UMLINDI
The Watchman

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ARC • LNR
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

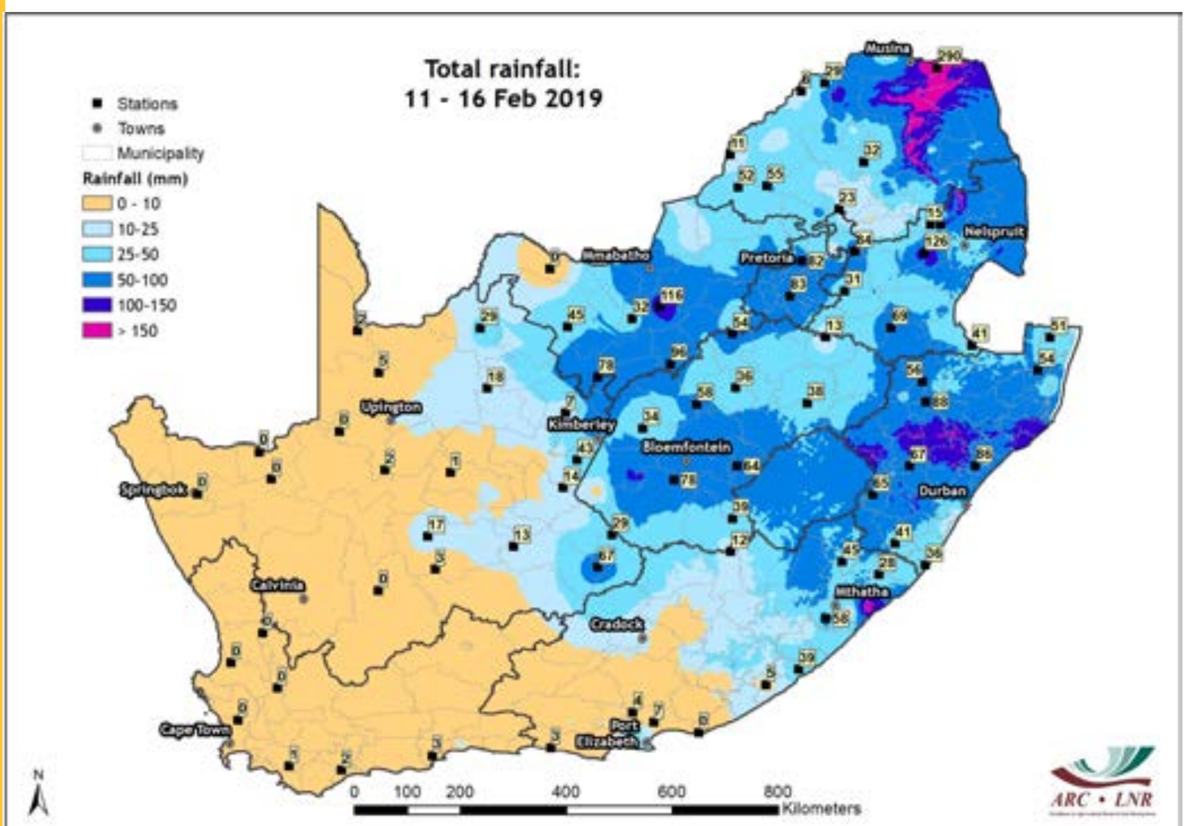
AMESD

176th Edition

Image of the Month

Widespread rain brings relief from the dry conditions in the northeast

The months of December and January in the 2018/19 summer season were associated with below-normal rainfall over much of eastern South Africa. Normal to above-normal rainfall was restricted to Gauteng and isolated parts of the North West and Limpopo provinces. Numerous agricultural sectors in South Africa, including maize and livestock production, remained under pressure during these generally dry months, which also turned out to be exceptionally warm. An important reason for the relatively dry December to January period was a general lack of tropical weather systems transporting moist air from the Indian Ocean and equatorial Africa into southern Africa. This situation changed during the period 11-16 February 2019 when a tropical low pressure system formed to the north of South Africa. It combined with a westerly wind trough over the southern parts of the country which resulted in the southward transport of moisture to the eastern interior. As a consequence, widespread rainfall occurred during this 6-day period (see map below). The highest totals fell over the escarpment areas of northeastern Limpopo, where more than 150 mm were recorded. Significant areas of the Limpopo, Mpumalanga, KwaZulu-Natal, Free State and North West provinces received 50-100 mm of rain during this period, with falls of at least 10 mm extending as far west as the eastern parts of the Northern Cape, and as far south as the eastern parts of the Eastern Cape.



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:

After a relatively dry October to December 2018 period, the summer rainfall region experienced improved rainfall conditions during January 2019. However, the areas that received good rainfall were confined to the northeastern parts of the country and mostly to the higher ground areas. Large parts of the maize producing regions, in particular the western areas, had another disappointing rainfall month. In combination with the lack of rainfall over the western maize producing regions, the month also experienced abnormally warm conditions with the maximum temperature up to 4 °C higher than normal. Over large parts of North West as well as the northwestern Free State, up to nine more heatwave days than normal occurred during the month of January. Towards the eastern parts of the maize producing region, maximum temperatures were up to 2 °C higher than normal. These areas also experienced more heatwave days than normal for the month of January, even though above-normal rainfall occurred.

The month of January started off with cloudy and rainy conditions over the eastern parts of the country caused by a weather system that became active over those areas during the last few days of December. This was the first good rainfall event of the 2018/19 summer season over the summer rainfall region in terms of its spatial extent as well as the amount of rainfall. However, rainfall occurred mainly over the northeastern parts of the country, whilst the very dry and hot conditions persisted further to the west. The pattern of rainfall activity over the northeastern parts of the country occurred on a fairly regular basis during the month of January, resulting in fewer consecutive dry days over those areas compared to the preceding summer months of the 2018/19 summer season. Over the remainder of the summer rainfall region, however, rainfall was limited in terms of the amounts as well as the frequency of rainfall days. Over the all-year rainfall region, rain days occurred quite frequently, but with limited amounts – resulting in below-normal rainfall for the month of January. A few frontal systems passed over the winter rainfall area, with quite a strong system around the 11th, resulting in good January rainfall totals over those areas.

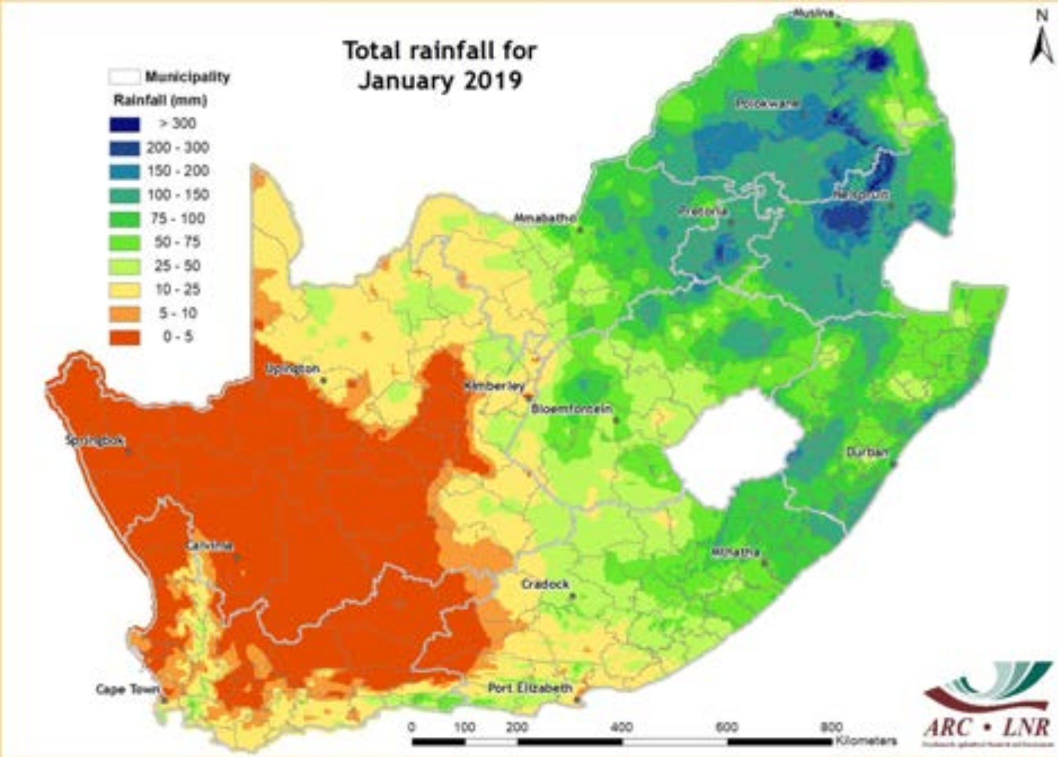


Figure 1

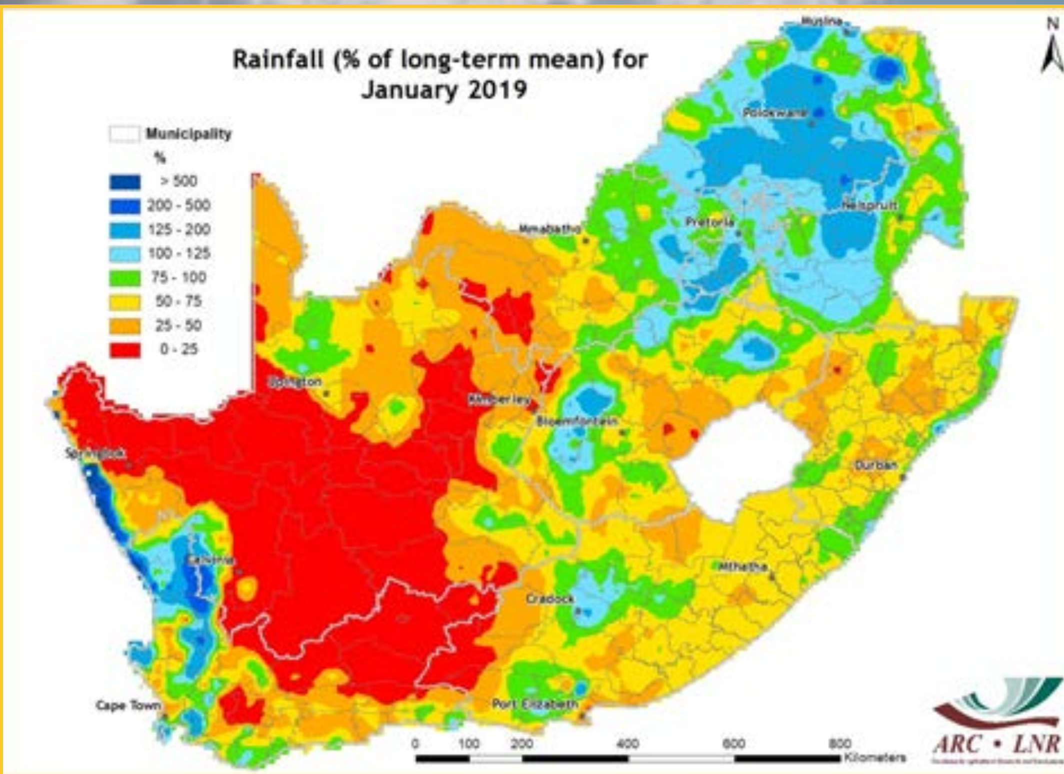


Figure 2

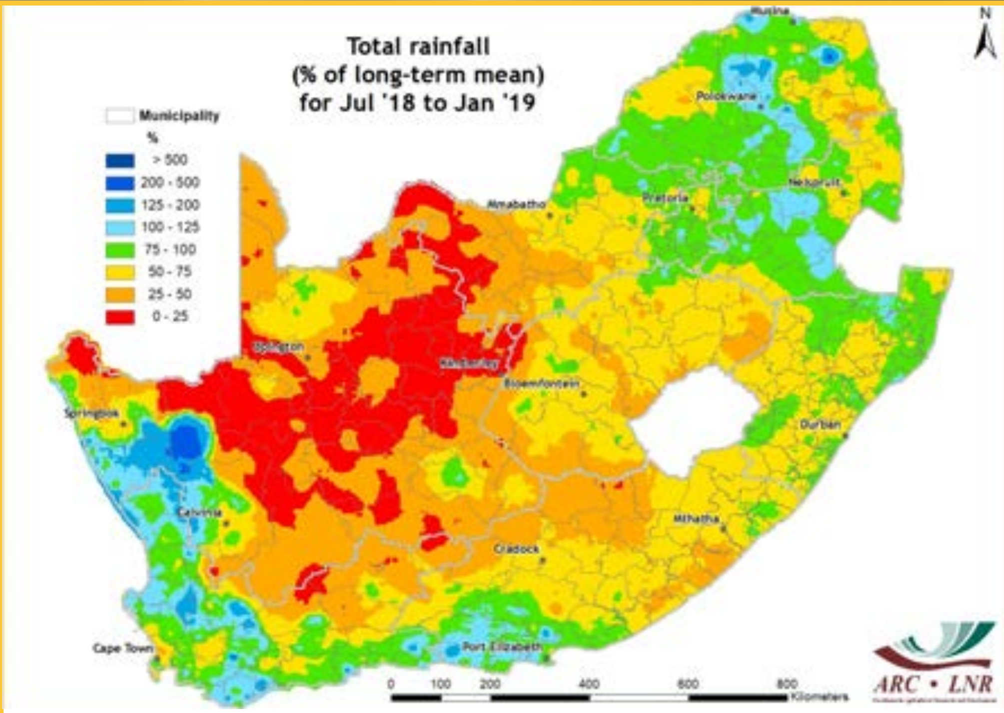


Figure 3

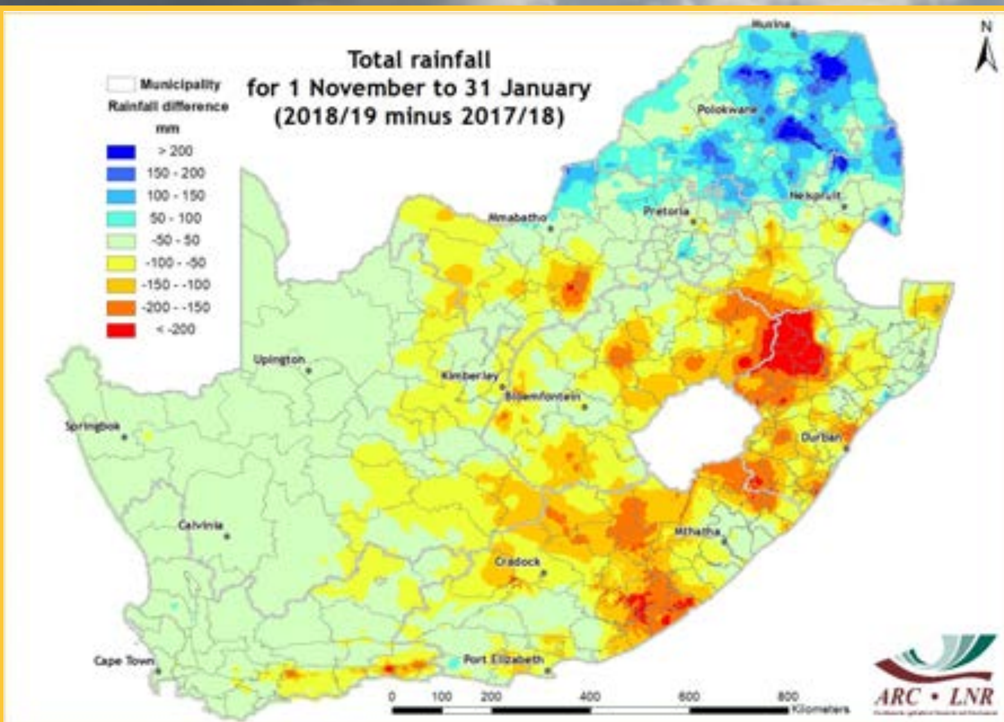


Figure 4

Figure 1:
Large parts of northeastern South Africa received more than 100 mm of rainfall during January, exceeding 200 mm in places. However, over the larger part of the western maize producing region only 25-50 mm occurred, resulting in another month of below-normal rainfall over those areas.

Figure 2:
Above-normal rainfall occurred over the northeastern part of the country as well as over very isolated areas of the central interior. A good rainfall event at the start of January contributed to the above-normal rainfall over northeastern South Africa. The month of January had more frequent rain days over the eastern part of the country than the preceding summer months.

Figure 3:
During this 7-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 during this period were actually very dry. Over the summer rainfall region, large areas received below-normal rainfall during this period. Some areas over the eastern parts received near-normal rainfall with some isolated areas that received 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 rain this year. Over the central to southeastern parts of the country the current November to January 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 36 months) as represented by the SPI ending in January 2019 shows signs of relief on the 6- 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. At this shorter time scale it is also evident that the central parts of the country are suffering from drought to severe drought conditions. The 6-month SPI is representative of soil moisture conditions. The excessive heat over those areas during the summer season so far is contributing to the drought conditions.

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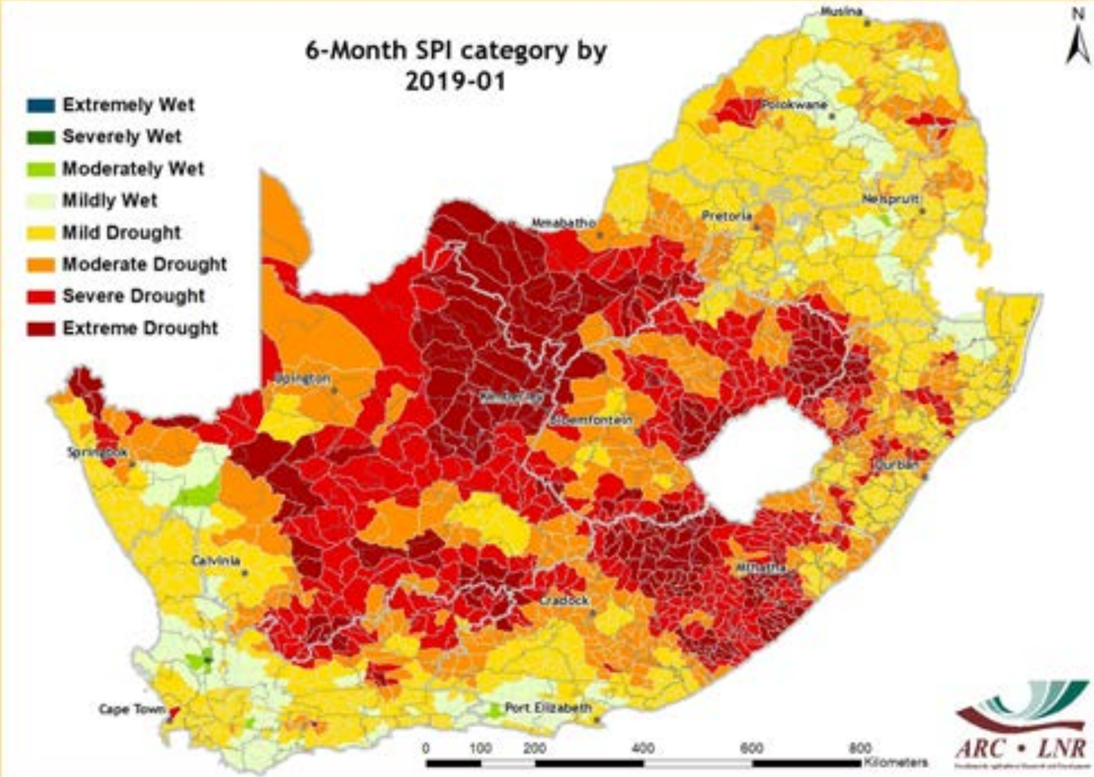

Figure 5

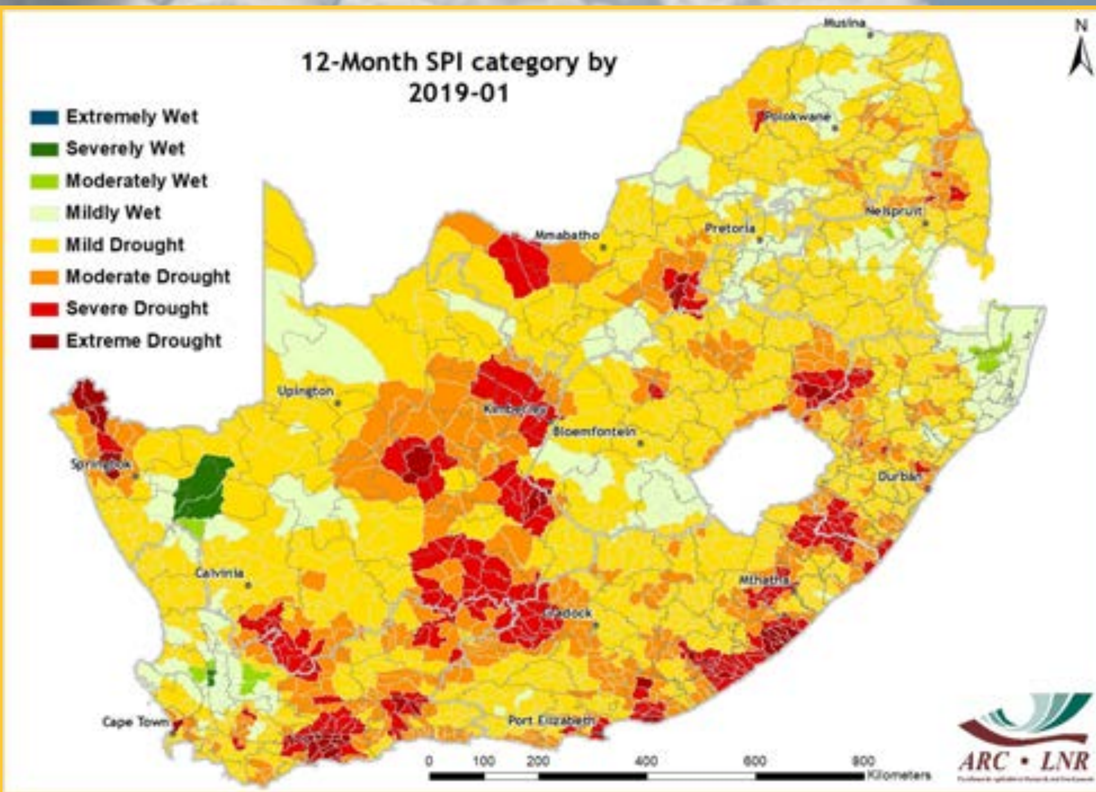

Figure 6

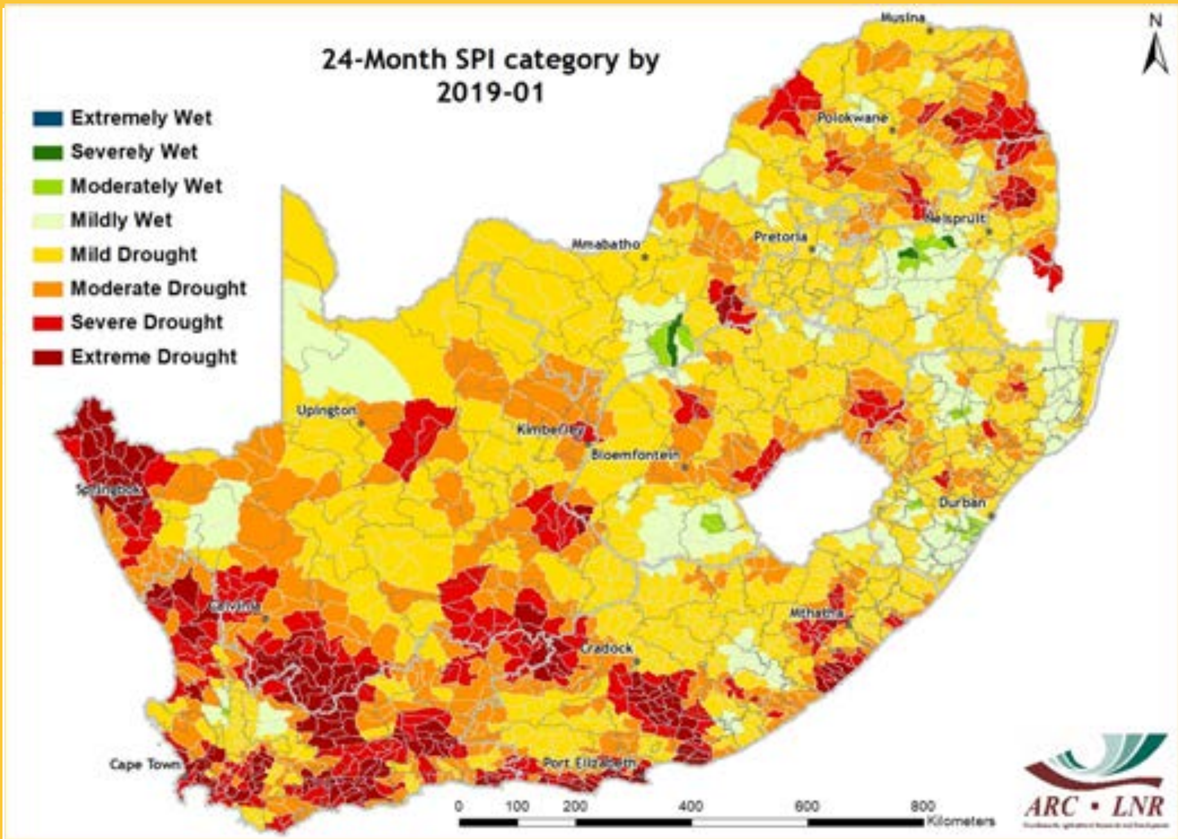

Figure 7

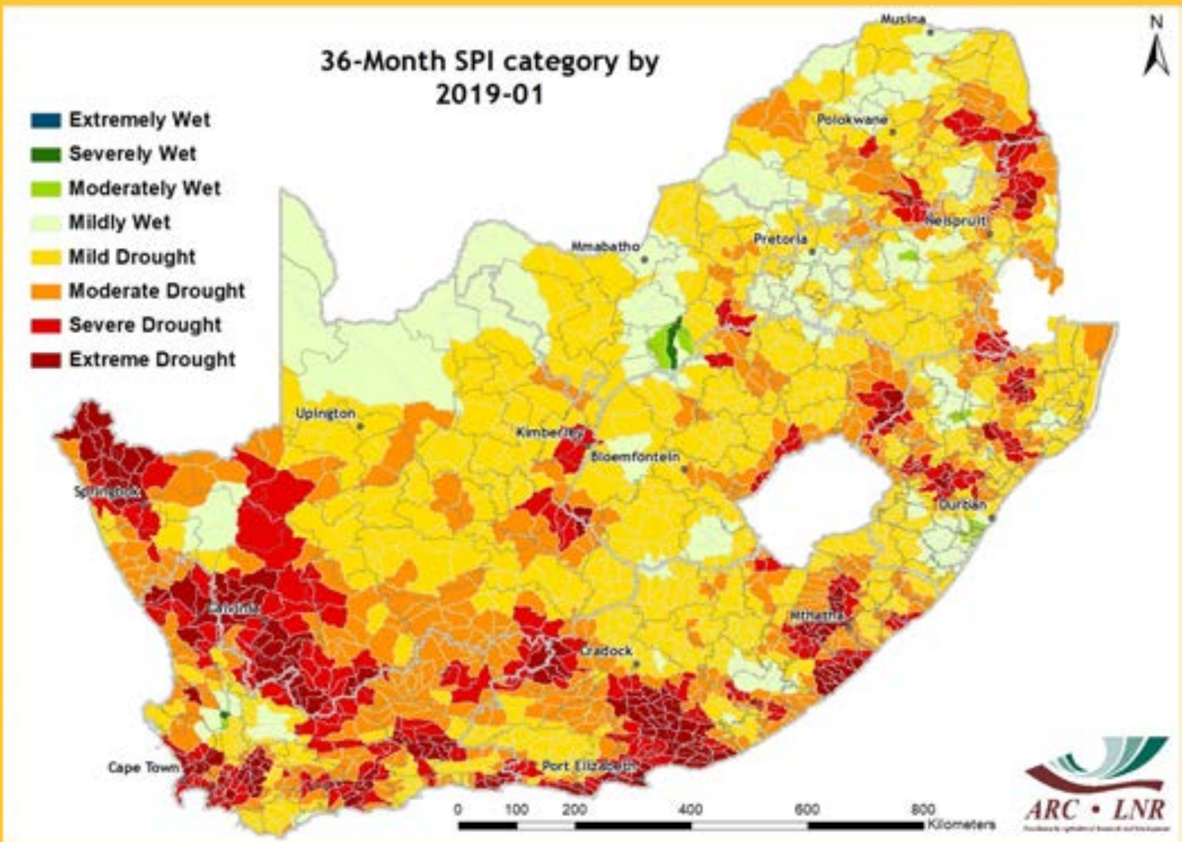

Figure 8

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.

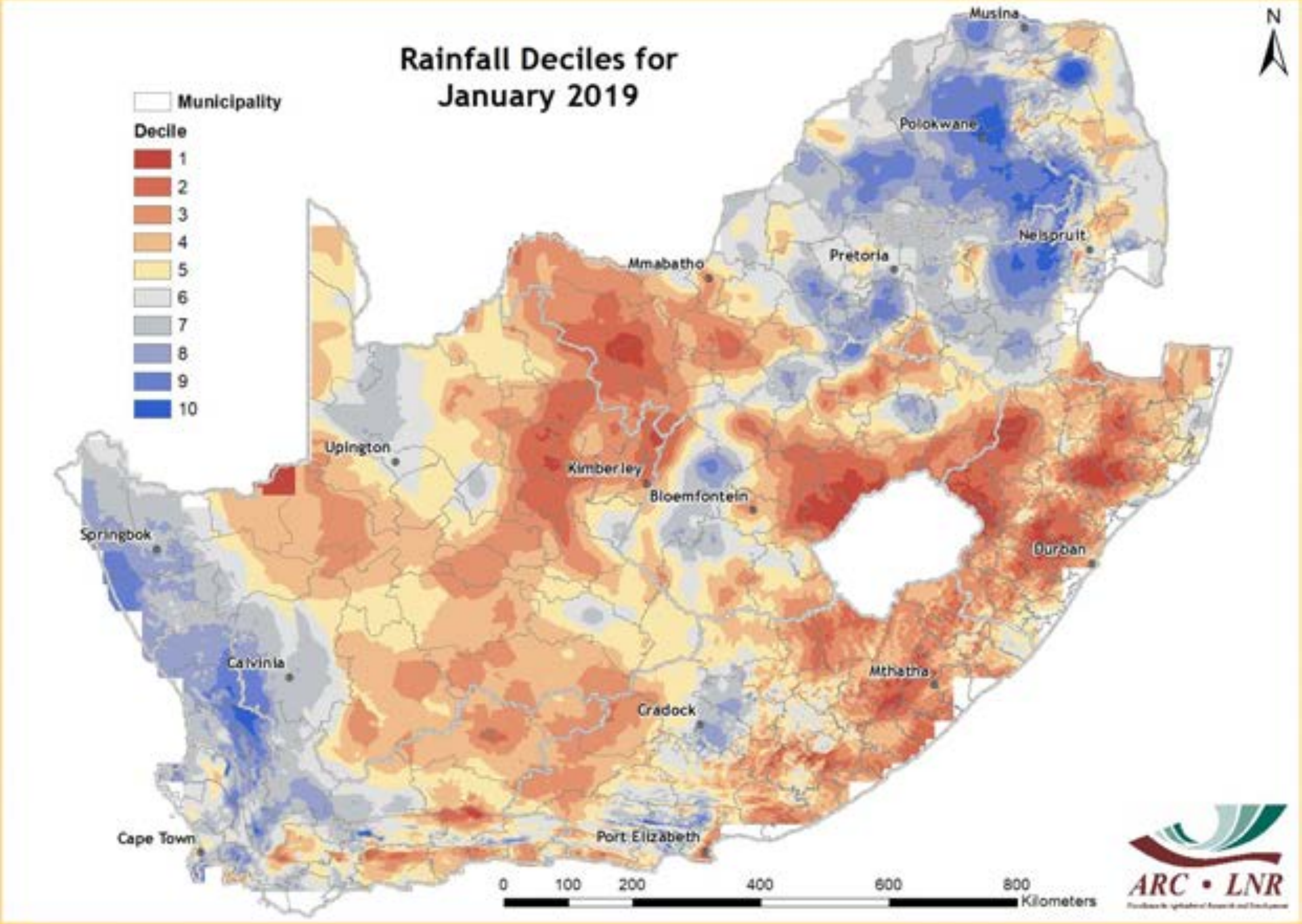

Figure 9

Figure 9:
Rainfall totals during the month of January 2019 over the southwestern and northeastern parts of the country fell within the wetter January months compared to historical January rainfall totals. The remainder of the country experienced a dry January 2019 compared to historical January months, especially the western parts of North West and parts of the Free State, KwaZulu-Natal and Eastern Cape provinces.

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4. Vegetation Conditions

Vegetation Mapping

The Normalized Difference Vegetation Index (NDVI) is computed from the equation:

NDVI=(IR-R)/(IR+R)

where:
IR = Infrared reflectance &
R = Red band

NDVI images describe the vegetation activity. A decadal NDVI image shows the highest possible "greenness" values that have been measured during a 10-day period.

Vegetated areas will generally yield high values because of their relatively high near infrared reflectance and low visible reflectance. For better interpretation and understanding of the NDVI images, a temporal image difference approach for change detection is used.

The Standardized Difference Vegetation Index (SDVI) is the standardized anomaly (according to the specific time of the year) of the NDVI.

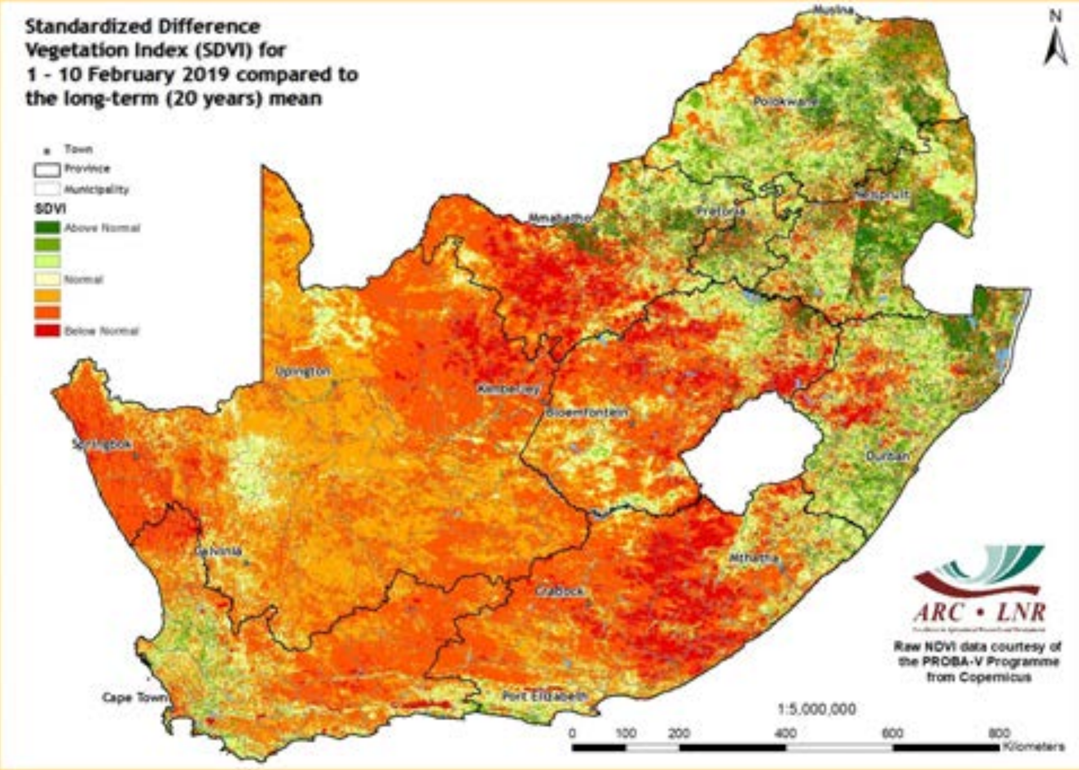

Figure 10

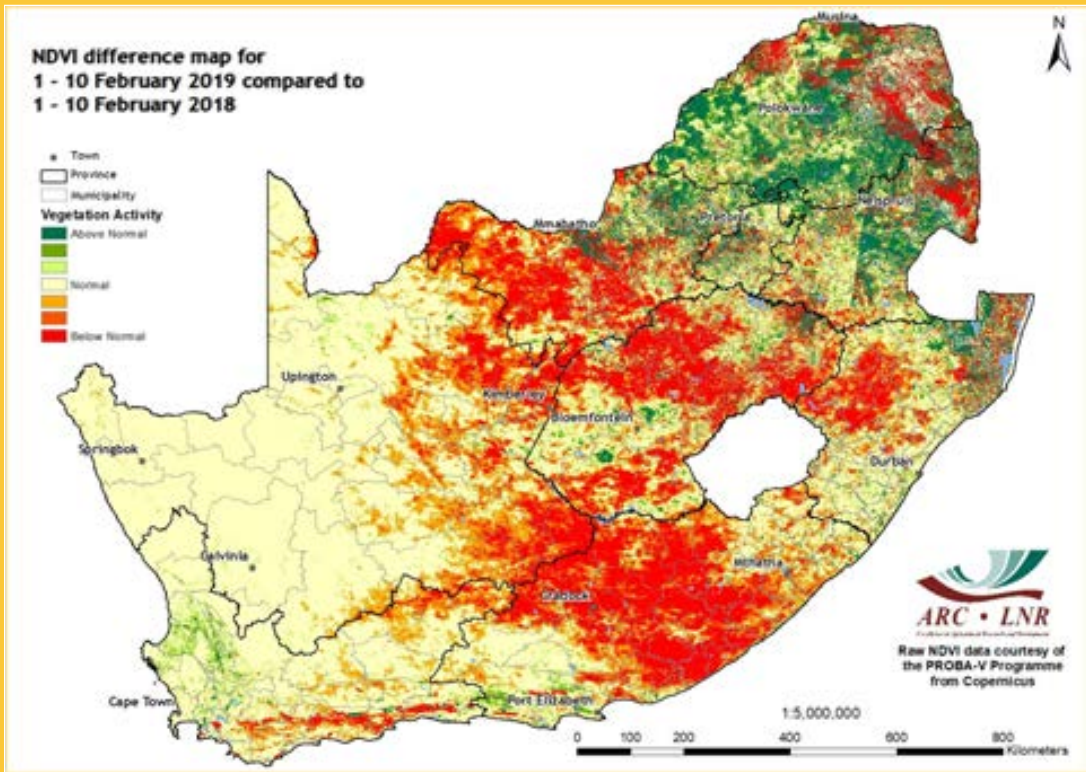

Figure 11

Figure 10:
When comparing the vegetation conditions in the first 10 days of 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. The summer rainfall brought relief over some areas in the northern parts, which stimulated greenness in vegetation.

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

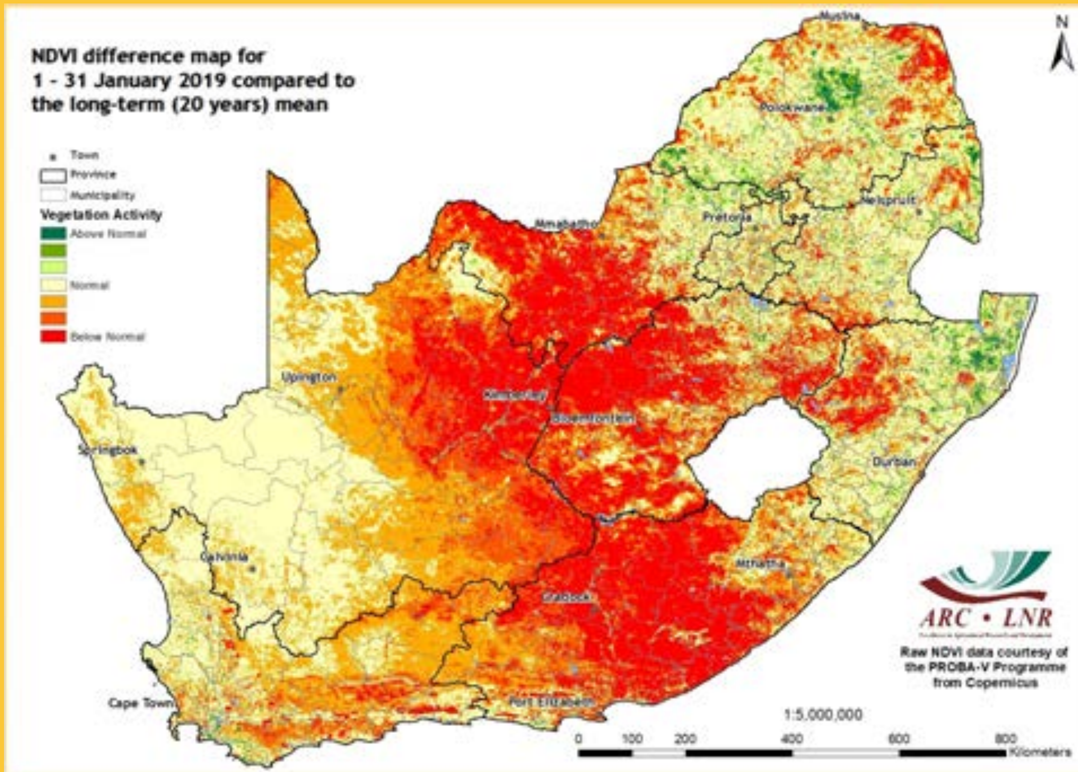

Figure 12

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

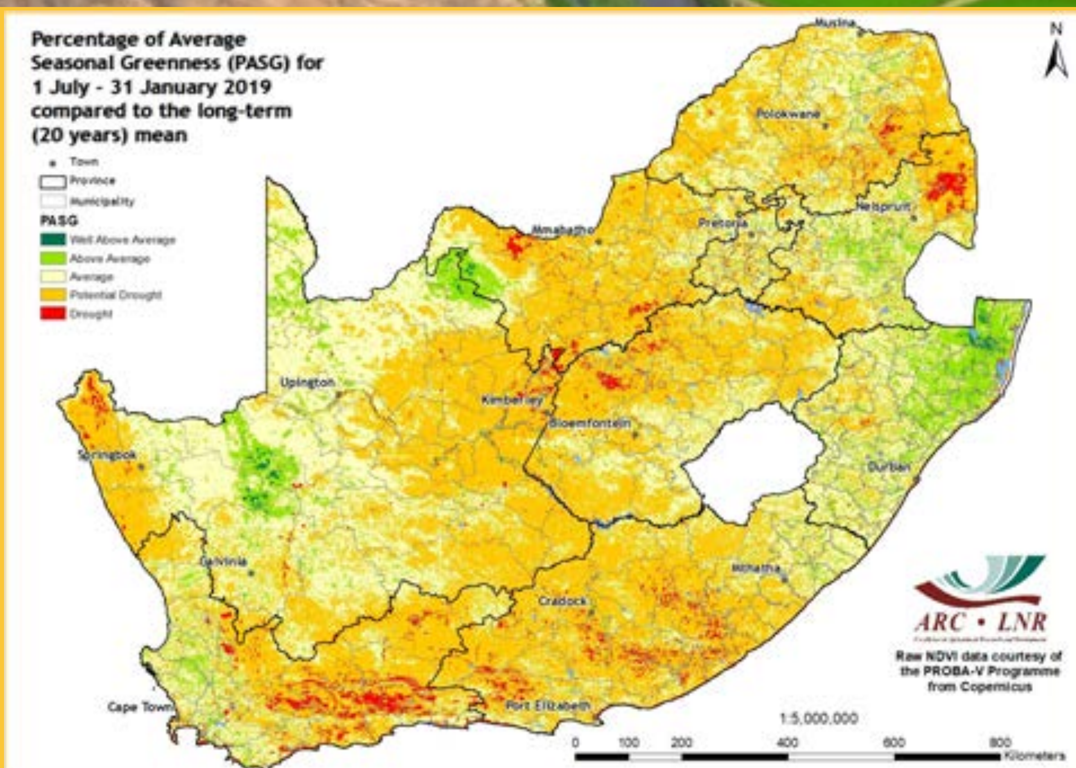

Figure 13

Figure 12:
Compared to the vegetation conditions calculated and averaged over 20 years, the NDVI difference map for January 2019 shows that below-normal vegetation activity remains dominant in the country's interior while much of the western parts of the Northern Cape, isolated areas in KZN, Mpumalanga, Limpopo and the Western Cape experienced normal vegetation activity.

Figure 13:
Over a 6-month period, potential drought conditions continued to occur over much of the country, with minor exceptions including some isolated areas in KZN, Mpumalanga and the central and northern parts of the Northern Cape.

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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.

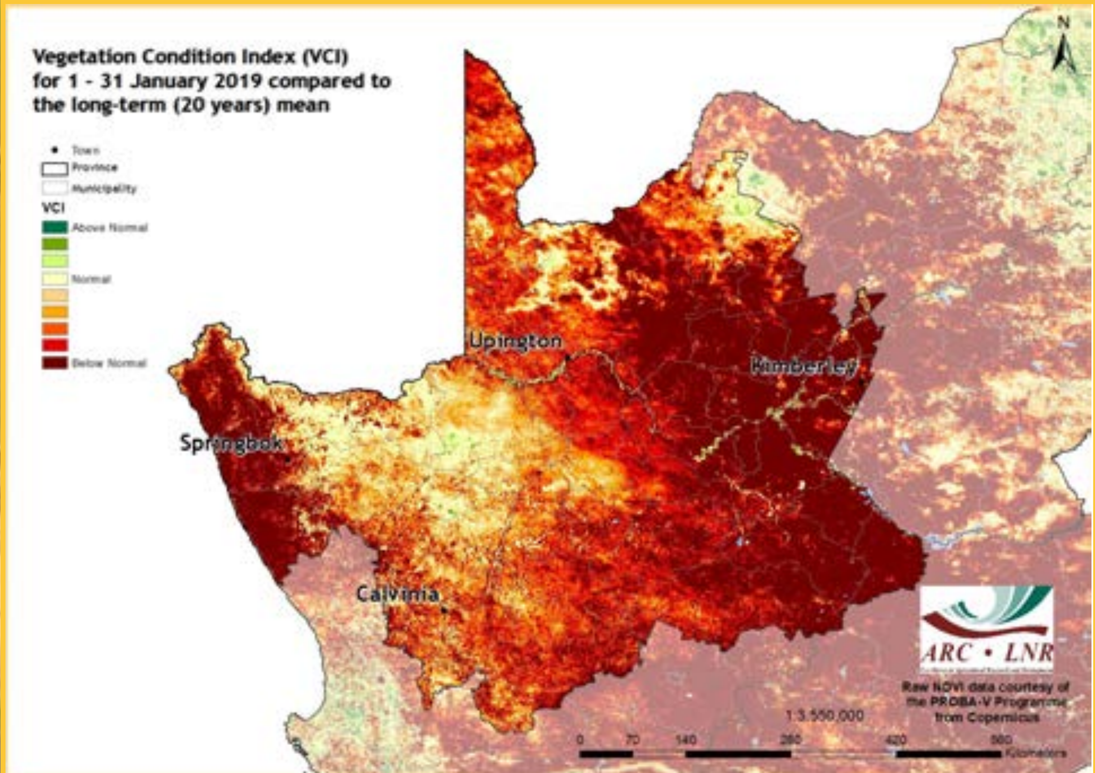
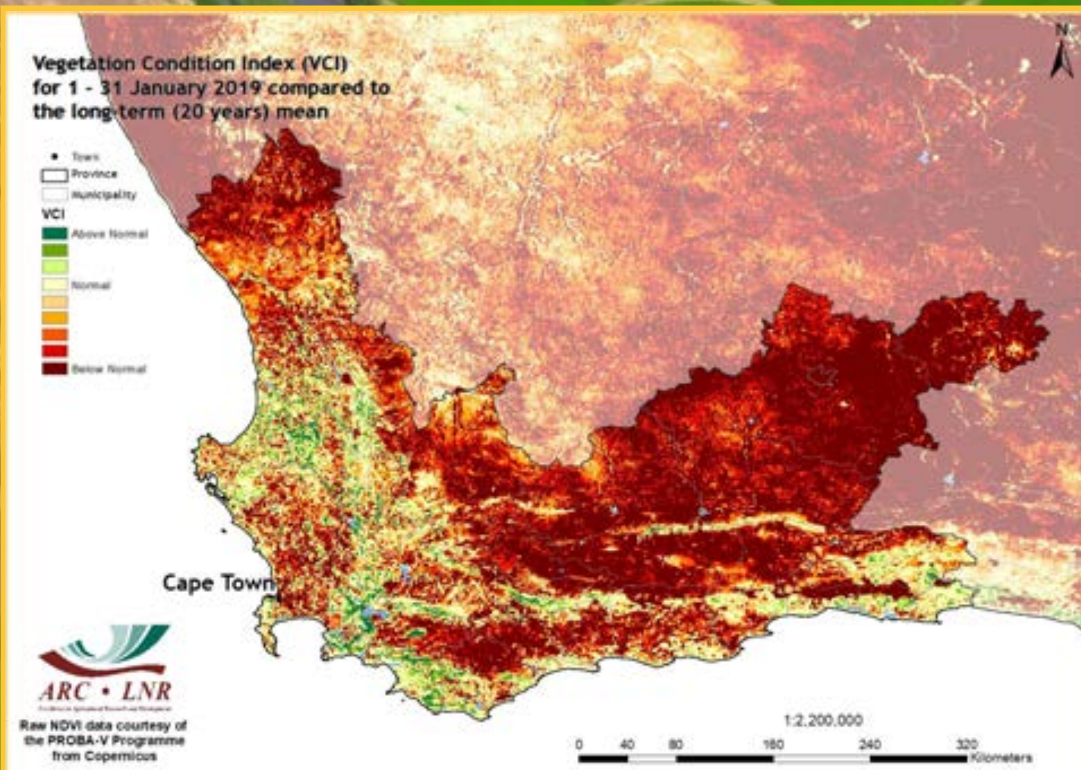


Figure 14

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

Figure 15:
The northern parts of the Central Karoo and West Coast of the Western Cape experienced very poor vegetation activity in January in relation to other parts of the province.



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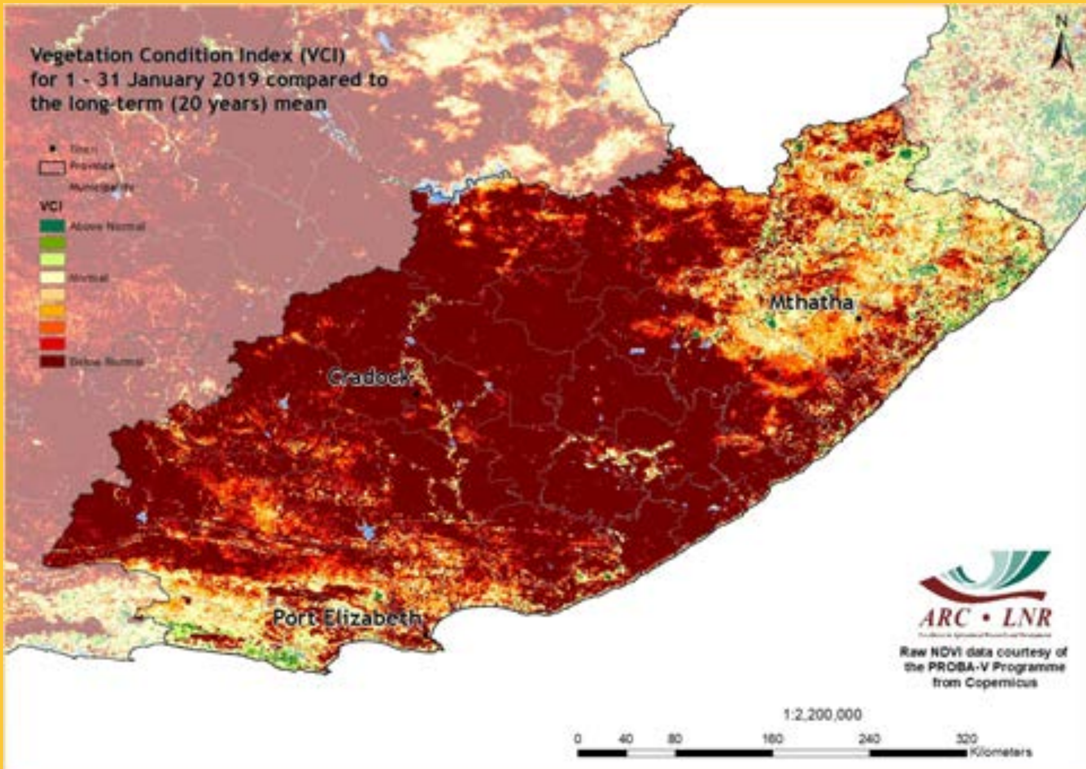

Figure 16

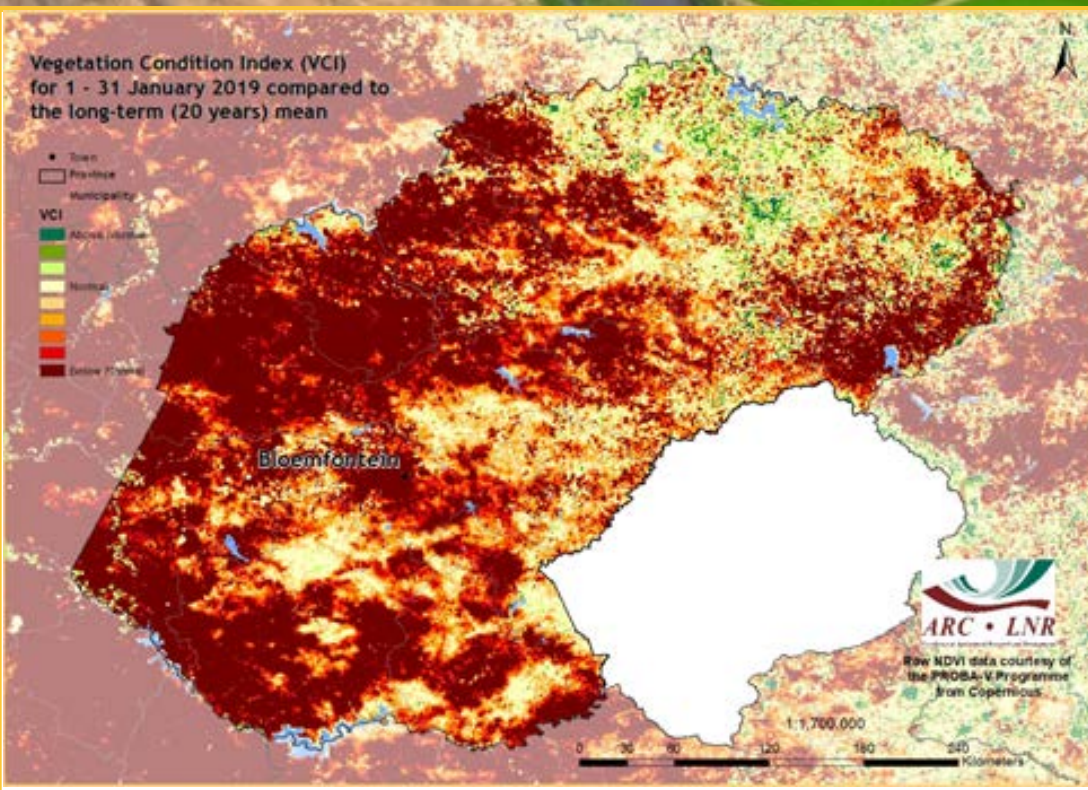

Figure 17

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

Figure 17:
The month of January was marked with extremely poor vegetation conditions over much of the Free State. Nevertheless, some isolated areas in the far northern parts of the province showed signs of relief.

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6. Vegetation Conditions & Rainfall

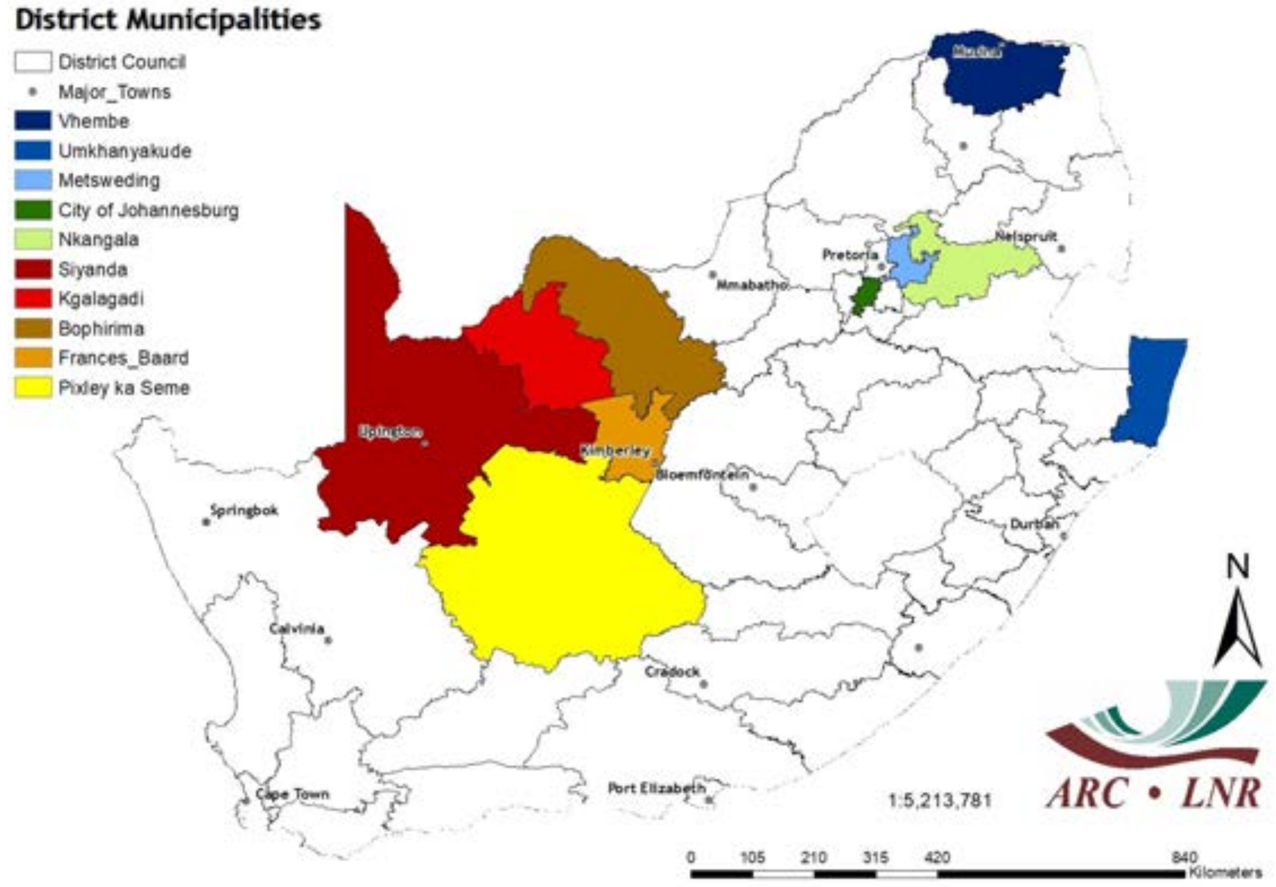

Figure 18

Rainfall and NDVI Graphs

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

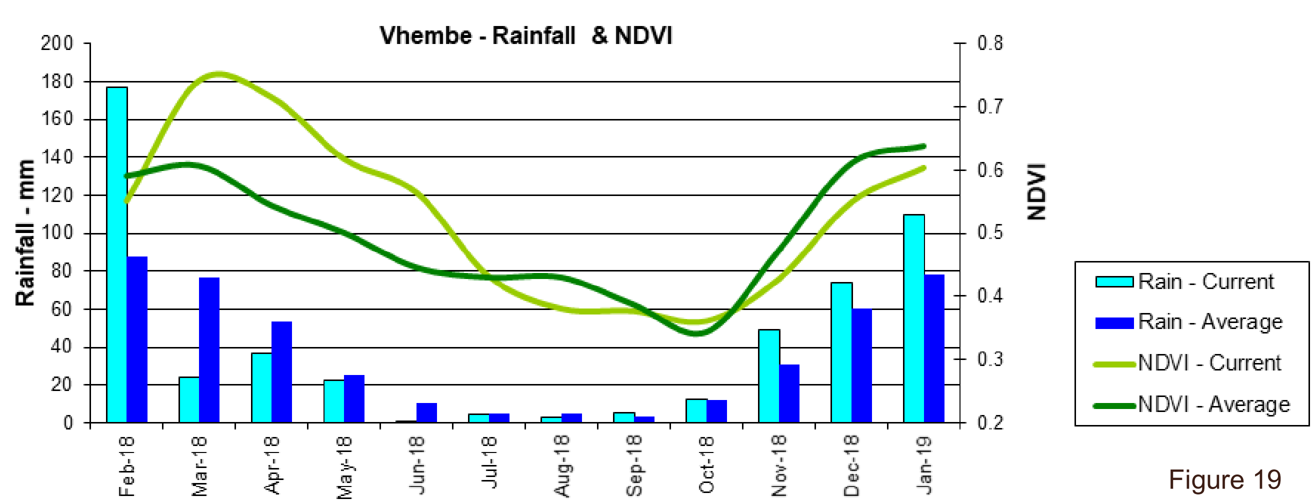


Figure 19

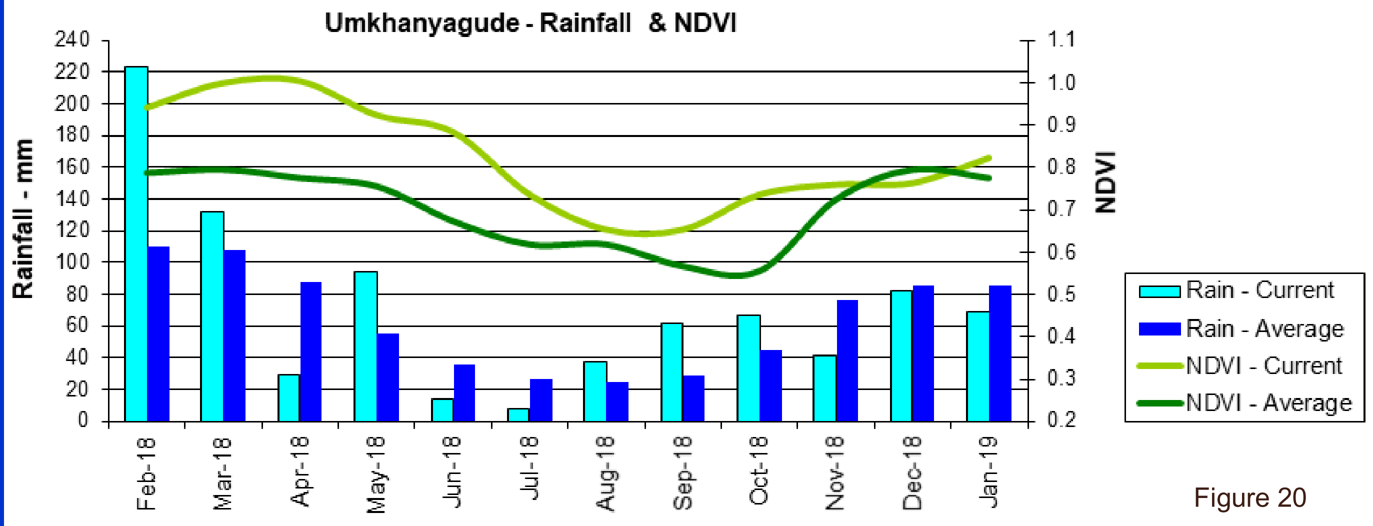


Figure 20

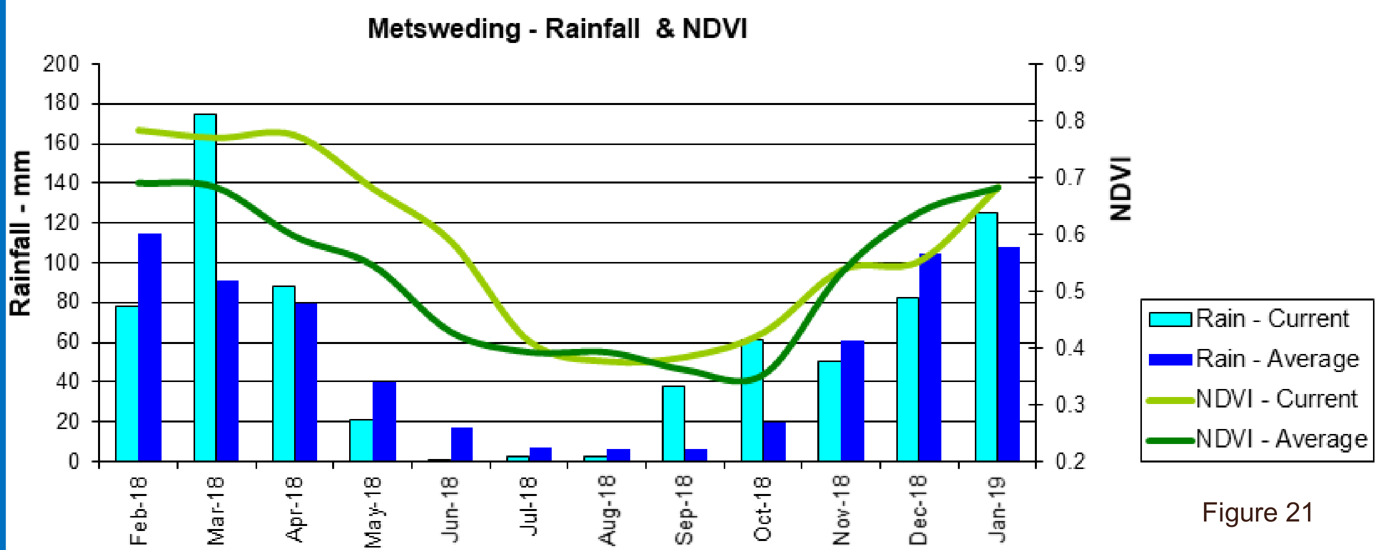
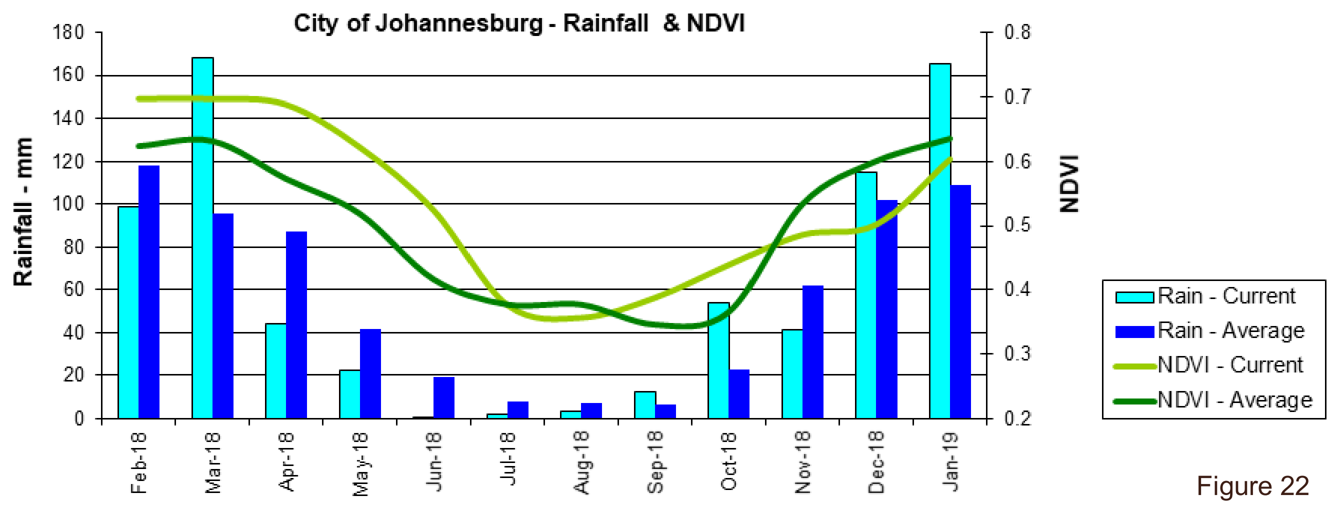


Figure 21



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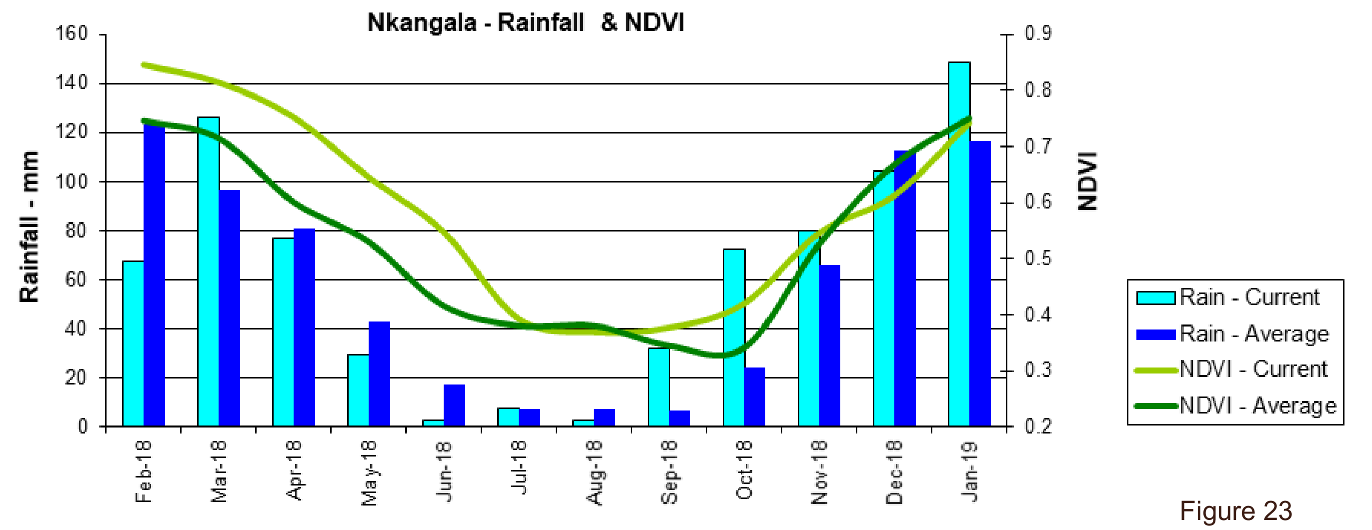
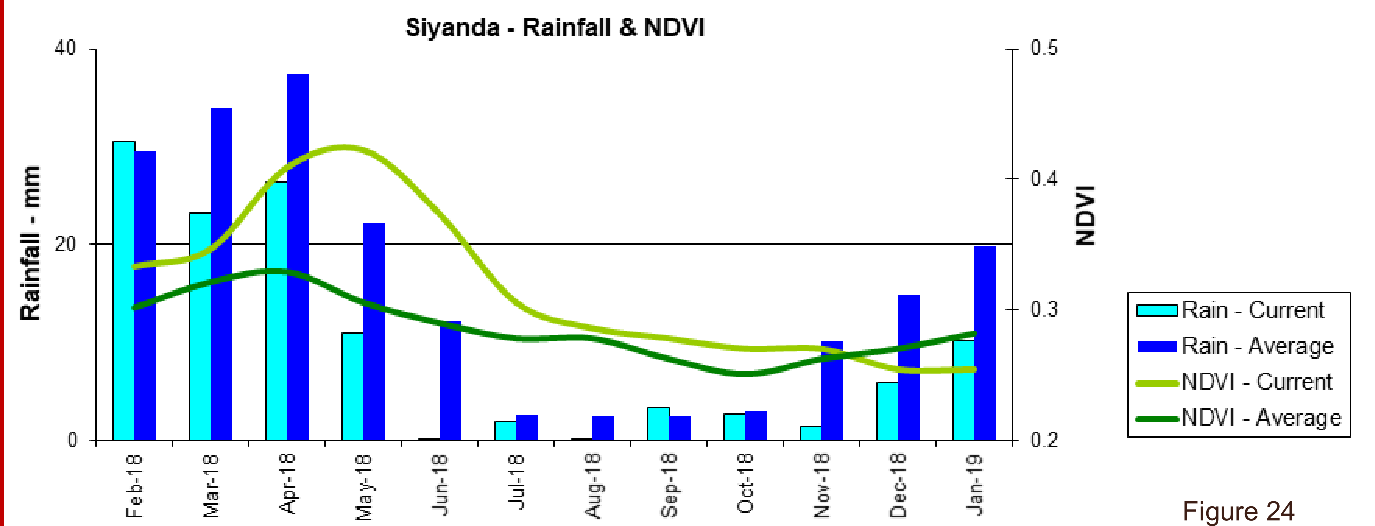


Figure 23



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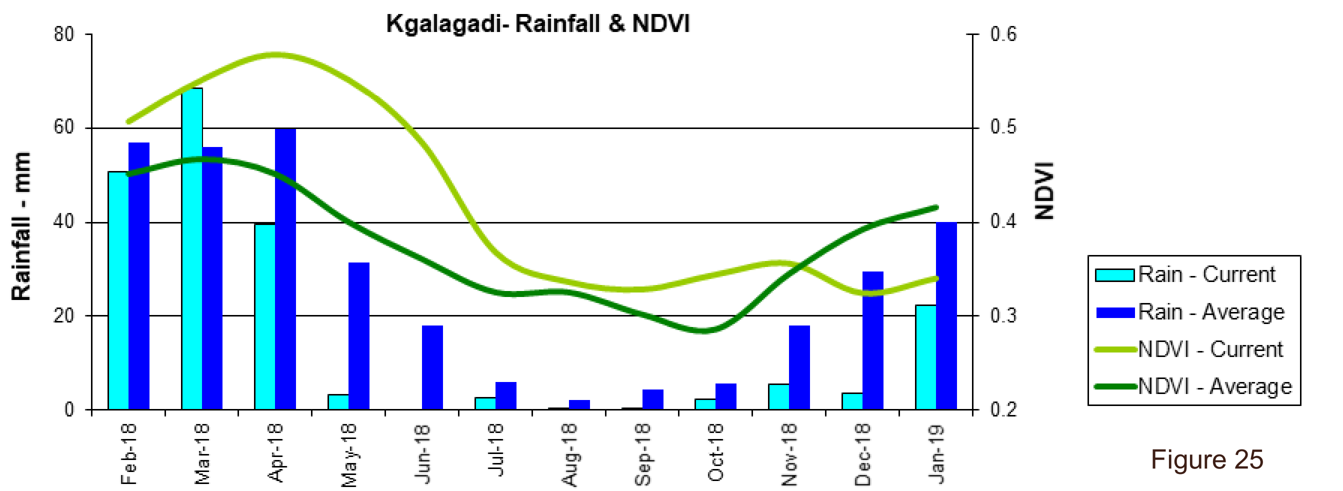
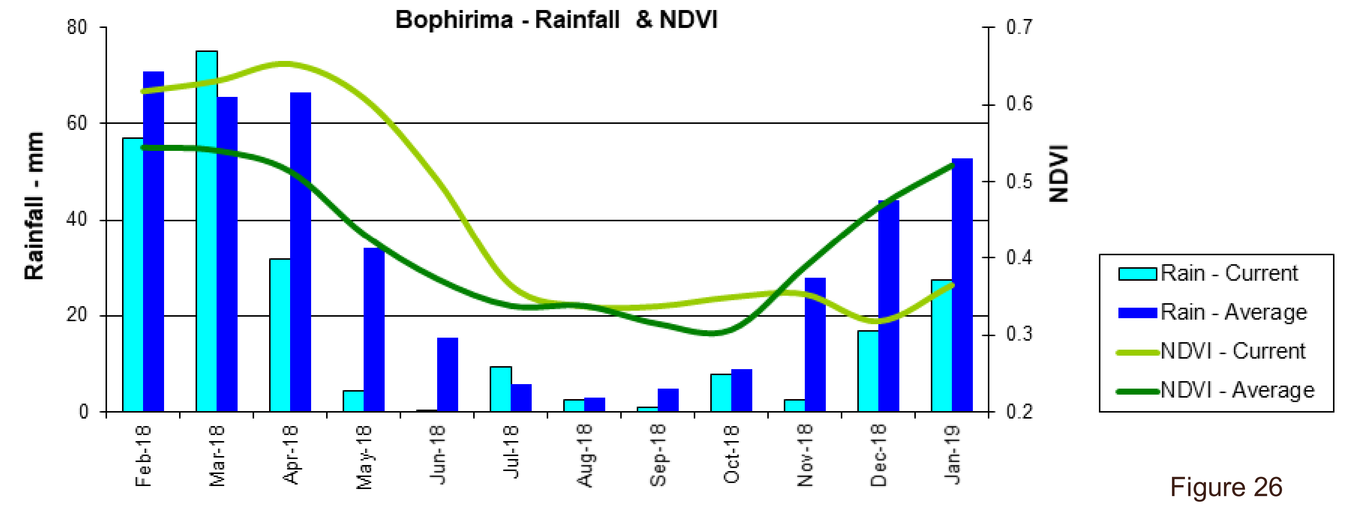


Figure 25



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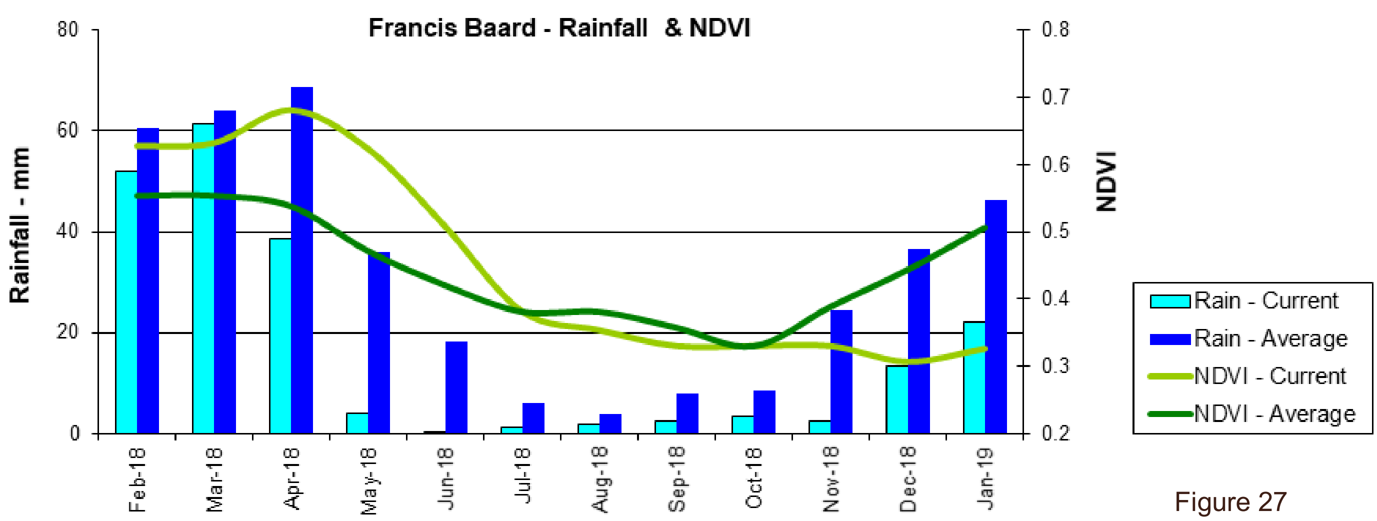

Figure 27

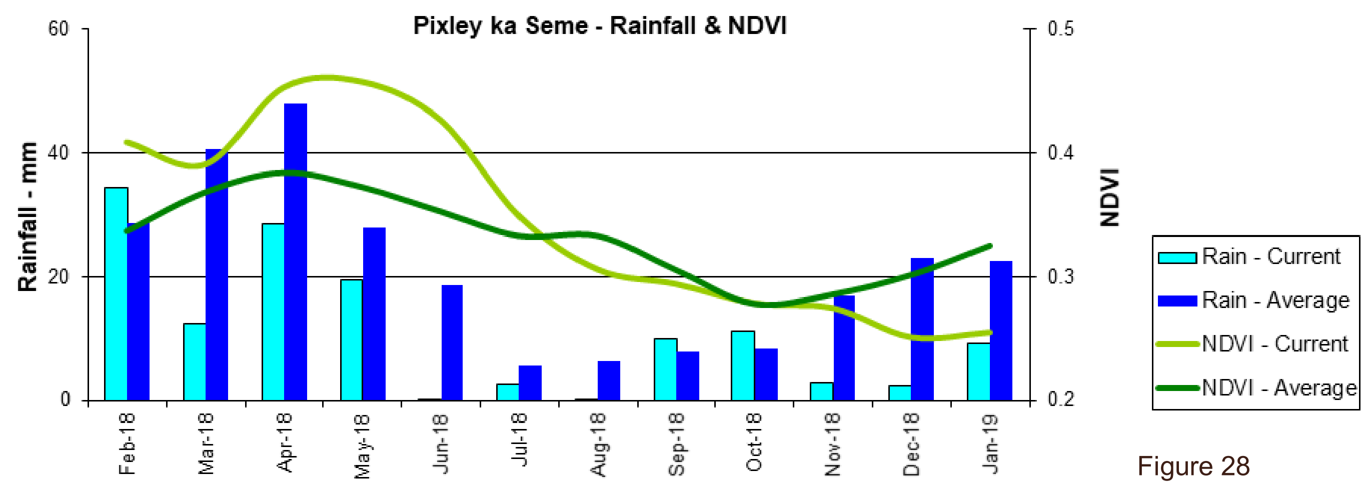

Figure 28

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

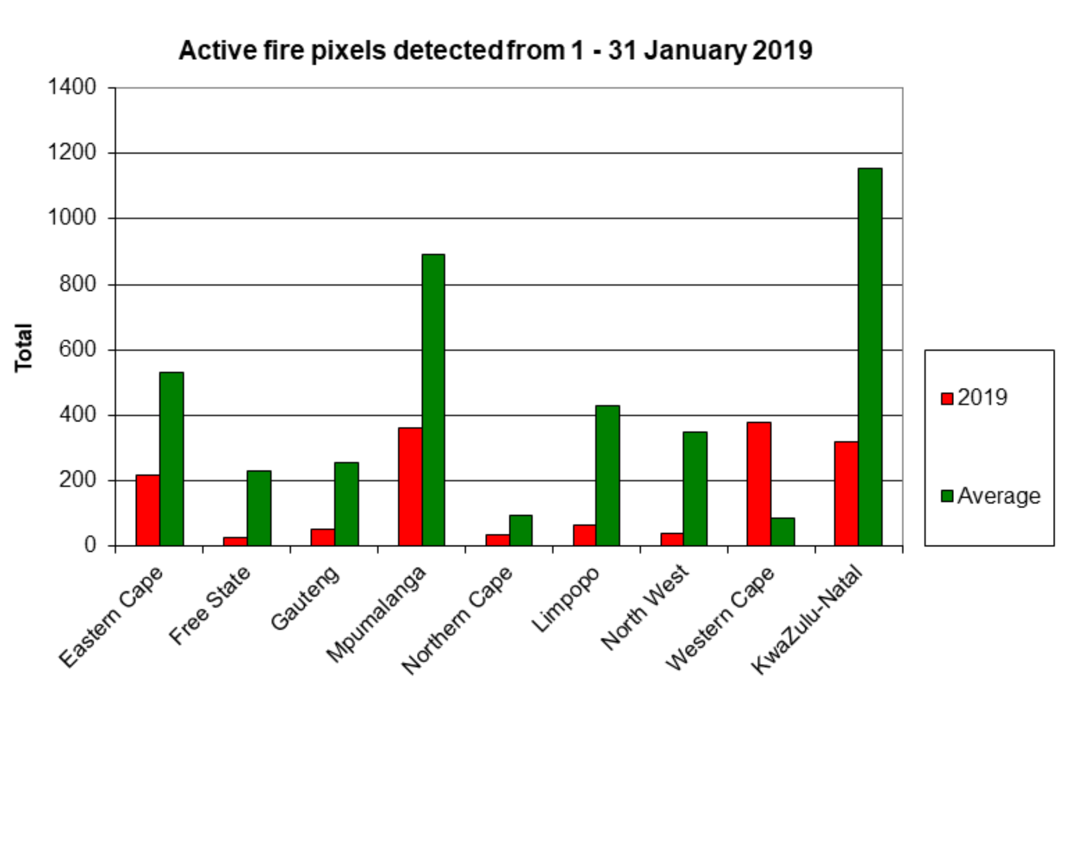

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-31 January 2019.

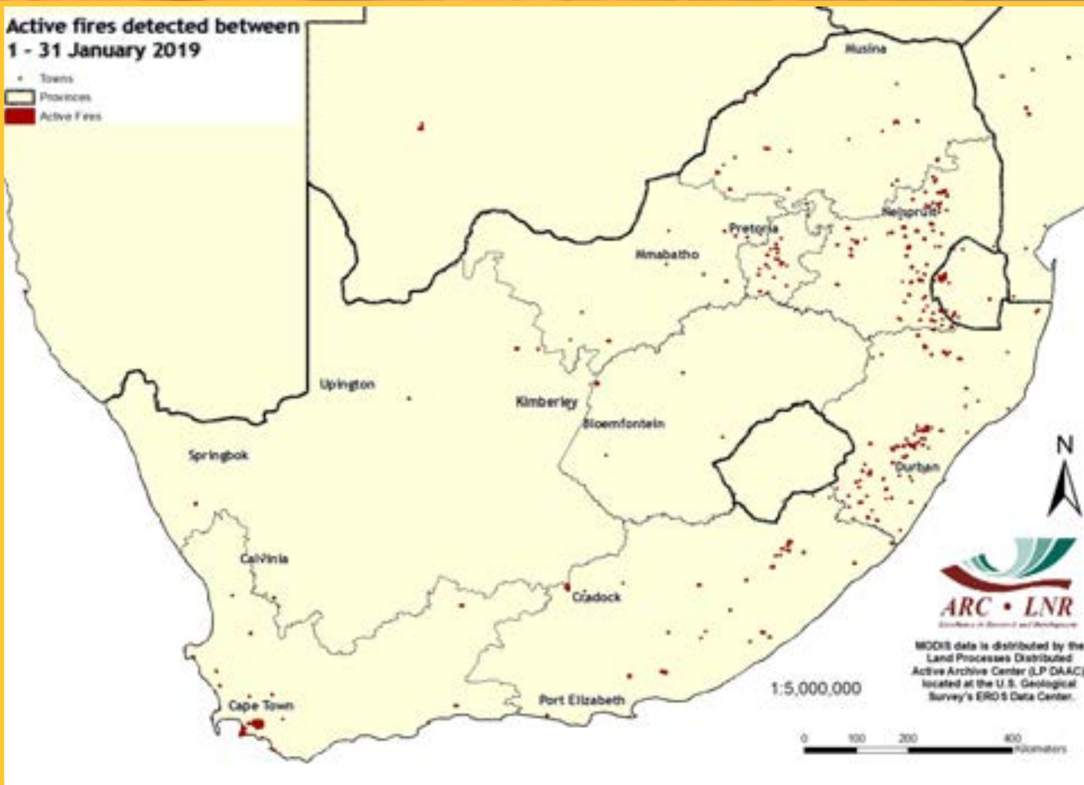

Figure 30

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 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 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 two maps show that the majority of water catchments across the country contain slightly less than the maximum water area recorded in those same catchments since the end of 2015. There are some notable areas of severe water reductions in the Karoo and Kalahari.

Comparison between January 2019 and January 2018 shows that generally the entire country has either equal or slightly lower water extents this year than the same month last year. There are, however, a few local catchments (shown in blue) that are exceptions to this rule.

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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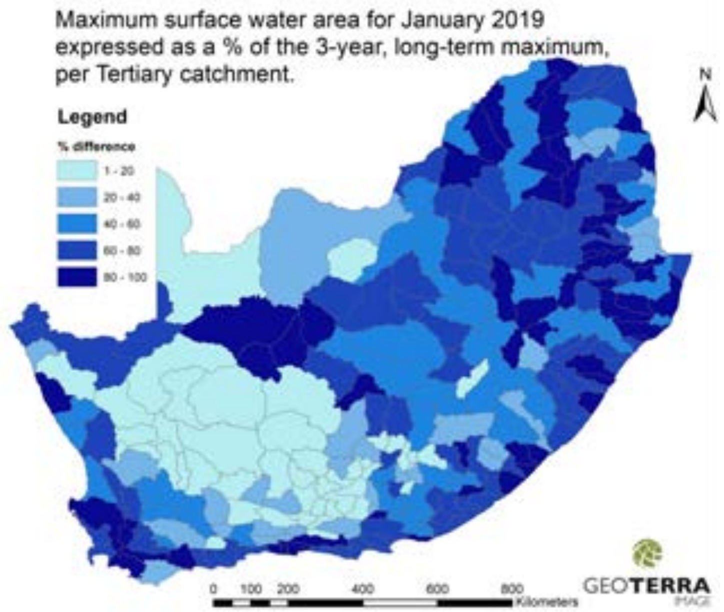

Figure 31

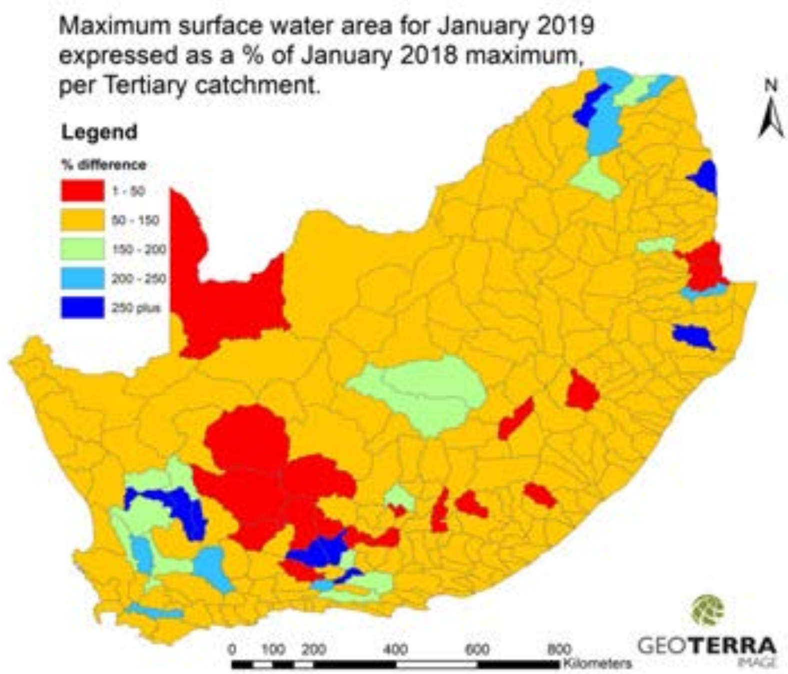

Figure 32

GEOTERRA IMAGE

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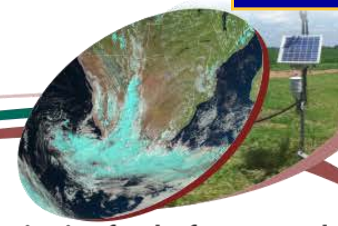
Agrometeorology



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”.