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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

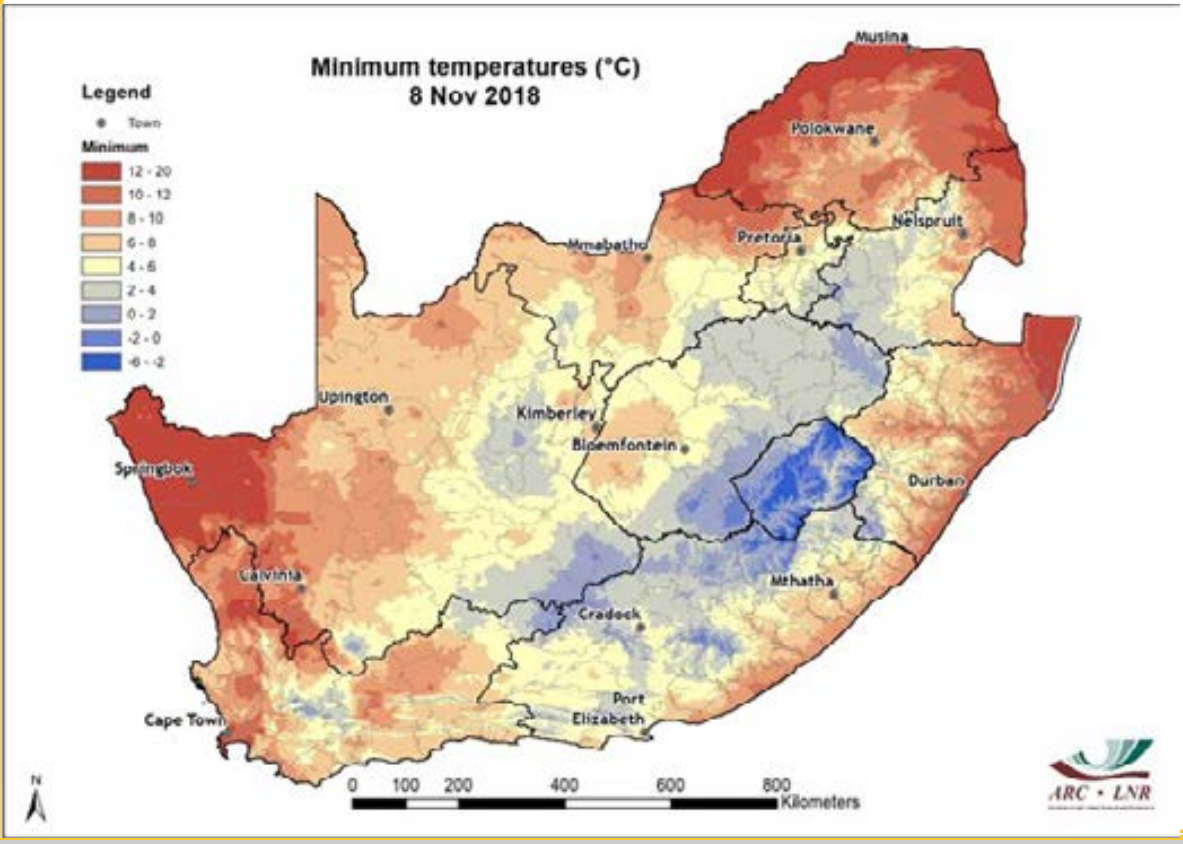
CONTENTS:

173rd Edition

Image of the Month

Hot conditions disrupted by cold snap during early November

October 2018 was hotter than normal over most of the country (except for the far northeastern parts), with more heatwave days occurring than the long-term average. Areas over the far western and southern interior were particularly hot, especially towards the end of the month when the maximum temperature exceeded 40 °C in places. It was during this period that the devastating fires occurred in the George region. Towards the start of November a change to cooler conditions occurred with the arrival of a frontal system. This was followed by a strong frontal system that neared the country on the 4th. This weather system brought cold conditions to South Africa and snow was reported as it swept eastwards. As the system exited the country, clearer skies occurred which resulted in very low minimum temperatures. The morning of the 8th of November was particularly cold, as can be seen on the map below. Minimum temperatures dropped below zero over parts of the eastern interior and frost was reported in some of these 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:

October 2018 was generally characterized by below-normal rainfall, except for some isolated areas in the summer rainfall region that received above-normal rainfall. Maximum temperatures were above normal over most of the country (except for the far northeastern parts), with exceptionally warm conditions occurring over the far western and southern parts of the country. Over those areas, the maximum temperatures for October 2018 were more than 4 °C higher than the long-term mean for the month of October. Heatwave events contributed to these above-normal temperatures. Over most of the maize producing regions of North West and the Free State, more than double of the typical number of heatwave days occurred during October 2018.

During the first few days of the month a weather system occurred that resulted in rainfall along the southern coastal belt as well as over the far eastern parts of the country. This system also caused an increase in moisture over the eastern parts of the country and aided in the development of some isolated thunderstorms on the boundary of the cooler air that moved in over those areas. However, the resulting rainfall was very limited. In the meantime, hot conditions developed over the far western parts of the country by the 5th of October, migrating along the west coast regions to reach the far southern interior by the 8th and continued until the 10th. Maximum temperatures in excess of 38 °C occurred during this time over the southern interior. A well developed weather system that promoted the development of a cloud band and rainfall moved over the country between 11-14 October brought an end to the extreme hot spell over the southern interior. This rainfall event contributed to most of the rain that occurred over the central as well as some of the eastern parts of the country during the month. The following week the weather patterns over the country were of such a nature that rainfall was confined to the far eastern parts, mostly eastwards of the escarpment. This weather was caused by a ridging high pressure system after the passage of a frontal system over the southern extremities of the country. By the 20th this high pressure system had intensified and moved into a position that caused cooler weather over the northeastern parts of the country. Around the 22nd, thunderstorm activity developed over the western interior as a cloud band from Namibia extended southwards over South Africa. Between 23-28 October, very hot conditions occurred over the far western and southern parts of the country as a high pressure system dominated the upper-air circulation. During this time, maximum temperatures in excess of 38 °C occurred in some areas, exceeding 40 °C on 28-29 October in areas west of Port Elizabeth. By the 29th an approaching cold front neared the country and cooler conditions invaded the areas that had experienced the extreme heat by 30 October.

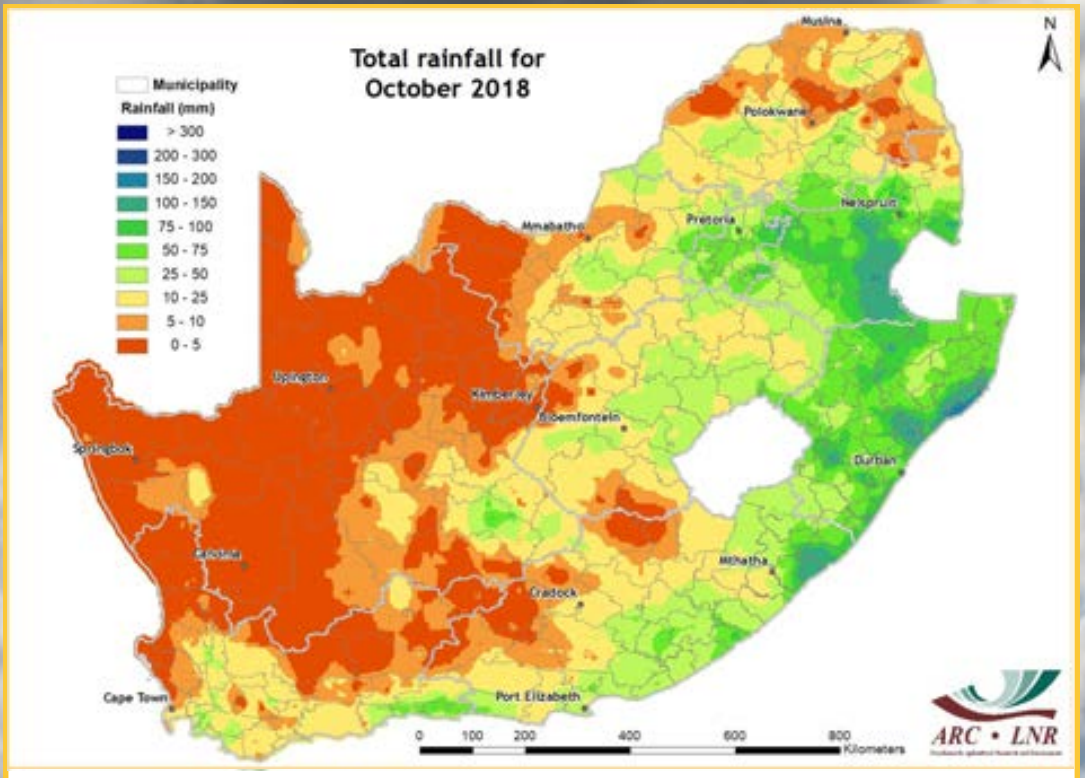


Figure 1

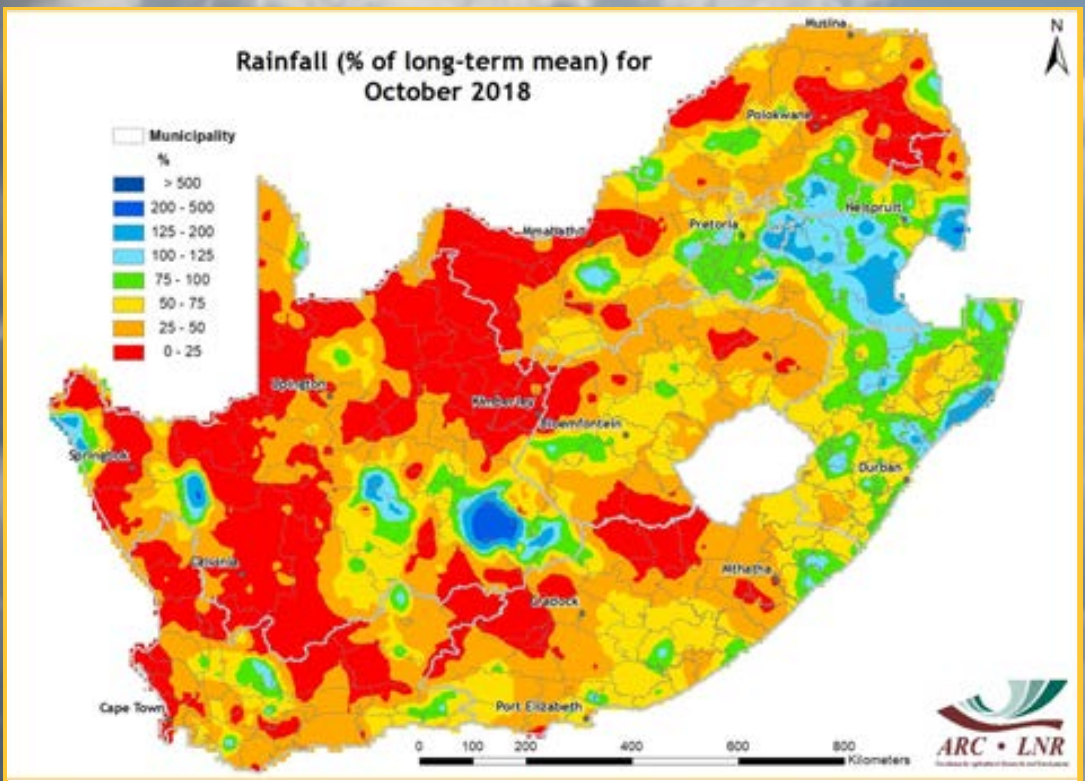
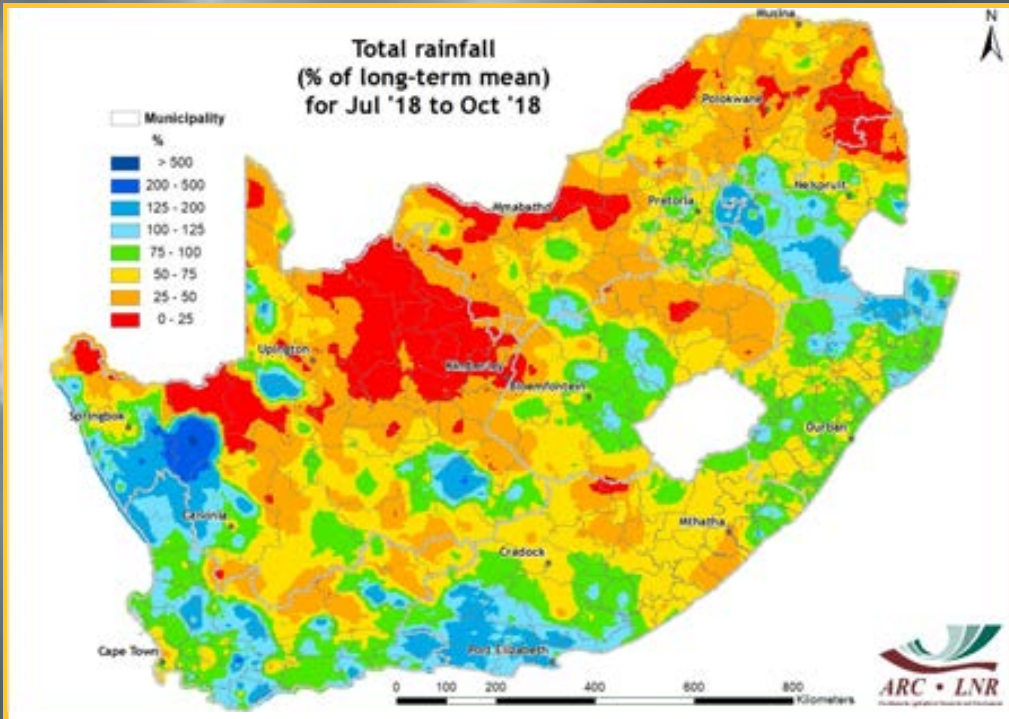


Figure 2



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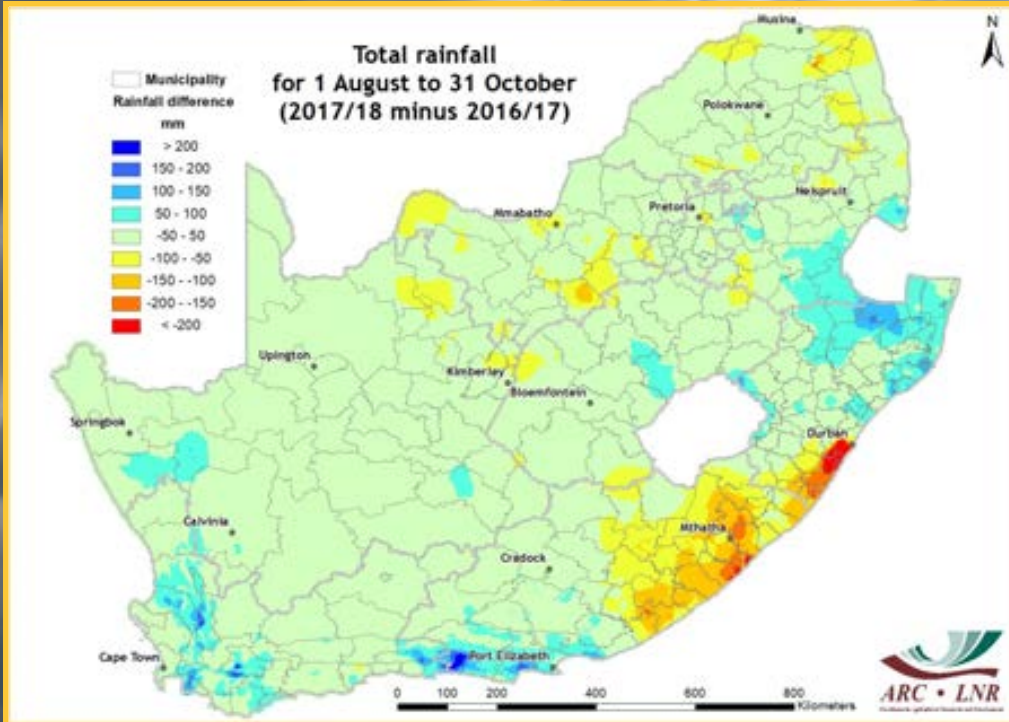

Figure 4

Figure 1:
As is typical for the month of October, an increase in rainfall activity occurred over the eastern parts of the country as spring arrived. However, over most of the eastern parts the rainfall totals for October 2018 were less than 50 mm. The eastern coastal belt and adjacent interior received the highest rainfall totals, exceeding 150 mm along the northern KwaZulu-Natal coast. Some rainfall also occurred along the southern coastal belt but the totals were generally less than 25 mm.

Figure 2:
Except for some isolated areas over the country that received above-normal rainfall, the month of October was characterized by below-normal rainfall. Areas along the northern parts of the KwaZulu-Natal coast and over parts of Mpumalanga received above-normal rainfall.

Figure 3:
During the 4-month period from July to October, near- to above-normal rainfall occurred over the winter and all-year rainfall regions. However, over the all-year rainfall region, much of this period was actually very dry, with the cut-off low event during the first week of September being responsible for most of the rainfall during this 4-month period. Over the summer rainfall region, most areas received below-normal rainfall during this 4-month period. Some areas over the central and eastern interior received above-normal rainfall, mostly of an isolated nature.

Figure 4:
Compared to the corresponding period in 2017, improved rainfall conditions occurred during August to October 2018 over parts of the winter rainfall region, the eastern parts of the all-year rainfall region, as well as over the northern parts of KwaZulu-Natal, extending into Mpumalanga. Good rainfall during September over the winter rainfall region and a cut-off low pressure system at the start of September over the all-year rainfall region contributed to the better rainfall that was experienced during August to October 2018.

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2. Standardized Precipitation Index

Standardized Precipitation Index

The Standardized Precipitation Index (SPI - McKee *et al.*, 1993) was developed to monitor the occurrence of droughts from rainfall data. The index quantifies precipitation deficits on different time scales and therefore also drought severity. It provides an indication of rainfall conditions per quaternary catchment (in this case) based on the historical distribution of rainfall.

REFERENCE:
McKee TB, Doesken NJ and Kliest J (1993) The relationship of drought frequency and duration to time scales. In: Proceedings of the 8th Conference on Applied Climatology, 17-22 January, Anaheim, CA. American Meteorological Society: Boston, MA; 179-184.

At the 36-month time scale, drought conditions occurred over many parts of the country, but in particular over the winter rainfall region, the Port Elizabeth and surrounding areas, as well as in areas over the eastern parts of the country where severe to extreme drought conditions occurred. Relief from the severe drought conditions occurred in the eastern parts on the 24-month time scale, whilst drought conditions intensified over the southwestern parts. On the 12-month SPI, severe to extreme drought conditions over the southwestern parts of the country improved to mild drought, with some isolated areas even mildly wet. Over the northeastern parts a slight deterioration occurred from mildly wet to mildly dry, as well as an expansion of the moderately dry areas. The most striking feature on the 6-month SPI is the moderate to severe drought conditions east of Upington towards Kimberley.

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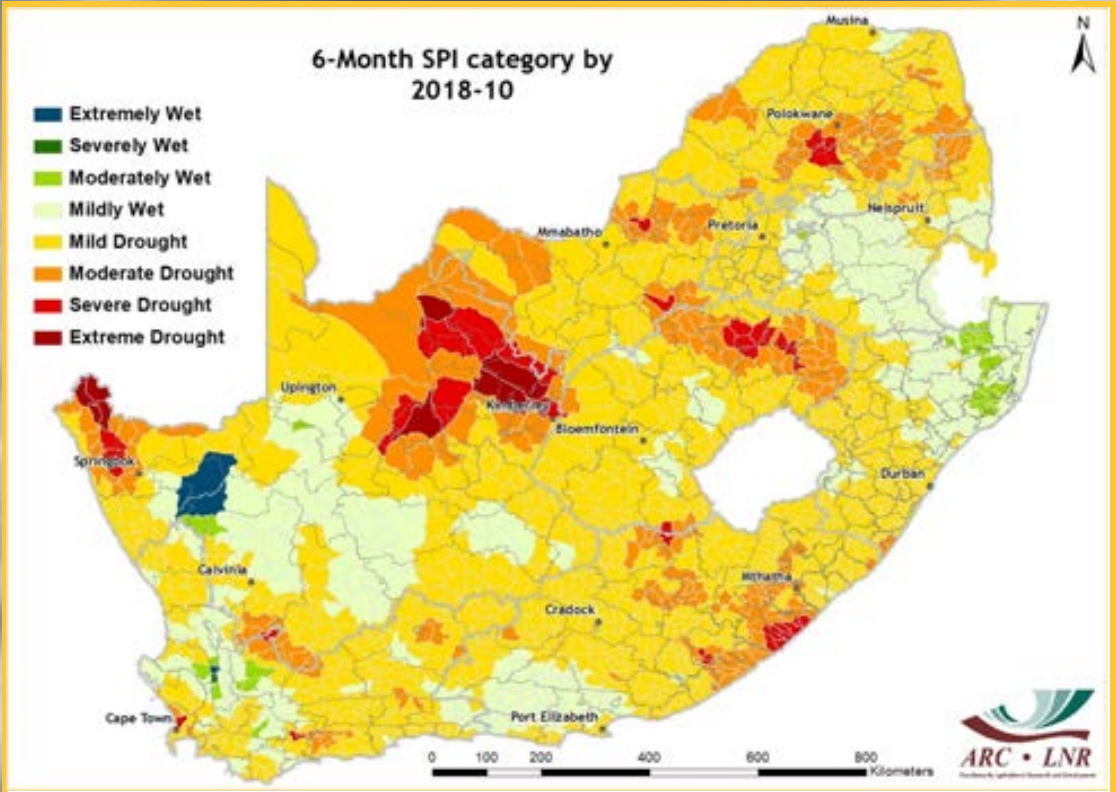

Figure 5

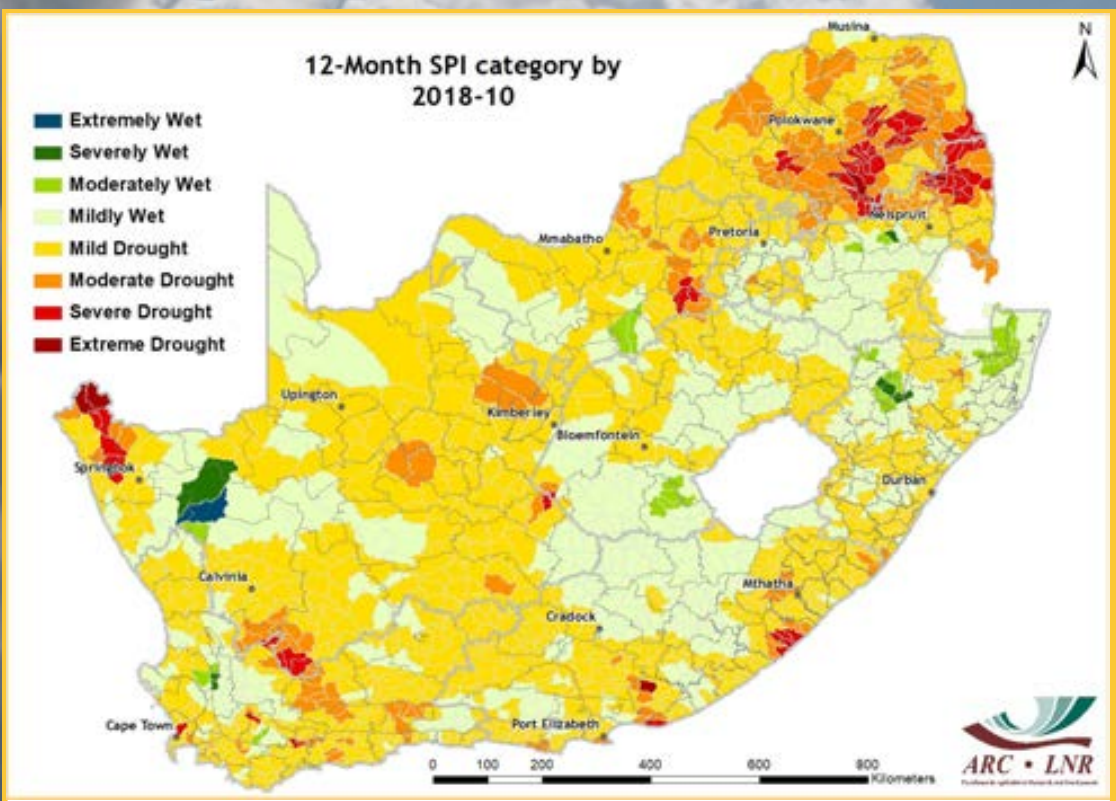

Figure 6

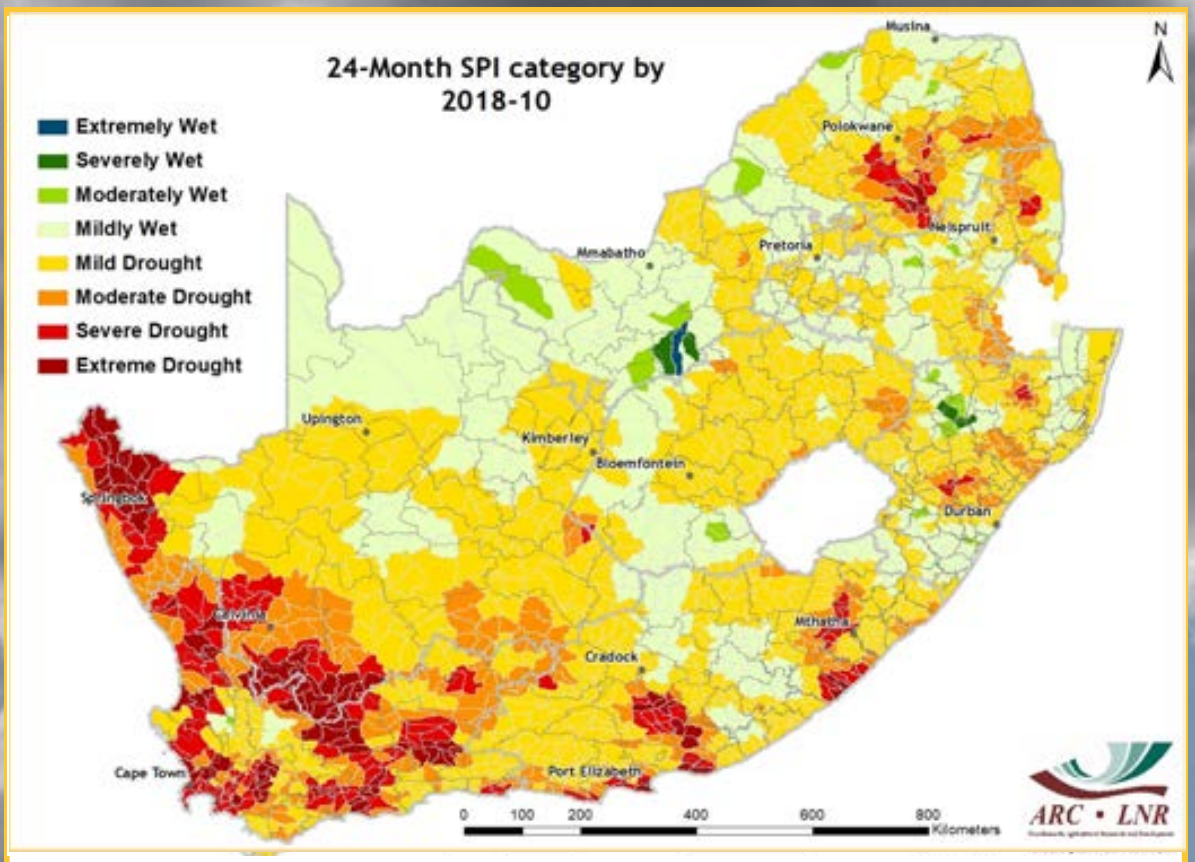

Figure 7

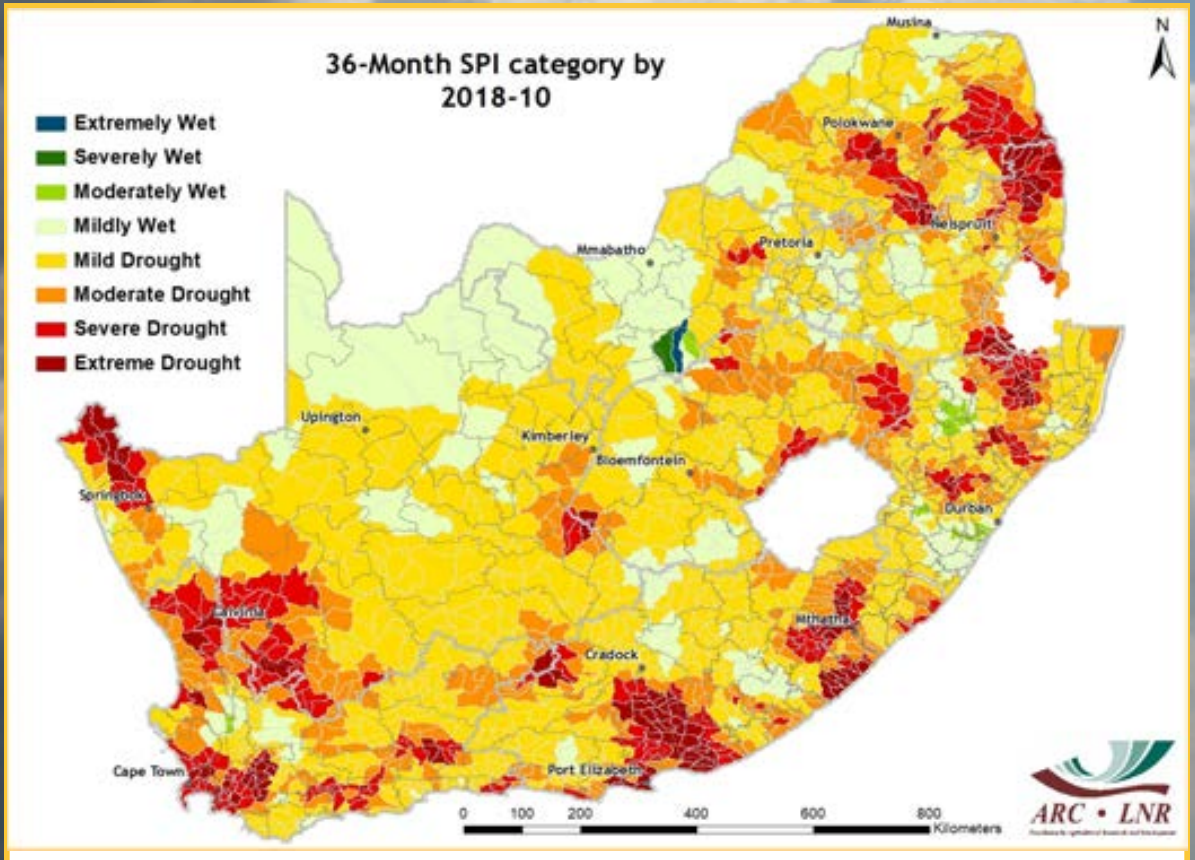

Figure 8

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.

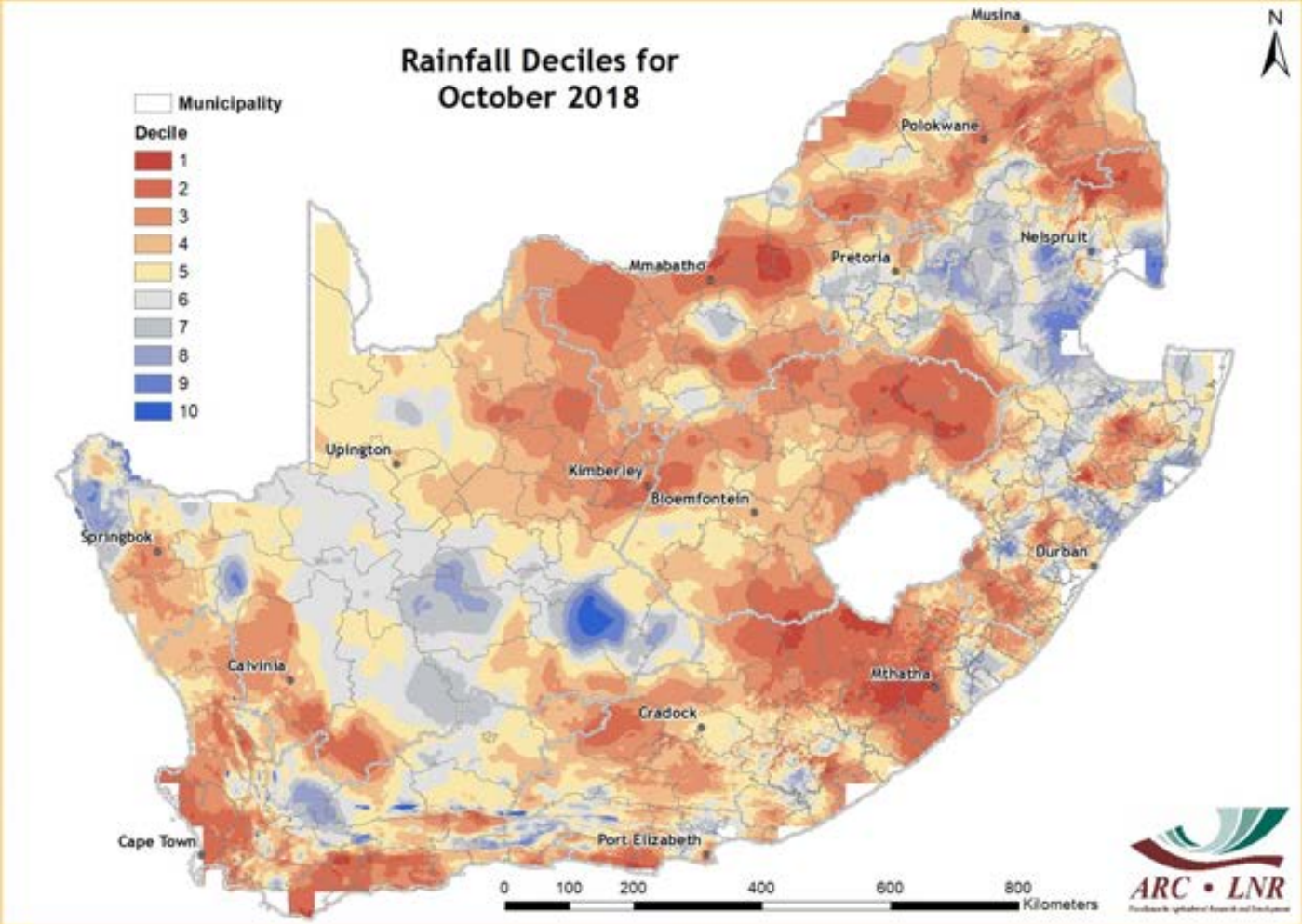

Figure 9

Figure 9:
Rainfall totals during October 2018 over most of the country fell within the drier October months compared to historical October rainfall totals. Exceptions occurred over some areas in the northeast as well as over parts of the western interior.

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4. Vegetation Conditions

Vegetation Mapping

The Normalized Difference Vegetation Index (NDVI) is computed from the equation:

NDVI=(IR-R)/(IR+R)

where:
IR = Infrared reflectance &
R = Red band

NDVI images describe the vegetation activity. A decadal NDVI image shows the highest possible "greenness" values that have been measured during a 10-day period.

Vegetated areas will generally yield high values because of their relatively high near infrared reflectance and low visible reflectance. For better interpretation and understanding of the NDVI images, a temporal image difference approach for change detection is used.

The Standardized Difference Vegetation Index (SDVI) is the standardized anomaly (according to the specific time of the year) of the NDVI.

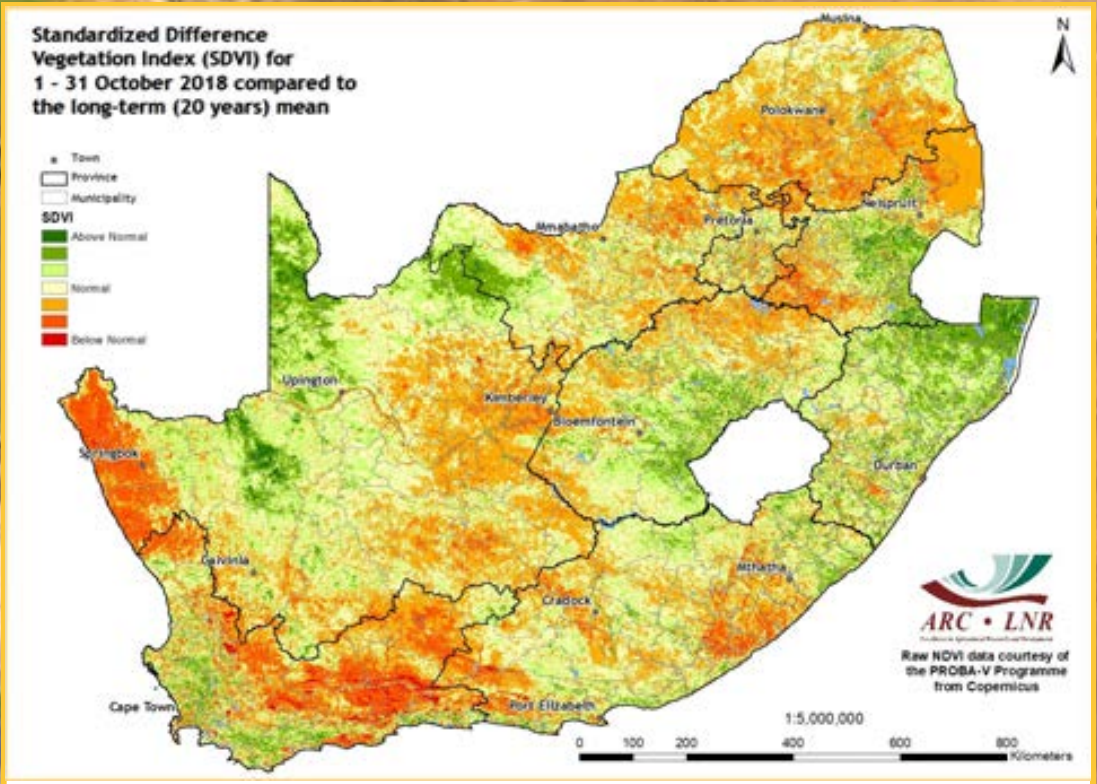

Figure 10

Figure 10:
The SDVI map for October shows that above-normal vegetation activity remains over much of the interior of the country. Meanwhile, parts of the Eden and Central Karoo districts of the Western Cape, southern parts of the Namakwa region, central and western parts of Limpopo, as well as the southwestern Eastern Cape, continue to experienced below-normal vegetation activity.

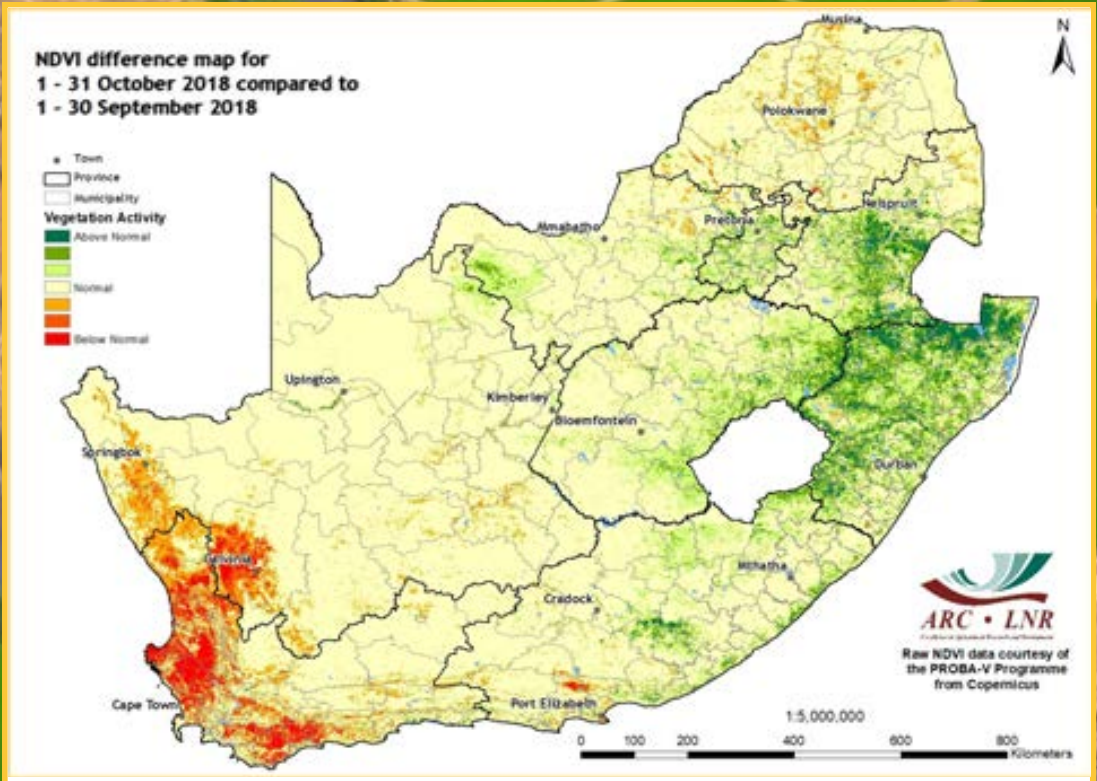

Figure 11

Figure 11:
Compared to the previous month, the NDVI map for October shows that major parts of the country experienced normal to above-normal vegetation activity, with the exception of the southern coast and the southern parts of the Northern Cape where vegetation activity was below normal.

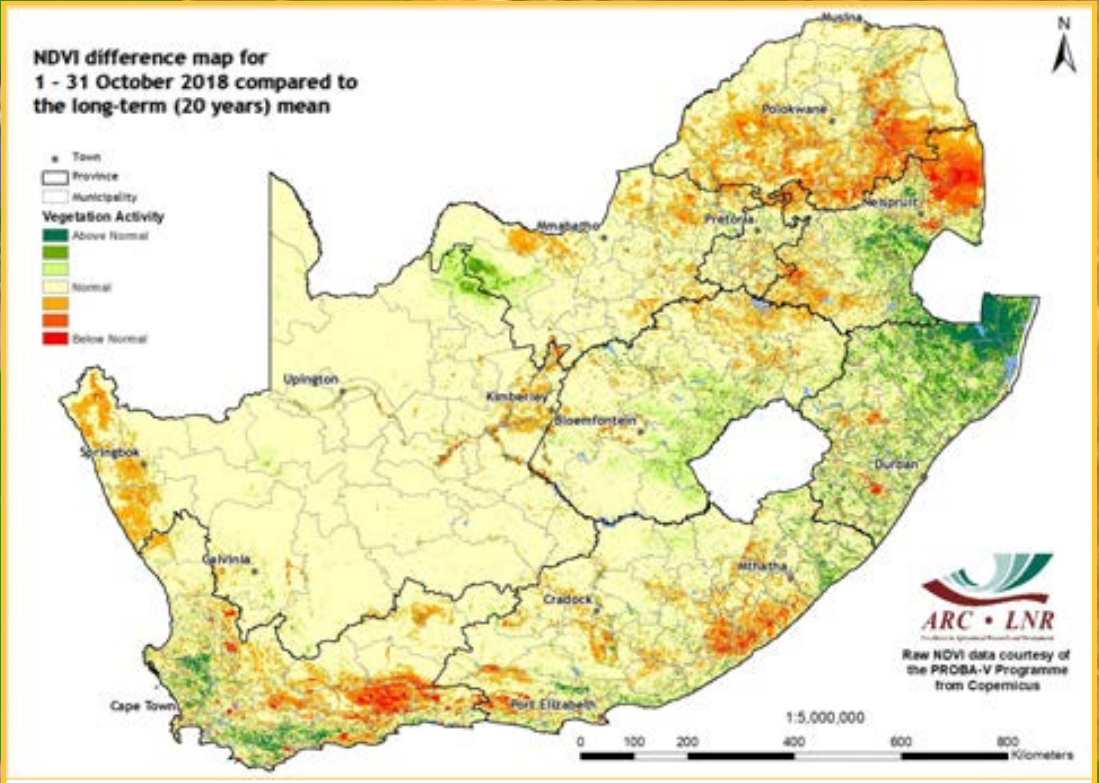

Figure 12

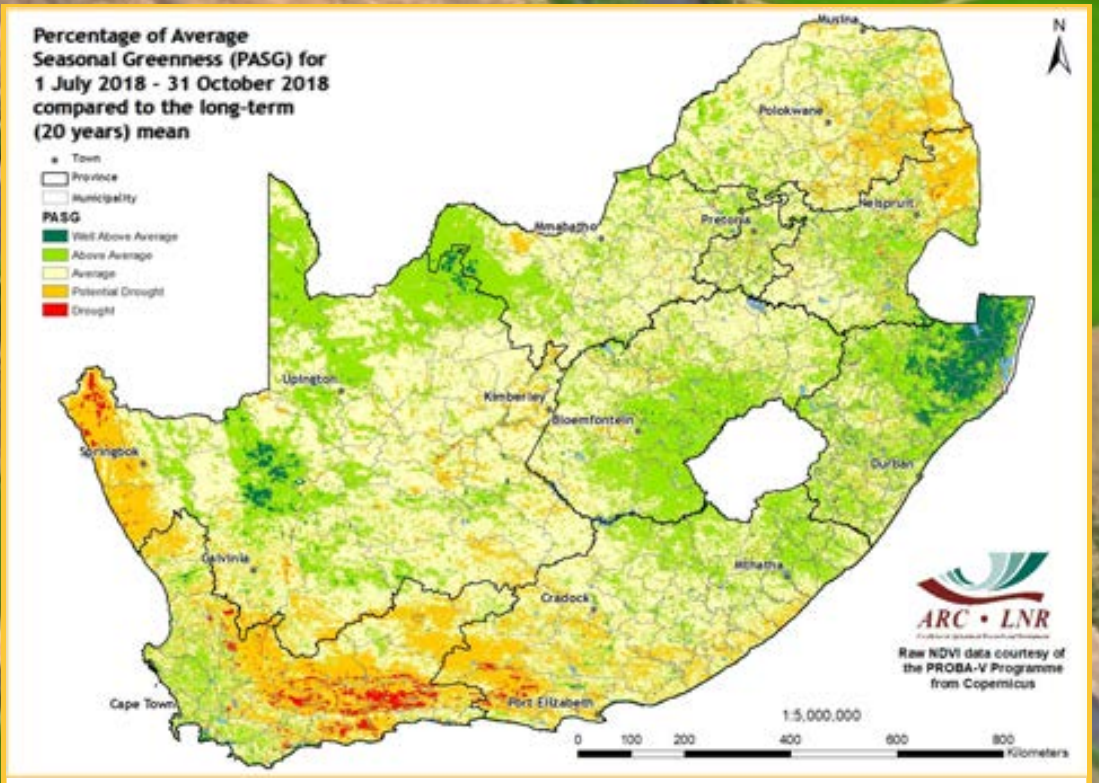

Figure 13

Vegetation Mapping
(continued from p. 7)

Interpretation of map legend

NDVI values range between 0 and 1. These values are incorporated in the legend of the difference maps, ranging from -1 (lower vegetation activity) to 1 (higher vegetation activity) with 0 indicating normal/the same vegetation activity or no significant difference between the images.

Cumulative NDVI maps:

Two cumulative NDVI datasets have been created for drought monitoring purposes:

Winter: January to December
Summer: July to June

Figure 12:
The NDVI difference map for October shows that normal vegetation activity remains over much of the interior, except for parts of Limpopo, Mpumalanga, Western Cape, Eastern Cape and Northern Cape where below-normal vegetation conditions prevail when compared to the conditions calculated and averaged over 20 years.

Figure 13:
Cumulative vegetation activity ranges from normal to above-normal over much of the interior. However, high temperatures continue to negatively affect vegetation activity in some distinct areas in Limpopo, Mpumalanga, Western Cape, Eastern Cape and Northern Cape.

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5. Vegetation Condition Index

Vegetation Condition Index (VCI)

The VCI is an indicator of the vigour of the vegetation cover as a function of the NDVI minimum and maximum encountered for a specific pixel and for a specific period, calculated over many years.

The VCI normalizes the NDVI according to its changeability over many years and results in a consistent index for various land cover types. It is an effort to split the short-term weather-related signal from the long-term climatological signal as reflected by the vegetation. The VCI is a better indicator of water stress than the NDVI.

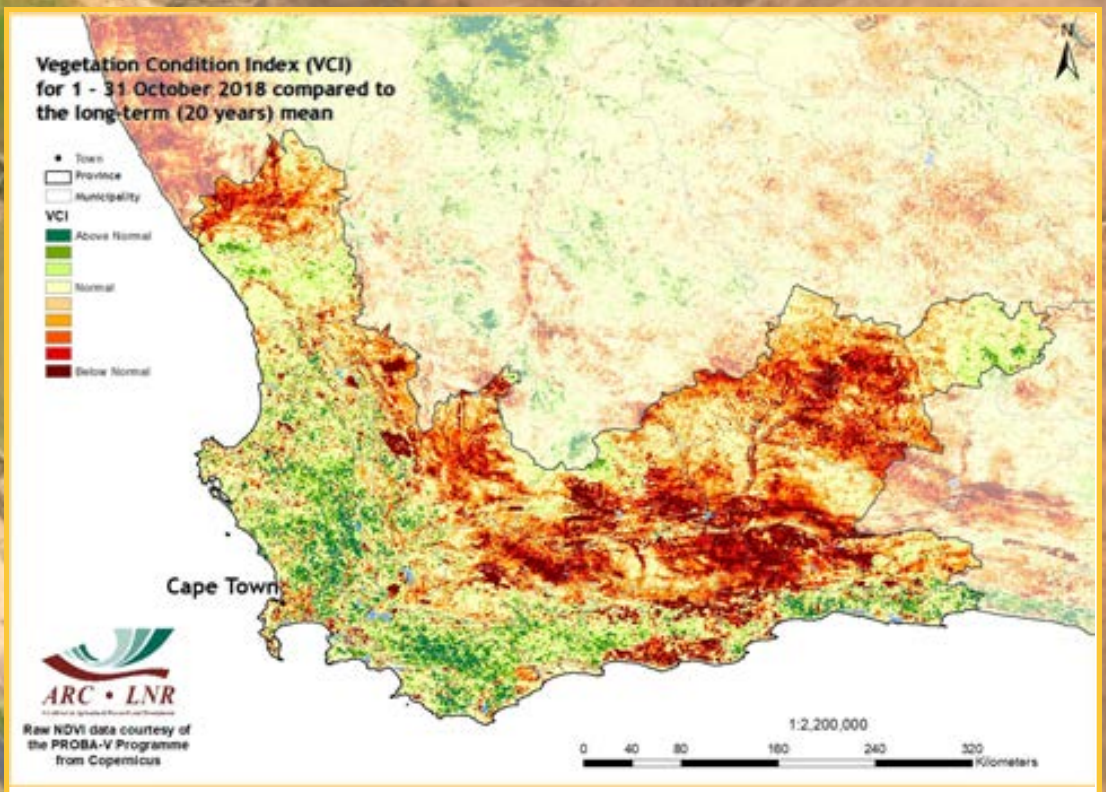

Figure 14

Figure 14:
The Eden and Central Karoo districts of the Western Cape remain areas of concern as the vegetation conditions in these areas remain below normal. Nevertheless, good vegetation activity persists along the south coast of the province.

Figure 15:
The spring rainfall which spread over much of the Limpopo Province did little justice to the vegetation conditions which, as evidenced by the VCI map for October, remain stressed.

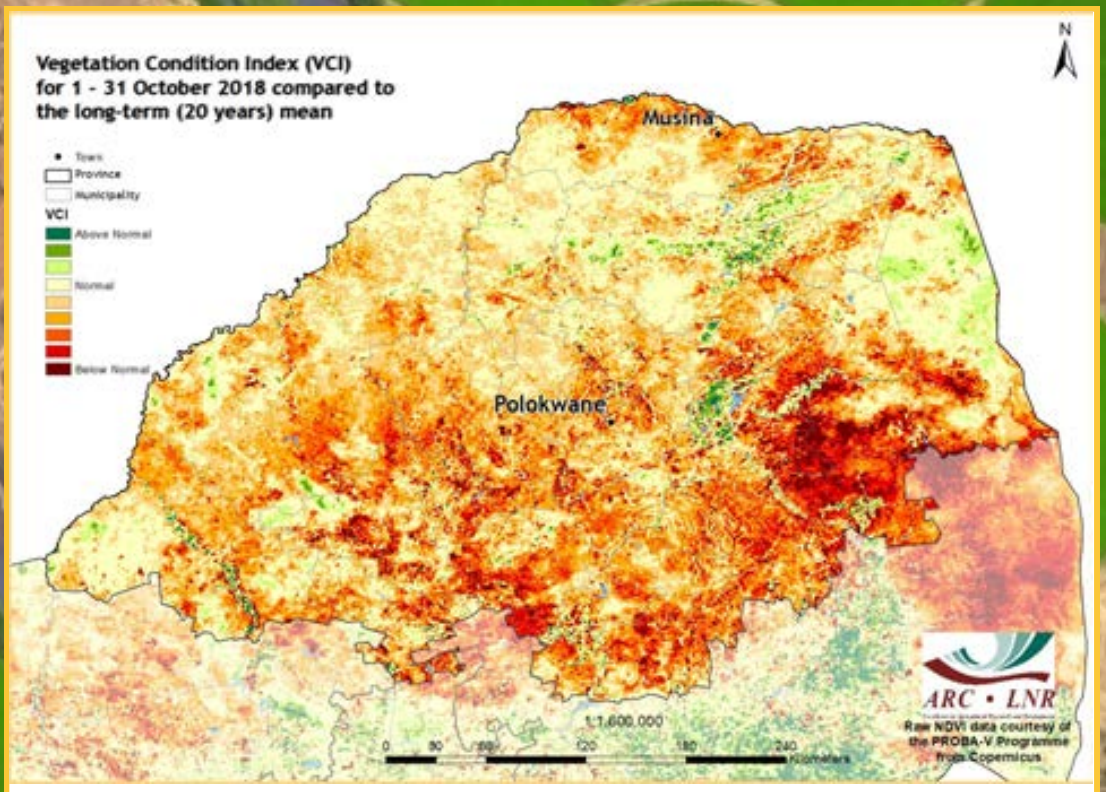

Figure 15

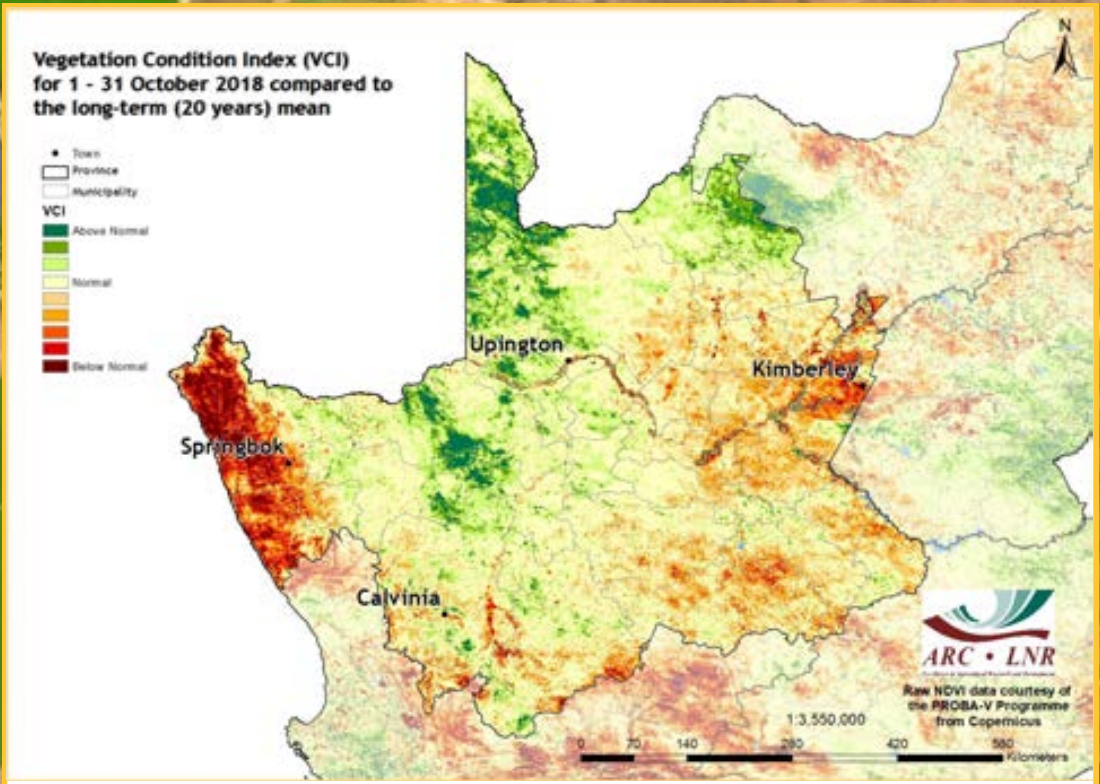

Figure 16

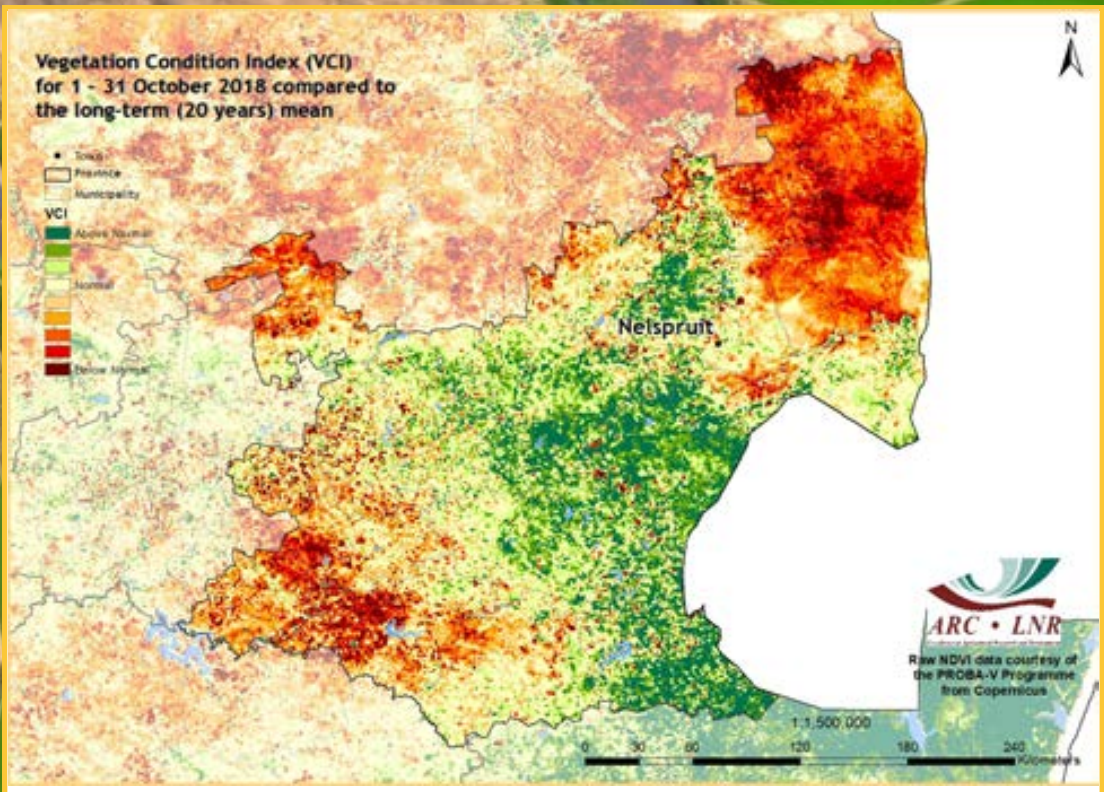

Figure 17

Figure 16:
As indicated on the VCI map for October, vegetation conditions remain stressed in the far western and southern parts of Namakwa, as well as some isolated areas in the Frances Baard district.

Figure 17:
While some areas, especially over much of the central parts of Mpumalanga, had above-normal vegetation conditions, the Kruger National Park and some isolated areas in the north and southwestern parts of the province showed extremely stressed vegetation conditions, especially when considering that the summer rainfall season has started.

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6. Vegetation Conditions & Rainfall

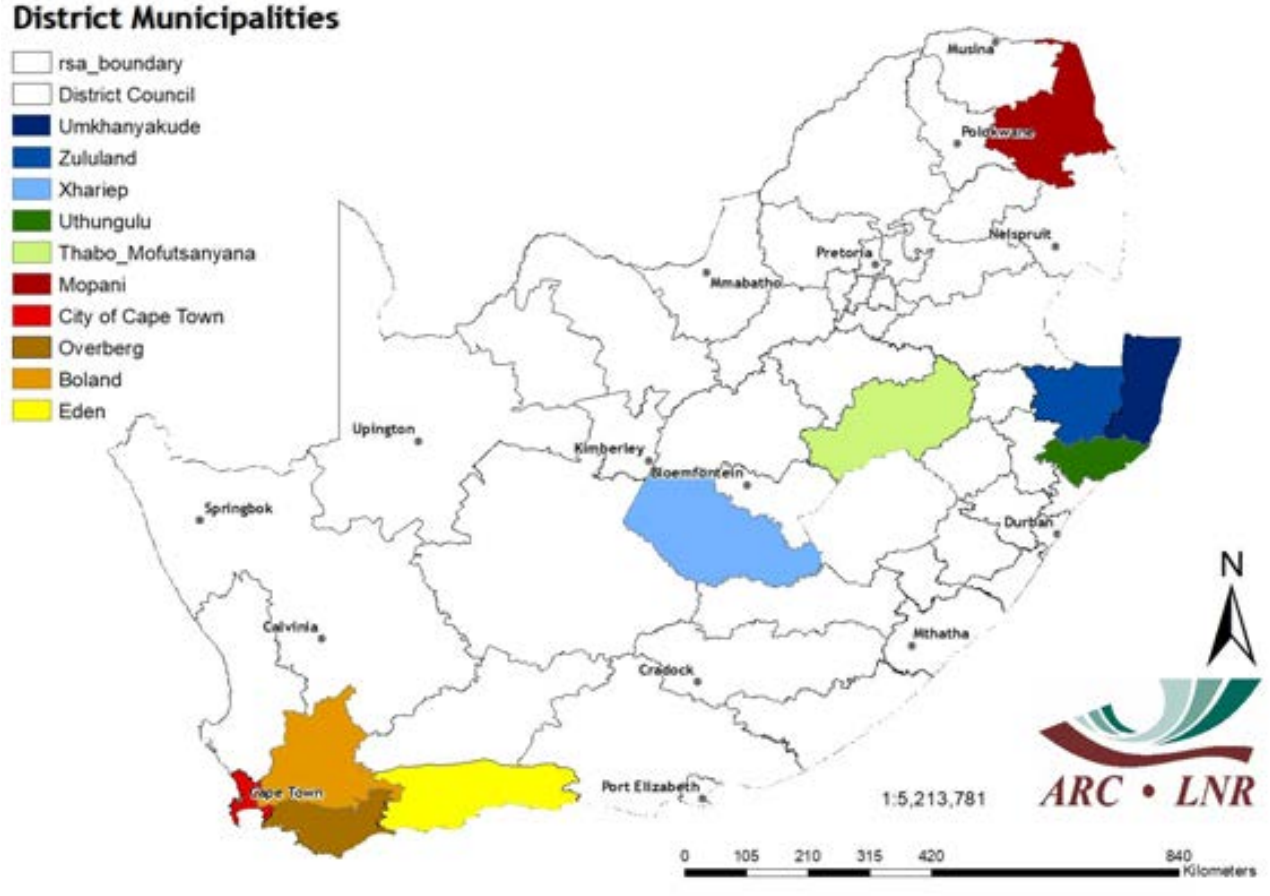

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for October 2018. The district colour matches the border of the corresponding graph.

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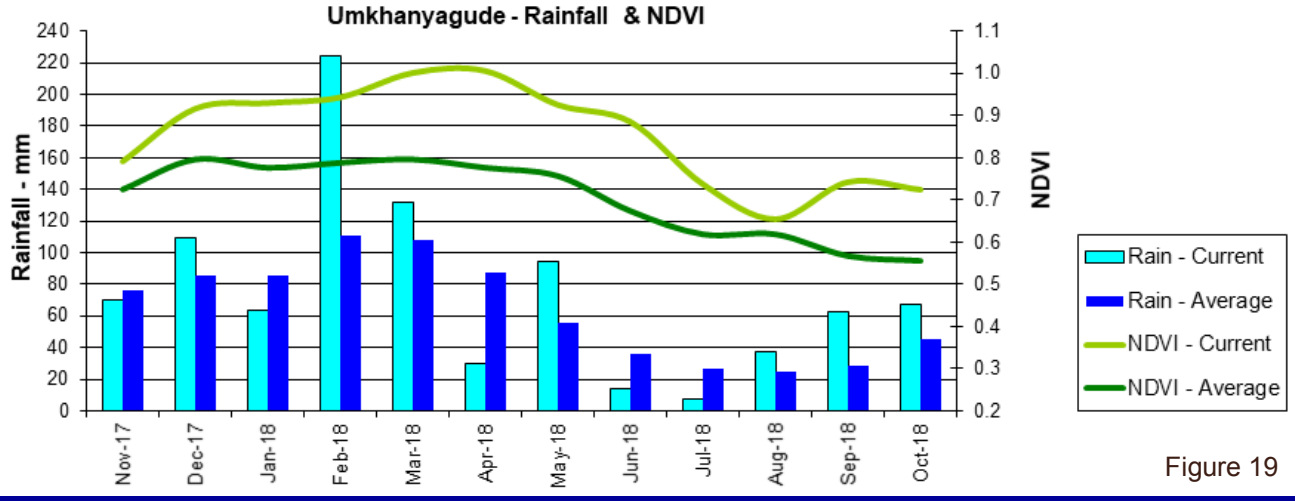
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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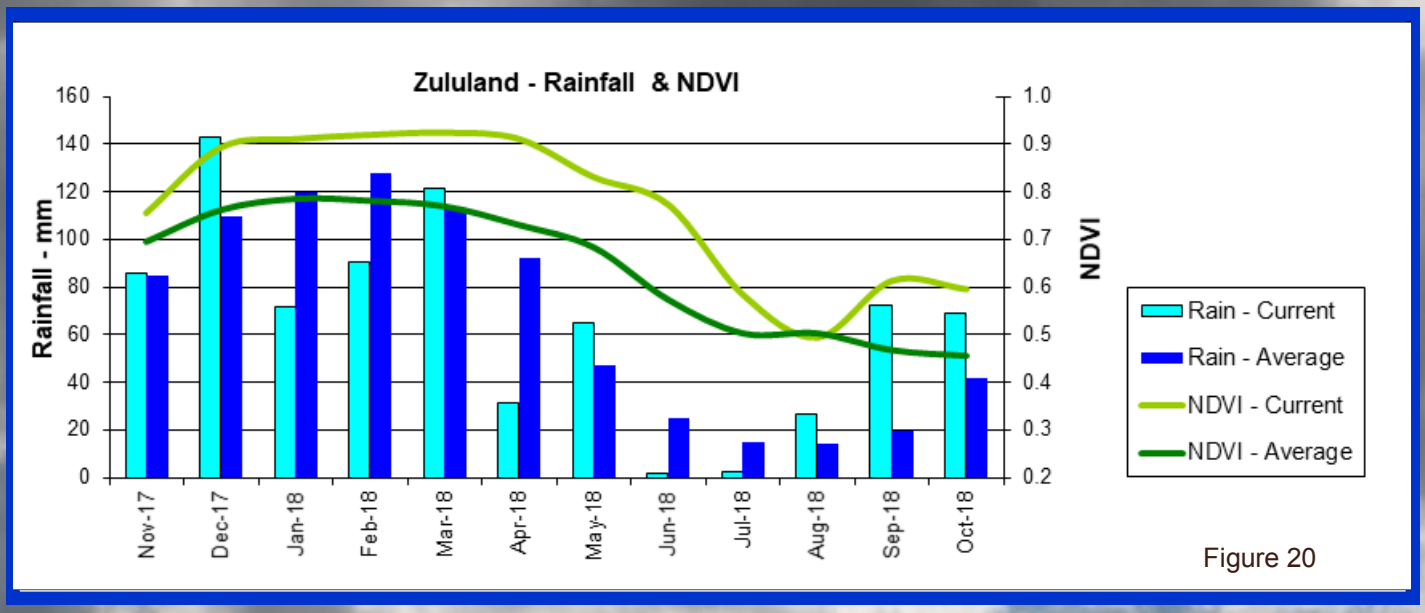

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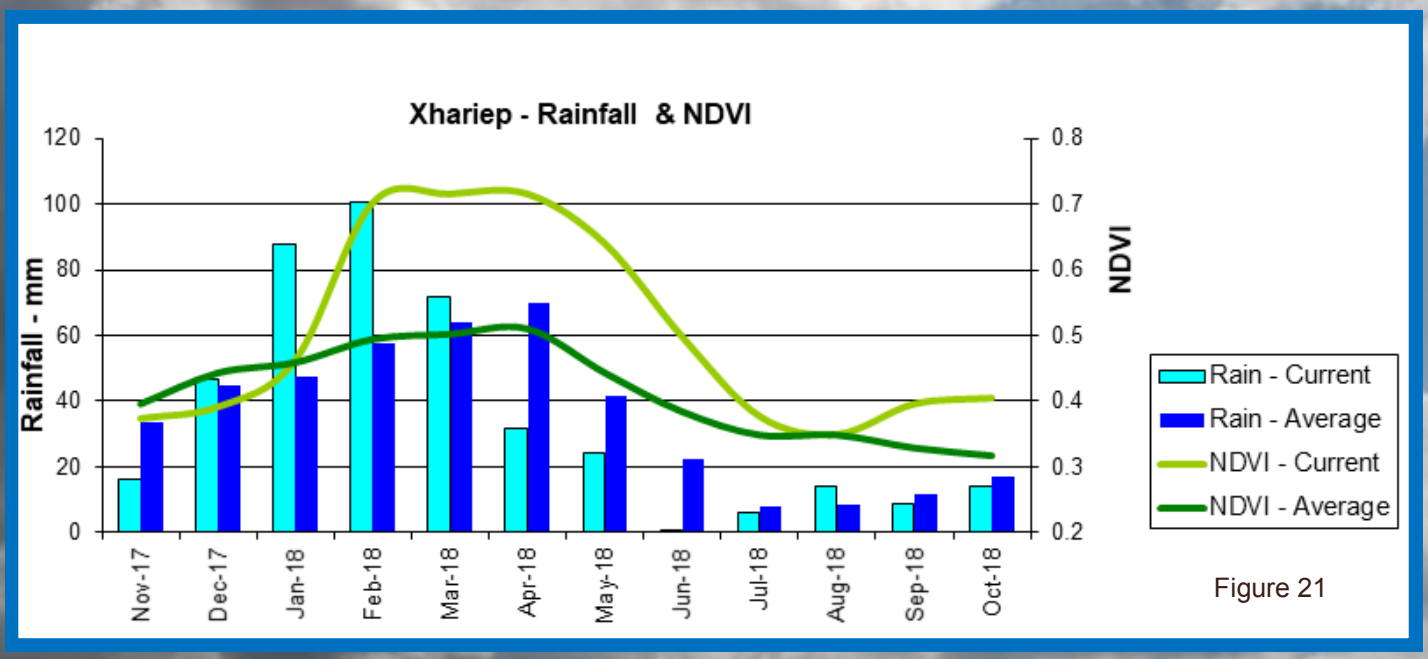

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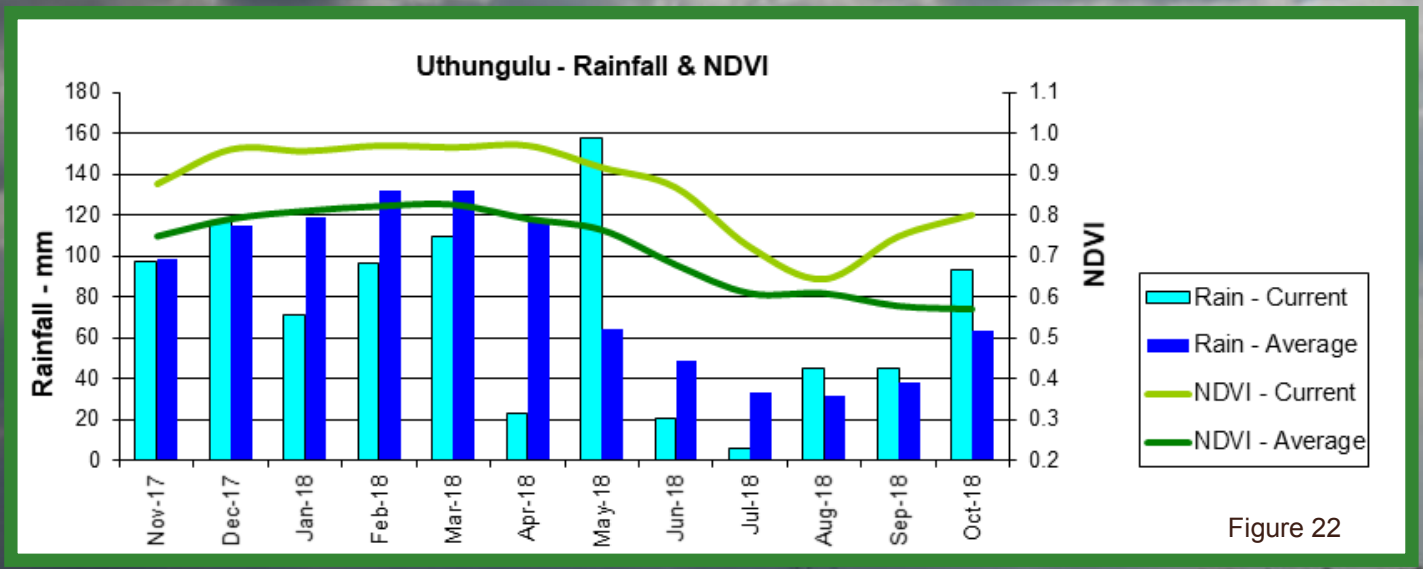

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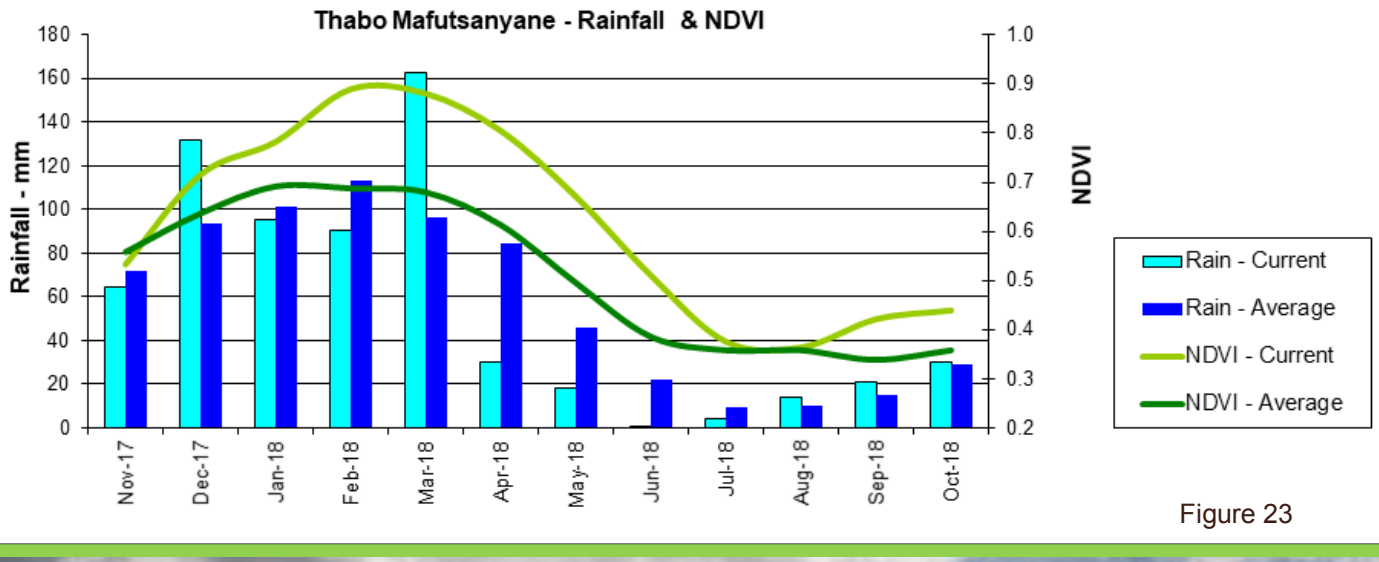

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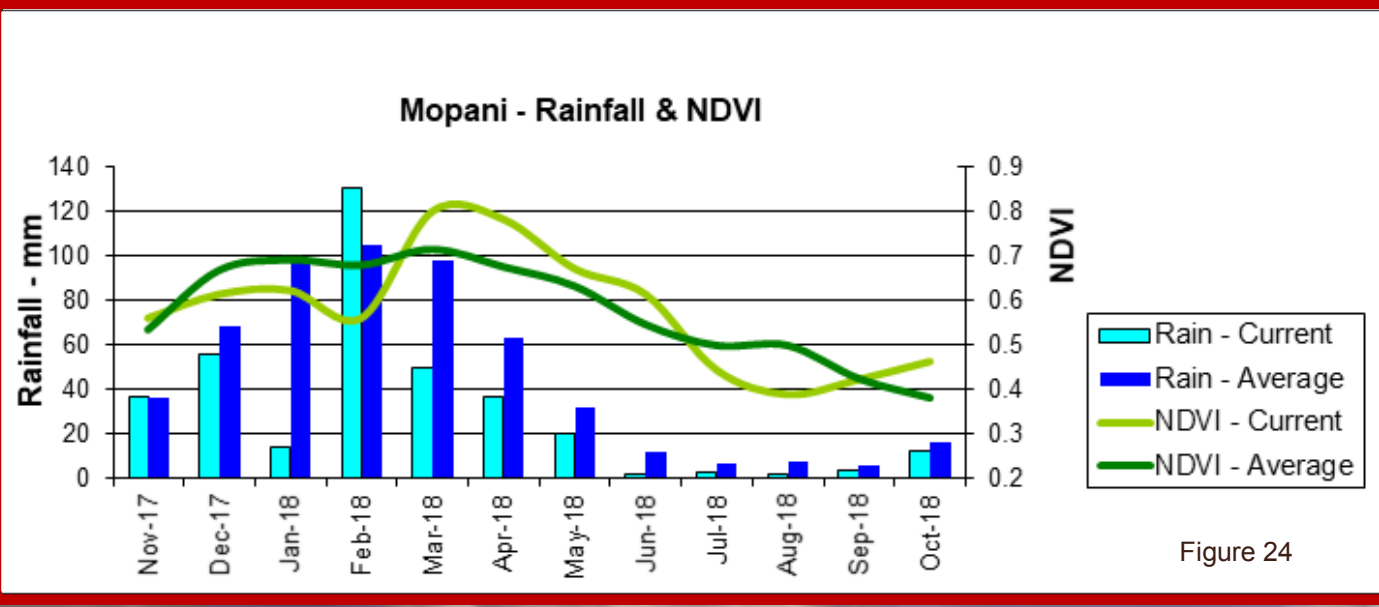

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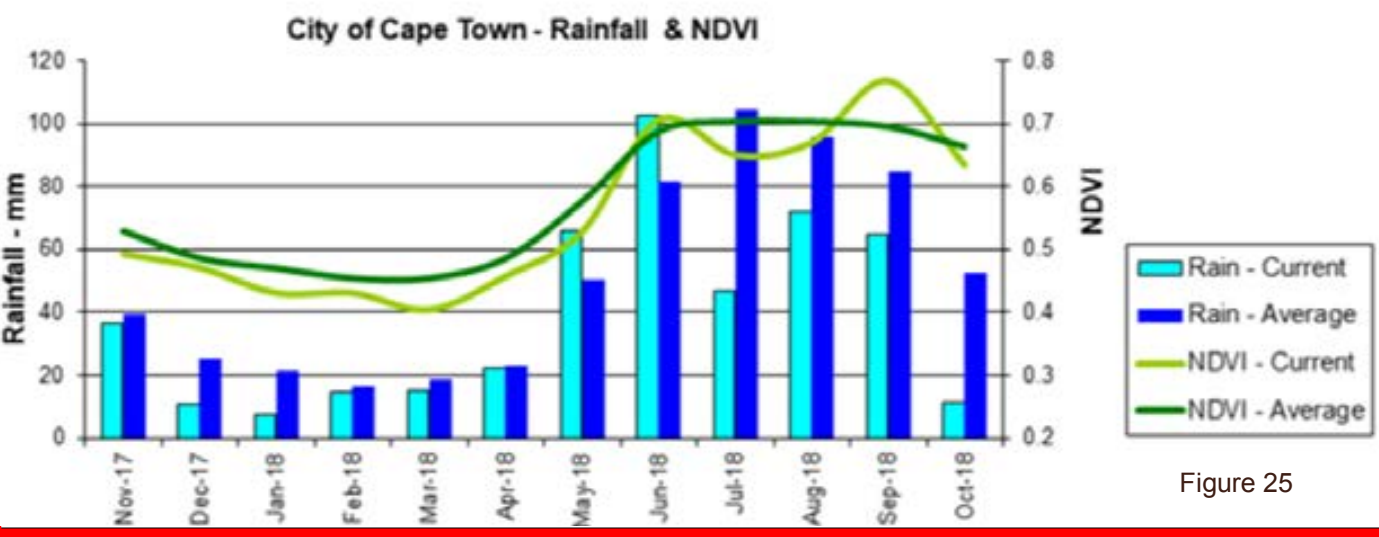

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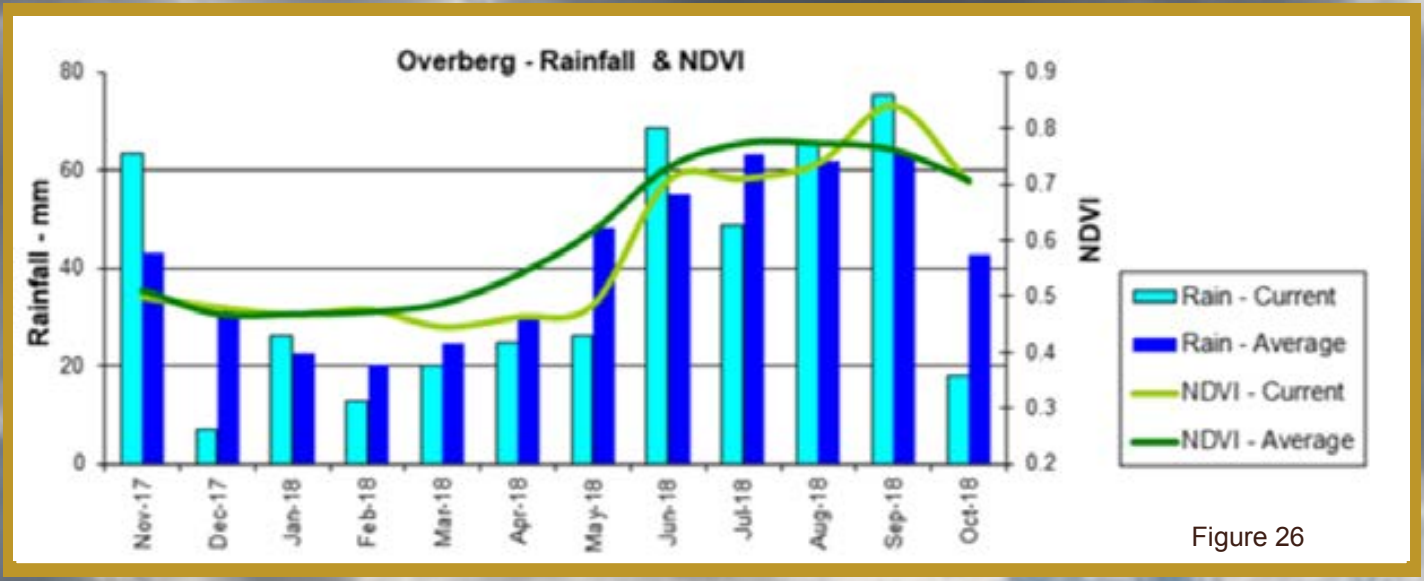

Figure 26

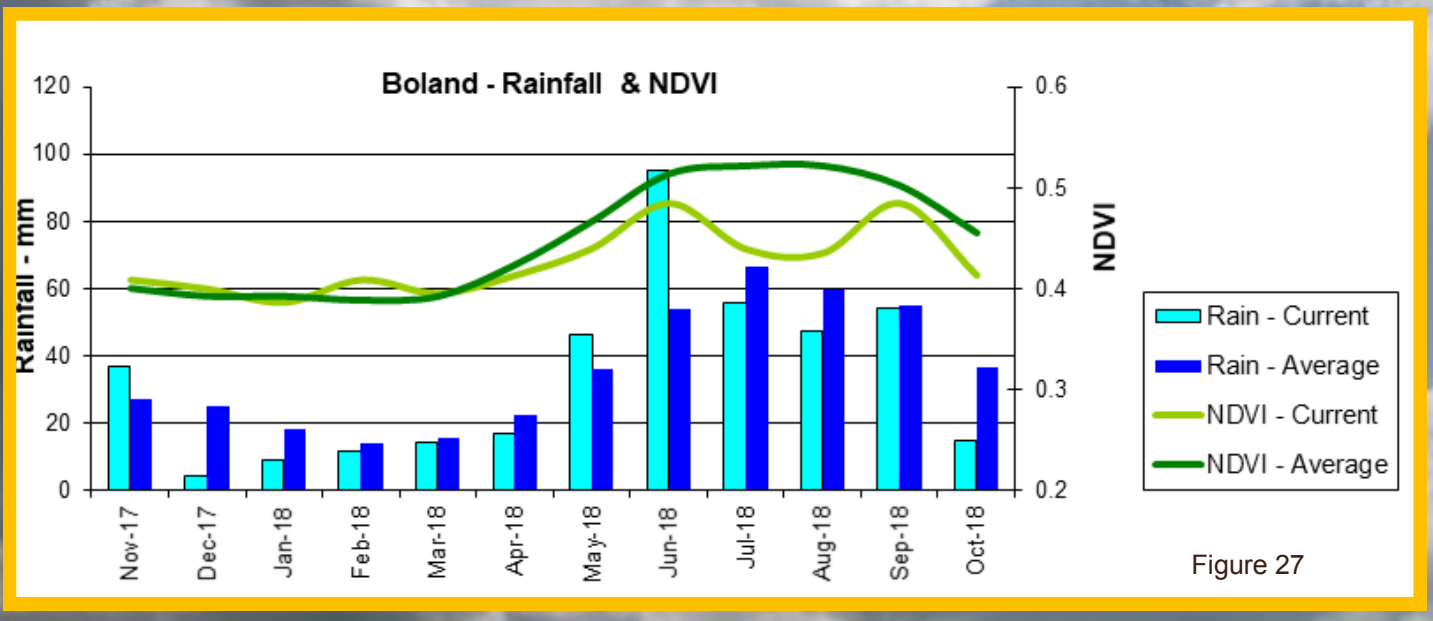

Figure 27

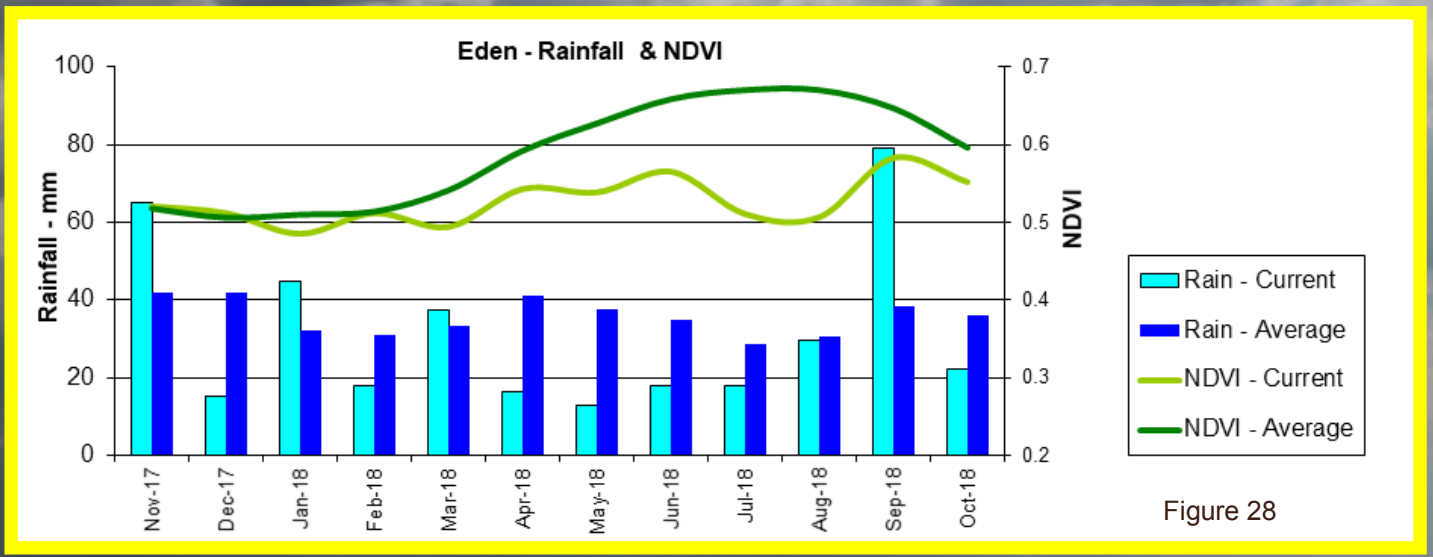

Figure 28

7. Surface Water Resources

Countywide surface water areas (SWA) are mapped on a monthly basis by GeoTerraImage using Sentinel 2 satellite imagery from the start of its availability at the end of 2015.

Figure 29 shows a tertiary-level comparison between the current month's maximum total surface water area and the 3-year maximum total surface water area, which represents the time period since the start of Sentinel 2 image availability at the end of 2015. Reported values are based on a percentage scale, where 100 represents tertiary catchments within which the current month's maximum total surface water area equals the 3-year, long-term maximum total surface water extent. Figure 30 shows a comparison between the current month's maximum total surface water area and the maximum total surface water recorded for the same month in the previous year. Reported values are based on a percentage scale, where a value of 100 represents tertiary catchments where the current maximum total surface water is the same as that recorded for the same month in the previous year (i.e. no change), values <100 represent catchments where the current maximum total surface water area is less than that recorded in the previous year, and values >100 represent catchments where the current maximum total surface water area is greater than that recorded for the same month in the previous year.

The comparison between October 2018 and the 3-year, long-term maximum water extents shows that the majority of catchments across the country are currently between 40-100% of the long-term maximum water area. Notably lower exceptions are the catchments in the Karoo, Kalahari, northern Limpopo and central Kruger National Park. The western regions of the Western Cape show significant increases in water extent compared to long-term conditions. The comparison between October 2018 and October 2017 shows that generally the central interior catchments are typically exhibiting greater water extents this year than last. However, catchments in the North West, Limpopo and Eastern Cape provinces are generally showing a reduced water extent compared to 2017.

The SWA maps are derived from the monthly data generated and available through GeoTerraImage's 'Msanzi Amanzi' web information service: https://www.water-southafrica.co.za

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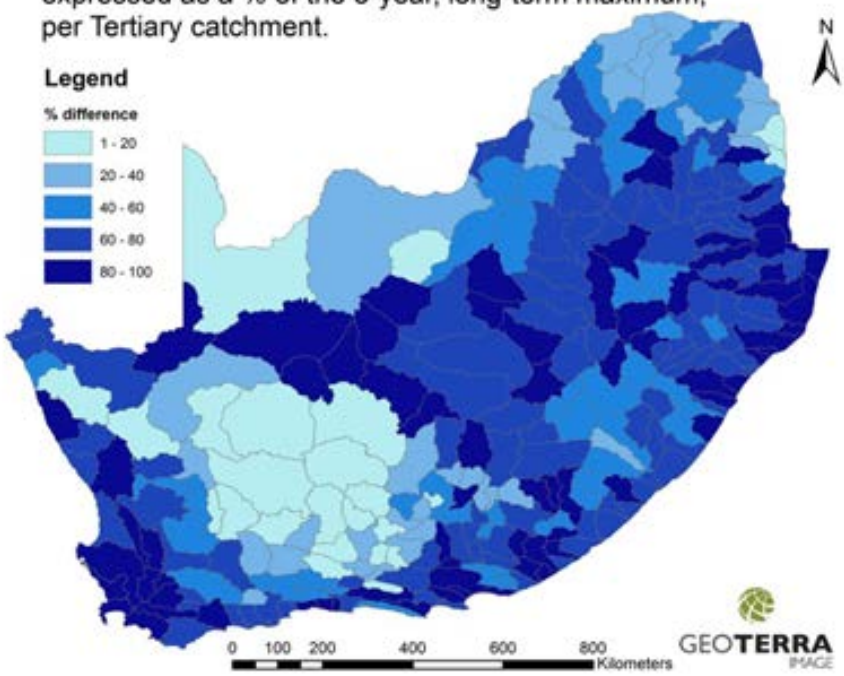

Figure 29

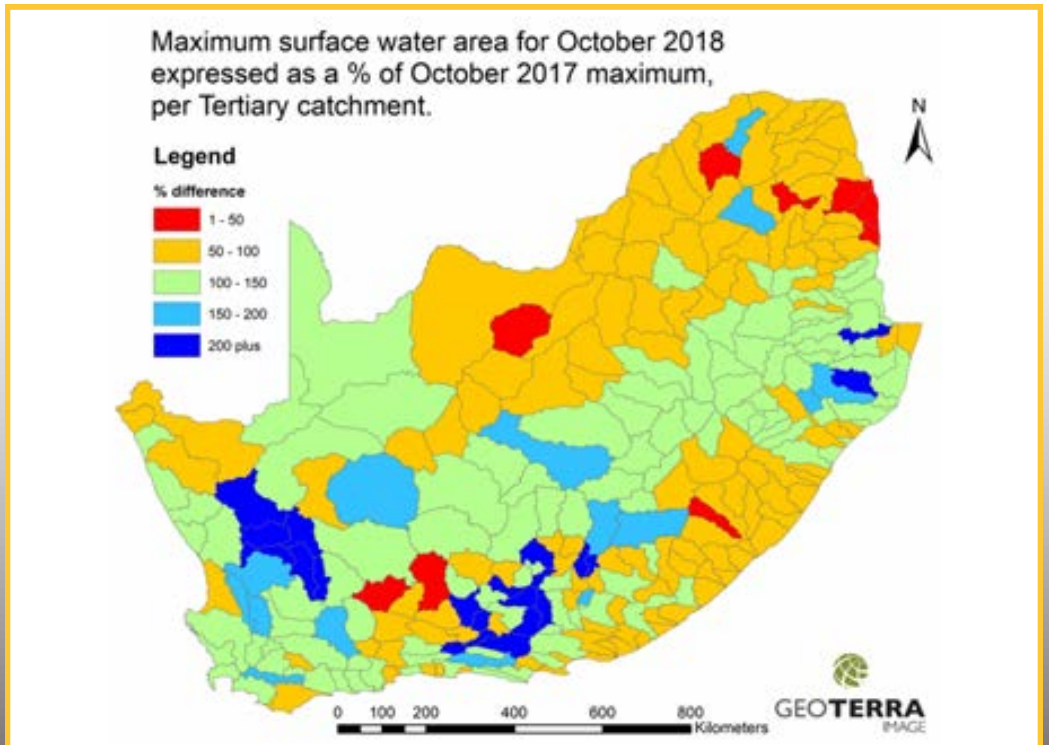

Figure 30

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

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

FOCUS AREAS

Decision Support Systems

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

Early Warning & Food Security

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

Natural Resources Monitoring

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

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The Coarse Resolution Imagery Database (CRID)

NOAA AVHRR

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

MODIS

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

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

Datasets include:

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

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

VGT4AFRICA and GEOSUCCESS

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

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

Meteosat Second Generation (MSG)

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

Rainfall maps

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

Solar Radiation and Evapotranspiration maps

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

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