UMLINDI
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INSTITUTE FOR SOIL, CLIMATE AND WATER

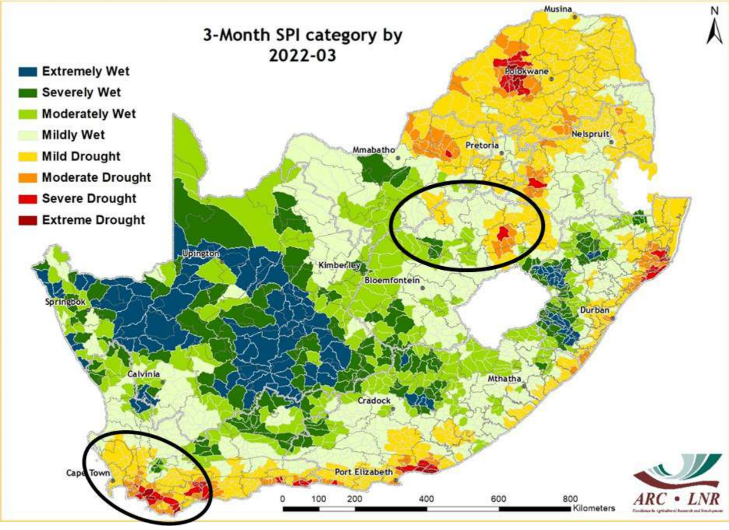
CONTENTS:

214th Edition

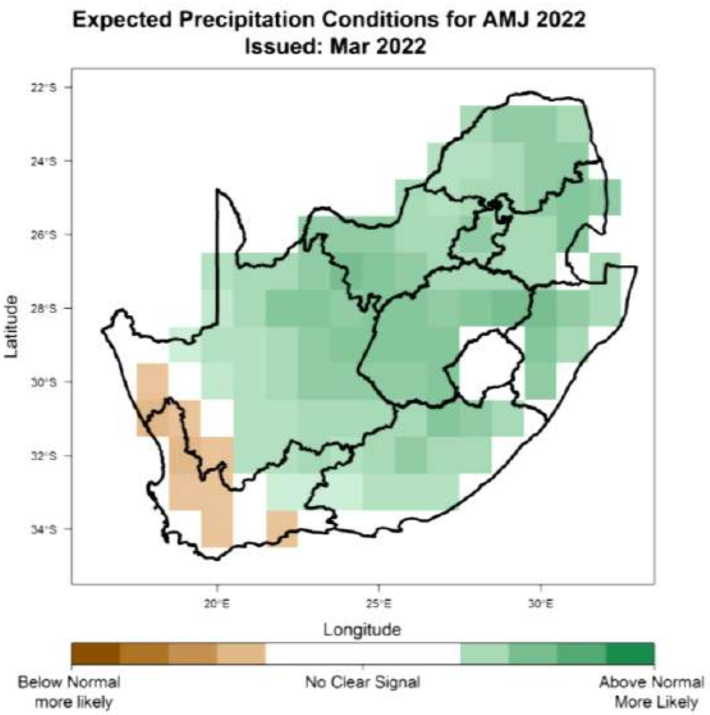
Images of the Month

Dry conditions ahead of the winter wheat production season

Wheat is an important winter cereal crop which is largely produced in the Western Cape and Free State provinces. It utilizes stored soil moisture accumulated during the preceding rainy season, especially in the Free State. Thus, the short-term mild to severe drought conditions in the wheat production regions indicated on the Standardized Precipitation Index map raises a concern for planting preparations.



Moreover, the rainfall forecast issued in March 2022 by the South African Weather Service (https://www.weathersa.co.za/home/seasonalclimate) indicates below-normal rainfall for the period April-May-June over the southwestern region of the country. This implies a relatively slow start to the winter rainy season, which may result in difficulty to plant during the planting window. For some farmers, irrigation remains an effective tool for eliminating the negative impacts of drought on crop production, hence the importance of managing irrigation water effectively. However, it is still possible that sufficient rainfall may occur later in May over the winter rainfall region.



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:

March 2022 was characterized by widespread rainfall over most of the country, except for the southwestern region and certain parts of the Highveld. Much of the rainfall was confined to the interior, particularly over the Northern Cape. Weather stations located near Warrenton, De Aar, Vaalharts and Victoria West recorded monthly totals exceeding 150 mm, with Kuruman recording >200 mm. This rainfall occurred throughout the month of March but was most profound during the middle and towards the end of the month. Low-lying areas were exposed to the risk of localized flooding due to heavy rainfall. Isolated areas over the Free State, Eastern Cape, Western Cape, Limpopo and KwaZulu-Natal experienced similar rainfall conditions, receiving amounts up to 200 mm. In contrast, large parts of the winter rainfall region recorded totals of between 5 and 50 mm, resulting in below-normal rainfall conditions when compared to the historical long-term mean. Similar conditions were observed in the Bushveld, along the south coast of the Eastern Cape and in northern parts of KZN.

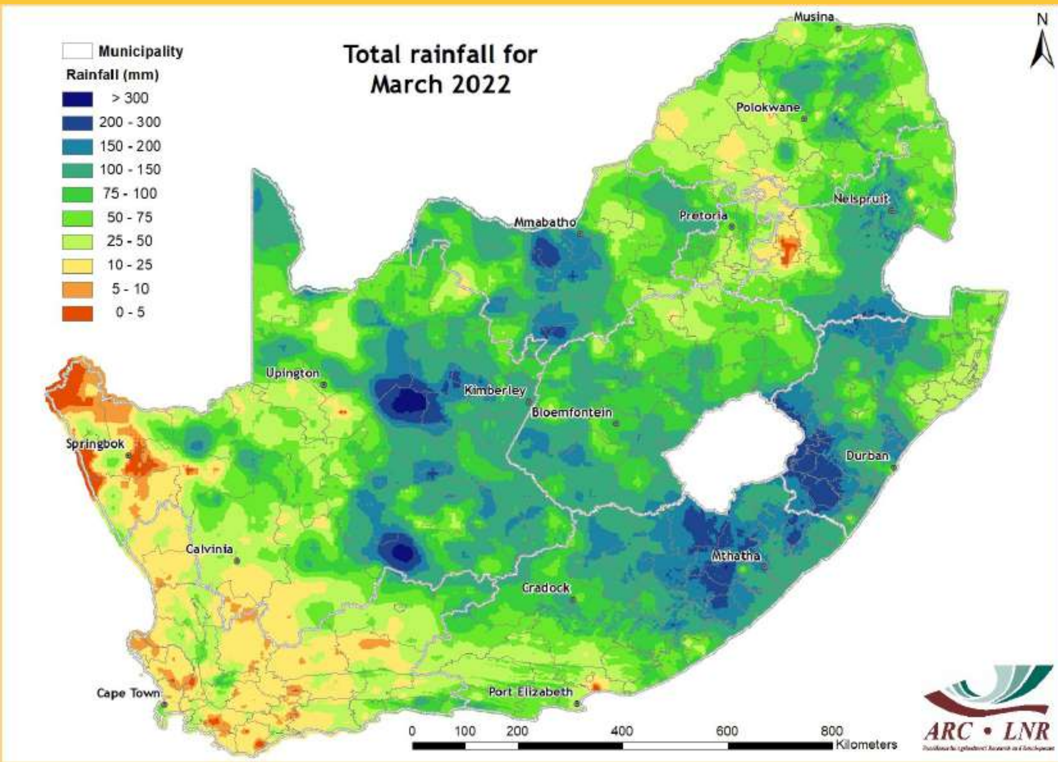


Figure 1

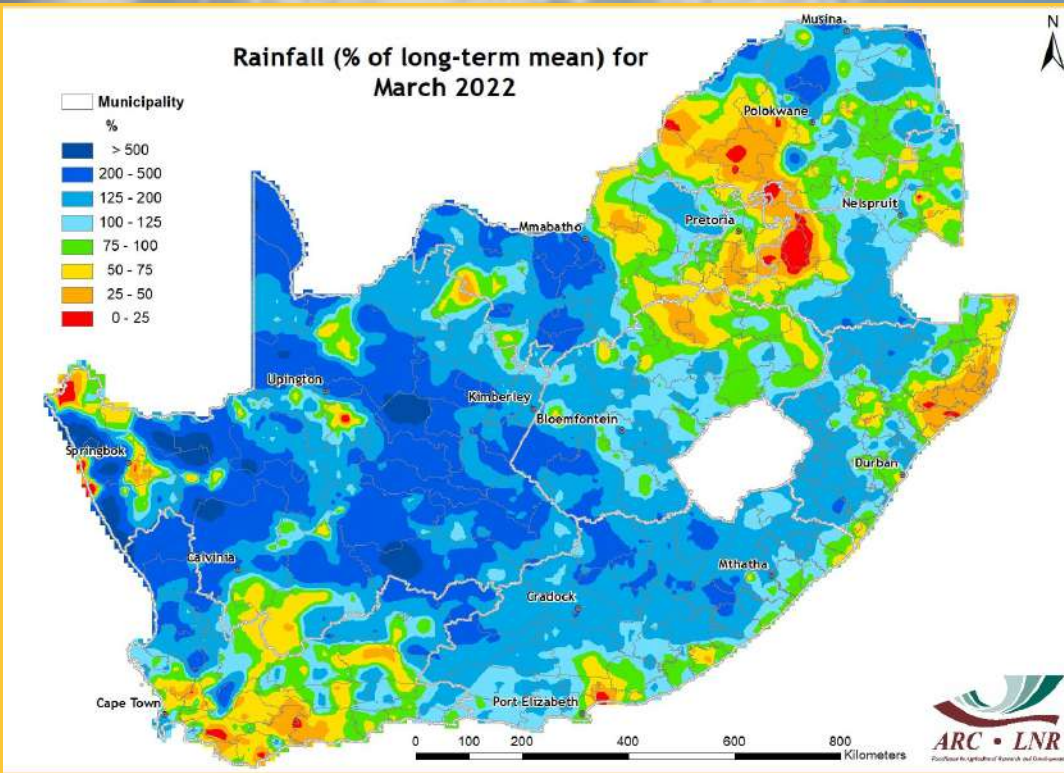


Figure 2

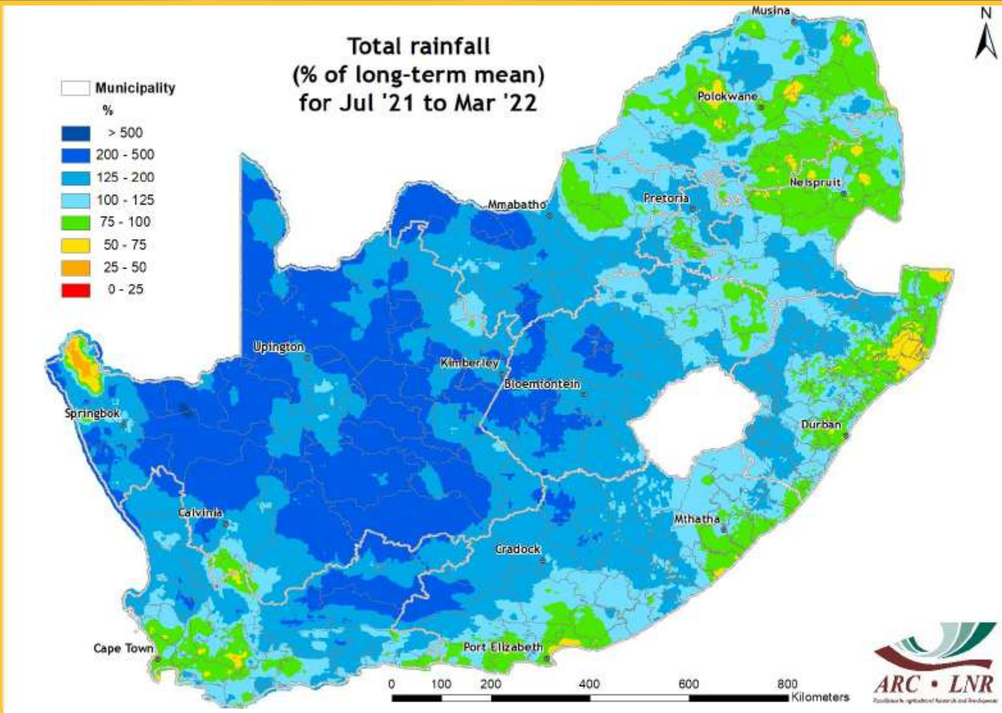


Figure 3

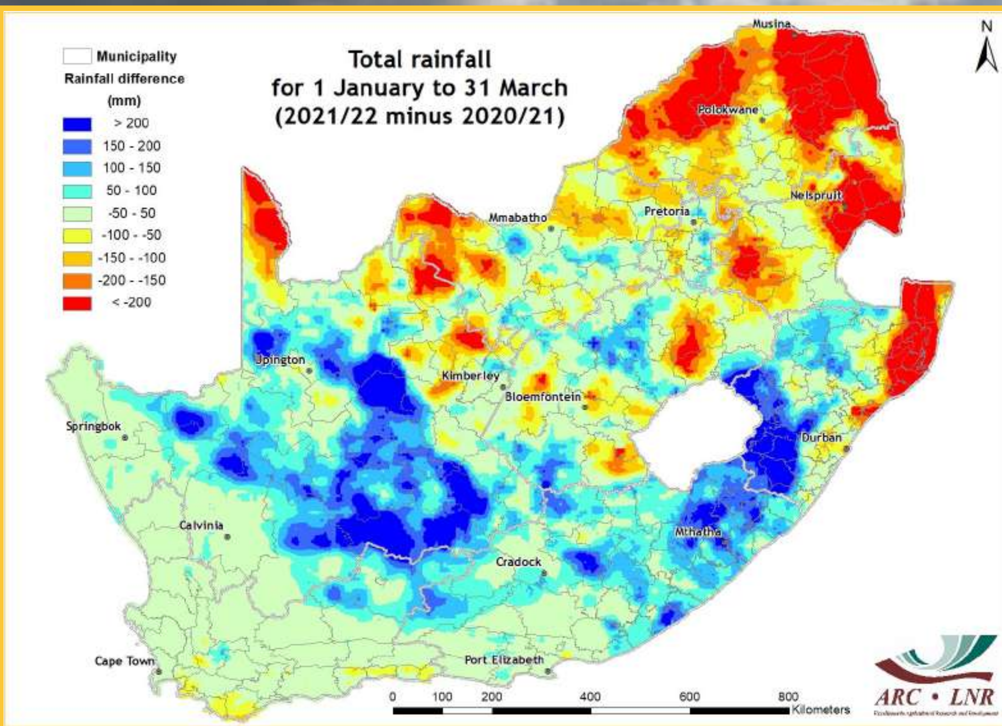


Figure 4

Figure 1:
Widespread rainfall occurred over most parts of the country in March 2022 with significant amounts recorded in the central and southeastern interior. Total rainfall of up to 25 mm was experienced mostly over the winter rainfall region and certain parts of Mpumalanga and Limpopo.

Figure 2:
Above-normal rainfall was observed over greater parts of the Northern Cape, adjacent parts of the Western and Eastern Cape and North West, as well as the KwaZulu-Natal Midlands and Lowveld of Limpopo. Meanwhile, the southeastern corner of the country, northern KZN and large parts of the Highveld recorded below-normal rainfall.

Figure 3:
The map shows cumulative total rainfall from July 2021 to March 2022 expressed as a percentage of the long-term mean. It is evident that above-normal rainfall conditions were experienced over almost the whole country.

Figure 4:
Large parts of the Northern Cape, Eastern Cape, KZN Midlands and isolated parts of Free State observed wetter conditions during January to March 2022 as compared to the corresponding period last year. Areas that received less rainfall include greater parts of Limpopo, northern areas of KZN, eastern Free State and neighbouring areas in North West and Northern Cape. Similar conditions, although to a lesser extent (up to -100 mm), were observed along the south coast of the Western Cape.

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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 March 2022 are shown in Figures 5-8. In general, wet conditions were prominent over most parts of the country. Given the short- and medium-term maps, high rainfall totals resulted in severe to extremely wet conditions over large parts of the interior and extending southwest towards the Karoo. Areas that revealed mild to moderate drought include Cape Town and adjacent areas, the eastern parts of the all-year rainfall region and large parts of the northeastern provinces. The long-term maps depict moderate to extremely wet conditions over the central interior, while severe to extreme drought conditions dominated the far western regions of the country, extending towards the Eastern Cape and the interior of Limpopo and Mpumalanga.

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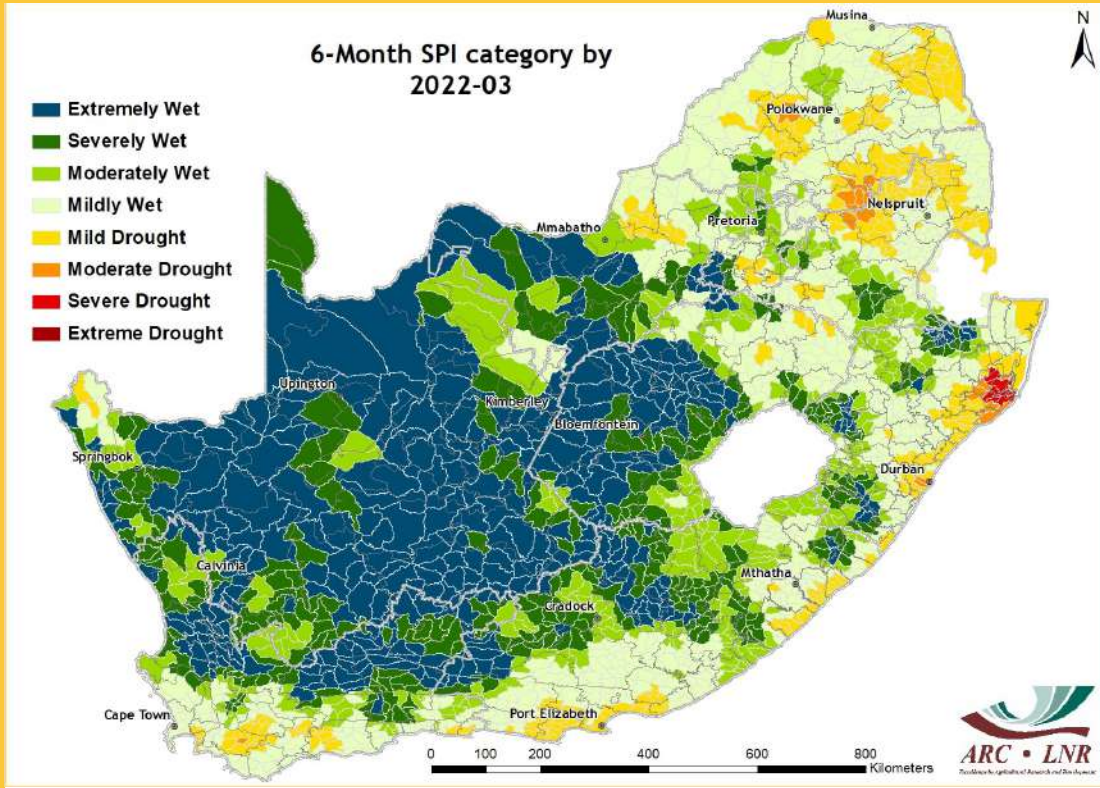

Figure 5

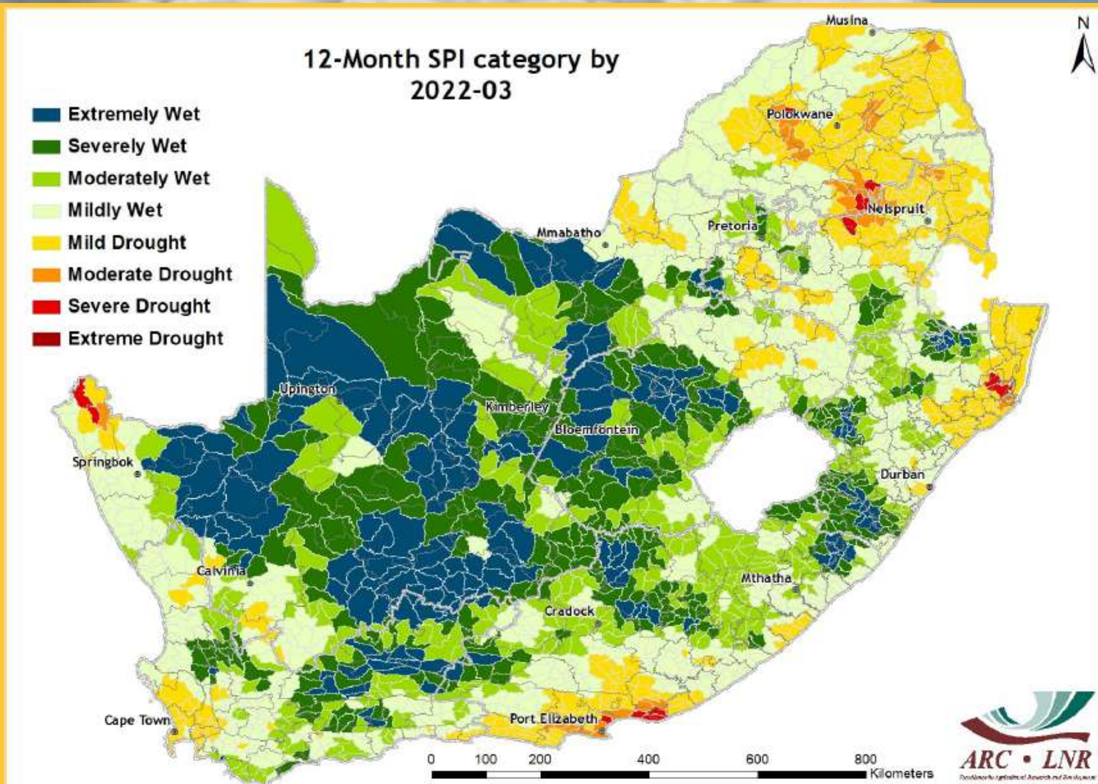

Figure 6

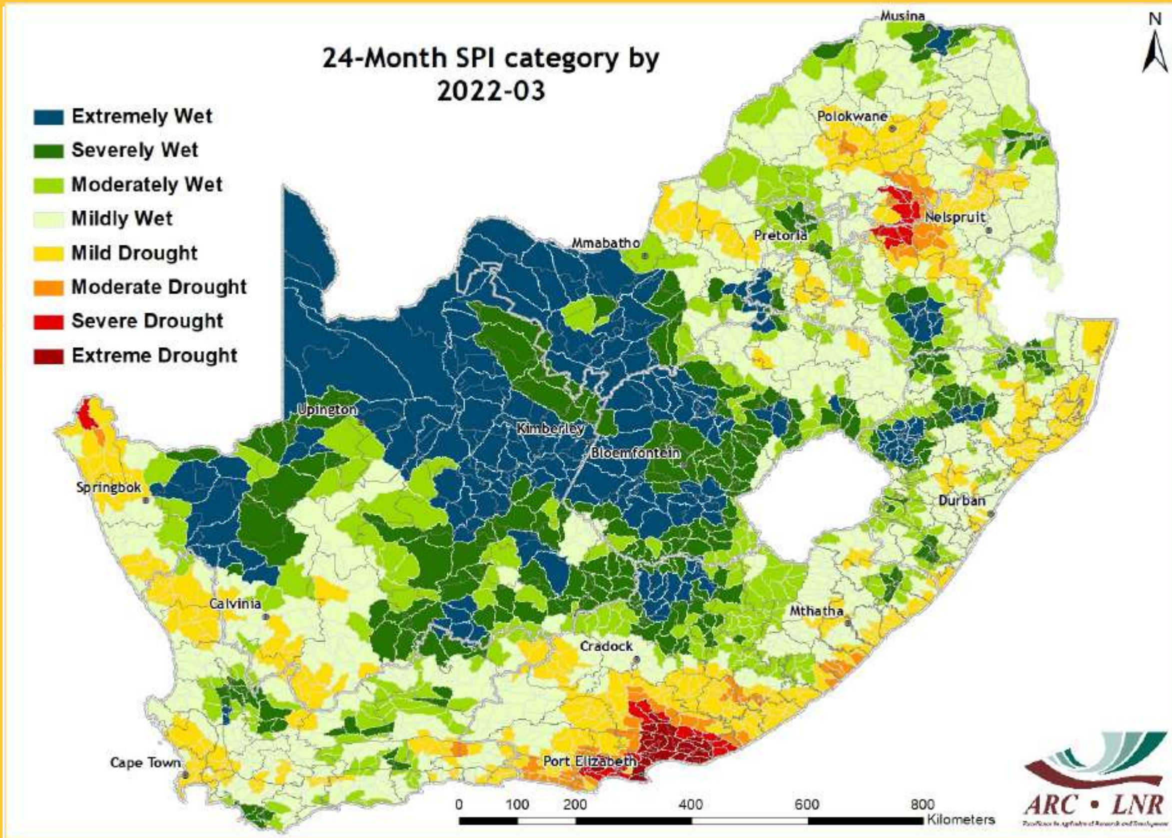

Figure 7

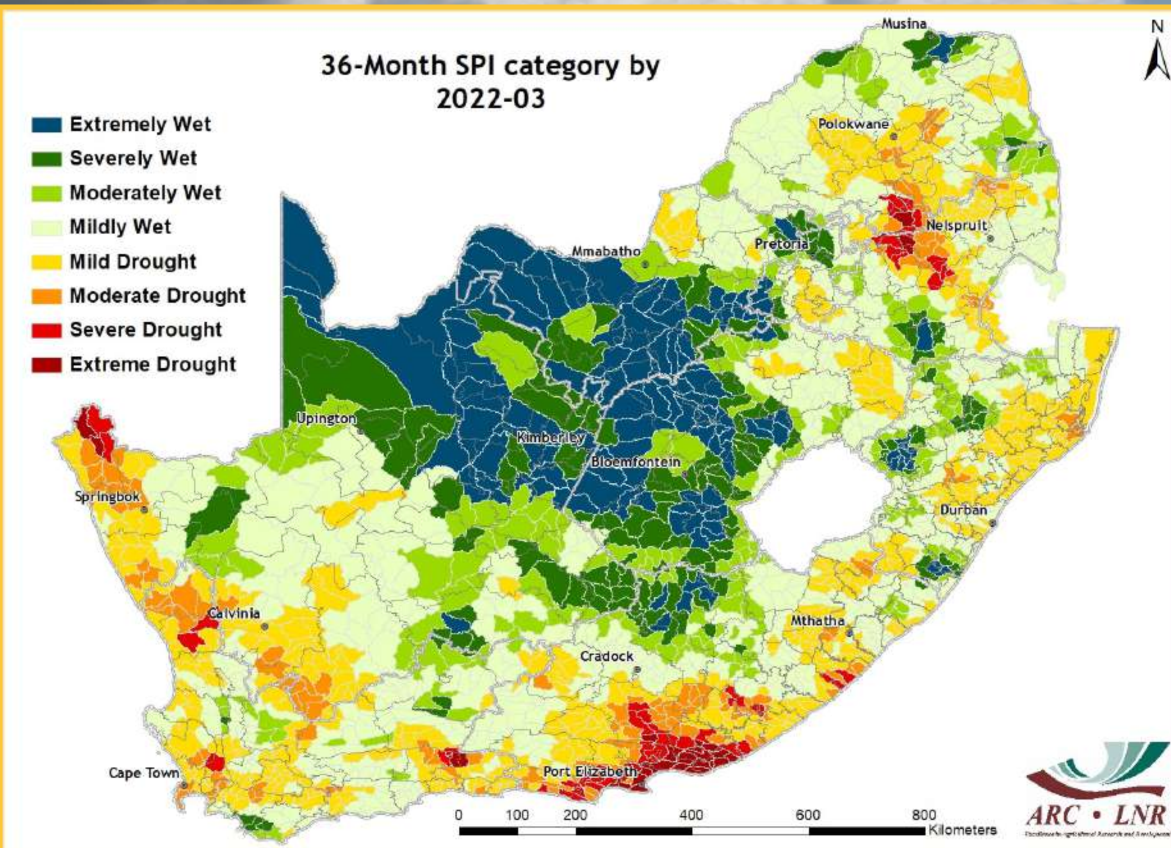

Figure 8

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.

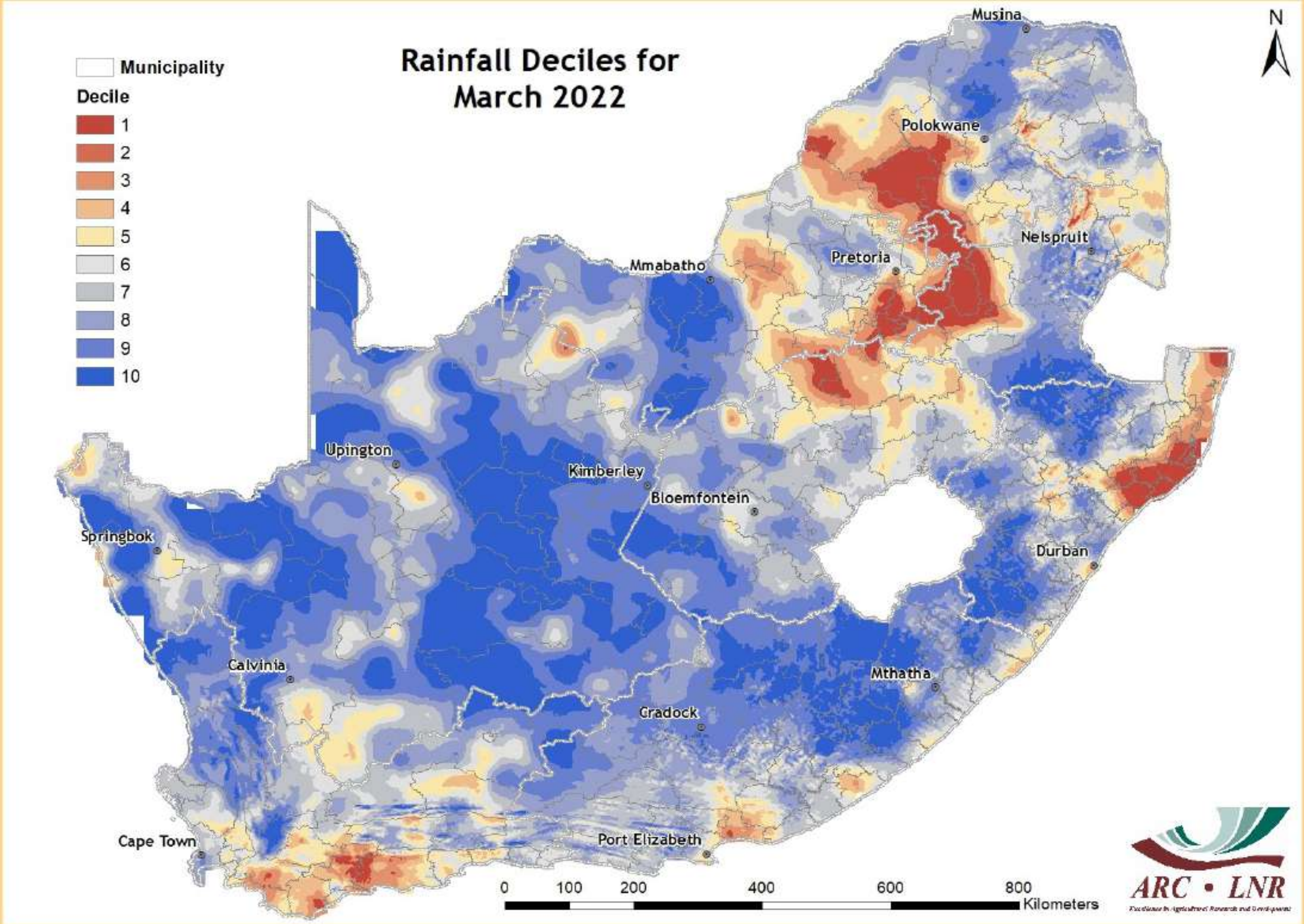

Figure 9

Figure 9:
Greater parts of the country received high rainfall totals during March 2022, which compare well with historically wetter March 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.

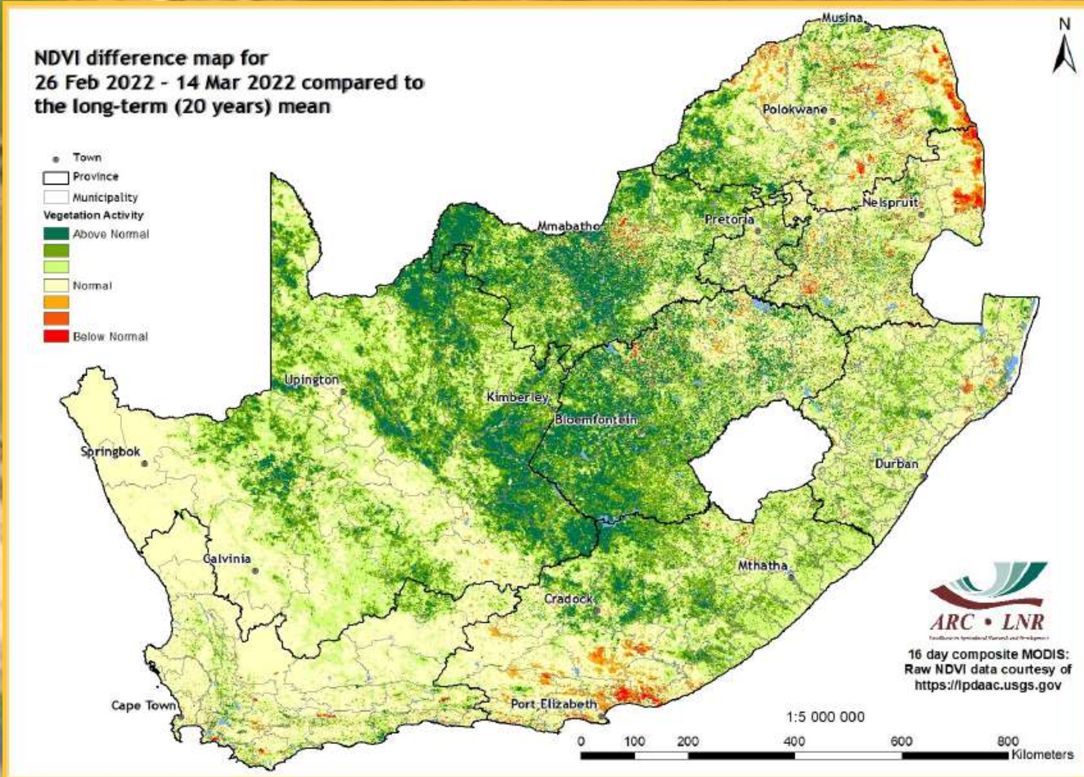

Figure 10

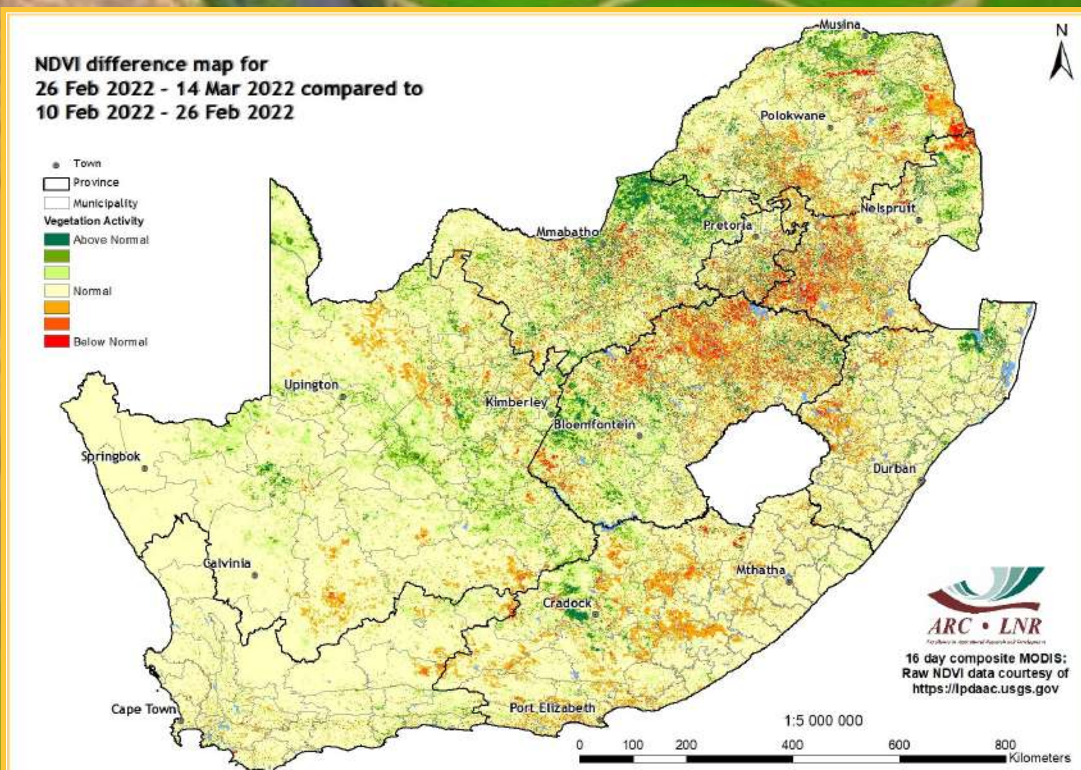

Figure 11

Figure 10:
Compared to the historical averaged vegetation conditions, the 16-day NDVI map for March 2022 shows that the central interior experienced above-normal vegetation activity with pockets of below-normal vegetation conditions in isolated areas.

Figure 11:
The 16-day NDVI difference map for March 2022 compared to the previous 16-day period shows that the country experienced mostly normal vegetation conditions with pockets of above-normal and below-normal conditions in some areas.

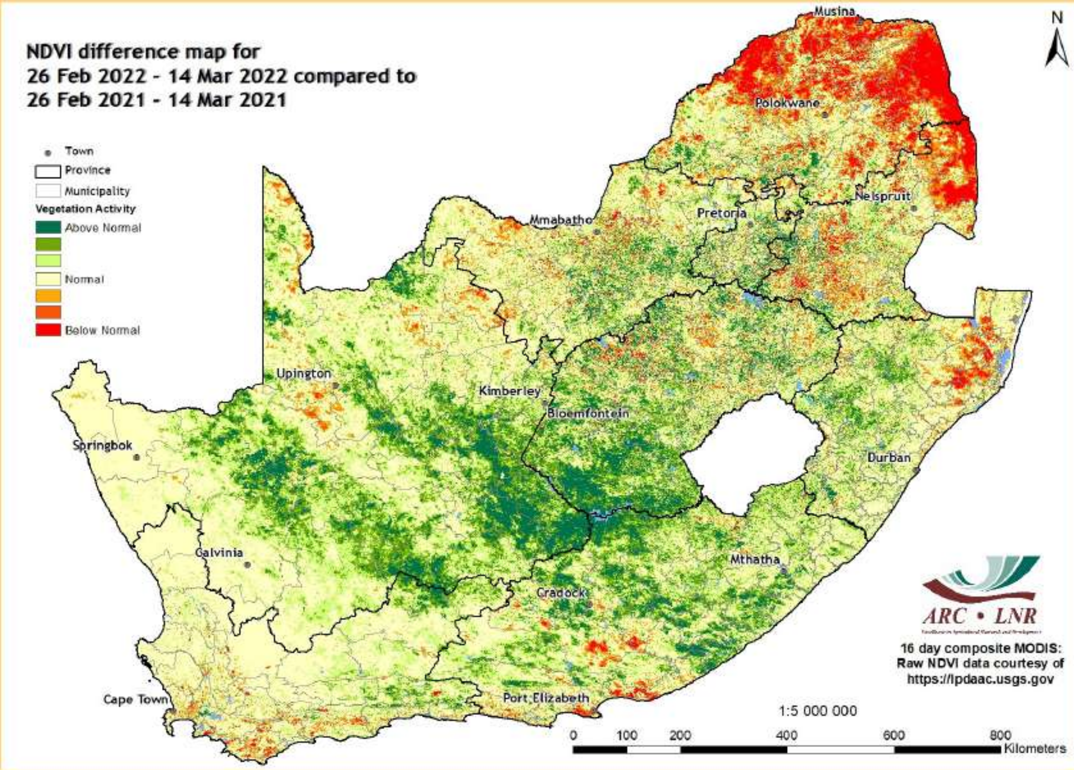

Figure 12

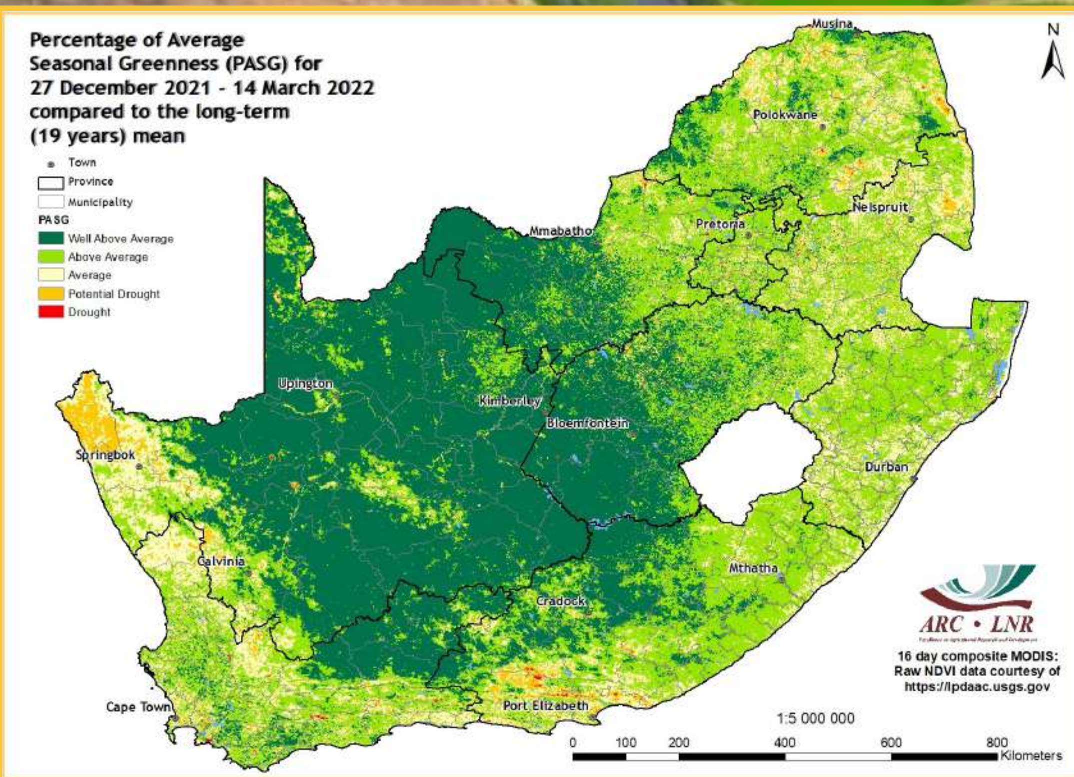

Figure 13

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 March 2022 compared to the same period last year shows that the far northern parts of the country experienced below-normal vegetation activity. The remaining areas experienced normal to above-normal vegetation conditions.

Figure 13:
The Percentage of Average Seasonal Greenness (PASG) map for the past 3 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 in isolated areas.

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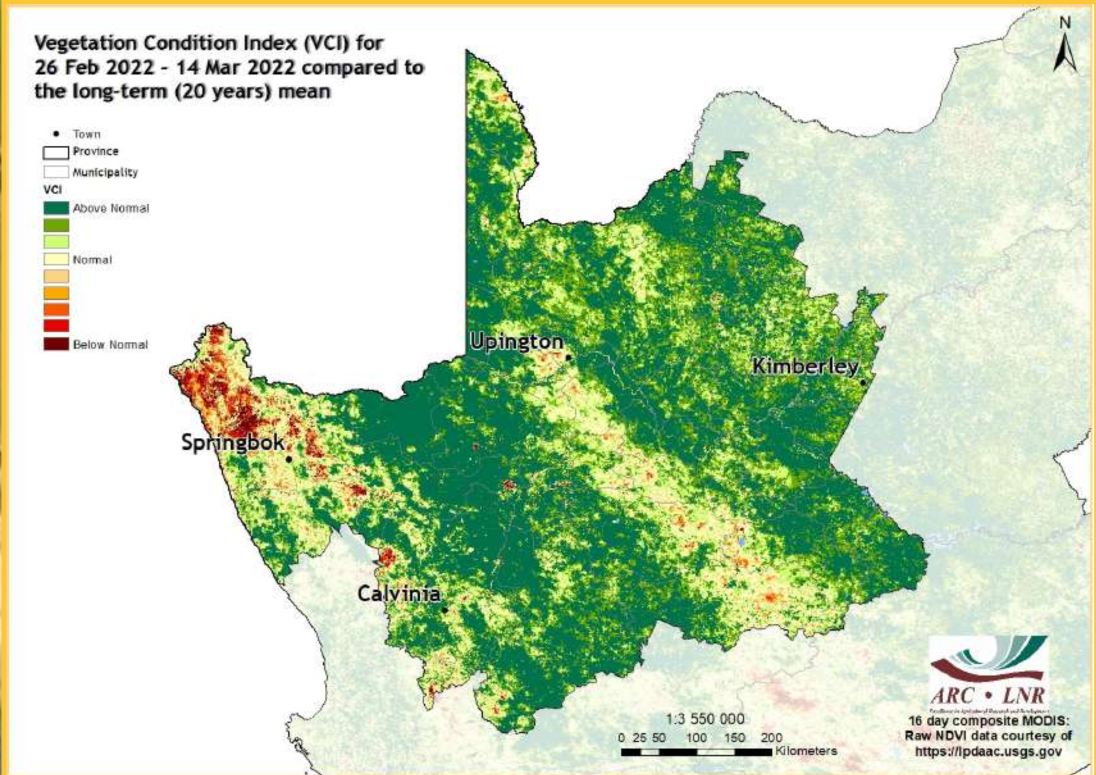
5. Vegetation Condition Index

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.



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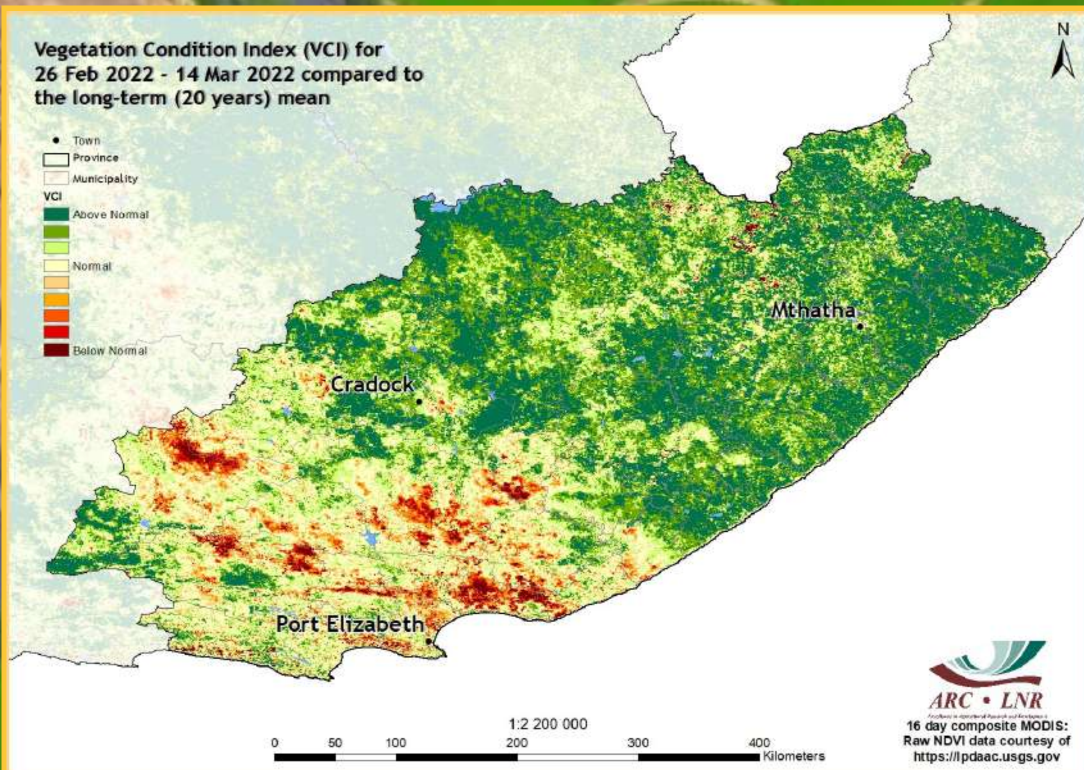
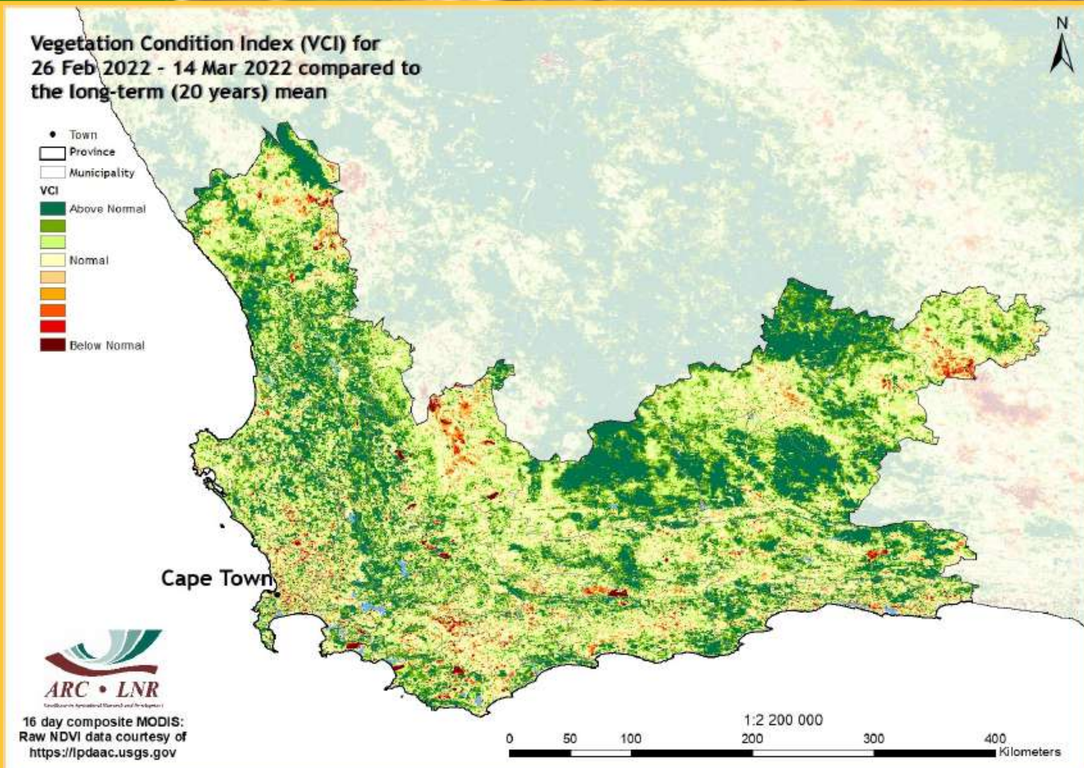


Figure 15

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

Figure 15:
The 16-day VCI map for March 2022 indicates that vegetation conditions have improved in most parts of the Eastern Cape, with the exception of the Sarah Baartman District Municipality which is still experiencing poor vegetation activity.



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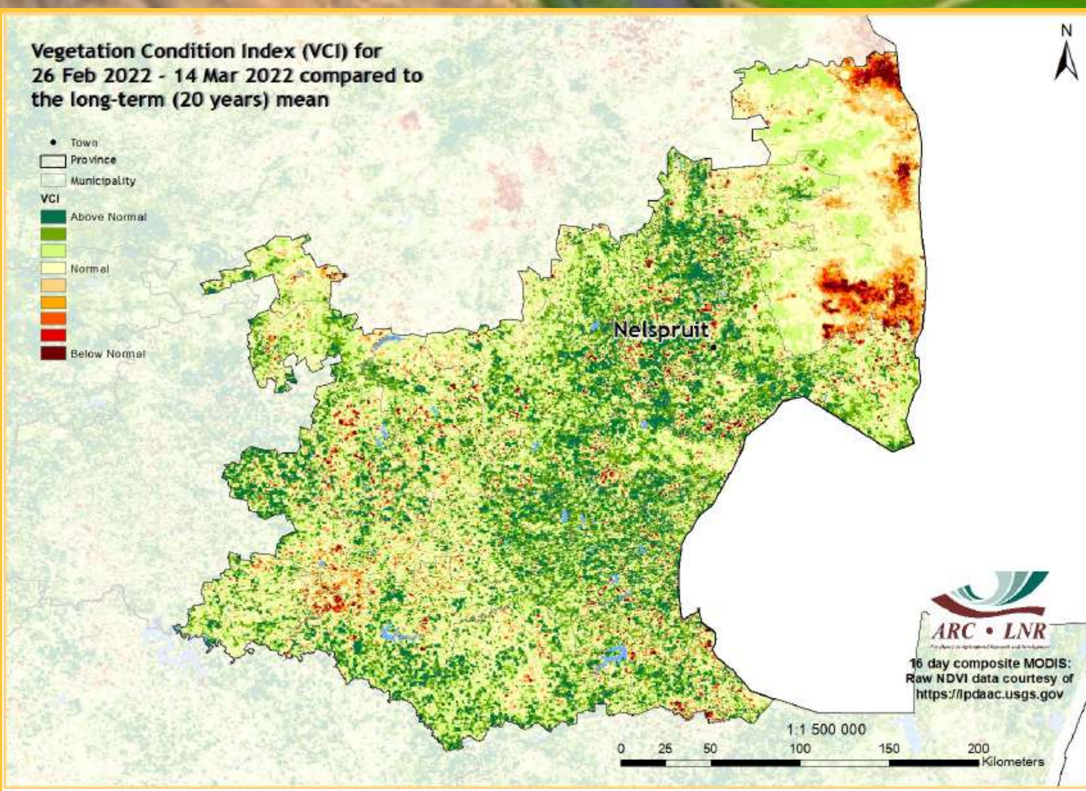

Figure 17

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

Figure 17:
The 16-day VCI map for March 2022 indicates that most parts of Mpumalanga continue to experience above-normal vegetation conditions, except for the far eastern parts of the province which continue to experience poor vegetation activity.

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6. Vegetation Conditions & Rainfall

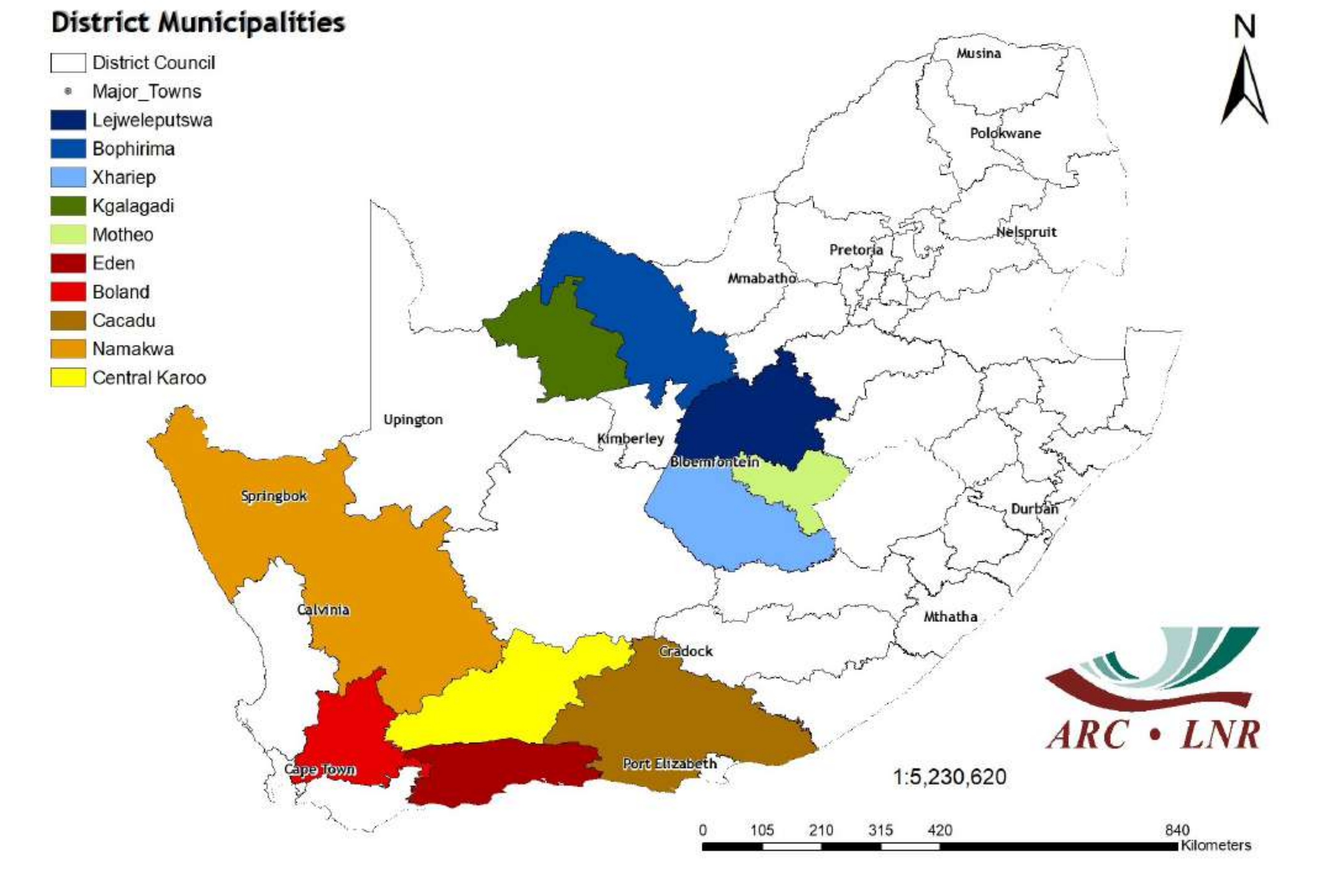

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for March 2022. The district colour matches the border of the corresponding graph.

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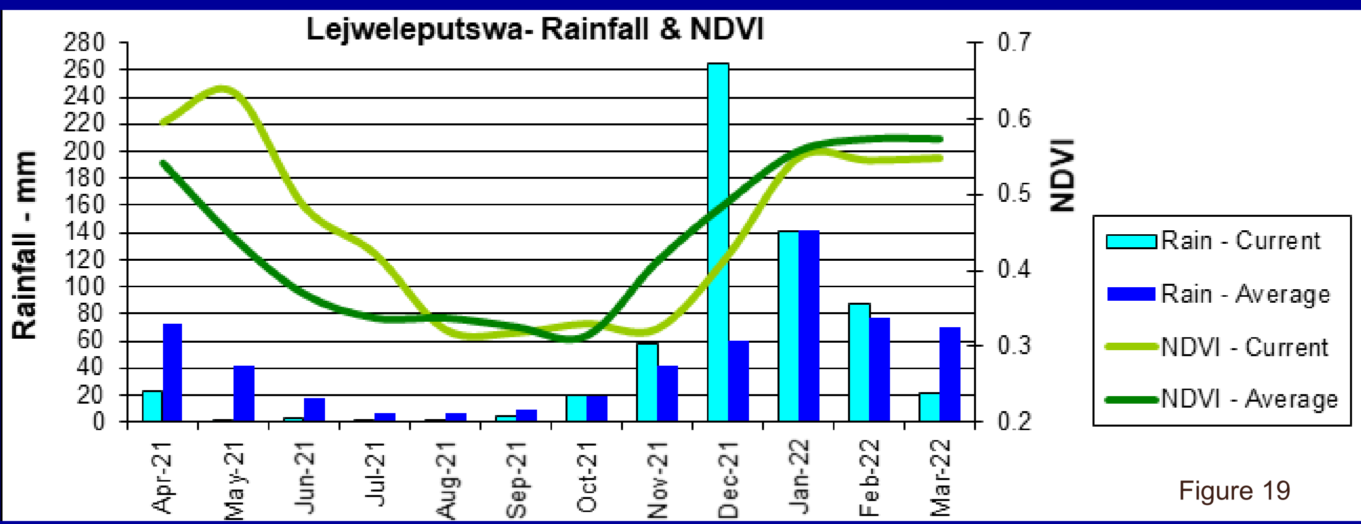
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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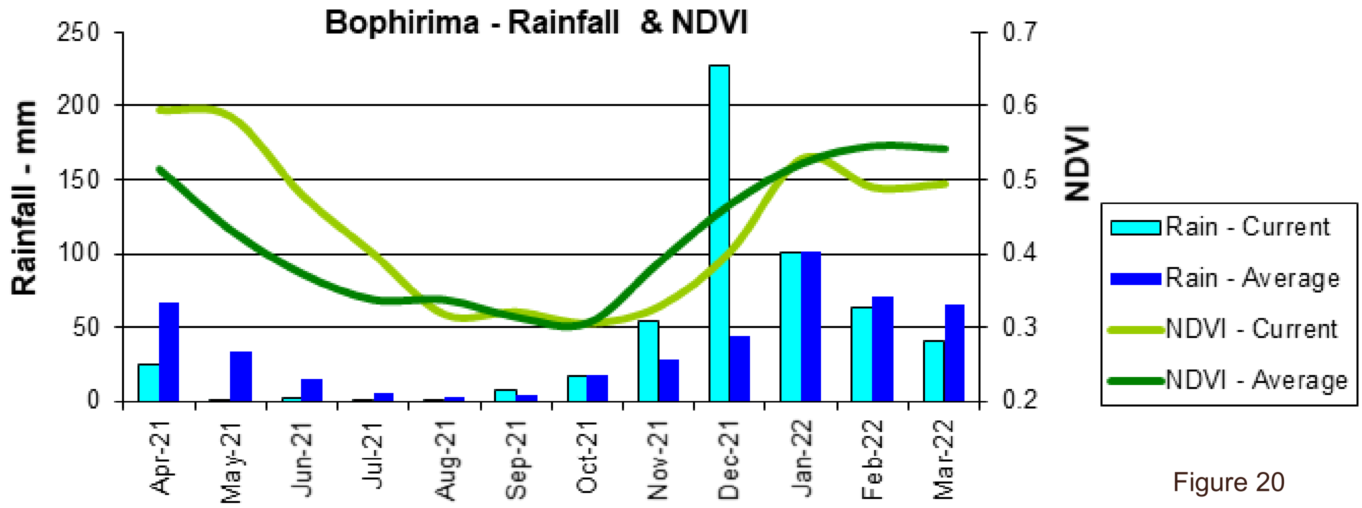

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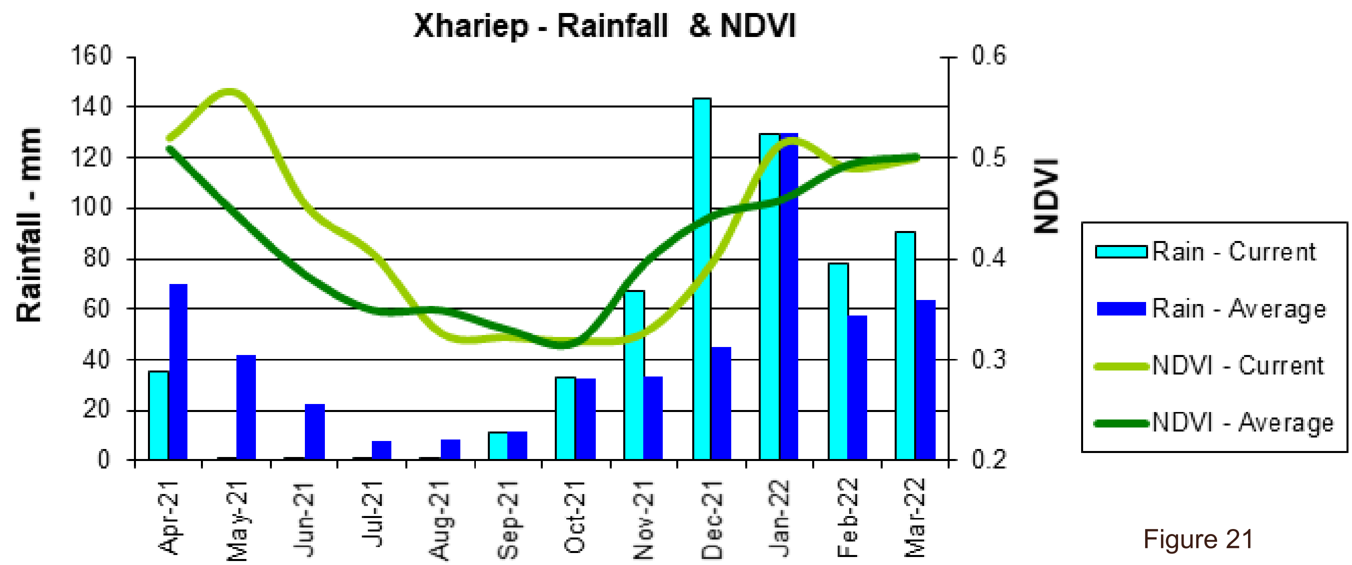

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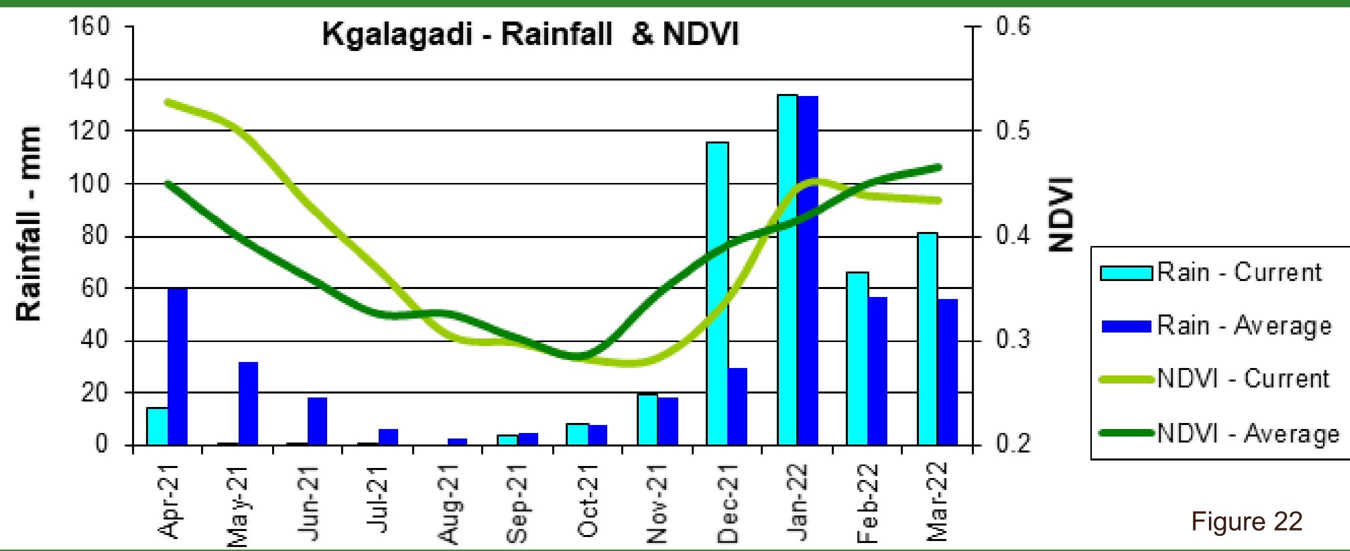
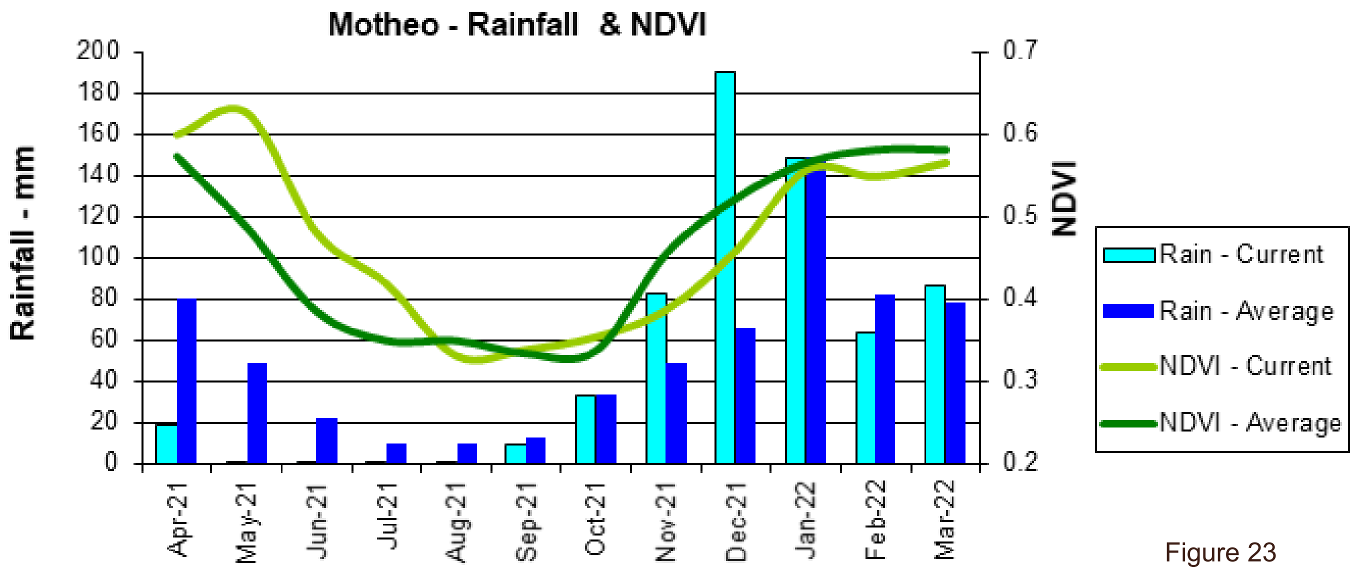


Figure 22



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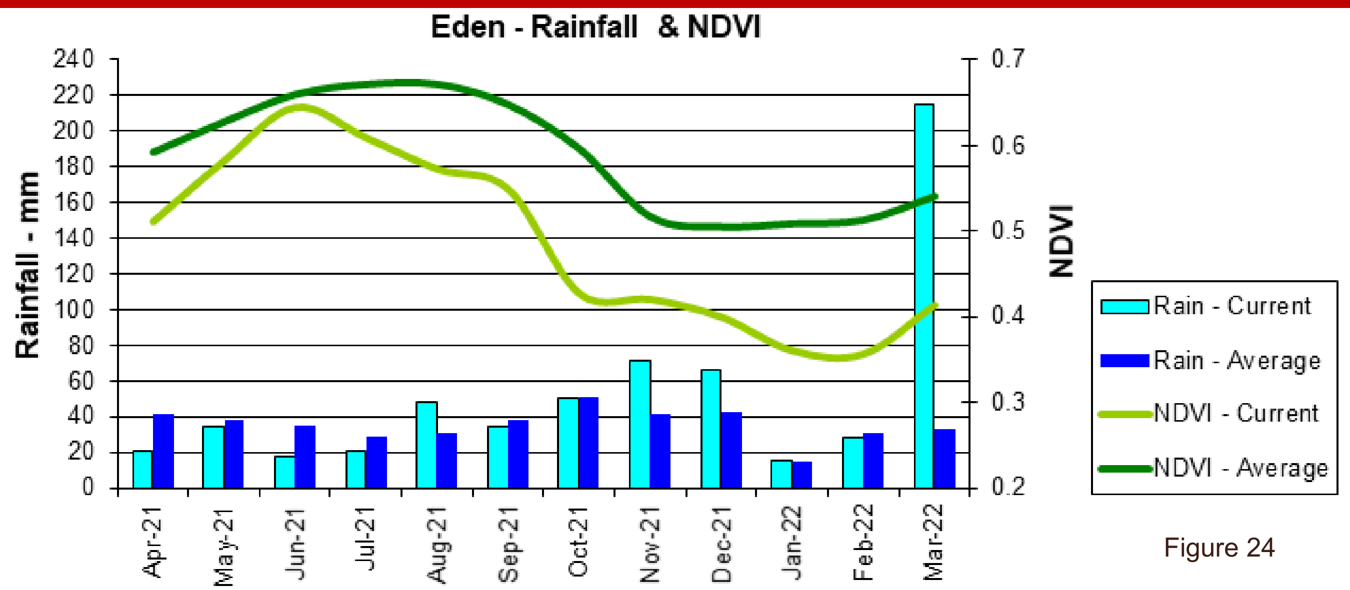

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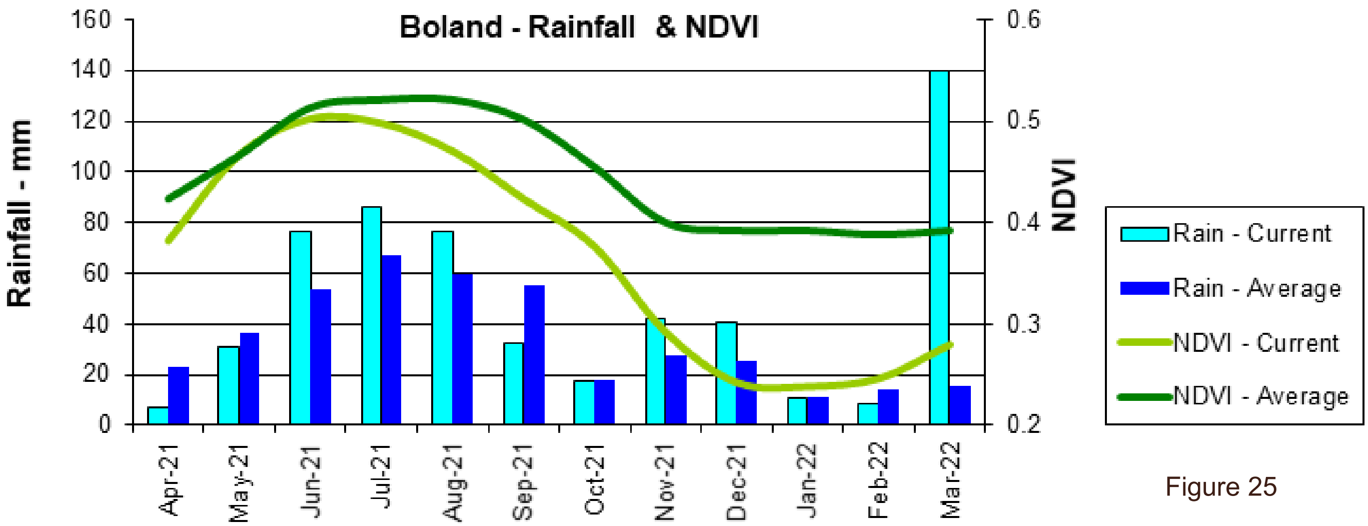

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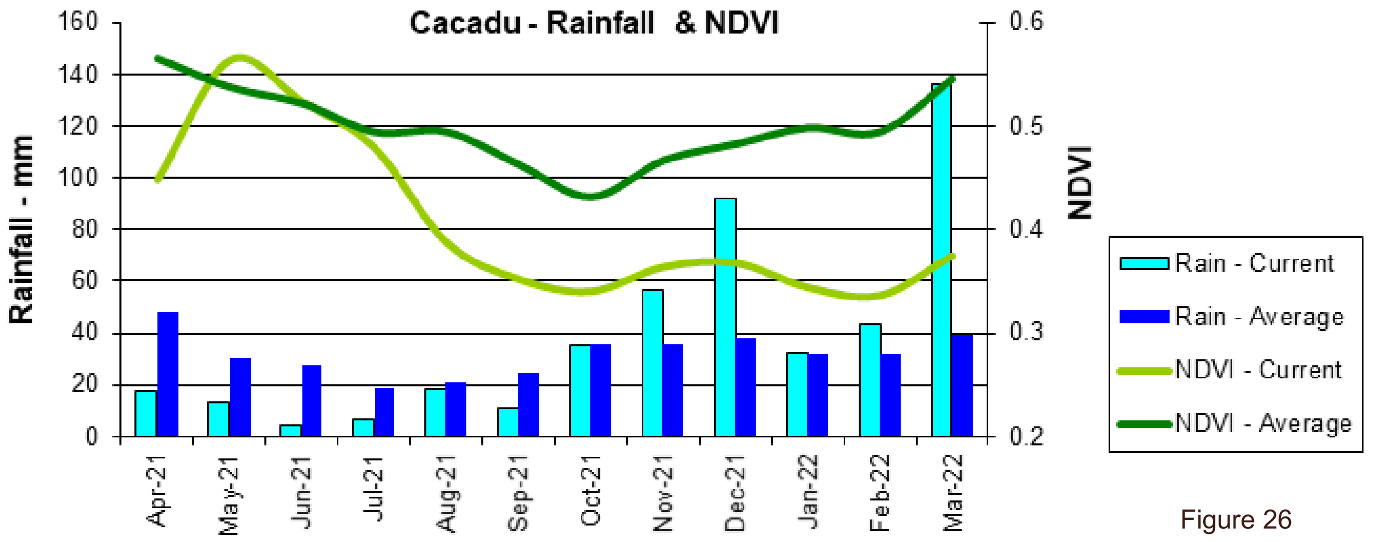
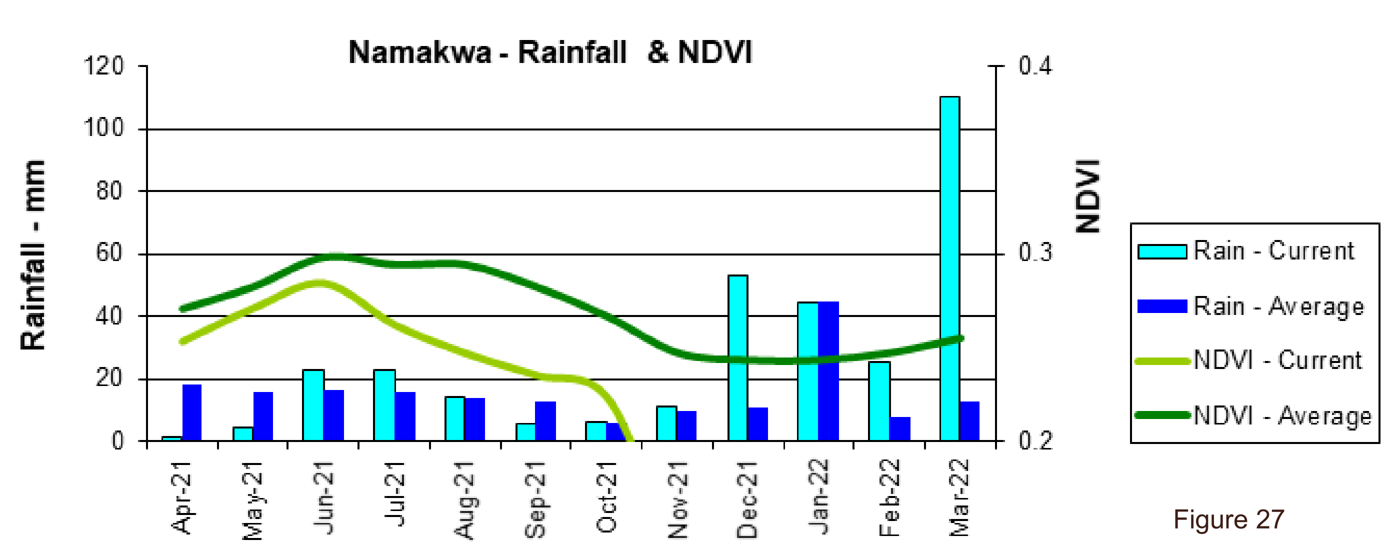


Figure 26



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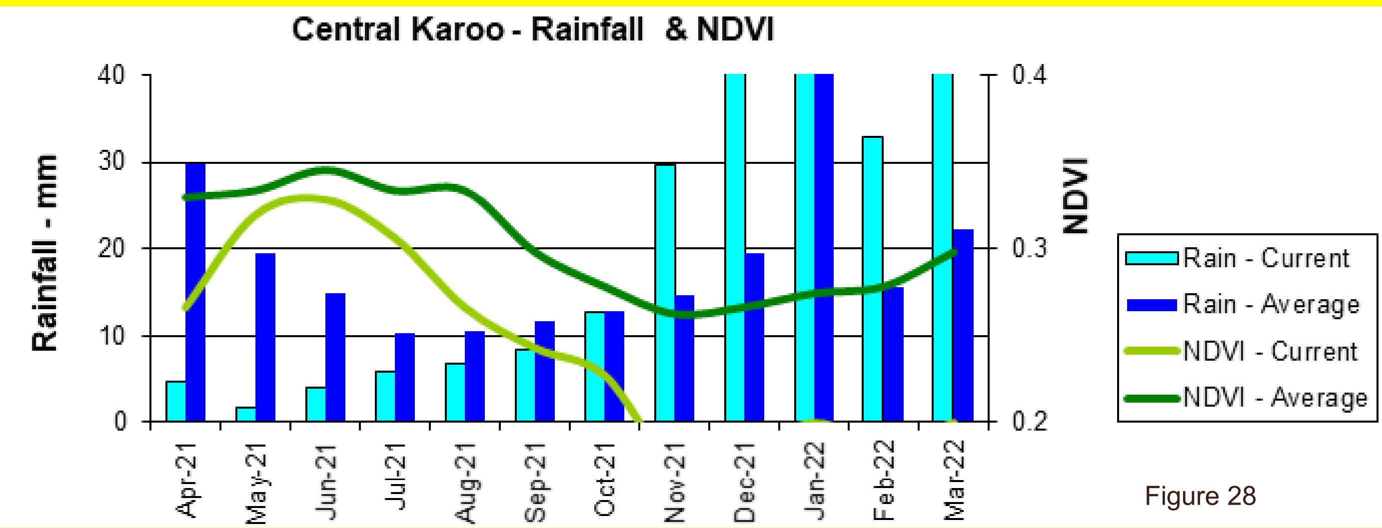

Figure 28

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 1-31 March 2022 per province. Fire activity was lower in all provinces except for the Western Cape, compared to the long-term average.

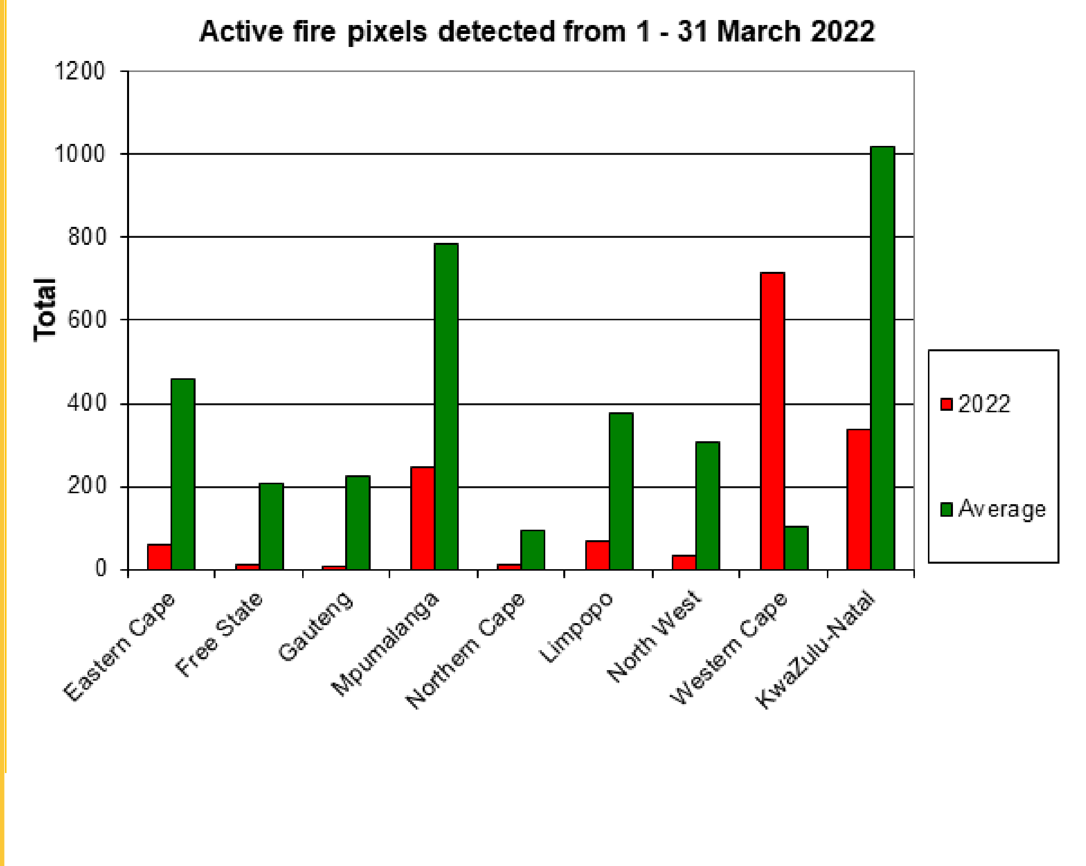

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-31 March 2022.

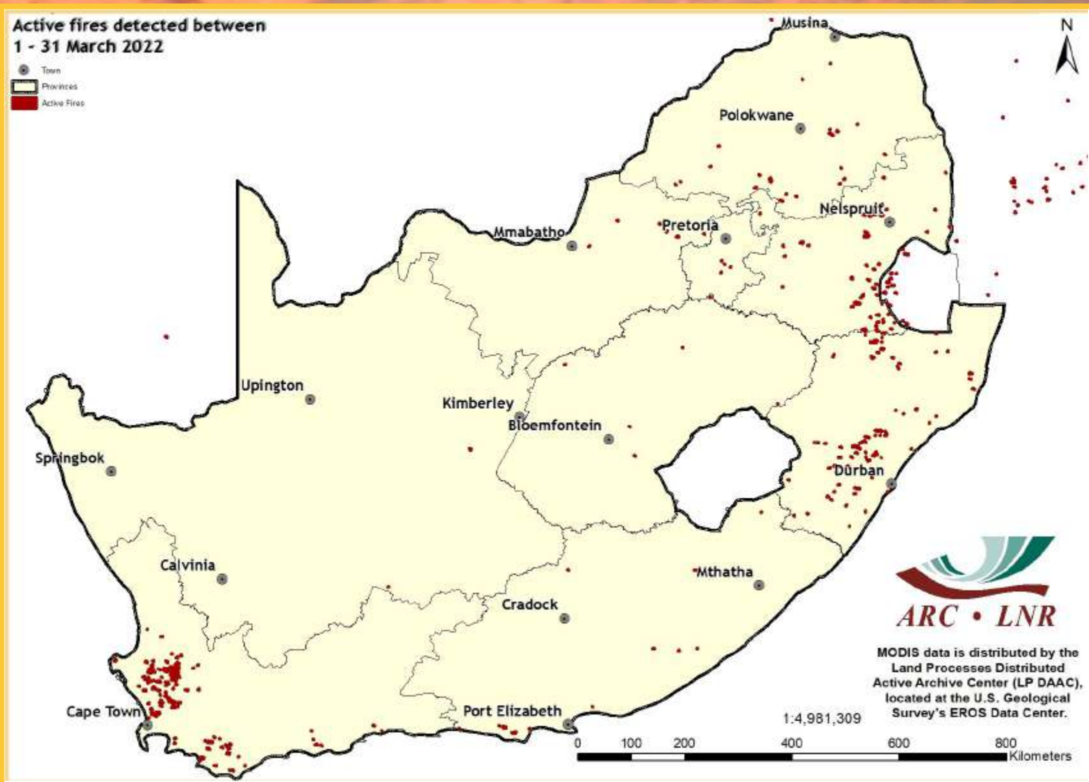

Figure 30

7. Fire Watch

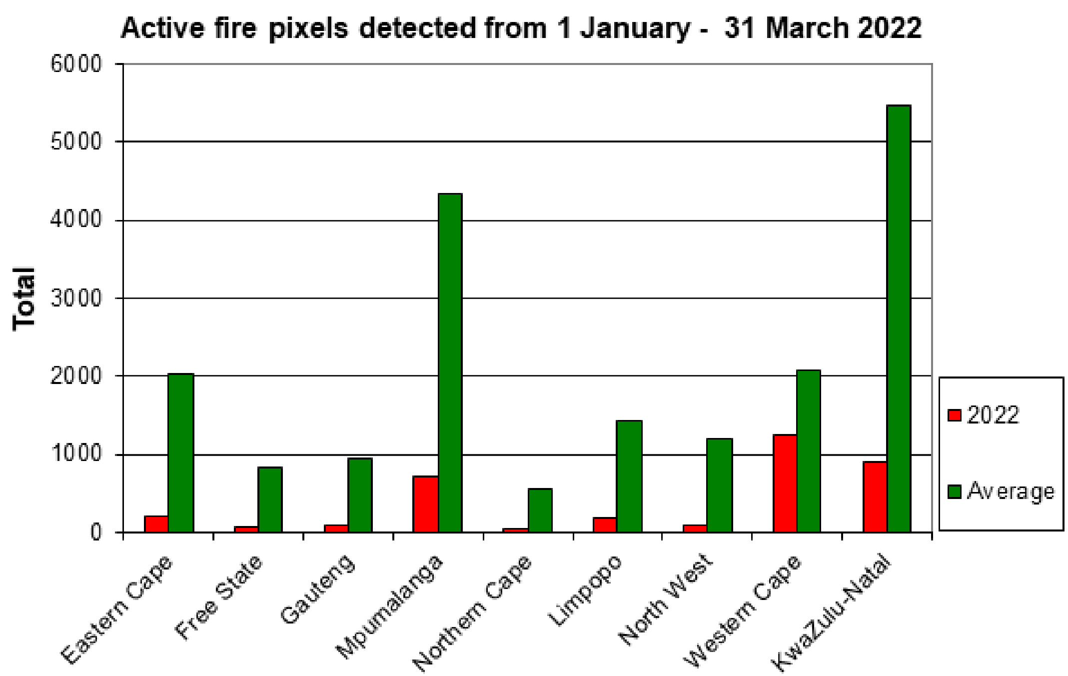

Figure 31

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

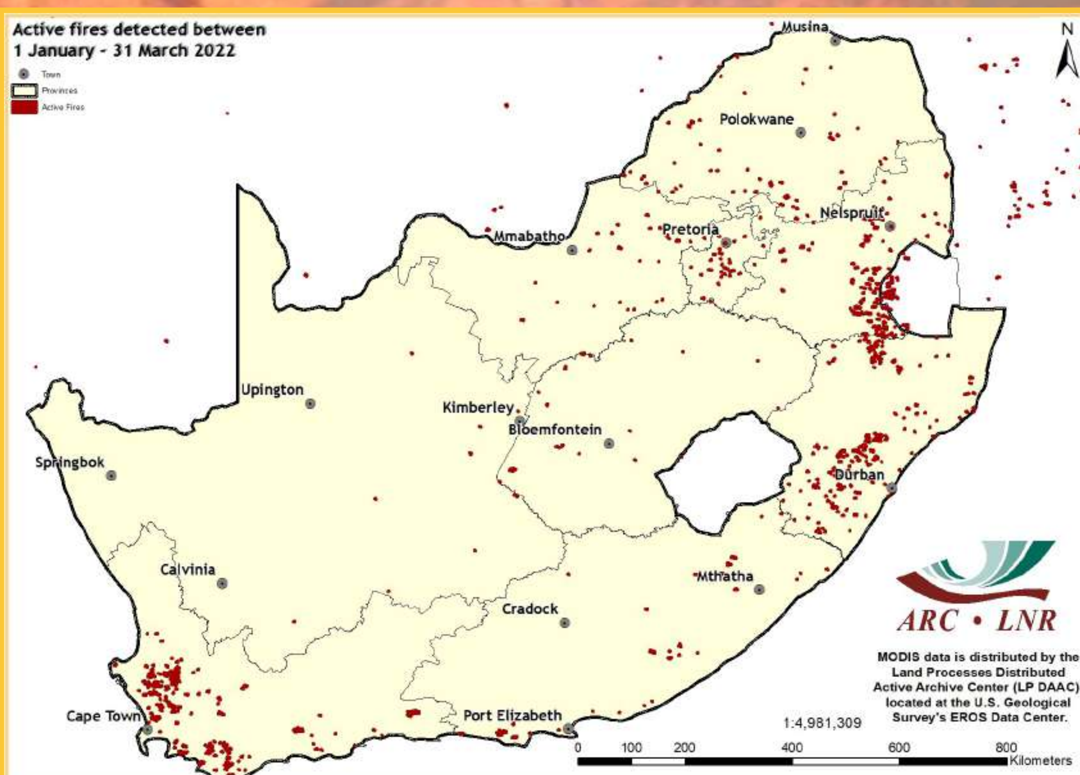

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January and 31 March 2022.

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 represents a comparison between the area of water available now and the maximum area of surface water recorded in the last 5 years. This 5-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 March 2022 shows a nearly identical water distribution pattern to the previous month. This continues to illustrate the significant impact of the widespread 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 5-year, long-term maximum water, similar to the February 2022 long-term map.

The comparison between March 2022 and March 2021 shows similar water level distribution patterns to last month, with most regions showing current water levels between 50% and 150% of the 2021 levels. The central Karoo and Kalahari regions continue to show exceptionally high water levels, whilst the central northern area of the Northern Cape, bordering Botswana, is the main exception and continues to show significantly less water compared to last month.

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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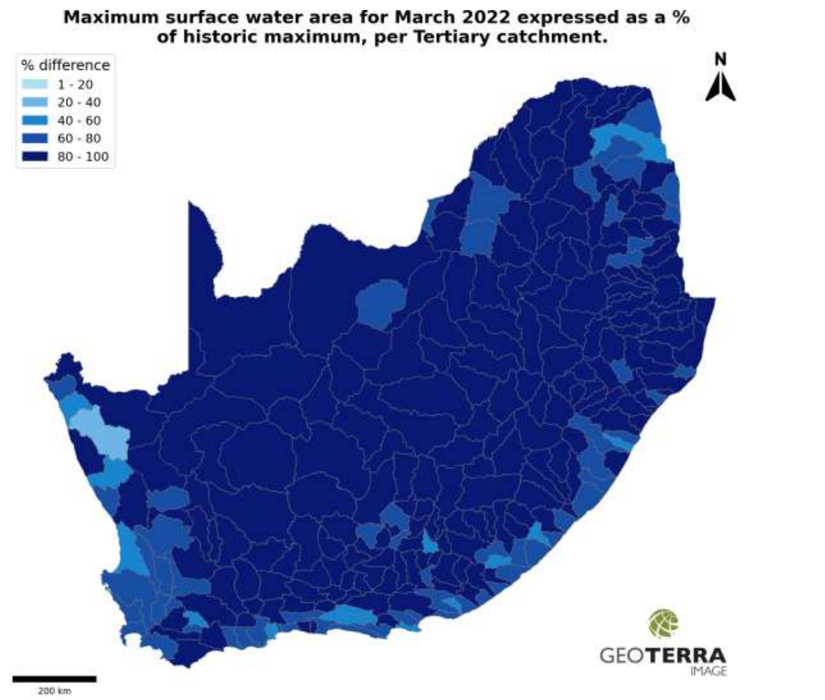

Figure 33

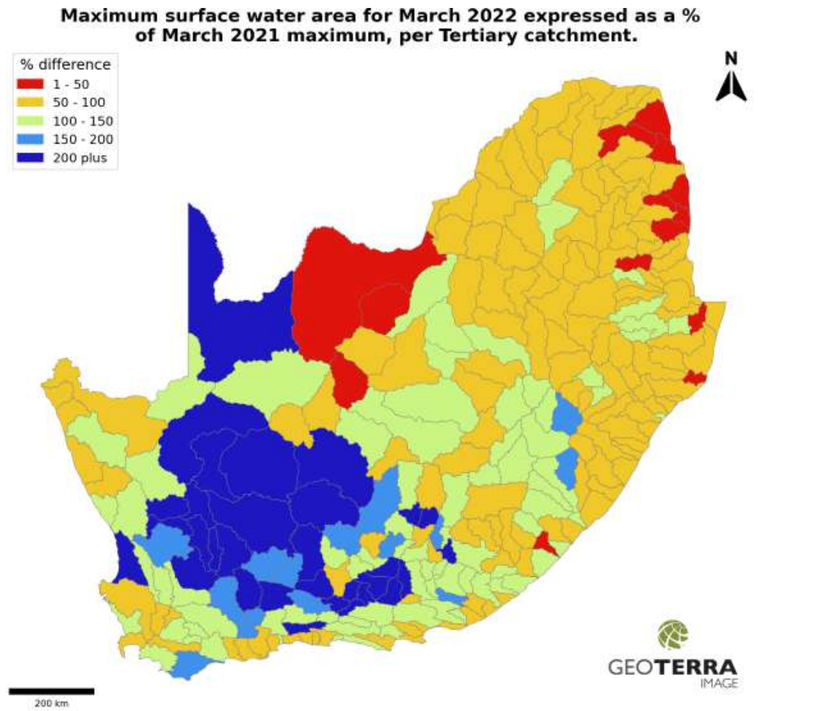

Figure 34

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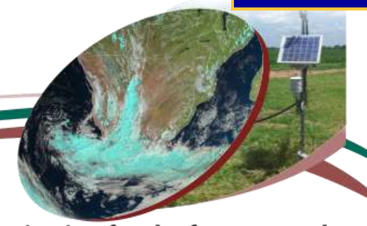
Agrometeorology



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".