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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

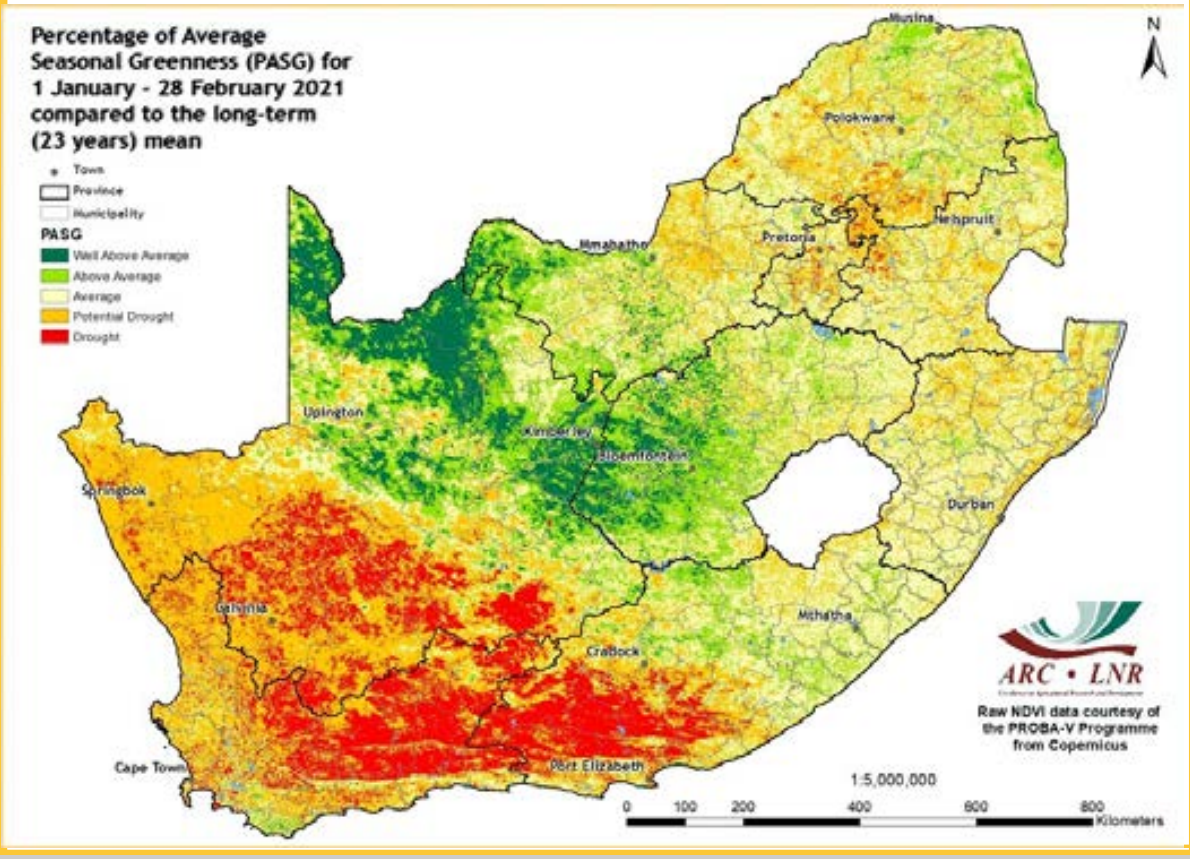
CONTENTS:

201st Edition

Image of the Month

Improved vegetation conditions following good rains over the interior

The 2020/21 summer rainfall season turned out to be relatively wet, with large parts of the country receiving above-normal rainfall since November 2020. Although this rainfall caused localized flooding in some areas, it improved soil water conditions necessary for optimal crop growth and thus boosted production of rainfed crops in the summer rainfall region. Recent significant rainfall totals also improved vegetation activity in the central interior and the northwestern parts of the country. This is depicted by the seasonal vegetation greenness map below, showing cumulative vegetation conditions for the first 2 months of 2021 compared with the long-term mean for the same period. However, the western parts continue to experience low levels of seasonal greenness (shown in red on the map). Farmers in drought affected areas can be advised that it is important to continue assessing the grazing and available feed for proper planning, as overgrazing can lead to reduced capacity for coping with adverse drought conditions. Potential drought can also be noted over the western parts of Limpopo, moving towards Mpumalanga, Gauteng and North West. In order to minimize the risk of potential drought effects, farmers should practise rainwater harvesting, increase water infiltration by adding organic material to improve soil structure and minimize the compaction of topsoil.



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:

Following good rainfall over the larger parts of the country during January, most areas of the summer rainfall region, specifically the mid- to late summer rainfall areas, received below-normal rainfall during February 2021. Widespread rain was observed over large parts of Limpopo, the Mpumalanga Lowveld and northern KwaZulu-Natal which recorded monthly totals in excess of 200 mm.

During the first 10 days of February, thunderstorms brought good rainfall to large parts of Gauteng, North West, KZN, Limpopo, Mpumalanga and the Free State, resulting in localized flooding in some areas. The relatively little rain that occurred over the Eastern Cape fell during mid-February, and more intensely over the northern regions from the 24th to the 26th. The summer rainfall region of the Northern Cape (eastern parts) similarly saw a decrease in total rainfall as compared to the previous month. Areas that received ≥90 mm for the month were Kuruman, Kathu and northern areas towards Botswana. The winter rainfall region remained dry as expected, while the all-year rainfall region recorded only light rain resulting in below-normal conditions.

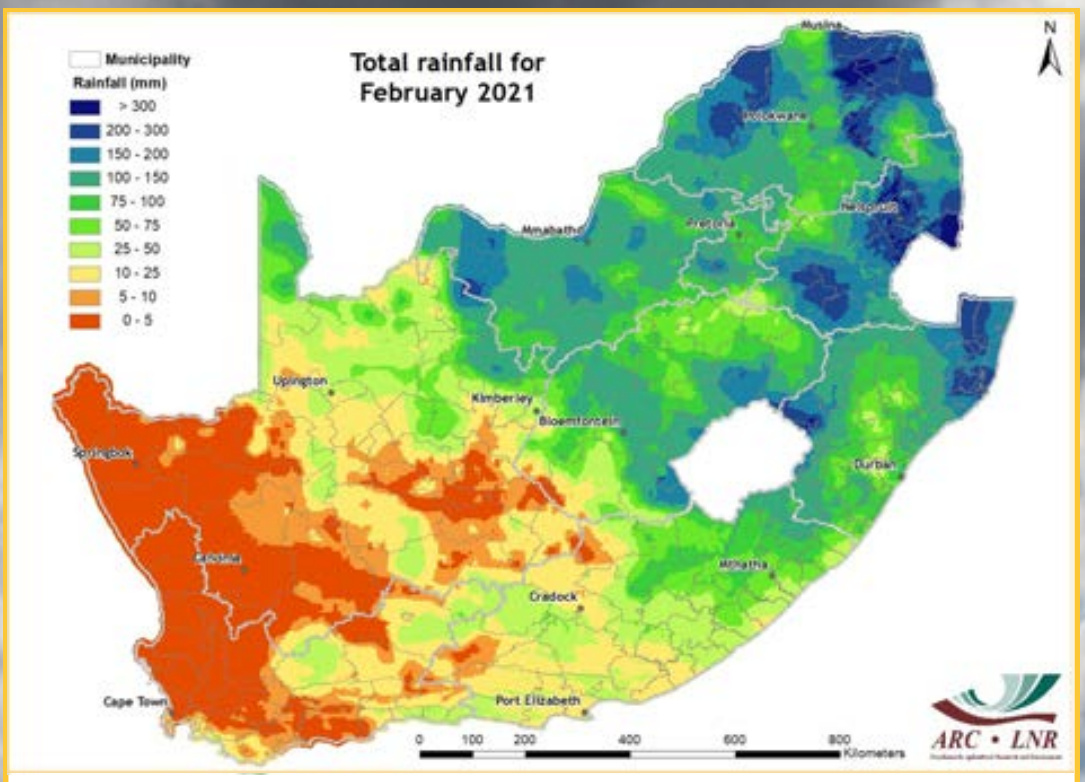


Figure 1

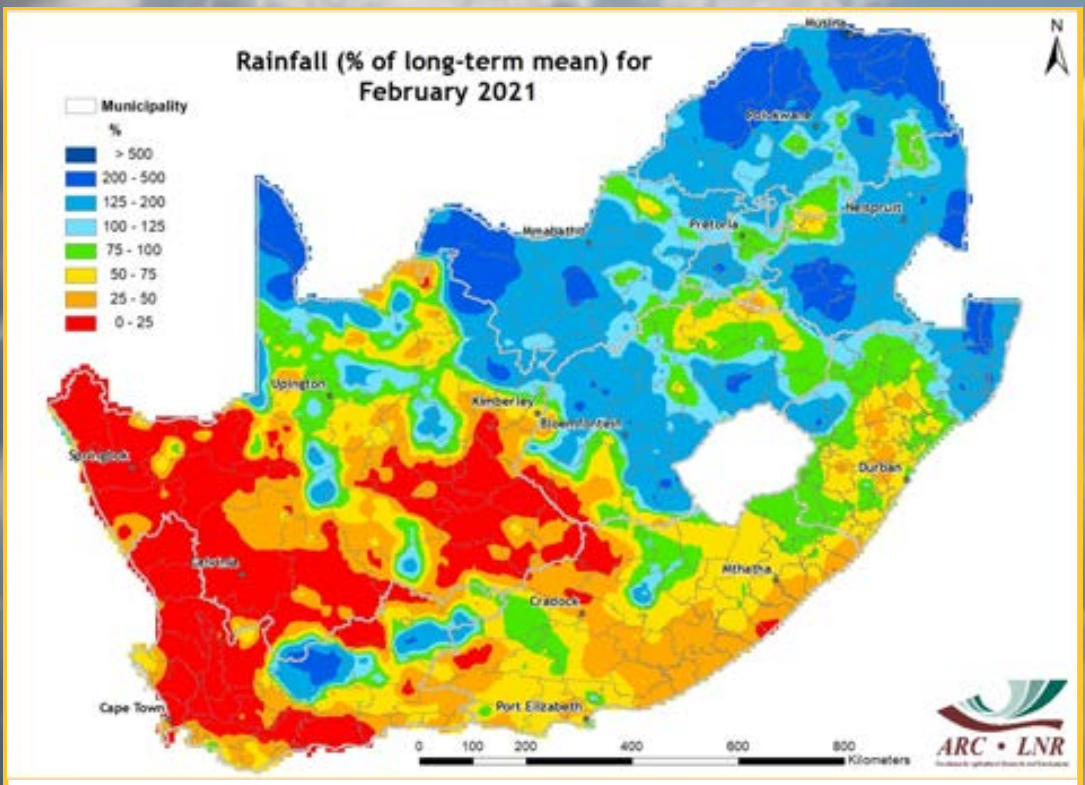
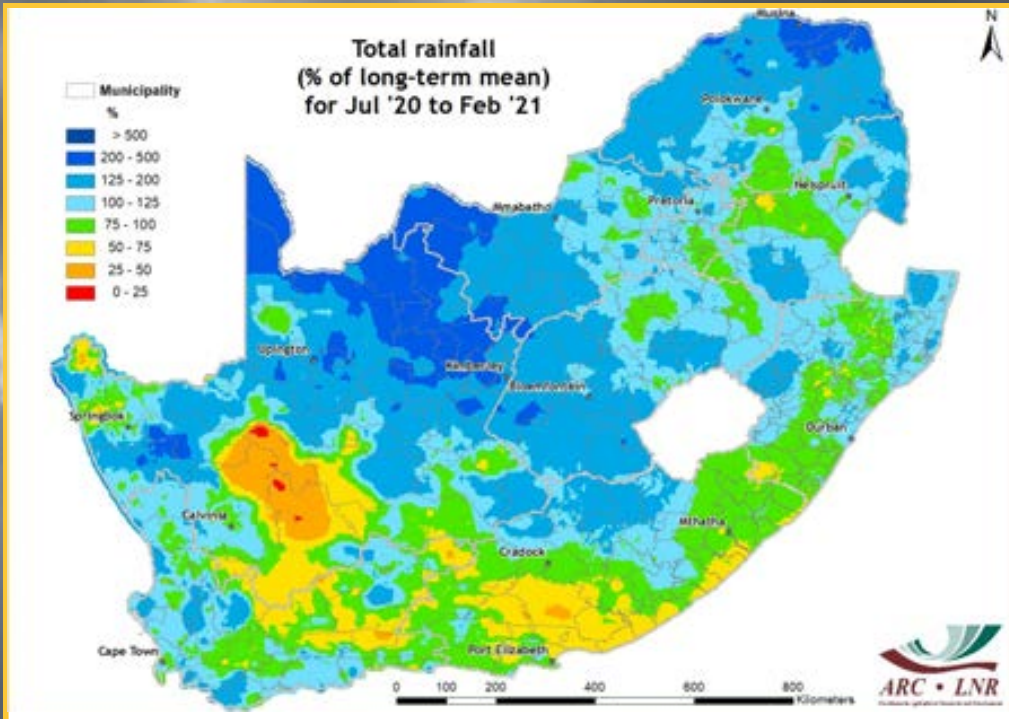


Figure 2



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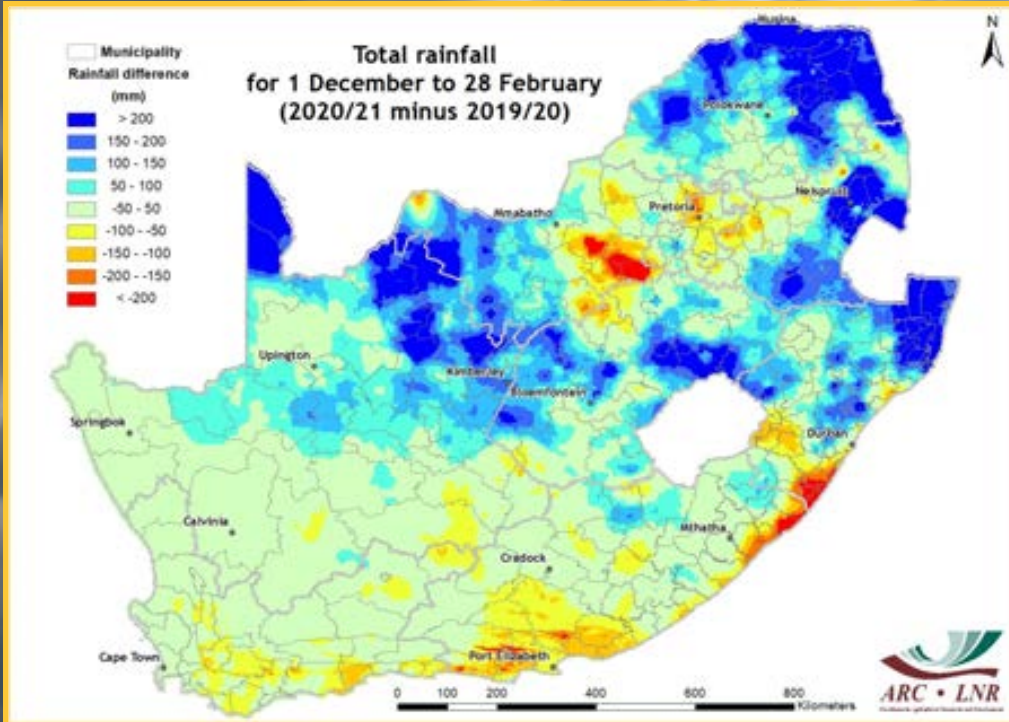

Figure 4

Figure 1:
Rainfall was largely confined to the eastern half of the country during February. The highest totals were observed over Limpopo, Mpumalanga, northern parts of KwaZulu-Natal and parts of the North West and Free State. Although insignificant, the Eastern Cape received some rainfall of between 5-75 mm for the month. Meanwhile, the winter rainfall region remained dry.

Figure 2:
Normal to above-normal rainfall was observed over most parts of the central interior, much of the northeastern parts of the country as well as the eastern Northern Cape in February. Below-normal rainfall occurred in the Eastern Cape, greater parts of KZN and the winter rainfall region.

Figure 3:
Since July 2020, greater parts of the country received near- to above-normal rainfall. Areas that recorded below-normal rainfall include parts of the Karoo as well as the Eastern Cape.

Figure 4:
Compared to the same period in 2019/20, total rainfall from December 2020 to February 2021 showed above-normal values (indicated by the blue colours) over parts of Limpopo, Mpumalanga, KZN, Free State, Northern Cape and North West. Meanwhile, northern regions of the Highveld, the south coast of KZN as well as south-western 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 February, rainfall totals resulted in wet conditions over the interior as well as the northeastern parts of the country. Similar conditions, although milder, were observed in the northern areas of the Highveld, moving towards KZN and northern parts of the Eastern Cape. Southern areas of the winter rainfall region also experienced mildly wet conditions. The 12-month SPI shows that the central to southeastern interior and parts of the Lowveld experienced moderate to extremely wet conditions, while mild to moderate drought was visible over the western region of the country, parts of the Eastern Cape and the interior of Limpopo and Mpumalanga. When considering the long-term drought conditions, SPI values corresponding to moderate, severe and extreme drought were noted, particularly in the Cape provinces, eastern Free State, parts of KZN, Limpopo and Mpumalanga.

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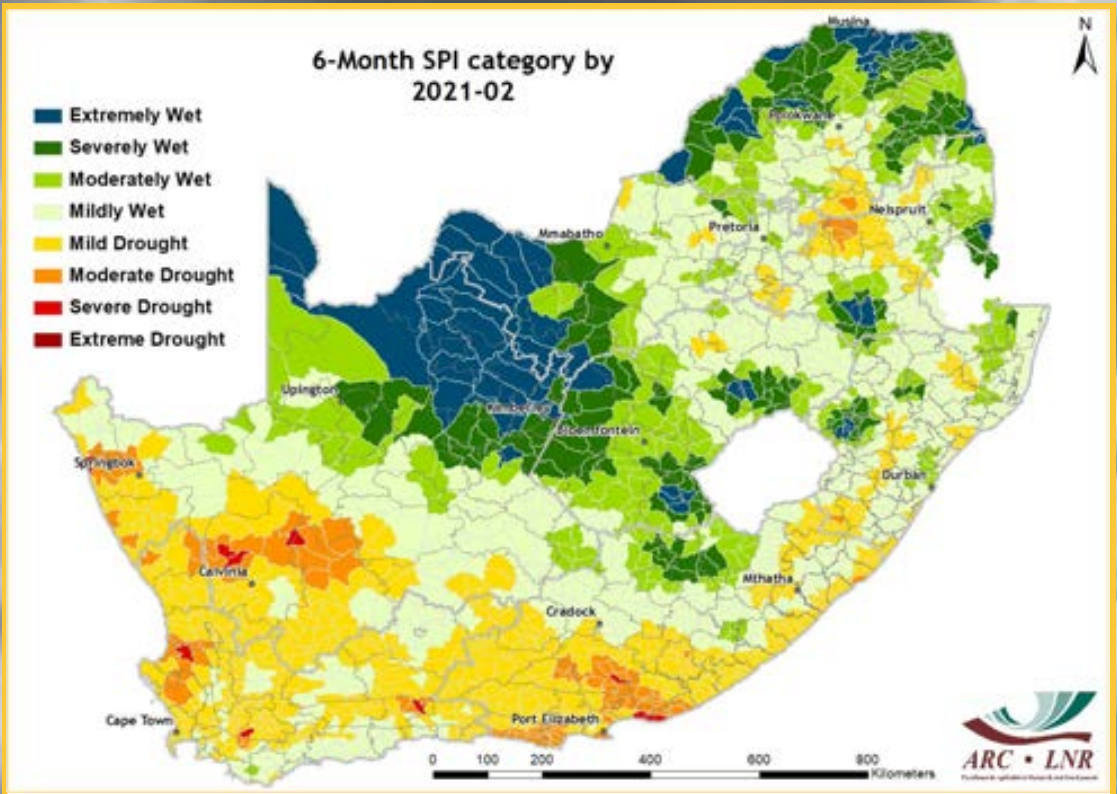

Figure 5

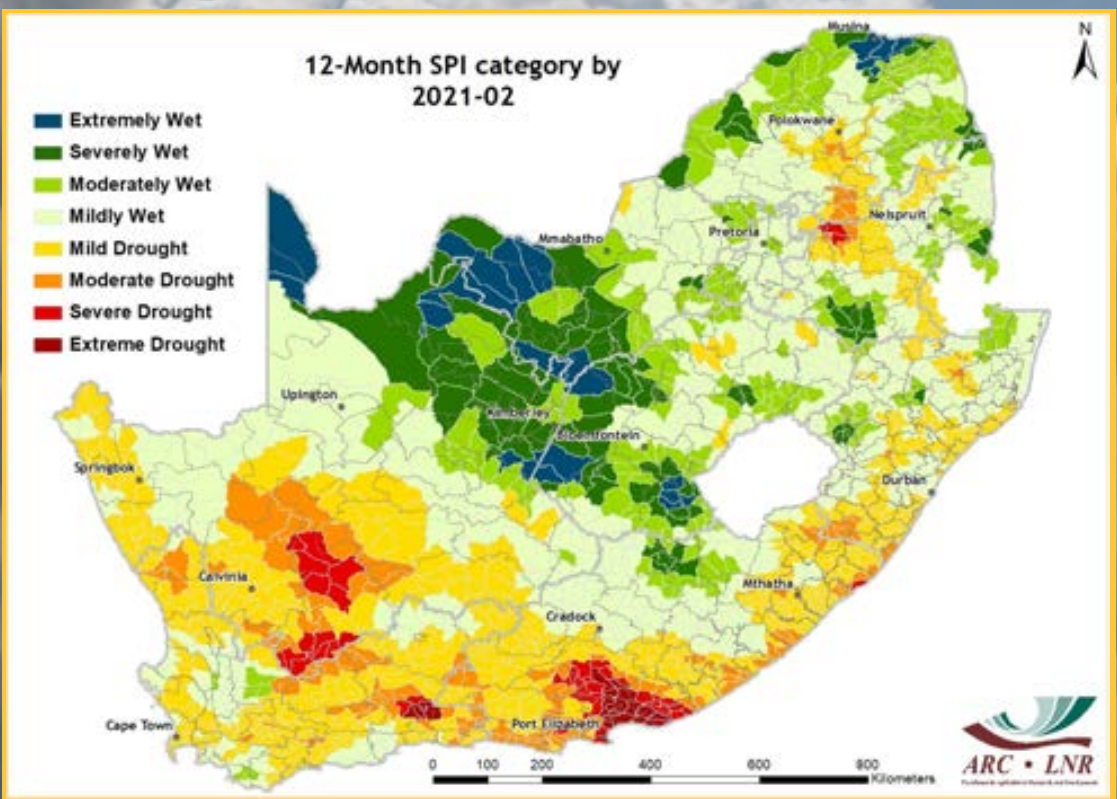

Figure 6

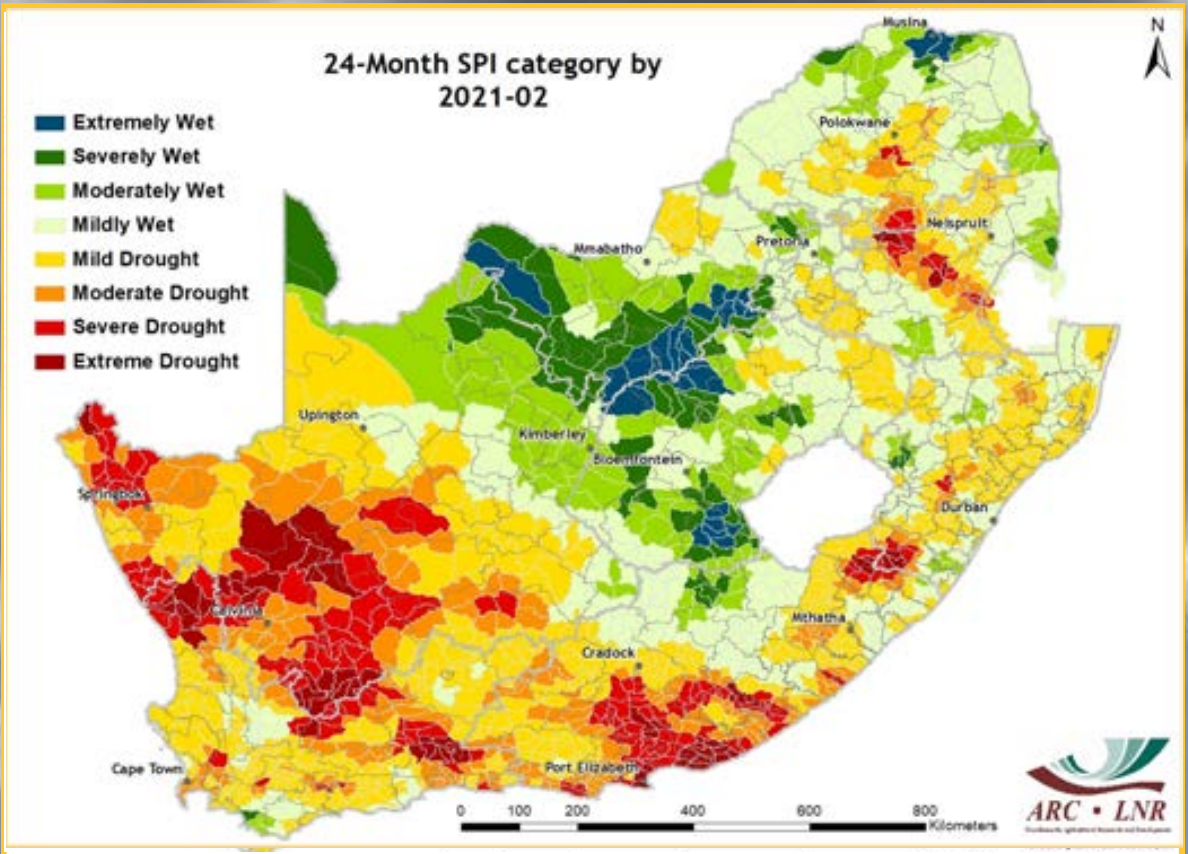

Figure 7

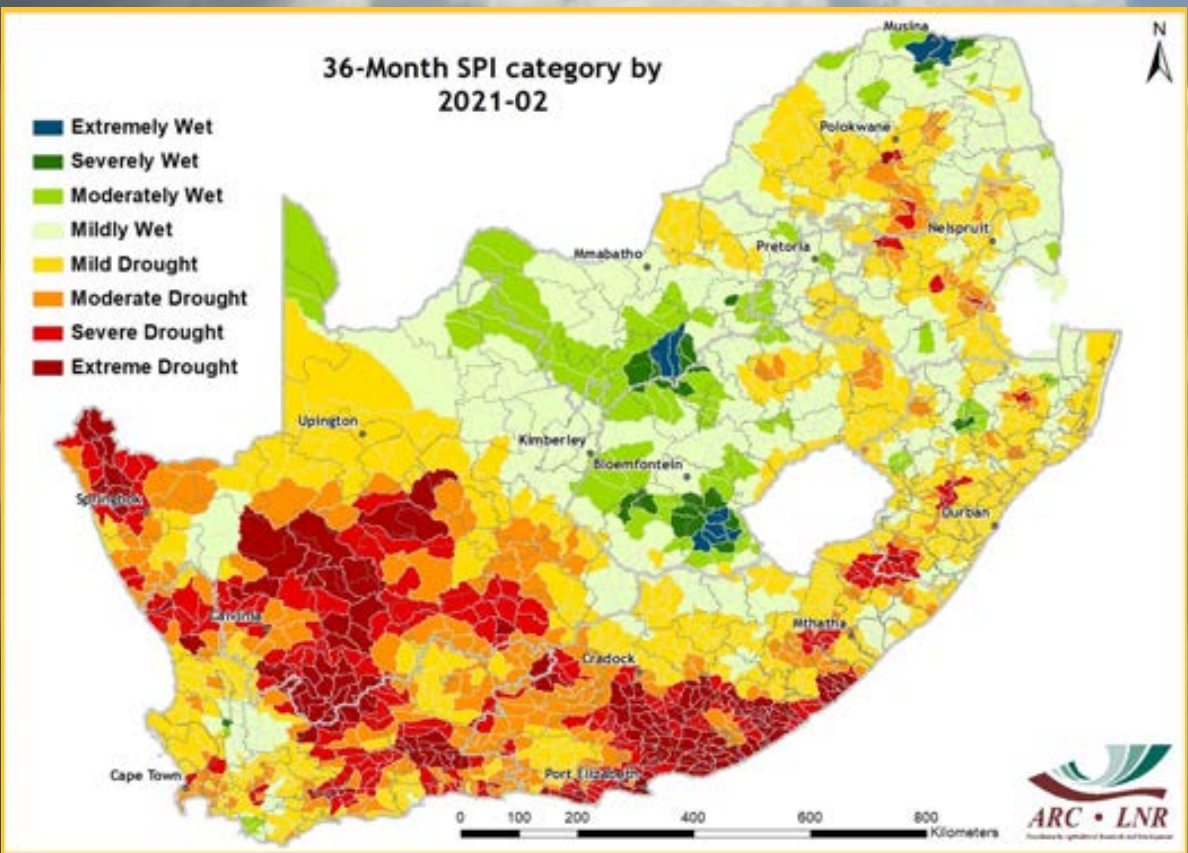

Figure 8

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.

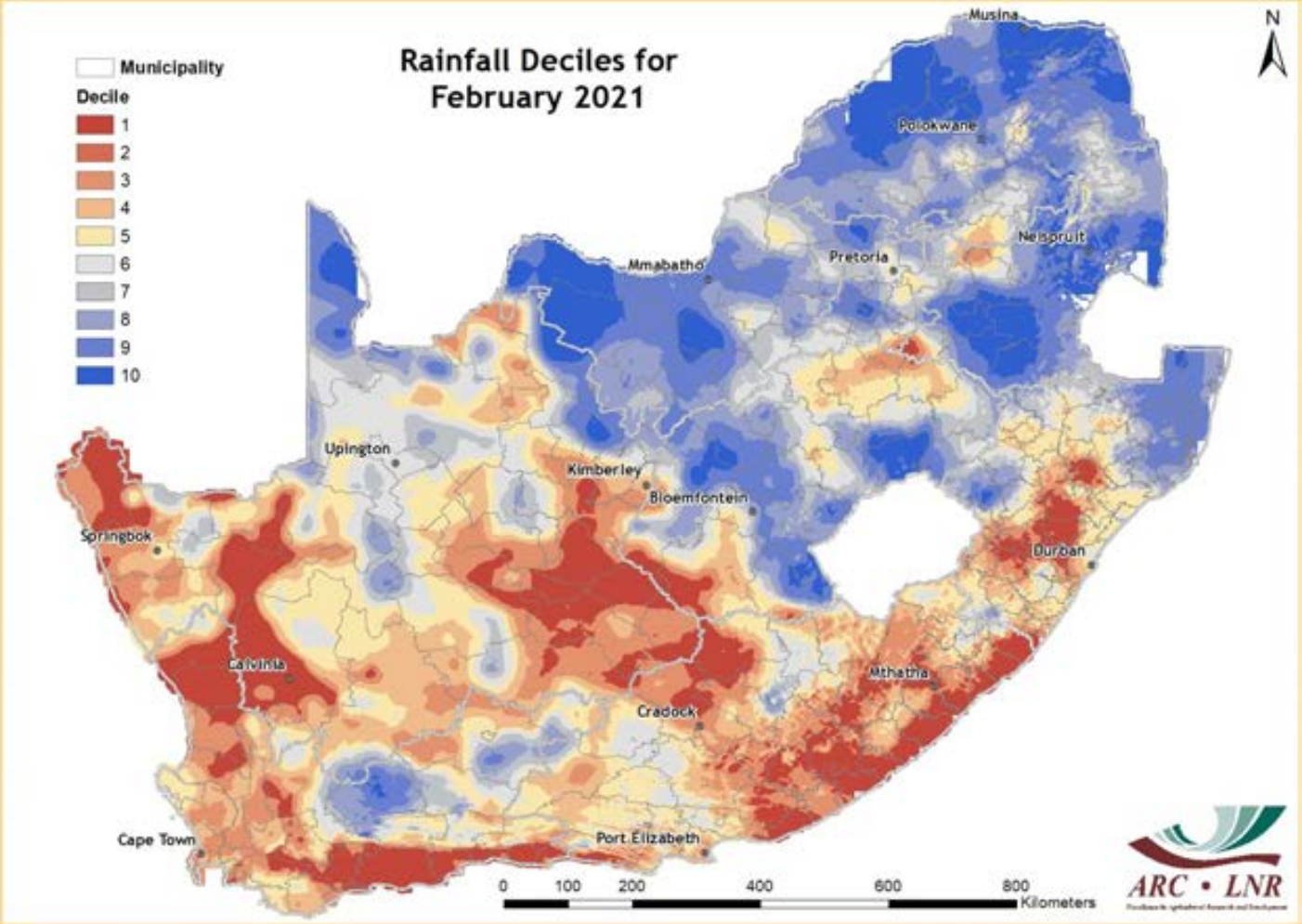

Figure 9

Figure 9:
Northeastern regions of the country experienced rainfall totals that compare well with historically wetter February months. Areas that recorded rainfall totals comparable with drier February months include the winter rainfall region, parts the Highveld, extending towards KwaZulu-Natal and the three Cape provinces.

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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.

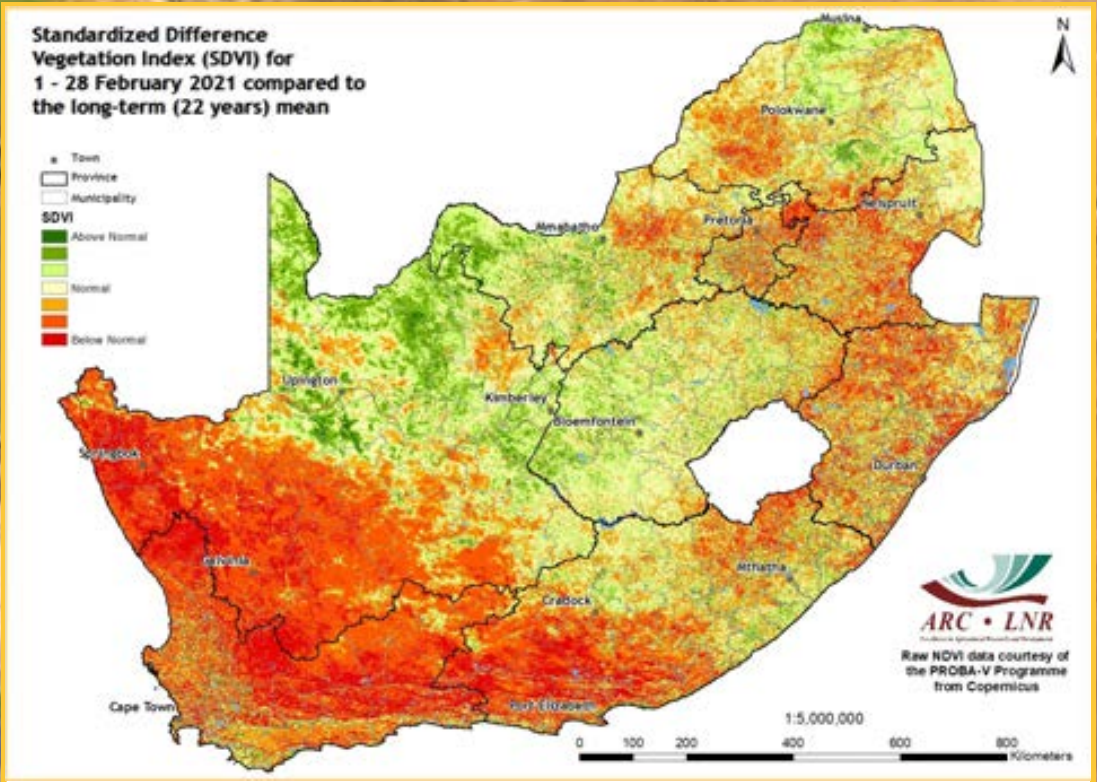

Figure 10

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

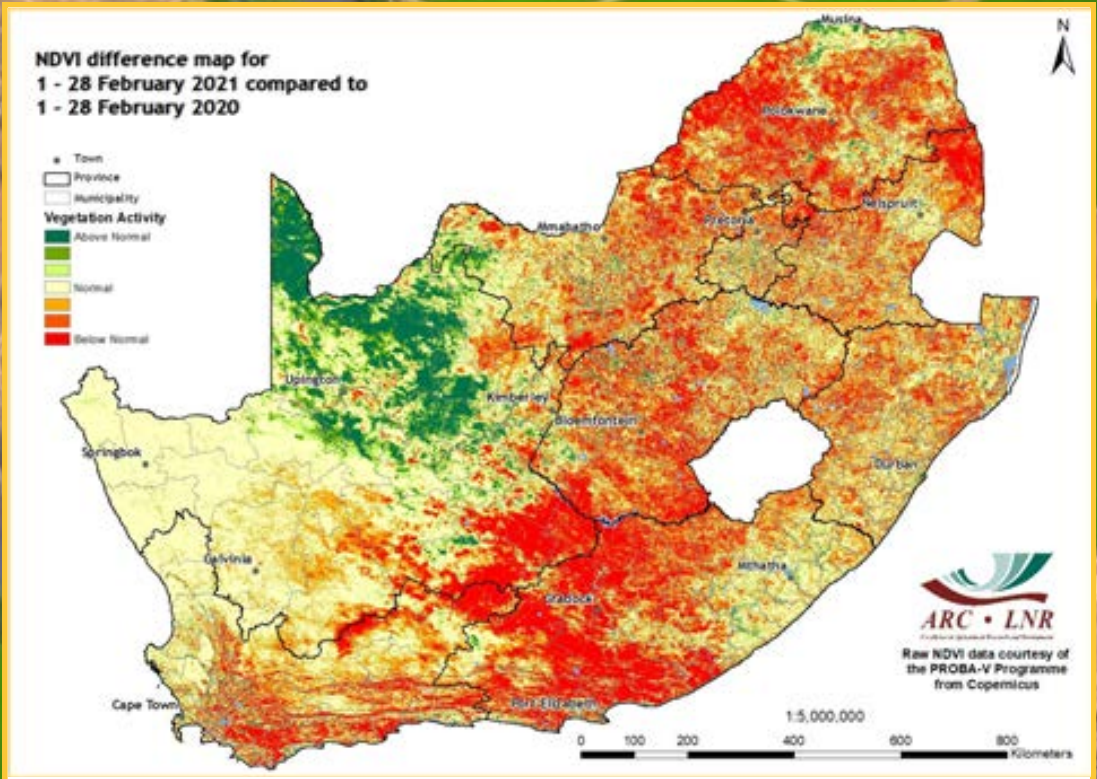

Figure 11

Figure 11:
The NDVI difference map for February 2021 compared to the same month last year shows that normal to above-normal vegetation activity occurred over the Northern Cape while the remaining parts of the country experienced below-normal vegetation activity.

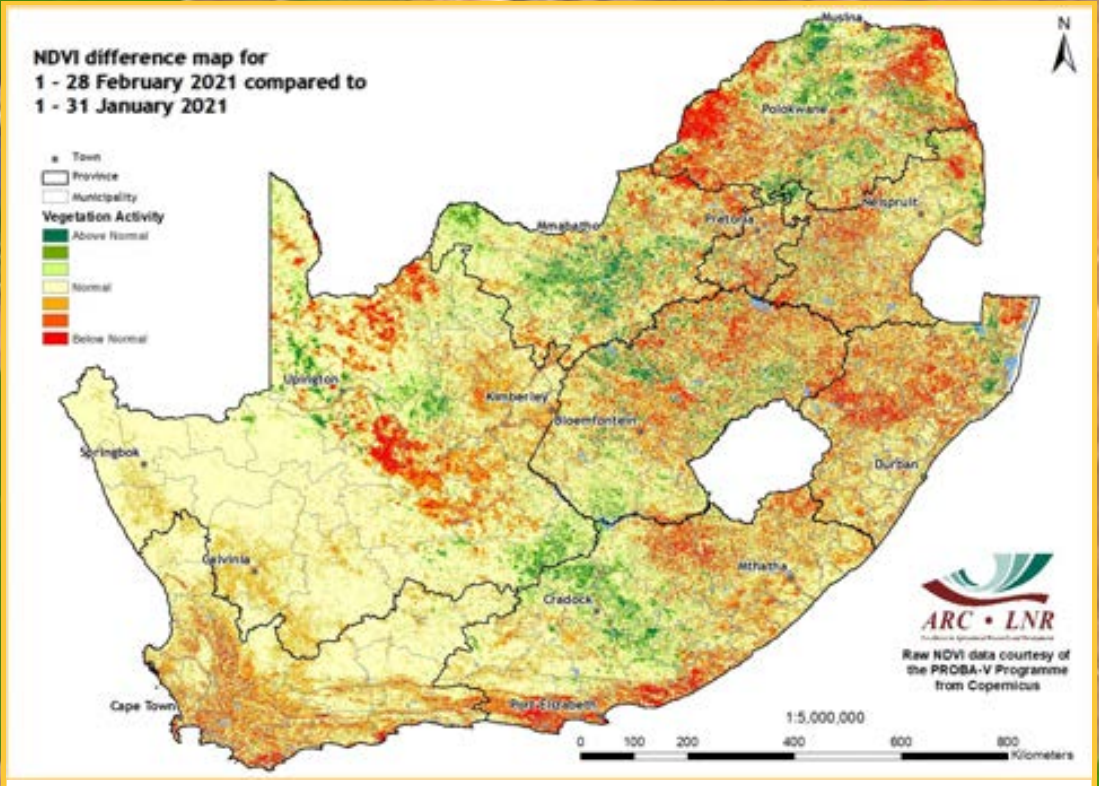

Figure 12

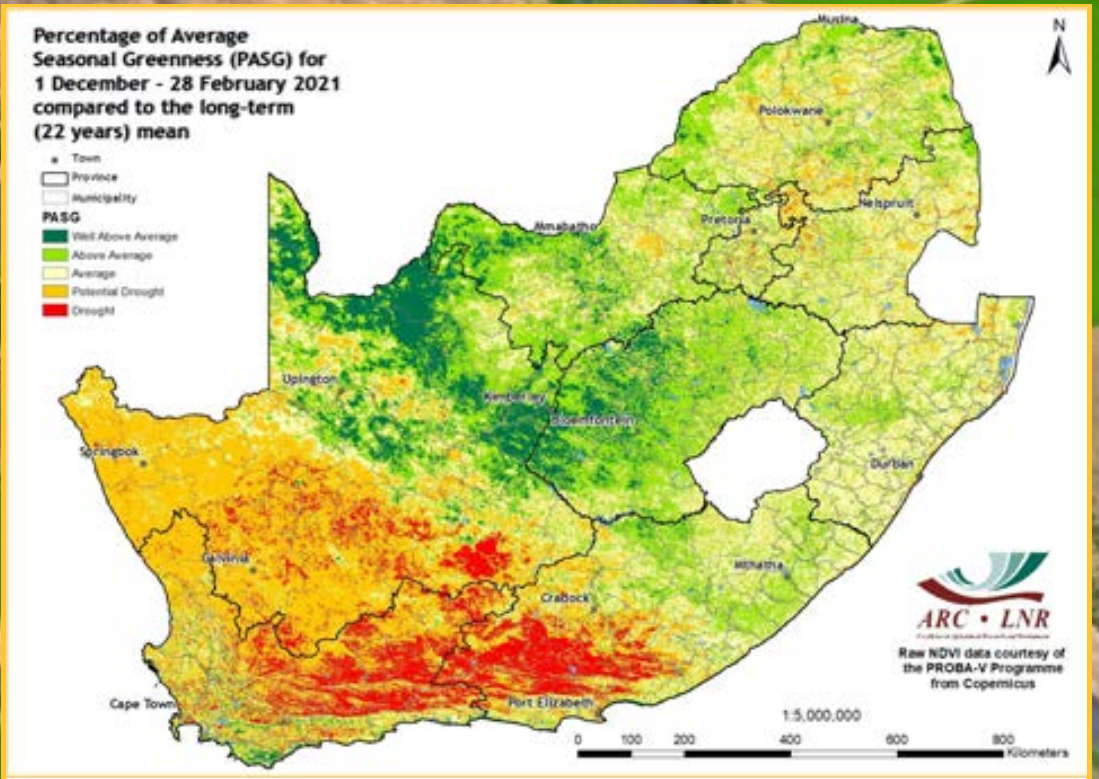

Figure 13

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:
Compared to the previous month, the NDVI difference map for February shows a mixture of vegetation conditions (below-normal – normal – above-normal) spread across the country.

Figure 13:
Cumulative vegetation conditions over a 3-month period compared to the long-term mean show that high levels of seasonal vegetation greenness remain dominant in the central and northern parts of the country. Meanwhile, the western parts continue to experience low levels of seasonal greenness.

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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.

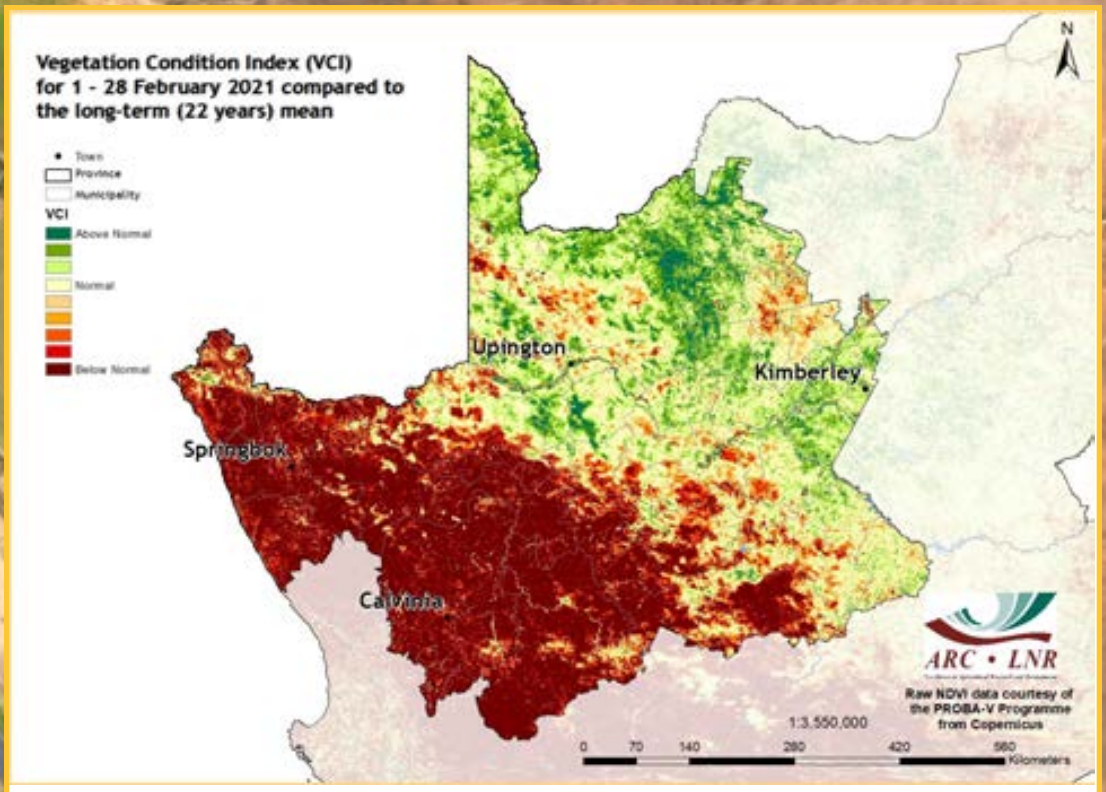

Figure 14

Figure 14:
The VCI map for February indicates that improved vegetation conditions persist in the far northeastern parts of the Northern Cape while the remaining areas continue to be severely affected by drought.

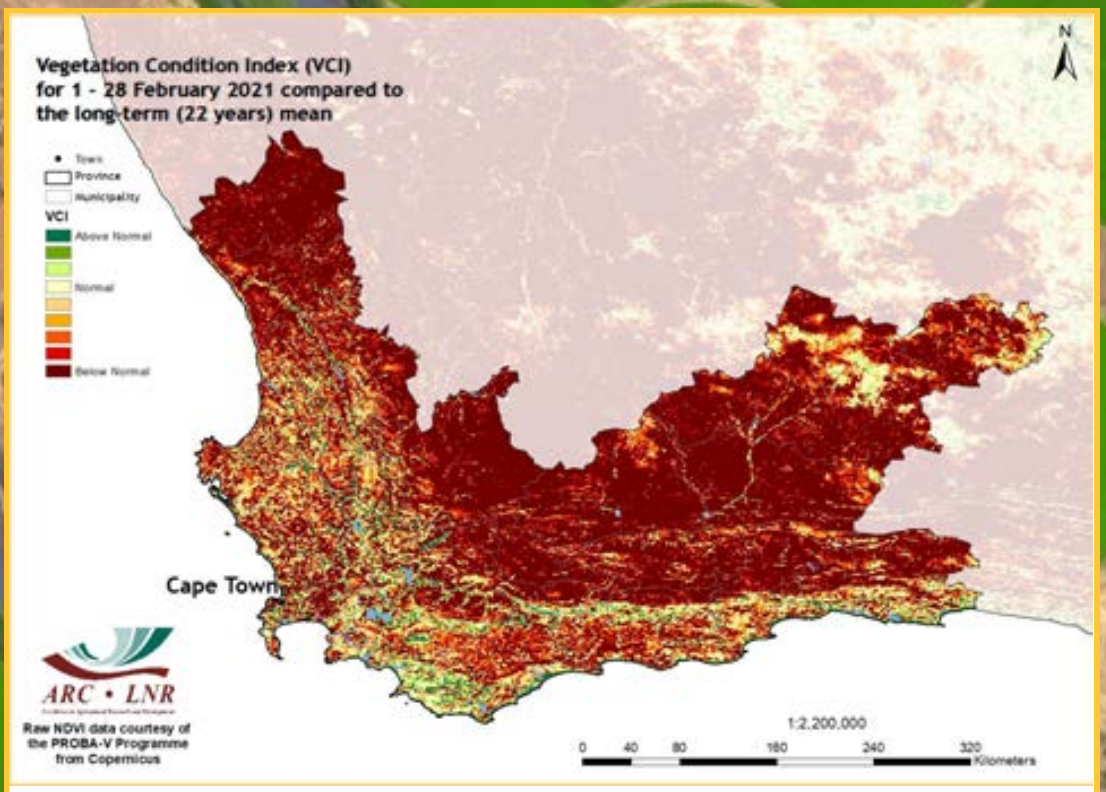

Figure 15

Figure 15:
The VCI map for February indicates that vegetation in almost the entire Western Cape remains stressed with only pockets of good vegetation conditions in isolated areas of the southern parts.

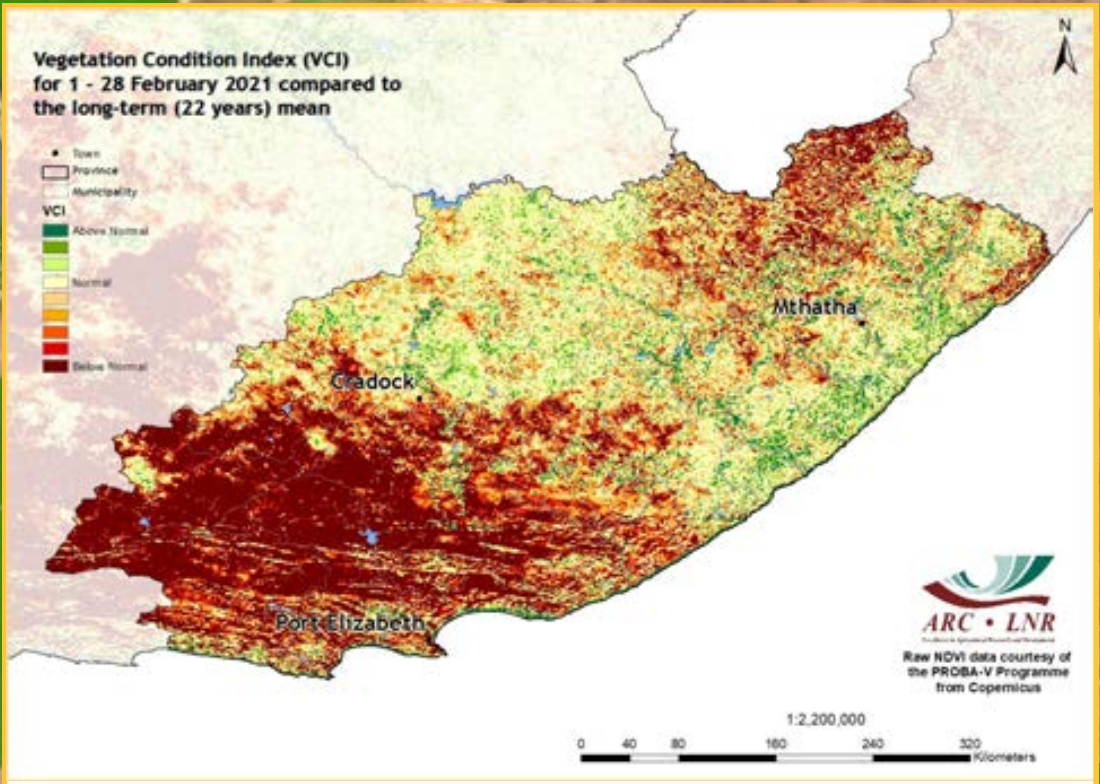

Figure 16

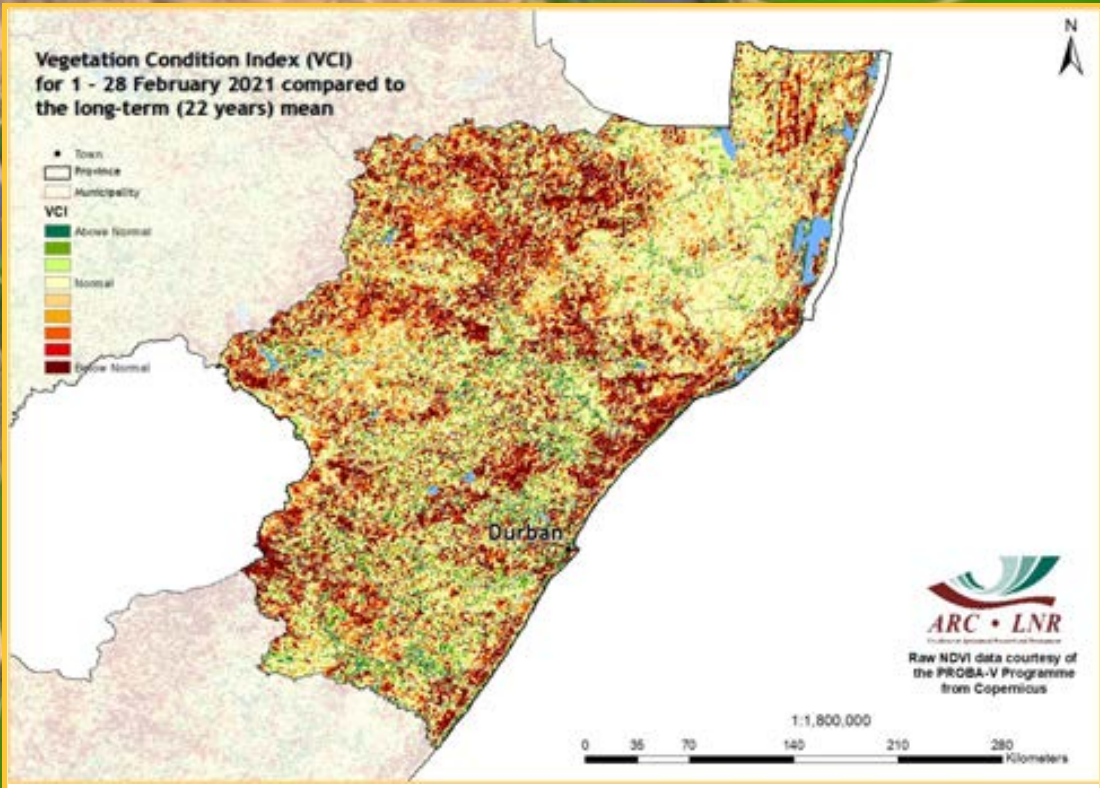

Figure 17

Figure 16:
The VCI map for February indicates that the western half of the Eastern Cape continues to experience poor vegetation conditions.

Figure 17:
The VCI map for February indicates that most parts of KwaZulu-Natal experienced poor vegetation activity.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

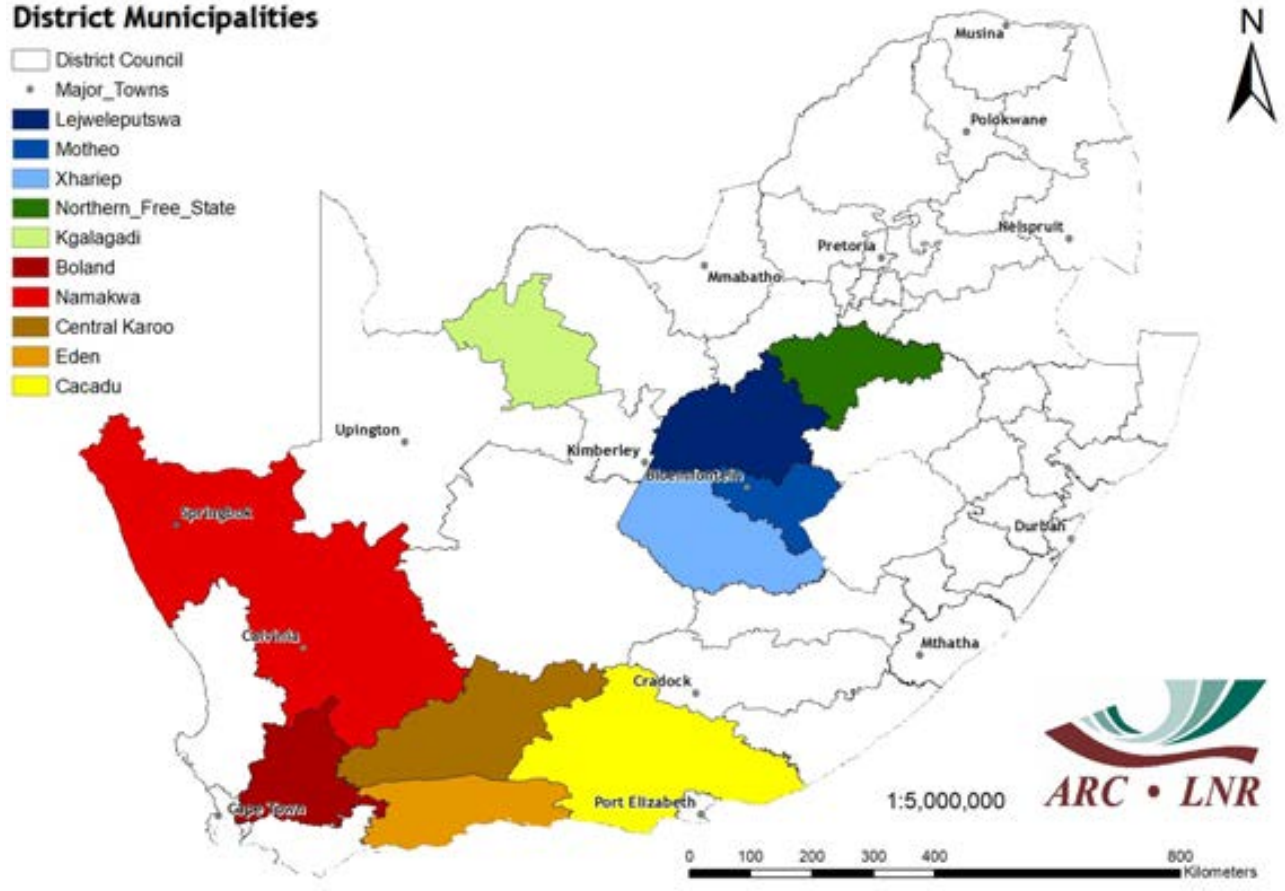

Figure 18

Rainfall and NDVI Graphs

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

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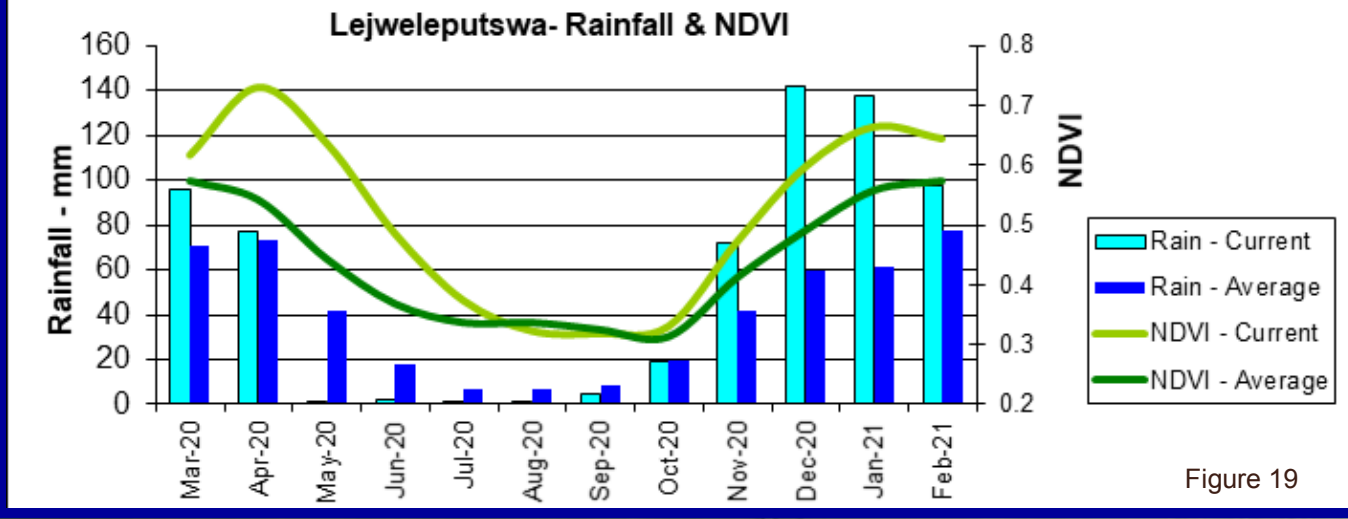
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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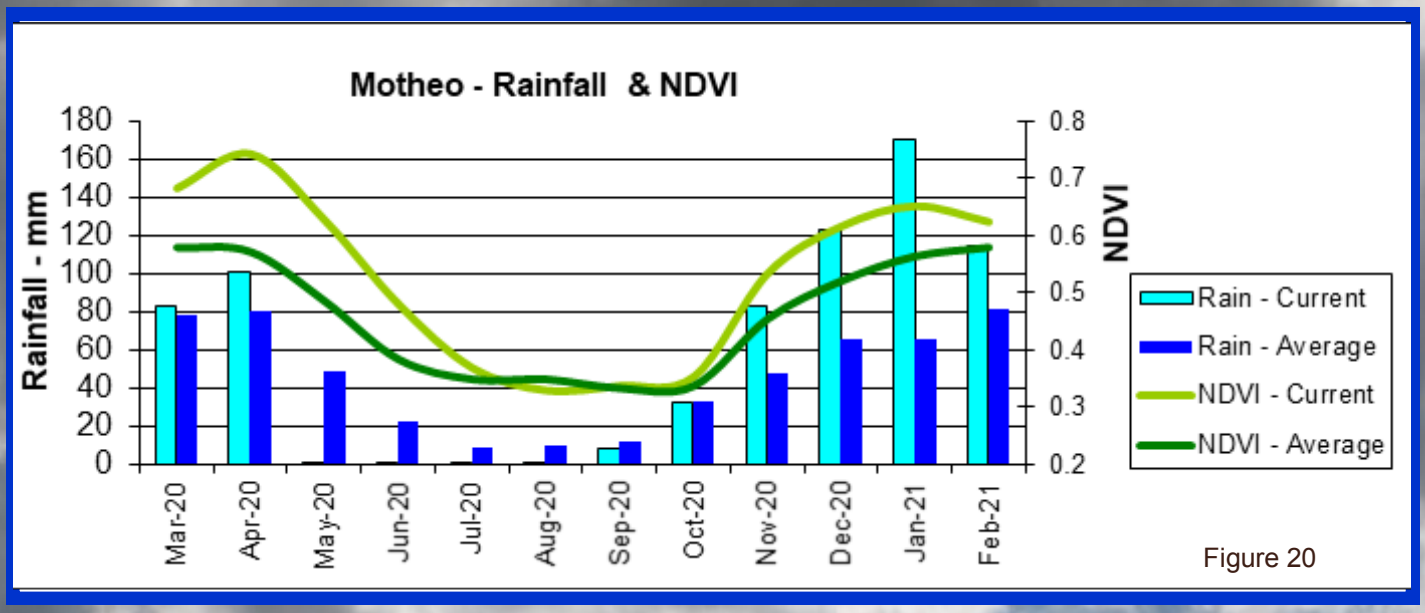

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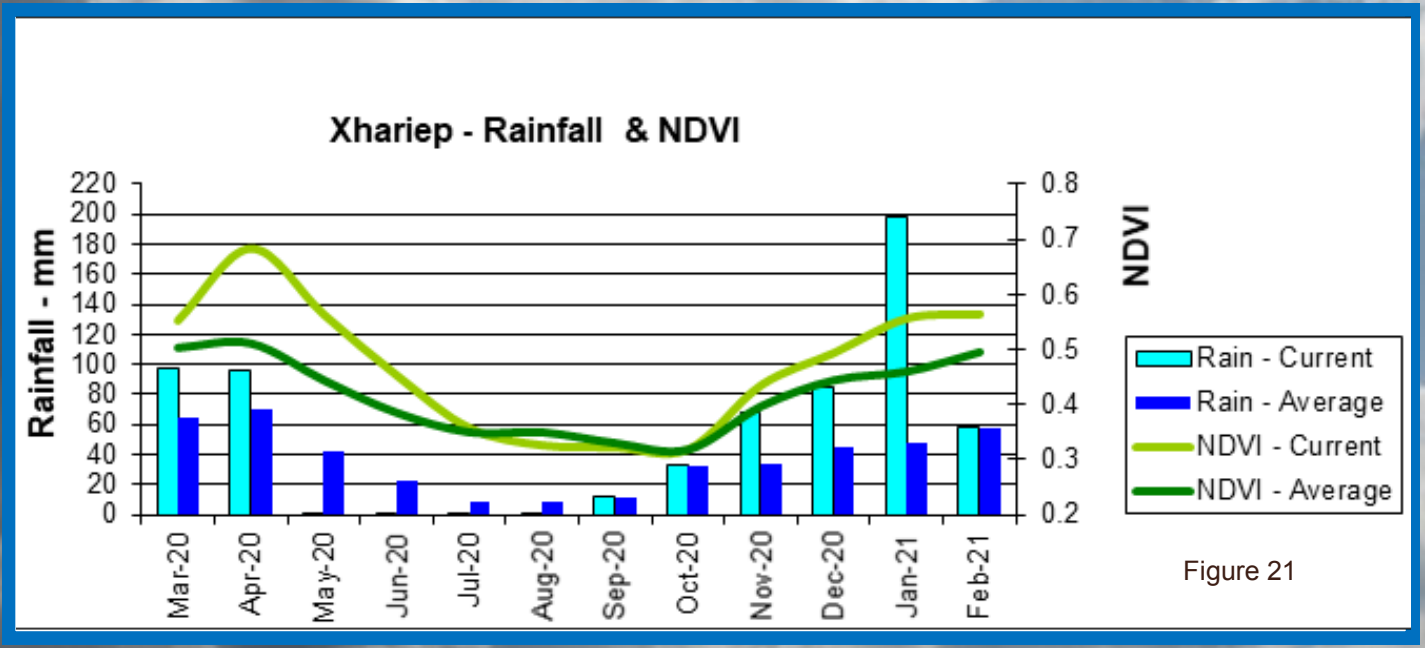

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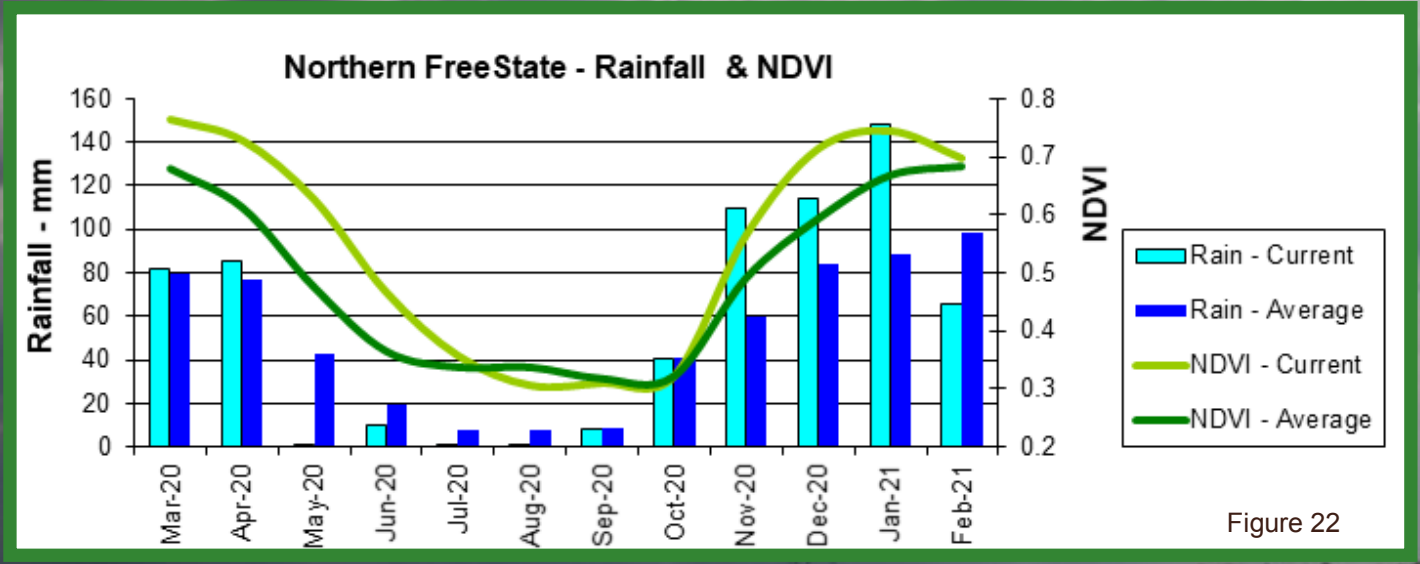

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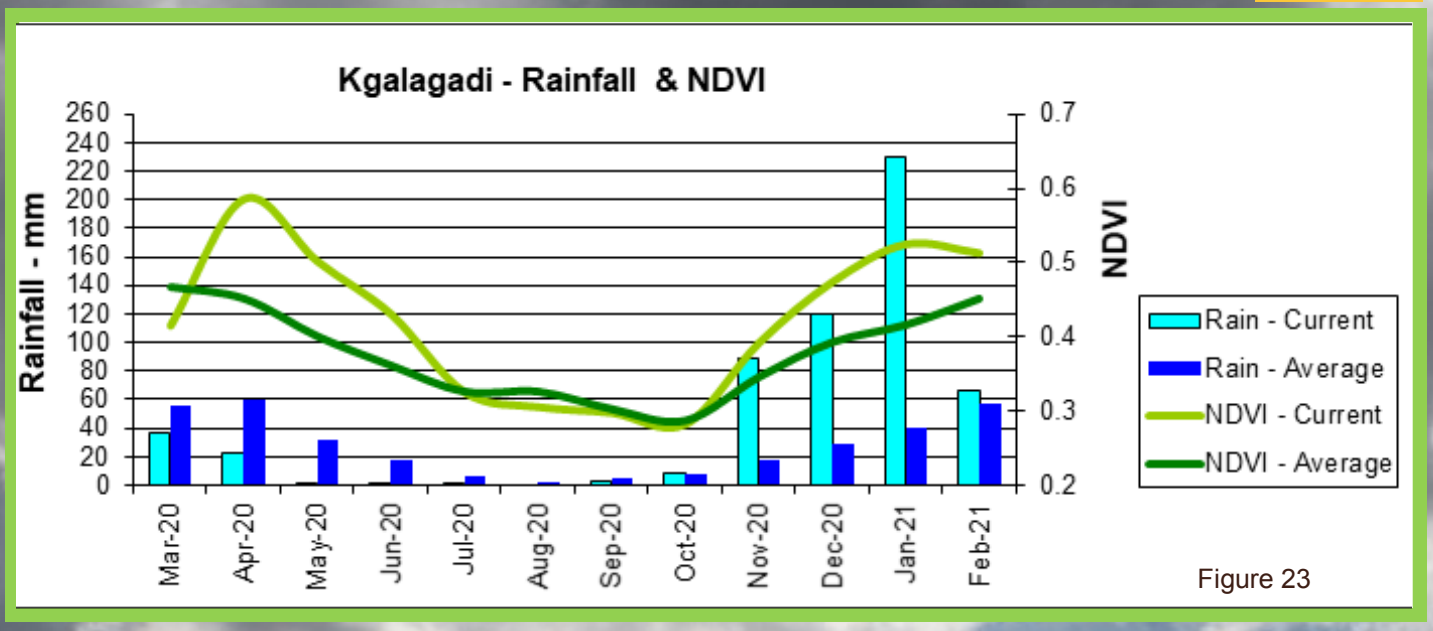

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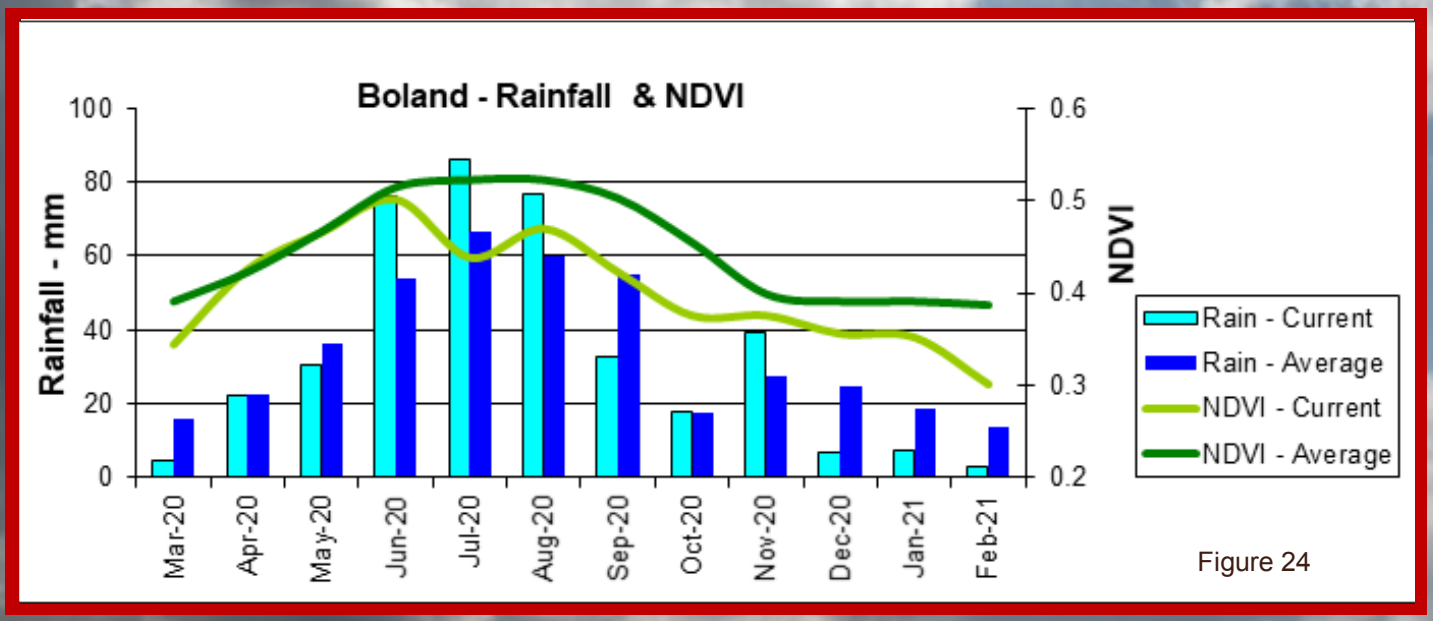

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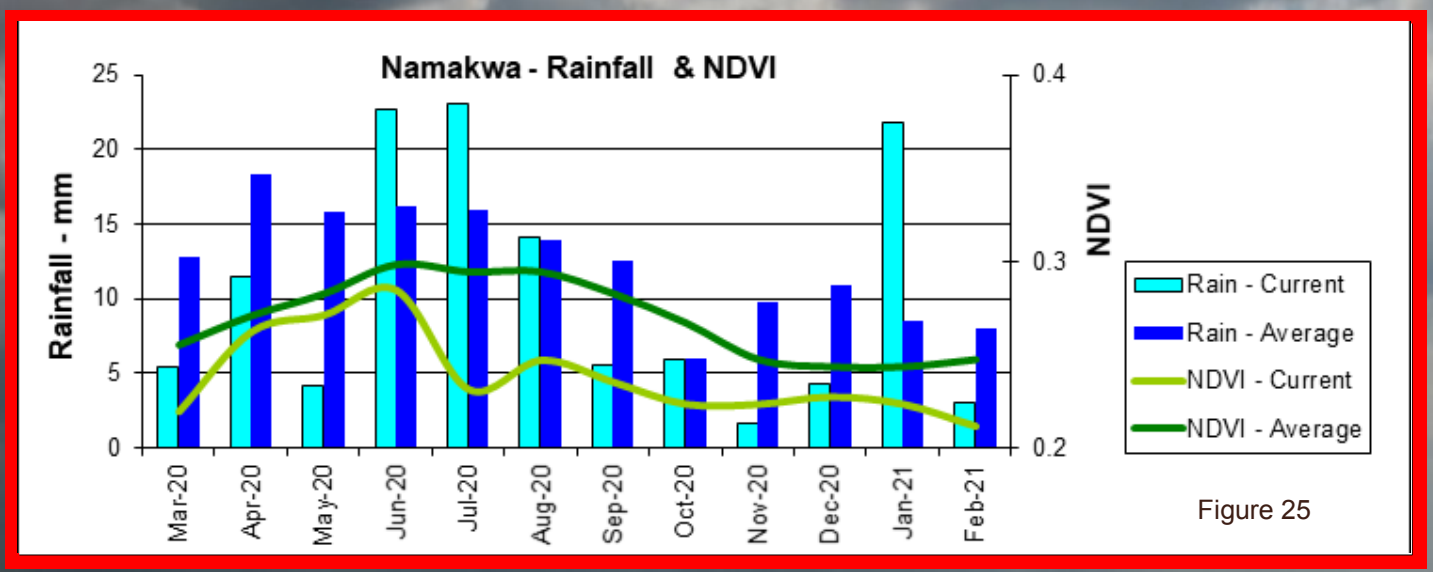


Figure 25

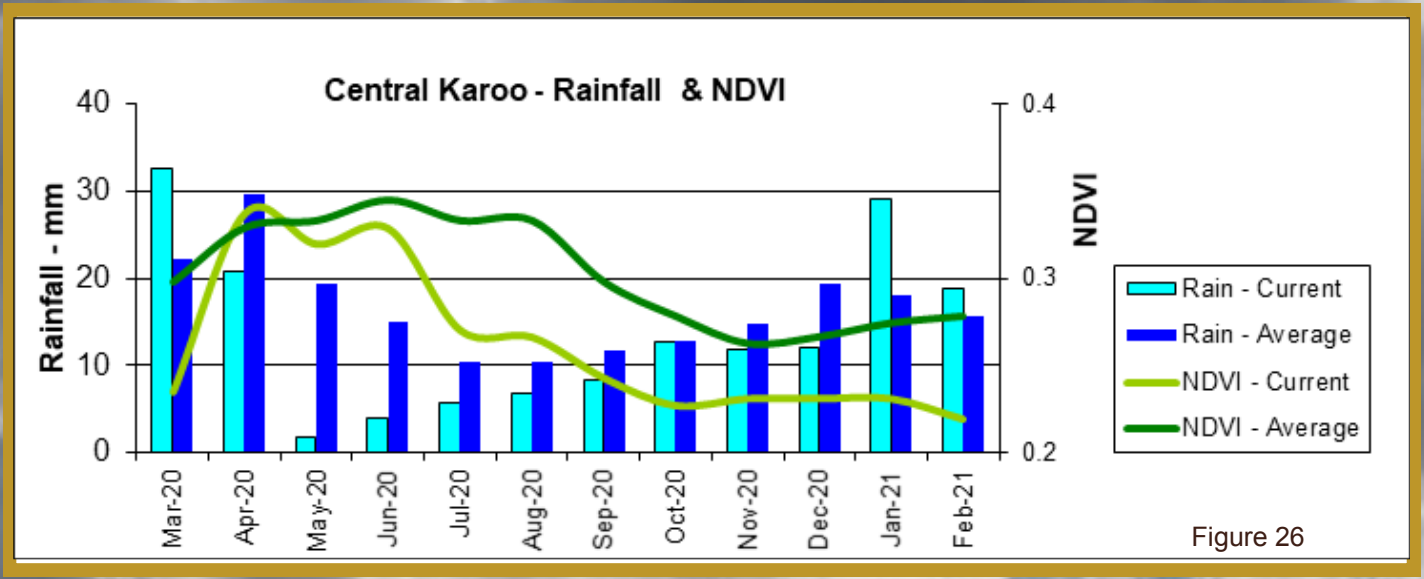
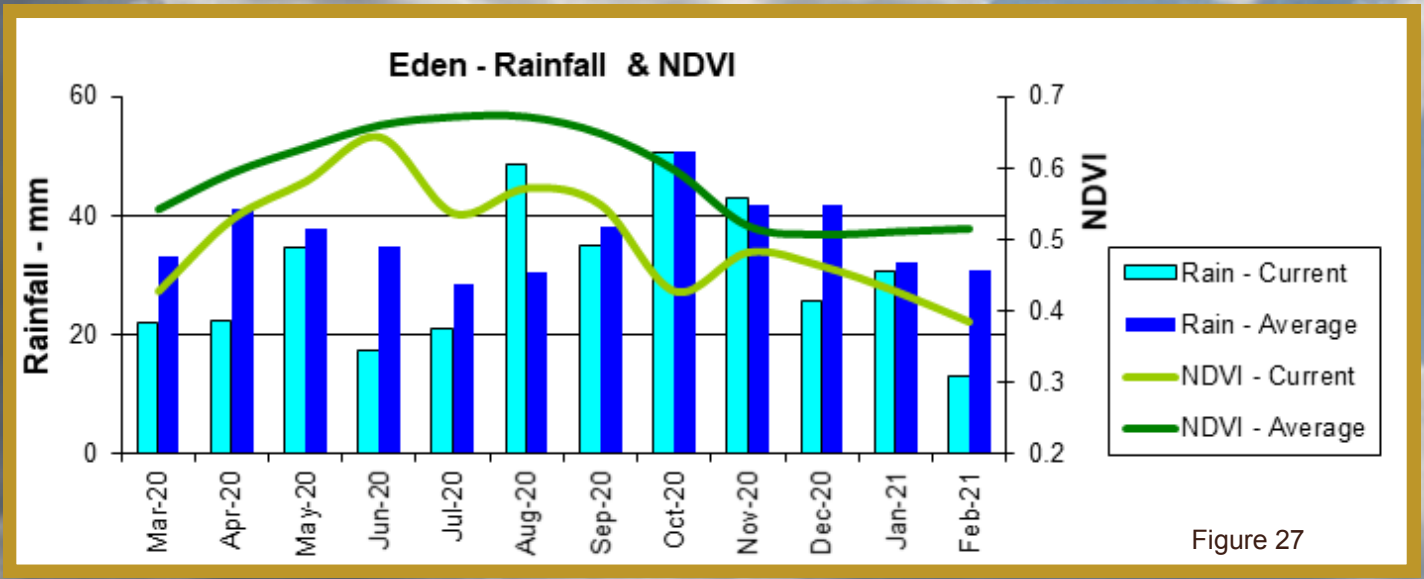


Figure 26



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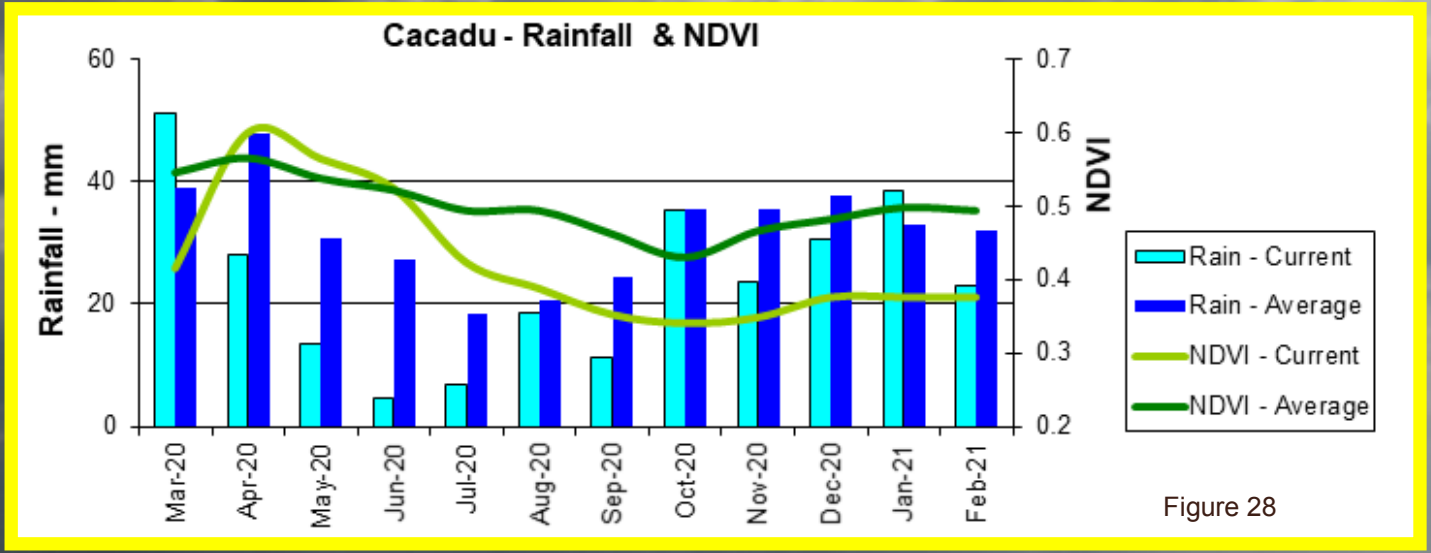

Figure 28

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 1-28 February 2021 per province. Fire activity was lower in all provinces except for the Western Cape compared to the long-term average.

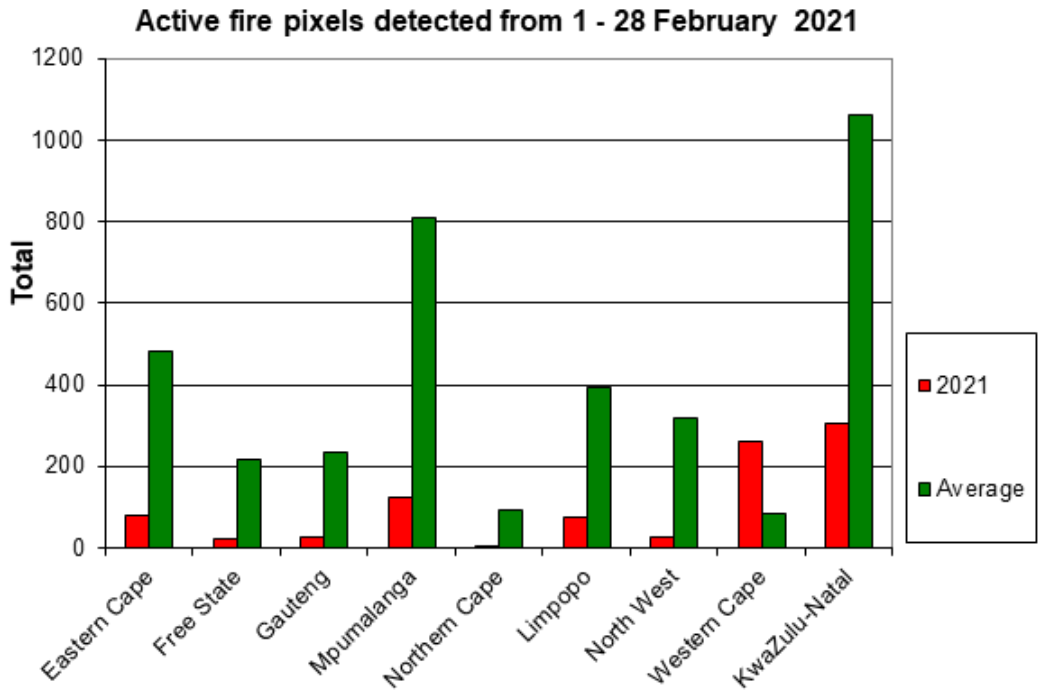

Figure 29

Figure 30:
The map shows the location of active fires detected between 1–28 February 2021.

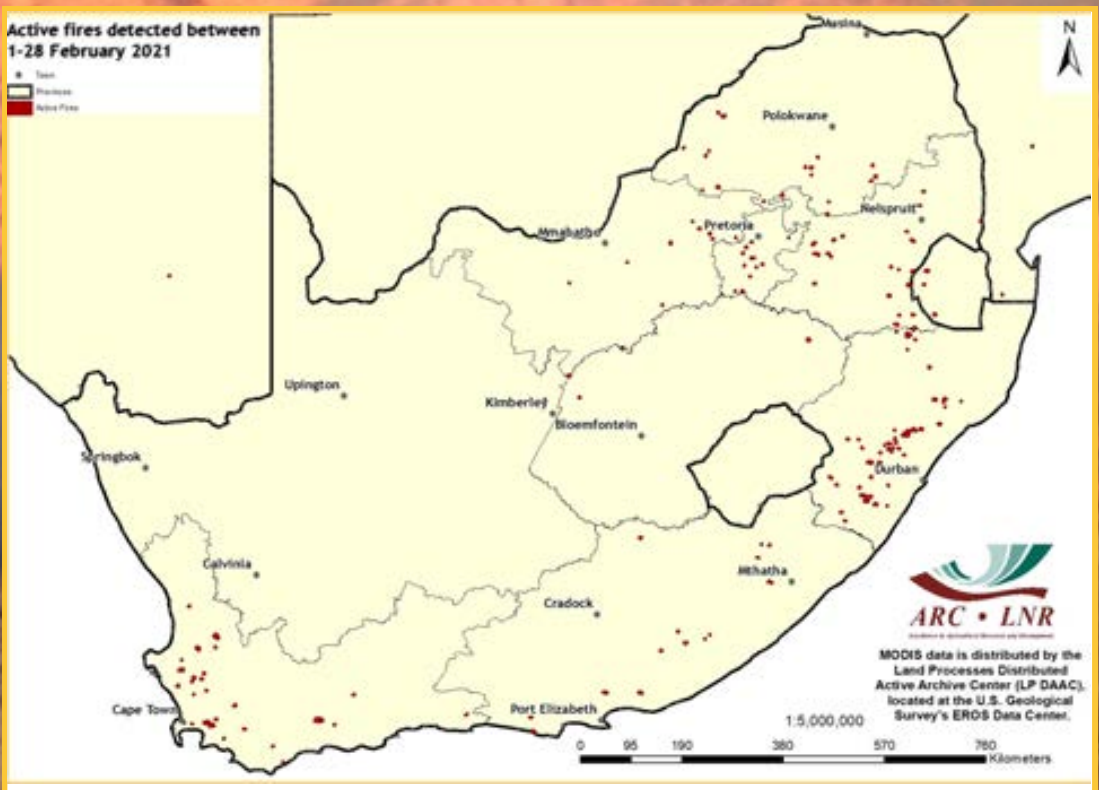

Figure 30

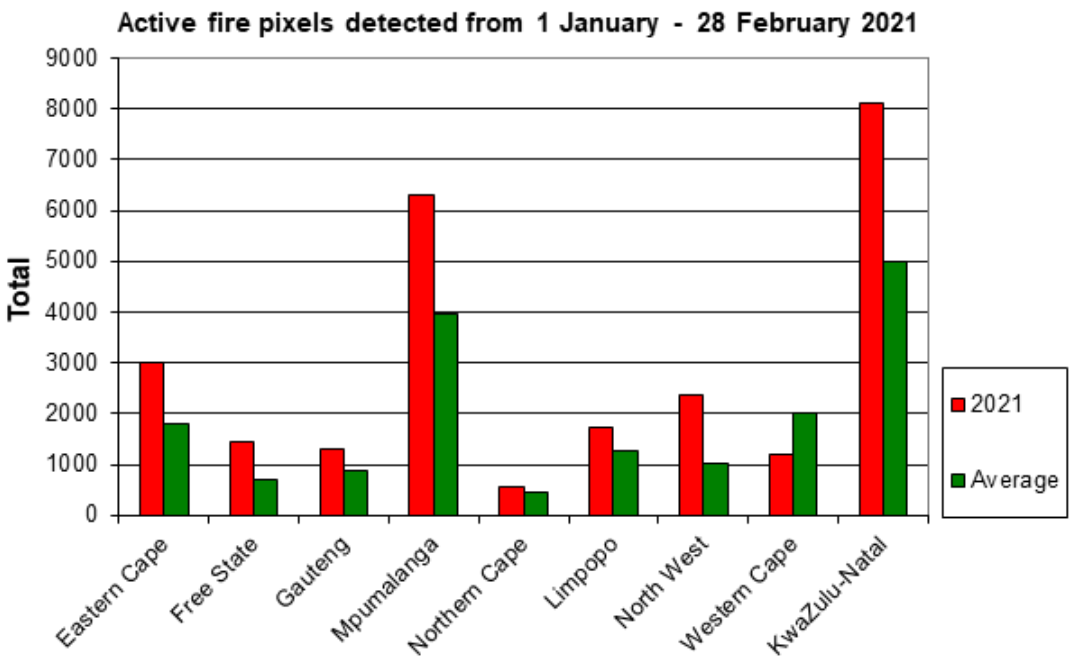

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January - 28 February 2021 per province. Cumulative fire activity was higher in all provinces except for the Western Cape compared to the long-term average.

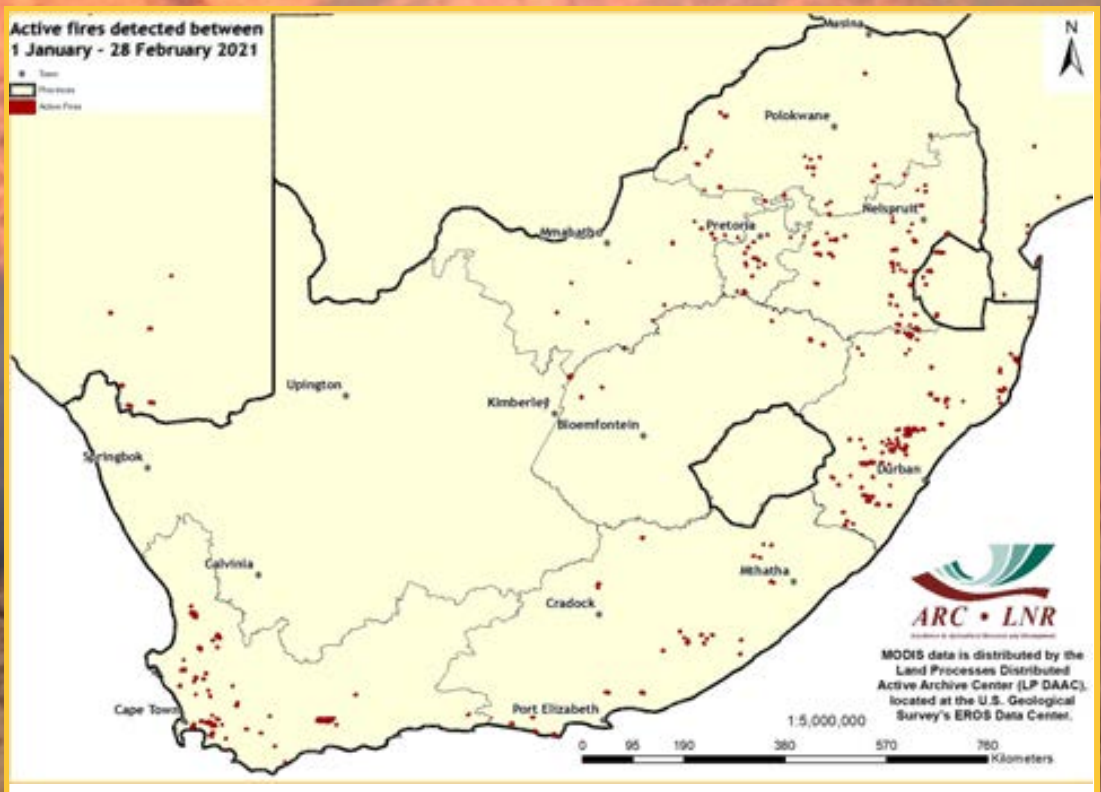

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January - 28 February 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 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 34 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 February 2021 shows a further increase in water resources across most of 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 western Karoo region, which continue to show significantly lower current water levels compared to long-term maximum values.

The comparison between February 2021 and February 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 inland areas of the Western and Eastern Cape, as well as Maputaland in KwaZulu-Natal, 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 February 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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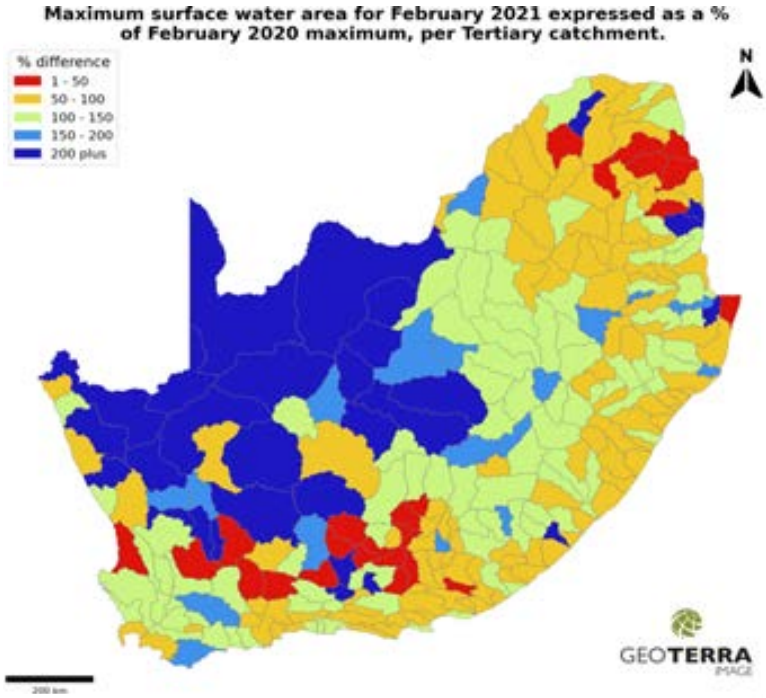

Figure 33

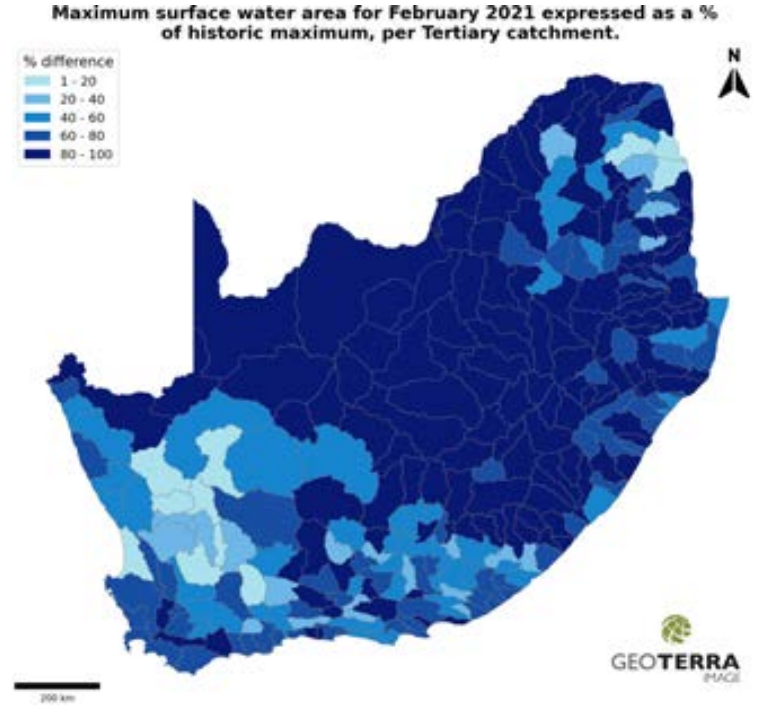

Figure 34

Agrometeorology

ARC • LNR

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

ARC • LNR

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".