UMLINDI

The Watchman

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

220th Edition

Image of the Month

A hot and dry start to October 2022

The first half of October 2022 was characterized by widespread hot and dry conditions over the summer rainfall region. During this period, rainfall ranged between 0-14 mm over the entire region, while daily maximum temperatures exceeded 30°C, particularly over Gauteng, Limpopo, Mpumalanga, North West and the Free State. On the 5th, positive surface air temperature anomalies exceeding 4°C were observed over the eastern half of the country (see map below), resulting in extremely hot weather conditions. For agriculture, these conditions pose an alarm for the onset of the summer rainfall season, as they may delay planting preparations. However, farmers are advised to adjust planting dates in accordance with the onset of rains and to continue to assess grazing and keep animals in small camps with water and shade. Moreover, sustainable water management strategies (such as conservation agriculture) should be planned in order to mitigate the possible impacts of heatwaves and dry spells.
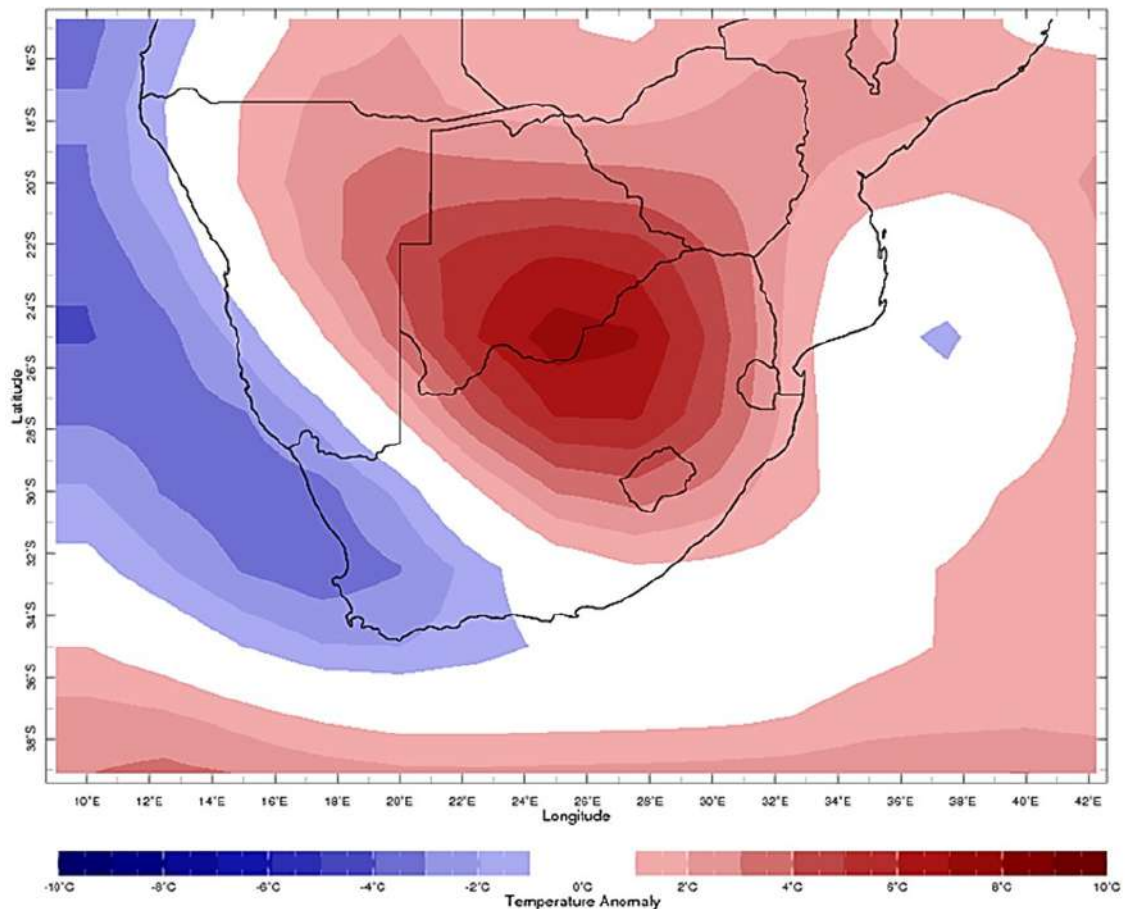
Data source: NCEP (National Centers for Environmental Prediction)

1. Rainfall

Overview:

A dry start to the summer rainfall season was observed during September 2022. In general, the month started with dry conditions over most of the country, with rainfall observed only in the Northern Cape and Western Cape during the first dekad (10-day period). Rainfall started to increase during the second dekad, particularly over the Western Cape, Eastern Cape and KwaZulu-Natal, while the northeastern provinces (Limpopo and Mpumalanga) received their rainfall during the second and more profoundly in the last dekad. Below-normal rainfall conditions were observed over the northern interior, extending towards Limpopo. The only areas that received somewhat significant rainfall include most parts of the Eastern Cape, the eastern region of the Great Karoo, KwaZulu-Natal, Mpumalanga and isolated parts of the Free State, Limpopo and Northern Cape. It was notable that much of this rainfall occurred over the Eastern Cape, with stations near Dohne and East London recording >200% of their normal September rainfall. Moreover, conditions over greater parts of this province, with the exception of the all-year rainfall region, compared well with historically wet September months, as depicted on the rainfall deciles map (see p. 6). Regarding the winter rainfall region, rainfall during September was confined to the southern parts of the Western Cape. Yet, the total rainfall was to a large extent between 25-75% of the region's normal rainfall, implying below-normal conditions.

Figure 1
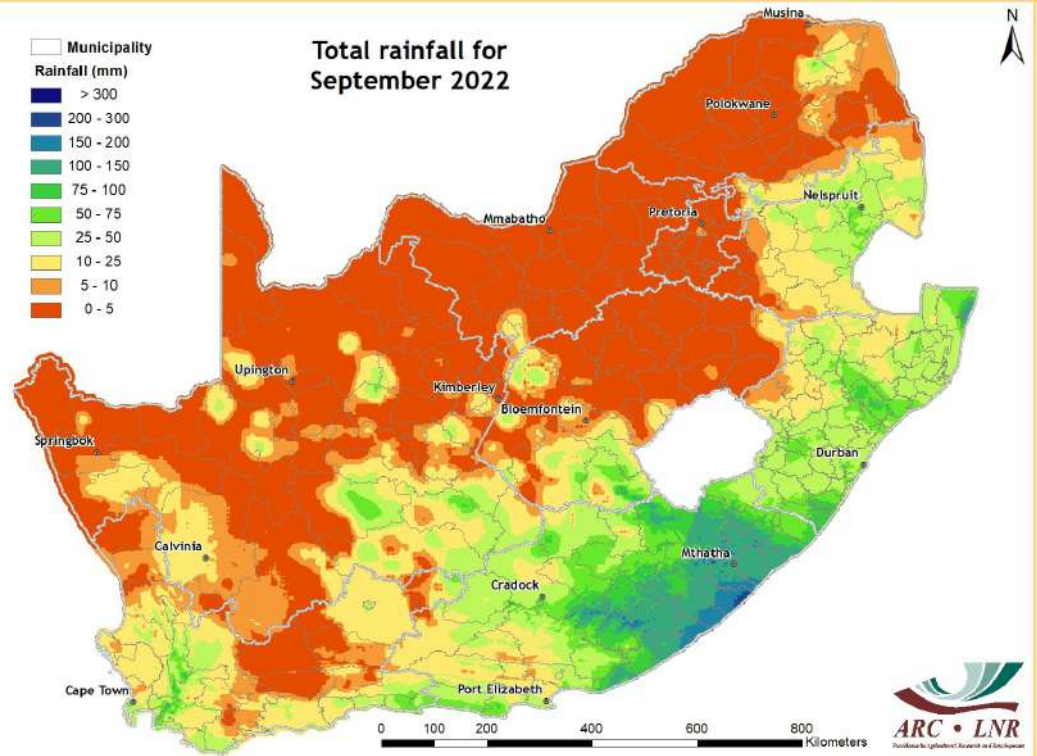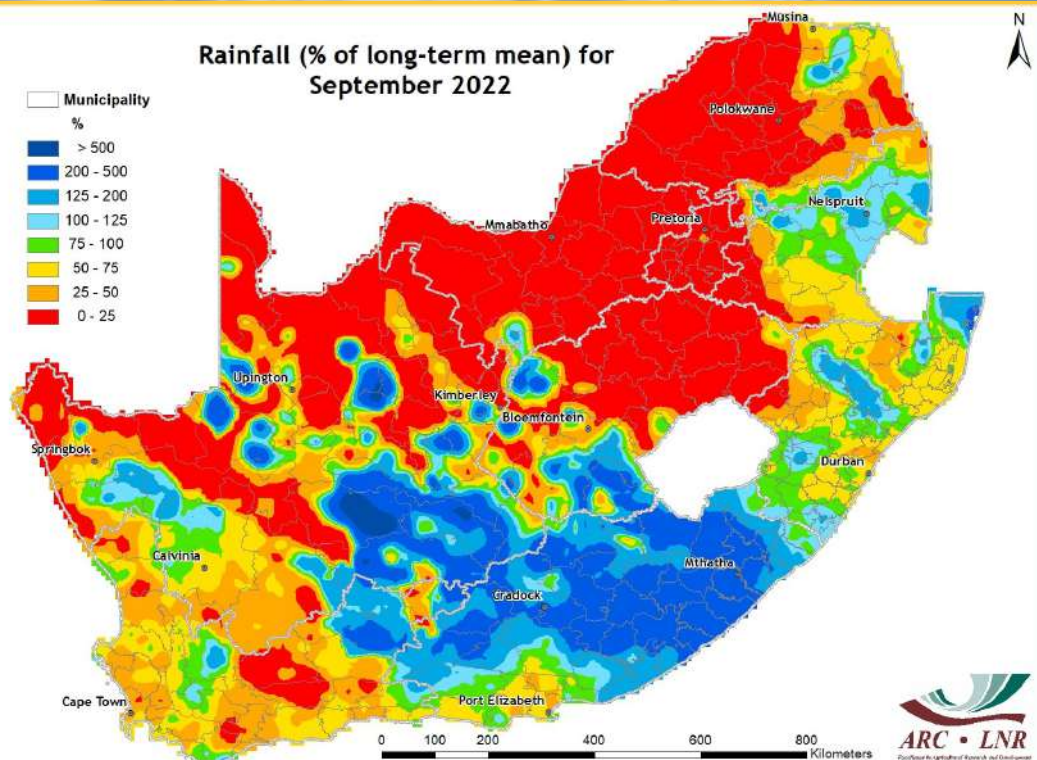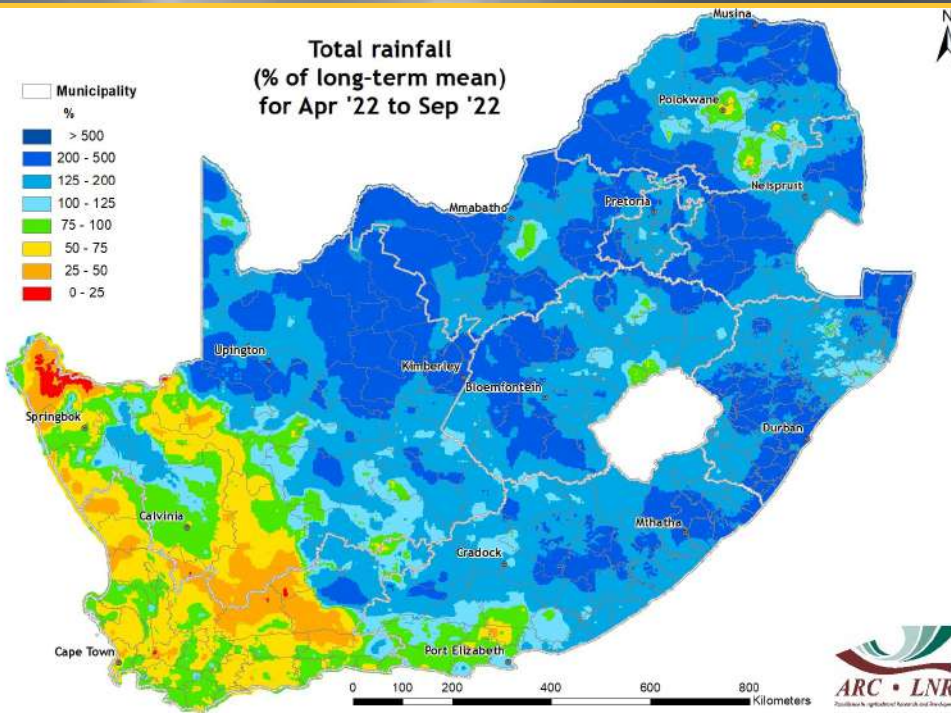

Figure 2

Figure 3

Figure 4

Figure 1:
Rainfall during September 2022 occurred over some parts of the winter rainfall region, Great Karoo, Free State, Limpopo, Mpumalanga and KwaZulu-Natal, as well as the Eastern Cape where the highest totals were recorded.

Figure 2:
Most parts of the summer rainfall region received below-normal rainfall in September 2022, while the Eastern Cape, parts of the Northern Cape, Free State and isolated areas of Limpopo, Mpumalanga and KZN received above-normal rainfall.

Figure 3:
Since April 2022, greater parts of the country experienced widespread above normal rainfall conditions, with near- to below-normal conditions observed over the winter rainfall region and adjacent areas of the Northern Cape, as well as the all-year rainfall region.

Figure 4:
When comparing total rainfall for July-September 2022 with that of the same period last year, it is evident that the northern half of the Eastern Cape recorded an excess of up to 150 mm. Meanwhile, much of KZN and certain areas of the Western Cape and Free State received less rainfall during this 3-month period than last year.

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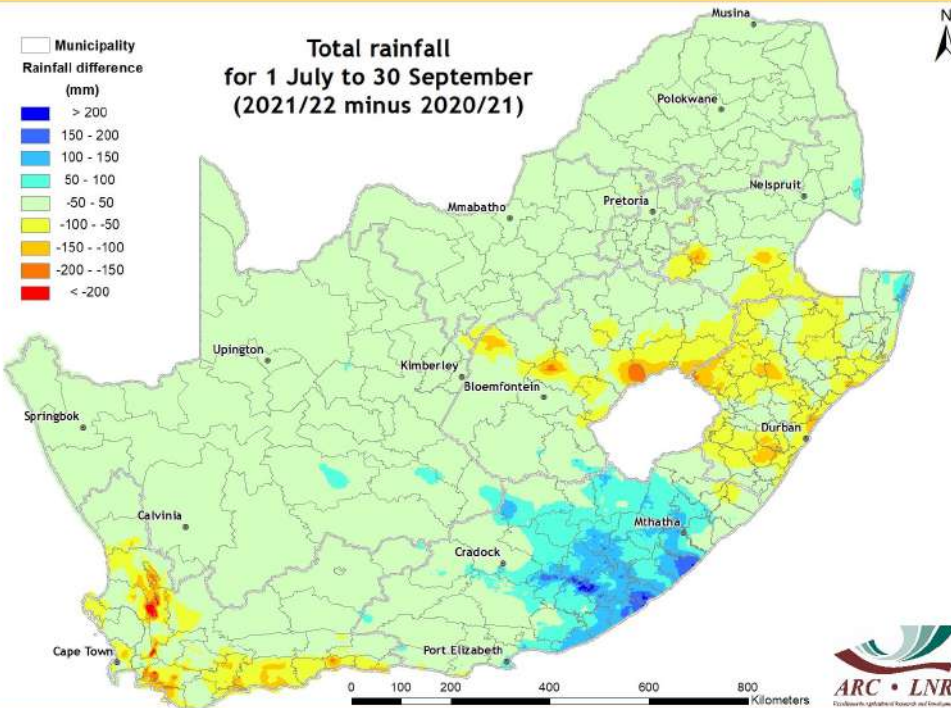*MasuphaE@arc.agric.za*
Johan@arc.agric.za

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 September 2022 are shown in Figures 5-8. Wet conditions are evident over most parts of the country, particularly over the summer rainfall region. However, the southwestern parts of the Eastern Cape are still experiencing long-term moderate to severe drought as depicted on the 24-month SPI map. Longer time scales show moderate to severe drought conditions over the southern parts of Limpopo, the Eastern Cape and most parts of the winter rainfall region.

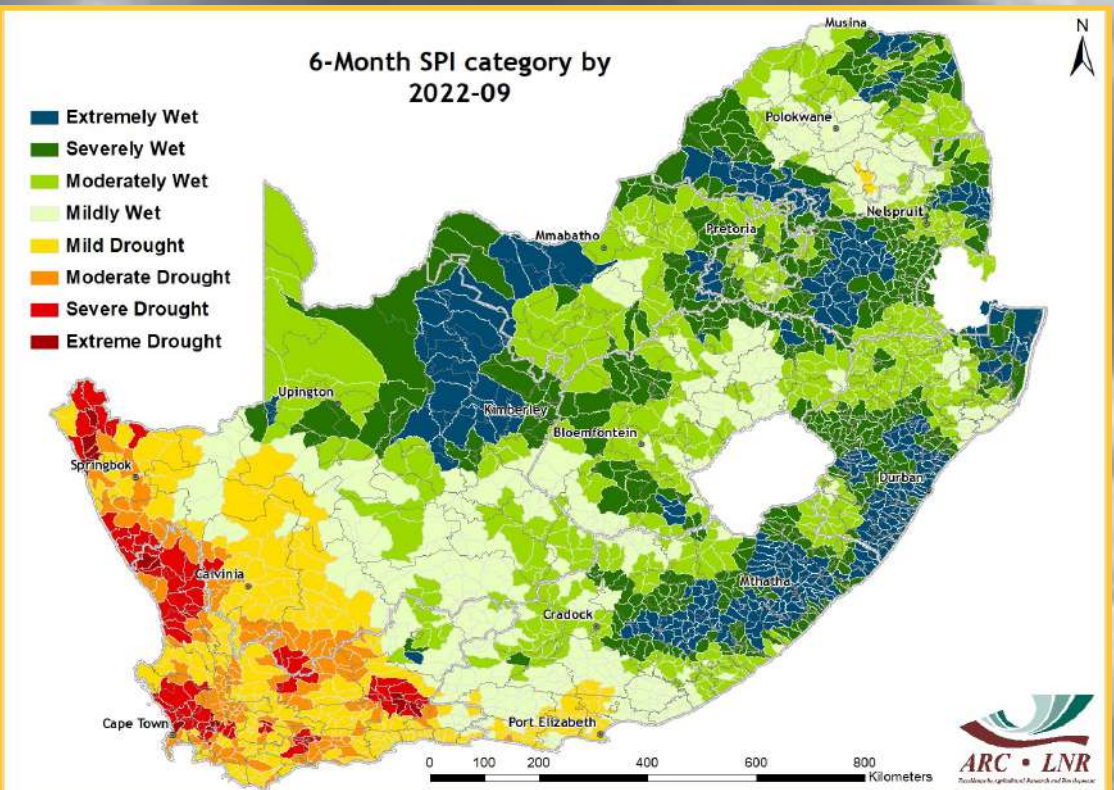**Questions/Comments:**
MasuphaE@arc.agric.za
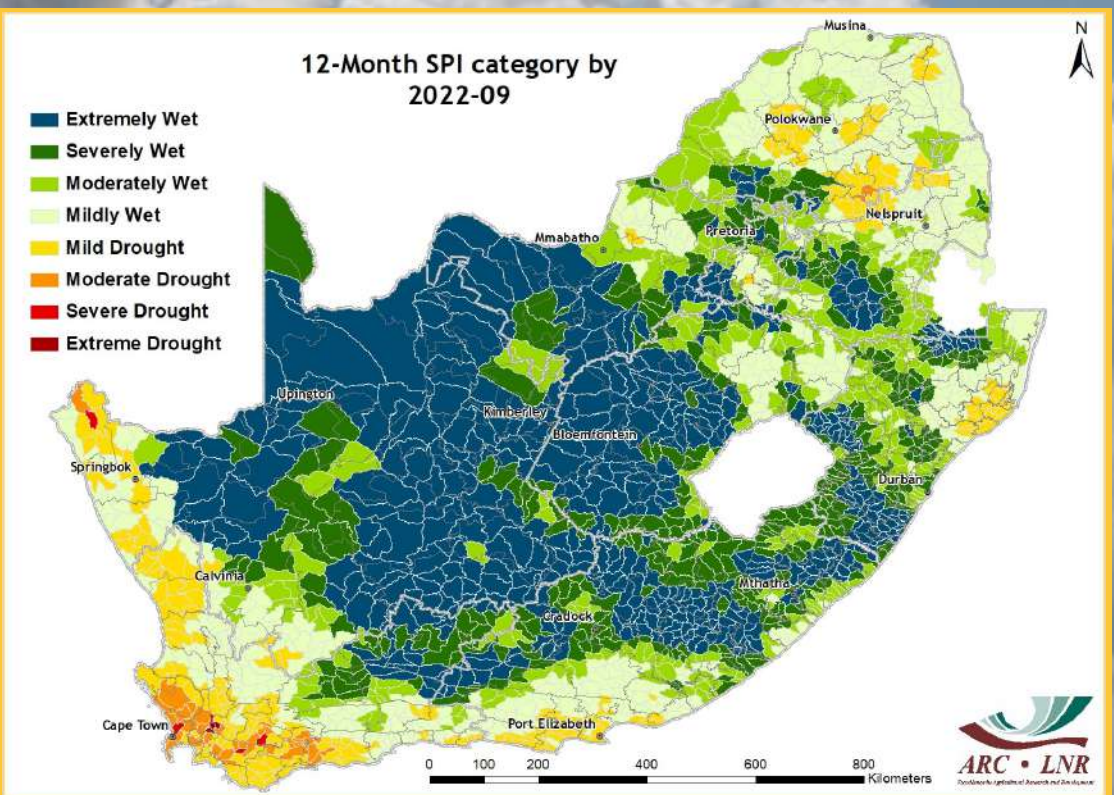*Johan@arc.agric.za*

Figure 5

Figure 6

24-Month SPI category by 2022-09

Legend:
- Extremely Wet
- Severely Wet
- Moderately Wet
- Mildly Wet
- Mild Drought
- Moderate Drought
- Severe Drought
- Extreme Drought

Figure 7

36-Month SPI category by 2022-09

Legend:
- Extremely Wet
- Severely Wet
- Moderately Wet
- Mildly Wet
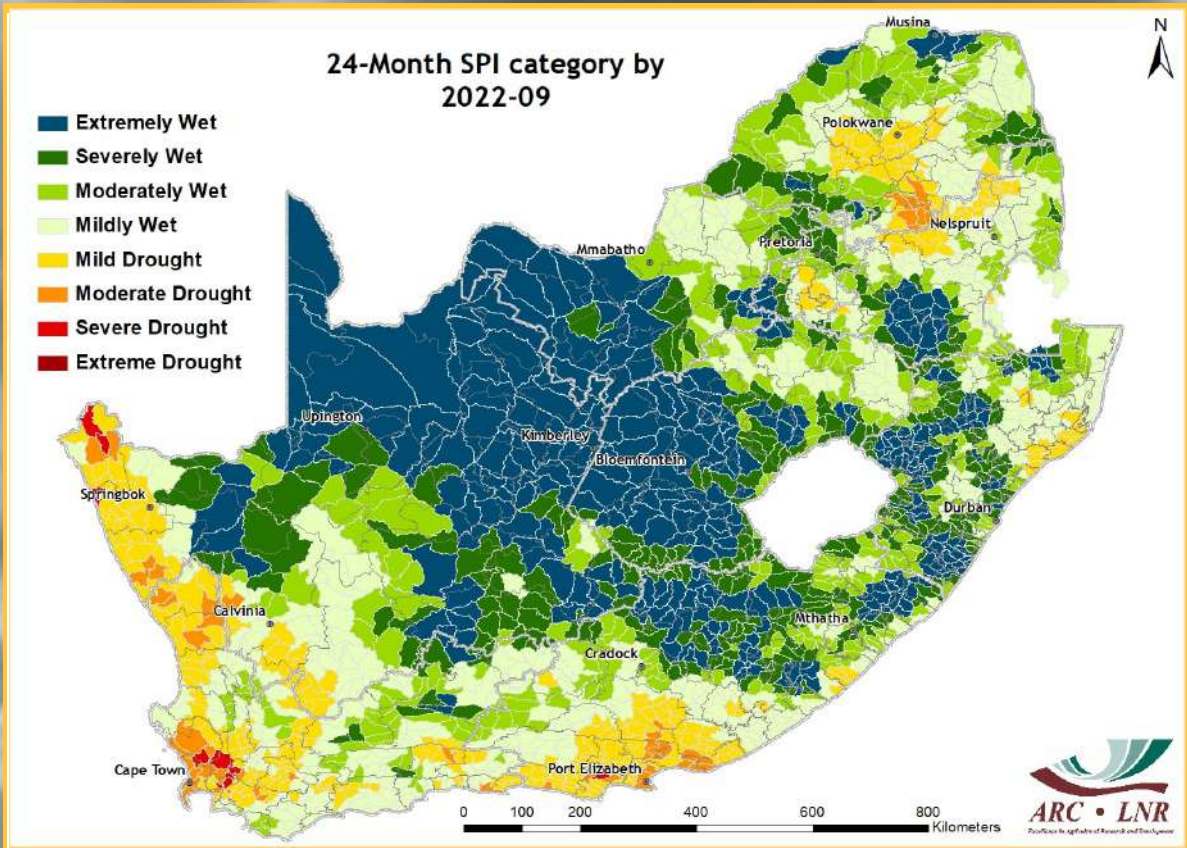- Mild Drought
- Moderate Drought
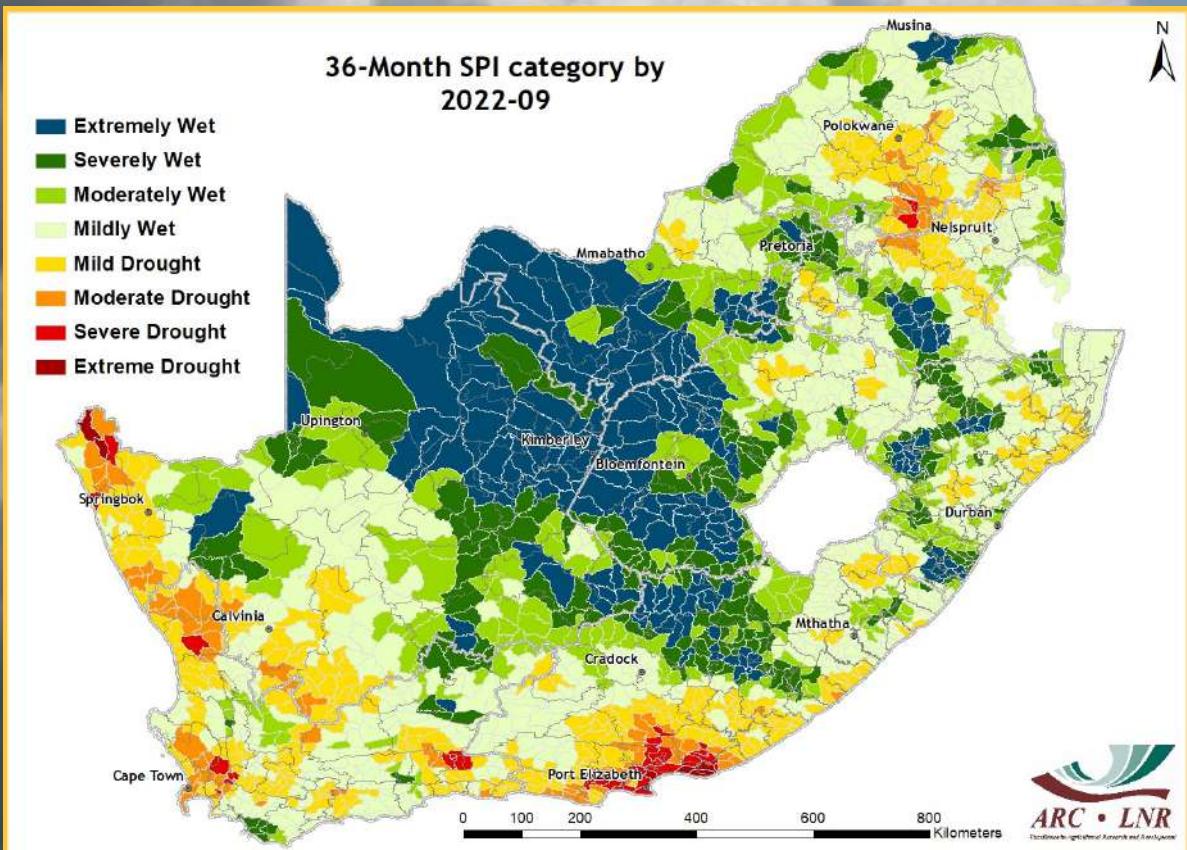- Severe Drought
- Extreme Drought

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.
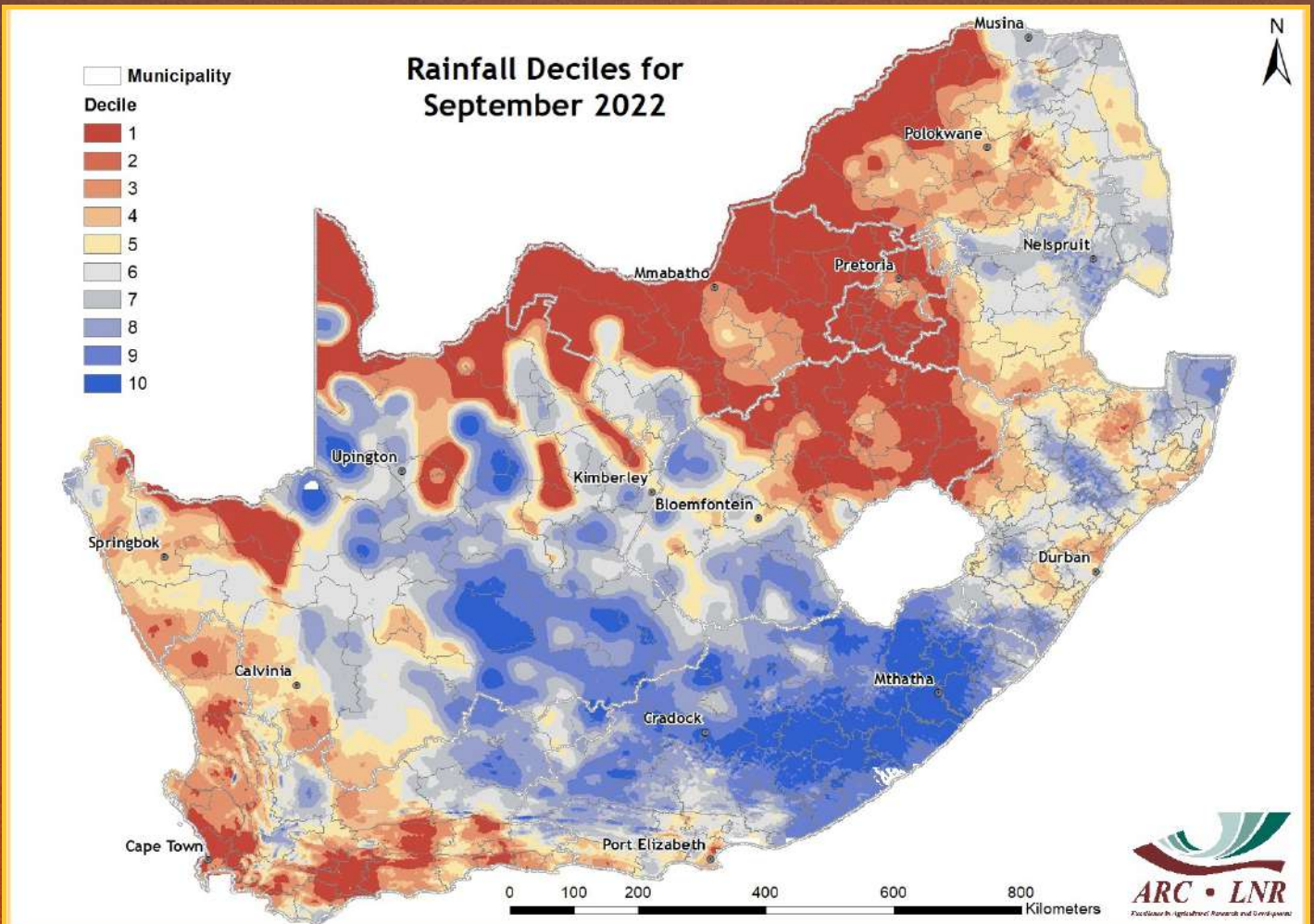

Figure 9

Figure 9:
Areas that received rainfall totals in September 2022 which compare well with historically wet September months include the central and southwestern interior, certain parts of Limpopo, Mpumalanga, KwaZulu-Natal and isolated areas in the winter rainfall region. The rest of the country observed dry conditions.

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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 SDVI map for September 2022 shows that some parts of the Cape provinces continue to experience poor vegetation activity.

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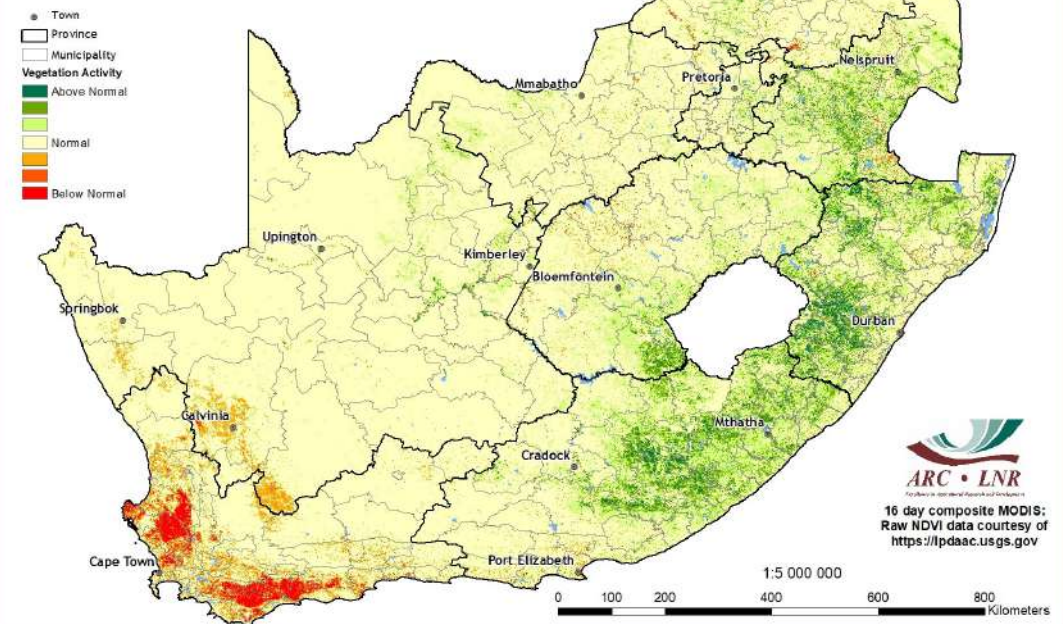

Figure 11

NDVI difference map for
6 Sep 2022 - 22 Sep 2022 compared to
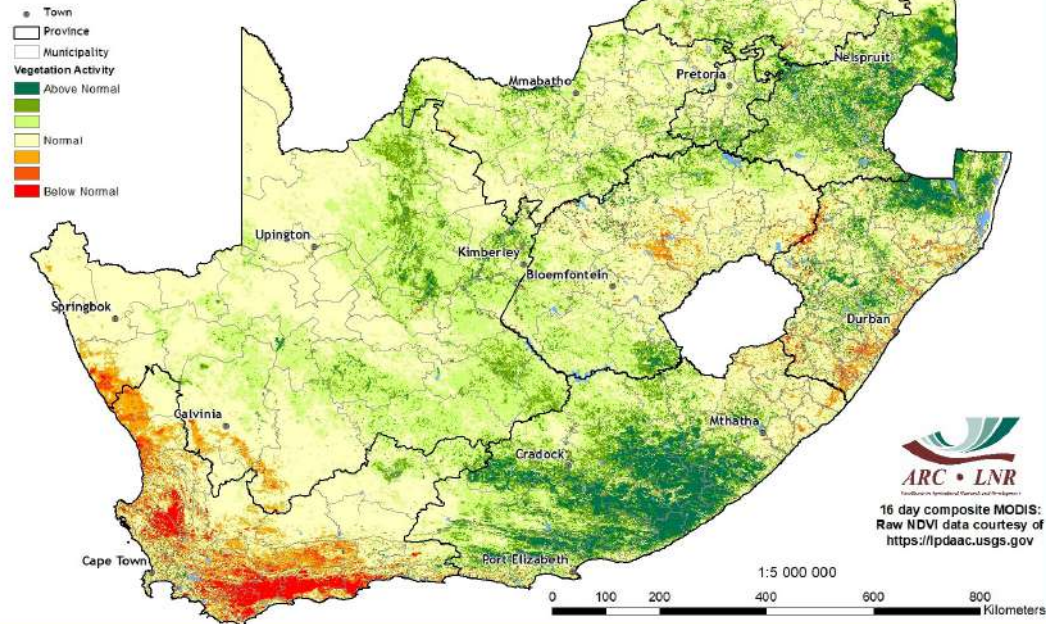6 Sep 2021 - 22 Sep 2021

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
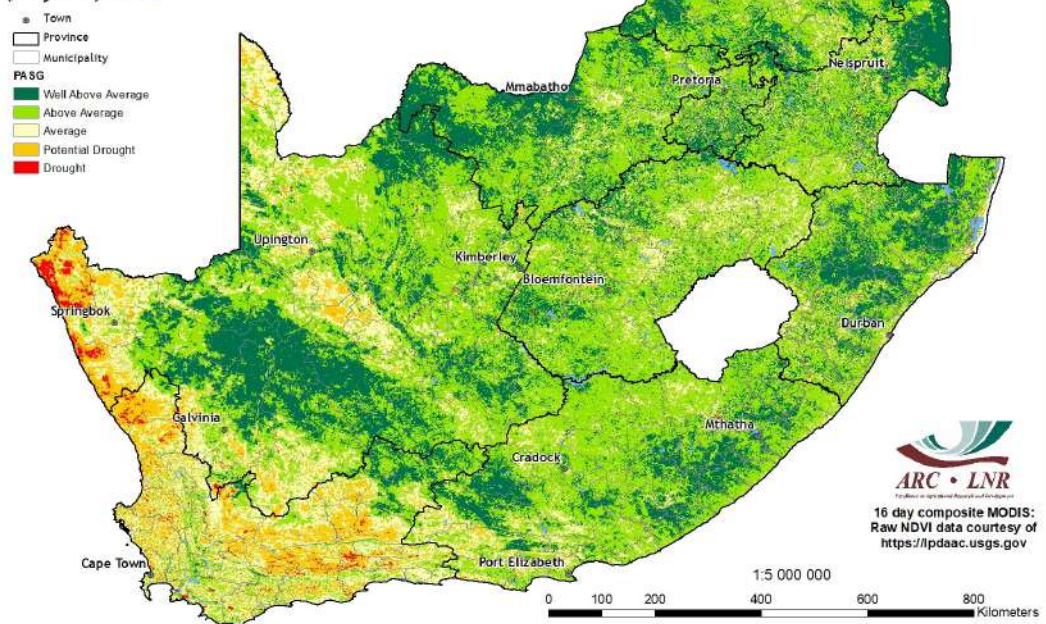18 June 2022 - 22 September 2022
compared to the long-term
(19 years) mean

Figure 13

Figure 12:
The 16-day NDVI difference map for September 2022 compared to the same period last year shows that most parts of the country continue to experience normal to above-normal vegetation activity, while below-normal activity prevails in the far western and northern parts.

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

Questions/Comments:
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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.
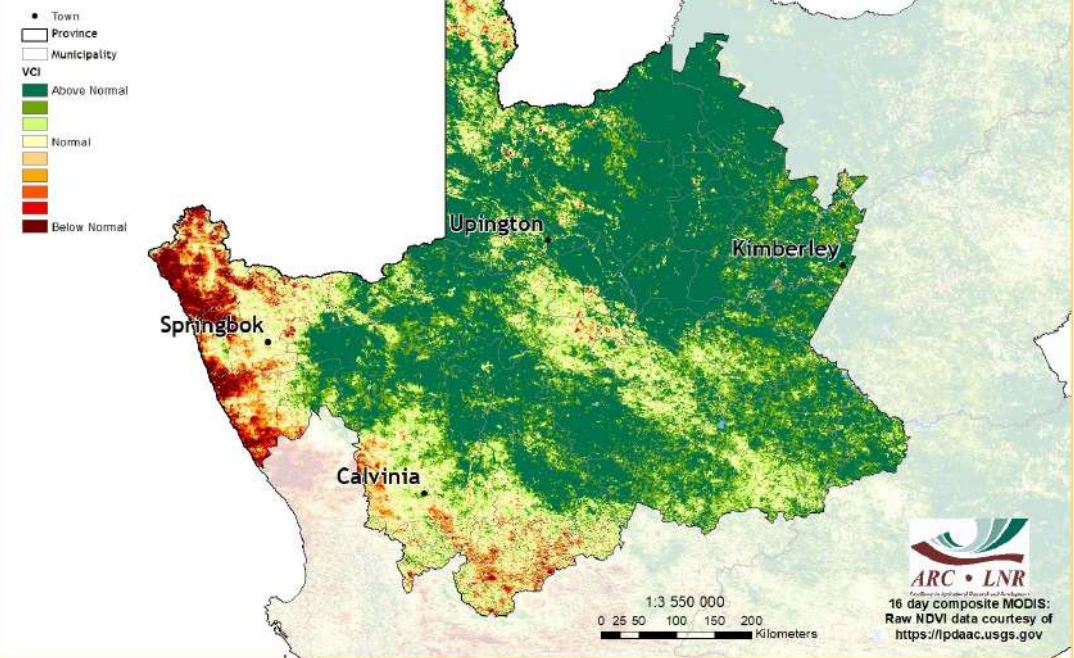

Figure 14

Figure 14:
The 16-day VCI map for September 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 September 2022 indicates that below-normal vegetation conditions are prevalent throughout the Western Cape. A few areas of good vegetation activity can also be observed, particularly in the northern parts of the Central Karoo district municipality.
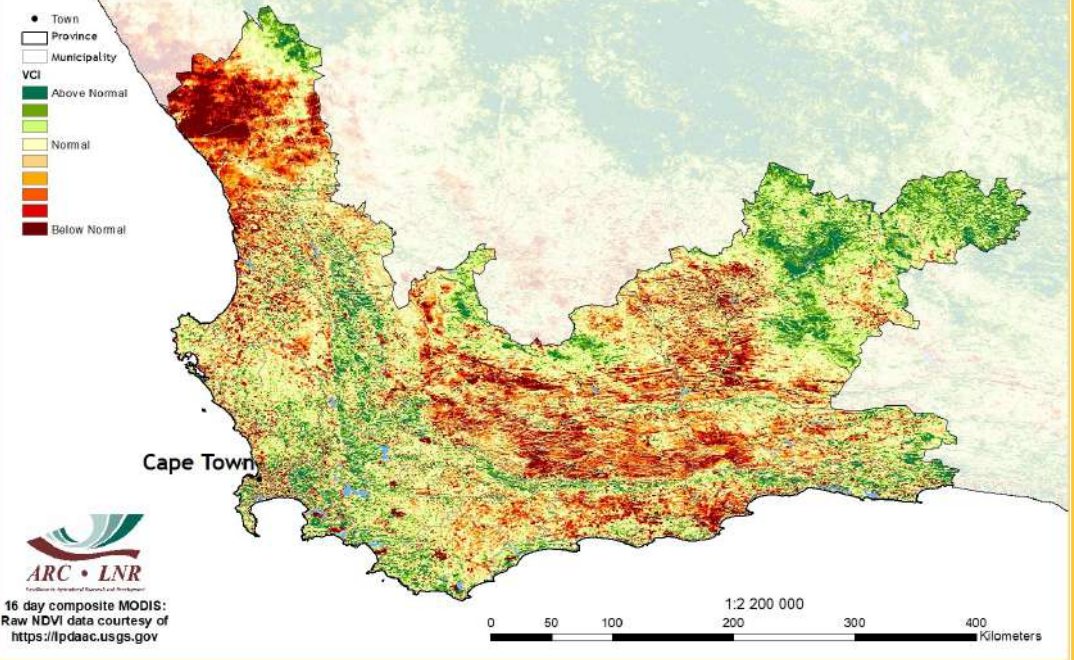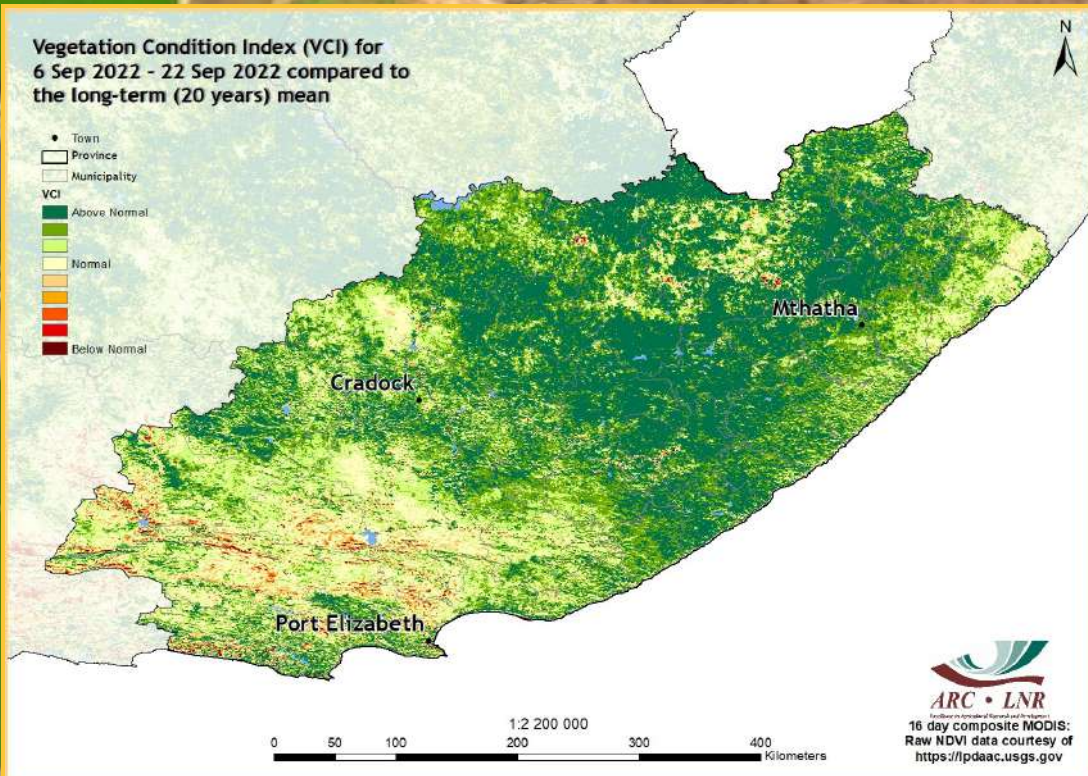

Figure 15

Figure 16

Figure 17

Figure 16:
The 16-day VCI map for September 2022 indicates that above-normal vegetation conditions remain prevalent in most parts of the Eastern Cape.
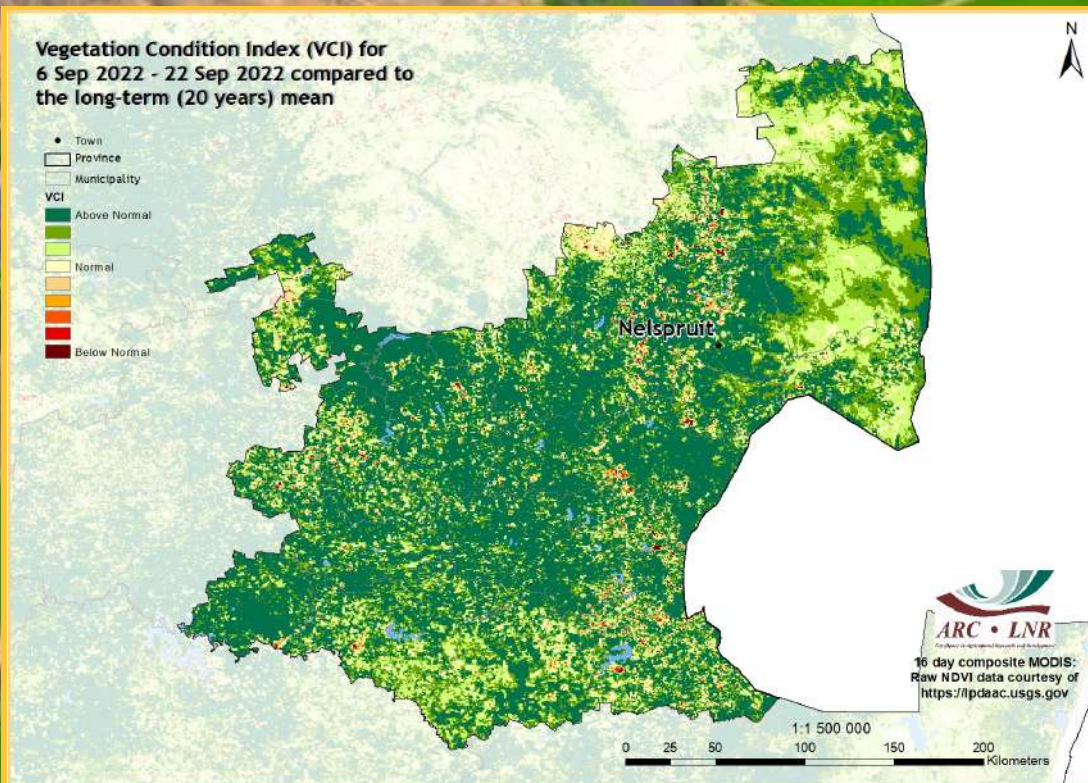
Figure 17:
The 16-day VCI map for September 2022 indicates that above-normal vegetation conditions remain prevalent throughout Mpumalanga.

Questions/Comments:
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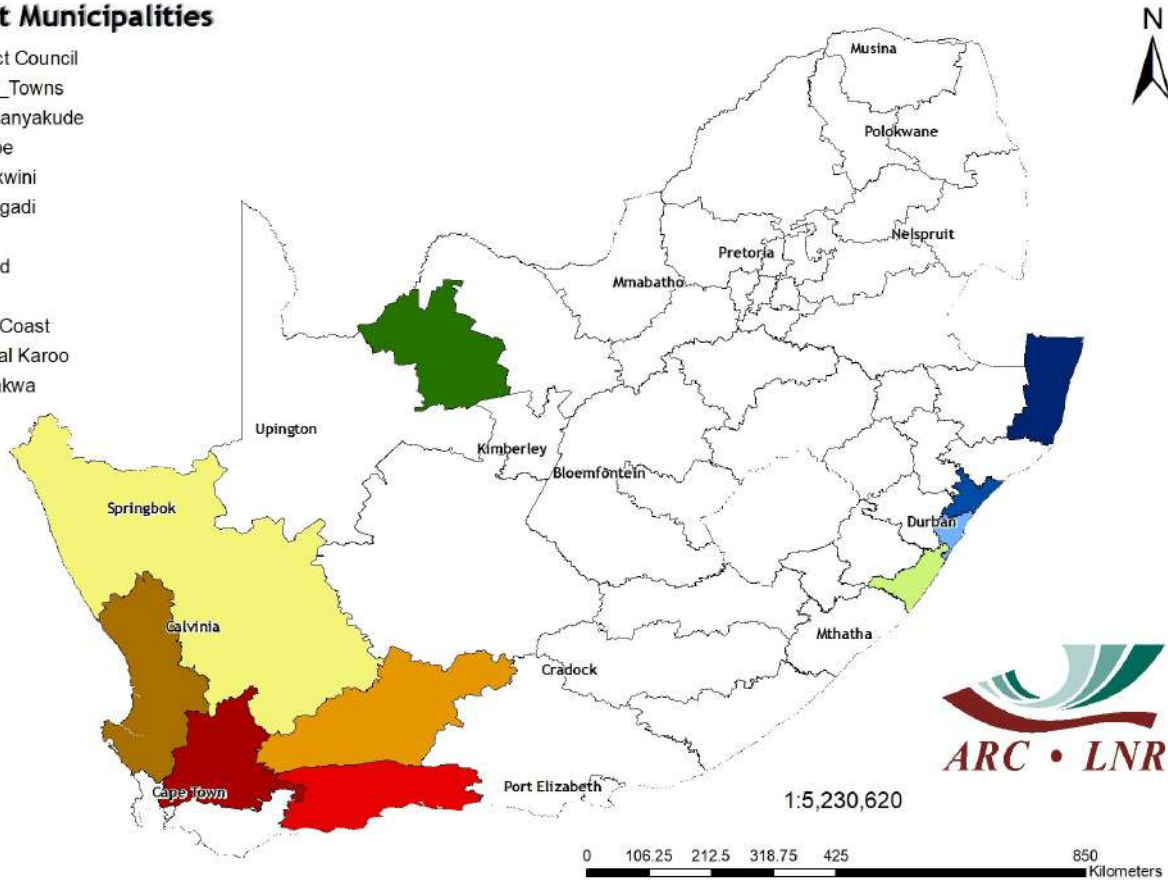
Figure 18

Rainfall and NDVI Graphs

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

Figure 19

iLembe - Rainfall & NDVI

Figure 20

eThekwini - Rainfall & NDVI

Figure 21

Kgalagadi - Rainfall & NDVI
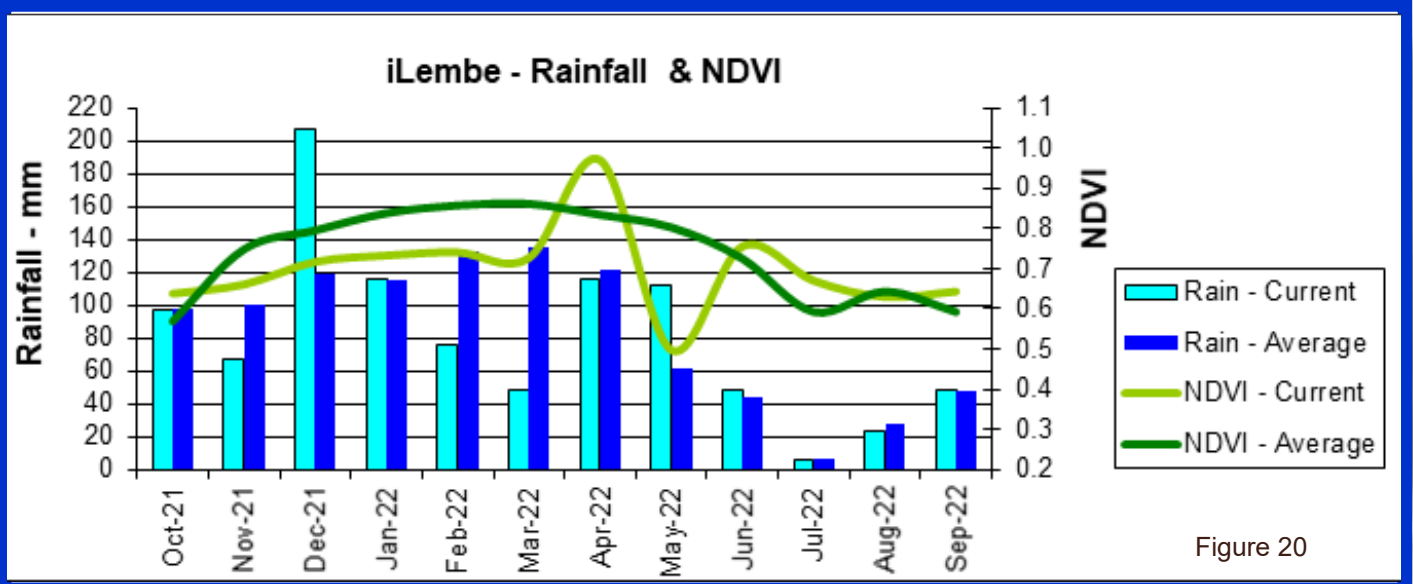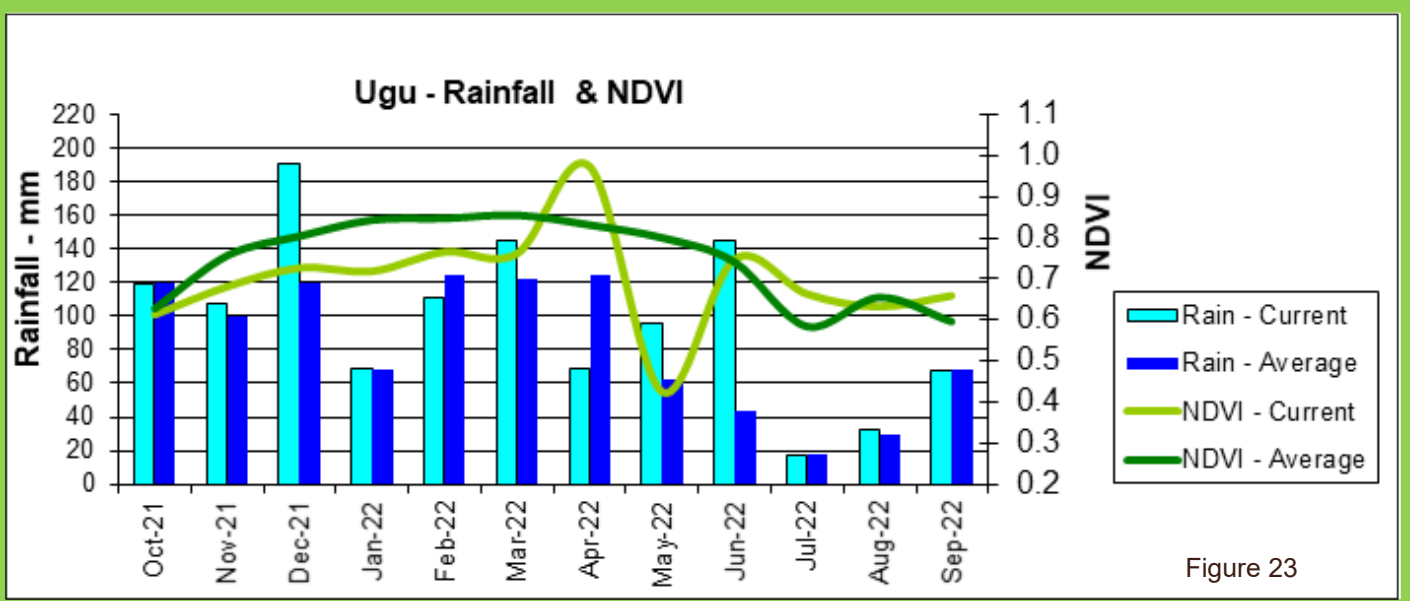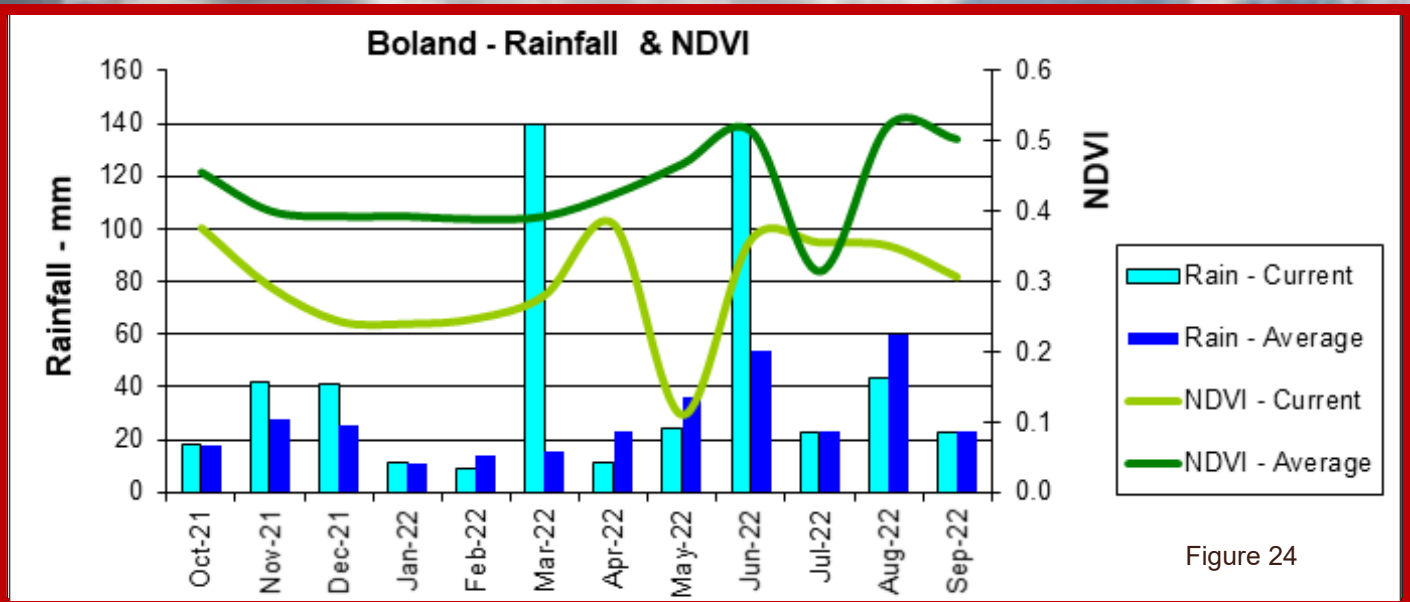
Figure 22
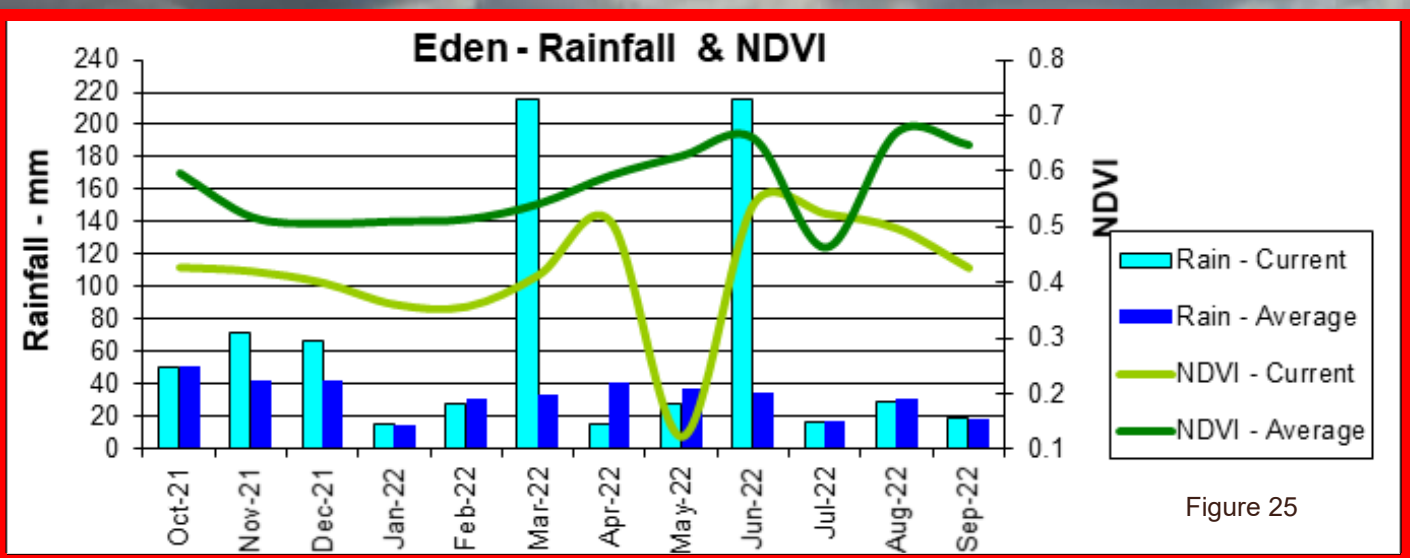
Figure 23

Figure 24

Figure 25
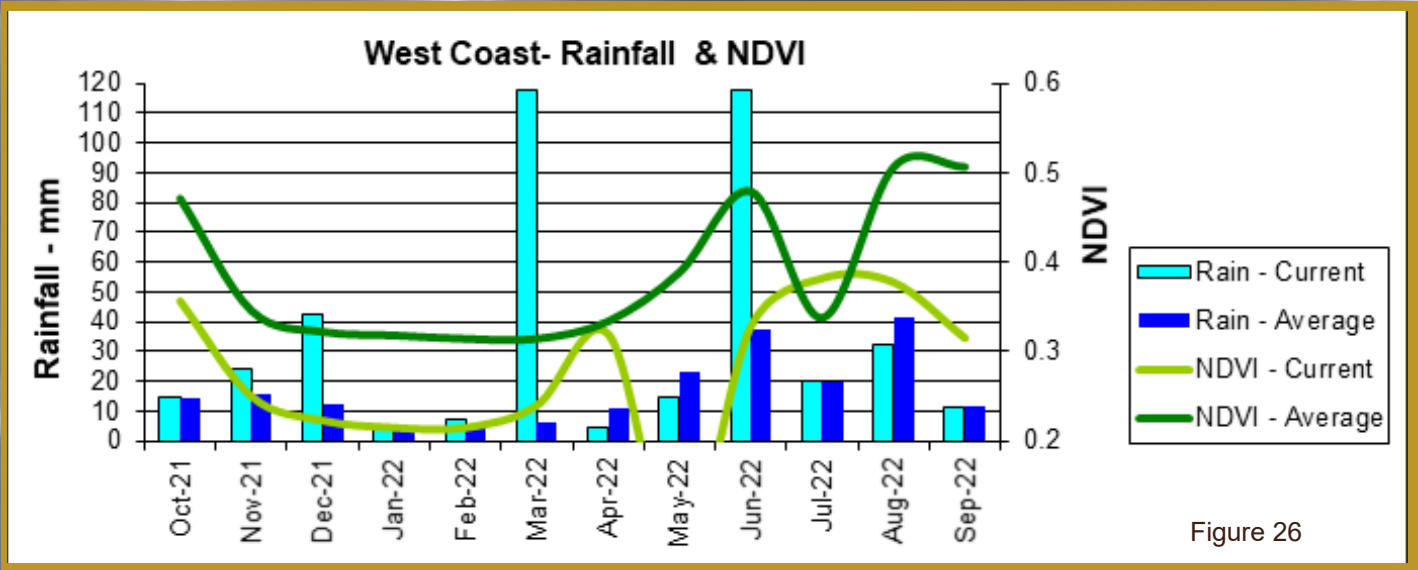
Figure 26
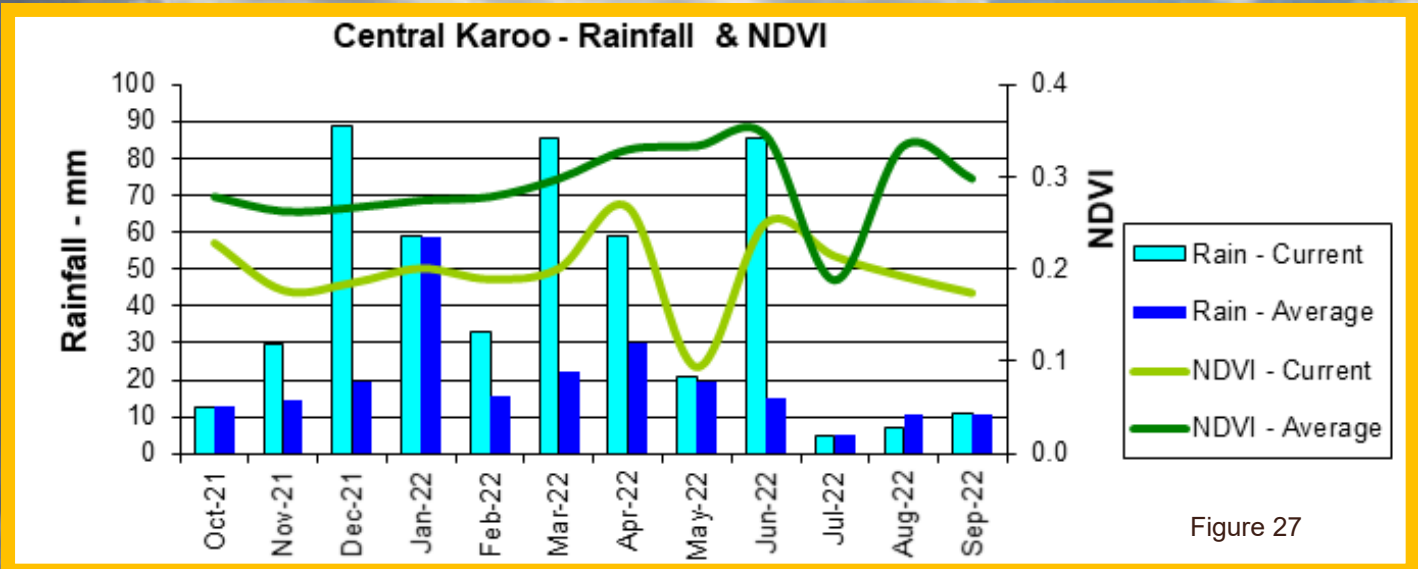
Figure 27
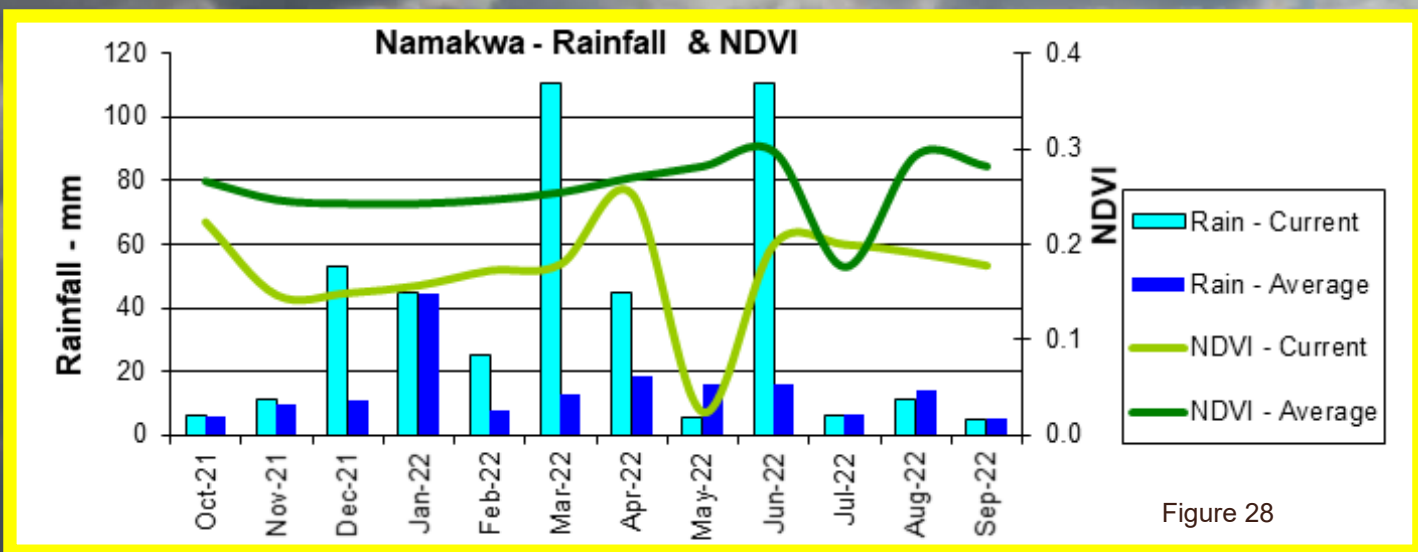
Figure 28

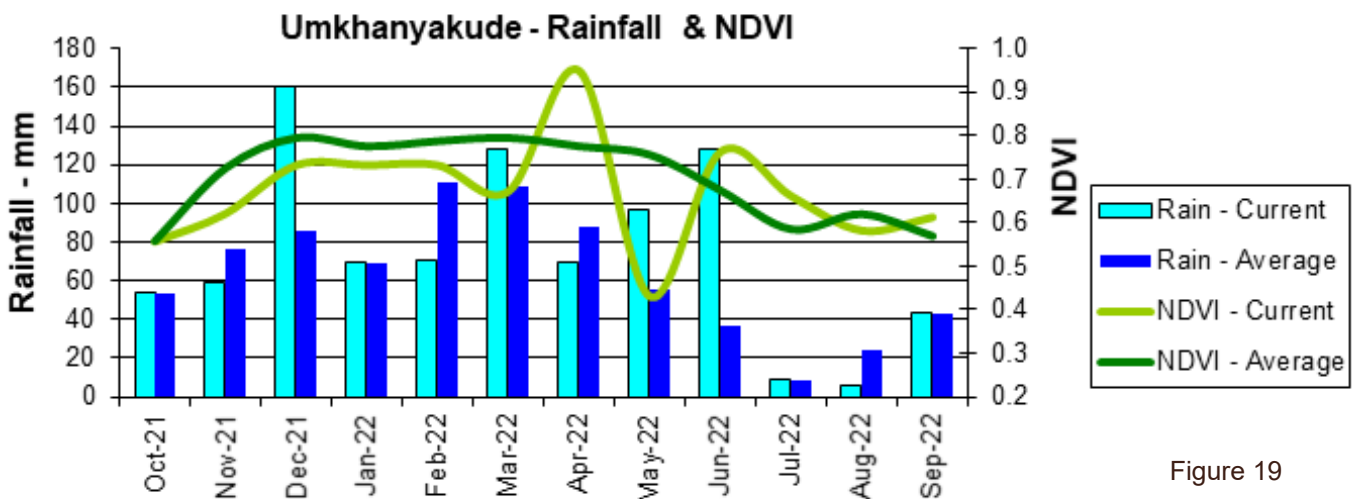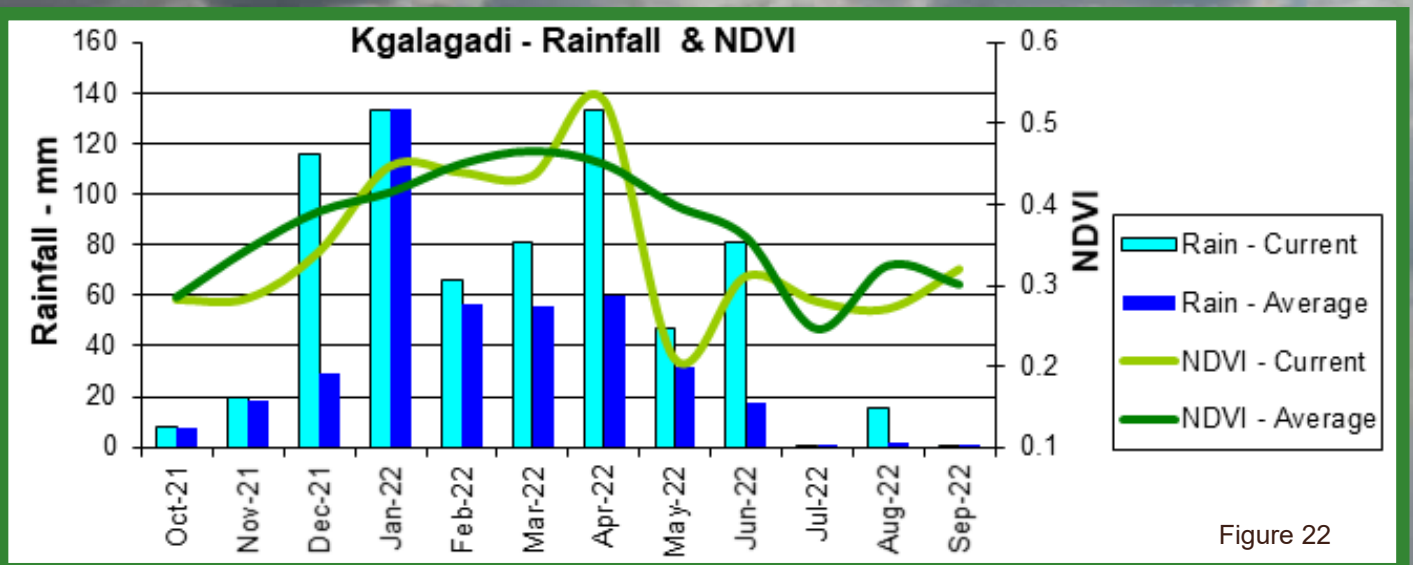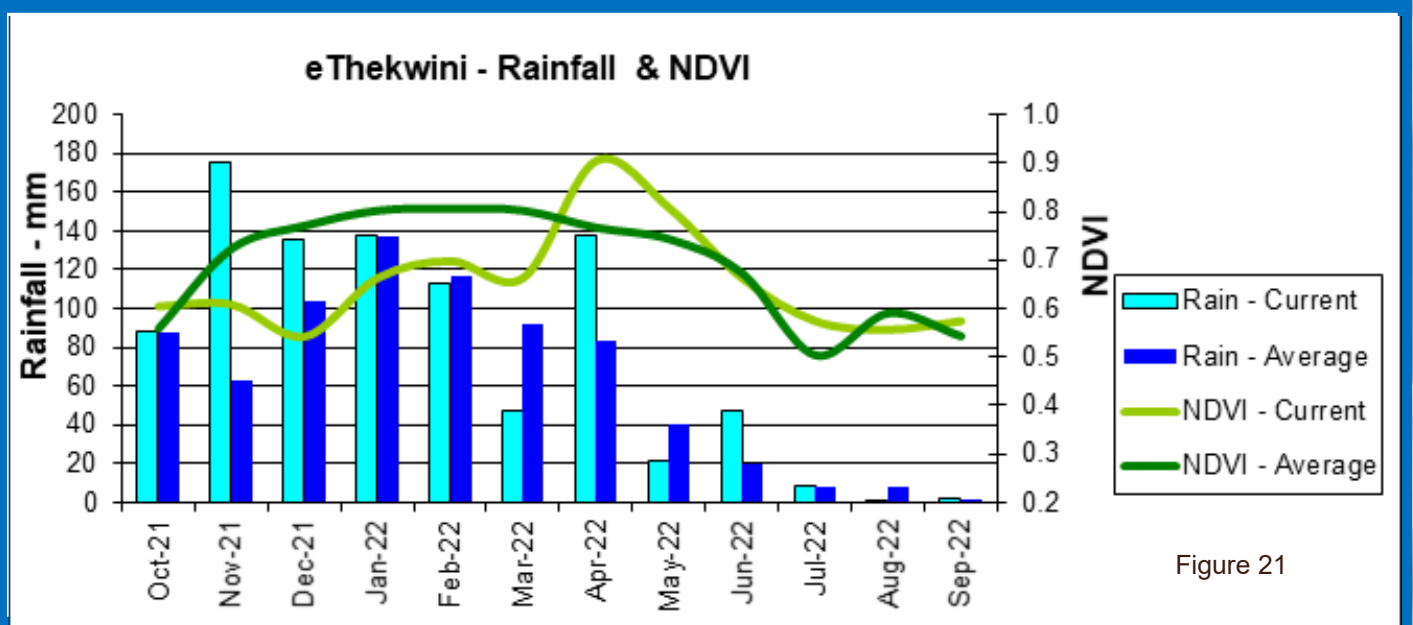# 7. Fire Watch

Active Fires *(Provided when data is available)*

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

Figure 29:
The graph shows the total number of active fires detected between 29 August and 30 September 2022 per province. Fire activity was higher in Gauteng, the Northern Cape, Limpopo, North West and the Western Cape compared to the long-term average.
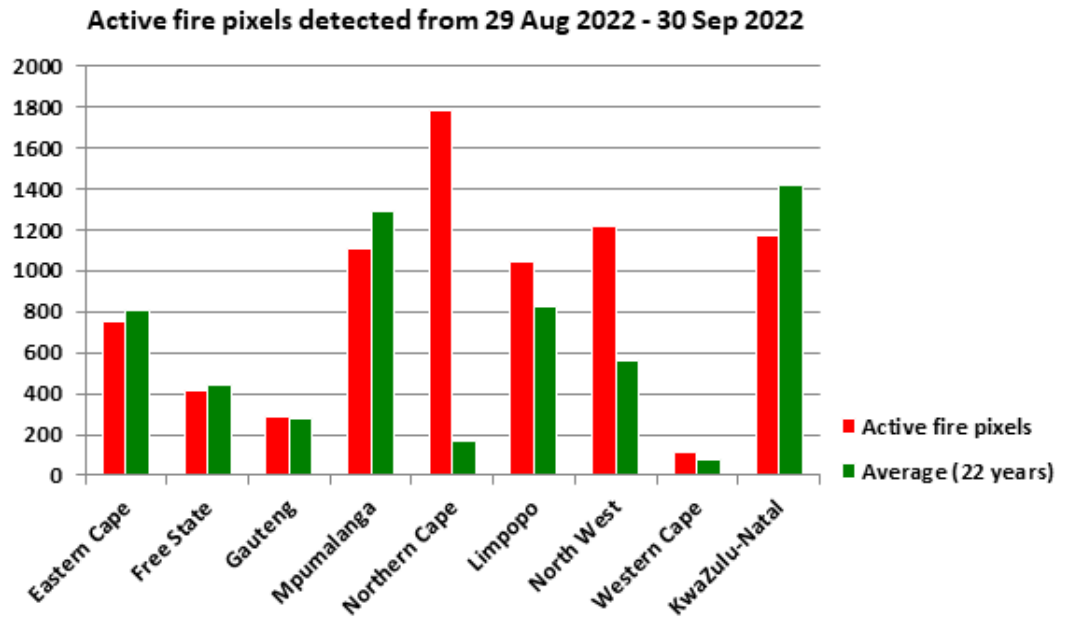
Figure 29
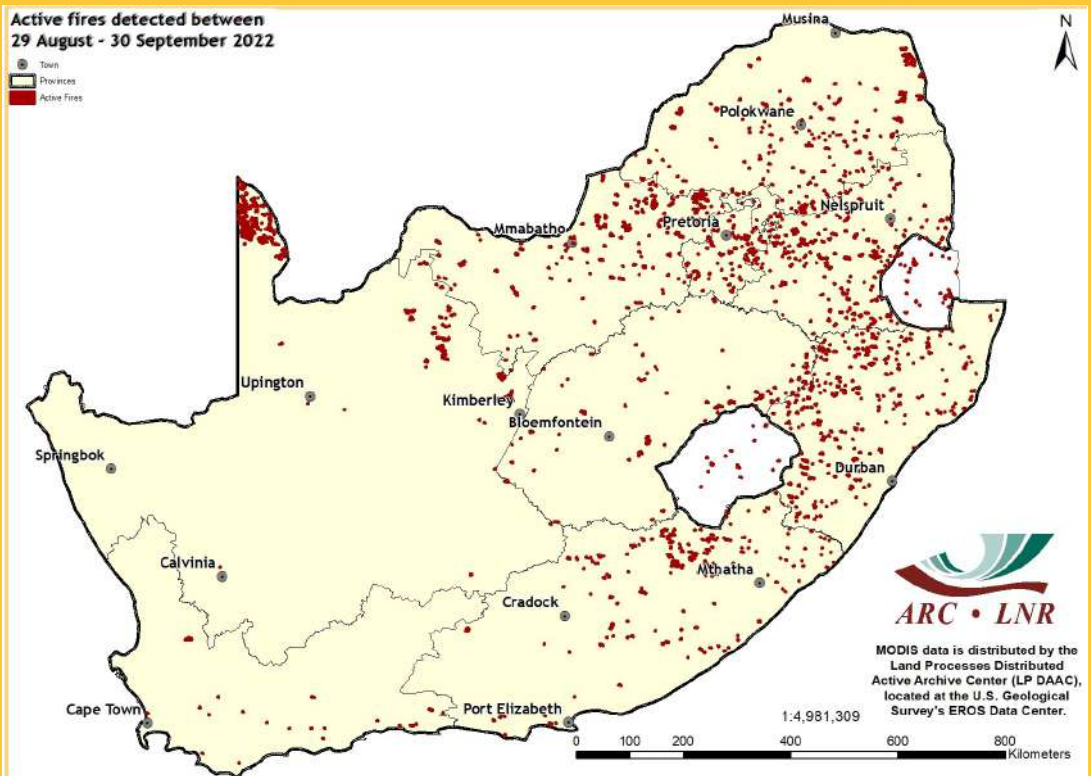
Figure 30:
The map shows the location of active fires detected between 29 August and 30 September 2022 .

Figure 30

Cumulative active fire pixels for 1 Jan 2022 - 30 Sep 2022

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January and 30 September 2022 per province. Cumulative fire activity was lower in all provinces, except for the Northern Cape and North West, compared to the long-term average.

Active fires detected between 1 January - 30 September 2022

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January and 30 September 2022.

Questions/Comments:
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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 oper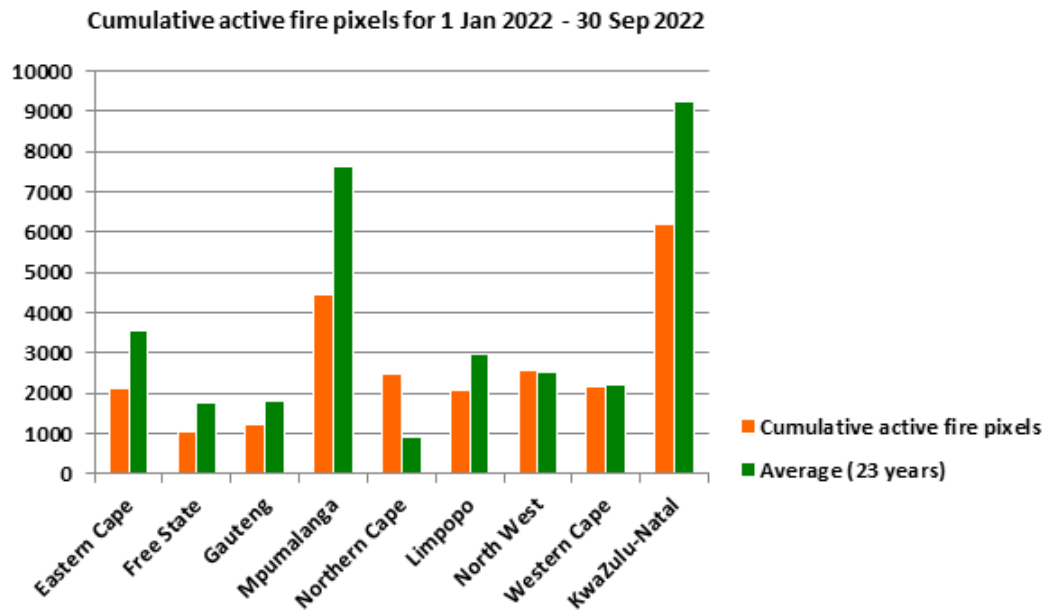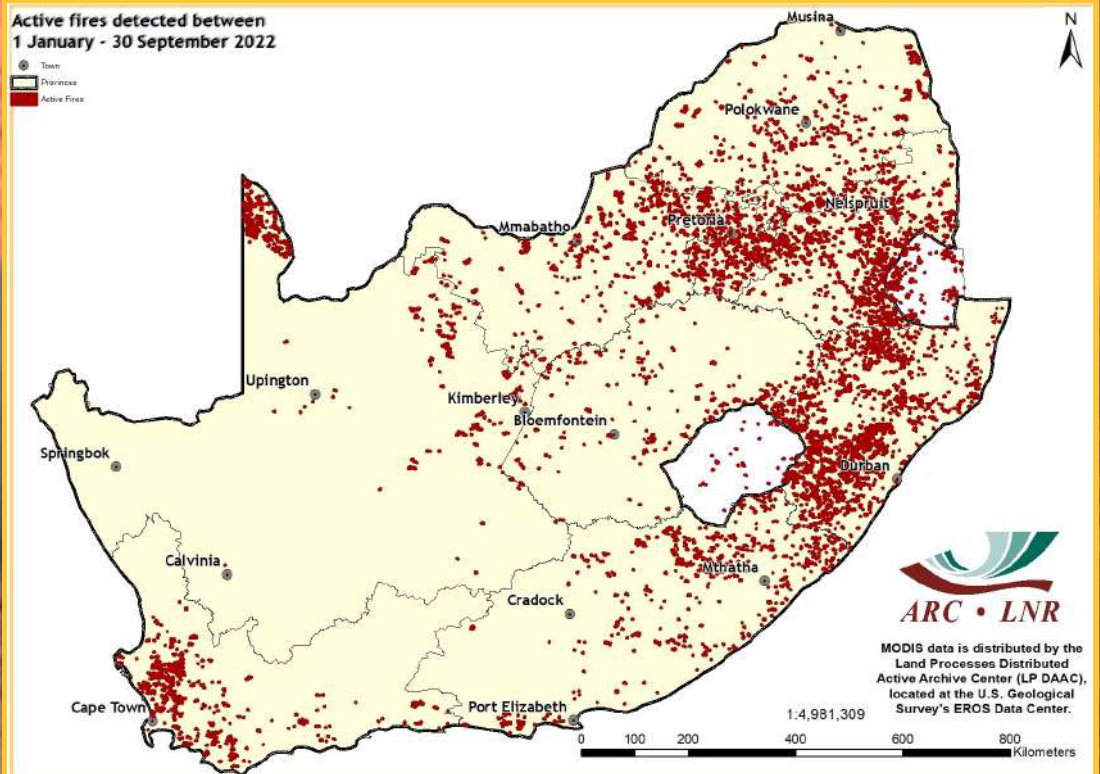ational period of the satellite from which the water information has been generated. In this map, any value less than 100 represents water catchments within which the current month's total surface water is less than the maximum extent recorded for the same area since the end of 2015.

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 September 2022 shows a nearly identical distribution pattern to the previous 3 months. This continues to illustrate the significant impact of the high rainfall experienced over most of the country since late December 2021, with very high water levels across most parts of the country. The majority of Tertiary catchments continue to show water levels equivalent to 80-100% of the 6-year, long-term maximum water, similar to the previous 2022 long-term maps.

The comparison between September 2022 and September 2021 shows similar water level distribution patterns to the last 3 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 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 September 2022 expressed as a % of historic maximum, per Tertiary catchment.
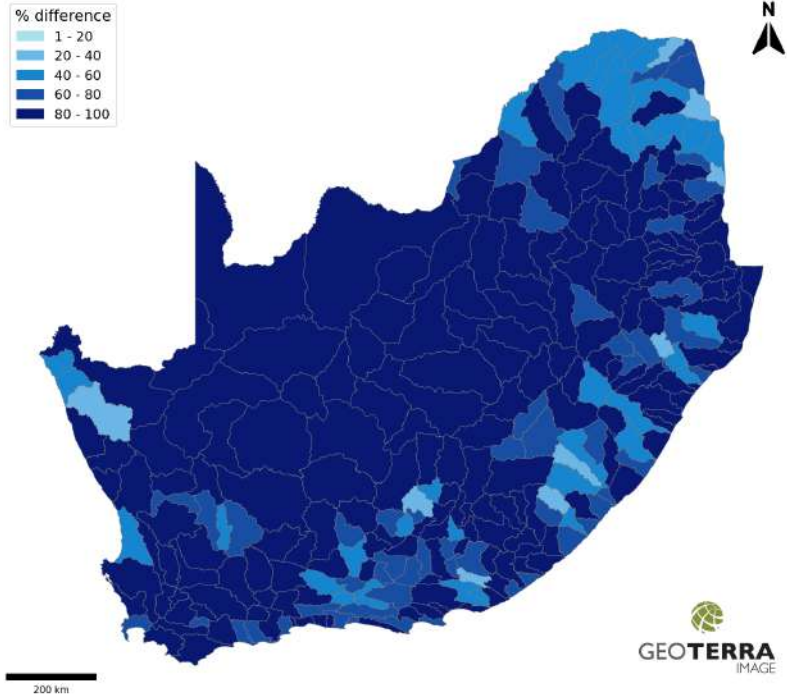
Figure 33

Maximum surface water area for September 2022 expressed as a % of September 2021 maximum, per Tertiary catchment.
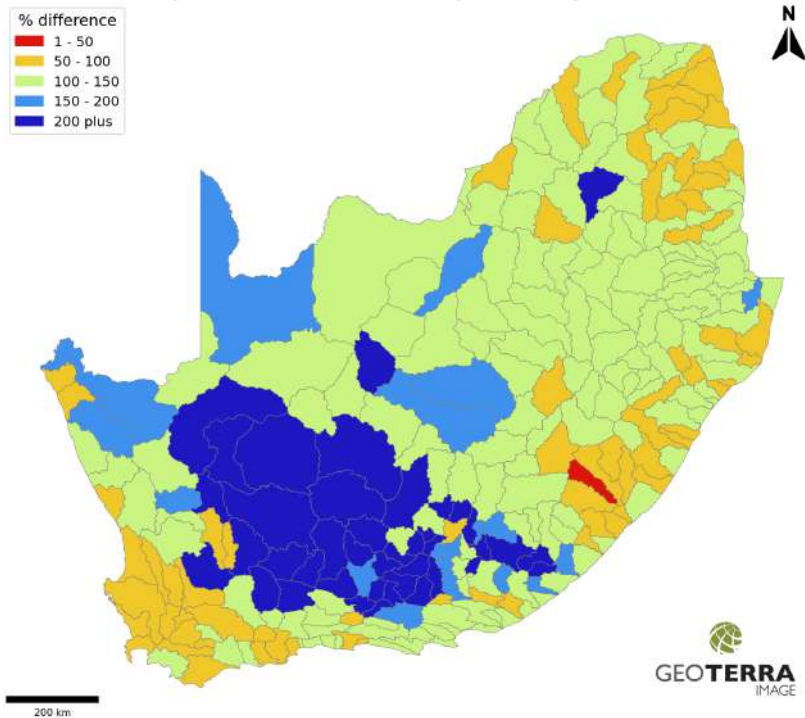
Figure 34

ARC - NATURAL RESOURCES AND ENGINEERING

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

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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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ARC - NATURAL RESOURCES AND ENGINEERING

SOIL, CLIMATE AND WATER

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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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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

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 Campus
600 Belvedere Street, Arcadia, 0083 • Private Bag X79, Pretoria 0001
Tel: 012 310 2500 • Fax: 012 323 1157
Website: www.arc.agric.za
For more information contact:
Adri Laas - Public Relations Officer • E-mail: adril@arc.agric.za

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**.

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NATURAL RESOURCES AND ENGINEERING
Soil, Climate and Water

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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".