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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

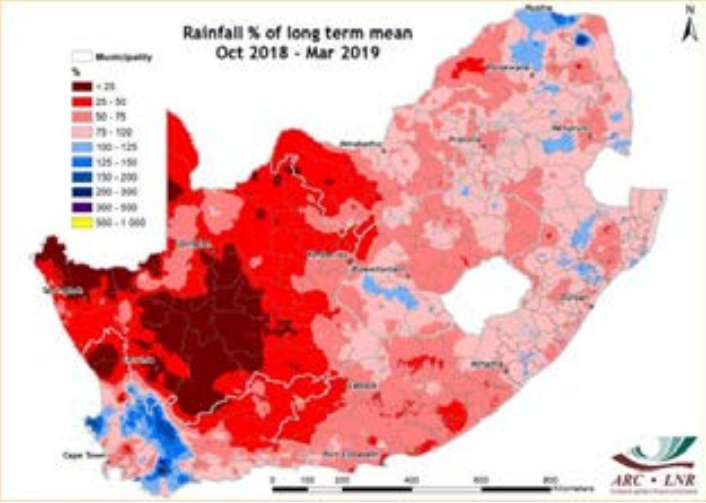
CONTENTS:

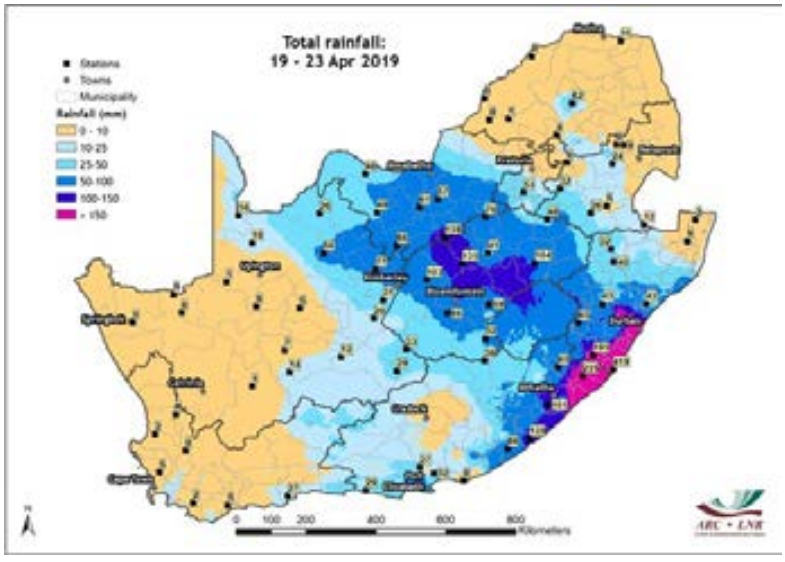
178th Edition

Images of the Month

Widespread autumn rainfall after a mostly dry and hot summer

The 2018/19 summer rainfall season turned out to be relatively dry with the larger part of the country receiving below-normal rainfall and experiencing above-normal temperatures. The first half of the season was very hot and dry with the first significant rainfall event occurring at the end of December and lasting into the start of January, after which dry conditions returned. February was by far the best rainfall month of the summer season with above-normal rainfall occurring over large parts of the country before dry and hot conditions returned in March. With this challenging start, the planting season was delayed, especially over the western parts of the summer crop production region. During the month of April so far, rainfall has been above average, reaching a crescendo between the 19th and 23rd when a cut-off low weather system caused widespread rain with flooding over the southeastern parts of the country. Durban recorded in excess of 400 mm during this period, (see map right). The generally cool and cloudy weather in April might pose challenges for the growth of some summer crops as it impacts on the delayed planting season.





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:

After the good rainfall over the larger part of the country during February, large parts of the summer rainfall region received far below-normal rainfall during March 2019. It was also a hot month with most of the country experiencing well above-normal temperatures.

The relatively little rain that occurred over the northeastern parts of the country fell during the first 10 days of the month, in particular over the maize production regions. The lack of rainfall over most of the northeastern parts of the country from mid-March onwards can be partly explained by the presence of tropical cyclone Idai over Mozambique which caused stable and dry conditions over South Africa. The high temperatures that occurred over the eastern parts of the country can also be partly attributed to the sinking motion of air that the tropical cyclone caused over those areas.

From about the second week into the third week of March, rainfall activity occurred over the central parts of the country, with good rains falling over the southeastern interior where the rainfall totals for March were above average. The frequent passage of frontal systems, as well as a good rainfall system that occurred around the 10th of March, caused good rainfall totals over fairly large parts of the winter rainfall region as well as the adjacent areas of the all-year rainfall region.

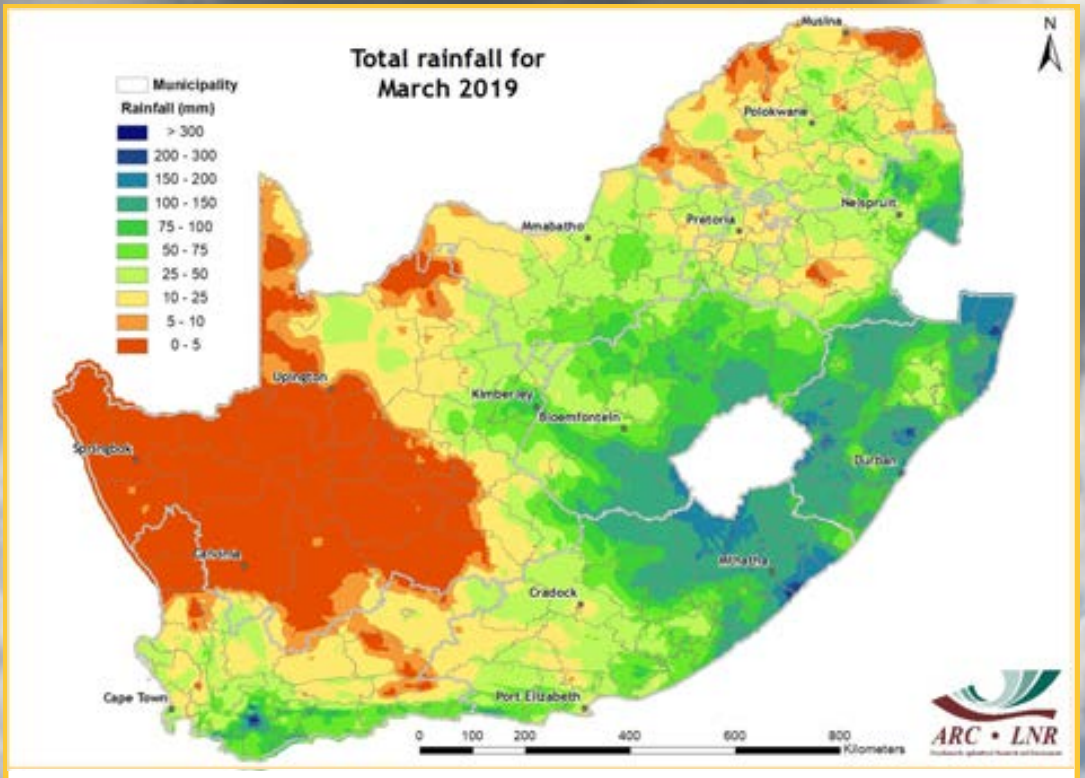


Figure 1

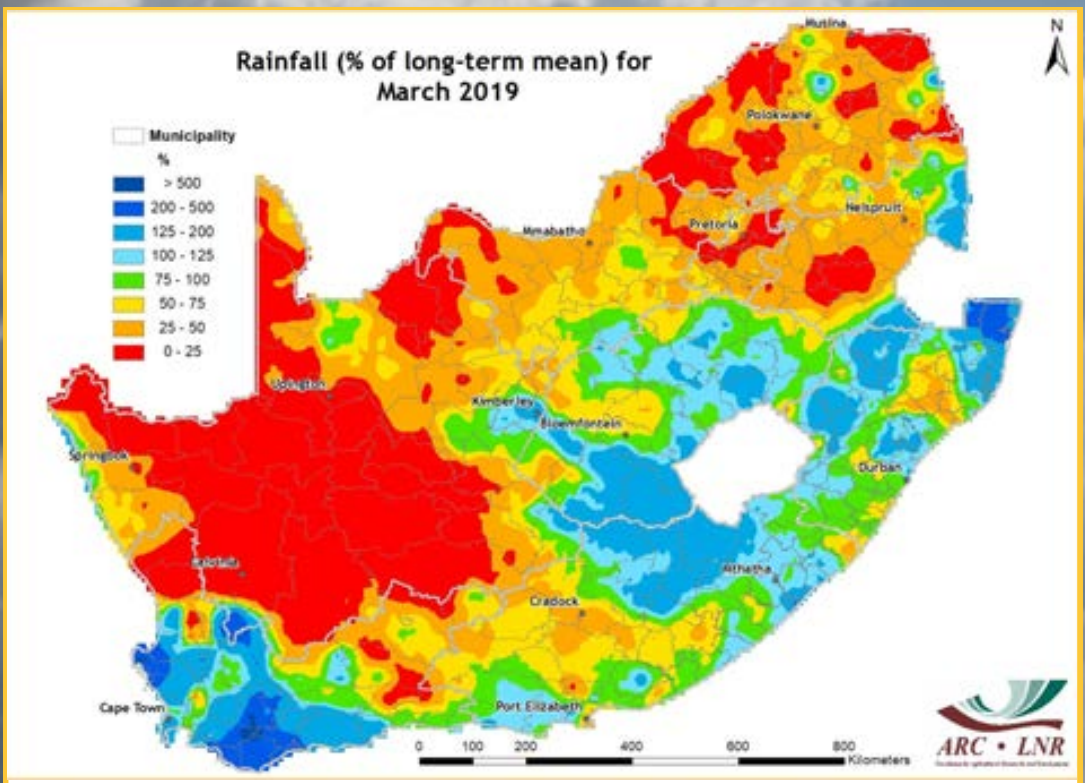


Figure 2

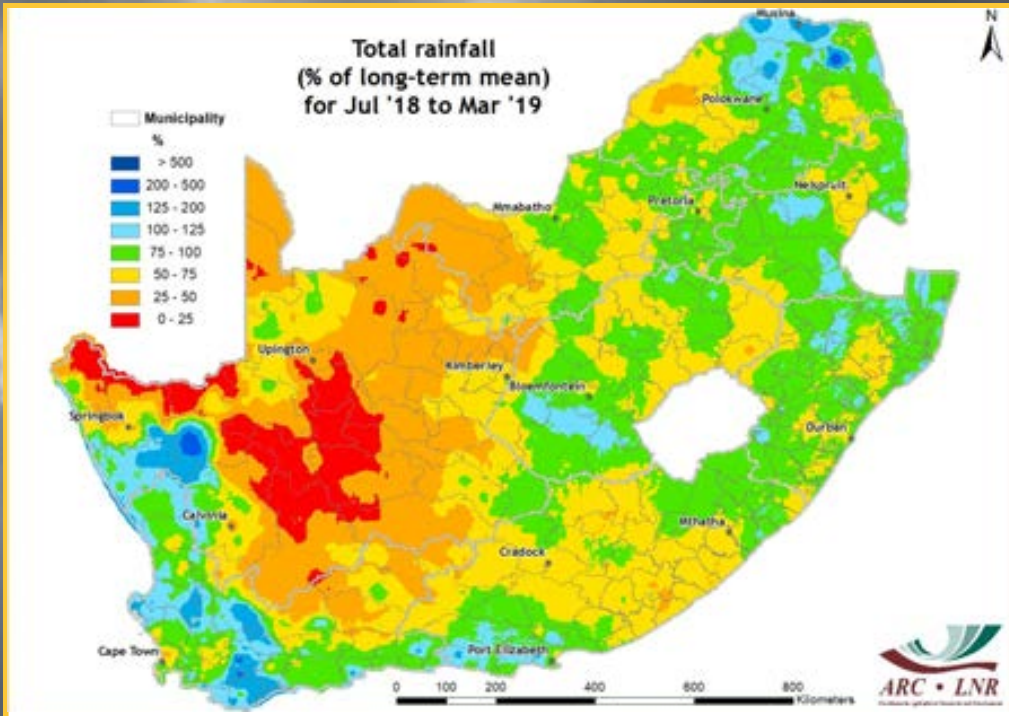


Figure 3

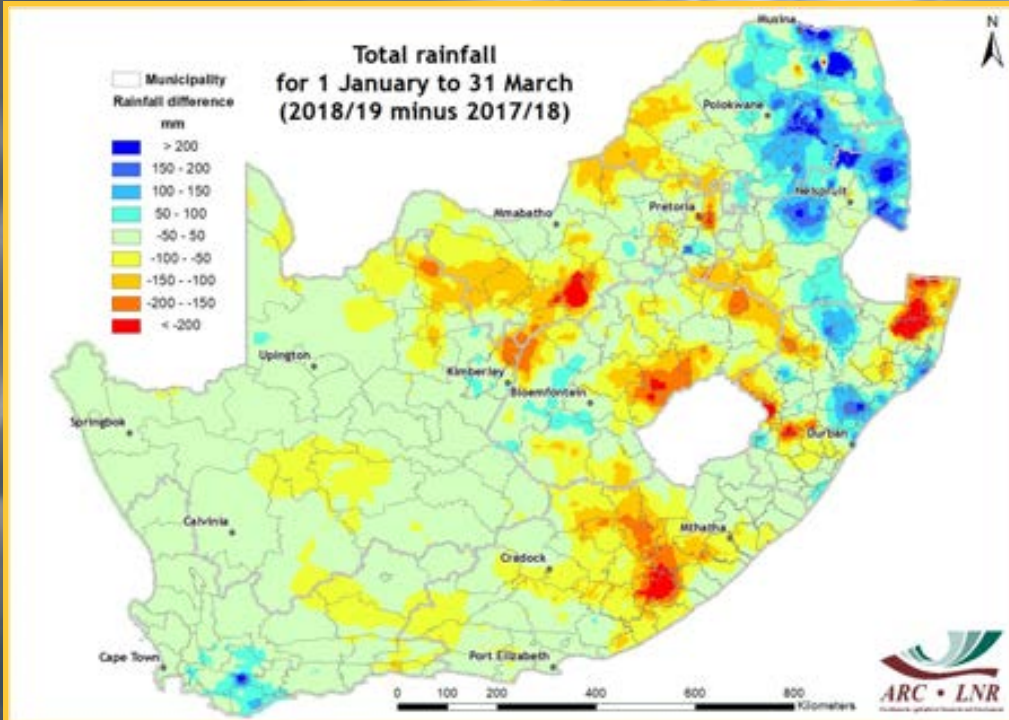


Figure 4

Figure 1:
Parts of the southeastern areas of the country as well as the extreme western part of the all-year rainfall region received rainfall totals that exceeded 100 mm during March 2019. Isolated areas along the eastern seaboard received monthly rainfall totals that exceeded 200 mm.

Figure 2:
Above-normal rainfall occurred over the southern parts of the winter rainfall region and extended into the western parts of the all-year rainfall region. Parts of the central to southeastern interior regions as well as the eastern coastal belt and adjacent interior of the country also received above-normal rainfall during the month of March

Figure 3:
During this 9-month period above-normal rainfall occurred over parts of the winter rainfall region. Further to the east along the Cape south coast, near-normal rainfall occurred with above-normal rainfall in some places. Over the summer rainfall region, large areas in the west to central parts of the country received below-normal rainfall during this period. Large areas over the eastern parts received near-normal rainfall with some isolated areas receiving above-normal rainfall. The above-normal rainfall over the far northern parts of the country can mostly be attributed to the good rains that fell during the month of February.

Figure 4:
Compared to the corresponding 3-month period a year ago, the far north-eastern parts of the country had areas that received up to 200 mm more rainfall this year, mostly east of the escarpment area. Over the central parts of the country the current 3-month period received less rain than the corresponding period last year – in some places more than 200 mm less.

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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 longer time scales (24 and 36 months), as represented by the SPI ending in March 2019, shows signs of relief on the shorter time scales (6 and 12 months). On all the time scales severe drought conditions are indicated over the southern interior of the country. On the 6-month SPI map, it can be seen that the western to central parts of the country experienced more severe drought conditions than these areas experienced before. Over the northeastern parts of the country, improved conditions are visible on the 6-month SPI map after the improved rainfall over those areas during January and February 2019.

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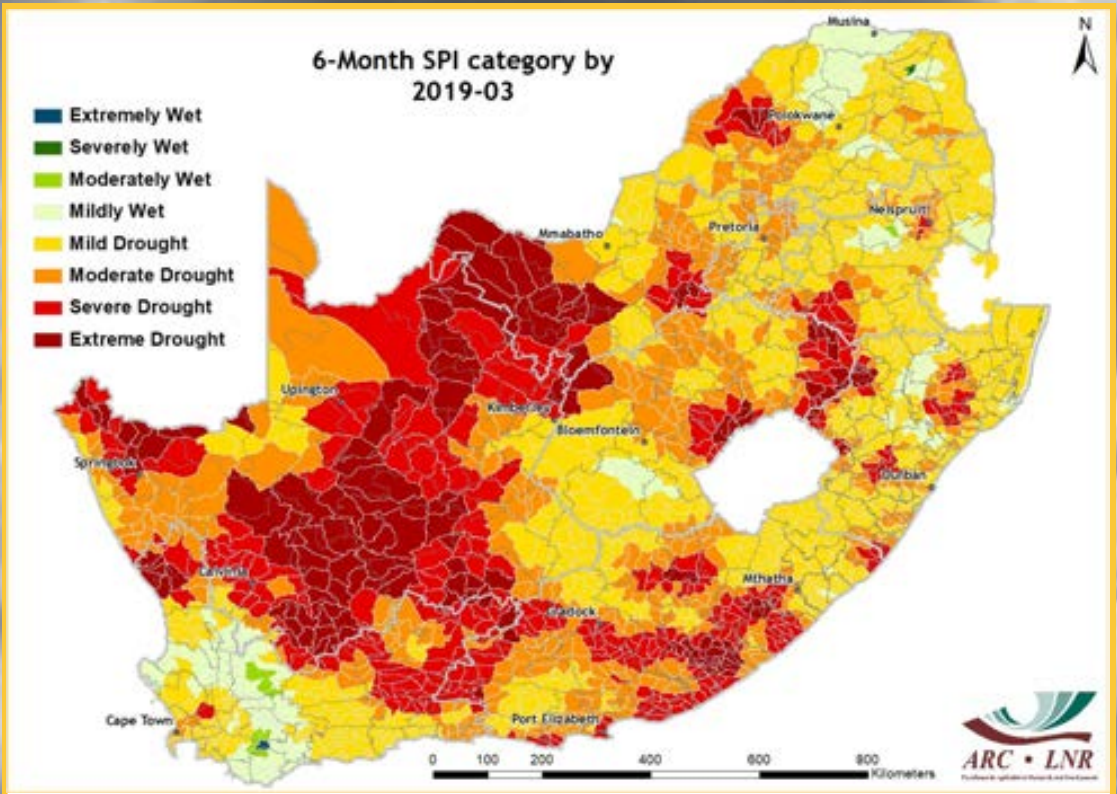

Figure 5

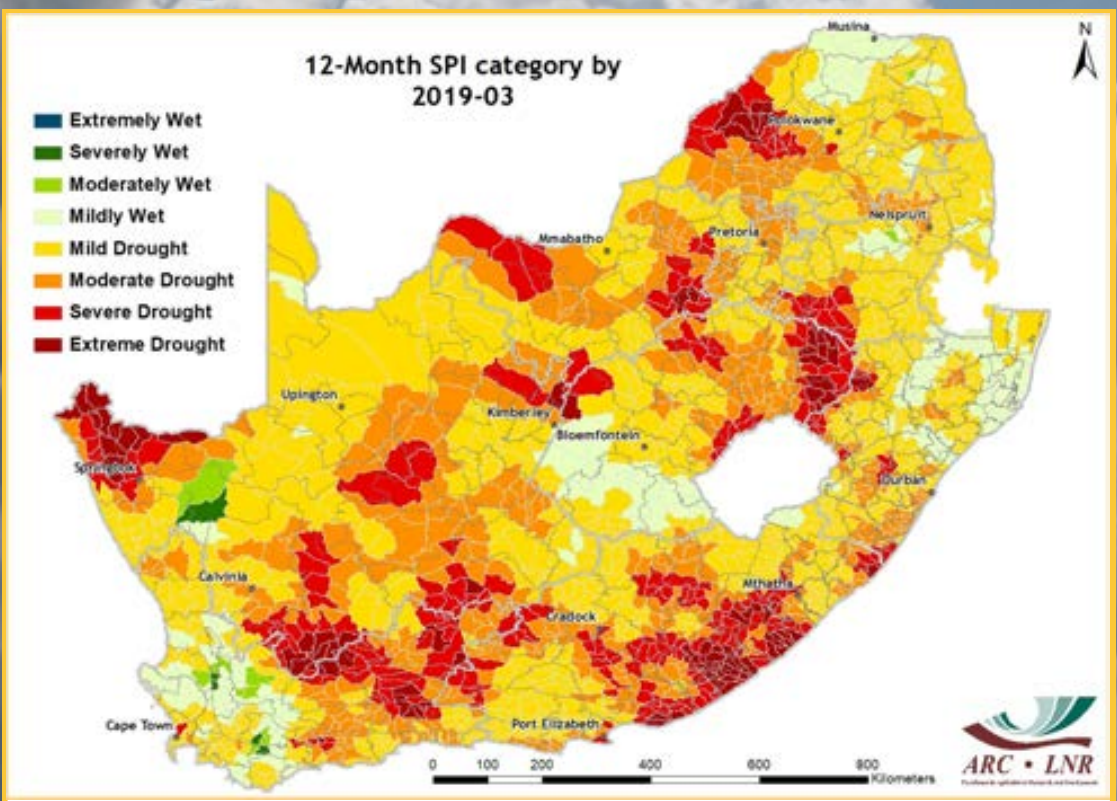

Figure 6

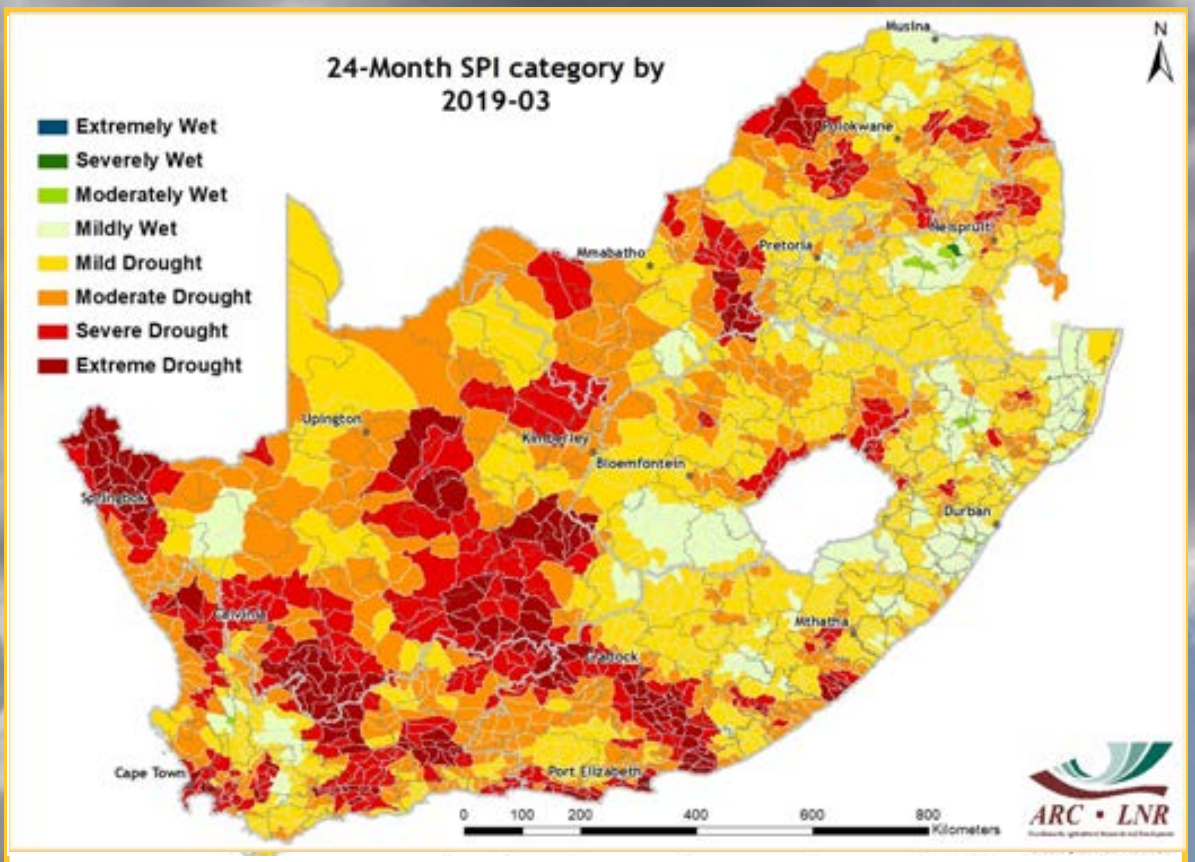

Figure 7

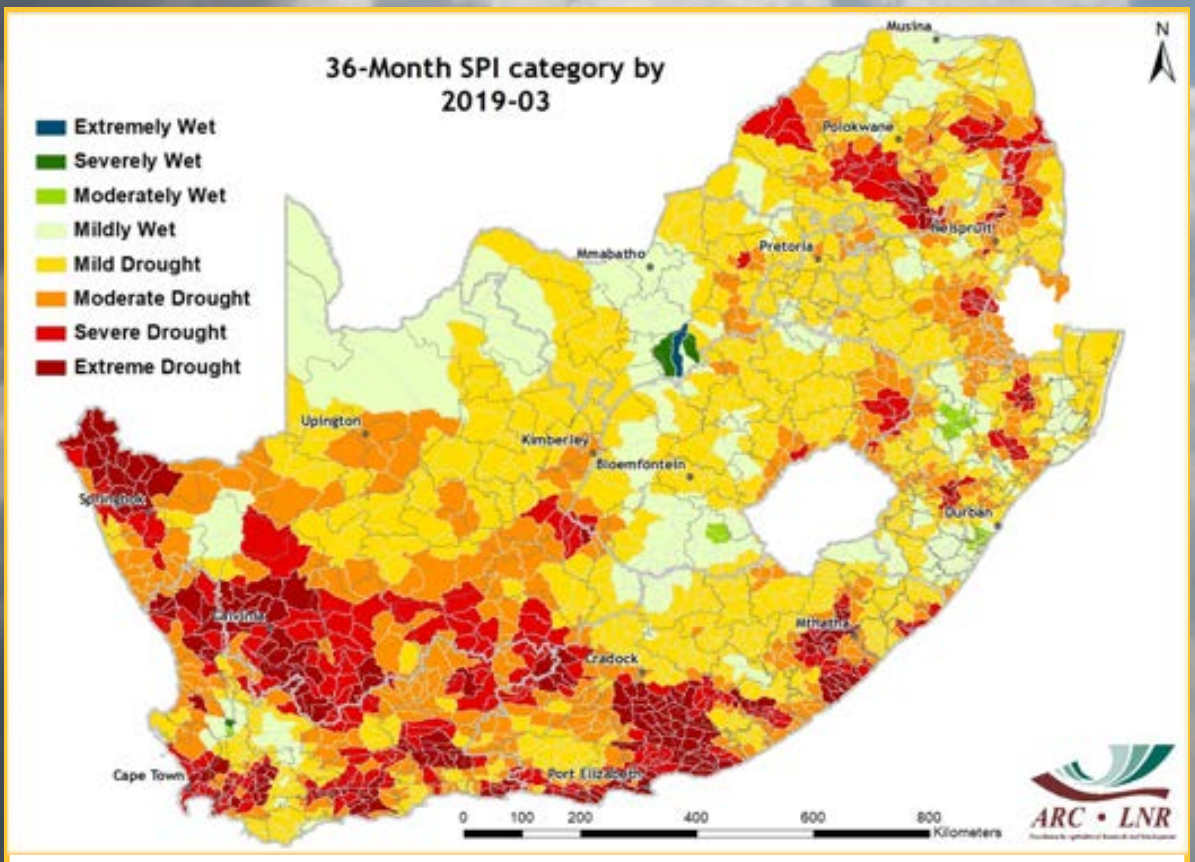

Figure 8

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.

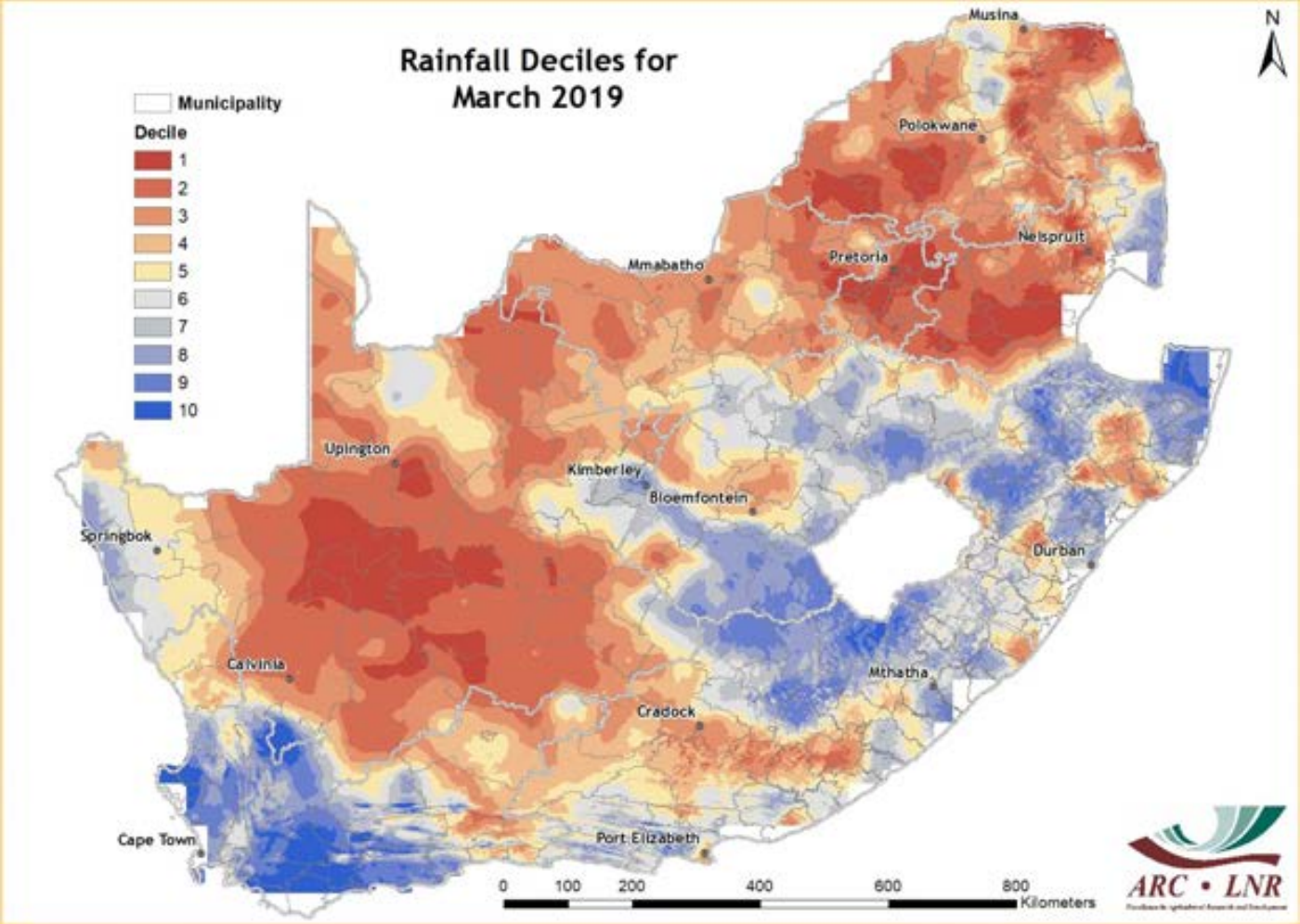

Figure 9

Figure 9:
Rainfall totals during March 2019 over the southwestern parts of the country as well as over fairly large areas of the southeastern parts received rainfall totals that compare well with the historically wetter March months. The northern and western parts of the summer rainfall region had rainfall totals that fall within the historically drier March months.

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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.

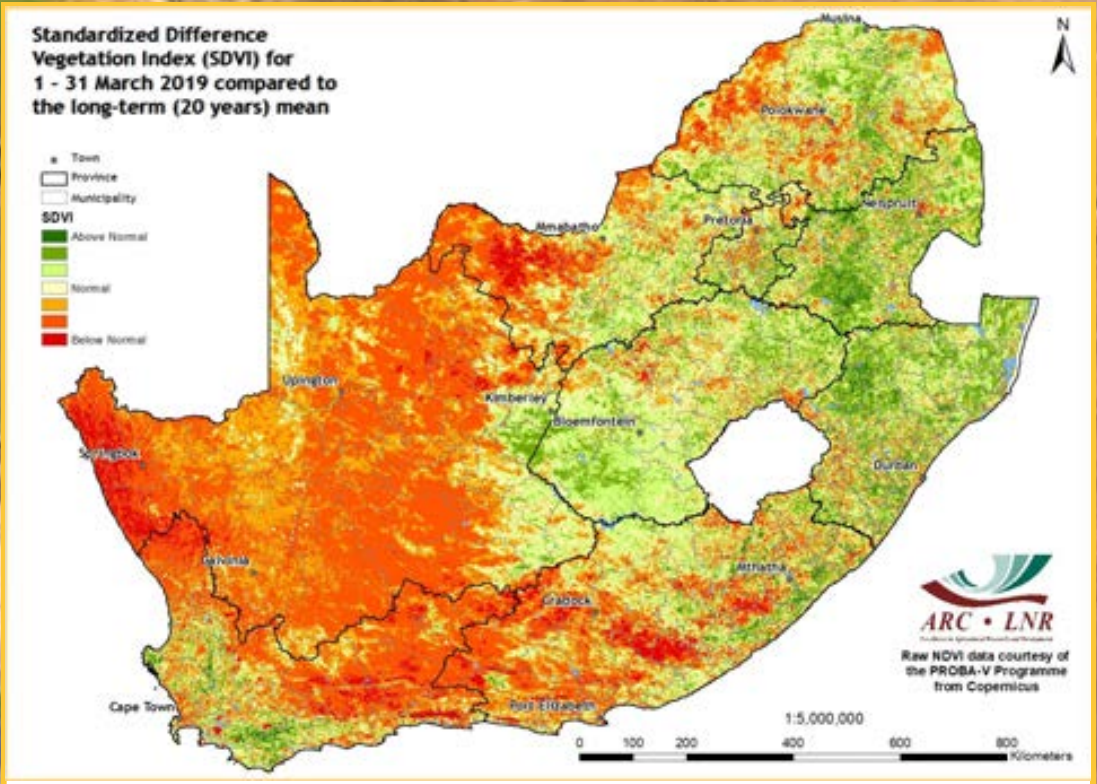

Figure 10

Figure 10:
When comparing the vegetation conditions in March 2019 to the range of conditions observed in previous years, the SDVI map shows that less favourable conditions for healthy vegetation to thrive remain dominant in the western parts of the country while the opposite was observed over areas in the eastern parts.

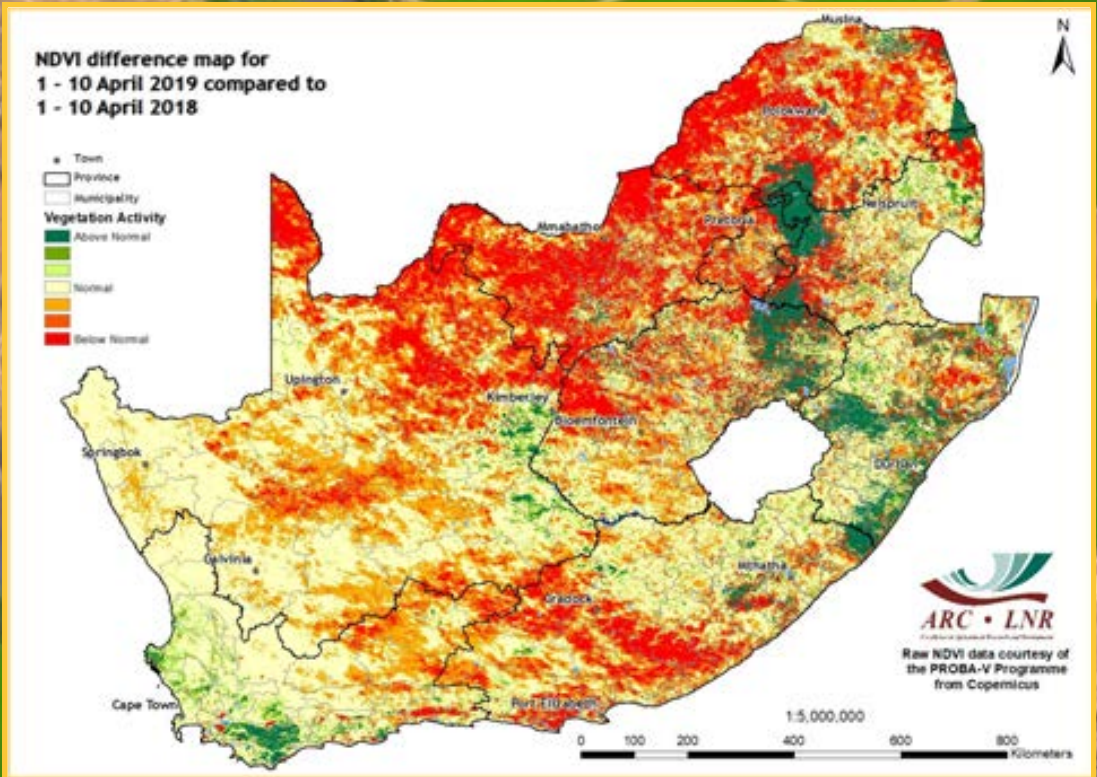

Figure 11

Figure 11:
When comparing the NDVI map for the first 10 days of April 2019 to the NDVI map for the same period last year, it can be observed that the major parts of the country experienced below-normal vegetation activity while pockets of above-normal activity occurred in isolated areas of the country.

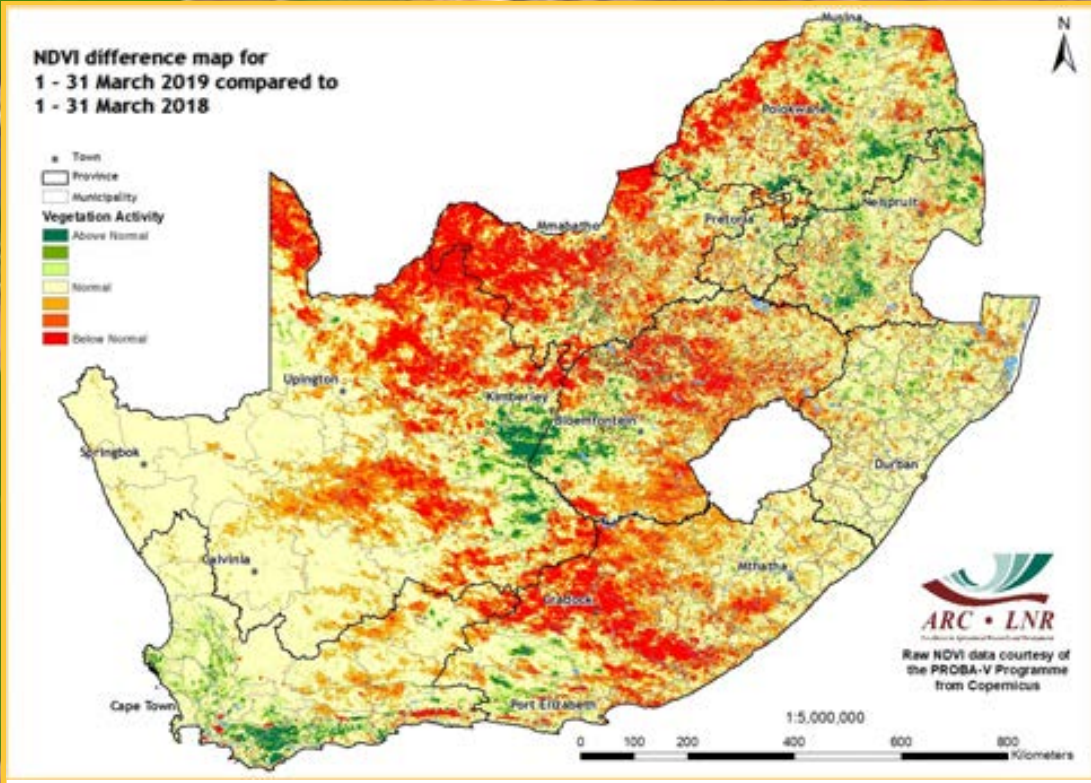

Figure 12

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

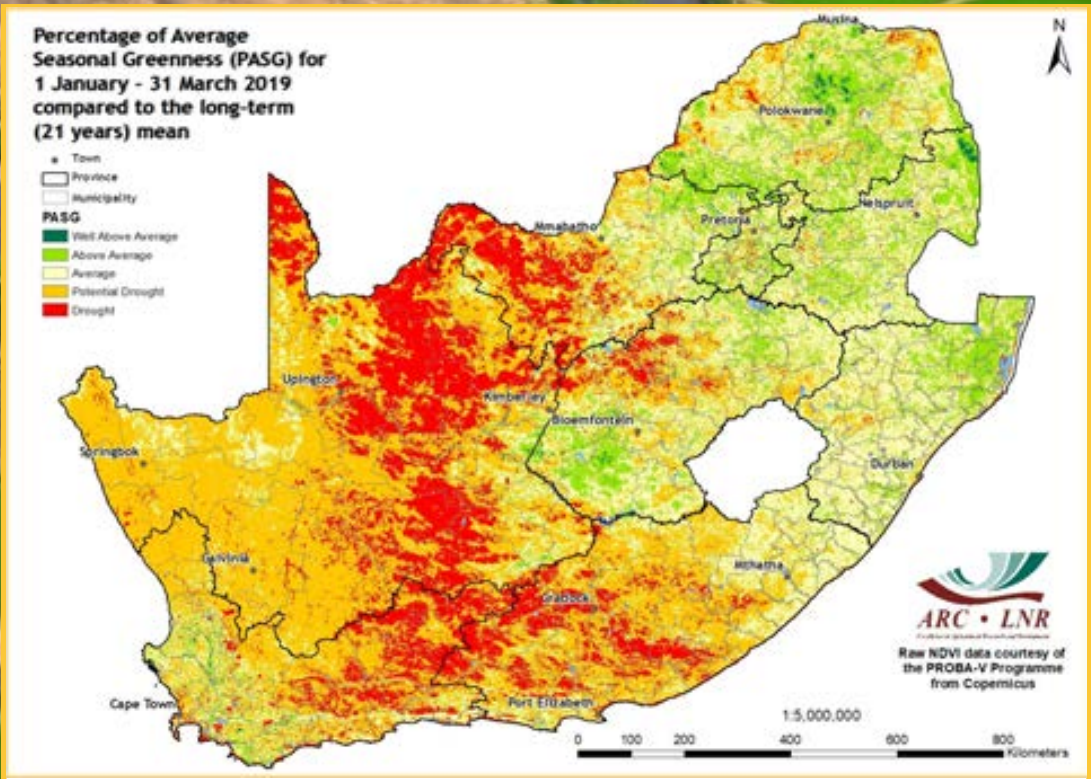

Figure 13

Figure 12:
Compared to the vegetation conditions calculated and averaged over 21 years, the NDVI difference map for March 2019 shows that below -normal vegetation activity remains dominant in the country's interior while pockets of above-normal activity were observed in Limpopo, the coastal region of the Western Cape, western Northern Cape and the far north of Mpumalanga.

Figure 13:
Over a 3-month period, drought conditions occurred in the central parts while a potential drought occurred in the remaining parts of the country. Pockets of above-average vegetation greenness were observed in the northern parts of the country.

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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.

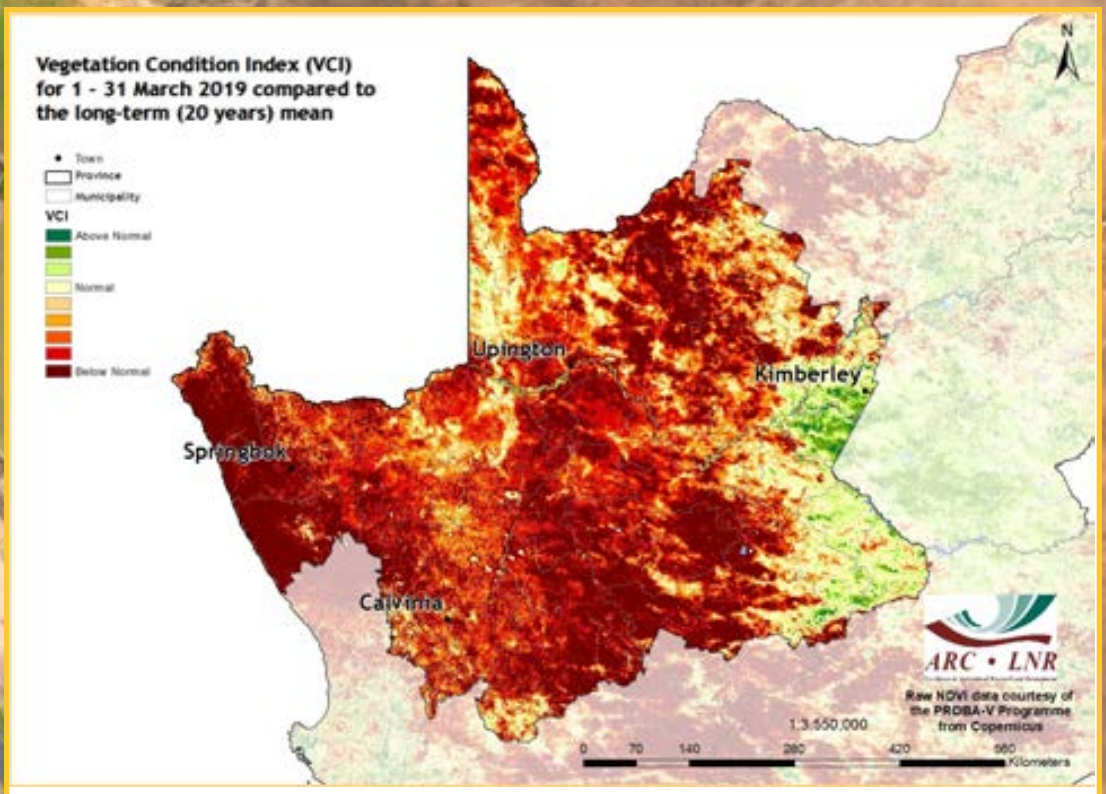

Figure 14

Figure 14:
The VCI map for March shows that nearly the entire Northern Cape Province experienced alarmingly poor vegetation conditions.

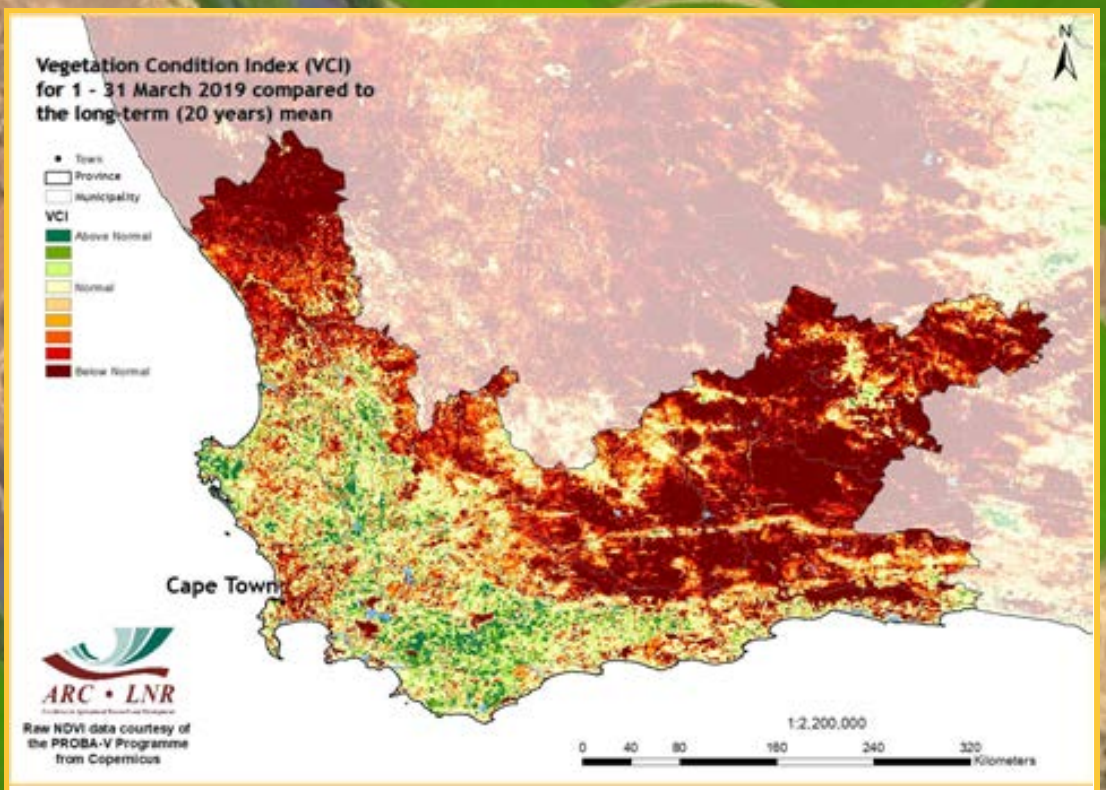

Figure 15

Figure 15:
As in the previous month, very poor vegetation activity continues to affect the northern parts of the Central Karoo and West Coast in relation to other parts of the Western Cape Province.

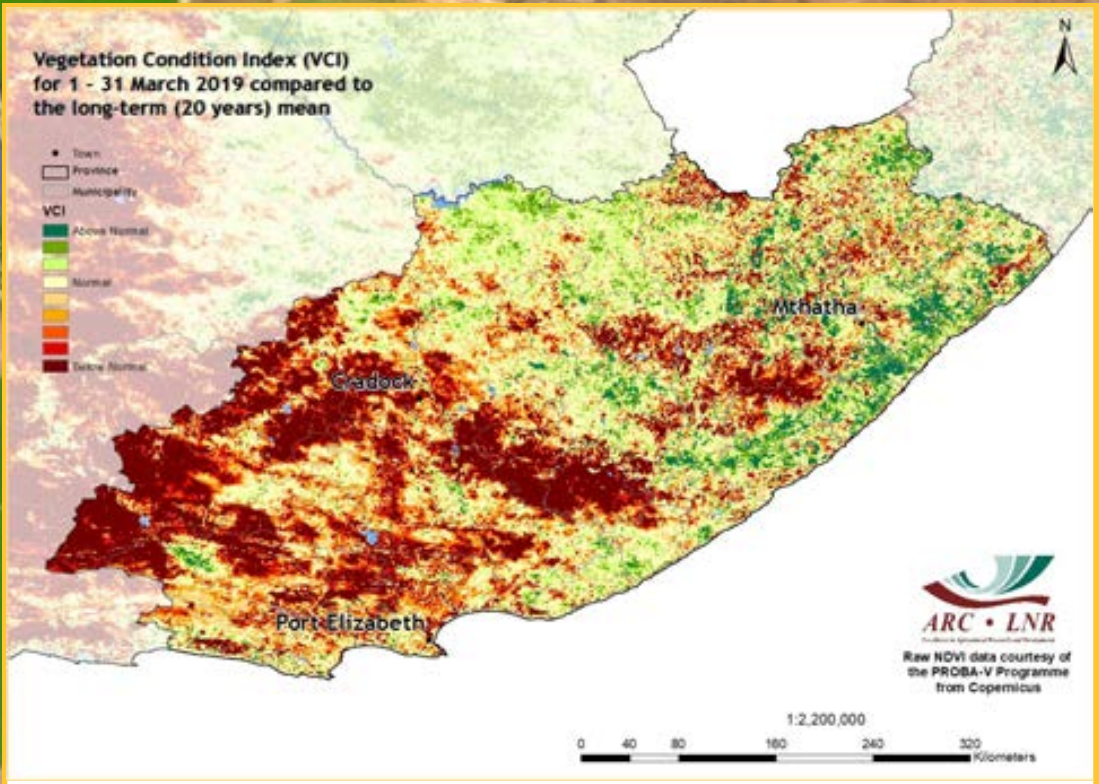

Figure 16

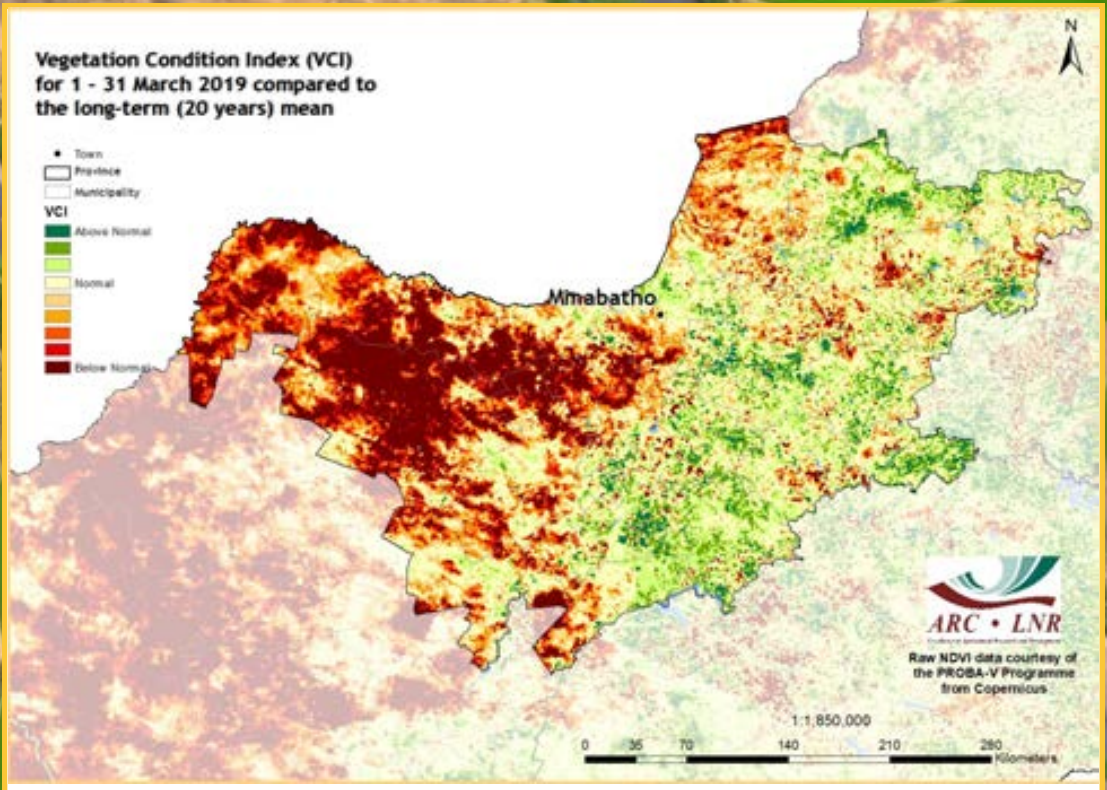

Figure 17

Figure 16:
The vegetation in many parts of the Eastern Cape Province continue to be stressed, although minor exceptions can be observed in some isolated parts of the province.

Figure 17:
The North West Province continues to experience a diverse range of vegetation conditions whereby extremely poor conditions were observed in the western parts and above -normal to normal vegetation was observed in the eastern parts of the province.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

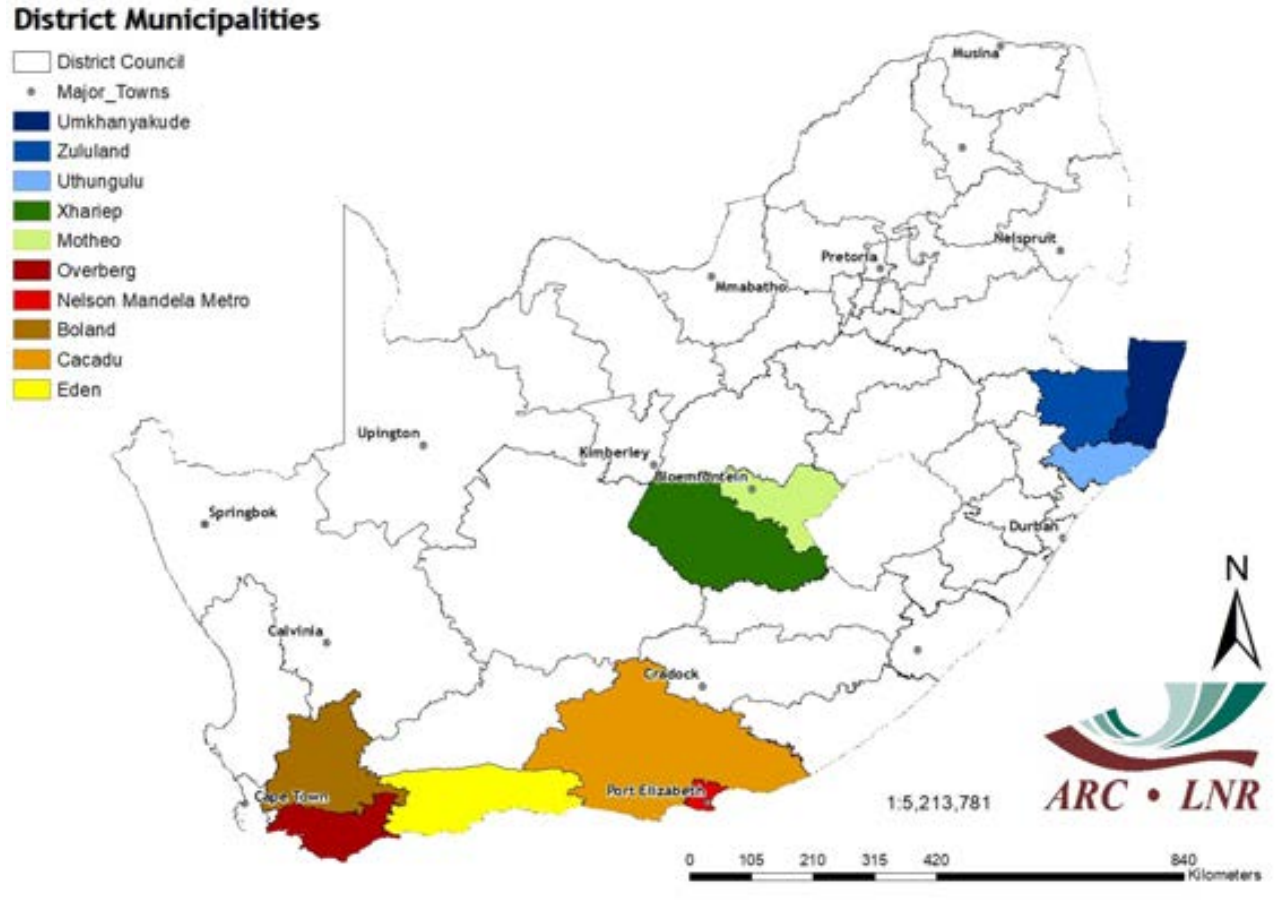

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for March 2019. The district colour matches the border of the corresponding graph.

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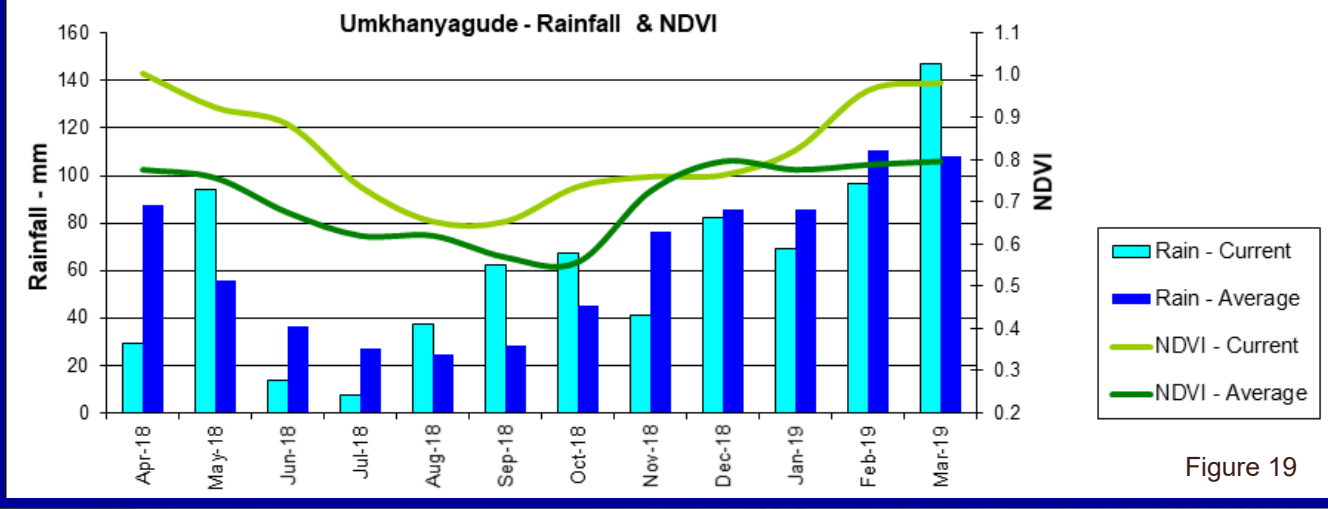
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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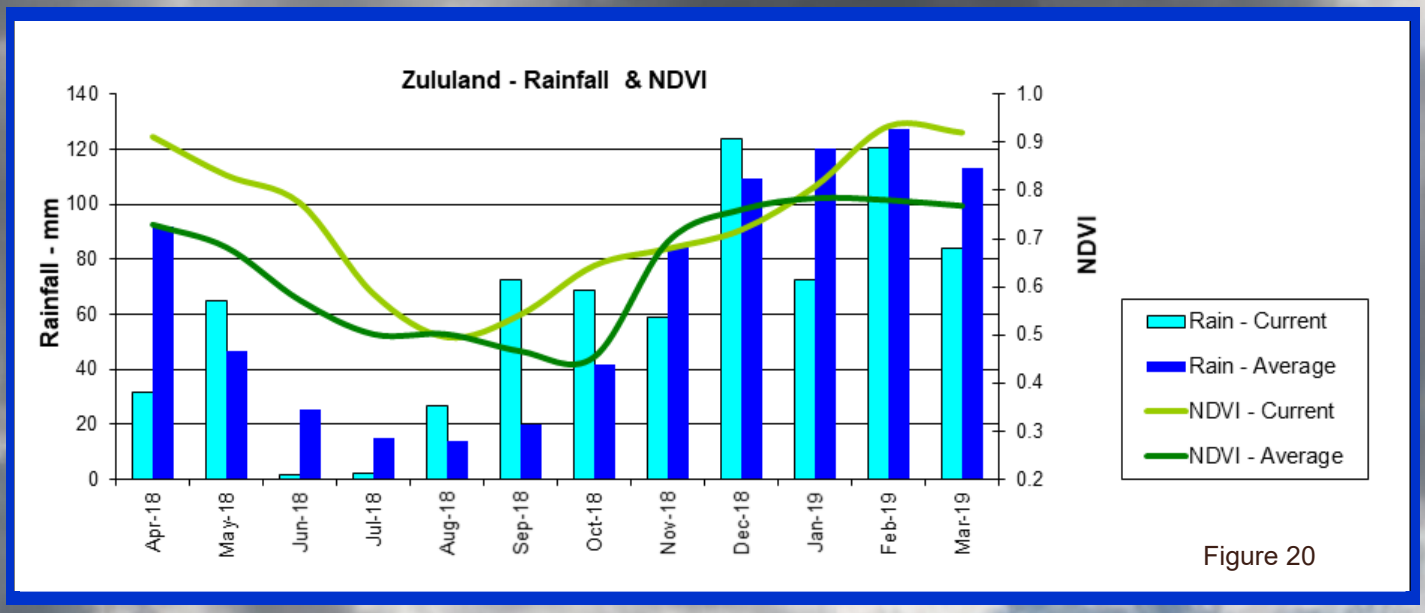
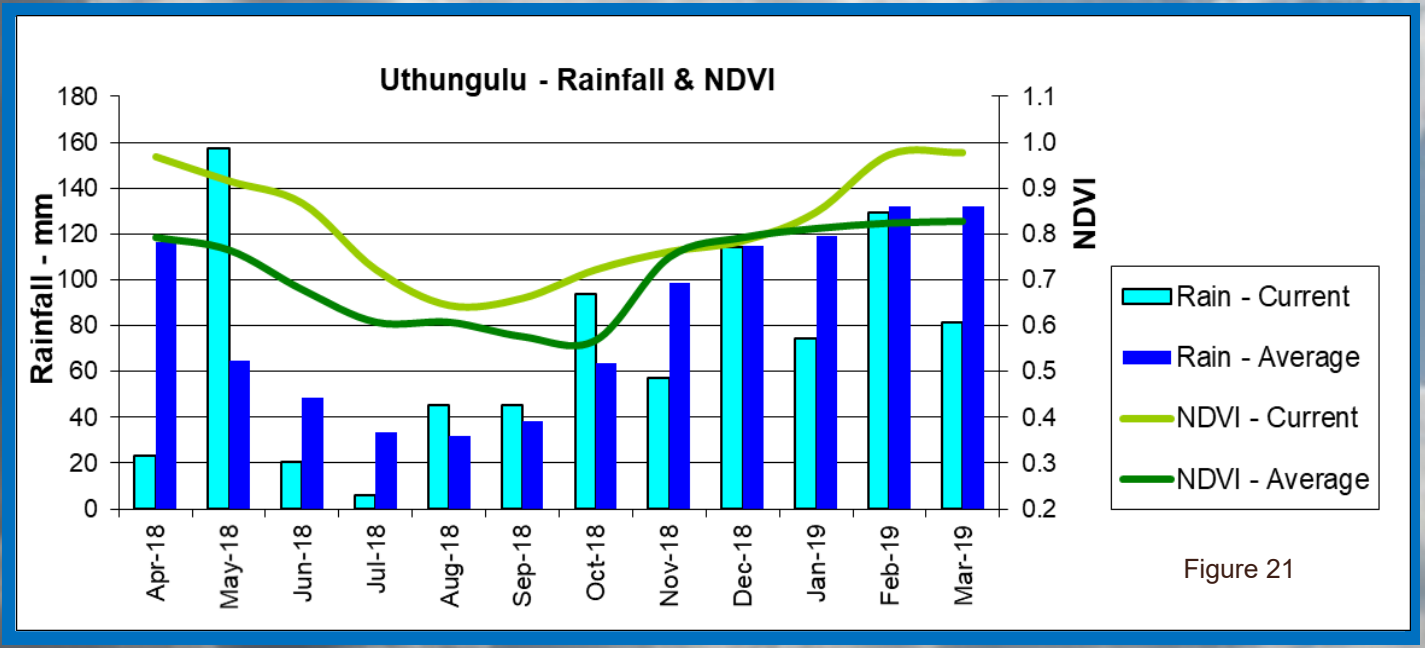


Figure 20



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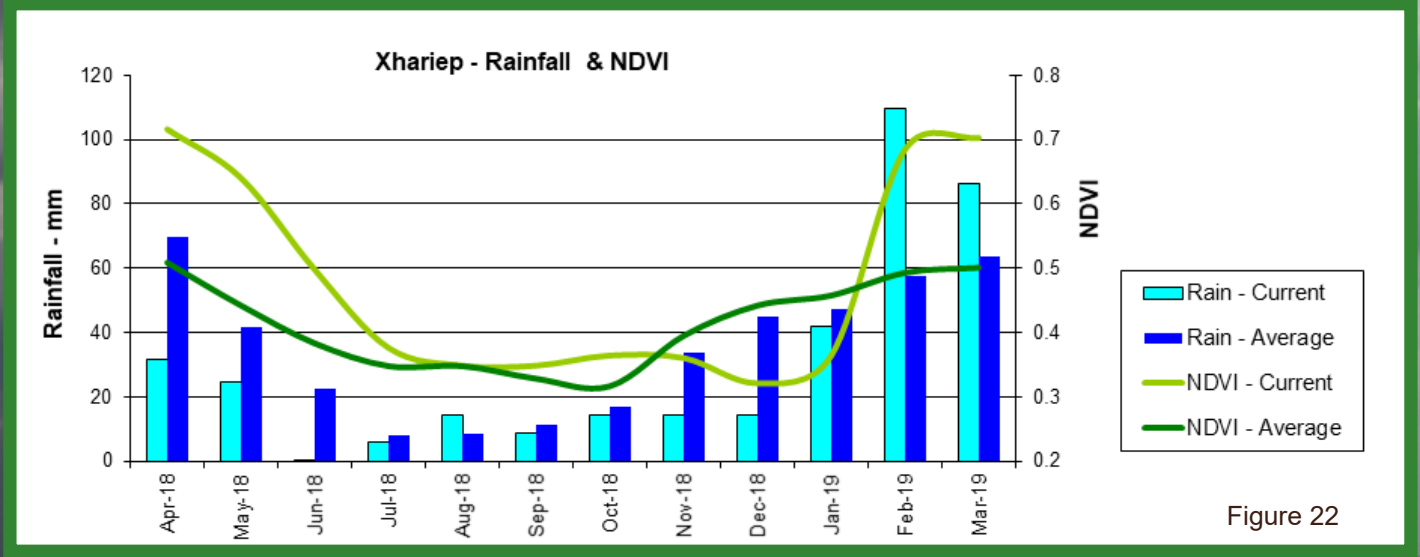

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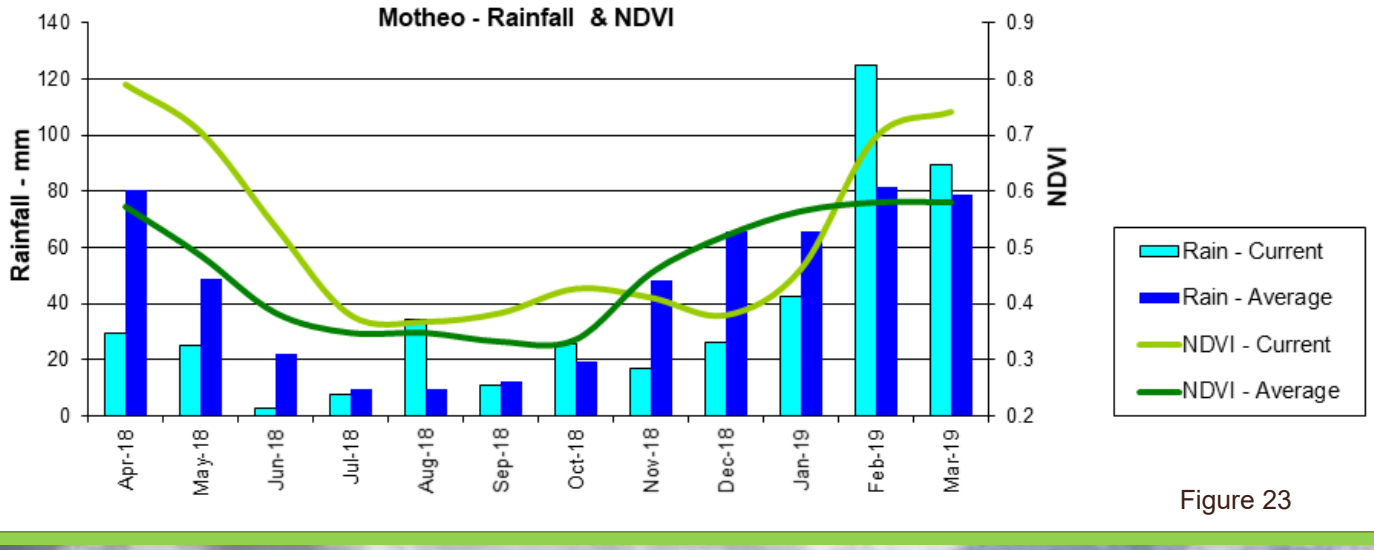
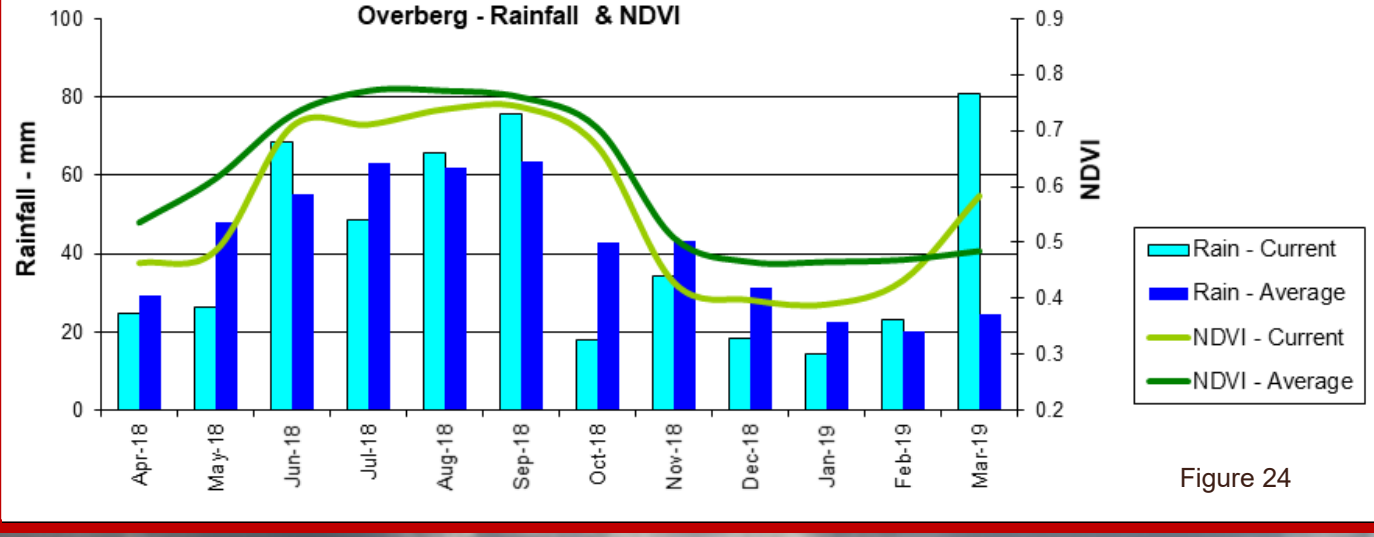


Figure 23



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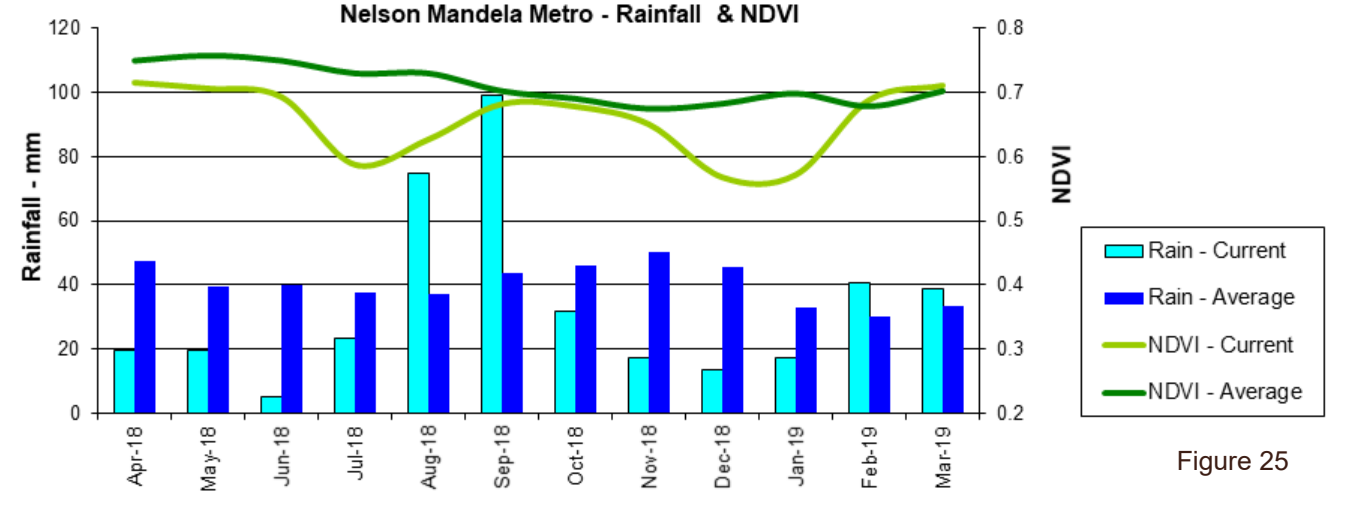

Figure 25

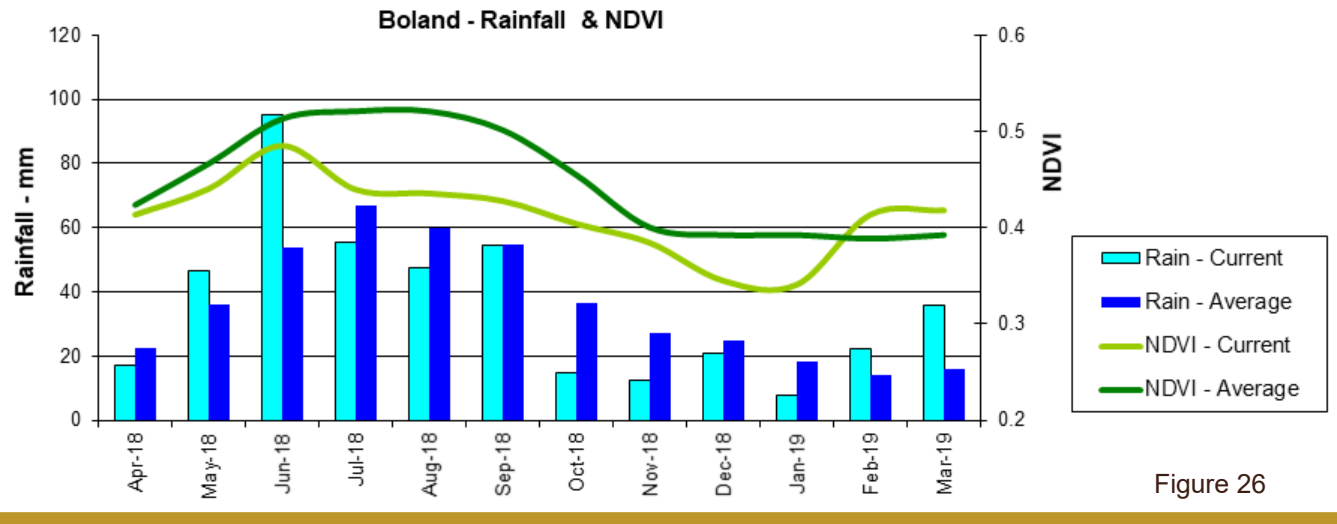

Figure 26

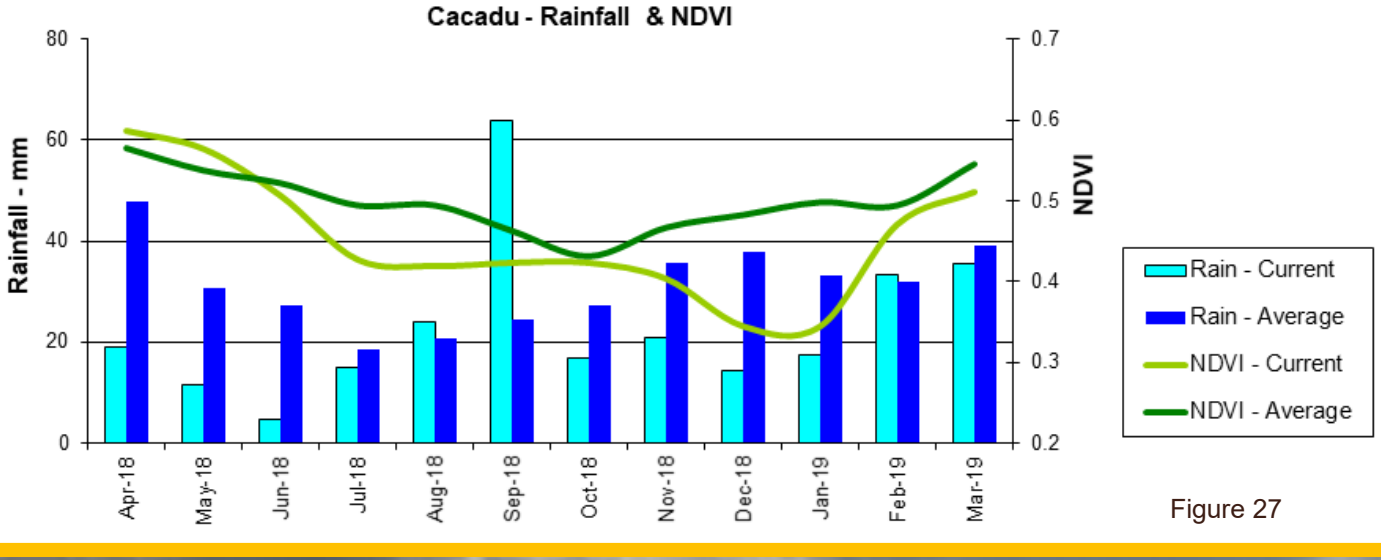

Figure 27

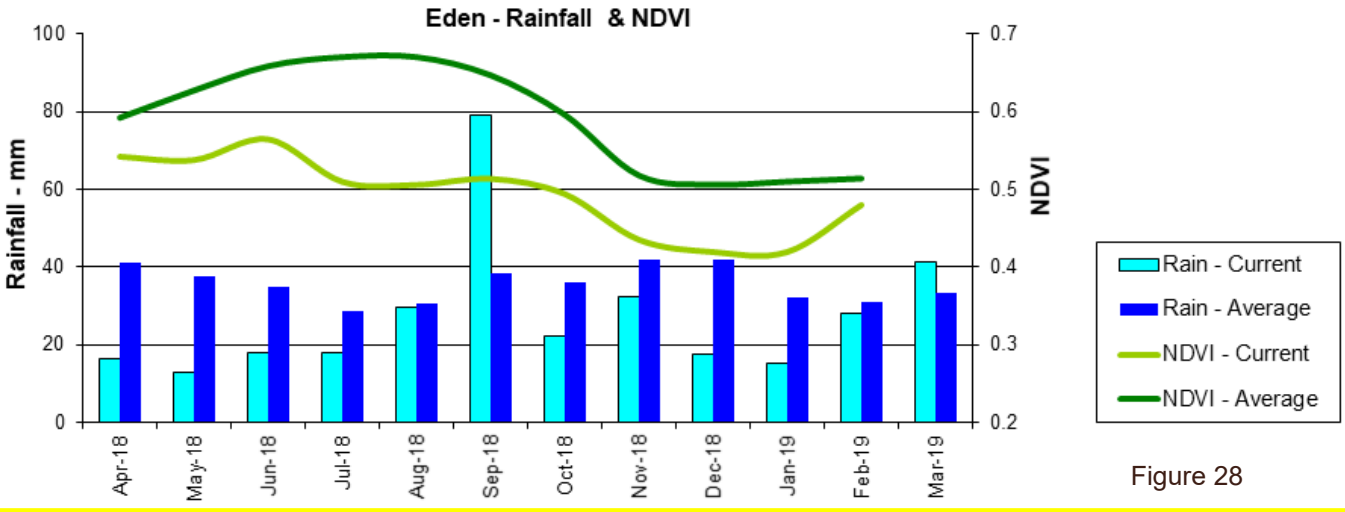

Figure 28

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 1-31 March 2019 per province. Fire activity was higher in the Western Cape compared to the long-term average.

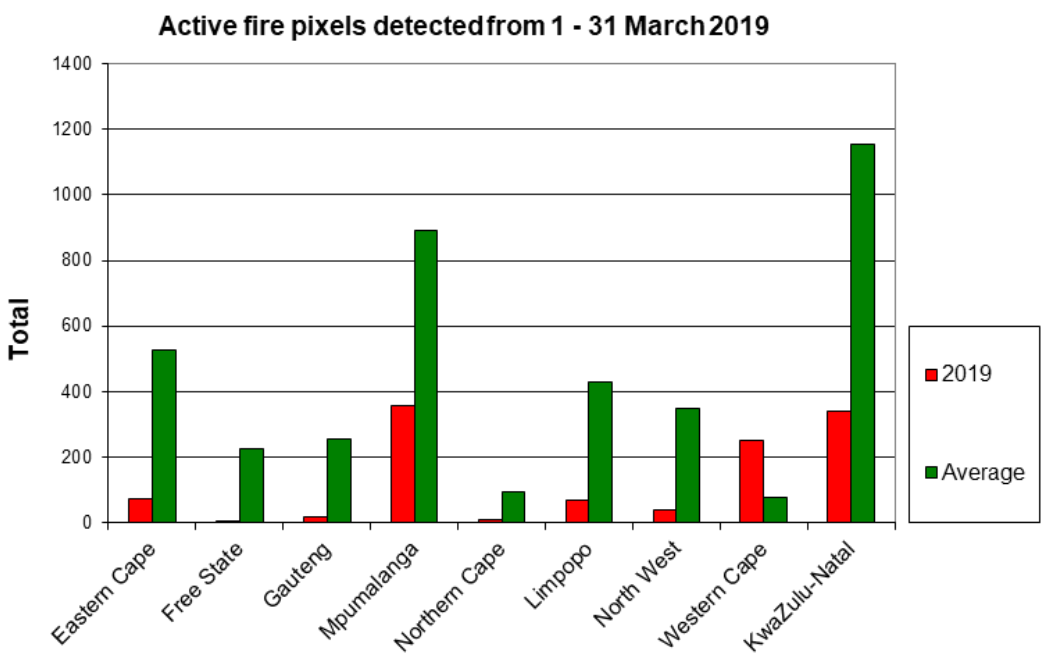

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-31 March 2019.

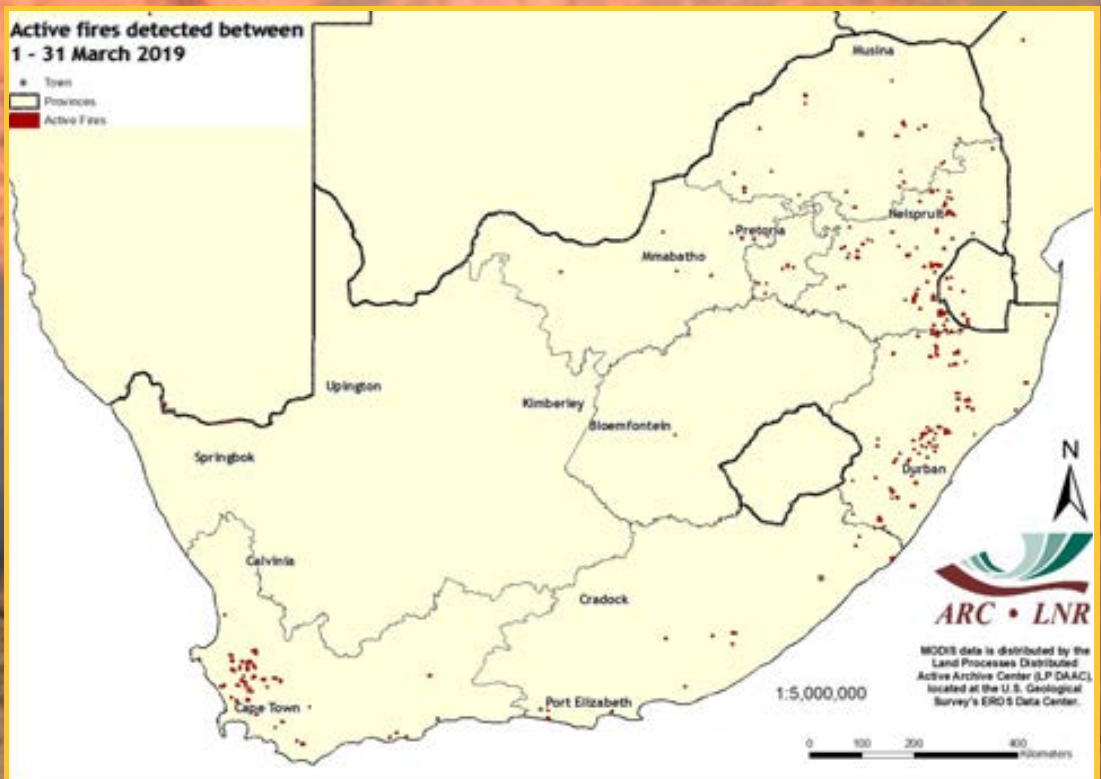

Figure 30

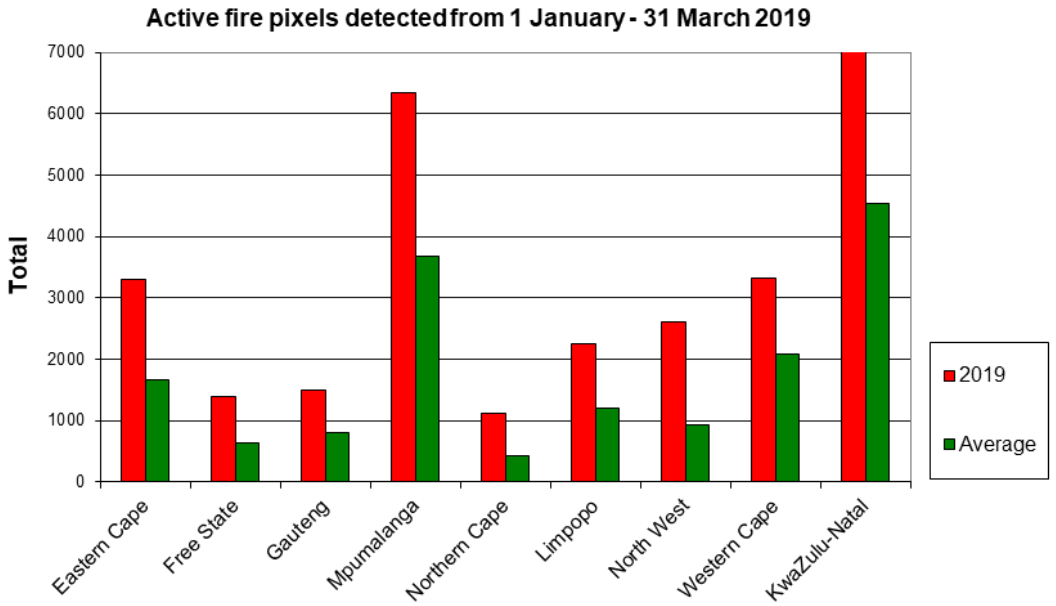

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January to 31 March 2019 per province. Fire activity was higher in all provinces compared to the long-term average.

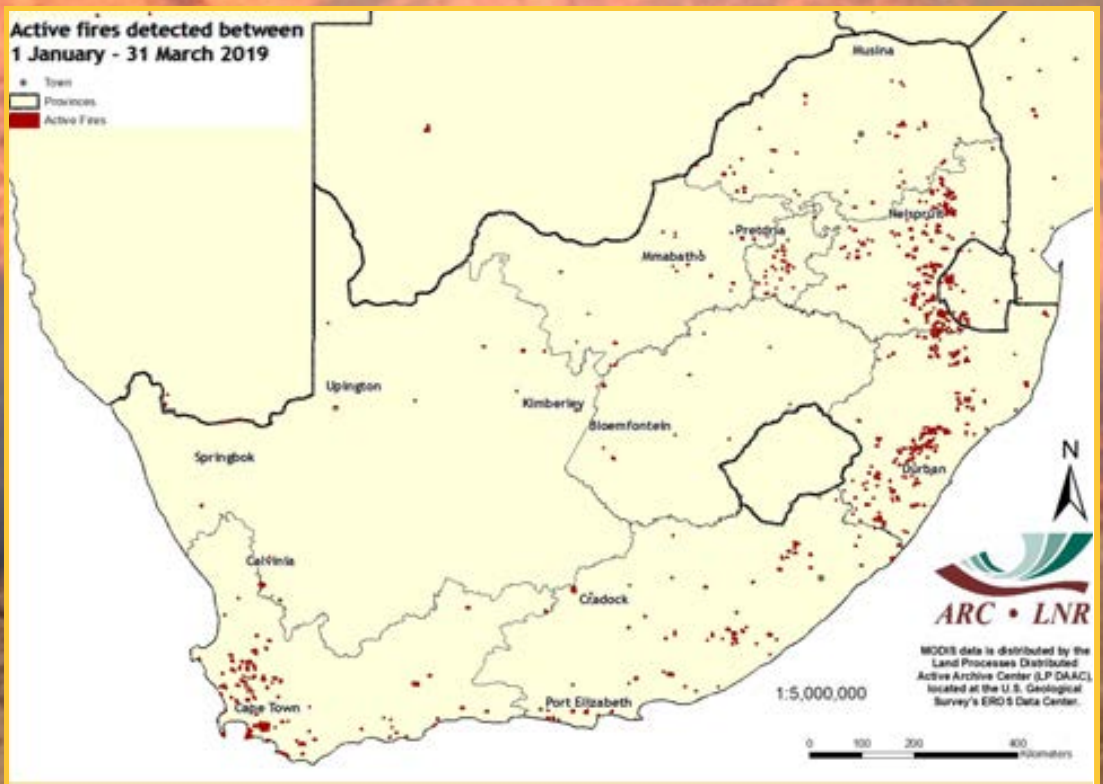

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January to 31 March 2019.

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 2018. On 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 2018.

The long-term map shows that the majority of water catchments across the country currently contain similar water areas to the maximum recorded in those same catchments since the end of 2015; with the exception of the severe water reductions in the Karoo and Kalahari.

Comparison between March 2019 and March 2018 shows that generally the entire country currently has either equal or slightly less water extents than the same period last year. The Karoo, Kalahari and a few local catchments in Lesotho, North West and Limpopo are, however, significant exceptions to this rule, and show much lower water values.

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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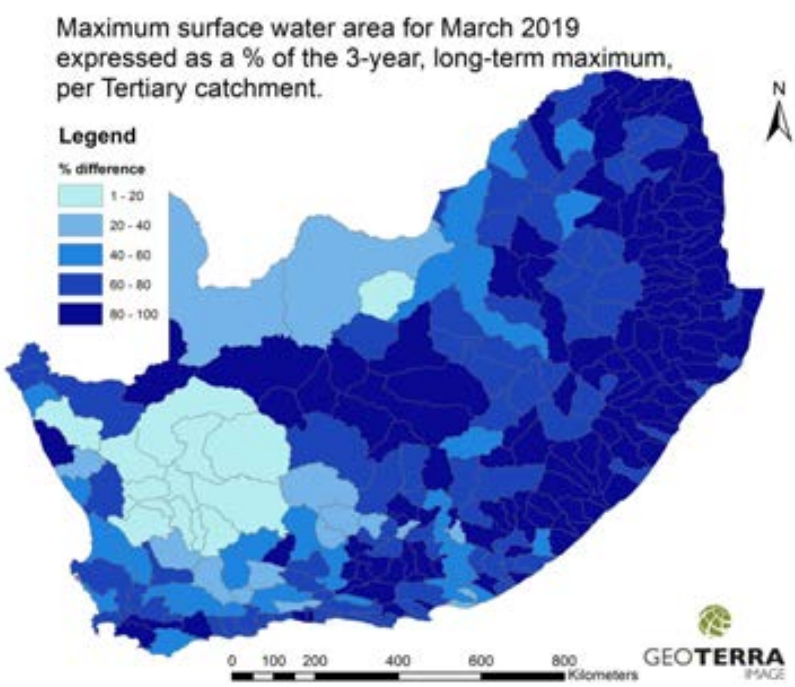

Figure 33

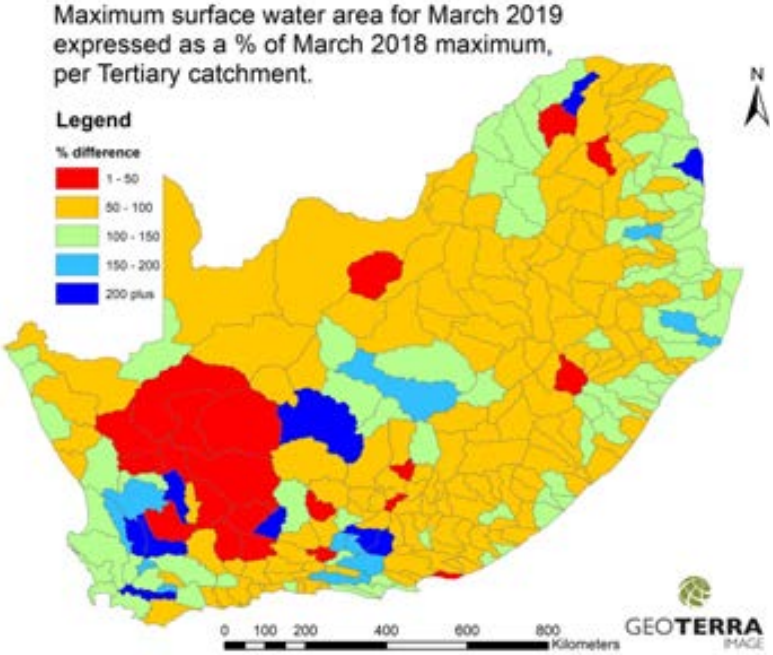

Figure 34

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

ARC • LNR

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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The operational Coarse Resolution Imagery Database (CRID) project of ARC-ISCW is funded by the National Department of Agriculture, Forestry and Fisheries. Development of the monitoring system was made possible at its inception through LEAD funding from the Department of Science and Technology.

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