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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

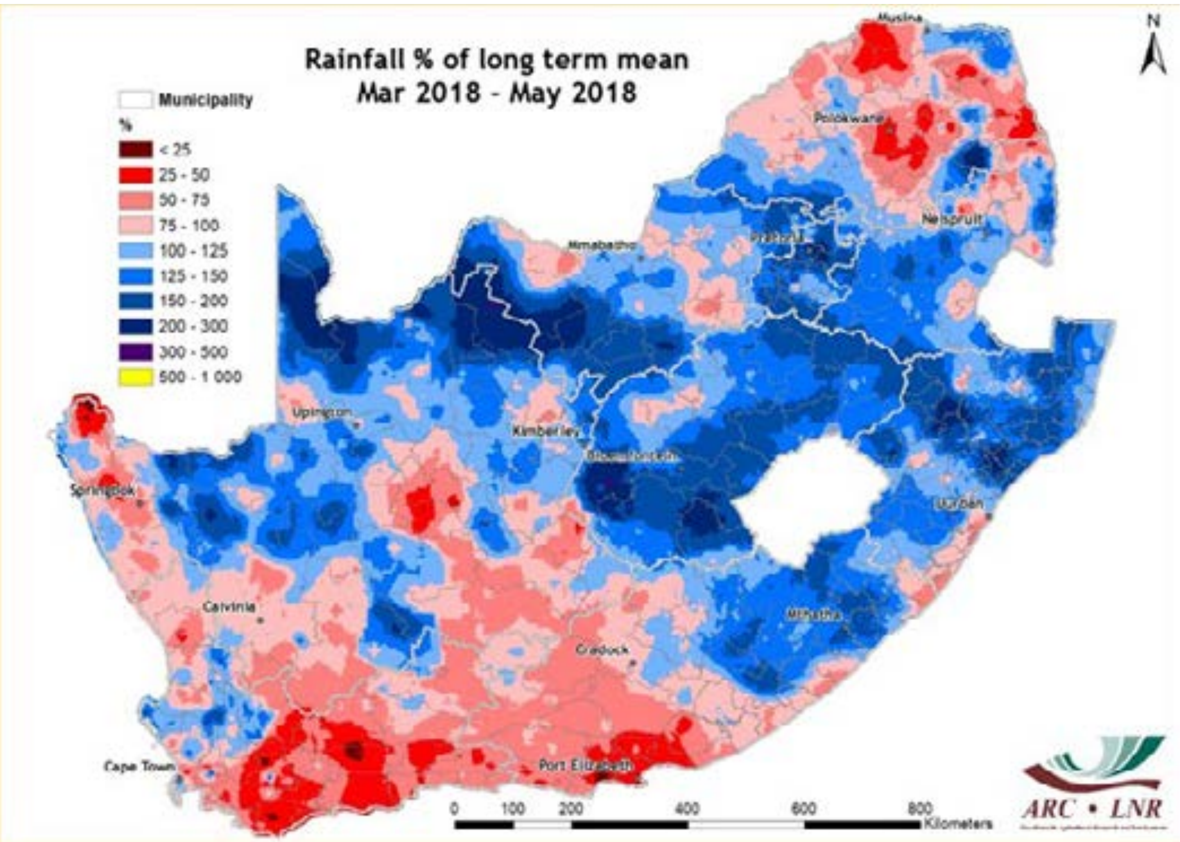
AMESD

168th Edition

Image of the Month

Drought prevailing over the southern parts of South Africa

The dire water situation over the southwestern parts of the country made worldwide headlines this year, with the focus on Cape Town and whether this would be the first major city to run out of water. The main hope to avoid such a situation was for good rainfall to replenish the water storage during the winter rainfall season. Frontal systems started to make landfall in mid-April and since then, near- to above-normal rainfall has occurred in some places over the far southwestern parts of the country. Thankfully, the immediate threat of running out of water was avoided. However, further to the east along the coast and adjacent interior towards the Port Elizabeth area, severe drought conditions are still present. Usually, this southern coastal strip receives rainfall throughout the year, peaking during autumn and spring. However, this already drought stricken area received below-normal rainfall in the autumn of 2018, with far below-normal rainfall over key areas such as the water catchment of the Kouga Dam (see map below). Apart from below-normal rainfall, bergwind-like conditions have occurred ahead of the frontal systems that brought the welcome rain to the far southwestern parts of the country, with maximum temperatures in the mid-thirties which enhanced evaporation from the already stressed vegetation.



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:

The movement of cold fronts over the southwestern parts of the country that commenced in mid-April continued during May 2018. This resulted in above-normal rainfall over the far southwestern parts and subsequent runoff into the dams over those areas, although much more rain is still needed over the Western Cape. Further to the east along the Cape south coast, yet another month of below-normal rainfall occurred. Even though frontal systems made landfall over the far southwestern parts of the country, and even moved far inland on a few occasions, the low-level flow in the wake of the frontal systems did not cause sufficient onshore flow along the southern coastal belt. One of the frontal systems that moved in over the country occurred during the first week of May. By the 3rd this cold front was situated just east of the country, where the low pressure system in which the front was embedded remained until the 6th. During this time, cloud-free conditions set in over the interior as a prominent surface high developed, creating favourable conditions for the occurrence of frost. The second frontal system of the month (much weaker than the previous one) neared the country on the 7th and quickly slipped southeastwards. The remainder of the second week of May was characterized by a series of frontal systems that swept eastwards, without any significant rainfall over the southwestern and southern parts of the country.

The weather systems responsible for the above-normal rainfall over large parts of the interior, in particular over the western to central interior as well as over the northern parts of KwaZulu-Natal, occurred between 14-20 May. During this period, a cut-off low developed over the central parts of the country and resulted in good rainfall over a 3-day period with extreme rainfall over KwaZulu-Natal on the 17th as the cut-off low exited the country. By the 18th, another cut-off low developed, this time just off the west coast and resulted in the above-normal rainfall experienced over the western interior. During the last third of the month, the regular eastward movement of a series of frontal systems returned to the country, although mostly confined to the southwestern parts. It is during this period that the largest contribution to the above-normal rainfall in that area occurred. One of these frontal systems moved far inland, resulting in minimum temperatures below zero over parts of the interior.

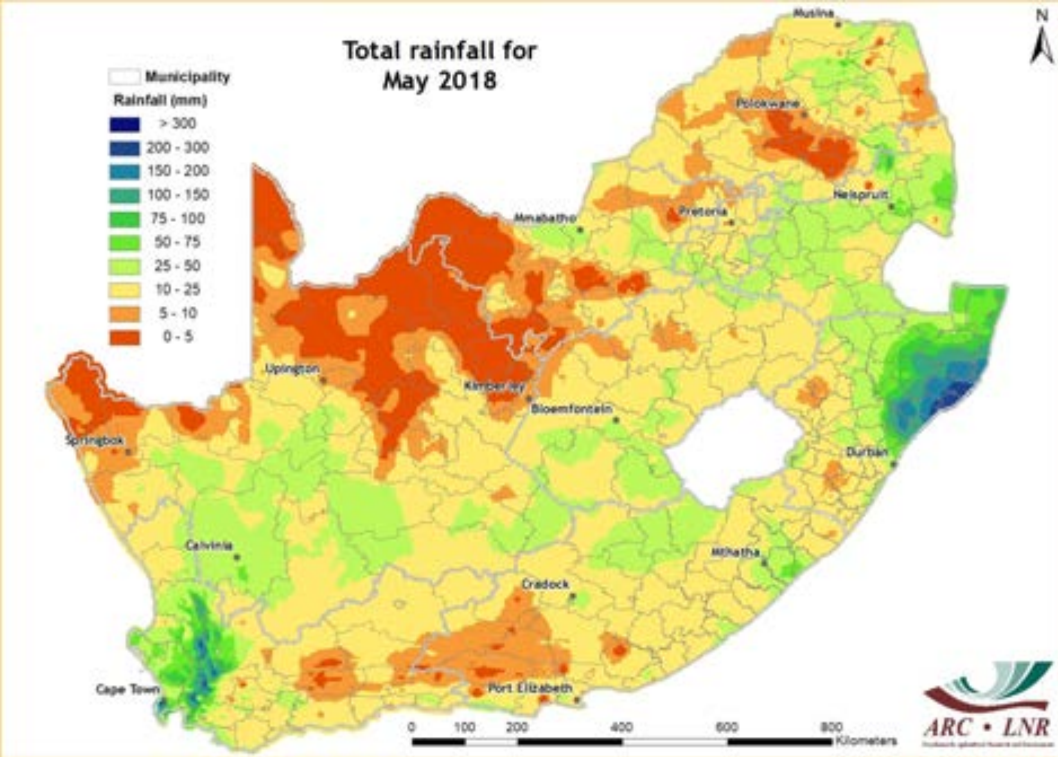
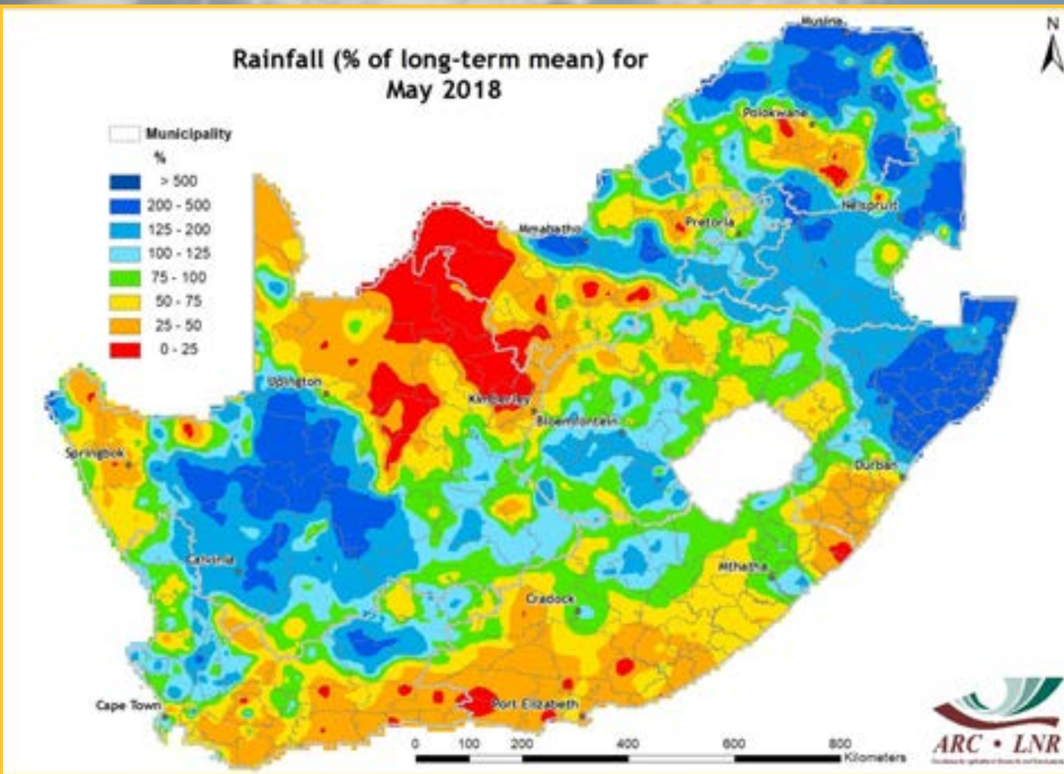


Figure 1



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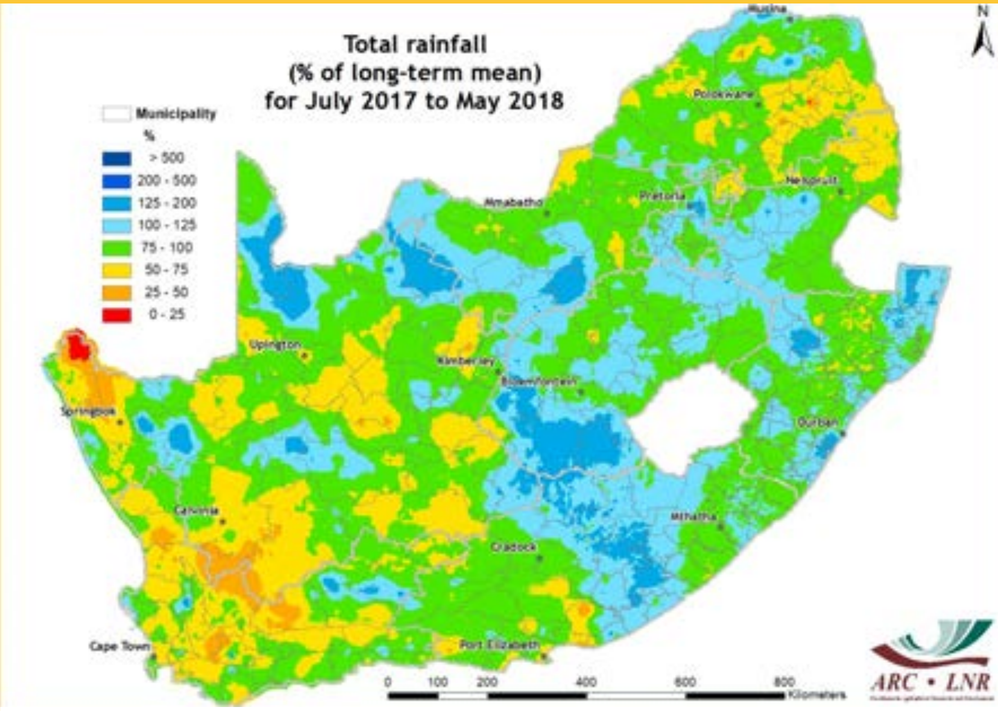

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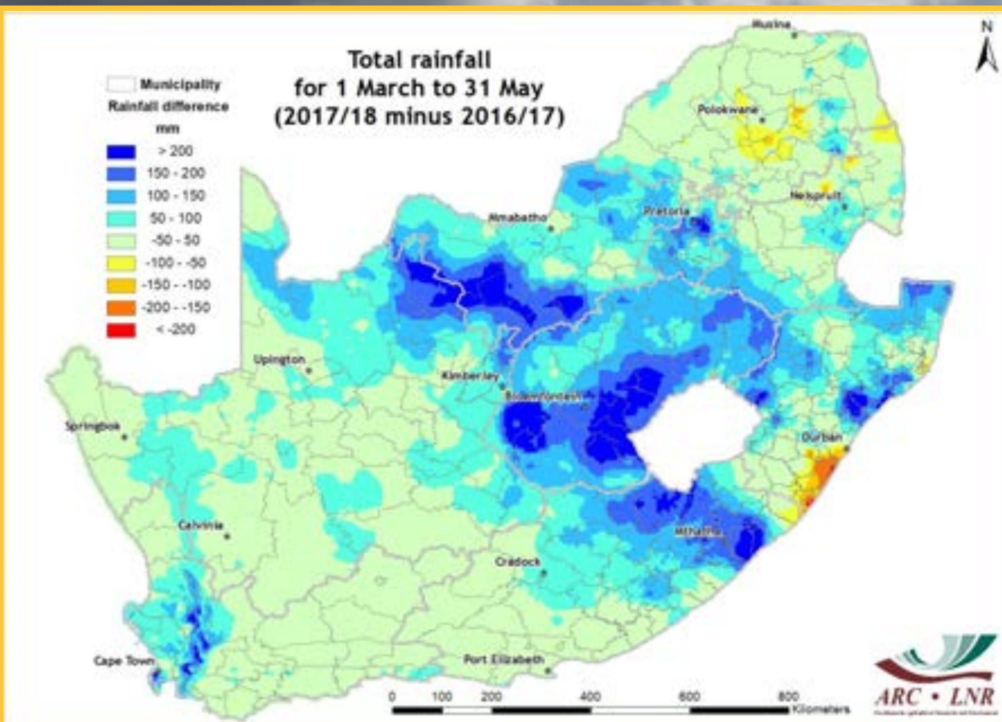

Figure 4

Figure 1:
Very good rainfall, exceeding 200 mm in places, occurred over the northern KwaZulu-Natal coast and adjacent interior during mid-May as the result of a cut-off low pressure system. Good rainfall totals, up to 50 mm, also occurred over the summer rainfall region during the month of May. The southwestern parts of the country received follow-up rain after last month's rainfall as frontal systems made landfall during the first and last third of the month.

Figure 2:
Above-normal rainfall occurred over large parts of the summer rainfall region, mostly caused by two cut-off low pressure systems. Over the winter rainfall region, above-normal rainfall occurred over important water catchment areas. However, this was confined to the far southwestern parts, with below-normal rainfall over the southern parts of the Western Cape extending eastwards along the Cape south coast and adjacent interior. This rainfall pattern is indicative of a lack of ridging behind the frontal systems that made landfall.

Figure 3:
From the winter of 2017 to the end of May 2018, near-normal rainfall occurred over large parts of the summer rainfall region with above-normal rainfall organized in a relatively narrow band over the central to southeastern parts of the country. Over the all-year rainfall region, below- to near-normal rainfall occurred during this period, even though these areas are currently experiencing drought conditions. Over the winter rainfall region, below-normal rainfall mostly occurred during this period. The influence of better rainfall experienced over the past 2 months is visible over some parts of the winter rainfall region.

Figure 4:
Compared to the corresponding period during 2017, improved rainfall conditions occurred during 2018 over the far southwestern parts of the country, as well as over the central to southeastern parts. Over some areas, the 2018 period received over 200 mm more rain than the corresponding 2017 period.

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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.

At the 36-month time scale, drought conditions occurred over many parts of the country, but particularly over the southwestern and eastern parts where severe to extreme drought conditions are visible. Relief from the severe drought conditions occurred over the central to southeastern parts of the country on the 24-month time scale. At the same time, the severe drought conditions over the southwestern parts extended eastwards along the Cape south coast region. At the 12-month time scale, drought conditions deteriorated slightly over the northeastern parts of the country compared to the 24-month time scale. The 6-month SPI indicates mildly to moderately wet conditions over the central to southeastern parts. An improvement from the drought conditions over the far western parts is also visible on the 6-month time scale, whilst drought conditions over the Cape south coast region experienced no improvement.

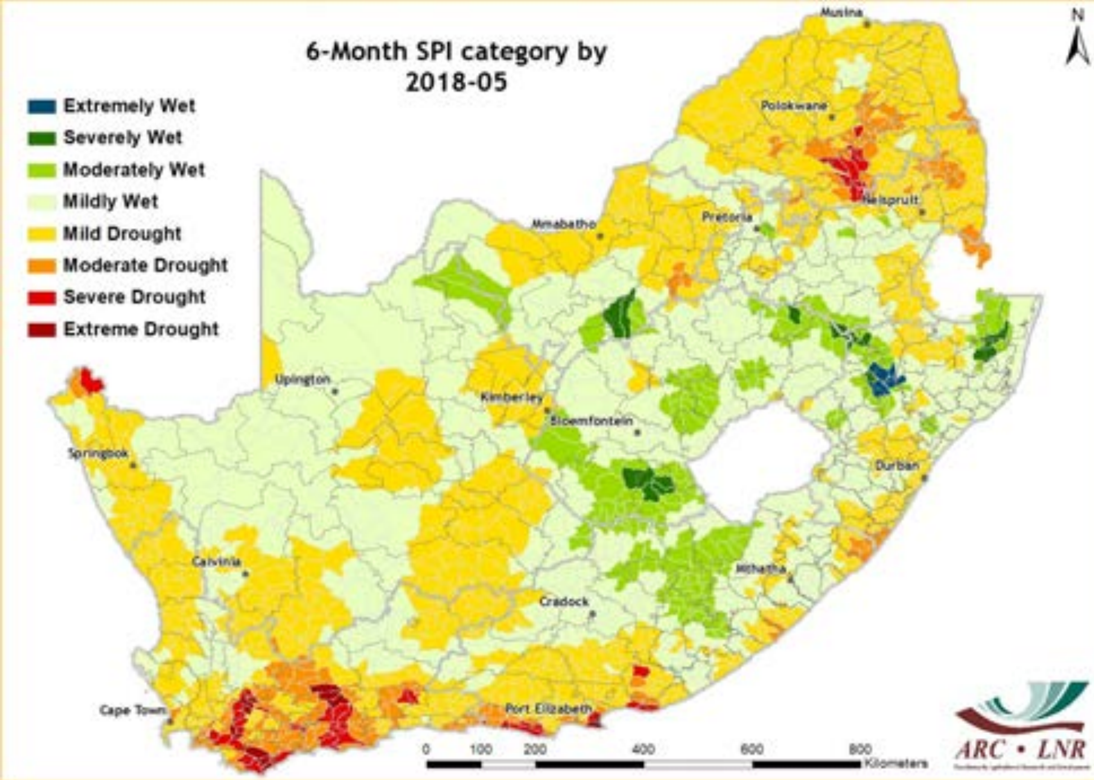
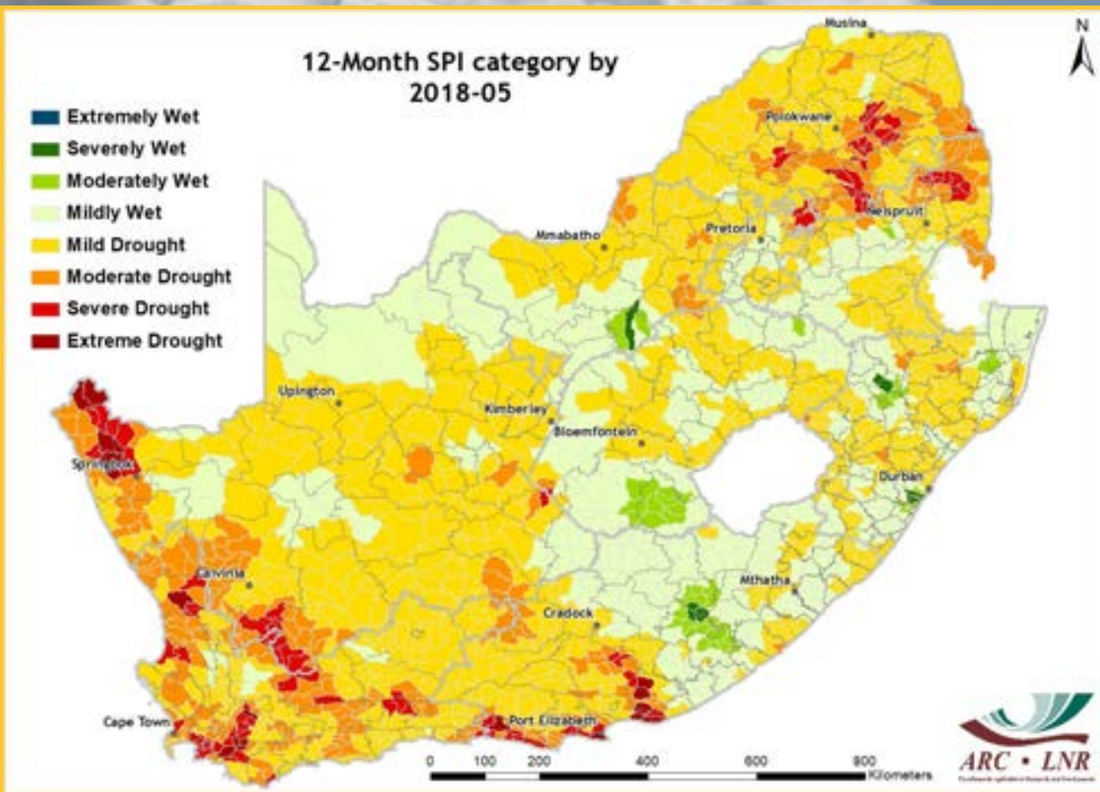


Figure 5



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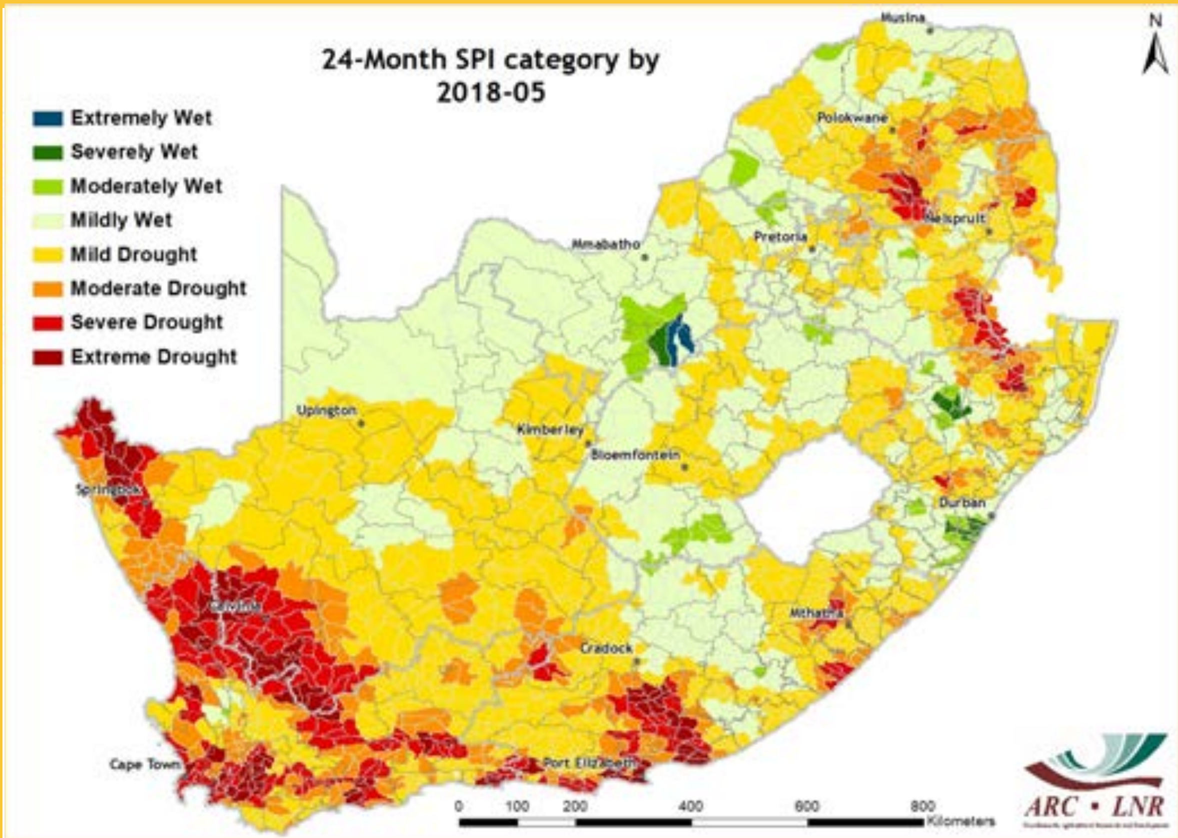

Figure 7

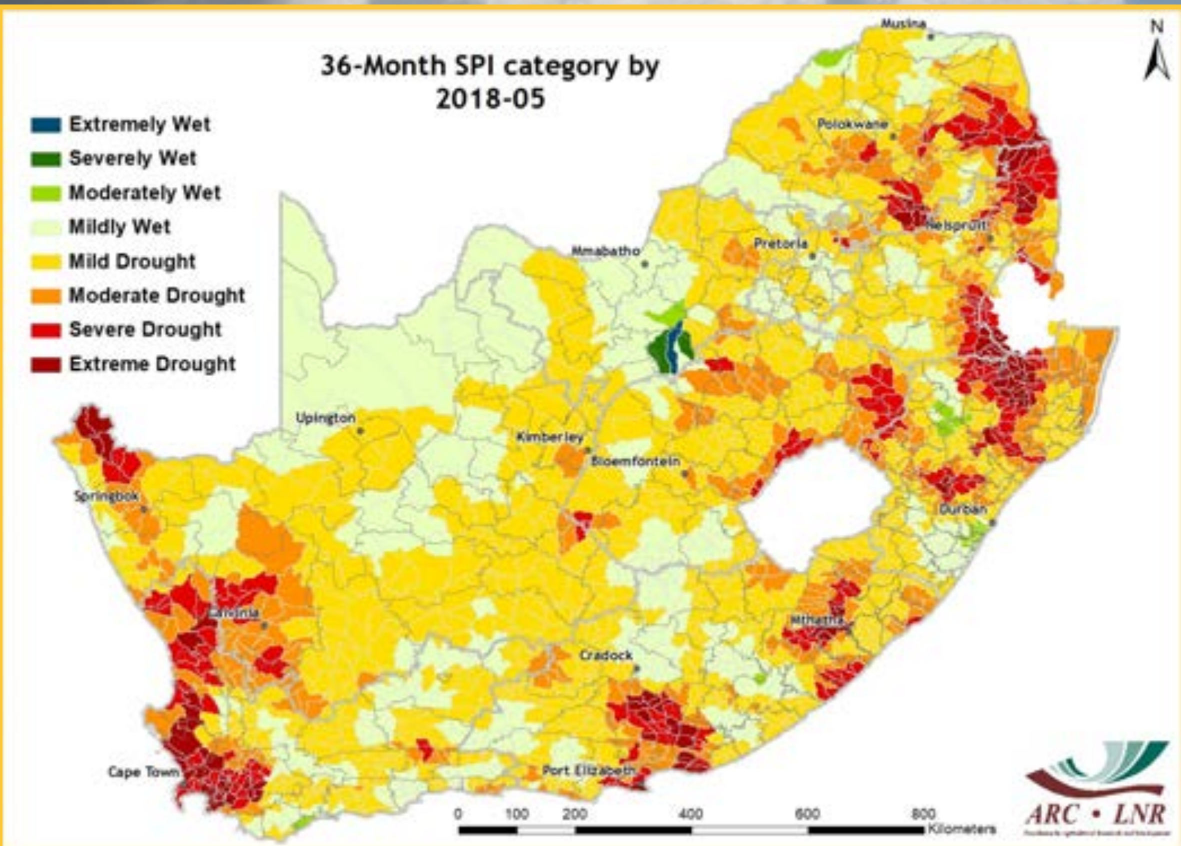

Figure 8

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.

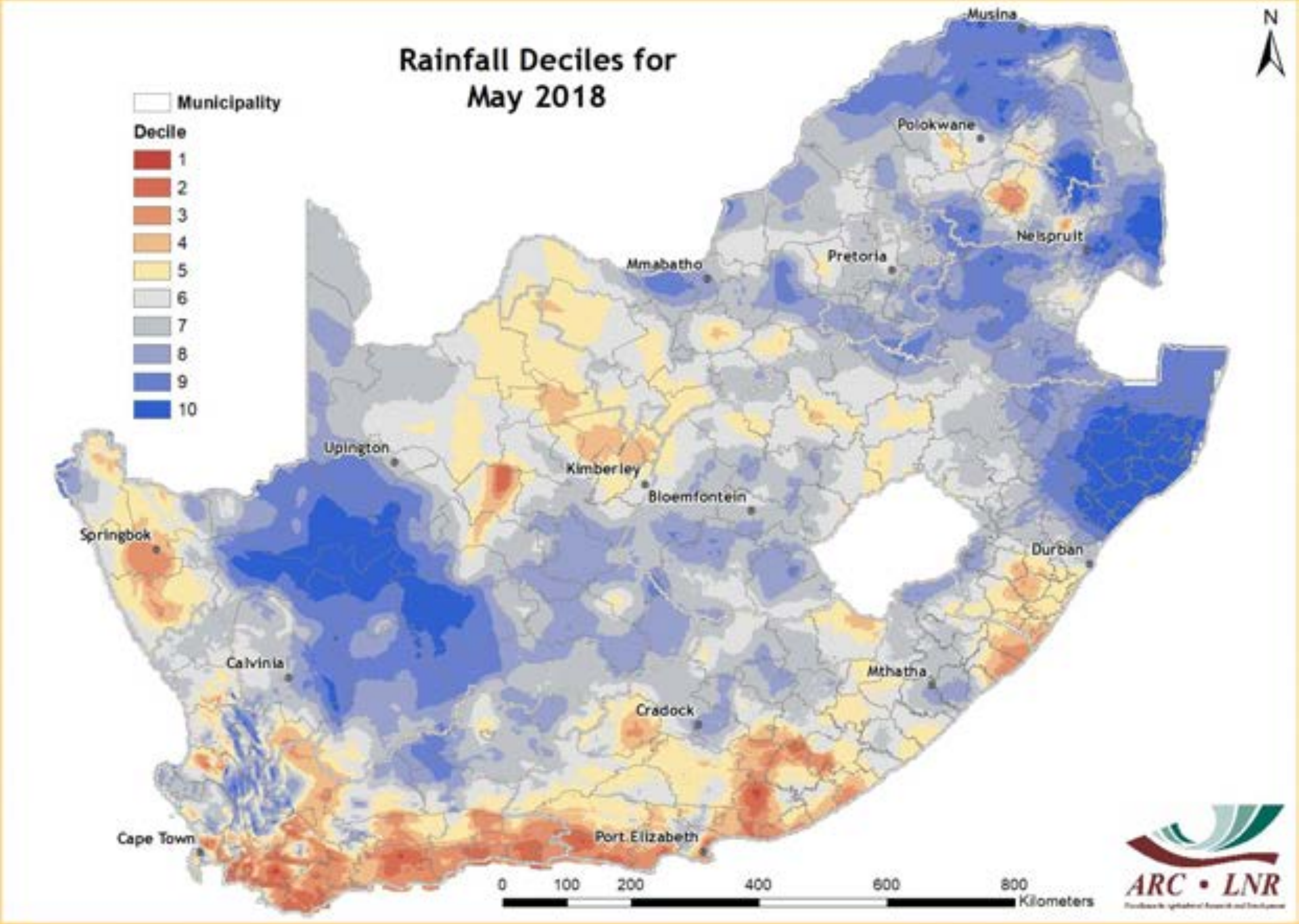

Figure 9

Figure 9:
Rainfall totals over the Cape south coast and adjacent interior during May 2018 fall within the drier May months compared to historical rainfall totals. Most of the remainder of the country, including the far southwestern parts of the country, experienced a wet month compared to historical May rainfall totals.

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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.

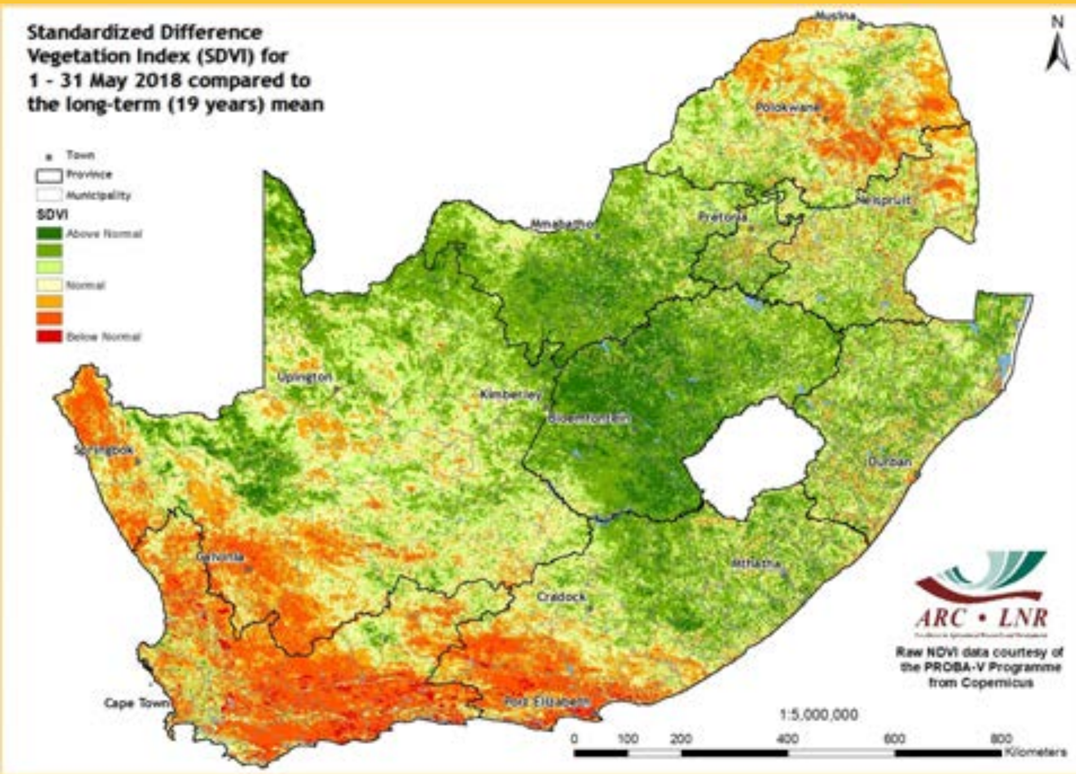
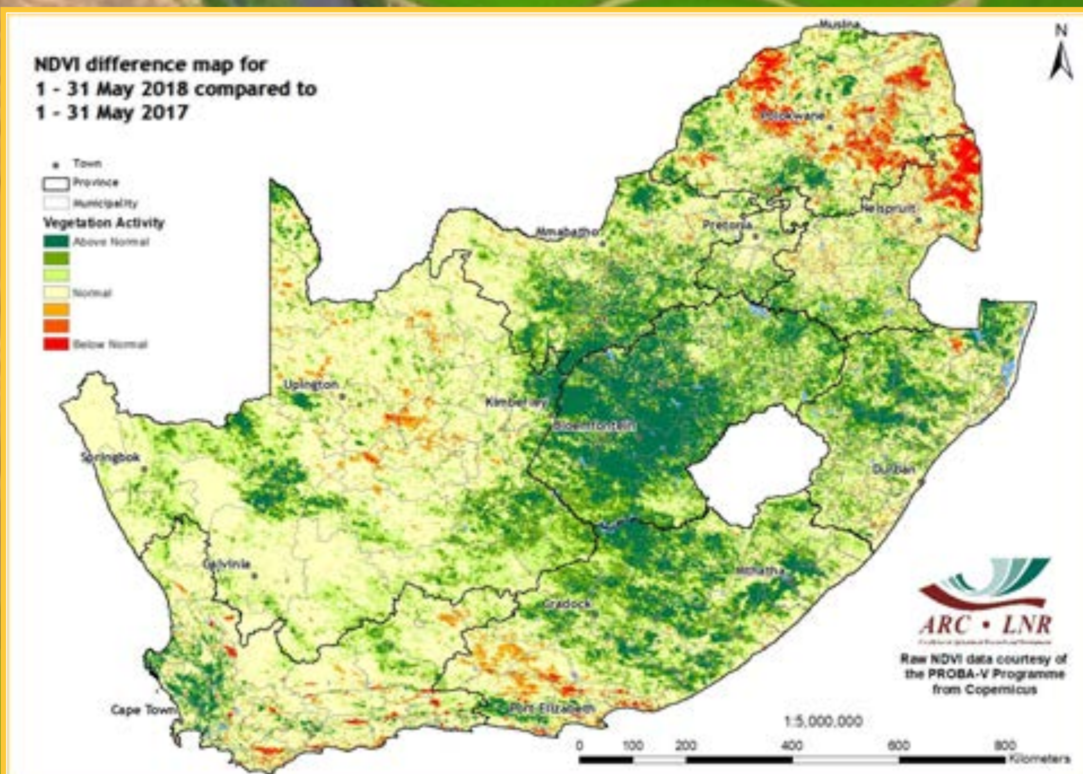


Figure 10

Figure 10:
The interior of the country continued to experience above-normal vegetation activity in May, while the state of vegetation remains poor in the Western Cape, southwestern Eastern Cape and some distinct areas in Limpopo, Northern Cape and Mpumalanga, compared to the long-term mean.

Figure 11:
Above-normal vegetation activity remains over much of the Free State, North West, isolated areas in the Eastern Cape, Limpopo, Gauteng, KZN and Mpumalanga in May 2018 compared to the same month last year. However, pockets of below-normal vegetation activity remain in some distinct parts of Limpopo, Mpumalanga, Western and Eastern Cape compared to May 2017.



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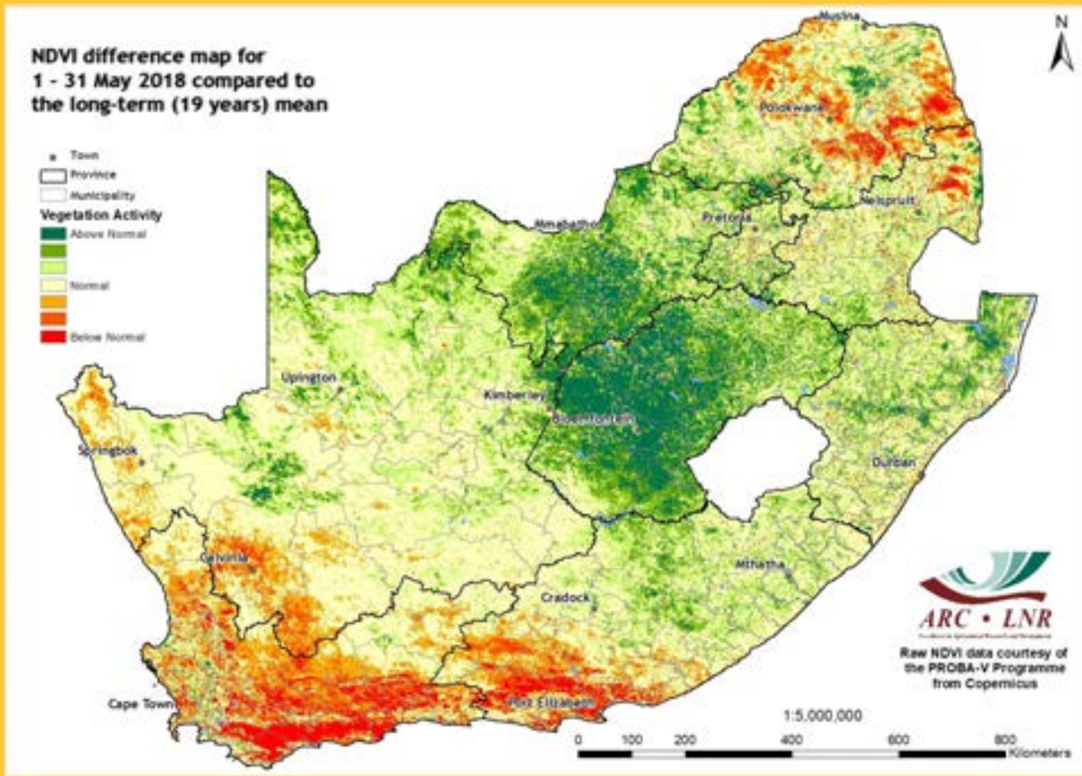

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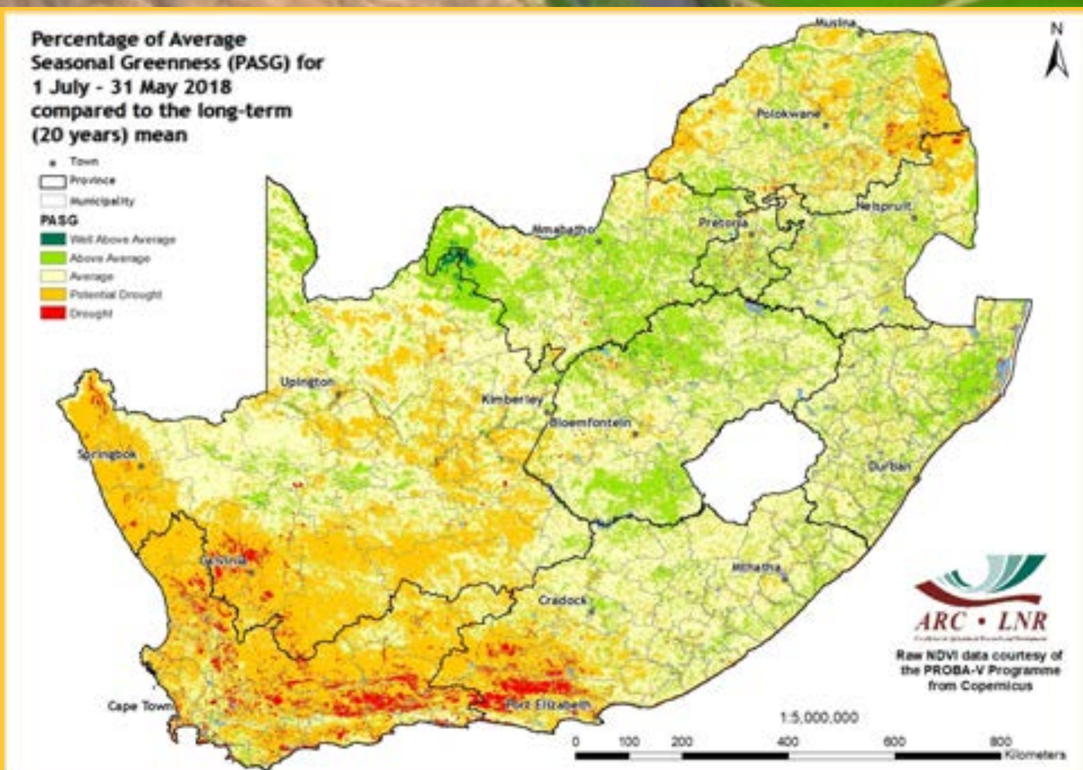

Figure 13

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 12:
The majority of the Free State and North West experienced above-normal vegetation activity in May. Meanwhile, an extreme decrease in vegetation activity can be observed over much of the Western Cape and southern Eastern Cape, as well as over some isolated areas in Limpopo, Northern Cape and Mpumalanga compared to the long-term mean.

Figure 13:
Cumulative vegetation activity remains stressed over much of the southwestern parts of the country. Distinct isolated areas in the country's interior experienced above-average cumulative vegetation activity.

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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.

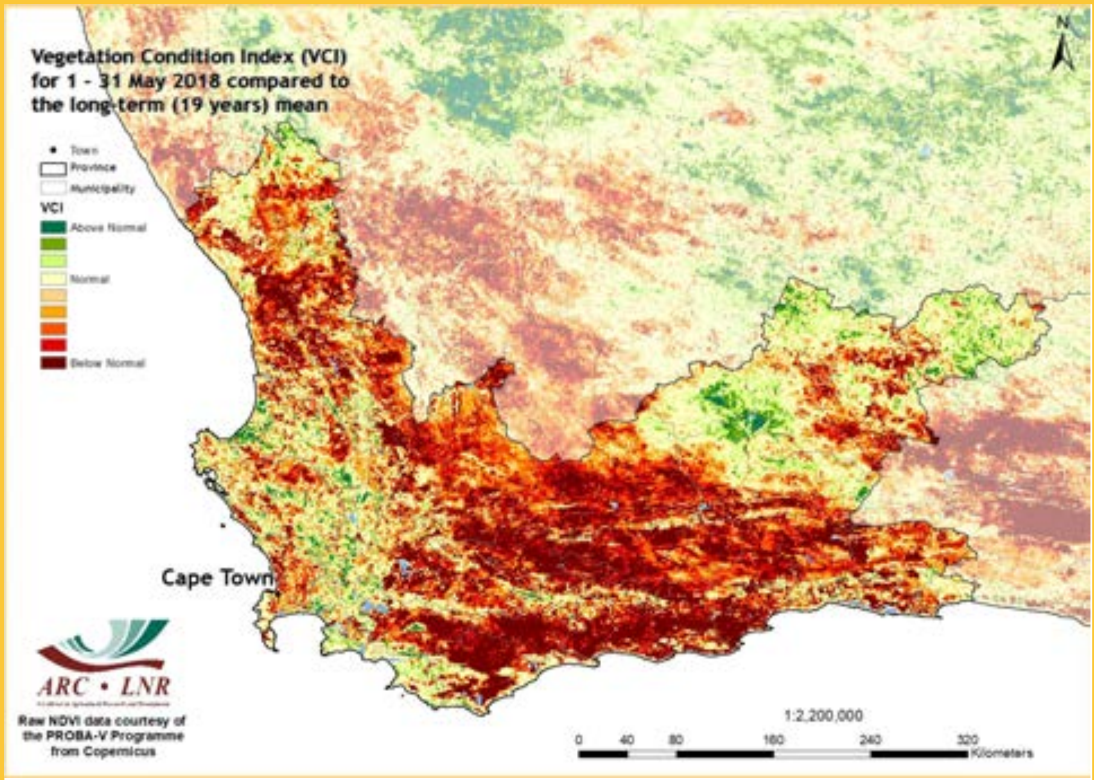
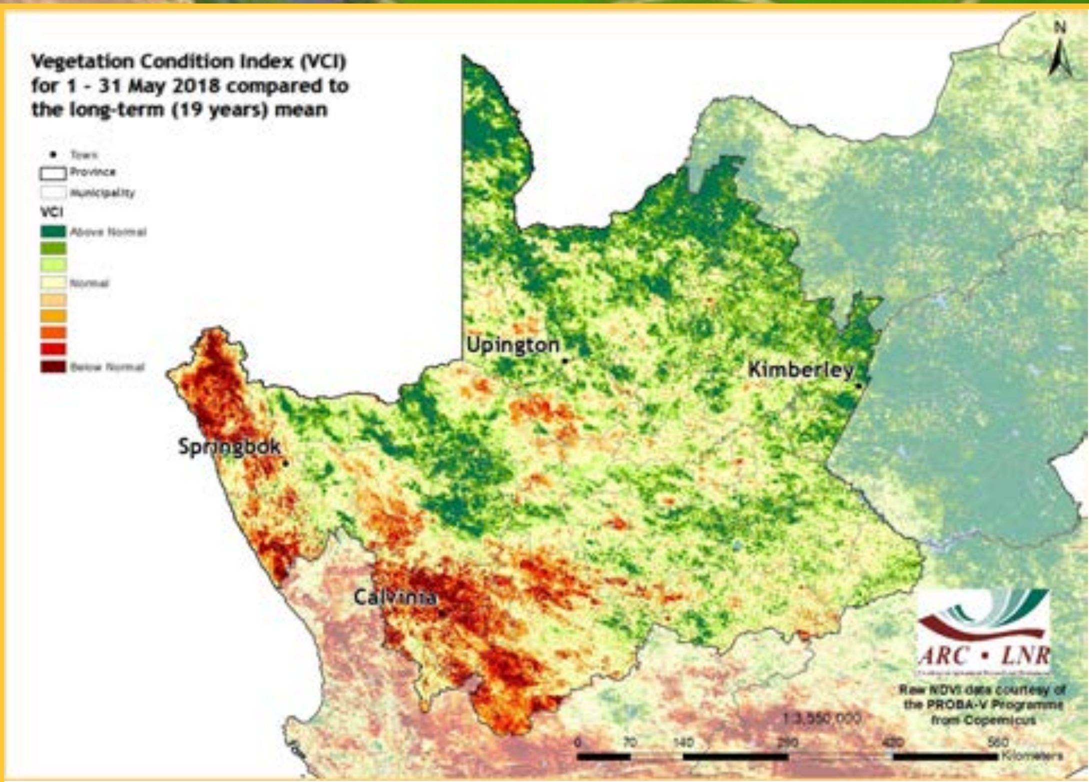


Figure 14

Figure 14:
The persistent drought condition over the majority of the Western Cape continues to reduce vegetation activity below the normal condition.

Figure 15:
Below-normal vegetation condition occurred mostly in the Namaqua region of the Northern Cape but the condition has improved over much of the Green Kalahari, Kalahari and the Diamond region of the province.



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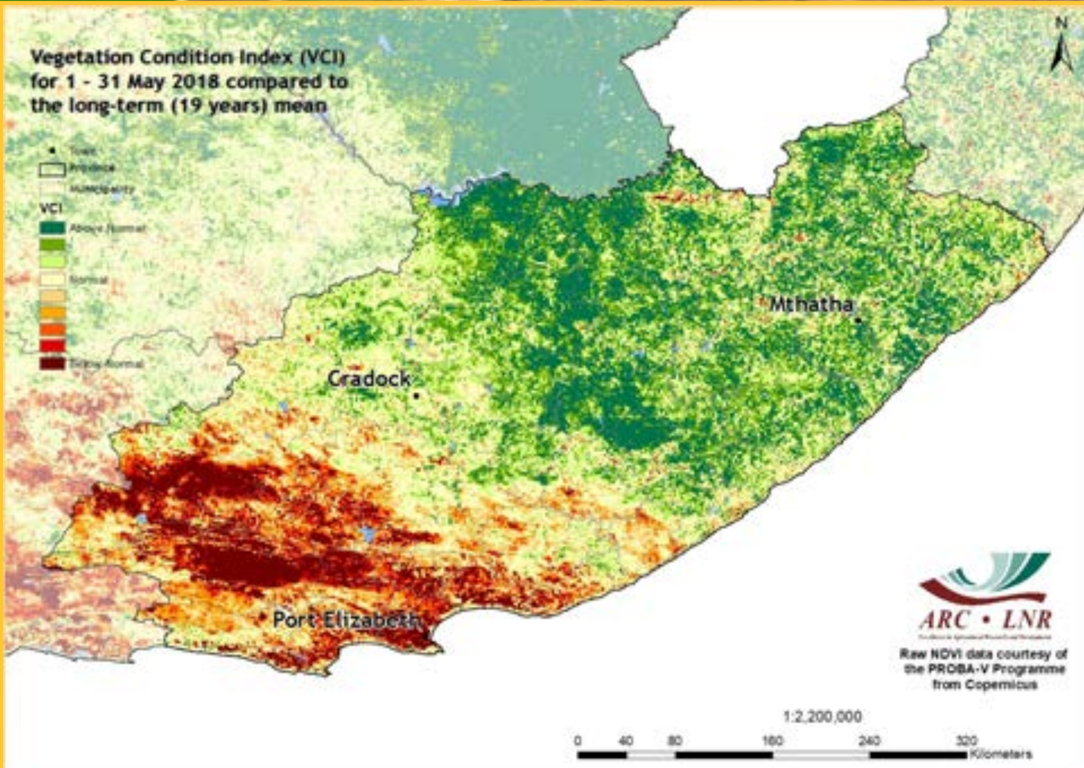

Figure 16

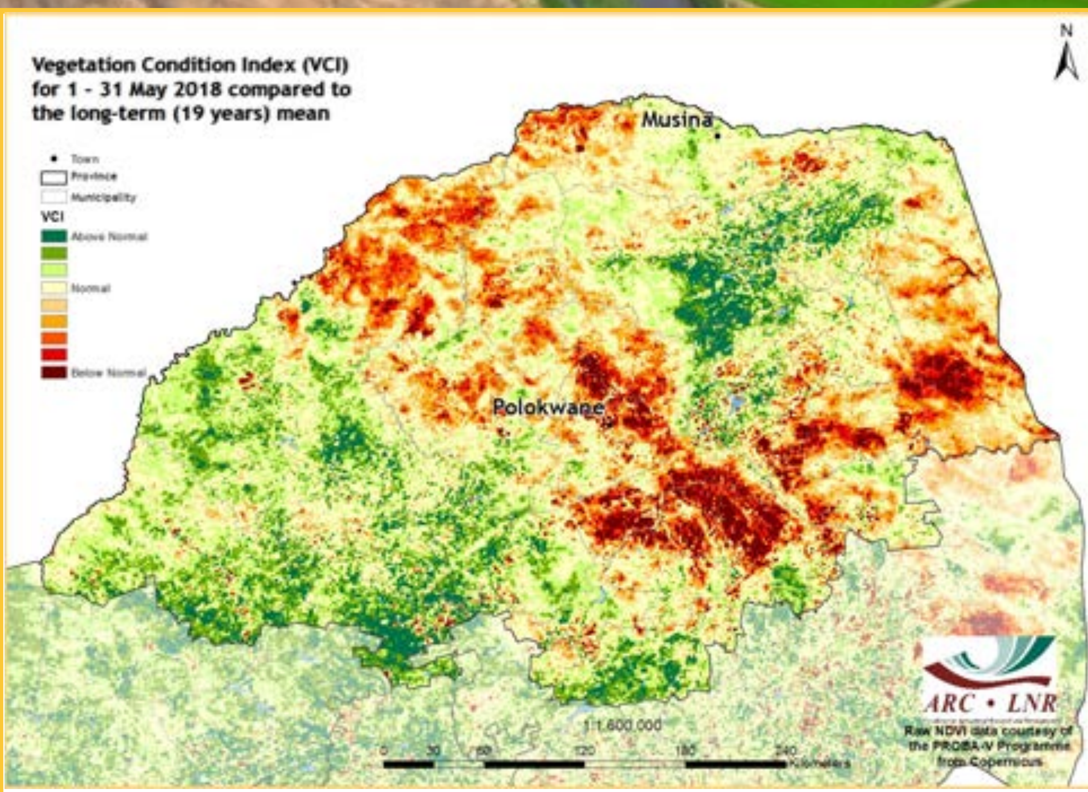

Figure 17

Figure 16:
The vegetation condition remains below the normal level over the western region of the Eastern Cape. In contrast, it has improved to above normal in the Amatola and Stormberg region as well as the Wild Coast and Berg region of the province.

Figure 17:
The northwestern and far southeastern parts of Limpopo experienced below-normal vegetation conditions in May. The situation improved in the southwestern and northeastern portion of the province where the vegetation condition is now above normal.

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6. Vegetation Conditions & Rainfall

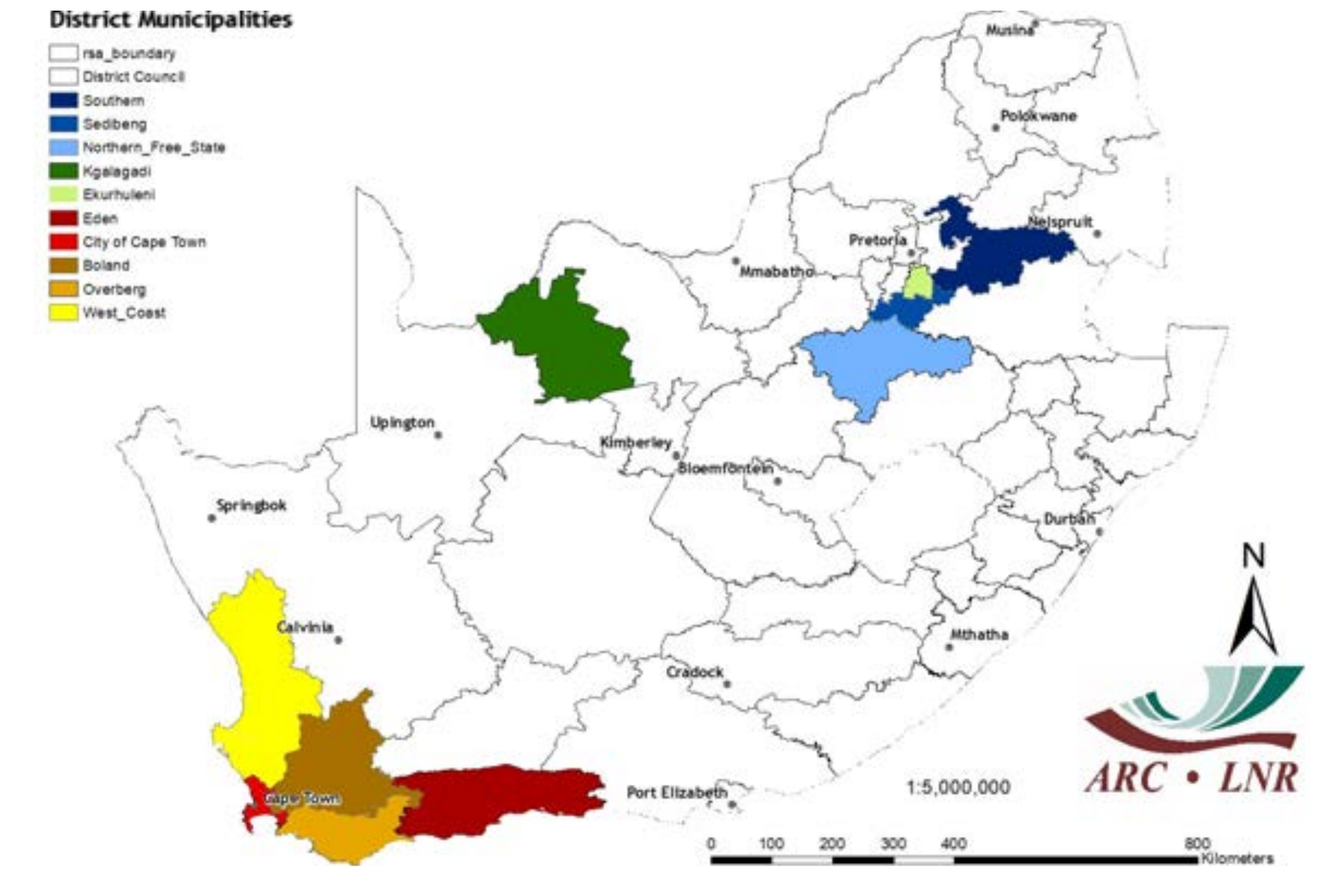

Figure 18

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

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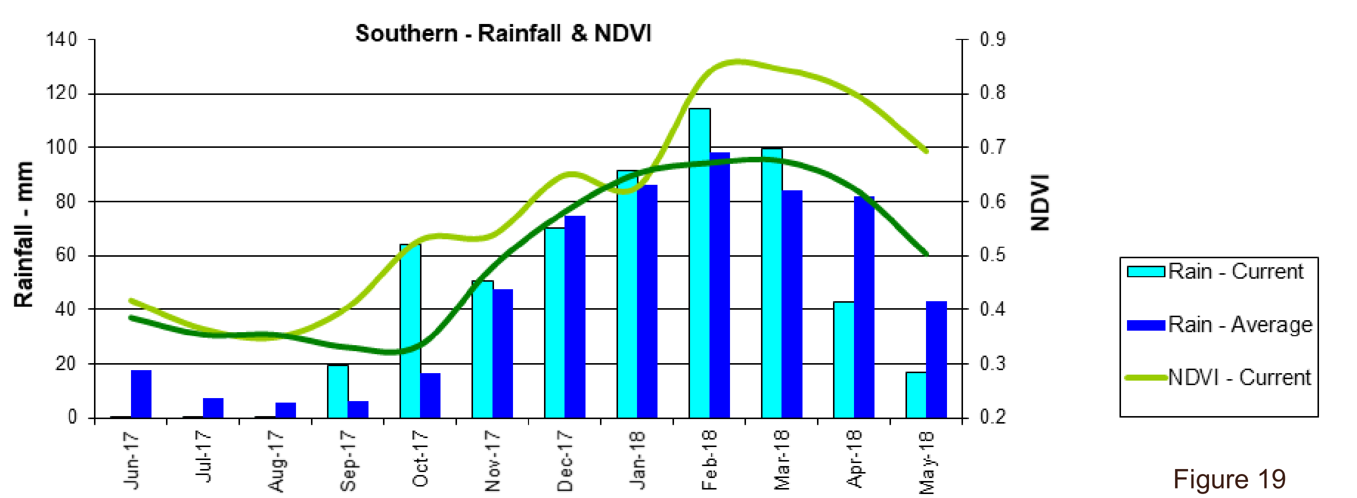
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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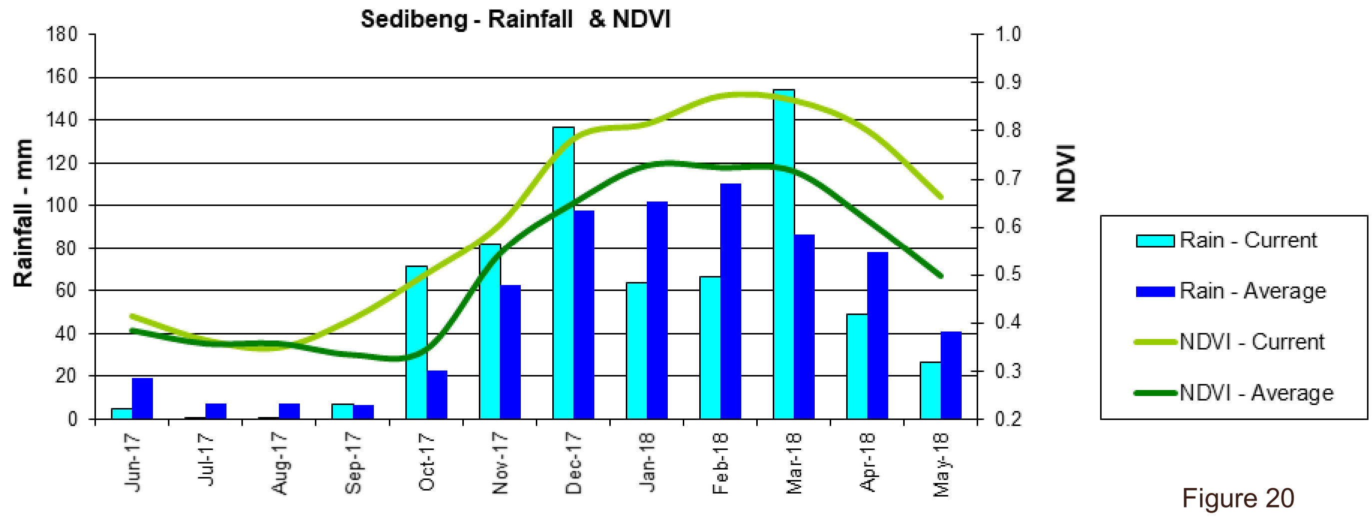

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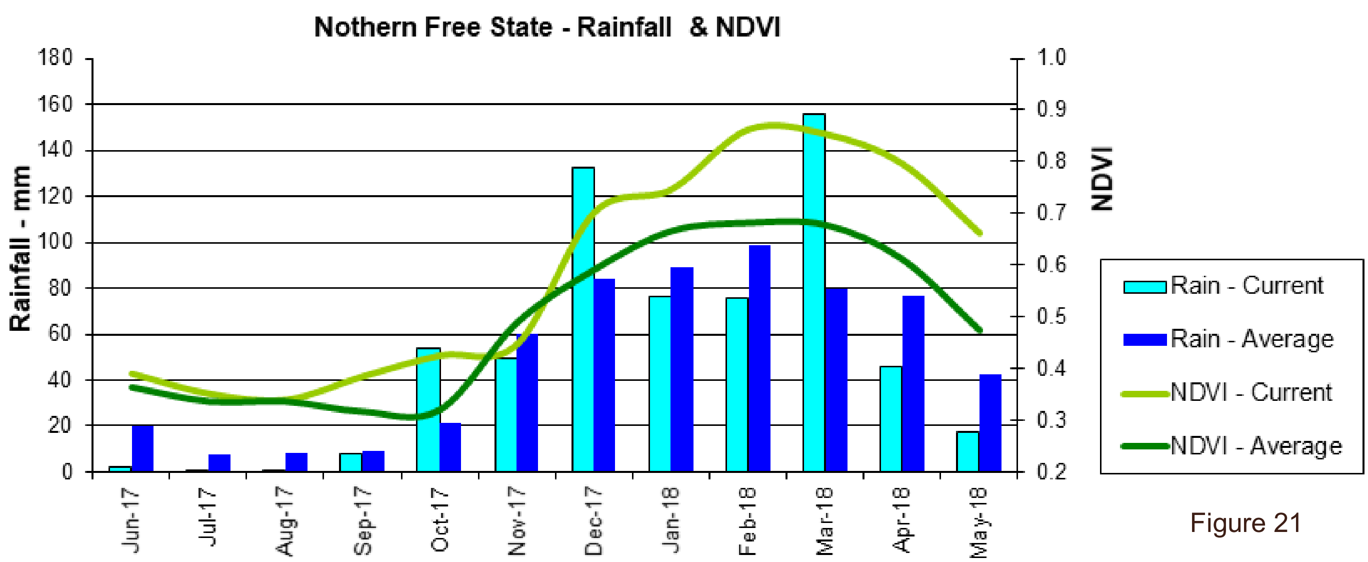

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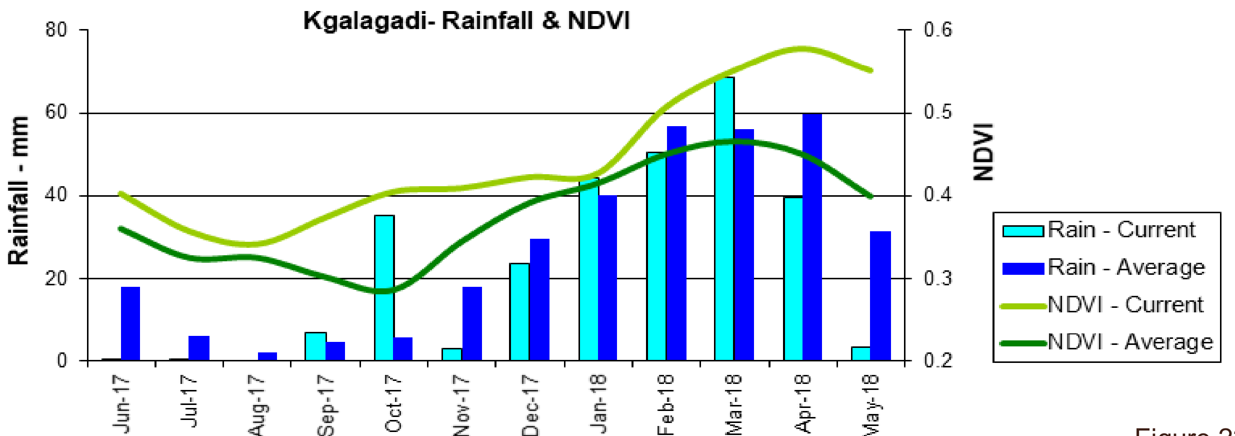

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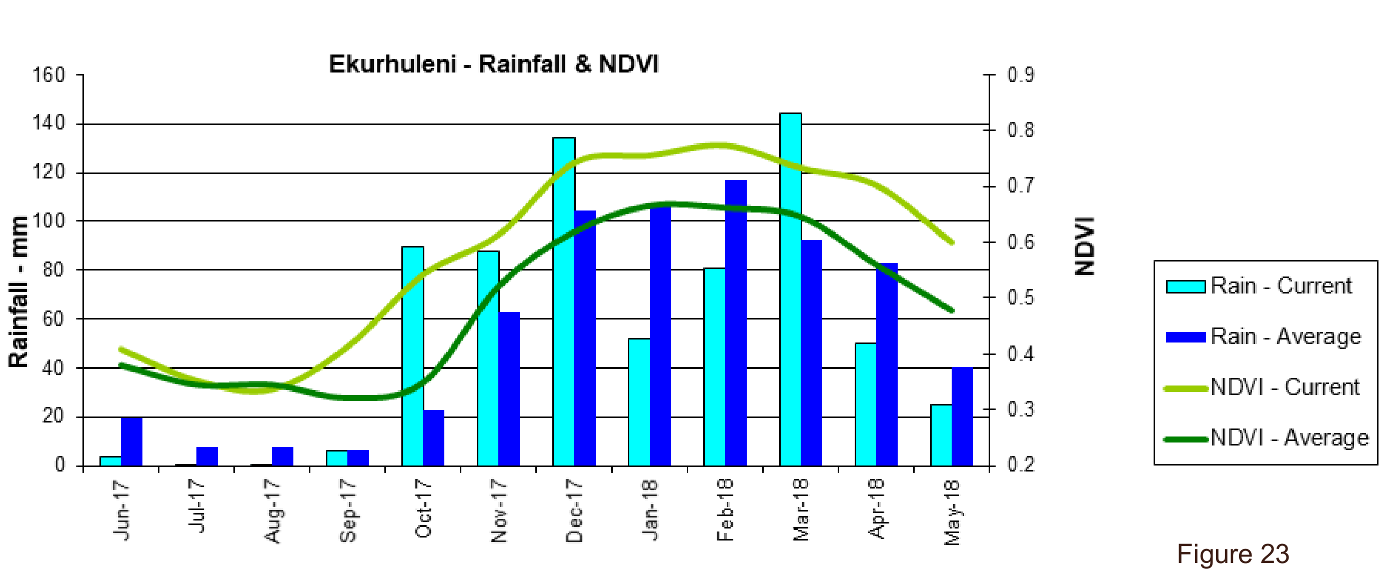

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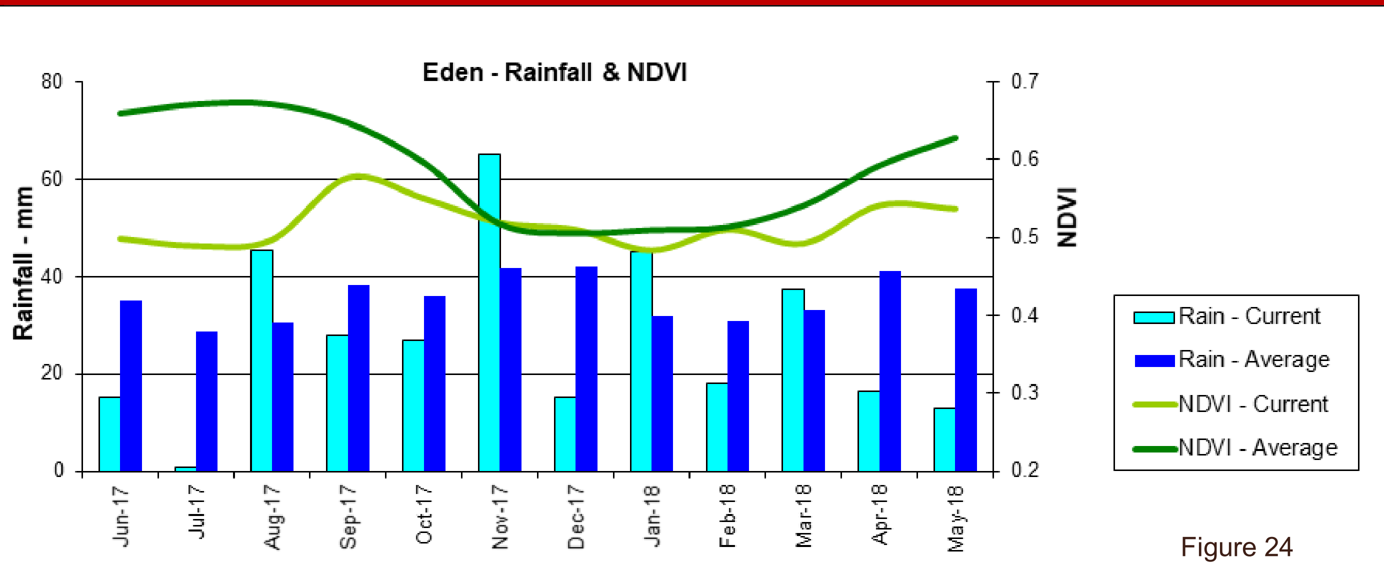

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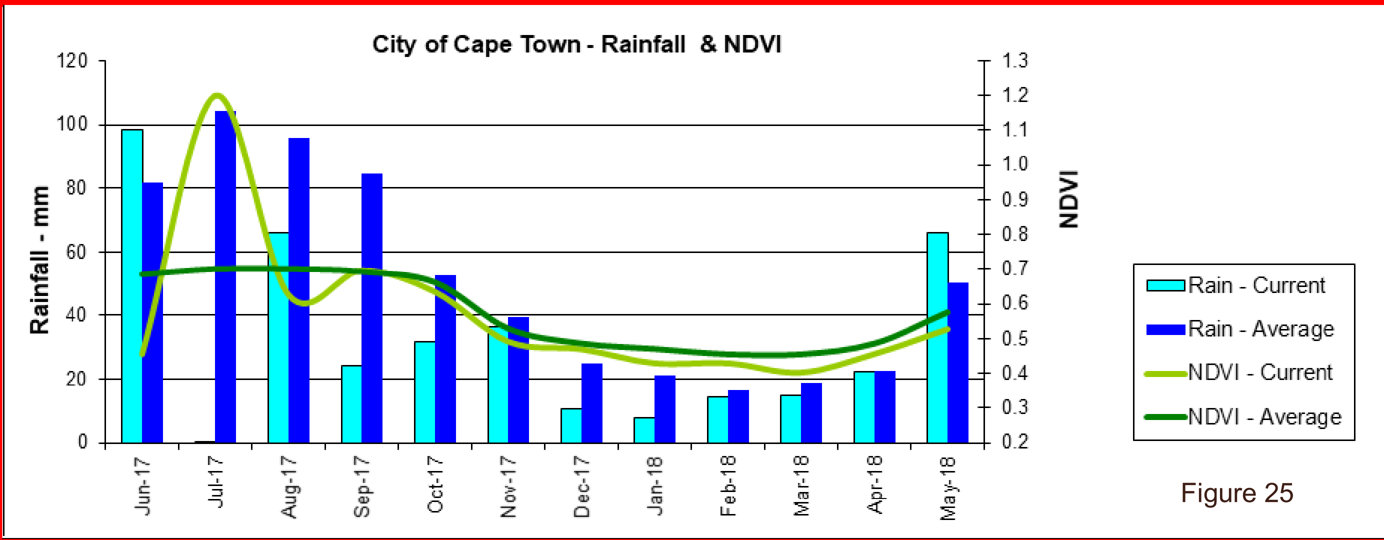

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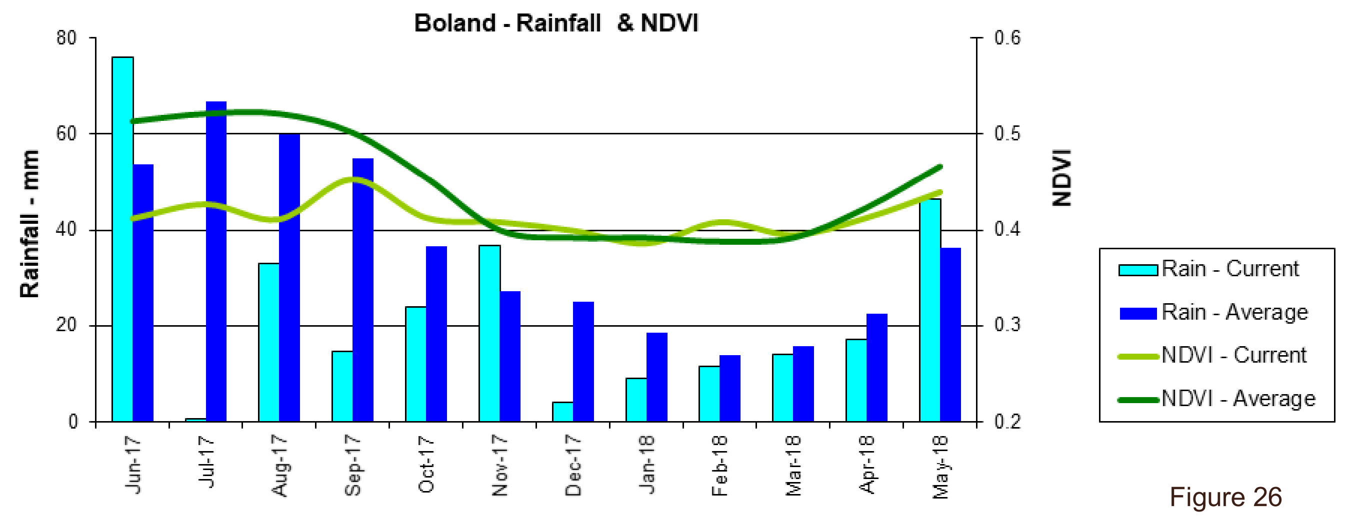

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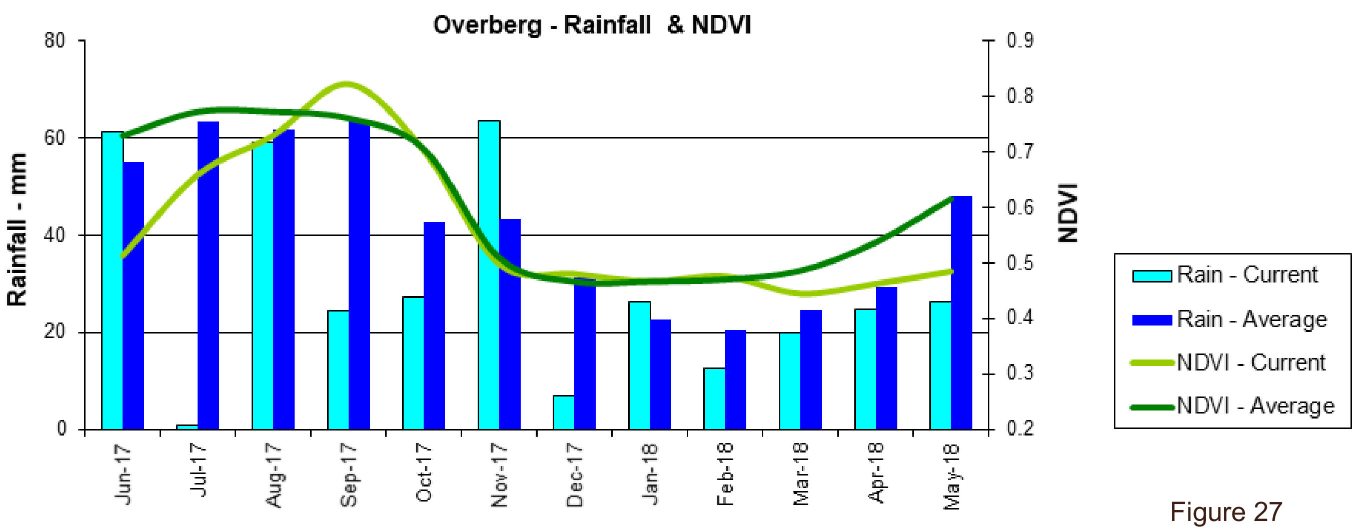

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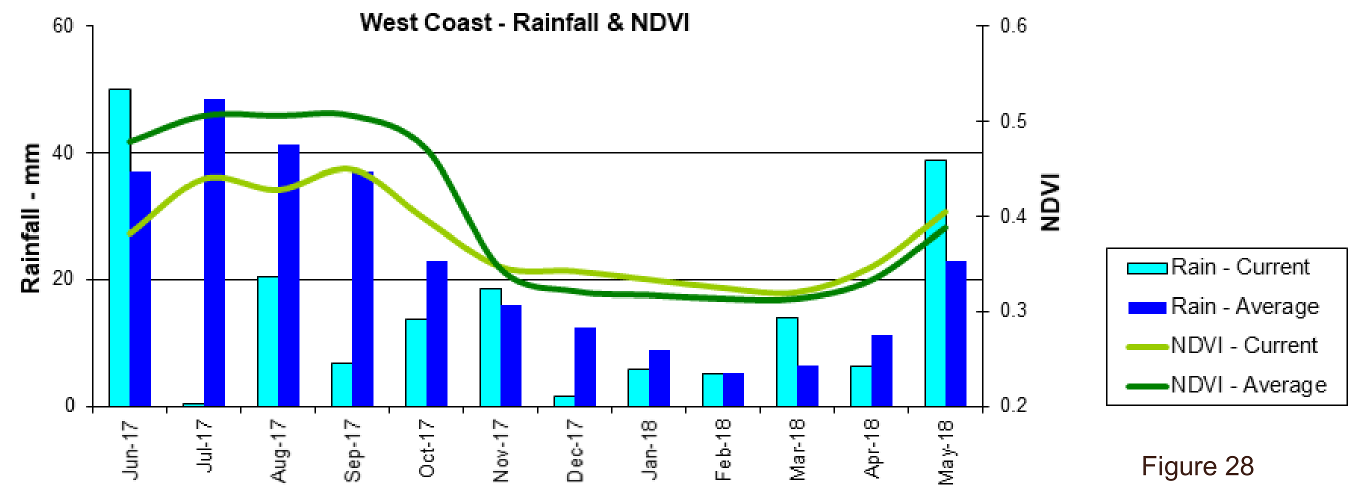

Figure 28

PAGE 15

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

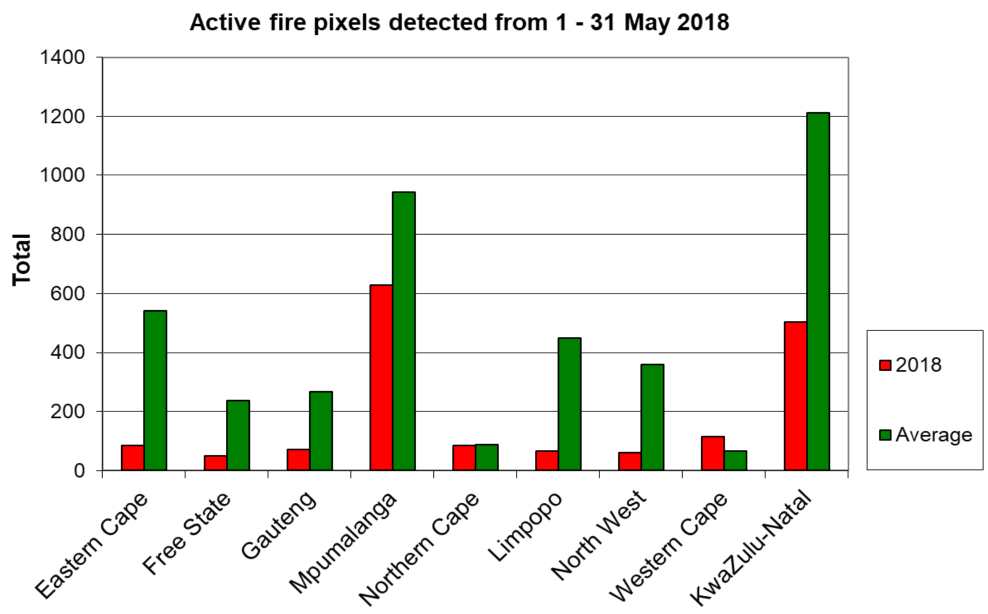

Figure 29

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

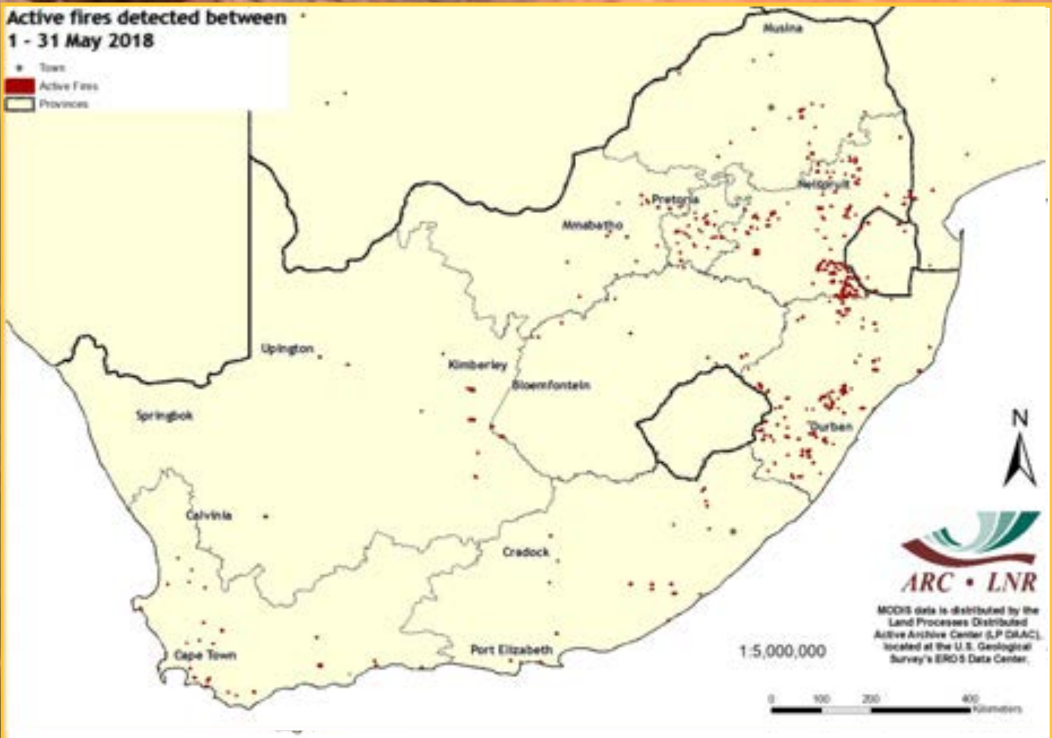

Figure 30

PAGE 16

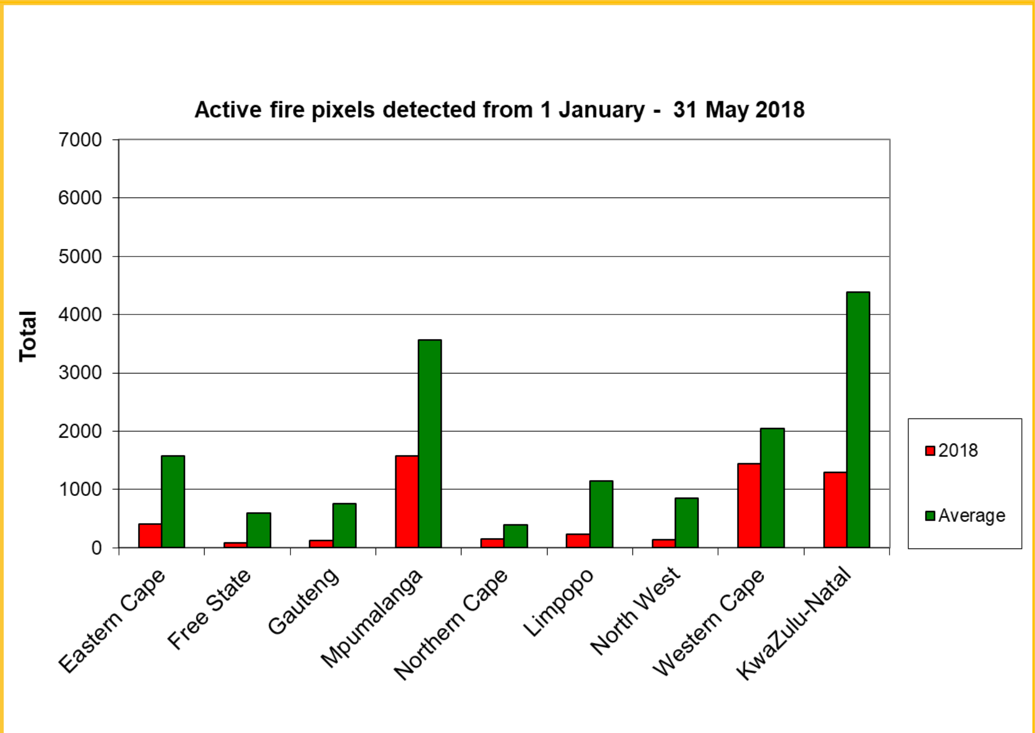

Figure 31

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

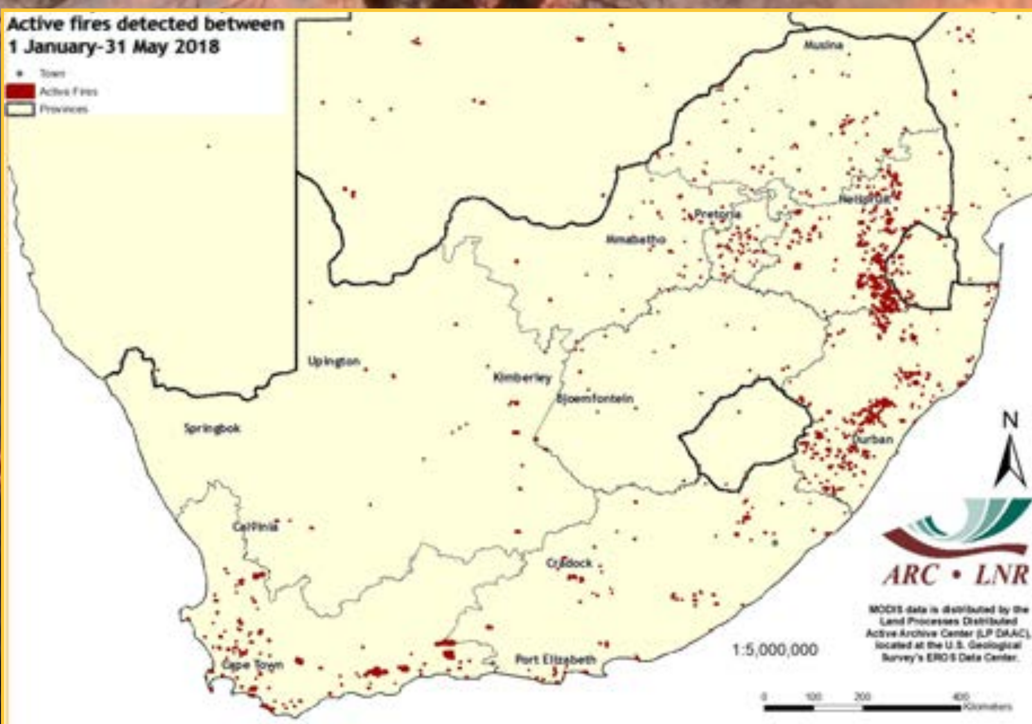

Figure 32

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

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Agrometeorology

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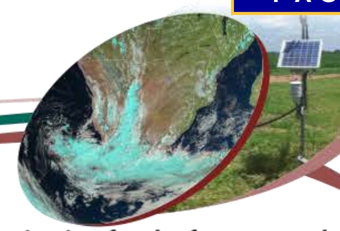

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national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

FOCUS AREAS

Climate Monitoring, Analysis & Modelling

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

Climate Change Adaptation & Mitigation

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

Climate Information Dissemination

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

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Adri Laas - Public Relations Officer • E-mail: adril@arc.agric.za

Geoinformation Science

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

FOCUS AREAS

Decision Support Systems

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

Early Warning & Food Security

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

Natural Resources Monitoring

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

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The Coarse Resolution Imagery Database (CRID)

NOAA AVHRR

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

MODIS

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

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

Datasets include:

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

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

VGT4AFRICA and GEOSUCCESS

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

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

Meteosat Second Generation (MSG)

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

Rainfall maps

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

Solar Radiation and Evapotranspiration maps

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

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