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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

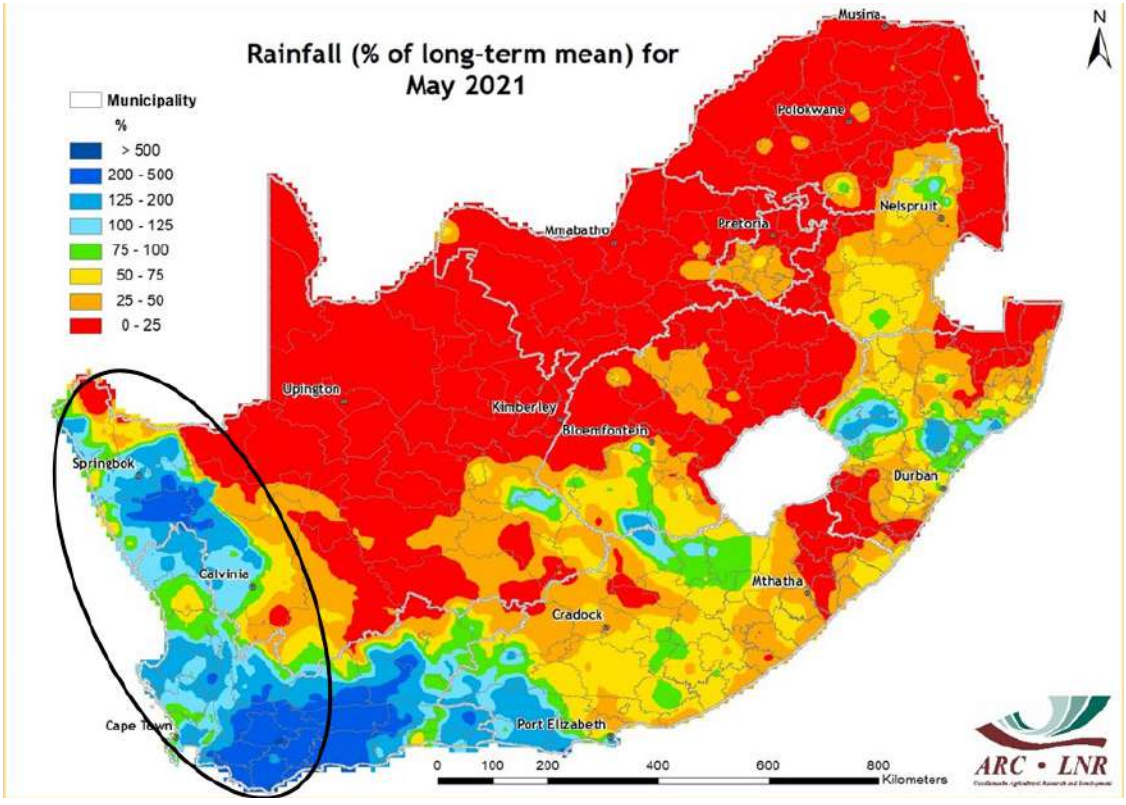
CONTENTS:

204th Edition

Image of the Month

May 2021 brings favourable rainy conditions over the winter rainfall region

The winter rainfall region welcomed the onset of its rainy season in May 2021 and more intensely towards the end of the month. Widespread precipitation occurred over the region, with stations in the Cape Agulhas and adjacent areas recording more than 150 mm during the first 15 days of the month. These were the first significant rains after the warm and dry conditions during April and were therefore of critical importance for the dryland crop production areas. A cut-off low pressure system developed in the southern Western Cape on the 5th, bringing heavy rainfall and strong winds. Similarly, from the 20th a series of cold fronts made landfall and advected cold, dry air over the interior, resulting in very cold conditions. The rainfall map below shows above-normal totals over the southwestern parts of the country, recorded mostly at the beginning and towards the end of the month. Winter is the season during which this part of the country can expect heavy rainfall and very low temperatures during frontal passages. Thus, it is advisable for farmers to build resilience by storing fodder in safe, dry areas ready for use after storms/flash floods. In order to minimize the risk of cold spell impacts during the winter season, farmers should also practise preventative measures with regard to livestock hypothermia and frost damage on 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:

A gradual cessation of rains was observed over the summer rainfall region during May 2021, with rainfall occurring over parts of the southern interior, isolated areas of Mpumalanga and KwaZulu-Natal. Areas that recorded totals of >100 mm for the month include parts of the KZN north coast, viz. Richards Bay and adjacent areas. The southern parts of the Free State extending towards the northern Eastern Cape followed a similar pattern, with thick bands of cloud bringing isolated showers and rainfall totals up to 50 mm being recorded during the first 10 days of the month.

The largest portion of the country's rainfall during May occurred over the winter rainfall region, resulting in above-normal rainfall conditions as is climatologically to be expected. This was driven by a series of cold fronts developing over the area around the 5th and again during the latter half of the month. These frontal systems resulted in cold and windy conditions over the southern parts of the country, as well as the interior, reaching areas as far north as the Highveld, KZN and Mpumalanga. These cold temperatures imply optimal conditions for chill unit accumulation in the Overberg District Municipality.

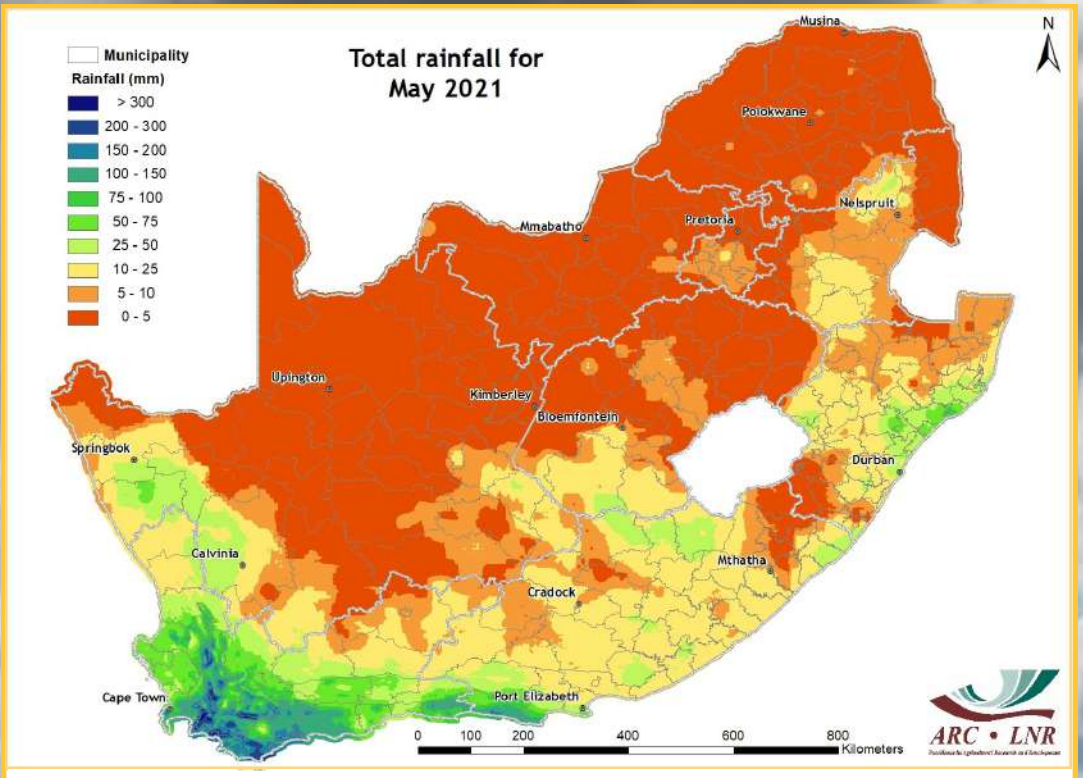


Figure 1

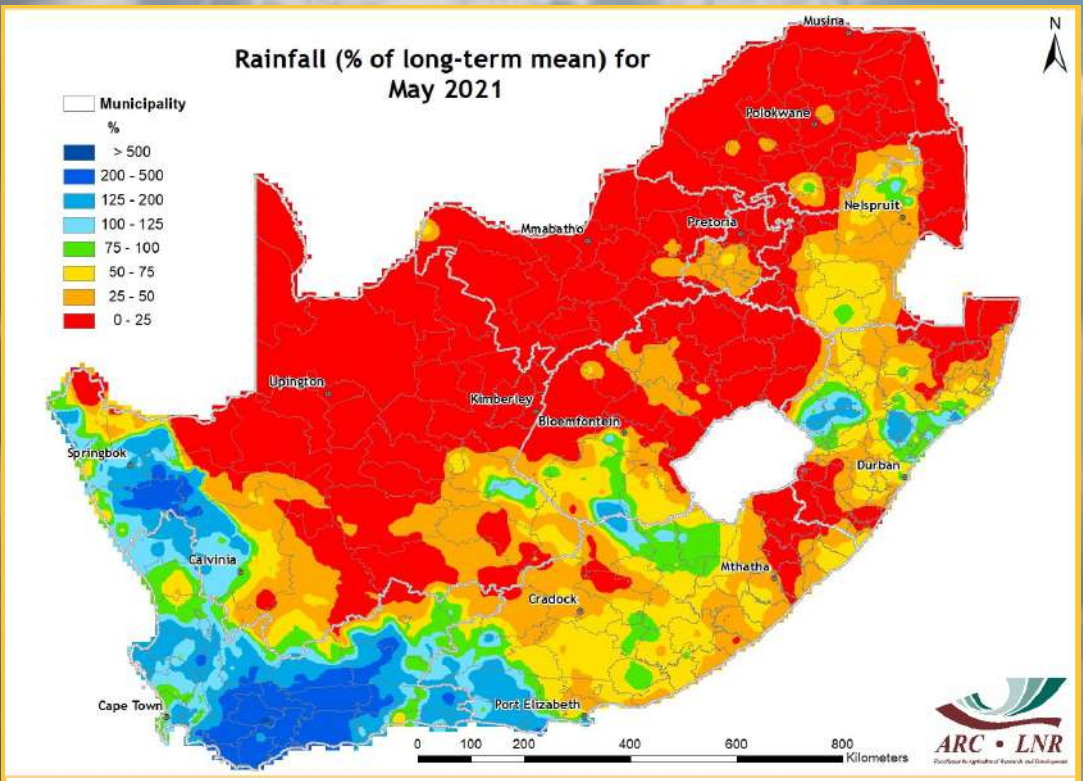


Figure 2

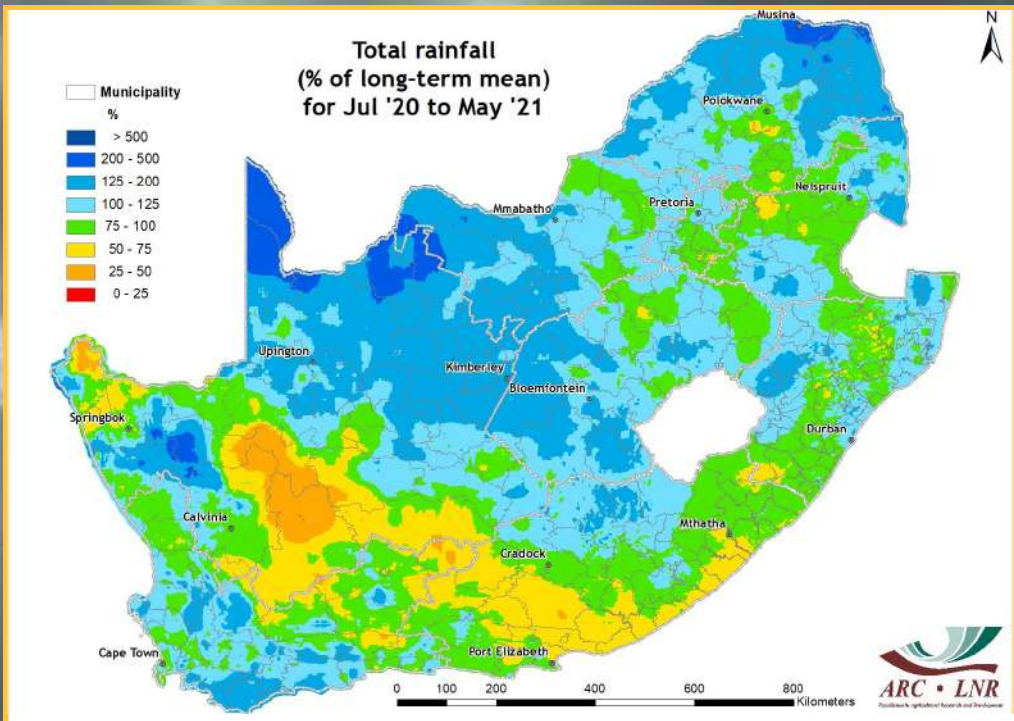


Figure 3

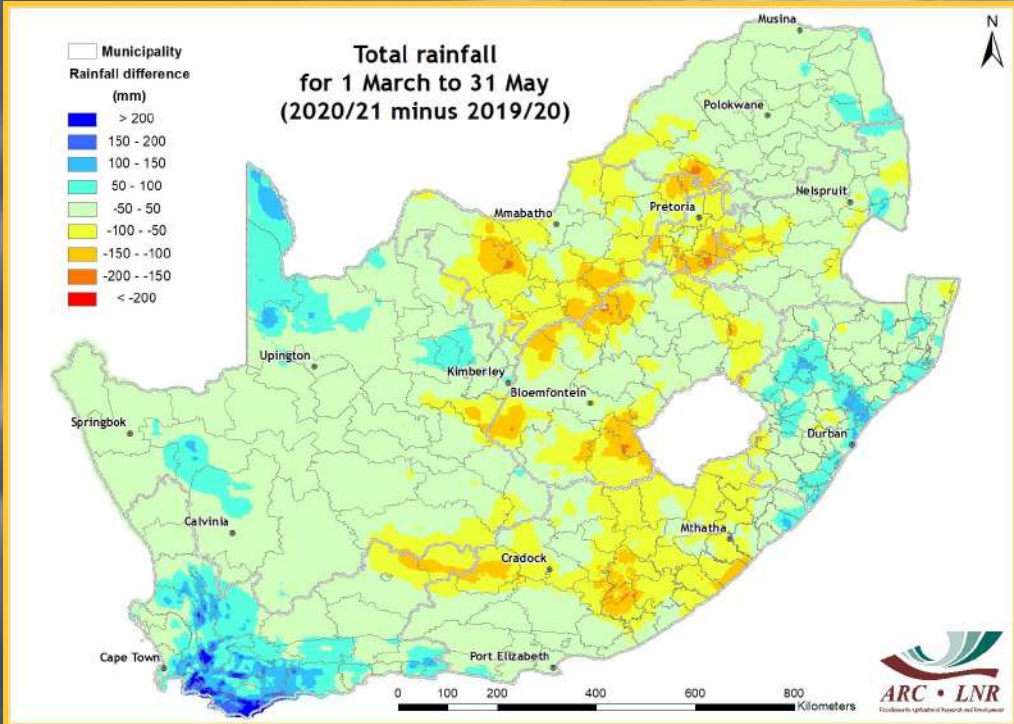


Figure 4

Figure 1:
Rainfall was largely absent over the summer rainfall region in May. Several frontal systems resulted in rainfall activity over parts of the southern and southwestern parts of the country, with some areas recording totals of >150 mm for the month.

Figure 2:
Below-normal rainfall was notable over much of the summer rainfall region, while some areas in KwaZulu-Natal and along the Eastern Cape and Free State borders received above-normal rainfall. As climatologically expected, above-normal rainfall occurred over the winter and all-year rainfall regions.

Figure 3:
Rainfall totals for the period between July 2020 and May 2021 indicate that near- to below-normal conditions occurred over much of the Cape provinces, KZN and further north towards Mpumalanga and Limpopo. Meanwhile, areas that received above-normal rainfall for the 11-month period were the central provinces, greater parts of Limpopo and the southwestern region of the country.

Figure 4:
When comparing rainfall during March to May 2021 with that of the previous year, it can be seen that areas that received more rain were isolated parts of KZN, Mpumalanga, Limpopo, North West, Northern Cape (towards the Botswana border) and the southwestern region of the country. Meanwhile, areas that recorded a difference of <-150 mm for the 3-month period include the central and southern interior as well as much of the Eastern Cape. The rest of the country 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. SPI ending in May 2021 showed short-term wet conditions over much of the summer rainfall region, with areas in central and southern Limpopo, extending towards the eastern parts of the Highveld, reflecting mild to moderate drought. Severe to extreme drought that was observed over the Northern Cape coast and adjacent areas, as well as parts of the Eastern Cape south coast in the all-year rainfall region are now visible in the medium-term map as opposed to the previous month. In addition, the 12-month SPI showed prevailing moderate-severely wet conditions over the northern interior as well as the Lowveld of Limpopo. The long-term SPI showed that the central to southeastern interior and parts of the Lowveld experienced mild to severe wet conditions, while moderate to severe drought was visible over the western region of the country, parts of the Eastern Cape, KZN and the interior of Limpopo and Mpumalanga.

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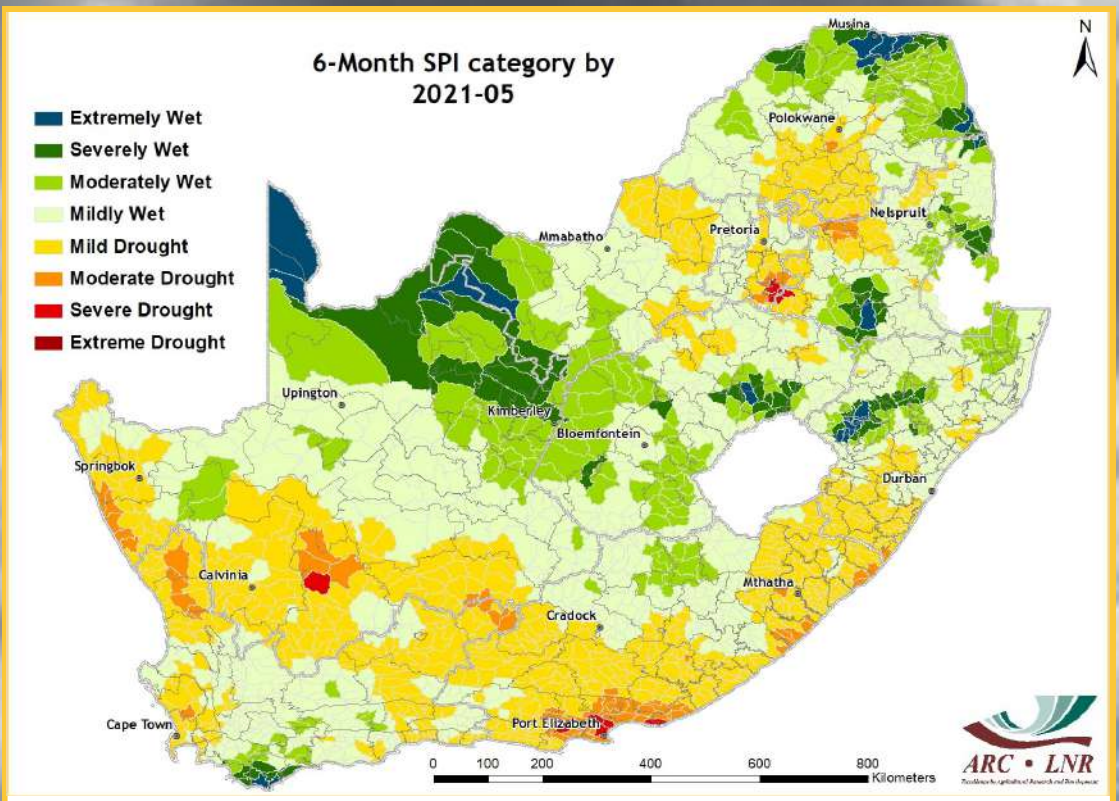

Figure 5

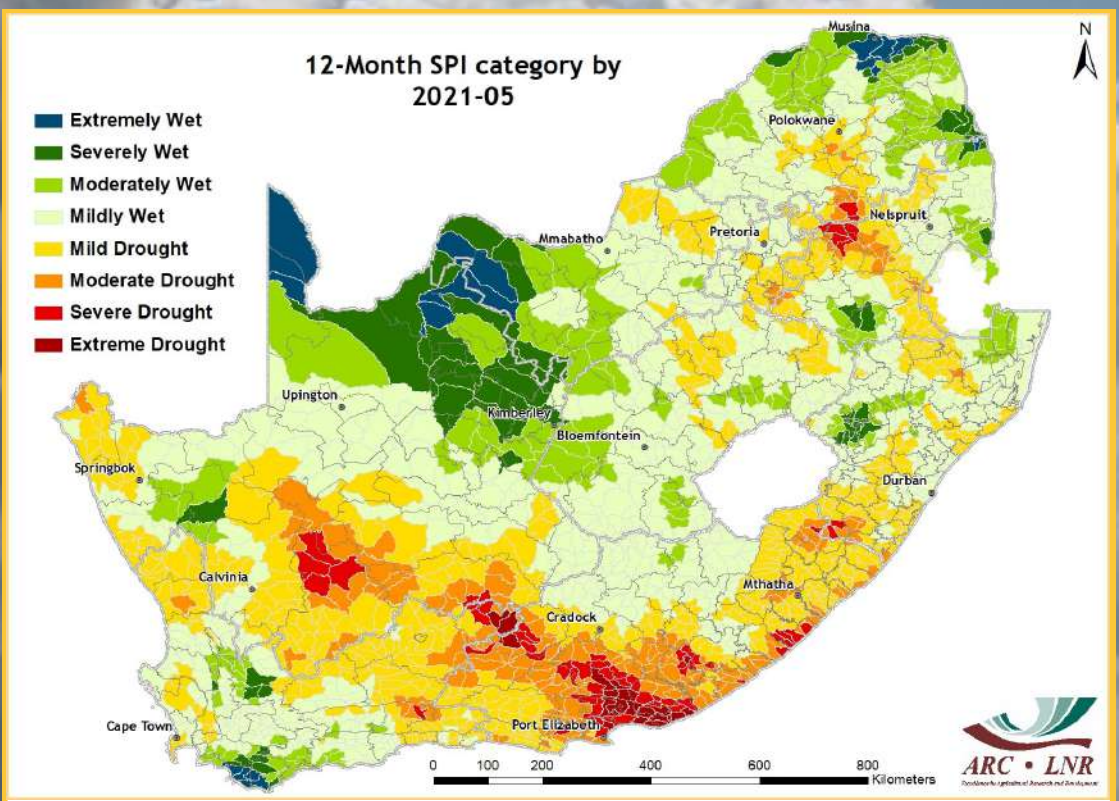

Figure 6

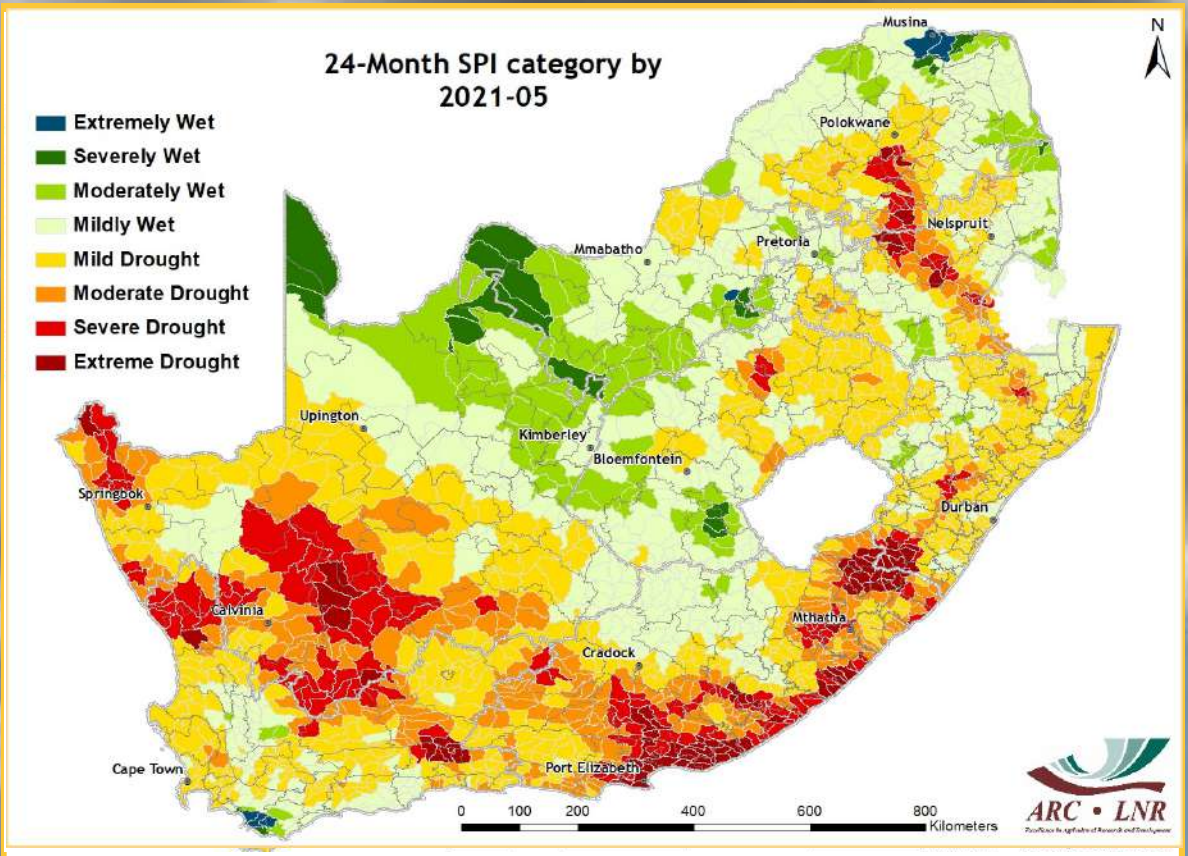

Figure 7

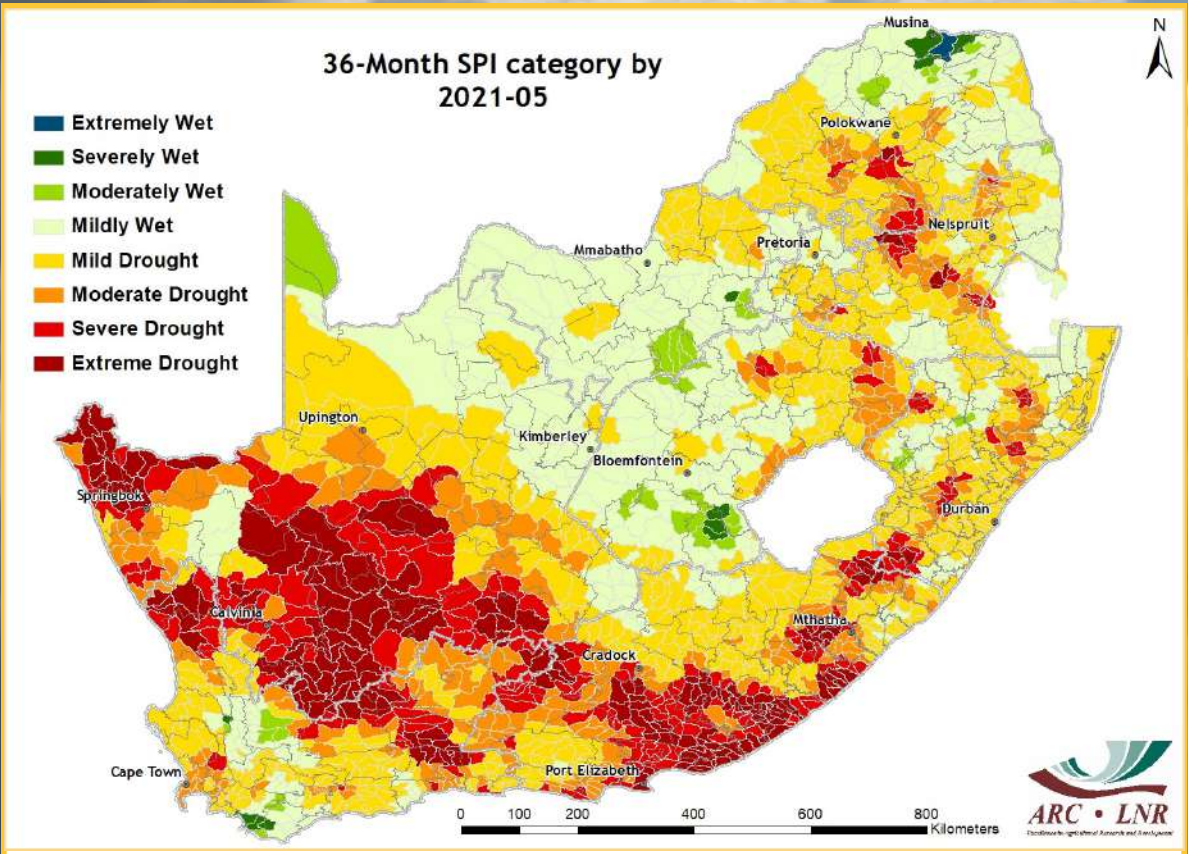

Figure 8

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.

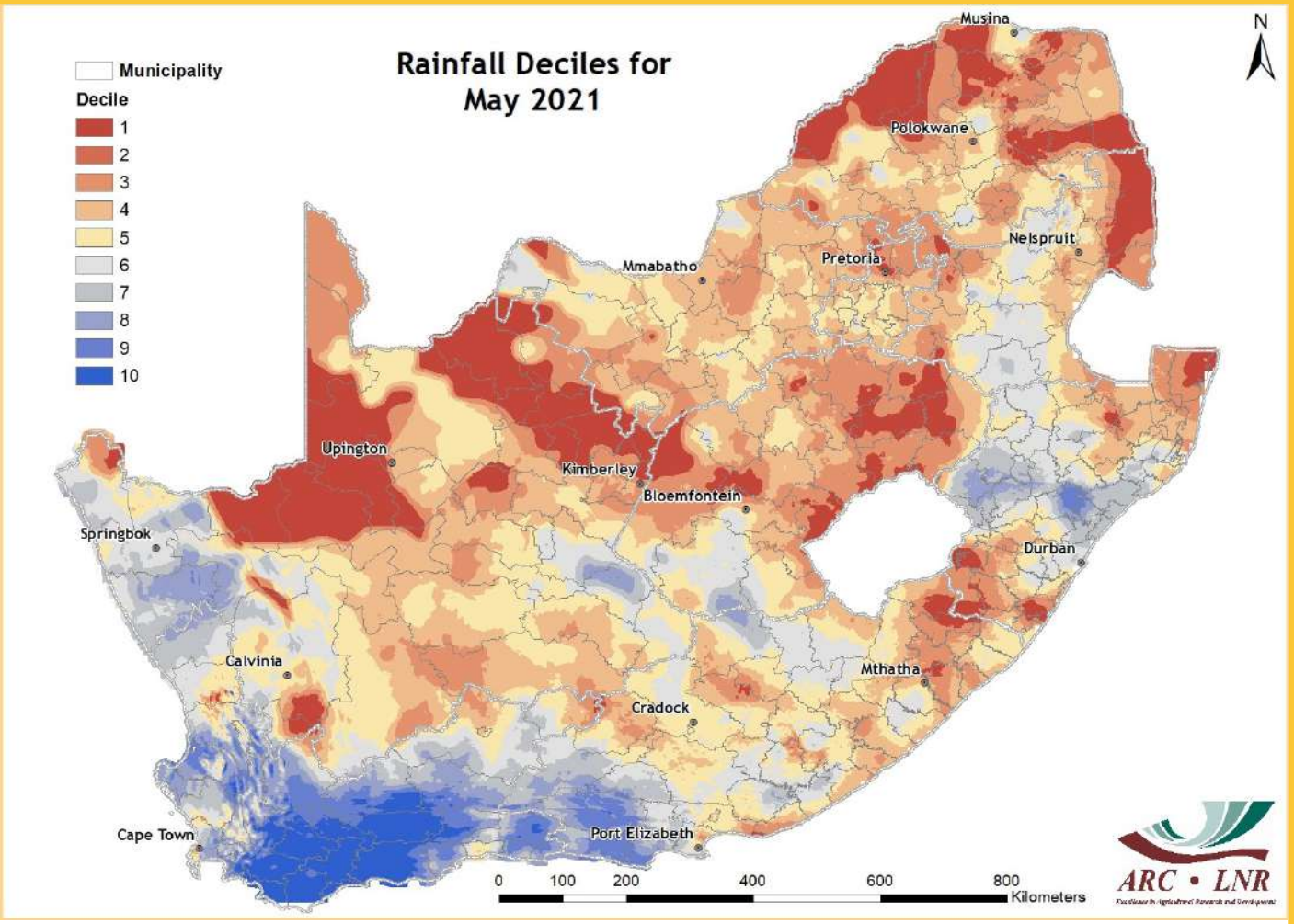

Figure 9

Figure 9:
Greater parts of the summer rainfall region experienced rainfall totals that compare well with historically drier May months, with the exception of parts of Mpumalanga, KwaZulu-Natal, southern Free State and northern Eastern Cape which experienced wetter than usual conditions. The all-year rainfall region, as well as the winter rainfall region, experienced rainfall totals that compare well with historically wetter May months.

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4. Vegetation Conditions

Vegetation Mapping

The Normalized Difference Vegetation Index (NDVI) is computed from the equation:

NDVI=(IR-R)/(IR+R)

where:
IR = Infrared reflectance &
R = Red band

NDVI images describe the vegetation activity. A decadal NDVI image shows the highest possible "greenness" values that have been measured during a 10-day period.

Vegetated areas will generally yield high values because of their relatively high near infrared reflectance and low visible reflectance. For better interpretation and understanding of the NDVI images, a temporal image difference approach for change detection is used.

The Standardized Difference Vegetation Index (SDVI) is the standardized anomaly (according to the specific time of the year) of the NDVI.

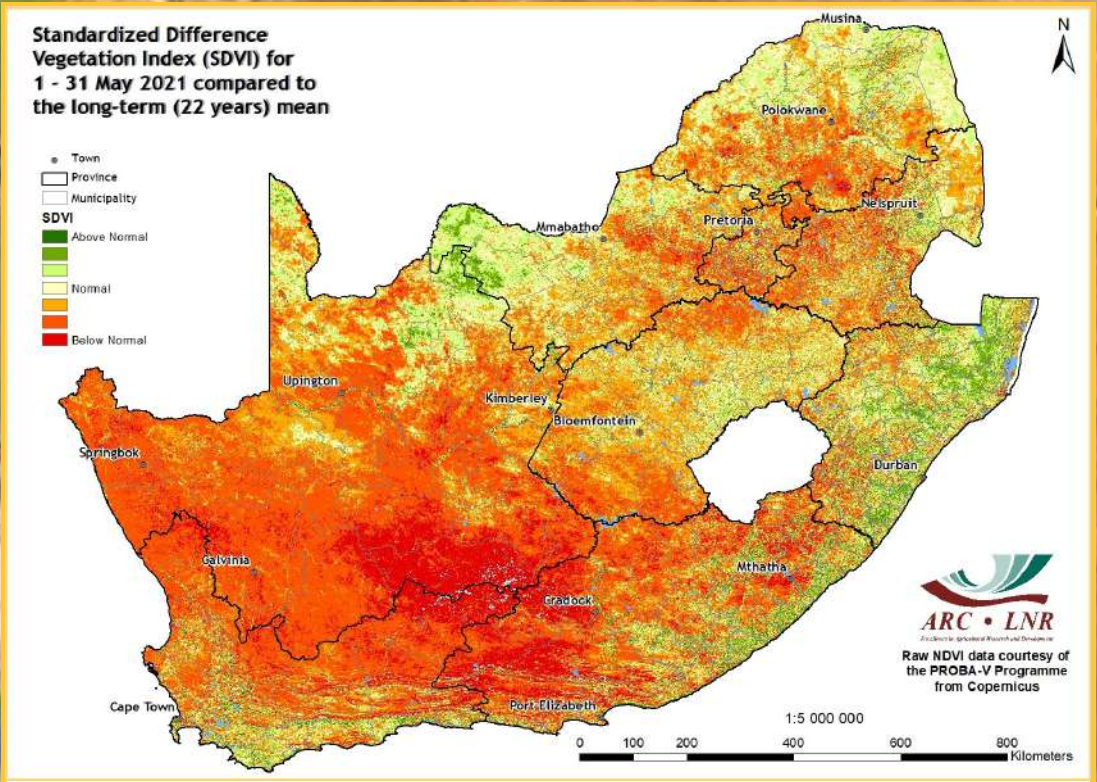

Figure 10

Figure 10:
Compared to the historical averaged vegetation conditions, the SDVI map for May 2021 shows that large parts of the country experienced below-normal vegetation activity.

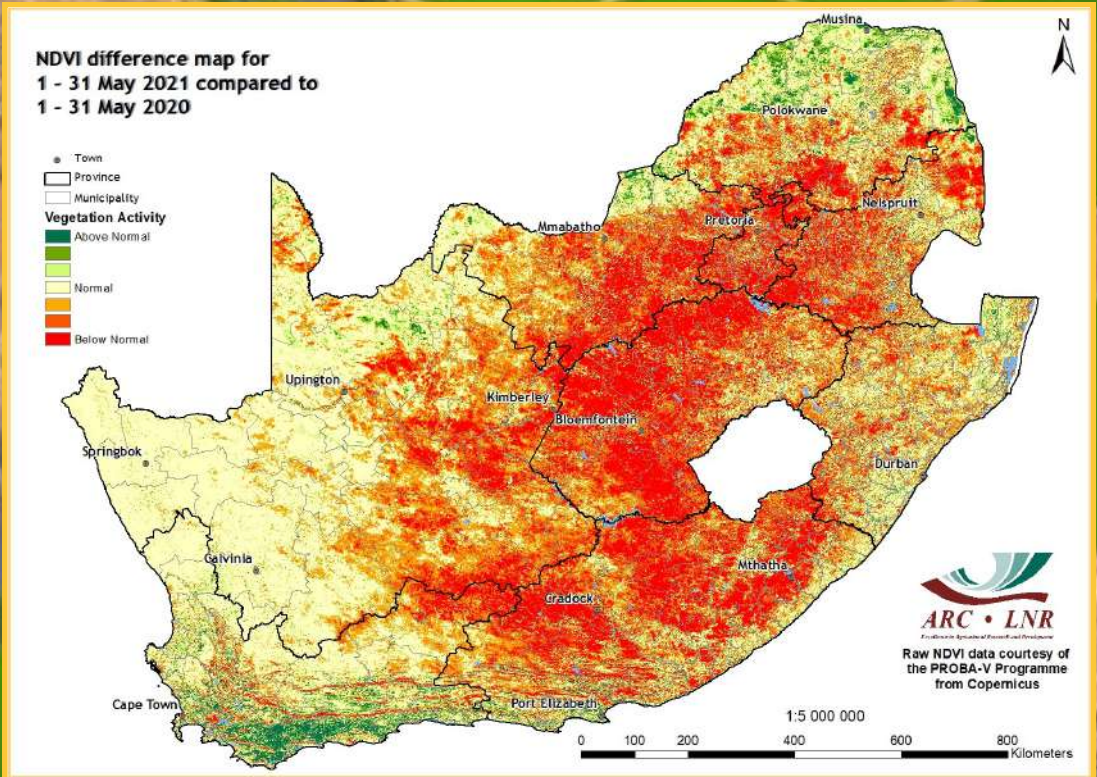

Figure 11

Figure 11:
When comparing the NDVI difference map for May 2021 to the same month last year, it can be observed that the central interior and eastern parts of the country experienced below-normal vegetation activity, with pockets of above-normal activity in the western parts of the country.

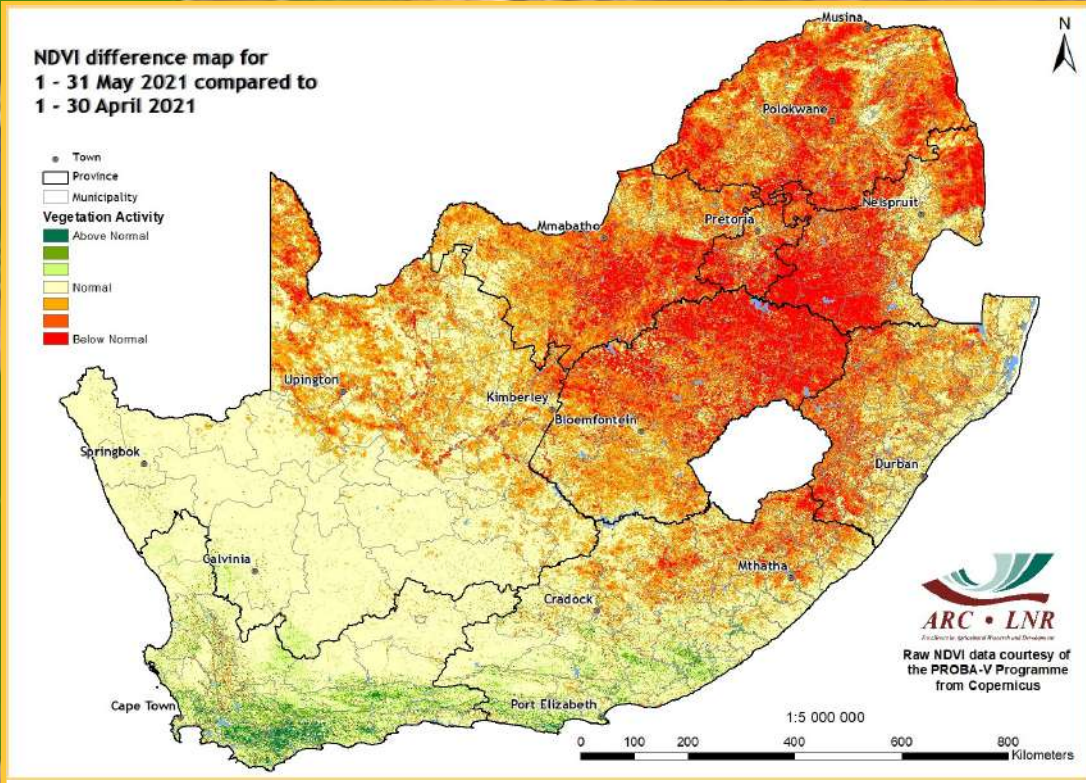

Figure 12

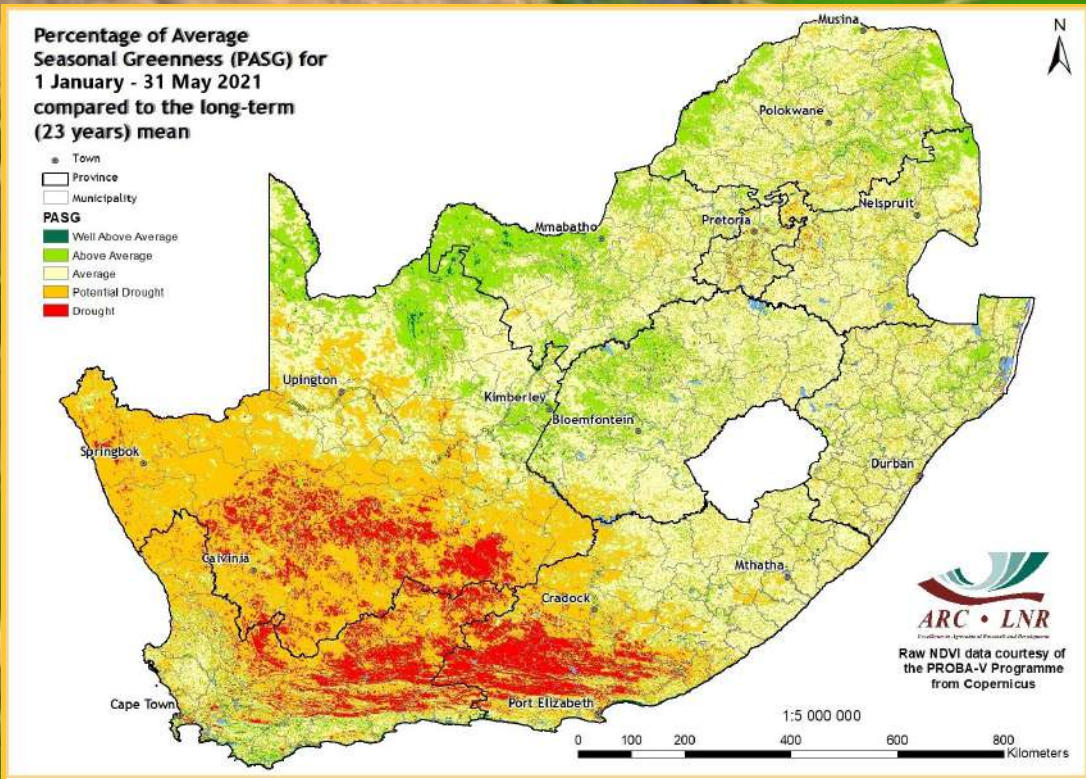

Figure 13

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 eastern half of the country experienced below-normal vegetation activity while the western half experienced normal vegetation activity.

Figure 13:
Cumulative vegetation conditions over a 5-month period compared to the long-term mean show that high levels of seasonal vegetation greenness remain dominant in the central and northern parts of the country. Meanwhile, the western parts continue to experience low levels of seasonal greenness.

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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.

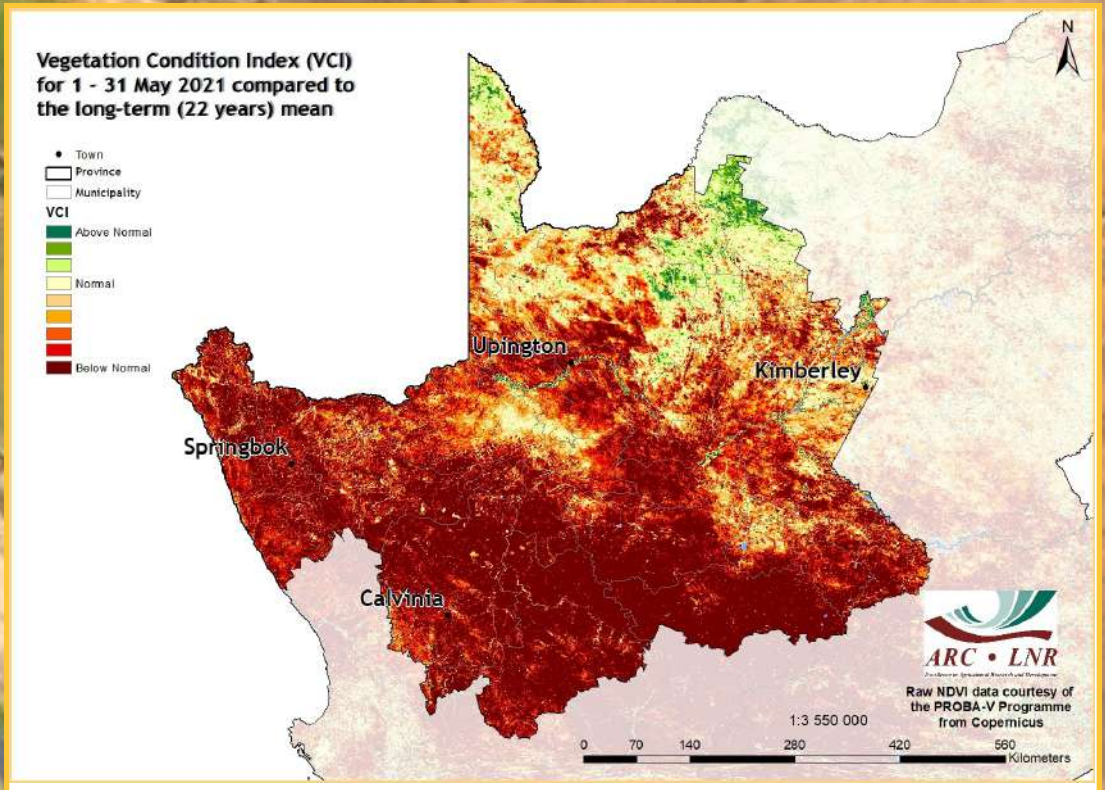

Figure 14

Figure 14:
The VCI map for May indicates that although the far northeastern parts of the Northern Cape continue to experience improved vegetation conditions, the remaining areas are still severely affected by drought.

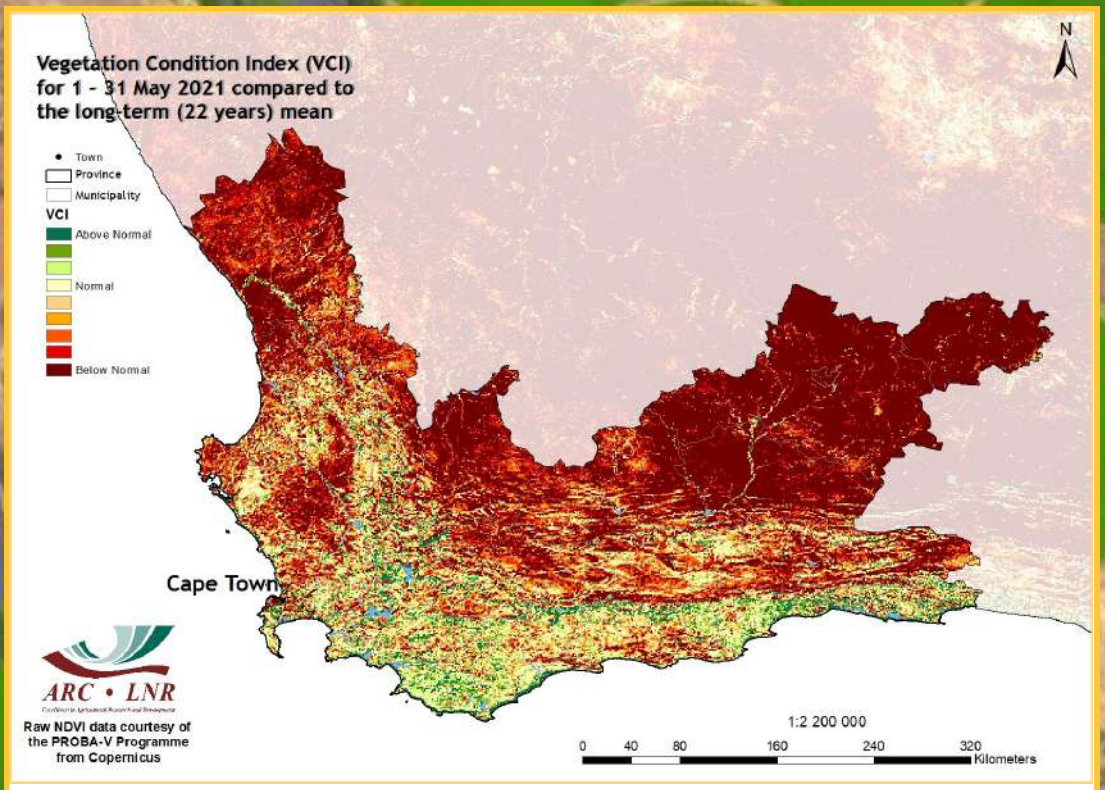

Figure 15

Figure 15:
The VCI map for May indicates that vegetation conditions in almost the entire Western Cape remain poor with only pockets of good conditions occurring in the southern parts.

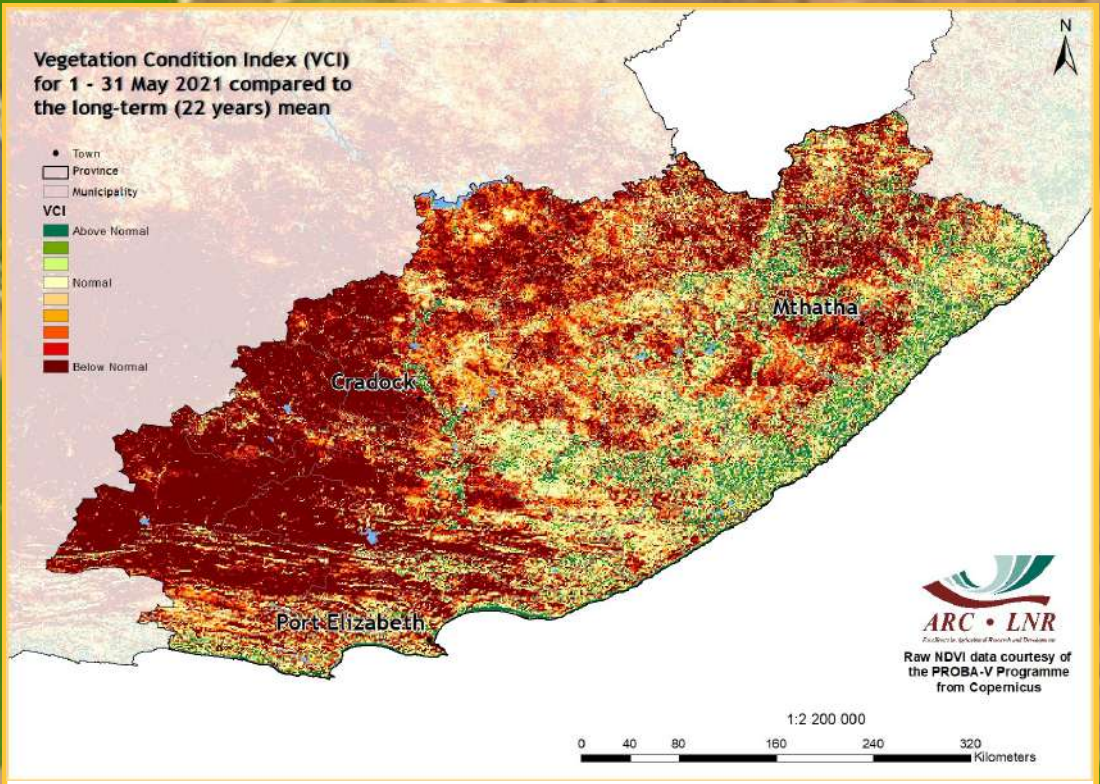

Figure 16

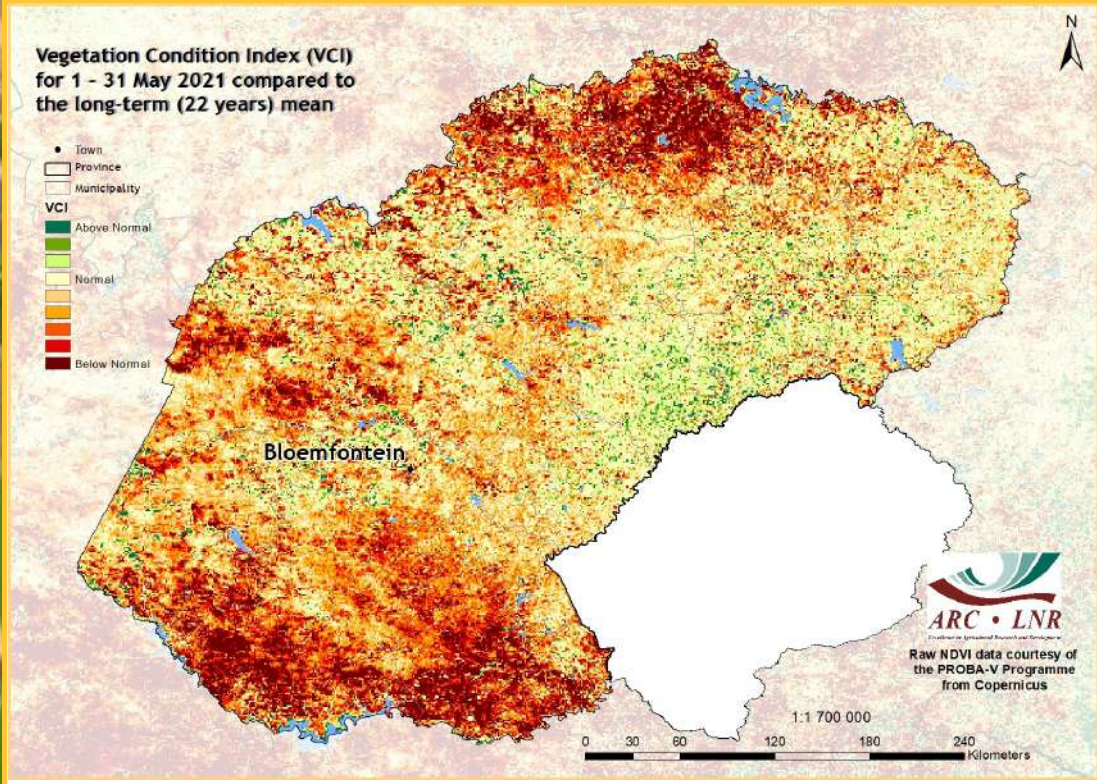

Figure 17

Figure 16:
The VCI map for May indicates that almost the entire Eastern Cape continues to experience poor vegetation conditions.

Figure 17:
The VCI map for May indicates that the southern and far northern parts of the Free State experienced relatively poor vegetation activity compared to other parts of the province.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

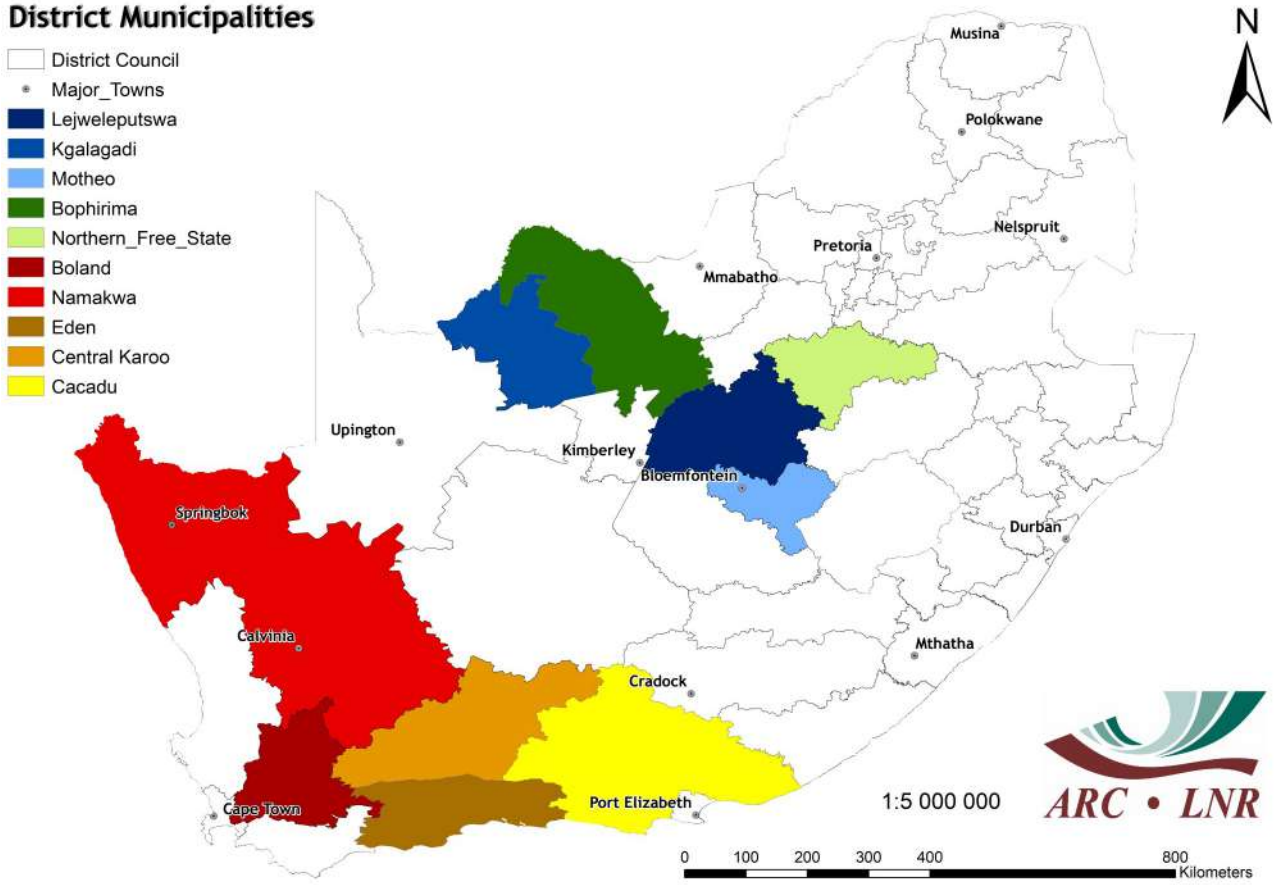

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for May 2021. 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.

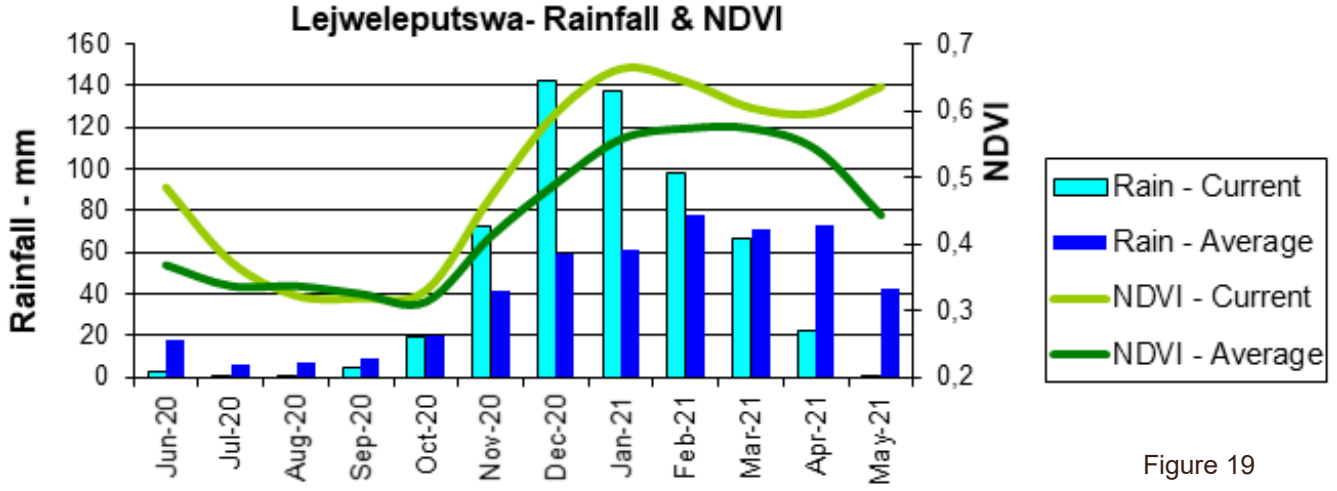
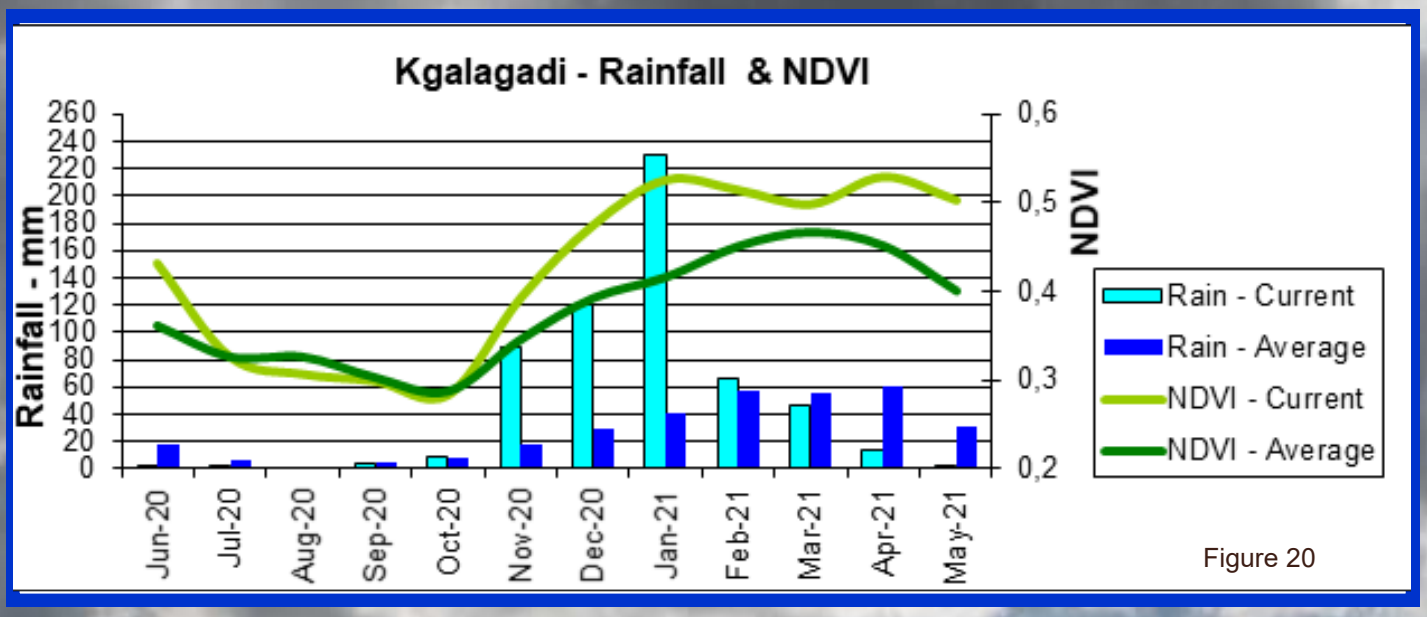


Figure 19



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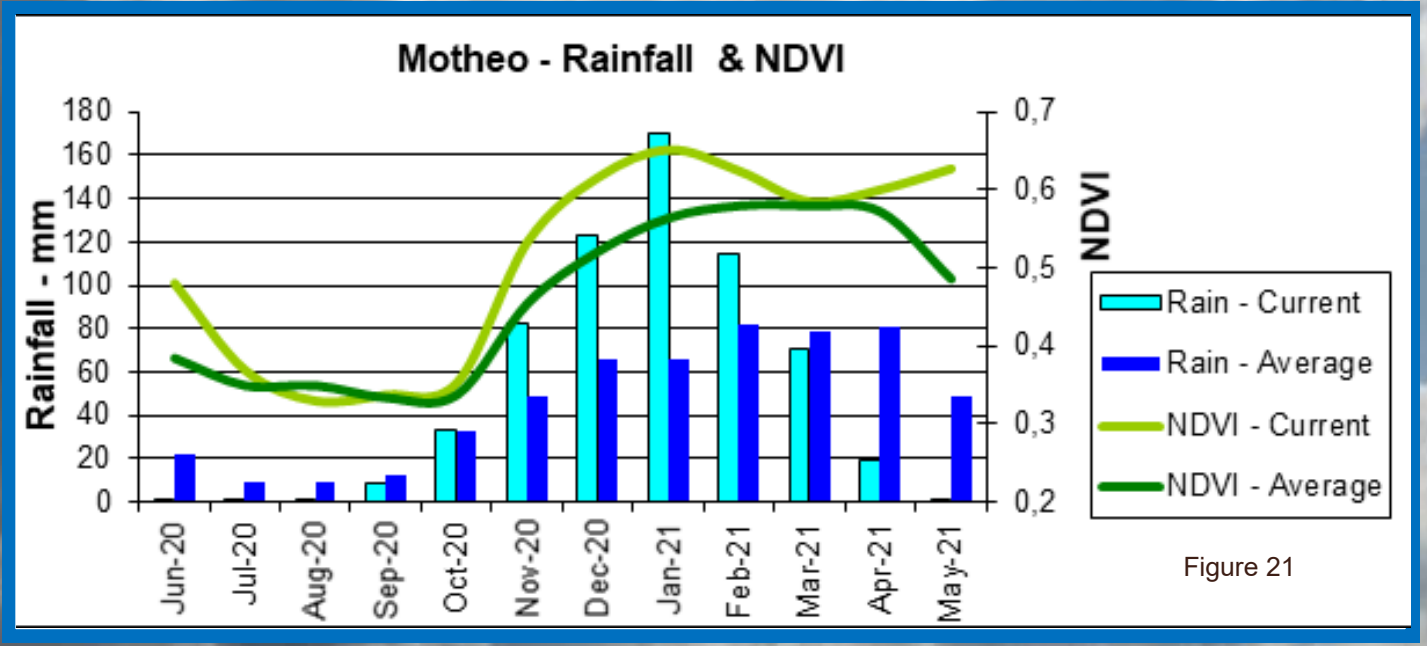

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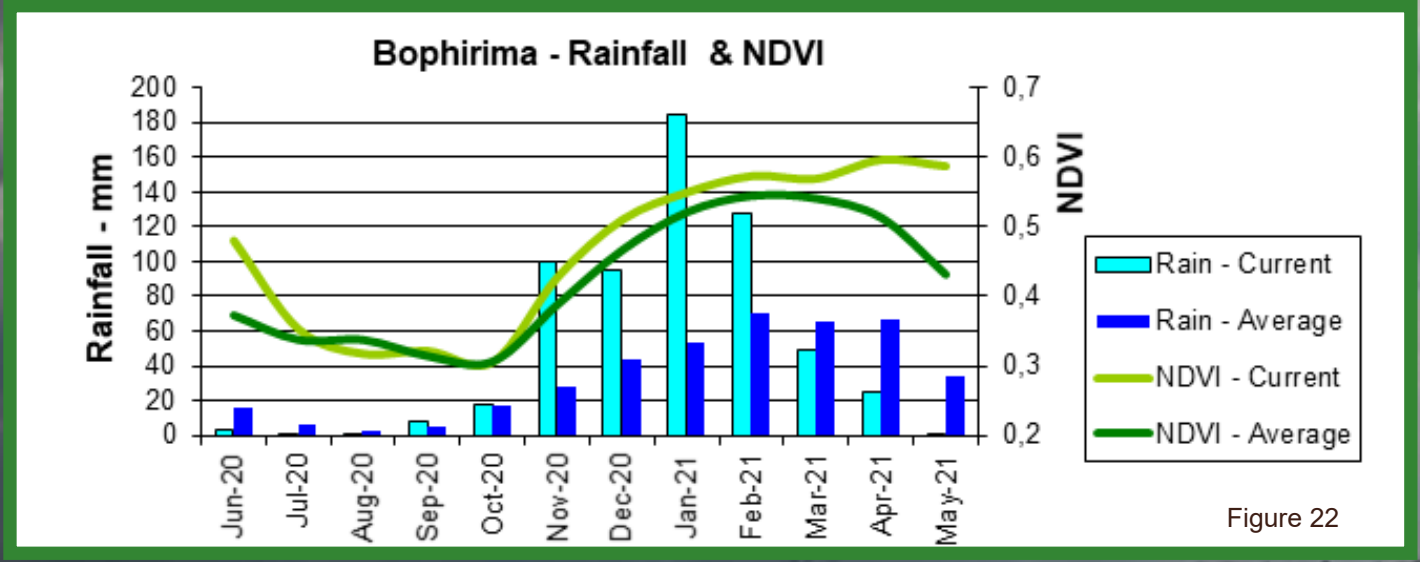

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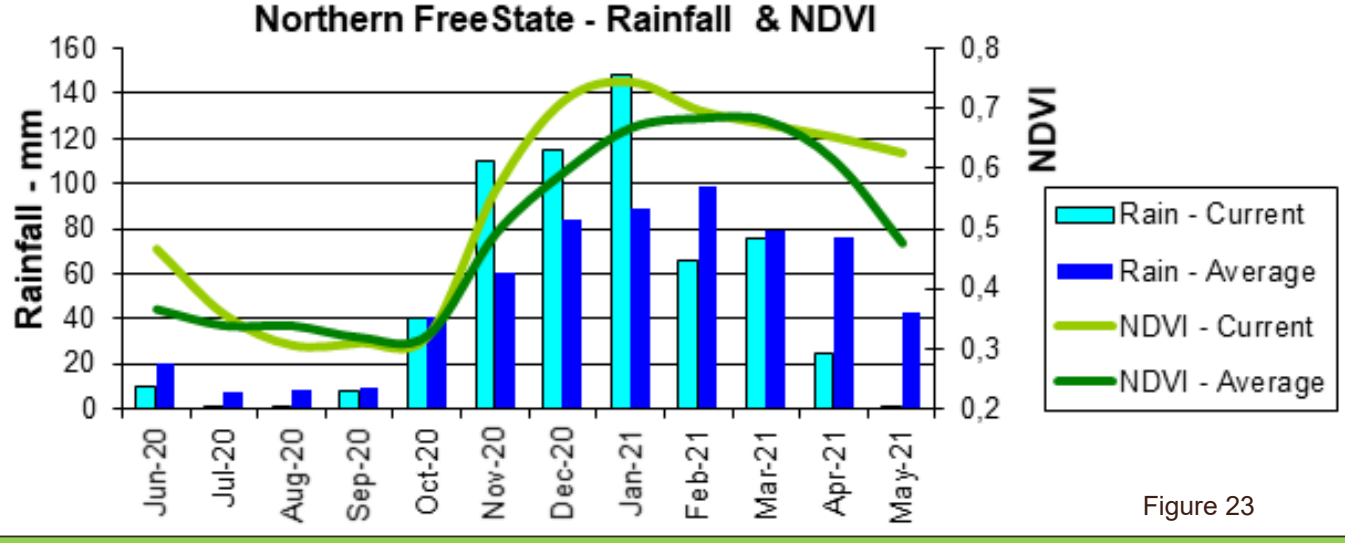

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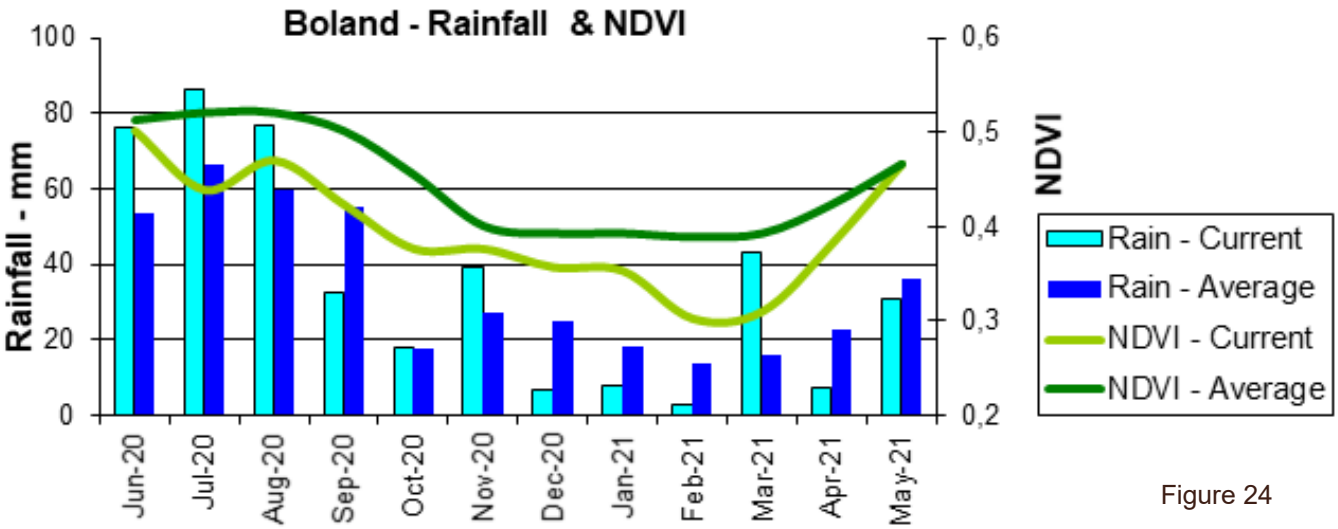

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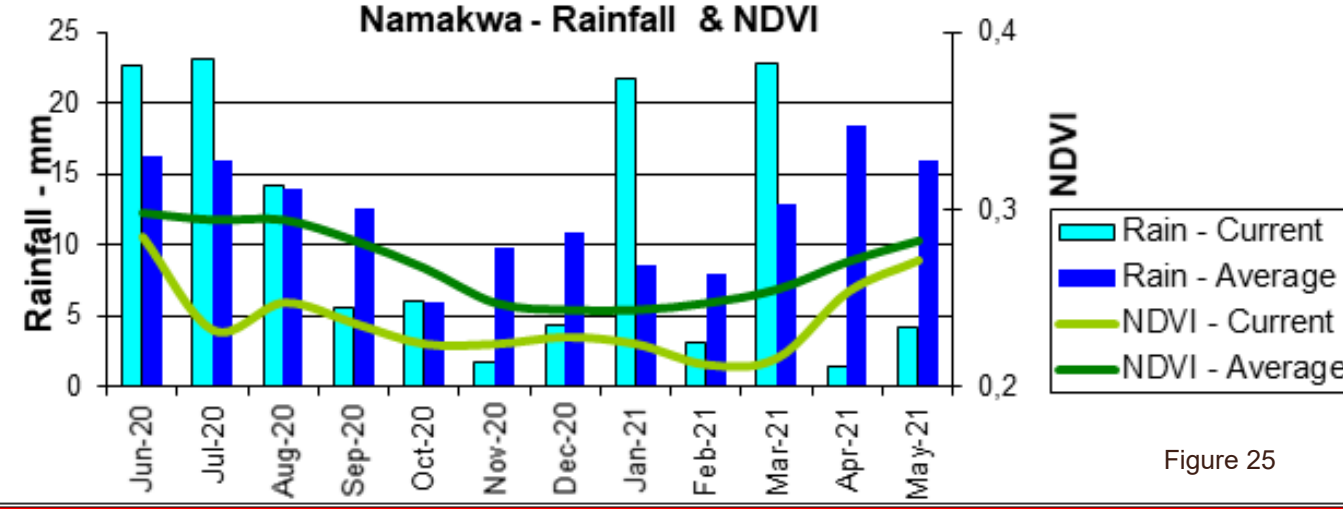
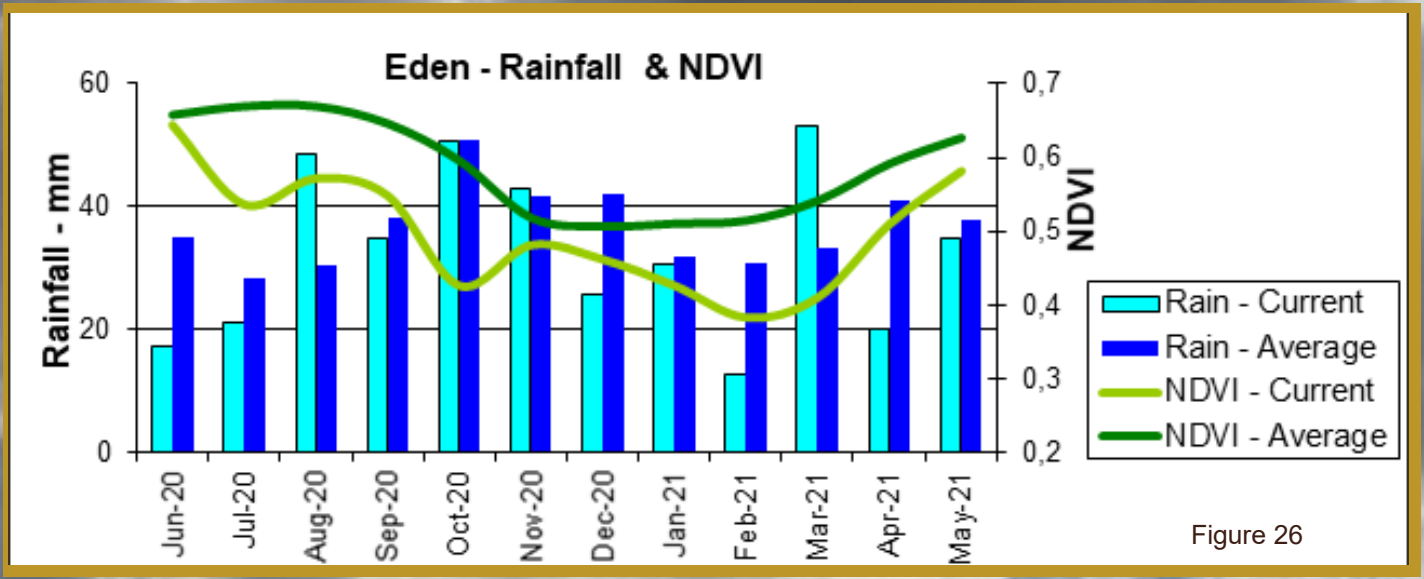


Figure 25



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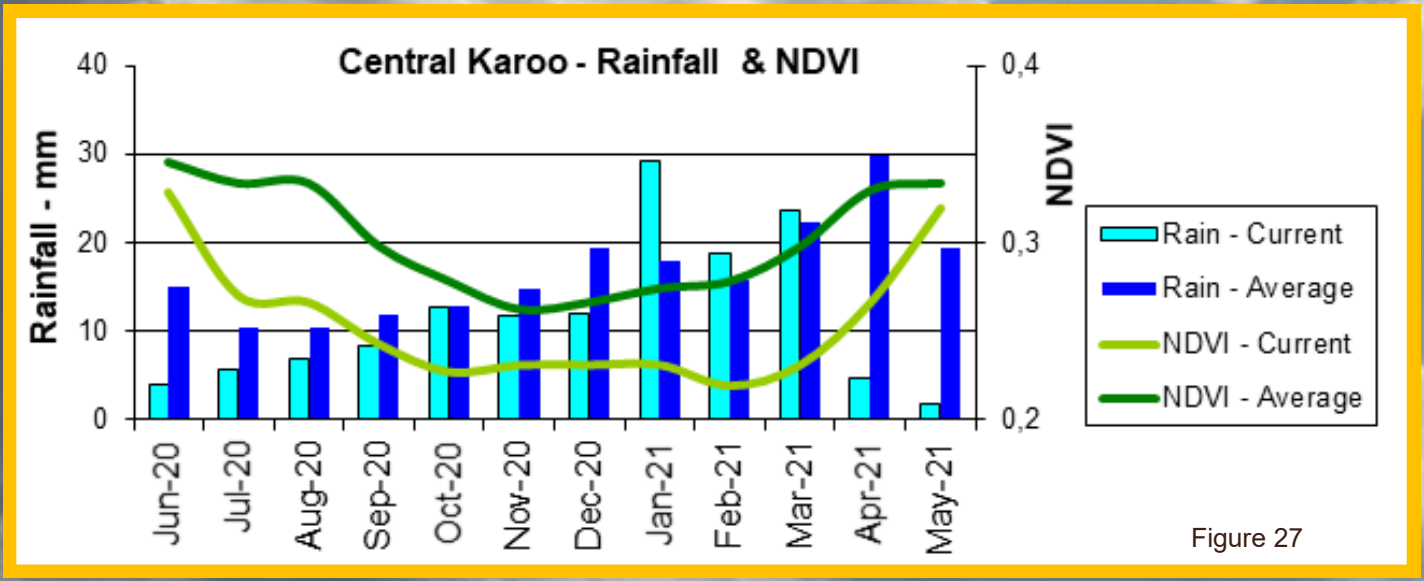

Figure 27

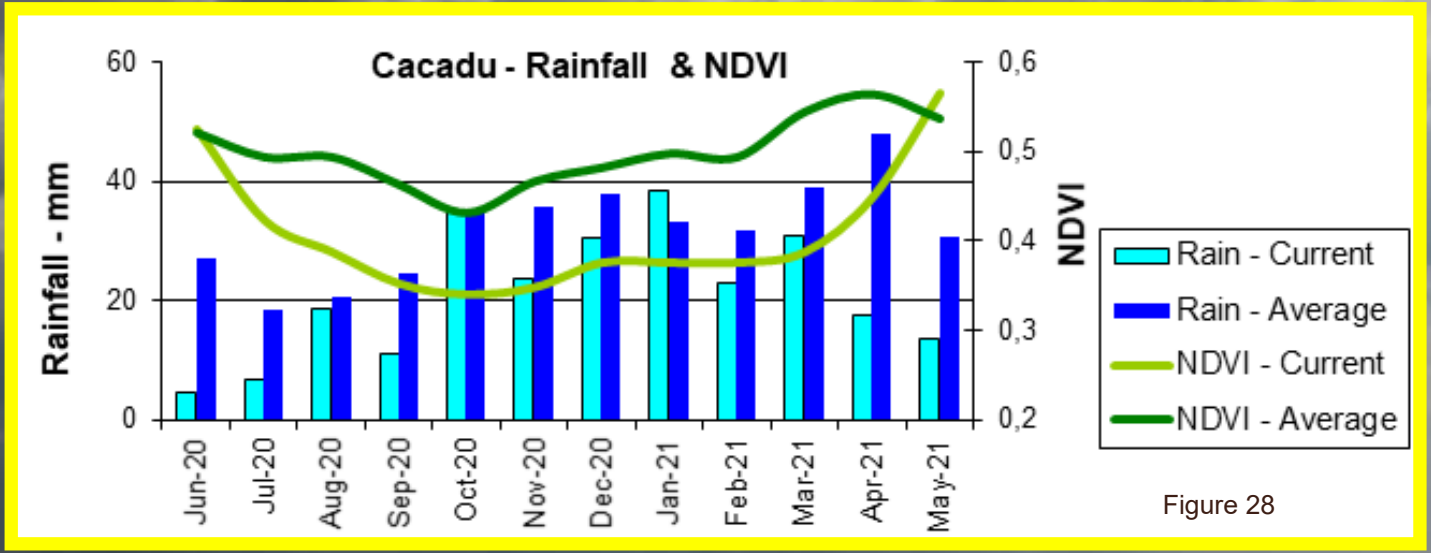

Figure 28

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 2021 per province. Fire activity was higher in Mpumalanga, Northern Cape and Western Cape compared to the long-term average.

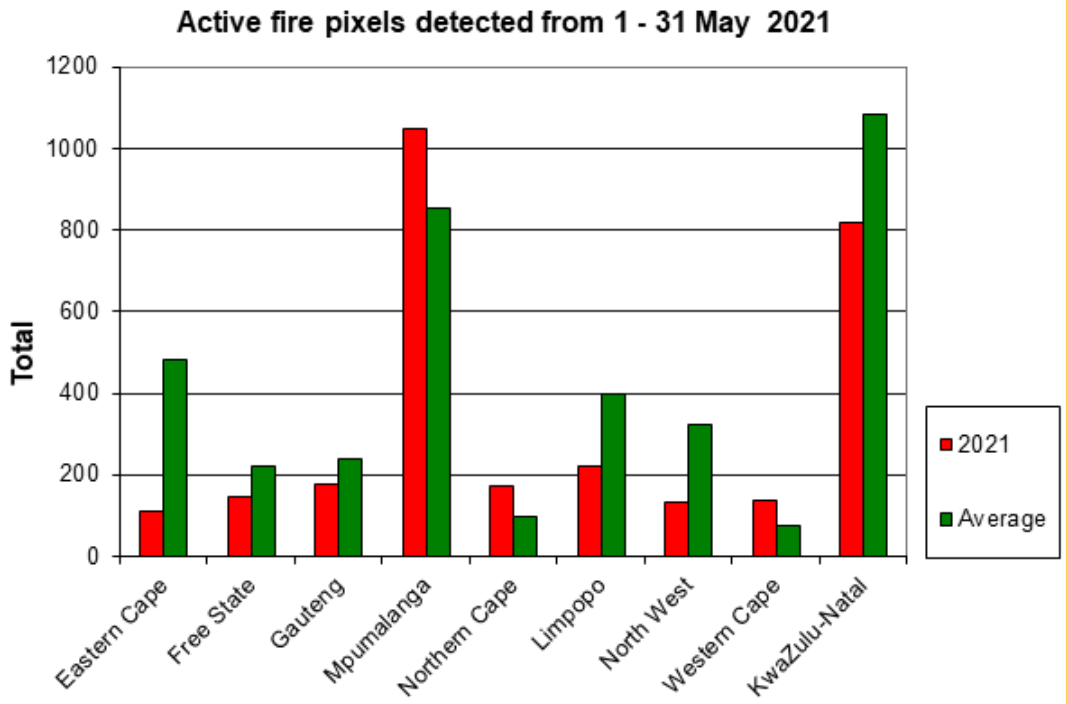

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-31 May 2021.

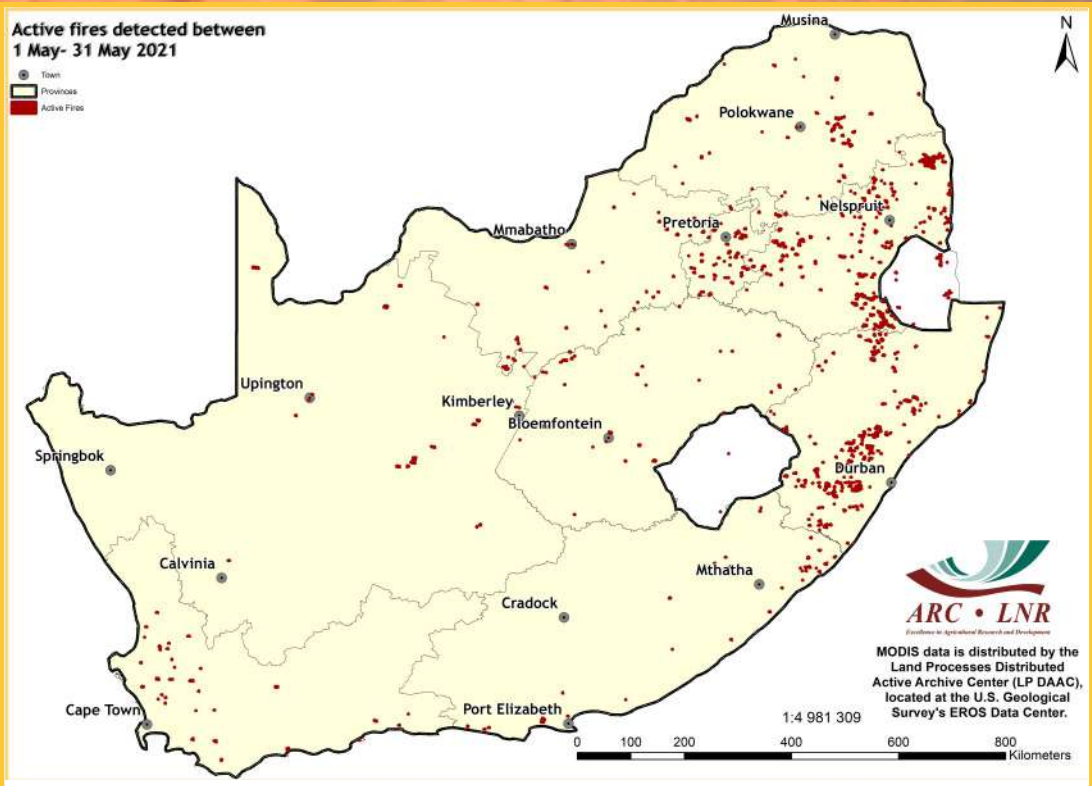

Figure 30

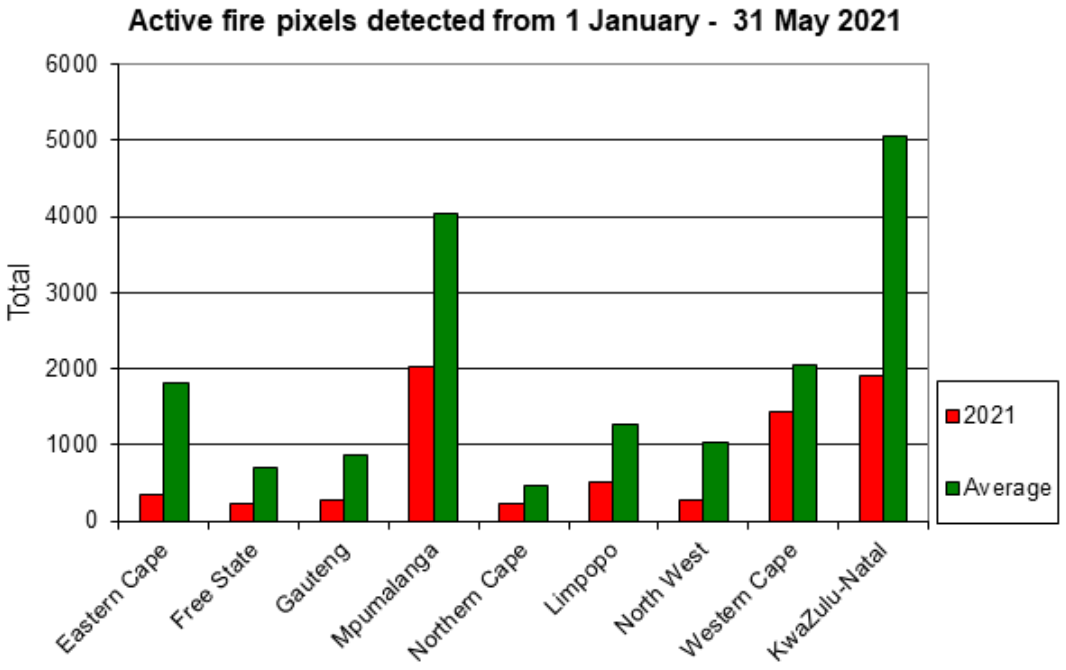

Figure 31:
The graph shows the total number of active fires detected between 1 January and 31 May 2021 per province. Cumulative fire activity was lower in all provinces compared to the long-term average.

Figure 31

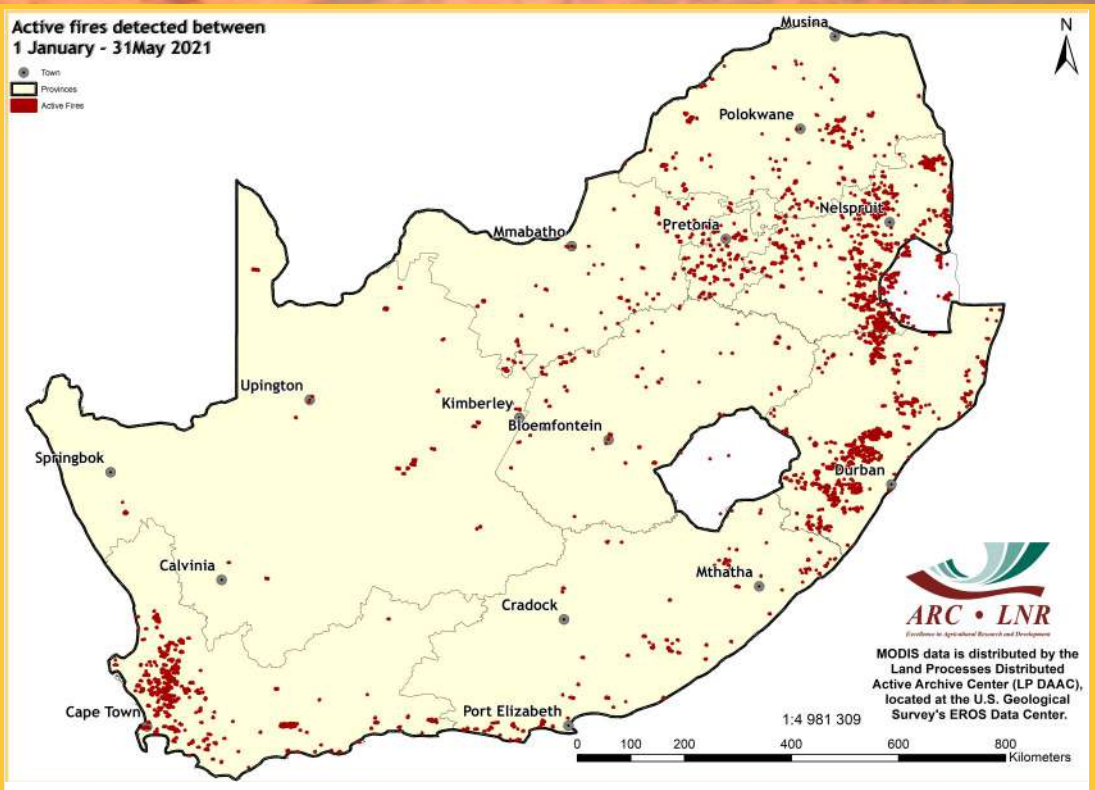

Figure 32:
The map shows the location of active fires detected between 1 January and 31 May 2021.

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 5 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 2020.

The long-term map for May 2021 shows very similar water patterns to the previous month, with the majority of the summer rainfall region catchments showing water levels equivalent to 80-100% of the 5-year, long-term maximum water. Catchments in the central Karoo, Western Cape and western coastal region of the Eastern Cape continue to show much more variable and typically lower current water levels compared to long-term maximum values.

The comparison between May 2021 and May 2020 indicates a similar pattern to that recorded last month, with the majority of the country showing current water levels between 50% and 150% of the 2020 levels. Exceptions to this are the central Karoo, which is still showing significantly lower water levels, and a number of catchments bordering Botswana and Zimbabwe which are still showing higher water levels in May 2021 compared to last year.

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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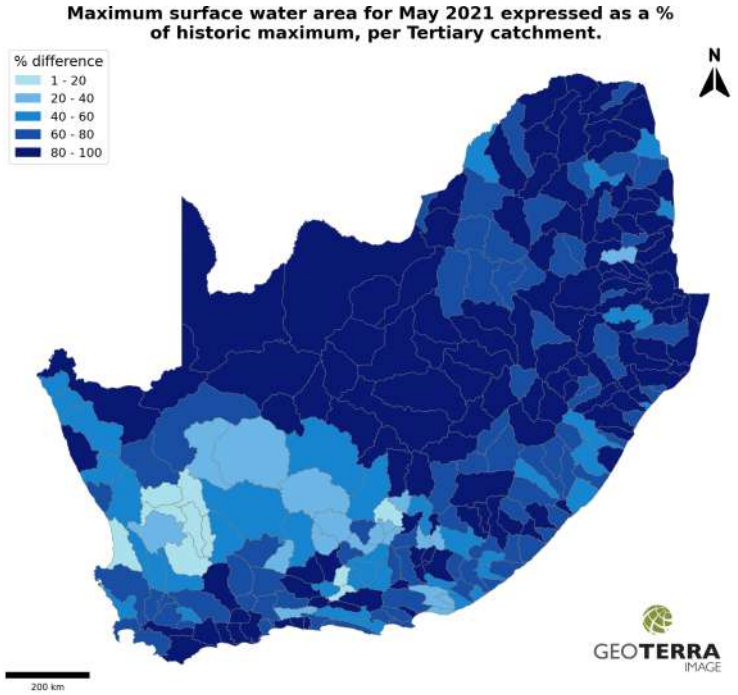

Figure 33

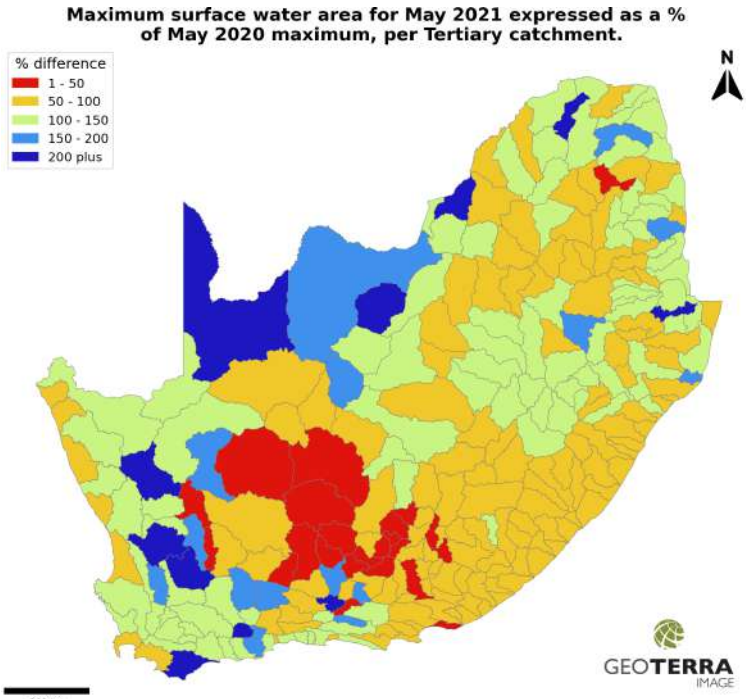

Figure 34

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".