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The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

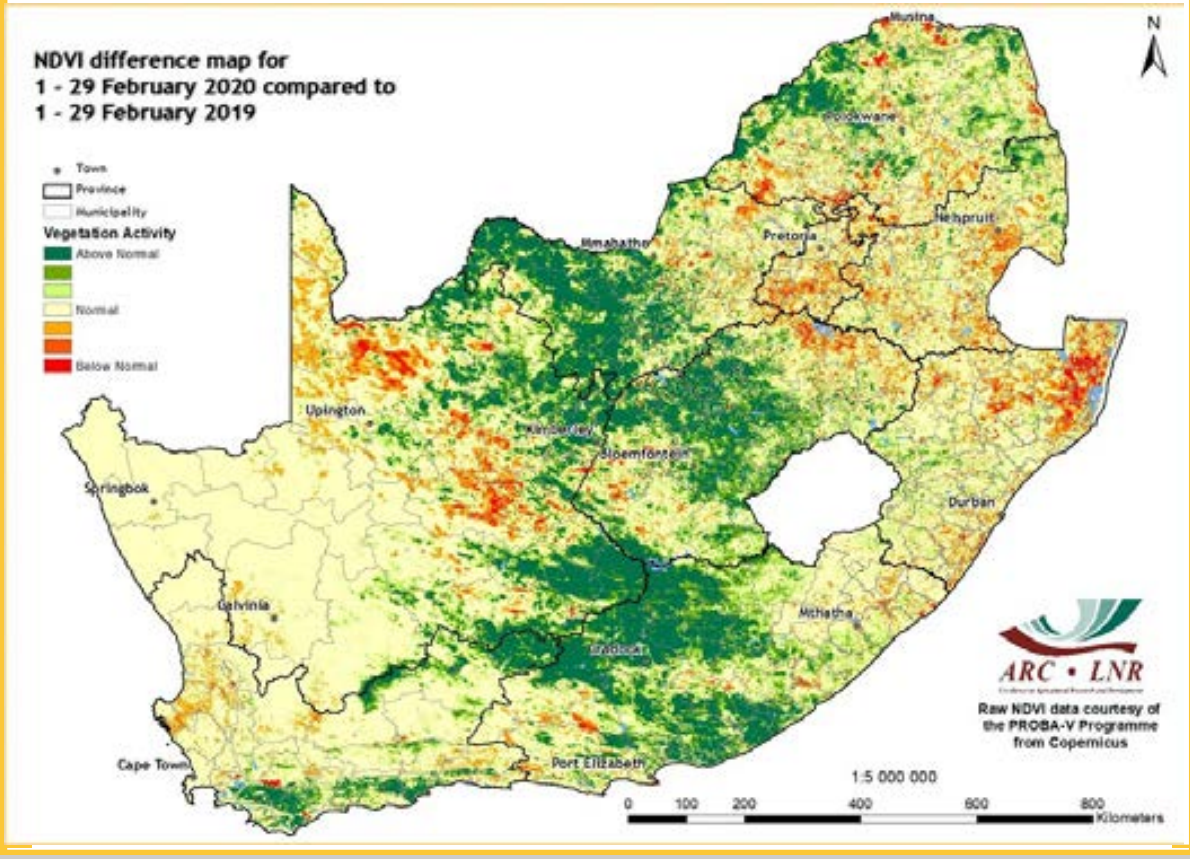
CONTENTS:

189th Edition

Image of the Month

Improvement in vegetation conditions

Recent rainfall conditions have improved vegetation activity in most parts of South Africa as compared to the same period last year. When reflecting back to February 2019, greater parts of the summer rainfall region showed significantly less active vegetation. Meanwhile, late rains boosted production for late planted crops (primarily maize), despite a dry start to the agricultural season. Contrasting, yet good conditions can be observed for February 2020 compared to the same month last year (see NDVI difference map below). Above-normal vegetation activity is dominant over the country's interior, parts of the Lowveld and the south coast. Above-normal rainfall conditions that occurred over the mid- to late summer rainfall region during February this year also improved soil water conditions necessary for optimal crop growth. Based on these agrometeorological observations, this could imply prospects of higher summer crop yields and improved livestock production compared to last year. However, below-normal vegetation activity over the eastern Free State still poses an alarm for agricultural productivity and the overall economy of the country.



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.

1. Rainfall

Overview:

The above-normal rainfall conditions that occurred over the summer rainfall region of South Africa during January continued throughout February 2020. Widespread rain was observed over large parts of northeastern Limpopo and the Mpumalanga Lowveld which recorded totals ≥200 mm. Much needed rainfall was also observed over the very late rainfall region (Northern Cape), with totals of between 25-75 mm. During the first 10 days (dekad) of February, thunderstorms brought good rainfall to large parts of the Eastern Cape and southern parts of KwaZulu-Natal. In Alice (Eastern Cape) the rainfall was accompanied by strong winds, resulting in localized flooding and structural damage. During the second dekad of the month, rainfall mainly occurred over the central regions of the country, while above-normal rainfall was confined to parts of Mpumalanga, Limpopo and the all-year rainfall region. In the final dekad of February, heavy rain was experienced in the Sekhukhune District (Limpopo), escarpment of Mpumalanga, the Wild Coast and northern Free State. However, areas of concern include the eastern Free State where below-normal rainfall was observed during the month of February. This poses an alarm for grain producers in the area as it implies possible water stress during critical growing stages of the crops. Meanwhile, the winter rainfall region remained dry as expected.

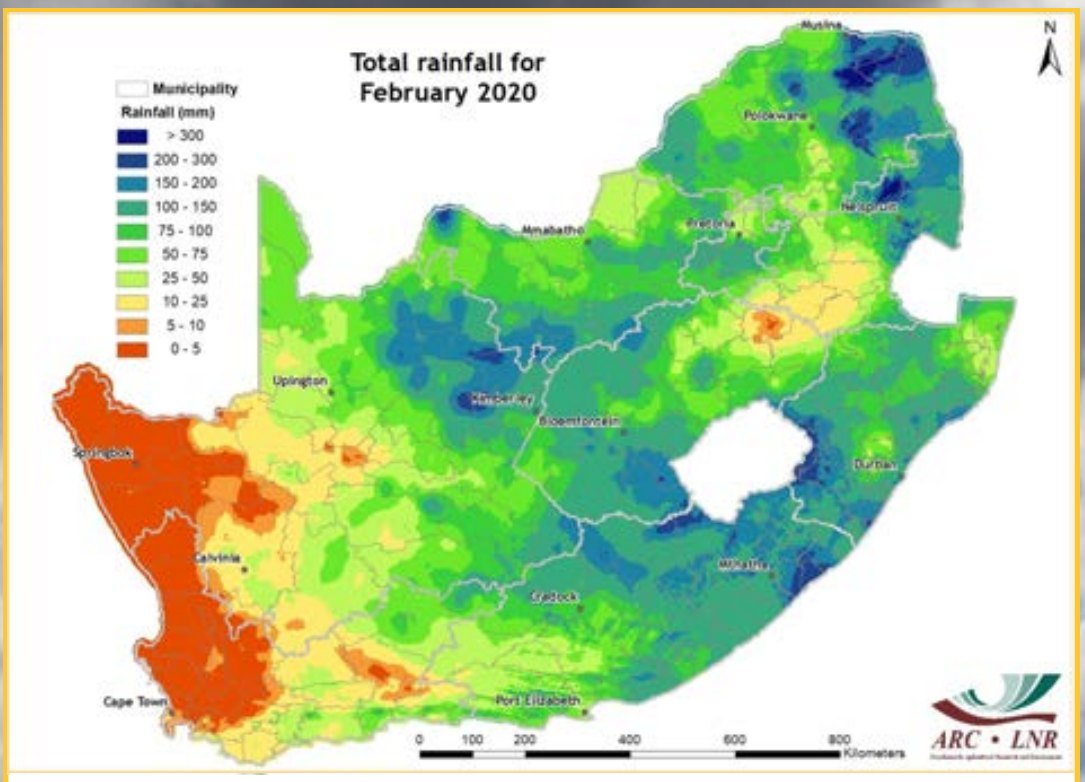


Figure 1

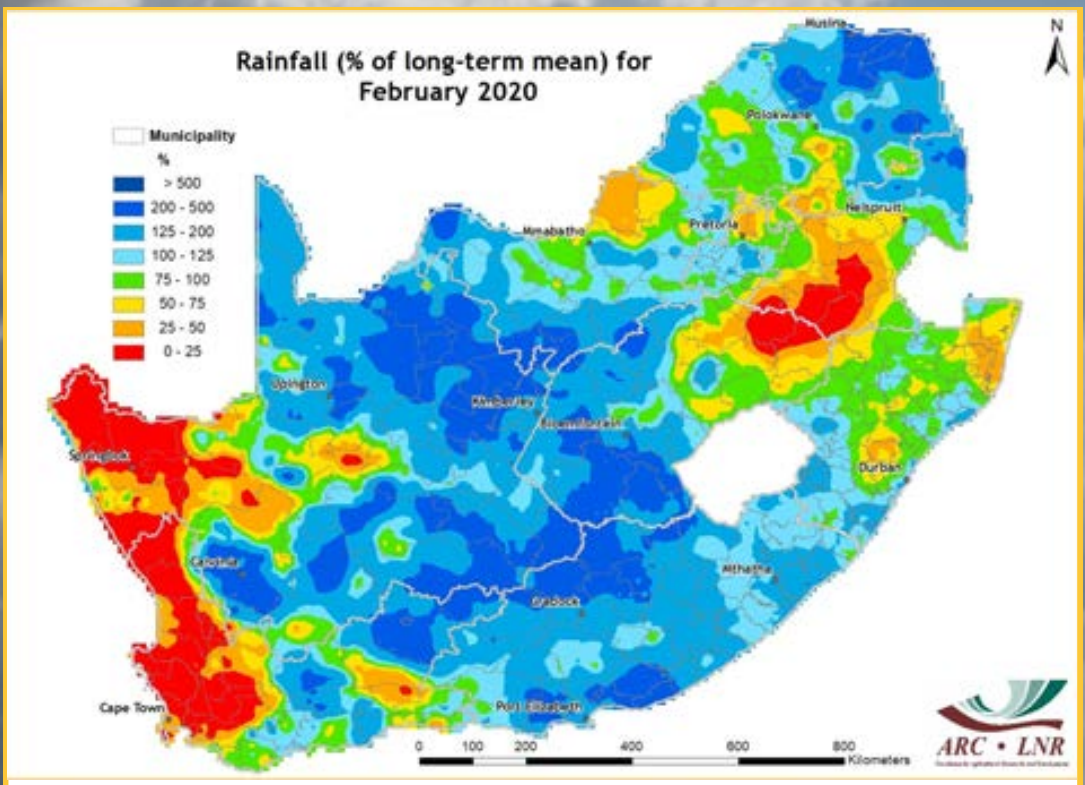


Figure 2

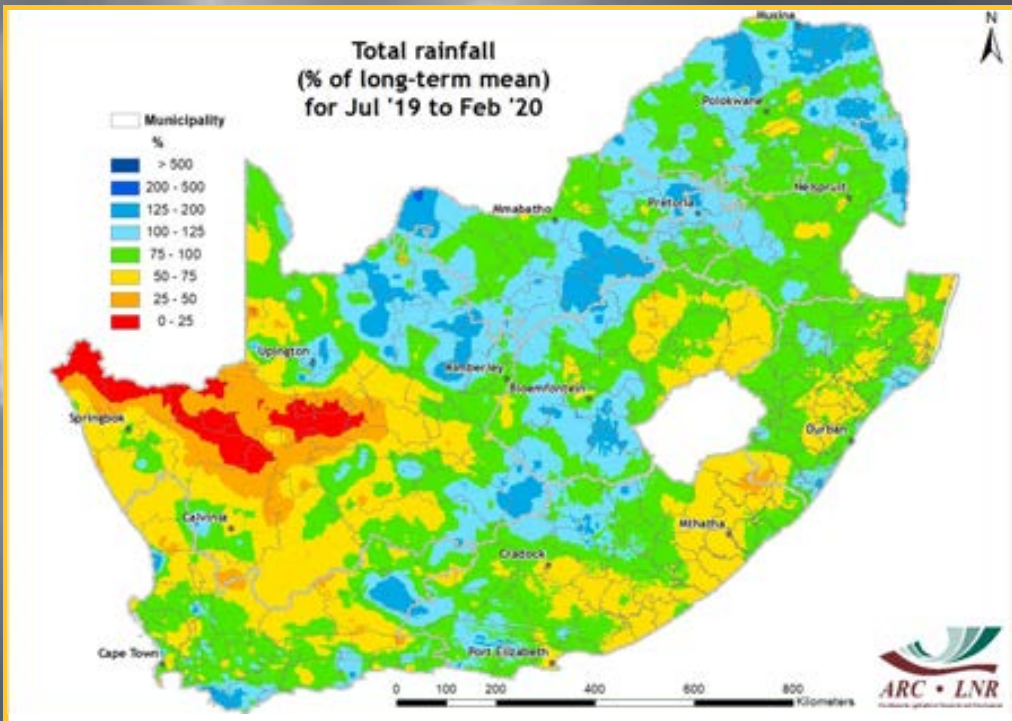


Figure 3

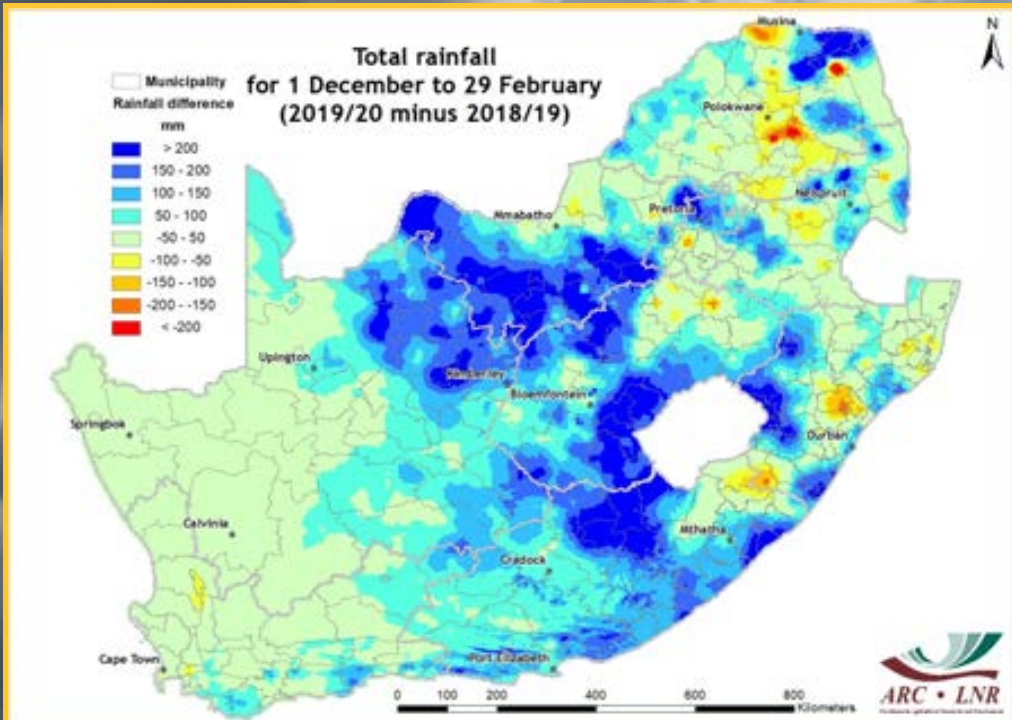


Figure 4

Figure 1:
The highest rainfall totals were observed over the northeastern Limpopo and Mpumalanga, northern parts of Eastern Cape, KwaZulu-Natal midlands and parts of the Northern Cape. Much of the winter rainfall region and the eastern Free State remained dry.

Figure 2:
Normal to above-normal rainfall was observed over most parts of the interior, much of the Eastern Cape and northern parts of Limpopo and Mpumalanga. Below-normal rainfall occurred in the eastern Free State 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, while parts of the Northern Cape, Eastern Cape, KwaZulu-Natal and eastern Free State were mostly below normal.

Figure 4:
The central interior and the Eastern Cape received significantly more rain this summer as compared to December-February of 2018/19. The rest of the country received relatively the same amounts of rainfall as compared to the same period of the previous year, 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 February, improved rainfall resulted in mildly wet conditions over the interior, Lowveld and parts of the Western and Eastern Cape. The medium-term SPI map shows severe to extreme drought in the central and western parts of the Northern Cape, as well as isolated areas in the Western Cape, Eastern Cape, KwaZulu-Natal and Mpumalanga. Similar to January, long-term severe to extreme droughts are prominent over the Cape provinces, eastern Free State, parts of KwaZulu-Natal, Limpopo and Mpumalanga, implying lower dam levels, and consequently impacting on agricultural production.

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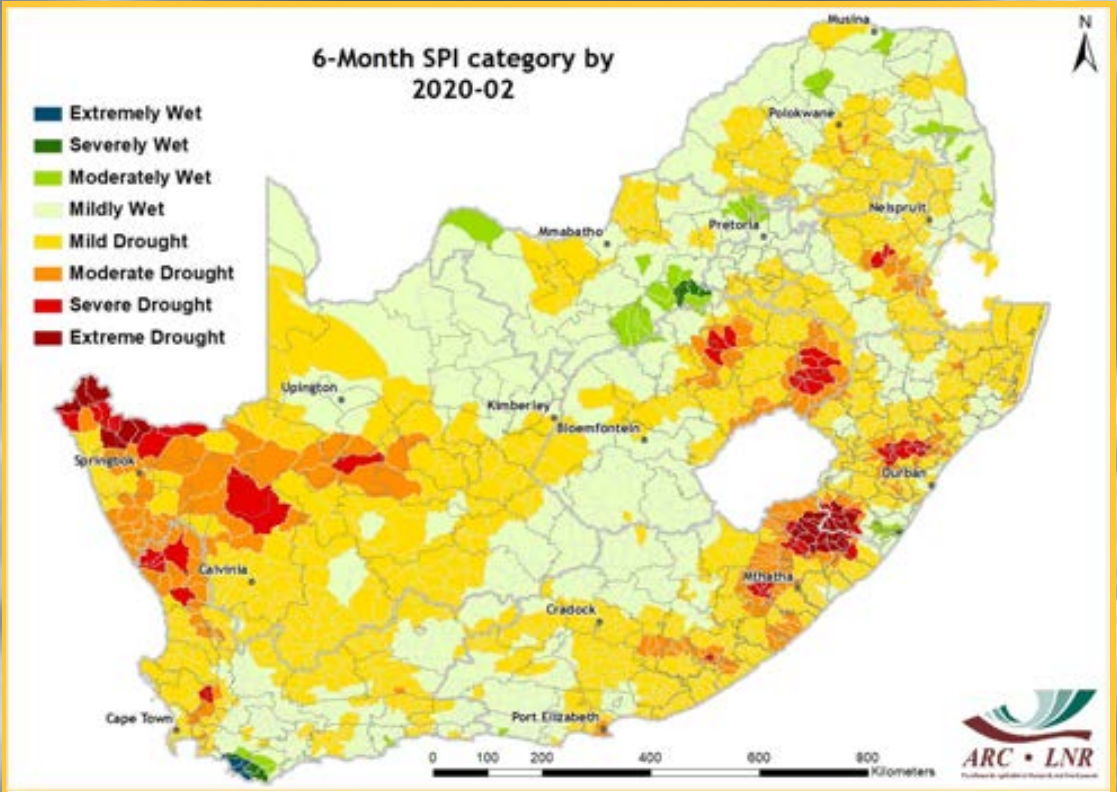

Figure 5

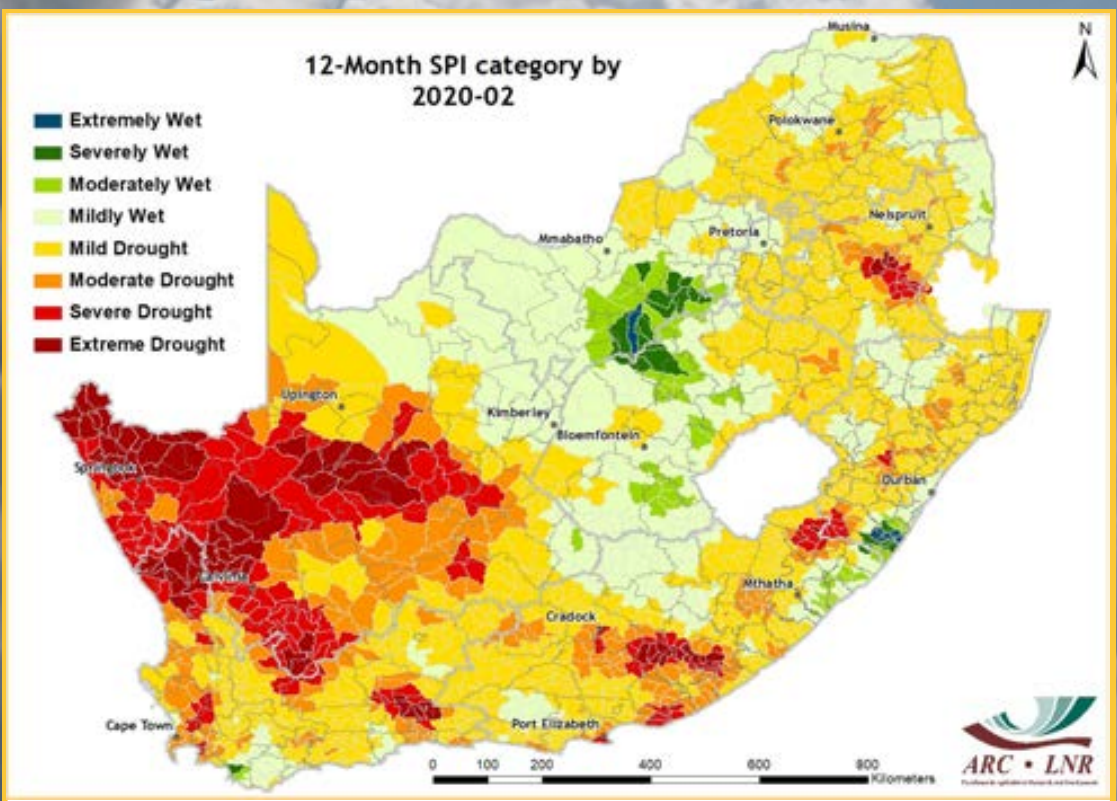

Figure 6

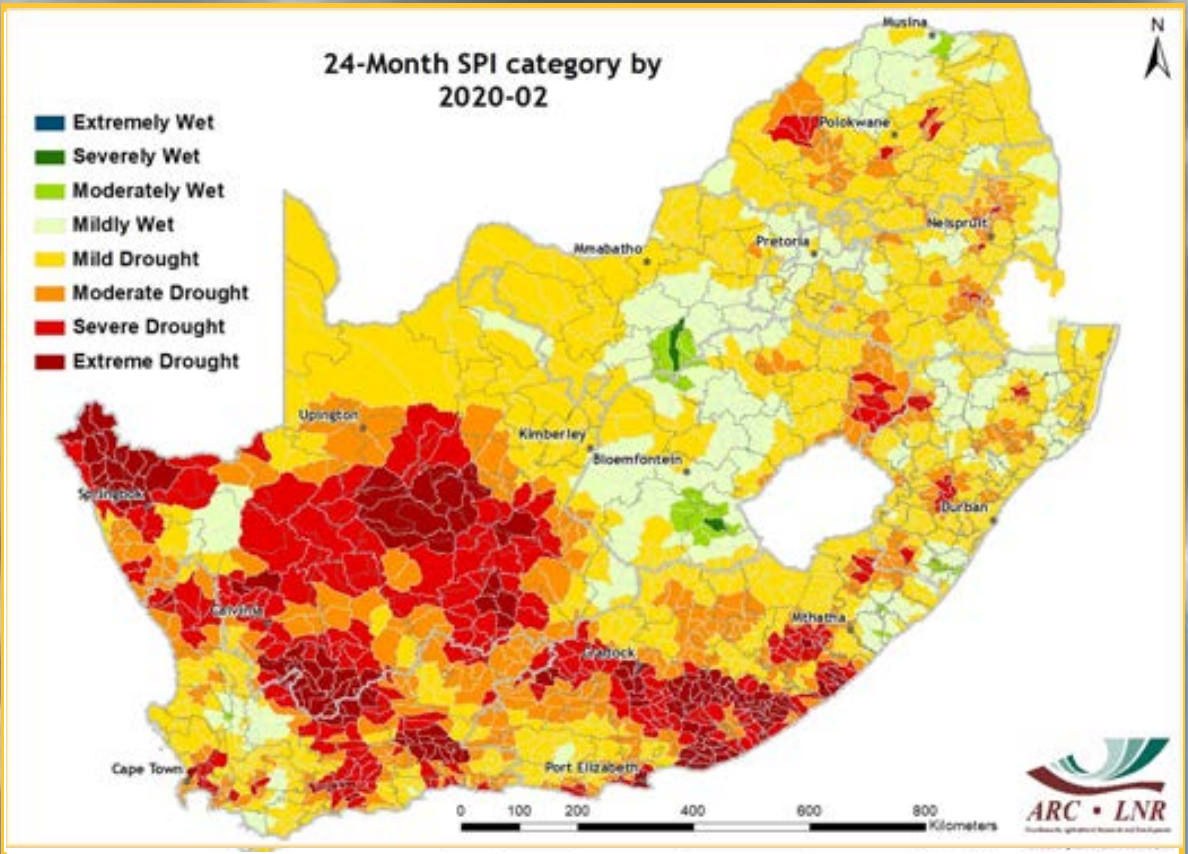

Figure 7

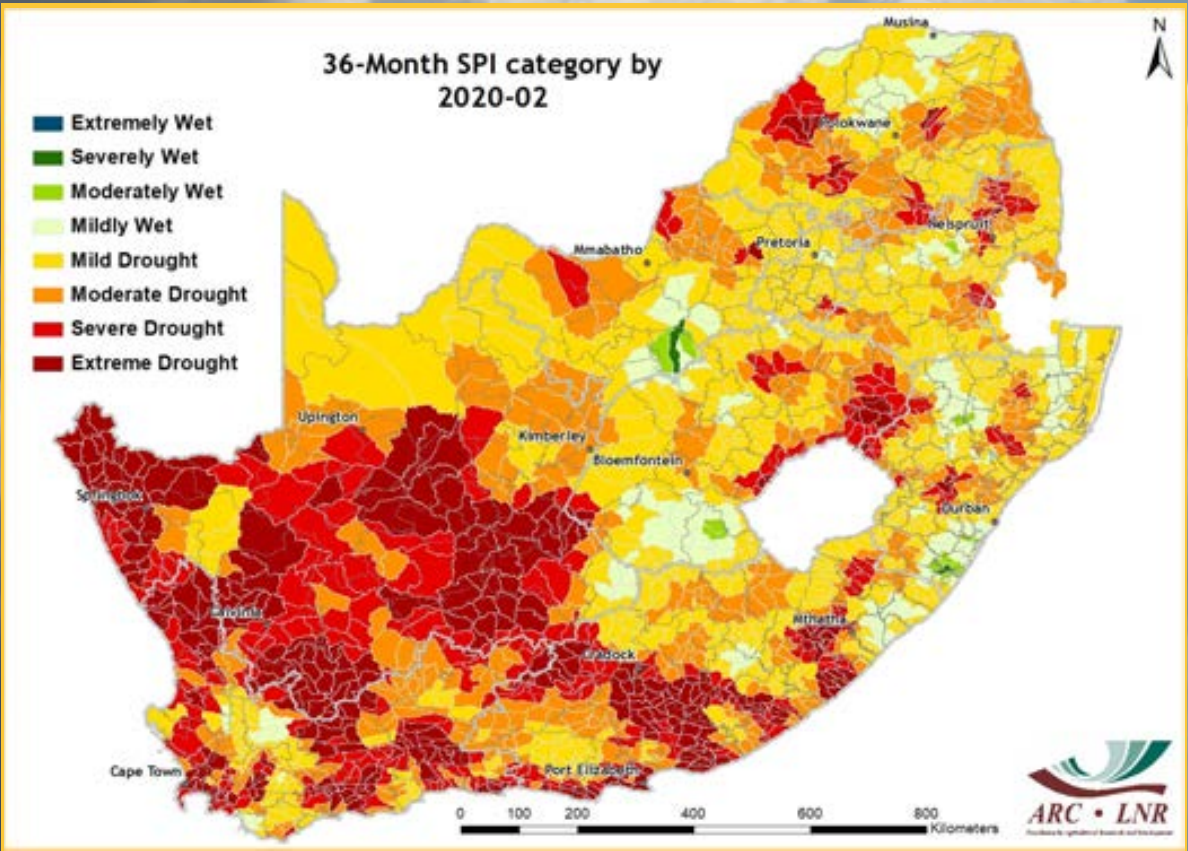

Figure 8

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.

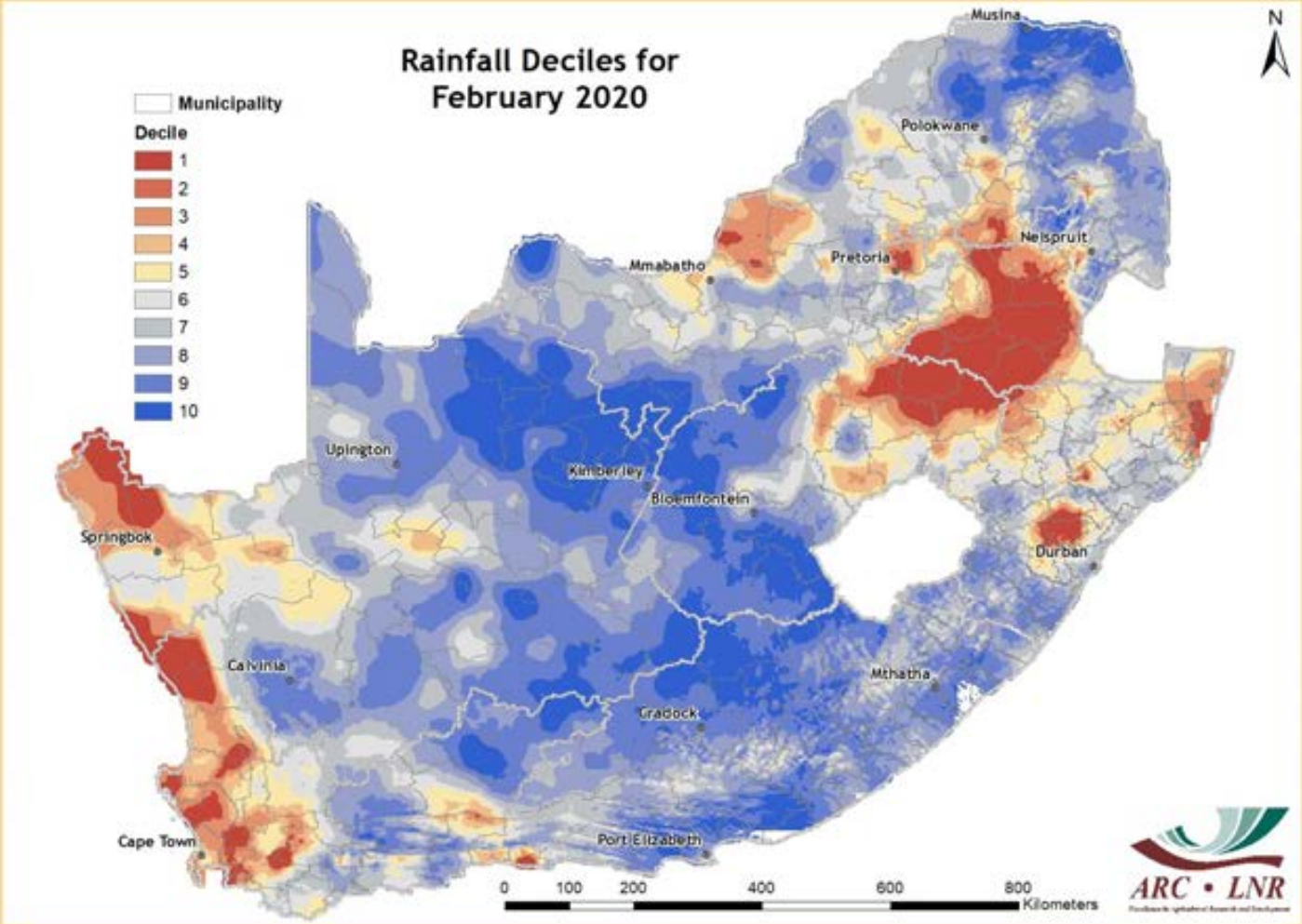

Figure 9

Figure 9:
Greater parts of the country, except for the winter rainfall region, eastern Highveld, parts of the North West and KwaZulu-Natal, experienced rainfall totals that compare well with the historically wetter February 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.

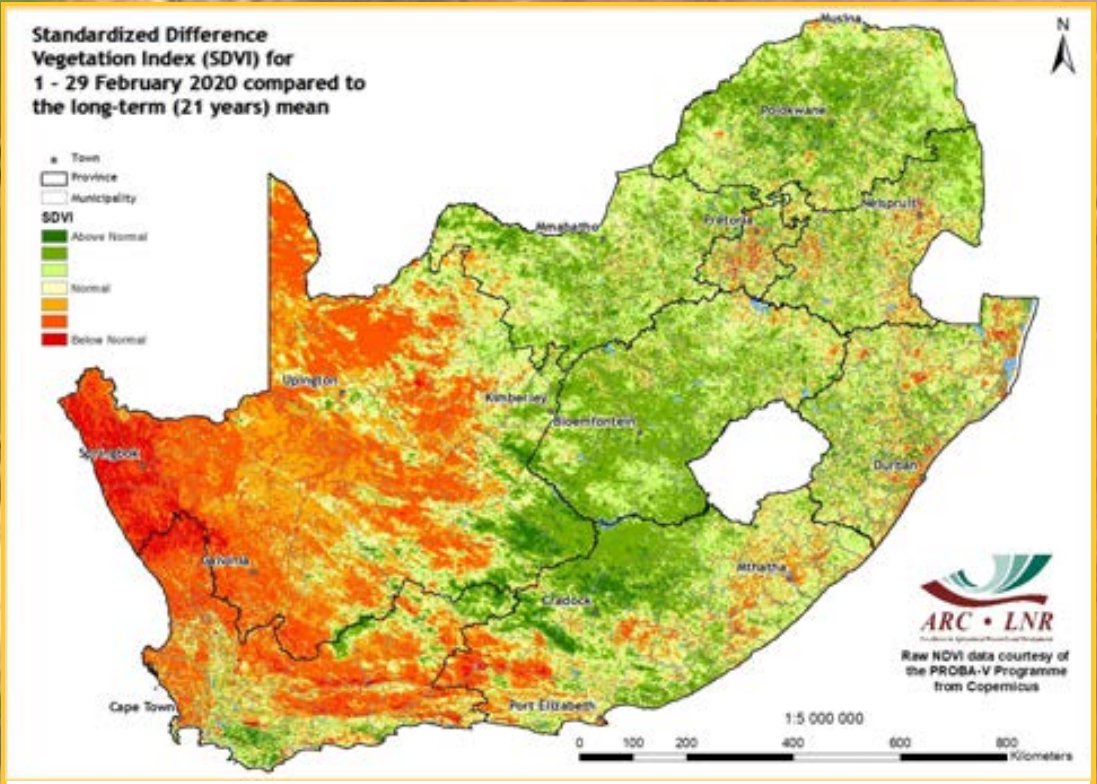

Figure 10

Figure 10:
The western parts of the country, particularly the Cape region, remain an area of concern with regard to vegetation conditions, but the central and northern parts of the country continue to be characterized by good vegetation activity.

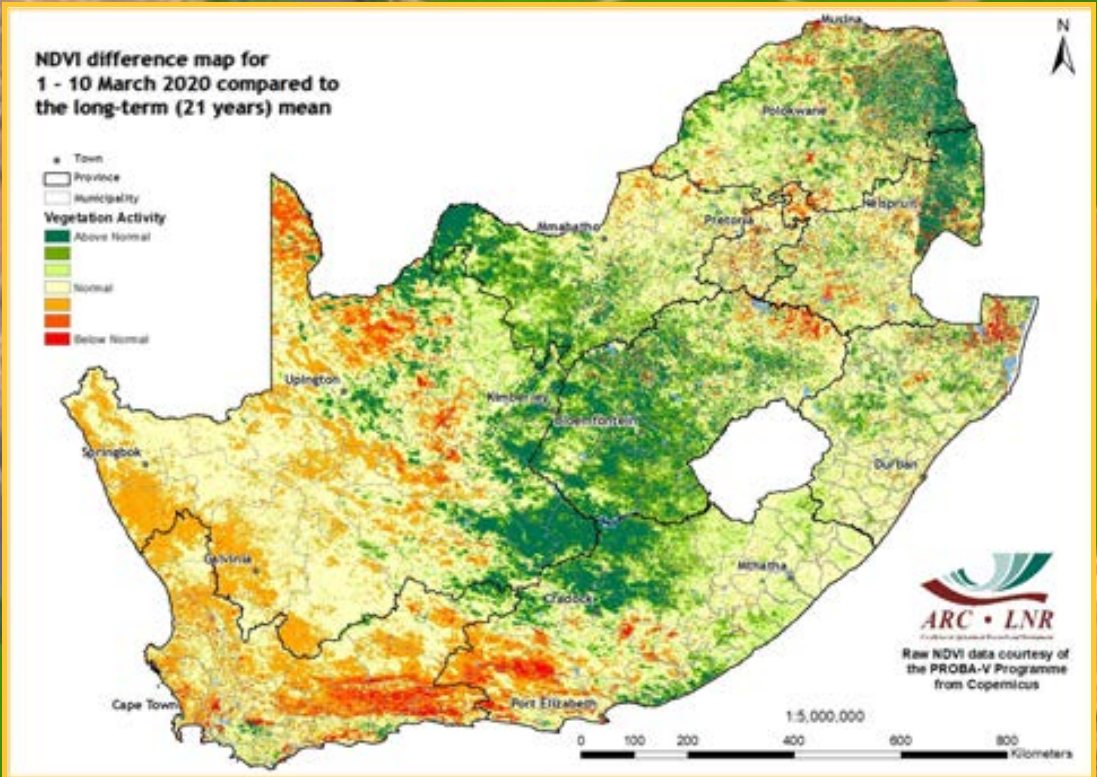

Figure 11

Figure 11:
The NDVI difference map for first 10 days of March 2020 shows improved vegetation conditions in the central and northern parts of the country compared to the long-term mean, while the western parts continue to experience below-normal vegetation activity.

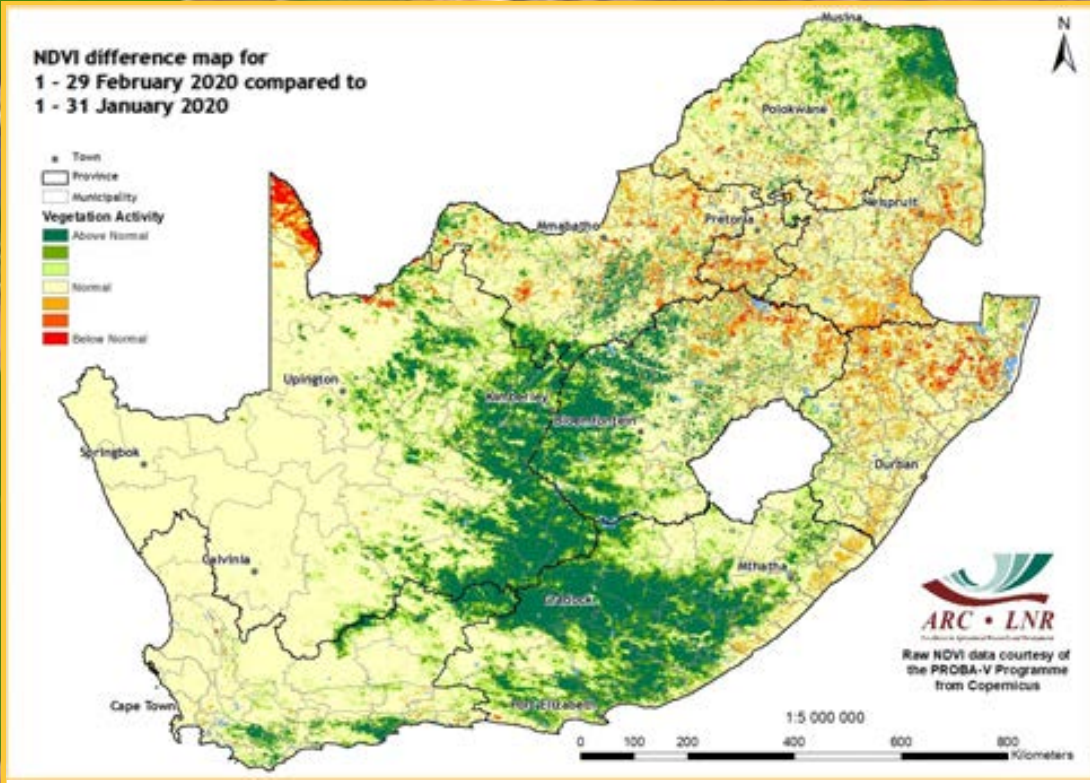

Figure 12

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

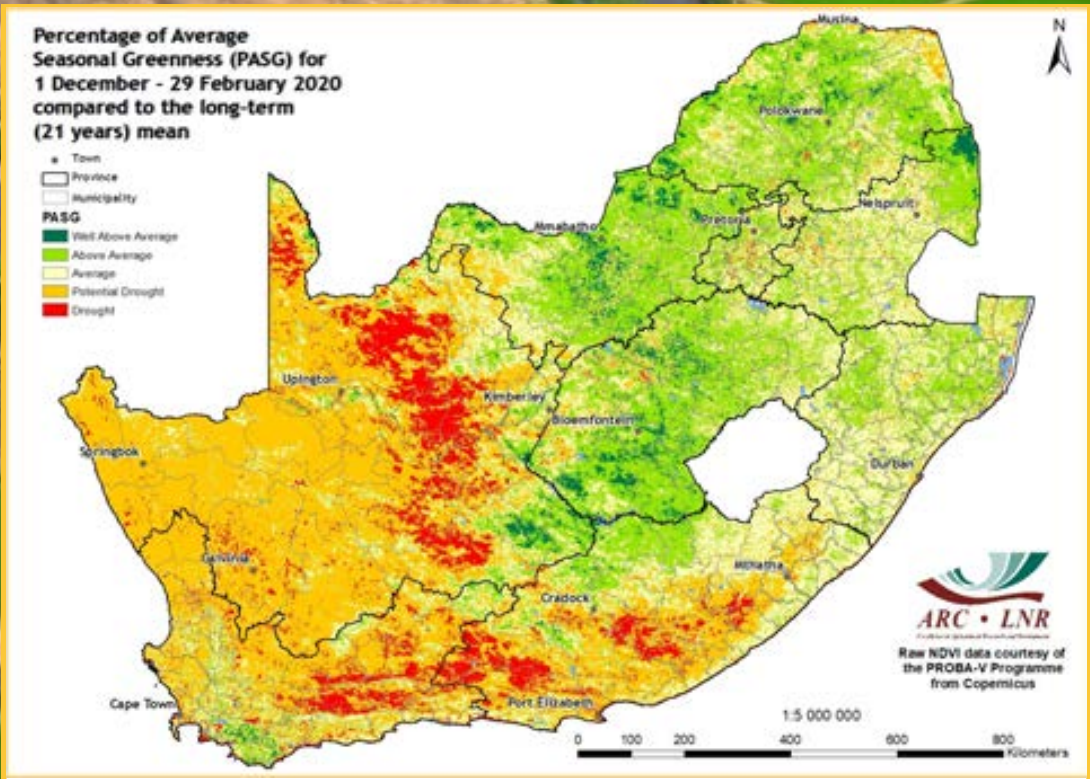

Figure 13

Figure 12:
Compared to the previous month, the February NDVI map shows that the country generally experienced normal to above-normal vegetation activity. Pockets of poor vegetation conditions were evident in isolated areas of Limpopo, KwaZulu-Natal and North West.

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.

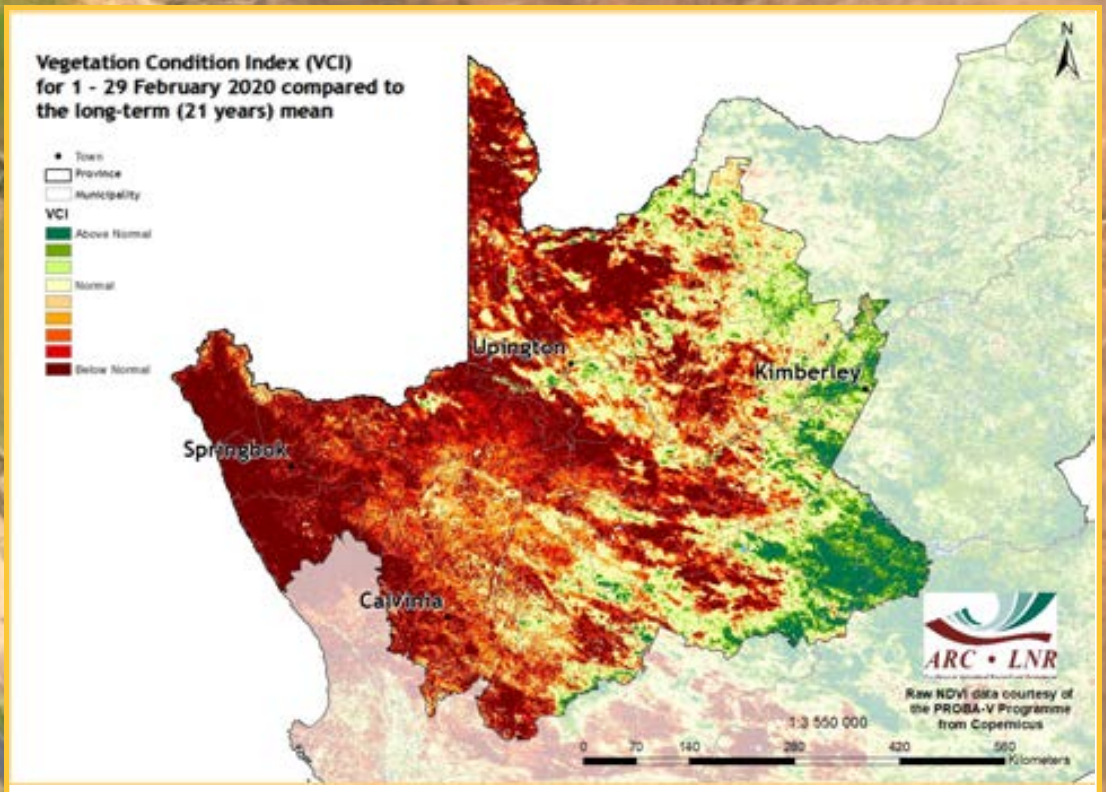

Figure 14

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

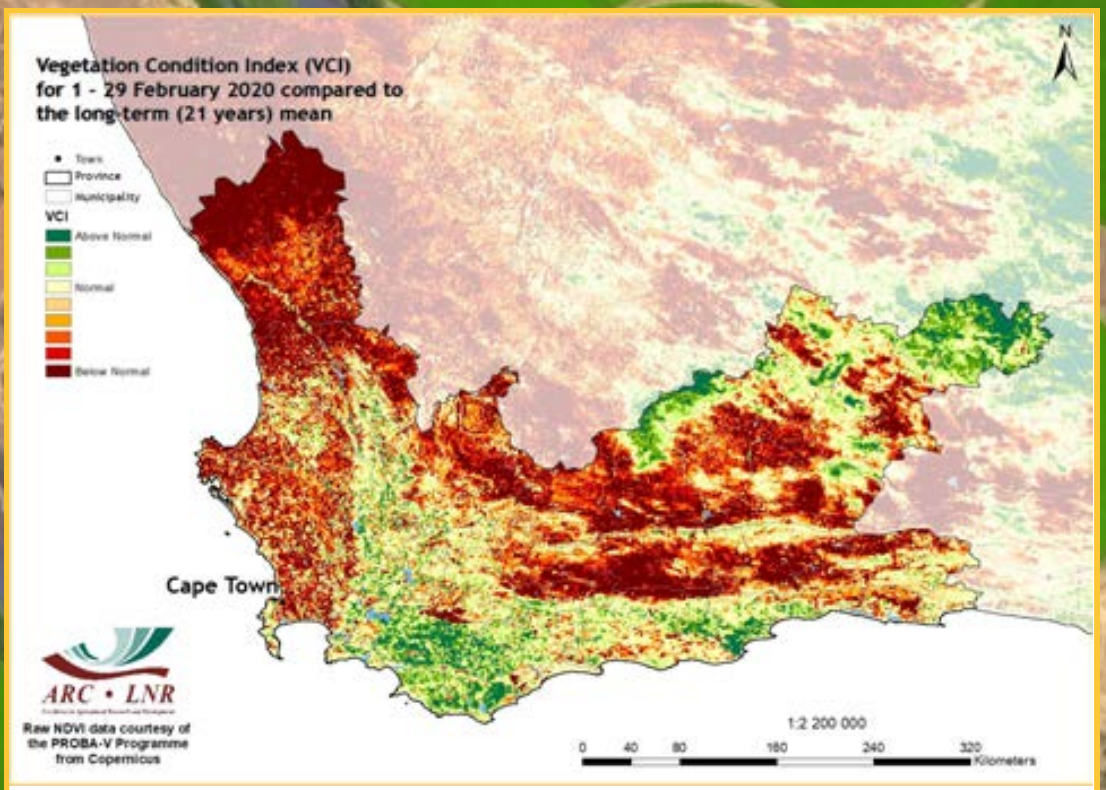

Figure 15

Figure 15:
The VCI map for February 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.

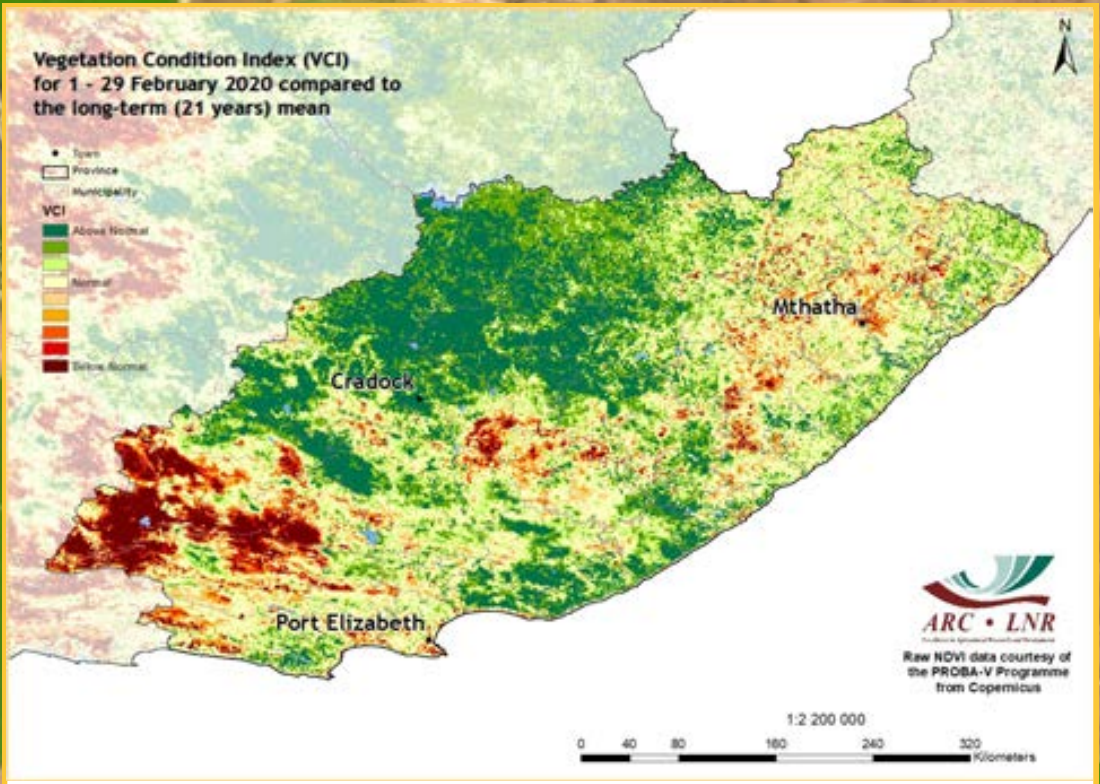

Figure 16

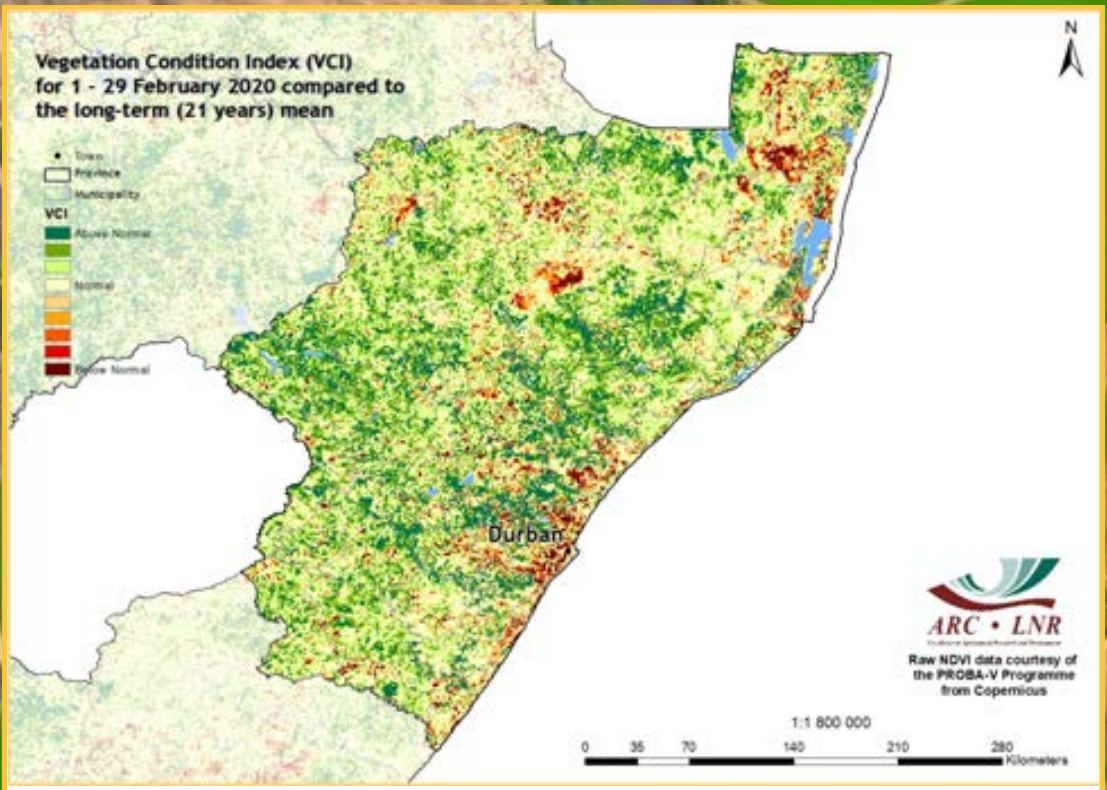

Figure 17

Figure 16:
The VCI map for February shows improved vegetation conditions over many parts of the Eastern Cape compared to the long-term average. A major exception remains the far western parts 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 February 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.

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6. Vegetation Conditions & Rainfall

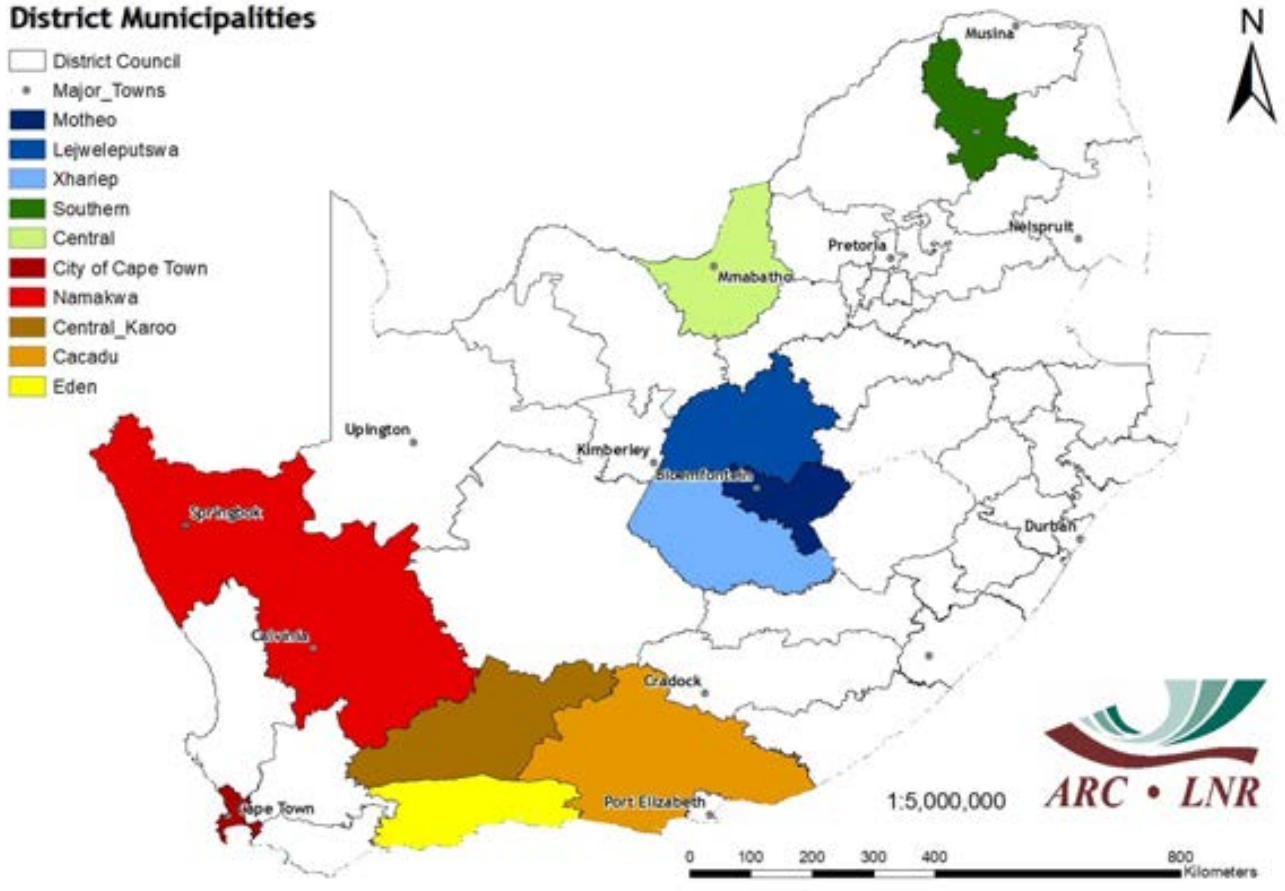

Figure 18

Rainfall and NDVI Graphs

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

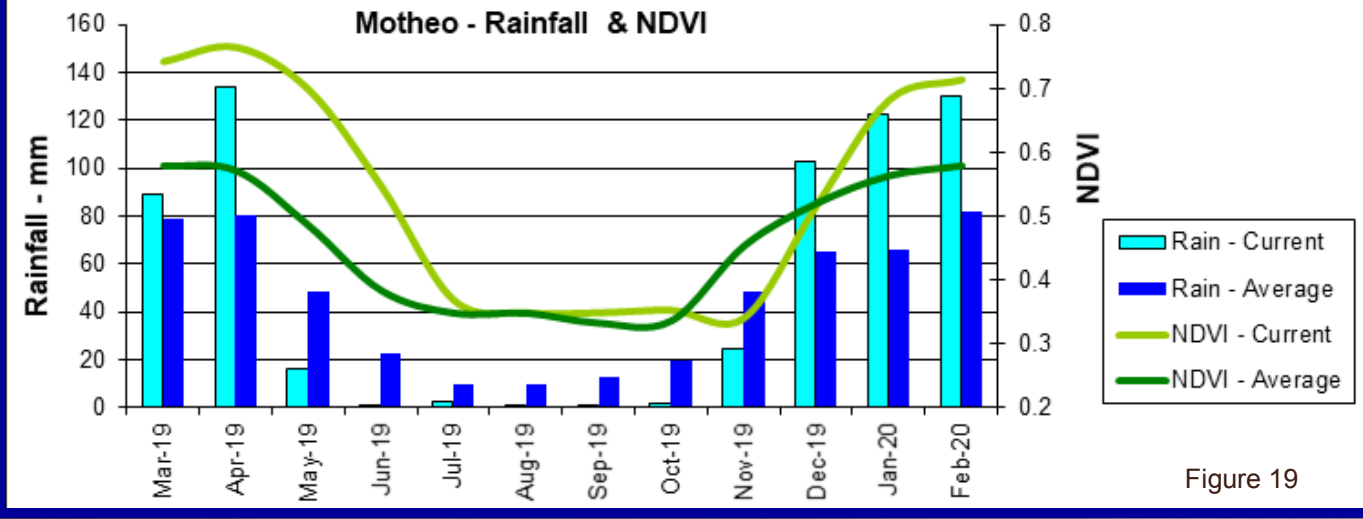
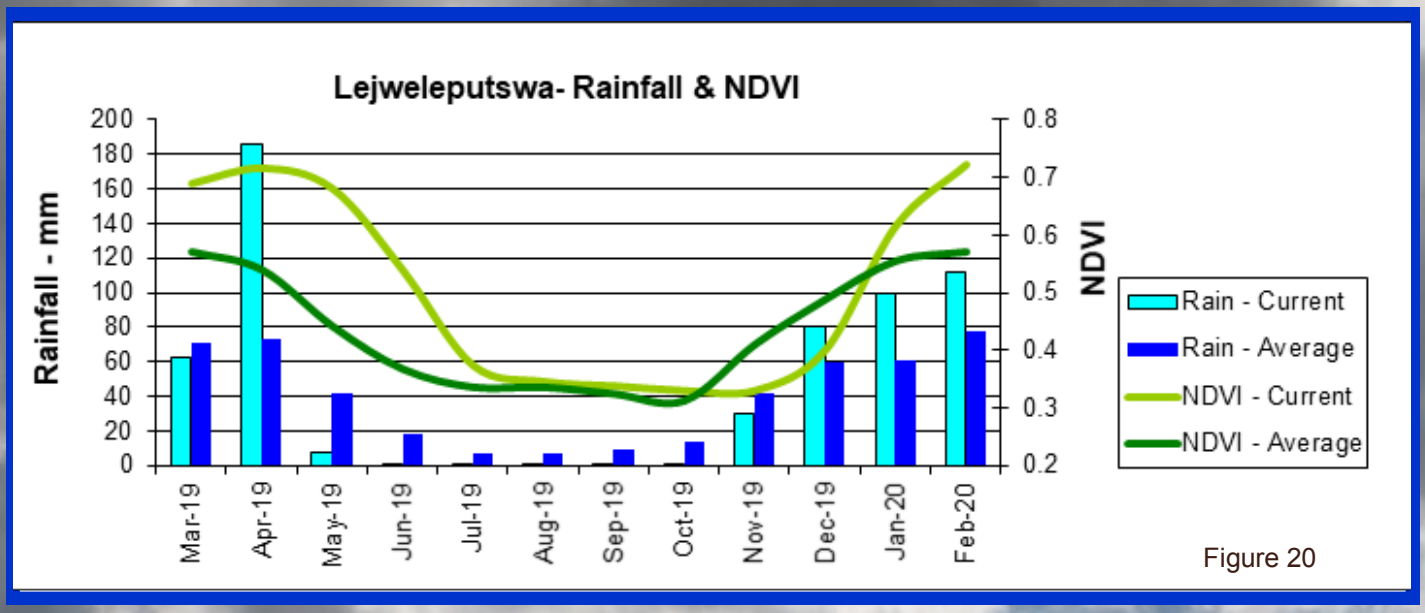


Figure 19



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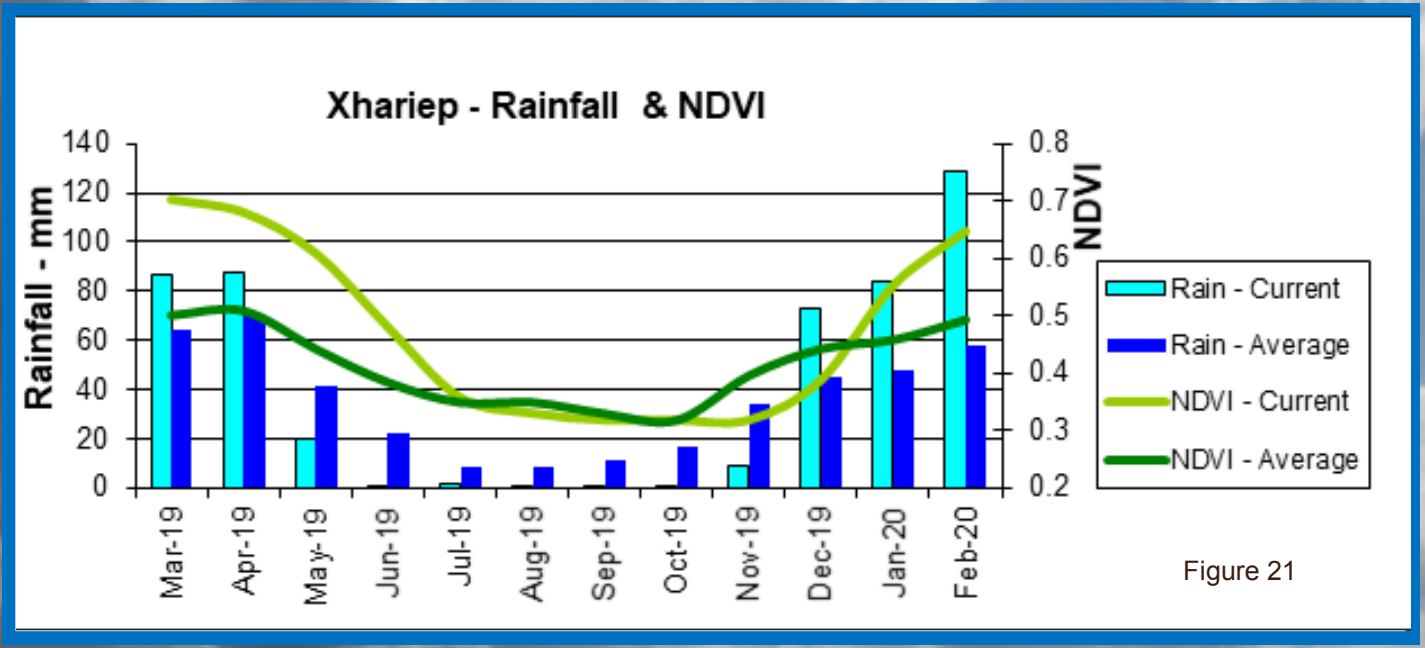

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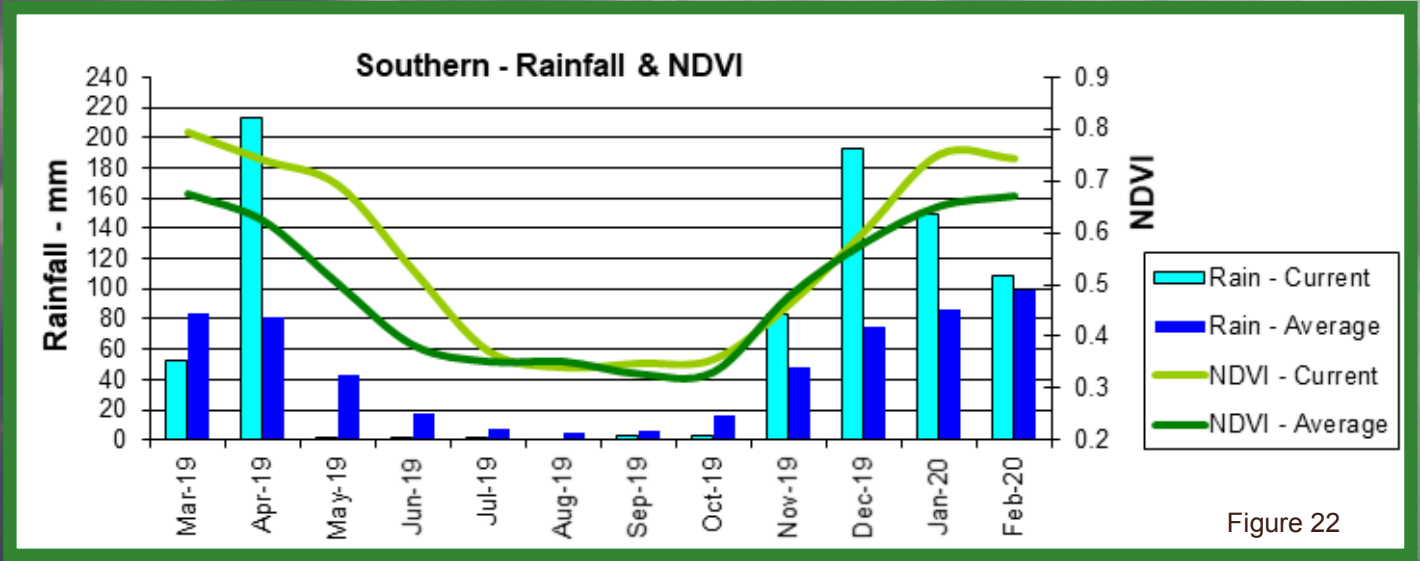

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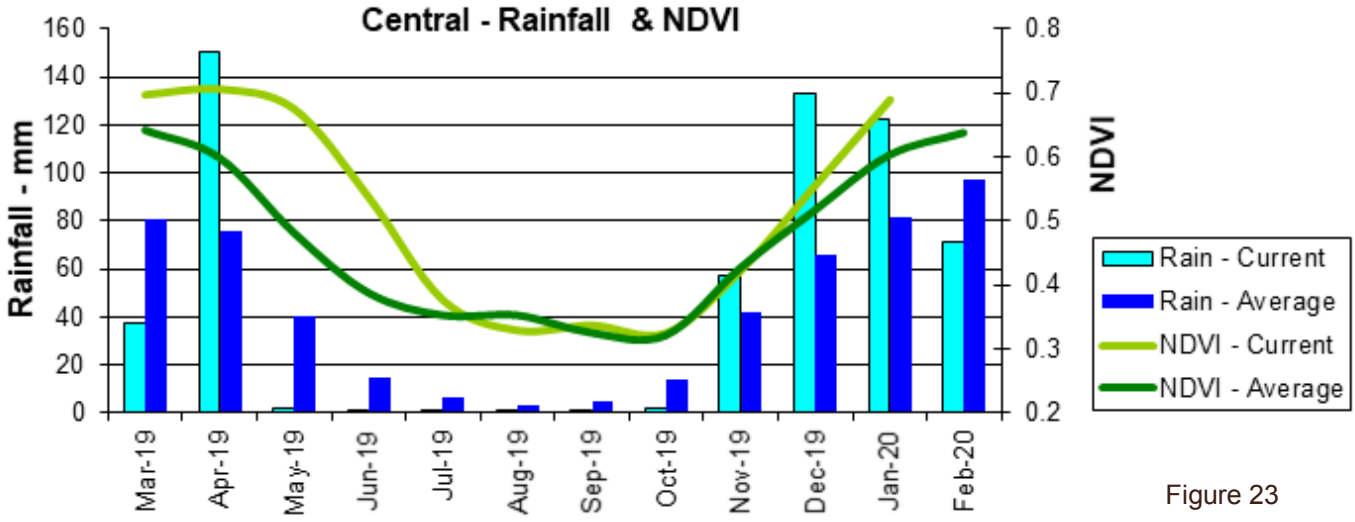

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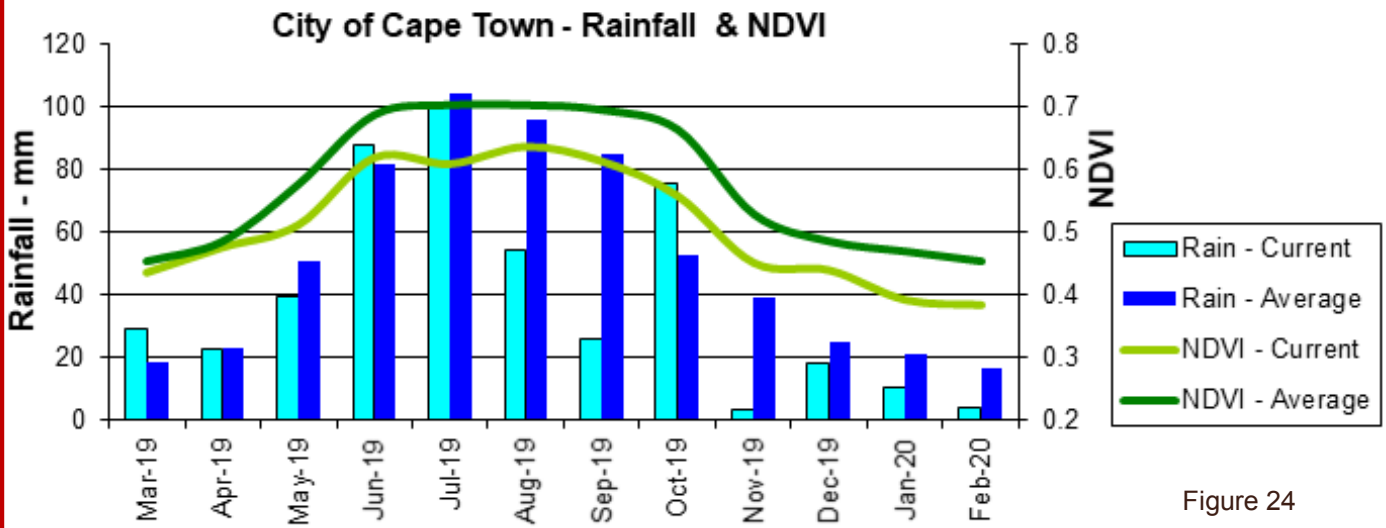

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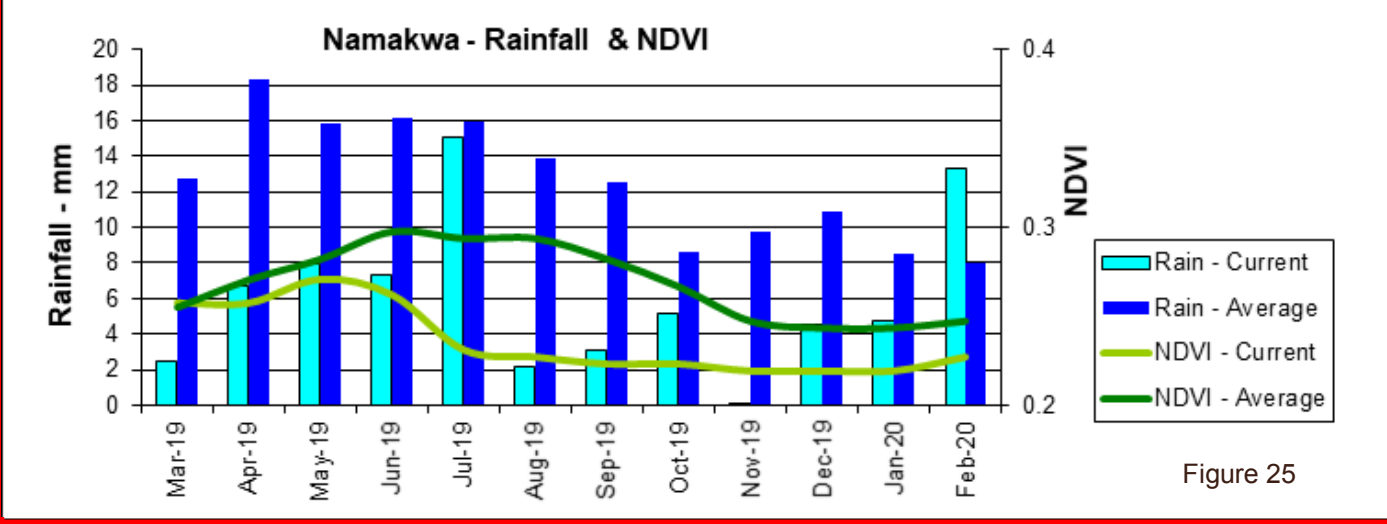

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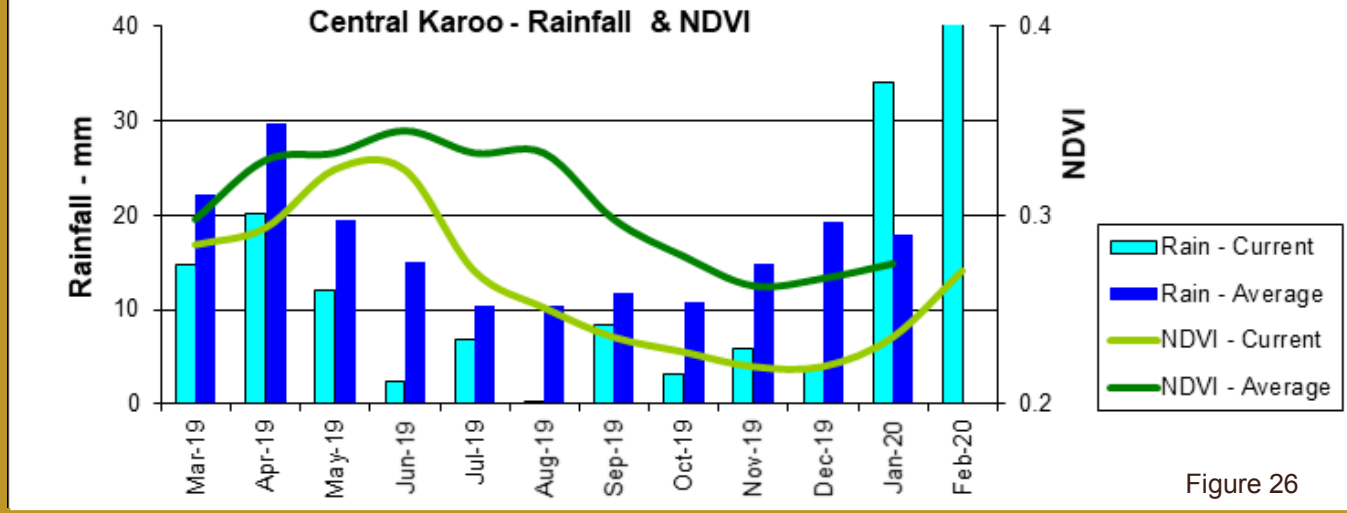

Figure 26

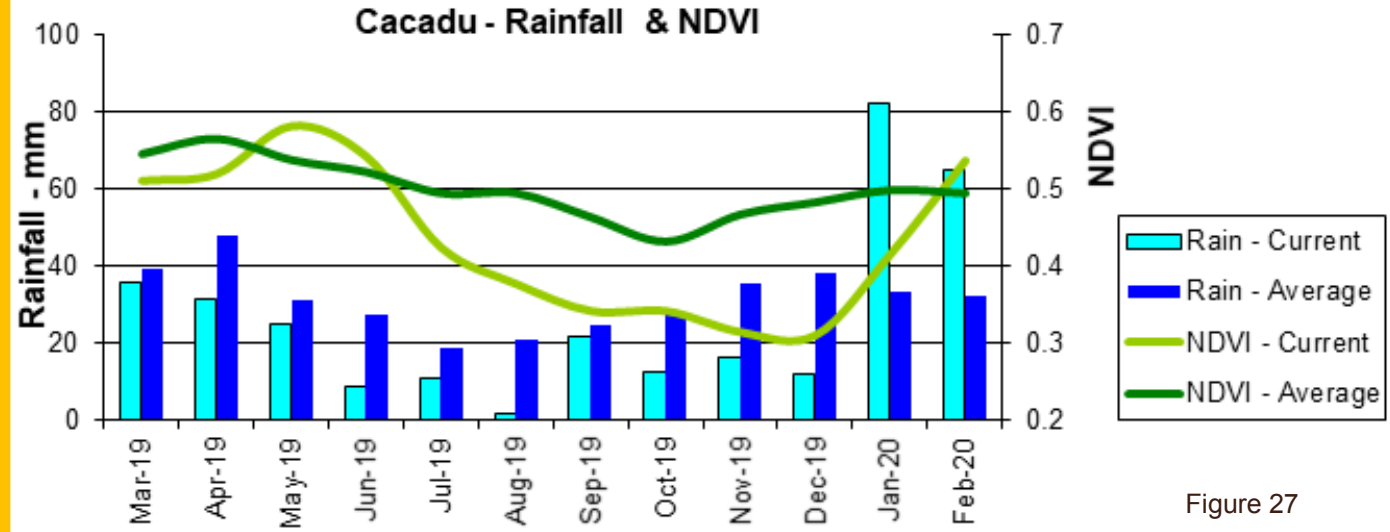

Figure 27

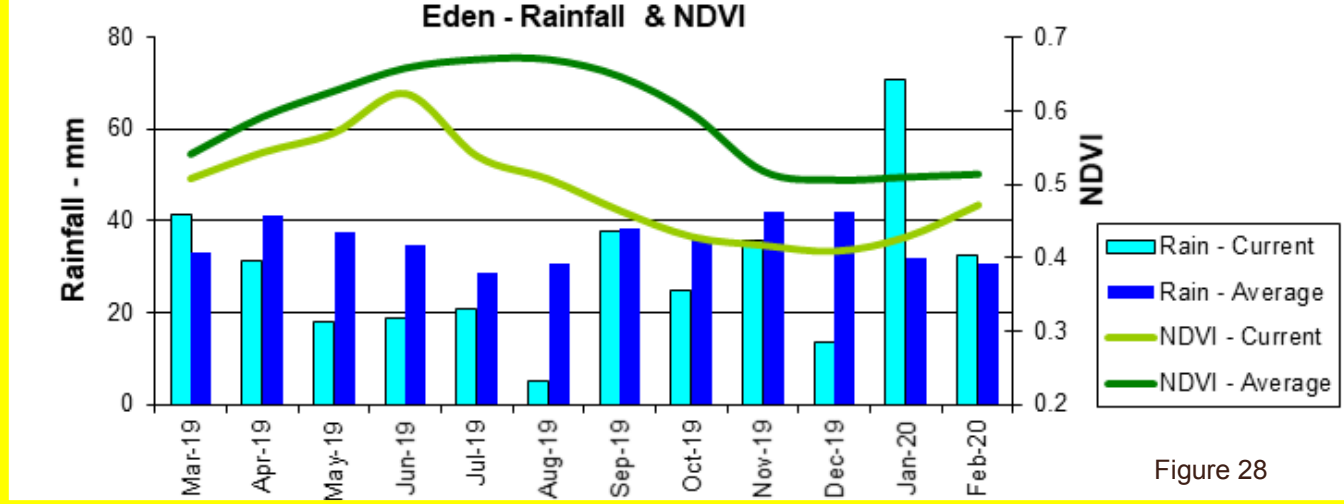

Figure 28

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 between 1-29 February 2020 per province. Fire activity was higher in the Western Cape compared to the long-term average.

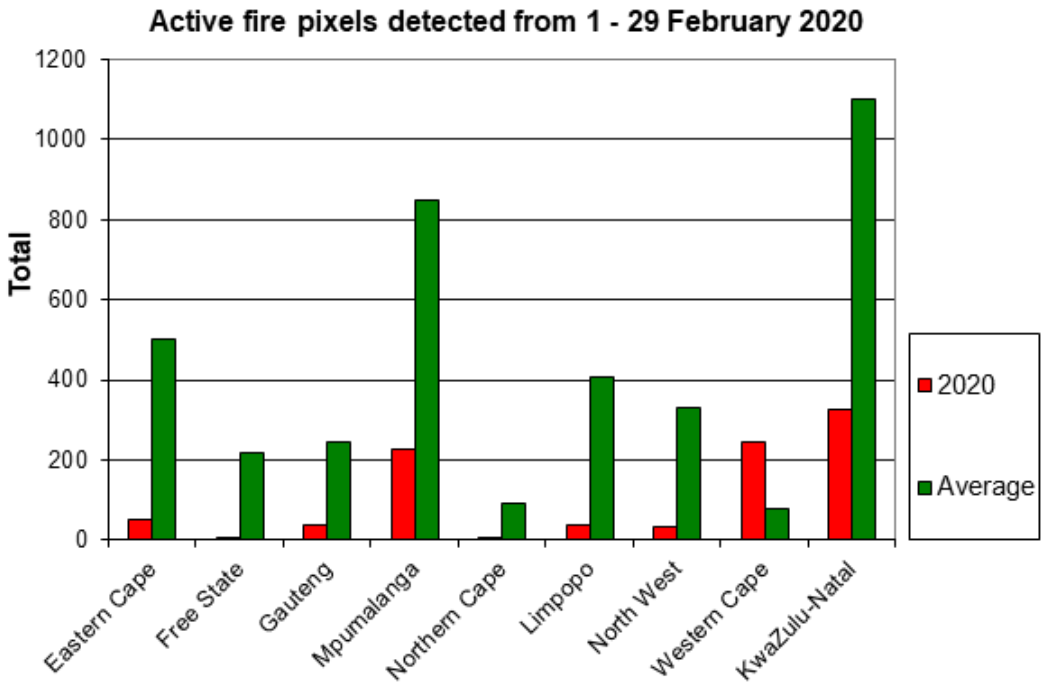

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-29 February 2020.

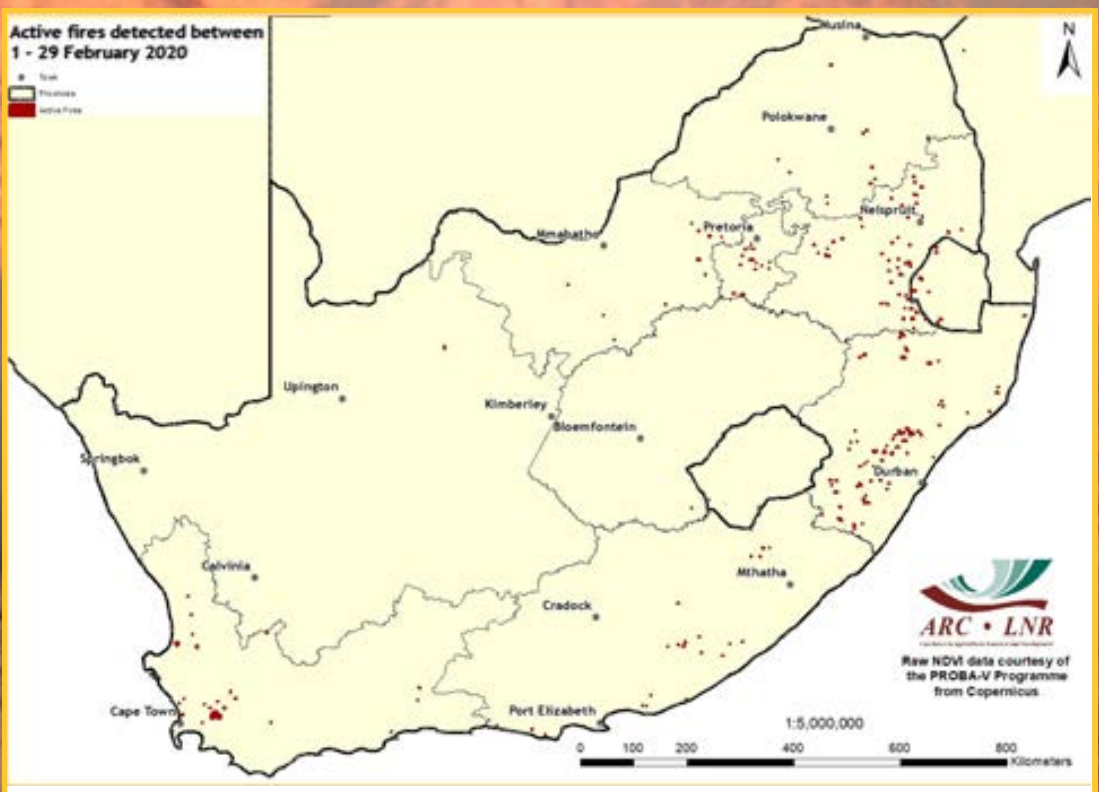

Figure 30

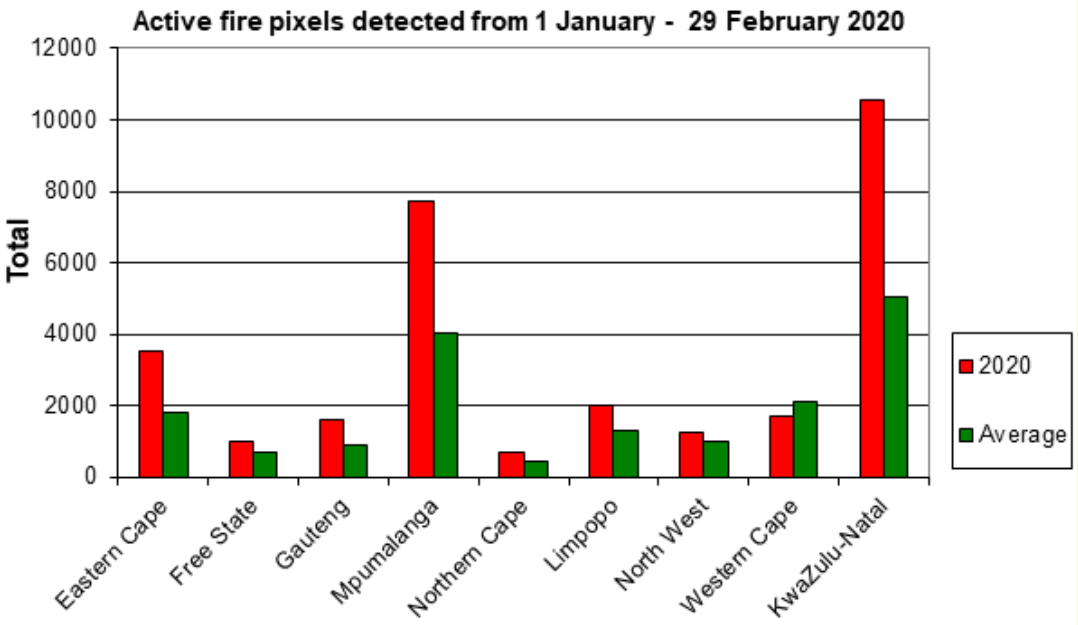

Figure 31:
The graph shows the total number of active fires detected between 1 January - 29 February 2020 per province. Fire activity was higher in all provinces except the Western Cape compared to the long-term average.

Figure 31

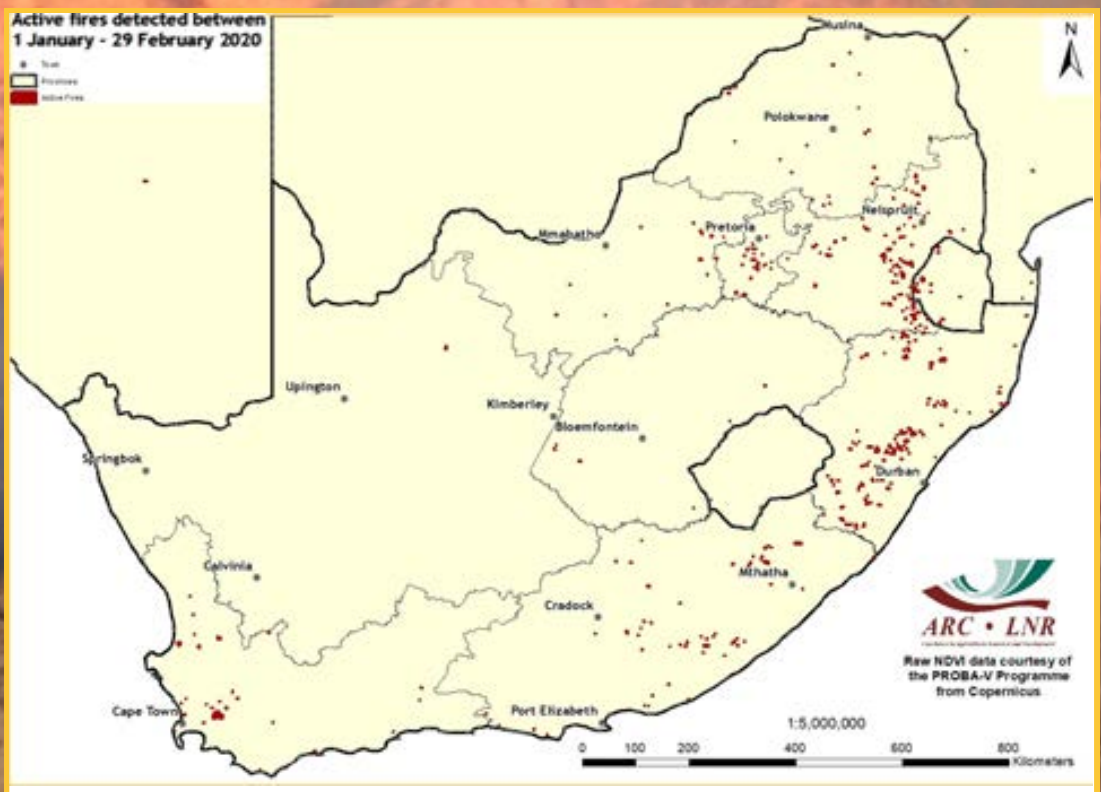

Figure 32:
The map shows the location of active fires detected between 1 January - 29 February 2020.

Questions/Comments:
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Figure 32

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 February 2020 shows very similar patterns to the long-term map for last month, with the majority of catchments now showing water levels equivalent to between 60-100% of the 4-year, long-term maximum water. The main exception to this remains the western regions of the Karoo and the Kalahari, which continue to show significantly lower water levels.

The comparison between February 2020 and February 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 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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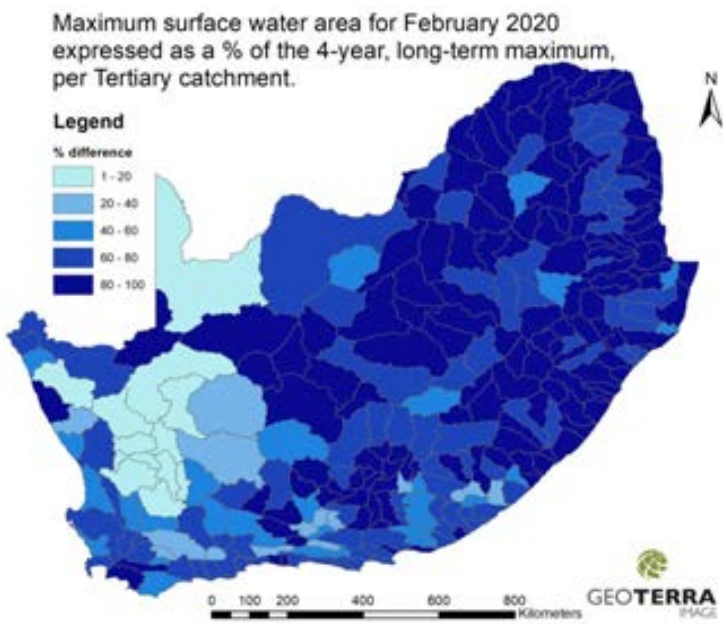

Figure 33

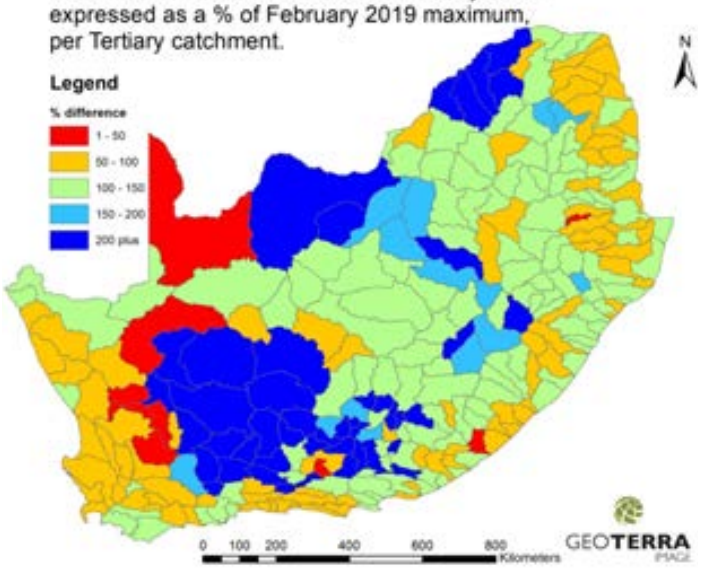

Figure 34

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, Land Reform and Rural Development. 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".