UMLINDI
The Watchman

ISSUE 2023-11 | 17 NOVEMBER 2023

ARC • LNR
Excellence in Research and Development

NATURAL RESOURCES AND ENGINEERING
Soil, Climate and Water

CONTENTS:

agriculture, land reform & rural development
Department:
Agriculture, Land Reform and Rural Development
REPUBLIC OF SOUTH AFRICA

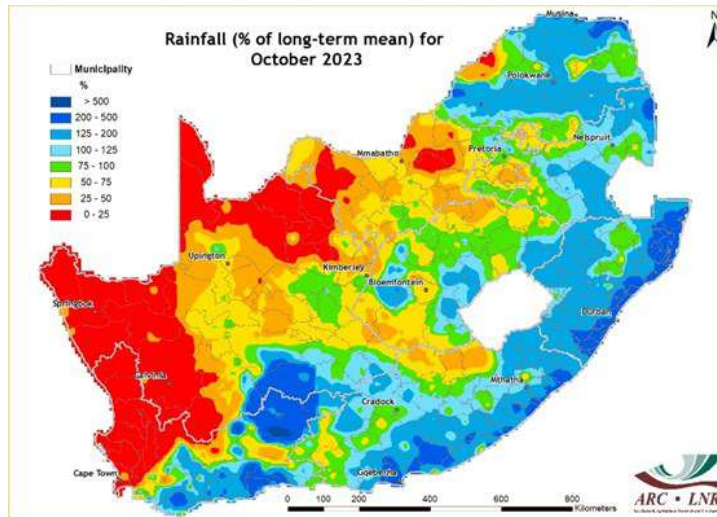South African Weather Service

233rd Edition
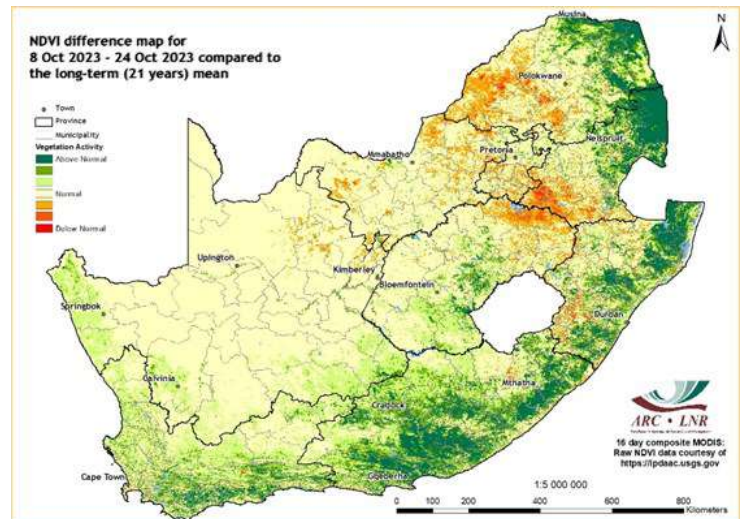
Images of the Month

Onset of the 2023/24 agricultural season

Following the conclusion of the winter rains, the onset of the 2023/24 summer rainfall season is underway. While September 2023 remained predominantly dry, above-normal rainfall in October was limited to the southern interior, along the coast towards KwaZulu-Natal, and the adjacent interior in Mpumalanga and Limpopo. The rainfall map for October indicates that specific areas in the Karoo, parts of the Eastern Cape and KZN received over 200% of their normal rainfall this month. This implies favourable conditions for the upcoming agricultural season as increased soil moisture in these areas is anticipated. However, regions like the Highveld received 50 mm or less, resulting in below- to near-normal rainfall and vegetation conditions (see vegetation map). Therefore, it is advisable to adhere to the regular planting window and adjust planting dates according to the regional onset of rains. Farmers should adopt diverse cropping strategies based on soil moisture levels and ensure proper field drainage to minimize the risk of waterlogging during intense rainy periods. The typical summer rainfall season may lead to uneven rainfall distribution, causing potential wet and dry spells. Hence, the agricultural sector should have flexible contingency plans in place to efficiently address potential challenges throughout the season.

1. Rainfall

Overview:

A notable decrease in rainfall was evident over the winter rainfall region in October 2023, with the Overberg municipality being the only area that received totals of between 75-100 mm for the month. These conditions implied favourable drier conditions that facilitated the harvesting of winter crops in the respective areas. The adjacent Garden Route, located in the all-year rainfall region, received higher rainfall amounts of >200 mm near areas including the Garden Route National Park, Mossel Bay and George. Similarly, considerable rainfall occurred in the eastern coastal region where areas such as Richards Bay, Mandini and Port Edward – which had experienced below-normal rainfall in September – recorded totals ranging from 200-300 mm. These amounts were in excess of 200% of the usual October rainfall. The neighbouring interior in the northeastern provinces, including Mpumalanga, Limpopo and the Highveld, received rainfall amounts of up to 200 mm. However, in the Highveld this resulted in below- to near-normal rainfall conditions.

Figure 1
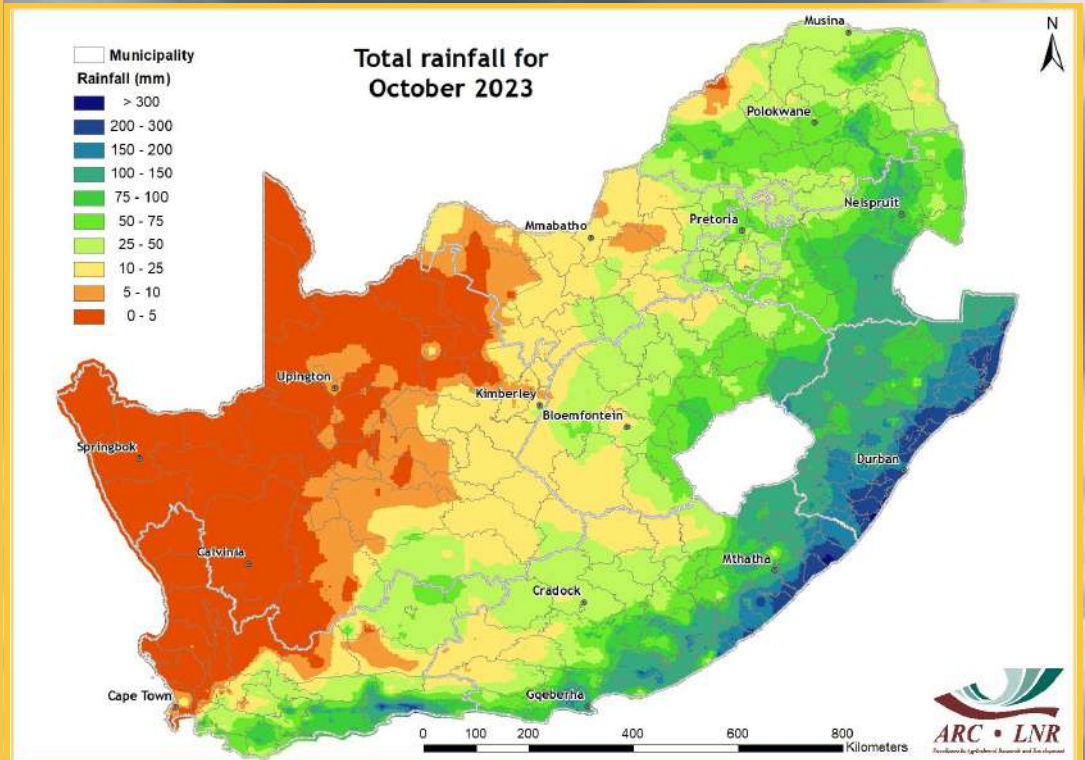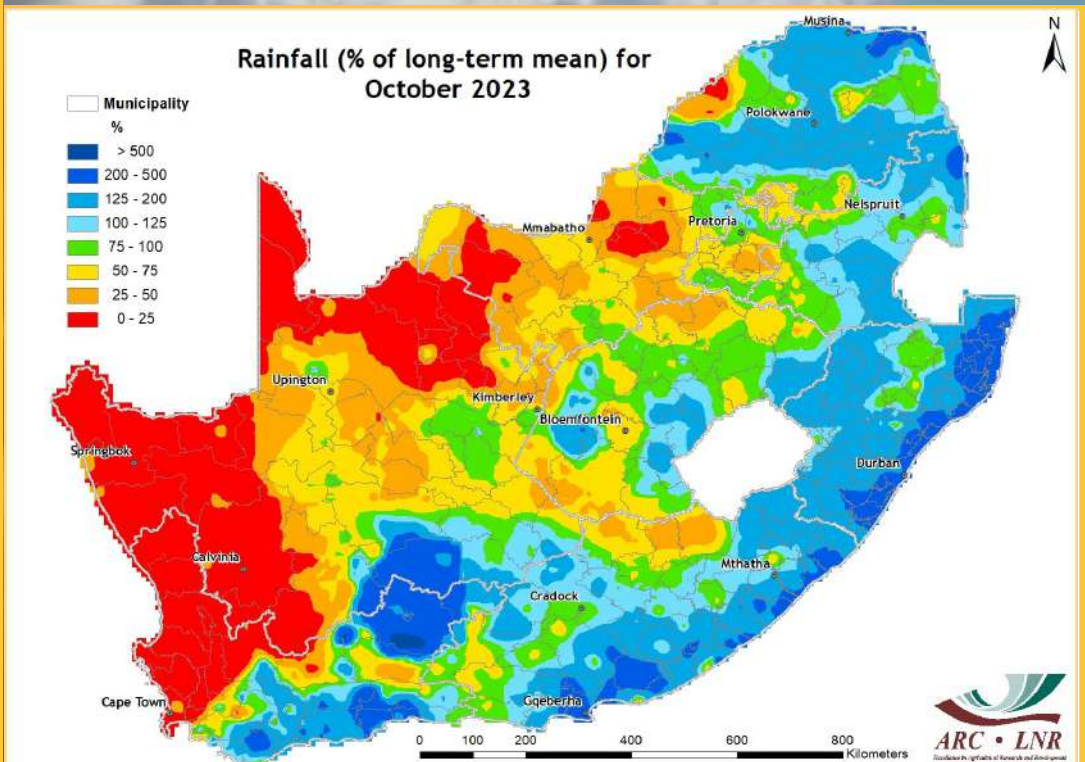

Figure 2

Total rainfall
(% of long-term mean)
for Jul '23 to Oct '23

Municipality
%
> 500
200 - 500
125 - 200
100 - 125
75 - 100
50 - 75
25 - 50
0 - 25

Figure 3

Total rainfall
for 1 August to 31 October
(2022/23 minus 2021/22)

Municipality
Rainfall difference
(mm)
> 200
150 - 200
100 - 150
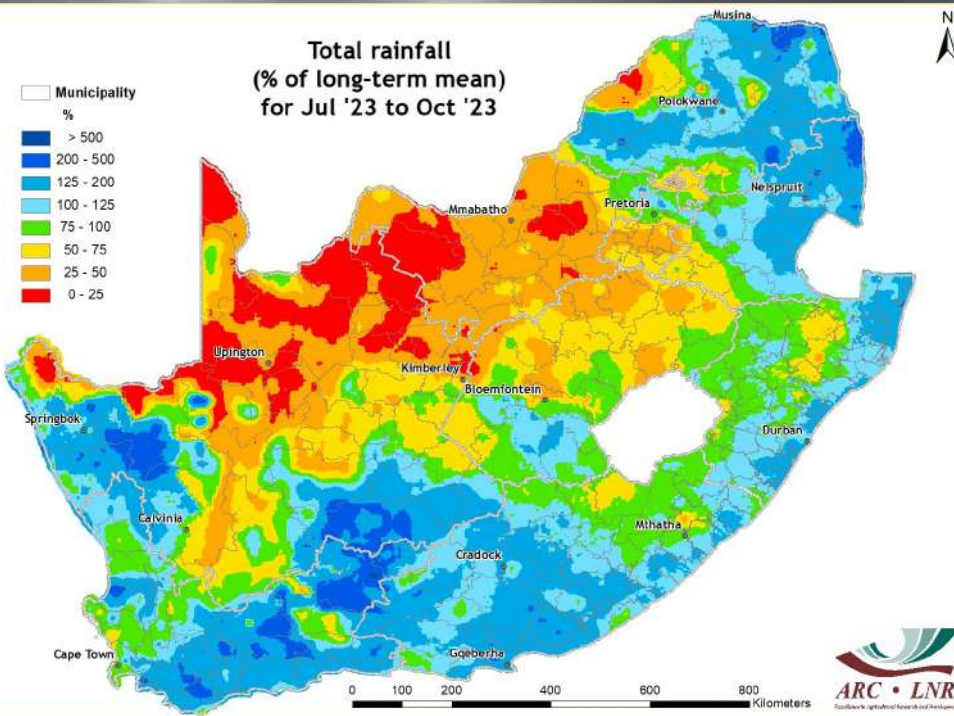50 - 100
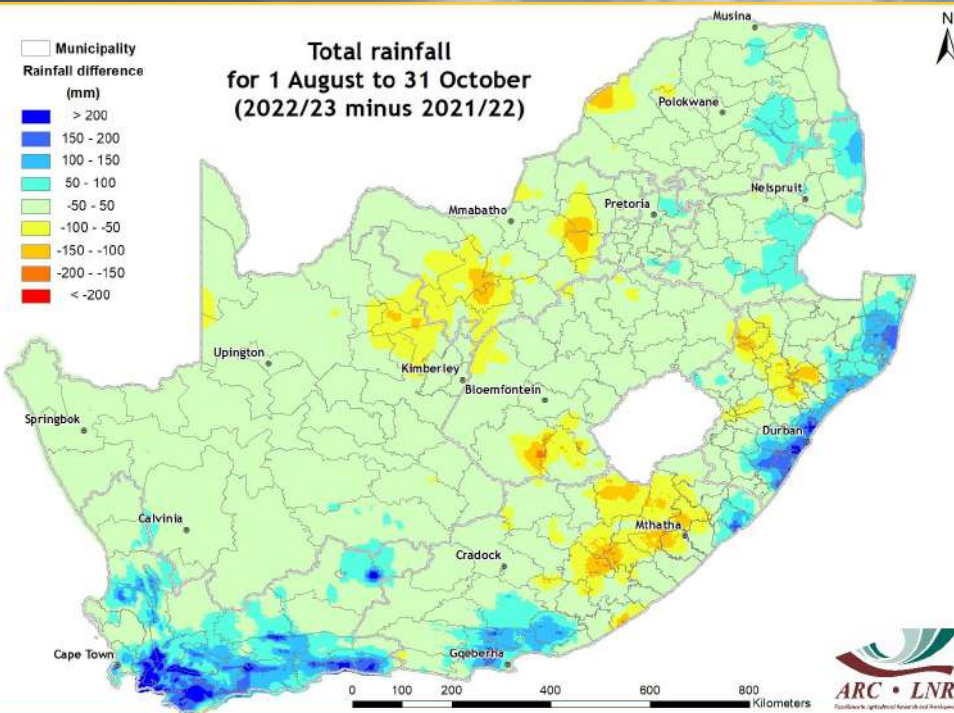-50 - 50
-100 - -50
-150 - -100
-200 - -150
< -200

Figure 4

Figure 1:
During October 2023, significant rainfall occurred in the southern and eastern coastal regions, with areas such as Pennington south and Paddock in KwaZulu-Natal recording >300 mm. Likewise, the nearby interior in the northeast, including Mpumalanga and Limpopo, also received good rainfall.

Figure 2:
In contrast to the previous month, in October 2023 below-normal rainfall was experienced in the winter rainfall region and neighbouring areas in the Northern Cape, extending towards North West. The interior received near-normal rainfall, whereas above-normal conditions were noted in regions such as the Overberg and Garden Route in the Western Cape, as well as extensive coastal areas and Limpopo.

Figure 3:
Between July and October 2023, greater parts of the country experienced near- to above-normal rainfall conditions, with below-normal conditions observed over the Northern Cape, North West and Free State.

Figure 4:
Comparing cumulative rainfall for August to October 2023 with that of the same period last year, the winter and all-year rainfall regions, as well as the KZN coast, received more rain, while parts of the Eastern Cape, the KZN Midlands and the interior received less rain.

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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 October 2023 are shown in Figures 5-8. The short- and medium-term SPI maps indicate predominantly mild to moderate drought over greater parts of the summer rainfall region, while moderate to extremely wet conditions can be noticed over the Western Cape, adjacent Eastern Cape, and some parts of Mpumalanga. The long-term SPI maps indicate near-normal and wet conditions over greater parts of the country.

Questions/Comments:
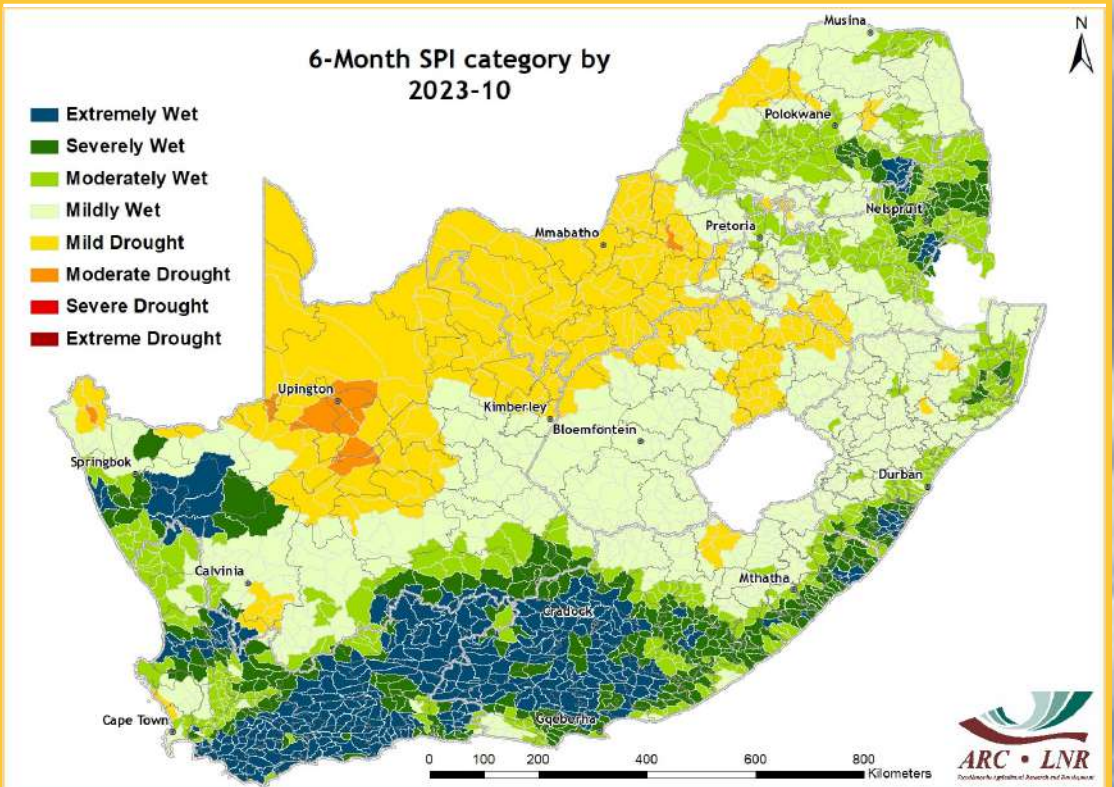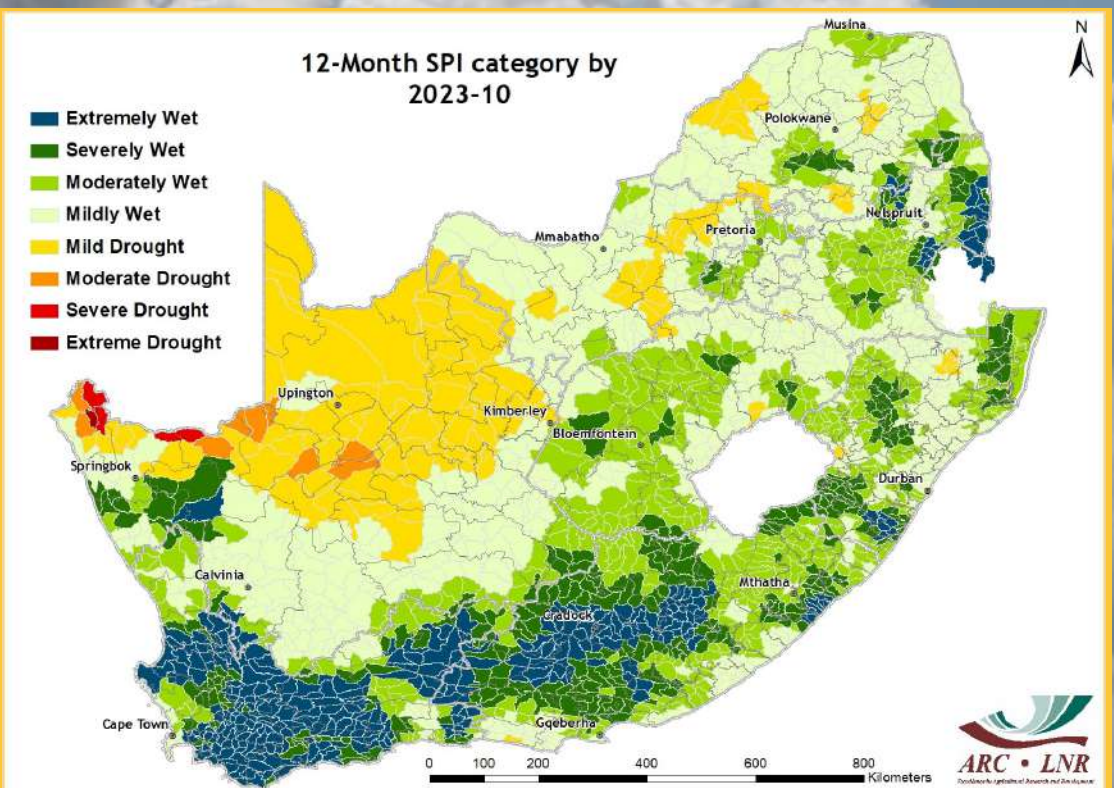*MasuphaE@arc.agric.za*
Johan@arc.agric.za

Figure 5

Figure 6

24-Month SPI category by 2023-10

Figure 7

36-Month SPI category by 2023-10
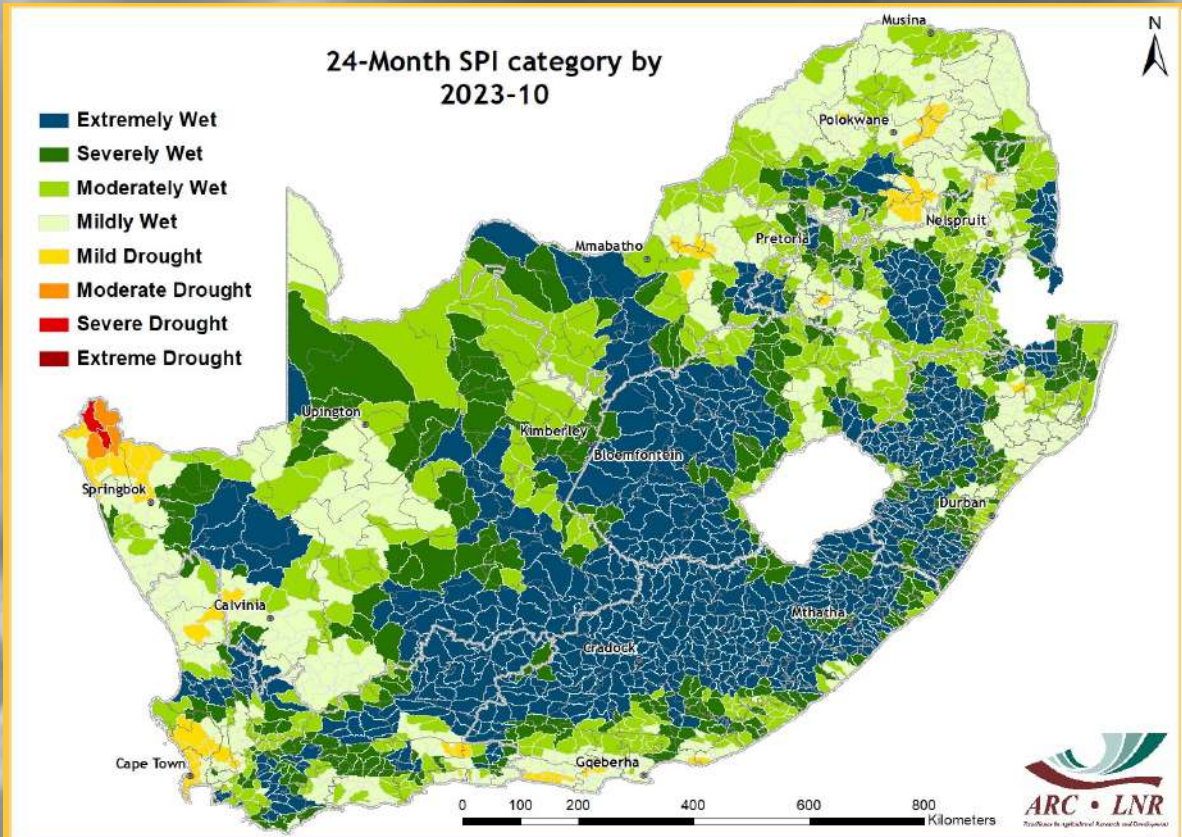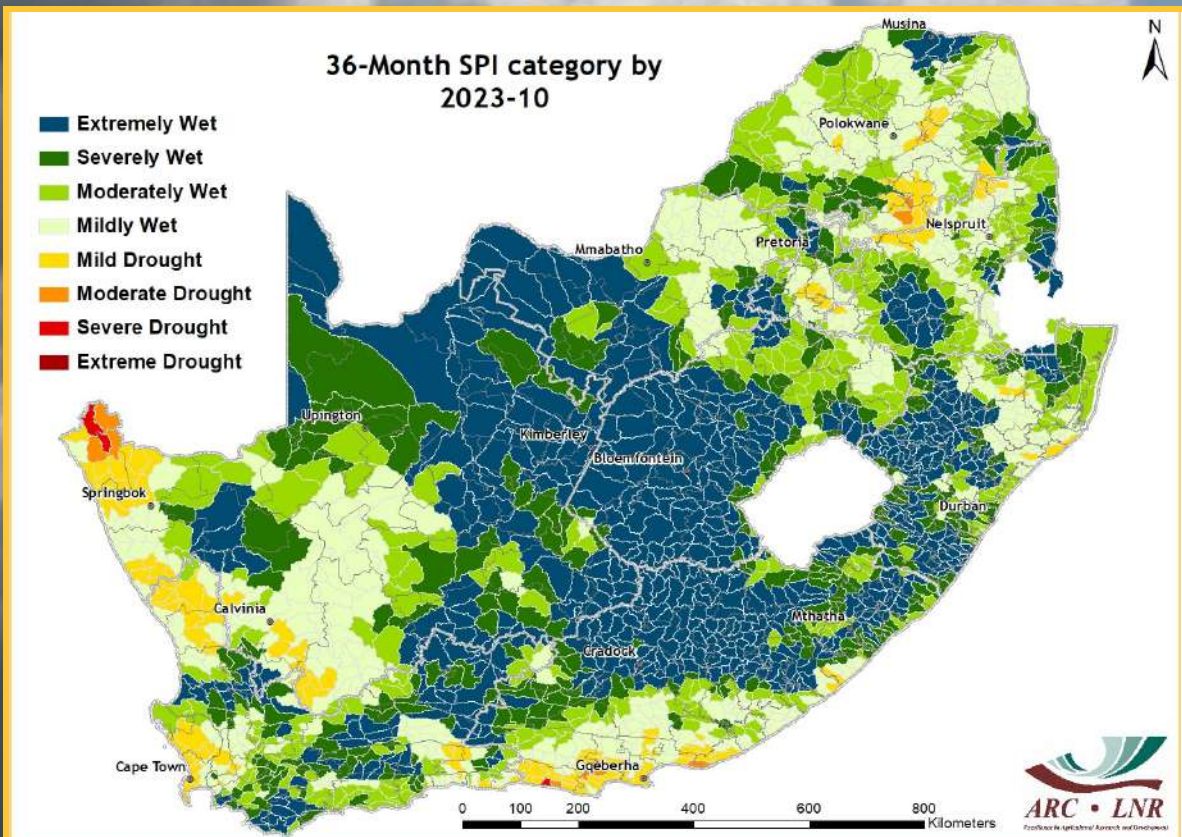
Figure 8

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.
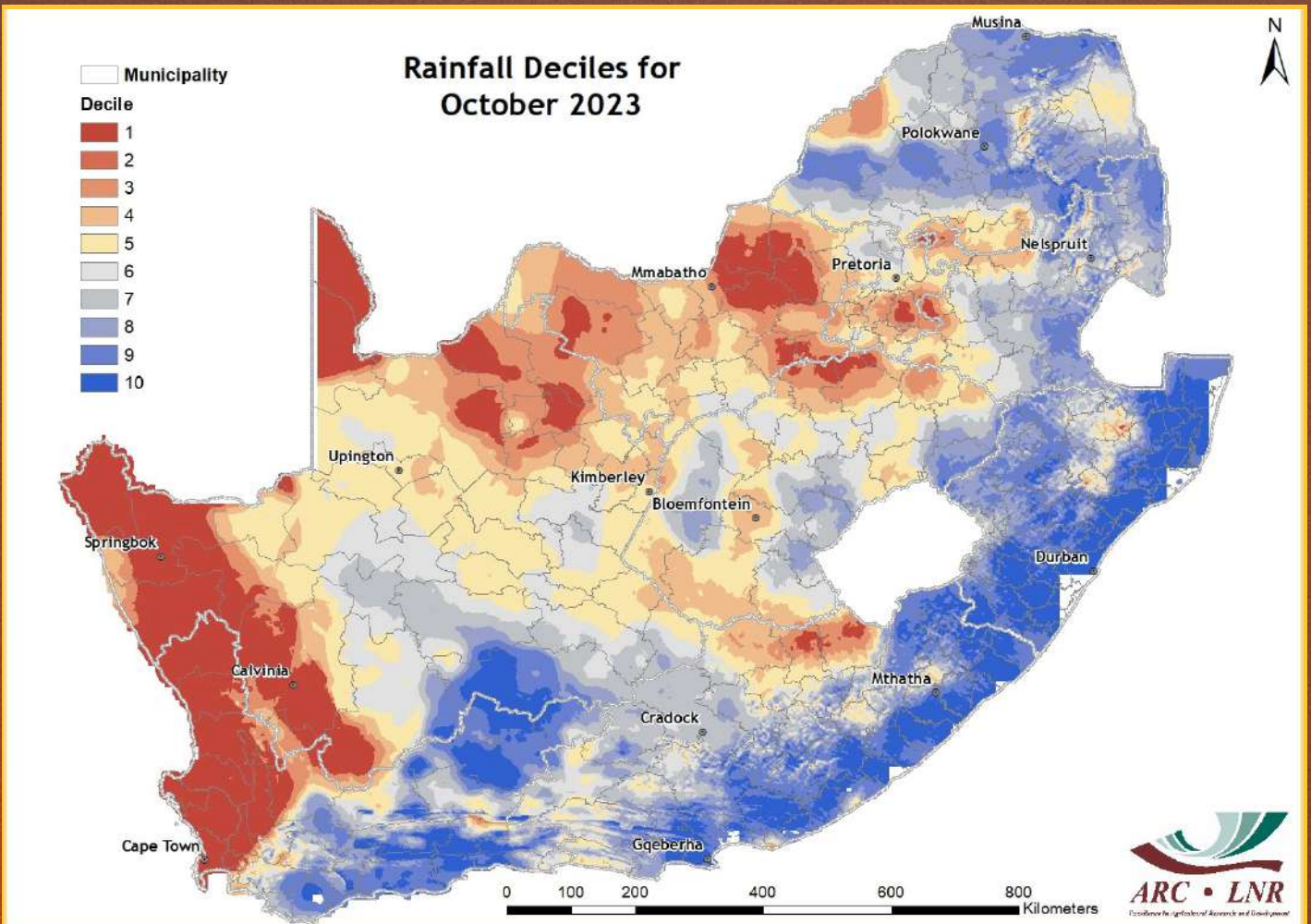

Figure 9

Figure 9:
In October 2023, areas that received rainfall amounts that compare well with historically wetter October months included the southern and eastern coastal regions and the nearby interior in the northeast. In contrast, the western and adjacent interior remained 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 under-standing 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.
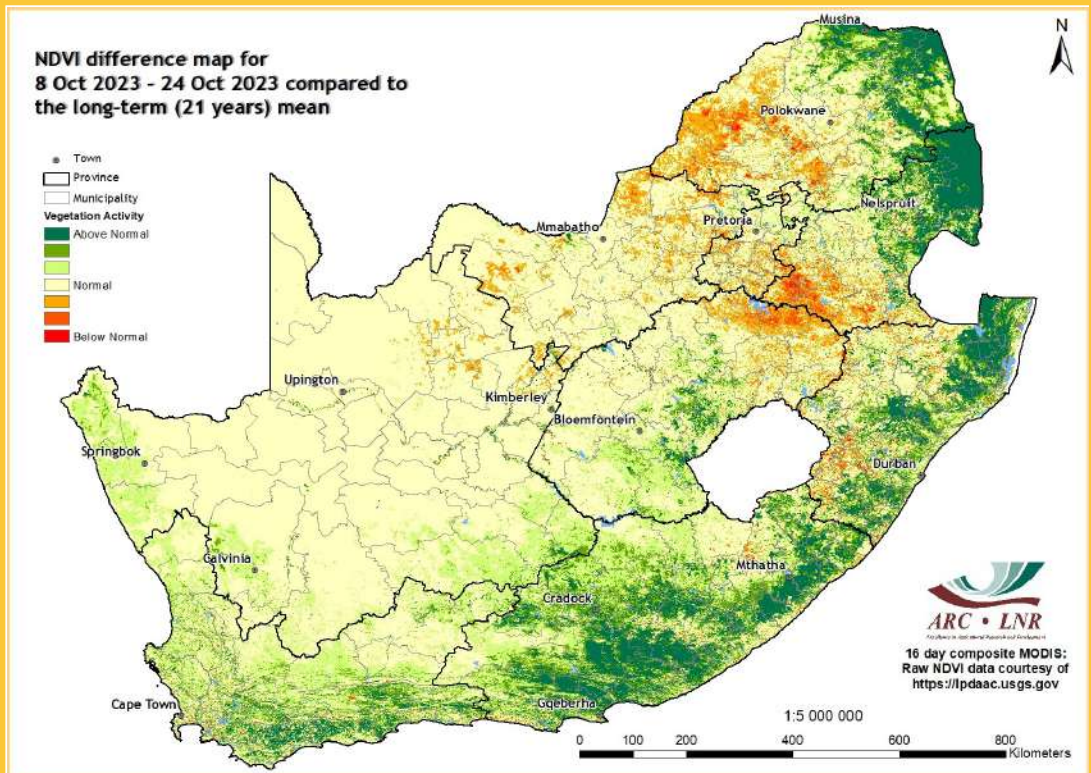
Figure 10

Figure 10:
Compared to the historical averaged vegetation conditions, the 16-day NDVI map for October 2023 shows that many parts of the country continue to experience normal to above-normal vegetation activity, with patches of below-normal activity in the northern parts.

Figure 11:
The 16-day NDVI difference map for October 2023 compared to the preceding 16-day period shows that many parts of the country continue to experience normal vegetation activity, with patches of below-normal activity in isolated areas.

Figure 11

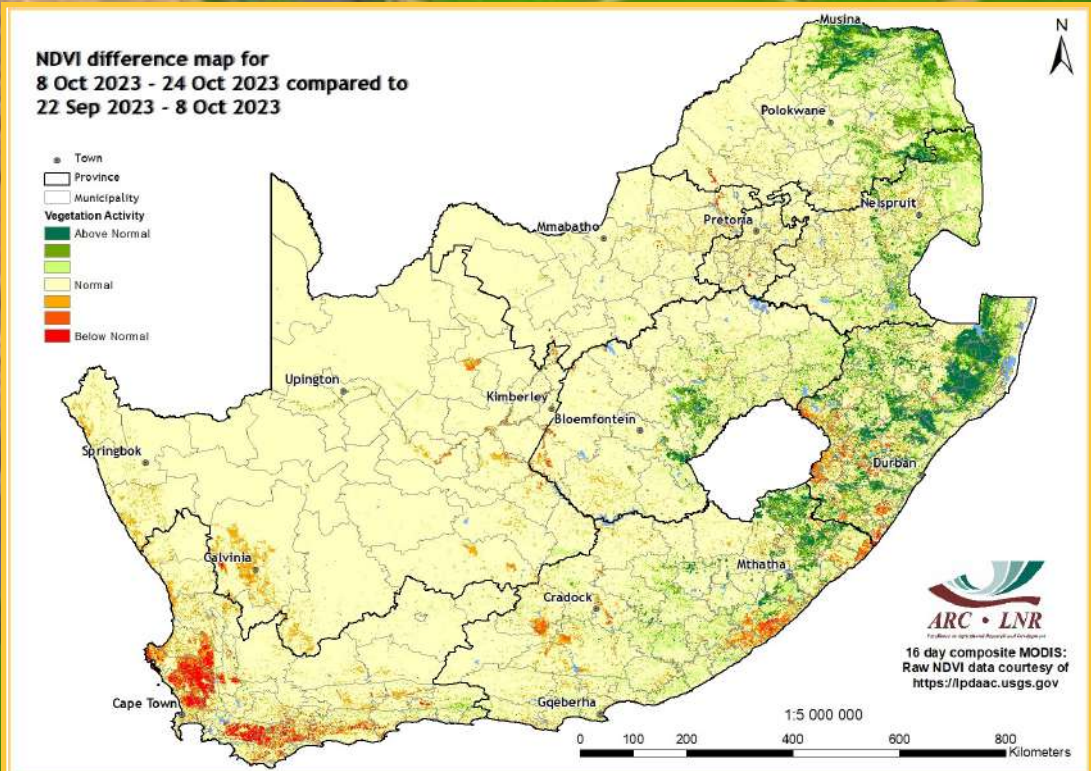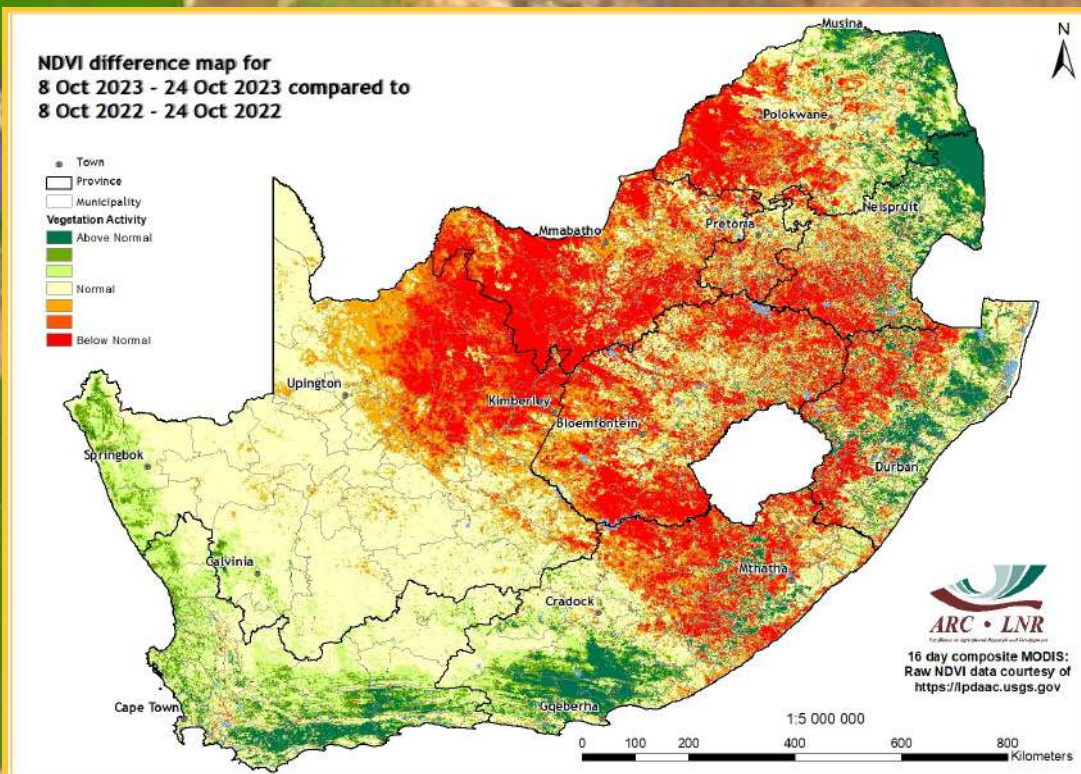NDVI difference map for
8 Oct 2023 - 24 Oct 2023 compared to
8 Oct 2022 - 24 Oct 2022

Town
Province
Municipality
Vegetation Activity
Above Normal

Normal

Below Normal

16 day composite MODIS:
Raw NDVI data courtesy of
https://lpdaac.usgs.gov

1:5 000 000

0 100 200   400   600   800
                              Kilometers

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 2023 - 24 October 2023
compared to the long-term
(20 years) mean

Town
Province
Municipality
PASG
Well Above Average
Above Average
Average
Potential Drought
Drought

16 day composite MODIS:
Raw NDVI data courtesy of
https://lpdaac.usgs.gov

1:5 000 000

0 100 200   400   600   800
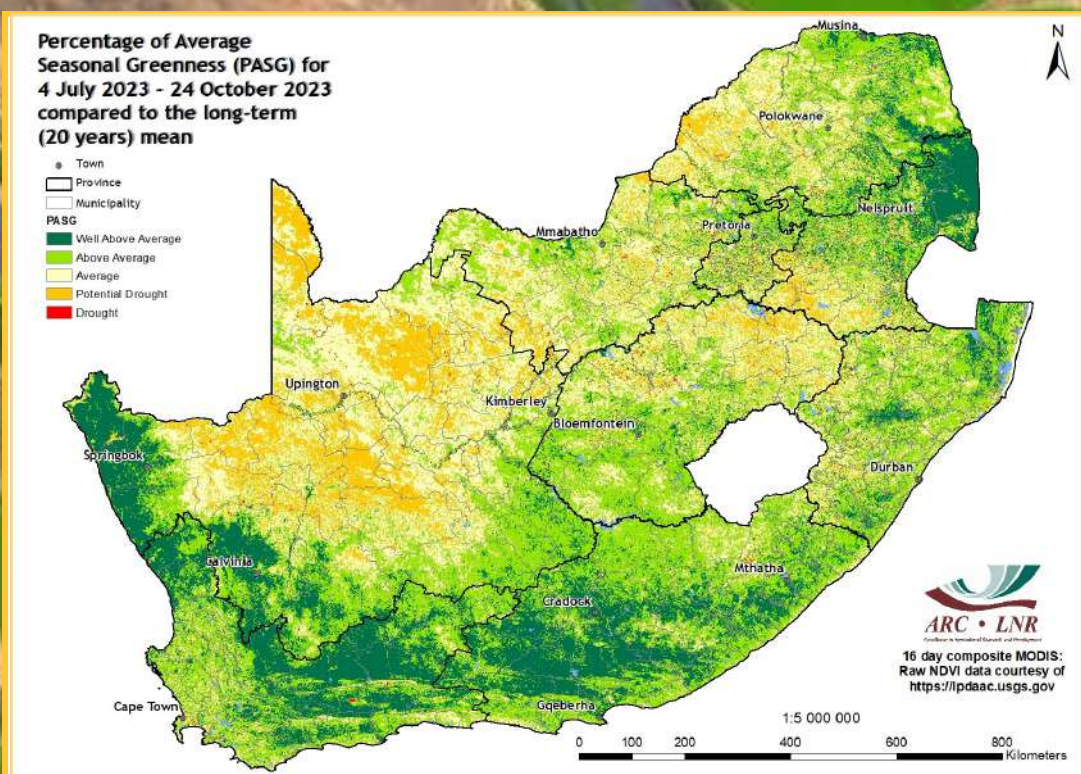   Kilometers

Figure 13

Figure 12:
The 16-day NDVI difference map for October 2023 compared to the same period last year shows that the central interior experienced poor vegetation conditions, while patches of above-normal activity remain in the far western and northern parts.

Figure 13:
The Percentage of Average Seasonal Greenness (PASG) map for the past 4 months, compared to the long-term mean, shows that above-normal seasonal vegetation greenness prevails in most parts of the country, but potential drought prevails in many parts of the Northern Cape.

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Vegetation Condition Index (VCI)

The VCI is an indicator of the vigour of the vegetation cover as a function of the NDVI minimum and maximum encountered for a specific pixel and for a specific period, calculated over many years.

The VCI normalizes the NDVI according to its changeability over many years and results in a consistent index for various land cover types. It is an effort to split the short-term weather-related signal from the long-term climatological signal as reflected by the vegetation. The VCI is a better indicator of water stress than the NDVI.
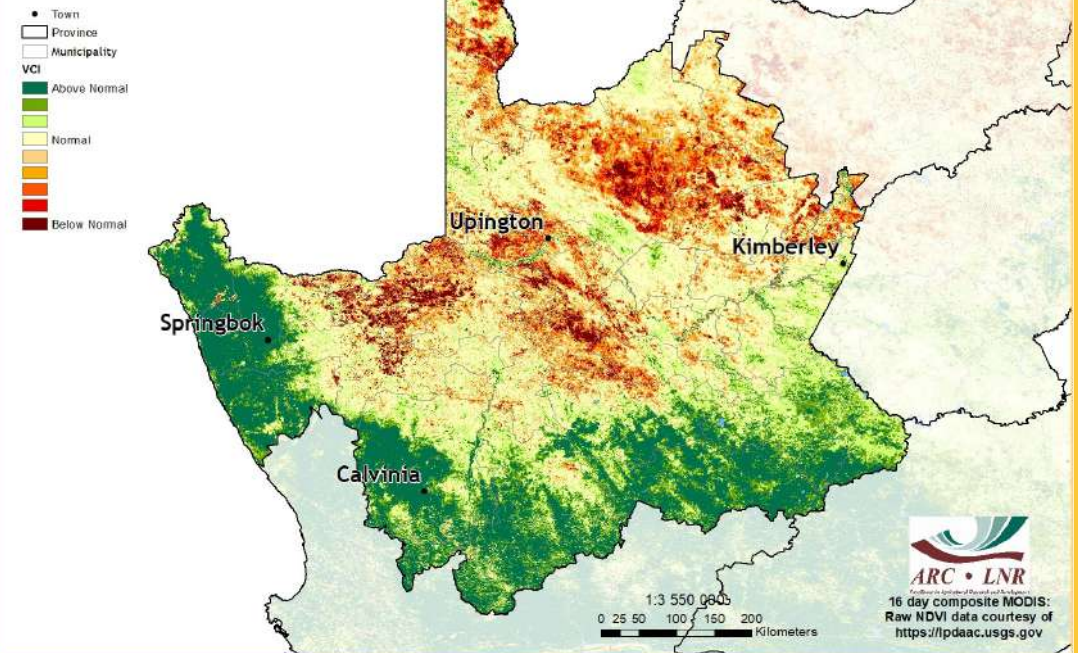

Figure 14

Figure 14:
The 16-day VCI map for October 2023 indicates that the northern and central parts of the Northern Cape continue to experience below-normal vegetation conditions, with areas of above-normal activity in the south and west of the province.

Figure 15:
The 16-day VCI map for October 2023 indicates that the western half of Limpopo experienced below-normal vegetation conditions, while the eastern half experienced above-normal activity.
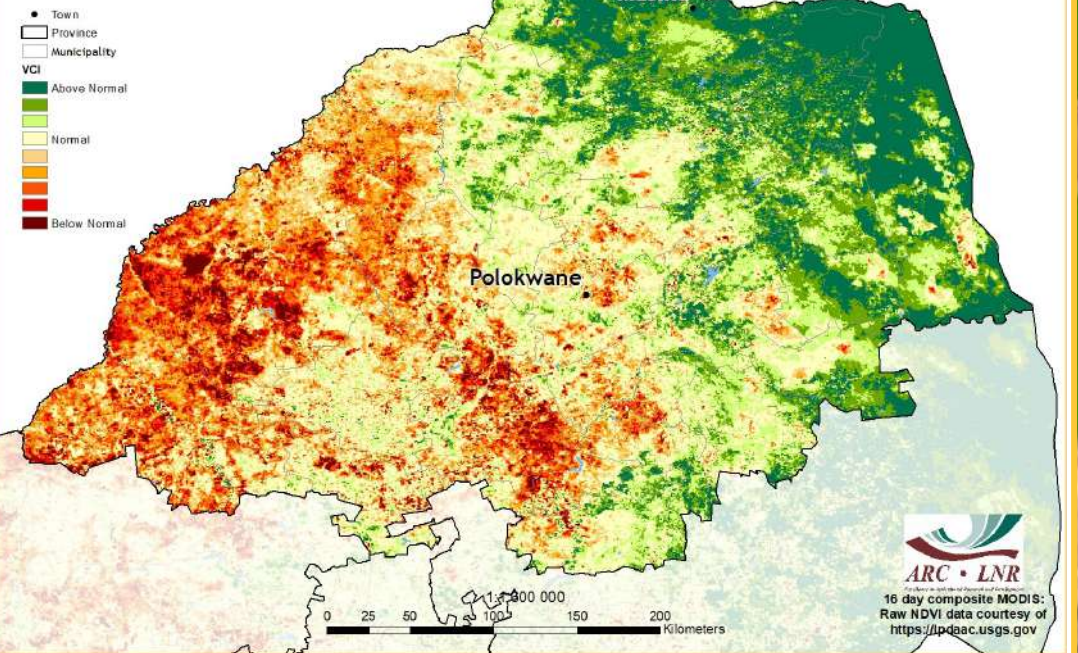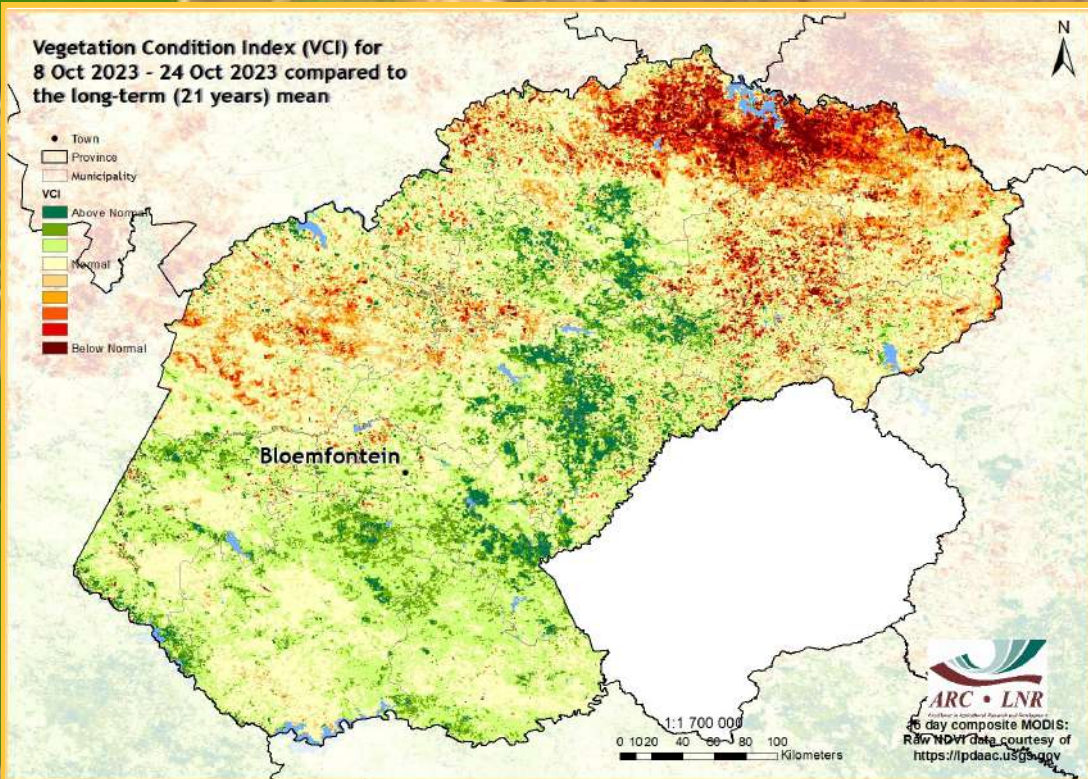

Figure 15

UMLINDI

Figure 16

Figure 17

Figure 16:
The 16-day VCI map for October 2023 indicates that eastern parts of the Free State experienced mostly below-normal vegetation conditions while the southwestern areas experienced normal to above-normal activity.
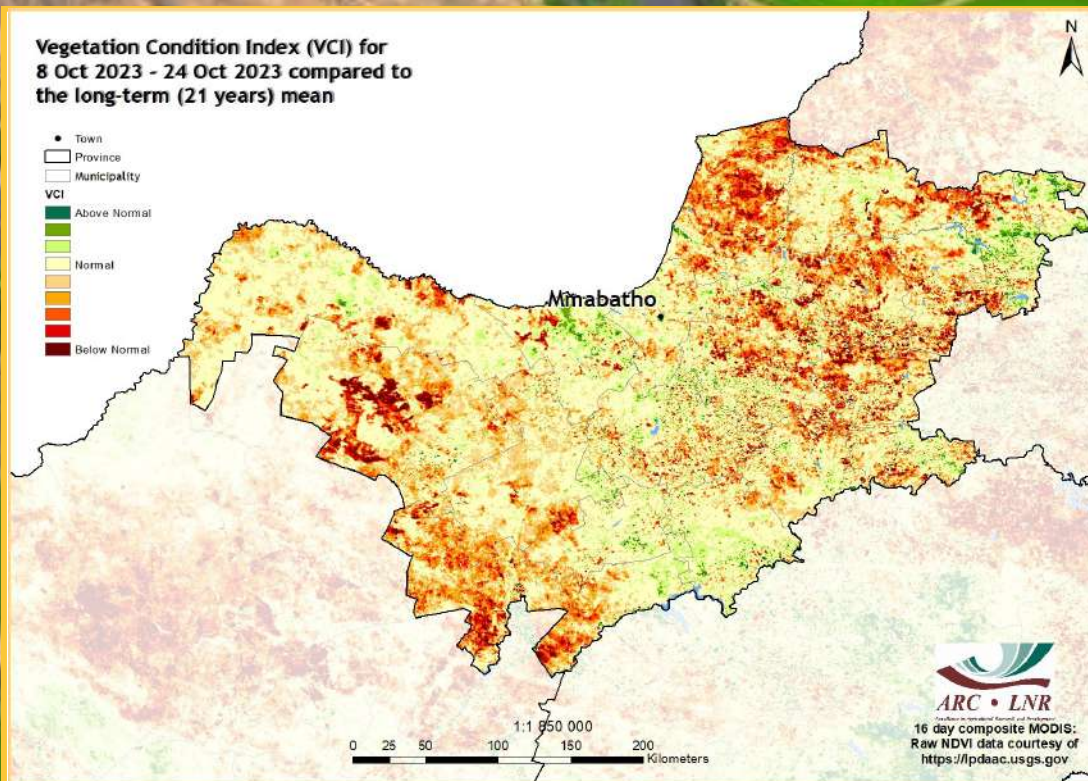
Figure 17:
The 16-day VCI map for October 2023 indicates that most parts of North West experienced below-normal vegetation conditions.

Questions/Comments:
MaakeR@arc.agric.za
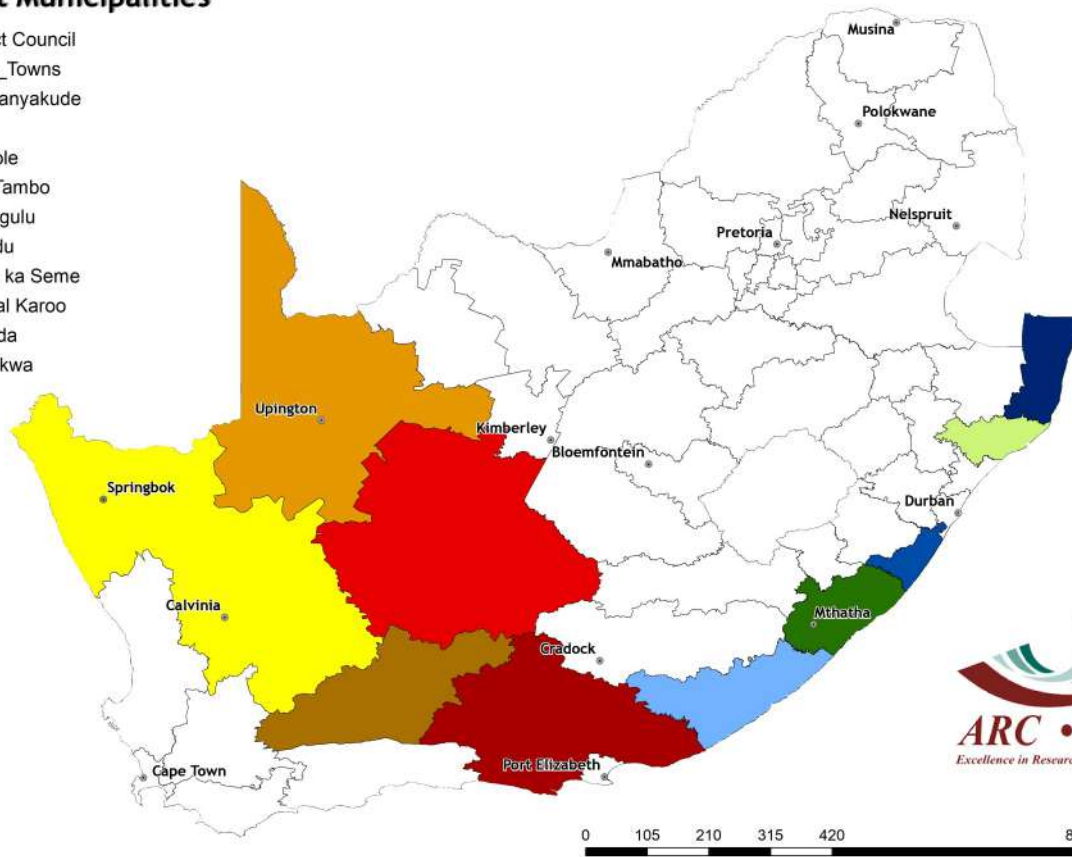
Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for October 2023. 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.

Figure 19

Figure 20
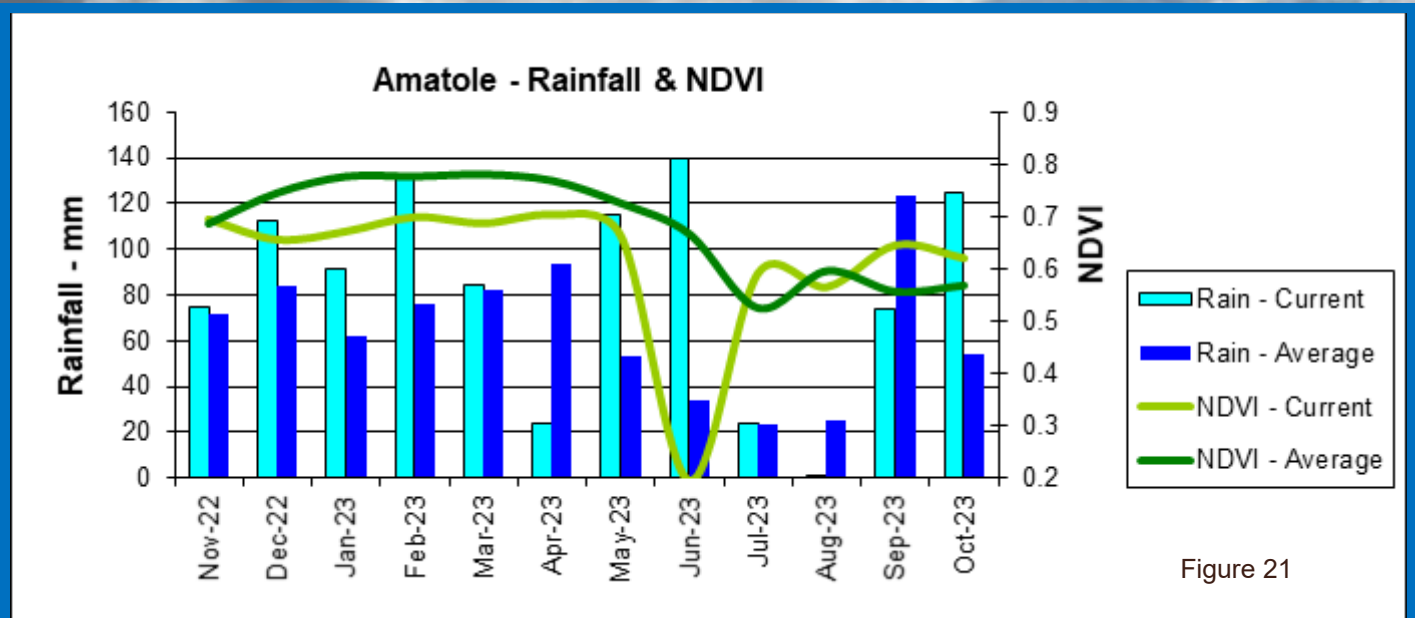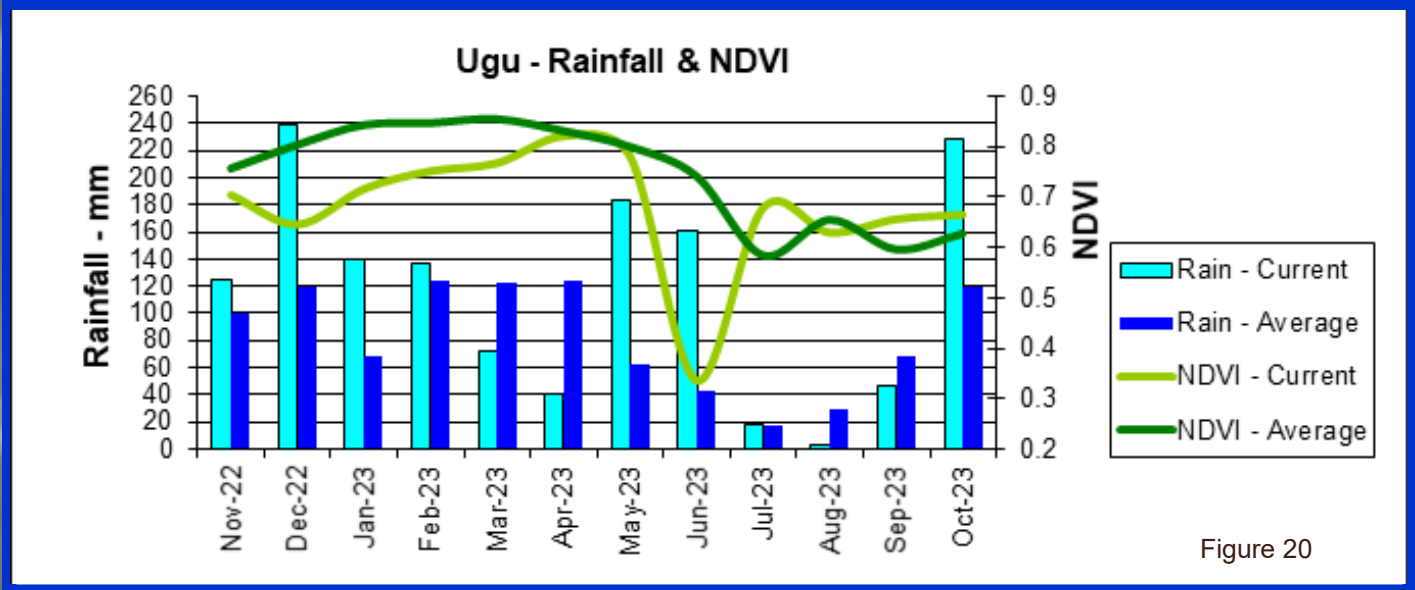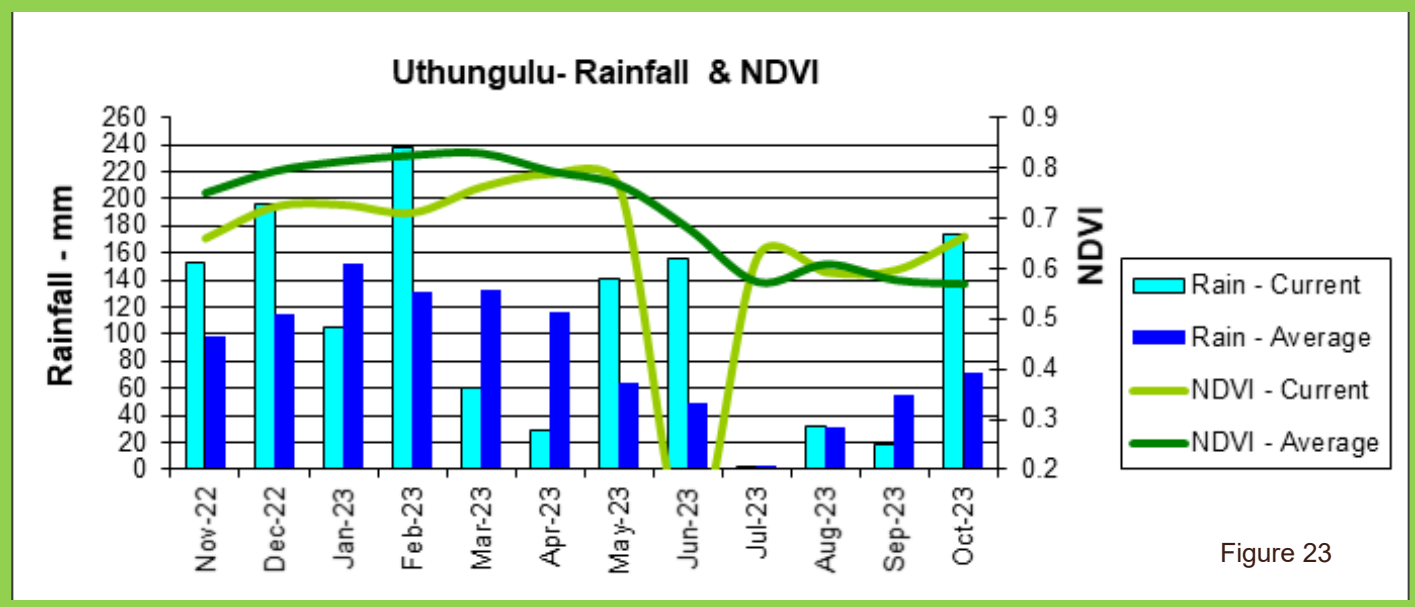
Figure 21

Figure 22

Figure 23

Figure 24

Figure 25

Central Karoo - Rainfall & NDVI

Figure 26

Siyanda - Rainfall & NDVI

Figure 27

Namakwa - Rainfall & NDVI
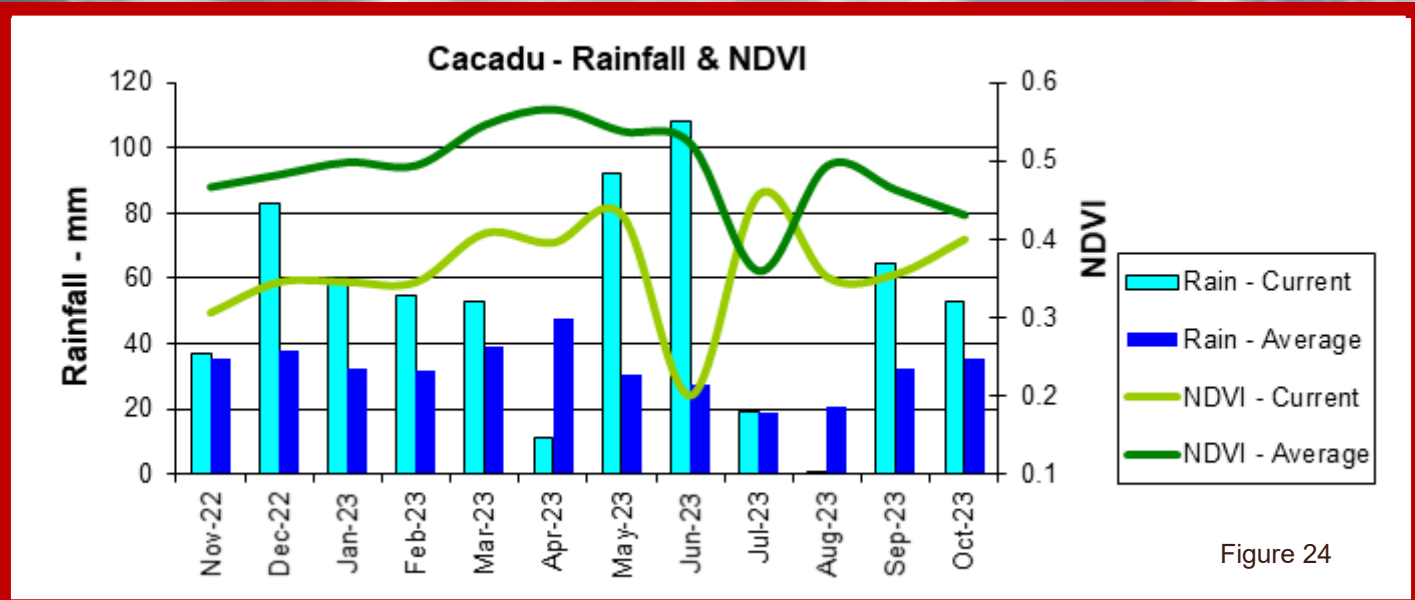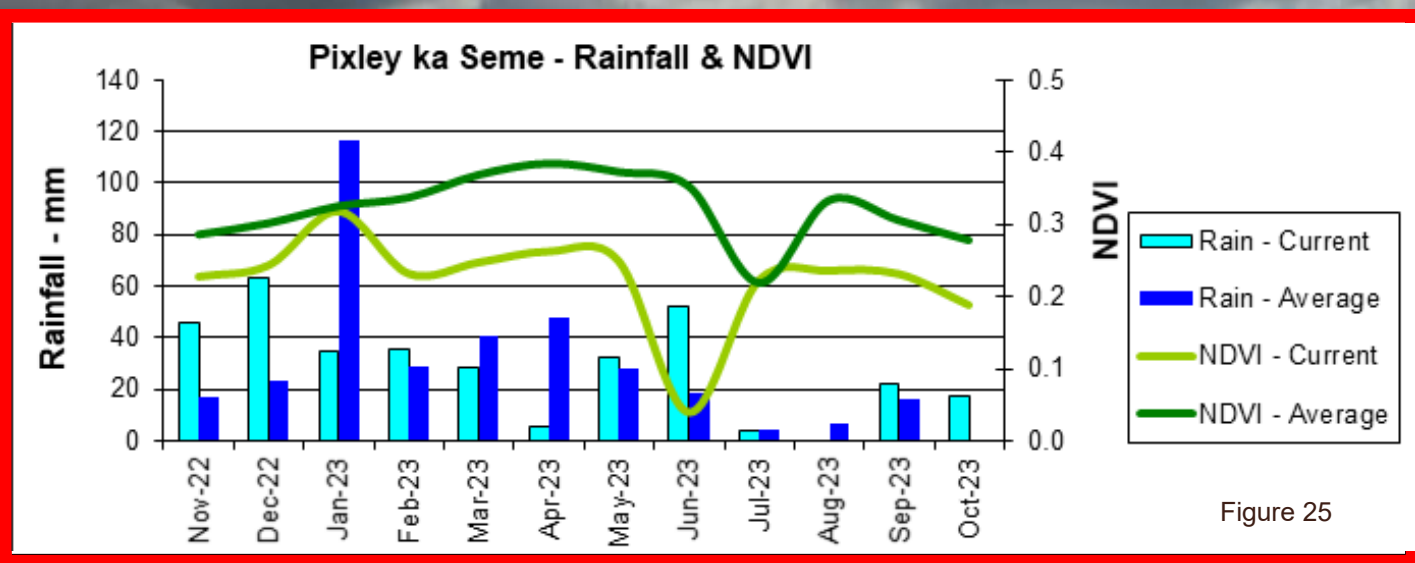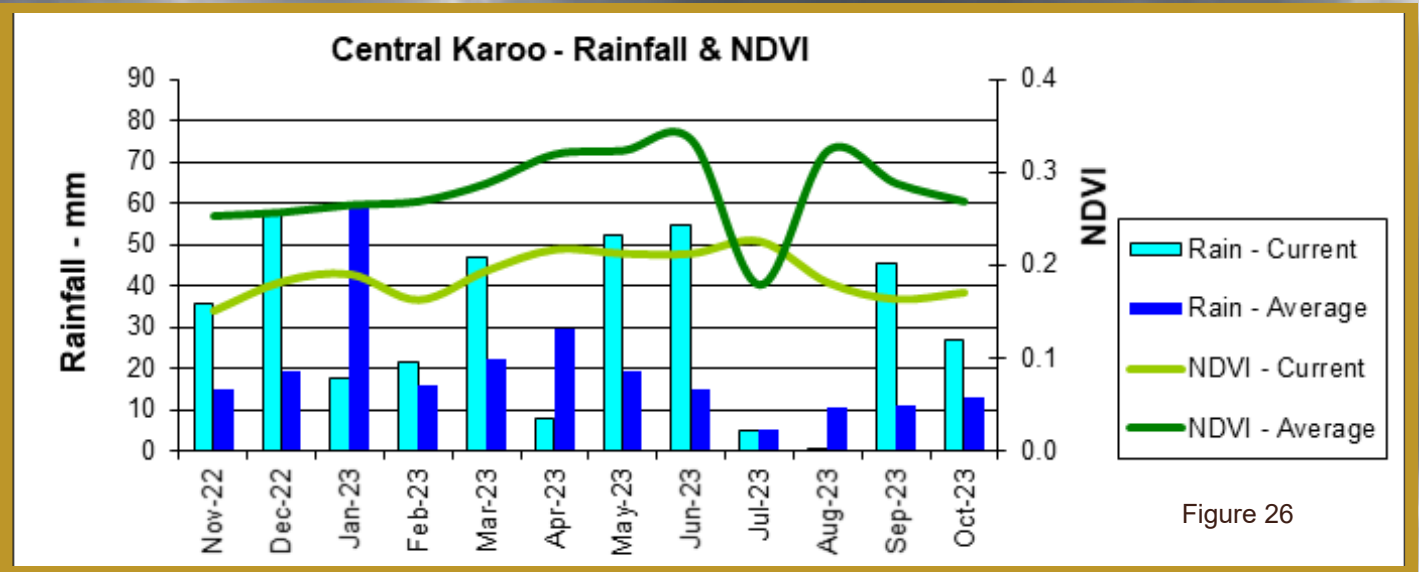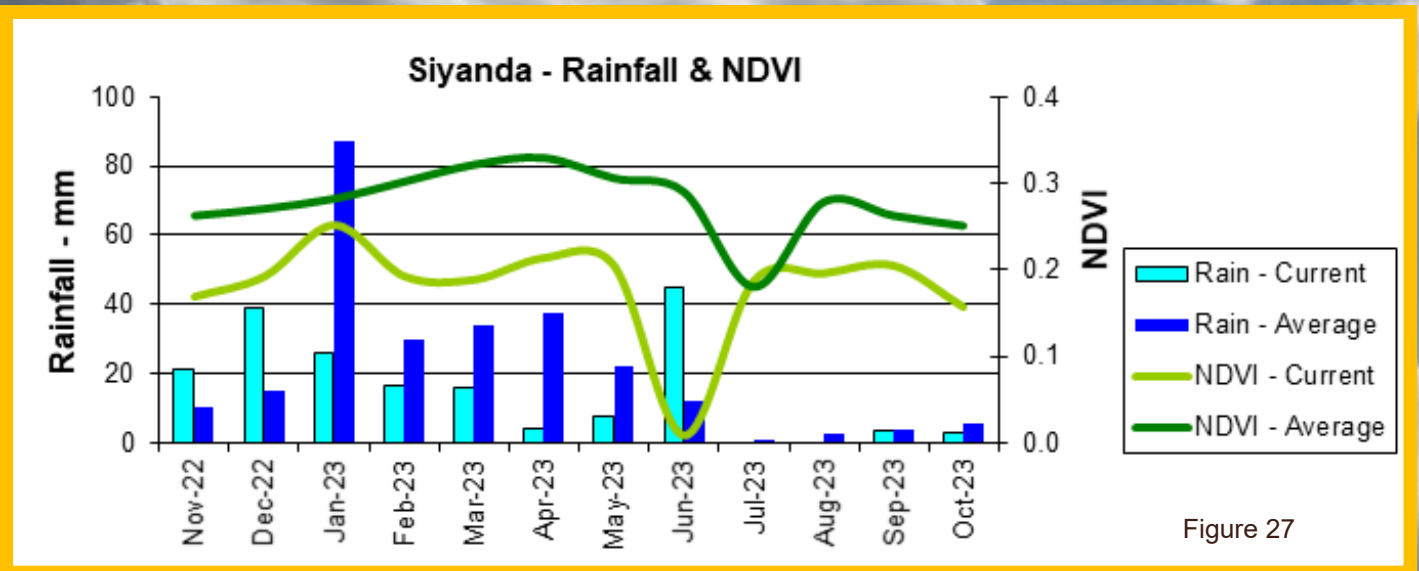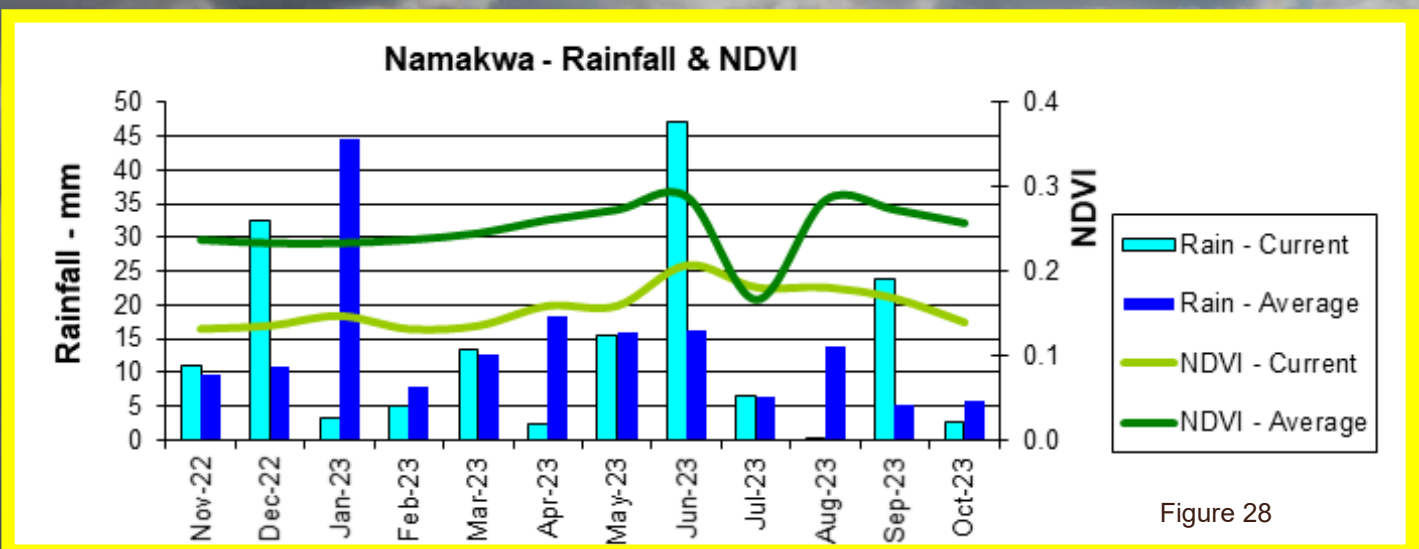
Figure 28

7. Fire Watch

Active Fires *(Provided when data is available)*

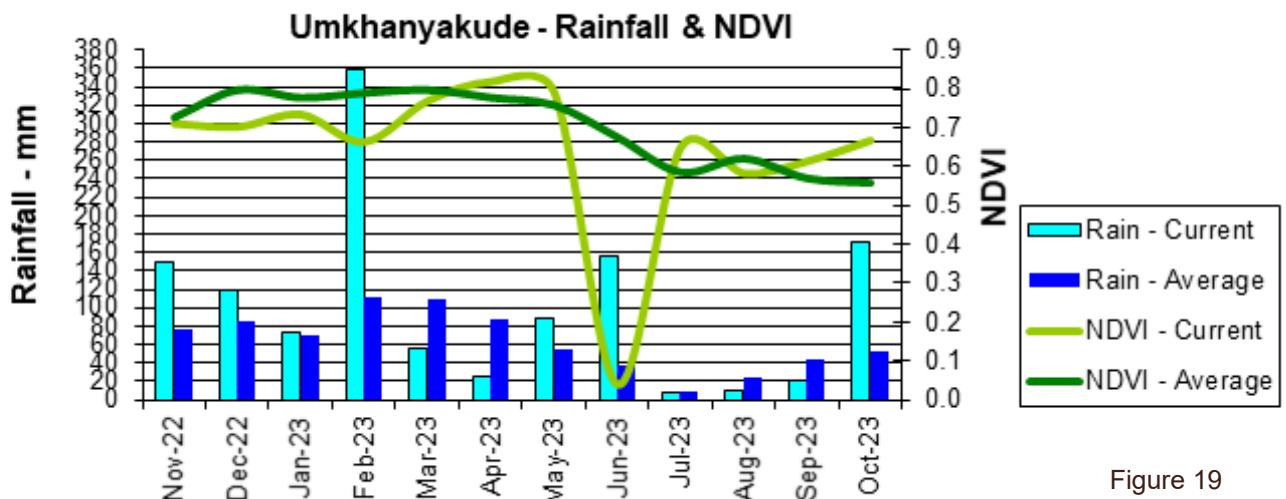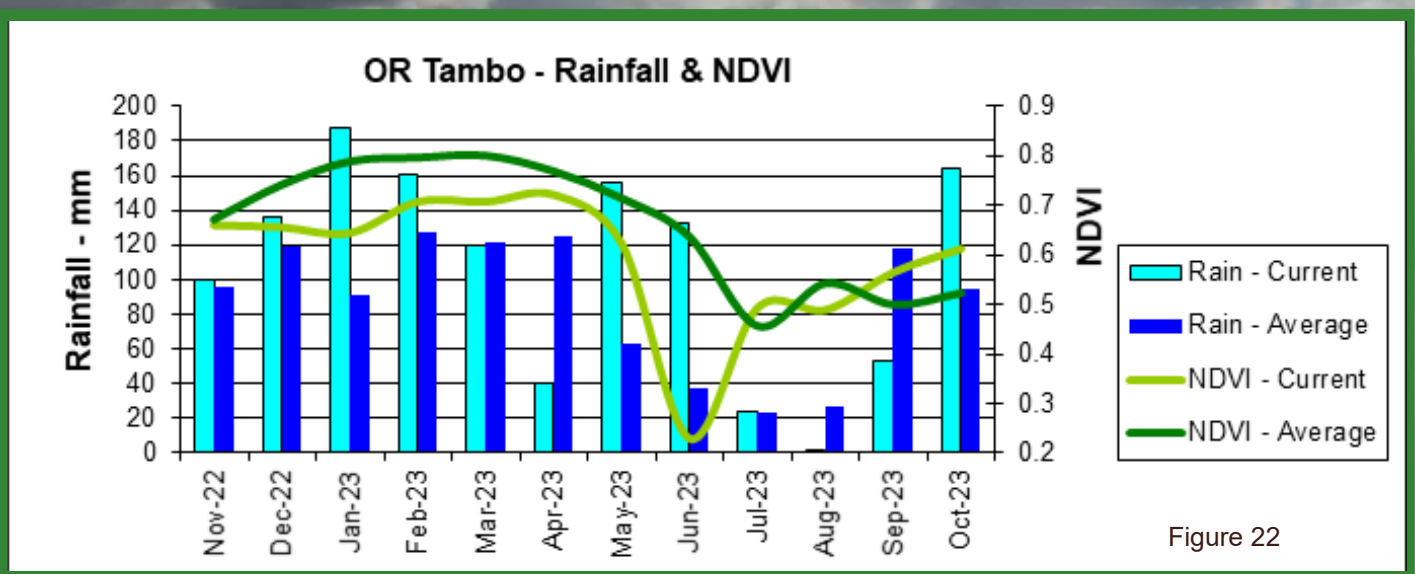Forest and vegetation fires have temperatures in the range of 500 K (Kelvin) to 1000 K. According to Wien's Displacement Law, the peak emission of radiance for blackbody surfaces of such temperatures is at around 4 μm. For an ambient temperature of 290 K, the peak of radiance emission is located at approximately 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 from 30 September to 1 November 2023 per province. Fire activity was higher in the Free State, Northern Cape and North West, compared to the long-term average.
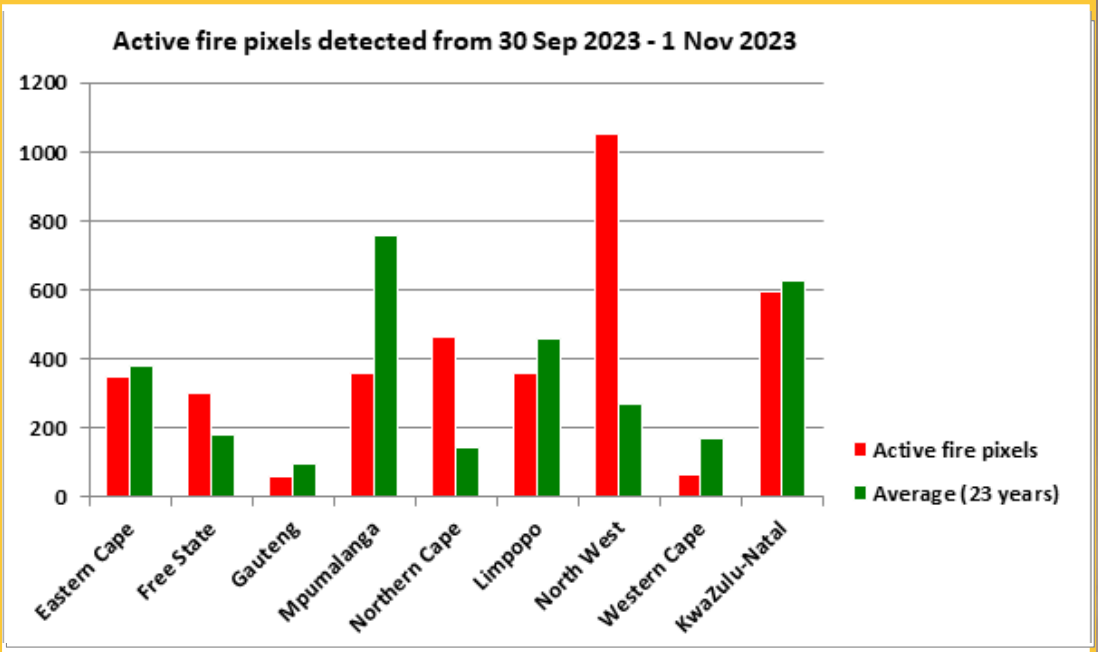
Figure 29
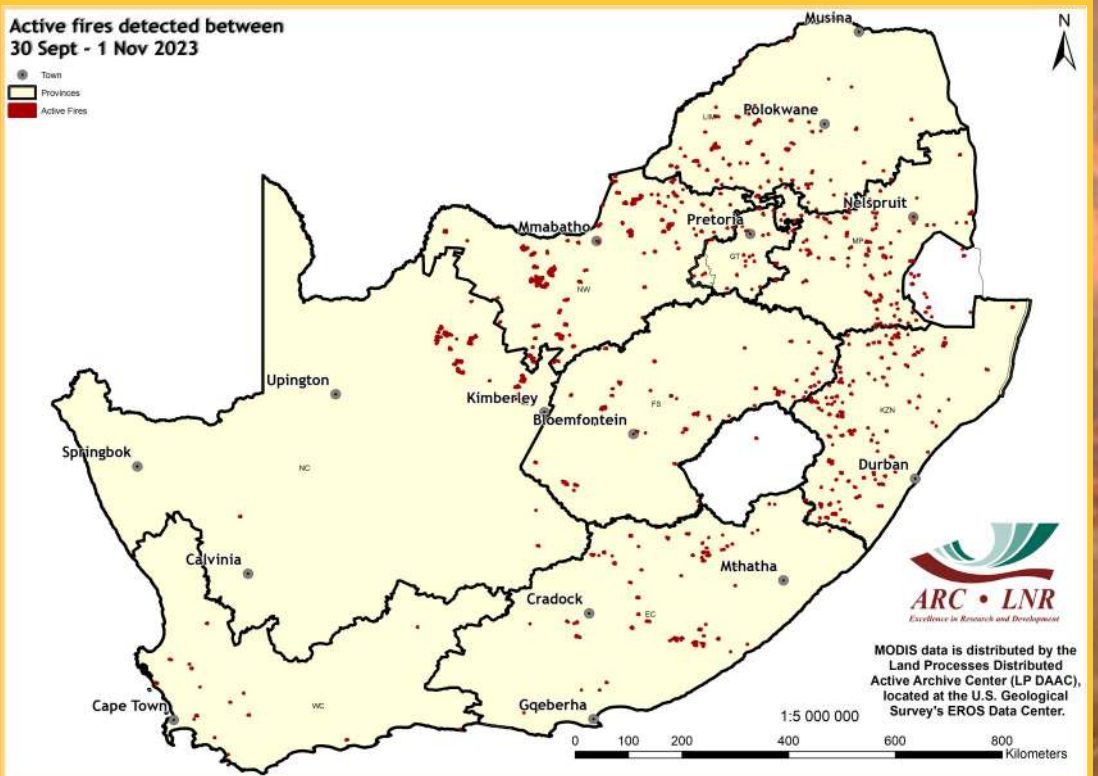
Figure 30:
The map shows the location of active fires detected between 30 September and 1 November 2023.

Figure 30

Cumulative active fire pixels for 1 Jan 2023 - 1 Nov 2023
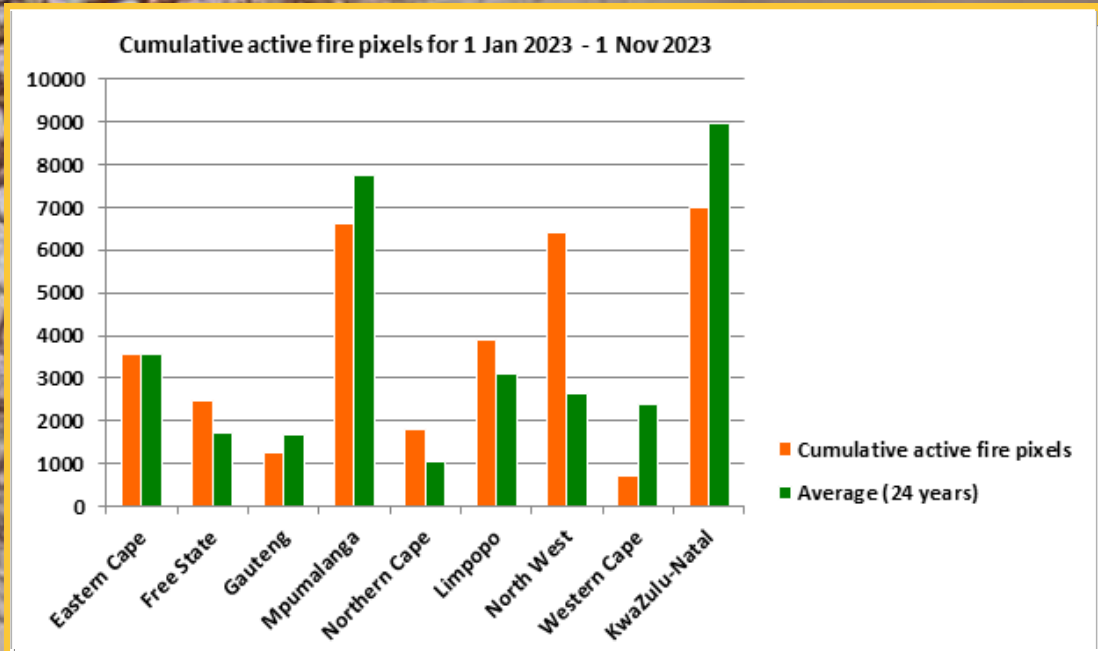
Figure 31:
The graph shows the total number of active fires detected from 1 January to 1 November 2023 per province. Fire activity remains higher in the Free State, Northern Cape, Limpopo and North West, compared to the long-term average.

Figure 31

Figure 32:
The map shows the location of active fires detected between 1 January and 1 November 2023.

Figure 32

Countrywide surface water areas (SWAs) are mapped on a monthly basis by GeoTerralmage 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 7 years. This 7-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.
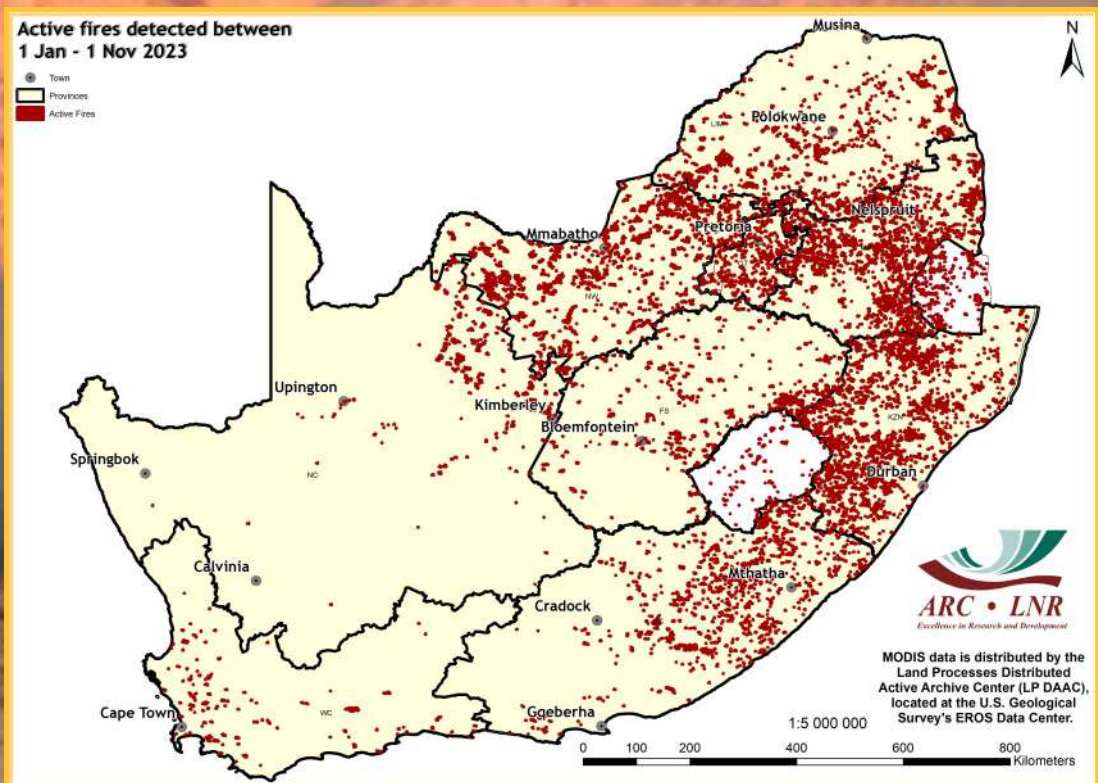
Figure 34 represents a comparison between the area of surface water now and for the same month last year. In this map, any value less than 100 represents water catchments within which the current month's total surface water is less than that recorded in the same water catchment, in the same month, last year.

The long-term map for October 2023 shows a near identical water distribution pattern to last month and a similar pattern to that since April. This continues to illustrate the significant impact of the high rainfall experienced over most of the country during the 2022/23 summer and 2023 winter seasons. The majority of Tertiary catchments continue to show water levels equivalent to 80-100% of the 7-year, long-term maximum water levels. The whole of the Western Cape and West Coast region of the Northern Cape are now showing maximum (80-100%) water levels.

The comparison between October 2023 and October 2022 also shows a near identical pattern to the previous few months, including the significant low value anomaly in the central section of the Northern Cape. The Western Cape coastal and mountainous regions continue to show high water levels, resulting from recent good winter rainfall.

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

Questions/Comments:
mark.thompson@geoterraimage.com

Maximum surface water area for October 2023 expressed as a % of historic maximum, per Tertiary catchment.

Figure 33

Maximum surface water area for October 2023 expressed as a % of October 2022 maximum, per Tertiary catchment.

Figure 34

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SOIL, CLIMATE AND WATER
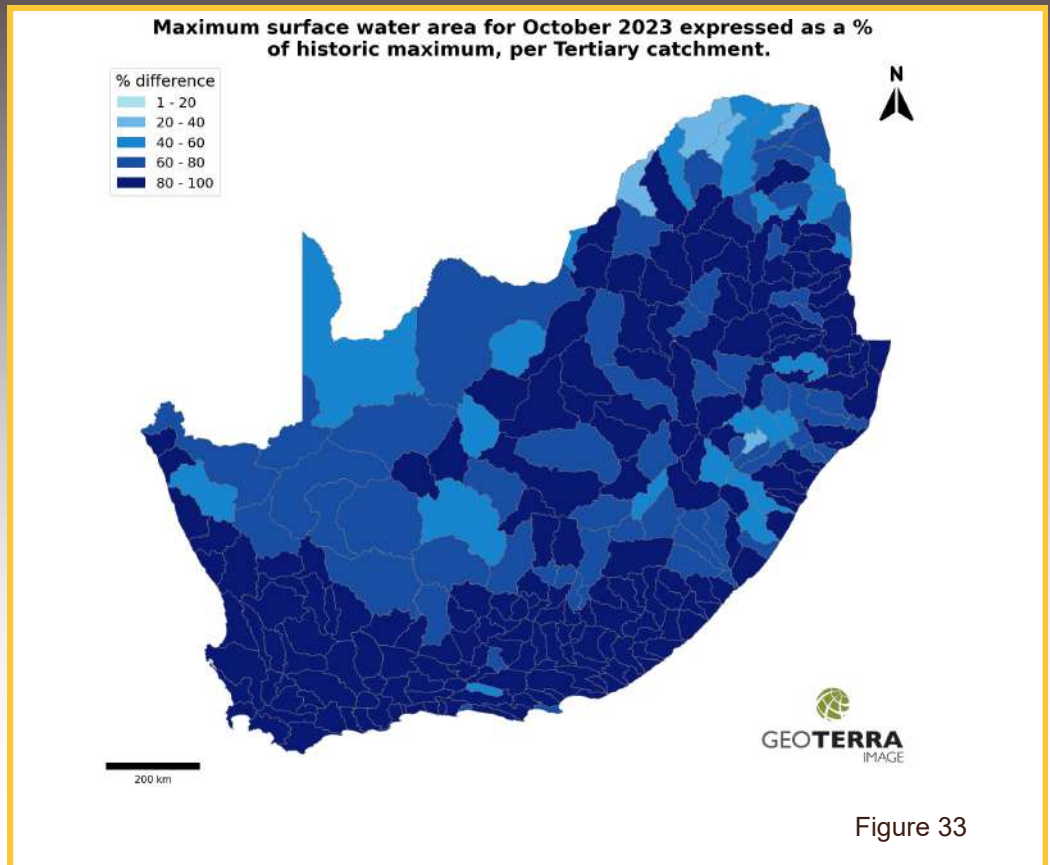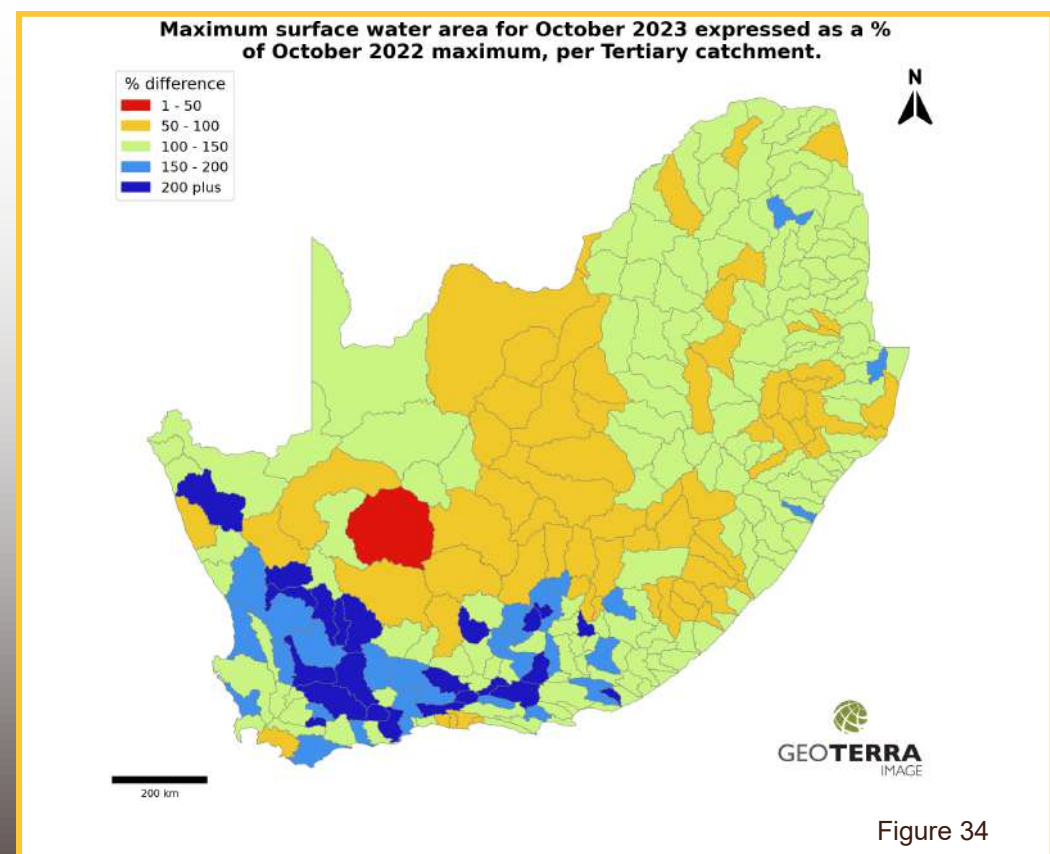
Agrometeorology

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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ARC - NATURAL RESOURCES AND ENGINEERING

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.

ARC-Natural Resources and Engineering
Soil, Climate and Water Campus
600 Belvedere Street, Arcadia, 0083 · Private Bag X79, Pretoria 0001
Tel: 012 310 2500 · Fax: 012 323 1157
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For more information contact:
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ARC - NATURAL RESOURCES AND ENGINEERING

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

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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^2 to 1 km^2) 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

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-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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To subscribe to the newsletter, please submit a request to:
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What does Umlindi mean?
UMLINDI is the Zulu word for "the watchman".