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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

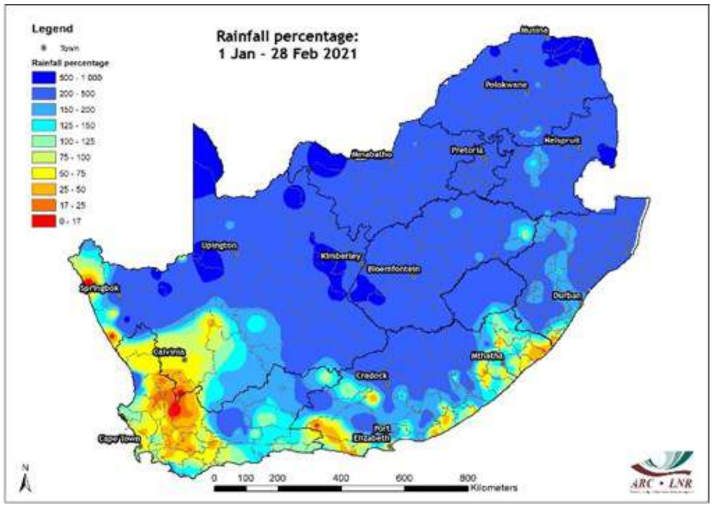
AMESD

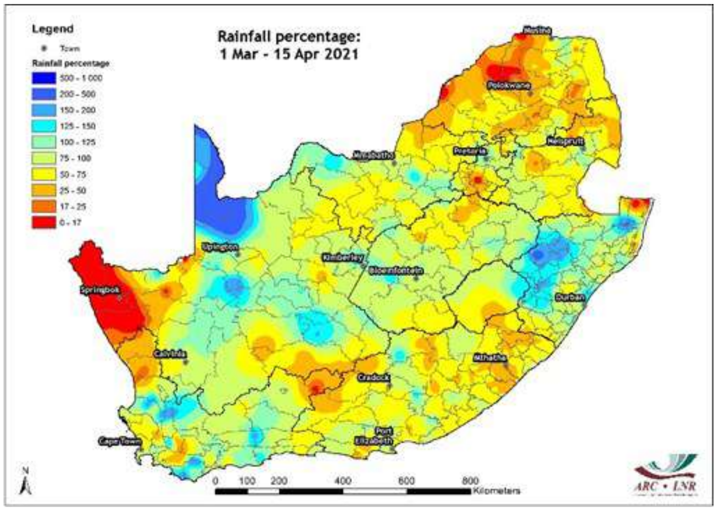
202nd Edition

Images of the Month

Drier end to an otherwise wet summer

The 2020/21 summer will go down as one of the wetter summer seasons in South African weather history for most of the summer rainfall region. An early advent of rainfall during the planting windows for summer crops brought a welcome change to the situation experienced during previous summers. Very wet conditions occurred during mid-summer, resulting in floods in river basins as far apart as the Orange and the Limpopo. Since early March, however, most of the summer rainfall region experienced relatively dry conditions, especially the northern to northeastern parts. These drier conditions also coincided with a weakening of the current La Niña event.





The drier conditions would have been a problem for grain crop production had the summer rainy season not started on time to allow for timeous cultivation. Given the very favourable conditions since October over much of the summer rainfall region, the drier conditions towards the end of the season rather played a supportive role for the ripening of the crops as well as harvest activities.

The two rainfall maps contrast the relatively wet conditions during January to February 2021 with the relatively dry conditions since March. The maps show the rainfall for the respective periods as a percentage of the long-term average and are based on preliminary information from the ARC weather station network, comprising more than 500 automatic weather stations.

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:

March 2021 turned out to be somewhat drier compared to the long-term average, in contrast to the previous few months which were characterized by widespread above-normal rainfall over the summer rainfall region. This trend is most pronounced over the western half of Limpopo and the surrounding areas of adjacent provinces. A few significant weather systems were still responsible for fairly widespread rainfall over especially the central to eastern parts of the country. This included several cloudy and wet spells especially over the Free State, North West and KwaZulu-Natal. As sometimes happens during early autumn, most of the country did indeed receive rain, including both the winter and summer rainfall regions. The rain over the winter rainfall region was mostly concentrated towards the beginning of the month, with drier conditions during late March into April.

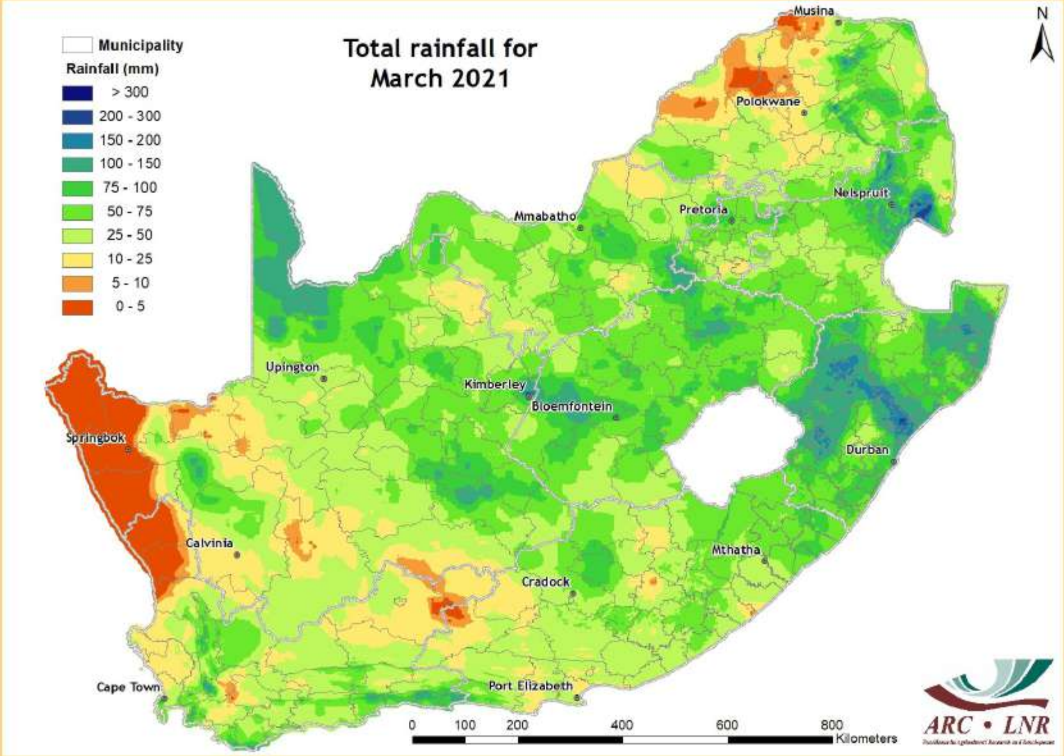


Figure 1

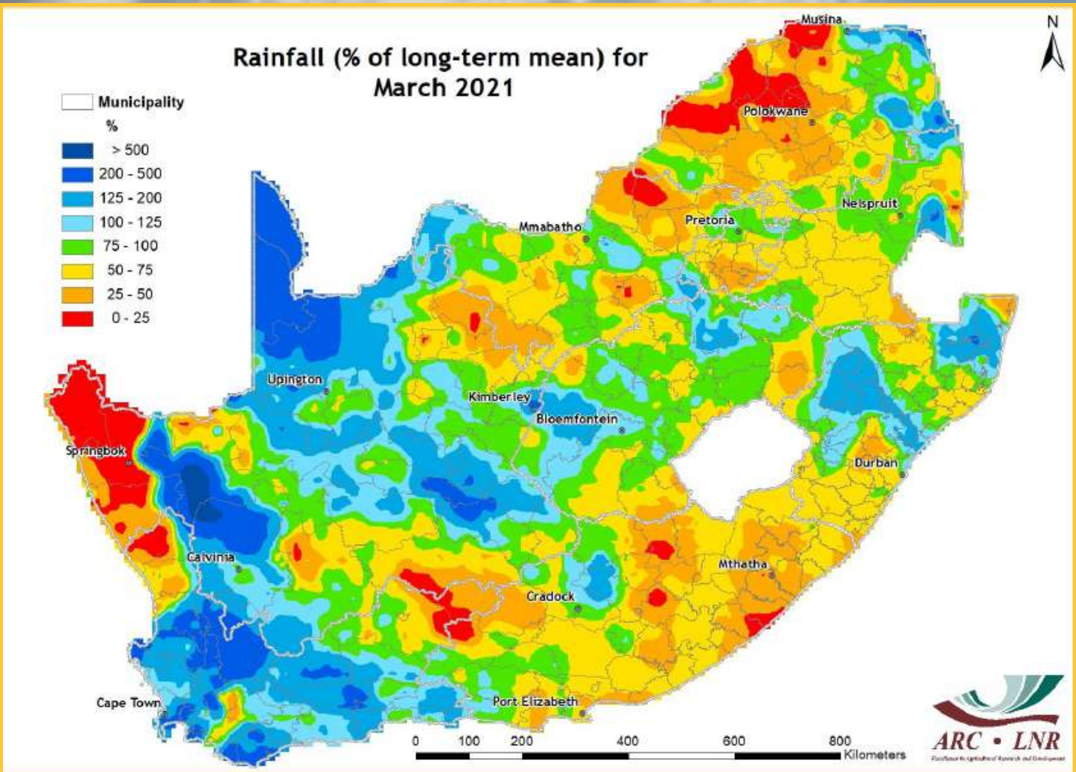


Figure 2

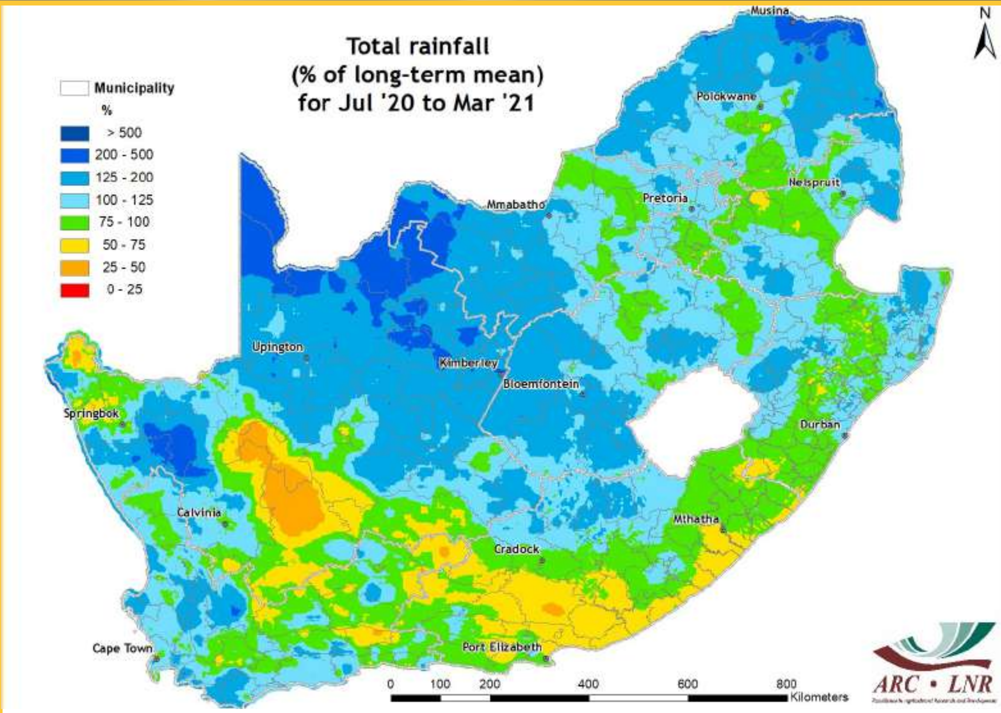


Figure 3

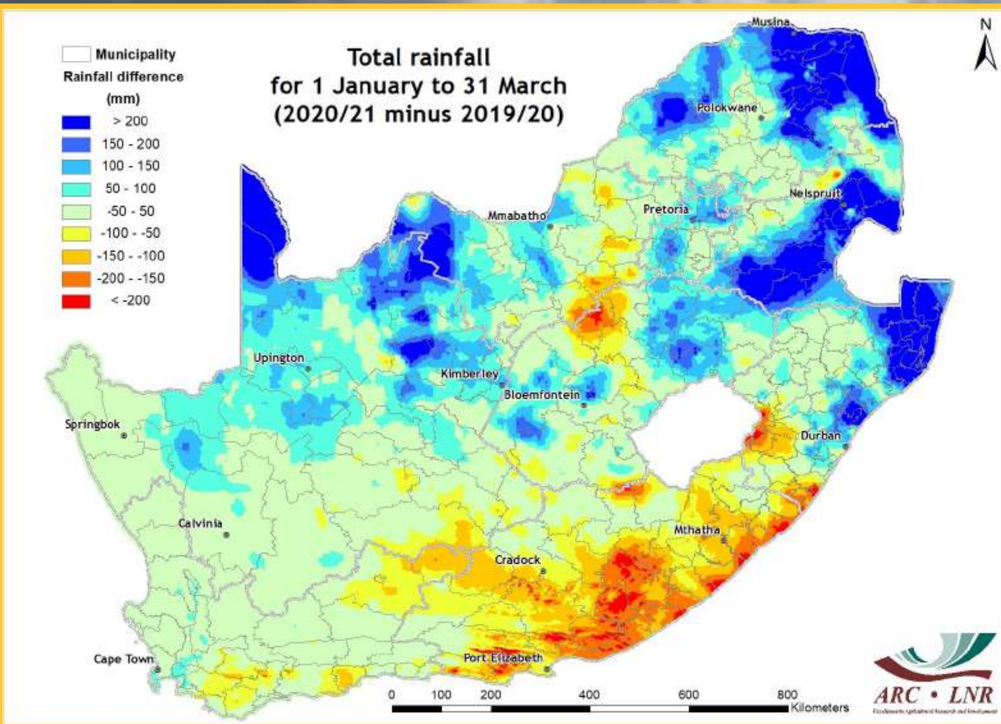


Figure 4

Figure 1:
Rainfall was confined to the north-western, interior and eastern parts of the country during March. The highest totals were observed in isolated areas of Mpumalanga and KwaZulu-Natal. The Eastern Cape's rainfall improved from a range of 5-75 mm in February to 10-100 mm for March. The driest areas were largely confined to the far western parts of the winter rainfall region.

Figure 2:
Normal to above-normal rainfall was observed over parts of the Northern Cape, Western Cape and some isolated areas in KZN in March. The northern parts of the country as well as larger parts of the Eastern Cape and the far western part of the Northern Cape received the lowest rainfall.

Figure 3:
Since July 2020, greater parts of the country received near- to above-normal rainfall with the exception of the Eastern Cape and some isolated areas in Northern and Western Cape which recorded below-normal rainfall.

Figure 4:
Compared to the same period in 2019/20, total rainfall from January to March 2021 showed above-normal values (indicated by the blue colours) over parts of Limpopo, Mpumalanga, KZN, Free State, Northern Cape and North West. Meanwhile, larger parts of the Eastern Cape, northern regions of the Highveld, the south coast of KZN as well as southwestern parts of the Western Cape received less rain (indicated by the yellow to red colours), 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. For March 2021, the shorter-term (3-6 month) SPI still reflects a very wet summer over the central parts as well as over the Limpopo River Basin in the northeast. There are no extensive areas of intense drought at this time scale according to the index. At longer time scales, the drought situation over the south-western interior and into the Eastern Cape is still prominent, progressively indicated more strongly (larger areas of severe to extreme drought conditions) as the length of the SPI period increases from 12 to 36 months. However, wetter conditions during especially the 2020 winter resulted in a much diminished drought signal – or in some cases neutral conditions – over the winter rainfall region in the south-west.

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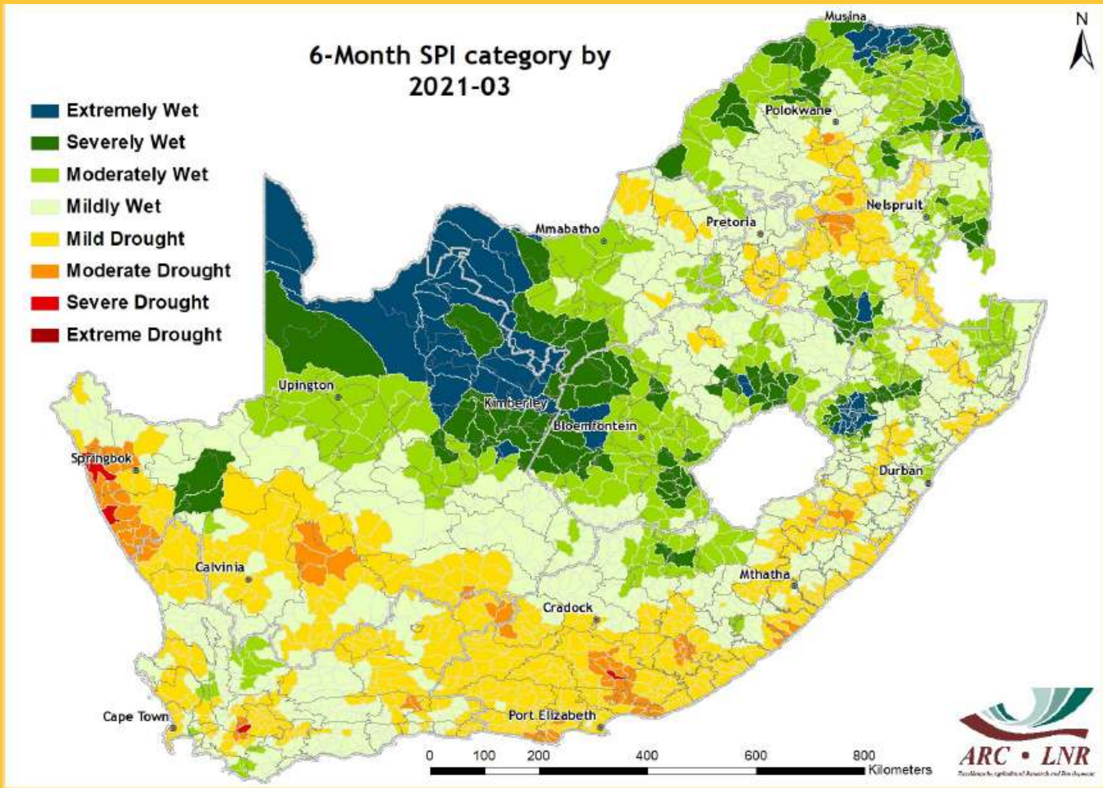

Figure 5

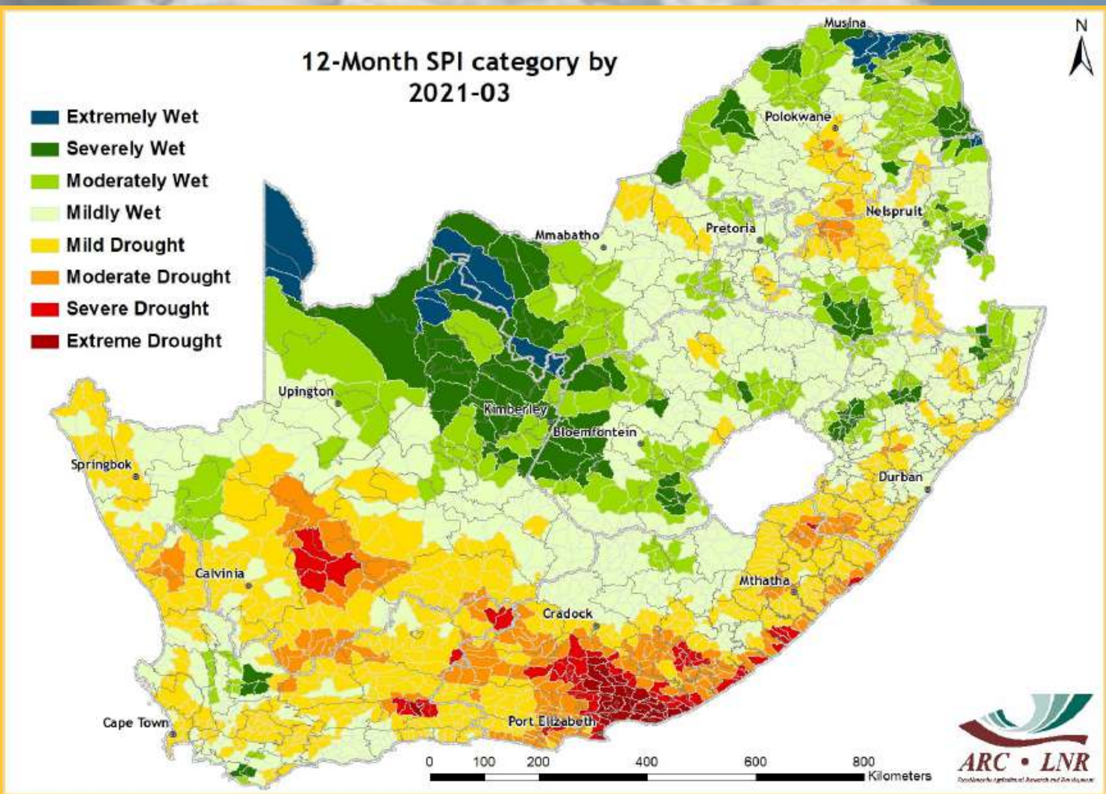

Figure 6

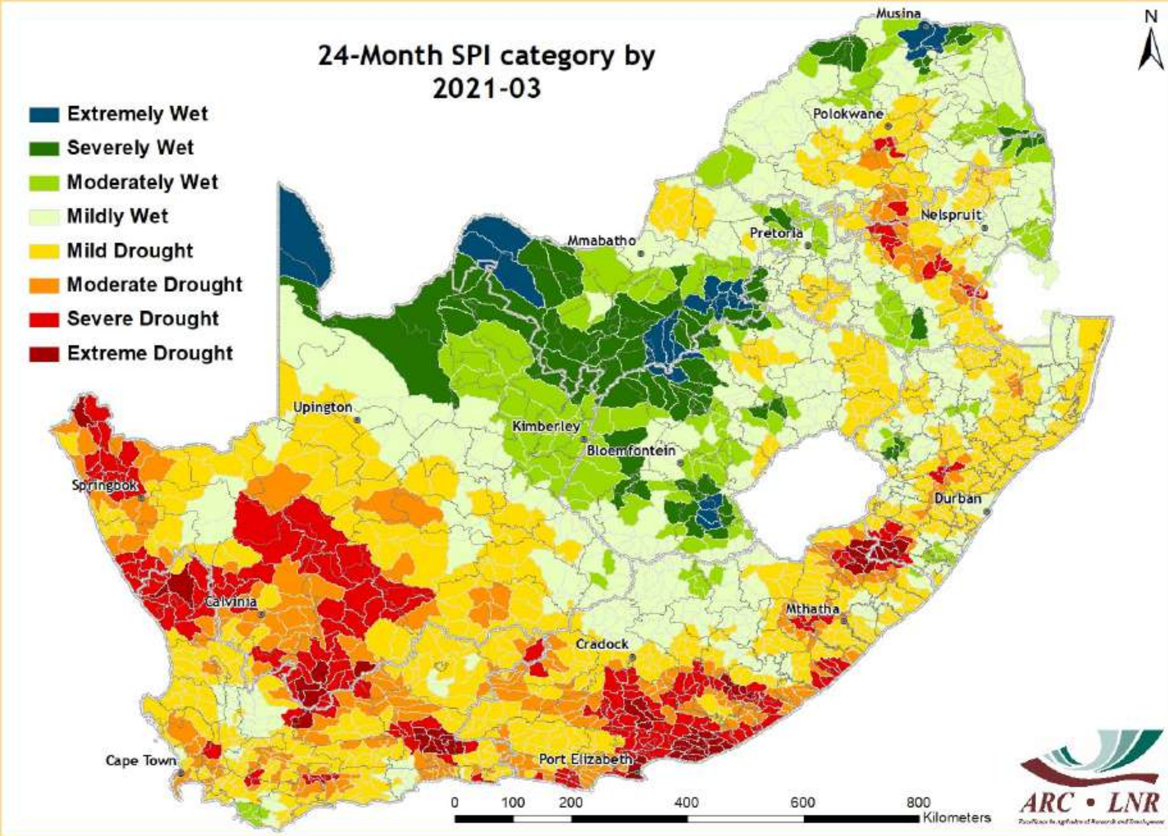

Figure 7

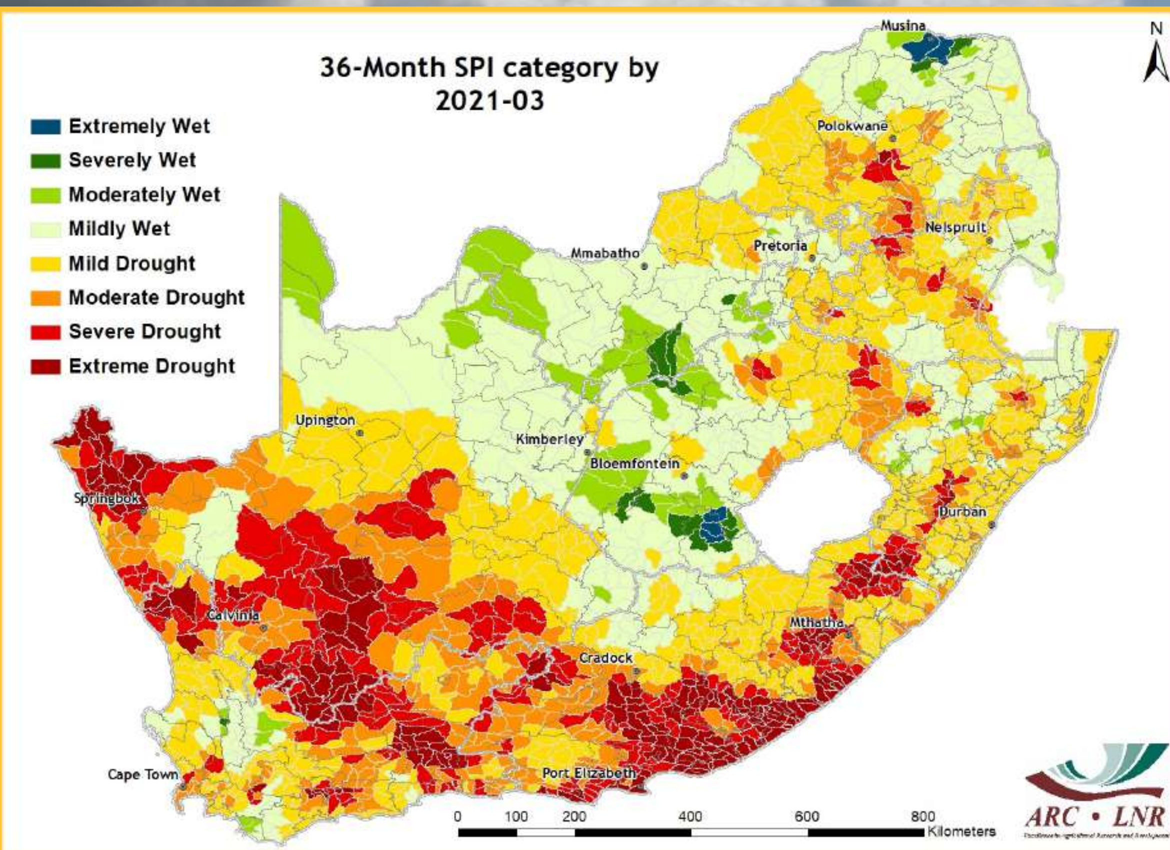

Figure 8

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.

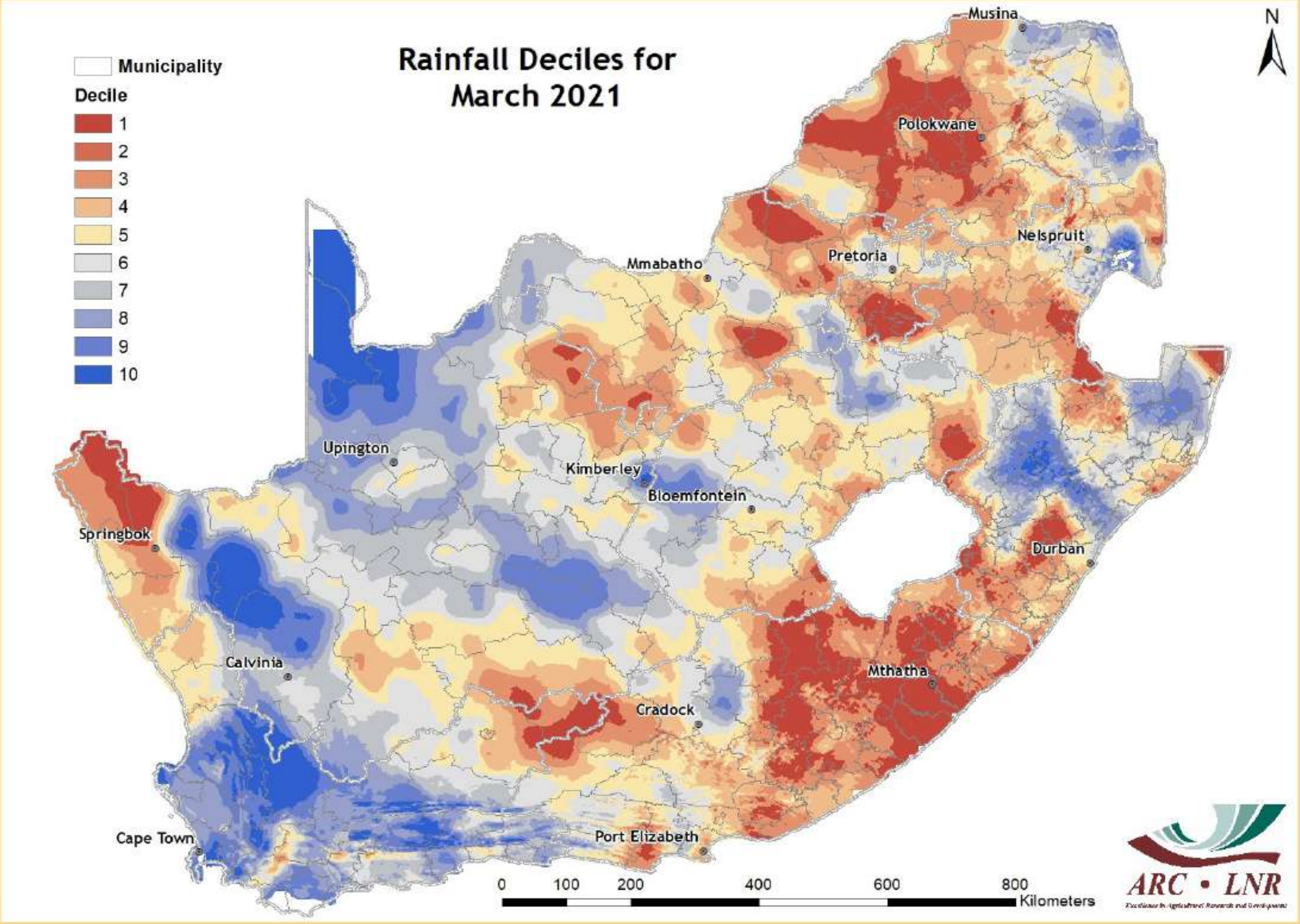

Figure 9

Figure 9:
The western half of the country experienced rainfall totals that compare well with historically wetter March months. Areas that recorded rainfall totals comparable with drier March months include the summer rainfall region, parts the Highveld, extending towards KwaZulu-Natal, and the Eastern Cape.

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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.

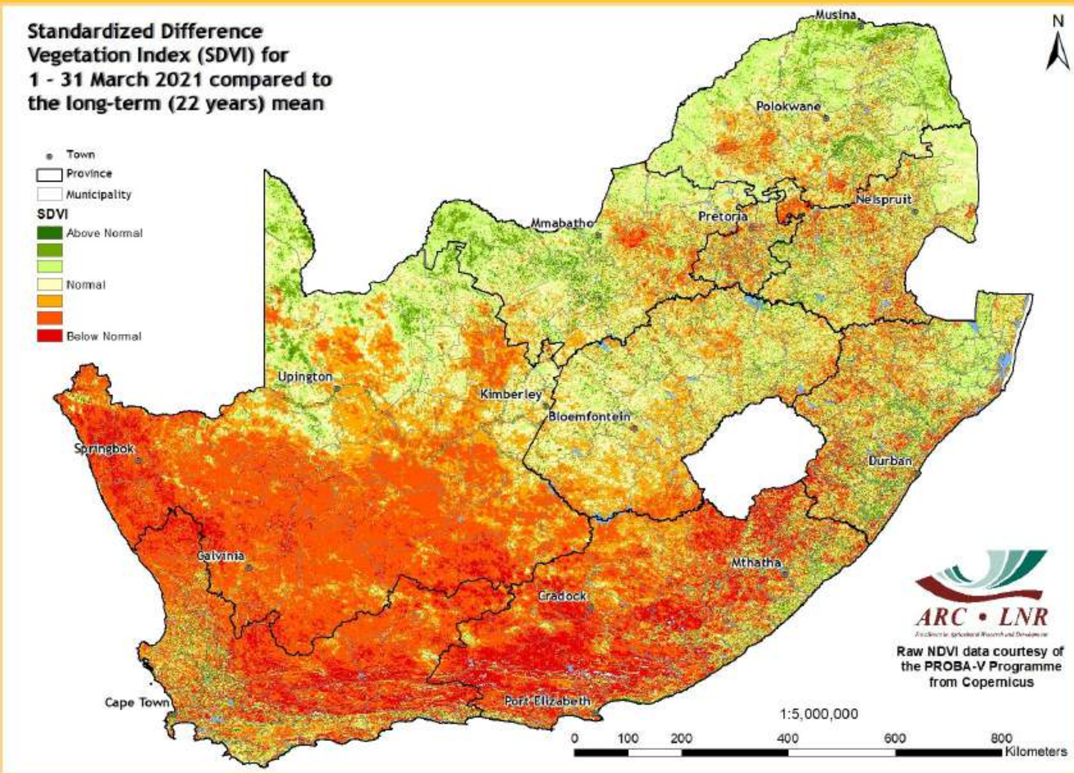

Figure 10

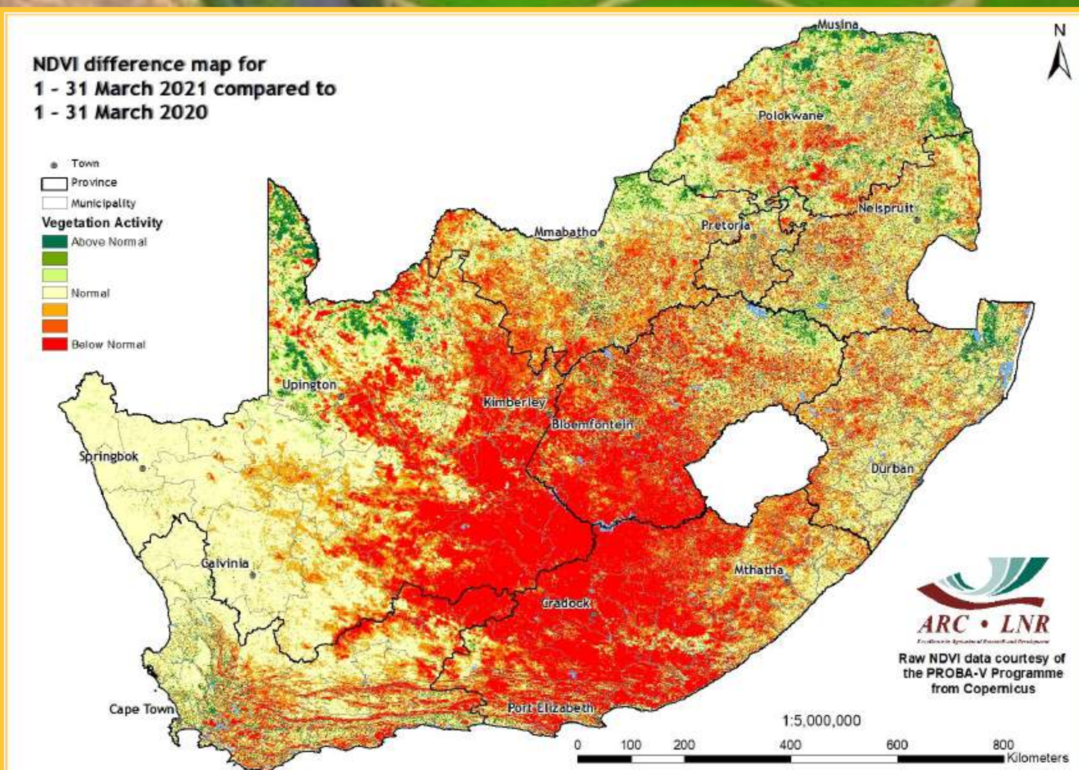

Figure 11

Figure 10:
Compared to the historical averaged vegetation conditions, the SDVI map for March 2021 shows that drought conditions remain dominant in the Cape provinces, with some pockets of dryness scattered in the northern parts of the country.

Figure 11:
The NDVI difference map for March 2021 compared to the same month last year shows that the interior of the country experienced below-normal vegetation activity while the far western parts experienced normal vegetation activity.

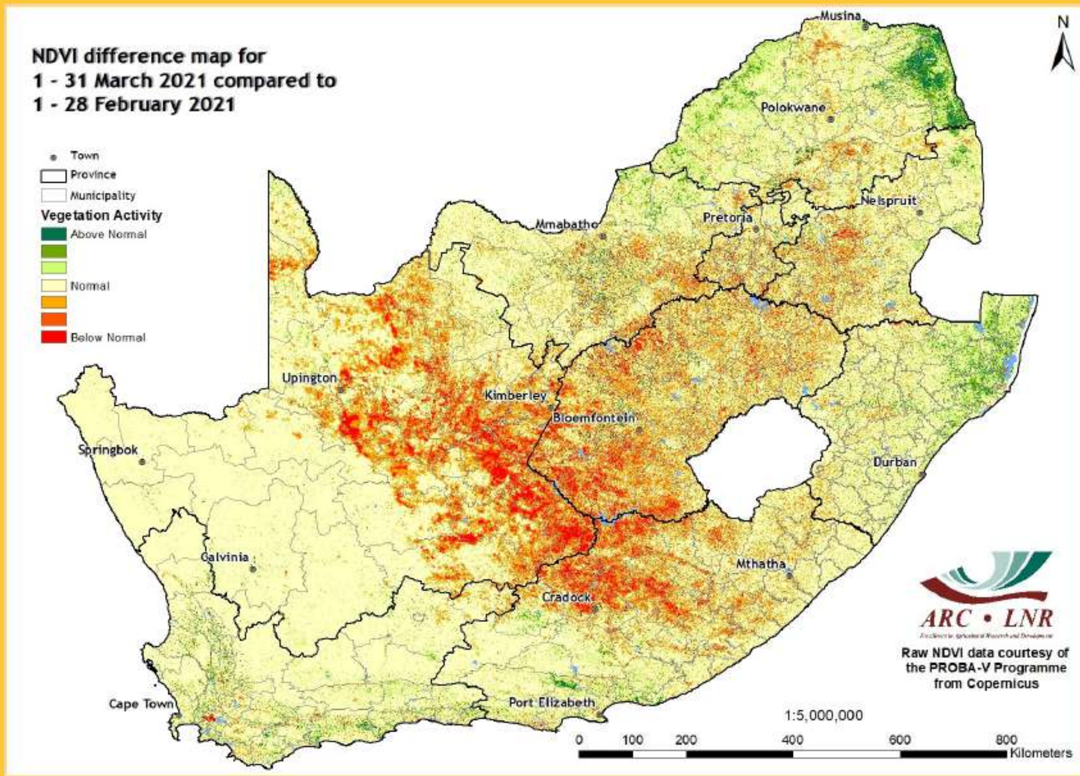

Figure 12

Vegetation Mapping
(continued from p. 7)

(continued from p. 7)

Interpretation of map legend

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

Cumulative NDVI maps:

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

Winter: January to December
Summer: July to June

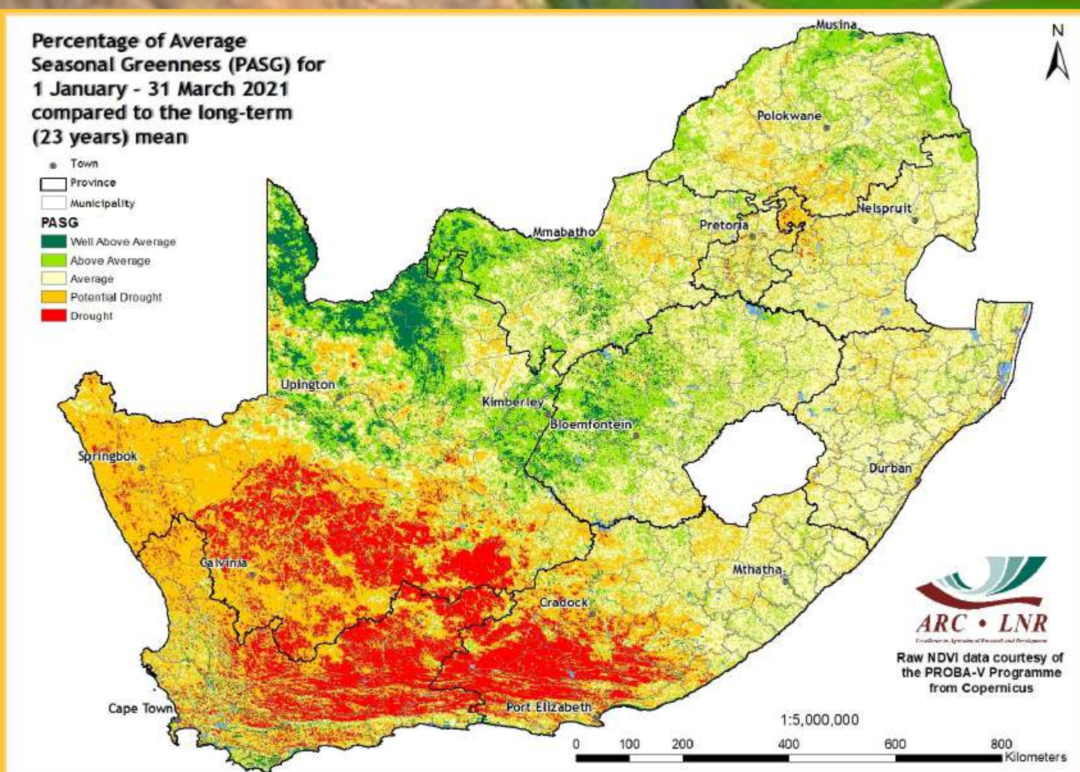

Figure 13

Figure 12:
Compared to the previous month, the NDVI difference map for March 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.

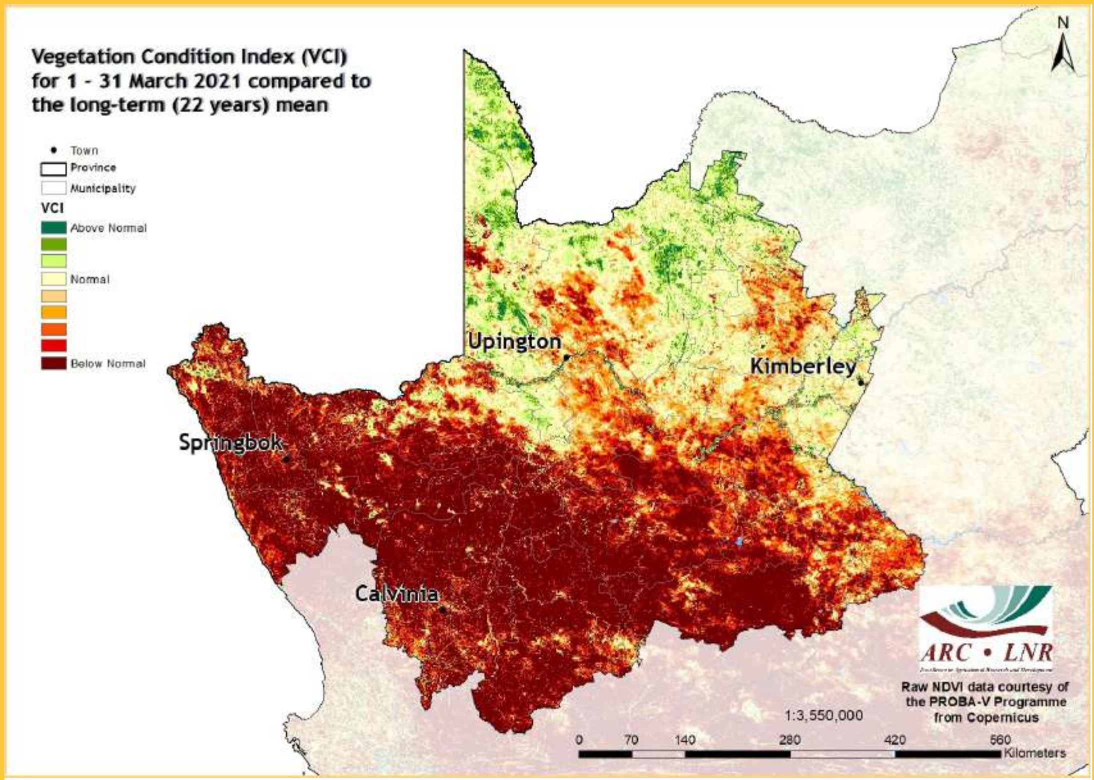

Figure 14

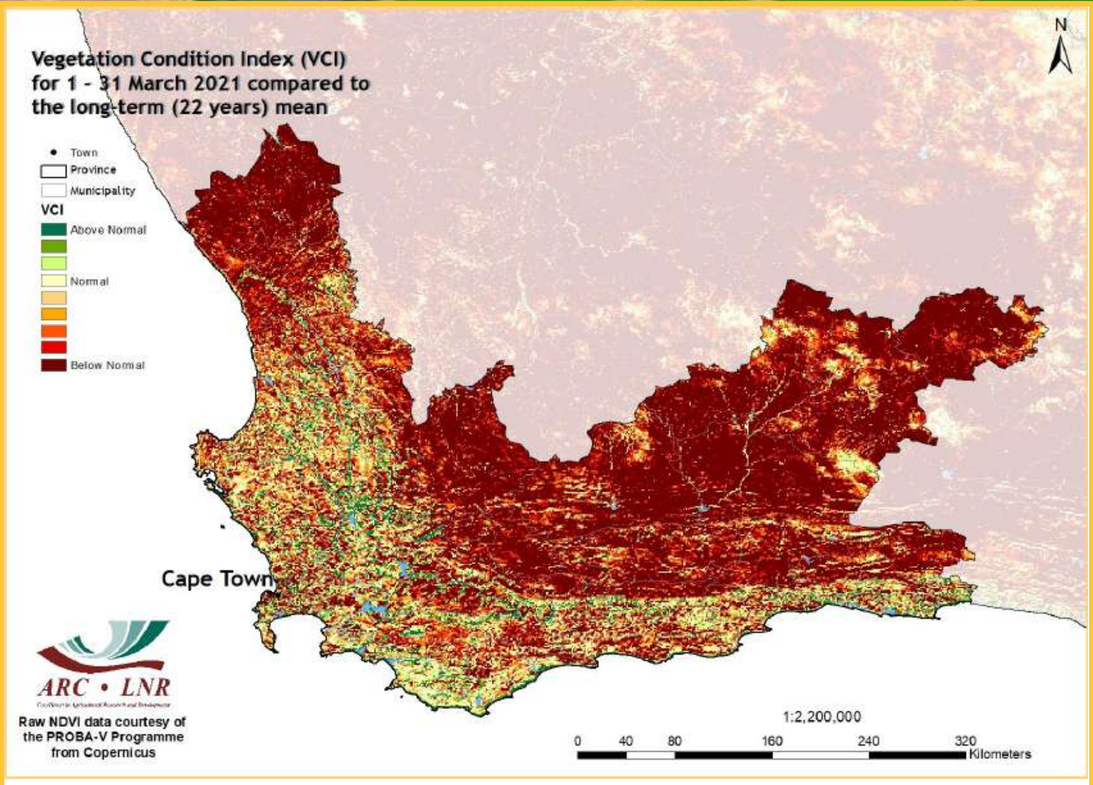

Figure 15

Figure 14:
The VCI map for March 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:
The VCI map for March 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.

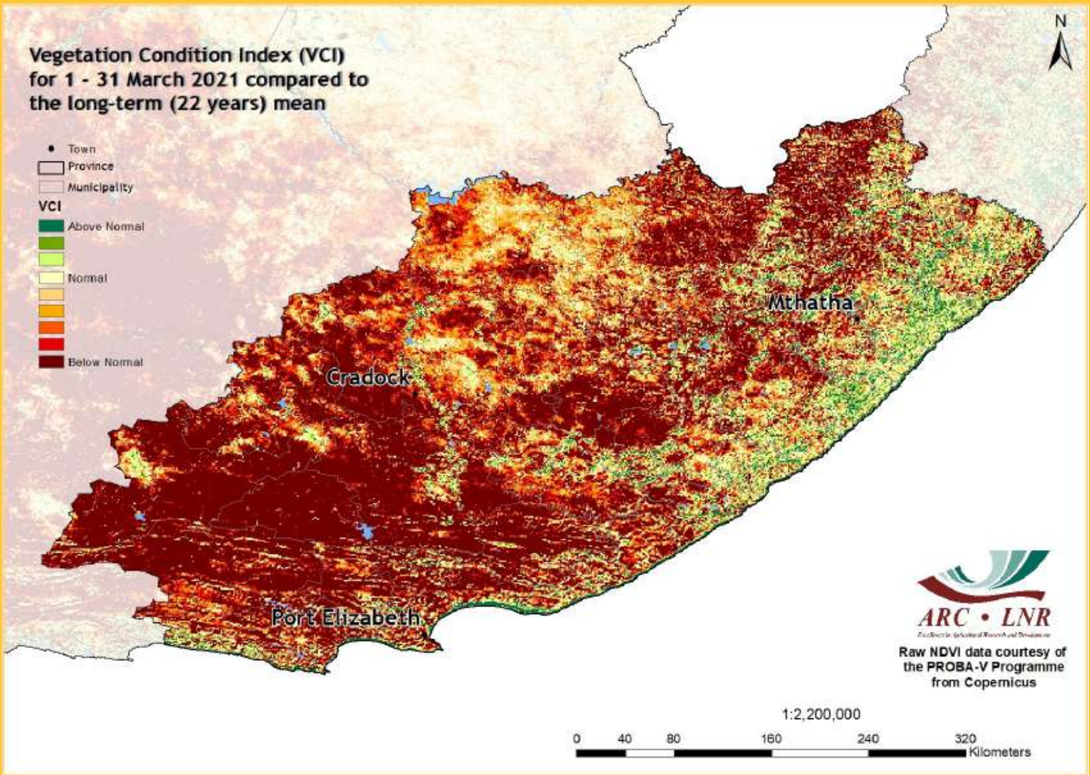

Figure 16

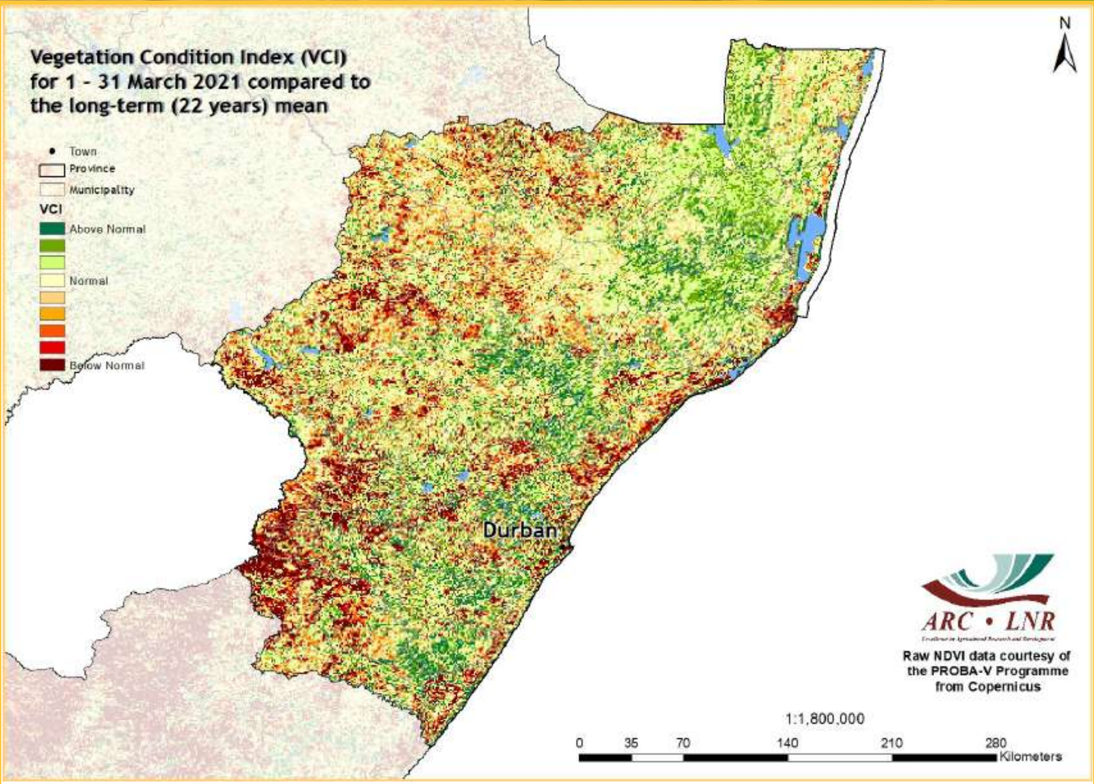

Figure 17

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

Figure 17:
The VCI map for March indicates that there are pockets of poor vegetation activity in most parts of KwaZulu-Natal.

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6. Vegetation Conditions & Rainfall

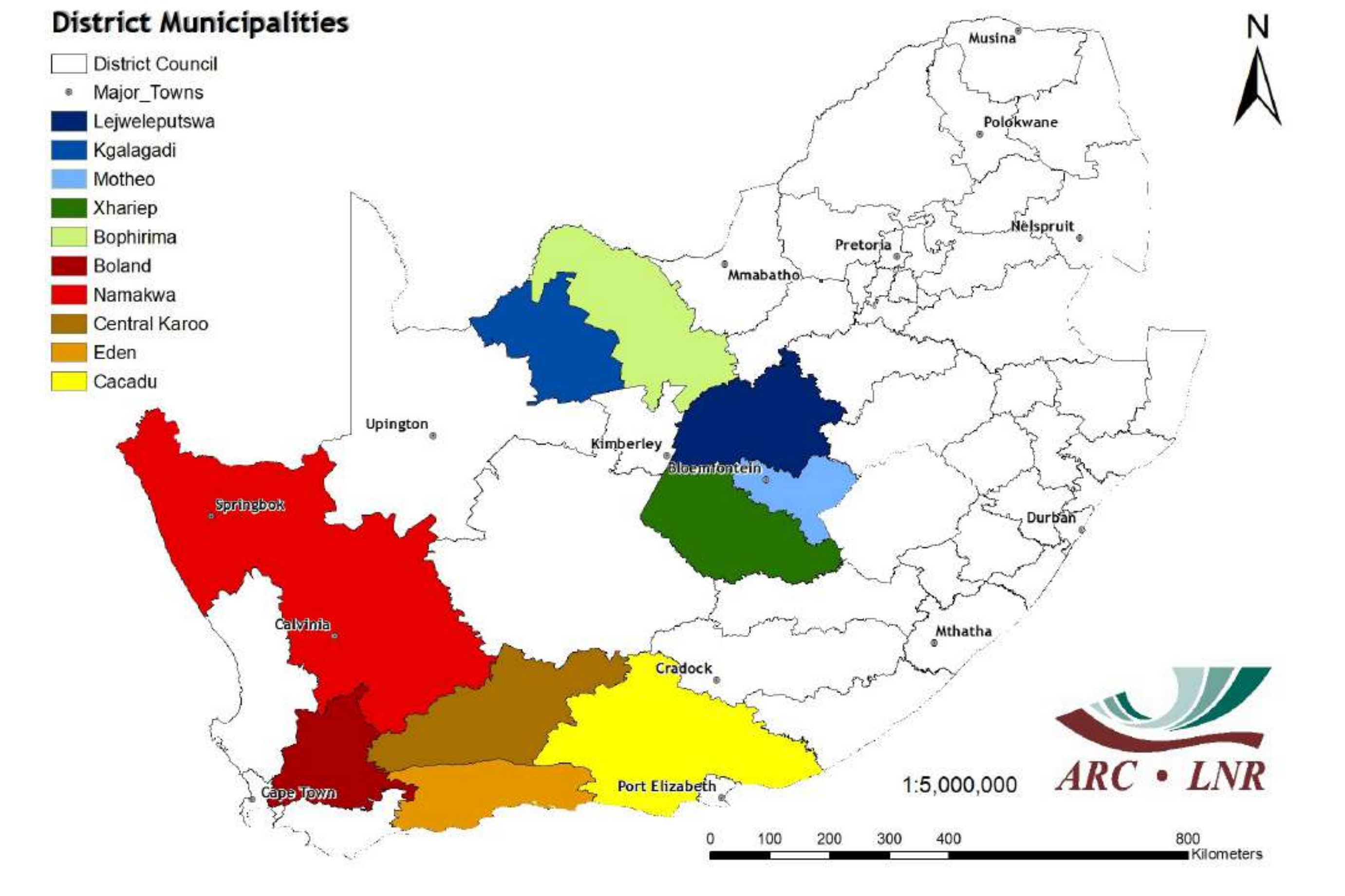

Figure 18

Rainfall and NDVI Graphs

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

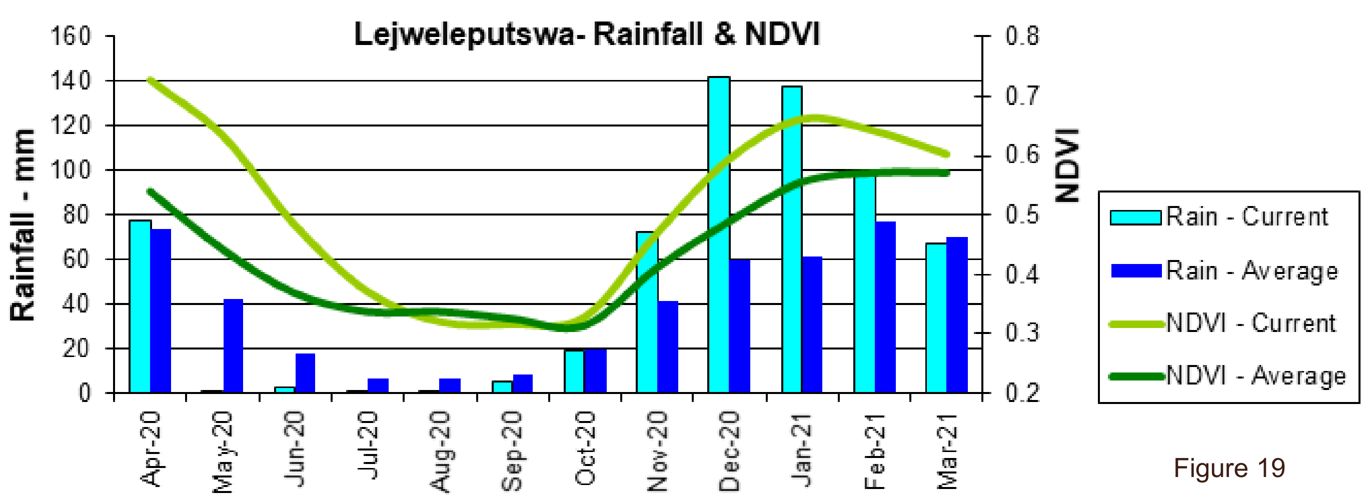
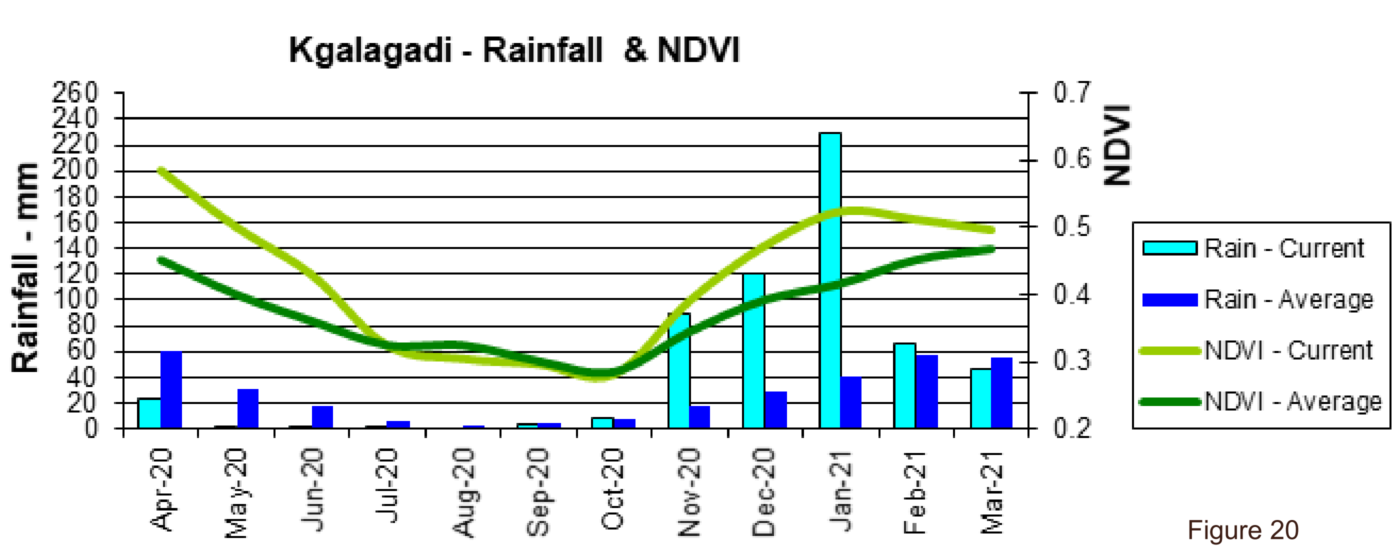


Figure 19



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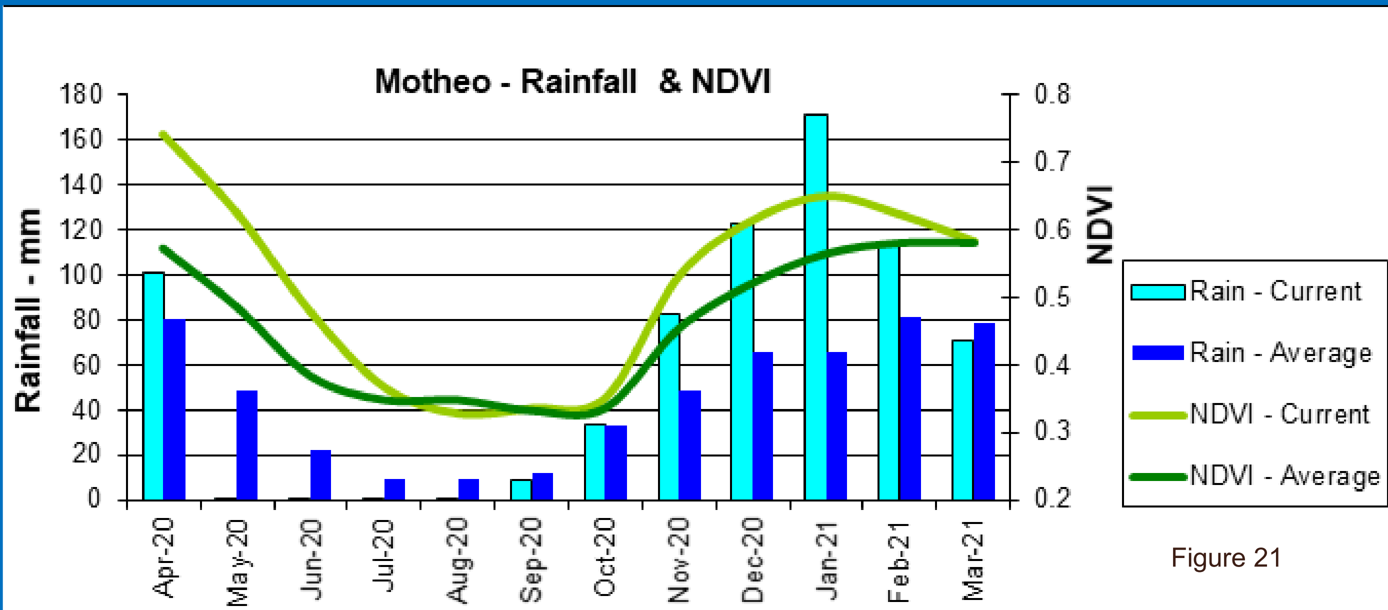


Figure 21

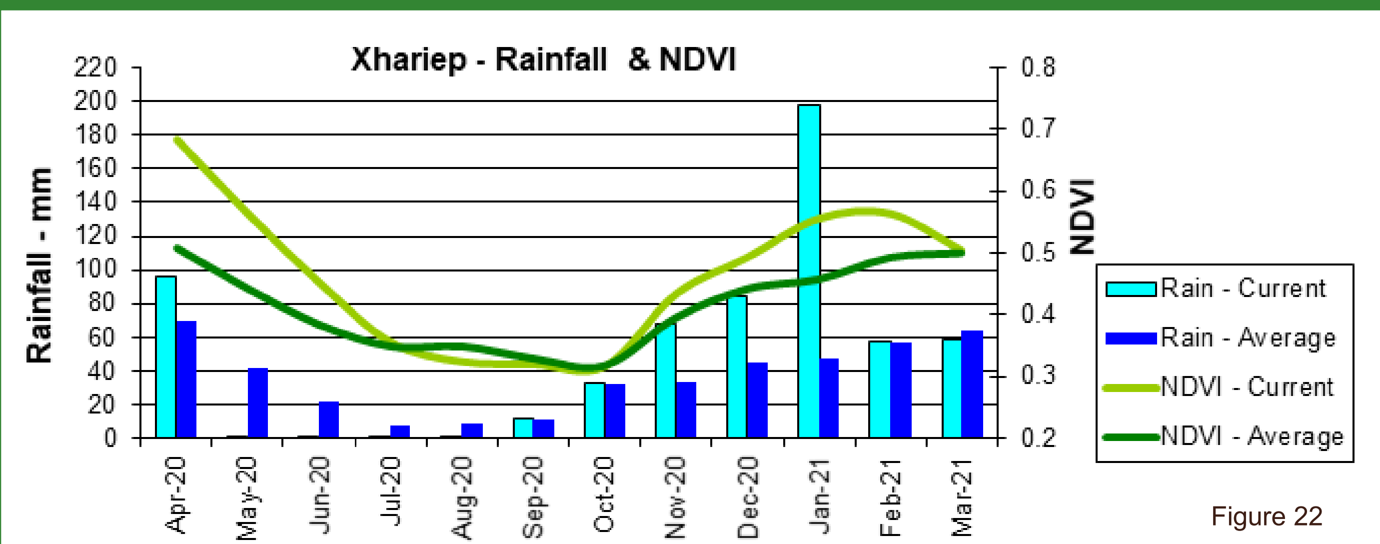
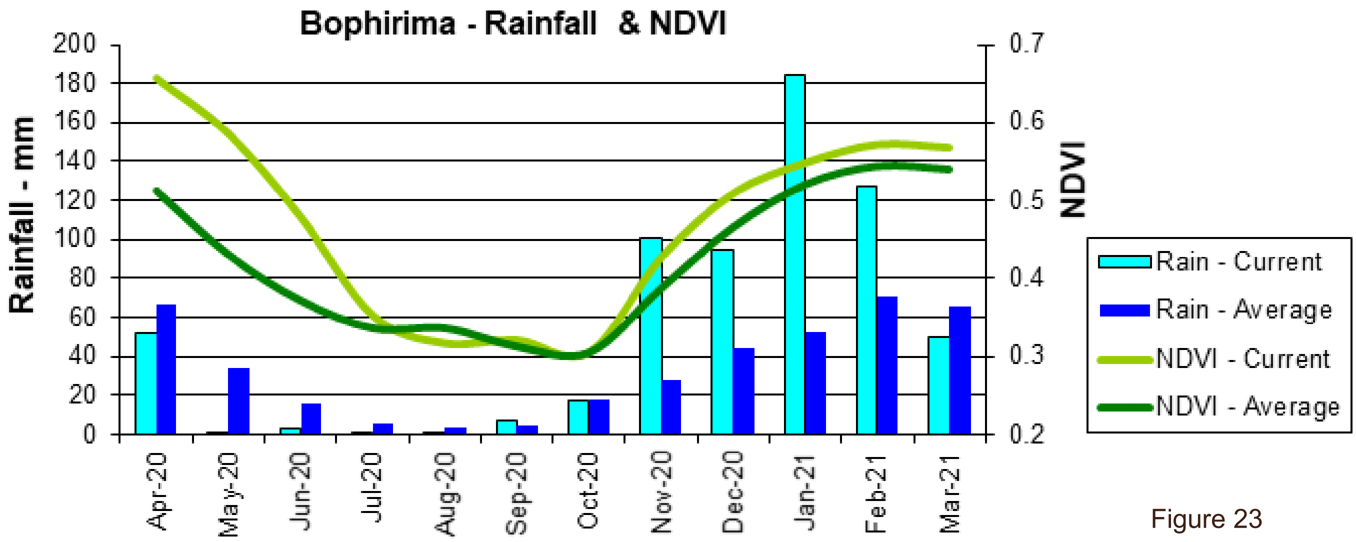


Figure 22



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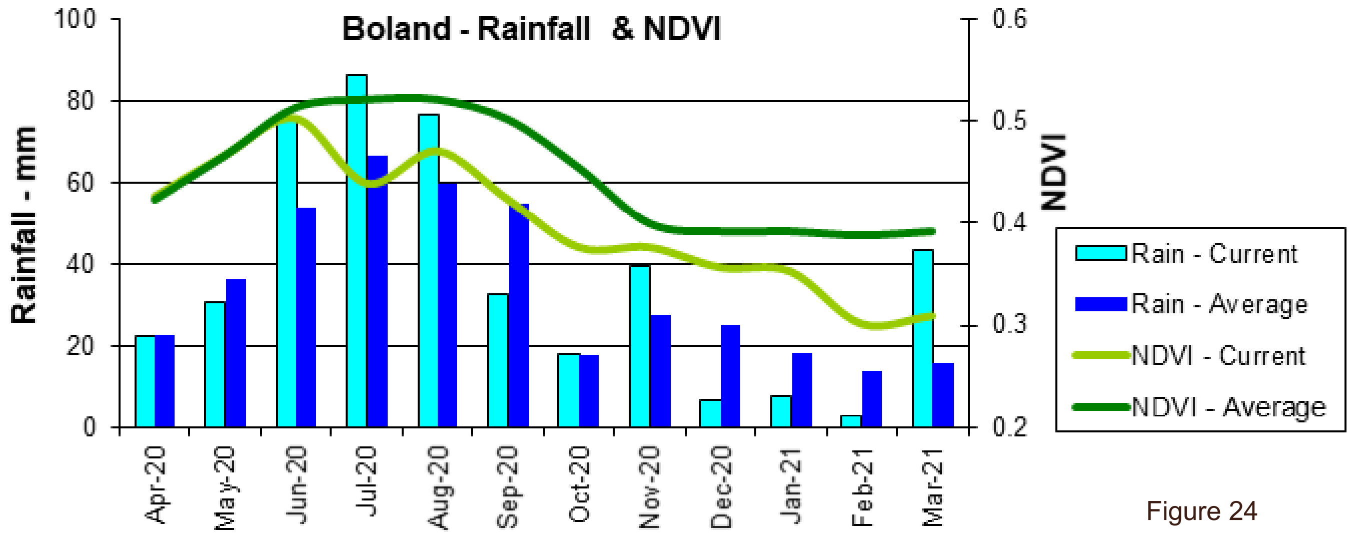

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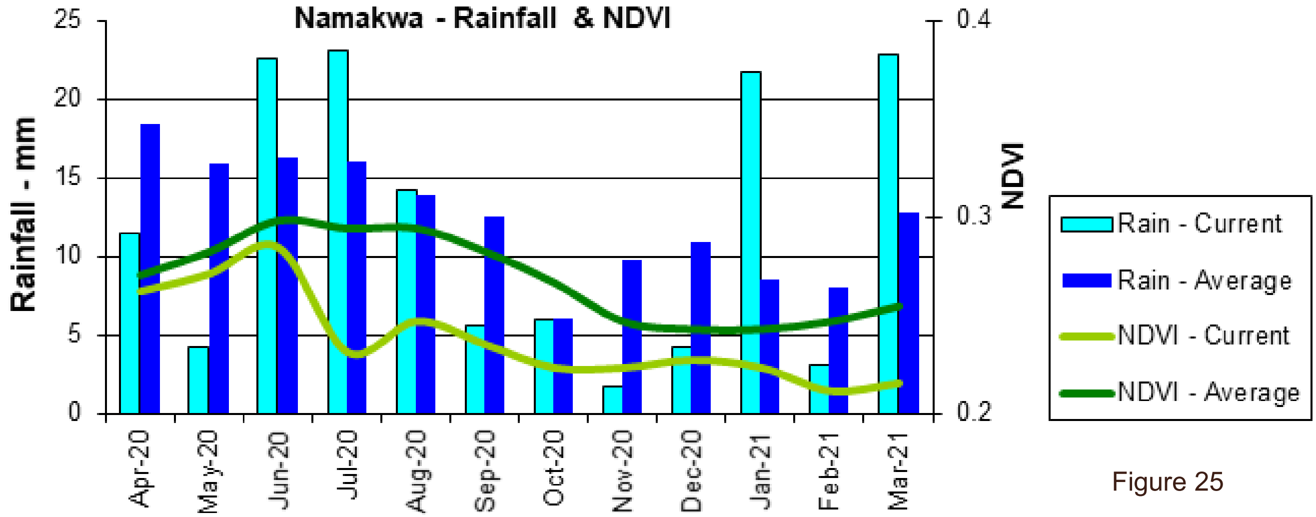

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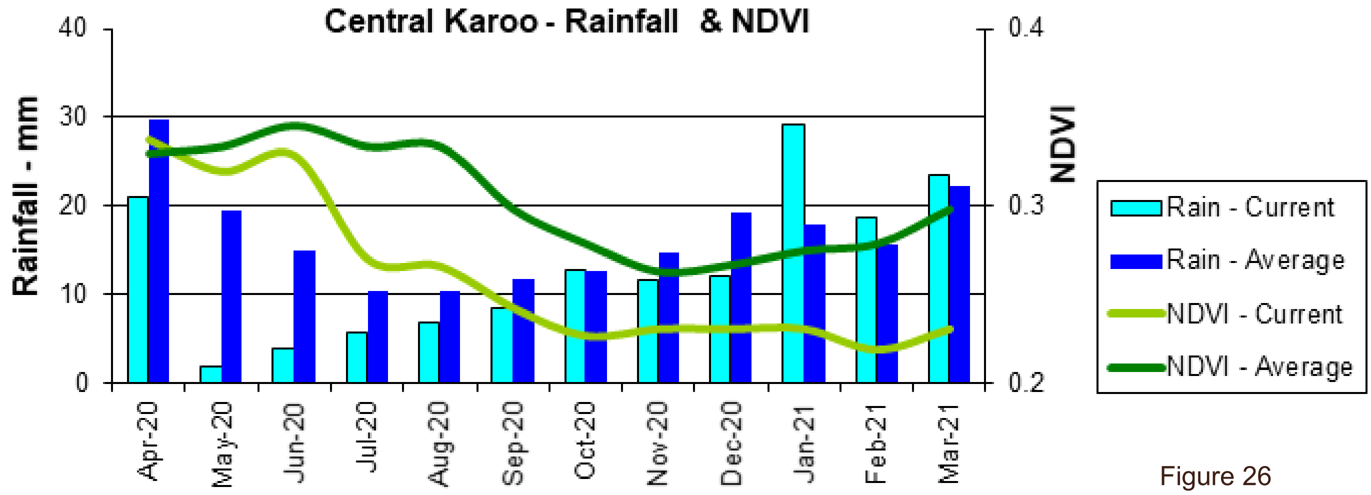

Figure 26

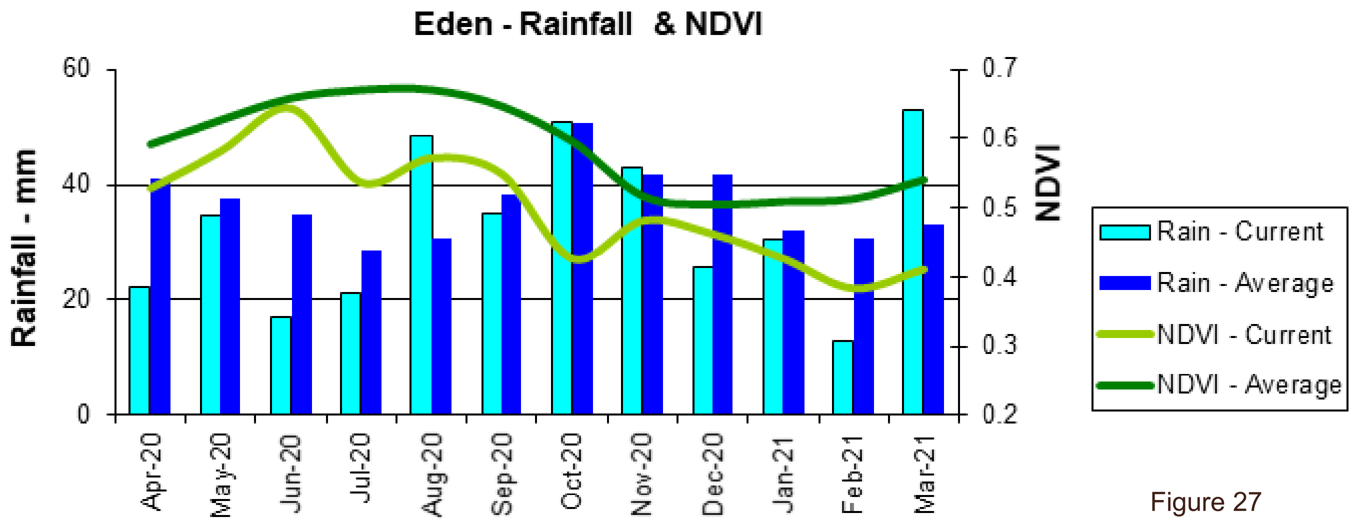

Figure 27

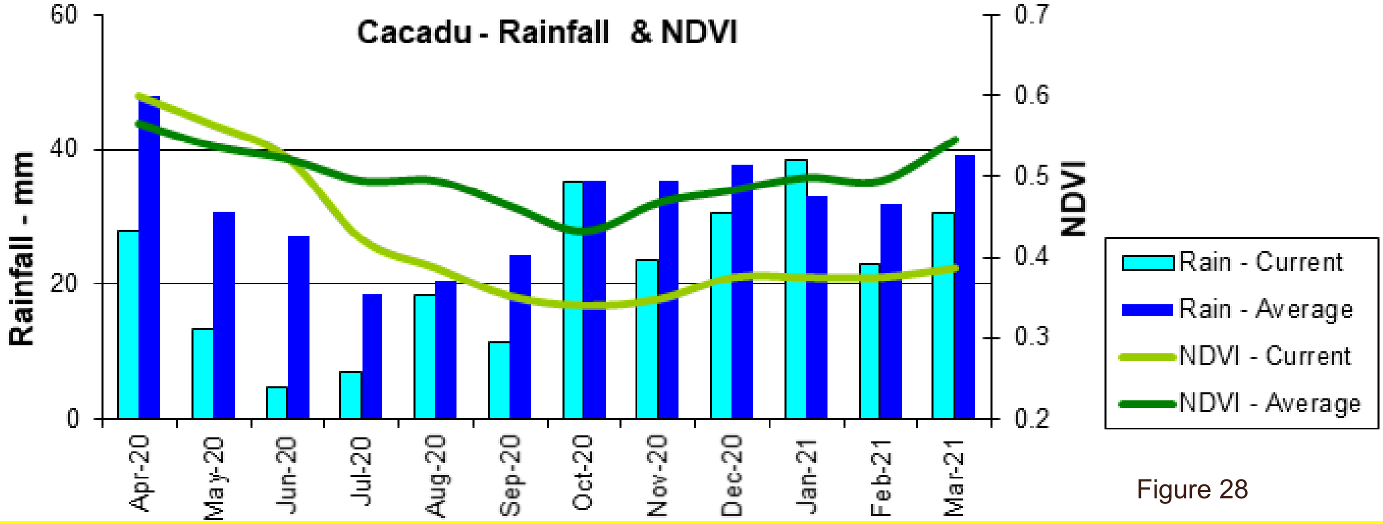

Figure 28

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

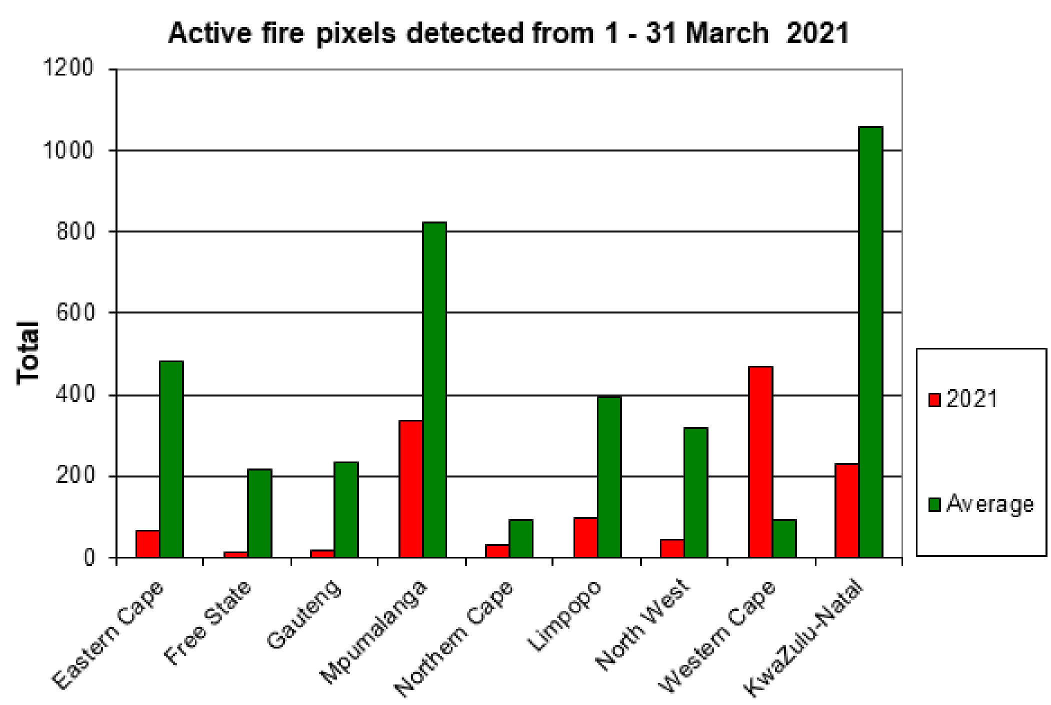

Figure 29

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

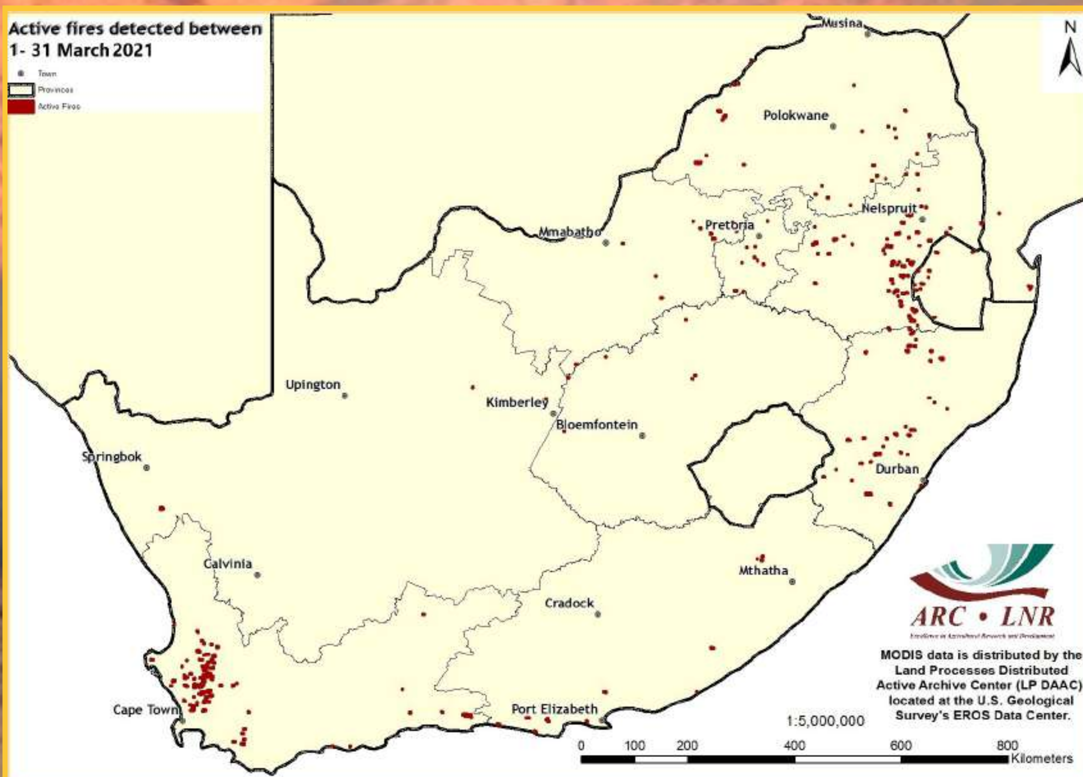

Figure 30

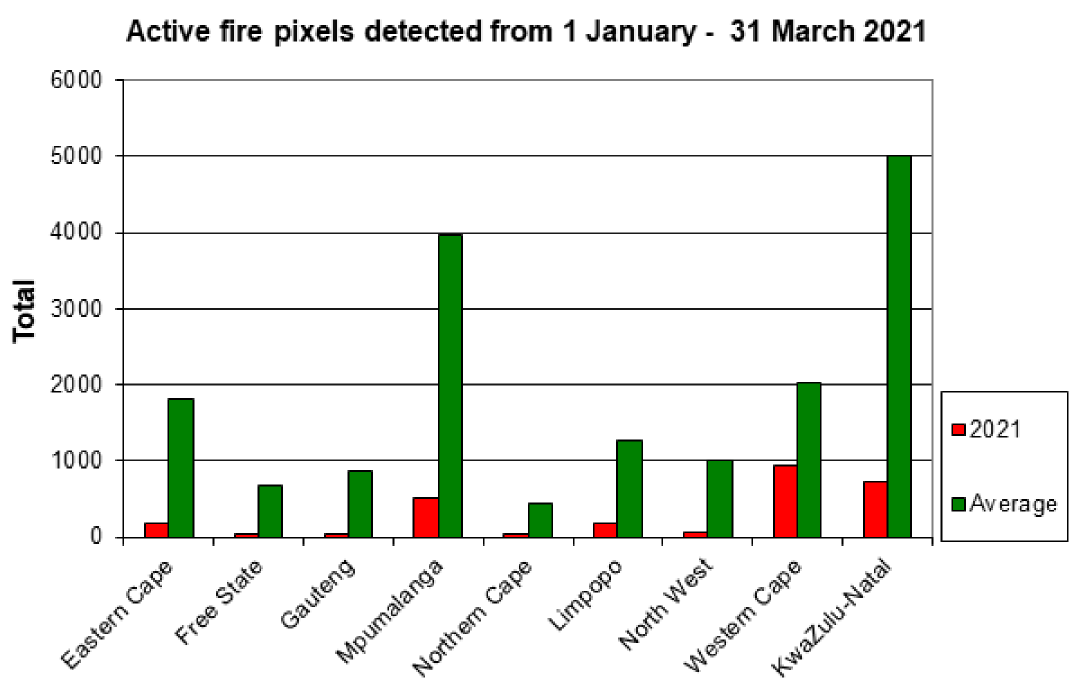

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January and 31 March 2021 per province. Cumulative fire activity was lower in all provinces compared to the long-term average.

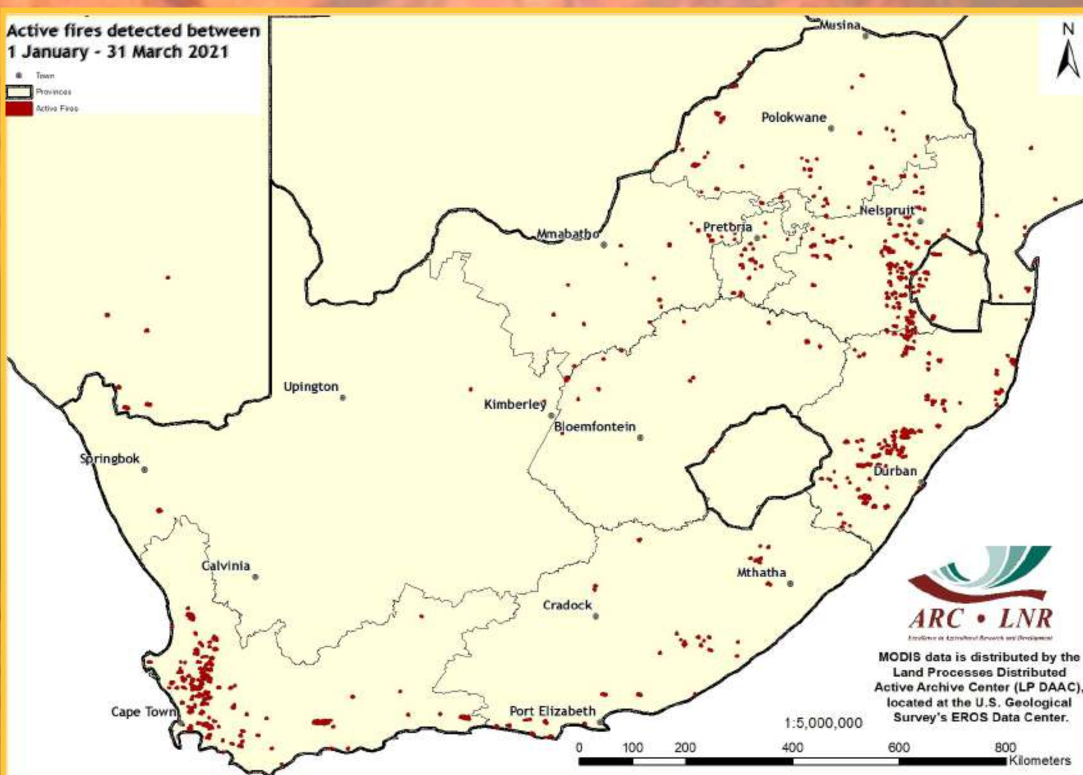

Figure 32

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

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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 March 2021 shows very similar water patterns to the previous month, with the majority of the summer rainfall region catchments showing water levels equivalent to 80-100% of the 5-year, long-term maximum water. Eastern and central areas of Limpopo and Mpumalanga show higher water levels in March compared to February. Catchments in the central Karoo, Western Cape and western coastal region of the Eastern Cape continue to show much more variable and typically lower current water levels compared to the long-term maximum values.

The comparison between March 2021 and March 2020 indicates a similar pattern to that recorded last month, but with a large number of catchments across the Northern Cape having significantly lower water levels in the March year-on-year comparison.

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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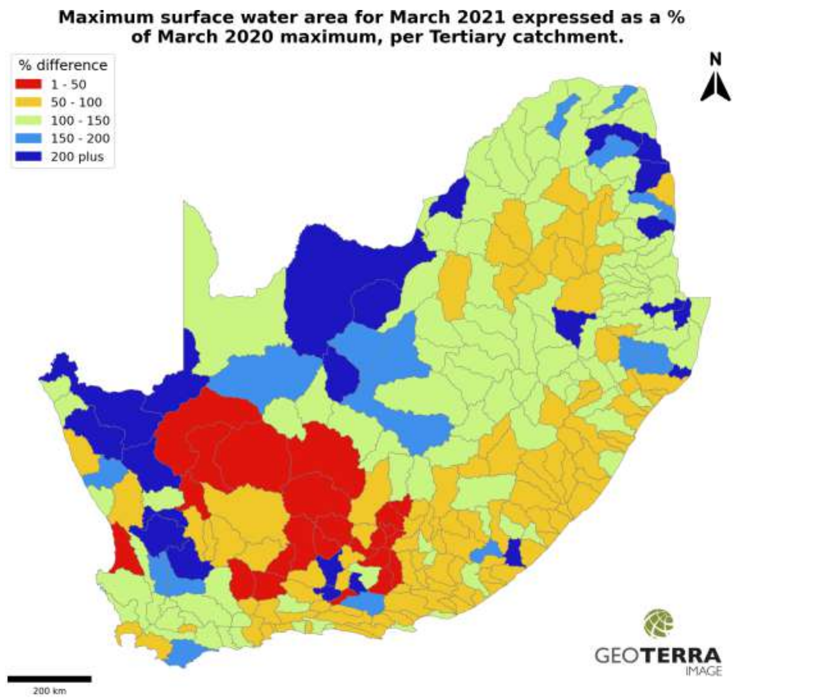


Figure 33

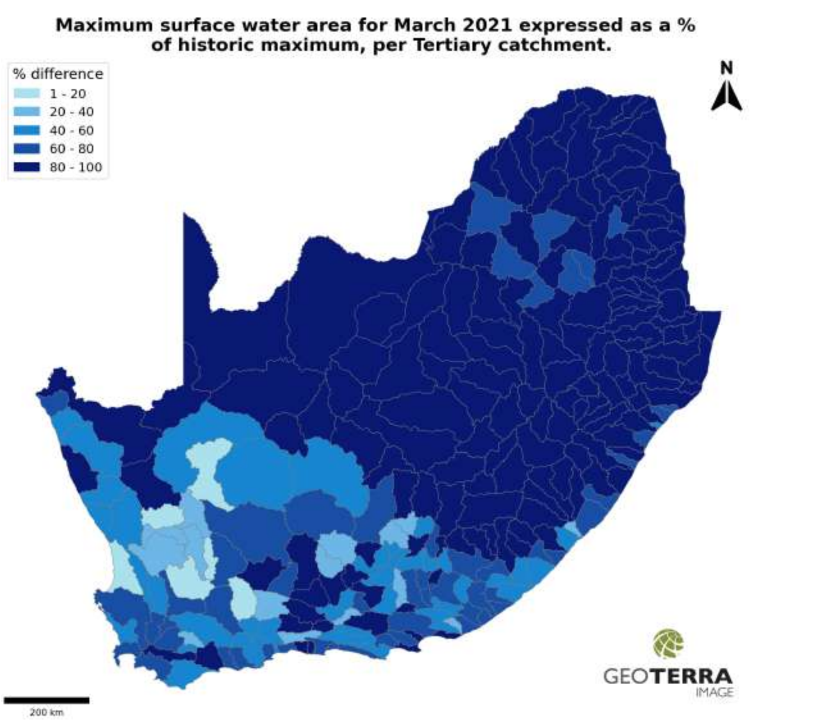
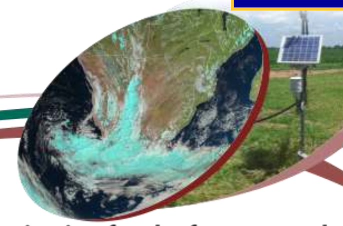


Figure 34

Agrometeorology



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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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".