ARC • LNR
Excellence in Research and Development

UMLINDI
The Watchman

ISSUE 2021-01 | 27 JANUARY 2021

INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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

South African Weather Service

AMESD

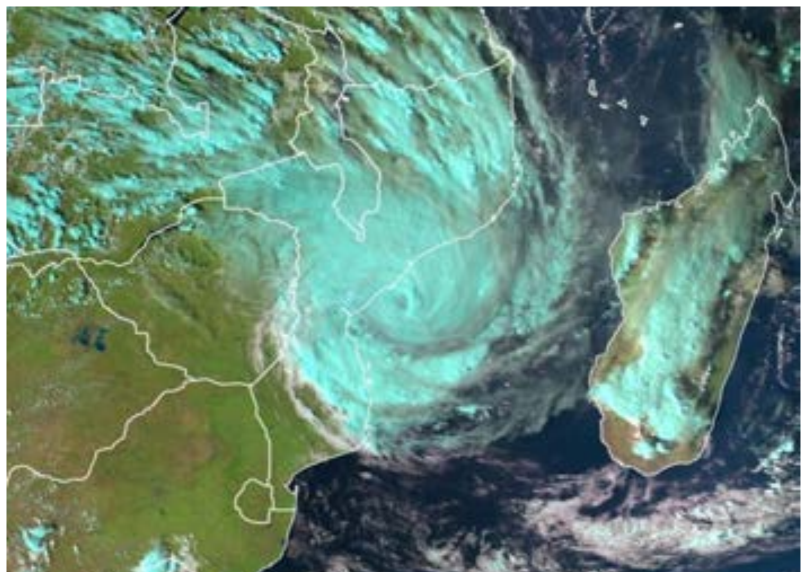
199th Edition

Images of the Month

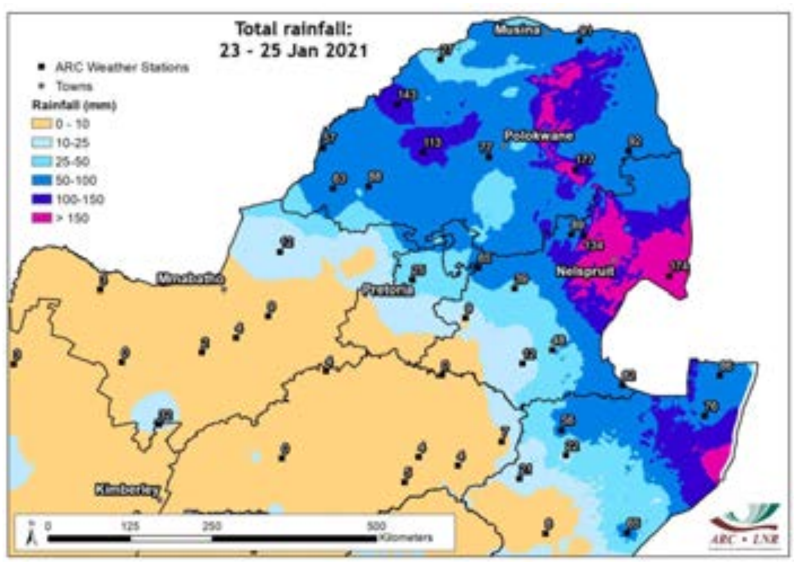
Tropical Cyclone Eloise brings widespread rain to the summer rainfall region

Tropical Cyclone Eloise made landfall near Beira on the Mozambican coast on 23 January 2021. The subsequent track inland, across the Limpopo Province southwestward towards southern Botswana is a rare occurrence. Tropical systems moving into the subcontinent can significantly boost seasonal rainfall totals over northeastern South Africa and sometimes, as seen in this case, result in widespread flooding over parts of Limpopo and Mpumalanga – especially the Lowveld. Due to the southwestward track inland of Eloise, rainfall associated with the system also made a meaningful contribution to the moisture budget over the interior. Rainfall totals exceeding 50 mm were recorded over large parts of the interior west of the escarpment within 3 days of the system making landfall.

While it was hot and dry over the interior during the days before the storm made landfall, conditions improved markedly for widespread rainfall over most of the summer rainfall region as the remnants of the system moved into southern Botswana and introduced large amounts of tropical moisture and atmospheric instability into the region.



MSG SEVIRI natural colour composite for 17:00 SAST on 22 January 2021, prior to landfall of Tropical Cyclone Eloise.



Total rainfall map for 23-25 January 2021. Rainfall over the northeastern parts of the country is associated with Tropical Cyclone Eloise. Based on rainfall recorded by the ARC Agro-Climate Network (a selection of the weather stations are shown).

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:

Significant amounts of rainfall were observed since the onset of the agricultural summer season in October 2020, with high totals recorded over greater parts of the country. However, considering the same period in 2019, areas that recorded less rain were the northern Highveld (eastern North West, Gauteng and central Mpumalanga) as well as the north coast of KwaZulu-Natal. The meteorological summer began in December 2020, with La Niña weather continuing to bring stormy conditions that resulted in above-normal rainfall over greater parts of the country. Much of the rain during this month was confined to the summer rainfall region, particularly over the Lowveld, Highveld, and midland areas of the Eastern Cape and KZN. Areas that recorded totals ≥200 mm for the month include Thohoyandou (254 mm) and Mukumbani (355 mm) in Limpopo, Lindley (217 mm), Senekal (210 mm) and Bethlehem (243 mm) in the eastern Free State, and Vryheid (200 mm) in northern KZN. Large positive deviations over the western (white) maize production areas (mostly in the Free State) were also noted, although this rainfall triggered localized flooding over certain regions.

Much needed rainfall that occurred over the drought-stricken Northern Cape during November continued during the first and last dekad of December, accumulating monthly totals >100 mm in Postmasburg, Boetsap, Vaalharts, Kathu and Kimberley. Conversely, the western parts of the province, which receives most of its rainfall between February and May, remained dry during this period. As climatologically expected, the winter rainfall region received almost no rain in December with only light falls (up to 50 mm) occurring over the Overberg district municipality in the Western Cape. The adjacent all-year rainfall region recorded somewhat similar conditions (below- to near-normal rainfall) as the previous month, with Port Alfred being the only area that received above-normal rainfall in December, offering a welcome short -term recovery from the drought.

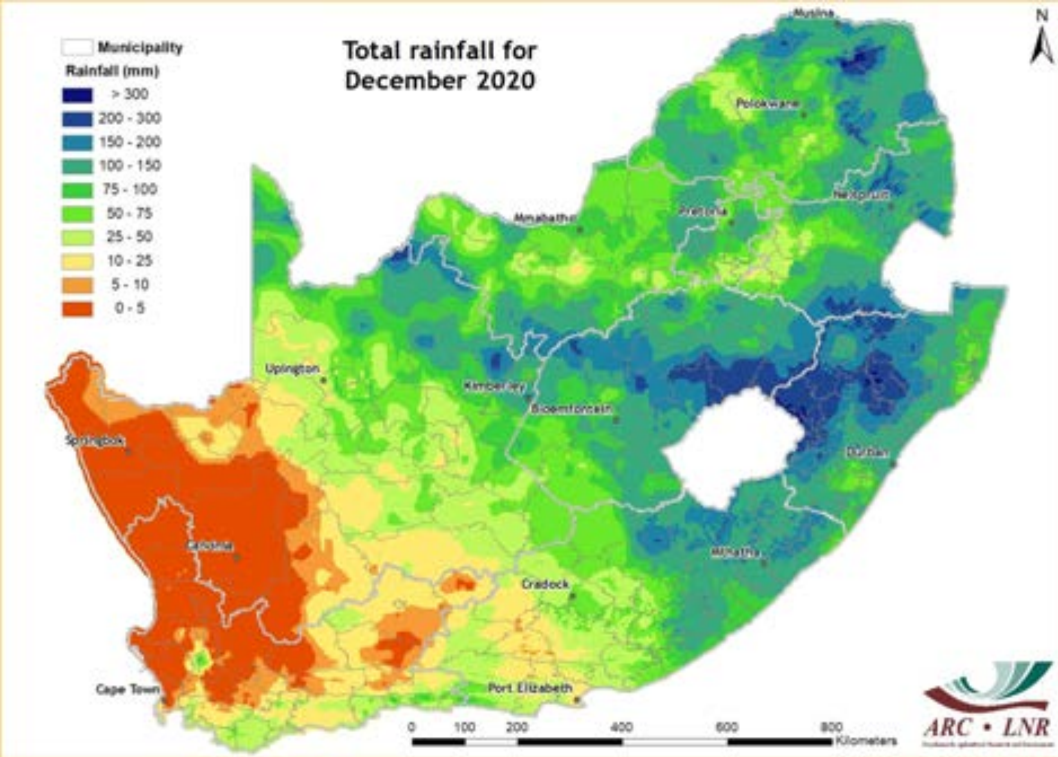


Figure 1

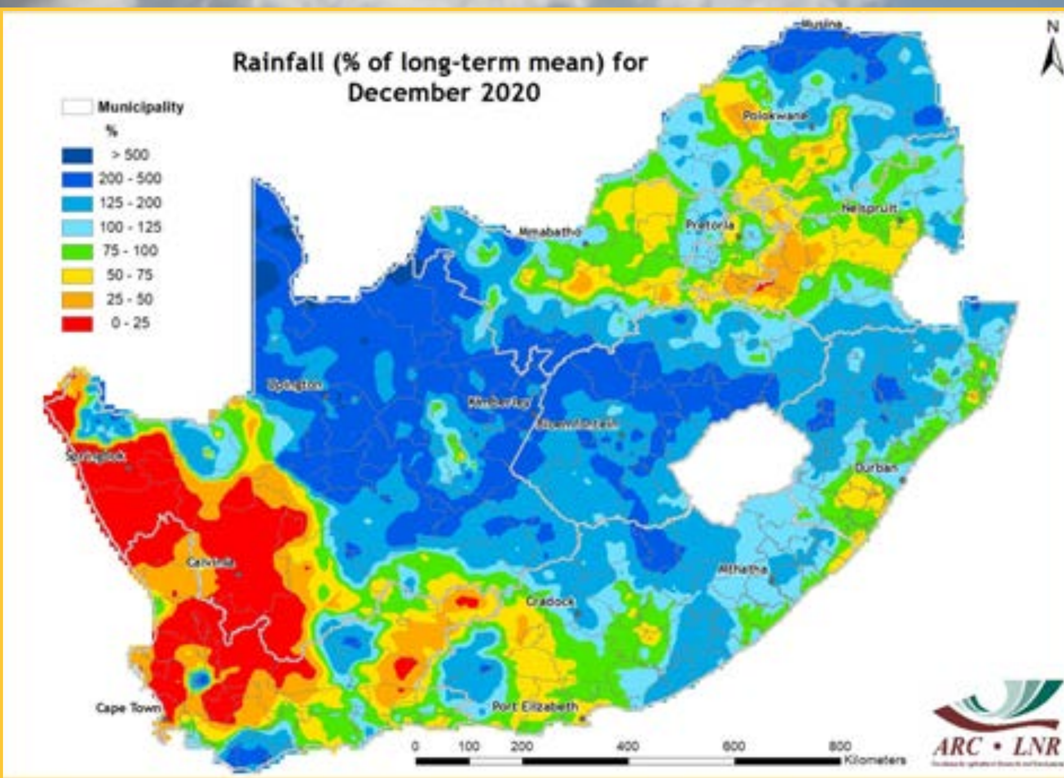


Figure 2

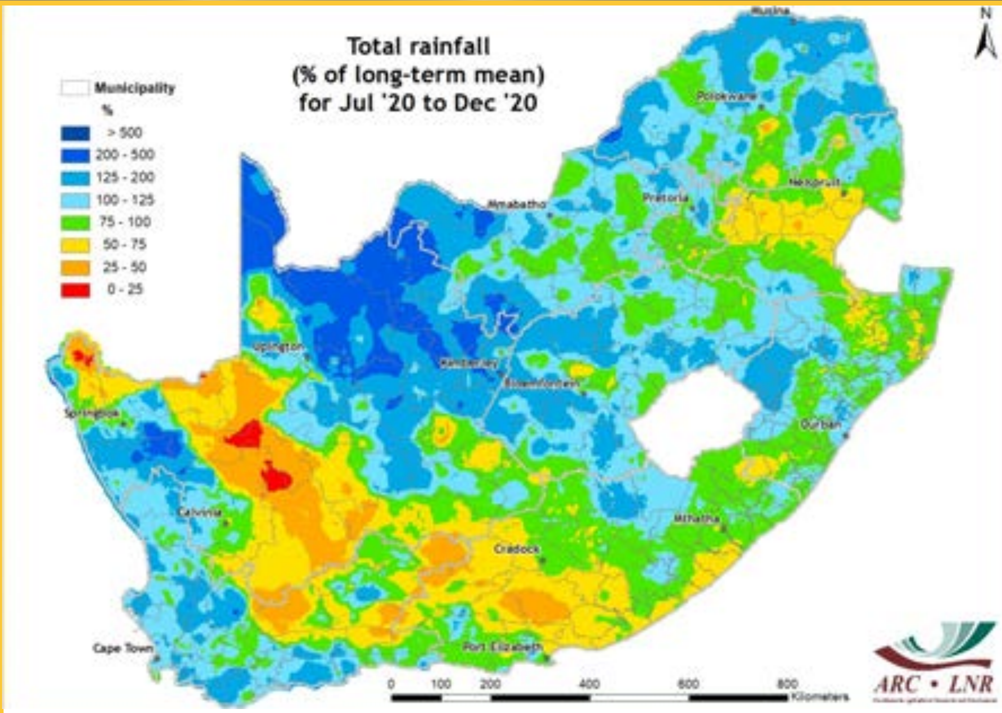


Figure 3

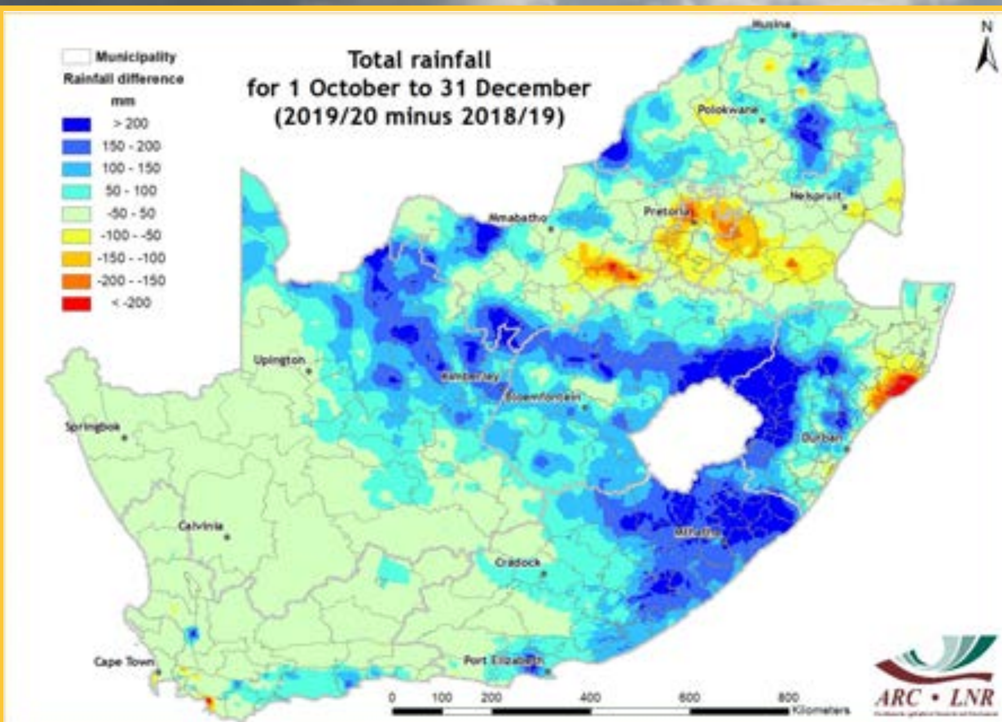


Figure 4

Figure 1:

Rainfall totals continued to increase in December 2020. Most significant rainfall activity occurred over the interior, towards the eastern and northern provinces. Several areas in the Free State, KwaZulu-Natal and Limpopo recorded totals exceeding 200 mm. Although dry conditions prevailed over the winter rainfall region, parts of the Overberg district received light rain, while the eastern parts of the all-year rainfall region (Port Alfred and surrounding area) recorded totals of up to 68 mm.

Figure 2:

Above-normal rainfall occurred over the eastern interior, moving southeast towards the midland areas of the Eastern Cape and KZN. These conditions were also observed over the Lowveld of Limpopo and Mpumalanga. Areas in the summer rainfall region that received near- to below-normal rainfall during December include greater parts of North West, Gauteng, Mpumalanga, the western interior of Limpopo, the coastal belt of KZN and the Karoo. Below-normal conditions were predominant in the western and southwestern parts of the country although a few limited areas received above-normal rainfall.

Figure 3:

The cumulative rainfall for July to December 2020 compared to the long-term mean of the same period indicates that above-normal conditions were experienced over the northern provinces, the interior and the winter rainfall region. The rest of the country experienced generally near- to below-normal rainfall.

Figure 4:

The Lowveld and isolated areas in Limpopo, the Eastern Cape and KZN midlands, Free State, eastern parts of the Northern Cape, northern parts of North West and certain areas along the Cape south coast received significantly more rain during October to December 2020 as compared to the same period last year. Meanwhile, the northern regions of the Highveld as well as the north coast of KZN received less rain, while the rest of the country received relatively the same amounts as in 2019.

Questions/Comments:
MasuphaE@arc.agric.za
Johan@arc.agric.za

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 December, high rainfall totals resulted in wet conditions over the winter rainfall region, KwaZulu-Natal midlands, as well as the Northern provinces. Similar conditions, although milder, were observed in the Free State, Eastern Cape midlands and northern Lowveld of Mpumalanga. The 12-month SPI shows that the central to southeastern interior and parts of the Western Cape experienced mild to extreme wet conditions during the medium term, while the prevalence of mild drought was visible over western and eastern parts of the country. When considering the long-term drought conditions, SPI values corresponding to wet conditions were noted over the central parts of the country, Lowveld of Limpopo and Mpumalanga, southern coastal areas of KZN and isolated areas of the winter rainfall region. In addition, long-term severe to extreme droughts were noted, predominantly in the Karoo, implying significantly low soil water levels.

Questions/Comments:
MasuphaE@arc.agric.za
Johan@arc.agric.za

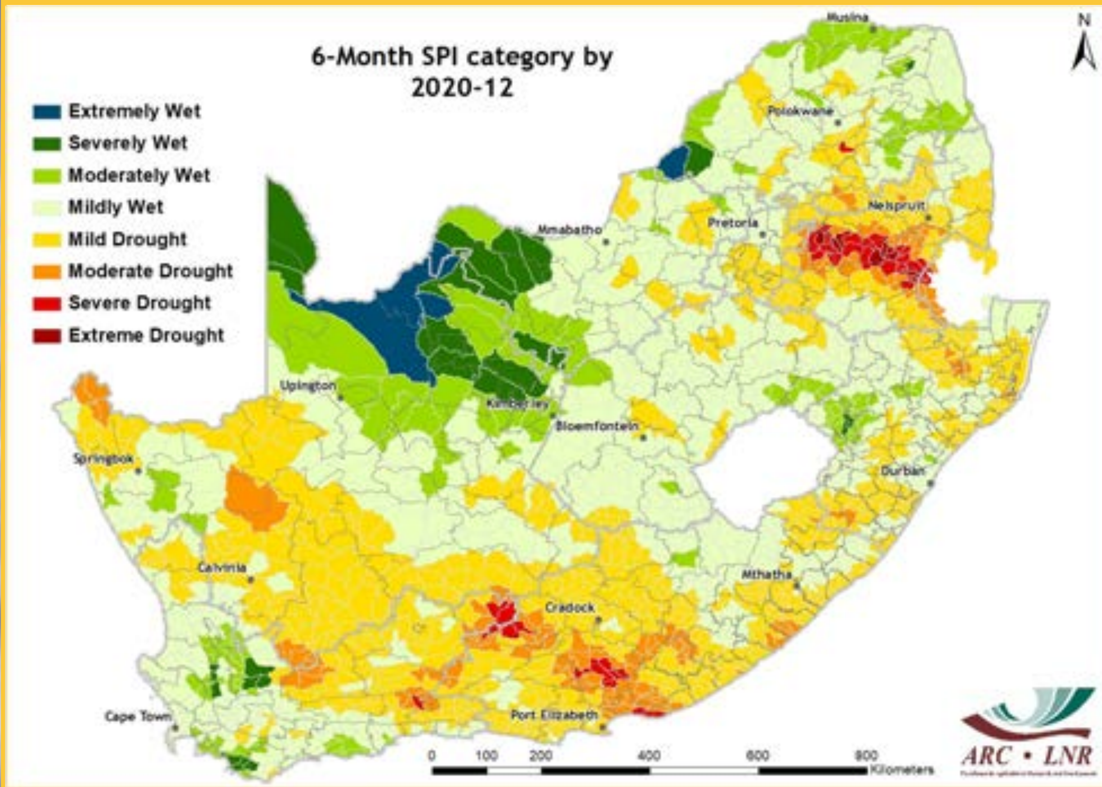


Figure 5

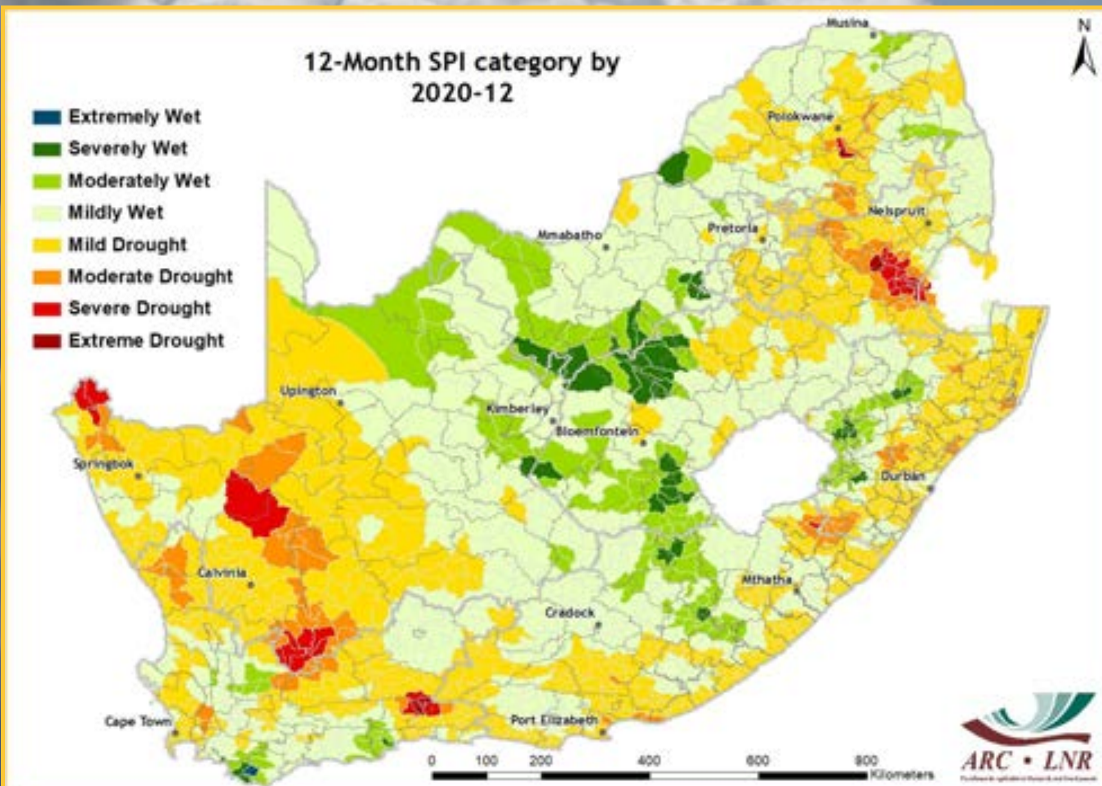


Figure 6

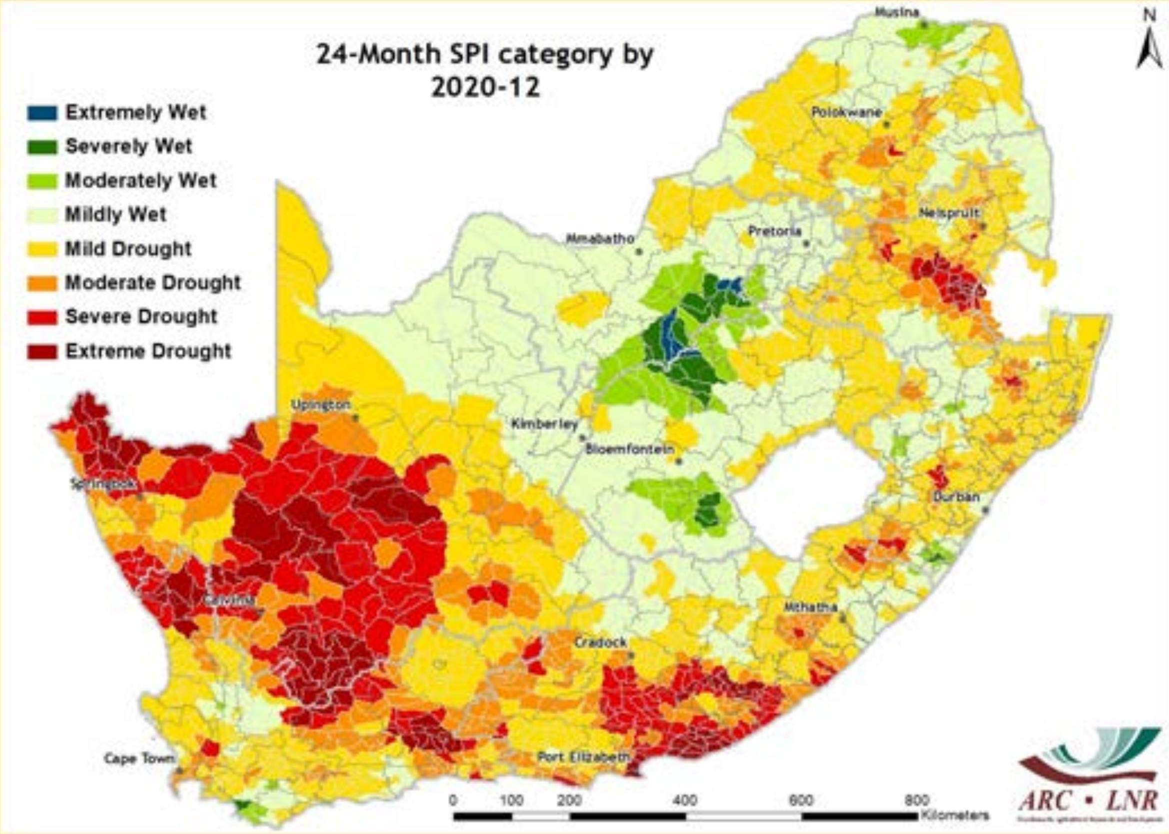


Figure 7

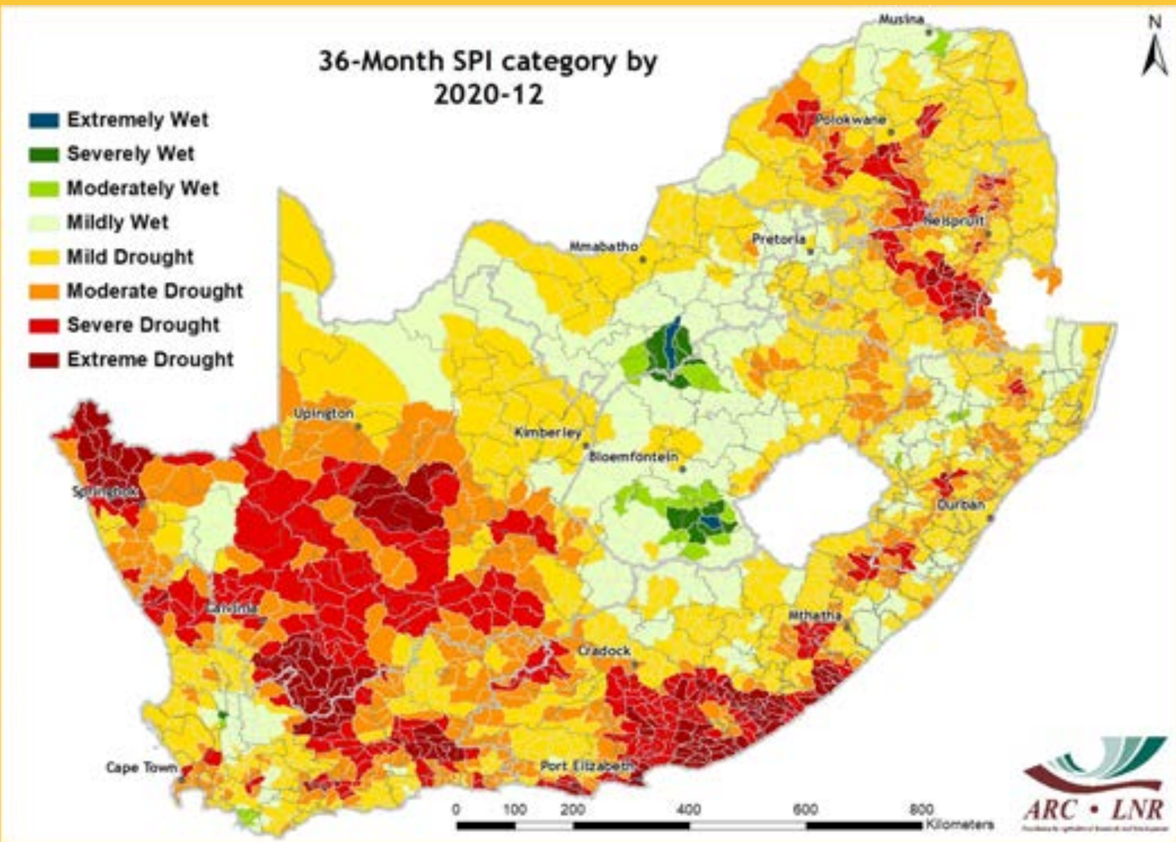


Figure 8

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.

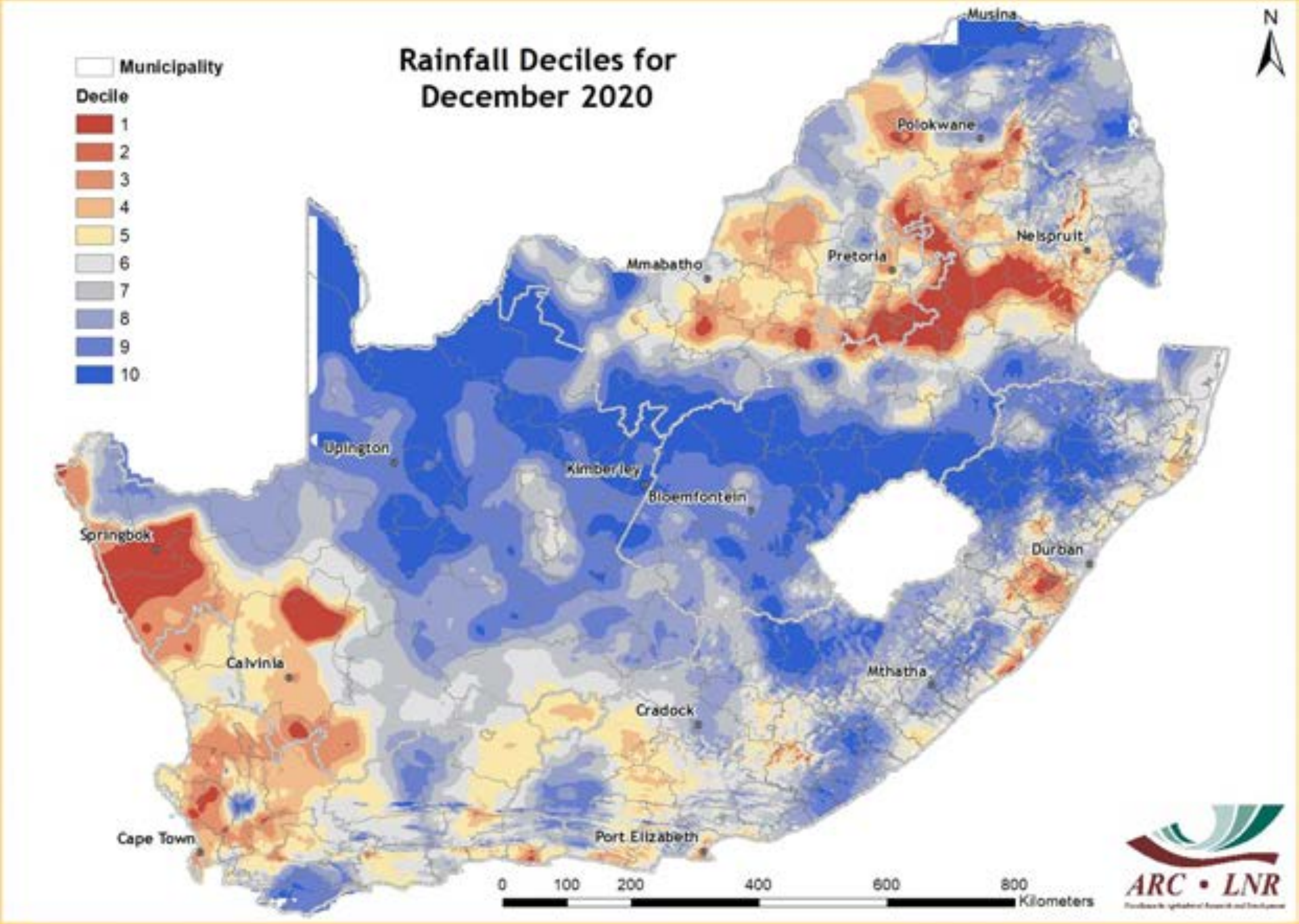


Figure 9

Figure 9:
In December 2020, greater parts of the country compared well with historically wetter December months. The only areas that recorded rainfall totals comparable with drier December months include the winter rainfall region, the northern Highveld, isolated parts of the Eastern Cape, Limpopo and KwaZulu-Natal.

Questions/Comments:
MasuphaE@arc.agric.za
Johan@arc.agric.za

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.

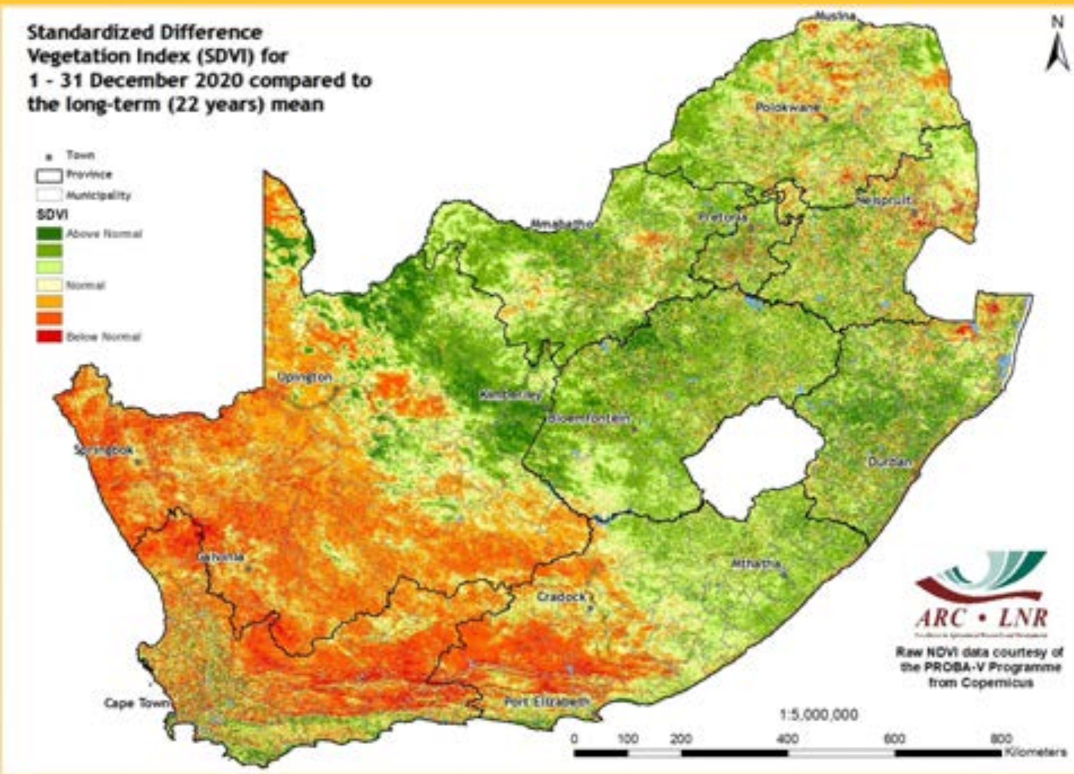


Figure 10

Figure 10:
Compared to the historical averaged vegetation conditions, the SDVI map for December 2020 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 December 2020 compared to the same month last year shows that normal to above-normal vegetation activity occurred over much of the country, with pockets of below-normal activity over isolated areas in the northern parts.

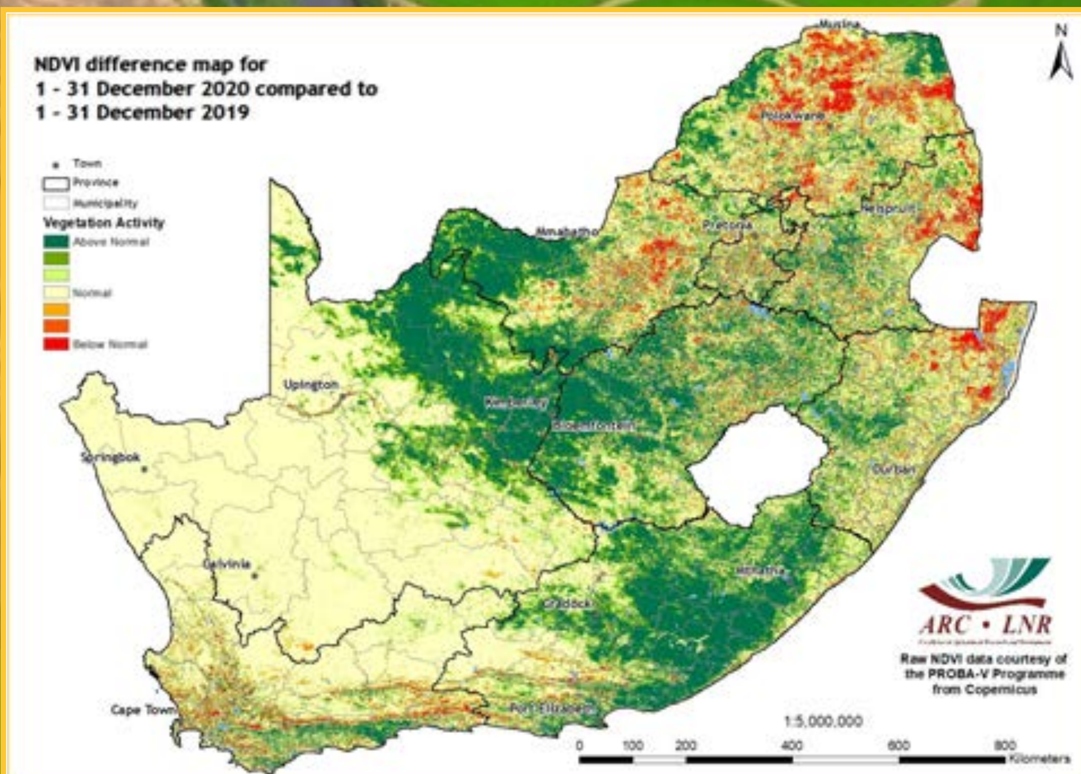


Figure 11

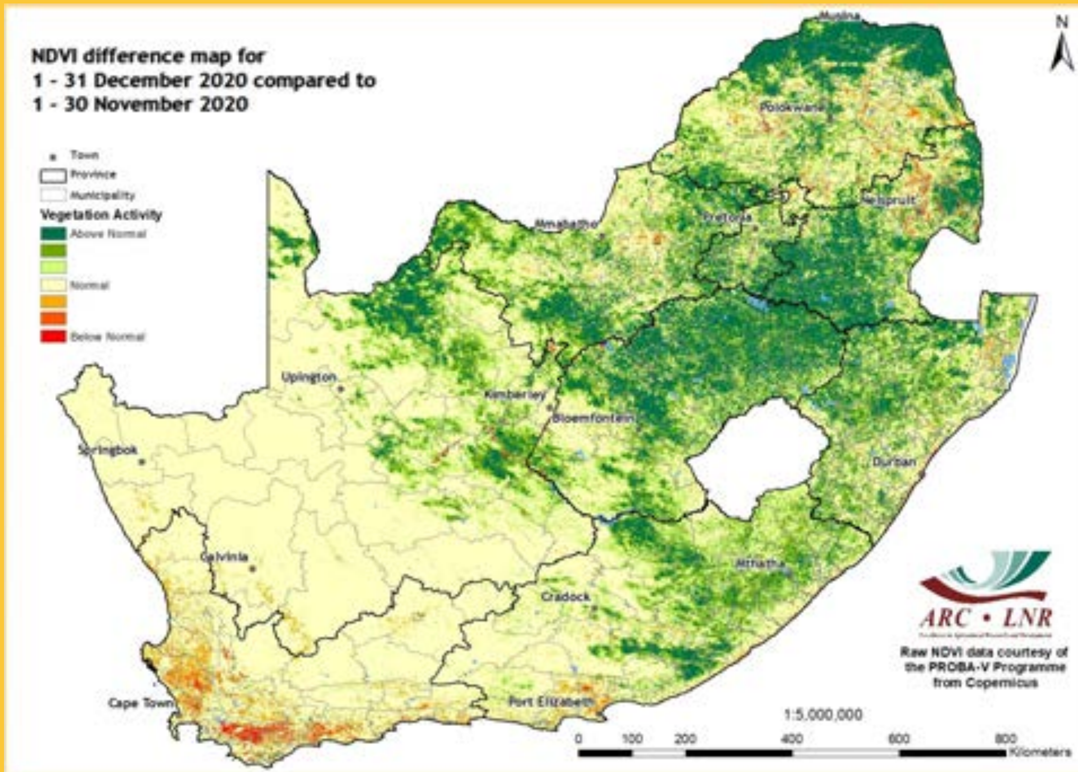


Figure 12

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

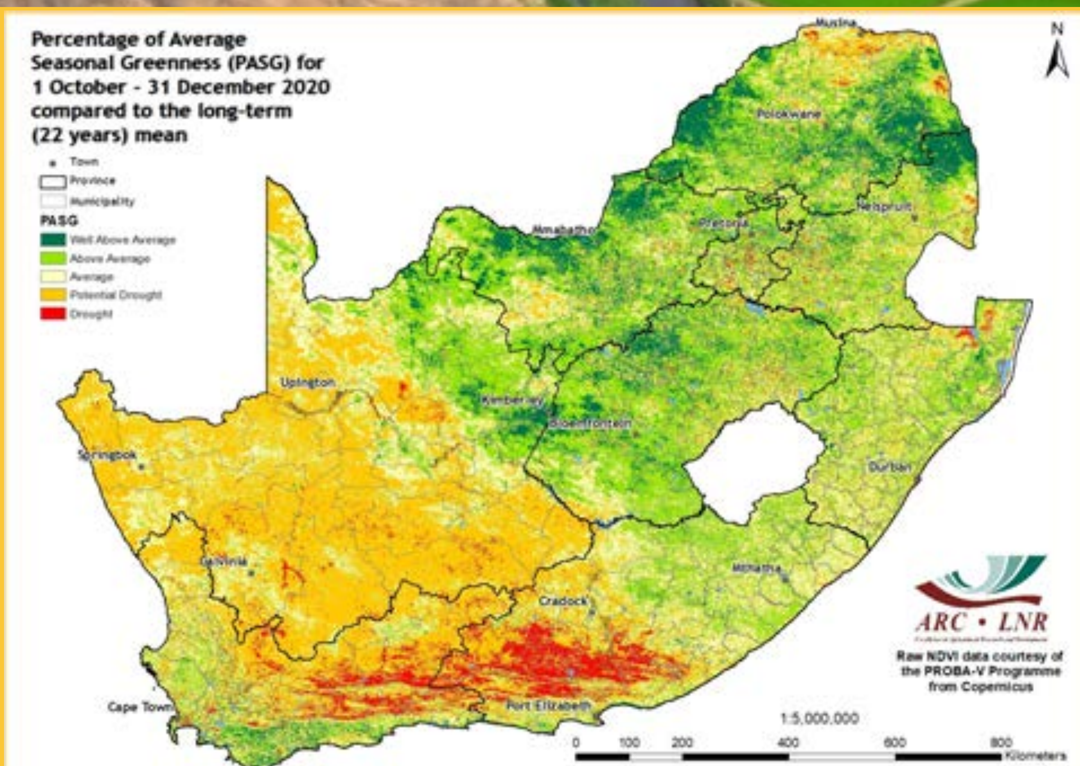


Figure 13

Figure 12:
Compared to the previous month, the NDVI difference map for December shows that the central interior extending to the northern parts of the country experienced above-normal vegetation conditions. Nevertheless, the larger part of the Cape region experienced normal vegetation conditions with pockets of below-normal vegetation activity in the far western parts.

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.

Questions/Comments:
MaakeR@arc.agric.za

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.

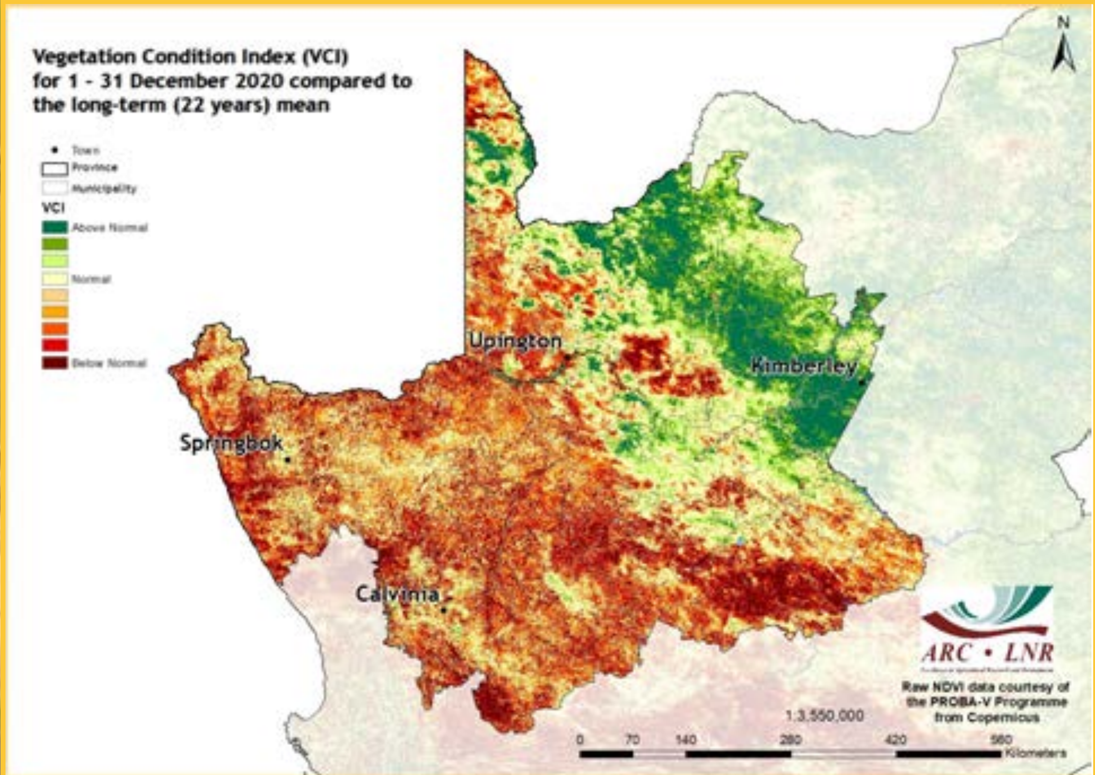


Figure 14

Figure 14:
The VCI map for December indicates that the far north-eastern parts of the Northern Cape experienced improved vegetation conditions while the remaining areas continue to be severely affected by drought.

Figure 15:
The VCI map for December indicates that vegetation in the eastern half of the Western Cape remains stressed. Meanwhile, the western half of the province continues to experience pockets of good vegetation conditions, spreading to larger isolated areas of the southern parts.

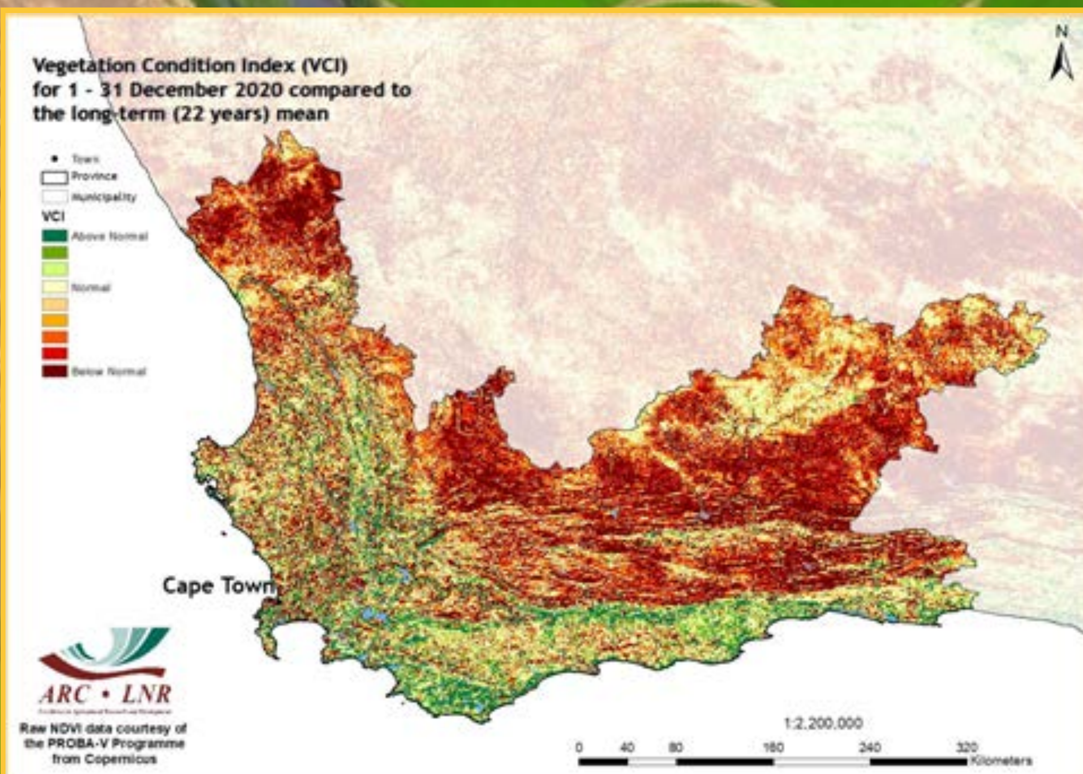


Figure 15

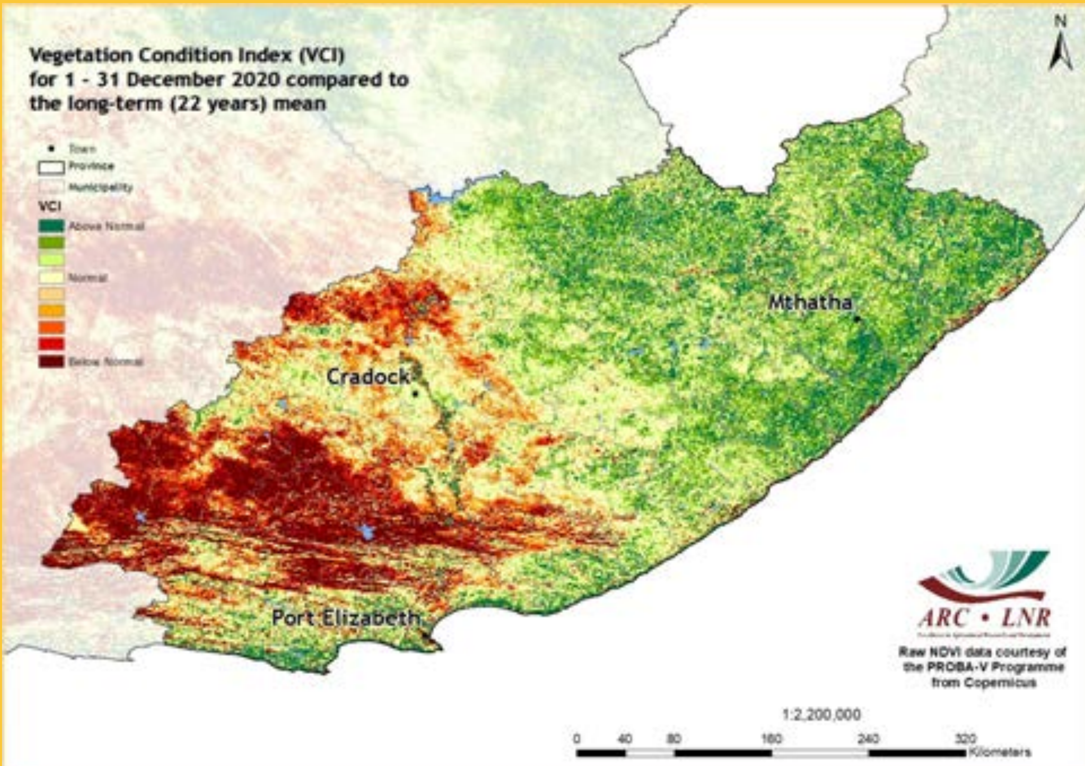


Figure 16

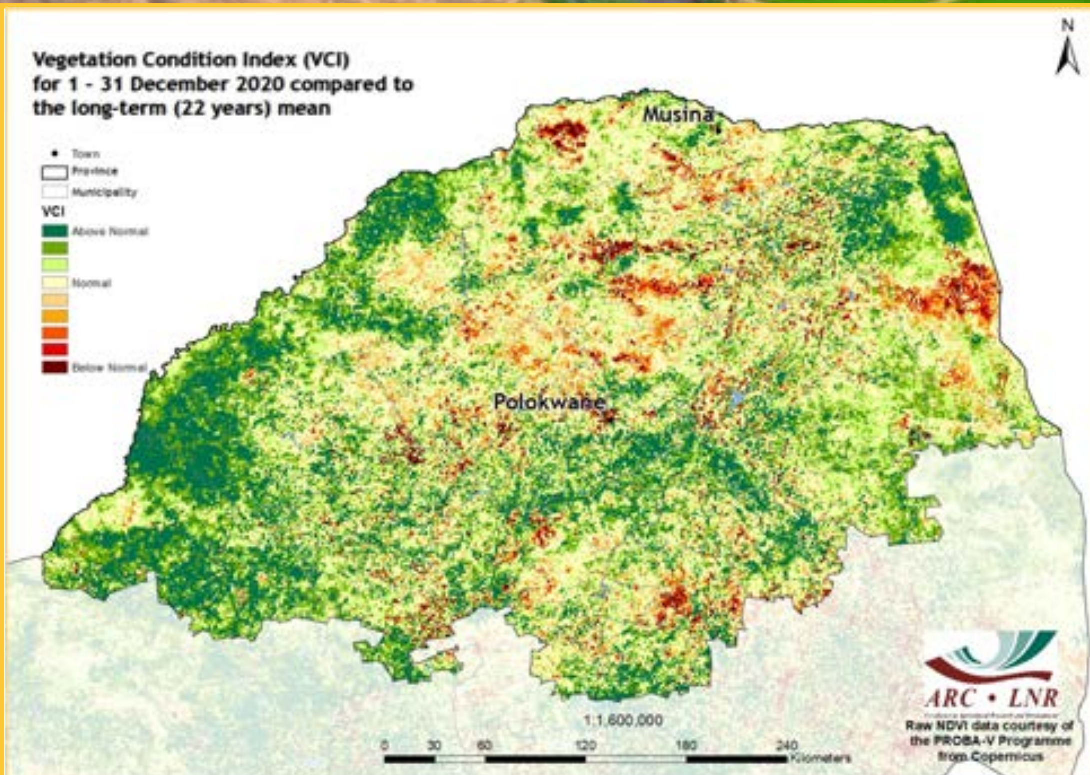


Figure 17

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

Figure 17:
The VCI map for December indicates that most parts of Limpopo are experiencing above-normal vegetation activity with pockets of poor activity in a few isolated areas.

Questions/Comments:
MaakeR@arc.agric.za

6. Vegetation Conditions & Rainfall

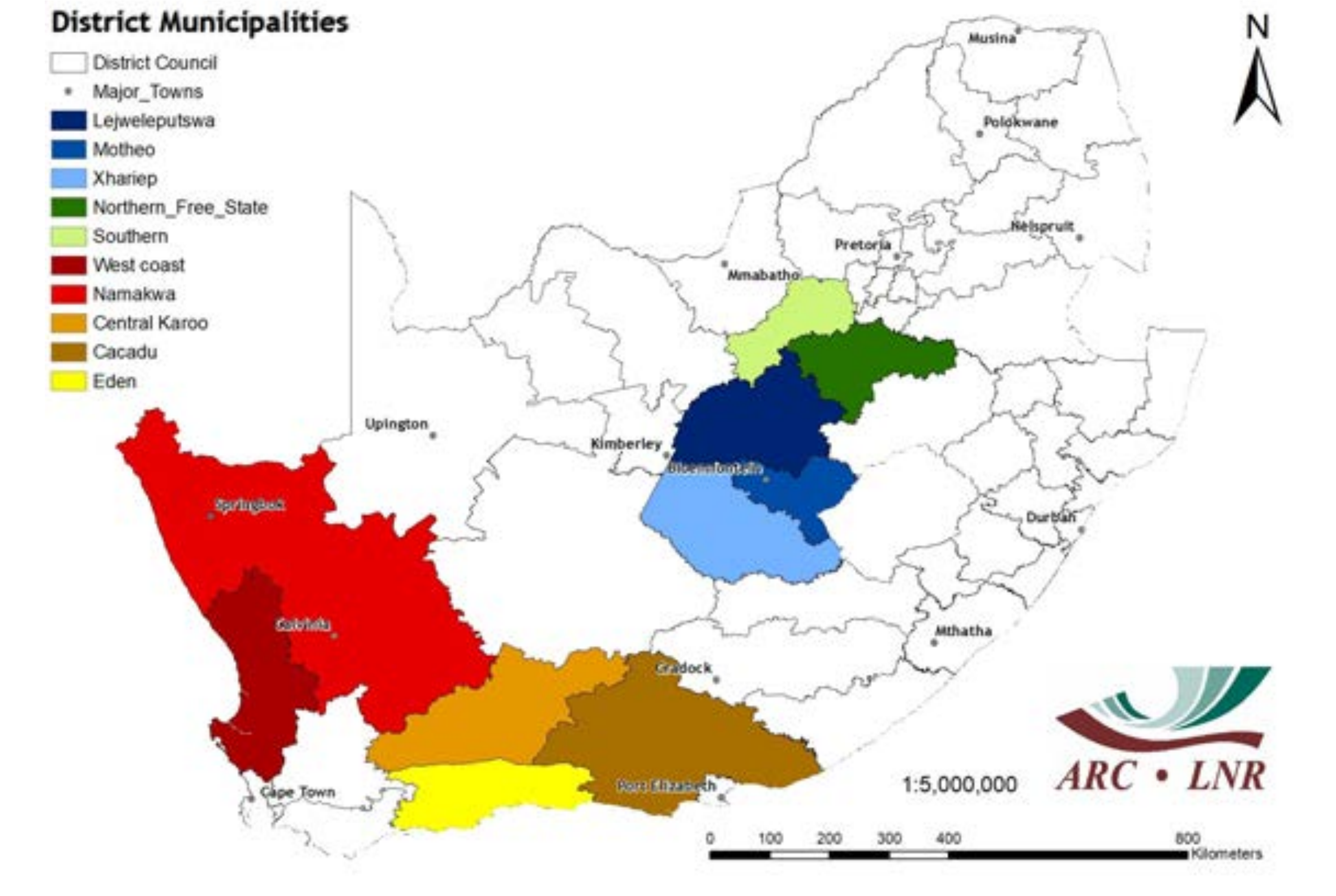


Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for December 2020. The district colour matches the border of the corresponding graph.

Questions/Comments:
MaakeR@arc.agric.za

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.

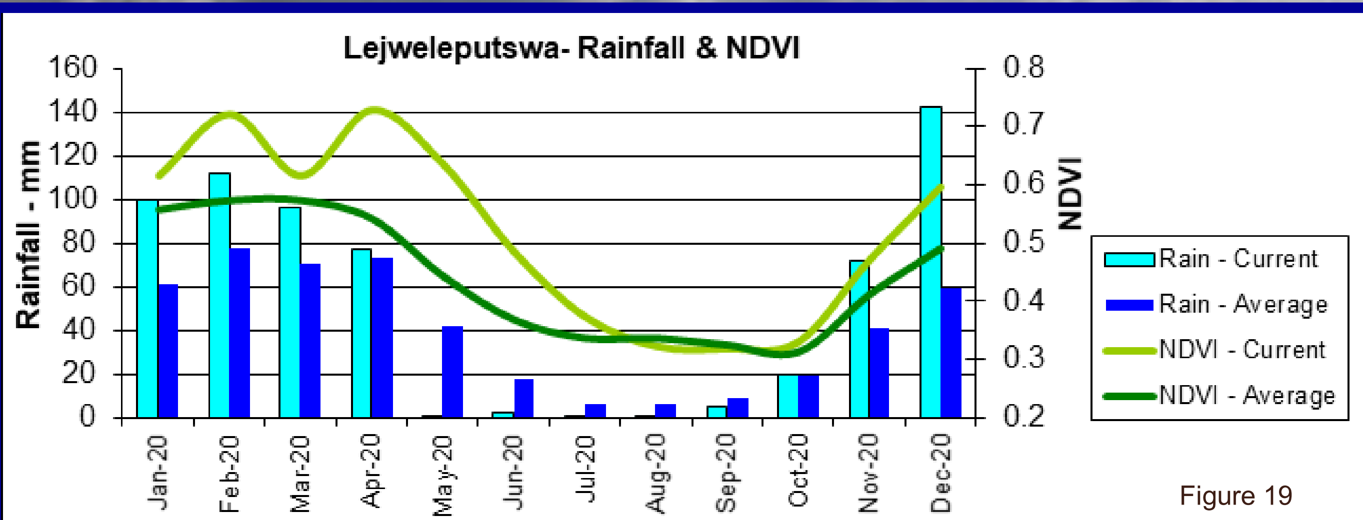


Figure 19

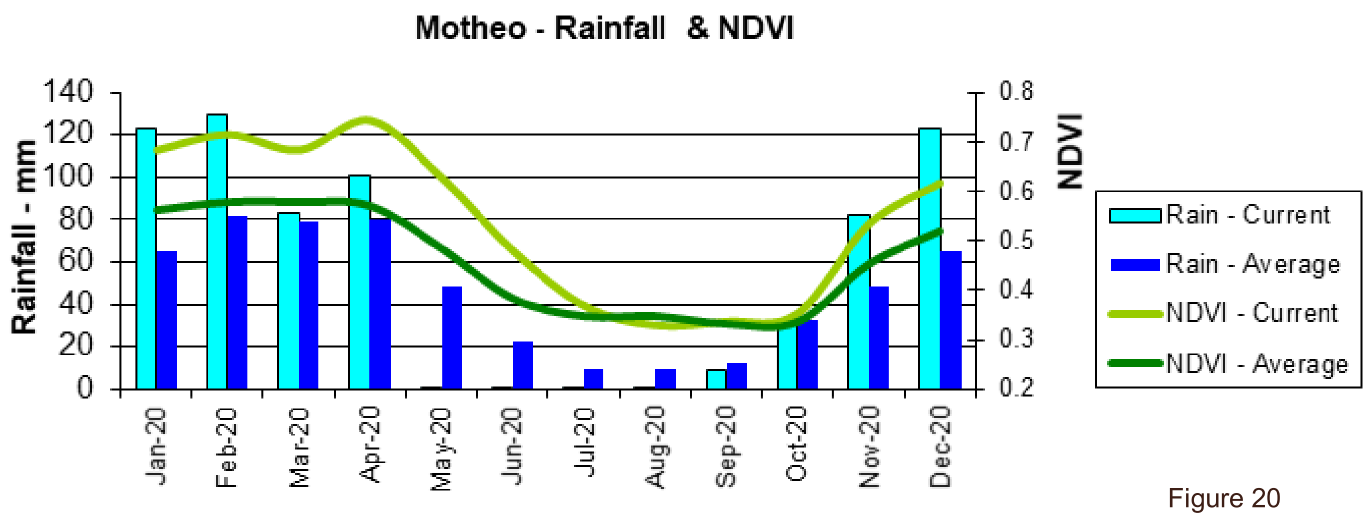


Figure 20

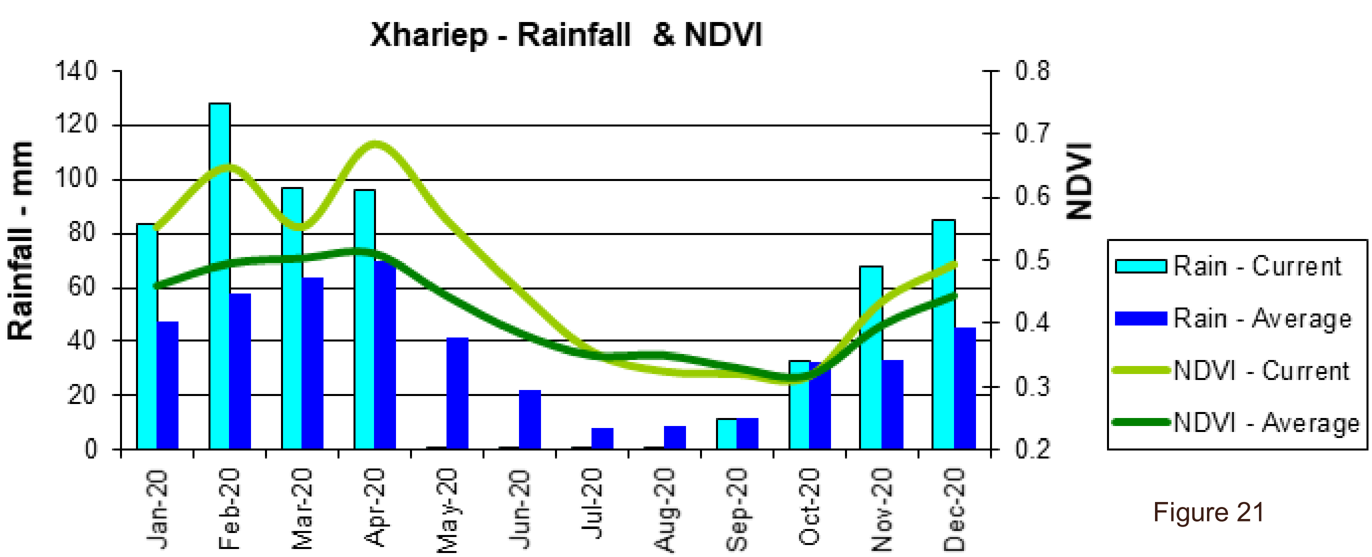


Figure 21

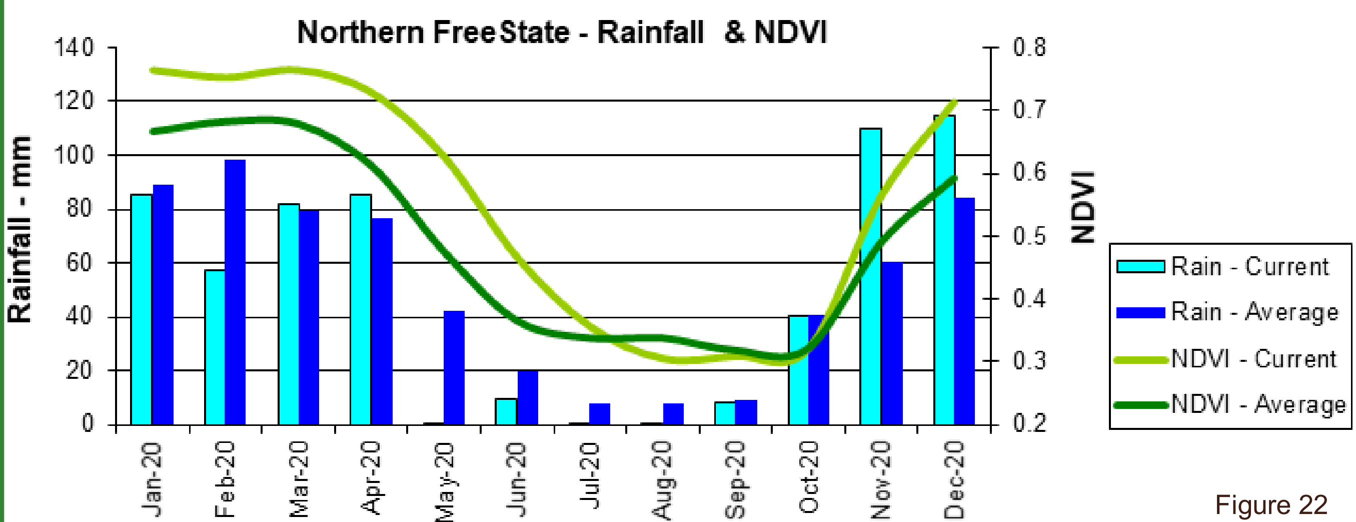


Figure 22

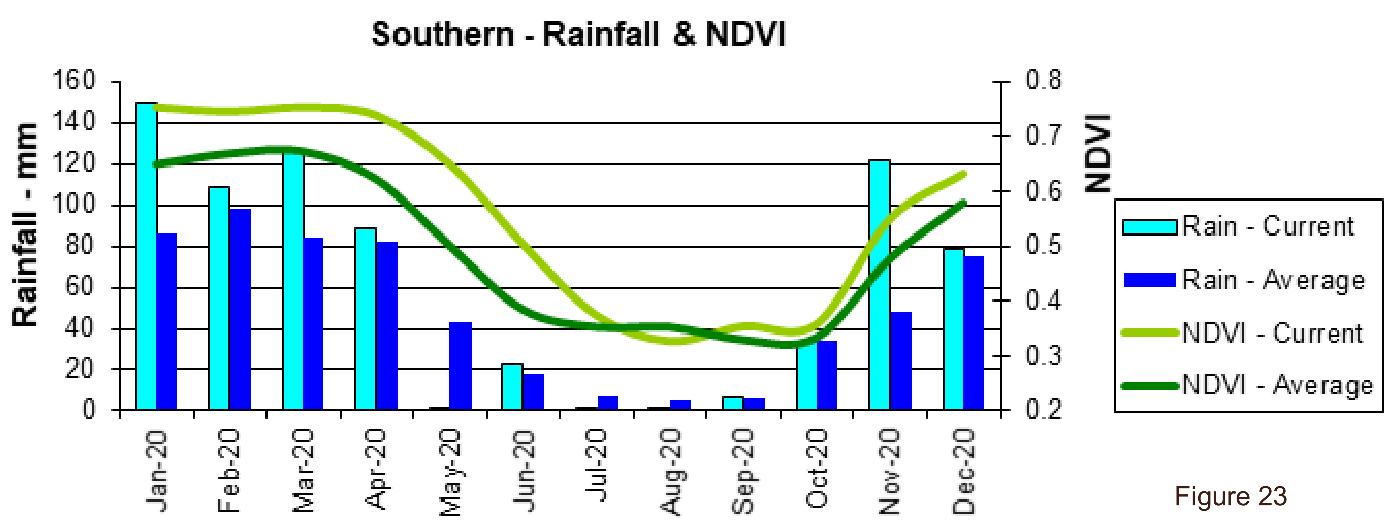


Figure 23

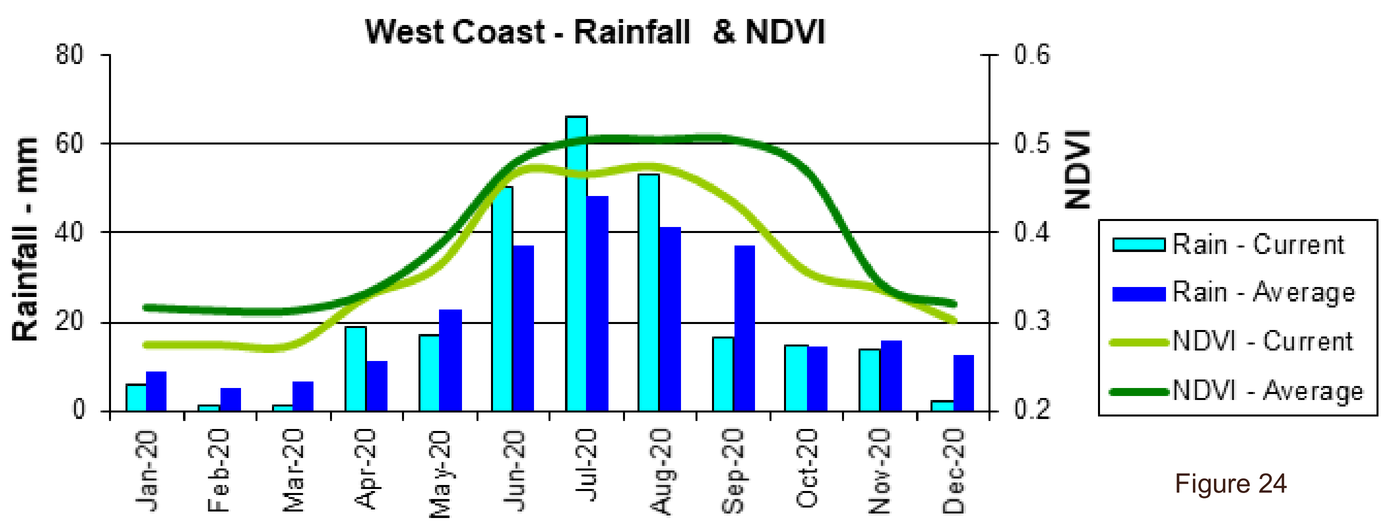


Figure 24

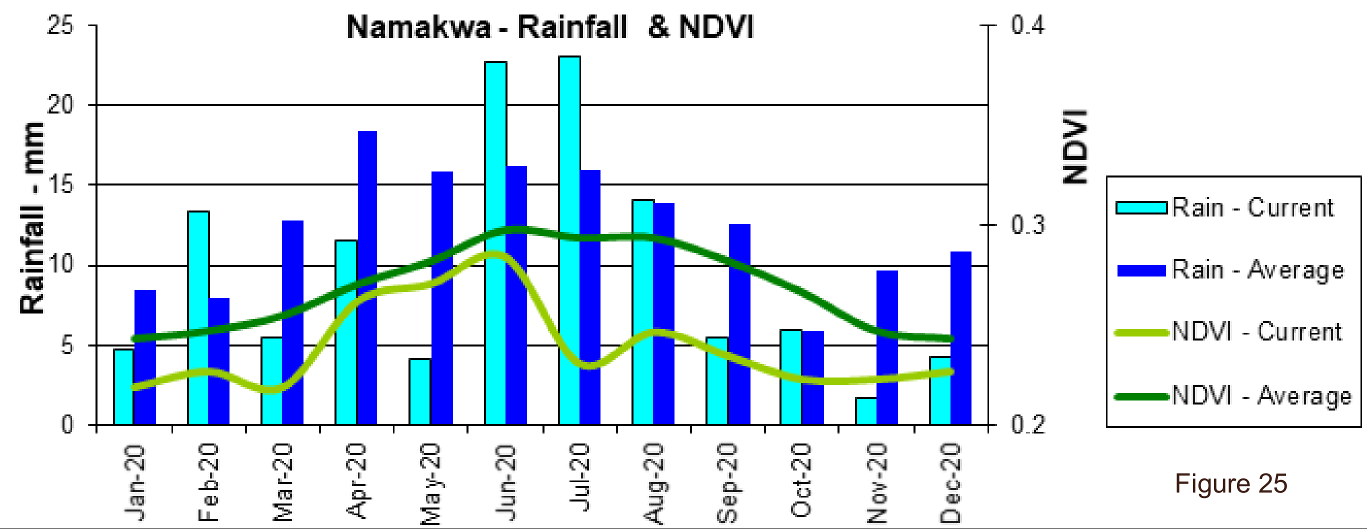


Figure 25

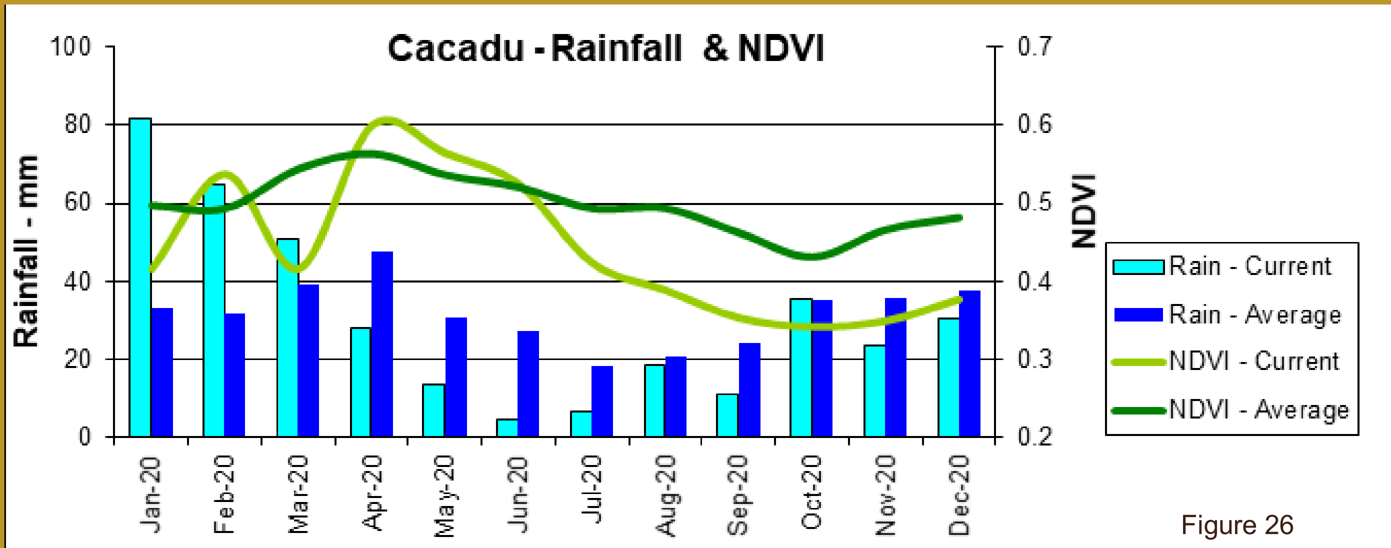


Figure 26

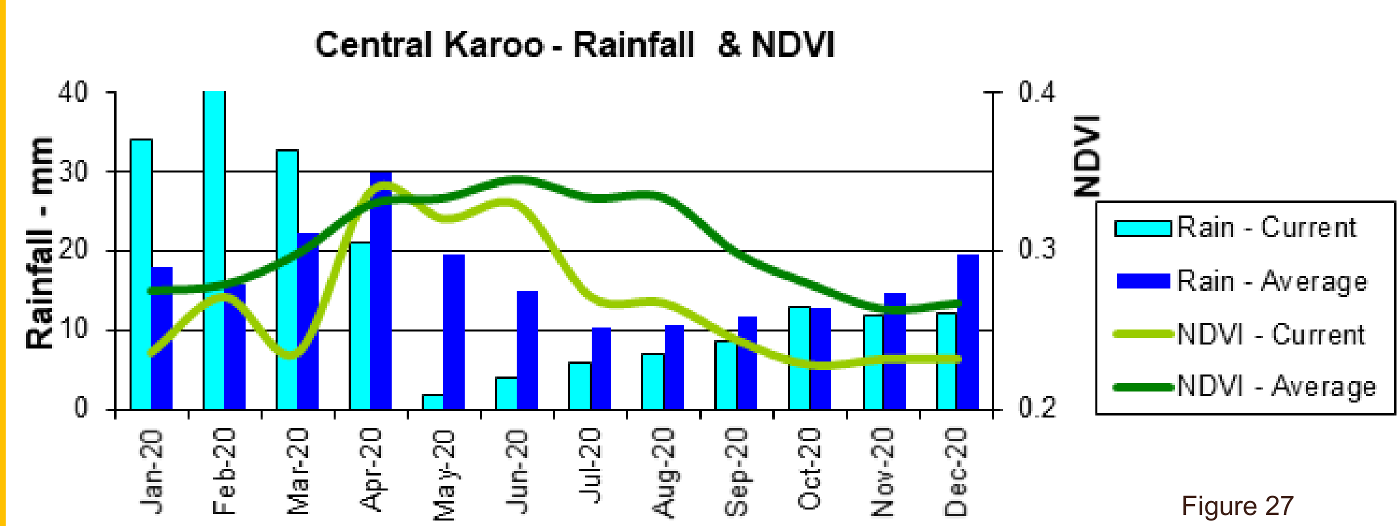


Figure 27

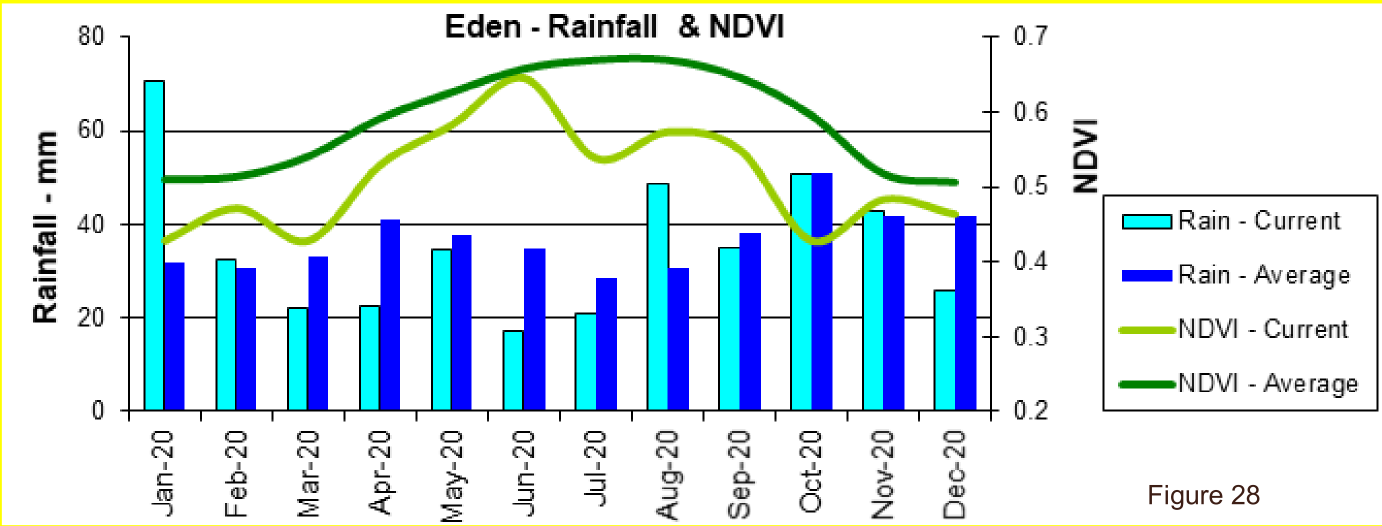


Figure 28

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 December 2020 per province. Fire activity was lower in all provinces except for the Western and Northern Cape compared to the long-term average.

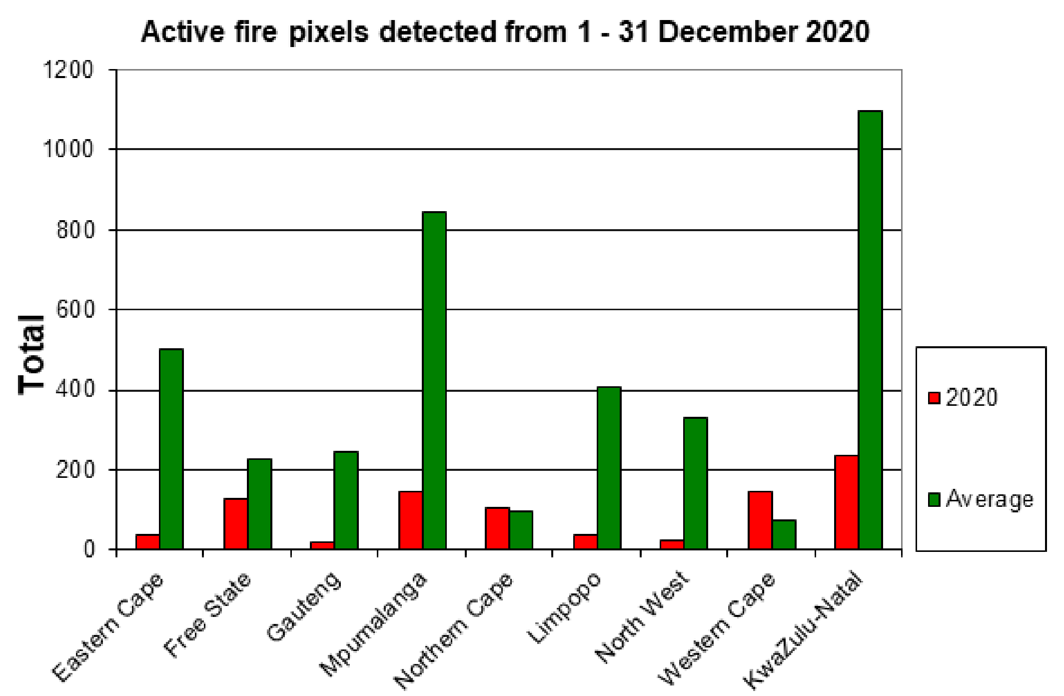


Figure 29

Figure 30:
The map shows the location of active fires detected between 1-31 December 2020.

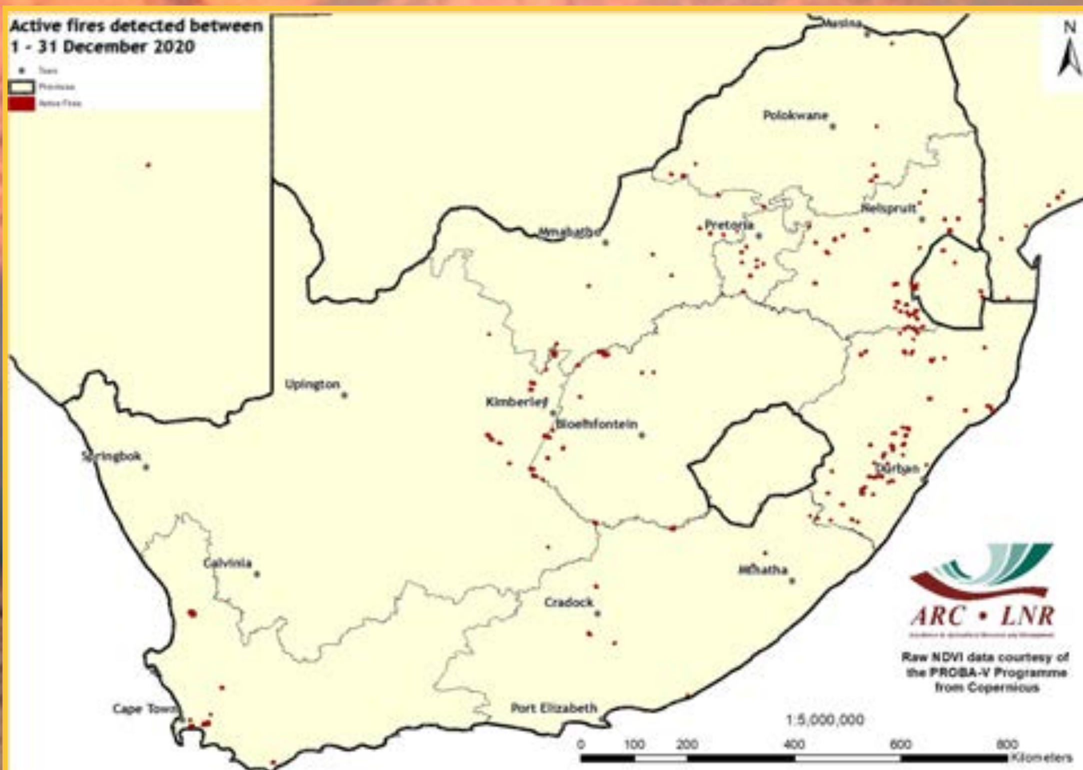


Figure 30

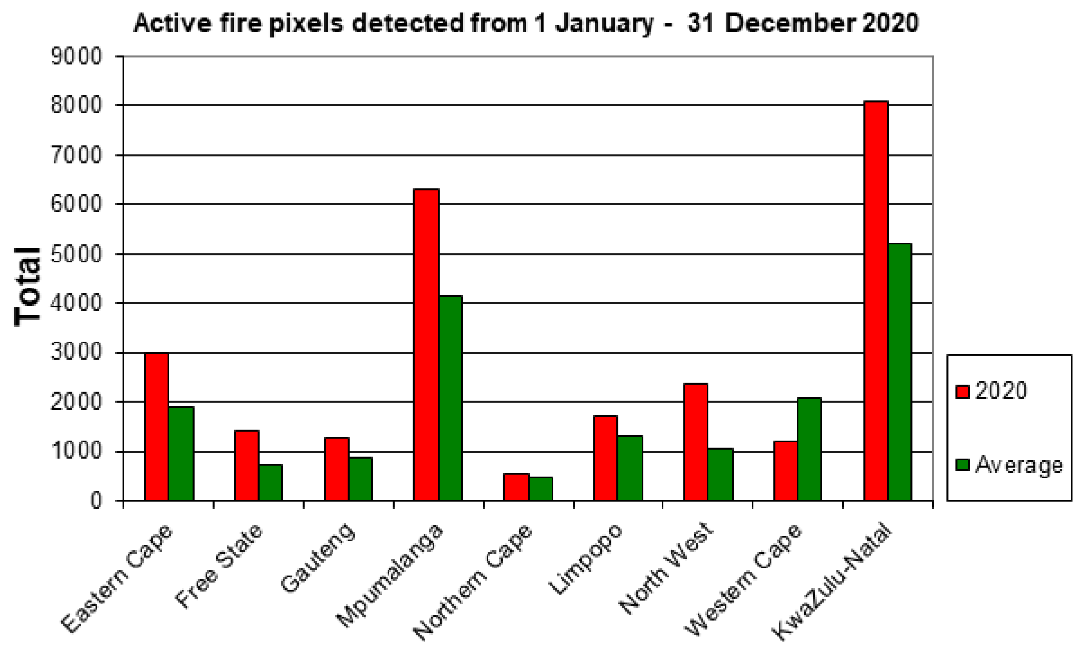


Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January - 31 December 2020 per province. Cumulative fire activity was higher in all provinces except for the Western Cape compared to the long-term average.

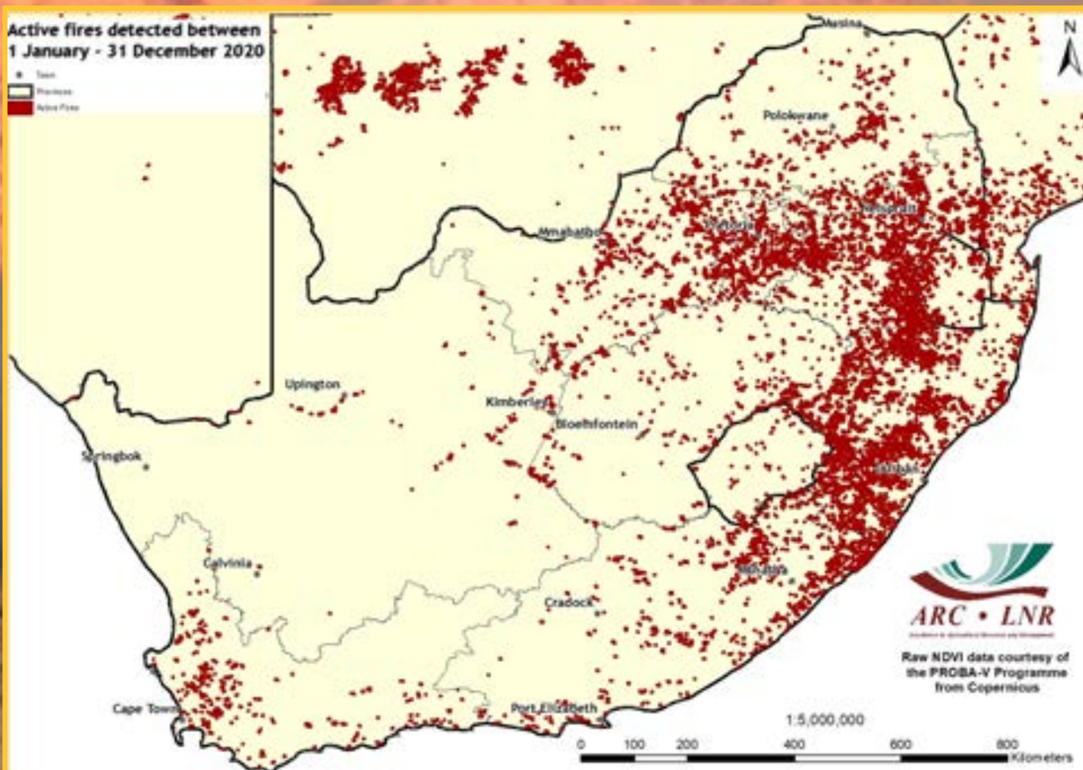


Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January - 31 December 2020.

Questions/Comments:
MaakeR@arc.agric.za

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 4 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 2019.

The long-term map for December 2020 shows a continuation of the November pattern and conditions, but with a general increase in water levels in the summer rainfall region, with the majority of catchments in this area now showing water levels equivalent to 60-100% of the 4-year, long-term maximum water. The exceptions are in the central Northern Cape and Kalahari regions, which continue to show significantly lower current water levels compared to long-term maximum values.

The comparison between December 2020 and December 2019 indicates a similar pattern to that reported last month, with significantly higher water levels in the Karoo and Overberg regions, as well as some boundary catchments in Limpopo, but otherwise generally the same or slightly lower water levels in all other areas compared to 2019. However, a few small catchments scattered across the Western and Eastern Cape, as well as Maputaland, continue to show significantly lower water levels.

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

Questions/Comments:
mark.thompson@geoterraimage.com

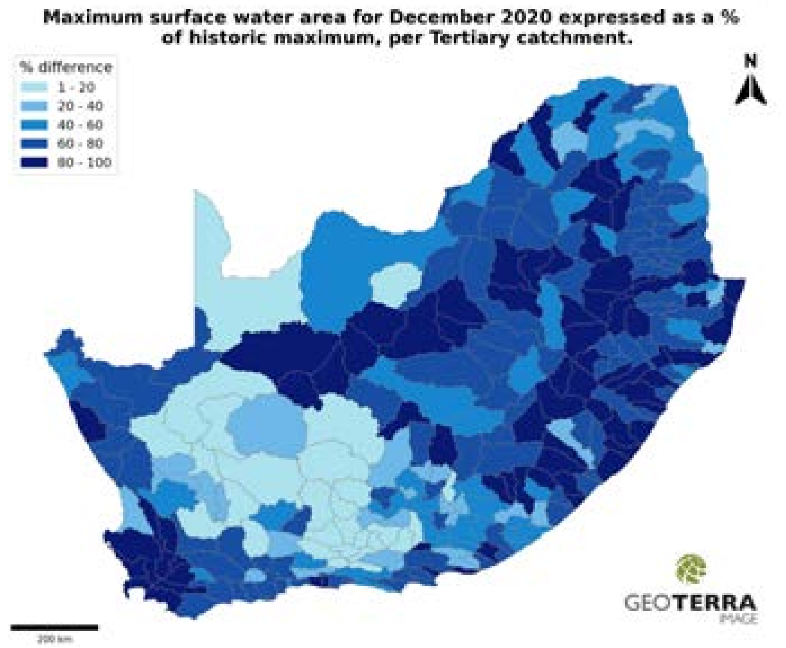


Figure 33

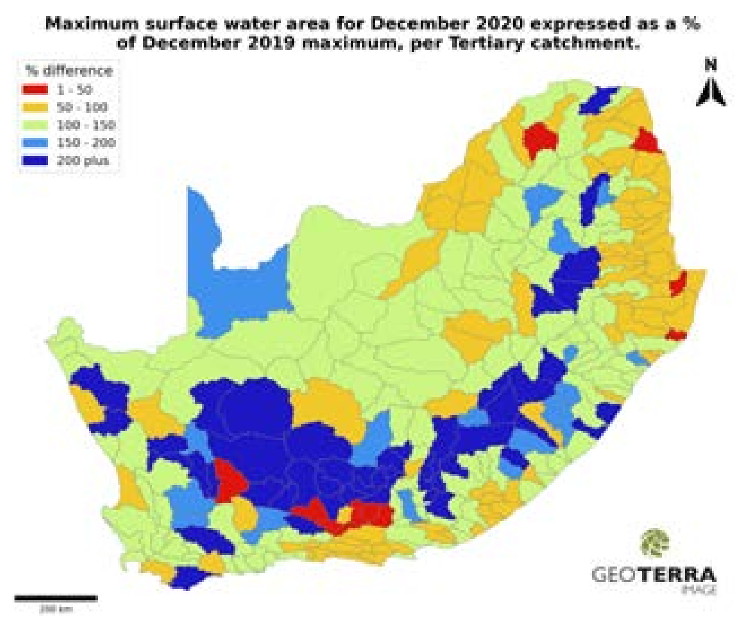
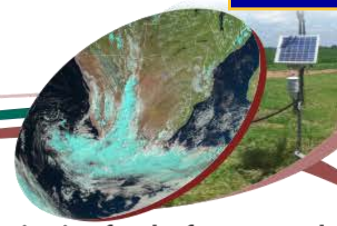


Figure 34

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

Contact Person:
Dr Mokhele Moeletsi
Tel: 012 310 2537
E-mail: moeletsim@arc.agric.za

ARC-Institute for Soil, Climate and Water
600 Belvedere Street, Arcadia • Private Bag X79, Pretoria 0001
Tel: 012 310 2500 • Fax: 012 323 1157 • Website: www.arc.agric.za
For more information contact:
Adri Laas - Public Relations Officer • E-mail: adril@arc.agric.za

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

Contact Person:
Dr George Chirima
Tel: 012 310 2672
E-mail: chirimaj@arc.agric.za

ARC-Institute for Soil, Climate and Water
600 Belvedere Street, Arcadia • Private Bag X79, Pretoria 0001
Tel: 012 310 2500 • Fax: 012 323 1157 • Website: www.arc.agric.za
For more information contact:
Adri Laas - Public Relations Officer • E-mail: adril@arc.agric.za

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**.

ARC • LNR
Excellence in Research and Development

Institute for Soil, Climate and Water

Private Bag X79, Pretoria 0001,
South Africa
600 Belvedere Street, Arcadia, Pretoria, South Africa

Reneilwe Maake
Project Leader: Coarse Resolution Imagery Database (CRID)
Phone: +27(0) 12 310 2533
Fax: +27(0) 12 323 1157
E-mail: MaakeR@arc.agric.za

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.

For further information please contact the following:
Reneilwe Maake – 012 310 2533, MaakeR@arc.agric.za
Adri Laas – 012 310 2518, AdriL@arc.agric.za

To subscribe to the newsletter, please submit a request to:
MaakeR@arc.agric.za

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