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UMLINDI The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

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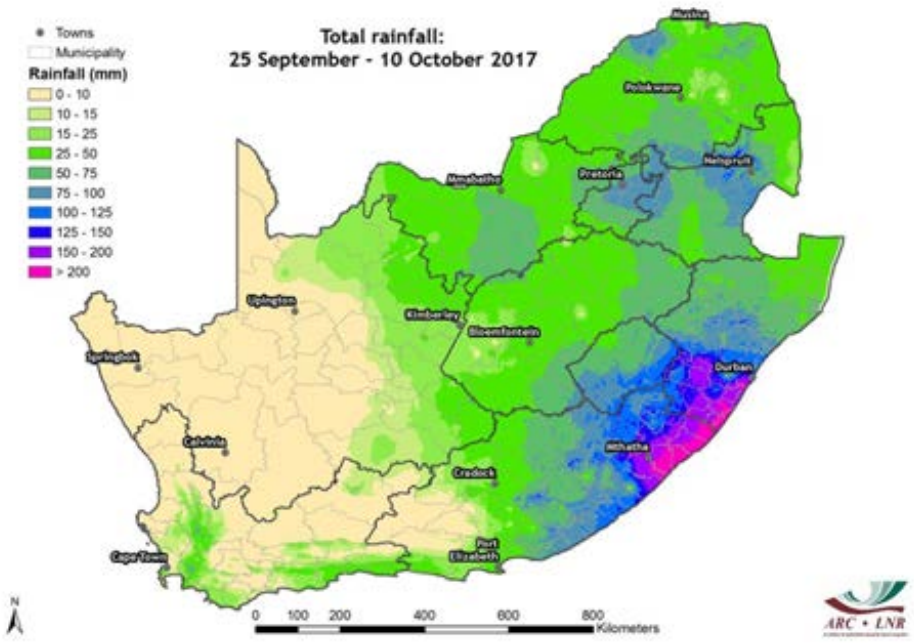
160th Edition

Image of the Month

Good early rains over the summer rainfall region

The summer rainfall region experienced a good start to the rainy season over a period of about two weeks starting at the end of September. Large areas over the eastern part of the country received rainfall totals of between 50 and 75 mm, reaching 100 mm in places, whilst in excess of 100 mm was recorded over southern KwaZulu-Natal and adjacent parts of the Eastern Cape (see rainfall map below). The first spring thundershowers occurred on 25 September over the eastern interior, aided by the passage of an upper-air trough over the country with an accompanying cold front that caused minimum temperatures to drop as low as -5°C over the central interior on the 27th. As this weather system moved to the east of the country, a moisture advecting surface ridge started to dominate the circulation over the eastern parts of the country. At the same time a surface trough that extended from the tropics formed over the western part of the country, whilst an upper-air trough approached South Africa. The combination of these systems resulted in a north-west to south-east aligned cloud band that brought the first spring rain to the summer rainfall region during the last few days of September.



The surface high to the east of the country was quite persistent and contributed to the formation of another tropically sourced cloud band that formed over South Africa on 3 October as another upper-air trough moved in over the country. This cloud band exited on the 6th after which a new upper-air trough neared the country that developed into a cut-off low on 9 October – the day that severe thunderstorms occurred in the Gauteng region and when two tornados were observed. The cut-off low was situated over KwaZulu-Natal on 10 October and caused significant rainfall and flooding along that coast.

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:

Normal to above-normal rainfall occurred along the coast and adjacent interior of the southern and eastern coastal belts of the country during September 2017, extending over the Lowveld of Mpumalanga. With the start of spring, convective activity occurred on a few occasions over the central to eastern interior and above-normal rainfall for the month of September was recorded over parts of the western maize producing region. The rest of the country had below-normal rainfall with the severely drought stricken Western Cape, especially the western part of the province, receiving less than half the normal September rainfall.

Rainfall over South Africa during the first two weeks of September was very limited. During this time, a few frontal systems that brushed the extreme southwestern part of the country caused some rainfall over the mountainous regions. Temperature wise, the month of September started off with a cold front that moved in over the country, causing low minimum temperatures over the central interior regions where minimums as low as -6°C occurred in some places over the Free State. After a relatively cold first week of September, the following week was characterized by being hot. The third week of the month started off with an upper-air trough that moved in over the country on the 15th, accompanied by a surface ridging high pressure system. The combination of these weather systems caused widespread rainfall along the southern coastal belt and adjacent interior, moving eastwards along the eastern coastal belt as the upper-air trough progressed eastwards and the surface high pressure system establish itself to the east of the country. Most of the rainfall during September along the southern coastal belt occurred during this event. By the 19th, a frontal system moved quickly over the southwestern and southern parts of the country, with the ridging high in the wake of the front leading to cloudy conditions east of the escarpment. Another cold front, also accompanied by an upper-air trough, moved in over the country on the 21st and progressed eastwards over the southwestern and southern parts of South Africa on the 22nd, with the ridging high pressure system behind the front causing cloudy conditions with rainfall east of the eastern escarpment by the 23rd.

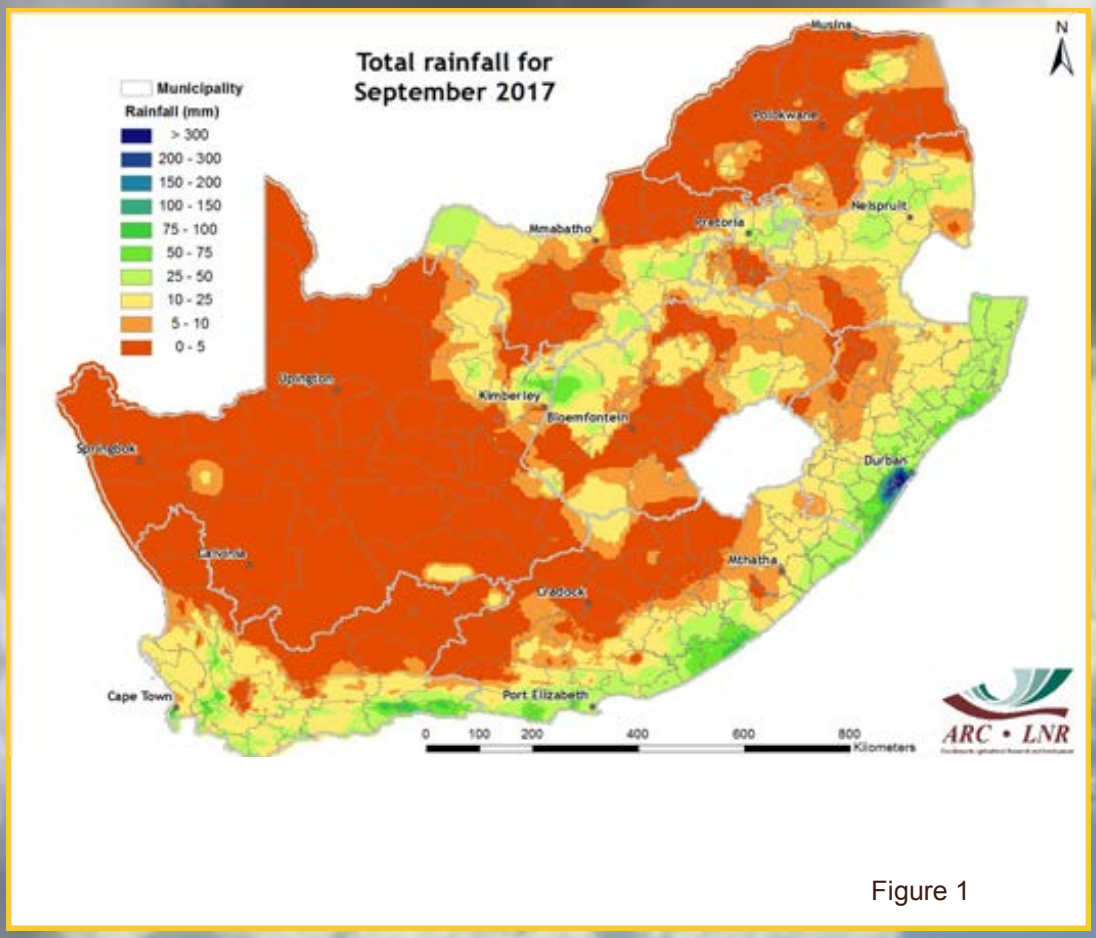


Figure 1

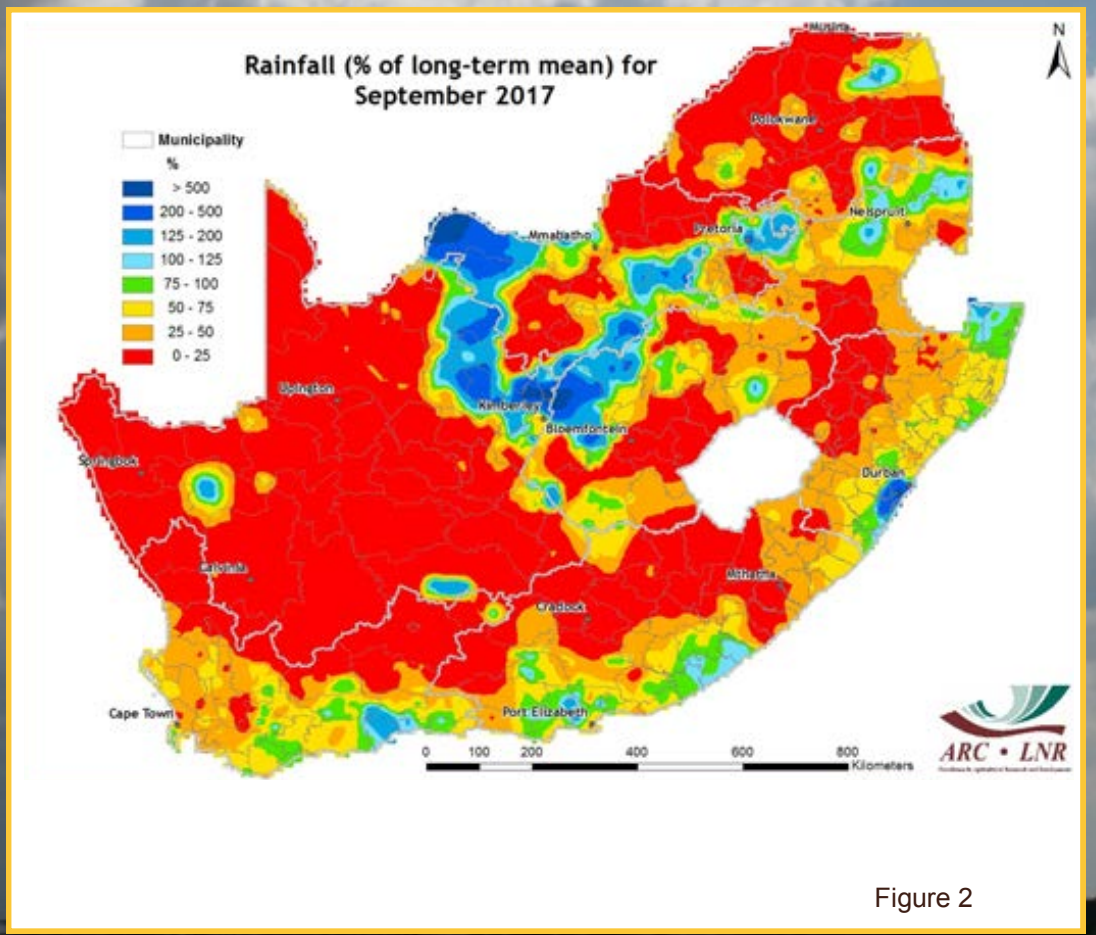
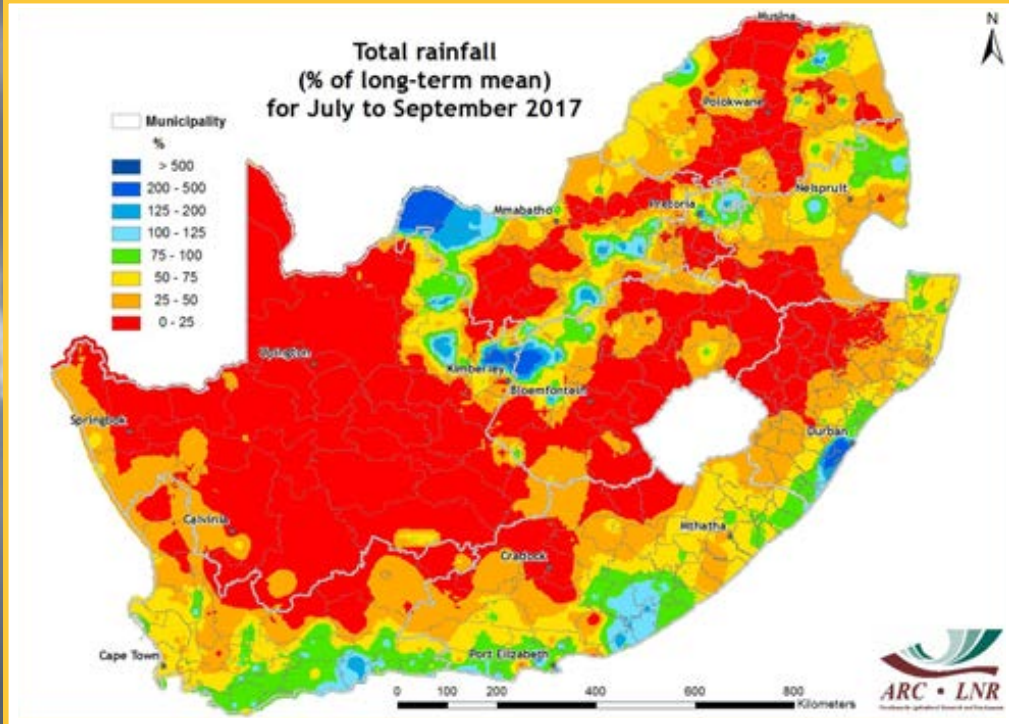


Figure 2



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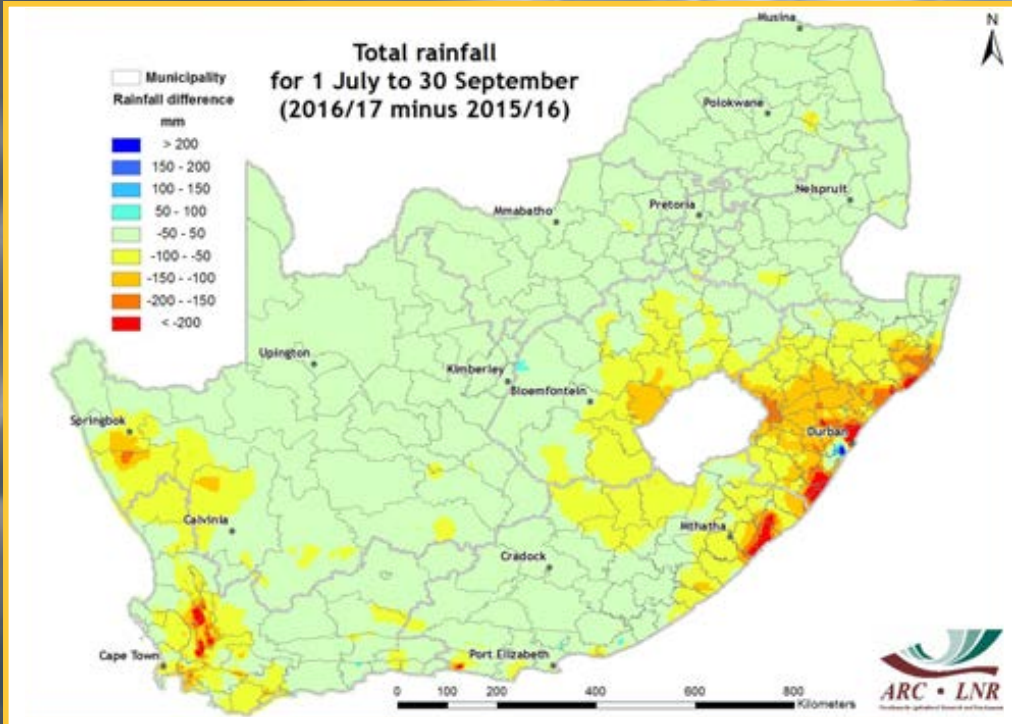

Figure 4

(*continued from p. 2*)

Between the 24th and 26th, an upper-air trough accompanied by a frontal wave moved over the country, introducing thunderstorms on the evening of the 25th over the eastern interior. Minimum temperatures dropped notably over the interior on the morning of the 27th after the passage of the frontal trough. From the 28th until the end of the month, a surface high pressure system ridging in over the eastern part of the country in combination with a surface trough that developed over the western parts of South Africa aided in the development of thundershowers over the central to eastern parts of the country.

Figure 1:
The rainfall distribution for the month of September looks quite similar to the August rainfall distribution, except for the thunderstorm activity that occurred over the central and eastern interior at the end of September. Also, the total monthly rainfall over the winter rainfall region was less during September compared to August as the main rainfall season over those areas is now over.

Figure 2:
Above-normal rainfall occurred over parts of the central and eastern interior as thundershowers occurred during the last few days of September. Some areas along the southern and eastern coastal belts received near-normal to above-normal rainfall that mostly occurred in mid-September during a ridging high pressure system event.

Figure 3:
Over the past three months, near-normal to above-normal rainfall occurred over the southern to southeastern coastal belts as well as over some isolated areas in the northeast of the country. The winter rainfall region received mostly below-normal rainfall.

Figure 4:
Over the mountainous regions in the western part of the Western Cape, the 2017 period received up to 200 mm less rainfall than during the corresponding 2016 period. The eastern coastal belt also received less rainfall during 2017 compared to 2016, with the rainfall deficit up to 200 mm in places.

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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 all the time scales, severe to extreme drought conditions are present over the winter rainfall region, expanding spatially eastwards from the 36-month time scale to the 12-month time scale. Slight relief from the severe to extreme drought is visible over the eastern parts of the Western Cape 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 from the 6-month time scale over the southern interior.

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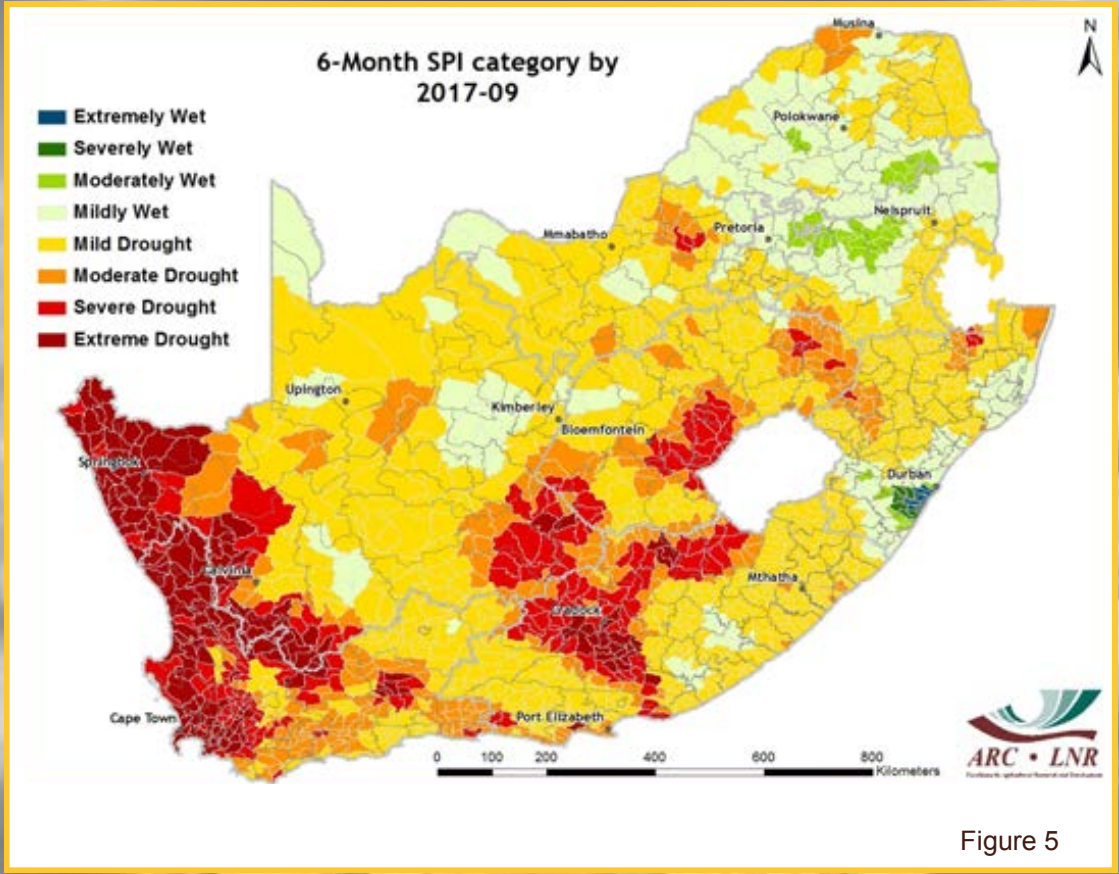

Figure 5

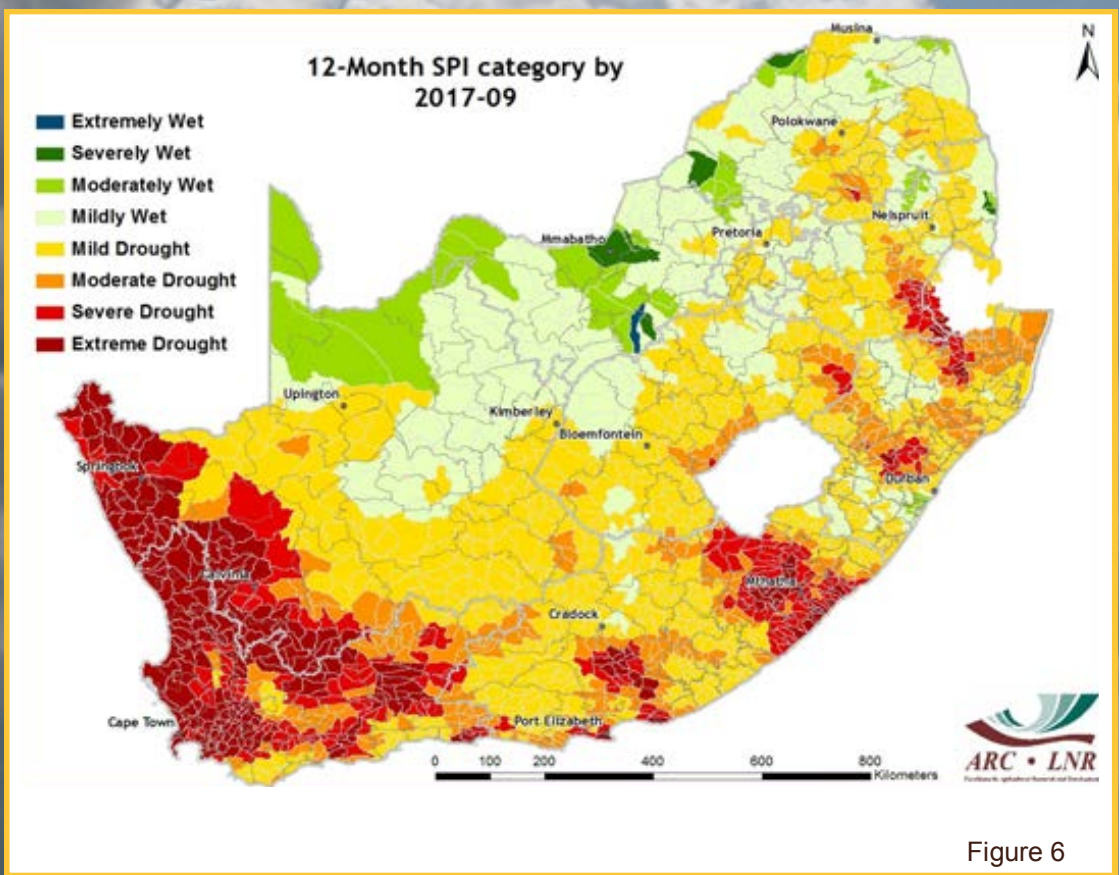

Figure 6

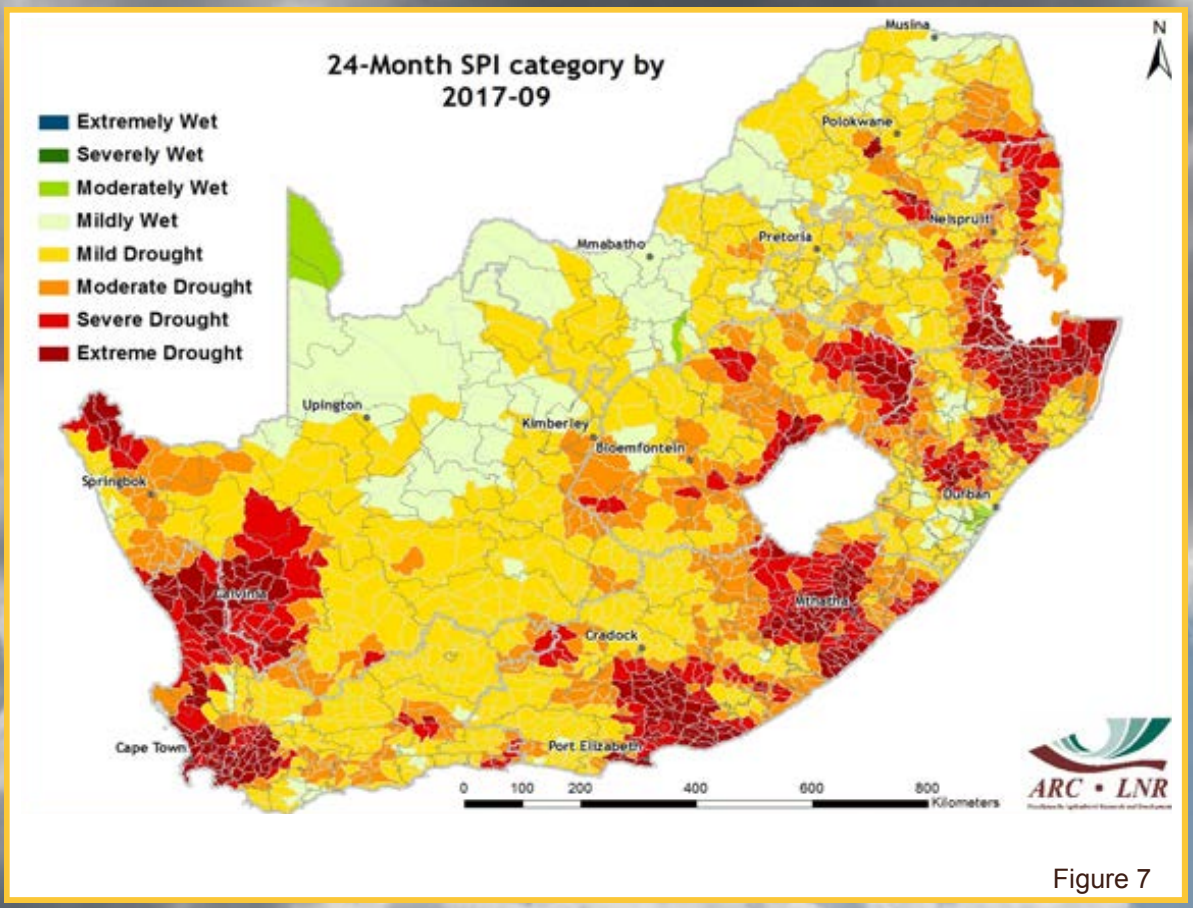

Figure 7

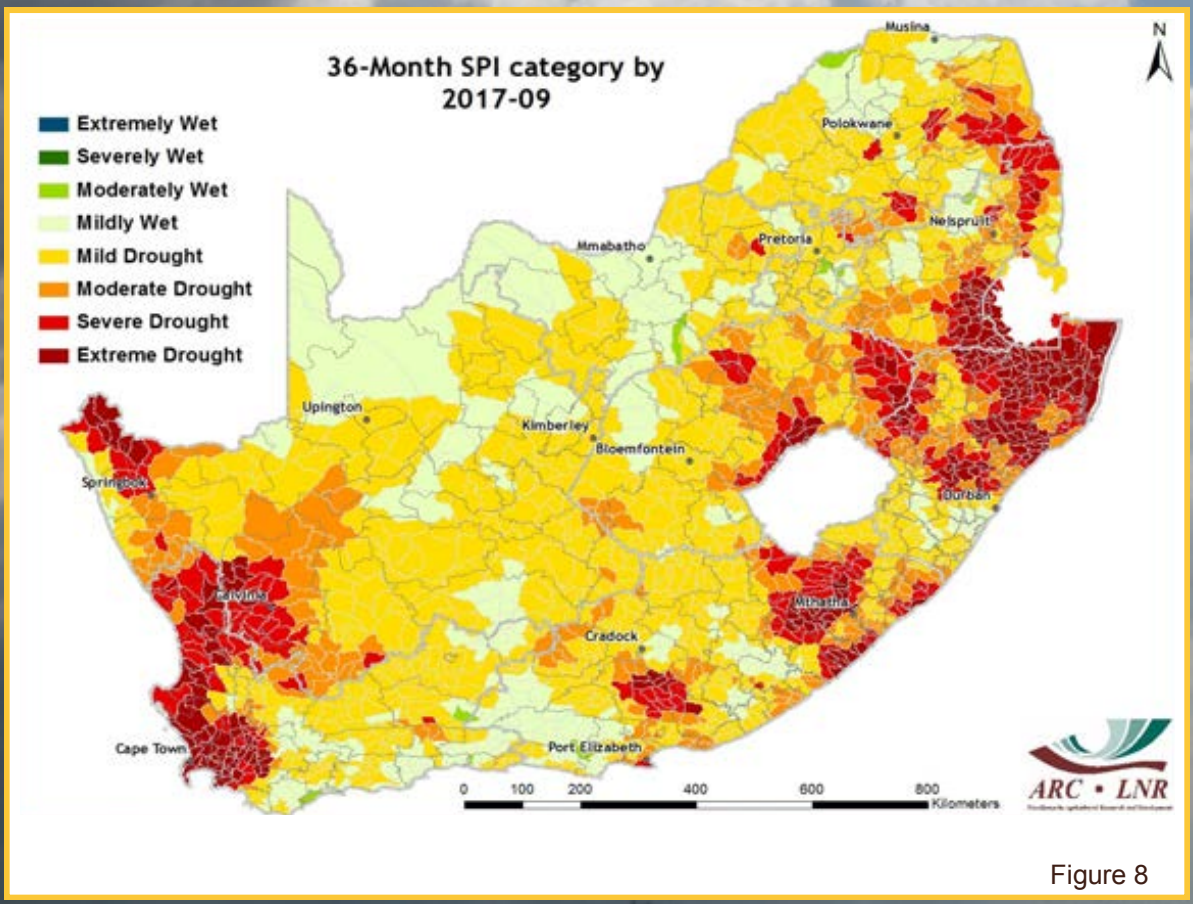

Figure 8

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.

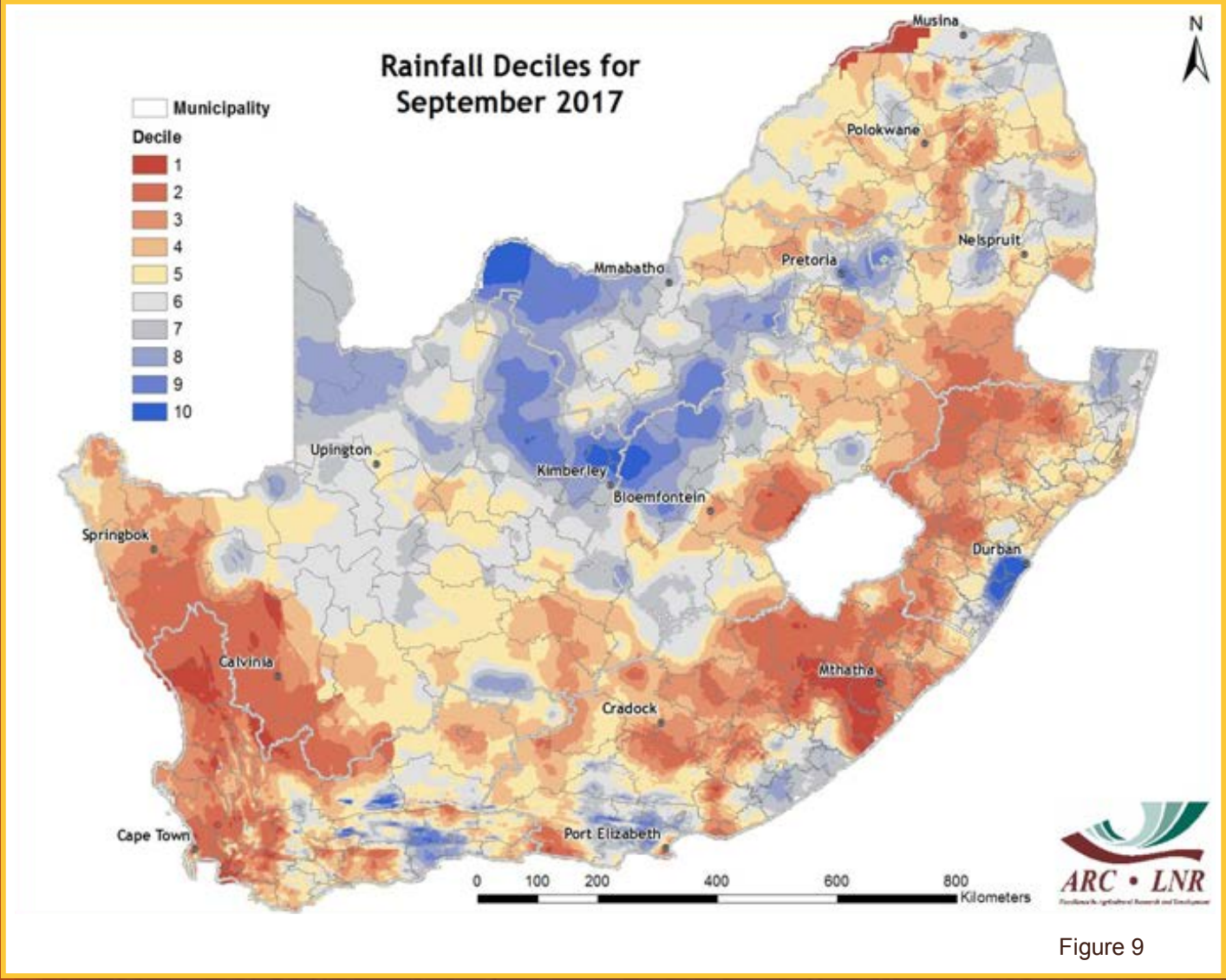

Figure 9

Figure 9:
Compared to historical rainfall totals during the month of September, September 2017 over most of the winter rainfall region compares well with the drier September months. Over some areas along the southern to southeastern coastal belts, the KwaZulu-Natal coast as well as over the central and northeastern interior, September 2017 falls within the wetter September months.

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4. Water Balance

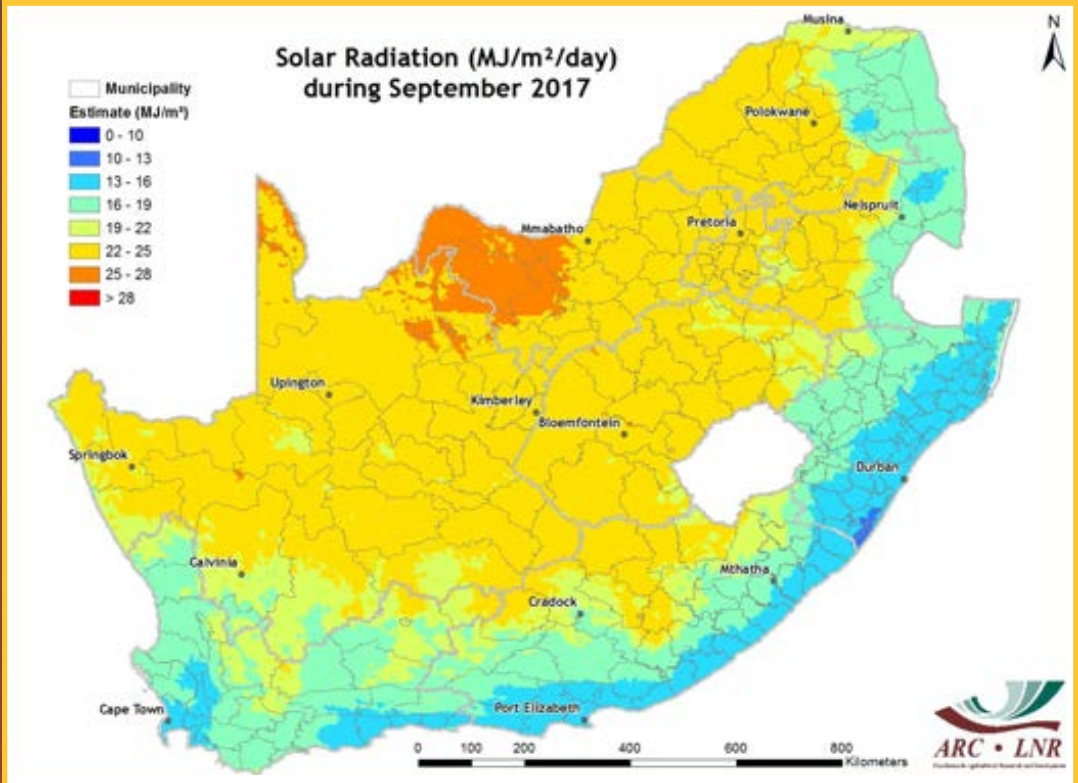

Figure 10

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 over the southern and eastern coastal belts of the country, with increasing values further northwards. The highest values are located over the northern parts of the country, to the south of Botswana.

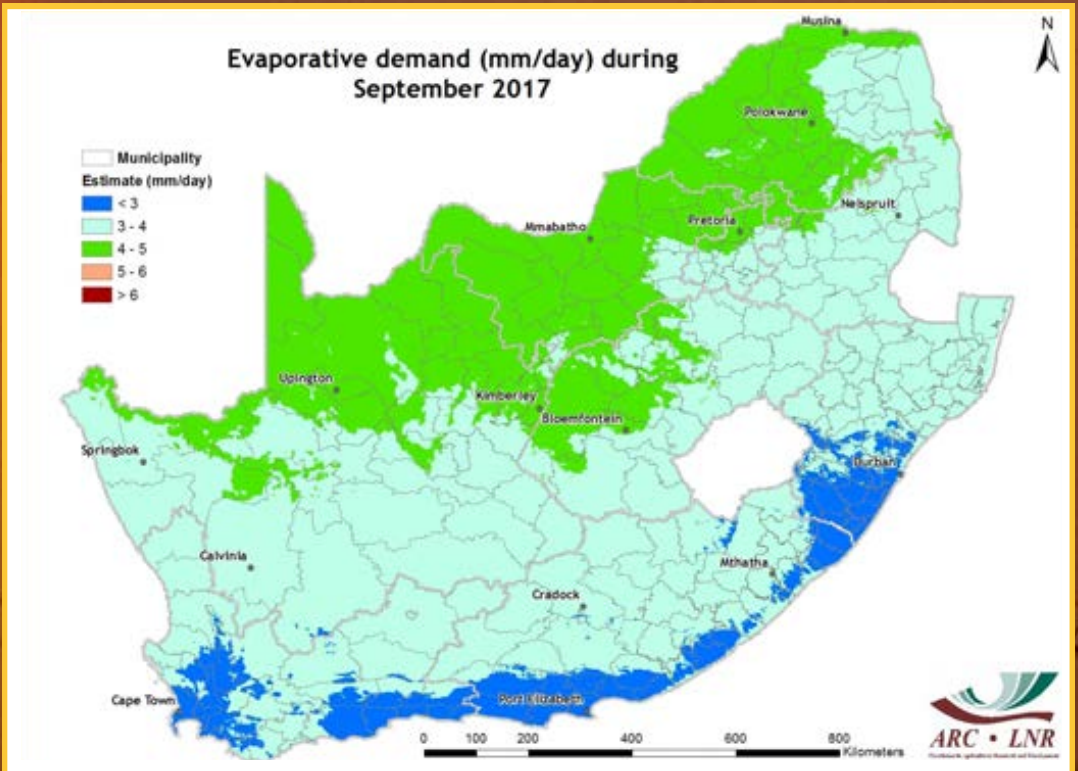

Figure 11

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 far southern parts of the country extending into southern KwaZulu-Natal. The evaporative demand increased towards the northern parts of the country where values exceeded 4 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.

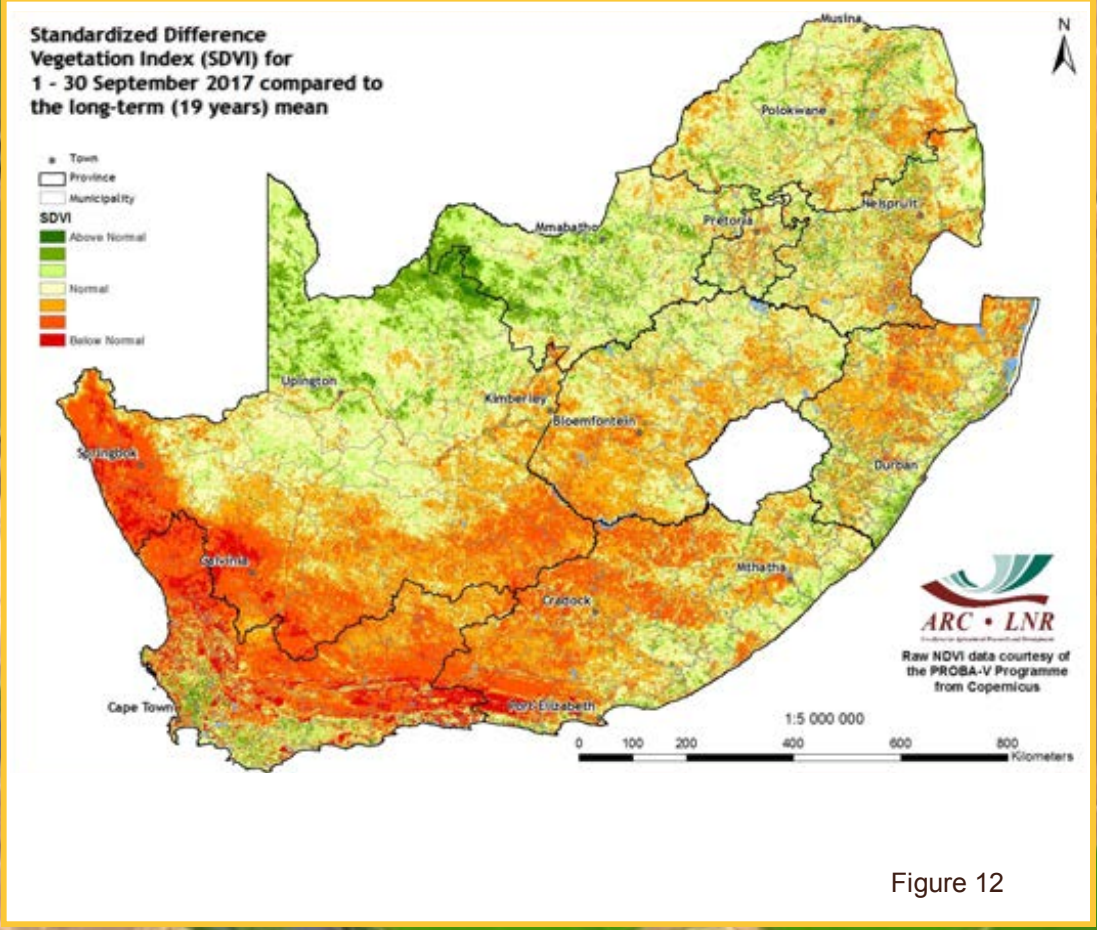

Figure 12

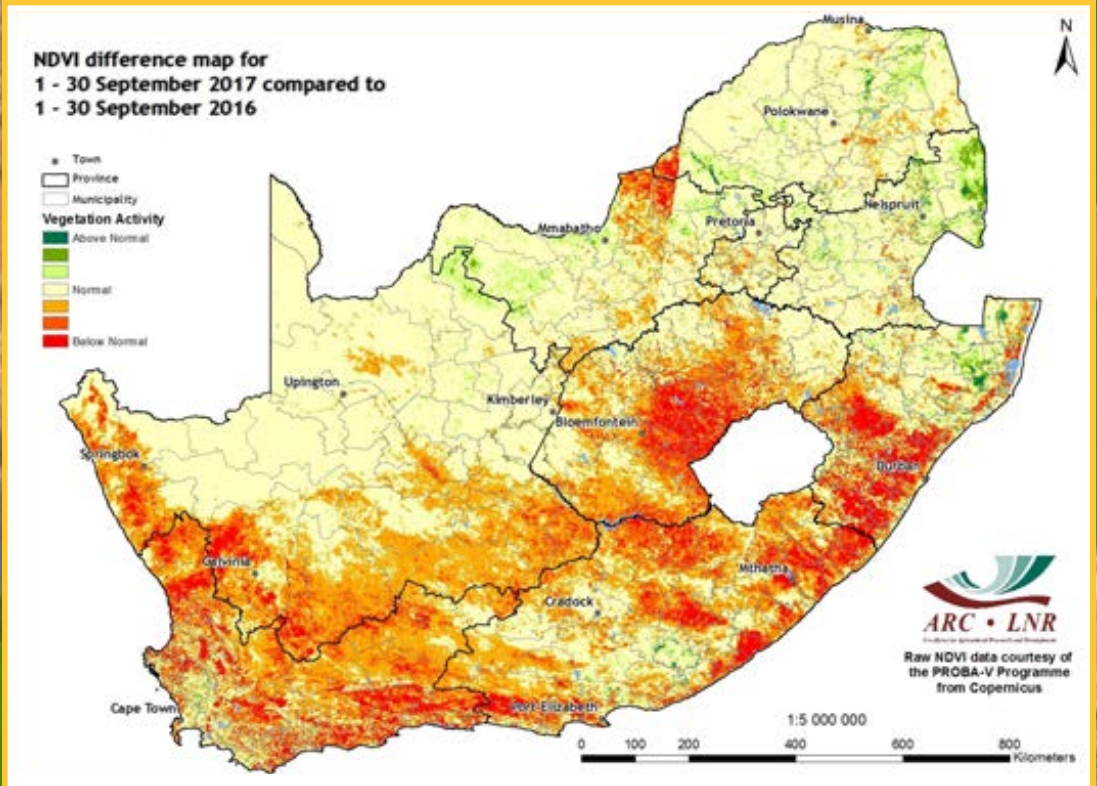

Figure 13

Figure 12:
The SDVI for September indicates above-normal vegetation activity over most of North West, northern parts of the Northern Cape and southwestern parts of the Western Cape. Isolated areas of KwaZulu-Natal, Limpopo, Mpumalanga and Gauteng show above-normal vegetation. However, dry conditions prevailed in most of the Eastern Cape, Western Cape, Free State and southern parts of the Northern Cape.

Figure 13:
Vegetation activity is lower over the southern and far western parts of the Northern Cape, greater Karoo region, Free State and Western Cape. Much of the Eastern Cape and southern parts of KwaZulu-Natal also experienced dry conditions.

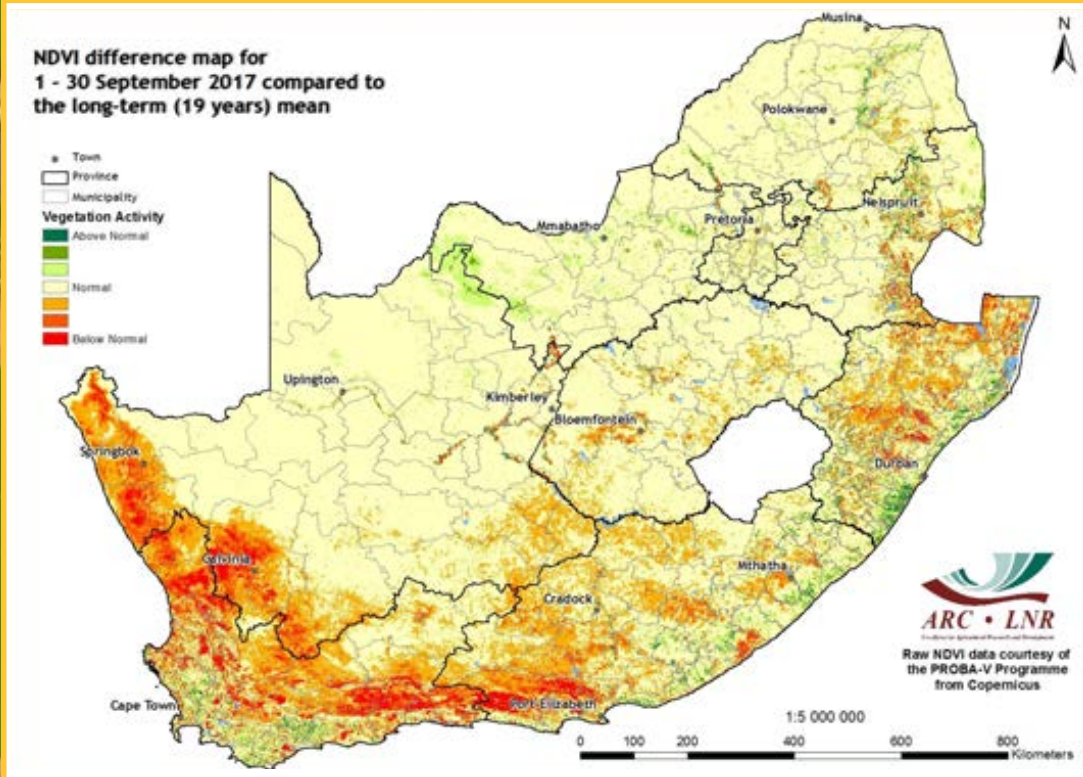

Figure 14

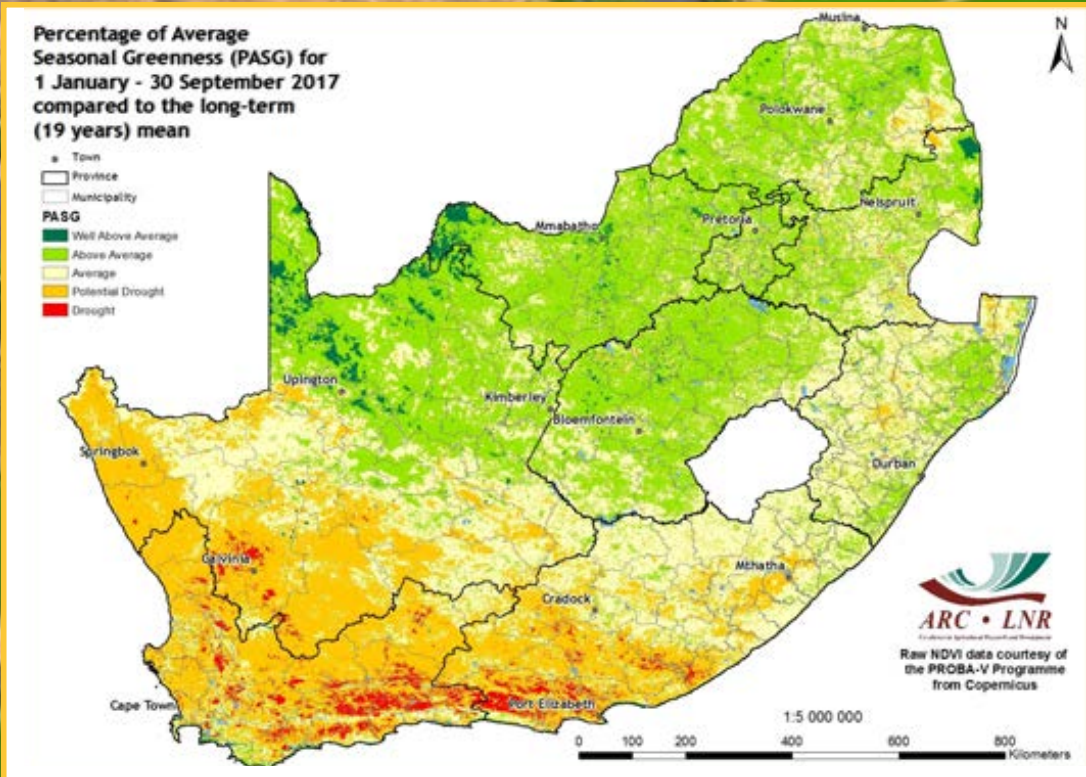

Figure 15

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 September was lower along the west and south coast, western parts of the Eastern Cape and southern parts of the Northern Cape. However, the KwaZulu-Natal coast experienced an increase in vegetation activity.

Figure 15:
Cumulative vegetation activity was above average in North West, Gauteng, Free State, Limpopo, Mpumalanga and northern parts of the Northern Cape. The southwestern parts of the country continue to experience potential drought conditions.

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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.

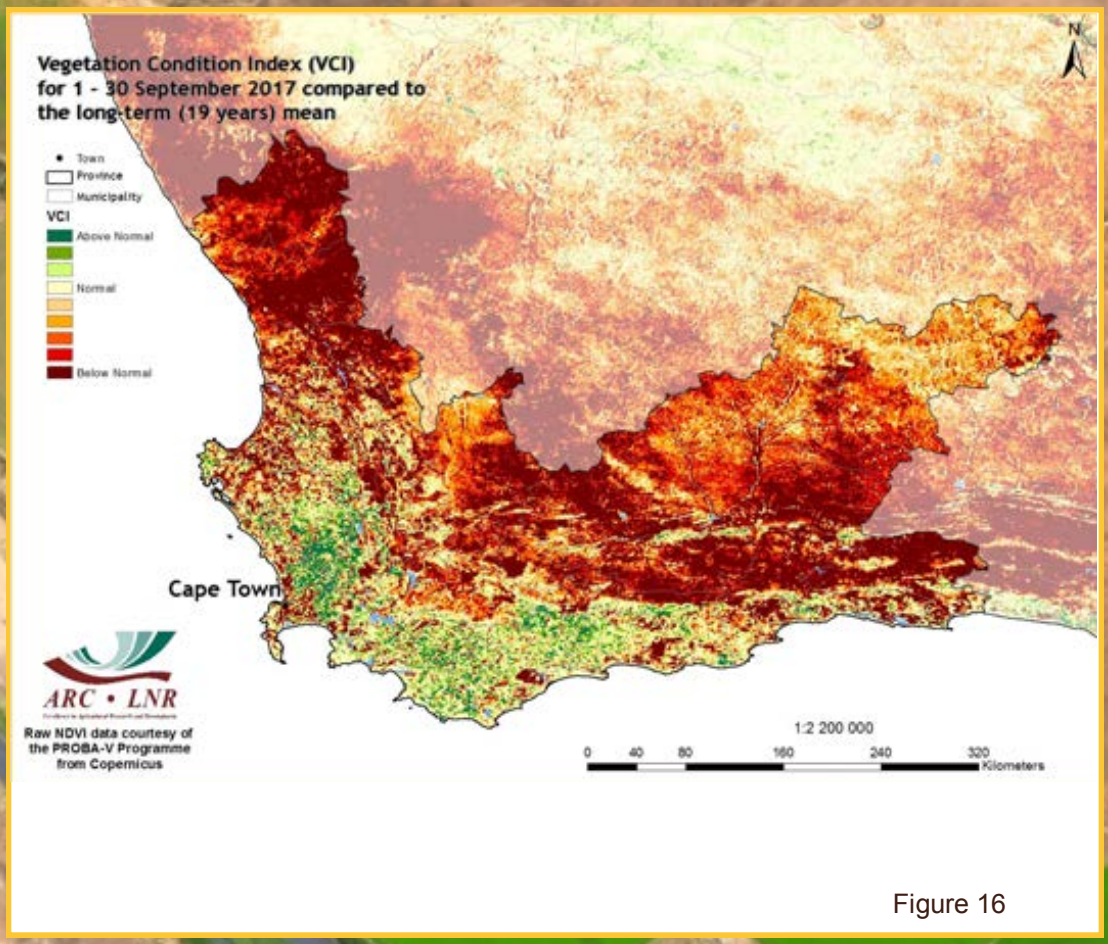
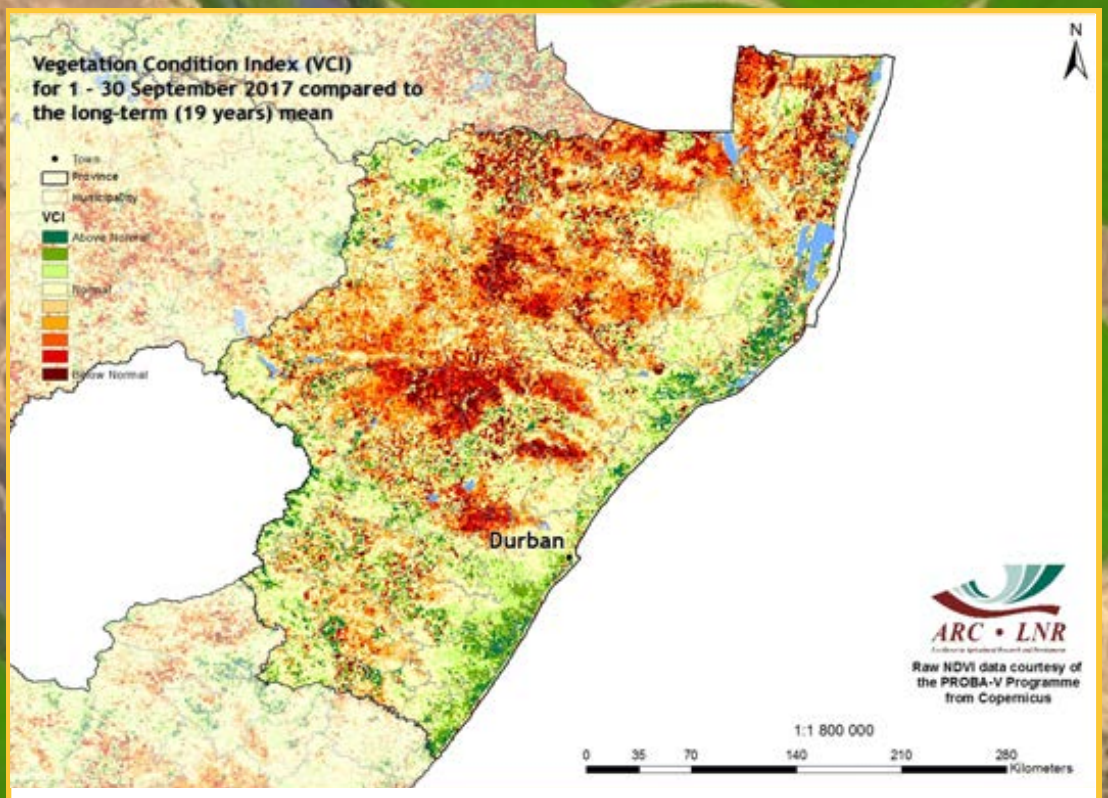


Figure 16

Figure 16:
The VCI map for September indicates below-normal vegetation activity over the northern parts of the Western Cape. Above-normal vegetation conditions are visible in the southwestern parts.

Figure 17:
The VCI map for September indicates below-normal vegetation activity over the northeastern and northwestern areas of KwaZulu-Natal.



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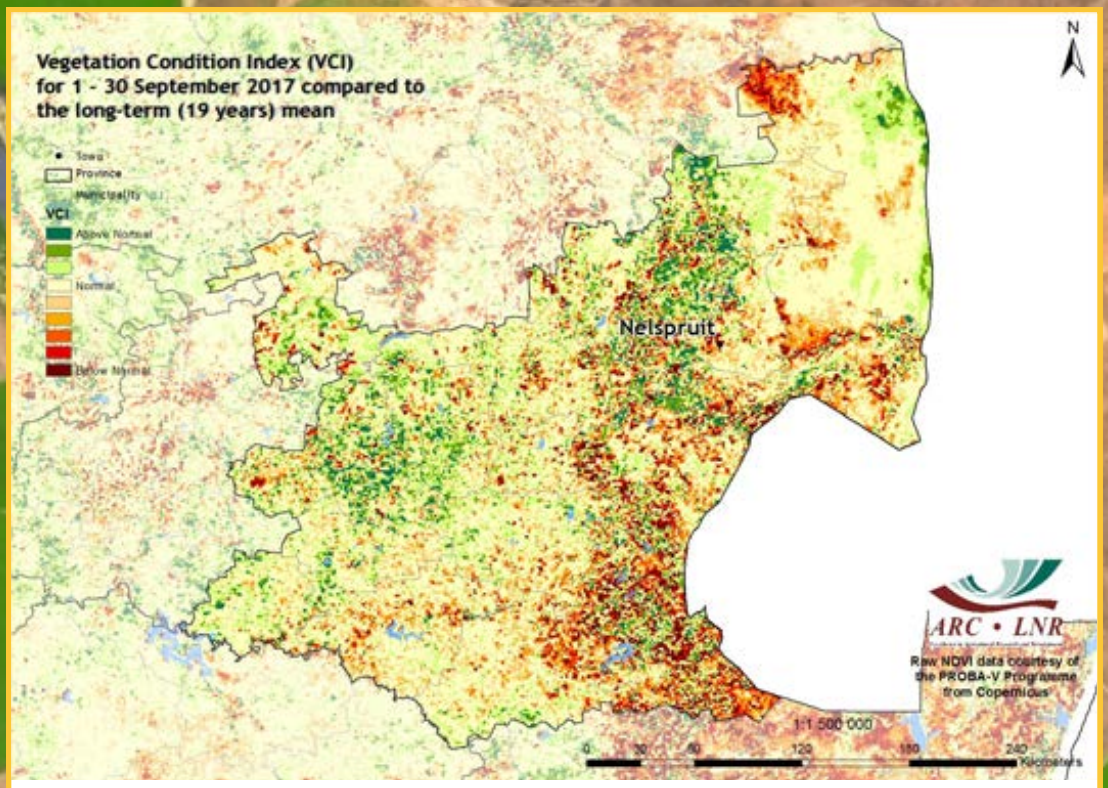

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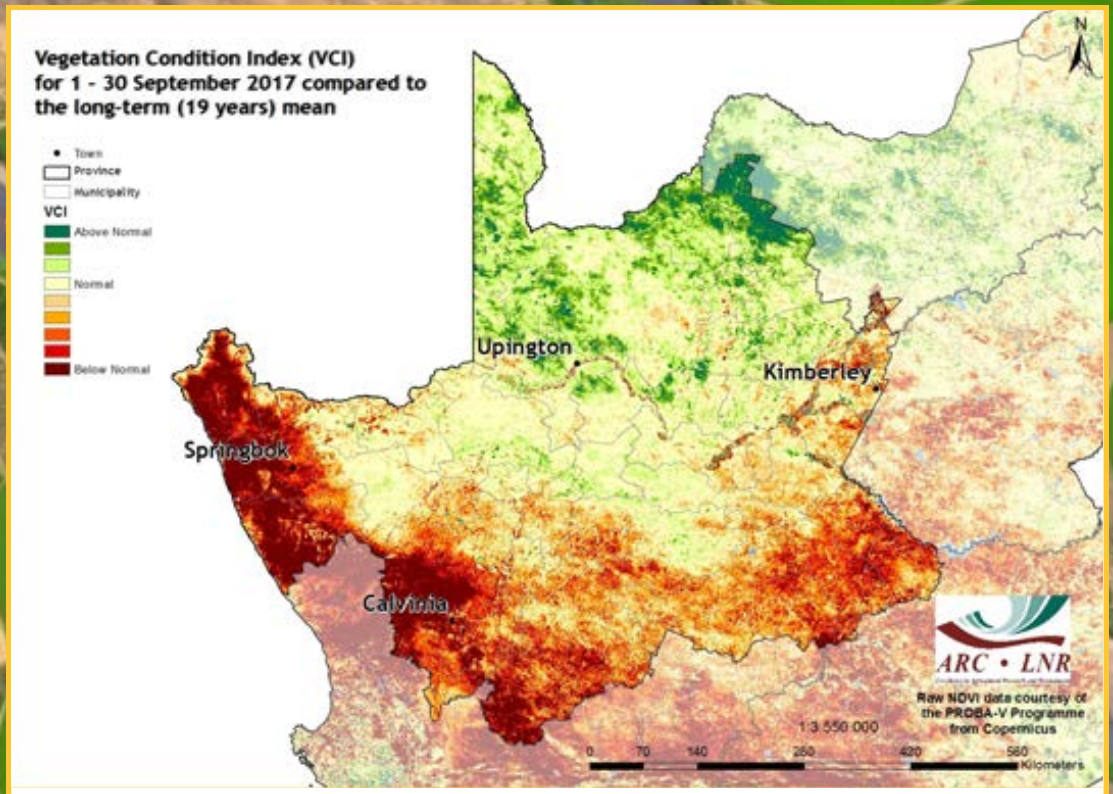

Figure 19

Figure 18:
The VCI map for September indicates below-normal vegetation activity over the interior and western parts of the Free State.

Figure 19:
The VCI map for September indicates below-normal vegetation activity over the southern parts of the Northern Cape.

Questions/Comments:
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7. Vegetation Conditions & Rainfall

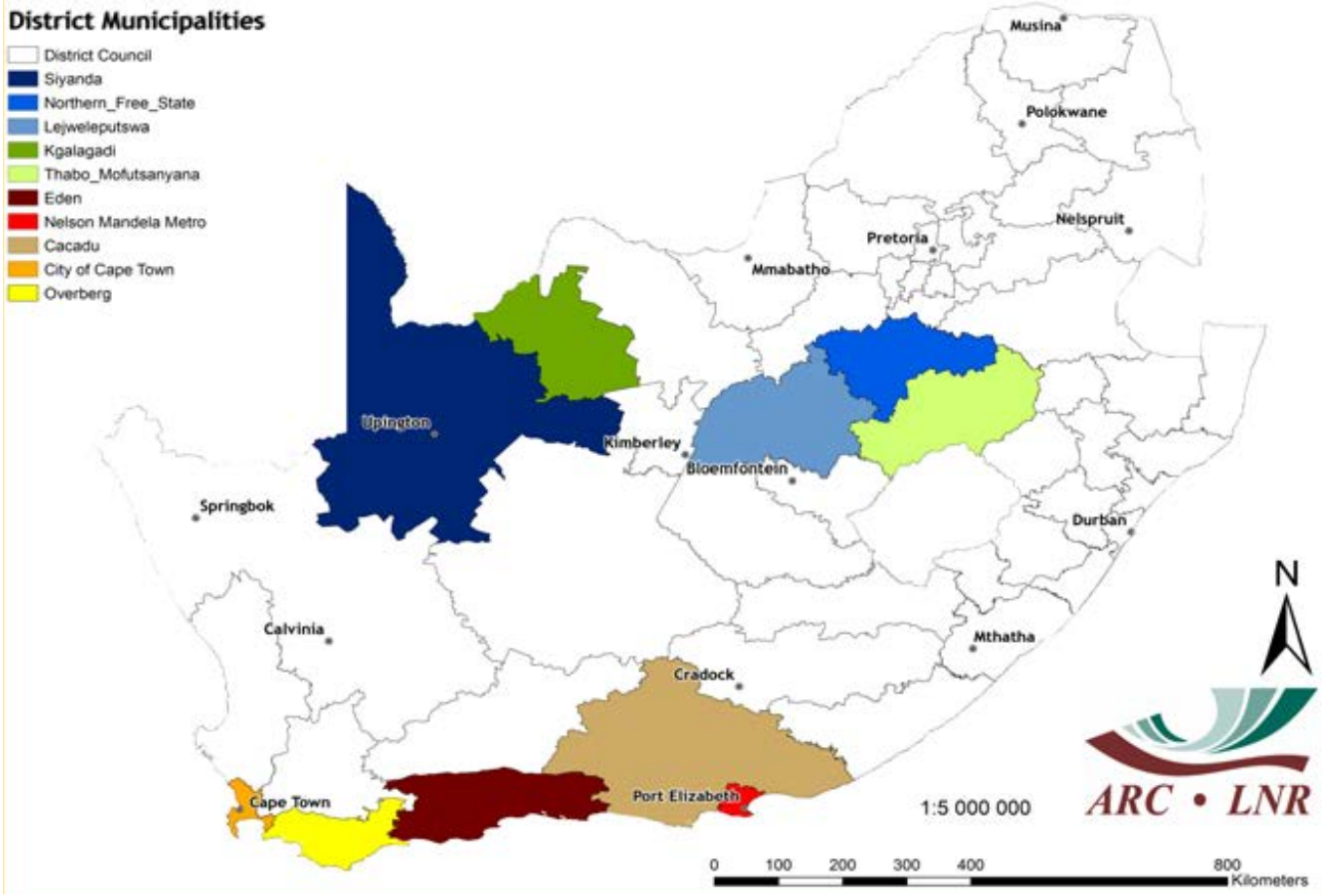

Figure 20

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

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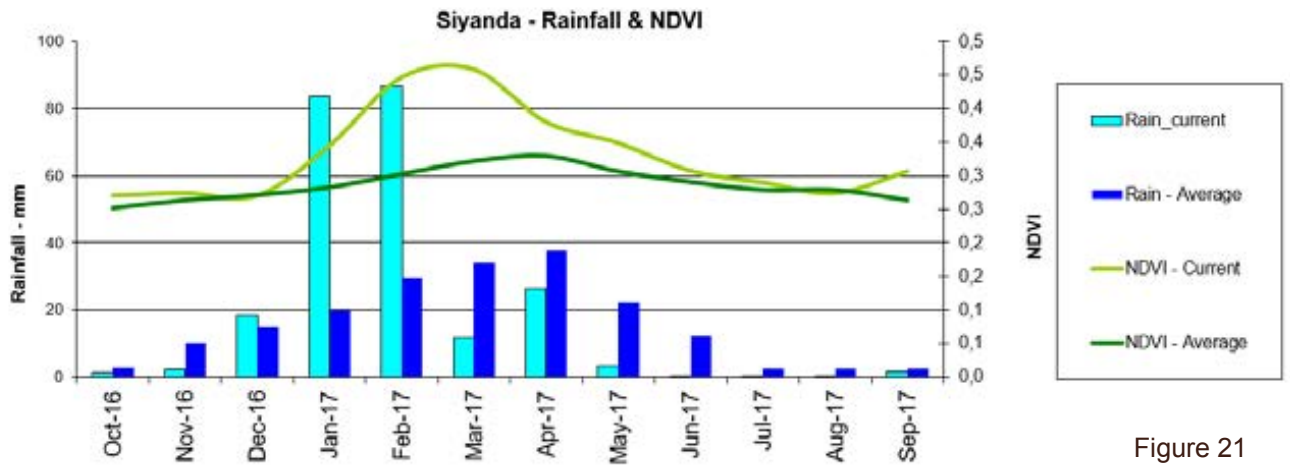
Figures 21-25:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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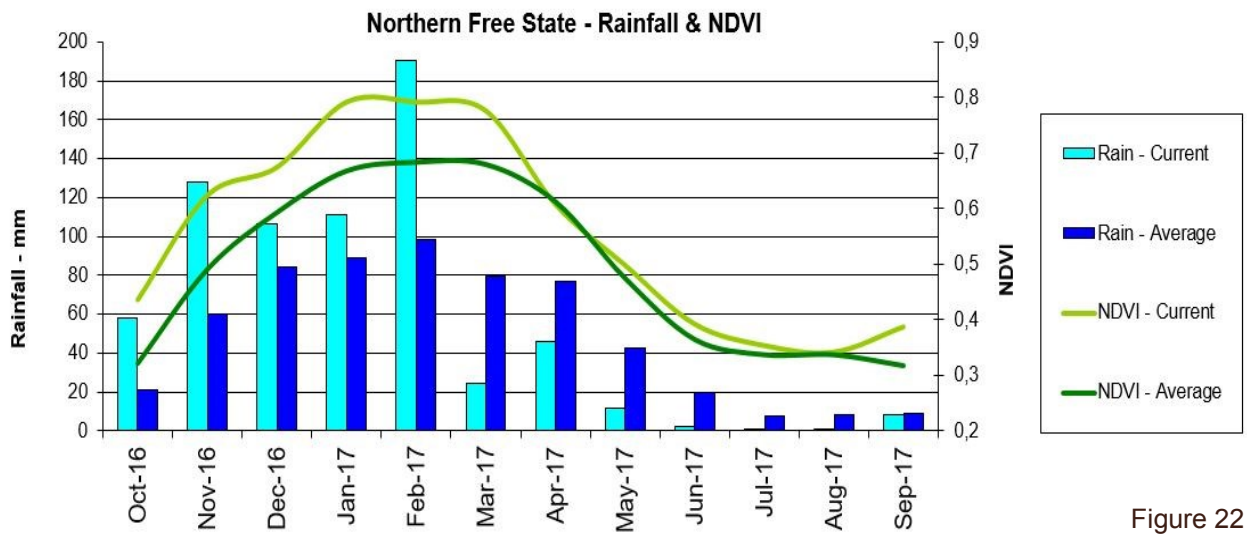

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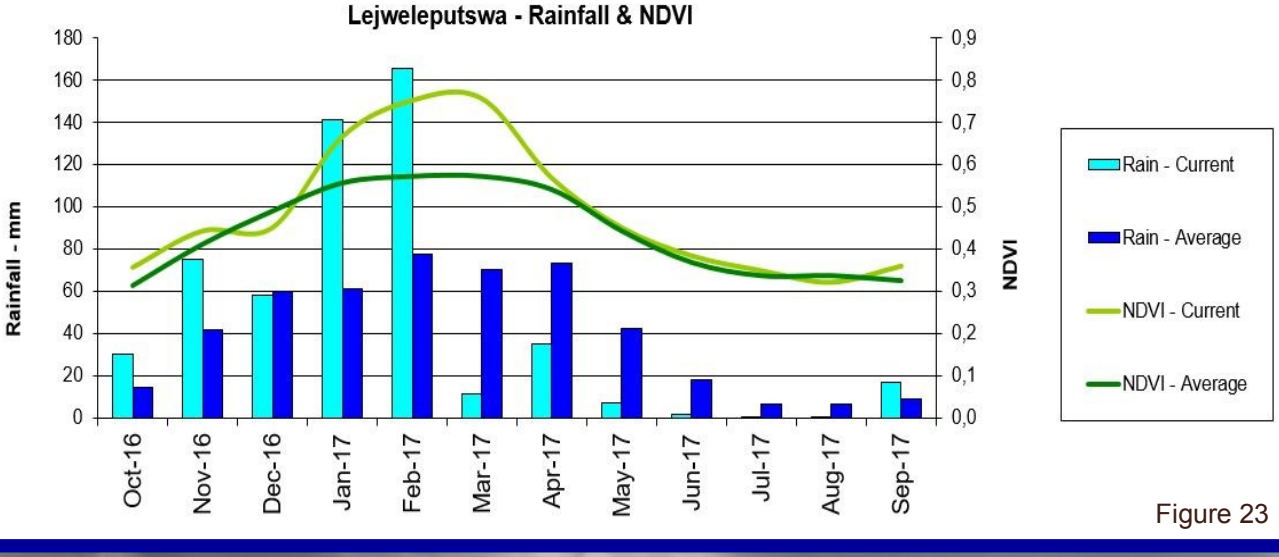

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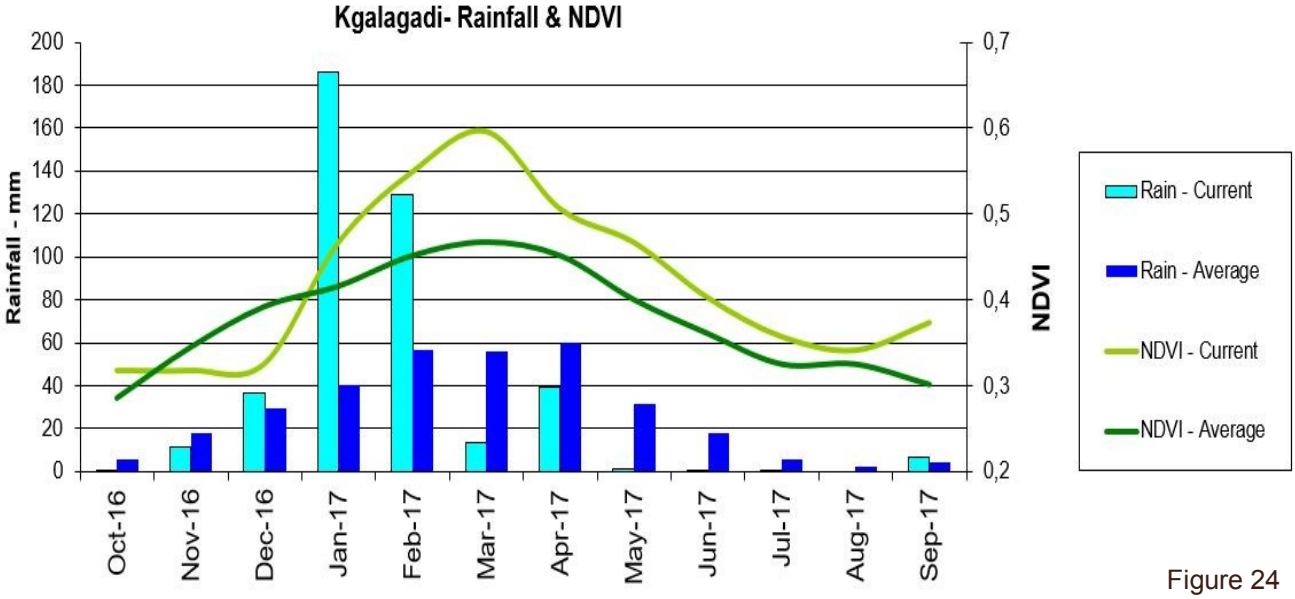

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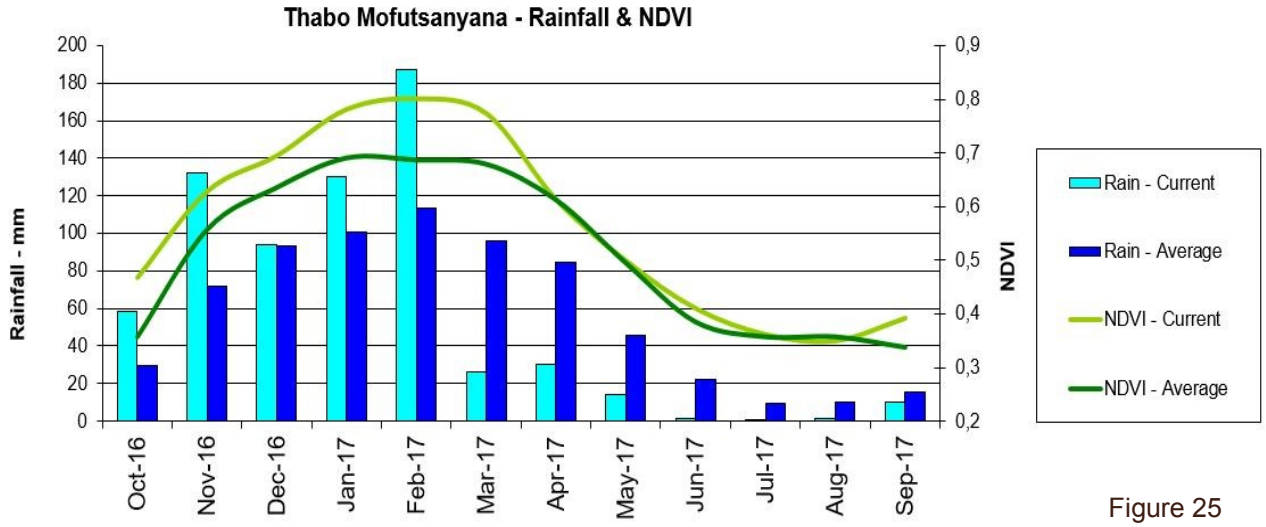


Figure 25

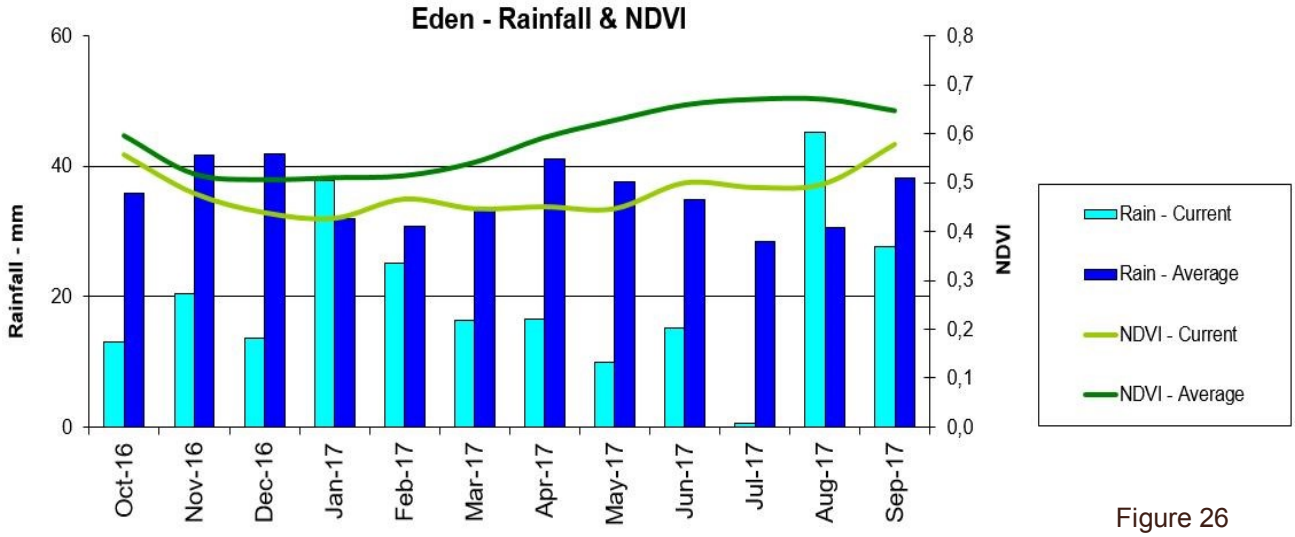
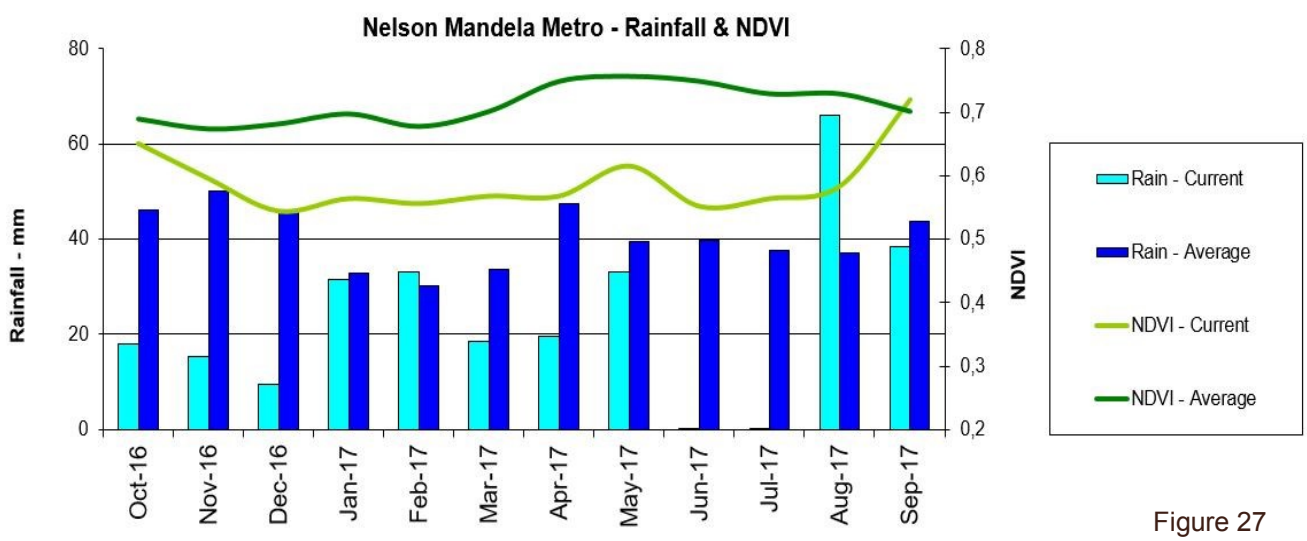


Figure 26



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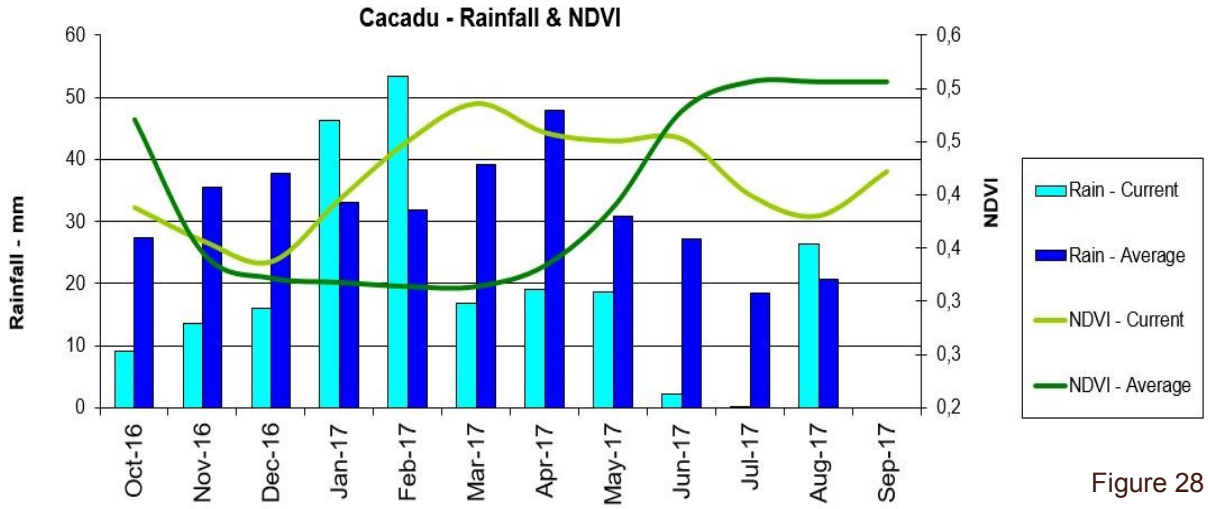
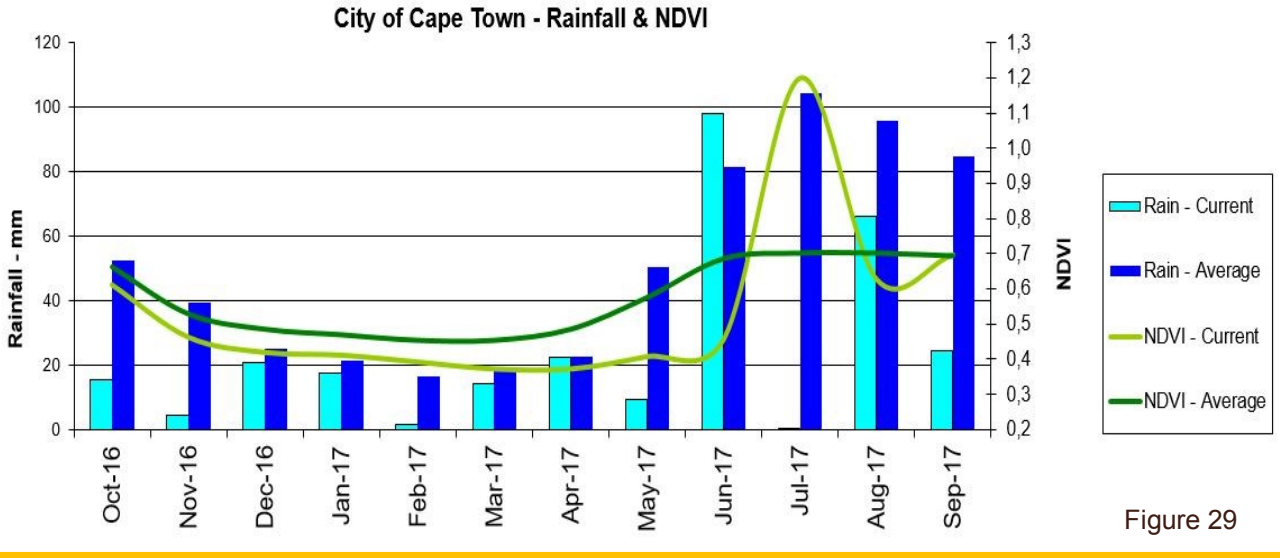


Figure 28



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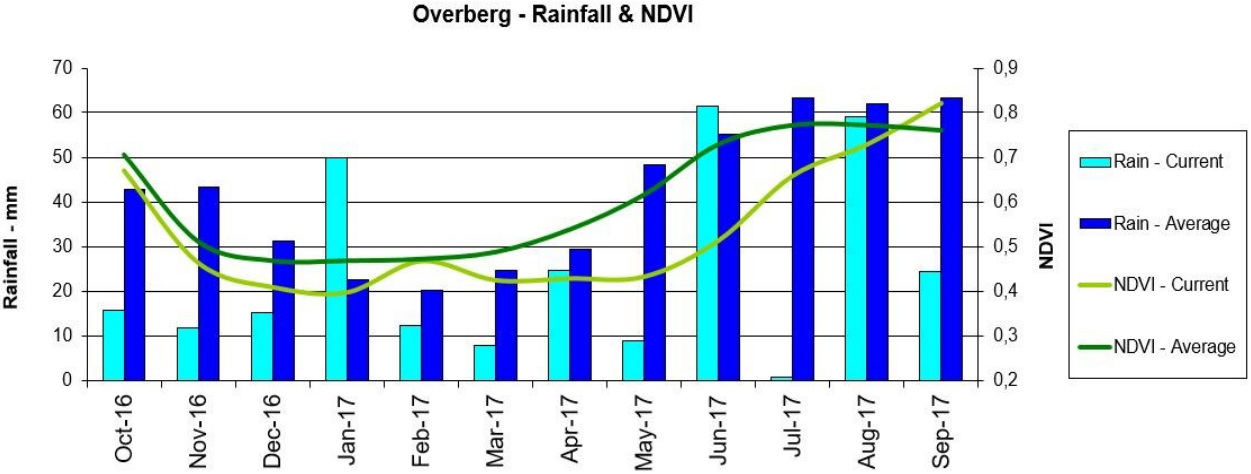

Figure 30

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

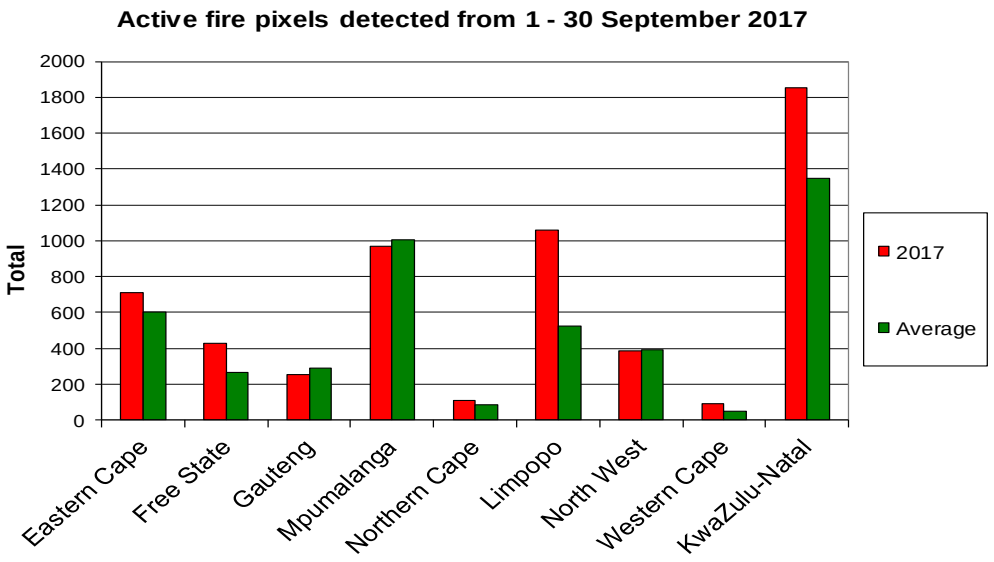

Figure 31

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

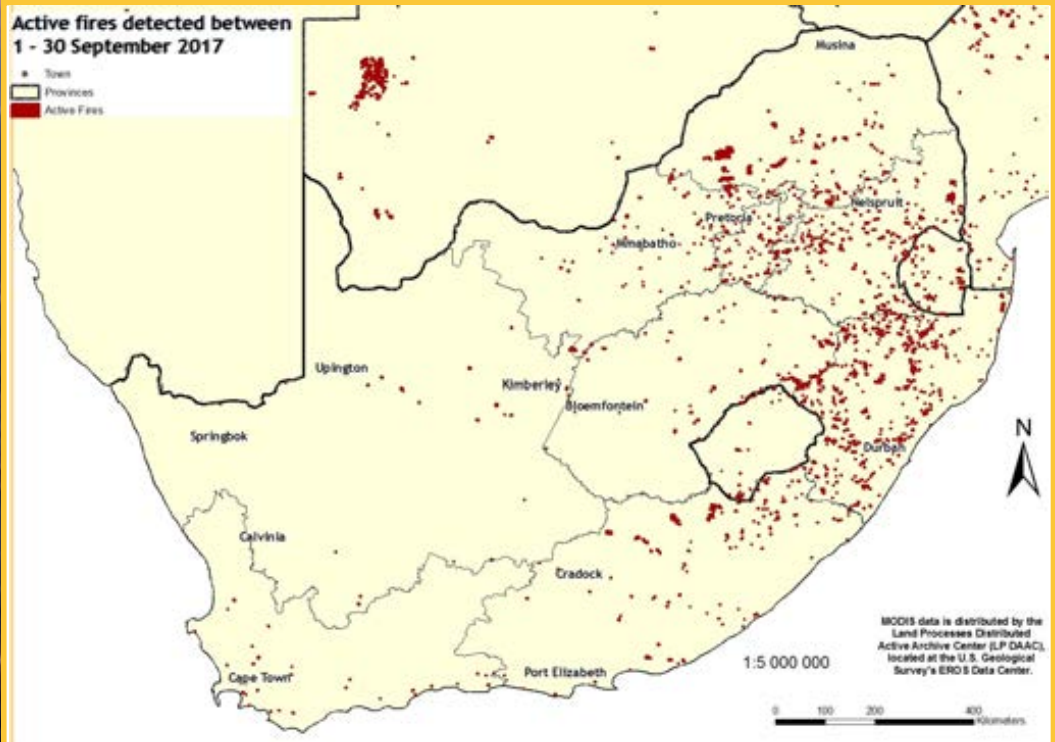

Figure 32

PAGE 17

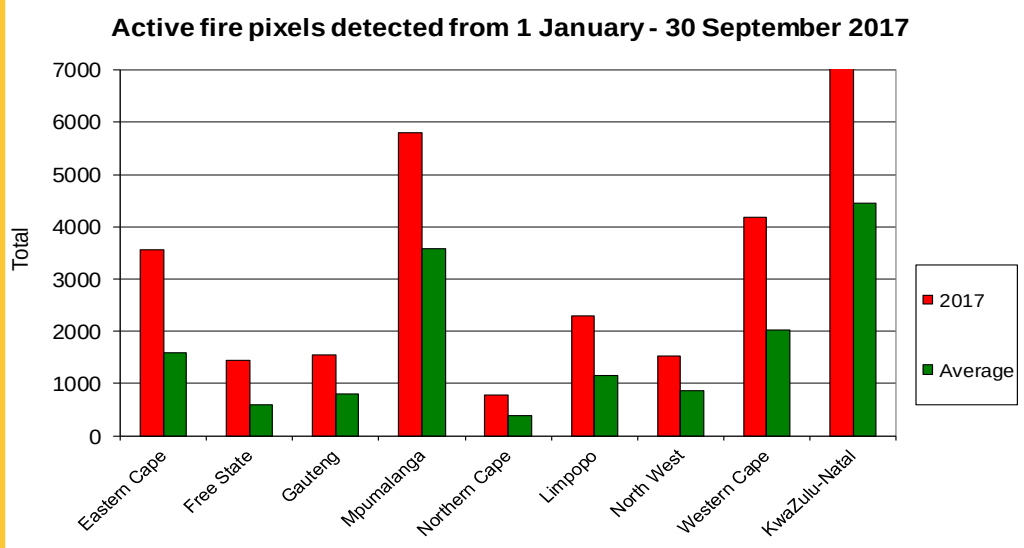

Figure 33

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

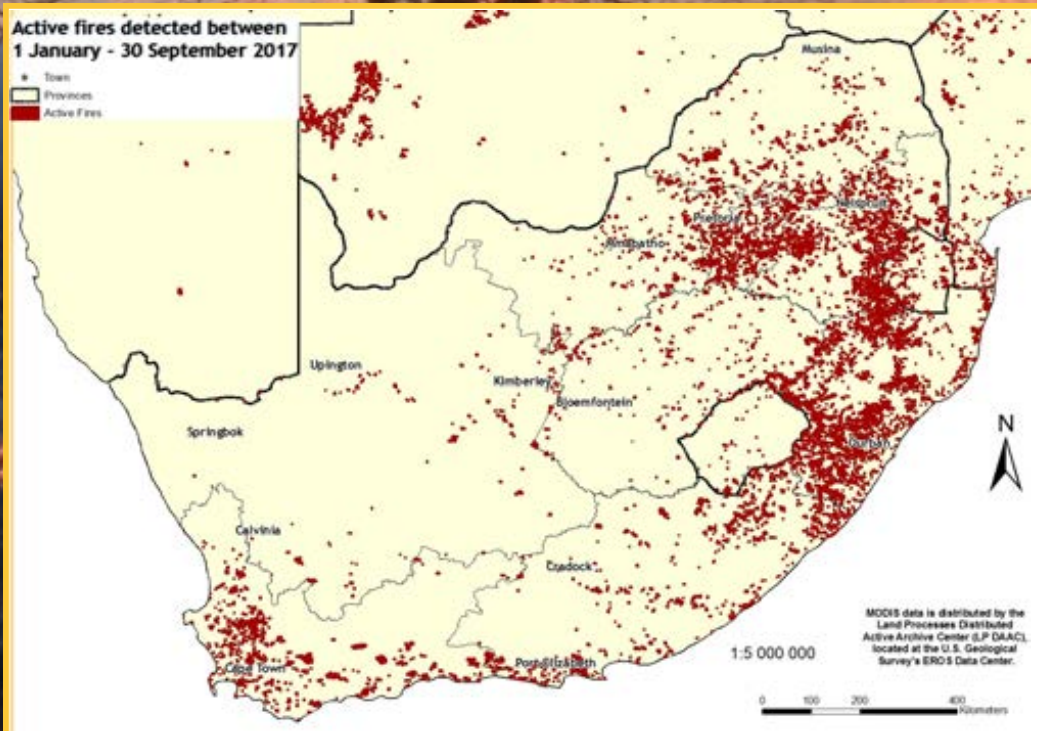

Figure 34

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

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

http://www.agis.agric.za