UMLINDI
The Watchman

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Excellence in Research and Development

INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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

South African Weather Service

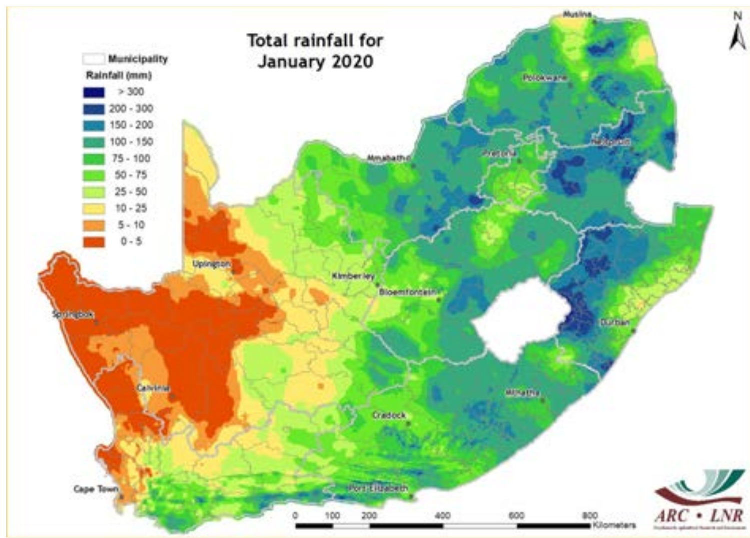
AMESD

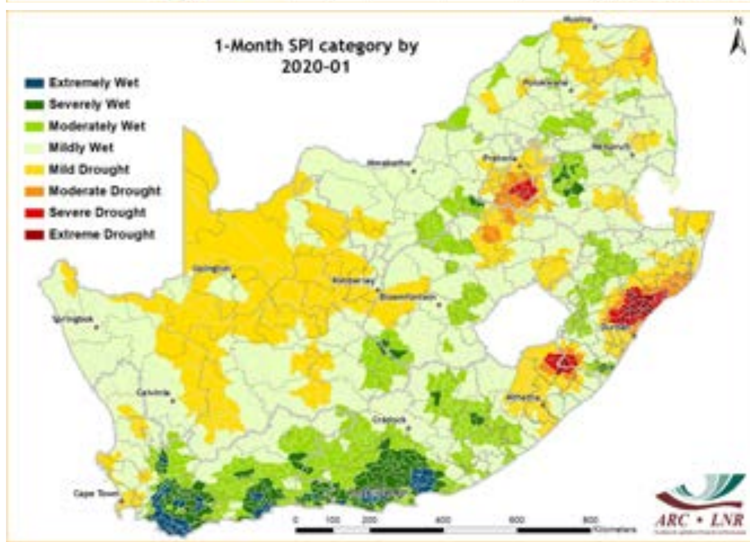
188th Edition

Images of the Month

Short-term drought conditions following good rainfall in January

The total rainfall map for January 2020 shows that the good rainfall was mainly restricted to the central areas of the country as well as the northeastern and southern interior, while much of the far west (including the Cape Peninsula) remained dry. It is important to note that significant rains occurred over much of the drought stricken Eastern Cape, which has been suffering from long-term drought conditions. Above-normal rainfall occurred mostly over the central areas towards the western parts of the province. The 1-month Standardized Precipitation Index (SPI) map for January shows that the above-normal rainfall totals in the Eastern Cape resulted in mild to extremely wet conditions, except for the Eastern Midlands which experienced mild drought. Although these rainy conditions indicate prospects of drought relief, it should be noted that the 1-month SPI is a good indicator of short-term soil moisture conditions and does not imply a break in the drought. Thus, in order to minimize the risk of potential drought effects during the season, farmers should practise rainwater harvesting, increase water infiltration by adding organic material to improve soil structure and minimize compaction of the 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:

Most of the summer rainfall region of South Africa received normal to above-normal rainfall during January 2020, with rainfall largely absent over much of the western parts. Areas that recorded totals in excess of 100 mm include the south coast, central and north-eastern interior of the country. Below-normal rainfall was observed over isolated parts of the winter rainfall region, KwaZulu-Natal, Mpumalanga, Limpopo and Gauteng. During the first few days of the month, areas that received good rainfall (thunderstorms accompanied by hail) were confined to the Eastern Cape coast, eastern parts of the Northern Cape, KwaZulu-Natal Midlands, southern North West and central Free State. The latter days of January were characterized by severe thundershowers and hailstorms, occurring frequently over the northern parts of the Highveld, moving towards the northwestern areas in the Northern Cape. The winter rainfall region experienced above-normal rainfall, except for the Cape Peninsula, which only received up to 10 mm of rain for the whole month.

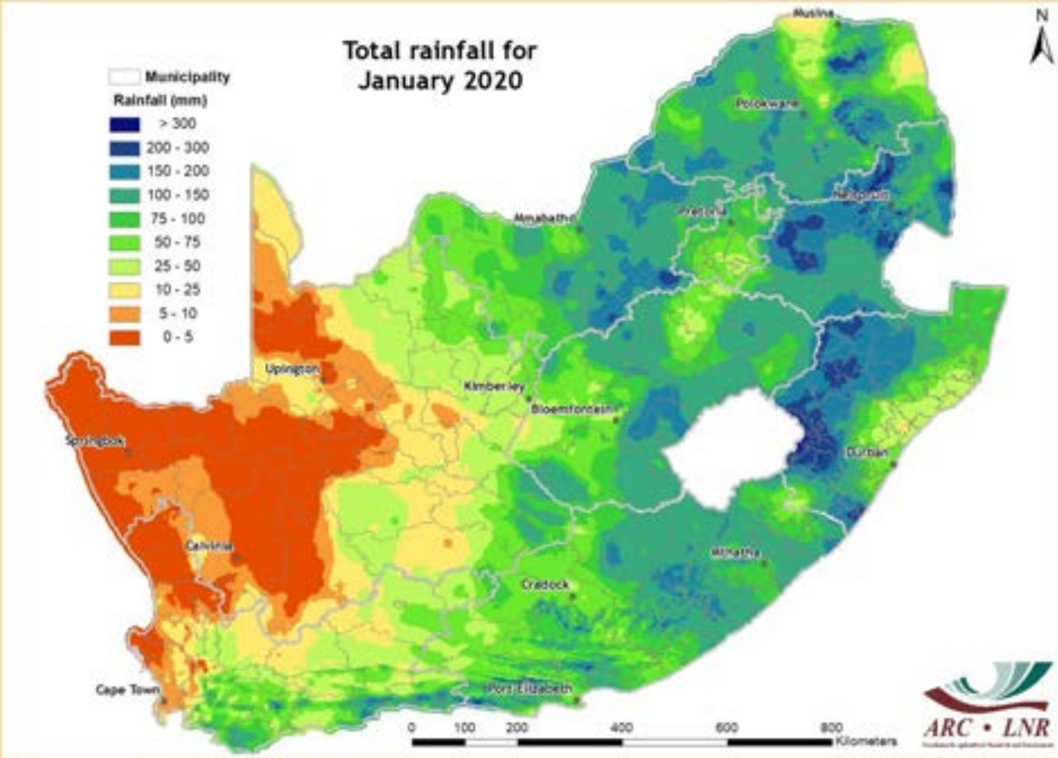


Figure 1

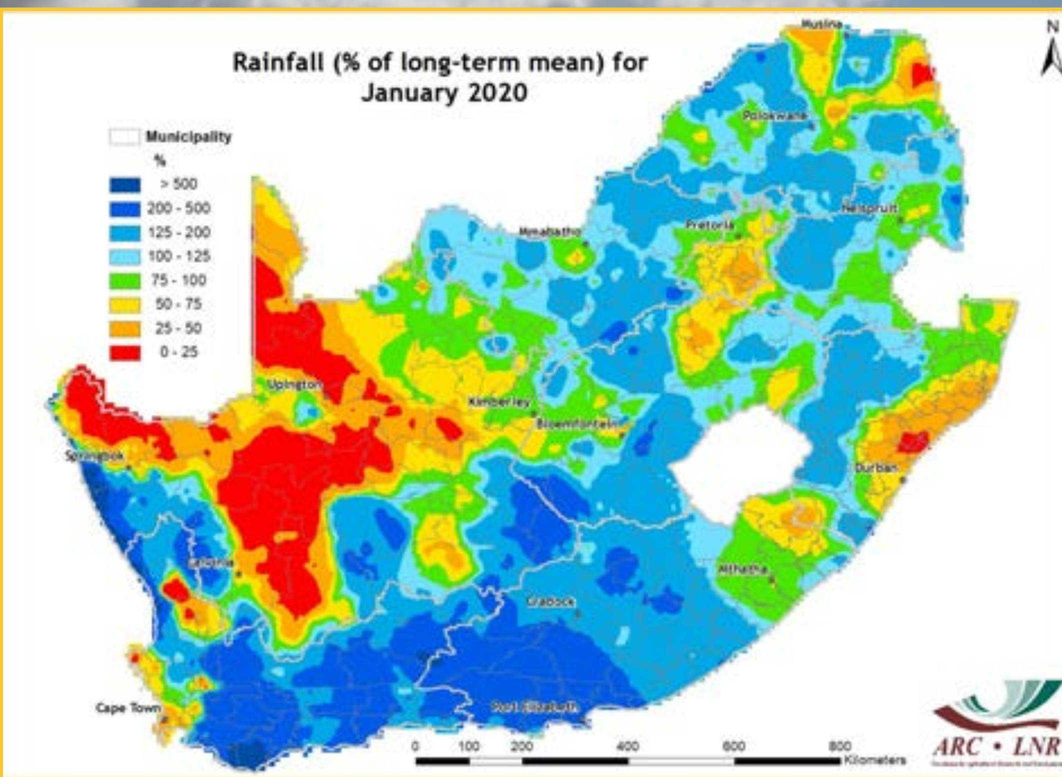


Figure 2

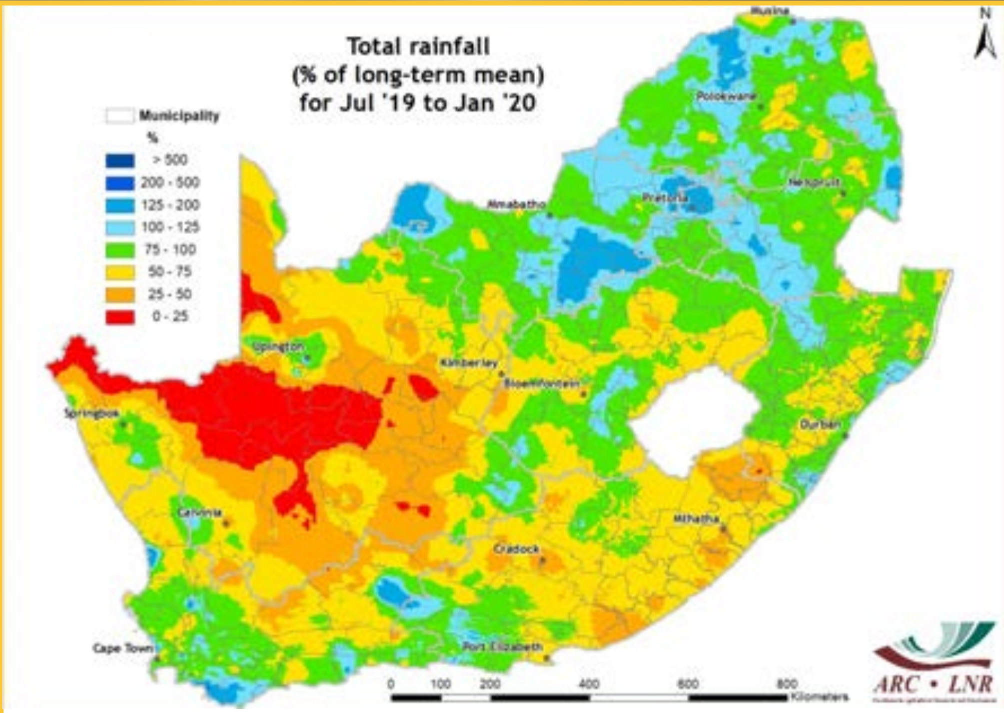


Figure 3

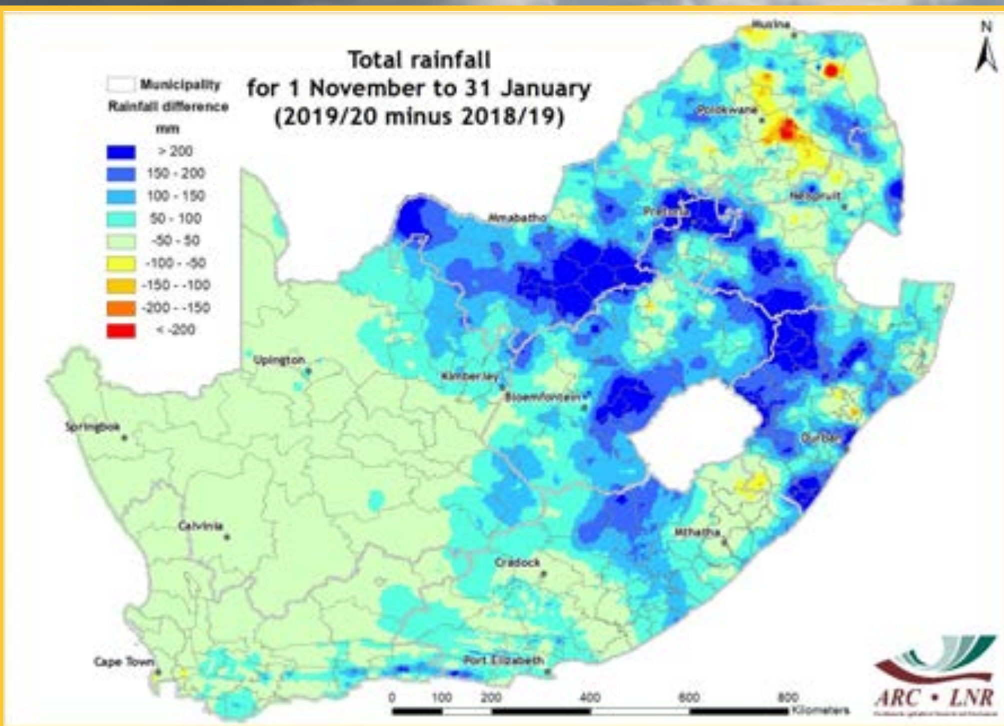


Figure 4

Figure 1:
The central to northeastern interior received mostly in excess of 100 mm of rain during January. Rainfall totals exceeded 200 mm in the KwaZulu-Natal Midlands, parts of Mpumalanga and Limpopo. Meanwhile, much of the Northern Cape and the Cape Peninsula remained dry.

Figure 2:
Above-normal rainfall was received over most parts of the southern interior, Cape south coast, parts of the West Coast and much of the summer rainfall region. The northern interior and isolated parts in the winter rainfall region, KwaZulu-Natal, Mpumalanga, Limpopo and Gauteng were drier than normal.

Figure 3:
Since July, rainfall over the Northern Cape and adjacent Western and Eastern Cape provinces was mostly below normal. The central interior received near-normal rainfall while the northeastern parts of the country experienced above-normal rainfall.

Figure 4:
The central interior received significantly more rain this summer as compared to November-January of 2018/19. The rest of the country received relatively the same amounts of rainfall as compared to the same period of the previous year, with isolated negative values noted in the Limpopo Bushveld.

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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 to medium drought conditions for the month of January, it is evident that mild to severe drought (SPI 0 to -2) is widespread over most parts of the country. Areas of concern include much of the Northern Cape, Eastern Cape and parts of the Western Cape. Moderate to severe wet conditions were noted over southern North West (Dr Kenneth Kaunda District Municipality) towards the central Free State. When considering the long-term drought conditions, SPI values corresponding to wet conditions were similarly noted over the central parts of the country. Long-term severe to extreme droughts were noted, particularly in the Cape provinces, eastern Free State, parts of KZN, Limpopo and Mpumalanga, implying significantly low dam levels, and consequently impacting agricultural production.

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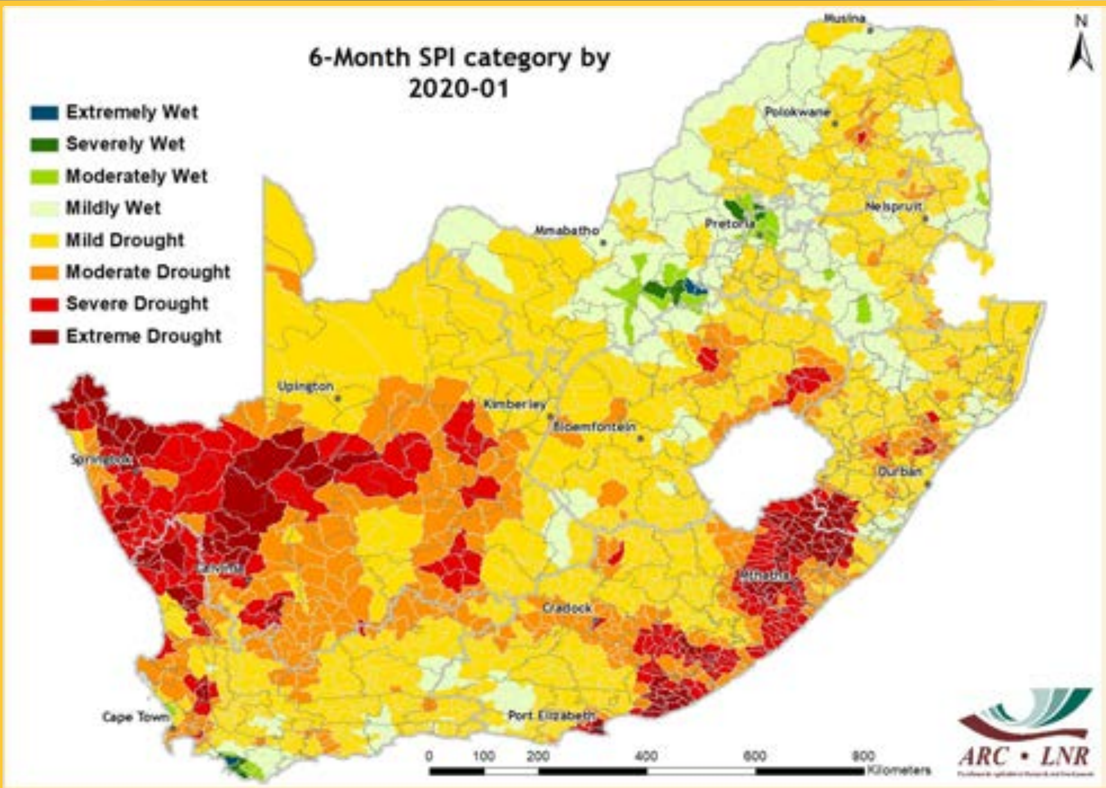

Figure 5

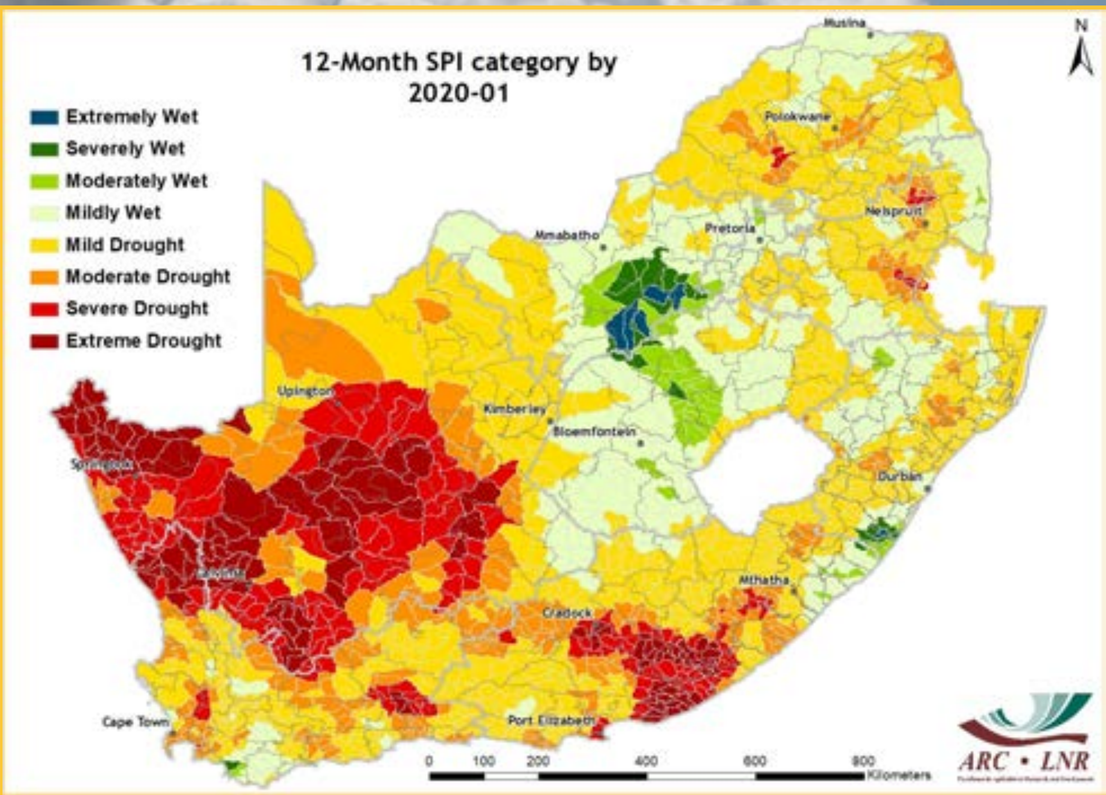

Figure 6

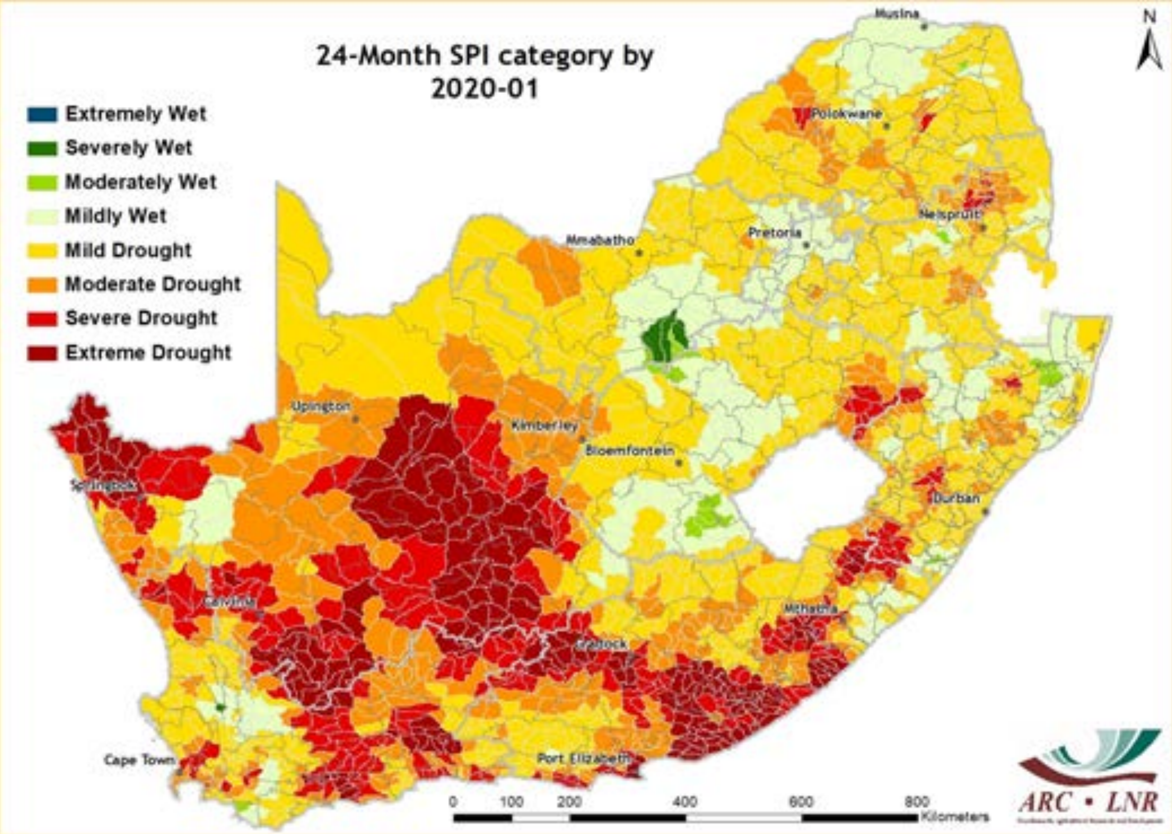

Figure 7

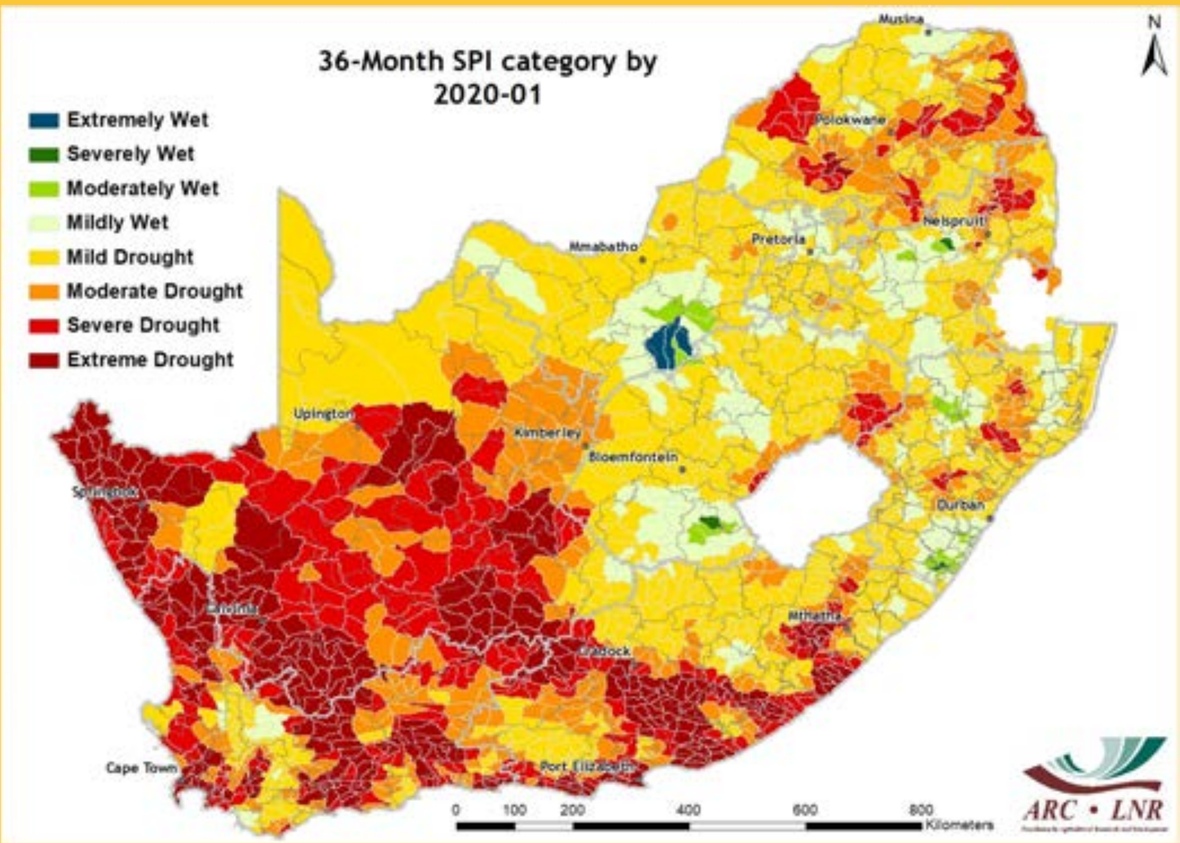

Figure 8

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.

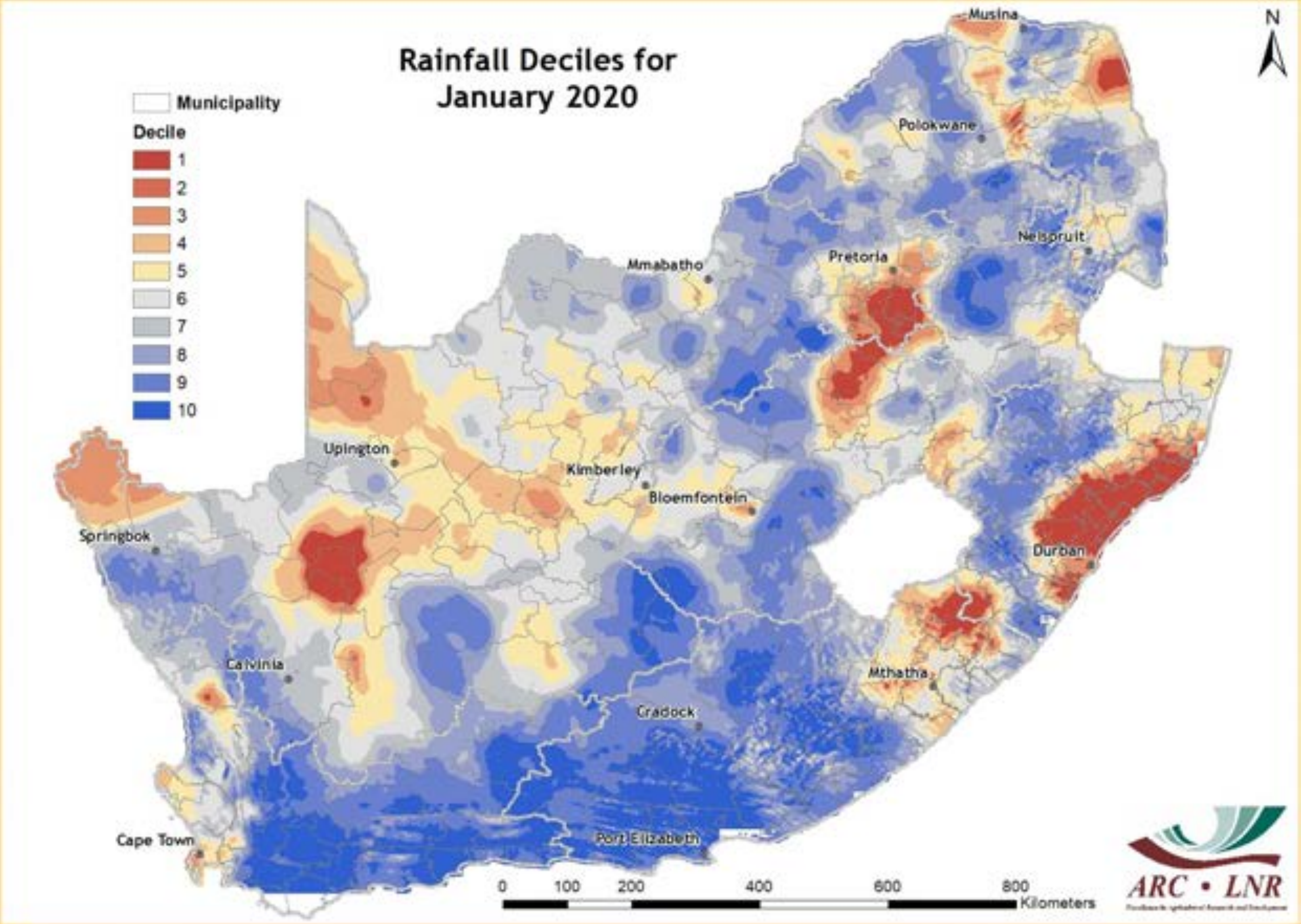

Figure 9

Figure 9:
Much of the southern interior, parts of the Cape south coast as well as areas over the West Coast and parts of the summer rainfall region experienced rainfall totals that compare well with the historically wetter January rainfall totals. The northern interior and isolated parts in the winter rainfall region, KwaZulu-Natal, Gauteng, Mpumalanga and Limpopo were drier than normal.

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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.

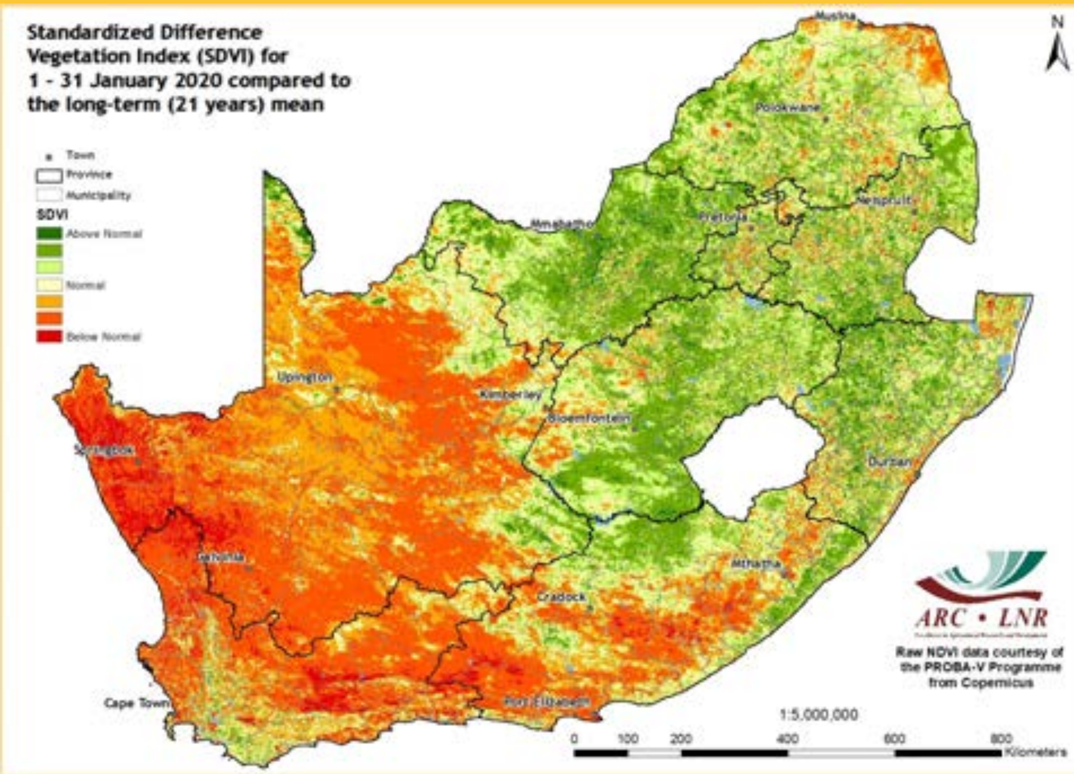

Figure 10

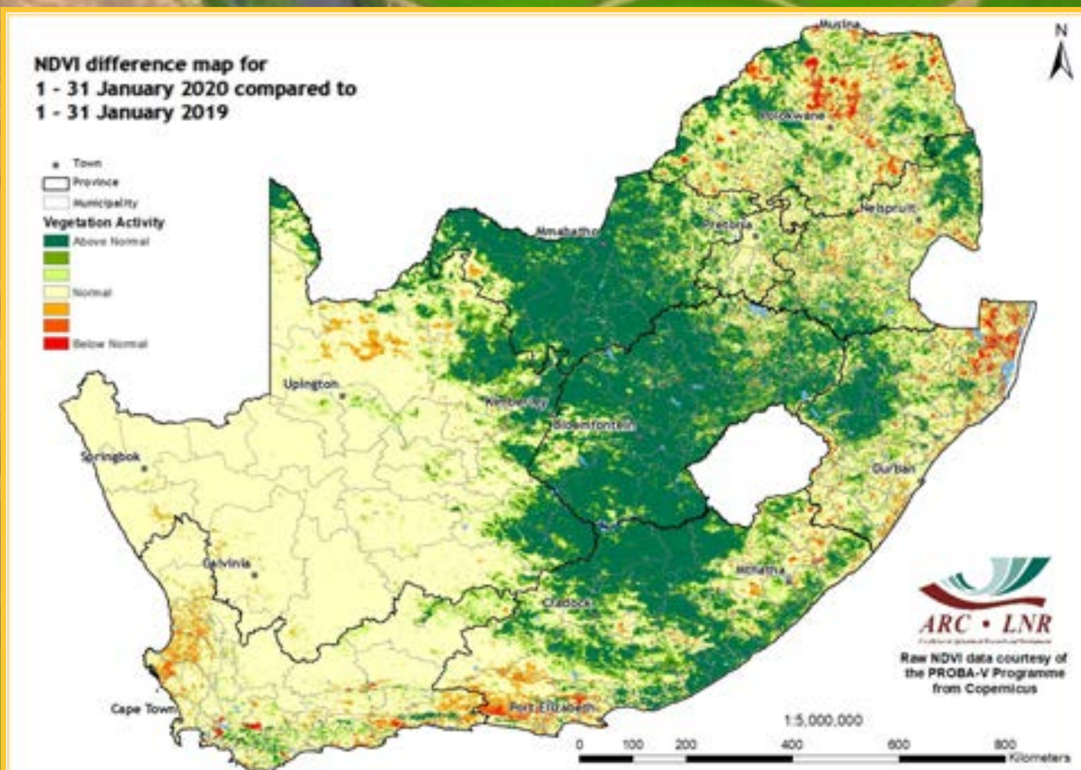

Figure 11

Figure 10:
The SDVI map for January shows that the western parts of the country, particularly the Cape region, remain an area of concern with regard to vegetation conditions. Conversely, the central and northern parts of the country are characterized by good vegetation activity.

Figure 11:
The NDVI difference map for January 2020 shows improved vegetation conditions in the central and northern parts compared to January last year. The remainder of the country continues to experience normal vegetation activity. However, pockets of below-normal activity are evident in isolated areas.

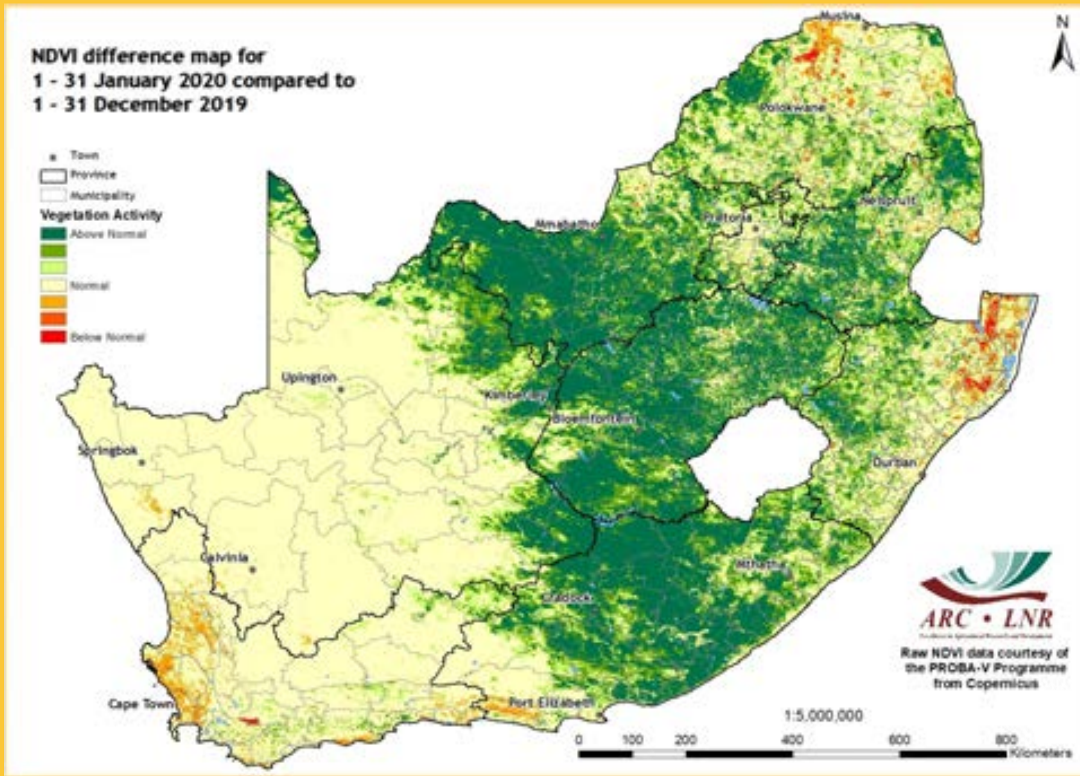

Figure 12

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

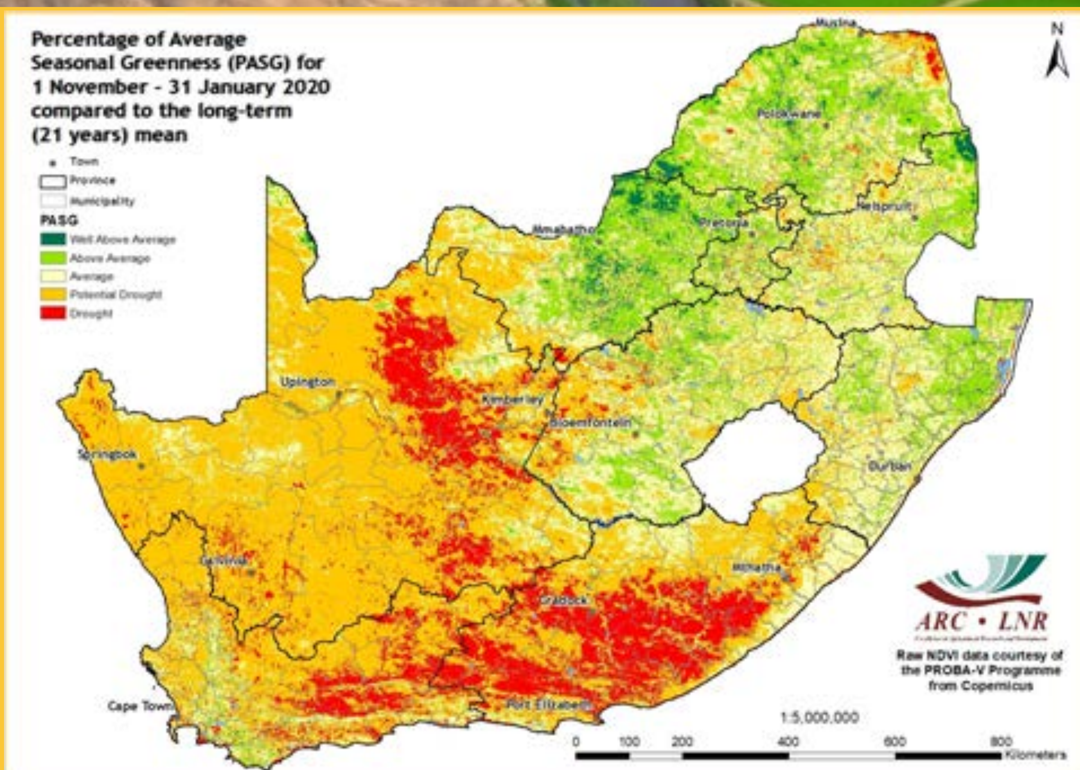

Figure 13

Figure 12:
Compared to the previous month, the January NDVI map shows that the country experienced normal to above-normal vegetation activity. Pockets of poor vegetation conditions were spotted in isolated areas of Limpopo, KwaZulu-Natal, Western and Eastern Cape provinces.

Figure 13:
The PASG map over a 3-month period compared to the long-term mean shows that the western part of the country continue to experience low levels of seasonal greenness in vegetation. Meanwhile, conditions in the northern and eastern parts of the country show improvement whereby the greenness has spread to larger geographical areas.

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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.

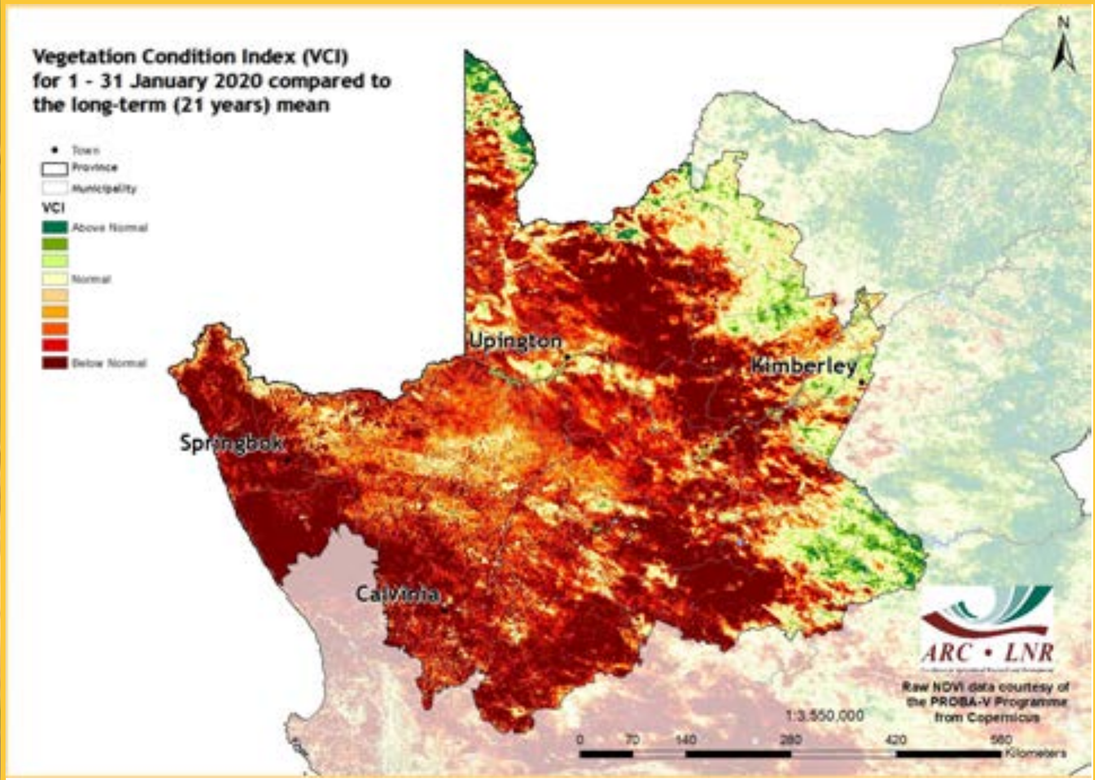

Figure 14

Figure 14:
The VCI map for January indicates that severe drought conditions continue to impact negatively on vegetation activity over larger areas of the Northern Cape.

Figure 15:
The VCI map for January indicates that many parts of the Western Cape continue to experience poor vegetation conditions, particularly the Central Karoo, northern parts of the West Coast, as well as northeastern and western parts of the Eden District Municipality. Minor exceptions were isolated areas in the western parts of the province.

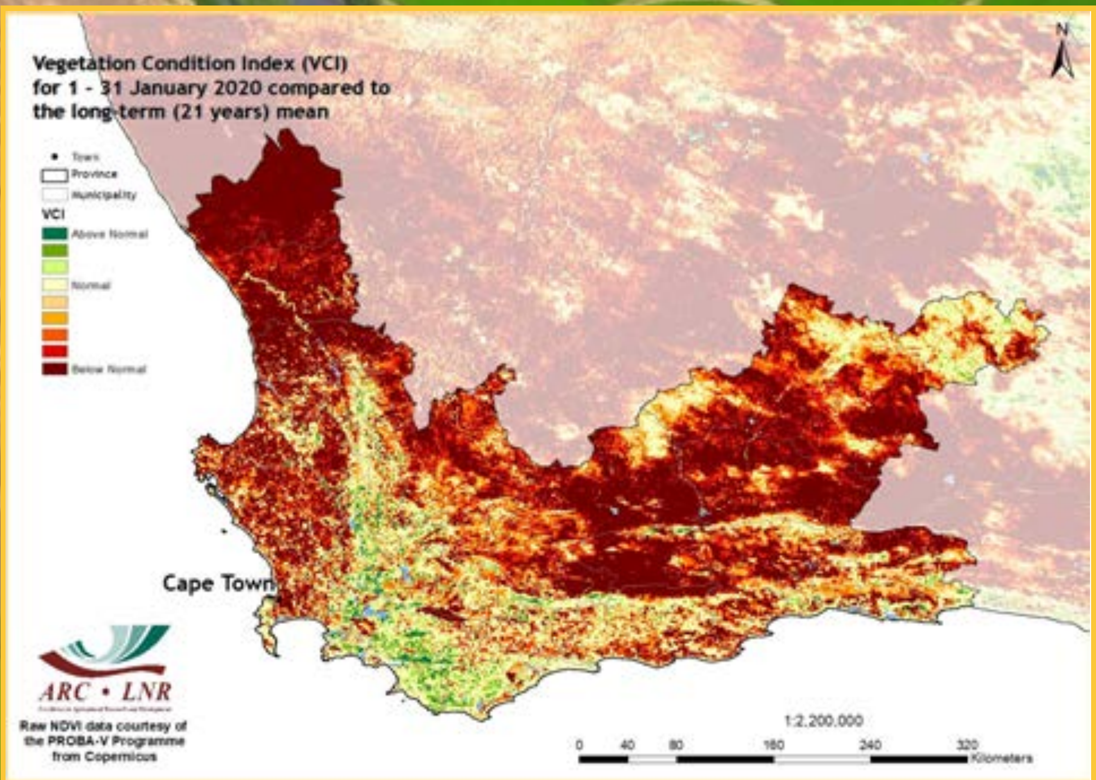

Figure 15

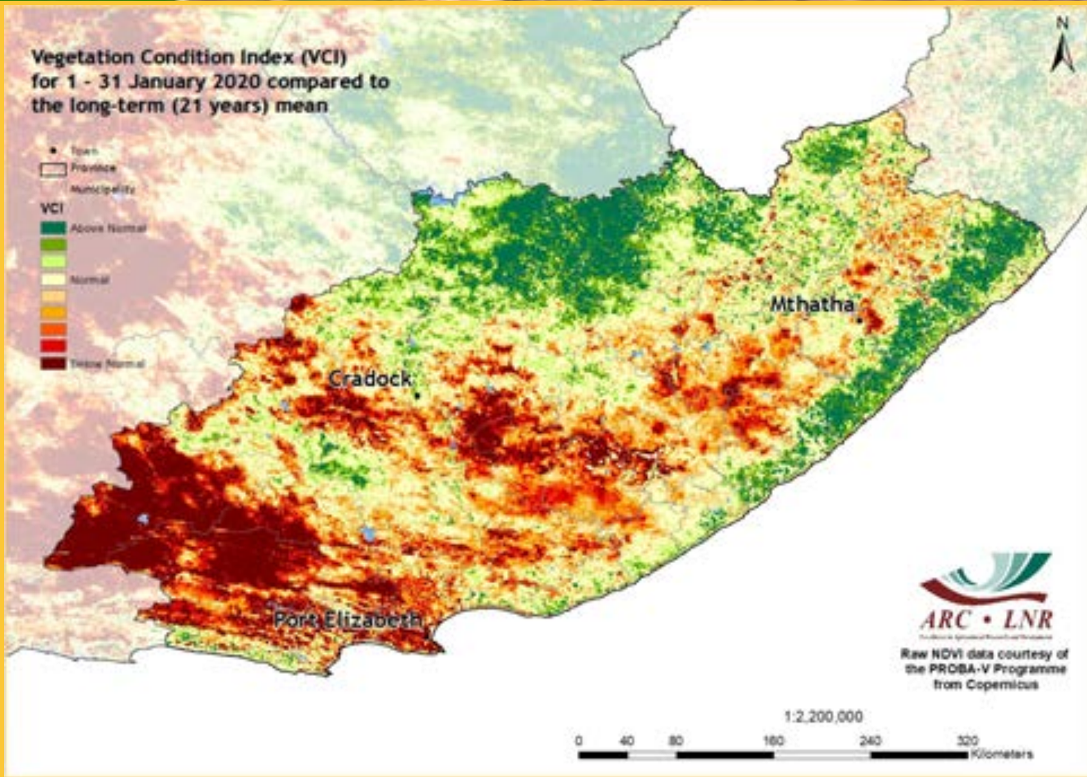

Figure 16

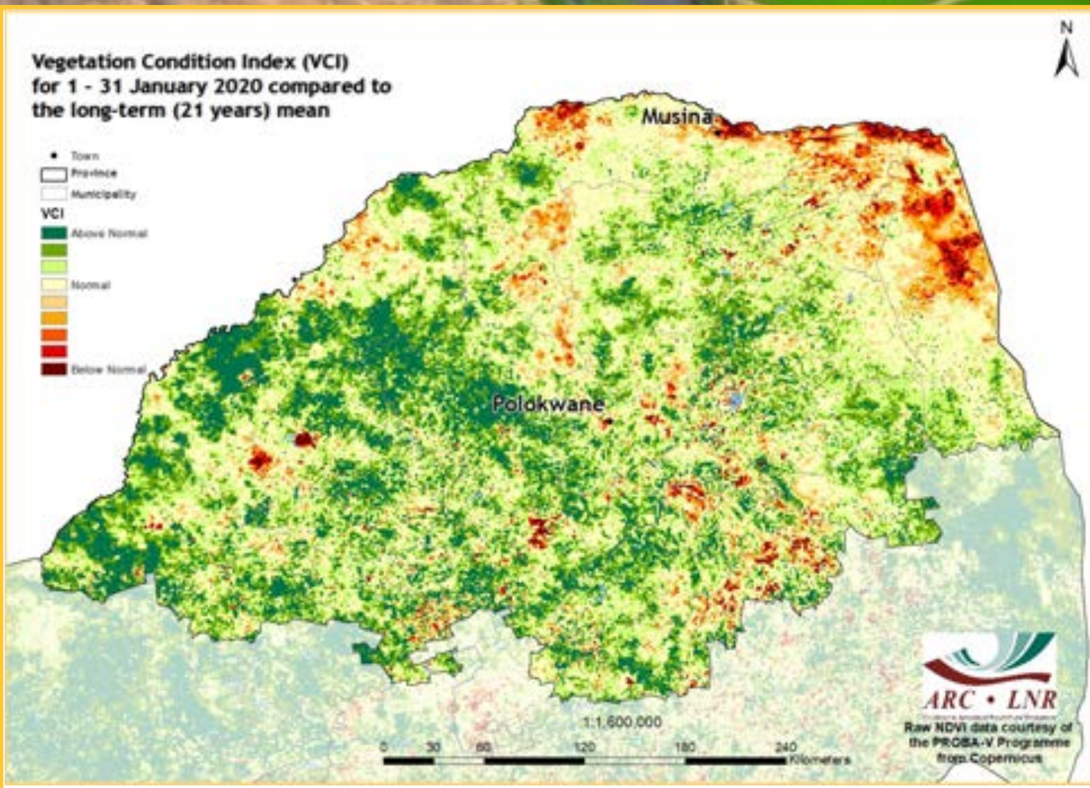

Figure 17

Figure 16:
The VCI map for January indicates that, compared to the long-term average, many parts of the Eastern Cape continue to experience poor vegetation activity. Minor exceptions can be observed in the northern and costal parts of the province.

Figure 17:
The VCI map for January indicates that the eastern parts and some other isolated areas of Limpopo experienced poor vegetation activity while the central and western parts of the province experienced above-normal conditions.

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6. Vegetation Conditions & Rainfall

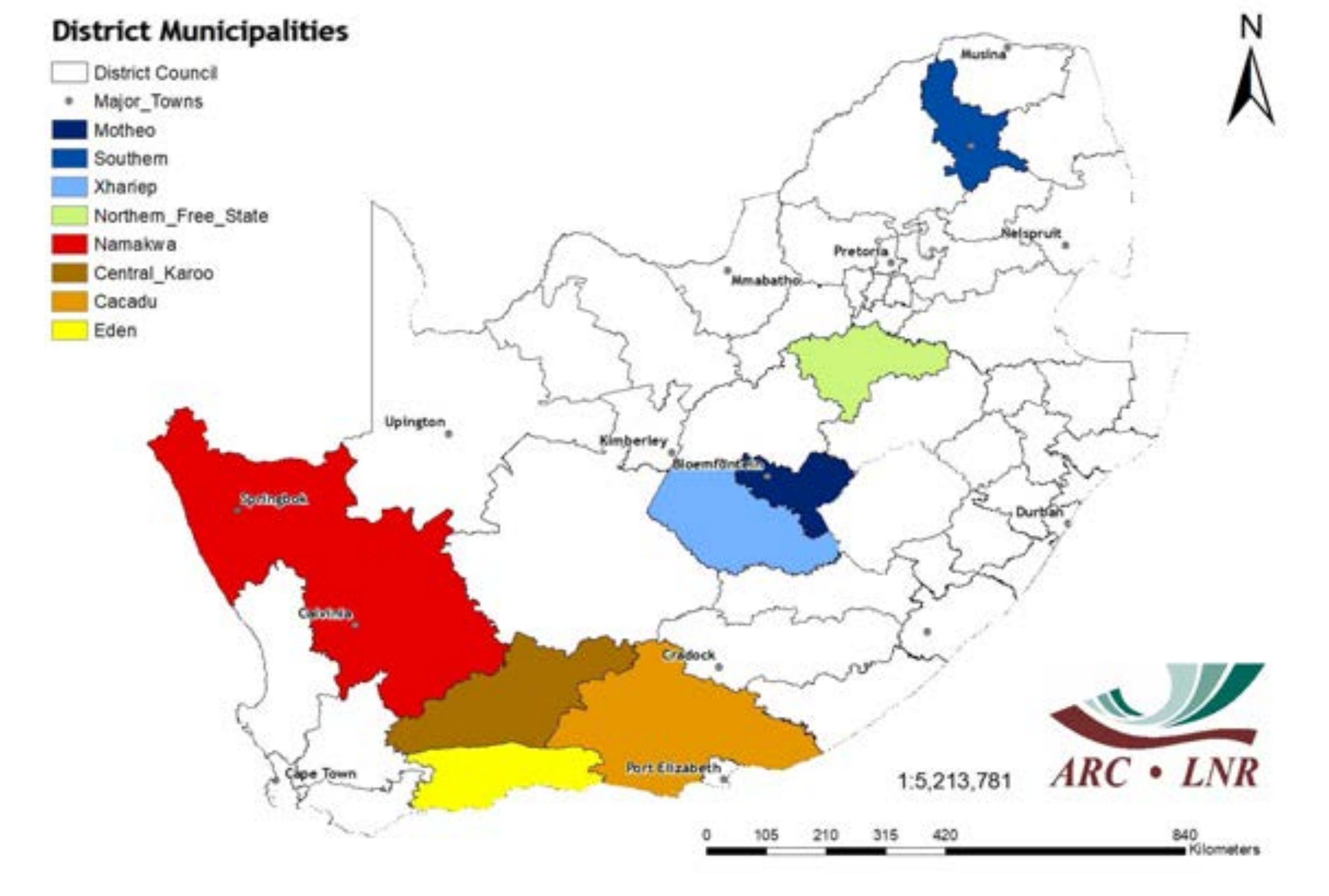

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for January 2020. 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.

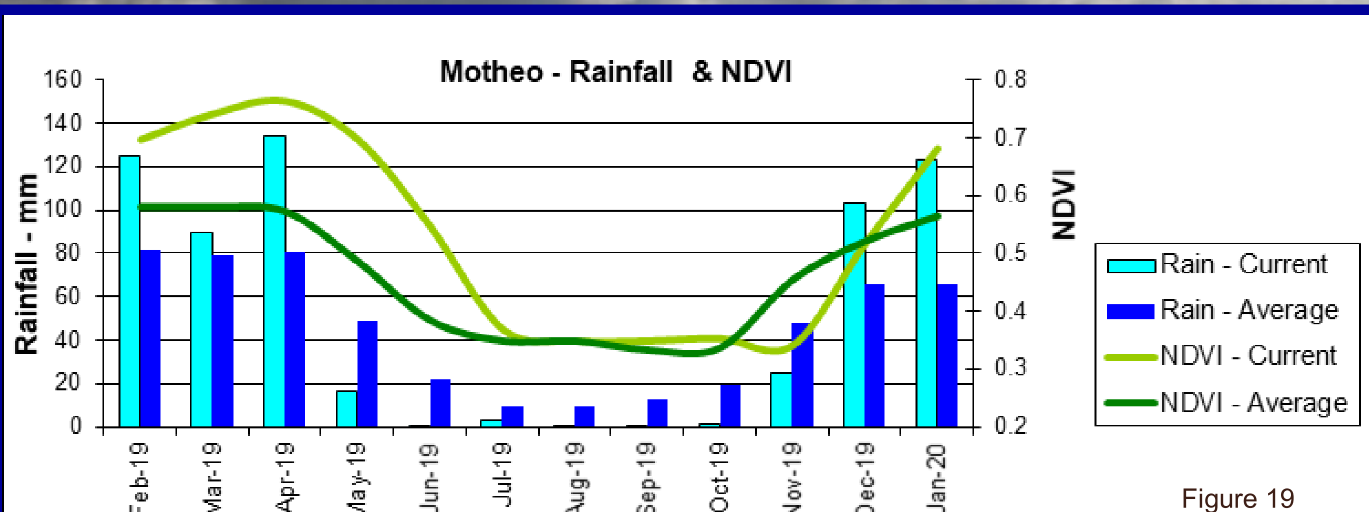


Figure 19

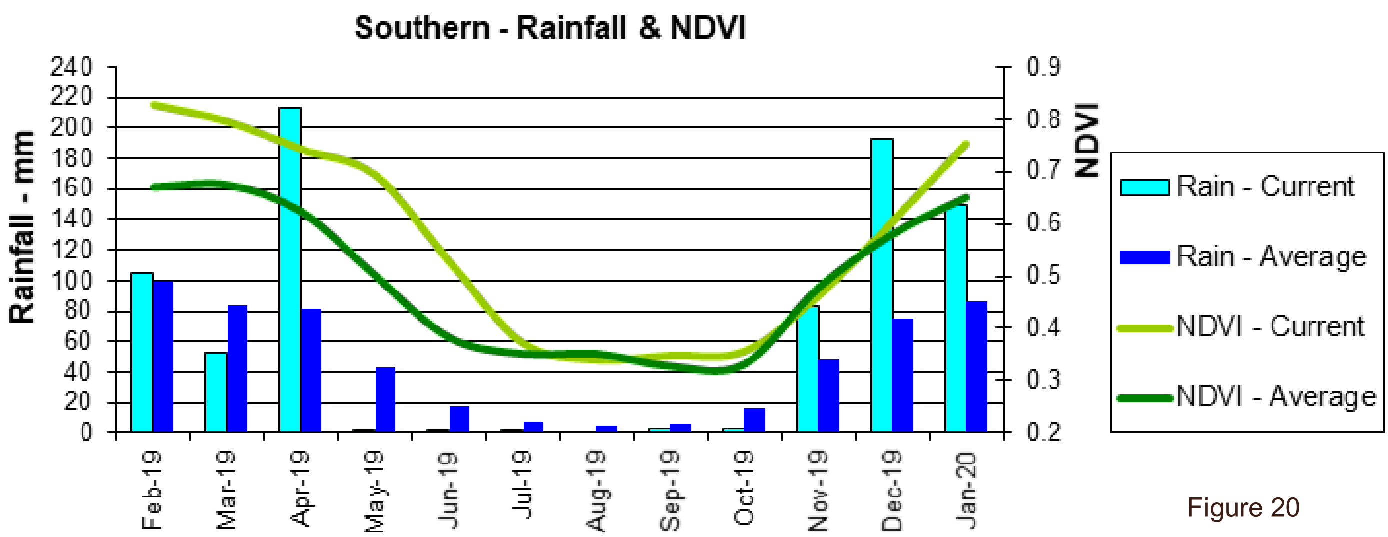


Figure 20

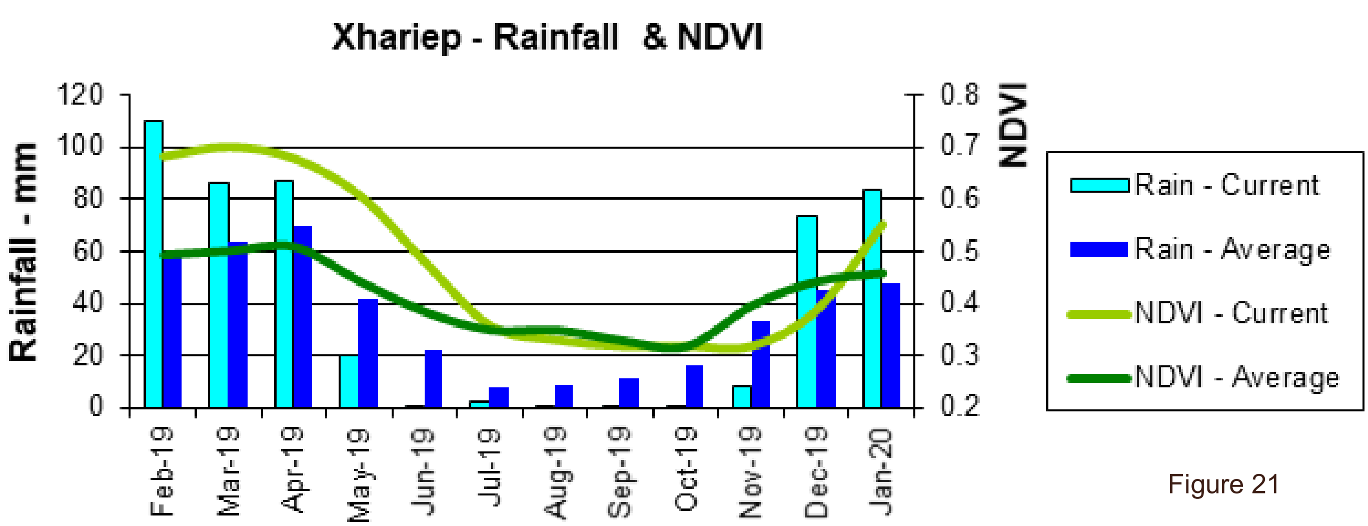


Figure 21

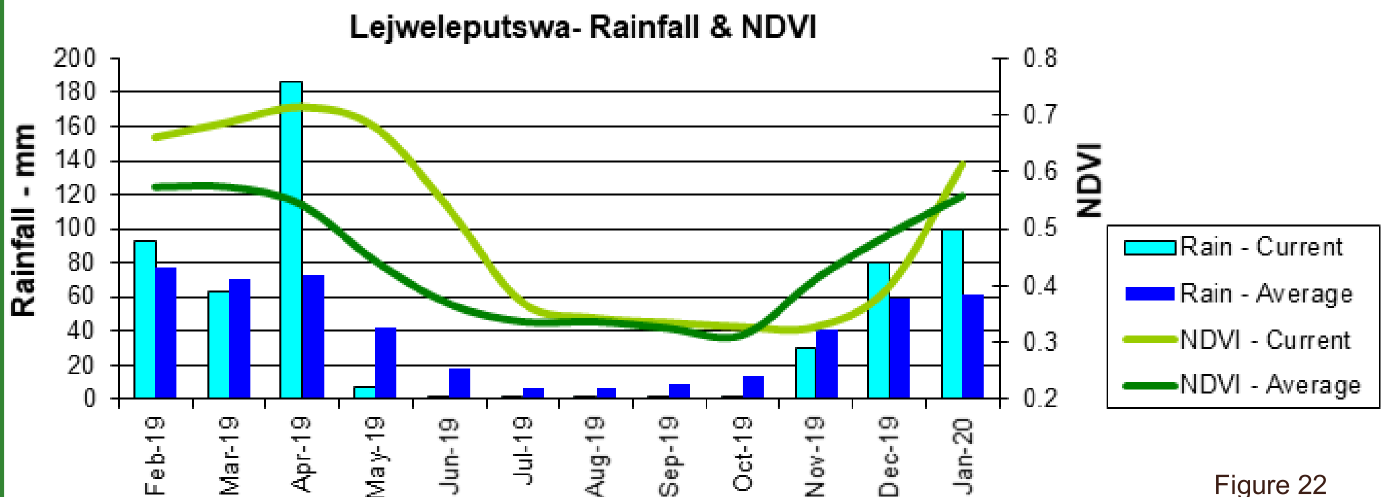
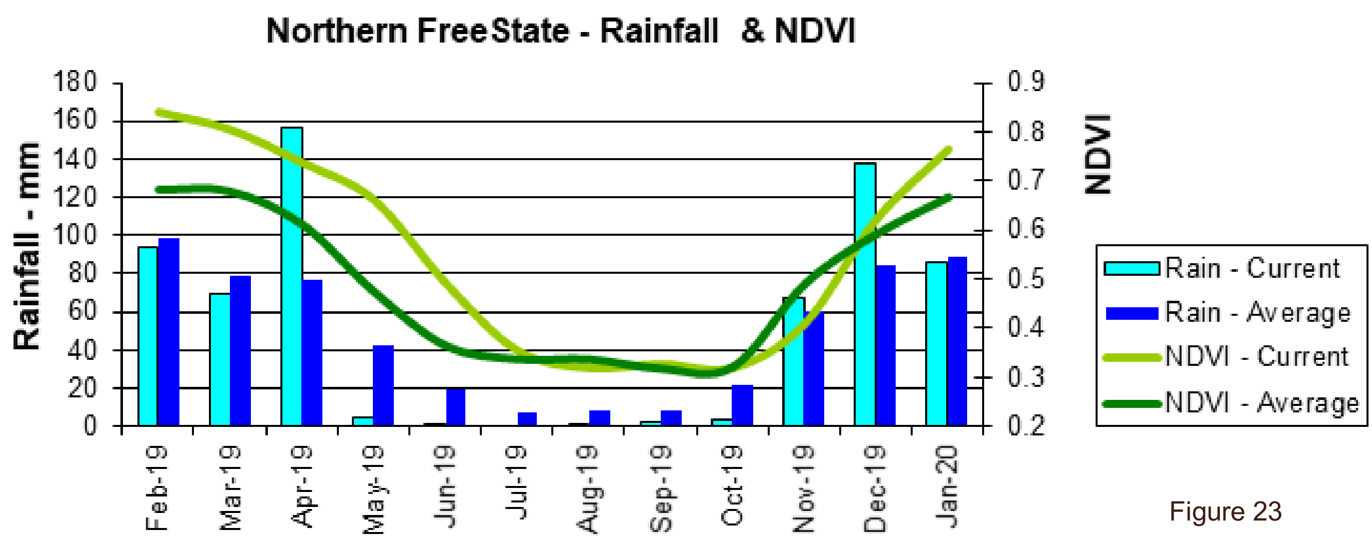


Figure 22



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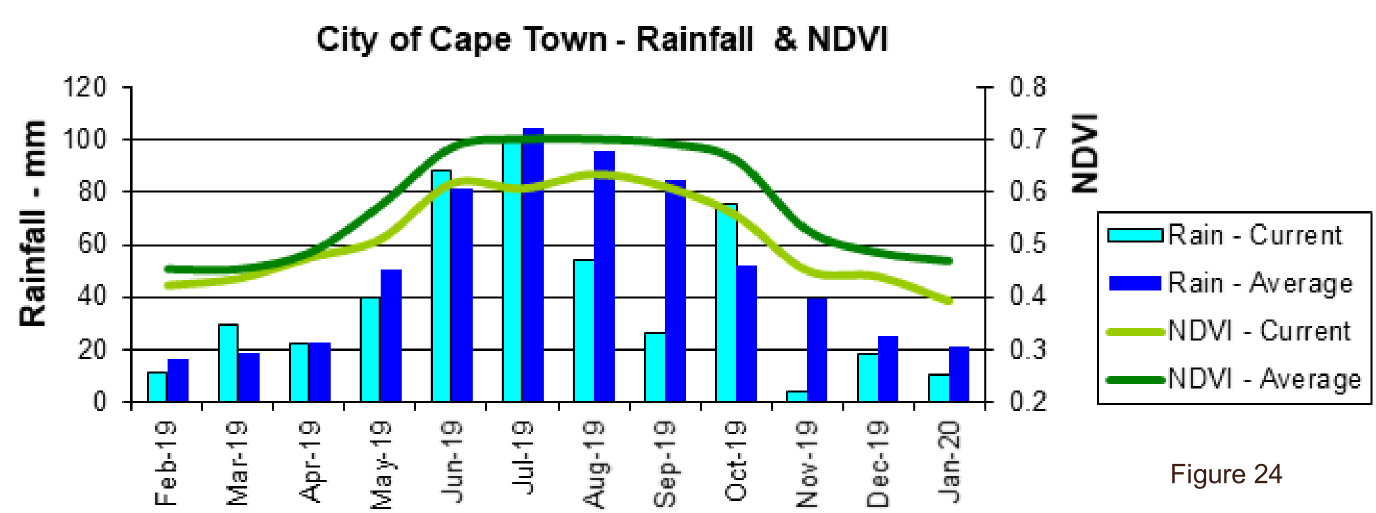

Figure 24

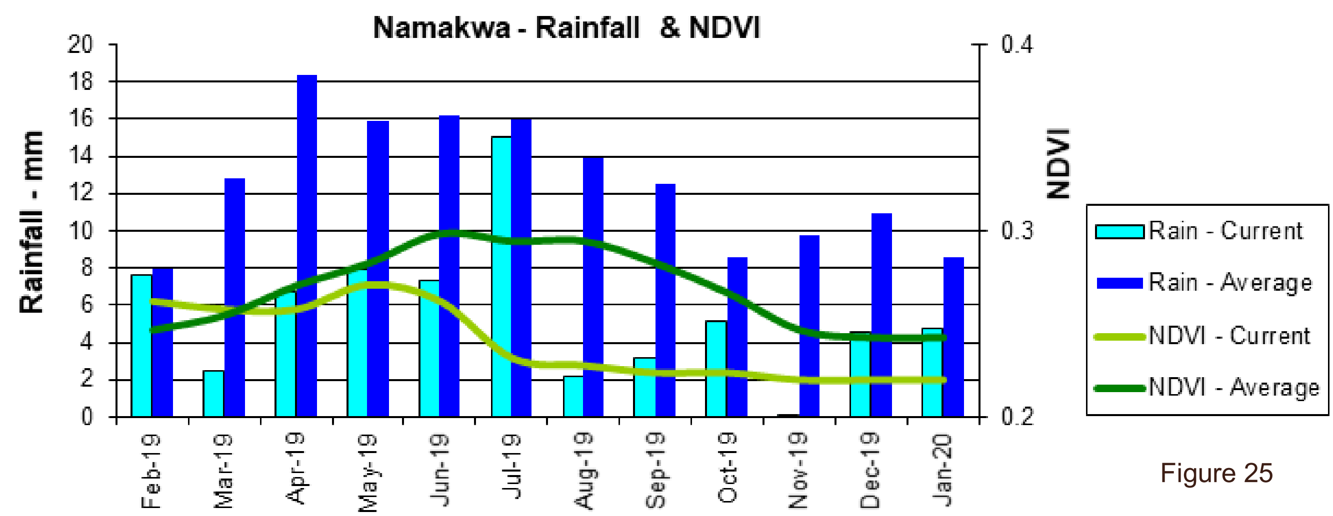

Figure 25

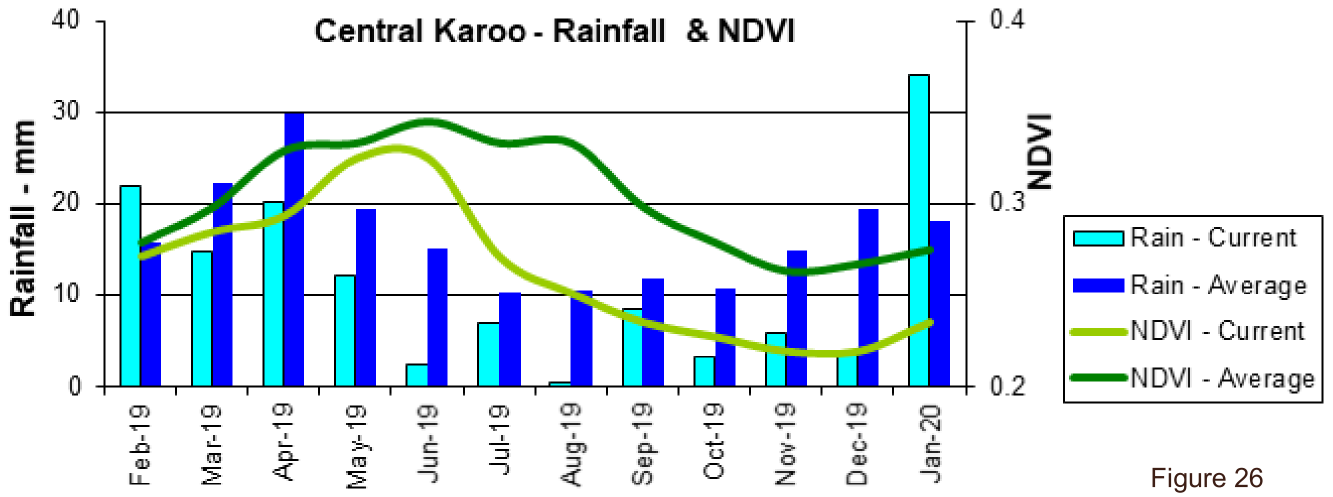

Figure 26

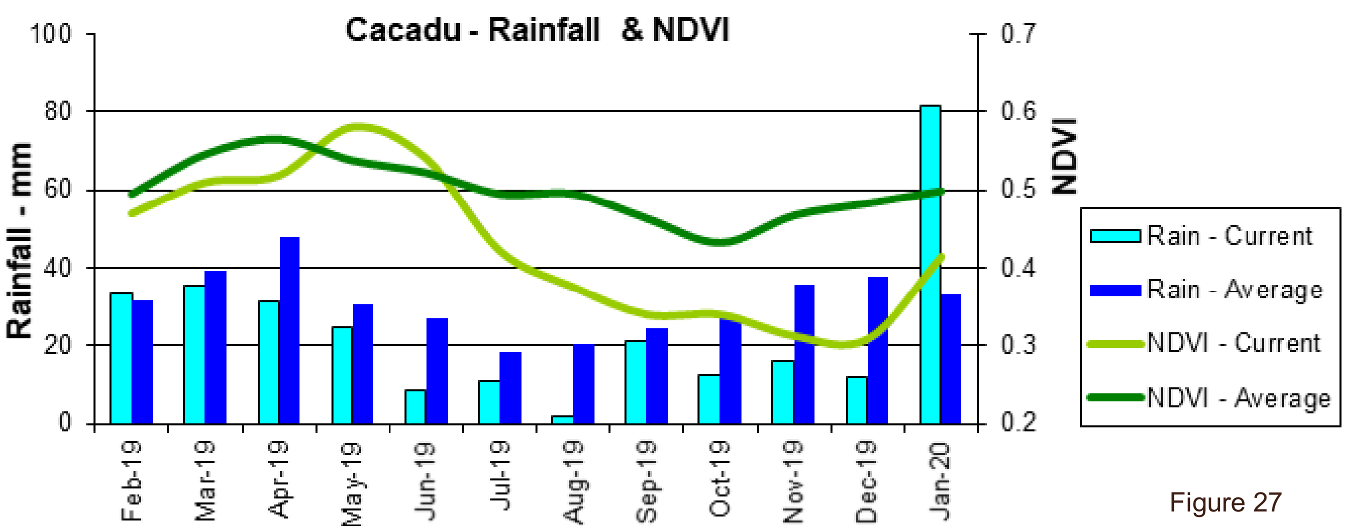

Figure 27

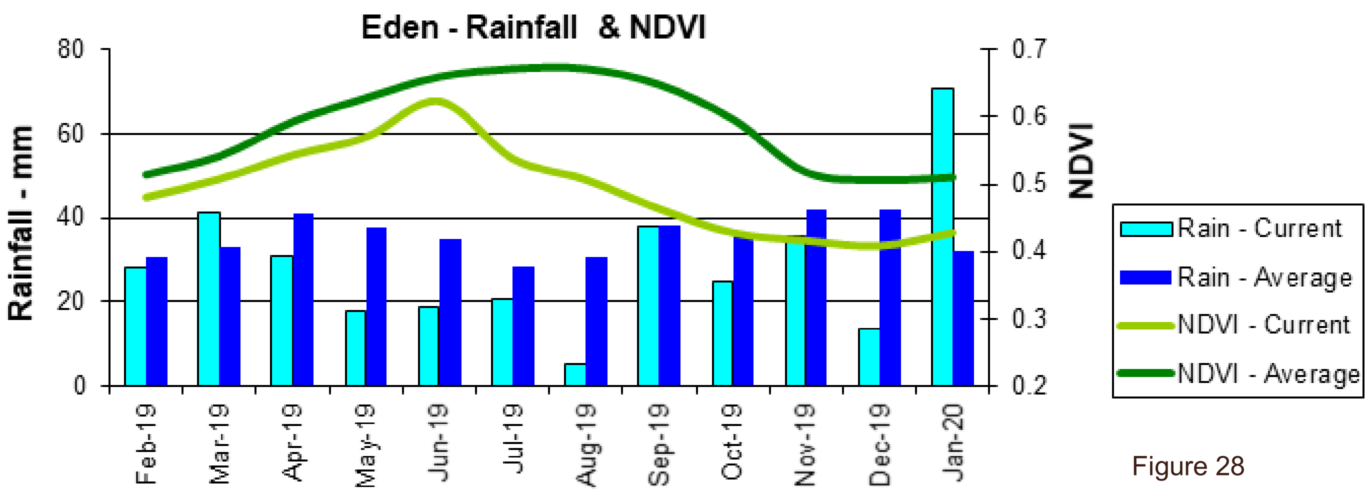

Figure 28

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 2020 per province. Fire activity was lower in all provinces compared to the long-term average.

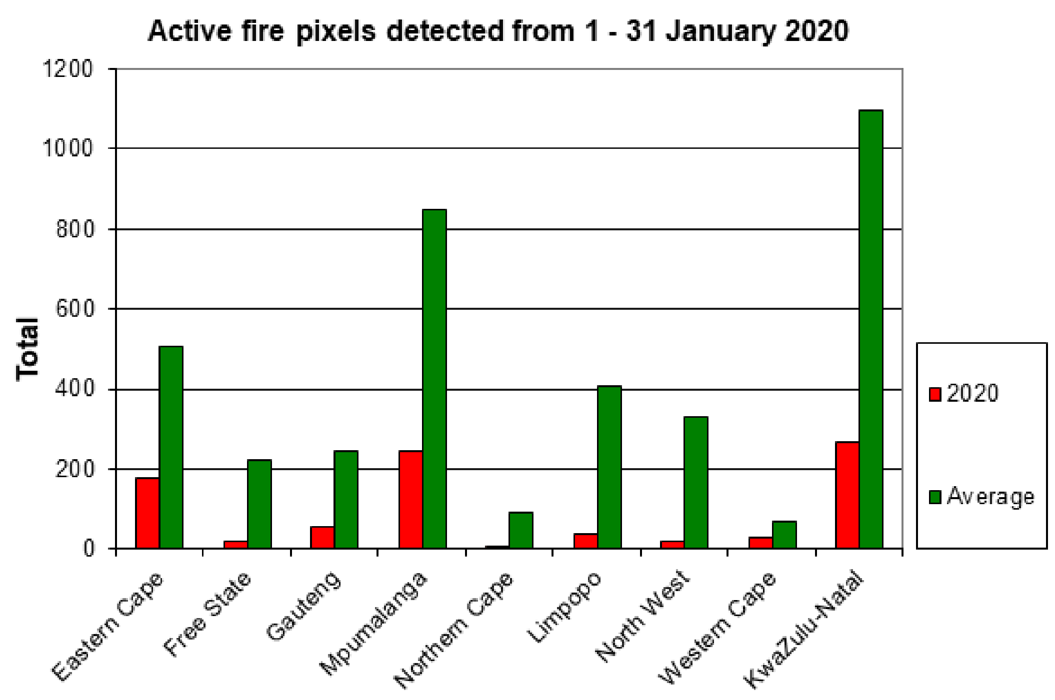

Figure 29

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

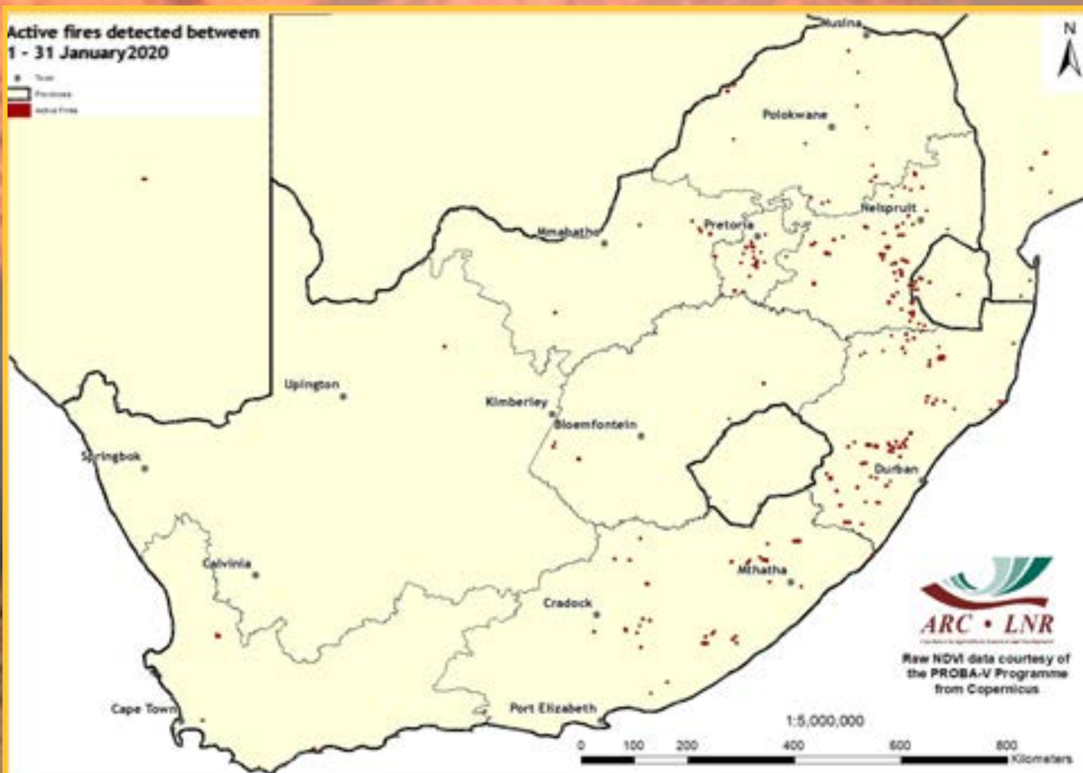

Figure 30

8. Surface Water Resources

Countrywide surface water areas (SWAs) are mapped on a monthly basis by GeoTerraImage using Sentinel 2 satellite imagery from the start of its availability at the end of 2015.

Figure 31 shows a comparison between the area of water available now and the maximum area of surface water recorded in the last 3 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 2019.

The long-term map for January 2020 shows significantly higher water levels in many catchments compared to the December 2019 long-term map, although catchments in the Karoo region continue to show similar, low water levels. A number of catchments above the escarpment in both Limpopo and Mpumalanga are also now showing lower water levels compared to the maximum recorded in the same catchments since the end of 2015, which is a significant change from the previous December 2019 long-term comparison map.

The comparison between January 2020 and January 2019 is now showing generally higher overall water levels across the country, compared to the equivalent situation last month. Significantly higher water levels are now found in a number of catchments across the country, especially in the Karoo and catchments bordering Botswana, Zimbabwe and Mozambique in the Limpopo, North West and Mpumalanga provinces.

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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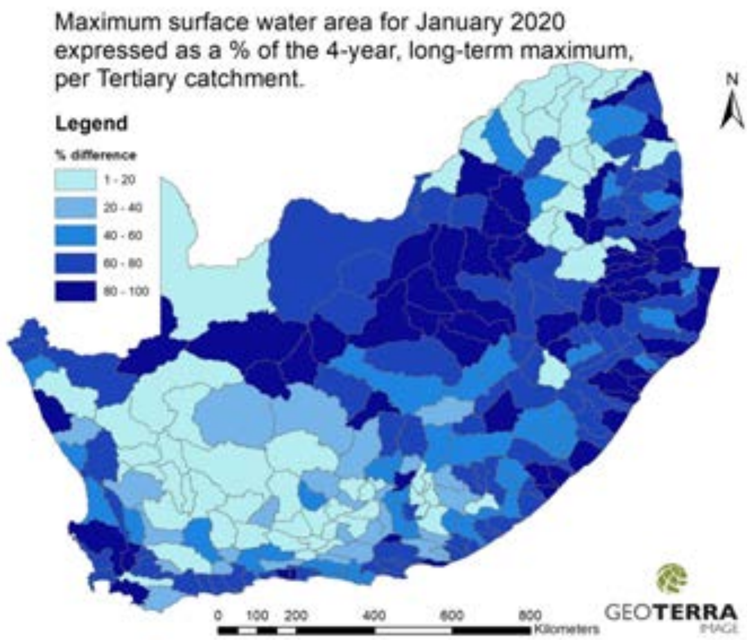


Figure 31

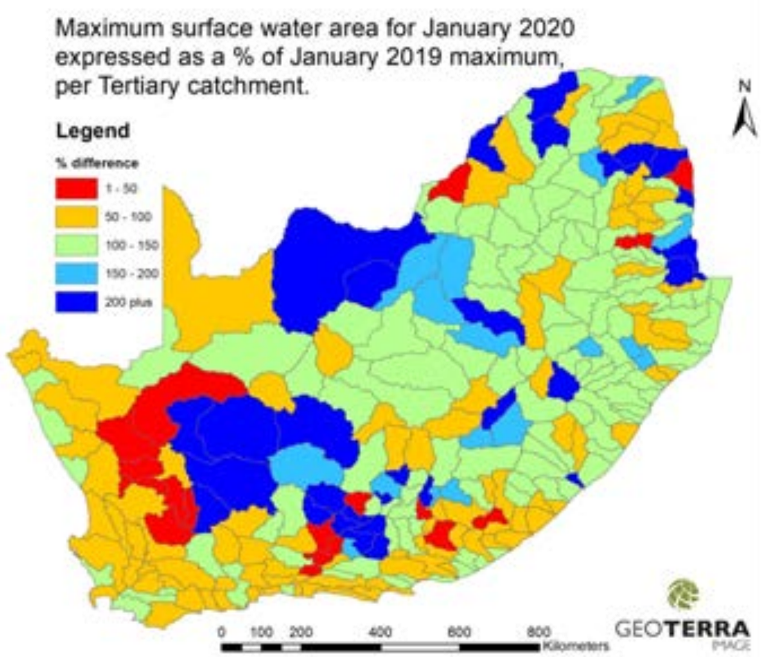
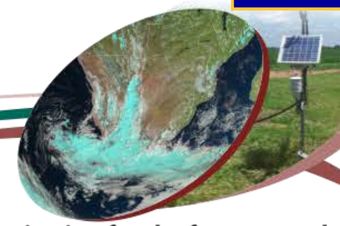


Figure 32

GEOTERRA IMAGE ARC • LNR

Agrometeorology



The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national asset.

FOCUS AREAS

Climate Monitoring, Analysis & Modelling

- Analysis of climate variability and climate model simulation
- Use of crop modelling to assess the impact of climate on agriculture
- Development of decision support tools for farmers

Climate Change Adaptation & Mitigation

- National greenhouse gas inventory in the agricultural sector
- Improvement of agricultural production technologies under climate change
- Adaptation and mitigation initiatives, e.g. biogas production in small-scale farming communities

Climate Information Dissemination

- Communication to farmers for alleviating weather-related disasters such as droughts
- Dissemination of information collected from weather stations
- Climate change awareness campaigns in farming communities

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Geoinformation Science

The programme focuses on applied Geographical Information Systems (GIS) and Earth Observation (EO)/Remote Sensing research and provides leadership in applied GIS products, solutions, and decision support systems for agriculture and natural resources management. The Coarse Resolution Satellite Image Archive and Information Database is maintained as a national asset.

FOCUS AREAS

Decision Support Systems

- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

Early Warning & Food Security

- Drought and vegetation production monitoring
- Crop estimates and yield modelling
- Animal biomass and grazing capacity mapping
- Global and local agricultural outlook forecasts
- Disaster monitoring for agricultural systems

Natural Resources Monitoring

- Land use/cover mapping
- Invasive species distribution
- Applications of GIS and EO on land degradation/erosion, desertification, hydrology and catchment areas
- Rangeland health assessments
- Carbon inventory monitoring

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The Coarse Resolution Imagery Database (CRID)

NOAA AVHRR

The ARC-ISCW has an archive of daily NOAA AVHRR data dating from 1985 to 2004. This database includes all 5 bands as well as the Normalized Difference Vegetation Index (NDVI), Active Fire and Land Surface Temperature (LST) images. The NOAA data are used, for example, for crop production and grazing capacity estimation.

MODIS

MODIS data is distributed by the Land Processes Distributed Active Archive Center (LP DAAC), located at the U.S. Geological Survey's EROS Data Center. The MODIS sensor is more advanced than NOAA with regard to its high spatial (250 m^2 to 1 km^2) and spectral resolution. The ARC-ISCW has an archive of MODIS (version 4 and 5) data.

- MODIS v4 from 2000 to 2006
- MODIS v5 from 2000 to present

Datasets include:

- MOD09 (Surface Reflectance)
- MOD11 (Land Surface Temperature)
- MOD13 (Vegetation Products)
- MOD14 (Active Fire)
- MOD15 (Leaf Area Index & Fraction of Photosynthetically Active Radiation
- MOD17 (Gross Primary Productivity)
- MCD43 (Albedo & Nadir Reflectance)
- MCD45 (Burn Scar)

Coverage for version 5 includes South Africa, Namibia, Botswana, Zimbabwe and Mozambique.
More information:
http://modis.gsfc.nasa.gov

VGT4AFRICA and GEOSUCCESS

SPOT NDVI data is provided courtesy of the VEGETATION Programme and the VGT4AFRICA project. The European Commission jointly developed the VEGETATION Programme. The VGT4AFRICA project disseminates VEGETATION products in Africa through GEONETCast.

ARC-ISCW has an archive of VEGETATION data dating from 1998 to the present. Other products distributed through VGT4AFRICA and GEOSUCCESS include Net Primary Productivity, Normalized Difference Wetness Index and Dry Matter Productivity data.

Meteosat Second Generation (MSG)

The ARC-ISCW has an operational MSG receiving station. Data from April 2005 to the present have been archived. MSG produces data with a 15-minute temporal resolution for the entire African continent. Over South Africa the spatial resolution of the data is in the order of 3 km. The ARC-ISCW investigated the potential for the development of products for application in agriculture. NDVI, LST and cloud cover products were some of the initial products derived from the MSG SEVIRI data. Other products derived from MSG used weather station data, including air temperature, humidity and solar radiation.

Rainfall maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network, 270 automatic rainfall recording stations from the SAWS, satellite rainfall estimates from the Famine Early Warning System Network: **http://earlywarning.usgs.gov** and long-term average climate surfaces developed at the ARC-ISCW.

Solar Radiation and Evapotranspiration maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network.
- Data from the METEOSAT Second Generation (MSG) 3 satellite via GEONETCAST: **http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast/GEONETCast/index.html**.

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