UMLINDI
The Watchman

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ARC • LNR
Excellence in Research and Development

INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

agriculture, forestry & fisheries

South African Weather Service

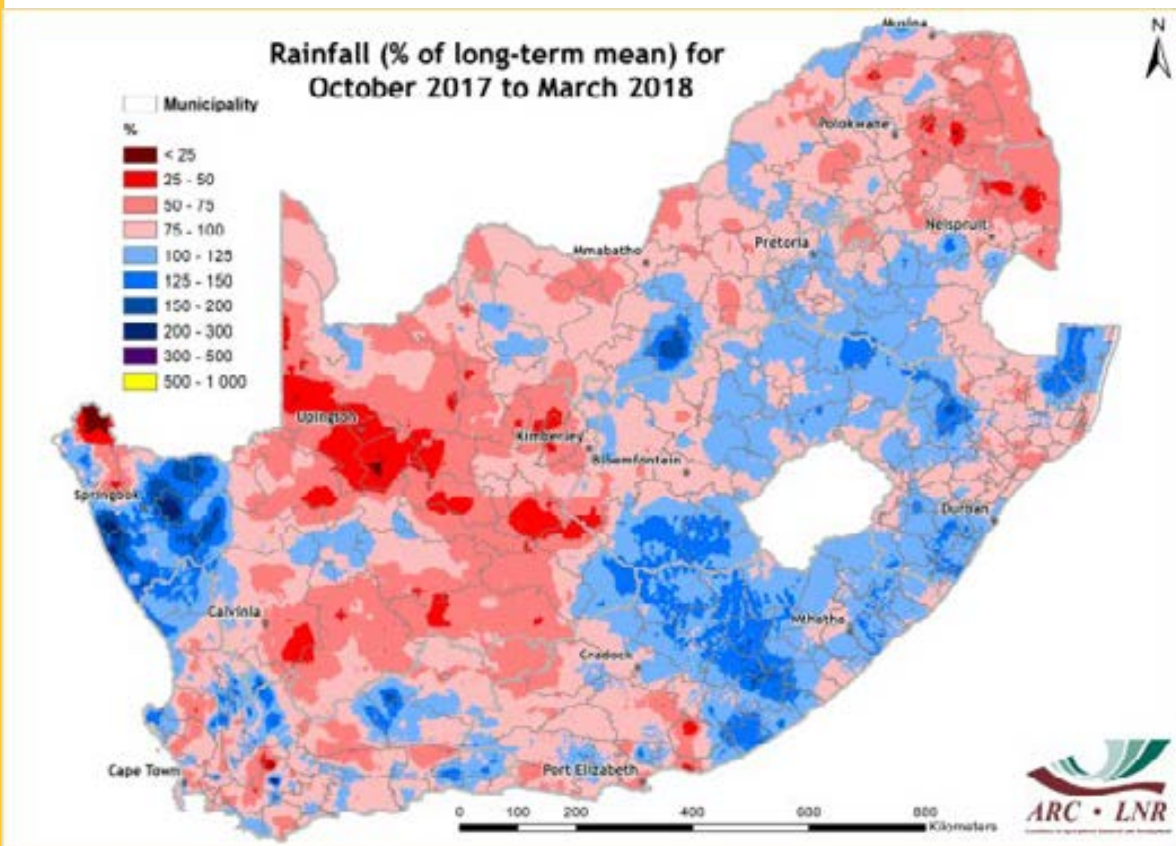
AMESD

166th Edition

Image of the Month

The 2017/18 summer rainfall season: mixed fortunes

After initial good rainfall over large parts of the country at the start of the summer rainfall season, the next few months were anomalously dry. The lack of rainfall over in particular the western maize producing regions was accompanied by hotter than normal temperatures during the mid-summer months with an extreme heatwave occurring at the start of 2018. The parts of the country that received above-normal rainfall during the October to December 2017 period included the far western areas, isolated areas over the drought stricken Western Cape, the southeastern interior and coastal belt, as well as the eastern high ground. Conditions for rainfall over the central to eastern interior improved only towards the end of the summer rainfall season. The good rains that fell during this time resulted in many of the country's important dams reaching full storage capacity, although if the entire summer season is considered (October 2017 to March 2018), large parts of the summer rainfall region received below-normal to near-normal rainfall (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:

With the exception of the far north-east, the remainder of the eastern parts of the summer rainfall region received high rainfall totals during March 2018. Over most of these areas, March was the best rainfall month of the 2017/18 summer season, resulting in runoff that contributed to the replenishment of many of the major dams that are located within the summer rainfall region.

Although good rains fell over large parts of the summer rainfall region in March, the nature of the cloud development that resulted in the rainfall lacked a prominent link with the tropics as is usually the case for this time of the year. Instead of the regular northwest to southeast aligned cloudbands that originate from the Angola/Namibian border further southeastwards in over South Africa that move from west to east over the country in association with the passage of upper-air troughs, there were rather two more prominent areas of convective activity. The first, concentrated over the northern parts of Namibia and the second concentrated over the southeastern to eastern high ground areas of South Africa where fairly regular convective activity contributed to March 2018 being a month of above-normal rainfall overall.

One of the occasions when a good link existed between the tropics and the mid-latitudes occurred from 21-23 March. During this time, a cut-off low that interacted with southward flowing moisture from the tropics resulted in rainfall totals over this 3-day period of between 50 and 100 mm in a northwest to southeast aligned band over the eastern interior. Extreme rainfall with localized flooding occurred during this period, with the northern parts of Gauteng receiving up to 240 mm.

Another tropically sourced cloudband developed on the 27th and was located over the far western parts of the country on the 28th before it exited the country on the 31st. This cloudband resulted in the above-normal rainfall over the far western interior of the country.

With the arrival of autumn, frontal systems associated with more pronounced cooling started to make landfall over the far southwestern parts of the country. However, rainfall associated with the frontal systems was minimal and confined to the coastal regions where topography could aid in rainfall formations, such as along the Garden Route.

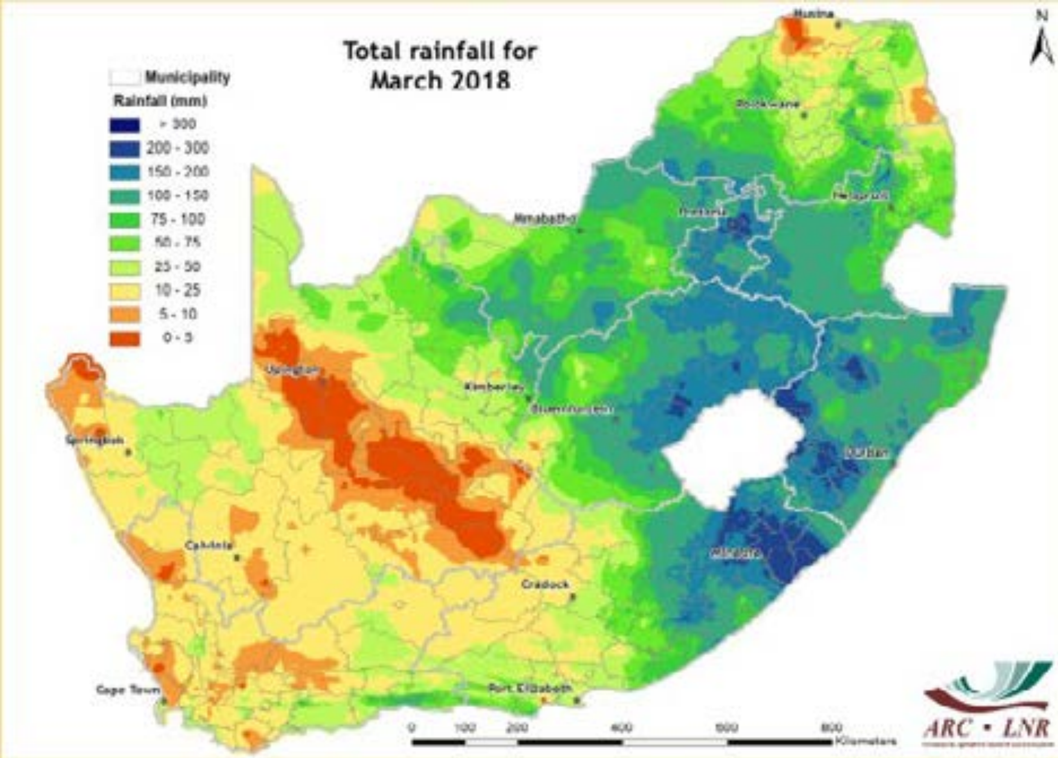


Figure 1

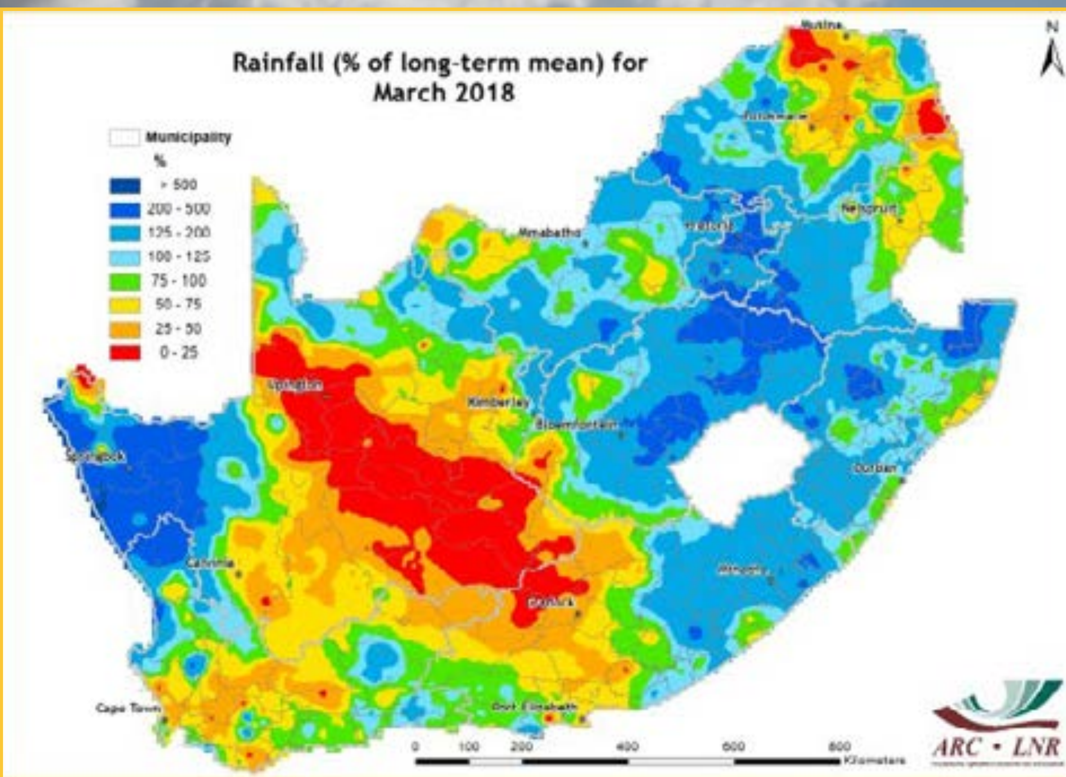


Figure 2

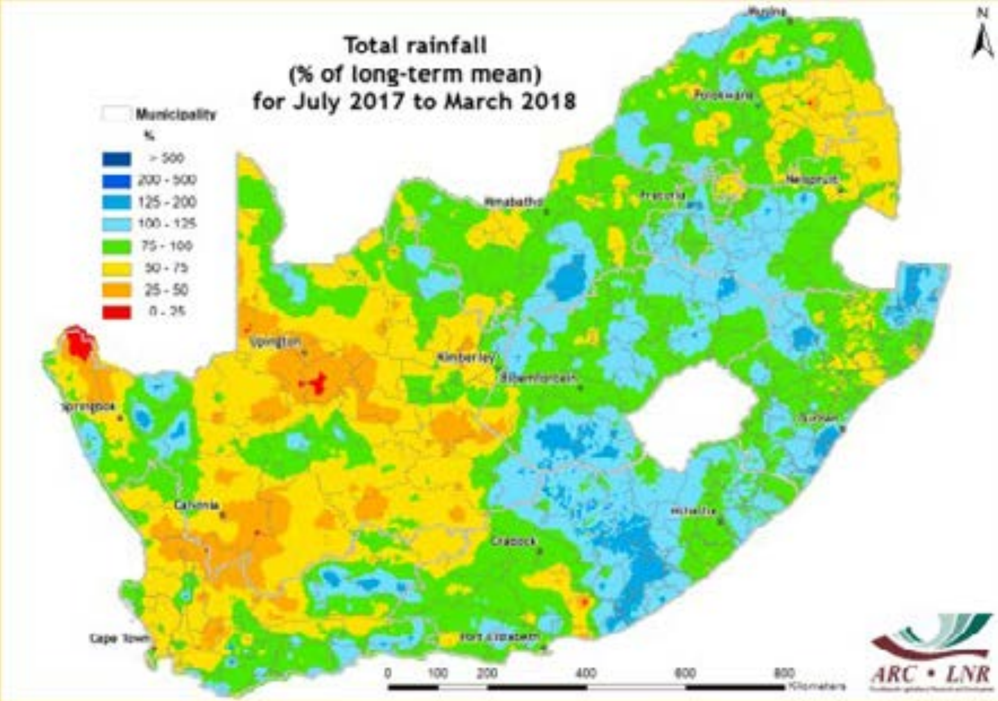


Figure 3

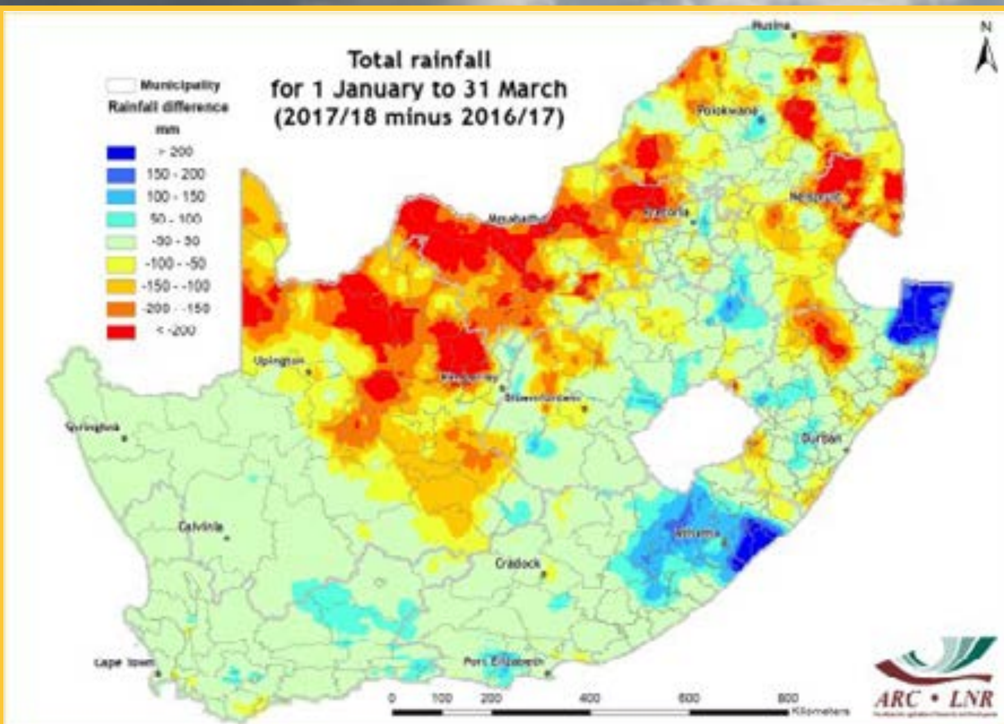


Figure 4

Figure 1:
Good rainfall totals occurred in a north-west to southeast aligned band that was located over the central to eastern interior and extended to the southeastern parts of the country. Over northern Gauteng and the southeastern parts of the country, the March 2018 rainfall totals exceeded 200 mm.

Figure 2:
Above-normal rainfall occurred over large parts of the summer rainfall region in March. The above-normal rains over the eastern interior were mostly as result of a cut-off low that aided in the southward transport of tropically sourced moisture around the 22nd. Further southwards, more regular rainfall events contributed to the above-normal monthly rainfall, whilst over the far western parts of the country it could be attributed to thundershowers that developed in a cloudband that formed over those areas towards the end of the month.

Figure 3:
Since the winter of 2017 to the end of the 2017/18 summer, near-normal to slightly above-normal rainfall occurred over the Cape south coast and adjacent interior. Further eastwards some areas over the southeastern parts of the country received above-normal rainfall as rainfall conditions improved over these areas over the last few months. Over the eastern parts of the country, the March 2018 rainfall contributed to the above-normal rainfall for this 9-month period, after most of the summer months experienced below-normal rainfall. The isolated areas of above-normal rainfall over the far western and south-western parts of the country can be attributed to convective development, rather than frontal systems of the 2017 winter months.

Figure 4:
January to March 2018 was drier than the corresponding period of a year ago over areas of the northeastern parts of the country, extending westwards into the maize producing regions through to the Northern Cape. Over the remainder of the country, isolated areas over the southern and southeastern parts of the country as well as over the northern parts of KwaZulu-Natal received more rainfall during the current 3-month period compared to the corresponding period of a year ago.

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.

At the 36-month time scale, severe drought conditions occurred over many parts of the country, but in particular over the southwestern and eastern parts. Relief from the drought occurred over the central parts of the country as can be seen on the 24-month SPI. At the same time, the severe drought conditions in the southwest extended eastwards along the Cape south coast. At the 12-month time scale, drought conditions returned to the central parts of the country after the brief relief seen at 24 months. The 6-month SPI indicates mildly wet conditions over the southeastern parts, extending to the eastern high ground areas. An improvement from the severe drought conditions over the far western parts of the country is also visible at this time scale.

Questions/Comments:
EngelbrechtC@arc.agric.za

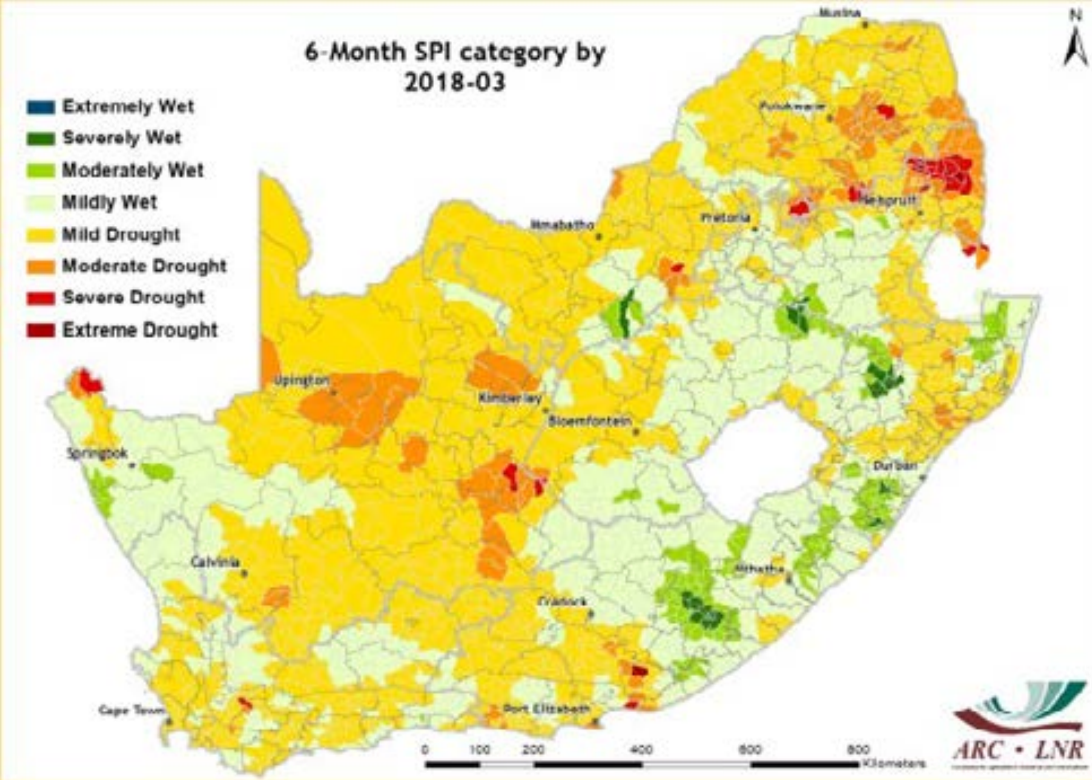


Figure 5

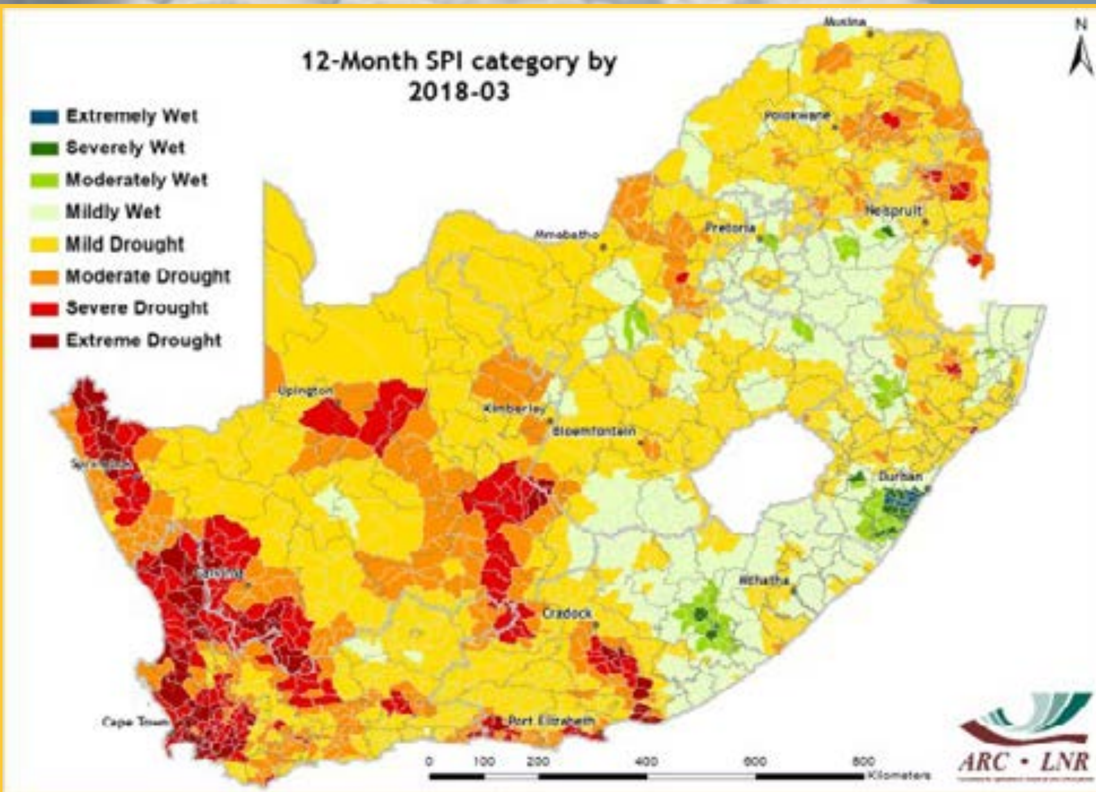


Figure 6

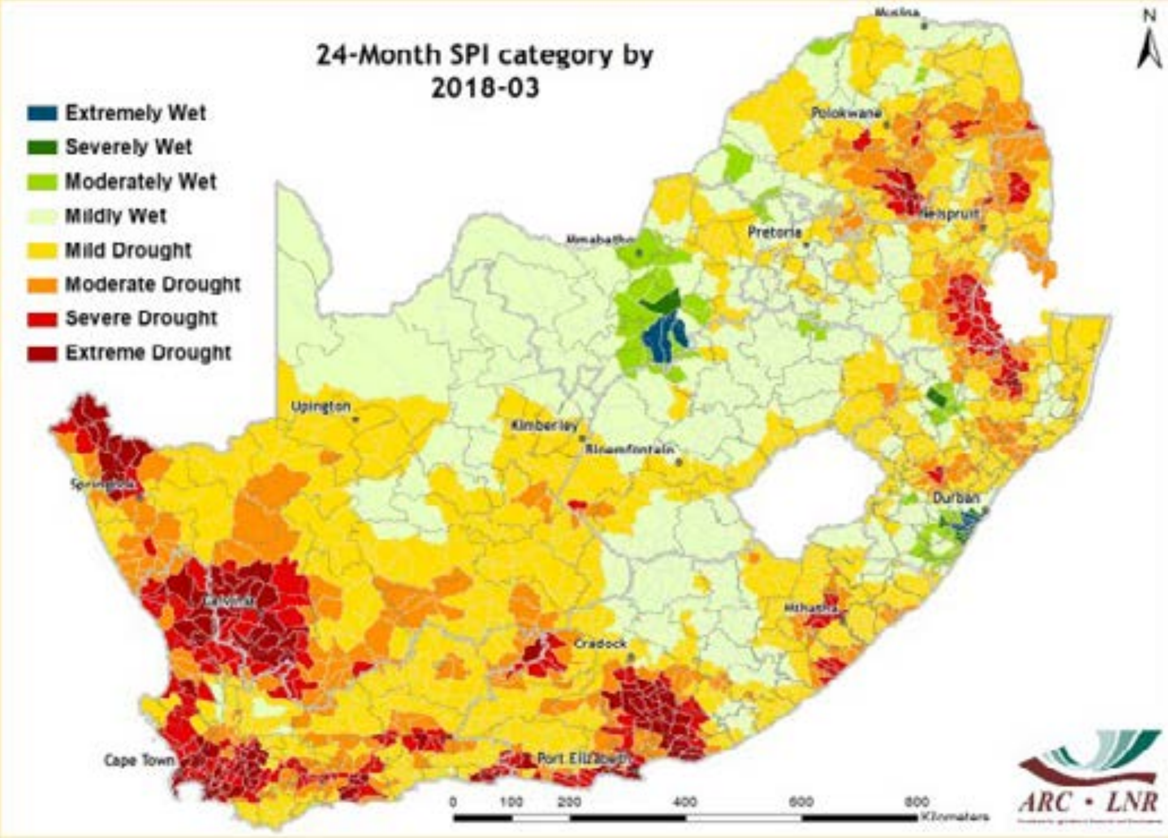


Figure 7

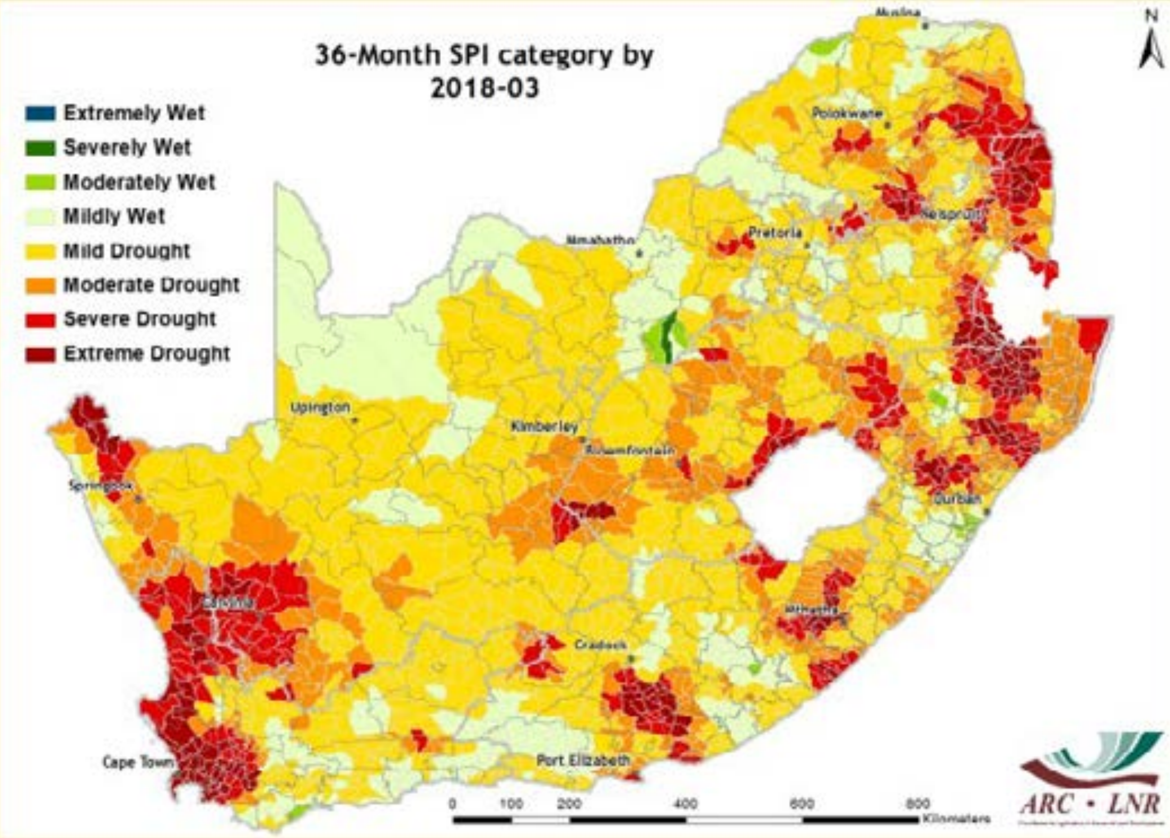


Figure 8

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.

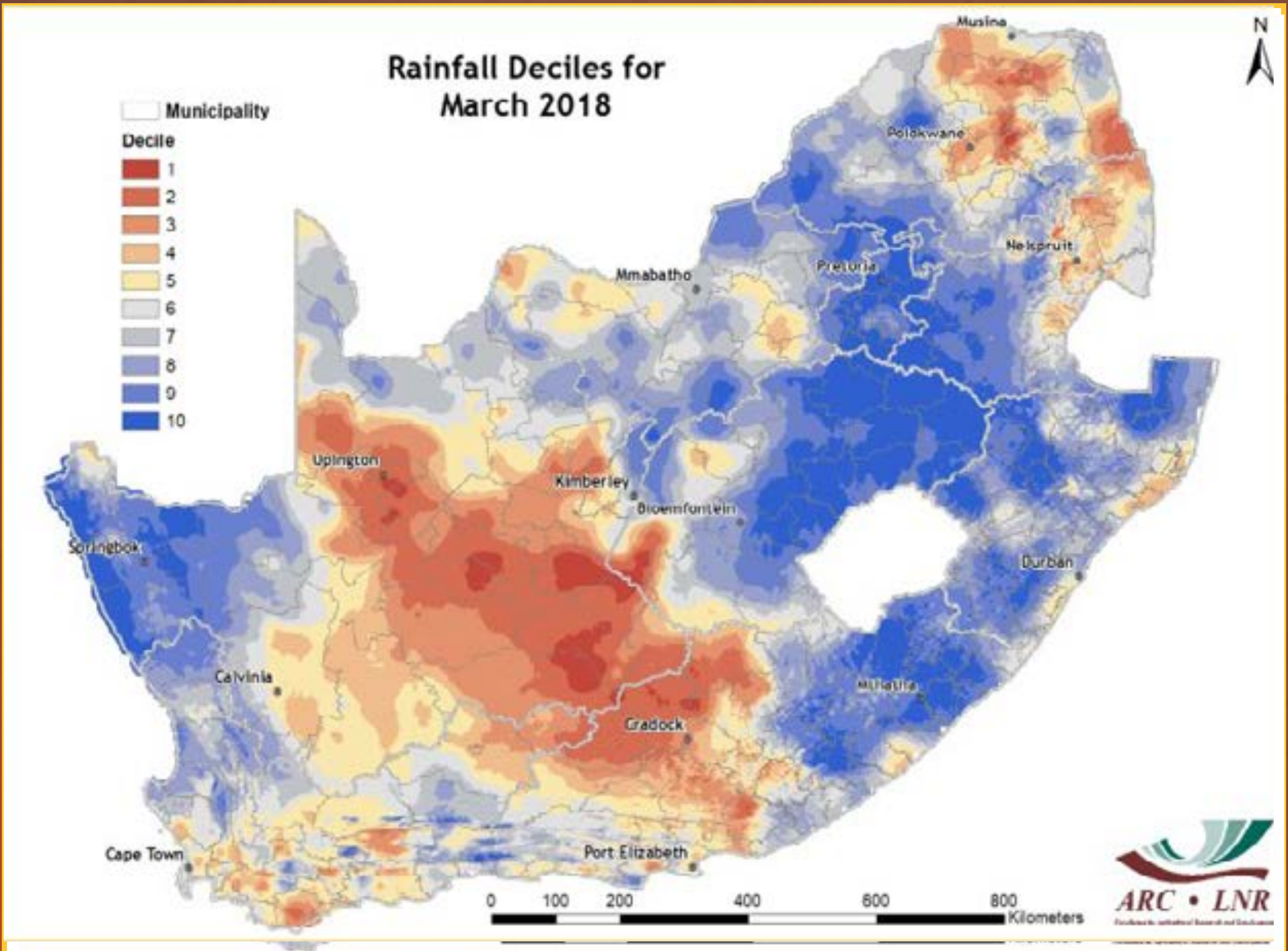


Figure 9

Figure 9:
Compared to historical rainfall totals during the month of March, March 2018 experienced totals that fall within the wetter March months over most parts of the country. Exceptions occurred over the western to central interior as well as over the far north-eastern parts of the country.

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.

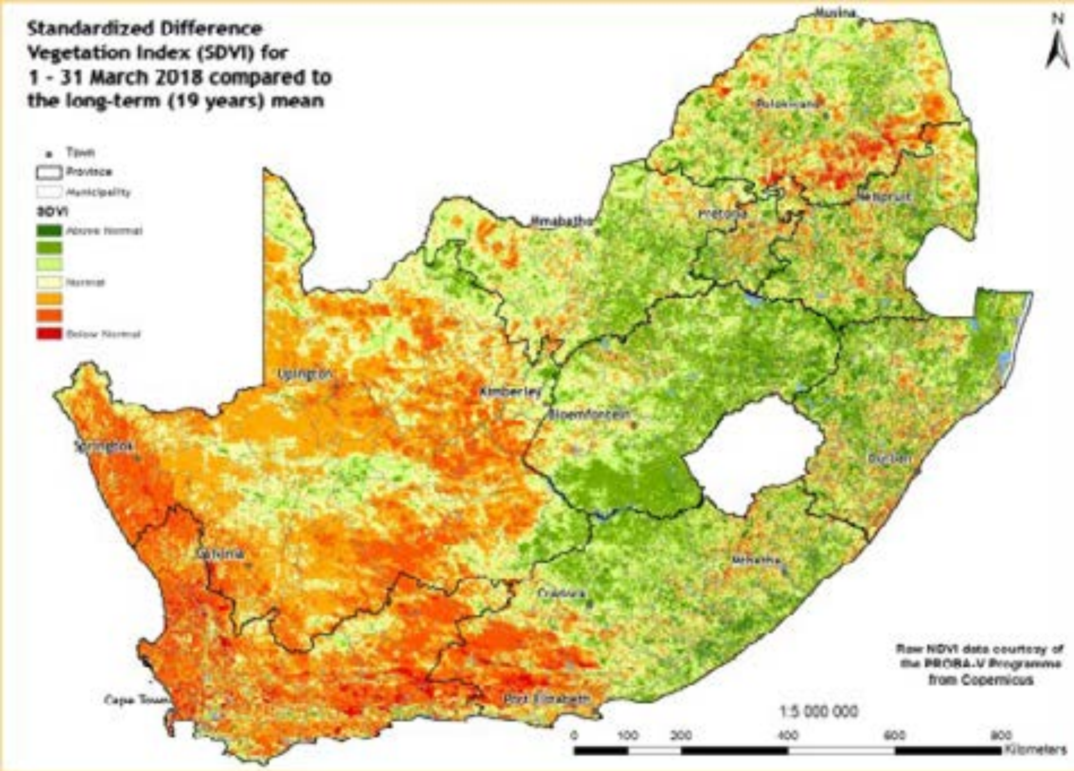


Figure 10

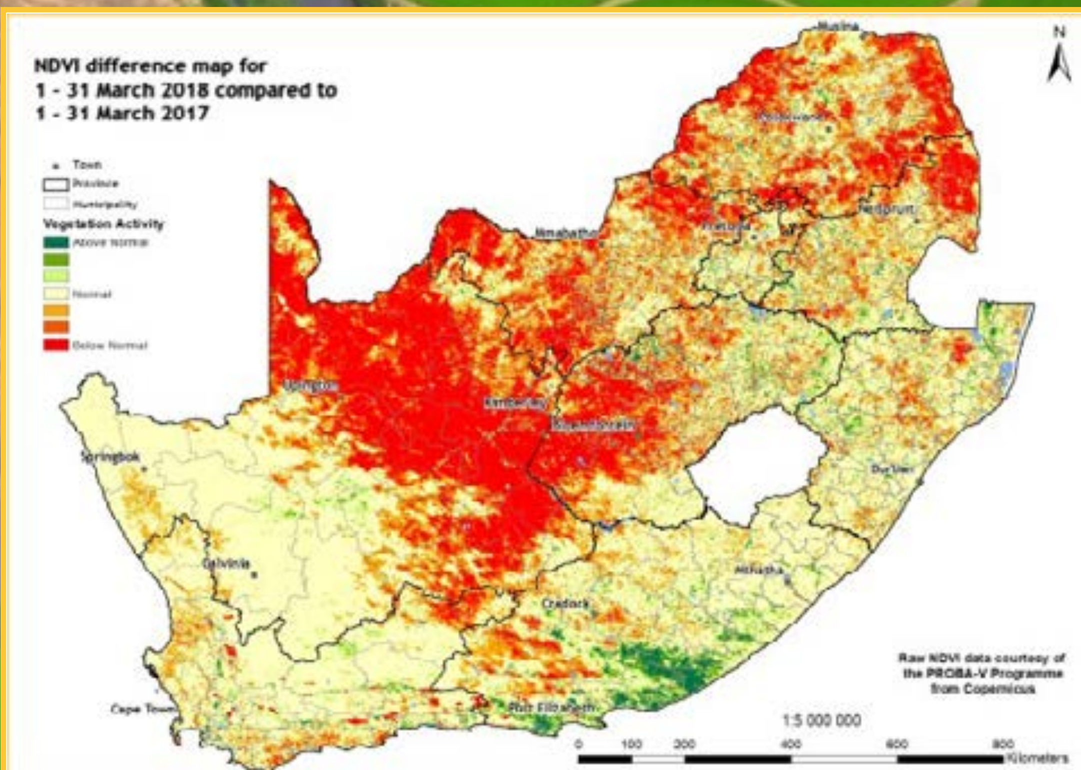


Figure 11

Figure 10:
Above-normal vegetation activity occurred over most parts in KwaZulu-Natal, Free State, Eastern Cape, some isolated areas in North West and the lower lying areas of Mpumalanga and Gauteng. Meanwhile, below-normal vegetation activity occurred over much of the Western Cape, Northern Cape, southern Eastern Cape and some parts of Limpopo.

Figure 11:
The NDVI difference map for March shows that below-normal vegetation activity occurred in Limpopo, northeastern and southeastern Northern Cape, central Free State, northeastern Mpumalanga and some distinct areas in the Western Cape compared to the same month in 2017. However, some parts of the Eastern Cape experienced above-normal vegetation activity.

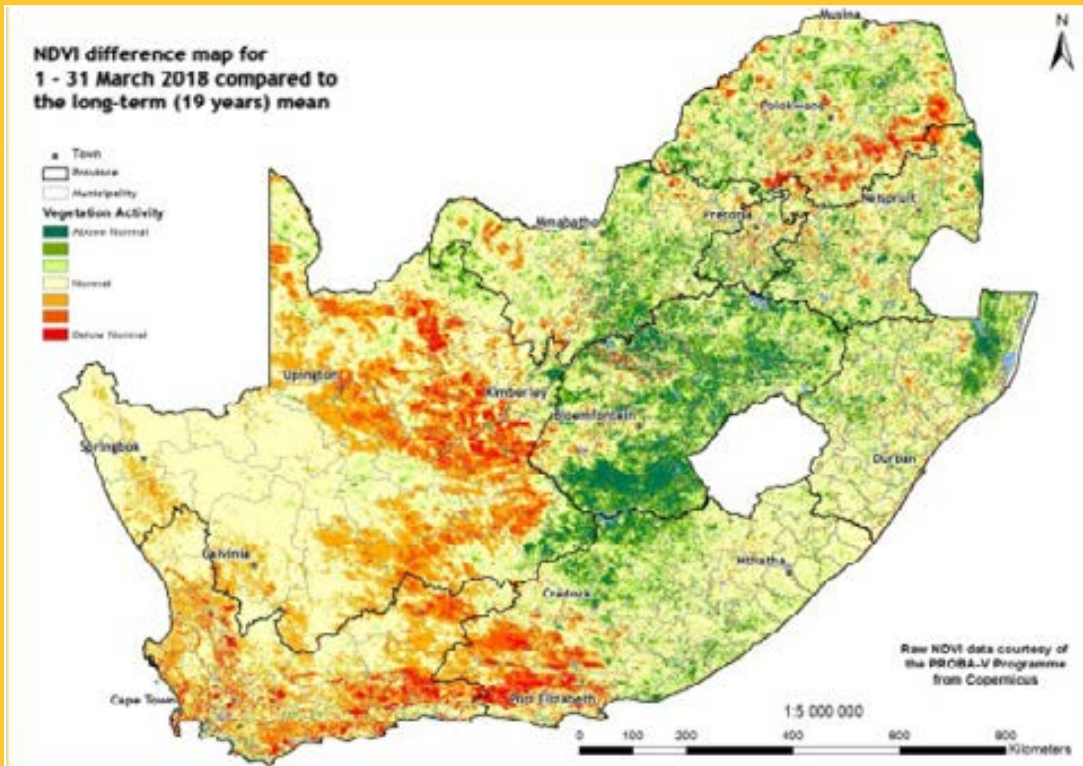


Figure 12

Vegetation Mapping
(continued from p. 7)

Interpretation of map legend

NDVI 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

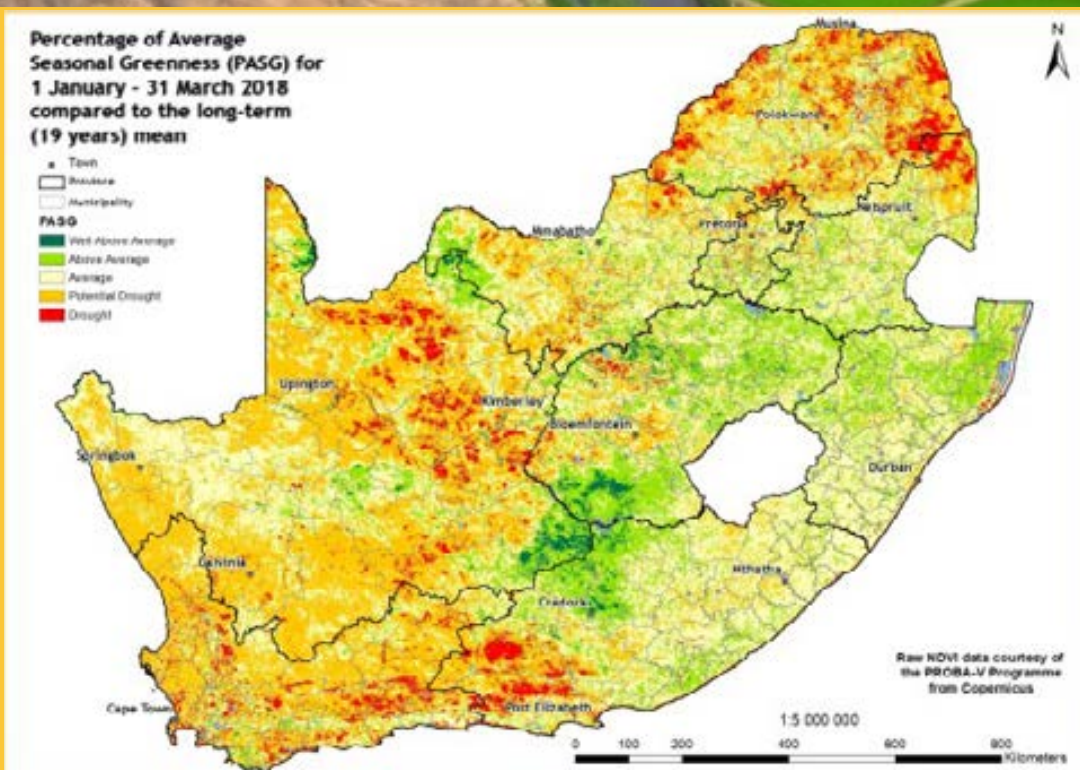


Figure 13

Figure 12:
The NDVI difference map for March indicates that above-normal vegetation activity occurred over much of the inland provinces compared to the long-term mean. Meanwhile, below-normal vegetation activity remains prevalent in isolated areas of Limpopo, Northern Cape, Western Cape, North West and the western region of the Eastern Cape.

Figure 13:
Most areas in Limpopo, the northeastern parts of Mpumalanga, and some isolated areas in the upper Northern and Western Cape continue to experience drought. However, some parts of the Eastern Cape, Free State, North West and KZN experienced high vegetation activity during March.

Questions/Comments:
MaakeR@arc.agric.za

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.

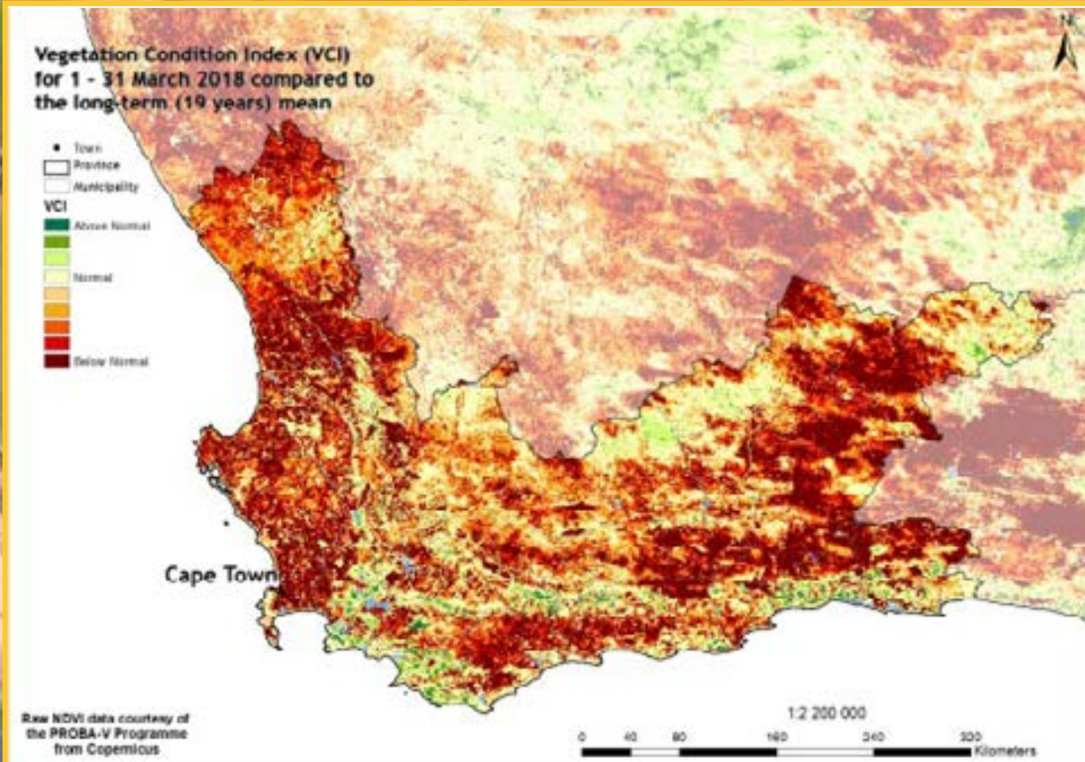


Figure 14

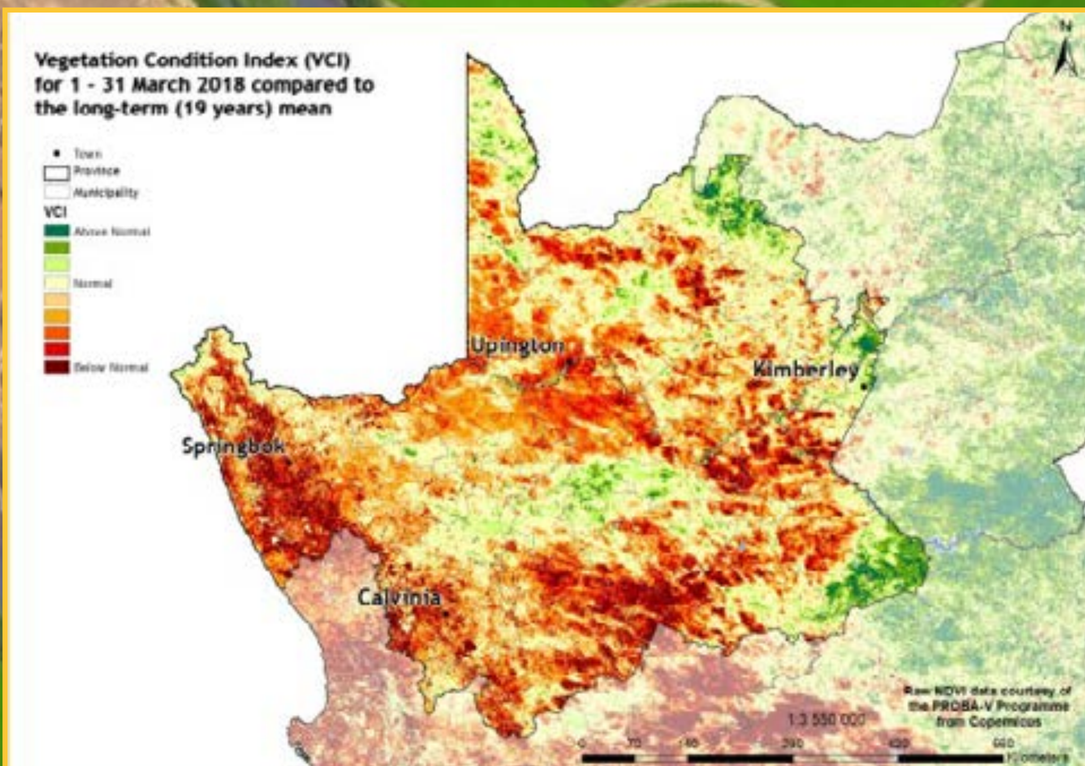


Figure 15

Figure 14:
Dry conditions remained prevalent over the majority of the Western Cape during March.

Figure 15:
Below-normal vegetation activity was observed over most of the Northern Cape during March.

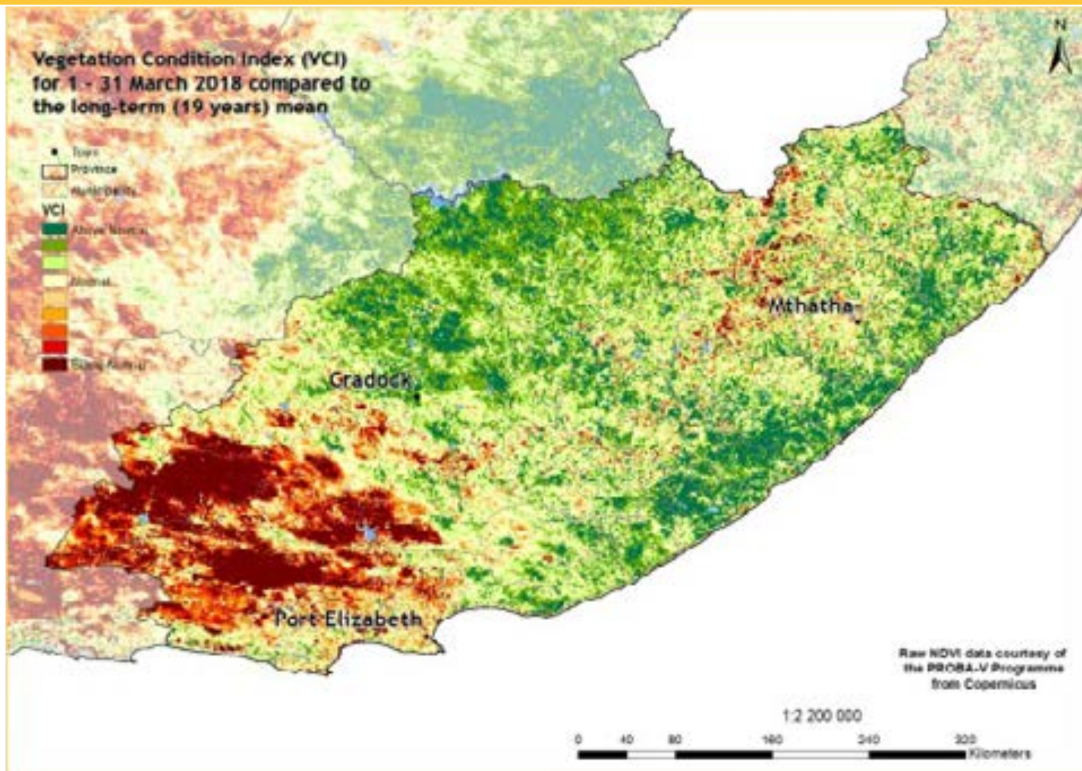


Figure 16

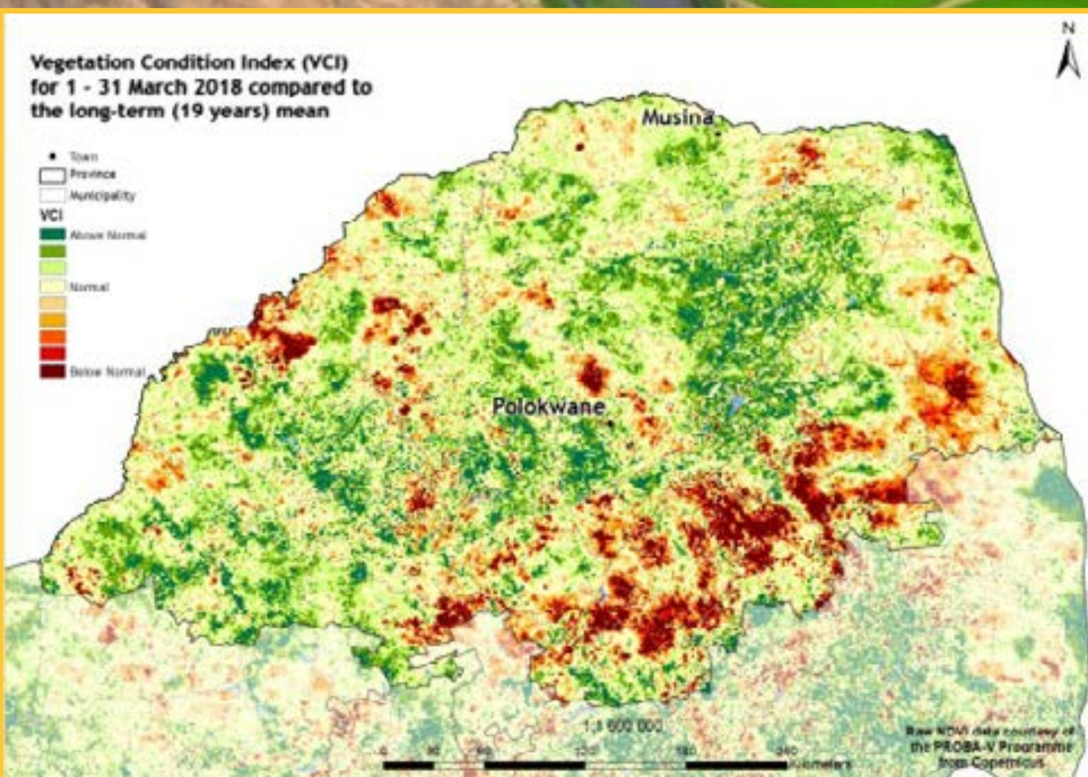


Figure 17

Figure 16:
The majority of the western region and distinct parts of the Wild Coast and Berg region of the Eastern Cape experienced below-normal vegetation activity during March.

Figure 17:
Vegetation activity was below-normal over most parts of Sekhukhune, southern Bohlabela and some isolated areas of the Waterberg region of Limpopo during March.

Questions/Comments:
MaakeR@arc.agric.za

6. Vegetation Conditions & Rainfall

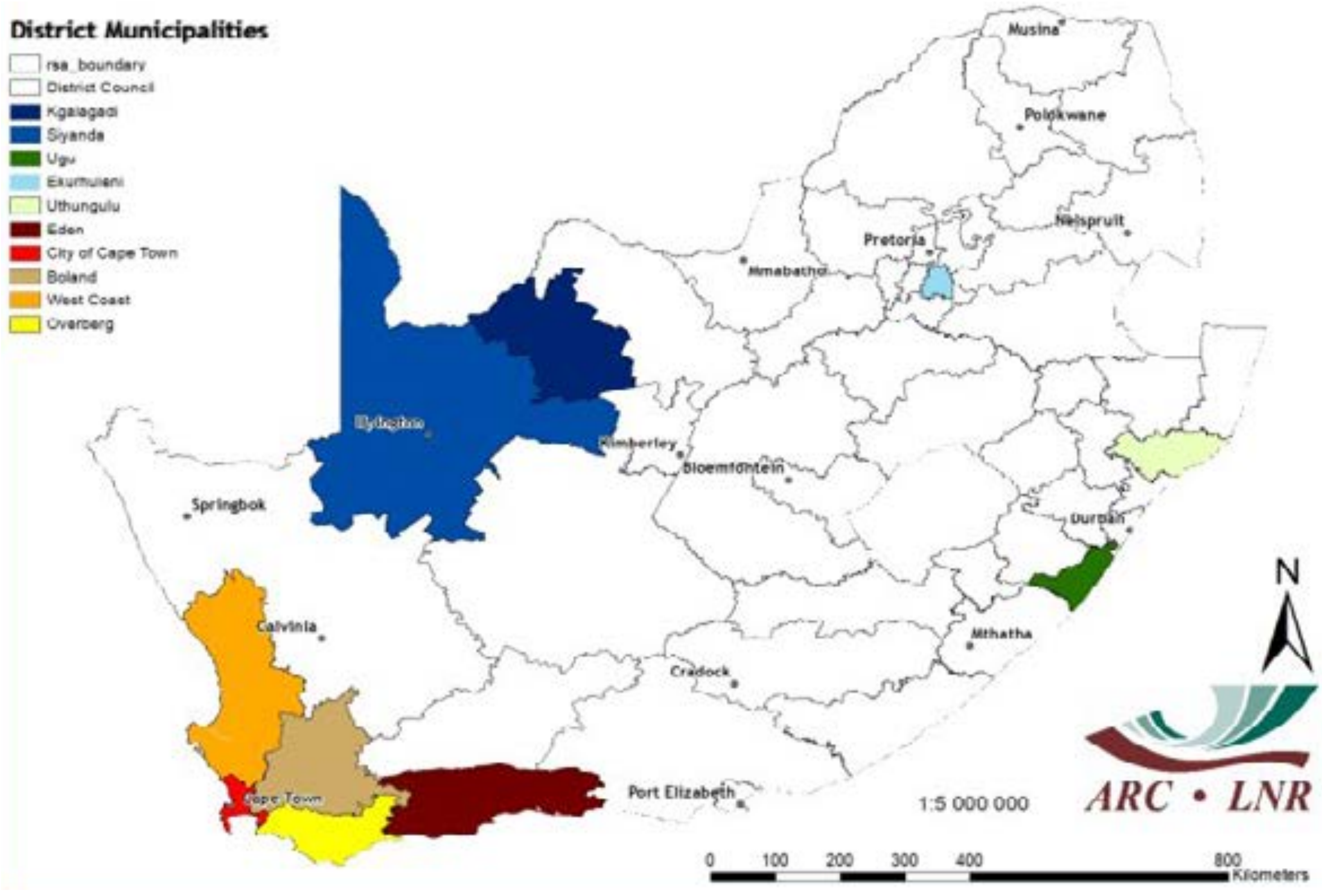


Figure 18

NDVI and Rainfall Graphs
Figure 18:
Orientation map showing the areas of interest for March 2018. The district colour matches the border of the corresponding graph.

Questions/Comments:
MaakeR@arc.agric.za / FergusonJ@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.

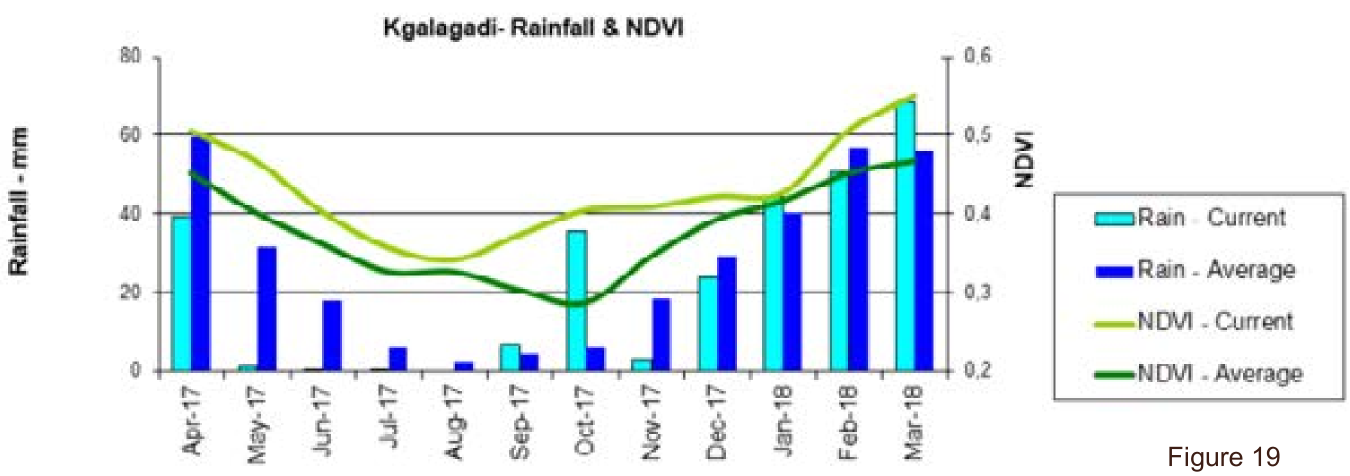
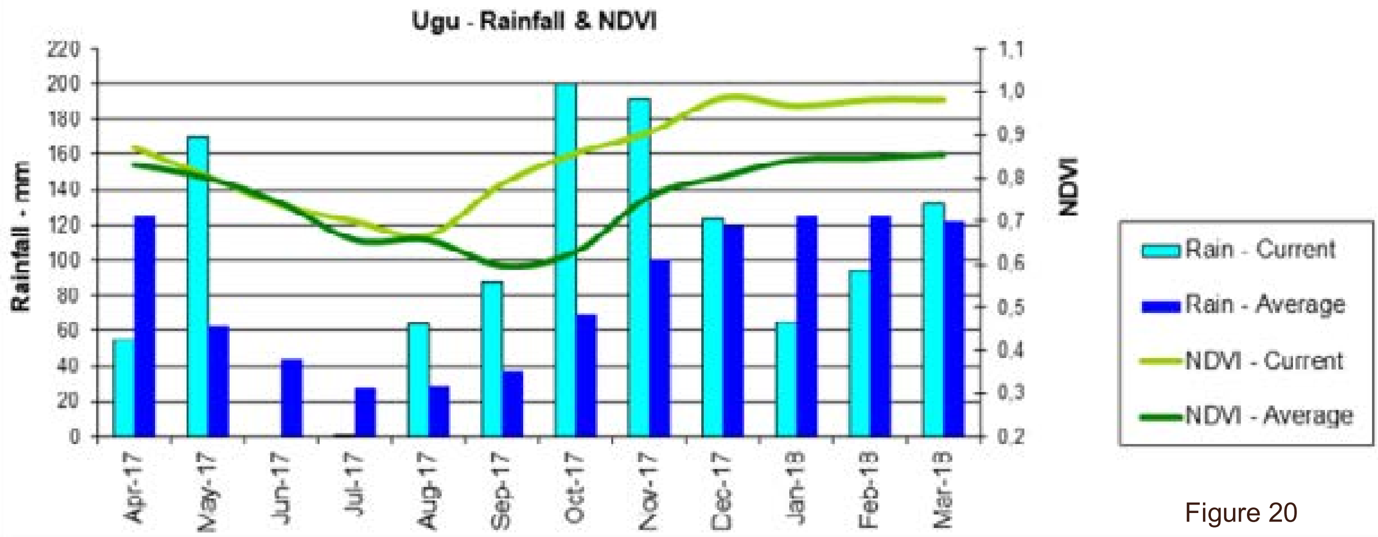


Figure 19



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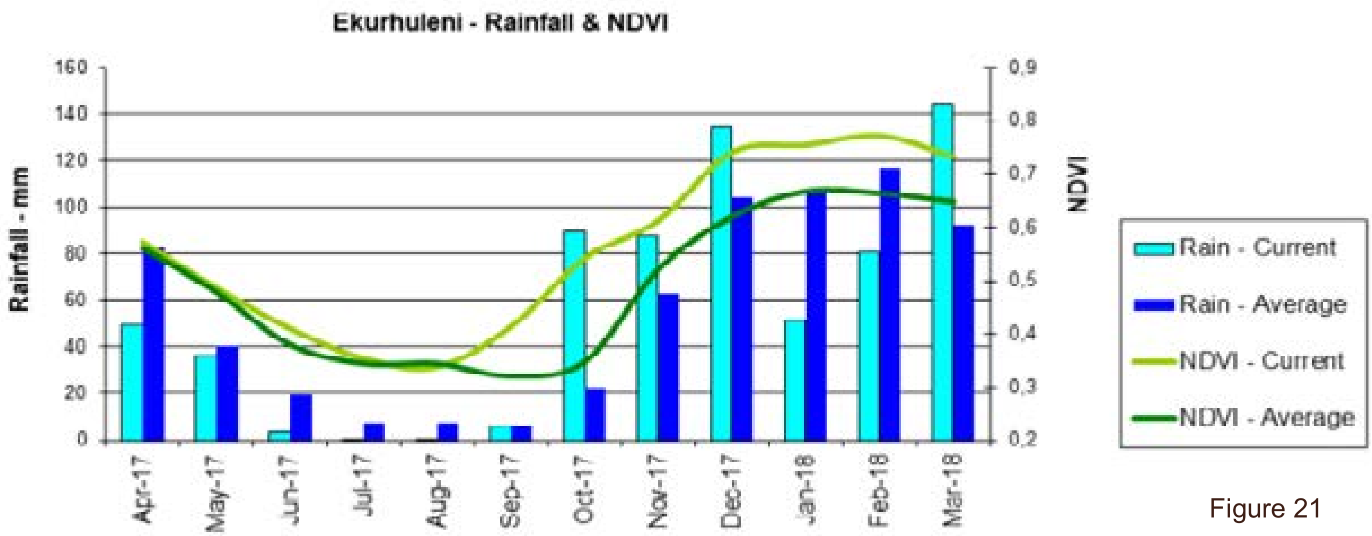

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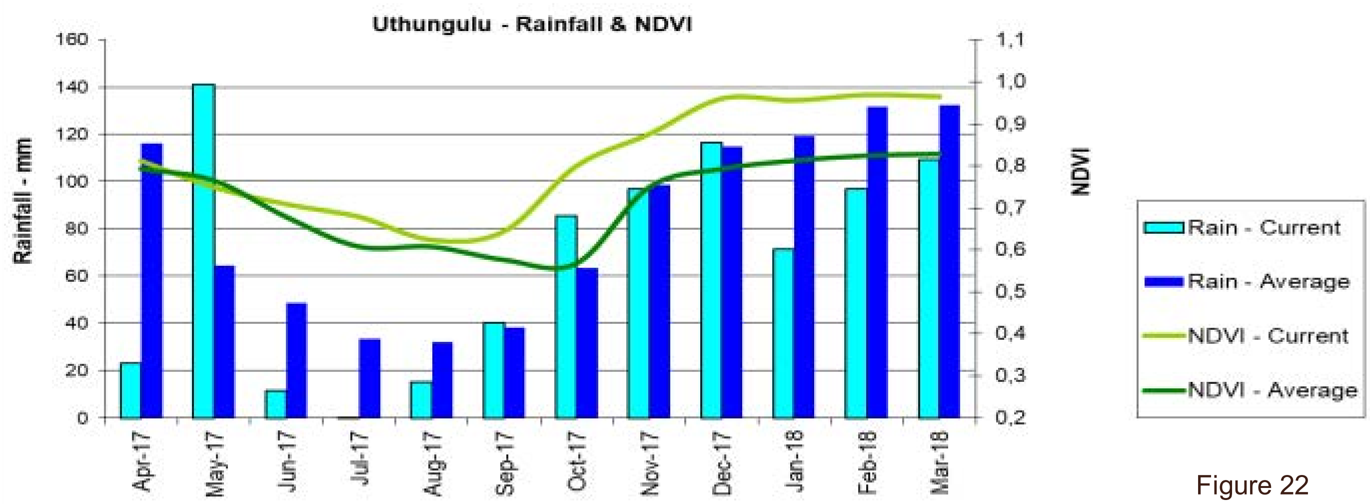

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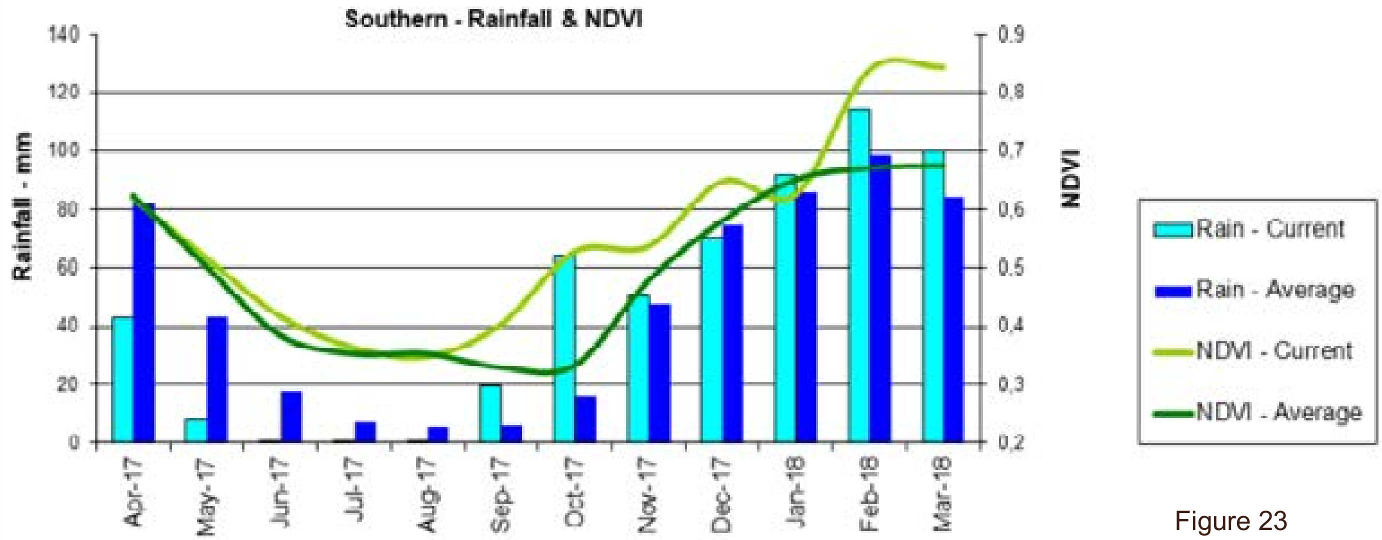

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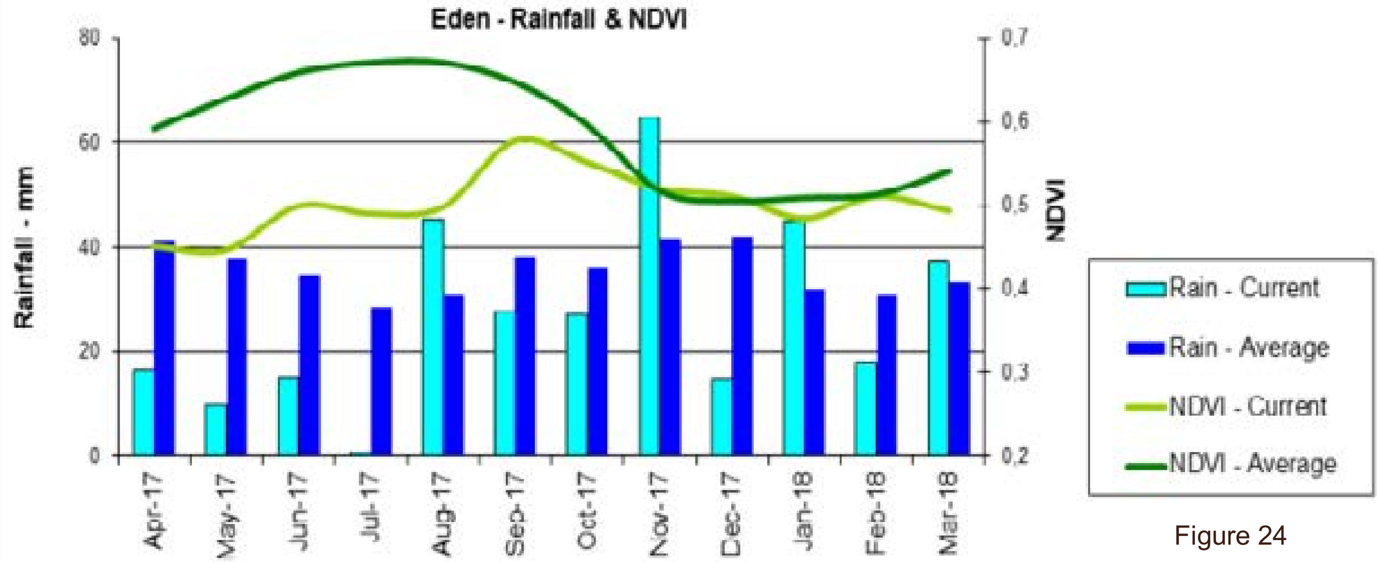

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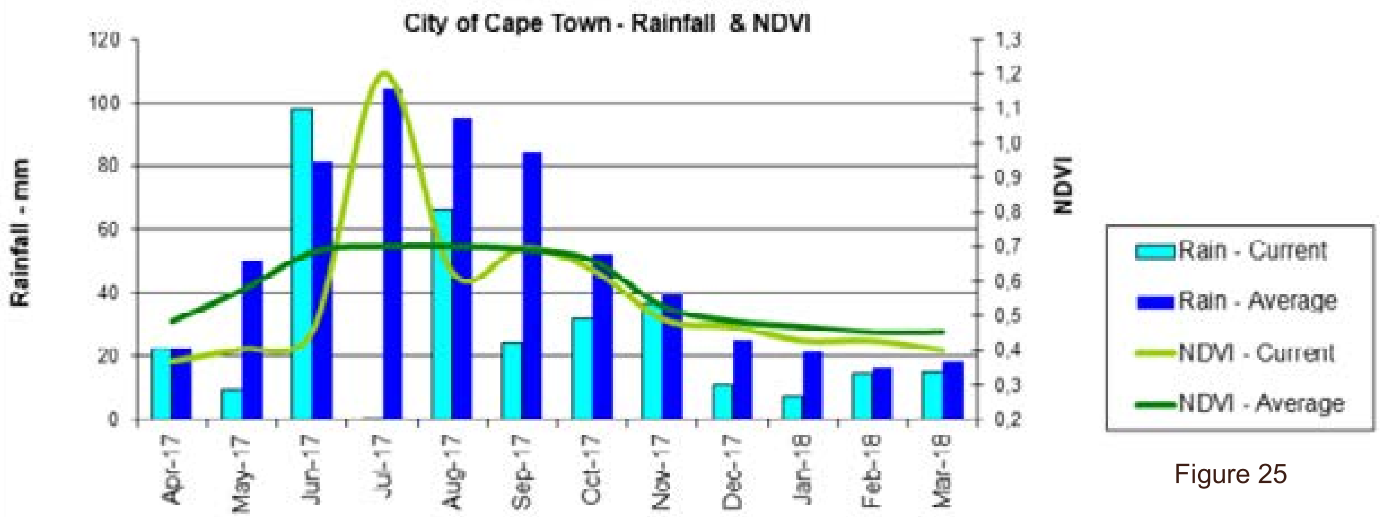


Figure 25

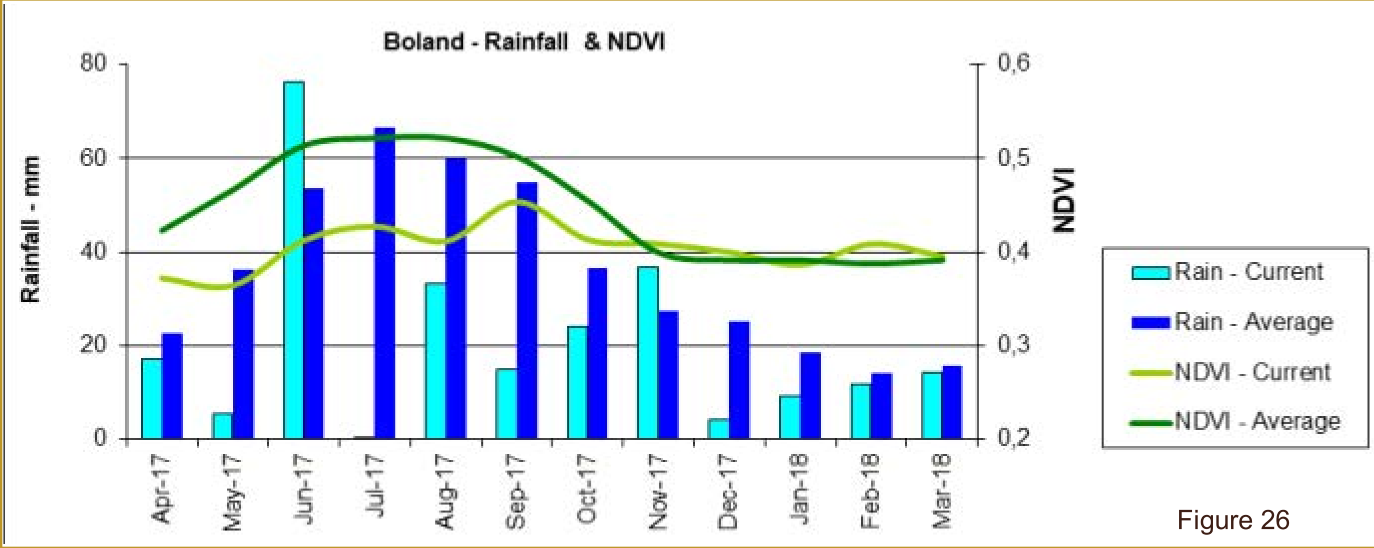


Figure 26

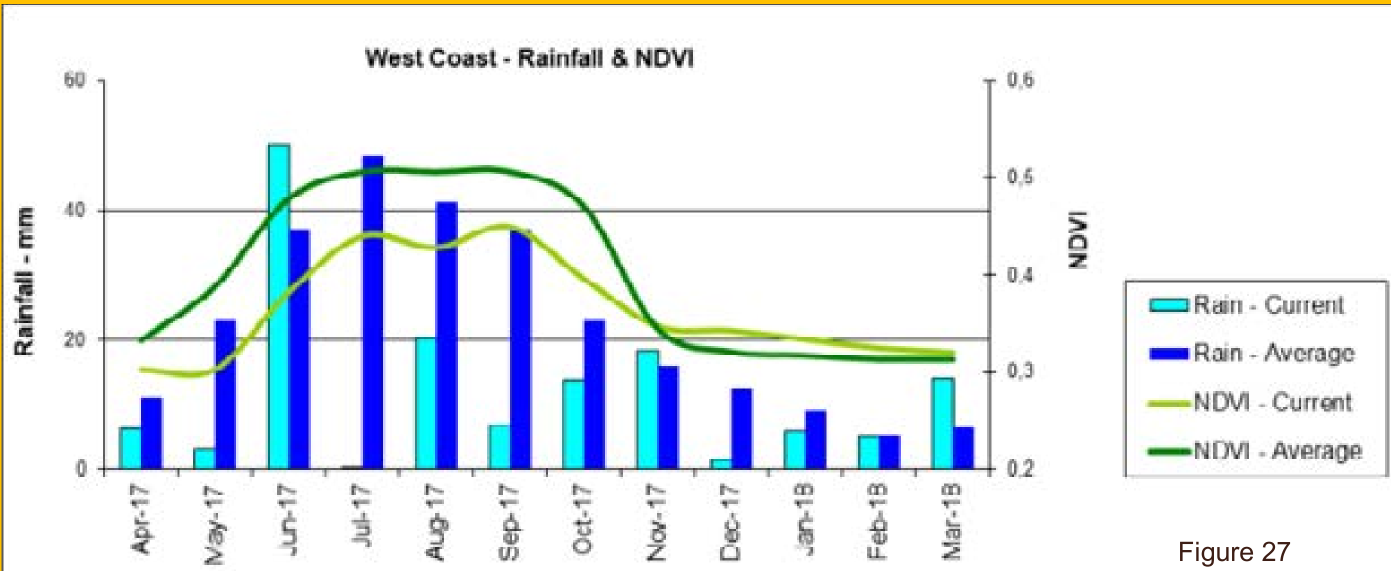


Figure 27

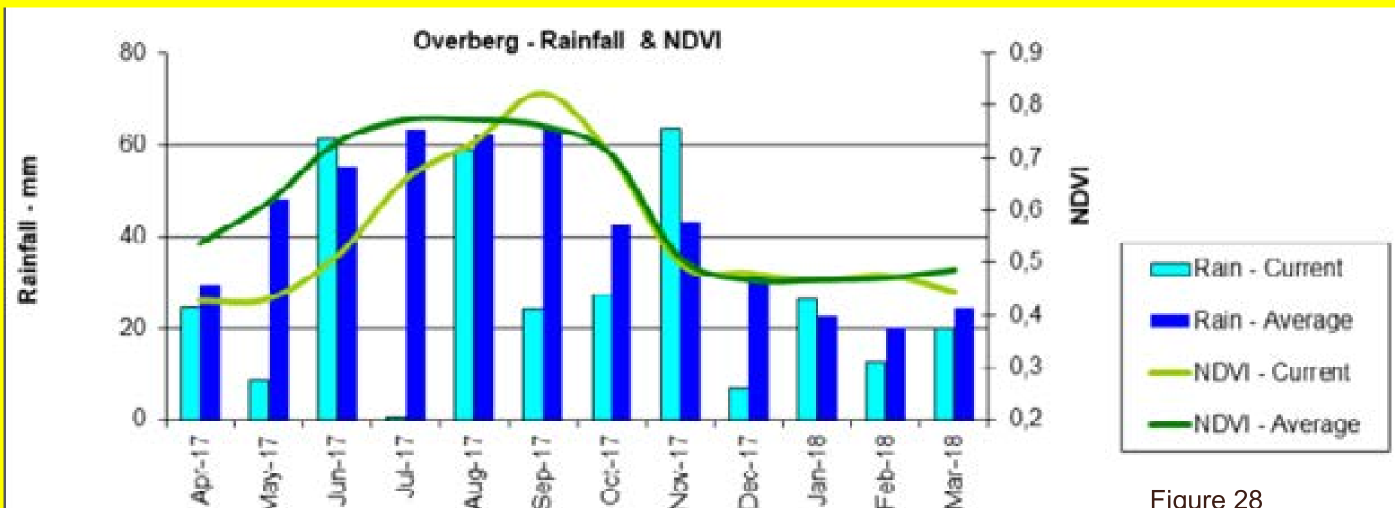


Figure 28

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 during the month of March per province. Fire activity was higher in the Western Cape compared to the average during the same period for the last 18 years.

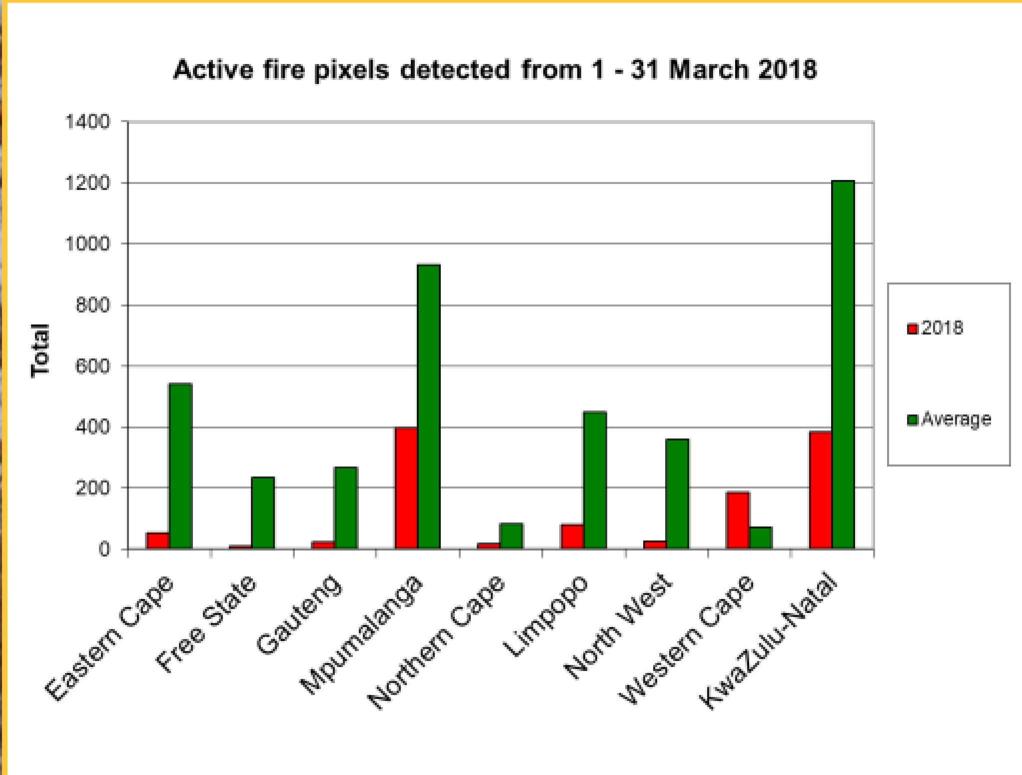


Figure 29

Figure 30:
The map shows the location of active fires detected between 1-31 March 2018.

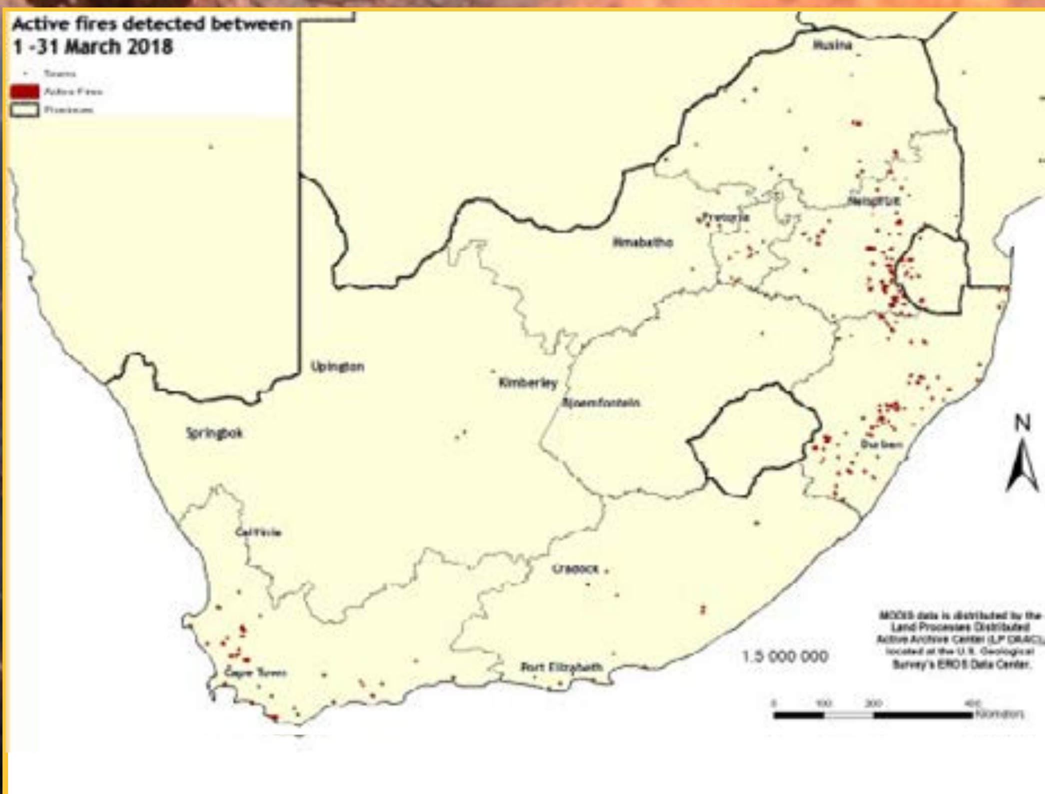


Figure 30

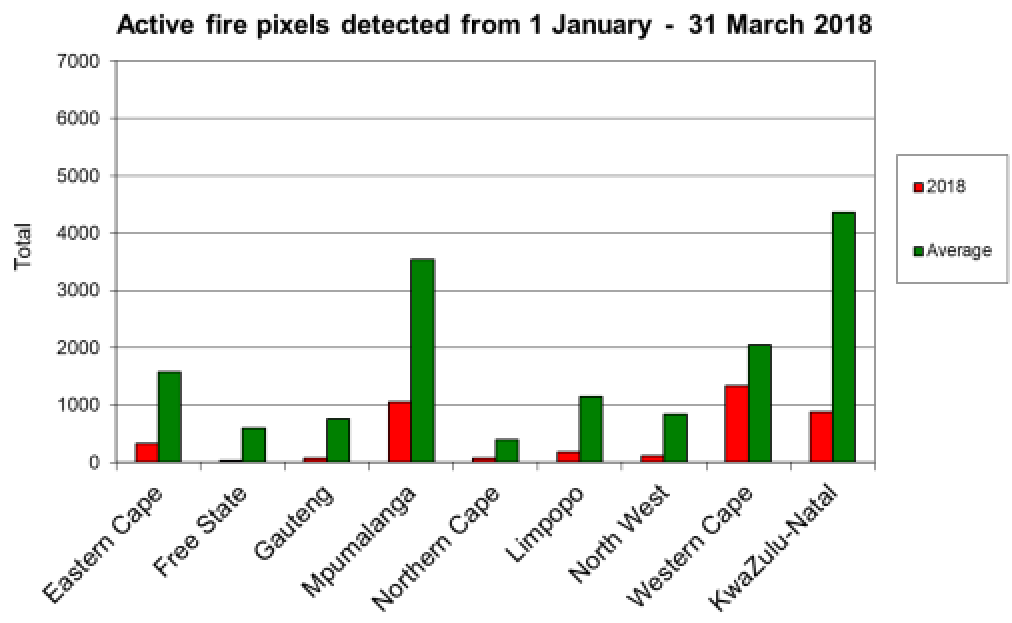


Figure 31

Figure 31:
The graph shows the total number of active fires detected from 1 January - 31 March per province. Fire activity was lower in all provinces compared to the average during the same period for the last 18 years.

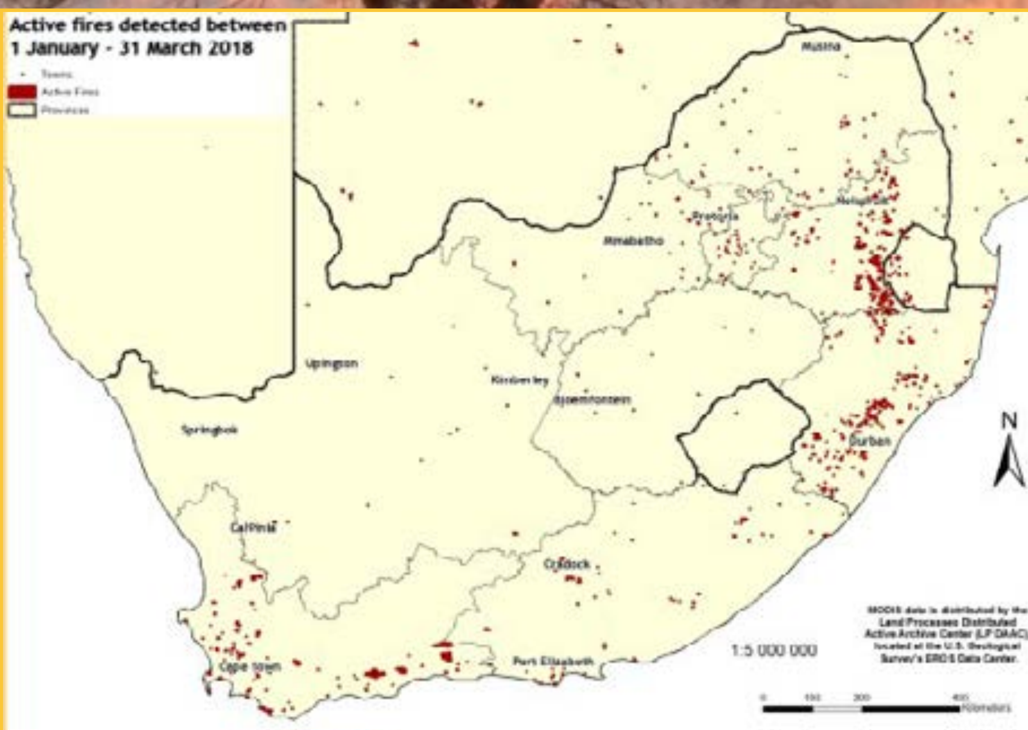
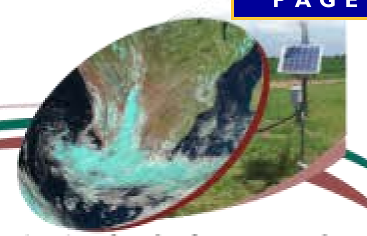


Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January - 31 March 2018.

Questions/Comments:
MaakeR@arc.agric.za

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

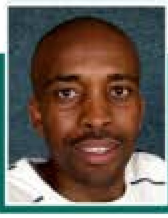
- Analysis of climate variability and climate model simulation
- Use of crop modelling to assess the impact of climate on agriculture
- Development of decision support tools for farmers

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

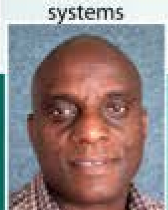
- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

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

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For further information please contact the following:
Adolph Nyamugama – 012 310 2582, NyamugamaA@arc.agric.za
Adri Laas – 012 310 2518, AdriL@arc.agric.za

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

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