UMLINDI
The Watchman

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Excellence in Research and Development

INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

1. Rainfall 2
2. Standardized Precipitation Index 4
3. Rainfall Deciles 6
4. Vegetation Conditions 7
5. Vegetation Condition Index 9
6. Vegetation Conditions & Rainfall 11
7. Fire Watch 15
8. Surface Water Resources 16
9. Agrometeorology 17
10. Geoinformation Science 17
11. CRID 18
12. Contact Details 18

agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

South African Weather Service

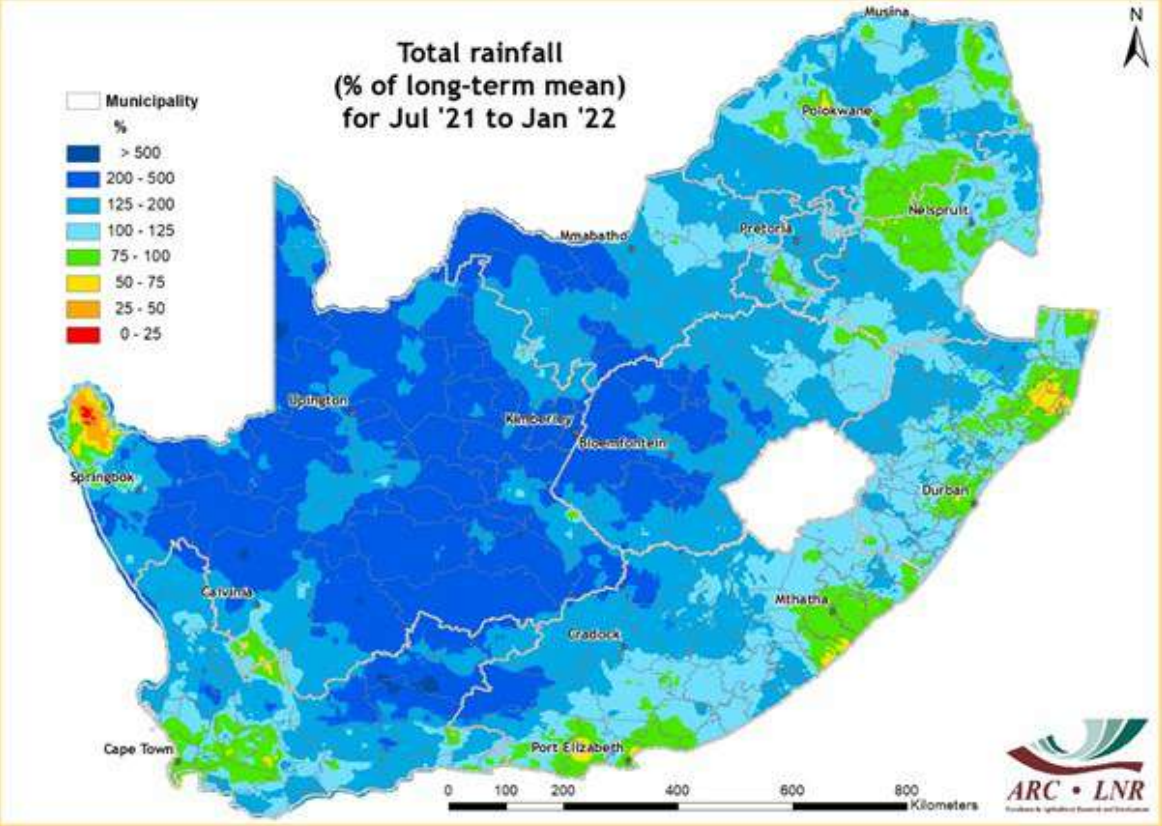
AMESD

212th Edition

Image of the Month

Overview of 2021/22 summer rainfall season

Most of the country has experienced above-normal rainfall during the 2021/22 summer rainfall season to date (see map below). The season began with the occurrence of unseasonable 'first-rain' during August 2021, which brought positive prospects for the agricultural community. Then a clear onset of summer rains was observed during the month of October, which was characterized by widespread rainfall. Rainfall totals increased further during November and December, often complemented by thunderstorms, strong winds and hail over some areas. This pattern of above-normal rainfall continued into January 2022. However, the occurrence of relatively high rainfall events resulted in damaging flood conditions and accordingly, on the 19th of January, the Department of Cooperative Governance and Traditional Affairs (CoGTA) classified these severe weather events as a national disaster, in terms of Section 23 of the Disaster Management Act, 2002 (https://www.cogta.gov.za/cgta_2016/wp-content/uploads/2022/01/Gazette.pdf). It is therefore important for farmers to continue with production practices that can mitigate the effects of agrometeorological risks during this period. Other potential risks include poor rainfall distribution resulting in both wet and dry spells, outbreaks of pests and diseases, invasive weeds and wild fires.



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:

Most of the summer rainfall region of South Africa received normal to above-normal rainfall during January 2022. These rainy conditions were mainly confined to the interior, the adjacent eastern areas and the Lowveld of Mpumalanga. Stations that recorded between 200 and 300 mm of rainfall for the month include Ermelo, Mukumbani Tea Estate, Gariep Dam, Kathu, Kokstad and Ladysmith, while totals >300 mm were recorded in isolated areas of the Limpopo, Mpumalanga, KwaZulu-Natal and Northern Cape provinces. When expressed as a percentage of the long-term mean, the latter areas all experienced above-normal rainfall, while near- and below-normal conditions were observed over parts of North West, Limpopo, the eastern Free State, KZN and the Eastern Cape. The winter and all-year rainfall regions received below-normal rainfall during the month which was a notable decrease since October 2021.

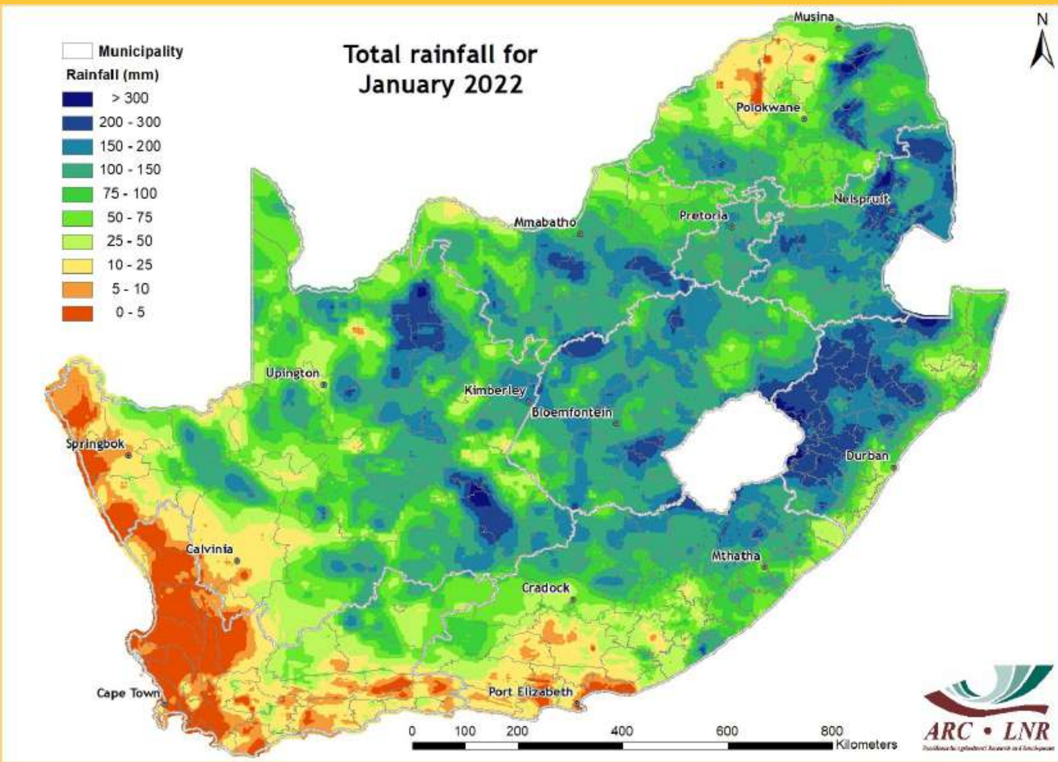


Figure 1

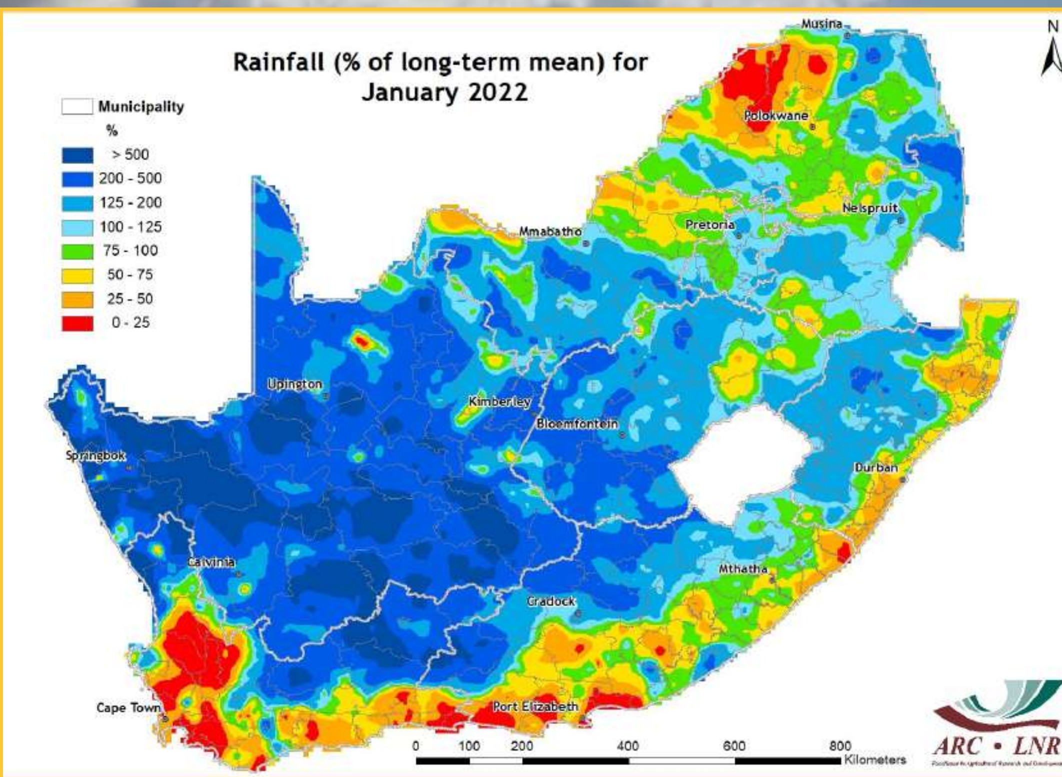


Figure 2

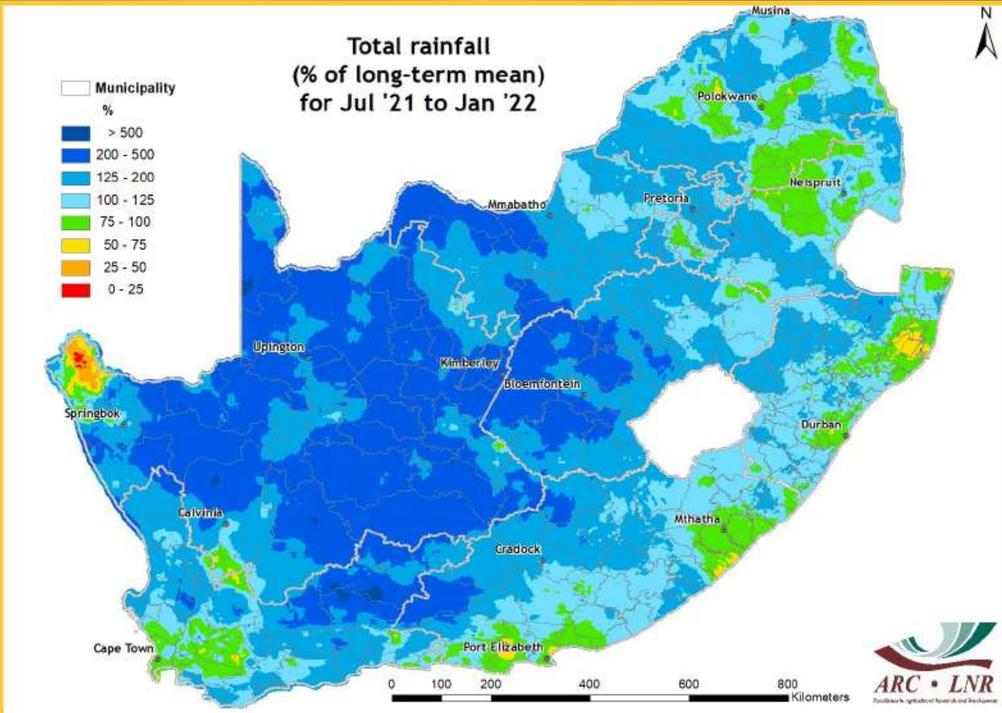


Figure 3

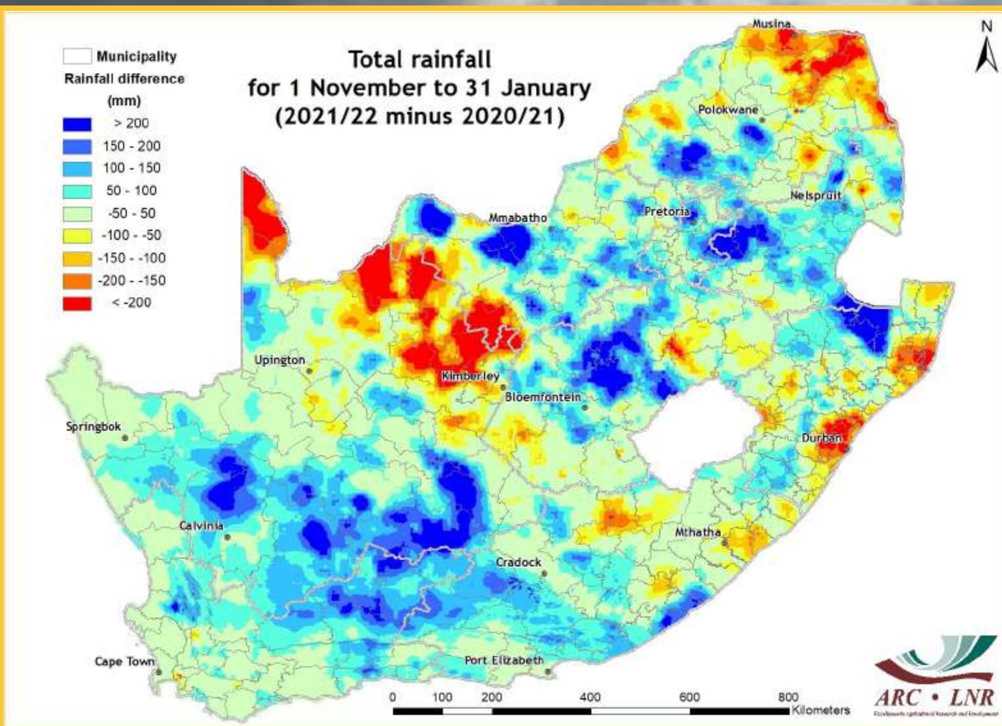


Figure 4

Figure 1:
Greater parts of the country, including the interior, moving towards the north-eastern regions, received in excess of 100 mm of rain during January 2022. Meanwhile, the northwestern parts of Limpopo and much of the winter and all-year rainfall regions recorded <25 mm of rain for the month.

Figure 2:
Above-normal rainfall occurred over most of the Northern Cape, adjacent areas of the Western and Eastern Cape, the Free State moving towards KZN, as well as certain parts of Mpumalanga, Gauteng, North West and Limpopo. Areas that received below-normal rainfall during January include greater parts of the winter and all-year rainfall regions, the KZN coast, central and western parts of Limpopo and isolated areas of North West and the Free State.

Figure 3:
This map shows cumulative total rainfall from July 2021 to January 2022 expressed as a percentage of the long-term mean. It is evident that above-normal conditions were experienced over the whole country, with small exceptions in the extreme west.

Figure 4:
Compared to the same period last summer, total rainfall from November 2021 to January 2022 showed above-normal values (given by the blue colours) over the Great Karoo and neighbouring areas of the Eastern Cape, parts of the Free State, North West, Gauteng, Mpumalanga and southern Limpopo. Areas that received less rain this summer include the Northern Cape/North West border, Lowveld of Limpopo, moving towards the eastern Free State, Eastern Cape and the KZN coast.

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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 January 2022 are shown in Figures 5-8. In general, wet conditions were prominent over most parts of the country, indicating an improvement from drought conditions. Given the short- and medium-term SPI maps, high rainfall totals resulted mostly in wet conditions over the interior and parts of the Karoo. Other regions specified near-normal conditions, with areas such as the water-scarce Richtersveld Municipality of the Northern Cape, parts of the all-year rainfall region and the Limpopo/ Mpumalanga border indicating moderate drought conditions. The long-term SPI maps depicted moderate to extremely wet conditions over the interior, parts of the Western Cape, KZN Midlands and the Lowveld of Limpopo and Mpumalanga, implying higher dam levels significant for agricultural water use.

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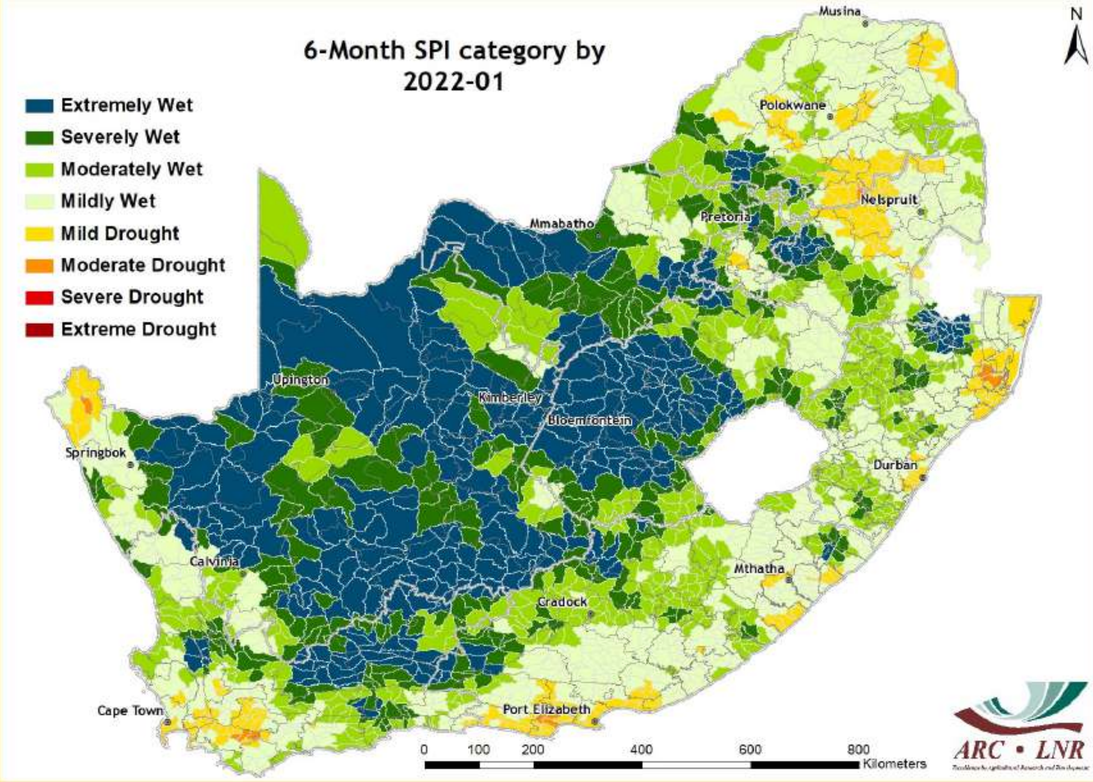

Figure 5

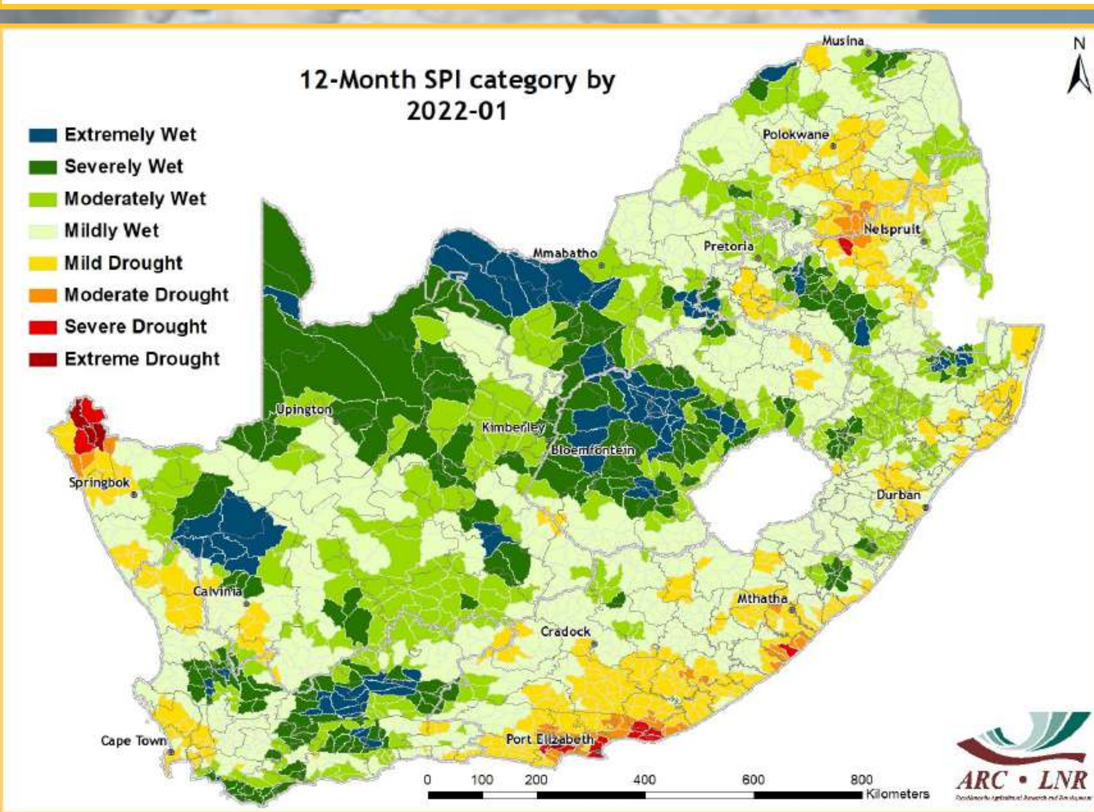

Figure 6

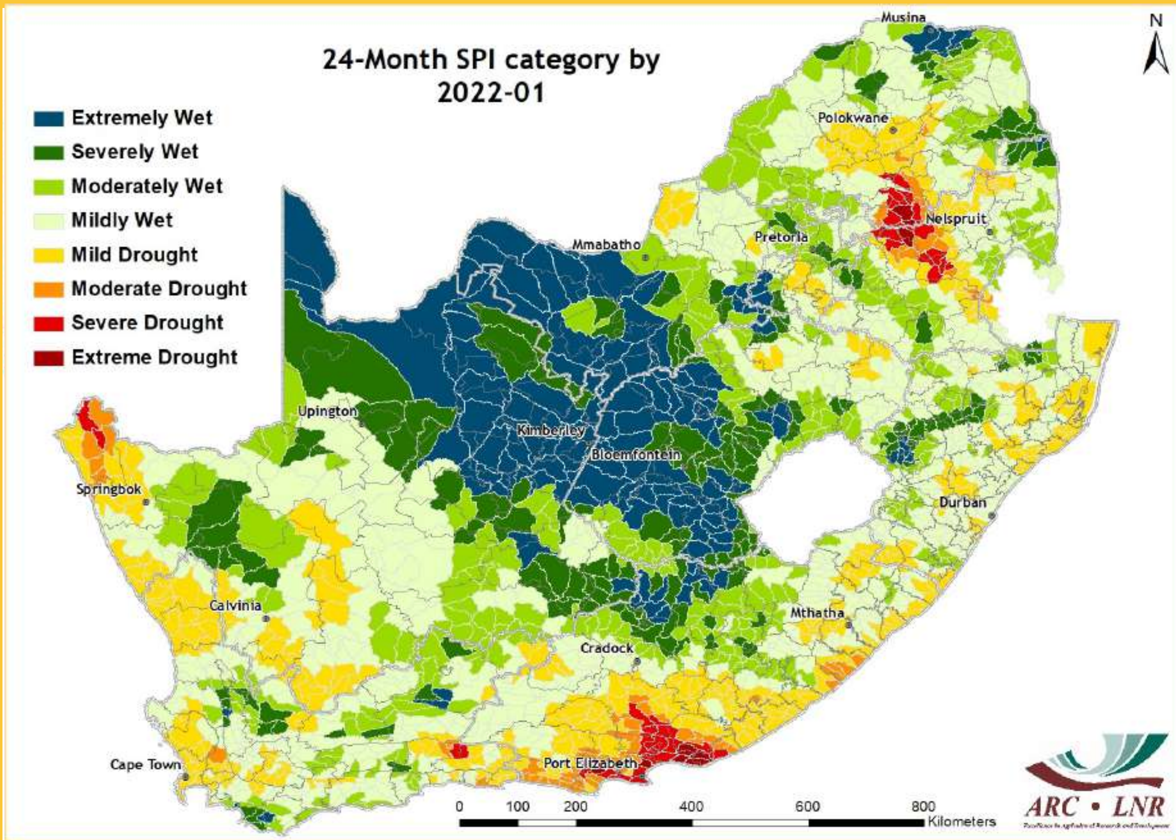

Figure 7

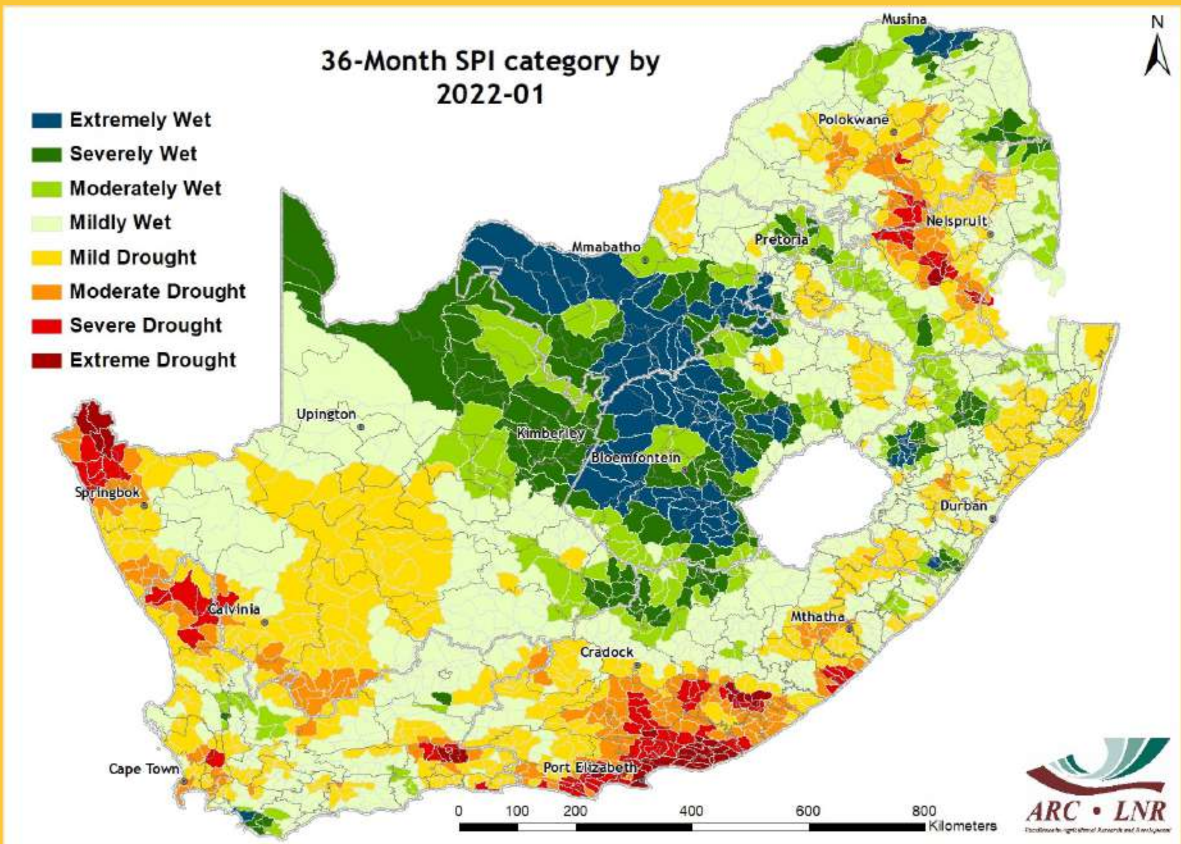

Figure 8

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.

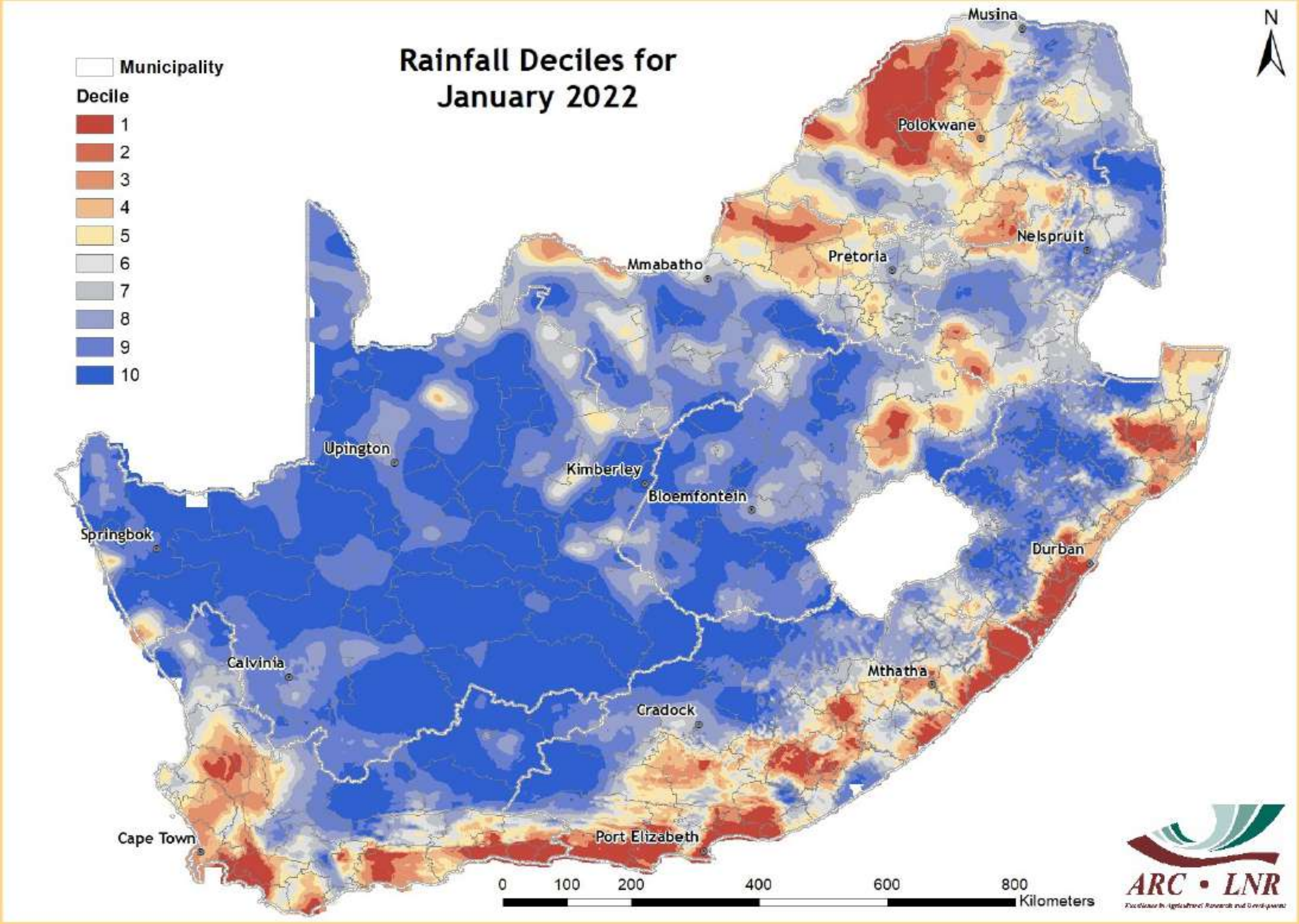

Figure 9

Figure 9:
During January 2022, greater parts of the country experienced rainfall totals that compare well with historically wetter January months. The only areas that recorded rainfall totals corresponding with historically drier January months include the winter and all-year rainfall regions, coastal areas of KZN and isolated parts of the Highveld, extending towards Limpopo.

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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.

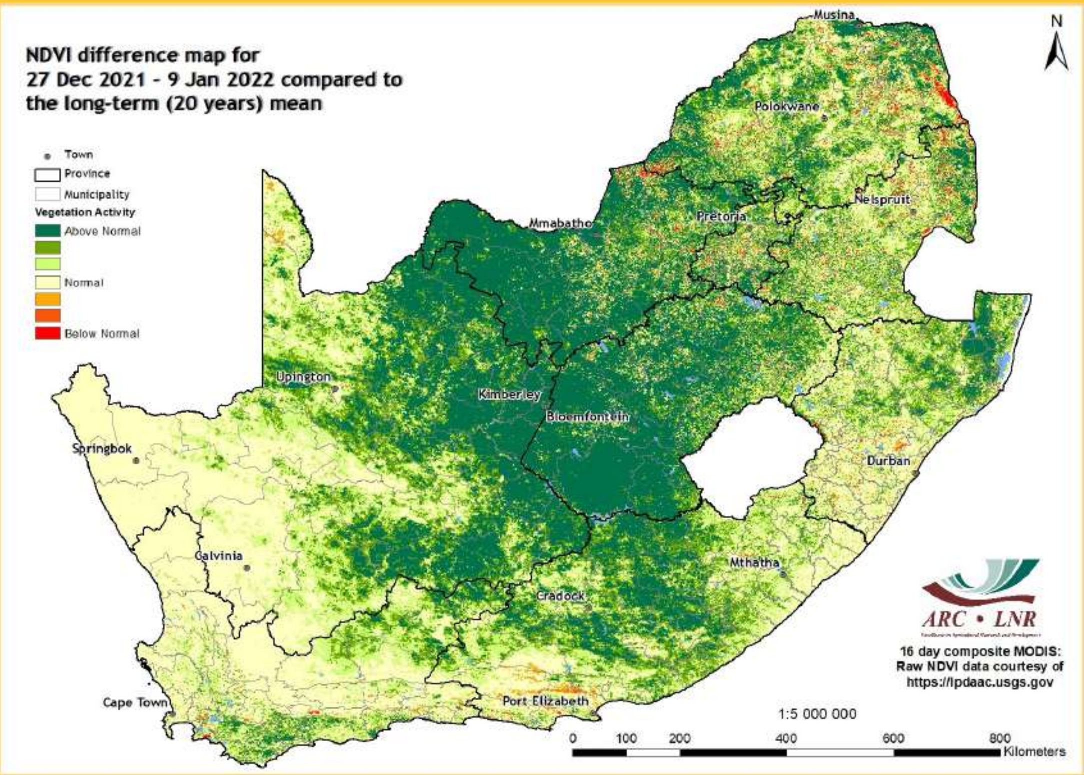

Figure 10

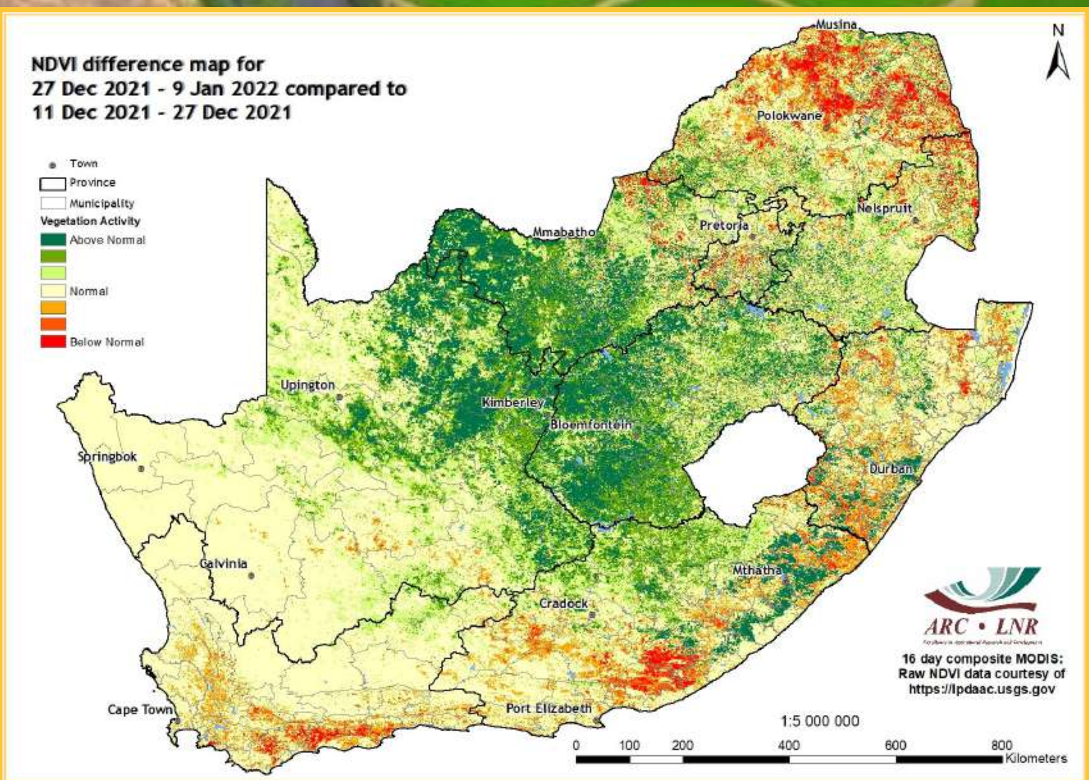

Figure 11

Figure 10:
Compared to the historical averaged vegetation conditions, the 16-day NDVI map for January 2022 shows that many parts of the country experienced above-normal vegetation activity with pockets of below-normal vegetation conditions in isolated areas.

Figure 11:
The 16-day NDVI difference map for January 2022 compared to last month shows that the country experienced mostly normal to above-normal vegetation conditions with pockets of below-normal conditions in isolated areas.

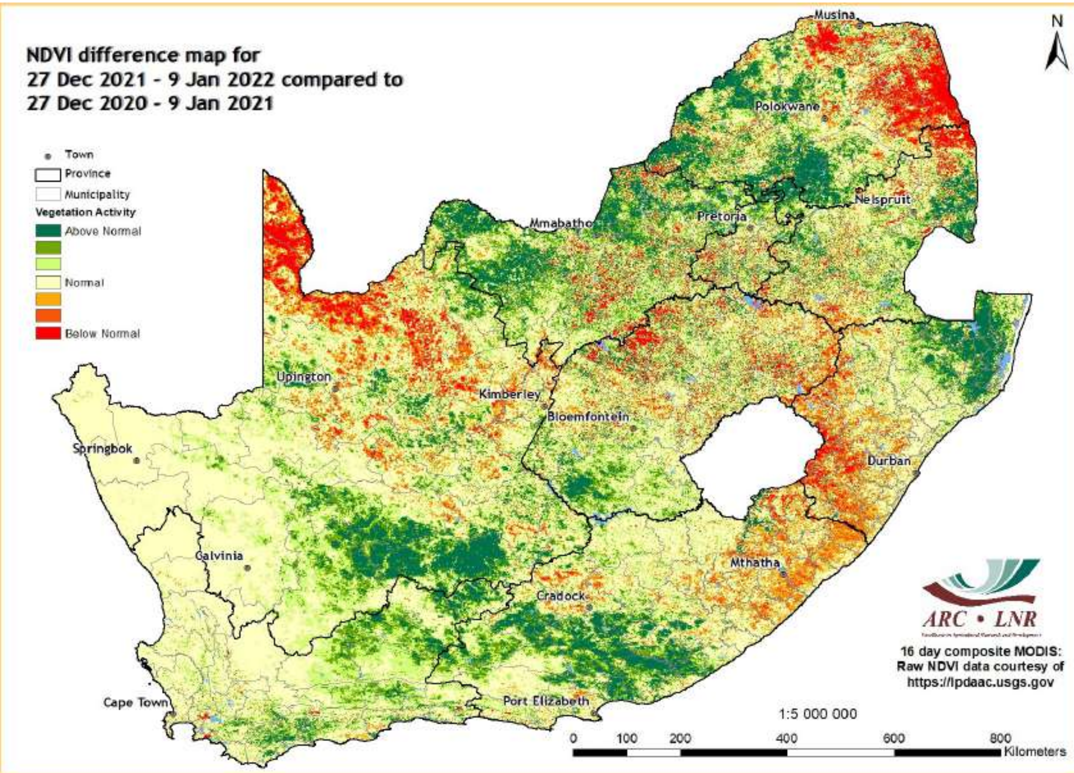

Figure 12

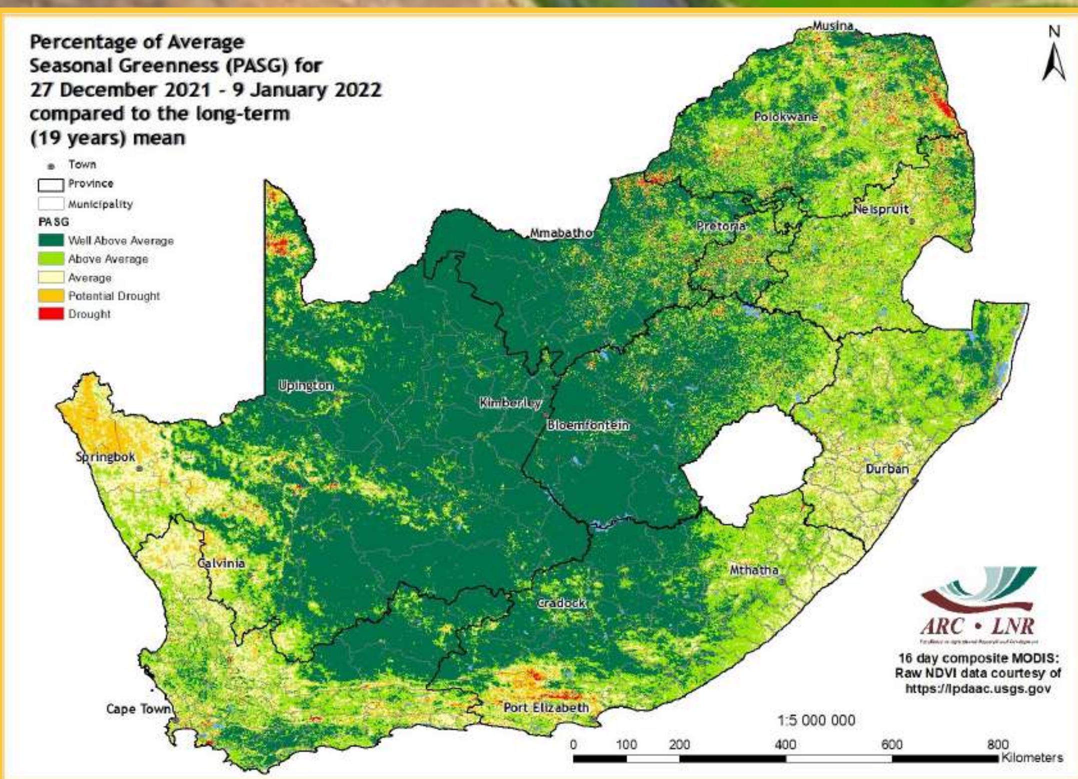

Figure 13

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 January 2022 compared to the same month last year shows 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 13:
The Percentage of Average Seasonal Greenness (PASG) map for the past 16 days, compared to the long-term mean, shows that South Africa experienced mostly high levels of seasonal vegetation greenness, with pockets of potential drought or drought conditions in isolated 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.

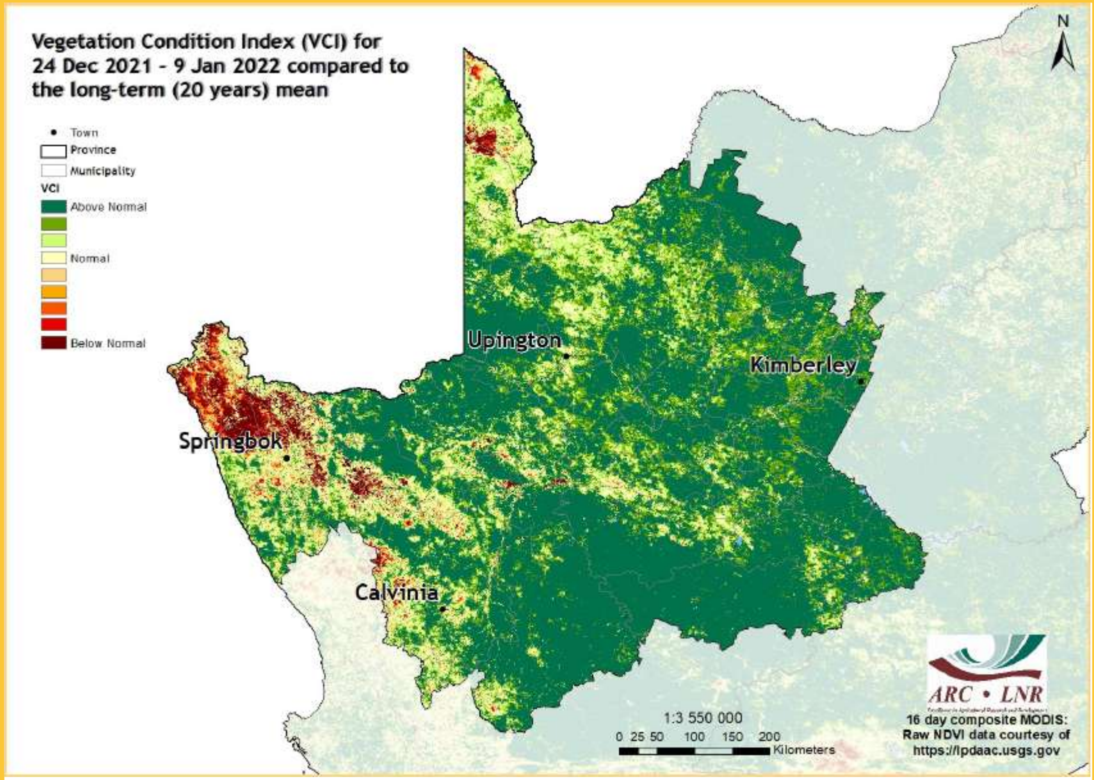


Figure 14

Figure 14:
The 16-day VCI map for January 2022 indicates that most parts of the Northern Cape continue to experience improved vegetation conditions, with only a few areas in the far western parts still experiencing drought conditions.

Figure 15:
The 16-day VCI map for January 2022 indicates that vegetation conditions have improved in most parts of the Eastern Cape, with the exception of the Sarah Baartman District Municipality which is still experiencing poor vegetation activity.

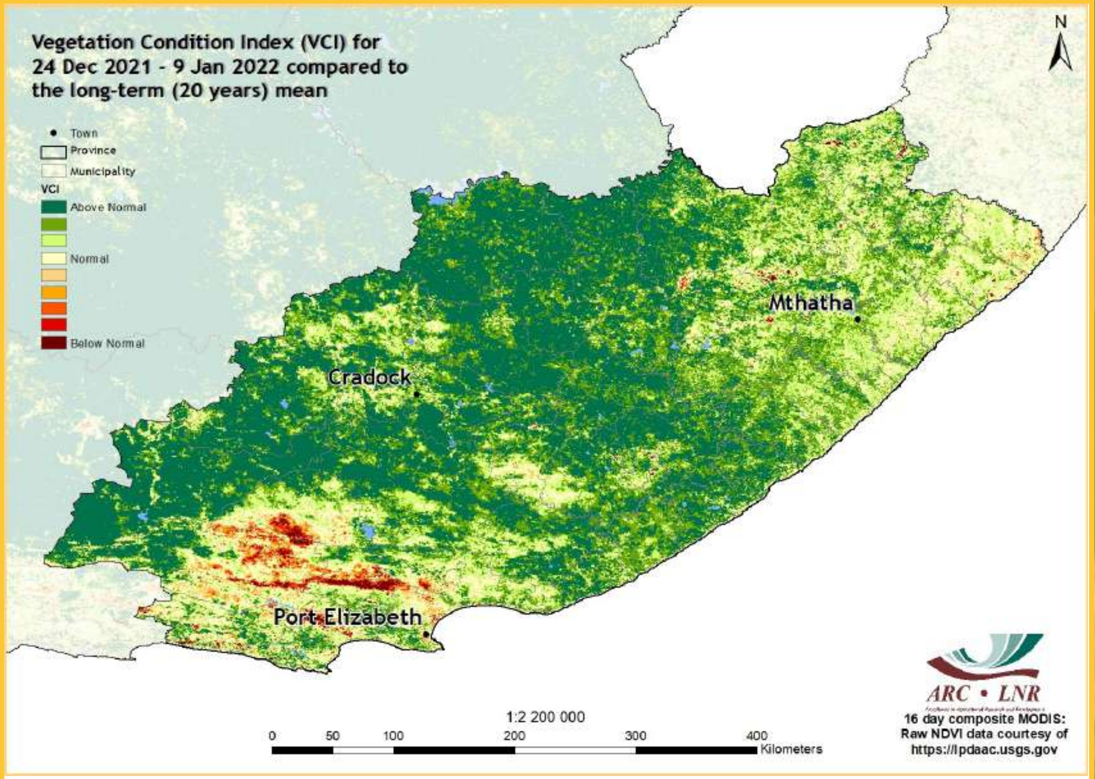
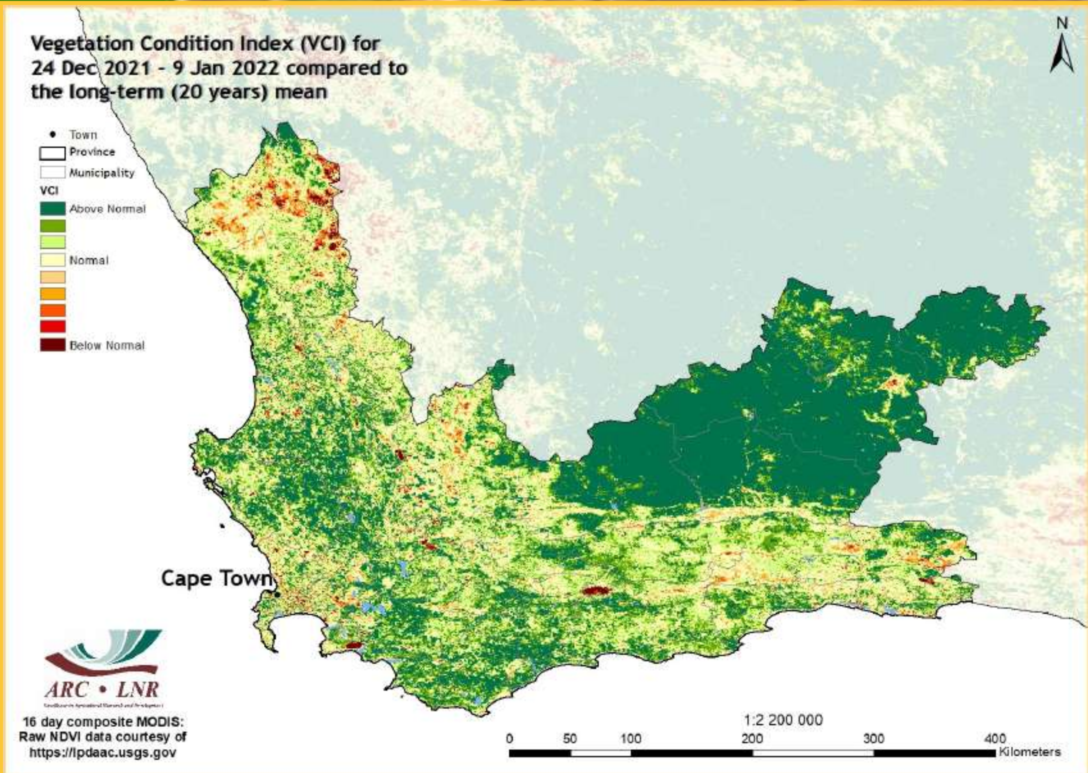


Figure 15



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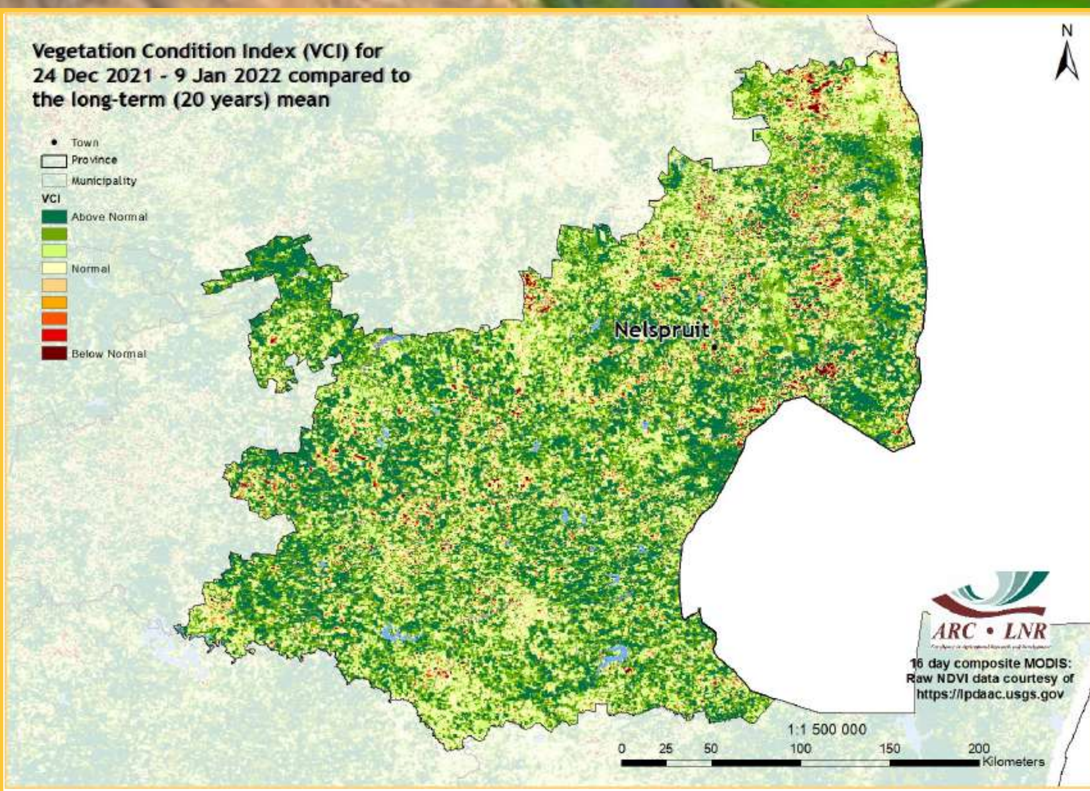

Figure 17

Figure 16:
The 16-day VCI map for January 2022 indicates that above-normal vegetation conditions have spread throughout the Western Cape, although pockets of poor vegetation activity can also be observed.

Figure 17:
The 16-day VCI map for January 2022 indicates that most parts of Mpumalanga continue to experience above-normal vegetation conditions, although pockets of poor vegetation activity can be observed in isolated areas of the province.

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6. Vegetation Conditions & Rainfall

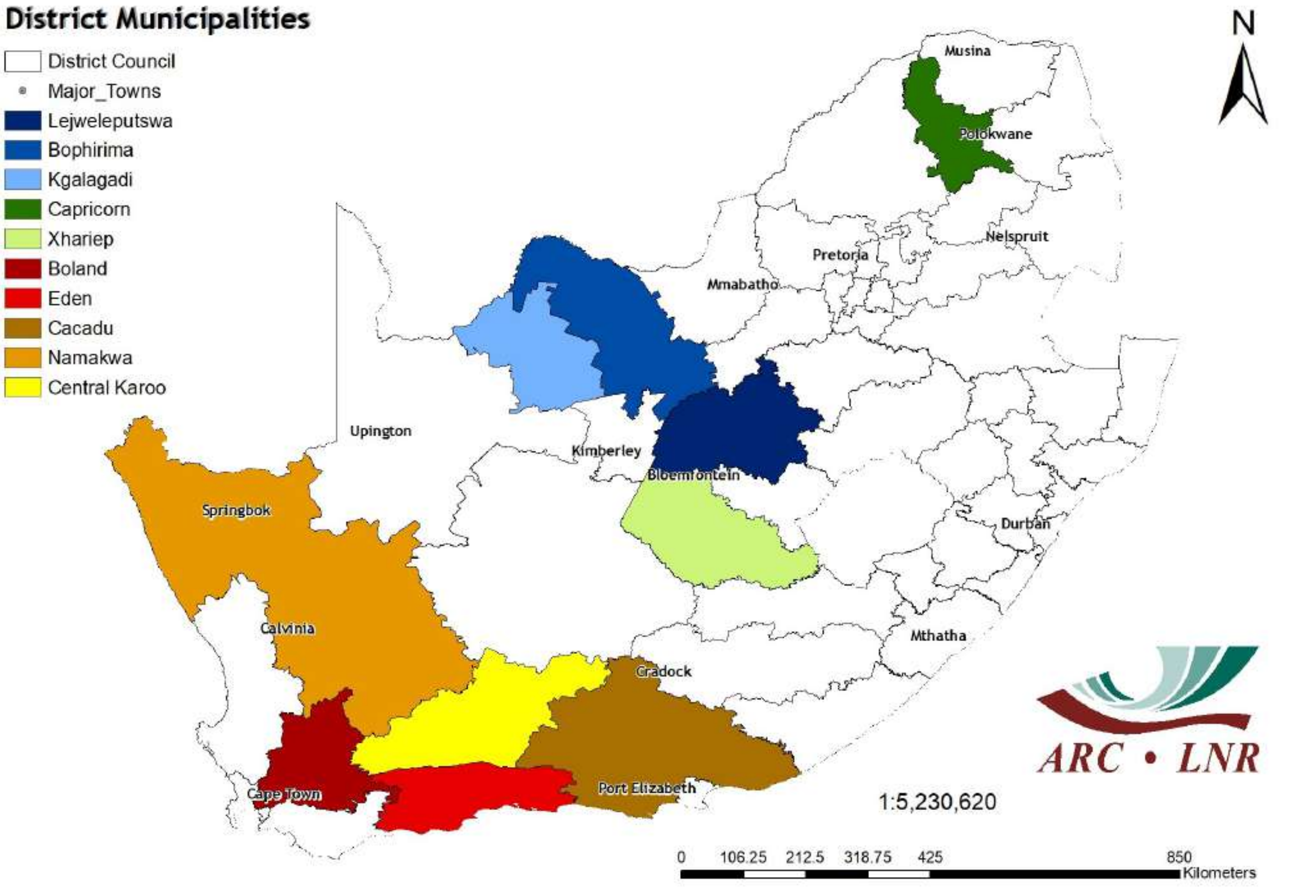

Figure 18

Rainfall and NDVI Graphs

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

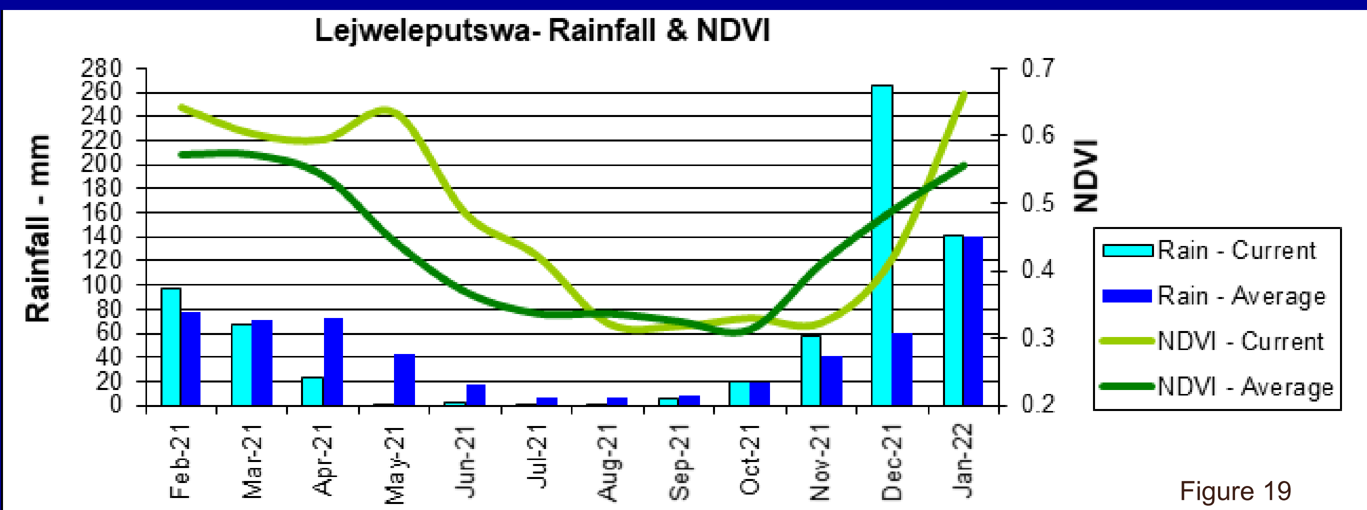


Figure 19

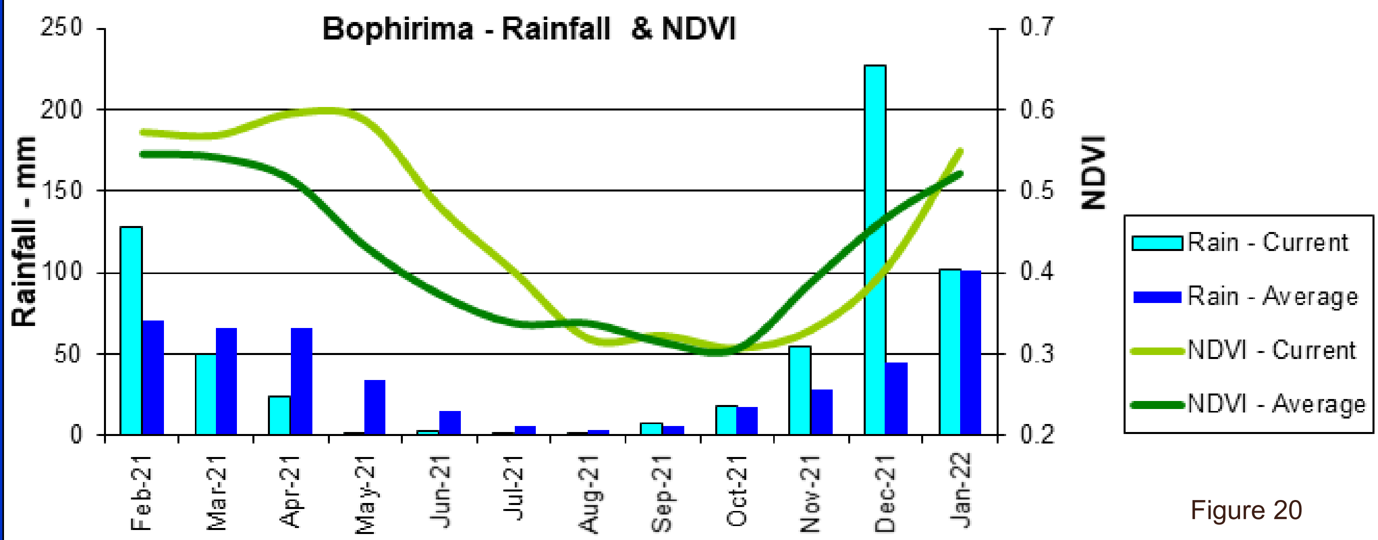


Figure 20

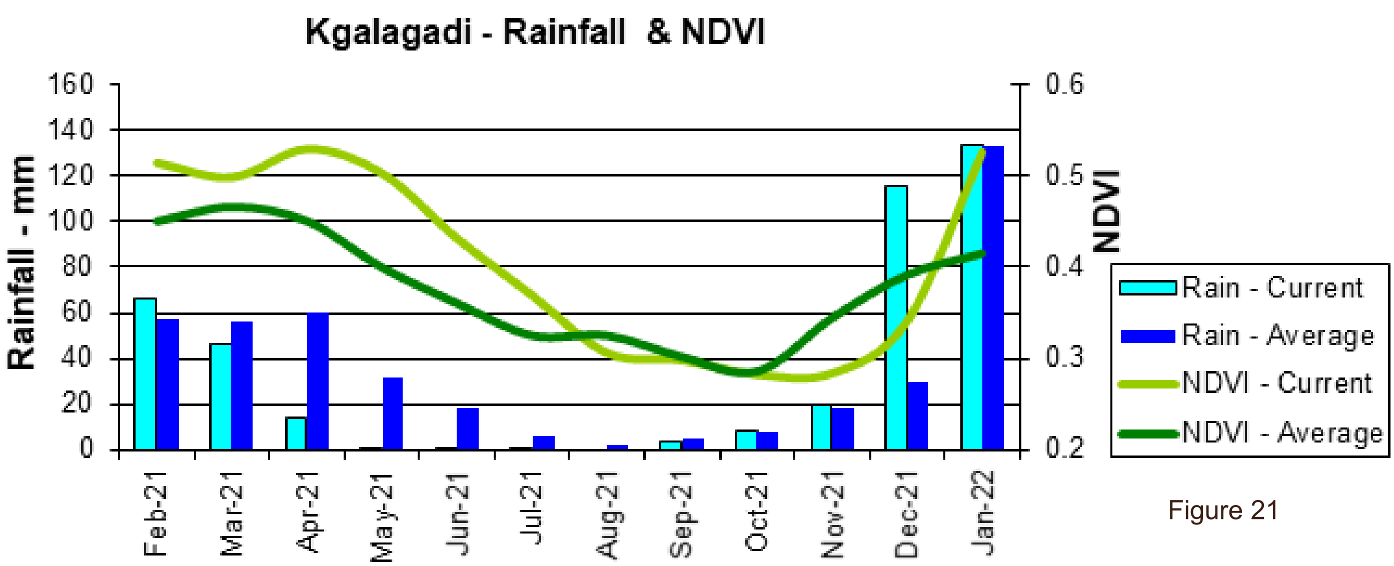
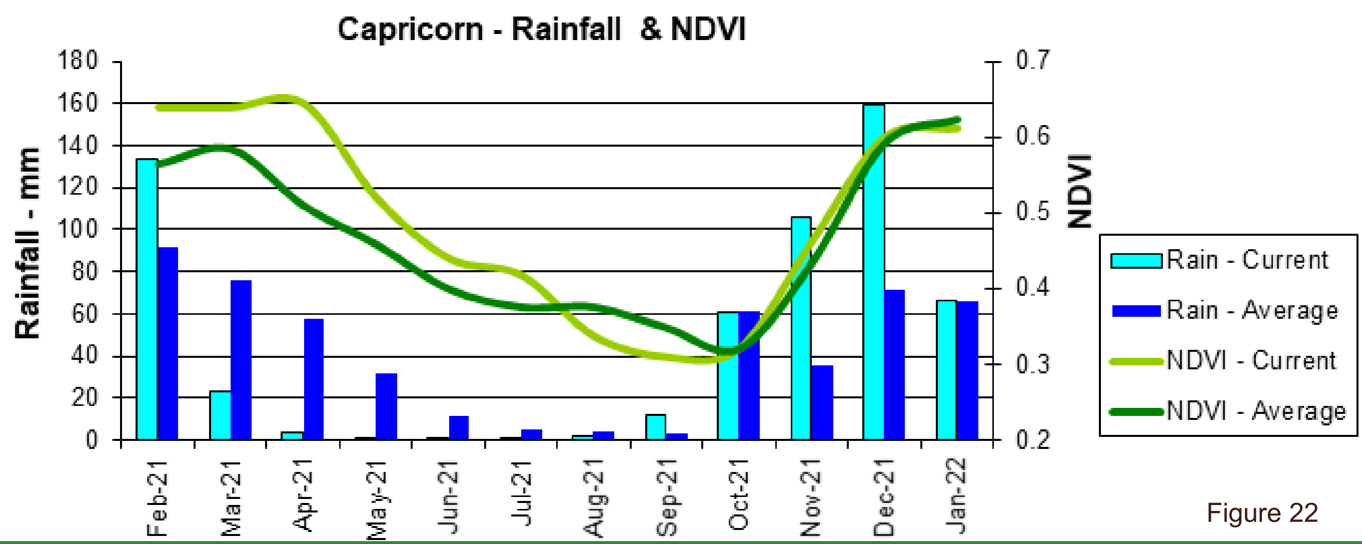


Figure 21



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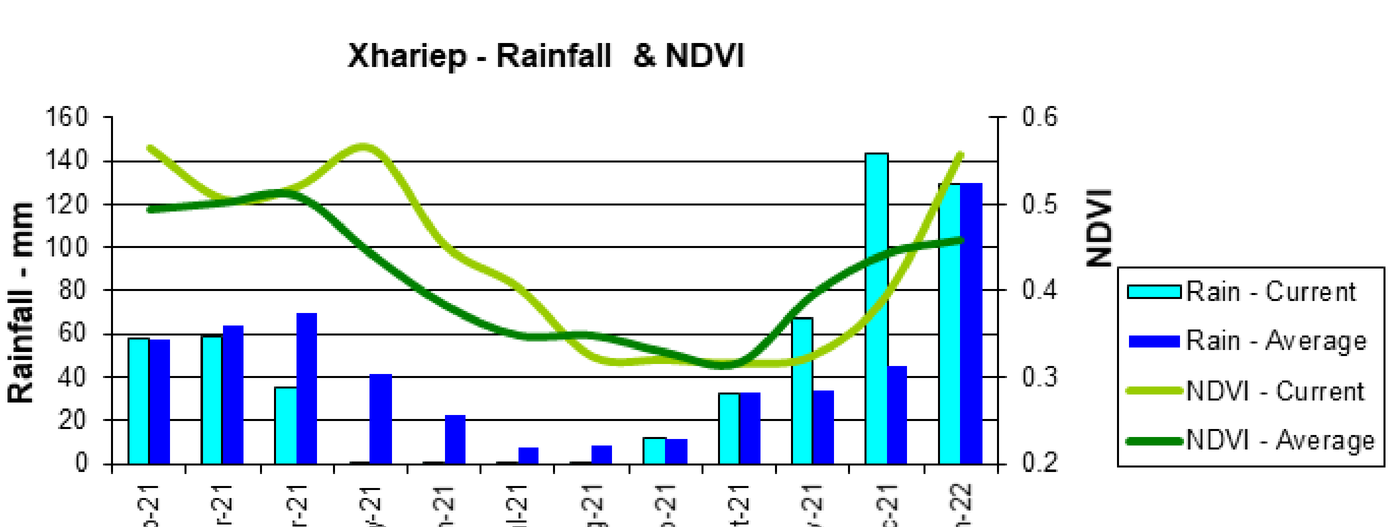
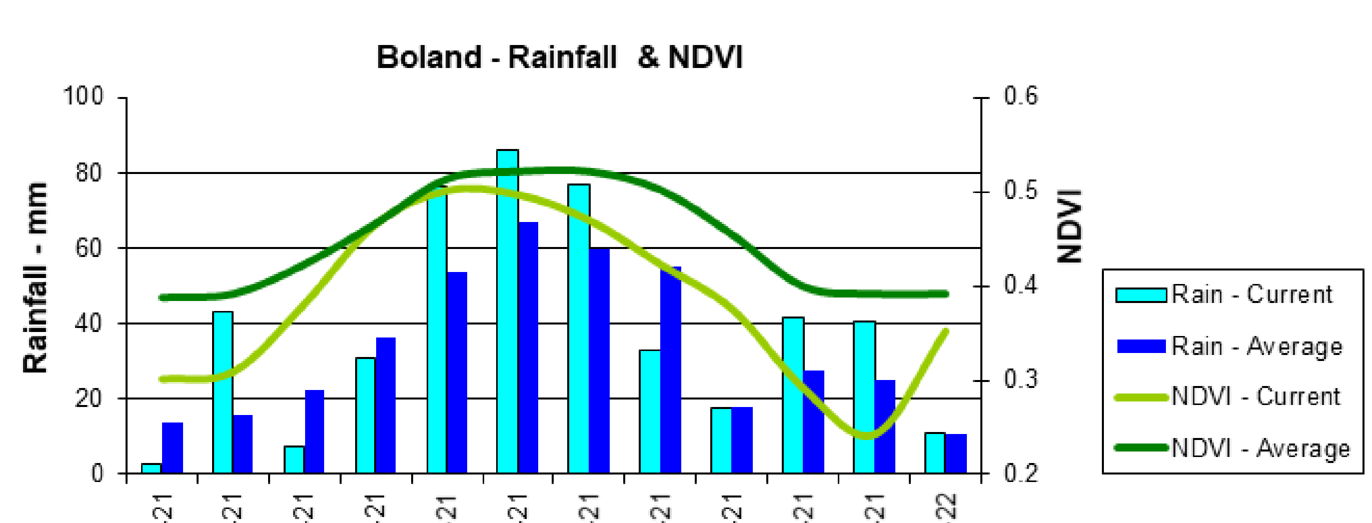


Figure 23



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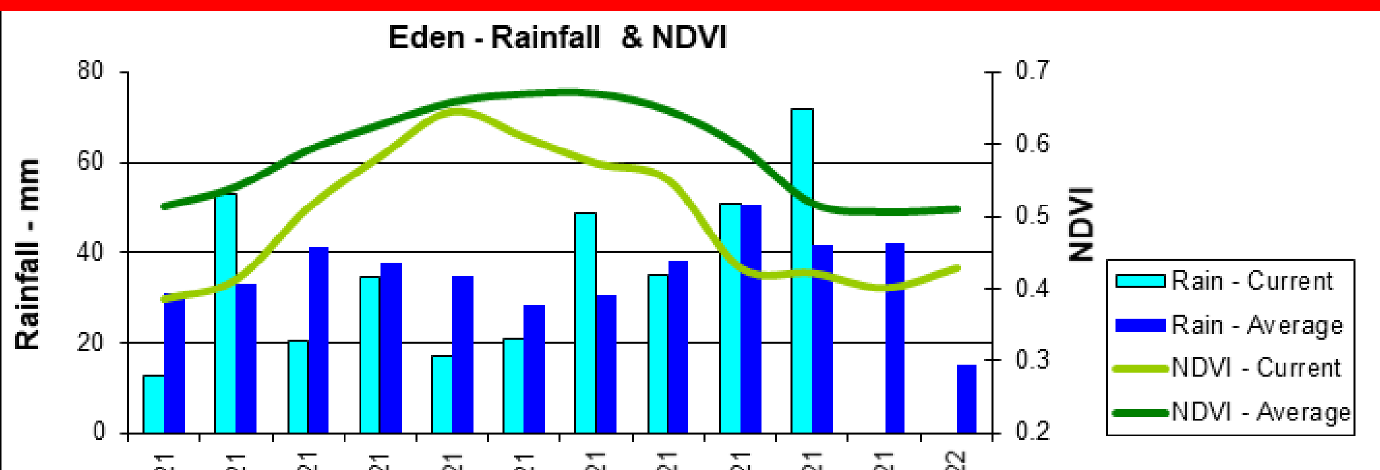


Figure 25

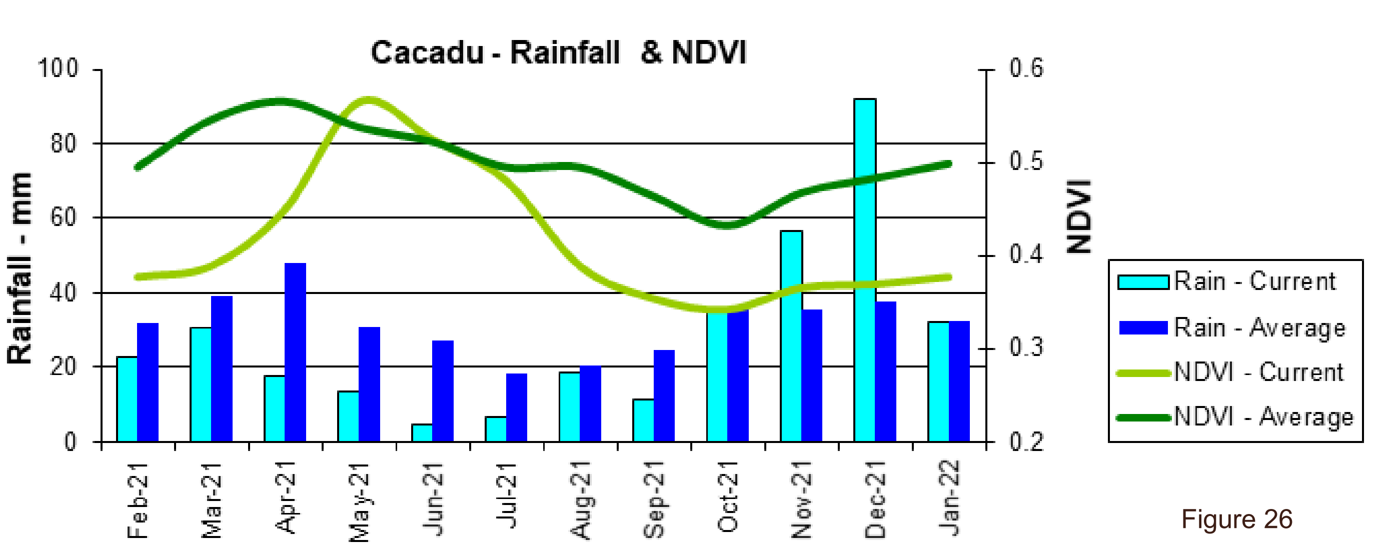
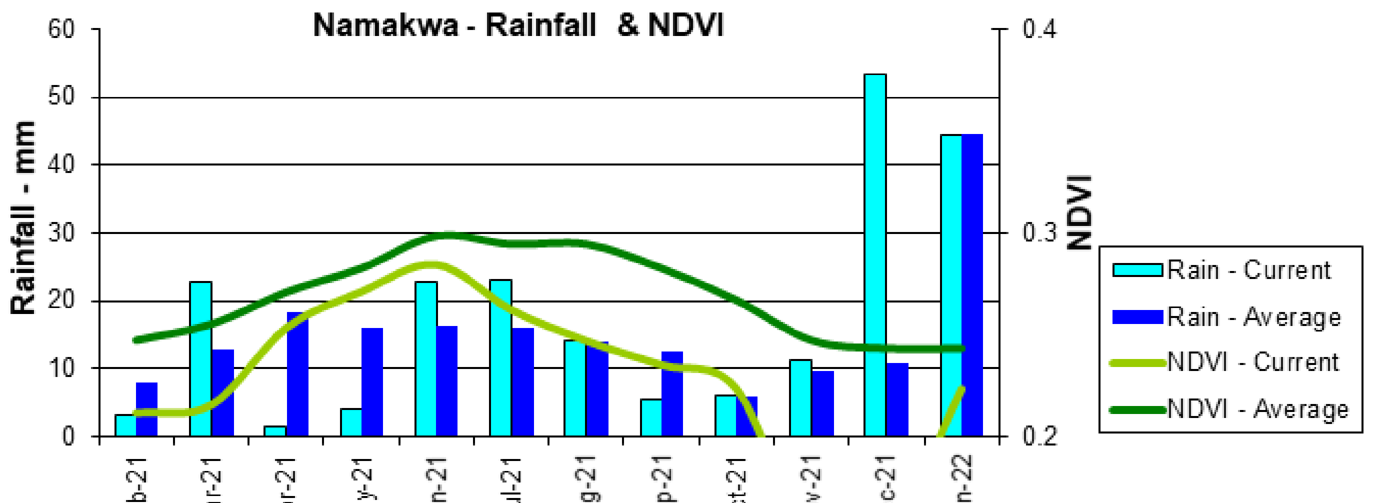


Figure 26



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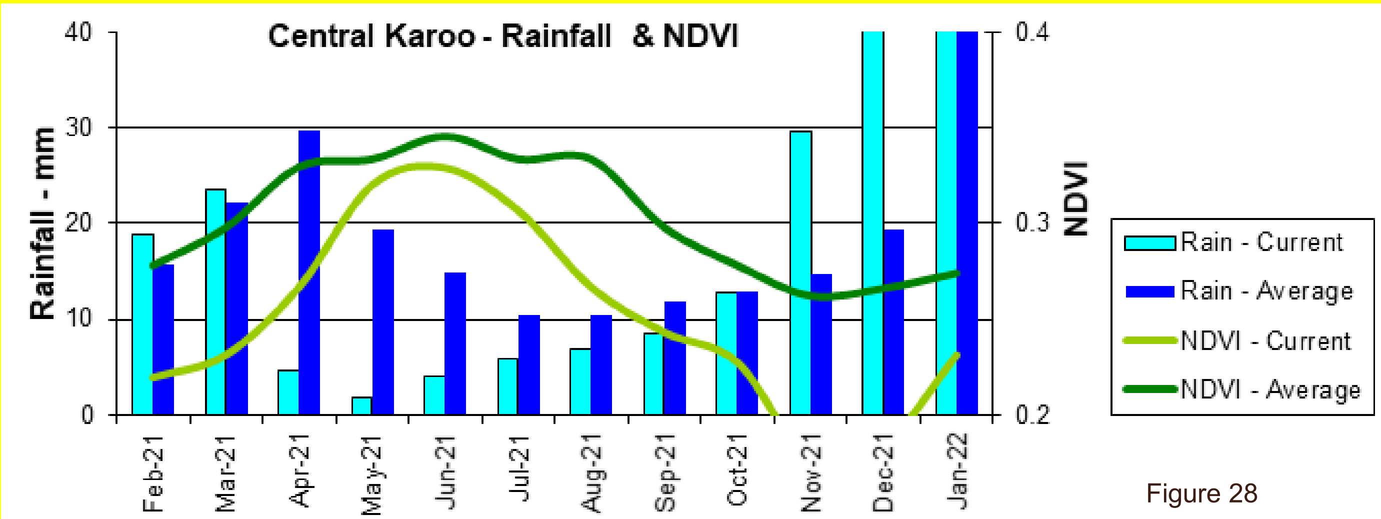

Figure 28

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 1-31 January 2022 per province. Fire activity was lower in all provinces except for the Western Cape, compared to the long-term average.

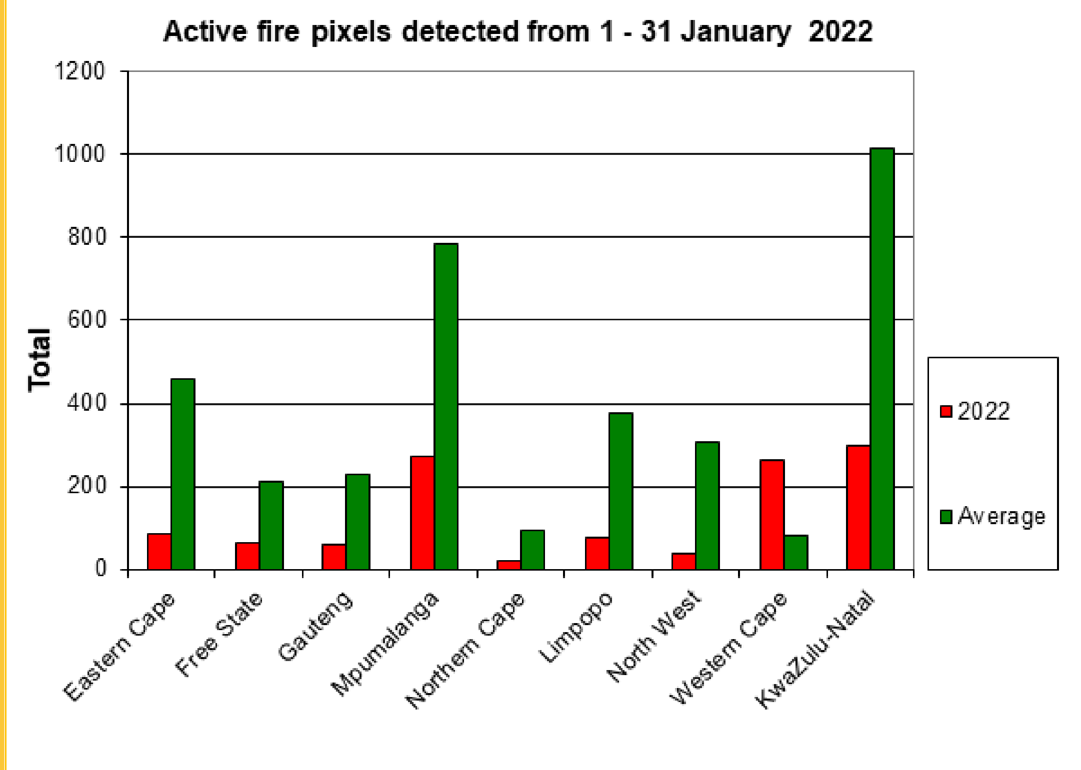

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-31 January 2022.

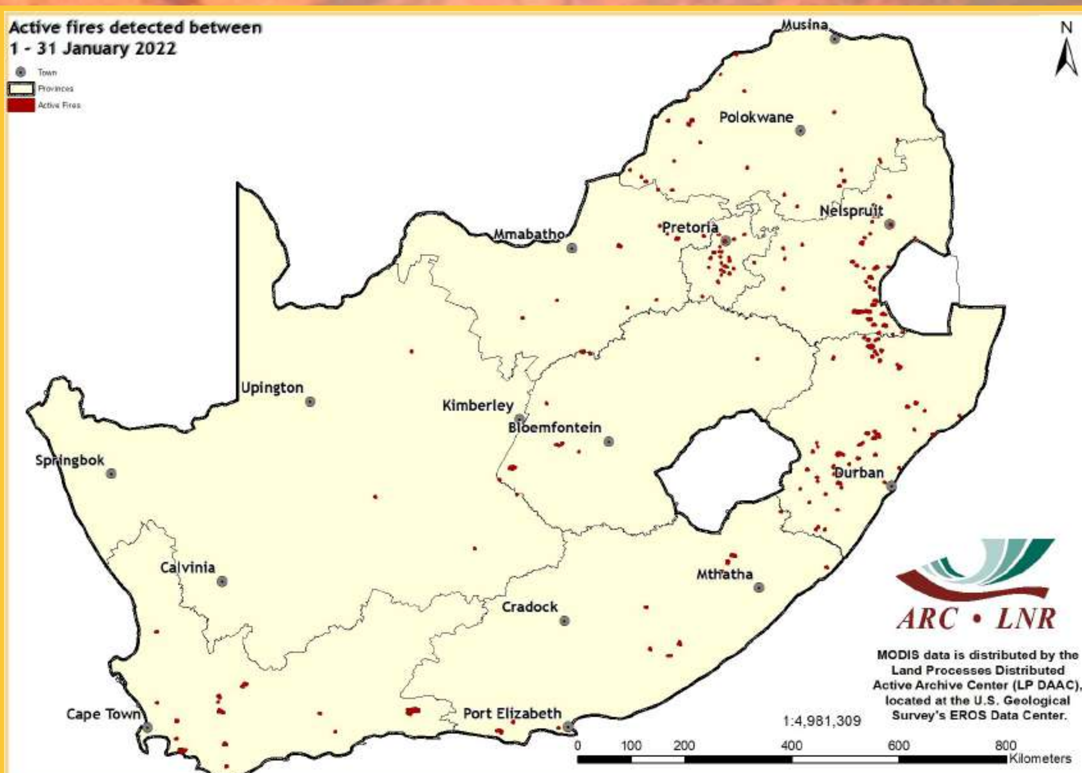

Figure 30

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 31 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 32 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 January 2022 shows the significant impact of the high rainfall experienced over most of the country during late December 2021 and January 2022, with much higher water levels across most parts of the country. The majority of Tertiary catchments are now showing water levels equivalent to 80-100% of the 5-year, long-term maximum water.

The comparison between January 2022 and January 2021 shows similar water level distribution patterns for both dates, but with 2021 trending one water level class higher in many individual catchments.

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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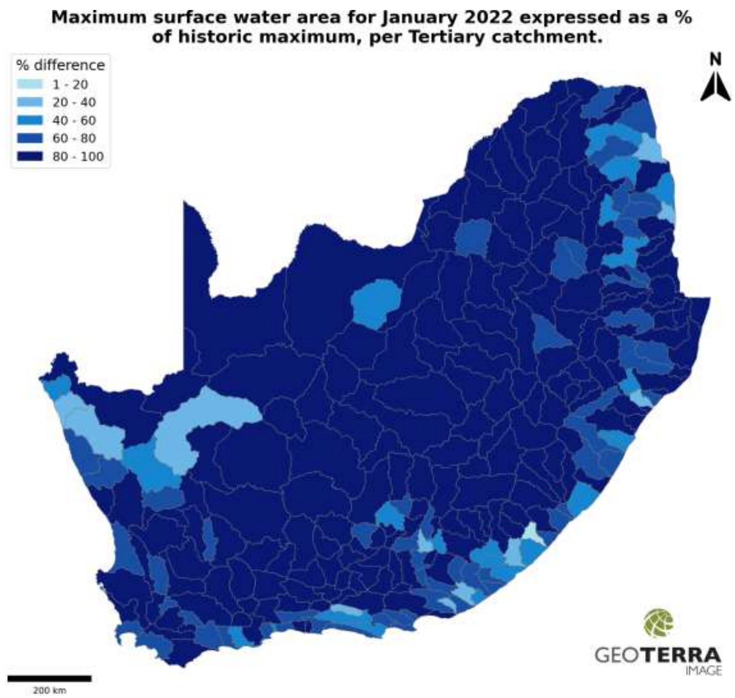


Figure 31

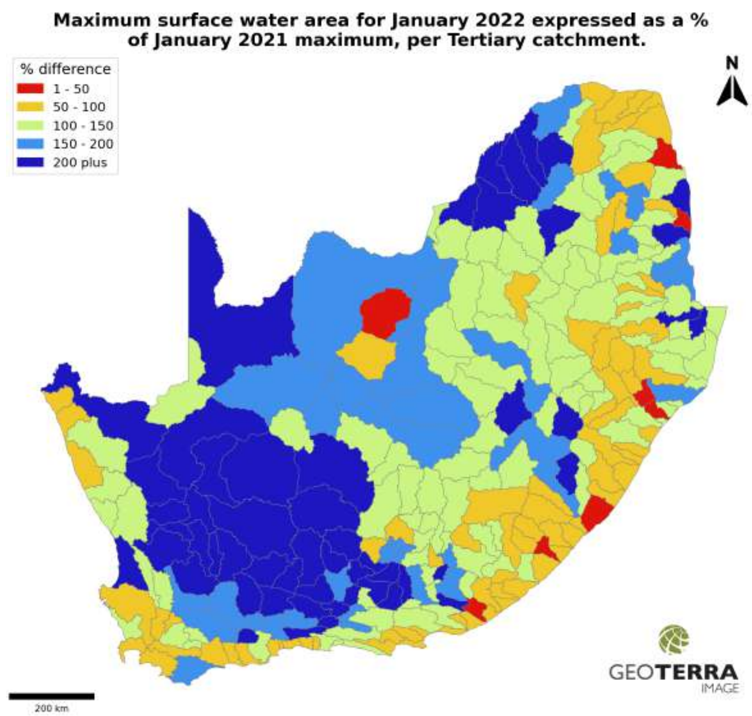
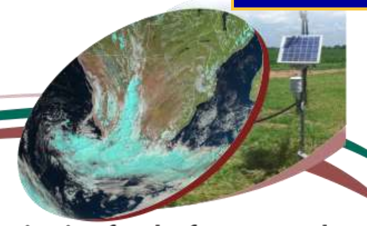


Figure 32

Agrometeorology



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

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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What does Umlindi mean?
UMLINDI is the Zulu word for "the watchman".