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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

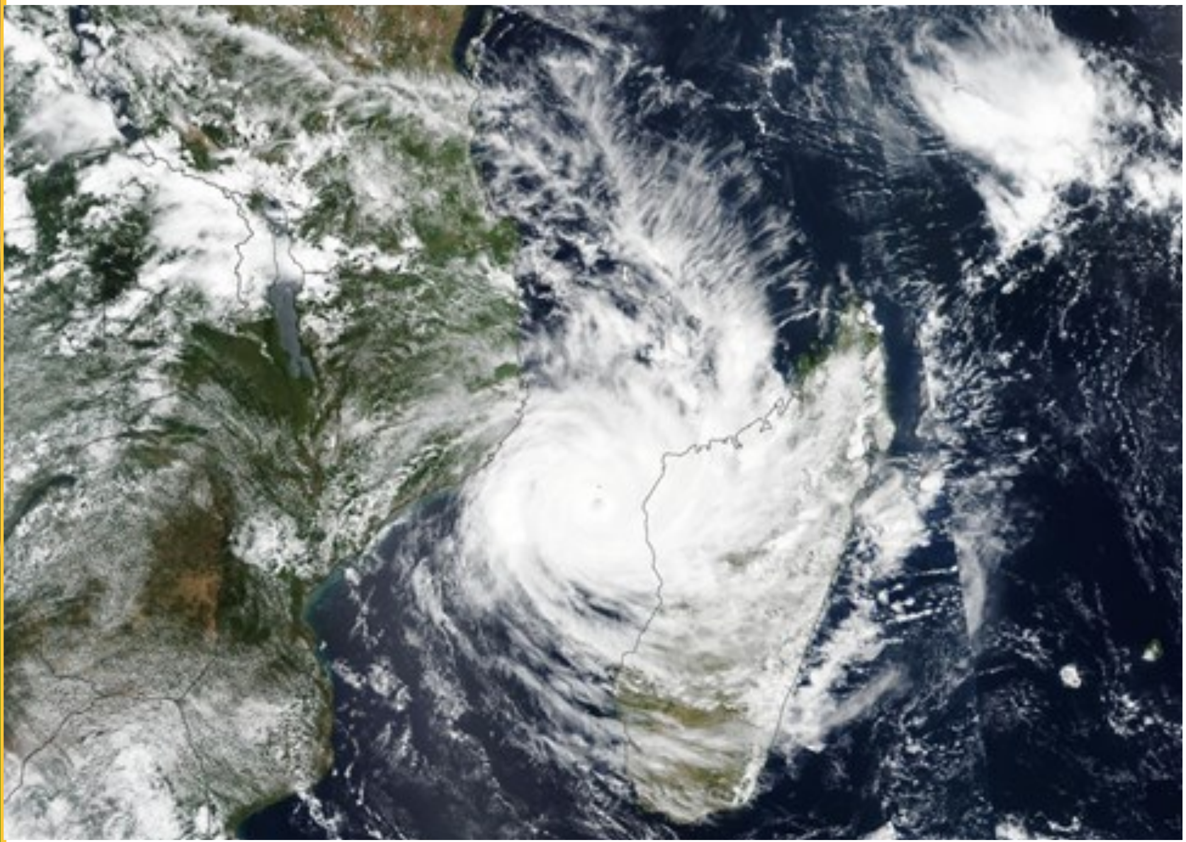
CONTENTS:

177th Edition

Image of the Month

Loss of life and widespread damage when tropical cyclone Idai makes landfall in Mozambique

Tropical cyclone Idai made landfall near Beira in central Mozambique late on Thursday, 14 March 2019. At the time of landfall the system was an intense tropical cyclone, an intensity equivalent to that of a category 3 hurricane in the North Atlantic Ocean basin. The system sustained winds with speeds of more than 165 km/h, peaking at times at over 200 km/h. The system brought widespread flooding over central and northern Mozambique, Uganda and eastern Zimbabwe. Official rainfall records still need to be confirmed but are currently estimated to have ranged between 150 and 300 mm over large areas in Mozambique. Widespread flooding occurred in Beira, which is situated on the northern banks of the Punge River, and spread northwards and eventually westwards on 16 March, when rivers also flooded in eastern Zimbabwe. Widespread damage and a devastating loss of life have since been reported. Initial reports were of about 500 human lives lost in Mozambique, Malawi and Zimbabwe, but it is feared that this number may increase, given that numerous people are still reported missing. Further to the south, in South Africa, landfall of the cyclone was associated with a dry spell and sunny conditions, due to the area of subsidence occurring to the south of the cyclone.



SOURCE: https://eoimages.gsfc.nasa.gov/images/imagerecords/144000/144651/idai_viirs_201970_lrg.jpg

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, Forestry and Fisheries (DAFF).

1. Rainfall

Overview:

February 2019 has been the best rainfall month of the 2018/19 summer rainfall season for the larger part of the country so far. Rainfall days occurred more frequently with a few good rainfall events that occurred over the central to eastern parts of South Africa. The month commenced with a cut-off low weather system that resulted in good rainfall over the southern and southeastern parts of the country that was displaced to the northeastern parts. Shortly after this rainfall producing weather system dissipated, the atmospheric circulation became favourable for rainfall formation over the western to central parts of the country. Into the second week of February, conditions were favourable for the frequent occurrence of rainfall over the central to eastern parts. The atmospheric circulation to the north of South Africa was of such a nature towards the middle of the month that it aided in rainfall formation over the northern and northeastern parts of the country. These conditions lasted for several days before ceasing as drier air moved in over the country from the west. By the start of the last week of the month, conditions were again favourable for the development of thunderstorm activity over the eastern parts of the country, particularly over the high ground regions. The last few days of February were characterized by rainfall that occurred along the southern and eastern coasts and adjacent interior regions.

The occurrence of heatwave days were generally less during the month of February as compared to the preceding months of the 2018/19 summer season. Over the maize producing region, only the western parts of North West experienced more heatwave days than normal.

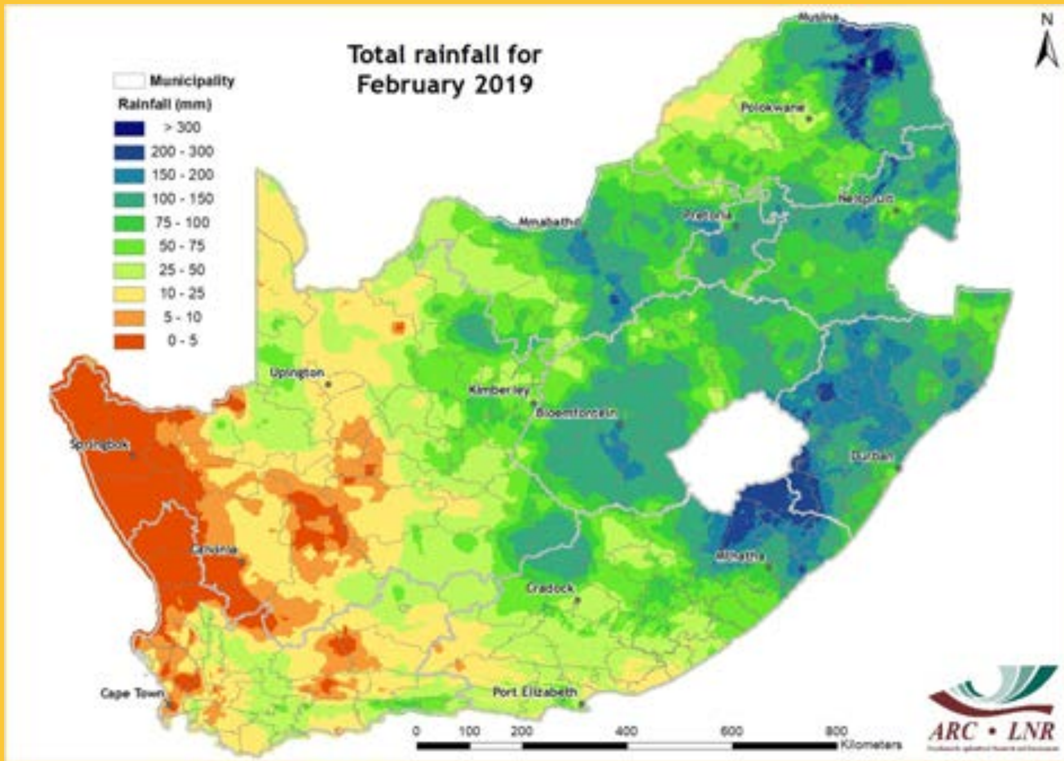


Figure 1

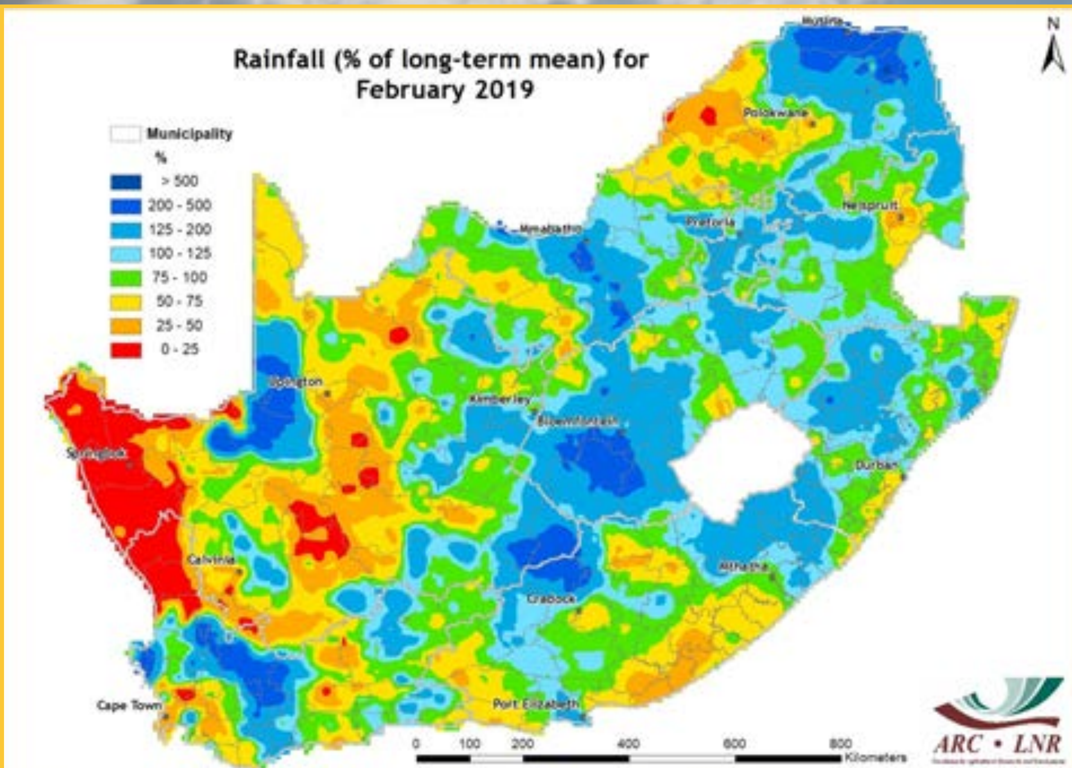


Figure 2

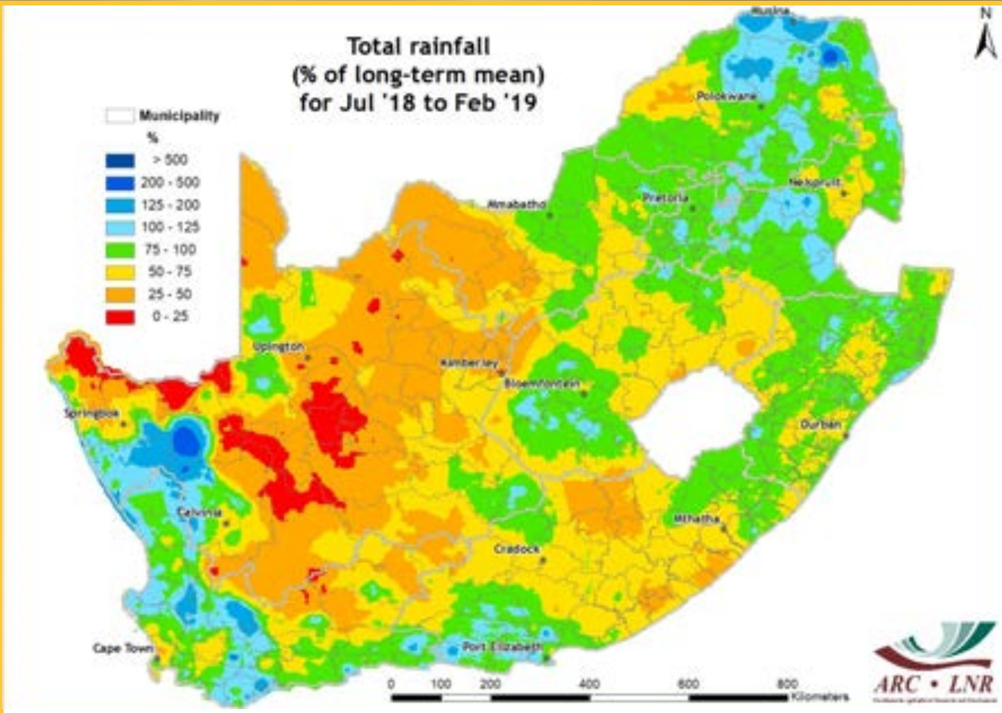


Figure 3

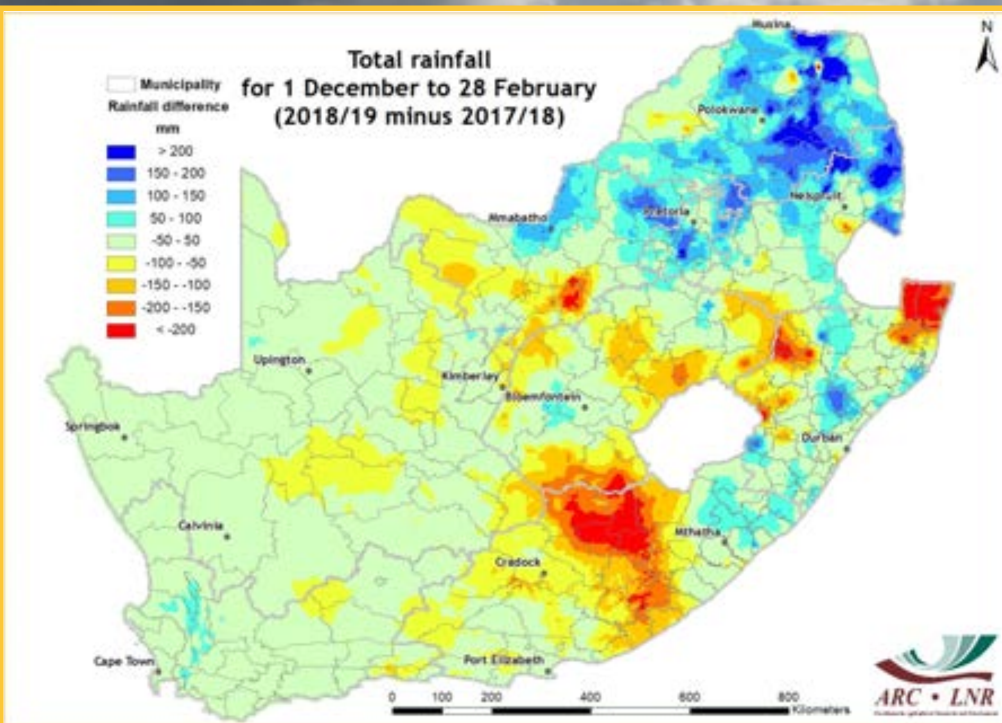


Figure 4

Figure 1:
Large parts of the central and eastern parts of the country received more than 100 mm of rainfall during February, exceeding 300 mm in places along the eastern escarpment .

Figure 2:
Near- to above-normal rainfall occurred over large parts of the country in February. At the start of the month a good rainfall system resulted in rain over the southern parts of the country, whilst the central to eastern parts of the country received good rains towards the middle of the month and again during the last week of the month. February had generally more rainfall days than the previous rainfall months of the 2018/19 summer season.

Figure 3:
During this 8-month period above-normal rainfall occurred over parts of the winter rainfall region. Further to the east along the Cape south coast, near-normal rainfall occurred with above-normal rainfall in some places. However, over the latter rainfall region, most of the months of this 8-month period were actually very dry. Over the summer rainfall region, large areas in the west to central parts of the country received below-normal rainfall during this period. Some areas over the eastern parts received near-normal rainfall with isolated areas receiving above-normal rainfall.

Figure 4:
Compared to the corresponding 3-month period a year ago, the far northeast of the country had areas that received up to 200 mm more this year. Over the southeastern parts of the country as well as some isolated areas further north, the current December to February period received less rain than last year – in some places more than 200 mm less.

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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 severe drought over the southwestern parts of the country visible on the longer time scales (24 and 48 months) as represented by the SPI ending in February 2019 shows signs of relief on the 6-month and 12-month SPI maps. The good rain at the end of August into the beginning of September 2018 that occurred along the Cape south coast brought relief to those areas as seen on the 6-month SPI map. On this time scale it can also be seen that the western to central parts of the country experienced more severe drought conditions than these areas had experienced before. Over the northeastern parts of the country, improved conditions are visible on the 6-month SPI map after the improved rainfall over those areas during January and February 2019.

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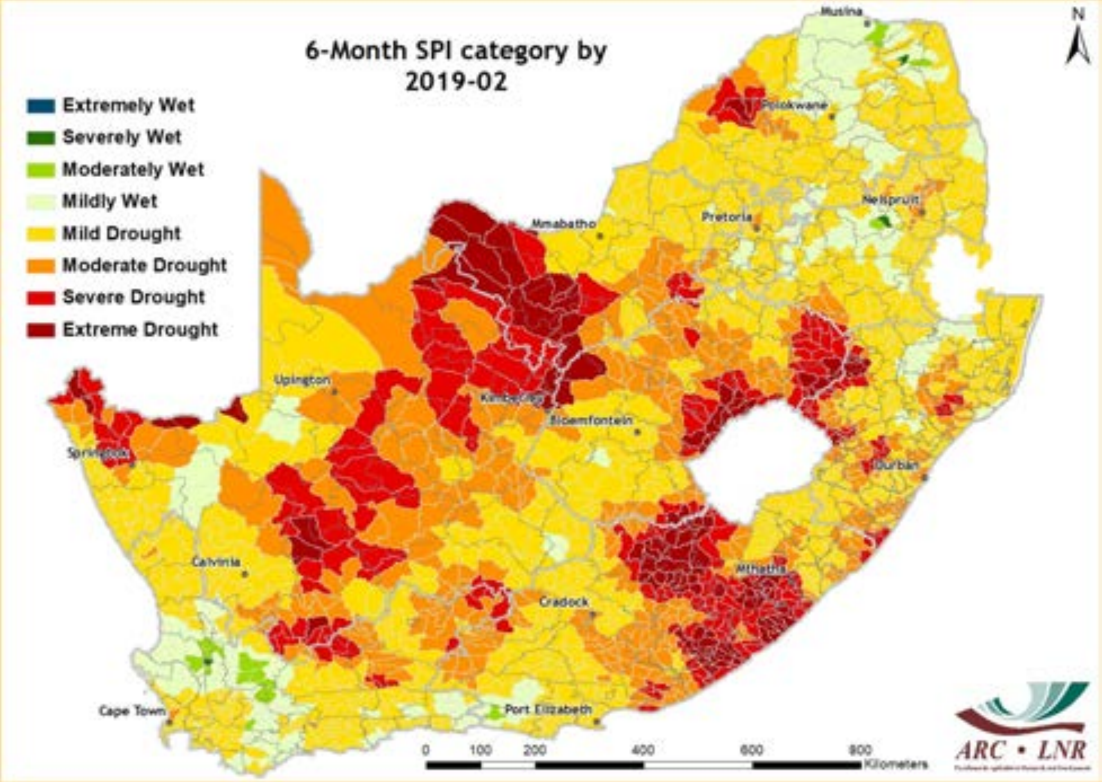


Figure 5

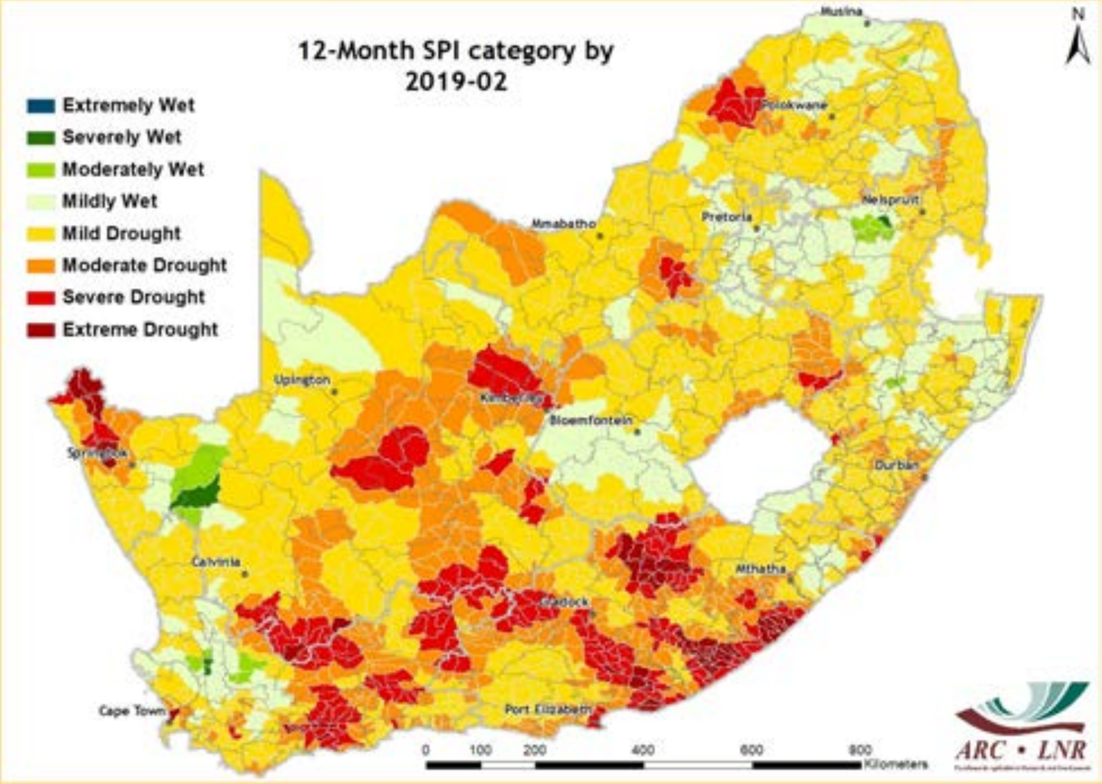
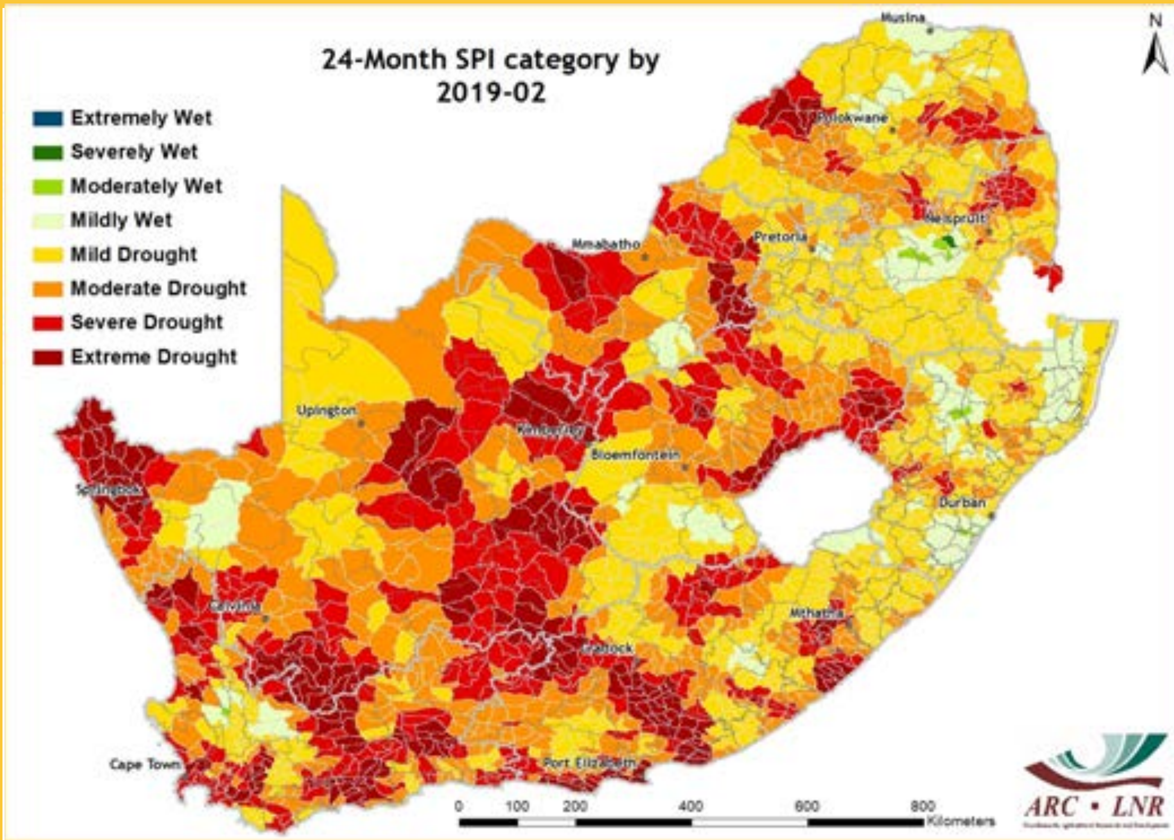


Figure 6



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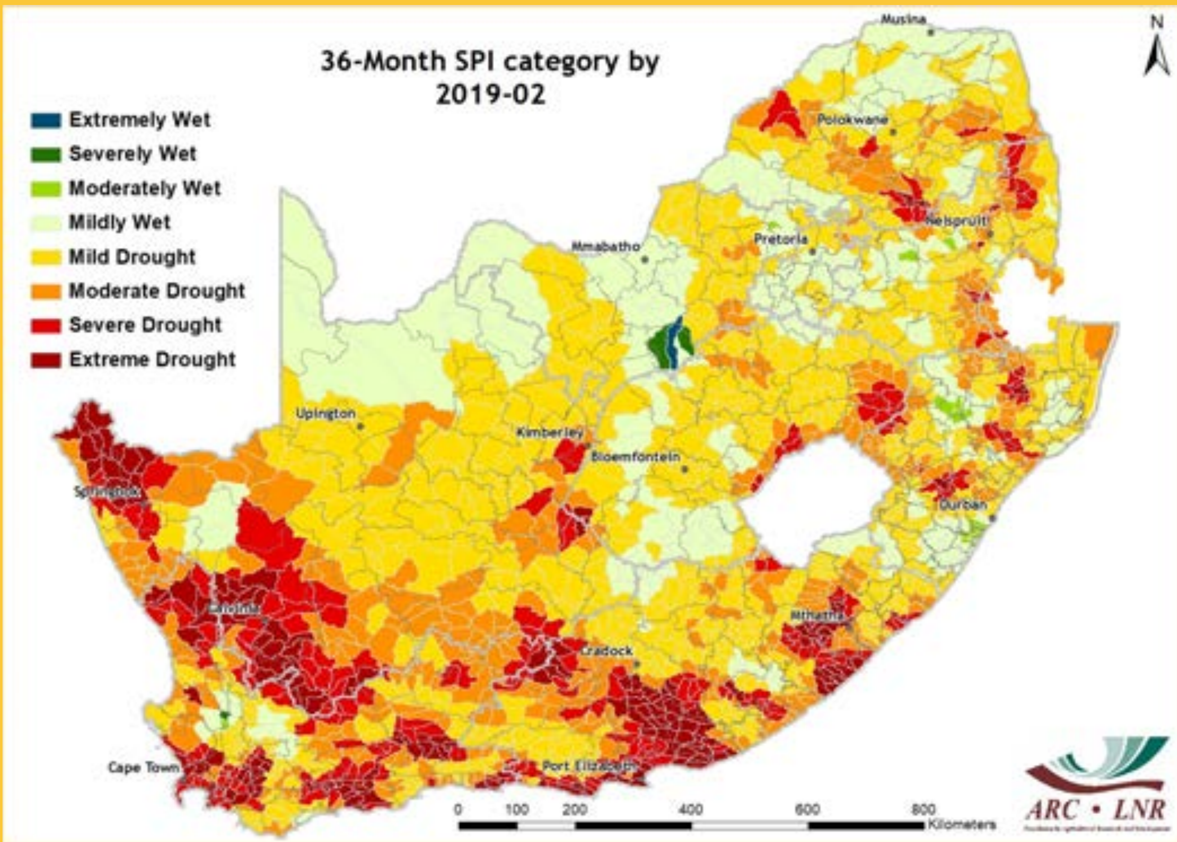

Figure 8

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.

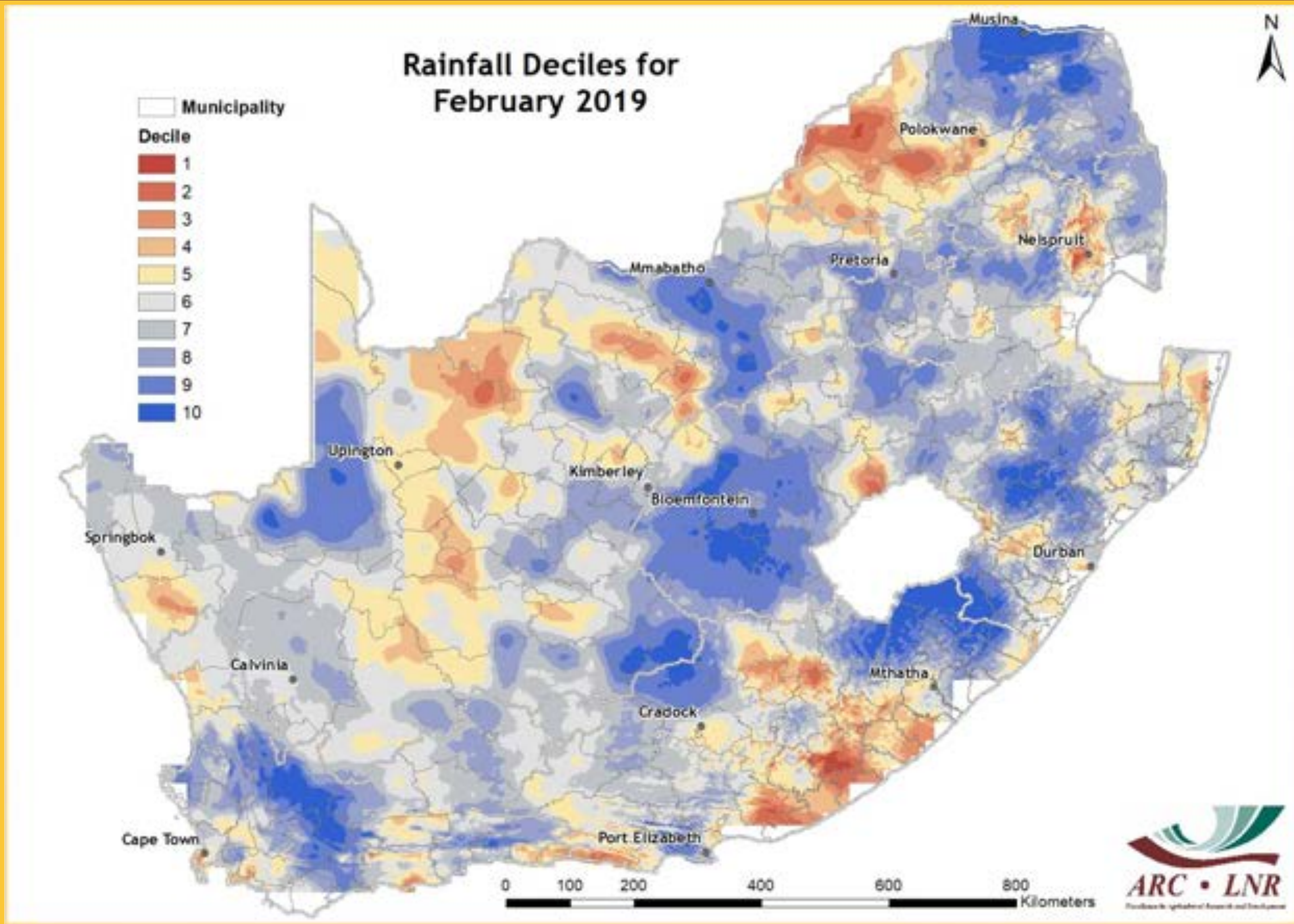

Figure 9

Figure 9:
Rainfall totals during February 2019 over large parts of the country, although isolated in nature, fell within the wetter February months compared to historical February totals. Similarly, some isolated areas such as over parts of the Eastern Cape and Limpopo provinces received rainfall totals that compare well with the drier historical February months.

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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.

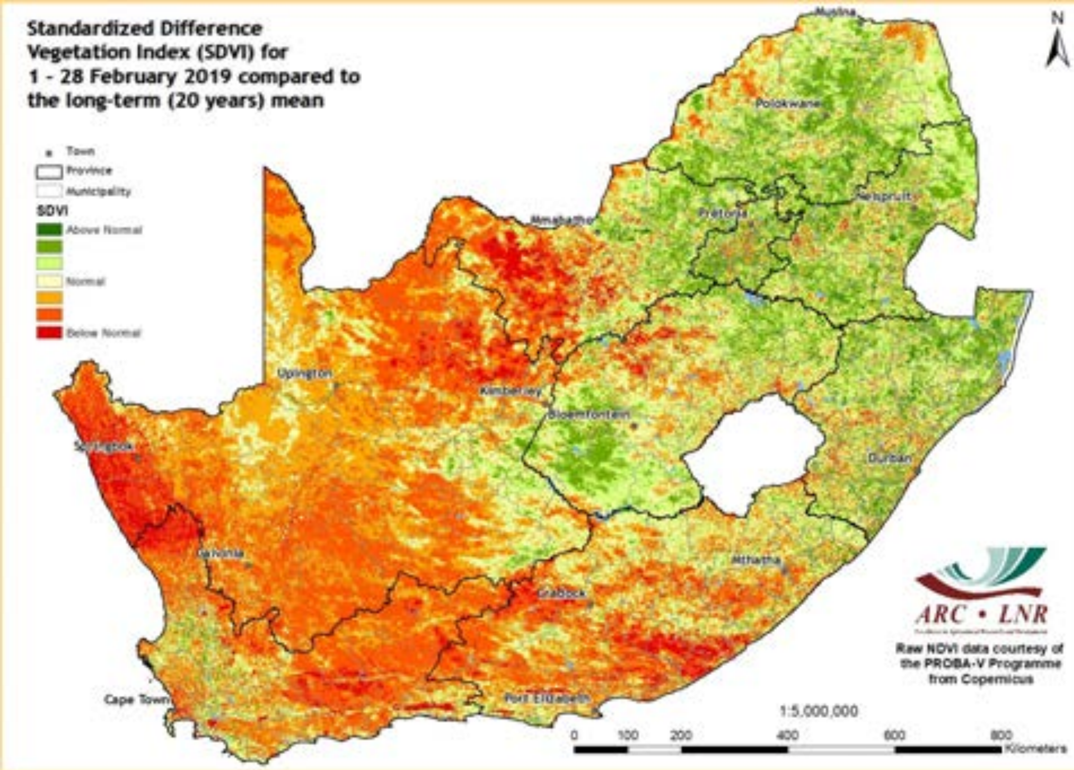

Figure 10

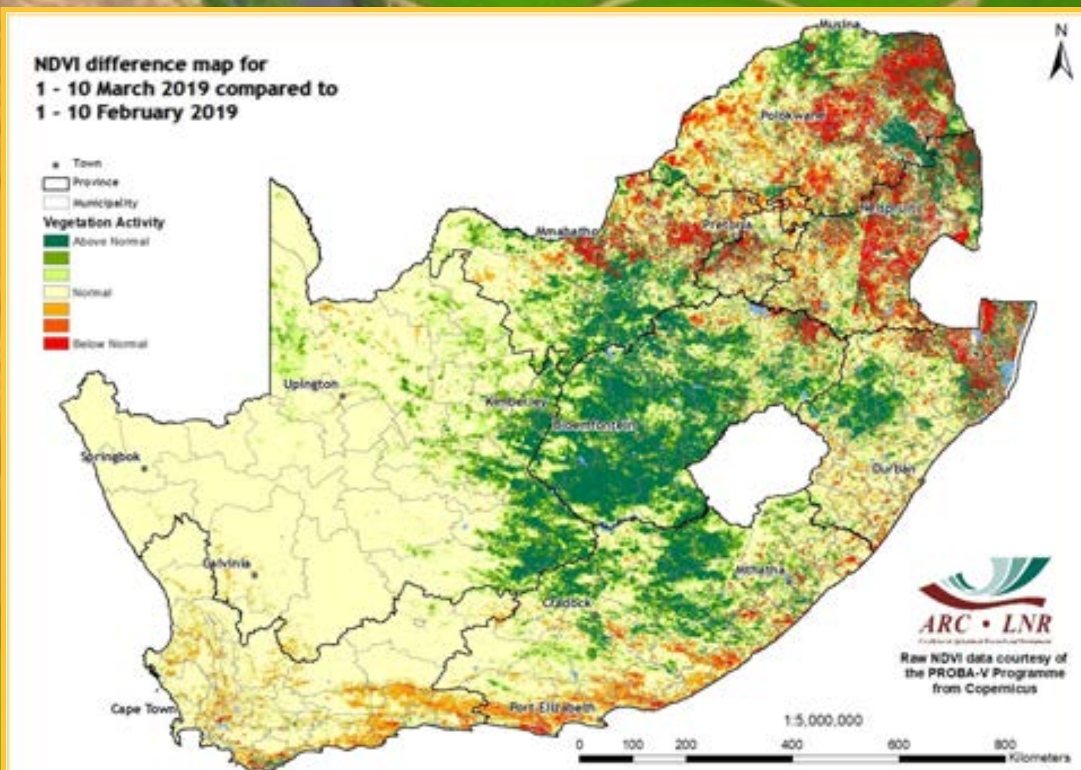

Figure 11

Figure 10:
When comparing the vegetation conditions in February 2019 to the range of conditions observed in previous years, the SDVI map shows that less favourable conditions for healthy vegetation to thrive remain dominant in the western parts of the country while the opposite was observed over areas in the northern parts.

Figure 11:
When comparing the NDVI map for the first 10 days of March 2019 to the NDVI map for the same period last month, it can be observed that the central parts of the country experienced above-normal vegetation activity while the northern parts experienced below-normal activity.

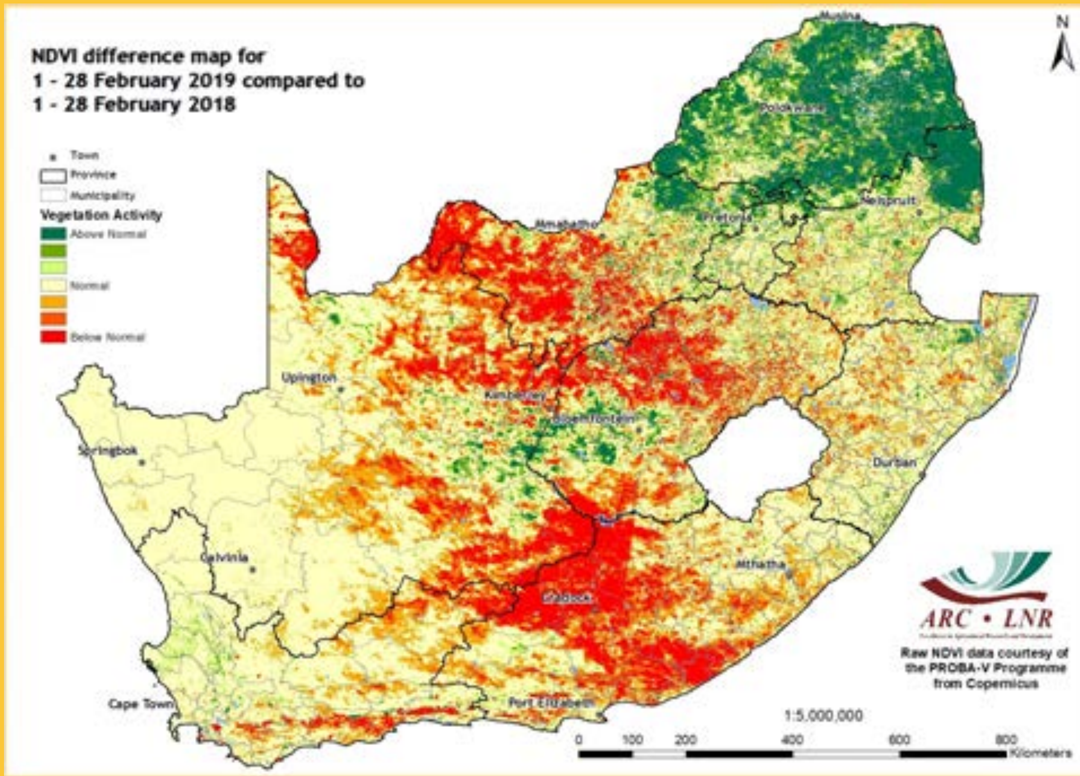

Figure 12

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

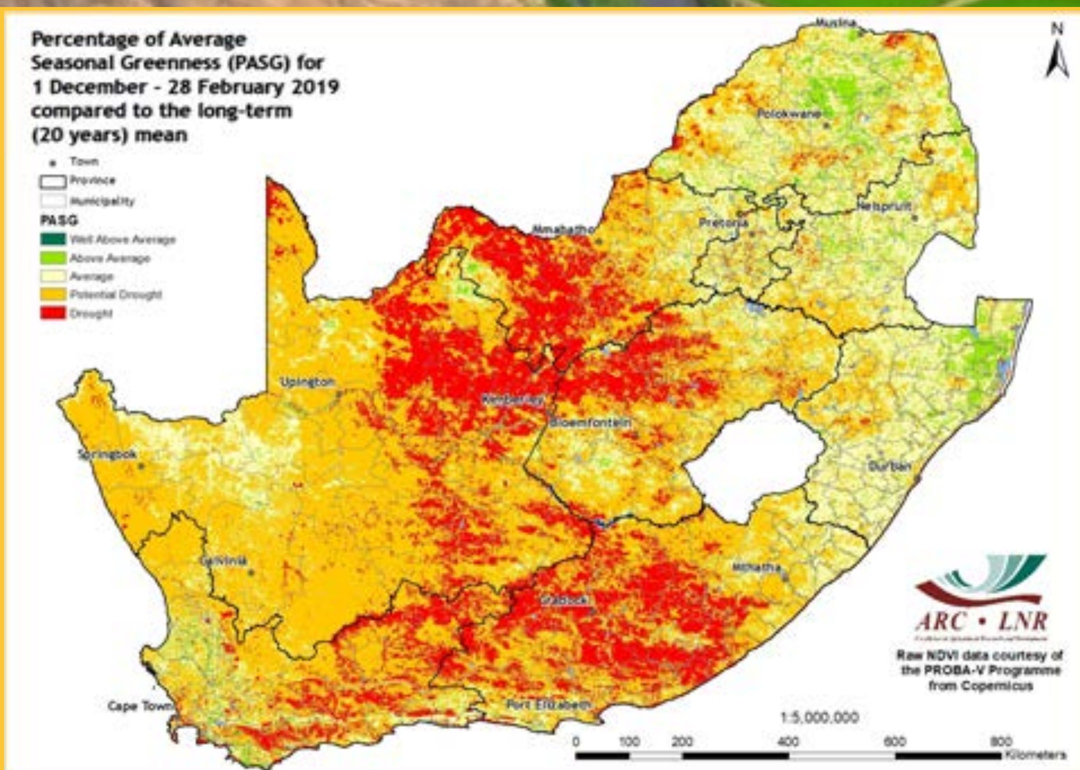

Figure 13

Figure 12:
Compared to the vegetation conditions calculated and averaged over 20 years, the NDVI difference map for February 2019 shows that below-normal vegetation activity remains dominant in the country's interior while much of Limpopo and the far north of Mpumalanga experienced above-normal activity.

Figure 13:
Over a 3-month period, drought conditions occurred along the central parts of the country while a potential drought occurred in the remaining parts of the country. Pockets of above-average vegetation greenness were observed in the northern parts of the country.

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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.

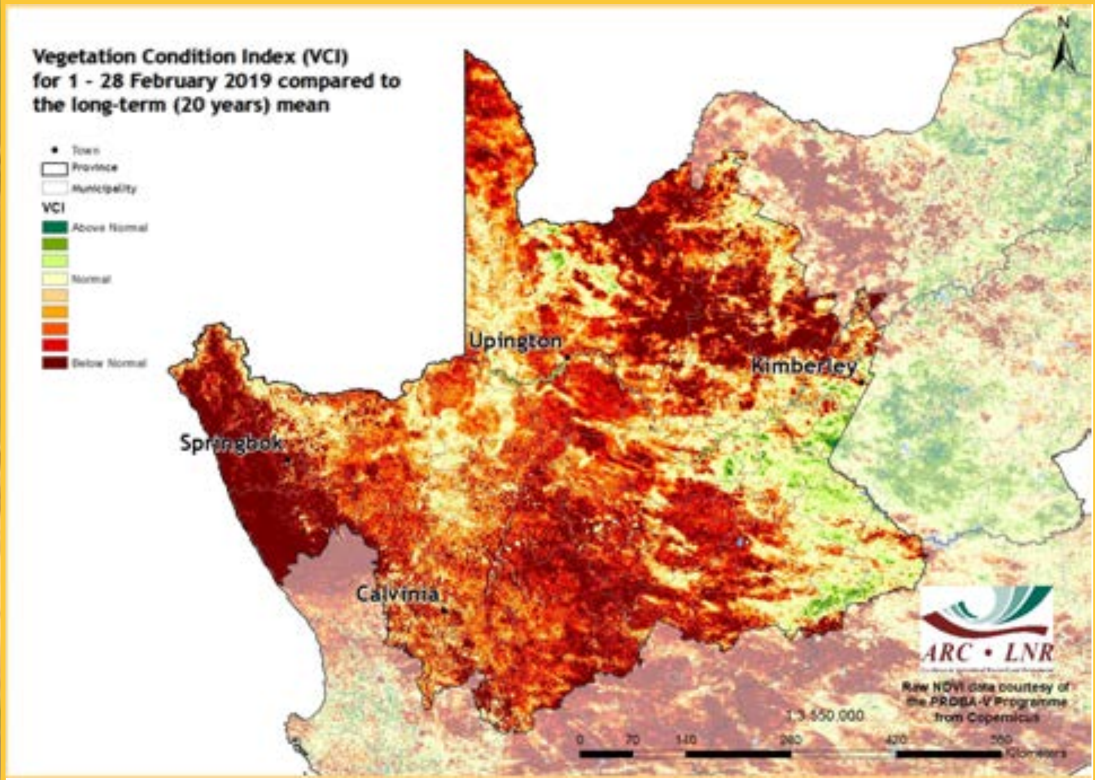

Figure 14

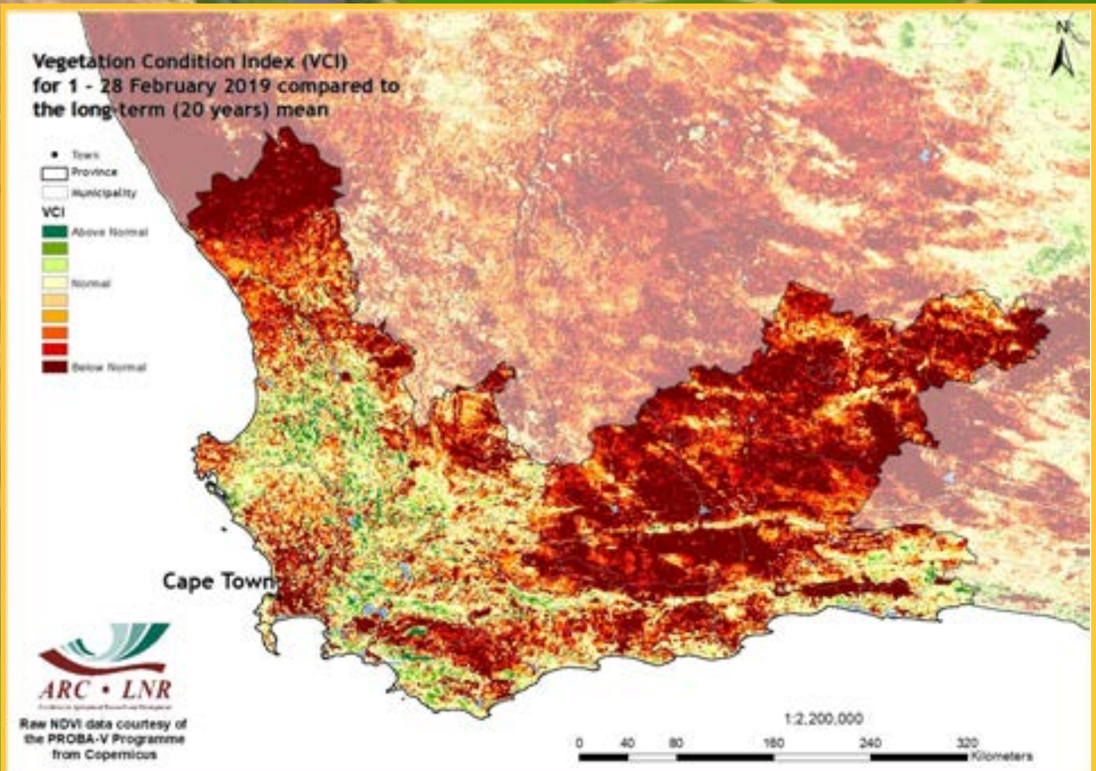

Figure 15

Figure 14:
The VCI map for February shows that nearly the entire Northern Cape Province experienced alarmingly poor vegetation conditions.

Figure 15:
As in the previous month, very poor vegetation activity continues to affect the northern parts of the Central Karoo and West Coast in relation to other parts of the Western Cape Province.

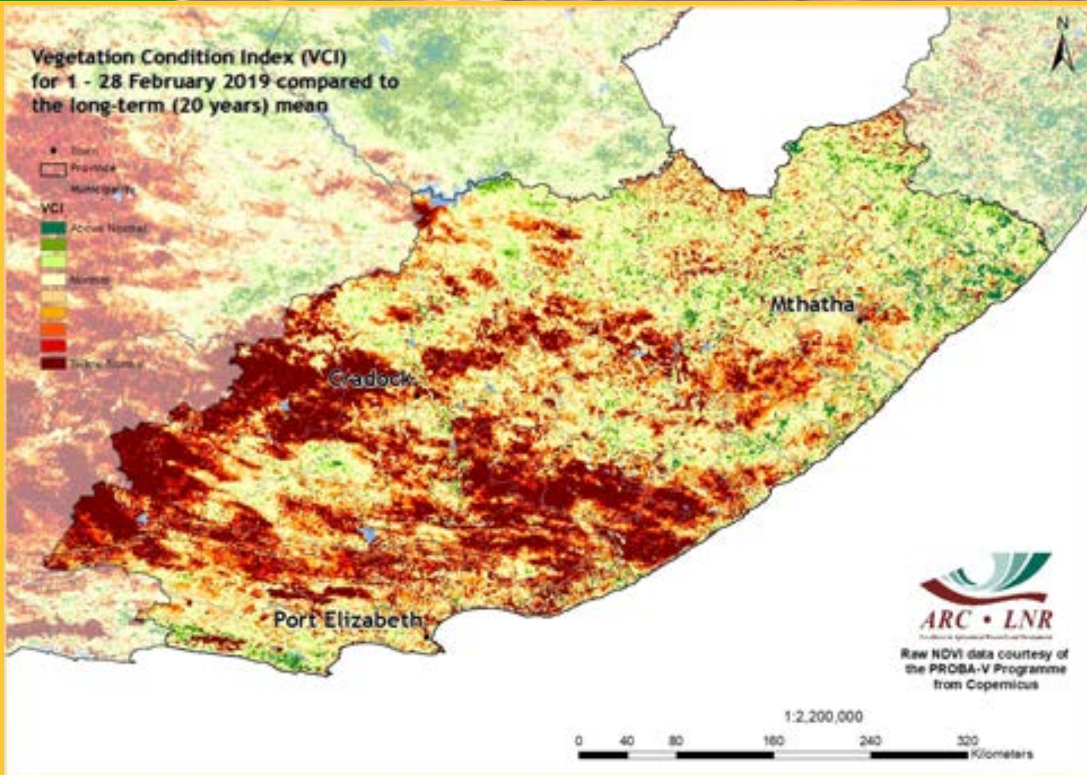

Figure 16

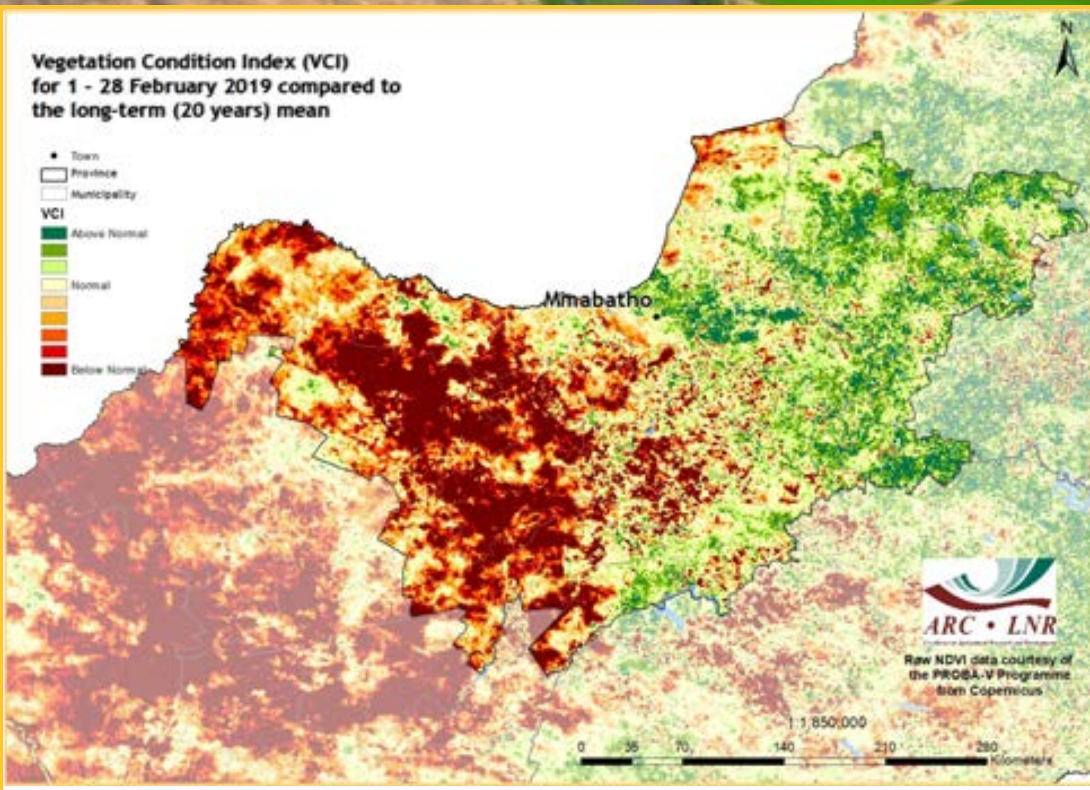

Figure 17

Figure 16:
The vegetation in many parts of the Eastern Cape continue to be stressed, although minor exceptions can be observed in some isolated parts of the province.

Figure 17:
The North West experienced a diverse range of vegetation conditions in February where extremely poor vegetation conditions were observed in the western parts and above-normal to normal vegetation conditions in the eastern parts of the province.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

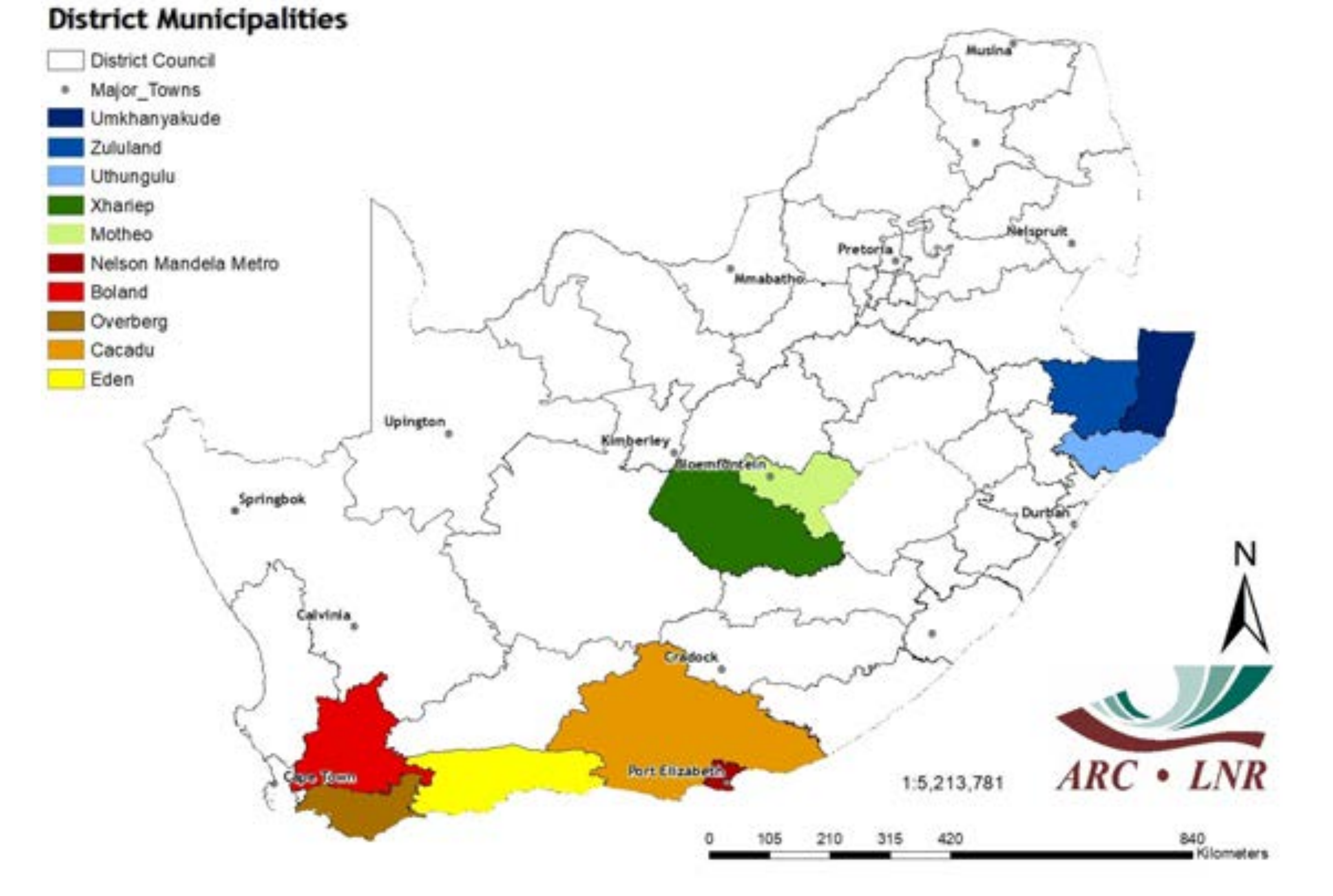

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for February 2019. 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.

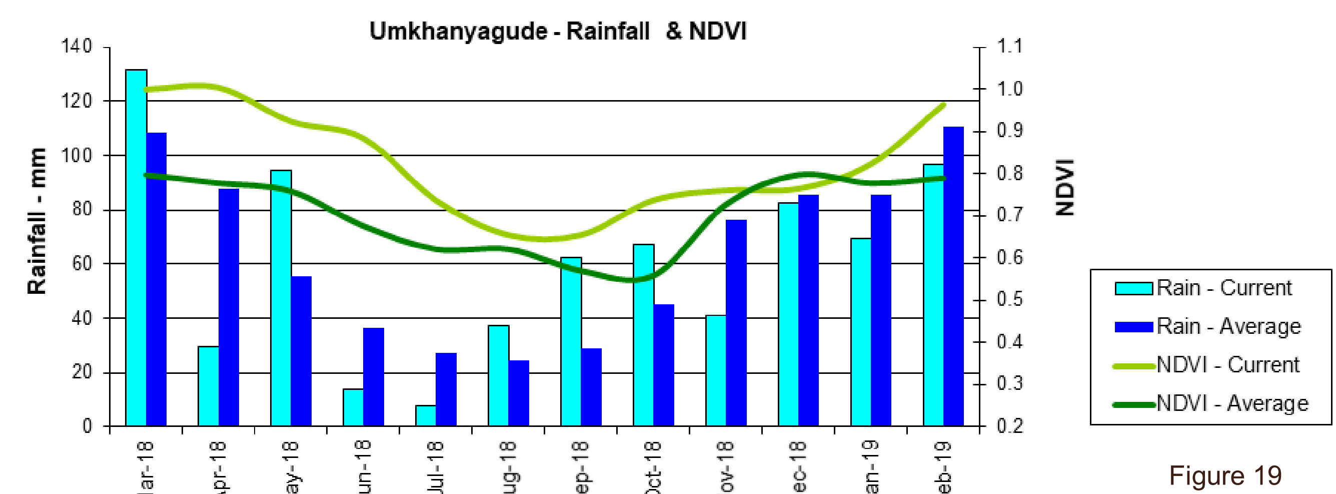
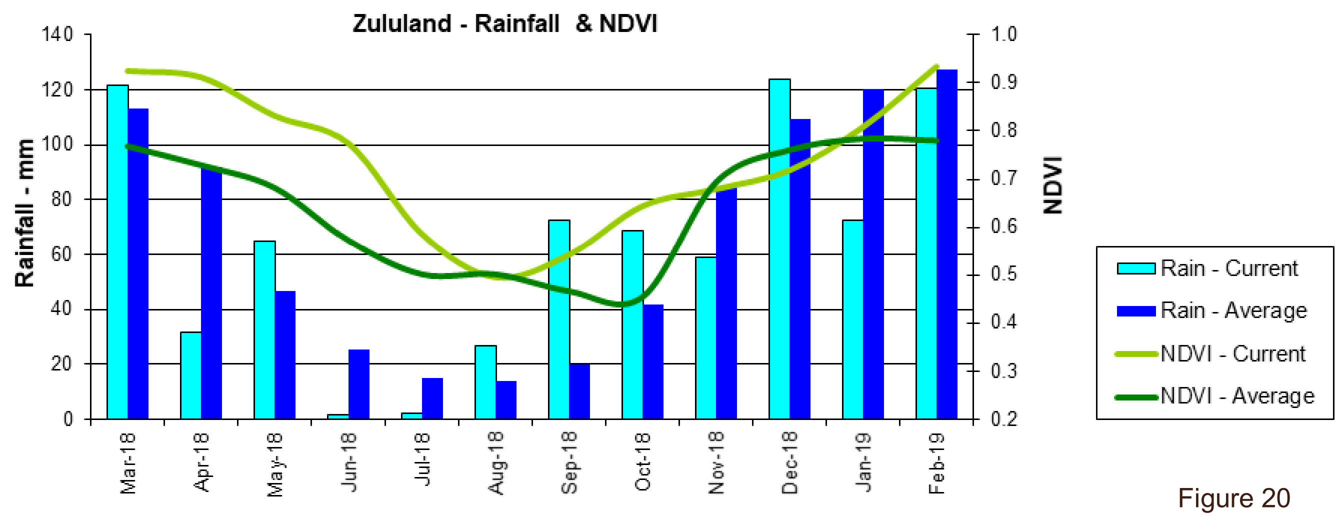


Figure 19



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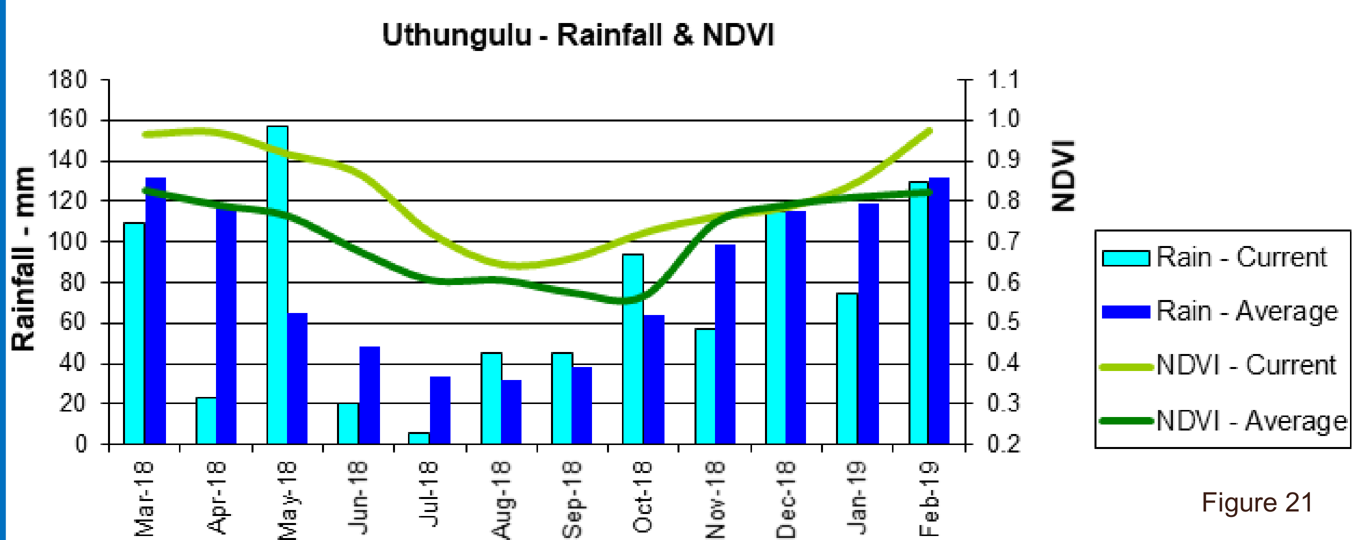


Figure 21

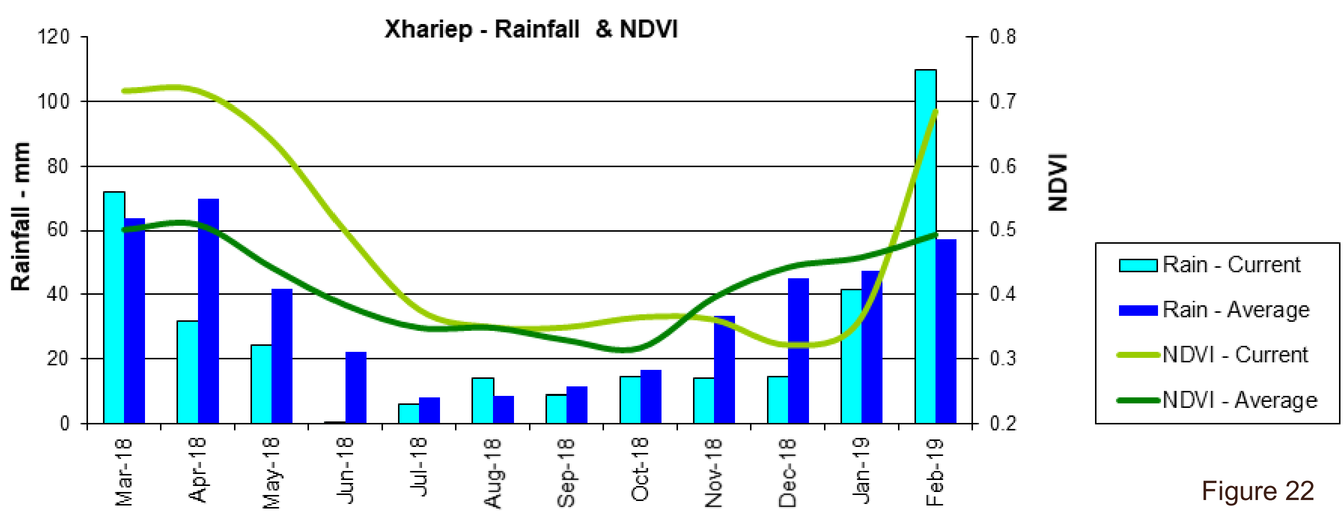
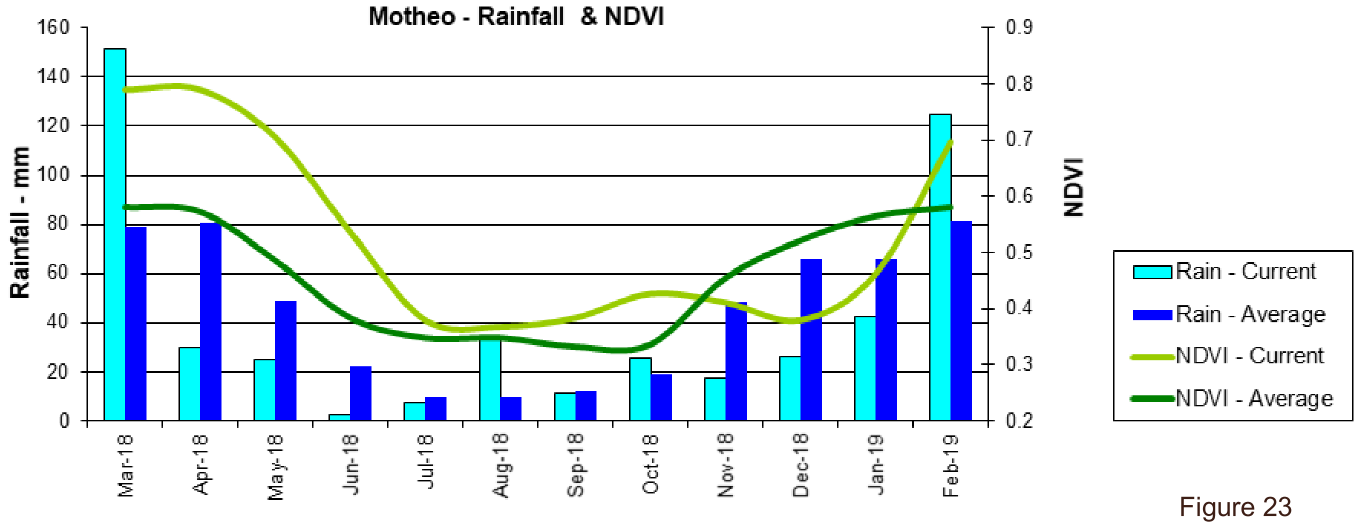


Figure 22



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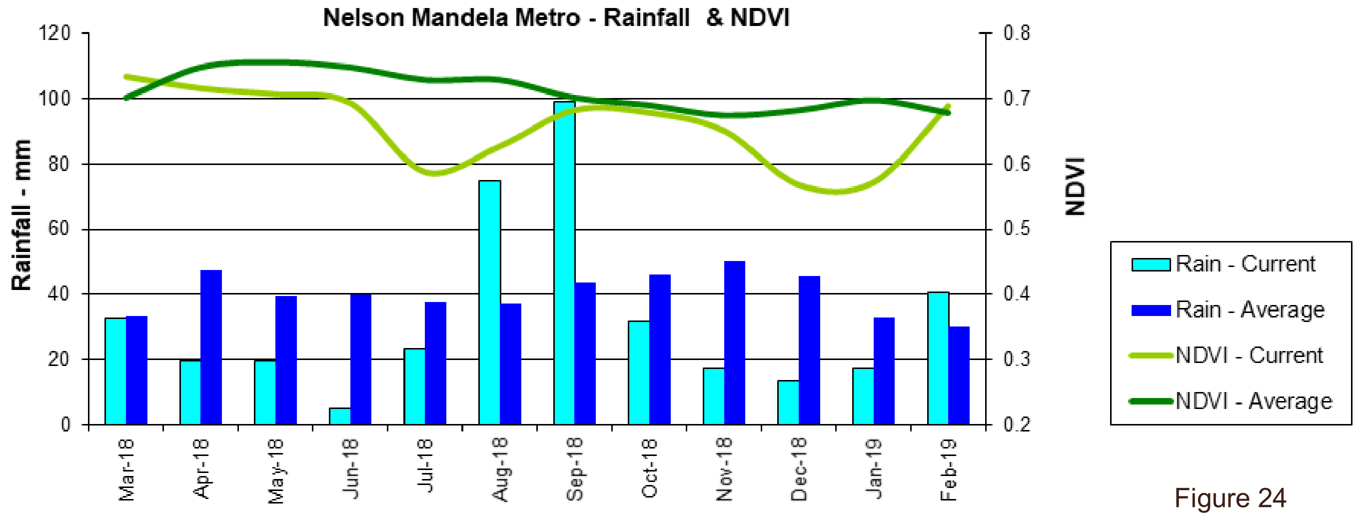

Figure 24

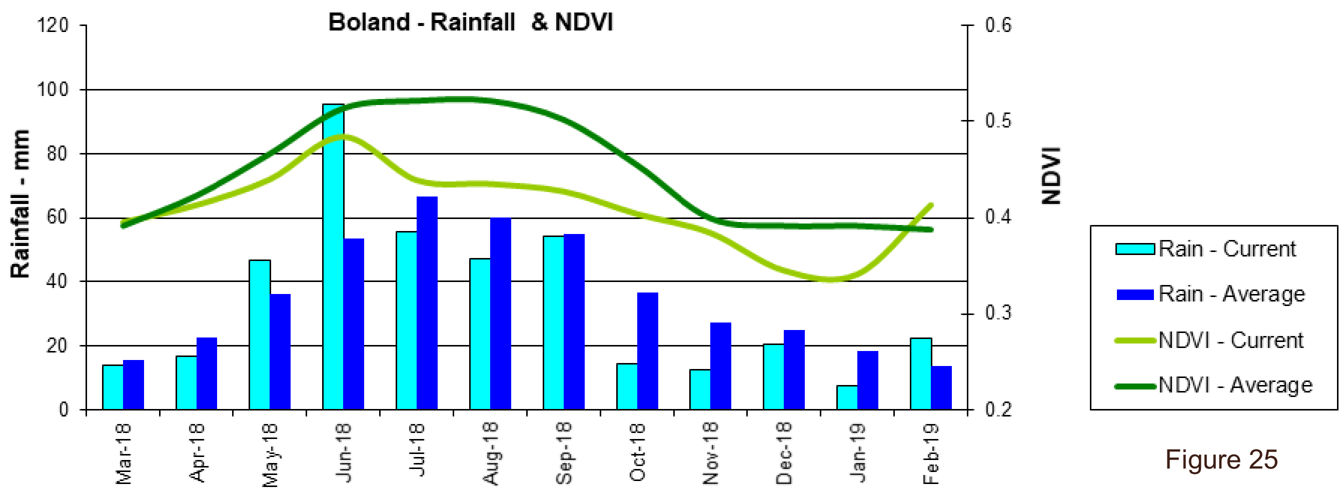

Figure 25

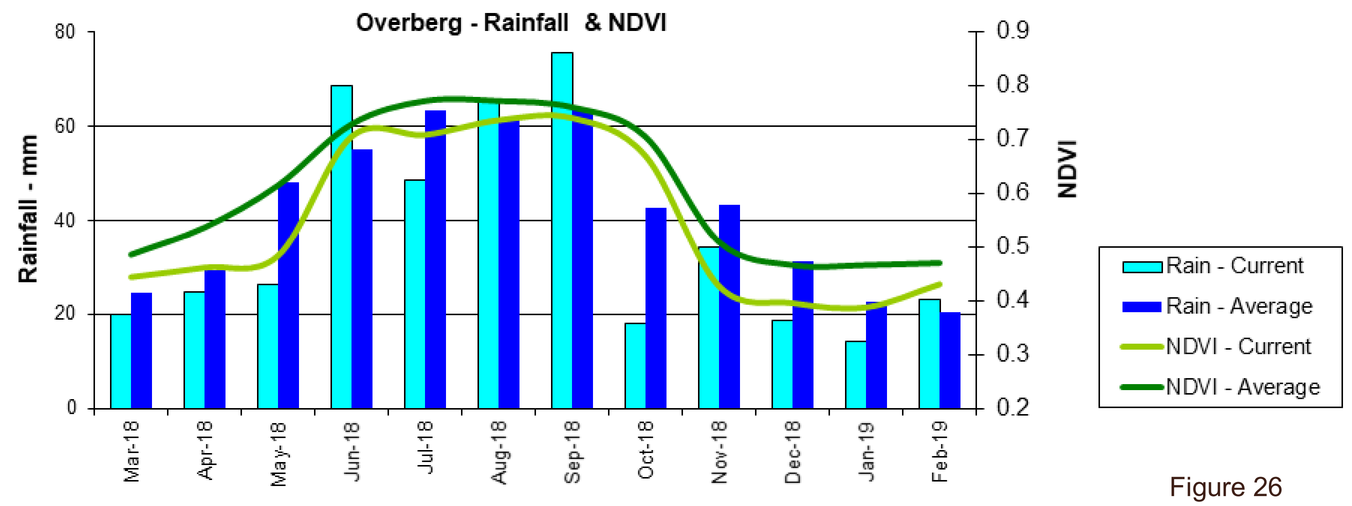

Figure 26

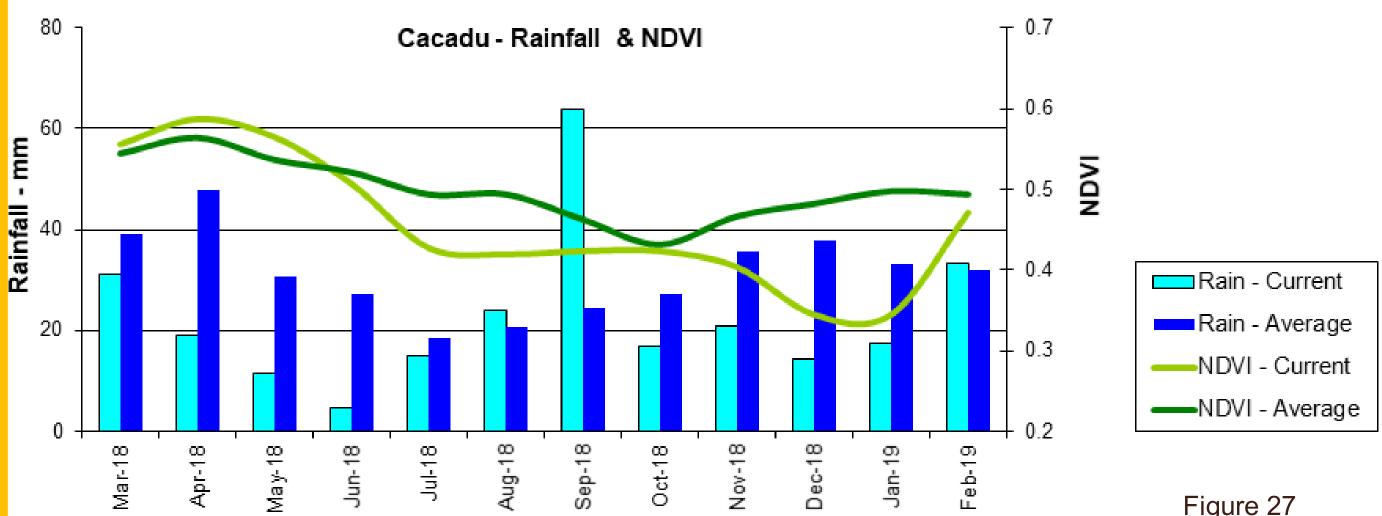

Figure 27

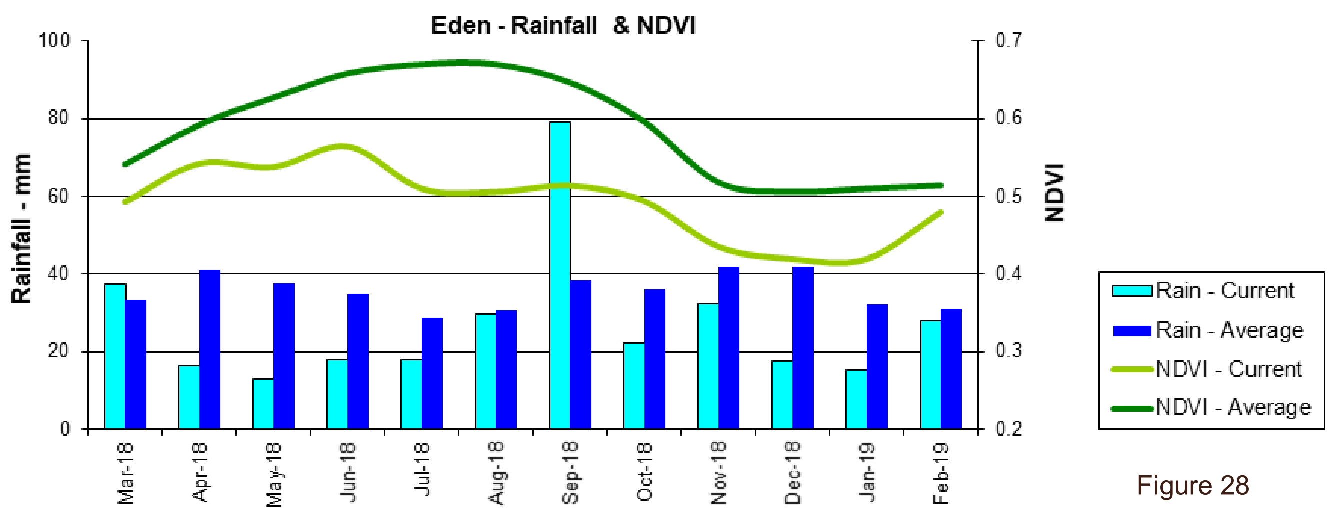

Figure 28

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 1-25 February 2019 per province. Fire activity was higher in the Western Cape compared to the long-term average.

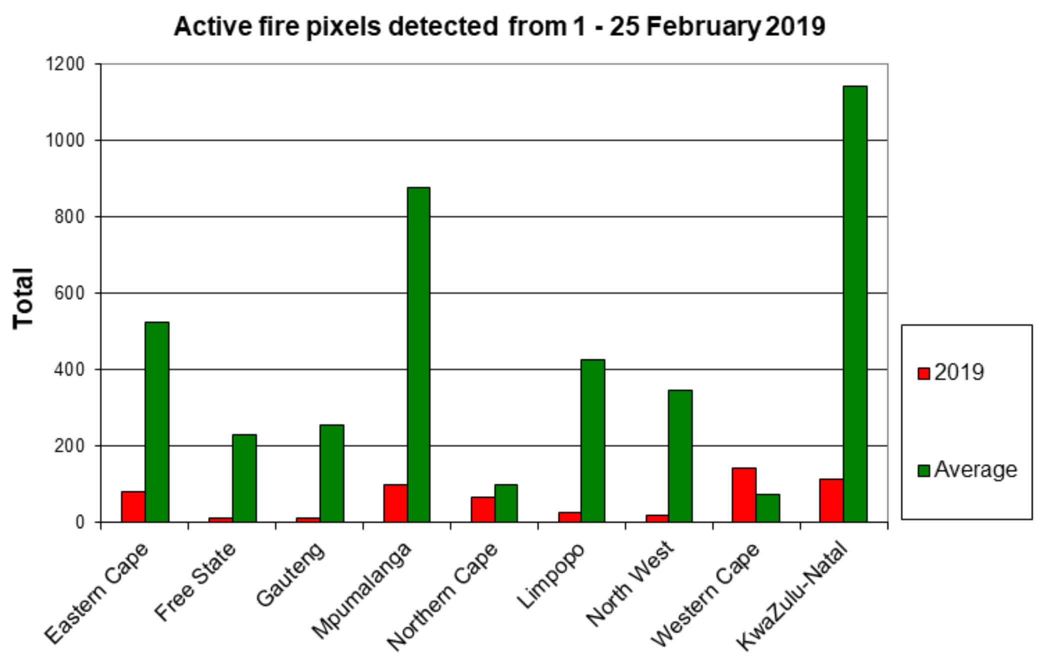

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-25 February 2019.

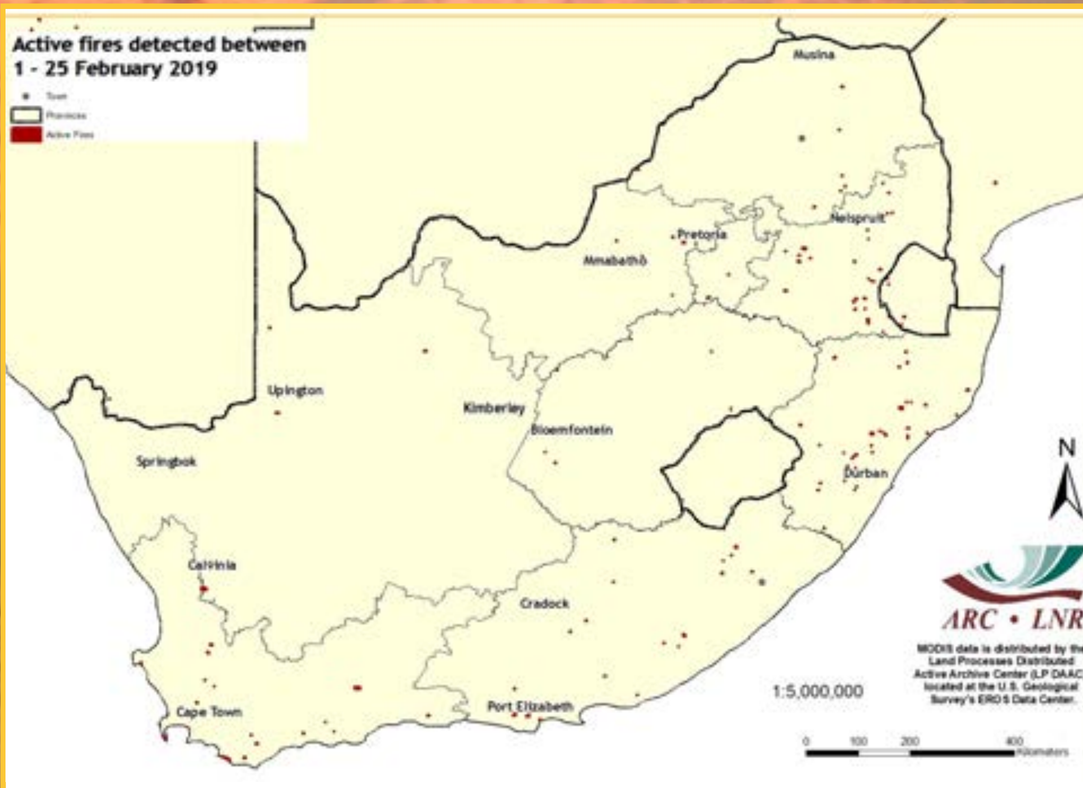

Figure 30

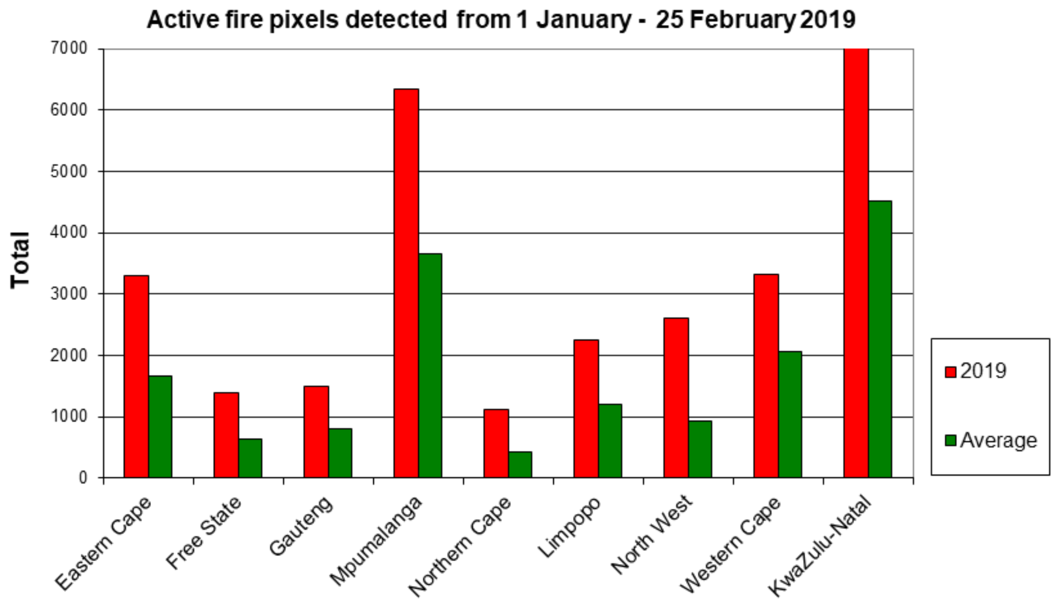

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January to 25 February 2019 per province. Fire activity was higher in all provinces compared to the long-term average.

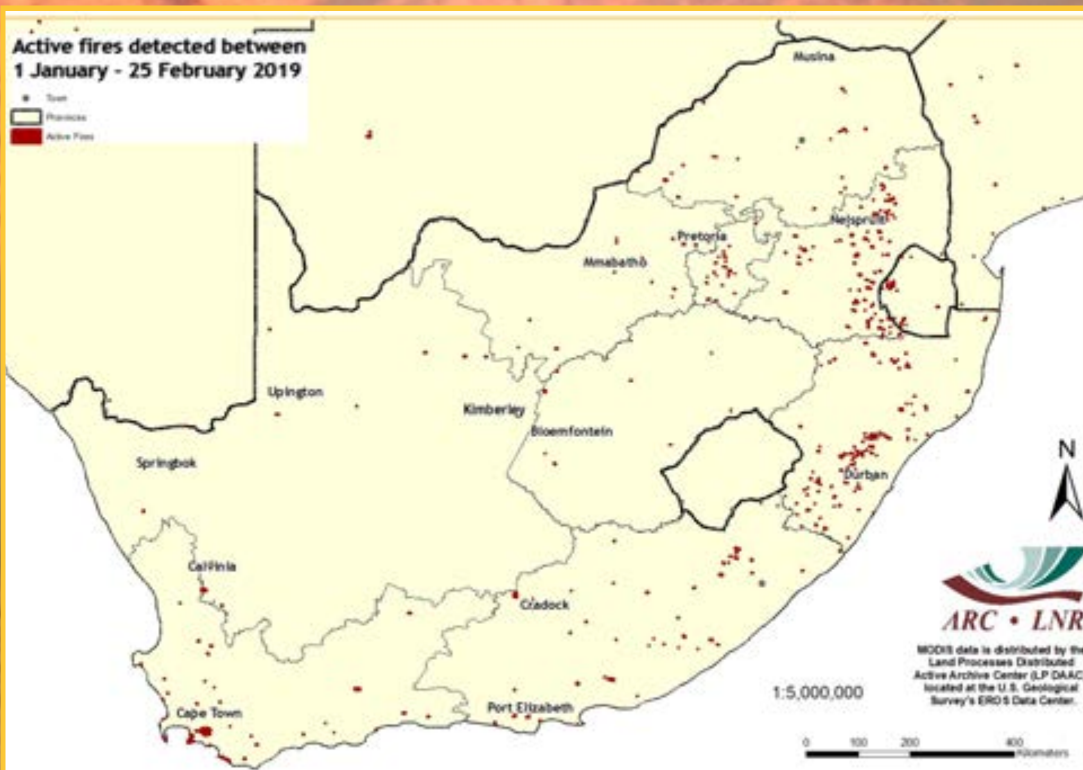

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January to 25 February 2019.

Questions/Comments:
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8. Surface Water Resources

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

Figure 33 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 34 shows a comparison between the area of water available now and for the same month in 2018. 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 2018.

The long-term map shows that the majority of water catchments across the country currently contain similar water areas to the maximum recorded in those same catchments since the end of 2015; with the exception of the severe water reductions in the Karoo and Kalahari.

Comparison between February 2019 and February 2018 shows that generally the entire country currently has either equal or slightly less water extents than the same month last year. The Karoo, Kalahari and a few local catchments in southern KZN are, however, significant exceptions to this rule, and show much lower water values.

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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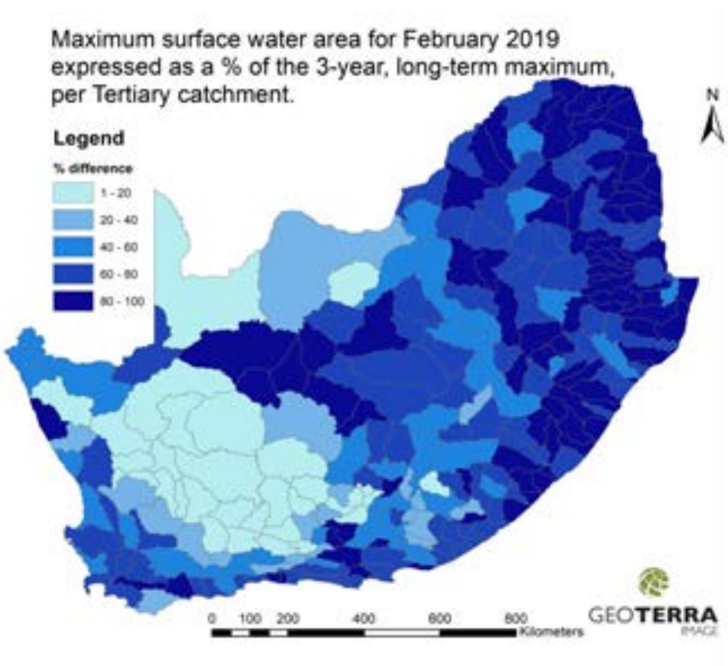

Figure 33

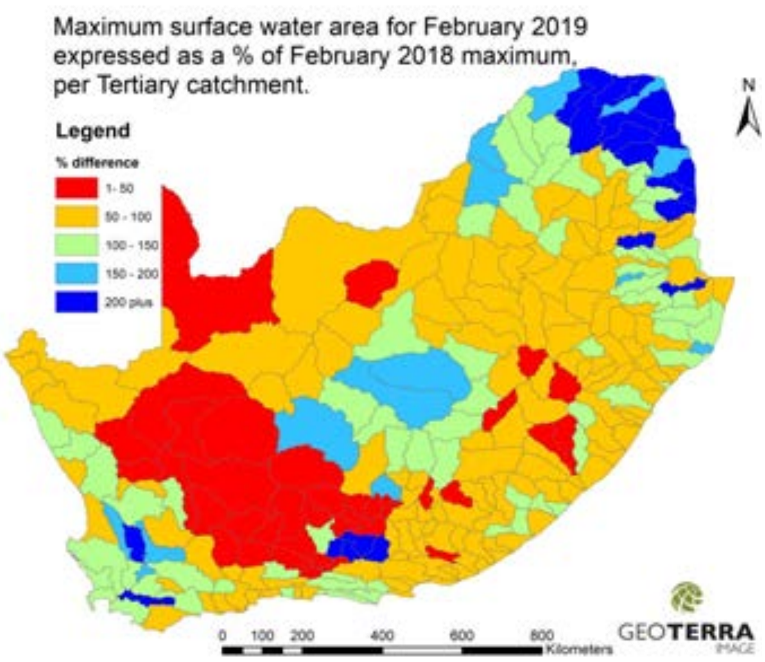

Figure 34

Agrometeorology

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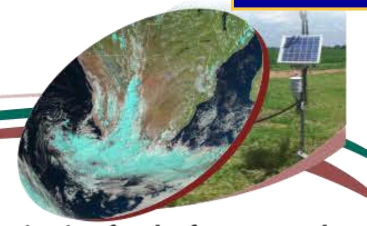

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national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

FOCUS AREAS

Climate Monitoring, Analysis & Modelling

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

Climate Change Adaptation & Mitigation

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

Climate Information Dissemination

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

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Geoinformation Science

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

FOCUS AREAS

Decision Support Systems

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

Early Warning & Food Security

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

Natural Resources Monitoring

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

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The Coarse Resolution Imagery Database (CRID)

NOAA AVHRR

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

MODIS

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

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

Datasets include:

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

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

VGT4AFRICA and GEOSUCCESS

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

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

Meteosat Second Generation (MSG)

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

Rainfall maps

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

Solar Radiation and Evapotranspiration maps

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

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The operational Coarse Resolution Imagery Database (CRID) project of ARC-ISCW is funded by the National Department of Agriculture, Forestry and Fisheries. 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".