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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

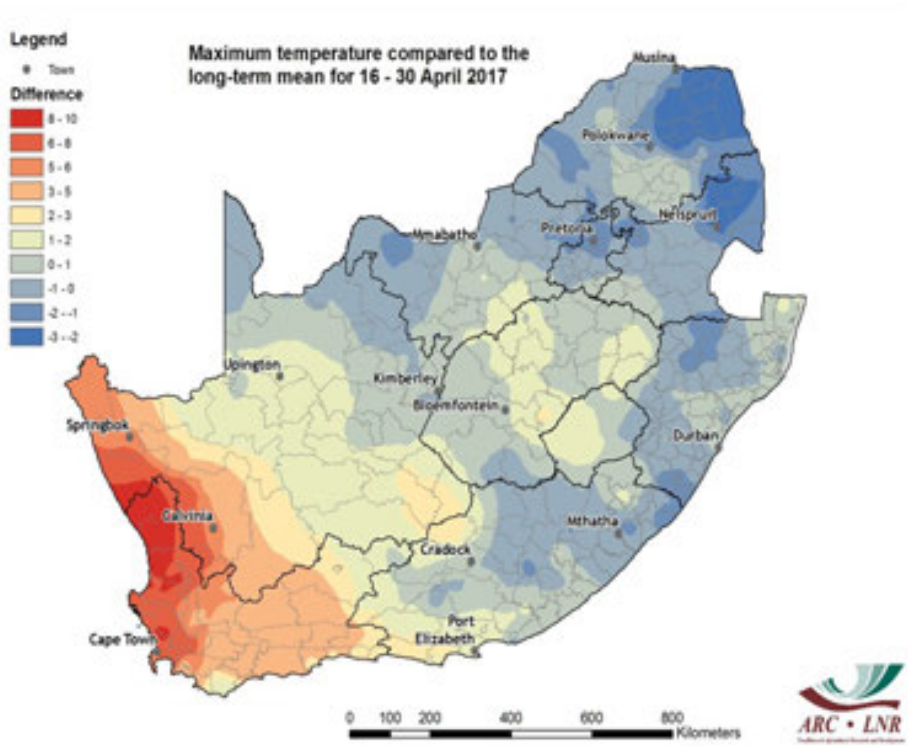
agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

South African Weather Service

AMESD

155th Edition

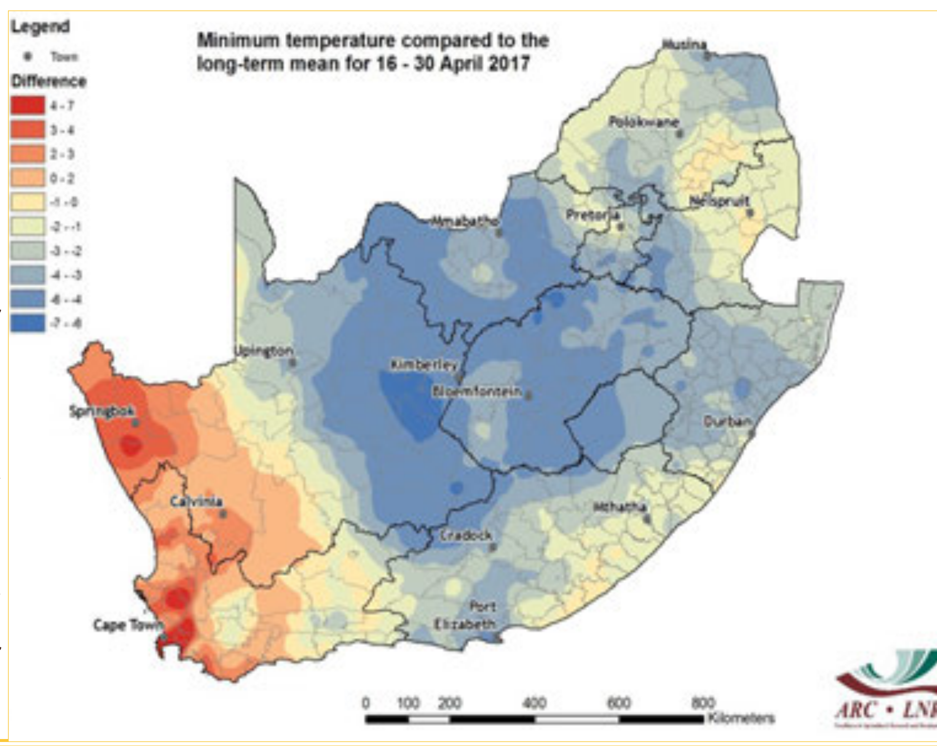
Images of the Month



Hot and dry conditions over the south-western Cape in April

Associated with the extremely dry conditions that continued over the southwestern Cape during April 2017, it was also anomalously hot. The two temperature difference maps show the maximum and minimum temperature anomalies, respectively, that occurred during the second half of the month (16th to 30th April). Maximum temperatures were up to 10˚C above normal while minimum temperatures were up to 7˚C above normal over the far western areas of the Western Cape.

These anomalously warm conditions occurred in association with persistent northerly to north-easterly winds over those areas.



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:
Cold fronts making landfall over the southwestern parts of the country during April 2017 were very limited and those that did influence the country were weak, resulting in a continuation of below-normal rainfall and above-normal temperatures over the already very dry southwestern Cape. The frontal rainfall that occurred was light and confined to the coastal regions. The rainfall that did occur over the southwestern parts of the country was mostly in the form of thunderstorms – hence the few isolated areas of above-normal rainfall within an otherwise very dry region. The remainder of the country, with the exception of the western interior and the northeastern parts, also received below-normal rainfall. Generally, most of the April rainfall occurred during the first 10 days of the month. During this time, a weak cold front brought rain to the southwestern and southern coastal regions while a sharp upper-air trough that briefly developed into a cut-off low system, resulted in a northwest-southeast orientated band of showers and thundershowers over the interior of the country. On the 12th of April a next sharp upper air trough neared the country and caused conditions favourable for the development of showers and thundershowers. This trough developed into another cut-off low system that moved to the southeast of the country by the 14th, where it remained almost stationary until the 20th. The position of this cut-off low was of such a nature that it inhibited rainfall over the country. A third cut-off low system for the month of April developed on the 20th just off the central Namibian coast. This system moved southeastwards while weakening and exited the country on the 24th, bringing some showers to the summer rainfall region. An upper air disturbance developed by the 25th west of the subcontinent, associated with a comma-shaped cloud band that resulted in showers over the southwestern parts of the country before it exited late on the 26th. The month concluded with rainfall of up to 30 mm along the northeastern escarpment due to low-level easterly flow over the eastern to northeastern parts of the country, while bergwind conditions occurred over parts of the southern interior, extending towards the coast.

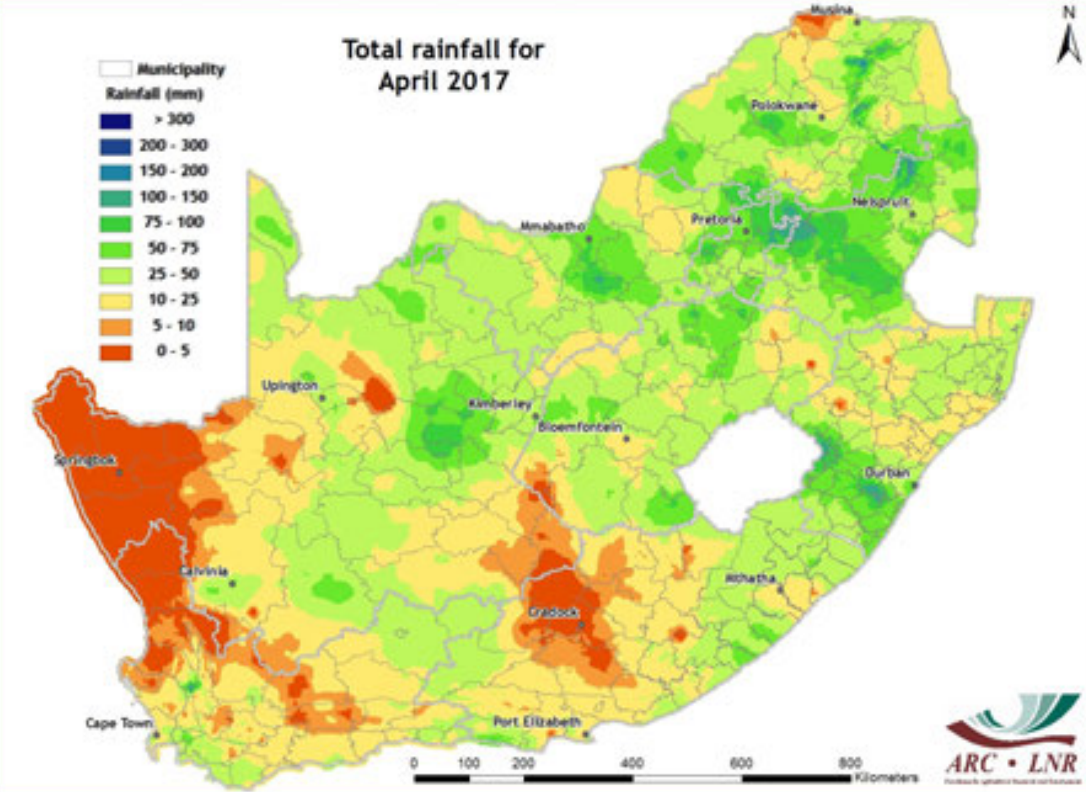


Figure 1

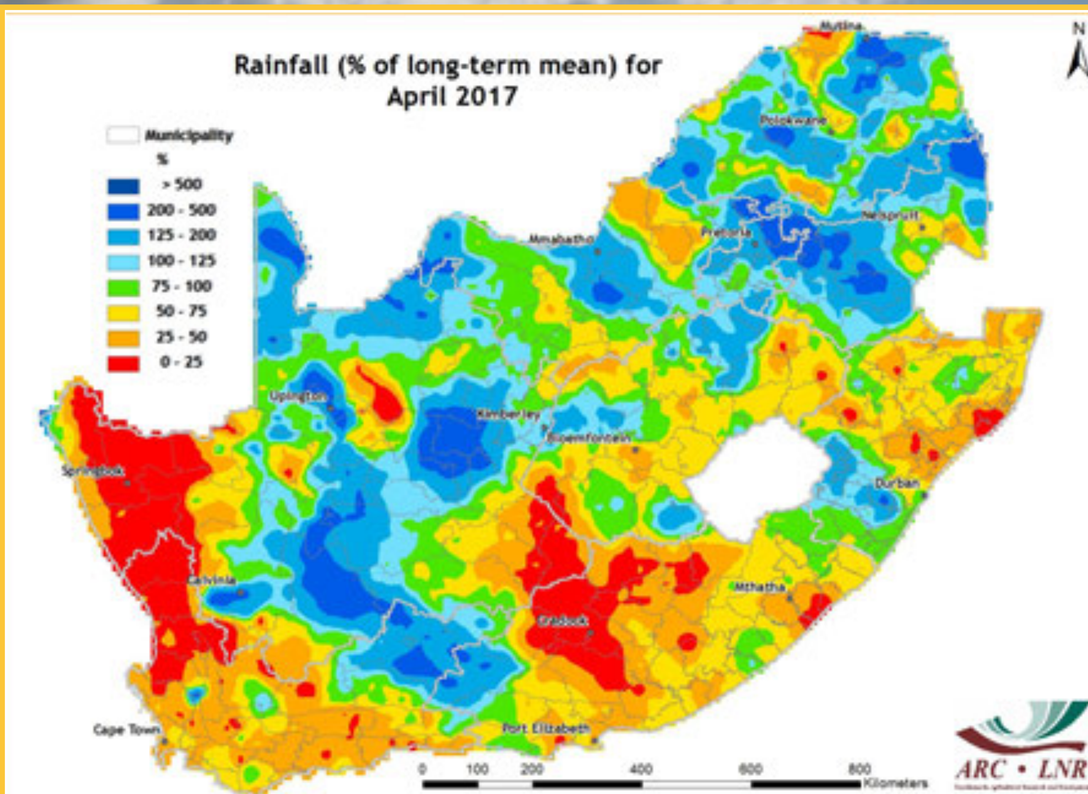
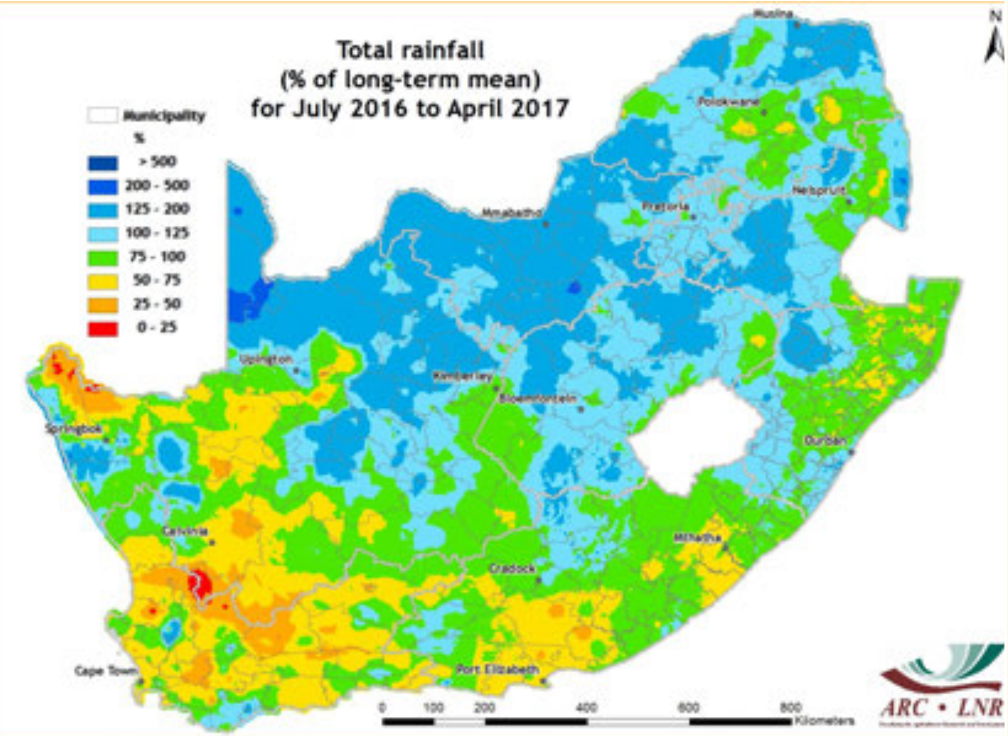


Figure 2



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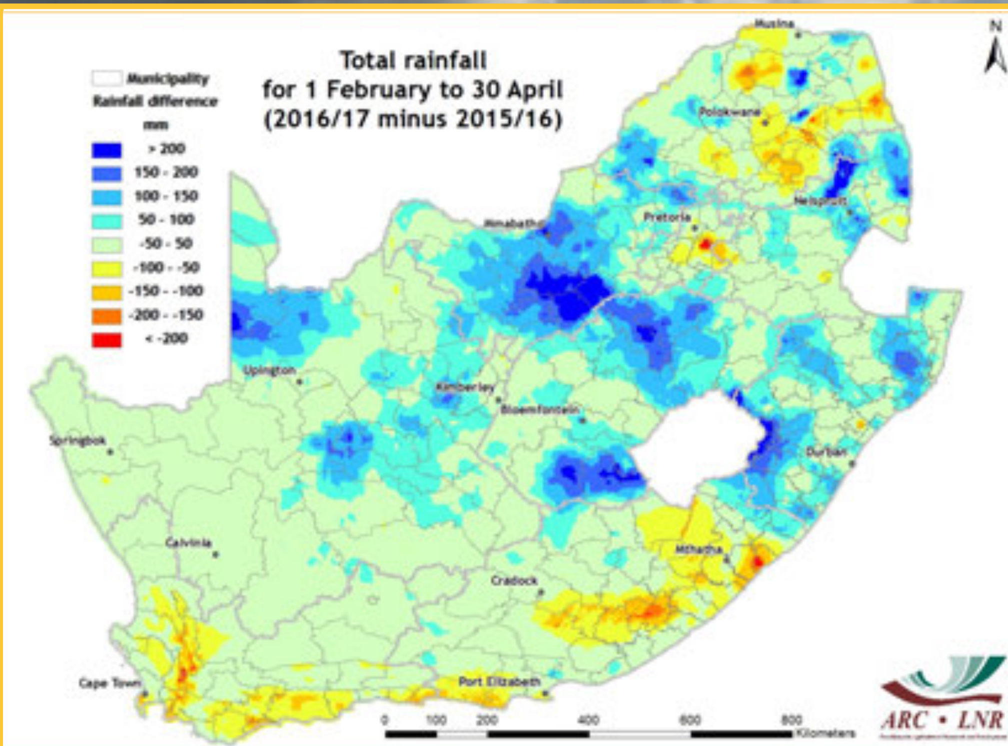


Figure 4

Figure 1:
Most of the summer rainfall region received rainfall totals in excess of 25 mm during April, reaching monthly totals in excess of 75 mm in places. Rainfall totals over the all-year rainfall region as well as the winter rainfall region were limited, with some areas over the drought stricken southwestern Cape receiving no more than 10 mm during April.

Figure 2:
Above-normal rainfall occurred over the northeastern parts as well as over the western interior. Below-normal rainfall continued over the drought stricken southwestern Cape, apart from a few isolated areas where above-normal rainfall occurred during April due to a few thundershowers.

Figure 3:
Since July 2016, rainfall over the northern to central parts of the country was mostly normal to above normal. Some isolated areas over the far southern parts of the country also received normal to above-normal rainfall during this 10-month period.

Figure 4:
Compared to the 2015/16 corresponding period, the central parts of the country have received 50-100 mm more rainfall this year, with some isolated areas receiving over 200 mm more. Most of the remainder of the country was drier than the previous year. Over the southwestern Cape, some areas had a rainfall deficit of 200 mm during 2016/17 compared to 2015/16.

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 short and long time scales, the current SPI maps (Figures 5-8) show that severe to extreme drought conditions are present over the extreme southwestern parts of the country and to a lesser extent over the eastern seaboard. Over the central to northeastern parts of the country, a recovery of the drought conditions visible on the longer time scales can be seen.

Questions/Comments:
EngelbrechtC@arc.agric.za

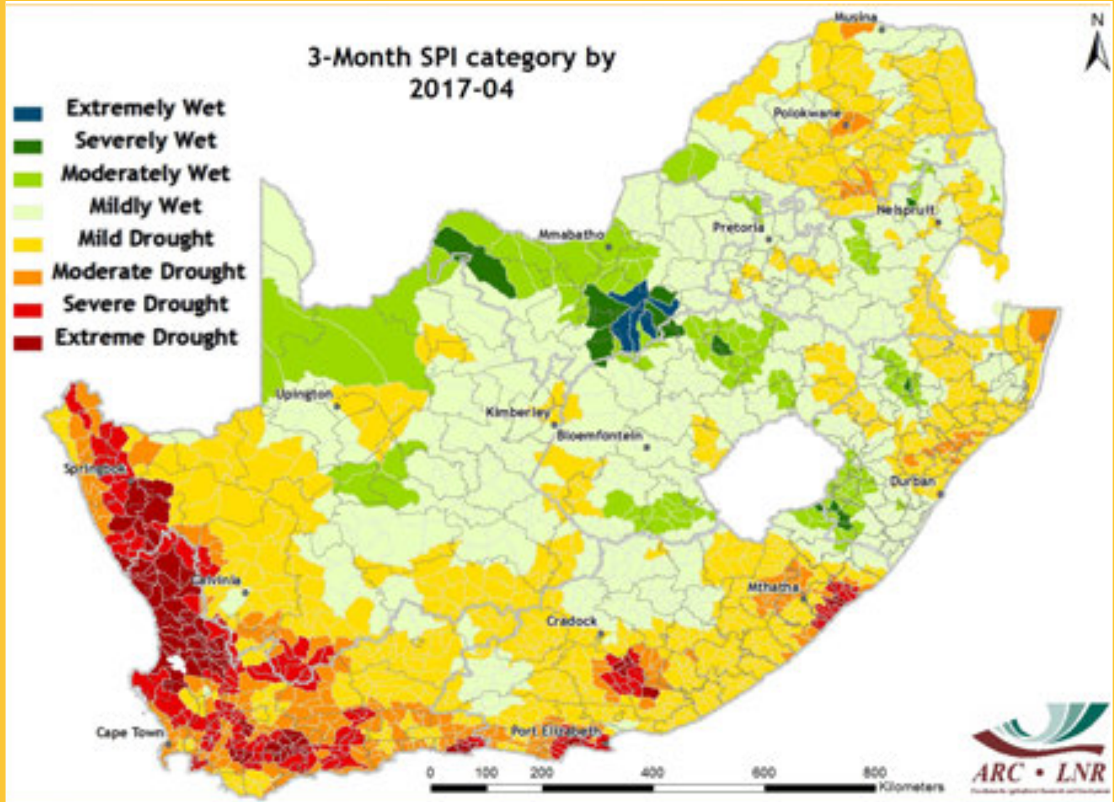
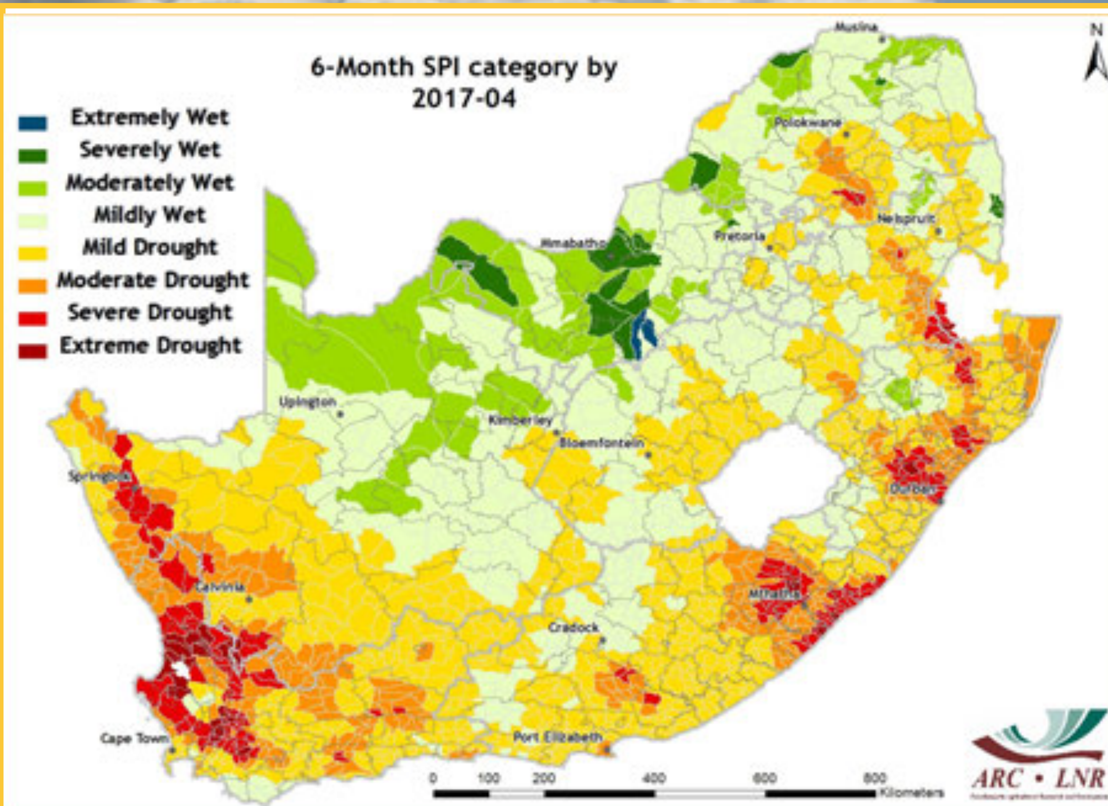


Figure 5



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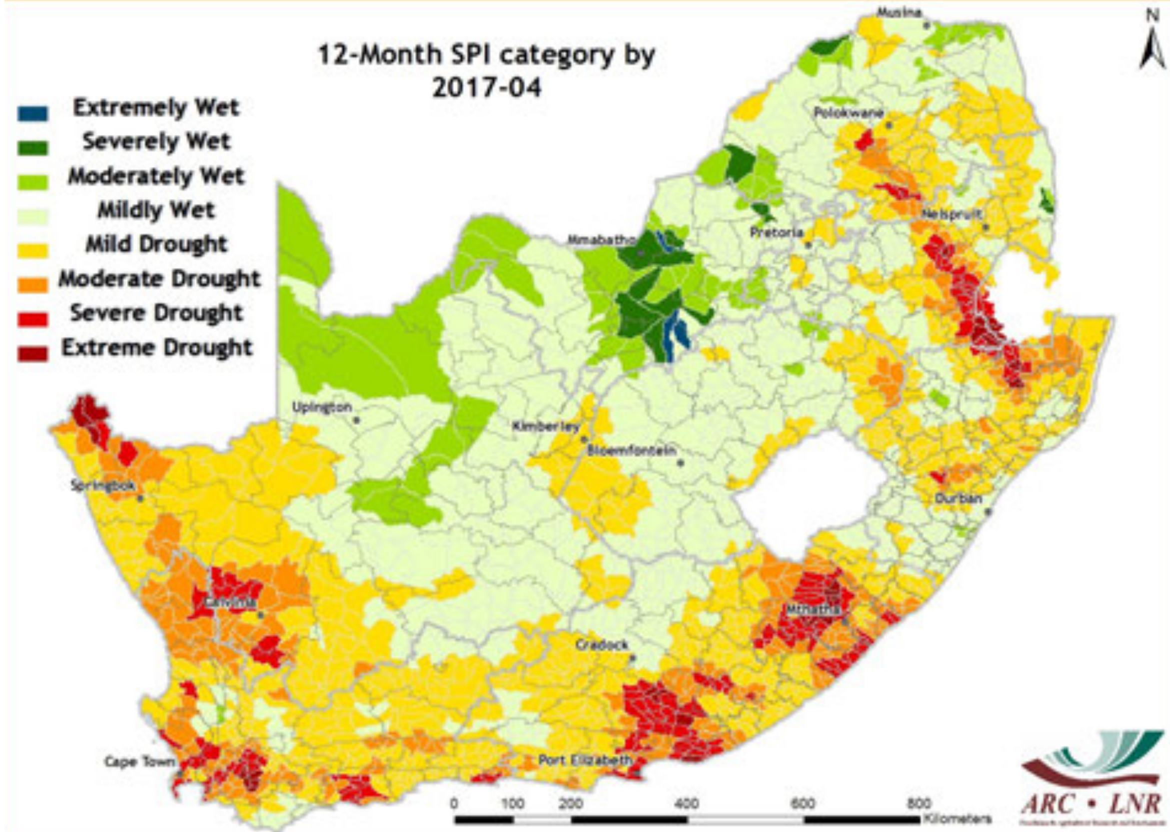

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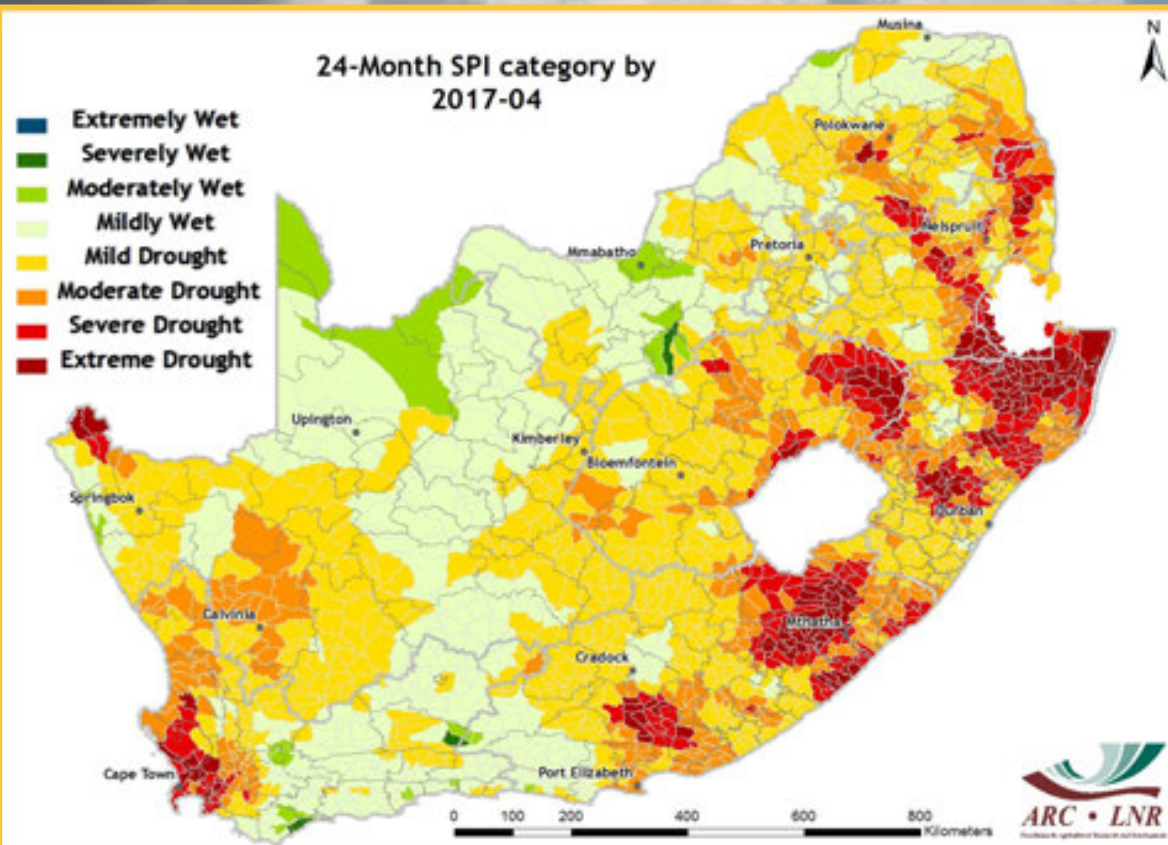


Figure 8

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.

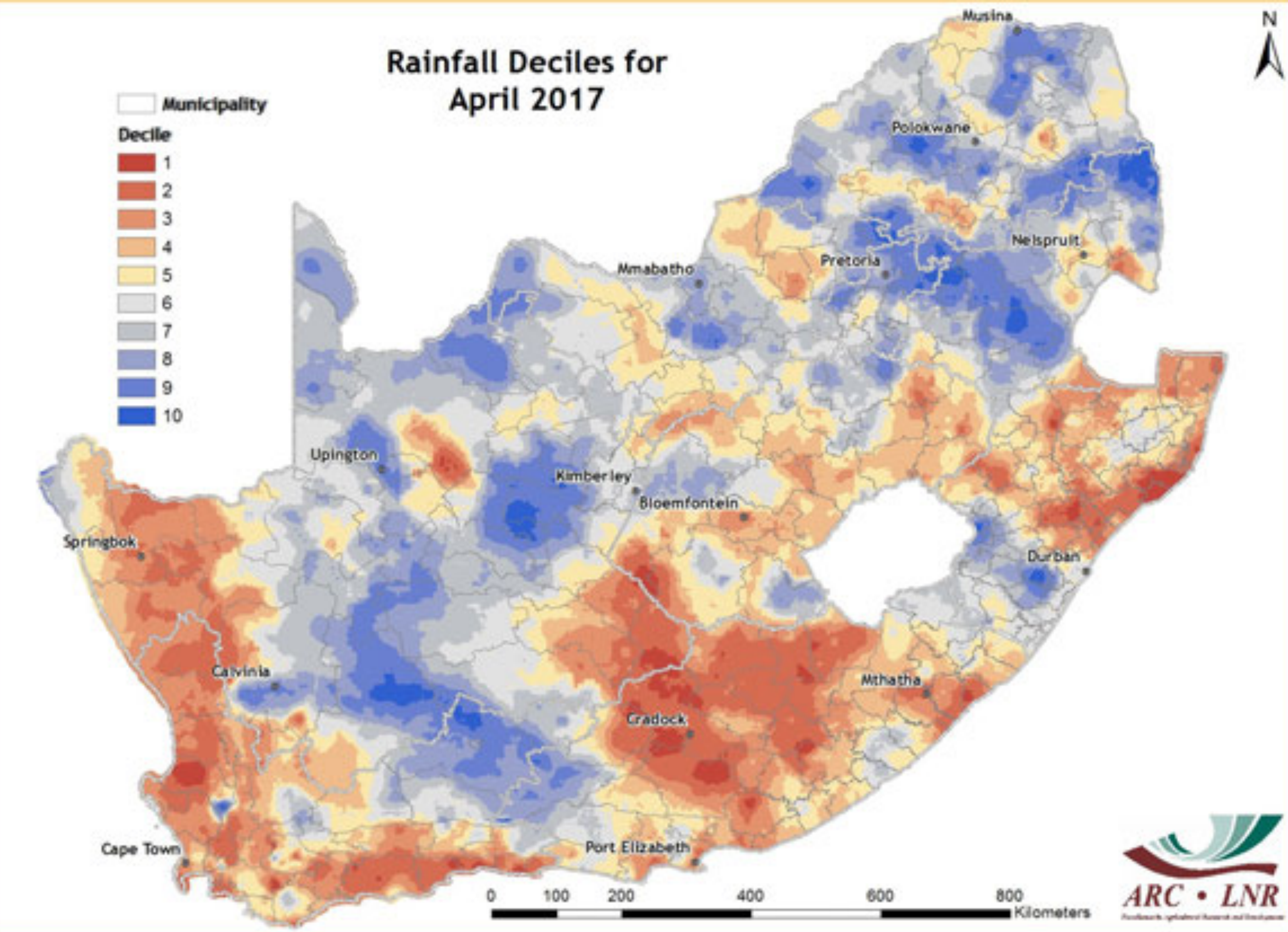


Figure 9

Figure 9:
Areas over the northeast and western interior were wet during April, while extremely dry conditions occurred over the western, southwestern and southeastern parts of the country.

Questions/Comments:
EngelbrechtC@arc.agric.za

4. Water Balance

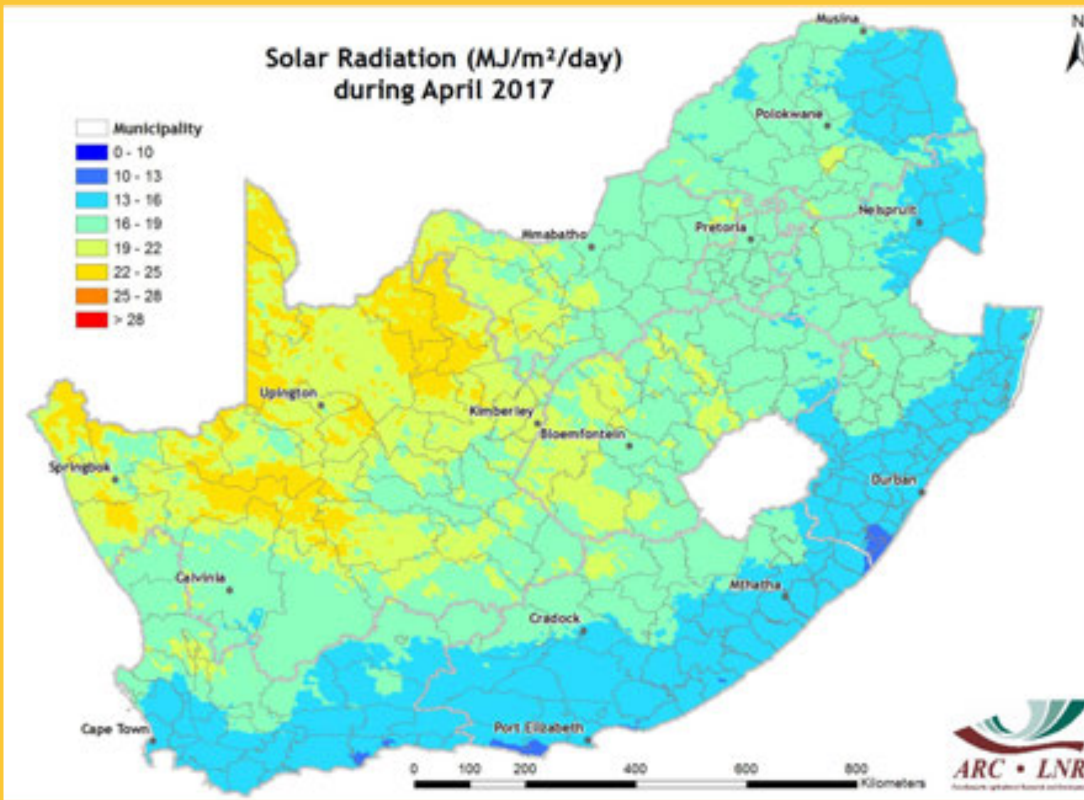


Figure 10

Solar Radiation

Daily solar radiation surfaces are created for South Africa by combining *in situ* measurements from the ARC-ISCW automatic weather station network with 15-minute data from the Meteosat Second Generation satellite.

Figure 10:
The lowest solar radiation values occurred over the southern and eastern coastal belts and adjacent interior regions with the highest values over the north-western parts of the country.

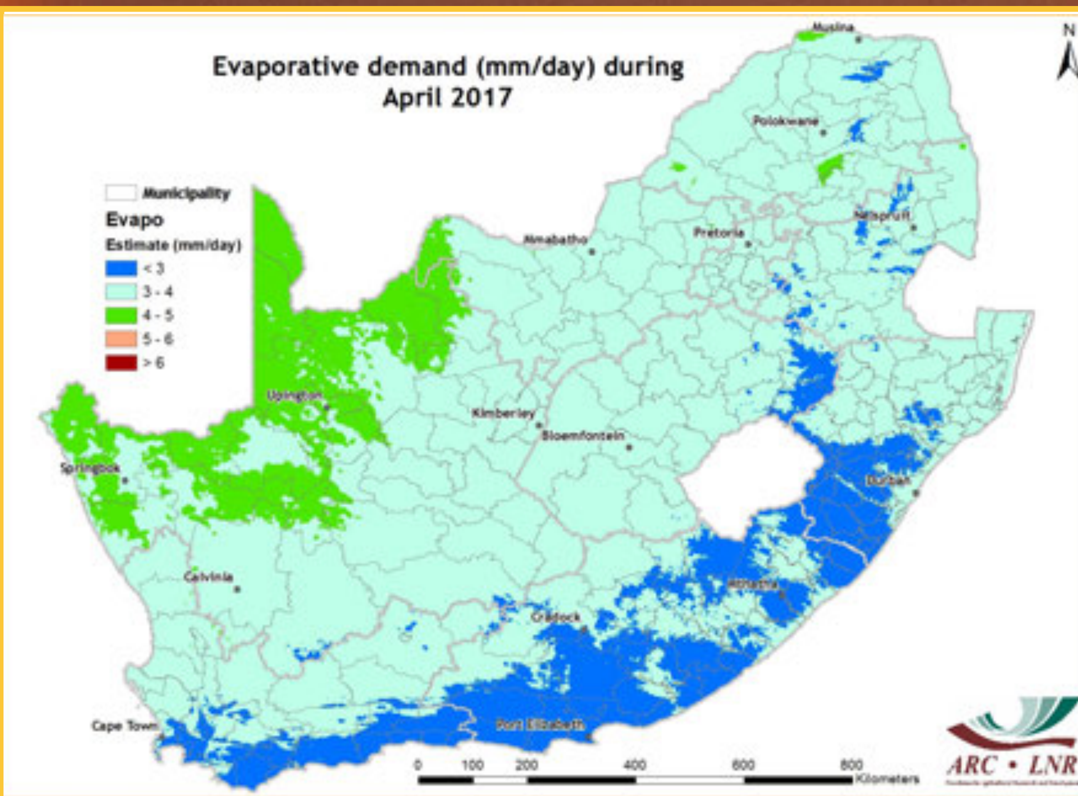


Figure 11

Potential Evapotranspiration

Potential evapotranspiration (PET) for a reference crop is calculated at about 450 automatic weather stations of the ARC-ISCW located across South Africa. At these stations hourly measured temperature, humidity, wind and solar radiation values are combined to estimate the PET.

Figure 11:
The evaporative demand follows a similar pattern to the solar radiation values, with the lowest evaporative demand occurring over the southern to southeastern coast and adjacent interior and the highest evaporative demand over the northwestern parts of the country.

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

5. 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.

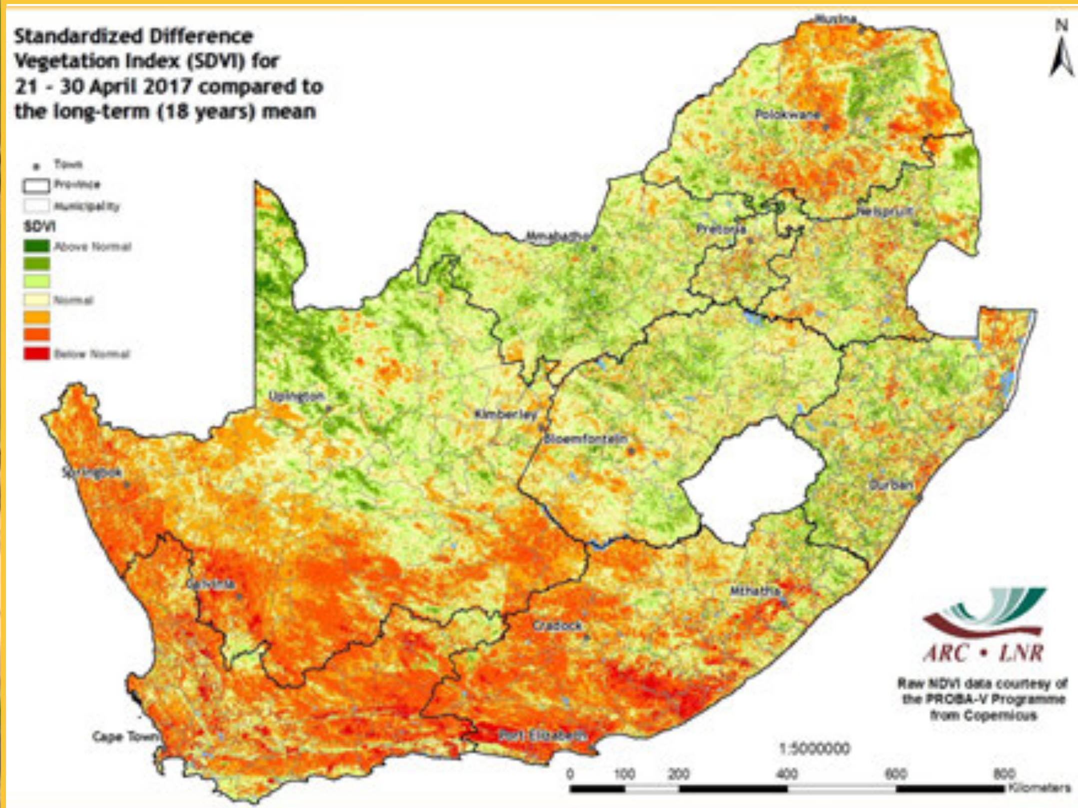


Figure 12

Figure 12:
The SDVI by late April indicates drought stress over the Western Cape, Eastern Cape and the western part of the Northern Cape, including the Highveld and Lowveld regions of Limpopo.

Figure 13:
Most parts of the country are drought stressed compared to the condition last year, except for some isolated areas in North West, Limpopo, Free State, KwaZulu-Natal, Mpumalanga and the Northern Cape.

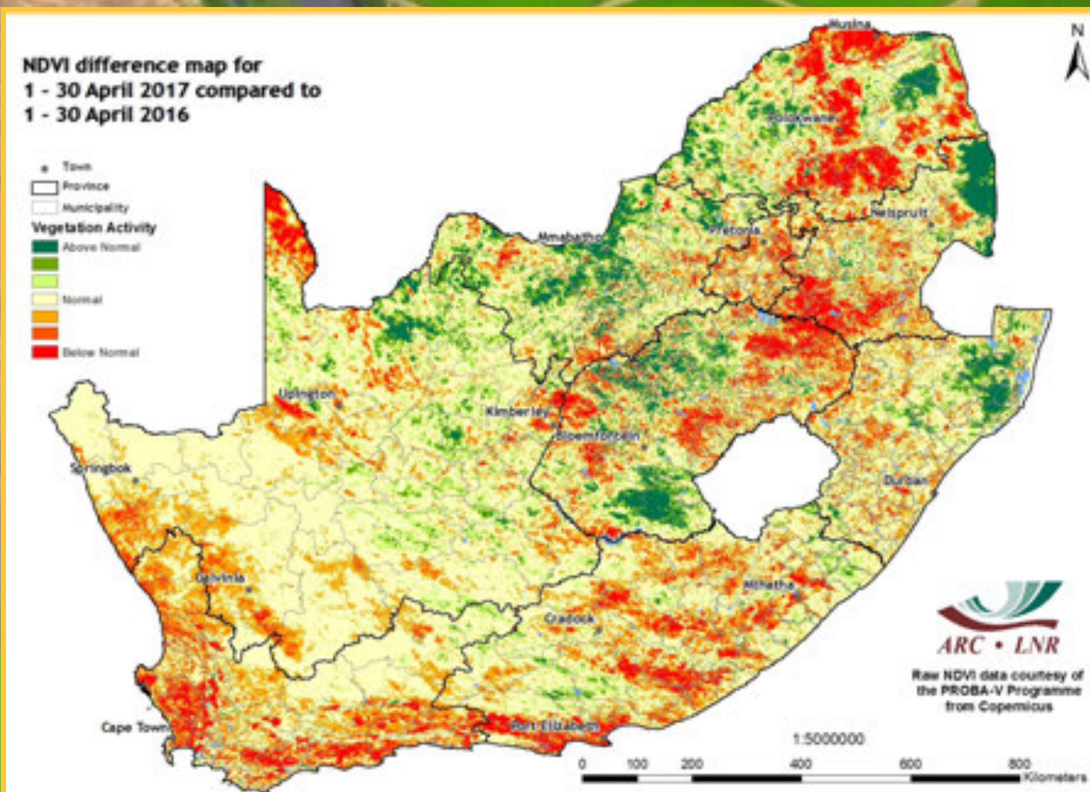


Figure 13

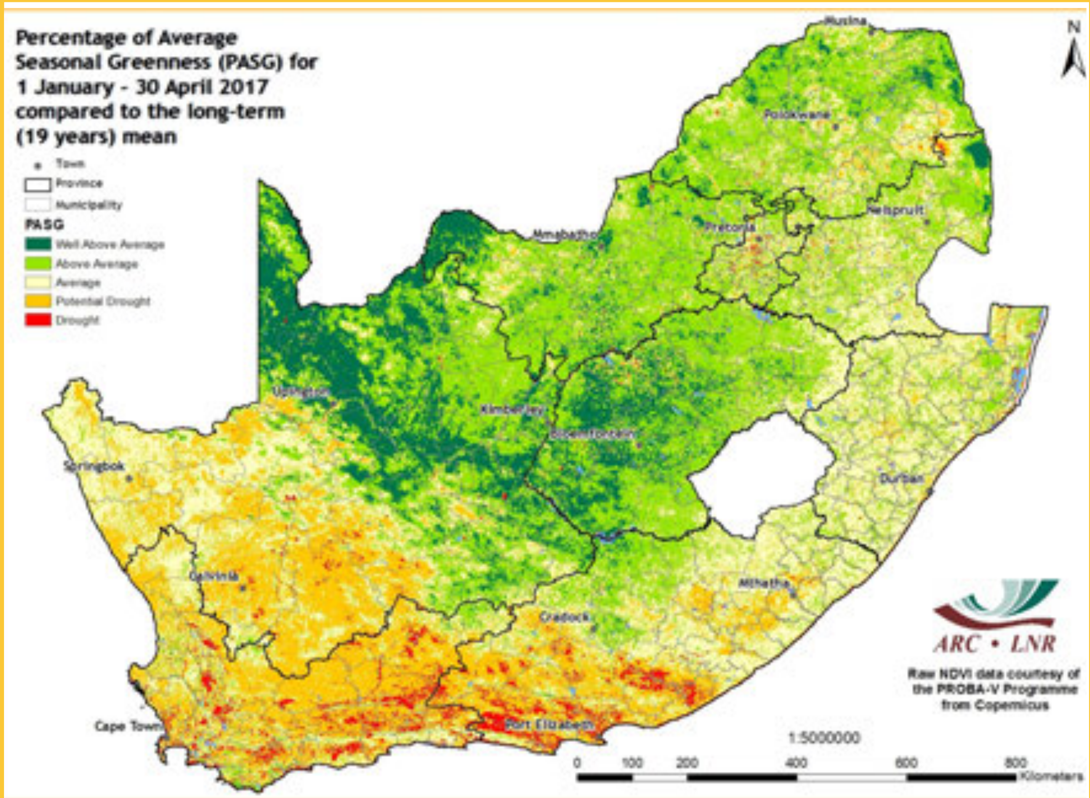


Figure 14

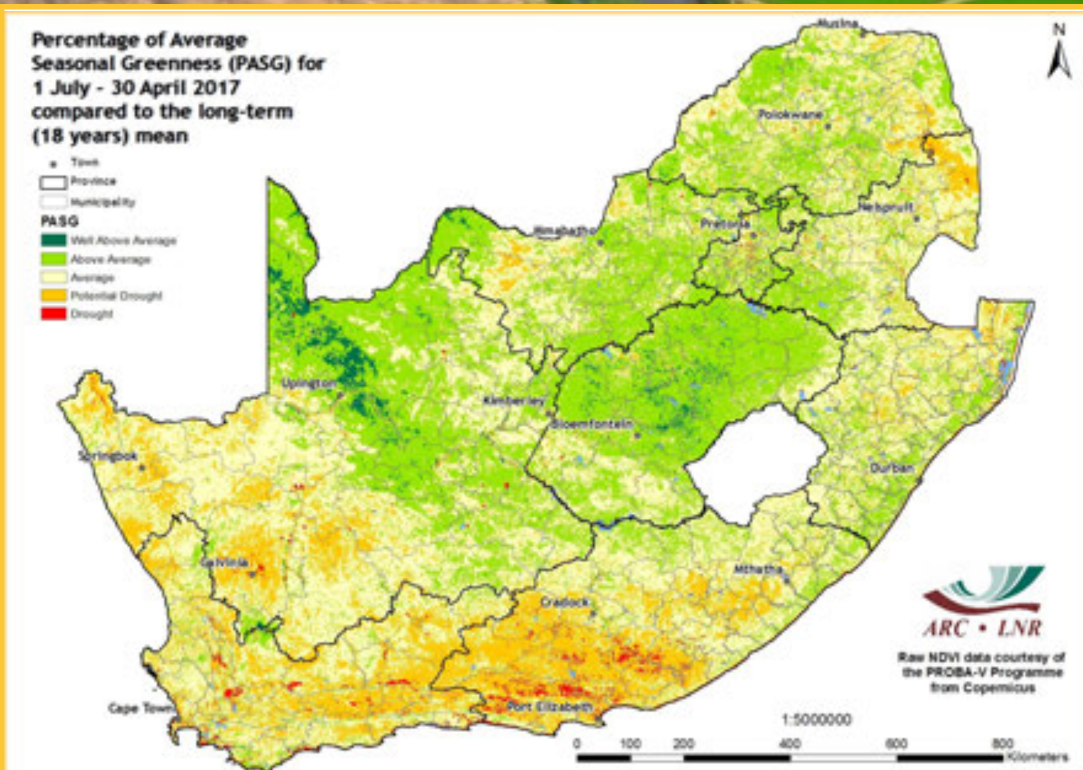


Figure 15

Vegetation Mapping
(continued from p. 8)

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 14:
Vegetation activity is lower over the Western Cape and western parts of the Eastern Cape and Northern Cape. The southern and eastern interior of the country experienced high vegetation activity.

Figure 15:
Cumulative vegetation activity anomalies indicate potential drought stress over the extreme western and southern parts of the country, including the northern parts of Mpumalanga.

Questions/Comments:
NkambuleV@arc.agric.za

6. 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.

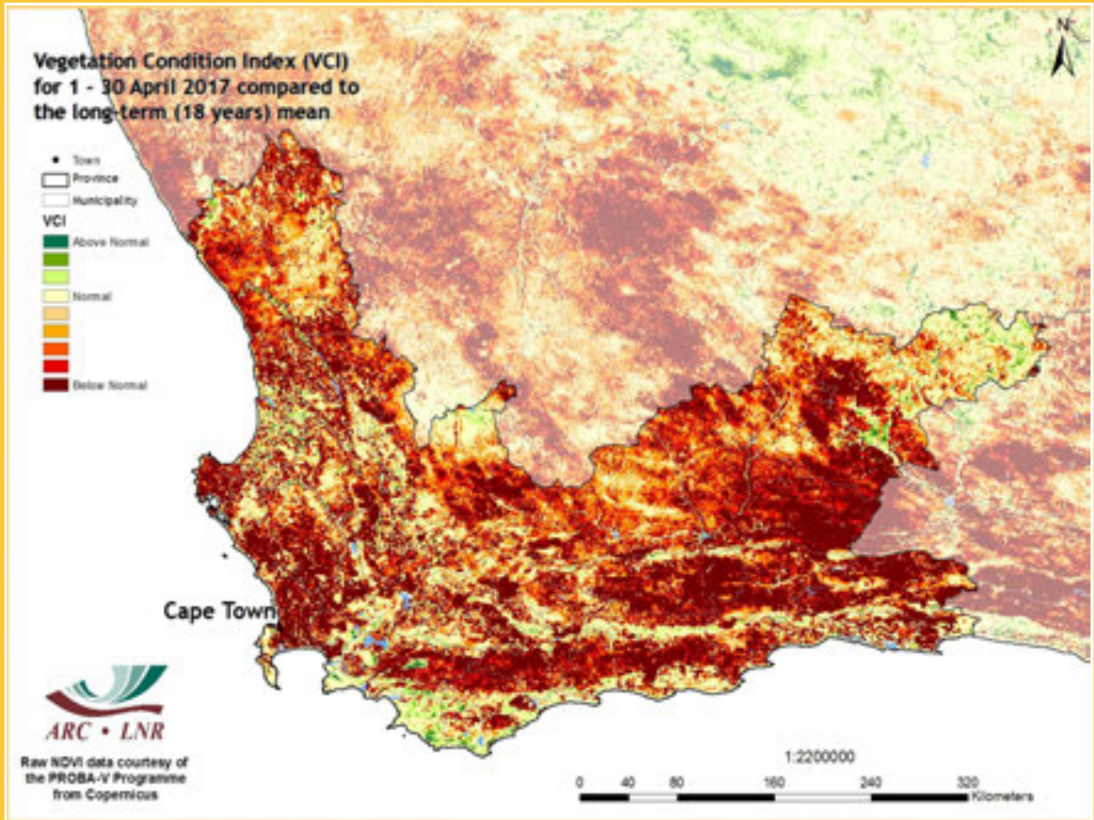


Figure 16

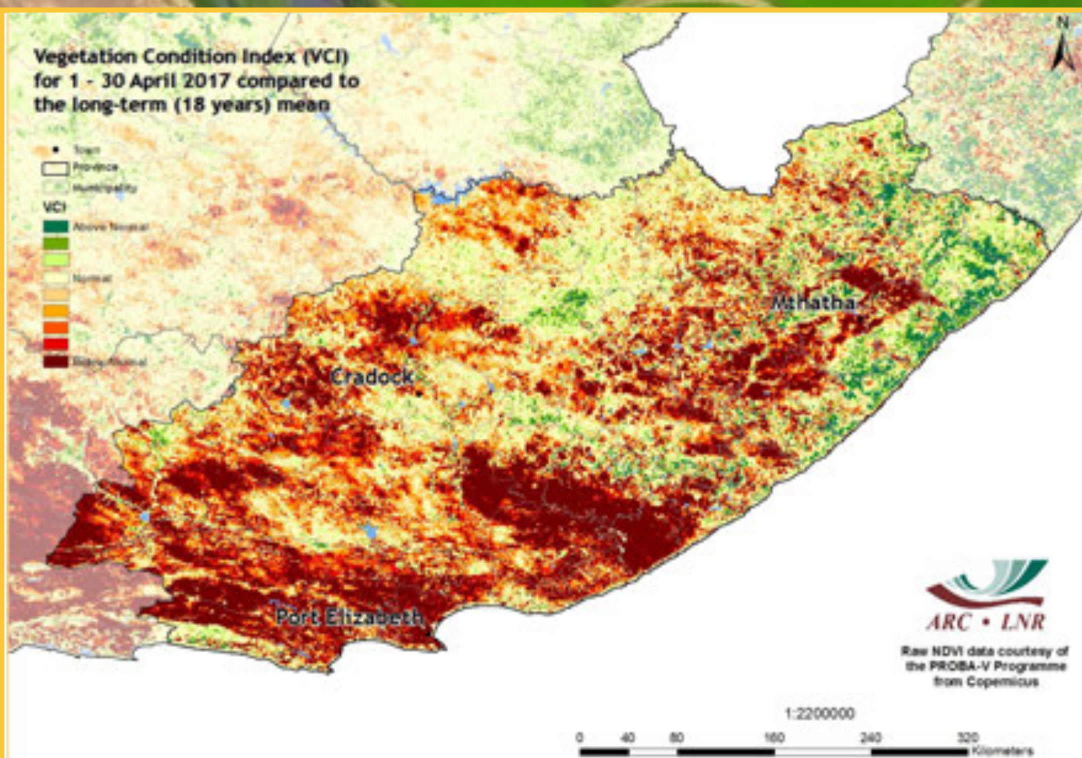


Figure 17

Figure 16:
The VCI map for April indicates below-normal vegetation activity over most parts of the Western Cape.

Figure 17:
The VCI map for April indicates below-normal vegetation activity over most parts of the Eastern Cape.

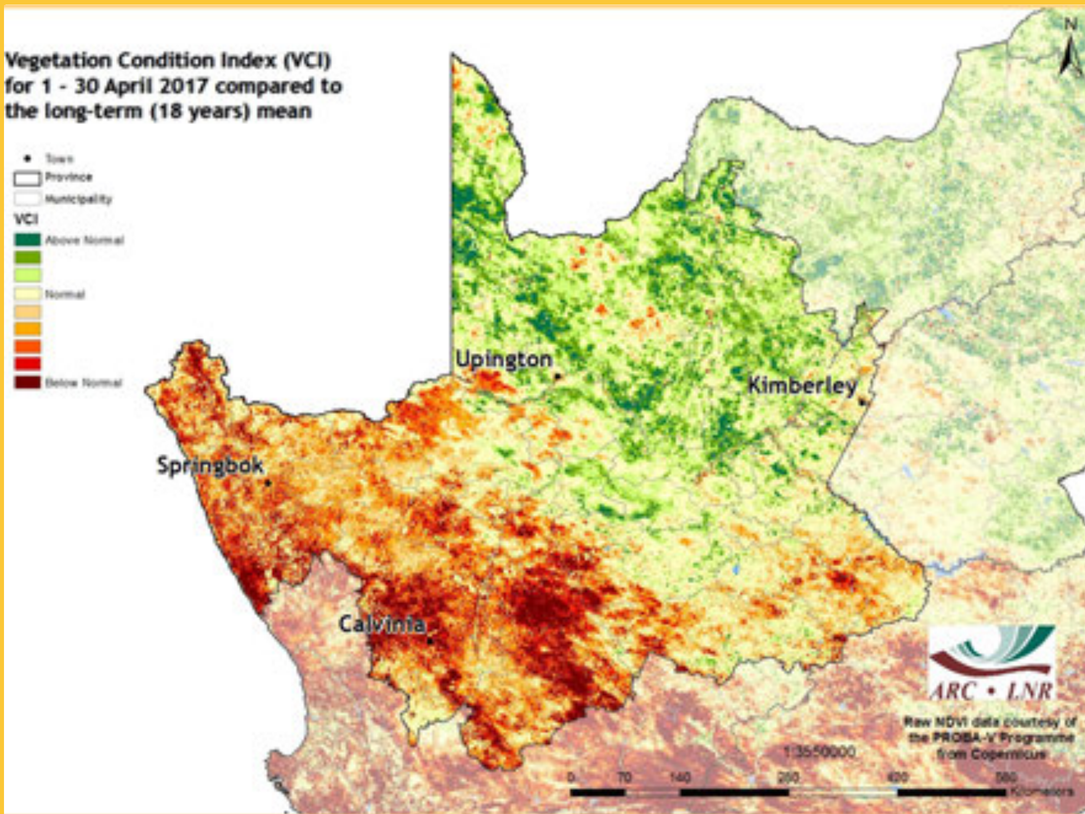


Figure 18

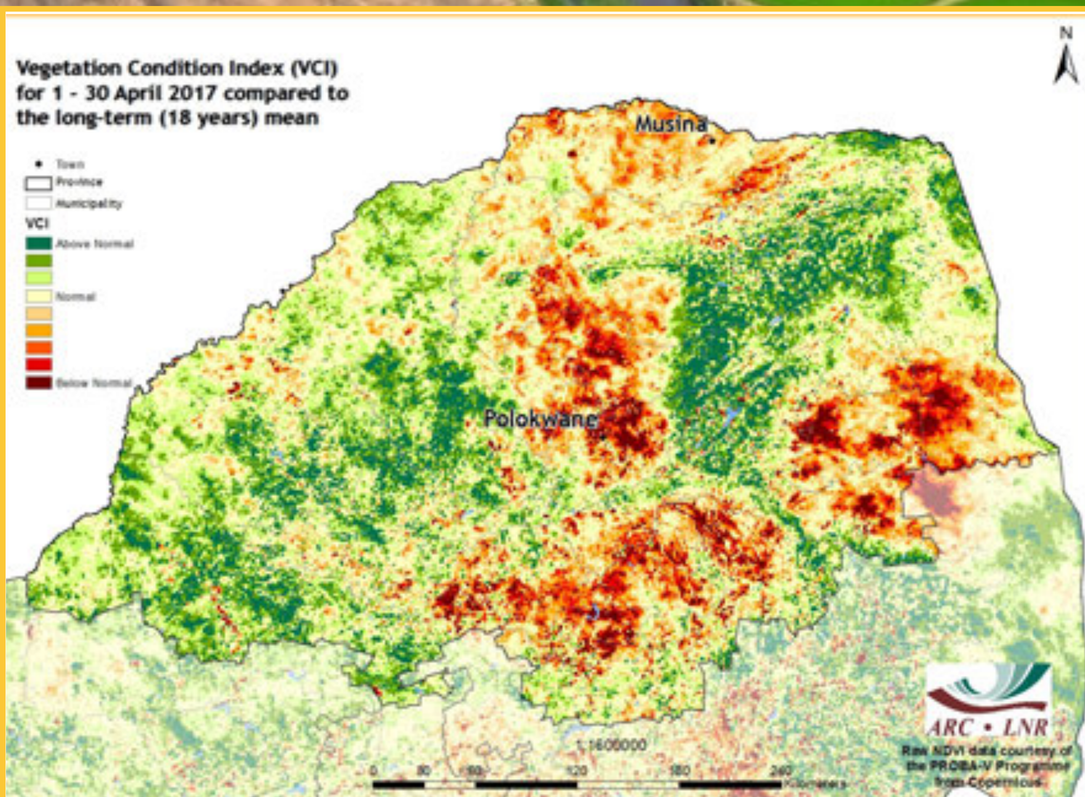


Figure 19

Figure 18:
The VCI map for April indicates below-normal vegetation activity over the southern and western parts of the Northern Cape.

Figure 19:
The VCI map for April indicates above-normal vegetation activity over the northern interior, central, southern interior to the northeastern parts of Limpopo.

Questions/Comments:
NkambuleV@arc.agric.za

7. Vegetation Conditions & Rainfall

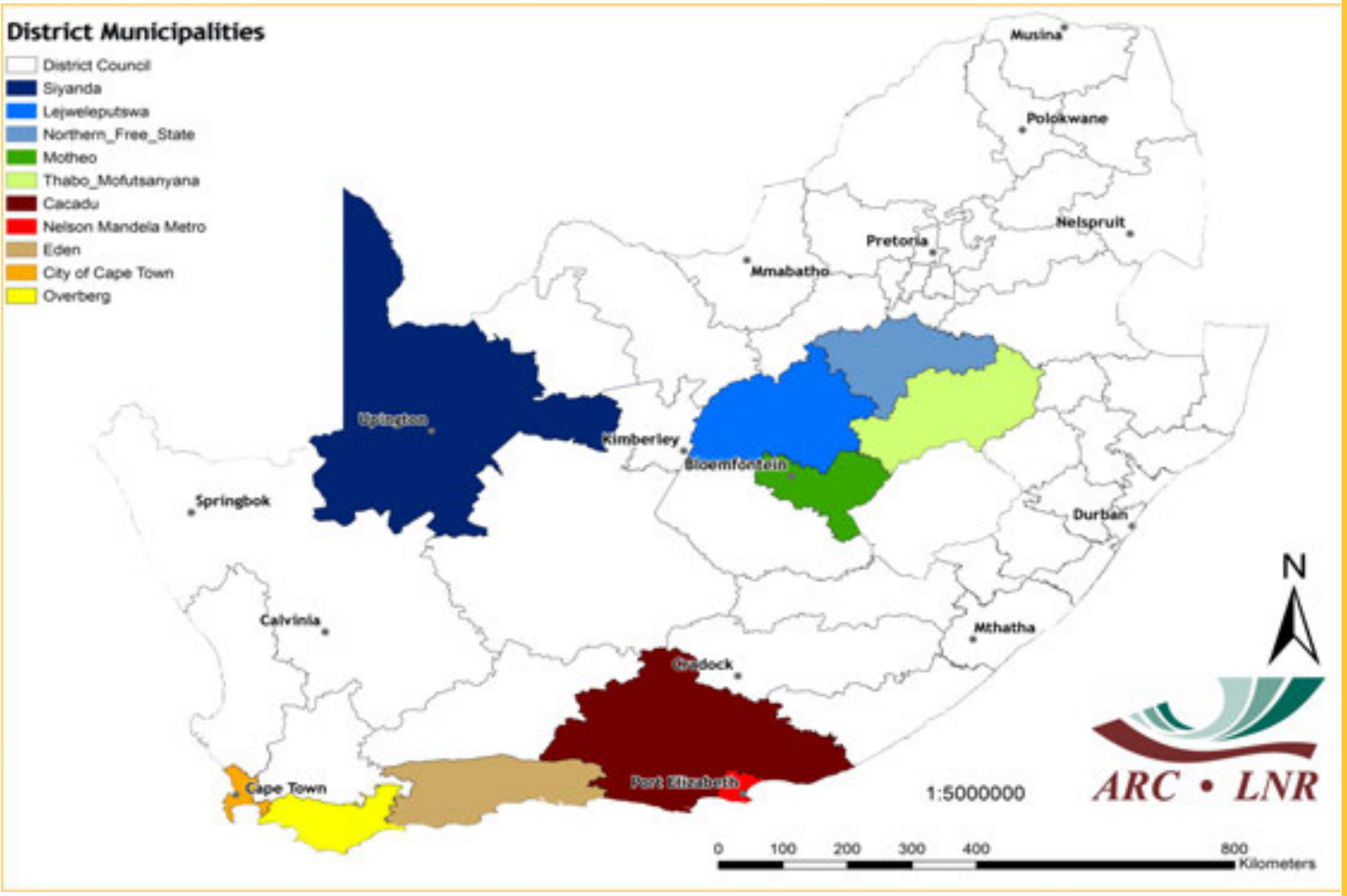


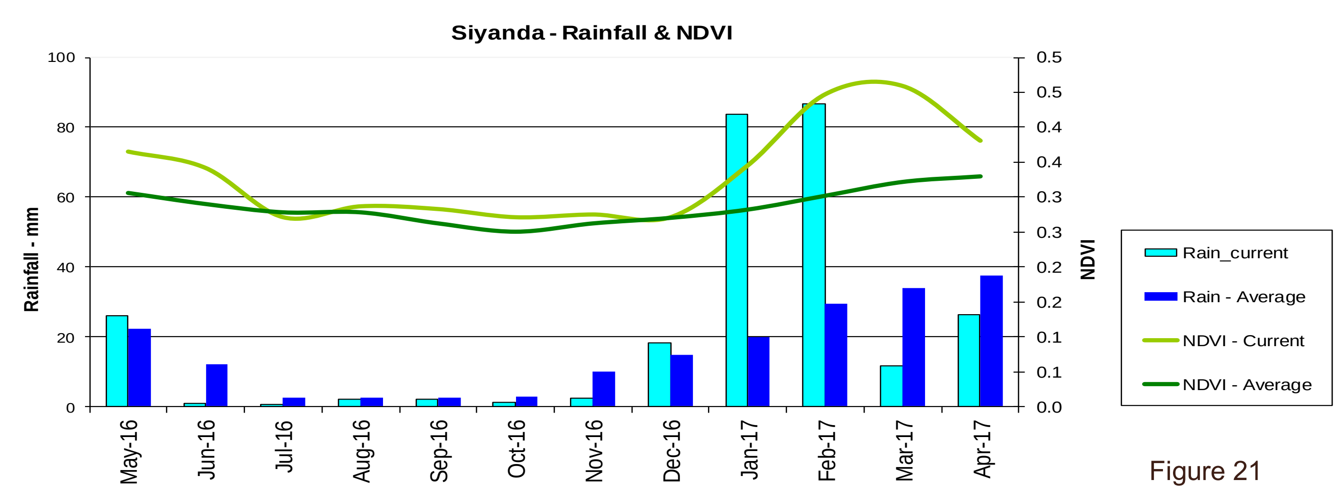
Figure 20

NDVI and Rainfall Graphs
Figure 20:
Orientation map showing the areas of interest for April 2017. The district colour matches the border of the corresponding graph.

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

Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

Figures 26-30:
Indicate areas with lower cumulative vegetation activity for the last year.



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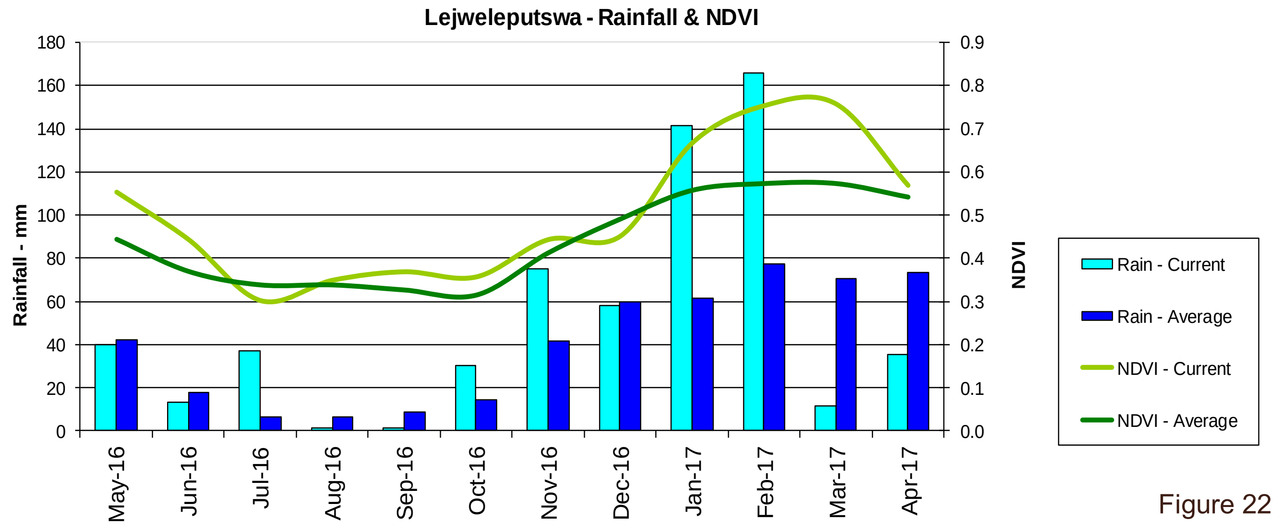

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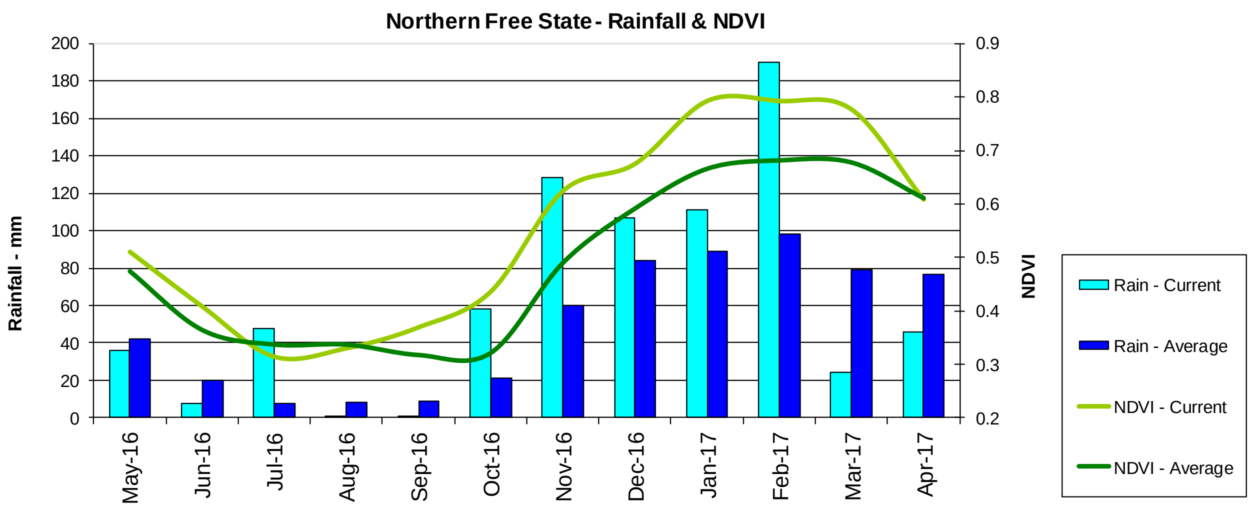

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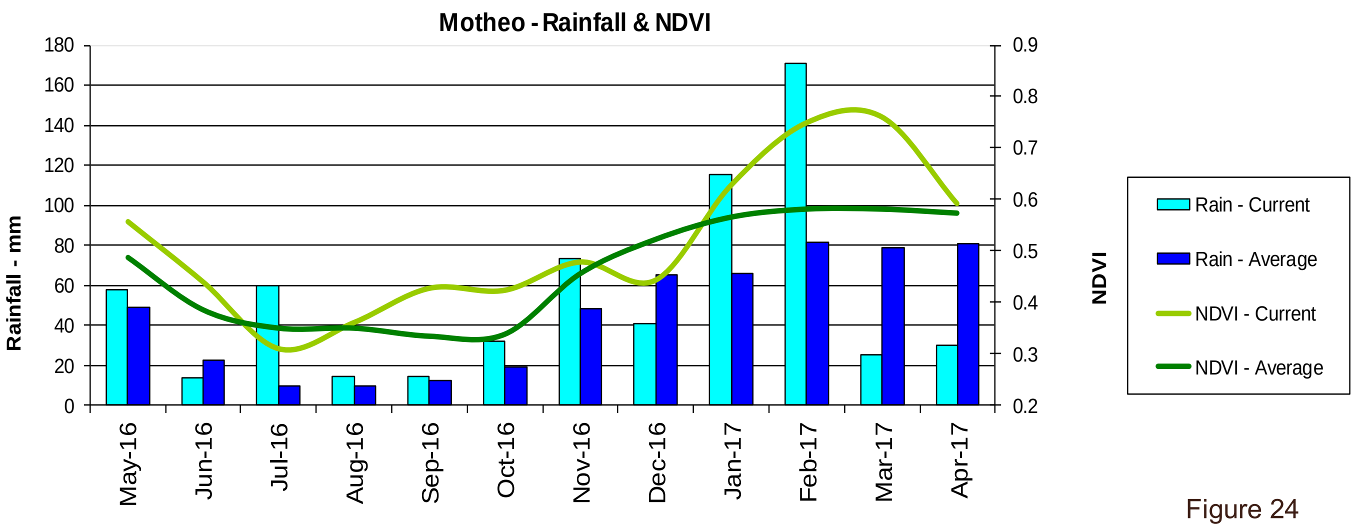

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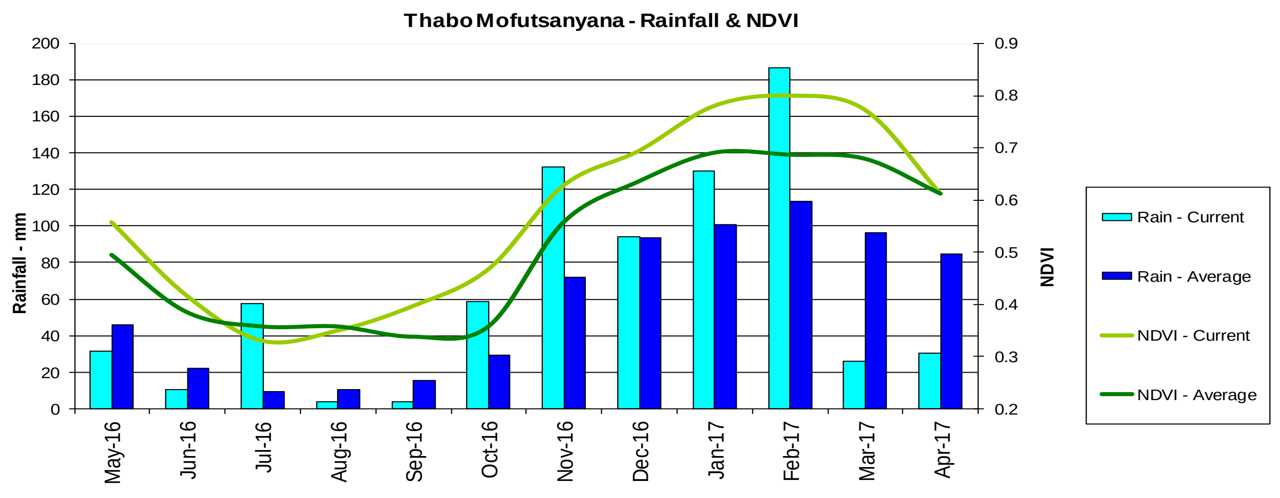

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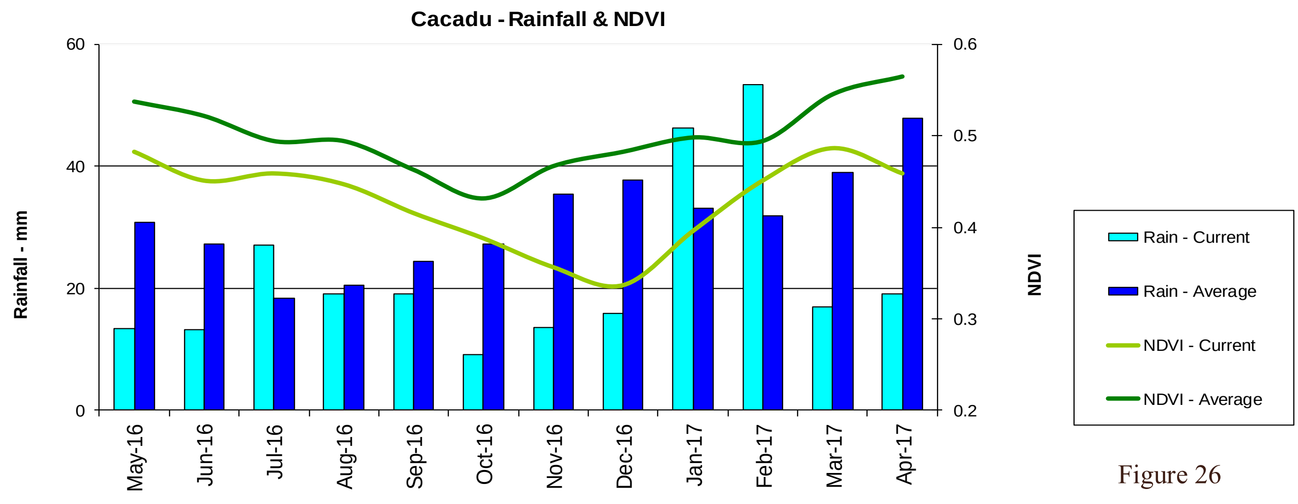

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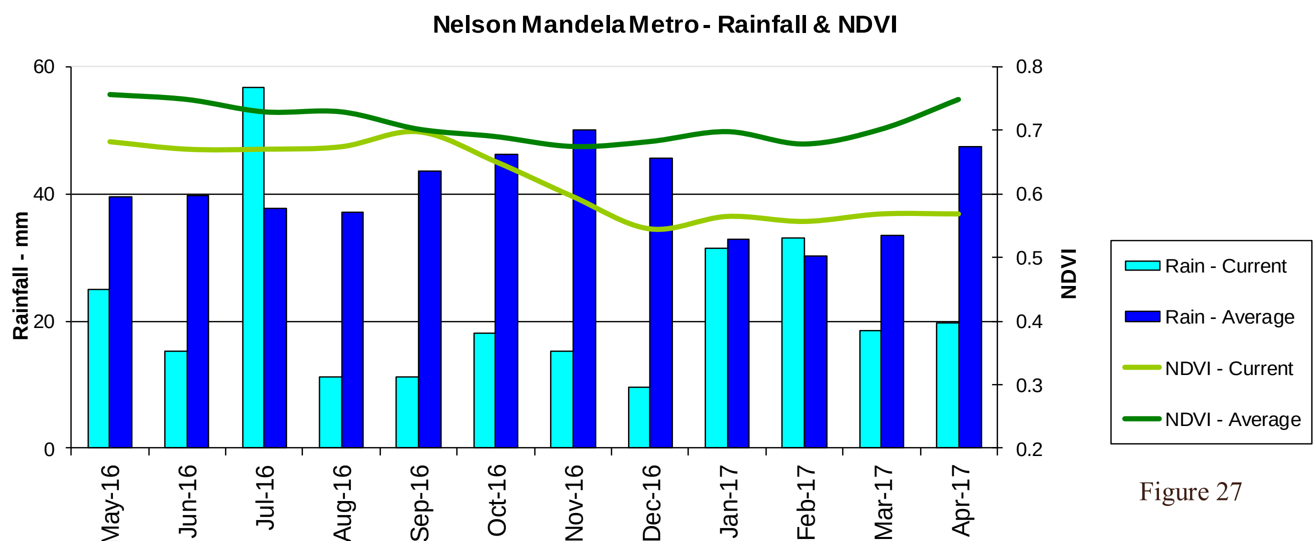

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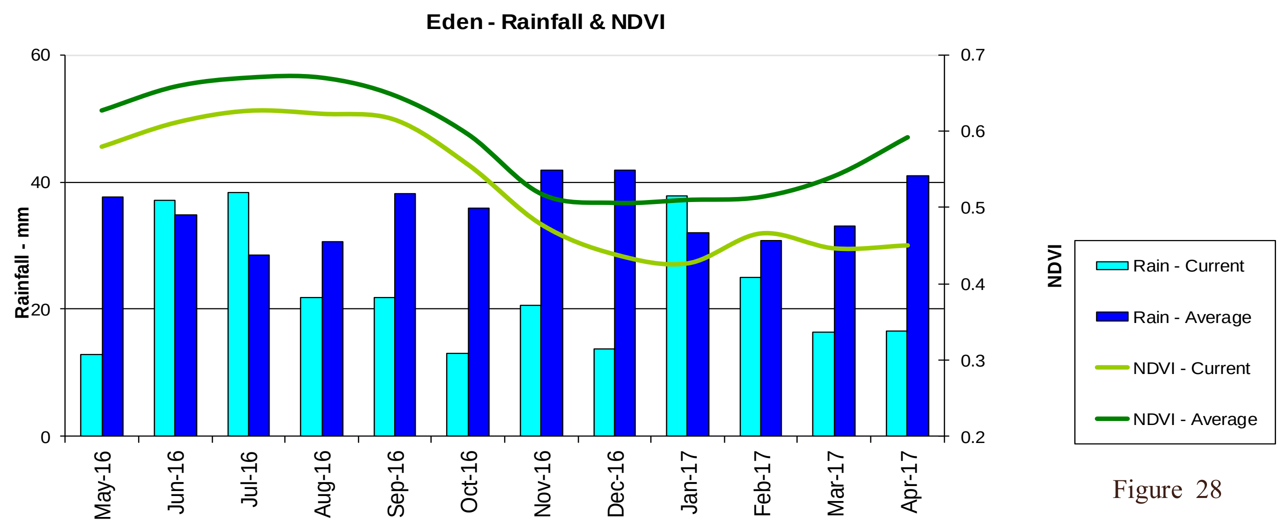

Figure 28

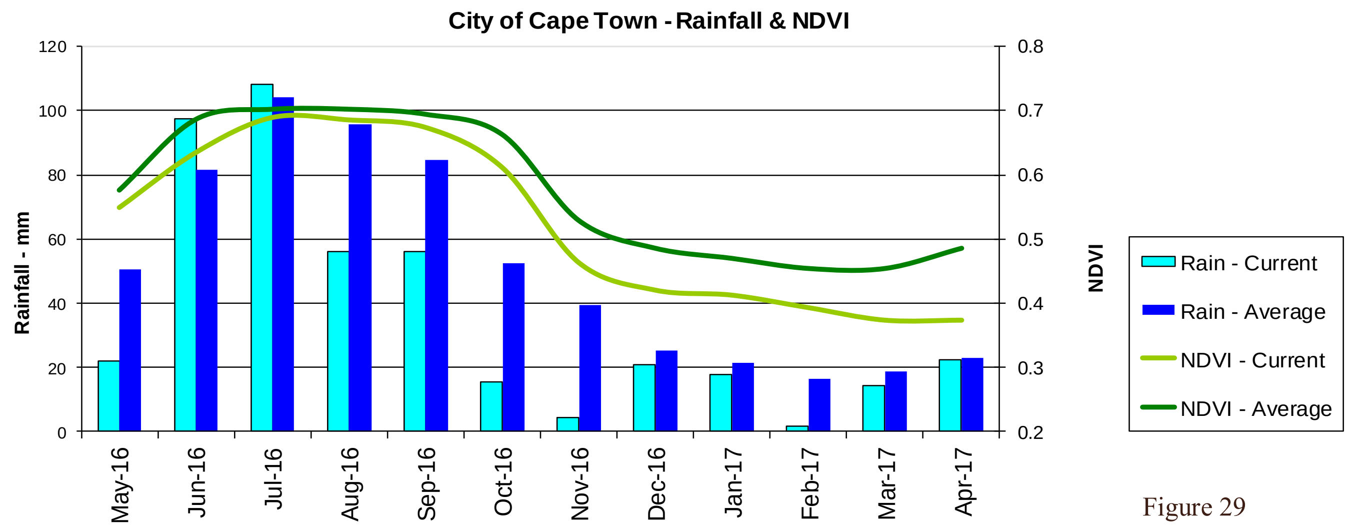

Figure 29

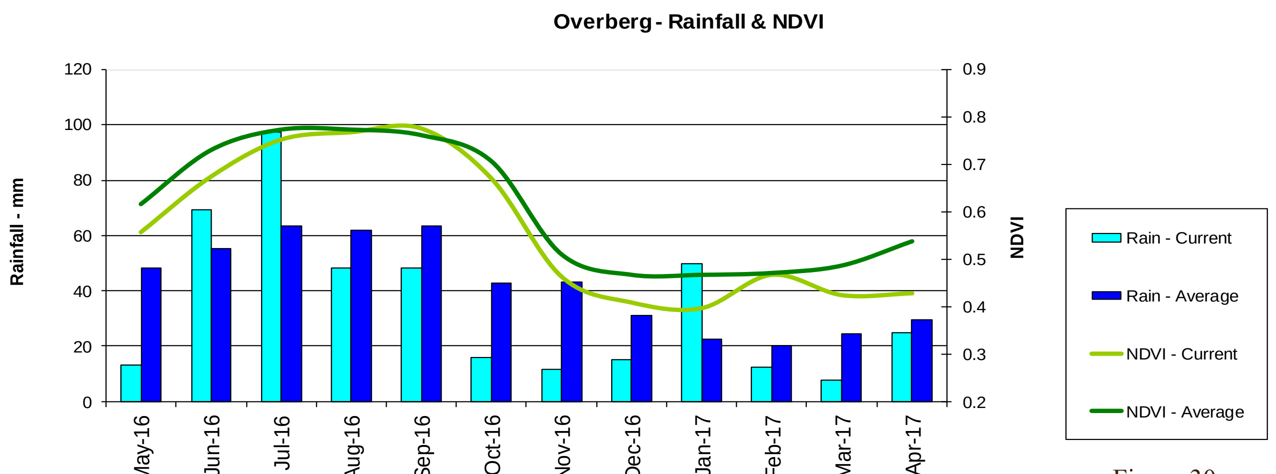

Figure 30

8. Soil Moisture

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Countywide soil moisture modelling by the University of KwaZulu-Natal Satellite Applications and Hydrology Group (SAHG)

Figure 31 shows the monthly averaged soil moisture conditions for April 2017. The colour scale ranging from brown to blue represents the Soil Saturation Index (SSI), defined as the percentage saturation of the soil store in the TOPKAPI hydrological model. The modelling is intended to represent the mean soil moisture state in the root zone. Figure 32 shows the SSI difference between April and March with brown colours showing the drier and the green colours the wetter areas. Similarly, the year-on-year SSI difference for April is shown in Figure 33.

The year-on-year and month-on-month SSI differences are in agreement with rainfall and vegetation trends observed elsewhere in the newsletter.

The SSI maps are produced at the ARC-ISCW in a collaborative effort with the University of KwaZulu-Natal Applications and Hydrology Group, made possible by the WMO.

Questions/Comments:
sinclaird@ukzn.ac.za

UNIVERSITY OF
KWAZULU-NATAL

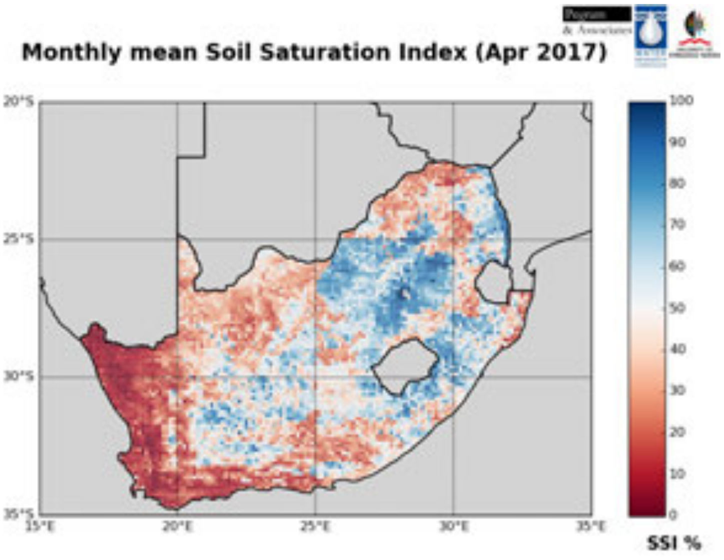

Figure 31

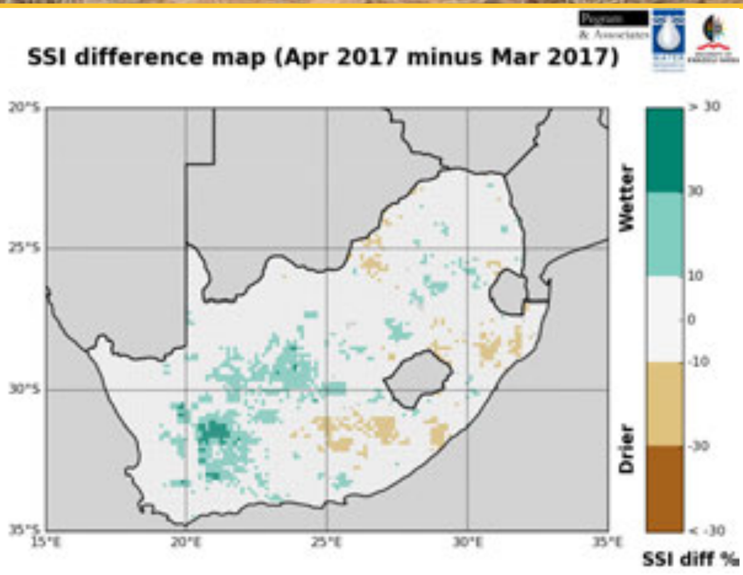

Figure 32

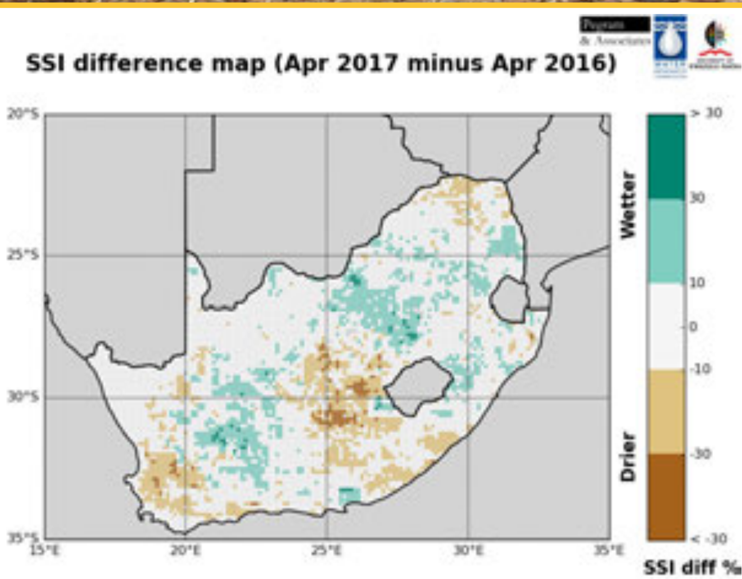

Figure 33

9. 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 34:
The graph shows the total number of active fires detected during the month of April per province. Fire activity was higher in all provinces except the Free State, Gauteng and the Northern Cape compared to the average during the same period for the last 17 years.

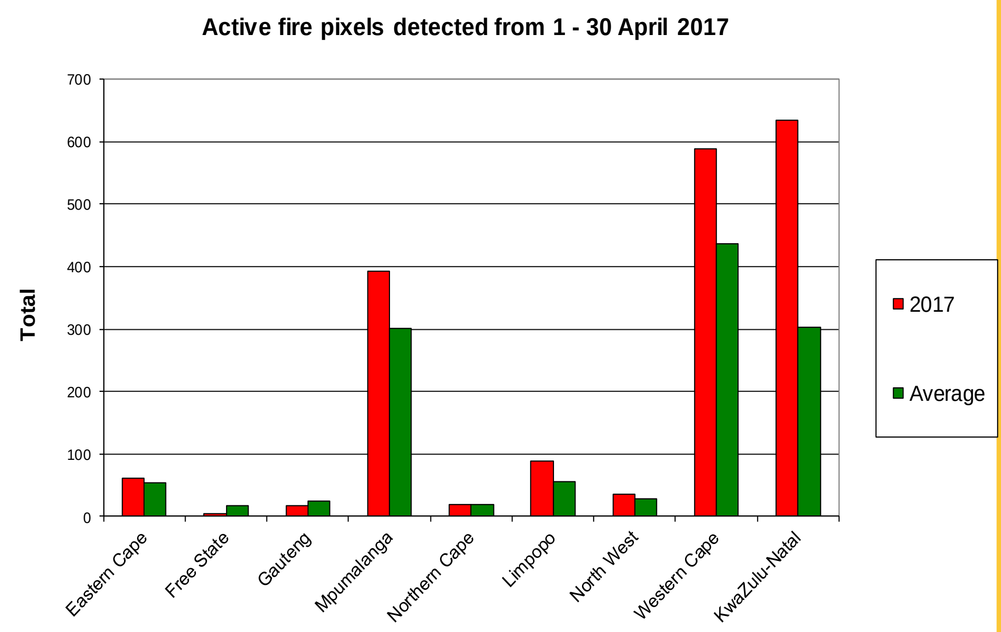

Figure 34

Figure 35:
The map shows the location of active fires detected between 1-30 April 2017.

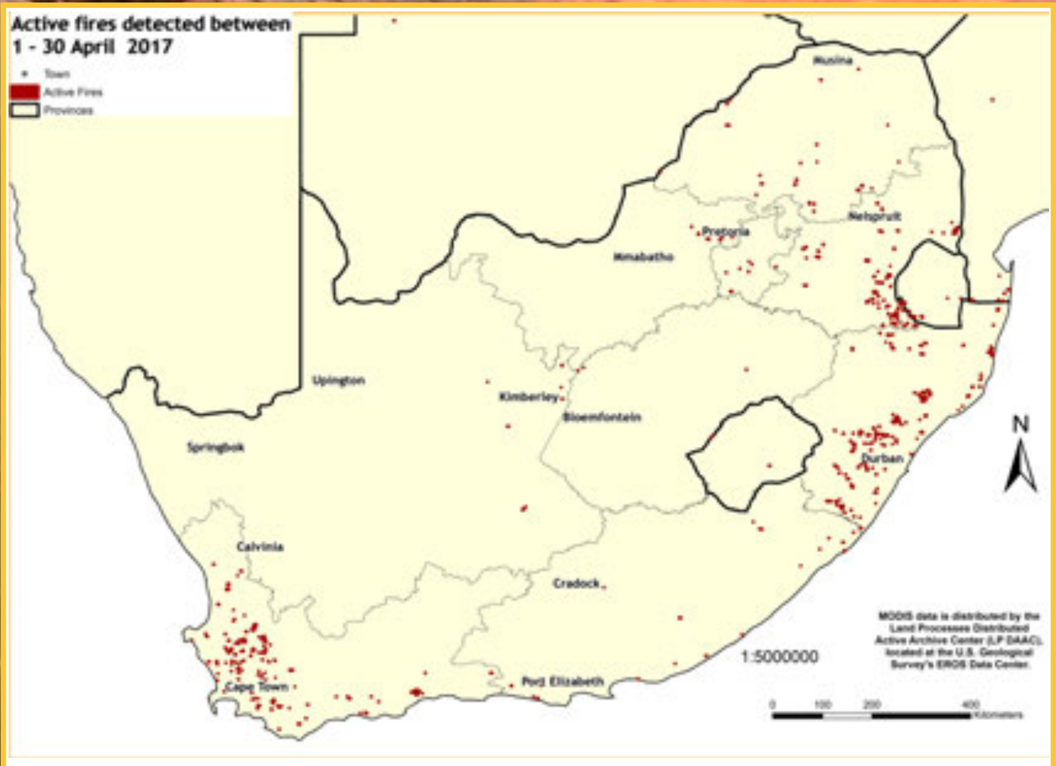

Figure 35

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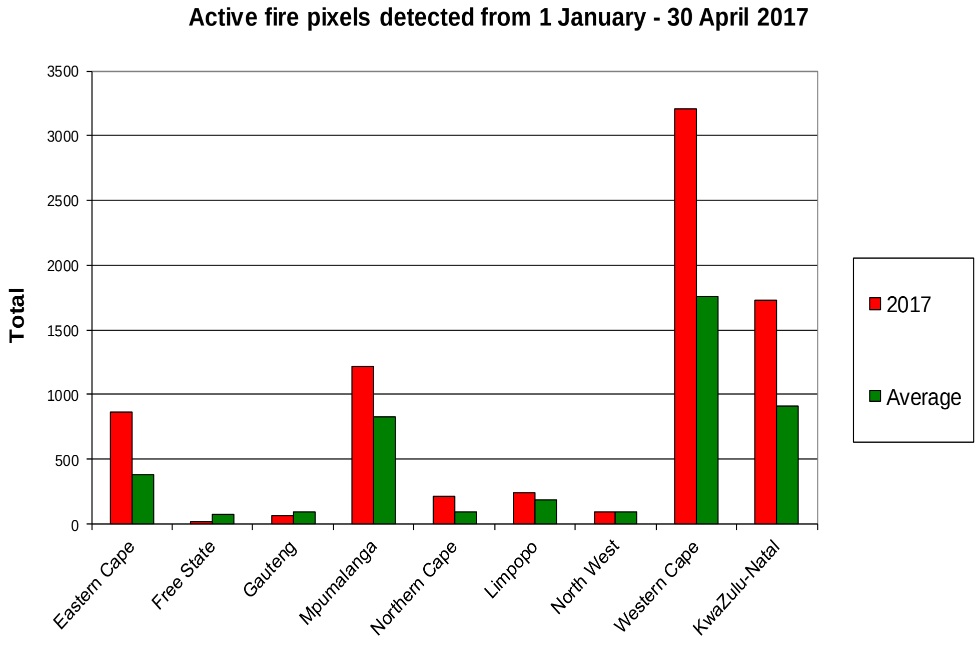

Figure 36

Figure 36:
The graph shows the total number of active fires detected from 1 January - 30 April 2017 per province. Fire activity was higher in all provinces except the Free State, Gauteng and North West compared to the average during the same period for the last 17 years.

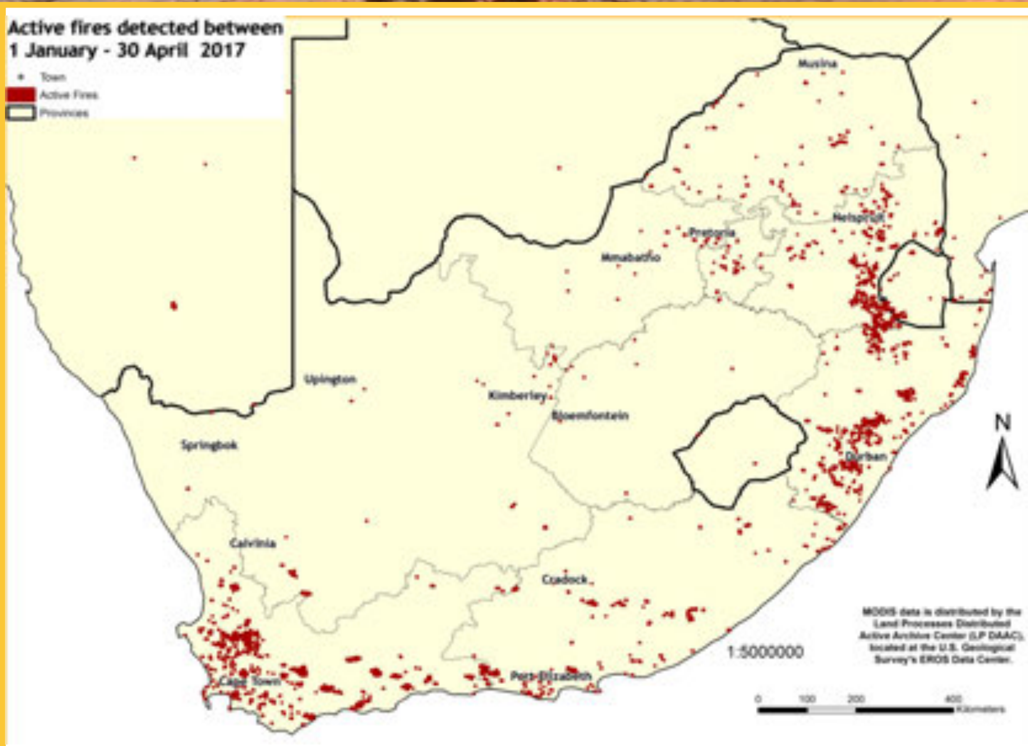

Figure 37

Figure 37:
The map shows the location of active fires detected between 1 January - 30 April 2017.

Questions/Comments:
NkambuleV@arc.agric.za

Agrometeorology

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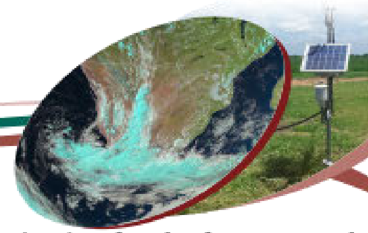

The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national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

Contact Person:
Dr Mitsuru Tsubo
Tel: 012 310 2502
E-mail: tsubom@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

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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

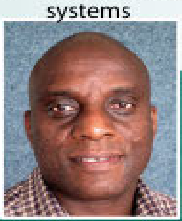
- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

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



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

Victoria Nkambule
Project Manager: Coarse Resolution Imagery Database (CRID)
Phone: +27(0) 12 310 2533
Fax: +27 (0) 12 323 1157
E-mail: NkambuleV@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:
Victoria Nkambule – 012 310 2533, NkambuleV@arc.agric.za
Adri Laas – 012 310 2518, AdriL@arc.agric.za

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

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

http://www.agis.agric.za