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The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

CONTENTS:

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Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

South African Weather Service

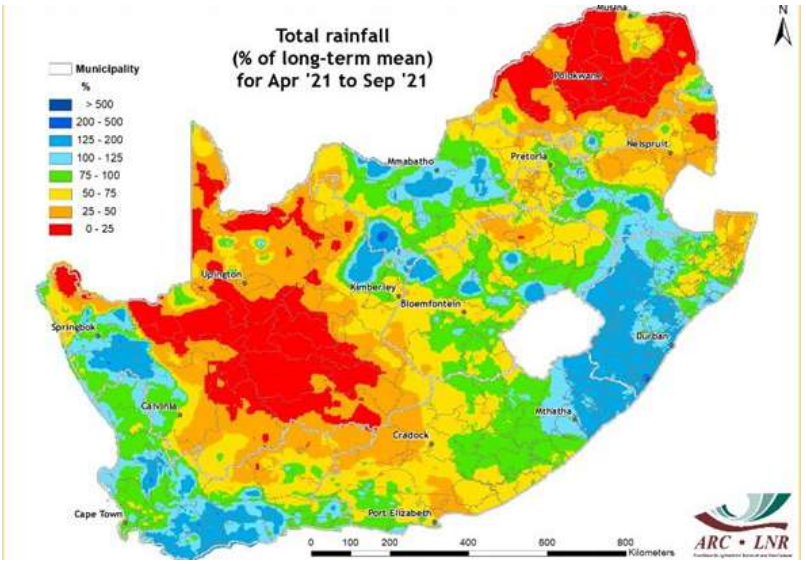
AMESD

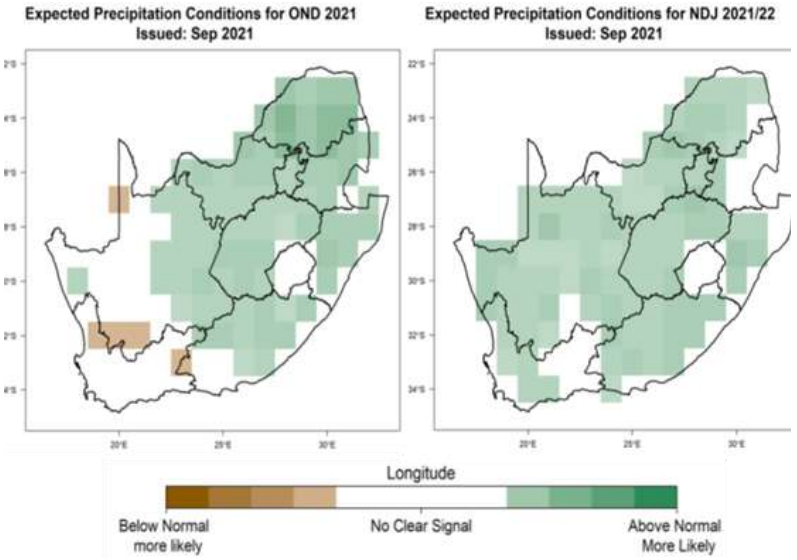
208th Edition

Images of the Month

Current rainfall conditions and implications of the seasonal outlook

The total rainfall map for April to September 2021 indicates that greater parts of KwaZulu-Natal, northern Eastern Cape and isolated areas in the North West, Free State, Mpumalanga and Northern Cape provinces experienced near- to above-normal rainfall conditions. Although similar conditions were observed over the winter rainfall region, in the summer rainfall region this implies a positive onset to its rainy season. Areas of concern, which received below-normal rainfall during this 6-month period, include Limpopo and the Lowveld of Mpumalanga. However, according to the latest seasonal forecast (September) issued by the South African Weather Service (see bottom figure), these areas can be expected to experience improved rainfall activity in late spring. Furthermore, the forecast generally predicts enhanced probabilities of above-normal rainfall in the summer rainfall region during the 2021/22 summer season. The agricultural sector should be prepared for a season characterized by good rainfall, localized flooding, possible livestock mortality, damage to infrastructure and the risk of poor rainfall distribution resulting in both wet and dry spells. Therefore, farmers are recommended to plant within the normal planting window and adjust the planting date following the onset of rains. To minimize the risk of potential drought effects during the season, farmers are encouraged to practise rainwater harvesting and increase water infiltration by adding organic material to improve soil structure and minimize compaction of the topsoil. Since hailstorms and destructive winds may be expected, it is advisable to practise rotational grazing and keep animals in small camps with water and shade.





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, Land Reform and Rural Development.

1. Rainfall

Overview:

The cessation of the winter rainfall season was notable during September 2021, with much of the rainfall, although less in totals, occurring at the beginning and again towards the end of the month. This cessation of rains occurred rather early when considering the same month in the previous 5 years.

With the start of spring, convective activity occurred on a few occasions over certain parts of the summer rainfall region, thus presenting a good start to the season. Above-normal rainfall conditions were observed over parts of the Highveld, the Midlands and the eastern coastal belt of KwaZulu-Natal and the Eastern Cape. Areas such as Mtunzini, Port Edward, Port St. Johns and Coffee Bay recorded between 150 and 200 mm of rain for the month. Some of these areas, together with parts of the Free State and Mpumalanga, experienced considerably higher cumulative rainfall since July when compared to the same period last year, implying positive prospects for the upcoming season. It was further noted that greater parts of Limpopo and the Lowveld of Mpumalanga, which are situated in the mid-summer rainfall region, remained dry during September. However, these conditions can be expected to improve during the subsequent months.

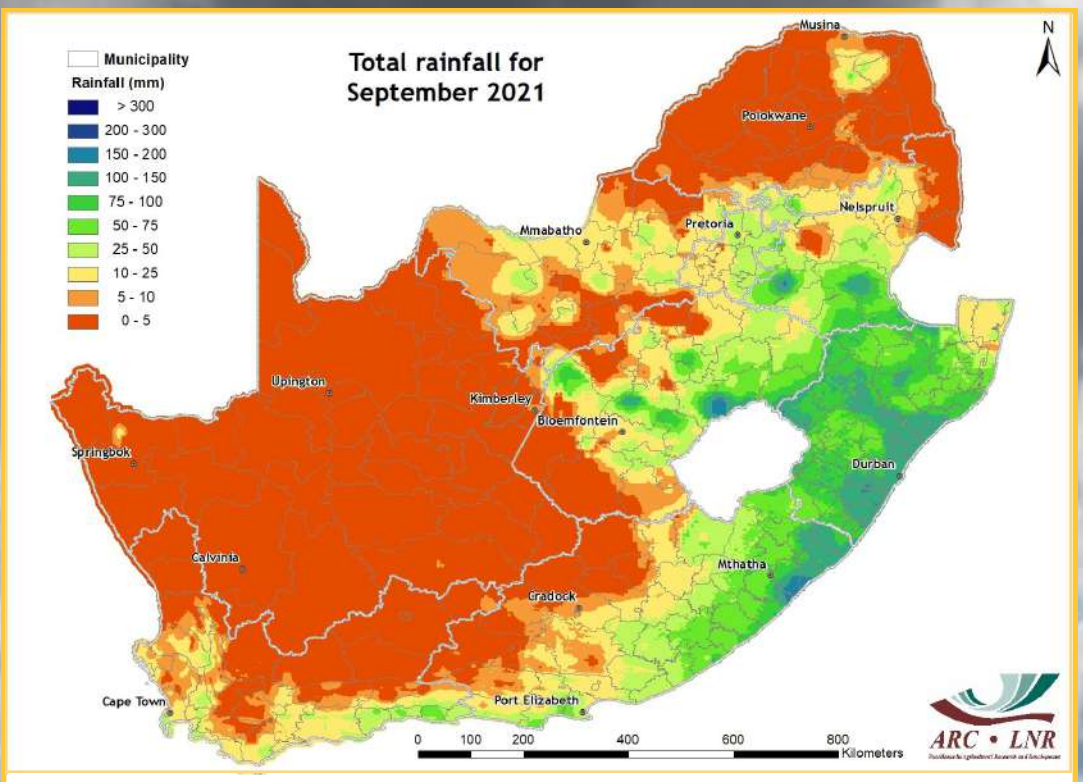


Figure 1

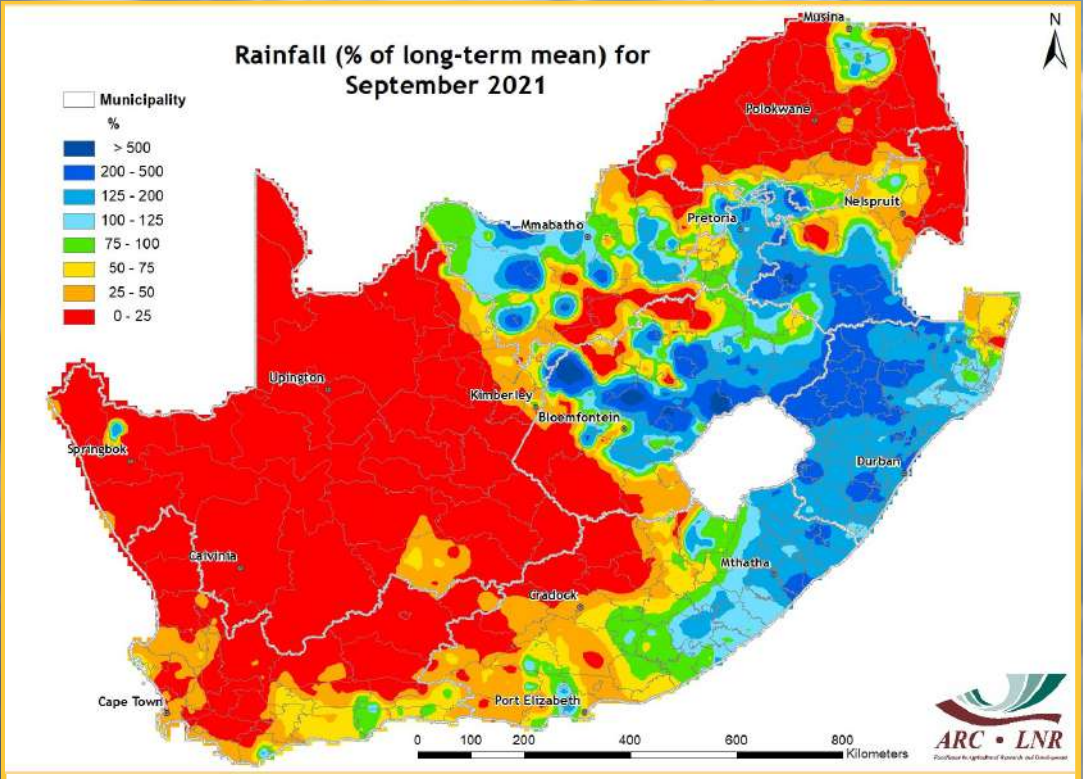


Figure 2

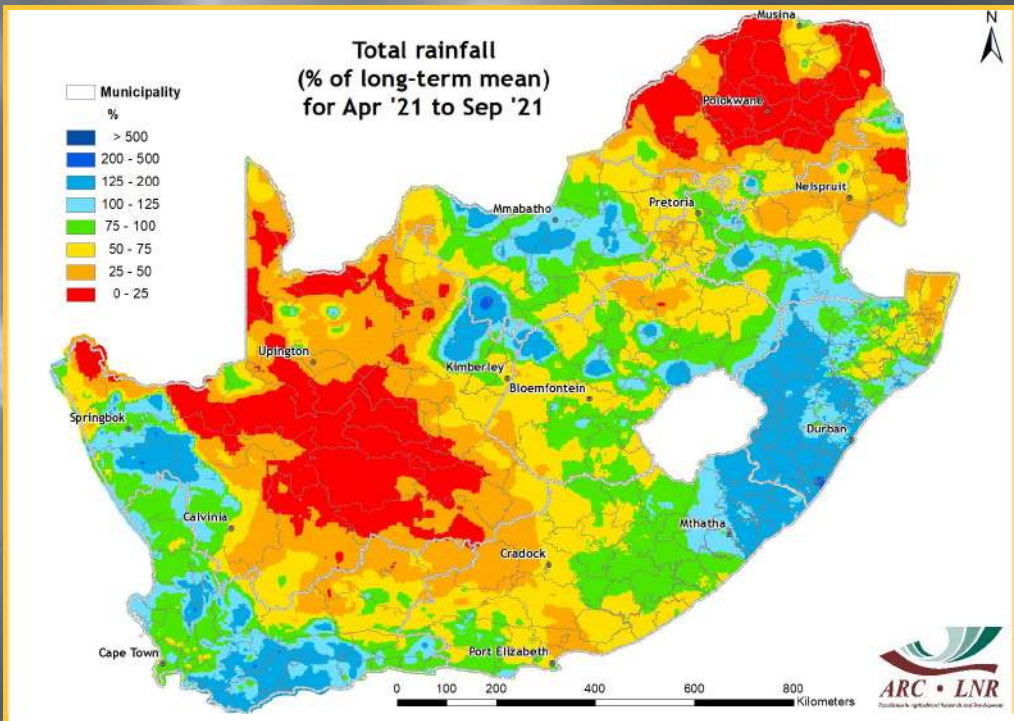


Figure 3

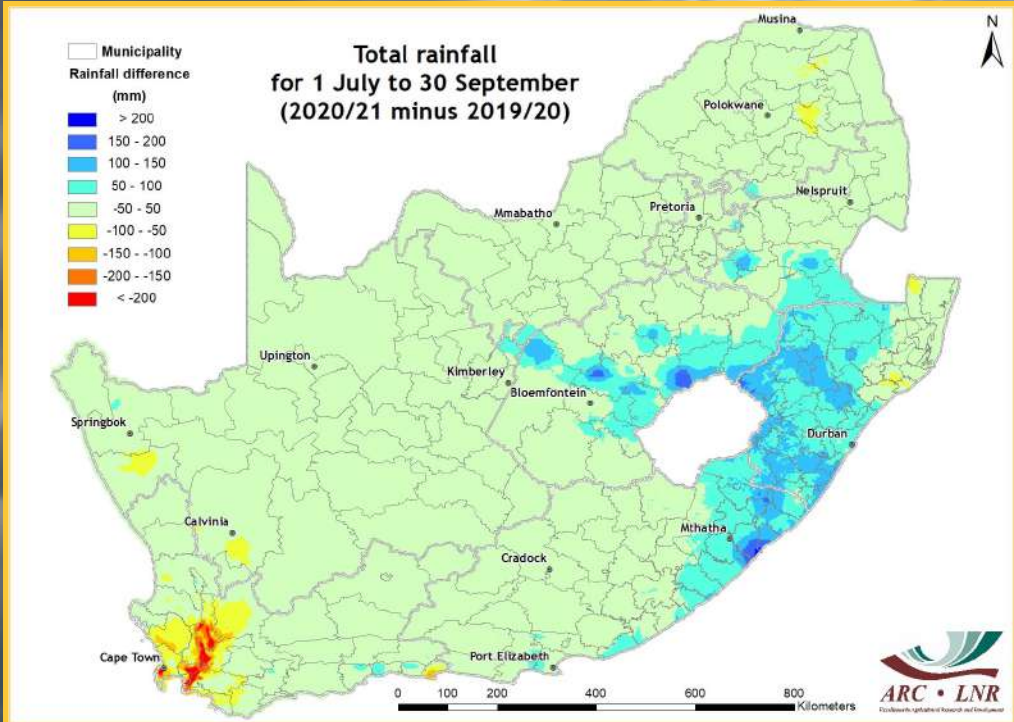


Figure 4

Figure 1:
Rainfall was largely confined to the eastern summer rainfall region during September 2021, with high totals recorded along the eastern coastal belt. Parts of the all-year and winter rainfall regions received rainfall totals of up to 75 mm, while the rest of the country experienced dry conditions.

Figure 2:
Above-normal rainfall conditions occurred over the eastern interior, moving southeast towards the Midlands and coastal regions of KwaZulu-Natal and the Eastern Cape. Below-normal rainfall was observed over greater parts of the country, including Limpopo, Northern Cape, Western Cape, western regions of the Eastern Cape, and isolated areas of North West, Gauteng and Mpumalanga.

Figure 3:
Cumulative rainfall since April 2021 as compared to the long-term mean for the same 6-month period indicates that the winter rainfall region, greater parts of KZN, northern Eastern Cape and isolated areas in North West, Free State, Mpumalanga and Northern Cape experienced near- to above-normal rainfall conditions.

Figure 4:
Generally, the country observed similar rainfall totals during the months of July, August and September 2021 as compared to the same period last year. The only areas which showed an improvement of rains were isolated parts of the Free State and Mpumalanga, as well as the adjacent Midlands and coastal regions of KZN and the Eastern Cape. Meanwhile, areas in and around the Cape Winelands received less rainfall than last year.

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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.

The SPI maps revealing short-term (6-month SPI), medium-term (12-month SPI) and long-term (24-month and 36-month SPI) drought conditions are shown in Figures 5-8. The short-term map ending in September indicates widespread near-normal conditions (given by mildly wet and mild drought classifications) over the country, except for the Karoo and adjacent parts of the Eastern Cape where moderate to extreme drought conditions are depicted. In addition, moderate to extreme drought conditions are visible over Limpopo, parts of Mpumalanga and Gauteng. In contrast, moderate-extremely wet conditions were experienced in parts of the Western Cape as well as KZN and adjacent Eastern Cape. This can be attributed to the above-normal rainfall since April. The medium to long-term maps show somewhat similar conditions as compared to the SPI of the previous month. It was observed that wet conditions characterized the northern interior, Lowveld of Limpopo and Mpumalanga as well as isolated areas of the Western Cape and KZN. However, severe to extreme drought conditions dominate the western regions of the country, extending towards the Eastern Cape, KZN, eastern Free State and the interior of Limpopo and Mpumalanga at the longer time scales (24-36 months).

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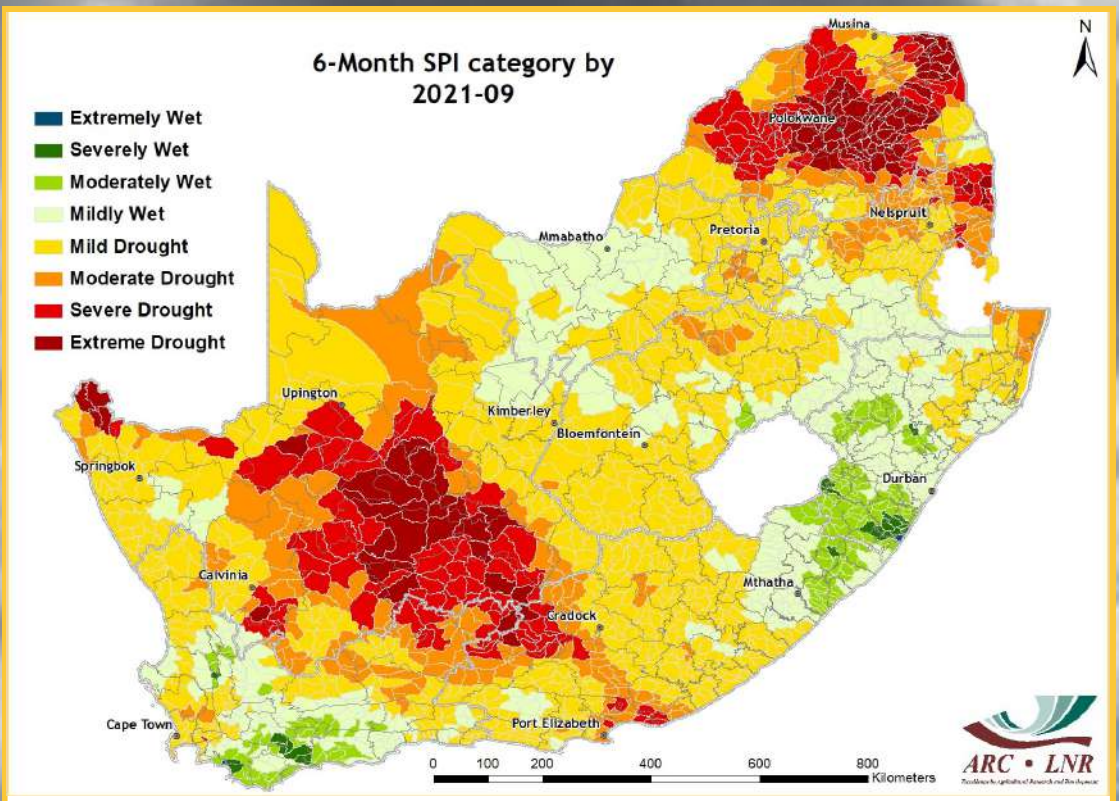

Figure 5

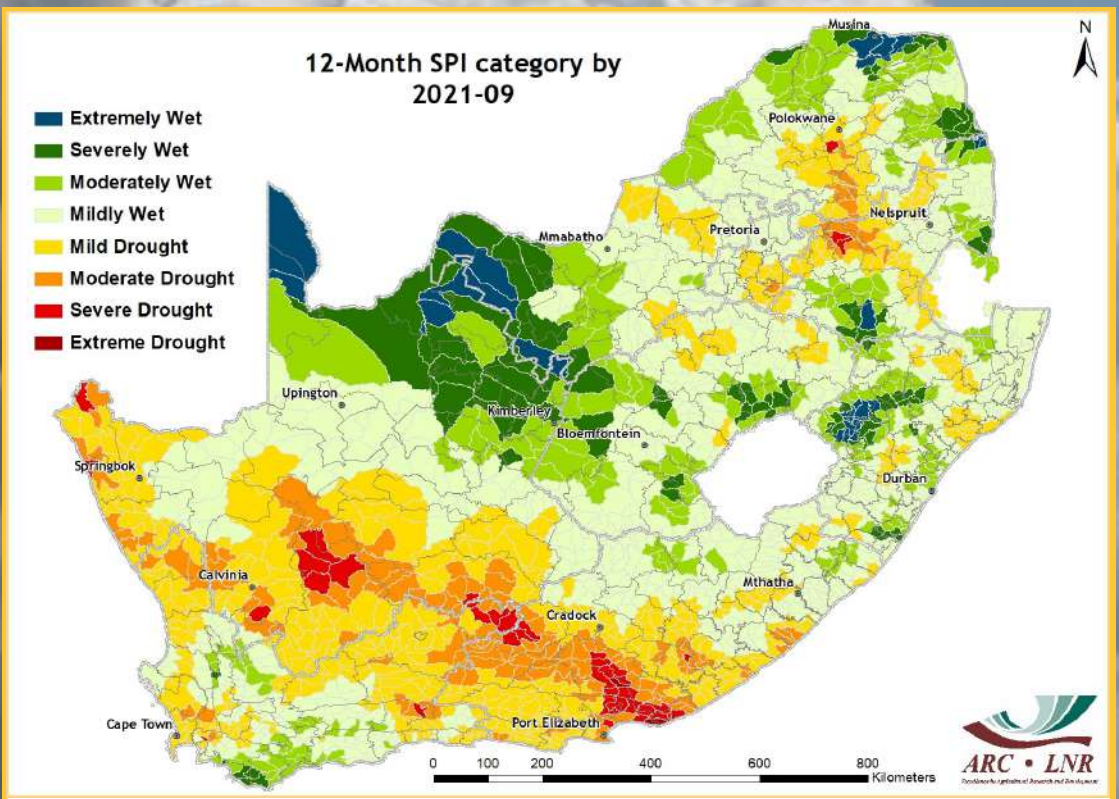

Figure 6

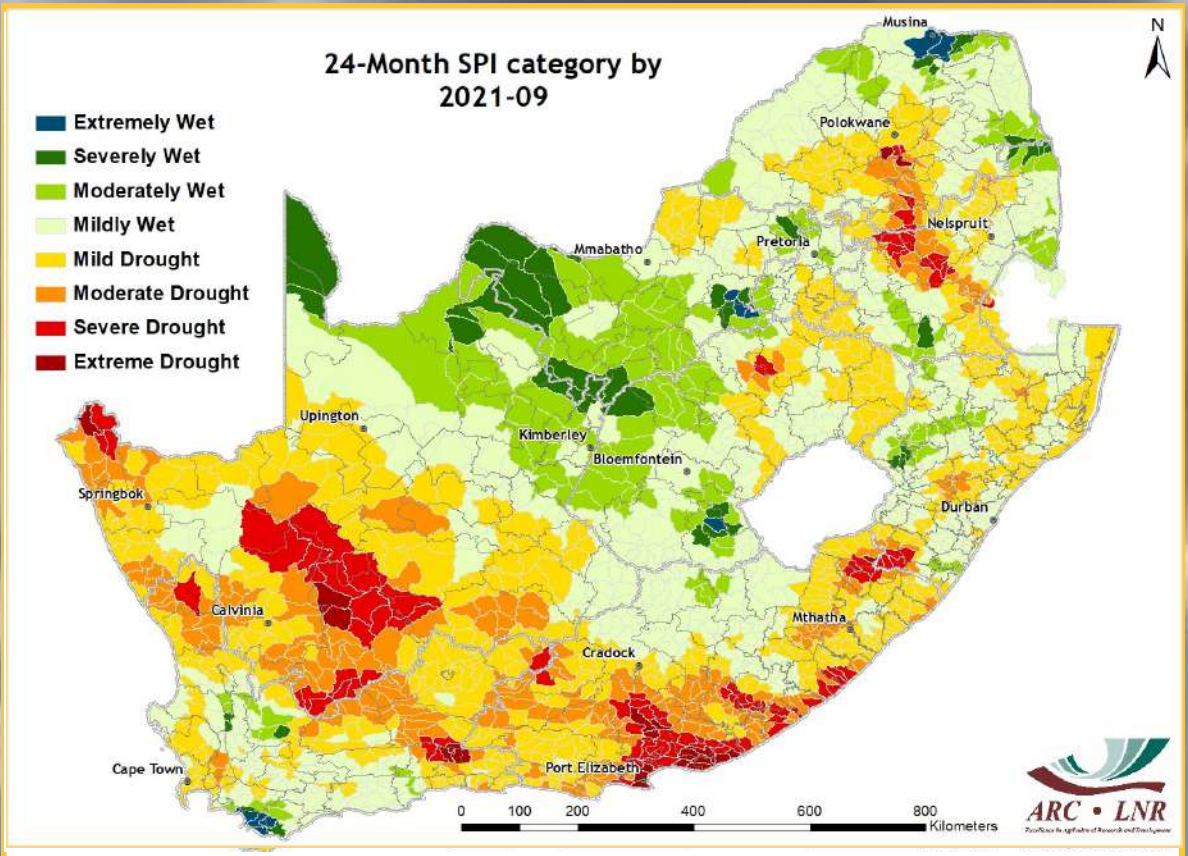

Figure 7

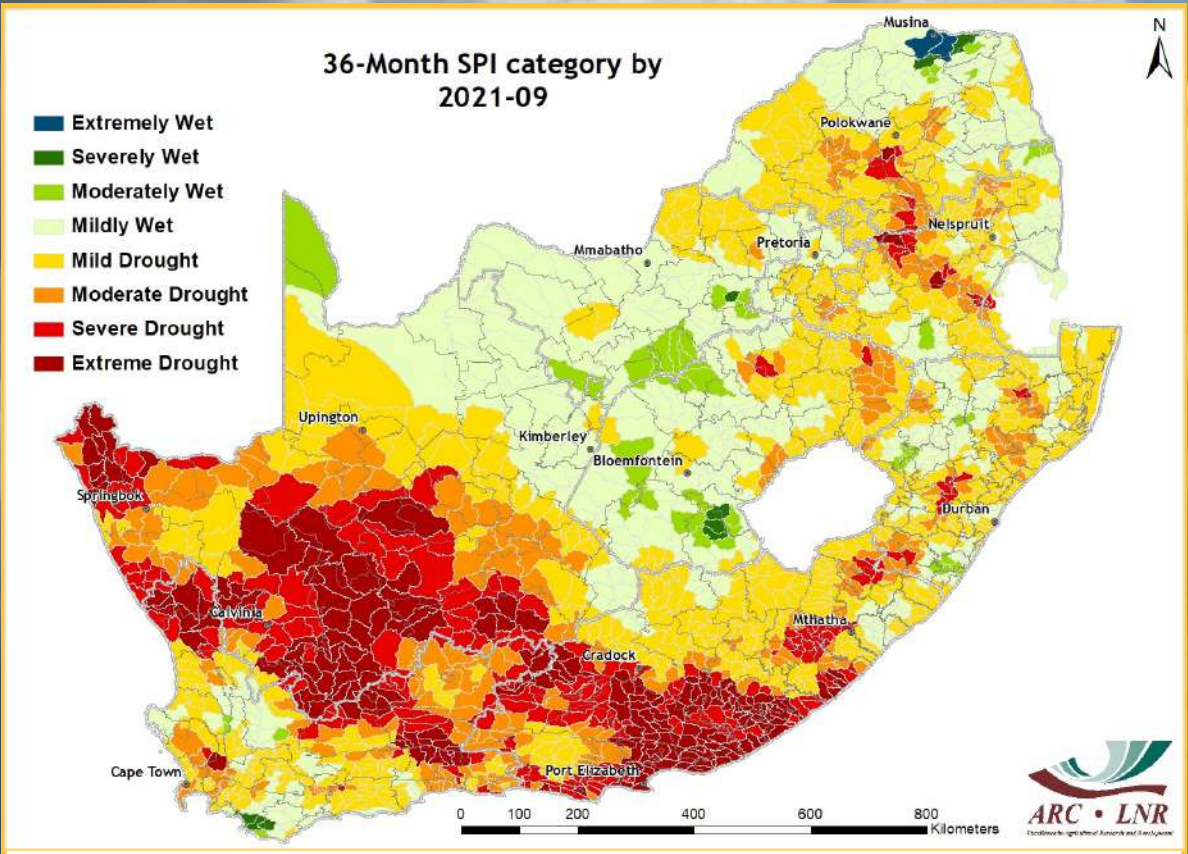

Figure 8

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.

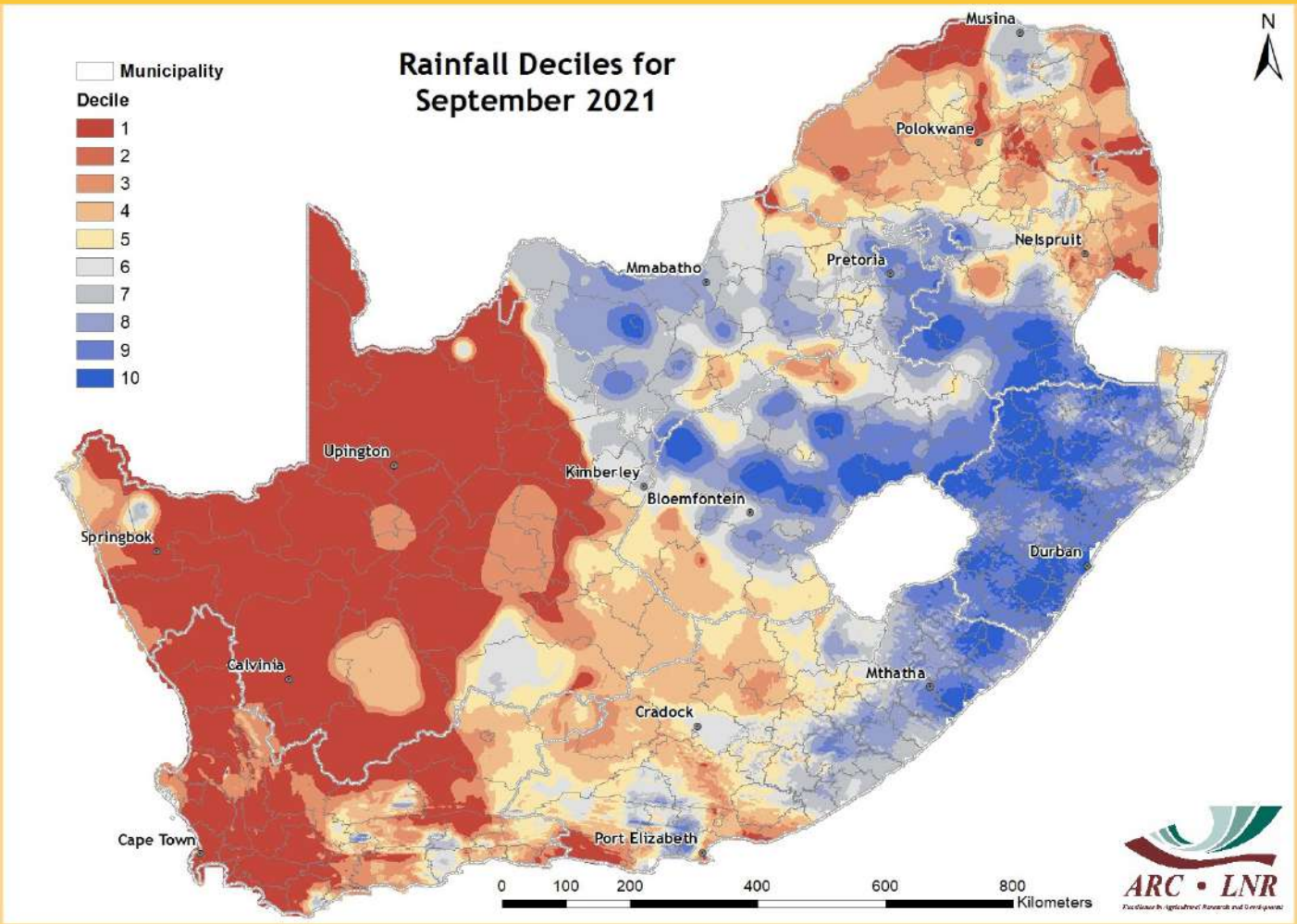

Figure 9

Figure 9:
Rainfall deciles for September 2021 indicate that the eastern interior, extending towards the Midlands and coastal regions of Kwa-Zulu-Natal and the Eastern Cape, as well as isolated parts of the Northern Cape, Western Cape and Limpopo, received rainfall totals that fall within the historically wetter September months. The rest of the country fell within the historically drier September months.

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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.

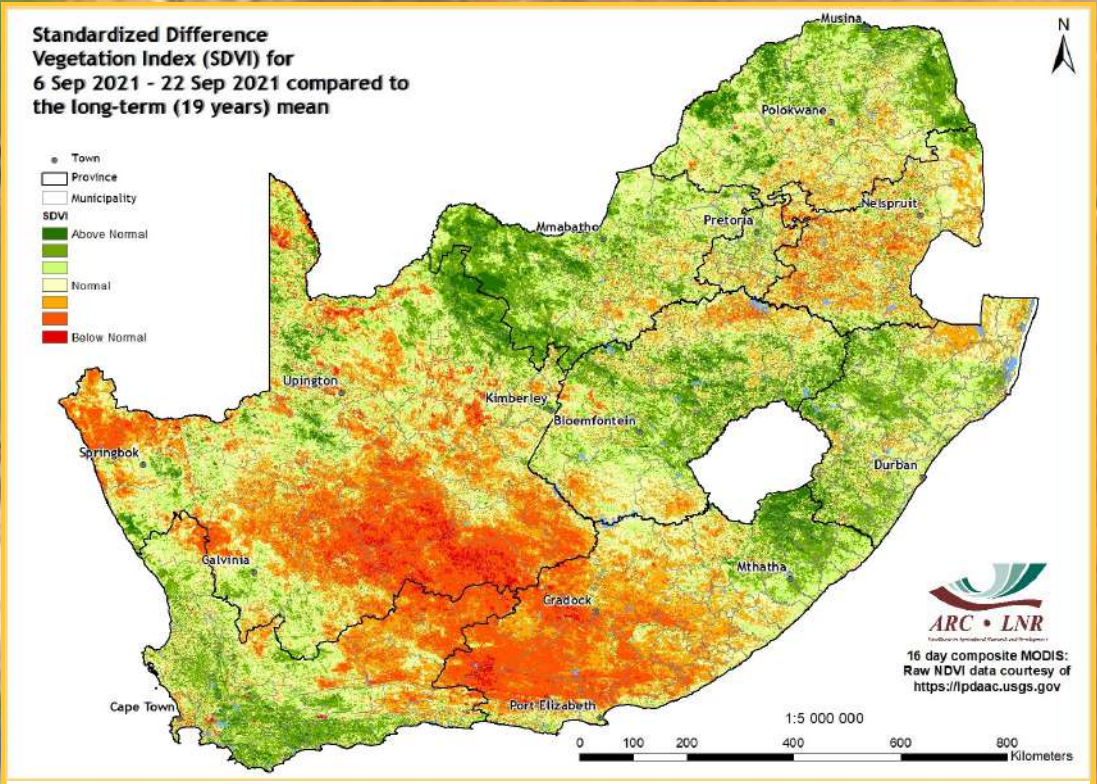

Figure 10

Figure 10:
Compared to the historical averaged vegetation conditions, the 16-day SDVI map for September 2021 shows that the western parts of the country experienced below-normal vegetation activity while the eastern and northern parts experienced above-normal vegetation activity.

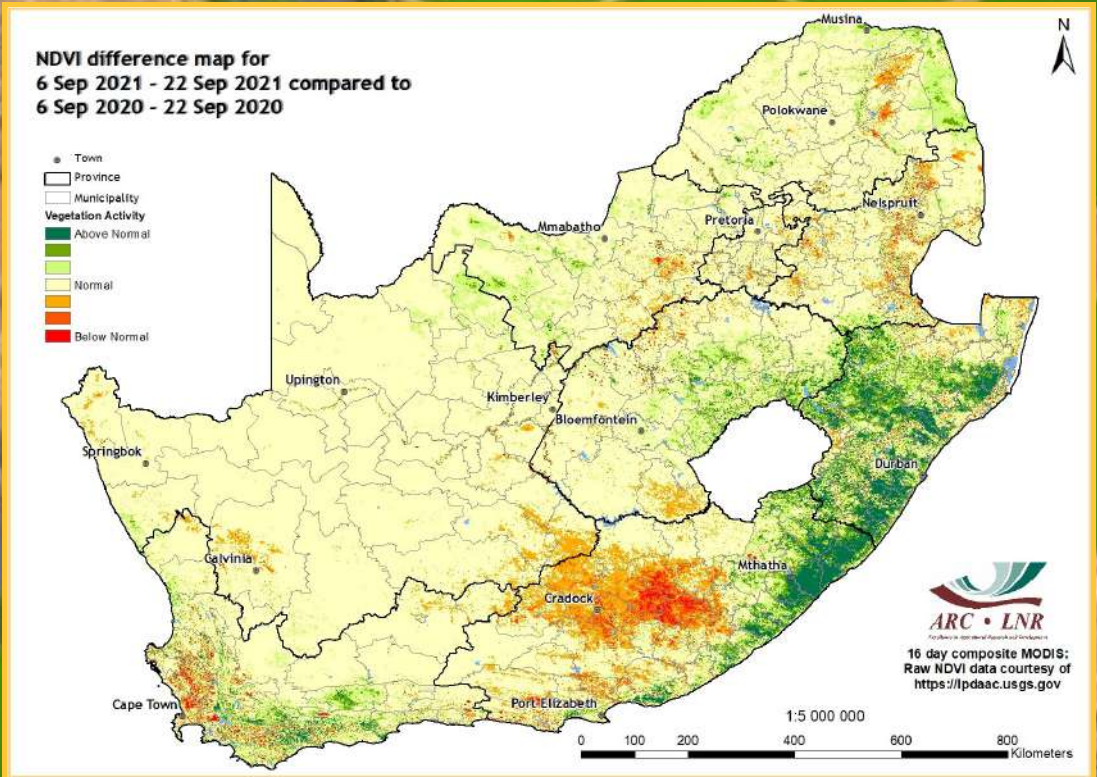

Figure 11

Figure 11:
When comparing the 16-day NDVI difference map for September 2021 to the same month last year, it can be observed that large parts of KwaZulu-Natal experienced above-normal vegetation conditions while the Eastern Cape experienced a mixture of above- and below-normal conditions. The rest of the country experienced normal vegetation conditions.

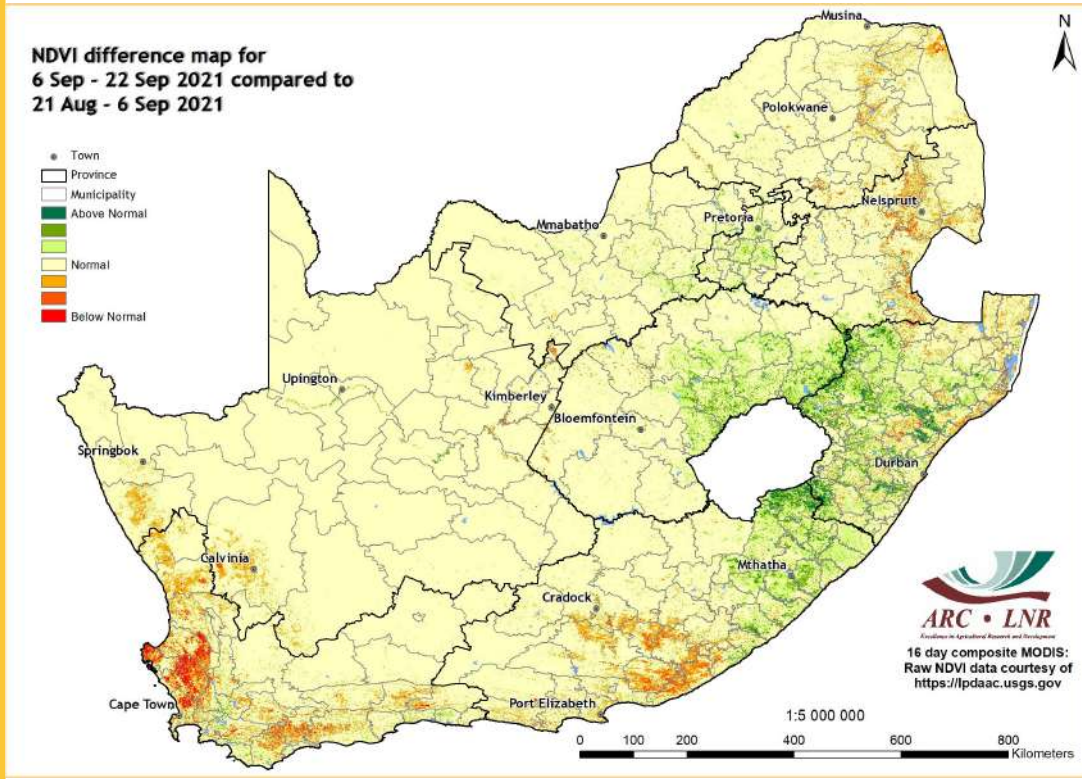

Figure 12

Vegetation Mapping
(continued from p. 7)

Interpretation of map legend

NDVI-based 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:
Compared to the previous month, the 16-day NDVI difference map for September shows that the country experienced normal vegetation conditions with pockets of below-normal conditions in the Western Cape and pockets of above-normal conditions in KZN, Eastern Cape, Free State and Gauteng.

Figure 13:
[Percentage of Average Seasonal Greenness (PASG) map currently not available.]

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Figure 13

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.

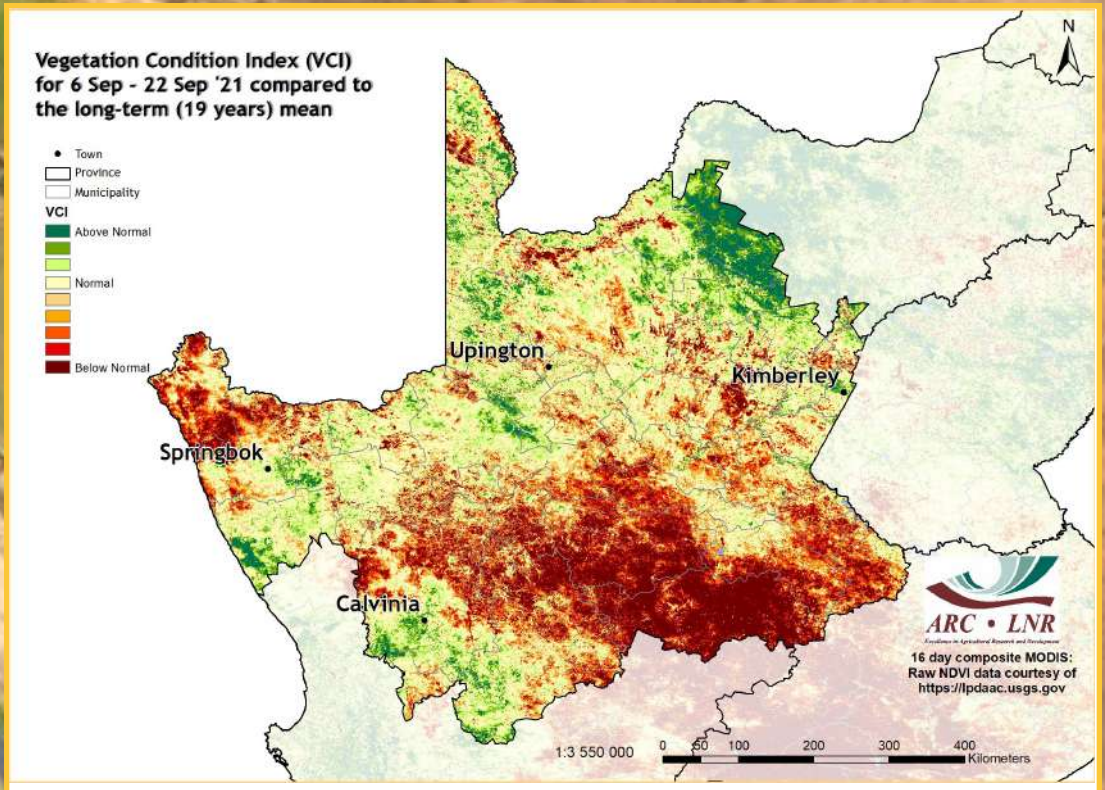

Figure 14

Figure 14:
The 16-day VCI map for September indicates that the Northern Cape continues to experience pockets of improved vegetation conditions while large parts of the province are still severely affected by drought.

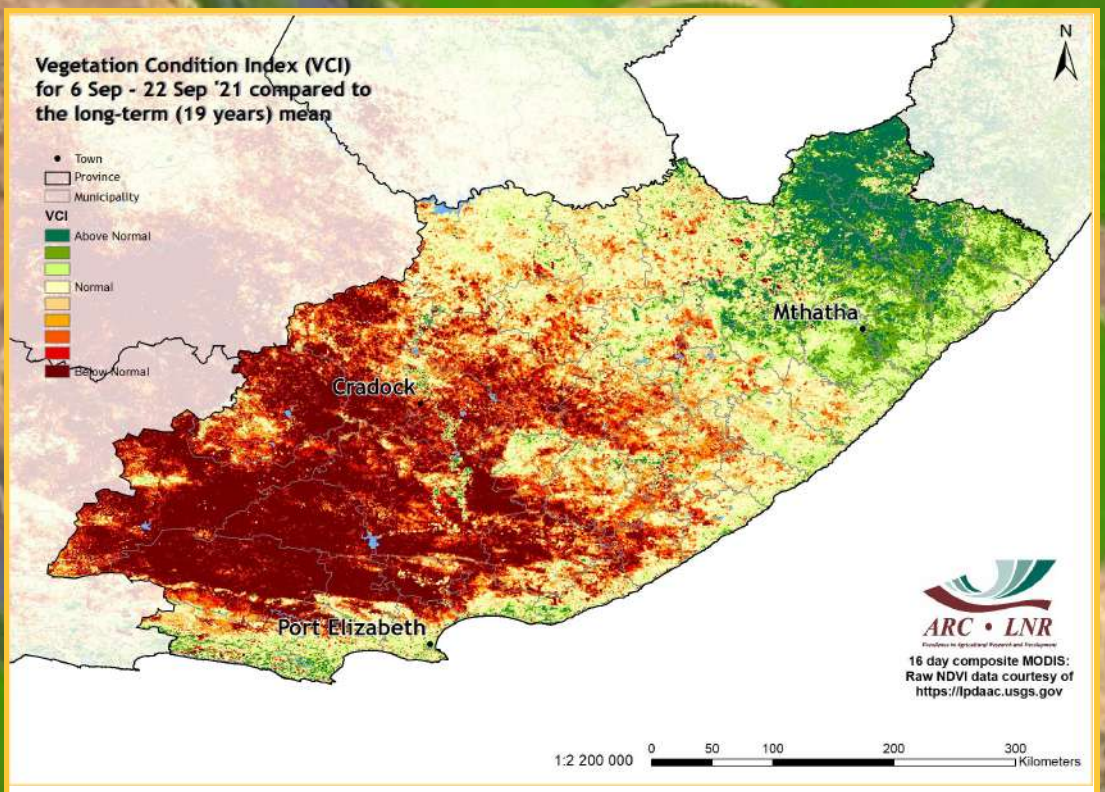

Figure 15

Figure 15:
The 16-day VCI map for September indicates that vegetation conditions in almost the entire Eastern Cape remain poor with only pockets of good vegetation conditions in the far eastern parts of the province.

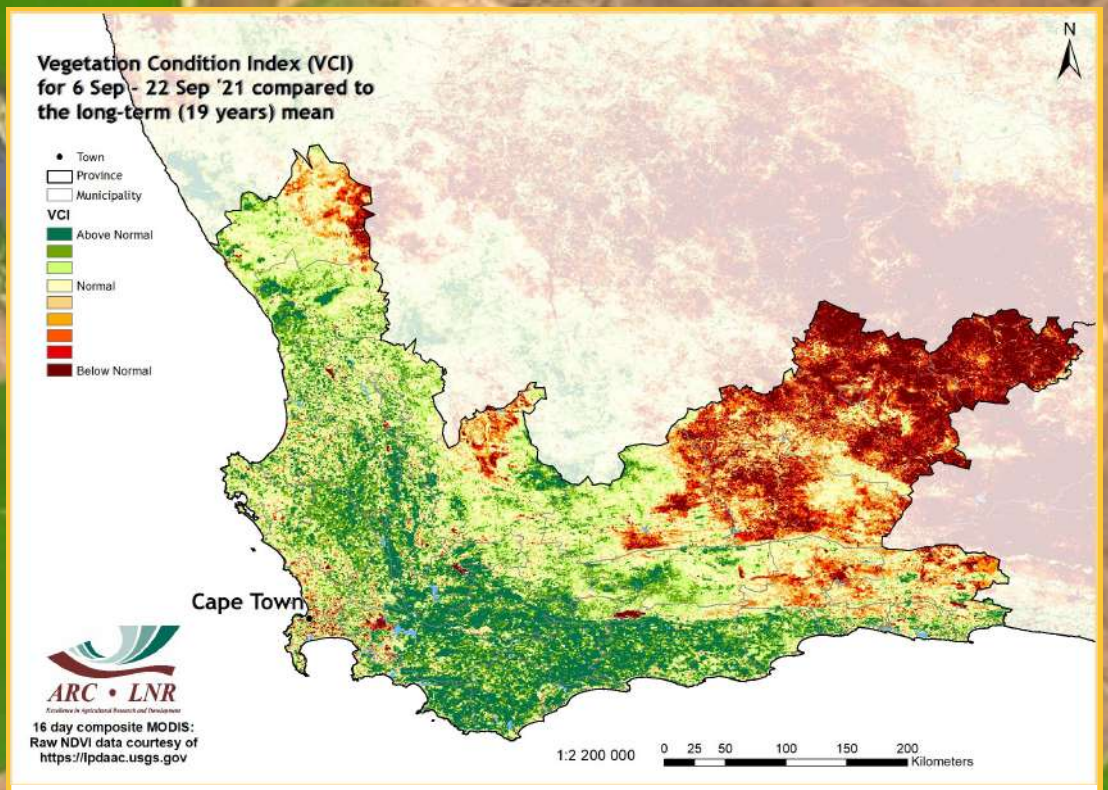

Figure 16

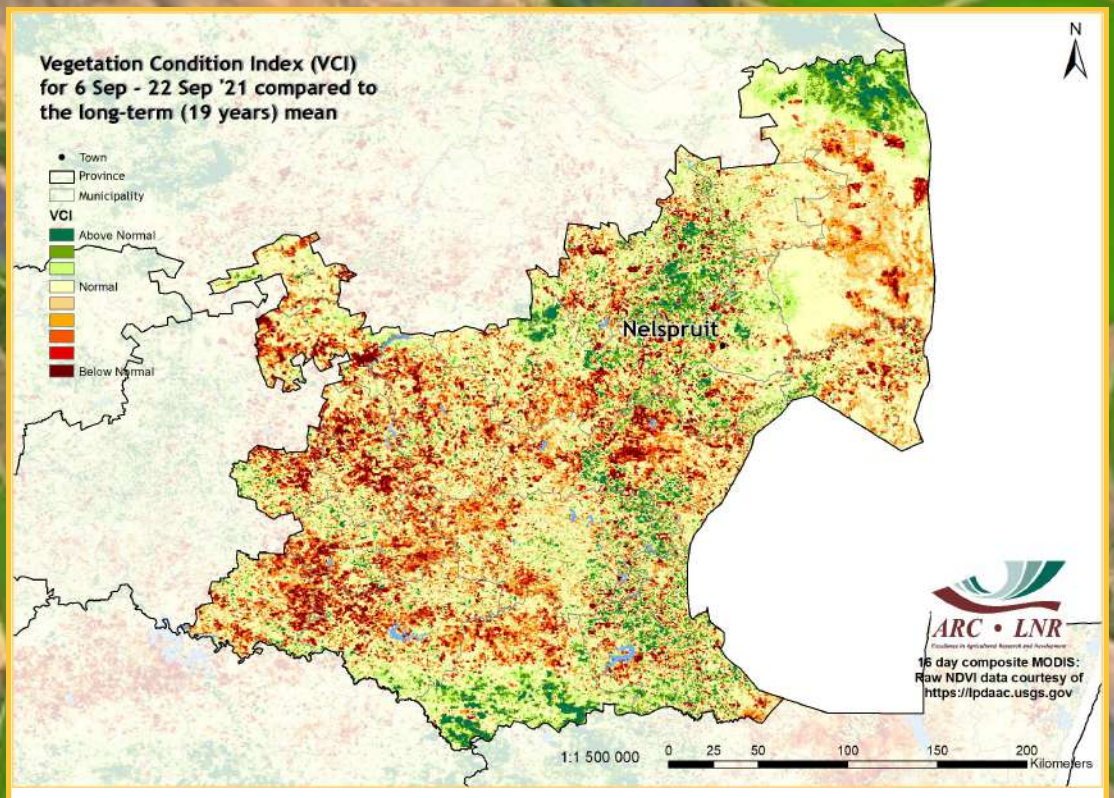

Figure 17

Figure 16:
The 16-day VCI map for September indicates poor vegetation conditions in the northeastern parts of the Western Cape with areas of good vegetation dominating in the western and southern parts of the province.

Figure 17:
The 16-day VCI map for September indicates pockets of poor vegetation conditions as well as above-normal vegetation spread across the Mpumalanga Province.

Questions/Comments:
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6. Vegetation Conditions & Rainfall

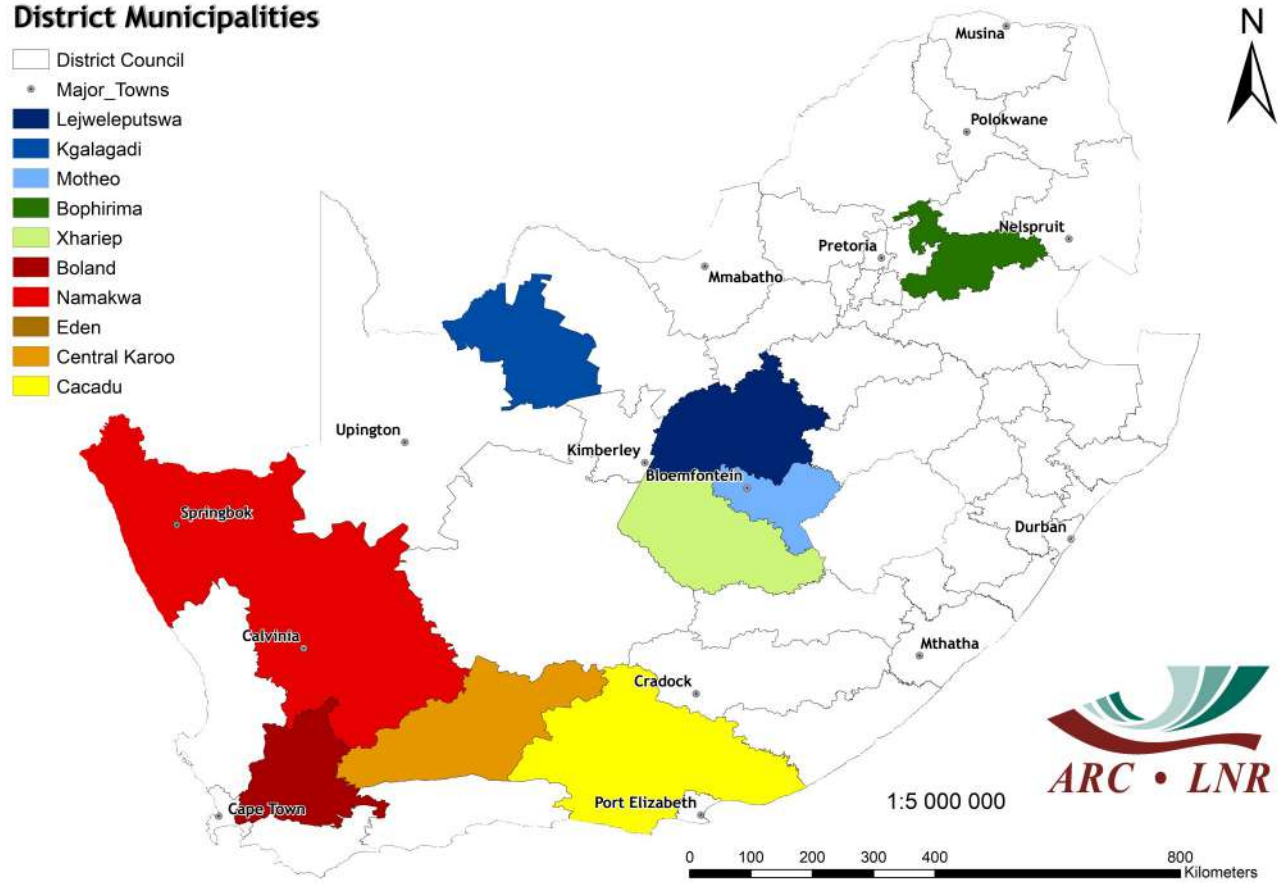

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for September 2021. The district colour matches the border of the corresponding graph.

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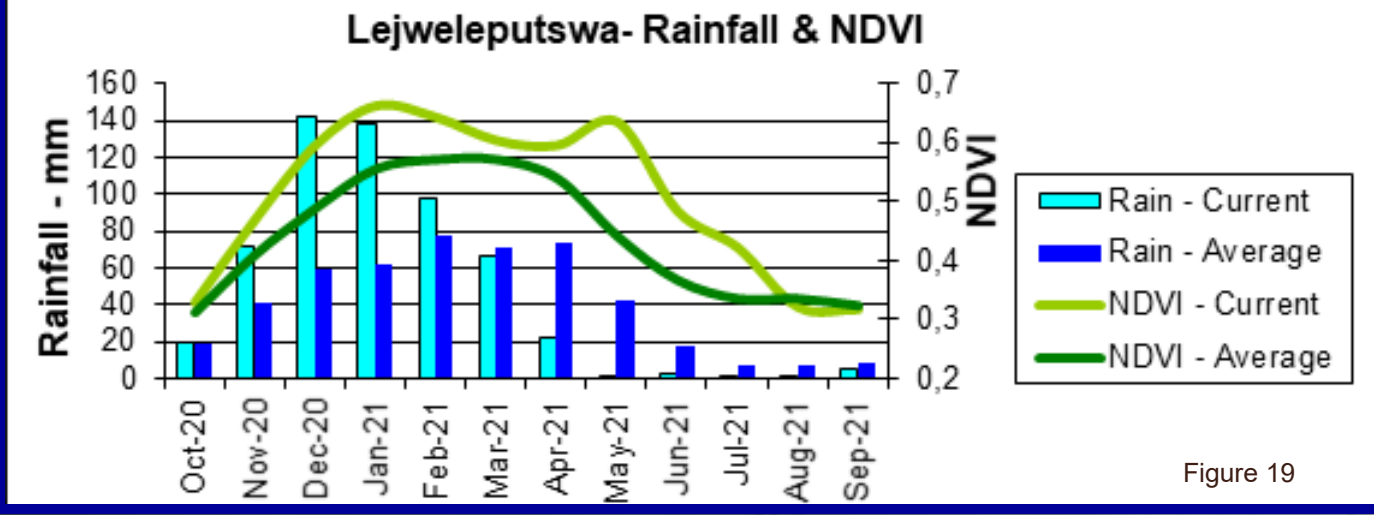
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

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



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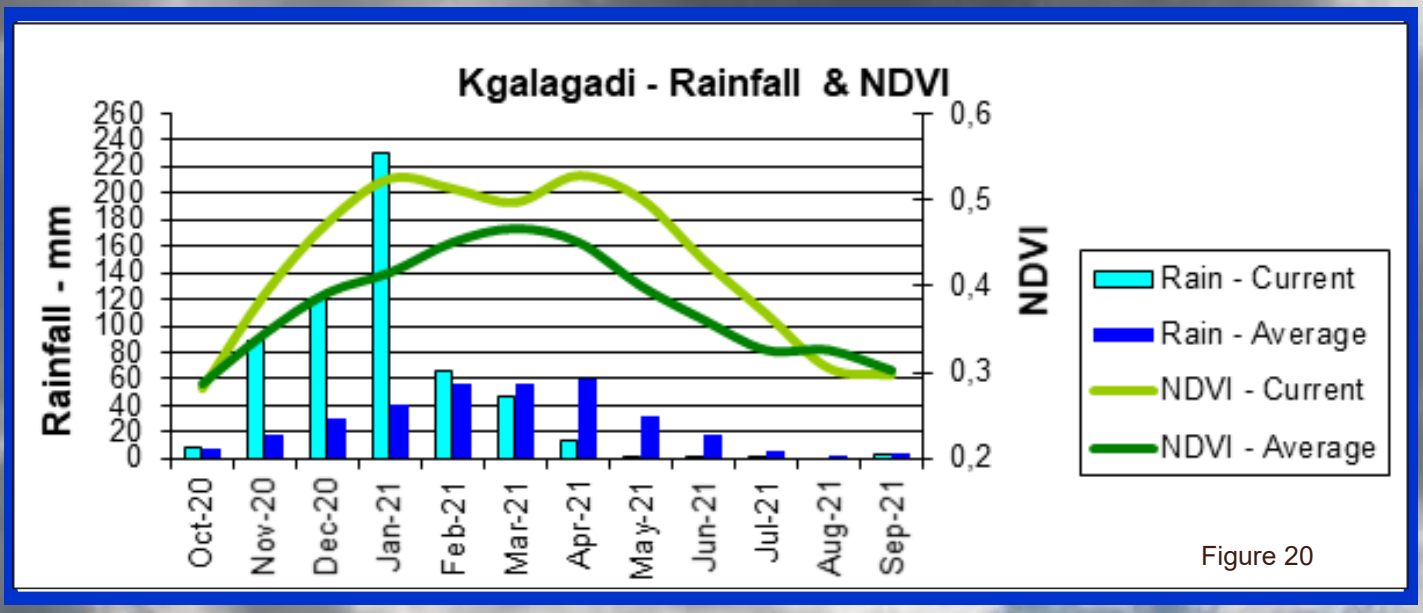

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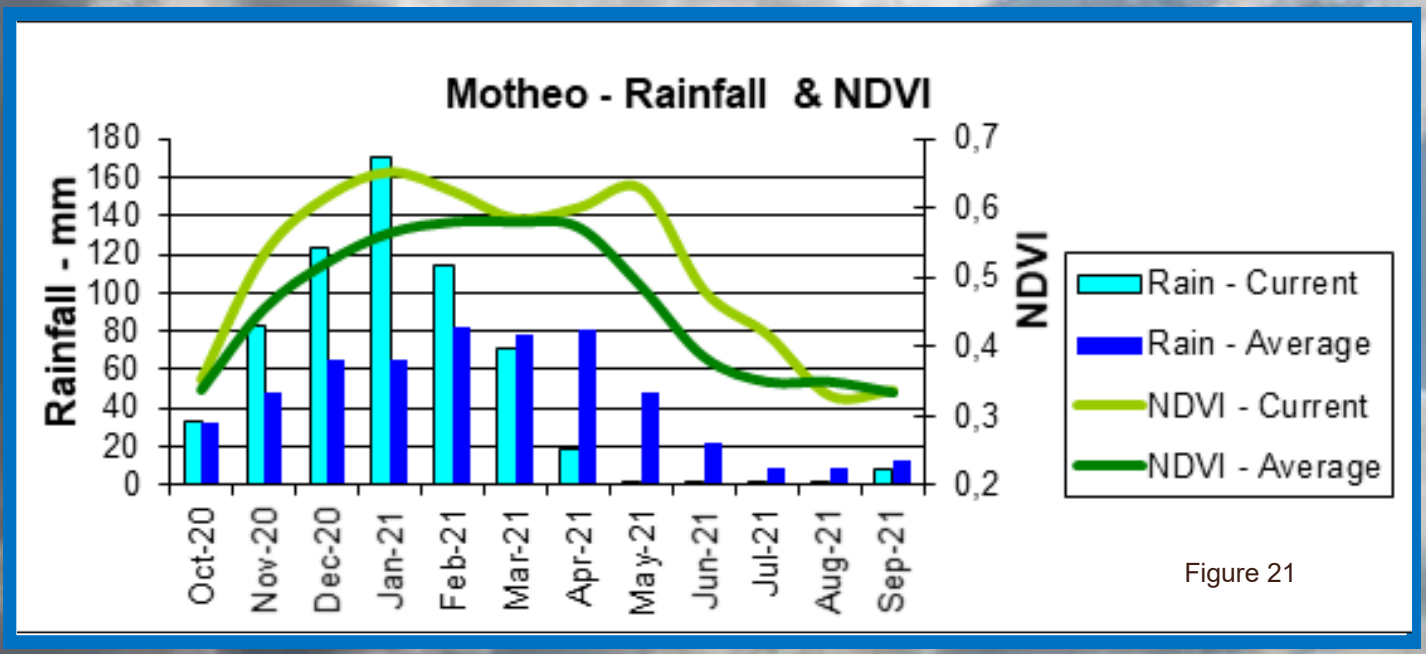

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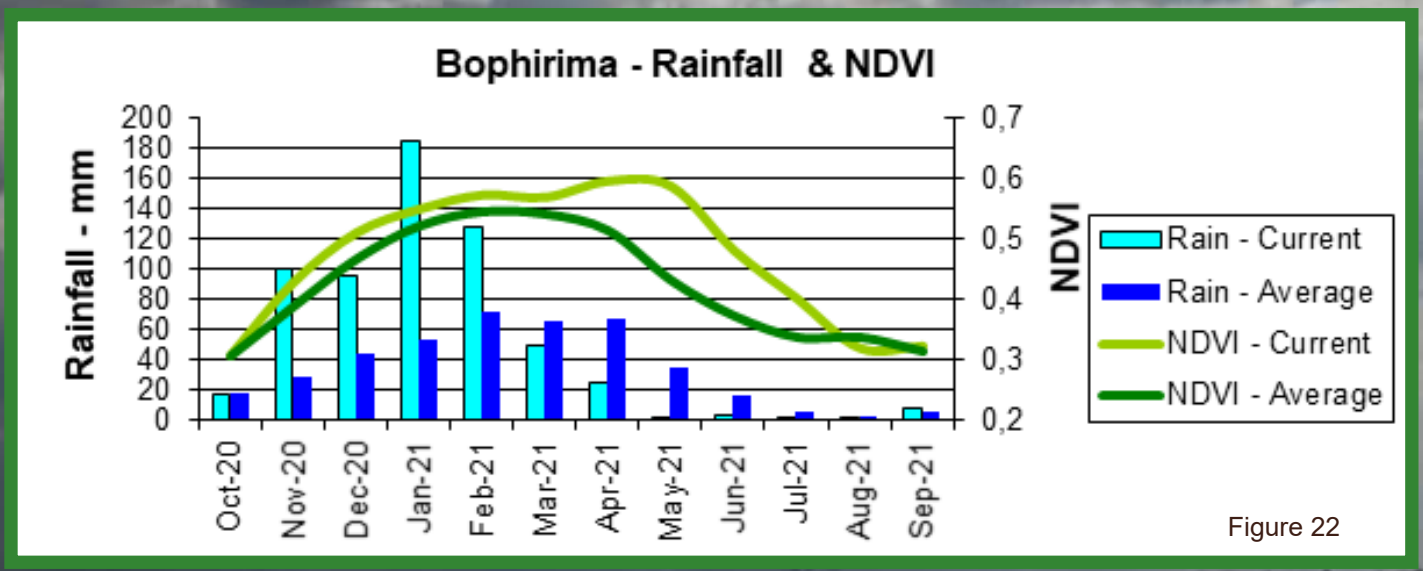
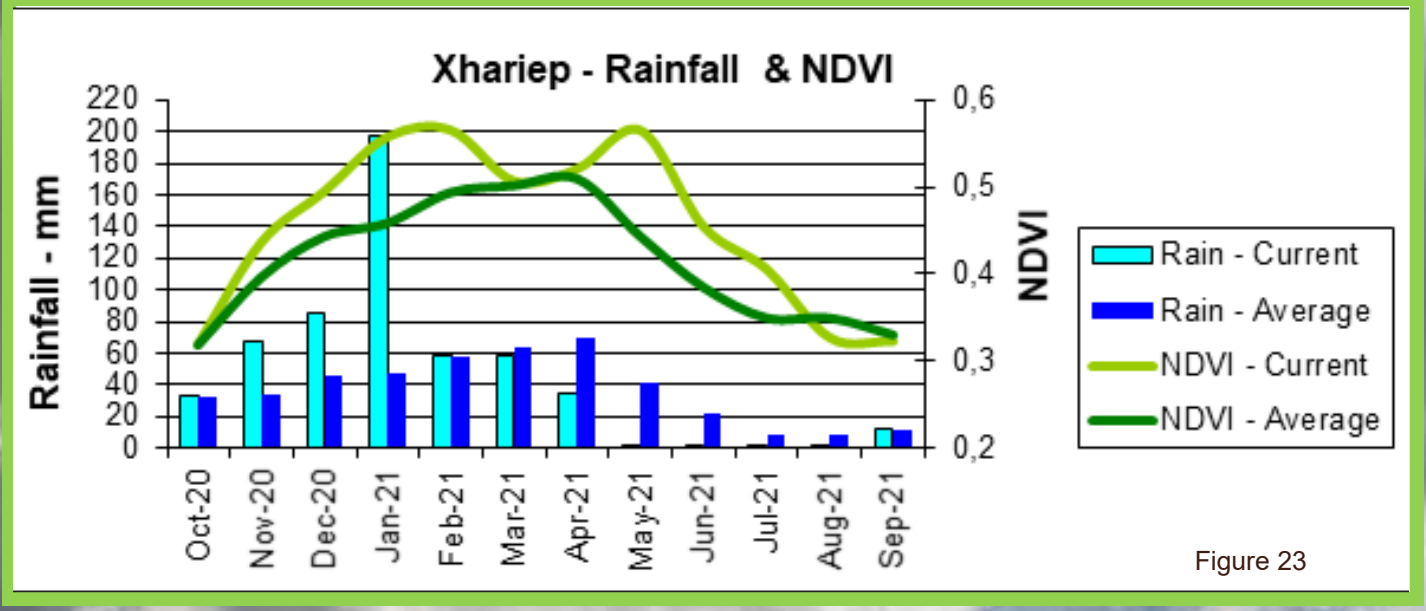


Figure 22



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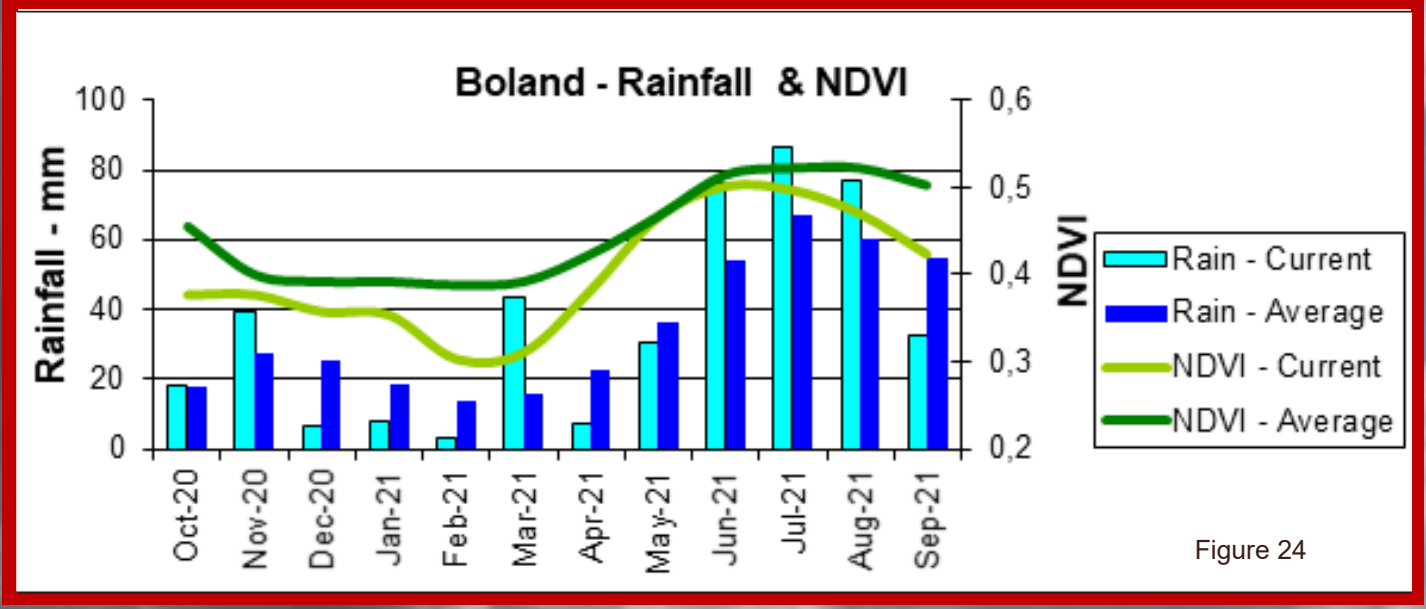

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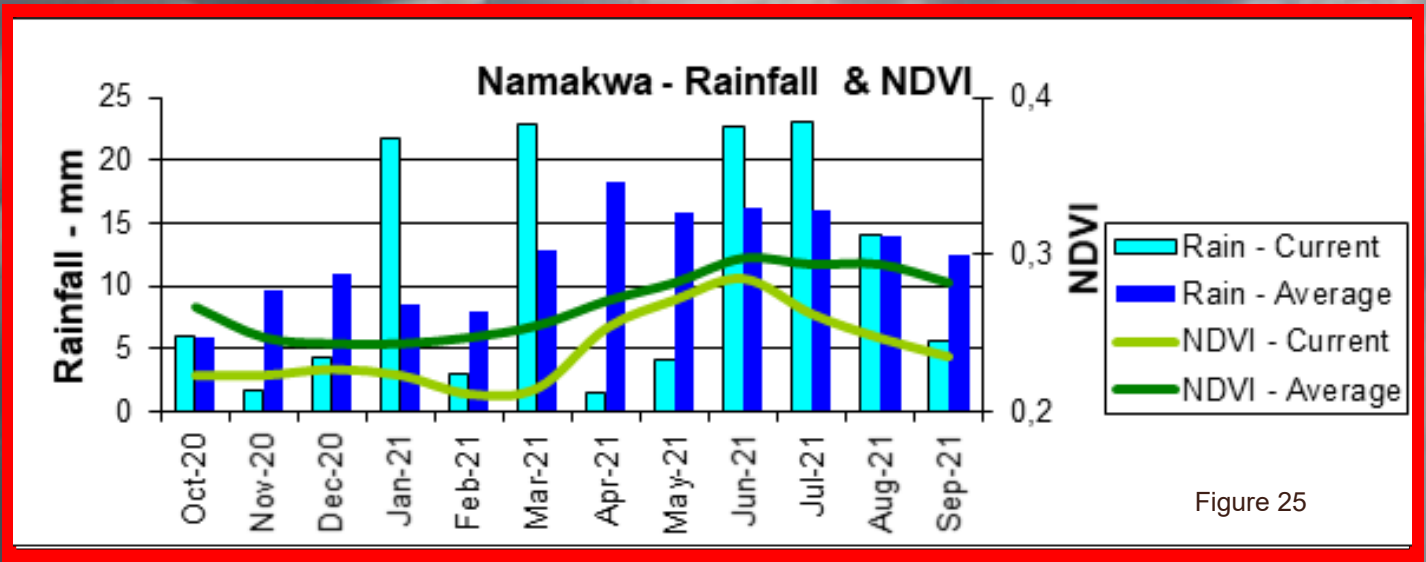

Figure 25

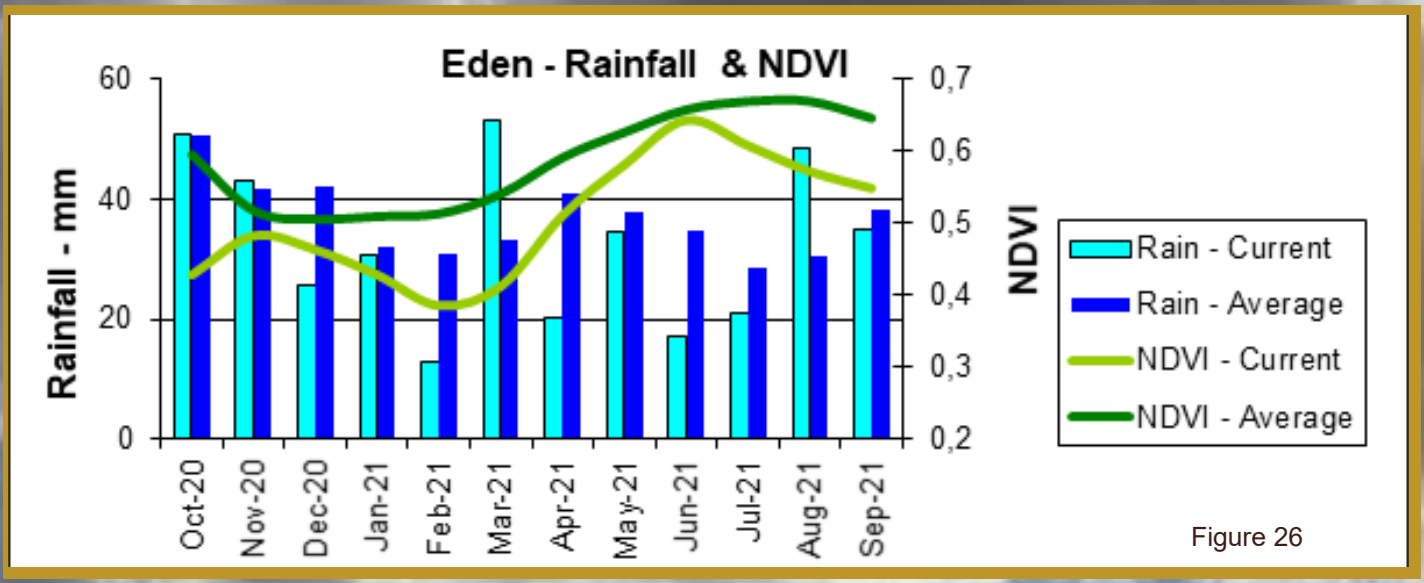

Figure 26

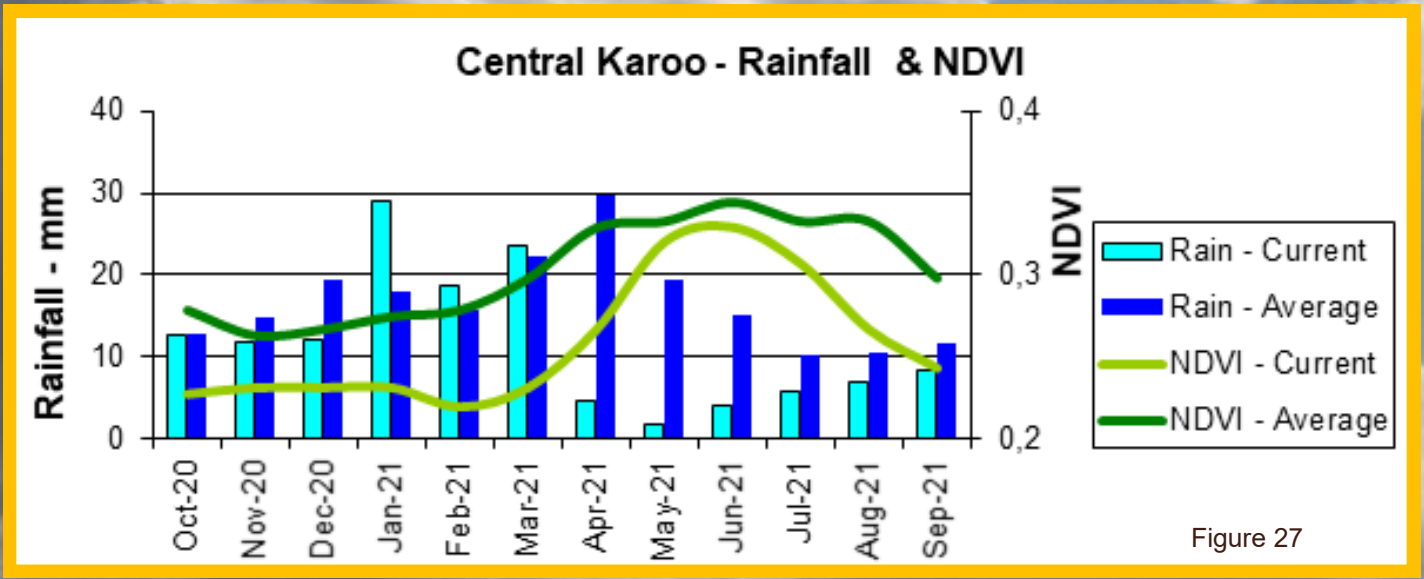

Figure 27

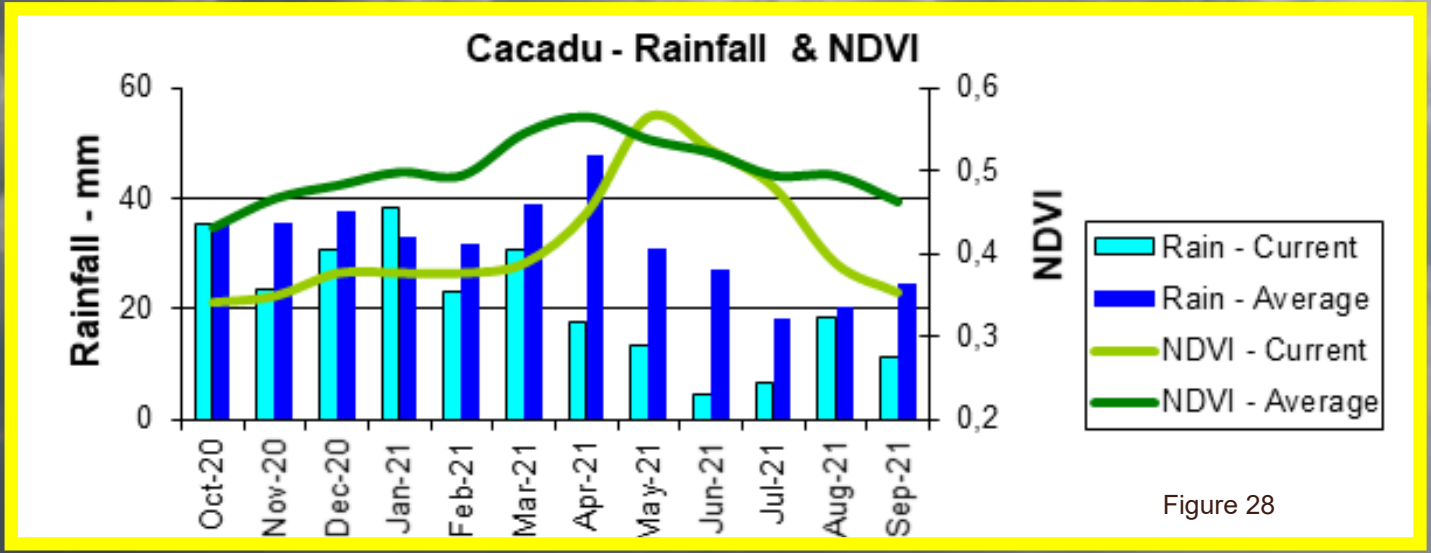

Figure 28

7. Fire Watch

Active Fires *(Provided when data is available)*

Forest and vegetation fires have temperatures in the range of 500 K (Kelvin) to 1000 K. According to Wien's Displacement Law, the peak emission of radiance for blackbody surfaces of such temperatures is at around 4 µm. For an ambient temperature of 290 K, the peak of radiance emission is located at approximately 11 µm. Active fire detection algorithms from remote sensing use this behaviour to detect "hot spot" fires.

Figure 29:
The graph shows the total number of active fires detected between 1-30 September 2021 per province. Fire activity was higher in all provinces except for the Western Cape, compared to the long-term average.

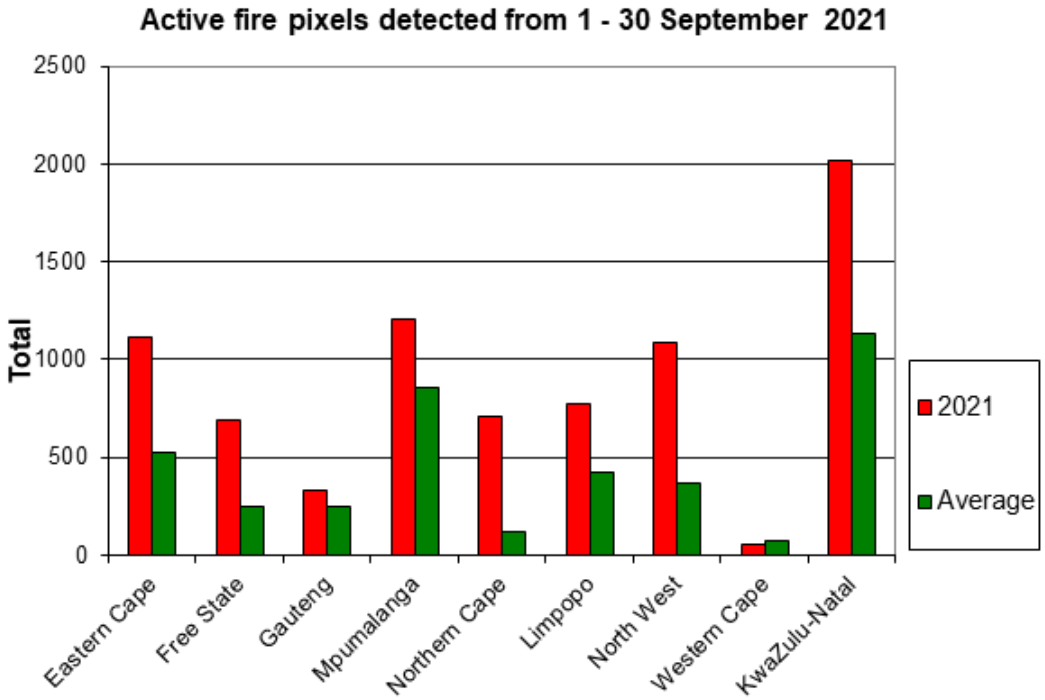

Figure 29

Figure 30:
The map shows the location of active fires detected between 1-30 September 2021.

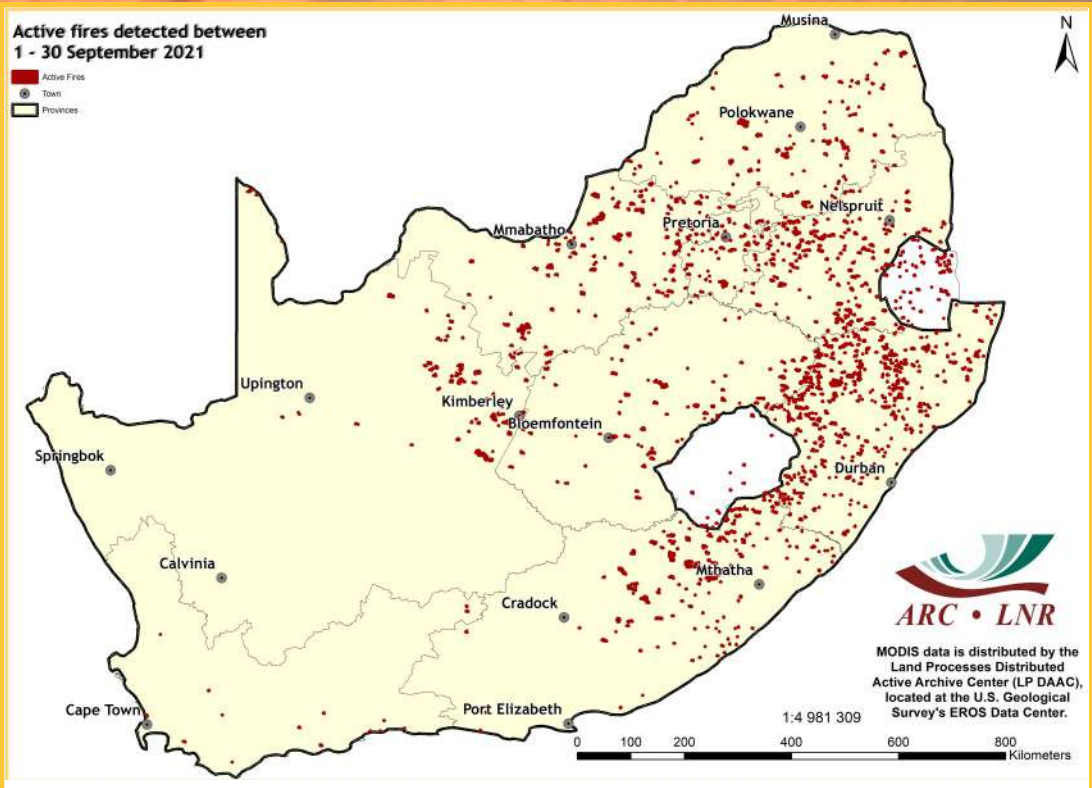

Figure 30

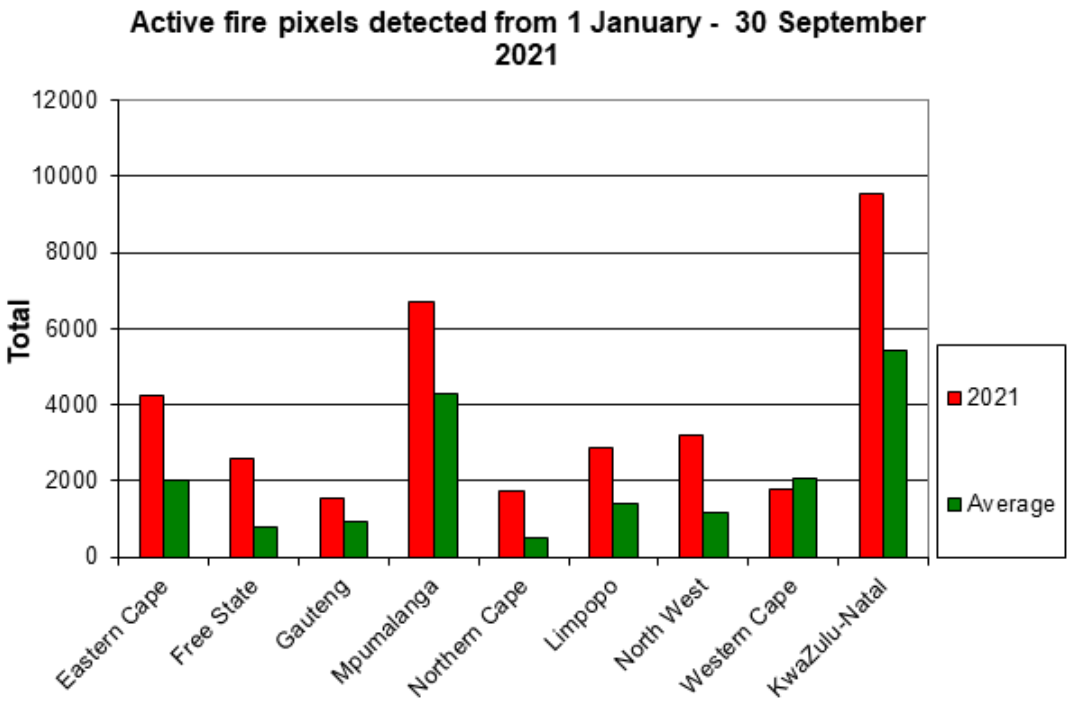

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January and 30 September 2021 per province. Cumulative fire activity was higher in all provinces except for the Western Cape, compared to the long-term average.

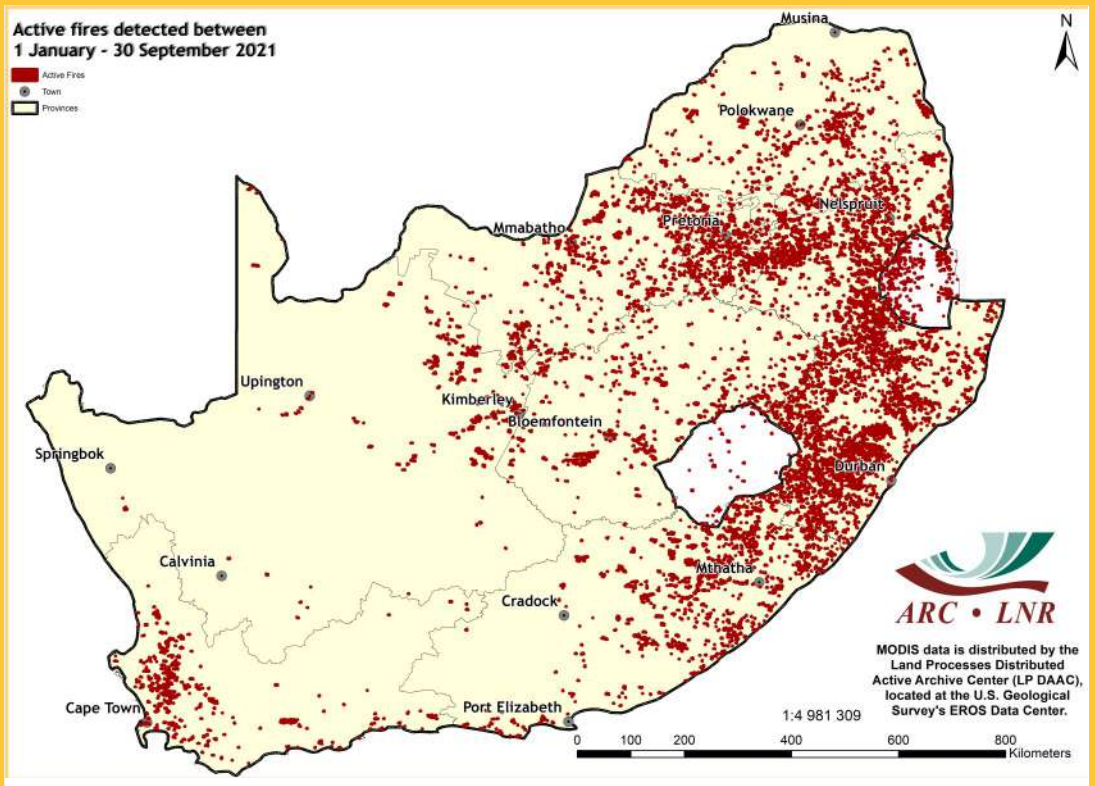

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January and 30 September 2021.

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8. Surface Water Resources

Countrywide surface water areas (SWAs) 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 33 represents a comparison between the area of water available now and the maximum area of surface water recorded in the last 5 years. This 5-year historical window represents the operational period of the satellite from which the water information has been generated. In this map, any value less than 100 represents water catchments within which the current month's total surface water is less than the maximum extent recorded for the same area since the end of 2015.

Figure 34 represents a comparison between the area of surface water now and for the same month last year. In this map, any value less than 100 represents water catchments within which the current month's total surface water is less than that recorded in the same water catchment, in the same month, last year.

The long-term map for September 2021 shows very similar water patterns to the previous month, with the majority of the summer rainfall region catchments showing water levels equivalent to 80-100% of the 5-year, long-term maximum water. Catchments in the central Karoo, interior of the Western Cape and western coastal regions of the Eastern Cape continue to show significantly lower current water levels compared to long-term maximum values.

The comparison between September 2021 and September 2020 indicates a similar pattern to that recorded last month, with the majority of the country showing current water levels between 50% and 150% of the 2020 levels. Exceptions to this are the central Karoo, which is still showing significantly lower water levels, and a number of catchments bordering Botswana and Zimbabwe, which are still showing higher water levels in September 2021 compared to last year.

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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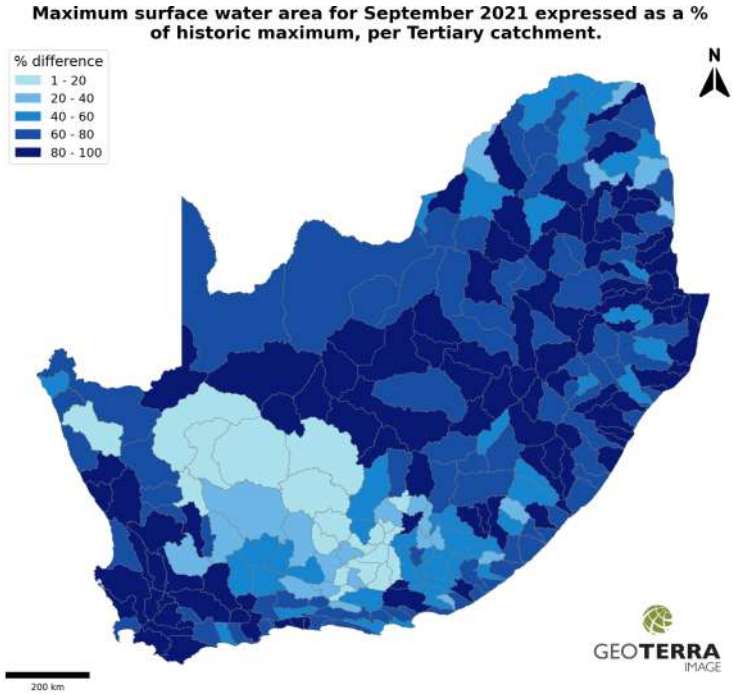

Figure 33

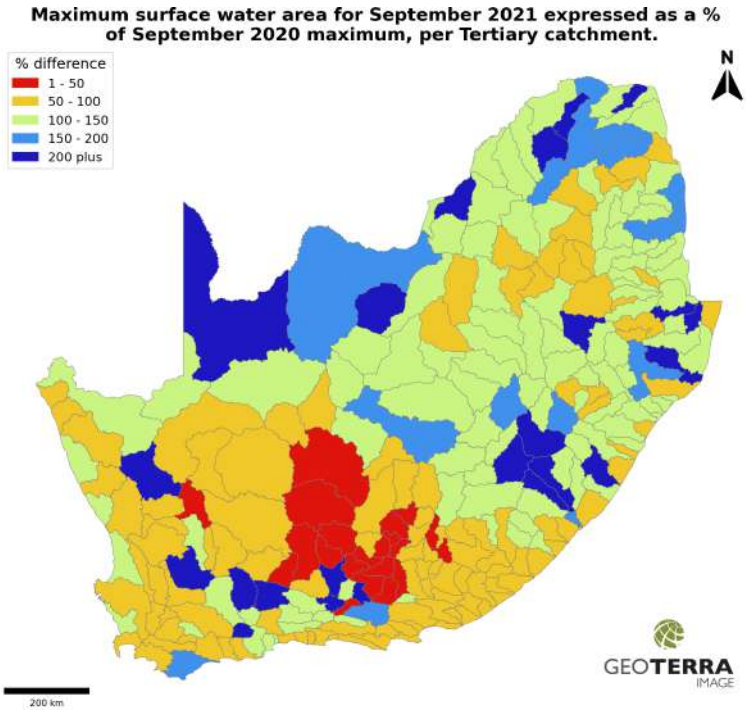

Figure 34

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

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, Land Reform and Rural Development. 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".