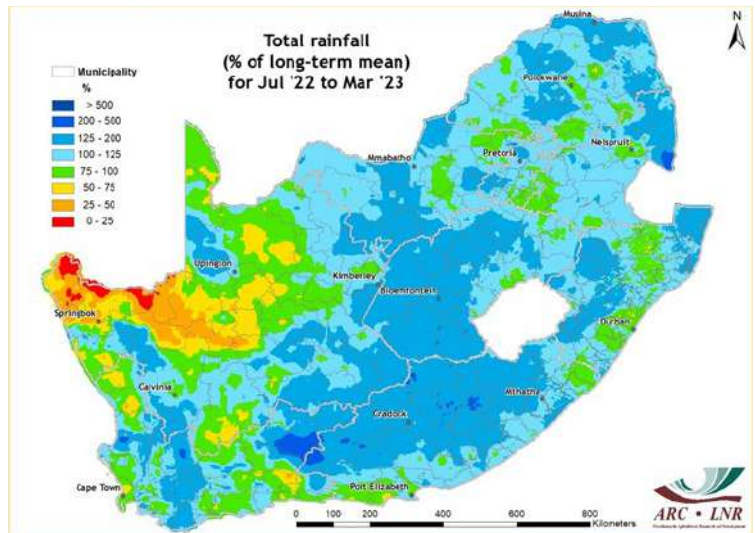




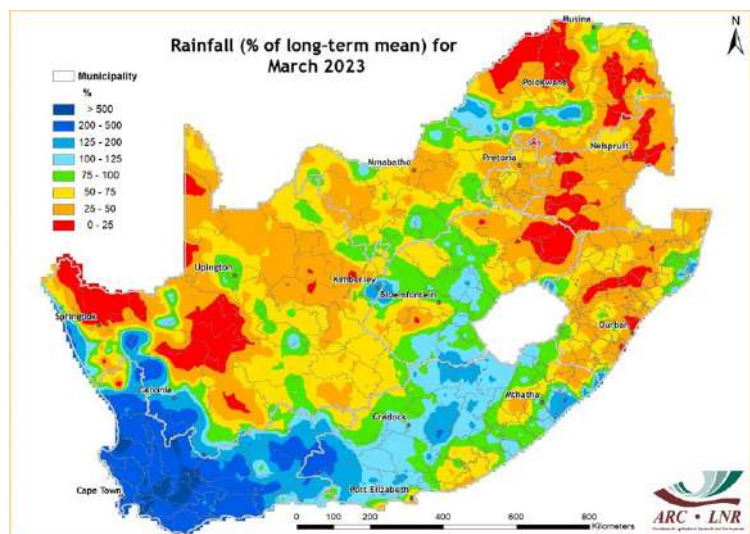
Images of the Month

Dry spell signals early cessation of a wet 2022/23 summer rainfall season

Most regions of the country have received near-normal to above-normal rainfall since July 2022 (see map below), and there were instances of heavy rain and flooding during mid-summer in many areas. Despite this, the rain had a positive effect on soil moisture and the growth of rain-fed crops, leading to increased production in the summer rainfall region, as anticipated in a La Niña summer.



In contrast, the northern to northeastern parts of the summer rainfall region experienced relatively dry conditions during March 2023 (see map below), which may have had negative effects on summer crops that were planted late, such as in late December. Nonetheless, the drier conditions towards the end of summer suggest a supportive role in the ripening of crops and harvesting activities due to the favourable rainfall conditions that have been experienced since October.



NATURAL RESOURCES AND ENGINEERING Soil, Climate and Water

CONTENTS:

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Overview:

South Africa experienced a decrease in total rainfall across most of the summer rainfall region in March 2023 when compared to the previous month. In February, the eastern provinces recorded the highest amounts of rainfall, with values greater than or equal to 300 mm. However, in March, these areas had below-average precipitation levels, except for certain parts of the Eastern Cape. On the other hand, the southwestern region of the country had higher rainfall in March, with totals exceeding 200 mm. In some areas this was up to 500% more than the normal rainfall expected for this period. The rainfall was mainly observed in the southern regions, such as the Garden Route, towards the Overberg District and the adjacent City of Cape Town. The interior of the Northern Cape remained dry in March, following the same trend observed in February, while, the western regions, in particular, recorded rainfall totals ranging from 0-50 mm.

1. Rainfall

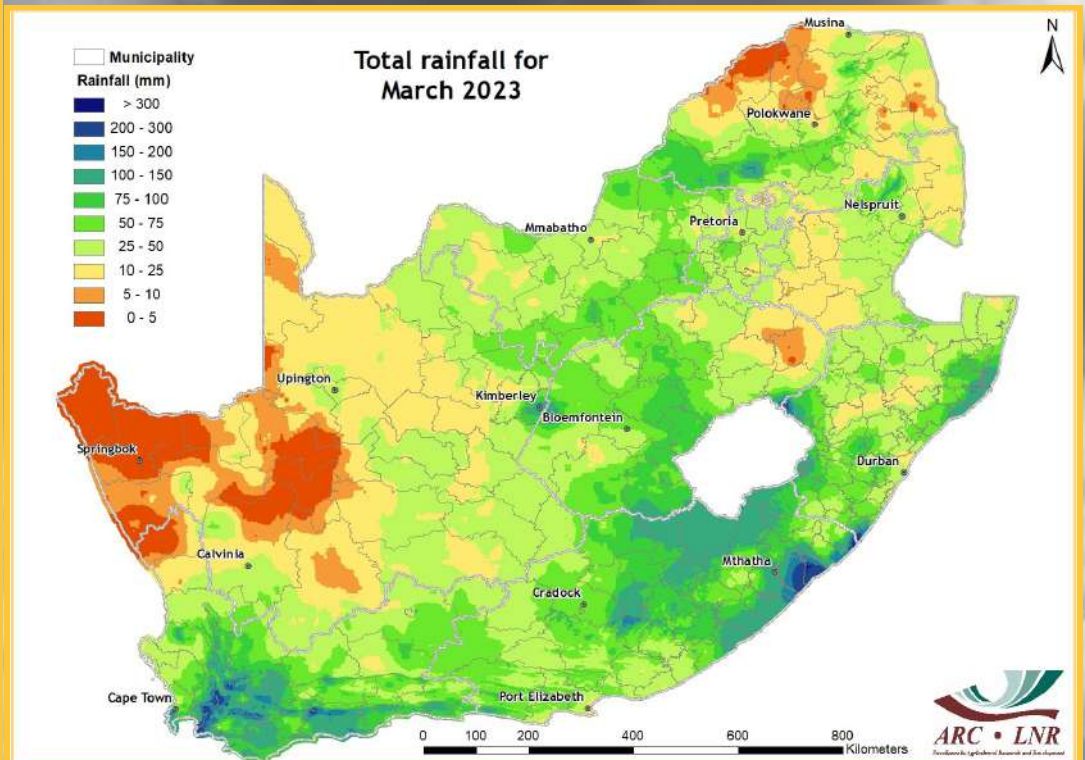


Figure 1

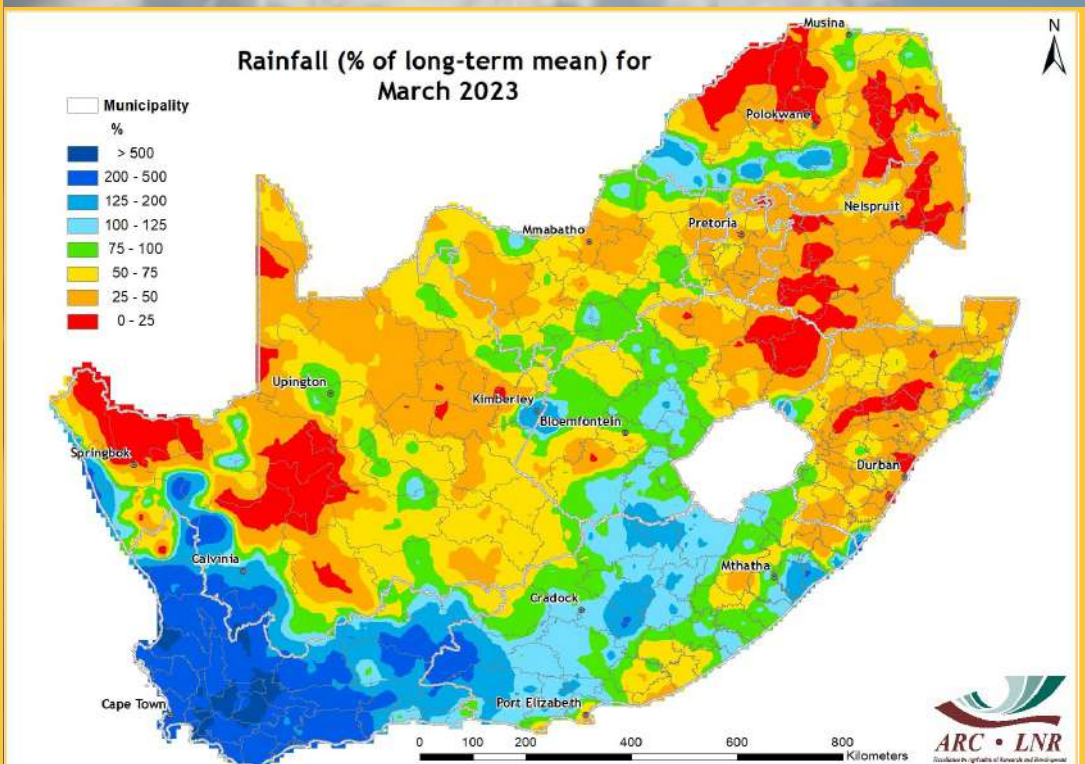


Figure 2

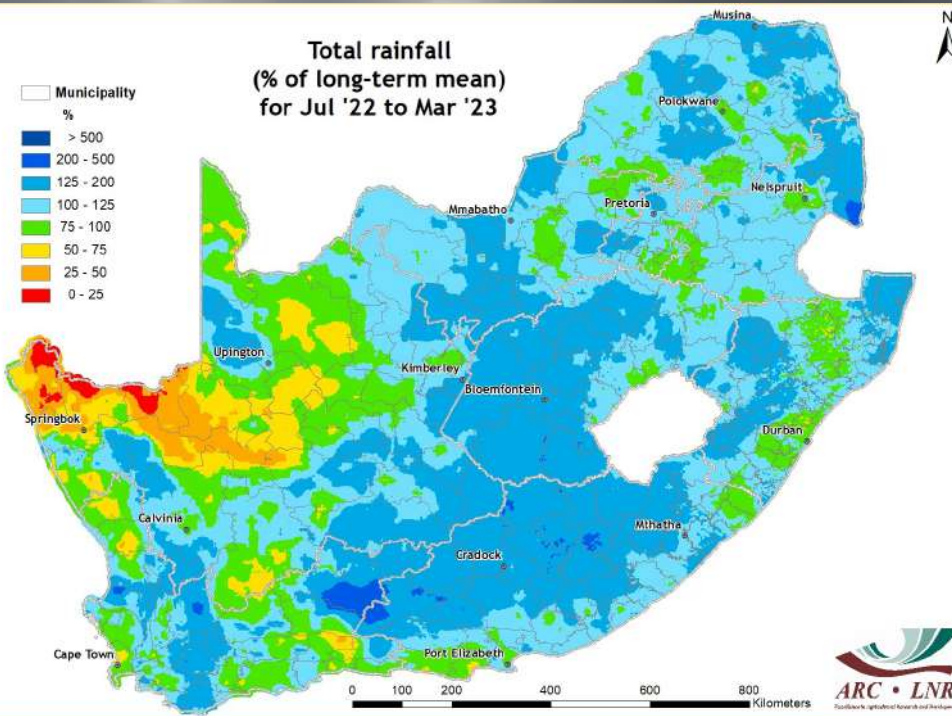


Figure 3

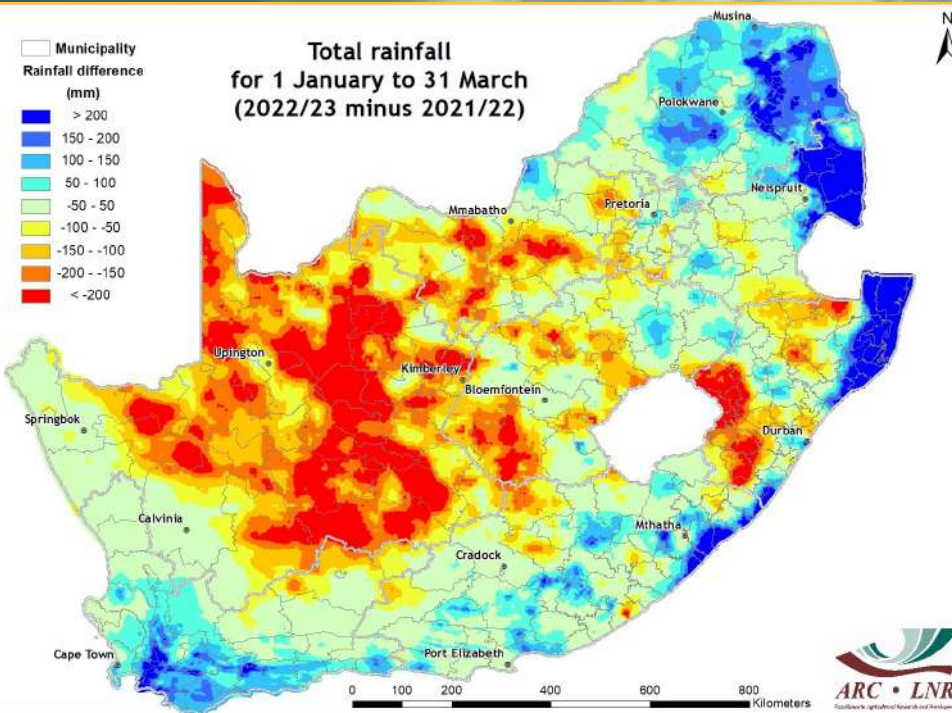


Figure 4

Figure 1:

In March 2023, certain areas of the central to southern interior and the southwestern region of the country experienced rainfall totalling between 75-100 mm. Meanwhile, parts of the Western Cape and the eastern coast from Coffee Bay to Port Edward received heavy rainfall, with amounts ranging from 200-300 mm. However, the Northern Cape interior remained dry during this period.

Figure 2:

The winter rainfall region and the western areas of the all-year rainfall region experienced above-normal rainfall in March. Similar conditions were also observed in certain parts of the central to southern interior, as well as the eastern coastal belt. The rest of the country, particularly the summer rainfall region, received below-normal rainfall during this period.

Figure 3:

Since July 2022, most regions of South Africa have experienced rainfall that was either normal or above-normal. The only exception was the far western corner of the country, which showed below-normal rainfall conditions.

Figure 4:

The total rainfall between 1 January and 31 March 2023, as compared to the same period in the previous year, indicates that the interior received less rainfall while the Lowveld, coastal regions and the southwestern parts of the Western Cape received an excess of rainfall amounting to 150-200 mm.

Questions/Comments:
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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 March 2023 are shown in Figures 5-8. The short-term SPI map indicates that the summer and winter rainfall regions experienced wet conditions due to high rainfall totals that had occurred since November 2022. However, below-normal rainfall activity during the preceding months resulted in indicators of mild drought over western parts of the Northern Cape and the all-year rainfall region. When considering long-term drought conditions, the SPI values indicate more pronounced wet conditions over the interior, towards the eastern provinces, and isolated areas of the winter rainfall region.

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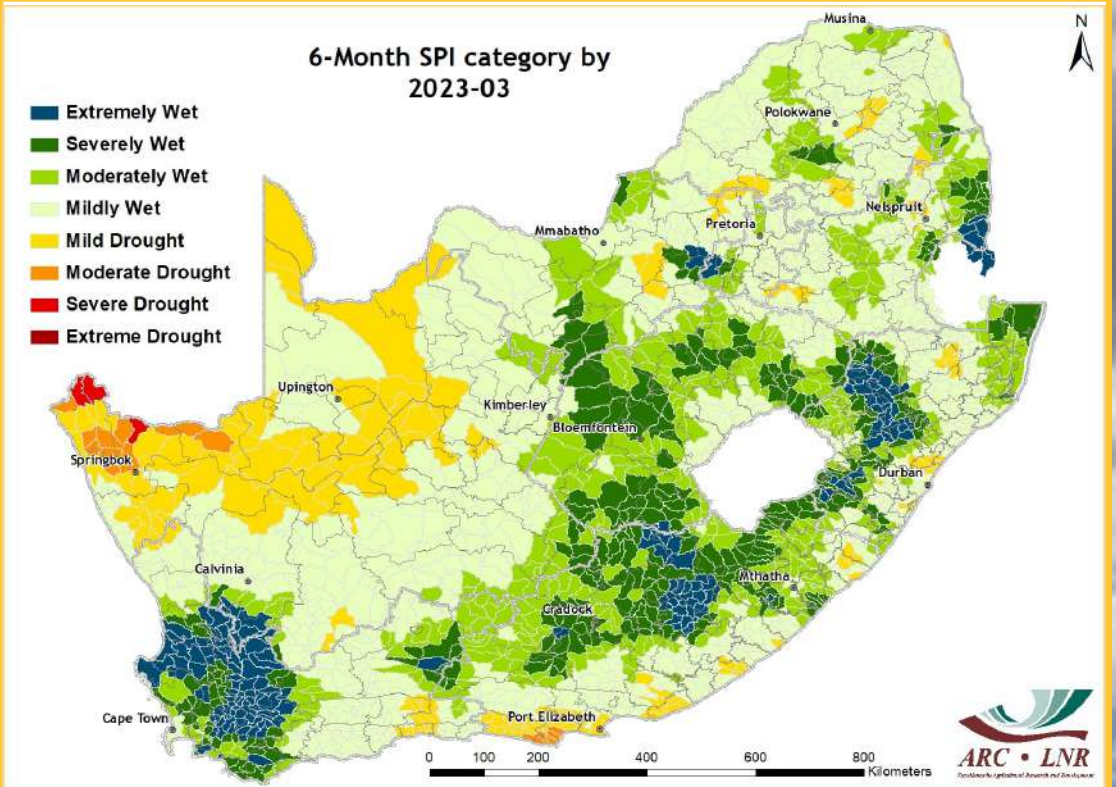


Figure 5

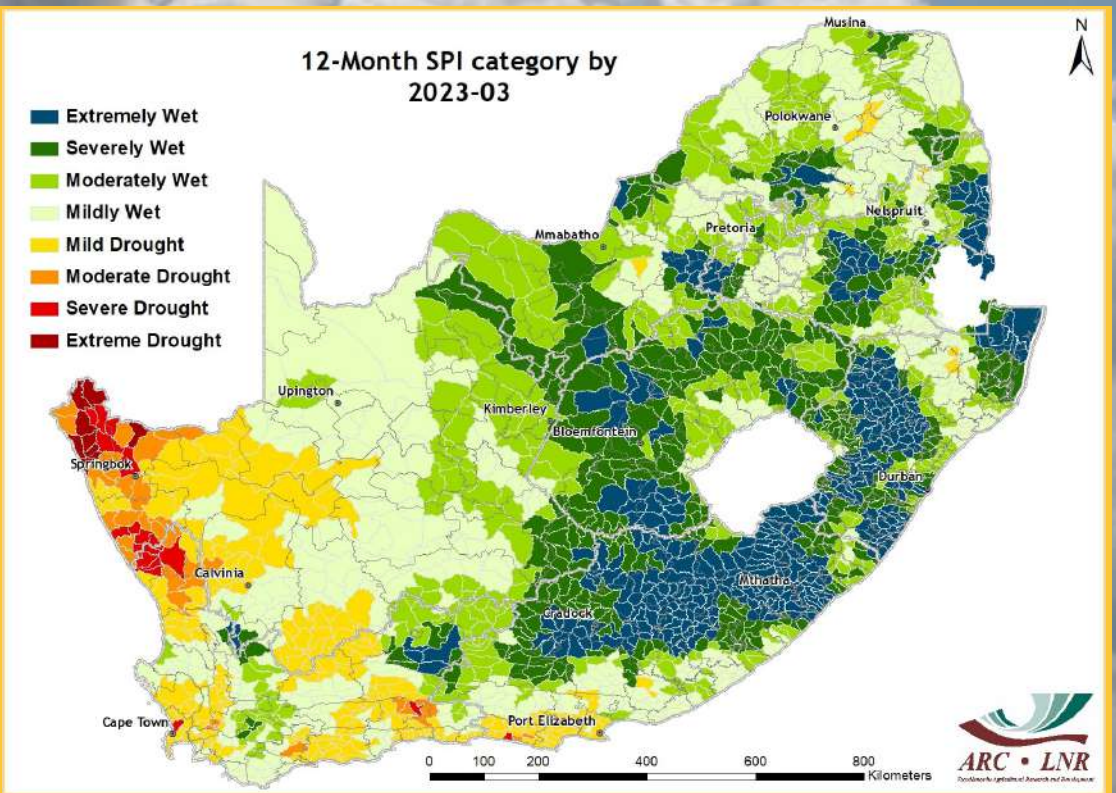
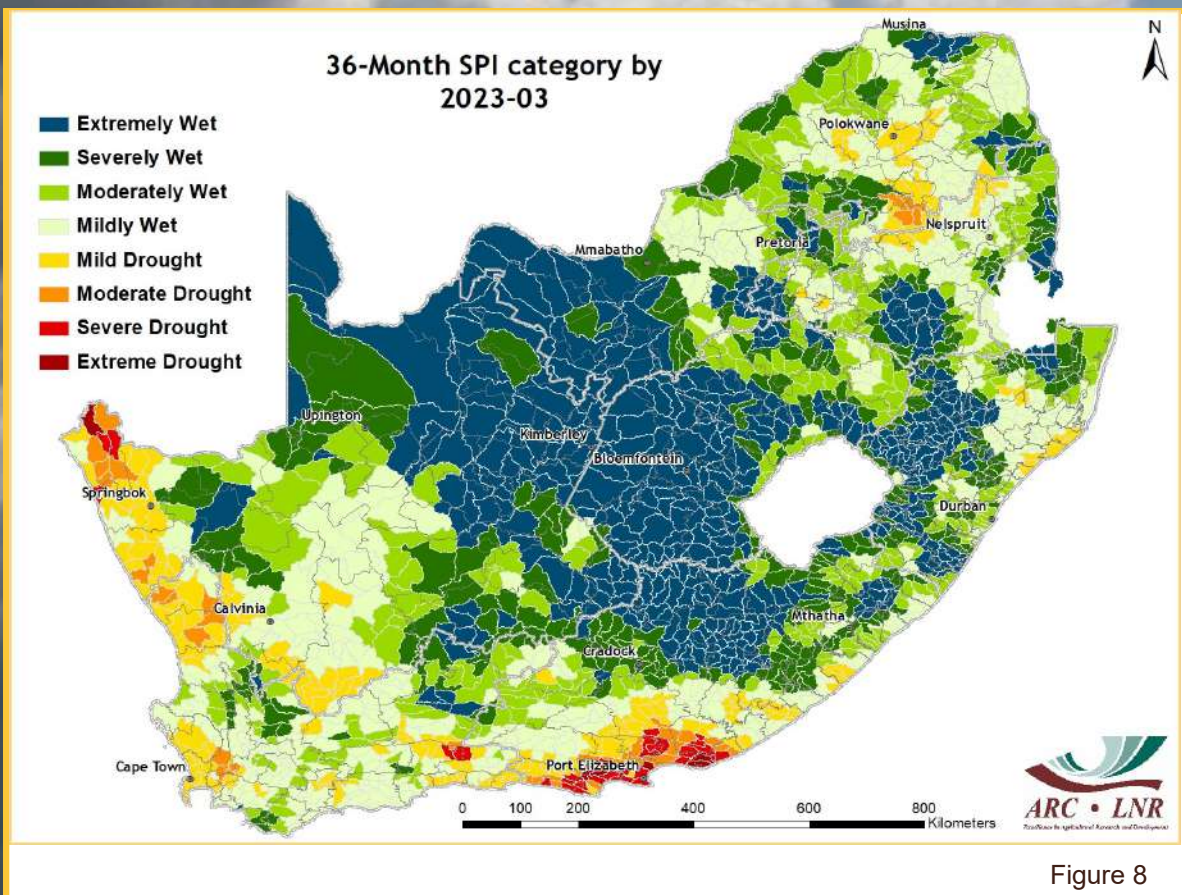
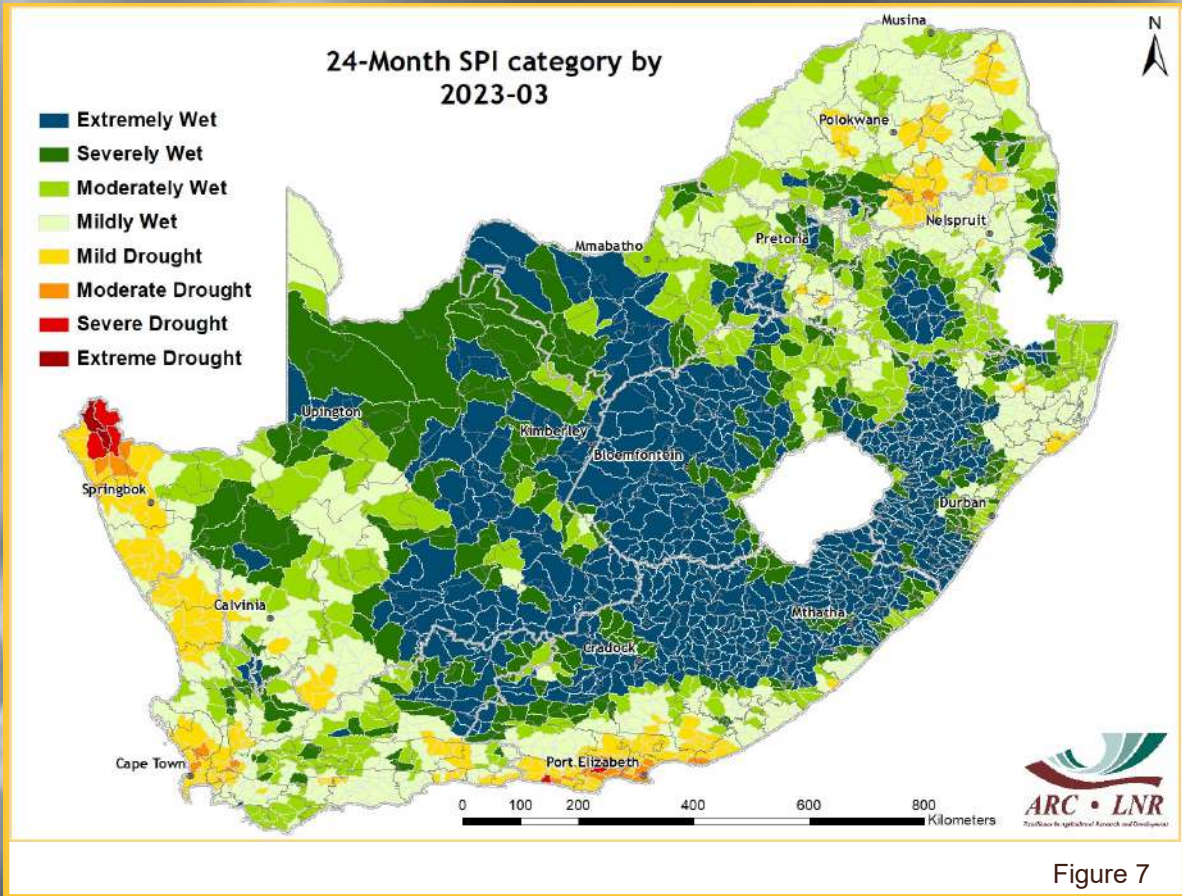


Figure 6



3. Rainfall Deciles

Deciles are used to express the ranking of rainfall for a specific period in terms of the historical time series. In the map, a value of 5 represents the median value for the time series. A value of 1 refers to the rainfall being as low or lower than experienced in the driest 10% of a particular month historically (even possibly the lowest on record for some areas), while a value of 10 represents rainfall as high as the value recorded only in the wettest 10% of the same period in the past (or even the highest on record). It therefore adds a measure of significance to the rainfall deviation.

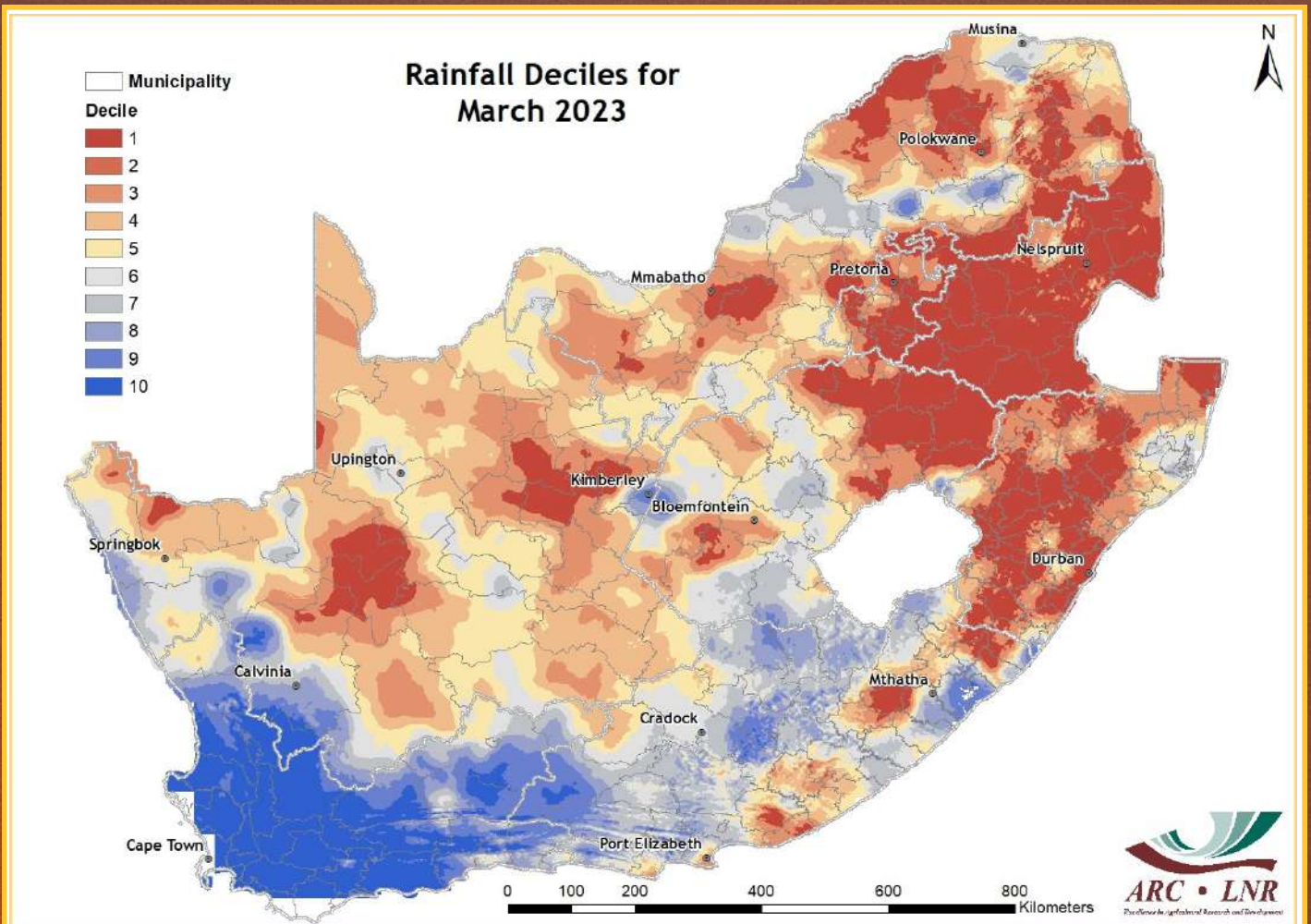


Figure 9

Figure 9:

Rainfall totals during March 2023 over the southwestern parts of the country, as well as over fairly large areas in the southeastern parts, received rainfall totals that compare well with historically wetter March months. However, in large parts of the summer rainfall region, rainfall totals were comparable to historically drier March months.

Questions/Comments:
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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

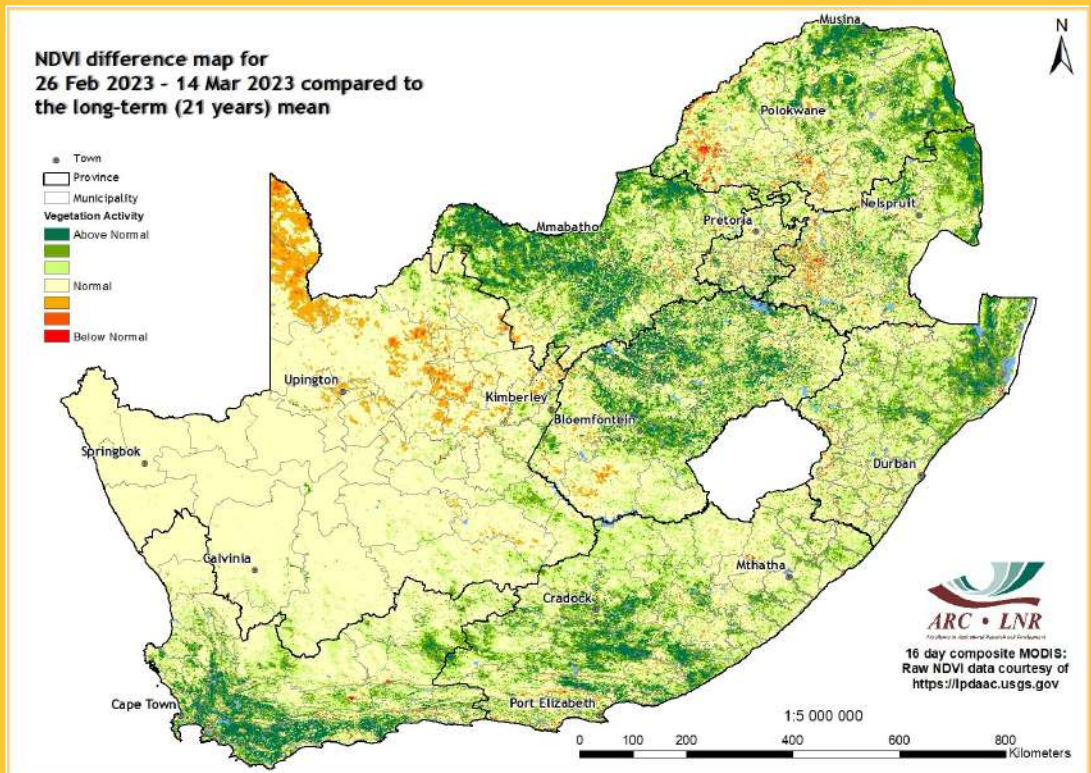


Figure 10

Figure 10:

Compared to the historical averaged vegetation conditions, the 16-day NDVI map for March 2023 shows that many parts of the county experienced normal to above-normal vegetation activity, with the exception of the northern and northwestern parts which experienced patches of below-normal conditions.

Figure 11:

The 16-day NDVI difference map for March 2023 compared to the preceding 16-day period shows that the central interior experienced below-normal vegetation activity while the remaining parts of the country experienced mainly normal conditions with patches of above-normal activity.

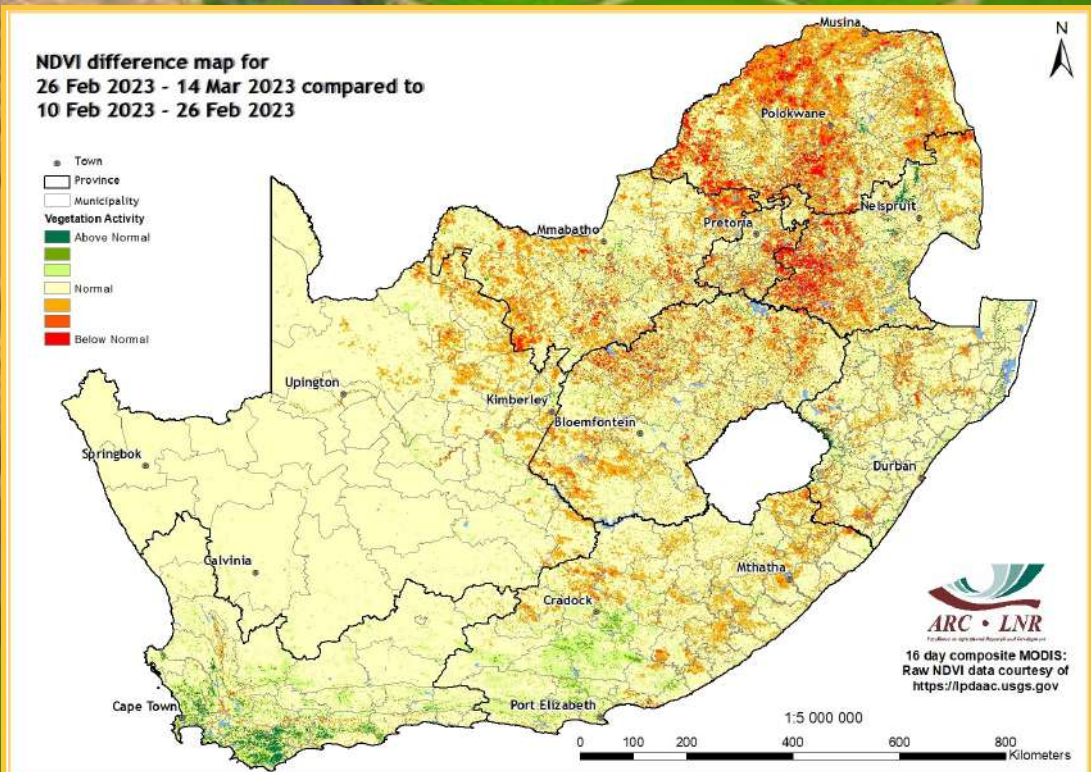


Figure 11

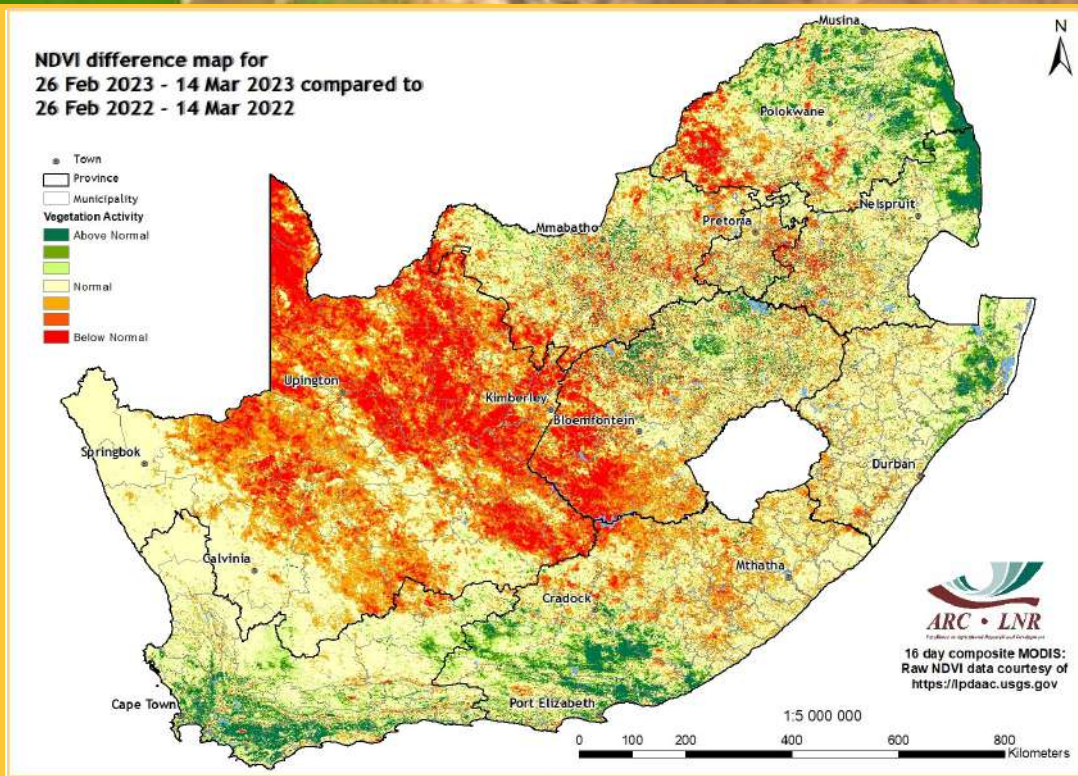


Figure 12

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

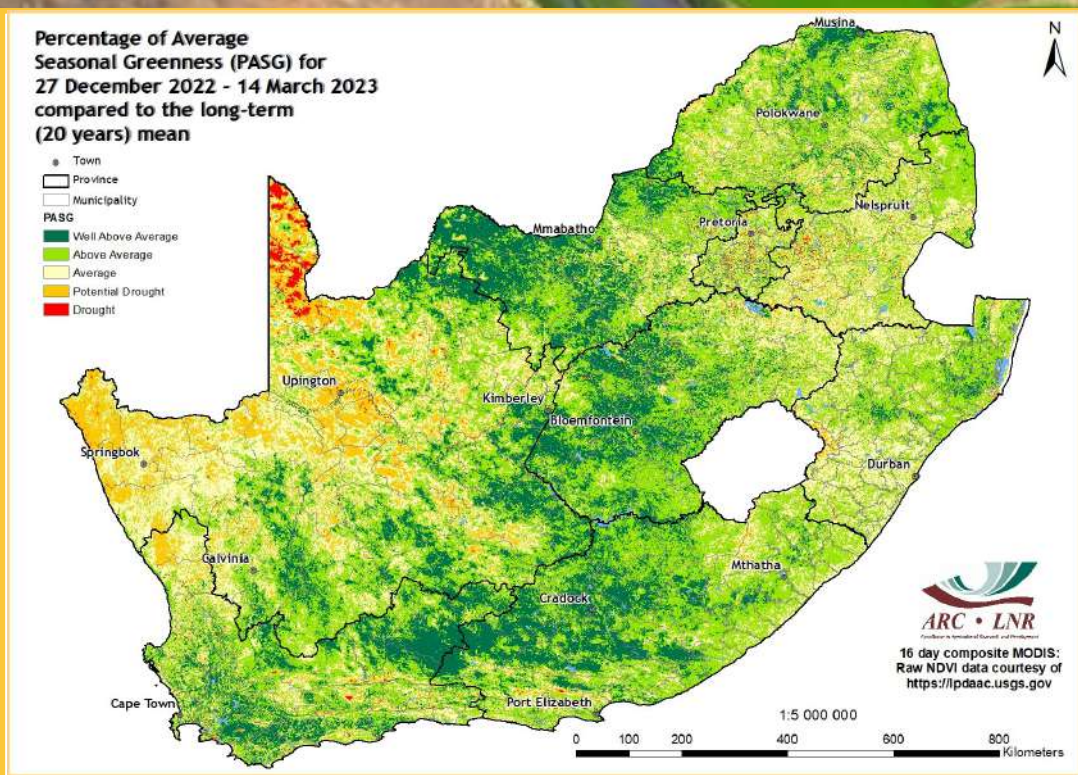


Figure 13

Figure 12:

The 16-day NDVI difference map for March 2023 compared to the same period last year shows that the central interior continued to experience poor vegetation conditions.

Figure 13:

The Percentage of Average Seasonal Greenness (PASG) map for the past 3 months, compared to the long-term mean, shows that high levels of seasonal vegetation greenness prevail in the central, eastern and northern parts of the country, with the exception of the far western parts.

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.

Vegetation Condition Index (VCI) for 26 Feb 2023 - 14 Mar 2023 compared to the long-term (21 years) mean

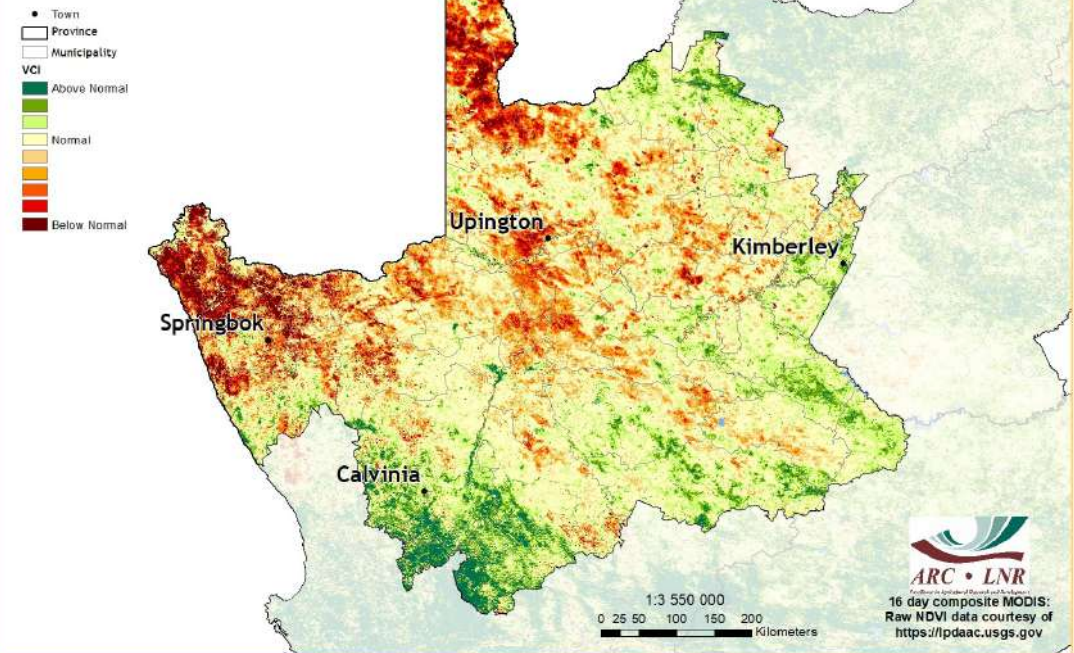


Figure 14

Figure 14:

The 16-day VCI map for March 2023 indicates that most parts of the Northern Cape experienced below-normal vegetation conditions, with patches of above-normal activity in the south and east.

Figure 15:

The 16-day VCI map for March 2023 indicates that near- to above-normal vegetation conditions are prevalent throughout the Western Cape, with patches of below-normal conditions in isolated areas.

Vegetation Condition Index (VCI) for 26 Feb 2023 - 14 Mar 2023 compared to the long-term (21 years) mean

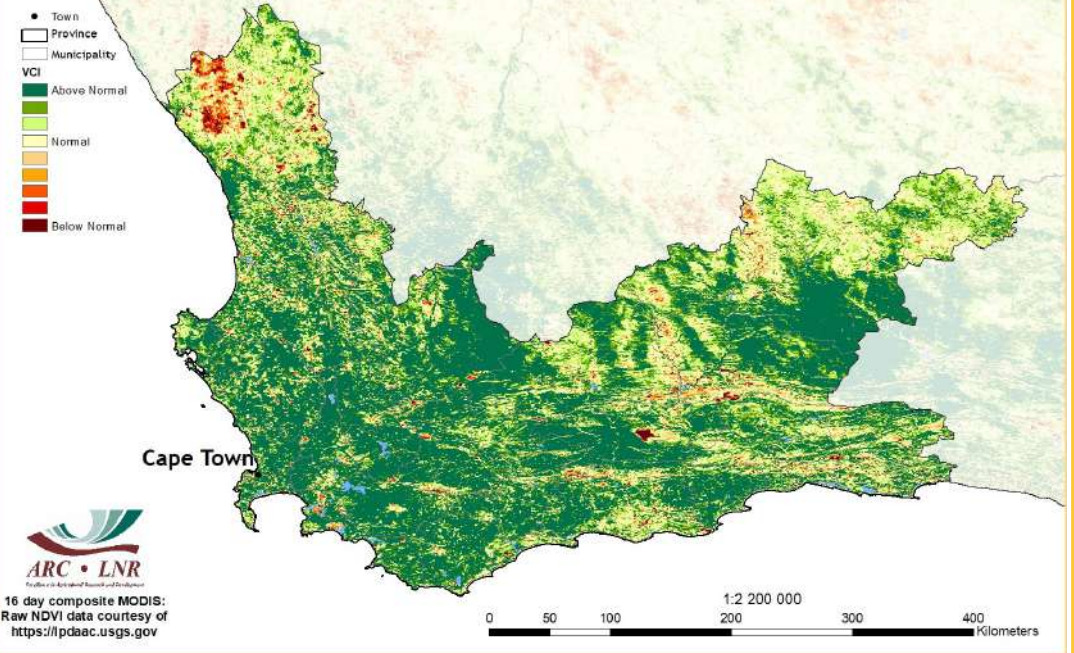


Figure 15

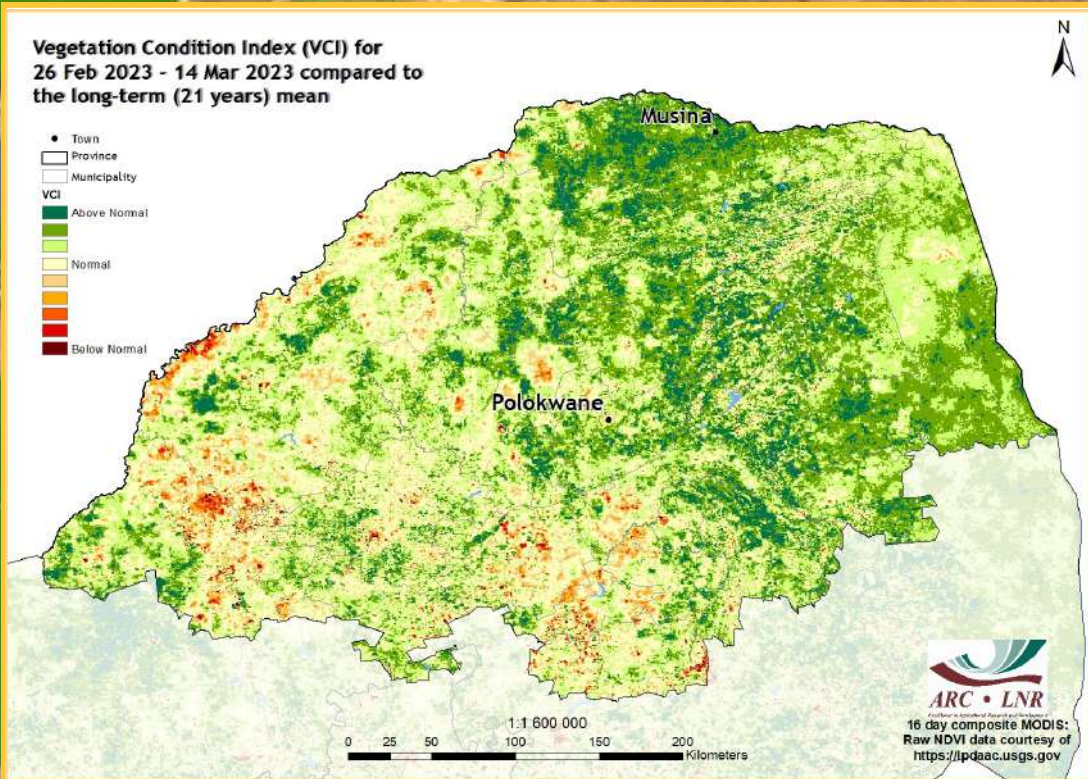


Figure 16

Figure 16:

The 16-day VCI map for March 2023 indicates near- to above-normal vegetation conditions over much of Limpopo, with patches of below-normal activity in isolated areas.

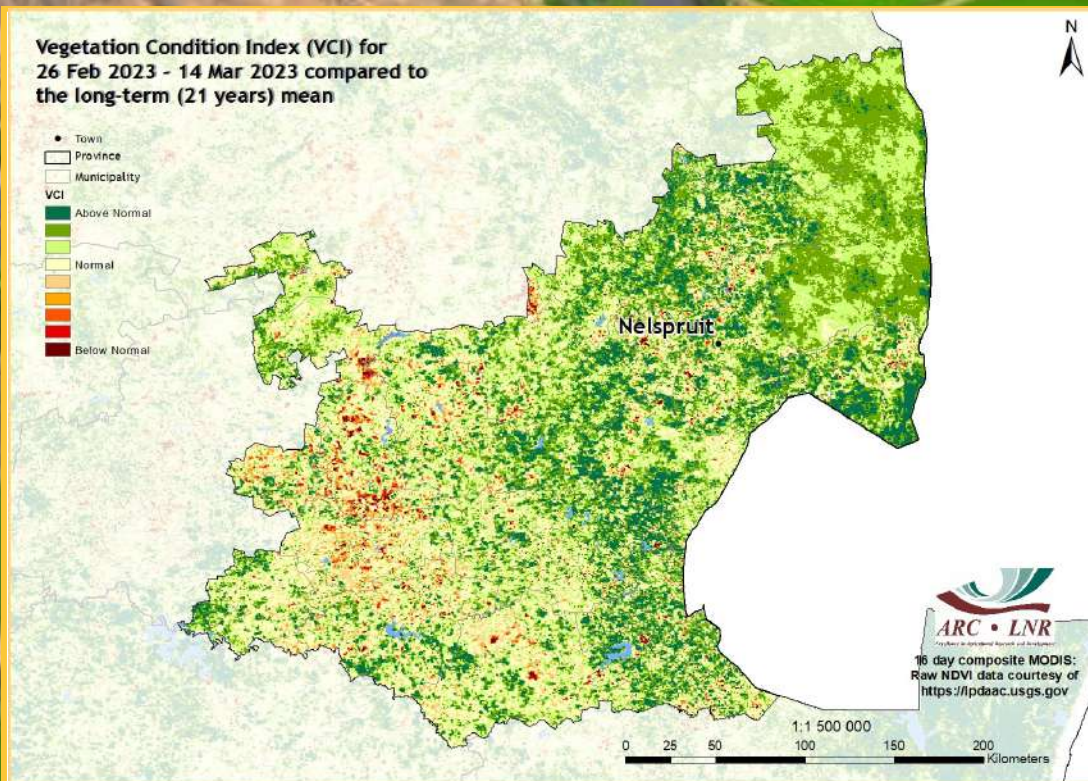


Figure 17

Figure 17:

The 16-day VCI map for March 2023 indicates near- to above-normal vegetation conditions over much of Mpumalanga, with patches of below-normal activity in isolated areas.

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6. Vegetation Conditions & Rainfall

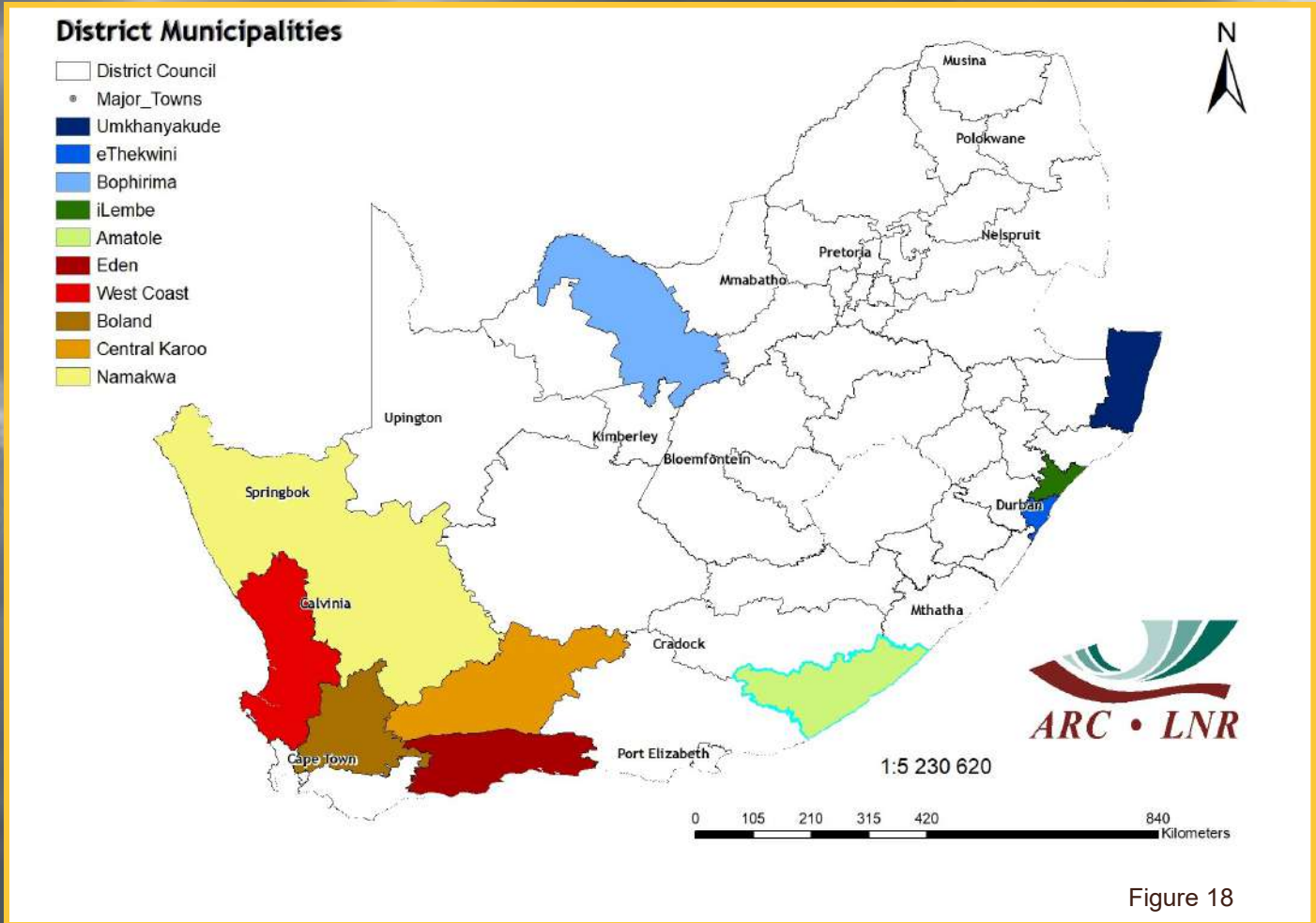


Figure 18

Rainfall and NDVI Graphs

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

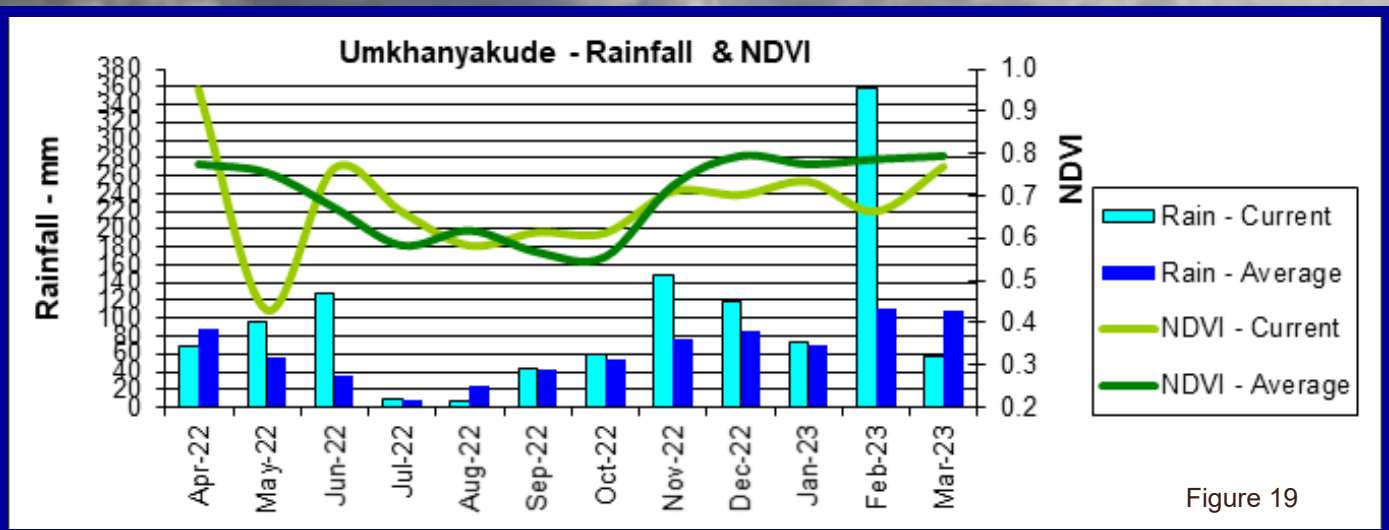


Figure 19

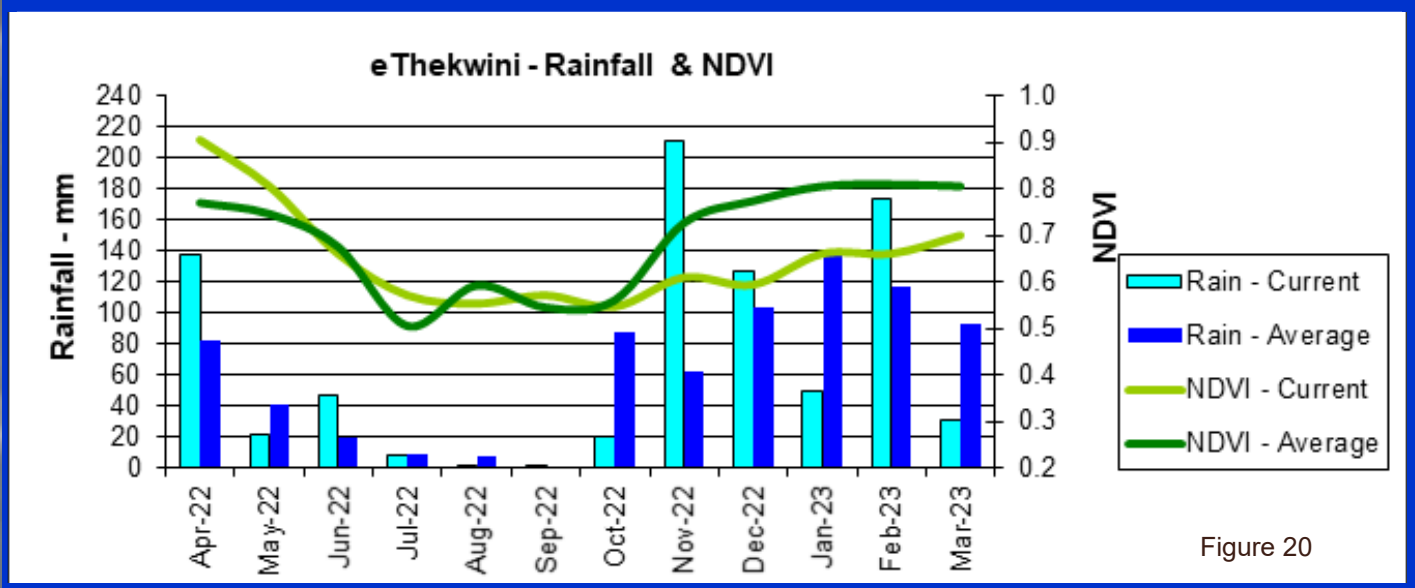


Figure 20

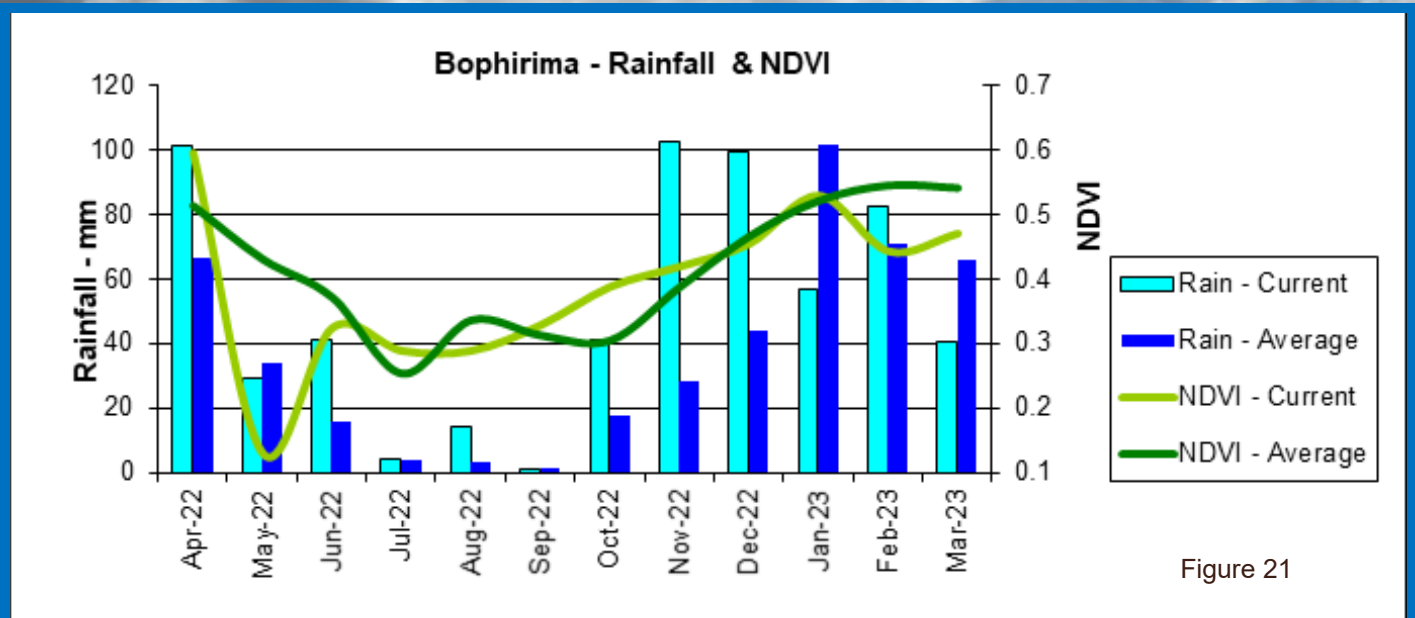


Figure 21

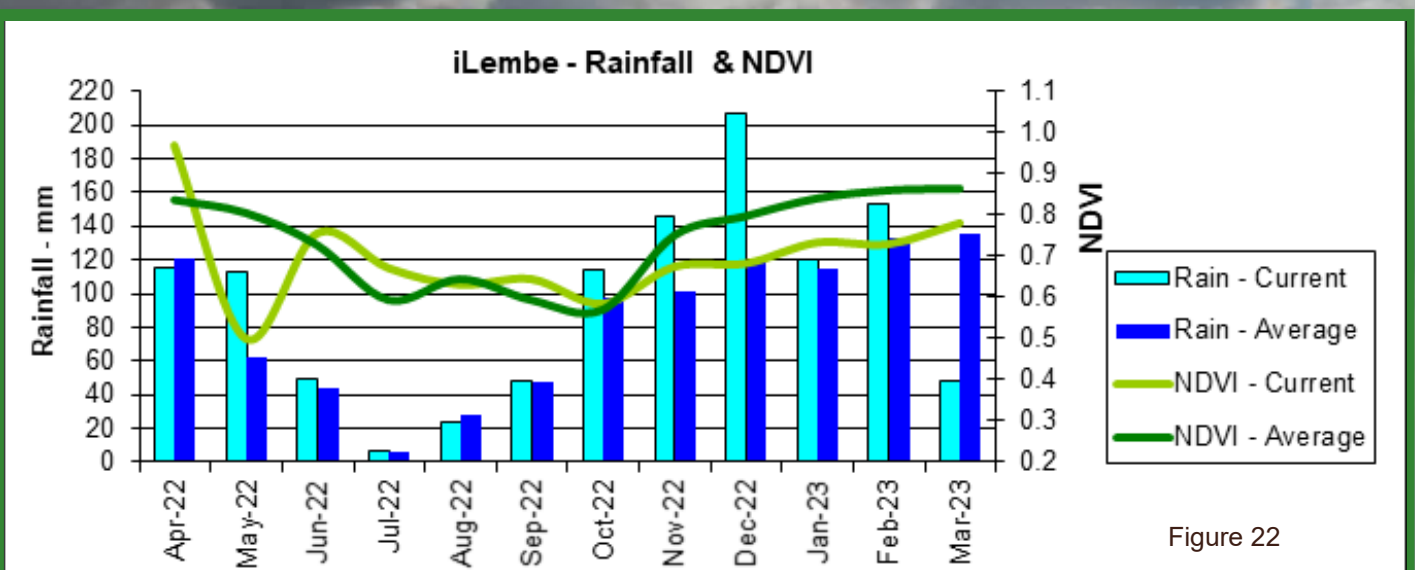


Figure 22

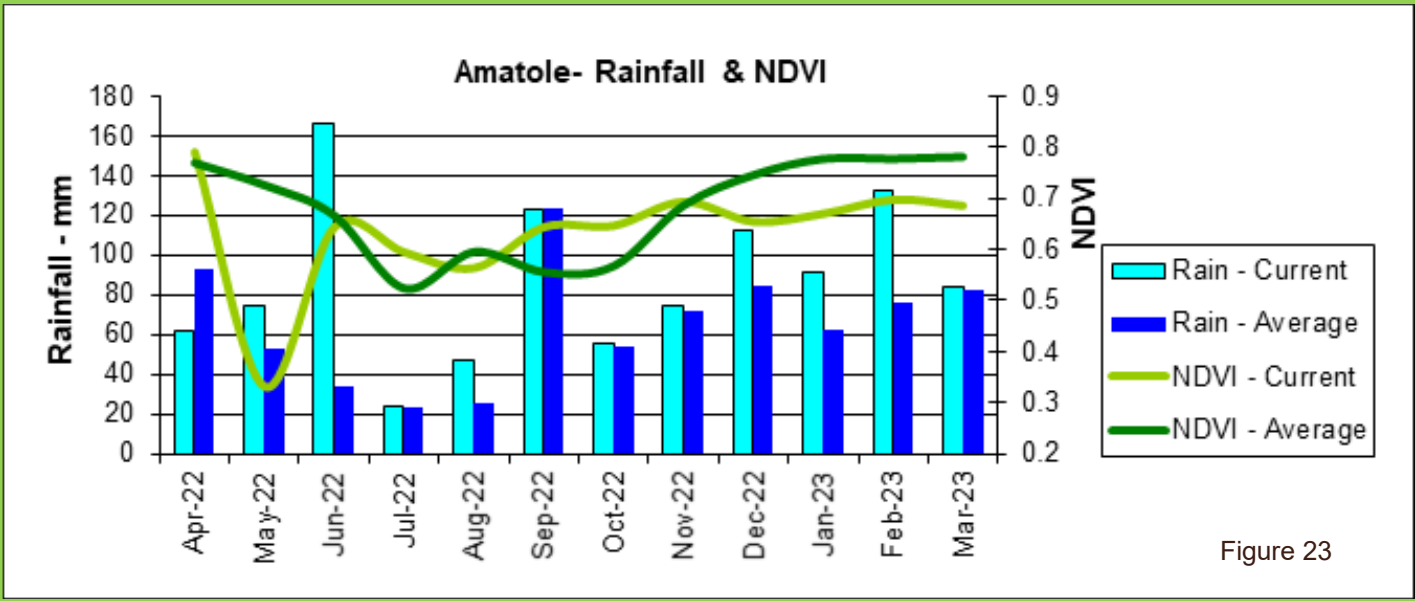


Figure 23

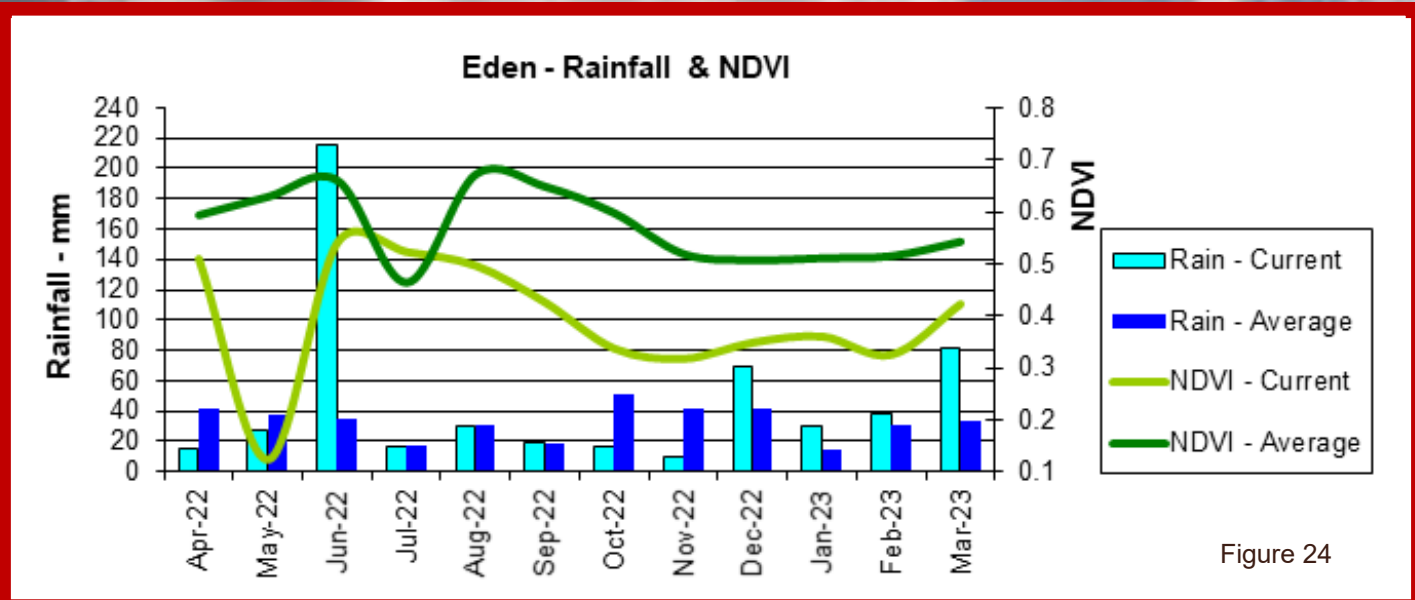


Figure 24

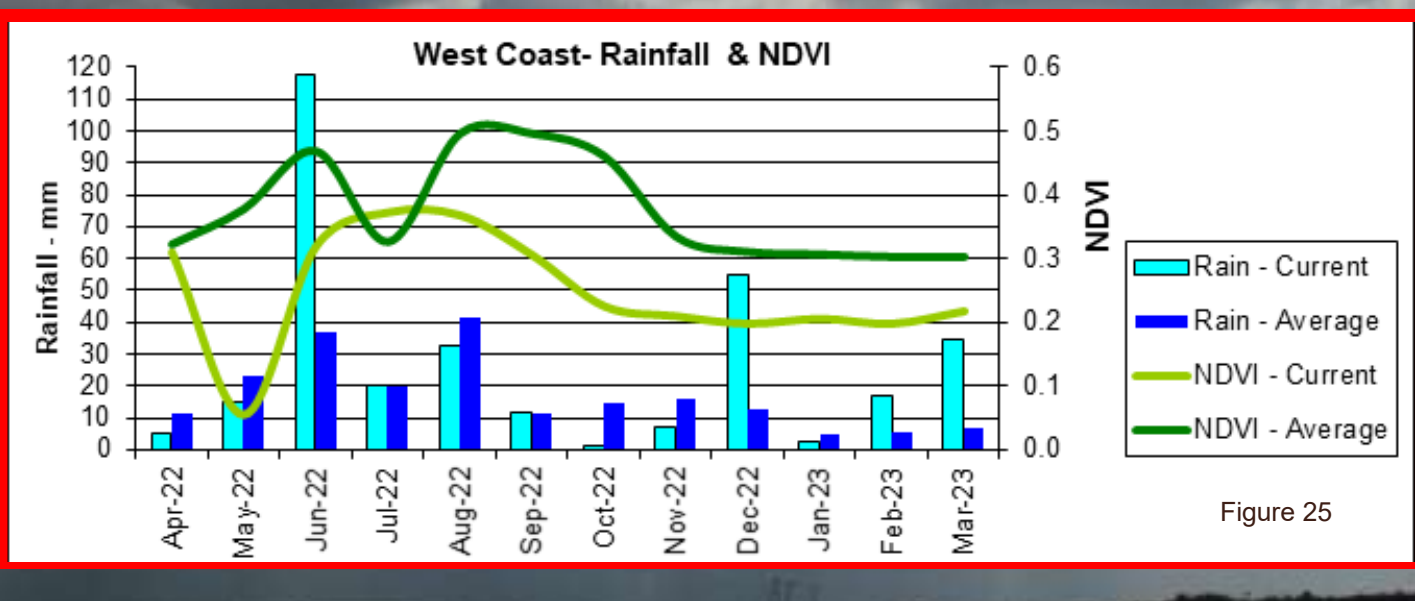


Figure 25

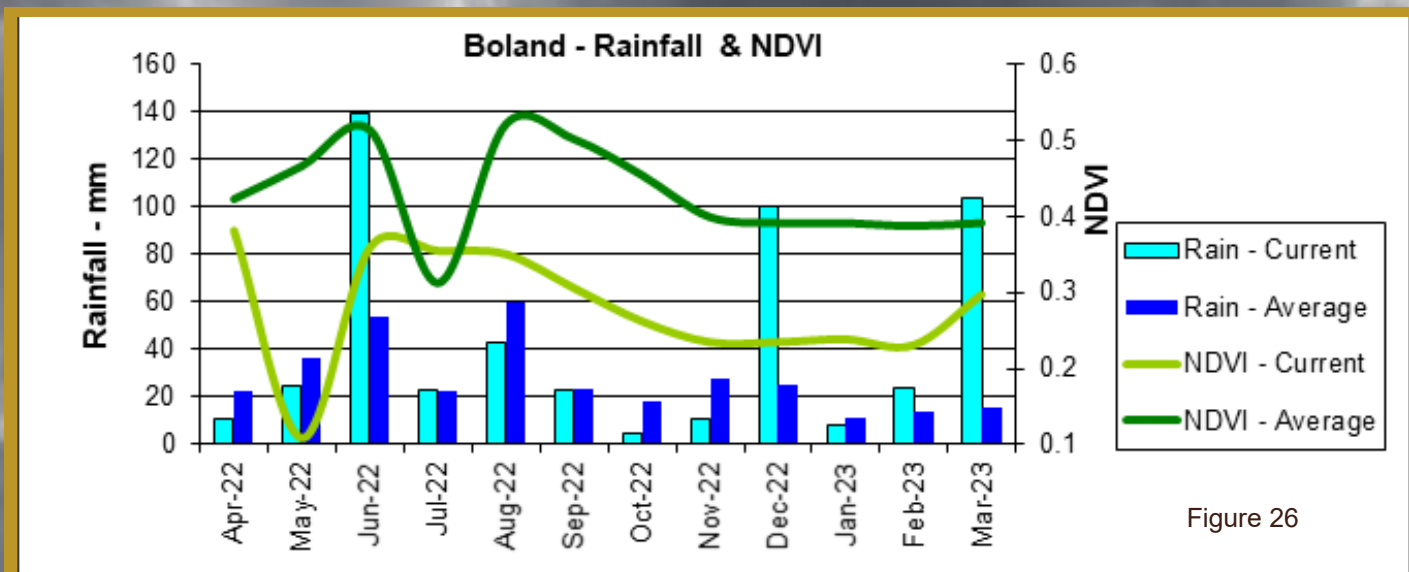


Figure 26

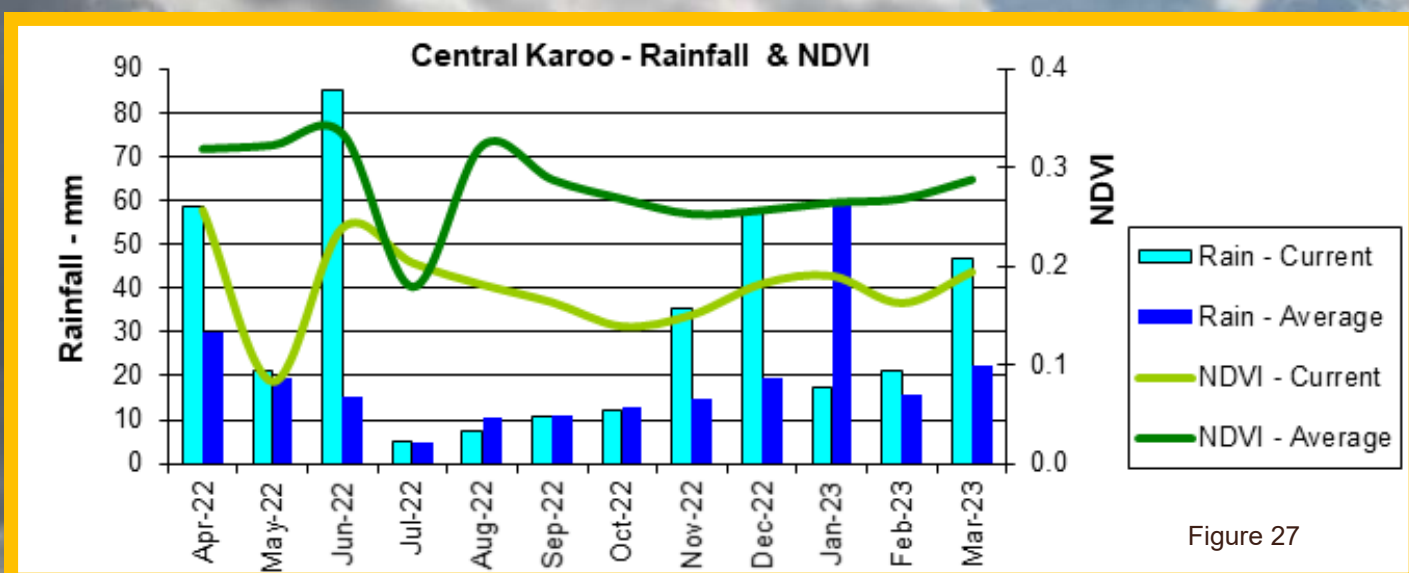


Figure 27

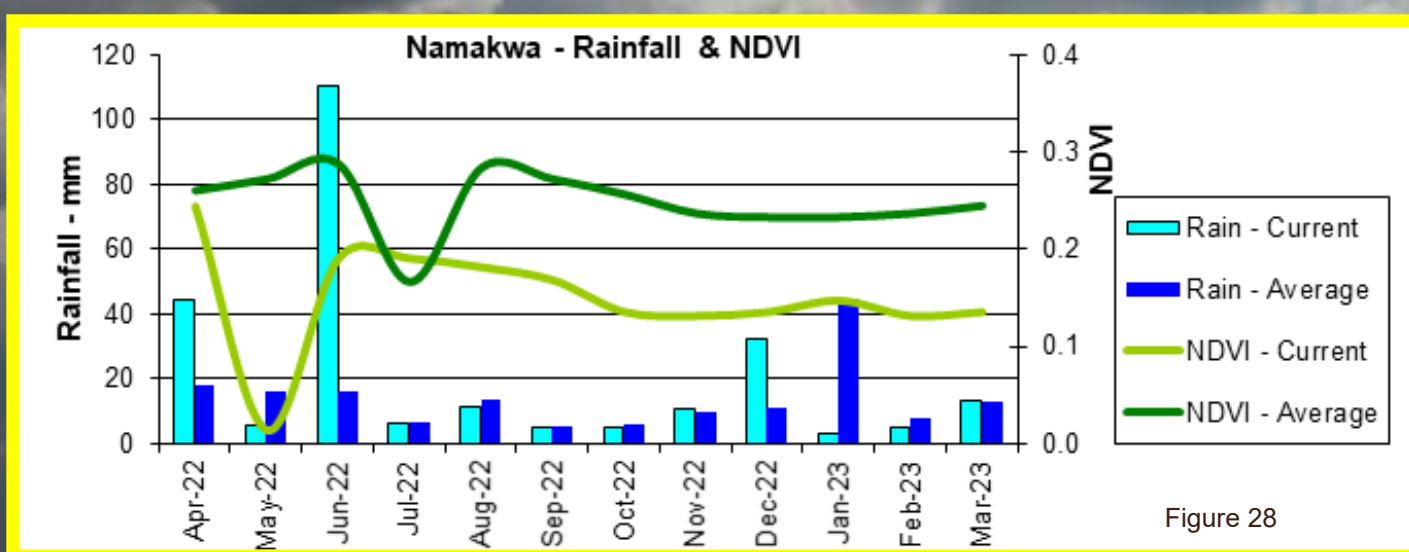


Figure 28

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 from 26 February to 30 March 2023 per province. Fire activity was higher in Free State, Gauteng, Northern Cape and Limpopo compared to the long-term average.

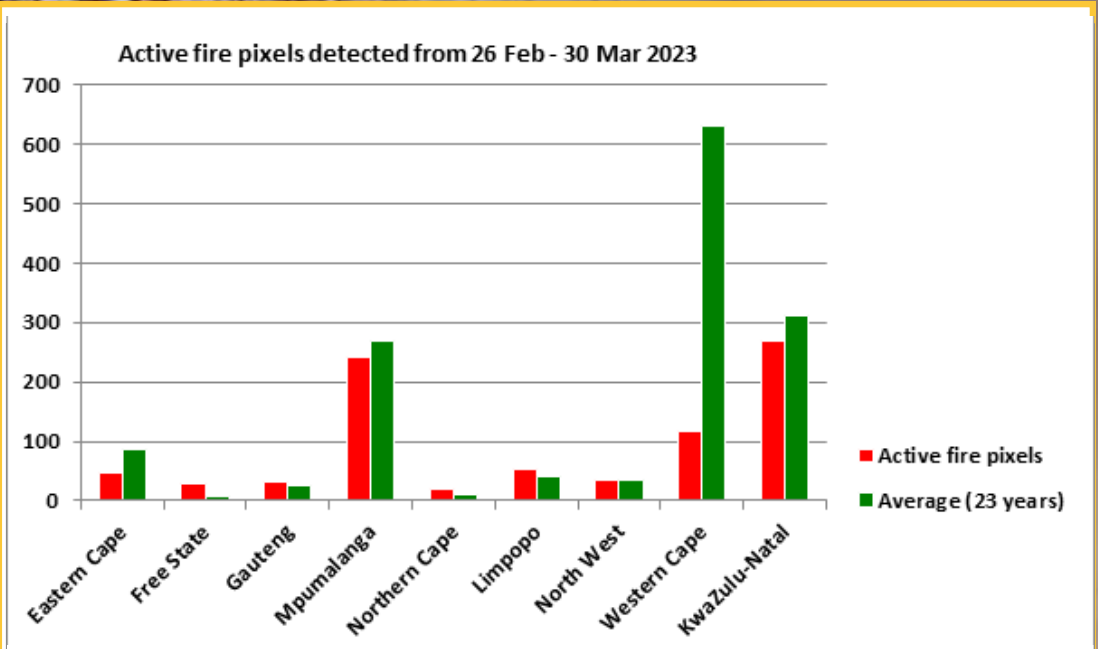


Figure 29

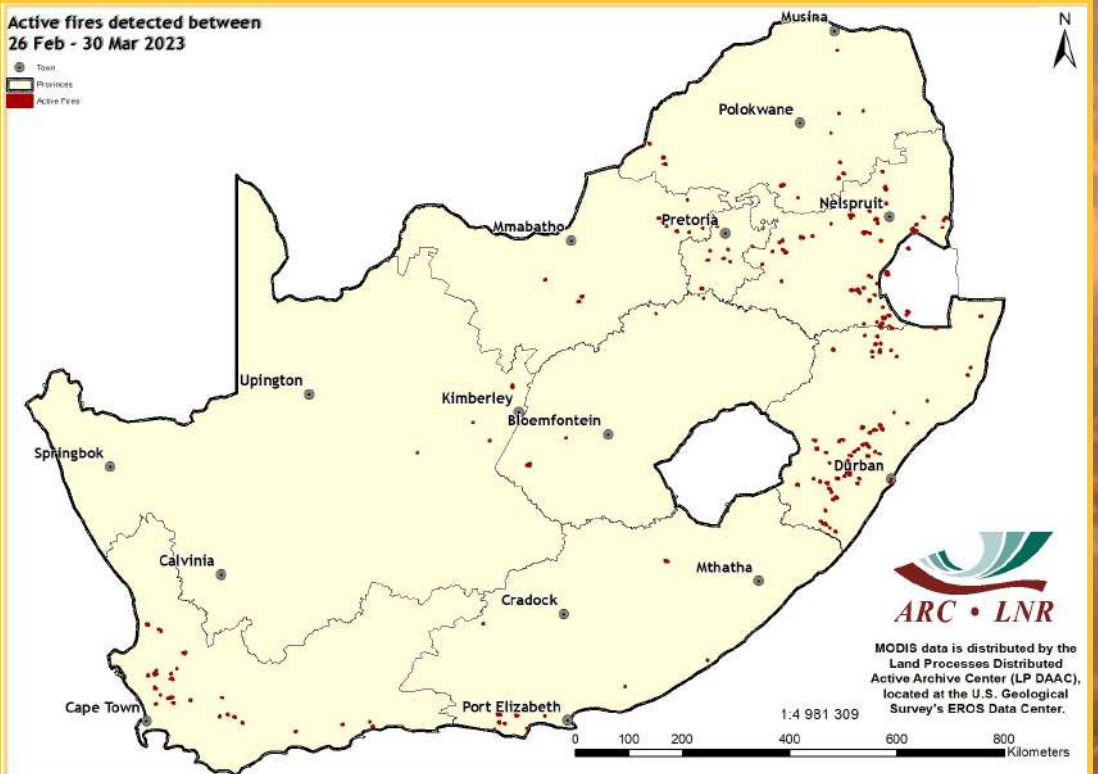


Figure 30

Figure 30:

The map shows the location of active fires detected between 26 February and 30 March 2023.

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 31:

The graph shows the total number of active fires detected from 1 January to 30 March 2023 per province. Fire activity was higher in the Northern Cape and North West compared to the long-term average.

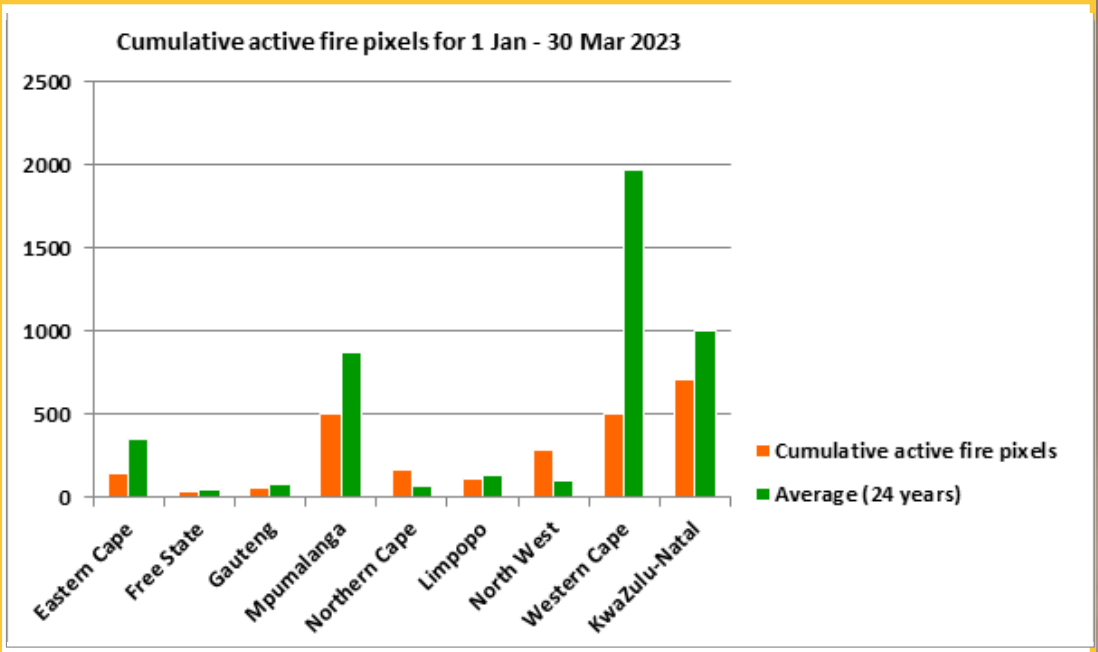


Figure 31

Figure 32:

The map shows the location of active fires detected between 1 January and 30 March 2023.

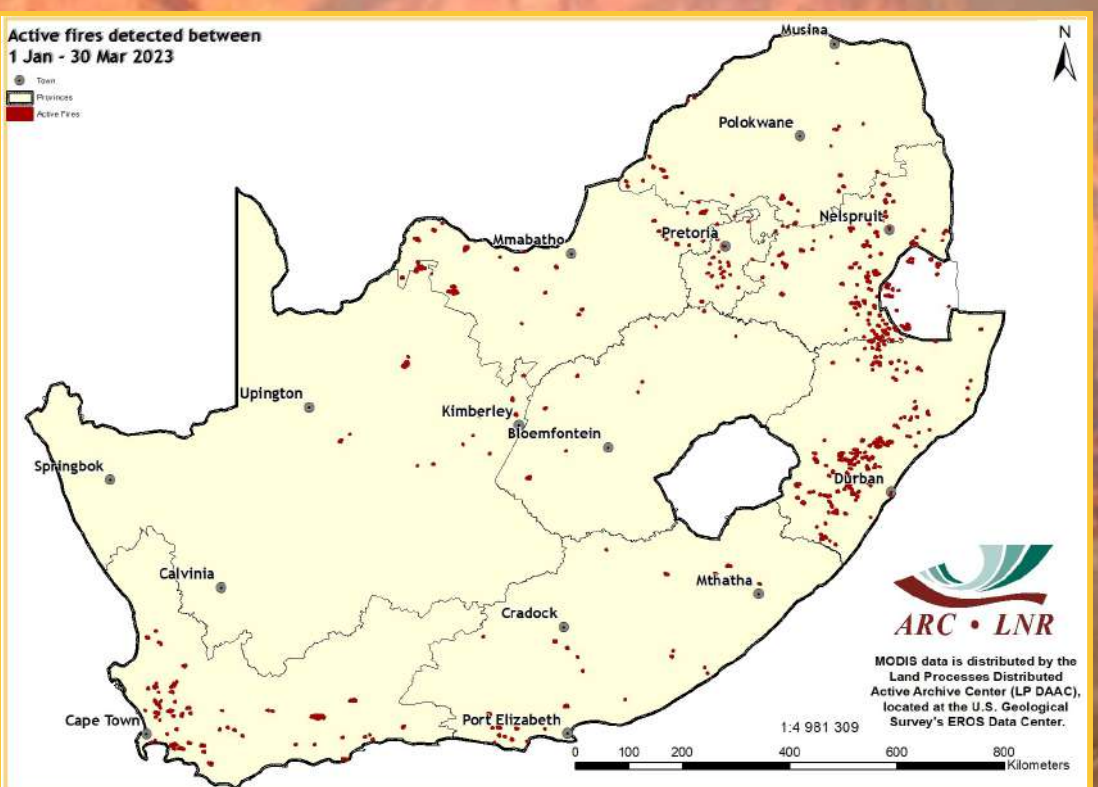


Figure 32

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 months 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 months total surface water is less than that recorded in the same water catchment, in the same month, last year.

The long-term map for March 2023 shows a near identical distribution pattern to the previous month. This continues to illustrate the significant impact of the high rainfall experienced over most of the country during the 2022/23 summer period. 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 monthly long-term maps.

The comparison between March 2023 and March 2022 shows a similar overall pattern to the previous month, but with increasing water levels in the catchments covering most of Kruger National Park, adjacent to the Mozambique border.

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 March 2023 expressed as a % of historic maximum, per Tertiary catchment.

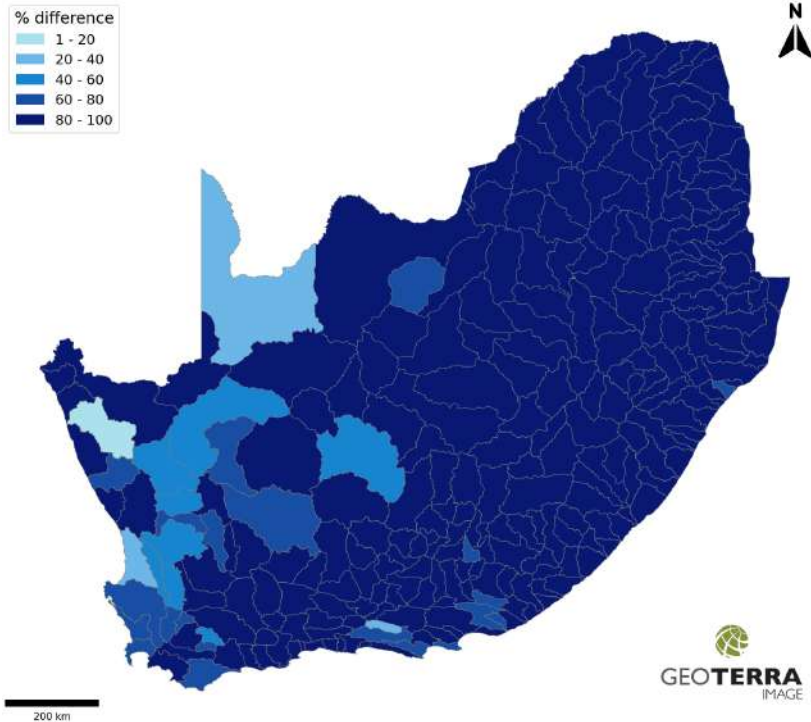


Figure 33

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

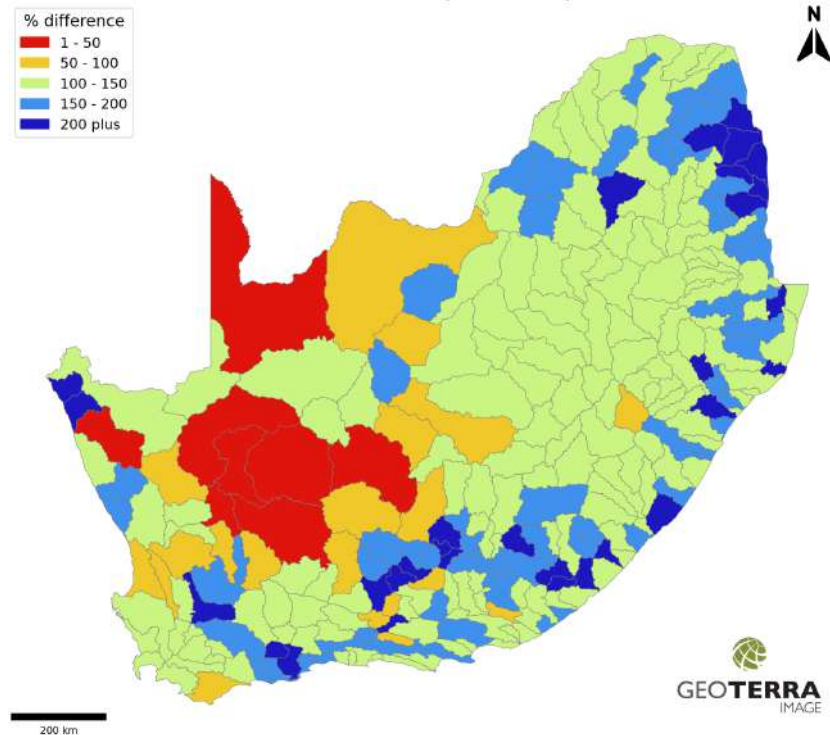


Figure 34



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

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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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 m² to 1 km²) 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>.



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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.