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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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

South African Weather Service

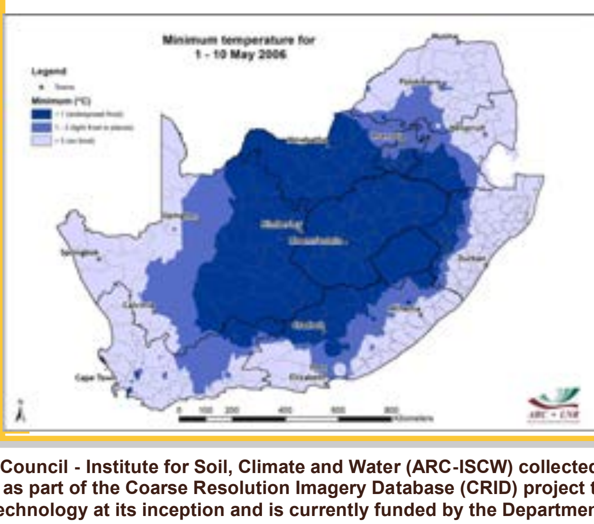
AMESD

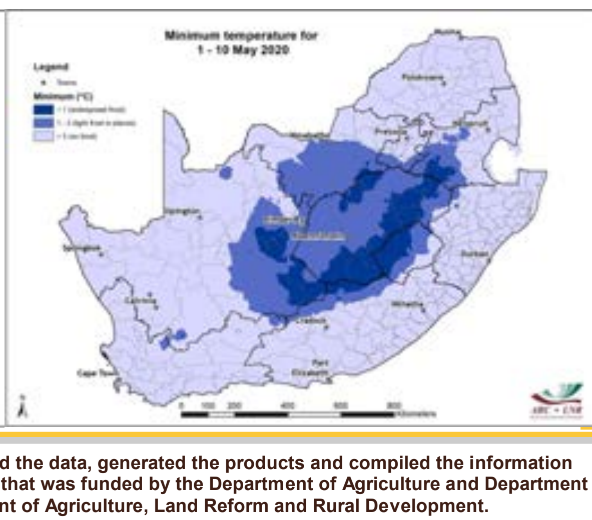
191st Edition

Images of the Month

Favourable weather conditions as the summer rainfall season nears its end

The first significant rains of the 2019/20 summer rainfall season occurred during November, thus allowing the planting of summer crops to commence and to some extent resulting in improved vegetation activity over most of the central to eastern and northeastern areas of the country. The latter is an indication of relatively favourable grazing development over most parts of the North West, Free State, Limpopo and KwaZulu-Natal provinces. However, below-normal rainfall conditions over parts of the Northern Cape, as well as the interiors of the Western Cape and Eastern Cape, resulted in below-normal cumulative vegetation activity. Therefore, in some areas grazing will be insufficient for normal densities of cattle (more towards the north) and sheep (more towards the south). Conversely, South Africa can expect a record maize production figure for 2019/20. Very favourable conditions supporting high yields included widespread above-normal rainfall since early November over most areas together with relatively warm conditions continuing into autumn, with a concomitant late onset of frost. The relatively late cold winter weather is demonstrated by contrasting the potential frost extent during the first 10 days of May this year with that of May 2006 (see minimum temperature maps below) when, despite above-normal rainfall, the late onset of rain coupled with early frost (and generally cooler conditions in late summer) resulted in very low maize production.





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 summer rainfall region received exceptionally high rainfall totals in April 2020. These high amounts compare well with the historically wetter rainfall totals for the month of April. An evident increase in total rainfall was notable over the eastern and the northeastern parts of the country – which were the only areas in the summer rainfall region that received below-normal rainfall in the previous month. However, the Capricorn district of Limpopo remained relatively dry, despite the abundance of rain over larger parts of the region.

The month started with cool temperatures and heavy rains over Gauteng and southern parts of Limpopo and the Mpumalanga Highveld. Towards mid-April, a cut-off low pressure system that developed on the 14th contributed to the low temperatures and heavy rainfall over the central and southeastern parts of the country. Snowfall was observed over the Drakensberg and Maluti mountains. Meanwhile, widespread thunderstorms with destructive winds occurred over parts of Gauteng, northeastern KZN and Free State, North West, Eastern Cape and Mpumalanga. These chilly and wet conditions continued throughout the month, with the eastern parts of the Northern Cape also receiving some rainfall by the 27th.

Considering the southwestern parts of the country, a cold front made landfall on the 12th which resulted in rainfall over much the West Coast, except for the Matzikama local municipality. In general, the winter rainfall region welcomed a weak start to its rainfall season, recording totals of up to 75 mm for April.

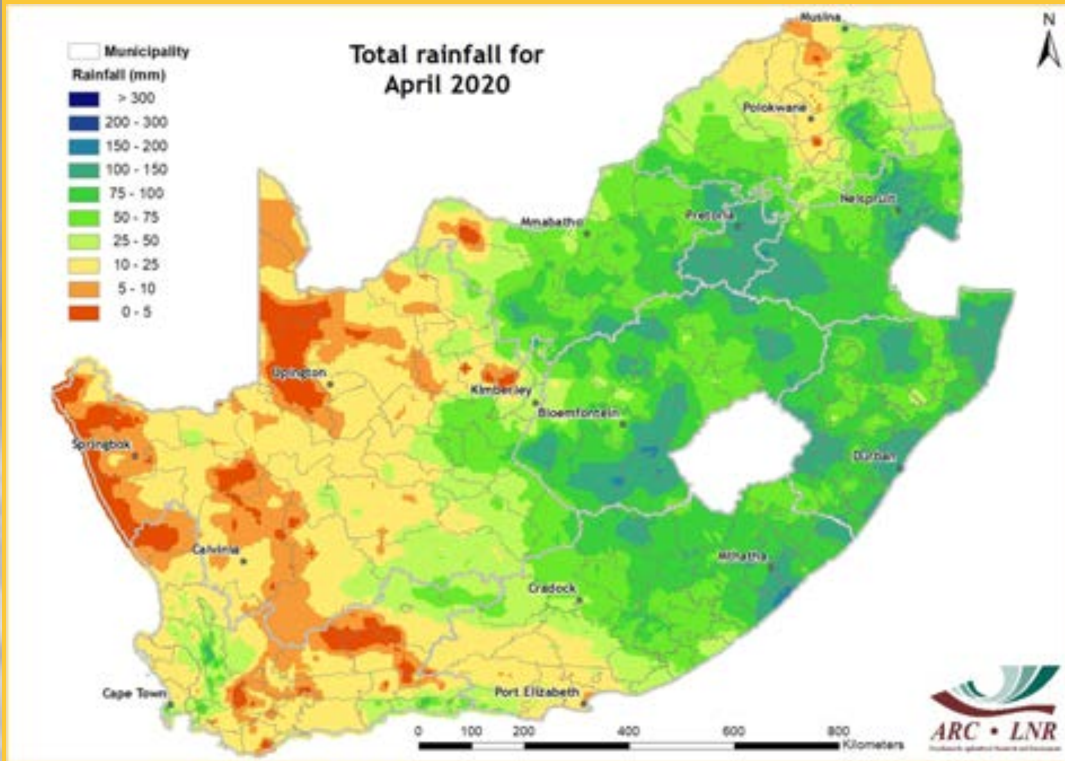


Figure 1

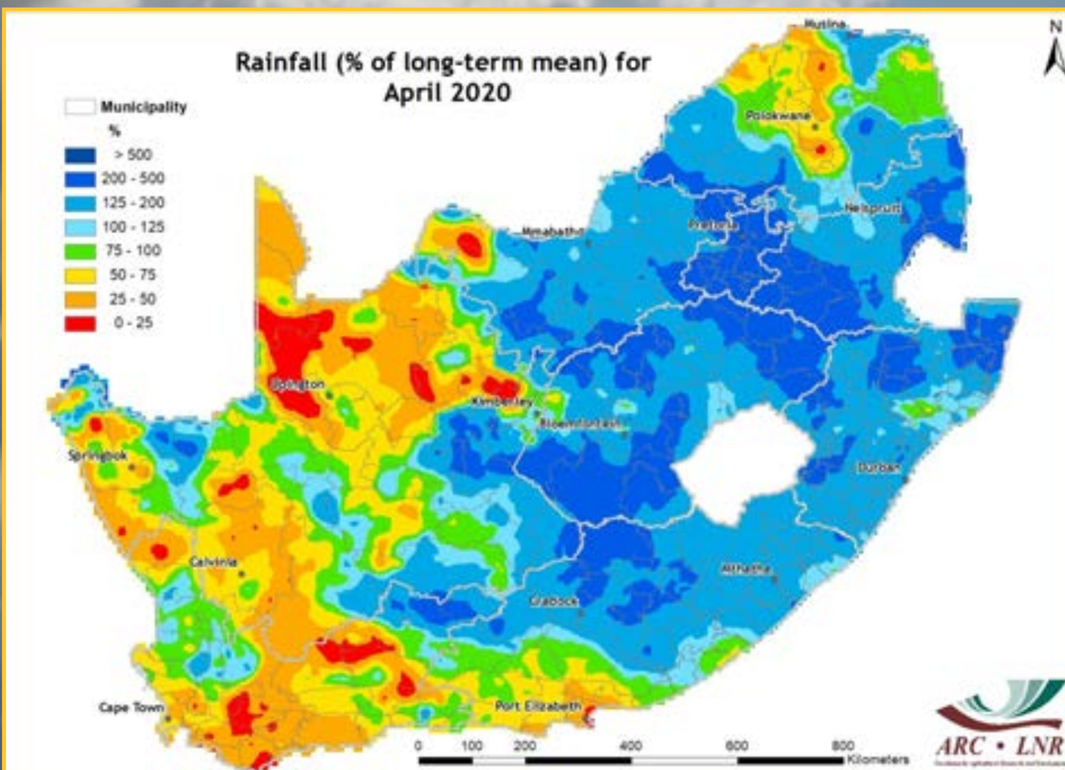


Figure 2

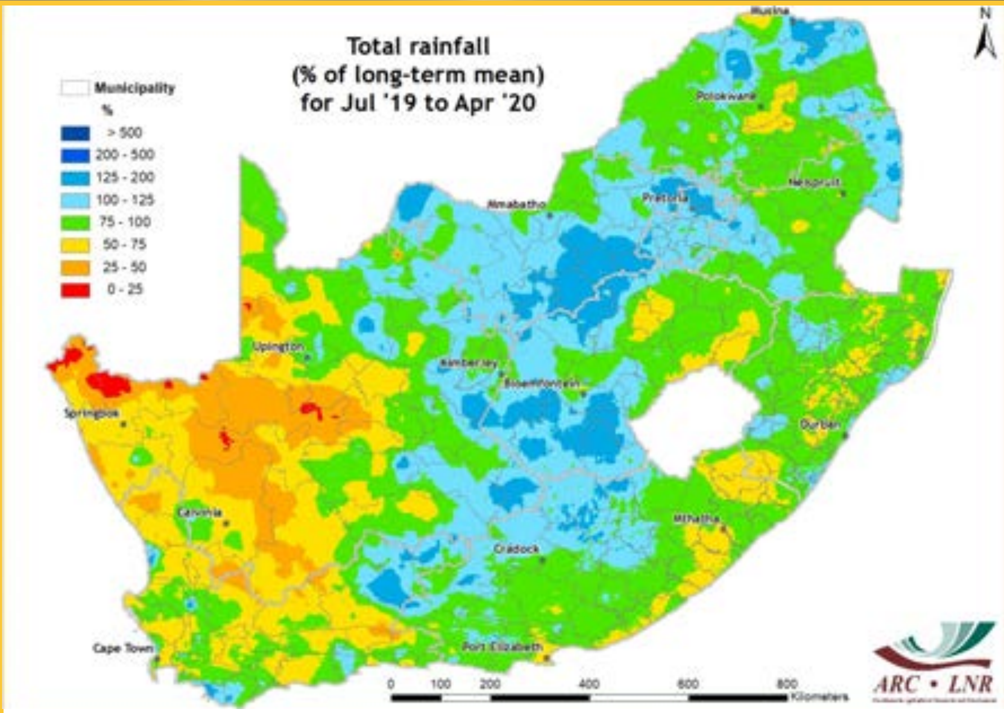


Figure 3

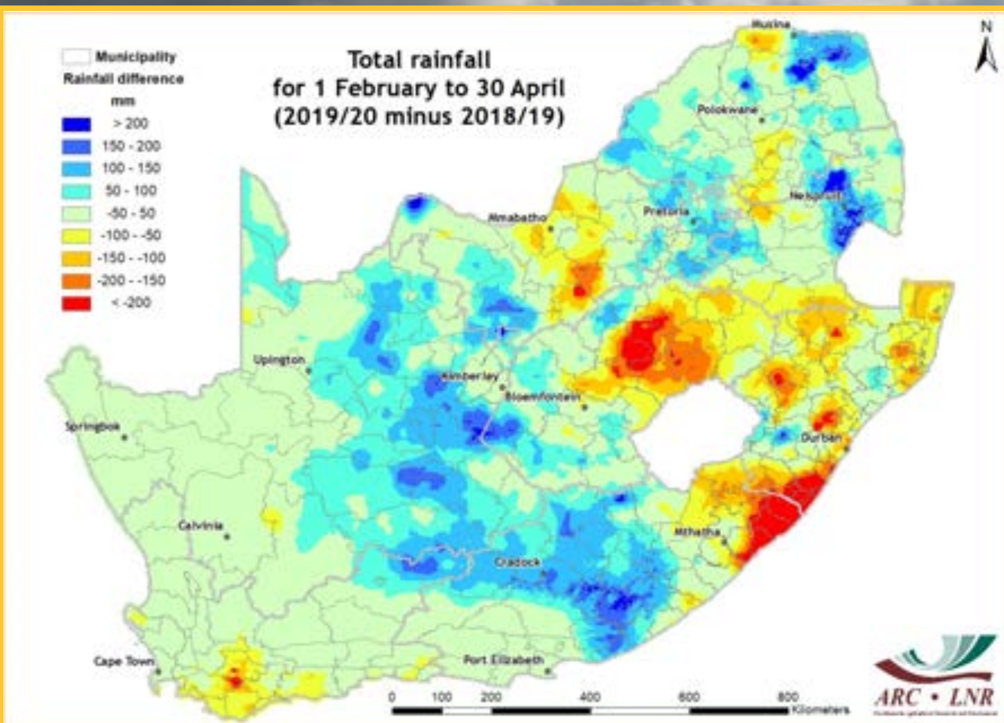


Figure 4

Figure 1:

April 2020 was characterized by widespread rainy days that resulted in good rainfall over the summer rainfall region, except for the central parts of Limpopo which recorded only 0-10 mm. Rainfall was largely absent over greater parts of the Northern Cape, Western Cape and southern parts of the Eastern Cape. A frontal system resulted in good rains over parts of the Wild Coast, with some areas recording totals of up to 75 mm.

Figure 2:

Above-normal rainfall was notable over much of the summer rainfall region. Below-normal rainfall conditions occurred over the western parts of the country, all-year rainfall region and the Capricorn district of Limpopo. The winter rainfall region was generally below-normal in April, with rainfall occurring over certain areas only.

Figure 3:

Rainfall totals for the period from July 2019 to April 2020 indicate that near-normal conditions occurred over much of the Eastern Cape, isolated parts of the Northern Cape and Western Cape, eastern Free State, KZN and further towards Mpumalanga and Limpopo. Meanwhile, 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 this 10-month period were larger parts of the Northern Cape, Western Cape and isolated parts of the eastern provinces, including the eastern Free State.

Figure 4:

Comparing rainfall during February to April 2019/20 with that of 2018/19, areas that received more rain are eastern parts of the Northern Cape, central parts of the Eastern Cape and isolated areas of Gauteng, Mpumalanga and Limpopo. Areas that recorded a difference of between -50 and -200 mm for the 3-month period include the eastern Free State, isolated parts of North West, Limpopo, Western Cape and the border of the Eastern Cape, Wild Coast and KZN. 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. The SPI ending in April 2020 shows signs of drought relief on the 6-month map for the Northern Cape, Eastern Cape, parts of Limpopo, Mpumalanga and eastern Free State. For the same time scale, mildly wet conditions were notable over much of the summer rainfall region, while moderate-severely wet conditions occurred over much of the central interior. Over the Cape Town region, the SPI indicates an occurrence of moderate to extreme drought. The 12-month map shows prevailing severe-extreme drought over the western parts of the Northern Cape, as well as isolated areas in Western Cape, and the border of Eastern Cape and KwaZulu-Natal. The long-term SPI maps depict widespread mild drought, with areas such as the southern region of North West, southwestern Free State and isolated parts of Limpopo and KZN showing moderate-severely wet conditions.

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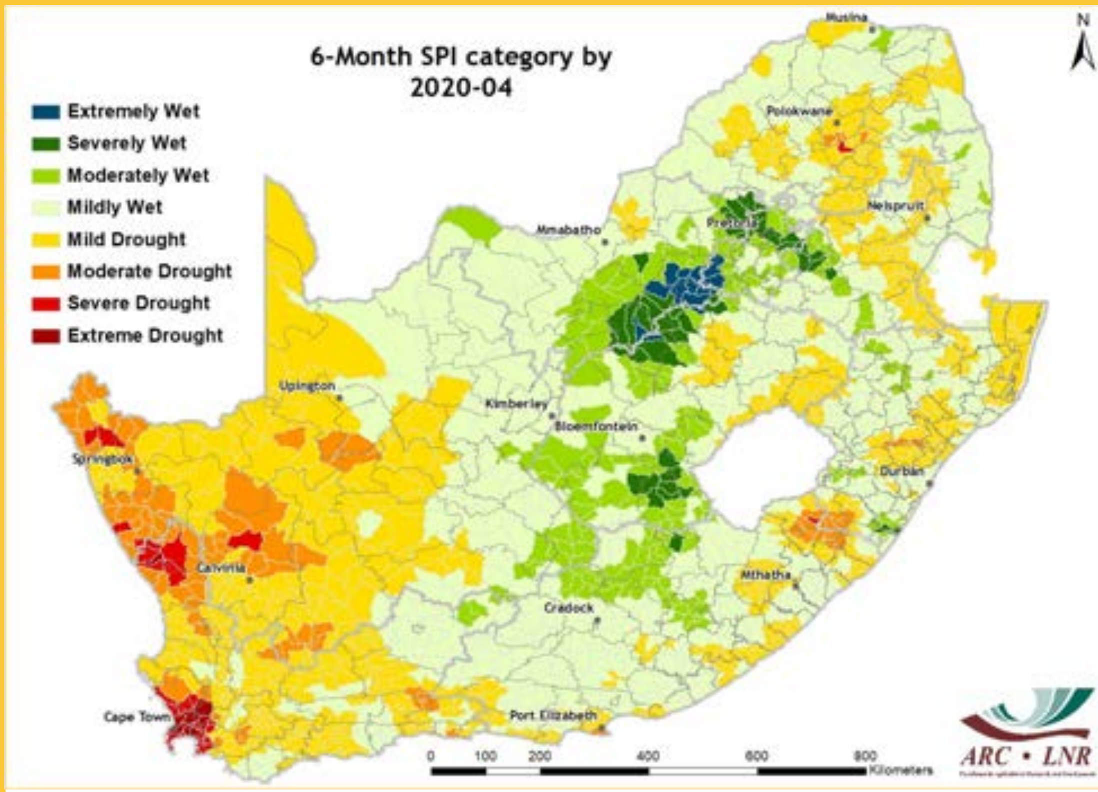

Figure 5

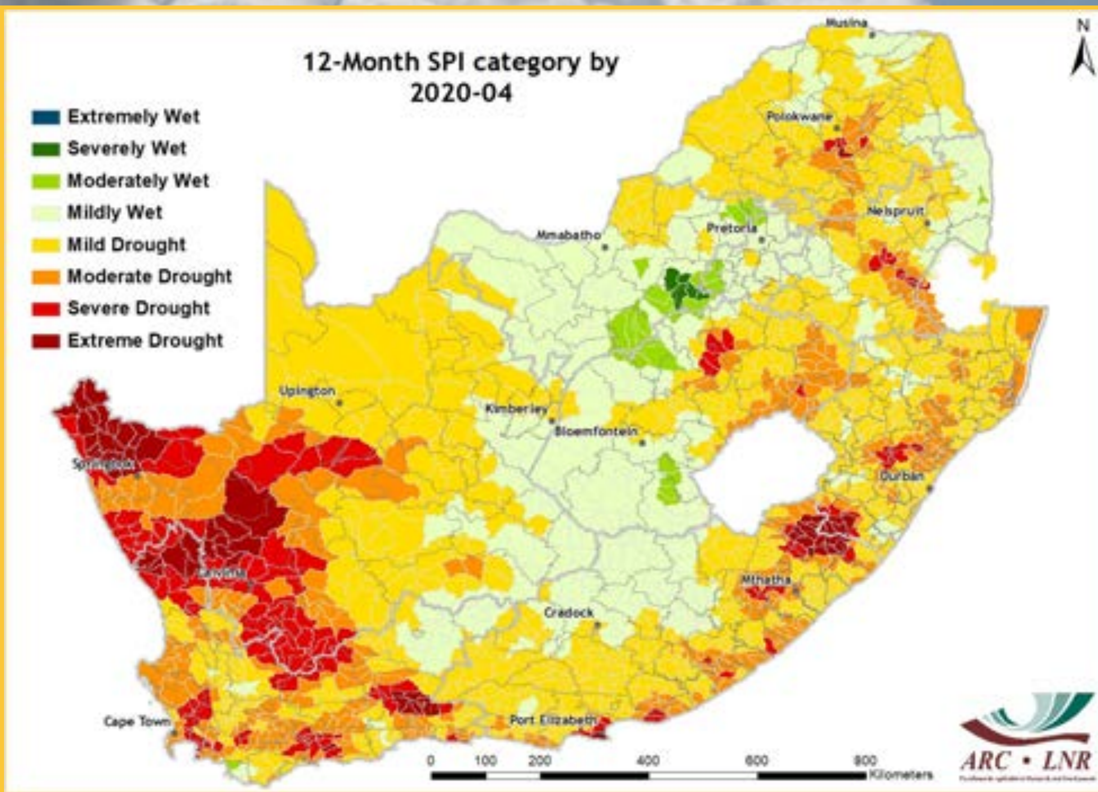

Figure 6

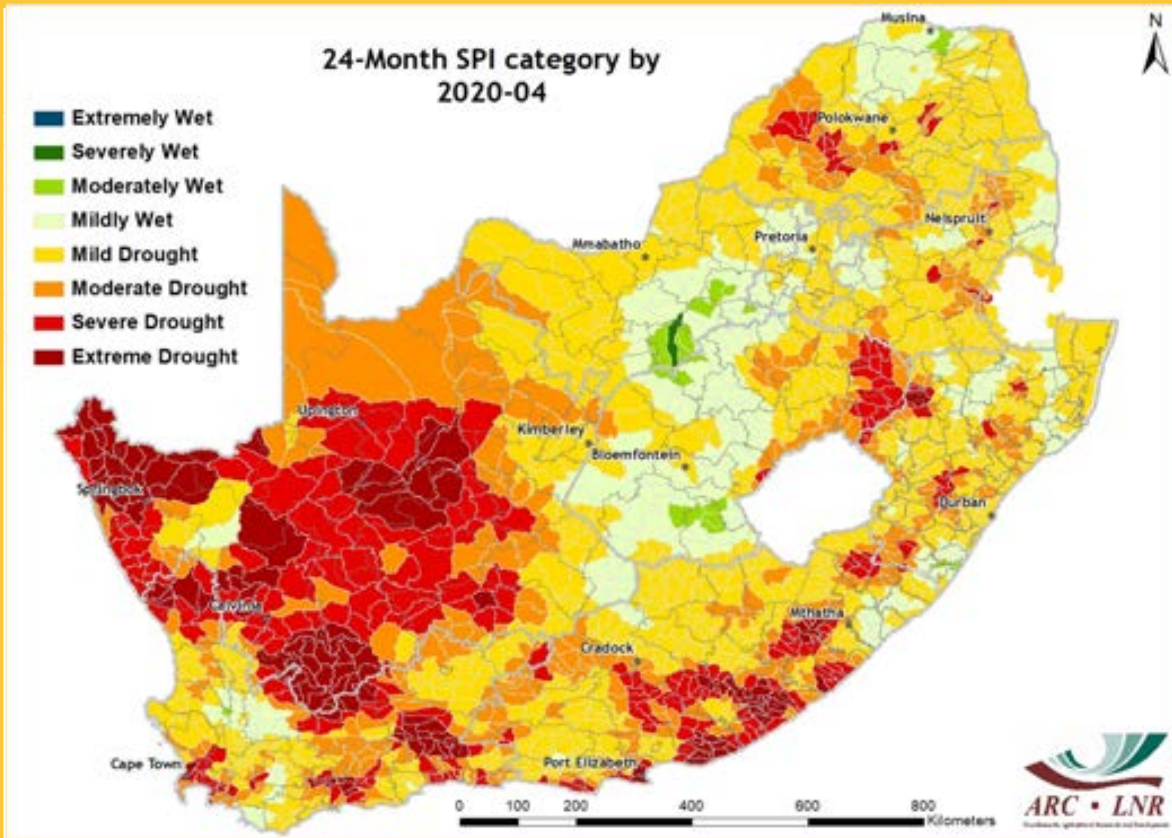

Figure 7

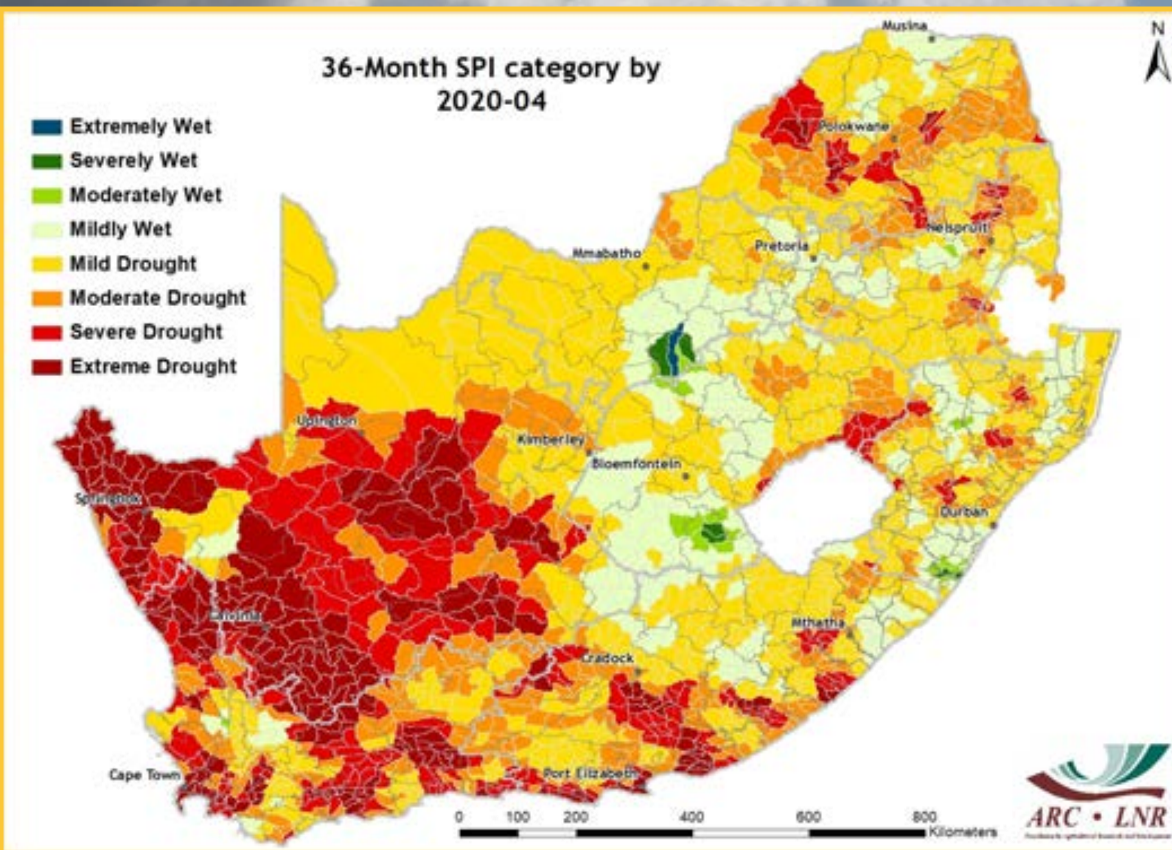

Figure 8

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.

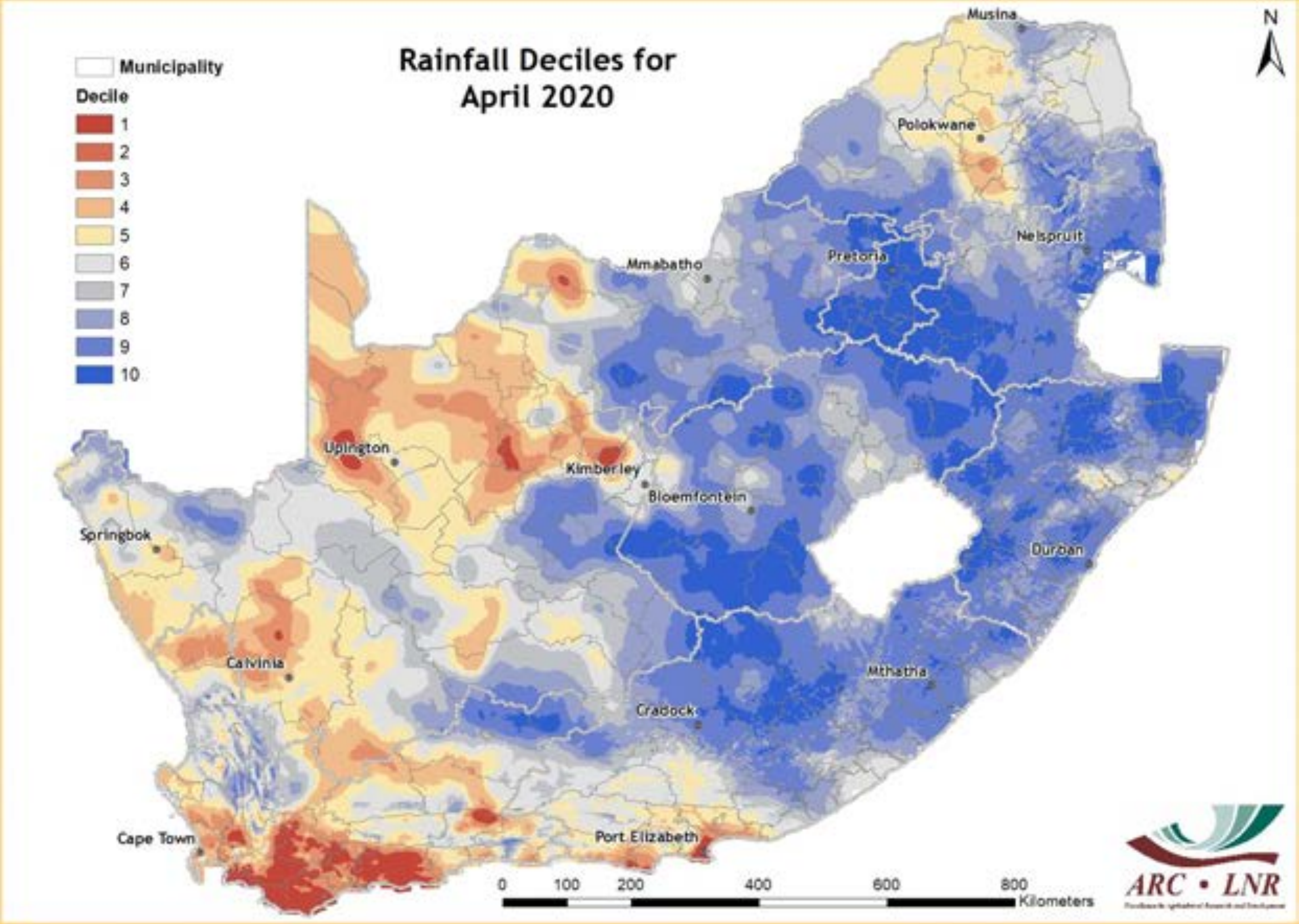

Figure 9

Figure 9:
Greater parts of the summer rainfall region, as well as some areas of the winter rainfall region (the West Coast in particular), experienced rainfall totals that compare well with the historically wetter April rainfall totals. Meanwhile, the all-year rainfall region, parts of the Western Cape, Northern Cape and the central region of Limpopo experienced rainfall totals that compare well with the historically drier rainfall totals for April.

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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.

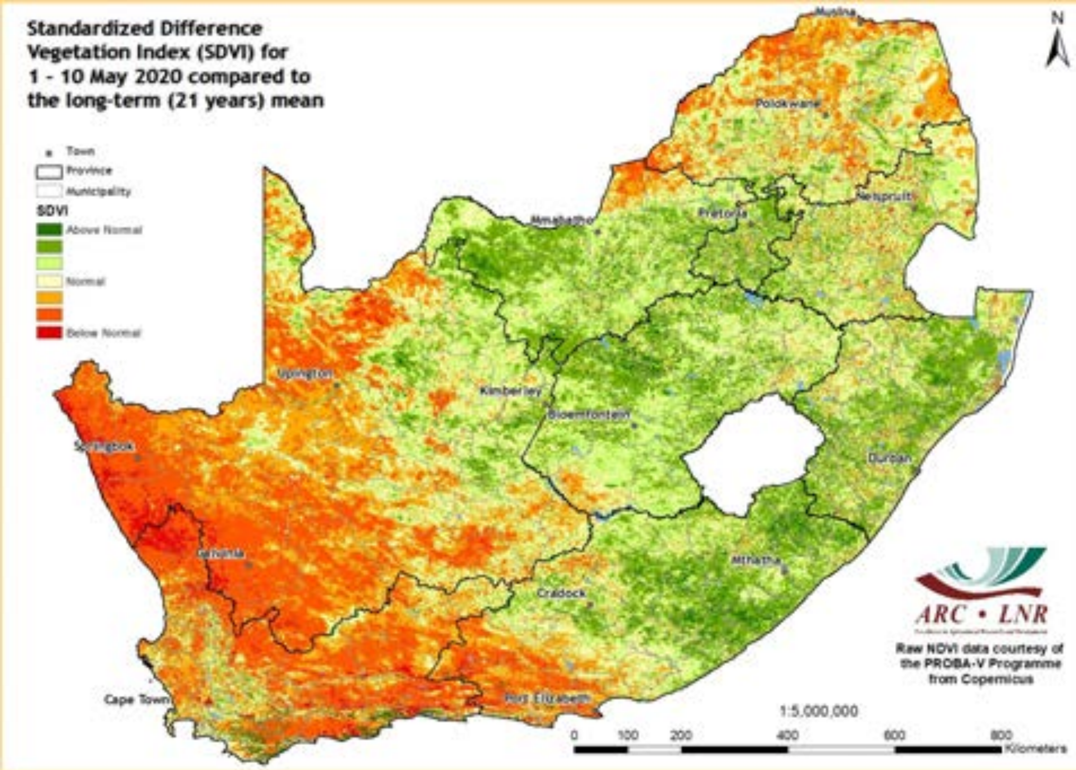

Figure 10

Figure 10:
Compared to the long-term average, the SDVI map for the first 10 days of 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:
The NDVI difference map for the first 10 days of May shows that vegetation activity was much lower over the central interior and the northern parts of the country compared to the same period last year. Pockets of above-normal vegetation conditions occurred in isolated areas across the country.

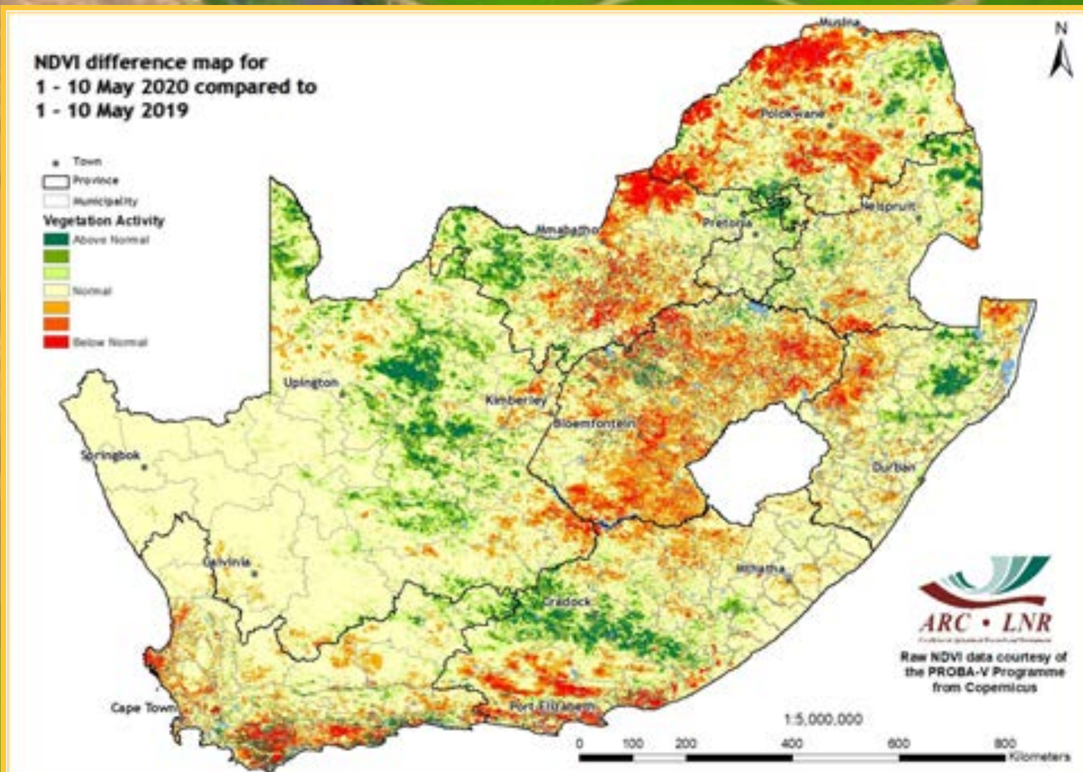

Figure 11

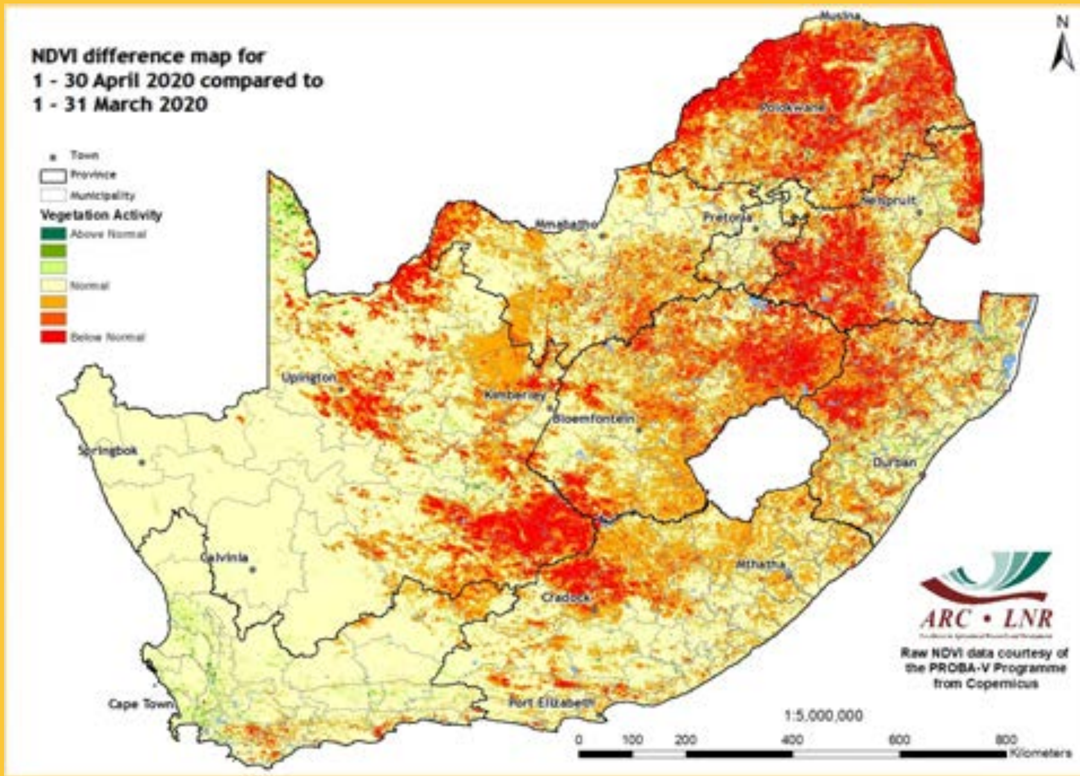

Figure 12

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

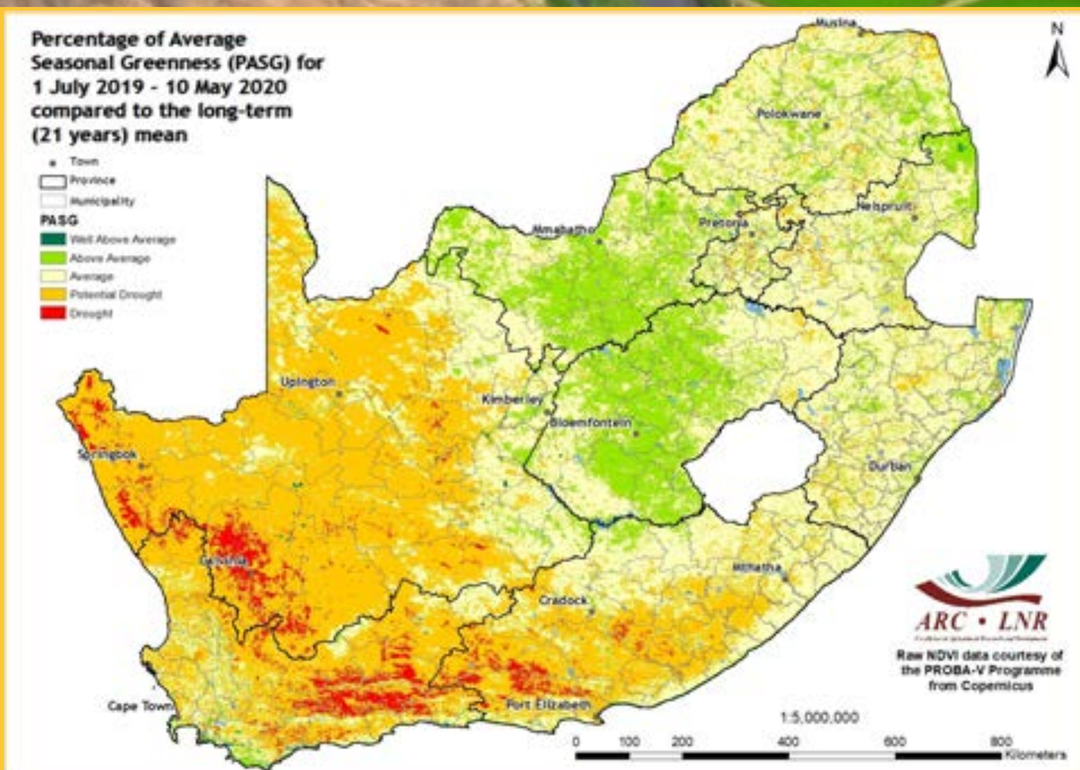

Figure 13

Figure 12:
The NDVI map for April shows that the western half of the country generally experienced normal vegetation activity compared to the previous month. Nevertheless, poor vegetation conditions were evident in the central and northern parts.

Figure 13:
The cumulative seasonal greenness in vegetation concurs with the cumulative rainfall anomalies during the period of 1 July to 10 May, showing above-normal vegetation activity over much of the central interior and 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.

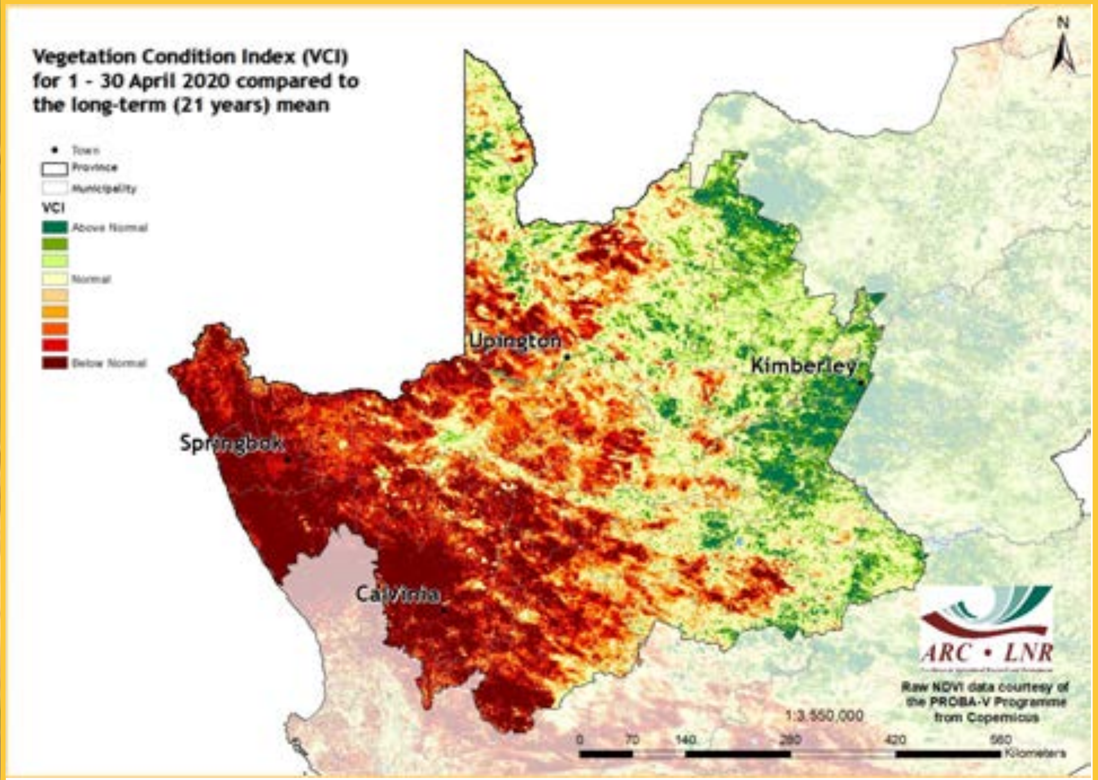

Figure 14

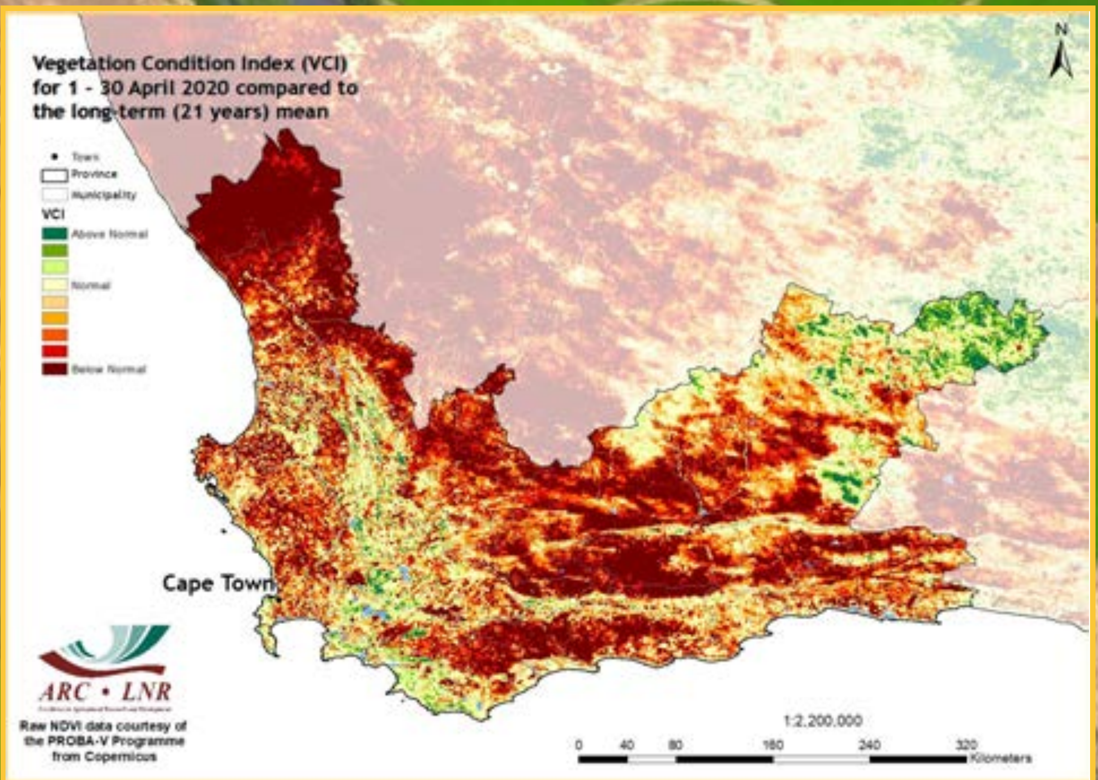

Figure 15

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

Figure 15:
The VCI map for April 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 good vegetation conditions.

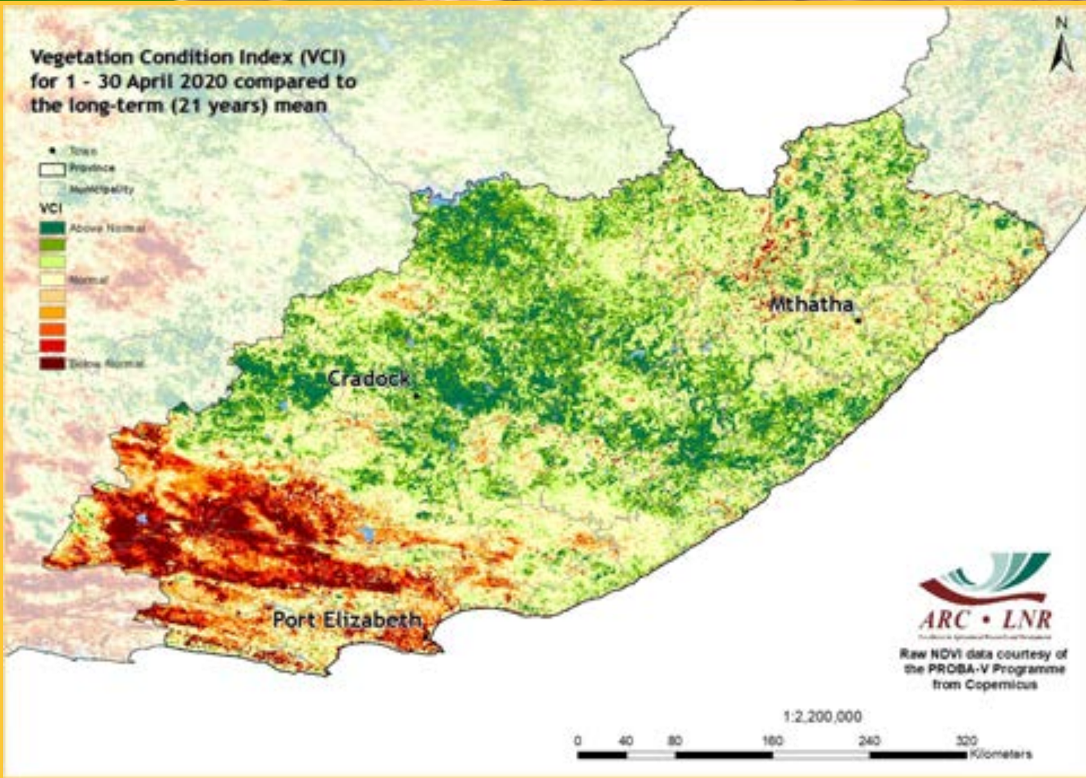

Figure 16

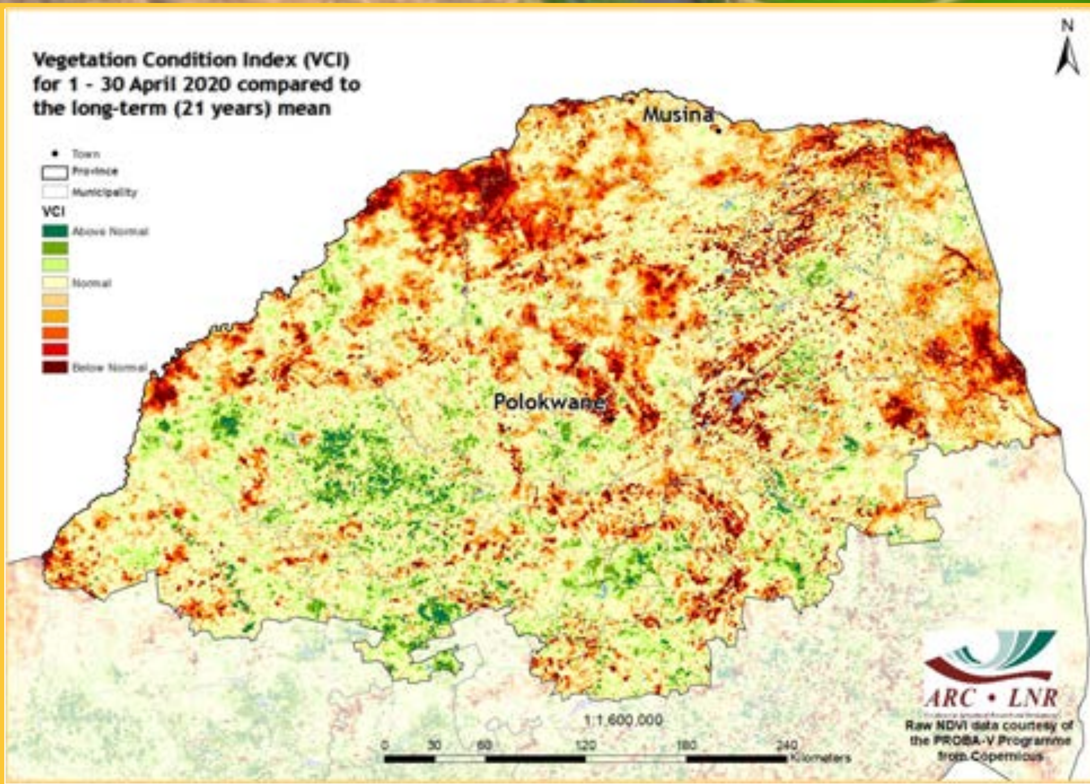

Figure 17

Figure 16:
The VCI map for April 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 April indicates that poor vegetation activity occurred across a wider geographical area of the Limpopo Province.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

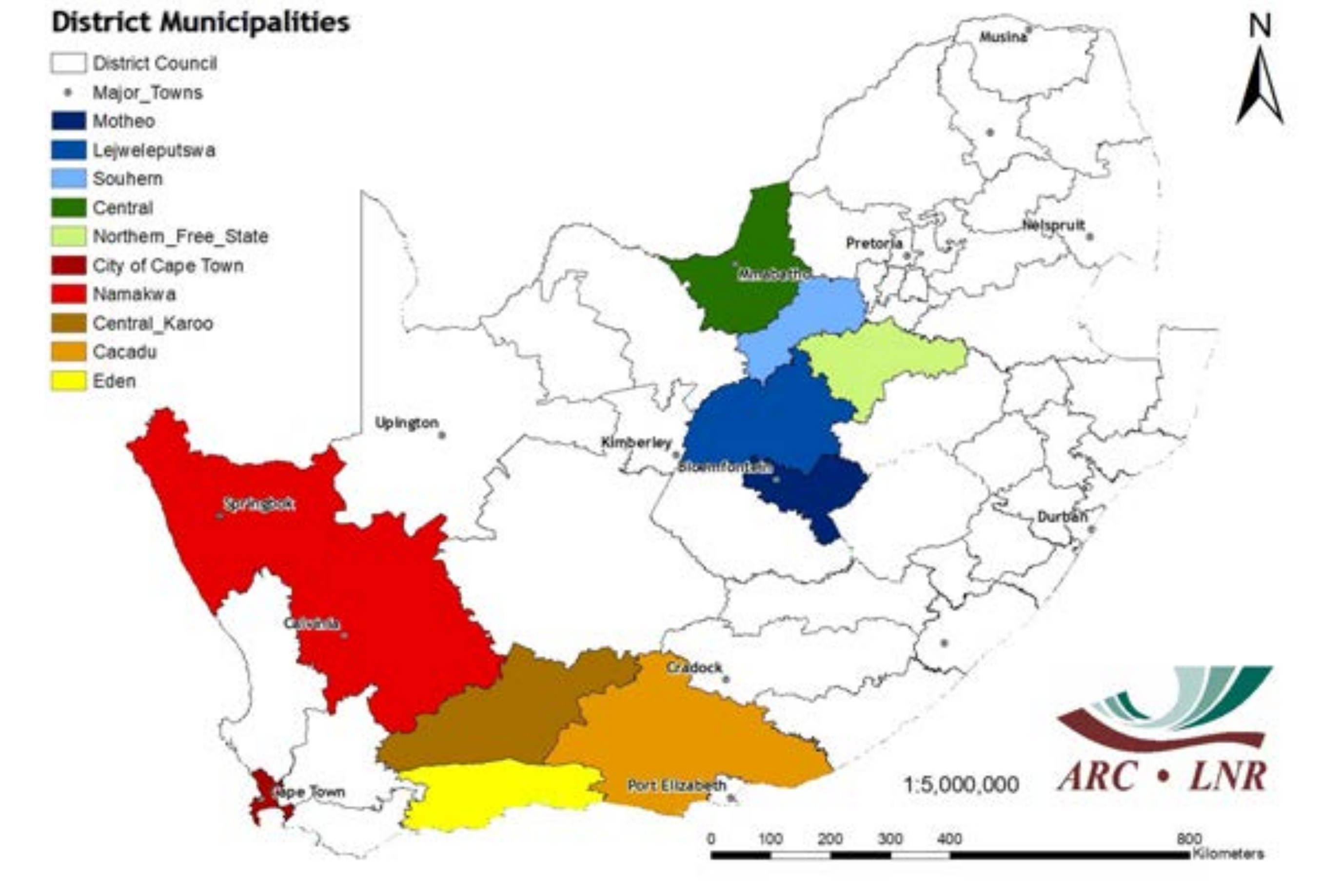

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for April 2020. The district colour matches the border of the corresponding graph.

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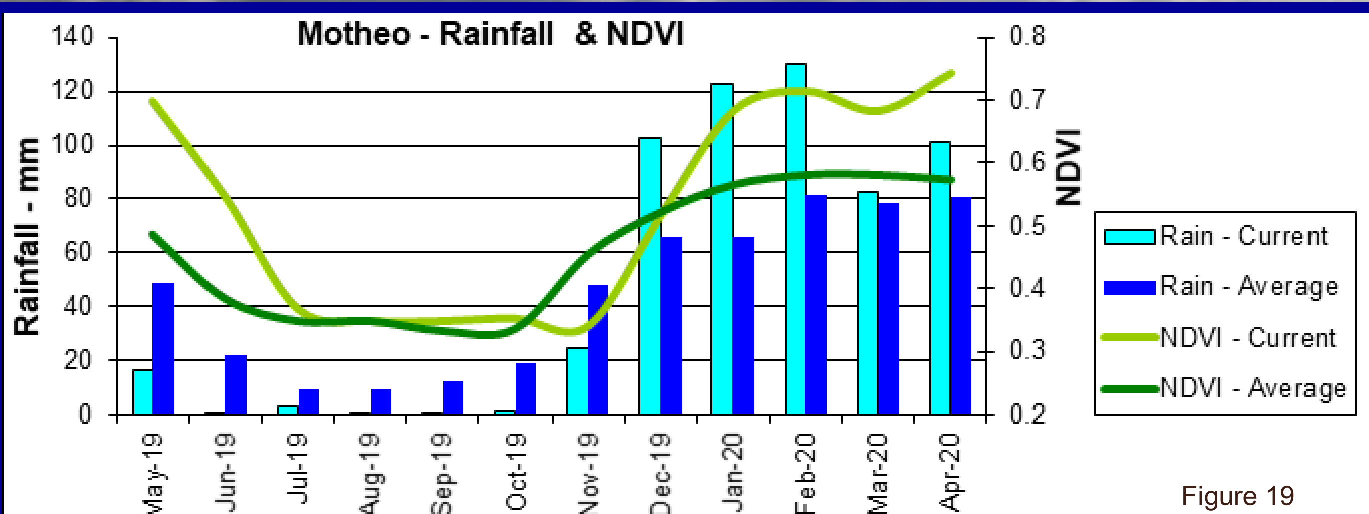
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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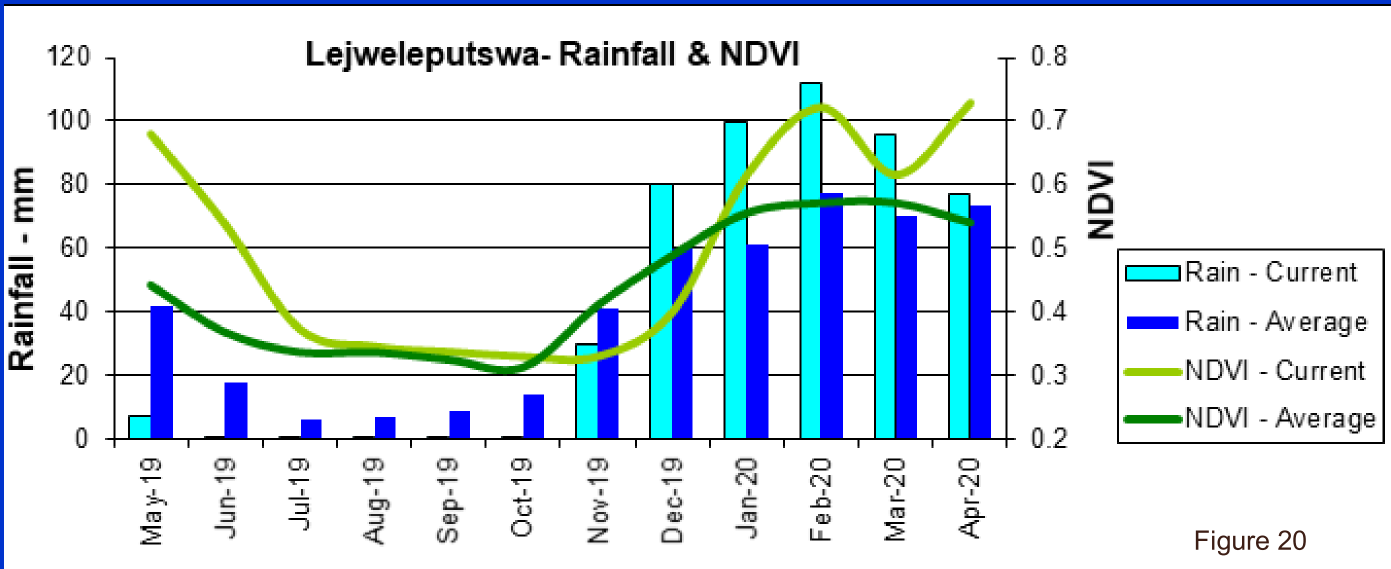

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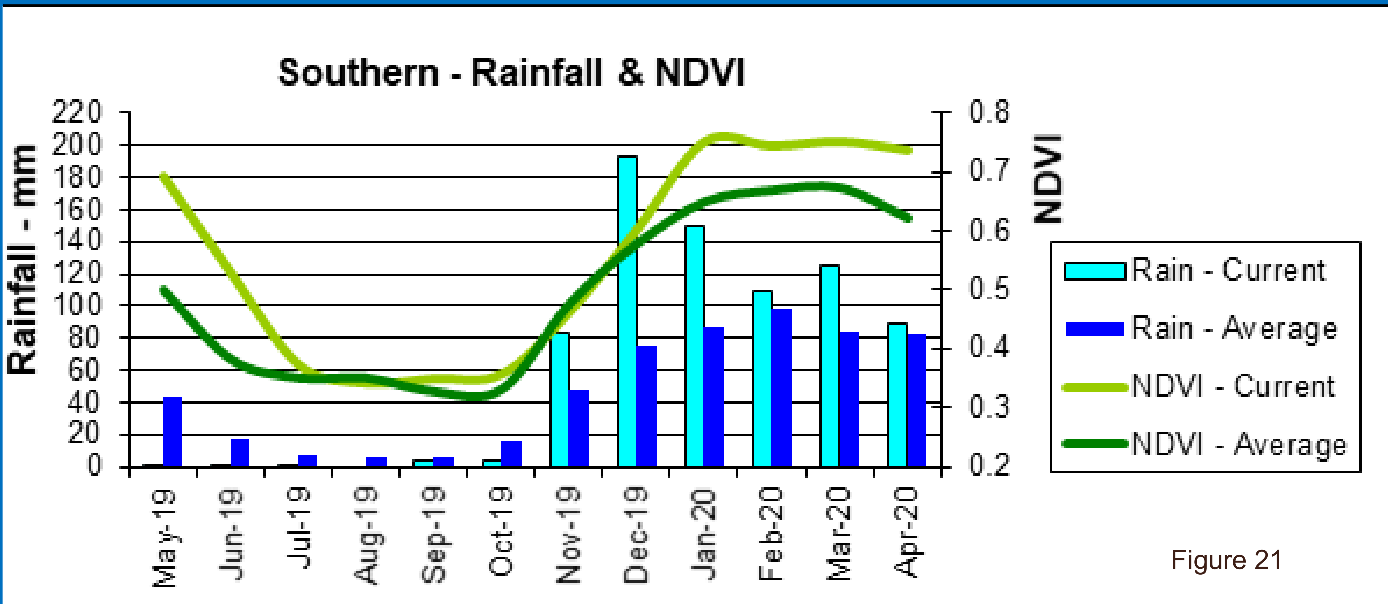

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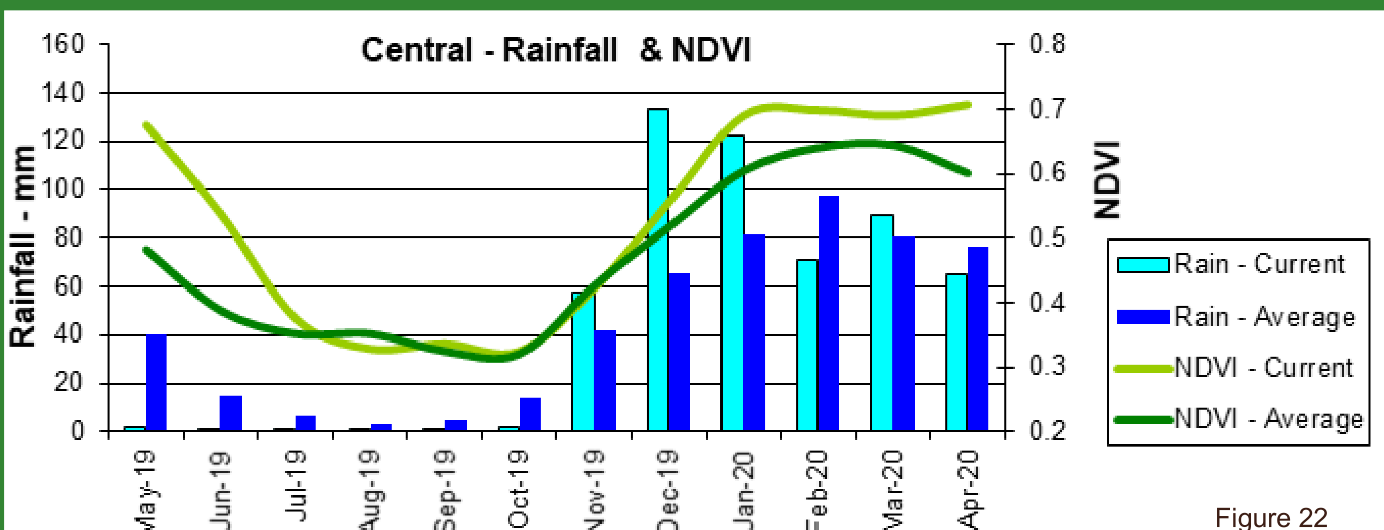

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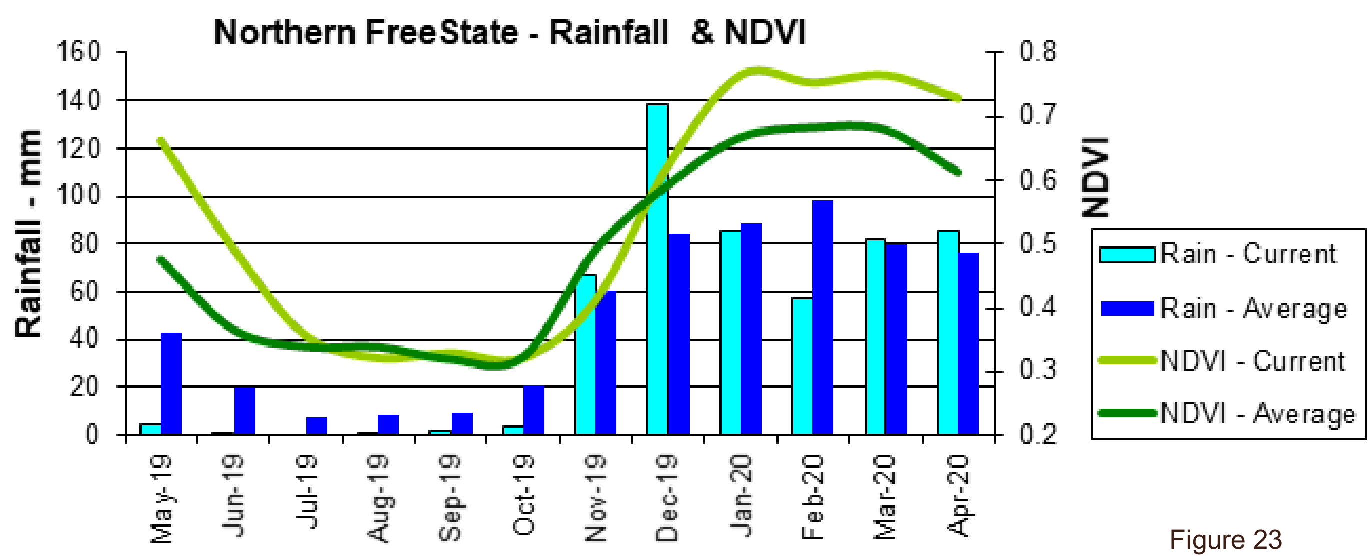

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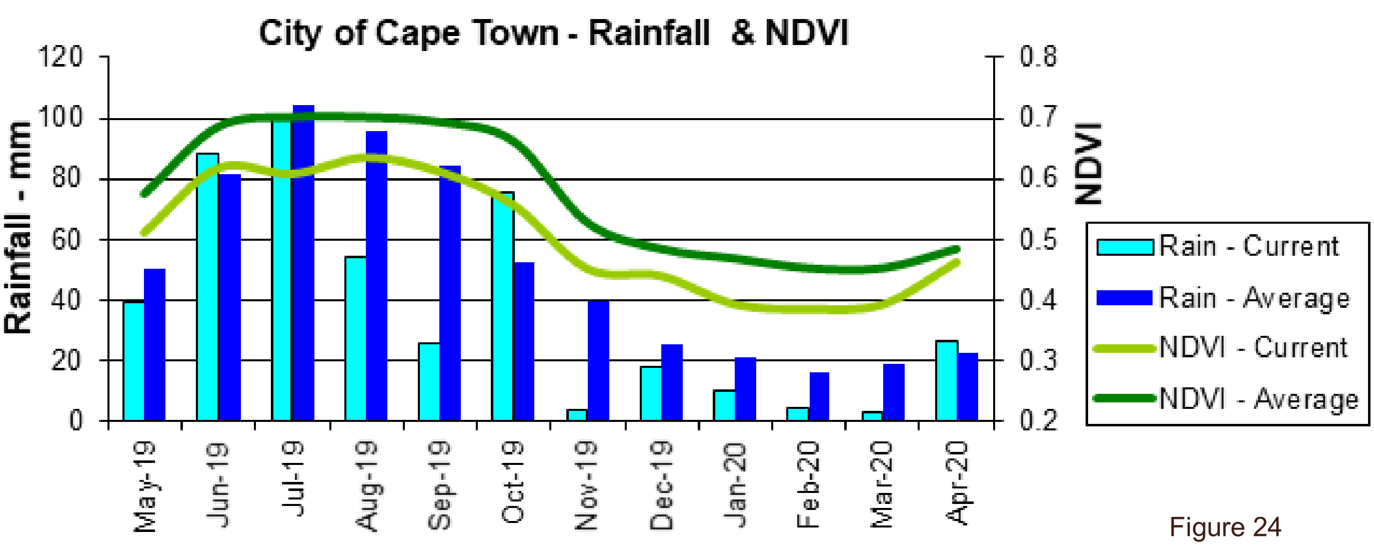

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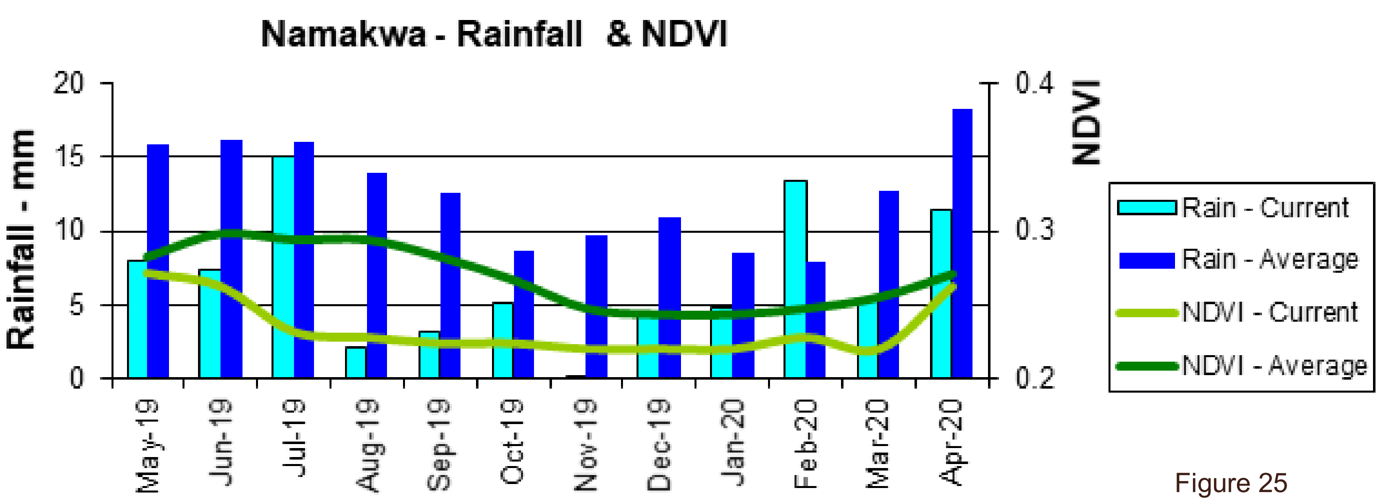


Figure 25

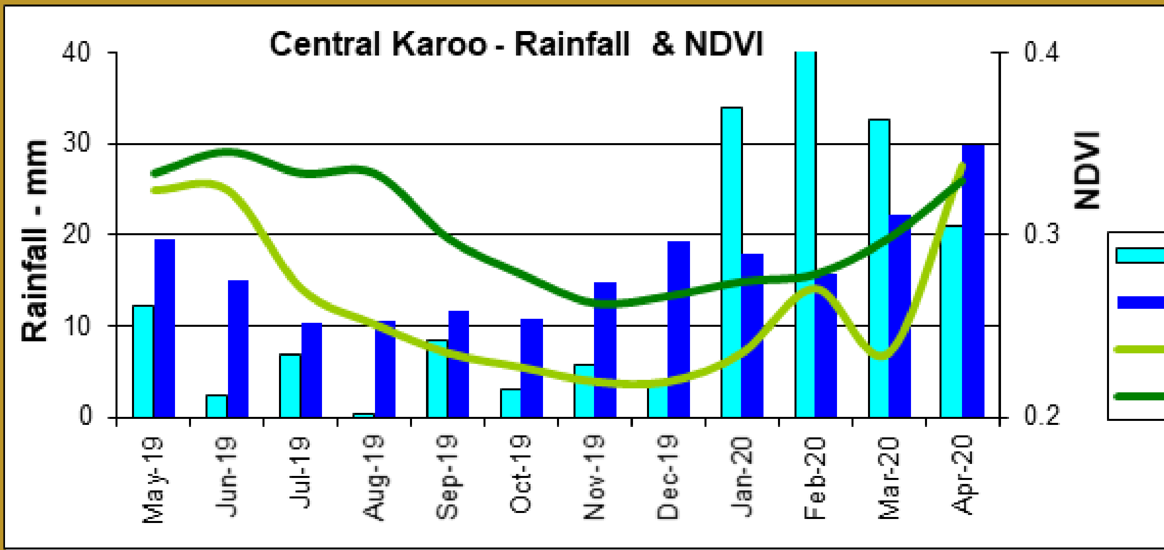
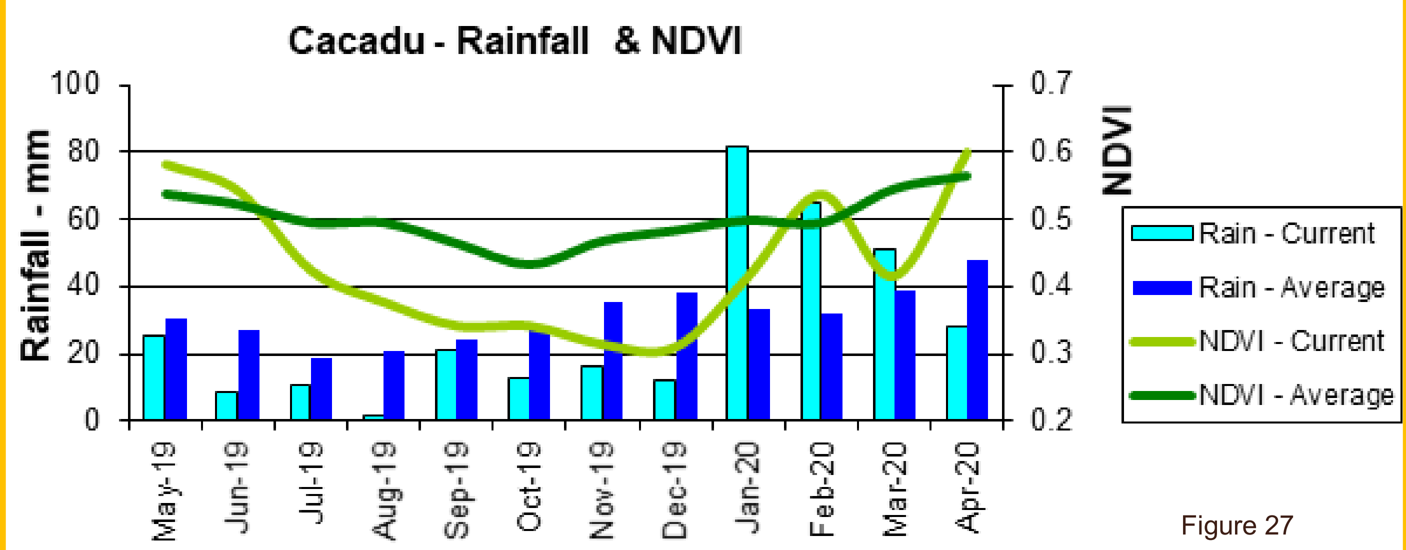


Figure 26



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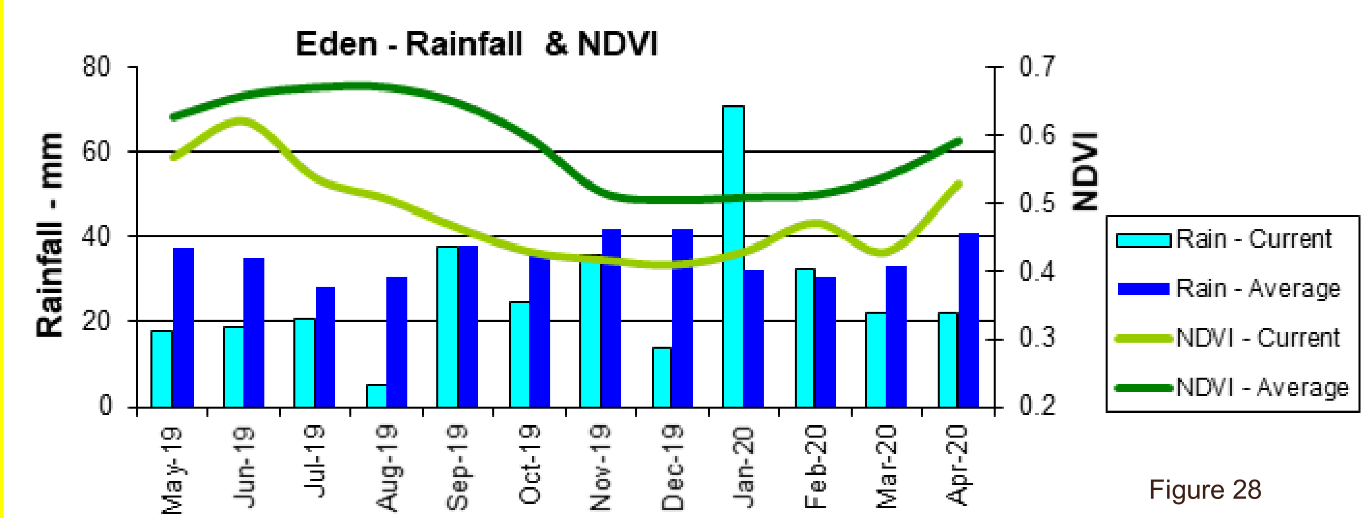

Figure 28

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:
The graph shows the total number of active fires detected between 1-30 April 2020 per province. Fire activity was higher in the Western Cape compared to the long-term average.

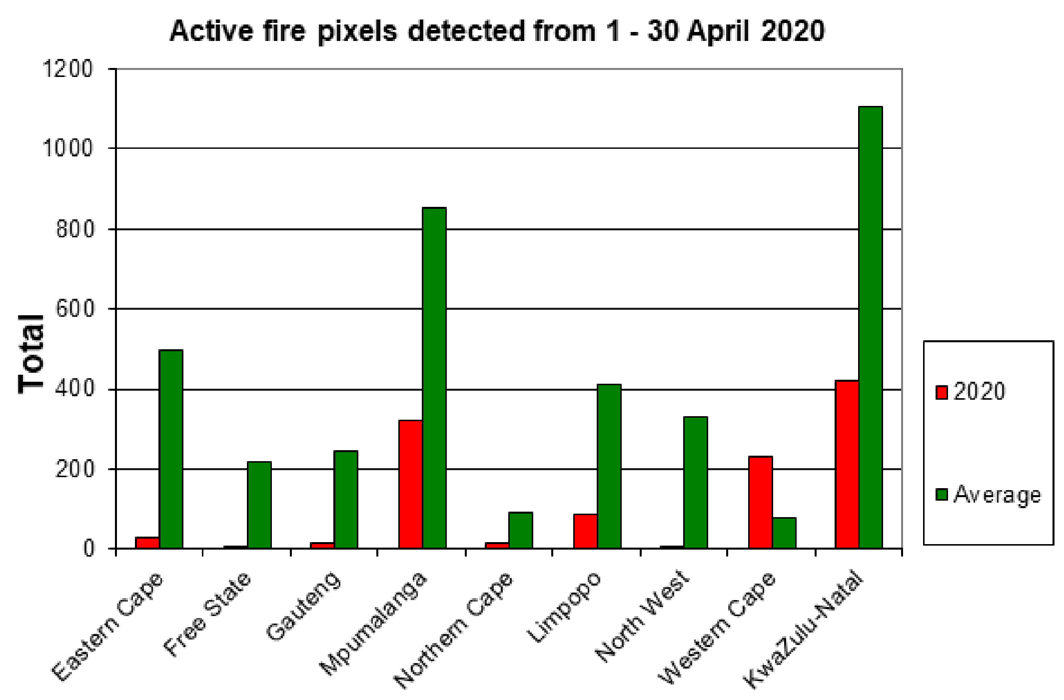

Figure 29

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

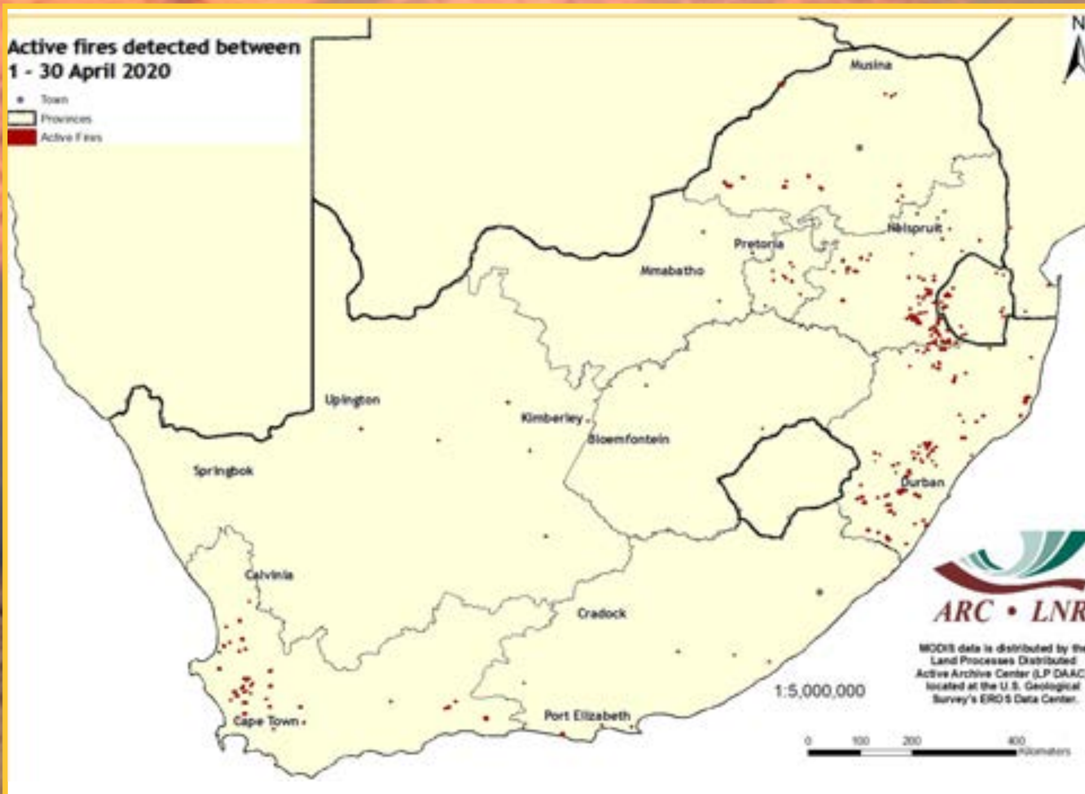

Figure 30

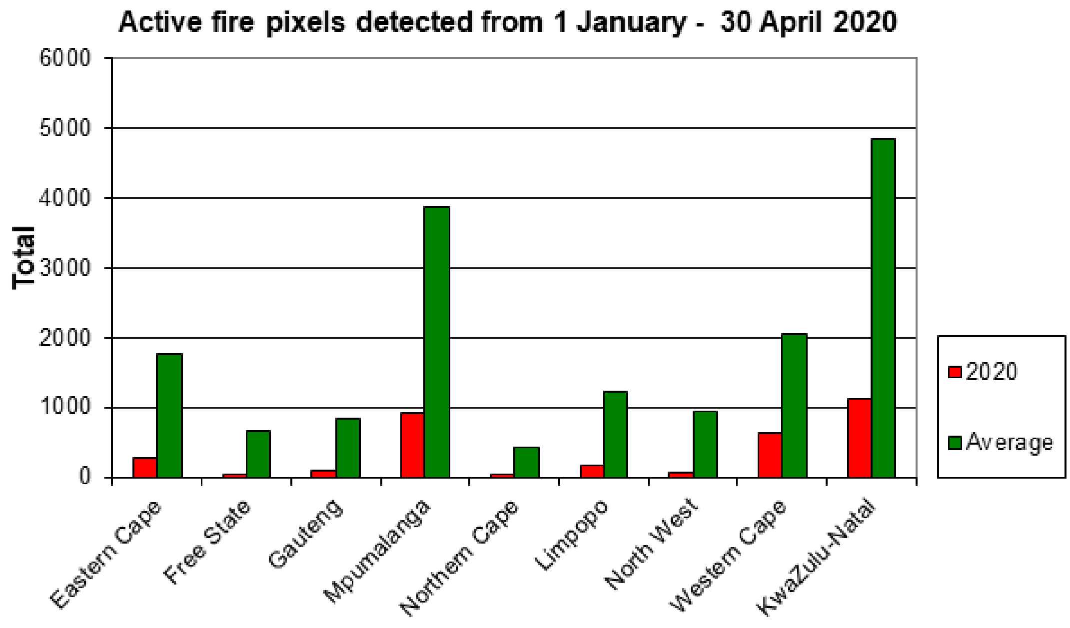

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January - 30 April 2020 per province. Fire activity was lower in all provinces compared to the long-term average.

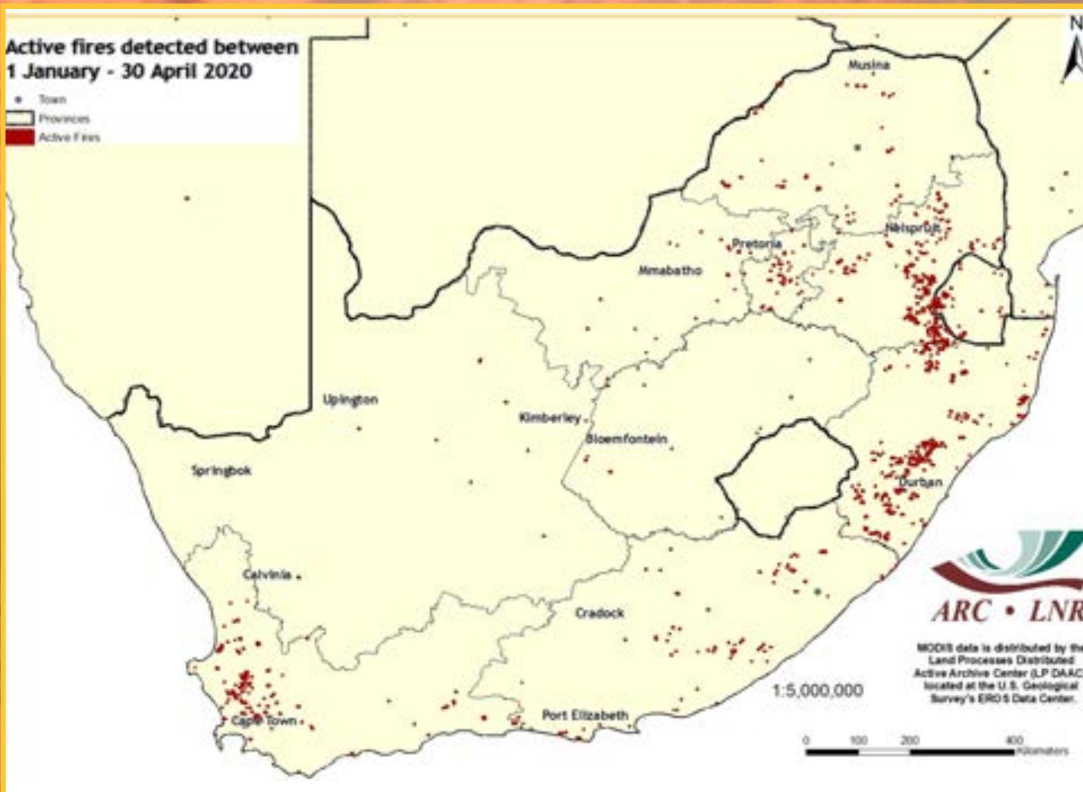

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January - 30 April 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 April 2020 shows a continuation of the conditions 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 April 2020 and April 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 Kalahari and 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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mark.thompson@geoterraimage.com

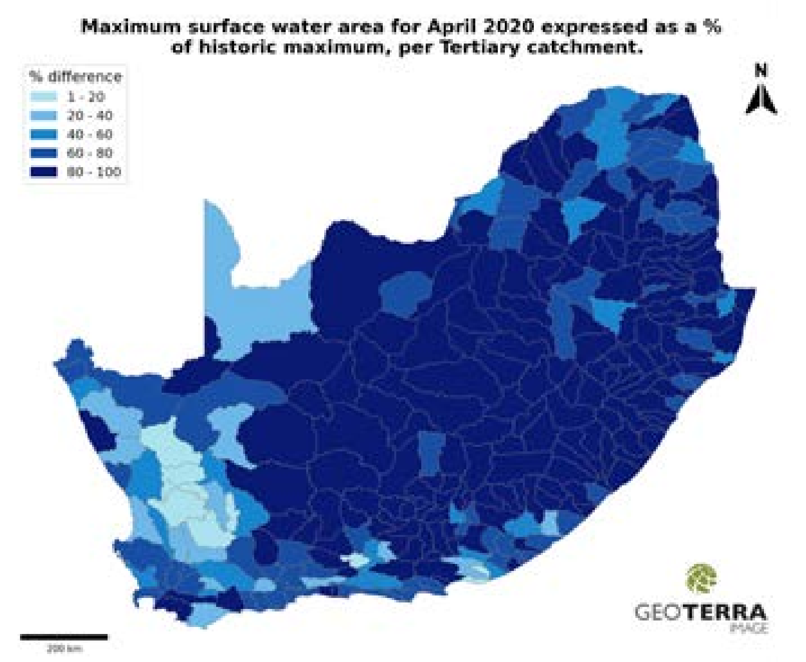

Figure 33

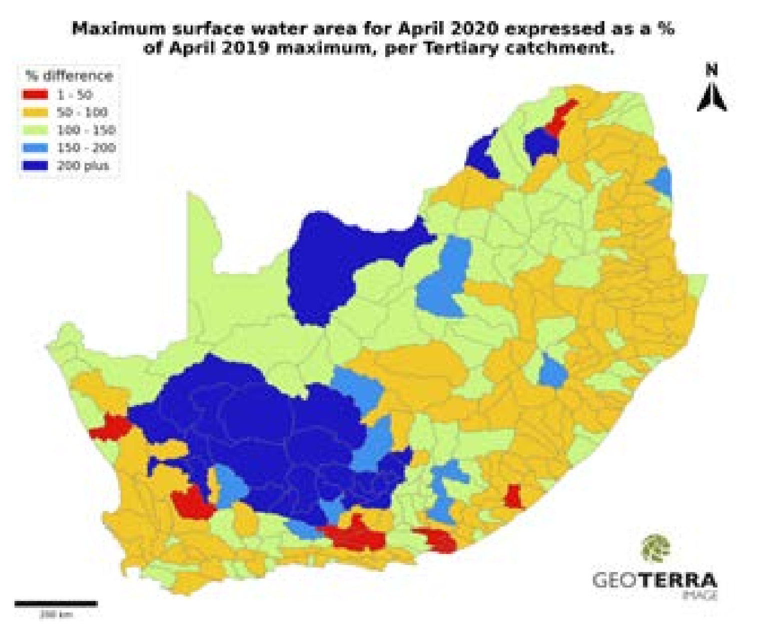

Figure 34

GEOTERRA IMAGE

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Agrometeorology

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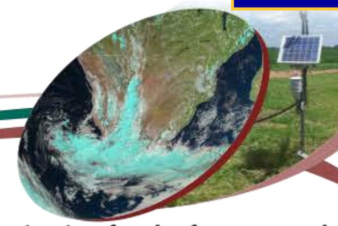

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national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