



### Image of the Month

### Favourable vegetation conditions over the summer rainfall region

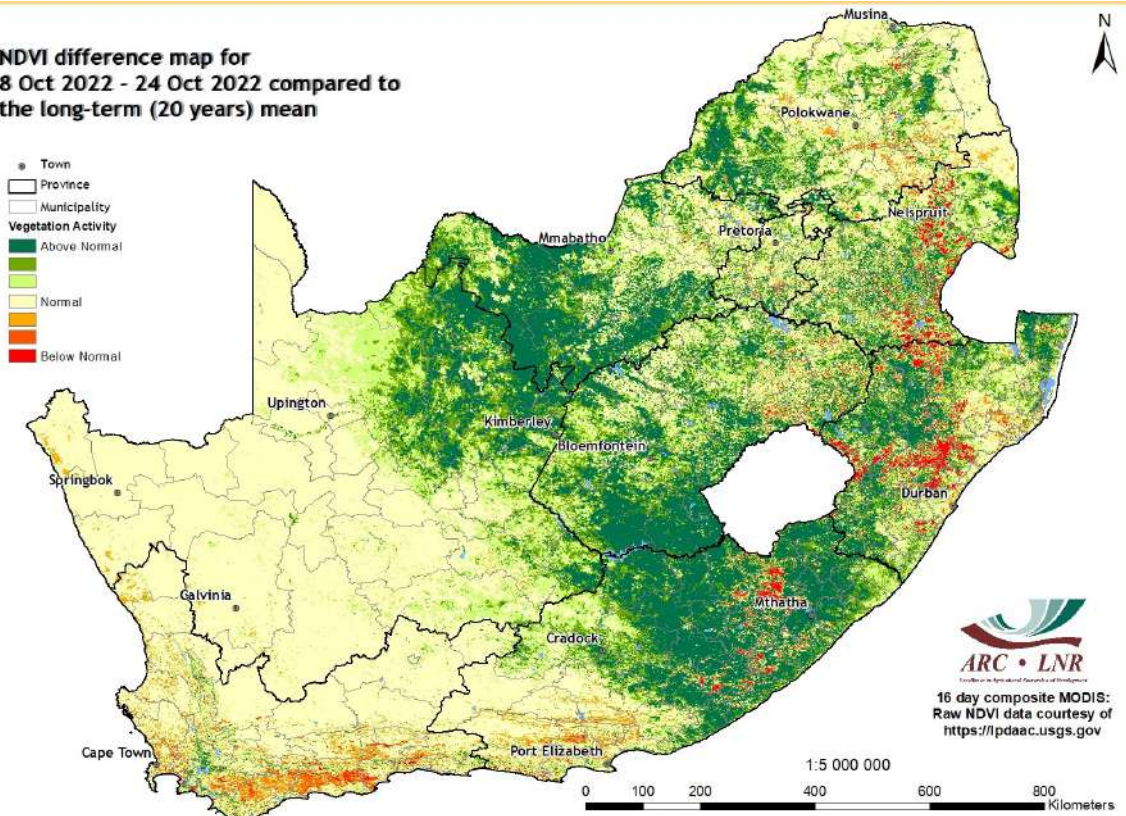
The 2022/23 summer rainfall season commenced with dry conditions over greater parts of the summer rainfall region, except for the Eastern Cape, adjacent areas in the Northern Cape, Free State and isolated areas of Limpopo, Mpumalanga and KwaZulu-Natal where above-normal rainfall was received in September. October 2022 began with extremely hot weather over the central and northeastern parts of the country, with a series of wet days occurring during the latter half of the month. Although delayed, this rainfall brought welcome relief from the very hot temperatures and created favourable conditions for planting crops. Moreover, the Normalized Difference Vegetation Index (NDVI) map from 8-24 October (see below) depicts above-normal vegetation activity over this region, although some isolated areas in the Eastern Cape and KZN, extending towards Mpumalanga and Limpopo, are still experiencing below-normal activity. However, the general improvement in vegetation conditions implies good prospects for agriculture, specifically the dominant cattle and grain farming areas in the region. Furthermore, rainfall prospects are expected to improve during the succeeding months which will support continued favourable conditions throughout the summer season.

**NATURAL RESOURCES AND ENGINEERING**  
Soil, Climate and Water

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**NDVI difference map for 8 Oct 2022 - 24 Oct 2022 compared to the long-term (20 years) mean**



## Overview:

A notable increase in total rainfall was observed in October 2022, following a somewhat dry September over the northern parts of the Highveld and the Bushveld in Limpopo. The month began with hot weather, with maximum temperatures exceeding  $4^{\circ}\text{C}$  positive anomalies in the northeastern region of the country. From the 13<sup>th</sup>, rainfall activity started occurring over parts of the KwaZulu-Natal Midlands and extended towards the interior from the 16<sup>th</sup>. These conditions continued throughout the latter of the month and resulted in isolated showers and thunderstorms over the summer rainfall region. Areas that recorded totals in excess of 100 mm for the month included various parts of KZN and isolated areas in Limpopo and the Free State. In contrast, the winter rainfall region experienced below-normal conditions while most parts of the all-year rainfall region received between 25-75% of their normal rainfall. Other areas that recorded below-normal rainfall included parts of the Northern Cape, Eastern Cape, Gauteng, North West, Mpumalanga and Limpopo.

# 1. Rainfall

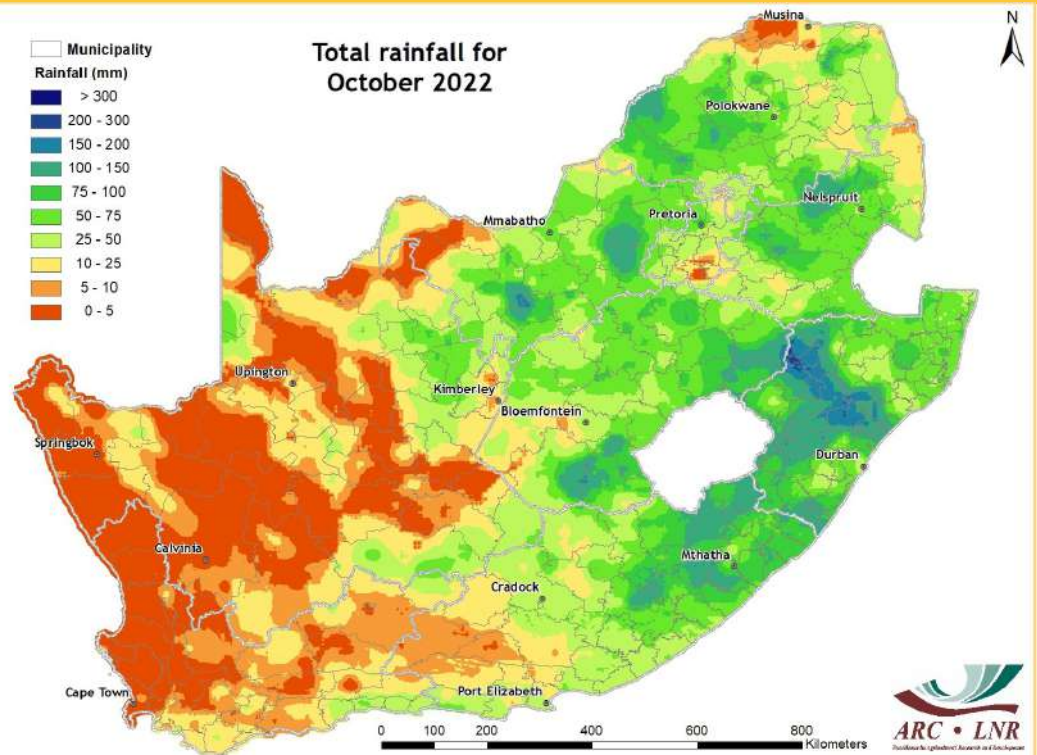


Figure 1

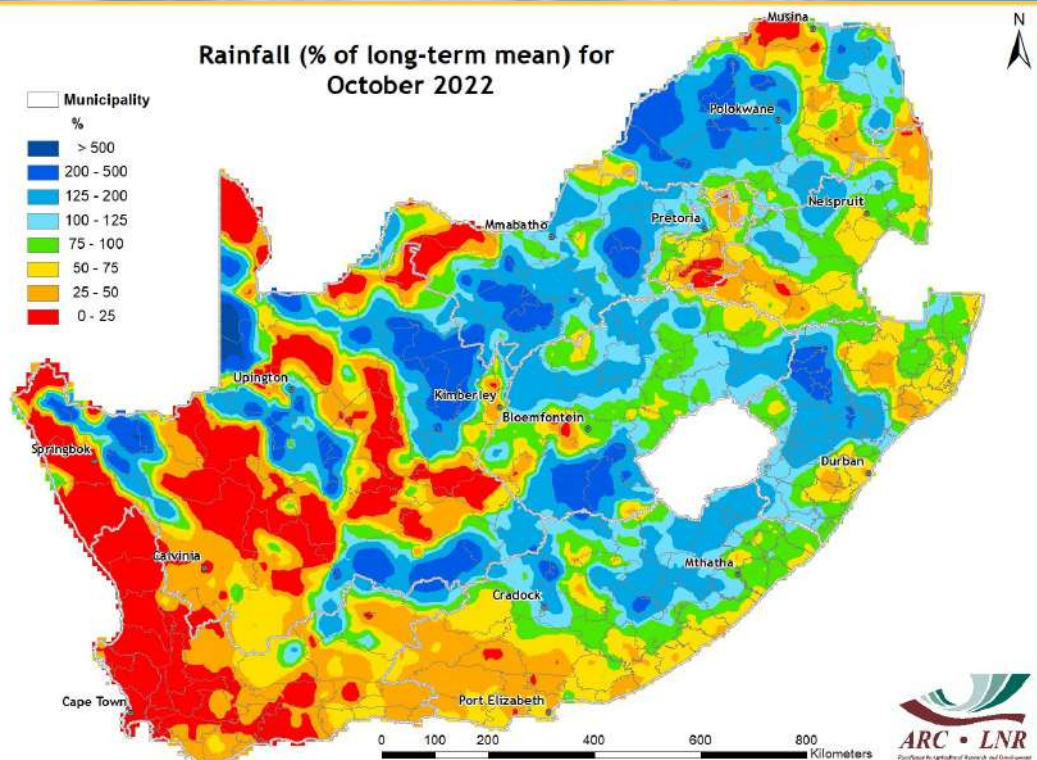


Figure 2

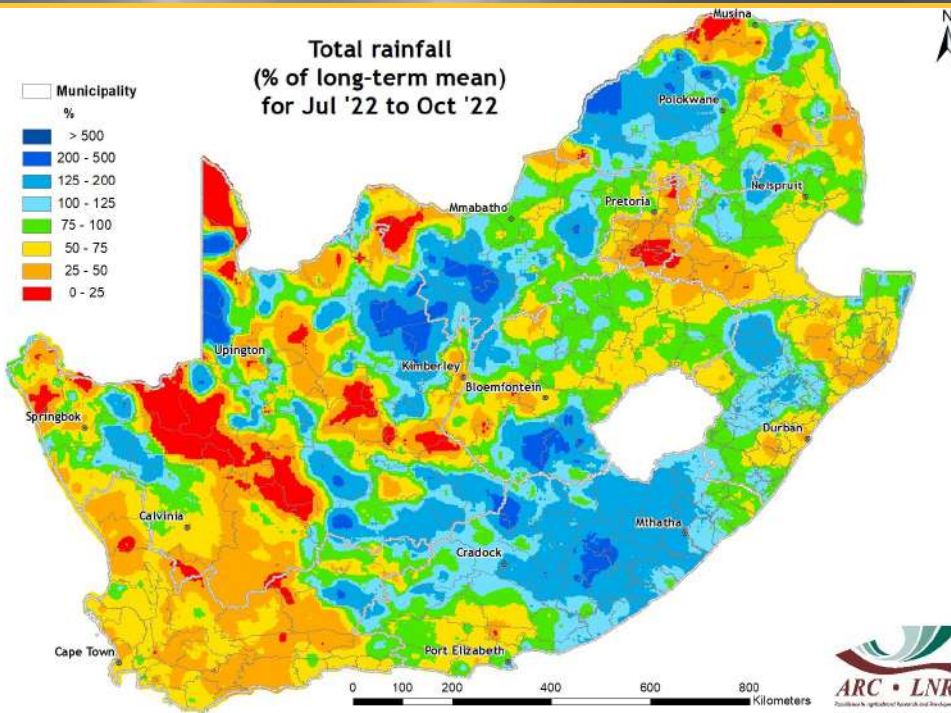


Figure 3

**Figure 1:**

Rainfall in October 2022 was largely confined to the summer rainfall region. The highest totals were recorded in KwaZulu-Natal, adjacent parts of the Eastern Cape and Free State, as well as isolated areas in Mpumalanga, North West and Limpopo. The western half of the country received little rainfall.

**Figure 2:**

Above-normal rainfall occurred over large parts of the interior during October while the rest of the country experienced near- to below-normal rainfall.

**Figure 3:**

Since July 2022, the central to southern interior and northern parts of the country received near- to above-normal rainfall. However, rainfall in parts of the Northern Cape, Western Cape and Gauteng was mostly below normal.

**Figure 4:**

When comparing total rainfall for August-October 2022 with that of the same period last year, it is evident that several areas in the central interior, KZN coast and the southwestern region of the country recorded less rain. The only areas that received more rain included the northern parts of the Eastern Cape and isolated areas in KZN, North West, Mpumalanga and Limpopo. The rest of the country received somewhat similar amounts of rainfall during this 3-month period to last year.

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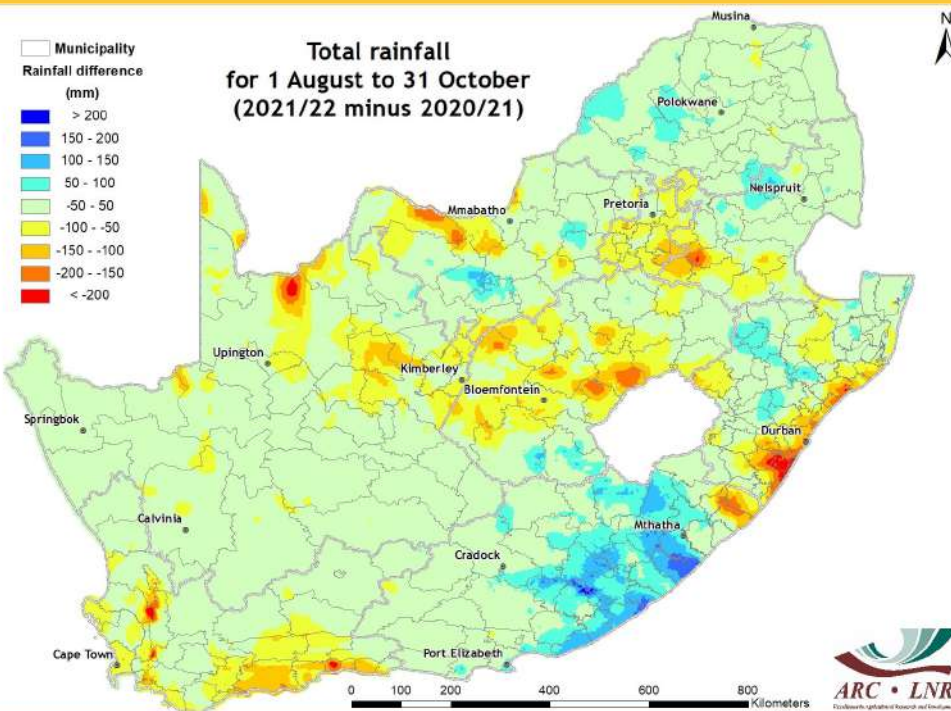


Figure 4

## 2. Standardized Precipitation Index

### Standardized Precipitation Index

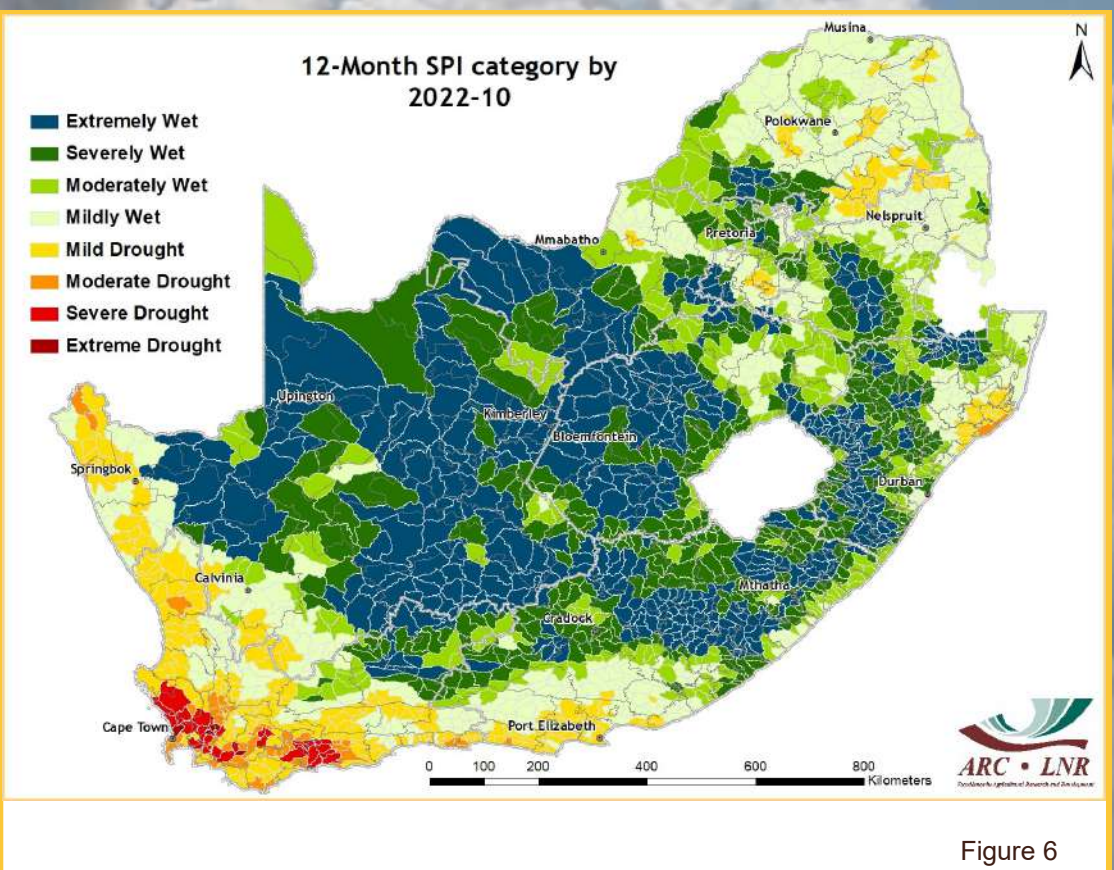
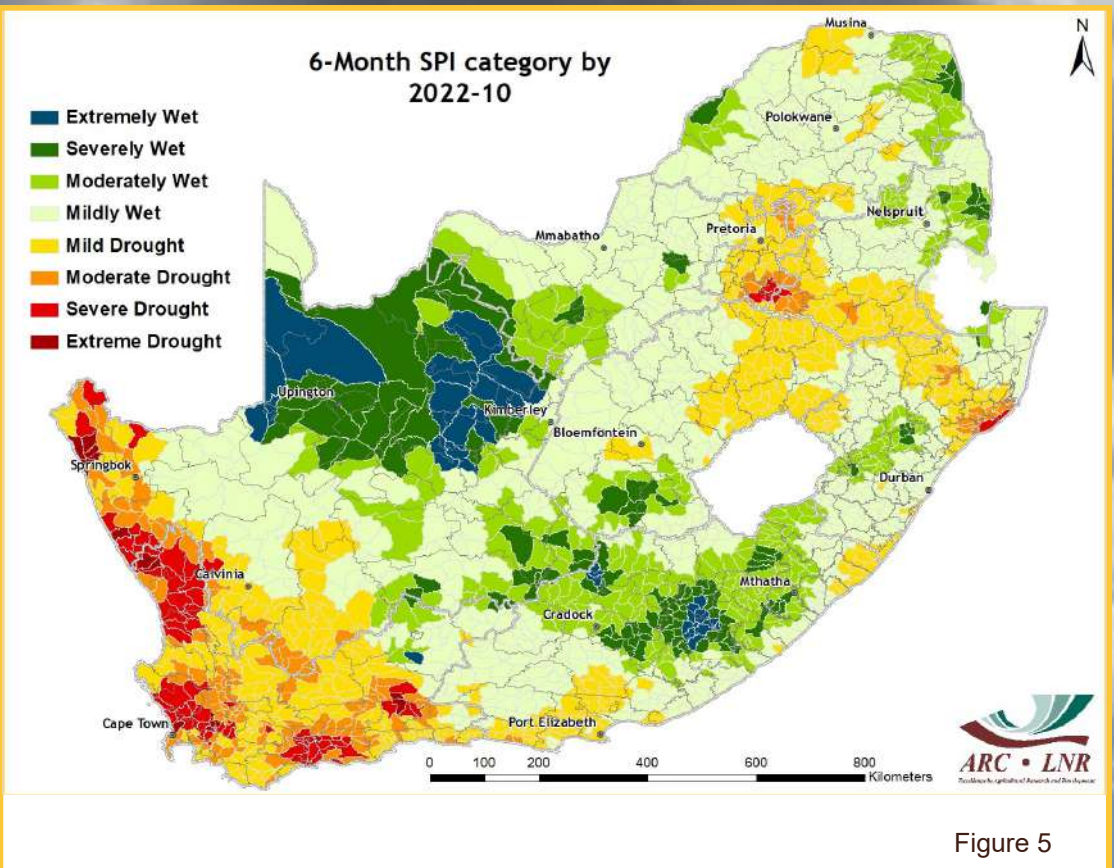
The Standardized Precipitation Index (SPI - McKee *et al.*, 1993) was developed to monitor the occurrence of droughts from rainfall data. The index quantifies precipitation deficits on different time scales and therefore also drought severity. It provides an indication of rainfall conditions per quaternary 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 8<sup>th</sup> 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 October 2022 are shown in Figures 5-8. The short-term SPI indicates near-normal to wet conditions over the summer rainfall region with moderate to severe drought visible over the southern parts of Gauteng and certain areas in northern KZN. Similar conditions are also evident over the Western Cape, extending north towards Springbok in the Northern Cape. The 12-month SPI shows drought conditions over the south-western region of Western Cape, with widespread wet conditions over the rest of the country. The long-term SPI indicates moderate to severe drought conditions over the southern parts of Limpopo, the Eastern Cape and most of the winter rainfall region.

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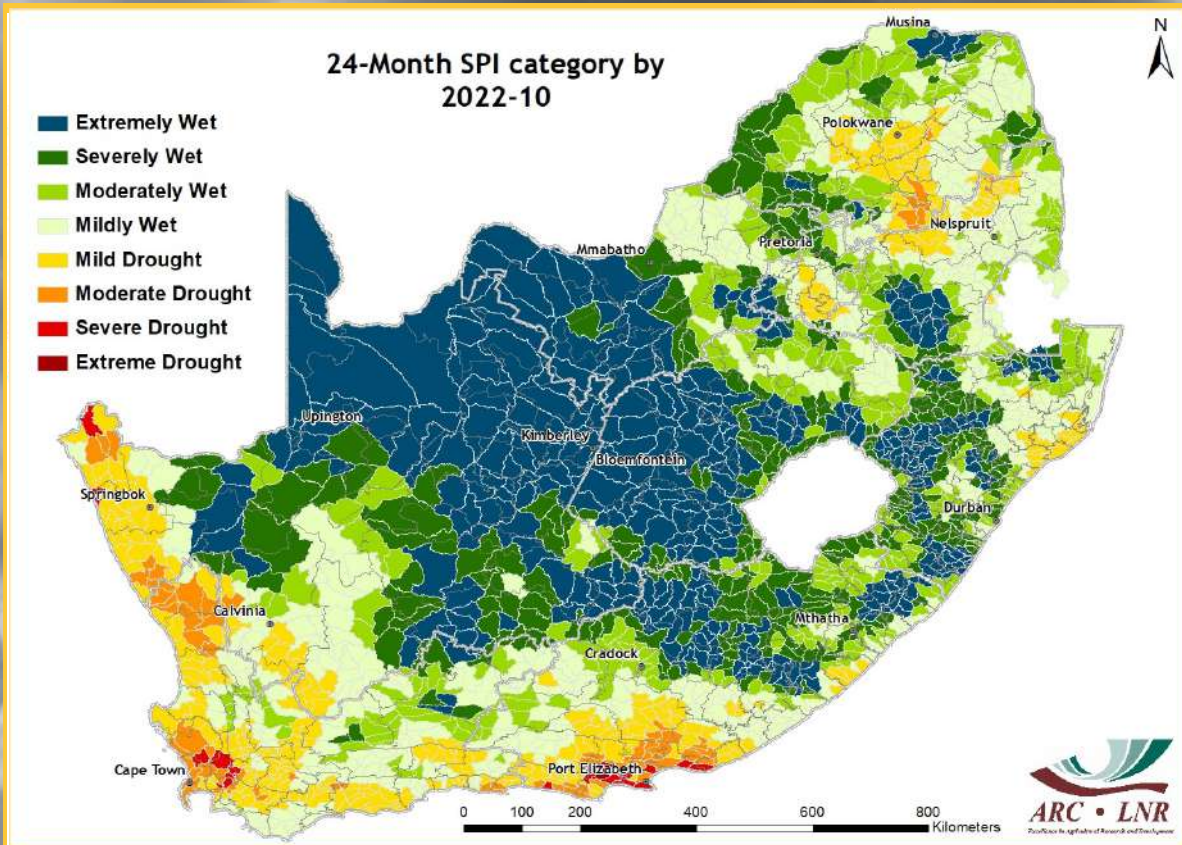


Figure 7

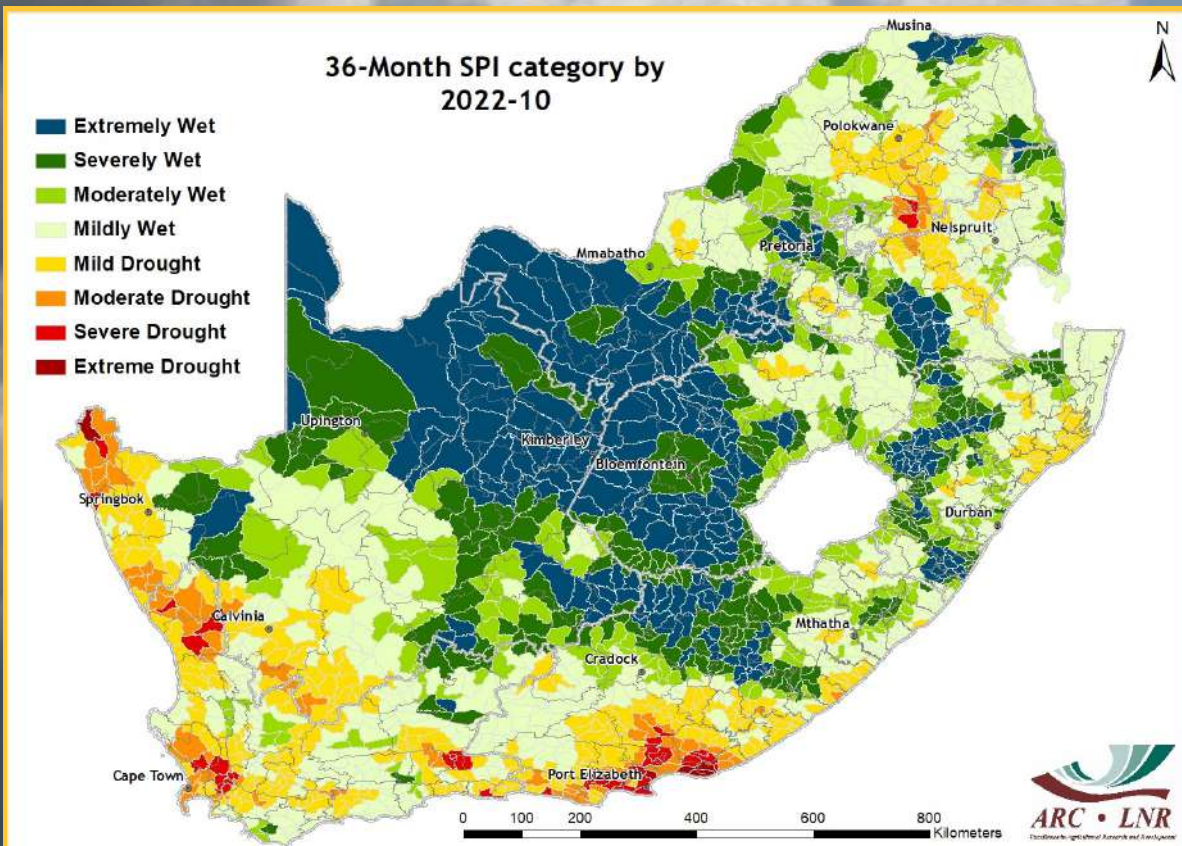


Figure 8

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.

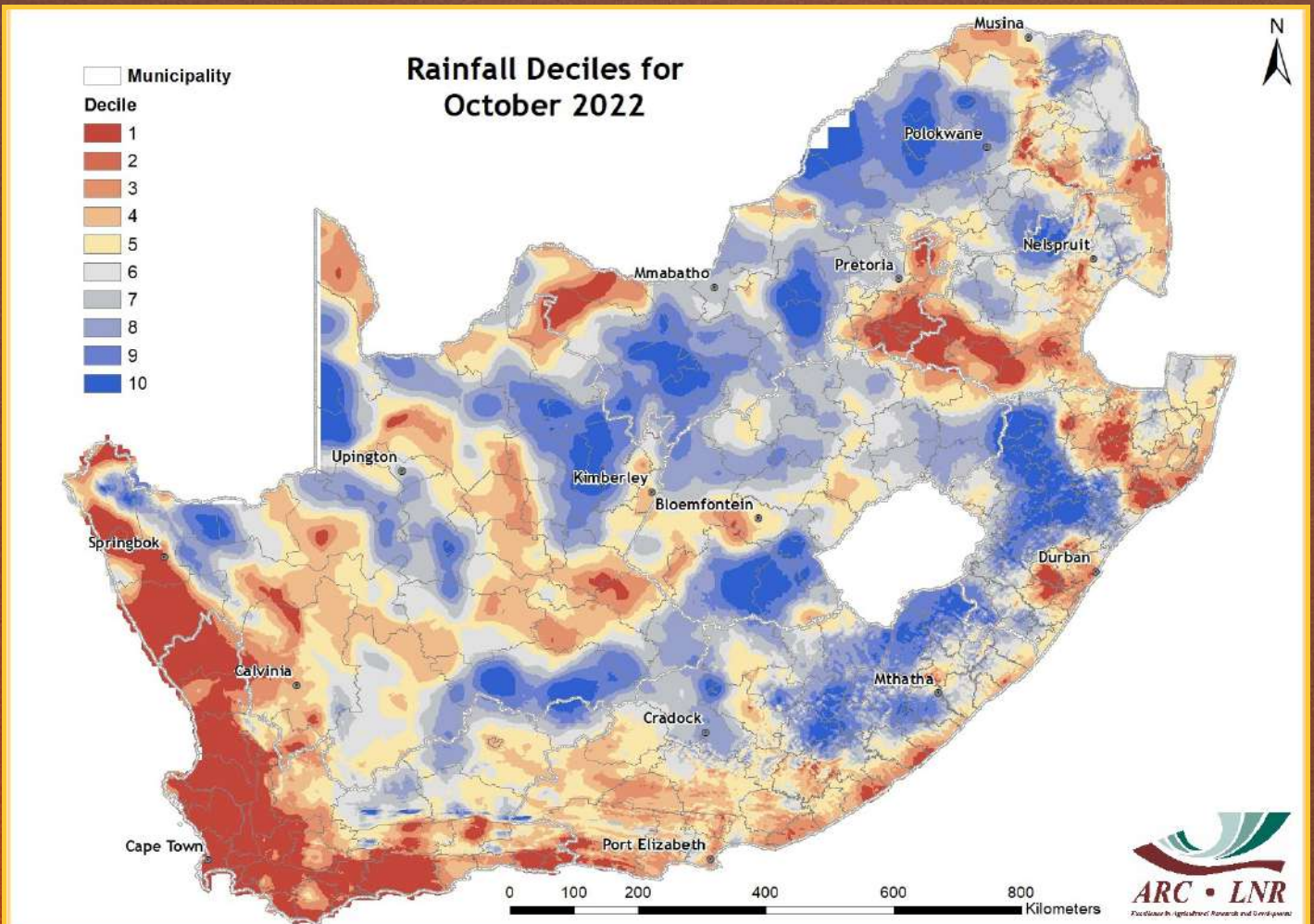


Figure 9

### Figure 9:

Rainfall that occurred over greater parts of the summer rainfall region in October 2022 compared well with historically wet October months, while the rest of the country remained dry.

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## Vegetation Mapping

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

$$NDVI = \frac{IR - R}{IR + R}$$

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.

# 4. Vegetation Conditions

**Standardized Difference Vegetation Index (SDVI) for 8 Oct 2022 - 24 Oct 2022 compared to the long-term (20 years) mean**

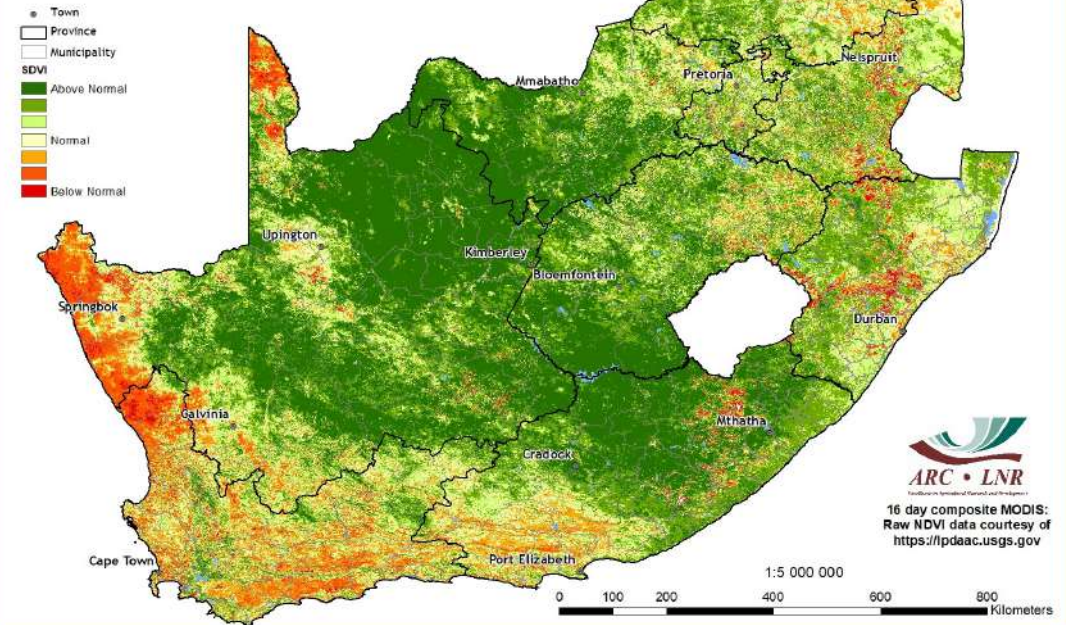


Figure 10

**Figure 10:**

Compared to the historical averaged vegetation conditions, the 16-day SDVI map for October 2022 shows that areas of poor vegetation activity were restricted to the periphery of the country.

**Figure 11:**

The 16-day NDVI difference map for October 2022 compared to the preceding 16-day period shows that the western and central interior continue to experience normal vegetation conditions while the far western and southern parts of the country experienced below-normal vegetation conditions.

**NDVI difference map for 8 Oct 2022 - 24 Oct 2022 compared to 22 Sep 2022 - 8 Oct 2022**

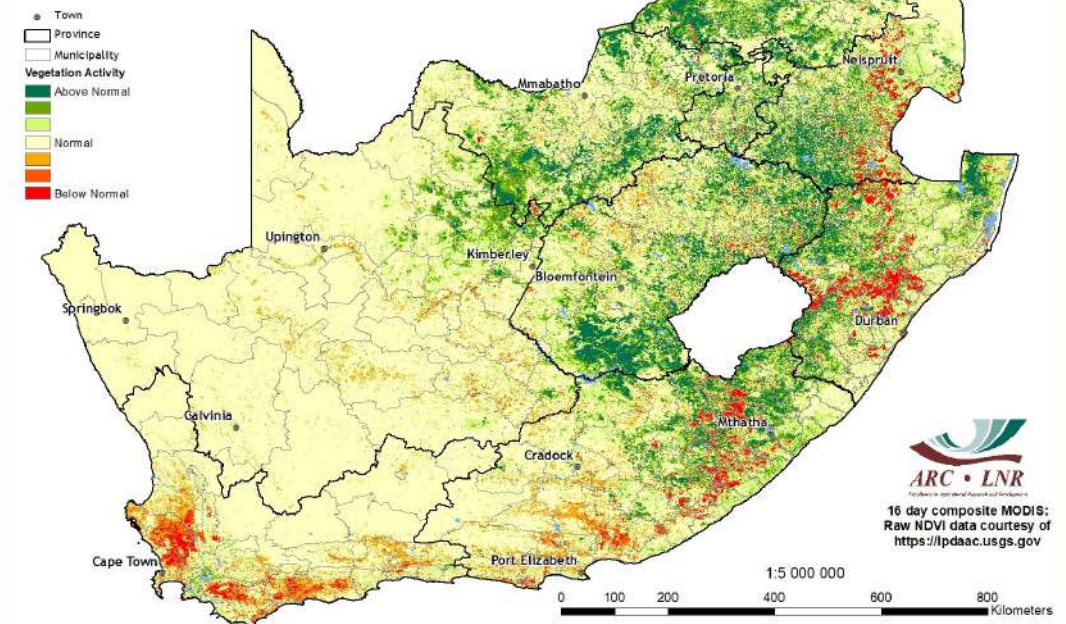


Figure 11

**NDVI difference map for  
8 Oct 2022 - 24 Oct 2022 compared to  
8 Oct 2021 - 24 Oct 2021**

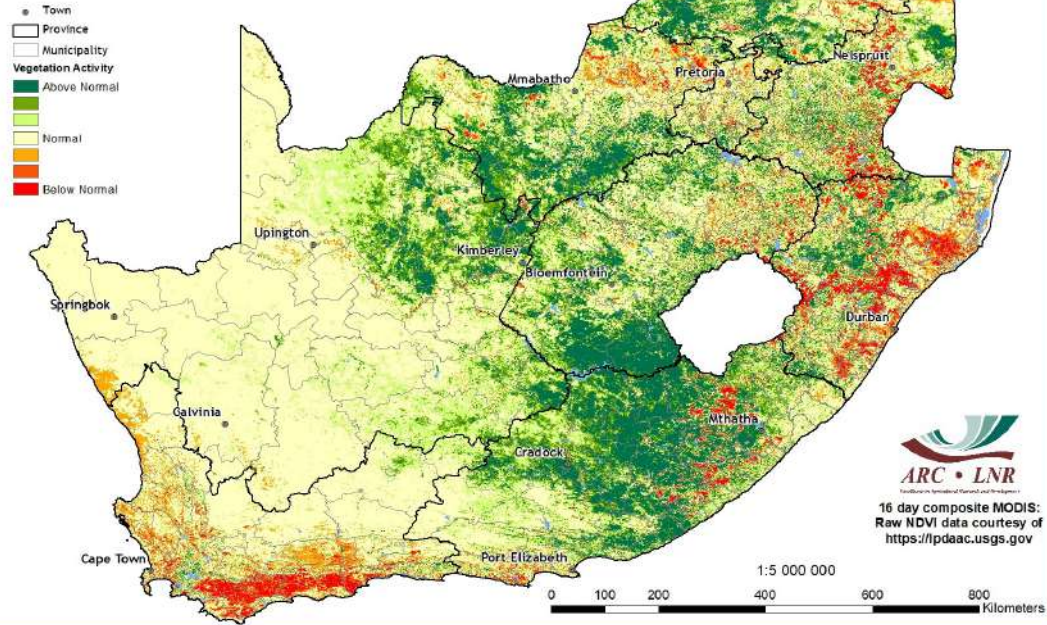


Figure 12

**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

**Percentage of Average Seasonal Greenness (PASG) for  
4 July 2022 - 24 October 2022  
compared to the long-term  
(19 years) mean**

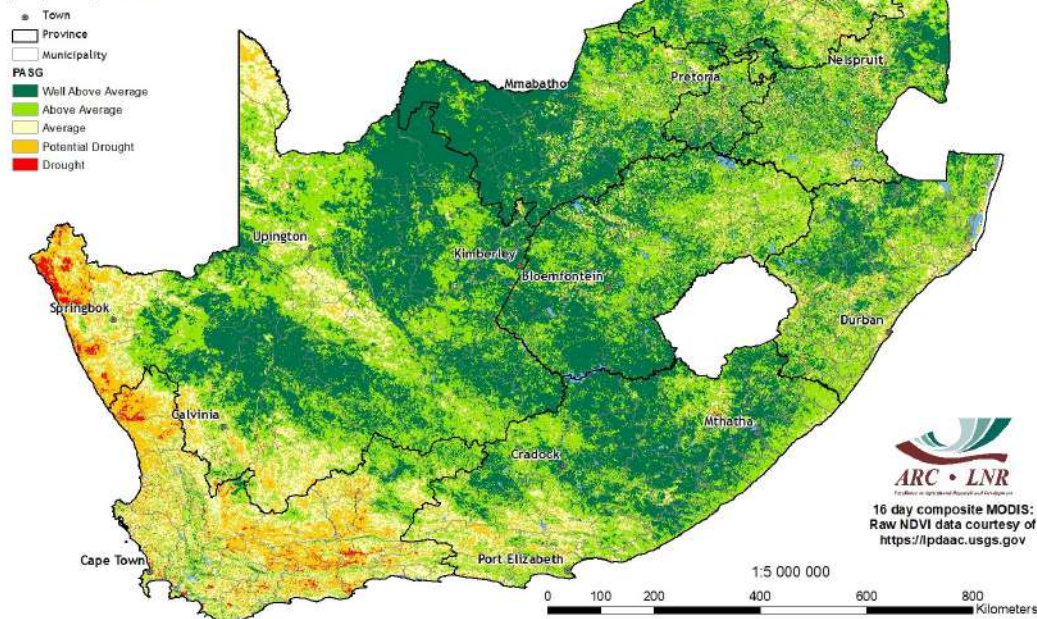


Figure 13

**Figure 12:**

The 16-day NDVI difference map for October 2022 compared to the same period last year shows a wide range of vegetation conditions across the country with clusters of above-normal vegetation in the interior, patches of below-normal vegetation in the far eastern and northern parts, and normal conditions more pronounced in the west.

**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, eastern and northern parts of the country, while potential drought conditions persist in the far western parts of 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.

Vegetation Condition Index (VCI) for 8 Oct 2022 - 24 Oct 2022 compared to the long-term (20 years) mean

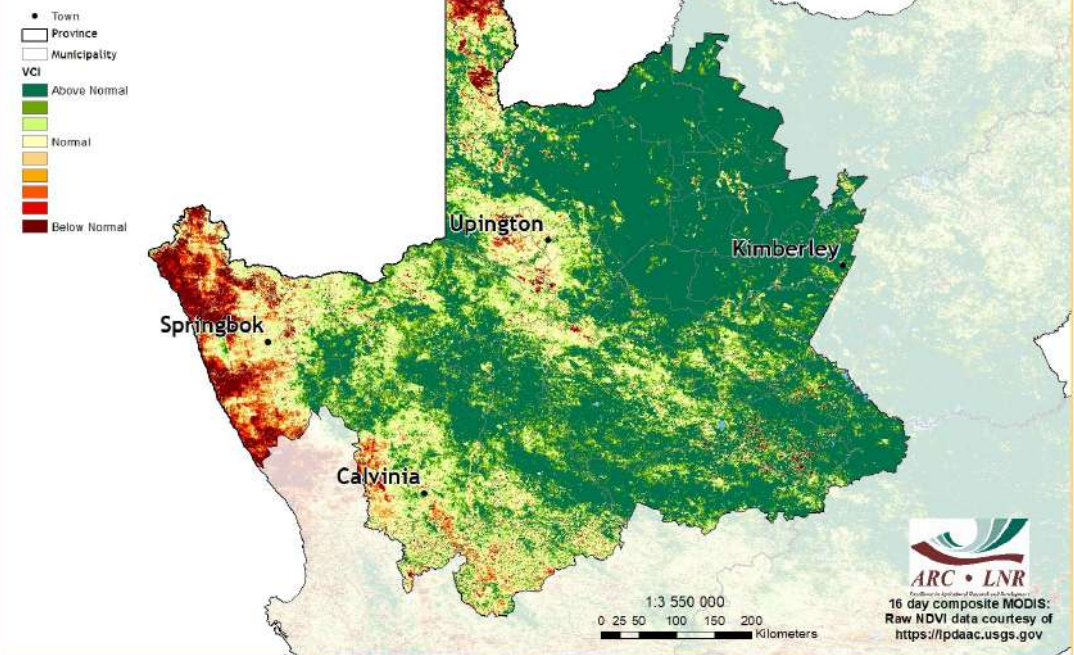


Figure 14

Figure 14:

The 16-day VCI map for October 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 October 2022 indicates that below-normal vegetation conditions are prevalent throughout the Western Cape, with good vegetation activity in some remote areas.

Vegetation Condition Index (VCI) for 8 Oct 2022 - 24 Oct 2022 compared to the long-term (20 years) mean

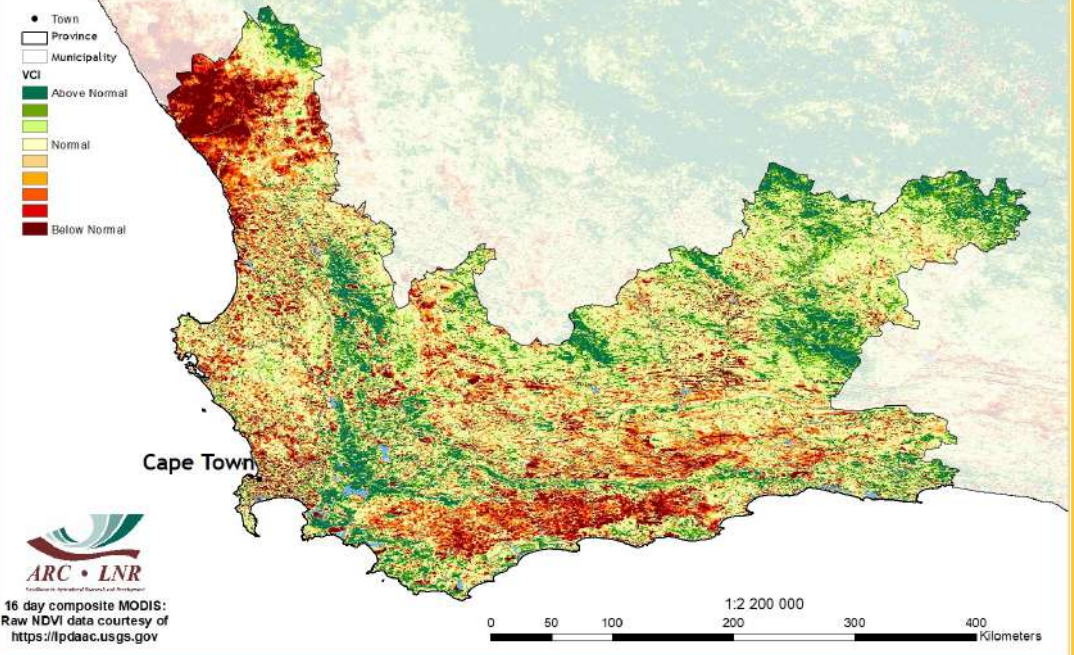


Figure 15

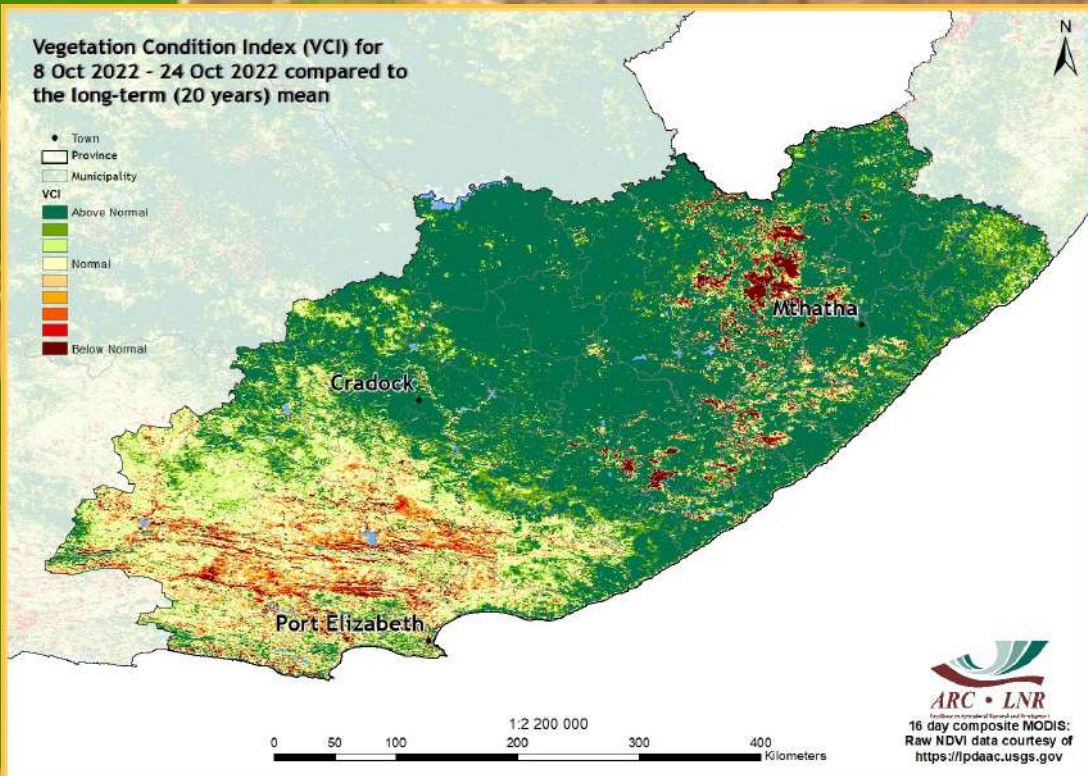


Figure 16

**Figure 16:** The 16-day VCI map for October 2022 indicates that above-normal vegetation conditions remain prevalent in most parts of the Eastern Cape, with the exception of the far southwestern parts of the province.

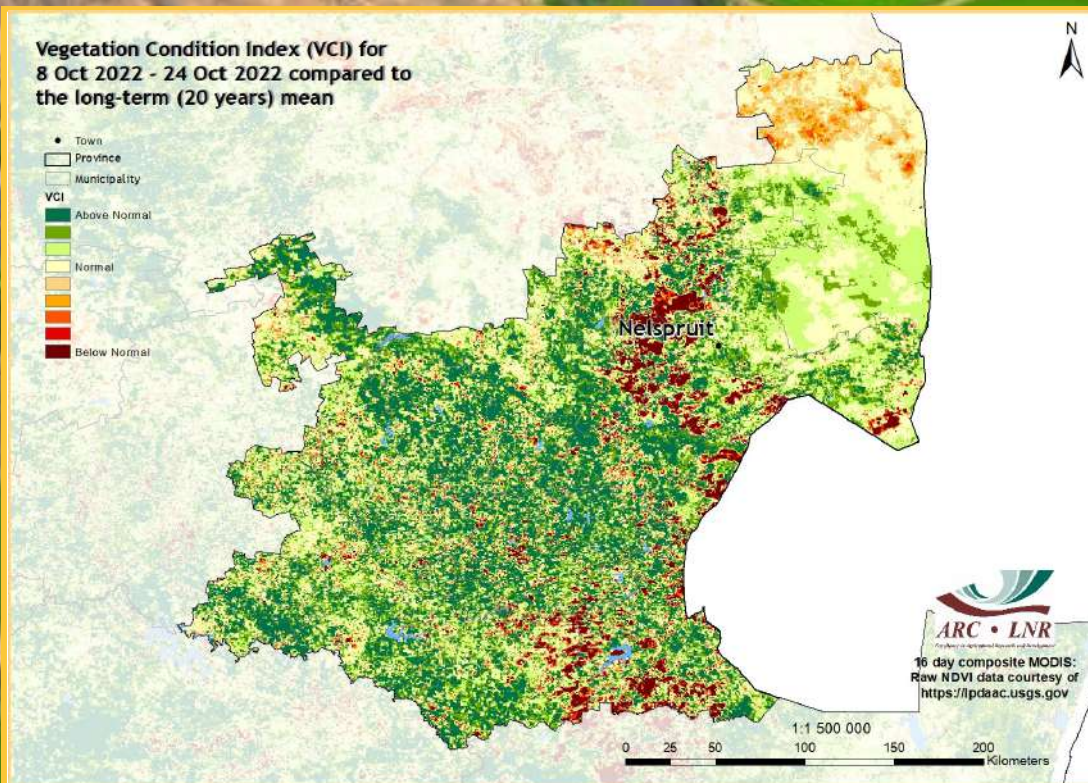


Figure 17

**Figure 17:** The 16-day VCI map for October 2022 indicates that above-normal vegetation conditions remain prevalent throughout Mpumalanga, although patches of below-normal vegetation condition can also be seen.

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# 6. Vegetation Conditions & Rainfall

## District Municipalities

- District Council
- Major\_Towns
- Umkhanyakude
- Kgalagadi
- iLembe
- Ugu
- Umgungundlovu
- Eden
- West Coast
- Boland
- Central Karoo
- Namakwa

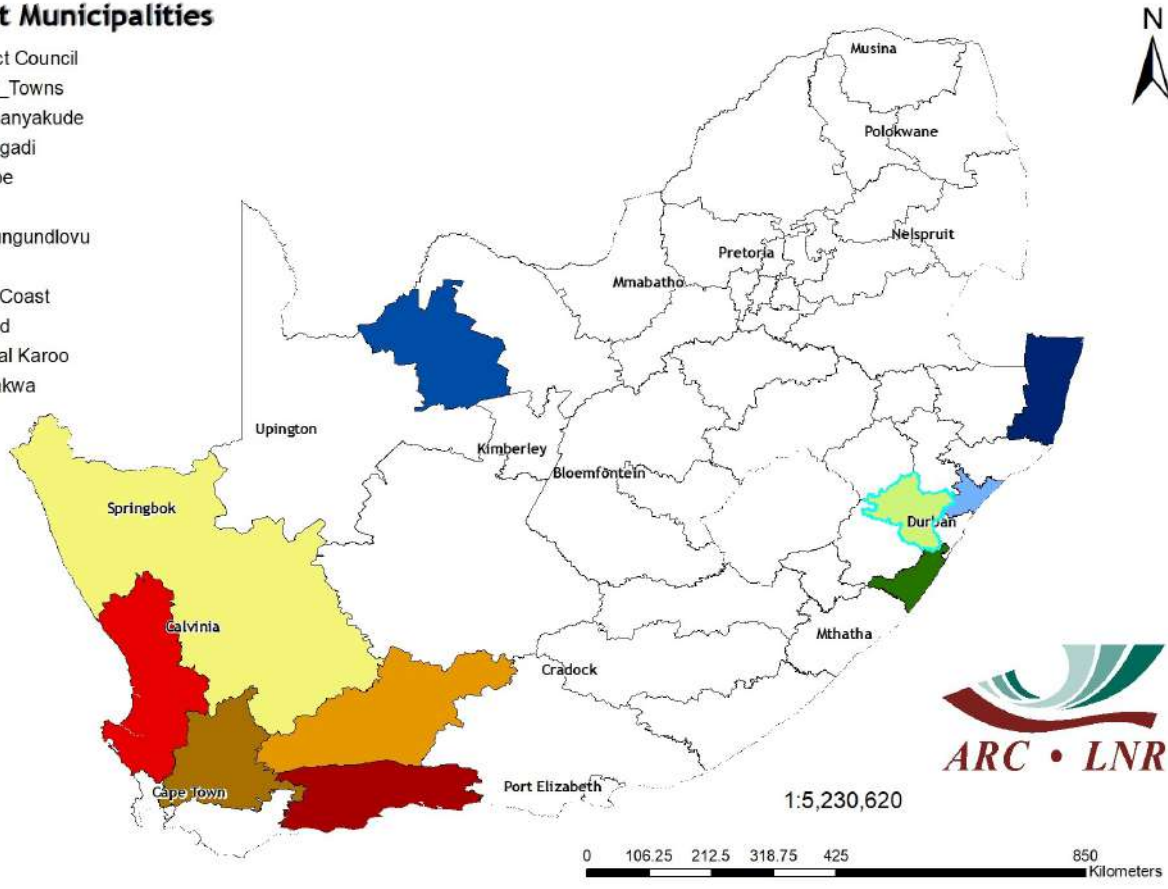


Figure 18

## Rainfall and NDVI Graphs

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

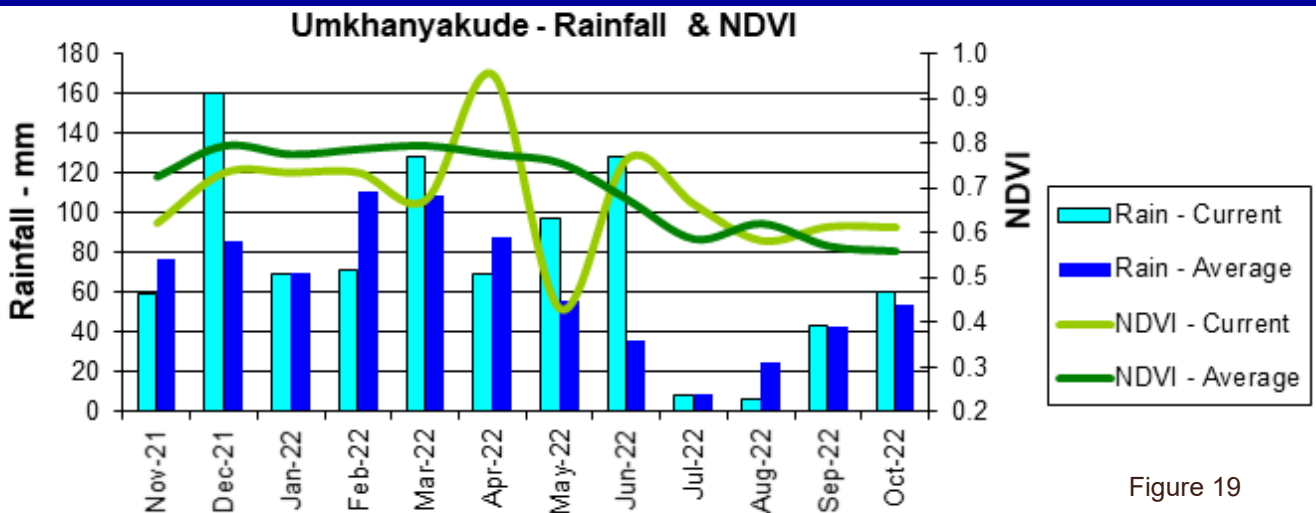


Figure 19

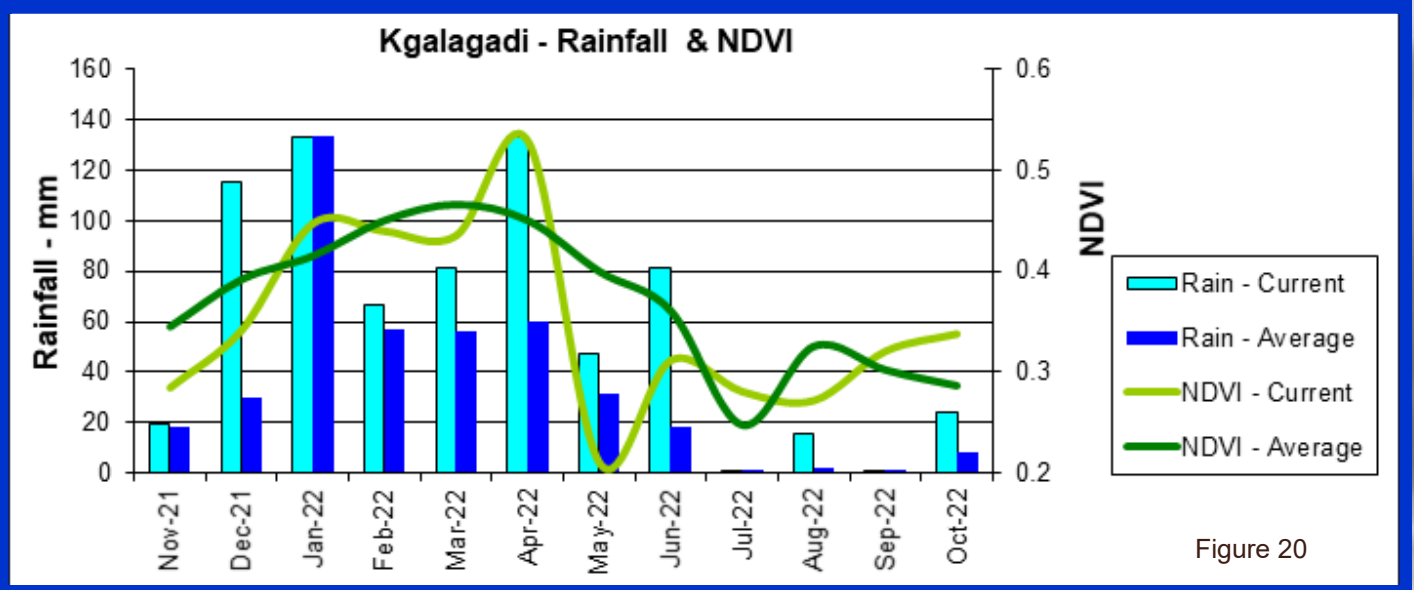


Figure 20

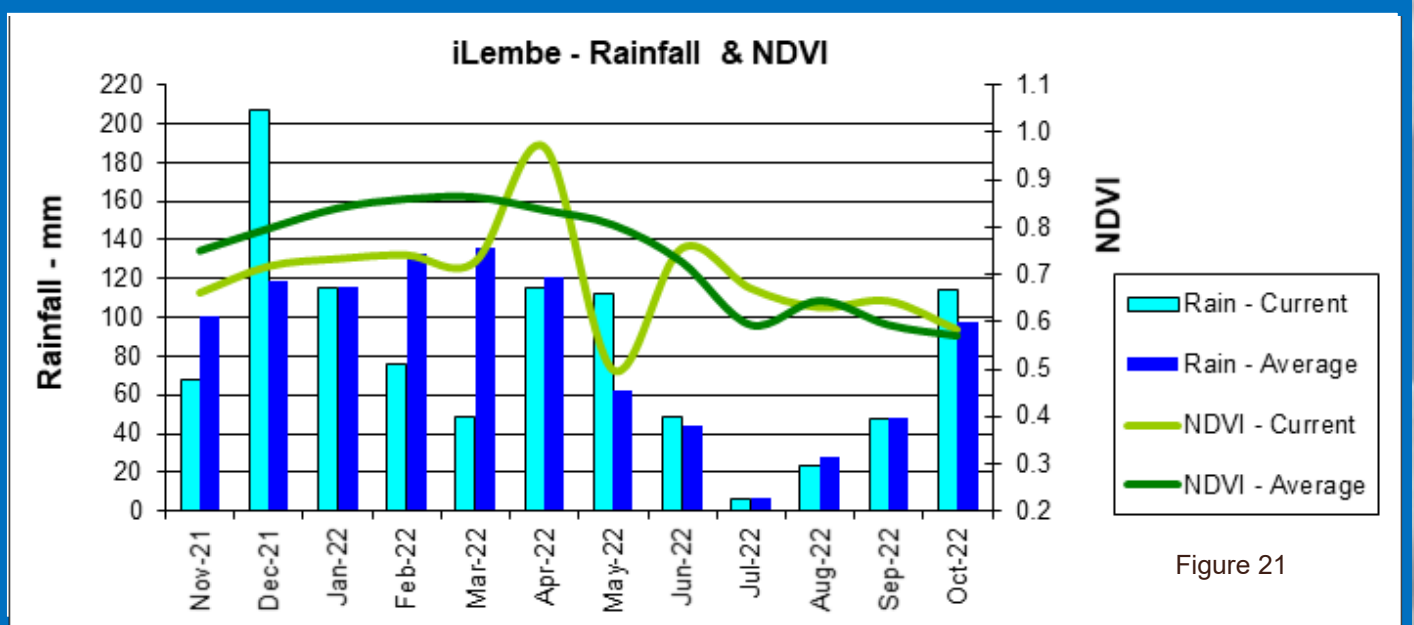
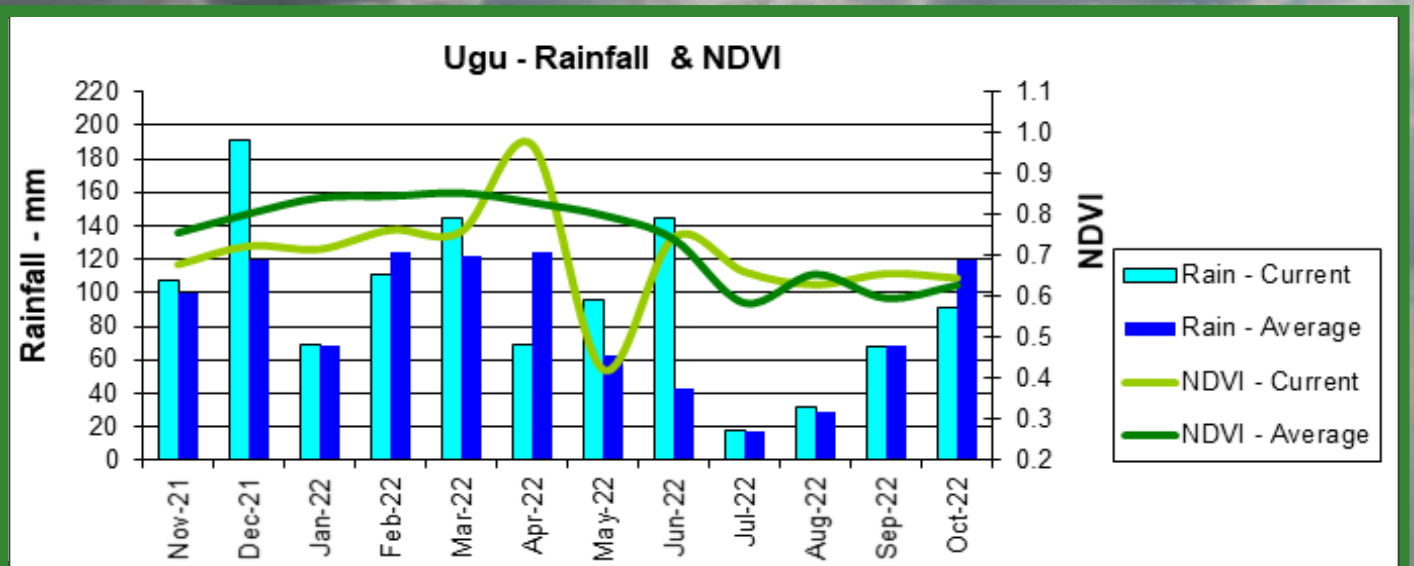
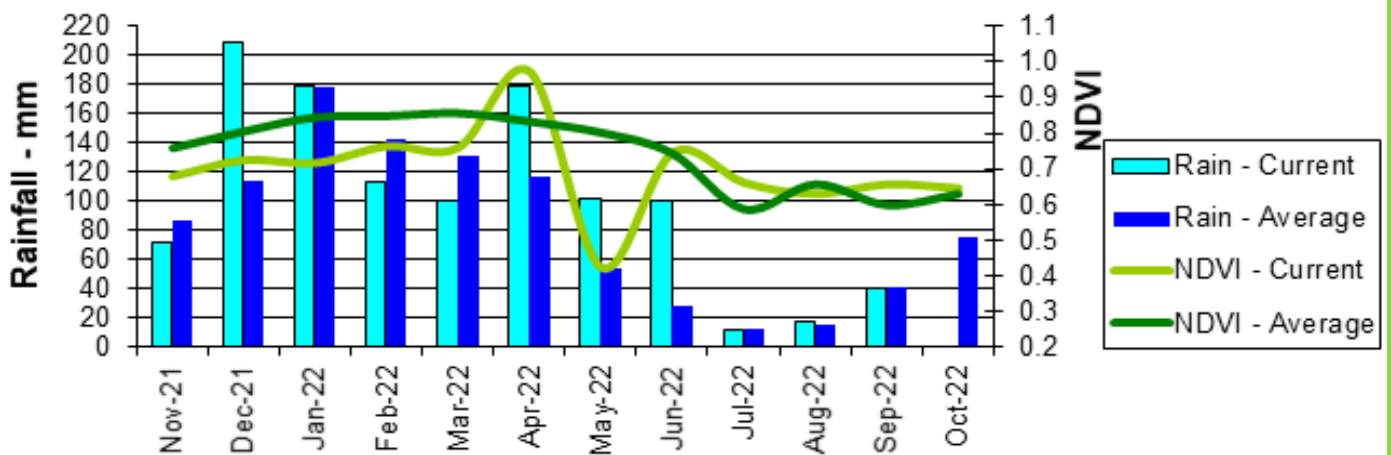


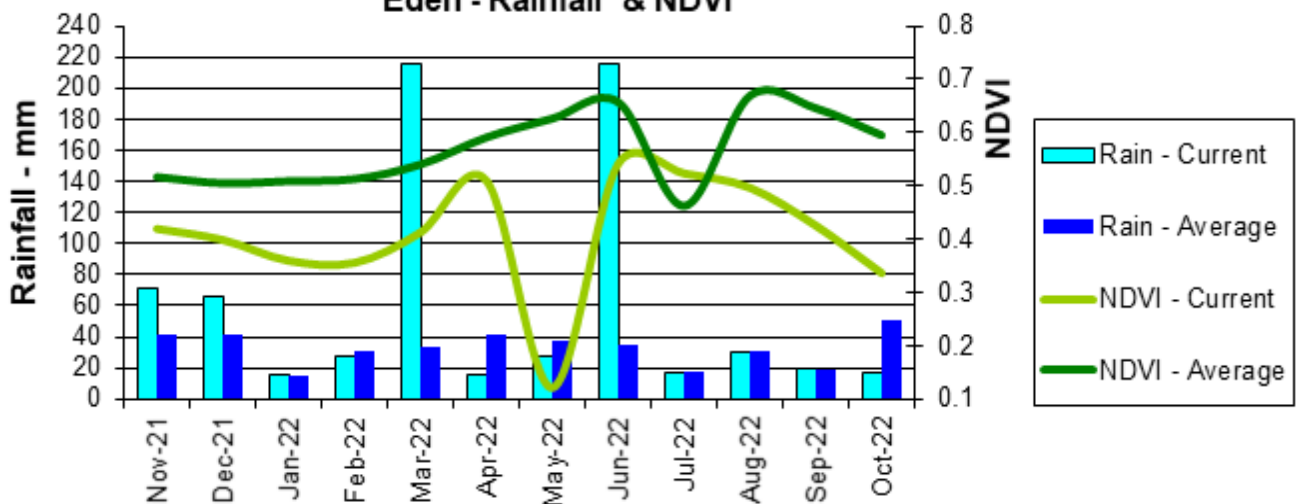
Figure 21



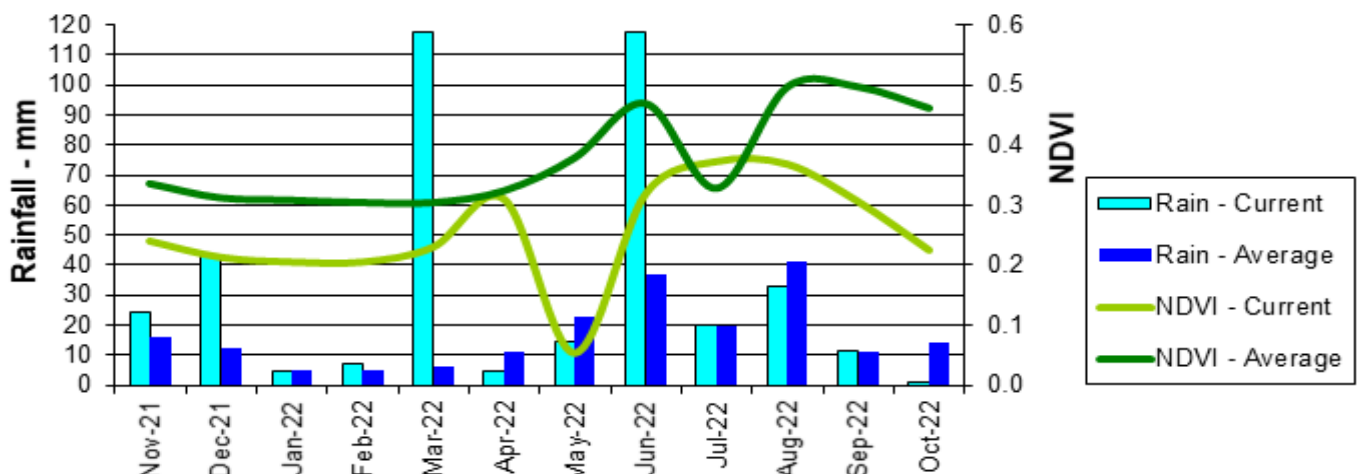
### Umgungundlovu - Rainfall & NDVI



### Eden - Rainfall & NDVI



### West Coast- Rainfall & NDVI



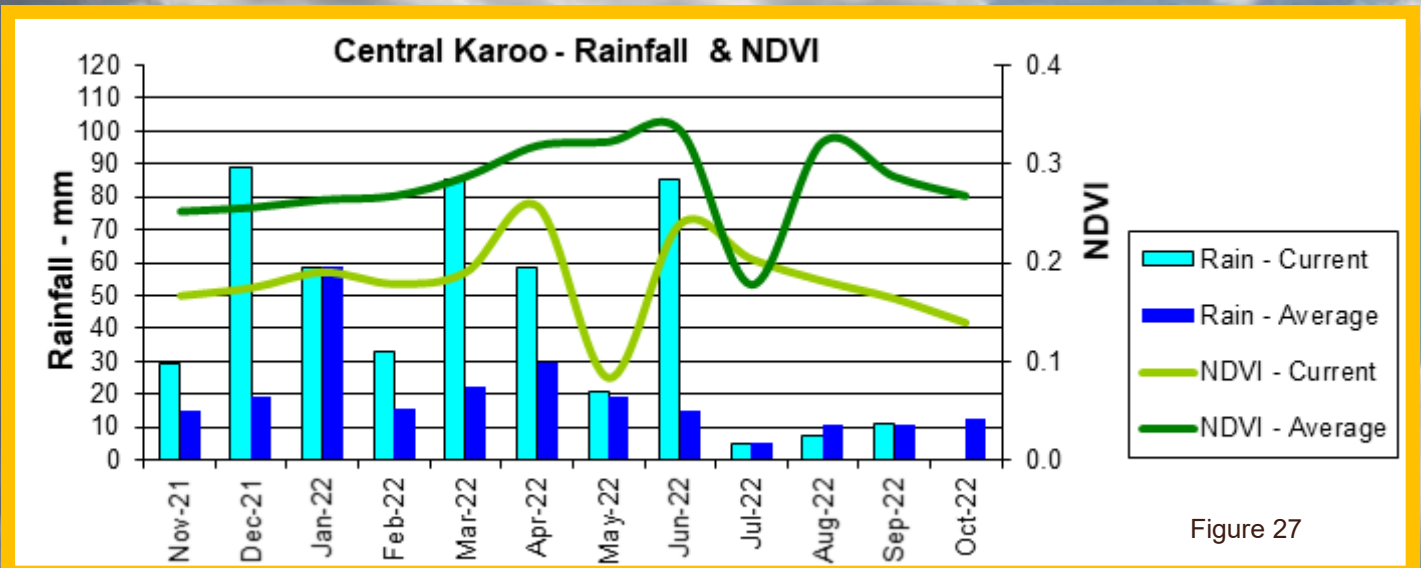
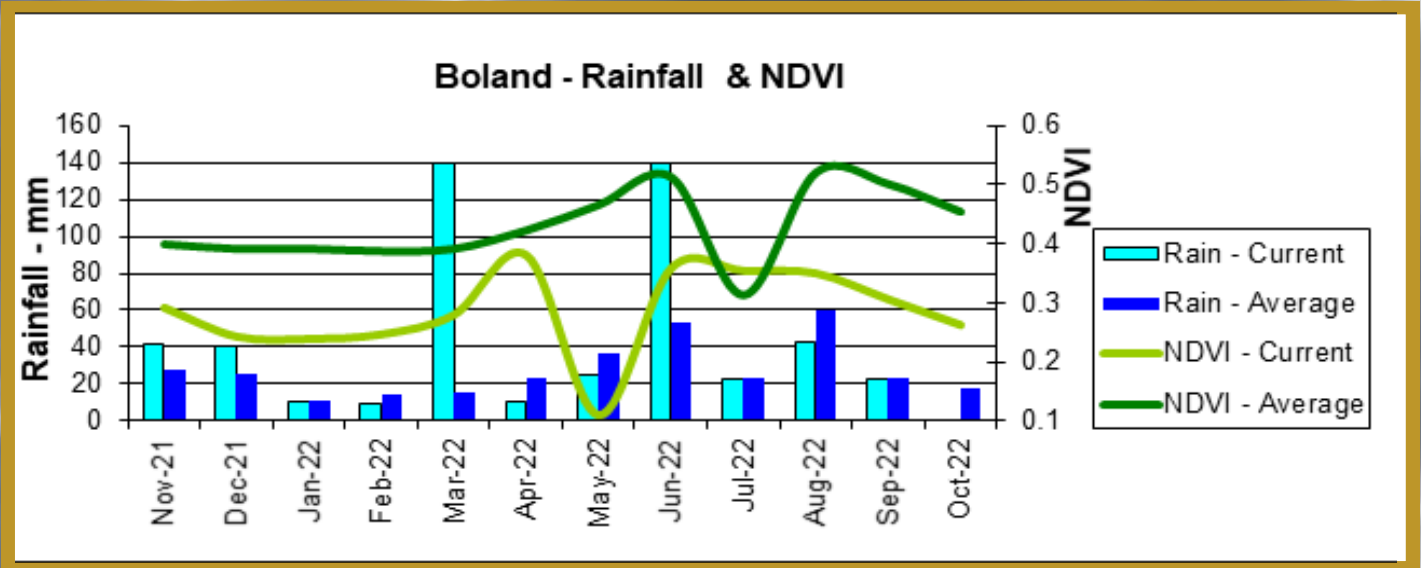


Figure 27

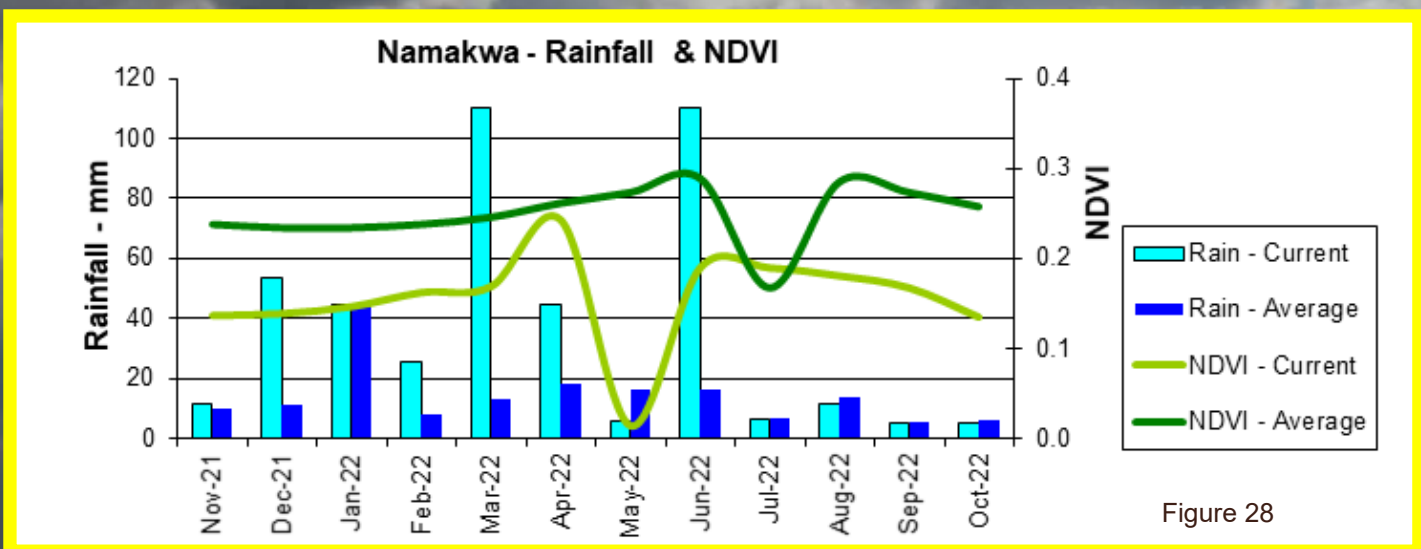


Figure 28

# 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  $\mu\text{m}$ . For an ambient temperature of 290 K, the peak of radiance emission is located at approximately 11  $\mu\text{m}$ . 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 30 September and 1 November 2022 per province. Fire activity was higher in Gauteng, the Northern Cape, Limpopo and North West, compared to the long-term average.

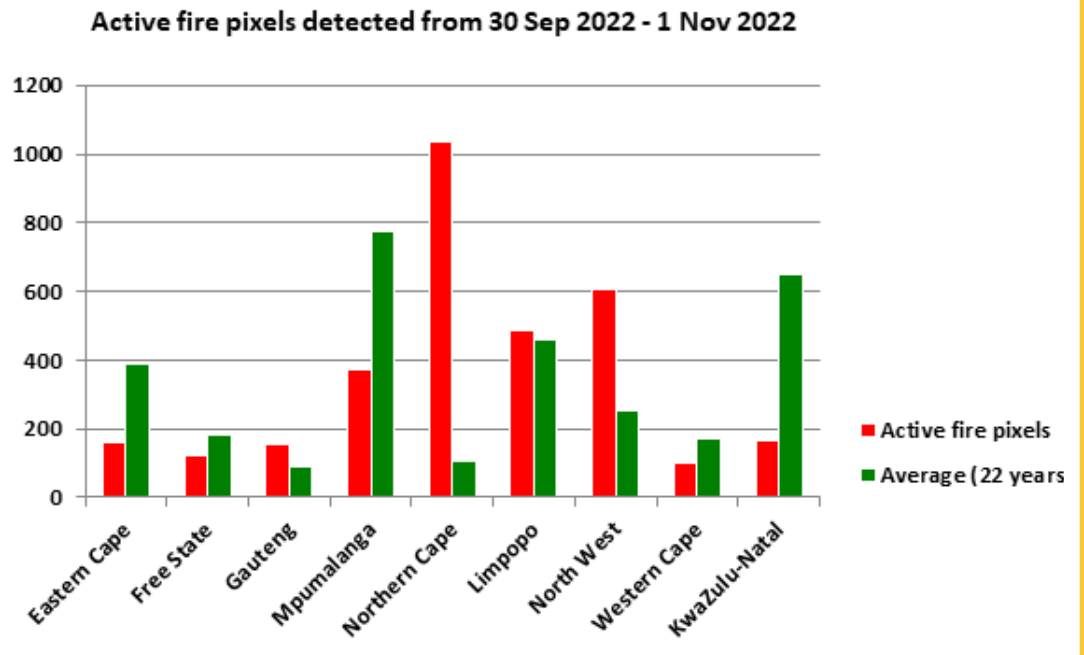


Figure 29

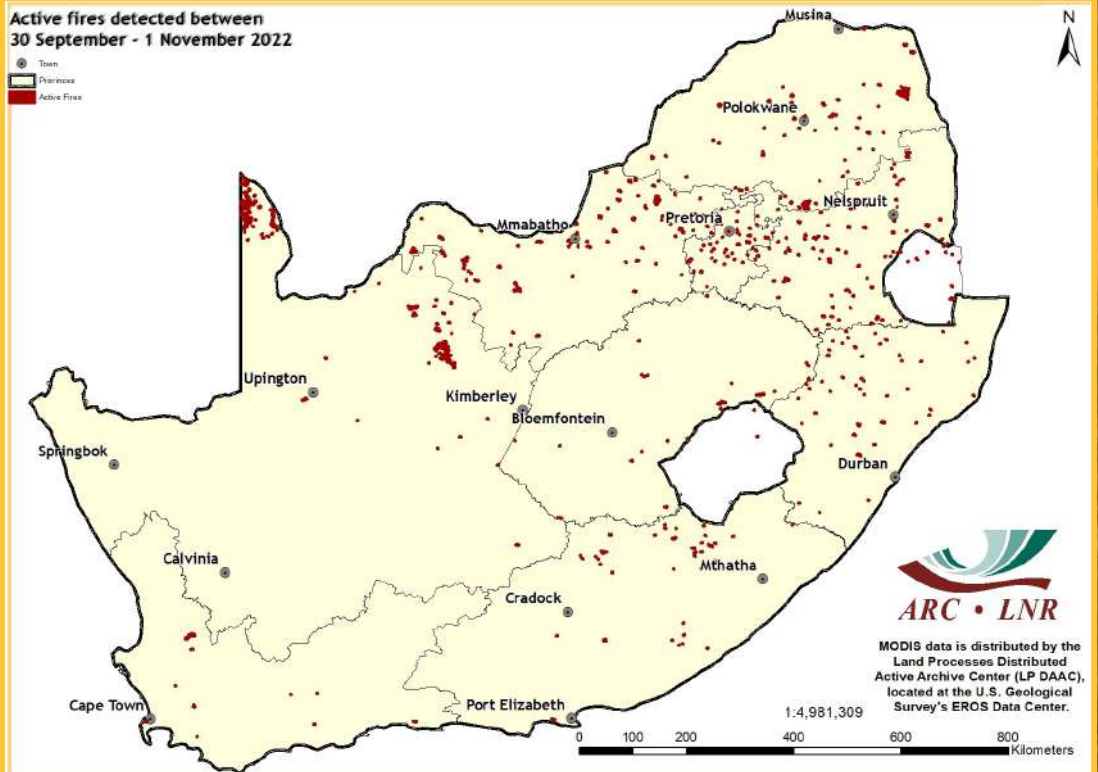


Figure 30

### Figure 30:

The map shows the location of active fires detected between 30 September and 1 November 2022.

**Figure 31:**

The graph shows the total number of active fires detected between 1 January and 1 November 2022 per province. Cumulative fire activity was higher in the Northern Cape and North West, compared to the long-term average.

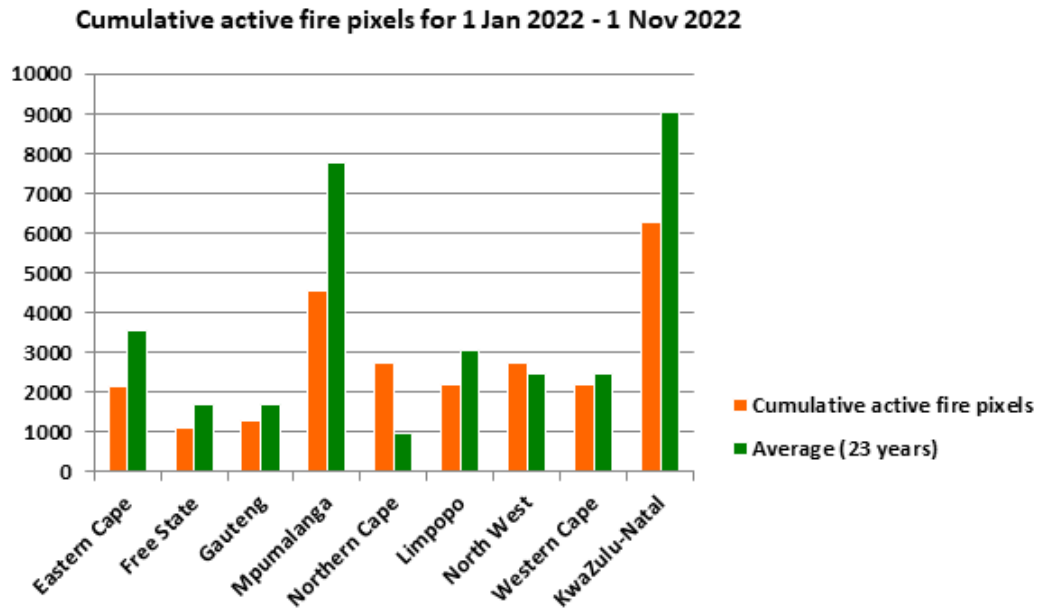


Figure 31

**Figure 32:**

The map shows the location of active fires detected between 1 January and 1 November 2022.

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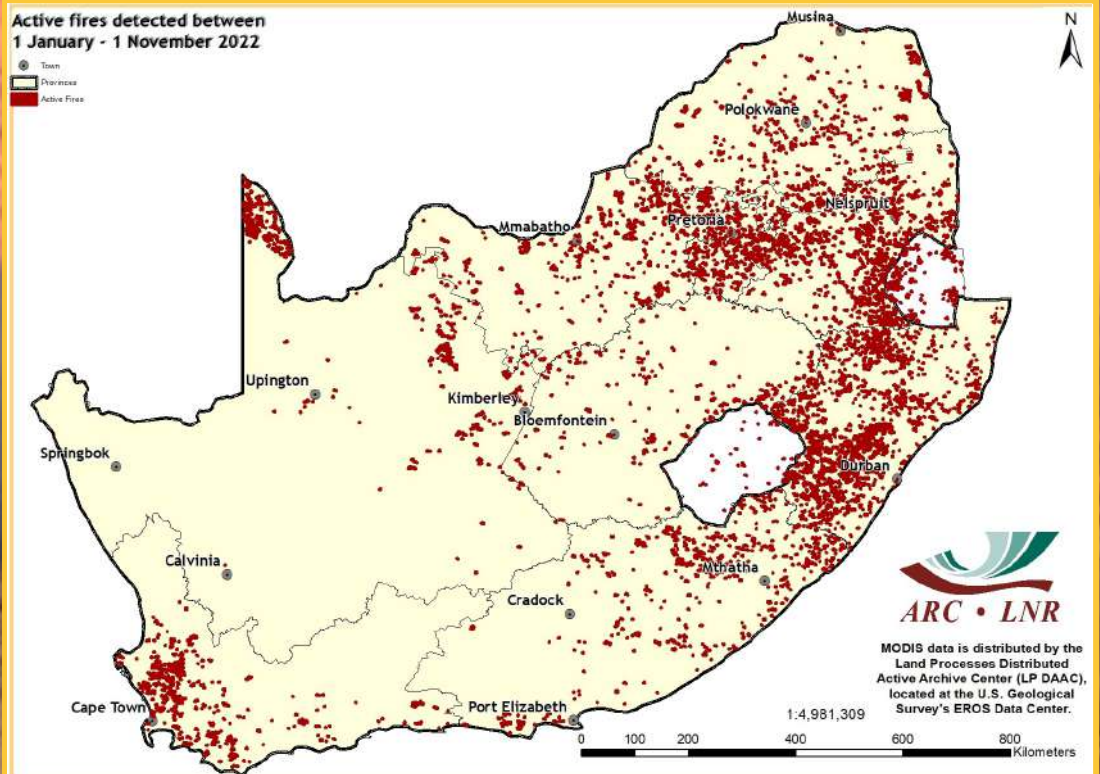


Figure 32



# 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 October 2022 shows a very similar distribution pattern to the previous 2 months. This continues to illustrate the significant impact of the high rainfall experienced over most of the country during the past year. 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 October 2022 and October 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 exhibit significantly higher (150-200%) water levels compared to monthly year-on-year comparisons for the preceding months of 2022. The water-stressed catchments in the Eastern Cape also appear to be showing some positive increases.

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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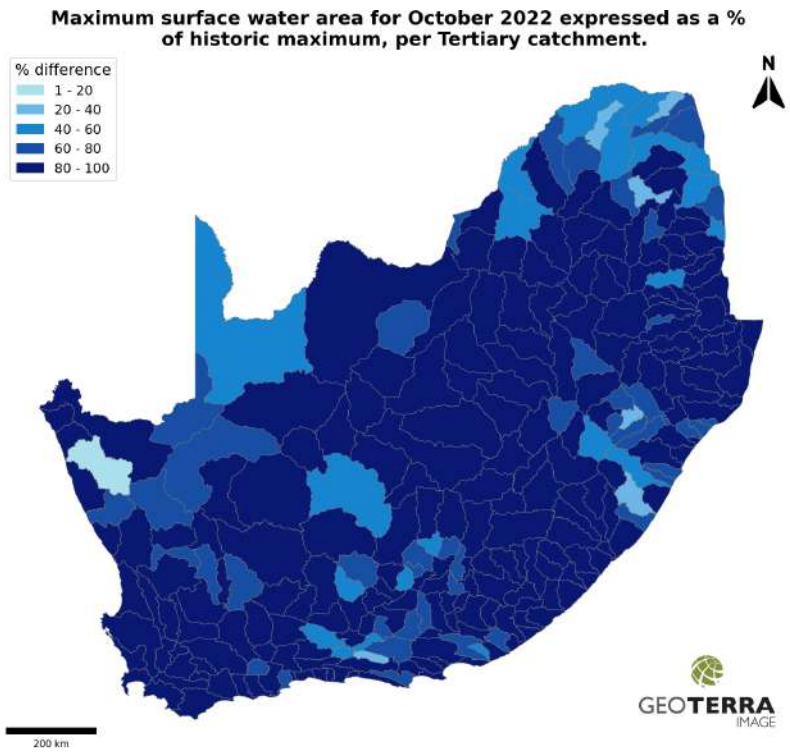


Figure 33

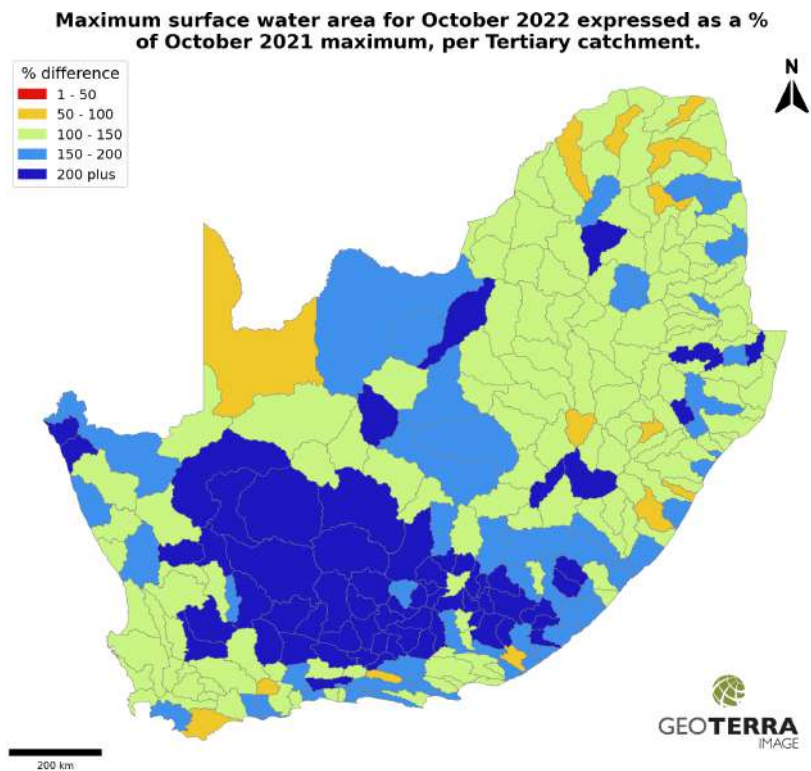


Figure 34



## Agrometeorology

*The programme uses weather and climate information for agricultural planning and the enhancement of crop and livestock production systems. The impact of climate variability and change in the agricultural sector is investigated. Due to the increasing pressure to reduce greenhouse gas emissions globally, climate change mitigation is also an important facet of our activities. The Weather Station Network and Climate Database are maintained as a national asset for the benefit of the agriculture sector.*

### Activities

#### Agrometeorology and Crop Modelling

- Assessing climate risk for an area in relation to a particular crop
- Agroclimatological analysis of the suitability for crop production at a particular location
- Development of early warning systems for climate hazards (e.g. drought, floods)
- Agrometeorological forecasting and advisory services
- Crop modelling to assess the impact of weather conditions and climate on agriculture
- Conducting crop yield forecasting exercises, hydrological modelling, hydrometeorology and biometereology studies

#### Climate Change Adaptation and Mitigation

- Conducting research on possible impact of projected climate change on agricultural activities, potential, greenhouse gas emissions from various land use, climate change, mitigation and adaptation strategies for agriculture
- Developing greenhouse gas inventories at farm and national levels
- Conducting research on climate change mitigation and adaptation strategies for agriculture
- Promoting low-carbon technologies

#### Climate Monitoring, Products and Services

- Developing and maintaining a network of over 500 weather stations distributed all over the country
- Archiving historical and current weather data of good quality with some datasets dating back to 1900
- Developing weather/climate products and services together with stakeholders and clients to meet their specific requirements
- Disseminating weather/climate data, products and services via multiple platforms

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SOIL, CLIMATE AND WATER



# GeoInformatics

*The programme focuses on applied Geographical Information Systems (GIS) and provides leadership in 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.*

## Activities

### Digital/Smart Agriculture/Drone Platform - Applications

- Yield & production estimation
- Insurance index
- Mapping crop types
- Monitoring growth stages
- Weed/invasive sp. mapping
- Water requirement
- Smart & digital agriculture
- Disease/pests



### Applications in Natural Resources/National Assets

- Early warnings
- National & Provincial advisories
- Crop suitability changes
- Crop statistics
- Crop stress
- Spatially explicit information dissemination systems, e.g. Umlindi newsletter



### Applications in Rangelands, Livestock and Wildlife

- Early warnings
- National & Provincial advisories
- Rangeland suitability
- Rangeland dynamics
- Rangeland stresses
- Spatially explicit information dissemination systems, e.g. Umlindi newsletter



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SOIL, CLIMATE AND WATER



# Analytical Laboratory

*The unit focuses on the various procedures to analyze and determine the properties of soil, water and associated materials, mainly for agricultural purposes. The laboratory operates a range of equipment and participates in various quality control schemes, both local and international. The water analysis for anions is SANAS-accredited and other accreditations are underway.*

## Analyses and Services

### Soil Physical Analysis

- Texture (sand, silt and clay content)
- Water-holding capacity
- Soil moisture content
- Bulk density
- Shrink-swell capacity

### Soil Chemical Analysis

- pH
- Exchangeable and extractable cations
- Acidity
- Soil Organic Carbon
- Nitrogen content and C/N ratio
- Phosphorus
- Micronutrients

### Soil Fertility

- Analysis package for farmers & gardeners
- Fertilizer recommendations for specific crops

### Water Analysis

- pH, EC, anions, cations
- Water quality

### ICP Scan

- Semi-quantitative scan for a range of elements (Li, Be, Ti, V, Cr, Mn, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Mo, Cd, Sn, Sb, Te, Cs, Ba, La, W, Pt, Hg, Tl, Pb, Bi, U), can be done on soil, water and plant

### Plant Material Analysis

For example: leaves, roots, growth media, etc. – drying, milling, pH, EC, C, N, nutrients and toxic elements

### Special Sample Analysis

- For example: sludges, compost, fertilizers – composition and other properties
- Elemental analysis of animal tissue (e.g. hair, bones, liver, muscle, milk)

**For more information or to obtain prices or quotation, contact the Laboratory Manager: Ms. Zanele Hlam**  
Tel: 012 310 2531 • E-mail: HlamZ@arc.agric.za

**In order to assist clients who wish to send samples to ARC, the courier costs can be borne by ARC for analysis packages of R10 000 or more.**

**Contact the Laboratory Manager for details.**



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## SOIL, CLIMATE AND WATER



# Microbiology and Environmental Biotechnology Laboratory

*The Microbiology and Environmental Biotechnology Research Group forms part of the Soil Science Programme at ARC-SCW. The research group utilizes both fundamental as well as applied microbiology and biotechnology approaches to address soil, climate and water related problems in a sustainable and eco-friendly manner.*

## Analyses and Services

### Renewable energy generation

- Gas Chromatography analysis of biogas - methane and carbon dioxide content measurements

### Nanotechnology

- UV-Visible spectrophotometer analysis for colloidal nanoparticle synthesis

### Phytochemical extraction

- Hotplate extraction of phytochemicals
- Soxhlet extraction of phytochemicals
- Microwave-assisted extraction of phytochemicals

### Community-Level Physiological Profiling (CLPP)

- Microbial functional analysis using Biolog 31C plates

**For information on microbiological analyses contact**

*Dr Ashira Roopnarain*

Tel: 012 310 2650 • E-mail: [RoopnarainA@arc.agric.za](mailto:RoopnarainA@arc.agric.za)

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# The Coarse Resolution Imagery Database (CRID)

## NOAA AVHRR

ARC-NRE 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<sup>2</sup> to 1 km<sup>2</sup>) and spectral resolution. ARC-NRE 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>

## VG4AFRICA 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-NRE 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)

ARC-NRE 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. ARC-NRE 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-NRE Soil, Climate and Water weather station network, 270 automatic rainfall recording stations from the South African Weather Service (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-NRE.

## Solar Radiation and Evapotranspiration maps

- Combined inputs from 450 automatic weather stations from the ARC-NRE Soil, Climate and Water 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>.



## NATURAL RESOURCES AND ENGINEERING Soil, Climate and Water

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The operational Coarse Resolution Imagery Database (CRID) project of ARC-NRE is funded by the Department of Agriculture, Land Reform and Rural Development (DALRRD). 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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[MaakeR@arc.agric.za](mailto:MaakeR@arc.agric.za)

**What does Umlindi mean?**  
UMLINDI is the Zulu word for “the watchman”.

### DISCLAIMER:

The ARC-NRE and its collaborators have obtained data from sources believed to be reliable and have made every reasonable effort to ensure accuracy of the data. The ARC-NRE and its collaborators cannot assume responsibility for errors and omissions in the data nor in the documentation accompanying them. The ARC-NRE and its collaborators will not be held responsible for any consequence from the use or misuse of the data by any organization or individual.