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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

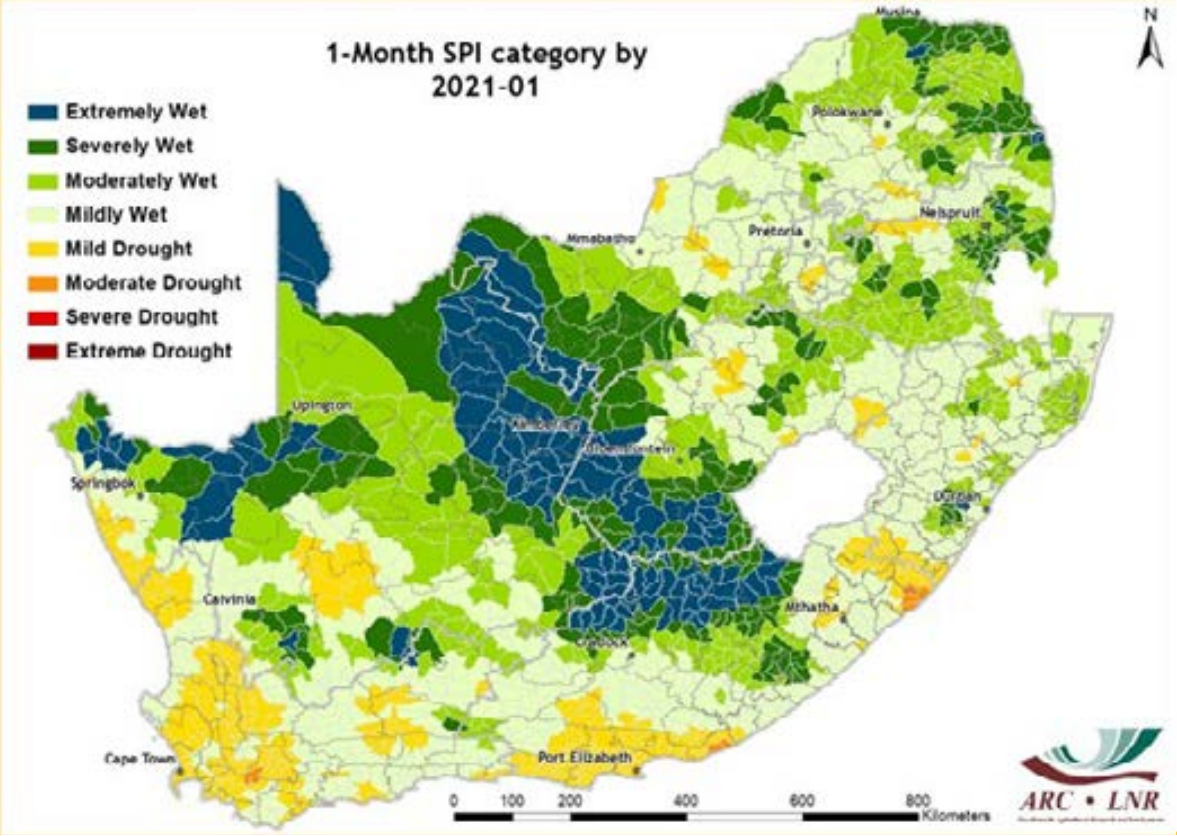
AMESD

200th Edition

Image of the Month

Widespread rainfall welcomes 2021

The month of January was associated with widespread above-normal rainfall over greater parts of South Africa, with significant rain occurring over parts of the summer rainfall region. Some of the highest totals were recorded in areas in central South Africa, including parts of the Northern Cape which has been gravely affected by drought conditions for the past 6 years. This pattern of relatively high rainfall is reflected in the Standardized Precipitation Index (SPI) at the 1-month time scale (see map below). Parts of the northern and eastern Northern Cape, southwestern North West and Free State, northern Eastern Cape and isolated parts of the Karoo and the Lowveld can be categorized as extremely wet according to the SPI. The welcome rainfall is of critical importance for the dryland crop production areas, especially over the eastern parts of the maize production area (mostly in Mpumalanga) where some parts had received below-normal rainfall earlier in the summer. However, such rainfall conditions, together with conducive temperatures, could also lead to the occurrence of high pest activity. Therefore, farmers should periodically monitor for insects, diseases and weeds, then consult their local extension services so that measures can be put in place to prevent outbreaks on their respective farms.



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:

Atmospheric circulation during January 2021 was of such a nature that rainfall was widespread throughout the month. This rainy weather was confined to the summer rainfall region, as expected, including parts of the late summer rainfall region (eastern Northern Cape, western North West and Free State). These conditions resulted in above-normal rainfall and the only areas that received below-normal rain were the winter rainfall region, parts of the Karoo and isolated areas in North West, Gauteng, KwaZulu-Natal, the Free State and Eastern Cape.

The month started with heavy rain that resulted in localized flooding over some areas. These conditions continued into the second dekad of the month, while significant amounts of rain towards the end of the month were as a result of interesting frontal activity. From the 23rd, Tropical Cyclone Eloise, although in a weakened state, made landfall and resulted in heavy rainfall over the northeastern corner of Limpopo, northern KZN and the Lowveld of Mpumalanga, including the Kruger National Park. Subsequently, another frontal system passed over the country on the 27th and contributed to the widespread high rainfall amounts recorded over the eastern Northern Cape, parts of North West, the Free State, KZN, Gauteng, Limpopo and the Eastern Cape provinces.

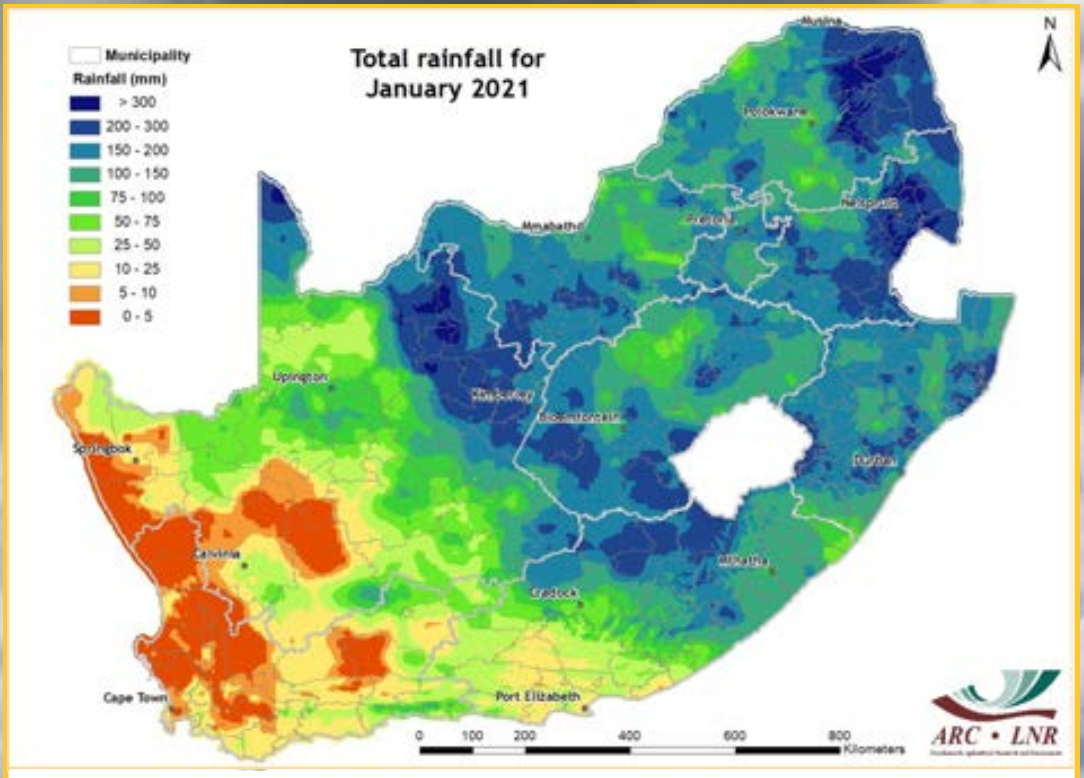


Figure 1

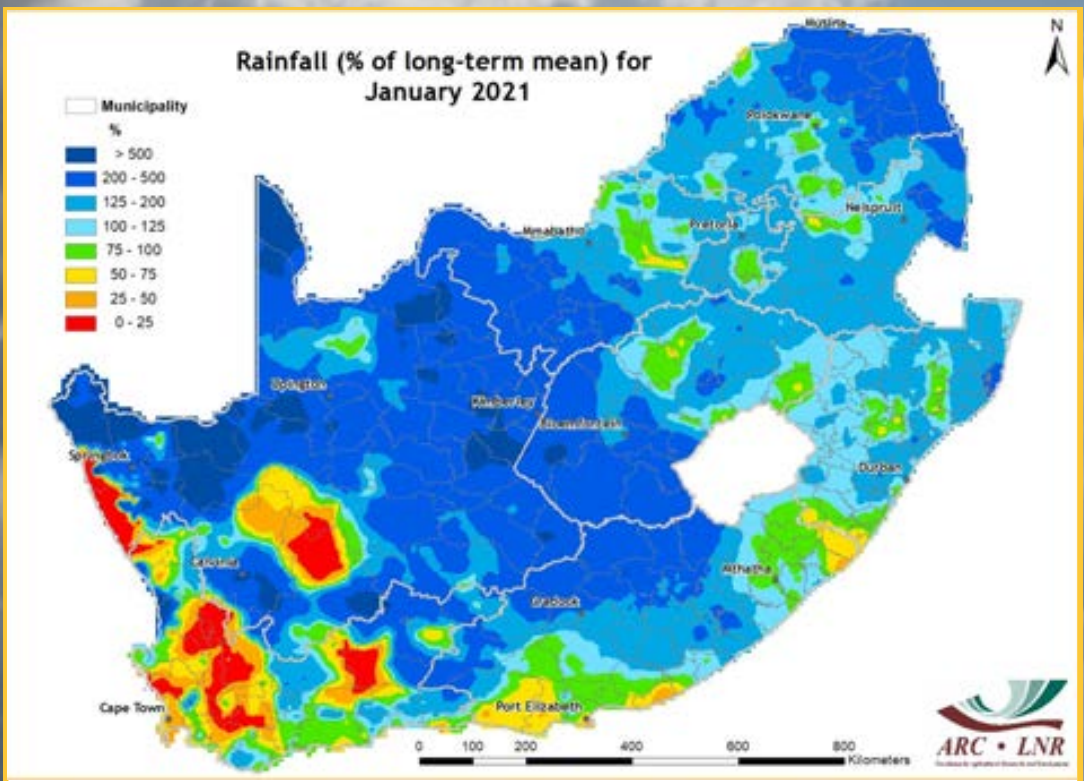
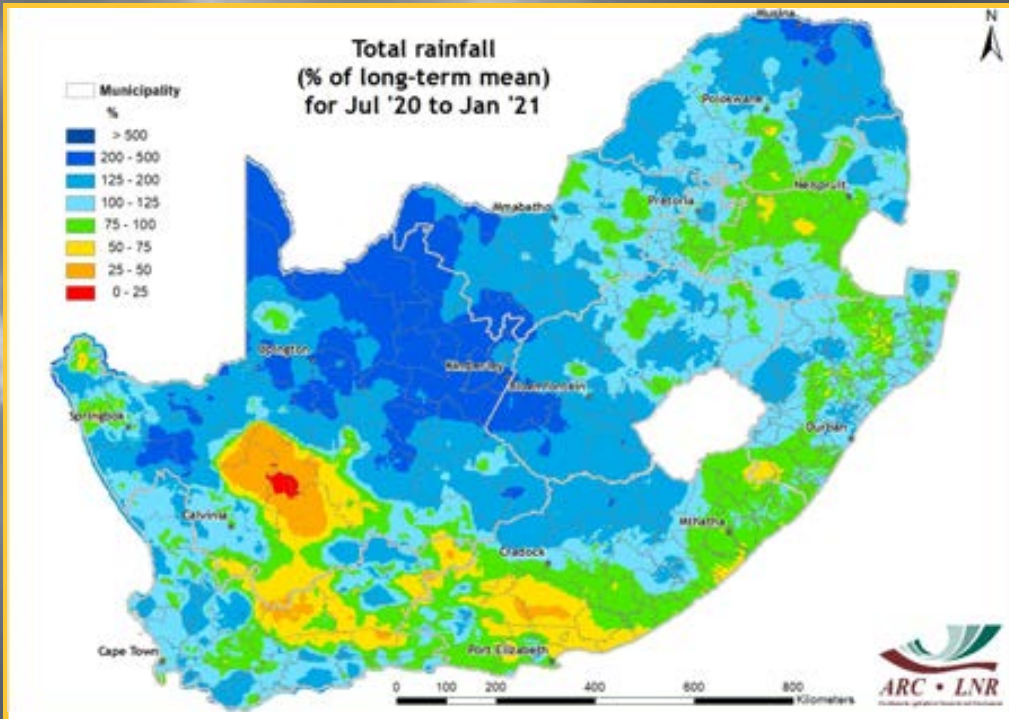


Figure 2



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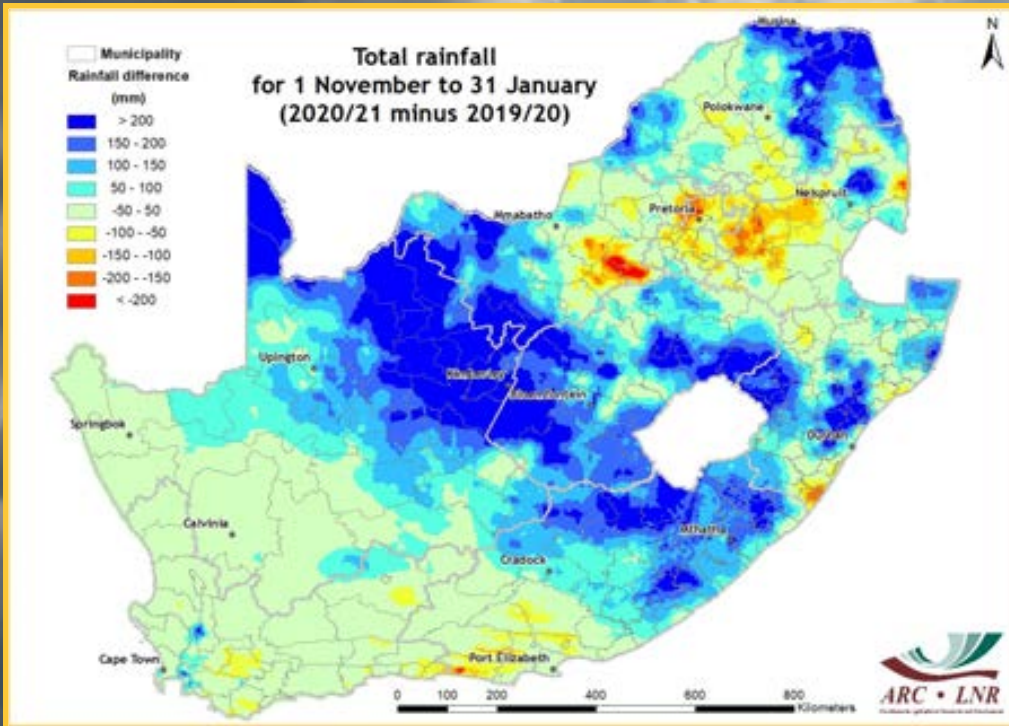

Figure 4

Figure 1:
Widespread rainfall occurred over greater parts of the country during January 2021. Most of the rain fell over the central regions, towards the east in the summer rainfall region. Dry conditions were observed over the western parts of the country.

Figure 2:
Above-normal rainfall occurred over over greater parts of the summer rainfall region. Areas that received below-normal rainfall during January 2021 include greater parts of the winter and all-year rainfall regions, parts of the Karoo and isolated areas in the eastern provinces.

Figure 3:
The cumulative rainfall from July 2020 to January 2021 compared to the long-term mean for the same period indicates that above-normal conditions were experienced over the interior, eastern and northeastern parts of the country, as well as the winter rainfall region in the west. Parts of the Karoo moving towards the Eastern Cape received below-normal rains during this period.

Figure 4:
Compared to the same period last year, total rainfall from November 2020 to January 2021 showed above-normal values (given by the blue colours) over the central interior and parts of the Limpopo, Mpumalanga and KwaZulu-Natal provinces. Meanwhile, northern regions of the Highveld, the south coast of KZN as well as the southwestern parts of the Eastern and Western Cape provinces received less rain while the rest of the country received relatively the same amounts as in 2019/20.

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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 SPI), medium-term (12-month SPI) and long-term (24-month and 36-month SPI) drought conditions are shown in Figures 5-8. Given the short-term SPI for the month of January, high rainfall totals resulted in wet conditions over the interior as well as the Lowveld of Limpopo. Similar conditions, although milder, were observed in northern areas of the Highveld, towards KZN. Parts of the winter rainfall region as well as the Cape south coast also experienced mild to moderately wet conditions. The 12-month SPI shows that the central to south-eastern interior and parts of the Lowveld experienced moderate to extreme wet conditions, while mild to moderate drought was visible over the western region, parts of the Eastern Cape and the interior of Limpopo and Mpumalanga. Long-term SPI values corresponding to wet conditions were noted over central SA, the Lowveld, northern regions of KZN and isolated areas of the winter rainfall region. Although less intense as compared to the same period last year, long-term severe to extreme droughts were noted, particularly in the Cape provinces, eastern Free State, parts of KZN, Limpopo and Mpumalanga.

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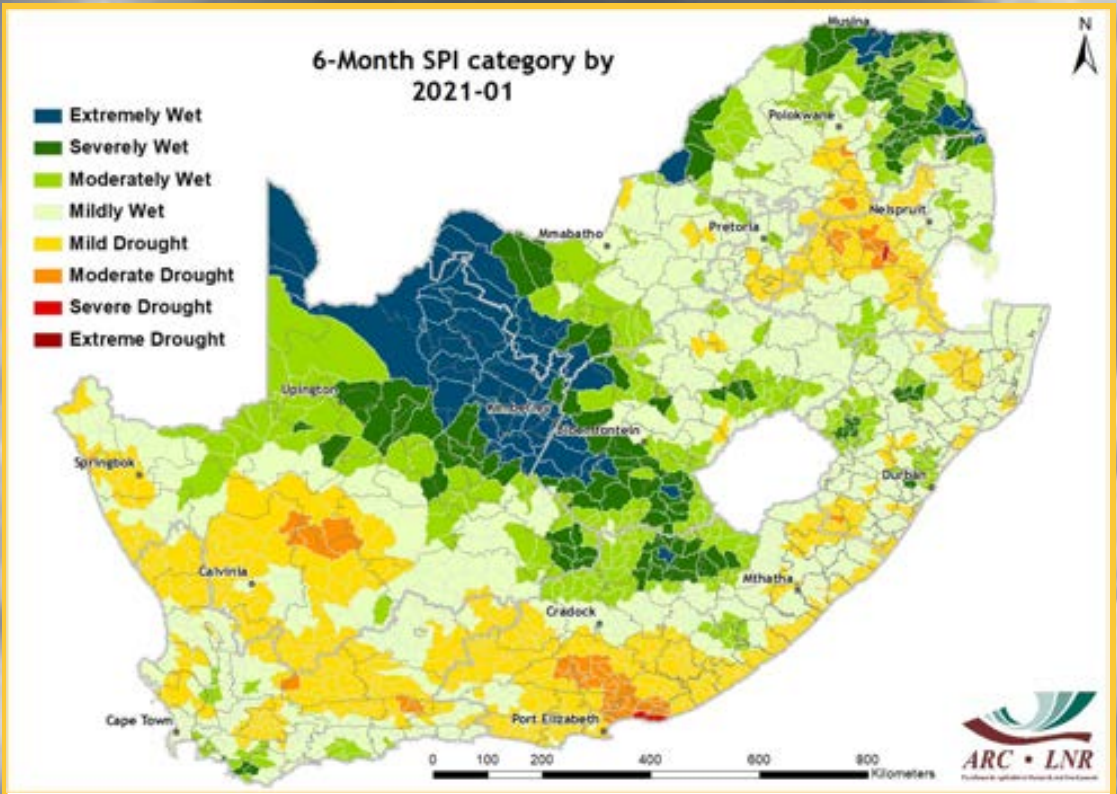

Figure 5

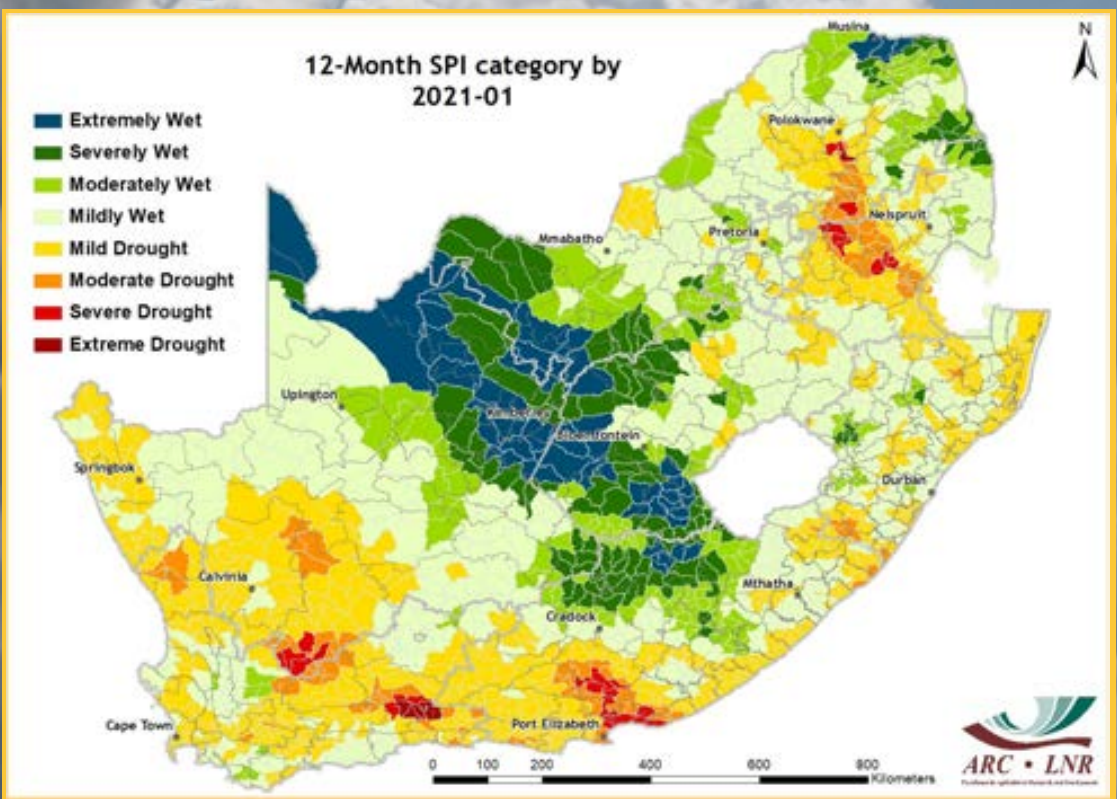

Figure 6

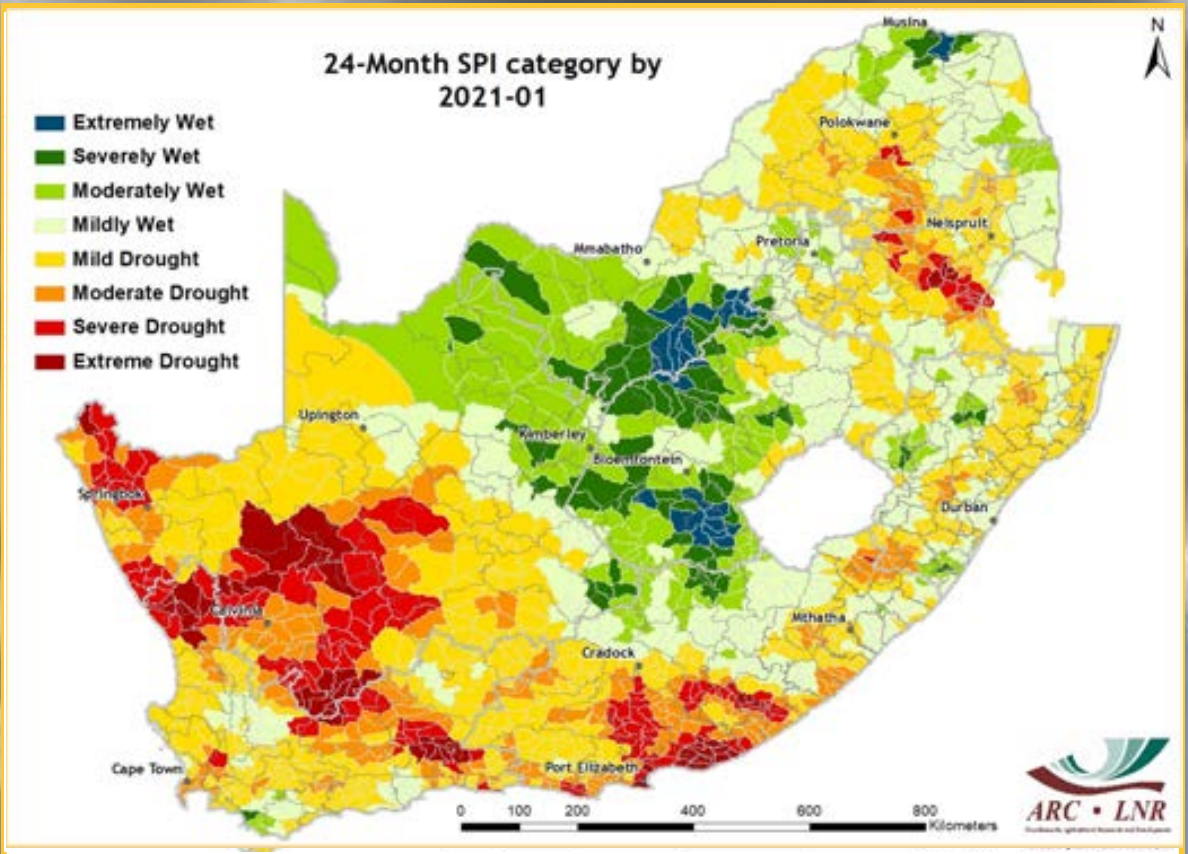

Figure 7

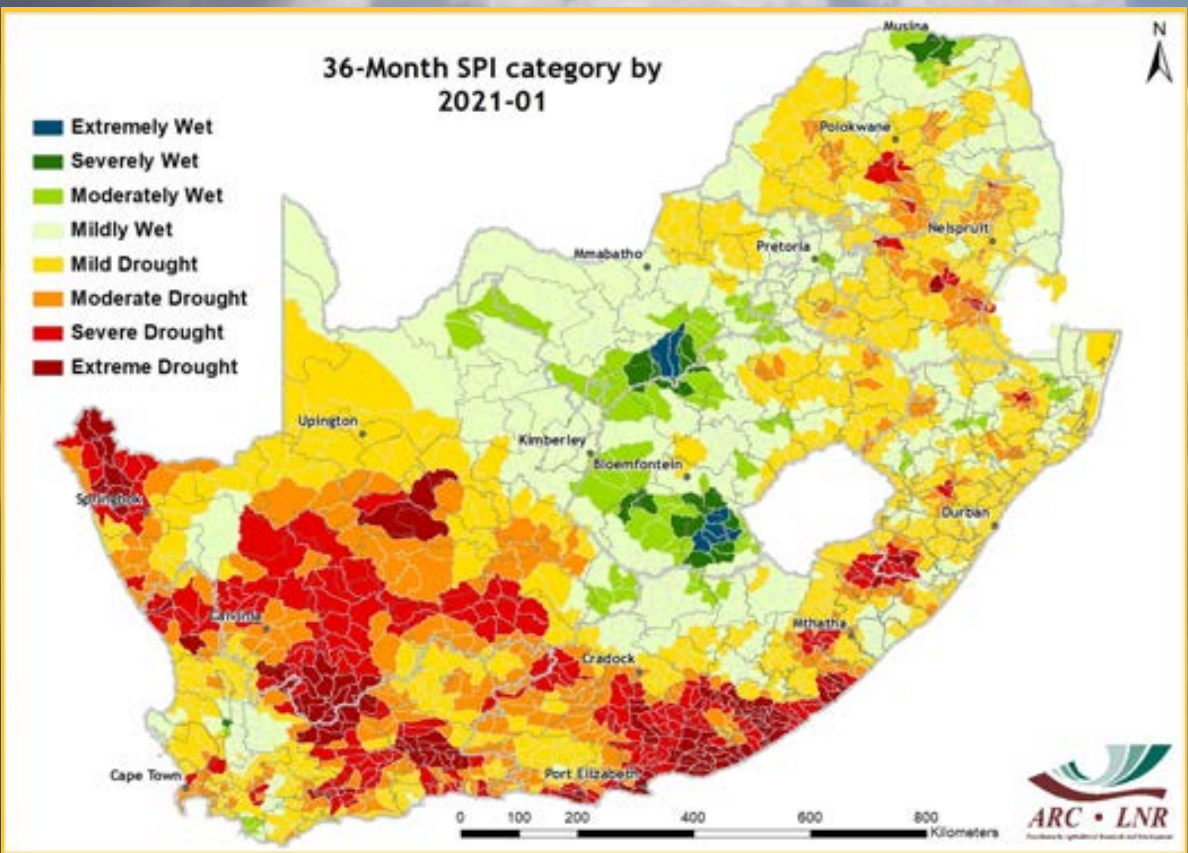

Figure 8

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.

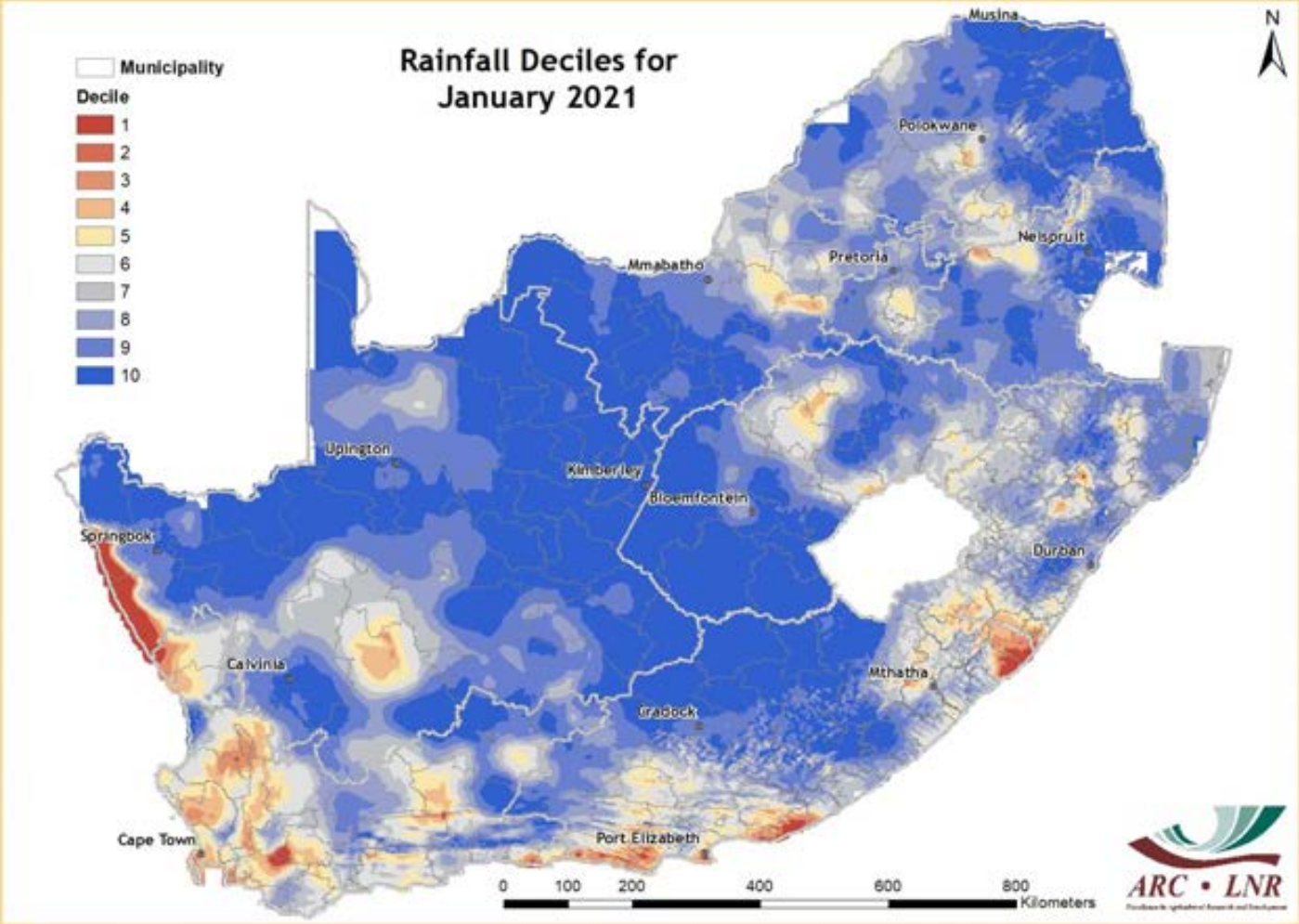

Figure 9

Figure 9:
In January 2021, greater parts of the country experienced rainfall amounts that compare well with historically wetter January months. The only areas that recorded totals comparable with drier January months include the winter rainfall region, parts the Highveld extending towards Limpopo, and southern regions of the Eastern Cape and KwaZulu-Natal.

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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.

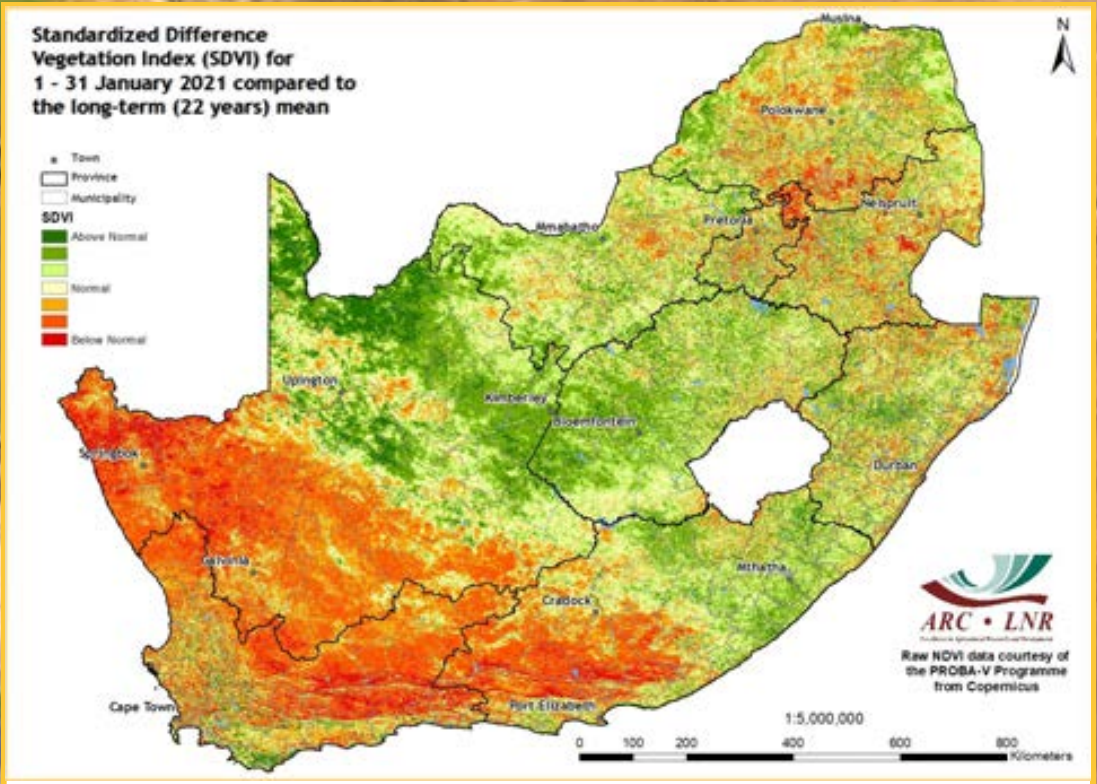

Figure 10

Figure 10:
Compared to the historical averaged vegetation conditions, the SDVI map for January 2021 shows that the central interior experienced good vegetation conditions while the western half of the country experienced poor vegetation activity.

Figure 11:
The NDVI difference map for January 2021 compared to the same month last year shows that normal to above-normal vegetation activity occurred over much of the central and western parts of the country, with pockets of below-normal activity over the northern parts.

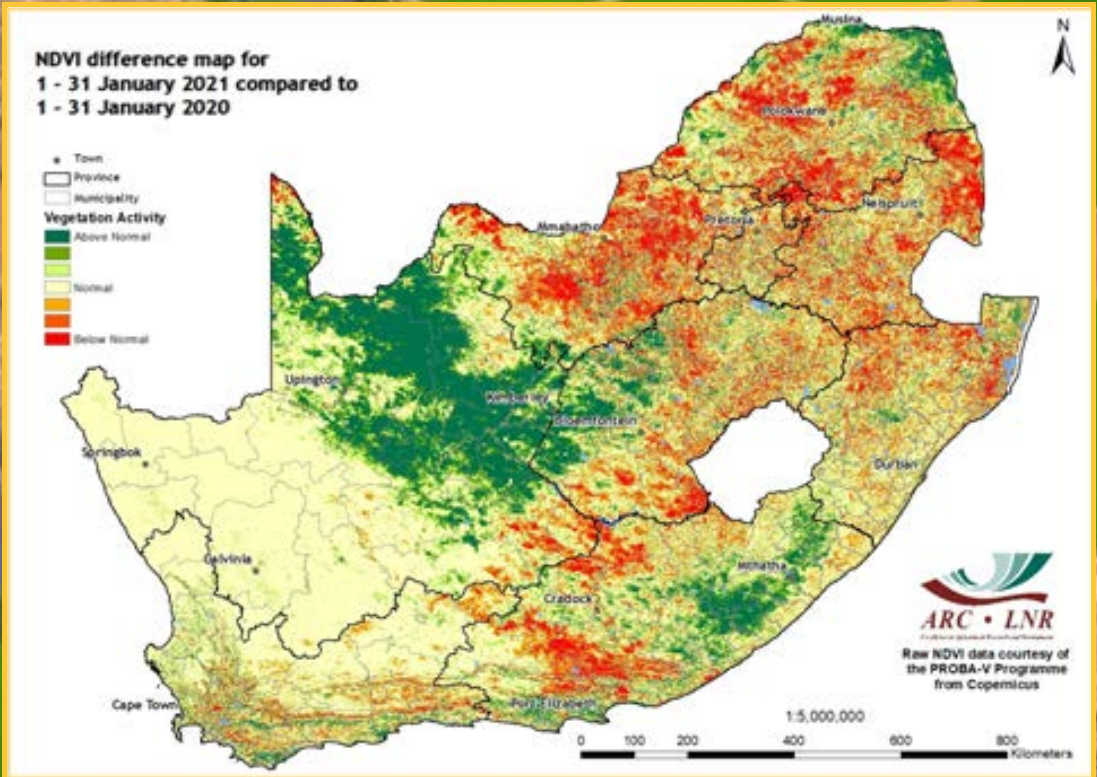

Figure 11

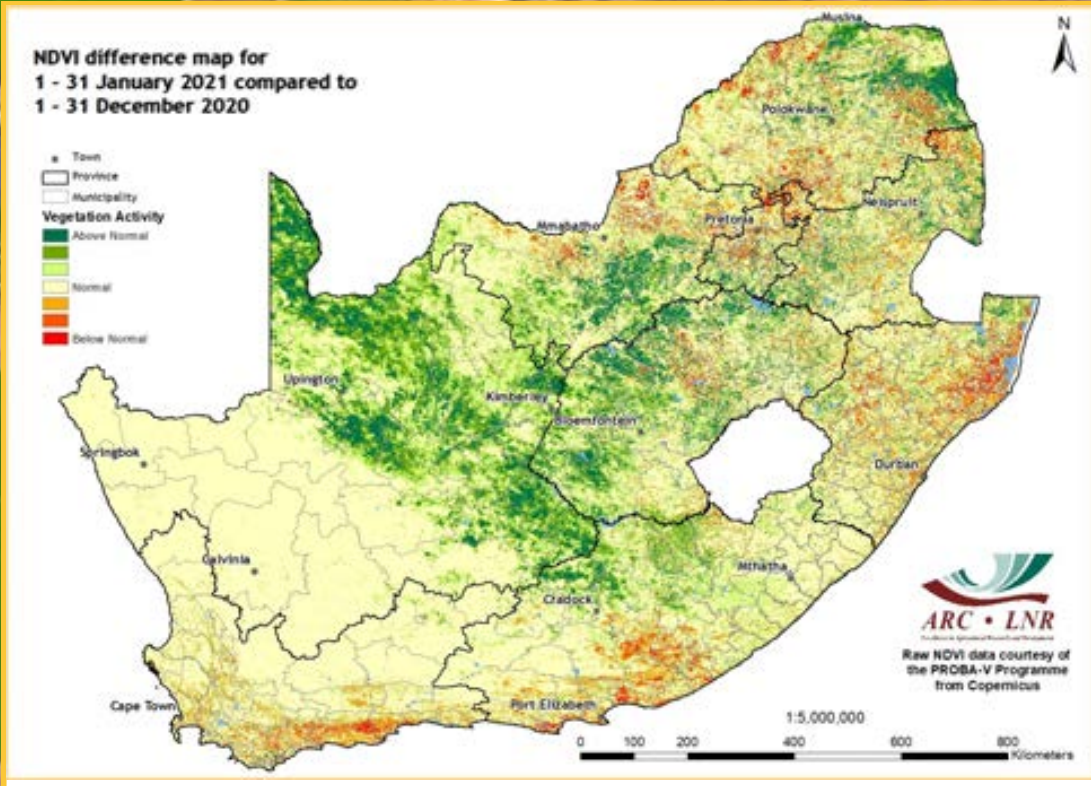

Figure 12

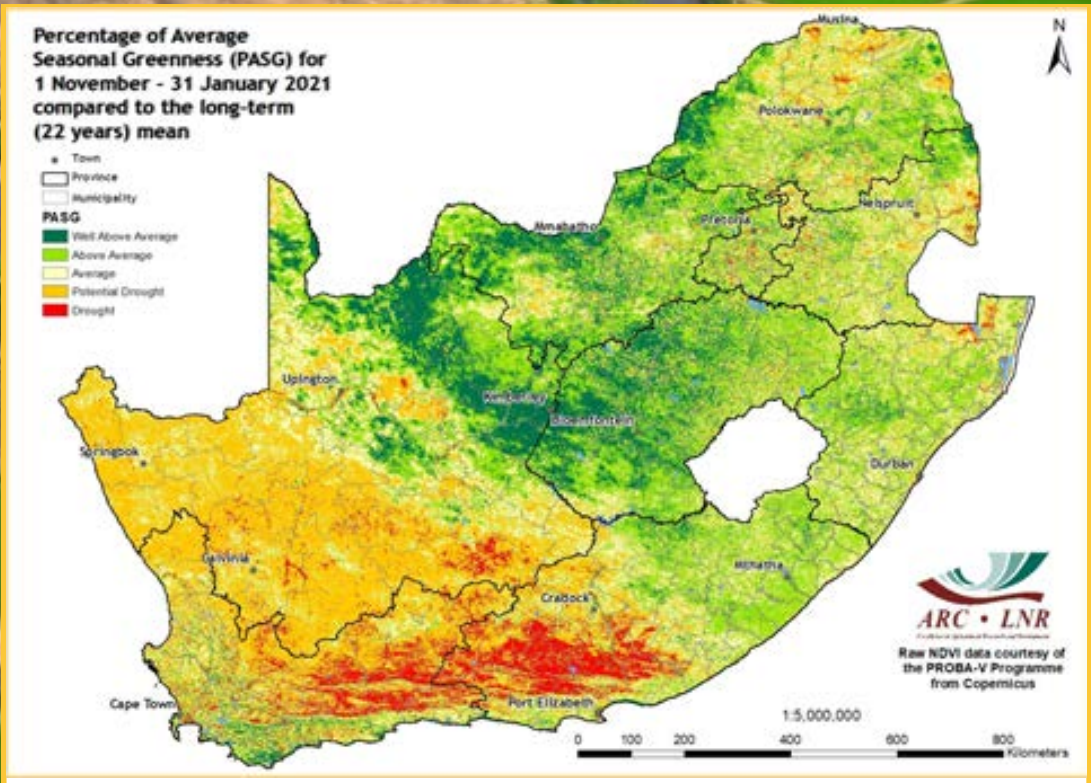

Figure 13

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:
Compared to the previous month, the NDVI difference map for January shows that the central interior extending to the western parts of the country experienced above-normal to normal vegetation conditions, while isolated parts in the northern region experienced poor vegetation conditions.

Figure 13:
Cumulative vegetation conditions over a 3-month period compared to the long-term mean show that the western half of the country continues to experience drought while the central, northern and eastern parts continue to experience good vegetation activity.

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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.

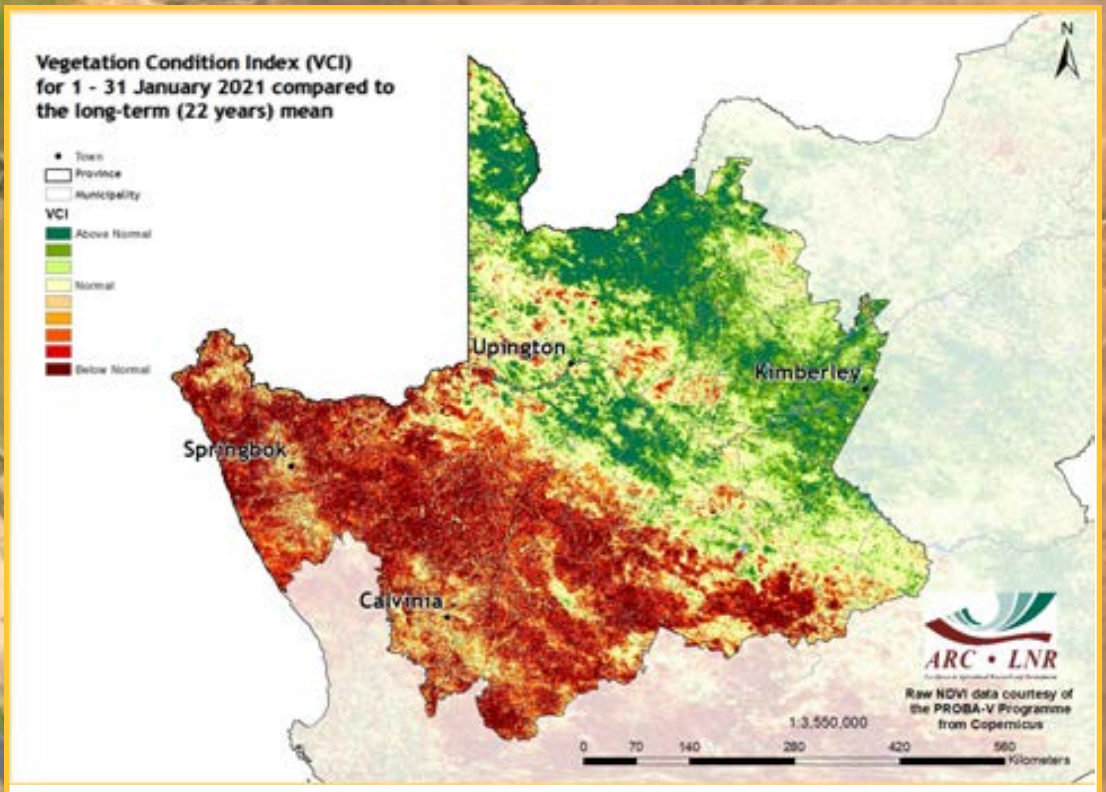

Figure 14

Figure 14:
The VCI map for January shows that the western half of the Northern Cape continues to experience alarmingly poor vegetation conditions while the northern and eastern parts experienced improved vegetation conditions.

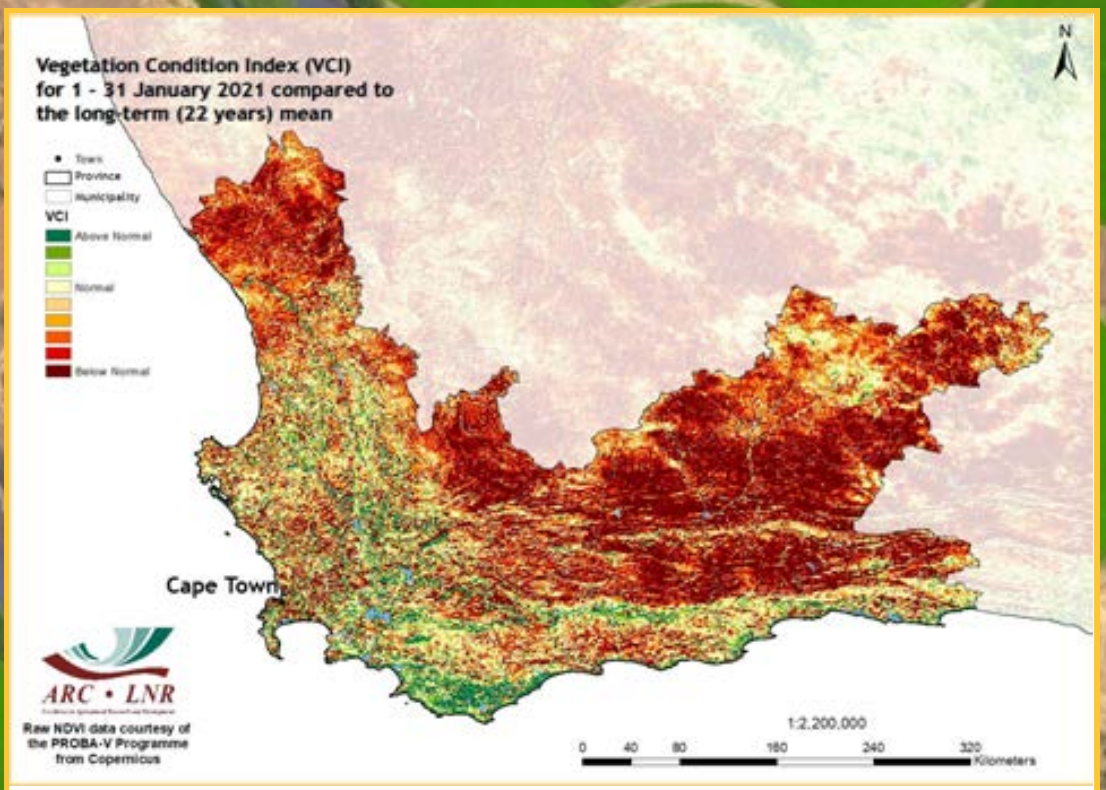

Figure 15

Figure 15:
The VCI map for January shows that long-standing poor vegetation conditions persist over the northern parts of the Central Karoo and West Coast of the Western Cape.

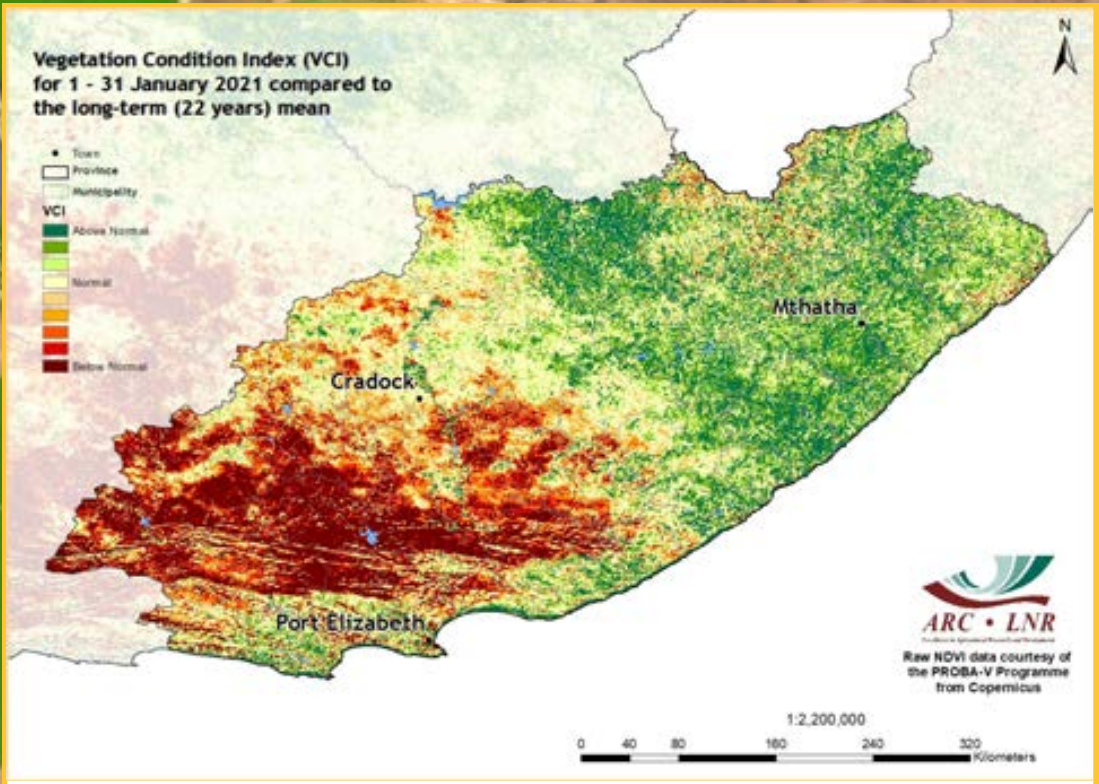

Figure 16

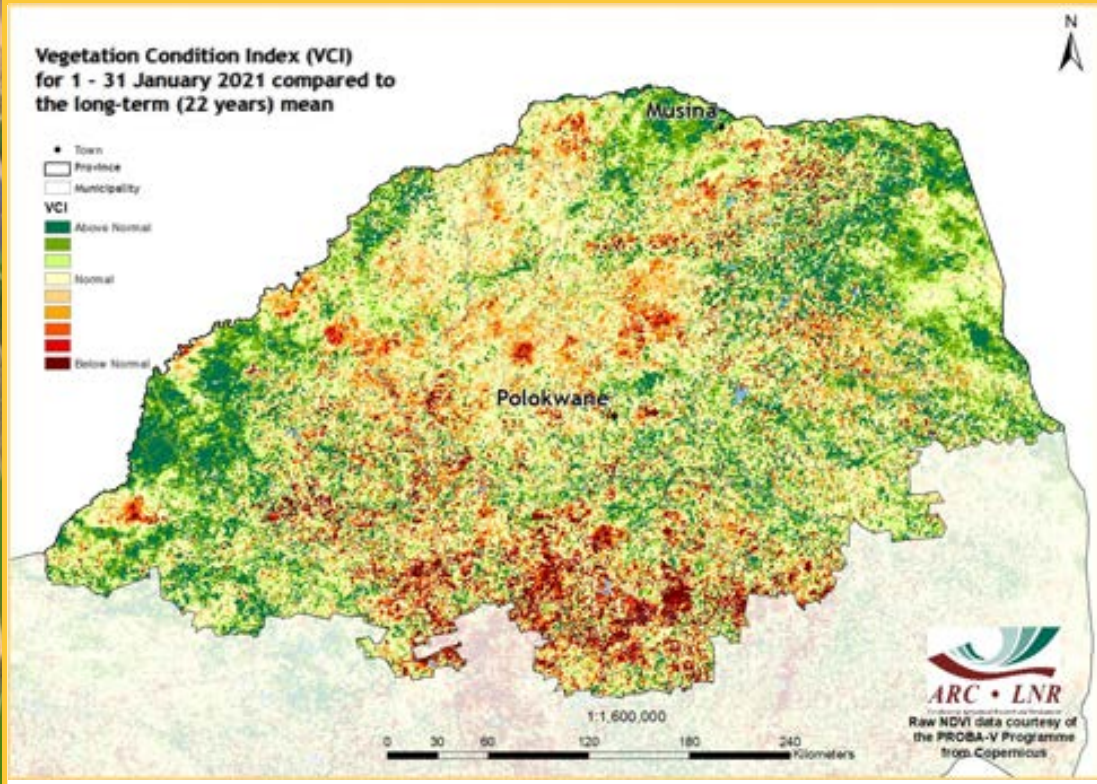

Figure 17

Figure 16:
The VCI map for January shows that vegetation in the western parts of the Eastern Cape continues to be stressed, with exceptions in the far northern and eastern parts of the province.

Figure 17:
The VCI map for January indicates extremely poor vegetation conditions over isolated areas of Limpopo. However, this may not be a true reflection given that large parts of the province experienced heavy rains during this month. Persistent cloud cover may have affected the true readings of the vegetation conditions from the satellite image.

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6. Vegetation Conditions & Rainfall

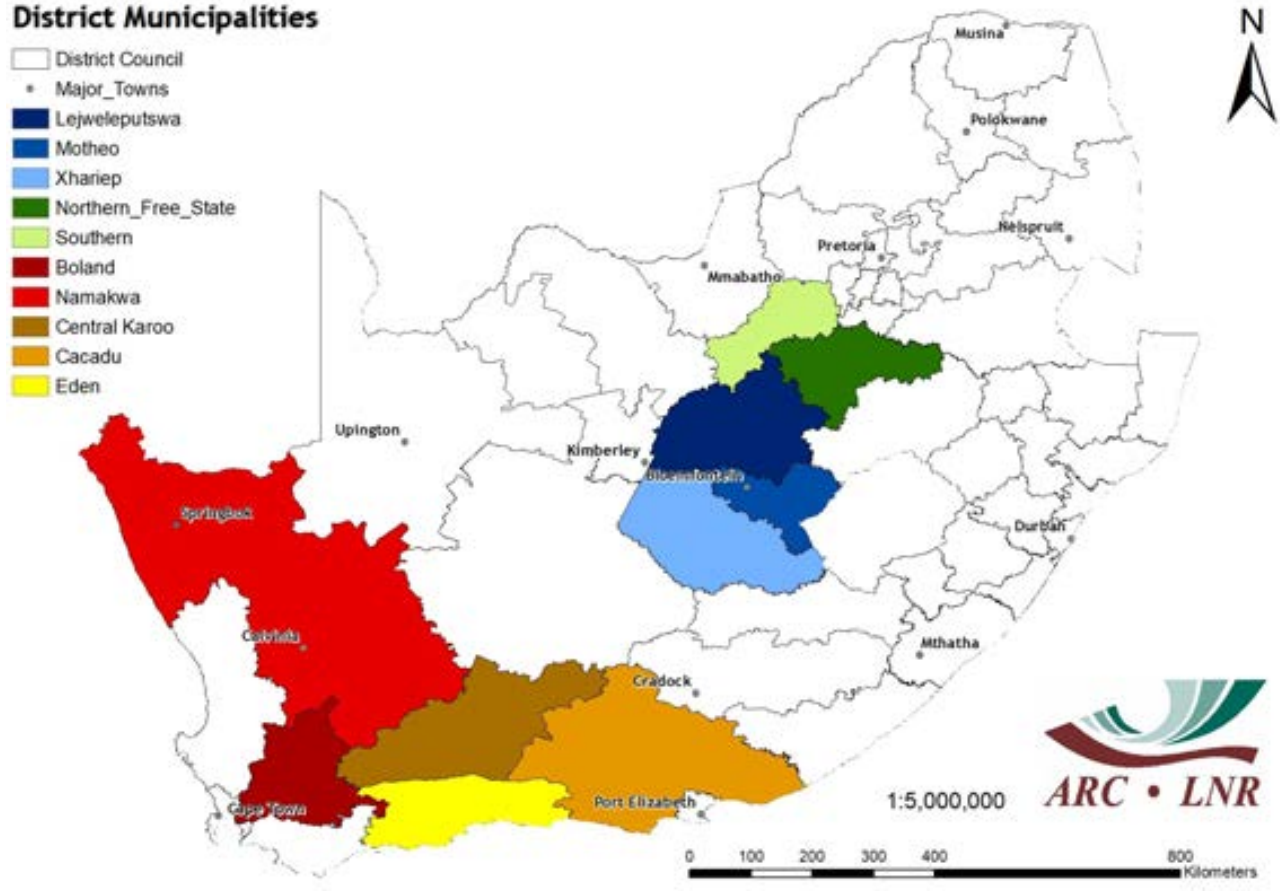

Figure 18

Rainfall and NDVI Graphs

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

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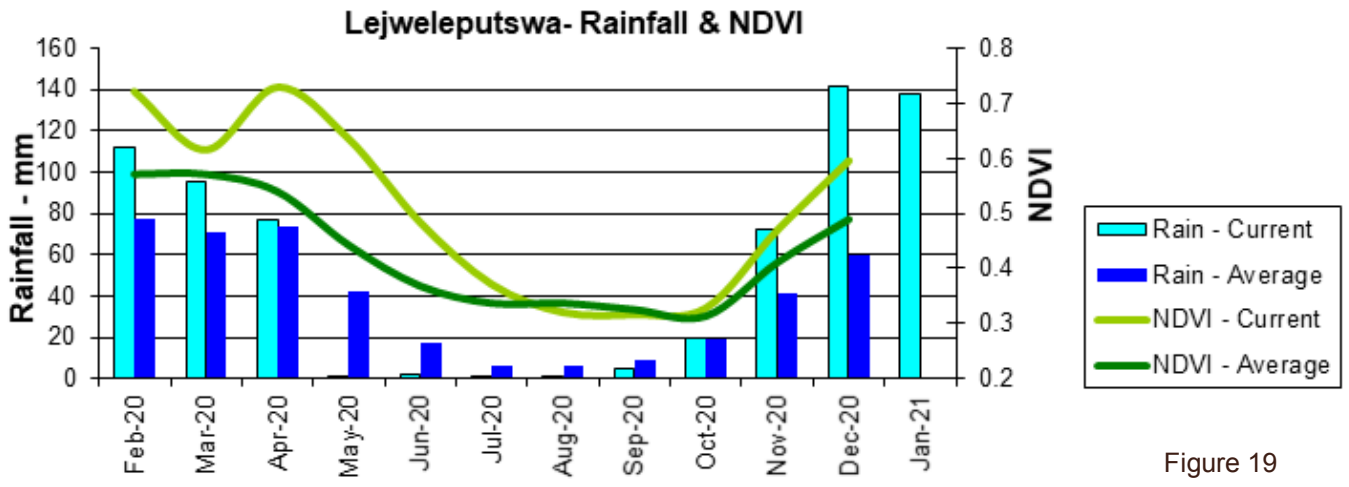
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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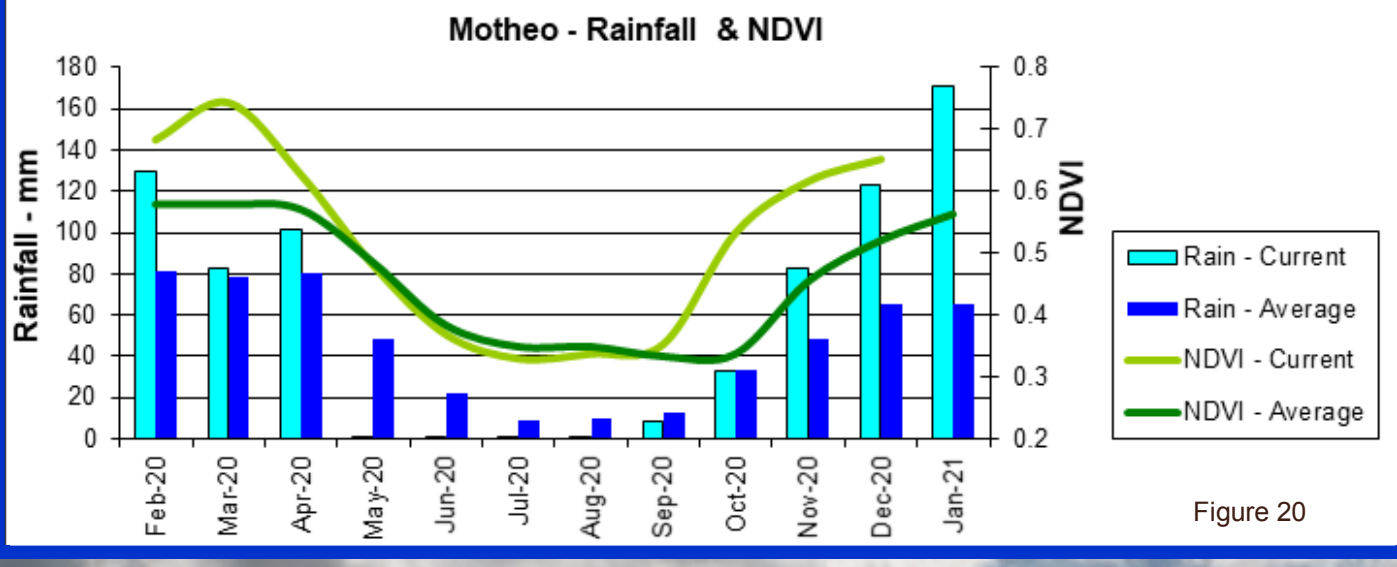

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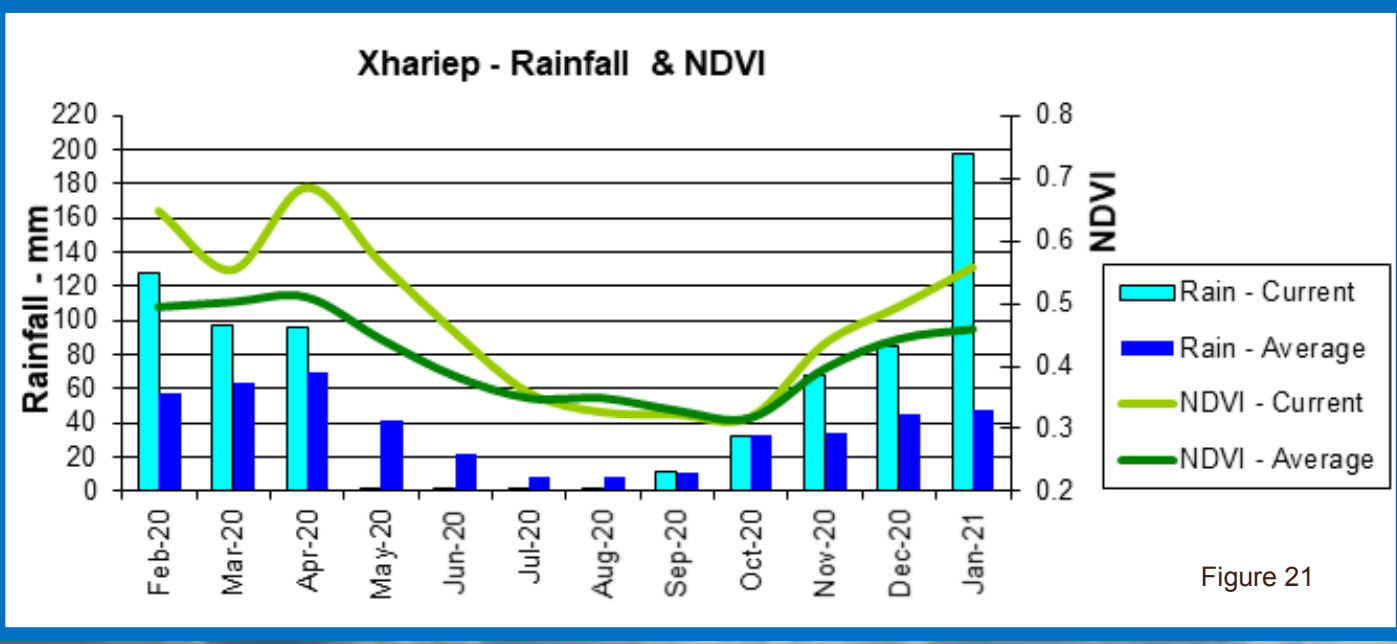

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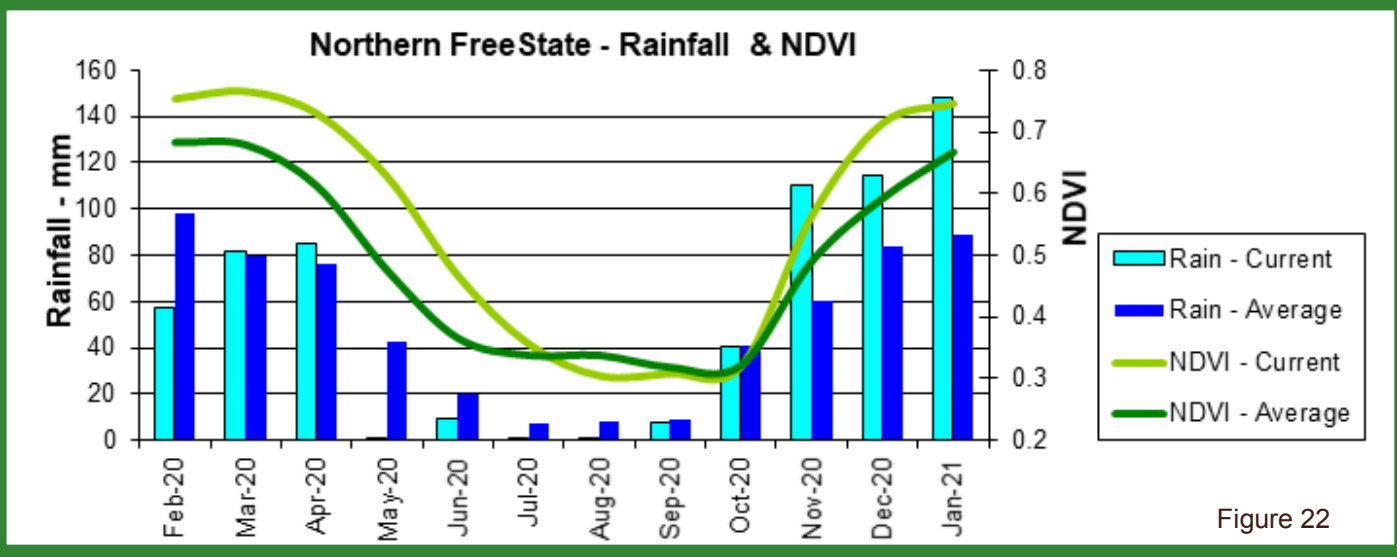

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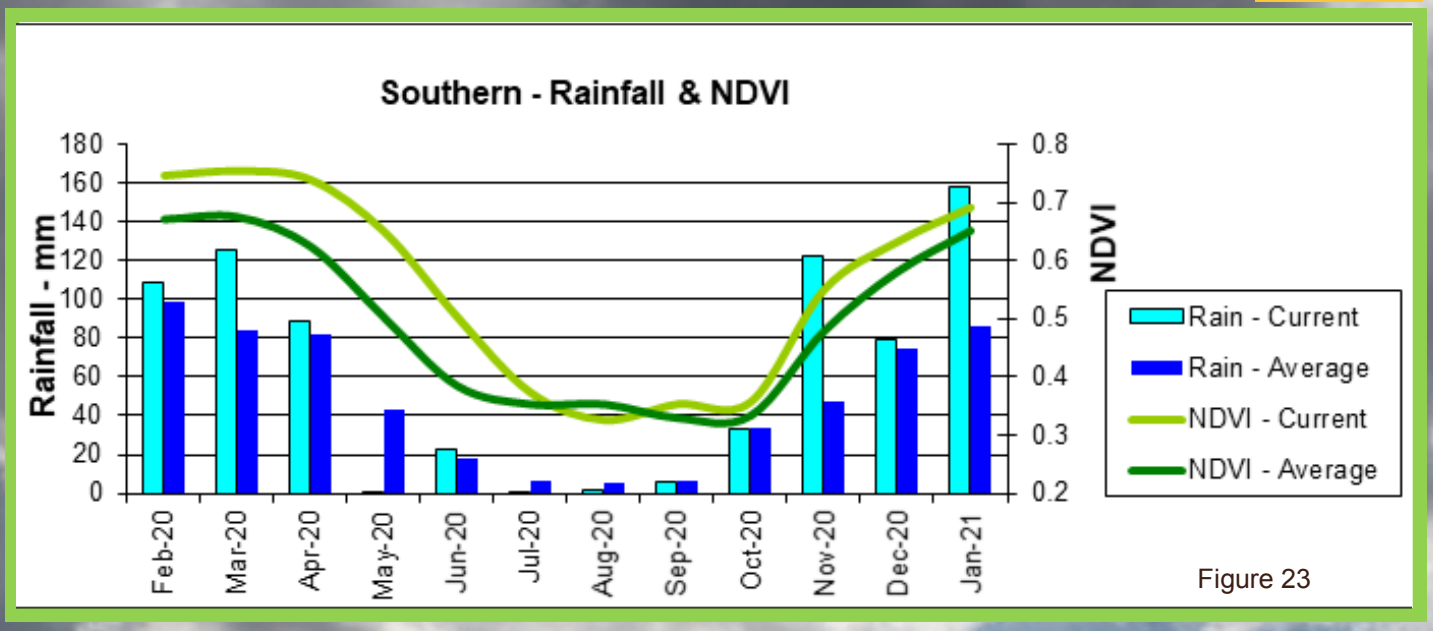

Figure 23

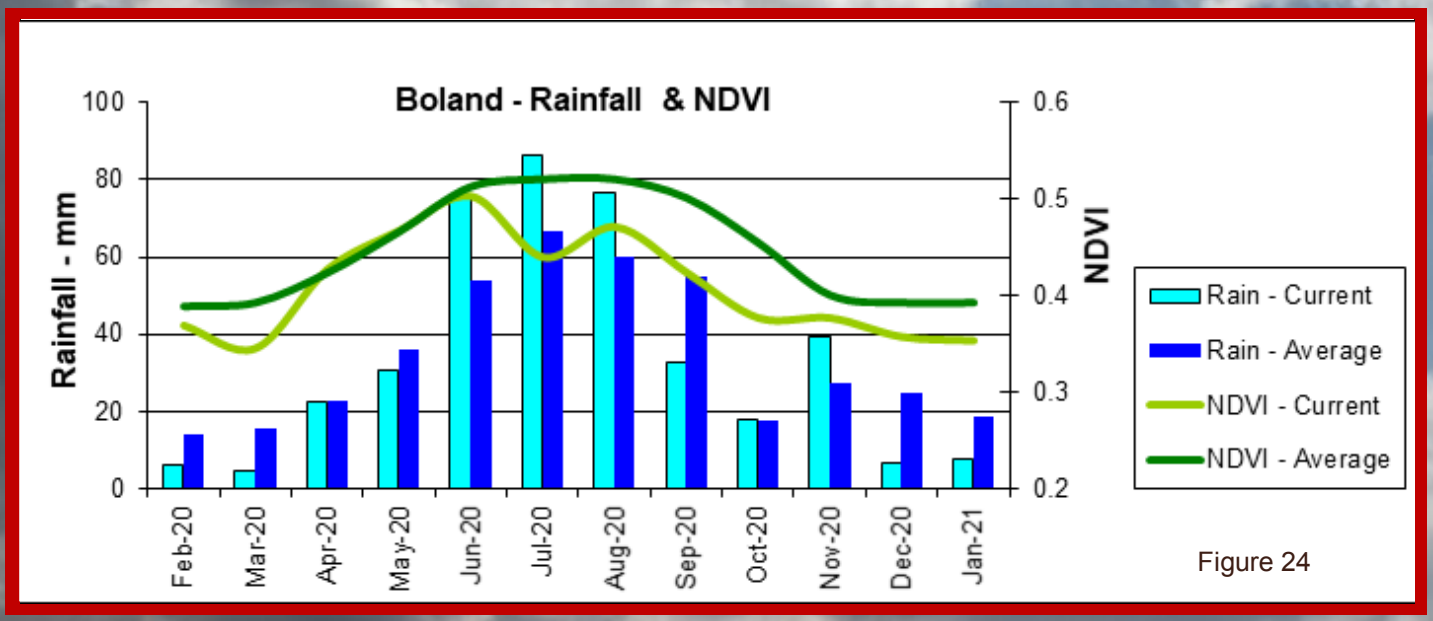

Figure 24

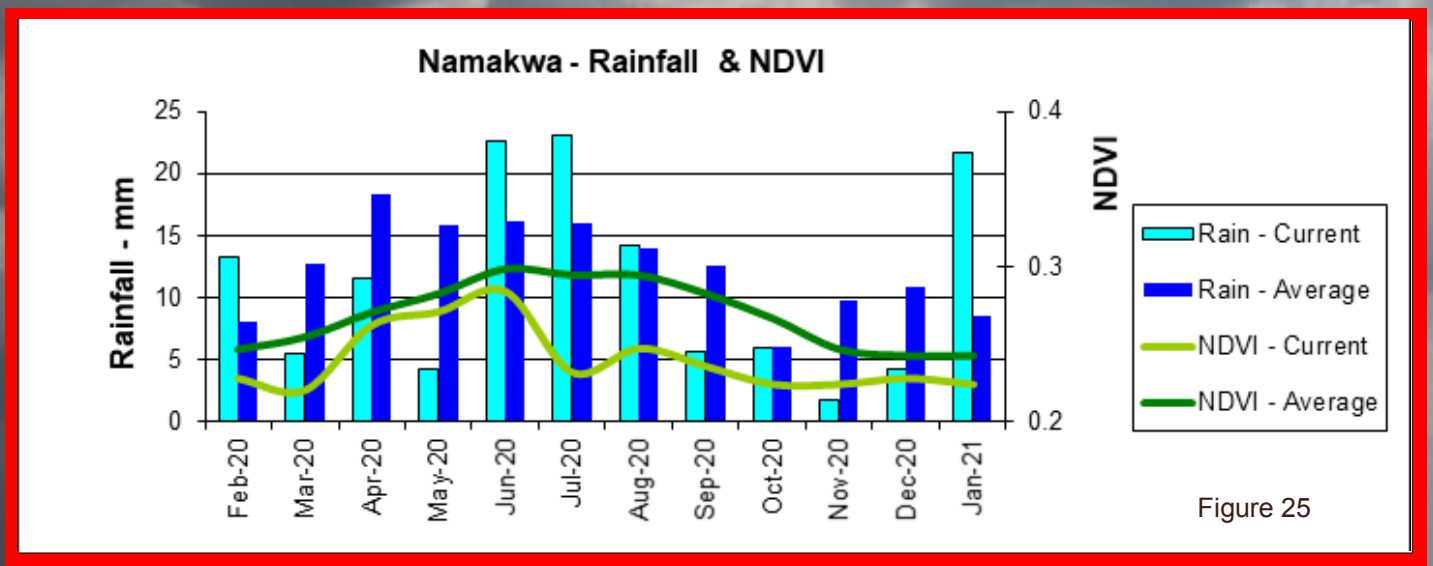

Figure 25

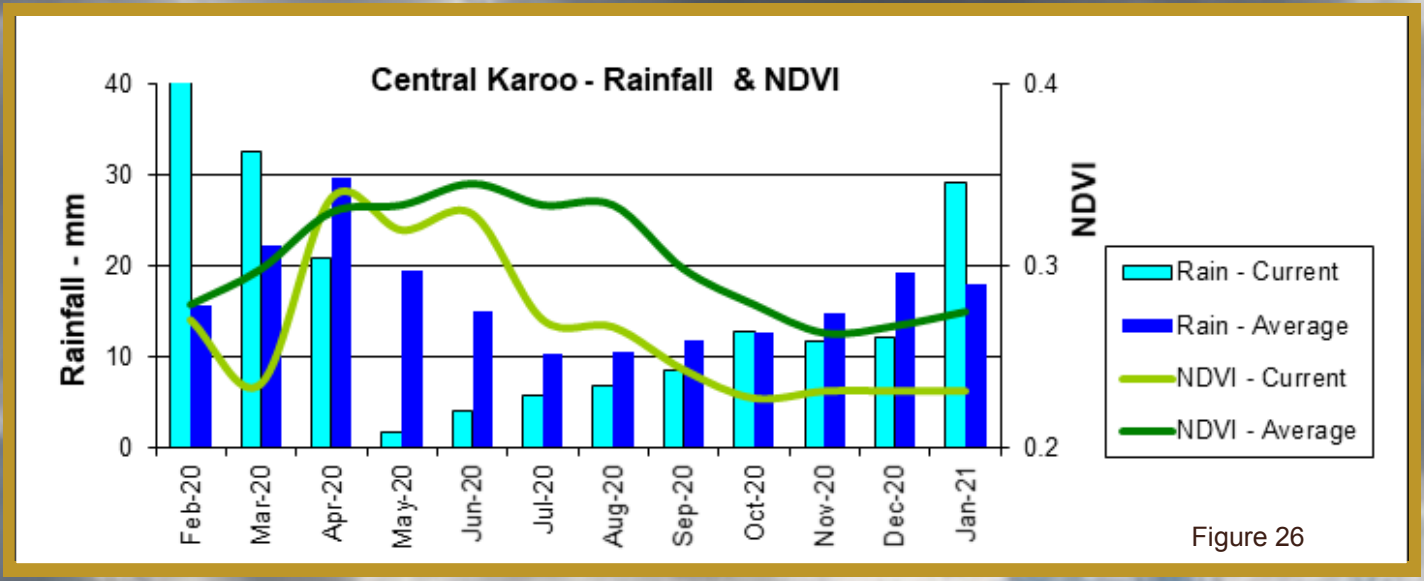

Figure 26

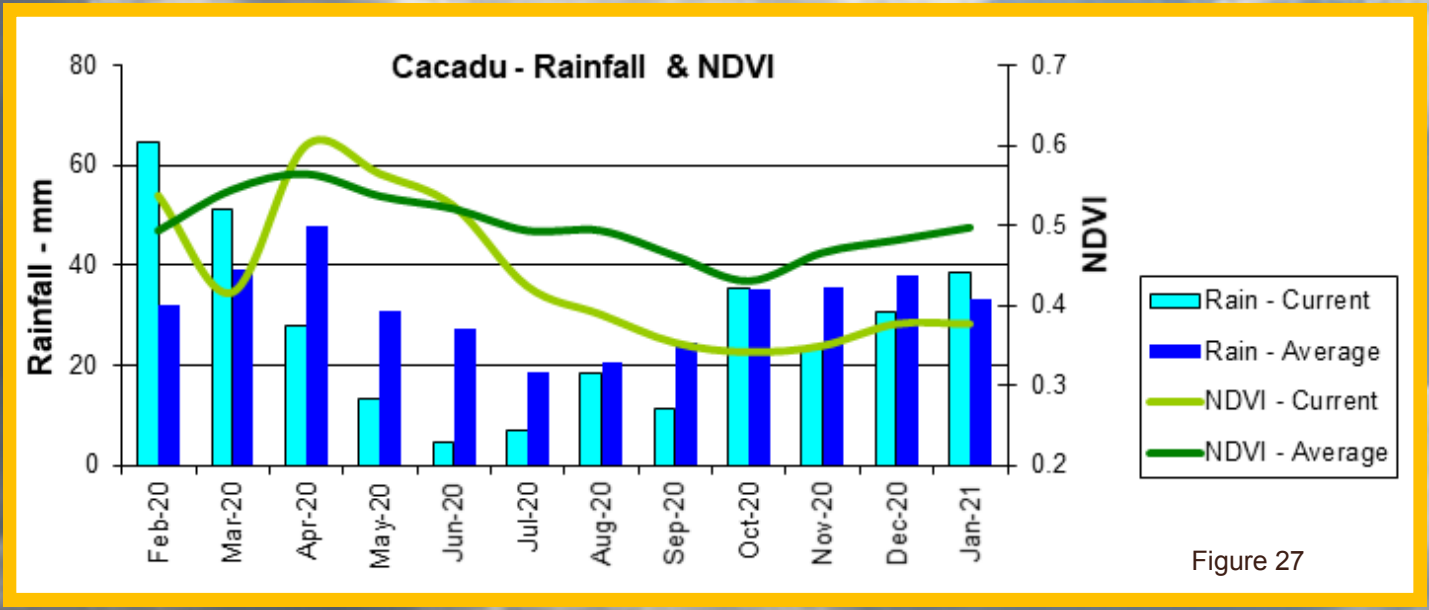

Figure 27

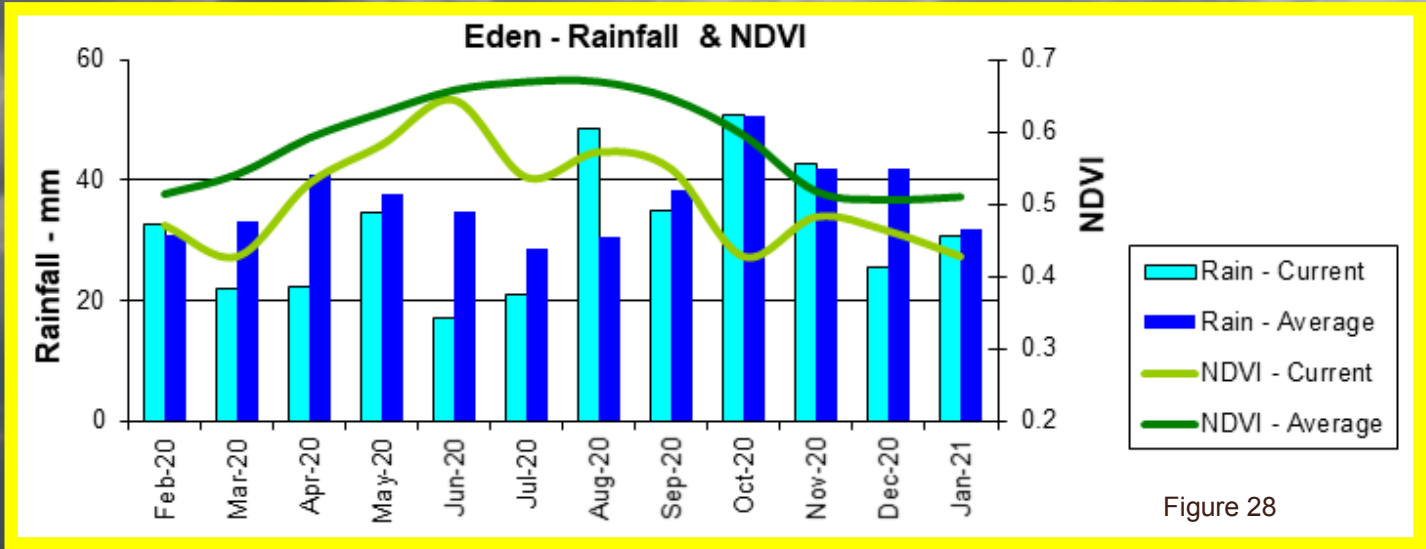

Figure 28

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 1-31 January 2021 per province. Fire activity was higher in the Western Cape compared to the long-term average.

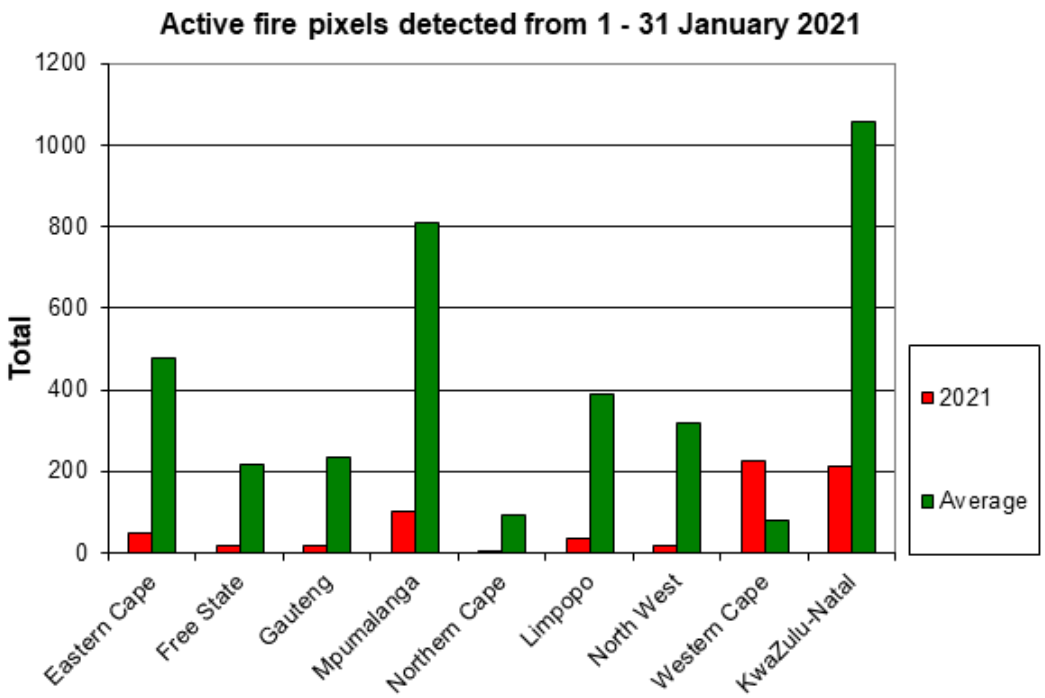

Figure 29

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

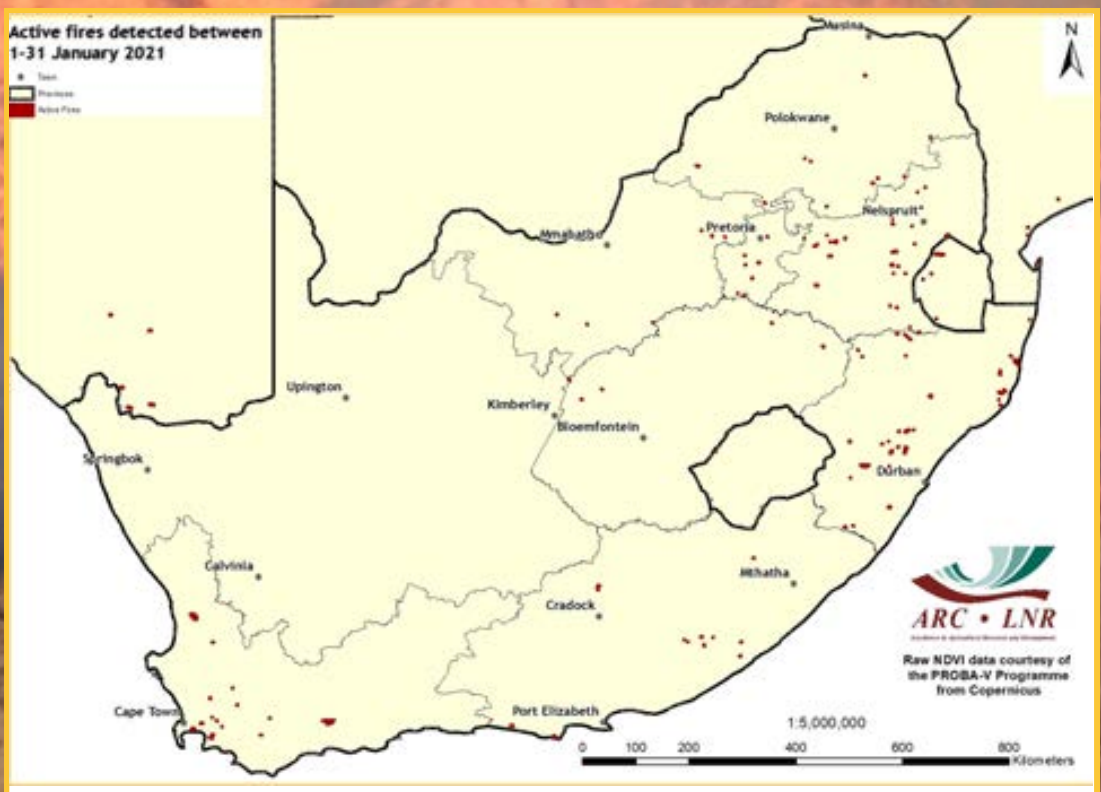

Figure 30

8. Surface Water Resources

Countywide surface water areas (SWA) 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 shows a comparison between the area of water available now and the maximum area of surface water recorded in the last 5 years. Values less than 100 represent 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 shows a comparison between the area of water available now and for the same month last year. On this map, values less than 100 represent 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, in 2020.

The long-term map for January 2021 shows a significant increase in water resources across the country compared to the previous month, especially across the central, eastern and northern parts. The majority of catchments in these areas are now showing water levels equivalent to 80-100% of the 5-year, long-term maximum water. The exceptions are isolated catchments in the central Karoo region, which continue to show significantly lower current water levels compared to long-term maximum values.

The comparison between January 2021 and January 2020 indicates a similar pattern to that reported last month, but with a greater number of catchments in the Karoo and central regions having significantly higher water levels compared to 2020. However, a few small catchments scattered across the Western and Eastern Cape, as well as Maputaland, continue to show significantly lower water levels.

N.B. The high temporal frequency of cloud cover in the summer rainfall region during the entire month of January 2021 will have impacted on the availability of usable cloud -free image acquisitions during this period, so all reported water levels in this area should be used with caution.

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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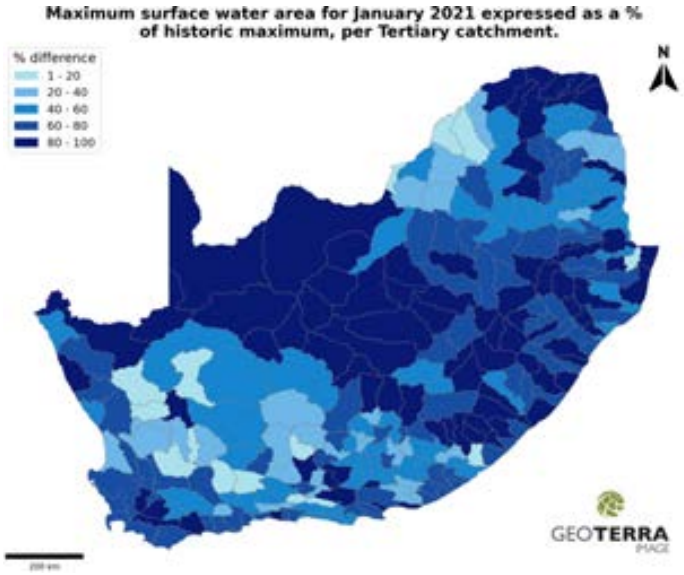

Figure 31

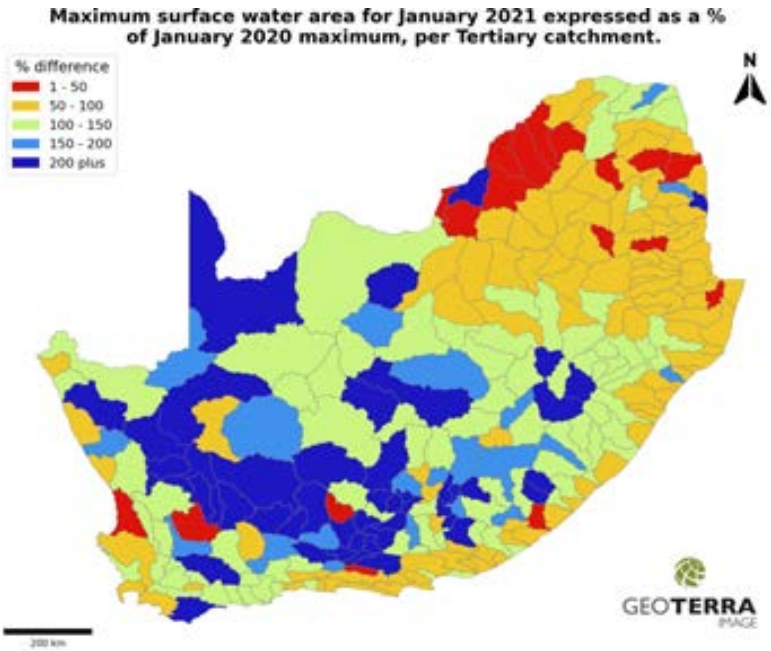

Figure 32

Agrometeorology

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