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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

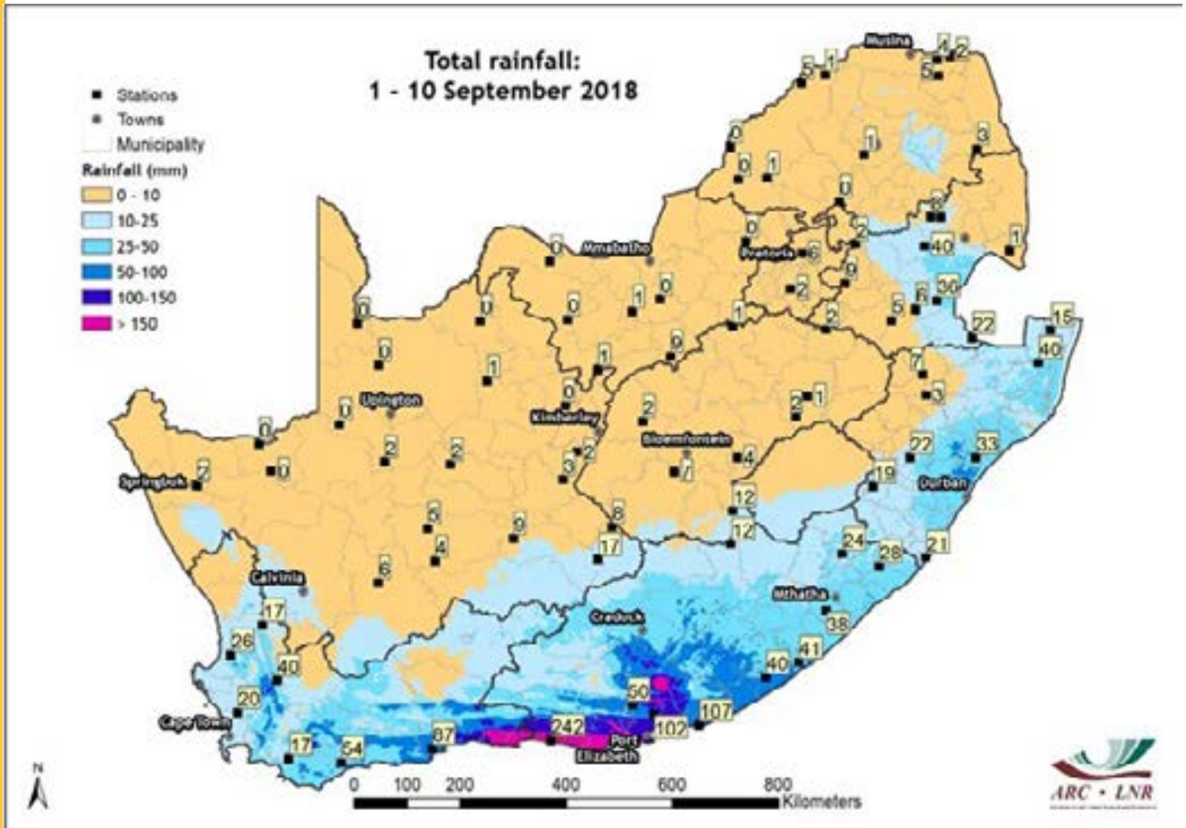
AMESD

171st Edition

Image of the Month

Good rainfall brings relief to drought-stricken Cape south coast

The southern coastal belt of South Africa has experienced far below-normal rainfall during most of the time since the end of 2015. This region of the country usually receives rainfall throughout the year, with the seasonal contribution to the annual rainfall quite comparable over the seasons, although the months of September to October typically contribute most to the annual rainfall total. Over the past few years, the lack of rainfall over this region became severe, resulting in diminished vegetation activity and critically low water storage levels. However, relief finally came at the beginning of September 2018 with even more rain that fell towards the end of the first week of September as a cut-off low weather system moved over this area. Some parts along the coast to the west of Port Elizabeth received more than 200 mm during this period, whilst most of this coastal belt received rainfall totals exceeding 50 mm (see map below). Unfortunately, although this rainfall brought huge relief in terms of water storage, it also had a negative impact on some agricultural activities due to water damage.



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:

During August 2018, the winter rainfall region received near-normal to above-normal rainfall with some isolated areas that received below-normal rainfall. Over the all-year rainfall region, the month of August experienced better rainfall conditions compared to the preceding winter months so far. It is in particular the area around Port Elizabeth that received better rainfall with totals over this areas that were above normal. Above-normal rainfall also occurred over parts of the western interior, central to southeastern parts of the country and along parts of the eastern escarpment.

After the month of July experienced a decrease in the passage of frontal systems that made landfall, an increase of frontal activity occurred during August. About five cold fronts made landfall that contributed to the August rainfall totals. Moreover, some of these frontal systems (around the 7th and 26th) were accompanied by snow over the mountains of the Western and Eastern Cape, contributing to water storage over these water stressed areas. The frequent passage of frontal systems caused below-normal maximum and minimum temperatures over most parts of the country, with the exception over the northeastern areas where temperatures were above normal.

The above-normal rainfall over the central to southeastern parts of the country occurred as result of a sharp upper-air trough that was situated just to the west of the country on the 9th of August. A good contribution of the above-normal rainfall during August in the drought stricken Kouga region occurred during the passage of this upper-air system that also caused snowfall over Lesotho as it progressed eastwards. Towards the middle of the month, the atmospheric flow was more of a zonal nature with weak frontal systems that passed south of the country before a stronger frontal system made landfall again on the 16th. The remainder of the month was characterized by the frequent passage of frontal systems, accompanied by upper-air support. The strongest system made landfall on the 25th of August and brought good rain and snow to the southwestern and southern parts of the country.

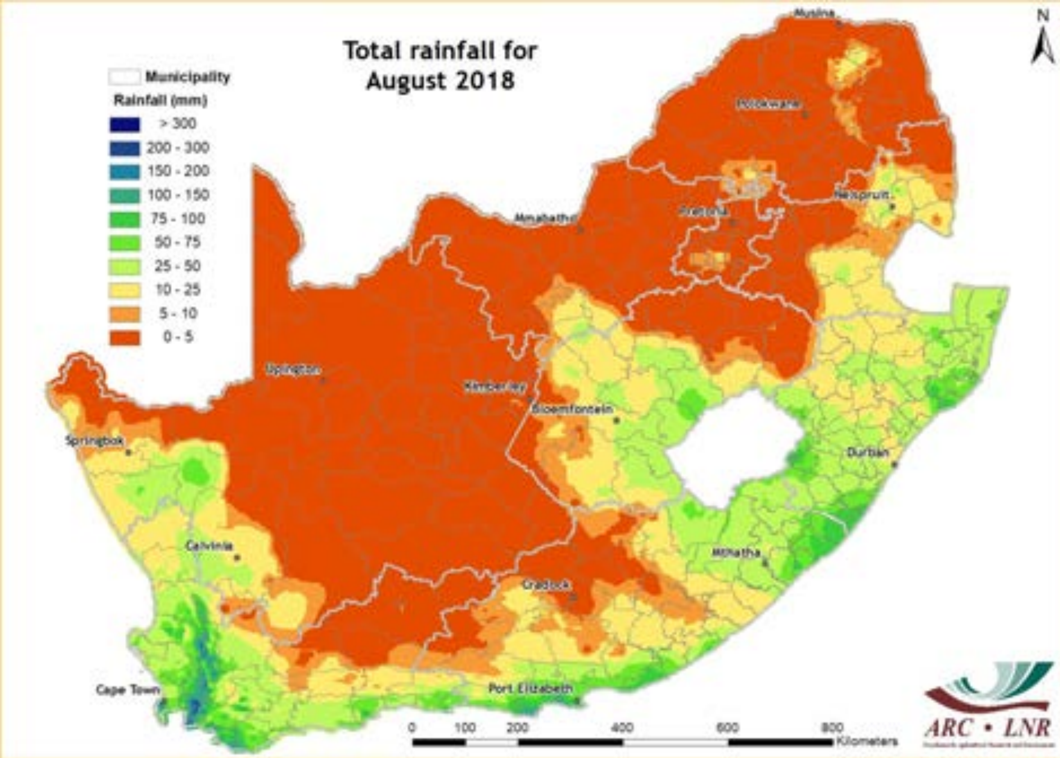


Figure 1

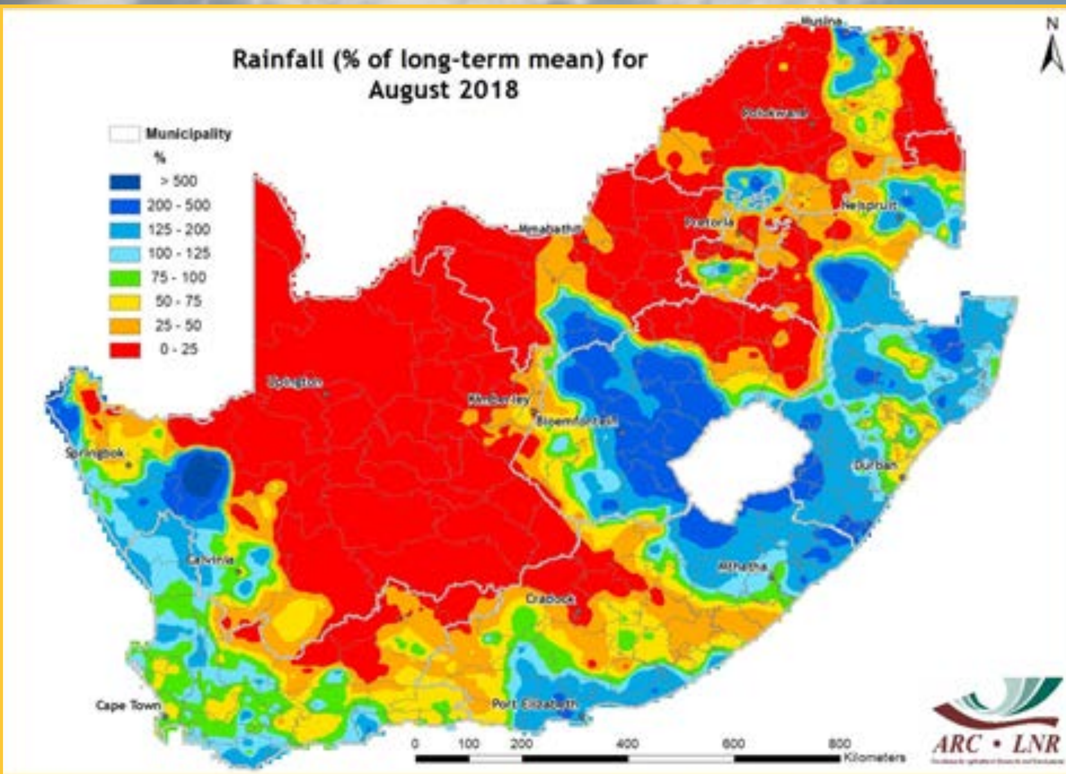


Figure 2

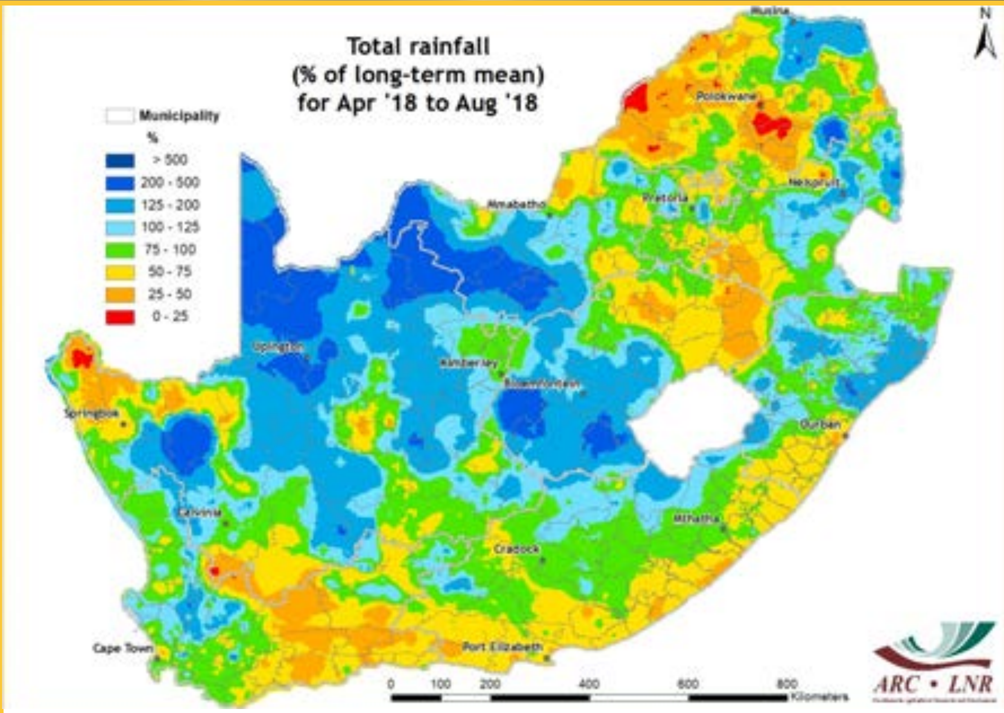


Figure 3

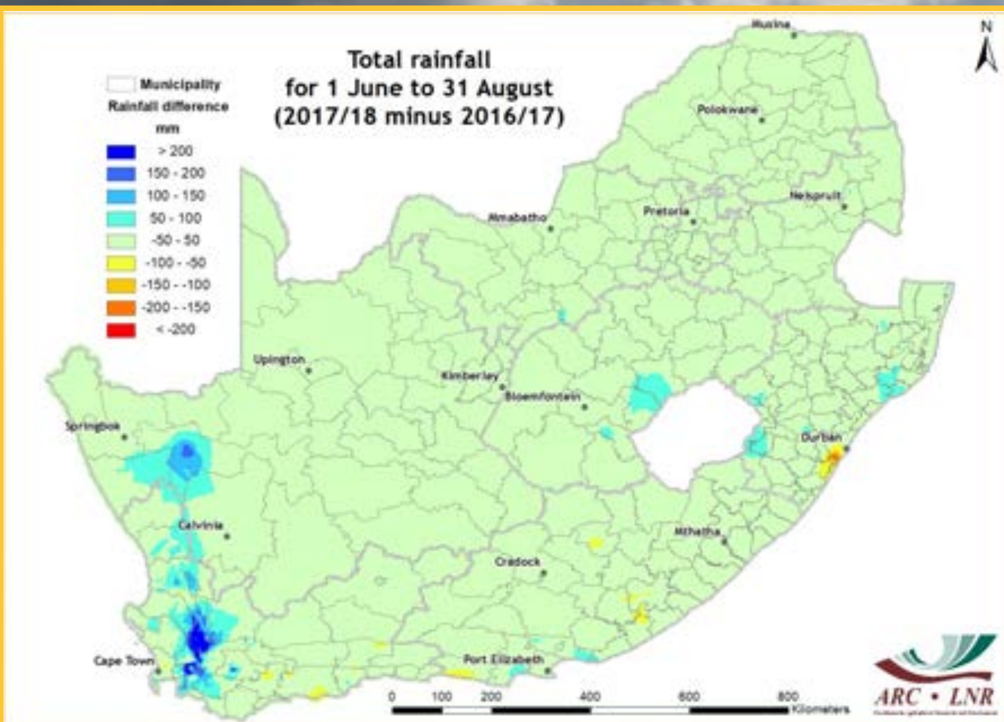


Figure 4

Figure 1:
The relatively frequent passage of frontal systems with some ridging that took place behind them resulted in rainfall over the winter and all-year rainfall regions extending to the eastern coastal belt and escarpment on occasion. The presence of upper-air systems around the 9th and 22nd resulted in rainfall occurring over parts of the interior that typically receives summer rainfall.

Figure 2:
Over the winter rainfall region, above-normal rainfall occurred over the northern parts along the west coast, whilst near-normal to above-normal rainfall occurred over the southwestern parts of this region. Along the southern coastal belt – the all-year rainfall region – the central parts received below-normal rainfall flanked by areas of above-normal rainfall. Above-normal rainfall also occurred over parts of the central to southeastern interior as well as along the eastern coastal belt and parts of the eastern escarpment.

Figure 3:
During the past 5 months – mostly winter months – the parts of the country that received above-normal rainfall are actually summer rainfall regions. Large parts of the western and central interior as well as large parts over the far east of the country (although of an isolated nature) received above-normal rainfall. Over the winter rainfall region a mixed signal can be seen, although in general rainfall was near normal, with above-normal rainfall further northwards on the boundary of the winter and summer rainfall regions. The all-year rainfall region experienced below-normal rainfall during this 5-month period.

Figure 4:
Compared to the corresponding period during 2017, improved rainfall conditions occurred during 2018 over the mountainous regions of the far southwestern parts of the country, extending northwards over the Northern Cape. Over the remainder of the country there is not much difference from the June-July-August rainfall of 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.

At the 36-month time scale, drought conditions occurred over many parts of the country, but in particular over the winter rainfall region, the Port Elizabeth and surrounding areas as well as areas in the eastern parts of the country where severe to extreme drought conditions occurred. Relief from the severe drought conditions occurred over areas of the central to southeastern parts on the 24-month time scale, whilst drought conditions over the southwestern parts intensified and extended eastwards along the Cape south coast region. On the 12-month time scale, drought conditions deteriorated slightly over the northeastern parts of the country compared to the 24-month time scale, whilst the intensity of the drought over the southwestern parts lifted somewhat and relief from the drought conditions is present over some isolated areas of the western interior. The 6-month SPI indicates mildly to moderately wet conditions over the central to southeastern parts of the country. An improvement from the drought conditions over the far western parts is also visible on the 6-month time scale, whilst drought conditions over the Cape south coast region became more severe and increased in spatial extent.

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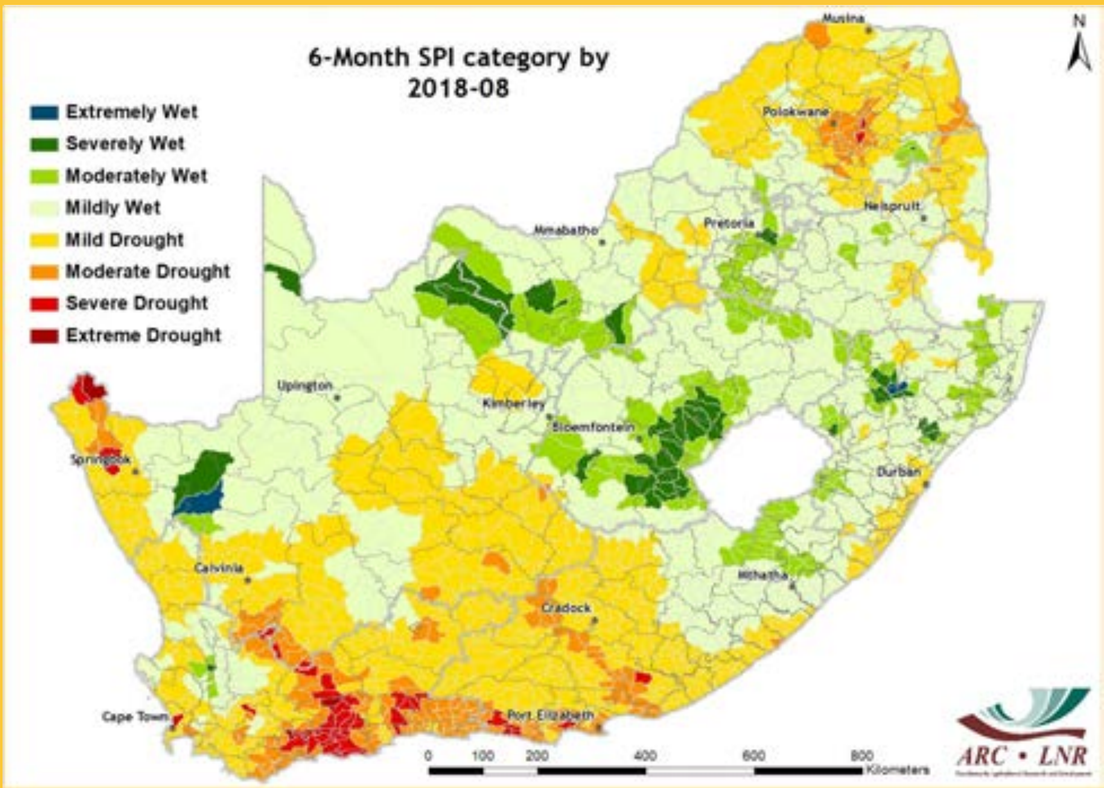

Figure 5

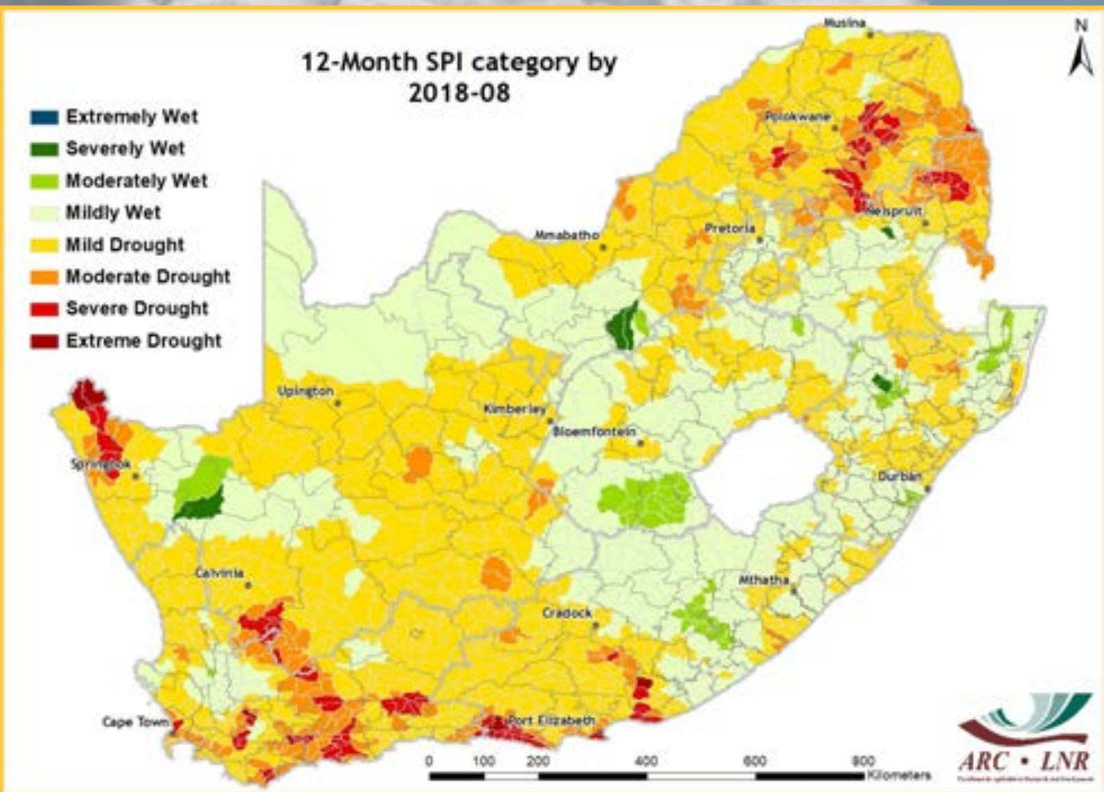

Figure 6

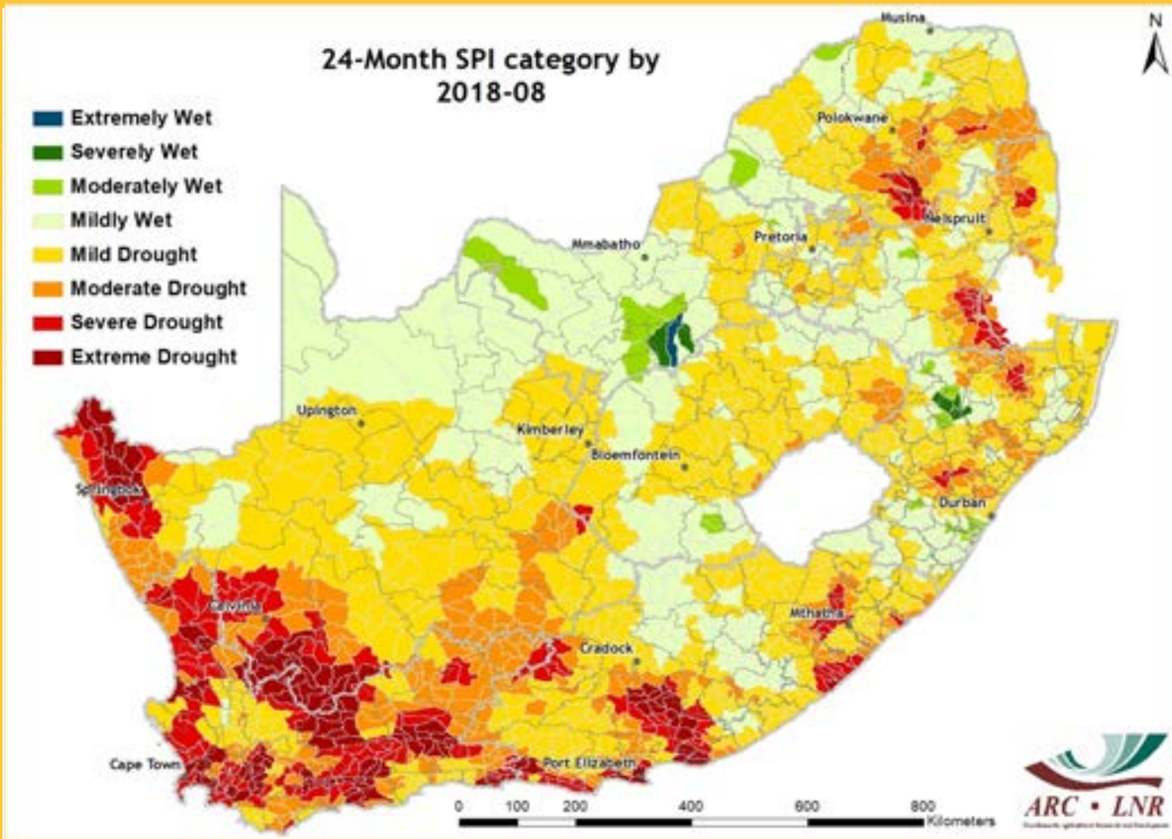

Figure 7

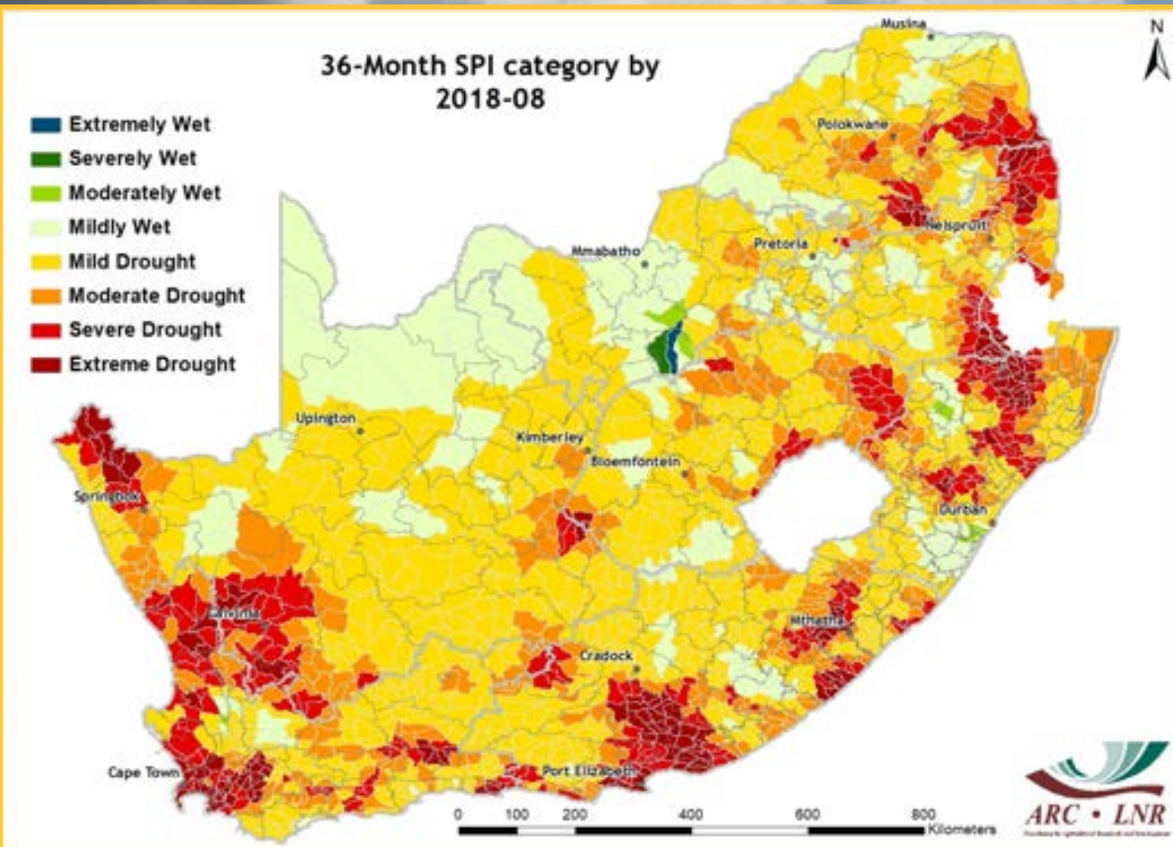

Figure 8

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.

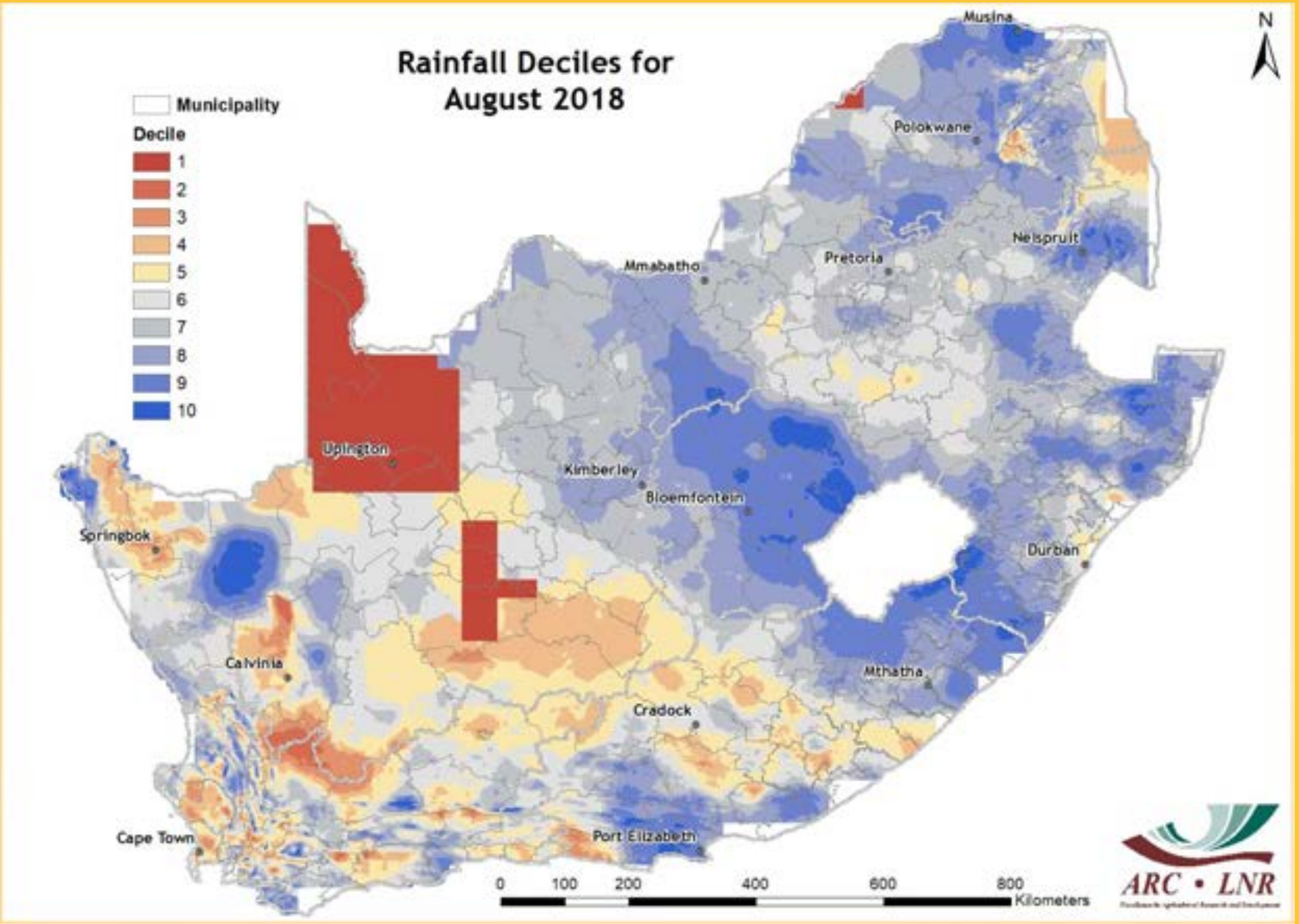

Figure 9

Figure 9:
Rainfall totals during August 2018 over most of the central to eastern and northeastern parts of the country fall within the wet August months compared to historical August rainfall totals. Over the winter and all-year rainfall regions, a mixed signal is present, with some areas falling within wet August months and the other areas within dry August months compared to historical August 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.

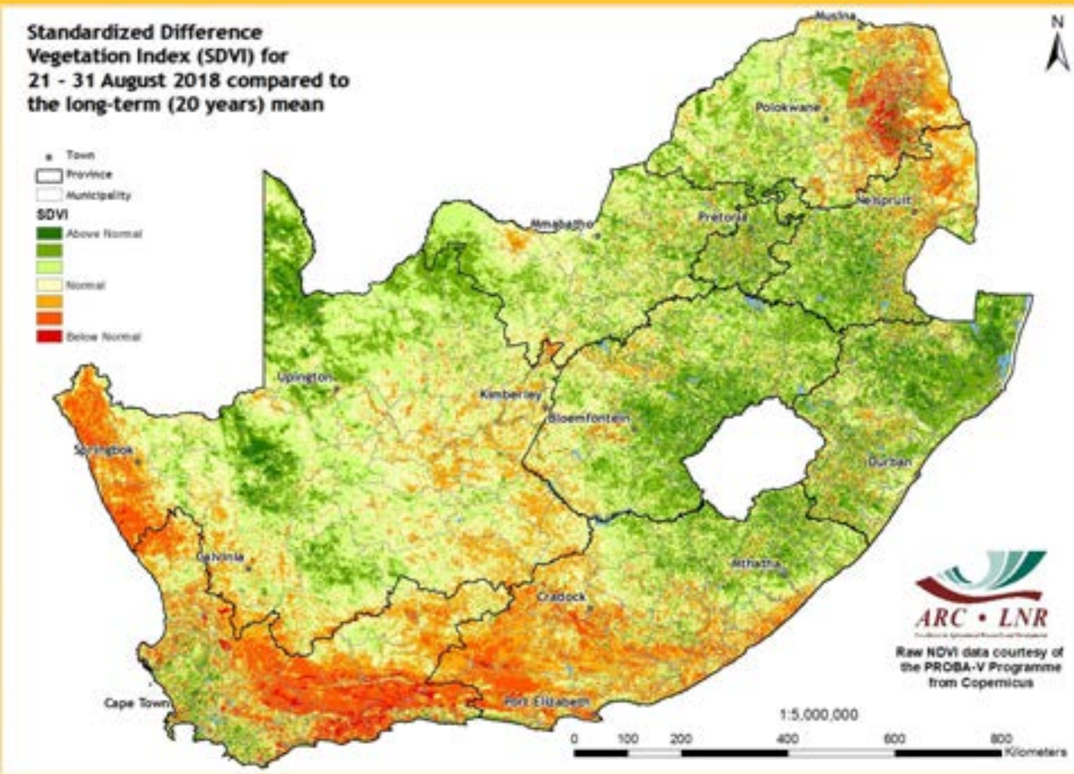

Figure 10

Figure 10:
Evidenced by the SDVI map, the last 10 days of August are associated above-normal vegetation activity over the interior of the country. Compared to the long-term mean, the Western Cape, south-western Eastern Cape and some distinct areas in Limpopo, Northern Cape and Mpumalanga, continue to experienced below-normal vegetation activity.

Figure 11:
Compared to the same month last year, the August NDVI map shows that major parts of the country experienced normal vegetation activity. However, small pockets of poor vegetation activity still occur in some isolated areas of Limpopo, Mpumalanga, KwaZulu-Natal and the Western and Eastern Cape.

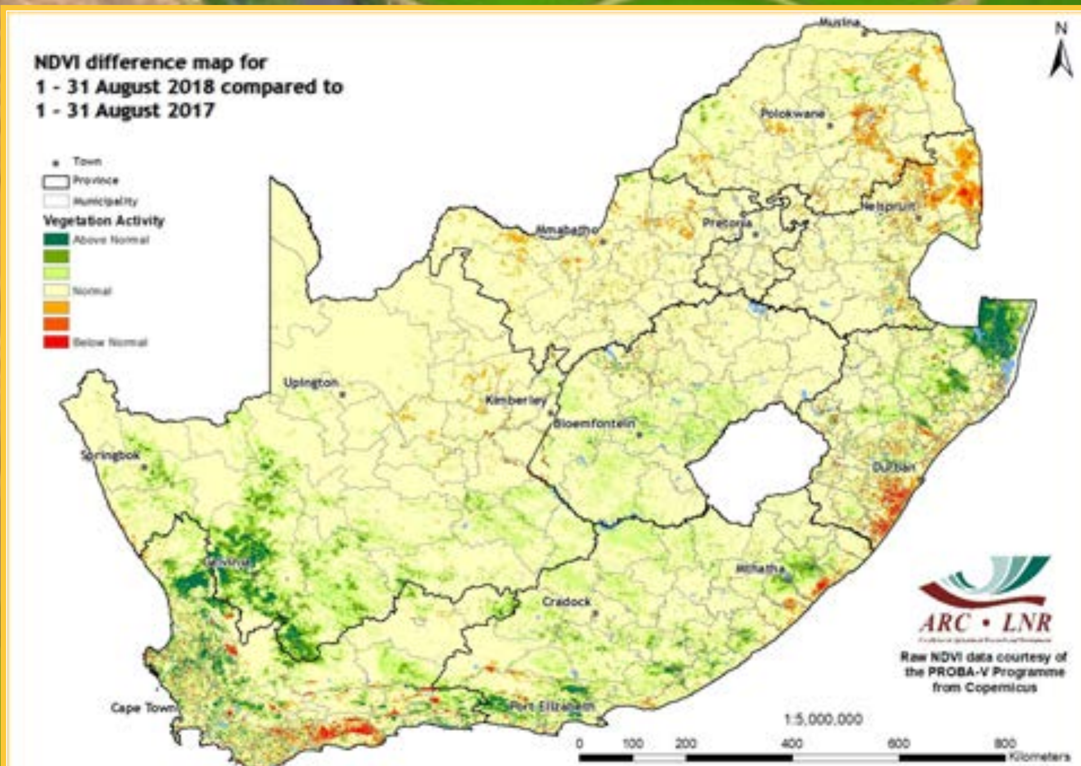

Figure 11

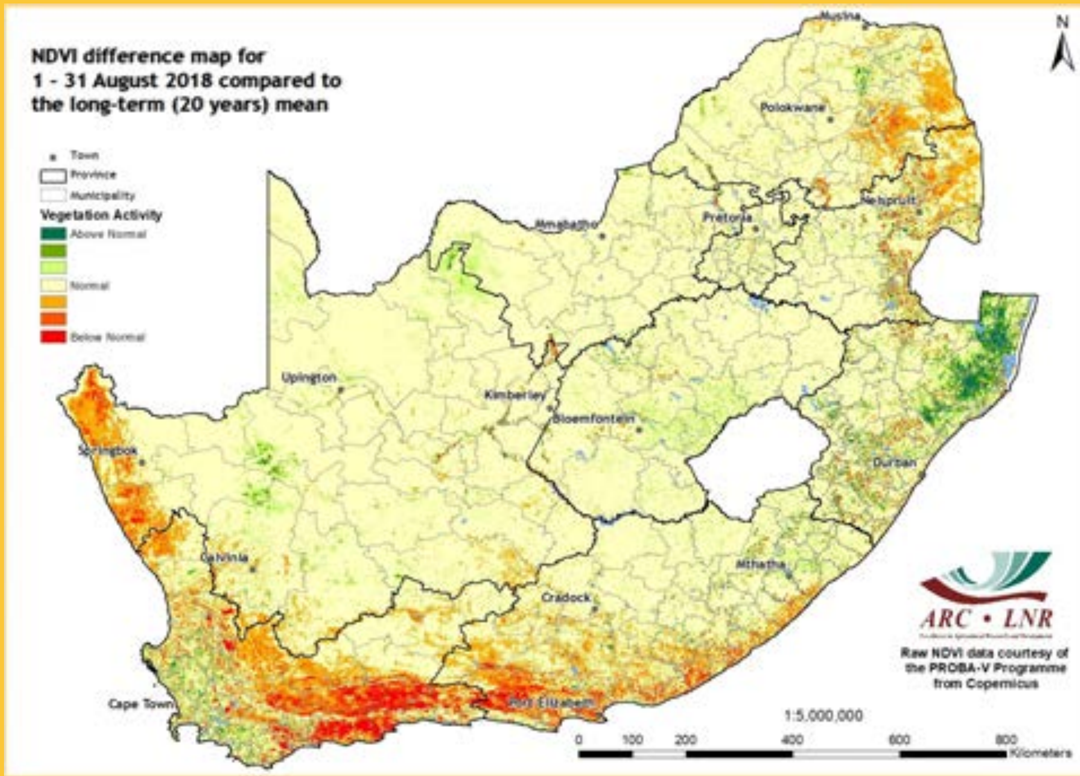

Figure 12

Vegetation Mapping
(continued from p. 7)

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

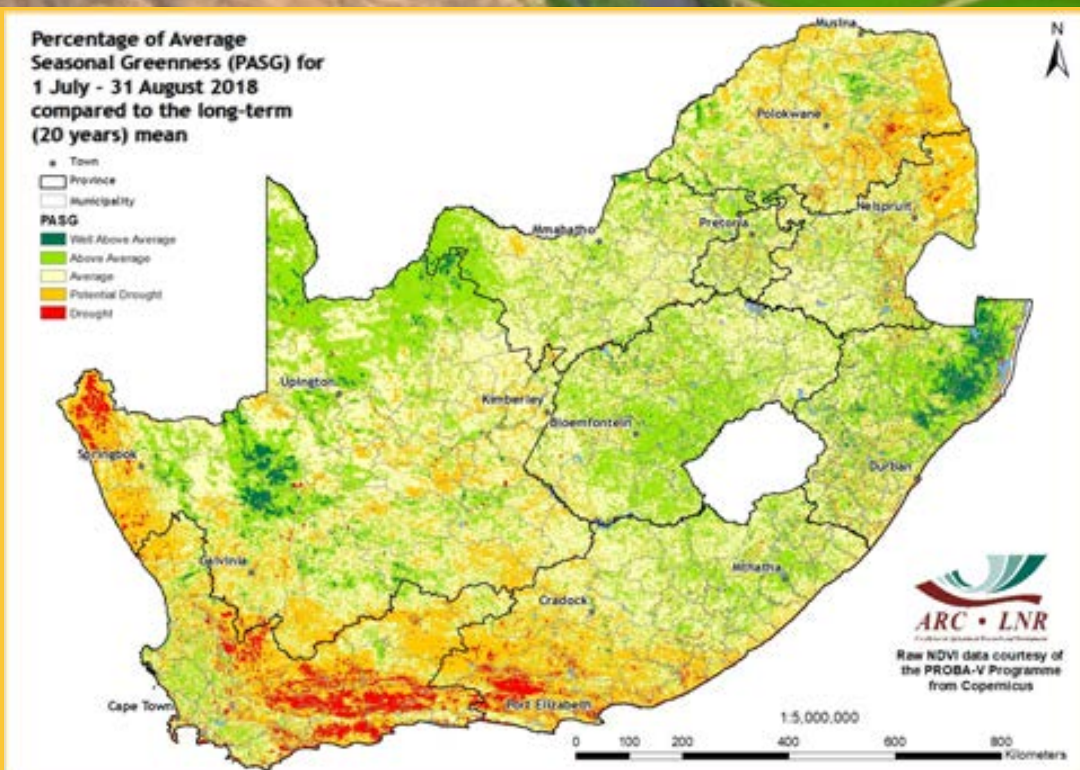

Figure 13

Figure 12:
The August NDVI difference map shows that the country's interior continues to experience normal vegetation activity while the coastal regions and some isolated areas in the northern parts of the country continue to experience below-normal vegetation activity compared to the long-term mean.

Figure 13:
The prolonged dry period continues to stress cumulative vegetation activity over much of the southwestern and northern parts of the country. Meanwhile, small pockets of above-average cumulative vegetation activity can be observed in isolated areas of KZN, the Free State and 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.

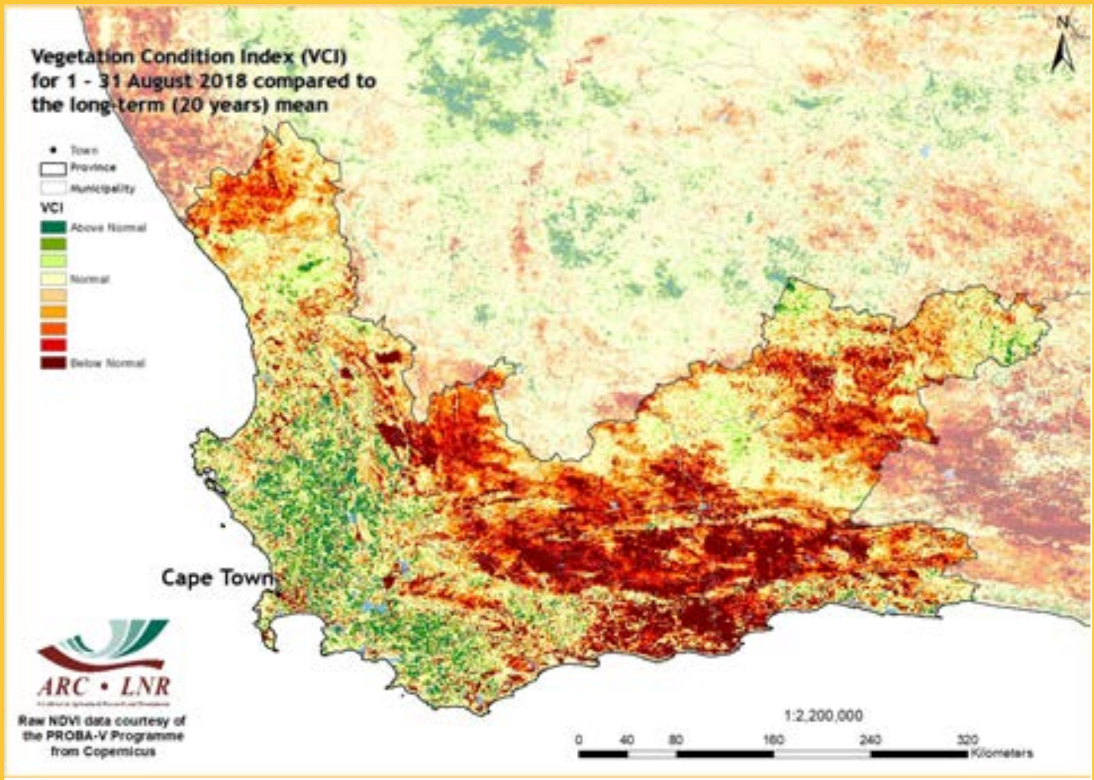

Figure 14

Figure 14:
The VCI map for August indicates that dry conditions persist in the Western Cape, particularly over much of Eden and the lower parts of the Central Karoo district where below-normal vegetation activity remains. The map also shows small pockets of good vegetation activity in isolated areas of the west coast, as well as the northern and far northeastern parts of the Beaufort West municipality.

Figure 15:
The dry spell continues to pressurize the vegetation condition over much of the western region of the Eastern Cape. Meanwhile the Amatola and Stormberg areas as well as the Wild Coast and Berg's vegetation activity remains above normal.

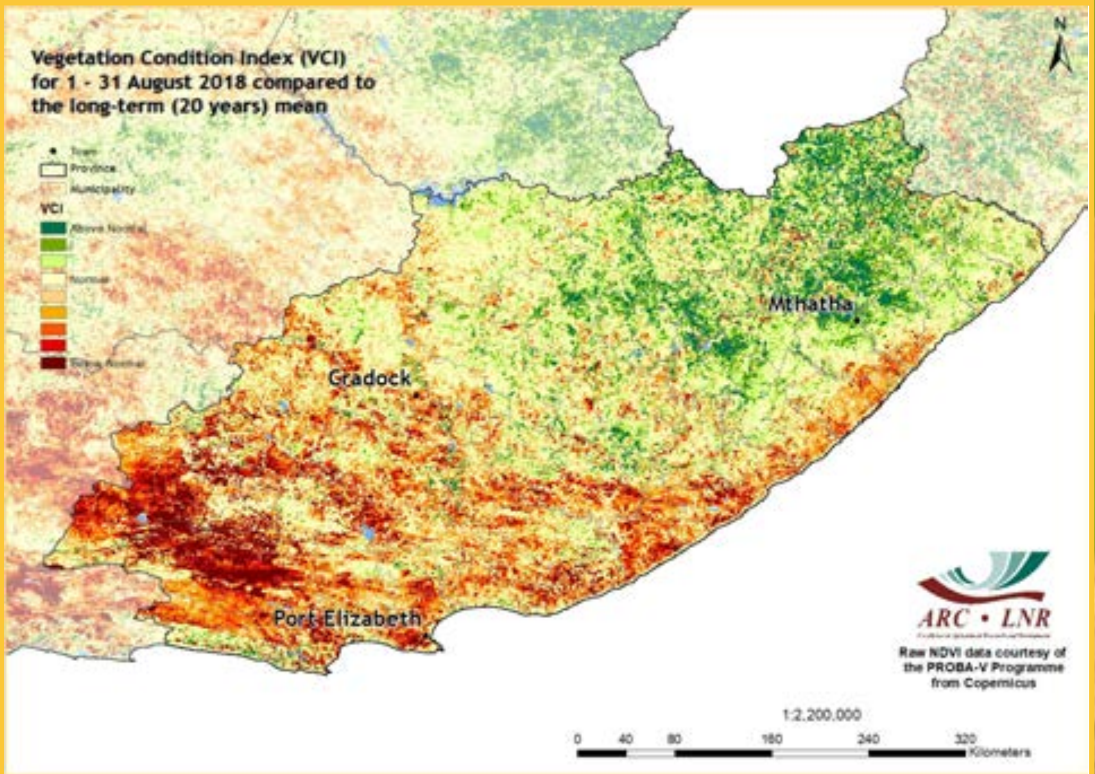

Figure 15

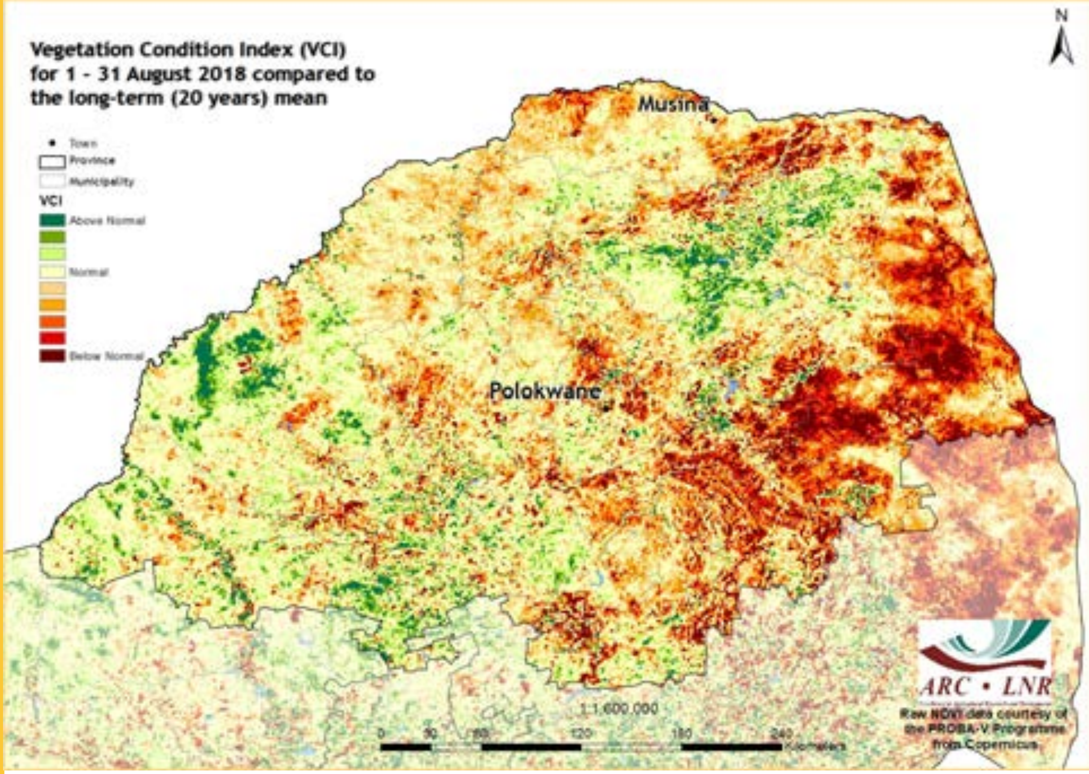

Figure 16

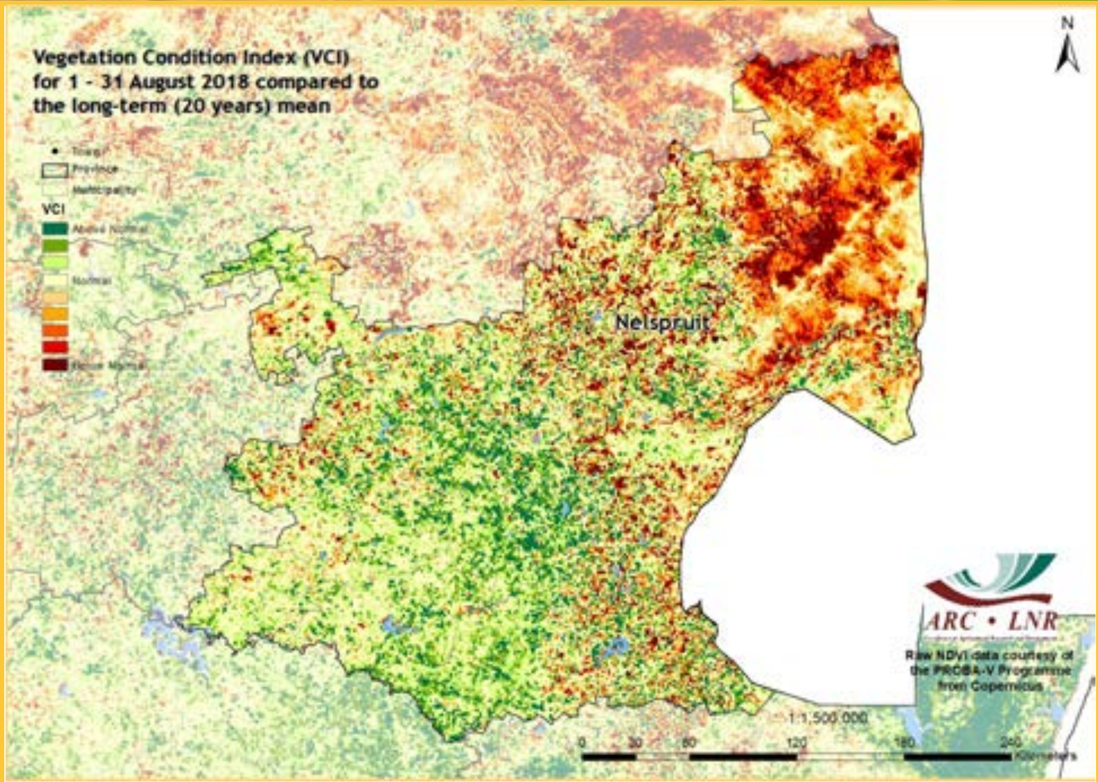

Figure 17

Figure 16:
Due to the persistent drought, below-normal vegetation conditions outweigh good vegetation conditions across the Limpopo Province.

Figure 17:
The VCI map for August shows that the northwestern parts of Mpumalanga experienced below-normal vegetation activity, especially over much of the Bushbuckridge, Nkomazi and Mbombela municipalities.

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6. Vegetation Conditions & Rainfall

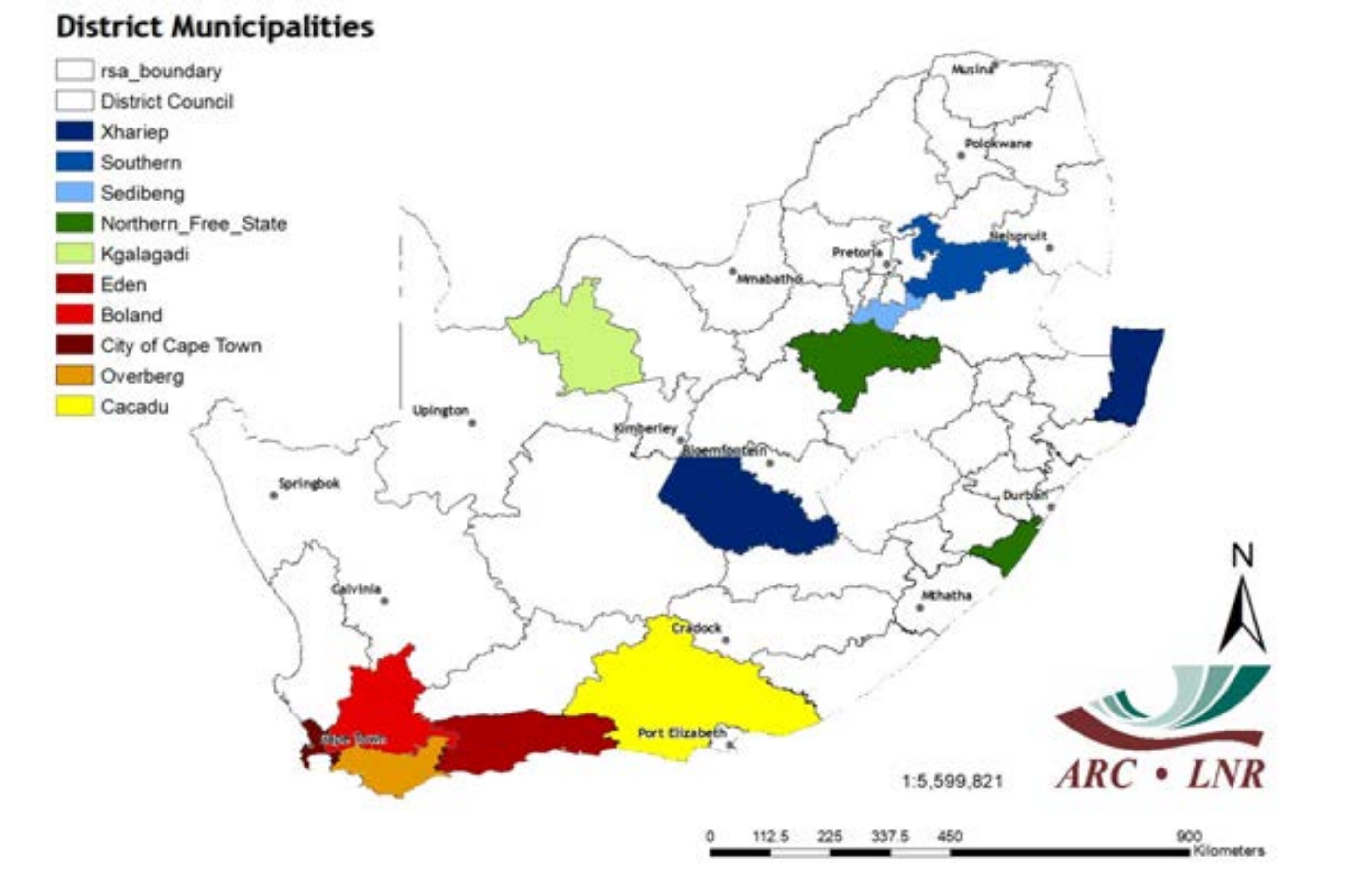

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for August 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.

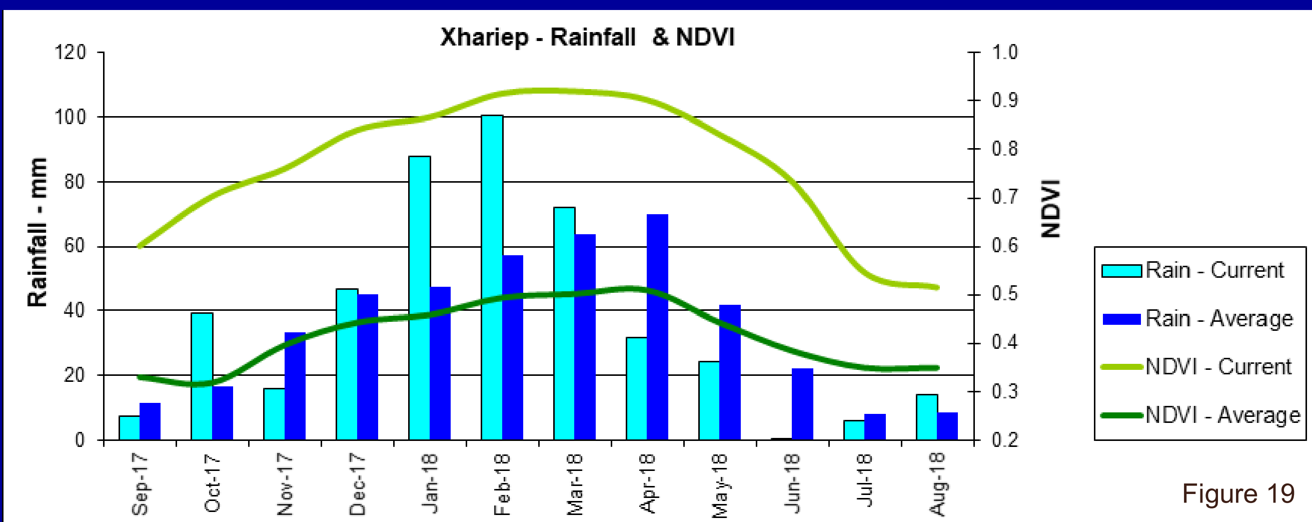
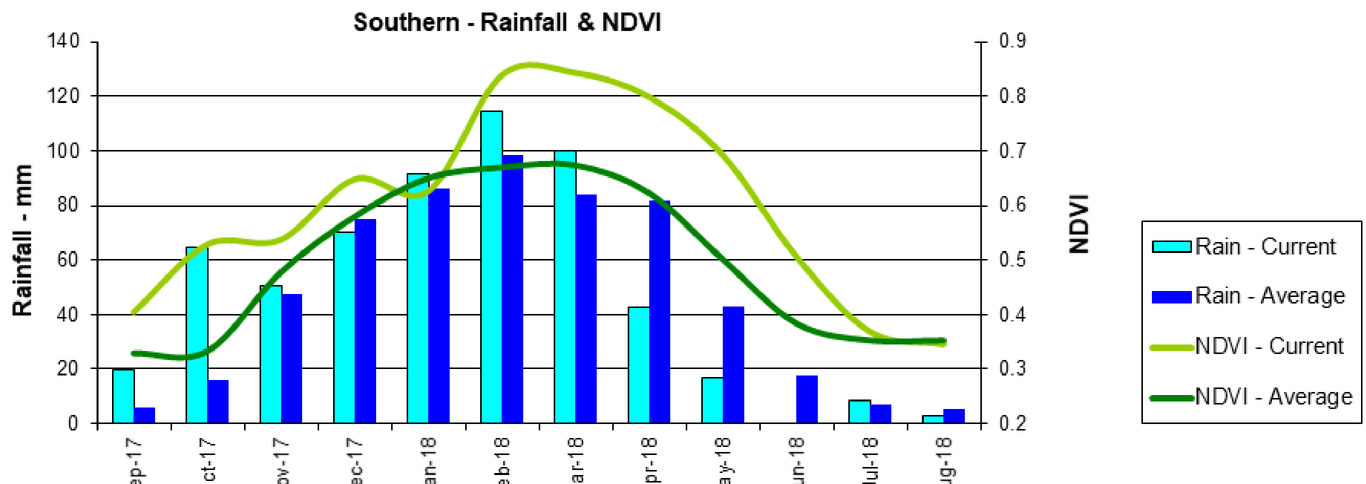


Figure 19



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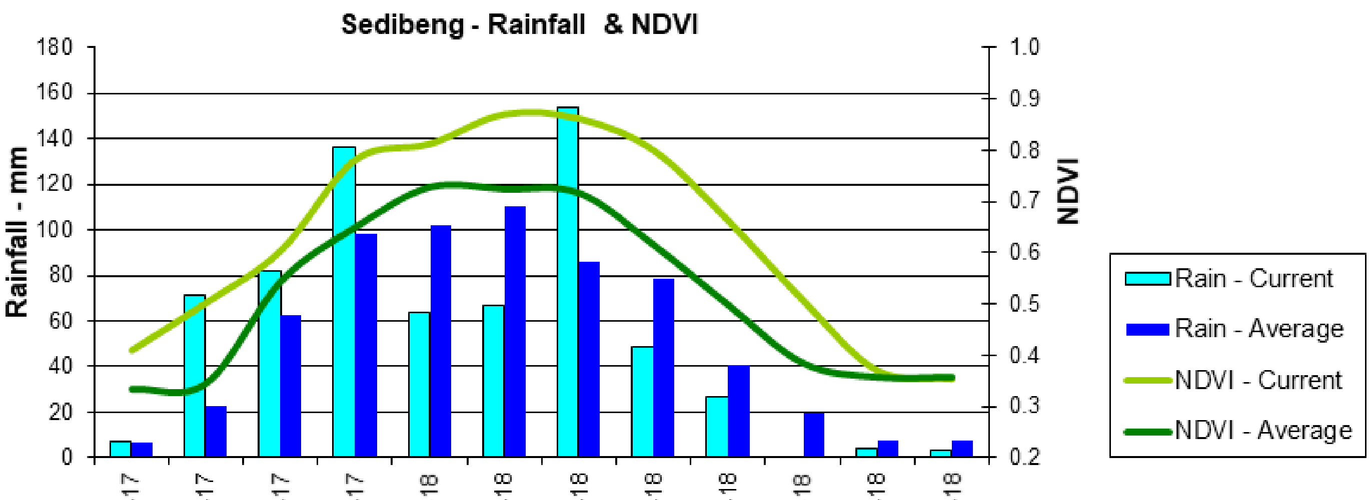

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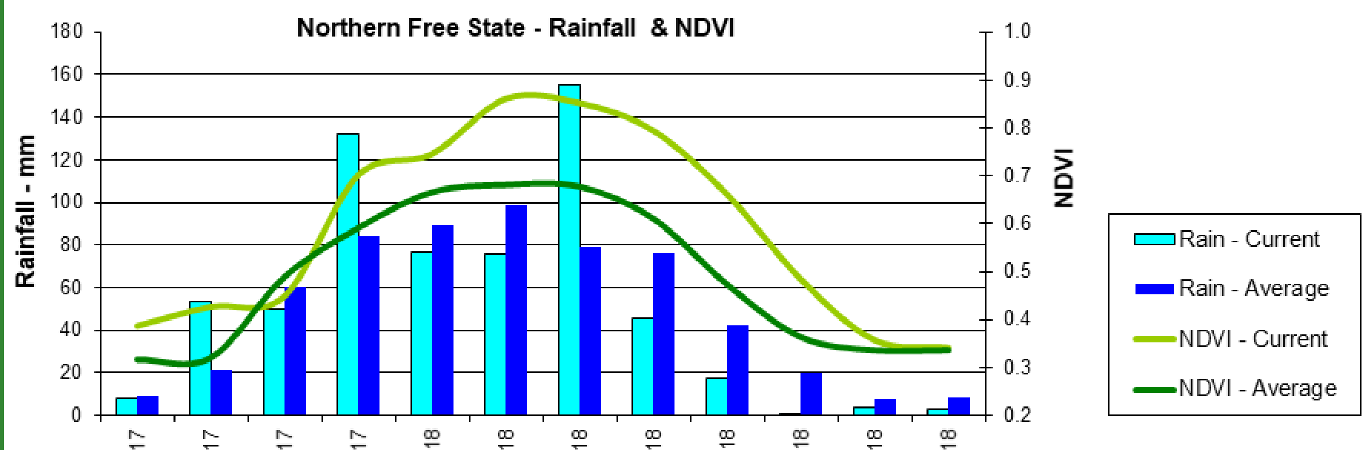

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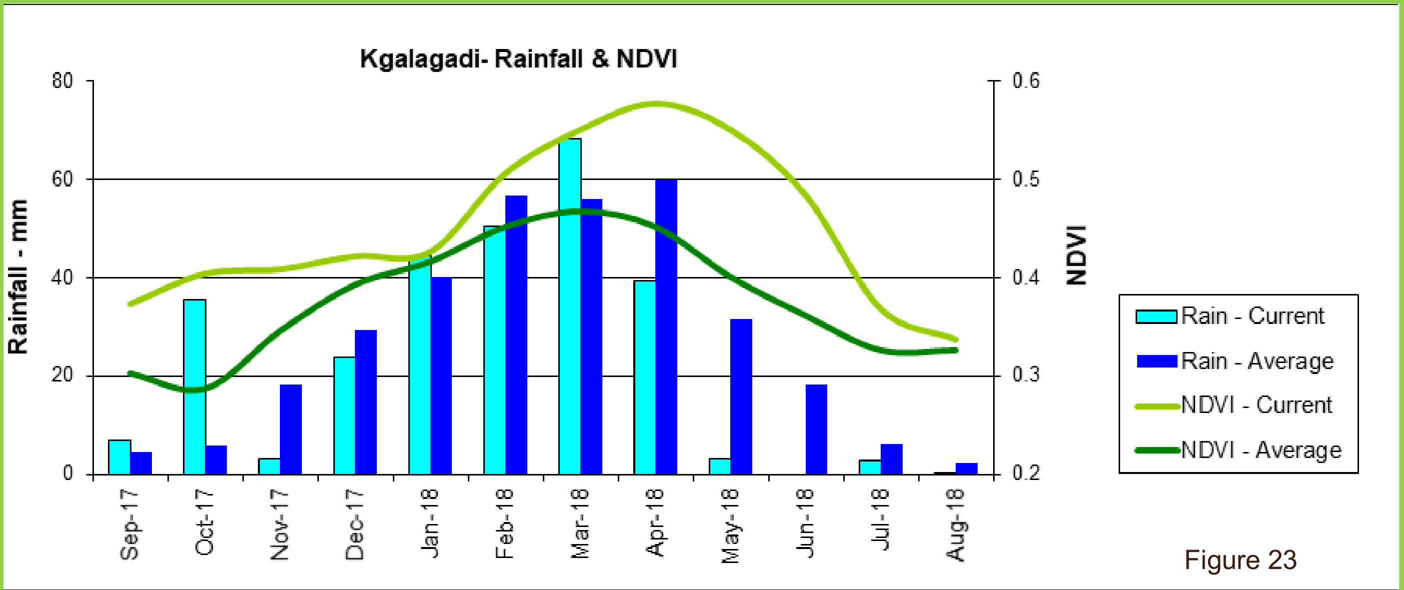

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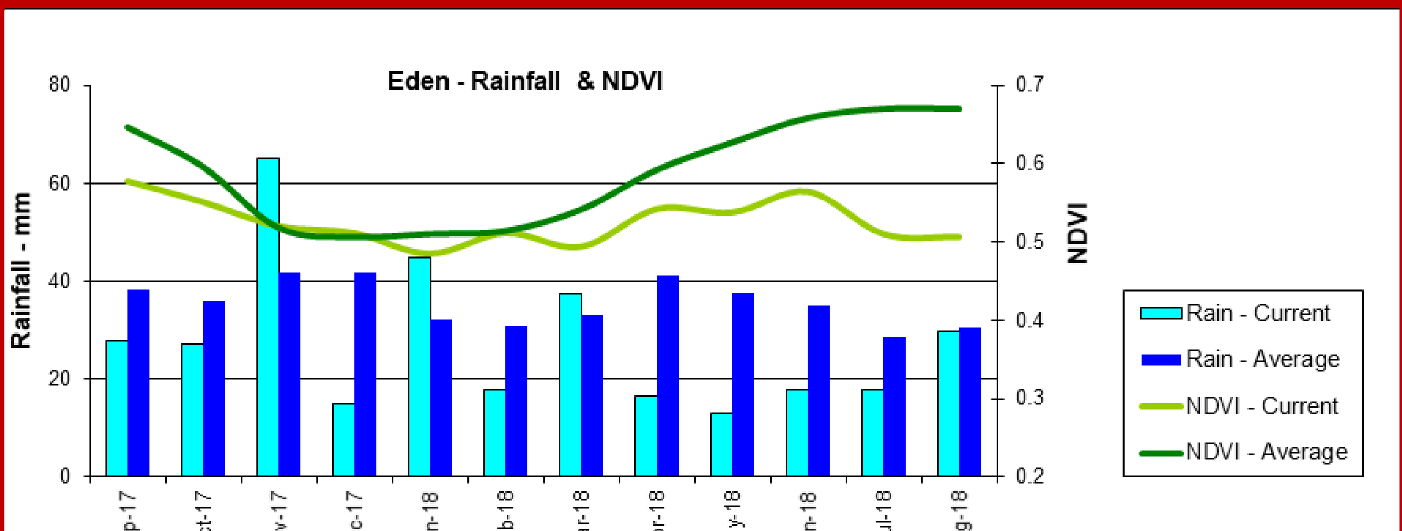

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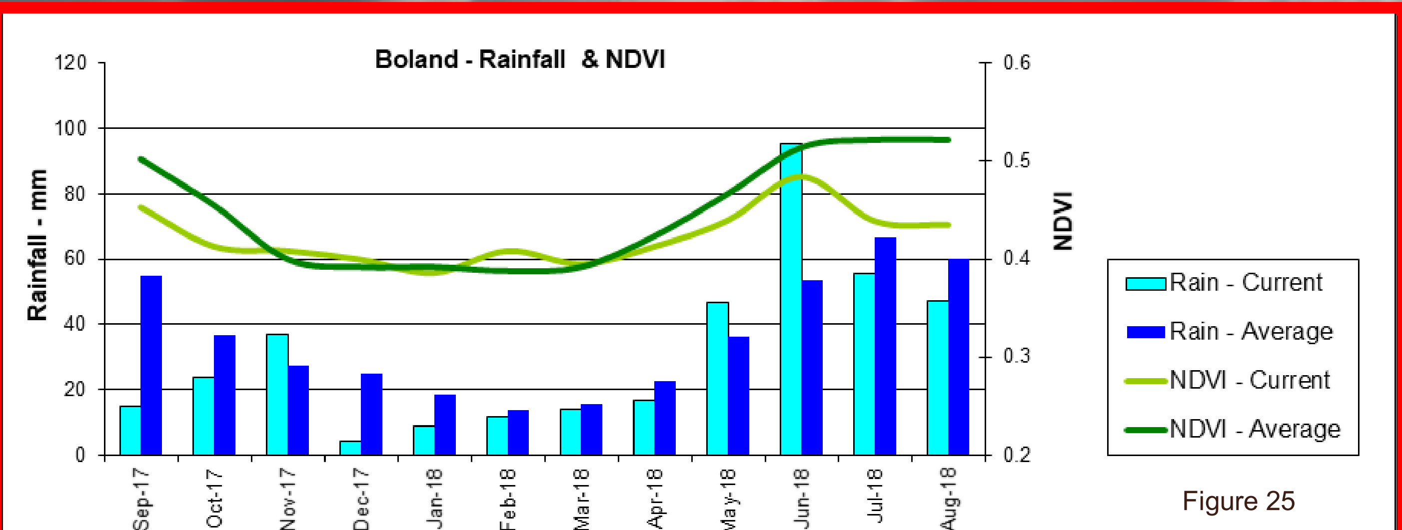

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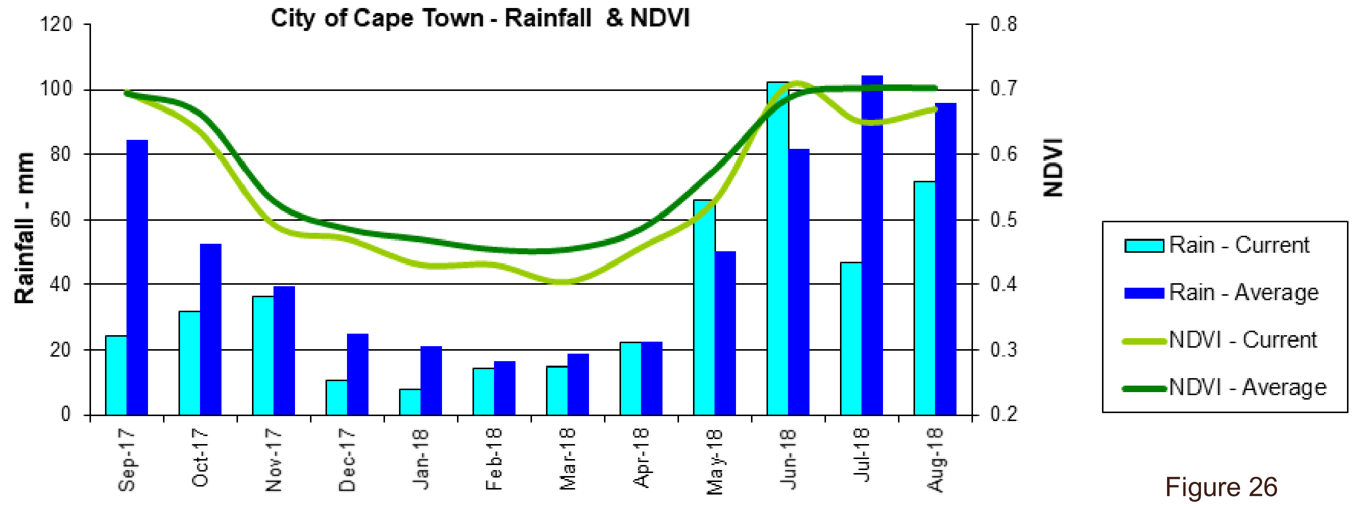

Figure 26

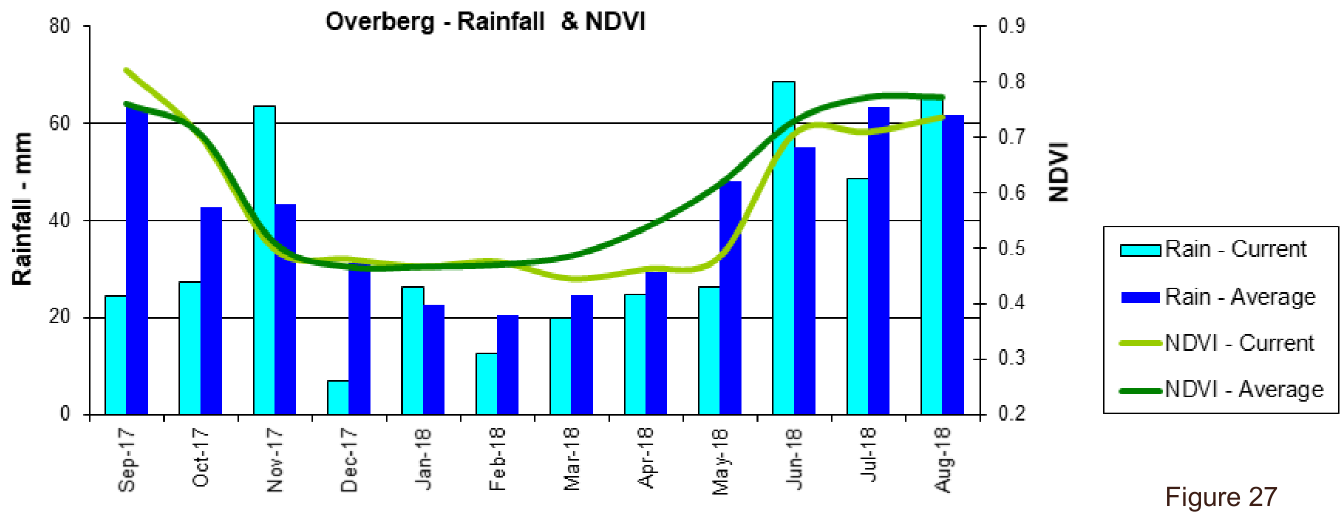

Figure 27

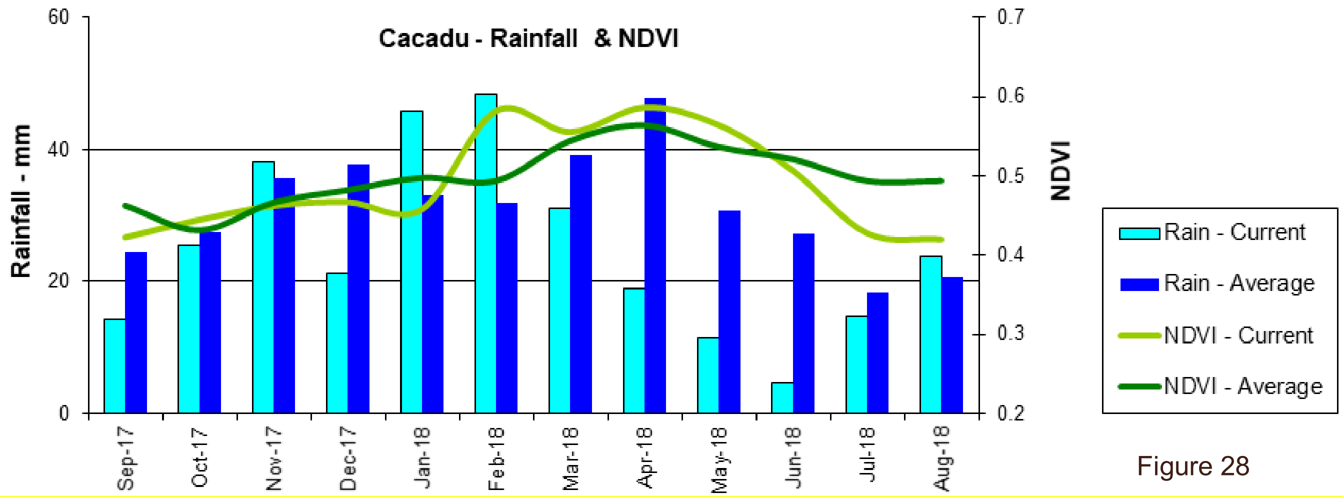

Figure 28

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 during August 2018 per province. Fire activity was higher in all provinces, except for the Eastern Cape, compared to the long-term August average.

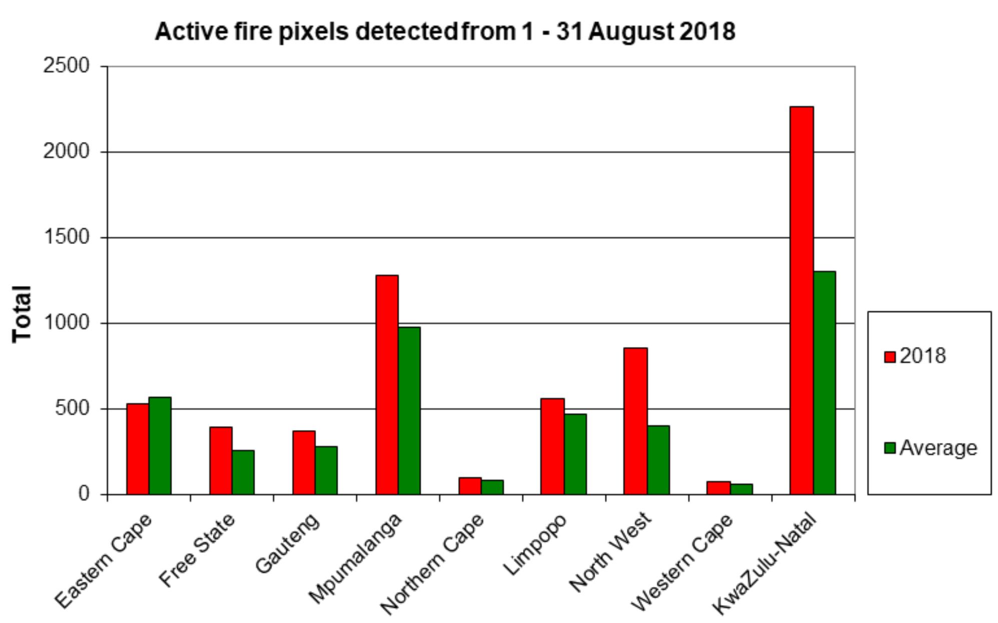

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-31 August 2018.

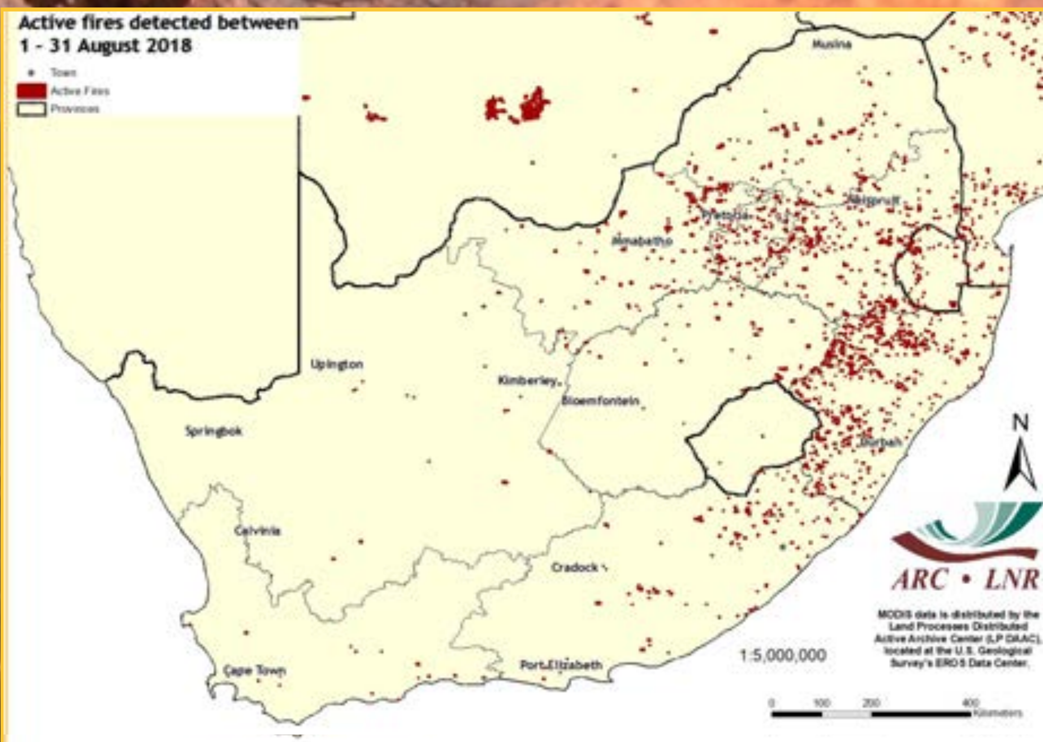

Figure 30

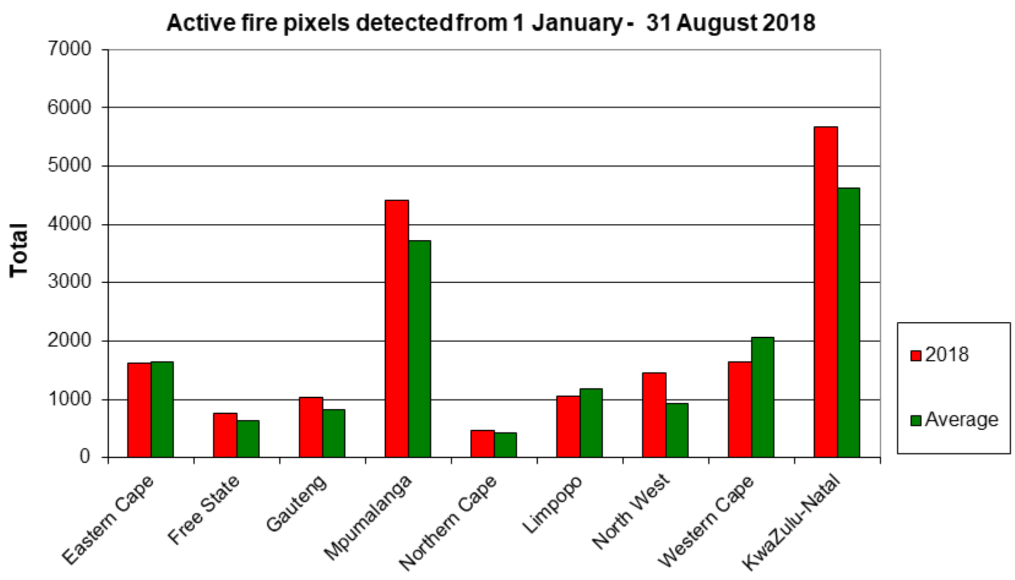

Figure 31

Figure 31:
The graph shows the total number of active fires detected from 1 January - 31 August 2018 per province. Fire activity was higher in the Free State, Gauteng, Mpumalanga, Northern Cape, North West and KwaZulu-Natal compared to the long- term August average.

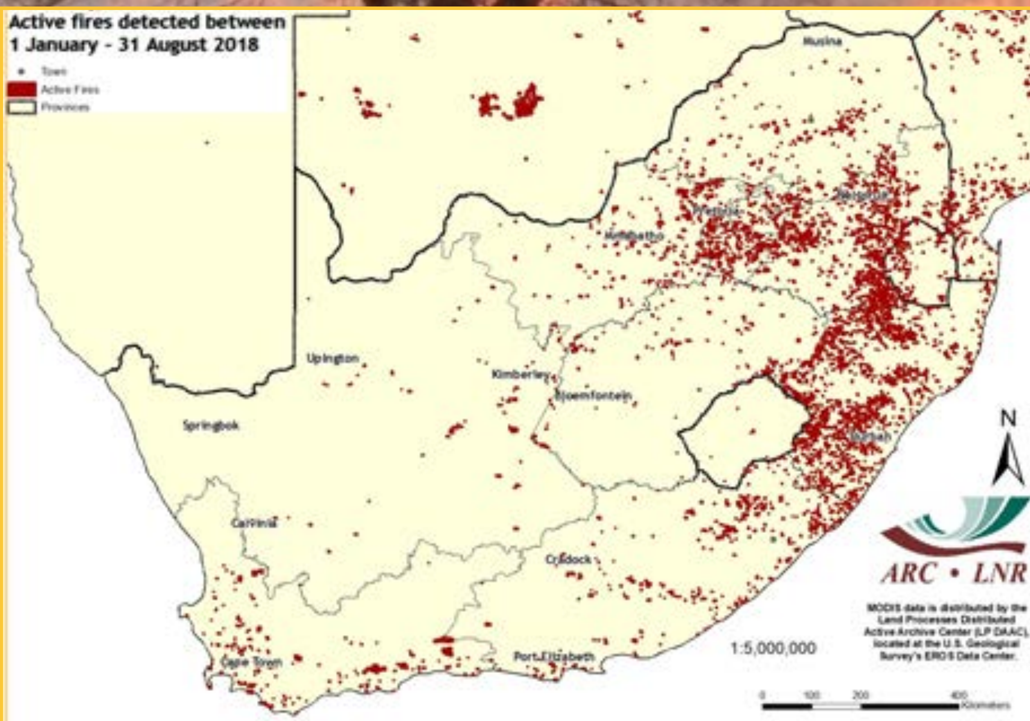

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January - 31 August 2018.

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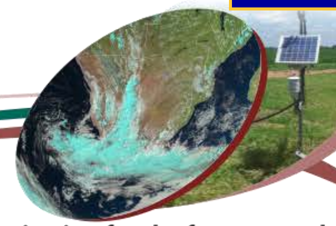
Agrometeorology



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**.

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What does Umlindi mean?
UMLINDI is the Zulu word for "the watchman".