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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

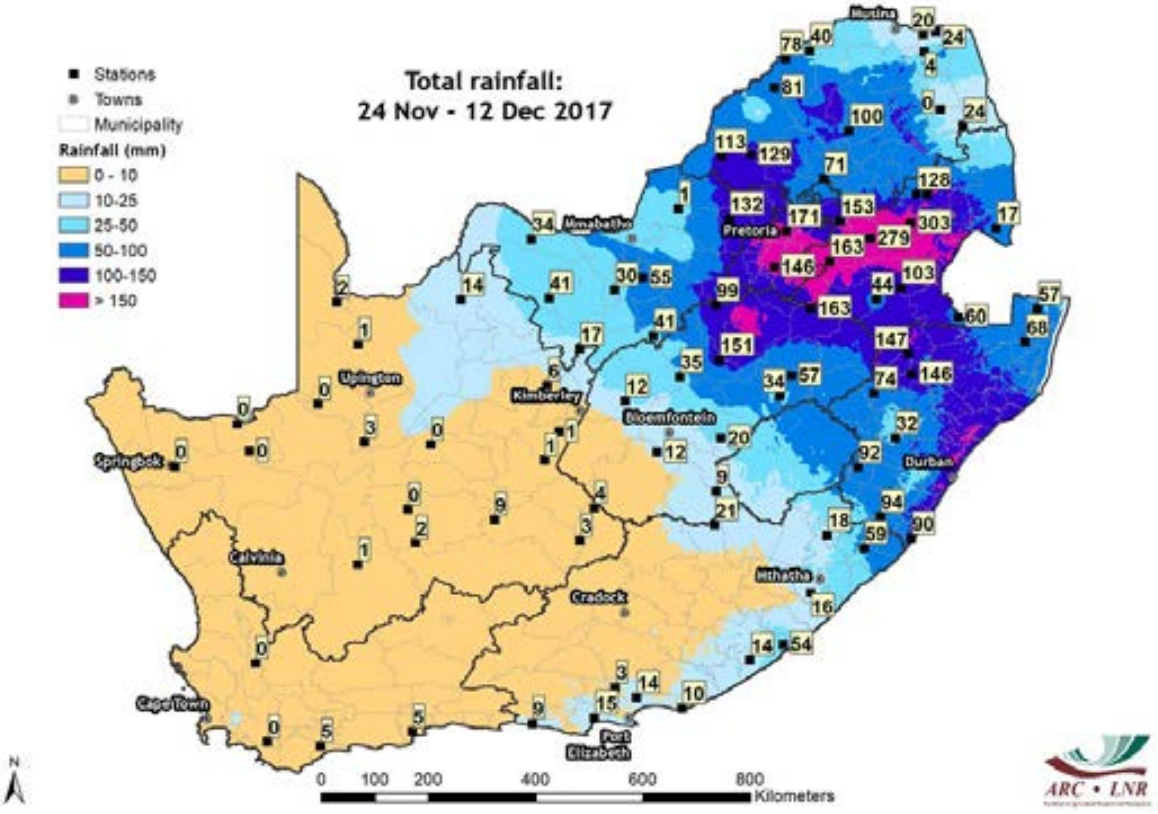
CONTENTS:

162nd Edition

Image of the Month

Early summer wet spell in eastern South Africa

Most of November 2017 was fairly dry over the eastern interior of South Africa, but conditions became favourable for rain during the last week of the month and continued into December. A cloud band developed around the 20th of November as an upper-air trough with an approaching cold front which resulted in thundershower activity over the eastern parts of the country between the 21st and 25th as the cloud band moved eastwards. Most days during this period (24 November to 12 December) were favourable for the development of thundershowers, but around the 6th of December a strong surface high pressure system advected moisture in over the eastern parts of the country, whilst an upper-air disturbance that moved over the country aided in the development of thundershowers associated with heavy downpours. These dynamically induced thundershowers were most active over the central parts of Gauteng and Mpumalanga where the accumulated rainfall during the period 24 November to 12 December was generally more than 150 mm, reaching up to 300 mm in places (see rainfall 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:

Spring 2017 concluded with the month of November when below-normal rainfall occurred over large parts of the summer rainfall region, whilst above-normal rainfall occurred over the winter rainfall region. In fact, several places in the Western Cape received better rainfall during November than in some months during the winter rainfall season. The month of November commenced with the uncharacteristic occurrence of thundershowers over western parts of the Western Cape. These were triggered by an upper-air disturbance and cold front west of the country in association with an already present cloud band over the far western parts of the country. This cloud band developed at the end of October, eastwards of a far westward located surface trough that aided in the southward transport of tropically sourced air. With the approaching upper-air disturbance and cold front, the cloud band over the western interior extended southwards and curled southwestwards in over the western parts of the Western Cape on the 2nd of November. The southward moving moist and relatively warmer air in the lower levels and the advancing cold mid-tropospheric air resulted in unstable atmospheric conditions. Nearly 14 mm was measured at the Noordhoek and Constantia weather stations, whilst further to the north over the winter rainfall region up to 20 mm of rain fell. The passage of two frontal systems, the first around the 14th and the second around the 20th, contributed to the rainfall over the Western Cape. The frontal system during the middle of the month was associated with good upper-air support as the trough developed into a cut-off low. This system moved in over the central parts of the country, resulting in cloudy conditions with rain as well as a drop in maximum and minimum temperatures. Freezing rain occurred in Bloemfontein on the morning of the 16th, followed by a significant drop in minimum temperatures on the morning of the 17th when a temperature of 0.5 °C was recorded at the Glen weather station. The second frontal system that made landfall arrived on the 20th of November. Secondary development took place in the cold air behind this system and aided in rainfall development over the winter rainfall region. The upper-air trough associated with this frontal system in combination with a surface trough facilitated the development of a cloud band originating in the tropics. Over the next few days, the summer rainfall region received the bulk of its November rainfall as this system moved eastwards. Temperature wise, minimum temperatures during November were anomalously cool countrywide, whilst the maximum temperatures had no clear signal, except over the central interior where they were about 2 °C above normal.

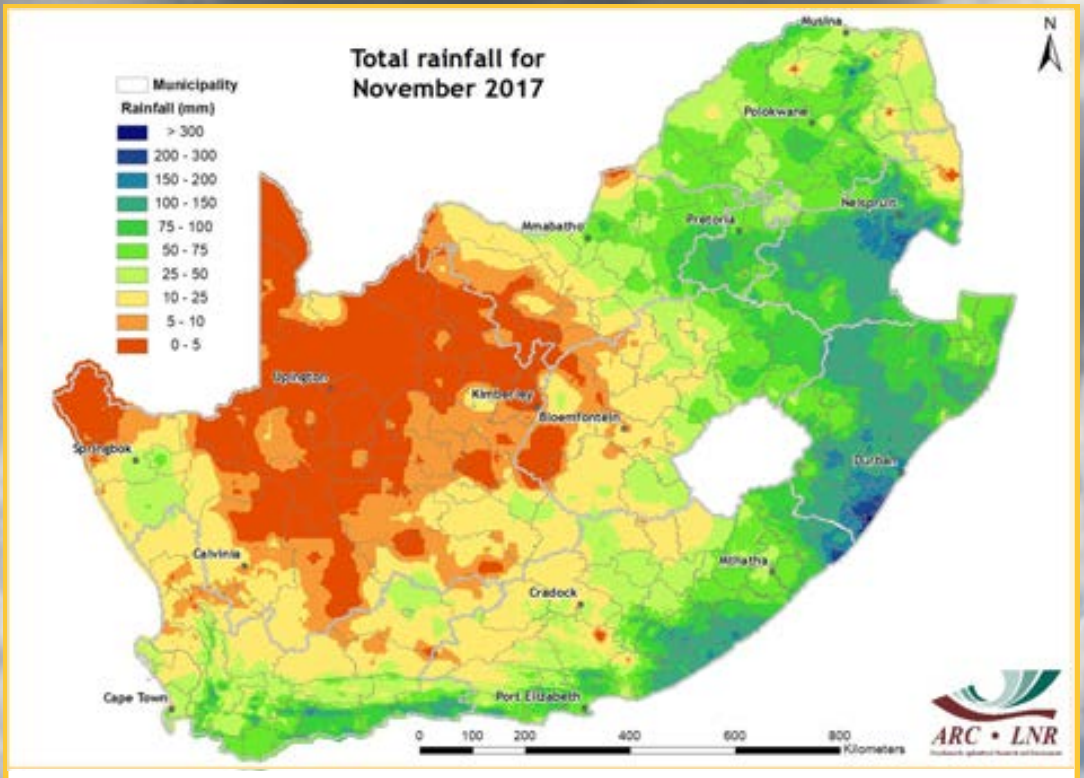


Figure 1

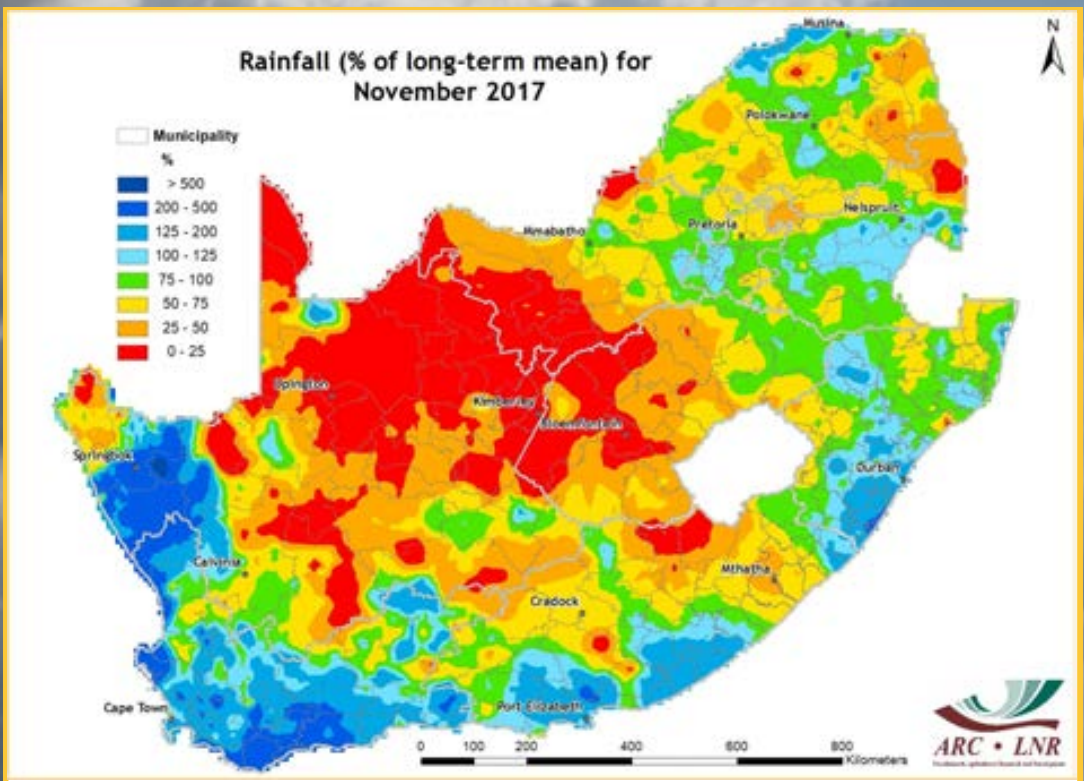


Figure 2

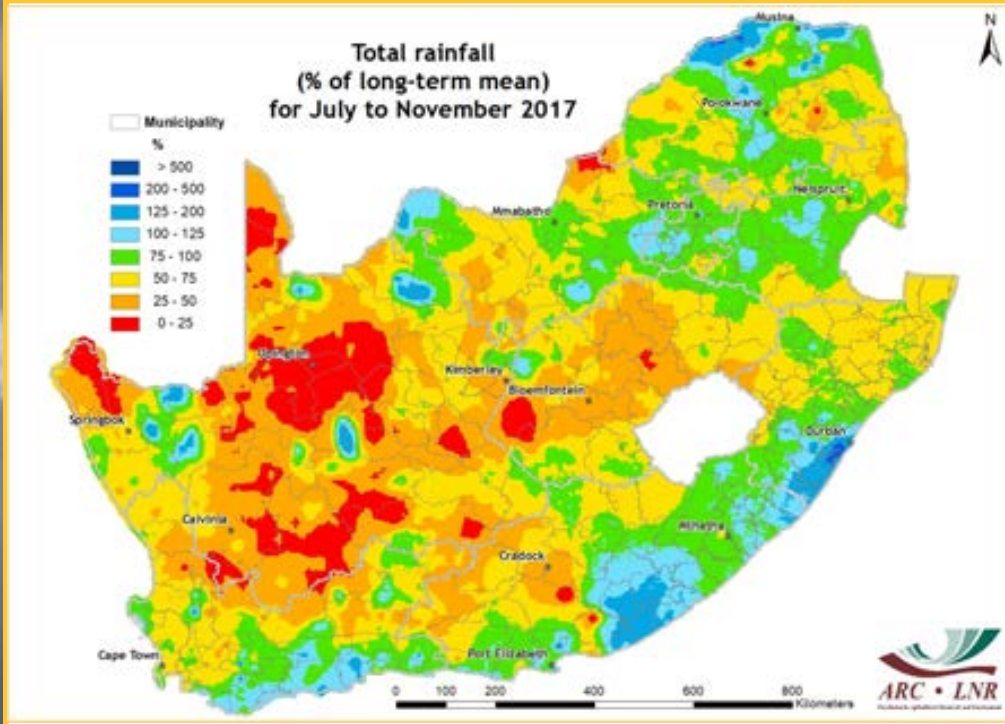


Figure 3

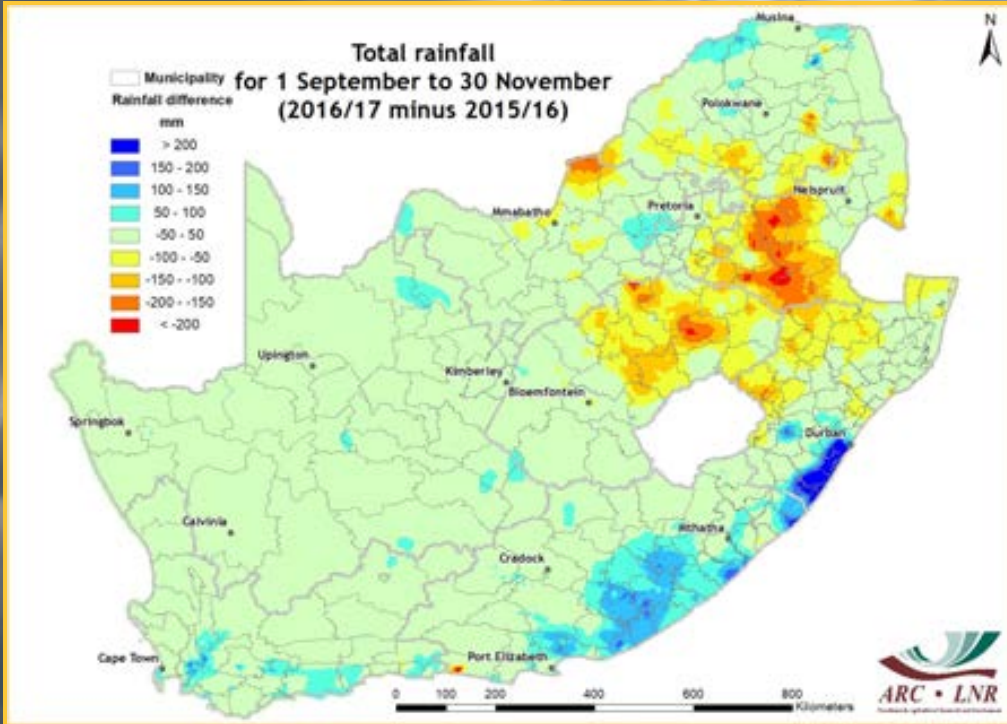


Figure 4

Figure 1:
Good rainfall occurred over parts of Mpumalanga, KwaZulu-Natal and the southern coastal belt in November, with some areas receiving totals of more than 200 mm. The winter rainfall region also experienced good rainfall for this time of the year, with some areas receiving totals of 25-50 mm.

Figure 2:
Above-normal rainfall occurred over the all-year rainfall region as well as over the far western parts of the Northern Cape and the western parts of the Western Cape. The summer rainfall region received below-normal to normal rainfall over most areas, with some isolated areas receiving above-normal rainfall.

Figure 3:
Normal to above-normal rainfall occurred over the southern and eastern coastal belts as well as over some isolated areas in the north and northeast of the country. The winter rainfall region, apart from its southern coastal region, received mostly below-normal rainfall. Areas over the western interior experienced rainfall far below-normal.

Figure 4:
Over most of the country, rainfall during the September to November 2017 period was very similar to the corresponding period in 2016. Over the southeastern coastal belt and adjacent interior, however, up to 200 mm more rain was received this year compared to the corresponding period last year. Some areas over the eastern interior received up to 200 mm less rain during September to November 2017 compared to the same period in 2016.

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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 most time scales, severe to extreme drought conditions are present over most of the winter rainfall region, with some relief on the 6-month time scale. 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 and central interior.

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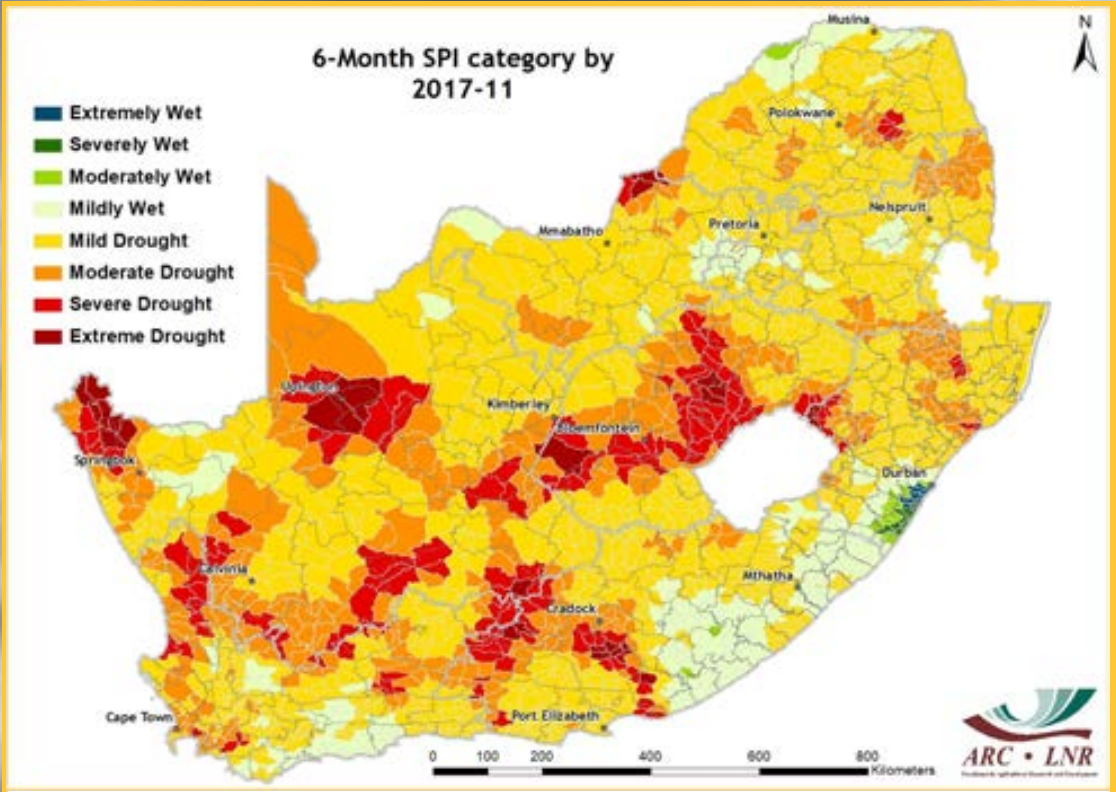
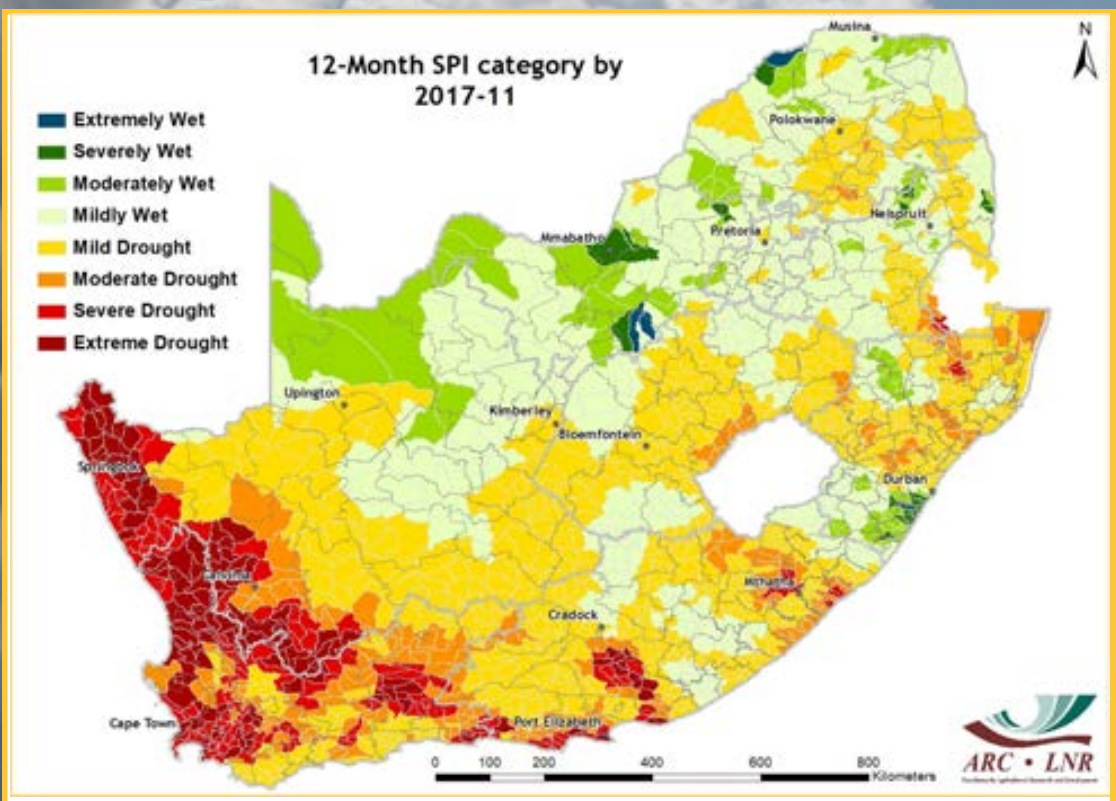


Figure 5



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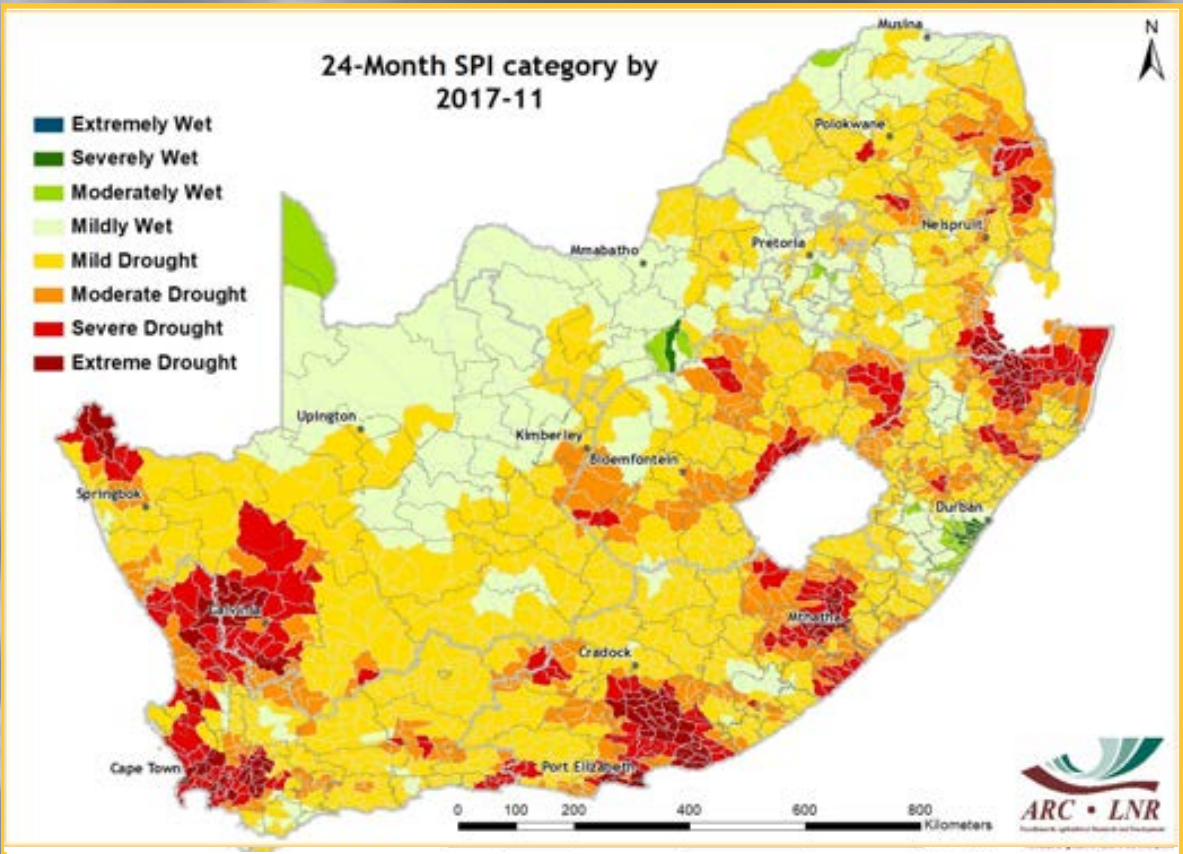

Figure 7

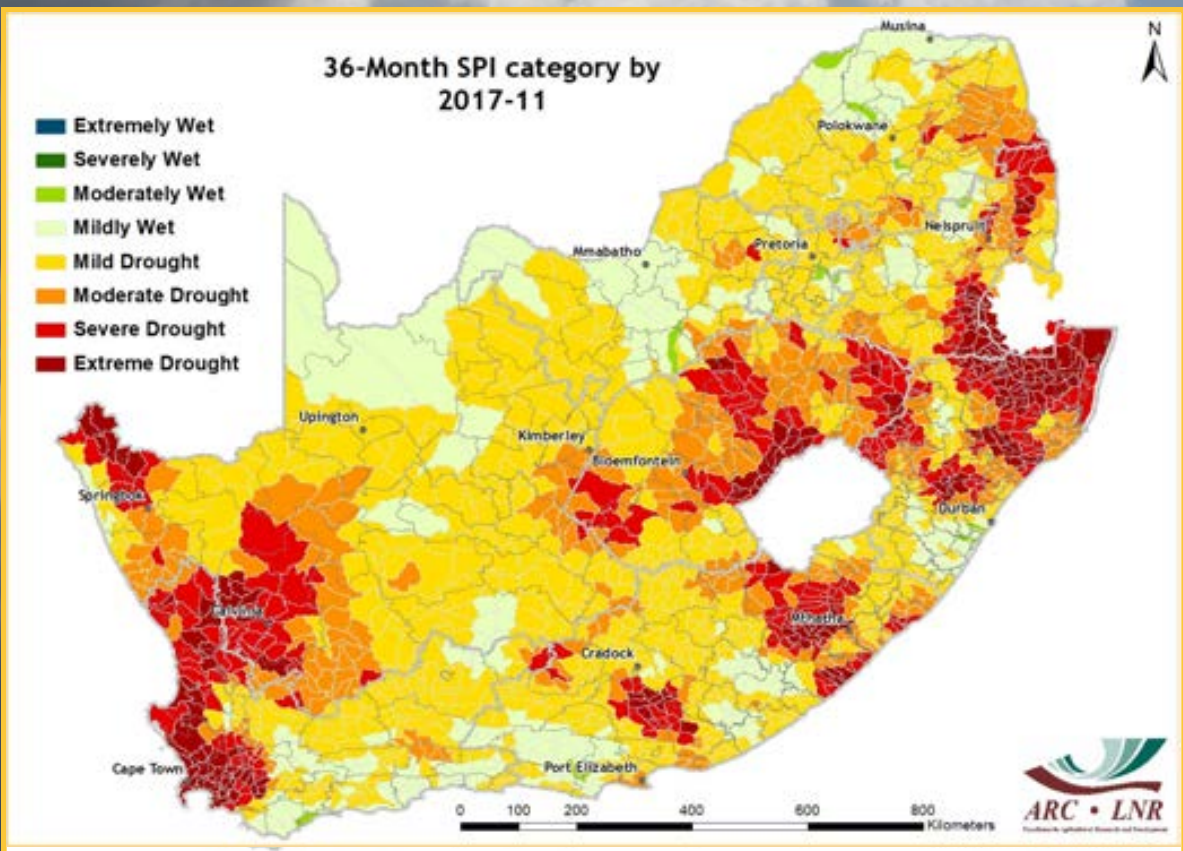

Figure 8

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.

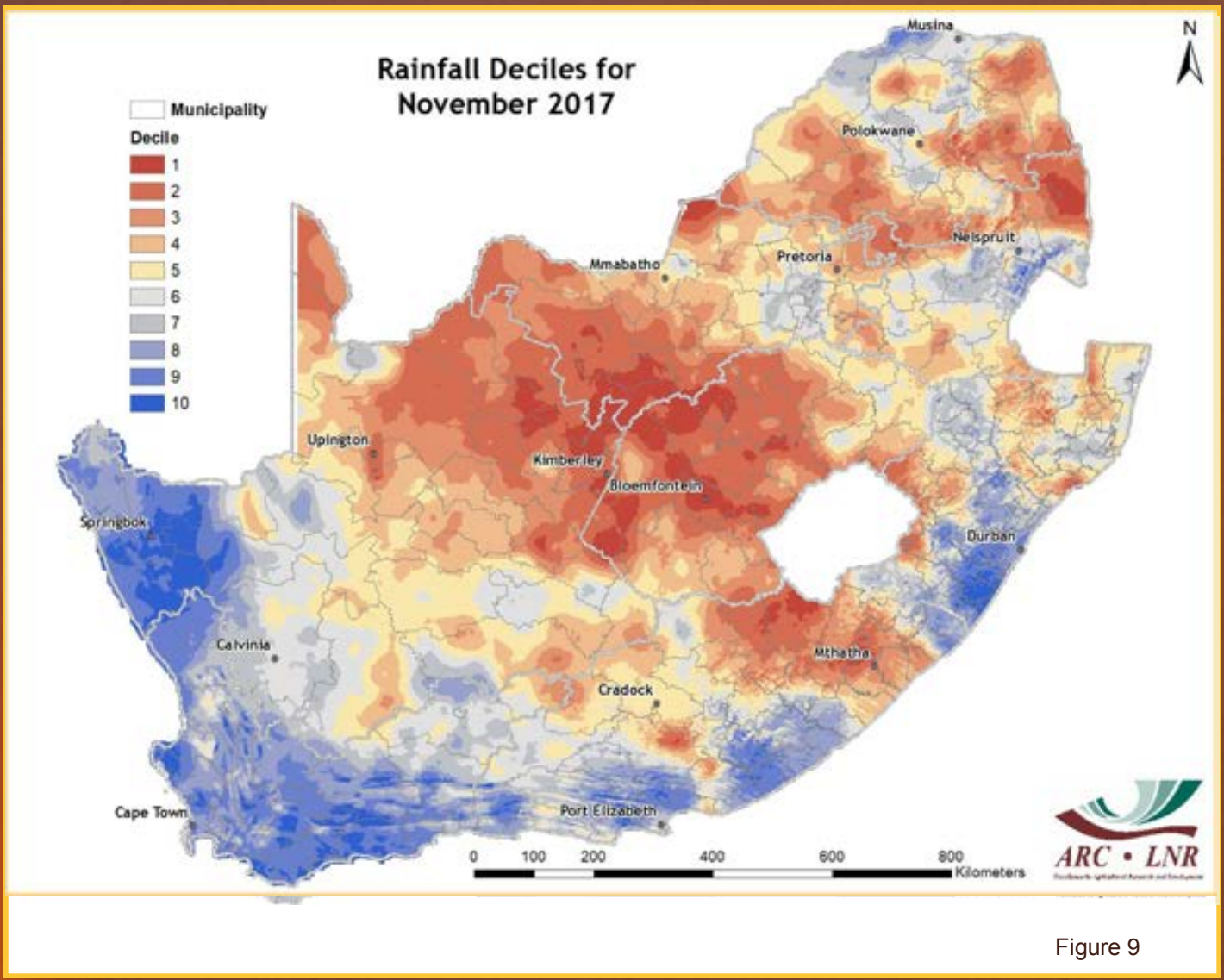

Figure 9

Figure 9:
Compared to historical rainfall totals during the month of November, November 2017 over most of the summer rainfall region compares well with the drier November months, in particular over the central interior of the country. Over the winter rainfall region as well as over the all-year rainfall region, November 2017 falls within the wetter November months.

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4. Water Balance

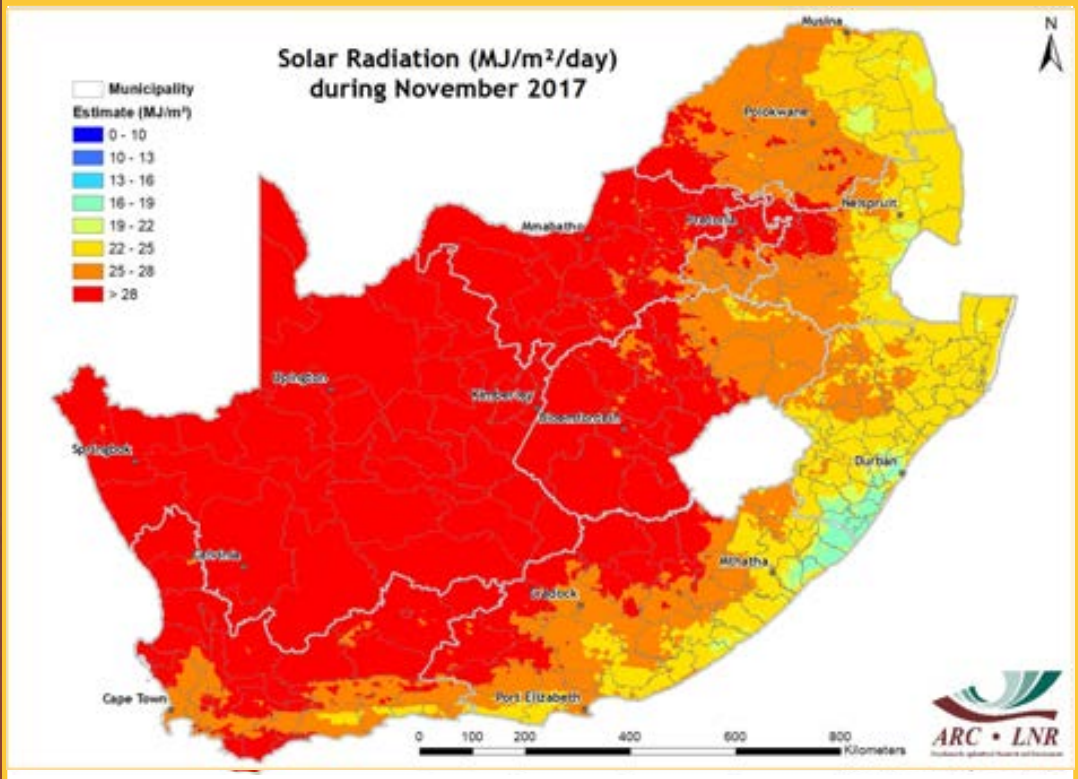

Figure 10

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 along the KwaZulu-Natal coast southwards of Durban, coinciding with the area with the highest November rainfall totals. Increasing solar radiation values occurred from east to west and from south to north over the country, with the tightest solar radiation gradients found south and eastwards of the southern and eastern escarpments.

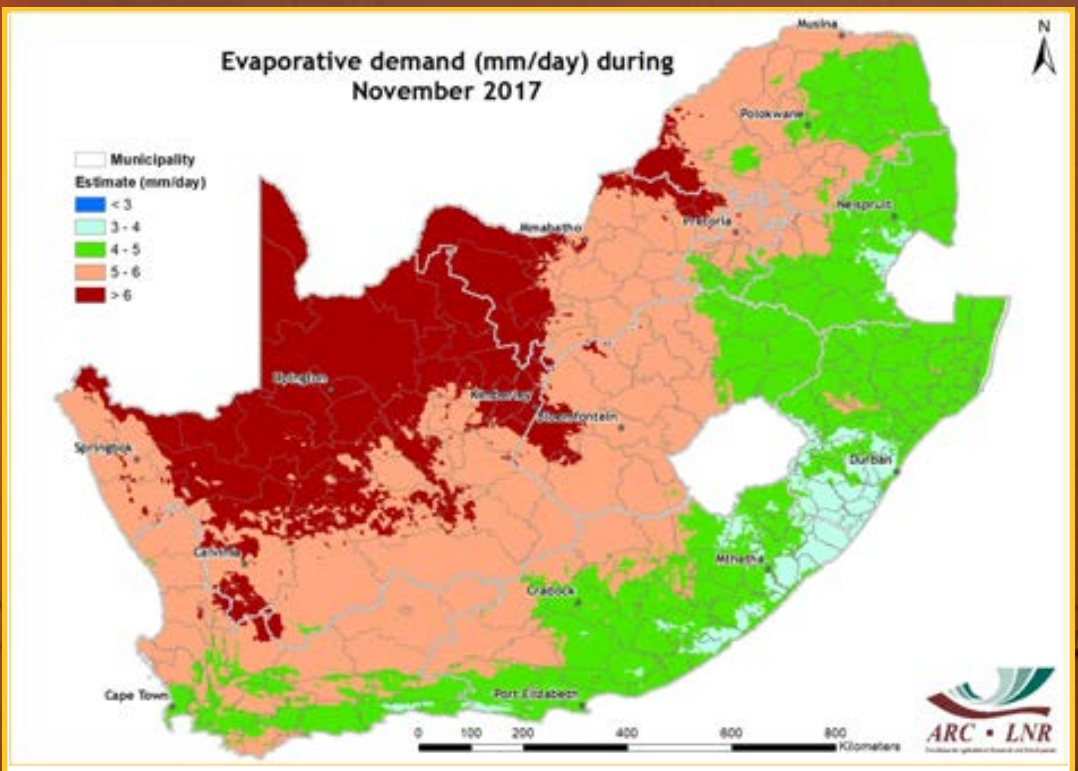

Figure 11

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 coastal belt where high rainfall totals occurred, with slightly higher values of 4-5 mm/day south and eastwards of the southern and eastern escarpments. The highest evaporative demand occurred over the northwestern parts of the country, exceeding 6 mm/day.

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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.

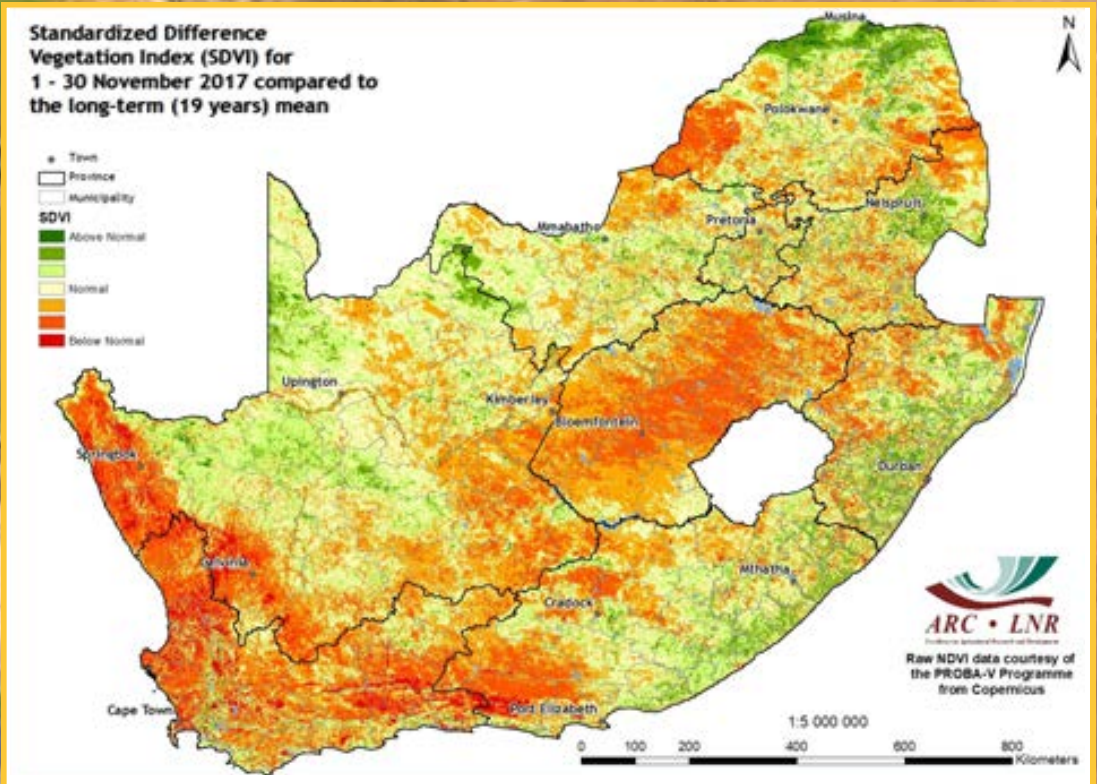

Figure 12

Figure 12:
The SDVI for November indicates above-normal vegetation activity over the northwestern parts of the Northern Cape, isolated areas of the Eastern Cape, Limpopo and KwaZulu-Natal. Dry conditions were present in the Western Cape and Free State. Isolated areas of the Northern Cape, North West, Eastern Cape and Mpumalanga also experienced dry conditions.

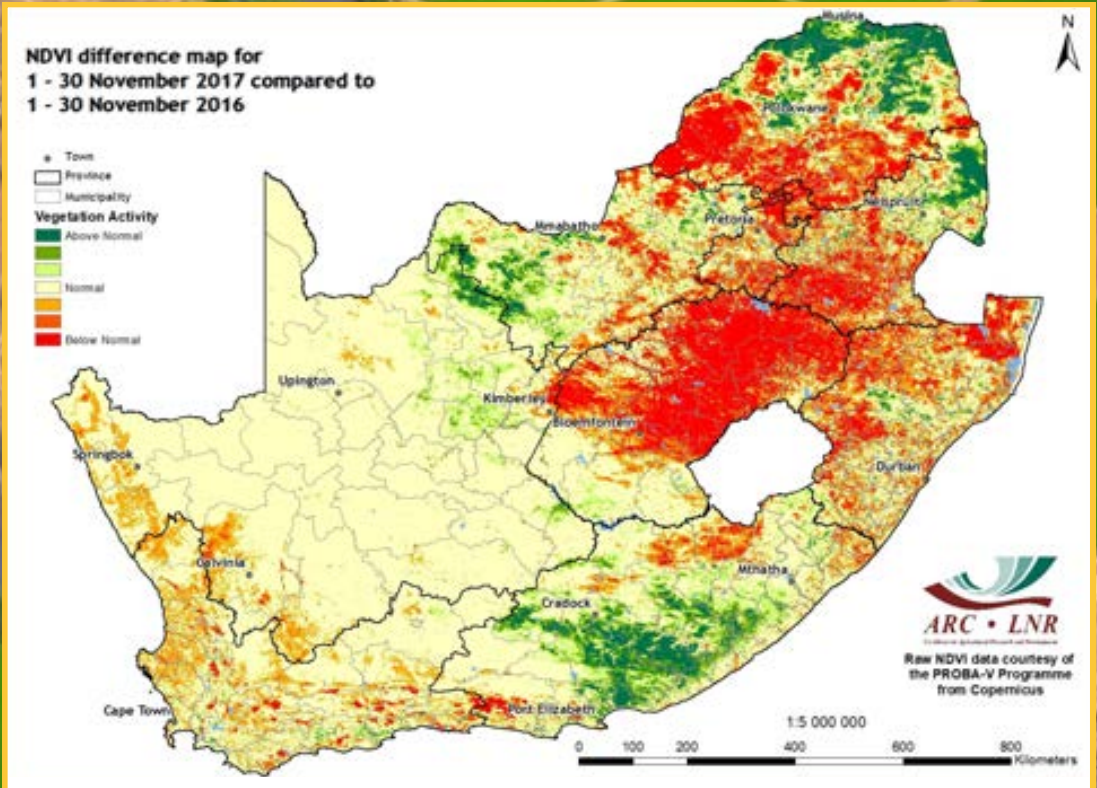

Figure 13

Figure 13:
Normal vegetation activity occurred over most of the northwestern and southwestern parts of the country. However, it was below normal in the Free State, Mpumalanga, KwaZulu-Natal, southern parts of Limpopo and Gauteng. Above-normal vegetation activity occurred in small distinct areas of the Eastern Cape, North West, Mpumalanga and Limpopo.

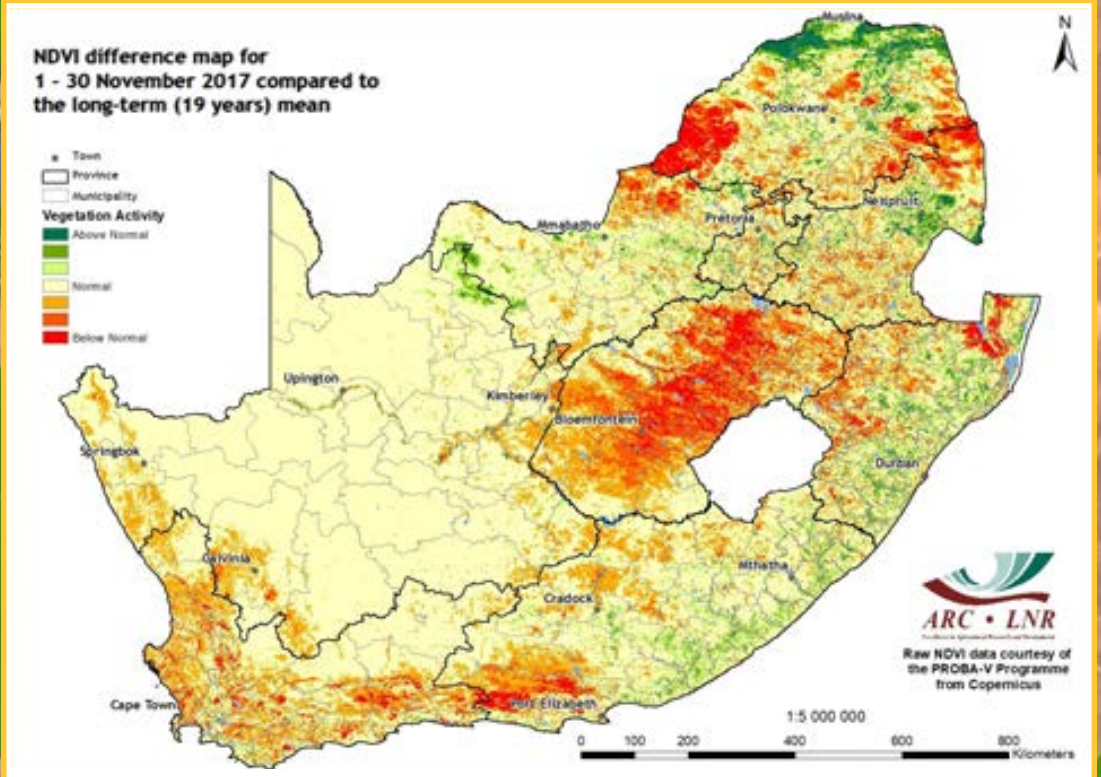

Figure 14

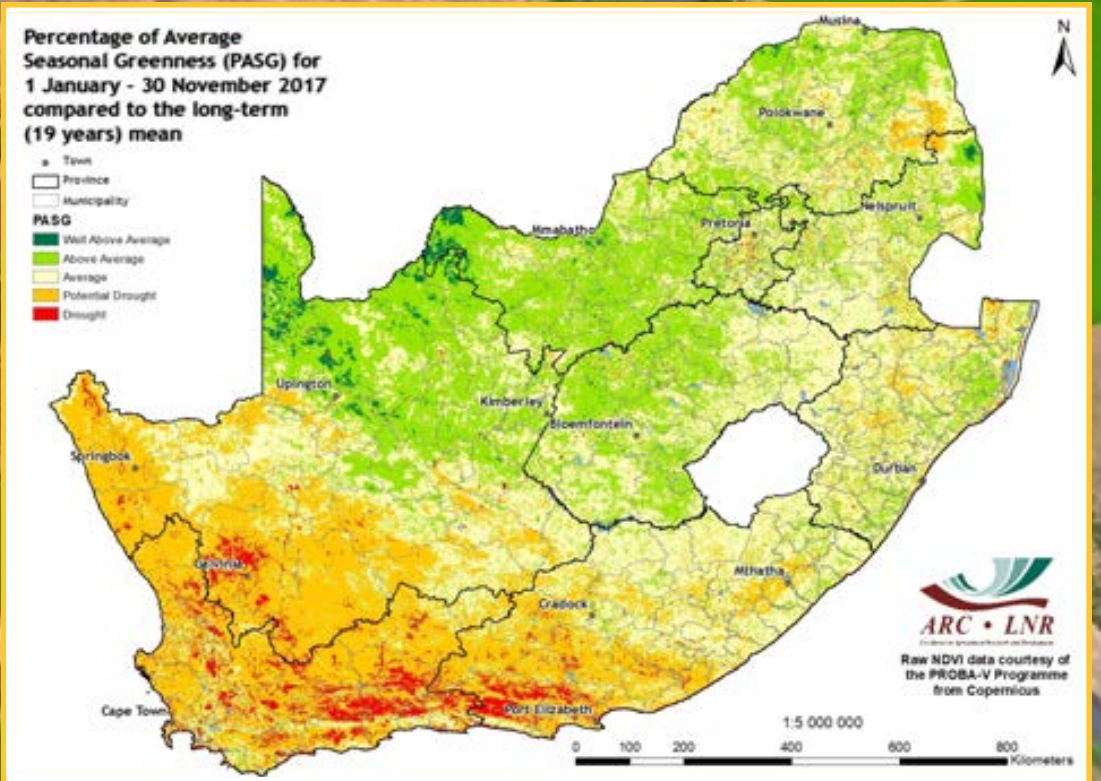

Figure 15

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:
The vegetation activity for November was low in the Western Cape and Free State. Isolated areas of the Eastern Cape, Limpopo, Mpumalanga and KwaZulu-Natal also experienced low vegetation activity.

Figure 15:
The vegetation activity was above average over northern parts of the Northern Cape, North West, Free State, Mpumalanga, Limpopo and Gauteng. Drought conditions prevailed over much of the Western Cape and southern parts of the Northern and Eastern Cape.

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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.

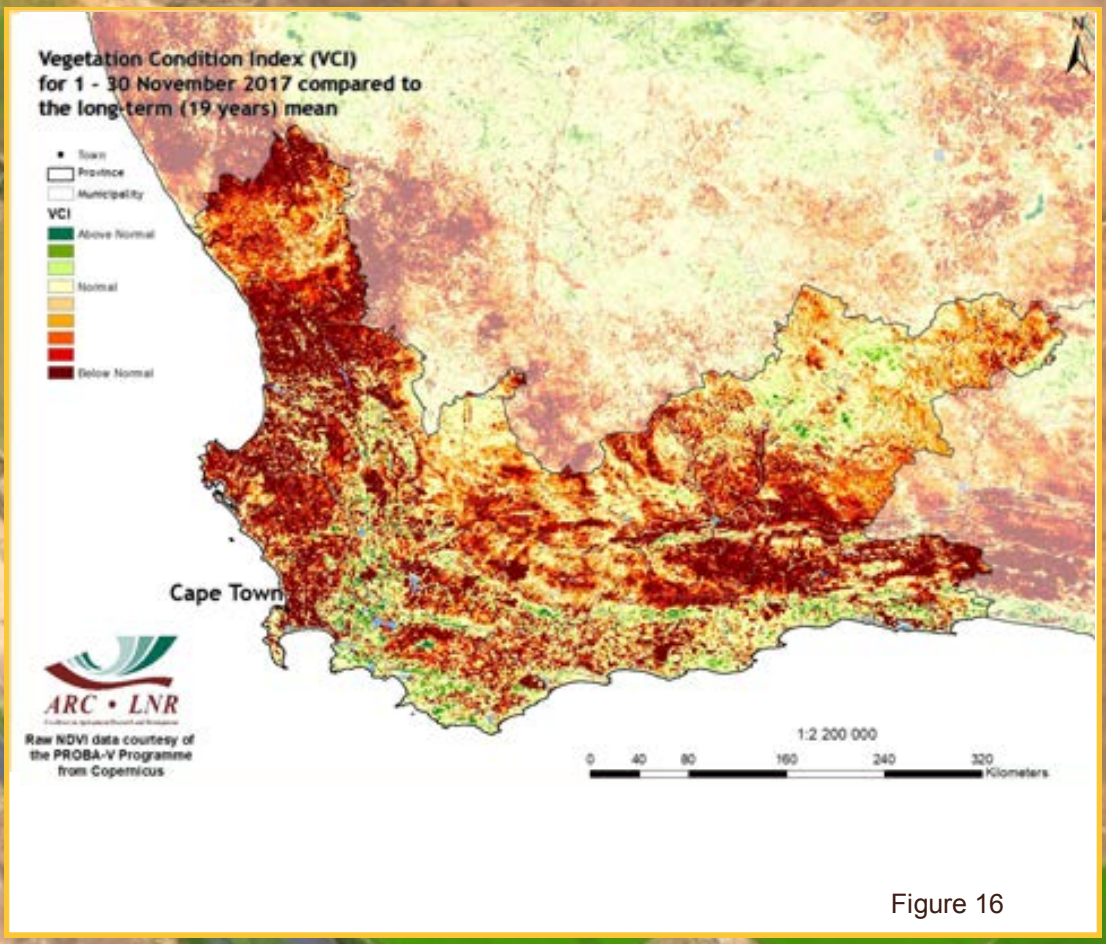

Figure 16

Figure 16:
The VCI map for November indicates that dry conditions were still present over much of the Western Cape.

Figure 17:
The VCI map for November indicates below-normal vegetation activity over large areas of the Free State.

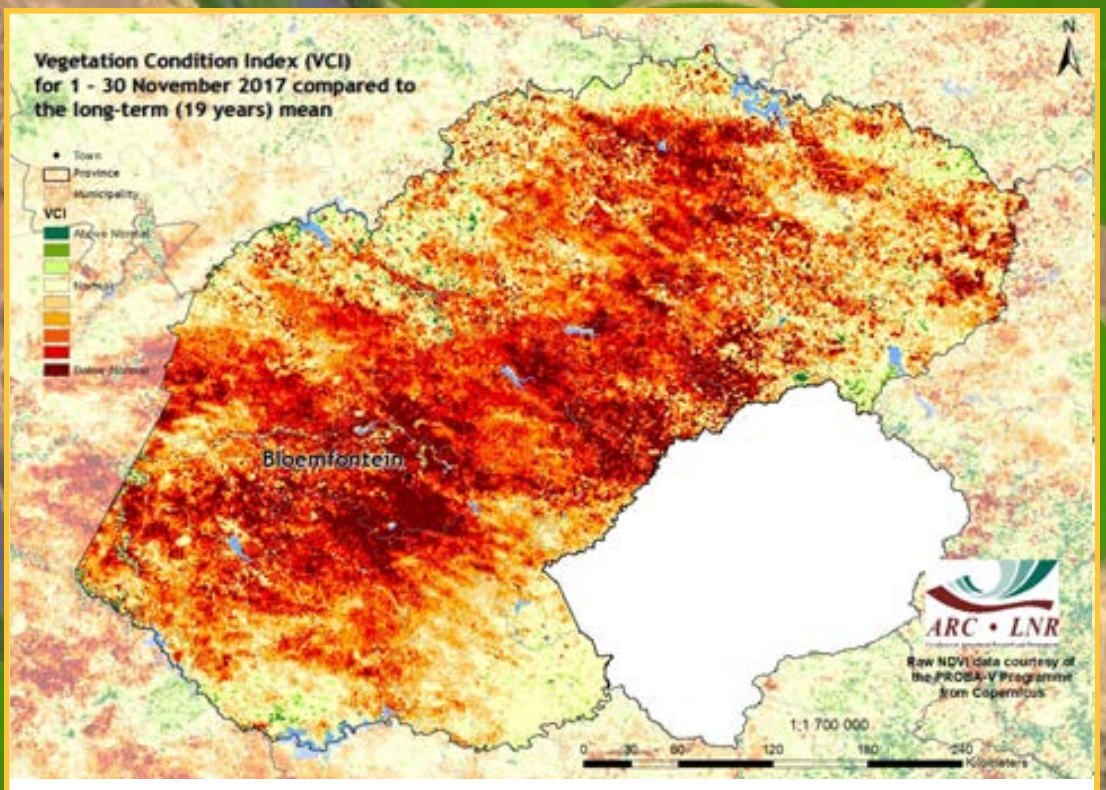

Figure 17

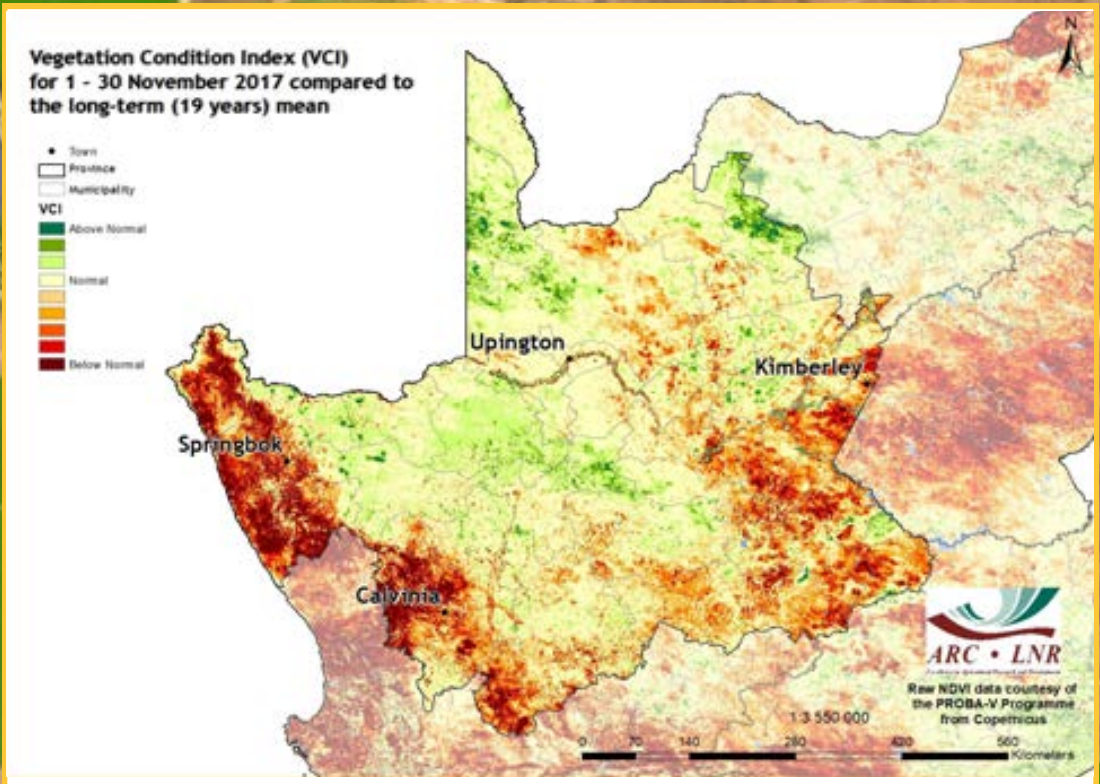

Figure 18

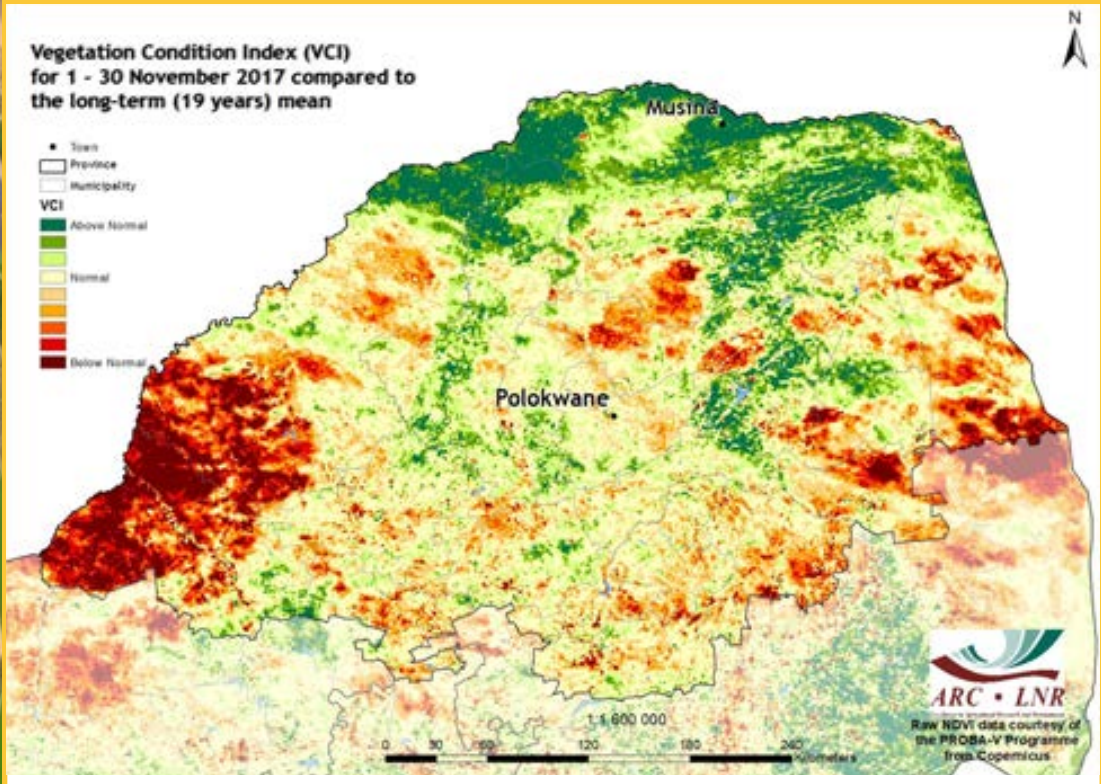

Figure 19

Figure 18:
The VCI map for November indicates low vegetation activity in the southwestern and southeastern parts of the Northern Cape.

Figure 19:
The VCI map for November indicates below-normal vegetation activity over the southwestern parts of Limpopo as well as some isolated areas in the southeast of the province.

Questions/Comments:
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7. Vegetation Conditions & Rainfall

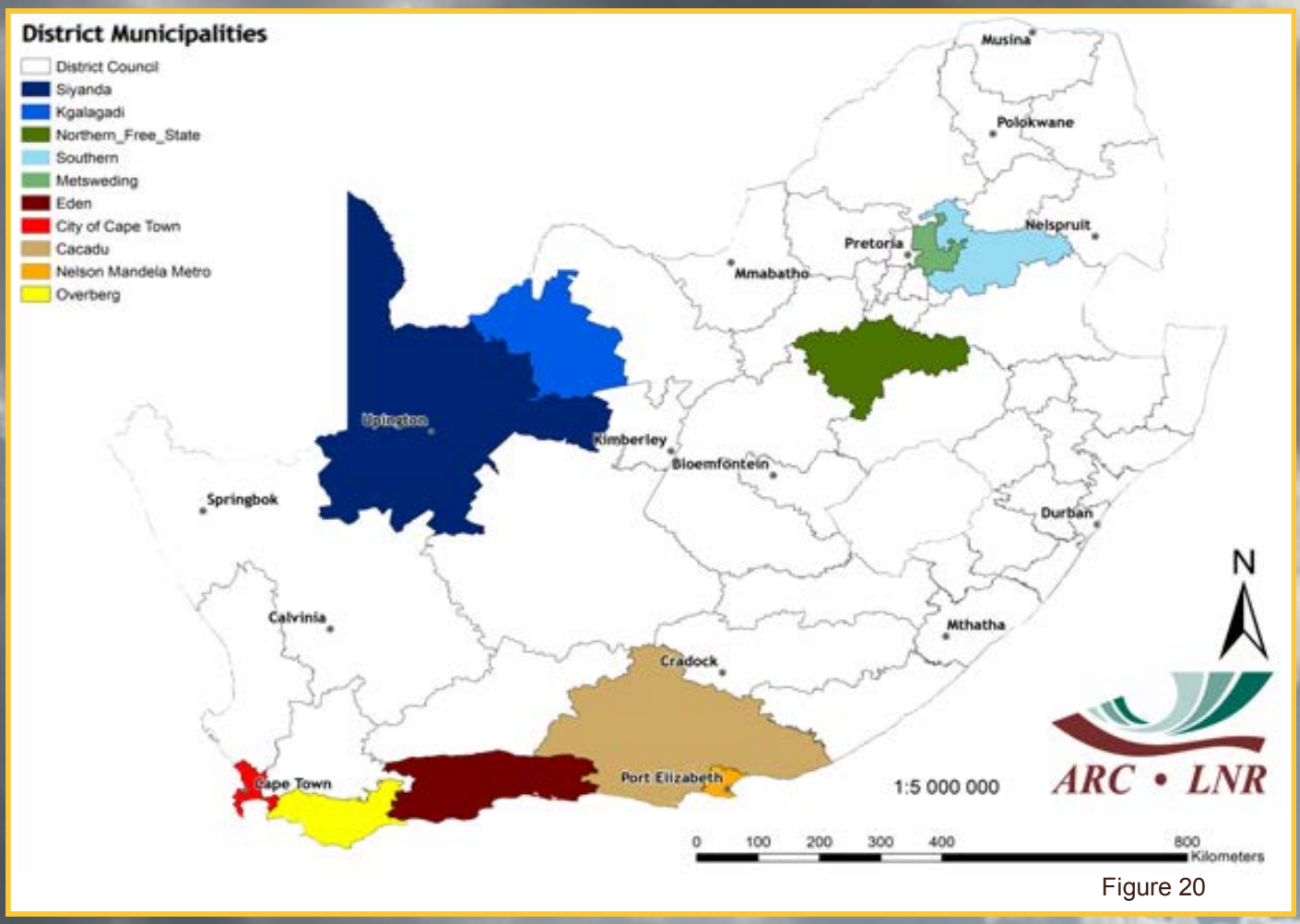

Figure 20

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

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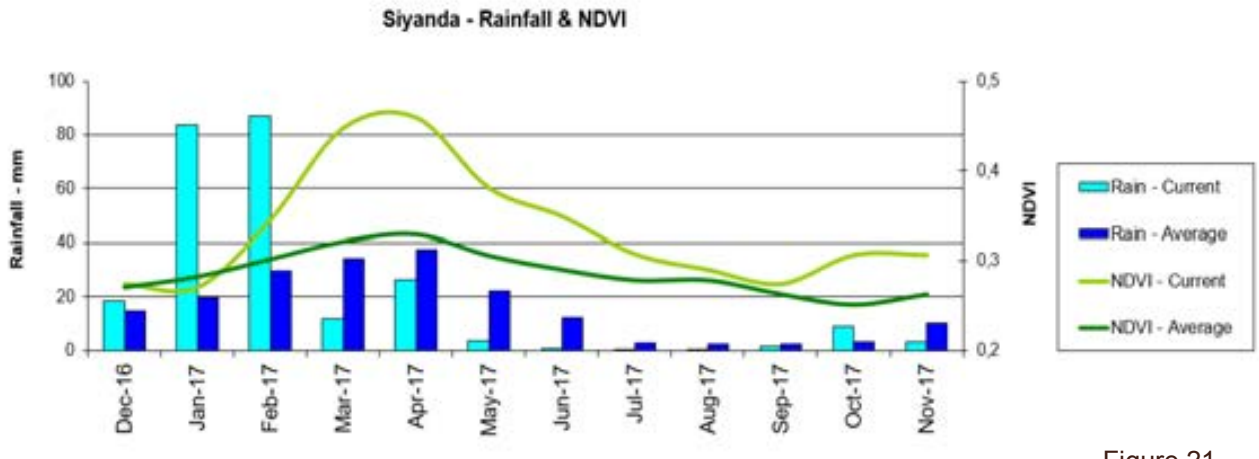
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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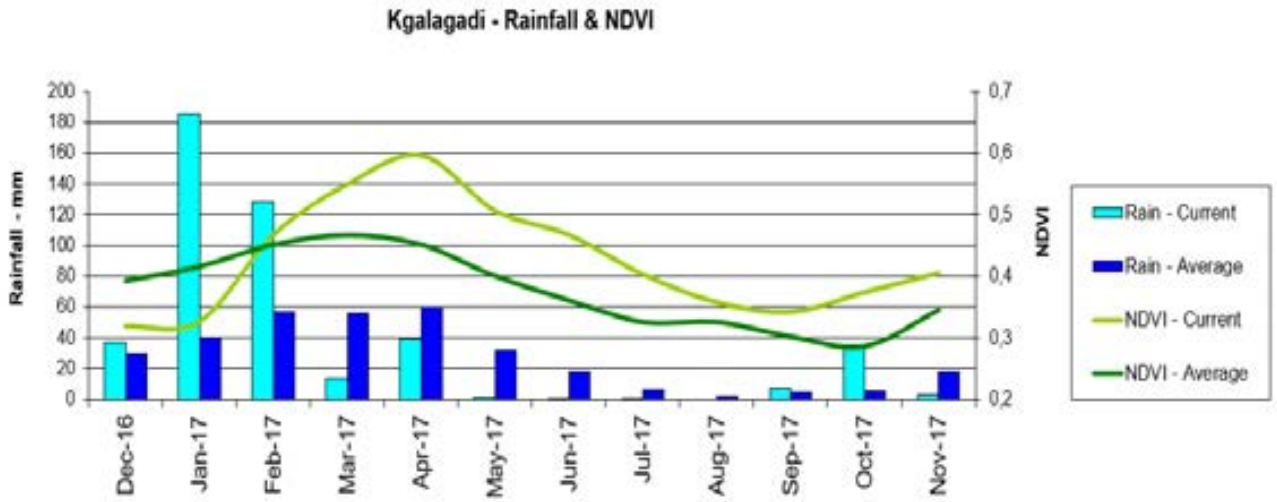
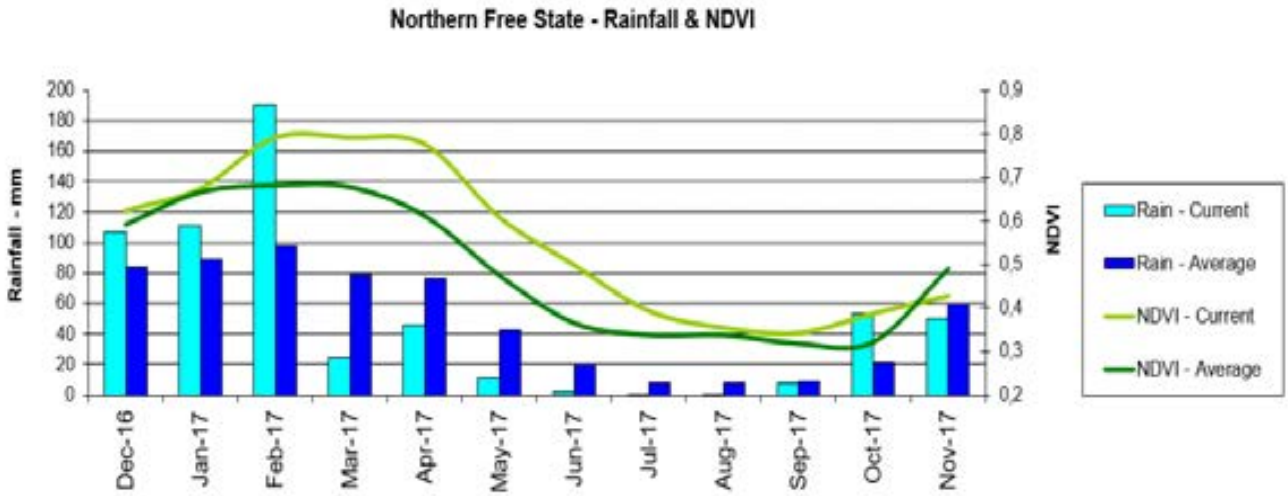


Figure 22



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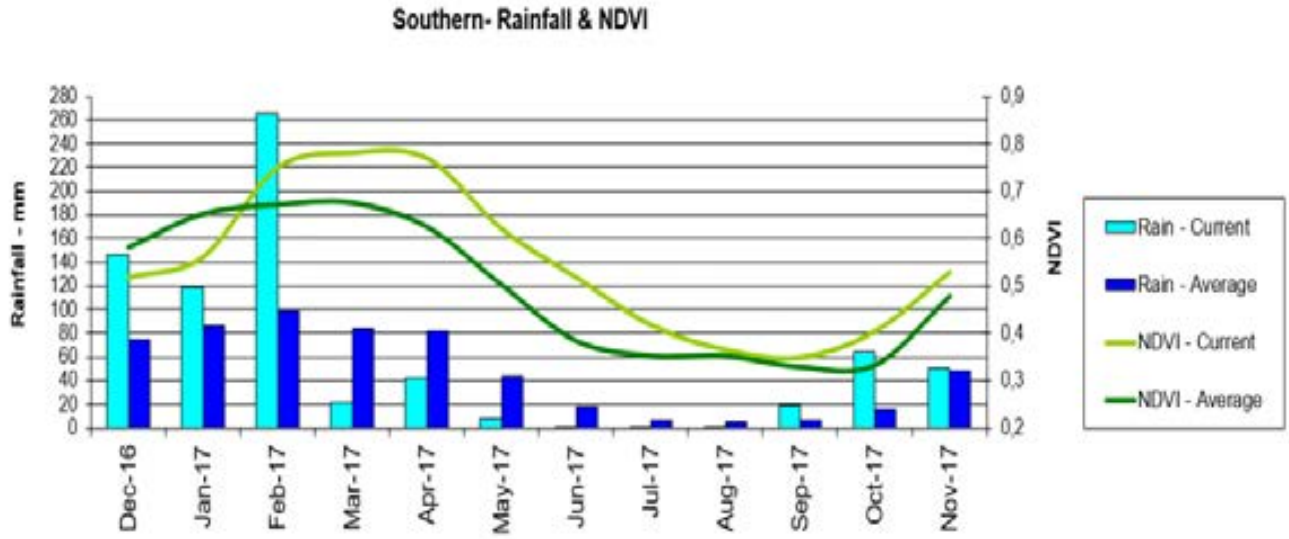
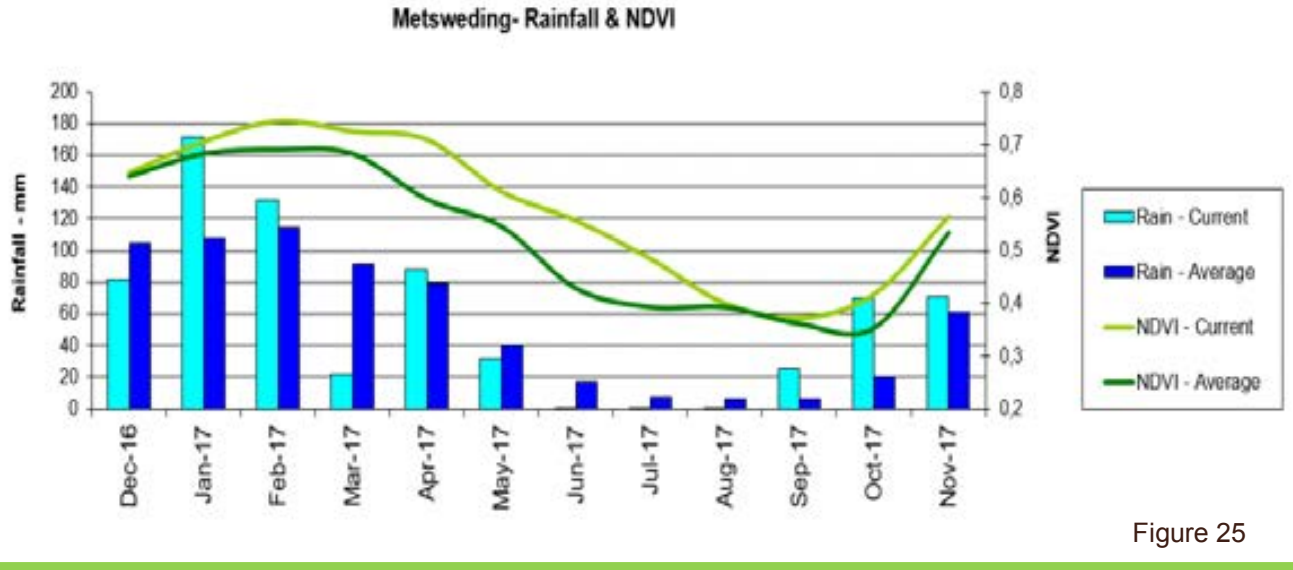


Figure 24



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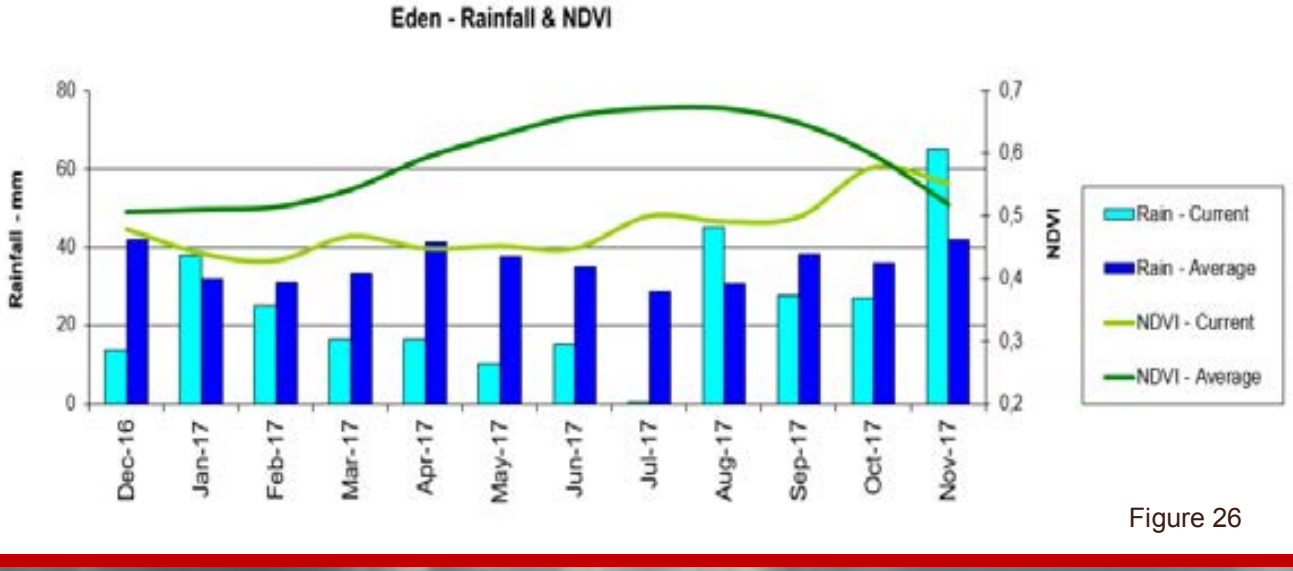
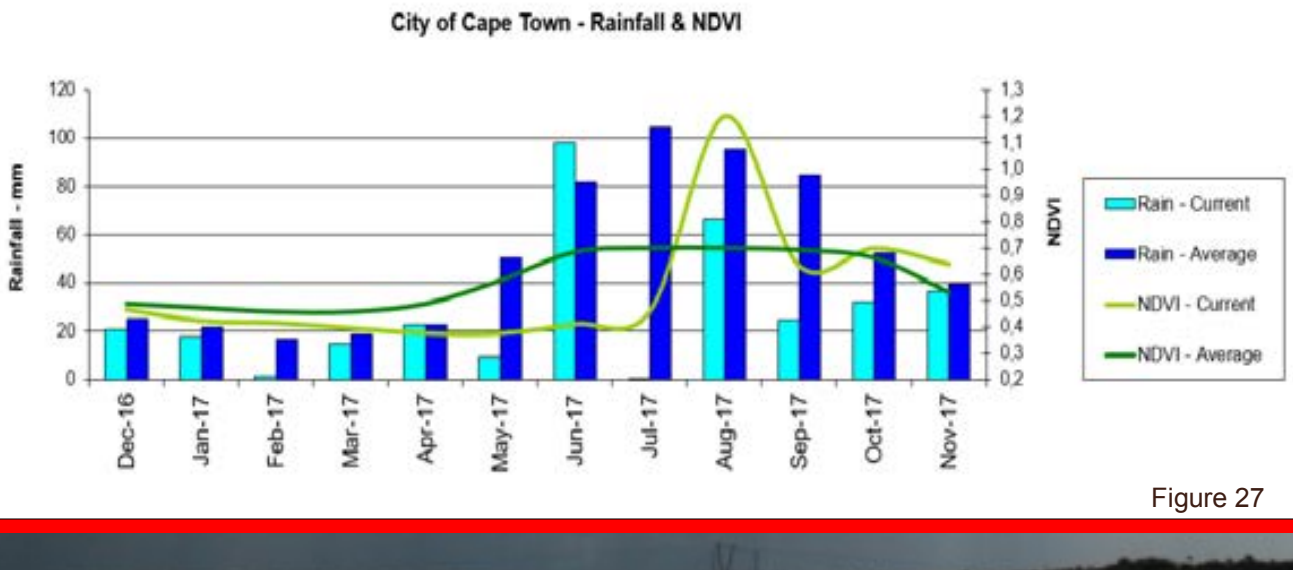


Figure 26



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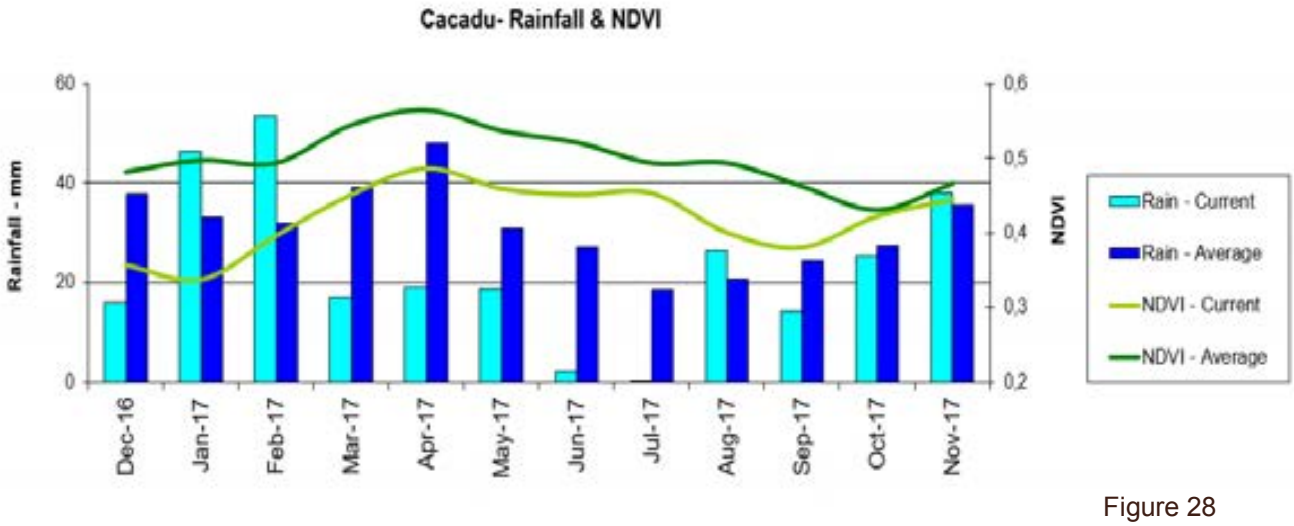

Figure 28

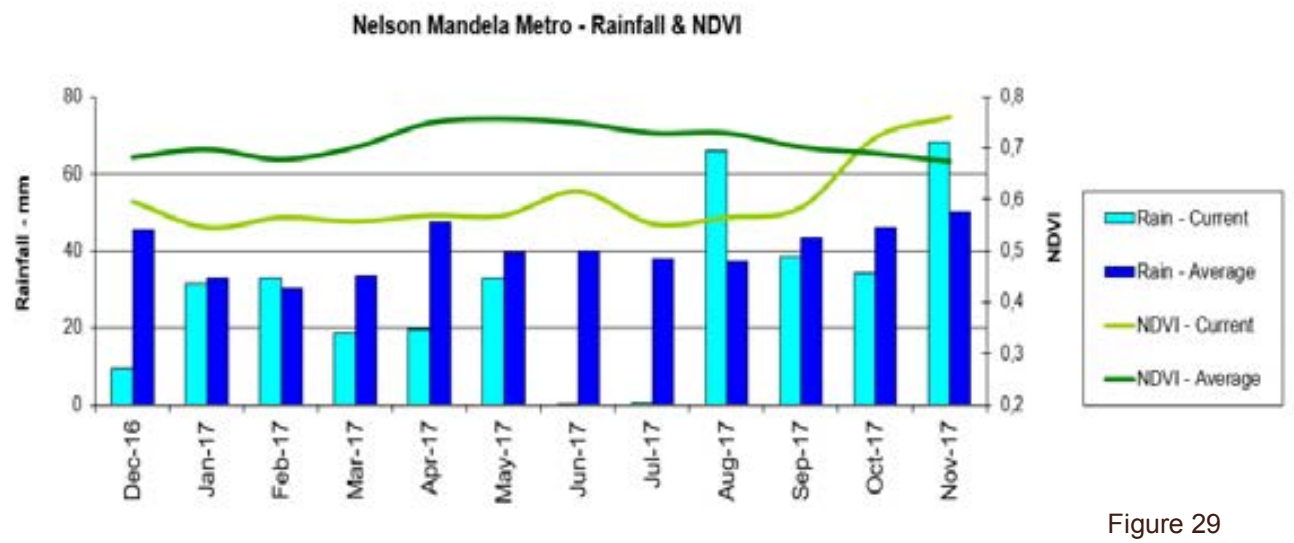

Figure 29

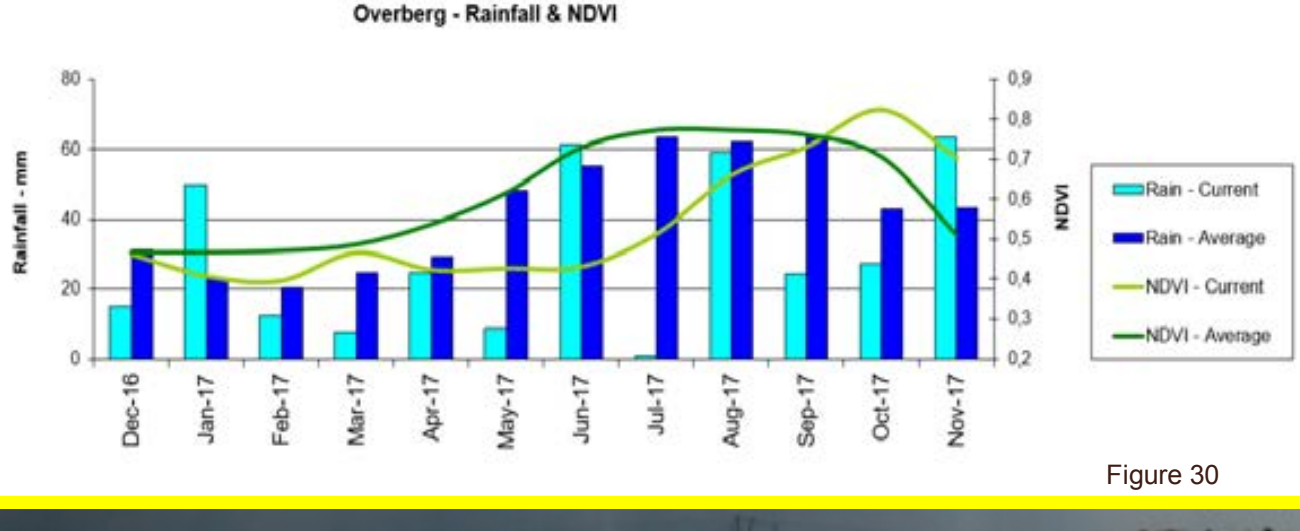

Figure 30

8. Fire Watch

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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 November per province. Fire activity was higher in the Western Cape, Northern Cape, Free State and Eastern Cape compared to the average during the same period for the last 17 years.

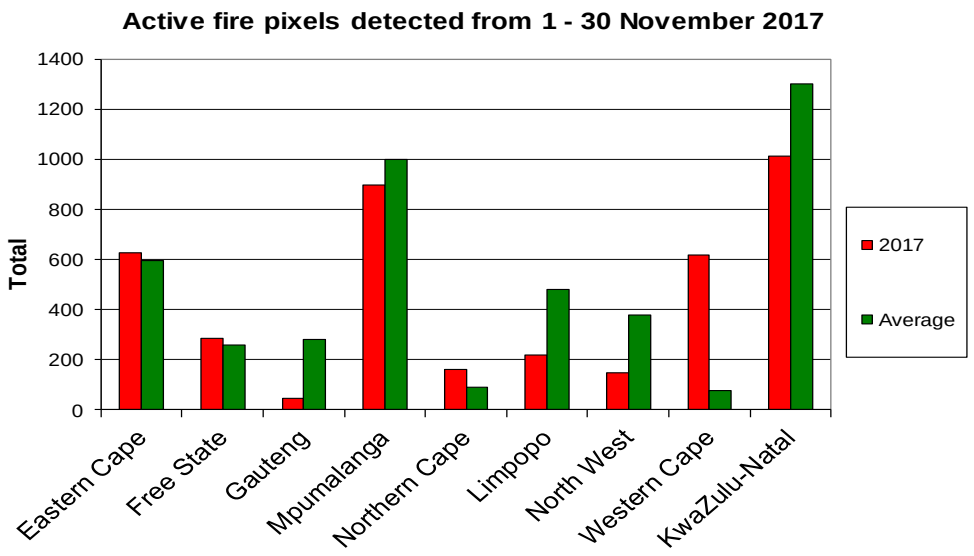

Figure 31

Figure 32:
The map shows the location of active fires detected between 1-30 November 2017.

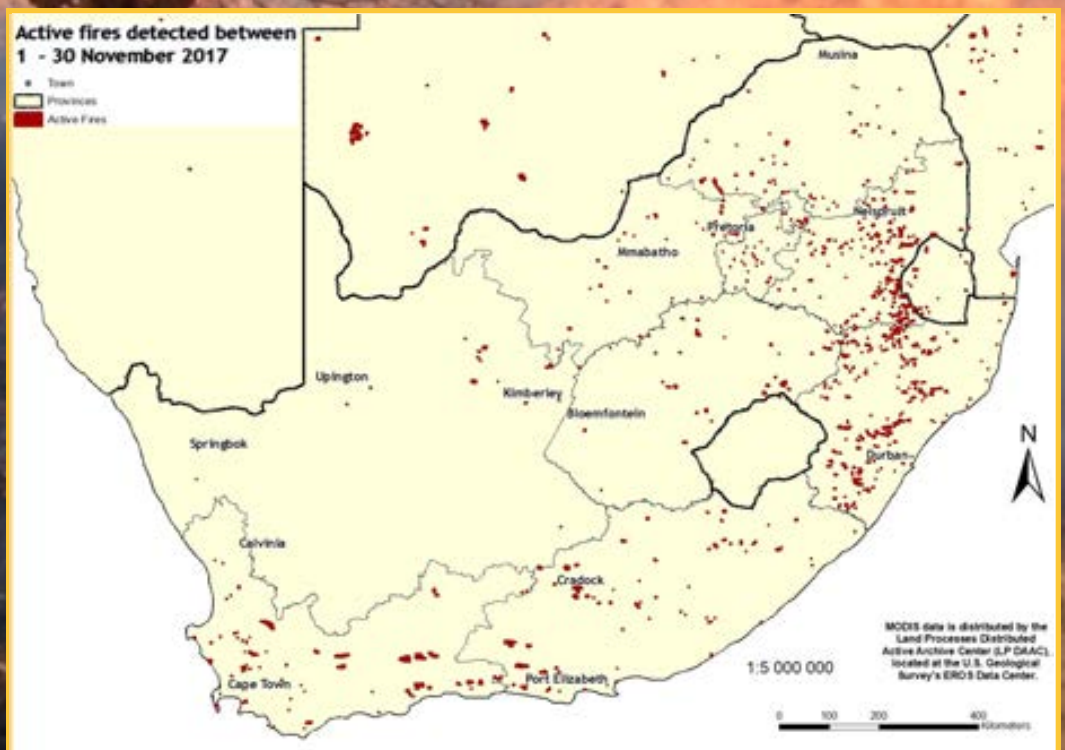

Figure 32

PAGE 17

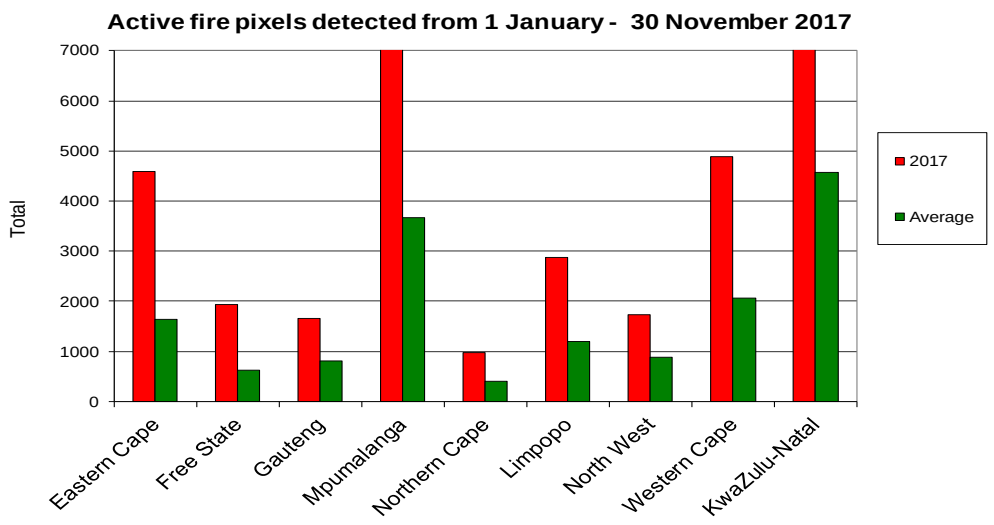

Figure 33

Figure 33:
The graph shows the total number of active fires detected from 1 January - 30 November 2017 per province. Fire activity was higher in all provinces compared to the average during the same period for the last 17 years.

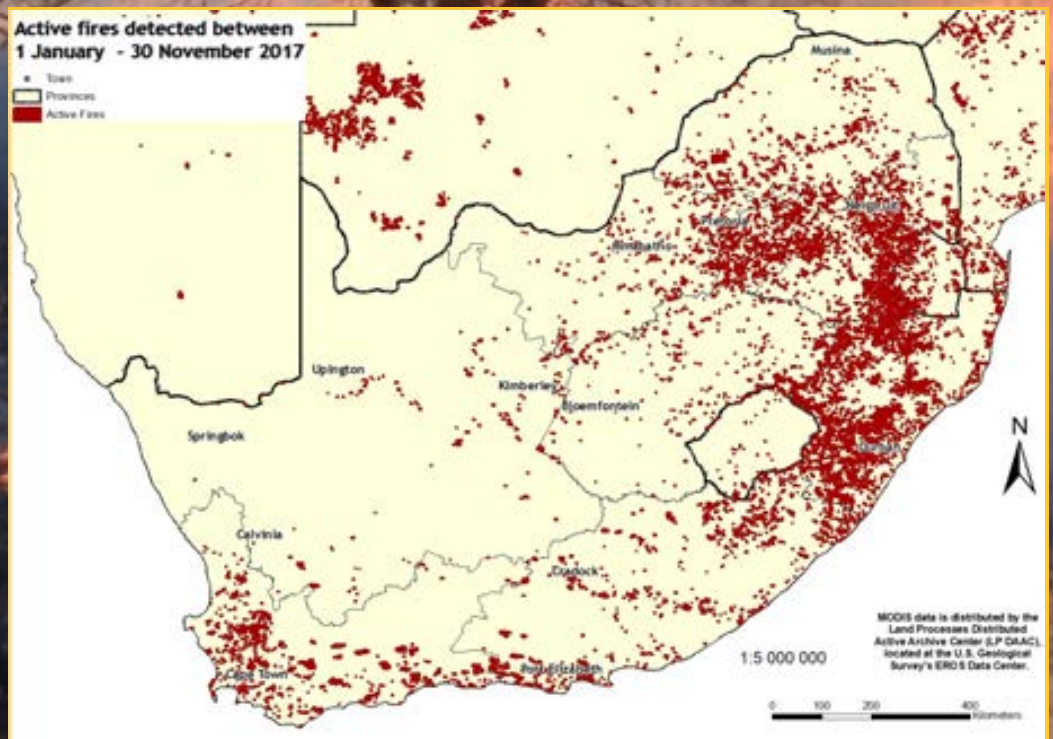

Figure 34

Figure 34:
The map shows the location of active fires detected between 1 January - 30 November 2017.

Questions/Comments:
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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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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

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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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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.

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

http://www.agis.agric.za