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UMLINDI

The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

agriculture, forestry & fisheries

Department: Agriculture, Forestry and Fisheries REPUBLIC OF SOUTH AFRICA

South African Weather Service

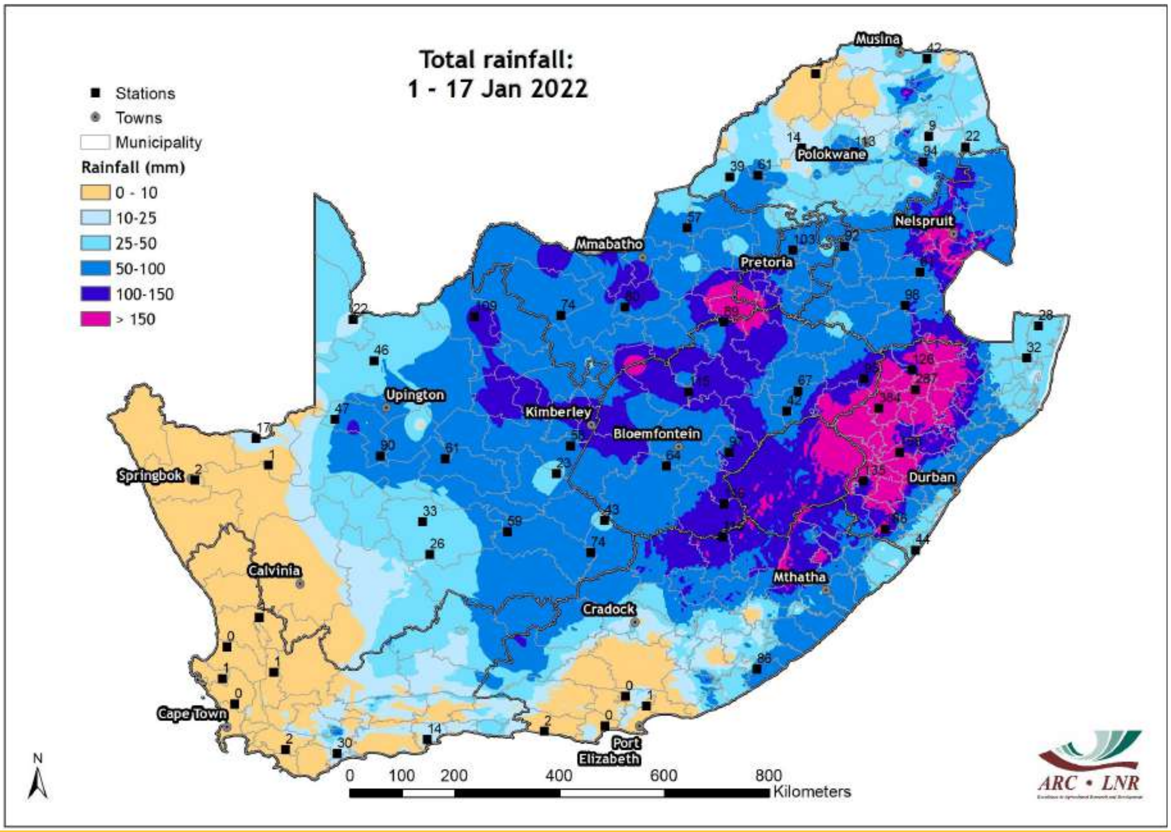
AMESD

211th Edition

Image of the Month

A rainy start to 2022

Since the beginning of January 2022, an outbreak of storms and heavy rainfall has occurred over most parts of South Africa. Significant rain was observed over the eastern and central interior and dam levels in the summer rainfall region have generally increased. During the first 17 days of the month, several stations in Mpumalanga, North West and Eastern Cape recorded totals in excess of 150 mm, while areas in and around the KwaZulu-Natal Midlands received >200 mm (see rainfall map below). These are typical summer conditions, often associated with the occurrence of a La Niña. However, several flash floods were triggered by high rainfall volumes over various parts of the Eastern Cape, North West, Gauteng, Free State and KZN provinces which caused damage to crops, livestock and property. It is noteworthy that although rainfall is considered beneficial for agricultural production, certain characteristics such as timing, duration and intensity play a crucial role in its effectiveness. Thus, even during a good rainy season, it is important to prepare for potential negative effects where possible.



The Agricultural Research Council - Institute for Soil, Climate and Water (ARC-ISCW) collected the data, generated the products and compiled the information contained in this newsletter, as part of the Coarse Resolution Imagery Database (CRID) project that was funded by the Department of Agriculture and Department of Science and Technology at its inception and is currently funded by the Department of Agriculture, Land Reform and Rural Development.

1. Rainfall

Overview:

Above-normal rainfall conditions that occurred over South Africa during November continued into December 2021, with a notable increase in totals. Significant monthly totals were recorded over most parts of the country, as compared to the previous 5-year period. Much of this rainfall was confined to the summer rainfall region, with higher totals observed over the interior as well as parts of the northern and eastern provinces. Severe thunderstorms that resulted in flooding of roads and low-lying areas became a hazard to crops, livestock and infrastructure over parts of the Eastern Cape, North West, Gauteng, Mpumalanga, Free State and KwaZulu-Natal.

Other parts of the country also experienced rainfall in December, resulting in above-normal conditions for the month. Over the winter rainfall region, moderately frequent rainfall events resulted in totals reaching ±100 mm in places, which is very good considering that December is climatologically a dry month for that region. Furthermore, certain parts of the Northern Cape, which were dry in November, similarly received rainfall in December, with areas such as Barkly West, Hanover, Kimberley, Orania and Victoria West recording >150 mm for the month. The only areas that recorded rainfall amounts below 5 mm were parts of Namaqualand, towards Port Nolloth and adjacent areas.

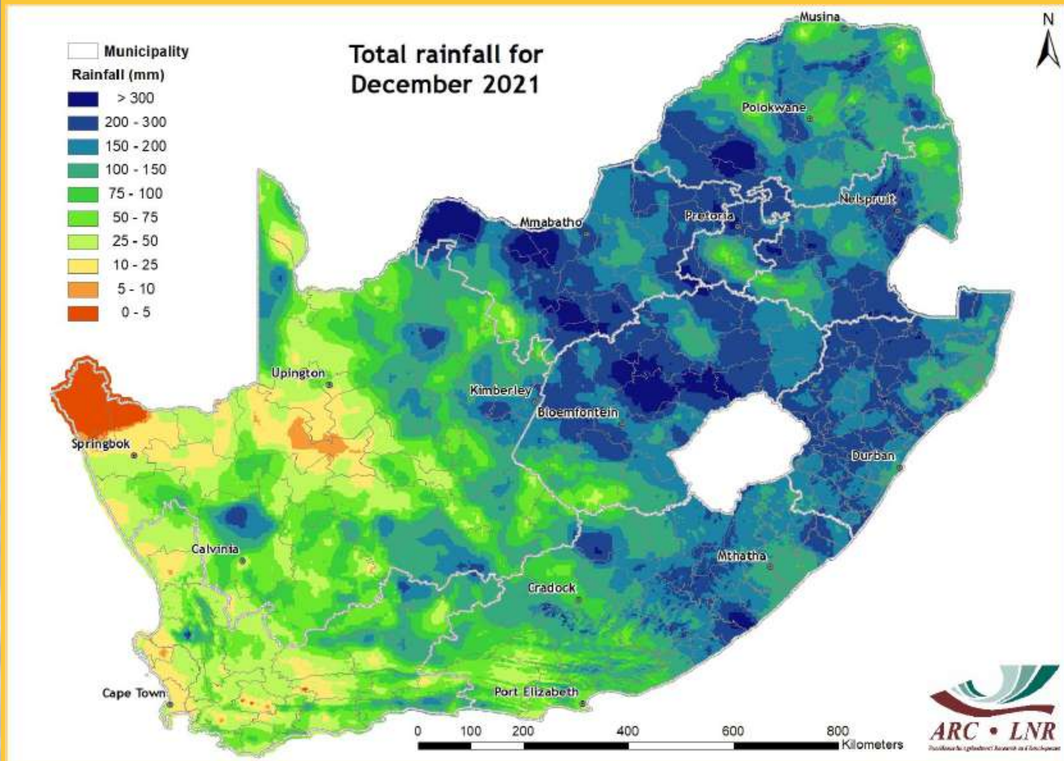


Figure 1

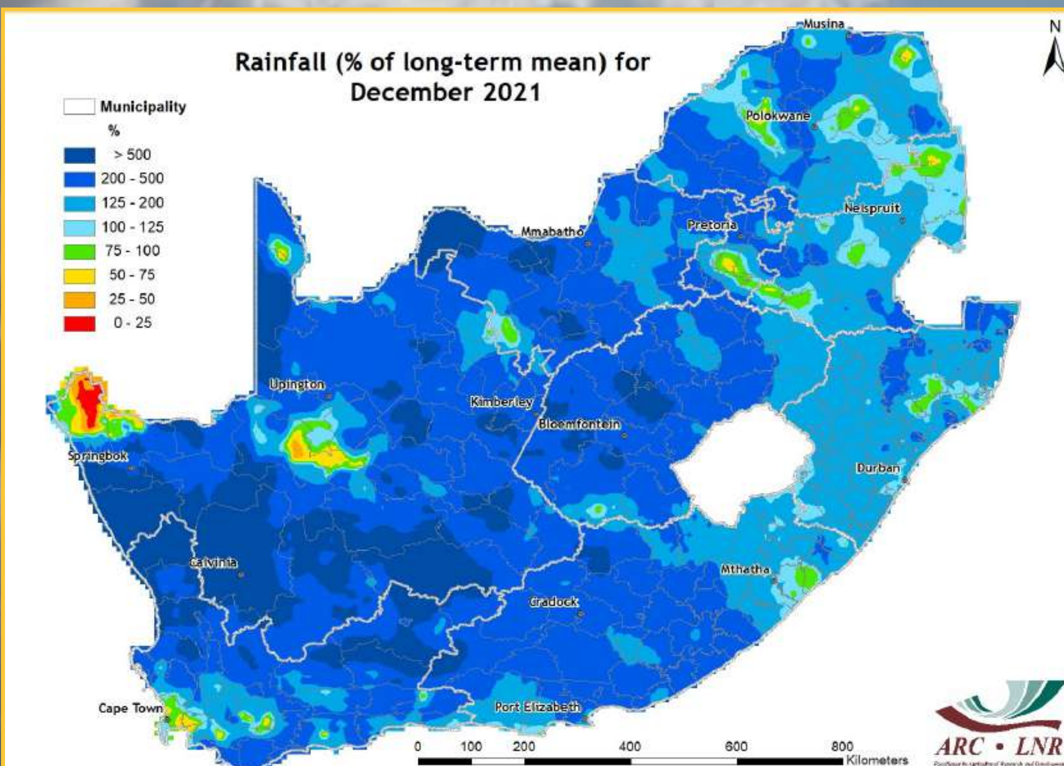


Figure 2

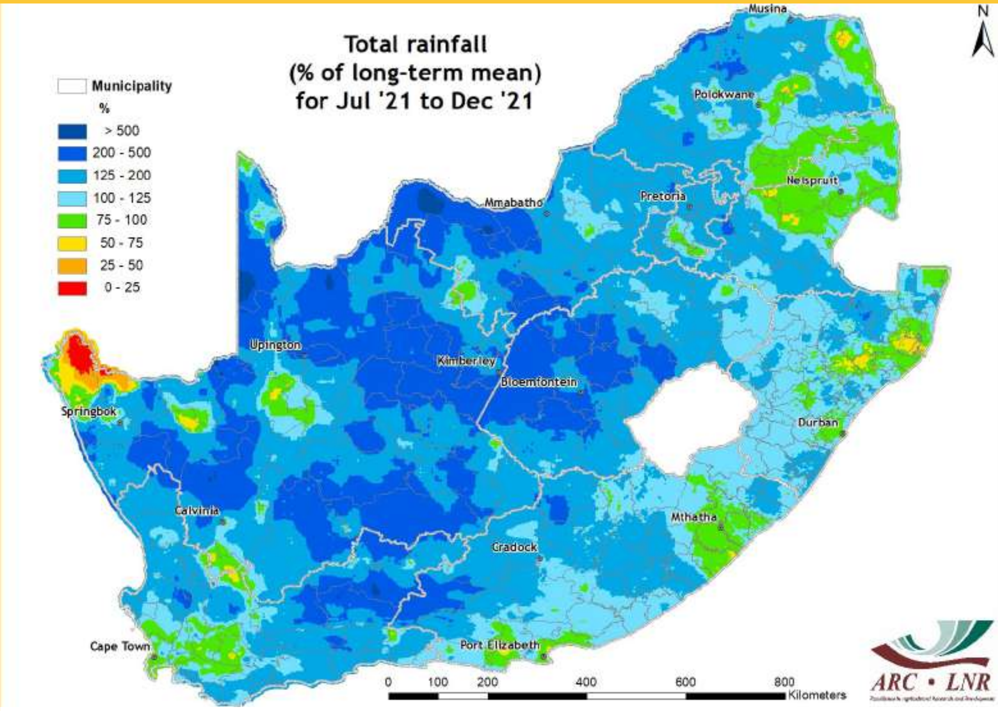


Figure 3

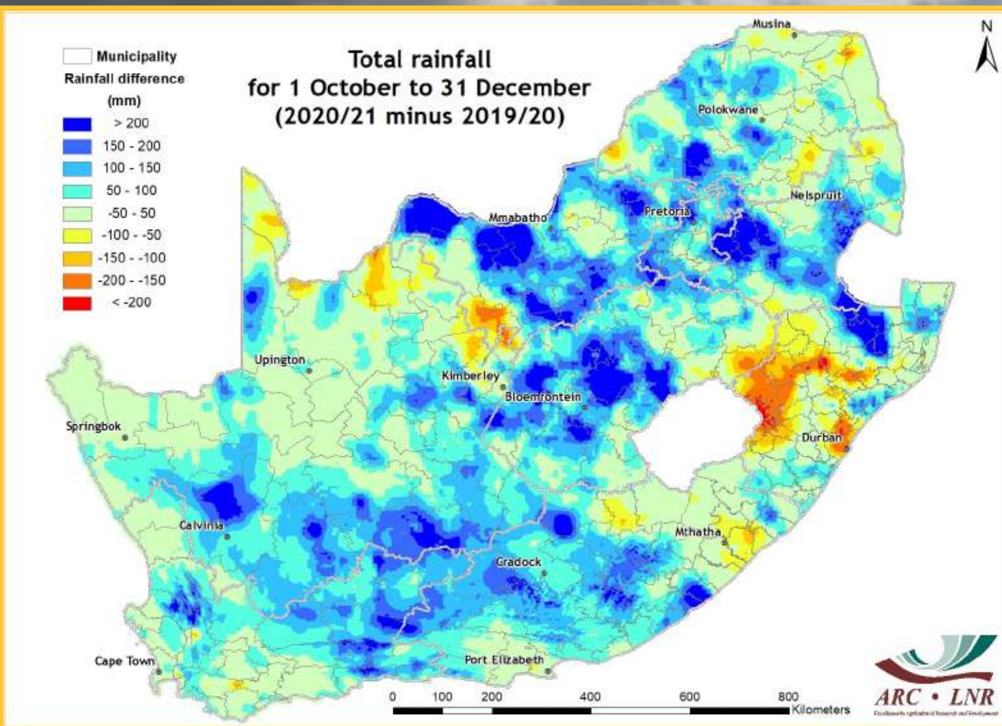


Figure 4

Figure 1:
Rainfall totals continued to increase over the summer rainfall region during December 2021, as climatologically expected. Most rainfall occurred over the eastern half of the country, but some parts of the Northern and Western Cape also recorded rainfall activity.

Figure 2:
Typical La Niña conditions resulted in widespread above-normal rainfall conditions over the country during December, with near-normal conditions observed over isolated areas of Limpopo, Mpumalanga, Gauteng, KwaZulu-Natal and the Eastern Cape. The only areas that received below-normal rainfall include Kenhardt in the Northern Cape and isolated areas in the extreme northwest of the country.

Figure 3:
Cumulative rainfall from July to December 2021, given as a percentage of the long-term mean for the same period, shows above-normal conditions over most parts of the country. Near-normal conditions were experienced over the eastern provinces, as well as isolated areas in the Northern and Western Cape.

Figure 4:
October to December 2021 was wetter than the corresponding period last year over most parts of the country. This was particularly so in the northern regions, extending down towards the central interior, the Karoo and the adjacent Cape Fold Belt, where some places received 200 mm more rain during this 3-month period. It can be observed that isolated areas in Limpopo, the border of North West and Northern Cape, as well as parts of KZN received less rain during October to December 2021 as compared to the same period last year.

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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 December 2021 are shown in Figures 5-8. In general, wet conditions were prominent over most parts of the country. Given the short- and medium-term SPI maps, high rainfall totals resulted in severe to extremely wet conditions over large parts of the northern provinces, the Free State and extending southwest towards the Western Cape. The long-term maps depict moderate to extremely wet conditions over the central interior and the Lowveld of Limpopo and Mpumalanga, implying higher dam levels significant for agricultural water use. Drought conditions varying from moderate to severe over the Greater Karoo, the adjacent areas of Eastern Cape, moving north towards KZN, Mpumalanga and the central region of Limpopo can be observed on the longer time scales but are not visible on the shorter time scales due to above-normal rainfall that occurred over those areas during October to December 2021.

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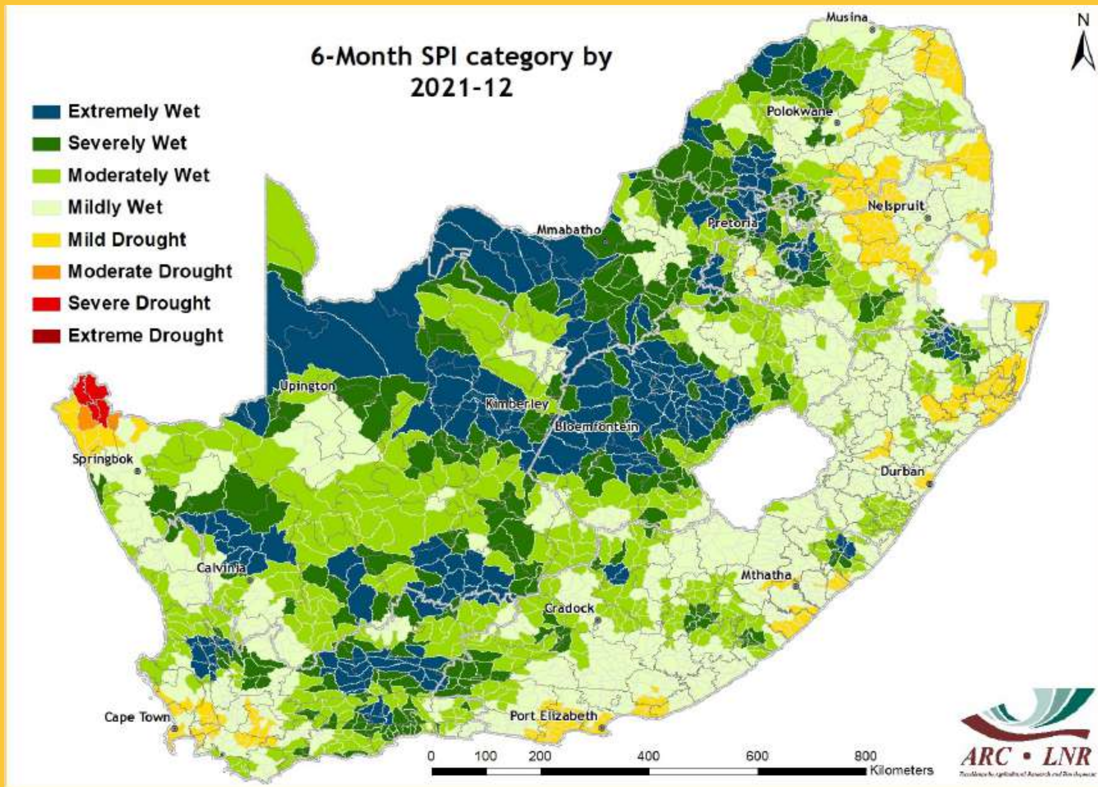

Figure 5

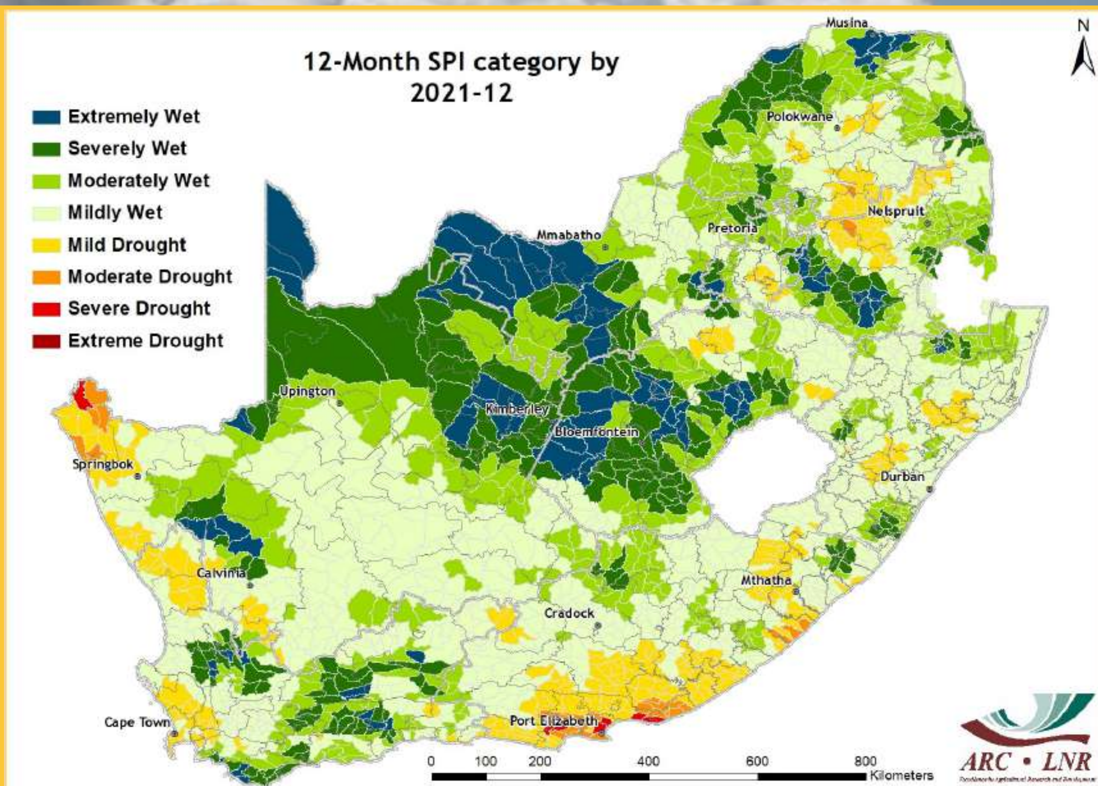

Figure 6

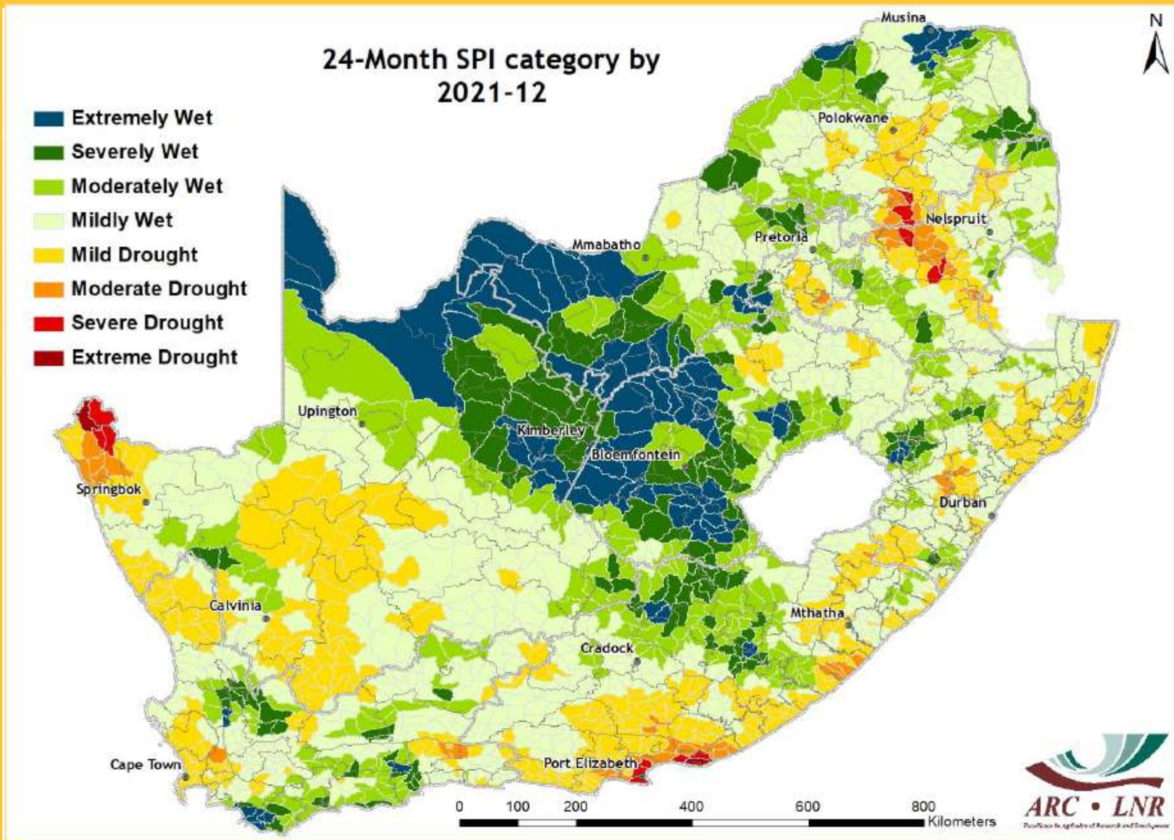

Figure 7

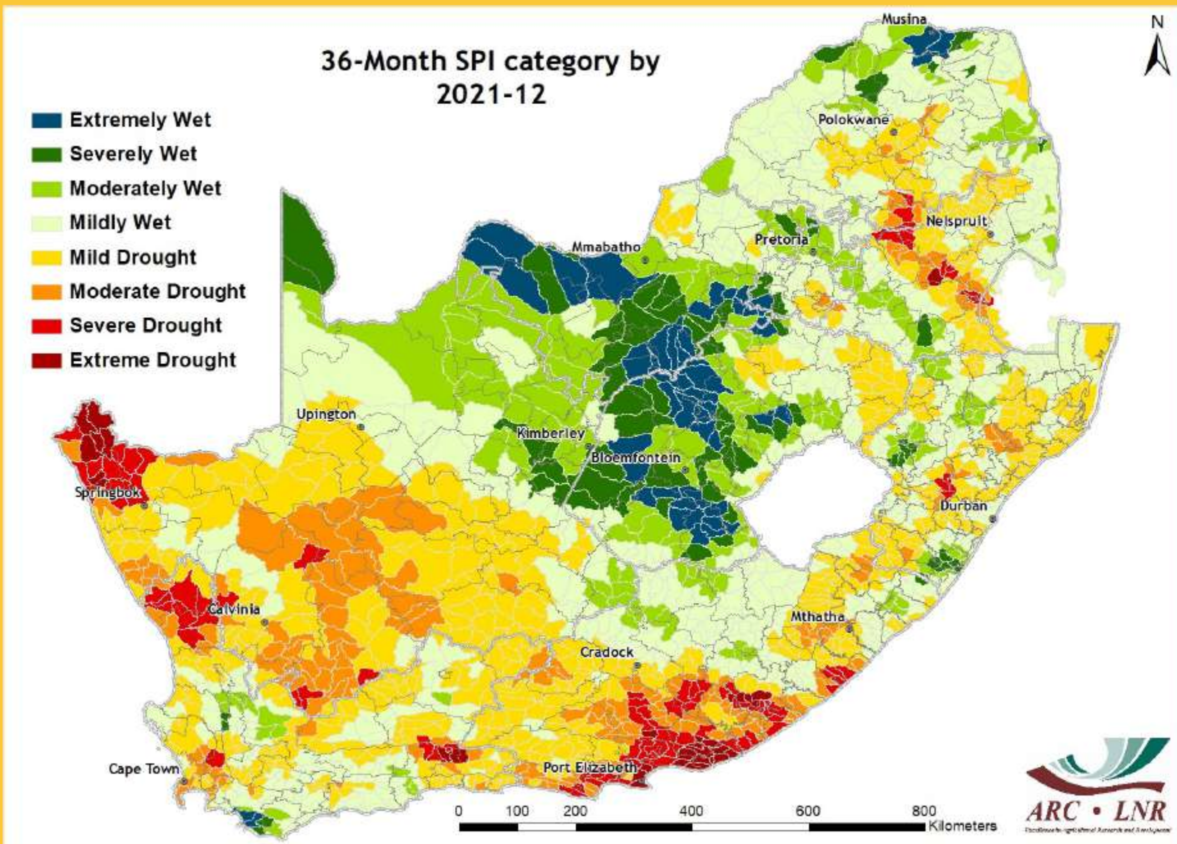

Figure 8

3. Rainfall Deciles

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

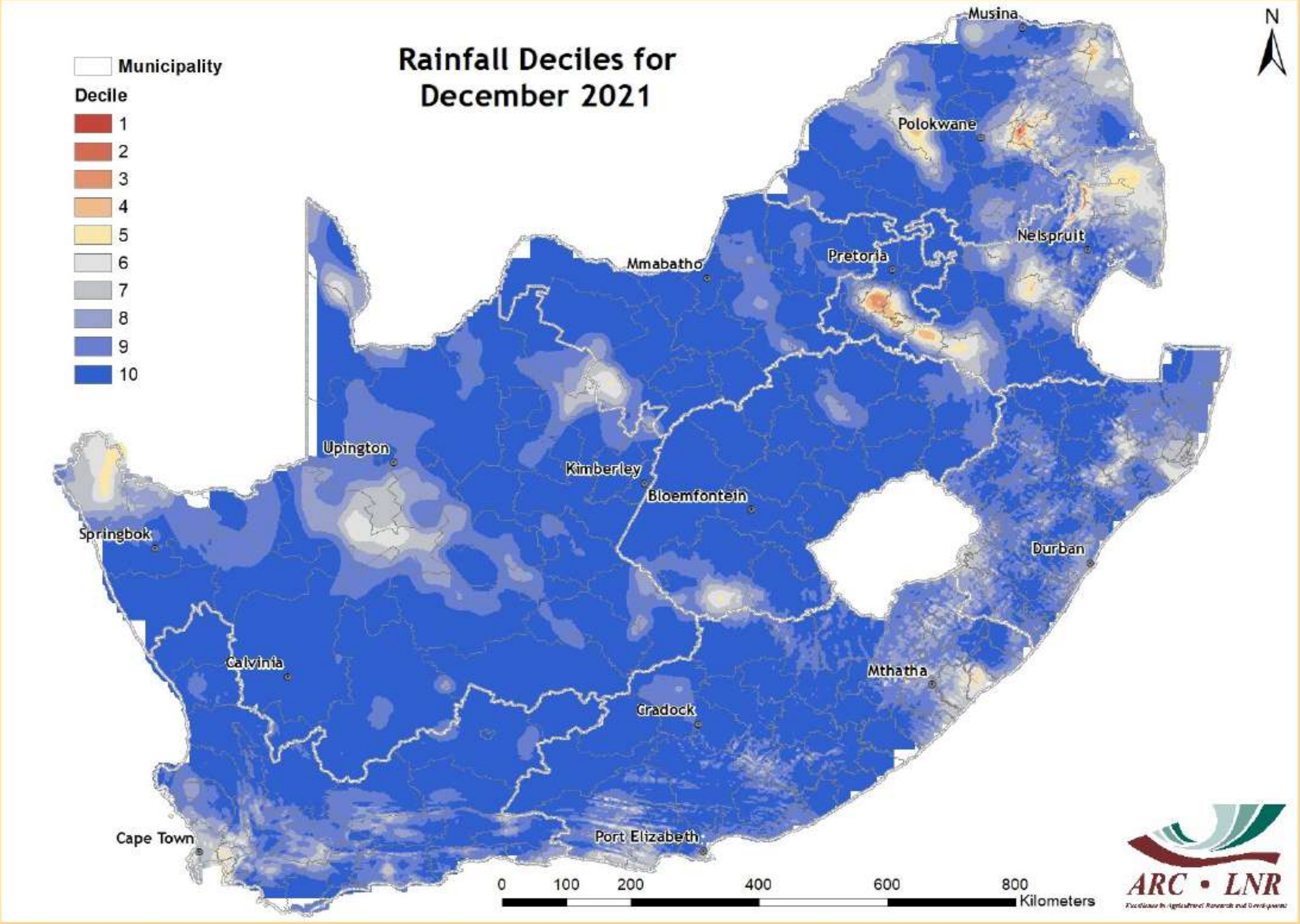

Figure 9

Figure 9:
Greater parts of the country received exceptionally high rainfall totals in December 2021, as compared to previous observations for the same month, thus corresponding well with historically wetter December months.

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4. Vegetation Conditions

Vegetation Mapping

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

NDVI=(IR-R)/(IR+R)

where:
IR = Infrared reflectance &
R = Red band

NDVI images describe the vegetation activity. A decadal NDVI image shows the highest possible "greenness" values that have been measured during a 10-day period.

Vegetated areas will generally yield high values because of their relatively high near infrared reflectance and low visible reflectance. For better interpretation and understanding of the NDVI images, a temporal image difference approach for change detection is used.

The Standardized Difference Vegetation Index (SDVI) is the standardized anomaly (according to the specific time of the year) of the NDVI.

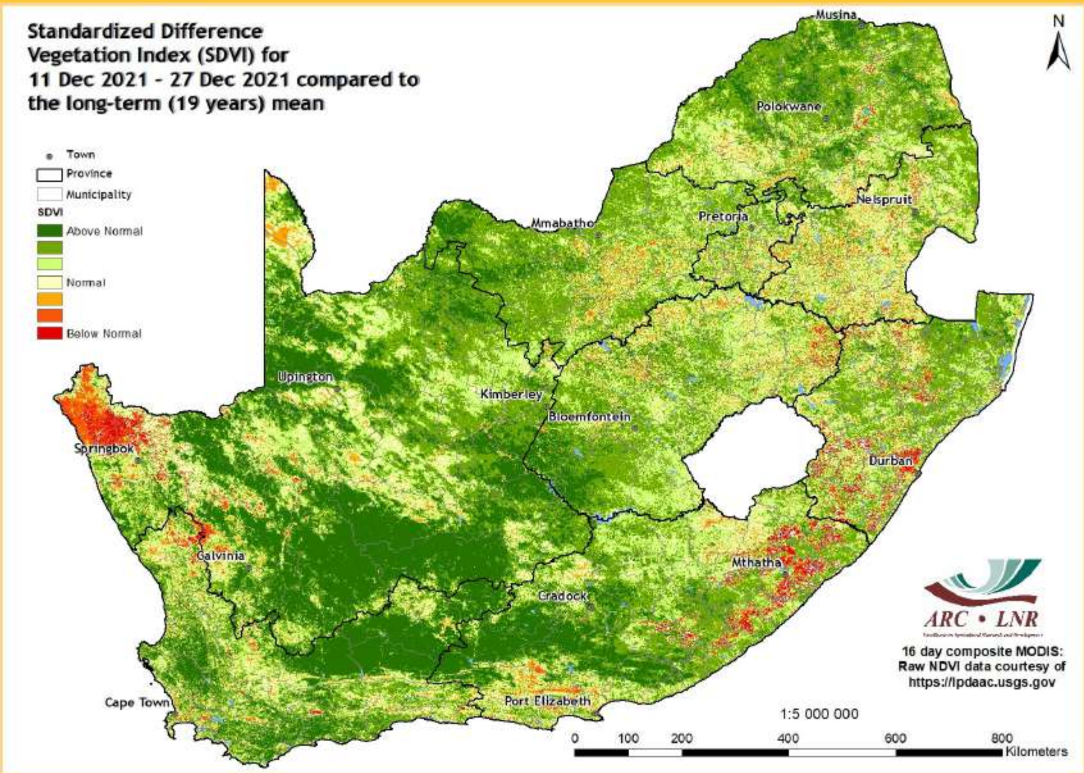

Figure 10

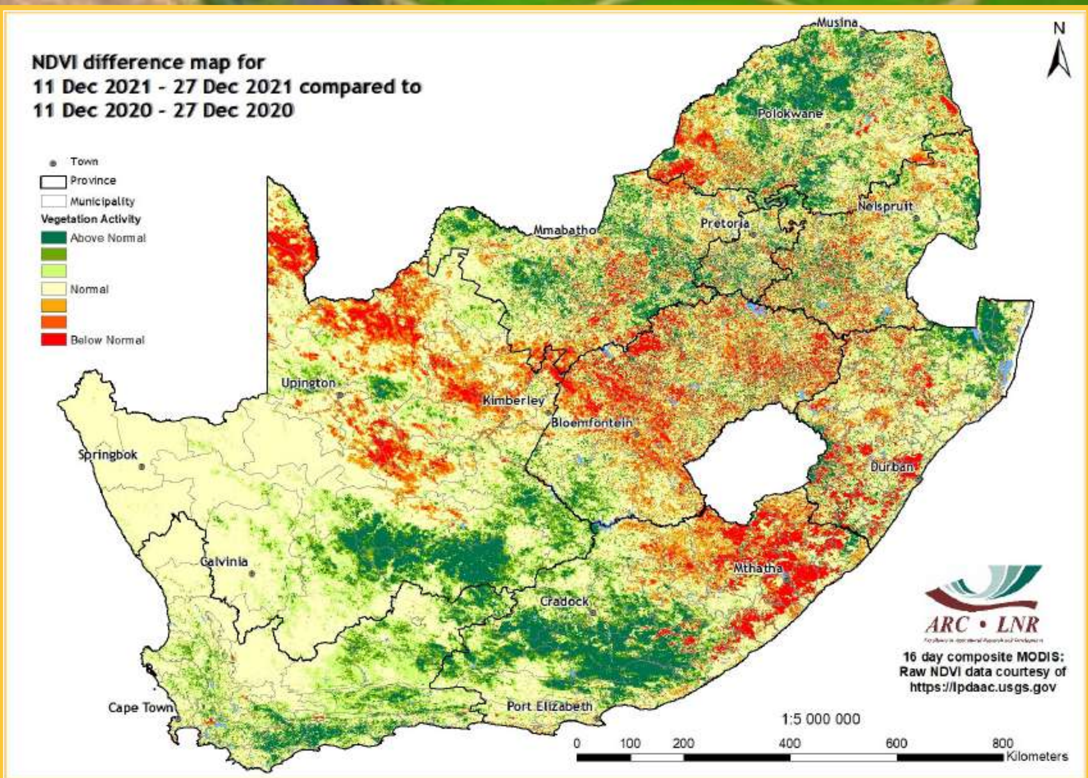

Figure 11

Figure 10:
Compared to the historical averaged vegetation conditions, the 16-day SDVI map for December 2021 shows that many parts of the country experienced above-normal vegetation activity with pockets of below-normal vegetation conditions in isolated areas.

Figure 11:
When comparing the 16-day NDVI difference map for December 2021 to the same month last year, it can be observed that the central and northern parts of the country experienced below-normal vegetation activity. The remaining areas experienced normal vegetation conditions with pockets of above-normal activity.

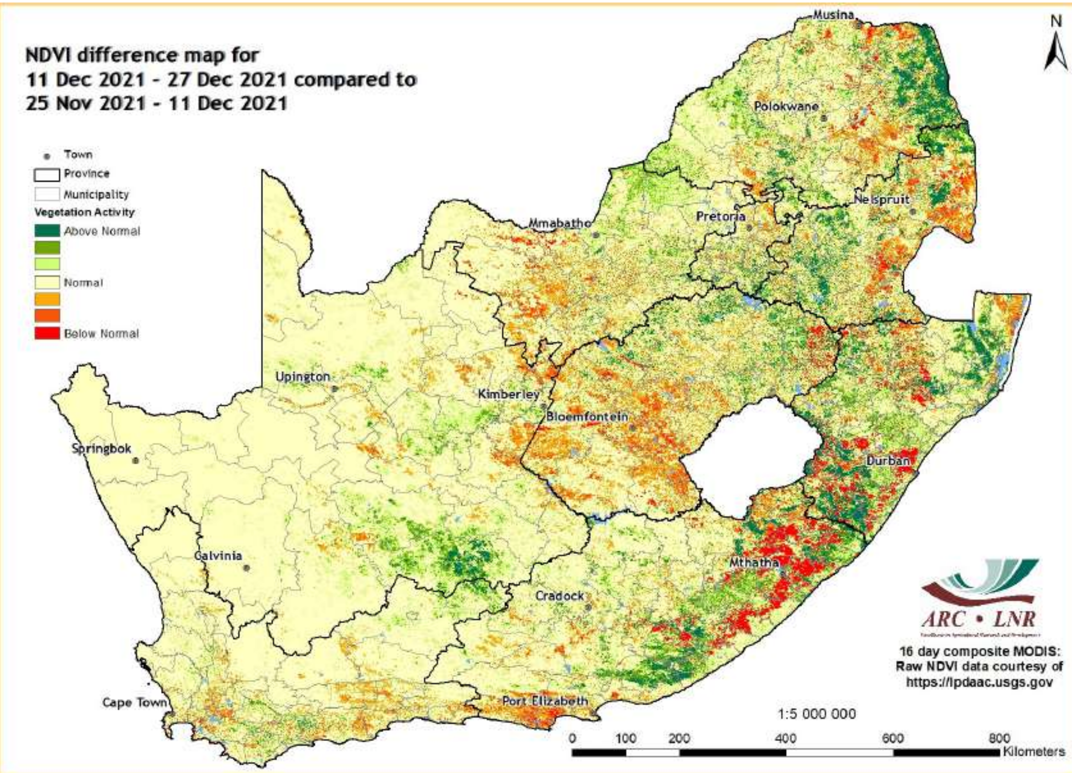

Figure 12

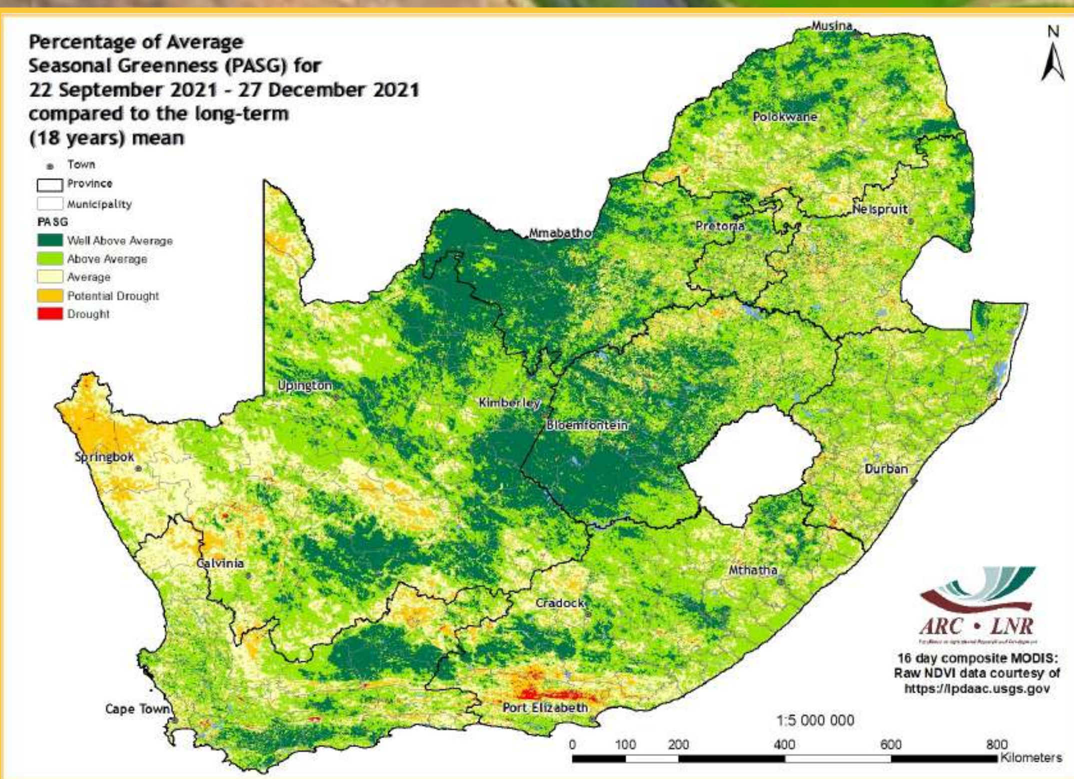

Figure 13

Vegetation Mapping
(continued from p. 7)

Interpretation of map legend

NDVI-based values range between 0 and 1. These values are incorporated in the legend of the difference maps, ranging from -1 (lower vegetation activity) to 1 (higher vegetation activity) with 0 indicating normal/the same vegetation activity or no significant difference between the images.

Cumulative NDVI maps:

Two cumulative NDVI datasets have been created for drought monitoring purposes:

Winter: January to December
Summer: July to June

Figure 12:
The 16-day NDVI difference map for December shows that the country experienced mostly normal to above-normal vegetation conditions with pockets of below-normal conditions in isolated areas.

Figure 13:
The Percentage of Average Seasonal Greenness (PASG) map over a 3-month period, compared to the long-term mean, shows that the country experienced mostly high levels of seasonal vegetation greenness, with pockets of potential drought or drought conditions towards the western parts of the country.

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5. Vegetation Condition Index

Vegetation Condition Index (VCI)

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

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

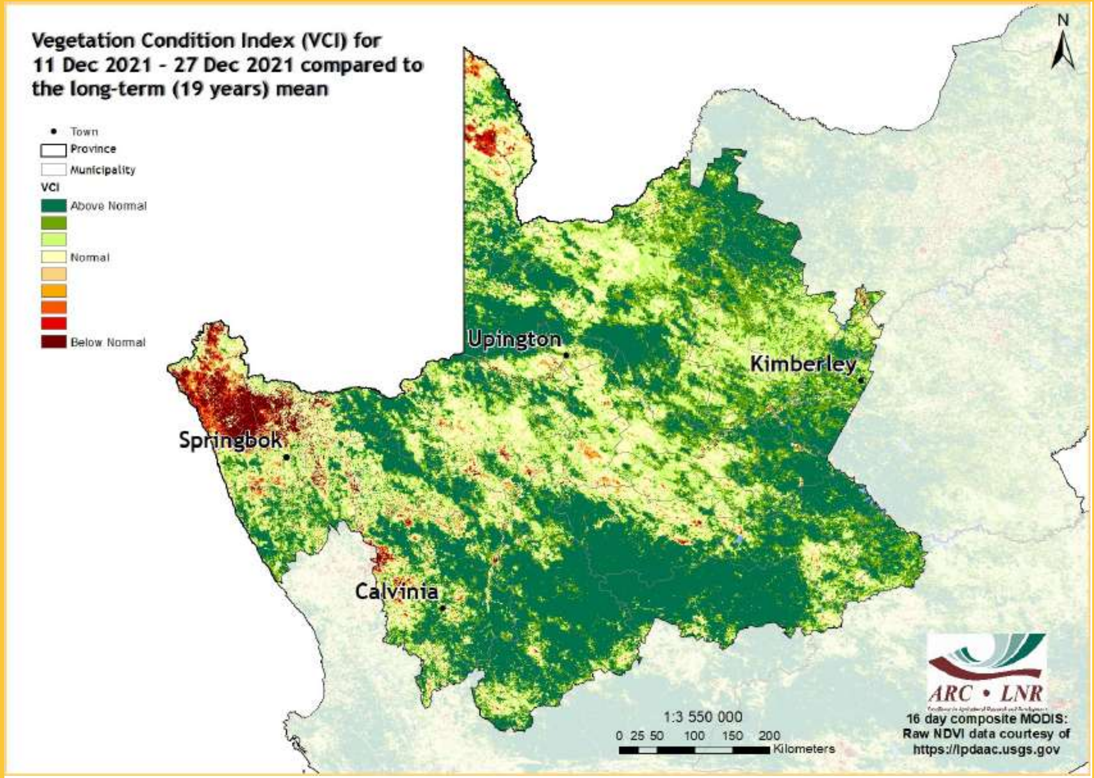


Figure 14

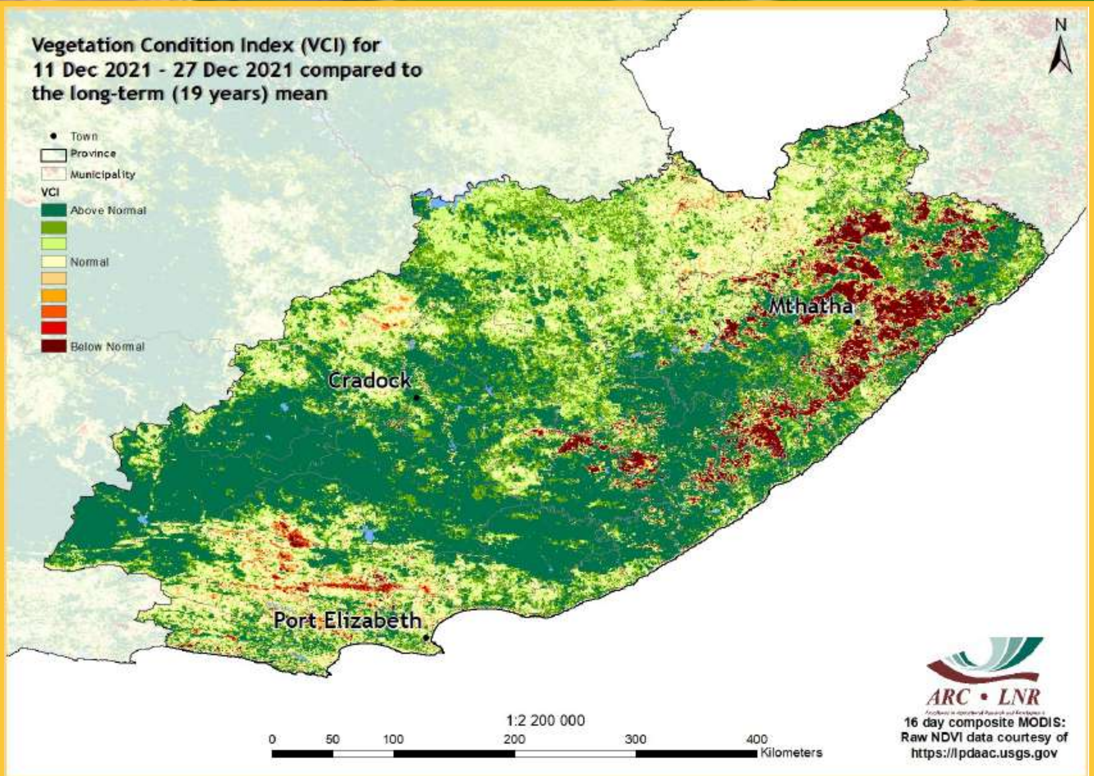
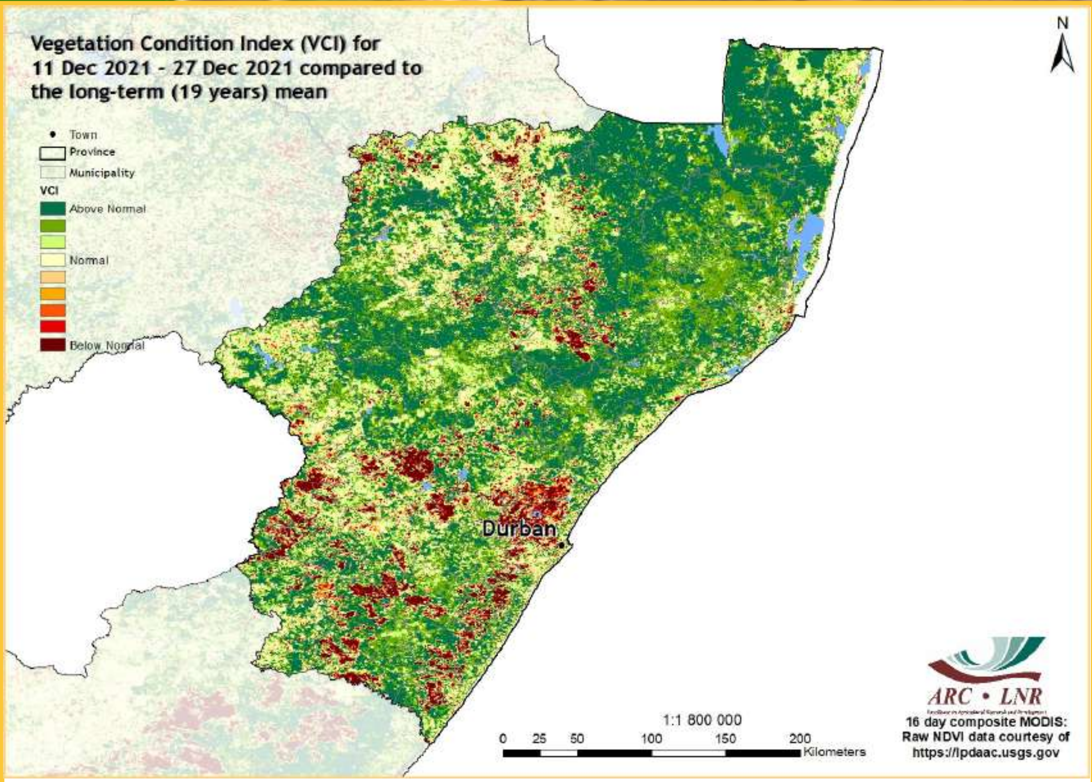


Figure 15

Figure 14:
The 16-day VCI map for December indicates that improved vegetation conditions have spread over many parts of the Northern Cape, with only a few areas still experiencing drought conditions.

Figure 15:
The 16-day VCI map for Dec ember indicates that vegetation conditions have improved in many parts of the Eastern Cape, although pockets of poor vegetation activity remain in the eastern parts of the province.



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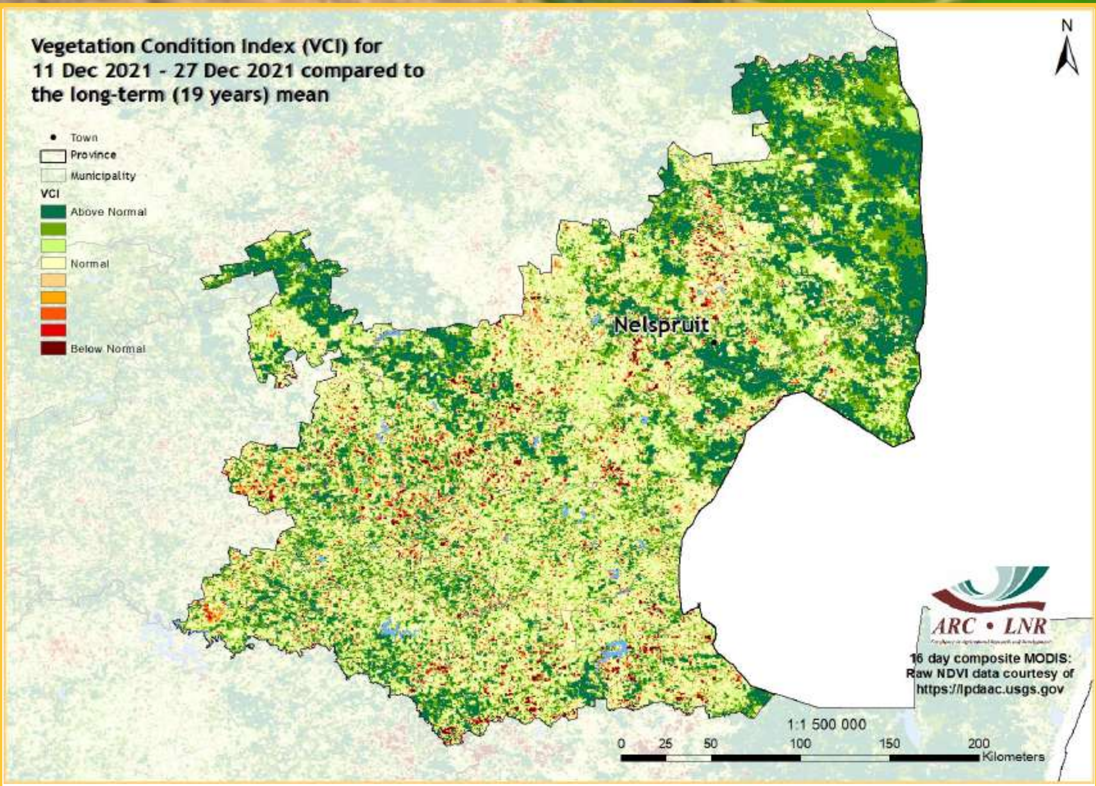

Figure 17

Figure 16:
The 16-day VCI map for December indicates that above-normal vegetation conditions have spread throughout KwaZulu-Natal, although pockets of poor vegetation activity can also be observed.

Figure 17:
The 16-day VCI map for December shows above-normal vegetation conditions throughout most of Mpumalanga, although pockets of poor vegetation activity can be observed in isolated areas of the province.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

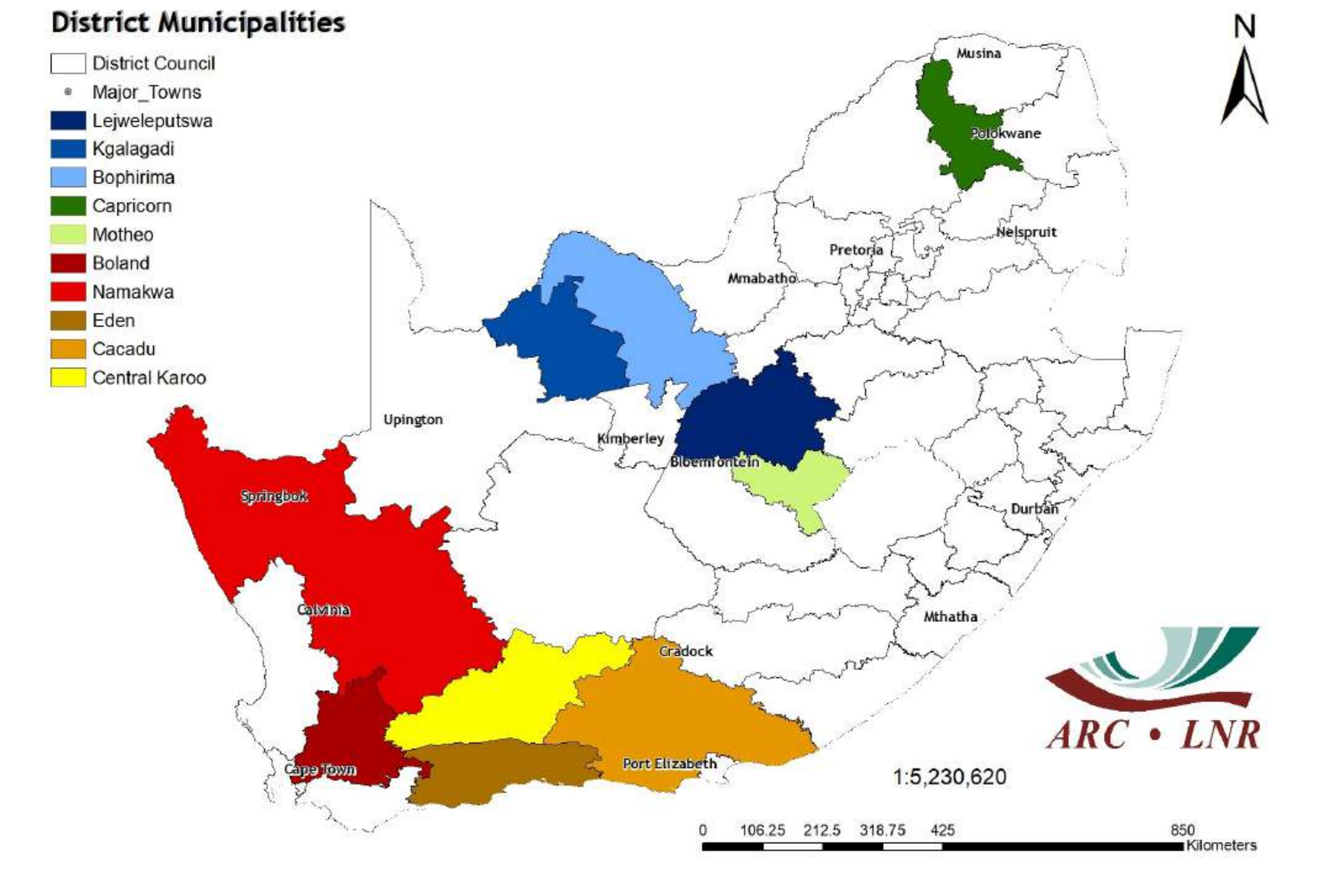

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for December 2021. The district colour matches the border of the corresponding graph.

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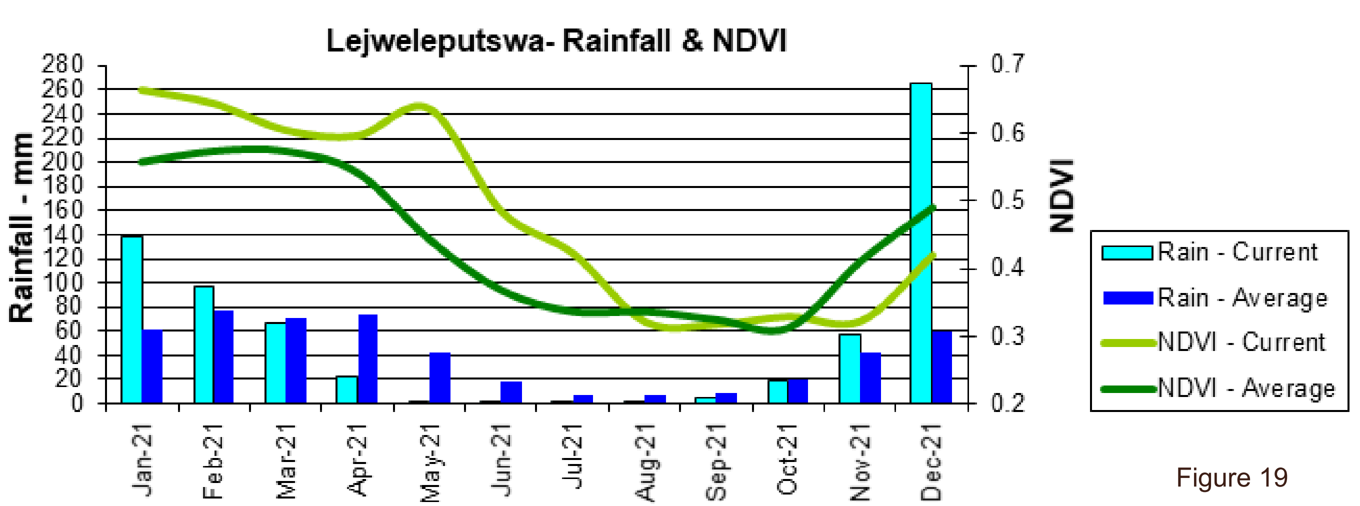
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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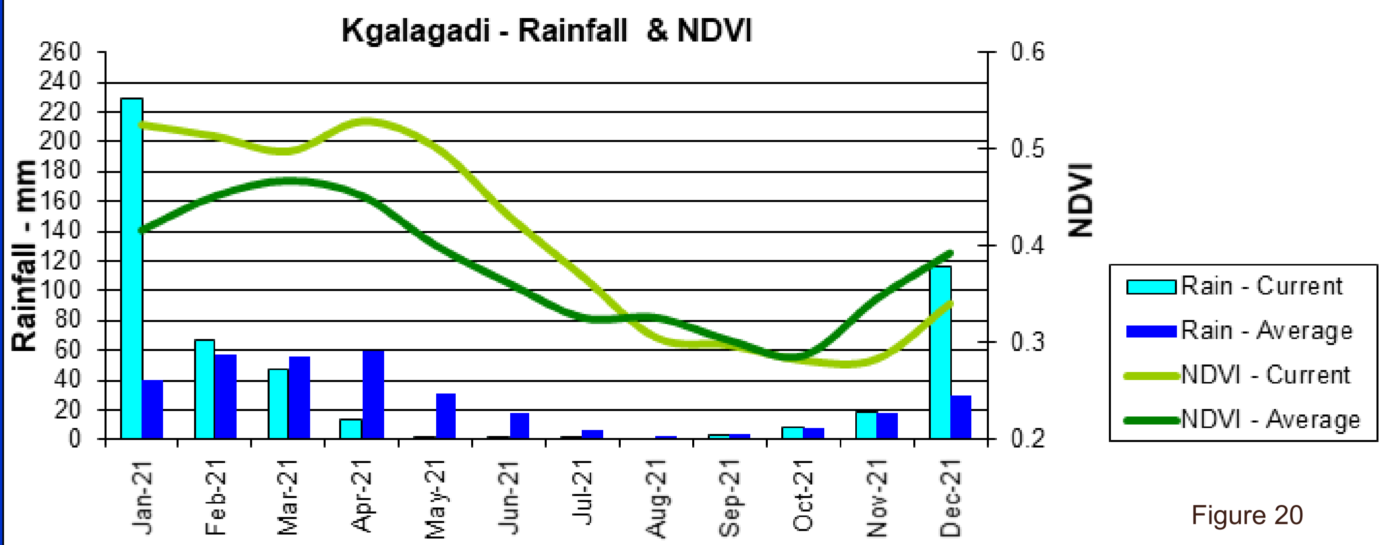

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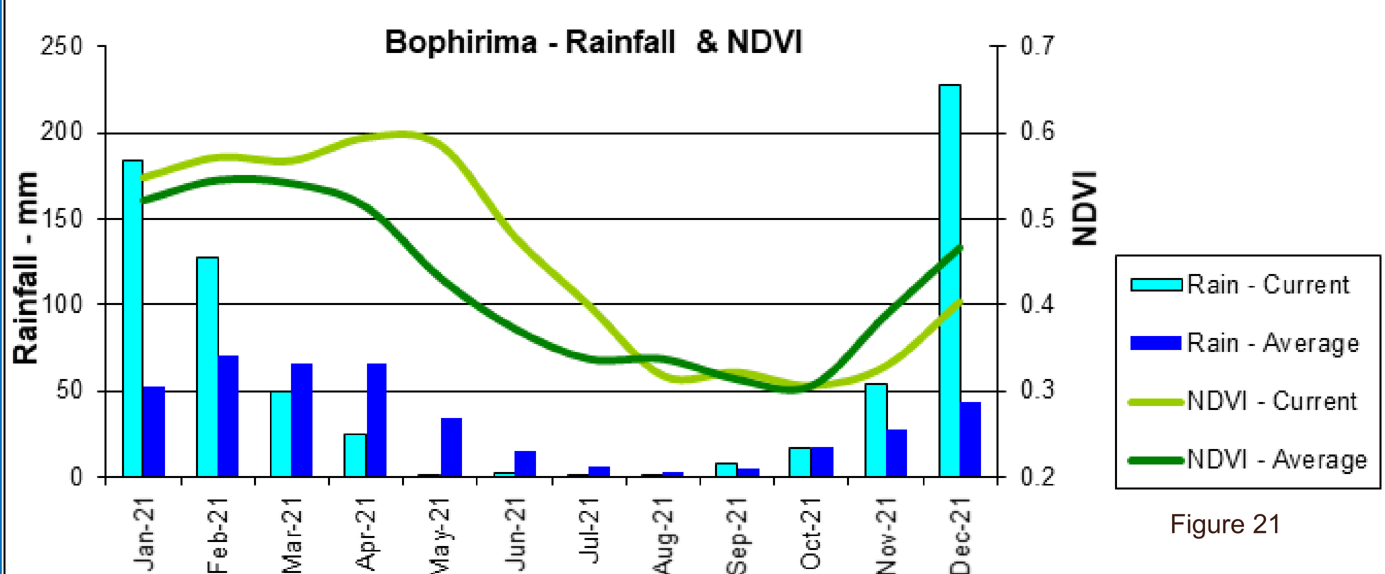


Figure 21

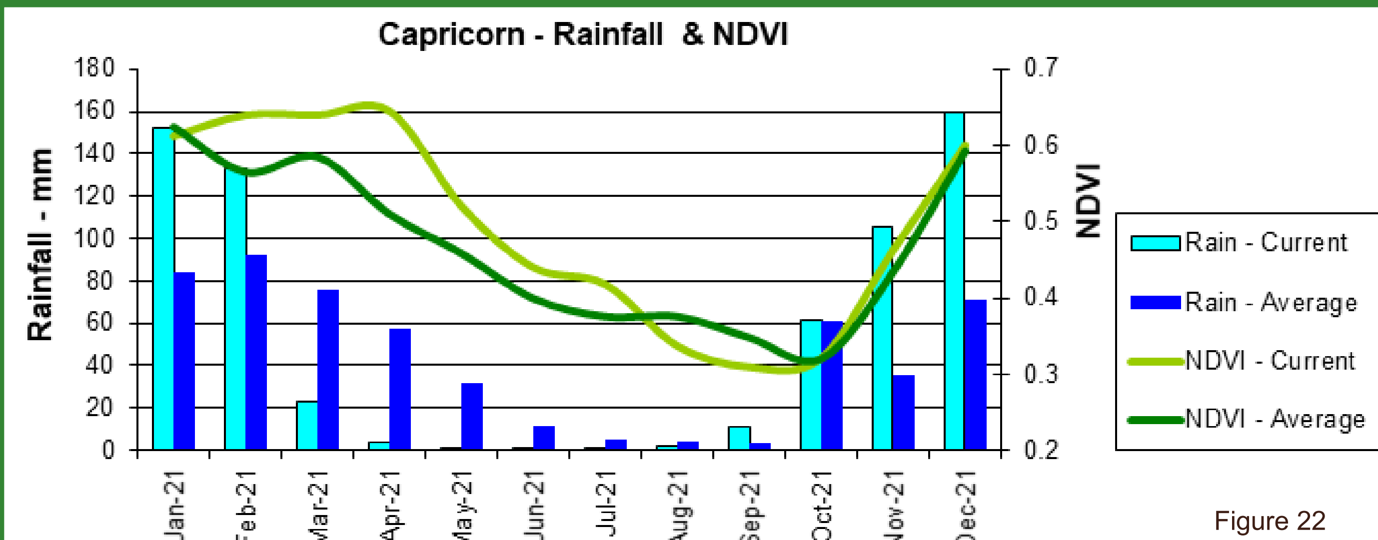


Figure 22

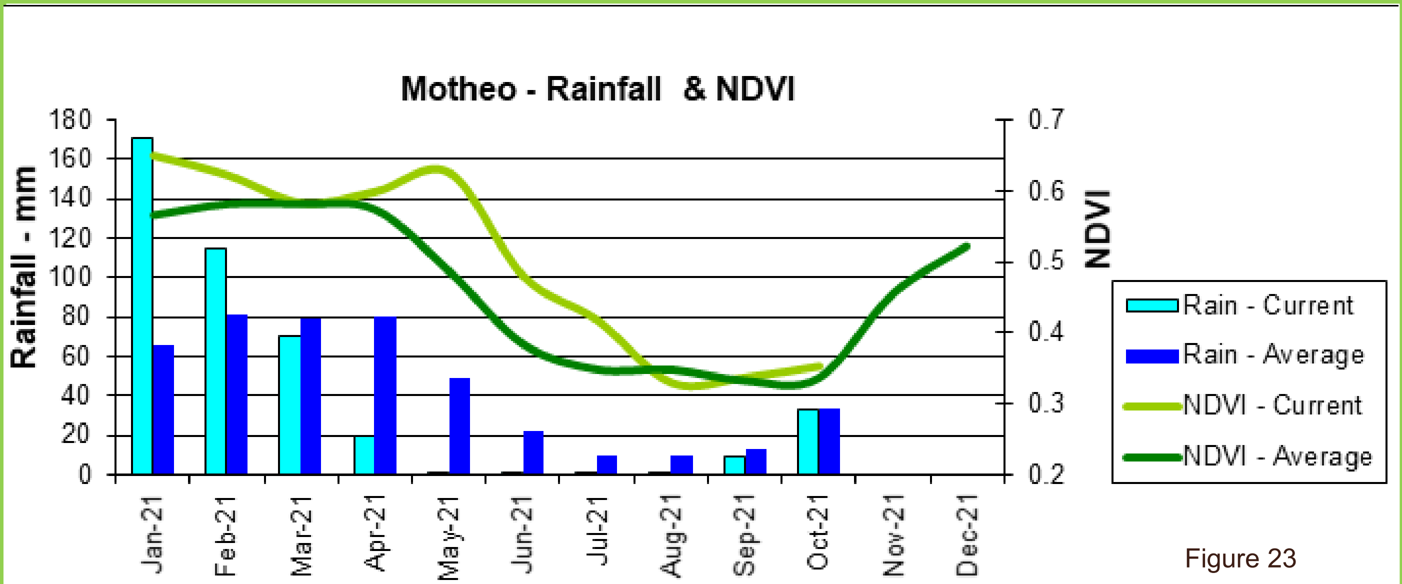


Figure 23

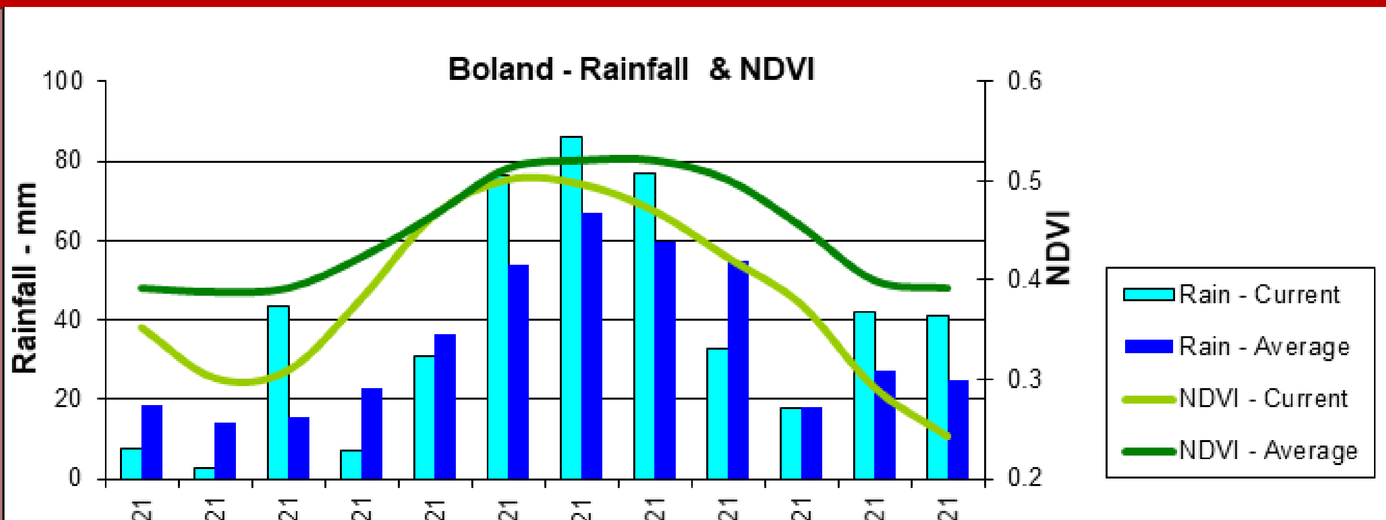
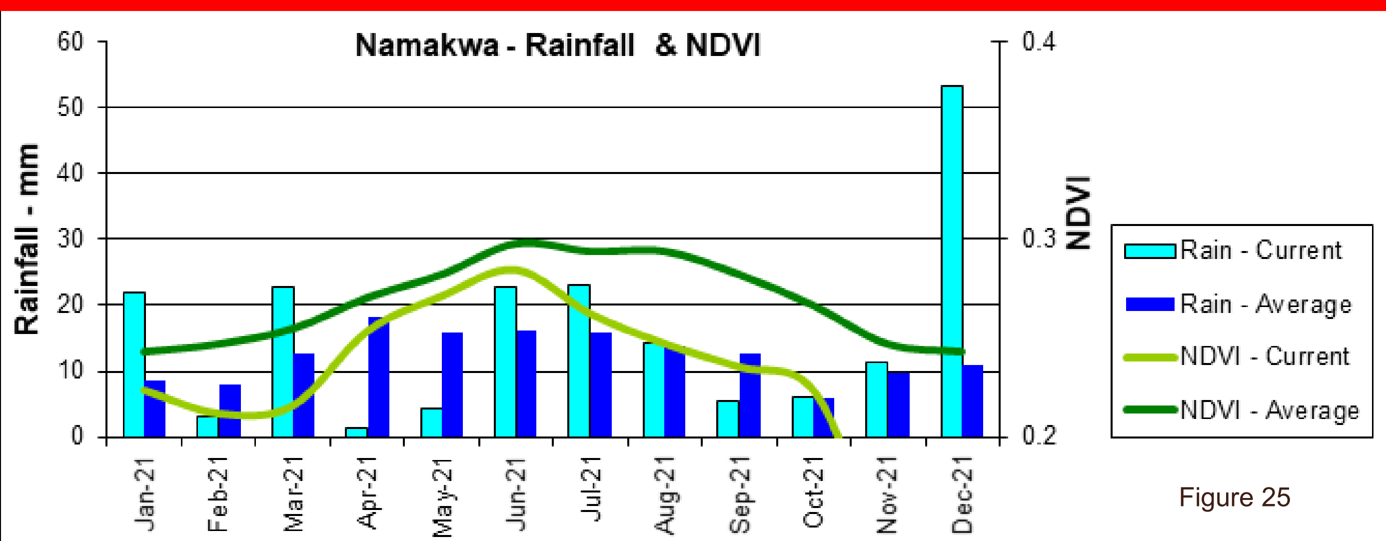


Figure 24



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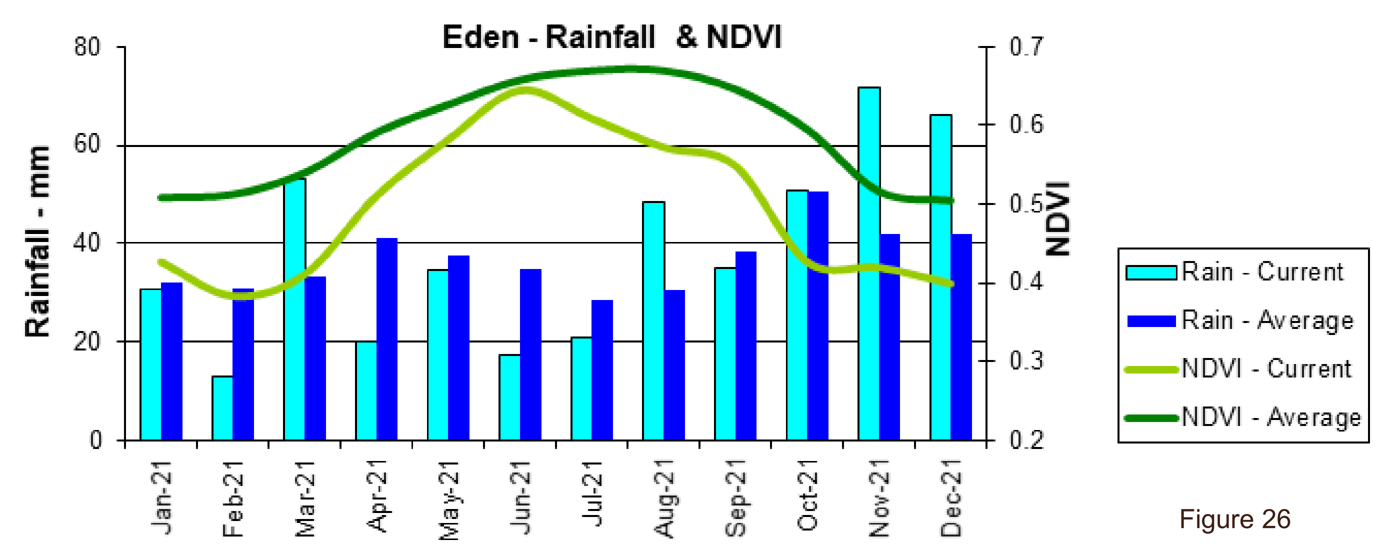

Figure 26

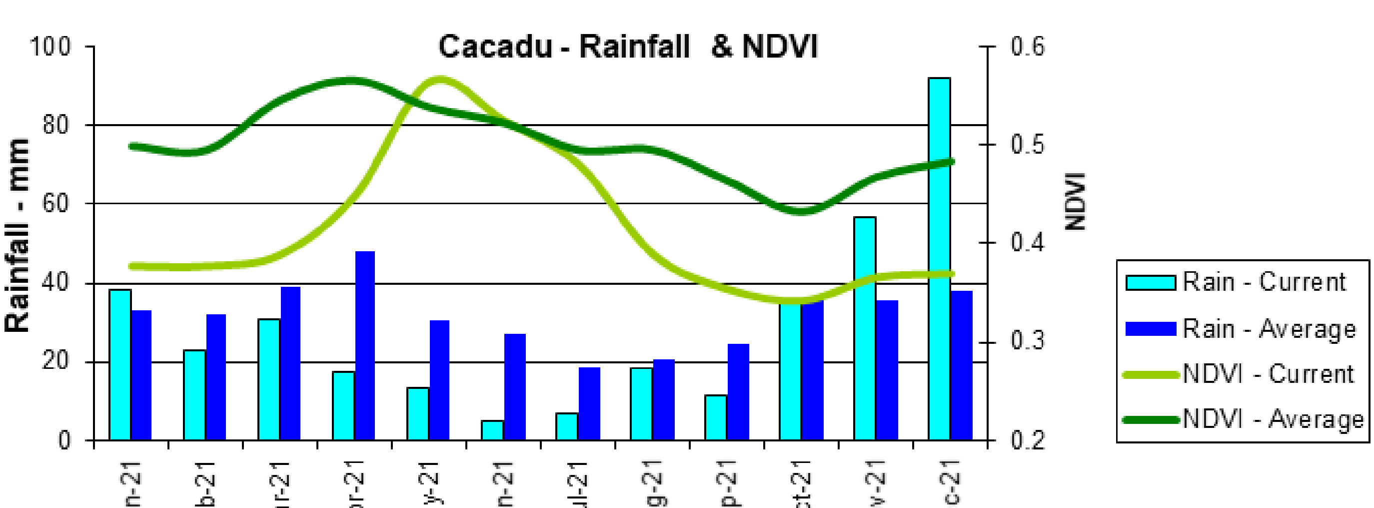

Figure 27

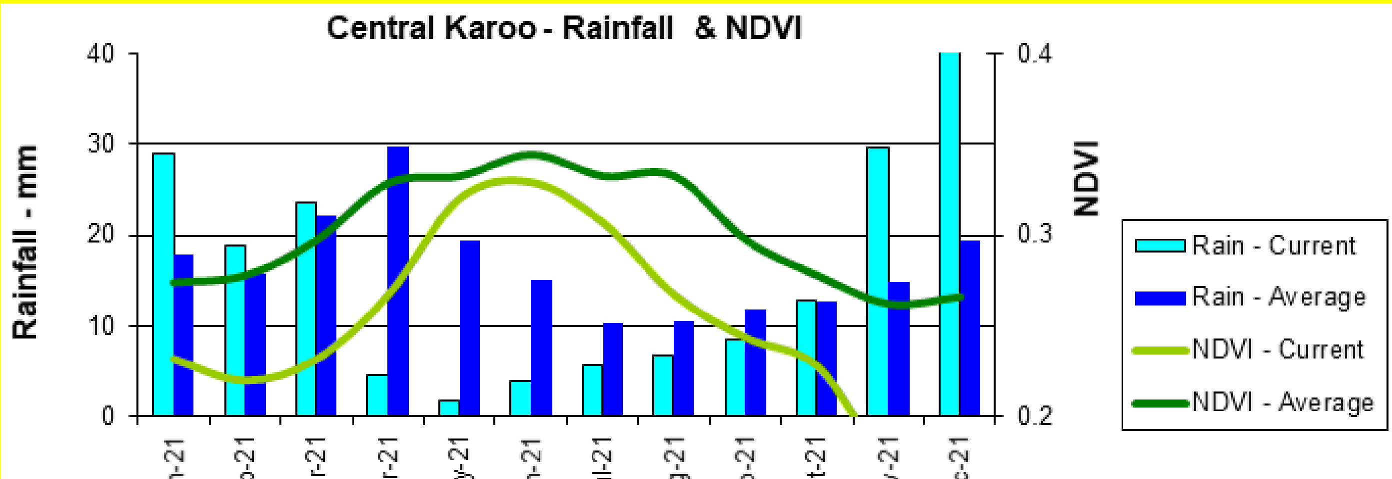

Figure 28

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.

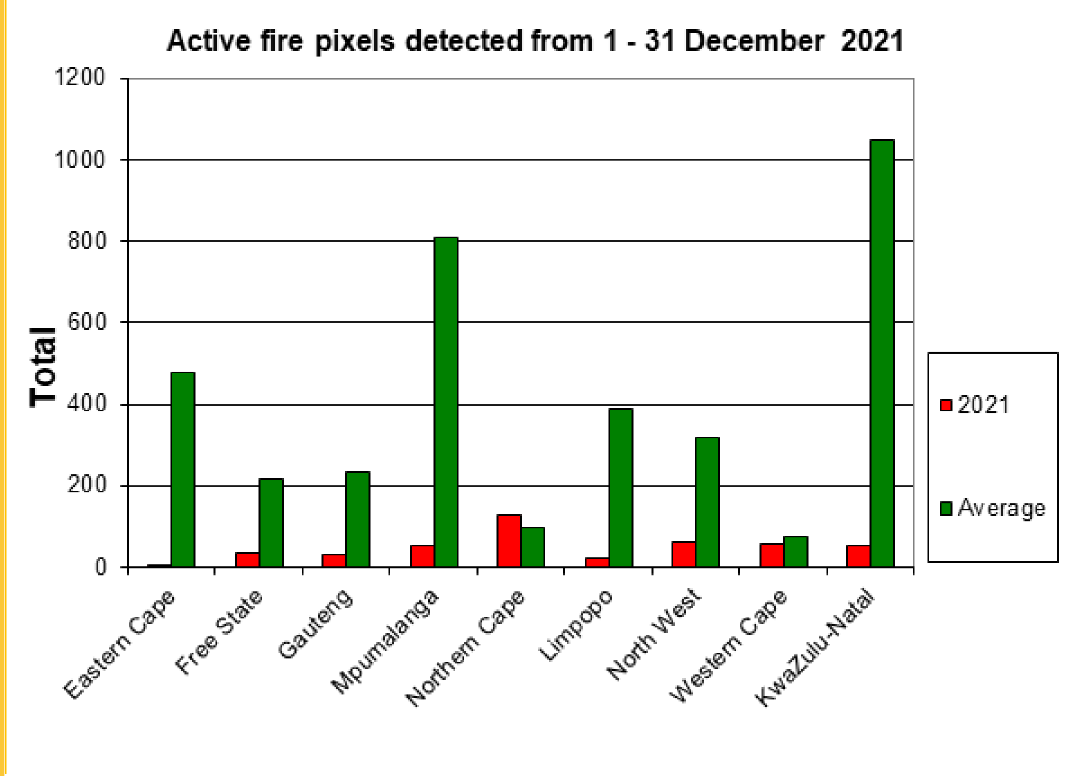

Figure 29

Figure 29:
The graph shows the total number of active fires detected between 1-31 December 2021 per province. Fire activity was lower in all provinces except for the Northern Cape, compared to the long-term average.

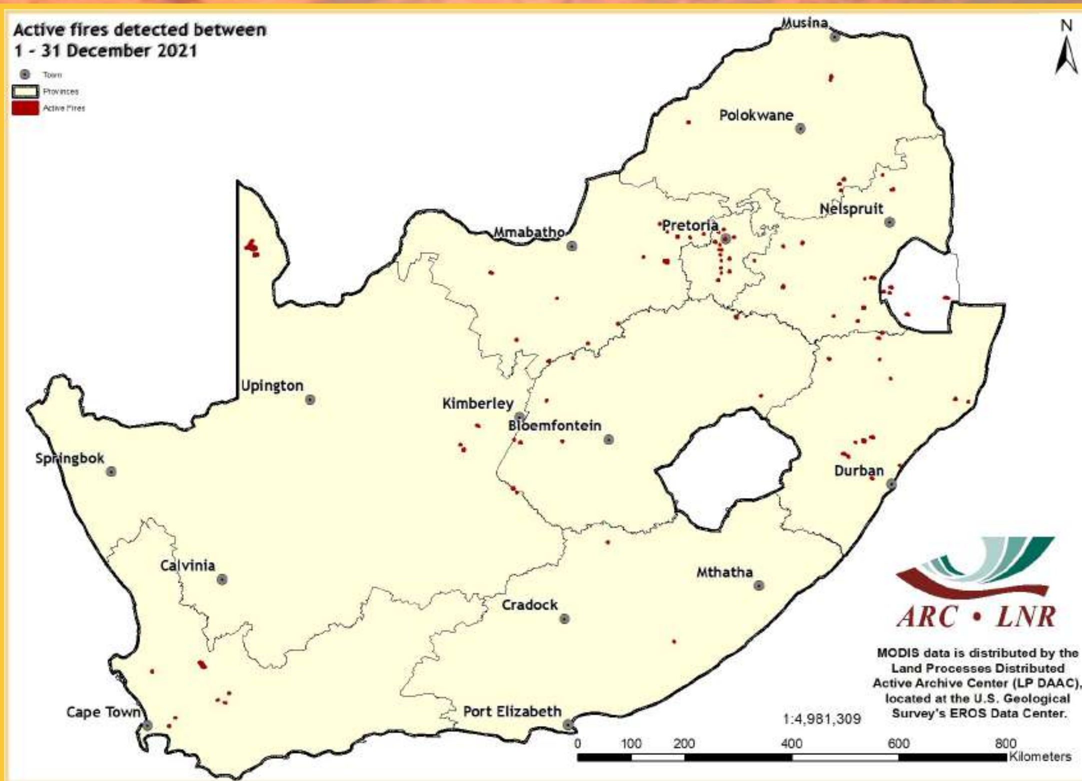

Figure 30

Figure 30:
The map shows the location of active fires detected between 1-31 December 2021.

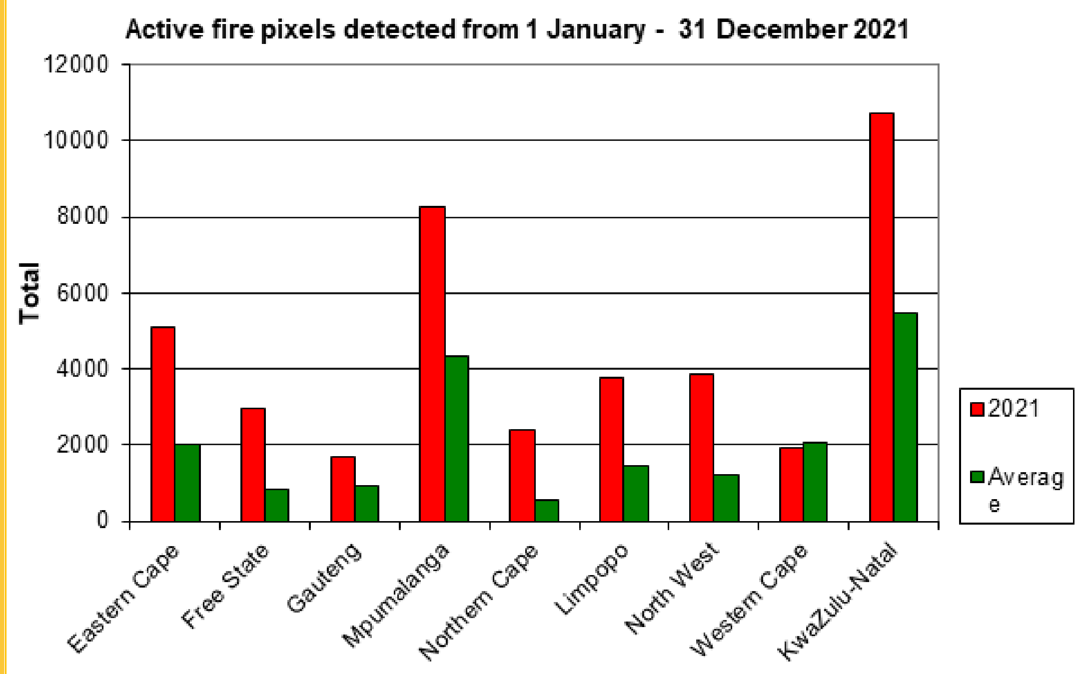

Figure 31

Figure 31: The graph shows the total number of active fires detected between 1 January and 31 December 2021 per province. Cumulative fire activity was higher in all provinces except for the Western Cape, compared to the long-term average.

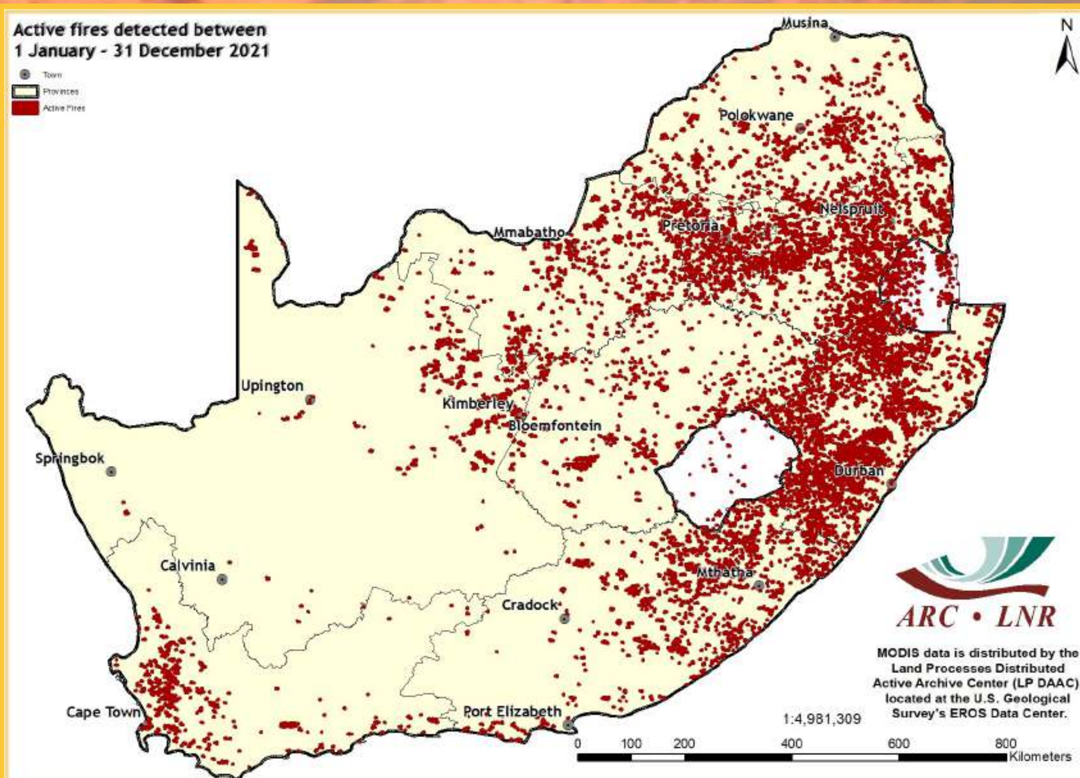

Figure 32

Figure 32: The map shows the location of active fires detected between 1 January and 31 December 2021.

Questions/Comments:
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8. Surface Water Resources

Countrywide surface water areas (SWAs) are mapped on a monthly basis by GeoTerraImage using Sentinel 2 satellite imagery from the start of its availability at the end of 2015.

Figure 33 represents a comparison between the area of water available now and the maximum area of surface water recorded in the last 5 years. This 5-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 December 2021 shows improved, higher water levels across central parts of the country and similar water patterns to the previous month across the rest of the country, with the majority of the summer rainfall region catchments showing water levels equivalent to 80-100% of the 5-year, long-term maximum water.

The comparison between December 2021 and December 2020 indicates an improvement to last month, with many of the highly stressed catchments on the map for November now showing significantly better water levels, especially in the central Karoo regions. Exceptions to this are a number of catchments in the Eastern Cape interior and bordering Botswana and Zimbabwe, which are still showing stressed water levels in December 2021, similar to the pattern recorded last month.

The SWA maps are derived from the monthly data generated and available through GeoTerraImage's 'Msanzi Amanzi' web information service: https://www.water-southafrica.co.za

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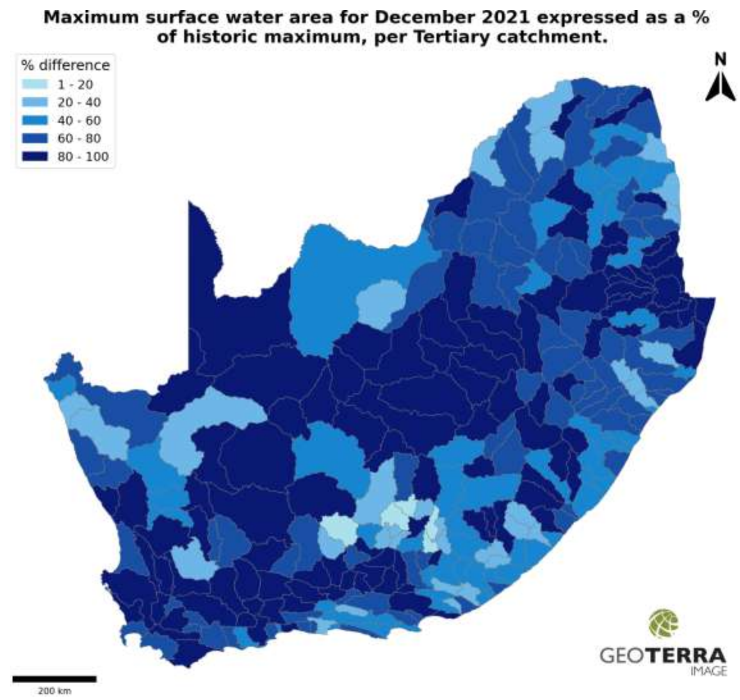

Figure 33

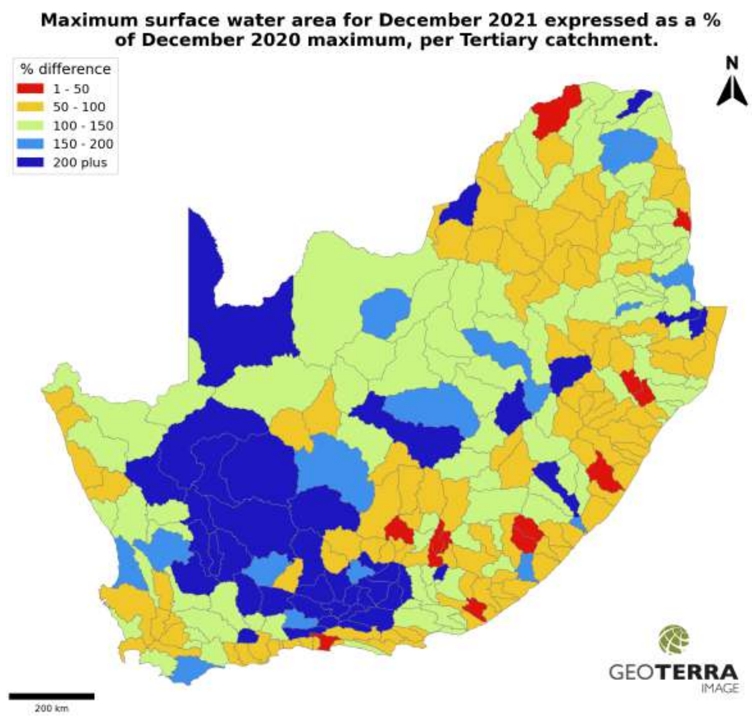

Figure 34

Agrometeorology

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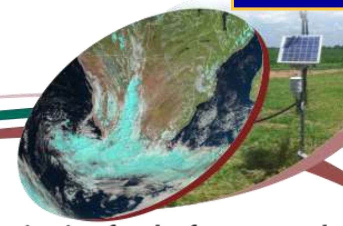

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national asset.

FOCUS AREAS

Climate Monitoring, Analysis & Modelling

- Analysis of climate variability and climate model simulation
- Use of crop modelling to assess the impact of climate on agriculture
- Development of decision support tools for farmers

Climate Change Adaptation & Mitigation

- National greenhouse gas inventory in the agricultural sector
- Improvement of agricultural production technologies under climate change
- Adaptation and mitigation initiatives, e.g. biogas production in small-scale farming communities

Climate Information Dissemination

- Communication to farmers for alleviating weather-related disasters such as droughts
- Dissemination of information collected from weather stations
- Climate change awareness campaigns in farming communities

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Geoinformation Science

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The programme focuses on applied Geographical Information Systems (GIS) and Earth Observation (EO)/Remote Sensing research and provides leadership in applied GIS products, solutions, and decision support systems for agriculture and natural resources management. The Coarse Resolution Satellite Image Archive and Information Database is maintained as a national asset.

FOCUS AREAS

Decision Support Systems

- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

Early Warning & Food Security

- Drought and vegetation production monitoring
- Crop estimates and yield modelling
- Animal biomass and grazing capacity mapping
- Global and local agricultural outlook forecasts
- Disaster monitoring for agricultural systems

Natural Resources Monitoring

- Land use/cover mapping
- Invasive species distribution
- Applications of GIS and EO on land degradation/erosion, desertification, hydrology and catchment areas
- Rangeland health assessments
- Carbon inventory monitoring

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The Coarse Resolution Imagery Database (CRID)

NOAA AVHRR

The ARC-ISCW has an archive of daily NOAA AVHRR data dating from 1985 to 2004. This database includes all 5 bands as well as the Normalized Difference Vegetation Index (NDVI), Active Fire and Land Surface Temperature (LST) images. The NOAA data are used, for example, for crop production and grazing capacity estimation.

MODIS

MODIS data is distributed by the Land Processes Distributed Active Archive Center (LP DAAC), located at the U.S. Geological Survey's EROS Data Center. The MODIS sensor is more advanced than NOAA with regard to its high spatial (250 m^2 to 1 km^2) and spectral resolution. The ARC-ISCW has an archive of MODIS (version 4 and 5) data.

- MODIS v4 from 2000 to 2006
- MODIS v5 from 2000 to present

Datasets include:

- MOD09 (Surface Reflectance)
- MOD11 (Land Surface Temperature)
- MOD13 (Vegetation Products)
- MOD14 (Active Fire)
- MOD15 (Leaf Area Index & Fraction of Photosynthetically Active Radiation
- MOD17 (Gross Primary Productivity)
- MCD43 (Albedo & Nadir Reflectance)
- MCD45 (Burn Scar)

Coverage for version 5 includes South Africa, Namibia, Botswana, Zimbabwe and Mozambique.
More information:
http://modis.gsfc.nasa.gov

VGT4AFRICA and GEOSUCCESS

SPOT NDVI data is provided courtesy of the VEGETATION Programme and the VGT4AFRICA project. The European Commission jointly developed the VEGETATION Programme. The VGT4AFRICA project disseminates VEGETATION products in Africa through GEONETCast.

ARC-ISCW has an archive of VEGETATION data dating from 1998 to the present. Other products distributed through VGT4AFRICA and GEOSUCCESS include Net Primary Productivity, Normalized Difference Wetness Index and Dry Matter Productivity data.

Meteosat Second Generation (MSG)

The ARC-ISCW has an operational MSG receiving station. Data from April 2005 to the present have been archived. MSG produces data with a 15-minute temporal resolution for the entire African continent. Over South Africa the spatial resolution of the data is in the order of 3 km. The ARC-ISCW investigated the potential for the development of products for application in agriculture. NDVI, LST and cloud cover products were some of the initial products derived from the MSG SEVIRI data. Other products derived from MSG used weather station data, including air temperature, humidity and solar radiation.

Rainfall maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network, 270 automatic rainfall recording stations from the SAWS, satellite rainfall estimates from the Famine Early Warning System Network: **http://earlywarning.usgs.gov** and long-term average climate surfaces developed at the ARC-ISCW.

Solar Radiation and Evapotranspiration maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network.
- Data from the METEOSAT Second Generation (MSG) 3 satellite via GEONETCAST: **http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast/GEONETCast/index.html**.

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The operational Coarse Resolution Imagery Database (CRID) project of ARC-ISCW is funded by the National Department of Agriculture, Land Reform and Rural Development. 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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What does Umlindi mean?
UMLINDI is the Zulu word for “the watchman”.