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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

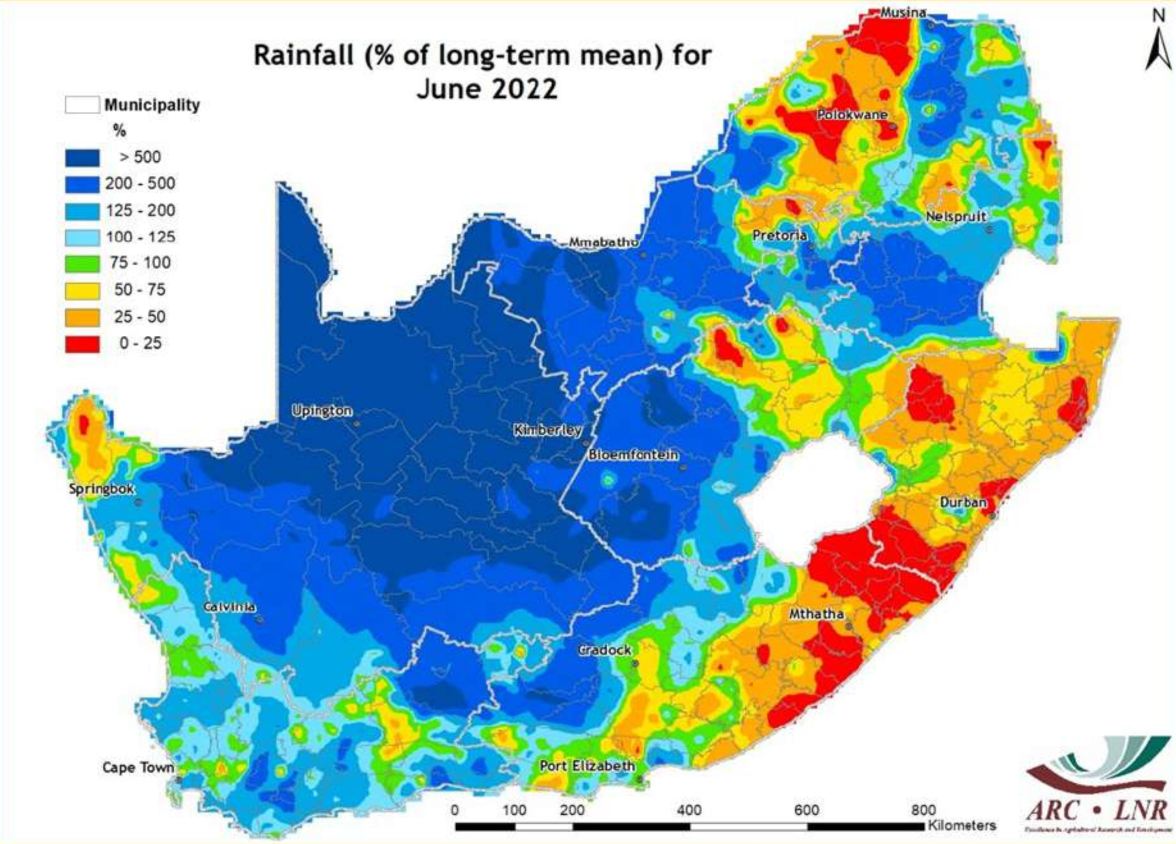
AMESD

217th Edition

Image of the Month

Wet and cold conditions return to the winter rainfall region

The 2022 winter rainfall season finally commenced by the end of May and more strongly from mid-June when widespread rainfall occurred over the entire winter rainfall region (see map below). Following dry conditions over the region during April and May, this rain was of critical importance for wheat, barley, canola and oats production as planting had been completed to a large extent. The rainfall events were driven by a series of cold fronts developing and pushing in moisture over the area. A strong cold front made landfall on 13 June and resulted in widespread rain with strong winds over the western parts of the country. Temperatures dropped due to the invasion of cold air and resulted in favourable conditions for chill units accumulation in the Cape Winelands. Furthermore, following the moderate and mild drought that was experienced during the preceding months, the rainfall activity suggests a slow recovery from the drought and thus could be favourable for dryland crop producers along the southern and western Cape coasts. These wet and cold conditions moved eastwards and started to affect the interior by the 15th. Accordingly, colder night and morning conditions occurred, with temperatures dropping below zero over parts of the Gauteng, Free State, North West and Eastern Cape provinces. From the 19th, a cut-off low pressure system moved over the Northern Cape and was the main contributor to the prolonged wet and cold conditions over most parts of the country. Farmers are thus continually encouraged to practise preventative measures as winter atmospheric conditions could be devastating to livestock (especially small stock) as well as posing a risk of veldfires.



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:

After a slow onset of the winter rainfall season due to below-normal rainfall in April and May, an evident increase in total rainfall was observed over the winter rainfall region during June 2022. However, the region recorded a significant difference of up to -200 mm for the period from April to June when compared to the same 3-month period last year. Considering the month of June, several frontal systems moved in over the region and resulted in good rainfall. These were the first significant rains as there had been great concern by the agricultural sector relating to dryland winter crop production. Areas that received rainfall totals of >100 mm for the month included Bellville, Cape Town and Ceres, while stations at Grabouw and Kirstenbosch recorded in excess of 200 mm. Thus, the rains were regarded as substantial for agricultural production. Apart from the southwest, above-normal rainfall was also experienced in other parts of the country, particularly the summer rainfall region. Rainfall occurred over the western interior, extending towards the northern parts of the Highveld and the northeastern corner of the country in Limpopo. The largest portion of this rainfall occurred during the latter half of the month. Climatologically, the late summer rains are expected to cease during May, hence these rainy conditions extended the 2021/22 summer rainfall season.

1. Rainfall

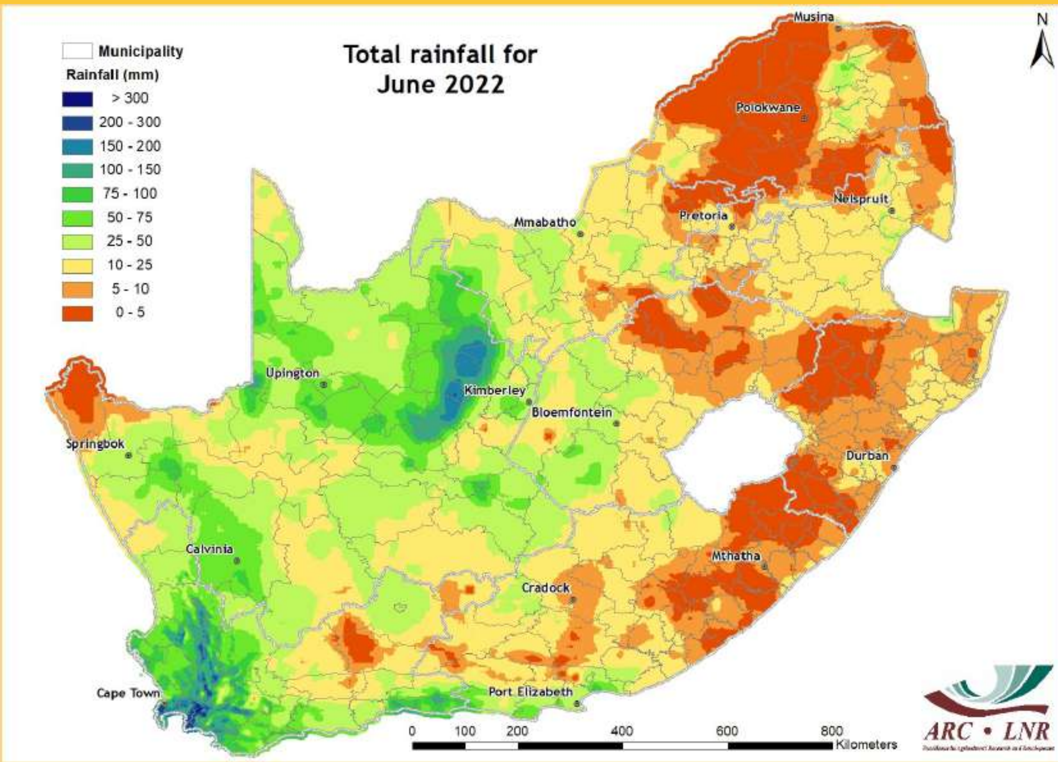


Figure 1

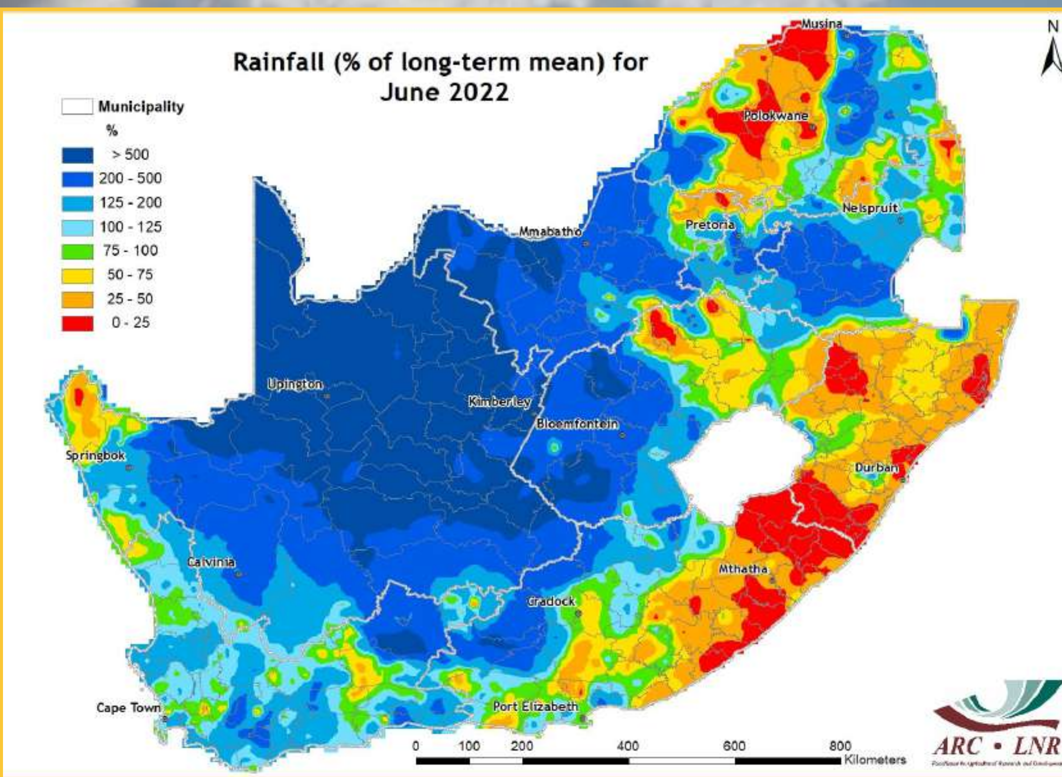


Figure 2

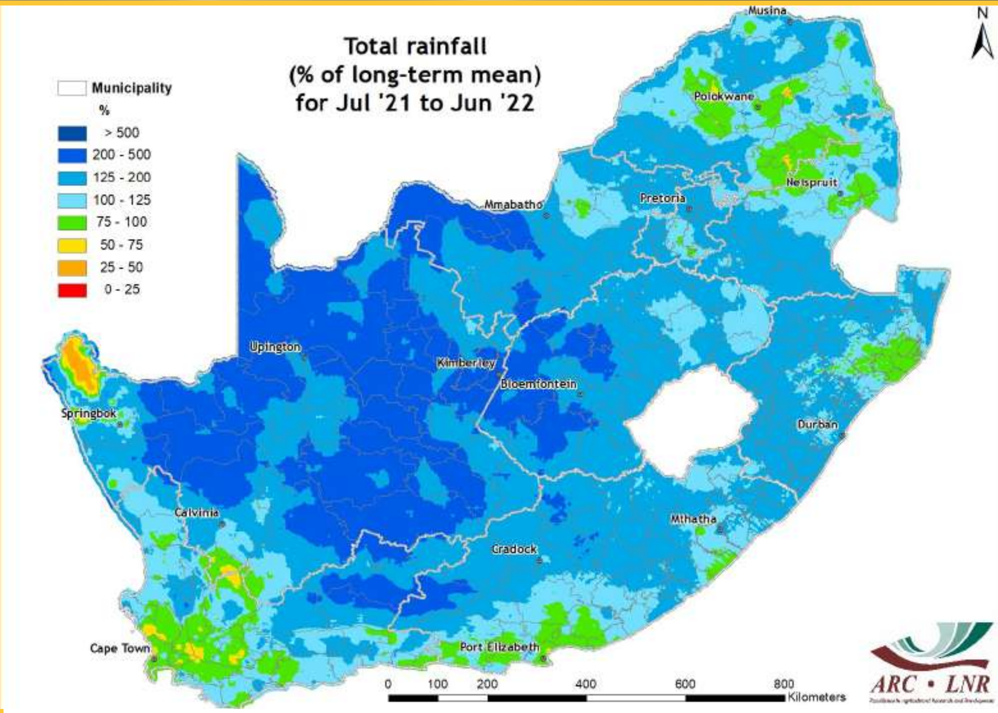


Figure 3

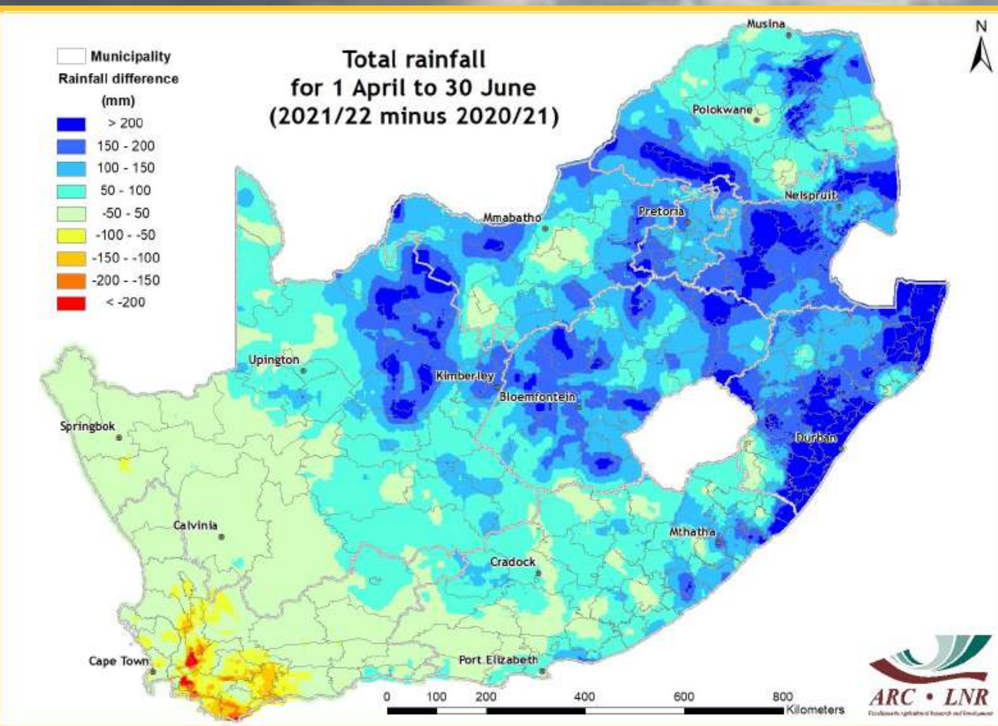


Figure 4

Figure 1:
Several frontal systems resulted in rainfall activity over the southwestern parts of the country in June 2022, with some areas recording totals of >200 mm for the month. Unseasonable rainfall occurrence during mid- to late June resulted in totals of between 10 and 75 mm over parts of the Northern Cape, North West, Free State, Gauteng, Mpumalanga, Limpopo, KwaZulu-Natal and Eastern Cape provinces.

Figure 2:
Above-normal rainfall conditions occurred over the winter rainfall region in June 2022, as well as over some parts of the summer rainfall region – notably the western interior, northern parts of the Highveld and eastern Limpopo. Below-normal rainfall conditions were observed over western Limpopo and isolated areas in the eastern Free State towards KZN and the Eastern Cape.

Figure 3:
Greater parts of the country experienced widespread above-normal rainfall conditions during the period between July 2021 and June 2022.

Figure 4:
A comparison of April-June 2022 with the same 3-month period in 2021 shows that the summer rainfall region recorded up to 200 mm more rain while the winter rainfall region received considerably less rain than last year. 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 June 2022 are shown in Figures 5-8. Wet conditions are evident over most parts of the country, especially the interior. These are clearly visible on the 6- and 24-month time scales. An improvement from drought conditions was observed over greater parts of the country. However, mild to severe drought conditions are also depicted over parts of the Cape provinces, Limpopo and Mpumalanga. The longer time scales show moderate to extreme wet conditions over the central interior, while moderate to severe drought conditions dominate in the areas showing drought on the medium-term time scale.

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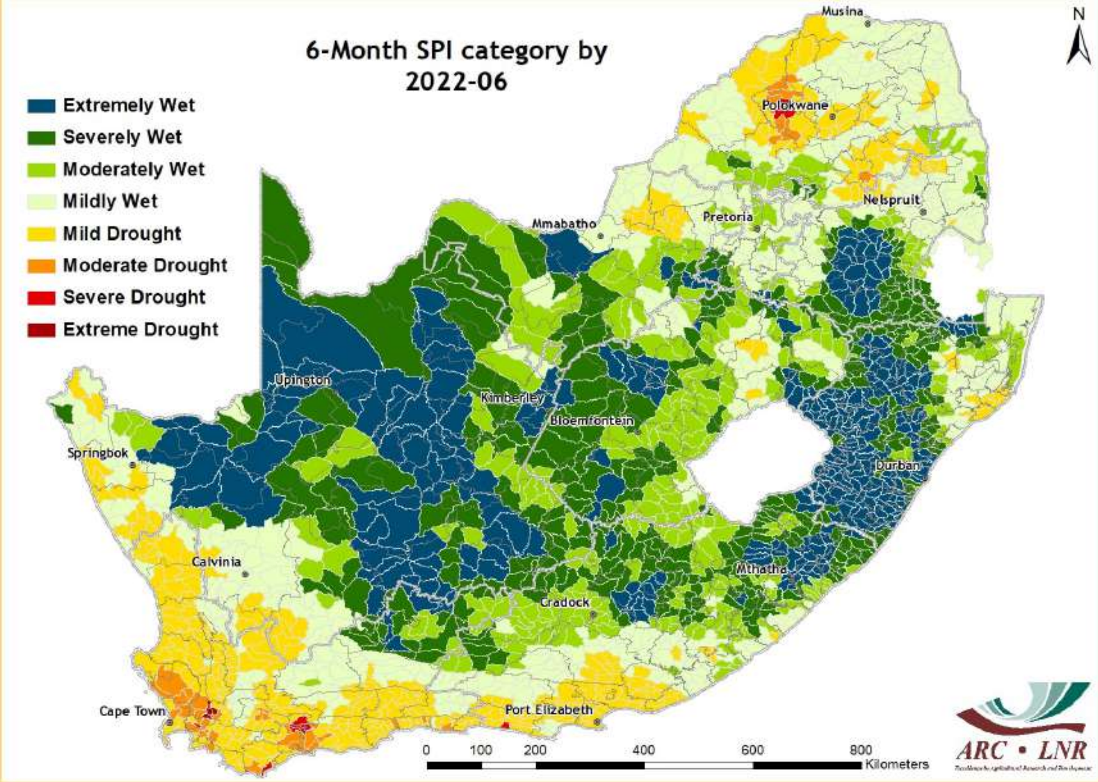

Figure 5

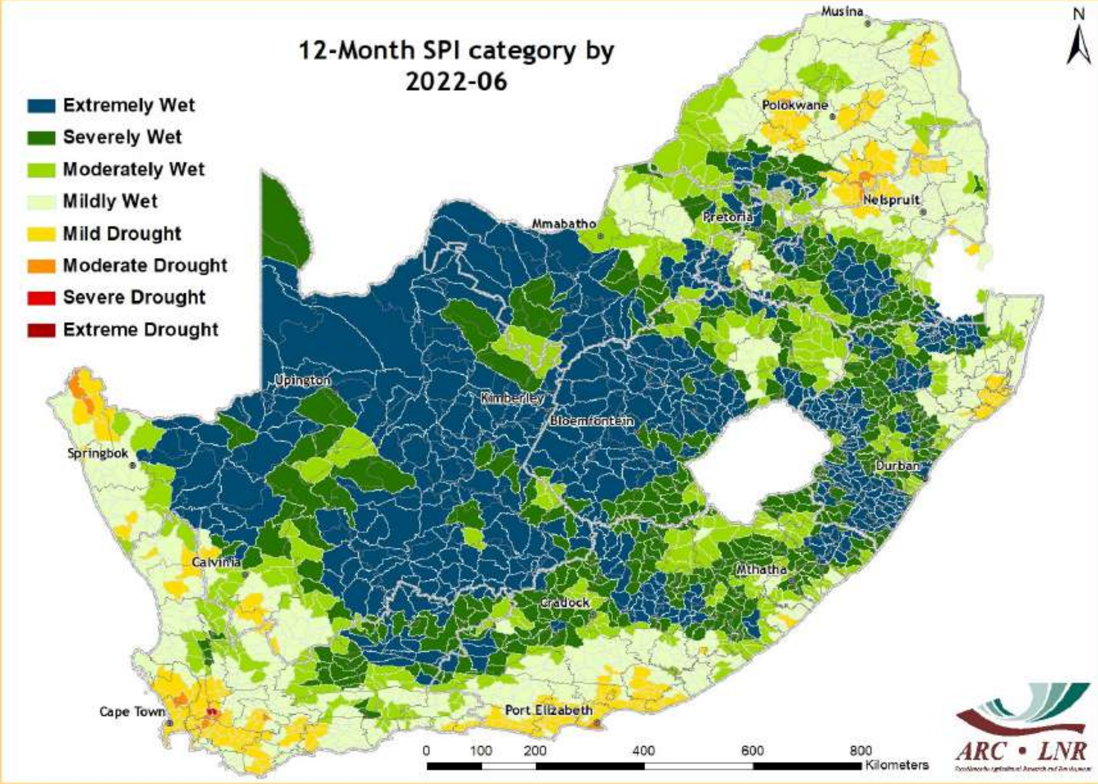

Figure 6

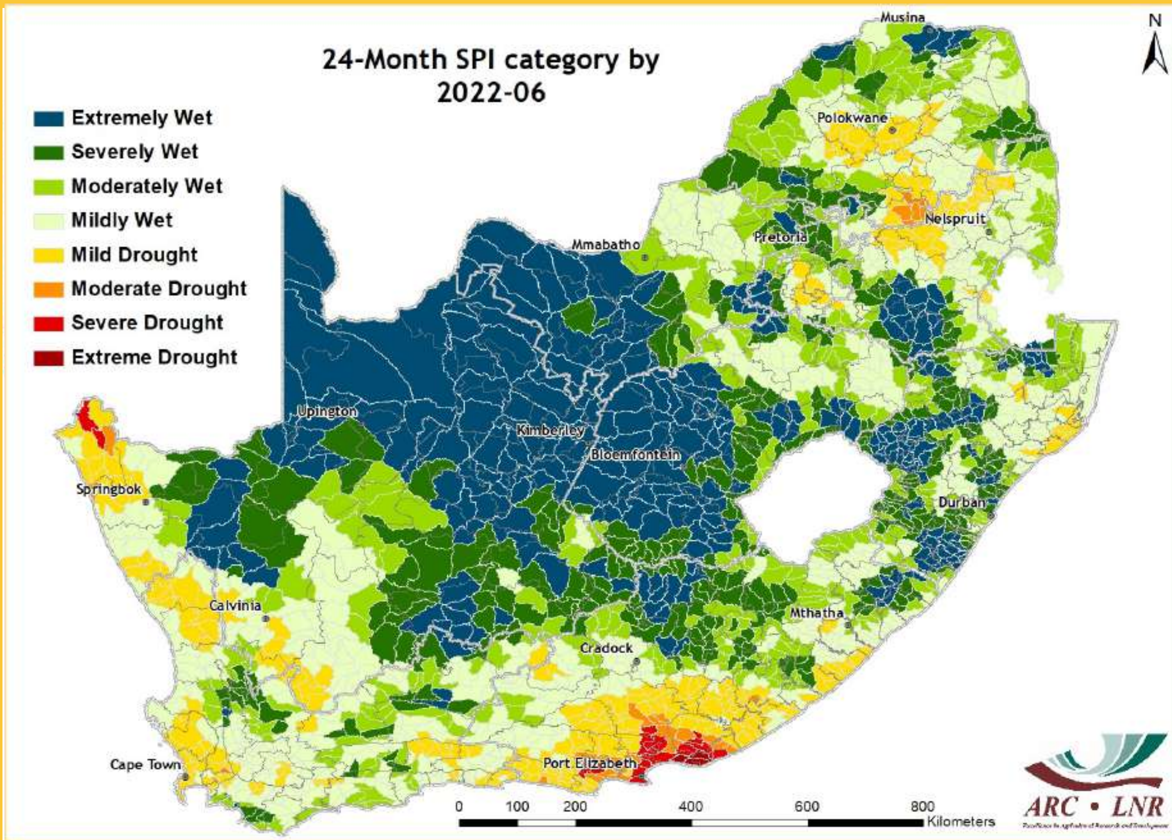

Figure 7

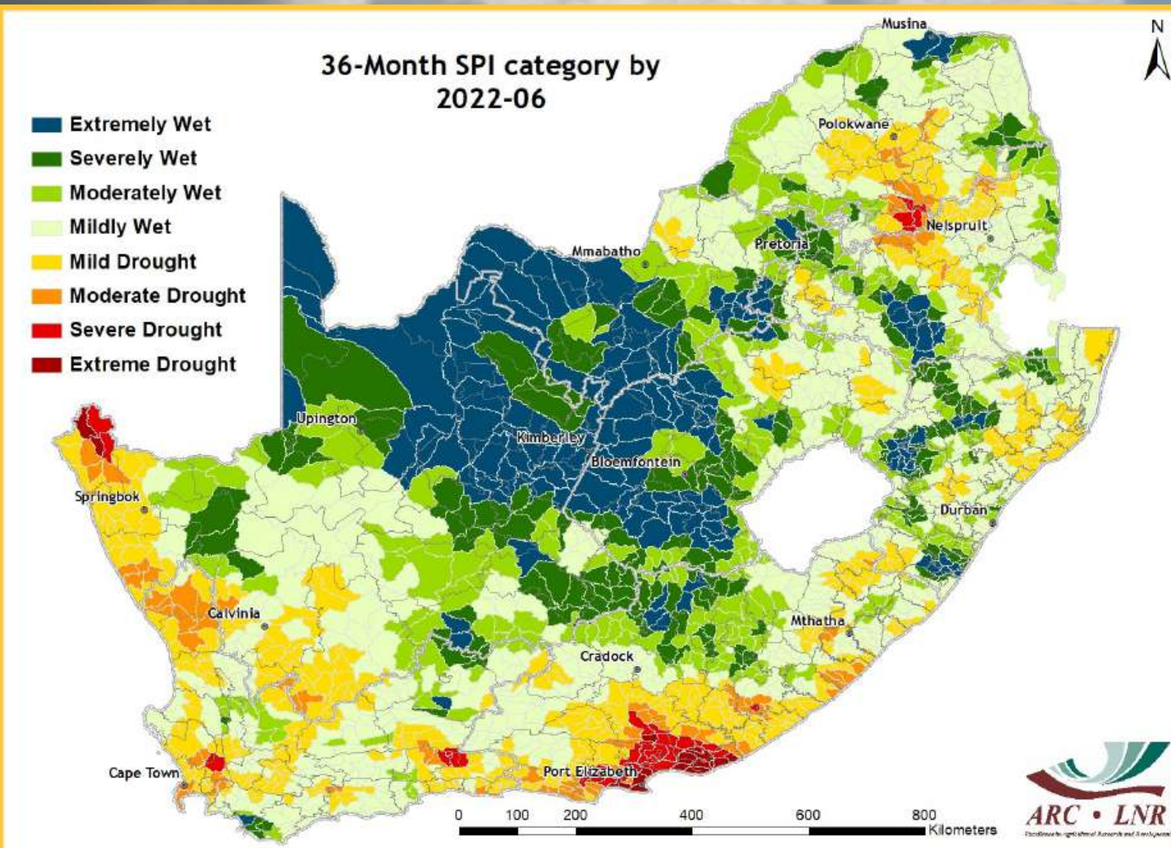

Figure 8

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.

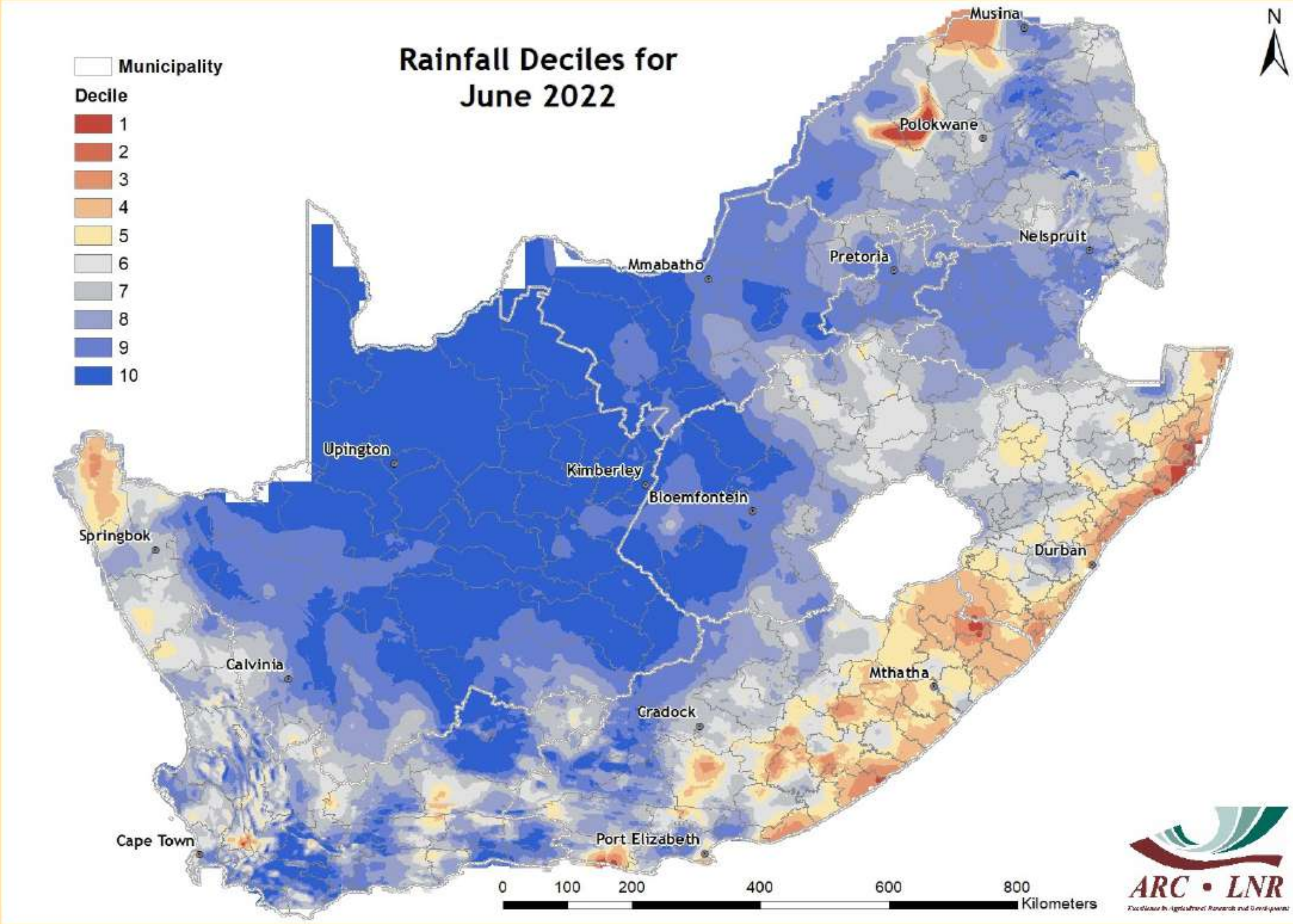

Figure 9

Figure 9:
The above-normal rainfall conditions that occurred during June 2022 compare well with historically wetter June months. However, certain areas in Limpopo, the far western Northern Cape, KwaZulu-Natal and the Eastern Cape were notably dry.

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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.

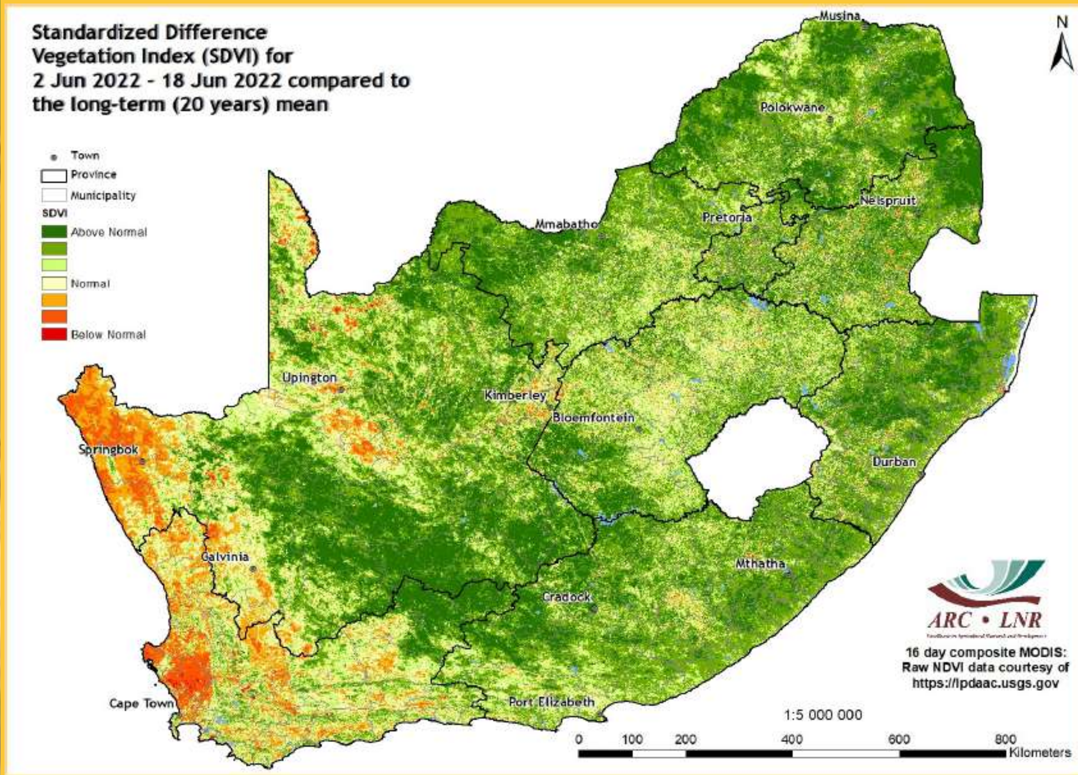

Figure 10

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

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

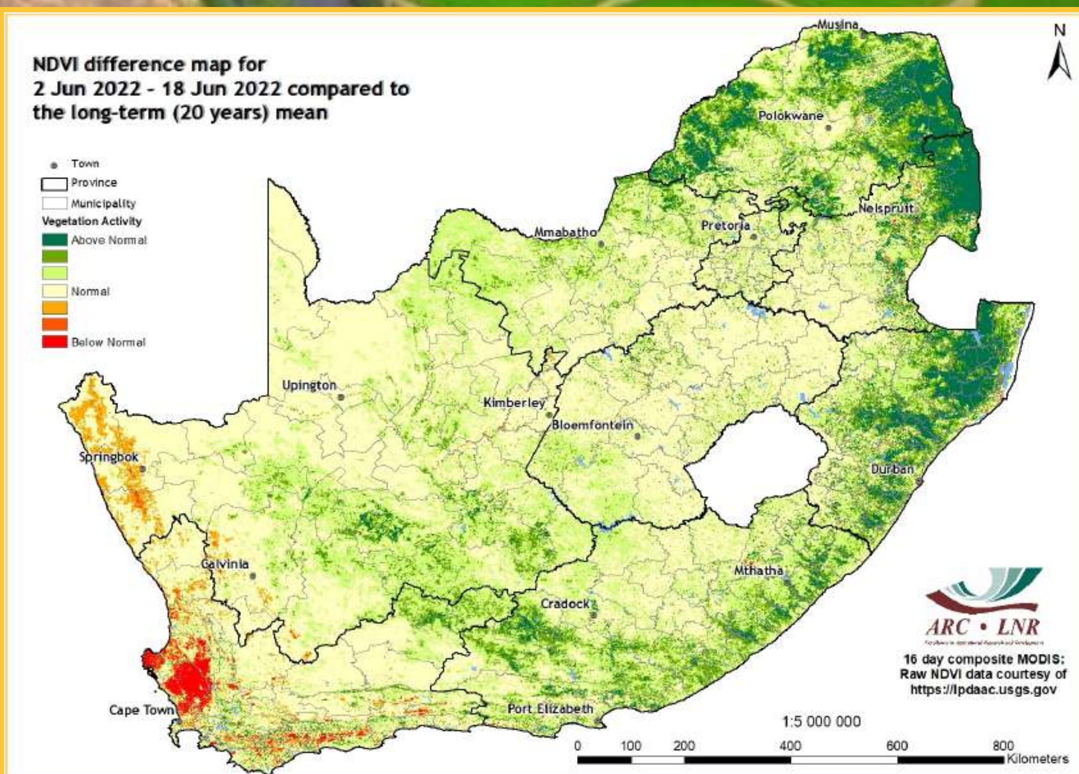

Figure 11

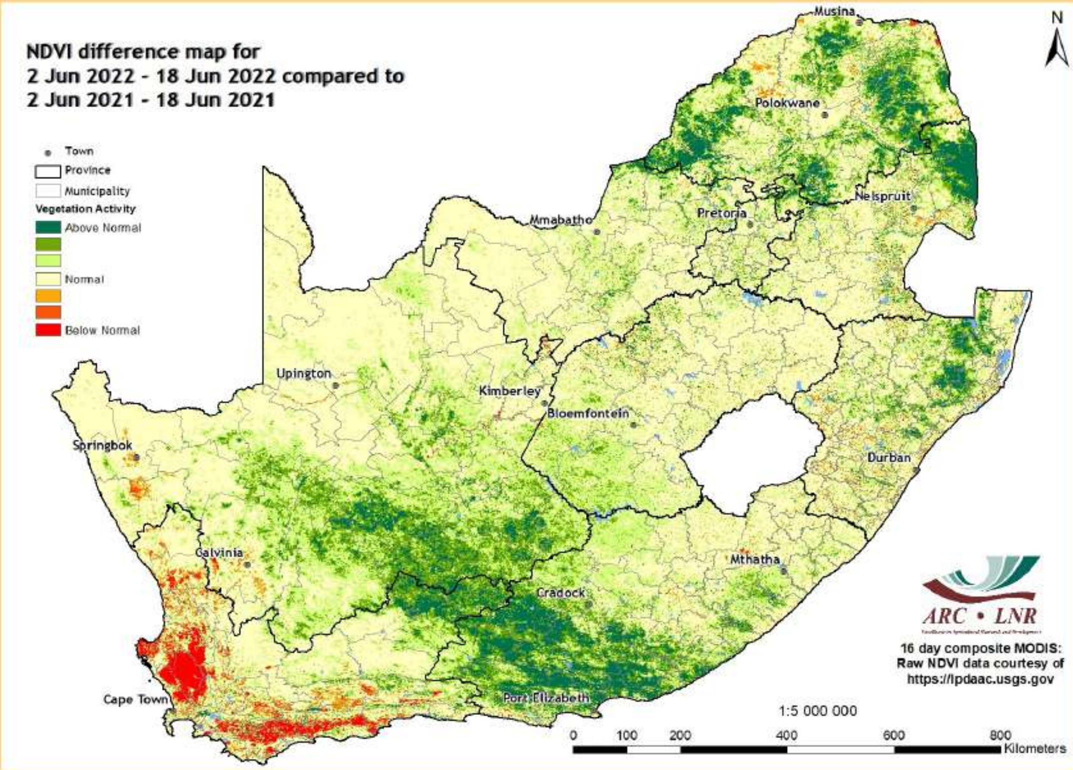

Figure 12

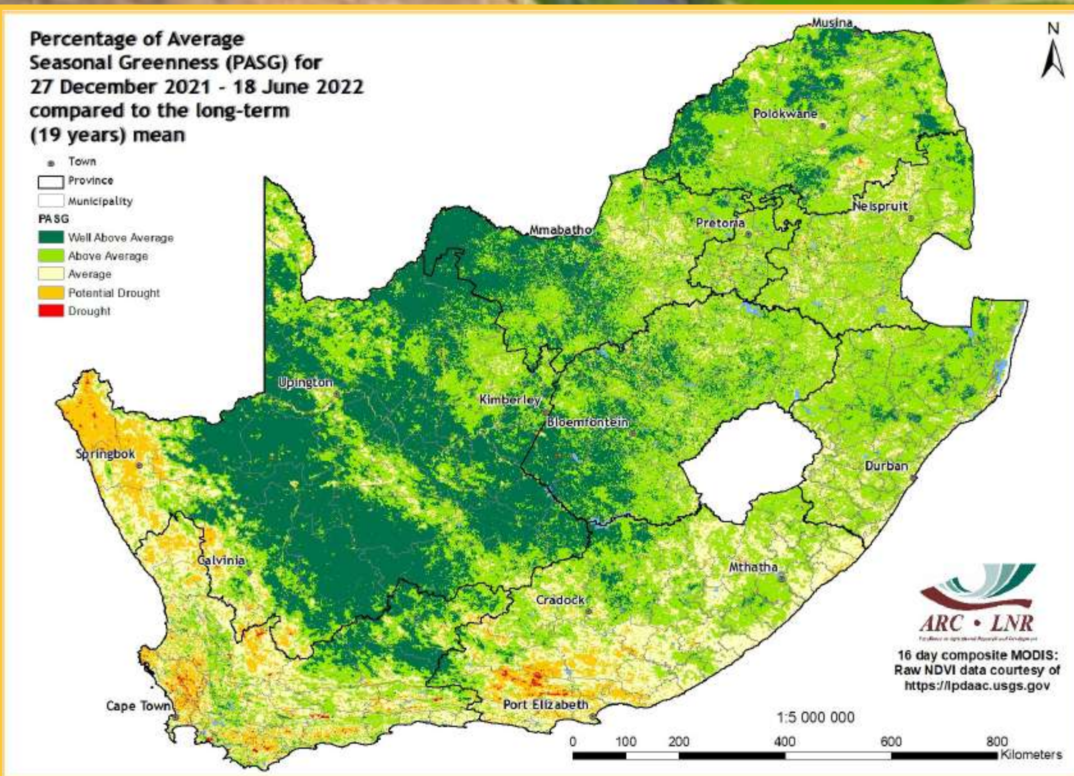

Figure 13

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 June 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 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.

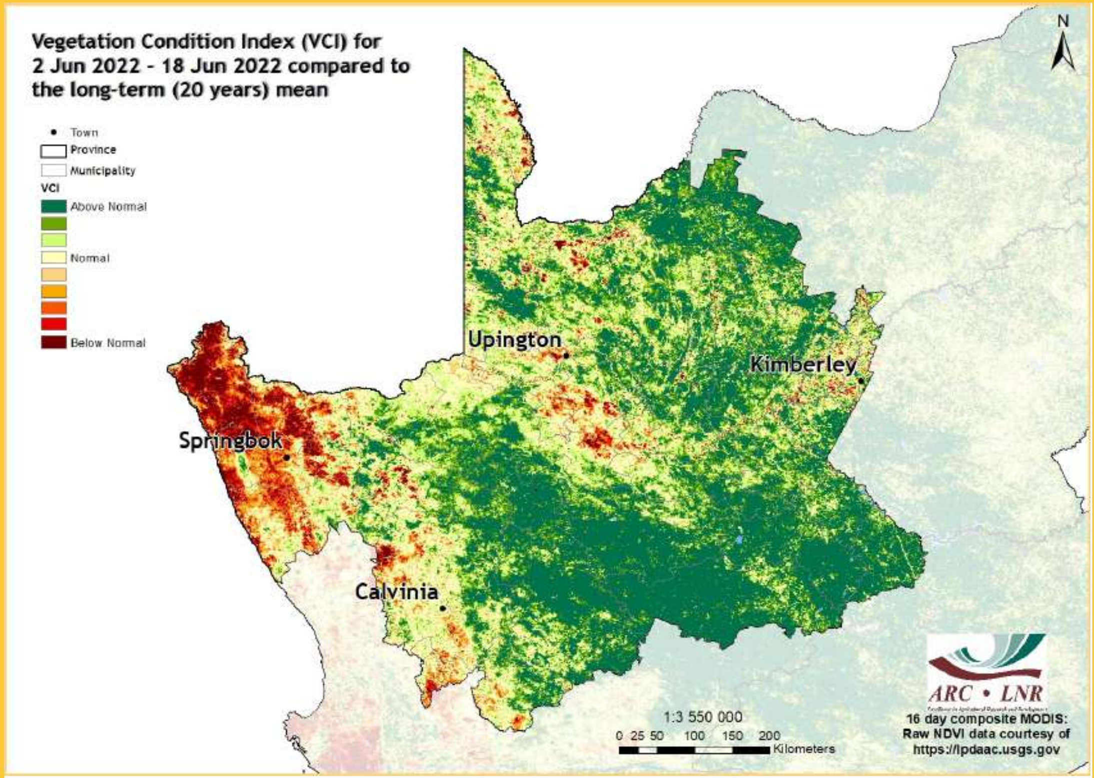


Figure 14

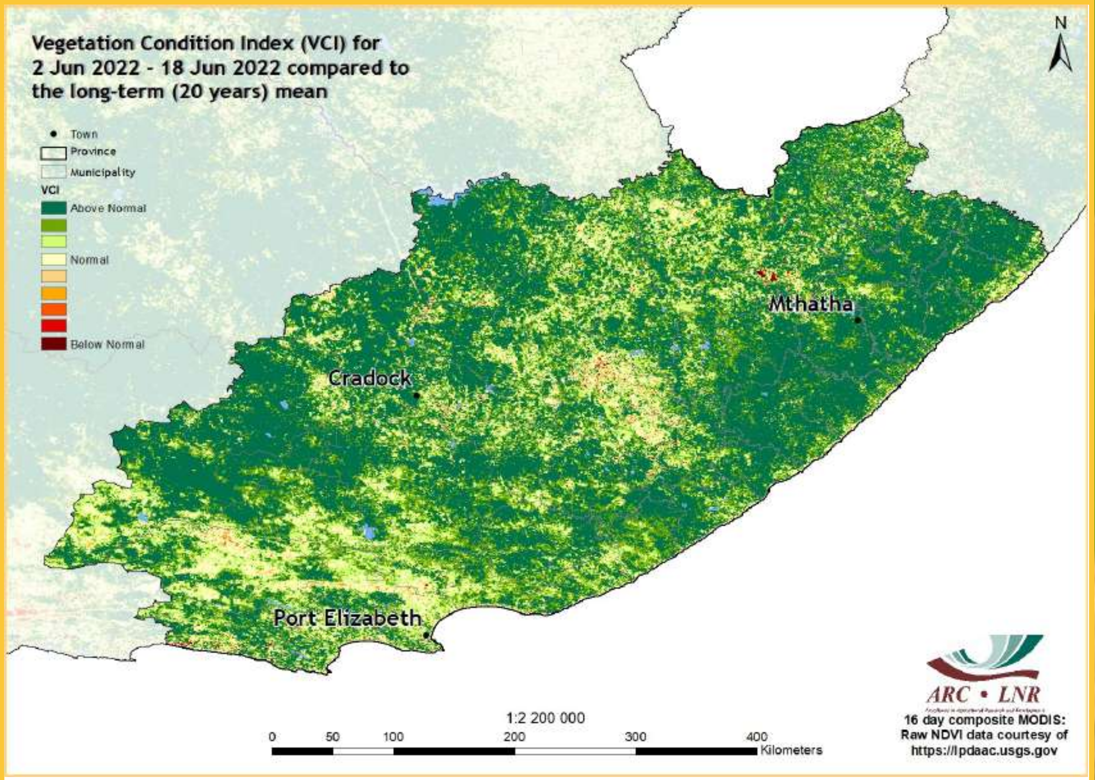
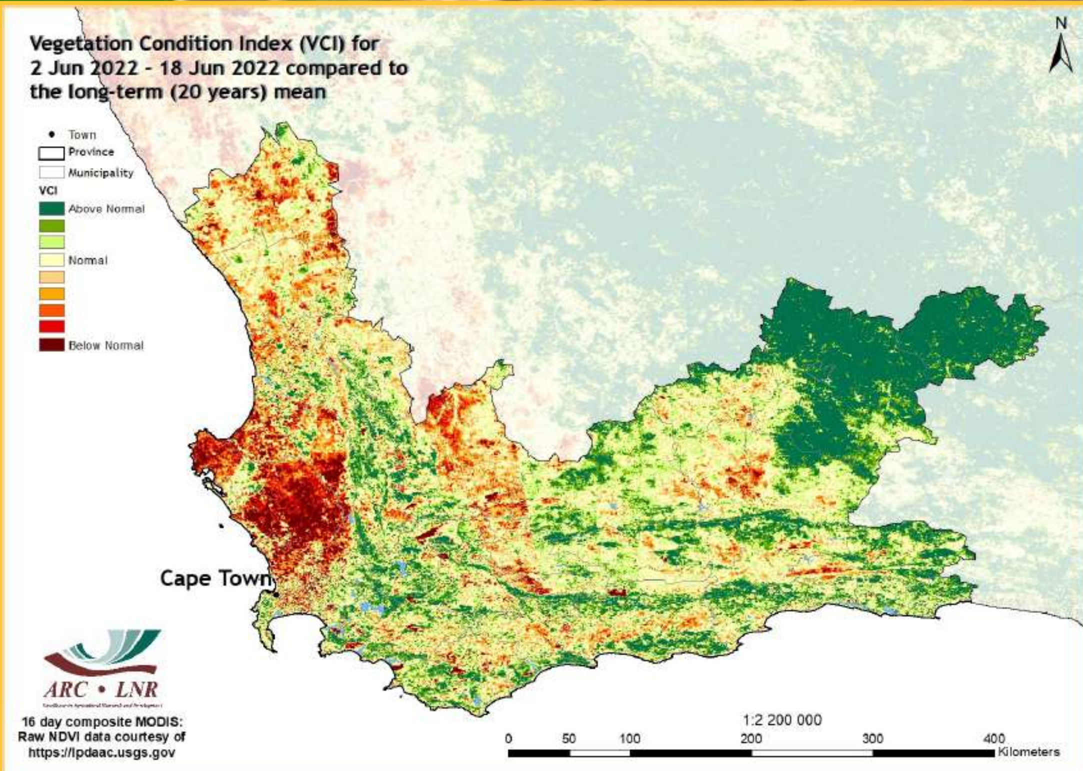


Figure 15

Figure 14:
The 16-day VCI map for June 2022 indicates that most parts of the Northern Cape continued 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:
The 16-day VCI map for June 2022 indicates that vegetation conditions have continued to improve in most parts of the Eastern Cape.



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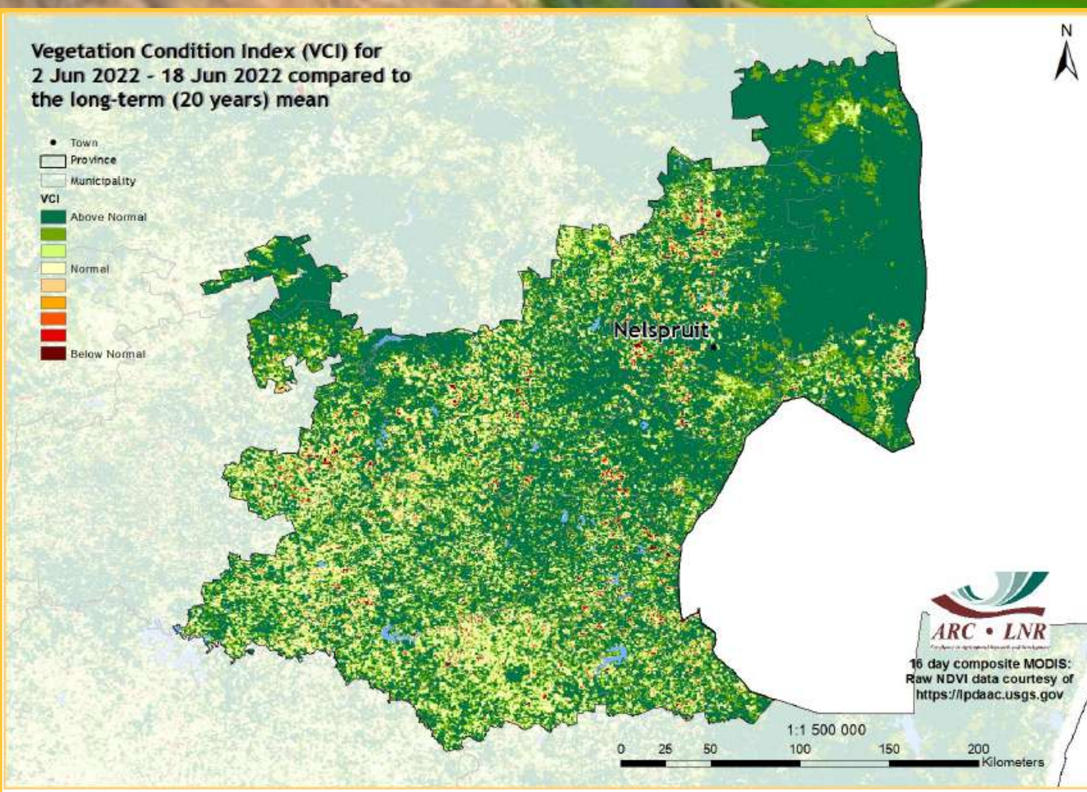

Figure 17

Figure 16:
The 16-day VCI map for June 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 far east.

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

Questions/Comments:
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6. Vegetation Conditions & Rainfall

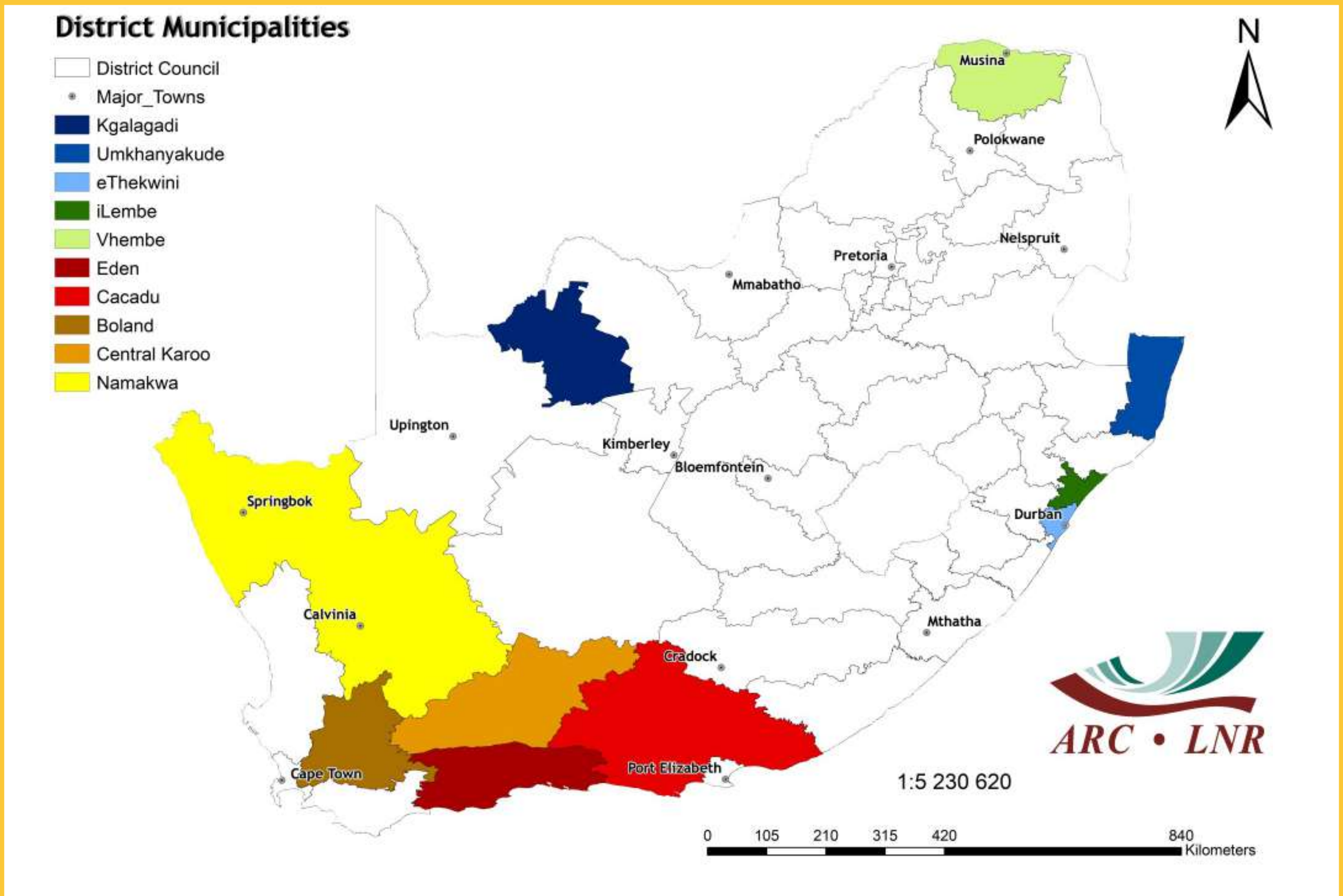

Figure 18

Rainfall and NDVI Graphs

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

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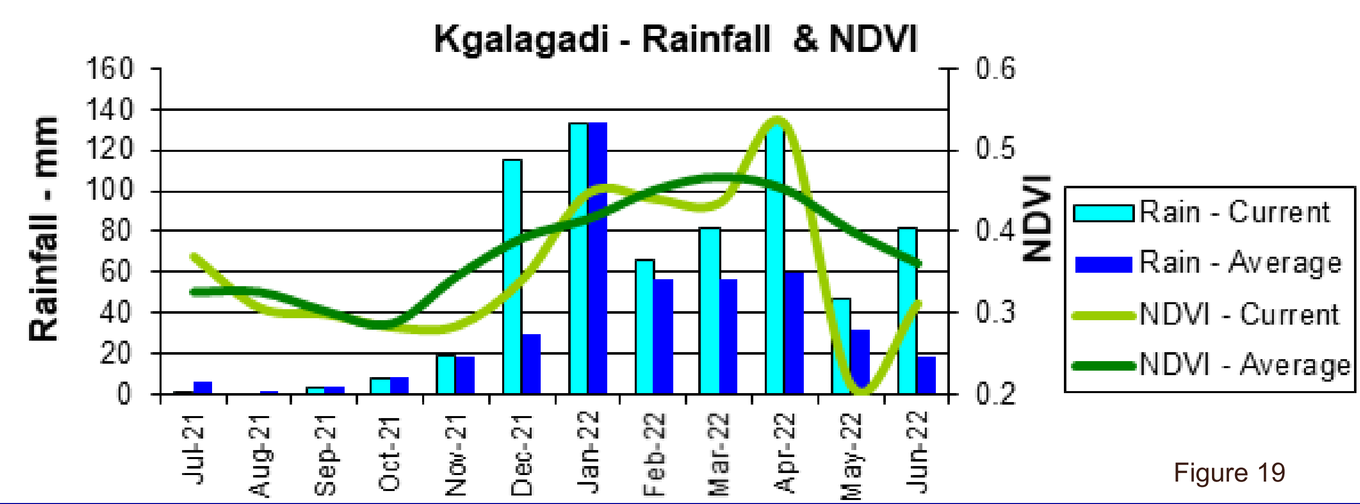
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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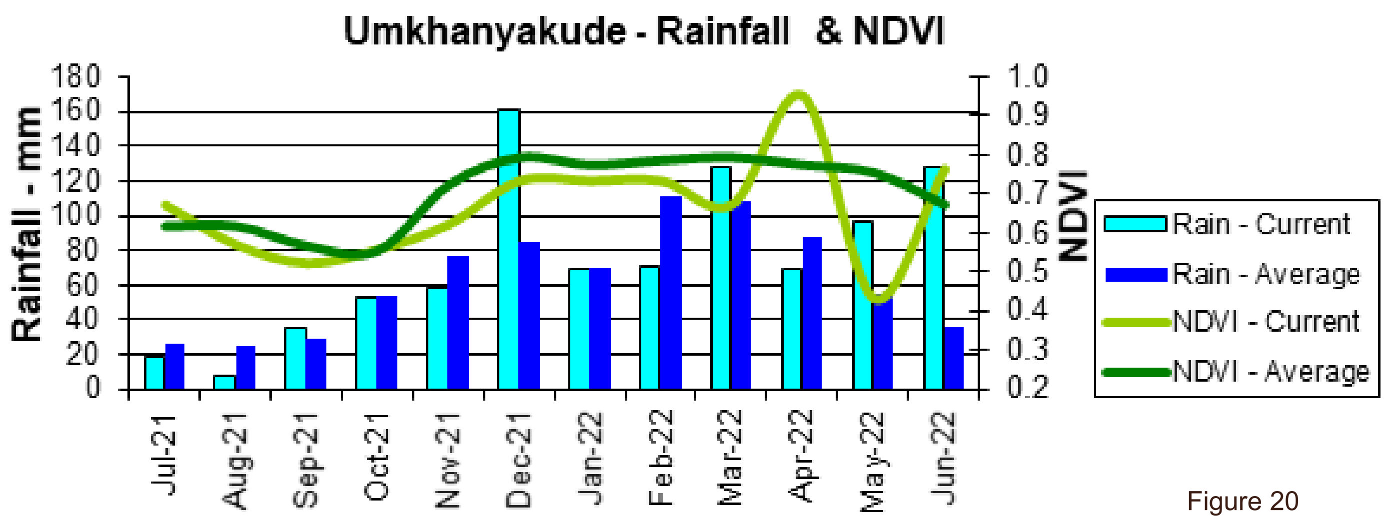

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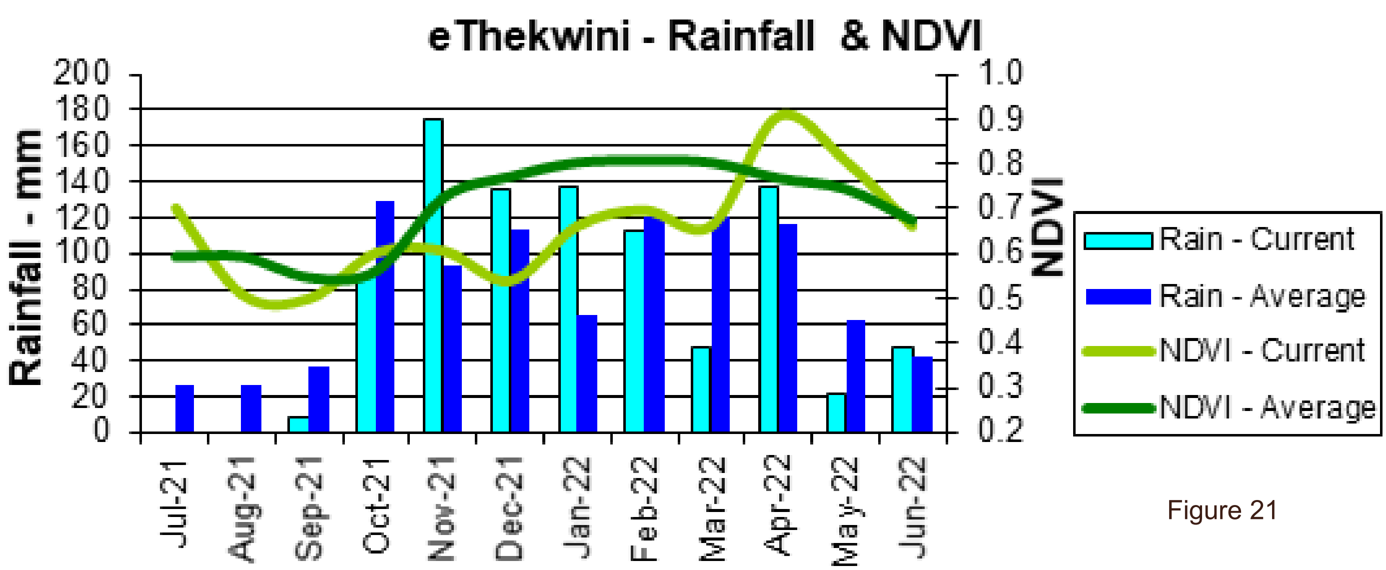


Figure 21

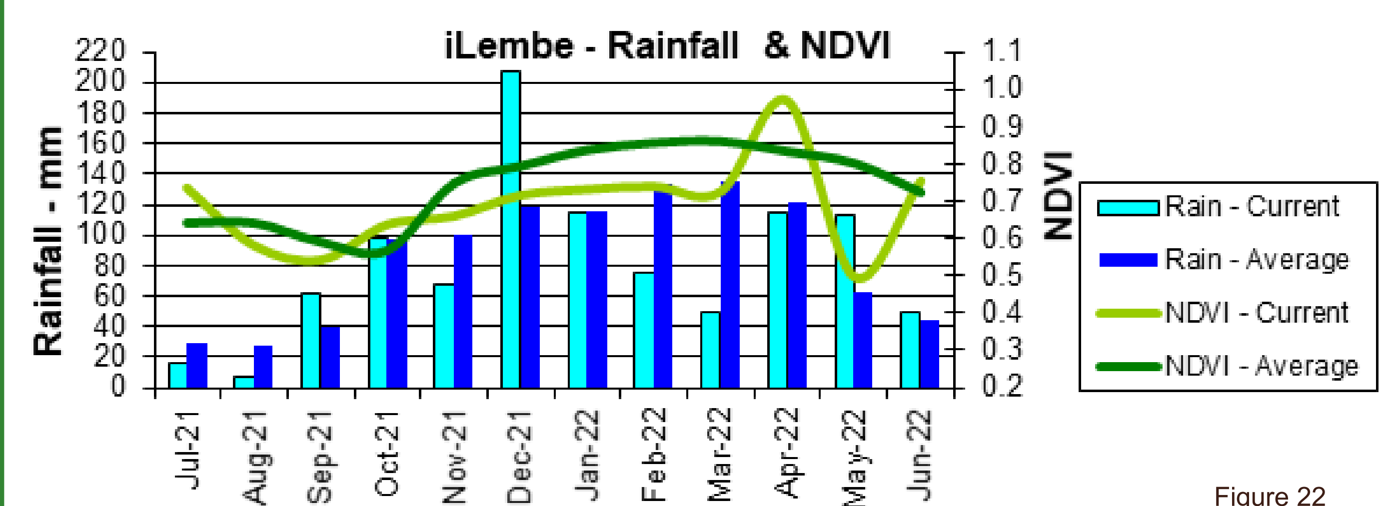


Figure 22

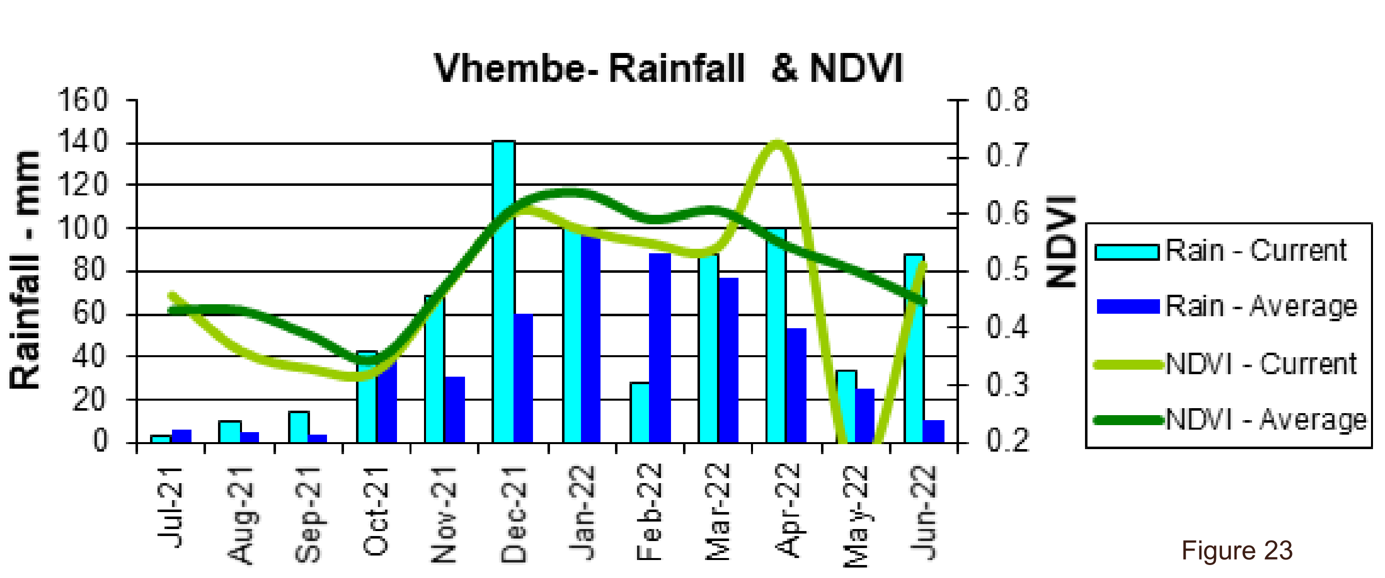


Figure 23

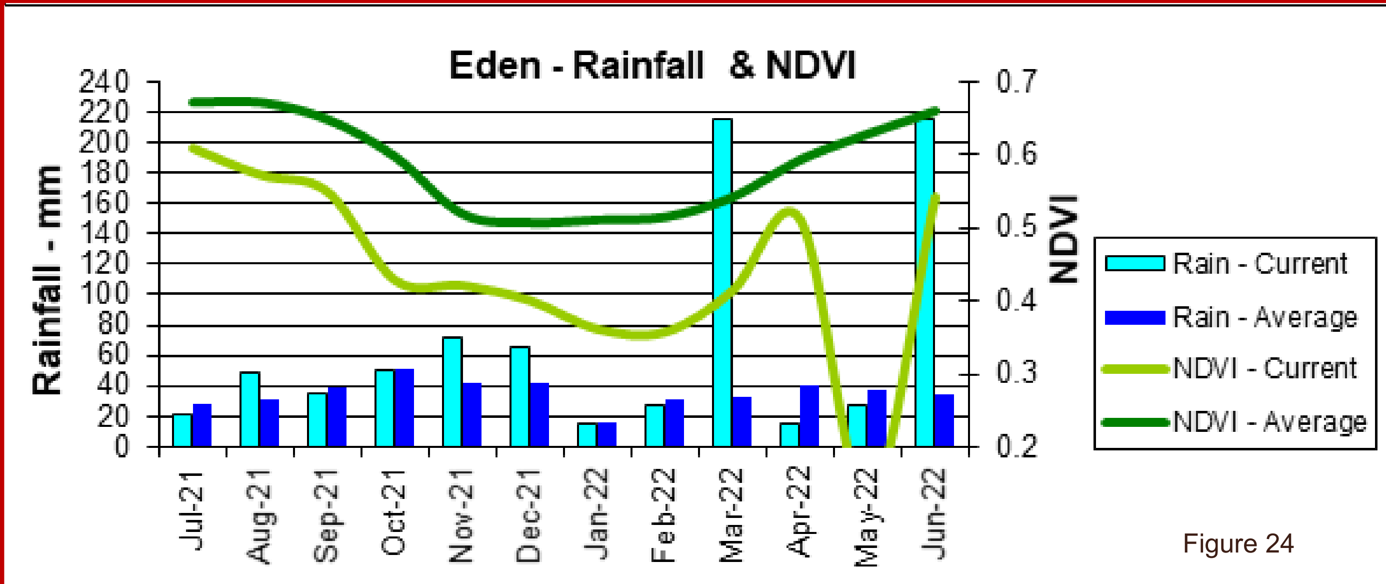


Figure 24

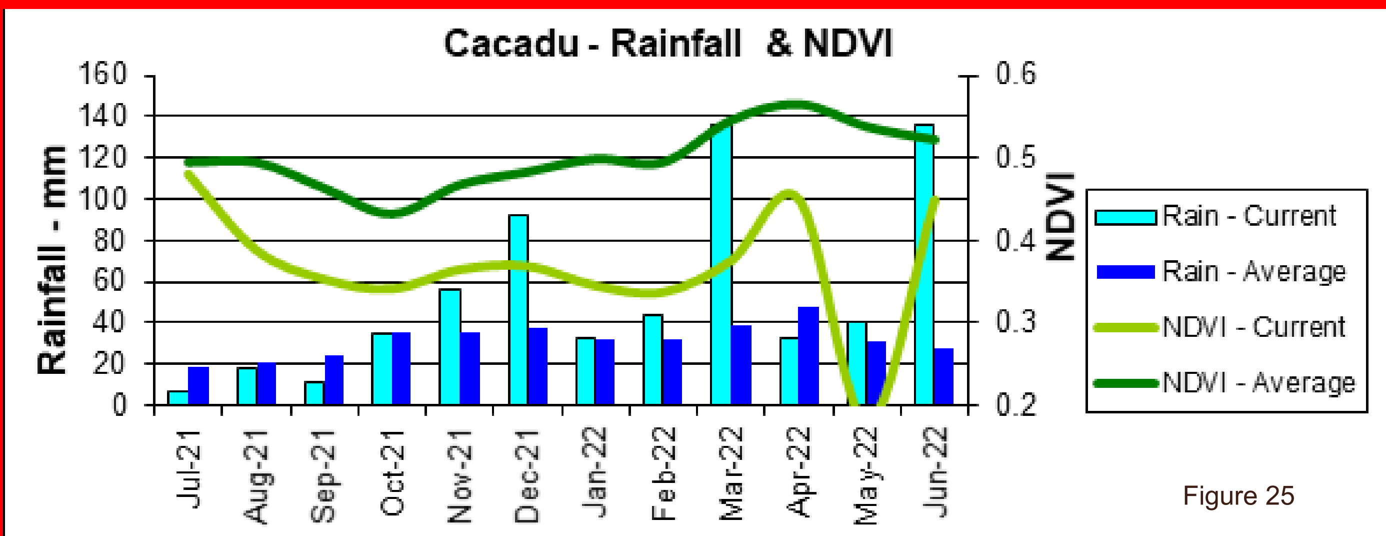


Figure 25

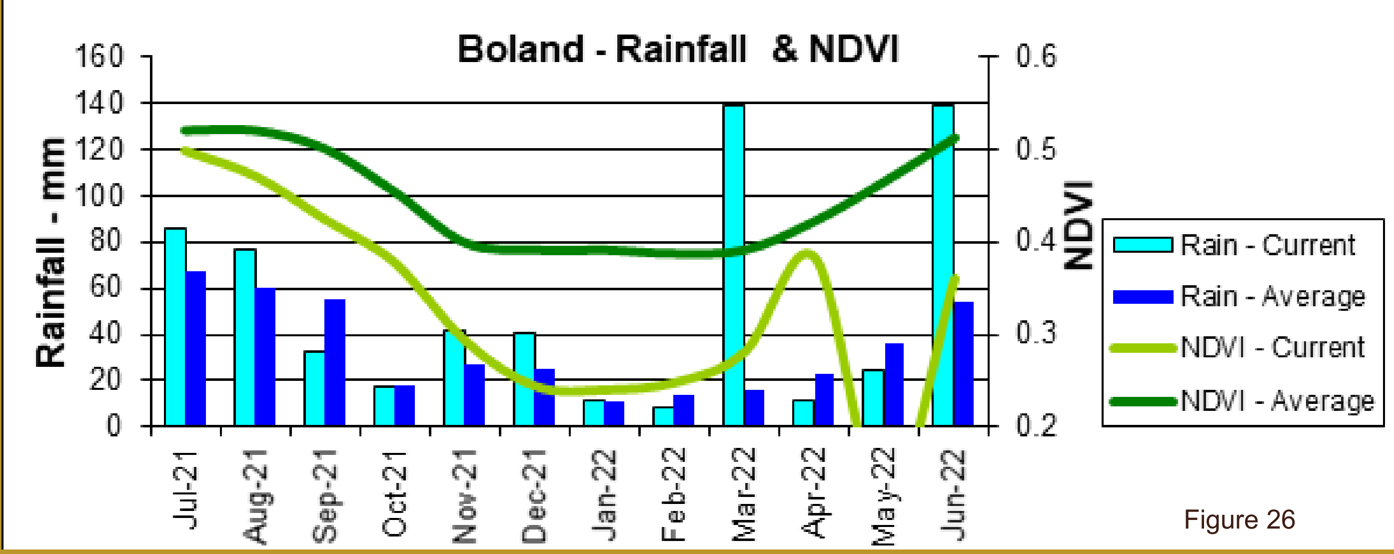
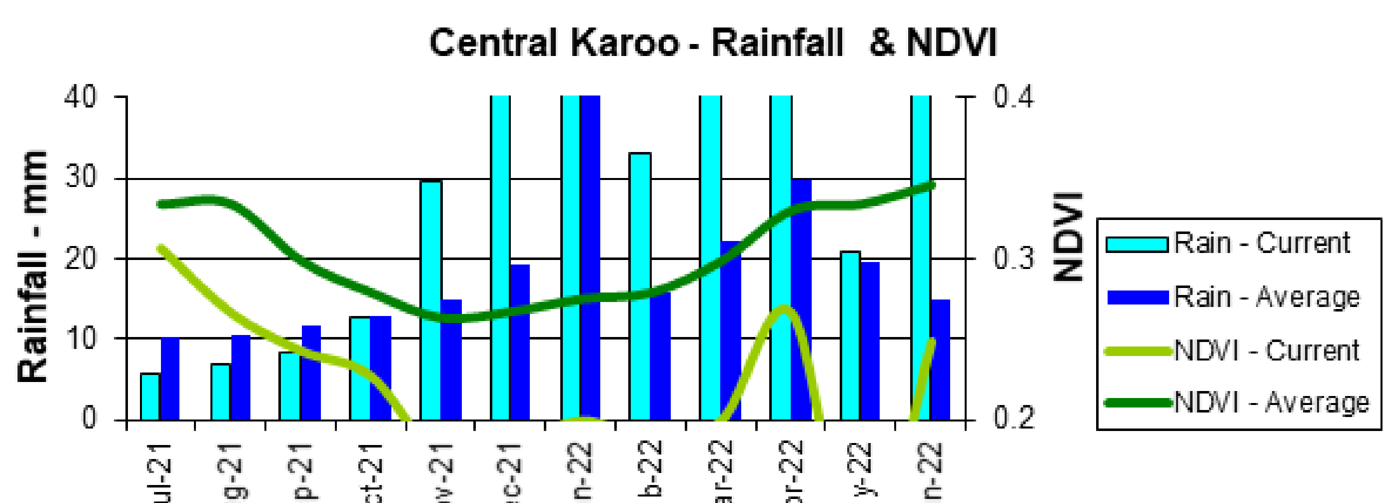


Figure 26



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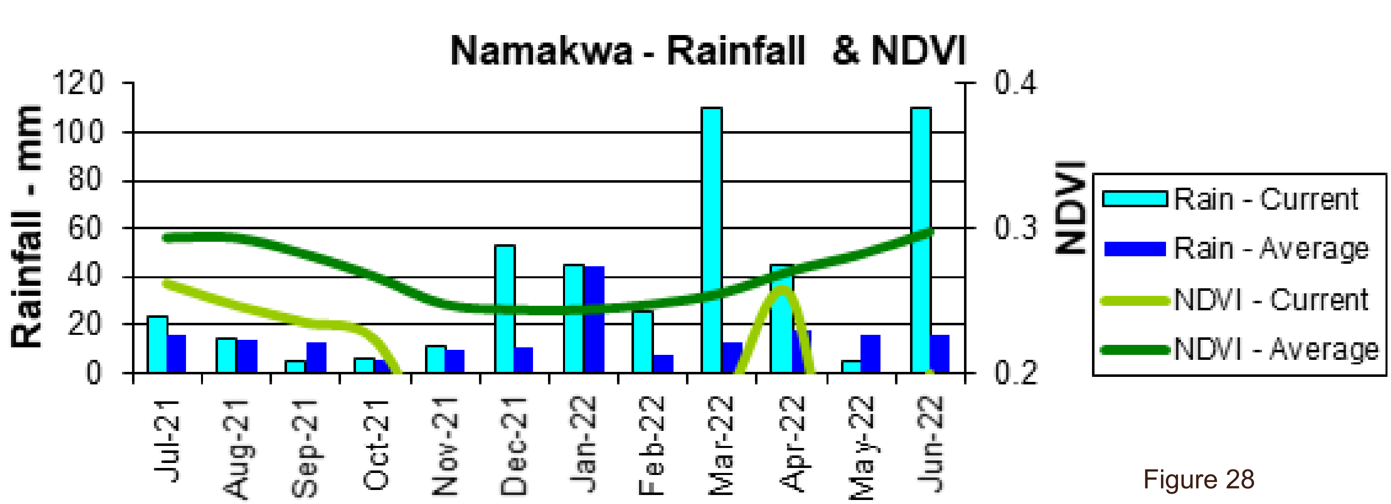

Figure 28

7. Fire Watch

Active Fires *(Provided when data is available)*

Forest and vegetation fires have temperatures in the range of 500 K (Kelvin) to 1000 K. According to Wien's Displacement Law, the peak emission of radiance for blackbody surfaces of such temperatures is at around 4 μm. For an ambient temperature of 290 K, the peak of radiance emission is located at approximately 11 μm. Active fire detection algorithms from remote sensing use this behaviour to detect "hot spot" fires.

Figure 29:
The graph shows the total number of active fires detected between 2-26 June 2022 per province. Fire activity was lower in all provinces compared to the long-term average.

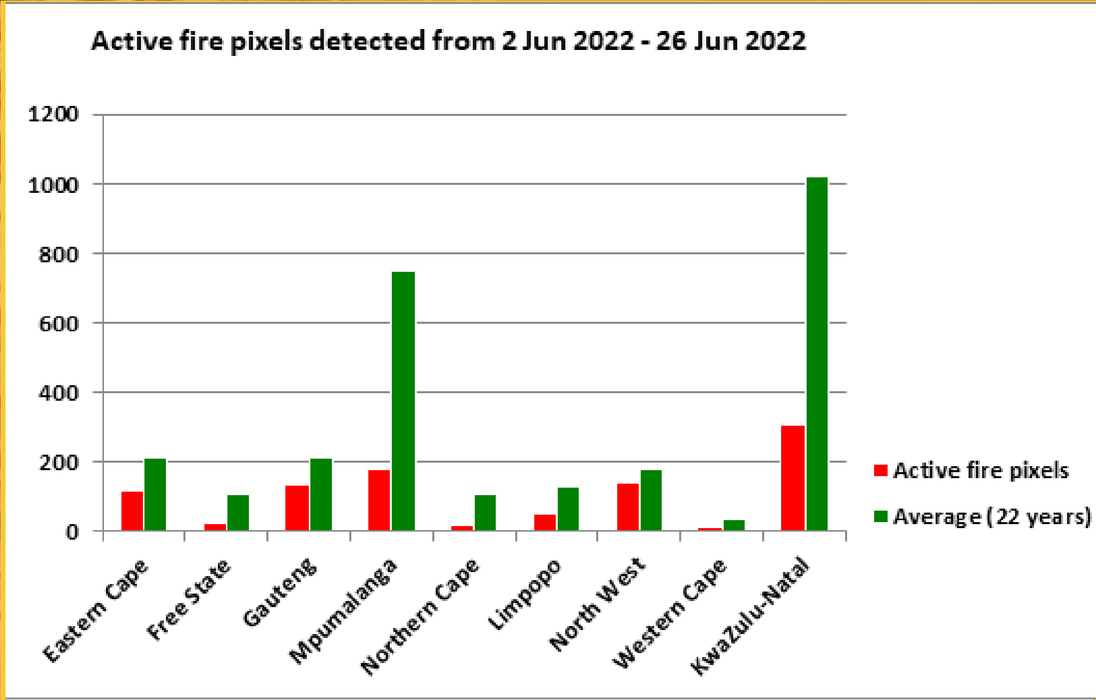

Figure 29

Figure 30:
The map shows the location of active fires detected between 2-26 June 2022.

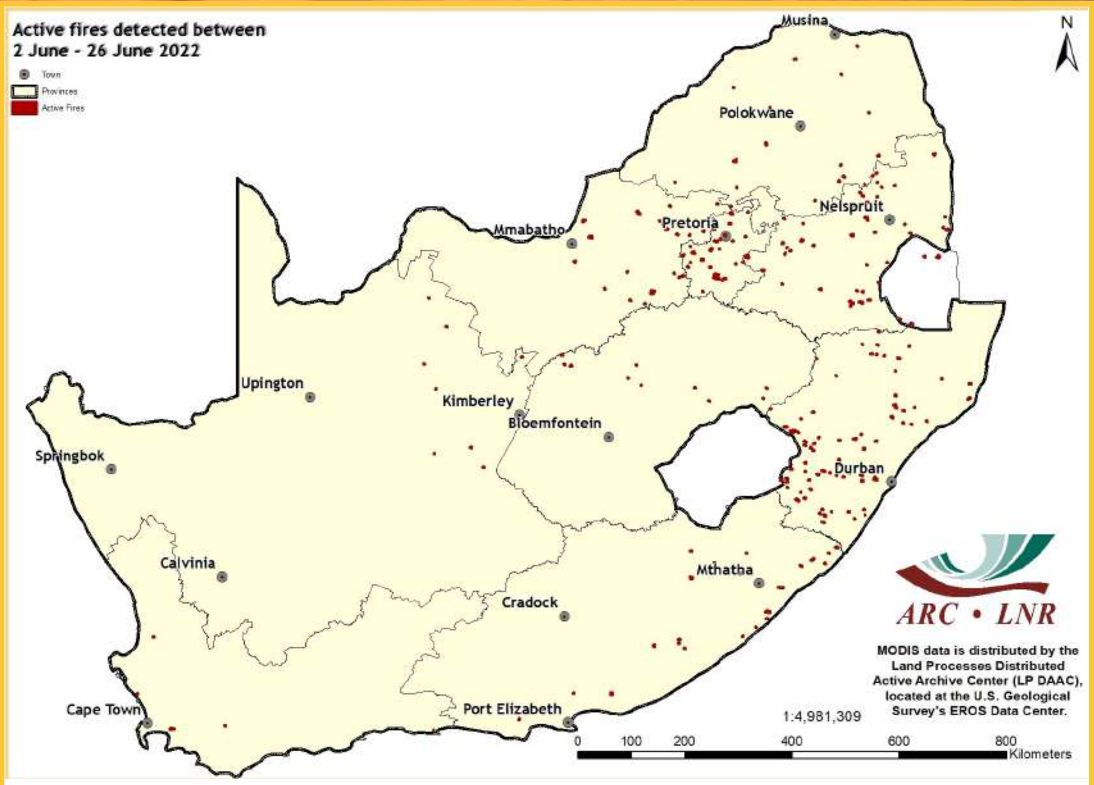

Figure 30

7. Fire Watch

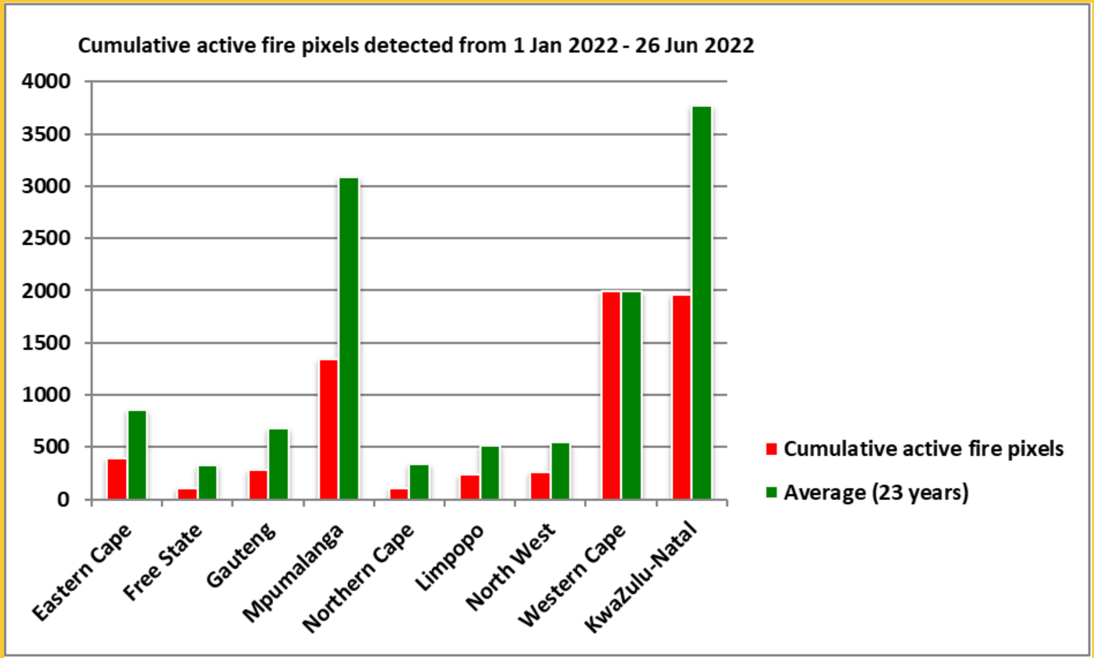

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January and 26 June 2022 per province. Cumulative fire activity was lower or the same in all provinces compared to the long-term average.

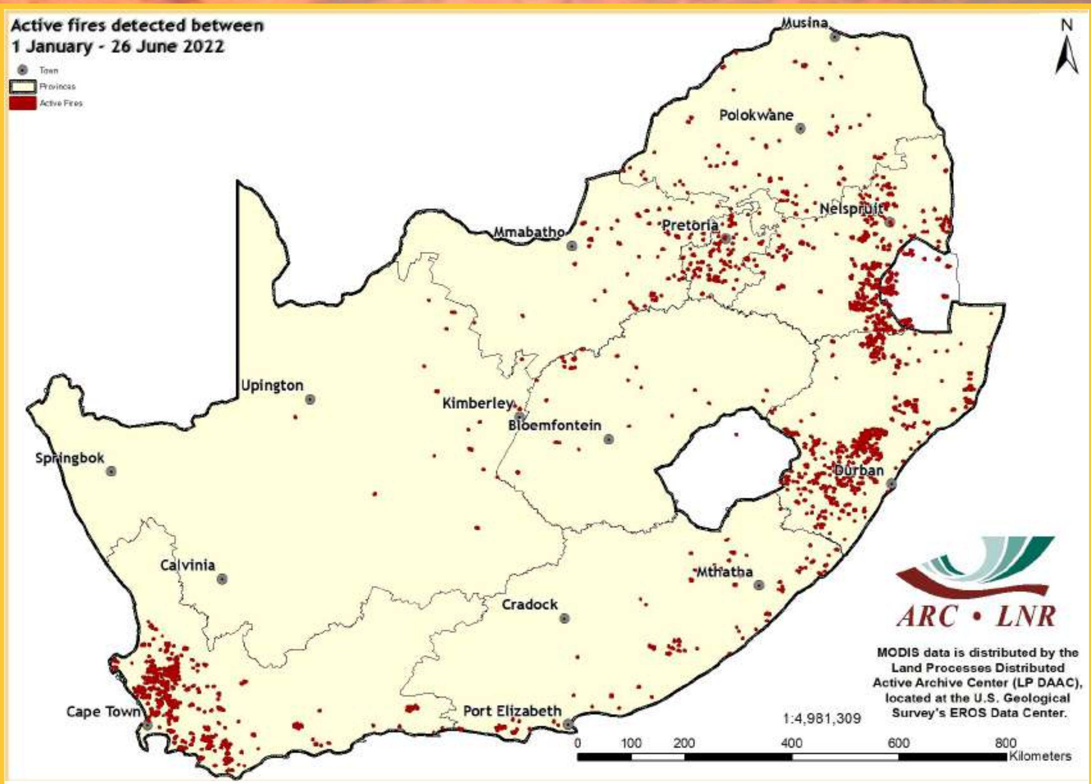

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January and 26 June 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 June 2022 shows a nearly identical distribution pattern to the previous two 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 June 2022 and June 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 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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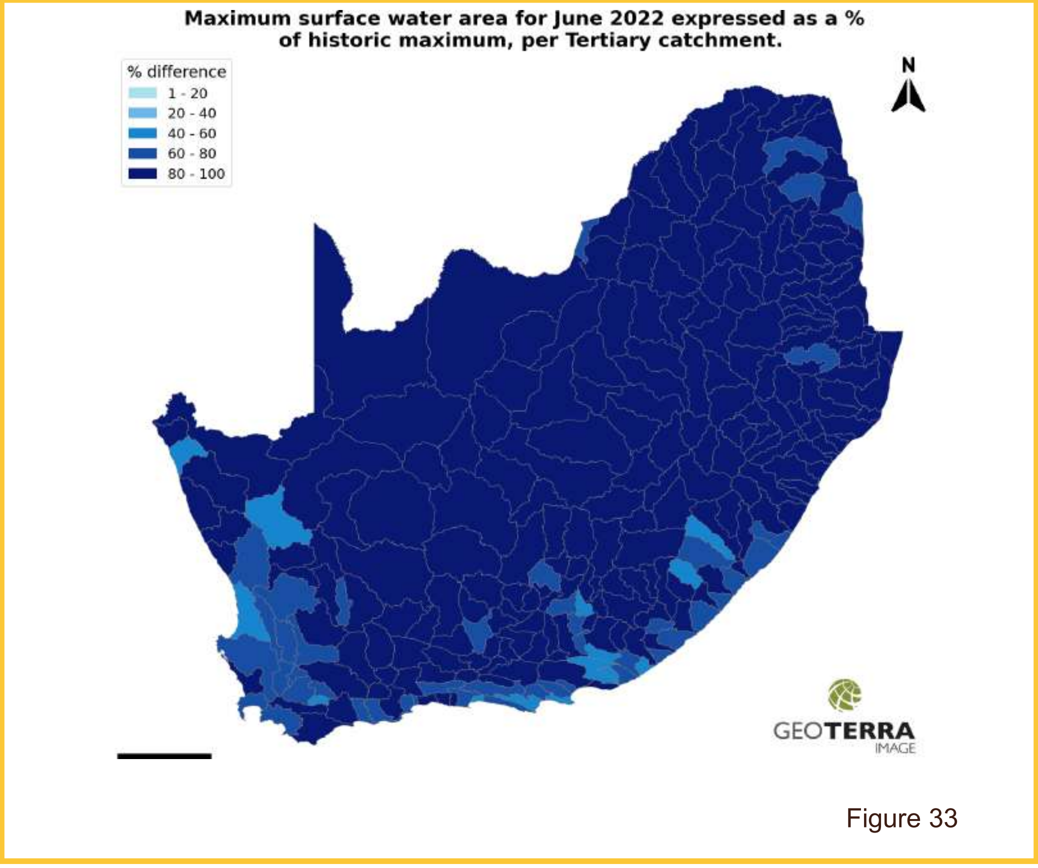

Figure 33

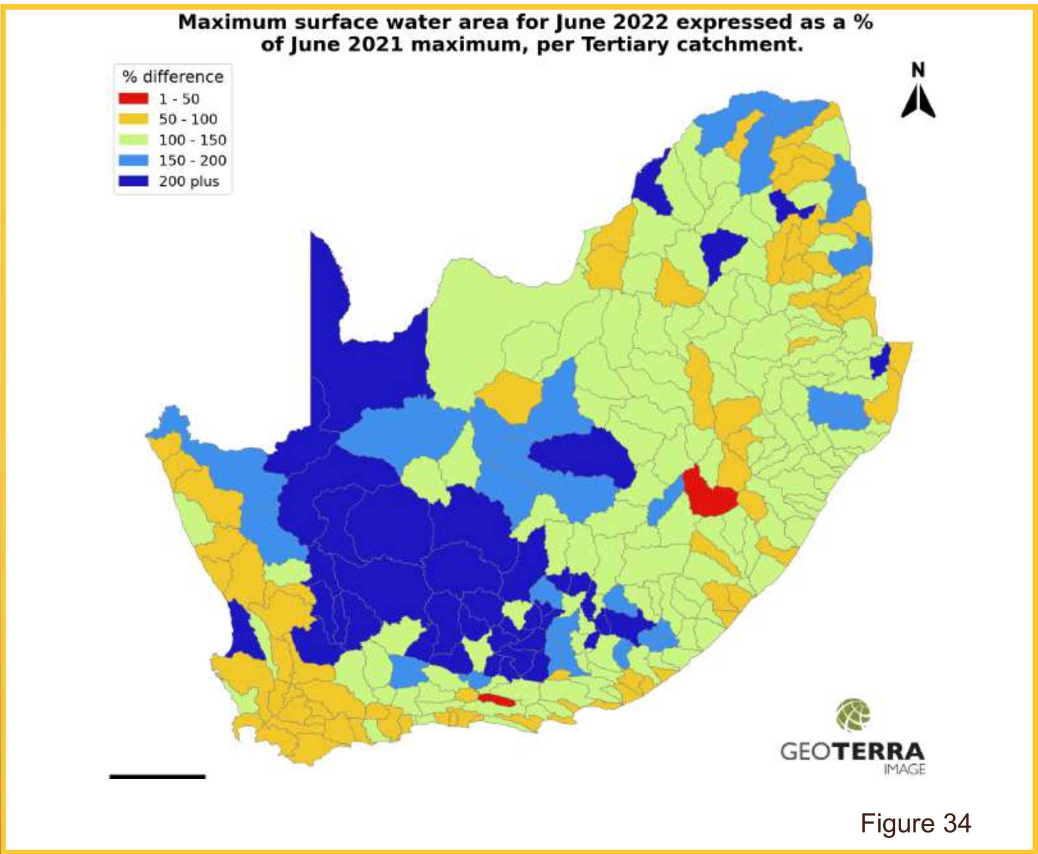

Figure 34

GEOTERRA IMAGE

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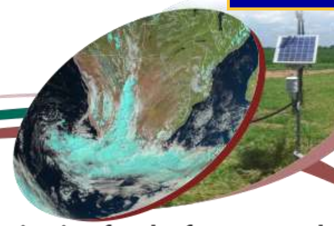
Agrometeorology



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".