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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

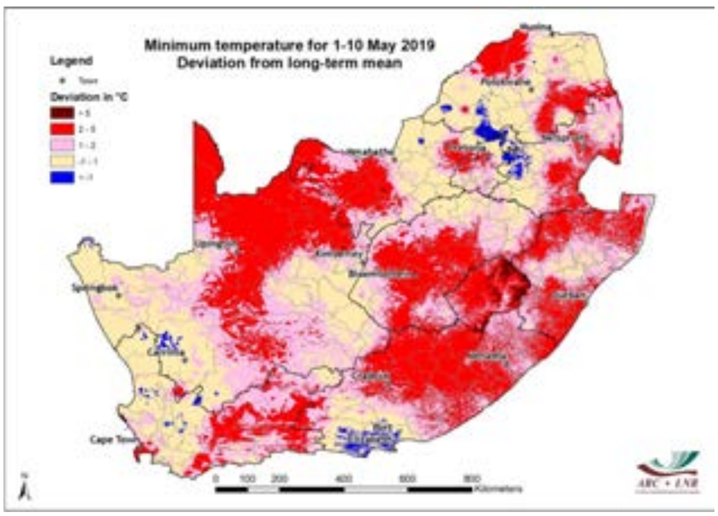
AMESD

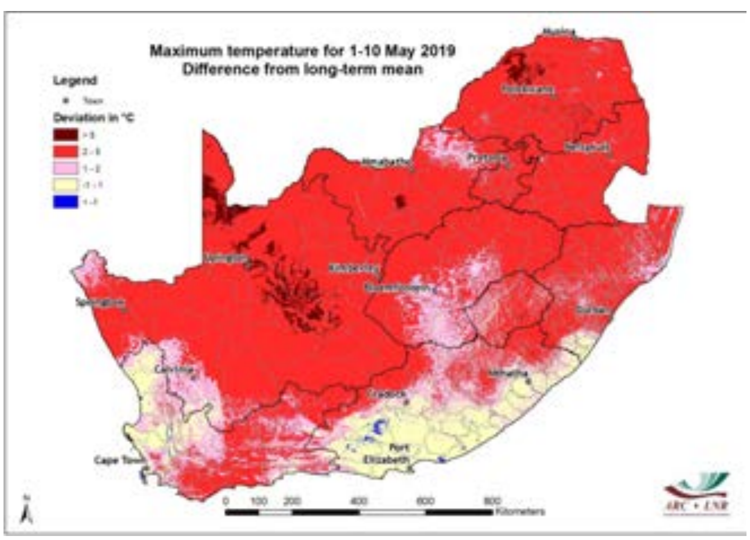
179th Edition

Images of the Month

A warm autumn and winter in the presence of El Niño?

Despite the widespread rainfall that occurred over eastern South Africa in April, both minimum and maximum temperatures were generally above normal - a trend which continued in the first 10 days of May (see maps). This forms part of a systematic trend of rising temperatures over the country, as a regional consequence of global warming, and may have important implications for the occurrence of frost over the interior in autumn and winter. There are already indications of fewer frost days and a shortening frost season manifesting over the interior in recent decades, in response to regional warming. With regard to the upcoming winter season, it may be noted that weak El Niño conditions remain present in the Pacific Ocean. Seasonal forecasts produced by international forecast centres are indicative of high probabilities of the El Niño event persisting through winter and into the 2019/20 summer season. The presence of El Niño combined with systematic regional warming gives a high probability of an anomalously warm winter over the interior. However, the strength of the El Niño event, and the extent to which it may induce drought in South Africa in spring and autumn, cannot be reliably predicted at this point in time.





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:

April 2019 was characterized by a high frequency of days with clouds that resulted in rainfall over the eastern half of South Africa. In particular the western parts of the eastern half of the country (areas over the North West and Free State provinces) received very high rainfall totals for the month of April, extending southeastwards to the KwaZulu-Natal coast where more than 400 mm of rain fell during a single weather event.

The regular occurrence of rainfall over the country was driven by the frequent passage of upper-air troughs, with two cut-off low weather systems that occurred during the month. The second cut-off low lasted for about 3 days over the country around the 23rd of April and was the weather system responsible for the floods in Durban.

While the larger part of the summer rainfall region received an abundance of rain, the winter rainfall region experienced a rather slow start to its rainfall season. Rainfall should start to pick up during the month of April over the southwestern parts of the country as frontal weather systems move in over those areas. However, despite the frequent occurrence of upper-air troughs over the country, the winter rainfall region had a disappointing start to its 2019 rainfall season.

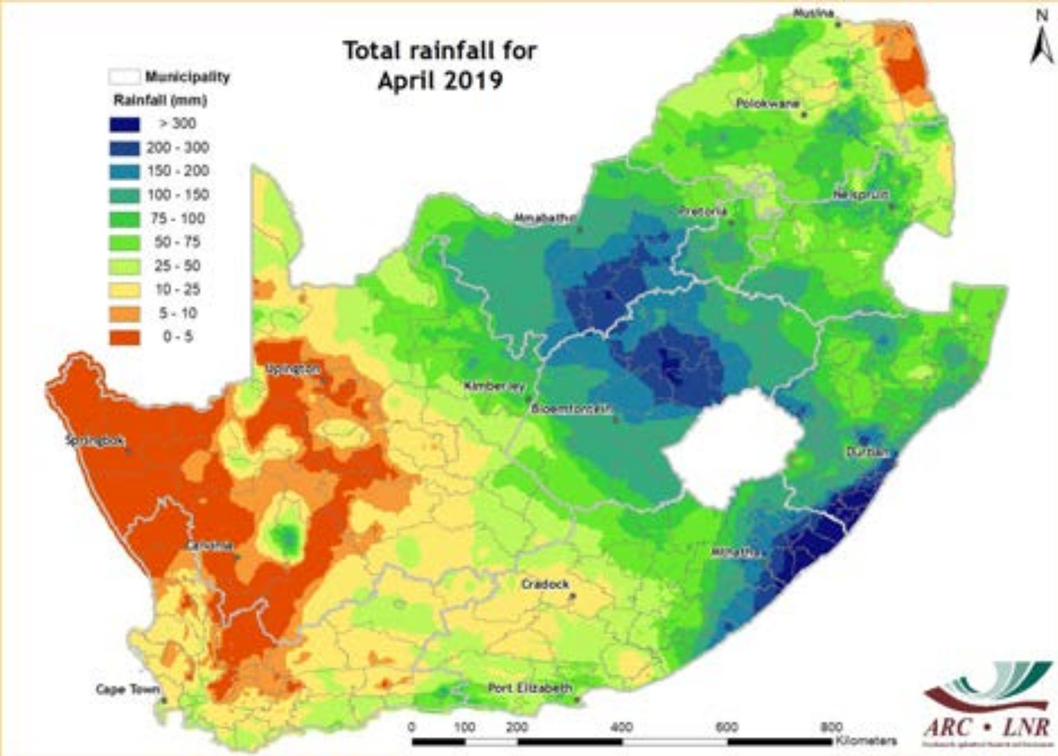


Figure 1

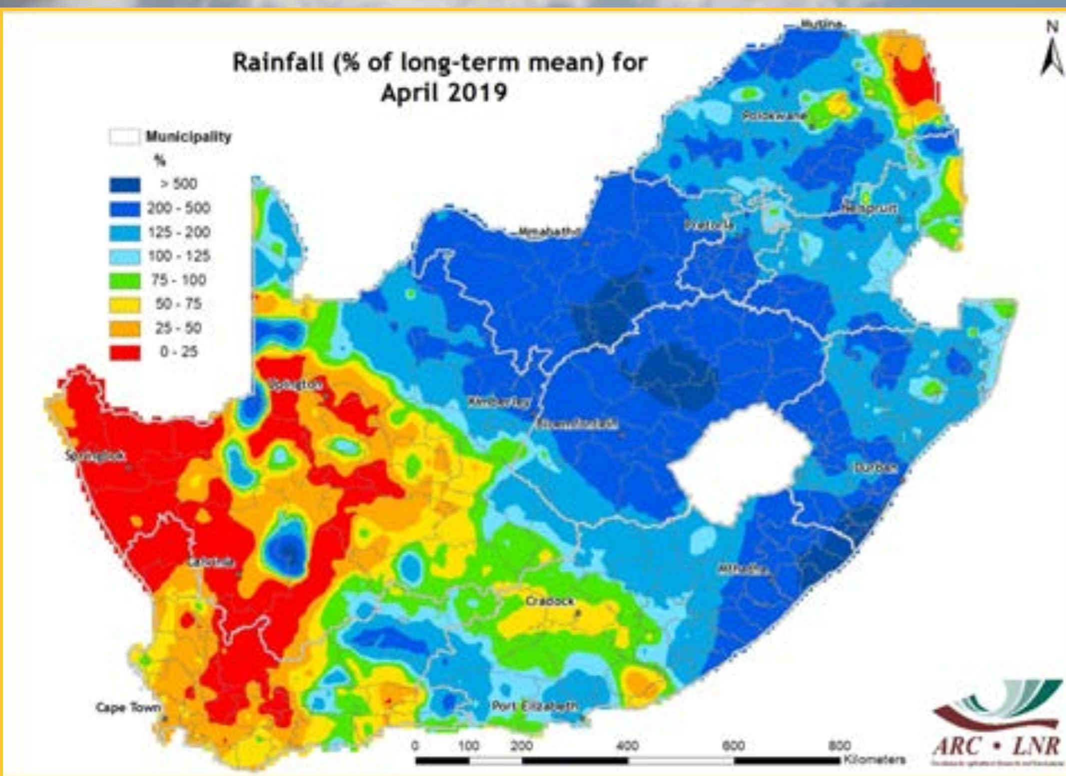


Figure 2

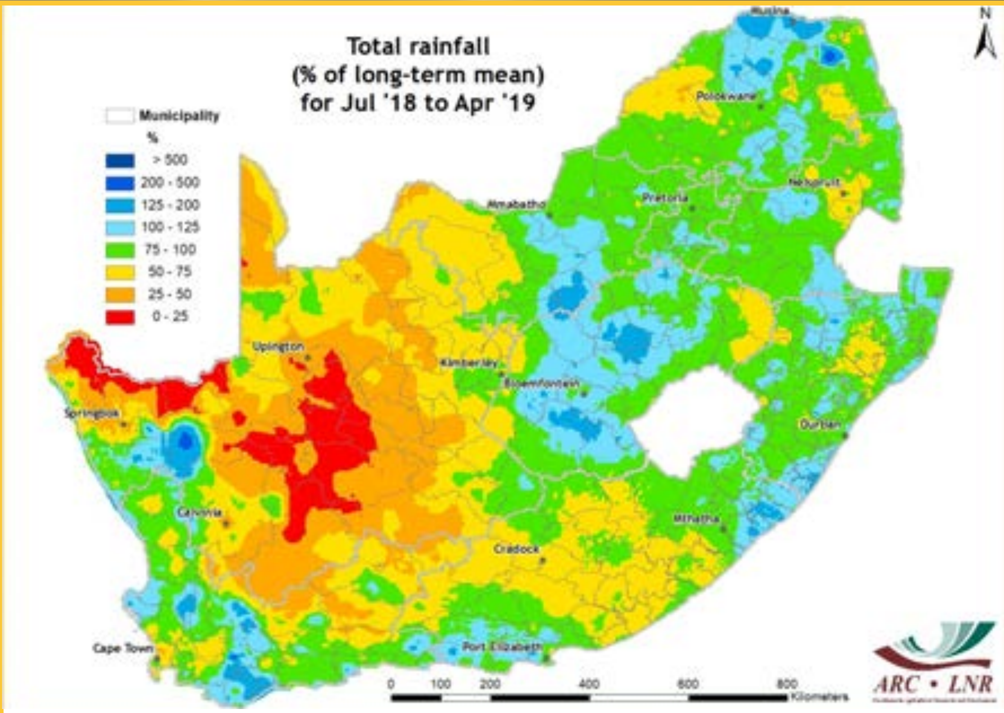


Figure 3

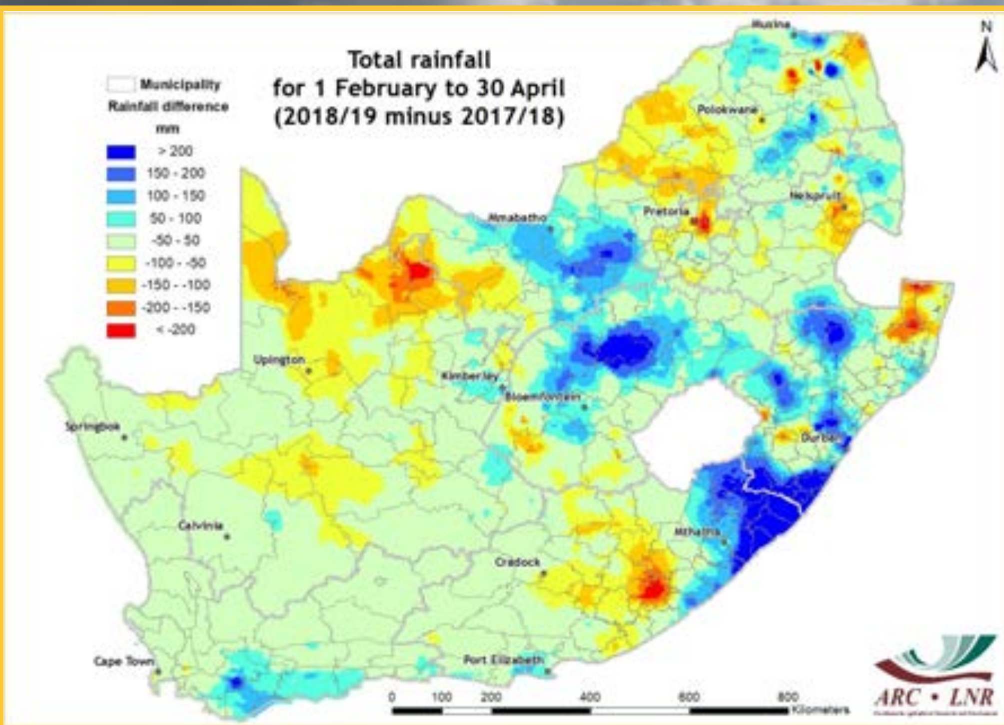


Figure 4

Figure 1:
The month of April 2019 was characterized by frequent cloud formation that resulted in rainfall over large parts of the summer rainfall region. A northwest to southeast aligned band was particularly favoured and those areas received 200-300 mm in places, whilst the coastal area south of Durban received more than 300 mm of rain.

Figure 2:
Most parts of the summer rainfall region received above-normal rainfall, with the central parts of the country in particular receiving good rainfall totals in April. Over the winter rainfall region, rainfall usually starts during the month of April. However, there was below-normal rainfall over the winter rainfall region this year.

Figure 3:
During this 10-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 places. Over the summer rainfall region, large areas in the west received below-normal rainfall during this 10-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, areas over the eastern interior received better rainfall this year. Over those areas, the February-April 2019 period recorded at least 200 mm more than in the corresponding period last year. The good rainfall during April 2019 explains the difference in the rainfall totals between these two periods. Other areas of the country where large differences occurred are isolated in nature.

Questions/Comments:
EngelbrechtC@arc.agric.za
Philip@arc.agric.za

2. Standardized Precipitation Index

Standardized Precipitation Index

The Standardized Precipitation Index (SPI - McKee *et al*., 1993) was developed to monitor the occurrence of droughts from rainfall data. The index quantifies precipitation deficits on different time scales and therefore also drought severity. It provides an indication of rainfall conditions per quaternary catchment (in this case) based on the historical distribution of rainfall.

REFERENCE:
McKee TB, Doesken NJ and Kliest J (1993) The relationship of drought frequency and duration to time scales. In: Proceedings of the 8th Conference on Applied Climatology, 17-22 January, Anaheim, CA. American Meteorological Society: Boston, MA; 179-184.

The severe drought over the southwestern parts of the country visible on the long time scales (24 and 36 months) as represented by the SPI ending in April 2019 shows signs of relief on the 12- and 6-month SPI maps. The drought conditions over the western interior intensified as seen on the 6-month SPI map - now reaching extreme drought status. 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 and early autumn of 2019.

Questions/Comments:
EngelbrechtC@arc.agric.za
Philip@arc.agric.za

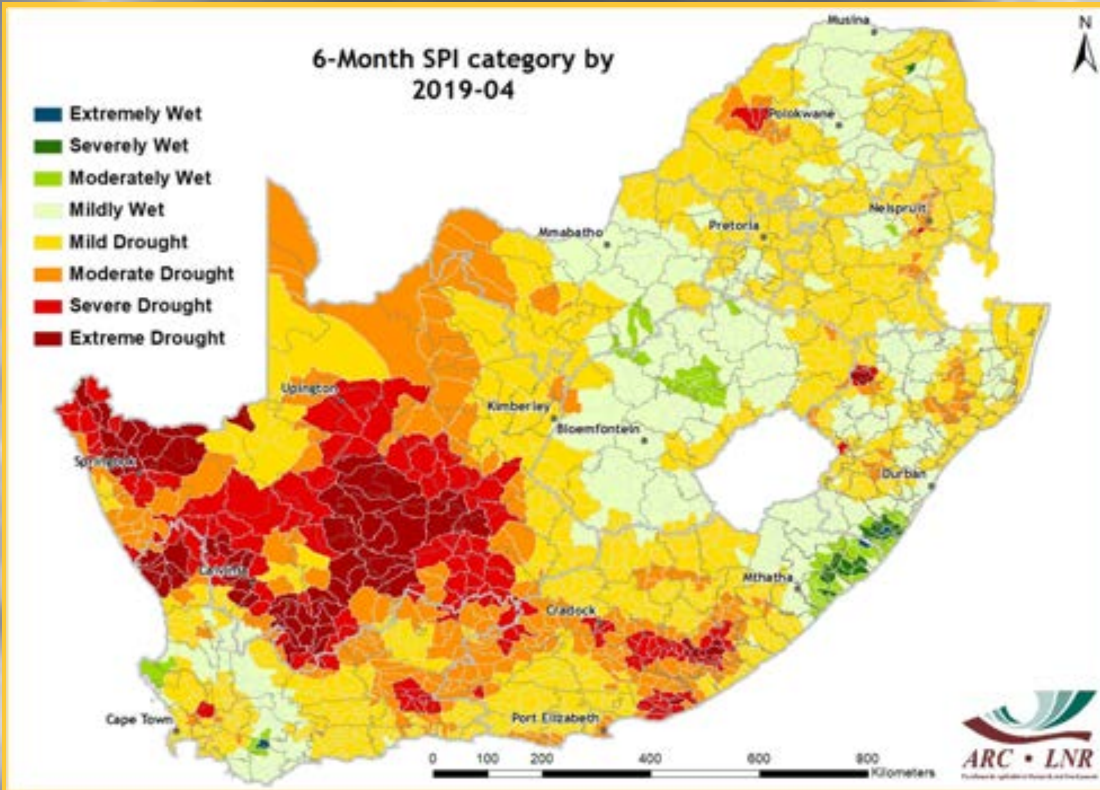
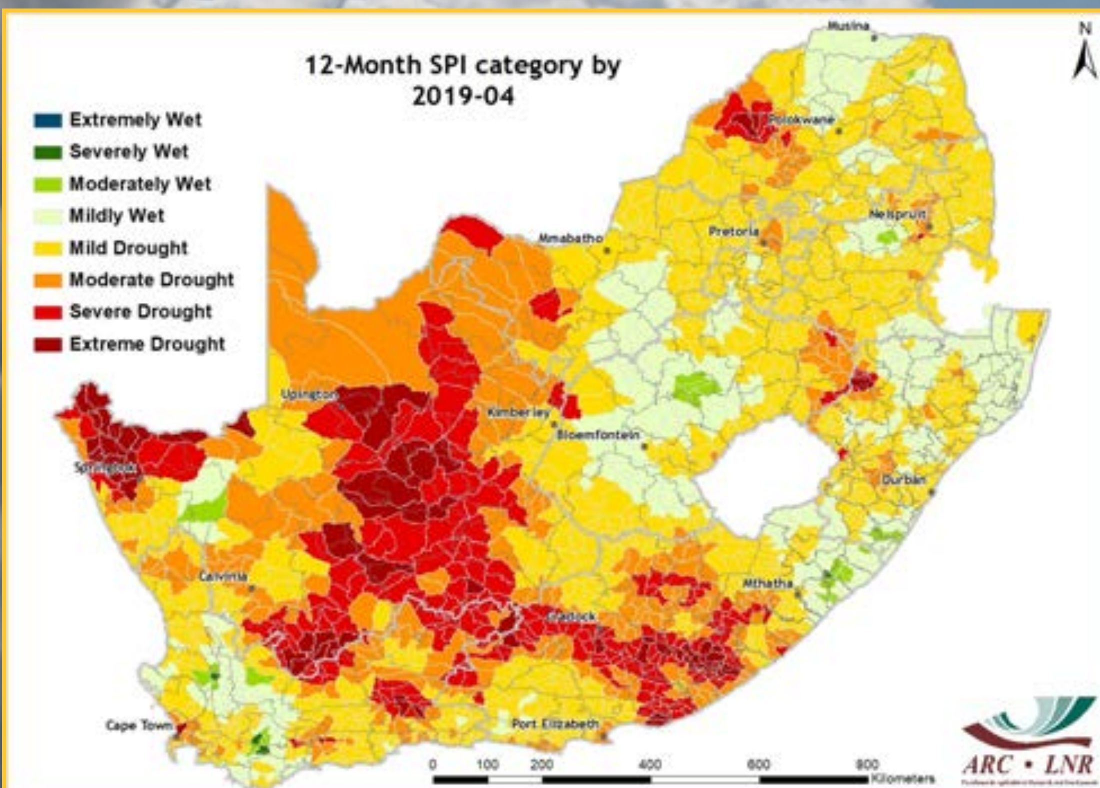


Figure 5



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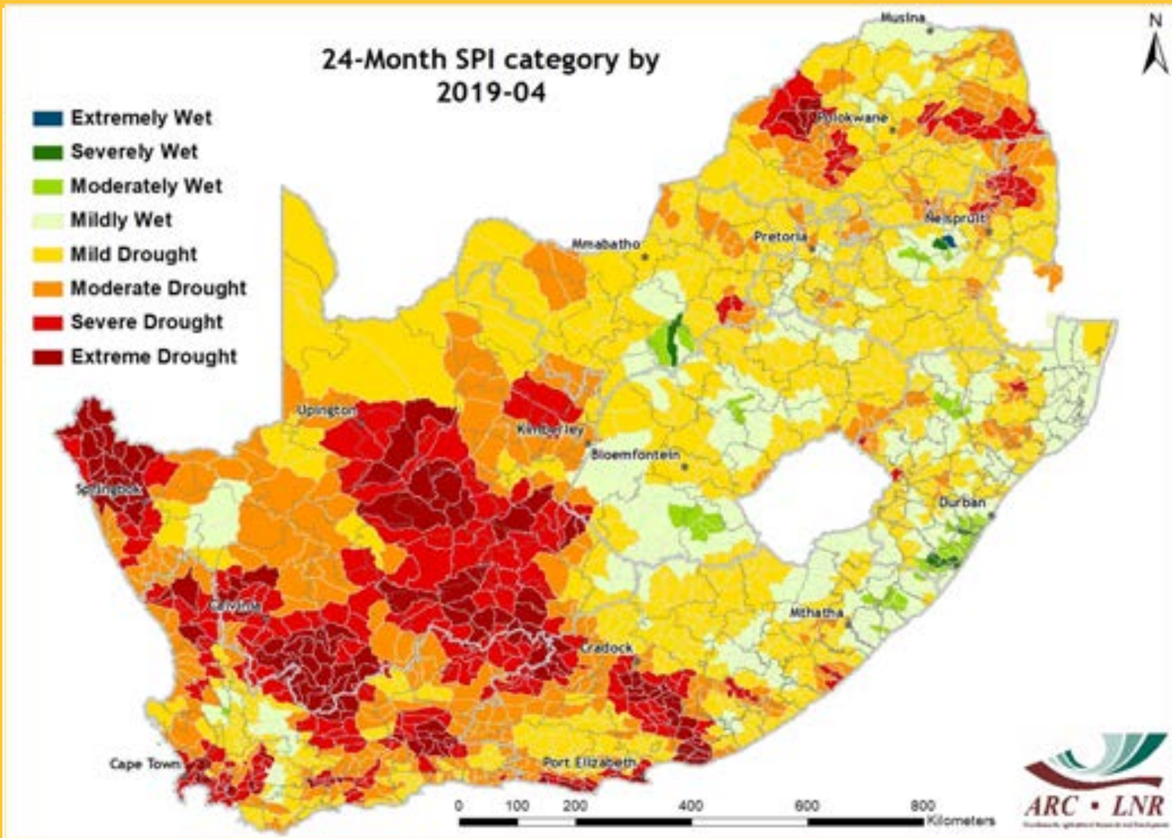

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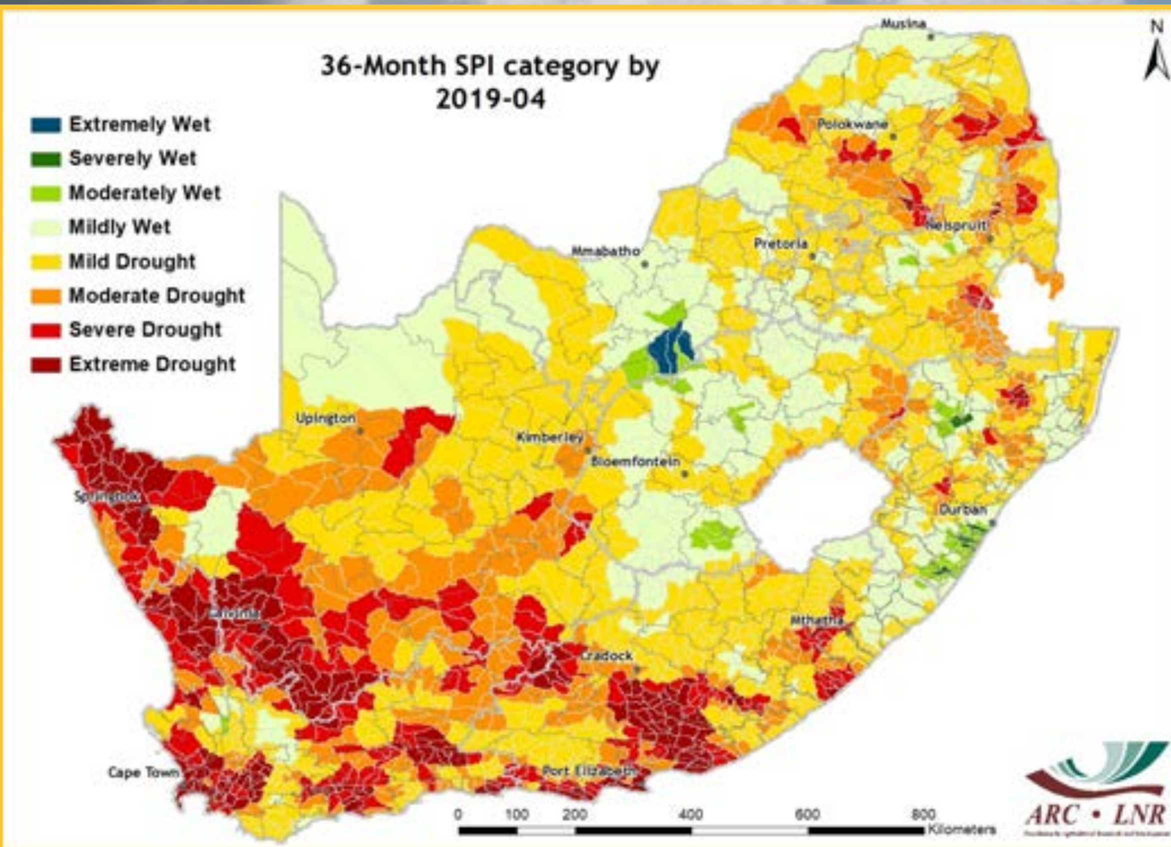


Figure 8

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.

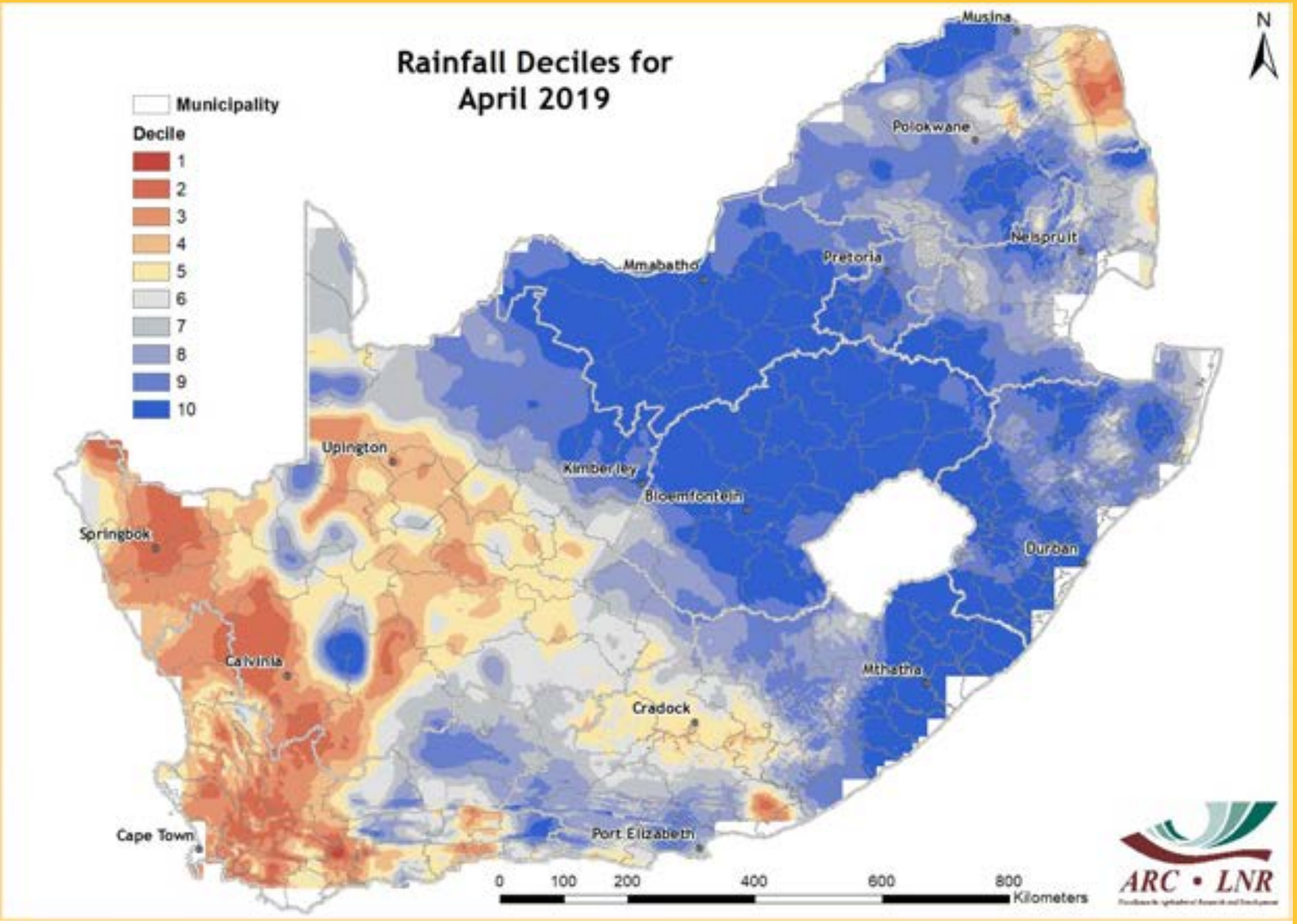


Figure 9

Figure 9:
Rainfall totals during the month of April 2019 over large parts of the summer rainfall region compare well with the historically wetter April months. Over the winter rainfall region, areas occur that compare well with the historically drier April months.

Questions / Comments:
EngelbrechtC@arc.agric.za
Philip@arc.agric.za

4. Vegetation Conditions

Vegetation Mapping

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

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

where:
IR = Infrared reflectance &
R = Red band

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

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

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

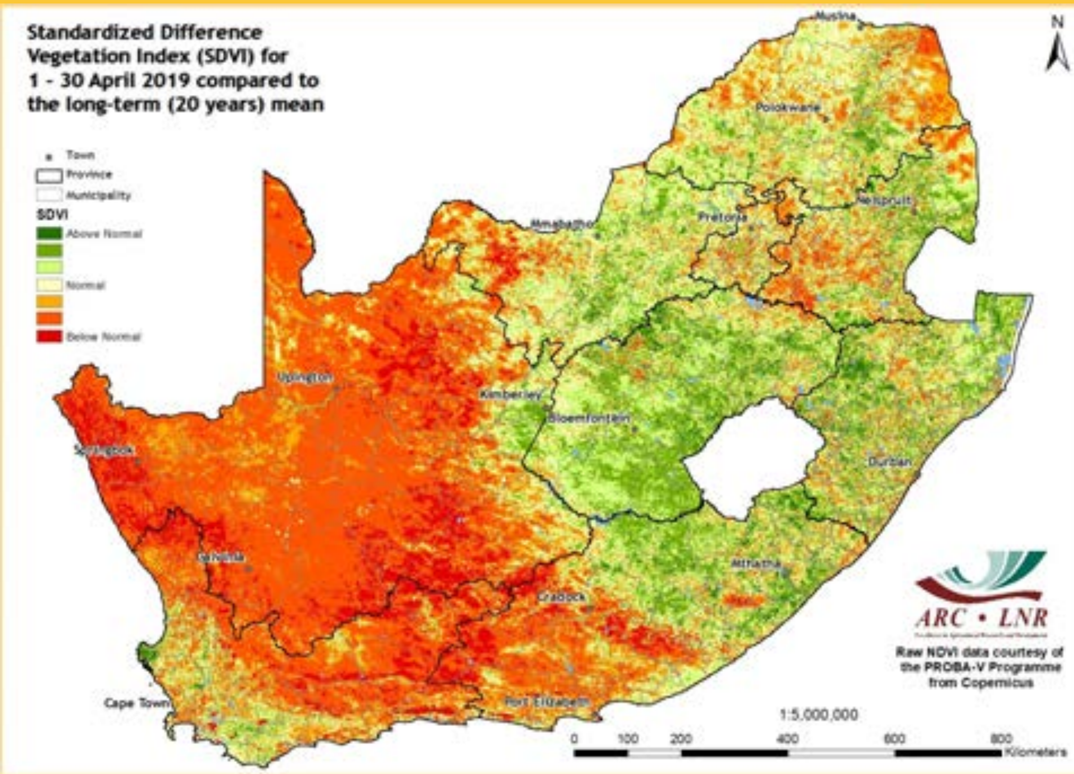


Figure 10

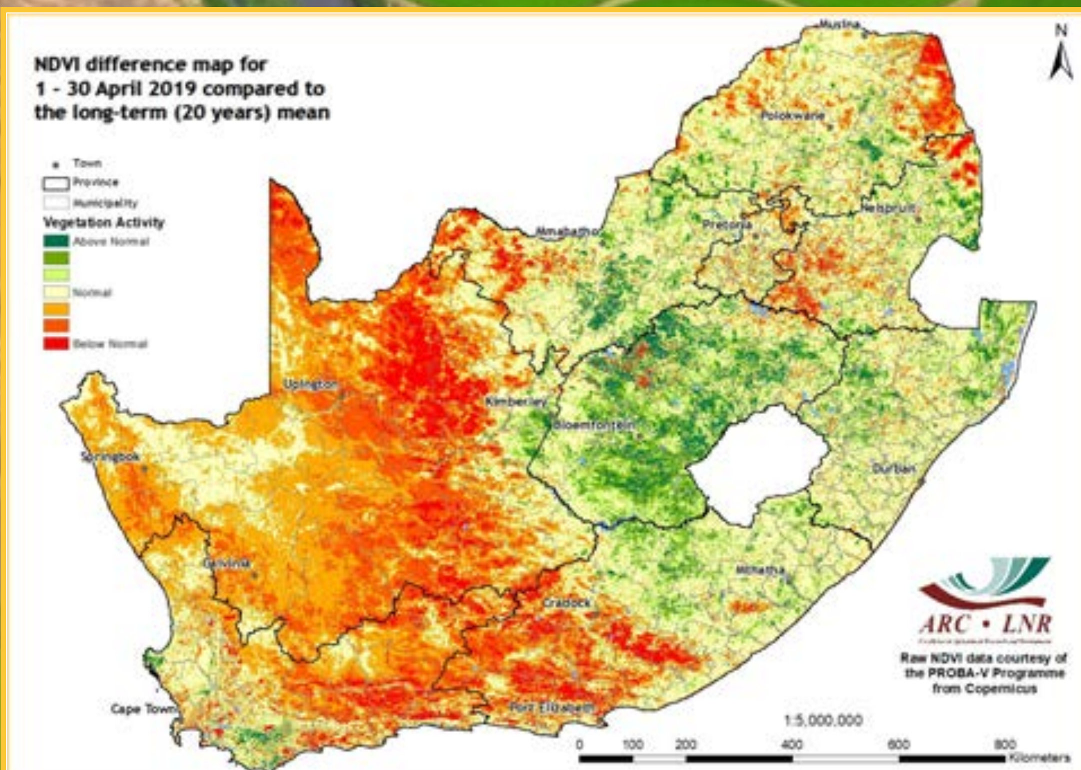


Figure 11

Figure 10:
The April 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 of the country experienced quite the opposite.

Figure 11:
Compared to the vegetation conditions calculated and averaged for April over 21 years, the NDVI difference map for April 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 and the far eastern parts of he country experienced above-normal vegetation activity.

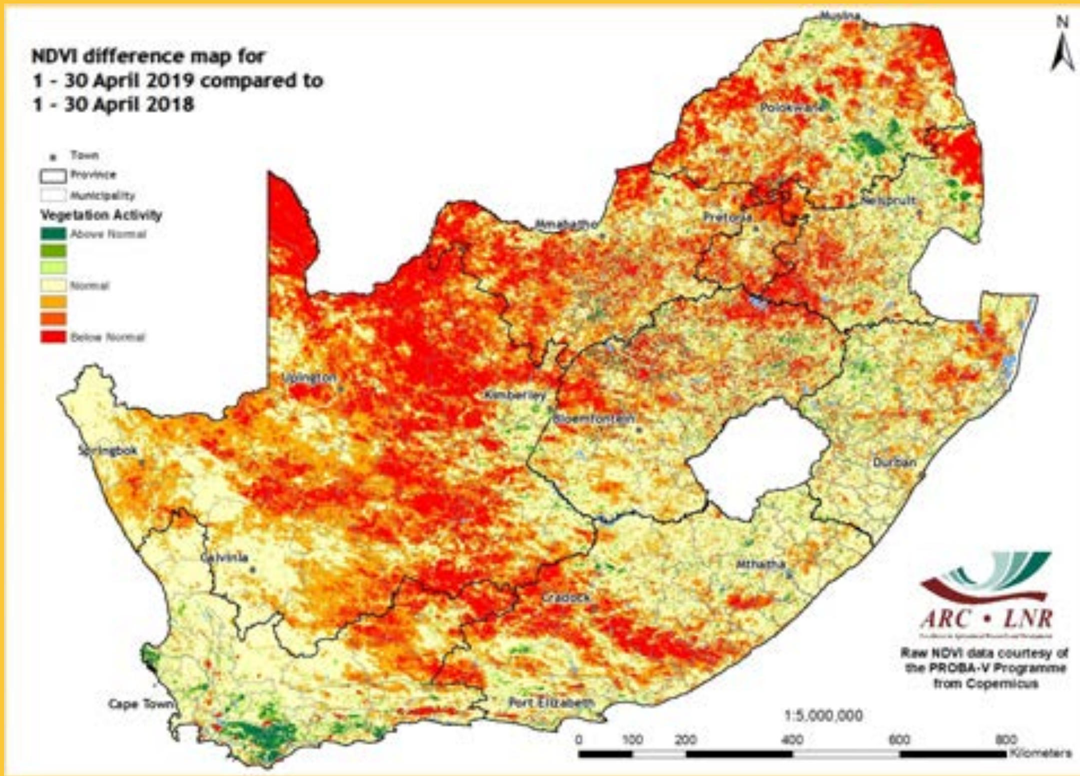


Figure 12

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

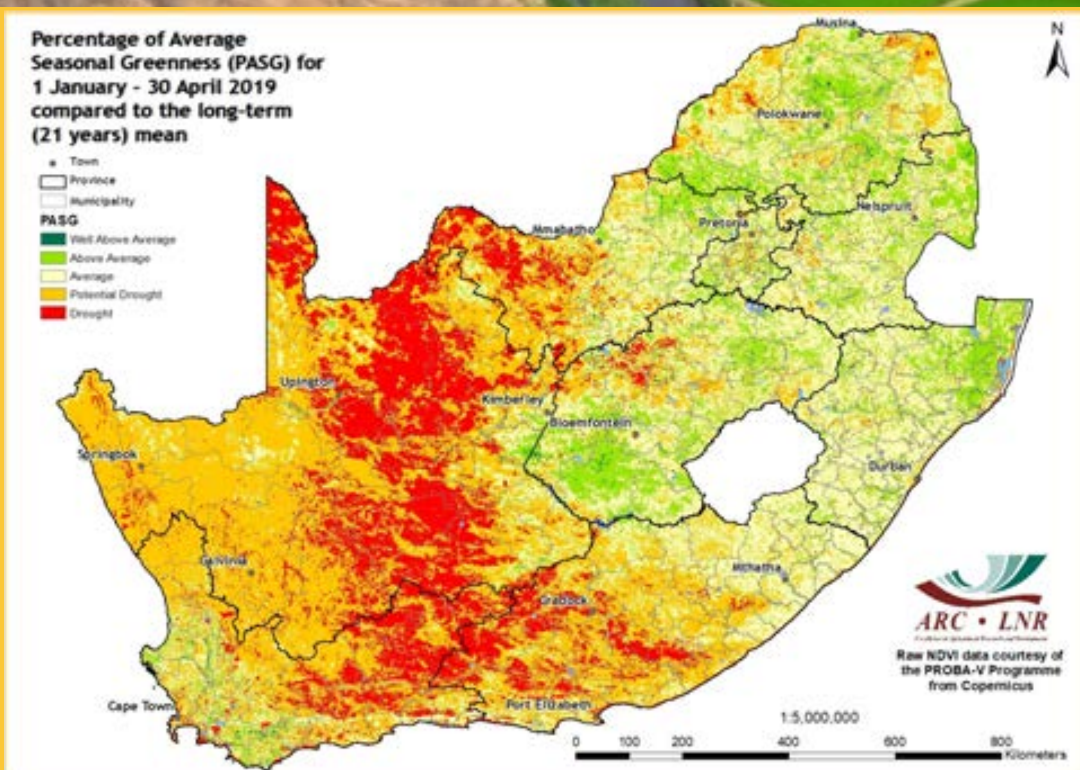


Figure 13

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

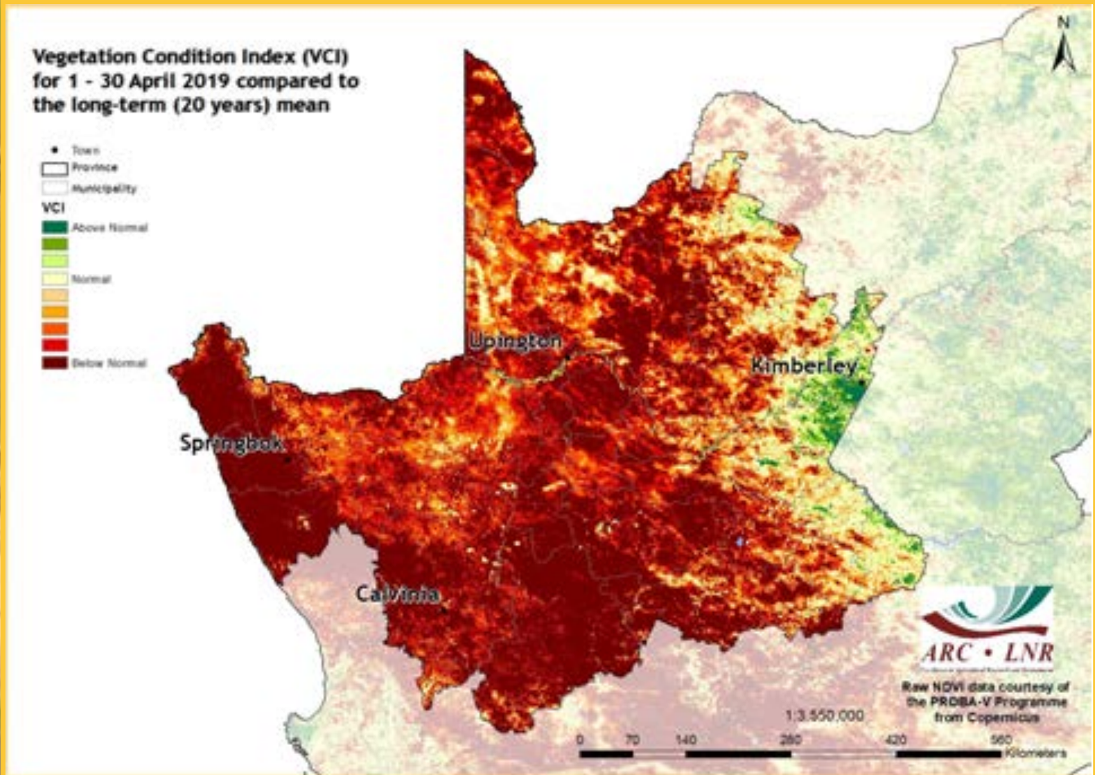
Figure 13:
Over a 4-month period, drought conditions occurred in the central parts while a potential drought occurred in the remaining parts of the country. Pockets of above-average vegetation greenness were observed in the northern parts.

Questions/Comments:
MaakeR@arc.agric.za

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.



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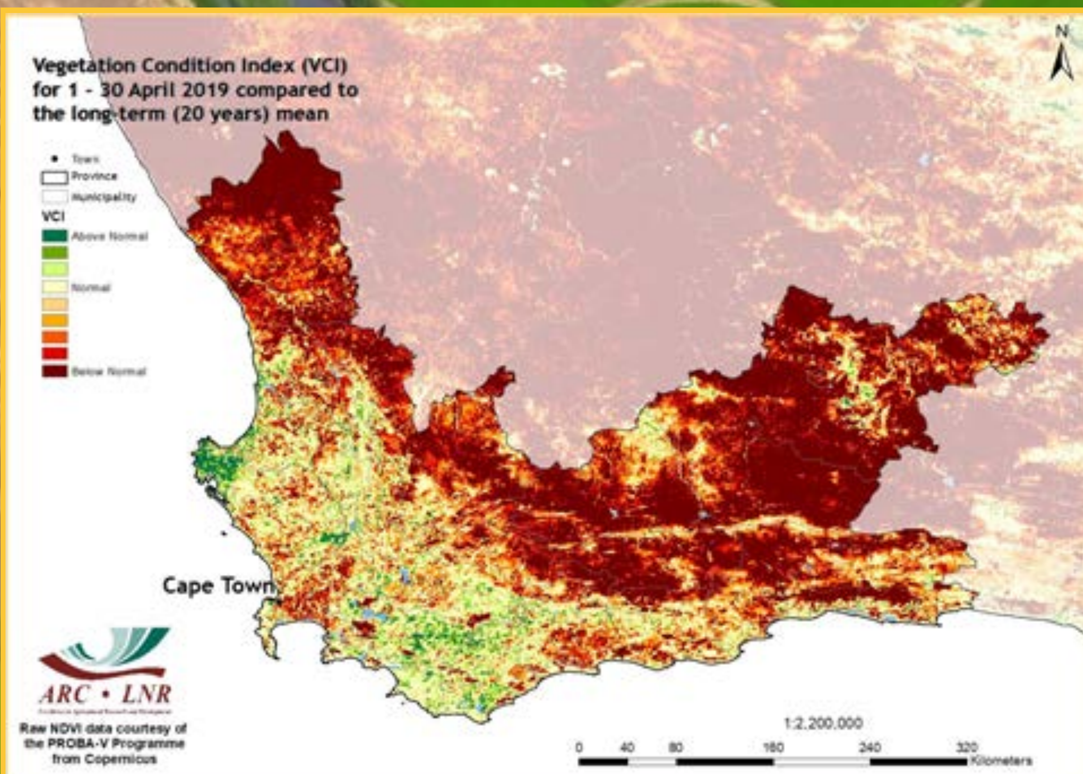
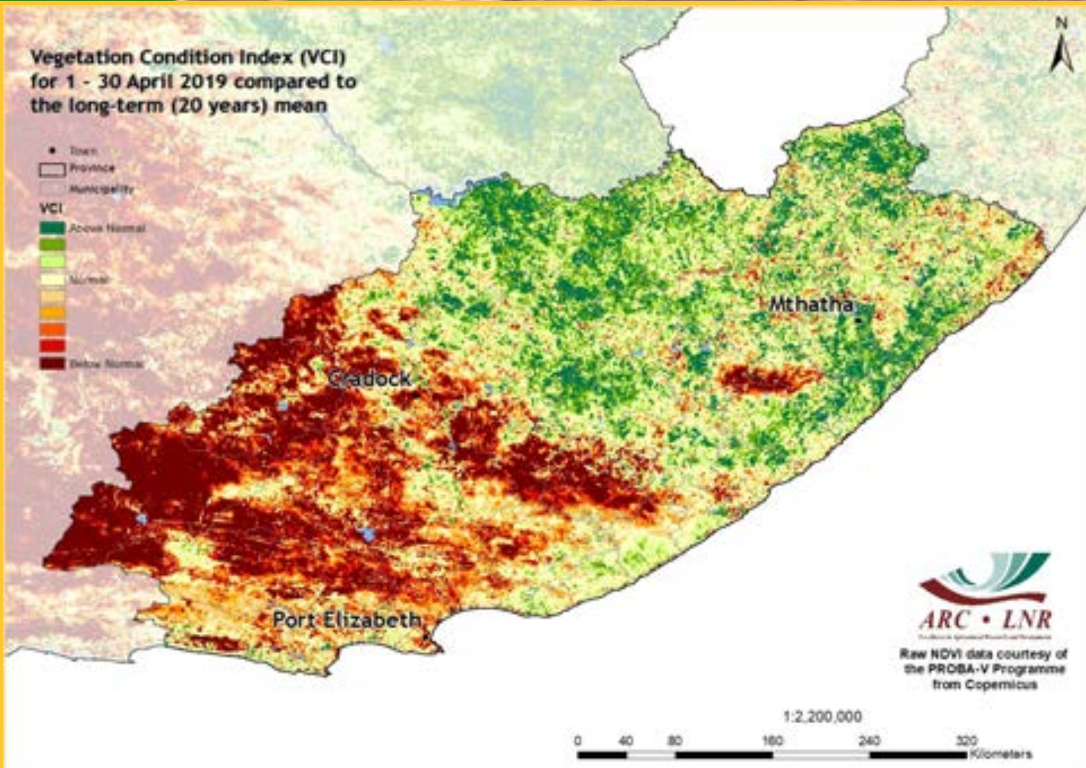


Figure 15

Figure 14:
The April VCI map for the Northern Cape shows that alarmingly poor vegetation conditions remain dominant in nearly the entire province.

Figure 15:
The April 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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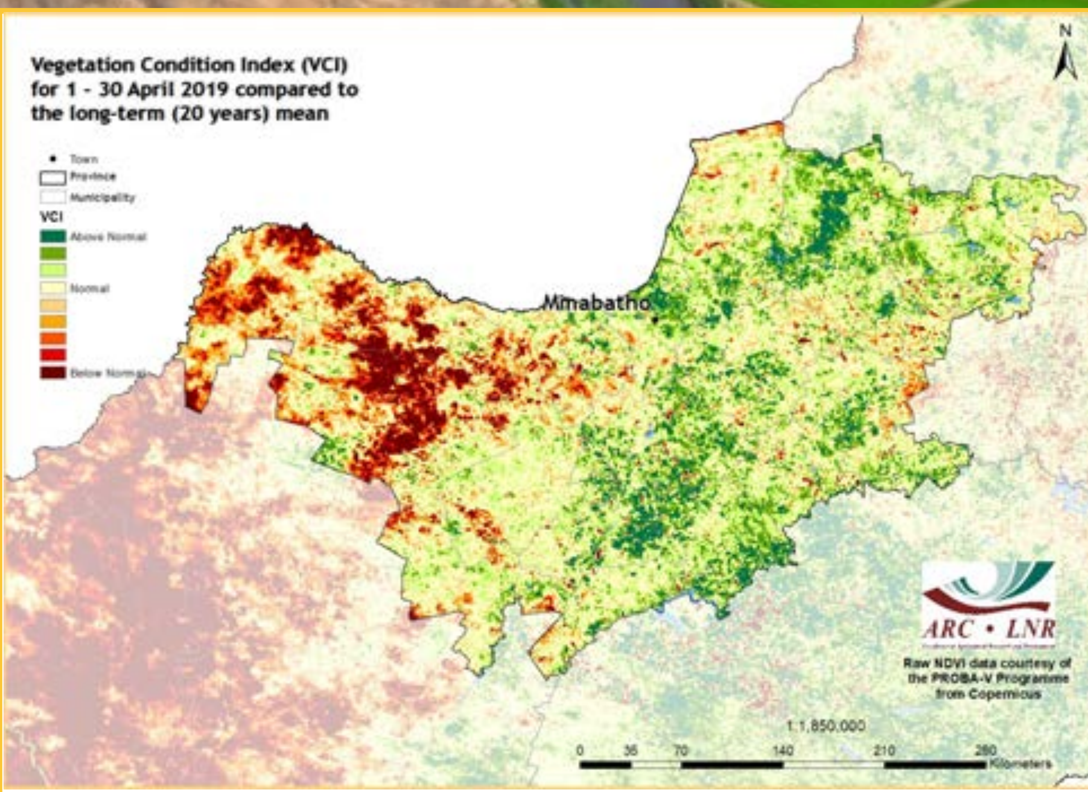


Figure 17

Figure 16:
The April VCI map for the Eastern Cape shows that many parts of the Sarah Baartman district municipality continue to experience poor vegetation activity. Meanwhile, minor exceptions include some district municipalities in the northern parts of the province.

Figure 17:
The April VCI map for North West shows that the province continues to experience a diverse range of vegetation conditions, from extremely poor in the western parts to above-normal to normal activity in the eastern parts.

Questions/Comments:
MaakeR@arc.agric.za

6. Vegetation Conditions & Rainfall

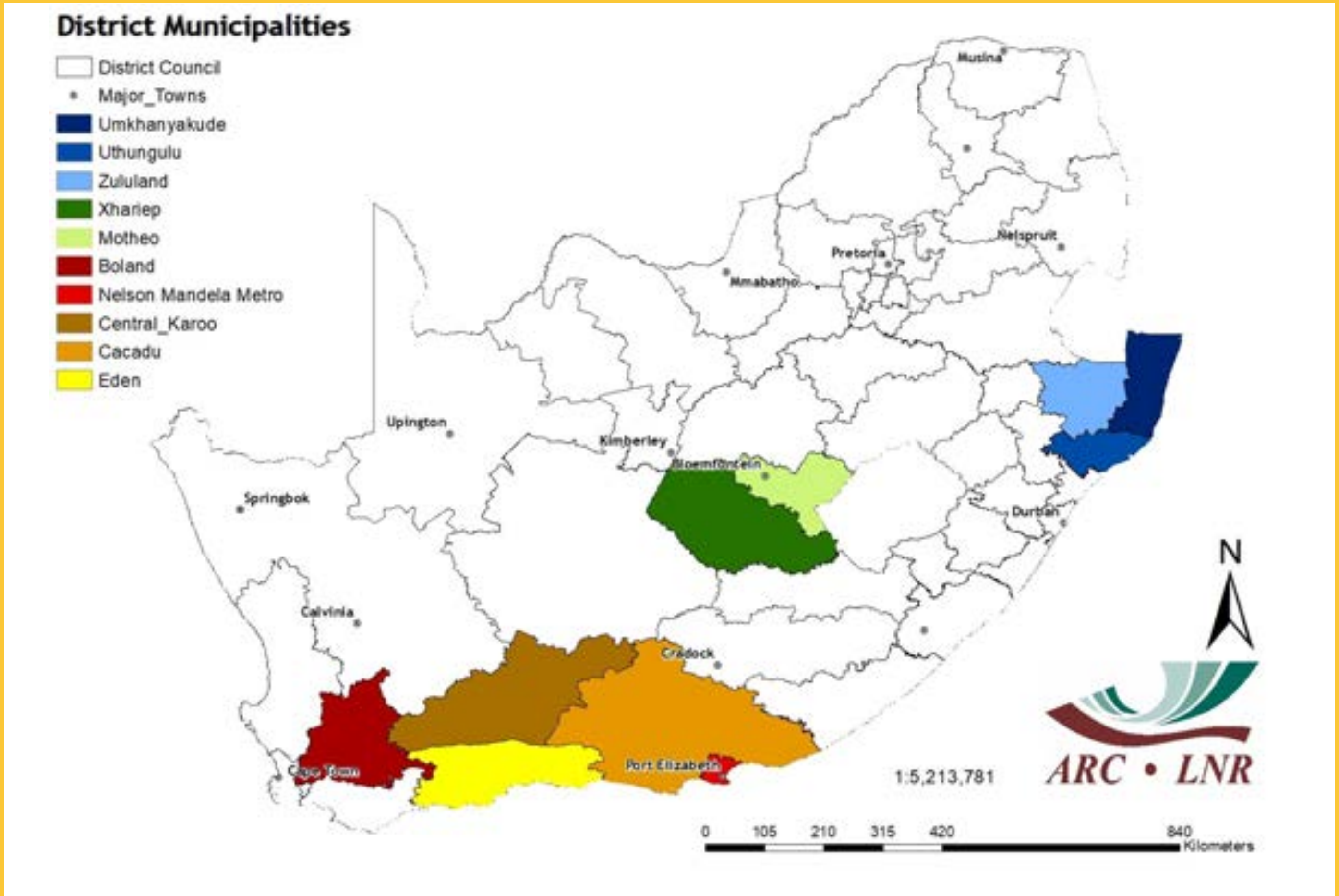


Figure 18

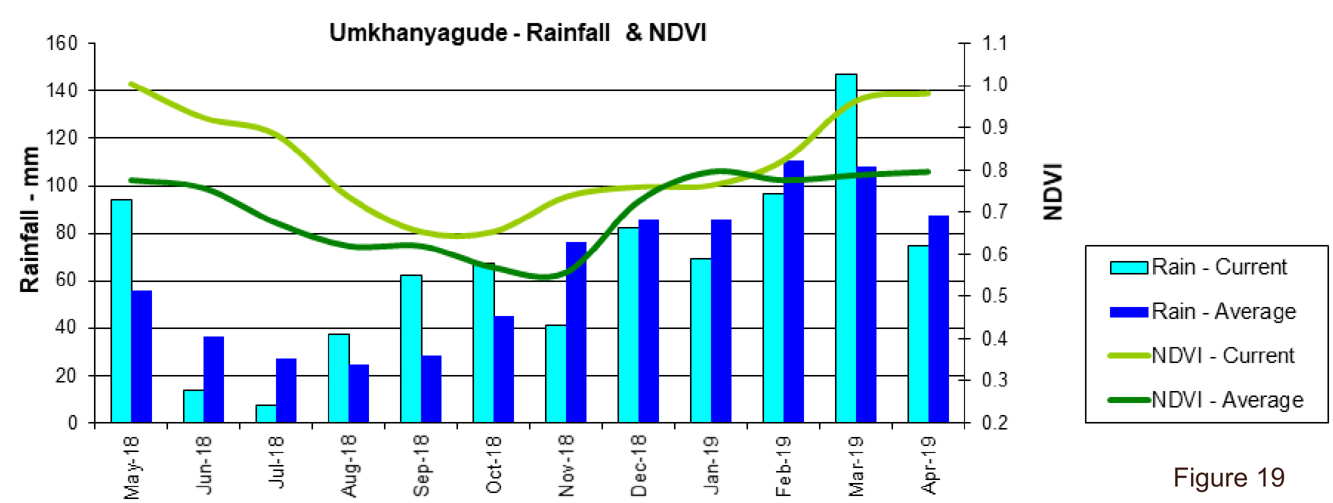
Rainfall and NDVI Graphs

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

Questions/Comments:
MaakeR@arc.agric.za

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

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



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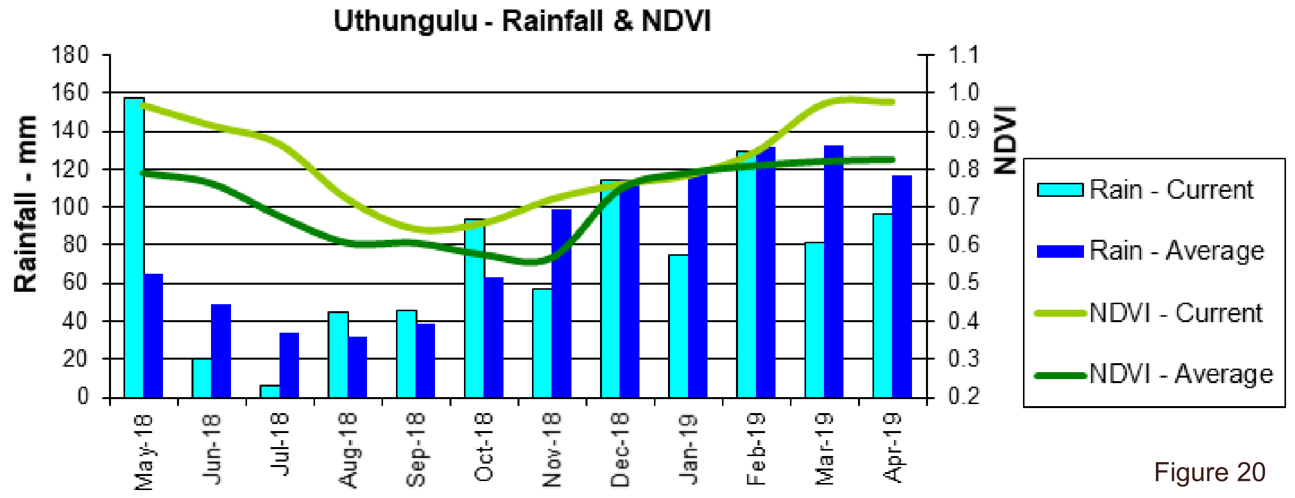

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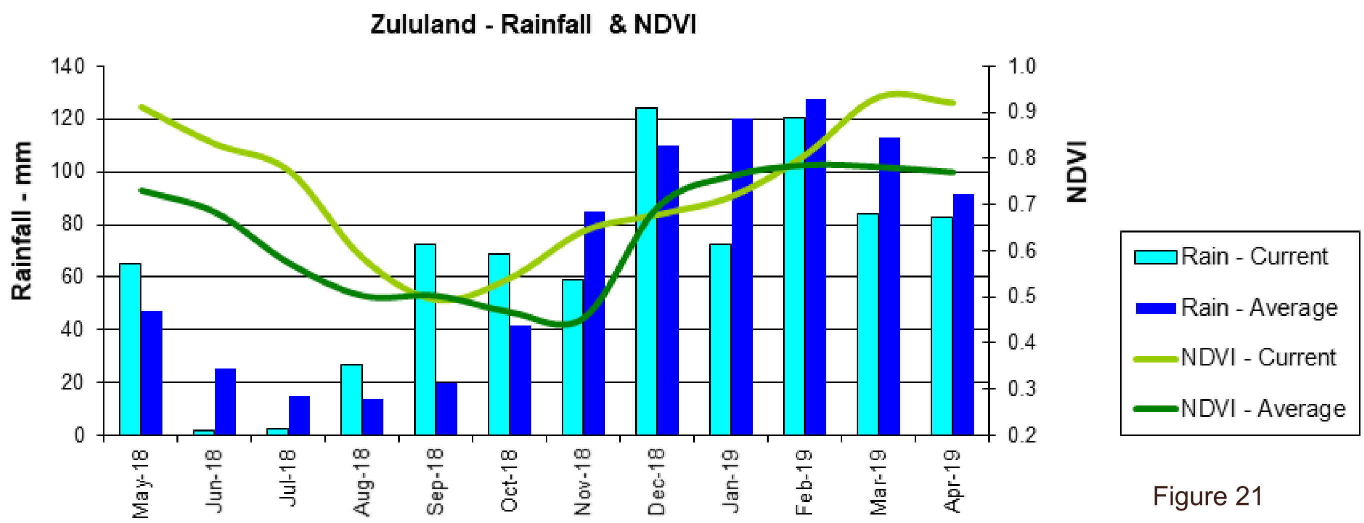

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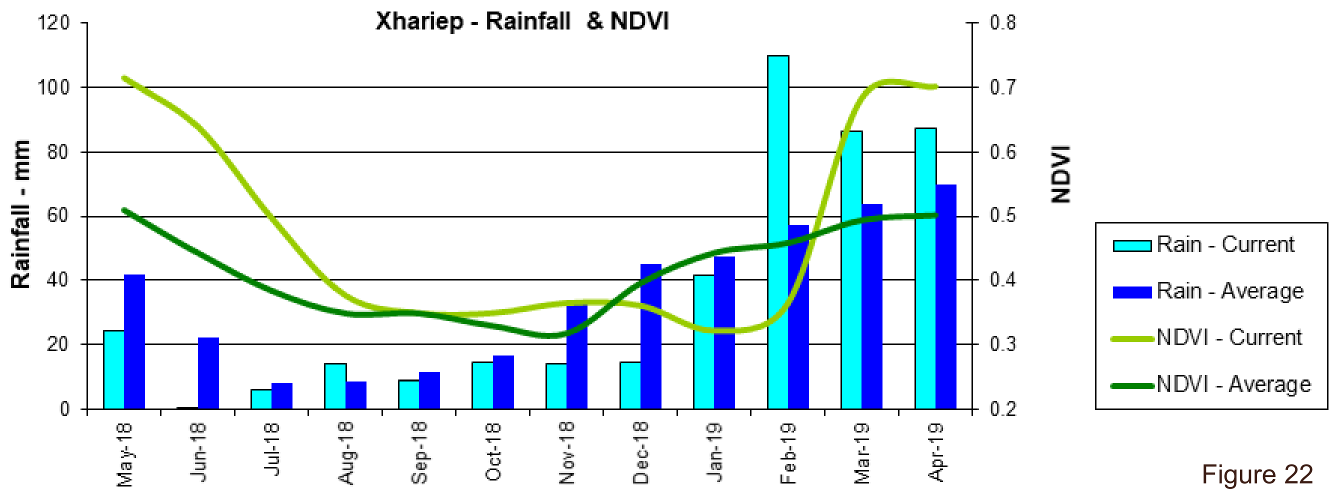

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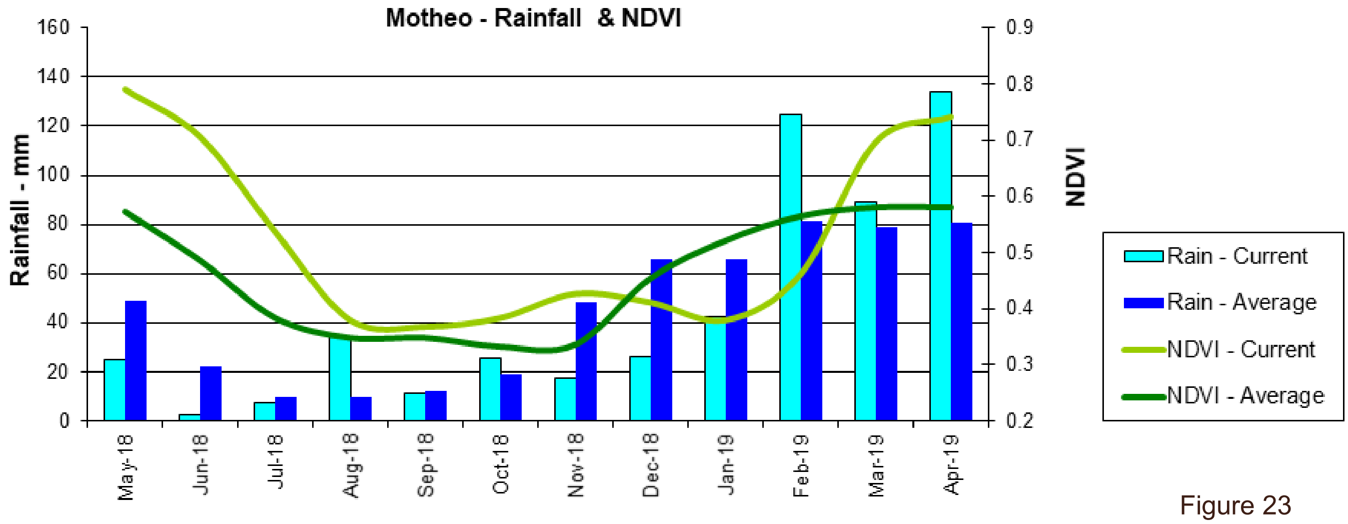

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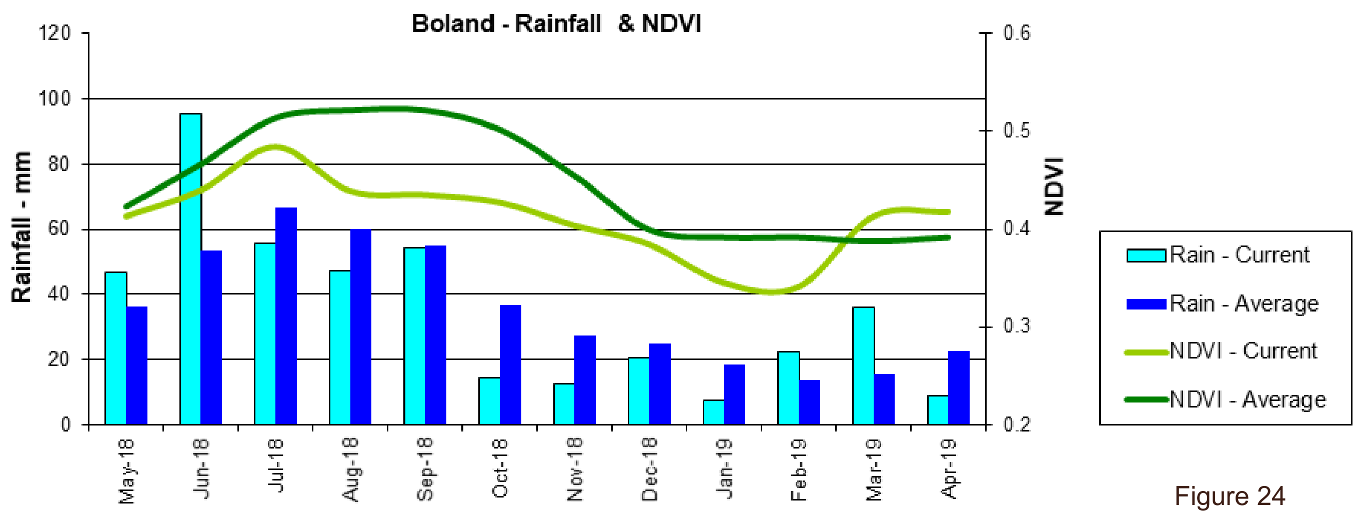
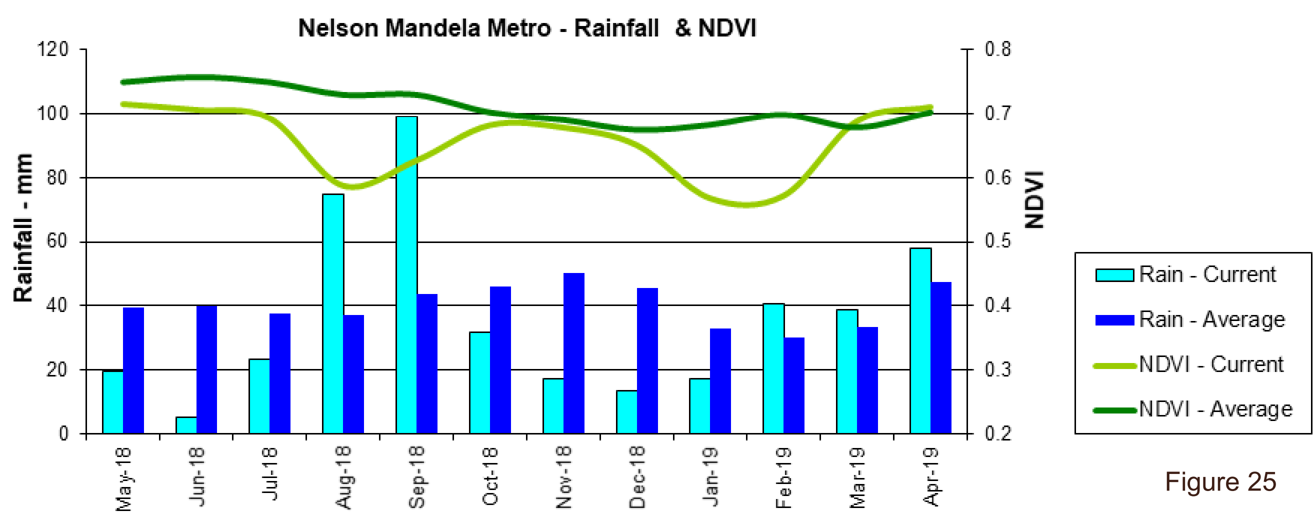


Figure 24



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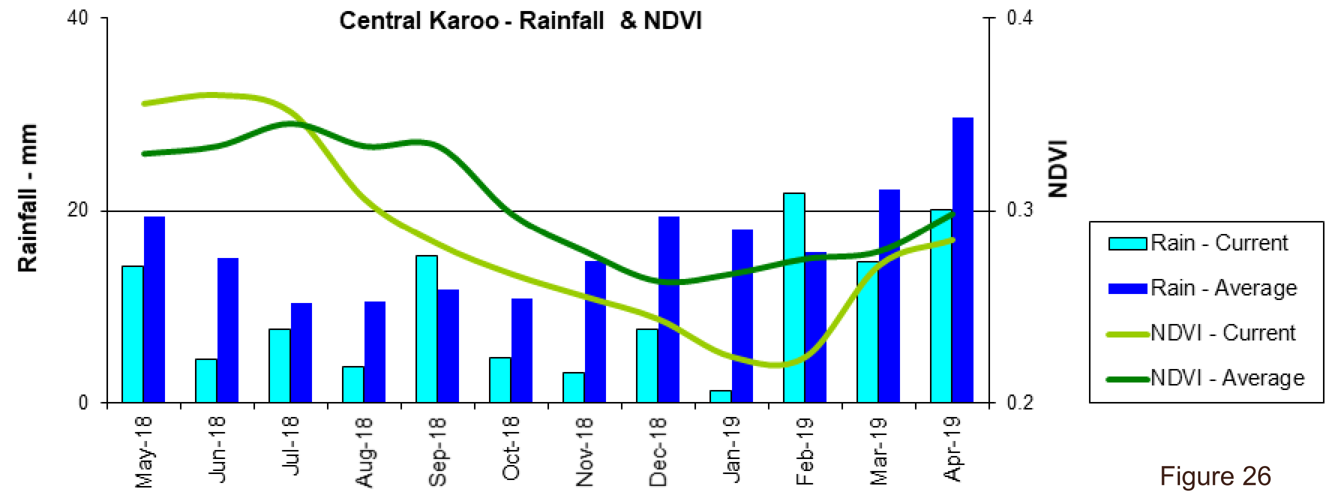

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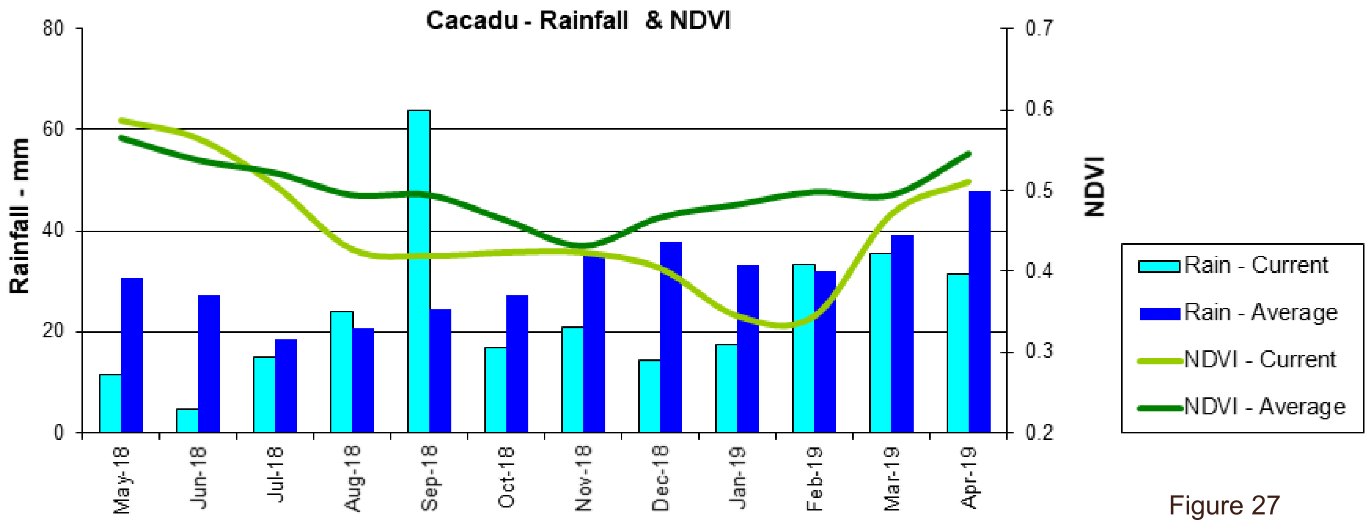


Figure 27

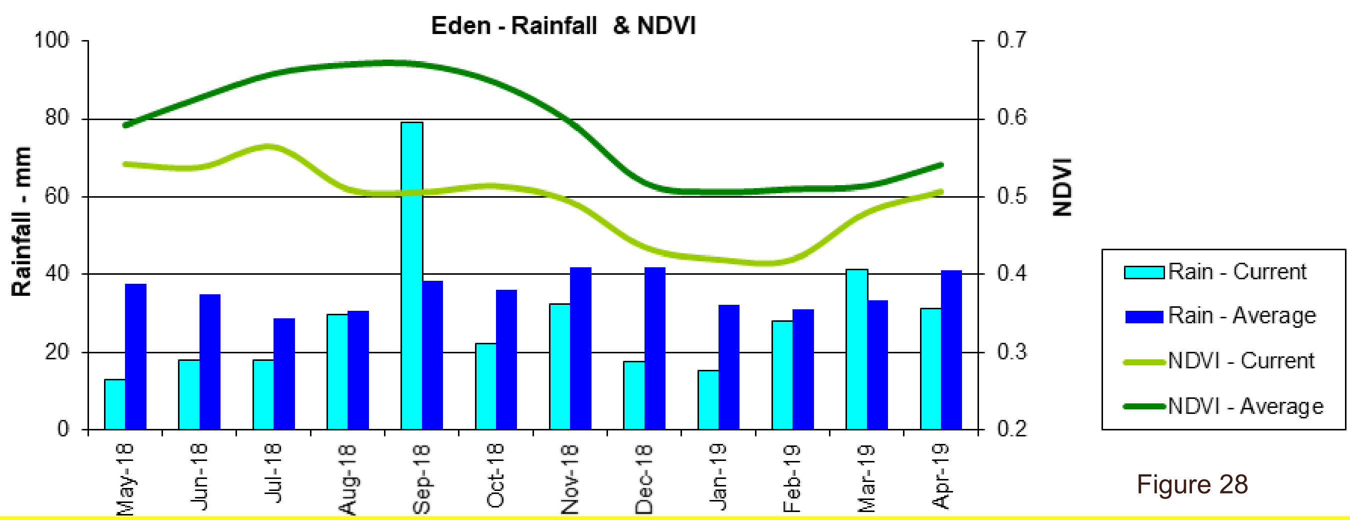


Figure 28

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 1-30 April 2019 per province. Fire activity was higher in the Western Cape compared to the long-term average.

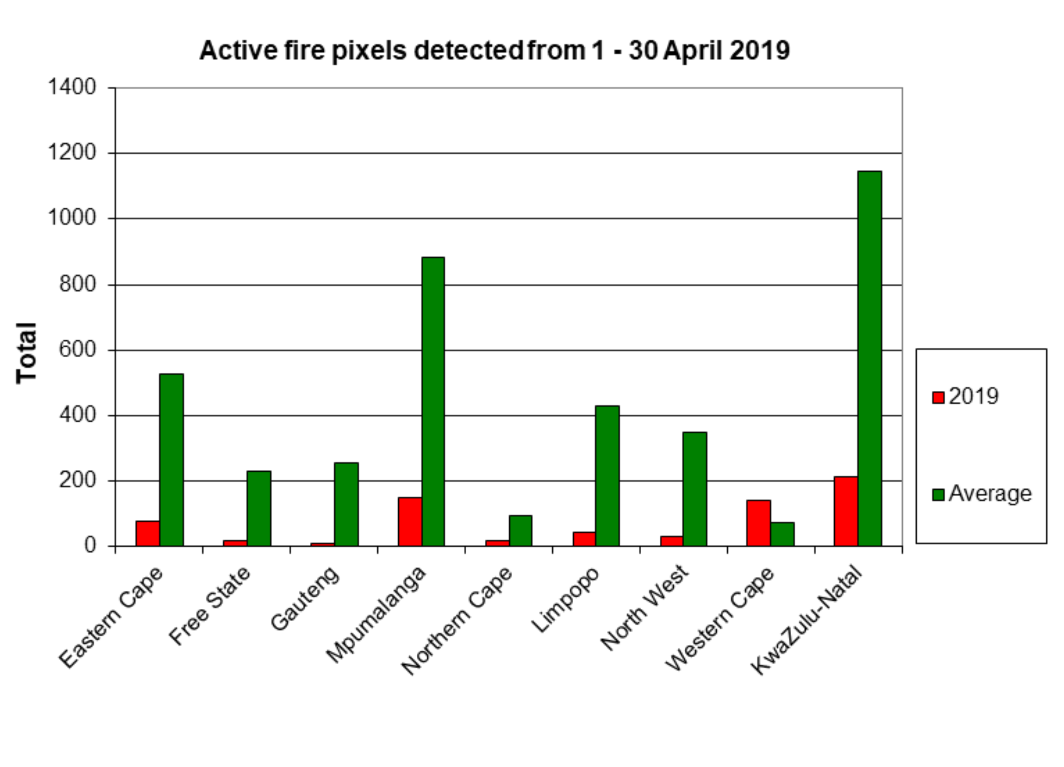


Figure 29

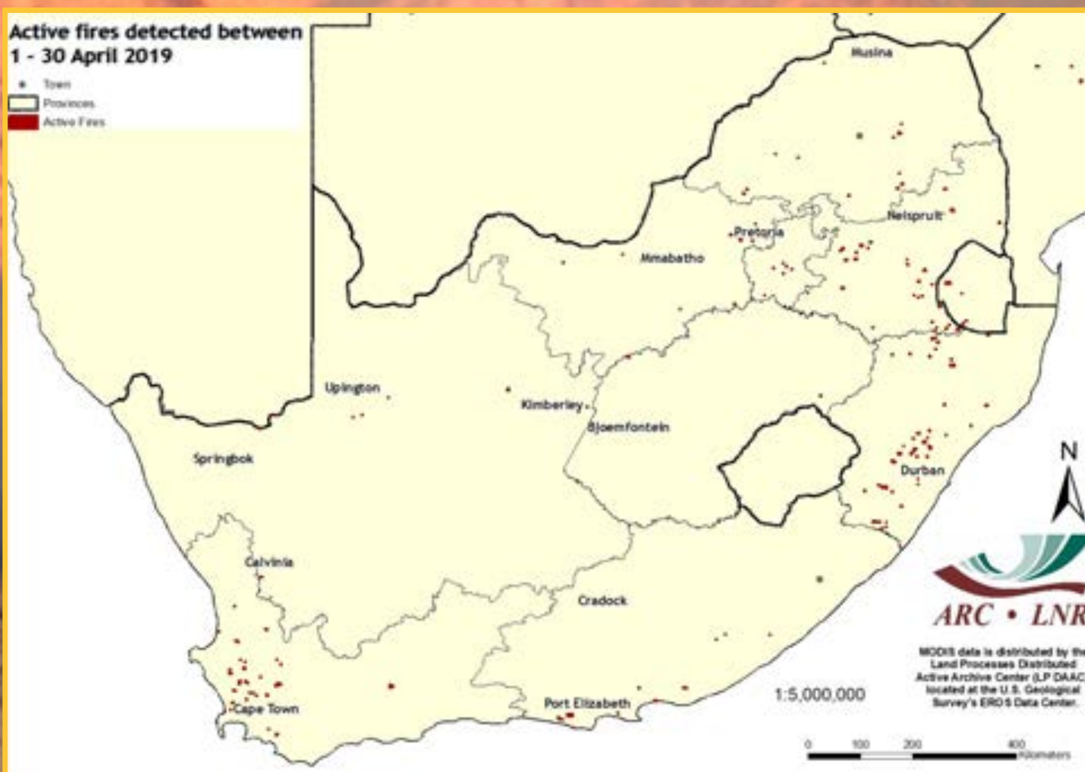


Figure 30

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

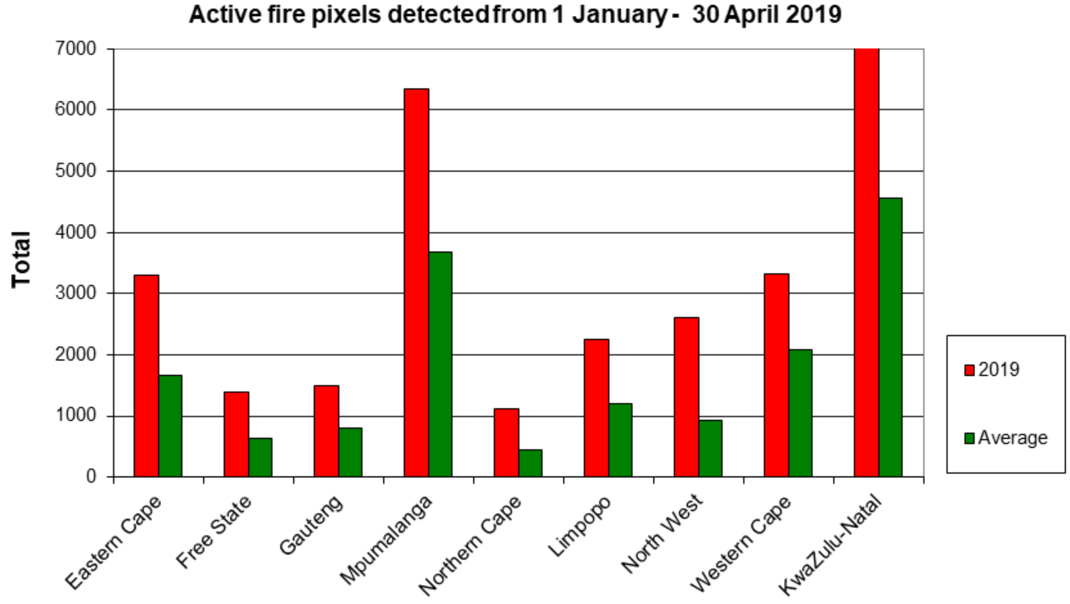


Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January to 30 April 2019 per province. Fire activity was higher in all provinces compared to the long-term average.

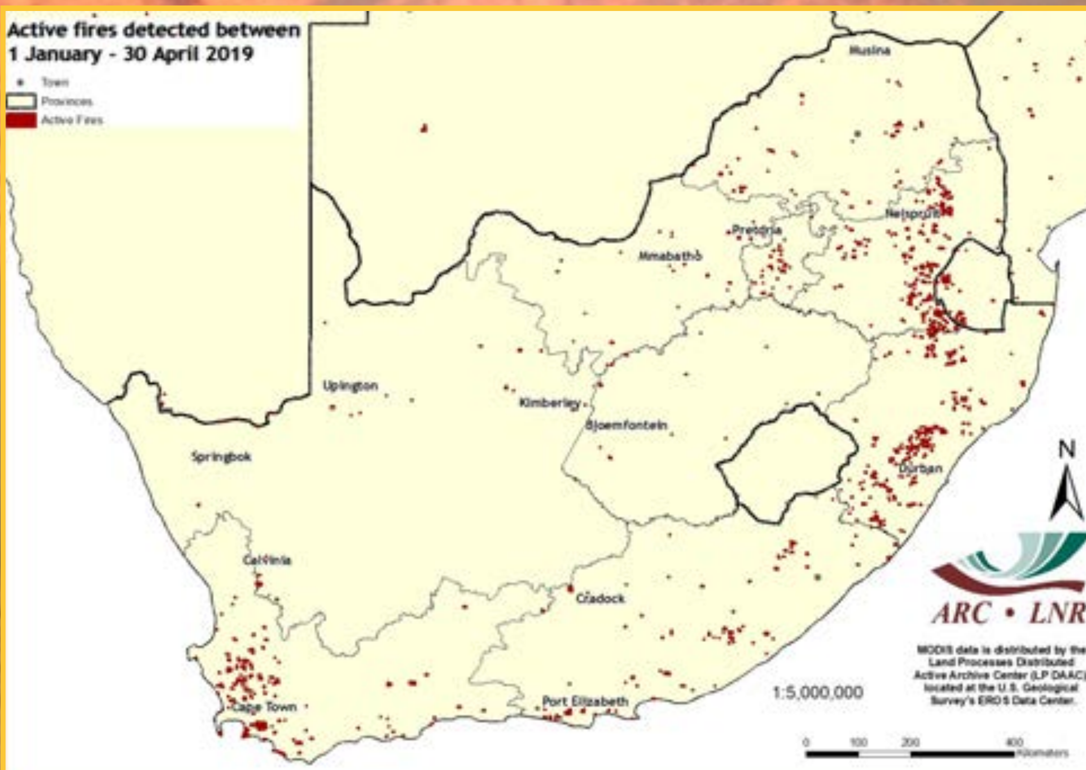


Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January to 30 April 2019.

Questions/Comments:
MaakeR@arc.agric.za

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 April 2019 and April 2018 shows that generally the entire country currently has either equal or slightly less water extents than last year. The Karoo, Kalahari and a few local catchments in Lesotho and Limpopo 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

Questions/Comments:
mark.thompson@geoterraimage.com

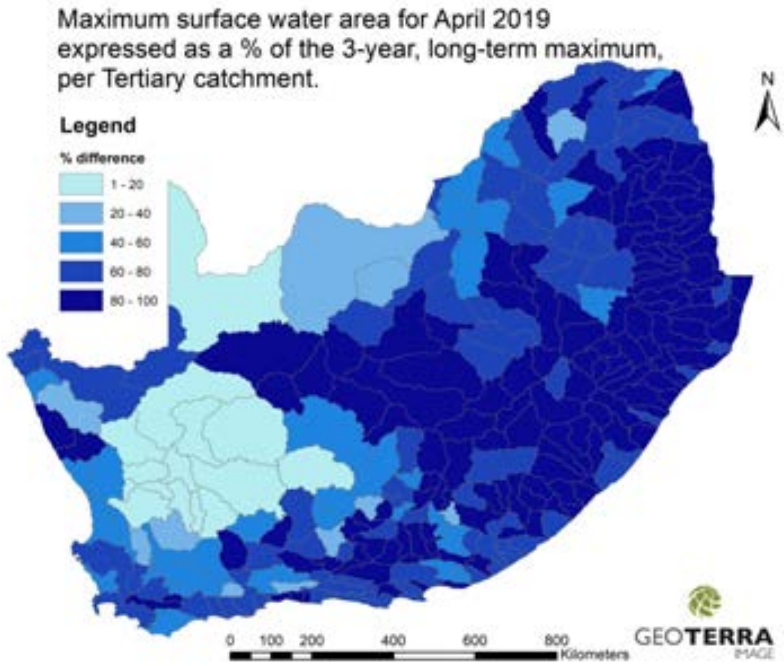


Figure 33

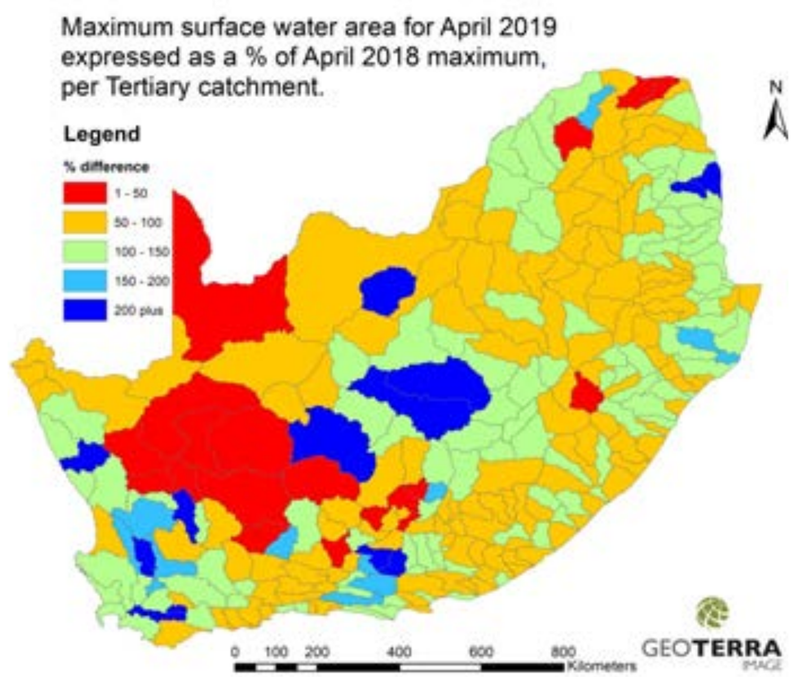
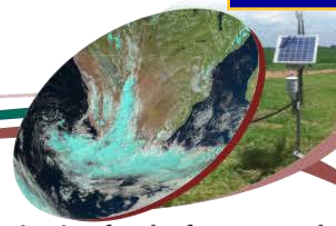


Figure 34

Agrometeorology



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

FOCUS AREAS

Climate Monitoring, Analysis & Modelling

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

Climate Change Adaptation & Mitigation

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

Climate Information Dissemination

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

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

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

Geoinformation Science

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

FOCUS AREAS

Decision Support Systems

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

Early Warning & Food Security

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

Natural Resources Monitoring

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

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

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

The Coarse Resolution Imagery Database (CRID)

NOAA AVHRR

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

MODIS

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

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

Datasets include:

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

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

VGT4AFRICA and GEOSUCCESS

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

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

Meteosat Second Generation (MSG)

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

Rainfall maps

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

Solar Radiation and Evapotranspiration maps

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

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Institute for Soil, Climate and Water

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

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

The operational Coarse Resolution Imagery Database (CRID) project of ARC-ISCW is funded by the National Department of Agriculture, Forestry and Fisheries. Development of the monitoring system was made possible at its inception through LEAD funding from the Department of Science and Technology.

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

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

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