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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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

South African Weather Service

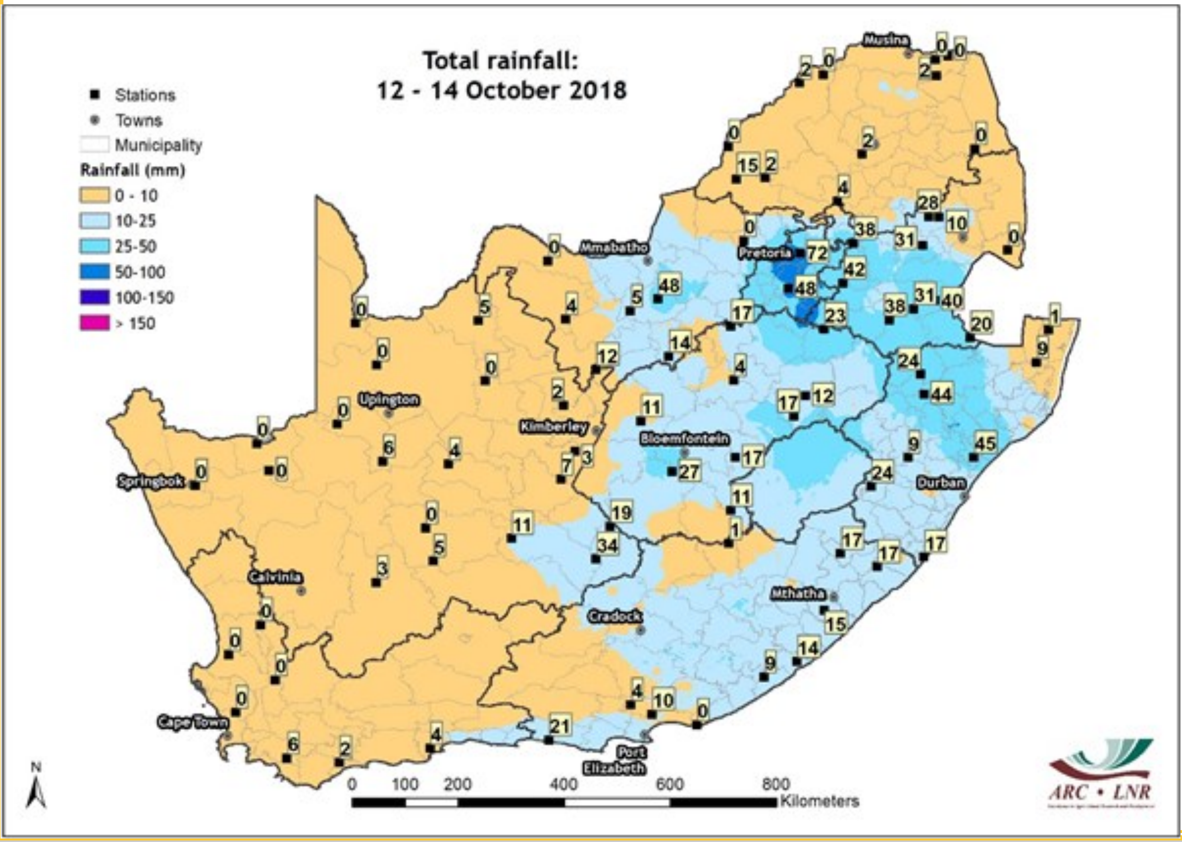
AMESD

172nd Edition

Image of the Month

Early spring rainfall over the maize producing region

Widespread rainfall occurred over the summer rainfall region of South Africa during the period 12-14 October 2018 (see map below). Over Gauteng the 3-day rainfall totals exceeded 50 mm in many locations. Further to the south over the Free State, Eastern Cape and KwaZulu-Natal, as well as westwards over North West, rainfall totals ranged between 15 mm to about 40 mm. However, Limpopo received very little rainfall during this period. This rainfall event was caused by a well-developed upper-air trough that was situated just west of South Africa on 11-12 October and then deepened into a cut-off low pressure system on the 13th. A low pressure system was present over the western interior in association with the cut-off low and it was this system that contributed to the transport of moisture from the east. This early spring rainfall event might imply a good onset to the summer rainy season, if follow-up rains occur within the next few weeks.



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:

The winter rainfall region had a good end to its rainy season with above-normal rainfall over almost this entire region during the month of September 2018. The all-year rainfall region also had above-normal rainfall during the month of September – much needed relief after multiple months of below-normal rainfall and severe drought conditions. Some early spring rain resulted in above-normal rainfall over some areas in the eastern parts of the summer rainfall region.

The good September rainfall totals over the winter rainfall region resulted from the regular passage of frontal systems around the 4th, 12th, 17th, 24th and 27th. Of these frontal systems, the cold front during the first week of the month was the strongest and moved far in over the interior as the system deepened into a cut-off low. High rainfall totals occurred along the coast to the west of Port Elizabeth (more than 200 mm in places) in association with the surface low that accompanied the cut-off low weather system, whilst snow occurred over the interior regions. After the cut-off low weather system exited the country, zonal flow and sunny conditions occurred over the country for some days while an upper air high pressure system invaded the country from the west. During this time, weak frontal systems only affected the far southwestern parts whilst heatwave conditions developed over the northeastern parts of the country. These heatwave conditions contributed to the September average maximum temperature being more than 3°C higher than normal. The hot conditions broke on 20 September as cool air was advected in from the east by a high pressure system. An approaching upper-air trough in combination with anticyclonic circulation just east of the country resulted in cloud development and thunderstorm activity over parts of the northeastern interior on the 22nd. During the remaining few days of the month, cloud development characteristic of summer atmospheric circulation occurred over the interior.

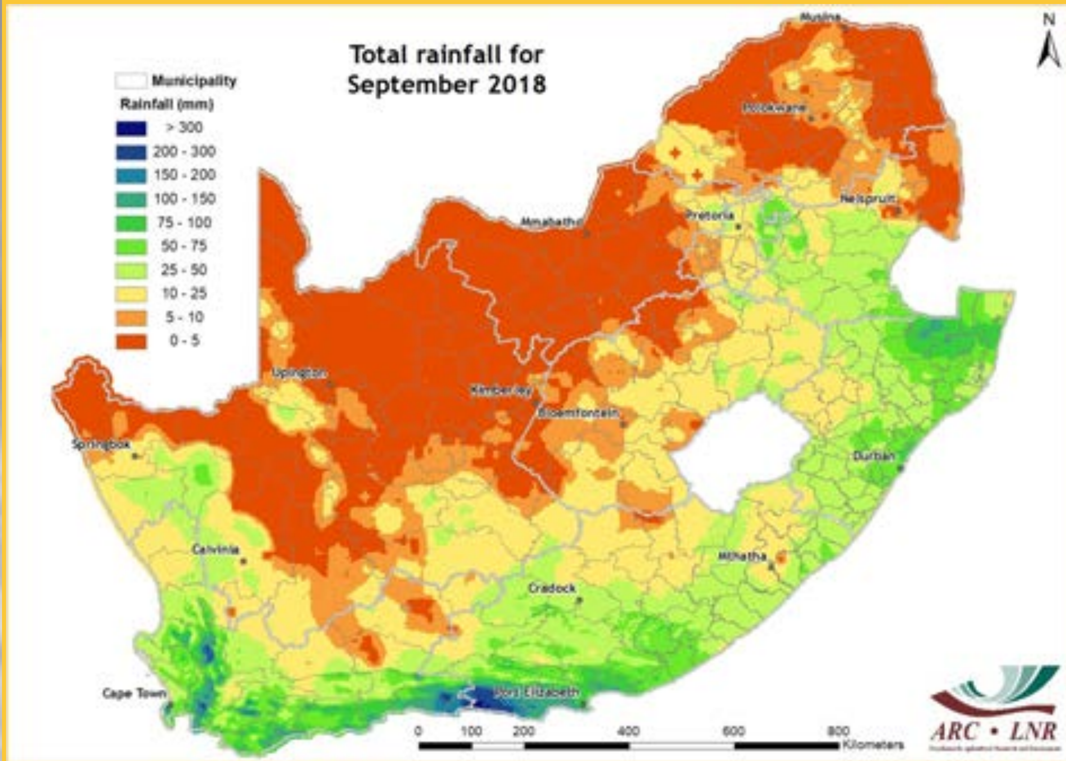


Figure 1

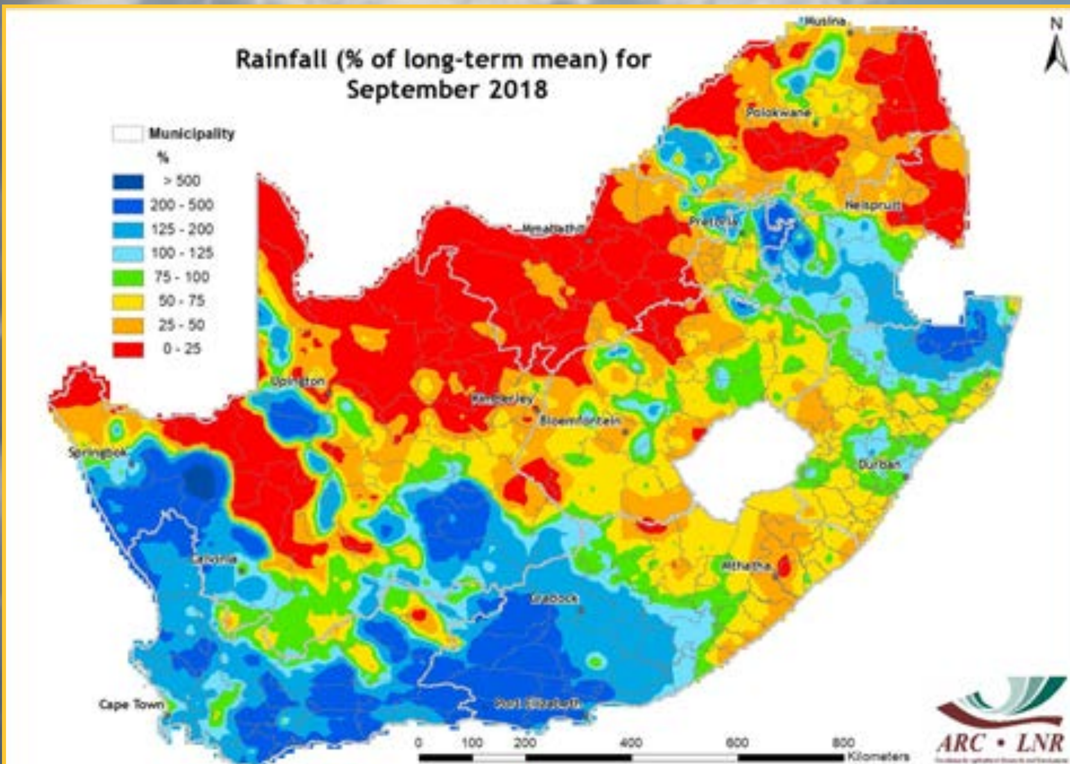


Figure 2

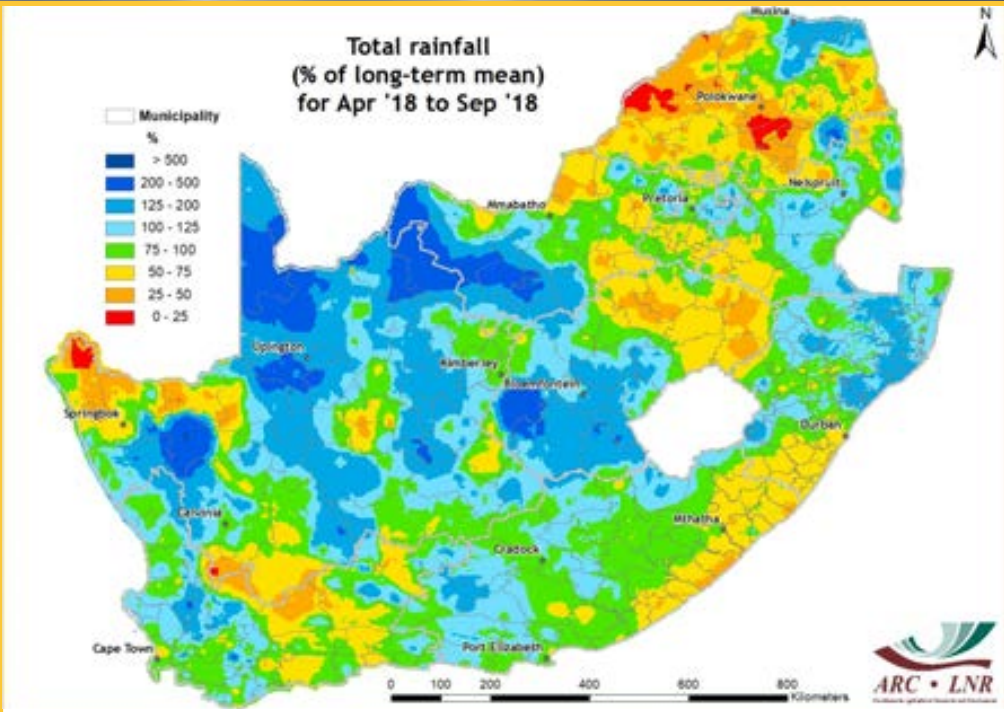


Figure 3

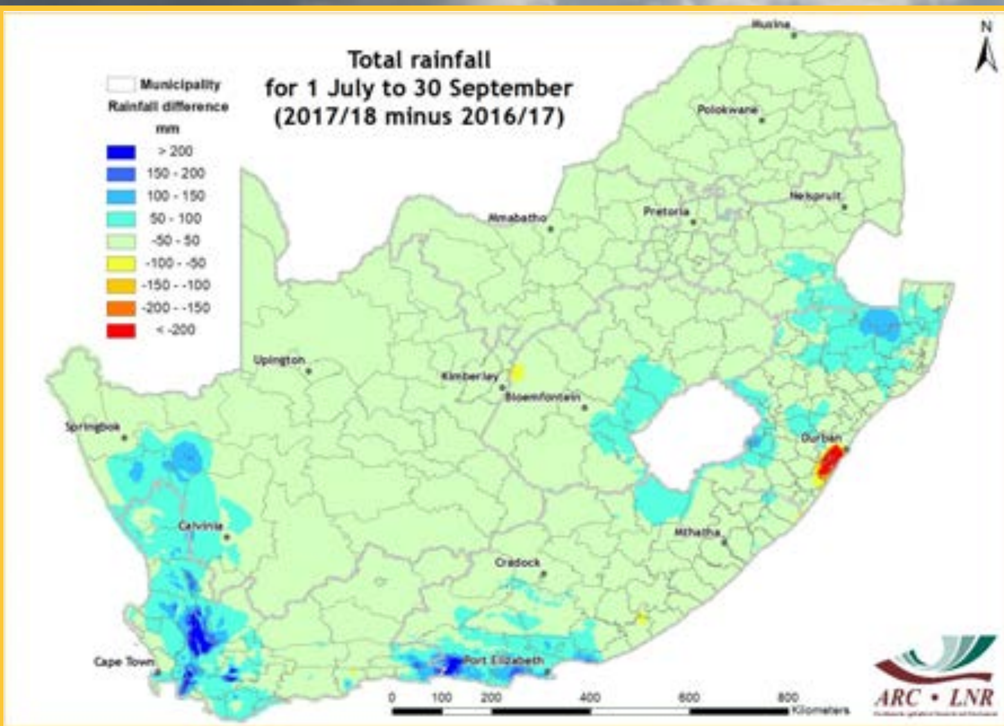


Figure 4

Figure 1:
A cut-off low system that developed by the end of the first week of September caused widespread rainfall along the Cape south coast and brought relief to important dams in the region that had very low water levels. Some areas to the west of Port Elizabeth received more than 200 mm of rain during this event. Good September rainfall also occurred over the winter rainfall region with the passage of frontal systems. Towards the end of the month, rainfall occurred over some isolated parts of the summer rainfall region as the spring-summer weather patterns started to emerge.

Figure 2:
Above-normal rainfall occurred in September over the winter rainfall region, the all-year rainfall region and some isolated parts of the summer rainfall region. A frontal system during the first week of the month resulted in about half of the monthly rainfall that occurred over the winter rainfall region. Frontal systems around the middle of the month and again towards the end of the month contributed to the good rainfall over the winter rainfall region. A cut-off low pressure system around the 7th was mostly responsible for the above-normal rainfall over the all-year rainfall region, whilst the first spring rains over the summer rainfall region resulted in isolated areas of above-normal rainfall over the central and eastern interior.

Figure 3:
During the 6-month period from April to September, also referred to as the winter half-year, near-normal to above-normal rainfall occurred over the winter rainfall region. The western parts of the all-year rainfall region received below-normal to normal rainfall, whilst the remainder of this region received normal to above-normal rainfall during this 6-month period. However, most months during this period were actually very dry over the all-year rainfall region, with the cut-off low event during the first week of September being responsible for a large contribution to the rainfall totals during this 6-month period. With the exception of the southeastern coastal belt and some areas over the eastern and northeastern interior, most of the remainder of the summer rainfall region received above-normal rainfall during this 6-month period.

Figure 4:
Compared to the corresponding period during 2017, improved rainfall conditions occurred during July to September 2018 over the winter rainfall region, in particular over the mountainous regions of the southwestern parts of the country. The Eastern Cape coastal belt west of Port Alfred experienced improved rainfall conditions this year compared to the corresponding 3-month period in 2017, which can be attributed to the early September cut-off low weather system.

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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, Port Elizabeth and surrounding areas, as well as areas over the eastern parts of the country where severe to extreme drought conditions occurred. Relief from the severe drought conditions occurred over areas in the eastern parts of the country on the 24-month time scale, whilst drought conditions intensified over the southwestern parts. On the 12-month time scale, the severe to extreme drought conditions over the southwestern parts of the country improved to mild drought, with some isolated areas even mildly wet. The 6-month SPI indicates mildly wet conditions over the central parts of the country with some areas over the northern central parts moderately wet.

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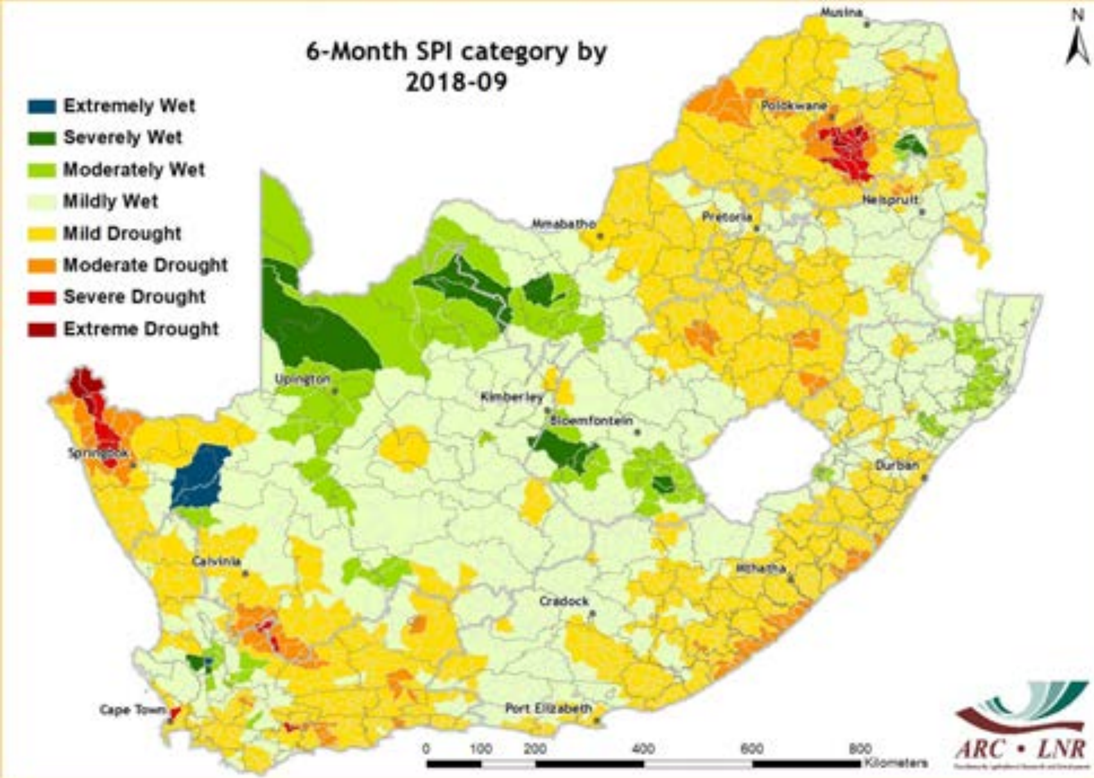
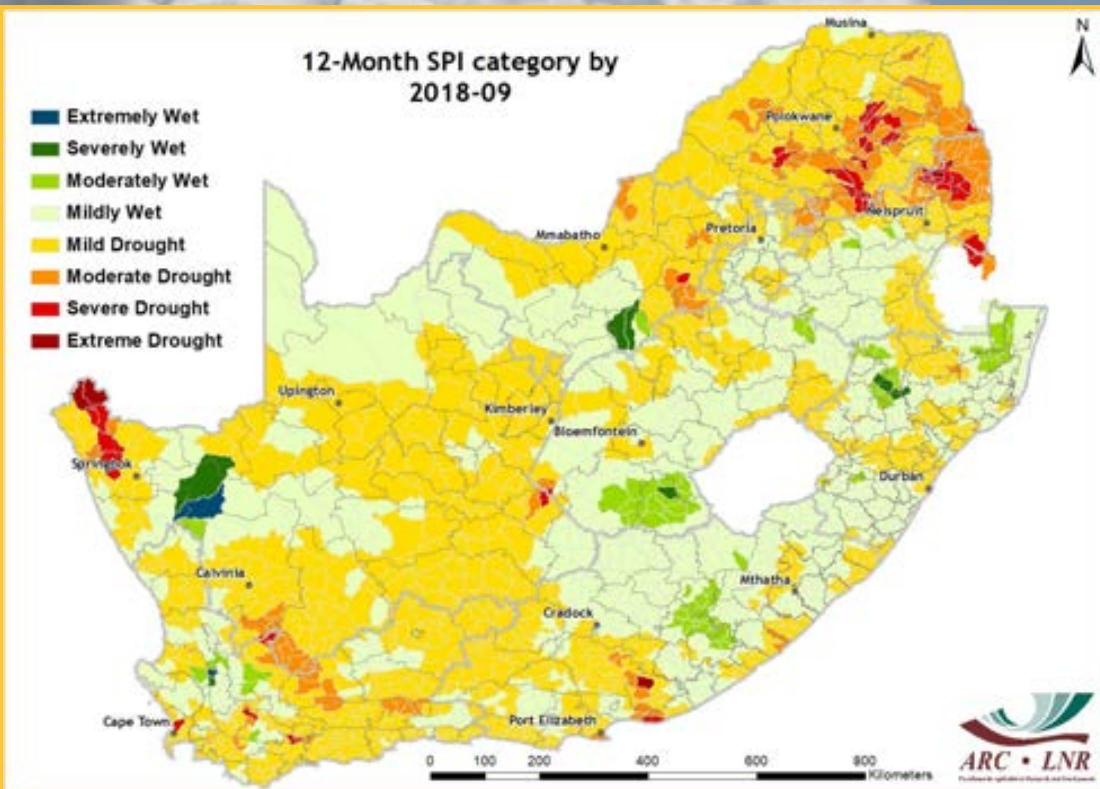


Figure 5



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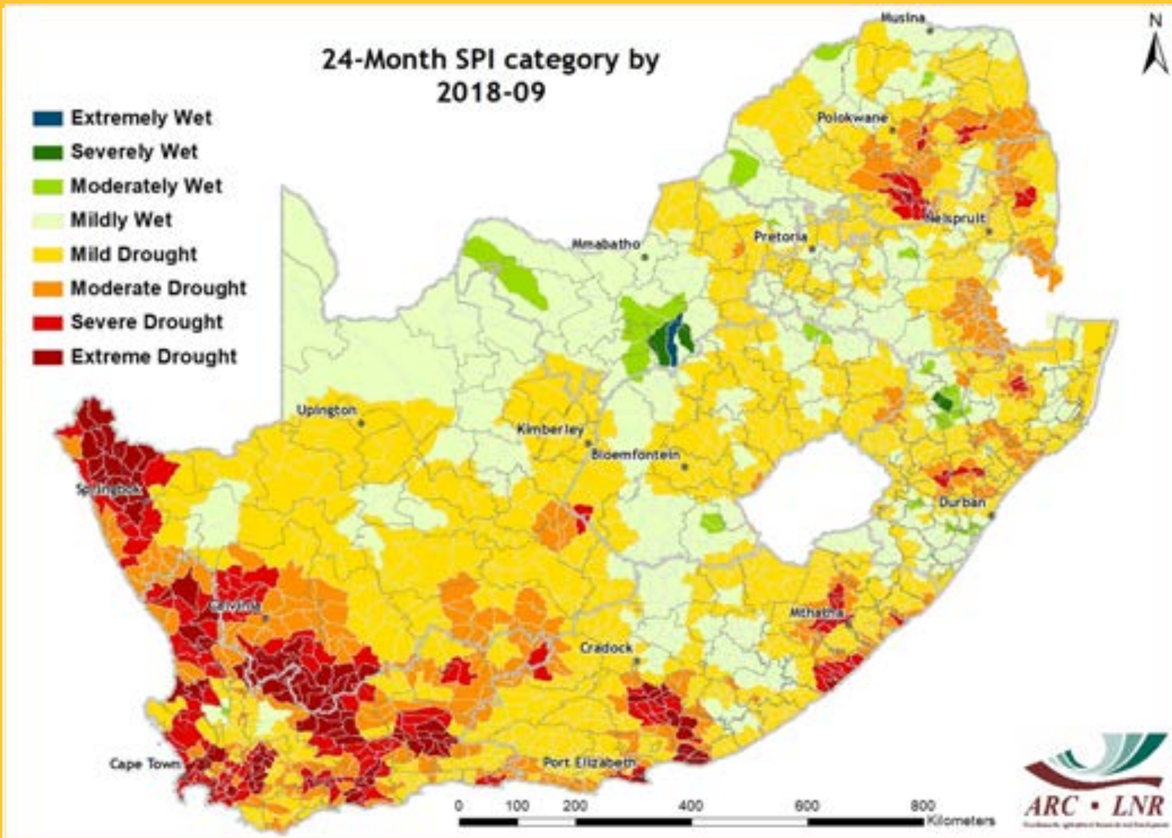

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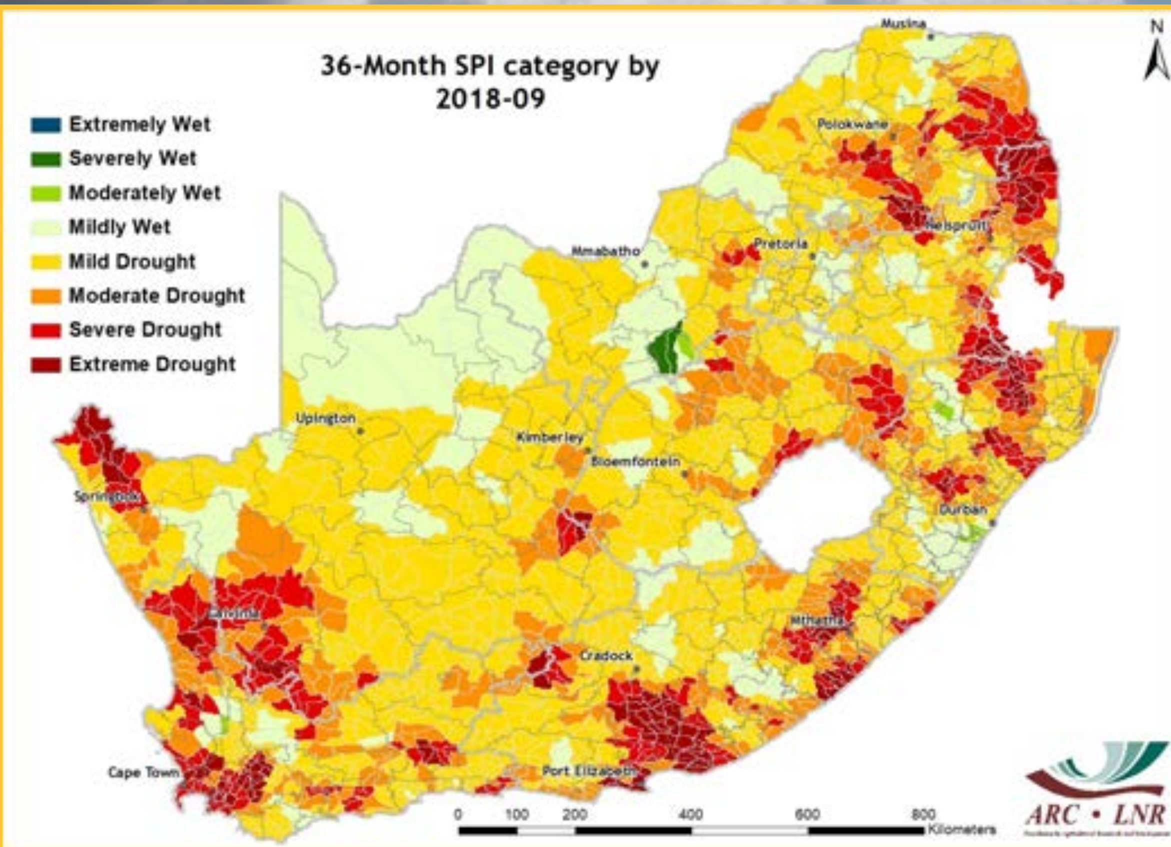

Figure 8

3. Rainfall Deciles

Deciles are used to express the ranking of rainfall for a specific period in terms of the historical time series. In the map, a value of 5 represents the median value for the time series. A value of 1 refers to the rainfall being as low or lower than experienced in the driest 10% of a particular month historically (even possibly the lowest on record for some areas), while a value of 10 represents rainfall as high as the value recorded only in the wettest 10% of the same period in the past (or even the highest on record). It therefore adds a measure of significance to the rainfall deviation.

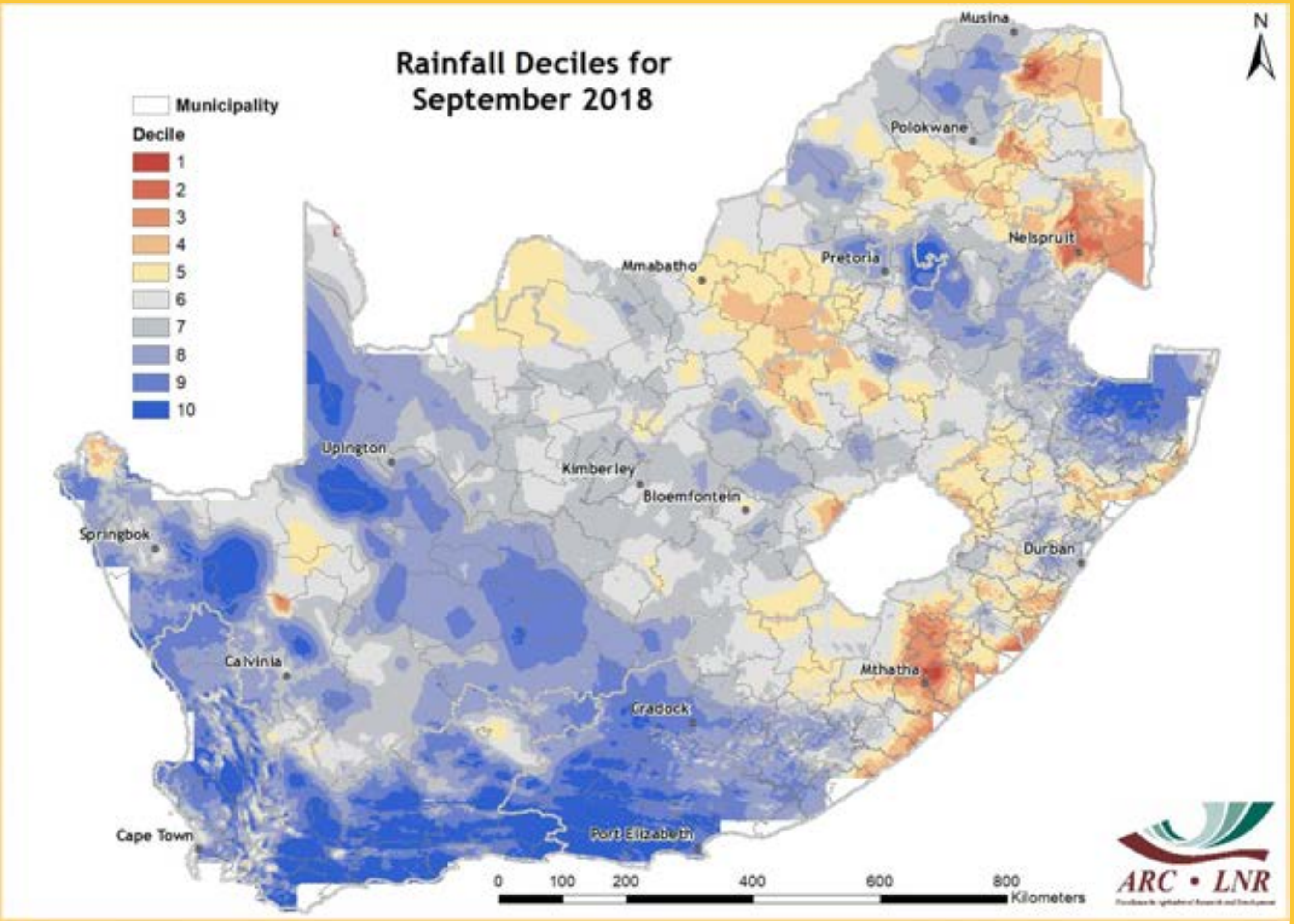

Figure 9

Figure 9:
Rainfall totals during September 2018 over most of the country fall within the wetter September rainfall totals compared to historical September rainfall totals, in particular over the western and southern parts of the country.

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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.

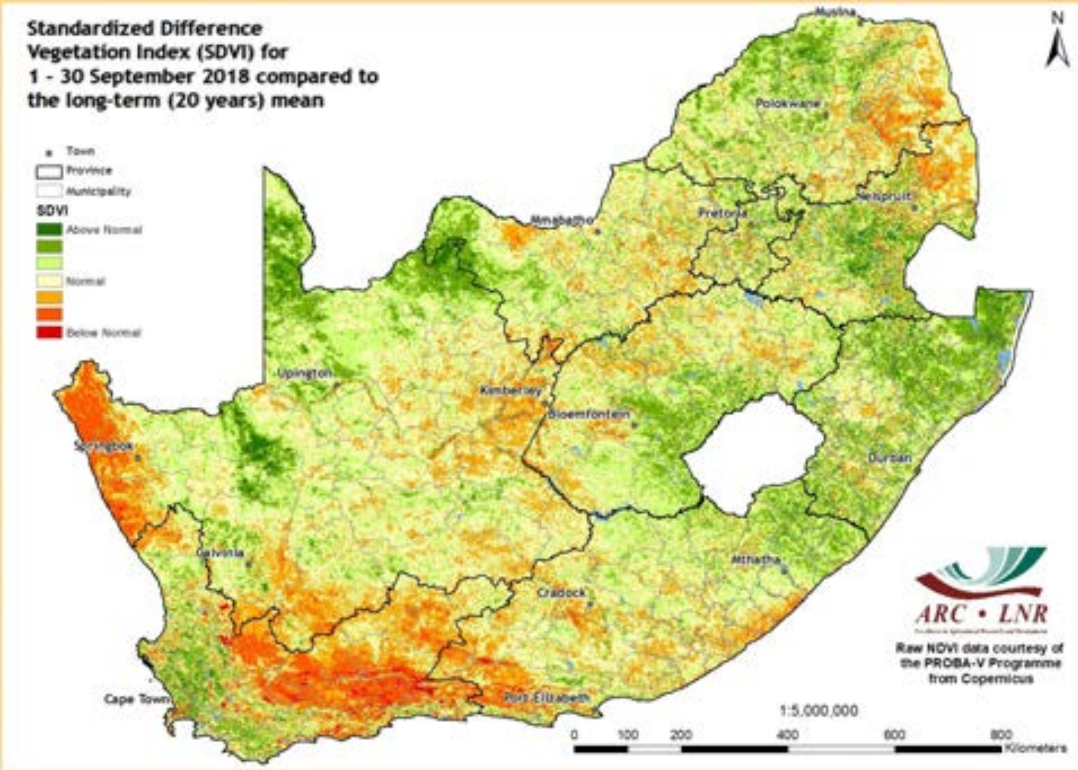

Figure 10

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

Figure 11:
Compared to September 2017, the NDVI map for September 2018 shows that major parts of the country experienced normal vegetation activity. Small pockets of poor vegetation activity only occurred in some isolated areas of Limpopo, Mpumalanga, KwaZulu-Natal and the Western and Eastern Cape.

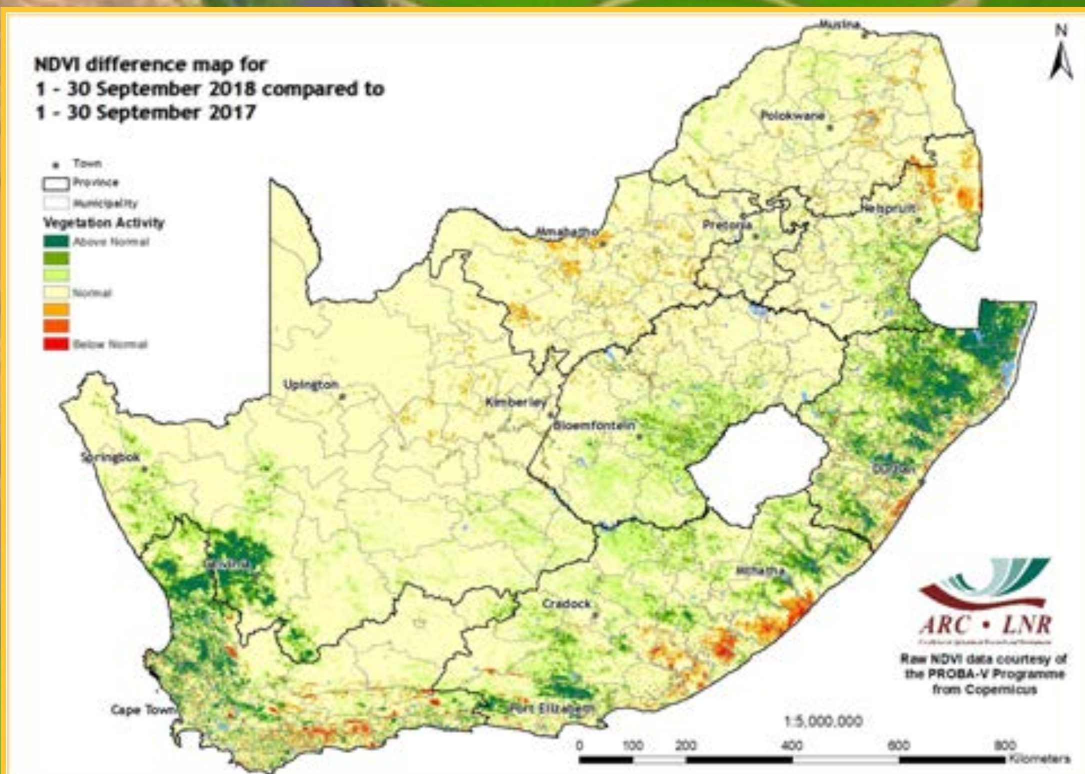

Figure 11

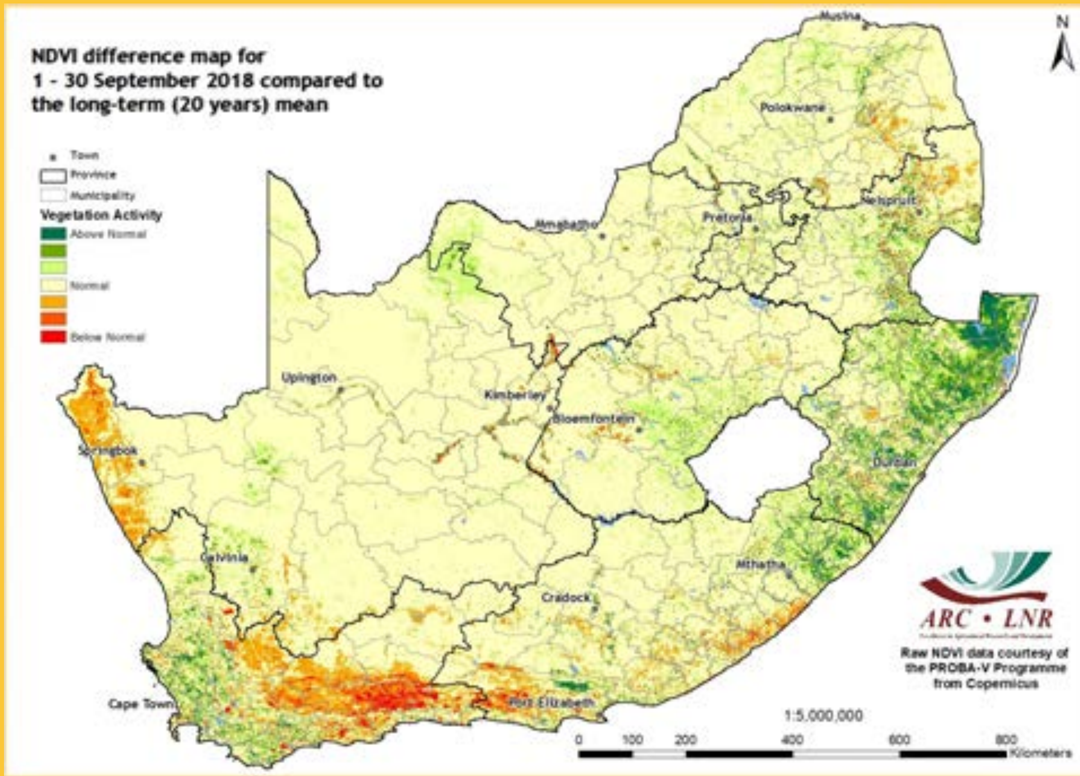

Figure 12

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

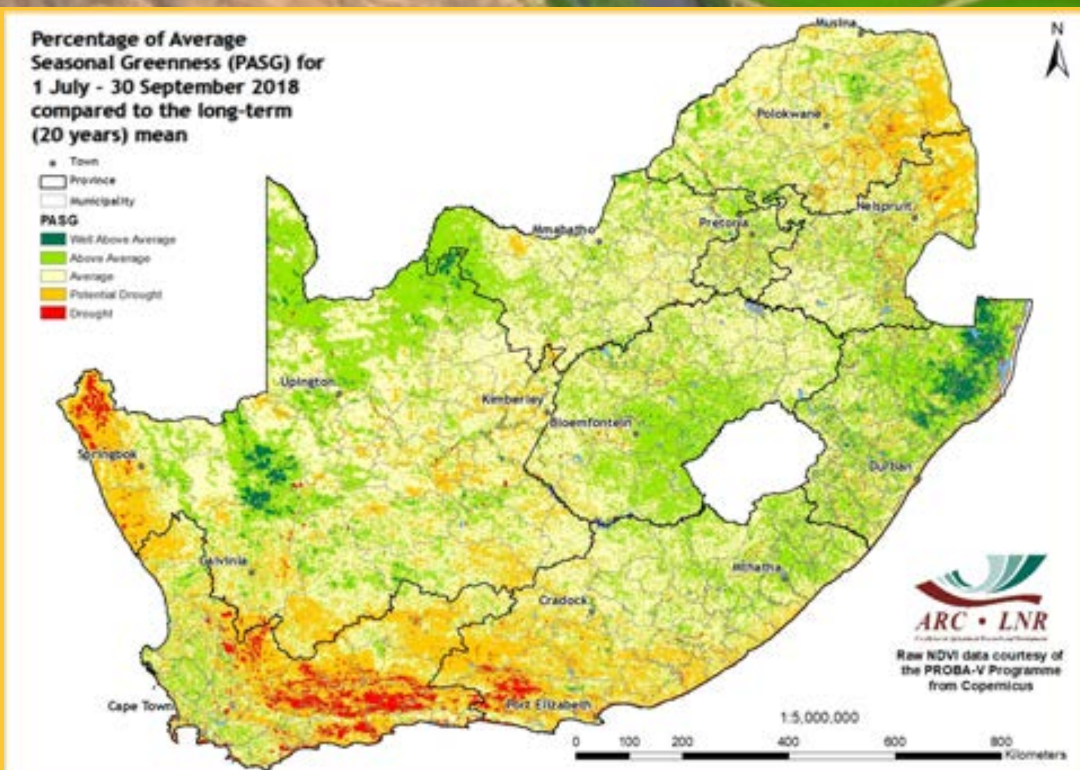

Figure 13

Figure 12:
The NDVI difference map for September shows that normal vegetation activity remains over much of country's interior, while the far western and southern parts of the Namakwa, the northern parts of the Western Cape and the southwestern parts of the Eastern Cape continue to experience below-normal vegetation activity compared to the long-term mean.

Figure 13:
Cumulative vegetation activity remains stressed over much of the southwestern and northern parts of the country due to drought. Meanwhile, some isolated areas in KZN, the Free State and Northern Cape continue to experience small pockets of above-normal cumulative vegetation activity.

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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.

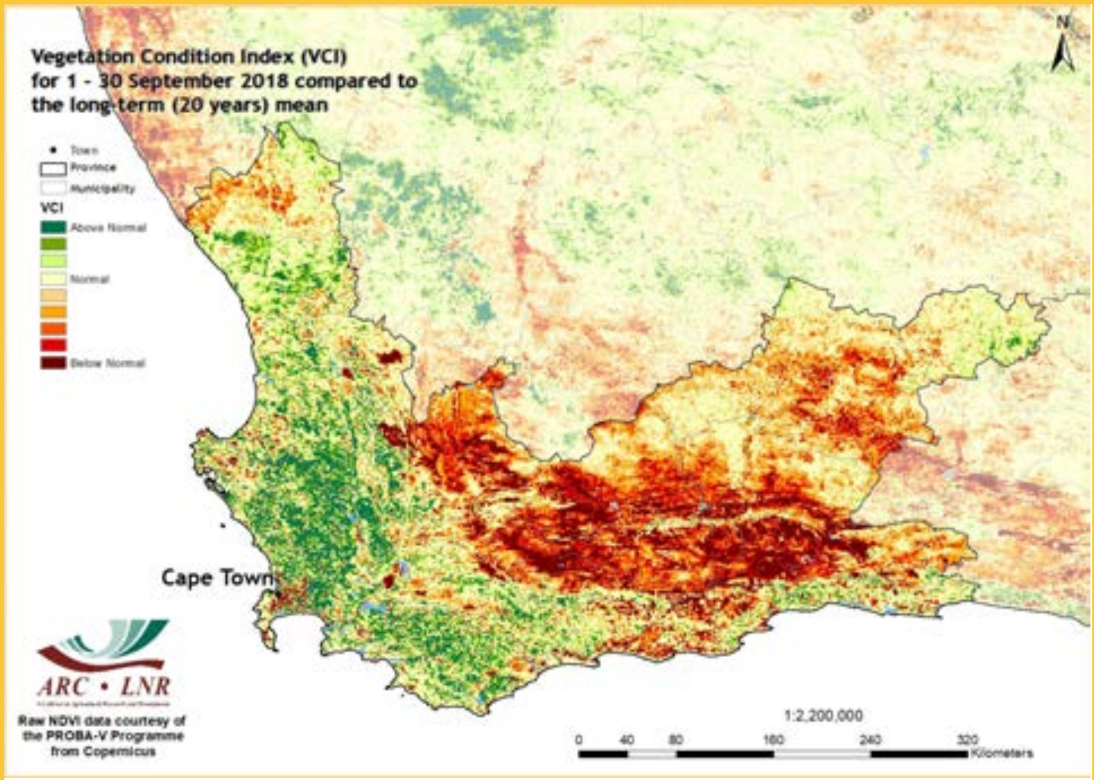


Figure 14

Figure 14:
The first spring rainfall which spread over much of the south coast of the Western Cape stimulated good vegetation activity in this region. However, some areas such as the Eden and the Central Karoo districts received insufficient rainfall in September, hence the vegetation activity in these areas remains below-normal.

Figure 15:
The southwestern parts of the Sarah Baartman District Municipality of the Eastern Cape continue to experience below-normal vegetation conditions. Meanwhile, the far northeastern parts of the province experienced above-normal vegetation activity.

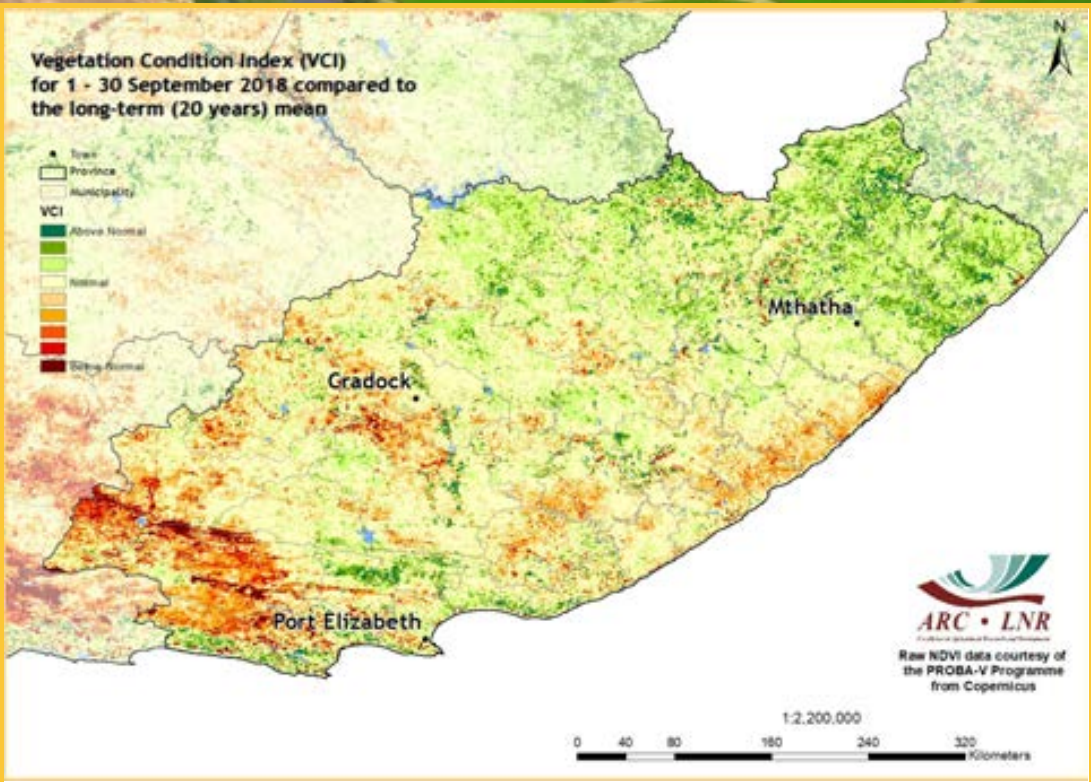
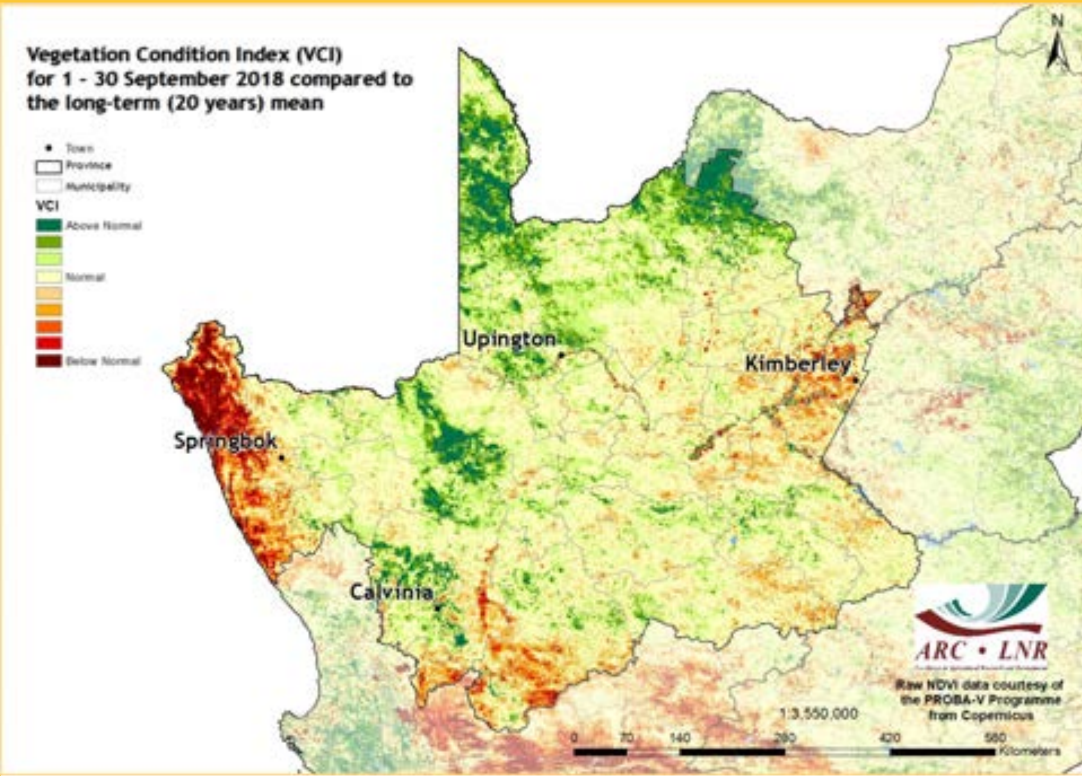


Figure 15



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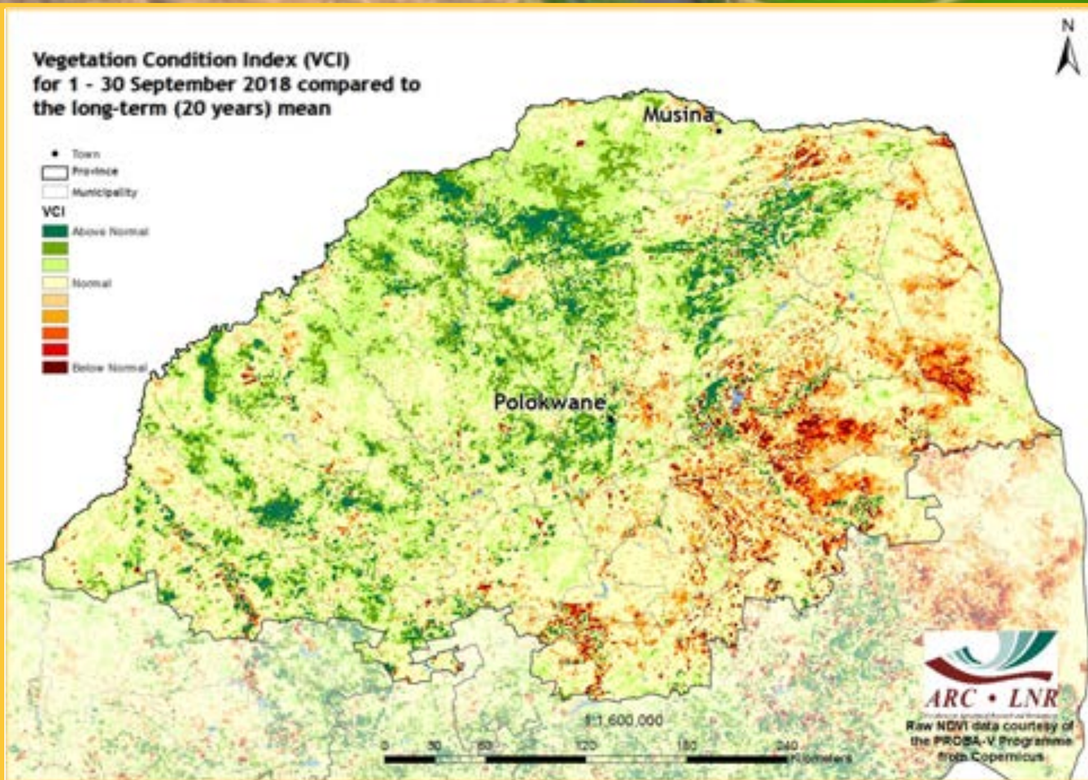

Figure 17

Figure 16:
The September VCI map shows that the far western and southern parts of Namakwa, as well as some isolated areas in the Frances Baard District Municipality experienced below-normal vegetation conditions.

Figure 17:
As a result of the first spring rainfall, above-normal vegetation activity occurred in some isolated areas, especially over much of the central and western parts of Limpopo. Pockets of below-normal vegetation activity occurred in the far eastern parts of the province.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

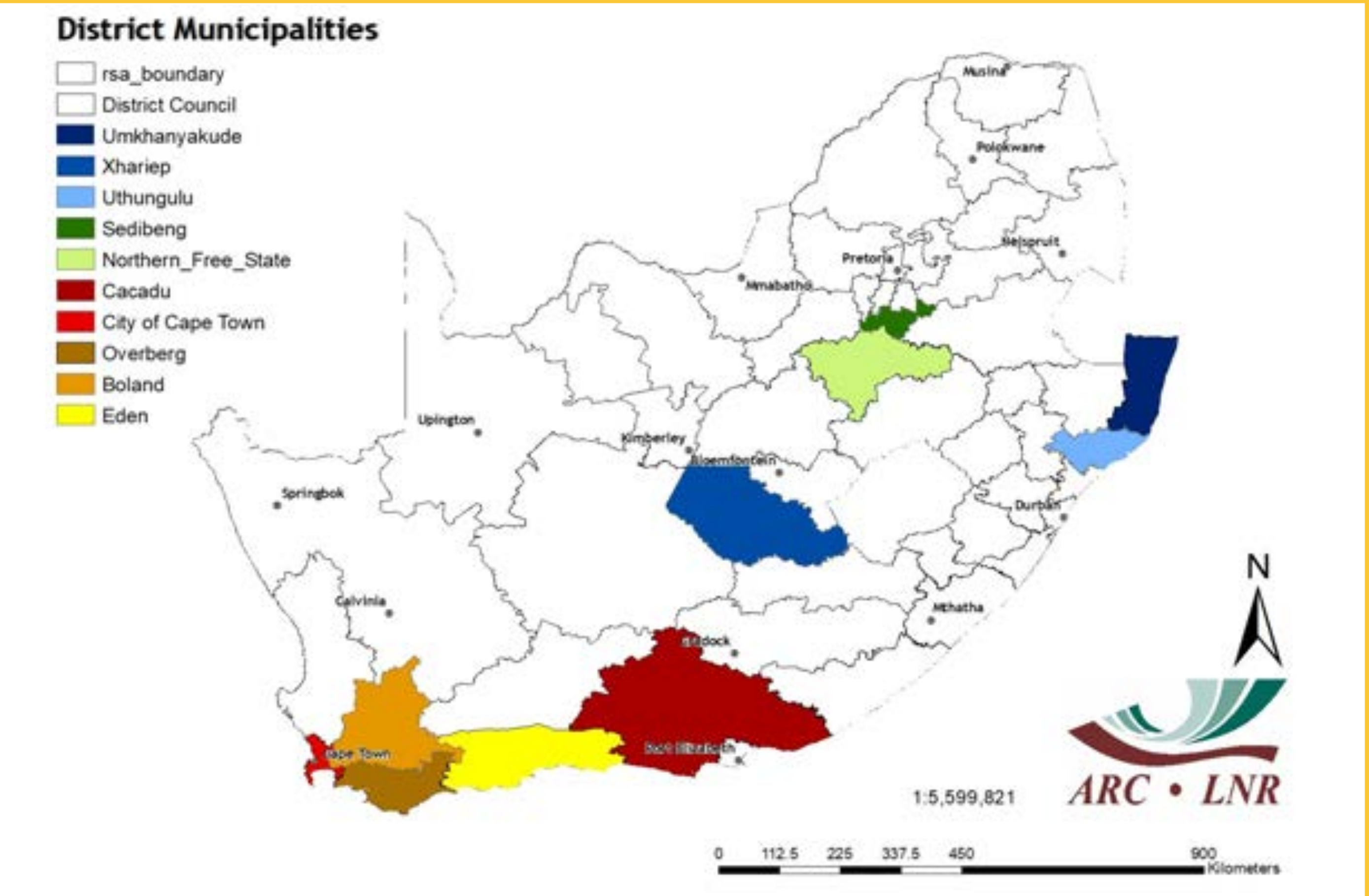

Figure 18

Rainfall and NDVI Graphs

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

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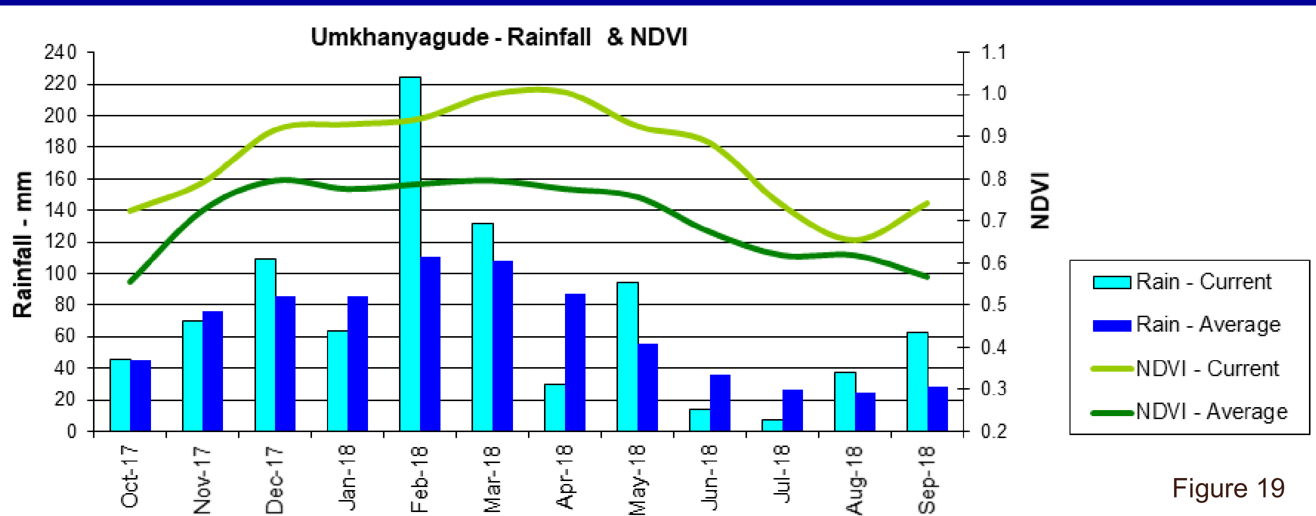
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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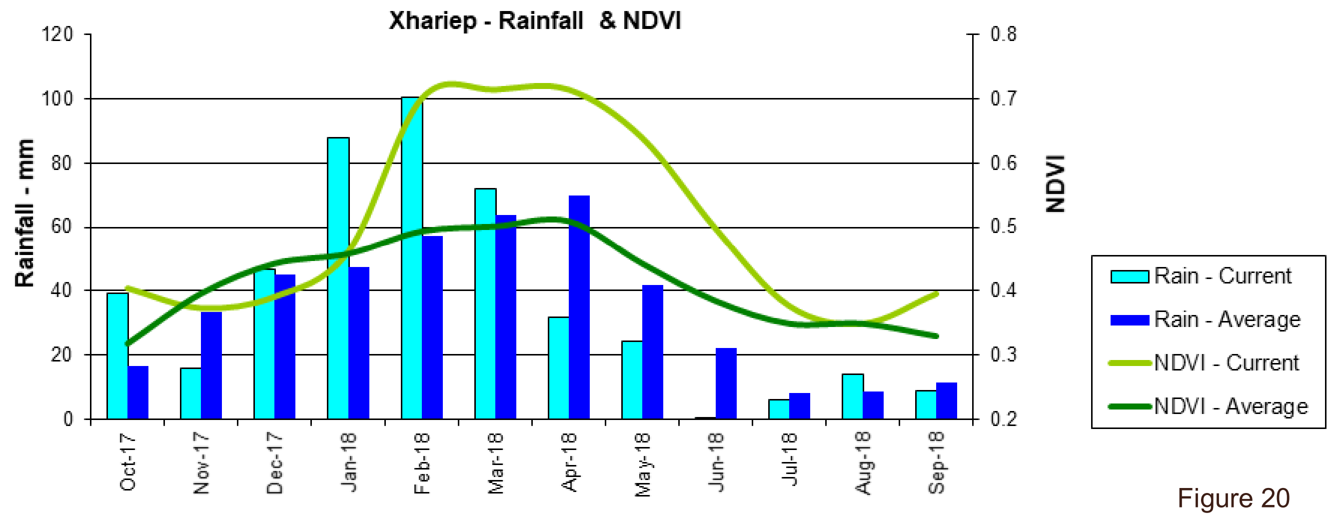

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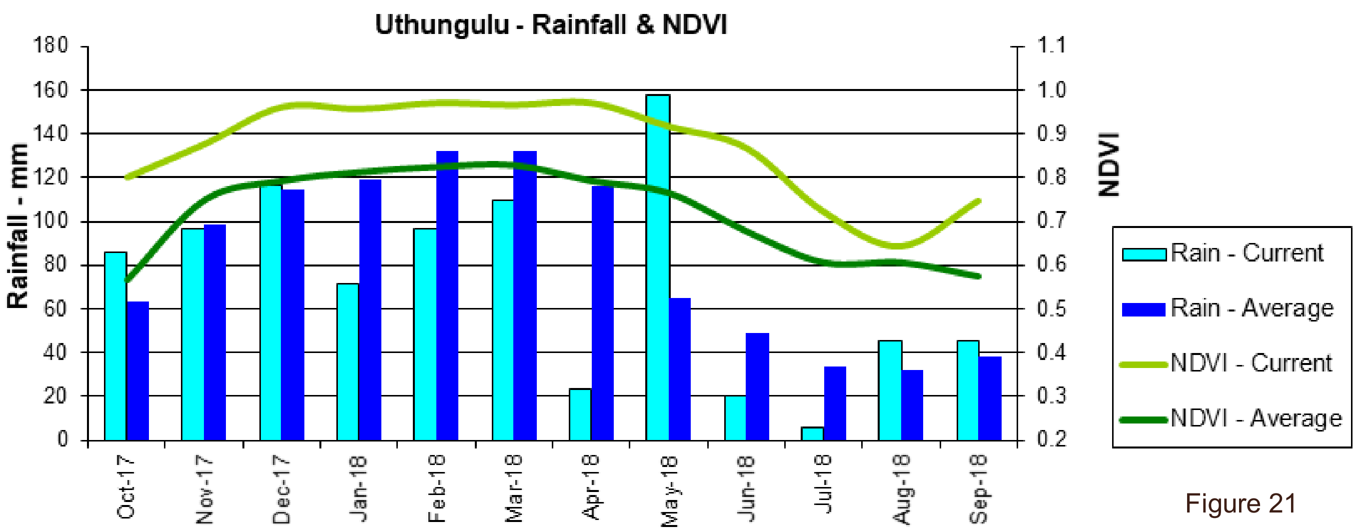
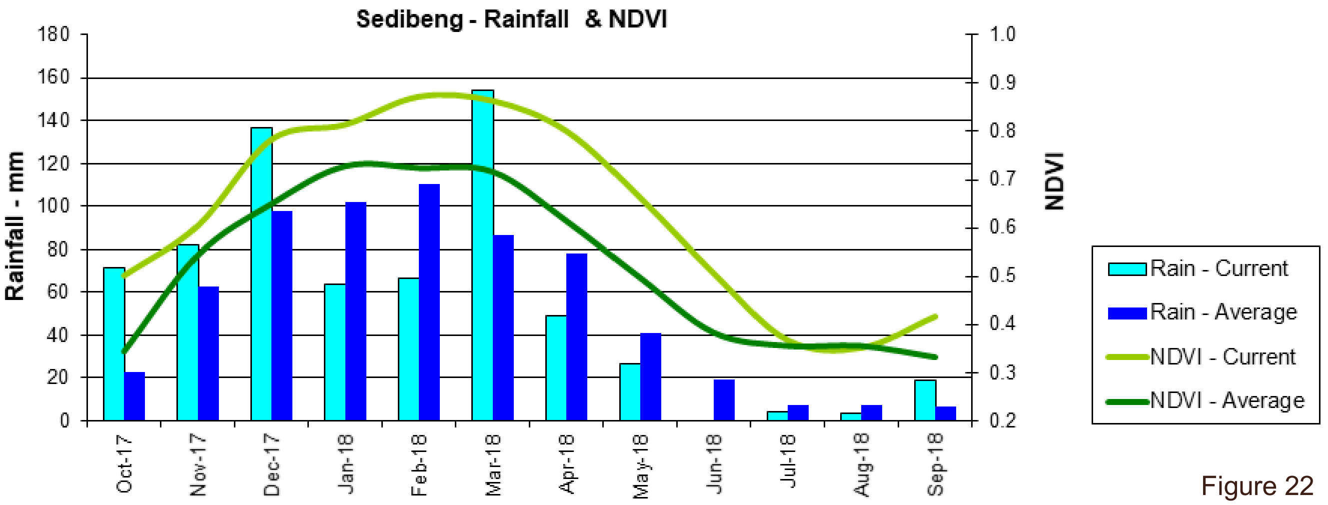


Figure 21



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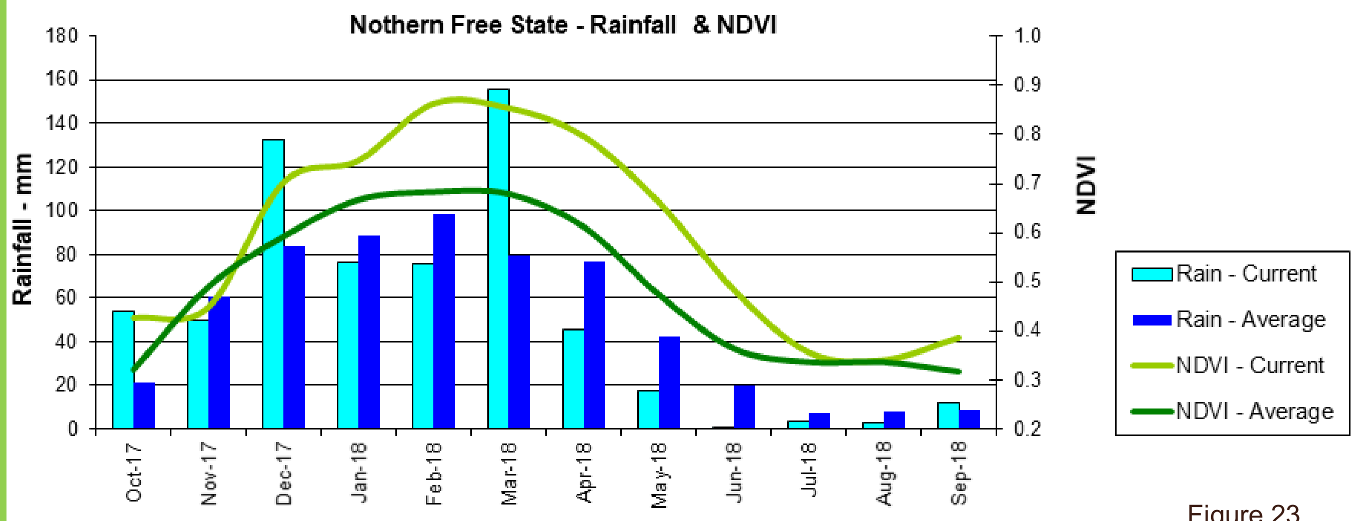

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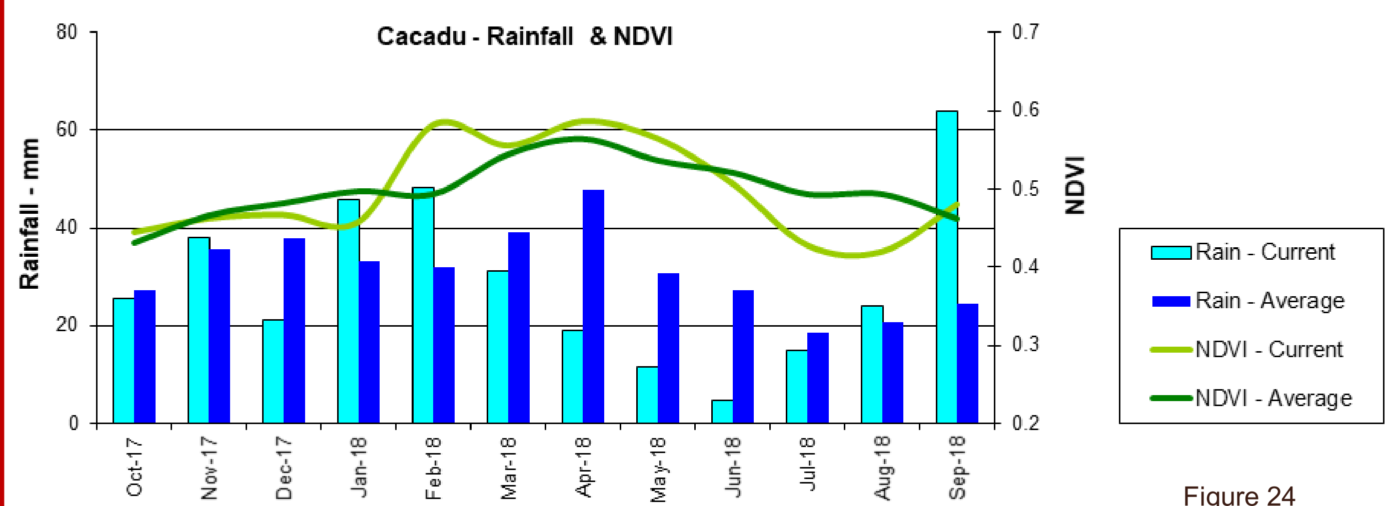

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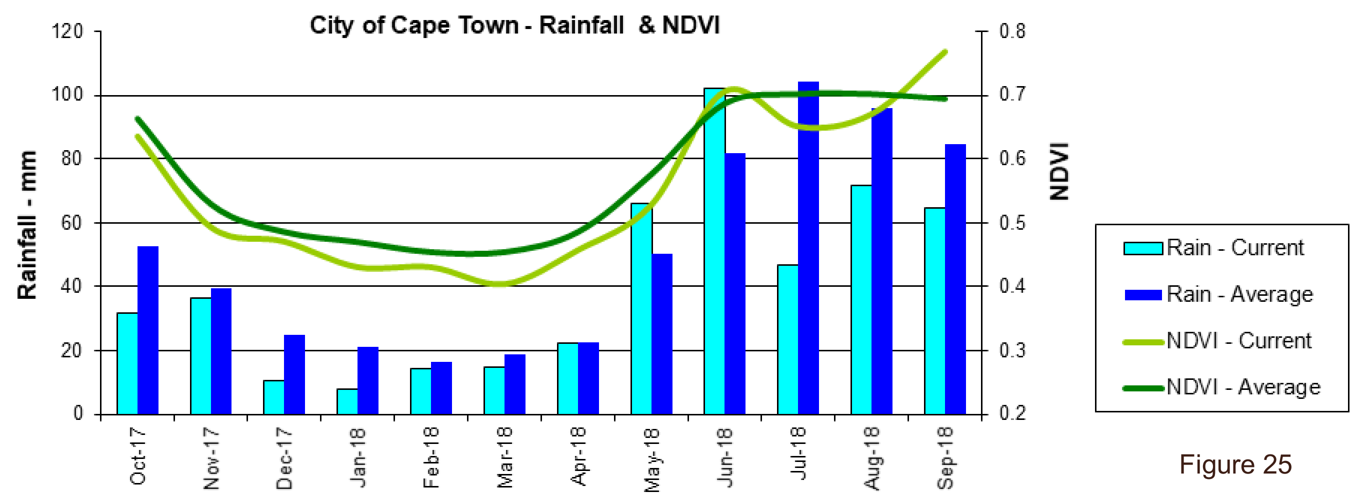

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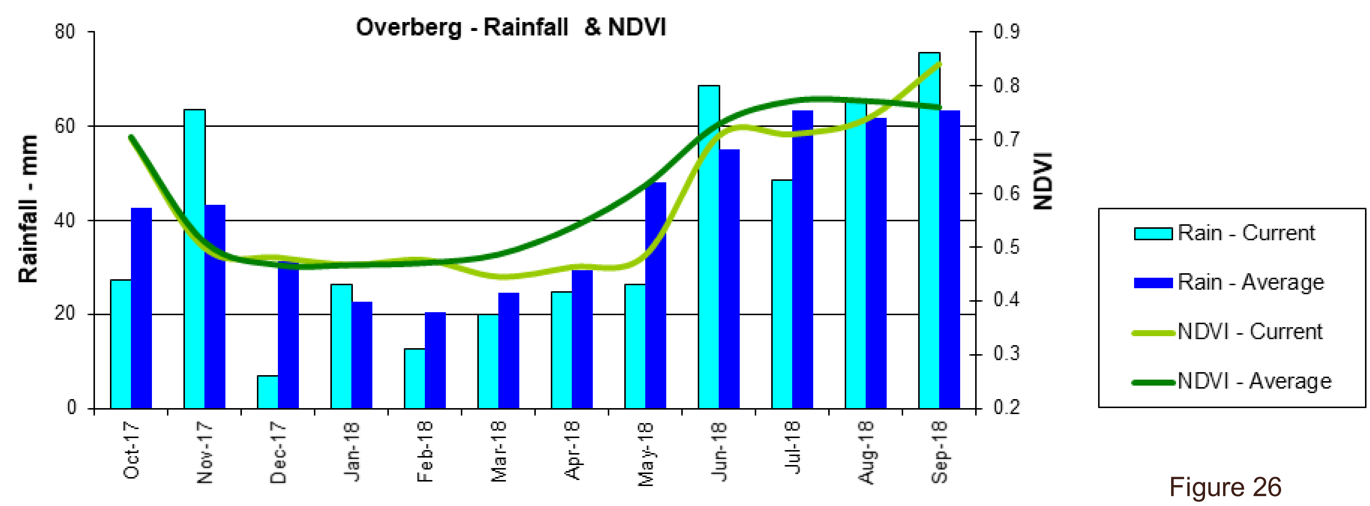

Figure 26

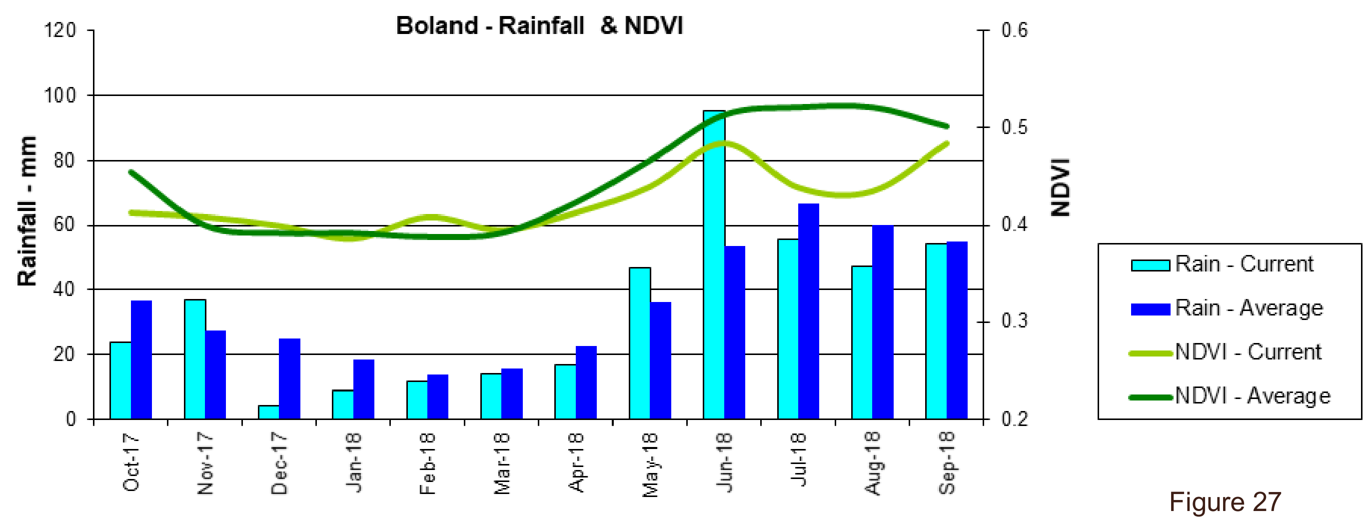

Figure 27

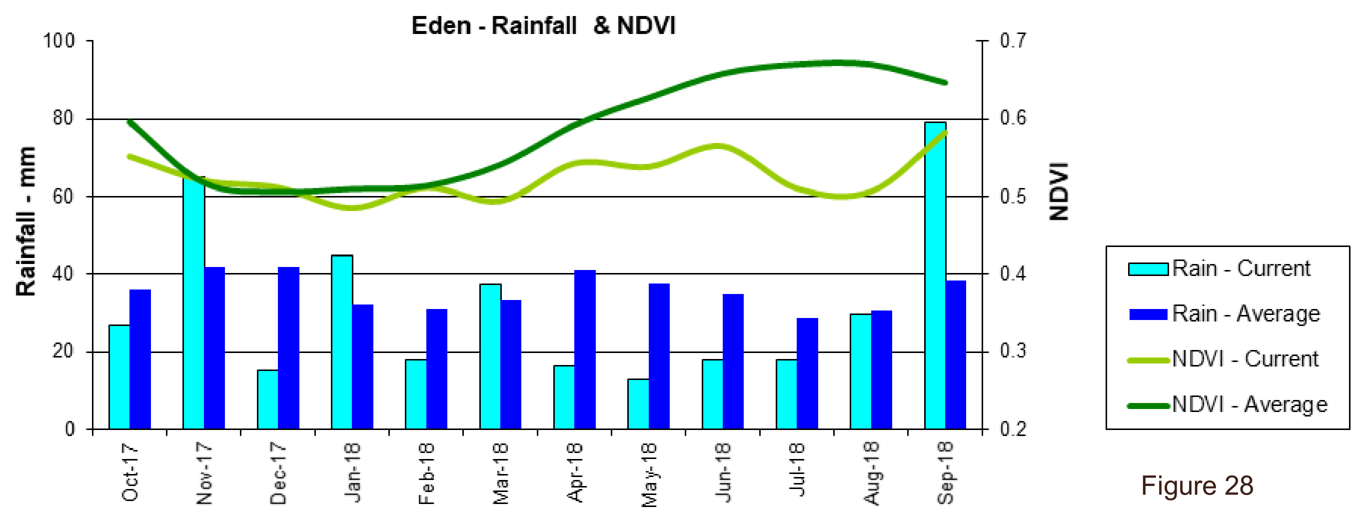

Figure 28

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 September 2018 and the 3-year long-term maximum water extents shows that the majority of catchments across the country are currently between 40-60% of the long-term maximum water area. Notably lower exceptions are catchments in the Karoo, Kalahari, central Lesotho, northern Limpopo and central parts of the Kruger National Park. However, western parts of the Western Cape show significant increases in water extent compared to longer-term conditions. Furthermore, the comparison between September 2018 and 2017 shows that generally the interior catchments are typically showing greater water extents this year than last year. Coastal-fronting catchments and those in North West and Limpopo are generally showing a reduced water extent compared to 2017 conditions.

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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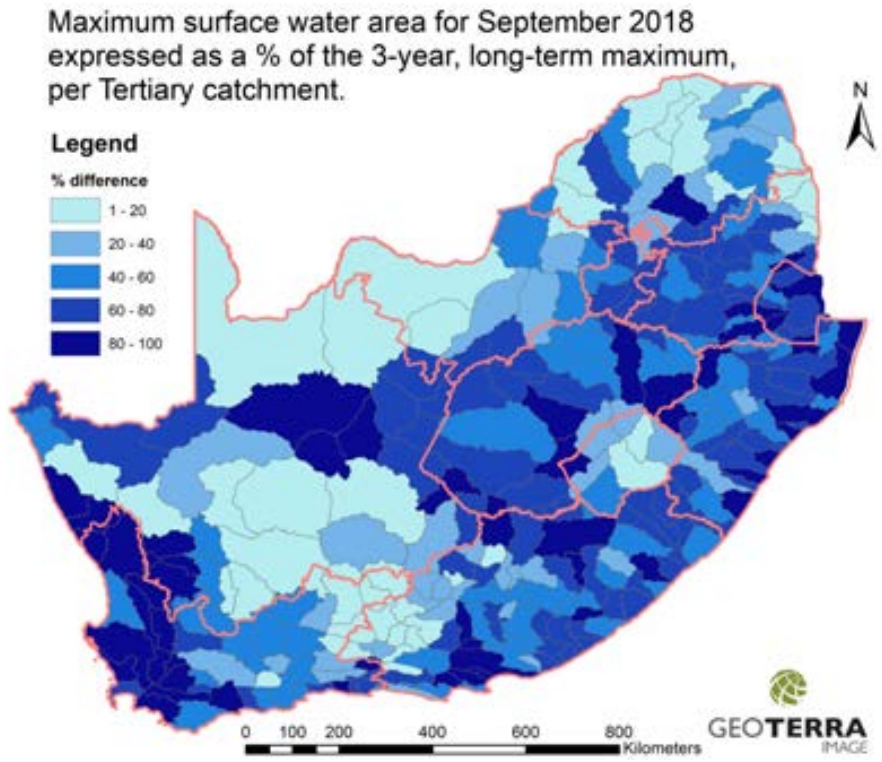


Figure 29

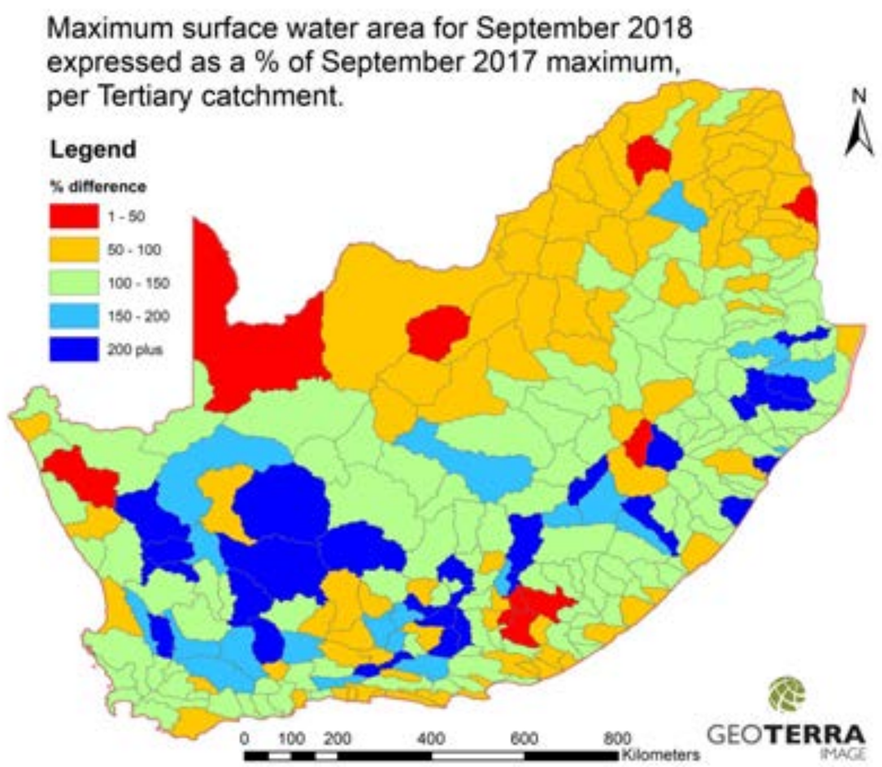
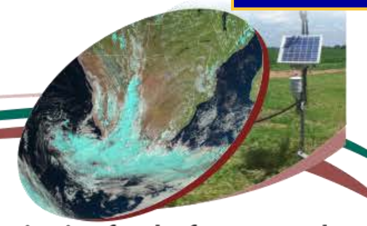


Figure 30

GEOTERRA IMAGE ARC • LNR

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

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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".