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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

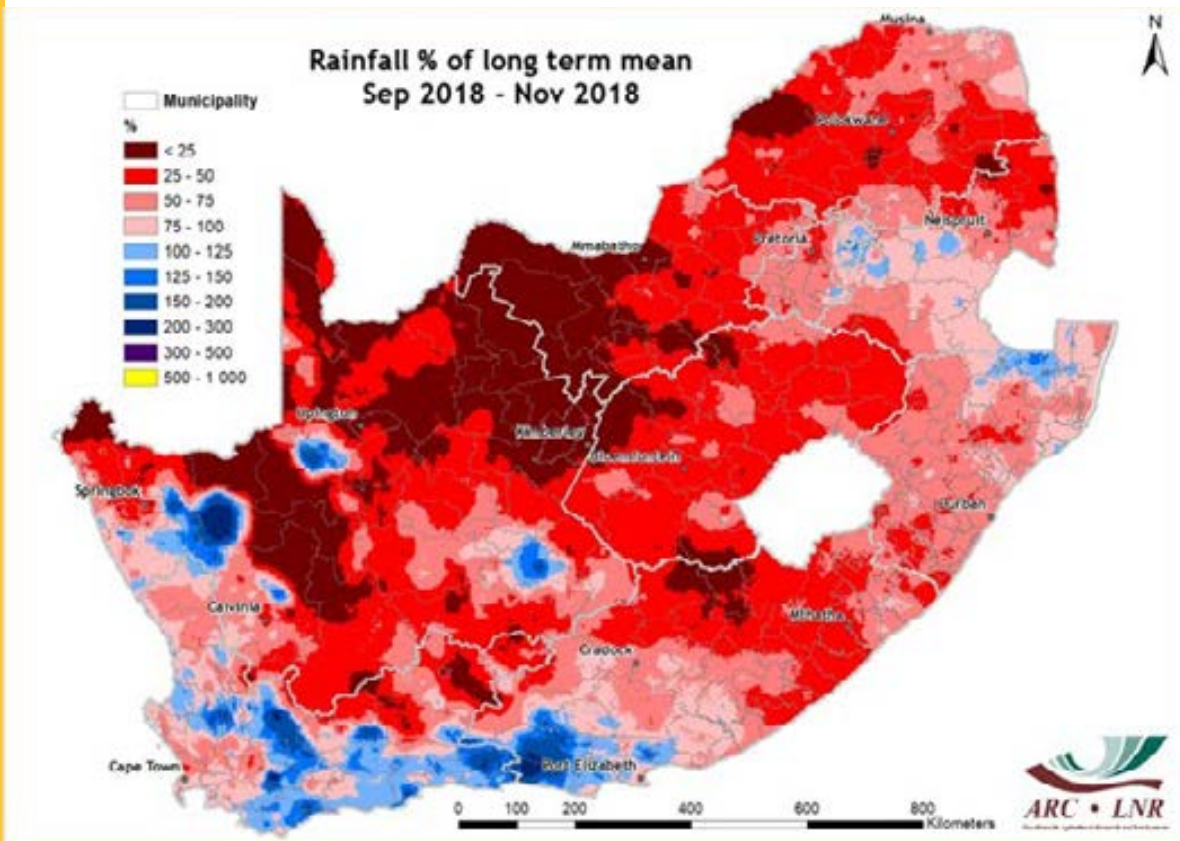
AMESD

174th Edition

Image of the Month

Sweltering heat during a dry spring

The larger part of the country experienced below-normal rainfall during the spring of 2018. In most of the areas where summer grain crops are grown, less than 50% of the normal spring rainfall occurred between September and November 2018 (see map below). It was also hotter than normal over these areas. Over the western parts of the maize-producing region, five heatwave events occurred during this period, with very little rainfall and a high number of consecutive days with no rain at all. Towards the eastern parts of the maize-producing region of Mpumalanga, conditions were slightly better, but still very challenging with the occurrence of two heatwave events in those areas. Over the southern coastal regions of the country, rainfall conditions improved from the winter to spring of 2018. However, these above-normal spring rainfall totals can mostly be attributed to about four good rainfall events that occurred at the start and the end of spring, with infrequent and only small rainfall events occurring in between and a very hot October period.



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).

Overview:

Except for some areas along the southern coastal region and the far northern parts of the Lowveld, below-normal rainfall occurred over South Africa during November 2018. With the exception of the far northeastern parts of the country, it was also hotter than normal over the larger part of South Africa, despite a cold snap that occurred around the 7th of November as a cold front moved over the country. Over the central interior, the maximum temperatures were 3-4°C higher than normal.

The month of November started off with the occurrence of thundershowers over the far eastern parts of the country, as well as the passage of a frontal system at the end of the first week. Over the next few days, the atmospheric conditions changed to a pattern that resulted in mostly dry and hot weather, especially over the western to central interior. Between the 10th and 18th very hot and dry conditions occurred over large parts of the country, reaching heatwave status. The weather pattern that caused the very hot and dry weather weakened by the 20th of November and relief from the heatwave conditions occurred as a cloud band moved over the country to exit it on the 22nd. Over the next few days some thunderstorms developed over large parts of the interior, but were isolated in nature. A weather pattern that aided the formation of rain-producing clouds moved in over the country on the 26th. This weather pattern was associated with a cold front, resulting in notably cooler conditions over the southern parts and moving to the eastern parts of the country all the way up to the Lowveld by the 29th of November.

1. Rainfall

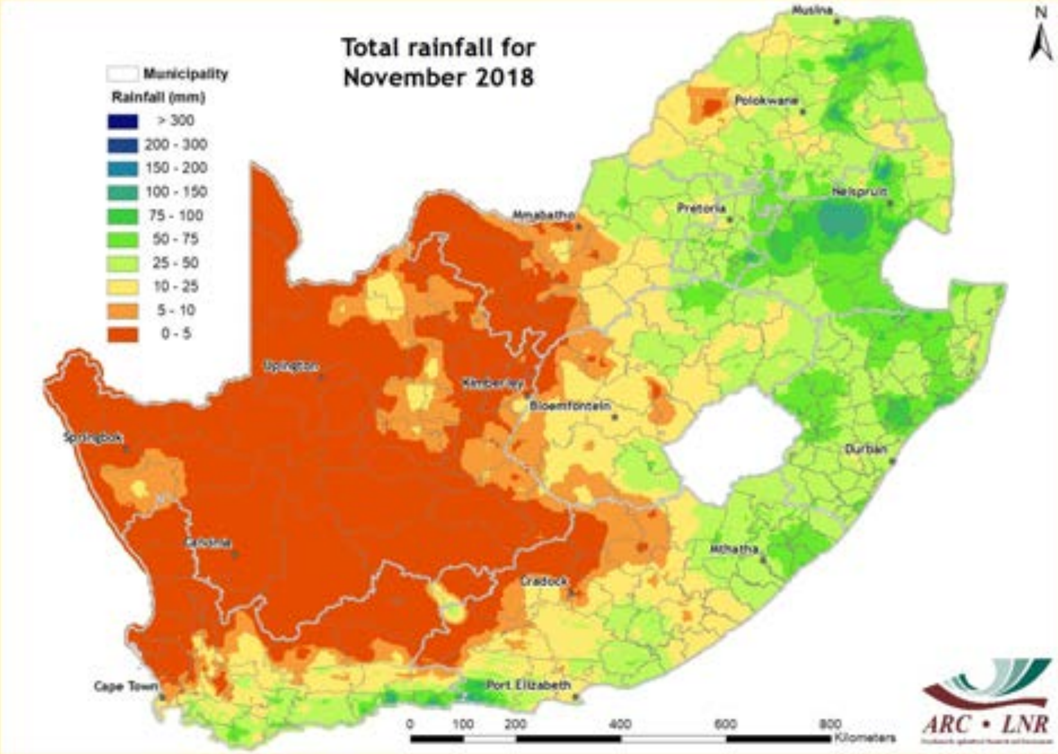


Figure 1

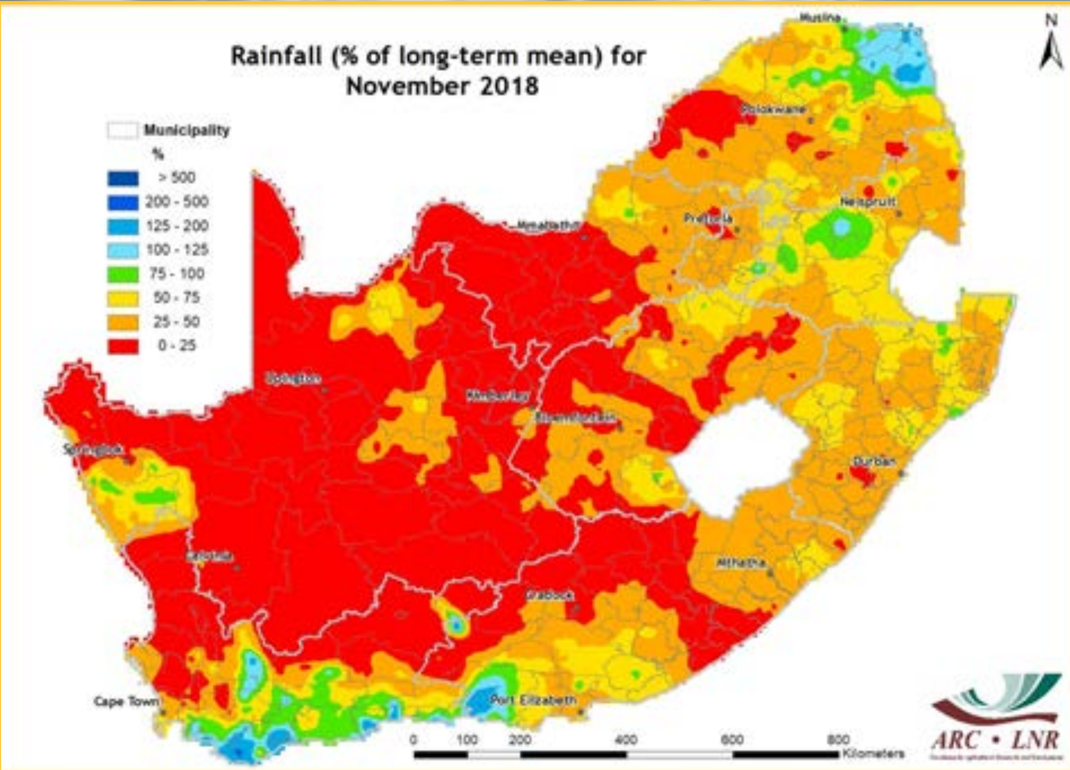


Figure 2

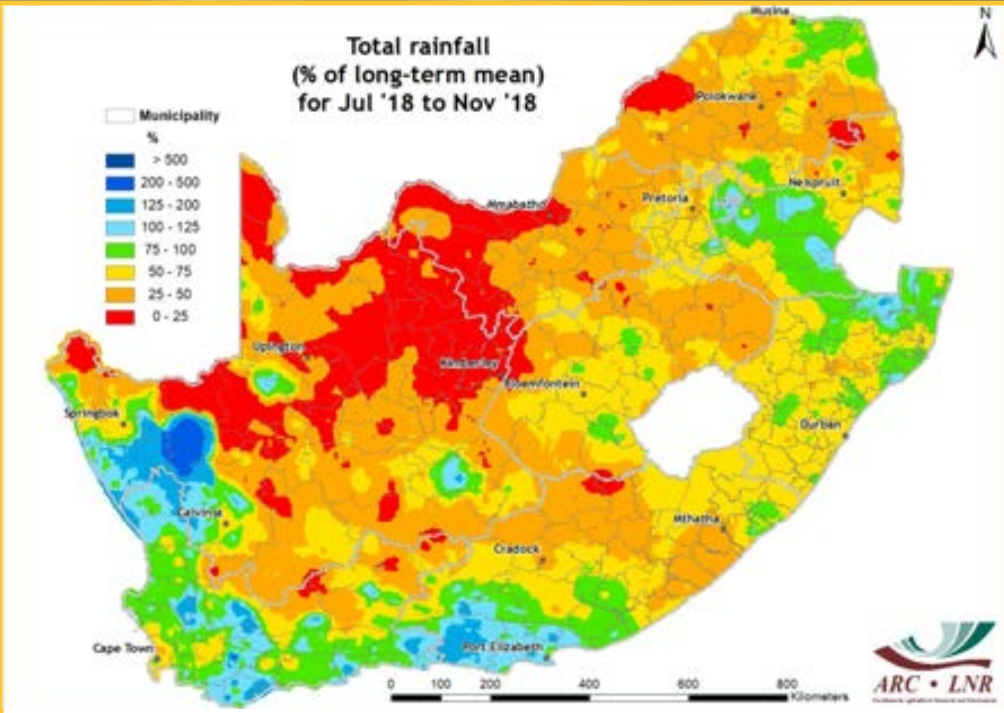


Figure 3

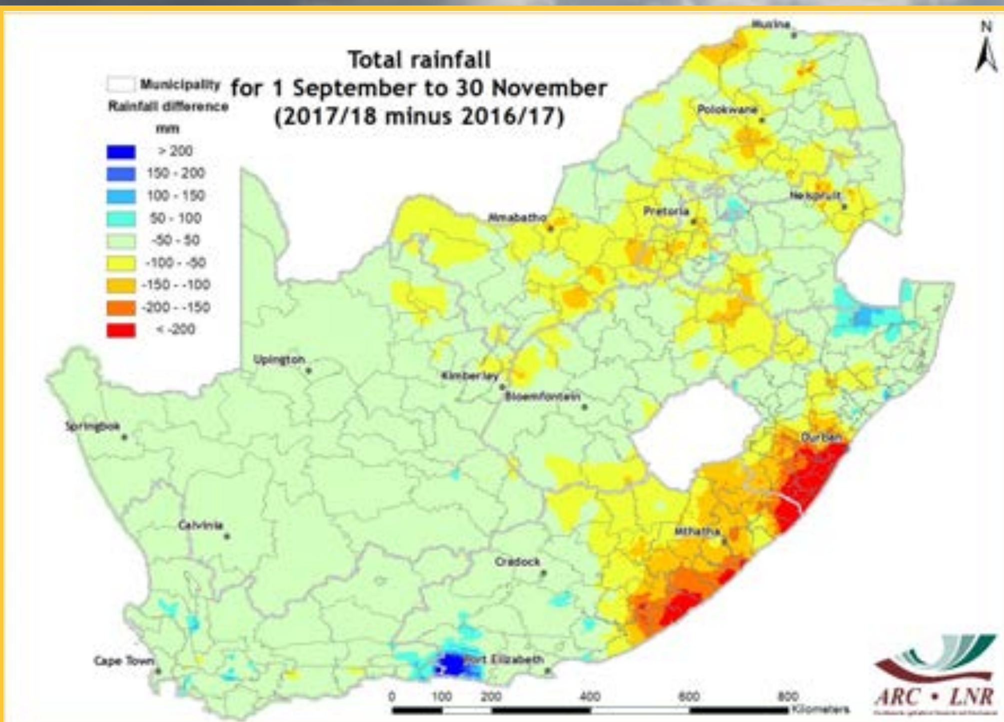


Figure 4

Figure 1:
Rainfall in excess of 25 mm occurred along the southern coastal belt as well as over the eastern parts of the country during November. Most of the rain along the southern coastal belt fell on the 20th, with some places receiving more than 50 mm. Over the eastern parts of the country, most of the rainfall occurred during the first week of the month and again during the last 10 days of November.

Figure 2:
Except for some isolated areas over the far northeastern parts of the country as well as areas along the southern coastal belt that received above-normal rainfall, the month of November was characterized by below-normal rainfall. Large parts of the summer rainfall region where summer grain crops are grown received less than half of the normal November rainfall totals.

Figure 3:
During the period from July to November, near- to above-normal rainfall occurred over the winter-and all-year rainfall regions. Over the summer rainfall region, most areas received below-normal rainfall during this 5-month period, with the exception of some isolated areas in Mpumalanga and northern KwaZulu-Natal.

Figure 4:
Compared to the corresponding period in 2017, the southeastern coastal region and adjacent interior received significantly less rainfall during September to November 2018 (more than 200 mm less in some places). Over the eastern parts of the country, many isolated areas received more than 100 mm less this year compared to the corresponding period in 2017. To the west of Port Elizabeth, the effect of the very good rainfall event that occurred during the first week of September 2018 can still be seen.

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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 the 36-month time scale, drought conditions occurred over many parts of the country, but in particular over the southwestern, southern and eastern parts where it was severe in places. Relief from the severe drought conditions occurred over areas in the east of the country on the 24-month time scale, whilst drought conditions over the southwestern parts intensified in terms of the spatial extent. On the 12-month time scale, the severe to extreme drought conditions over the southwestern parts of the country improved to mostly mild drought, with some isolated areas even mildly wet. The 6-month SPI indicates moderate drought over the larger part of the summer rainfall region, reaching severe drought conditions in places.

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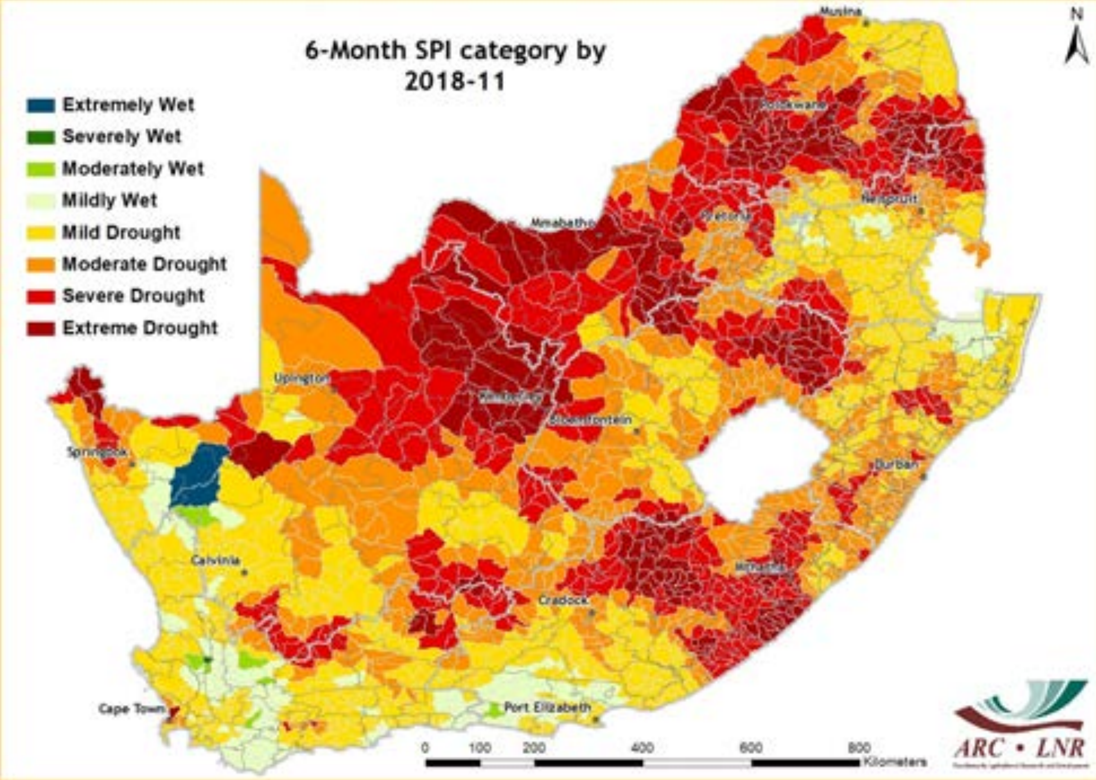

Figure 5

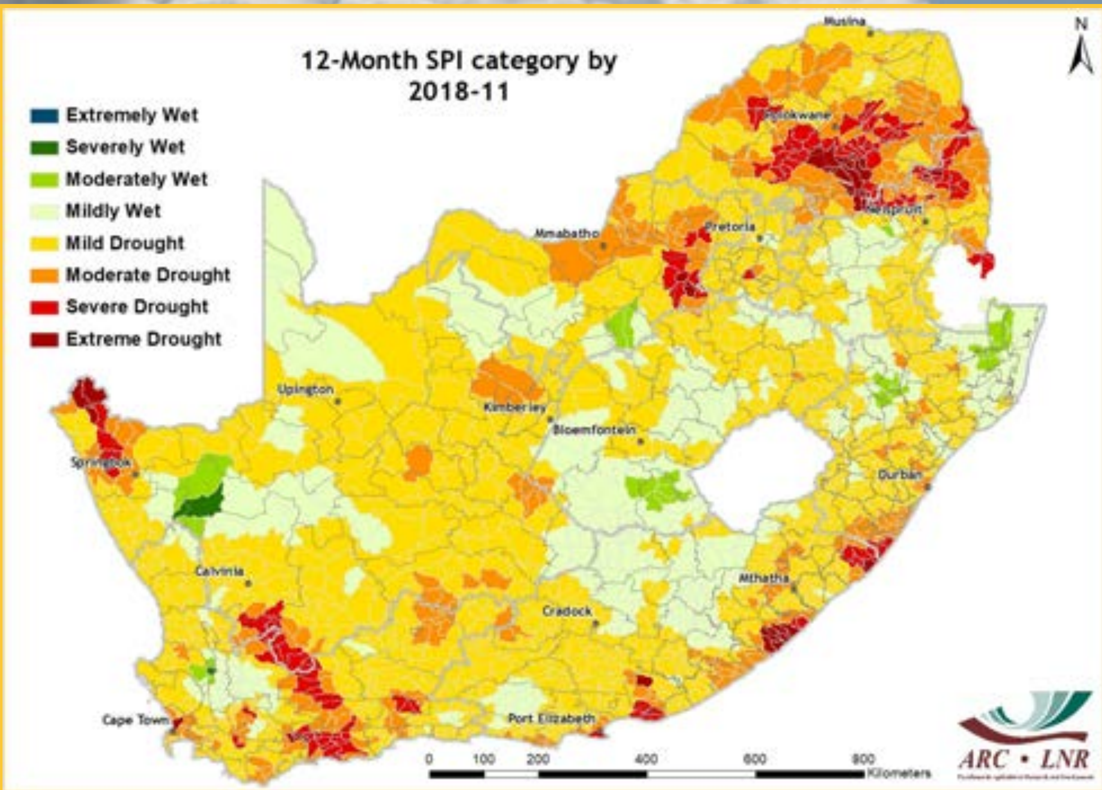

Figure 6

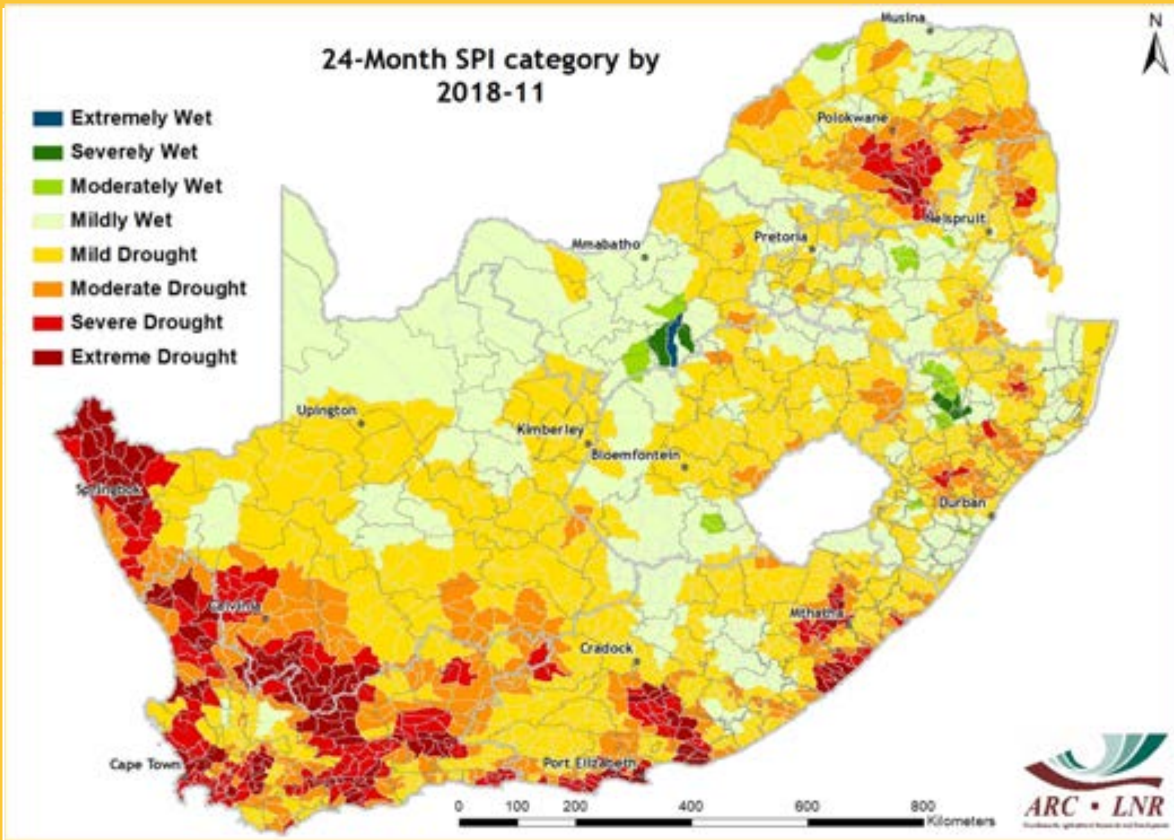

Figure 7

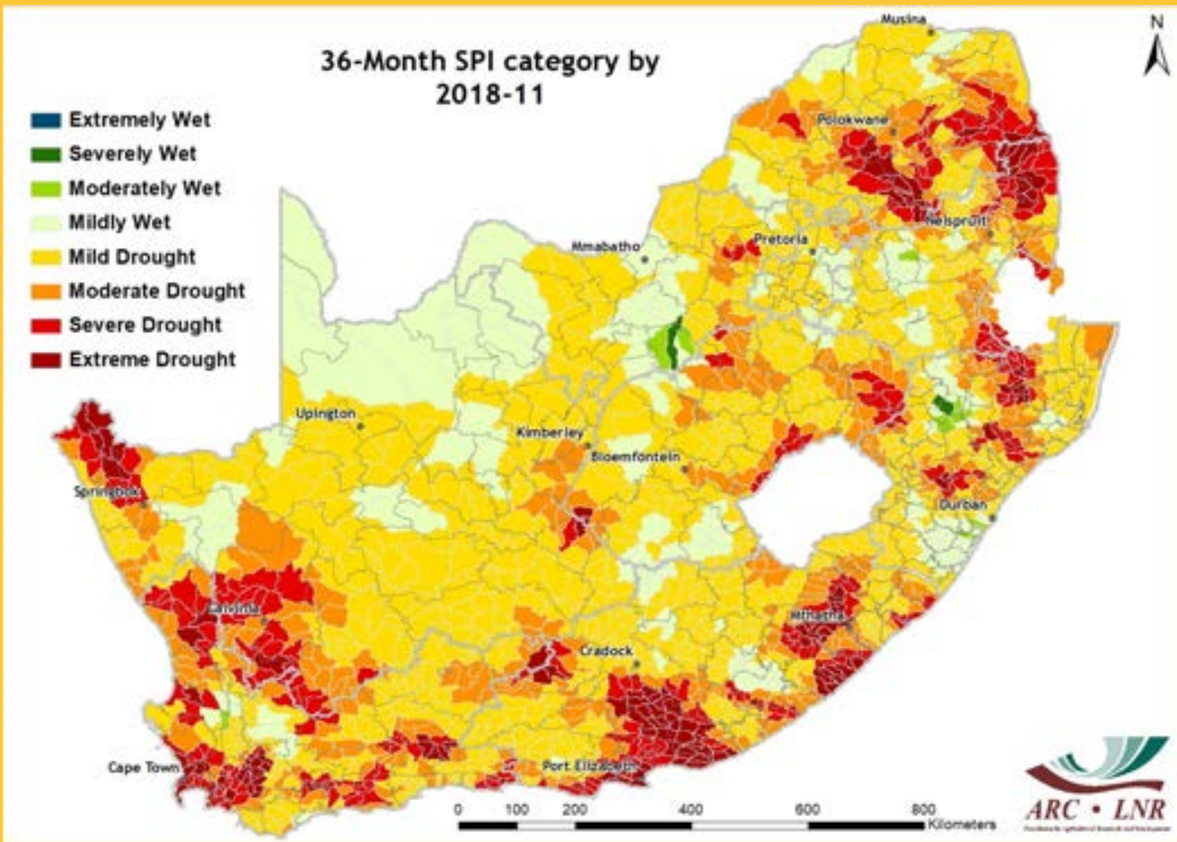

Figure 8

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.

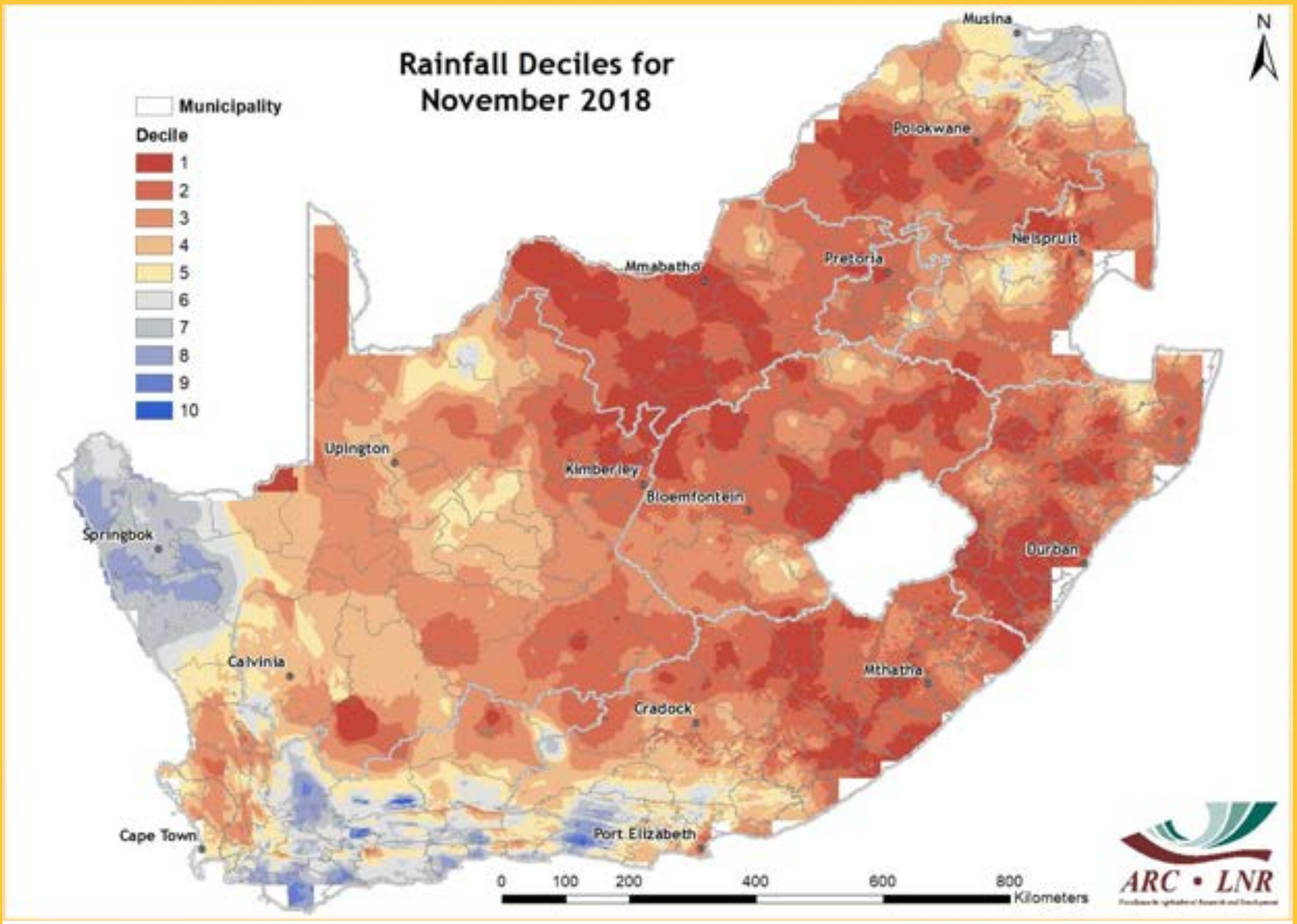

Figure 9

Figure 9:
Rainfall totals during November 2018 over most of the country fell within the drier November months compared to historical November rainfall totals. Over the central to southeastern parts of the country, November 2018 was particularly dry. However, some areas in the southern parts of the country had a decent rainfall month compared to historical November rainfall totals.

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4. 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.

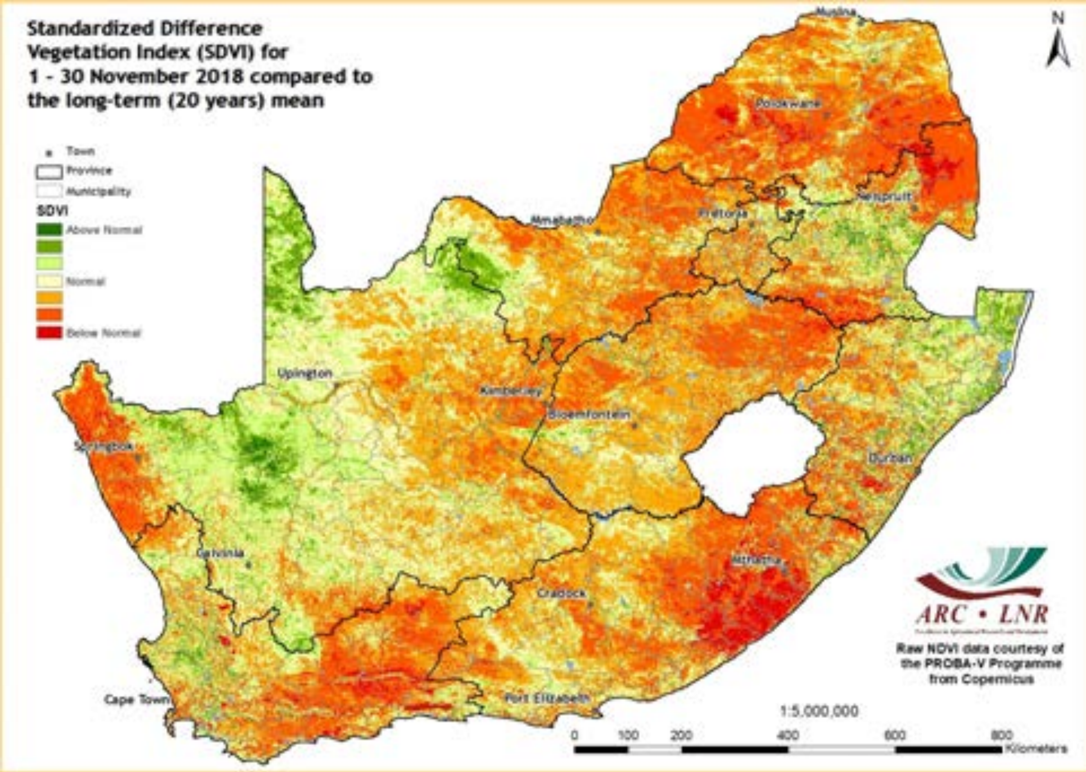

Figure 10

Figure 10:
As shown on the November SDVI map, below-normal vegetation conditions have spread from one to many provinces in the country, including the summer rainfall regions such as Limpopo where vegetation conditions are expected to be normal given that the rainy season has began.

Figure 11:
The NDVI difference map indicates that, compared to November 2017, the western parts of the country experienced improved vegetation conditions in November this year, while below-normal vegetation activity spread to much larger geographical areas in the eastern parts.

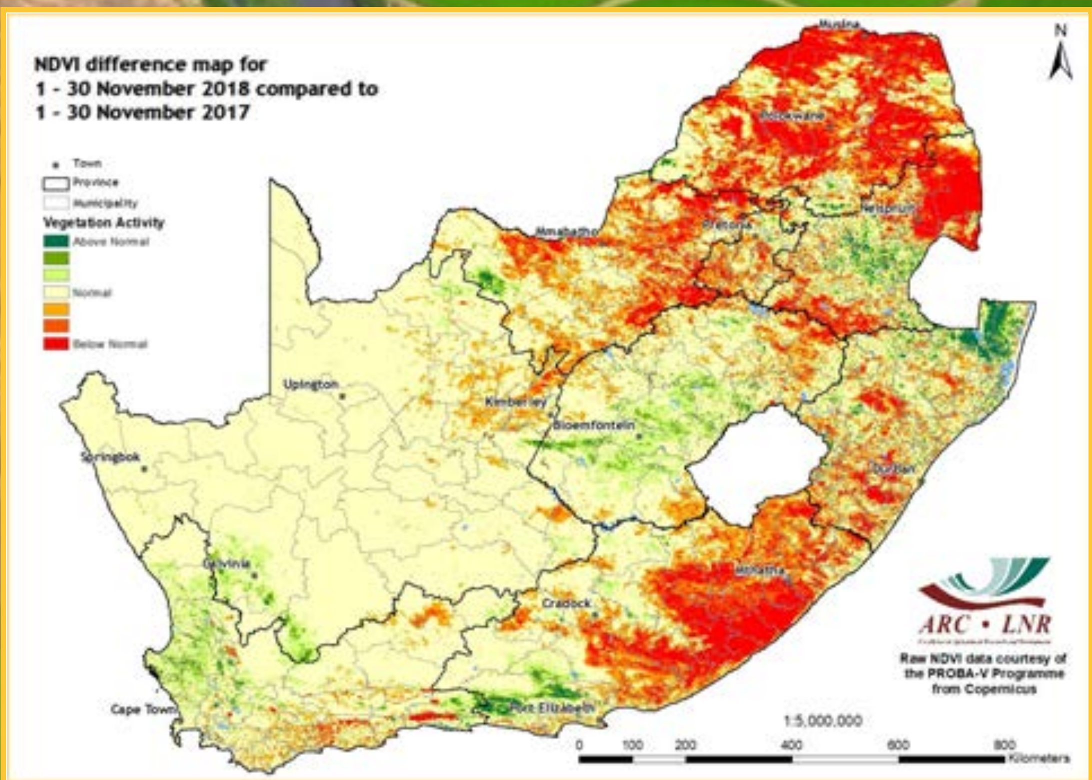

Figure 11

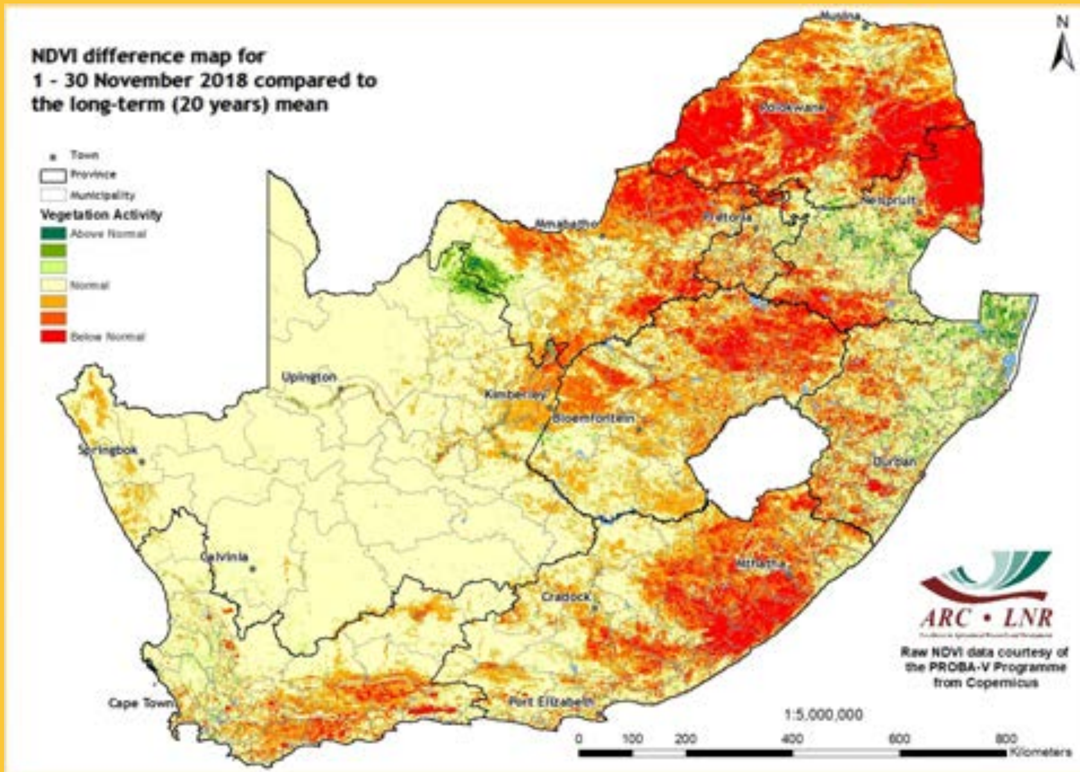

Figure 12

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

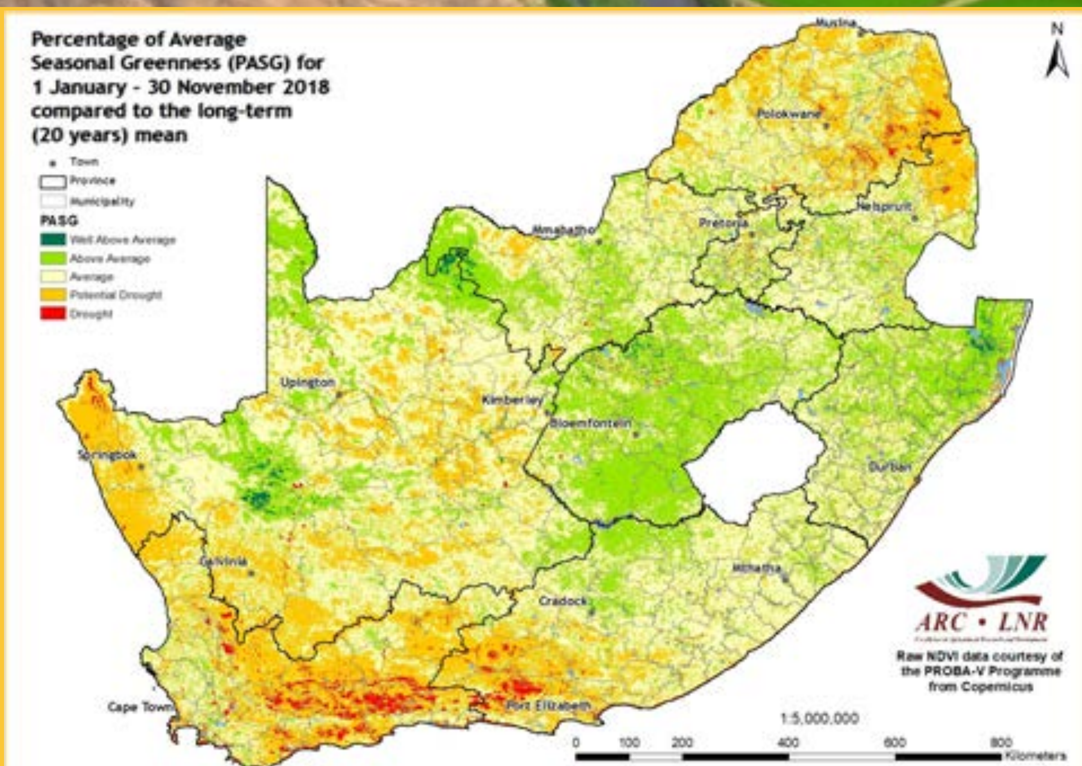

Figure 13

Figure 12:
Compared to the vegetation conditions calculated and averaged over 20 years, the NDVI difference map for November 2018 shows that the country's interior experienced below-normal vegetation activity while much of the Northern Cape experienced normal activity.

Figure 13:
As shown on the PASG map for November, the vegetation greenness observed and averaged over an 11-month window was normal over much of the interior. However, the opposite was observed in Limpopo, Western Cape, Eastern Cape and much 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.

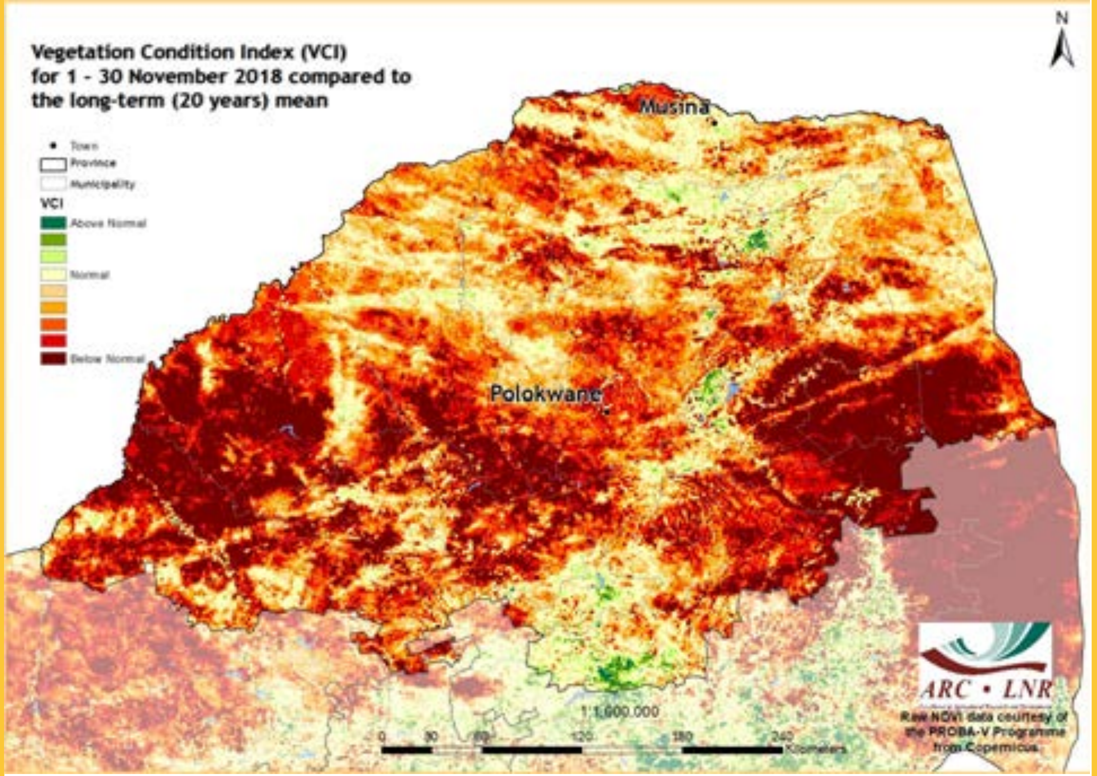

Figure 14

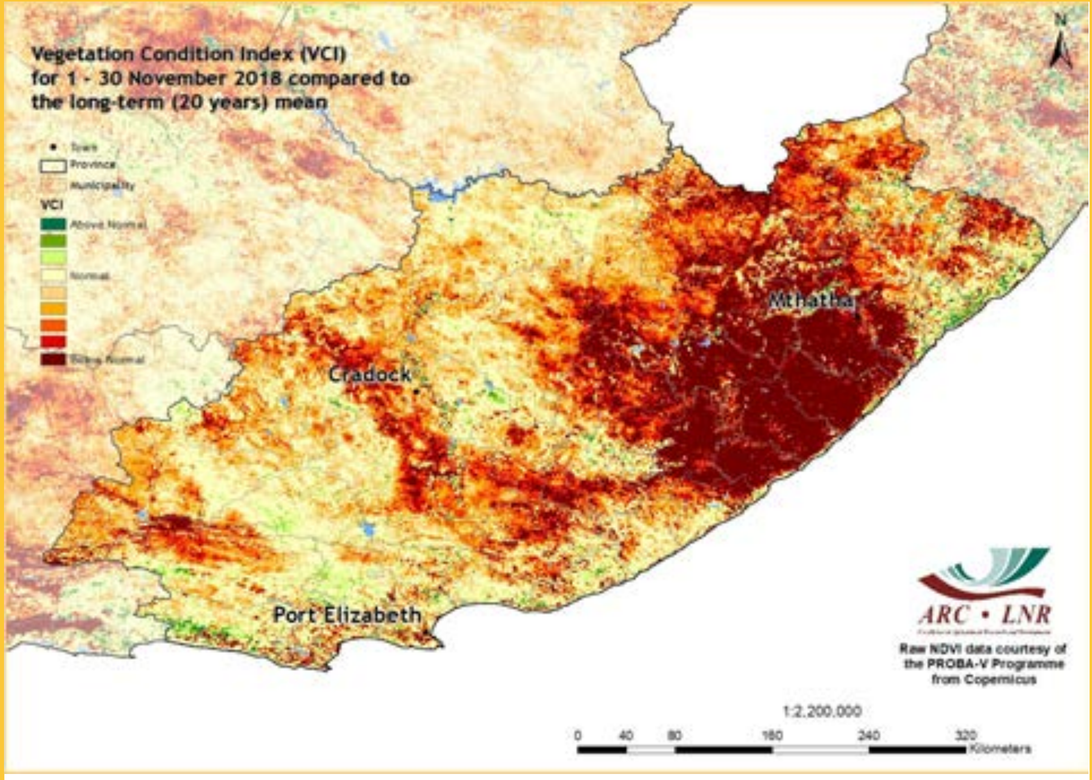

Figure 15

Figure 14:
Inadequate and poorly distributed rainfall continue to accelerate the spread of unfavorable conditions for plant growth and the decline of vegetation greenness to wider geographical areas of the Limpopo Province, as shown on the VCI map for November.

Figure 15:
The extent of poor vegetation conditions has, for the past few months, been dominant in the western region of the Eastern Cape. However, the November VCI map, shows that these conditions have spread across the entire province with the Amathole and Chris Hani districts being the most critical areas of concern.

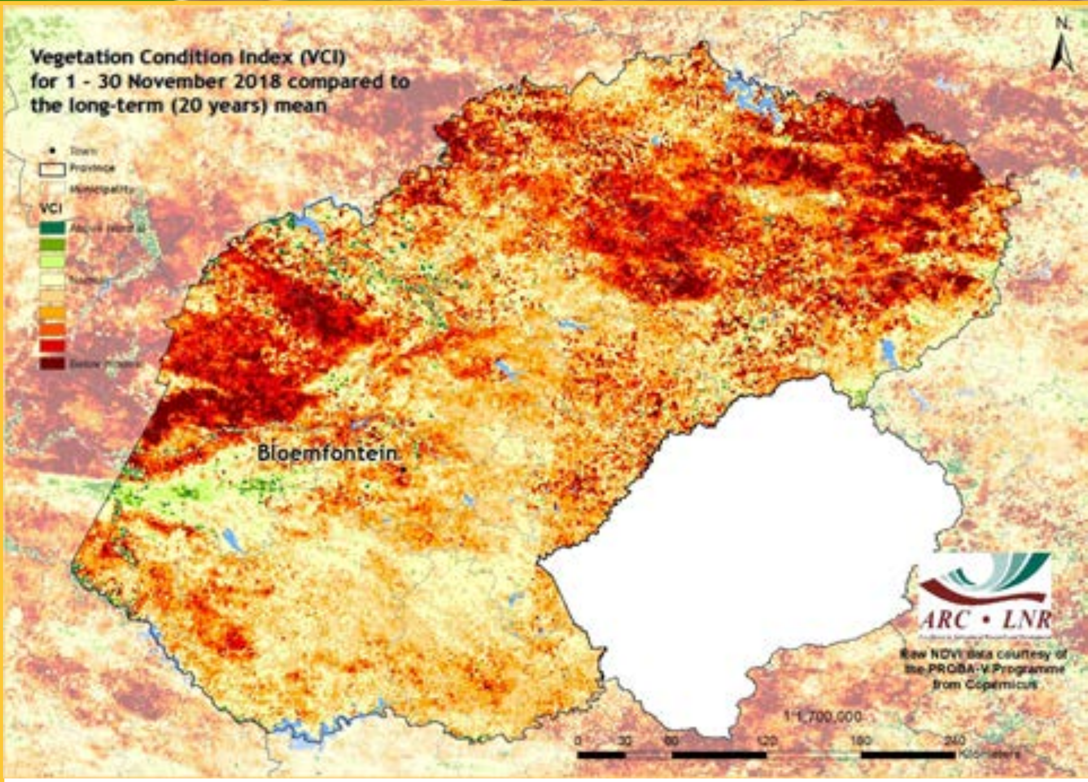

Figure 16

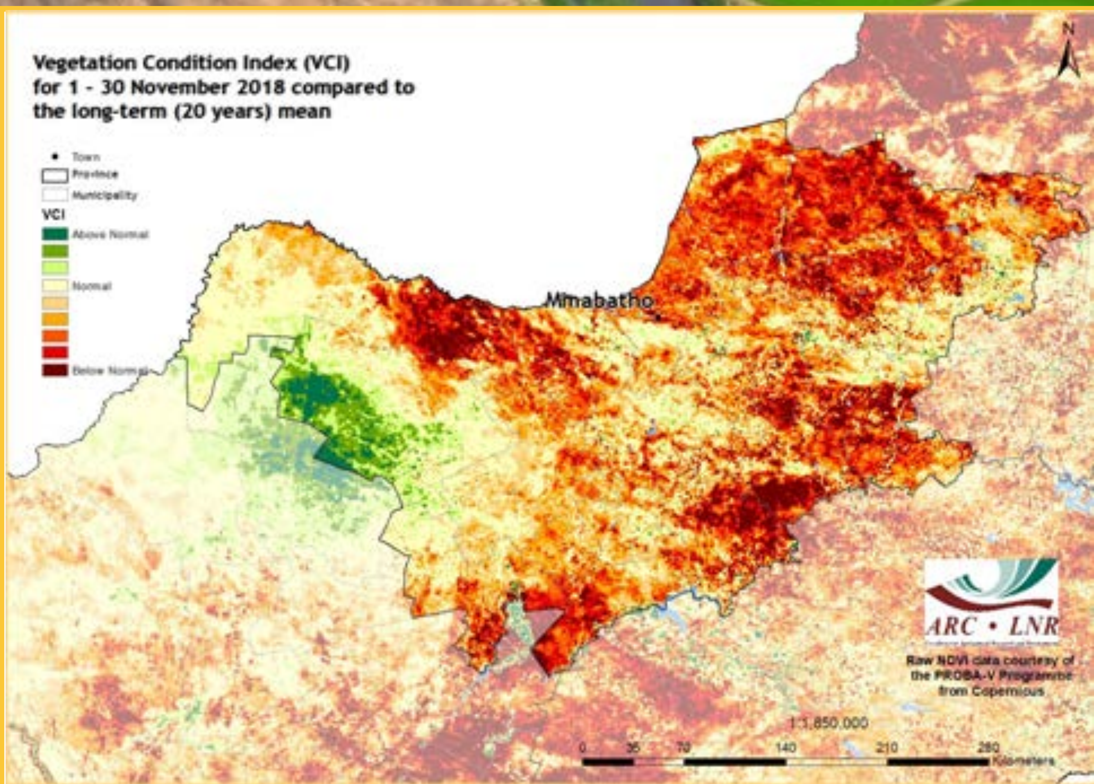

Figure 17

Figure 16:
Compared to other provinces in the country, below-normal vegetation activity has been limited to isolated areas of the Free State. However, the opposite was observed in November where unfavourable conditions were experienced in most parts of the province.

Figure 17:
Major parts of the North West experienced widespread extremely stressed vegetation conditions in November. Nevertheless, a cluster of above-normal vegetation conditions was observed in the far west of the province.

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6. Vegetation Conditions & Rainfall

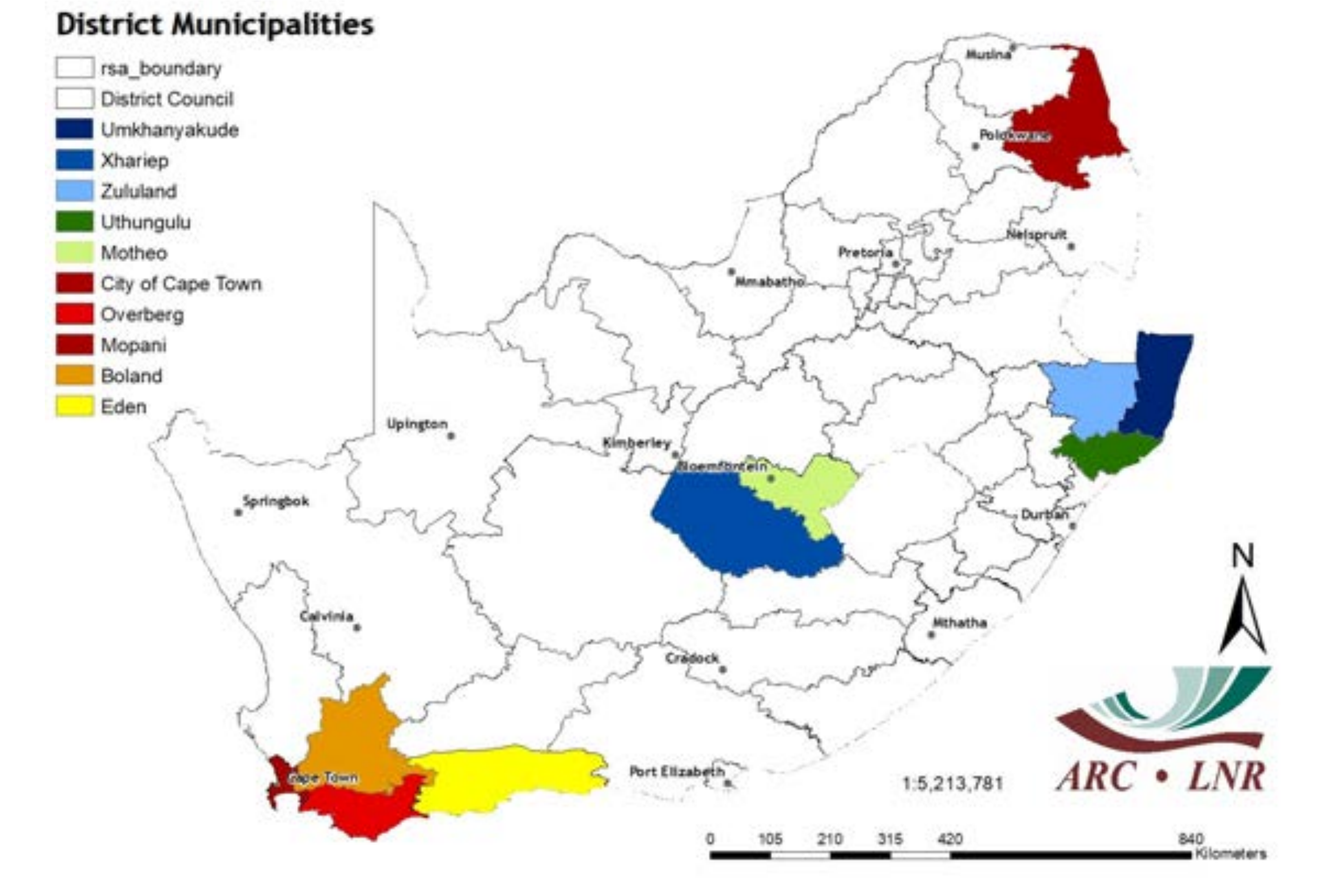

Figure 18

Rainfall and NDVI Graphs

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

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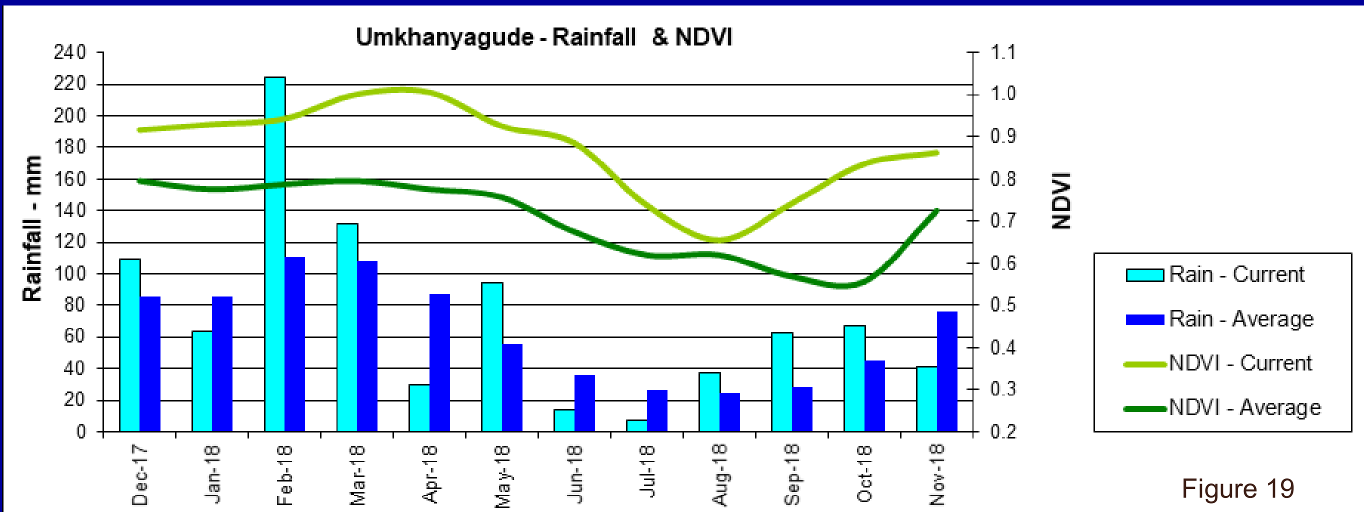
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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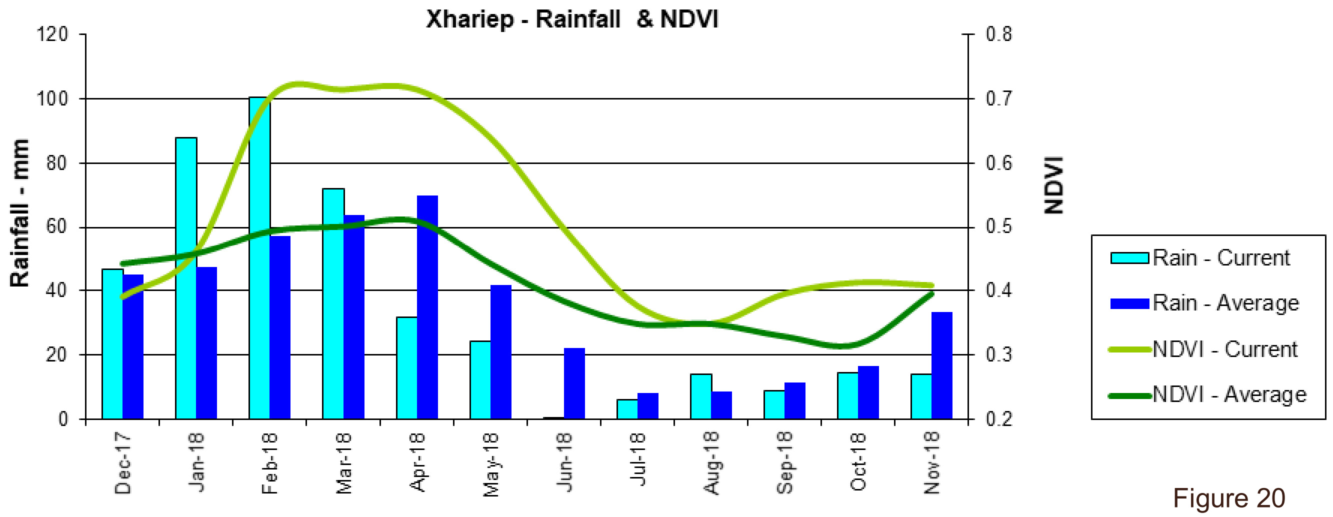

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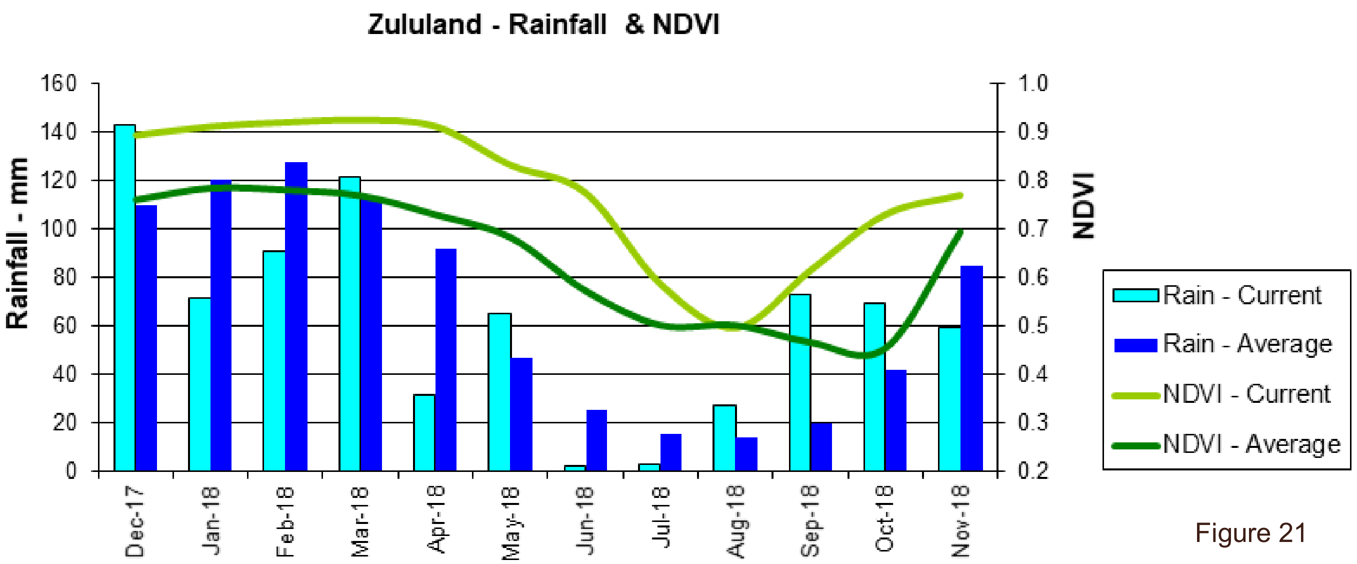

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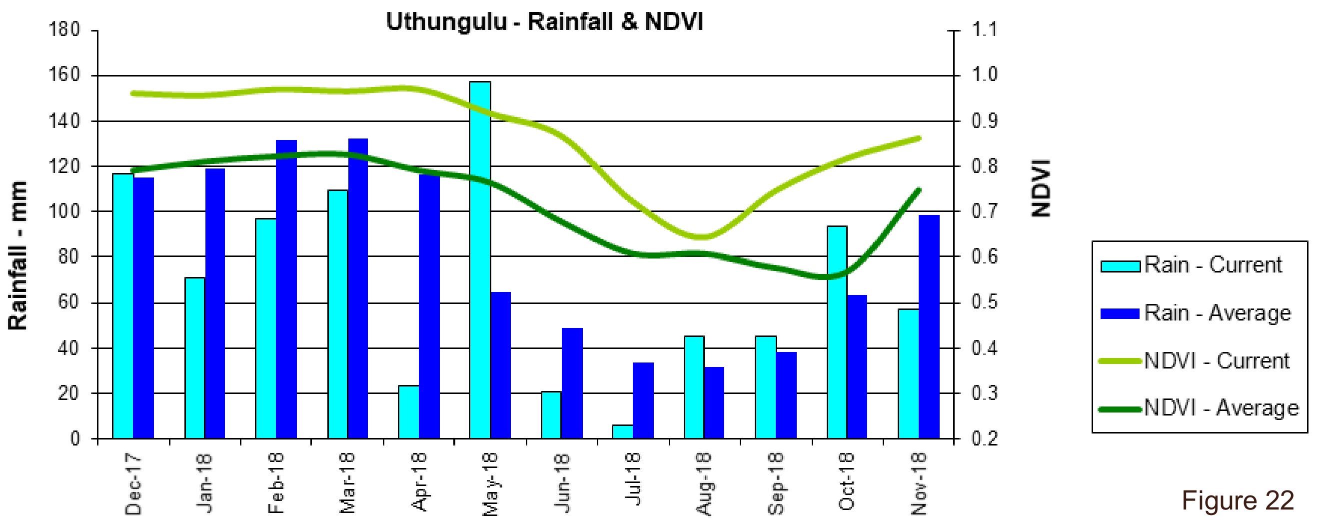

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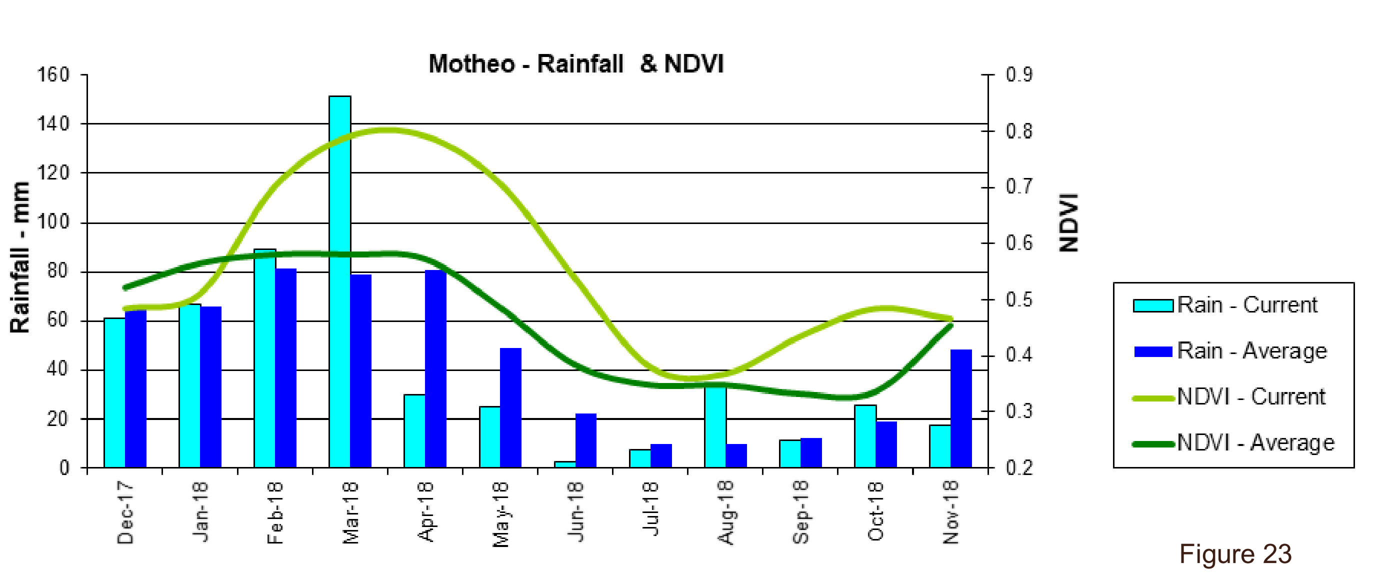

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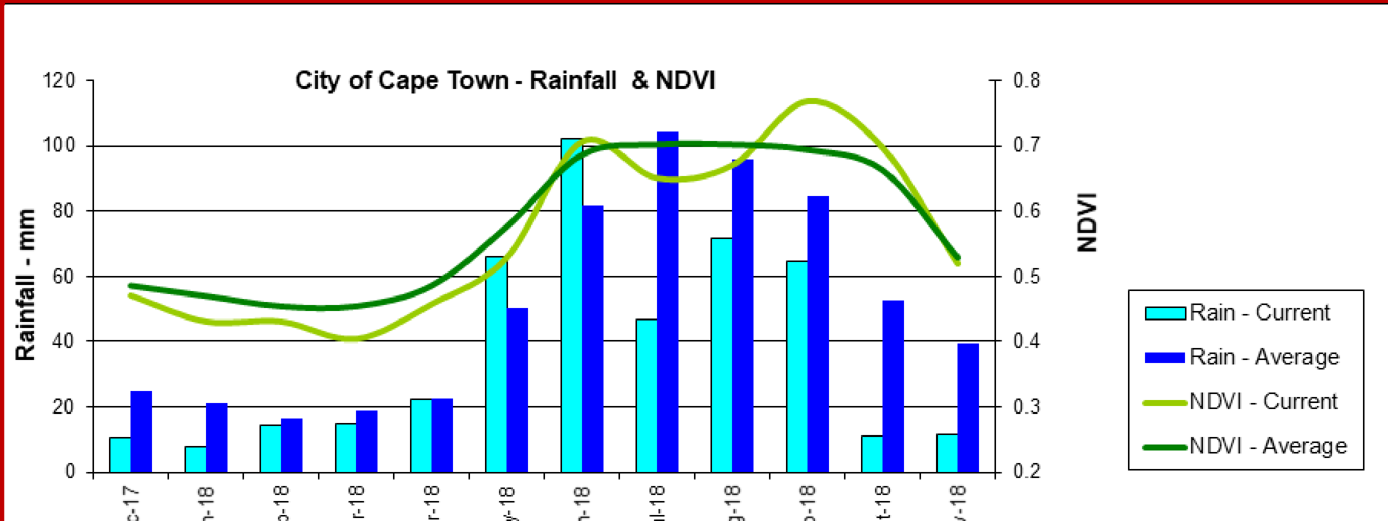

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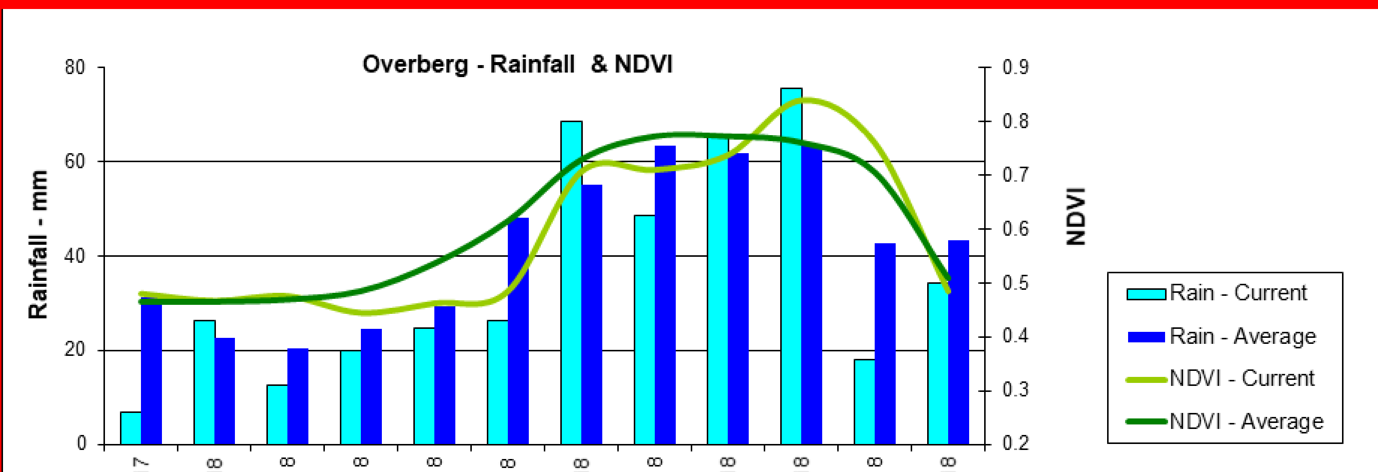

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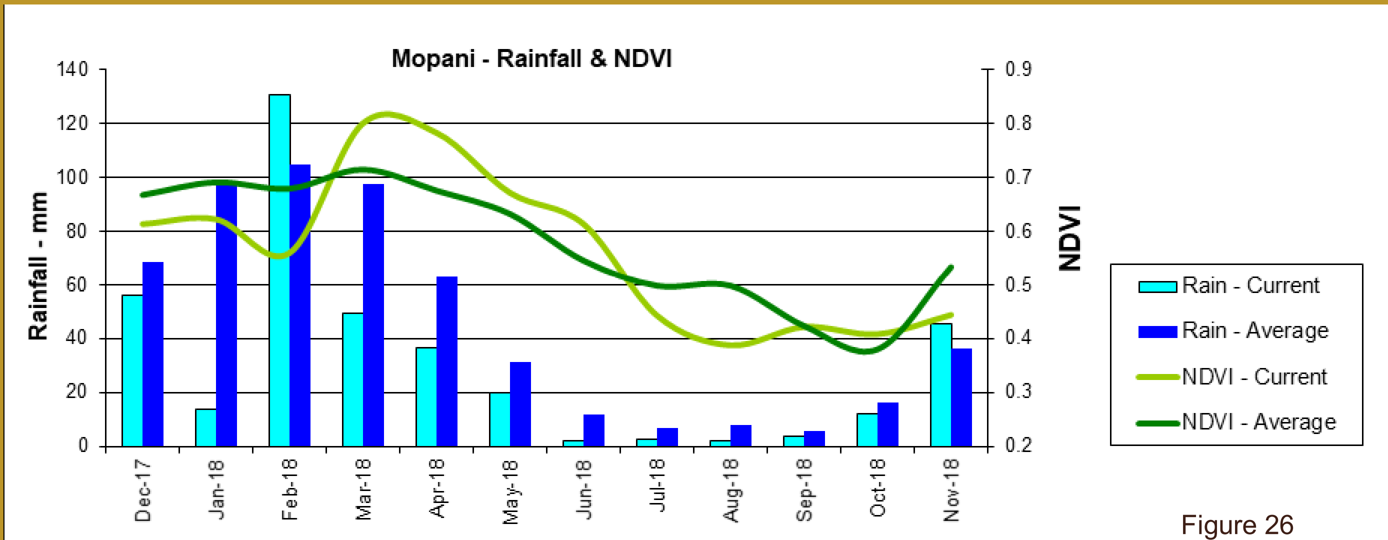
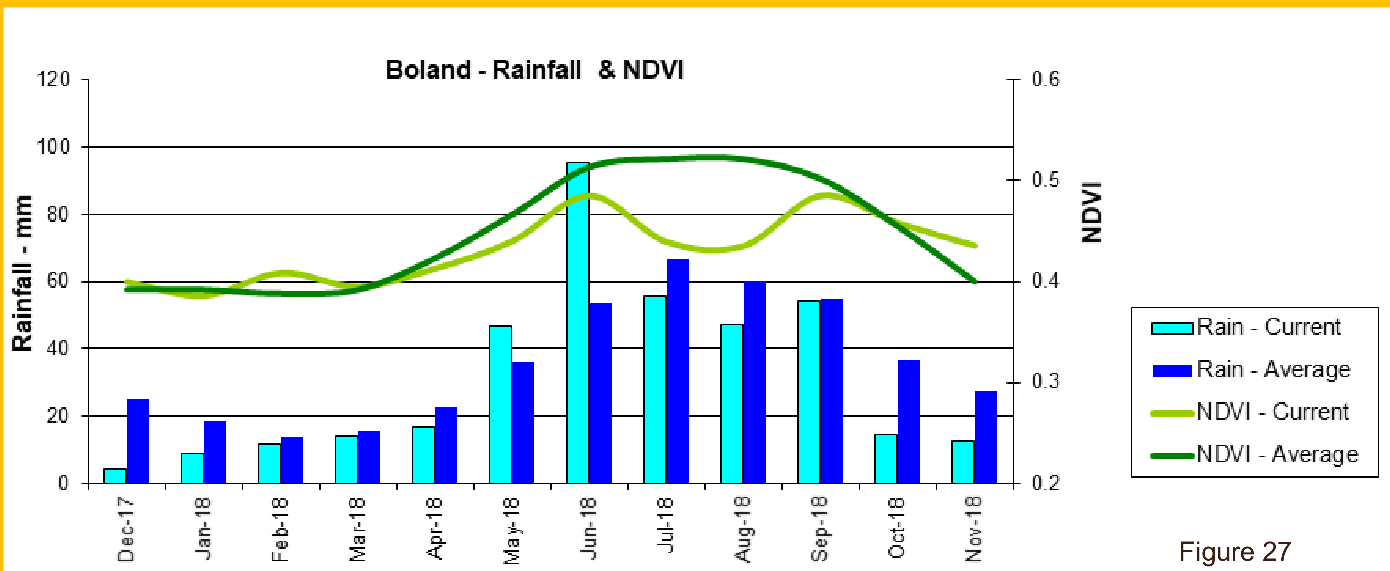


Figure 26



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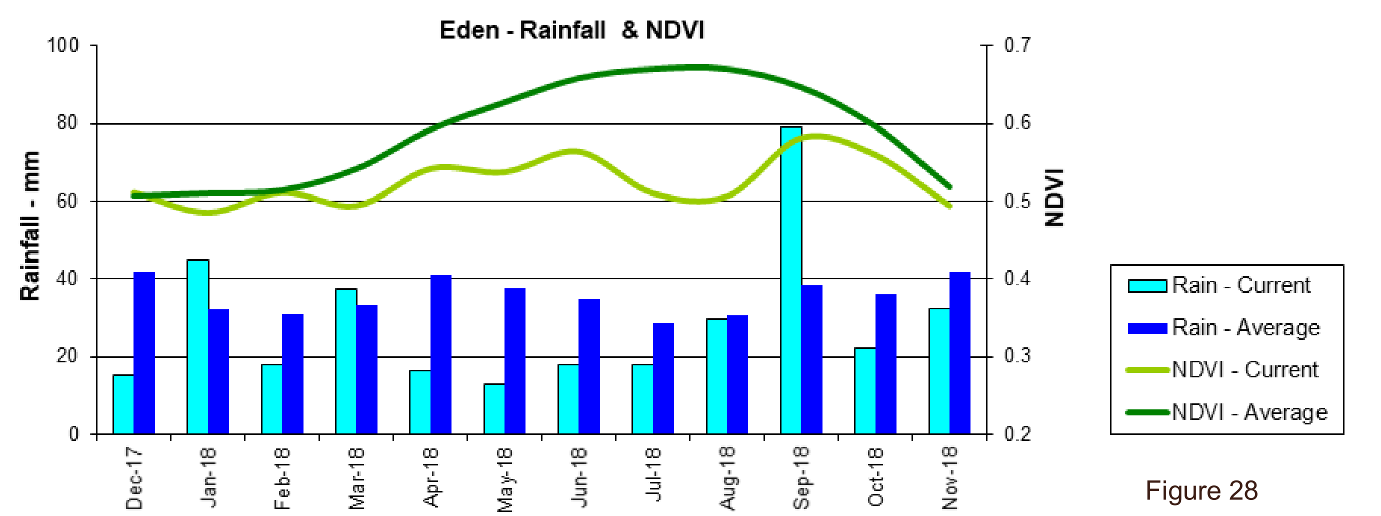

Figure 28

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 18 November - 1 December 2018 per province. Fire activity was higher in the Western Cape compared to the long-term average.

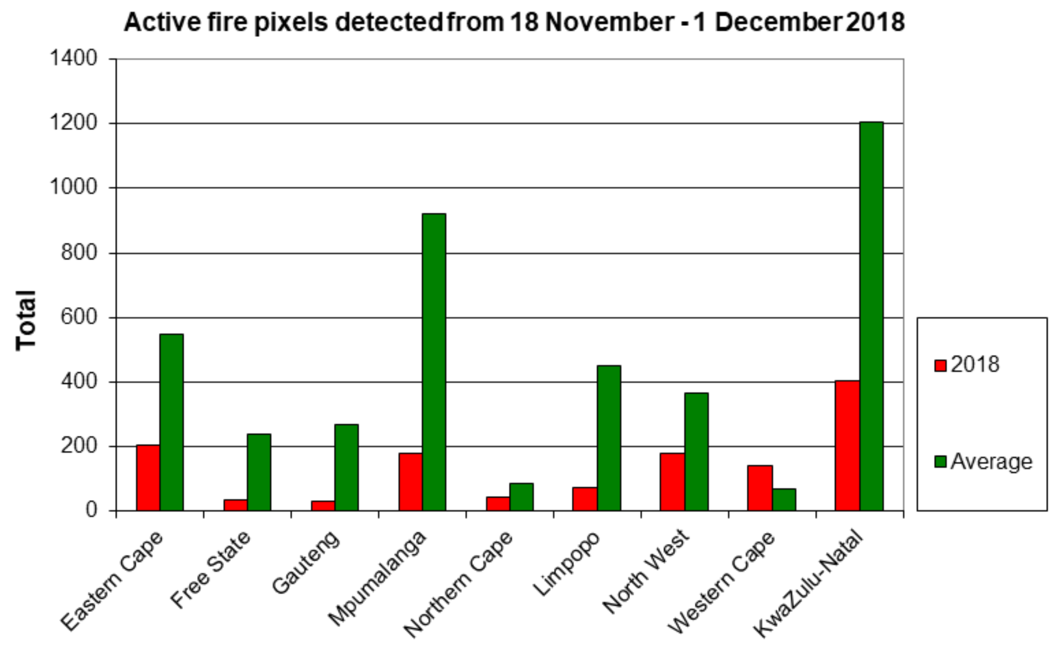

Figure 29

Figure 30:
The map shows the location of active fires detected between 18 November - 1 December 2018.

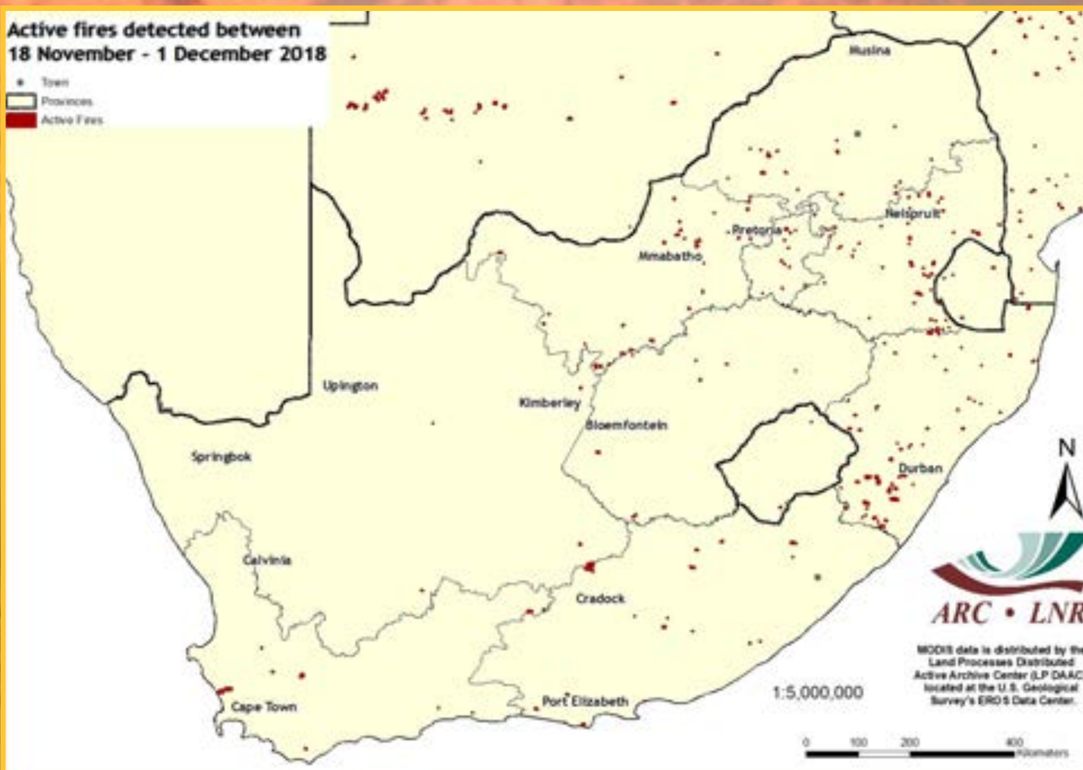

Figure 30

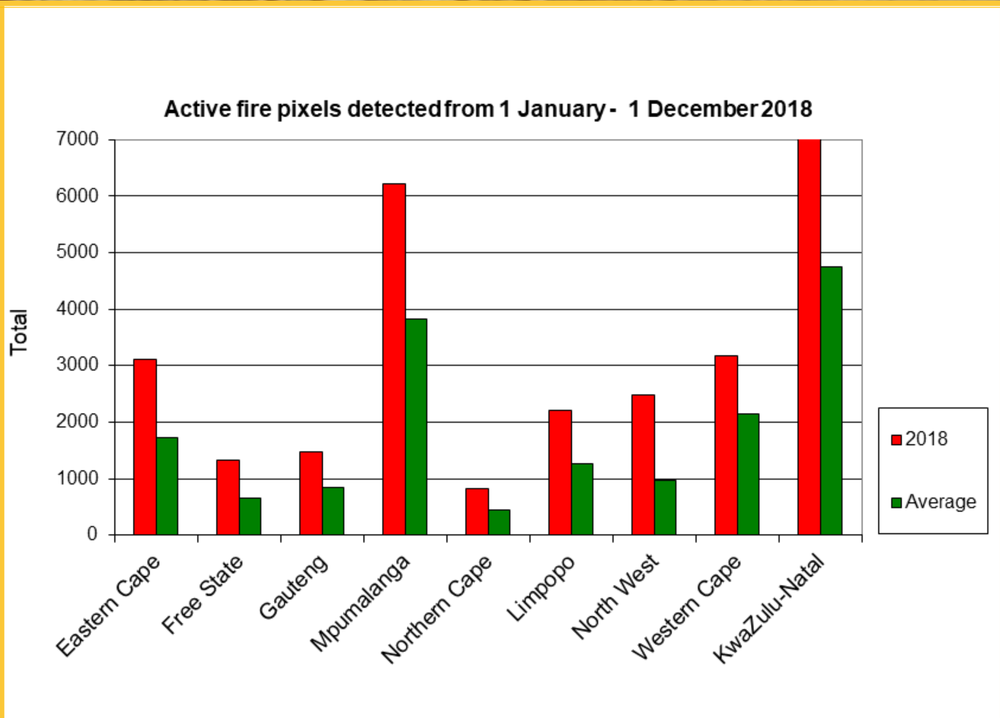

Figure 31

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

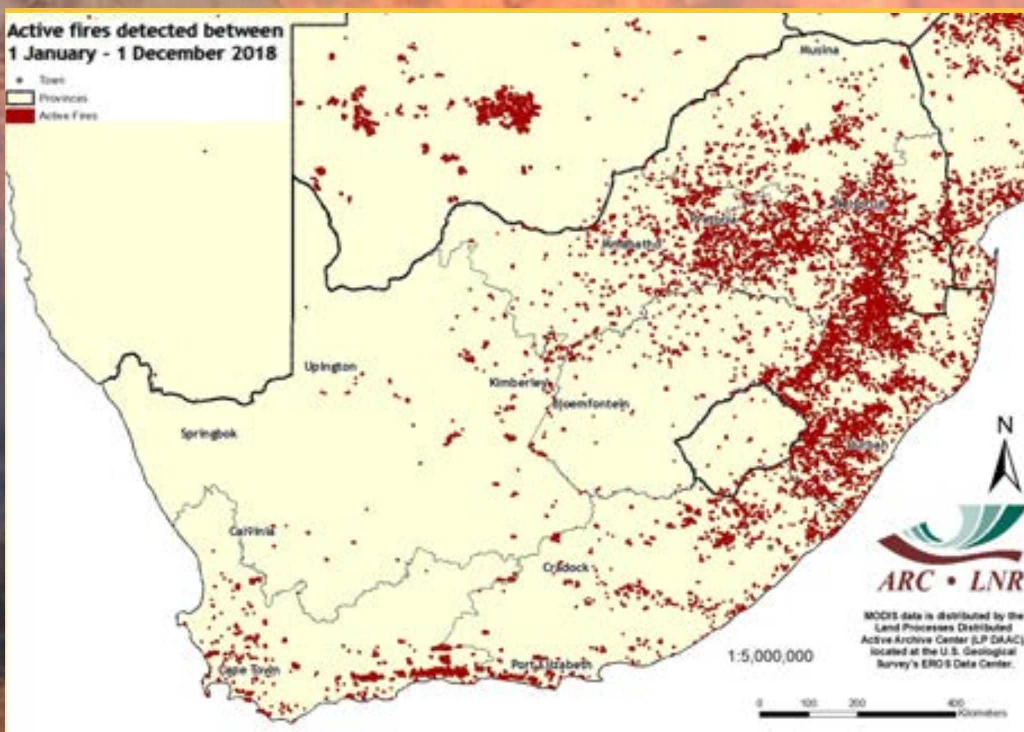

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January - 1 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, any value less than 100 represents 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 last year.

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. In the western regions of the Western Cape, however, some catchments are currently at their long-term maximum extent.

Comparison between November 2018 and November 2017 shows that generally the central interior catchments are typically experiencing equivalent or greater water extents this year than last year. However, specific (red) catchments in the 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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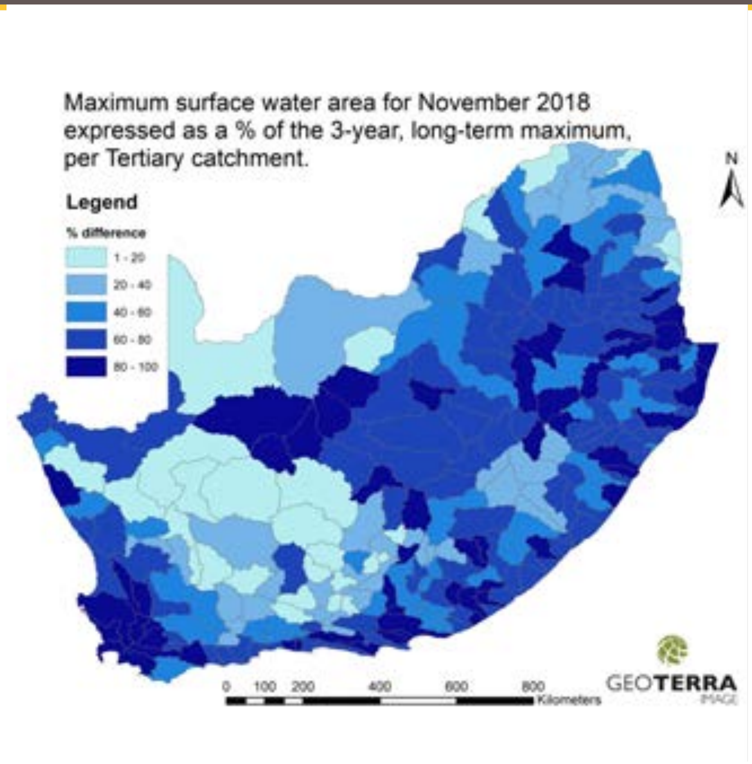

Figure 33

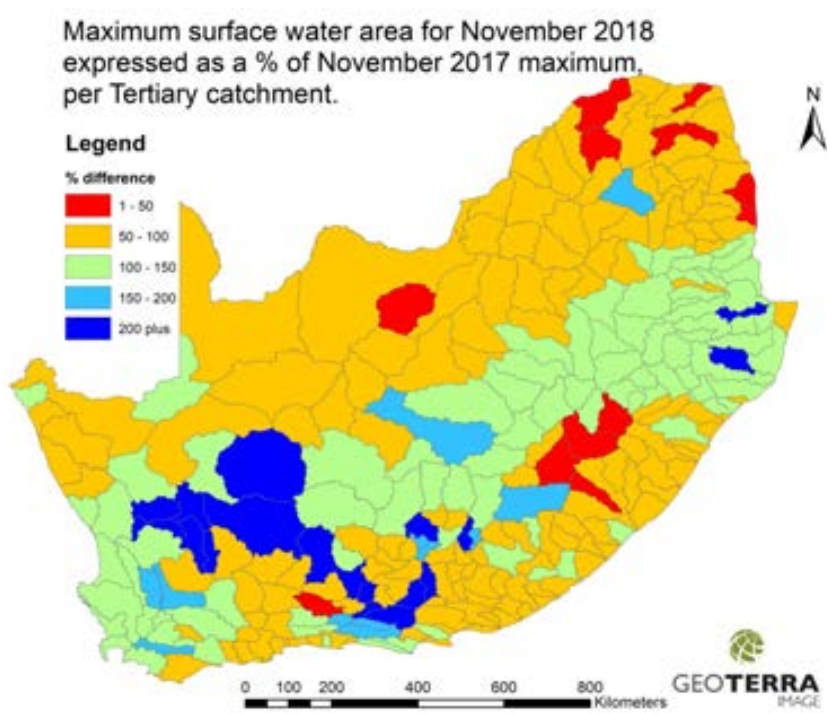

Figure 34

Agrometeorology

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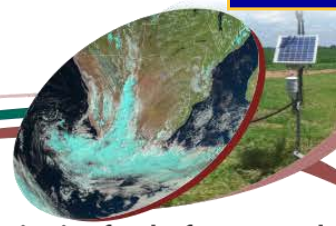

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national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