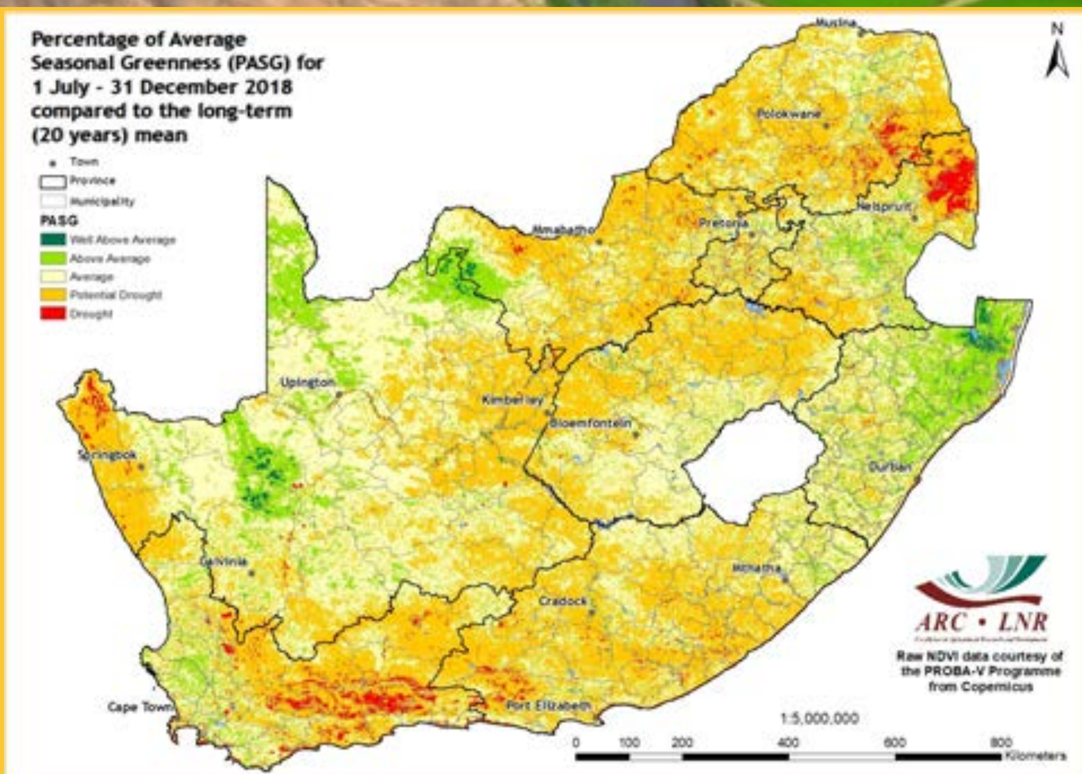

Figure 13

Figure 12:
Compared to the vegetation conditions calculated and averaged over 20 years, the NDVI difference map for December shows that the country's interior experienced below-normal vegetation activity while much of the Northern Cape, isolated areas in KwaZulu-Natal, Mpumalanga, Limpopo and the Western Cape experienced normal vegetation activity.

Figure 13:
Over a 6-month period, potential drought conditions occurred over much of the country, with minor exceptions including some isolated areas in KZN, Mpumalanga and central and the northern parts of the Northern Cape.

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5. 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.

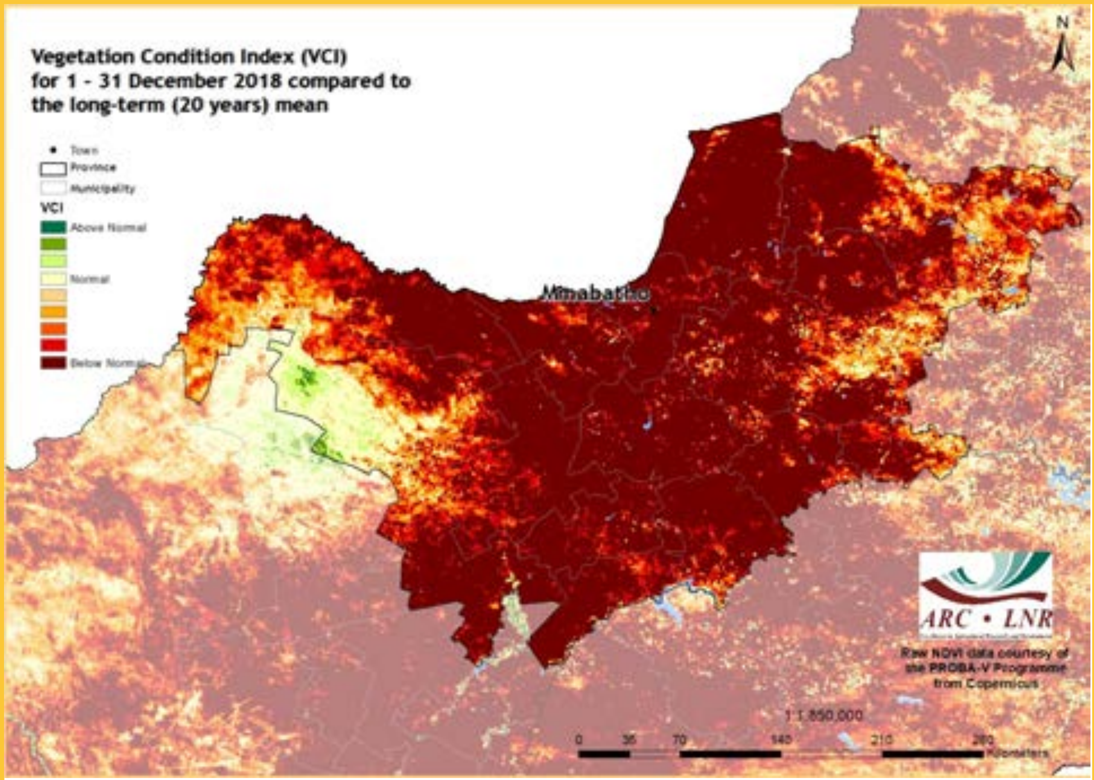

Figure 14

Figure 14:
The VCI map for December shows that unfavourable conditions for plants to thrive and the decline of vegetation greenness continue to spread over much of the North West Province.

Figure 15:
The VCI map for December shows that nearly the entire Free State Province experienced alarmingly poor vegetation conditions.

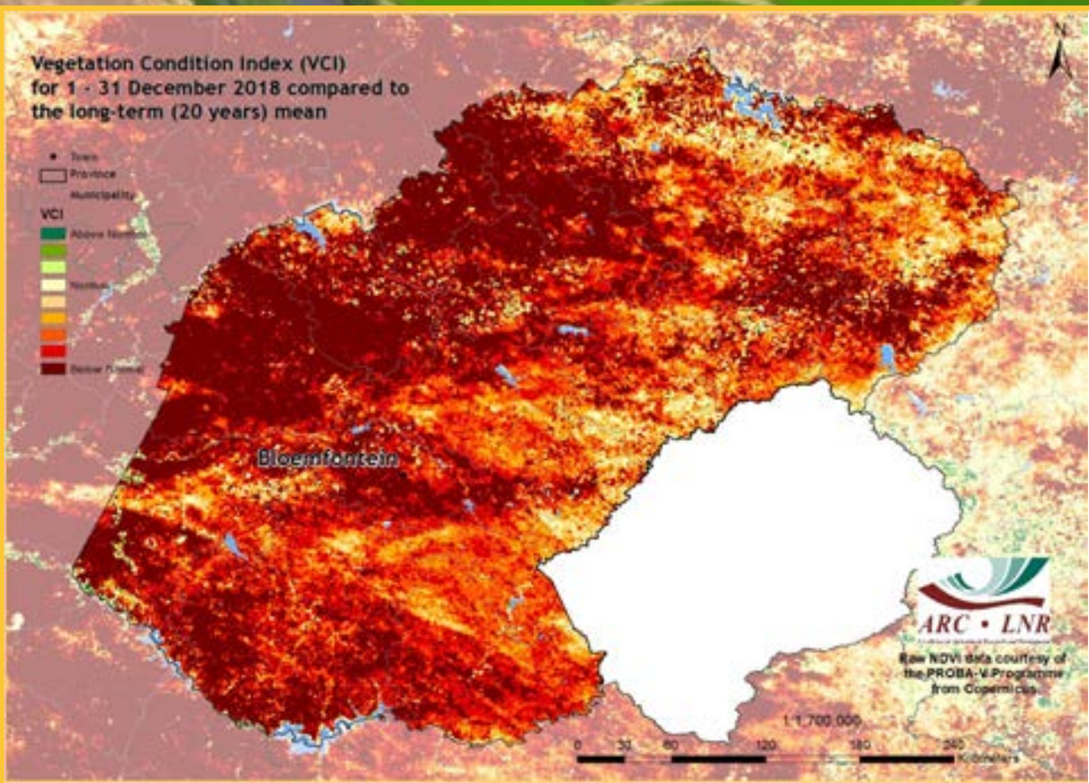

Figure 15

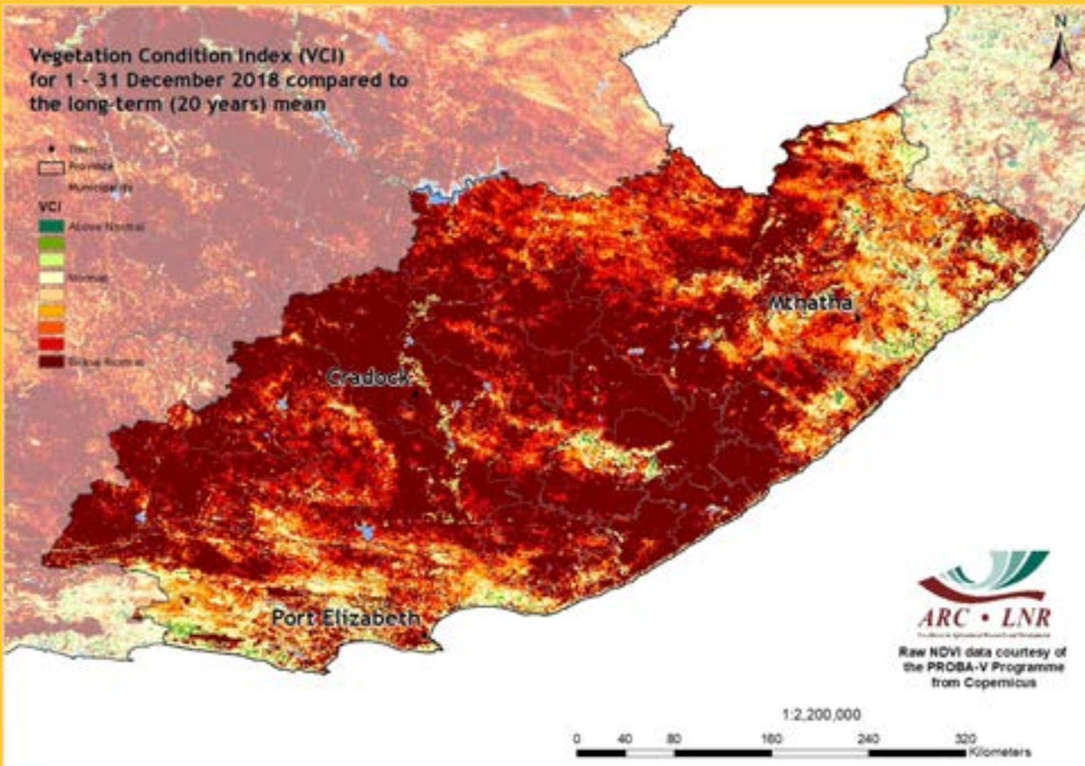

Figure 16

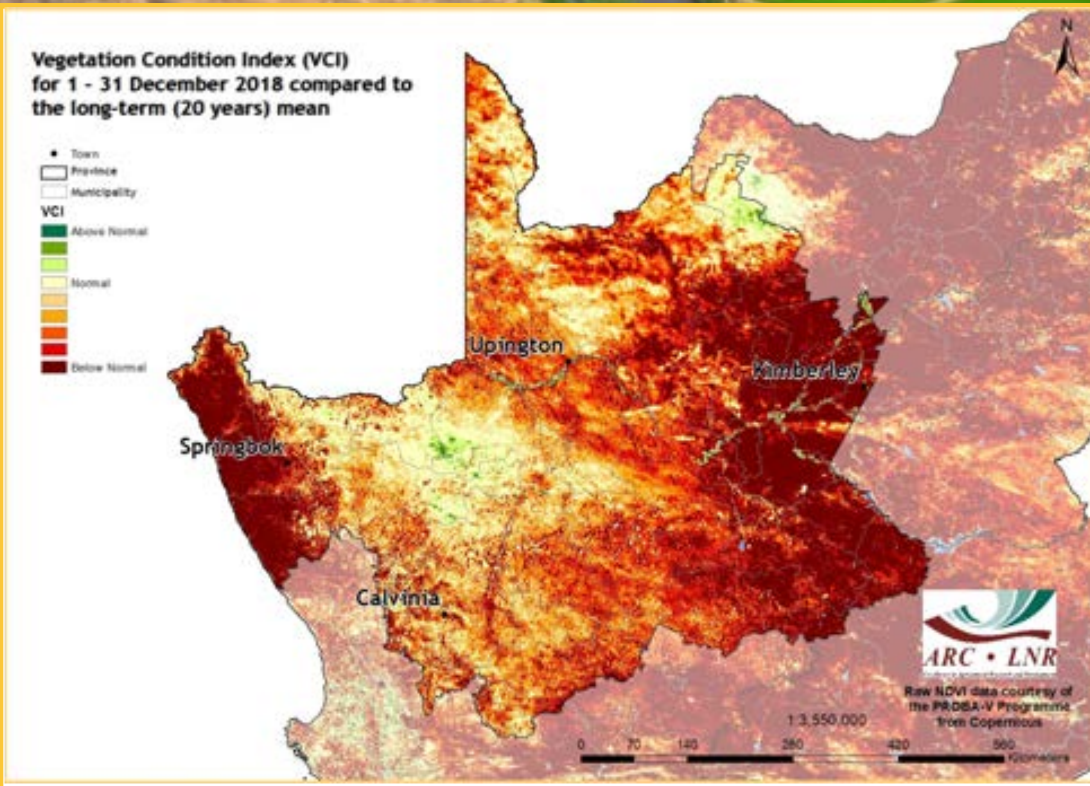

Figure 17

Figure 16:
For quite a while, below-normal vegetation activity has been dominant in the western region of the Eastern Cape. However, in December these unfavourable conditions spread across the whole province.

Figure 17:
Major parts of the Northern Cape experienced extremely stressed vegetation conditions in December. Nevertheless, minor exceptions were observed in the central parts of the province which experienced normal vegetation conditions.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

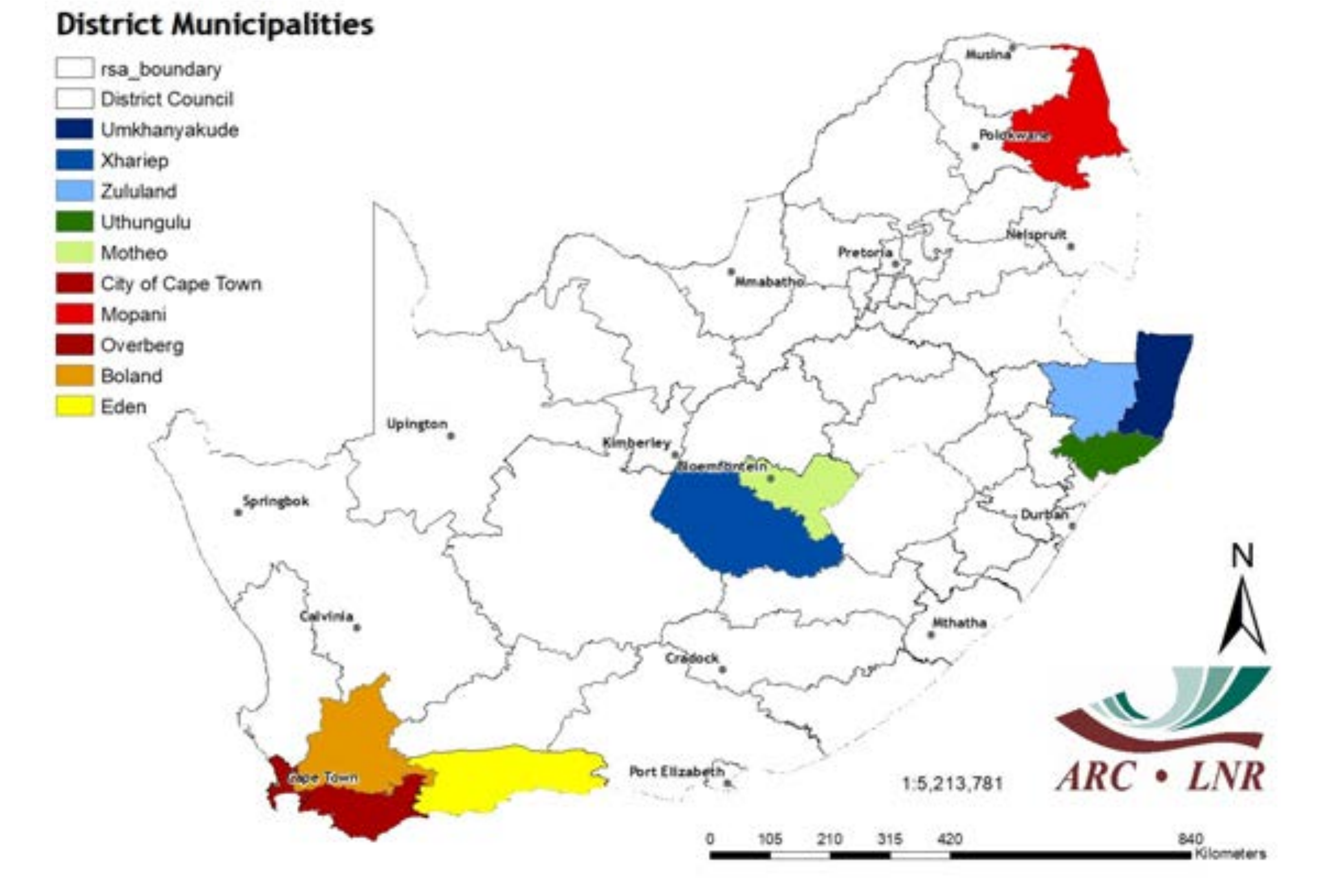

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for December 2018. The district colour matches the border of the corresponding graph.

Questions/Comments:
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Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

Figures 24-28:
Indicate areas with lower cumulative vegetation activity for the last year.

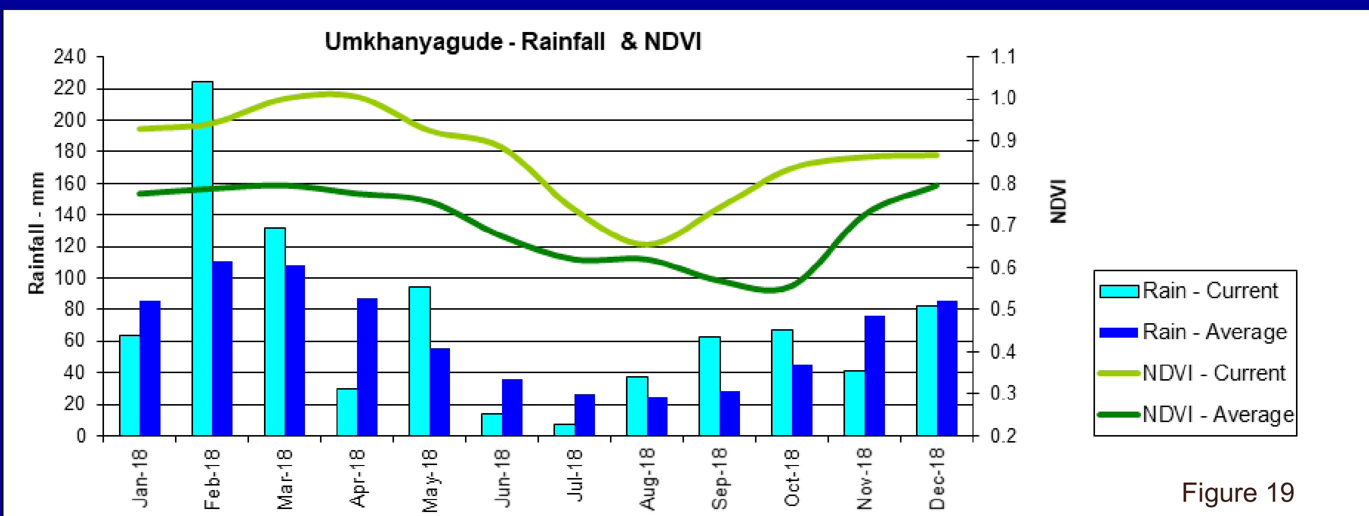


Figure 19

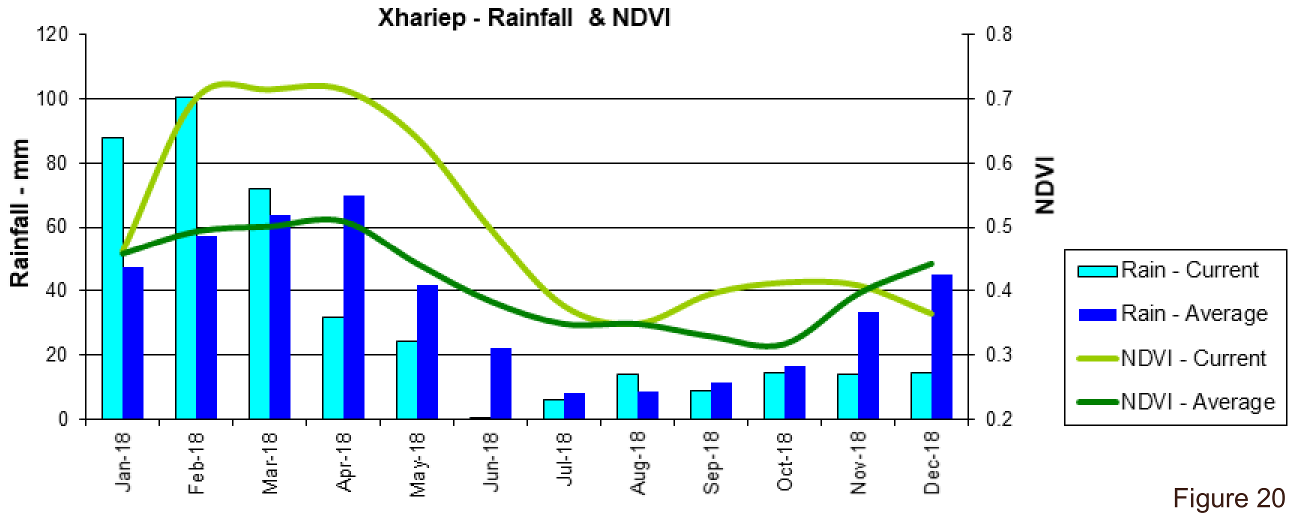
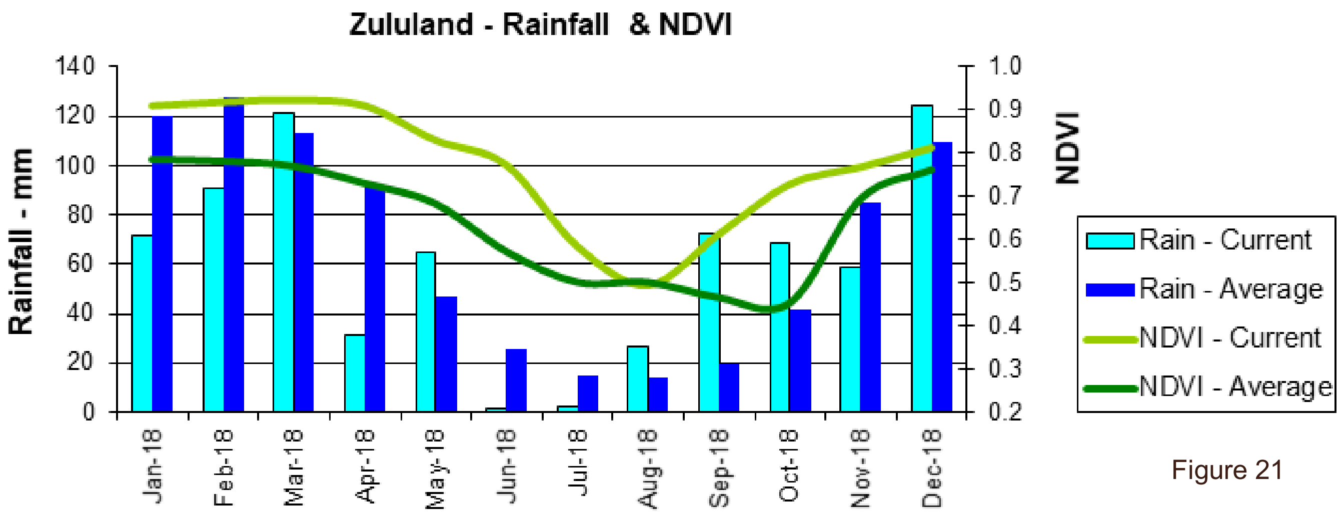


Figure 20



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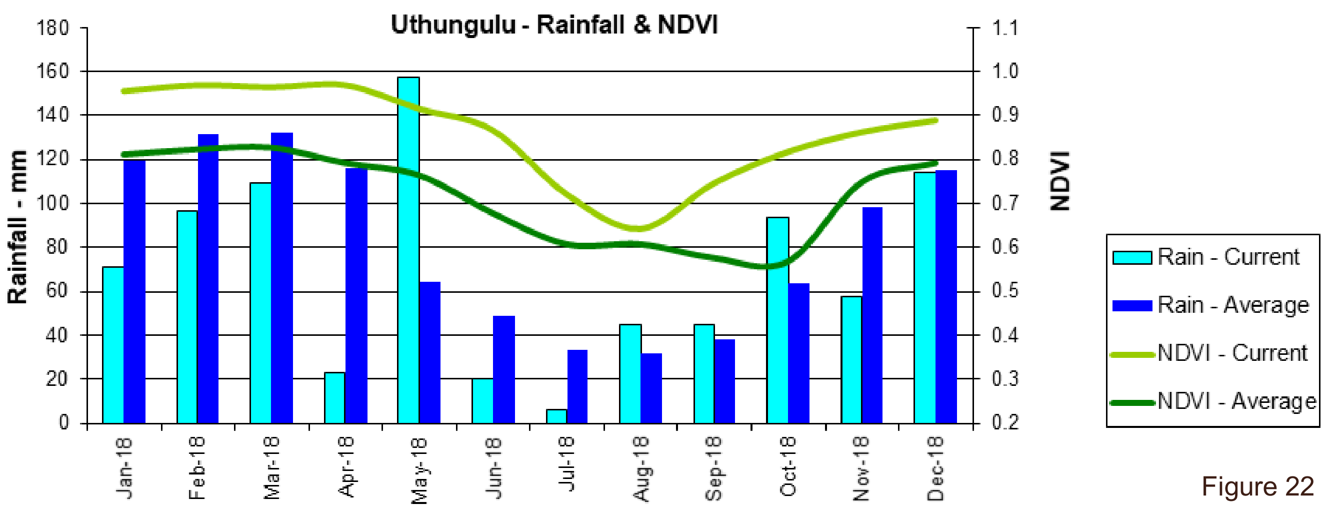
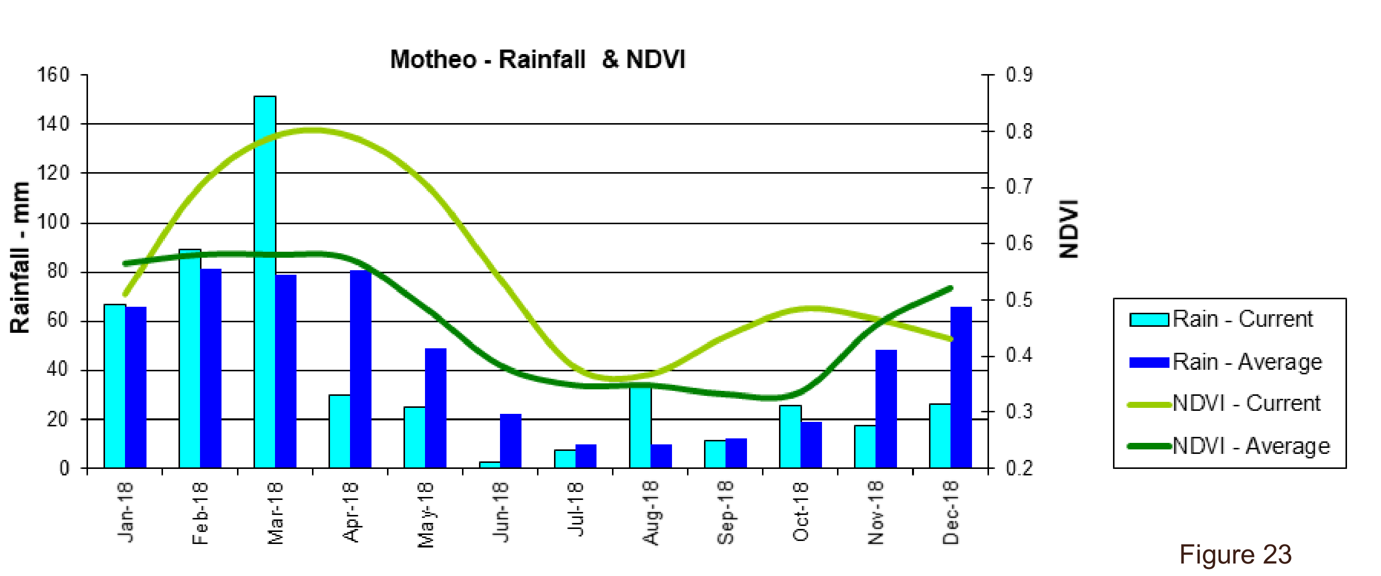


Figure 22



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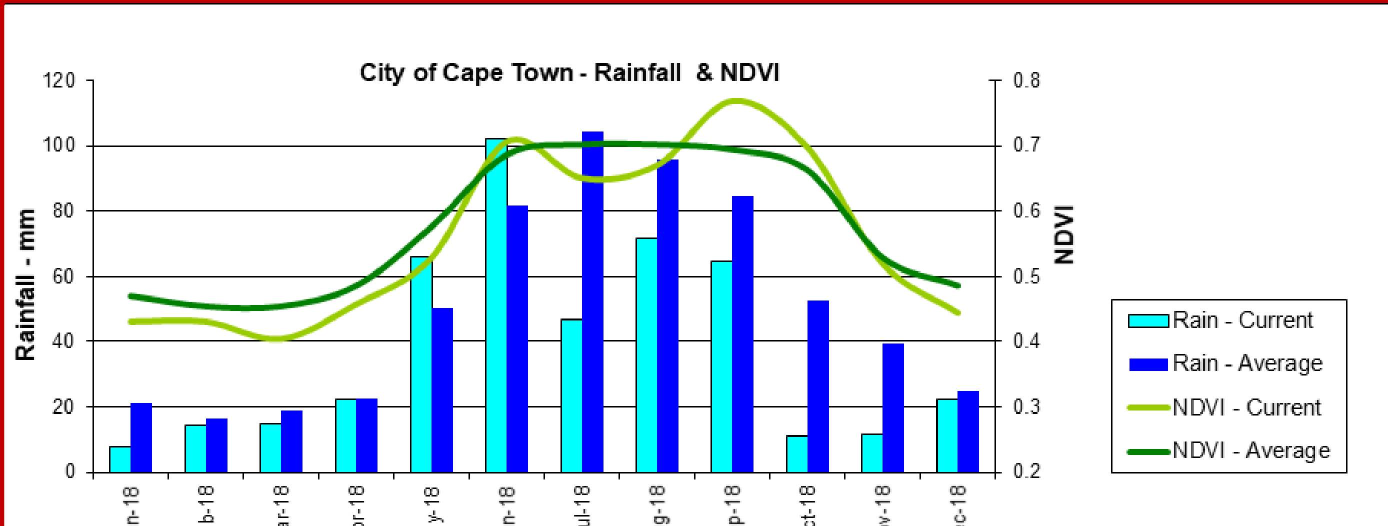

Figure 24

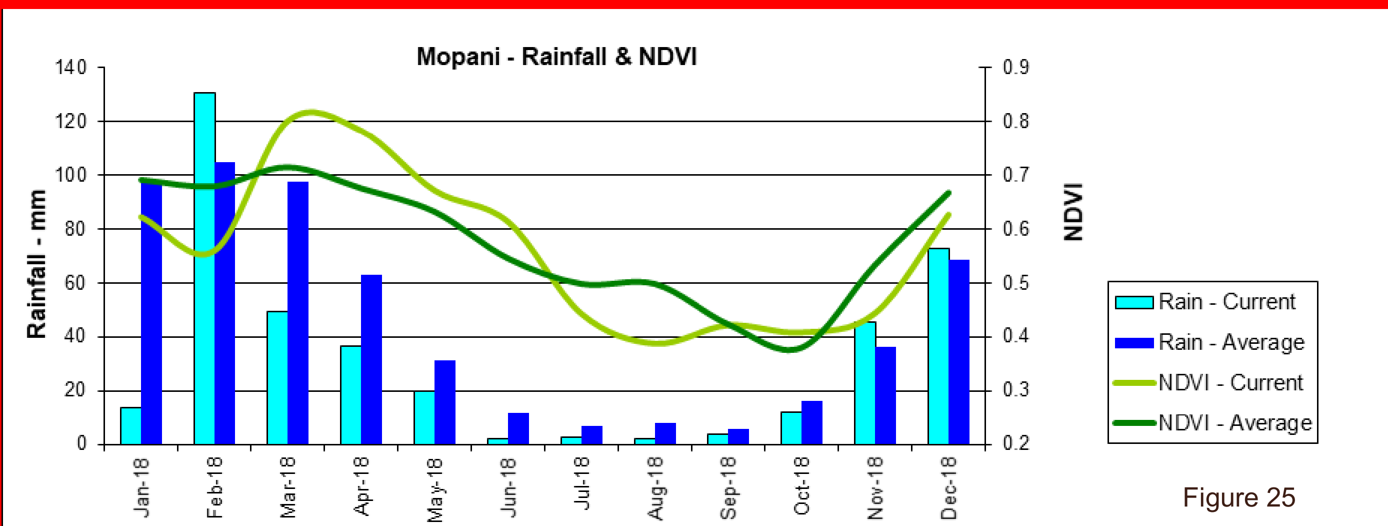

Figure 25

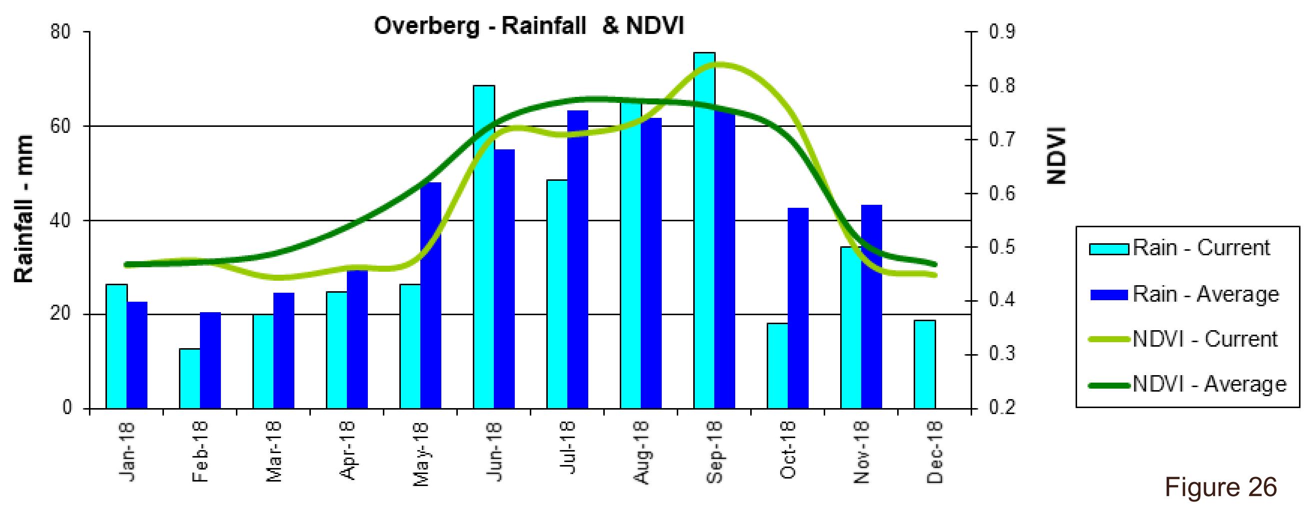

Figure 26

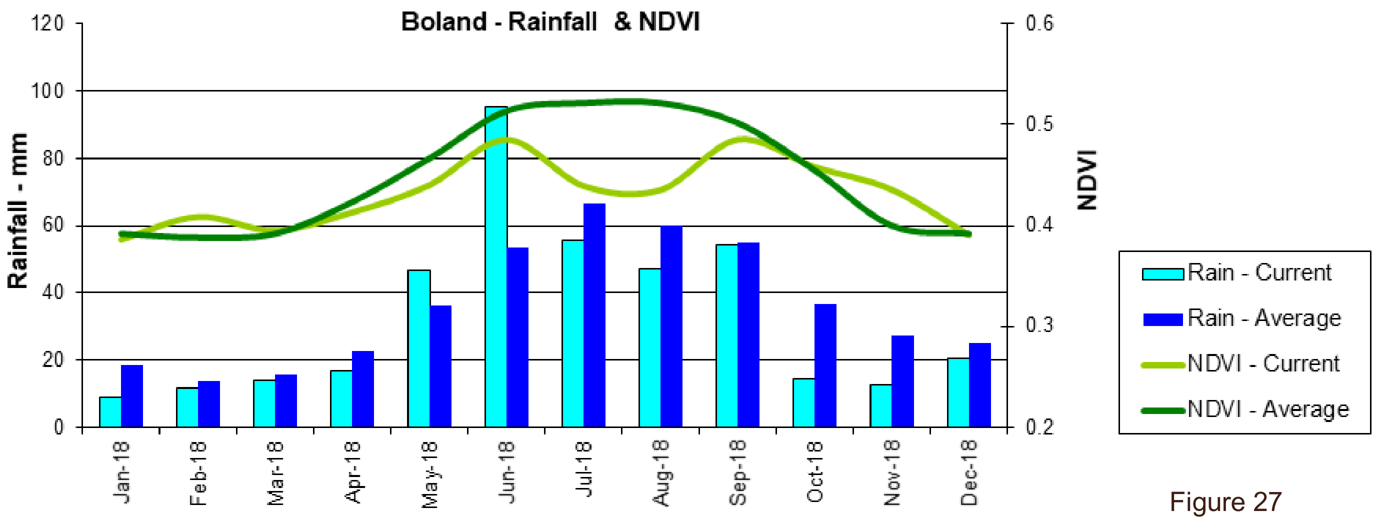

Figure 27

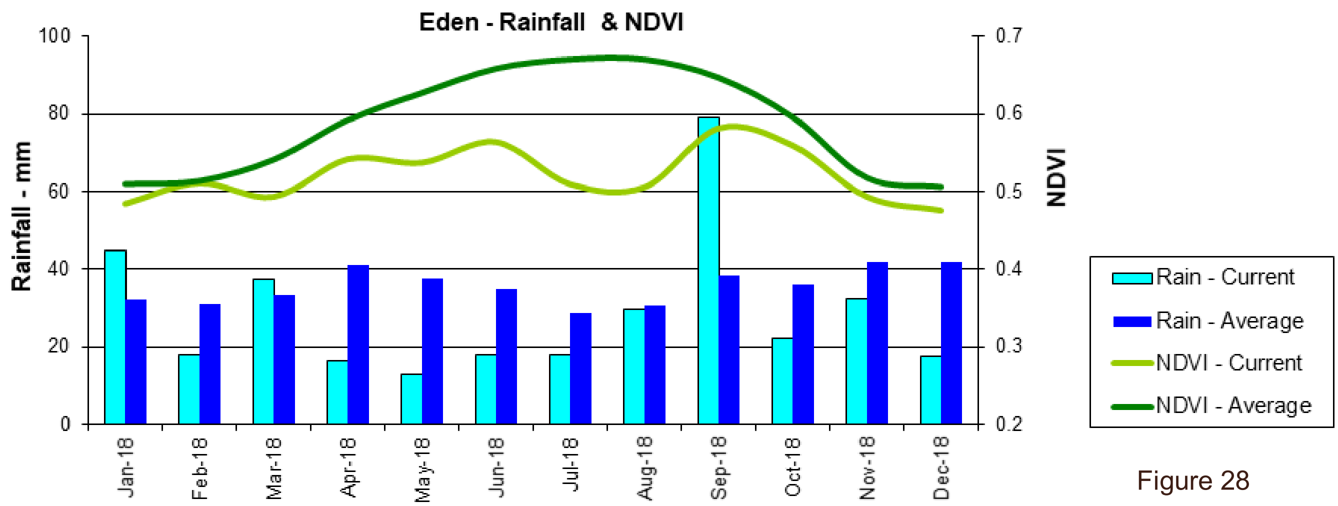

Figure 28

7. 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 29:
The graph shows the total number of active fires detected between 3-27 December 2018 per province. Fire activity was higher in the Northern Cape and Western Cape compared to the long-term average.

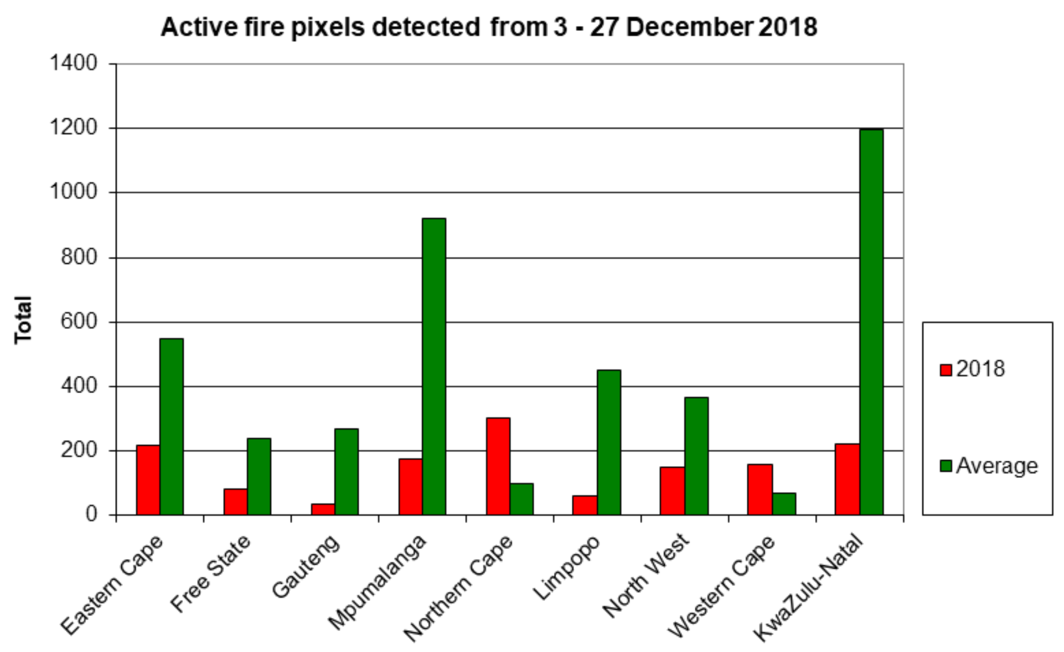

Figure 29

Figure 30:
The map shows the location of active fires detected between 3-27 December 2018.

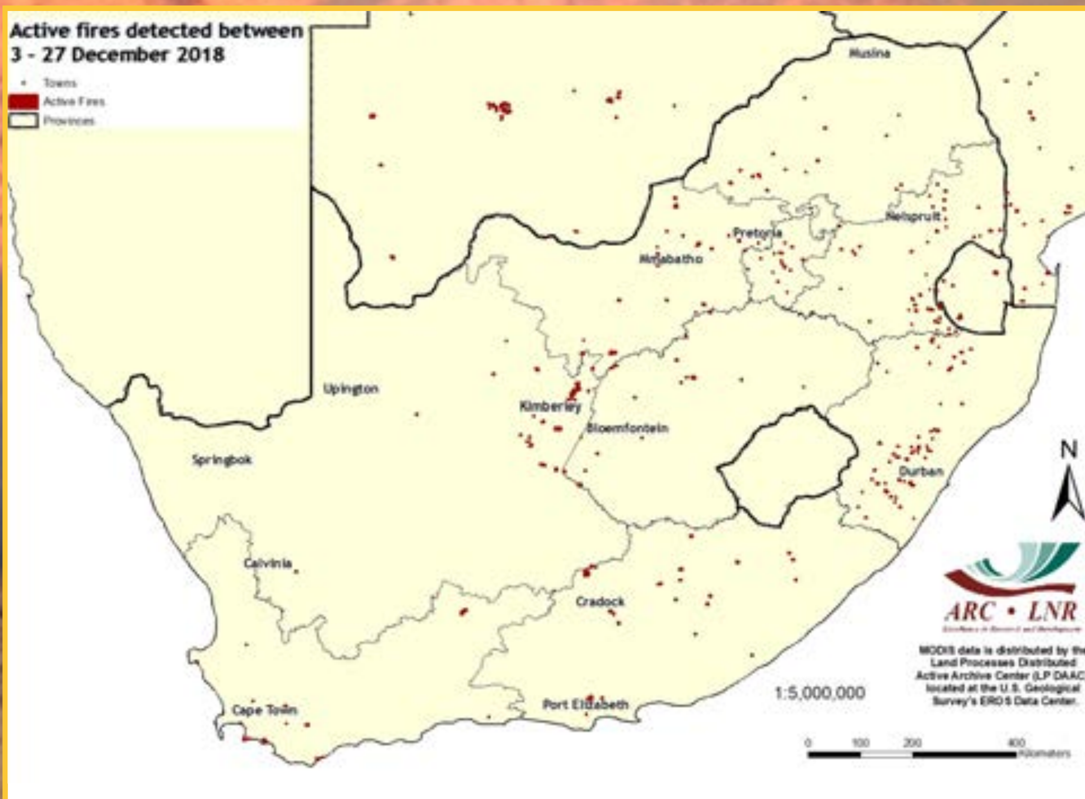

Figure 30

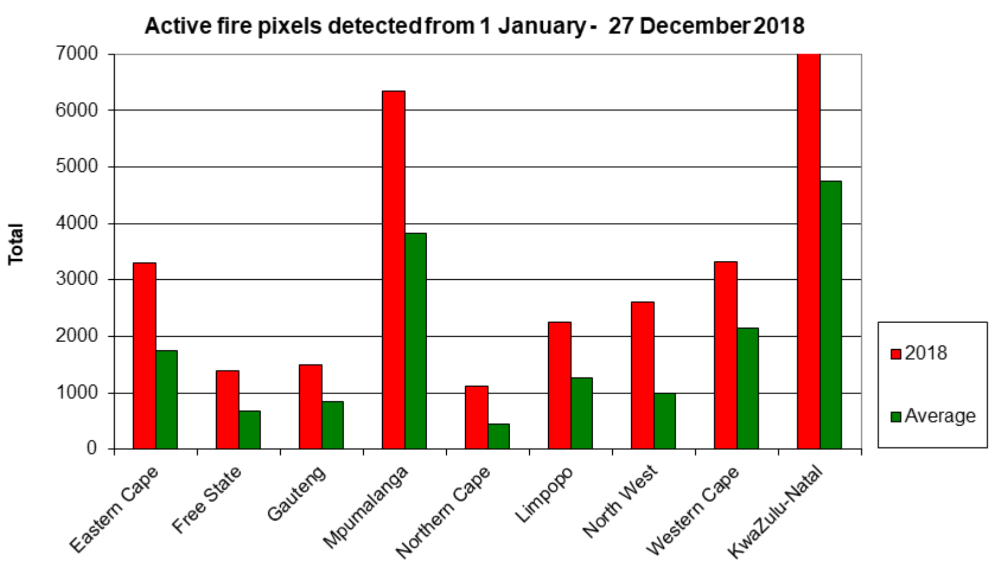

Figure 31

Figure 31:
The graph shows the total number of active fires detected from 1 January - 27 December 2018 per province. Fire activity exceeded the long-term average in all provinces.

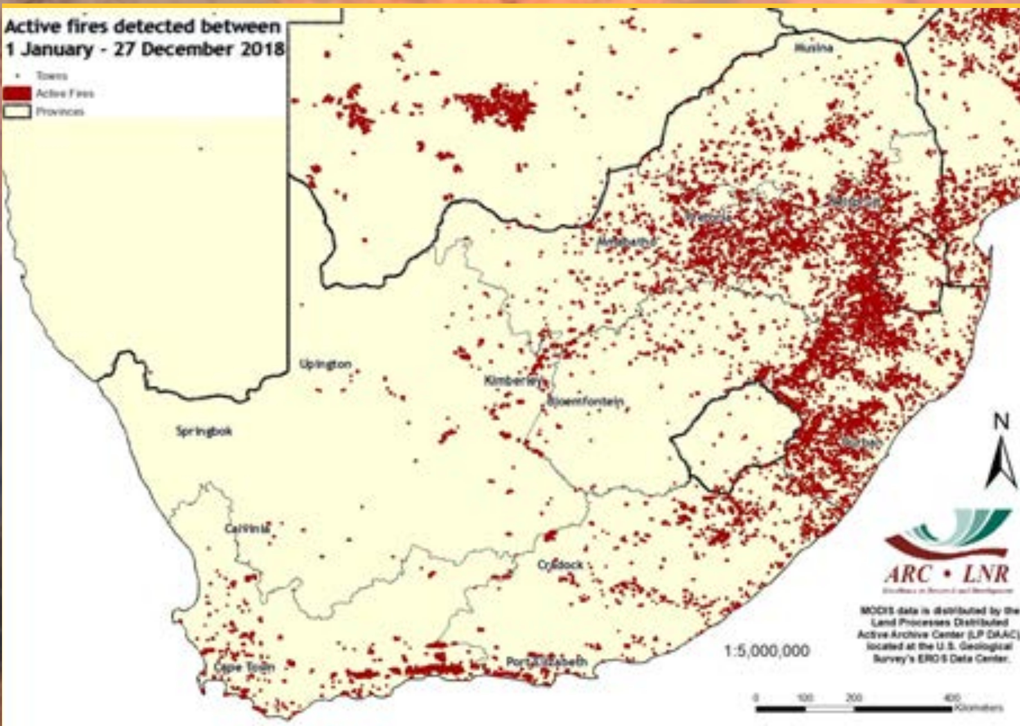

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January - 27 December 2018.

Questions/Comments:
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8. Surface Water Resources

Countywide surface water areas (SWA) are mapped on a monthly basis by GeoTerraImage using Sentinel 2 satellite imagery from the start of its availability at the end of 2015.

Figure 33 shows a comparison between the area of water available now, and the maximum area of surface water recorded in the last 3 years. Values less than 100 represent water catchments within which the current month's total surface water is less than the maximum extent recorded for the same area since the end of 2015. Figure 34 shows a comparison between the area of water available now, and for the same month in 2017. In this map, values less than 100 represent water catchments within which the current month's total surface water is less than that recorded in the same water catchment, in the same month, in 2017.

The two maps show that the majority of water catchments across the country contain slightly less than the maximum water area recorded in those same catchments since the end of 2015. There are some notable areas of severe water reductions in the Karoo, Kalahari, northern Limpopo and central parts of the Kruger National Park.

Comparison between December 2018 and December 2017 shows that generally the central interior catchments are typically experiencing equivalent or greater water extents this year than last year. However, specific catchments in the Northern Cape, North West, Limpopo and Eastern Cape provinces are showing a significant reduction in water extent compared to 2017 conditions.

The SWA maps are derived from the monthly data generated and available through GeoTerraImage's 'Msanzi Amanzi' web information service: https://www.water-southafrica.co.za

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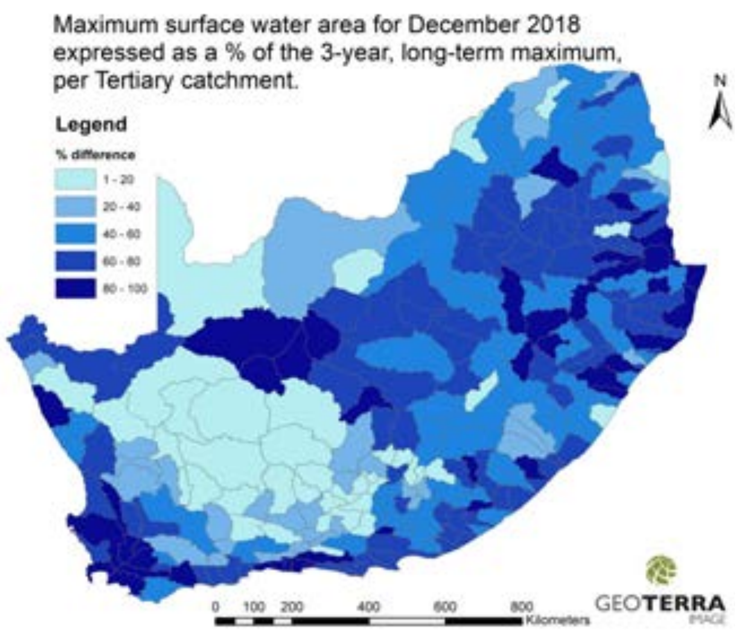

Figure 33

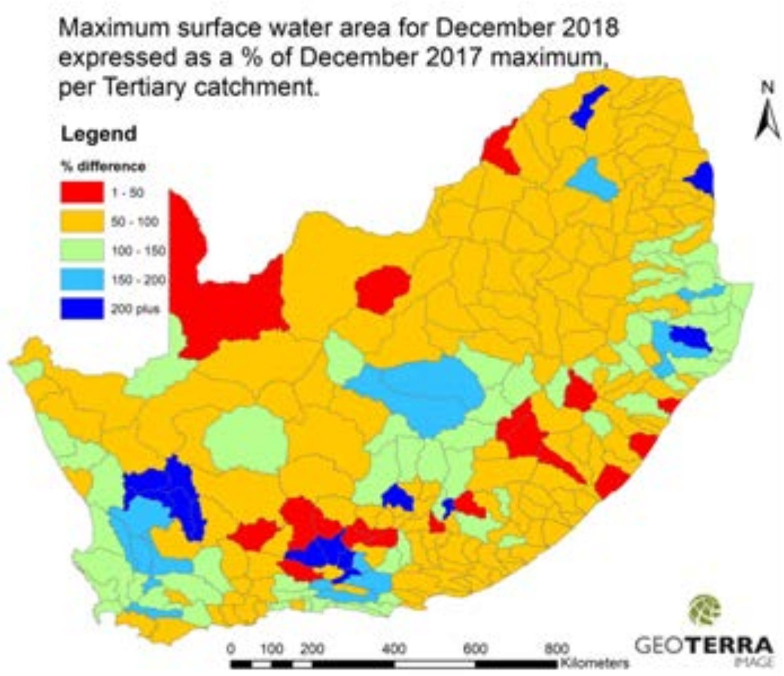

Figure 34

Agrometeorology

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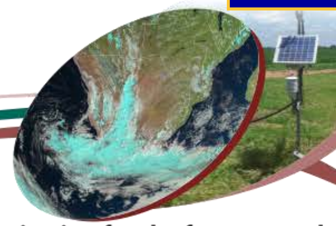

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national 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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What does Umlindi mean?
UMLINDI is the Zulu word for "the watchman".