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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

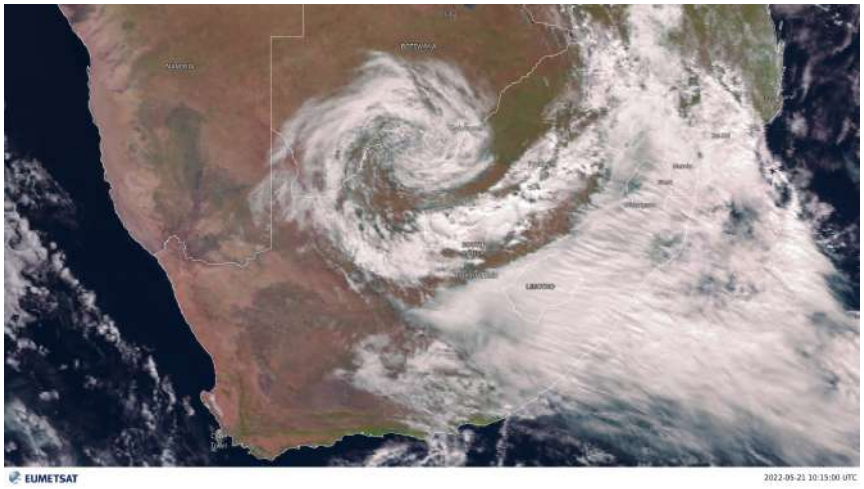
AMESD

216th Edition

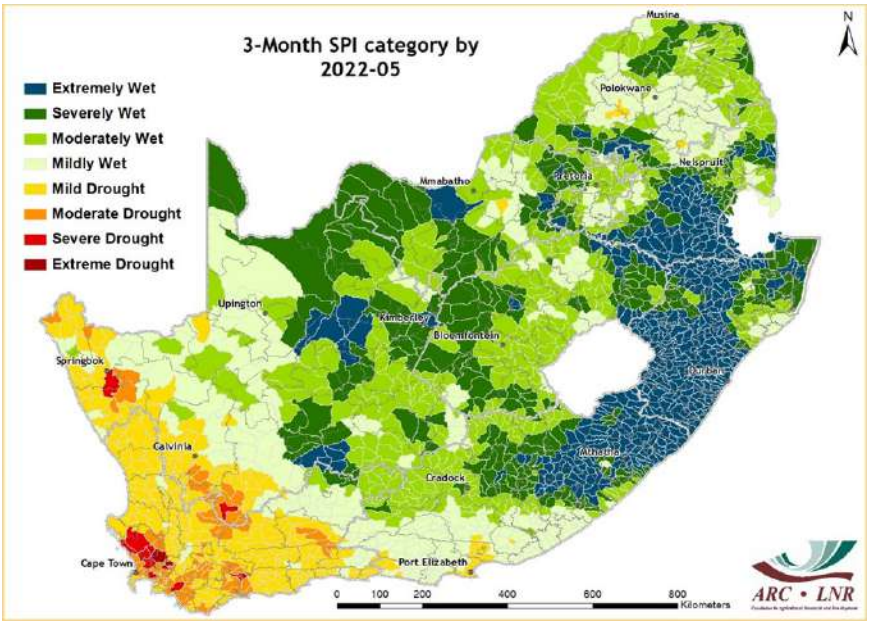
Images of the Month

Delayed onset of the winter rainfall season

It is evident that winter weather patterns are now present over the country. One prominent system during the month of May 2022 was an upper-air trough that developed into a cut-off low pressure system over the northwestern interior, resulting in wet and cold weather from 19-21 May. This system is evident on the Meteosat-11 SEVIRI natural colour enhanced image for 12:15 SAST on 21 May. During this period, high-lying areas of the eastern Free State and KwaZulu-Natal experienced light snowfalls, with mountainous areas in the Cape Winelands experiencing heavier snowfall. However, the winter rainfall region received below-normal rainfall during May, due to cold fronts tracking somewhat far south. The only areas in the winter rainfall region that recorded monthly totals exceeding 100 mm include Kirstenbosch Botanical Gardens in Cape Town and the town of Grabouw located in the Overberg District Municipality. This suggests a slow start to the winter rainfall season.



Moreover, the 3-month Standardized Precipitation Index (SPI) map ending in May shows mild to severe drought conditions evident over the winter rainfall region (southwestern parts of the country), which is concerning for agricultural production. Farmers in the drought affected areas can be advised that it is important to sell mature livestock and to continue assessing the grazing and available feed for proper planning, as overgrazing can lead to reduced capacity for coping with adverse drought conditions. Crop production practices that can mitigate the effects of drought risks during this winter rainfall season need to be determined per region and conveyed effectively to farmers.



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:

Although lesser in amount, contrasting rainfall conditions observed in April continued during May 2022. Unseasonably wet conditions resulting in above-normal rainfall occurred over the summer rainfall region, as against the somewhat dry winter rainfall region. The month started with dry and warm daytime temperatures over greater parts of the country. Then on the 6th a cold front made landfall, resulting in rainy conditions over most parts of the Western Cape and some parts of the all-year rainfall region in the Eastern Cape. A day later, parts of the interior experienced light showers, specifically, in Gauteng, North West, Northern Cape, Free State, Mpumalanga and KwaZulu-Natal. The second dekad was characterized by a series of light rainy days over the Western Cape and the northeastern region of the country. These conditions were then intensified by a cut-off low pressure system that resulted in heavy rains and freezing conditions over the interior, moving southeast towards KZN and the Eastern Cape. This system brought widespread frost to the interior, snow in mountainous areas and was the main contributor to the above-normal conditions visible over the summer rainfall region.

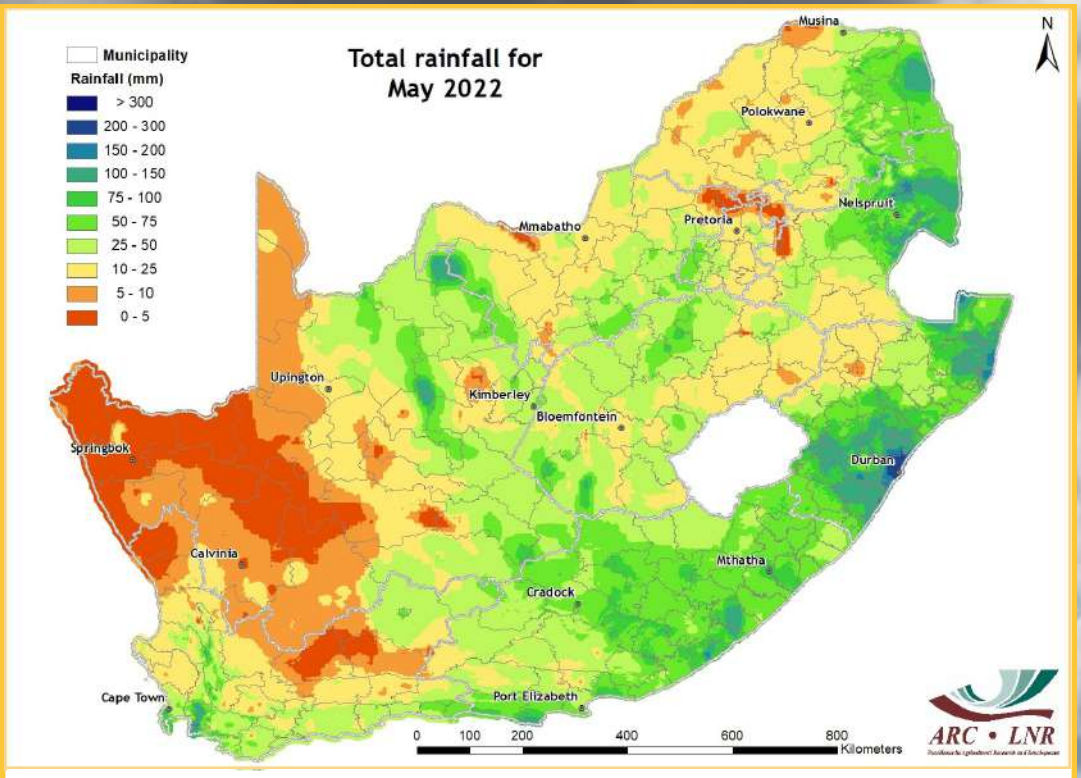
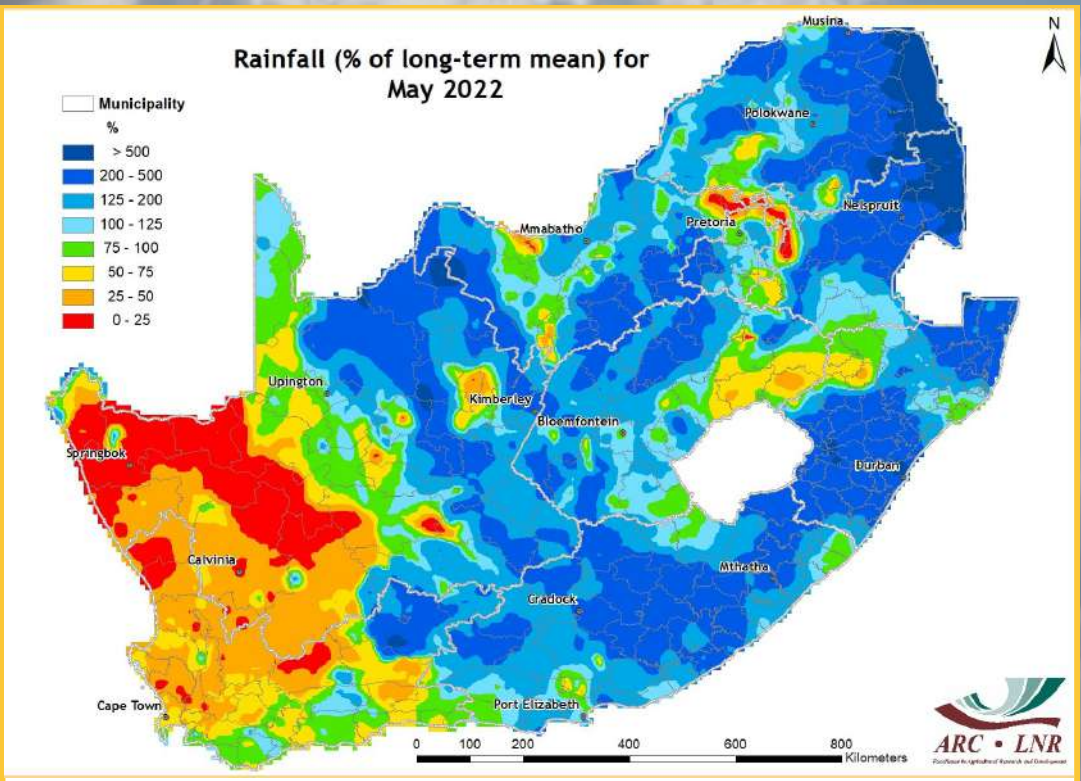


Figure 1



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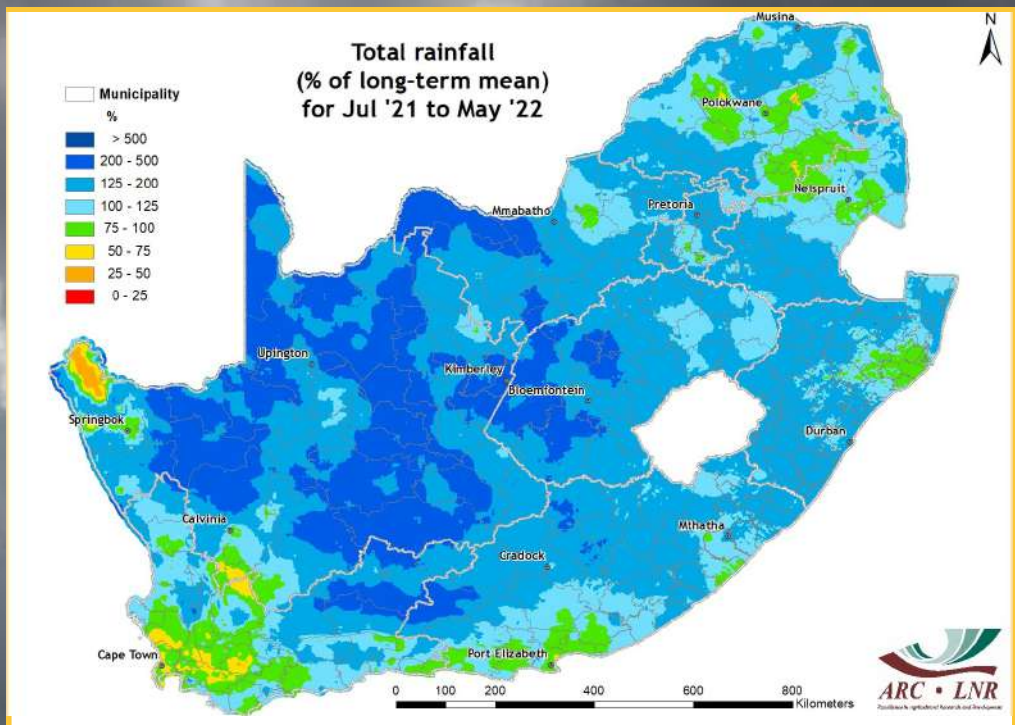

Figure 3

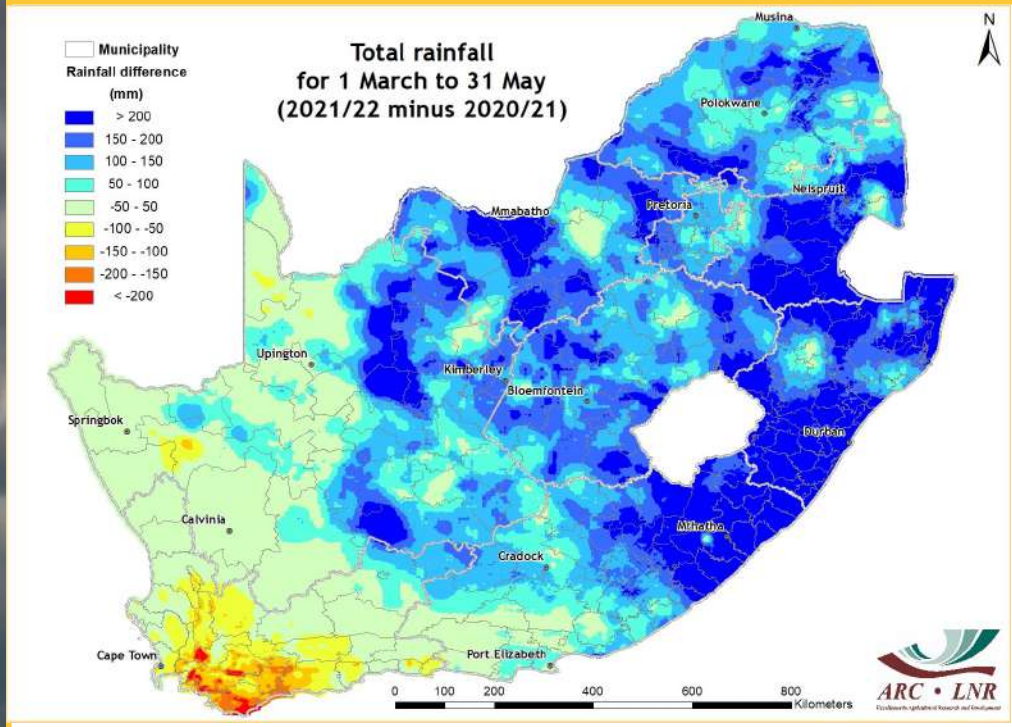

Figure 4

Figure 1:
Good rainfall totals, exceeding 200 mm in places, occurred over the eastern to southeastern parts of the country in May 2022. Several frontal systems resulted in rainfall activity over greater parts of the country, but the winter rainfall region recorded totals of <150 mm for the month.

Figure 2:
Above-normal rainfall occurred over the eastern half of the country during May 2022 whilst below-normal conditions were predominant in the western and southwestern parts. The all-year rainfall region received near-normal rainfall.

Figure 3:
Rainfall totals for the period between July 2021 and May 2022 indicate widespread above-normal rainfall conditions over greater parts of the country.

Figure 4:
Large areas over the interior, moving southeast towards the Eastern Cape and KwaZulu-Natal, received significantly more rain (up to 200 mm) during March to May 2022 as compared to the corresponding period last year. In contrast, the southeastern corner in the Western Cape received considerably less rain while the western parts 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), medium-term (12-month) and long-term (24- and 36-month) drought conditions ending in May 2022 are shown in Figures 5-8. The occurrence of wet conditions over most parts of the country is clearly visible on the 6- and 12-month time scales. However, mild to severe drought conditions are also depicted on the short to medium term maps. Longer time scales show moderate to extremely wet conditions over the central interior, while moderate to severe drought conditions dominate the far western regions of the country, extending towards the Eastern Cape and the interior of Limpopo and Mpumalanga.

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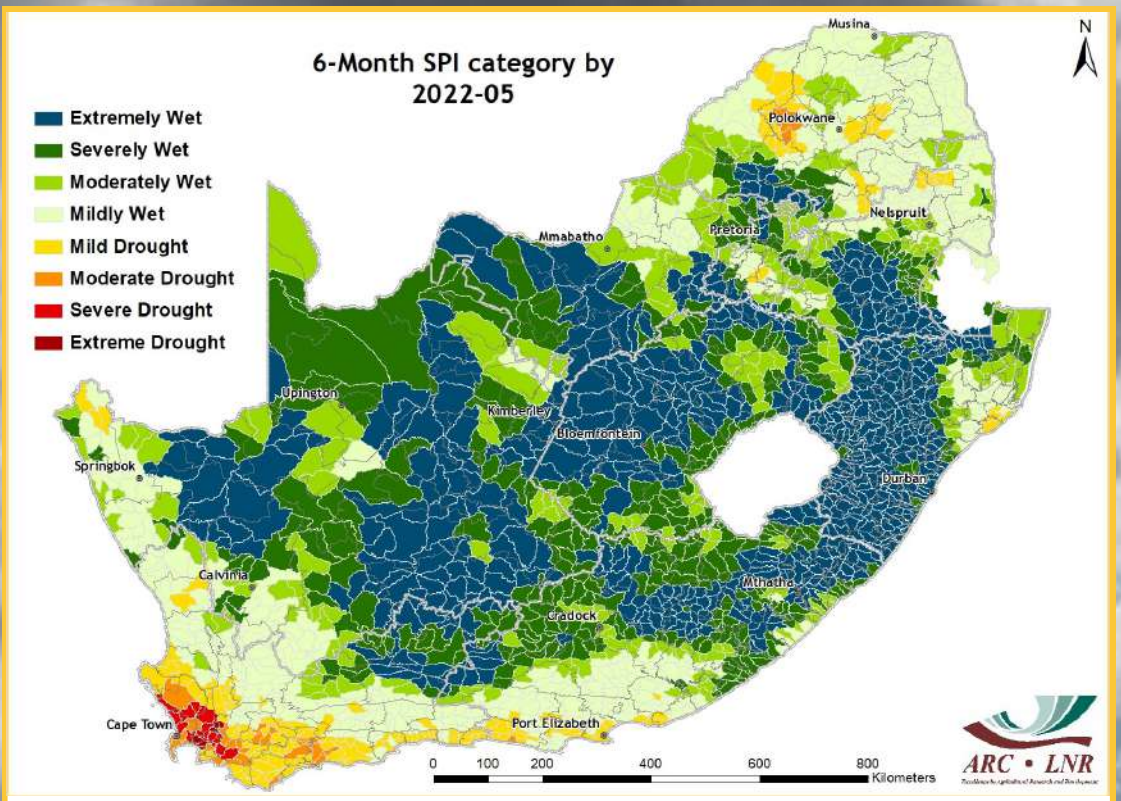

Figure 5

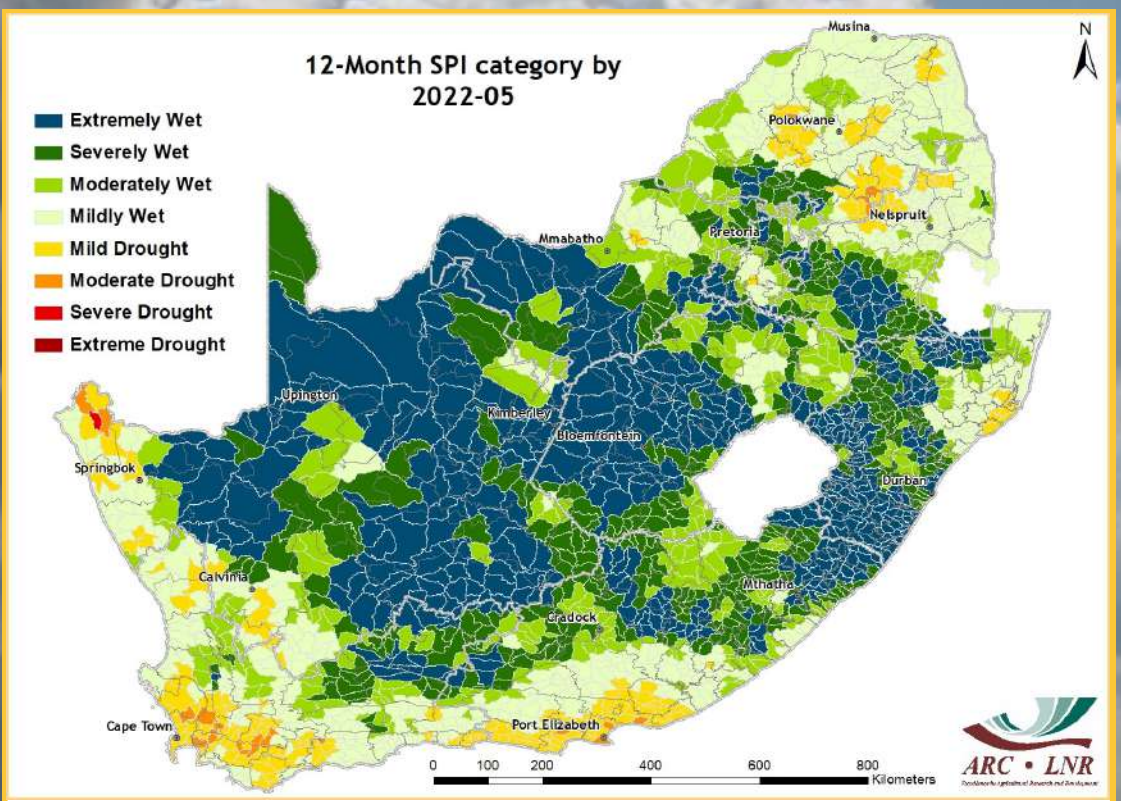

Figure 6

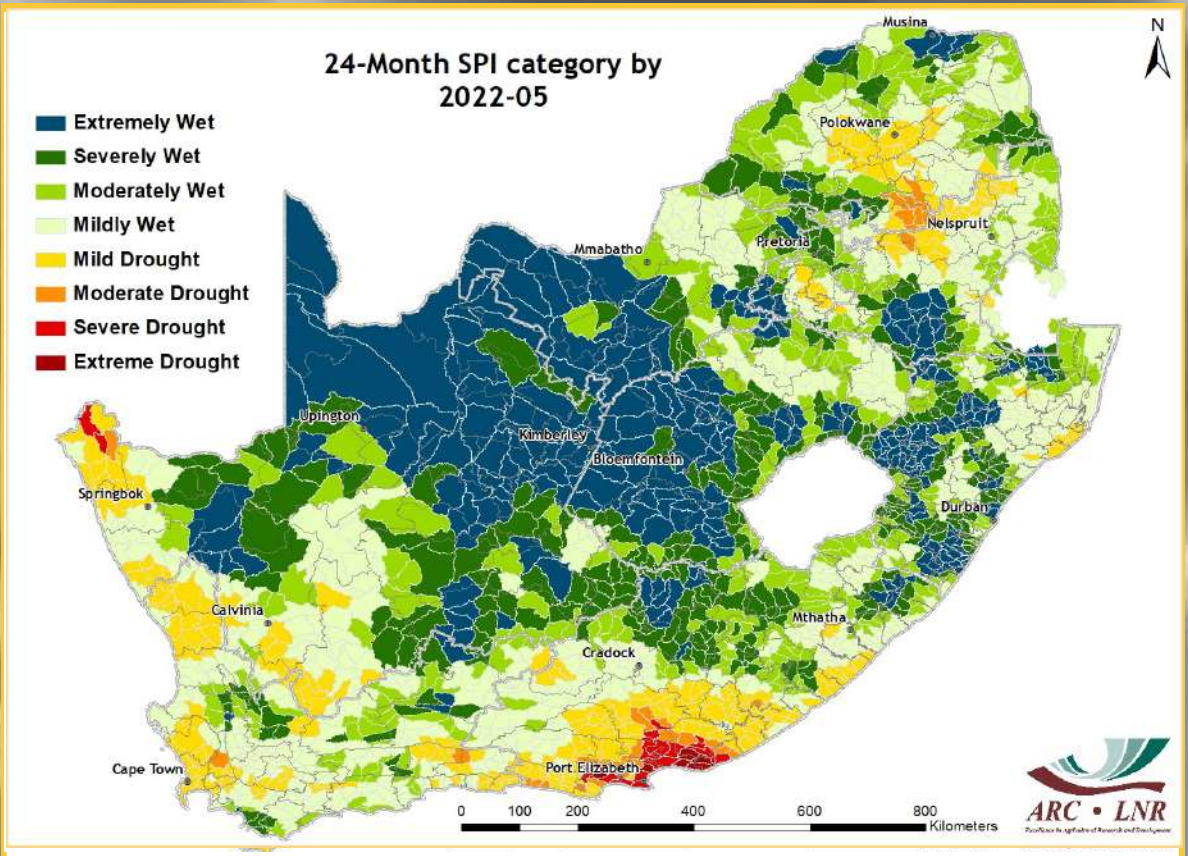

Figure 7

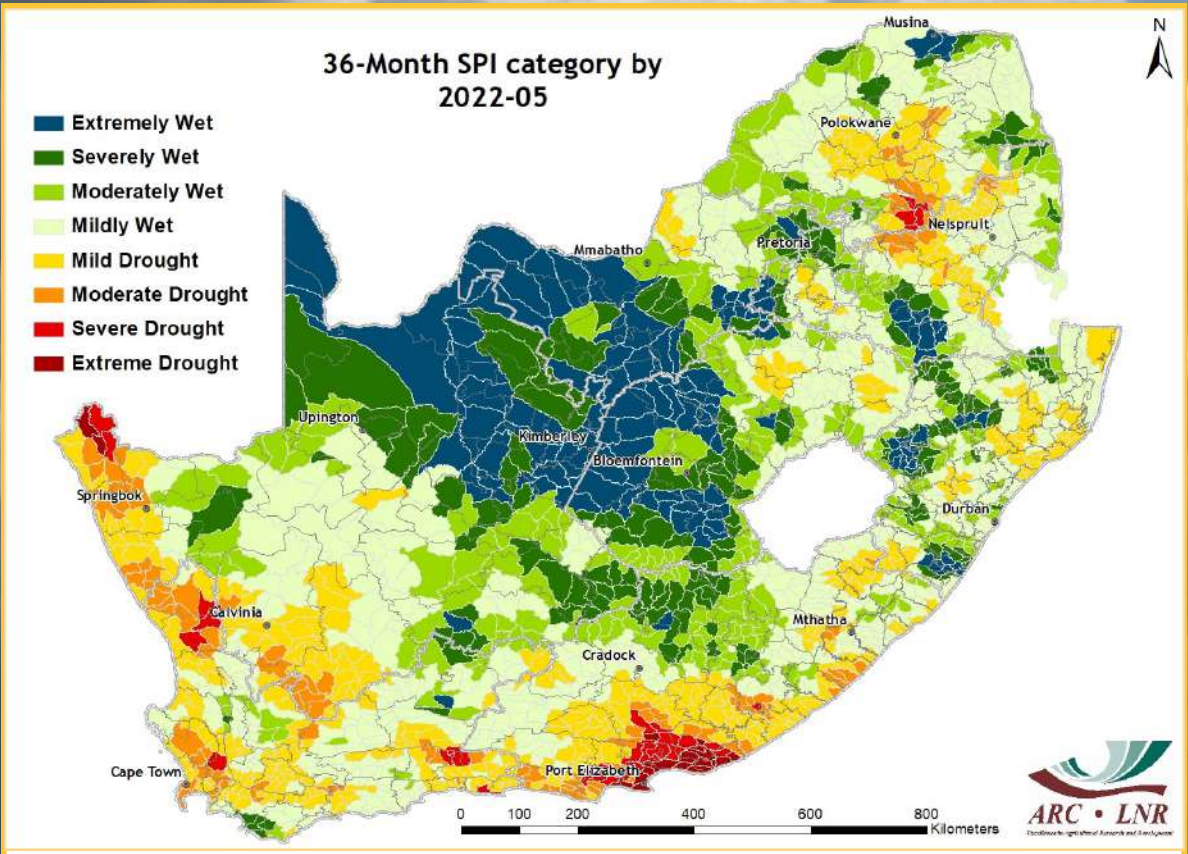

Figure 8

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.

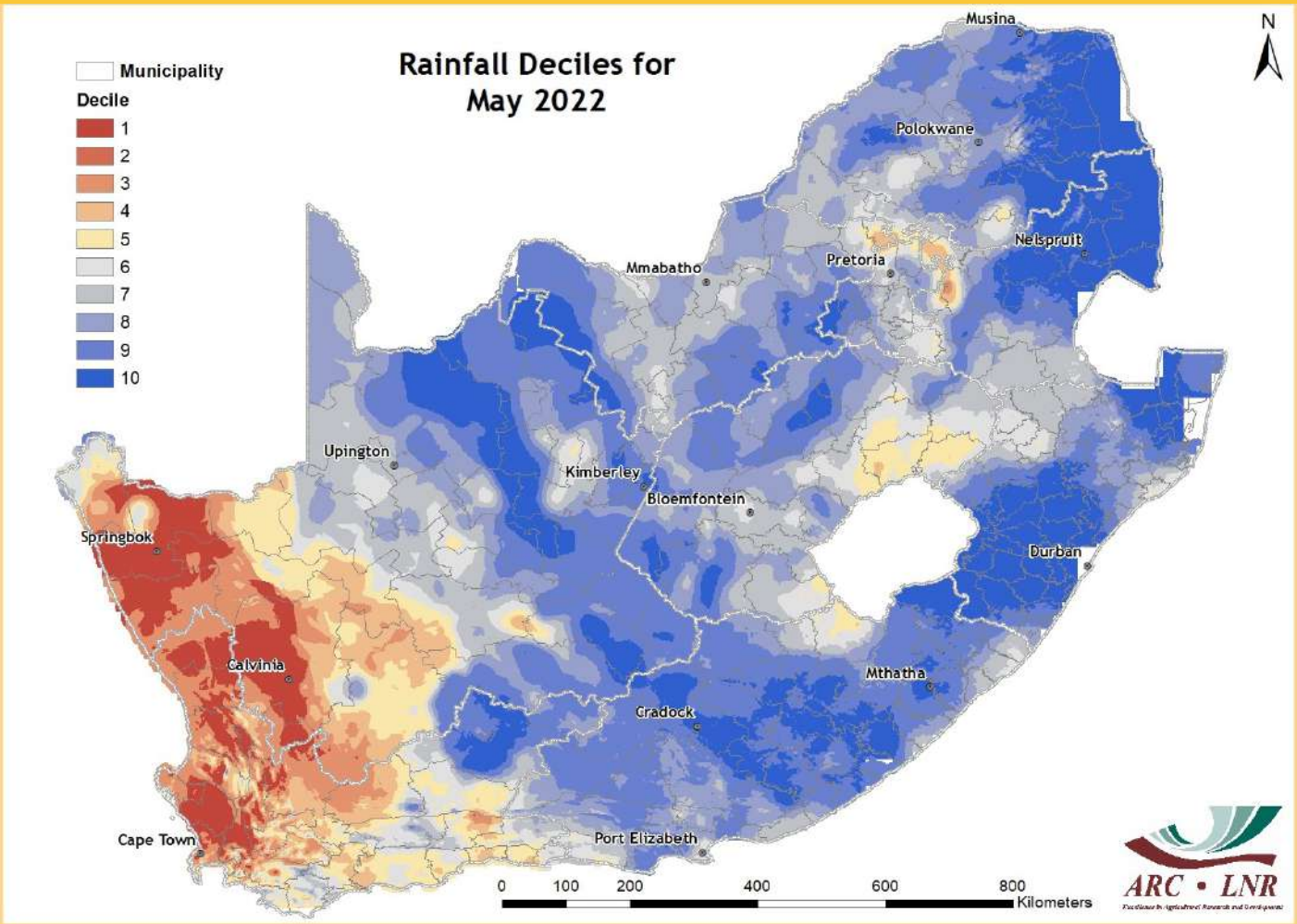

Figure 9

Figure 9:
The winter rainfall region and the adjacent areas of the Cape provinces were noticeably dry during May 2022, while most parts of the summer rainfall region 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.

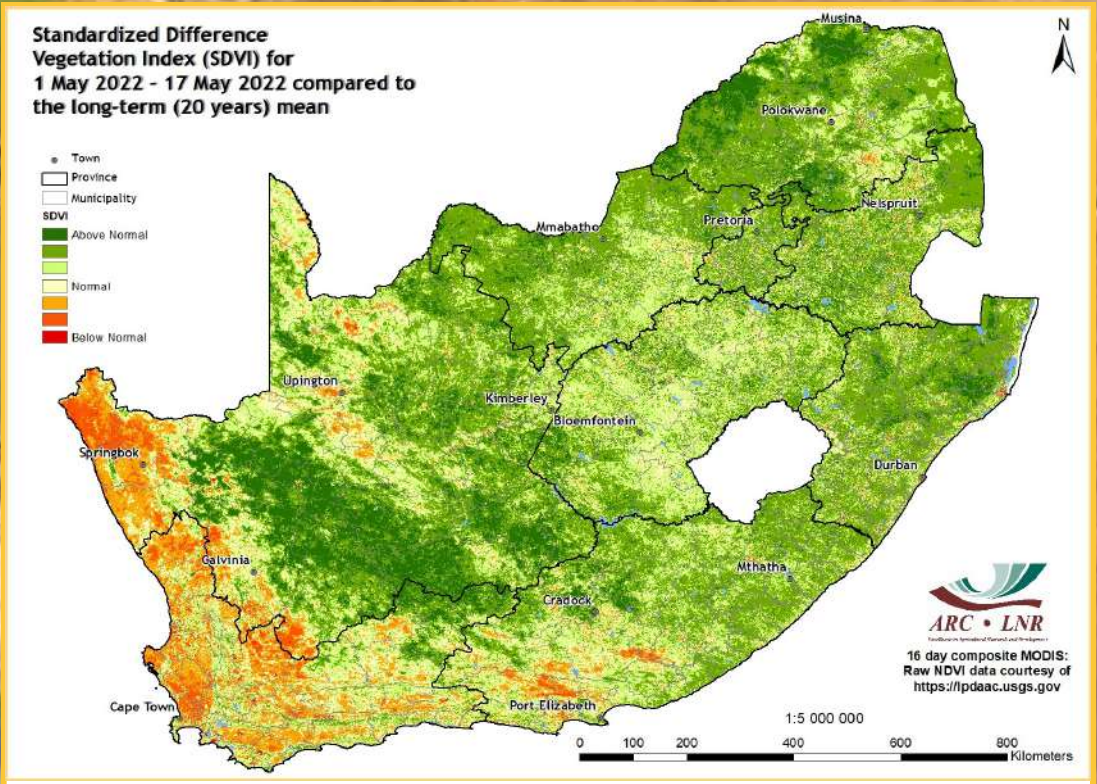

Figure 10

Figure 10:
Compared to the historical averaged vegetation conditions, the 16-day SDVI map for May 2022 shows that many parts of the country experienced above-normal vegetation activity, except for the Cape provinces.

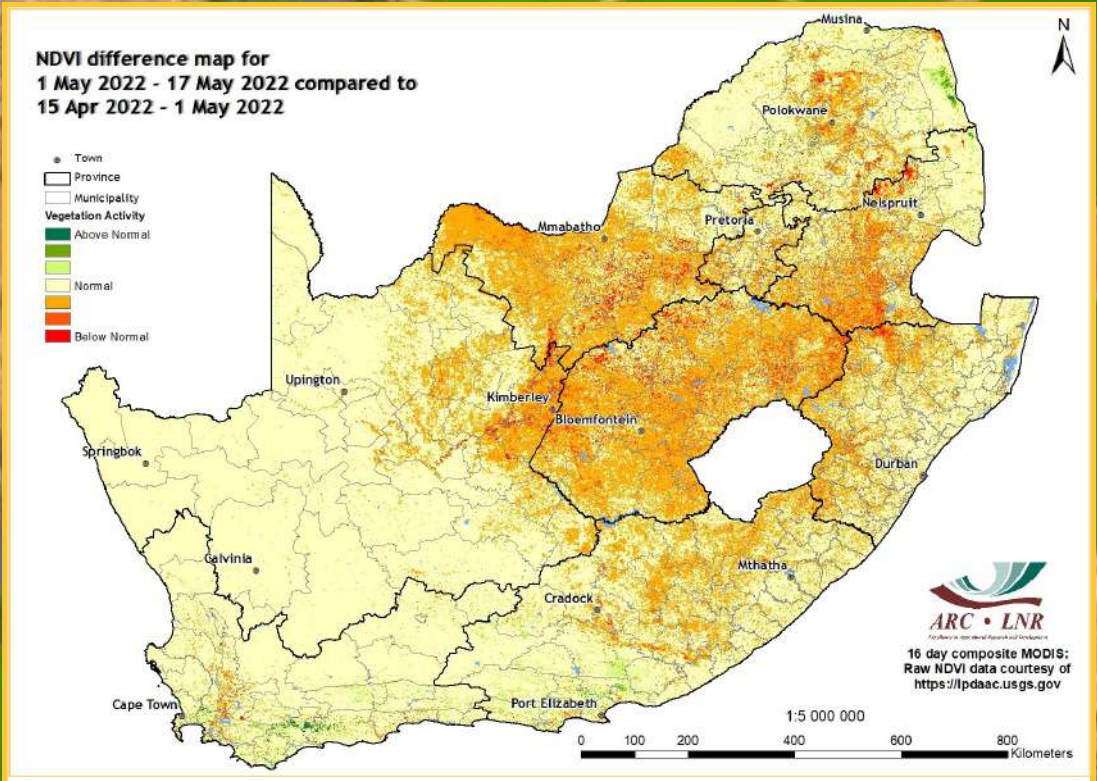

Figure 11

Figure 11:
The 16-day NDVI difference map for May 2022 compared to the previous 16-day period shows that the central interior experienced mostly below-normal vegetation conditions while the remaining parts of the country experienced normal vegetation conditions.

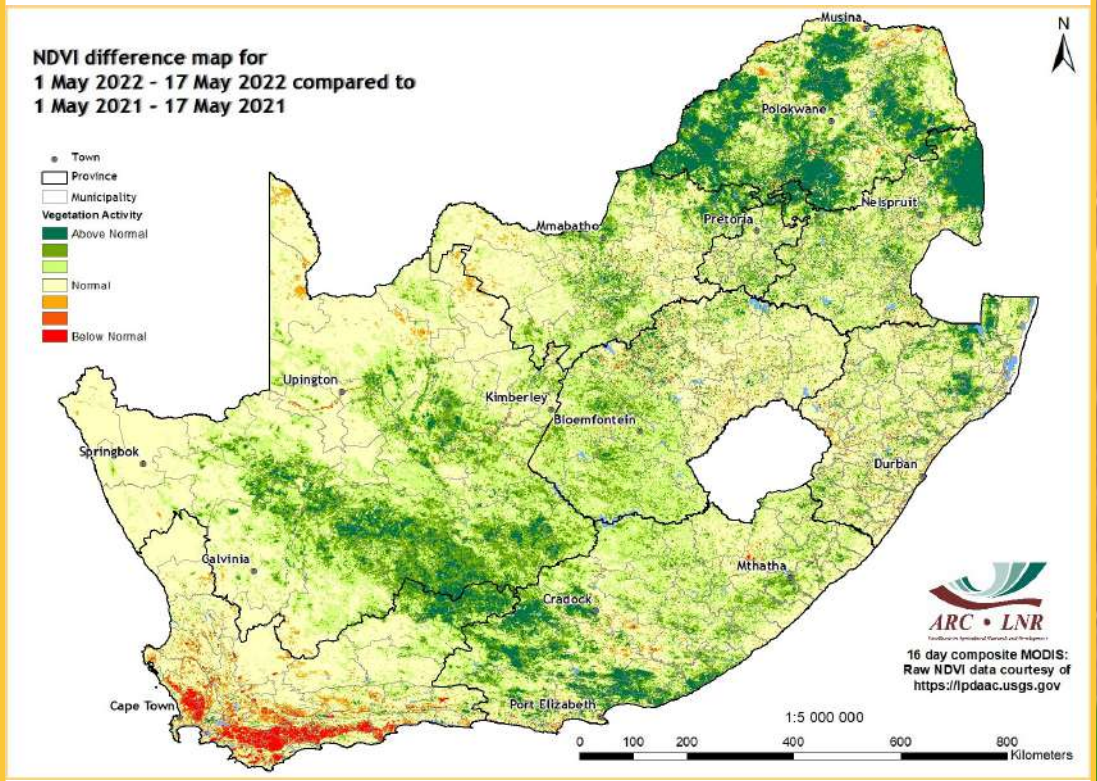

Figure 12

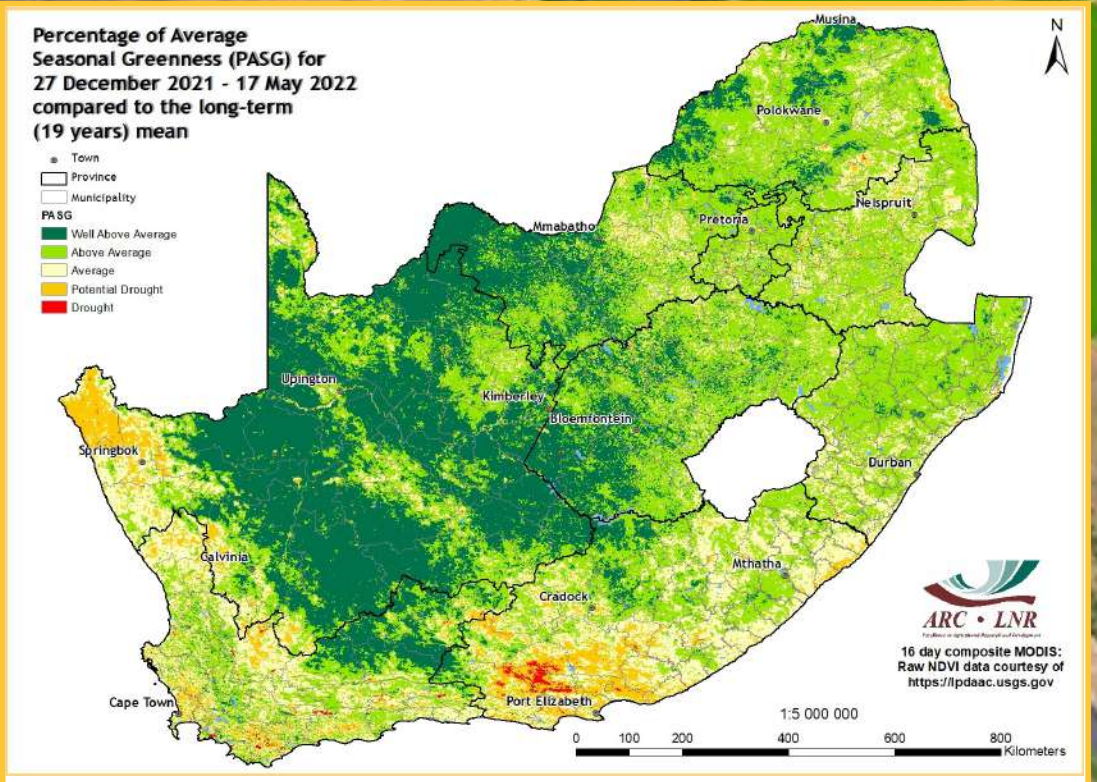

Figure 13

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:
The 16-day NDVI difference map for May 2022 compared to the same period last year shows that most parts of the country experienced normal to above-normal vegetation activity with pockets of below-normal vegetation in isolated areas.

Figure 13:
The Percentage of Average Seasonal Greenness (PASG) map for the past 5 months, compared to the long-term mean, shows high levels of seasonal vegetation greenness in the central inferior of the country. Pockets of potential drought conditions were observed, mostly in the Cape provinces.

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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.

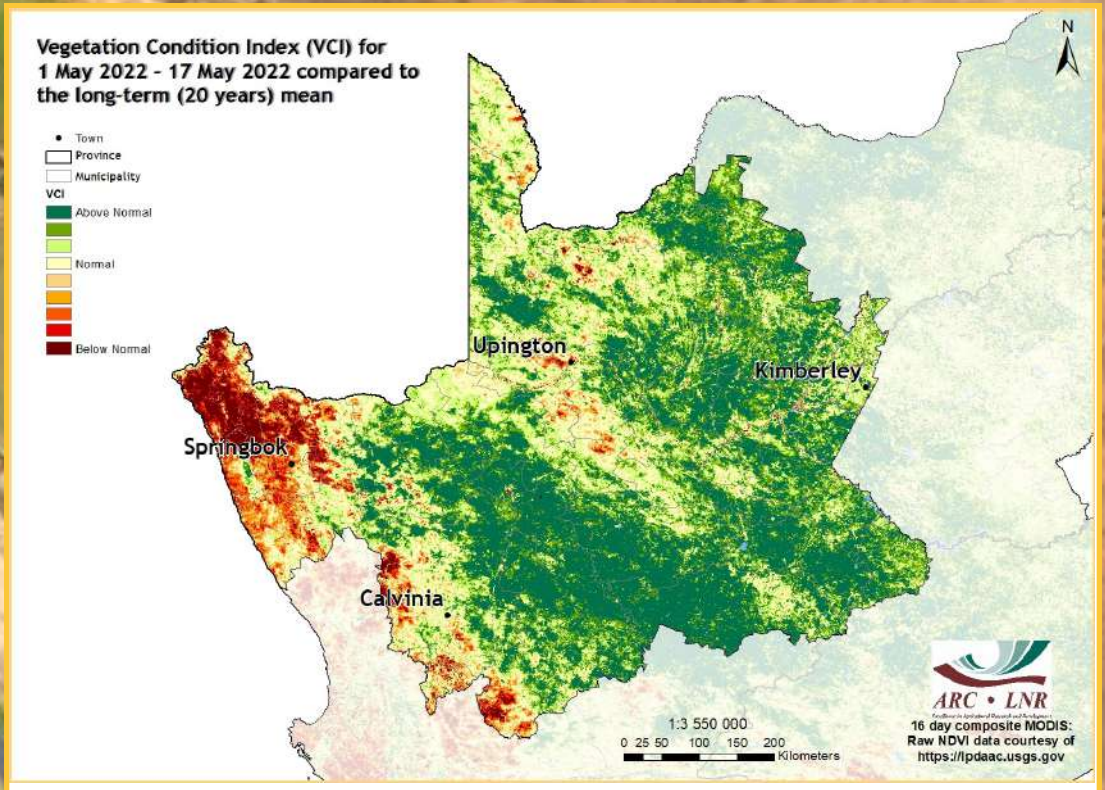

Figure 14

Figure 14:
The 16-day VCI map for May 2022 indicates that most parts of the Northern Cape continue to experience improved vegetation conditions, except for the far western parts and a few areas in the central region which are still experiencing drought conditions.

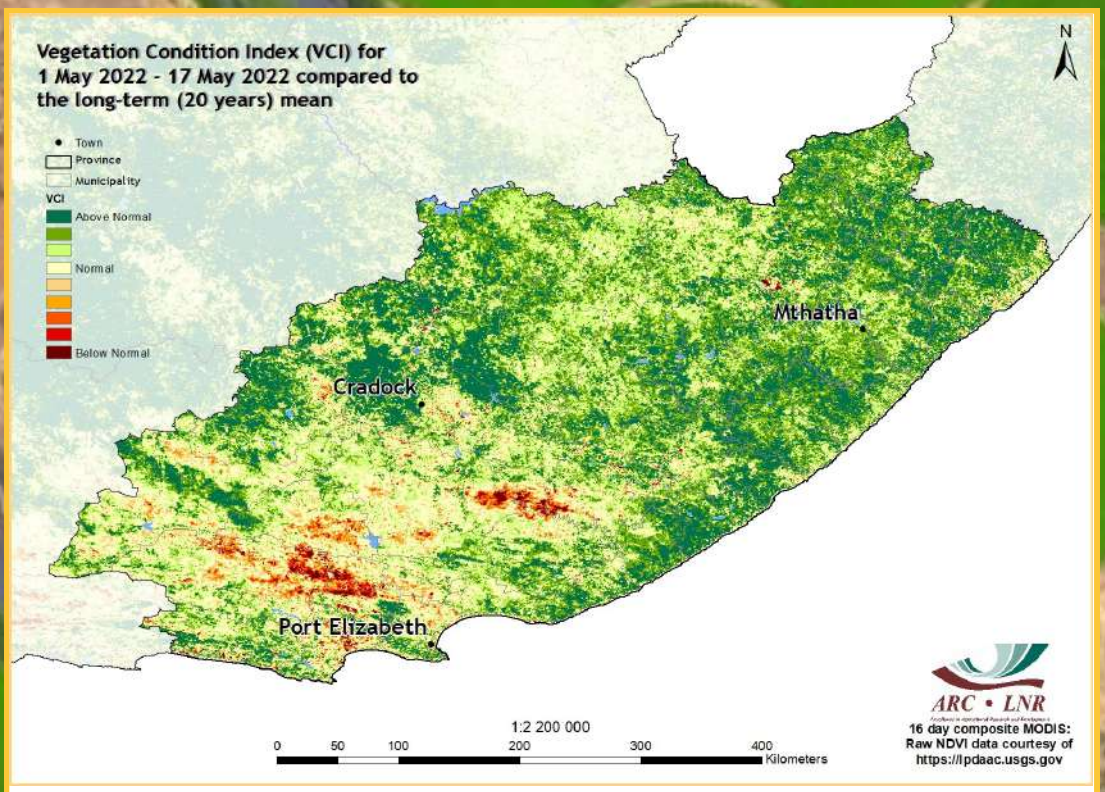

Figure 15

Figure 15:
The 16-day VCI map for May 2022 indicates that vegetation conditions have improved in most parts of the Eastern Cape. However, poor vegetation activity persists in the Sarah Baartman District Municipality.

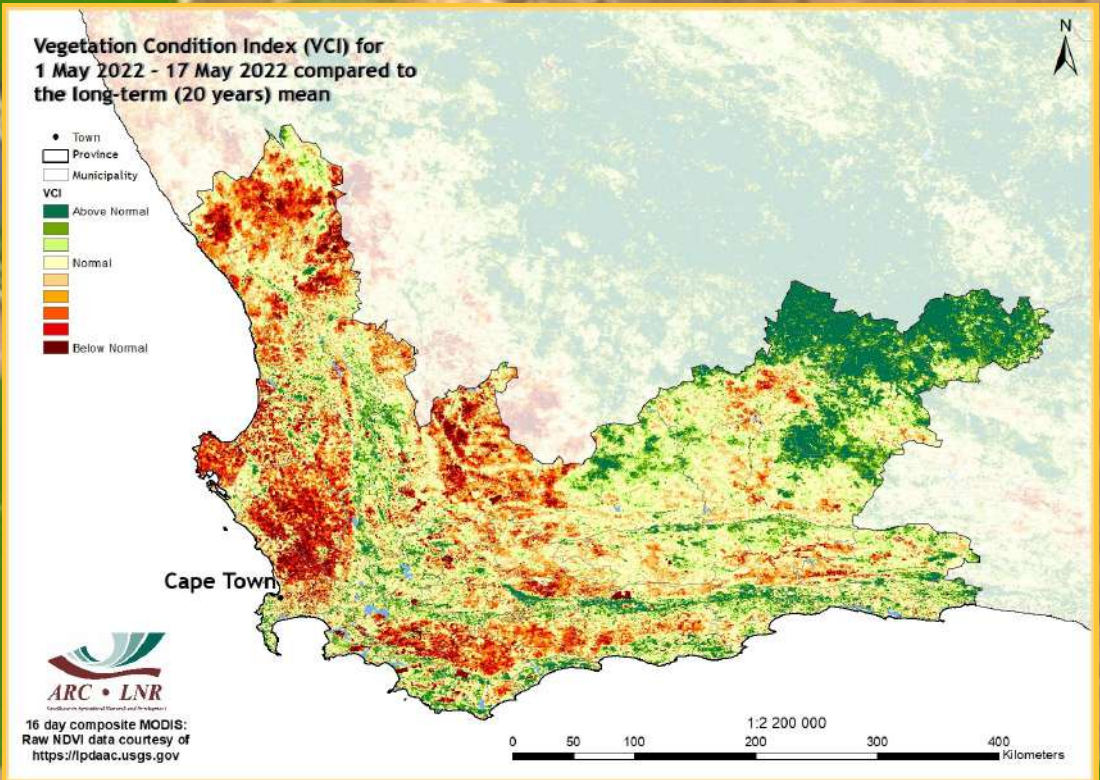

Figure 16

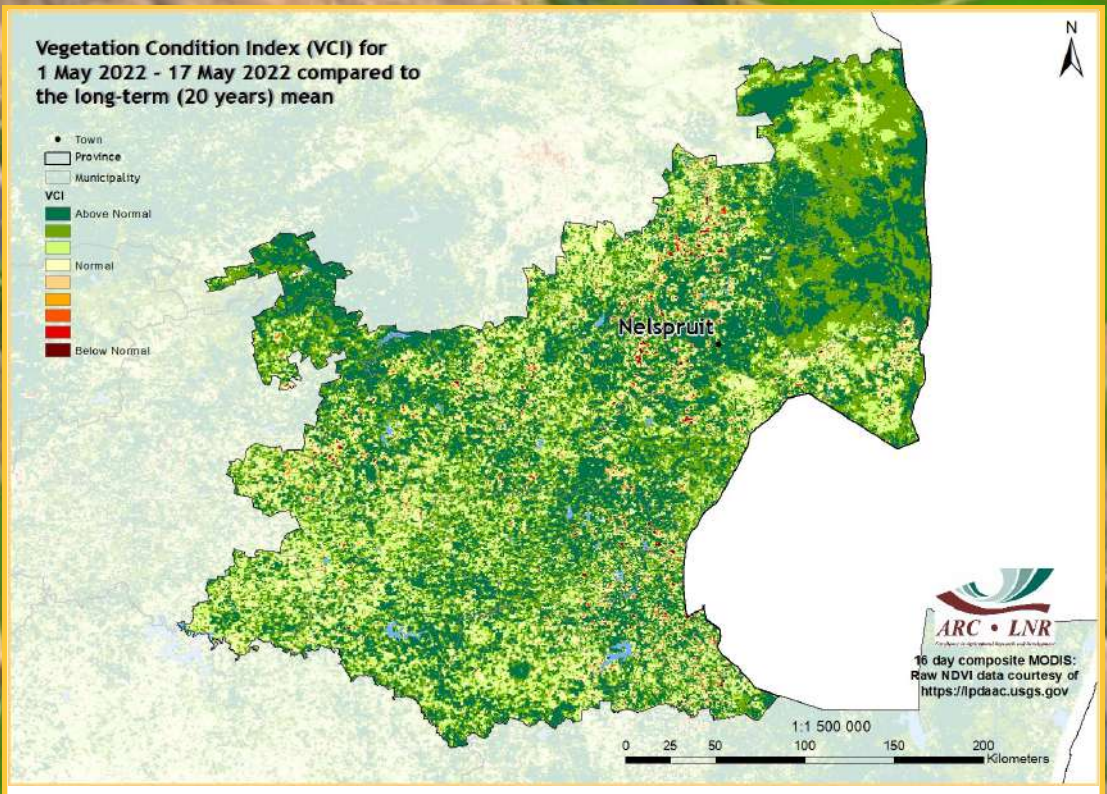

Figure 17

Figure 16:
The 16-day VCI map for May 2022 indicates that below-normal vegetation conditions are prevalent throughout the Western Cape, although a few pockets of good vegetation activity can also be observed.

Figure 17:
The 16-day VCI map for May 2022 indicates that above-normal vegetation conditions are now prevalent throughout Mpumalanga.

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6. Vegetation Conditions & Rainfall

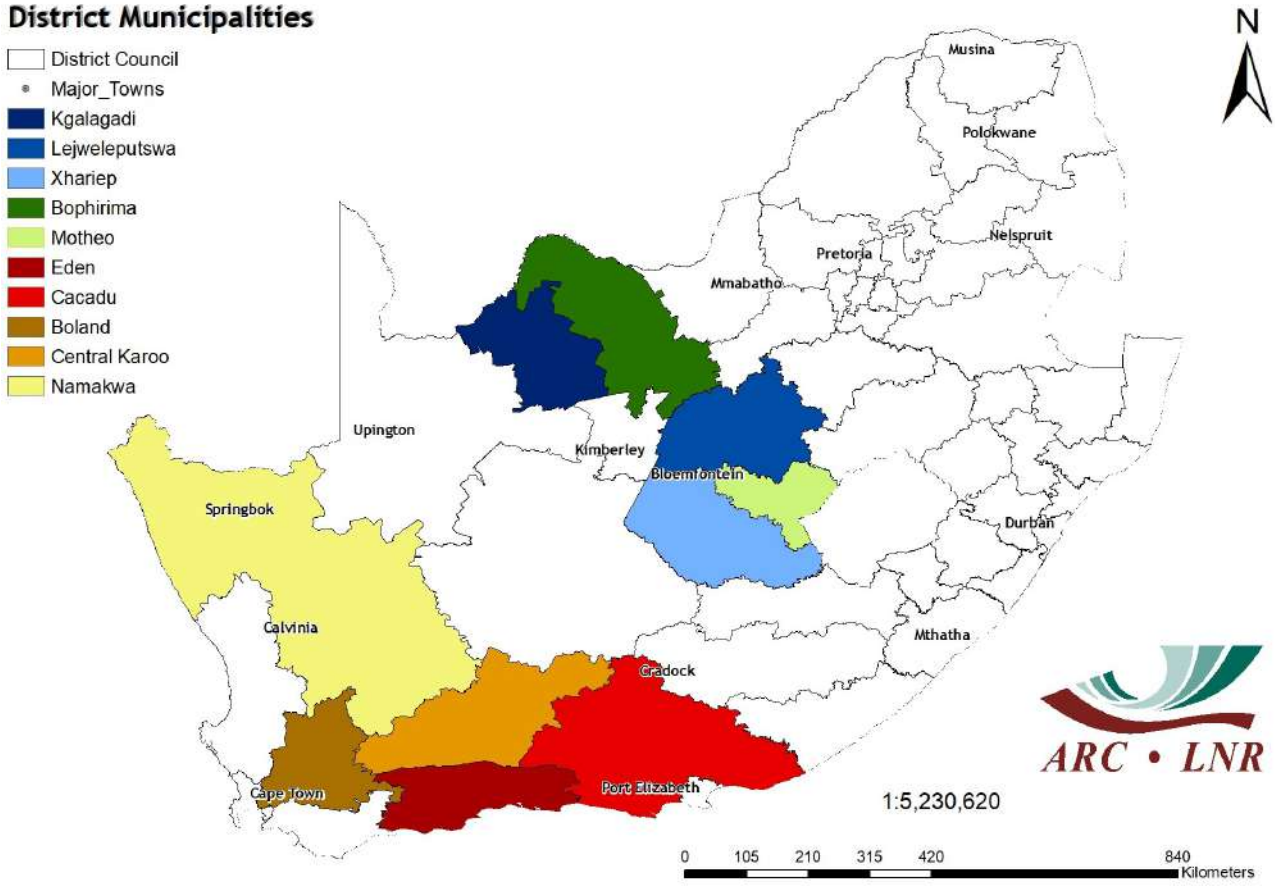

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for May 2022. 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.

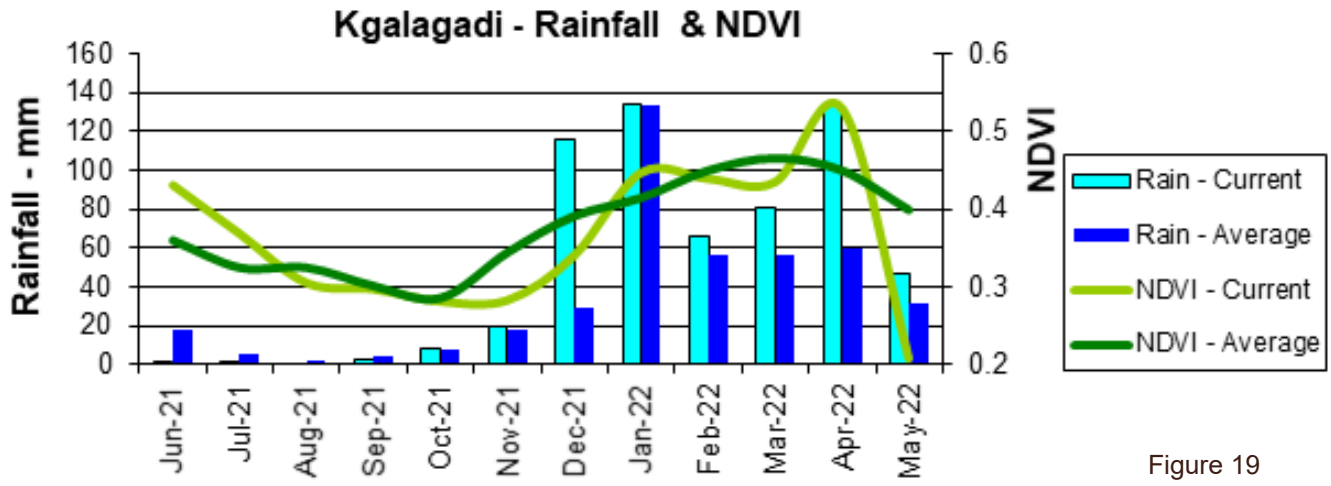
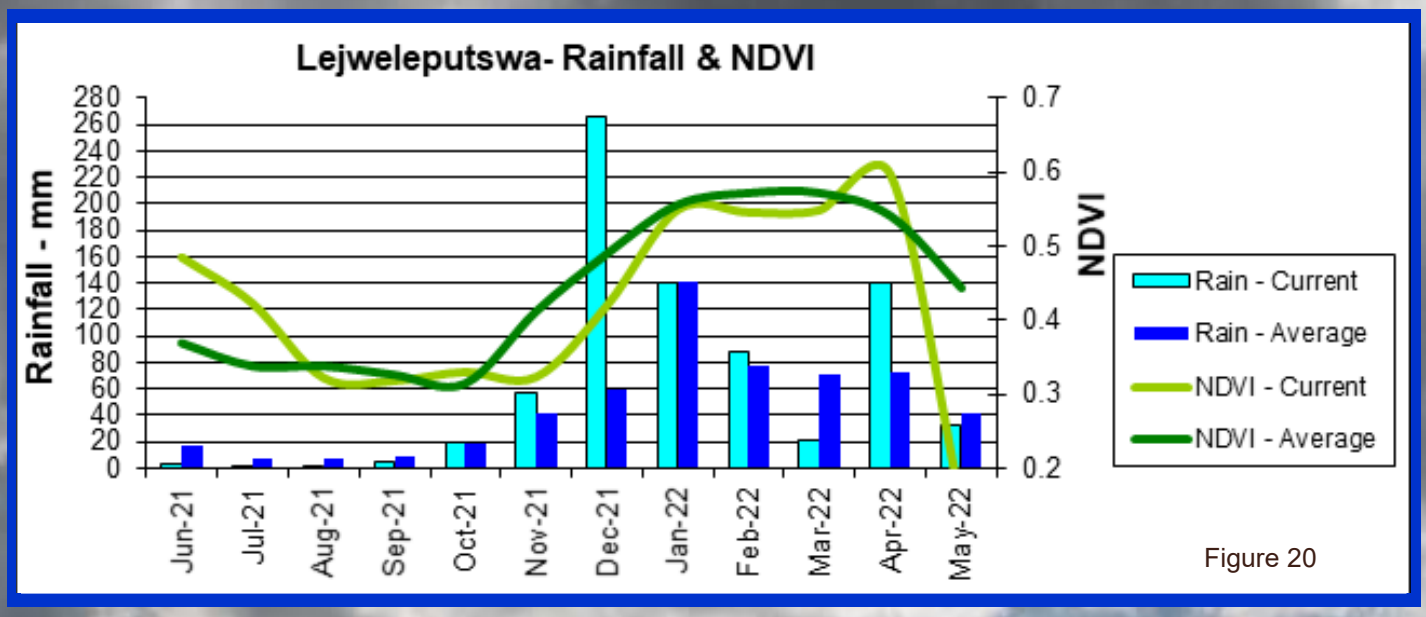


Figure 19



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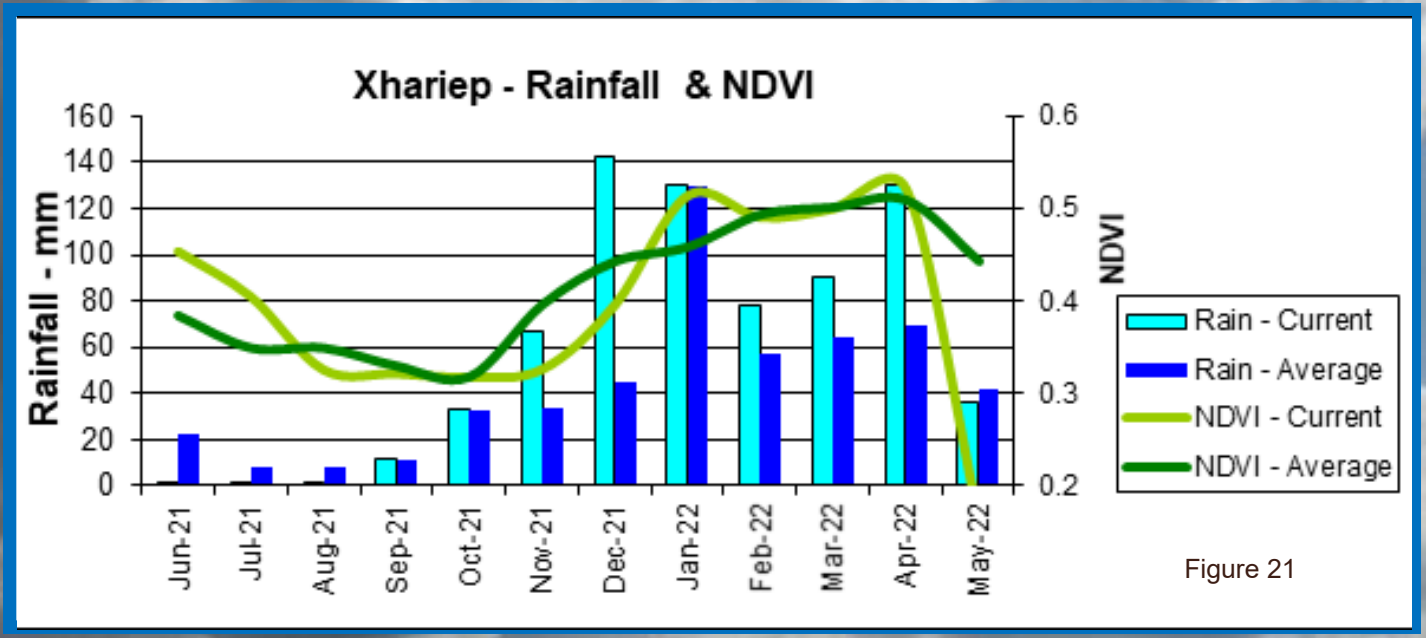

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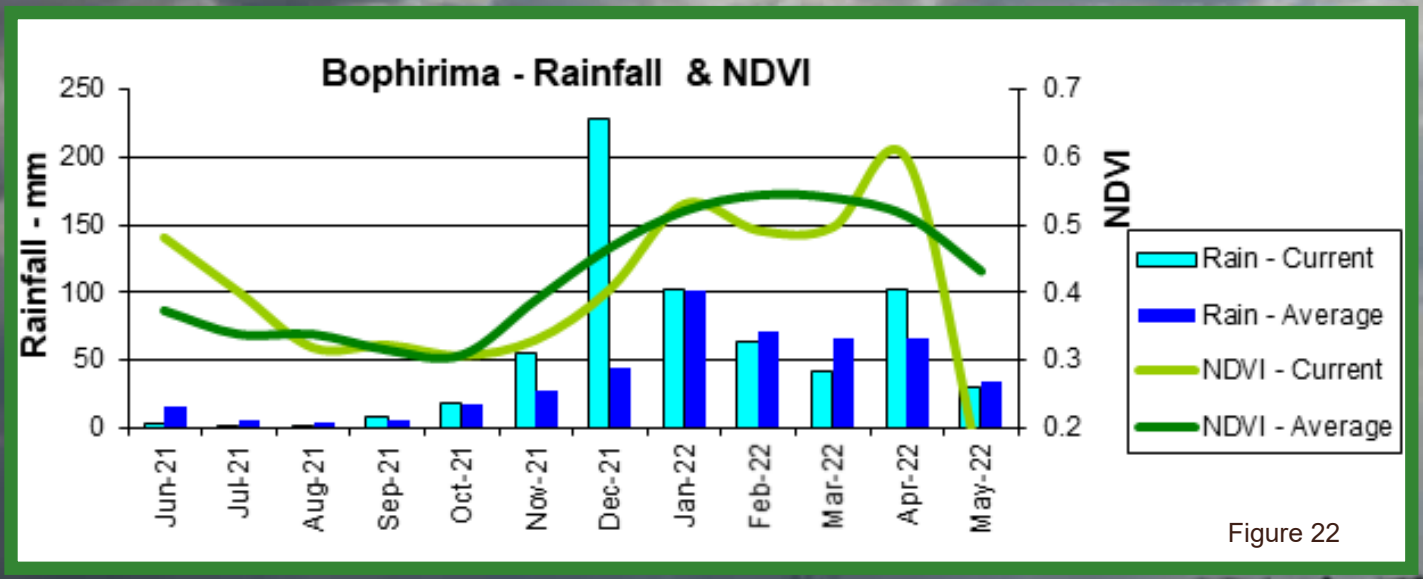

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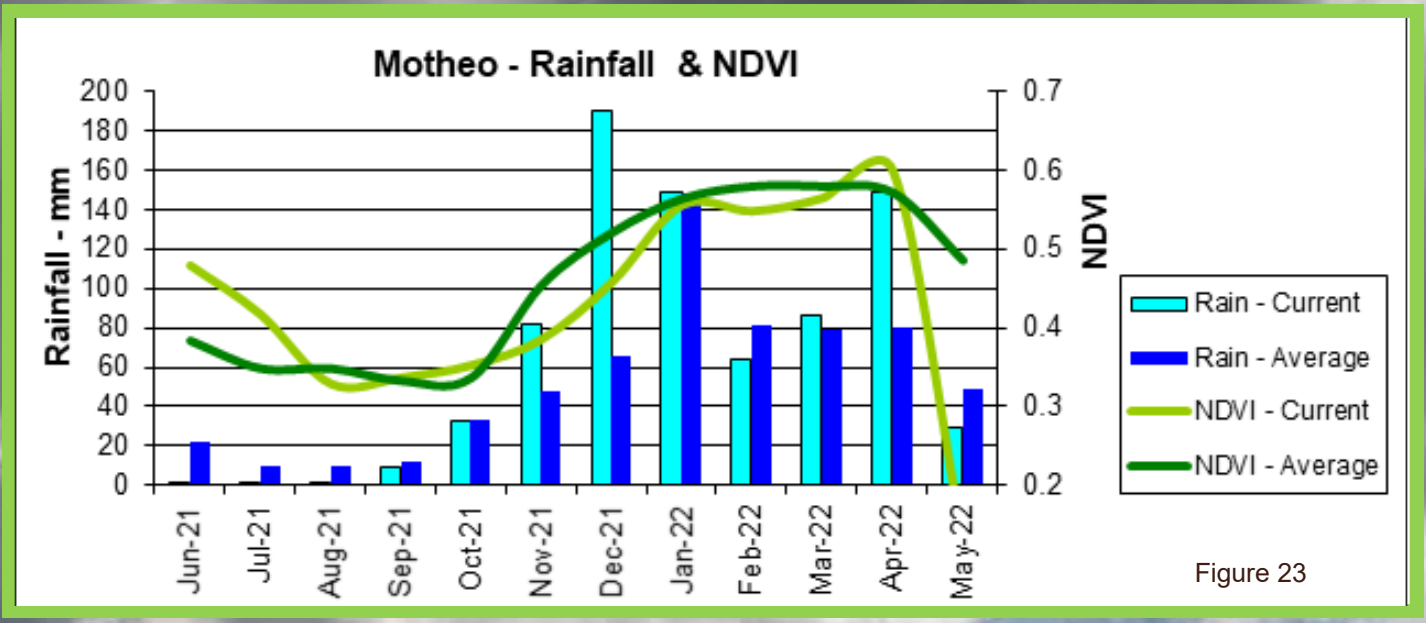

Figure 23

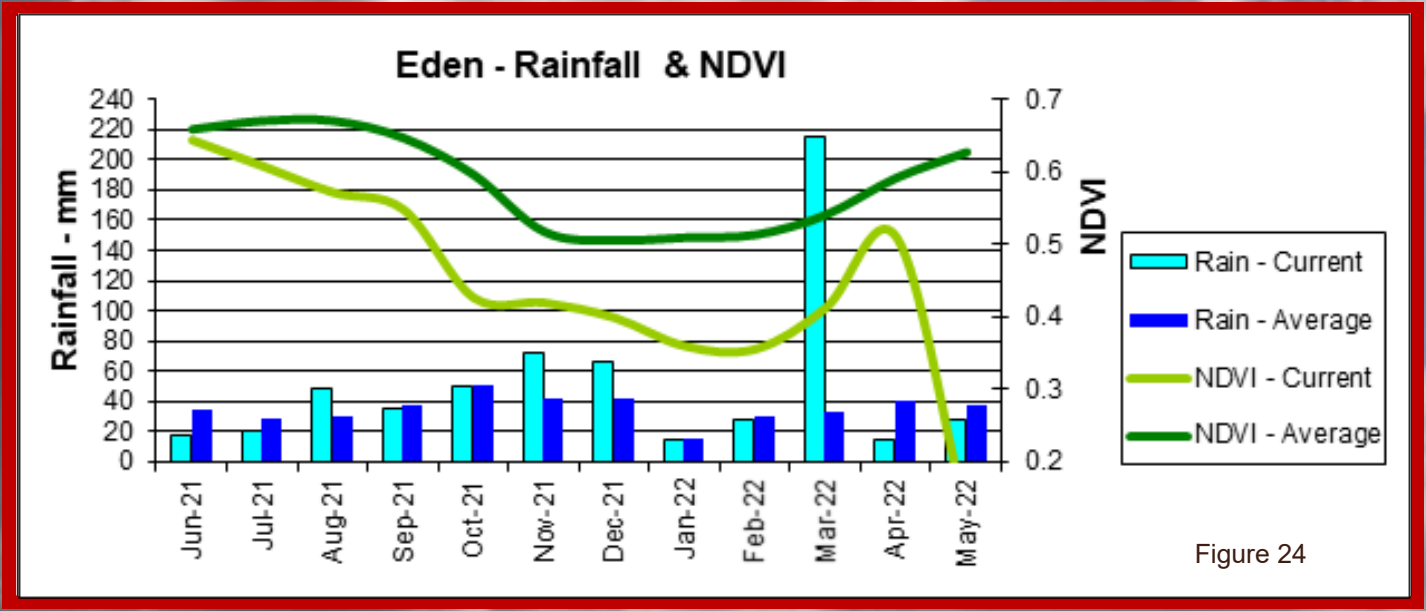

Figure 24

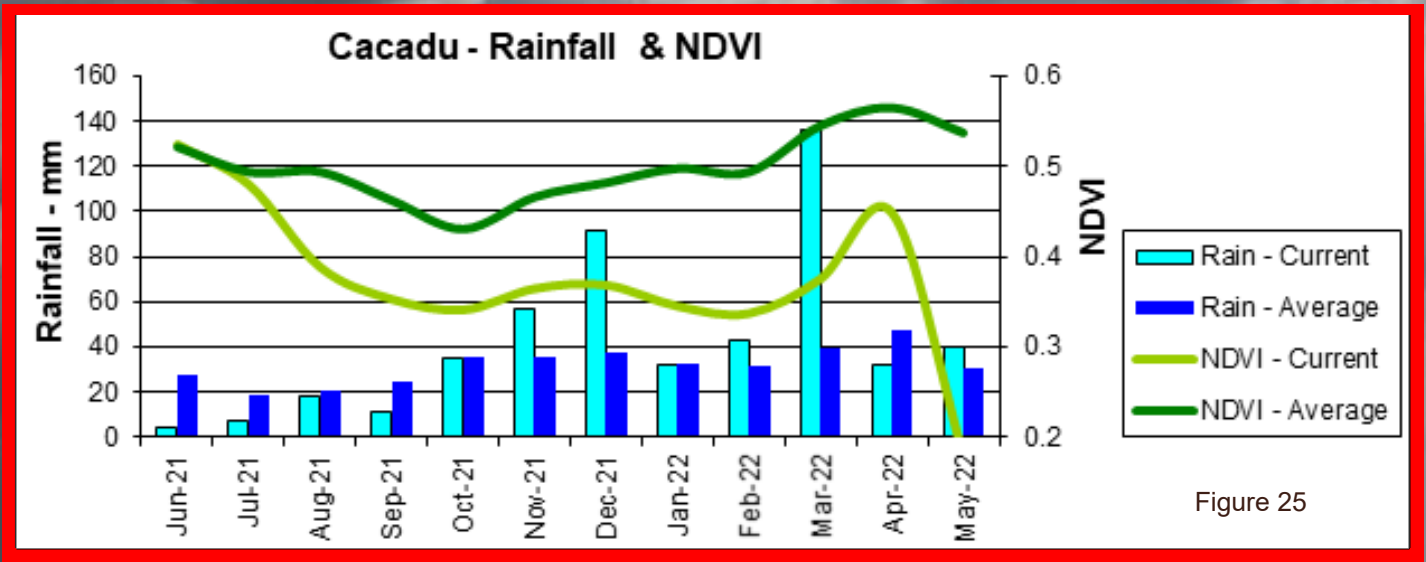

Figure 25

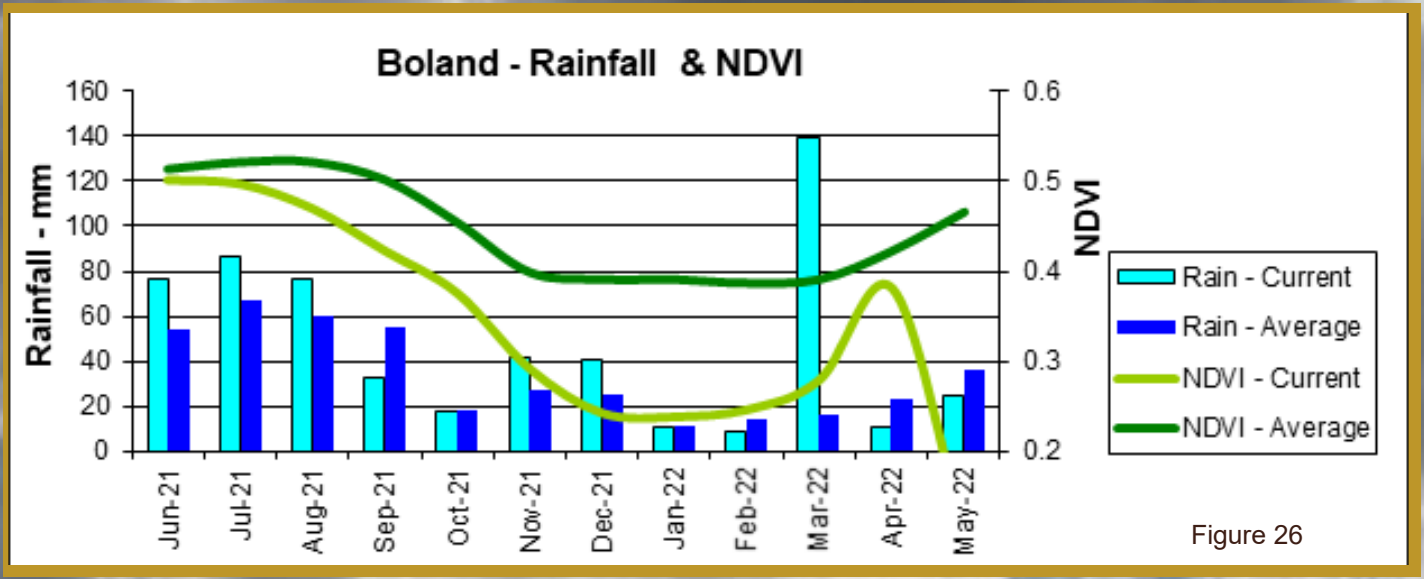

Figure 26

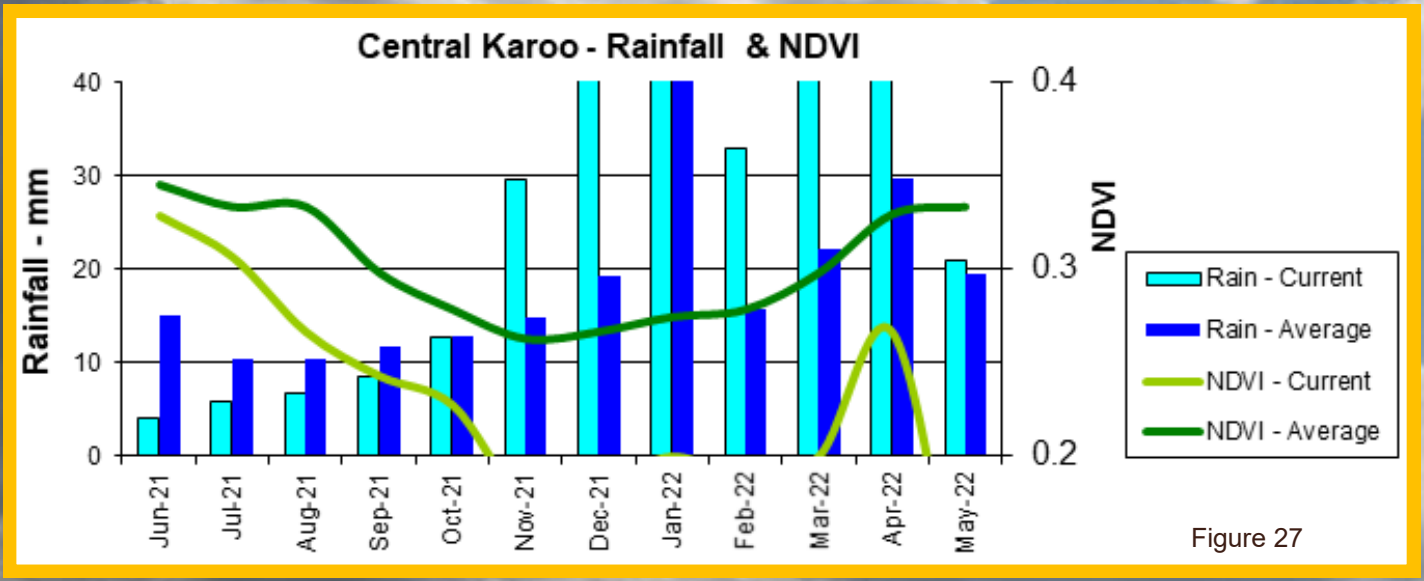

Figure 27

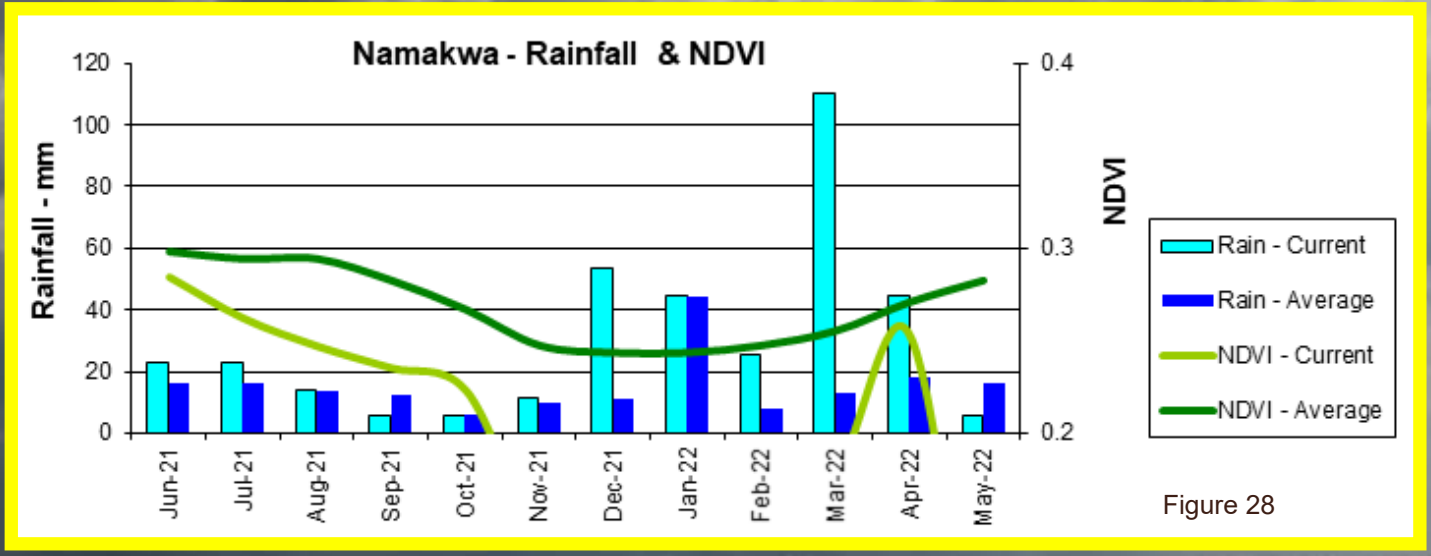

Figure 28

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 May and 2 June 2022 per province. Fire activity was the same or lower in all provinces except for the Western Cape, compared to the long-term average.

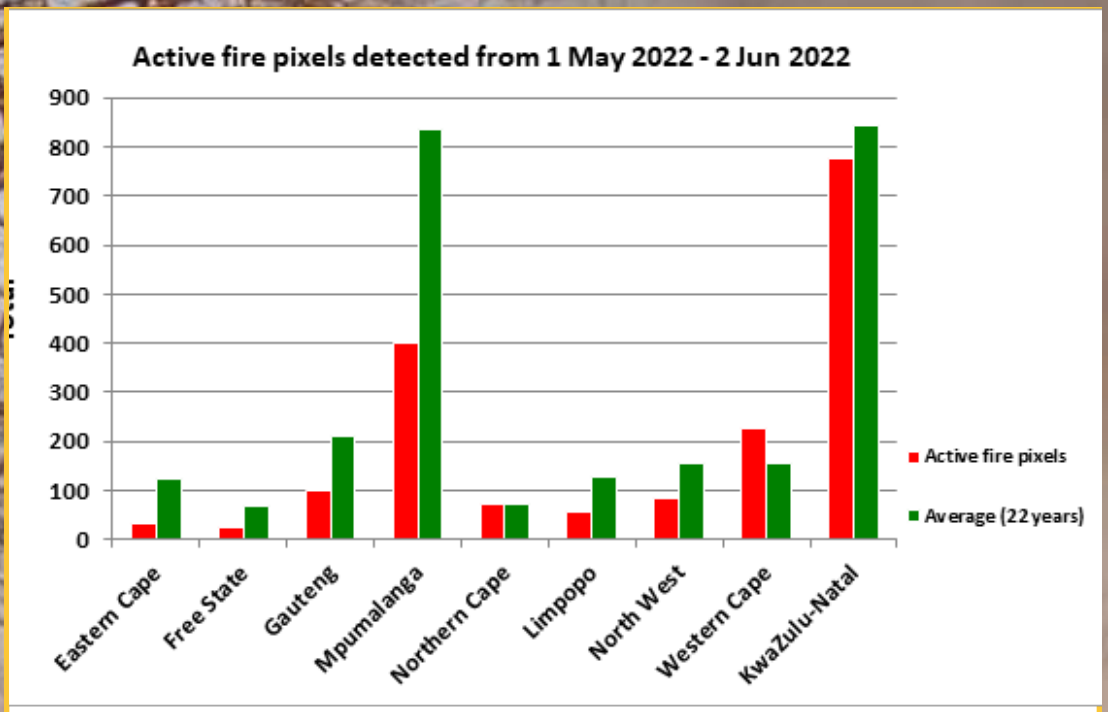

Figure 29

Figure 30:
The map shows the location of active fires detected between 1 May and 2 June 2022.

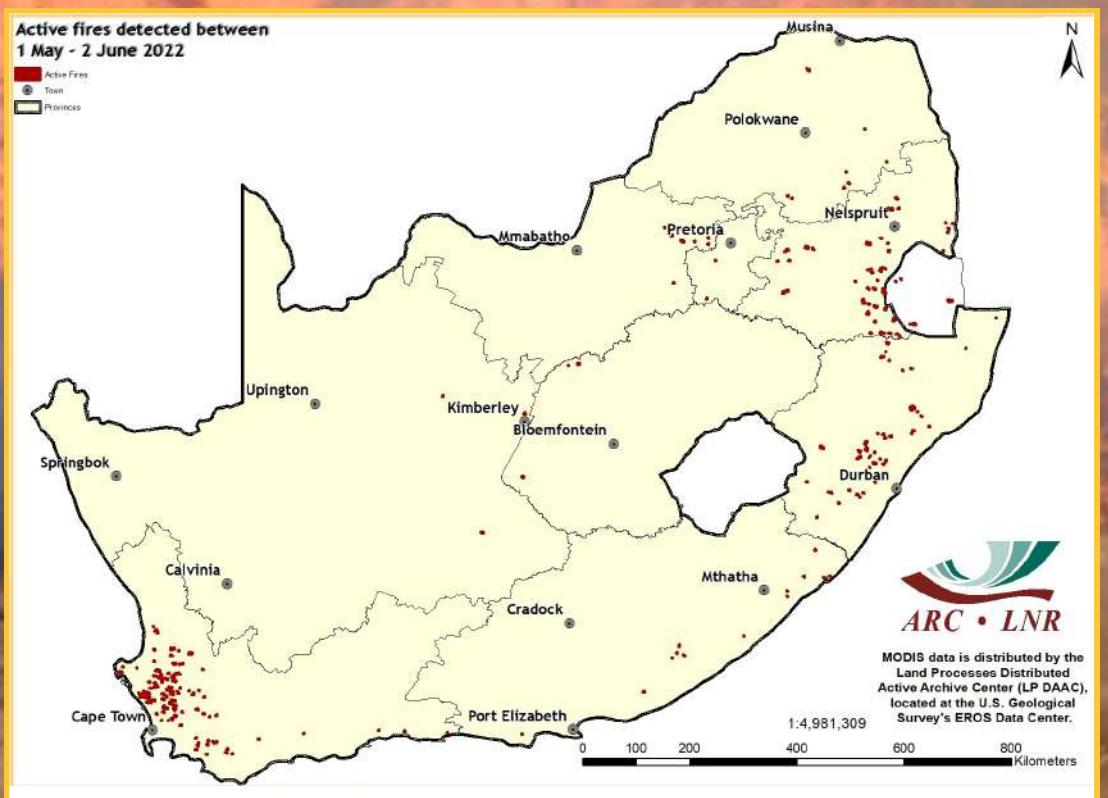

Figure 30

7. Fire Watch

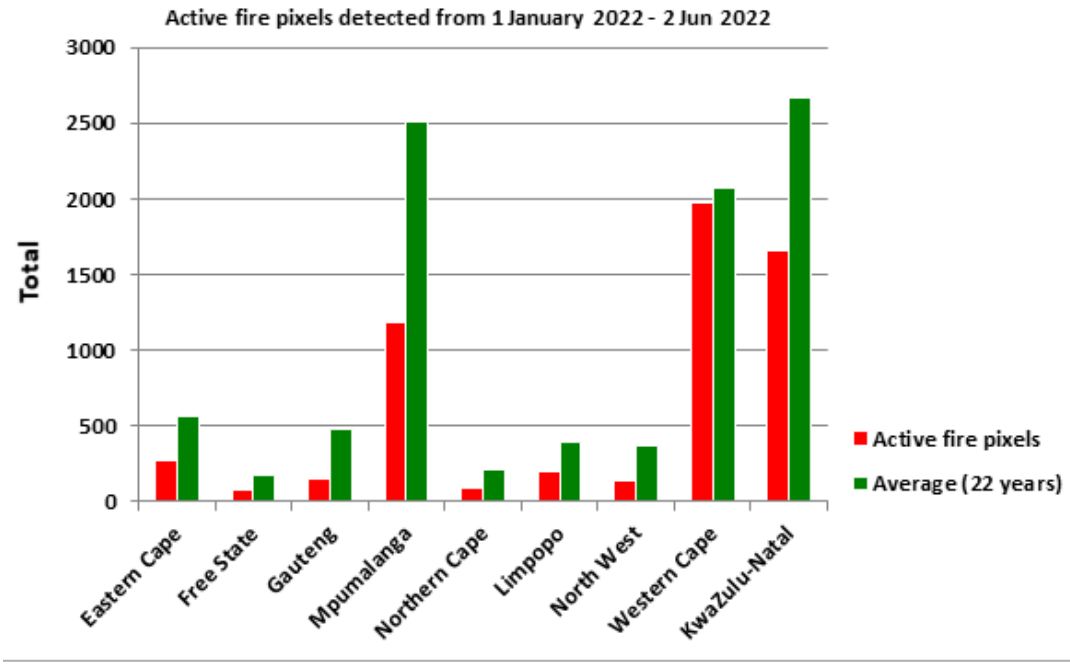

Figure 31:
The graph shows the total number of active fires detected between 1 January and 2 June 2022 per province. Cumulative fire activity was lower in all provinces compared to the long-term average.

Figure 31

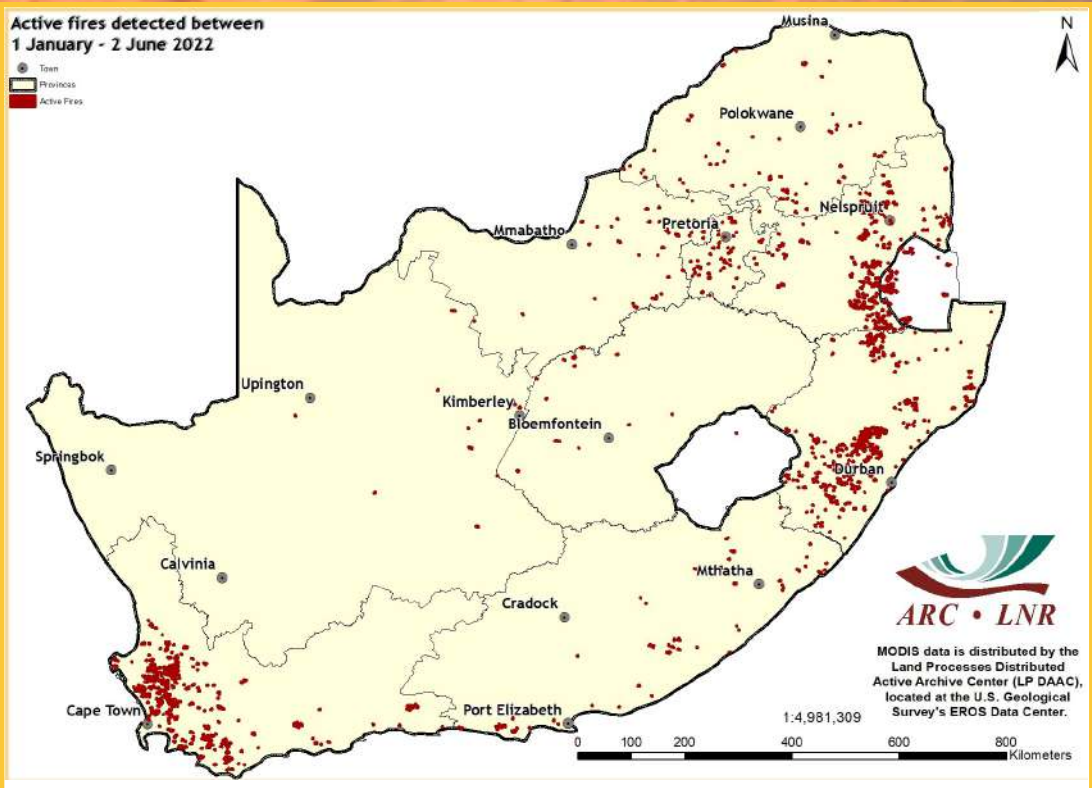

Figure 32:
The map shows the location of active fires detected between 1 January and 2 June 2022.

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 represents a comparison between the area of water available now and the maximum area of surface water recorded in the last 6 years. This 6-year historical window represents the operational period of the satellite from which the water information has been generated. In this map, any value less than 100 represents 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 represents a comparison between the area of surface water now and for the same month last year. In this map, any value less than 100 represents 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, last year.

The long-term map for May 2022 shows a nearly identical distribution pattern to the previous month. This continues to illustrate the significant impact of the high rainfall experienced since late December 2021, with very high water levels across most parts of the country. The majority of Tertiary catchments are showing water levels equivalent to 80-100% of the 6-year, long-term maximum water, similar to the February, March and April 2022 long-term maps.

The comparison between May 2022 and May 2021 shows similar water level distribution patterns to last month, with most regions still showing current water levels between 50% and 150% of the 2021 levels. The majority of the Northern Cape and central Karoo regions are now showing significantly high water levels, compared to monthly year-on-year comparisons for the first few months of 2022.

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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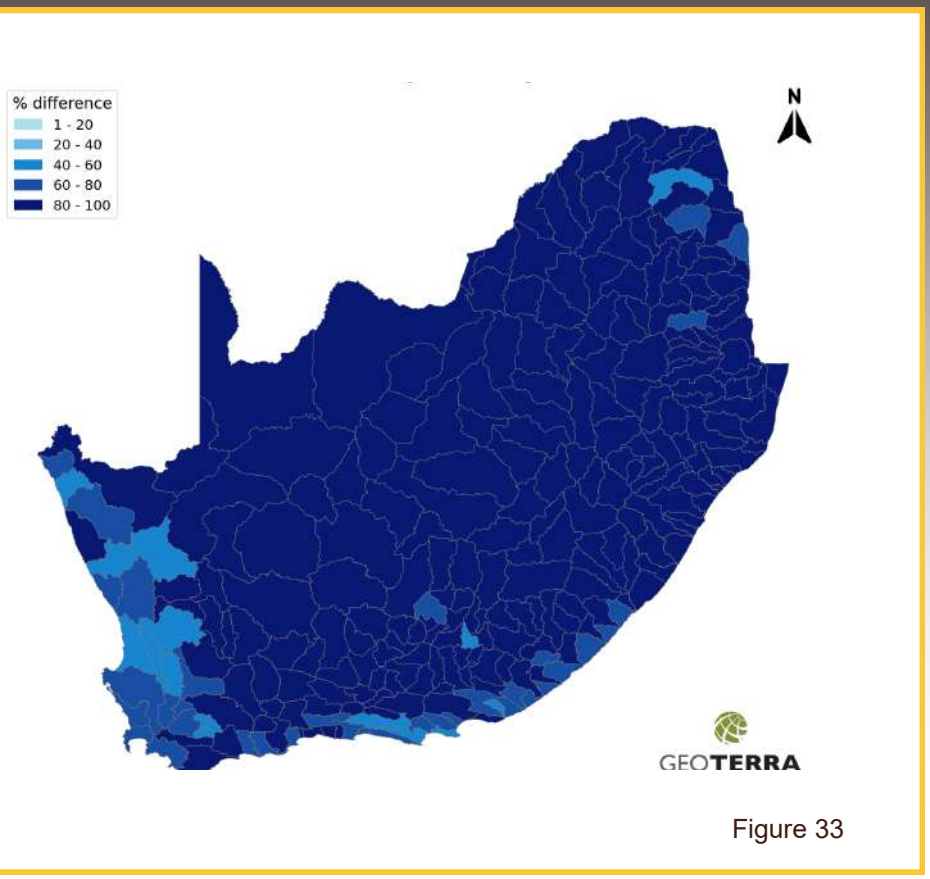

Figure 33

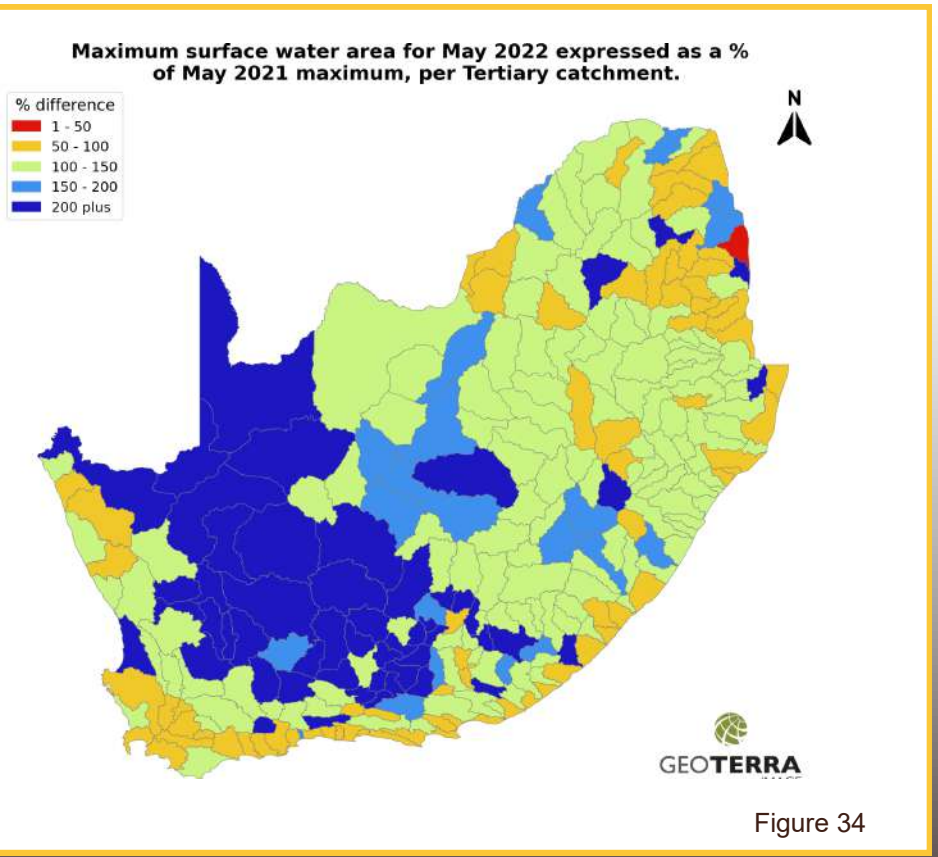

Figure 34

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".