UMLINDI
The Watchman
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Excellence in Research and Development

INSTITUTE FOR SOIL, CLIMATE AND WATER

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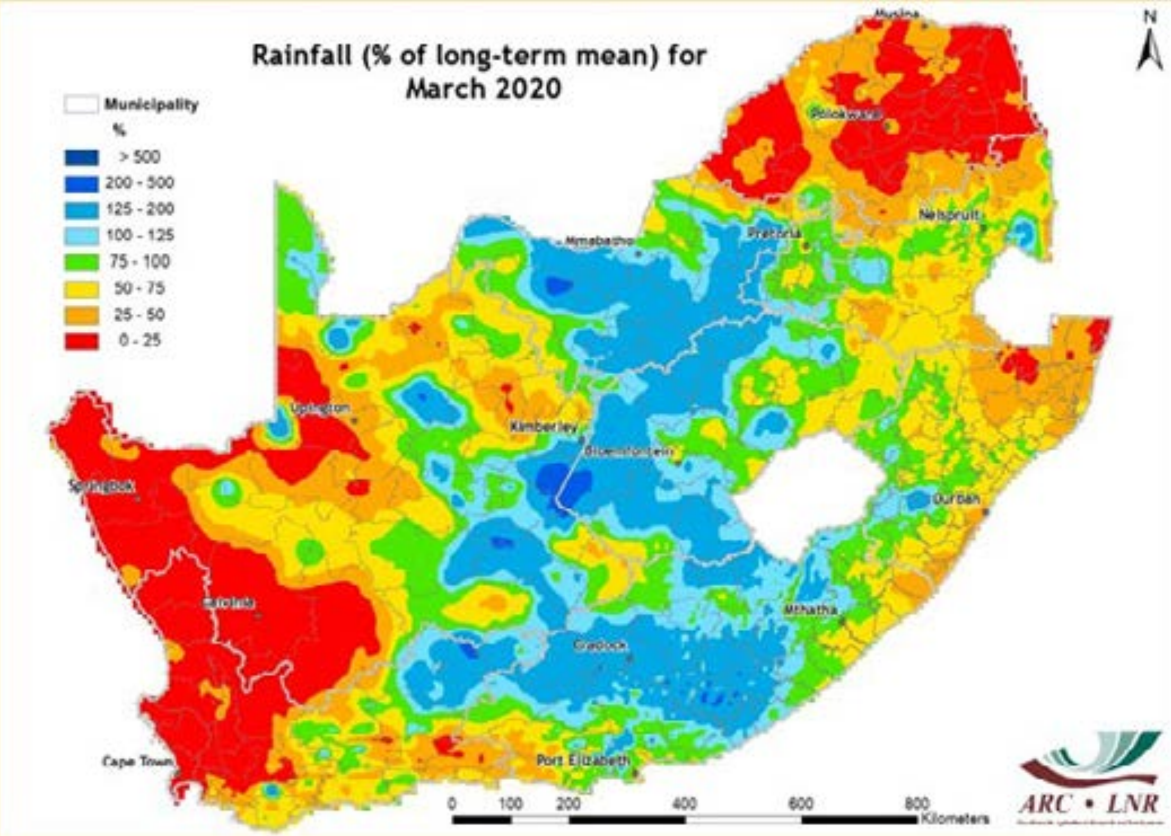
190th Edition

Images of the Month

'Count Every Drop. Every Drop Counts' as the world celebrates World Meteorological Day 2020

Source: WMO (2020) https://worldmetday.wmo.int/

The World Meteorological Organization (WMO) celebrates World Meteorological Day annually on 23 March to commemorate the establishment of the WMO in 1950. Every year the international meteorological community celebrates the day under a different theme to raise awareness on various aspects relating to meteorology. The theme for 2020 is 'Climate & Water' which is motivated by the inevitable climate change challenges affecting water resources around the world. South Africa is no exception as there is substantial evidence that water-related climate hazards such as drought and floods have been occurring in many parts of the country. In addition, the country can expect to experience changes in frequency, intensity, duration and timing of these events due to climate change. The rainfall map for March 2020 (see below) could be used as an example of the spatial variation of rain across the country. However, it should be noted that South Africa has a wide variety of climatic conditions, varying from arid in the west to humid subtropical in the east, while most of the northern and central interior is characterized by semi-arid conditions. Therefore, regardless of agroclimatic environments, the take-home message from World Meteorological Day 2020 is 'Count Every Drop. Every Drop Counts'. For our country's agriculture, this can undoubtedly be aligned with effective preparedness strategies and proper management of agricultural water during both wet and dry periods



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, Land Reform and Rural Development.

Overview:

There was a reduction in total rainfall over most parts of the country in March 2020 as compared to the preceding month. The Limpopo Province, which recorded the highest rainfall amounts (≥200 mm) in February, experienced below-normal rainfall conditions in March. In contrast, the eastern Free State experienced an improvement in rainfall, recording totals of up to 100 mm as compared to 0-25 mm that was received in February. Although wet conditions with total rainfall of up to 150 mm continued over larger parts of the central and southern interior, the coastal regions of the Western Cape, Eastern Cape and KwaZulu-Natal experienced below-normal conditions. The Northern Cape followed a similar pattern, although isolated areas in Pixley ka Seme, Frances Baard and ZF Mgcawu Districts received above-normal rainfall.

The Eastern Cape Province experienced some very hot weather in March, with stations near Port Elizabeth recording maximum temperatures of >42°C on the 4th. Parts of the Western Cape, including areas along the Garden Route, also recorded highs of 40-42°C at the beginning of the month.

1. Rainfall

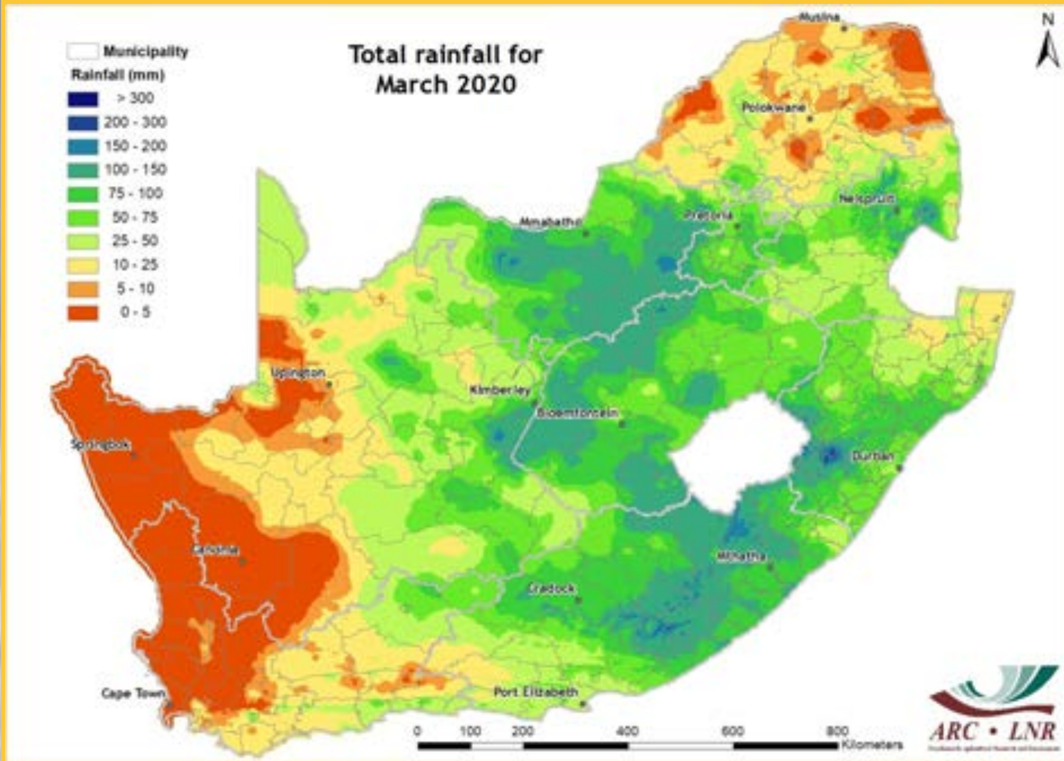


Figure 1

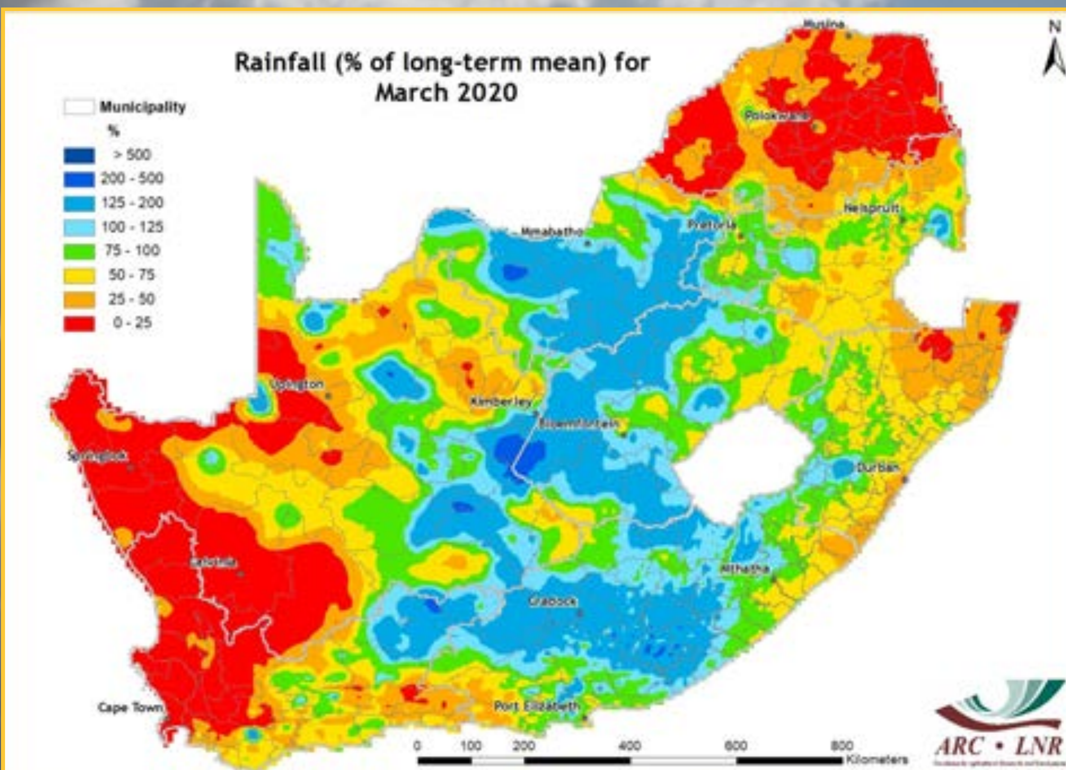


Figure 2

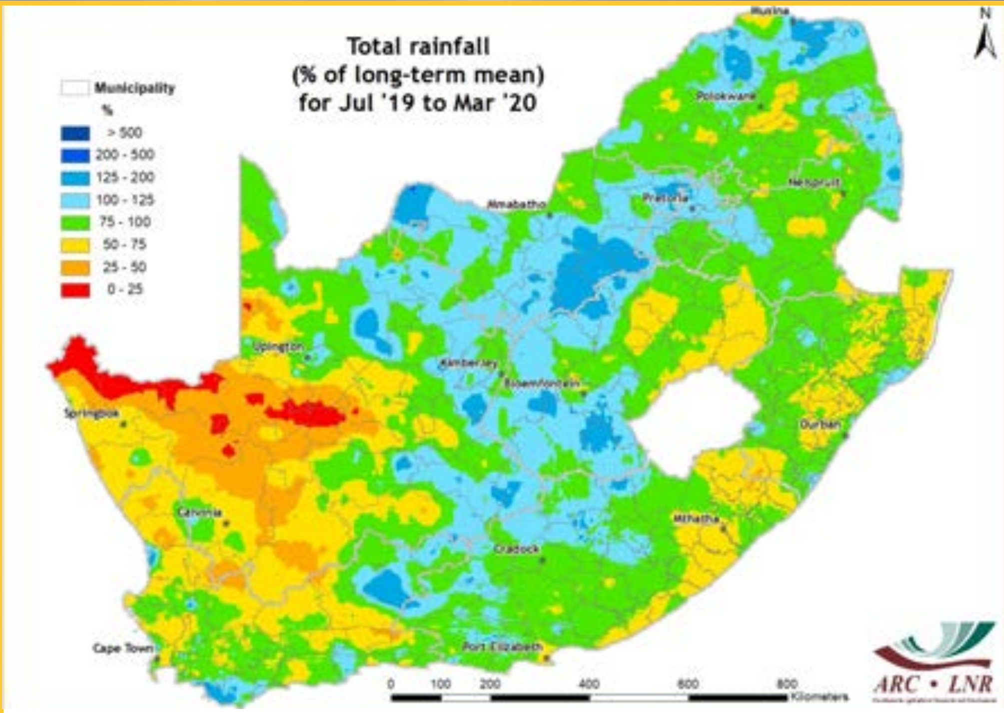


Figure 3

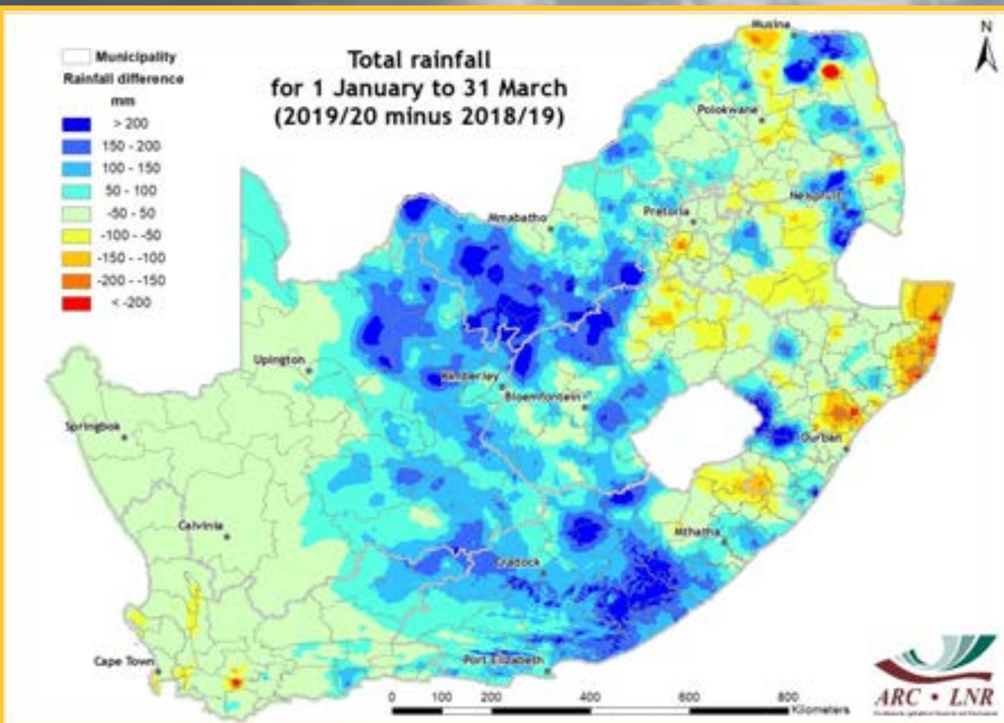


Figure 4

Figure 1:
Rainfall in March 2020 was largely dominant over much of the summer rainfall region except for the Limpopo Province. Meanwhile, the winter rainfall region remained dry.

Figure 2:
Normal to above-normal rainfall was observed over most parts of the central and southern interior. Below-normal rainfall occurred in Limpopo, parts of Mpumalanga, KwaZulu-Natal and the winter rainfall region.

Figure 3:
Since July 2019, the central interior and northern parts of the country received near- to above-normal rainfall. Parts of the Northern Cape, Eastern Cape, KwaZulu-Natal and eastern Free State were mostly below normal.

Figure 4:
The central and southern interior received significantly more rain during January-March 2020 as compared to the same period last year. The rest of the country received somewhat the same amount of rainfall as compared to the same period in 2019, with isolated negative values noted in the Limpopo Bushveld, Free State and KwaZulu-Natal.

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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 SPI maps revealing short-term (6-month SPI), medium-term (12-month SPI) and long-term (24-month and 36-month SPI) drought conditions are shown in Figures 5-8. Given the short-term SPI for the month of March, high rainfall totals resulted in mild wet conditions over the interior and parts of the Western Cape and Eastern Cape. The medium-term SPI map shows severe to extreme drought over the western parts of the Northern Cape, as well as isolated areas in the Western Cape, Mpumalanga and the border of Eastern Cape and KwaZulu-Natal. The southern region of the North West Province shows mild to extreme wet conditions, mainly due to the high amounts of rainfall that occurred since December 2019. The long-term SPI maps indicate severe to extreme droughts over the Cape provinces, eastern Free State, parts of KZN, Limpopo and Mpumalanga.

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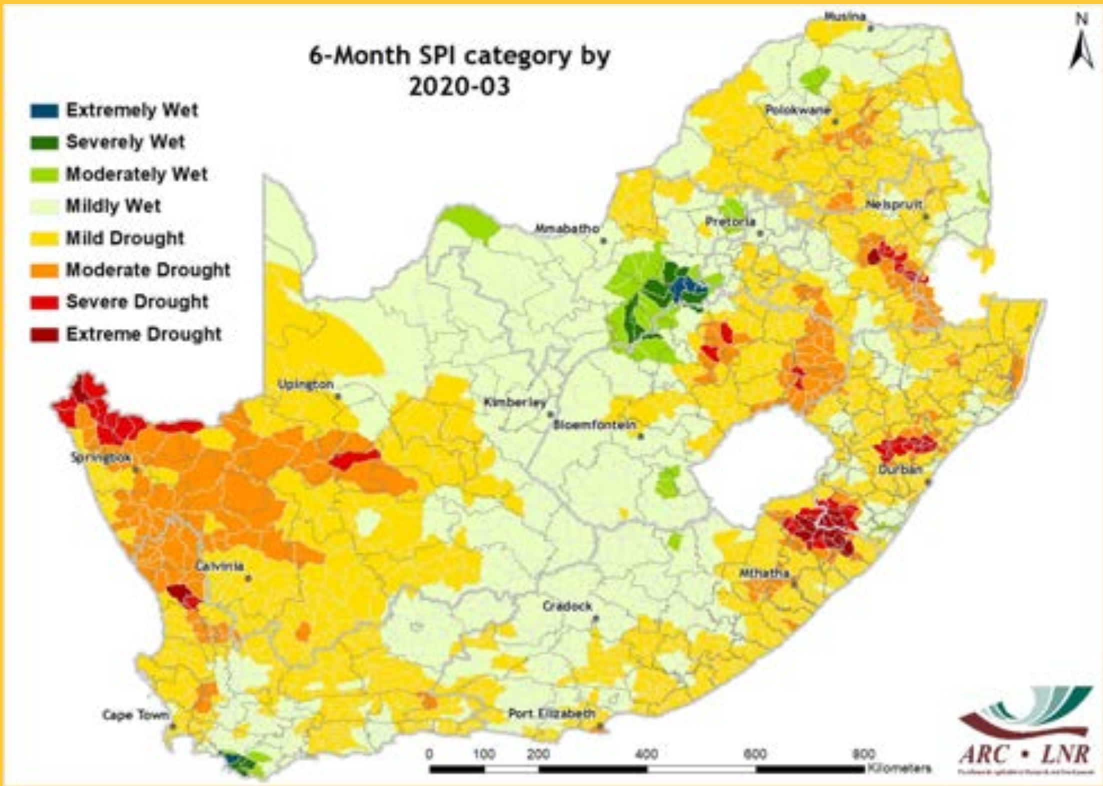

Figure 5

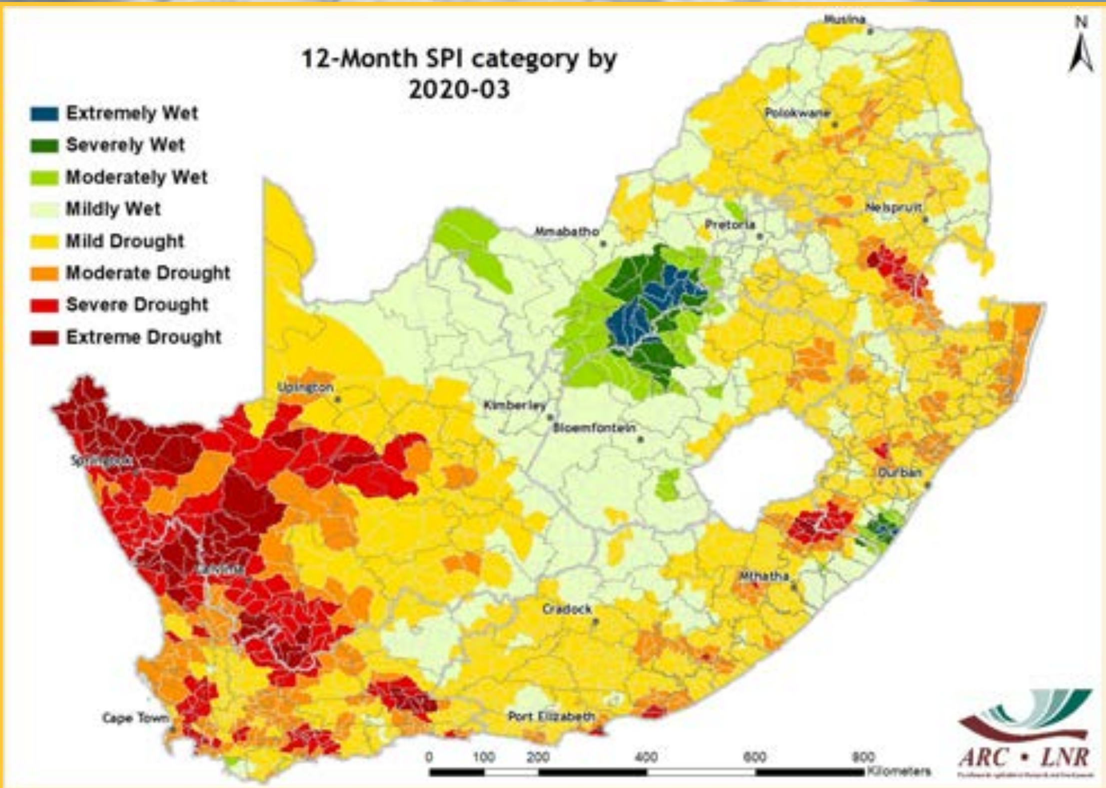

Figure 6

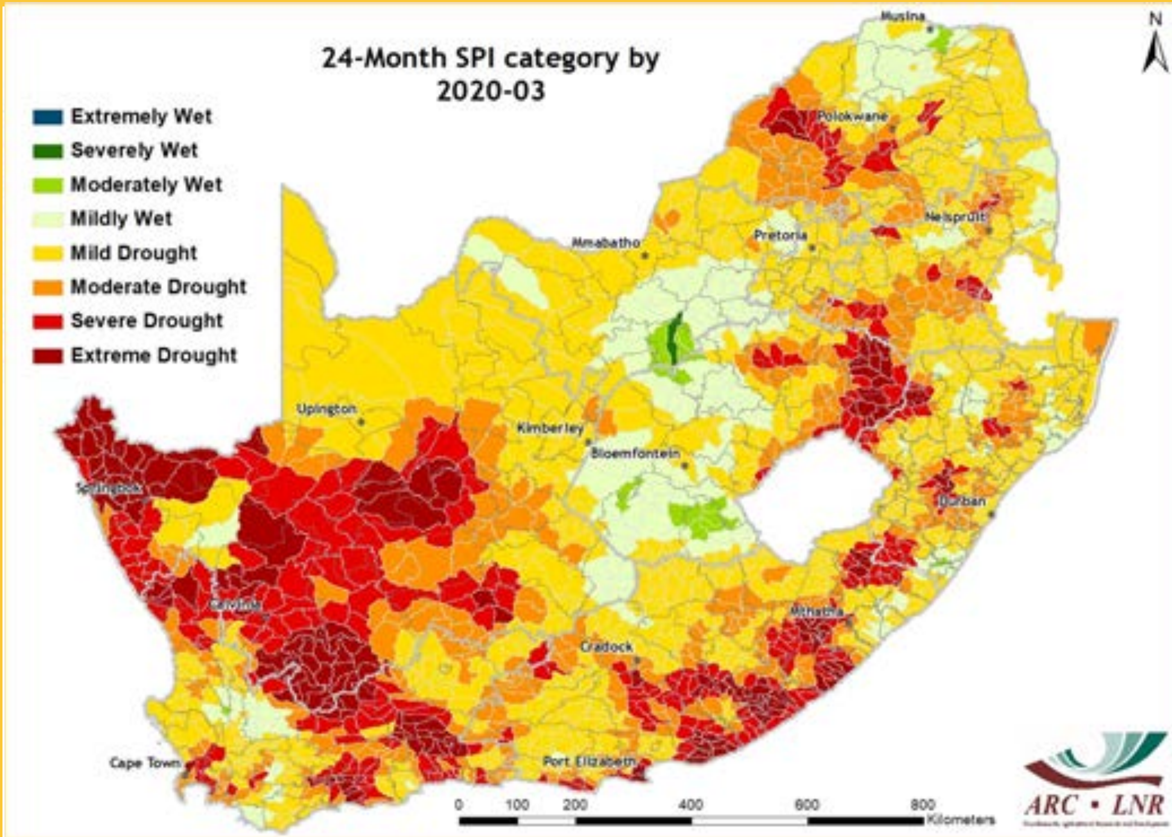

Figure 7

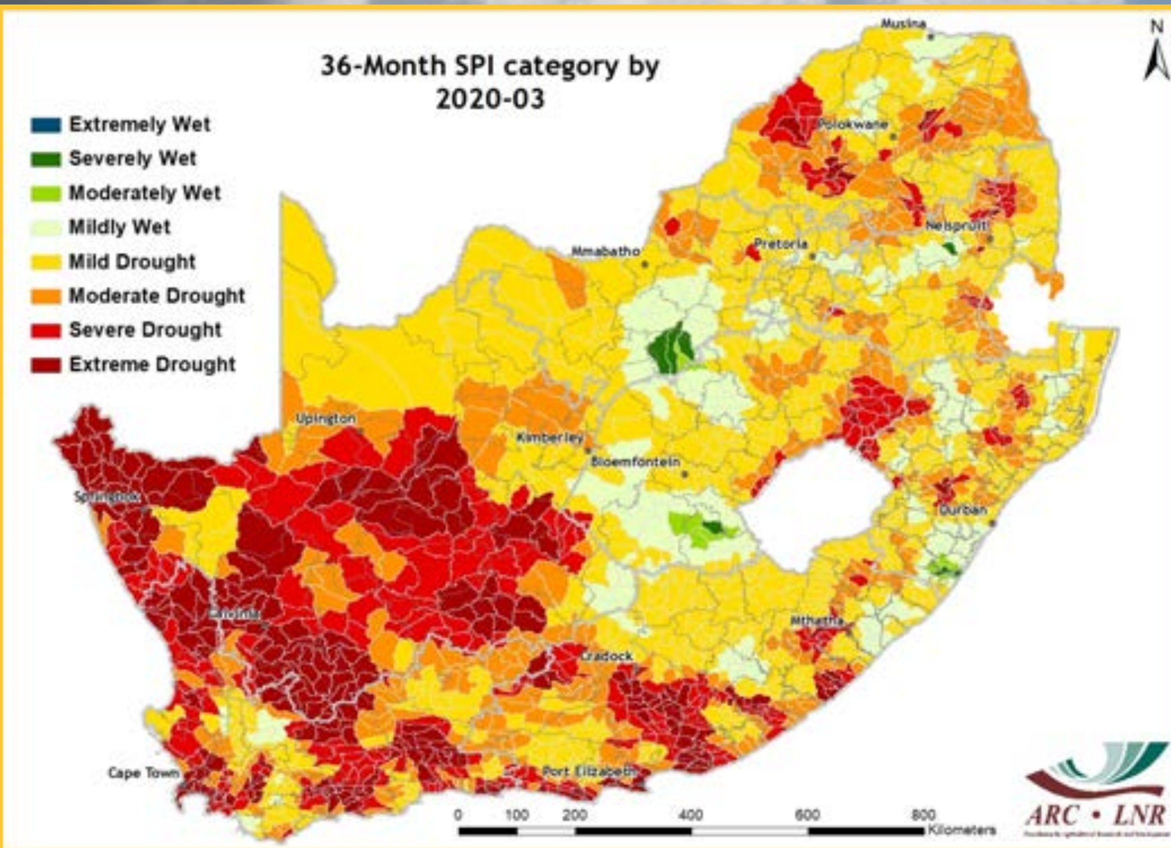

Figure 8

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.

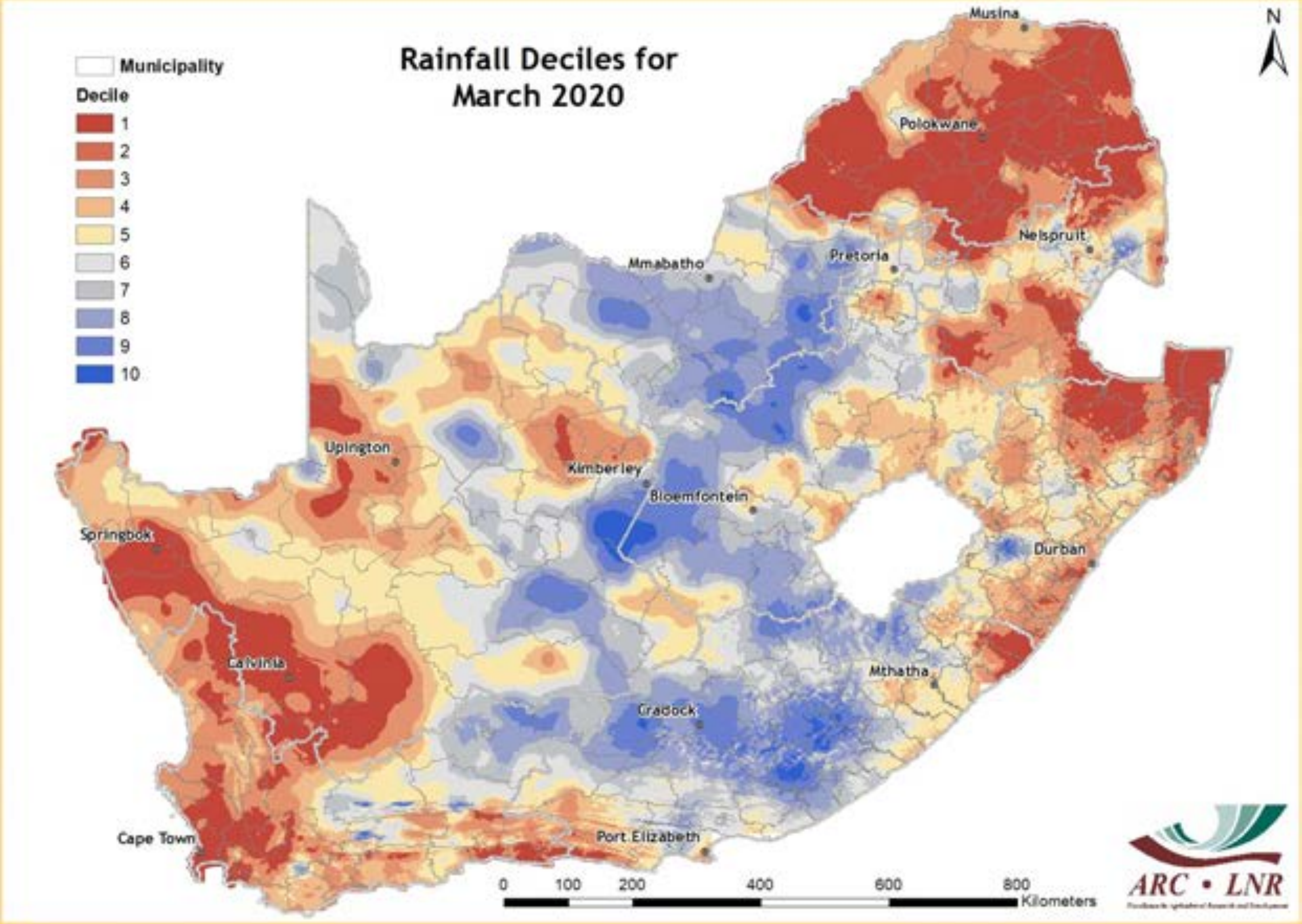

Figure 9

Figure 9:
The central and southern interior of the country experienced rainfall totals that compare well with the historically wetter March rainfall totals, whereas the northeastern and western parts fell within the drier periods.

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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.

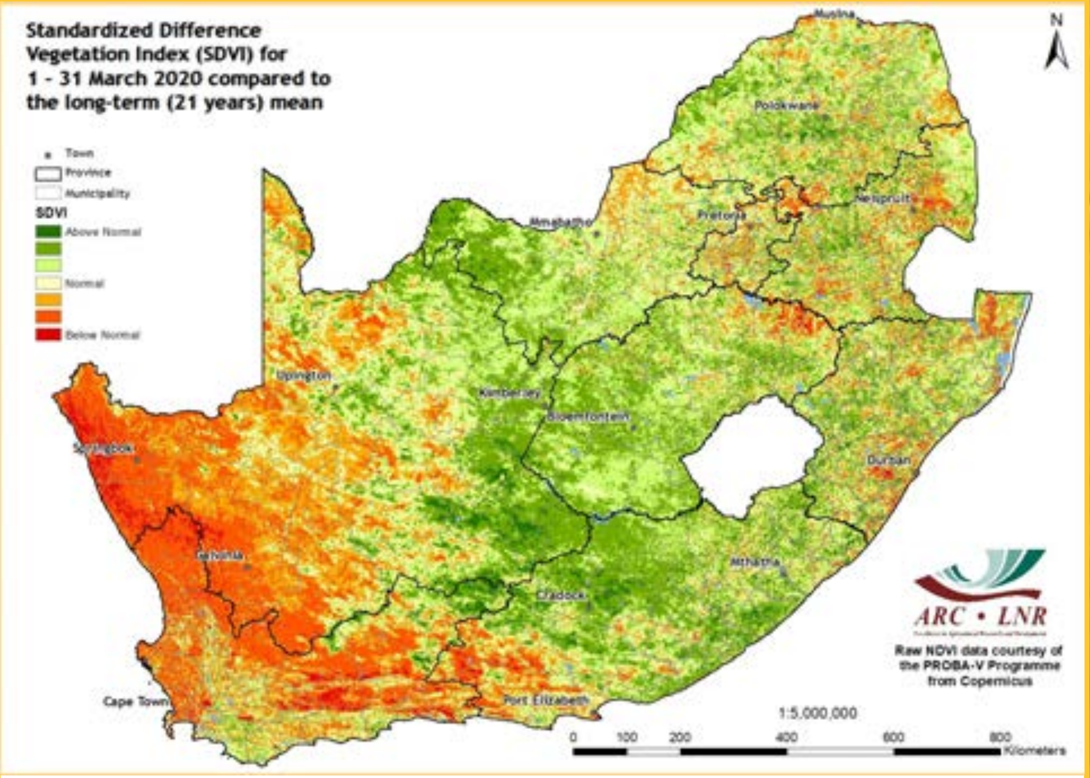

Figure 10

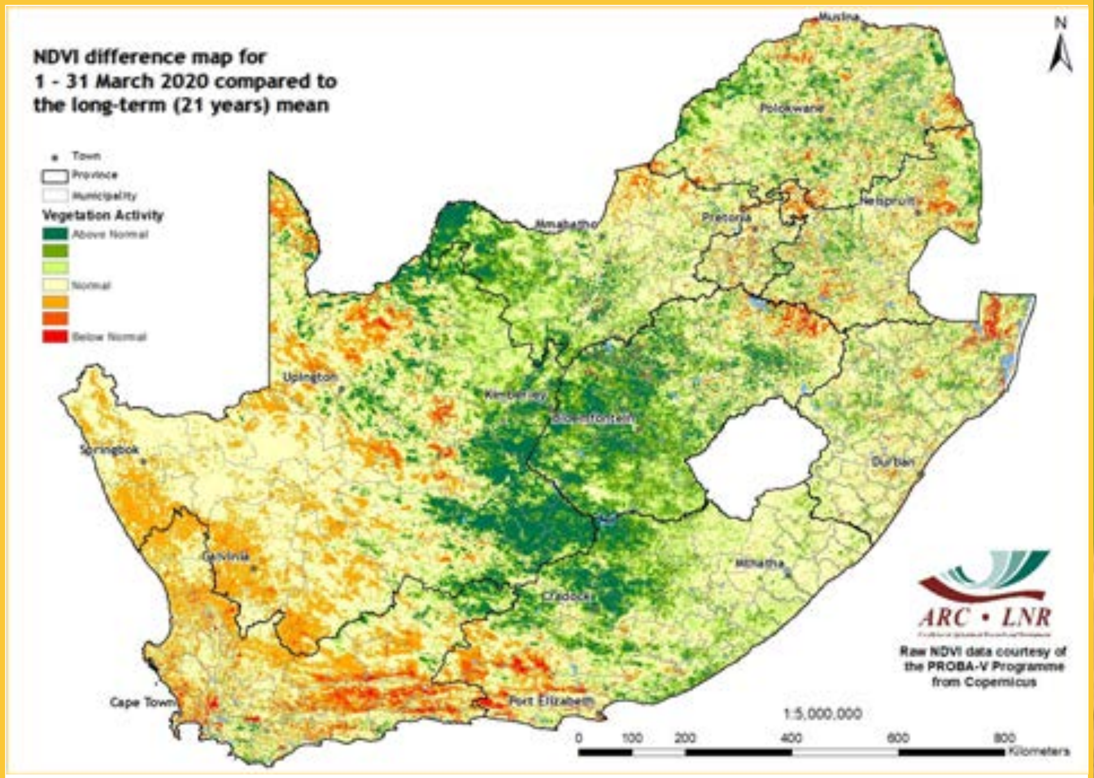

Figure 11

Figure 10:
Compared to the long-term average, the SDVI map for March 2020 shows that the western parts of the country, particularly the Cape region, remain an area of concern with regard to vegetation conditions, whereas the central and northern parts continue to be characterized by good vegetation activity.

Figure 11:
Compared to the long-term average, the NDVI difference map for March shows improved vegetation conditions in the central and northern parts of the country, while the western parts continue to experience below-normal vegetation activity.

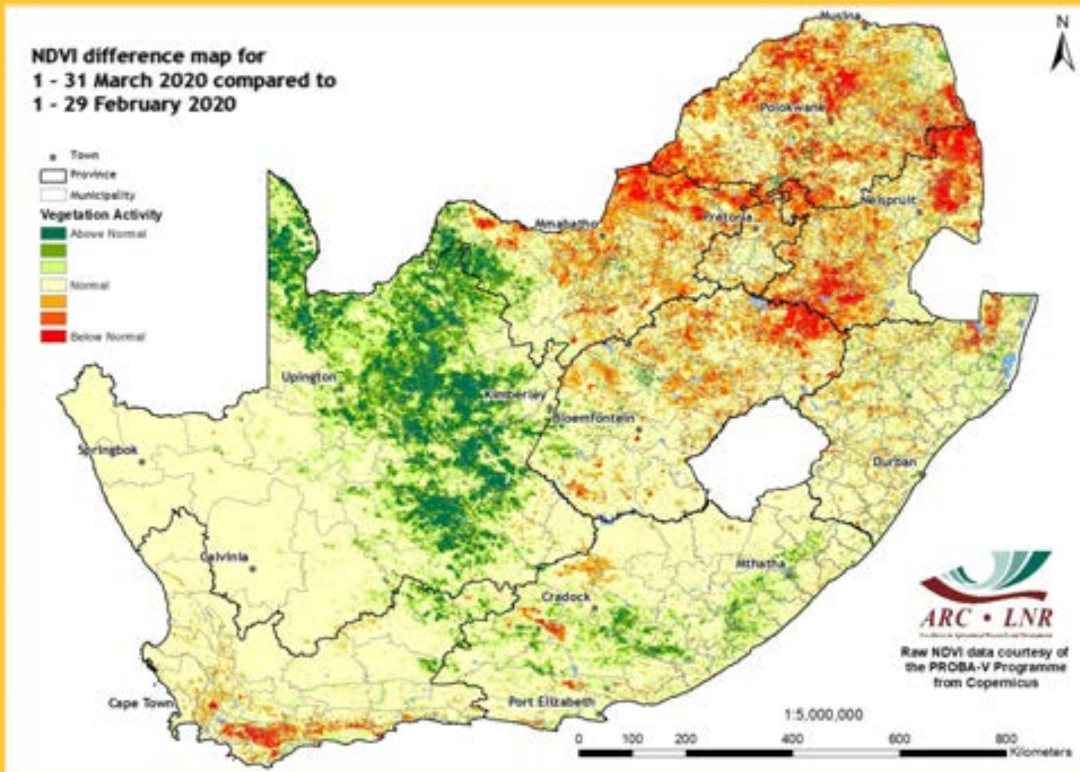

Figure 12

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

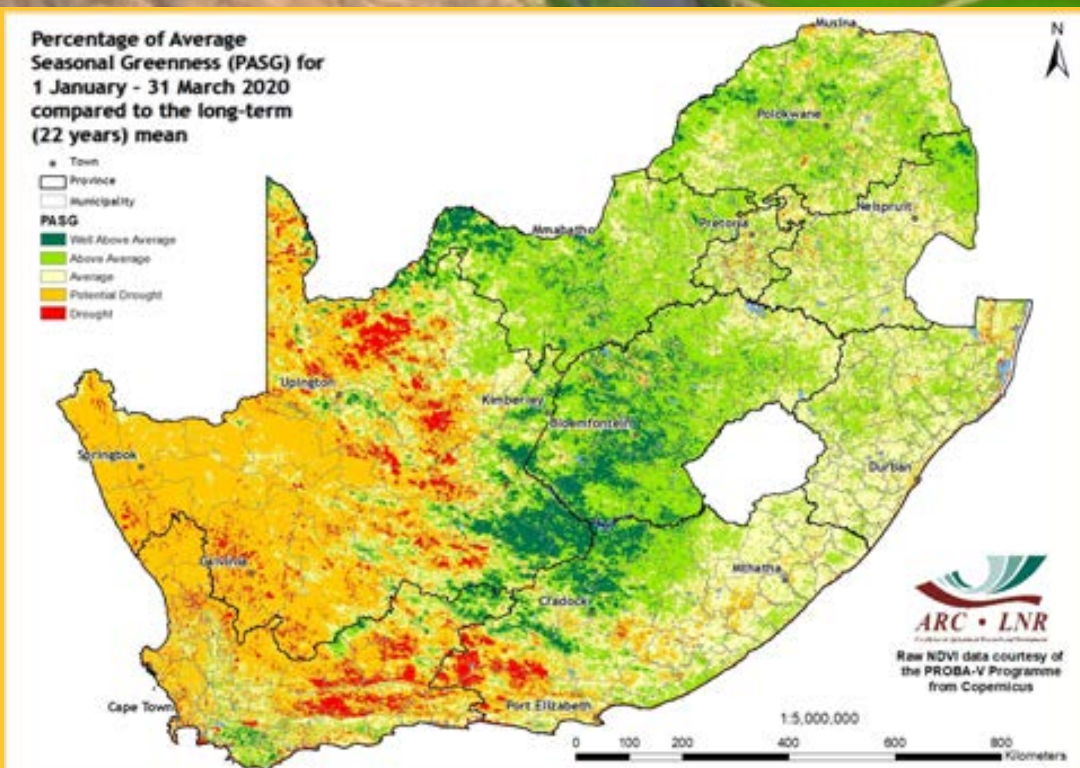

Figure 13

Figure 12:
Compared to the previous month, the NDVI map for March shows that the western half of the country generally experienced normal to above-normal vegetation activity. Nevertheless, poor vegetation conditions were evident in the northern parts of the country.

Figure 13:
The PASG map over a 3-month period compared to the long-term mean shows that the western parts of the country continue to experience low levels of seasonal greenness in vegetation. Meanwhile, the central, northern and eastern parts show improved vegetation conditions.

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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.

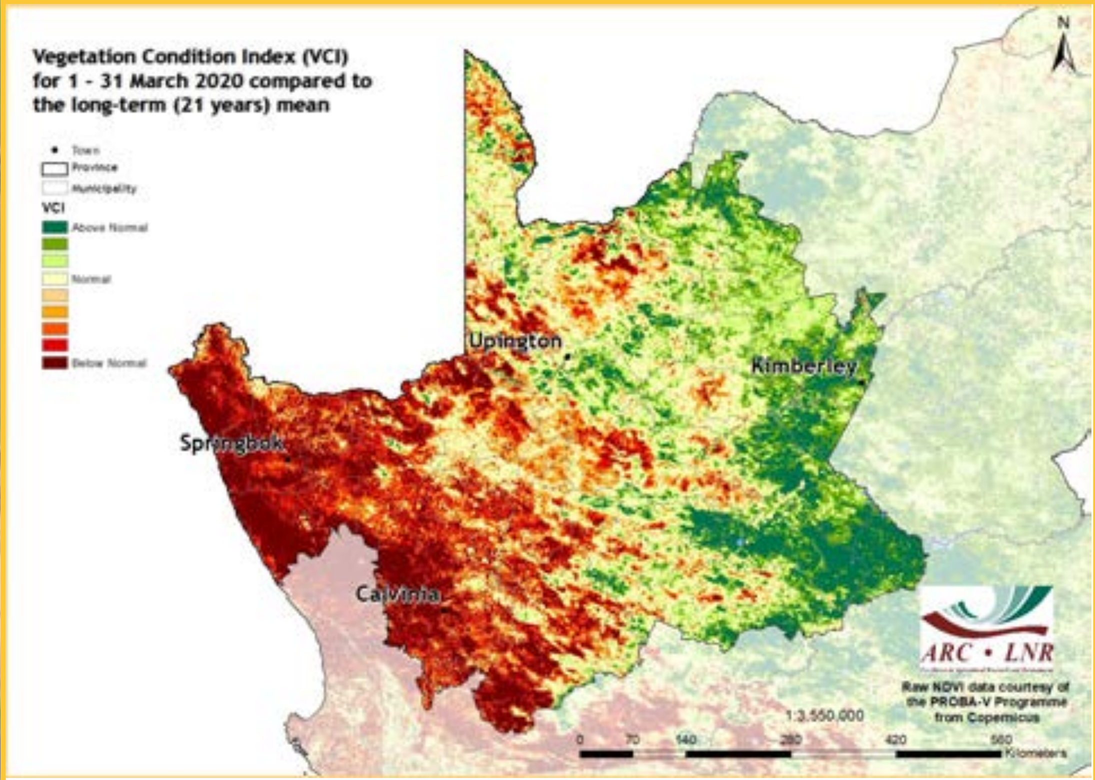

Figure 14

Figure 14:
The VCI map for March shows that severe drought conditions continue to impact negatively on vegetation activity over the larger part of the Northern Cape.

Figure 15:
The VCI map for March shows that a larger portion of the Western Cape continues to experience poor vegetation conditions, particularly the Central Karoo, northern parts of the West Coast, as well as northeastern and western parts of the Eden District Municipality. Minor exceptions were isolated areas in the western parts and the southern coastal areas of the province.

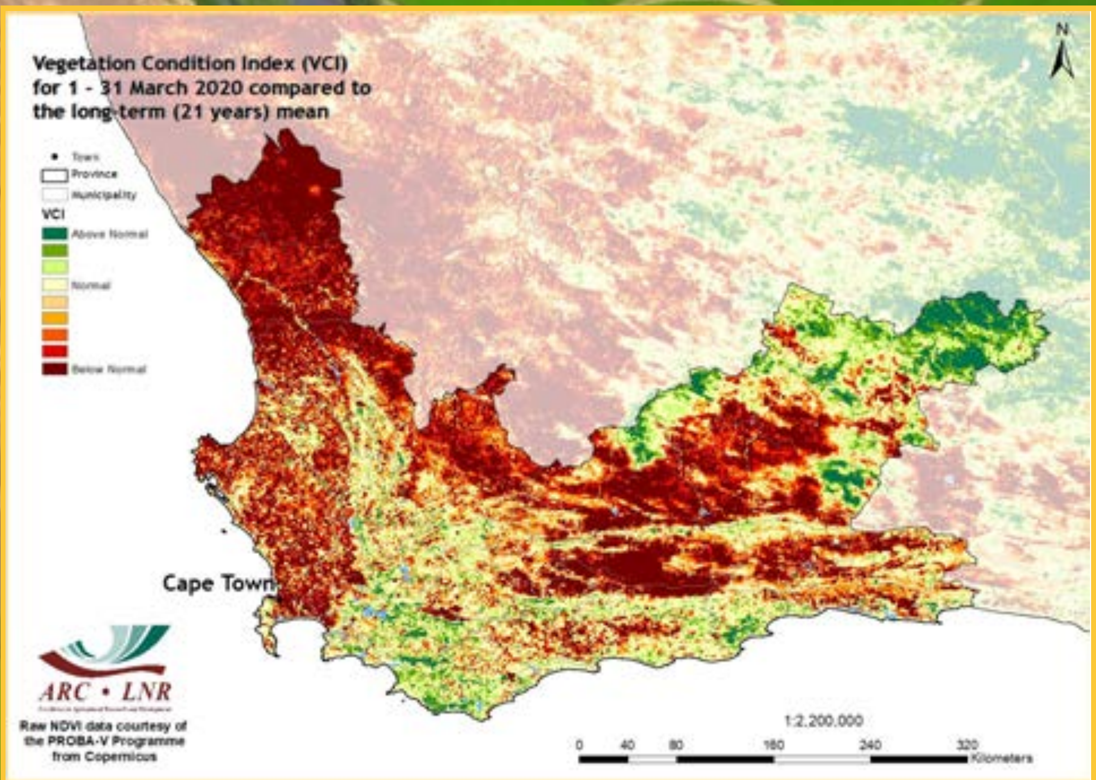

Figure 15

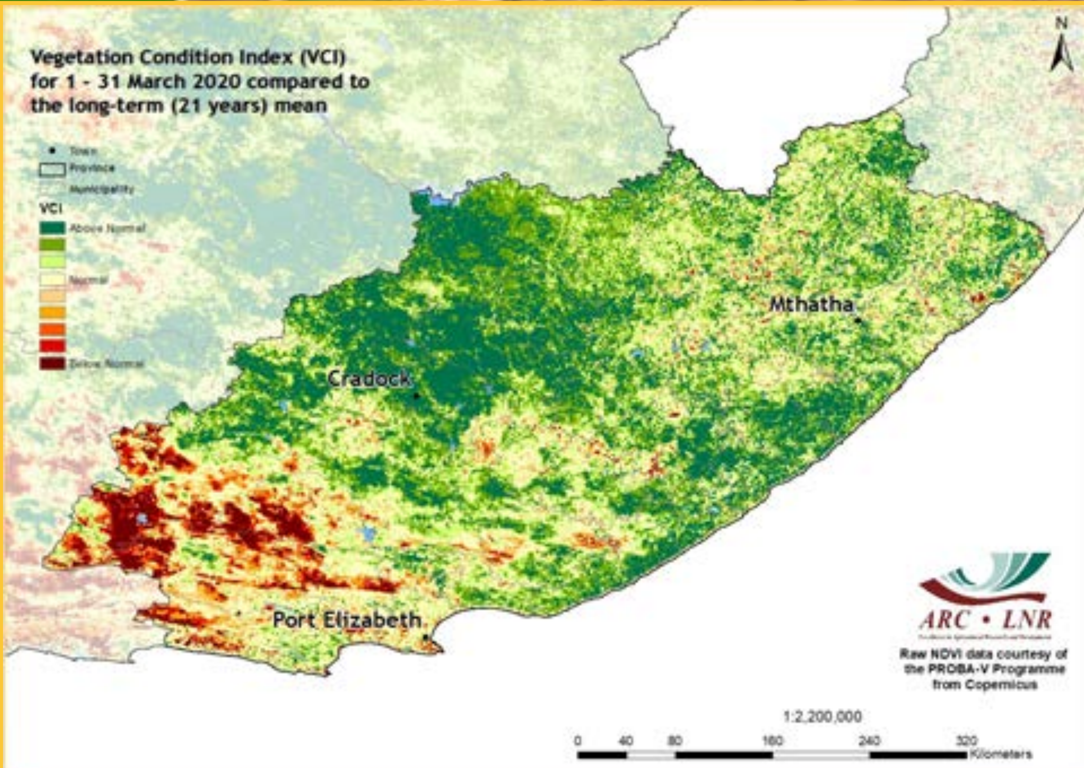

Figure 16

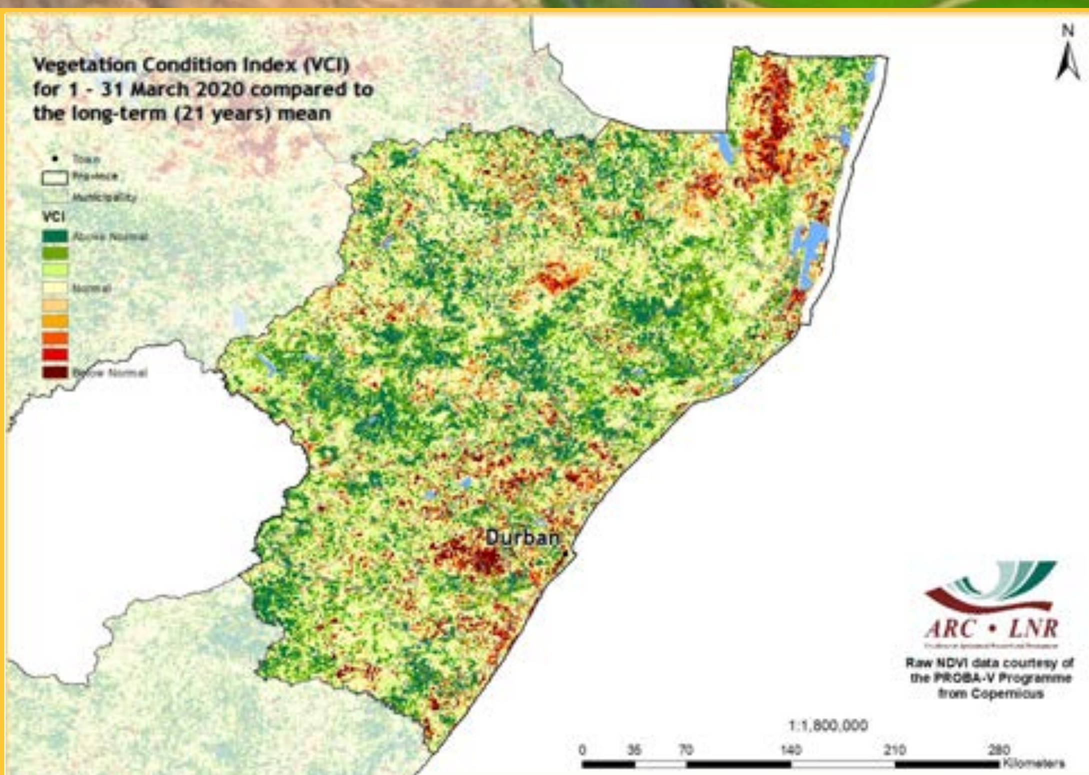

Figure 17

Figure 16:
The VCI map for March shows improved vegetation conditions over many parts of the Eastern Cape compared to the long-term average. A major exception remains the far western part of the Sarah Baartman Local Municipality which continues to experience poor vegetation activity, as well as some isolated areas in the far eastern parts of the province.

Figure 17:
The VCI map for March shows improved vegetation conditions spread over many parts of KwaZulu-Natal, although pockets of poor vegetation activity still exist in isolated areas across the province.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

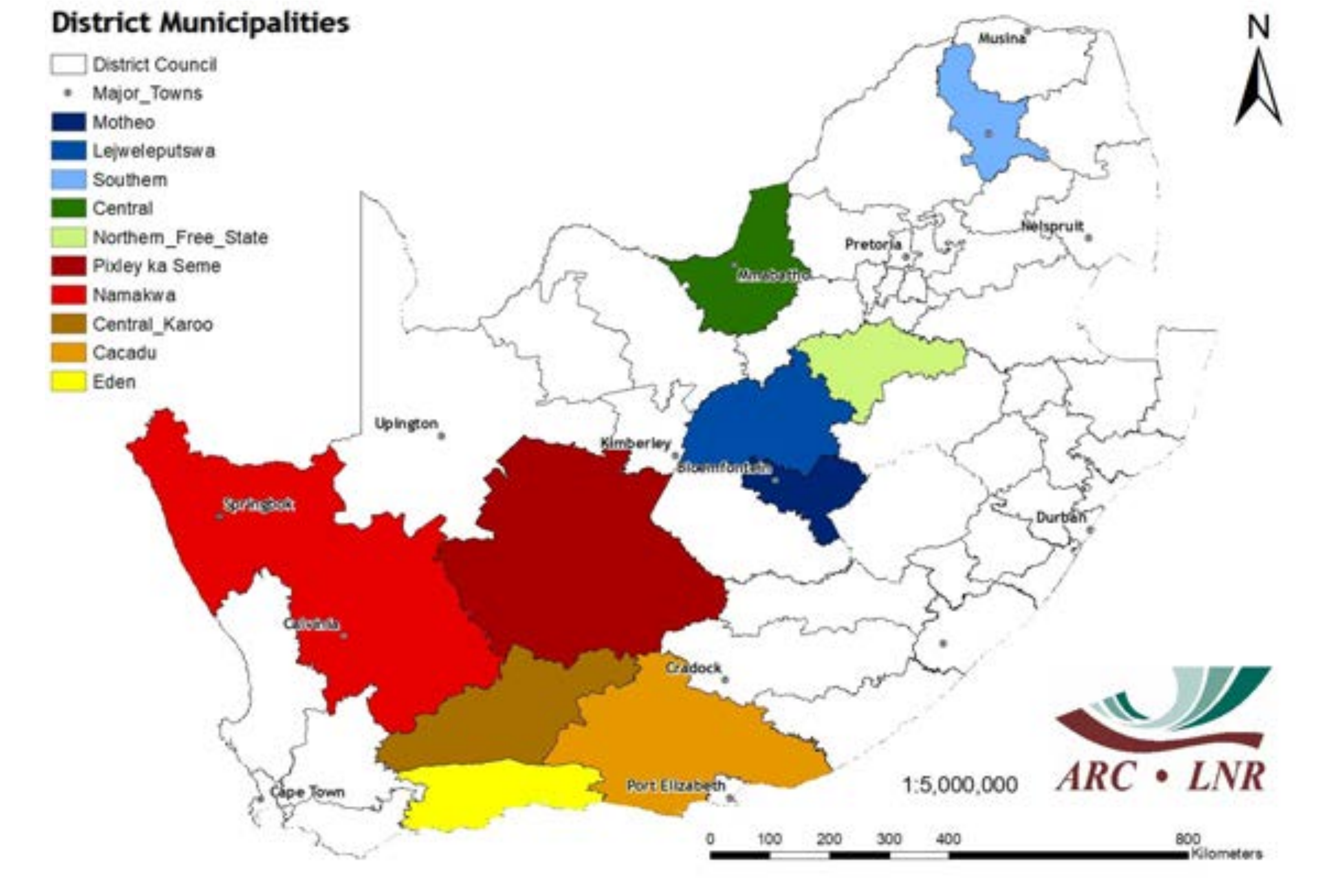

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for March 2020. 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.

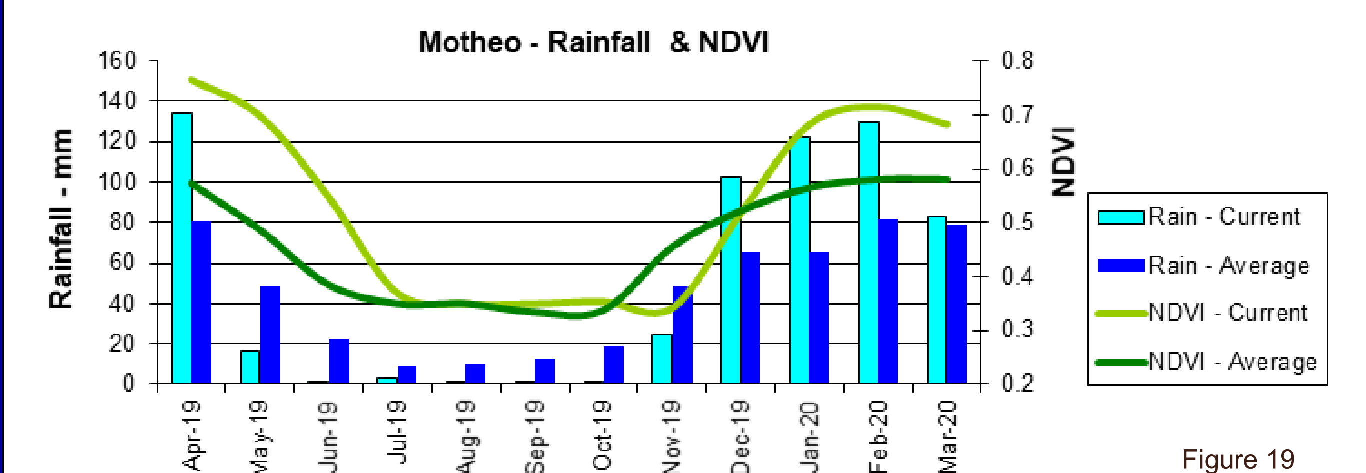


Figure 19

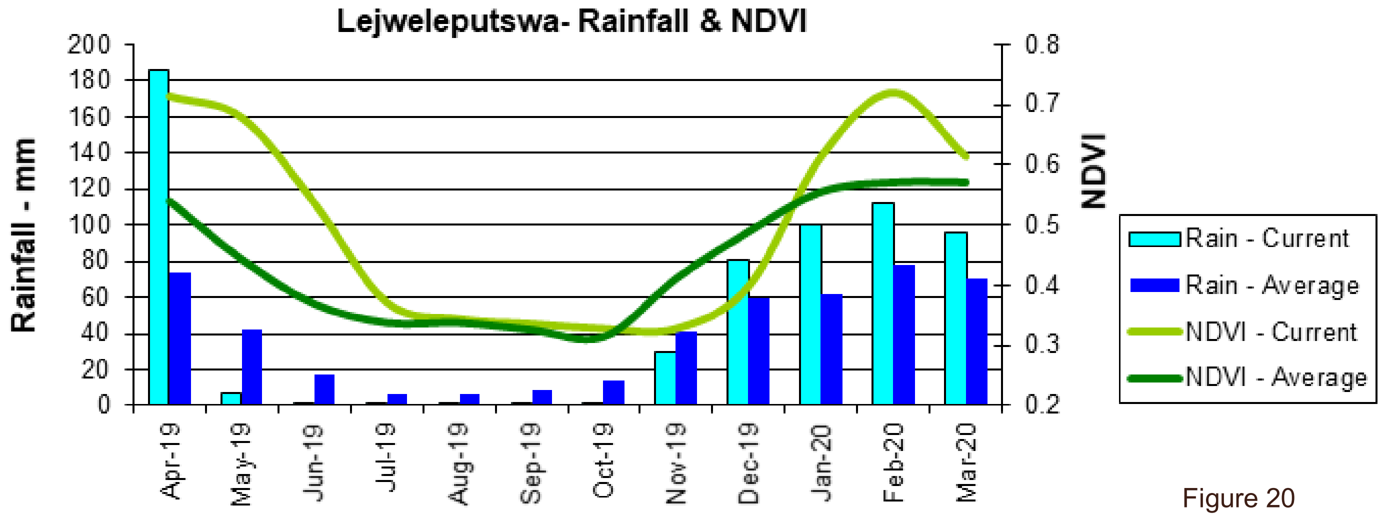


Figure 20

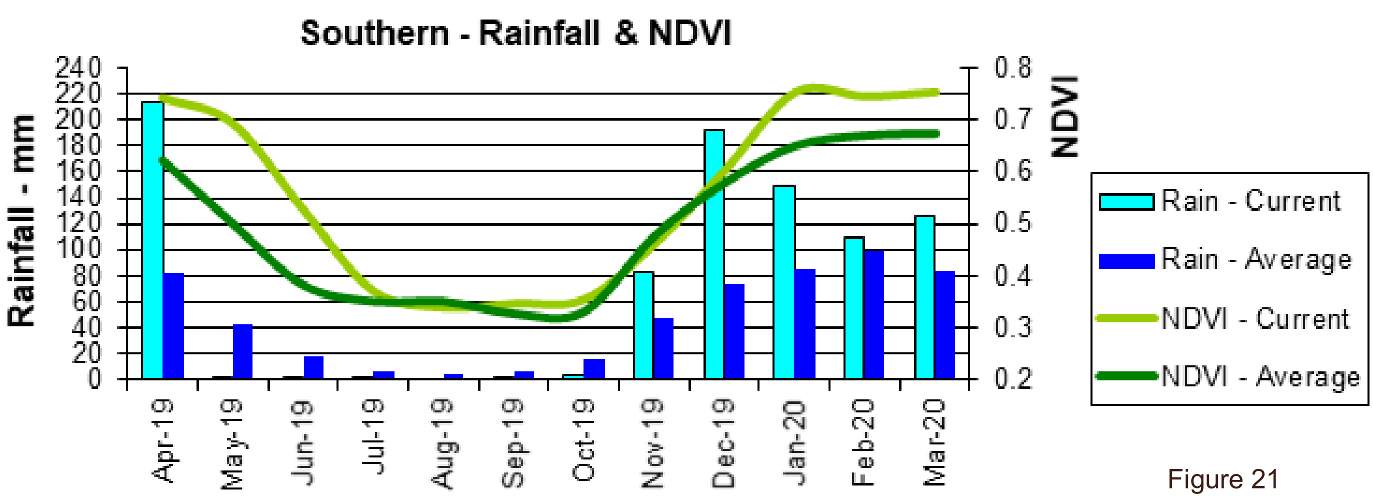


Figure 21

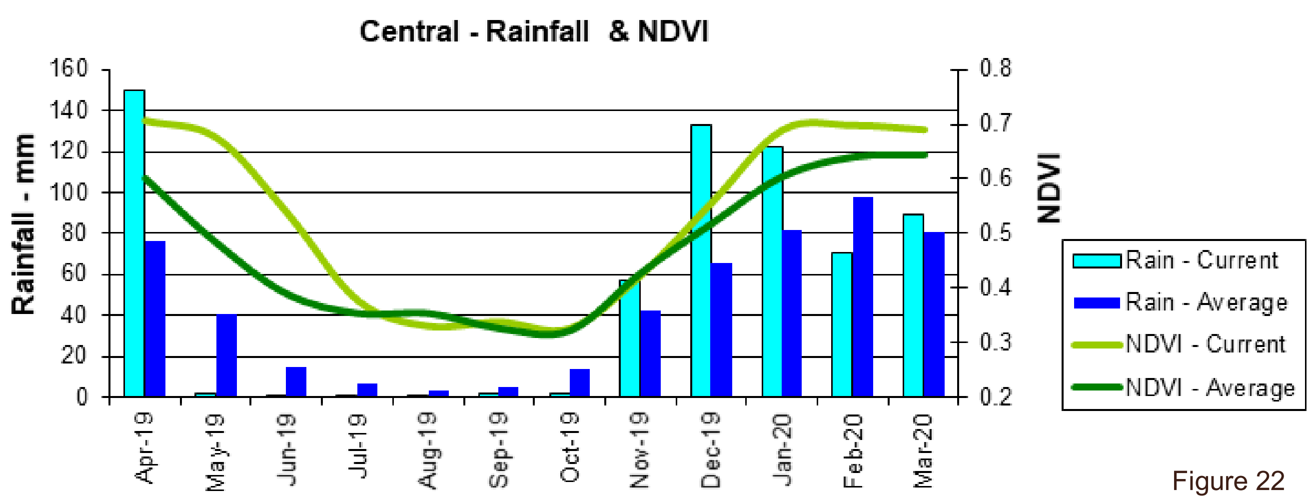


Figure 22

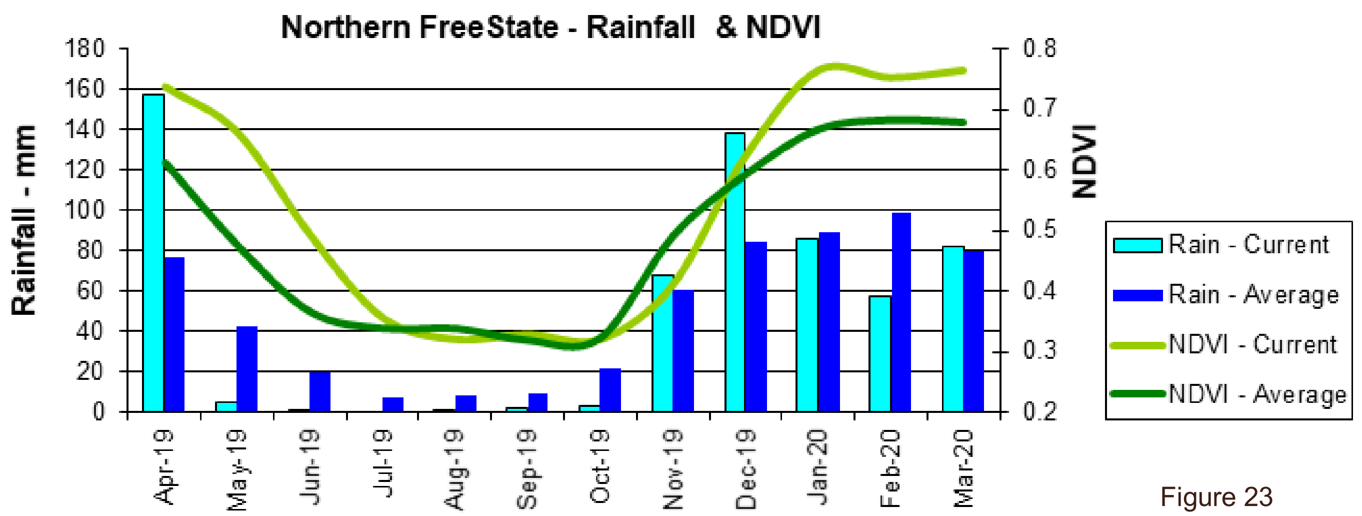


Figure 23

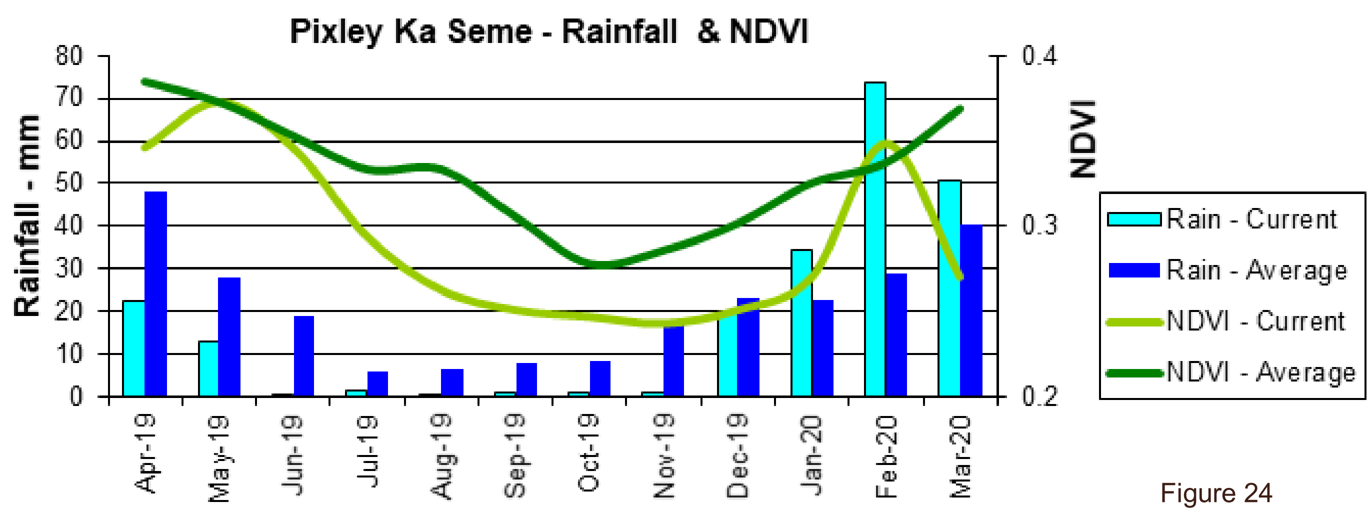


Figure 24

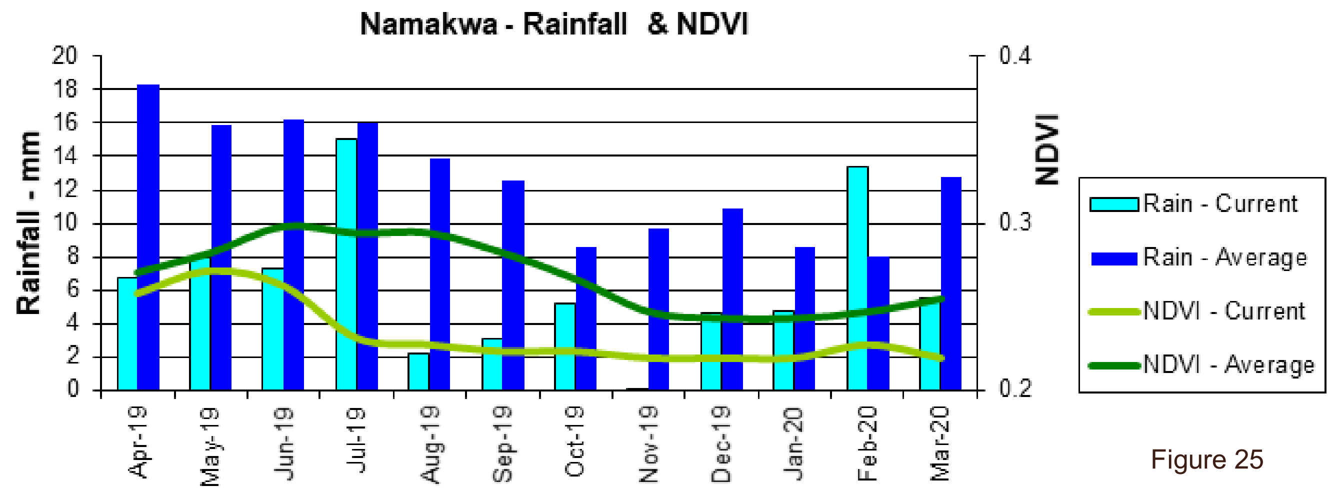


Figure 25

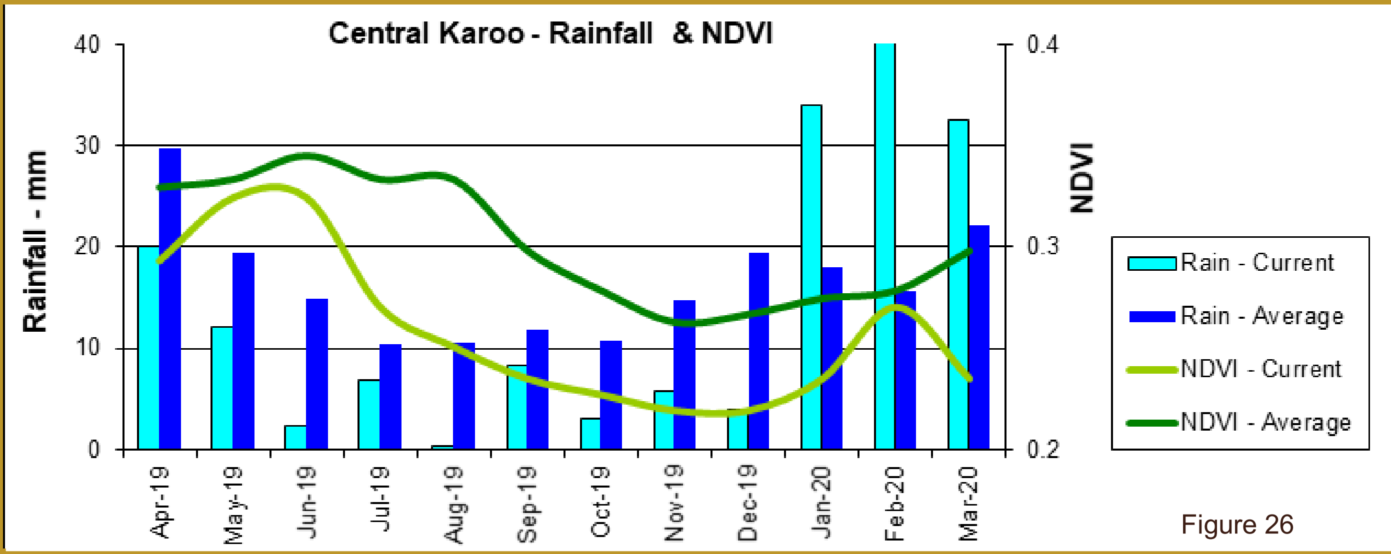
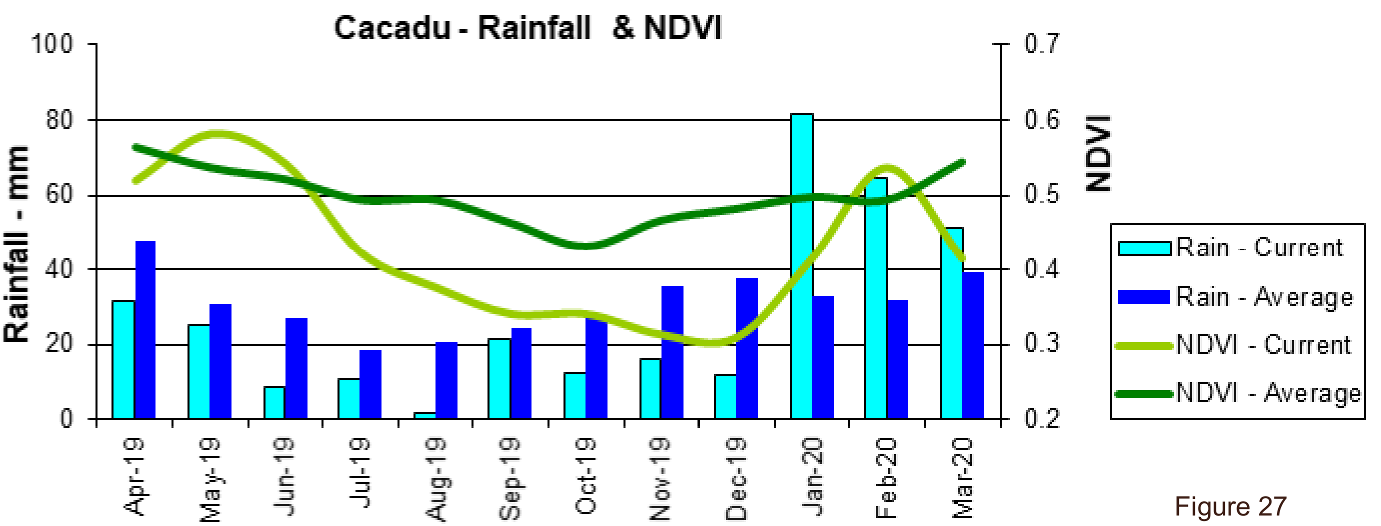


Figure 26



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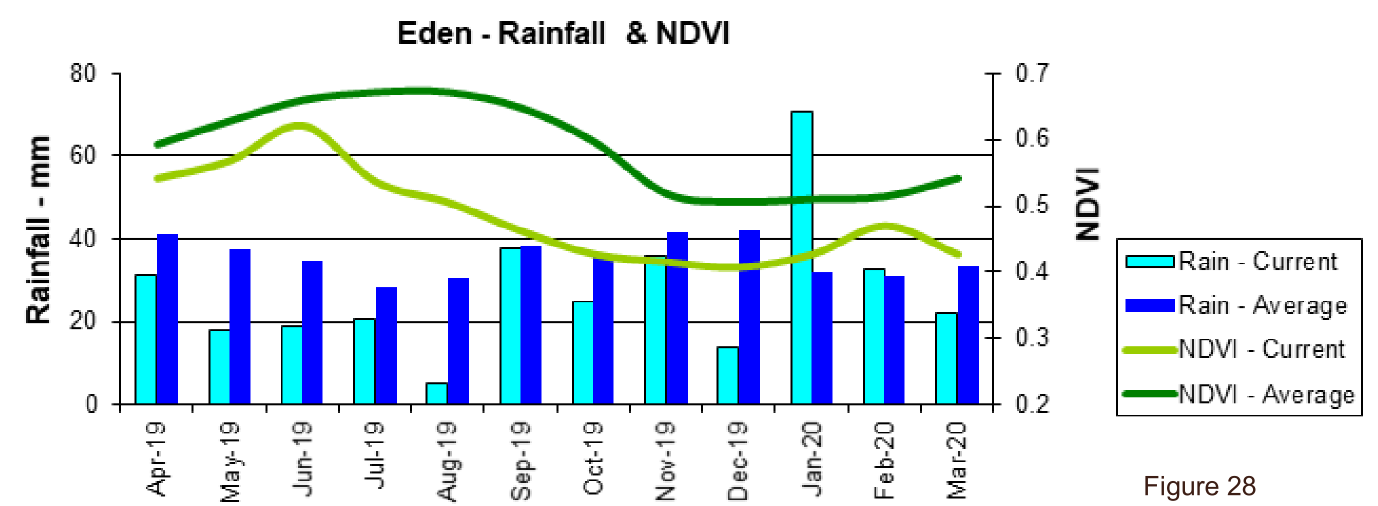

Figure 28

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.

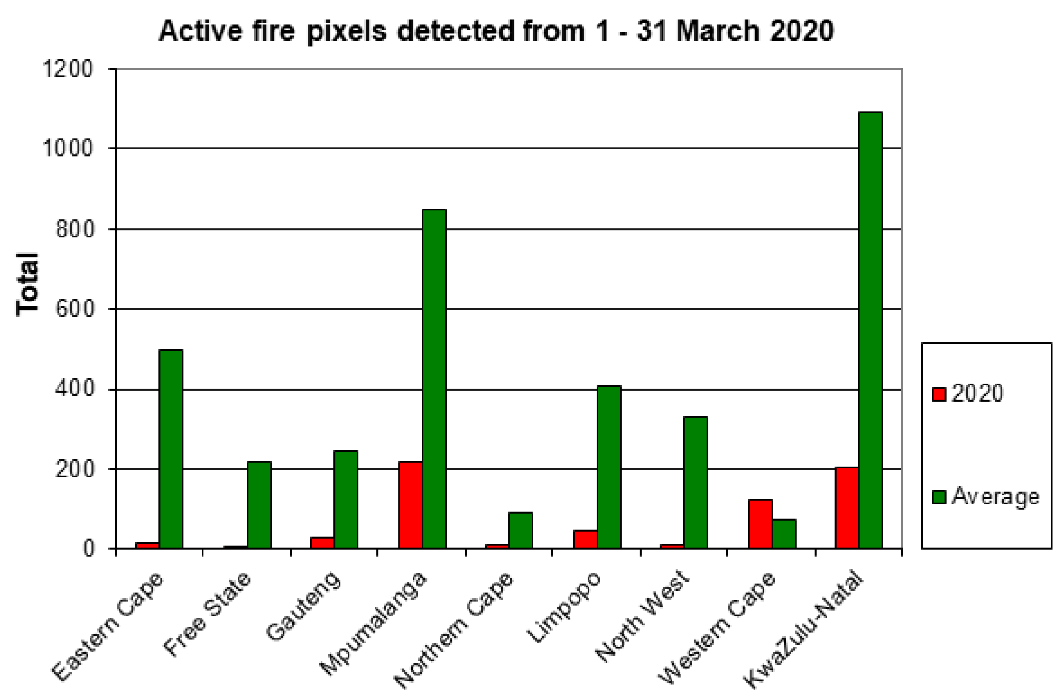

Figure 29

Figure 29:
The graph shows the total number of active fires detected between 1-31 March 2020 per province. Fire activity was higher in the Western Cape compared to the long-term average.

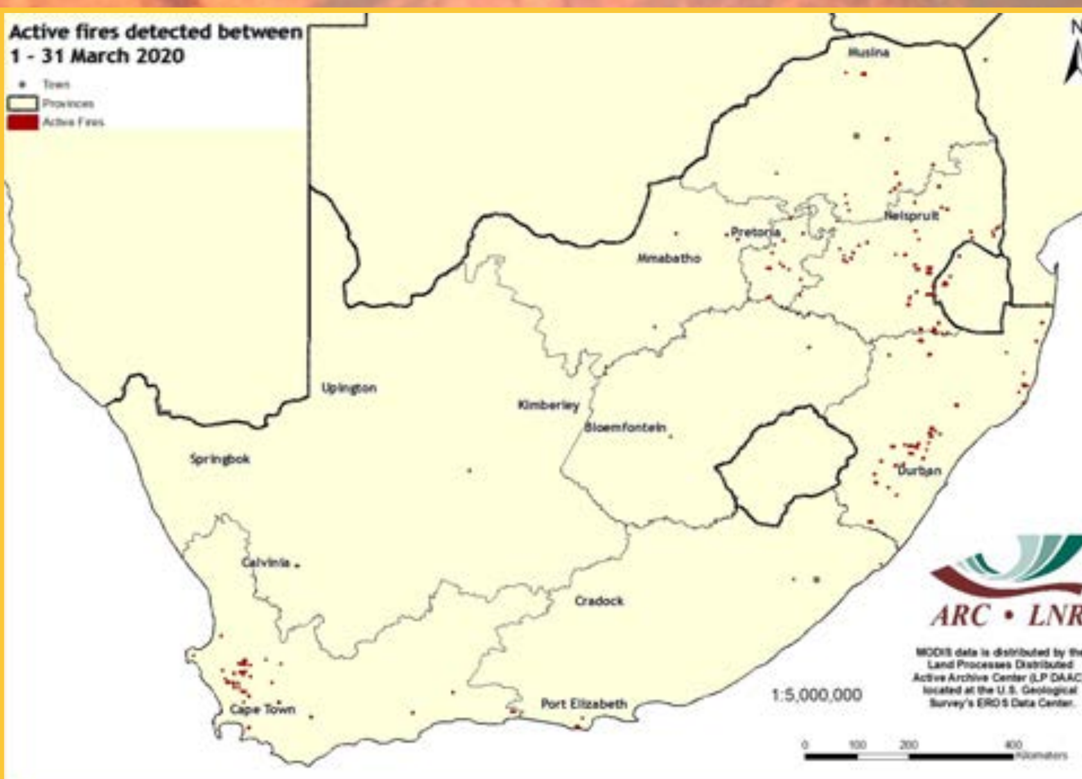

Figure 30

Figure 30:
The map shows the location of active fires detected between 1-31 March 2020.

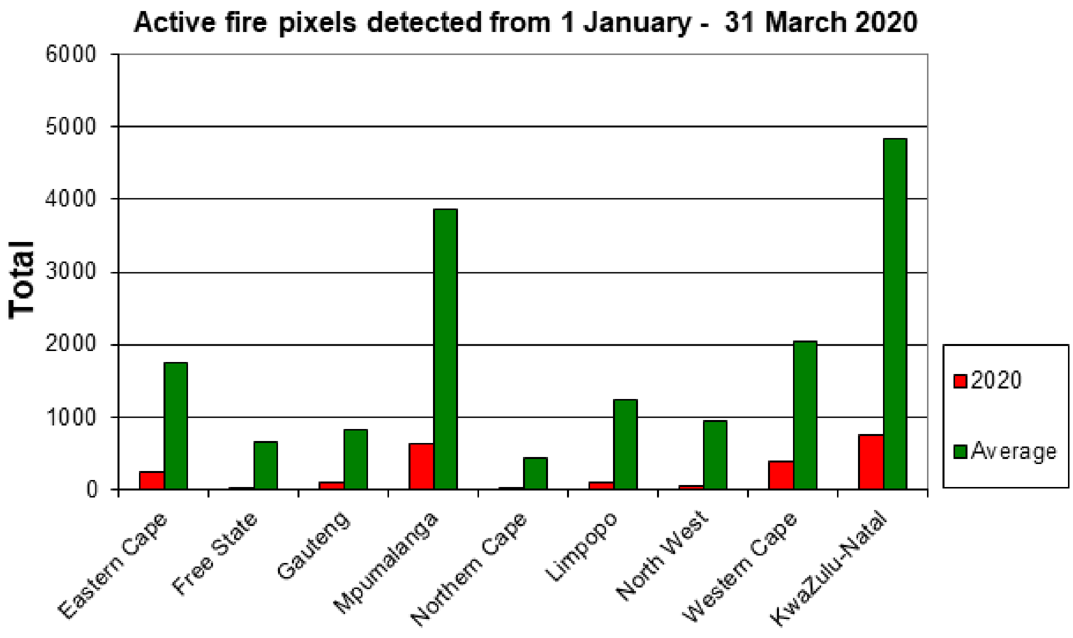

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January – 31 March 2020 per province. Fire activity was lower in all provinces compared to the long-term average.

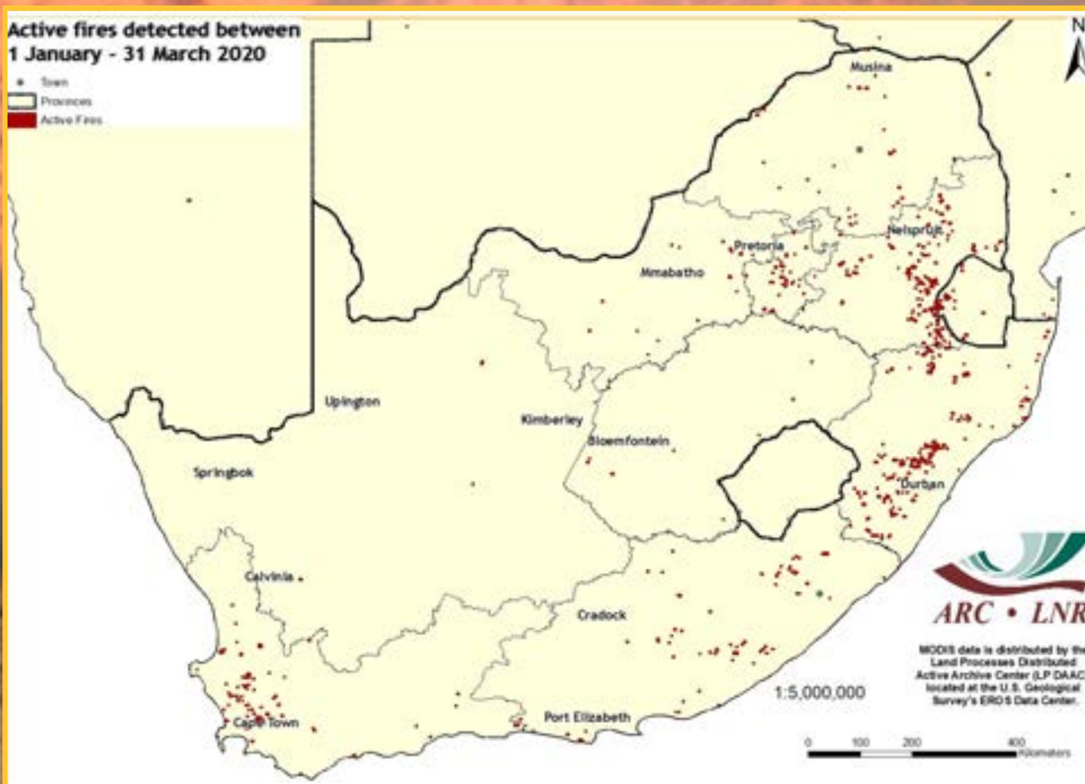

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January - 31 March 2020.

Questions/Comments:
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8. Surface Water Resources

Countrywide surface water areas (SWAs) 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 4 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 last year. 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 2019.

The long-term map for March 2020 shows a marked improvement to the long-term map for the previous month, with the majority of catchments across the entire country now showing water levels equivalent to between 60% and 100% of the 4-year, long-term maximum water. The main exception to this remains the western region of the Karoo, which continues to show significantly lower water levels.

The comparison between March 2020 and March 2019 continues to show a similar pattern to that reported last month, namely generally higher overall water levels across the country, compared to the situation in 2019. Significantly higher water levels are now found in a number of catchments across the country, especially in the Kalahari, Karoo and catchments bordering Botswana and Zimbabwe in the Limpopo and North West provinces.

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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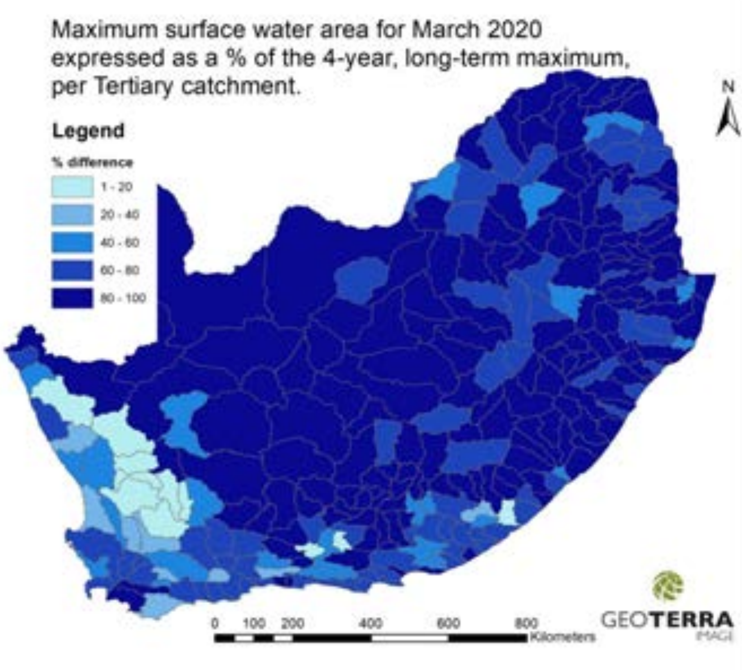

Figure 33

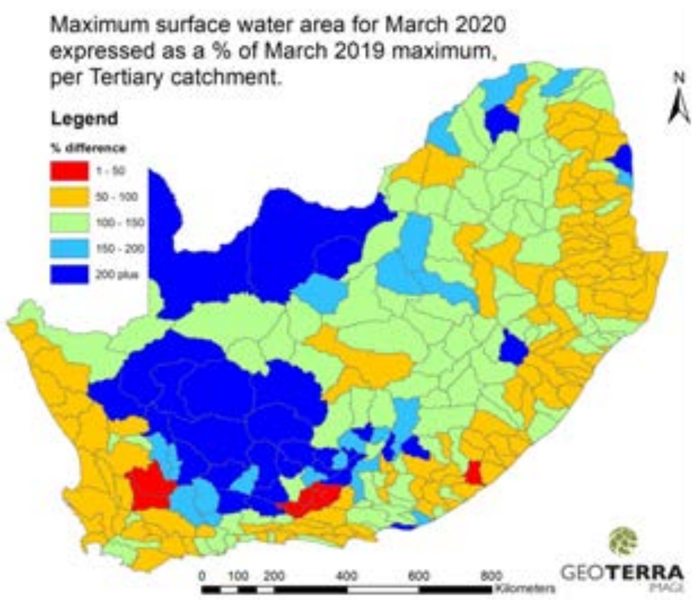

Figure 34

GEOTERRA IMAGE
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Agrometeorology

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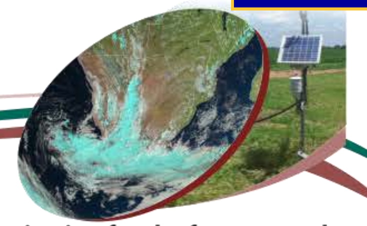

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national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