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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

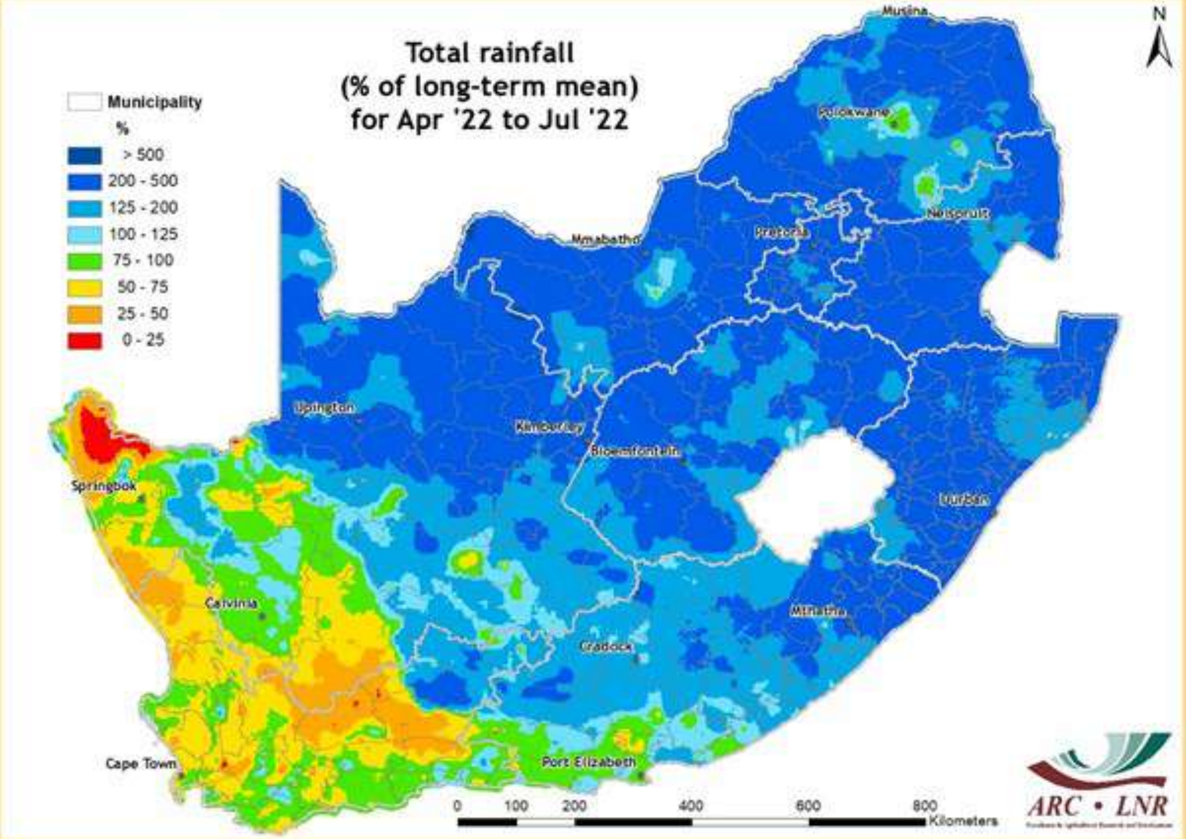
AMESD

218th Edition

Image of the Month

Current rainfall conditions over the winter rainfall region

During the past four months, the winter rainfall region received around 50-75% of its normal rainfall for the period from April to July (see map below). This follows a weak start to the 2022 winter rainfall season, with below-normal rainfall being recorded in April and May. The region welcomed the onset of its rainy season towards the end of May and more intensely during the first half of June. This was mainly due to the passage of strong cold fronts over the south-western parts of the country with some areas recording totals of >200 mm for the month of June. Moreover, this rainfall contributed to the above-normal conditions visible on the rainfall map for the last four months since July was also characterized by below-normal rainfall. This raises concerns for rain-fed agricultural activity in the region so it is recommended that preventative measures be applied to minimize the risk of dry spells on developing crops. Farmers should consider rainwater harvesting and prepare for heavy rains and destructive winds due to the risk of poor rainfall distribution during the remainder of the winter season.



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.

Overview:

Following a cold and wet June over greater parts of the country, a notable decrease in total rainfall was evident in July 2022. Most parts of the summer rainfall region were somewhat dry due to unfavourable upper air conditions and/or dry surface conditions, as is to be expected during the winter season. However, certain stations recorded totals of up to 50 mm, thus resulting in above-normal rainfall conditions in some areas. These included most parts of the Eastern Cape and adjacent parts of KwaZulu-Natal, eastern Free State and isolated areas in North West, Mpumalanga and Limpopo.

The summer rainfall areas of the Northern Cape were dry during July, following significant rainfall amounts since the onset of the summer rains in October 2021. In contrast, much of the rainfall activity that occurred over the winter and all-year rainfall regions resulted in below-normal conditions. This is due to the fact that these regions commonly experience high rainfall totals at this time of year, owing to the frequent passage of frontal systems. The only areas that recorded >100 mm of rain during July were Kirstenbosch, Paarl and along the Jonkershoek mountains.

1. Rainfall

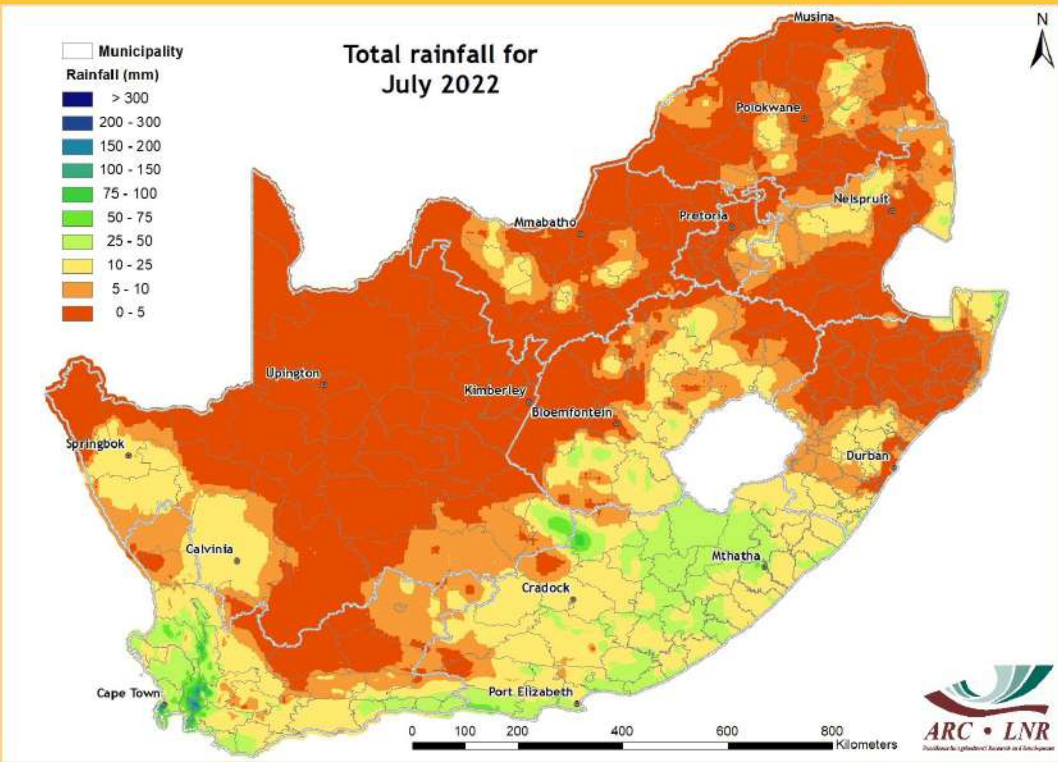


Figure 1

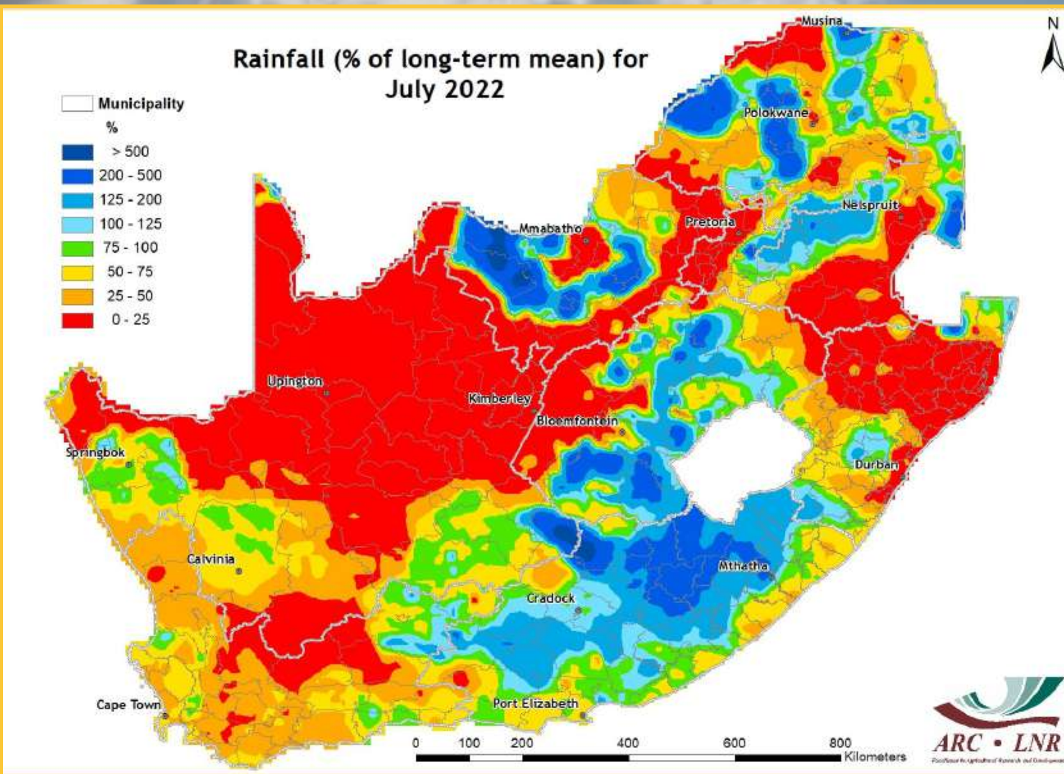


Figure 2

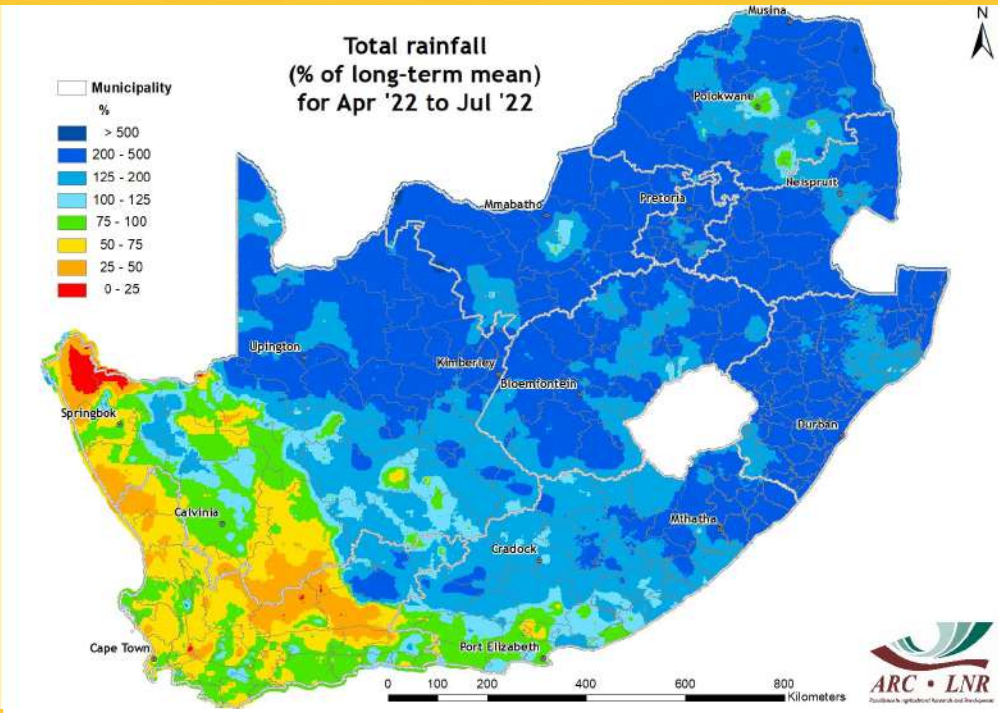


Figure 3

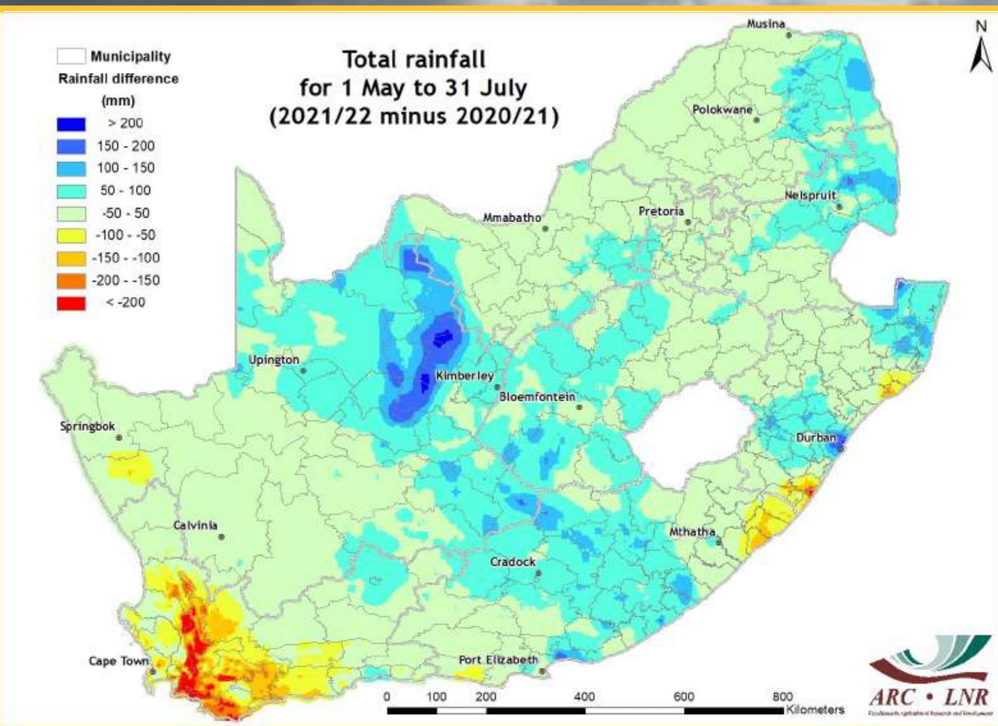


Figure 4

Figure 1:
Rainfall in July 2022 was confined to the winter and all-year rainfall regions, extending eastwards to parts of the Eastern Cape and Free State. Several areas in the summer rainfall region, including parts of the Limpopo, Mpumalanga, North West and KwaZulu-Natal provinces, did record some rainfall during the month but the totals were generally <25 mm.

Figure 2:
The unseasonable rainfall that occurred over certain parts of the summer rainfall region during July 2022 resulted in above-normal conditions, while below-normal rainfall occurred over most parts of the winter rainfall region, greater parts of the Northern Cape and adjacent areas of the Free State and North West.

Figure 3:
Greater parts of the country experienced widespread above-normal rainfall conditions during the last 4 months, with near- to below-normal rainfall observed over the Cape south coast and western region of the country, respectively.

Figure 4:
Compared to the corresponding 3-month period last year, rainfall during May to July 2022 was higher over the summer rainfall region, while the winter rainfall region received considerably less rain. Most of the all-year rainfall region recorded near-normal conditions.

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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 July 2022 are shown in Figures 5-8. Wet conditions are evident over most parts of the country, particularly over the interior. These are clearly visible on the 6- and 24-month time scales and an improvement from drought conditions was observed over greater parts of the country. Longer time scales show moderate to severe drought conditions over the southern parts of Limpopo, the Eastern Cape and most parts of the winter rainfall region.

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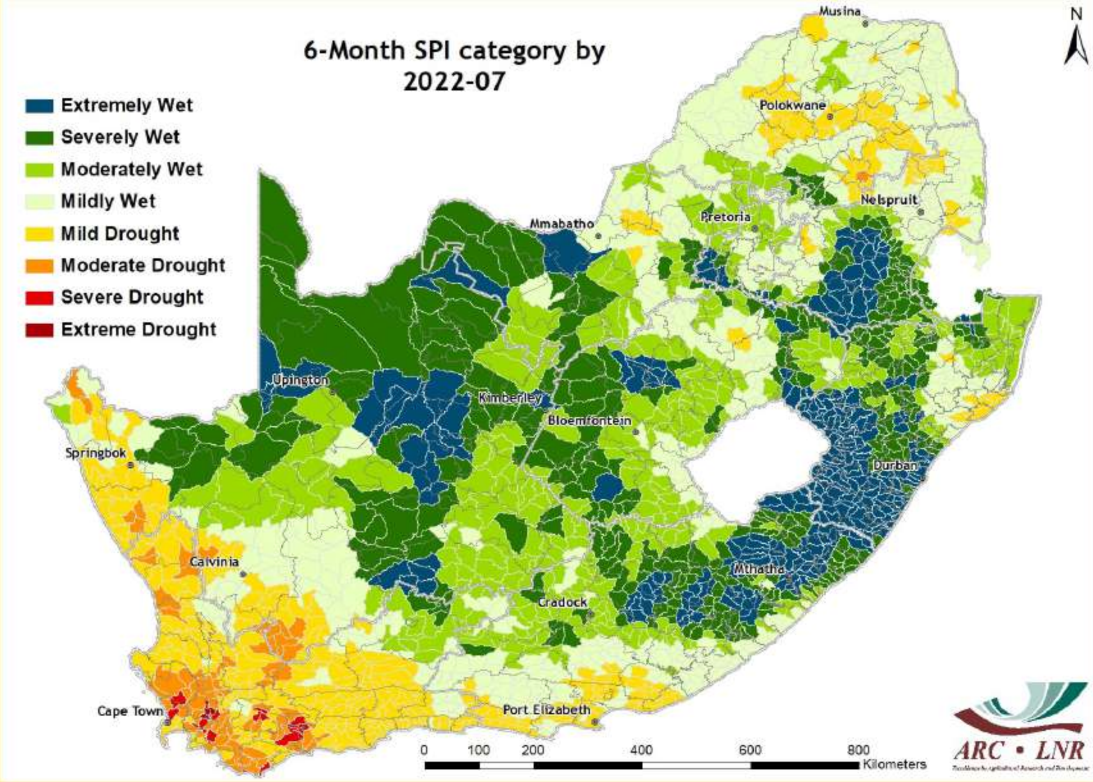

Figure 5

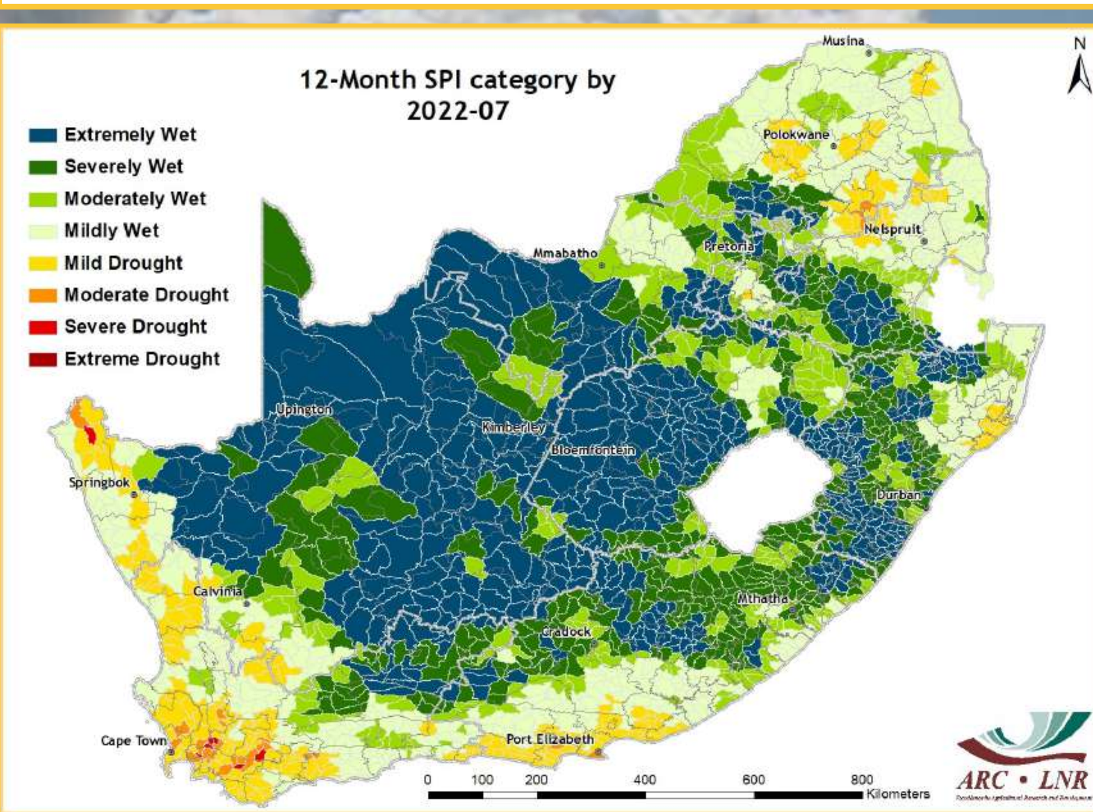

Figure 6

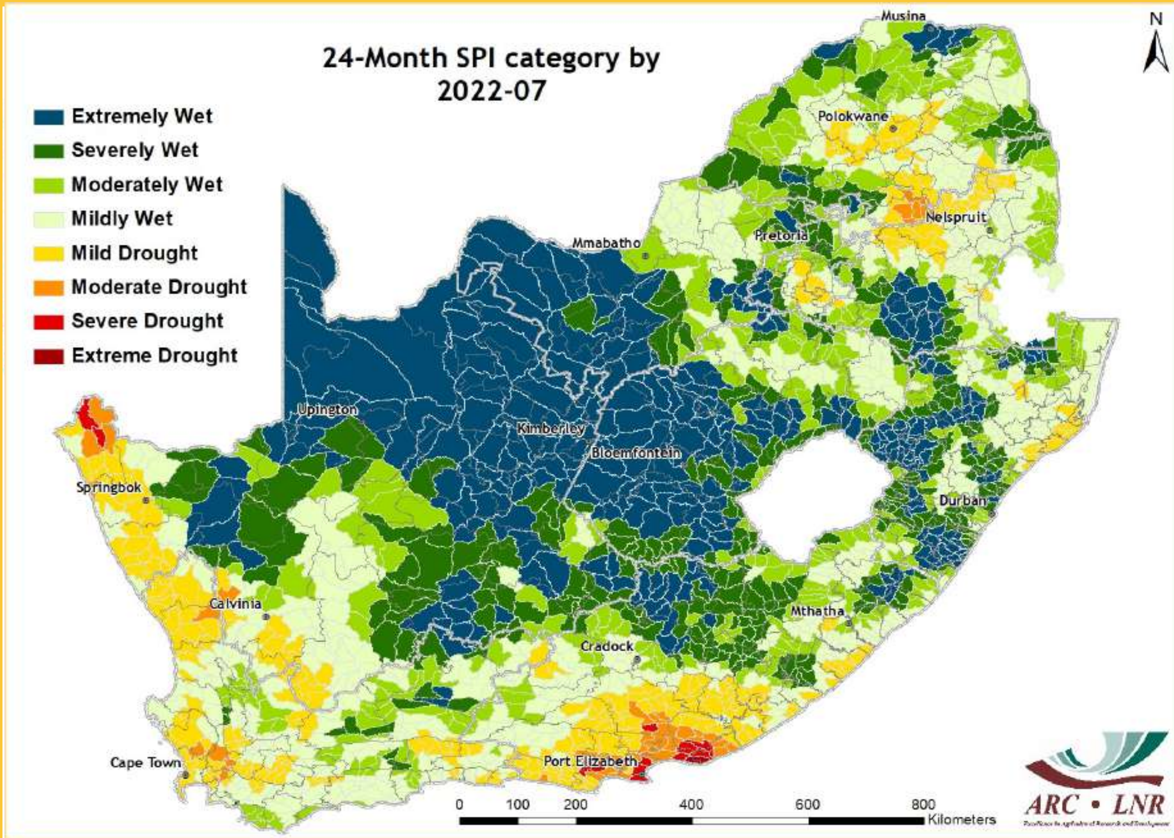

Figure 7

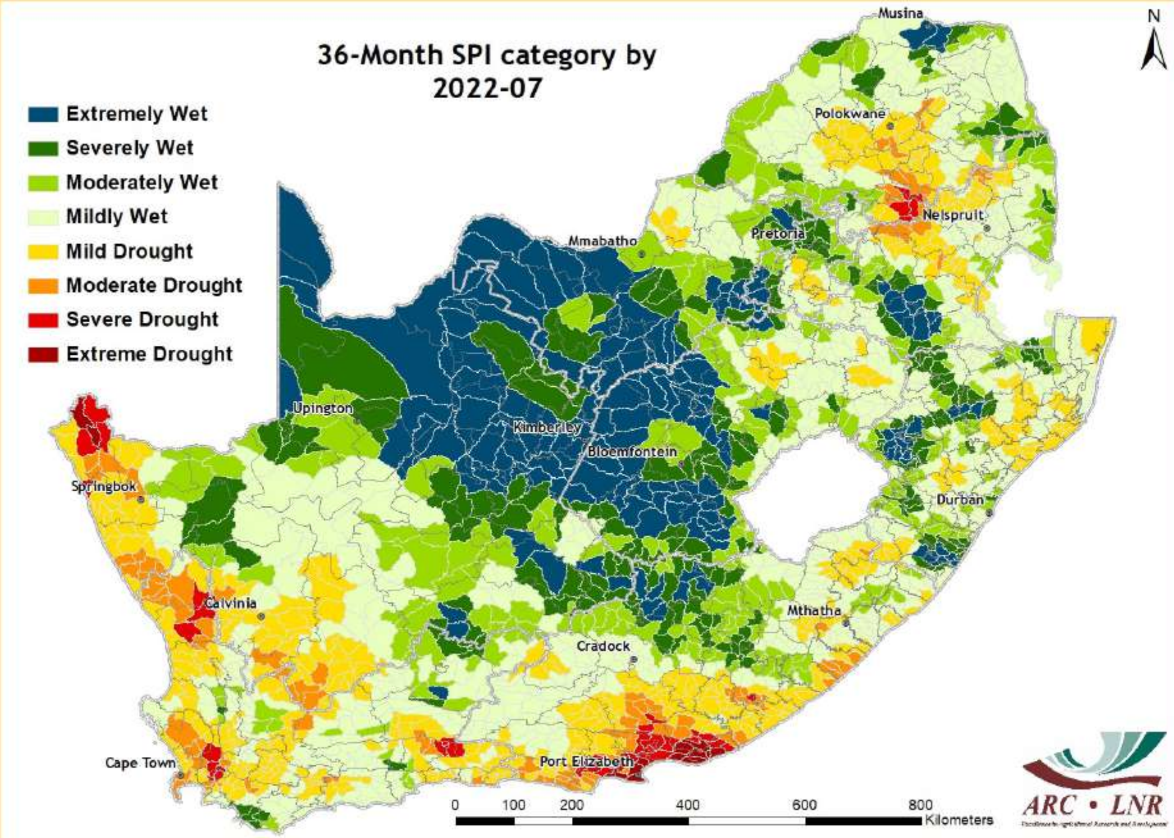

Figure 8

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.

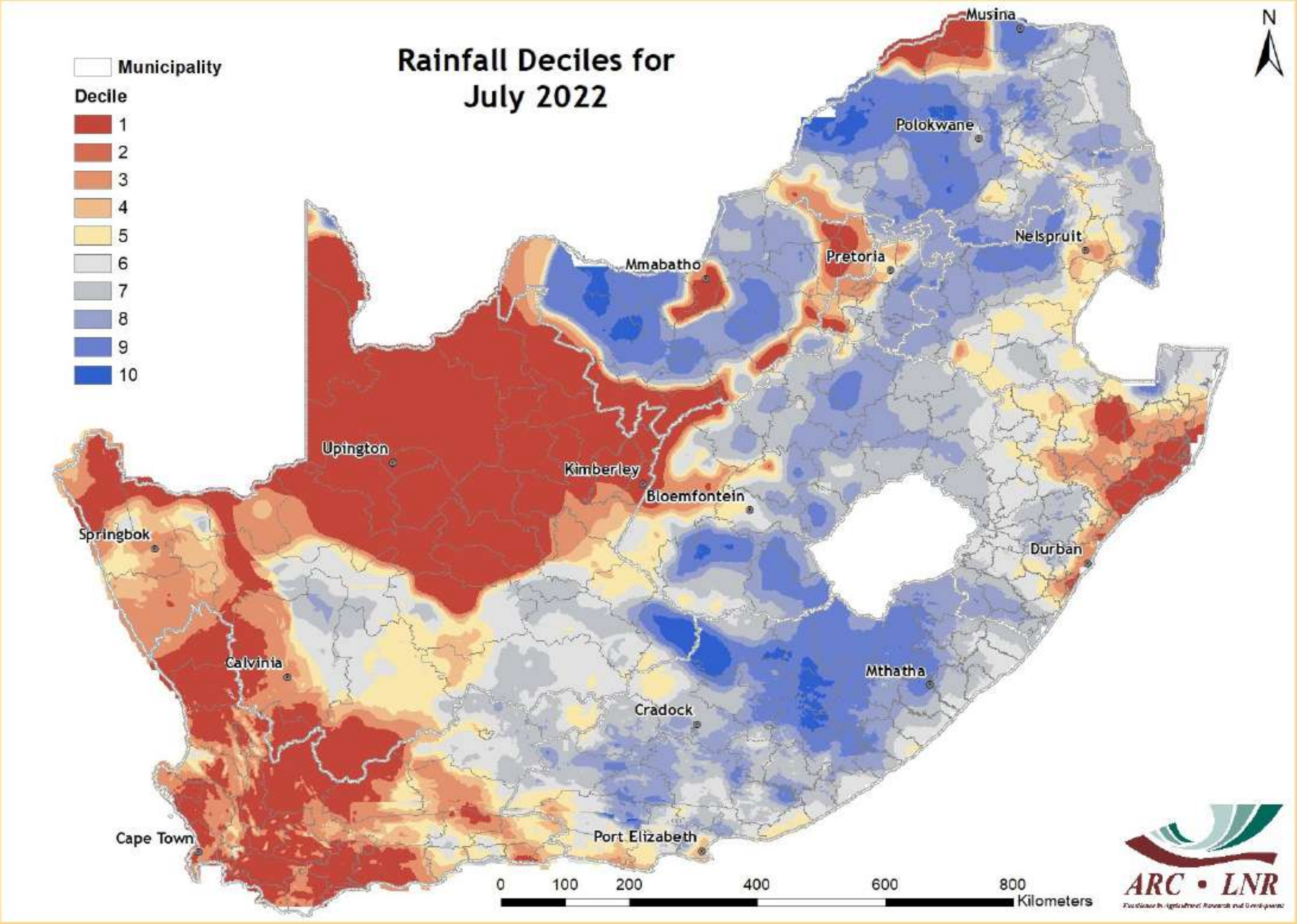

Figure 9

Figure 9:
Rainfall totals for July 2022 over the winter and all-year rainfall regions compare well with historically drier July months. The summer rainfall region experienced a wetter than normal July, except for certain parts of KwaZulu-Natal, Limpopo, North West and the Northern Cape.

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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.

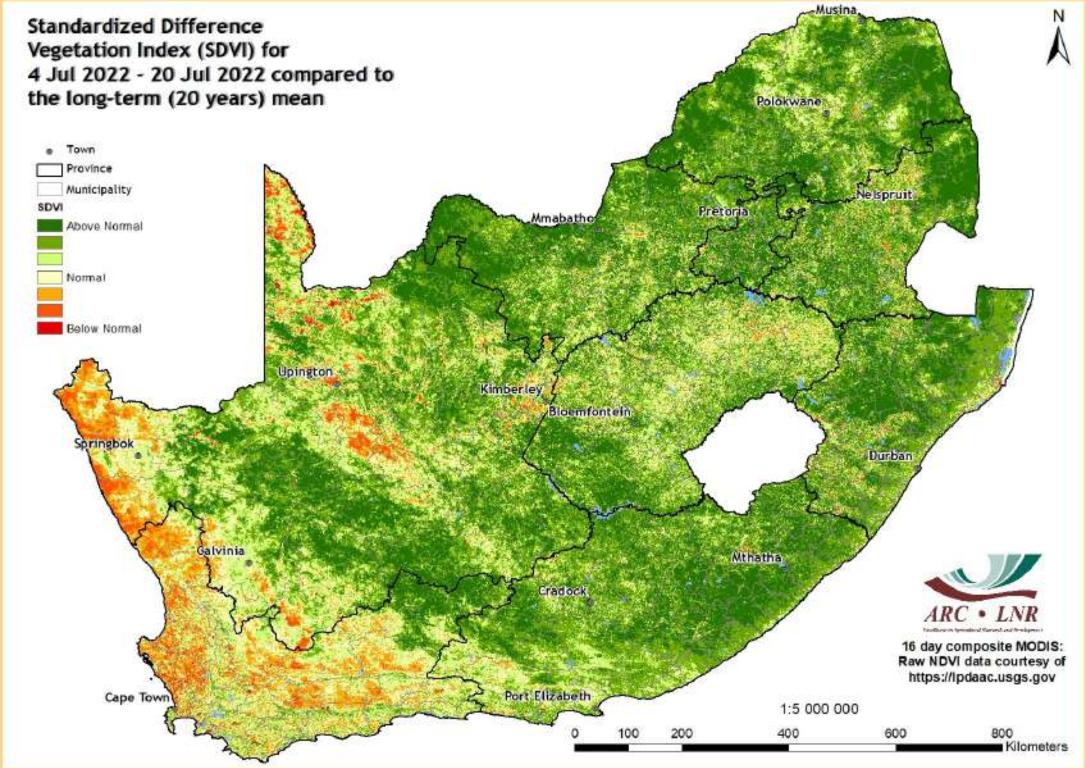

Figure 10

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

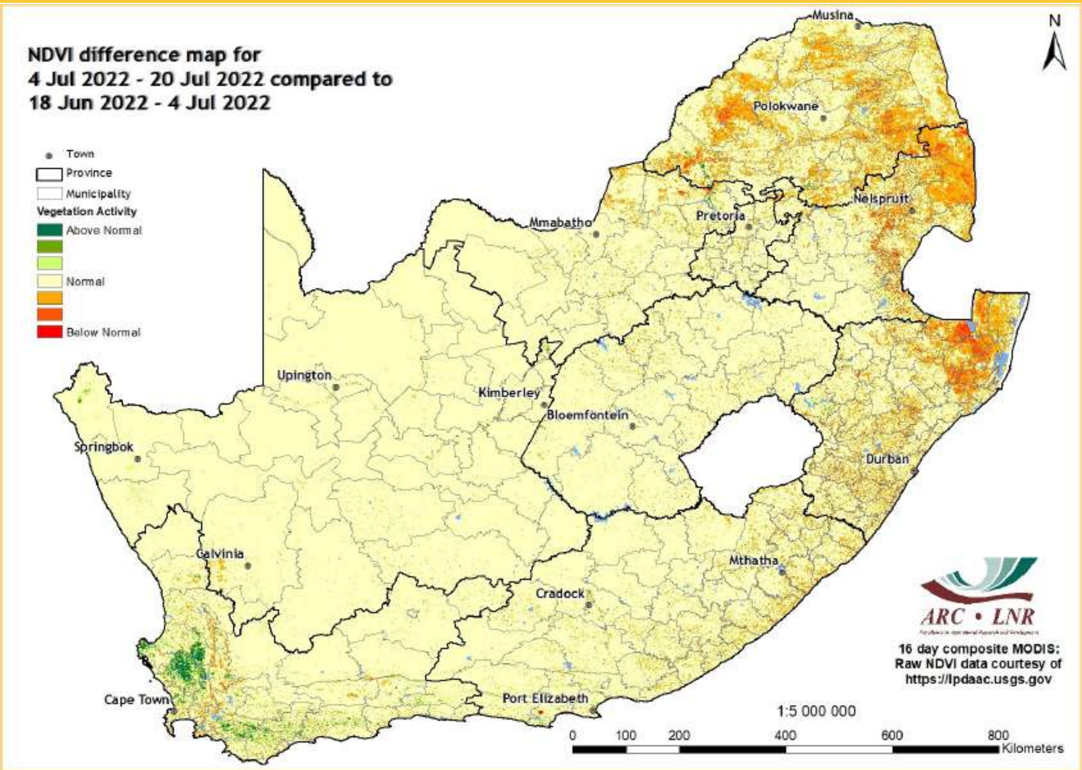

Figure 11

Figure 11:
The 16-day NDVI difference map for July 2022 compared to the preceding 16-day period shows that the western and central interior experienced normal vegetation conditions while the far northern parts of the country experienced below-normal vegetation conditions.

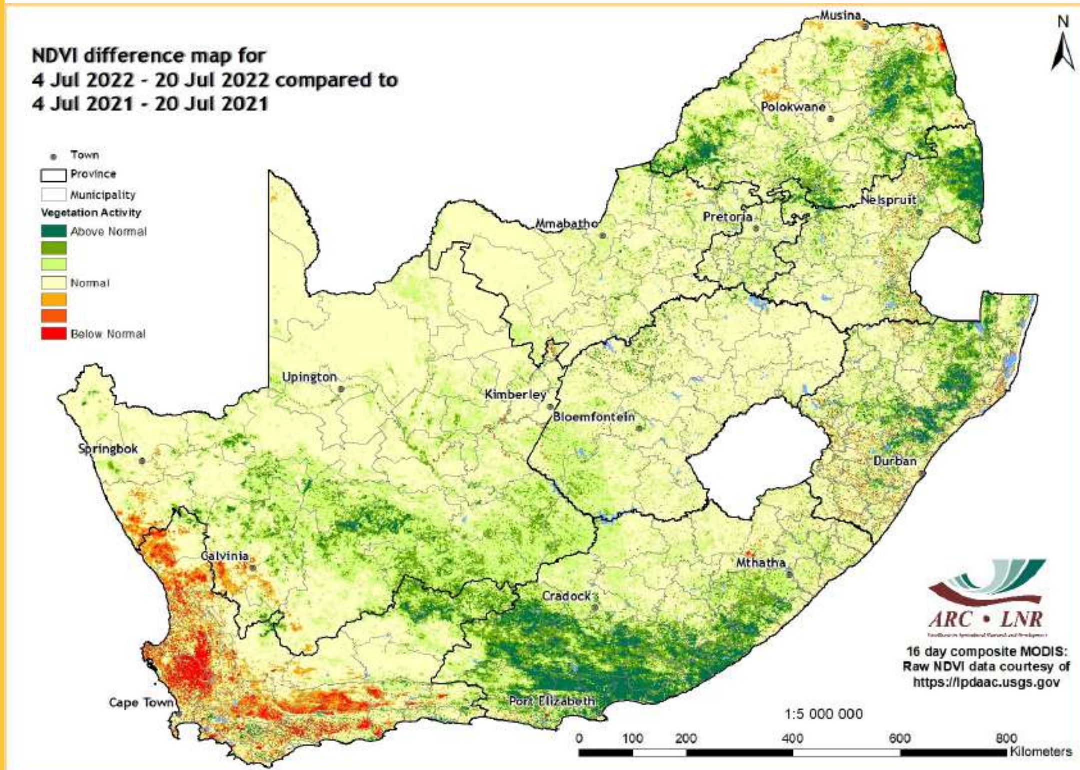

Figure 12

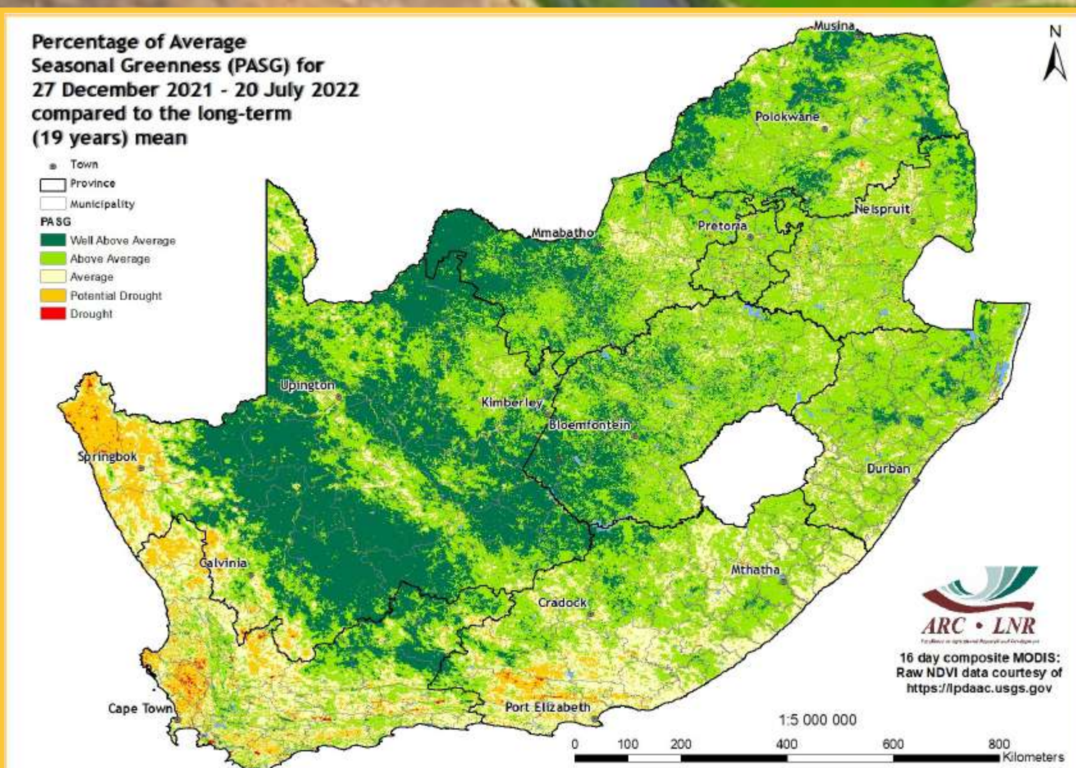

Figure 13

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 July 2022 compared to the same period last year shows that most parts of the country experienced normal to above-normal vegetation activity. In contrast, the far western and northern parts exhibited below-normal vegetation patterns.

Figure 13:
The Percentage of Average Seasonal Greenness (PASG) map for the past 6 months, compared to the long-term mean, shows high levels of seasonal vegetation greenness in the central interior 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.

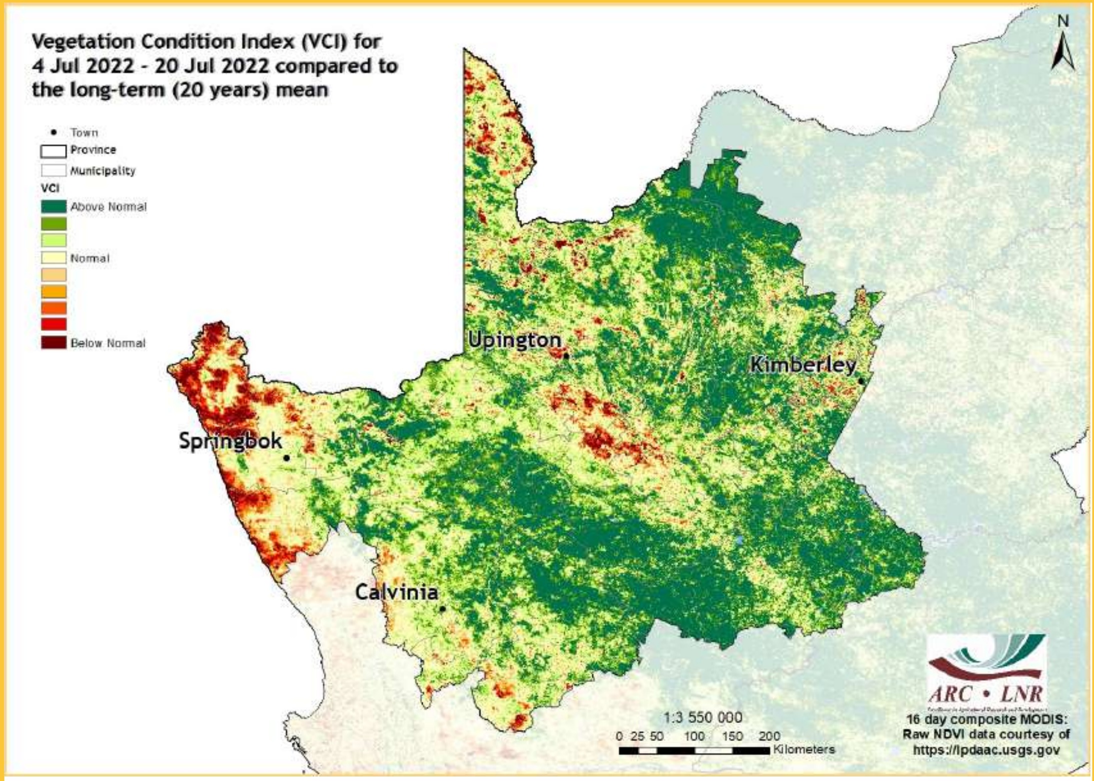


Figure 14

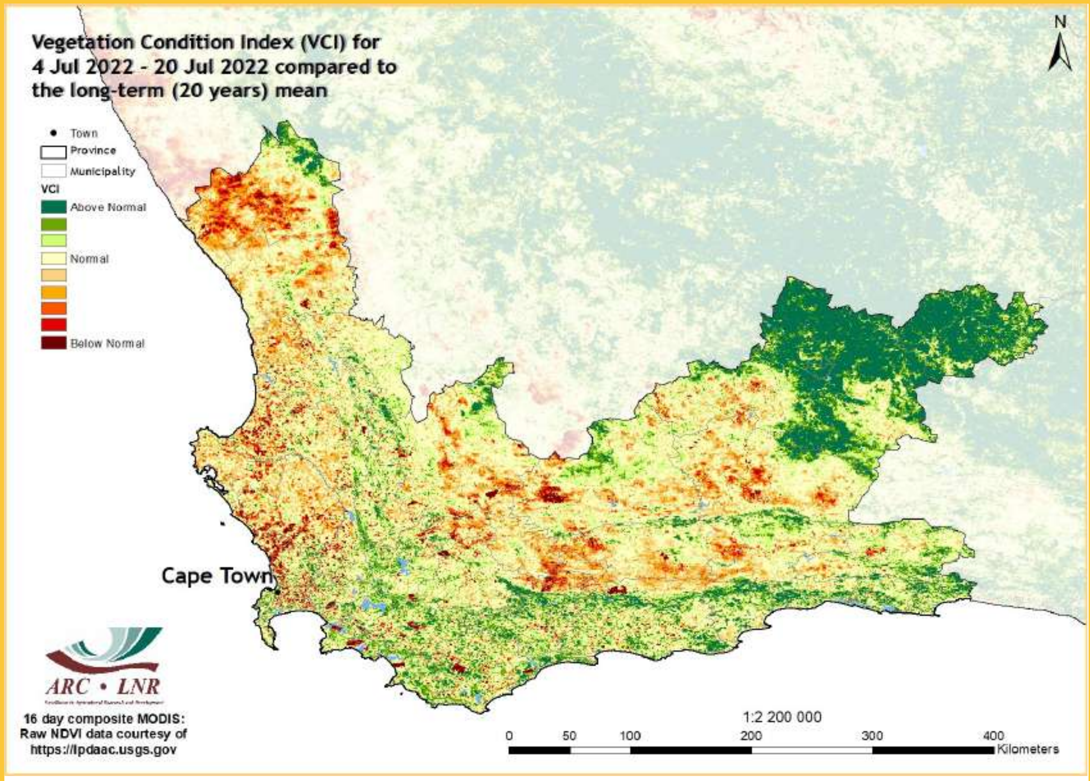
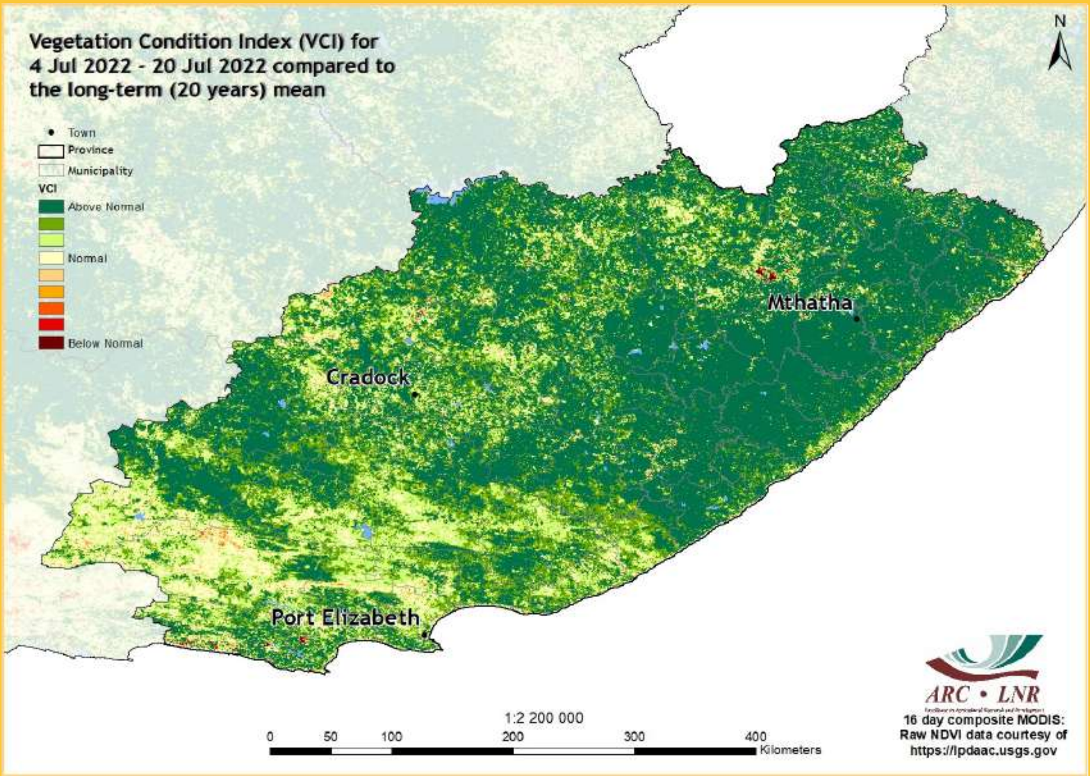


Figure 15

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

Figure 15:
The 16-day VCI map for July 2022 indicates that below-normal vegetation conditions are prevalent throughout the Western Cape, although a few areas of good vegetation activity can also be observed, particularly in the northern parts of the Central Karoo district municipality.



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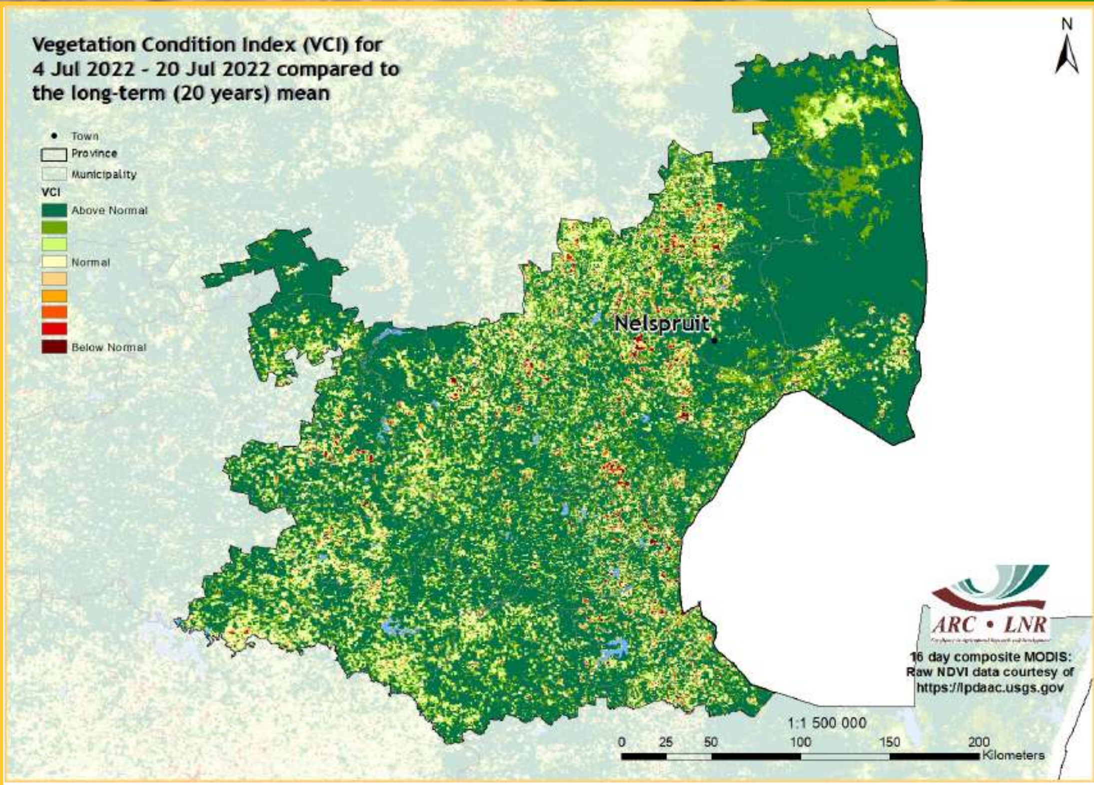

Figure 17

Figure 16:
The 16-day VCI map for July 2022 indicates that above-normal vegetation conditions are prevalent in most parts of the Eastern Cape.

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

Questions/Comments:
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6. Vegetation Conditions & Rainfall

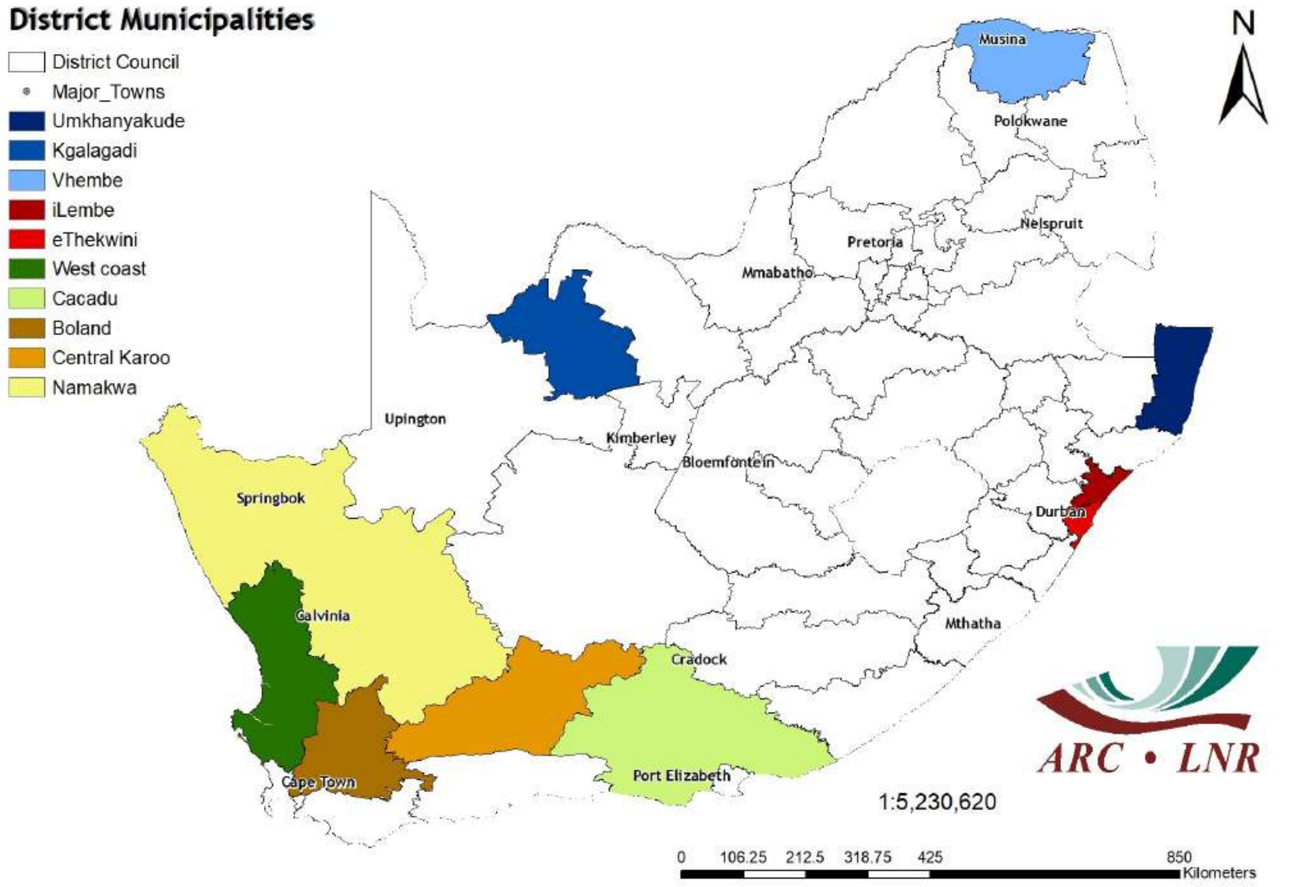

Figure 18

Rainfall and NDVI Graphs

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

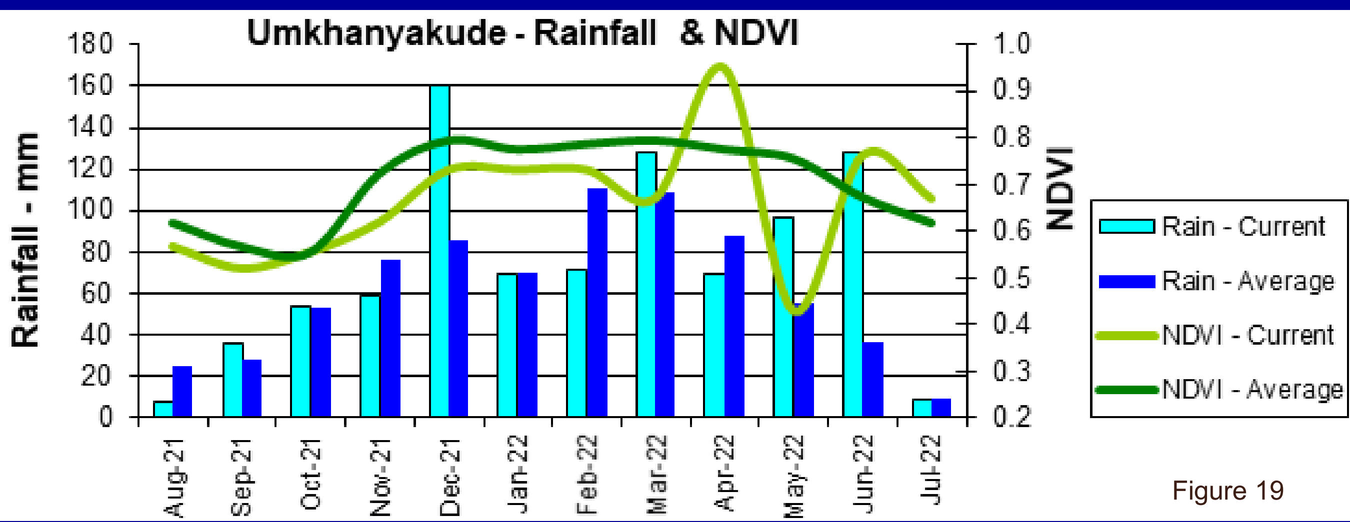
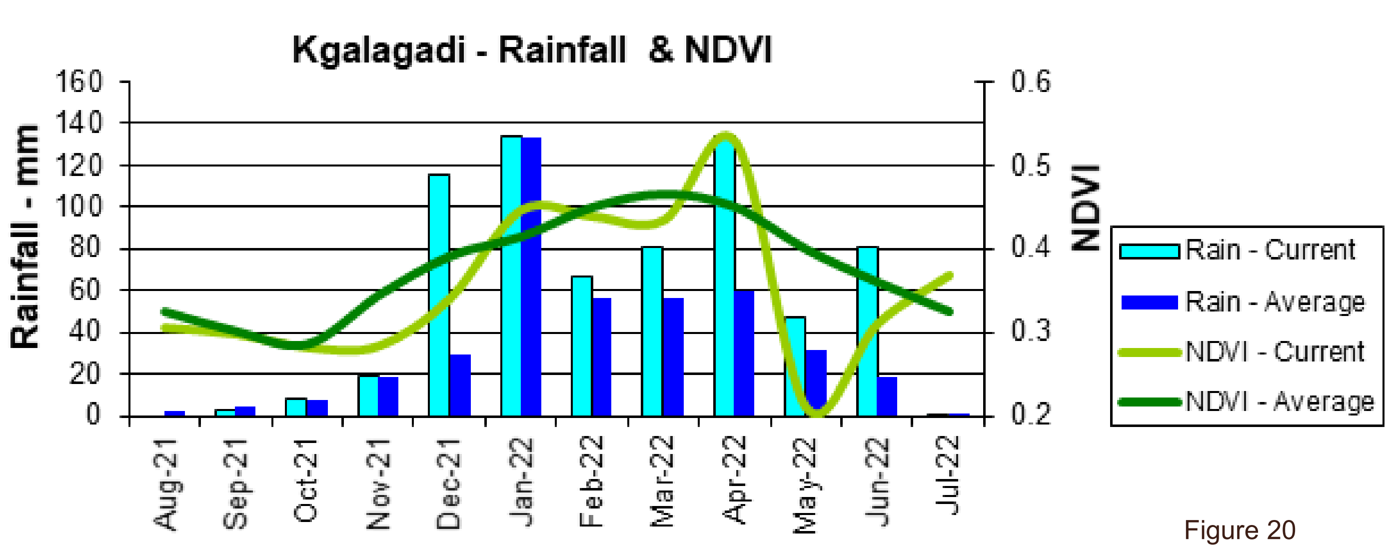


Figure 19



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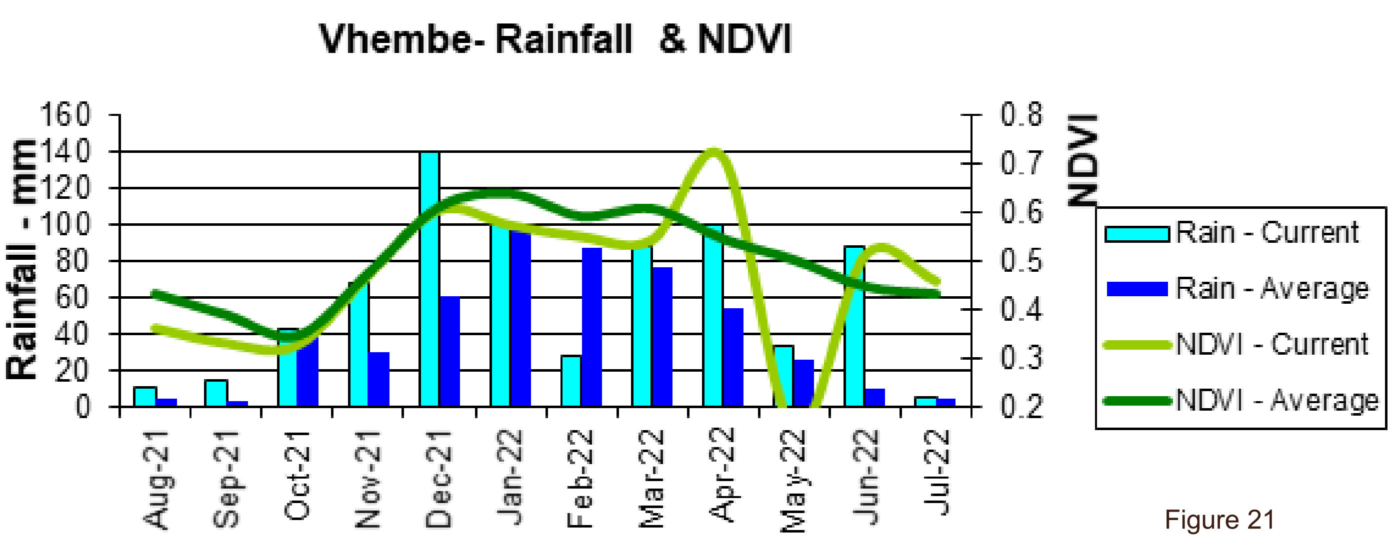

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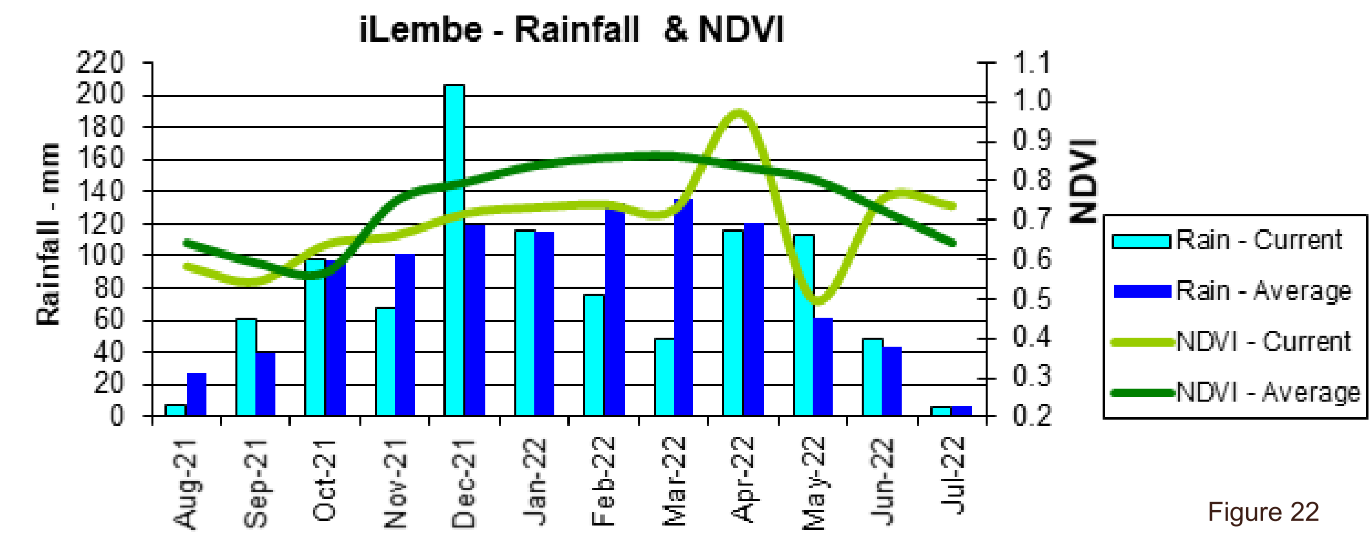

Figure 22

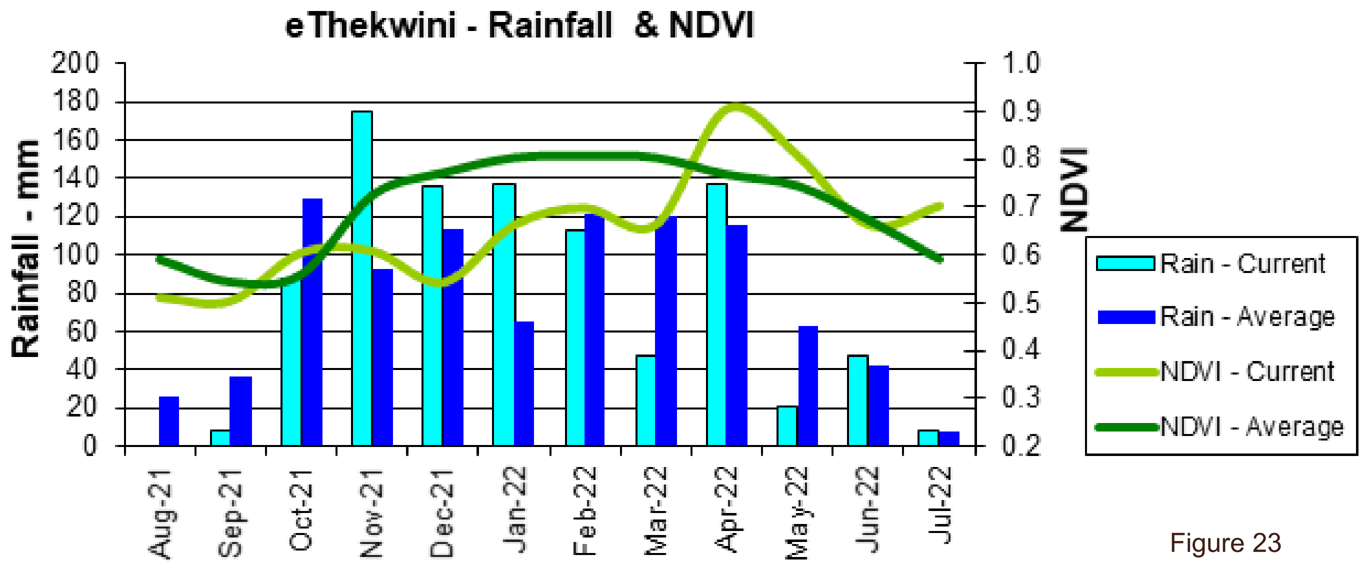

Figure 23

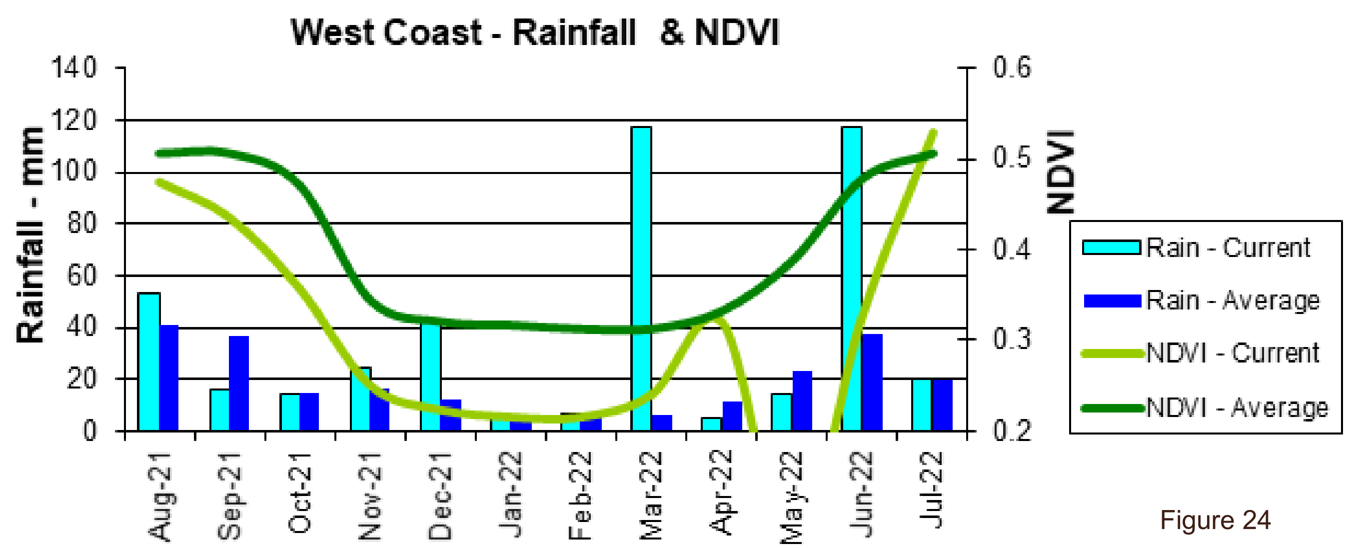

Figure 24

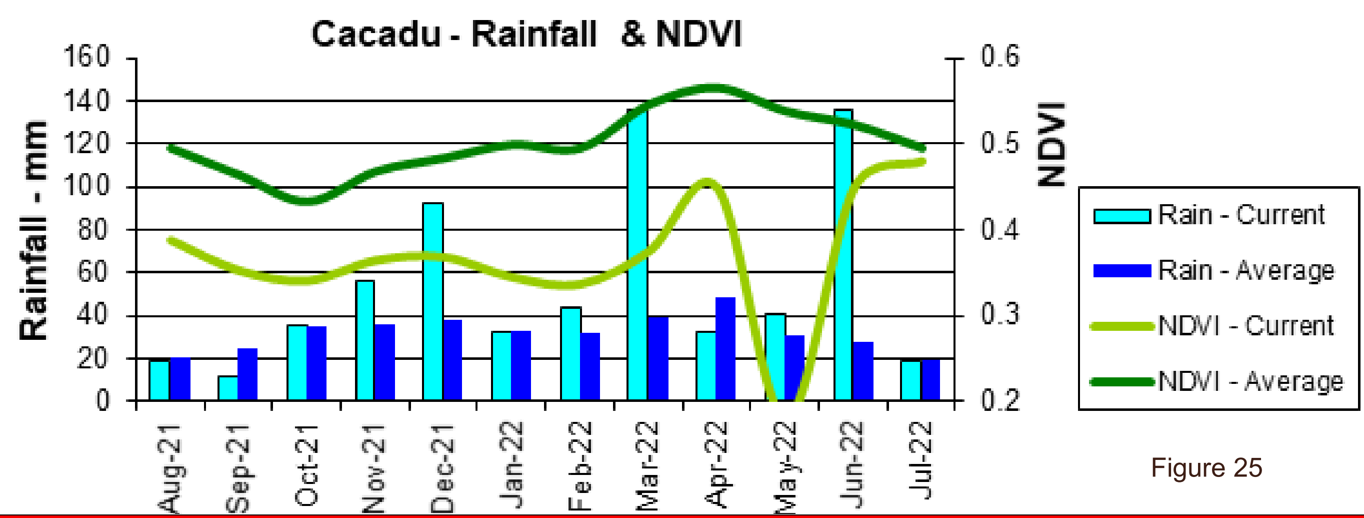

Figure 25

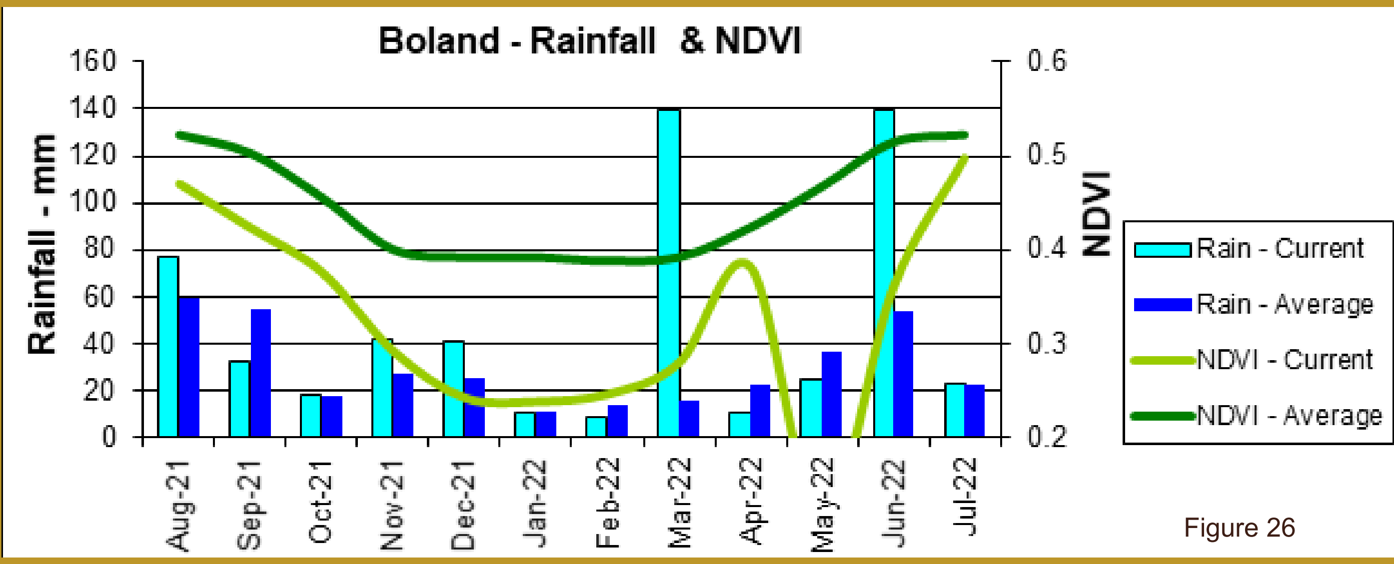

Figure 26

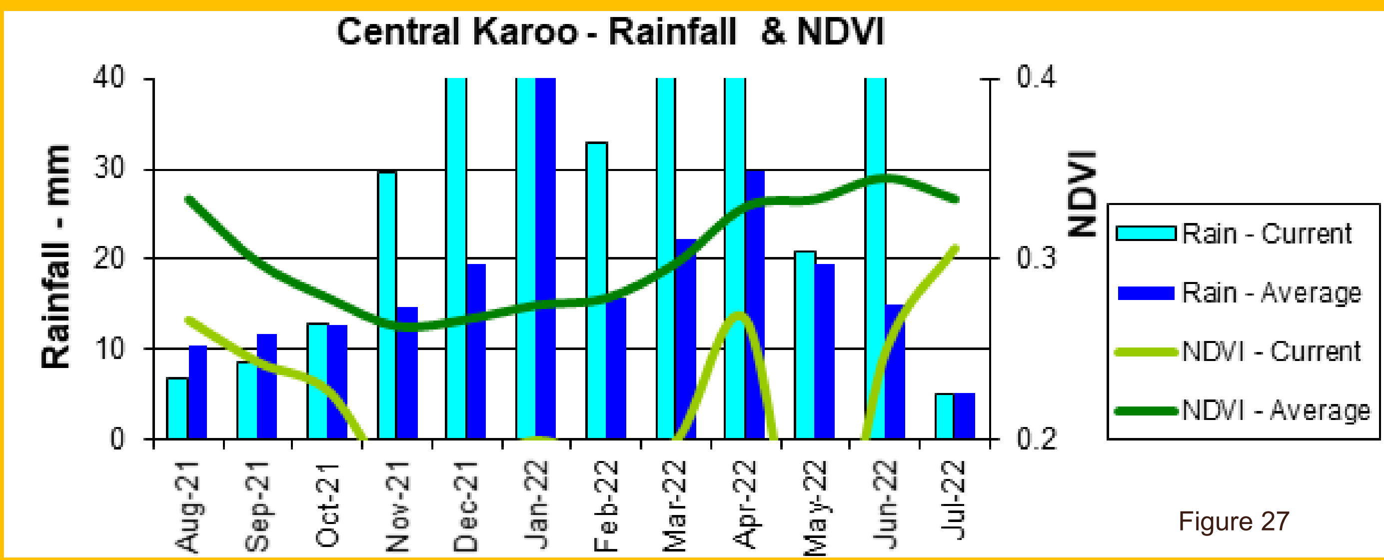

Figure 27

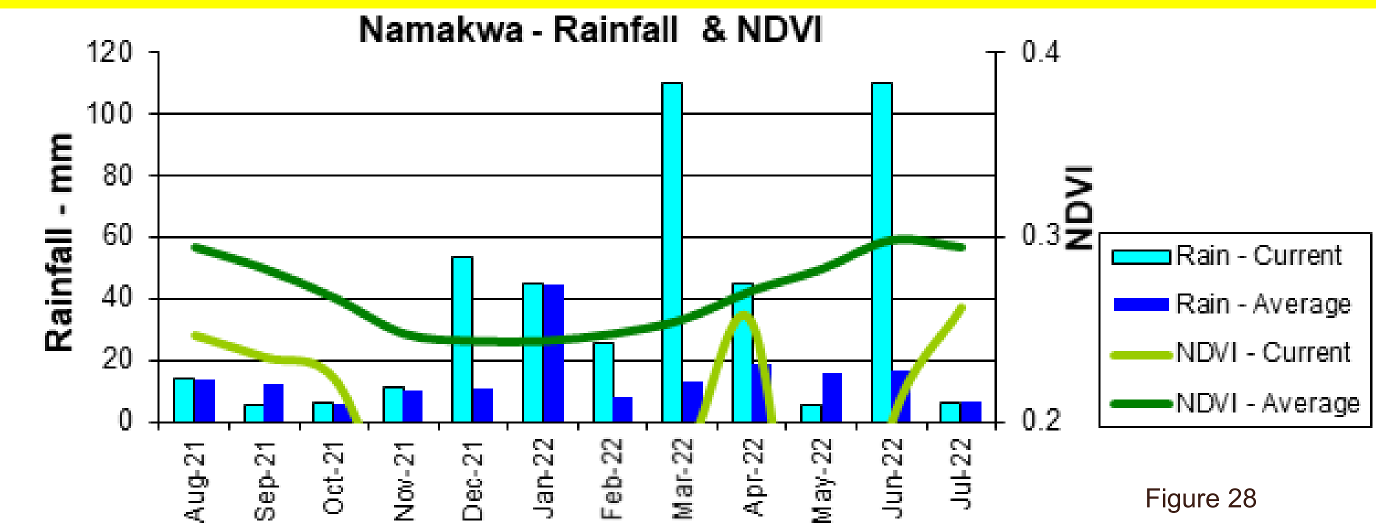

Figure 28

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 26 June and 28 July 2022 per province. Fire activity was lower in all provinces except for the Northern Cape, compared to the long-term average.

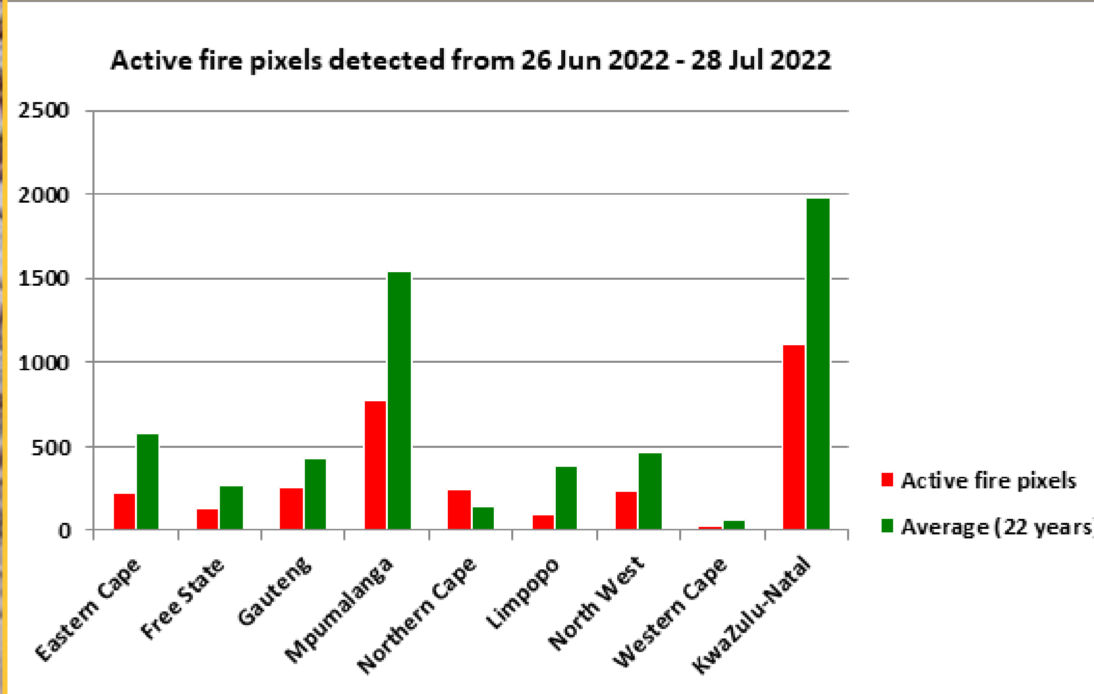

Figure 29

Figure 30:
The map shows the location of active fires detected between 26 June and 28 July 2022.

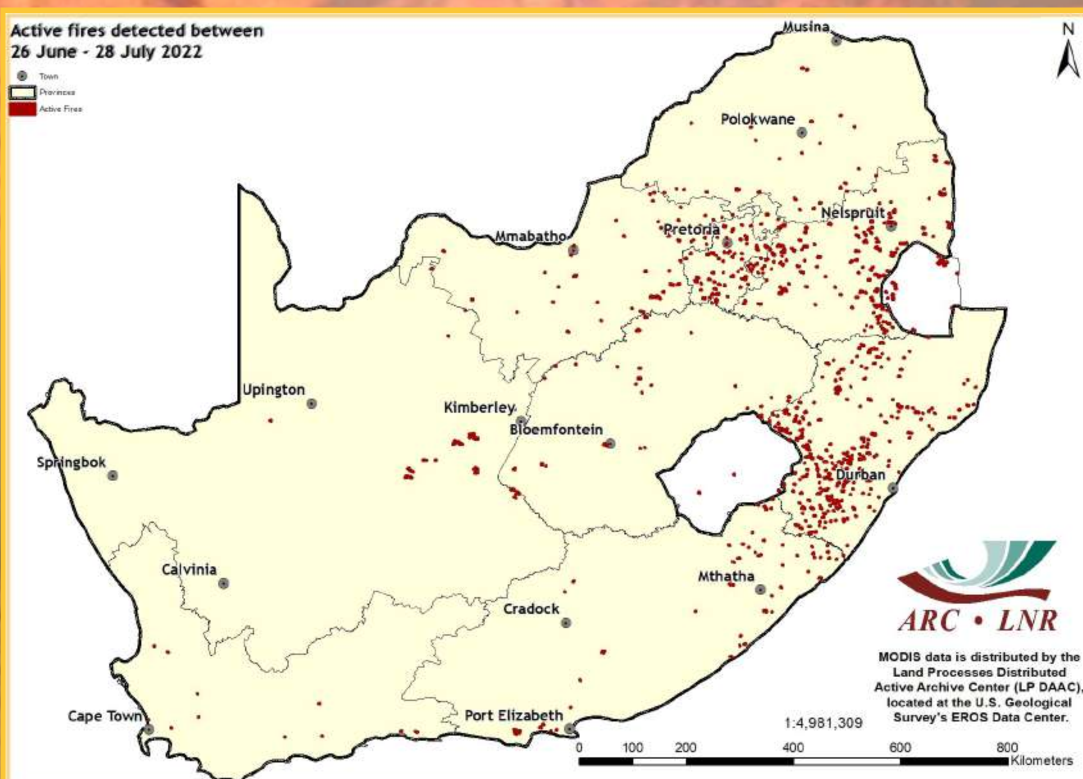

Figure 30

7. Fire Watch

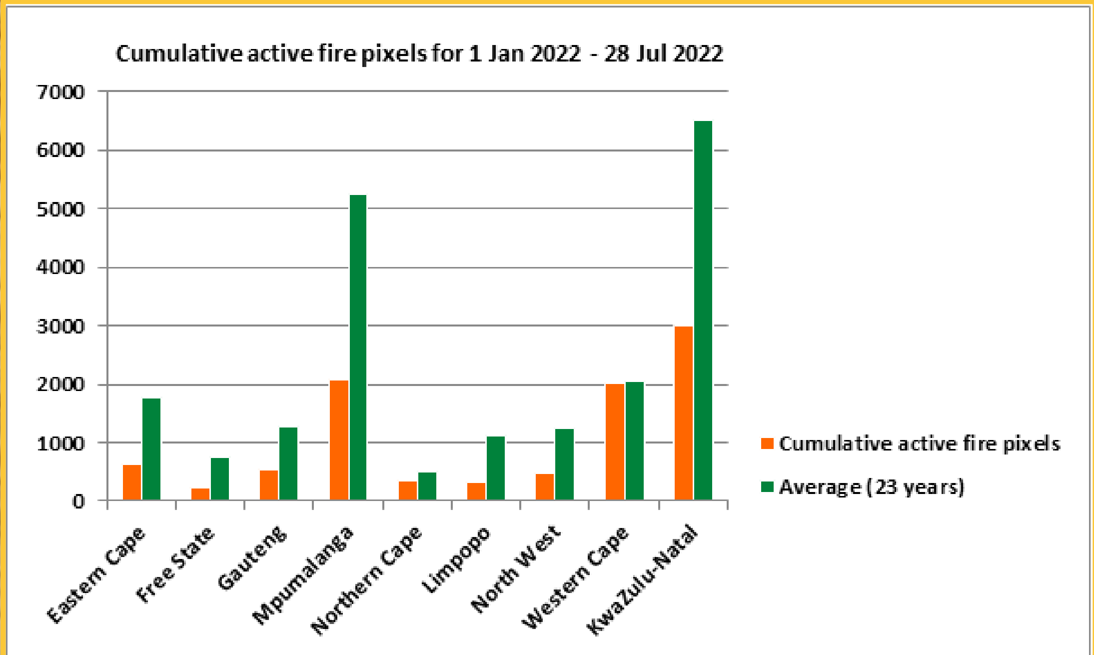

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January and 28 July 2022 per province. Cumulative fire activity was lower in all provinces compared to the long-term average.

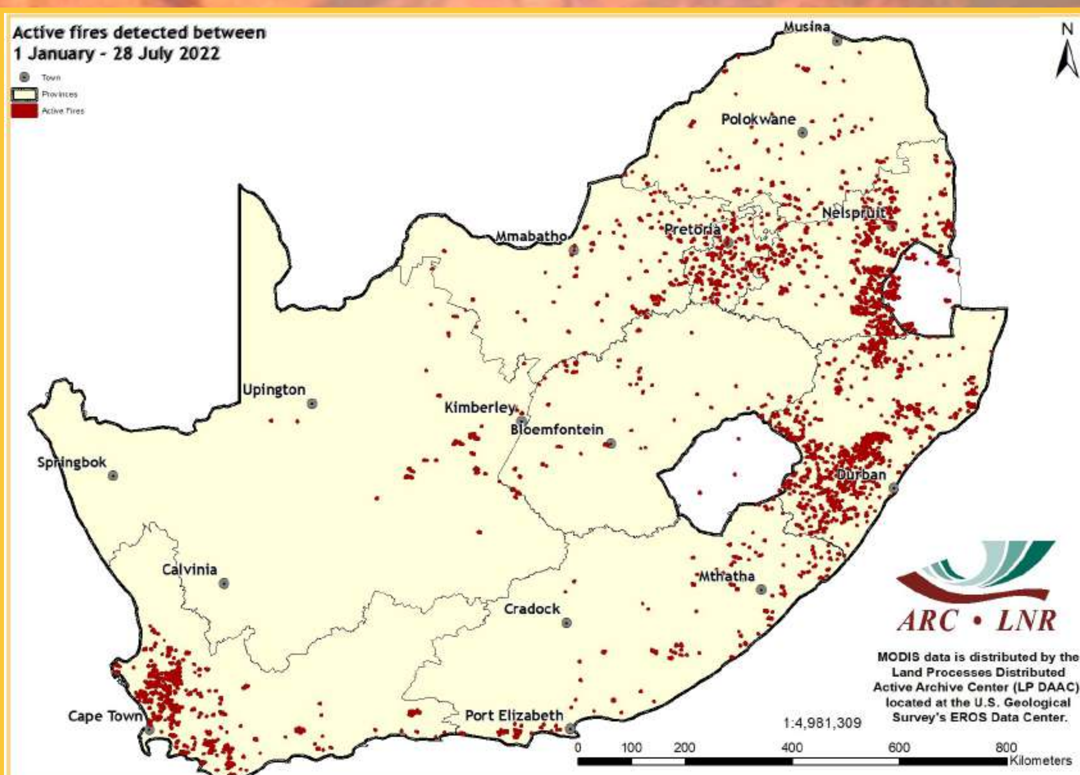

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January and 28 July 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 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 July 2022 shows a nearly identical distribution pattern to the previous 3 months. This continues to illustrate the significant impact of the high rainfall experienced over most of the country since late December 2021, with very high water levels across most parts of the country. The majority of Tertiary catchments continue to show water levels equivalent to 80-100% of the 6-year, long-term maximum water, similar to the previous 2022 long-term maps.

The comparison between July 2022 and July 2021 shows similar water level distribution patterns to the last 2 months across most of the country, with most regions still showing current water levels between 50% and 150% of the 2021 levels. The exception is the majority of the Northern Cape and central Karoo regions which continue to show significantly higher 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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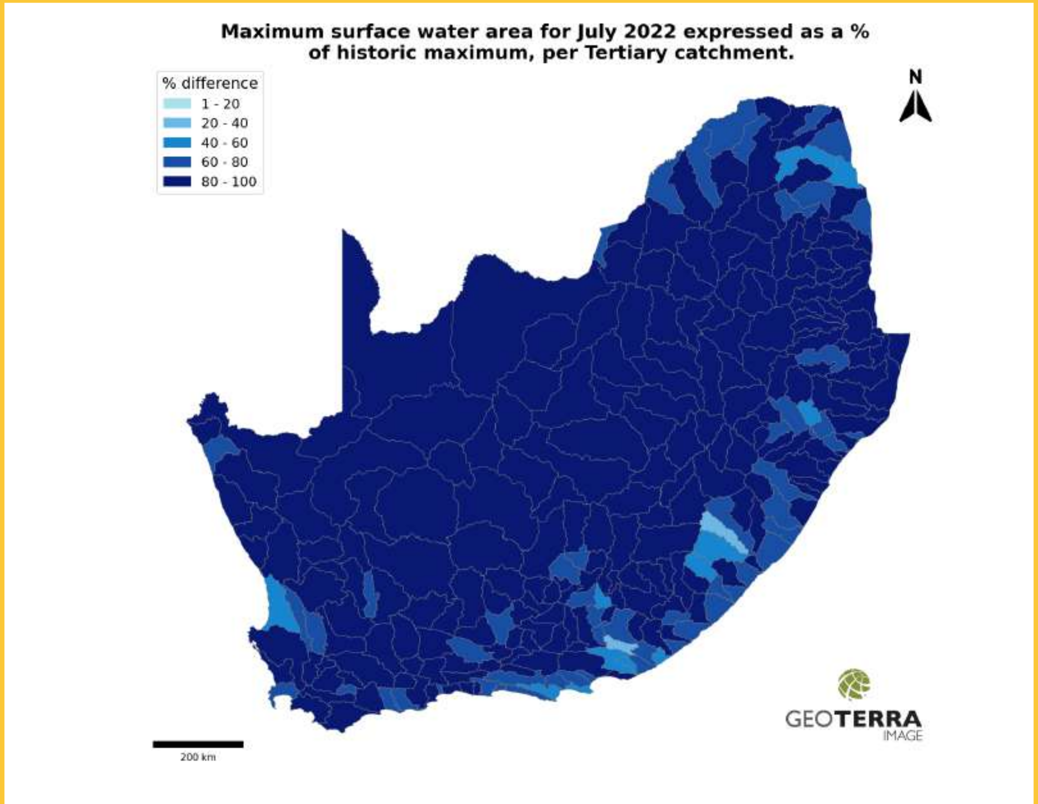


Figure 33

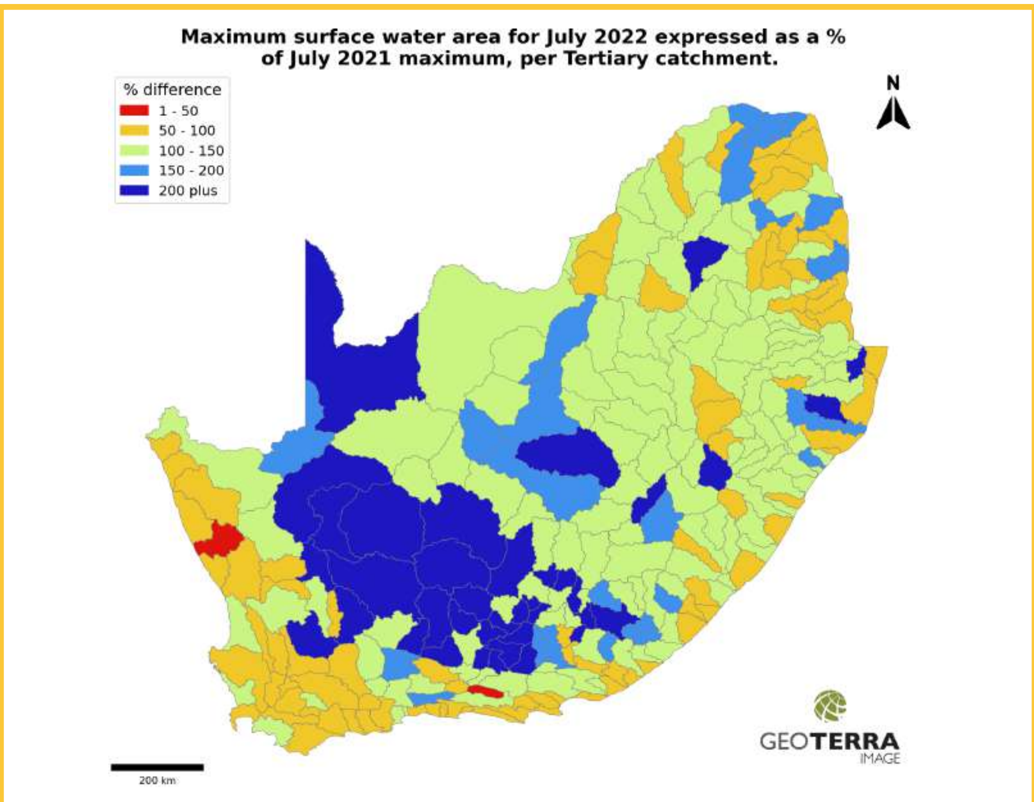
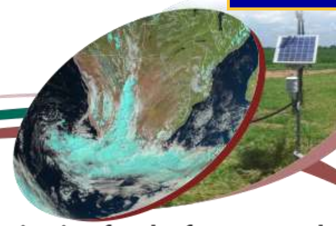


Figure 34

Agrometeorology



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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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".