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Excellence in Research and Development

UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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

South African Weather Service

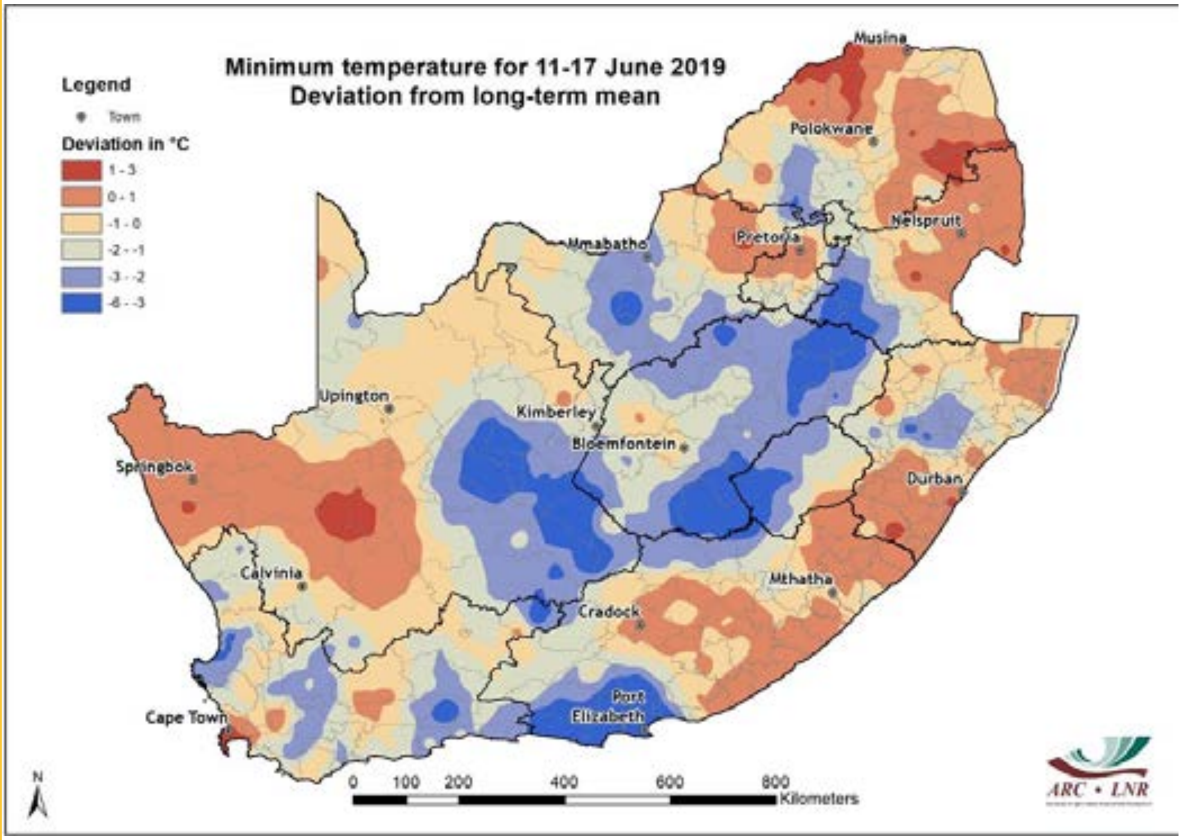
AMESD

180th Edition

Image of the Month

Minimum temperatures dip below freezing over the interior

After relatively warm and dry weather in May 2019, the start of June was more winter-like with a frontal system that brought good rainfall on the 4th and 5th in places over the winter rainfall region. More than 50 mm was measured at the ARC Constantia weather station on the 4th of June, followed by nearly 30 mm the following day. This was the first good rainfall in that region this winter. Whereas minimum temperatures have been relatively high so far during the autumn and winter months, colder morning conditions started to occur towards mid-June. Consecutive days with morning temperatures that dropped below freezing occurred over the central and eastern interior. Minimum temperatures as low as -8˚C were recorded in places over the interior between the 14th and 16th of June. Compared to the long-term mean, the period from 11 to 17 June 2019 experienced minimum temperatures that were up to 6˚C lower than normal over parts of the central and eastern interior (see map below).



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 the very good rainfall over parts of the country during April 2019, the month of May was characterized by the absence of a good rainfall system. The only area of South Africa that received above-normal rainfall during May is the southern interior – where relatively small rainfall totals are needed in order to be above normal for this time of the year. The winter rainfall region received below-normal rainfall during May 2019, with most areas recording totals that are less than half of the long-term average. This resulted from the absence of good frontal rainfall as well as a low frequency of frontal activity that would normally be expected to move in over the country. The largest portion of the May rainfall over the winter rainfall region occurred around the 20th, with little rainfall occurring during the remainder of the month. The relatively good rainfall over the southern interior of the country resulted from two rainfall events, around the 8th and 27th of May, when cloud development associated with the passage of upper-air troughs took place.

Temperature-wise, the country experienced mostly above normal maximum and minimum temperatures during the month of May. The higher than normal temperatures contributed to extend the growing season together with the good April rainfall over some parts of the summer rainfall region. This was welcomed by the agricultural sector as the 2018/19 summer season started off with below-normal rainfall conditions and a late start to the planting season.

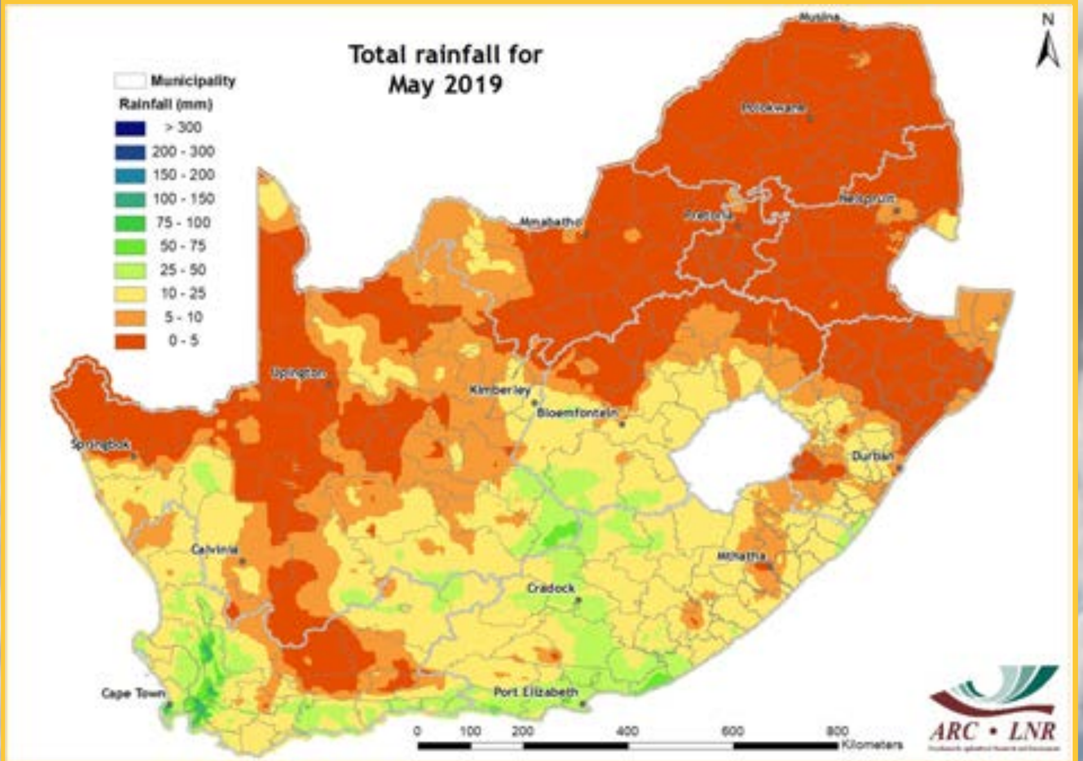


Figure 1

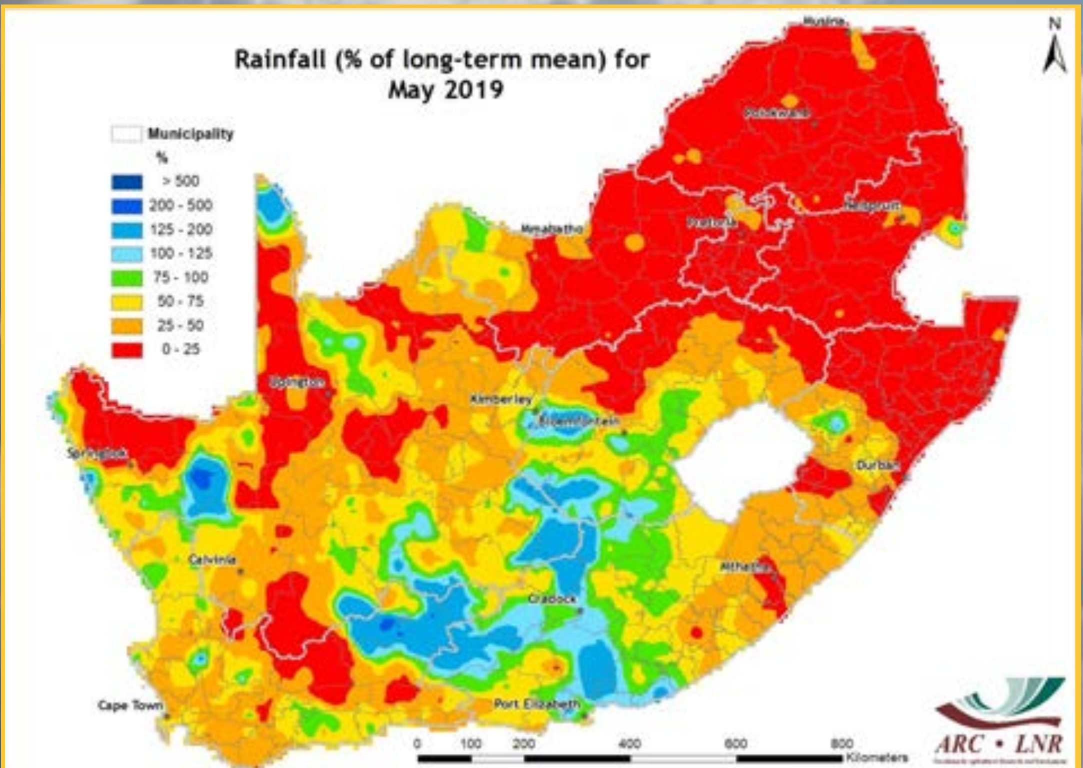


Figure 2

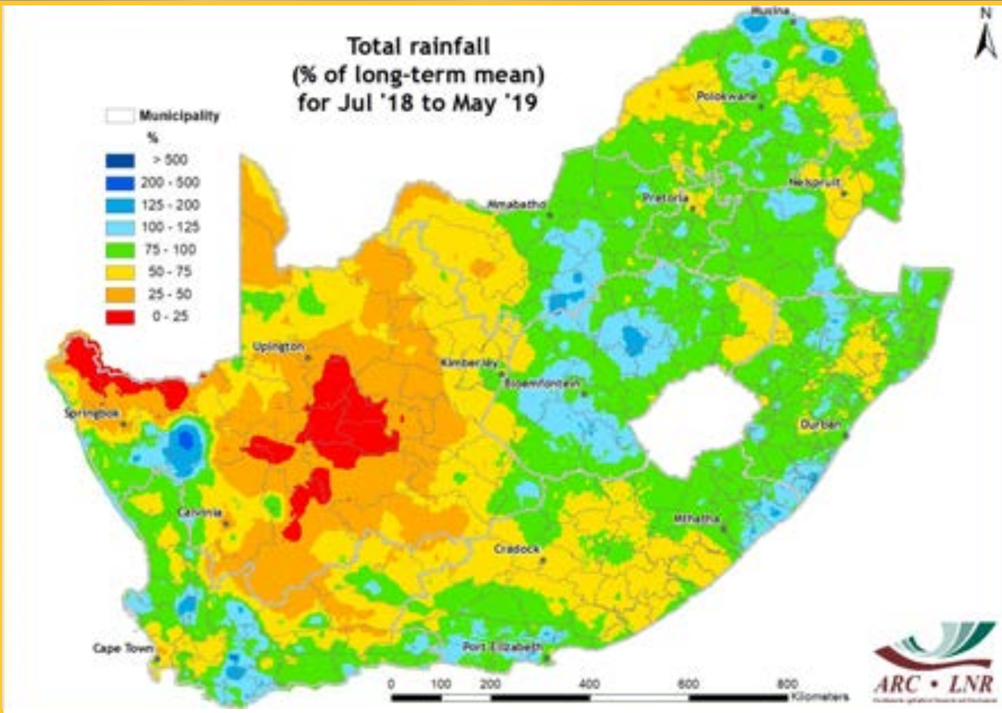


Figure 3

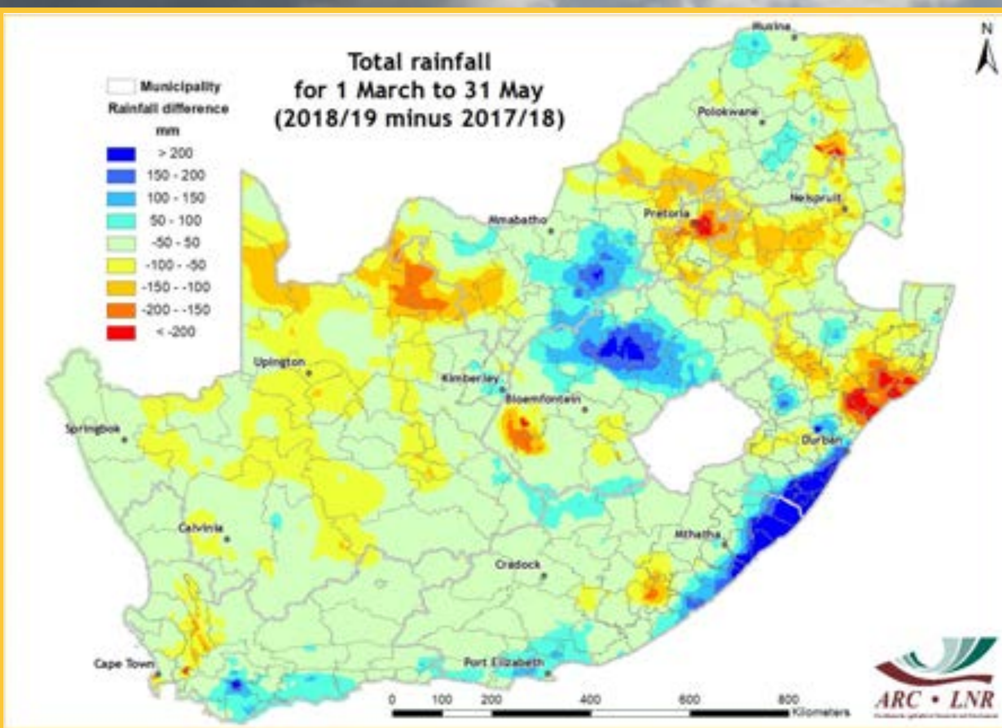


Figure 4

Figure 1:
Winter weather patterns are now present over South Africa and rainfall over the largest part of the summer rainfall region has ceased. Rainfall that occurred over the country was mostly associated with frontal systems and the accompanying upper-air troughs.

Figure 2:
The winter frontal systems that neared or moved in over the country only brought below-normal rainfall during the month of May. The cloud systems that developed ahead of the surface frontal systems brought some rain over the southern interior that resulted in above-normal rainfall in those areas.

Figure 3:
During this 11-month period above-normal rainfall occurred over parts of the winter rainfall region, but not in the water catchment region of the most important water reservoirs for that area. Further to the east along the Cape south coast, near-normal rainfall occurred with above-normal rainfall in some places. Over the summer rainfall region, large areas in the west received below-normal rainfall during this 11-month period. The very good rainfall during April 2019 resulted in the above-normal rainfall over the central parts of the country (Free State and North West). Further to the east and north-east, near-normal rainfall occurred in general with some isolated areas that received above-normal rainfall.

Figure 4:
Compared to the corresponding 3-month period a year ago, important water catchment regions over the winter rainfall region received between 100 and 200 mm less rain during 2019 – indicative of a much poorer start to the 2019 rainfall season for those areas compared to 2018. Over the summer rainfall region, isolated areas also received up to 200 mm less during March-May 2019 vs the corresponding period last year, whilst relatively small areas over the central interior as well as along the eastern coastal regions received over 200 mm more this year. This is due to the excessive rain that occurred during April 2019 over those areas.

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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 far southwestern parts of the Western Cape visible on the longer time scales (24 and 36 months) as represented by the SPI ending in May 2019 shows signs of relief on the 12- and 6-month SPI maps in terms of magnitude and spatial extent. However, the drought conditions over the western interior persisted and show extreme drought status over the central parts of the Northern Cape on the 6-month SPI map. Parts of the Eastern Cape have also not yet escaped the drought conditions on all the time scales presented here. Over the northeastern parts of the country as well as parts of the central interior, improved conditions are visible on the 6-month SPI map after the improved rainfall over those areas during the late summer / early autumn of 2019.

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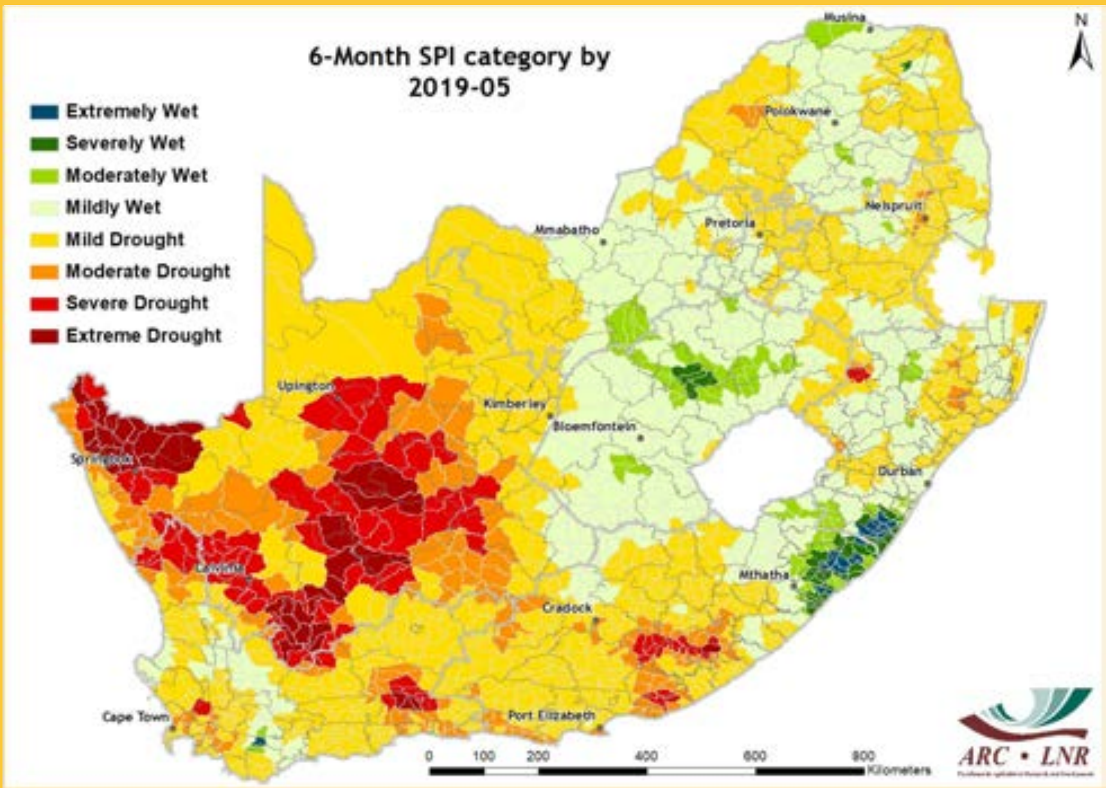
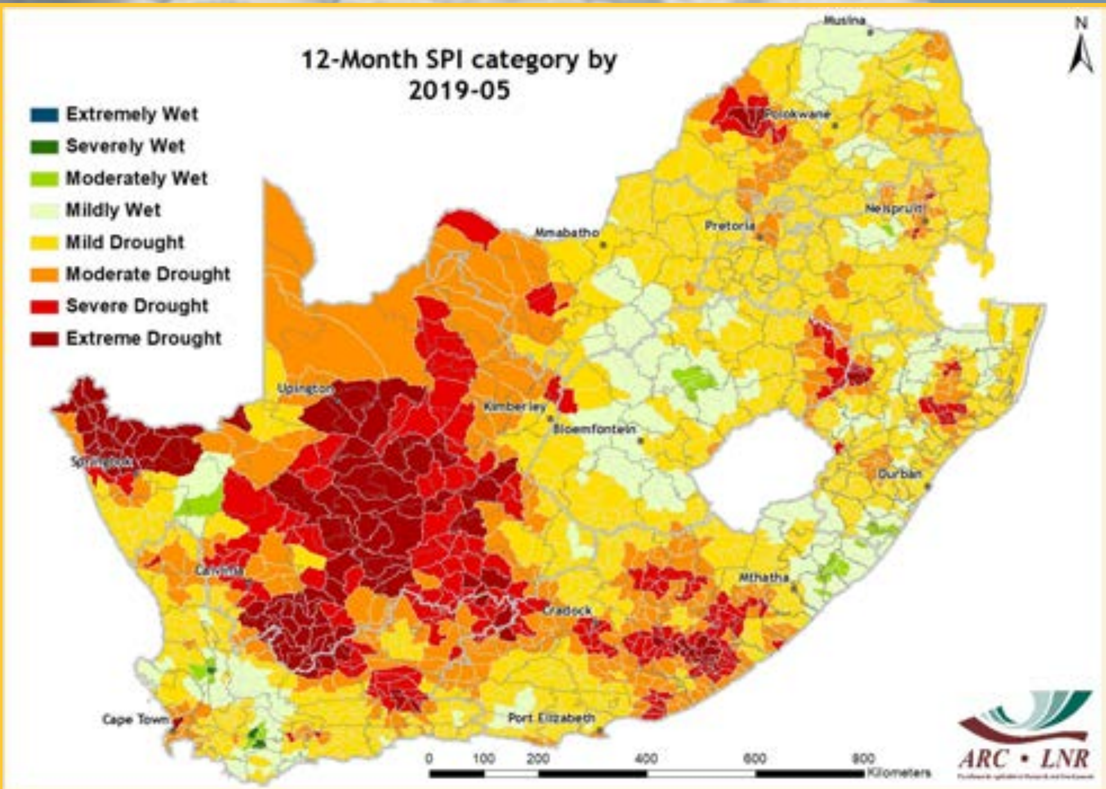


Figure 5



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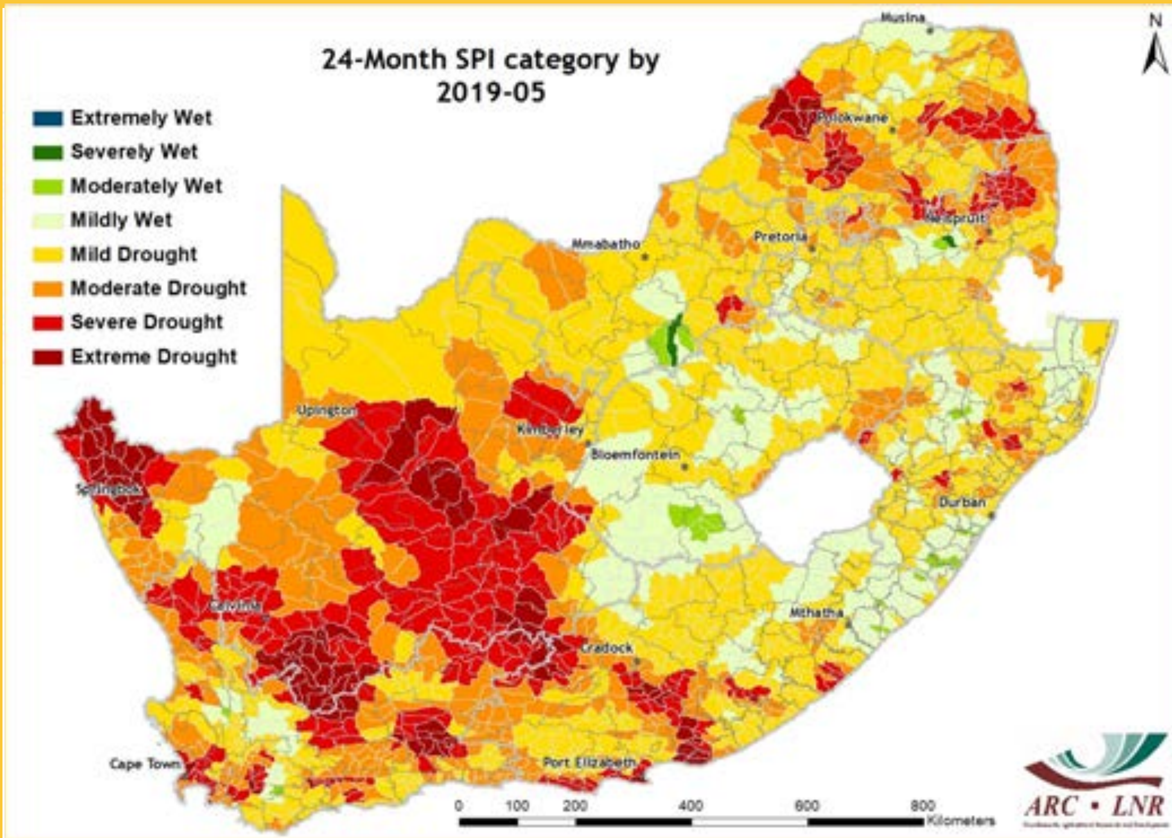

Figure 7

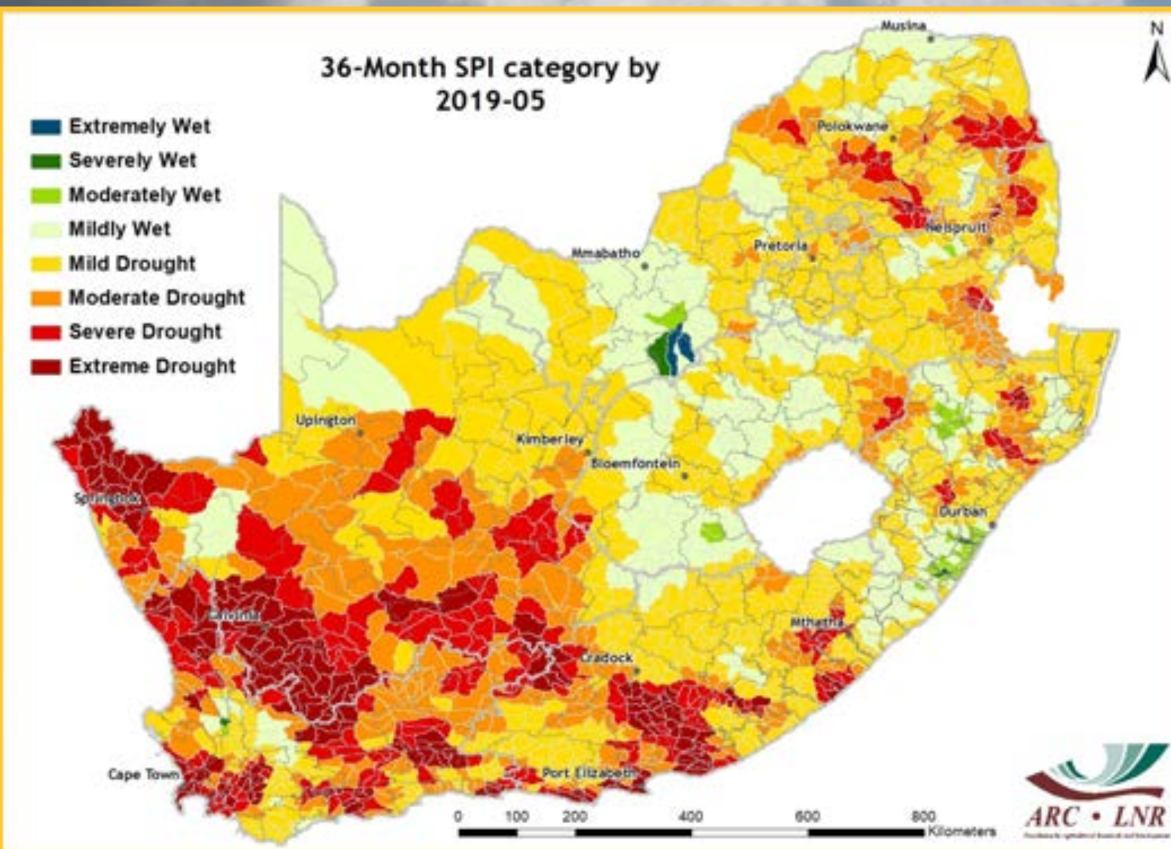

Figure 8

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.

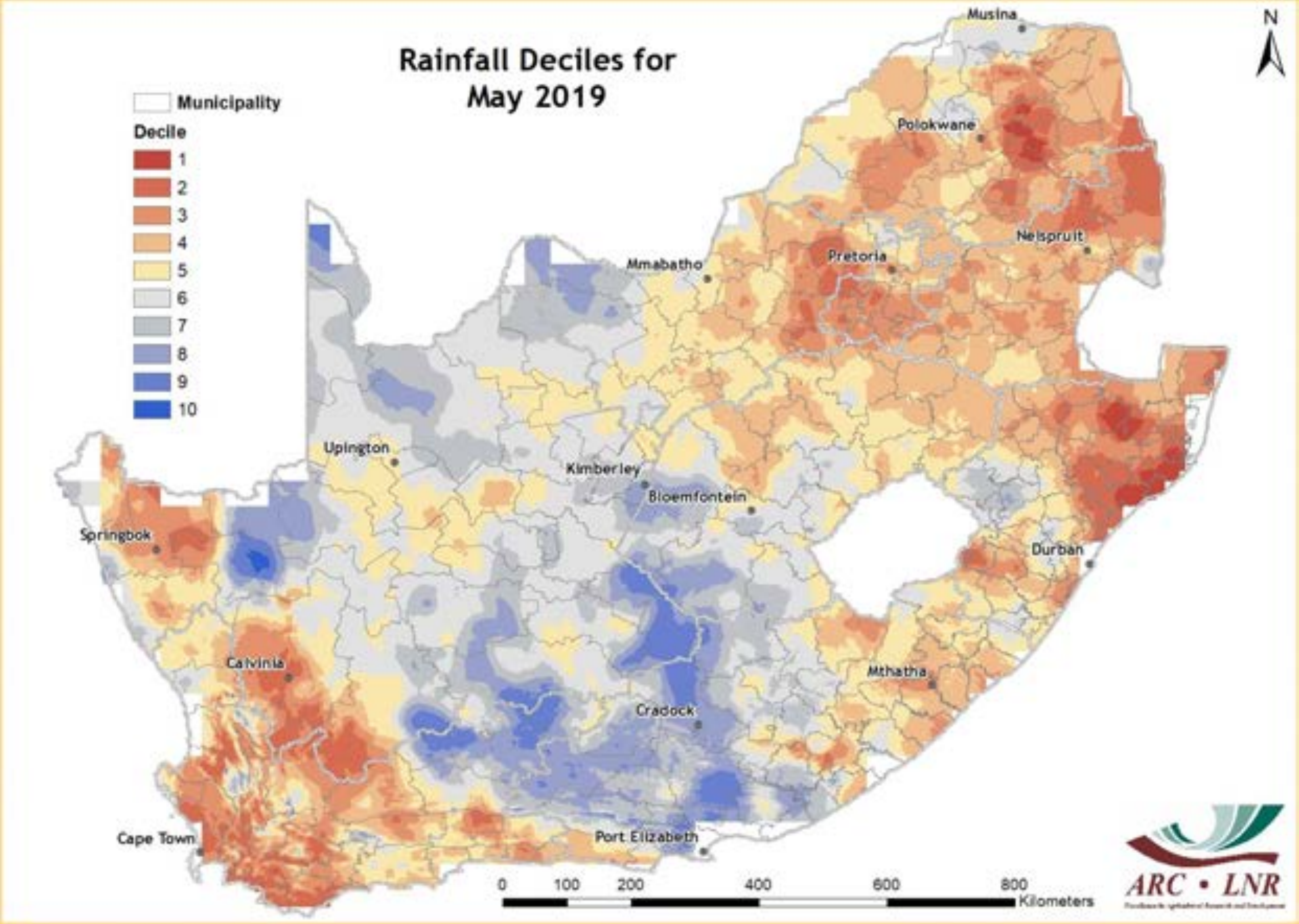

Figure 9

Figure 9:
Rainfall totals during May 2019 over parts of the western to central interior extending southwards to the western half of the Eastern Cape compare well with the historically wetter May months. Over the southwestern parts of the country, rainfall totals were similar to those of historically drier May 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.

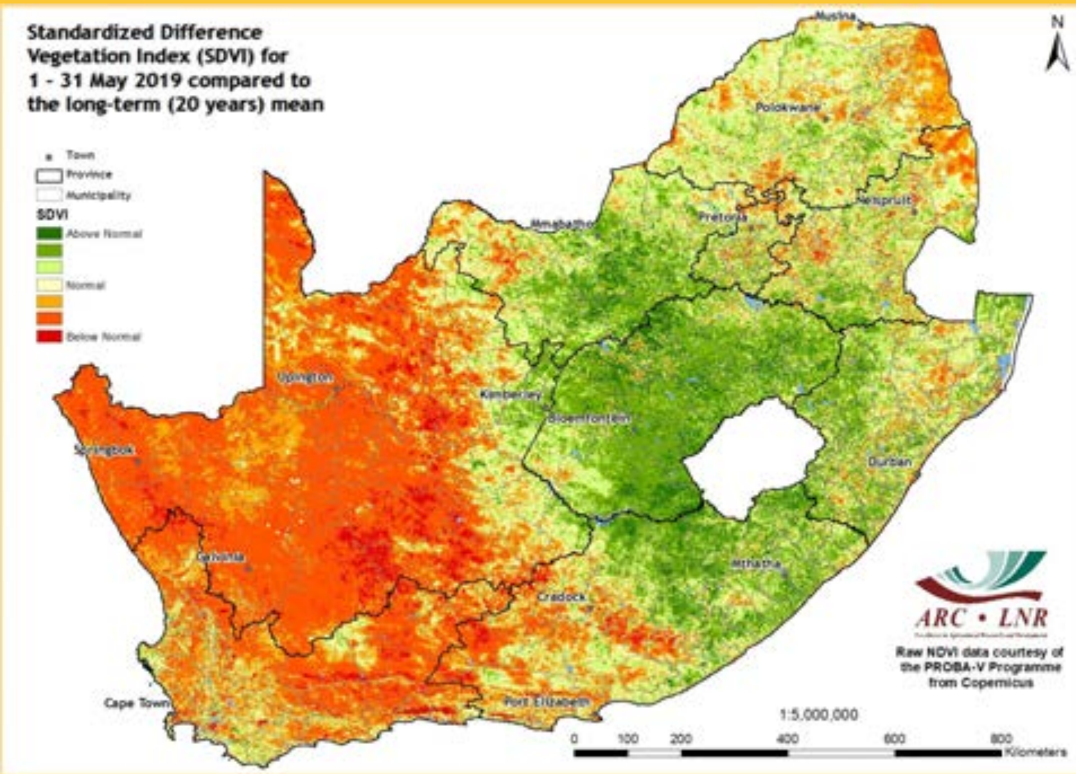

Figure 10

Figure 10:
The May 2019 SDVI map shows that less favourable conditions for healthy vegetation to thrive remain dominant in the western parts of the country. However, the eastern parts experienced quite the opposite.

Figure 11:
Compared to the vegetation conditions calculated and averaged over 21 years, the NDVI difference map for May 2019 shows that below-normal vegetation activity occurred mainly in the western parts of the country and some isolated areas in Limpopo. Meanwhile, the central parts of he country experienced above-normal vegetation activity.

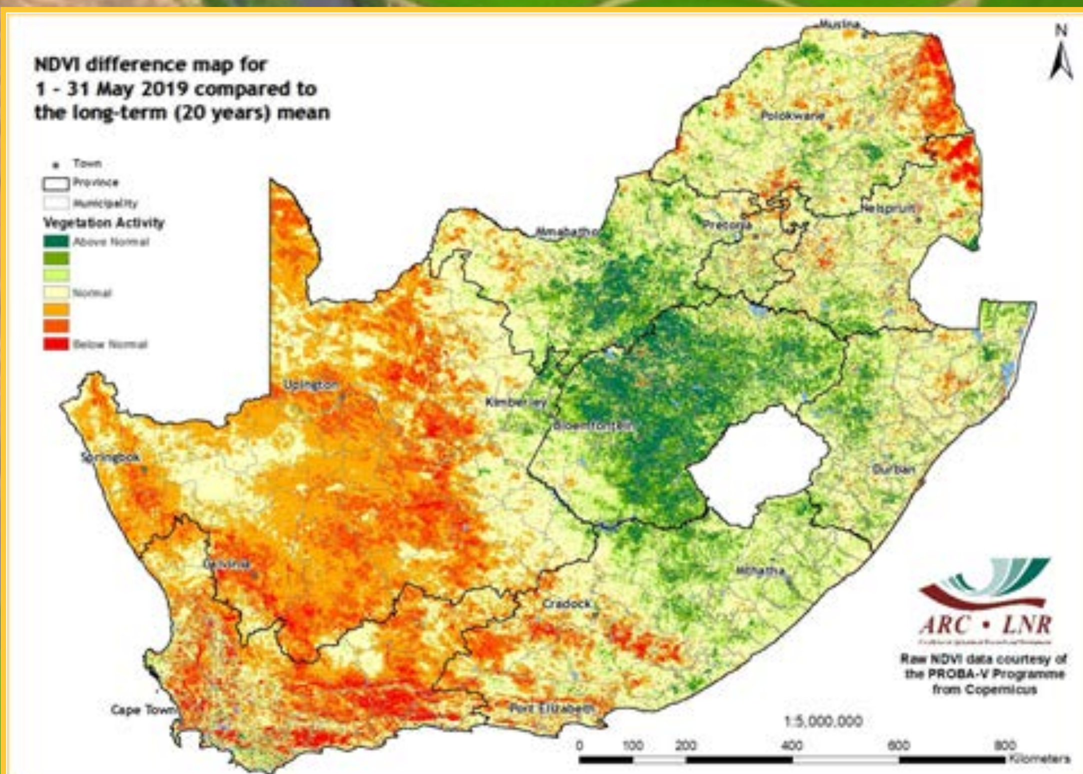

Figure 11

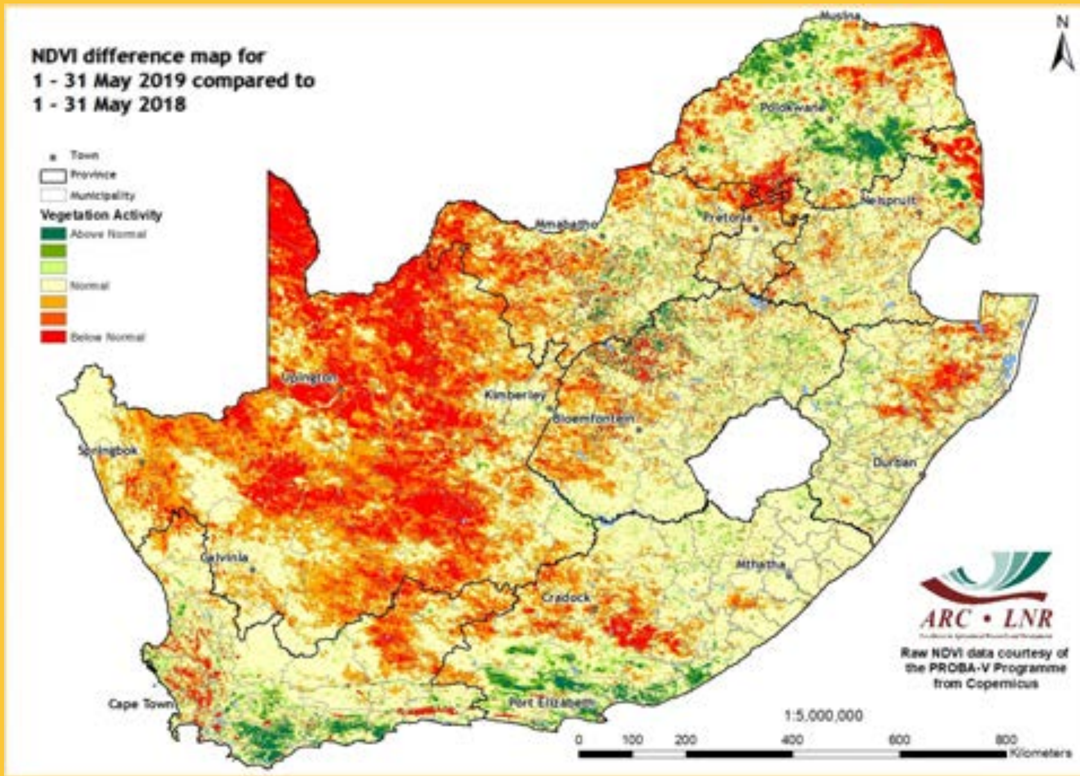

Figure 12

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

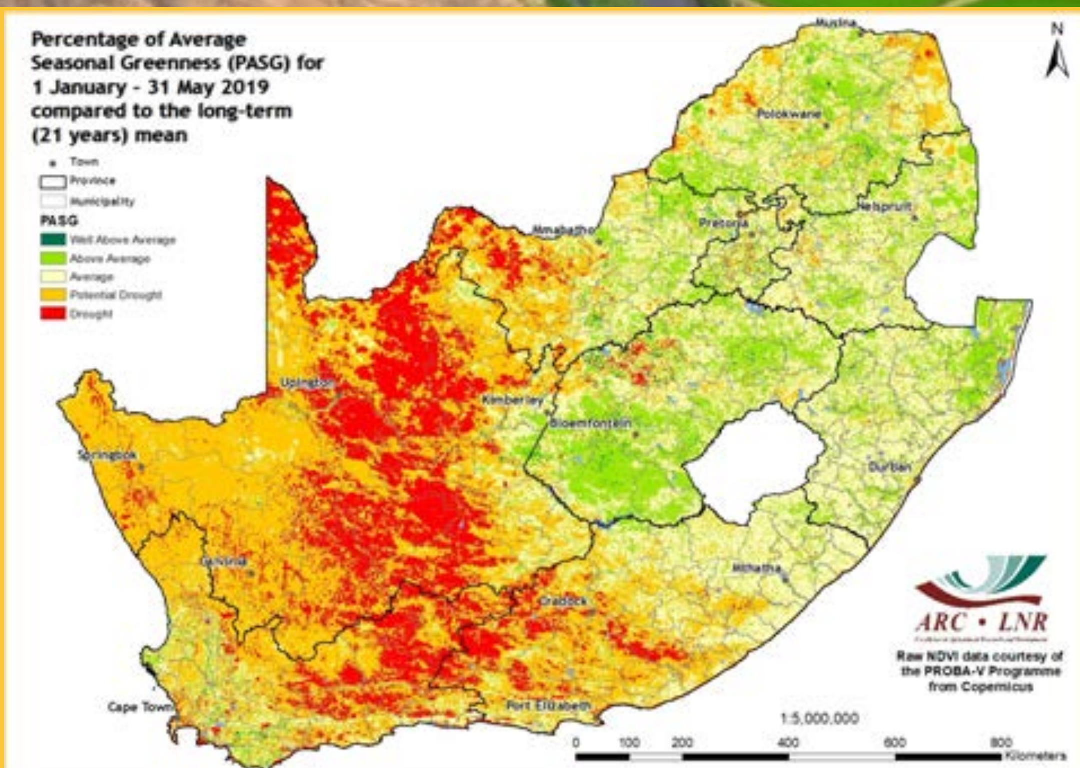

Figure 13

Figure 12:
When comparing the NDVI map for May 2019 to the same period last year, it can be observed that below-normal vegetation activity spread over much of the Northern Cape while pockets of above-normal vegetation activity occurred in isolated areas of the Western Cape, Eastern Cape and Limpopo.

Figure 13:
Over a 5-month period, drought conditions occurred over much of the Western parts of the country while Eastern parts of the country experienced above-average vegetation greenness.

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5. Vegetation Condition Index

Vegetation Condition Index (VCI)

The VCI is an indicator of the vigour of the vegetation cover as a function of the NDVI minimum and maximum encountered for a specific pixel and for a specific period, calculated over many years.

The VCI normalizes the NDVI according to its changeability over many years and results in a consistent index for various land cover types. It is an effort to split the short-term weather-related signal from the long-term climatological signal as reflected by the vegetation. The VCI is a better indicator of water stress than the NDVI.

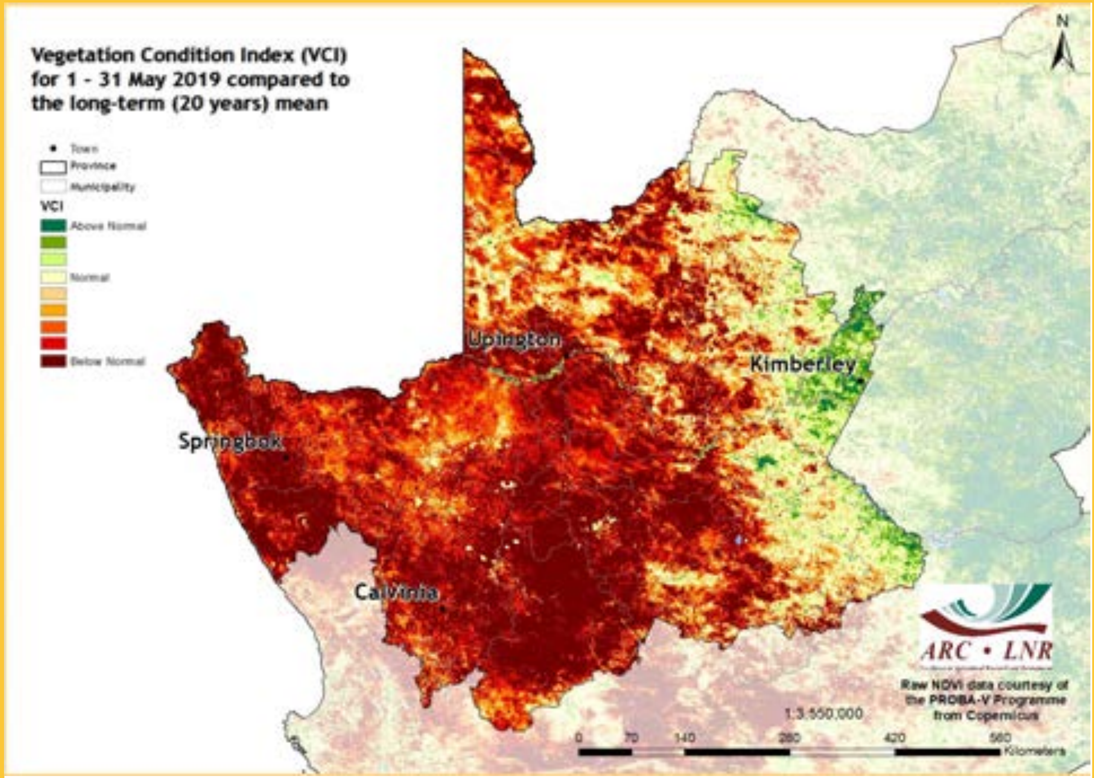
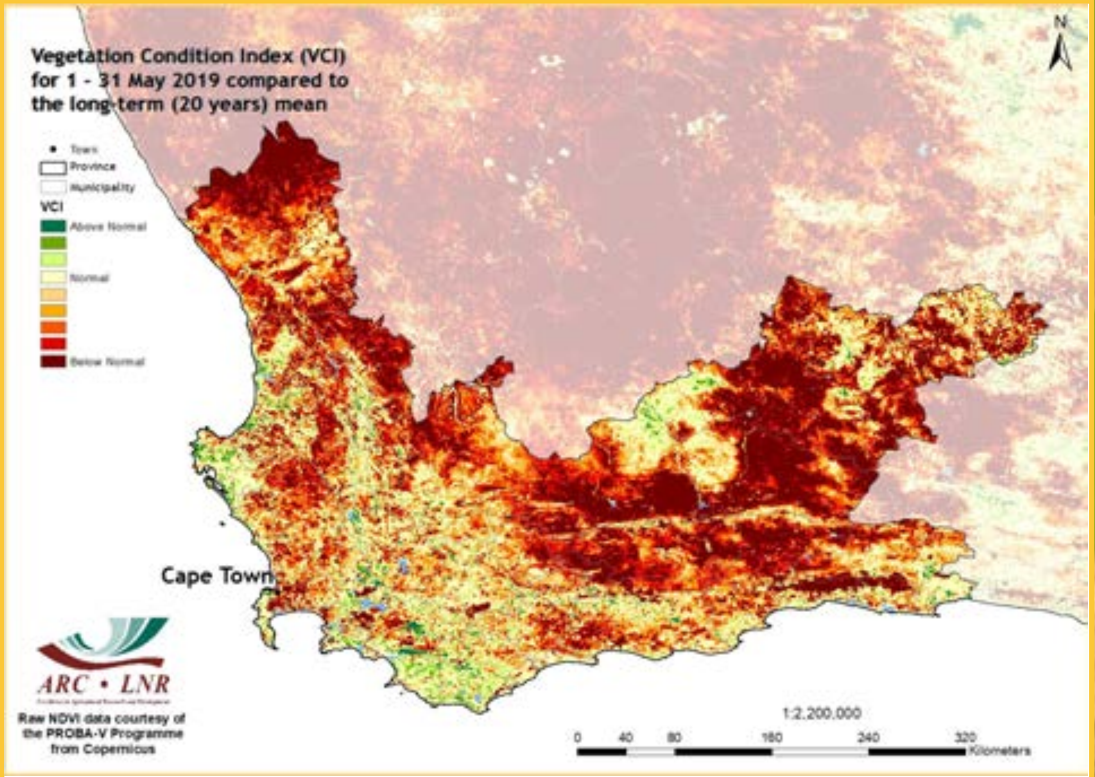


Figure 14

Figure 14:
The May 2019 VCI map for the Northern Cape shows that alarmingly poor vegetation conditions continue to affect nearly the entire province.

Figure 15:
The May 2019 VCI map for the Western Cape indicates that northern parts of the Central Karoo and West Coast continue to experience very poor vegetation activity.



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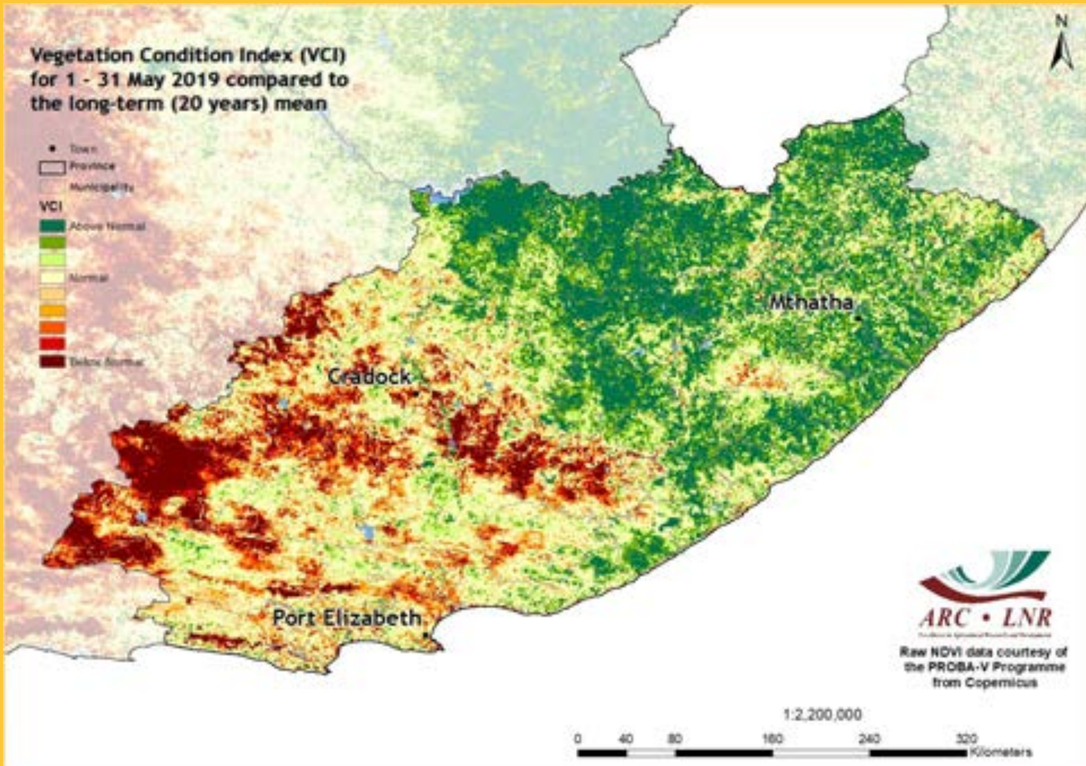

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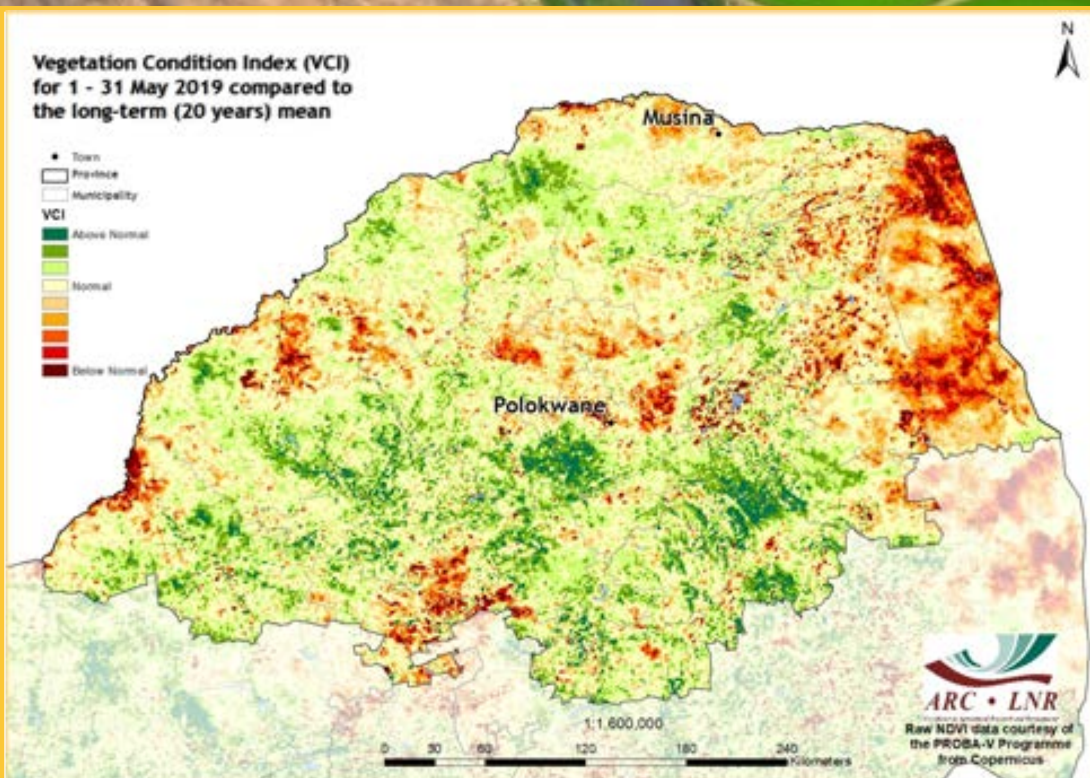

Figure 17

Figure 16:
The May 2019 VCI map for the Eastern Cape shows that many parts of the Sarah Baartman district municipality continue to experience poor vegetation activity while districts in the north of the province experienced above-normal vegetation activity.

Figure 17:
The May 2019 VCI map for Limpopo shows that poor vegetation activity occurred over much of the Kruger National Park with small pockets extending in some isolated areas of the province.

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6. Vegetation Conditions & Rainfall

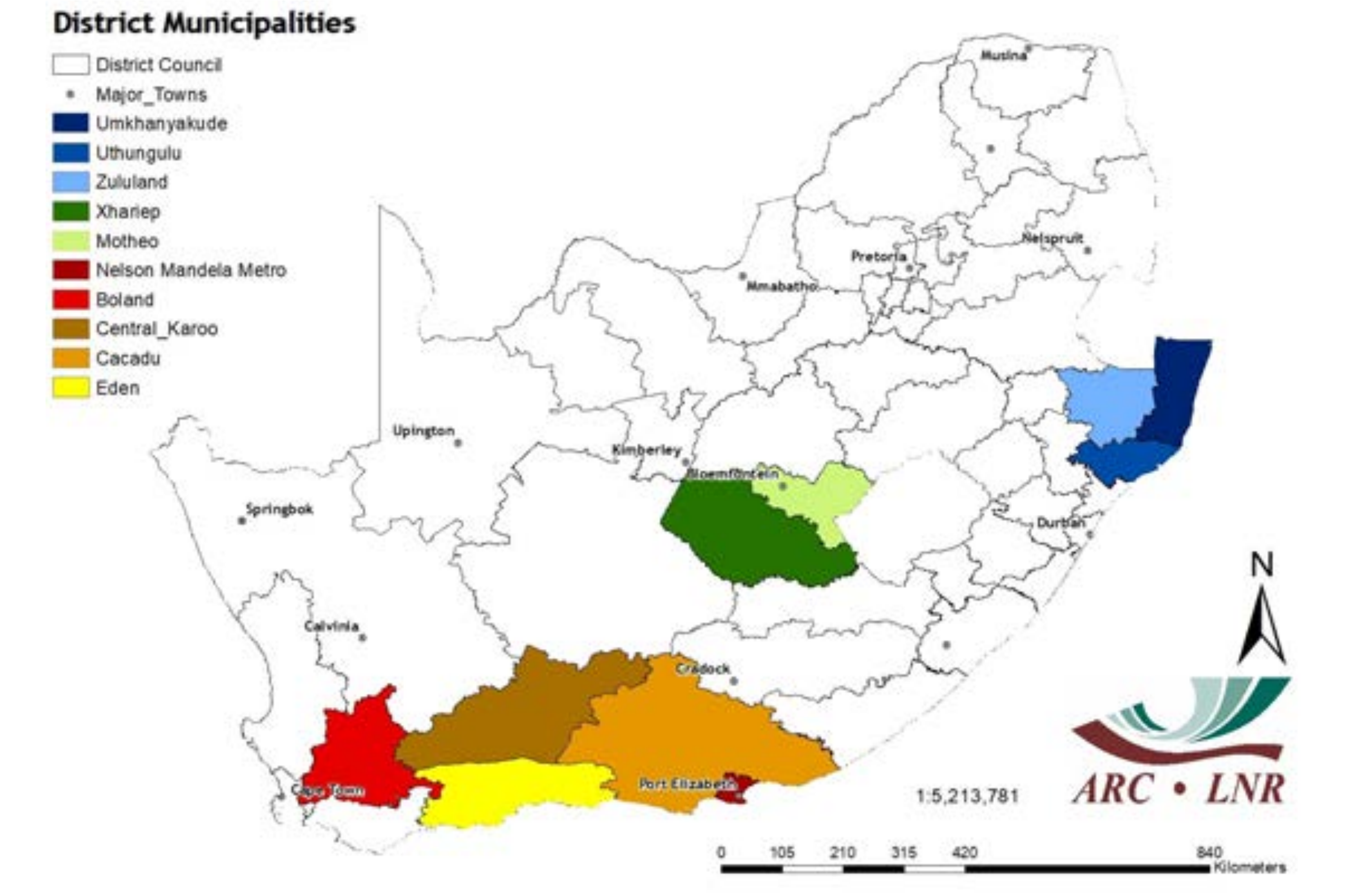

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for May 2019. The district colour matches the border of the corresponding graph.

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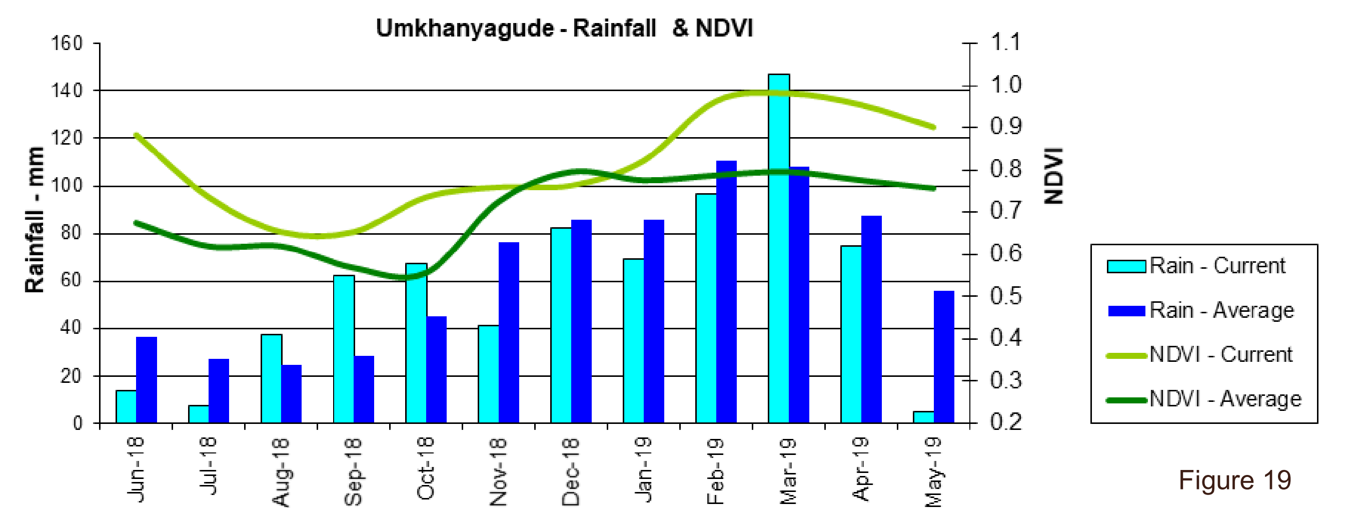
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

Figures 24-28:
Indicate areas with lower cumulative vegetation activity for the last year.



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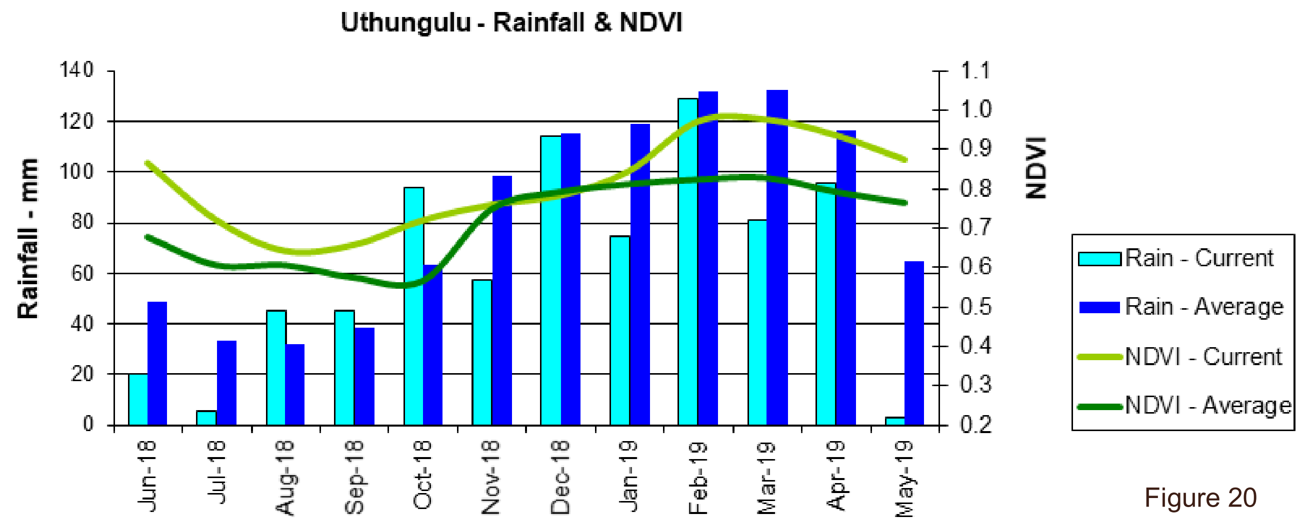

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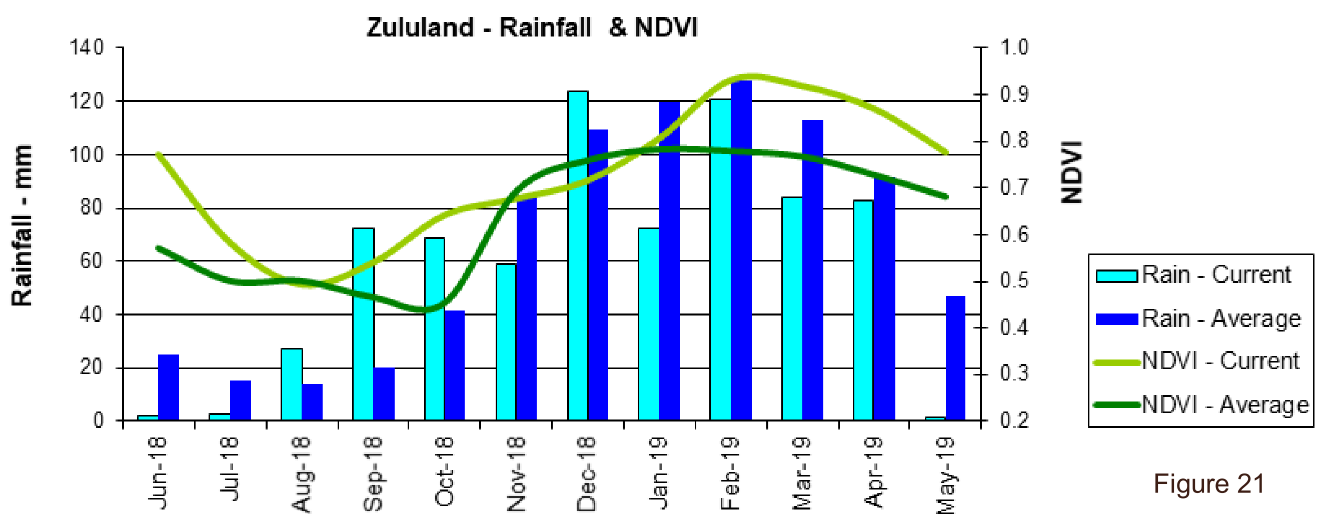
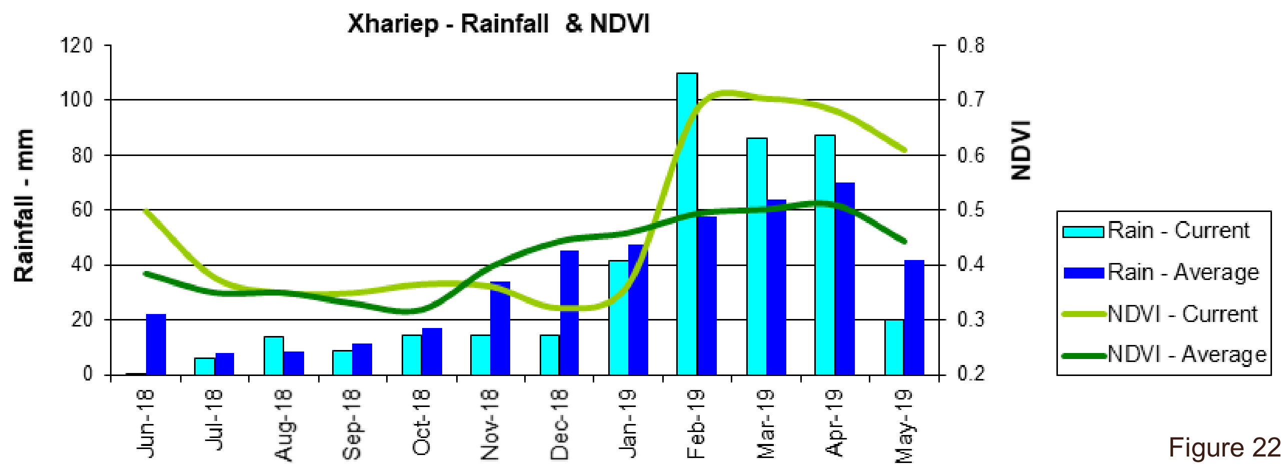


Figure 21



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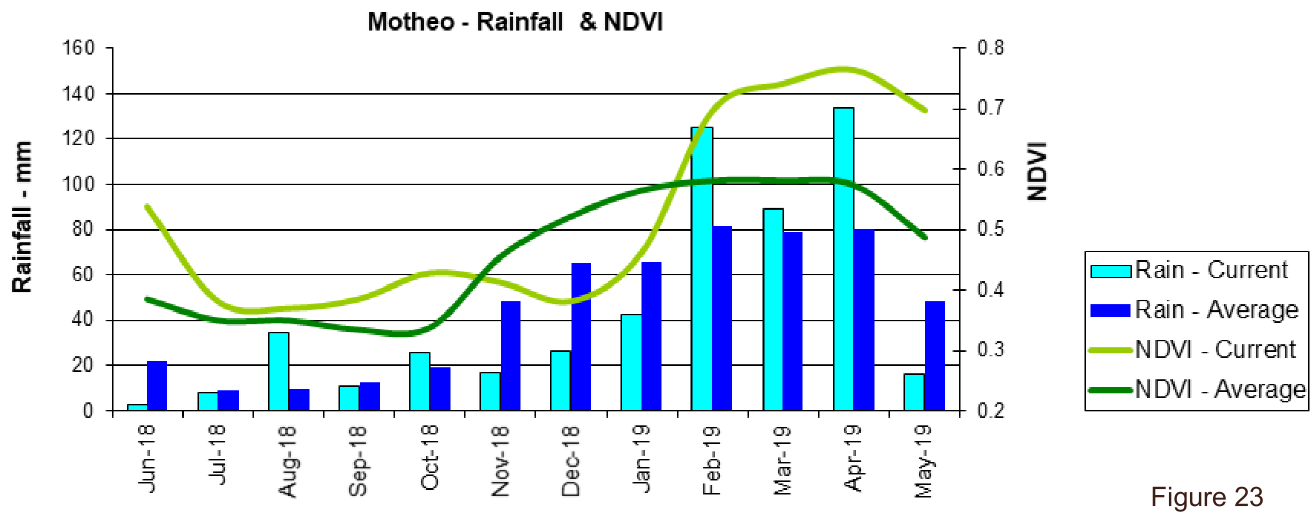

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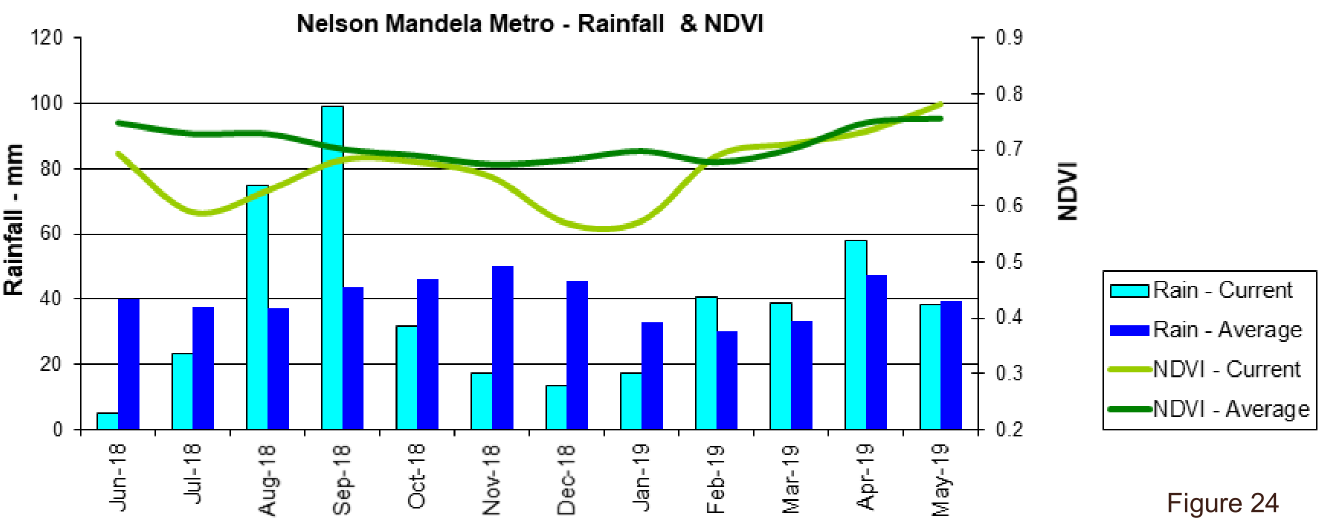

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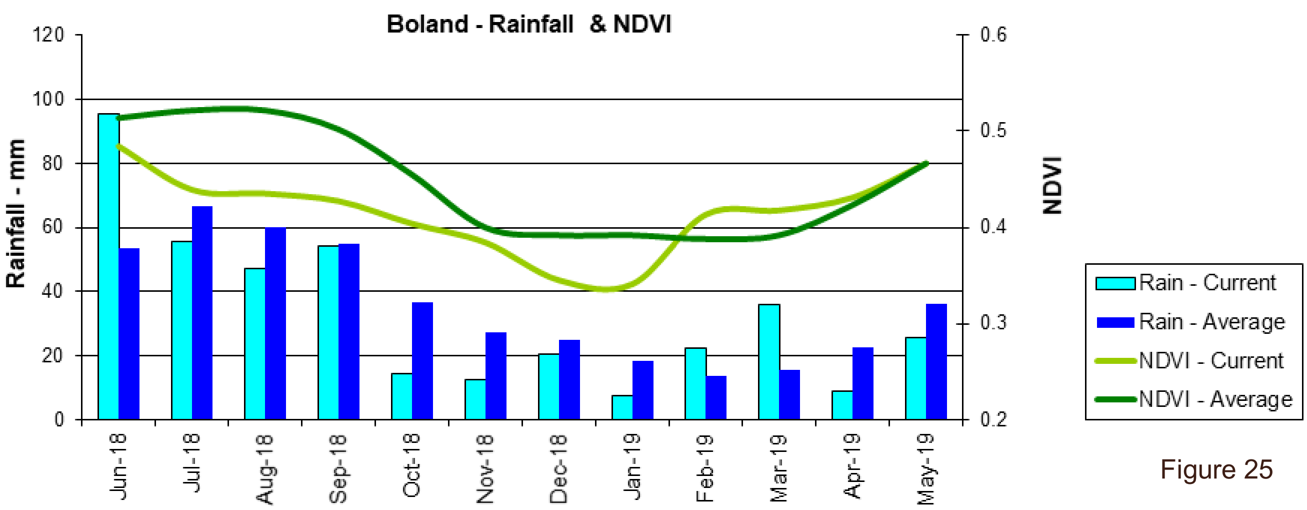

Figure 25

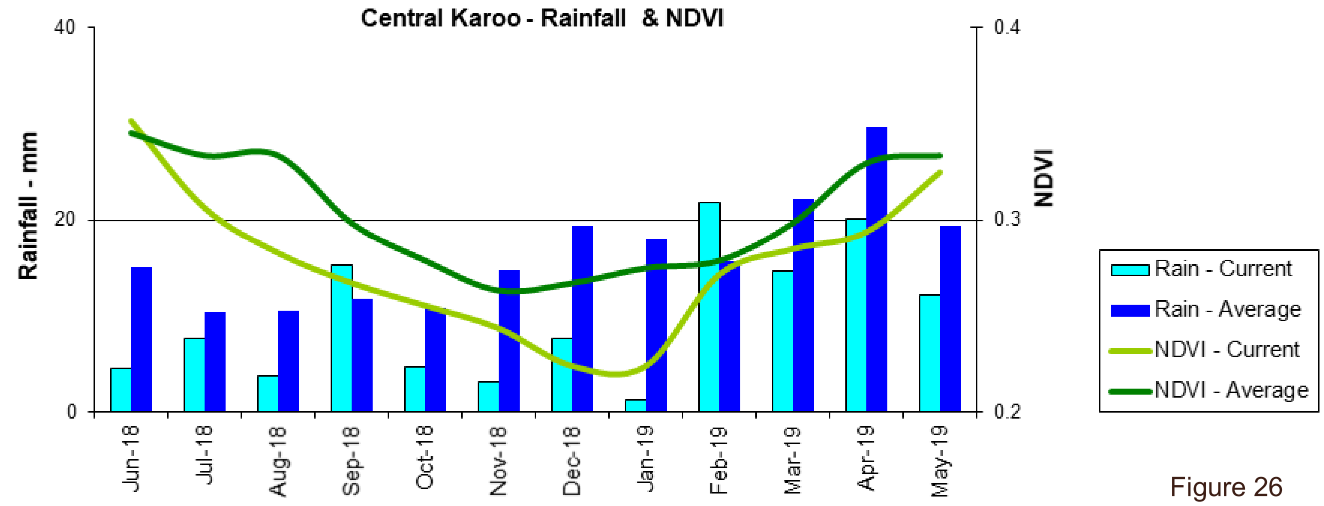

Figure 26

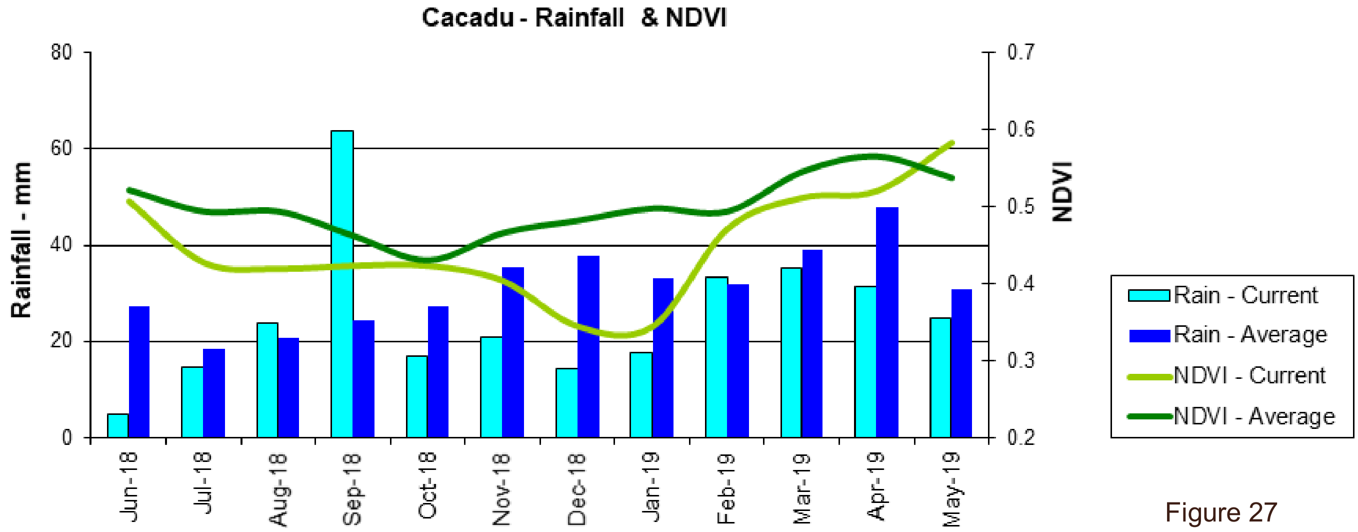

Figure 27

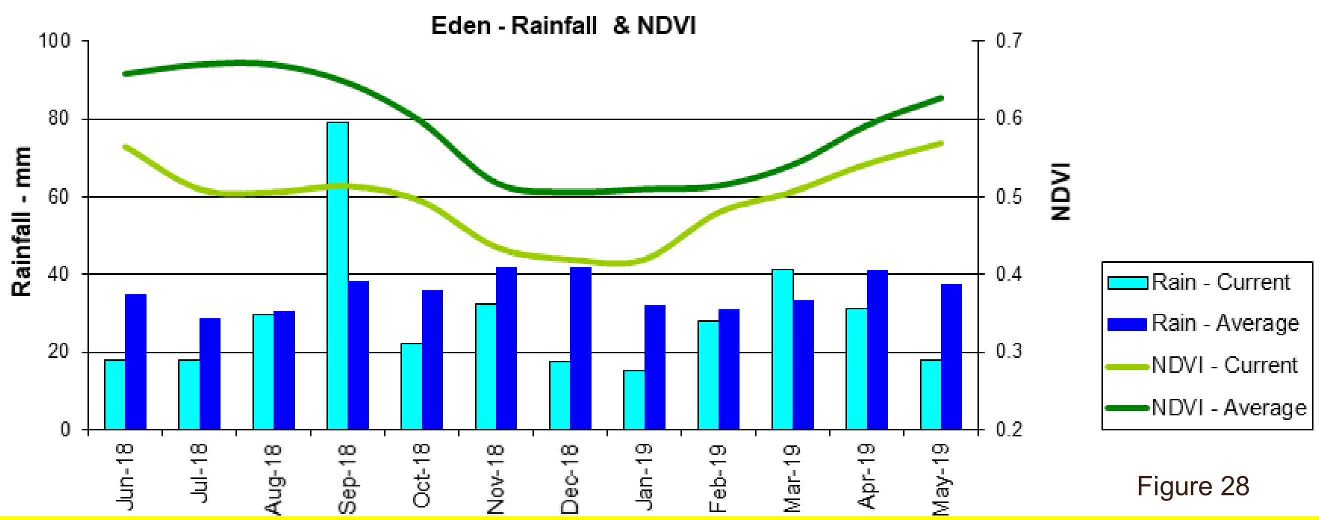

Figure 28

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 May 2019 per province. Fire activity was lower in all provinces compared to the long-term average.

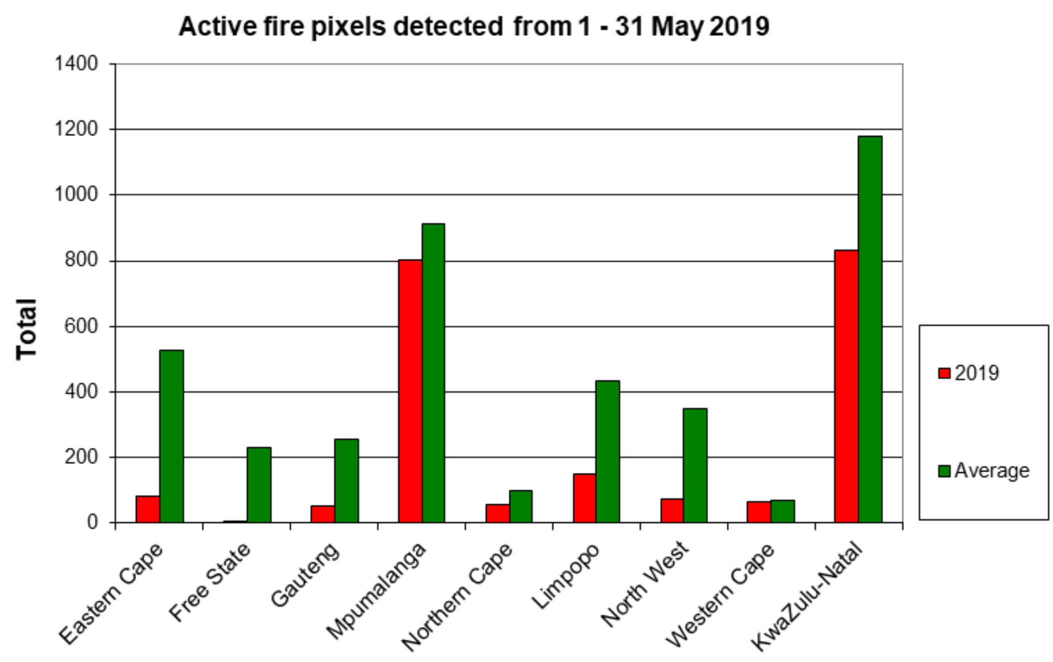

Figure 29

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

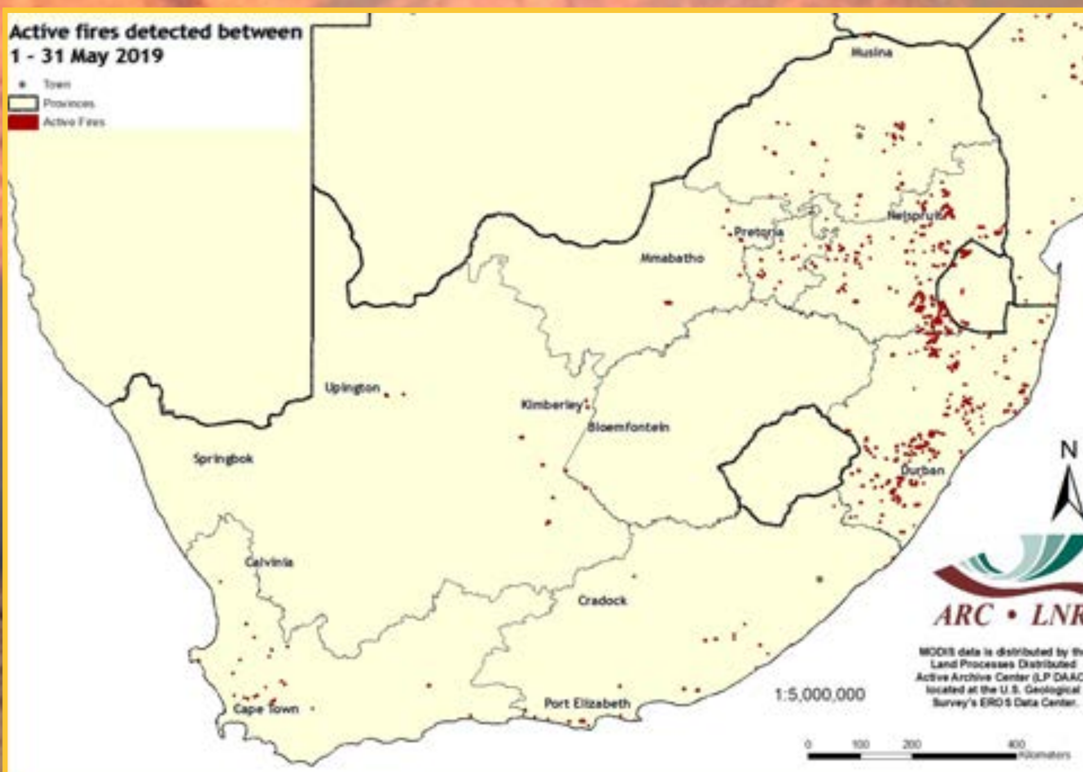

Figure 30

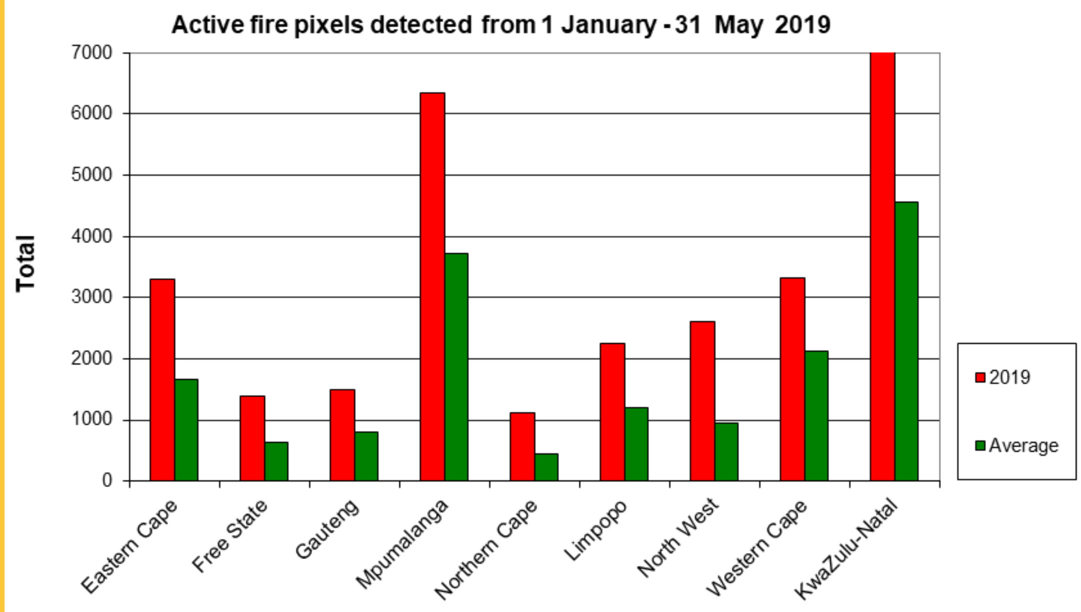

Figure 31

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

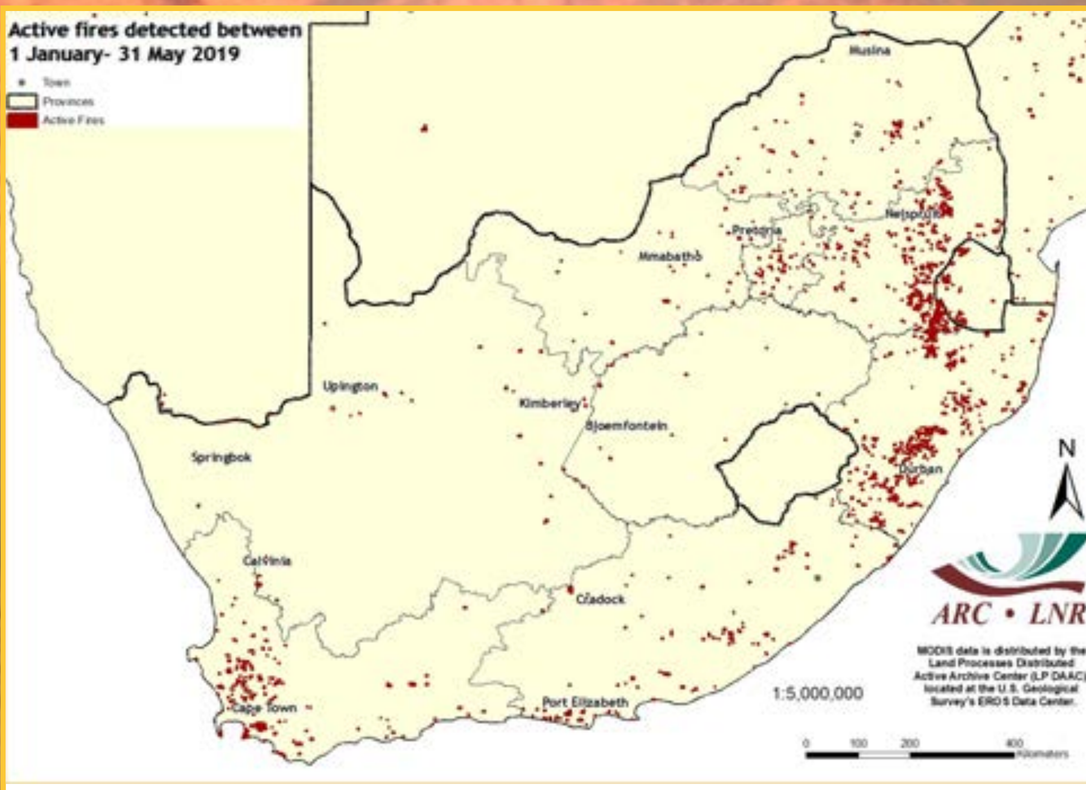

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January to 31 May 2019.

Questions/Comments:
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8. Surface Water Resources

Countrywide 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 and some areas in Limpopo Province.

Comparison between May 2019 and May 2018 shows that generally the entire country currently has either equal or slightly less water extents than last year; with the exception of the Karoo, Kalahari and a few local catchments in Lesotho and Limpopo, which are showing significantly 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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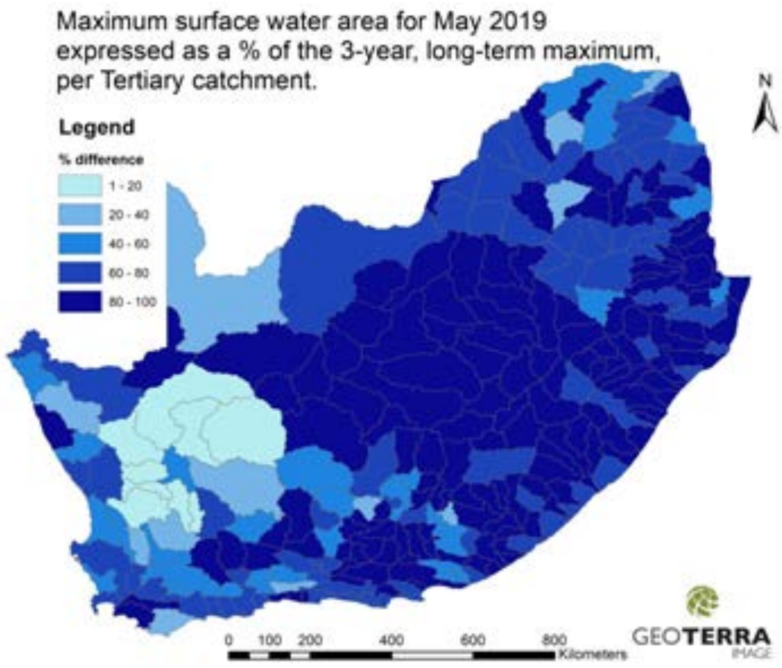


Figure 33

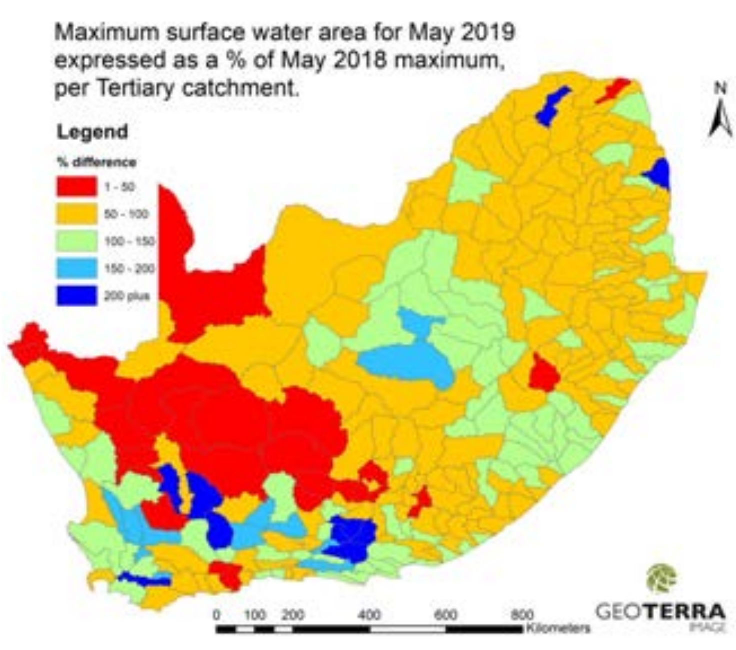
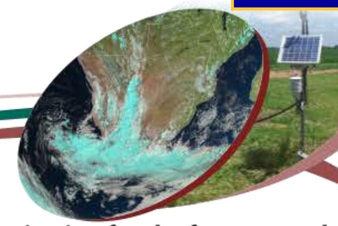


Figure 34

Agrometeorology



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".

Disclaimer:
The ARC-ISCW and its collaborators have obtained data from sources believed to be reliable and have made every reasonable effort to ensure accuracy of the data. The ARC-ISCW and its collaborators cannot assume responsibility for errors and omissions in the data nor in the documentation accompanying them. The ARC-ISCW and its collaborators will not be held responsible for any consequence from the use or misuse of the data by any organization or individual.