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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

South African Weather Service

AMESD

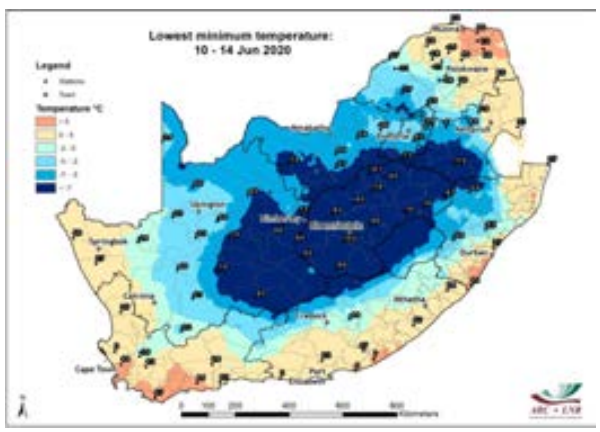
192nd Edition

Images of the Month

Strong frontal system brings welcome winter rain in the southwest and freezing temperatures over the interior

A strong cold front made landfall over the Cape on 9 June 2020 and resulted in widespread rain with strong winds over the winter rainfall region and snow over the mountain ranges in the southwestern to southern parts of the country, as far east as Lesotho. This system is visible on the Meteosat-11 SEVIRI natural colour enhanced image for 12:00 SAST on 10 June (right). Wet and cold conditions continued until 11 June over the southern and southwestern parts and rainfall totals over the grain-producing areas in the southwest ranged mostly between 35-70 mm, with higher totals (exceeding 100 mm) over the mountainous areas. Welcome rain and snow also occurred over the western to southern parts of the Northern Cape where large areas received more than 25 mm of rain, with totals in the mountainous areas exceeding 70 mm. Since most of these areas were hard hit by a multi-year drought, the widespread rain in the Northern Cape brought some much needed relief.

The cold front and widespread rain over the winter rainfall region followed another system in late May that also resulted in widespread rain. Together, these two systems point to a good start to the rainy season in the winter rainfall region – much stronger than what has been the norm during the last few years and especially during the drought of 2015-2017. This rain will go a long way to supporting wheat production over the winter rainfall region where the outlook is somewhat better than was the case during 2019 when production was below normal. The strong cold front during late May brought the first widespread frost to the interior. Similarly, the latest system also resulted in freezing temperatures over the interior. The minimum temperature map (right) shows the lowest recorded temperatures from 10 to 14 June 2020. Much of the central interior recorded temperatures below -7°C, with some stations recording below -10°C. Such cold conditions could be devastating to livestock, especially small stock, and also imply a risk for the development of runaway veldfires. Farmers should practise preventative measures concerning livestock hypothermia and frost damage to crops.



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:

Greater parts of the country experienced below-normal rainfall conditions during May 2020. An evident decrease in total rainfall was notable over the summer rainfall region – which was the only area that received good rainfall in the preceding months, as expected. However, the cessation of rains occurred rather early when considering the same month in the previous 4 years. Although dry conditions were observed in May, the season was characterized by favourable climatic conditions supporting high yields since the onset of rains in November 2019. This dry weather supported harvesting, especially of white maize (western production areas in North West and Free State), rather than negatively impacting production.

A lack of intense weather systems moving across the country resulted in relatively high daytime temperatures during the first few days of the month. Consequently, a significant frontal system caused widespread frost over the northern interior of the Eastern Cape, towards the Free State and Northern Cape, from the 25th.

Rainfall was confined to the southern and southwestern parts of the country, viz. all-year and winter rainfall regions. However, the latter received below-normal rainfall due to cold fronts tracking somewhat far south. Only by the 26th and at the end of the month, as circulation patterns changed, did cold fronts start to influence the southwestern parts. These resulted in rainy, cold conditions accompanied by strong winds. Snowfall was also observed in the Little Karoo mountains and moving towards the Cape Winelands District Municipality.

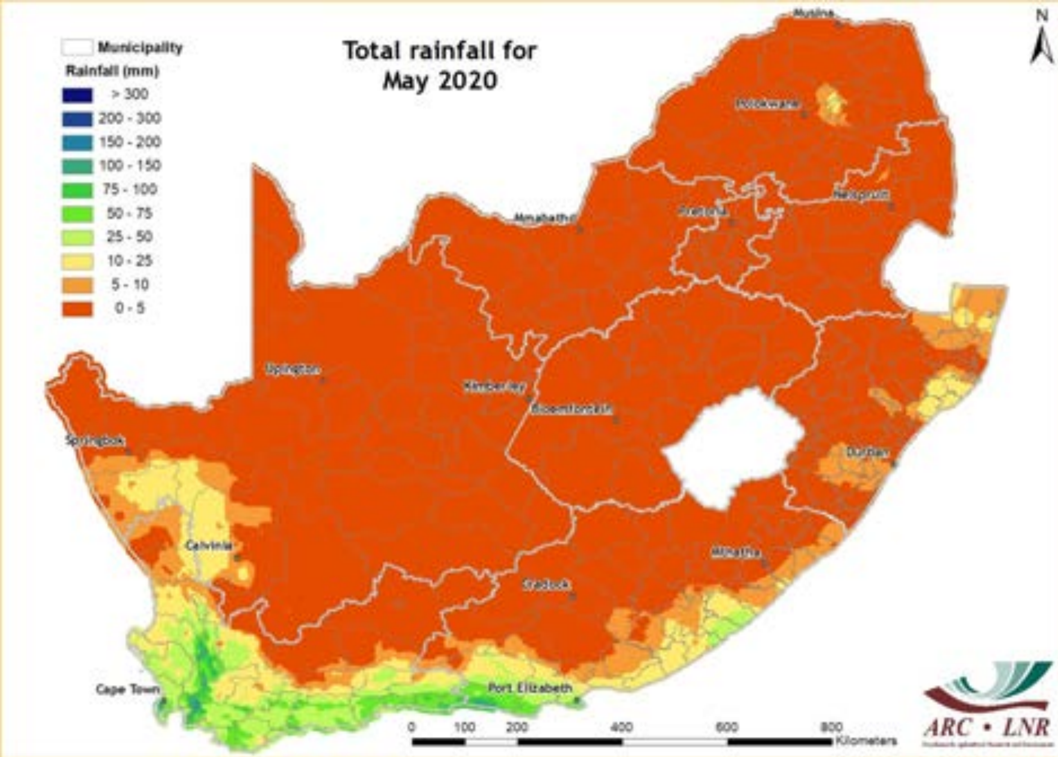


Figure 1

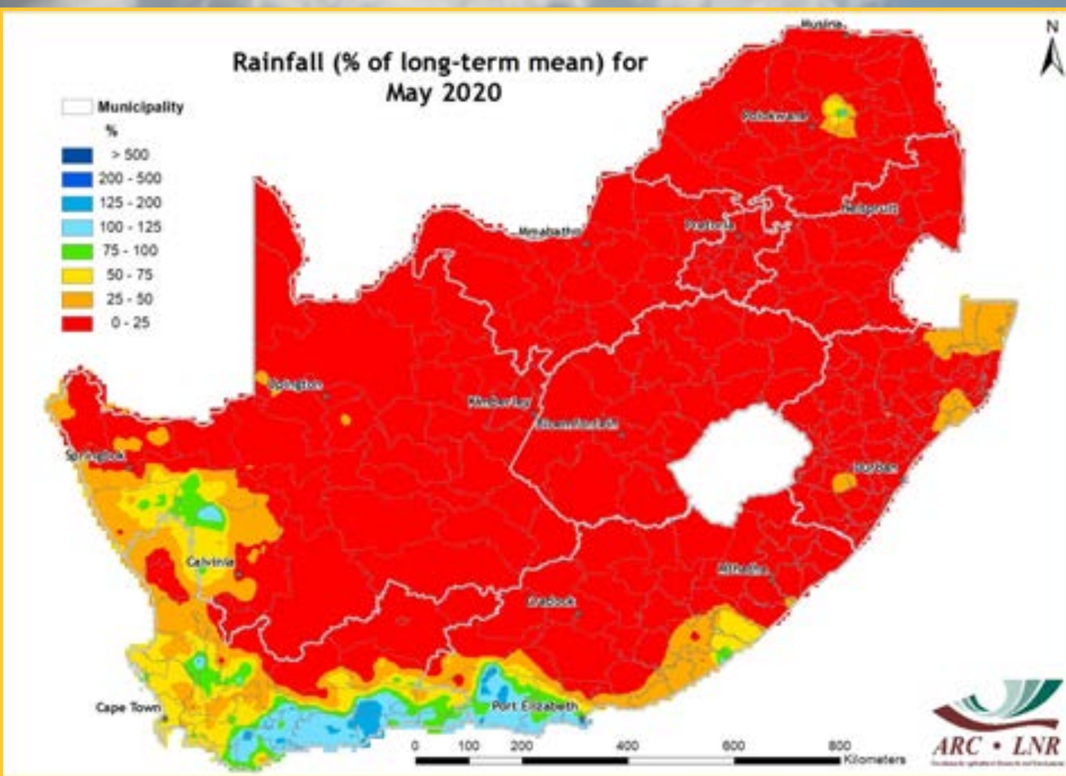


Figure 2

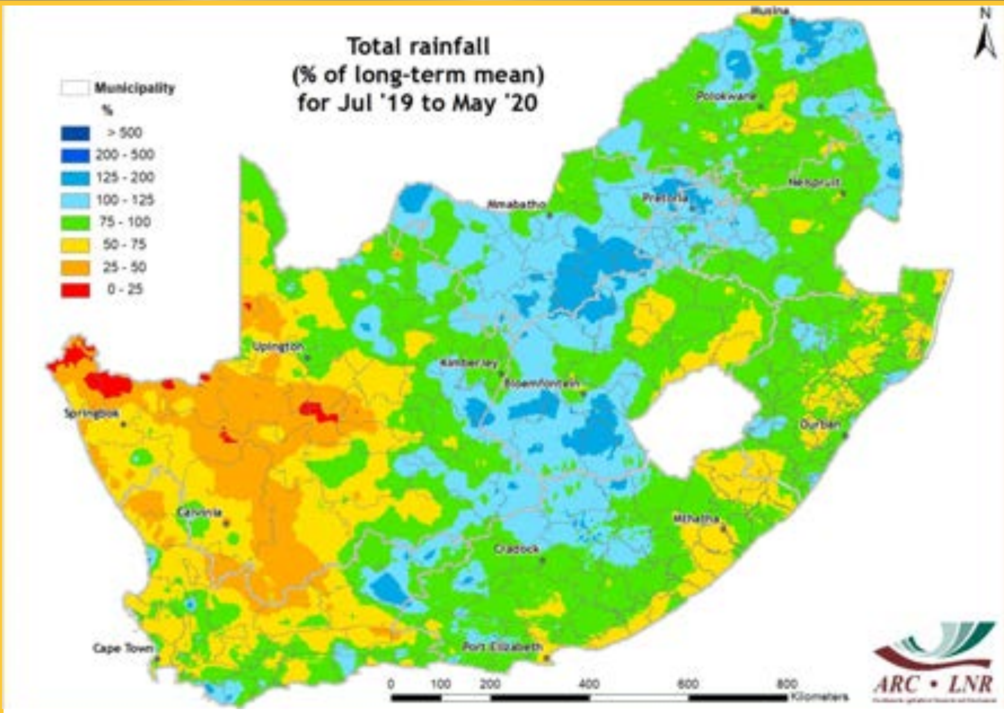


Figure 3

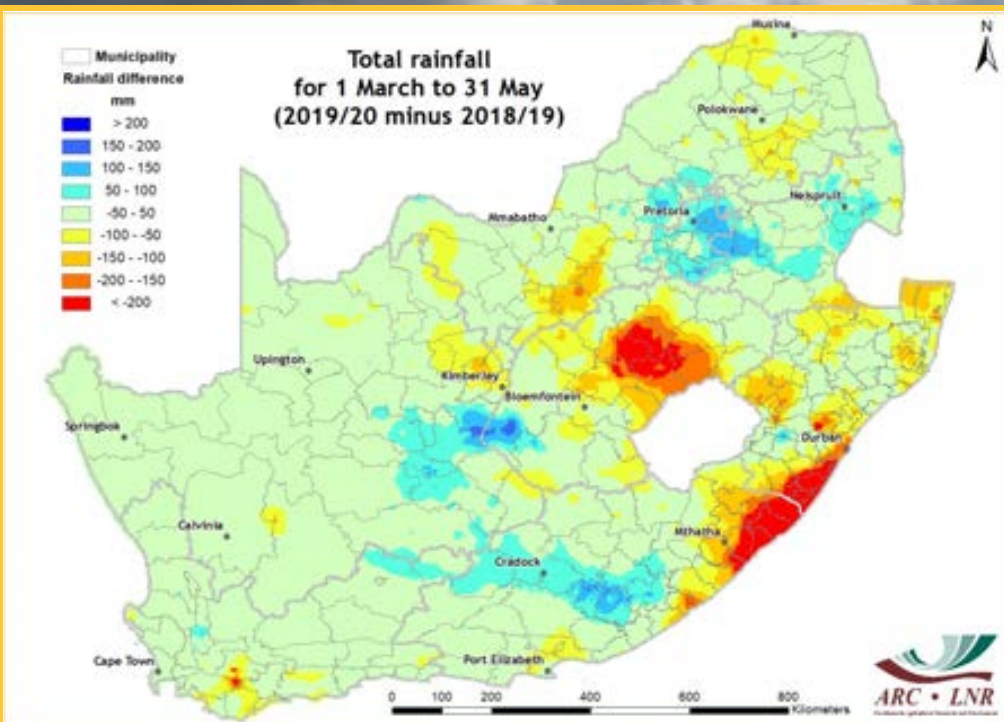


Figure 4

Figure 1:
Rainfall was largely absent over the summer rainfall region during May 2020. A frontal system resulted in rainfall activity over parts of the southern and southwestern parts of the country, with some areas recording totals of >75 mm for the month.

Figure 2:
Below-normal rainfall was notable over much of the summer and winter rainfall regions. Above-normal rainfall conditions occurred over the all-year rainfall region.

Figure 3:
Rainfall totals for the period between July 2019 and May 2020 indicate that above-normal rainfall occurred over the central provinces as well as parts of Limpopo and the Kruger National Park. Areas that received below-normal rainfall for the 11-month period consist of larger parts of the Northern Cape, Western Cape and isolated parts of the eastern provinces, including the eastern Free State.

Figure 4:
When comparing rainfall during the period between March and May 2020 with that of the previous summer, it can be seen that areas that received more rain are the eastern parts of the Northern Cape and towards the central region of the Eastern Cape, as well as parts of Gauteng and Mpumalanga. Areas that recorded a difference of < -200 mm for the 3-month period include the eastern Free State and the border of the Eastern Cape Wild Coast and KwaZulu-Natal. Other areas received relatively the same amount of rainfall as last year.

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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 6-month SPI map ending in May 2020, wet conditions were observed over the interior, with severely to extremely wet conditions in the southern regions of the North West and Free State provinces. It is evident that mild to moderate drought has been widespread over the western parts of the Northern Cape, as well as the eastern and northern provinces, particularly KwaZulu-Natal, Mpumalanga and Limpopo. Moderate to severe drought in the eastern Free State is visible on the 12- and 24-month SPI maps. The long-term SPI maps also reveal severe to extreme droughts over the Cape provinces, parts of KwaZulu-Natal, Limpopo and Mpumalanga.

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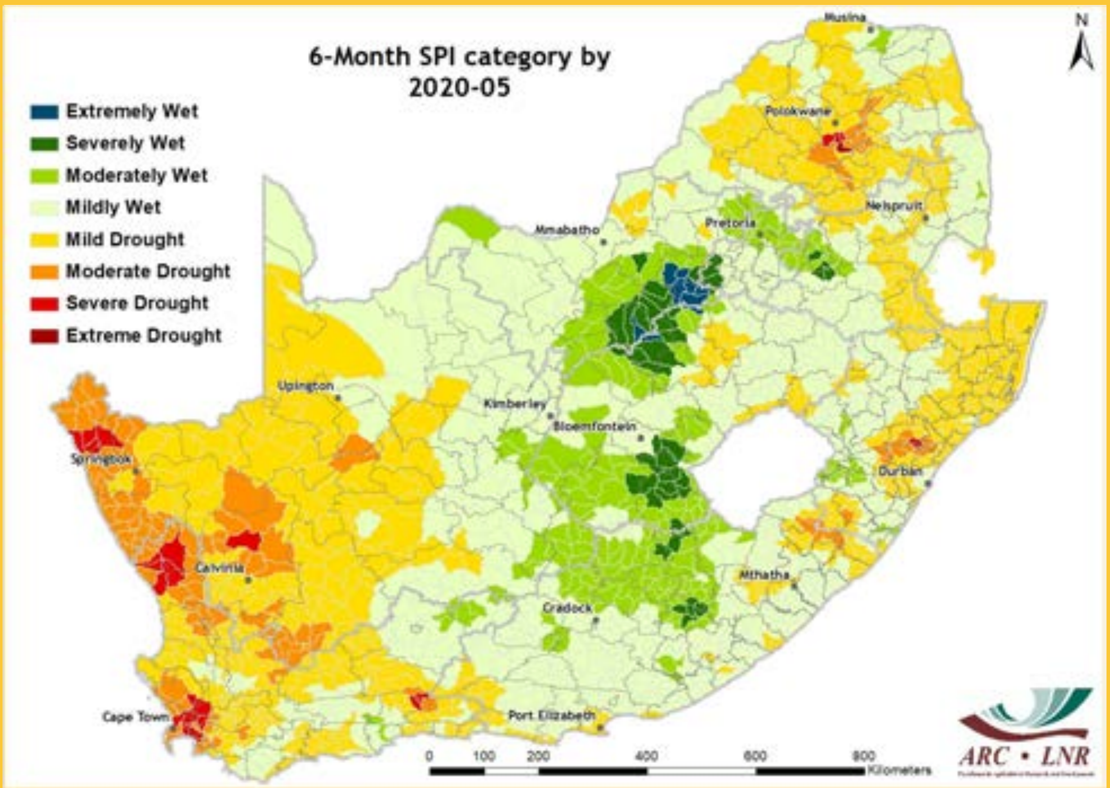
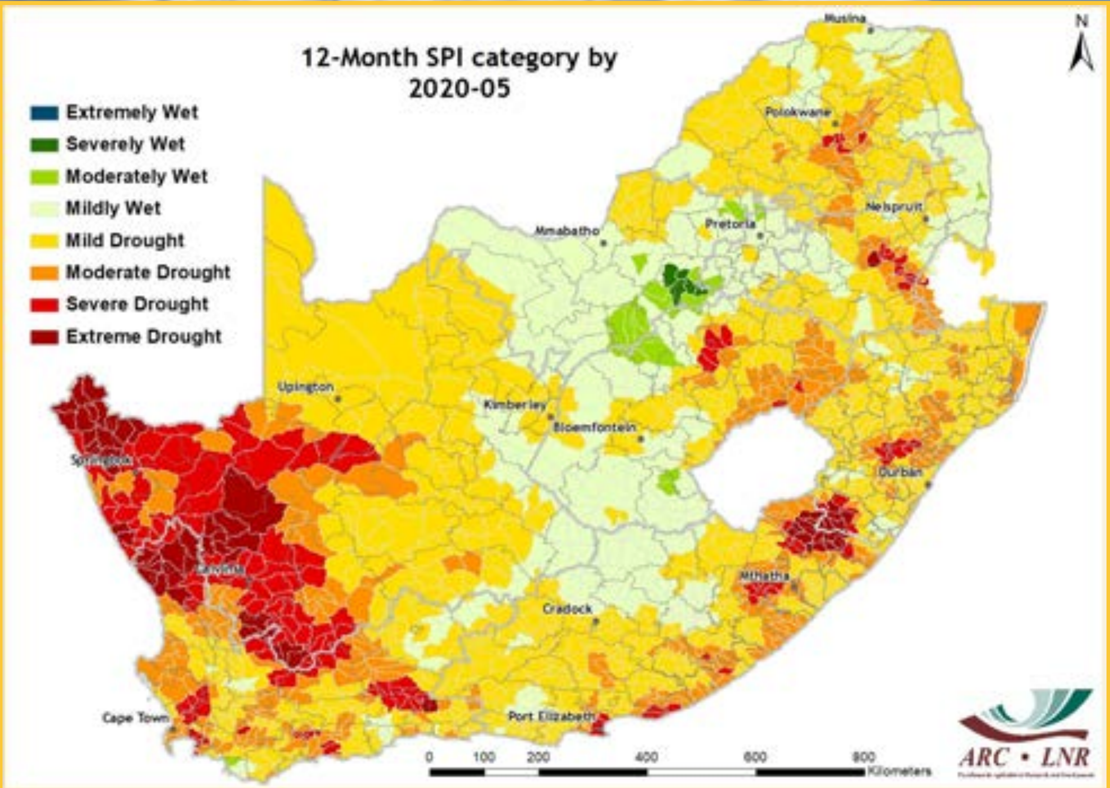


Figure 5



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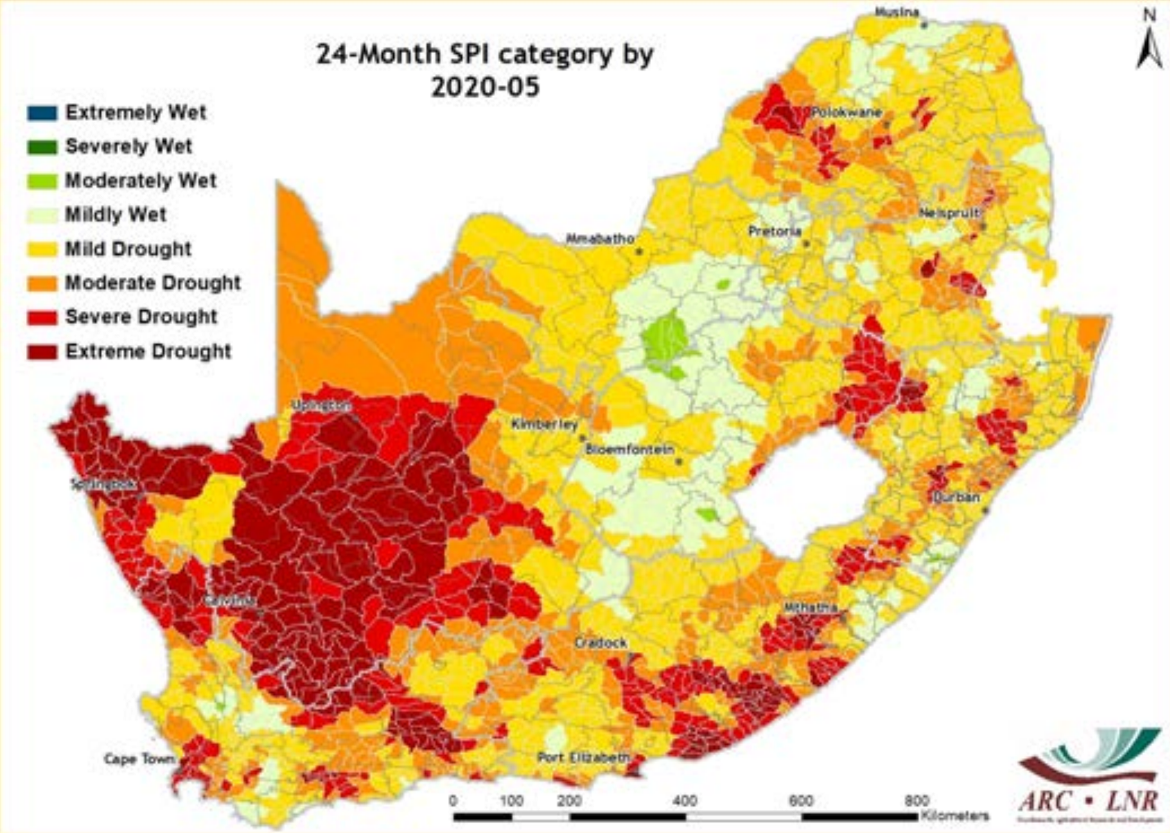

Figure 7

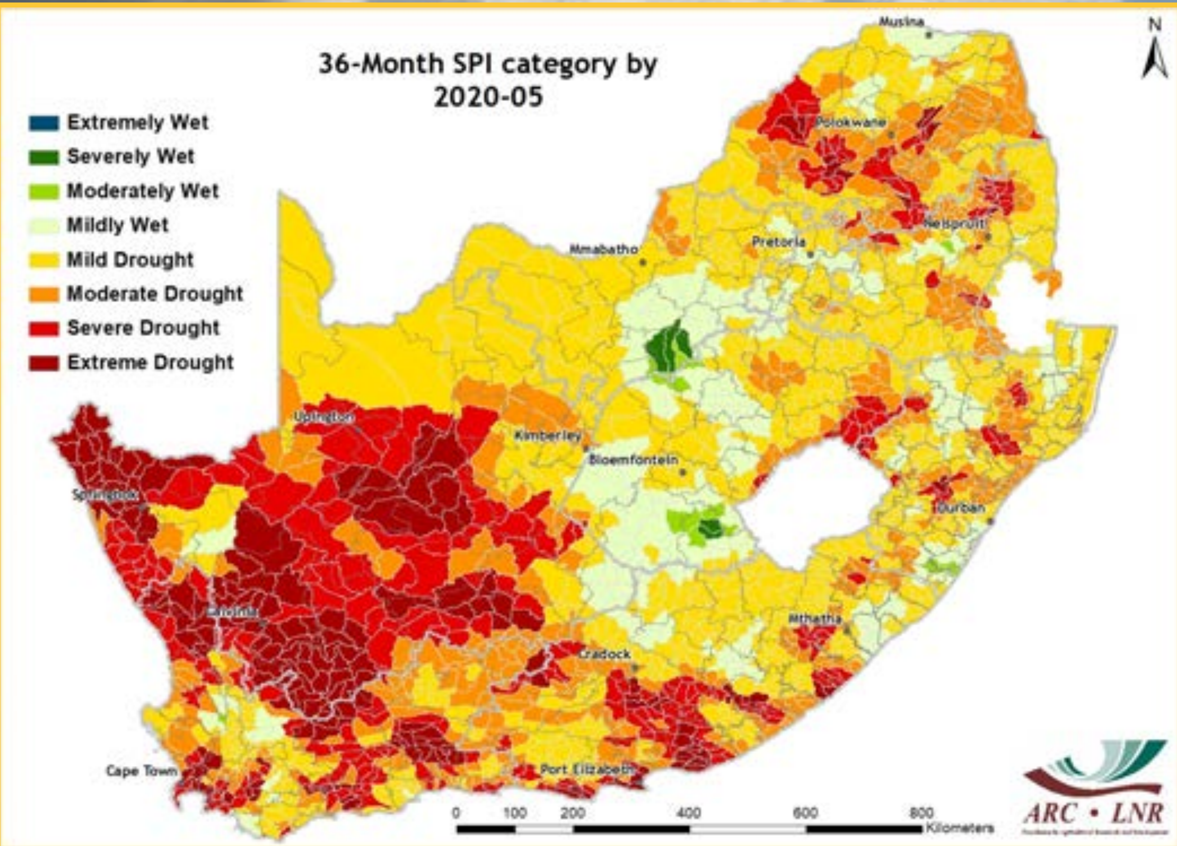

Figure 8

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.

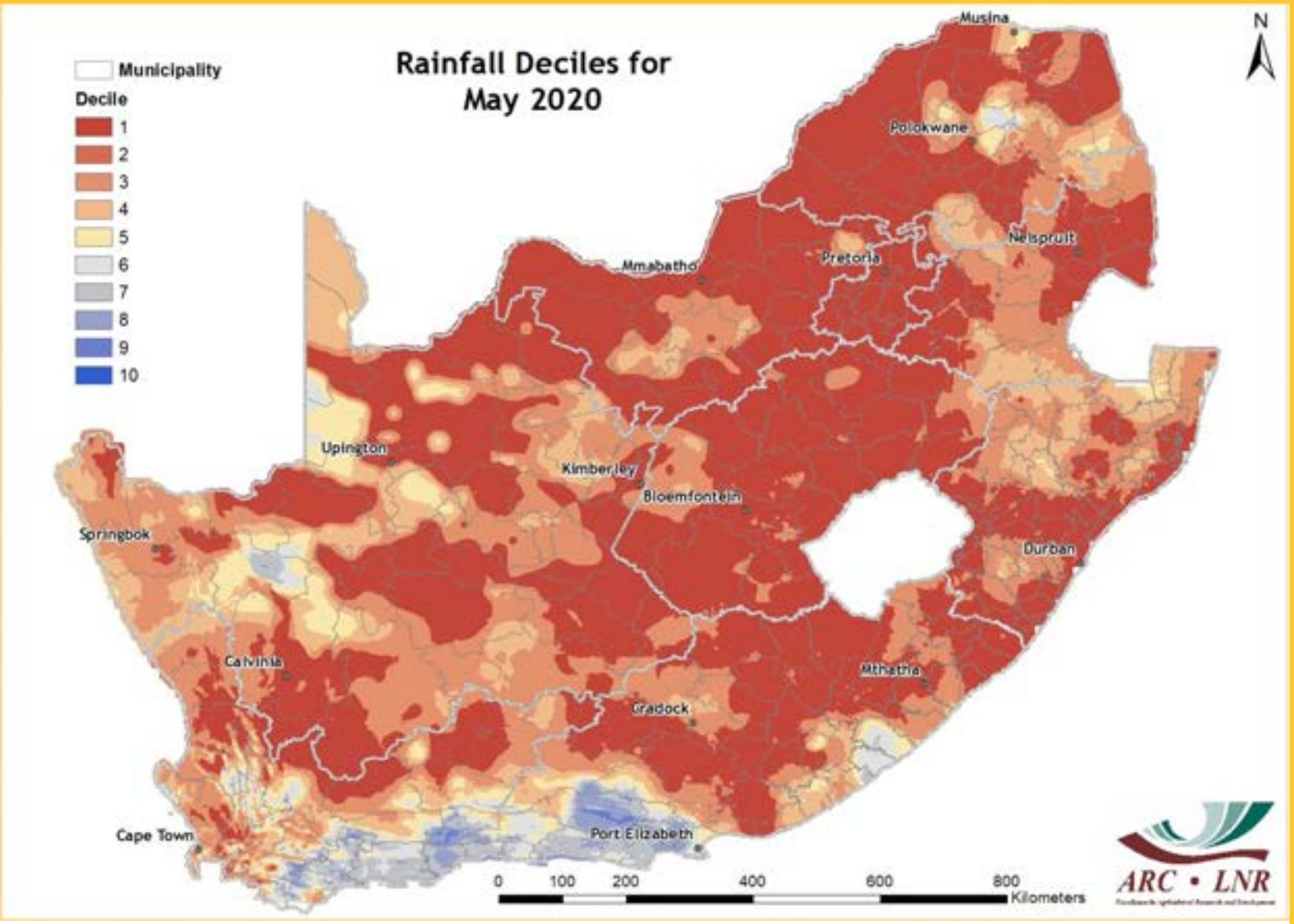

Figure 9

Figure 9:
Greater parts of the summer rainfall region, as well as the winter rainfall region, experienced rainfall totals that compare well with the historically drier May rainfall totals. The all-year rainfall region experienced rainfall totals that compare well with the historically wetter May rainfall totals, while isolated parts of the Eastern Cape, Northern Cape and the central region of Limpopo compared with near-normal 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.

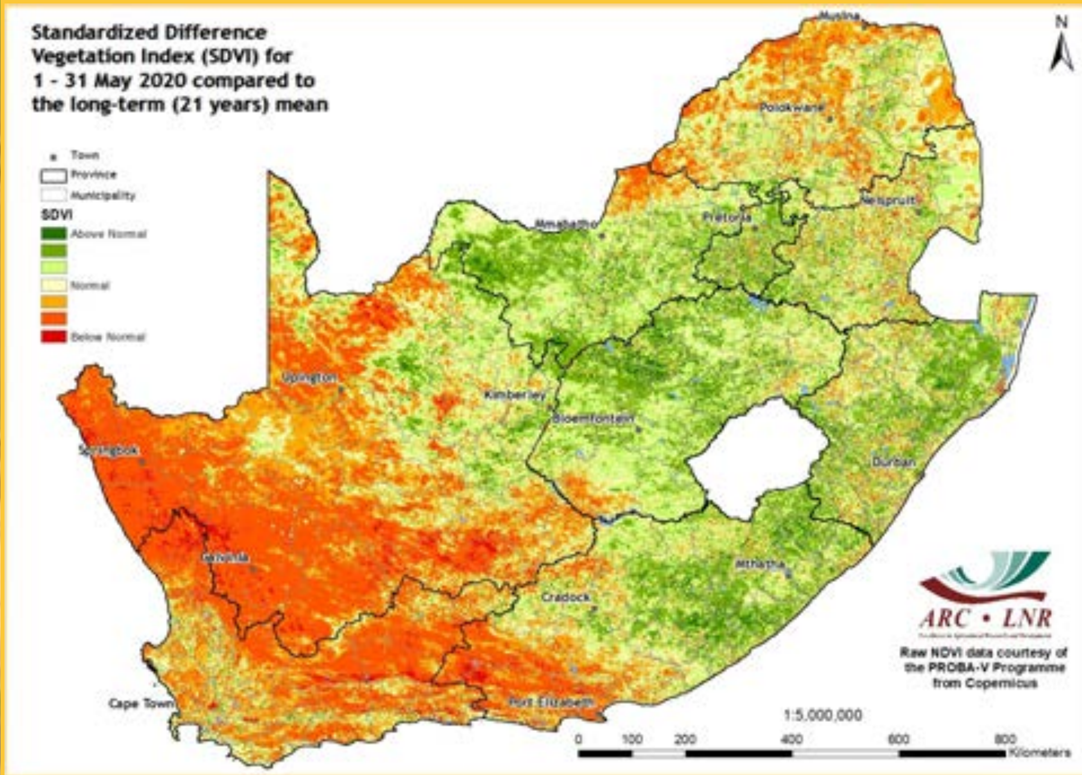

Figure 10

Figure 10:
Compared to the long-term average, the SDVI map for May shows that the western parts of the country and some isolated areas in the northern parts experienced poor vegetation conditions, whereas the central and the far eastern parts experienced good vegetation activity.

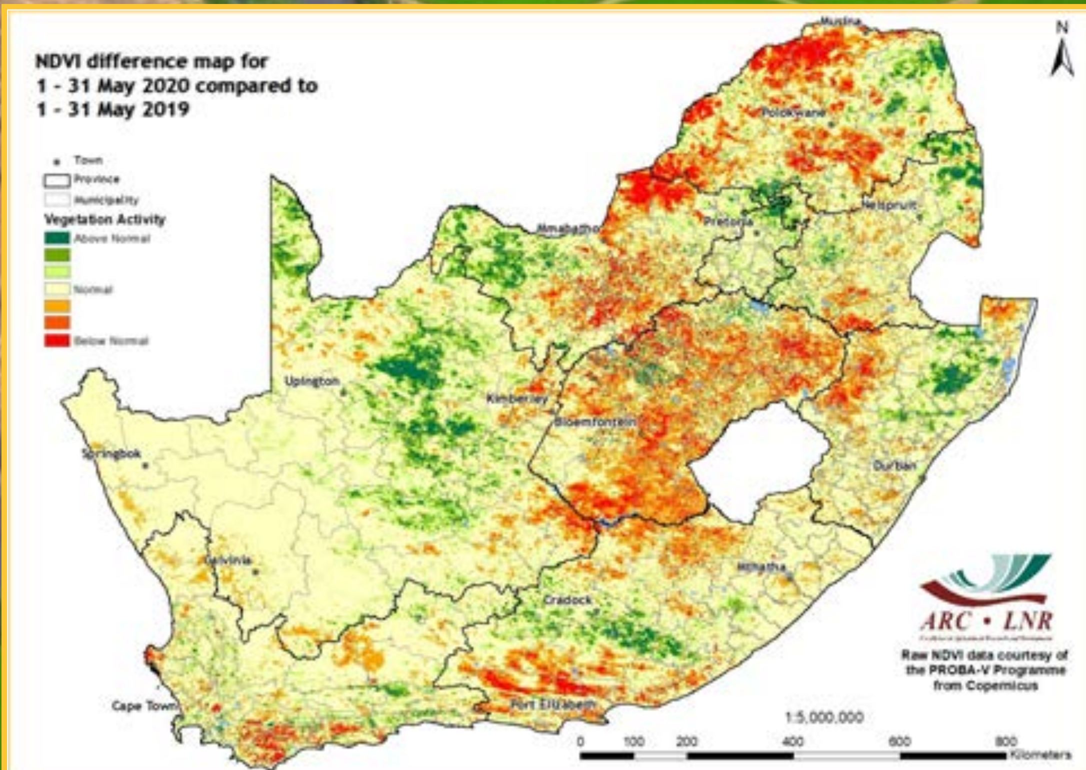

Figure 11

Figure 11:
Compared to the same month last year, the NDVI difference map for May shows that vegetation activity was much lower over the central interior and the northern parts of the country. Pockets of above-normal vegetation conditions occurred in isolated areas across the country.

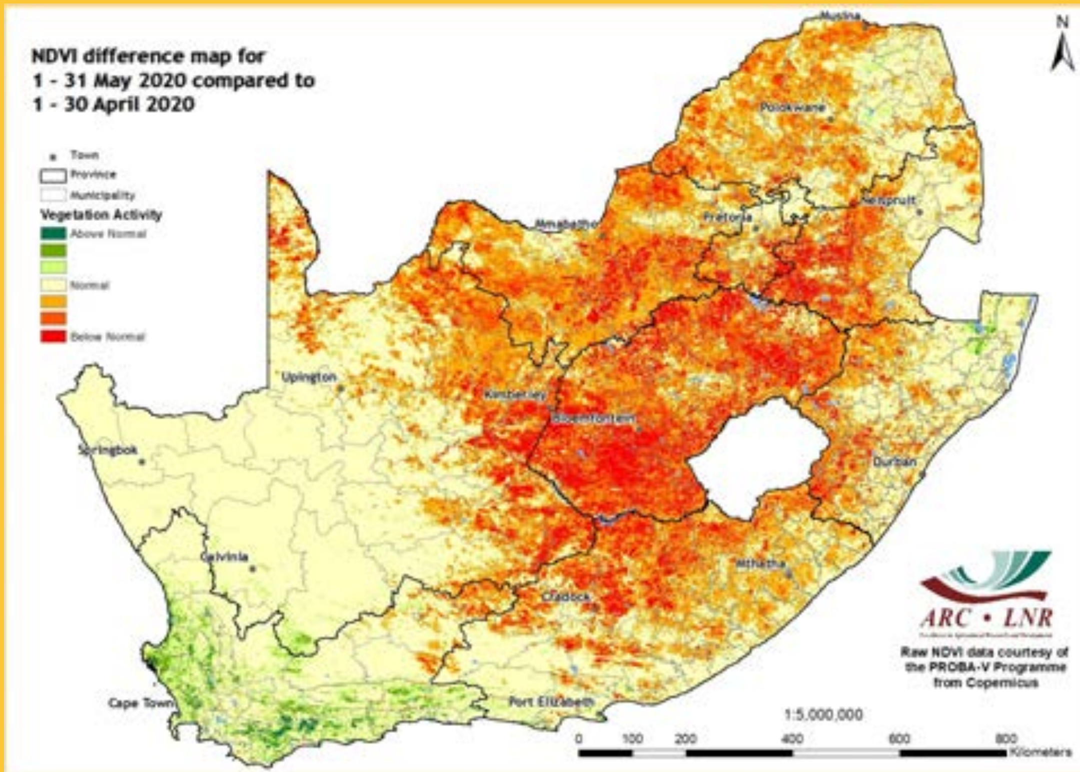

Figure 12

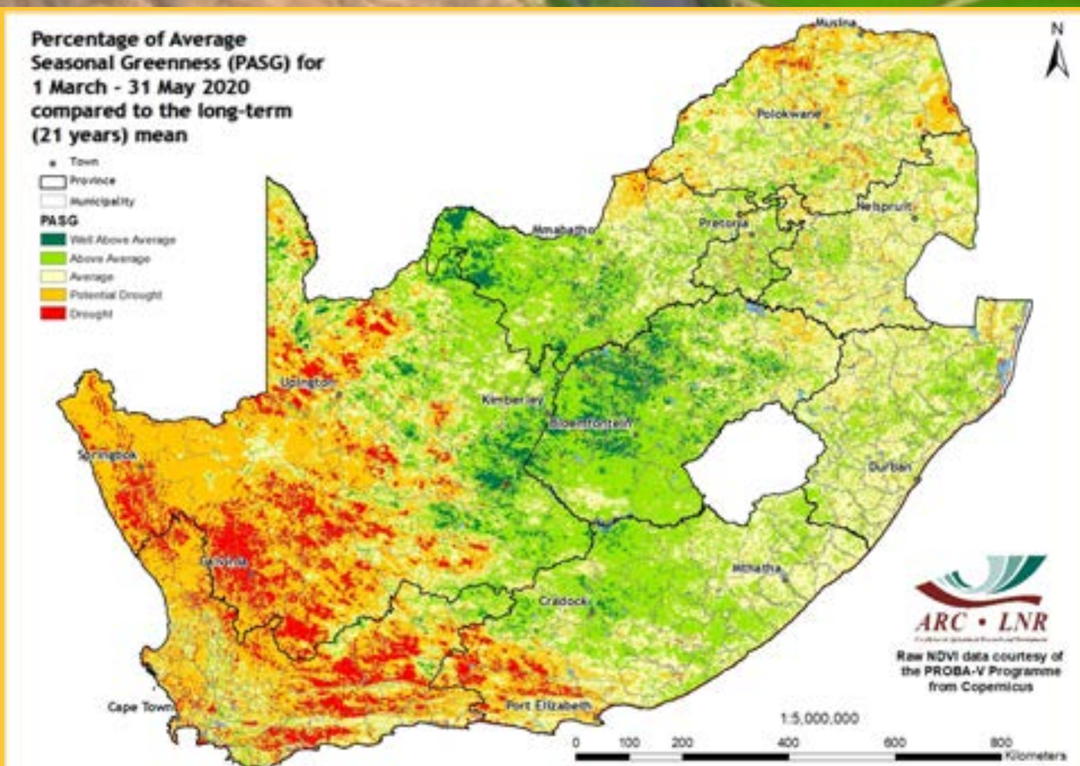

Figure 13

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 12:
Compared to the previous month, the NDVI difference map for May shows that the western half of the country and some isolated areas in the far east generally experienced normal vegetation activity. Nevertheless, poor vegetation conditions were evident in the central and northern parts.

Figure 13:
The PASG over a 3-month period shows that high levels of seasonal greenness in vegetation occurred in the central interior and in some isolated areas in the northern parts of the country. Meanwhile, the western parts continue to experience low levels of seasonal greenness in vegetation.

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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.

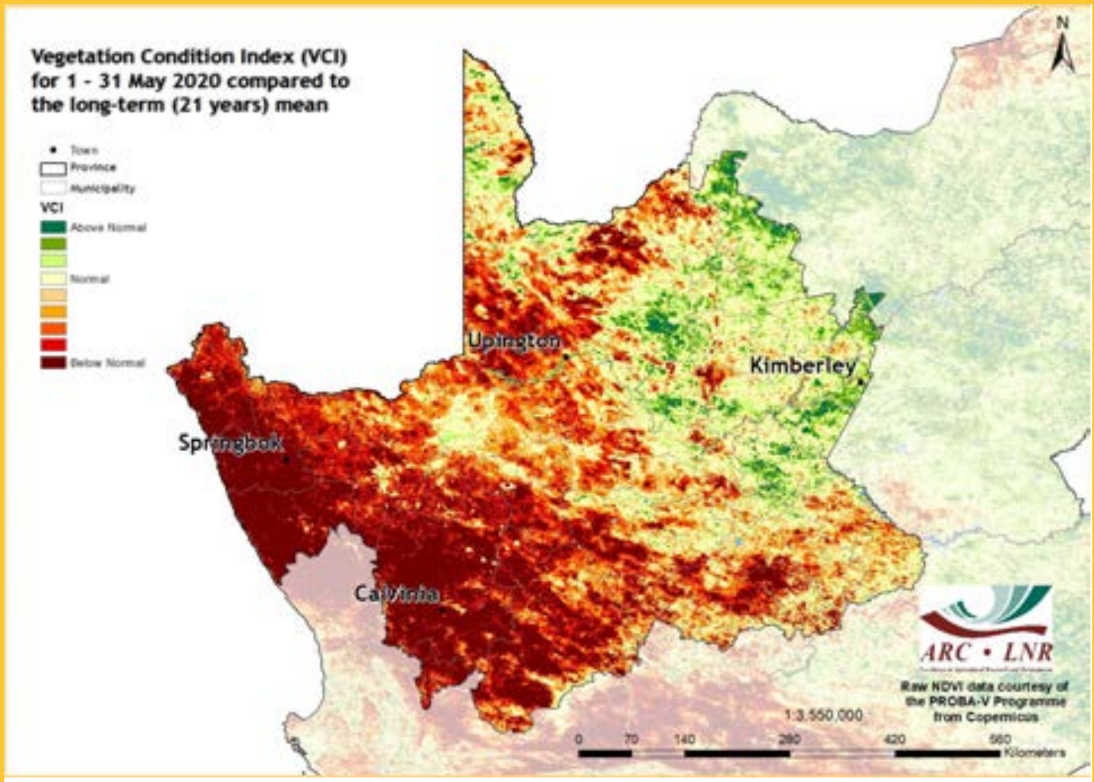

Figure 14

Figure 14:
The VCI map for May indicates that severe drought conditions continue to prevail in larger parts of the Northern Cape.

Figure 15:
The VCI map for May indicates that the Central Karoo, northern parts of the West Coast, as well as northeastern and western parts of the Eden district municipality continue to experience poor vegetation conditions. Meanwhile, isolated areas in the western parts and the southern coastal areas of the Western Cape continue to experience pockets of good vegetation conditions.

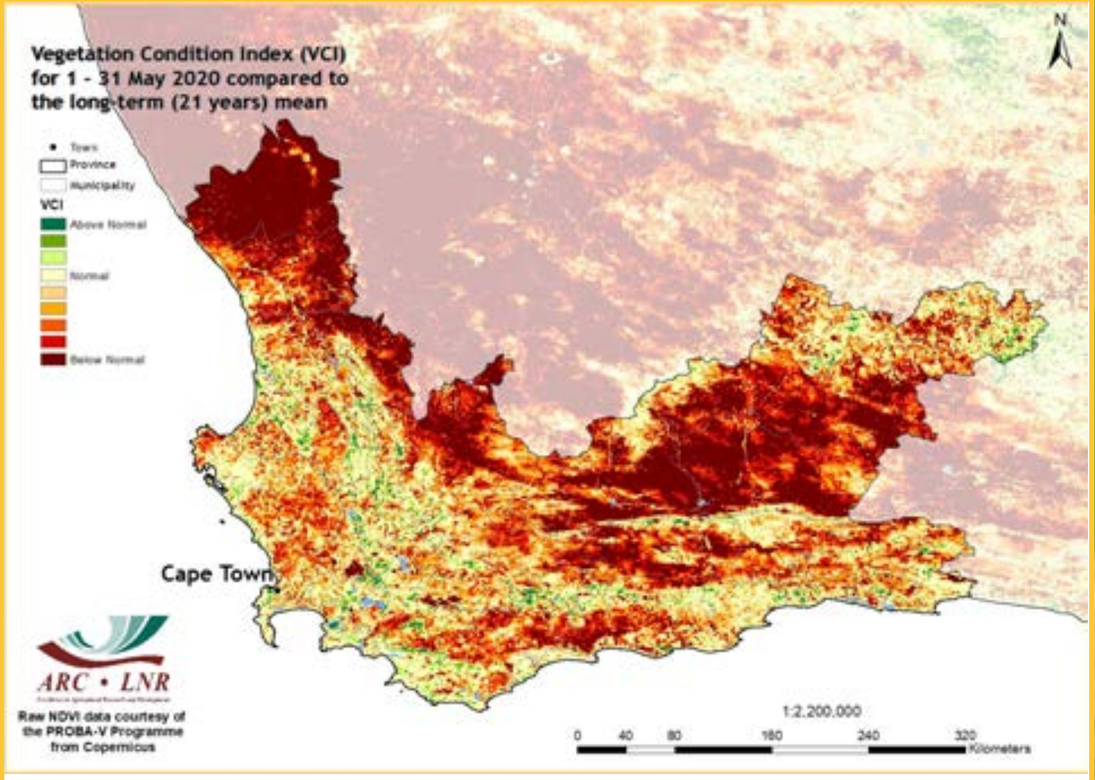

Figure 15

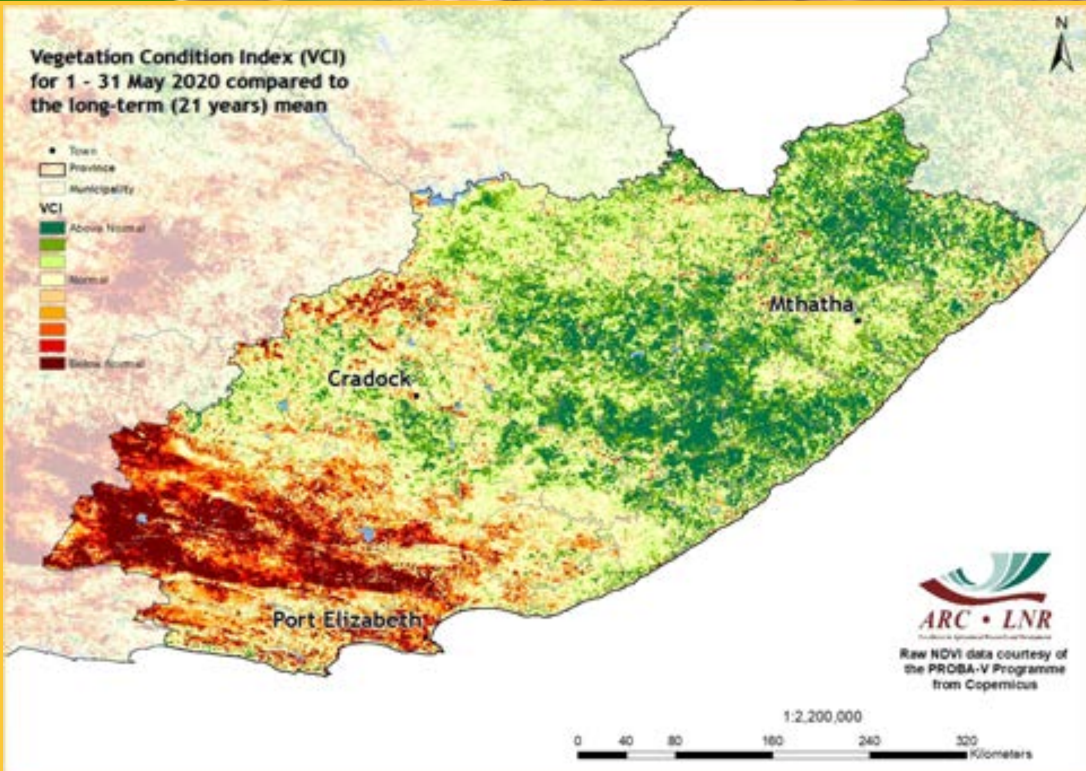

Figure 16

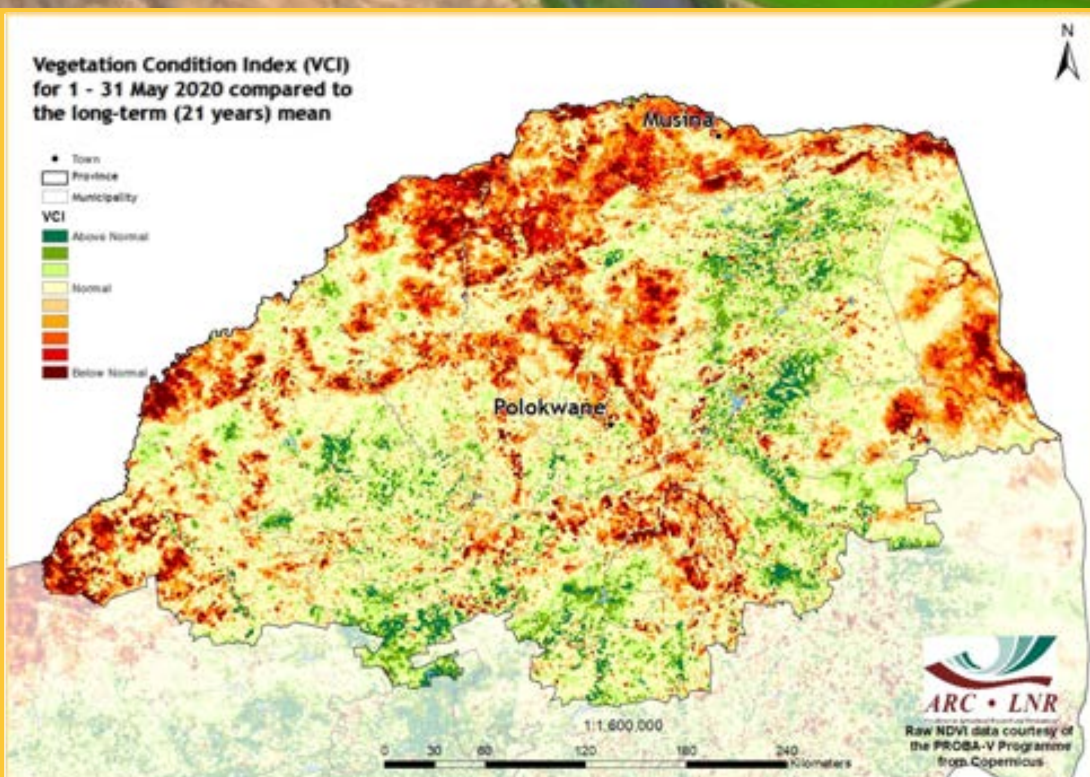

Figure 17

Figure 16:
The VCI map for May indicates that improved vegetation conditions prevail over many parts of the Eastern Cape compared to the long-term average. However, the Sarah Baartman local municipality as well as some isolated areas in the far eastern parts of the province continue to experience poor vegetation activity.

Figure 17:
The VCI map for May indicates that poor vegetation activity continues to spread across a wider geographical area of Limpopo.

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6. Vegetation Conditions & Rainfall

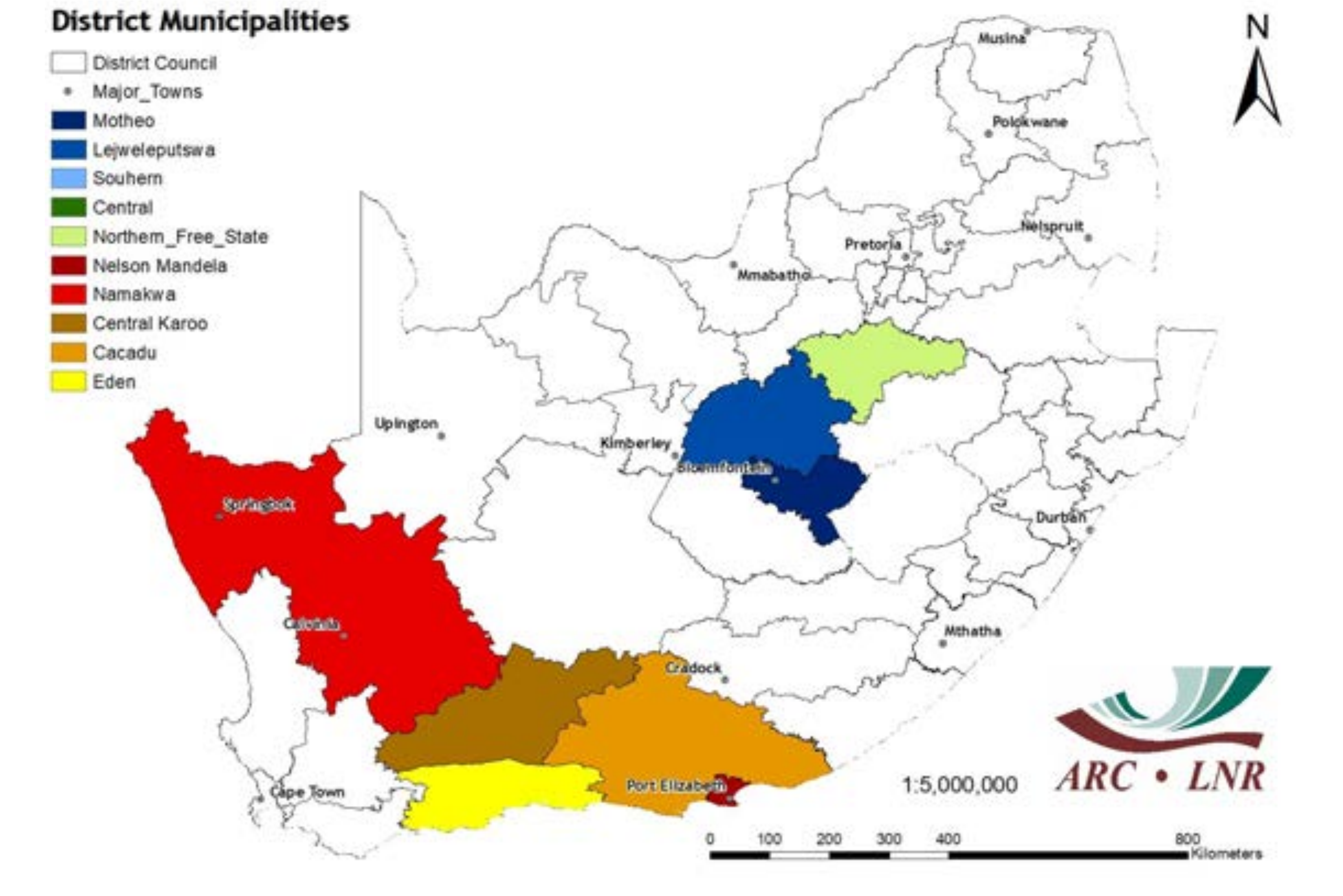

Figure 18

Rainfall and NDVI Graphs

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

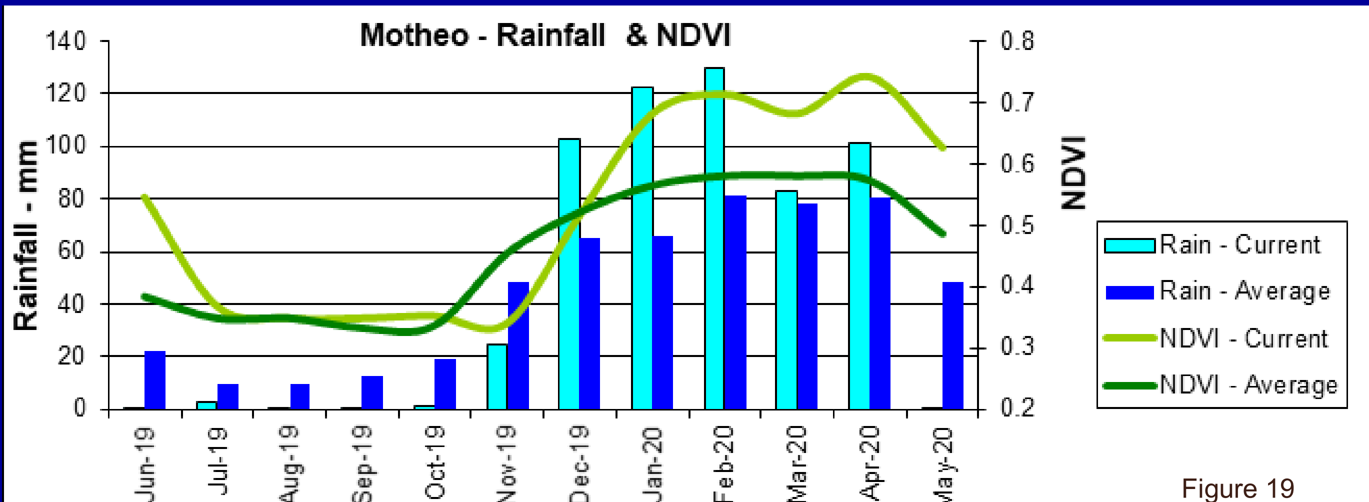
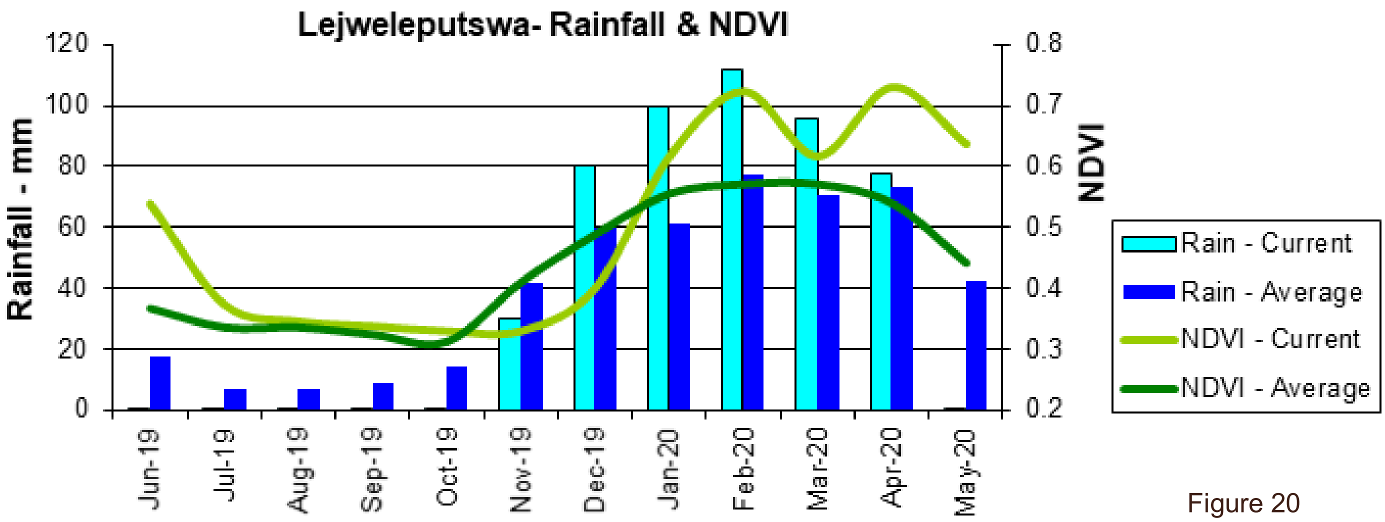


Figure 19



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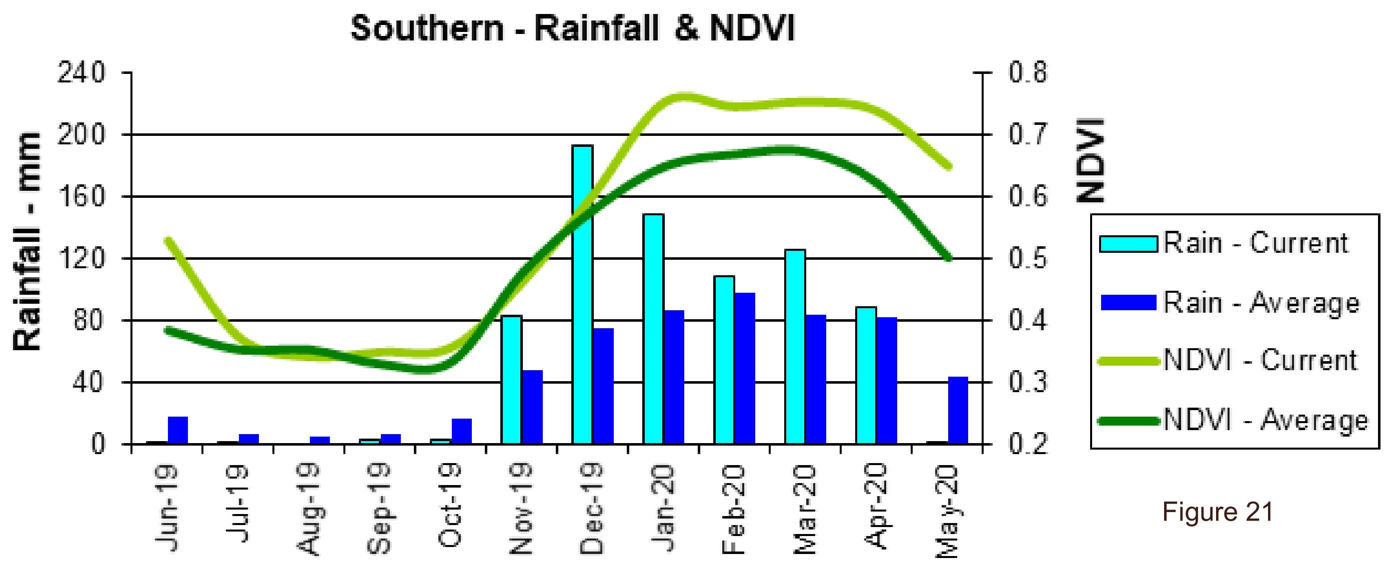

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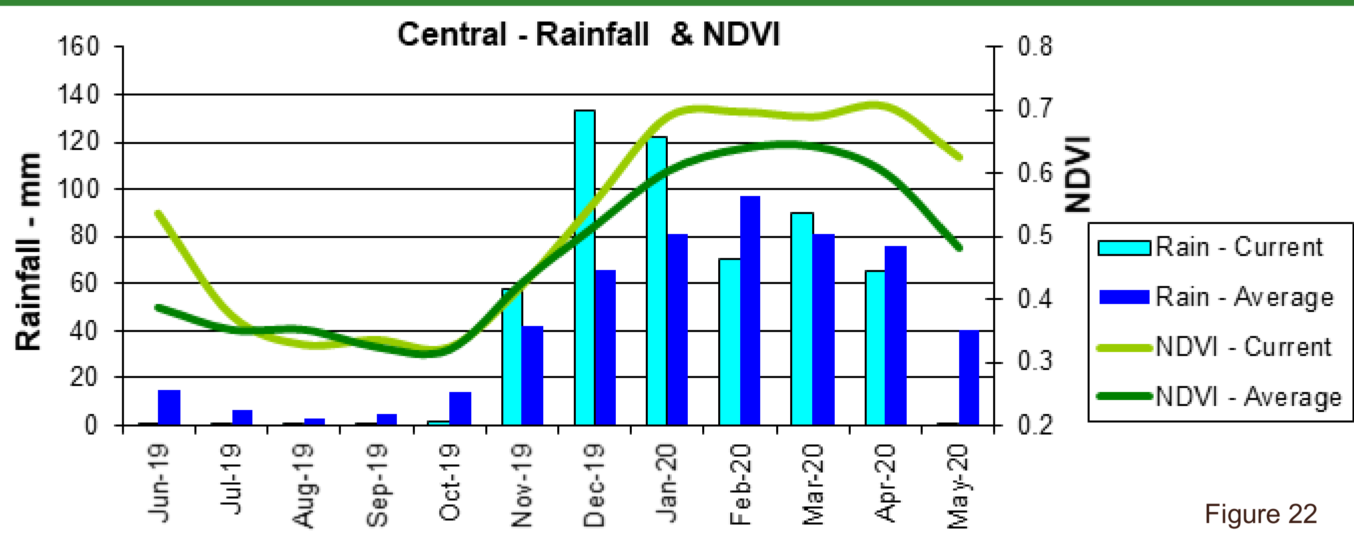


Figure 22

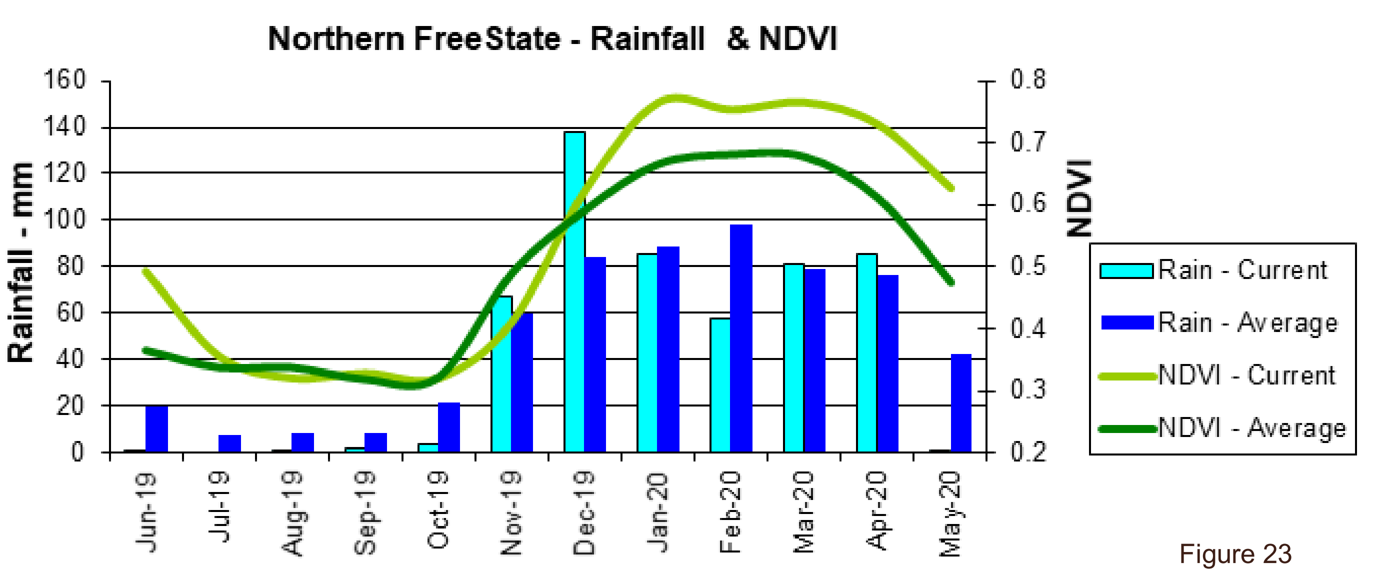
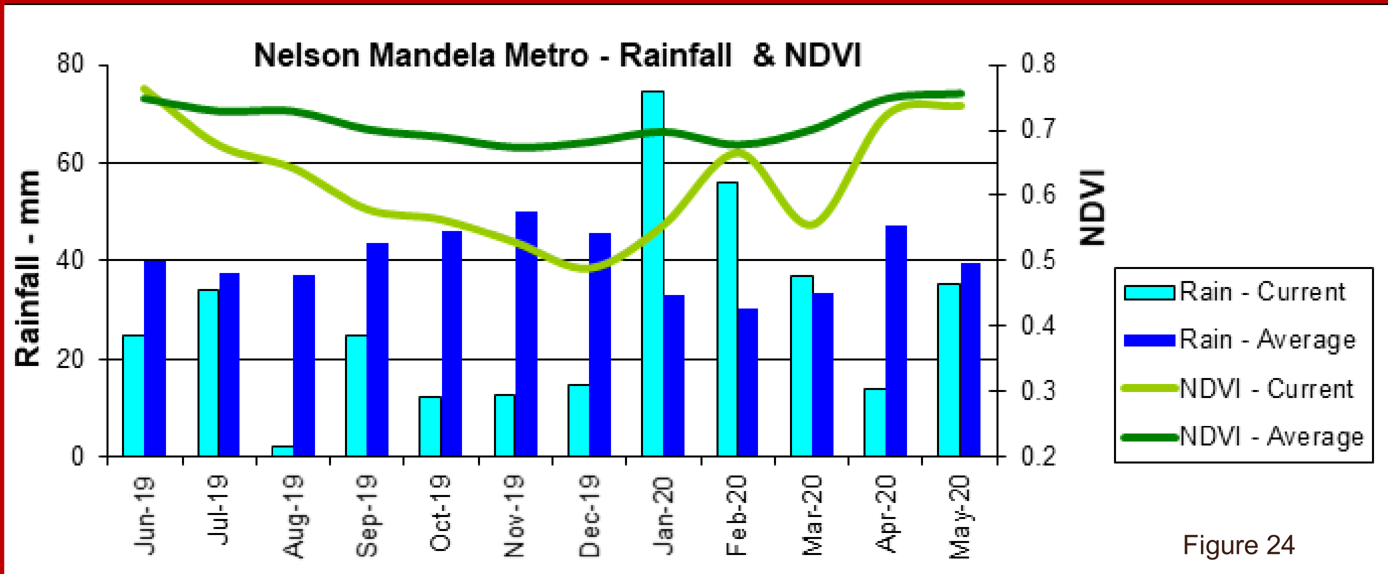


Figure 23



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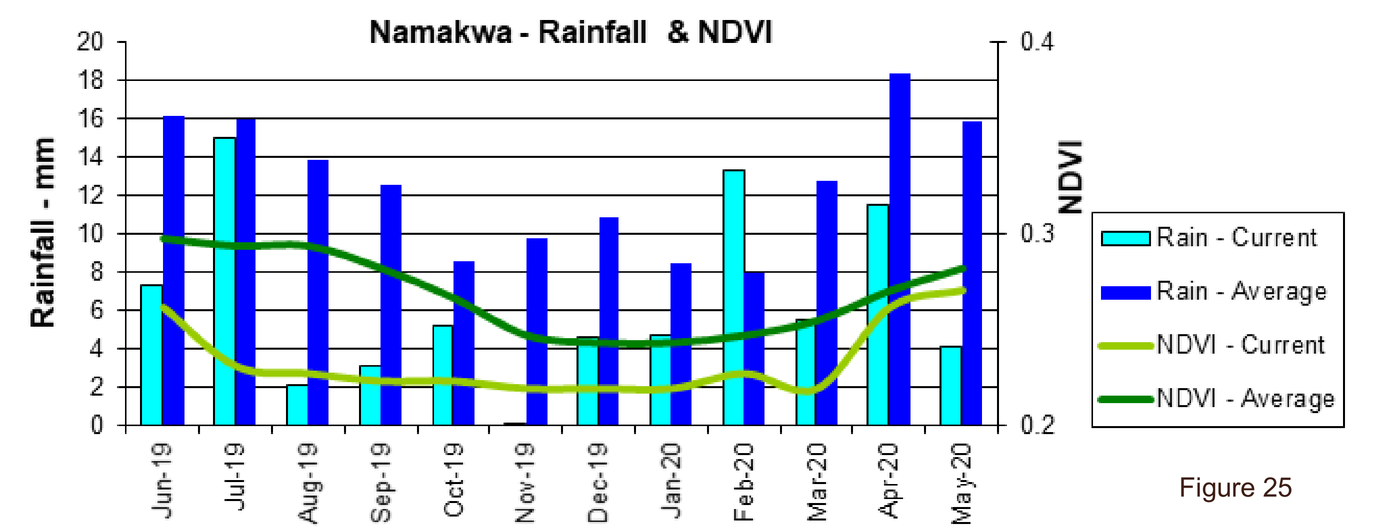

Figure 25

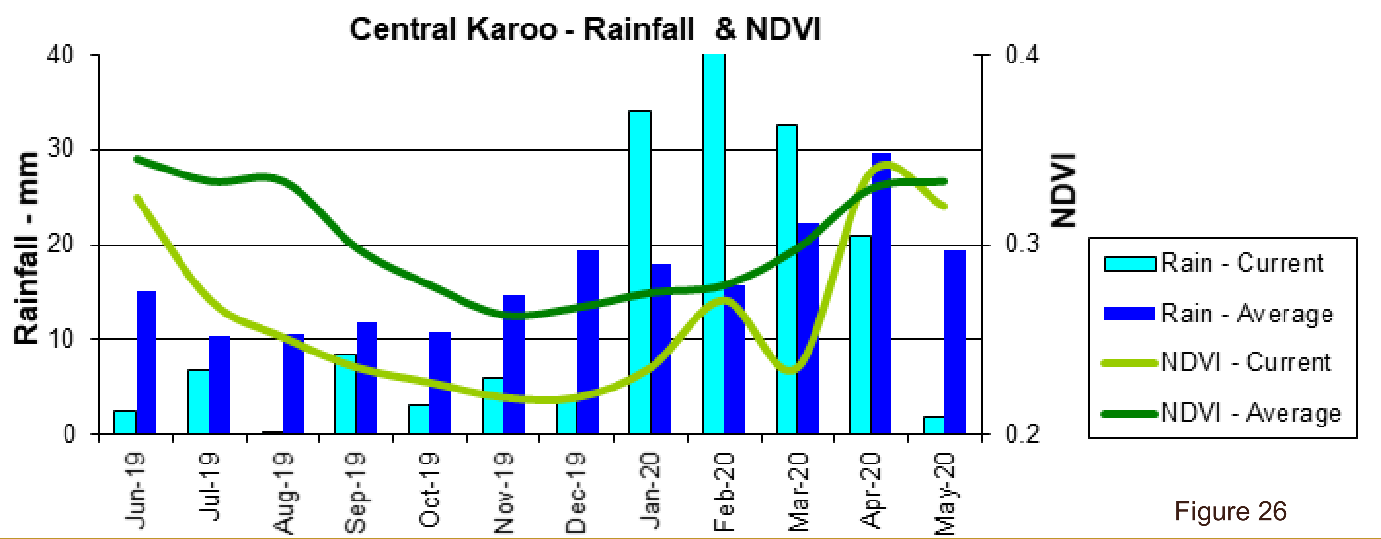

Figure 26

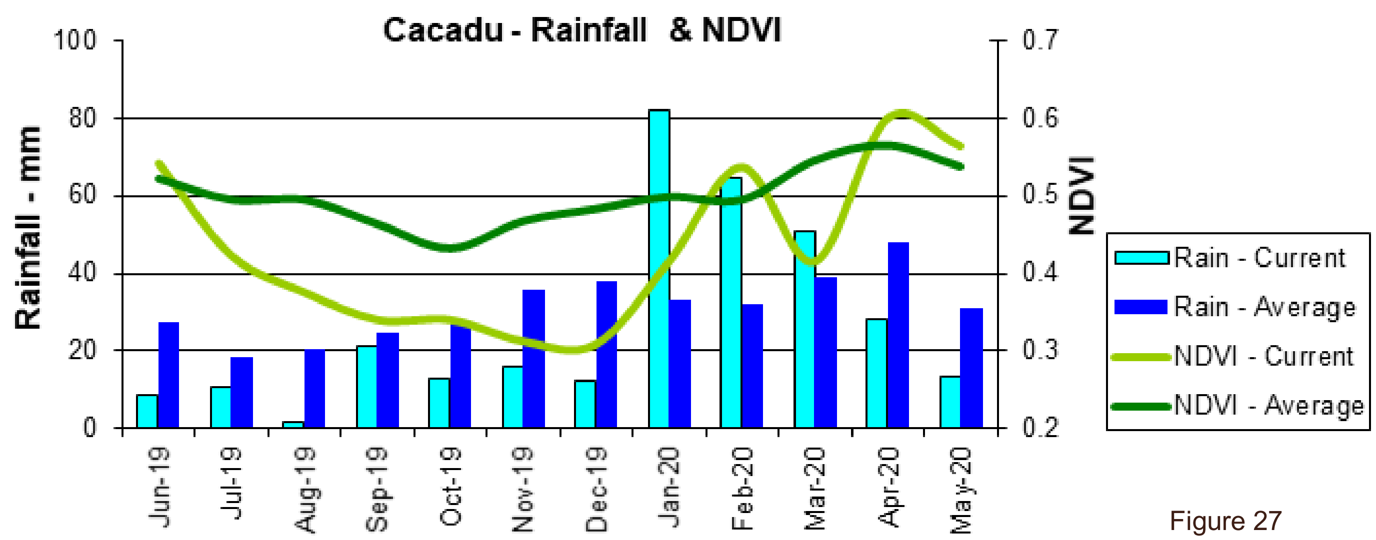

Figure 27

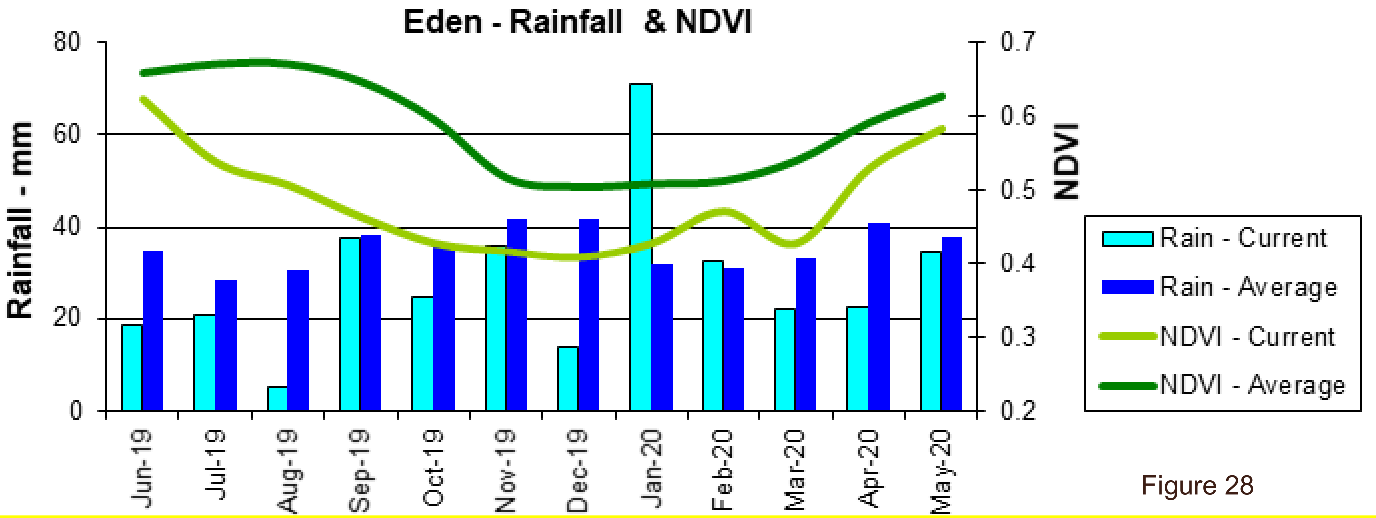

Figure 28

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 May 2020 per province. Fire activity was higher in the Western Cape compared to the long-term average.

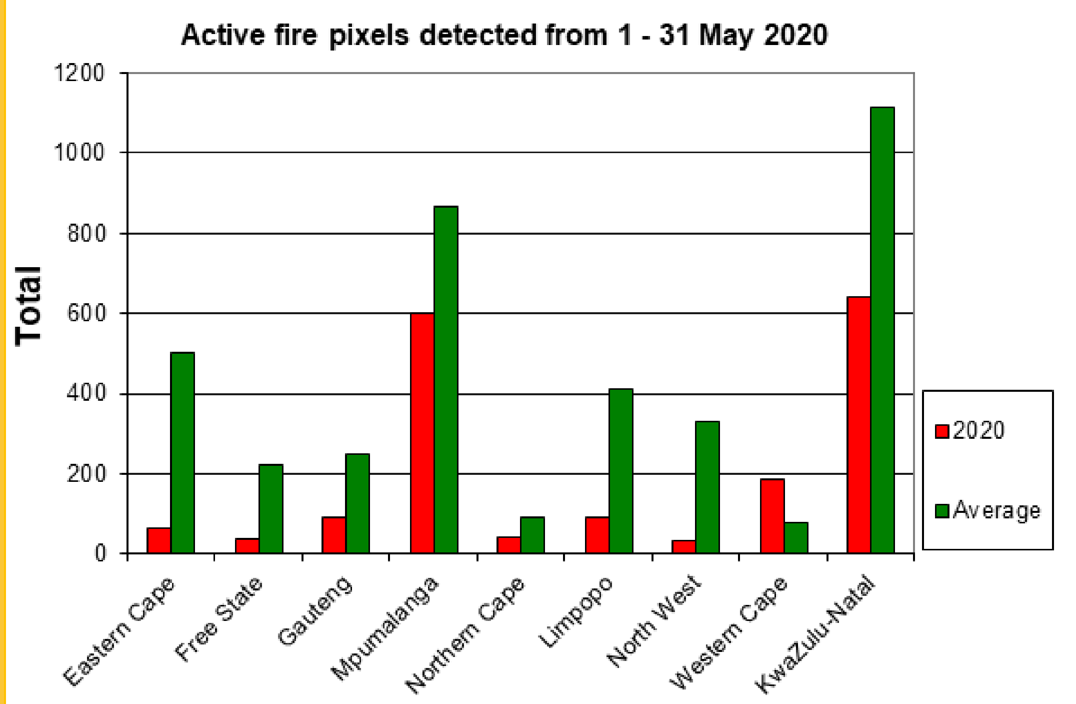

Figure 29

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

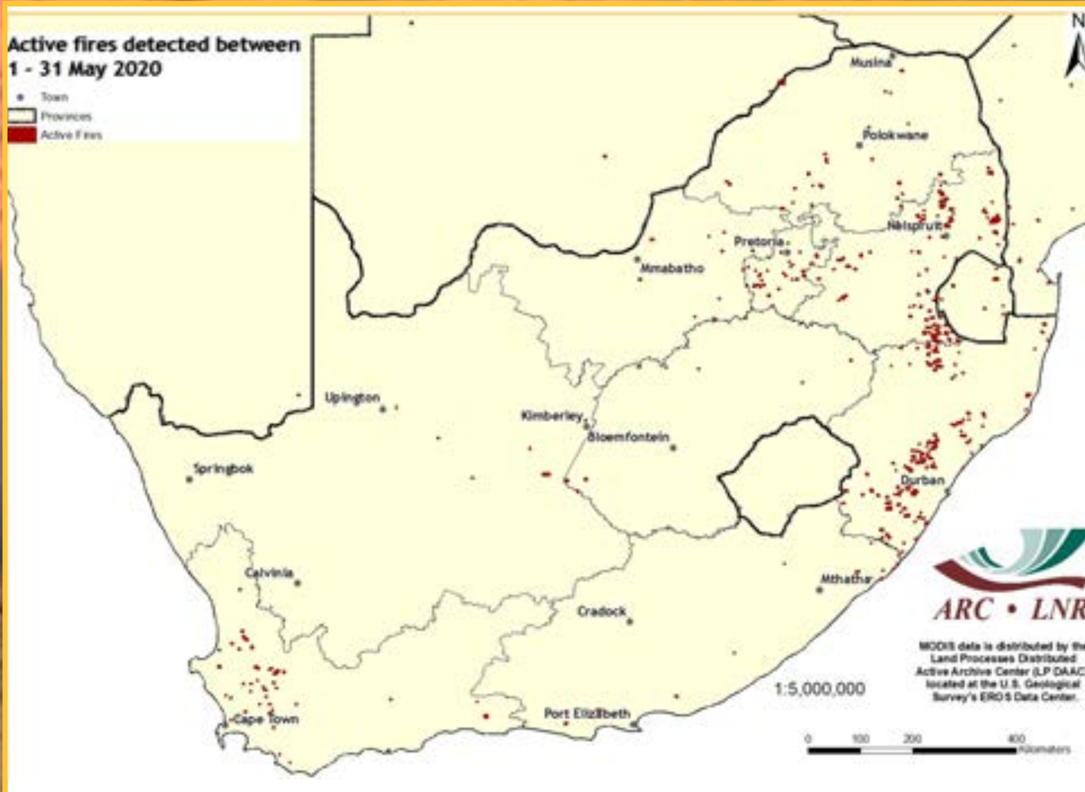

Figure 30

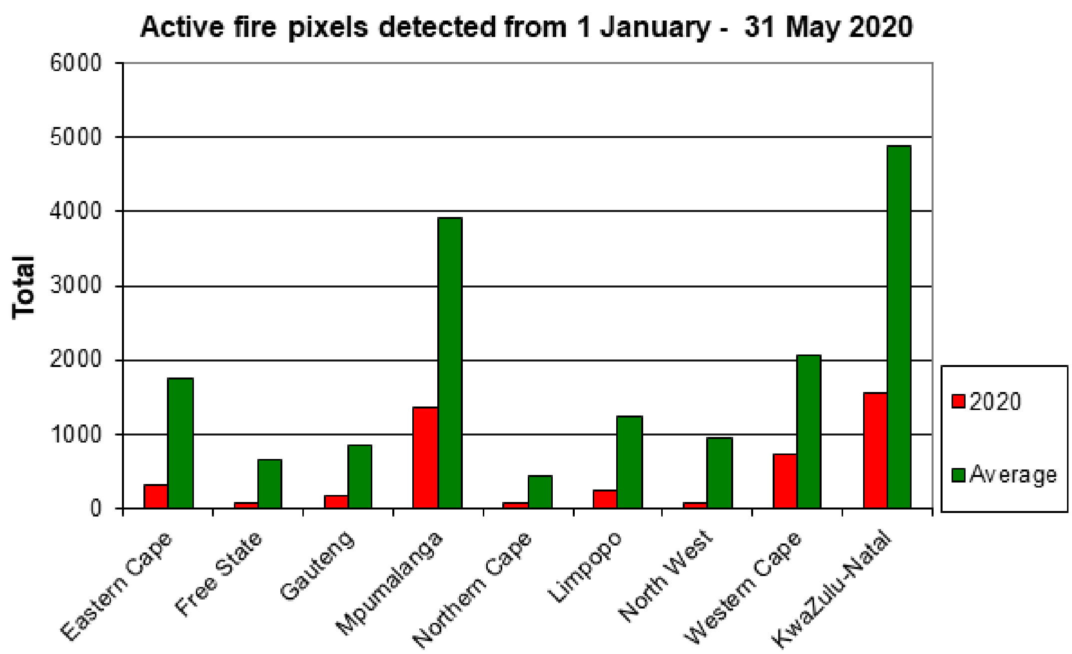

Figure 31

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

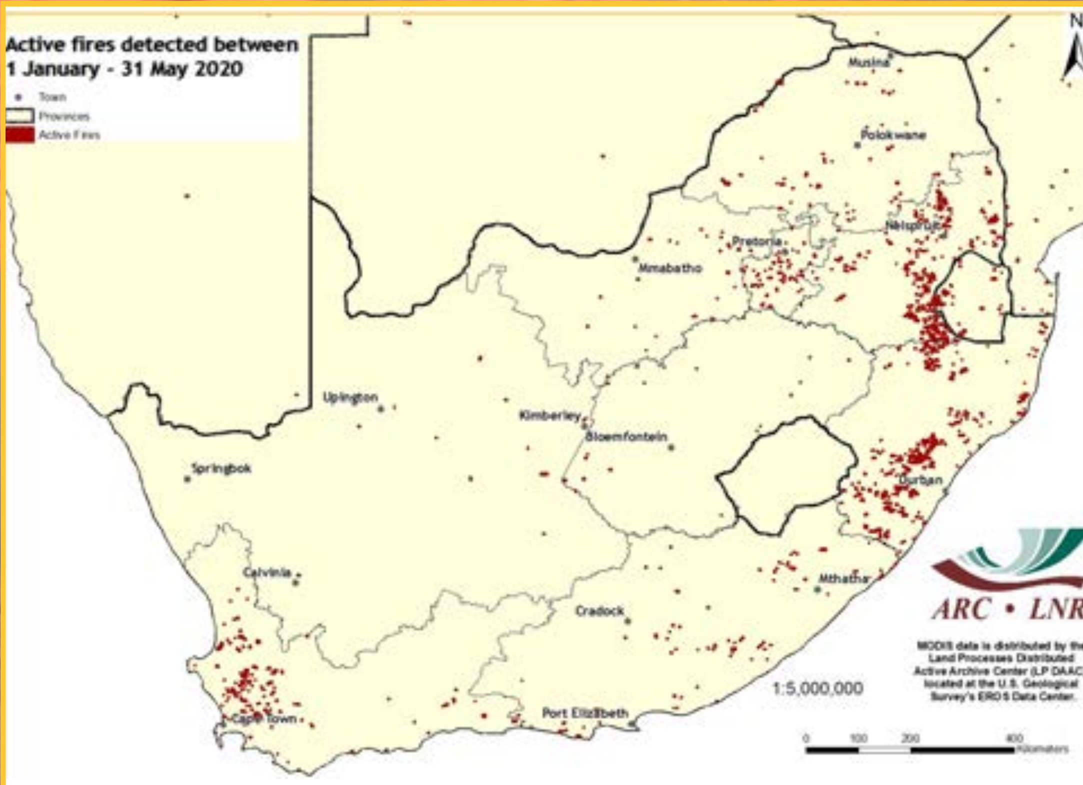

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January - 31 May 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 May 2020 shows a continuation of the March and April 2020 conditions, with the majority of catchments across the entire country 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 region of the Karoo, which continues to show significantly lower water levels.

The comparison between May 2020 and May 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 still found in a number of catchments across the country, especially in the Karoo. However, a few small catchments scattered across the Western and Eastern Cape as well as Limpopo are now showing significantly lower water levels compared to 2019.

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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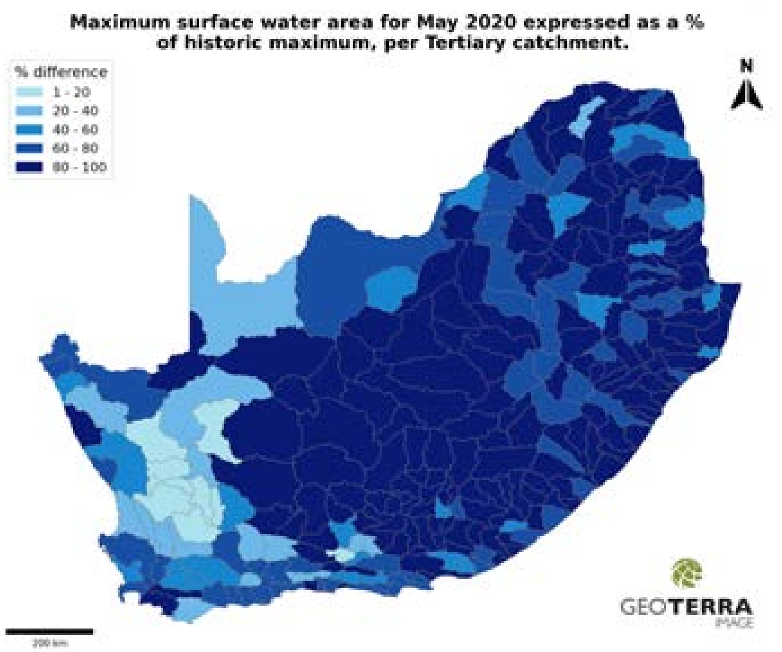


Figure 33

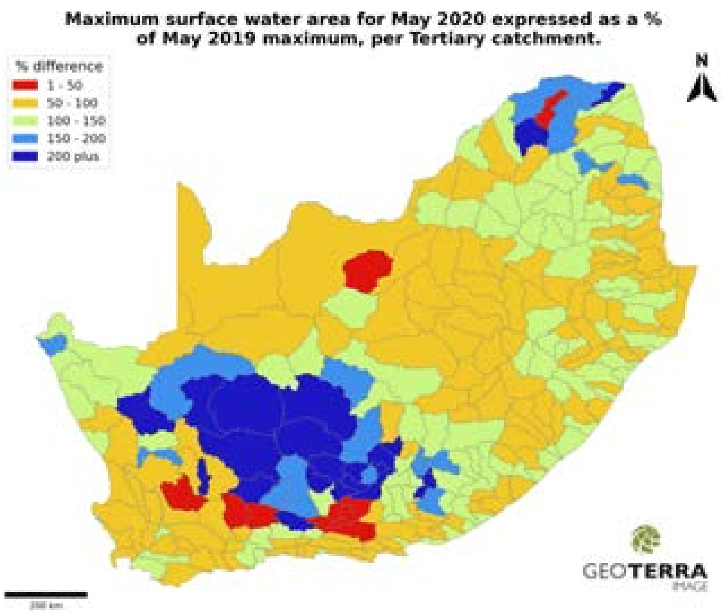
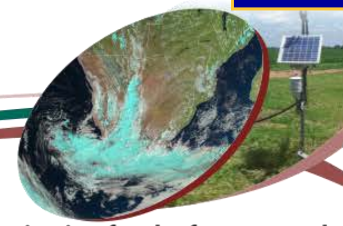


Figure 34

Agrometeorology



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”.