ARC • LNR
Excellence in Research and Development

UMLINDI
The Watchman

ISSUE 2017-11 | 17 NOVEMBER 2017

INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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

South African Weather Service

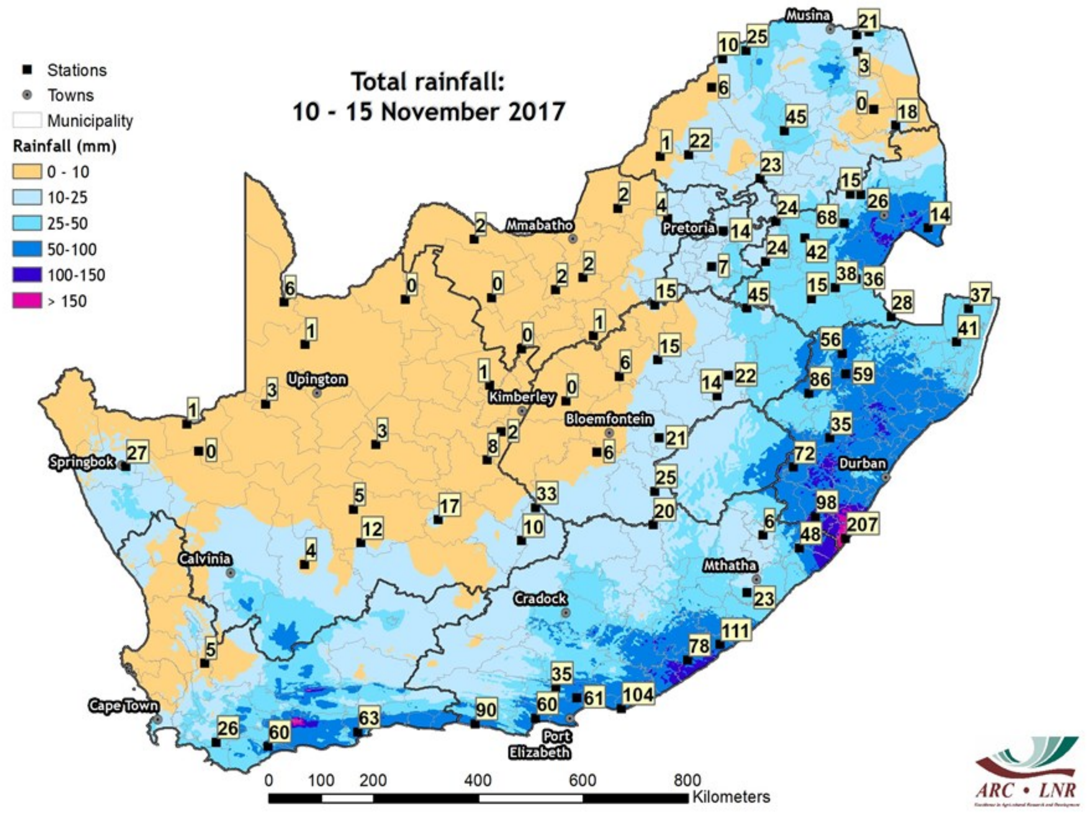
AMESD

161st Edition

Image of the Month

Mid-November cold snap

After the good start to the summer rainfall season that occurred at the end of September and the start of October, the latter half of October was relatively dry over the summer rainfall region of South Africa, followed by hot conditions at the start of November. However, South Africans were reminded of just how variable our weather can be when a significant cold snap occurred towards mid-November. The combination of a strong surface high pressure system and strong upper air circulation in the form of a cut-off low introduced cold and wet conditions on the 14th and 15th. Good falls of rain occurred along the Cape south coast, exceeding 100 mm in some places in the vicinity of Port Elizabeth and along the Wild Coast, with even higher amounts recorded along the southern KwaZulu-Natal coast (see rainfall map below). This cold snap even resulted in snowfalls over the mountainous regions of the southern and southeastern interior and as far north as the northeastern Free State. A rare phenomenon for this time of year – freezing rain – was also reported in Bloemfontein early on the 16th of November.



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

Overview:
With a surface trough located over the far western parts as a frontal system approached the country, and anticyclonic circulation over the Indian Ocean feeding moisture in over southern Africa, the month of October commenced with thunderstorm activity over large parts of the interior. The frontal system was accompanied by a sharp upper air trough and facilitated the formation of a tropically sourced cloud band that moved over the central to eastern parts of South Africa from the 3rd to the 6th, developing briefly into a cut-off low on the 6th before exiting the country, whilst the frontal system brought some rainfall to the Western Cape mountainous areas and along the southern coast. By the 9th a new cut-off low developed over the western interior, moving southeastwards the following day. A surface low developed in association with the cut-off low and caused widespread heavy rain over the southeastern parts of the country as it moved out into the ocean near Durban. The atmospheric circulation over the next few days was characterized by the cut-off low that had moved far southeastwards over the ocean, resulting in diminished cloud activity over the country, except for some cloud confined to the southern and eastern coastal regions. Weak frontal systems moved in over the far southwestern parts of the country during 15-19 October, resulting in little rainfall. By the 20th the circulation had changed to anomalously higher pressure to the east of the country over the Indian Ocean. With an approaching upper air trough, conditions were favourable for the development of thundershowers within a cloud band over the central to eastern parts of the country over the next few days. By the 25th a frontal system moved in over the Western Cape which had good upper air support and was accompanied by rainfall as it moved eastwards. Also, a strong surface high pressure system followed in the wake of this cold front, advecting cold air over the interior. By the 28th of October this strong surface high pressure system was situated to the east of the country and caused cloudy and cold conditions over the eastern parts with maximum temperatures as low as 7°C recorded along the Mpumalanga escarpment. The month concluded with the formation of a band of thunderstorms over the extreme western parts, triggered by the influx of moisture and the anomalous far westward location of the surface trough in response to the strong high east of the country.

1. Rainfall

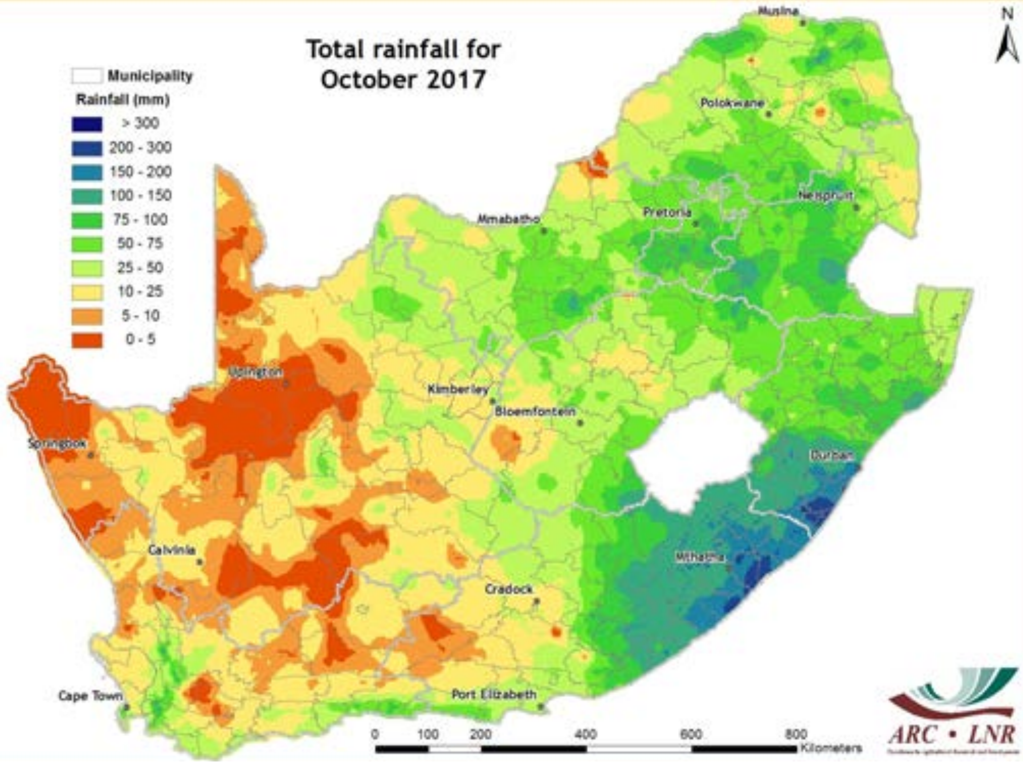


Figure 1

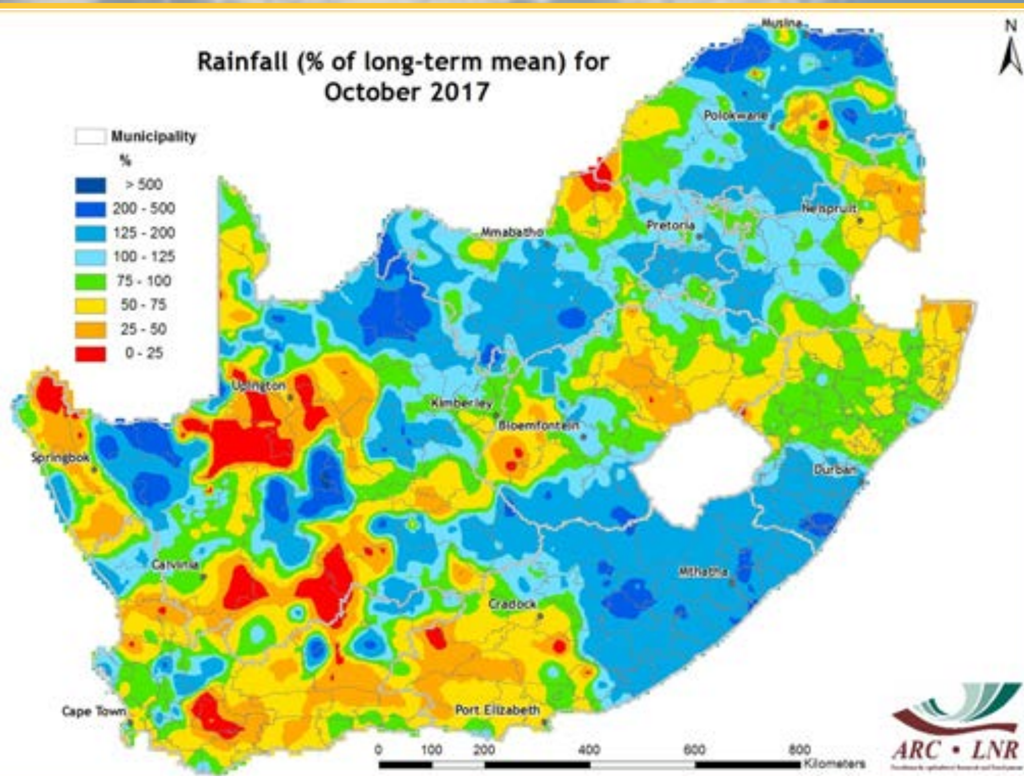


Figure 2

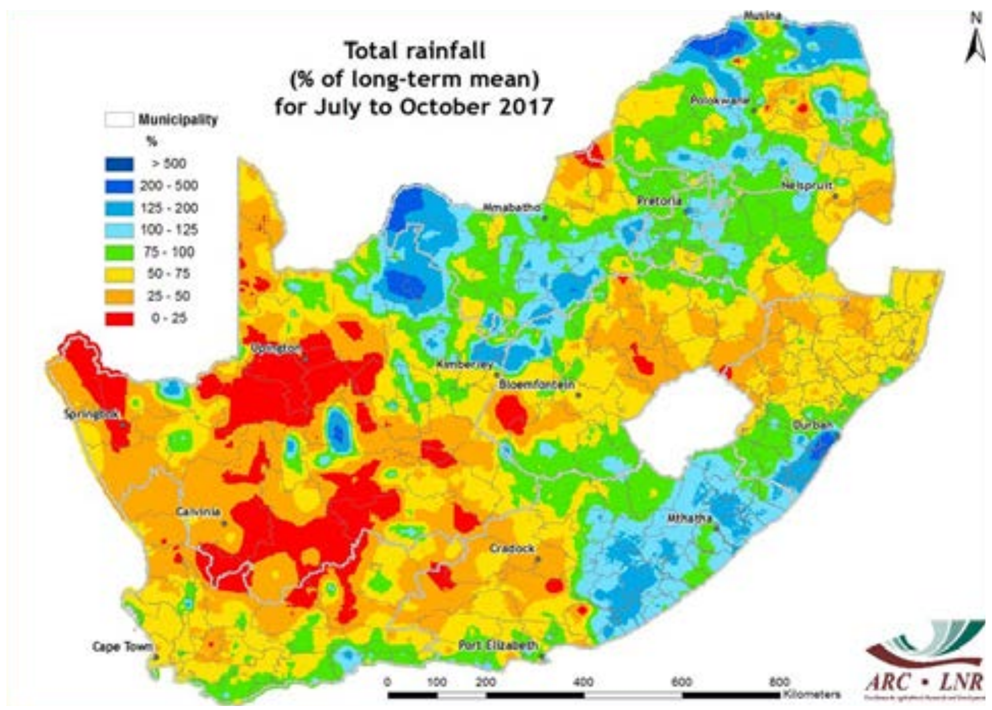


Figure 3

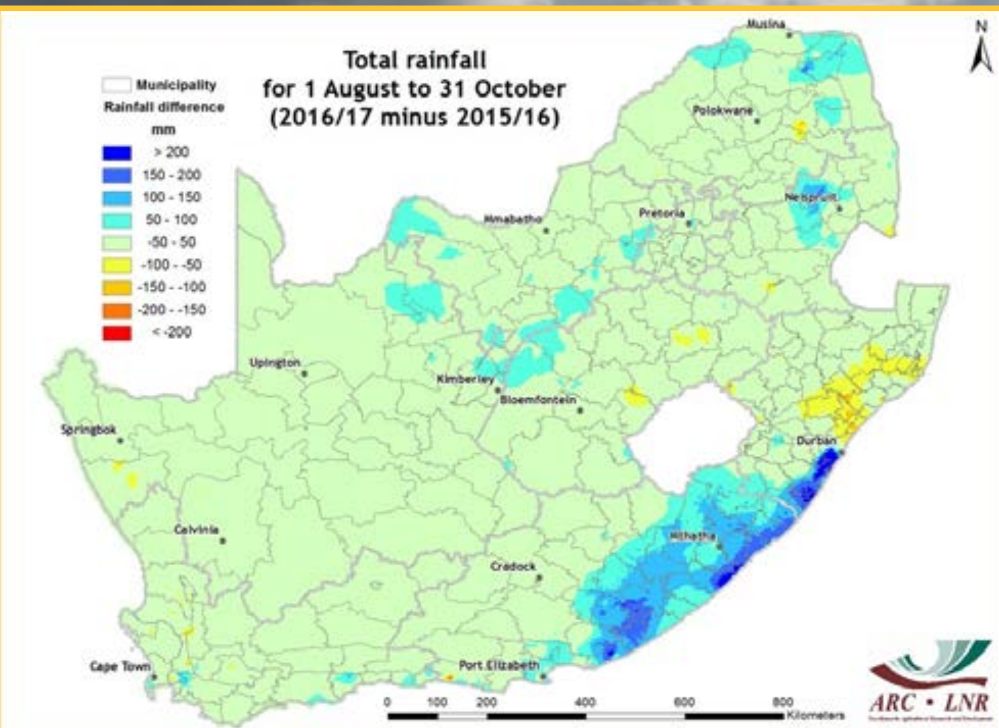


Figure 4

Figure 1:
Good rainfall totals occurred in October over most of the eastern parts of the country, particularly along the coast and adjacent interior in the southeast. The largest contribution to this rainfall occurred during the first week of the month. Good rainfall totals, although of an isolated nature, also occurred over the western and central interior.

Figure 2:
Above-normal rainfall occurred over large parts of the interior as well as over the southeastern parts of the country. Most of the above-normal rainfall over the eastern parts of the country occurred towards the start of the month, while the areas of above-normal rainfall over the western parts of the country occurred around the middle and again at the end of the month.

Figure 3:
Over the past four months, near-normal rainfall occurred over the southern coastal belt with above-normal rainfall along the southeastern coastal belt and adjacent interior as well as over some isolated areas in the north and northeast of the country. The winter rainfall region, apart from the southern coastal area, received mostly below-normal rainfall.

Figure 4:
Over most of the country, rainfall during the 2017 August to October period was very similar to the corresponding 2016 period. Over the southeastern coastal belt and adjacent interior, however, up to 200 mm more rain was received in 2017 compared to the same period the previous year. Some isolated areas over the northern and northeastern parts of the country also experienced a wetter 2017 with about 100 mm more rainfall compared to the corresponding 3-month period in 2016.

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 all the time scales, severe to extreme drought conditions are present over most of the winter rainfall region. Over the eastern parts of the country, severe to extreme drought conditions improve from the longer to the shorter time scales, whilst severe drought conditions are visible at the short time scale over the southern interior.

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

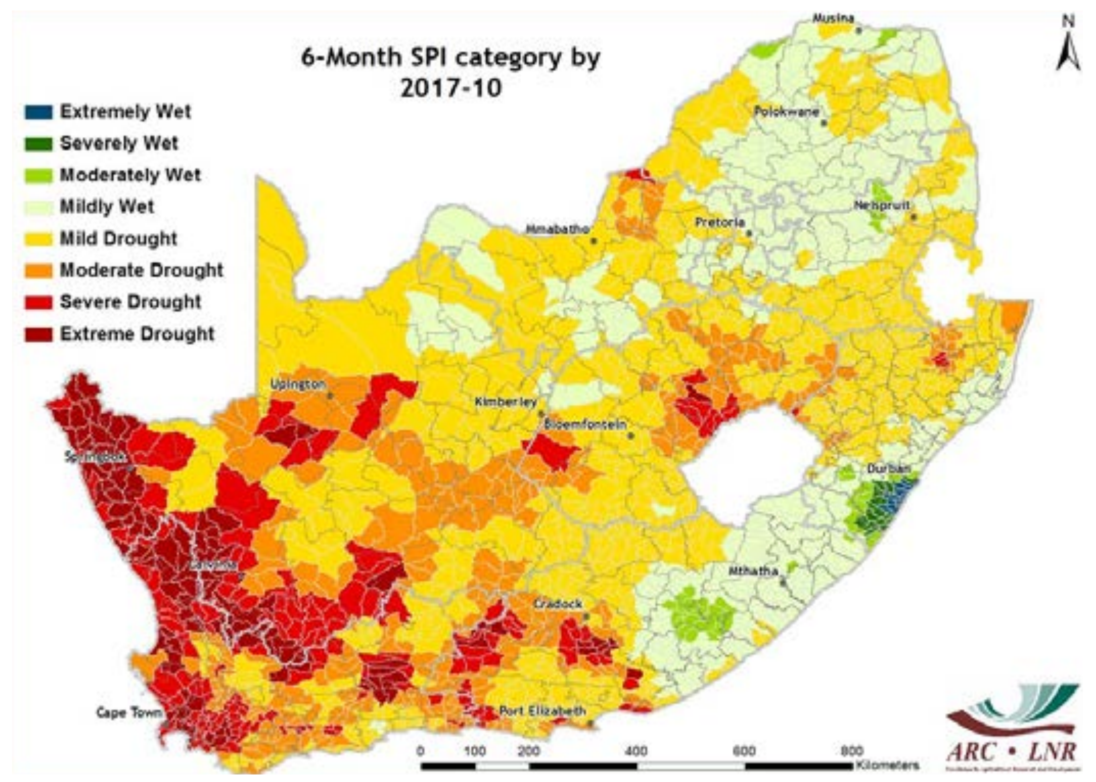


Figure 5

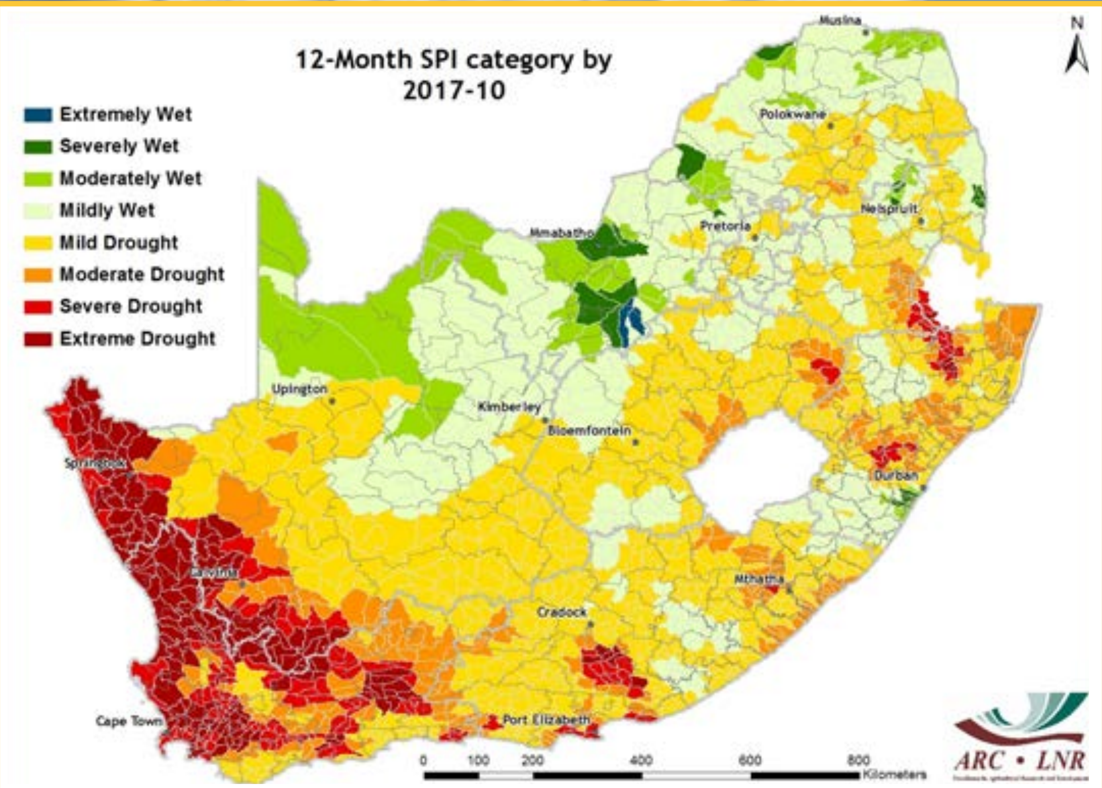


Figure 6

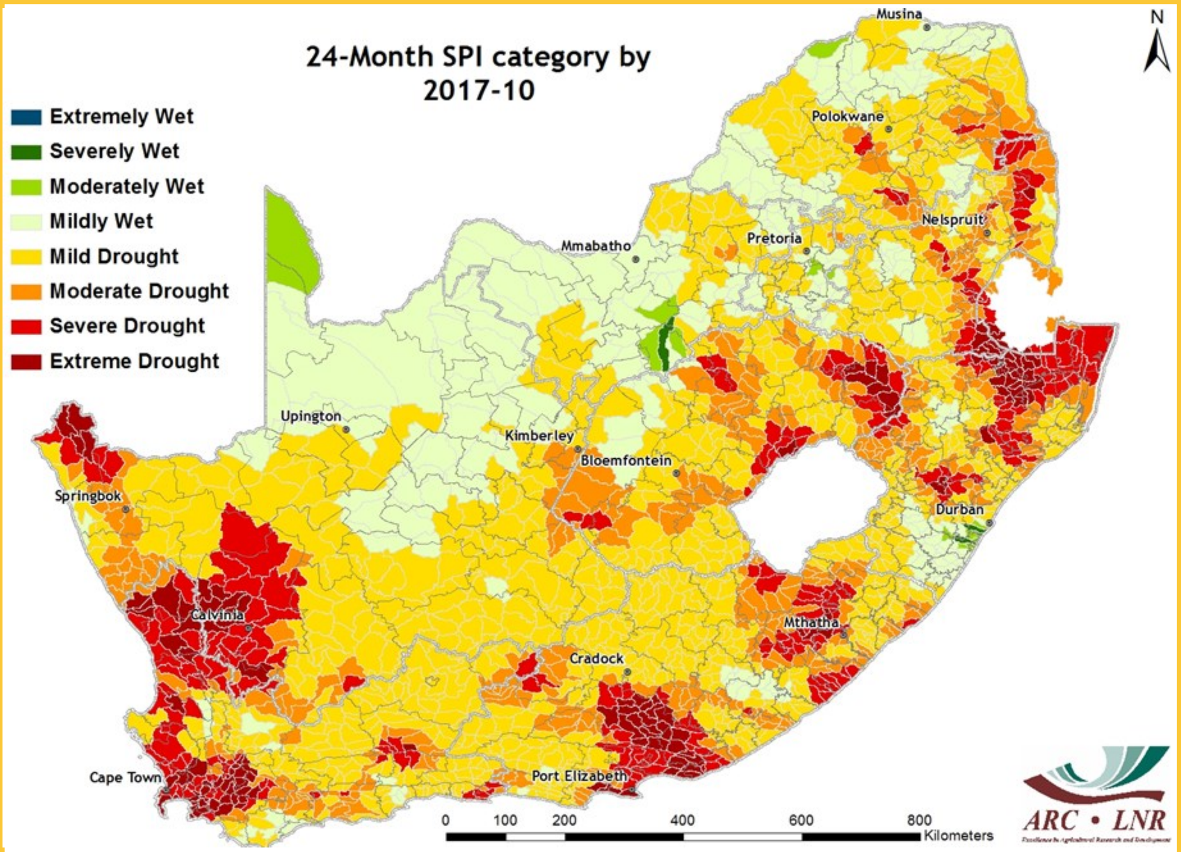


Figure 7

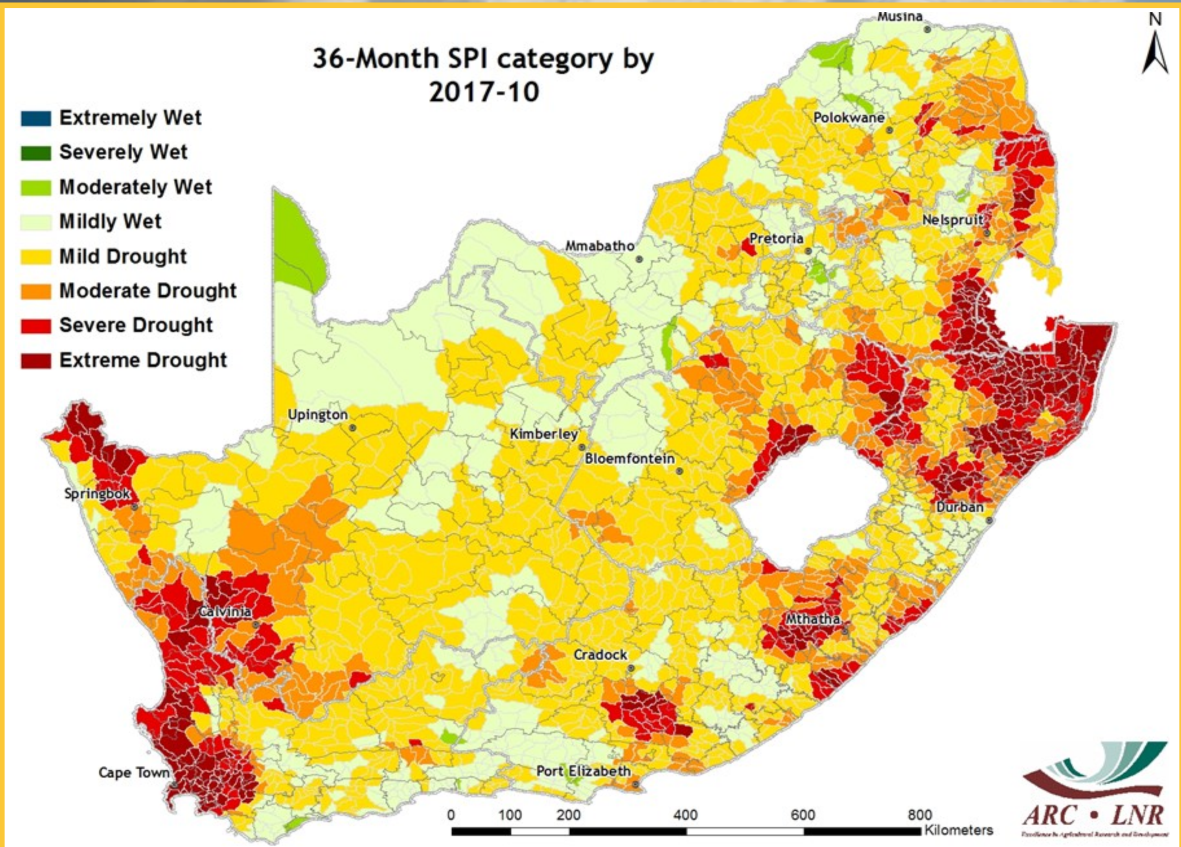


Figure 8

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.

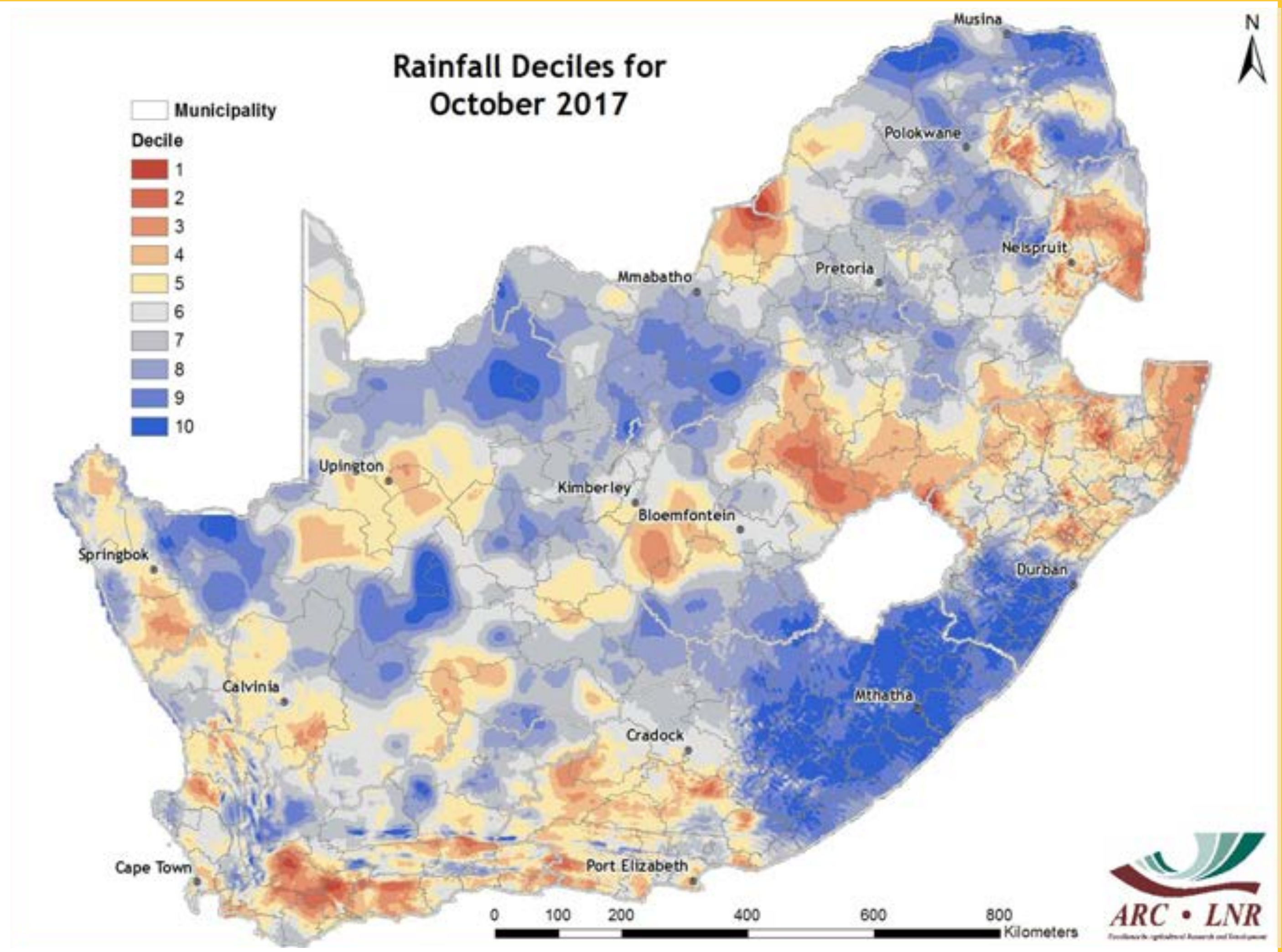


Figure 9

Figure 9:
Compared to historical rainfall totals during the month of October, October 2017 over most of the country compares well with the wetter October months, in particular over the far southeastern parts of the country. Over some areas along the southern coastal belt, as well as over isolated areas over the interior and parts of the Western Cape, October 2017 falls within the drier October months.

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

4. Water Balance

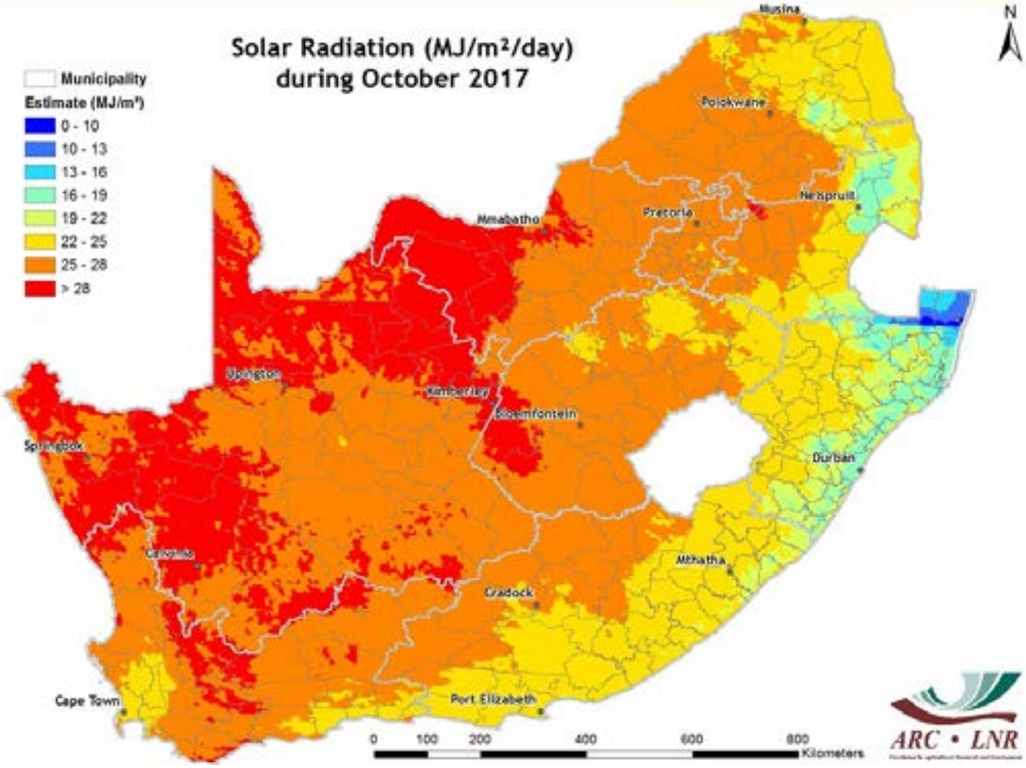


Figure 10

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 eastern coastal belt of the country and along the eastern escarpment, with increasing values further north and westwards.

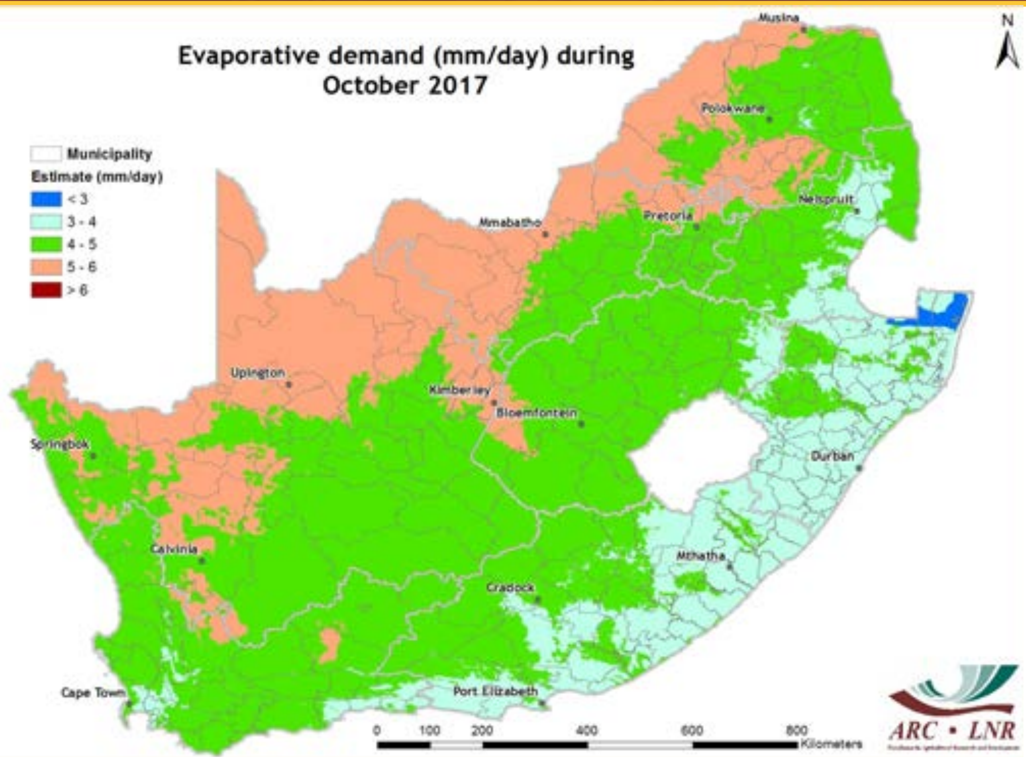


Figure 11

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 was lowest over the southeastern and eastern parts of the country, extending into the Mpumalanga southern escarpment. The evaporative demand increased towards the northern parts of the country where values exceeded 5 mm/day.

Questions/Comments:
EngelbrechtC@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 standard anomaly (according to the specific time of the year) of the NDVI.

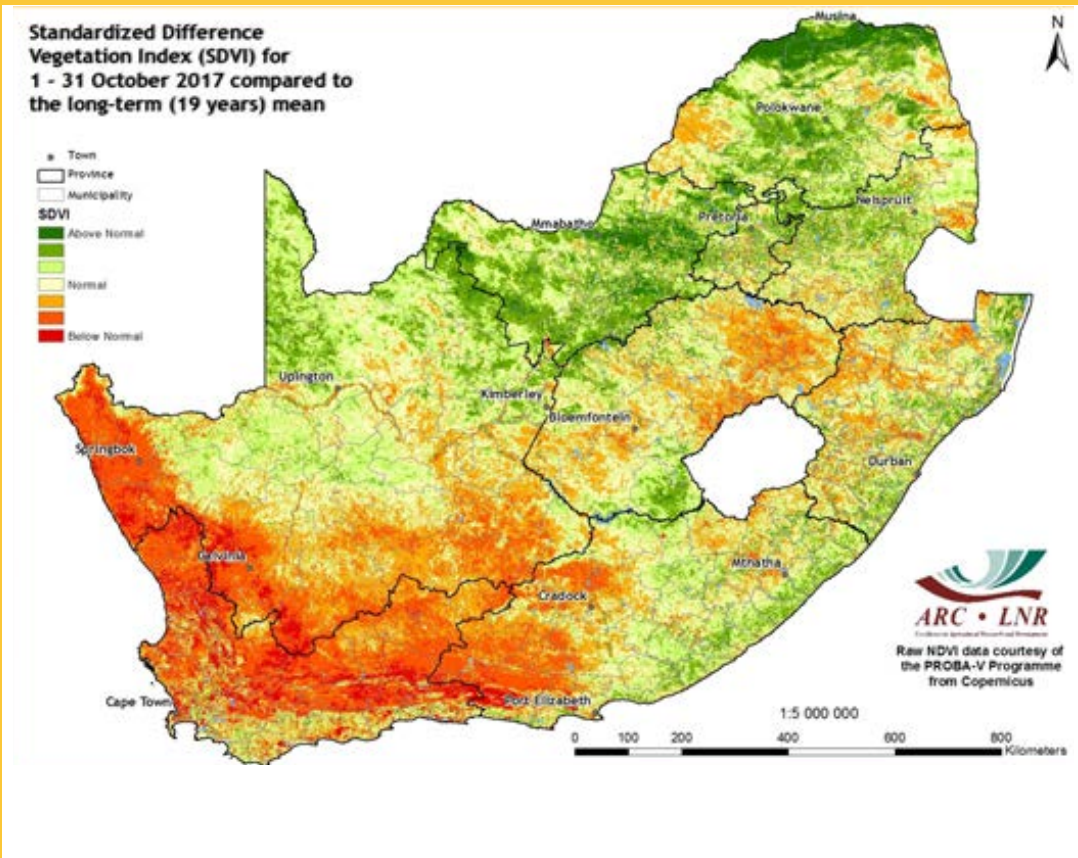


Figure 12

Figure 12:
The SDVI for October indicates above-normal vegetation activity over most of North West, Limpopo, central Mpumalanga and some northern parts of the Northern Cape. Meanwhile, the majority of the Little and Great Karoo and western parts of Namaqualand remain extremely dry. Some isolated areas in the Free State and KZN also experienced dry conditions.

Figure 13:
Vegetation activity is lower over the northern parts of the Free State, most of KZN and the Western Cape and southern parts of Mpumalanga. Moreover, southern parts of the Northern and Eastern Cape experienced dry conditions. Much of North West, Limpopo and northern parts of Mpumalanga as well as isolated parts of the Eastern Cape show above-normal vegetation activity.

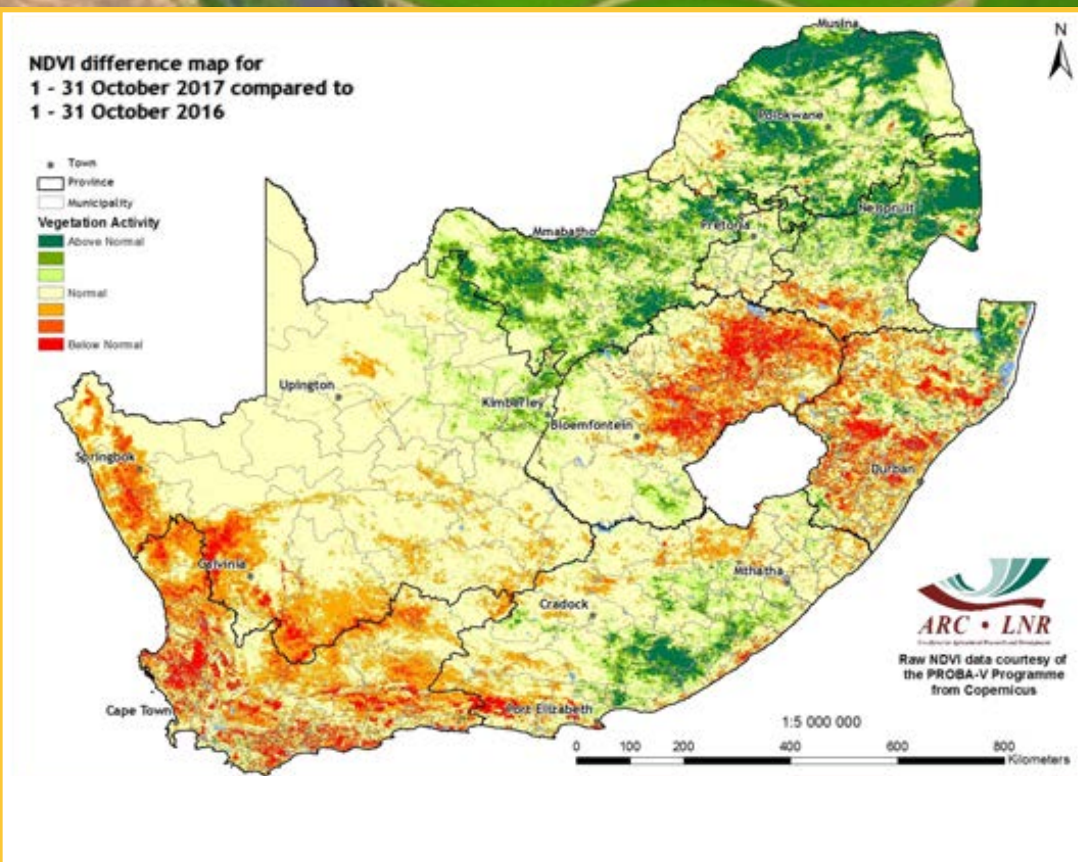


Figure 13

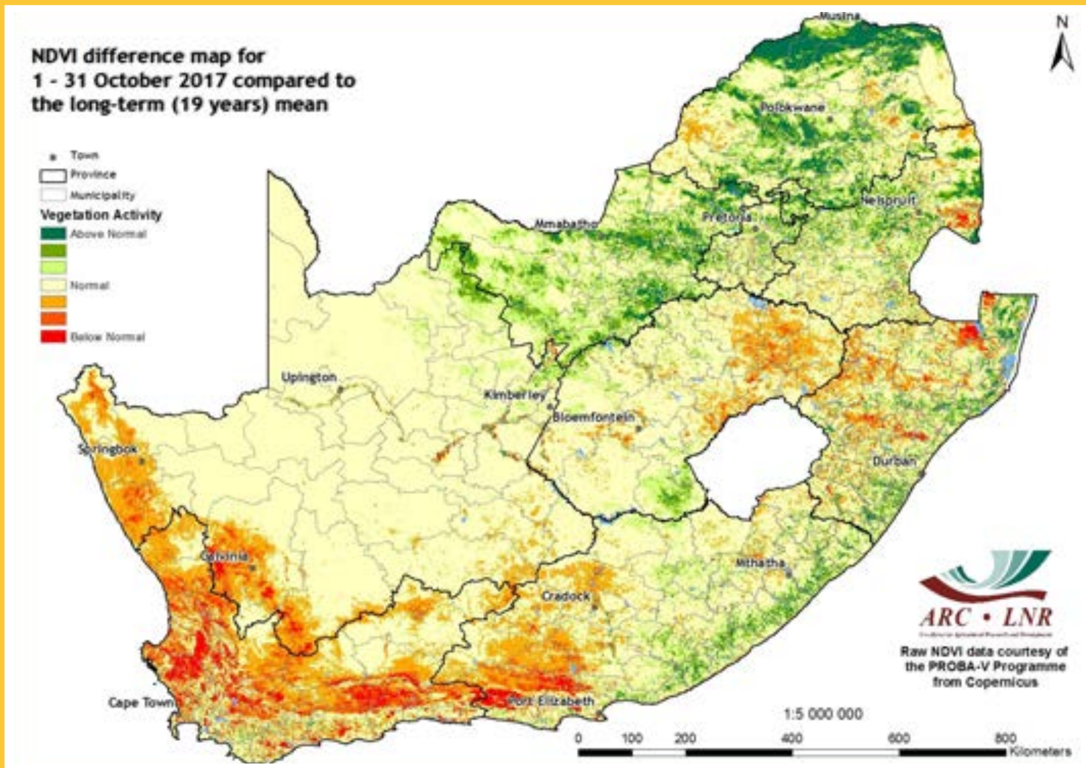


Figure 14

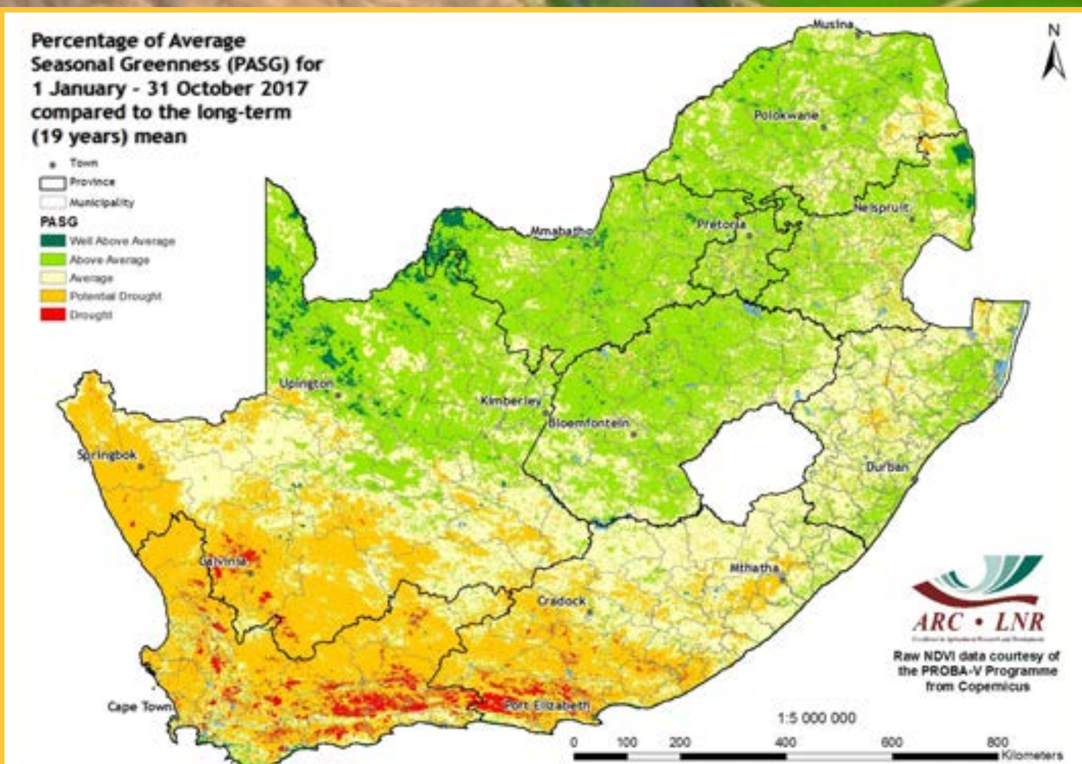


Figure 15

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 for October was lower over most of the winter rainfall region and the western parts of Namaqualand. Most of the Free State, Limpopo and some isolated parts of Mpumalanga and Kwa-Zulu-Natal experienced increased vegetation activity.

Figure 15:
Cumulative vegetation activity was above average over the Kalahari, Highveld, Bushveld and Lowveld. Meanwhile, potential drought conditions continue to dominate over the majority of the Western Cape and southern parts of the Northern and Eastern Cape. Drought conditions can also be observed over small distinct areas of the Cape regions.

Questions/Comments:
MaakeR@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.

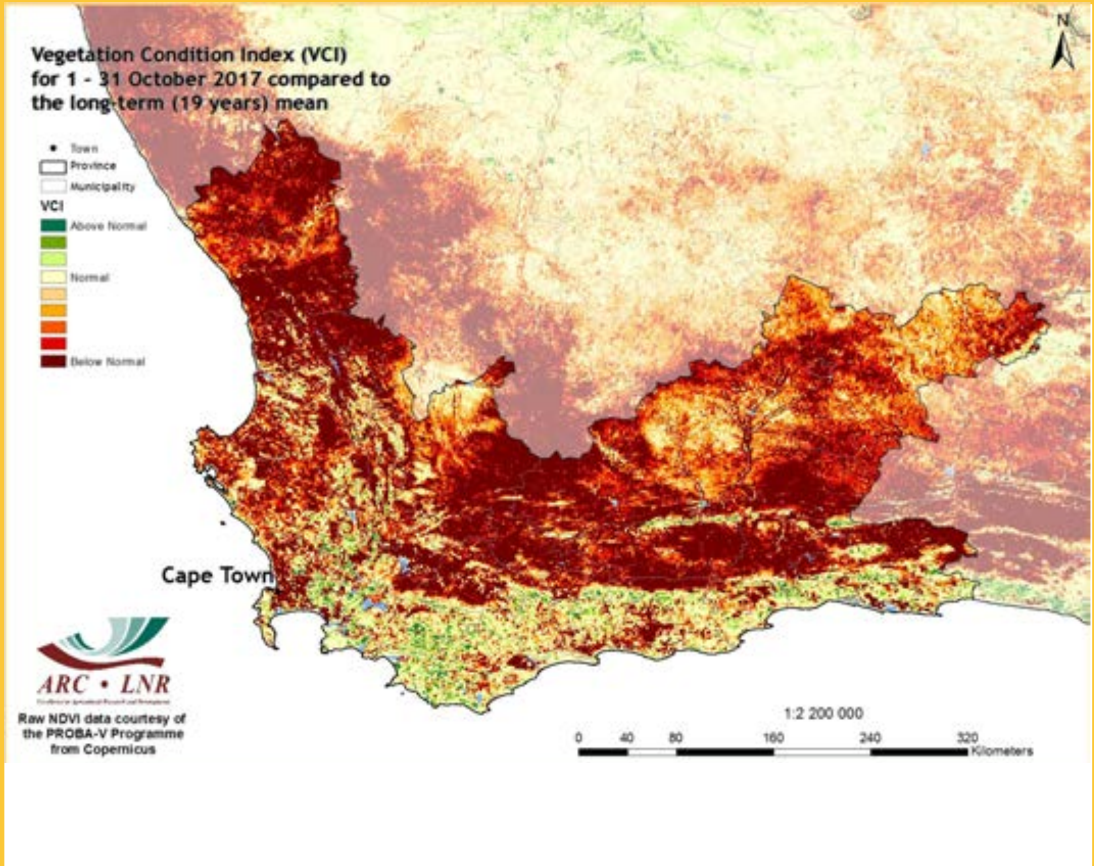


Figure 16

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

Figure 17:
The VCI map for October indicates below-normal vegetation activity over the western, southern and some isolated eastern parts of the Northern Cape.

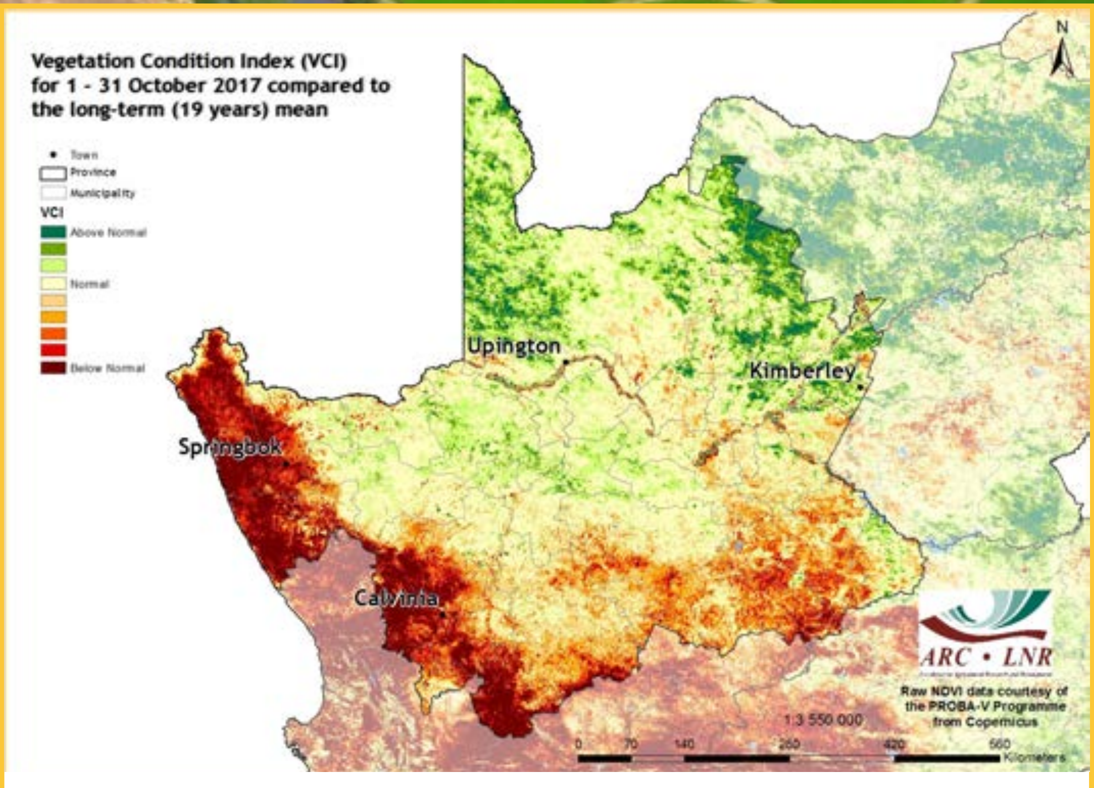


Figure 17

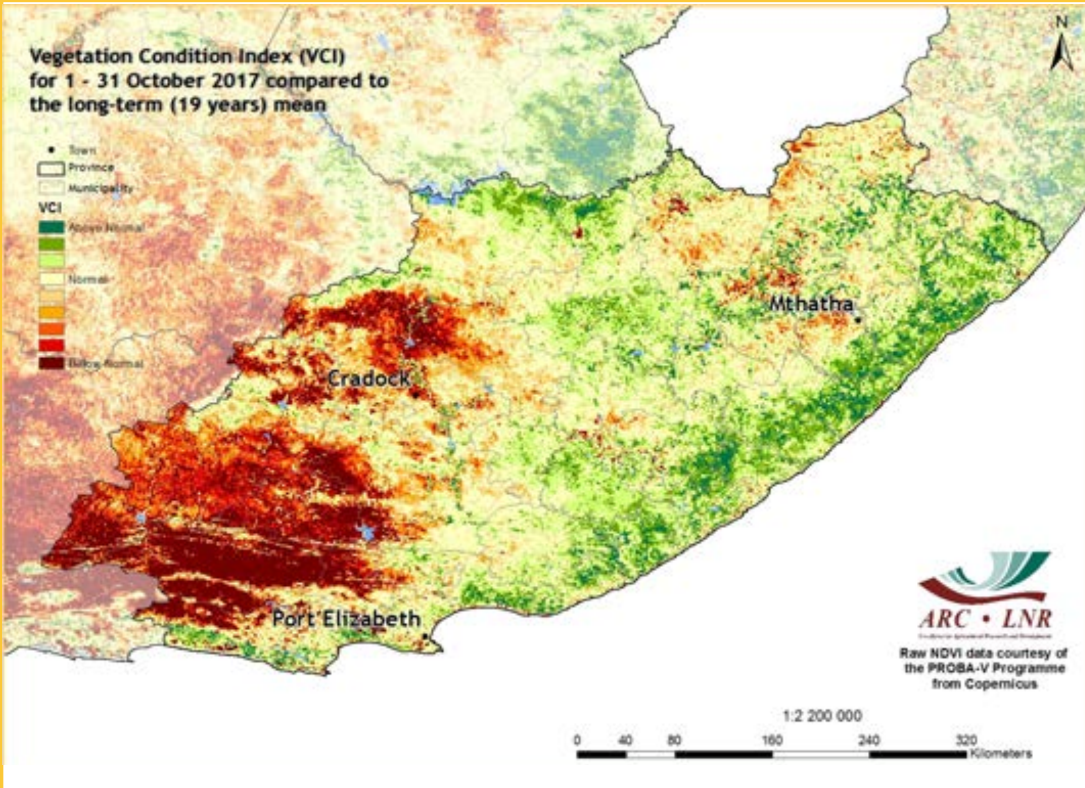


Figure 18

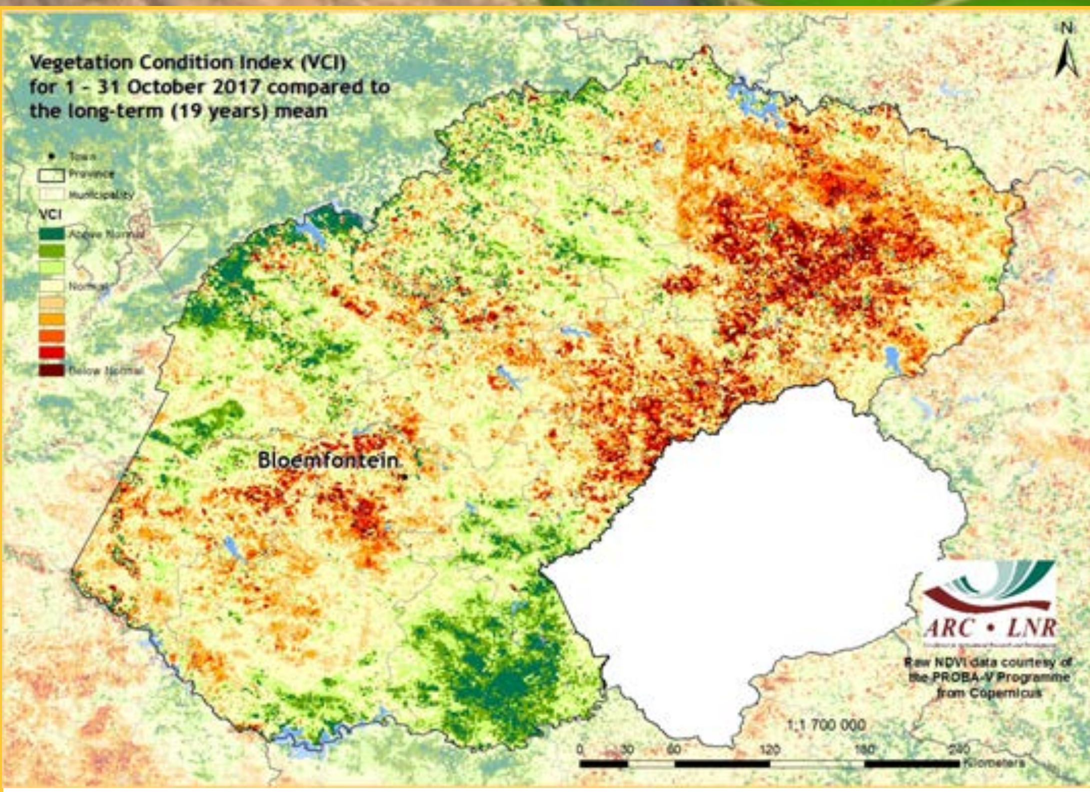


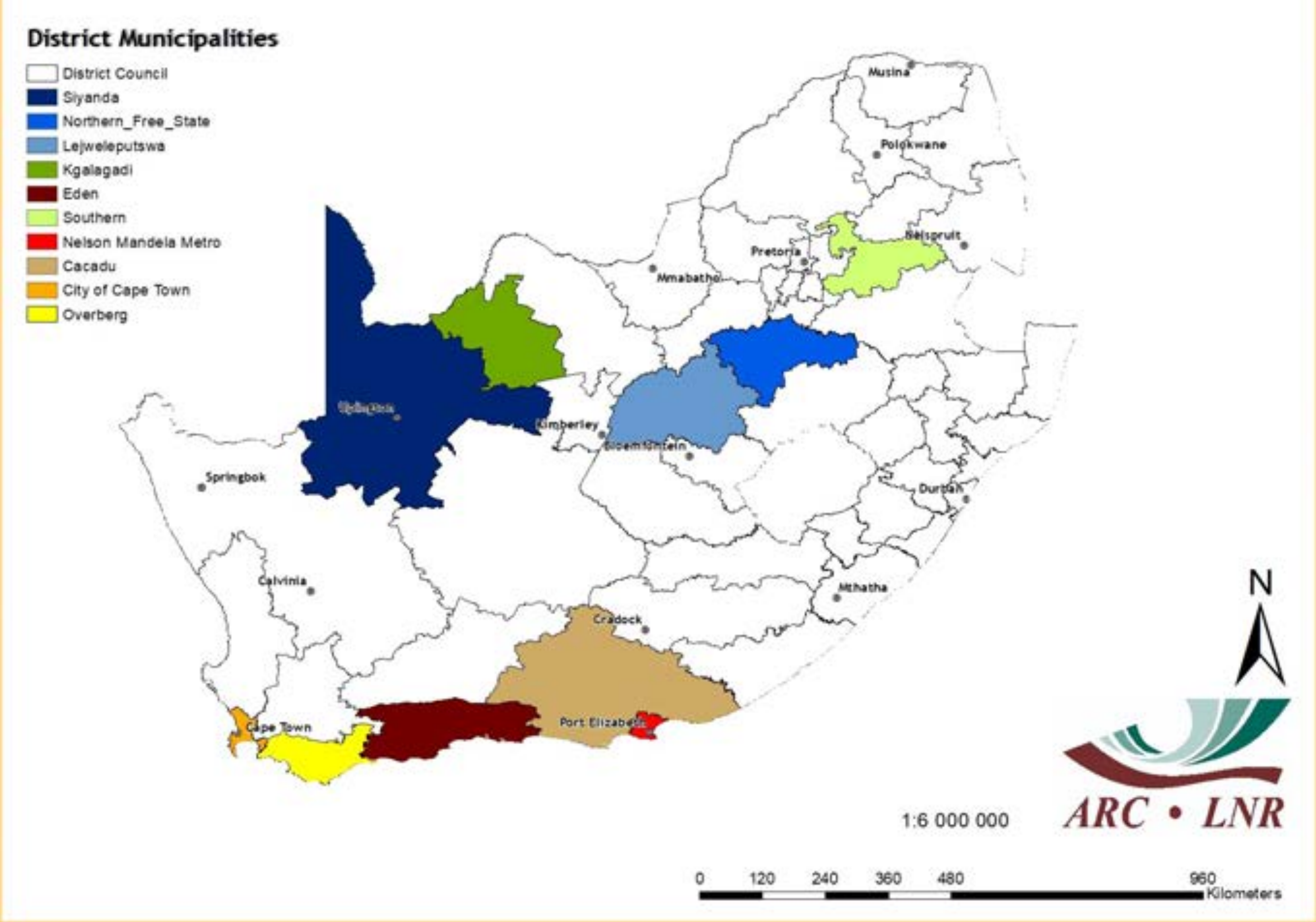
Figure 19

Figure 18:
The VCI map for October indicates below-normal vegetation activity over the far western parts of the Eastern Cape.

Figure 19:
The VCI map for October indicates below-normal vegetation activity over the northwestern parts and some other isolated areas of the Free State.

Questions/Comments:
MaakeR@arc.agric.za

7. Vegetation Conditions & Rainfall



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

Questions/Comments:
MaakeR@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.

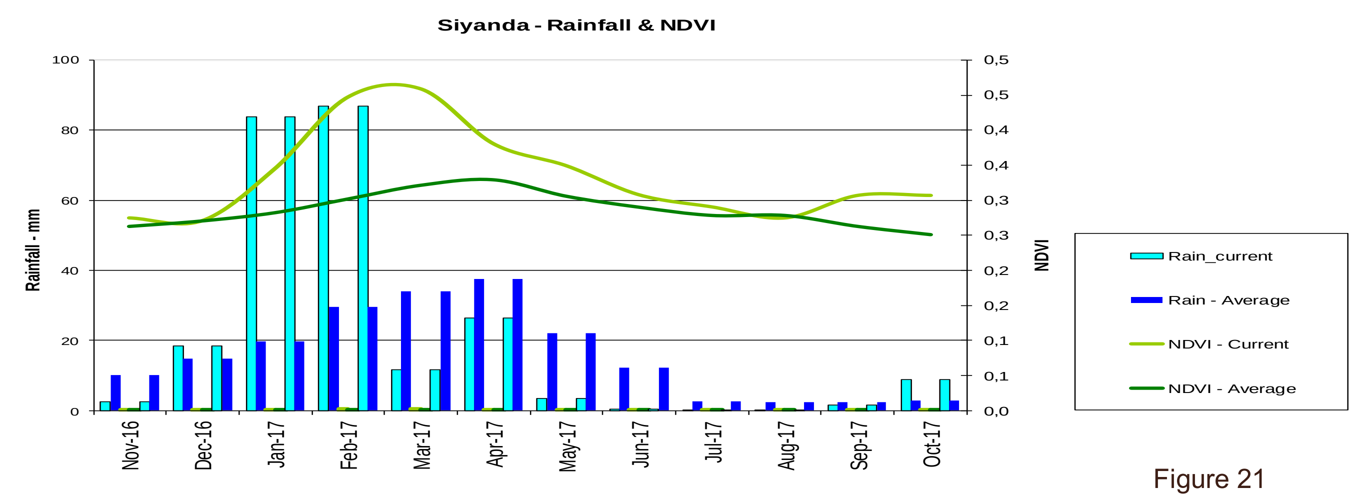


Figure 21

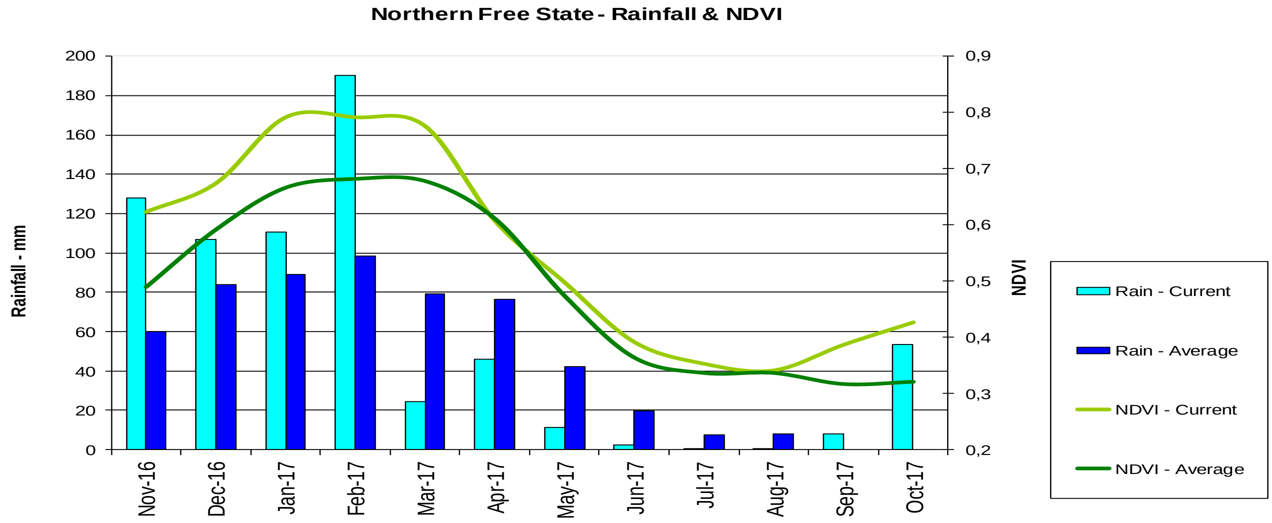


Figure 22

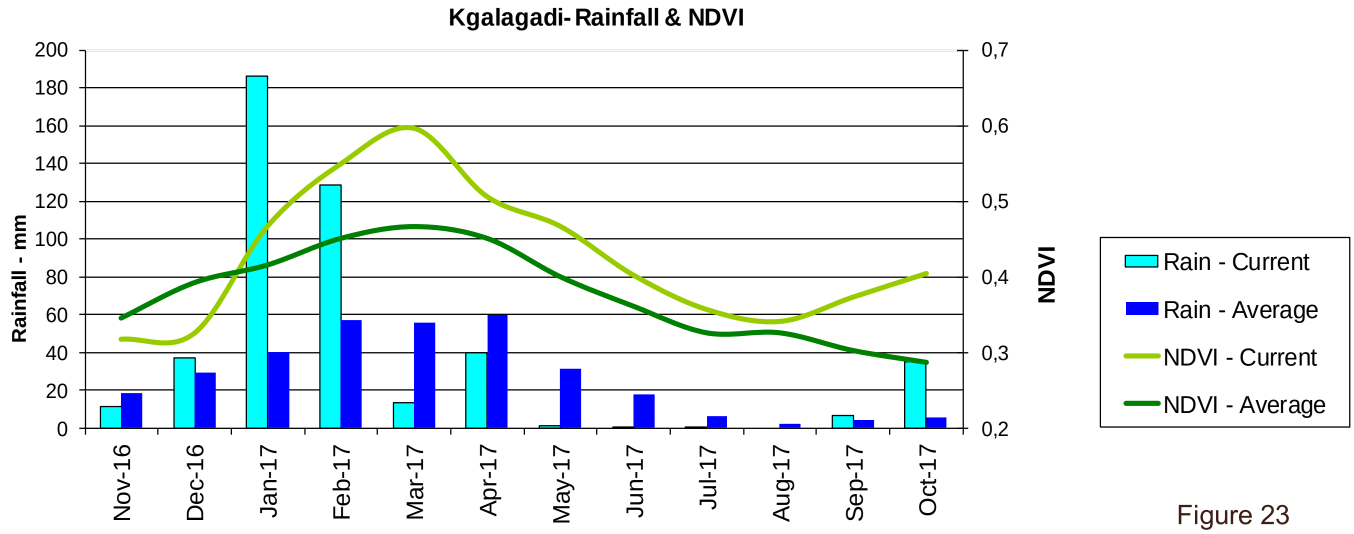


Figure 23

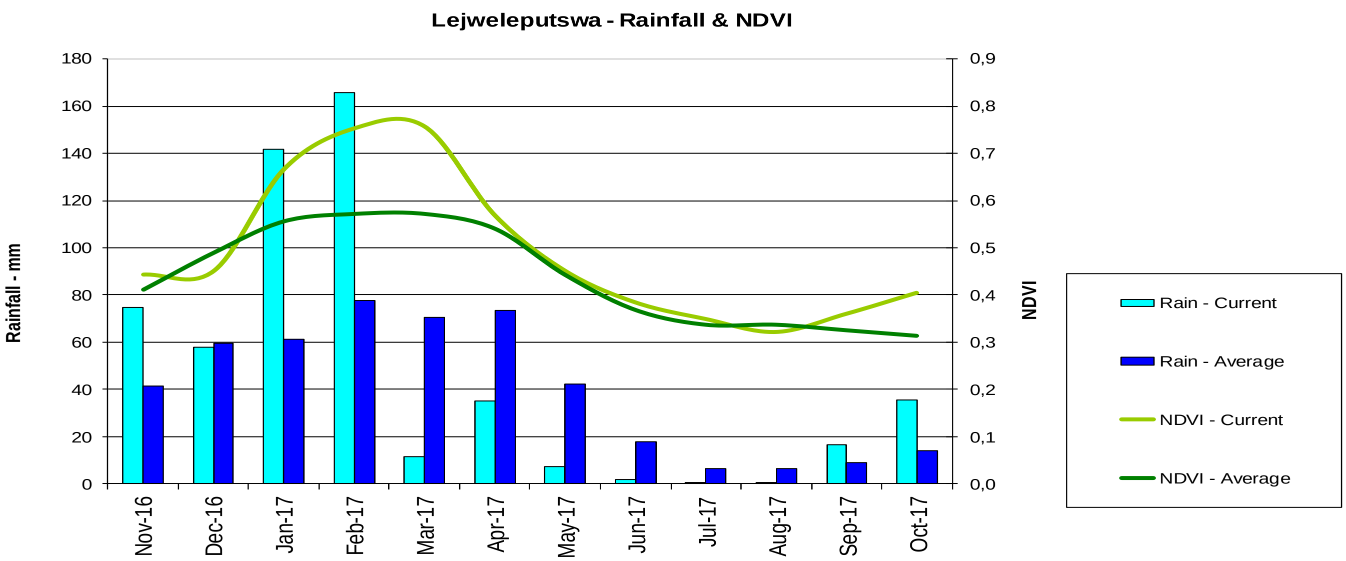


Figure 24

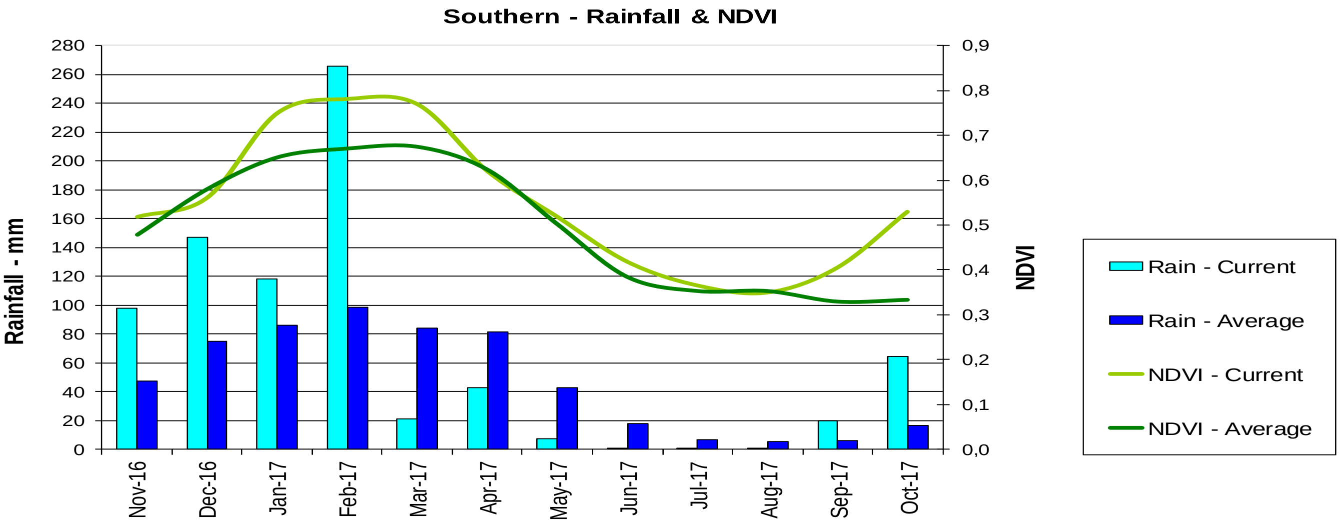


Figure 25

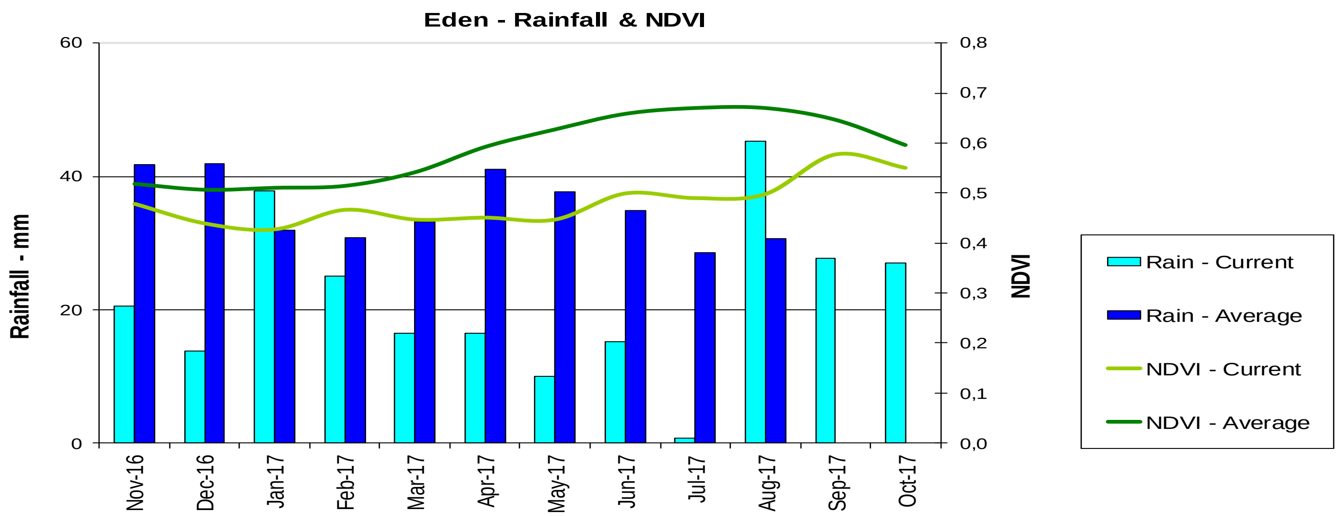


Figure 26

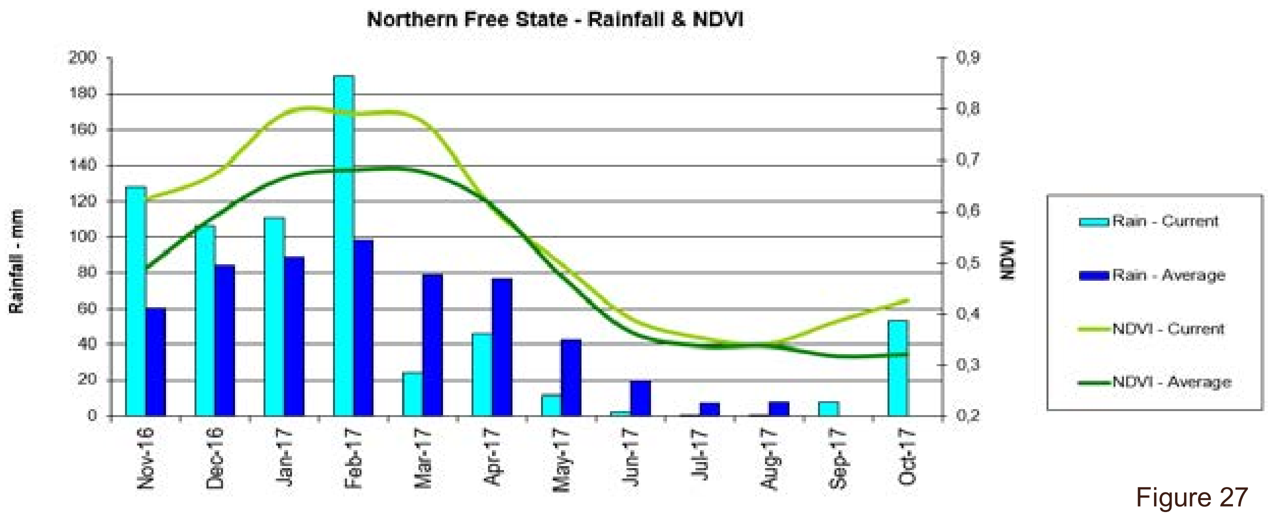


Figure 27

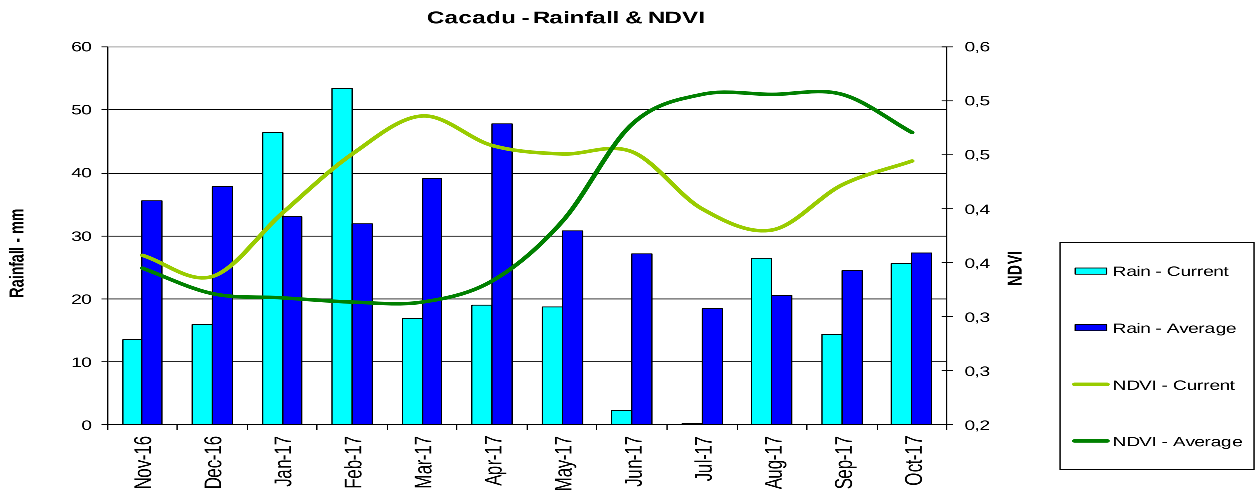


Figure 28

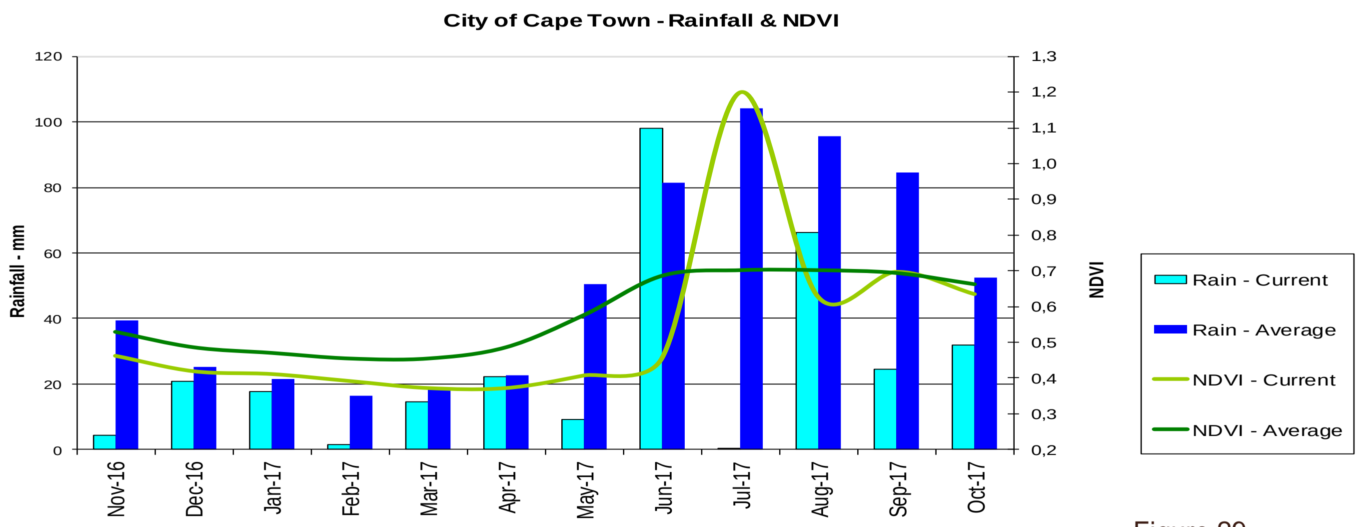


Figure 29

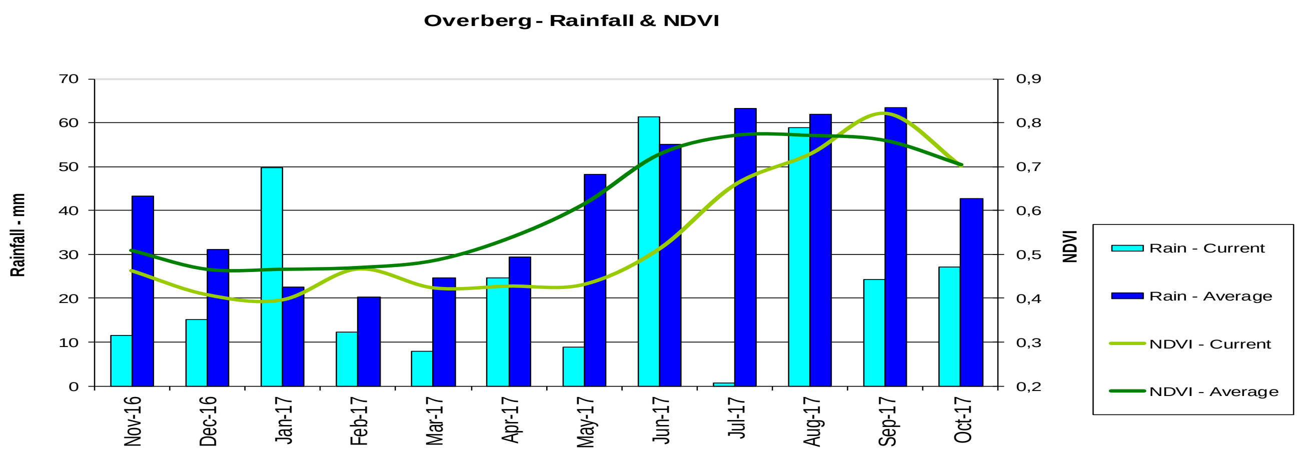


Figure 30

8. 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 31:
The graph shows the total number of active fires detected during the month of October per province. Fire activity was higher in the Free State, Mpumalanga, Western Cape and KwaZulu-Natal compared to the average during the same period for the last 17 years.

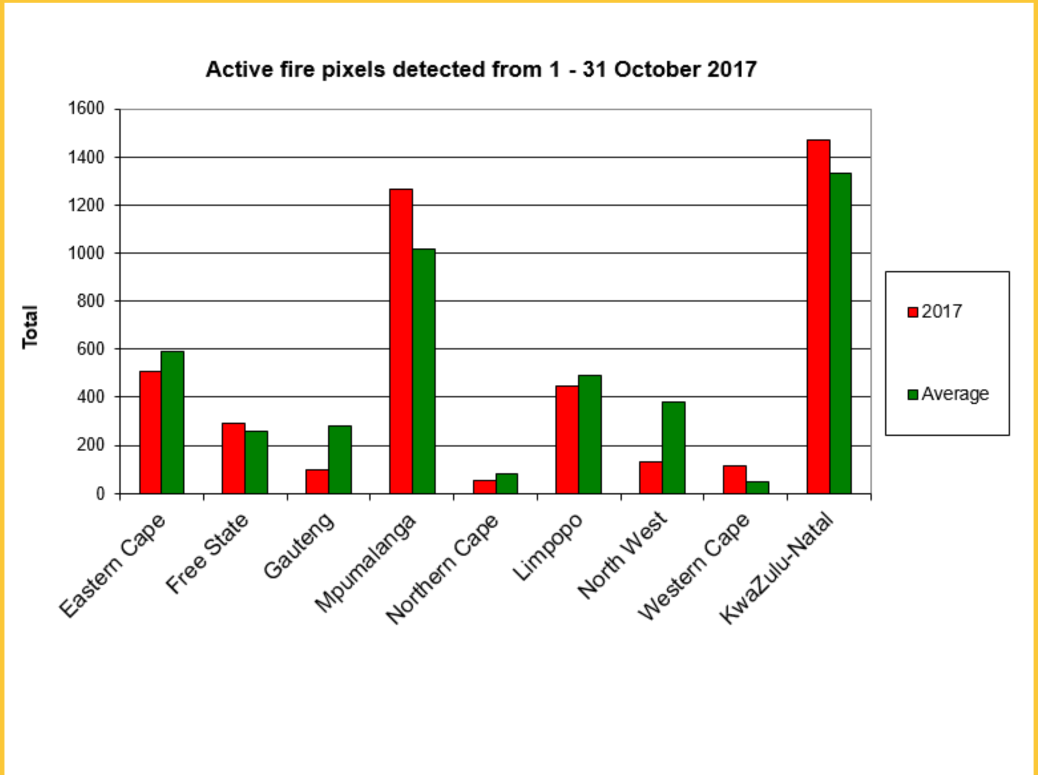


Figure 31

Figure 32:
The map shows the location of active fires detected between 1-31 October 2017.

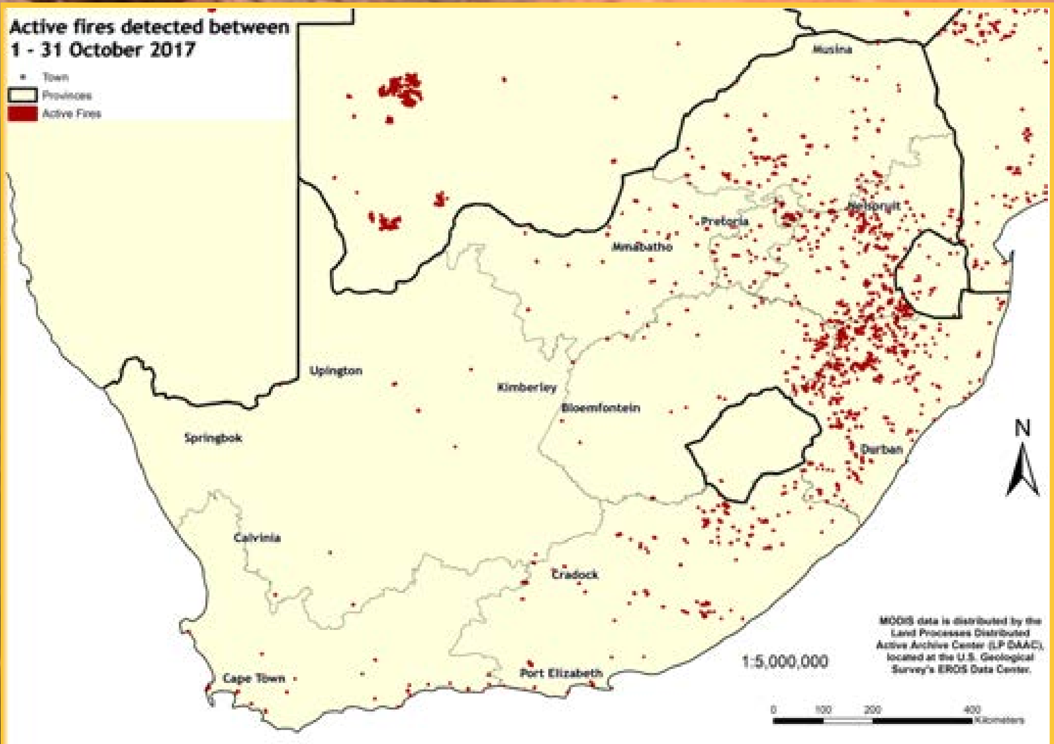


Figure 32

PAGE 17

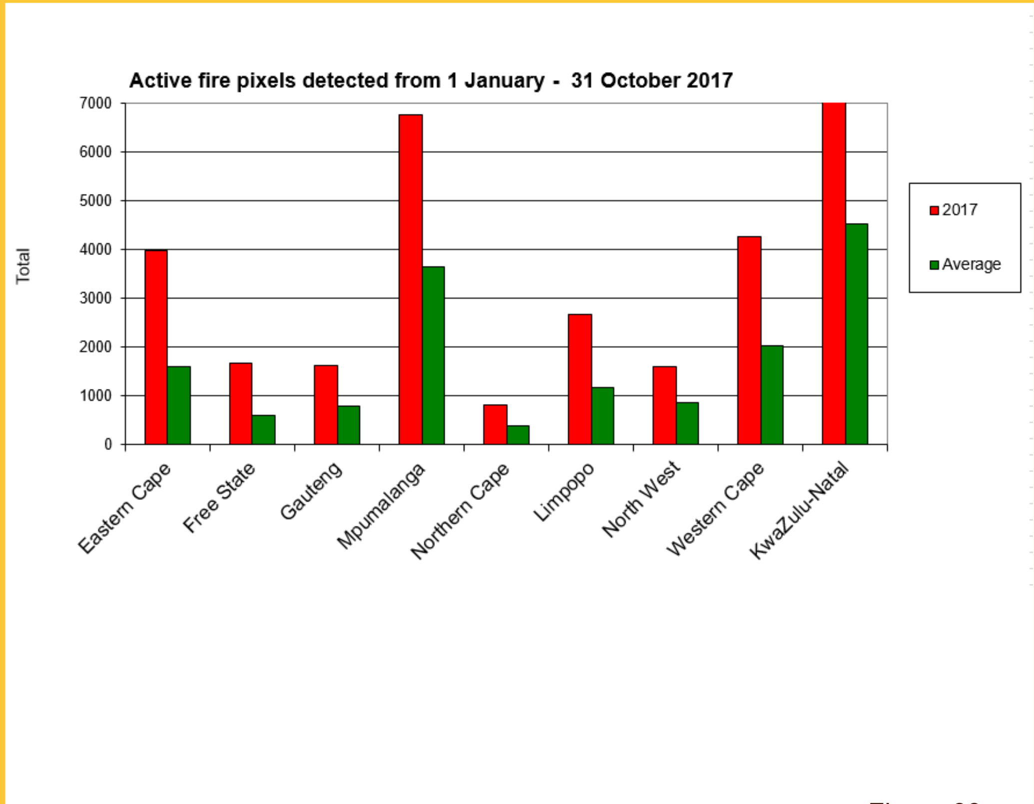


Figure 33

Figure 33:
The graph shows the total number of active fires detected from 1 January - 31 October 2017 per province. Fire activity was higher in all provinces compared to the average during the same period for the last 17 years.

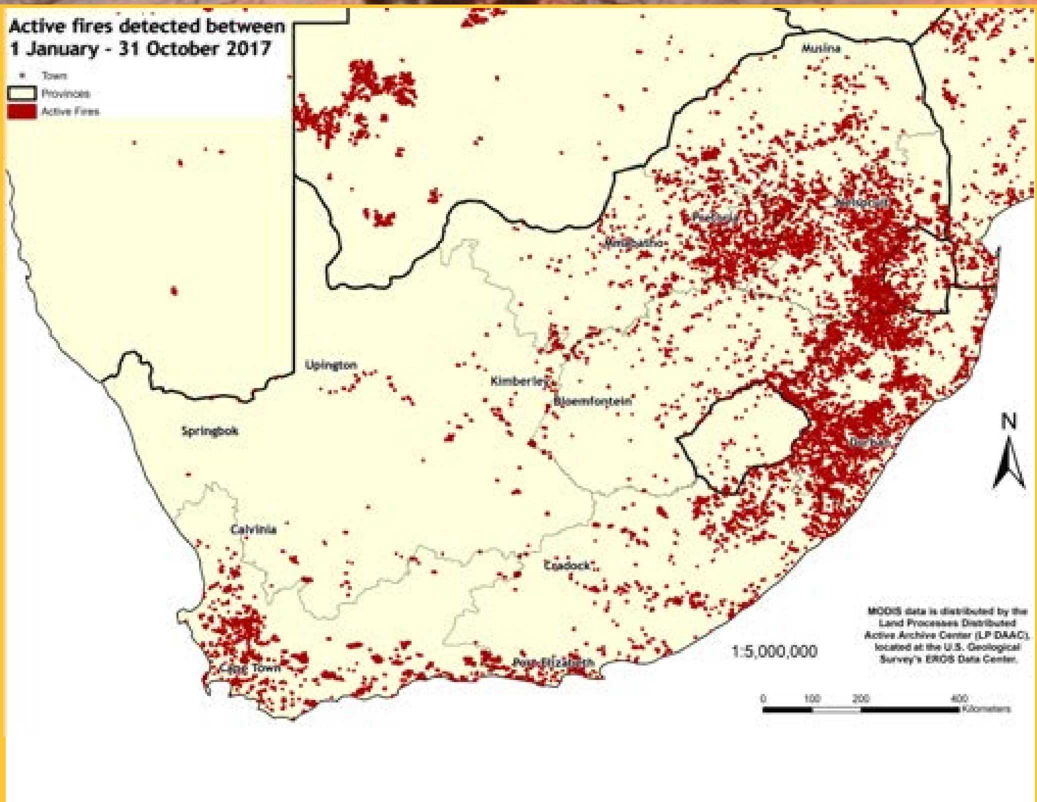
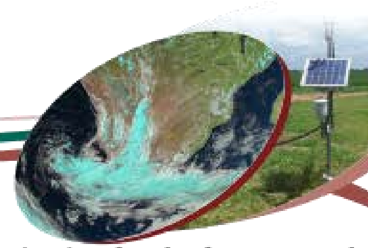


Figure 34

Figure 34:
The map shows the location of active fires detected between 1 January - 31 October 2017.

Questions/Comments:
MashabaZ@arc.agric.za

Agrometeorology



ARC • LNR

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

ARC • LNR

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

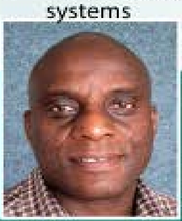
- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

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**.

ARC • LNR
Excellence in Research and Development

Institute for Soil, Climate and Water

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

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:
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".

http://www.agis.agric.za

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