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Perspective

The Umlindi Newsletter: Disseminating Climate-Related Information on the Management of Natural Disaster and Agricultural Production in South Africa

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Abstract: The Umlindi newsletter was developed to provide information towards climate advisories, considering, for instance, drought conditions, presented in a relevant manner for the agricultural and disaster sectors in South Africa. This newsletter, which is disseminated on a monthly basis, provides information derived from climate-related monitoring products obtained from an integration of remote sensing and in situ data from weather stations. It contains useful indicators, such as rainfall, vegetation, and fire conditions, that provide an overview of conditions across the country. The present study demonstrates how these natural resource indices are integrated and consolidated for utilization by farmers, policy-makers, private organizations, and the general public to make day-to-day decisions on the management and mitigation of natural disasters. However, there is a need to expand these baseline observation initiatives, including the following: (1) forecasting future conditions to strengthen coping mechanisms of government, farmers, and communities at large; and (2) incorporating information on other natural disasters such as floods and extreme heat. In the context of South Africa, this information is important to improve disaster preparedness and management for agricultural productivity. In a global context, the Umlindi newsletter can be insightful for developing and disseminating natural resources information on adaptation to and mitigation of climate change and variability impacts to other regions facing similar risks. Furthermore, while international organizations also provide natural resource information, the Umlindi newsletter may be distinguished by its regional focus and linkages to individual communities. It bridges the gap between global environmental data and local decision-making by illustrating how global scientific knowledge may be applied locally.

Keywords: climate change and variability; disaster risk management; rainfall monitoring; vegetation conditions; fire monitoring; water resource management

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1. Introduction

1.1. Background

For the past decade, the world has witnessed the proliferation of intense extreme weather events such as droughts, floods, tornadoes, and heatwaves [1–3]. The occurrence and magnitude of these extreme weather events is estimated to become more frequent and intense due to global warming [4]. For example, the Centre for Research on the Epidemiology of Disasters (CRED), which manages a worldwide disaster database, documents more than 600 disasters annually, on a global scale [5]. Such extreme weather events have huge negative socio-economic and environmental impacts [1–3]. In South Africa, droughts and floods are among the most frequently occurring and detrimental natural disasters [6]. Due to above-normal rainfall during recent austral summers (i.e., October–March/April), the country has witnessed a proliferation of flood events that have undone many recent development achievements [7]. For example, some parts of South Africa have experienced damage to infrastructure such as roads, bridges, rail lines, and properties, as well as injuries and loss of human lives due to floods [8]. The rate and frequency at which natural disasters occur in Africa, South Africa in particular, has resulted in a demand for regular and up-to-date natural resources information dissemination [9]. Furthermore, this information is also crucial for climate initiatives within the framework of development agendas such as the Sustainable Development Goals (SDGs), the Sendai Framework for Disaster Risk Reduction, the New Urban Agenda, and the Paris Agreement [10]. In the face of the hardships resulting from these natural disasters, sustainable dissemination of climate-related information offers a way for practitioners to make informed decisions and build an understanding of the occurrence of extreme events over time. The provision of up-to-date information, through various types of climate services (e.g., online portals, newsletters, and stakeholder engagement meetings), increases the resilience and preparedness of society for the sudden changes resulting from natural disasters [11].

Governments and policy developers have initiated various mechanisms to reduce the resultant impacts of climate-related disasters. For example, the World Meteorological Organization (WMO) founded the Global Framework for Climate Services (GFCS) in 2009 to strengthen the production, availability, delivery, and application of science-based climate services [12,13]. For such initiatives to function effectively, an observation of the drivers of climate change at high spatio-temporal resolutions is necessary [14]. It is also important to establish suitable and operational institutional mechanisms to foster the production and dissemination of information to society at different levels [14].

Unfortunately, limited data to generate the required information for climate services remain a setback hindering decision-making processes, especially in developing countries such as South Africa. Nevertheless, there are several international entities who serve in the nexus of climate science, including the World Meteorological Climate Service, the National Oceanic and Atmospheric Administration (NOAA) Climate Services center, the Australia National Climate Center, and the Southern African Development Community—Climate Services Centre [15]. As part of the facilities complementing the South African Weather Services, the Agricultural Research Council (ARC) established a network of over 600 weather stations across South Africa, as well as the Coarse Resolution Imagery Database (CRID), for environmental monitoring purposes. These National Public Good Assets are maintained in line with regulations set by international bodies such as the WMO. The dissemination and effective advocacy of climate information from these datasets are vital for the protection of livelihoods and infrastructure. Thus, this study presents an ARC initiative called the Umlindi newsletter, which is a dissemination tool aimed at monitoring climate-related conditions to assist the agricultural community in making timely and informed decisions for proper planning. Here, we provide a sample of the Umlindi newsletter using various examples, considering the following: (1) recent drought conditions over the country through the lens of rainfall and vegetation data; (2) a recent view of the status of the country's water resources; and (3) a view of the seasonal occurrence of wild fires. These are presented to demonstrate the application of the indicators and indices presented in the Umlindi newsletter and used for decision-making in the disaster management and agricultural sectors of South Africa.

1.2. Study Area

South Africa is located in the subtropics, from ~22–35° S, and covers an area of ~1,219,603 km^2 (Figure 1). It has a highly heterogeneous, subtropical climate, with most regions being characterized by semi-arid conditions [16]. The country receives an average annual rainfall of ~464 mm. However, annual rainfall totals are spatially highly variable, following an average west–east gradient [17], with most eastern regions receiving ~600–1500 mm, while many western regions receive <400 mm. Most of the country falls within the summer rainfall region and receives the majority of its rainfall during October–March/April, but the southwestern Cape and western coastal regions receive rainfall predominantly during the winter months (April–September), and the southern coastal areas and the adjacent interior can receive rain throughout the year.

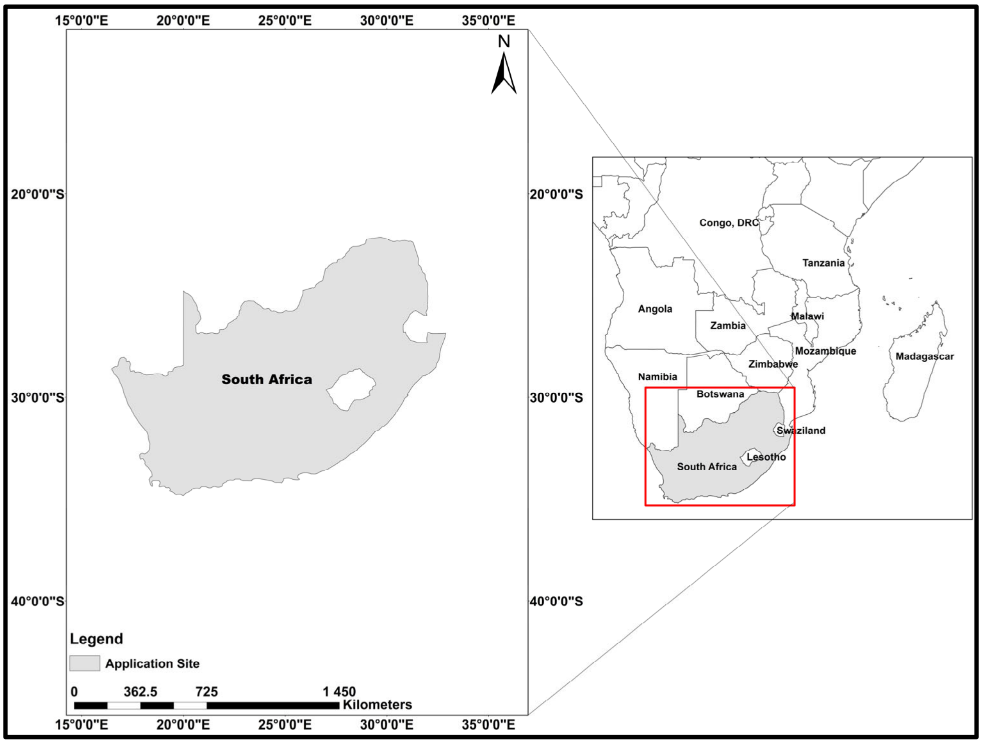
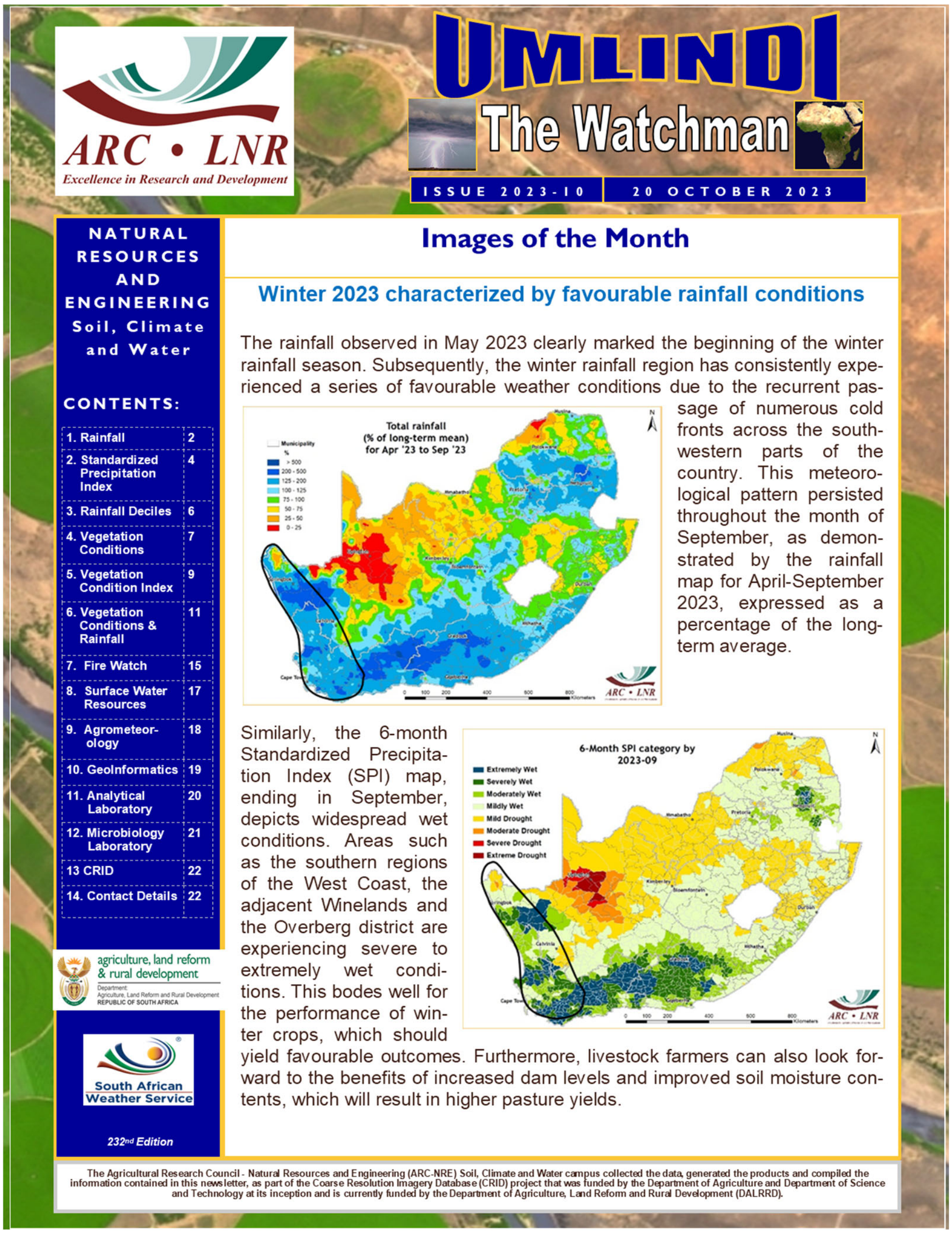


Figure 1. A map of the Umlindi newsletter application site, South Africa, in relation to other countries within southern Africa, defined here as the Southern African Development Community (SADC).

2. Operational Framework

The Umlindi (a Zulu word for "the watchman") newsletter compiles information obtained from scientific research in a simplified manner intended for decision-makers, policy-makers, and the general public. The utilization of the products in the newsletter over several years by various committees within the agricultural sector and the National Disaster Management Centre (NDMC), together with regular inquiries from the general public receiving the newsletter, demonstrates the usefulness of the information and also the fact that it is presented in an understandable format. Due to its multi-disciplinary nature, the newsletter was established by a team of professionals from various fields, viz. geoinformation science, hydrology, agrometeorology, and computer science. The development of the newsletter entailed assimilating value-added products based on rainfall, vegetation activity, active fire, and surface water resources data covering the whole of South Africa. The rainfall products offered include those obtained from the combined inputs of the automatic weather station network of the ARC [18], while the vegetation conditions and active fire information are represented with remotely sensed products extracted from data archived in the CRID using automated Python scripts. In addition, the surface water resources products are also derived from remote sensing imagery, and supported with advanced machine and deep learning techniques. To visualize spatial distribution, maps are generated using a continually improved geographical information system (GIS) software known as ArcGIS version 10.8, developed by ESRI https://www.arcgis.com/features/index.html (accessed on 4 September 2023).

Each month, the Umlindi newsletter is published as a Portable Document Format (PDF) document on the ARC website https://www.arc.agric.za/arc-iscw/Newsletter%2520Library/Forms/AllItems.aspx (accessed 4 September 2023) and is also distributed via e-mail to subscribing individuals, ranging from government officials, farmers, university personnel, private organizations such as insurance companies, consulting agencies, and farmers' associations to government entities at multiple scales (i.e., national, provincial, and local). The cover page displays the table of contents and a summary of significant climate-related events, their impact on agriculture, and relevant recommendations (Figure 2).



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NATURAL RESOURCES AND ENGINEERING
Soil, Climate and Water

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232nd Edition

Images of the Month

Winter 2023 characterized by favourable rainfall conditions

The rainfall observed in May 2023 clearly marked the beginning of the winter rainfall season. Subsequently, the winter rainfall region has consistently experienced a series of favourable weather conditions due to the recurrent passage of numerous cold fronts across the south-western parts of the country. This meteorological pattern persisted throughout the month of September, as demonstrated by the rainfall map for April-September 2023, expressed as a percentage of the long-term average.

Total rainfall (% of long-term mean) for Apr '23 to Sep '23

Similarly, the 6-month Standardized Precipitation Index (SPI) map, ending in September, depicts widespread wet conditions. Areas such as the southern regions of the West Coast, the adjacent Winelands and the Overberg district are experiencing severe to extremely wet conditions. This bodes well for the performance of winter crops, which should yield favourable outcomes. Furthermore, livestock farmers can also look forward to the benefits of increased dam levels and improved soil moisture contents, which will result in higher pasture yields.

6-Month SPI category by 2023-09
Extremely Wet
Severely Wet
Moderately Wet
Mildly Wet
Mild Drought
Moderate Drought
Severe Drought
Extreme Drought

The Agricultural Research Council - Natural Resources and Engineering (ARC-NRE) Soil, Climate and Water campus 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 (DALRRD).

Figure 2. Example cover page of the Umlindi newsletter from October 2023.

3. Base Indices and Product Development

3.1. Rainfall

Monthly precipitation data are primarily obtained from the ARC's in-house agro-climate databank (see [18] for details regarding this databank and the weather stations therein). Near real-time, public-good, 10-daily rainfall data from the South African Weather Service (SAWS) and the Kruger National Park are also utilized in the monthly production of GIS rainfall surfaces, which also include satellite-derived rainfall estimates (Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) data [19]) as the input to the combined final product at a 10-daily time scale (see [20] for a detailed description on how the monthly GIS rainfall surfaces are created).

The rainfall data are quality-controlled operationally at the ARC on a monthly basis. This is achieved by interrogating the daily or 10-daily rainfall totals per station, for the stations where persistently low or high rainfall values relative to the values of the surrounding stations occur. The stations with suspicious data are identified by considering a time series of interpolated rainfall maps for various accumulation periods. After considering the daily or 10-daily data at the suspicious stations, the stations with faulty data are removed by adding them to a fault list. The stations on the fault list are omitted during the creation of the final monthly rainfall GIS surface. The list of ARC stations with faulty data is provided to the station technicians who provide feedback regarding station visits to the Umlindi team.

Utilizing the most recent monthly accumulated rainfall GIS surface, various rainfall-based indices are calculated to produce rainfall products for the month in question. These include the total rainfall, the percentage of long-term mean rainfall, the cumulative total rainfall for the preceding 12 months expressed as a percentage of the long-term mean, and the total rainfall for the preceding 3 months compared to the same period in the previous year. The newsletter also features two additional rainfall-based indices used in various countries to delineate drought, based on the original rainfall GIS surfaces, namely, rainfall deciles and the Standardized Precipitation Index.

Rainfall deciles are calculated by determining the ranking of the total rainfall for a specific period (in this case a calendar month) relative to the other instances for the same period in the historical archive. The ranking for the focus period is then classified from 1 (lowest value or within the lowest 10% of values historically) to 10 (highest value or within the highest 10% of values historically).

The Standardized Precipitation Index (SPI) was developed to monitor the occurrence of drought using only rainfall data [21]. This index quantifies precipitation deficits on different time scales and, therefore, also drought severity. The SPI is calculated operationally using the most recent GIS rainfall surface with the archive of historical monthly surfaces dating back to 1920 for various time scales to highlight the development or continuation of drought conditions. These time scales are 1-, 3-, 6-, 9-, 12-, 24-, 36-, and 48-month periods. For the Umlindi newsletter, the SPI is calculated per quaternary catchment and, therefore, provides an indication of rainfall conditions per catchment based on the historical distribution of rainfall in that catchment.

3.2. Vegetation Conditions

The CRID provides the most recent and archived data for vegetation monitoring products. While the best available datasets for operational monitoring change over time depending on, amongst others, satellite lifespan, the 16-day MODIS Normalized Difference Vegetation Index (NDVI) at a 500 m spatial resolution distributed by the Land Processes Distributed Active Archive Center (LP DAAC), located in the U.S. Geological Survey's EROS Data Center, is currently used to generate the vegetation condition maps. The NDVI, developed by [22] and provided by the LP DAAC using per-pixel quality data, is based on the ratio between near-infrared and red reflectance and describes vegetation activity based on vegetation abundance and vigor. This well-known and widely used index is computed from the following equation:

$$\text{NDVI} = (\text{NIR} - \text{R}) \div (\text{NIR} + \text{R}) \tag{1}$$

where NIR = near-infrared band reflectance and R = red band reflectance.

Products such as the NDVI-based Standardized Difference Vegetation Index (SDVI), Percentage of Average Seasonal Greenness (PASG), and Vegetation Condition Index (VCI) are generated at the ARC to show monthly and seasonal differences or longer-term deviations of vegetation conditions. During the computation of the above-mentioned NDVI-based indices, the per-pixel quality data are incorporated to ensure the use of only valid pixels. The indices are computed from the following equations:

$$SDVI = (NDVI - NDVI_{Min}) \div (NDVI + NDVI_{Max}) \tag{2}$$

where $NDVI_{Min}$ = minimum NDVI value for the average season and $NDVI_{Max}$ = maximum NDVI value for the average season.

$$PASG = [(NDVI - NDVI_{Min}) \div (NDVI_{Max} + NDVI_{Min})] \times 100 \tag{3}$$

where $NDVI_{Min}$ = minimum NDVI value in the study area (usually measured over a specific period) and $NDVI_{Max}$ = maximum NDVI value in the study area (usually measured over the same period).

$$VCI = [(NDVI - NDVI_{Min}) \div (NDVI_{Max} - NDVI_{Min})] \times 100 \tag{4}$$

where $NDVI_{Min}$ = minimum NDVI value typically observed for healthy vegetation and $NDVI_{Max}$ = maximum NDVI value typically observed for healthy vegetation.

The derived maps are useful for depicting changes in vegetation activity over specific areas and time periods. They signify deviations from normal vegetation conditions and provide an indication of how the month or season under observation compares to other similar periods. A below-normal vegetation may be due to water or nutrient deficiencies, while above-normal conditions refer to improved vegetation productivity, usually also related to favorable weather and environmental conditions. The ground end-users of the maps provide regular feedback via mail regarding the usefulness and accuracy of the products.

3.3. Surface Water Resources

The surface water resources maps are derived from monthly surface water data generated by the "Mzansi Amanzi" monthly water information service www.water-southafrica.co.za (4 September 2023). This information service has been developed and operationalized by GeoTerraImage and generates monthly updated national coverage raster datasets that illustrate and spatially quantify the location and extent of all surface water features across South Africa, irrespective of whether they are natural or man-made. The service data repository contains monthly surface water datasets for all months, dating all the way back to January 2016, which is the operational source date of Sentinel-2 imagery, on which the service capability is based.

The time-based comparisons of current monthly water extents are compared to the long-term monthly data histories to derive both the annual and long-term water resource status comparisons. The surface water features are expressed as a percentage, which represents the percentage extent in relation to the average extent for the data gathered since the end of 2015. The annual comparison represents the current target month compared to the same month in the previous year. Here, 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. The long-term comparison represents the current target month compared to the long-term maximum (based on all monthly records dating all the way back to January 2016). Here, 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. All comparisons are reported in terms of tertiary-level water catchment boundaries.

These surface water datasets represent the combined spatial extent of both natural and man-made water features, nationally, across South Africa. The water features are mapped from a combination of 20 m resolution Sentinel-2 optical imagery and Sentinel-1 Synthetic Aperture Radar (SAR) imagery, using advanced machine learning and deep learning classification techniques. The inclusion of the SAR image format supports all-weather water feature detection, every month, regardless of cloud cover. The broad approach is to use Sentinel-2 imagery as the primary water detection dataset, with the all-weather capabilities of Sentinel-1 SAR imagery being used to "fill-in" cloud-obscured water surfaces. This approach ensures that the high spatial detail and accuracy of optically detected surface water areas using 20 m resolution Sentinel-2 imagery are retained as the primary controller of output content wherever possible. These surface water detection capabilities support the individual identification of water features, typically >0.25 ha, to be mapped in a repeatable and accurate manner.

This Sentinel-based water detection and mapping method has been validated through participation in the European Space Agency's Global Water Round Robin program (Surface Water Dynamics from Space: A Round Robin. Inter-comparison of Using Optical and SAR High-Resolution Satellite Observations for Regional Surface Water Detection) [23]. The monthly surface water monitoring capability is currently used to support a national, wall-to-wall monthly information service on the state of all surface water resources across South Africa.

3.4. Fire Activity

Remote sensing-based detection of active fires is based on detecting the thermal signature of fires, using a contextual algorithm [24]. Actively burning fires can be identified and located by detecting the elevated energy released relative to their non-burning surroundings at mid-infrared to thermal wavelengths (i.e., 3.6–12 μm). The 8-day MODIS active fire product distributed by the LP DAAC is used to derive active fire data. The images are downloaded in an HDF file format, where the point represents the center of the MODIS pixel, being 1 km at nadir [25], and are then converted to GeoTIFF using the MODIS conversion tool. The 8-day images are used to build up the monthly datasets. The number of fire pixels observed in each 8-day Terra MODIS image are accumulated using a maximum value composite to generate a monthly active fires' image. In addition to the quality check perfomed as indicated in [25], an indpendant consistency check of the fire product is executed in-house through the use of media reports.

4. Case Study Applications

4.1. Monitoring the Most Recent Countrywide Drought Using Rainfall Data

The most recent major drought event that significantly impacted agricultural production and resulted in water restrictions over many areas of South Africa occurred during 2015–2016 [26]. This drought spanned two summer seasons, starting in the second half of the summer of 2014/2015 and reaching a maximum during the middle of the summer of 2015/2016. The 24-month SPI map shows in red the most severely affected areas for this longer time scale, up until June 2016 (Figure 3a). Large dams in these areas were significantly affected, and water restrictions were put in place by mid-2016 in many of the associated river catchments. Over the northern parts of KwaZulu-Natal, where the drought at that time was most intense, the dam levels dropped to multi-decadal lows [27].

The rainfall for the period from July to December 2015, the first half of the second summer (2015/2016) within the drought period, expressed as a percentage of the long-term mean, was below-normal over a large part of the interior areas, especially the central to northwestern parts and the more isolated areas in the northeast (Figure 3b). At the 3-month time scale, from October to December 2015, the SPI map shows that severe to extreme drought dominated much of the central to northern and eastern parts of the country during this very important phase of the summer growing season (Figure 3c). Also, for December 2015 specifically, the 1-month rainfall deciles indicate that the rainfall received over large parts of central South Africa either ranked within the lowest 10% of years or were the driest ones on record (Figure 3d). Given the dire rainfall situation during the first half of the 2015/2016 summer, vegetation was severely stressed, as demonstrated by, amongst other things, a 40% reduction in maize production compared to what had been produced during previous summers [28].

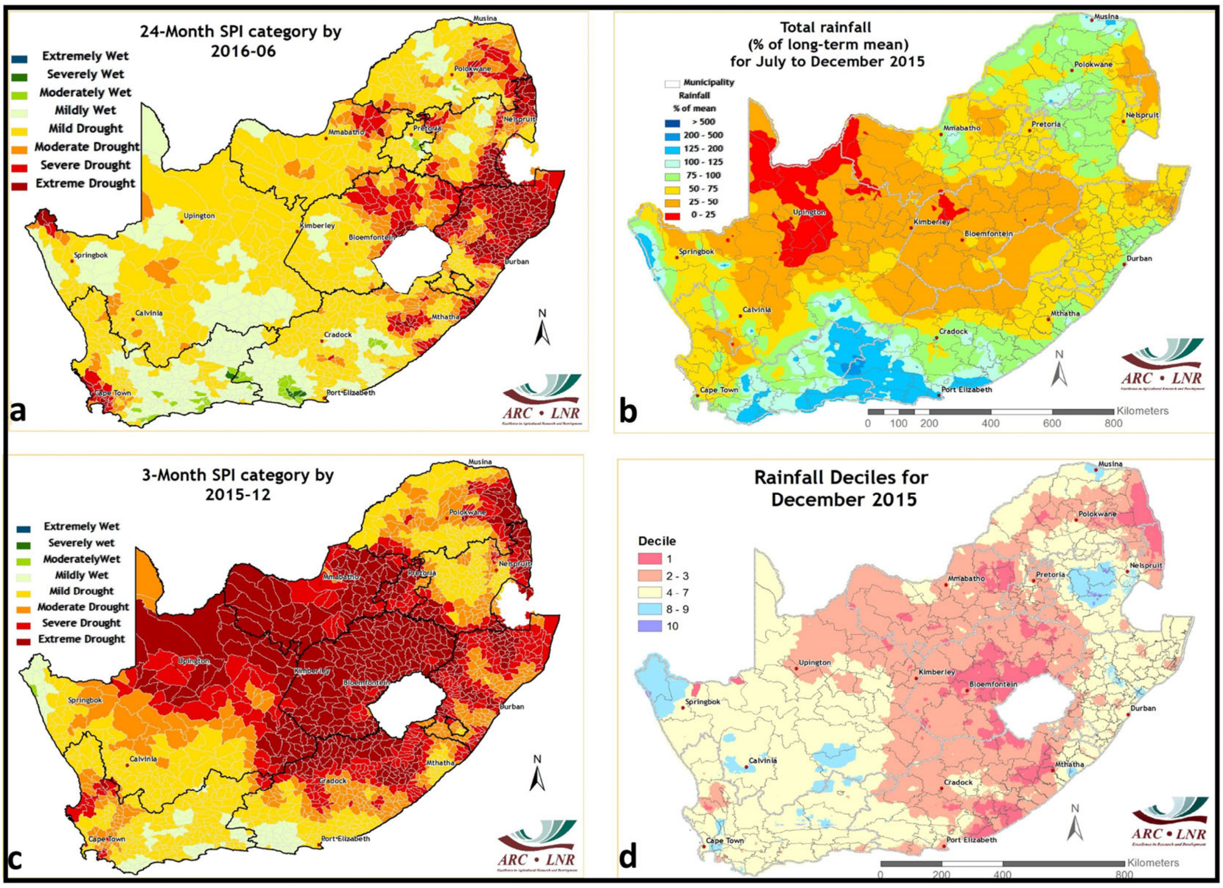

Figure 3. Drought monitoring indices derived from weather station data, published during the 2015–2016 drought: (**a**) 24-month Standardized Precipitation Index (SPI) up to June 2016, showing the impact of longer-term drought by that point and areas where hydrological drought is likely; (**b**) rainfall as a percentage of the long-term mean for the first 6 months of the 2015/2016 summer (July–December 2015); (**c**) 3-month SPI for October–December 2015, constituting the first part of the main summer growing season; and (**d**) rainfall deciles for December 2015, expressing the ranking of rainfall for the indicated period in terms of the historical time series.

4.2. Monitoring the Most Recent Countrywide Drought Using Remotely Sensed Vegetation Data

The 2015–2016 drought resulted in large animal die-offs due to the reduction in grazing material, while commercial maize production was at a multi-year low due to the hot and dry conditions which occurred during the agriculturally important early-to-mid-summer period in the main summer crop production region [29,30]. Figure 4 shows the progression and cumulative effect of this drought event on vegetation activity as published in the Umlindi newsletter and, as with the rainfall products, utilized by various stakeholders to delineate severely drought-affected areas. The first three maps show the gradual progression and intensification of drought during early-to-mid-summer 2015/2016, as reflected in the vegetation activity according to the VCI by late October (Figure 4a), late November (Figure 4b), and late December 2015 (Figure 4c). The cumulative effect of the dry conditions on vegetation activity is shown by the PASG for the period from July 2015 to early January 2016 (Figure 4d).

4.3. Near-Present Drought Conditions over South Africa

Using observed rainfall and vegetation activity maps featured in the Umlindi newsletter as indicators, Figure 5 reflects the change in drought intensity and extent from 2019 until 2022. There was a prolonged drought in the Cape provinces over the past 5 years, focused in the southern to southwestern and western parts, including, at times, the winter rainfall region [23,30] of the country, while areas further to the northeast generally experienced near-normal rainfall. Figure 5a,b show the drought situation by mid-2020, when its extent over these areas was at a maximum. The 24-month SPI map indicates severe to extreme drought over an extensive region (Figure 5a), also reflected in below-normal seasonal cumulative vegetation activity as per the PASG by mid-2020 (Figure 5b).

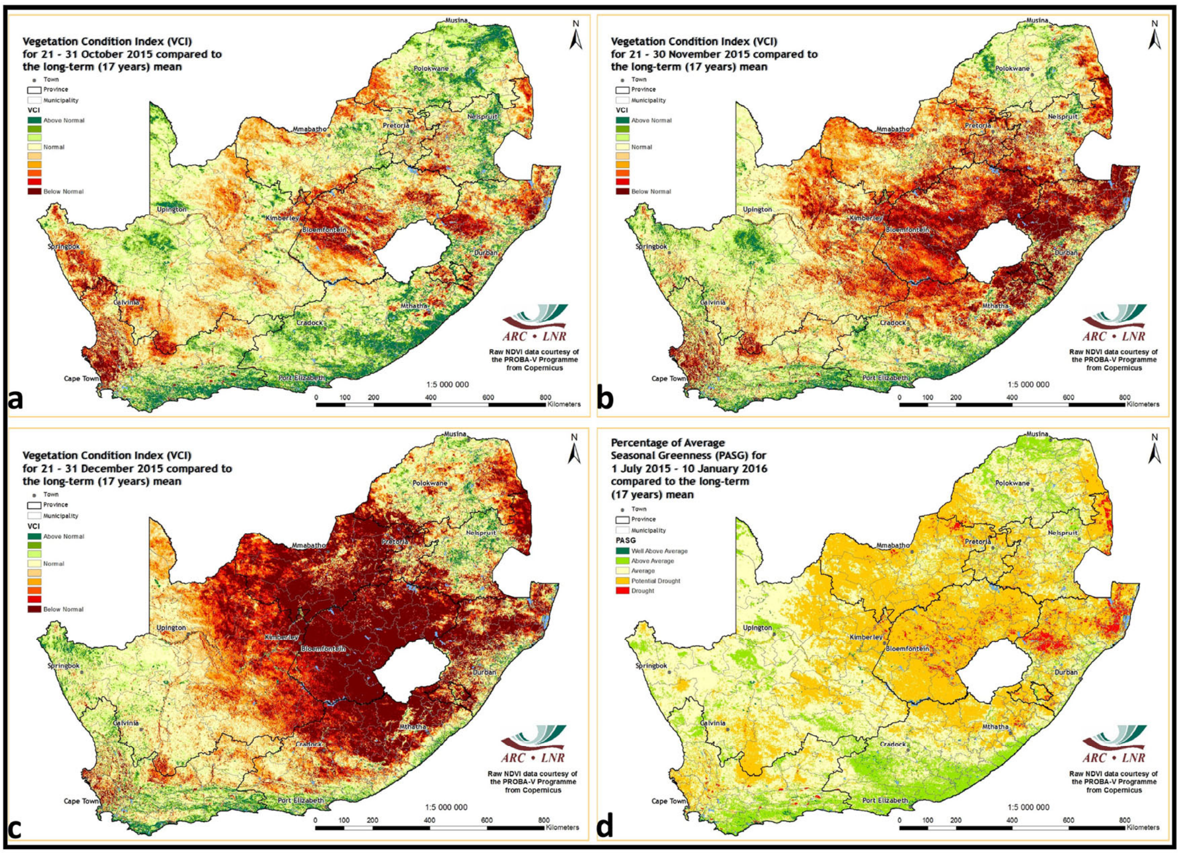

Figure 4. Normalized Difference Vegetation Index (NDVI)-based drought monitoring indices derived from remotely sensed vegetation data during the 2015–2016 drought. The Vegetation Condition Index (VCI) maps show increasing vegetation stress from late October (**a**), late November (**b**), and ultimately reaching the maximum extent in late December 2015 (**c**). The cumulative effect of dry conditions since the previous summer and during the period October–December 2015 is shown in the Percentage of Average Seasonal Greenness (PASG) map of early January 2016 (**d**).

These SPI and PASG maps were used extensively by the Western Cape and Northern Cape Provincial Departments of Agriculture, together with the NDMC, to delineate the most significantly drought-affected areas. Following widespread above-normal rainfall during 2021 and 2022 over much of the region, the drought-affected area contracted significantly, as indicated in the SPI and PASG maps of mid-2022 (Figure 5c,d, respectively), showing mostly wet to extremely wet conditions according to the SPI, complemented by above-average seasonal cumulative vegetation activity as indicated by the high PASG values. By mid-2022, the drought was confined to a relatively small area, visible over the southern parts of the Eastern Cape Province.

4.4. Monitoring the Status of Surface Water Resources

Figure 6 shows the long-term surface water resources map for two summer and winter seasons, from 2021 to 2022. High volumes of surface water resources were observed in the central parts of the country for the summer and winter seasons of 2021 (Figure 6a,c, respectively). The outskirts of the country witnessed low volumes compared to the previous

December (2020)'s long-term conditions, especially across the far western, eastern, and northern parts. The majority of catchments in these areas showed water levels equivalent to 20–80% of the 5-year, long-term maximum water. The opposite was observed for the summer and winter seasons of 2022 (Figure 6b,d, respectively), where most parts of the country experienced higher water levels compared to the long-term maximum values.

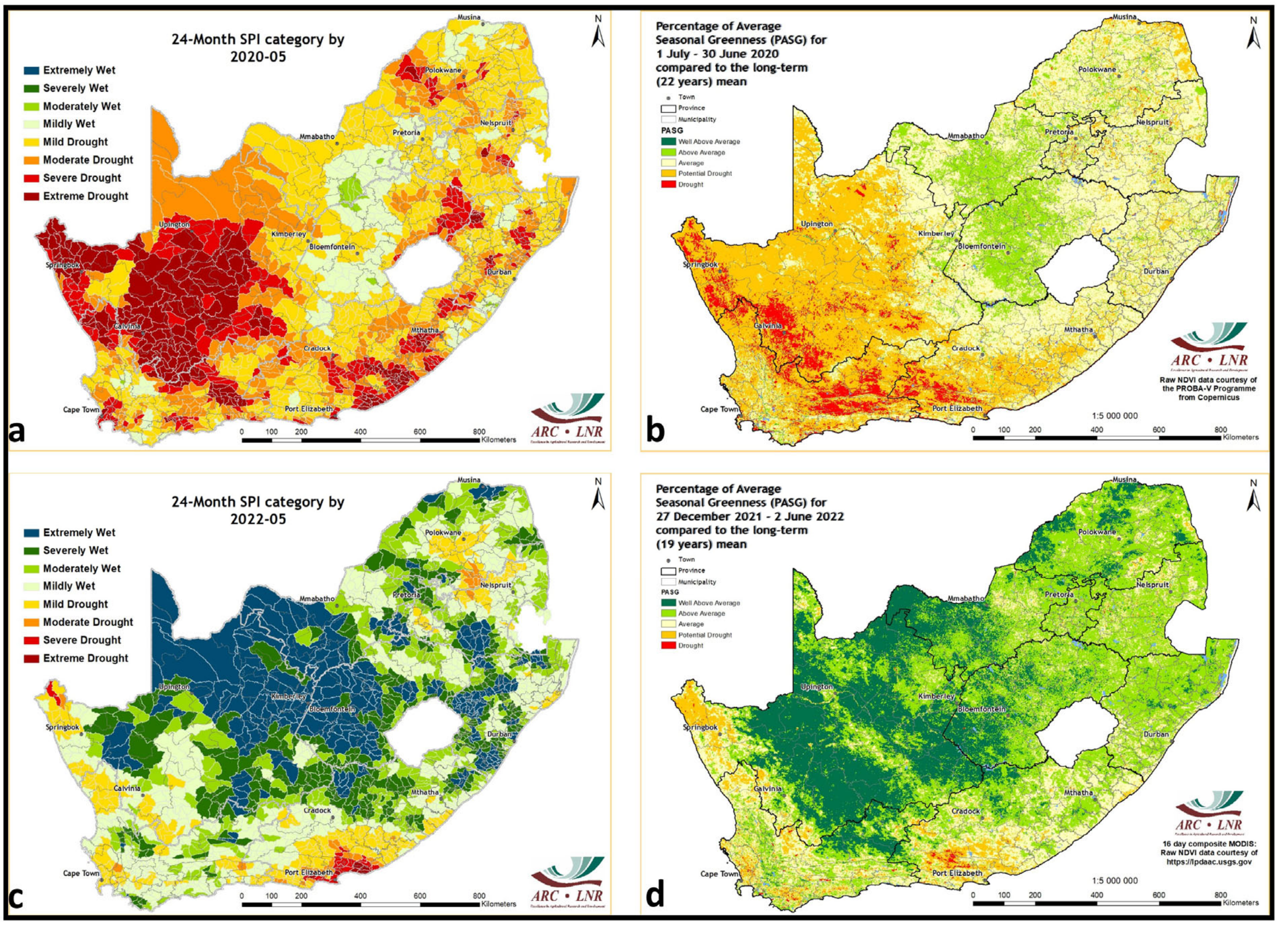

Figure 5. 24-month SPI and corresponding 12-month PASG by mid-2020 (**a**,**b**), as well as by mid-2022 (**c**,**d**).

4.5. Seasonal Occurrence of Wildfires

In addition to vegetation conditions, the ARC monitors the occurrence of wildfires across the country using remote sensing data. Figure 7 shows active fire maps derived from the 8-day MODIS active fire product, specifically the location of active fires detected during a winter month (July 2021) and a summer month (February 2021).

The active fire information is also summarized and compared by province to provide an indication of the relative severity of a specific fire season. With a number of wildfires in recent years leading to widespread damage to farms, these maps are used to understand the evolution and abundance of fires operationally and help create a fire climatology useful in fire hazard assessment. The two examples in Figure 7 show the typical large-scale distribution of fires across South Africa, with a relatively large number of fires occurring over the southwestern winter rainfall region during summer (Figure 7a), whilst occurring almost exclusively and in a widespread manner over the summer rainfall region, especially towards the east, during winter (Figure 7b).

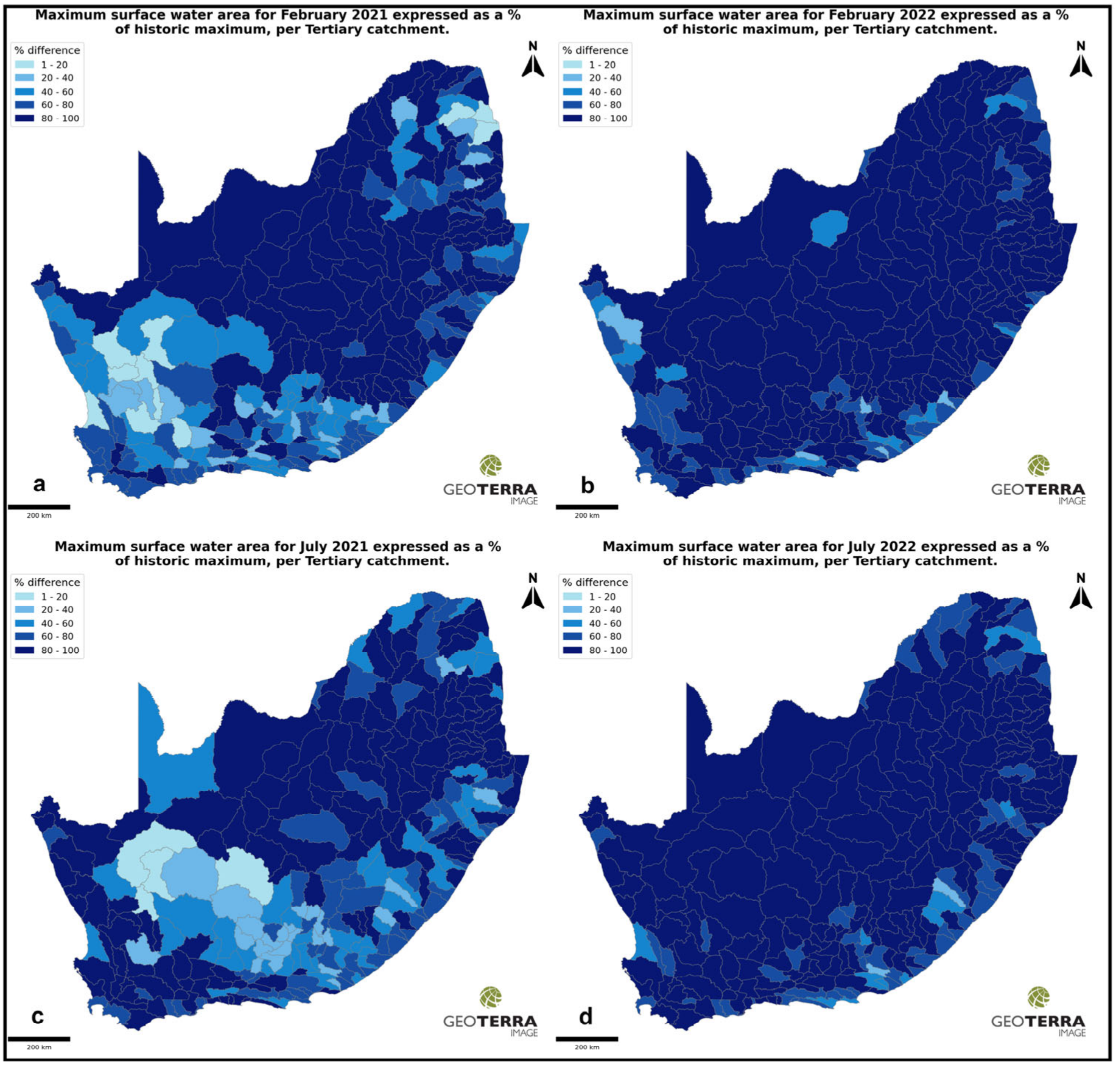

Figure 6. Surface water resources maps derived from Sentinel-2 satellite data for the summer and winter periods spanning from 2021 to 2022: (**a**) maximum surface water area by February 2021; (**b**) maximum surface water area by February 2022; (**c**) maximum surface water area by July 2021; and (**d**) maximum surface water area by July 2022.

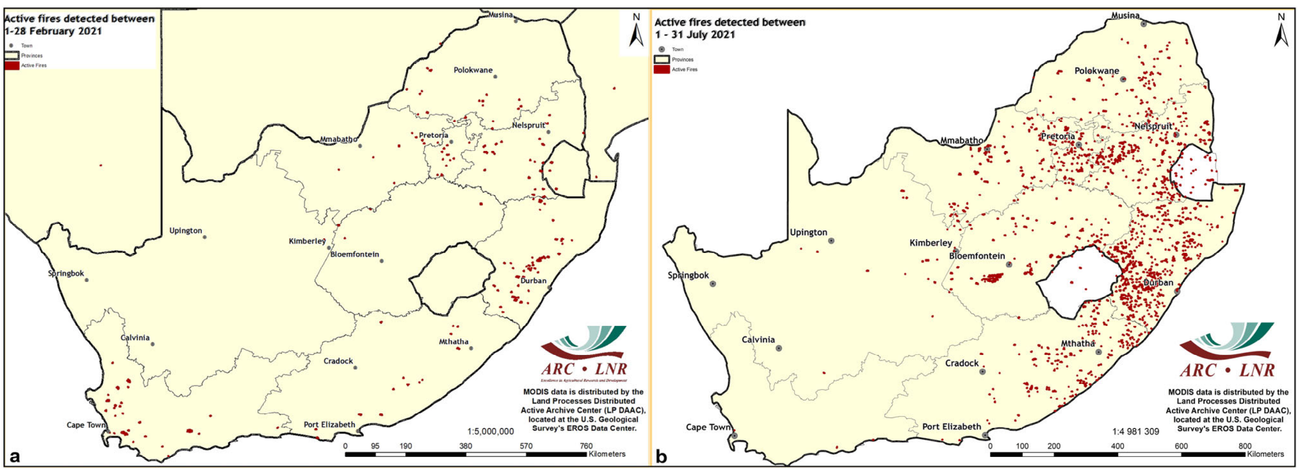

Figure 7. Active fire maps derived from the 8-day MODIS active fire product for a summer month (February 2021; (**a**)) and a winter month (July 2021; (**b**)).

5. Practical Implications

Climate change and natural disasters are detrimental to sustainable development, posing as barriers to development worldwide, including in South Africa. Thus, the ARC developed a natural resources monitoring system that processes various input data, including weather data, vegetation condition images, fire images, and surface water images, to produce useful products which are disseminated on a monthly basis via the Umlindi newsletter. This newsletter can provide valuable insights to the global scientific community in various ways for developing and disseminating natural resources information. For example, it focuses on South Africa and its specific environmental challenges, therefore providing a localized point of reference for global scientists with interest in understanding the dynamics of natural resources management for regions of interest. Furthermore, the Umlindi newsletter highlights the significance of establishing data collection and monitoring networks at the community level. This can stimulate scientists to explore the potential of local data sources and their impact on regional and global trends.

The National Disaster Management Centre (NDMC) uses information from the Umlindi newsletter to prepare drought assessment reports for the National Joint Drought Coordinating Committee (NJDCC). The Standardized Precipitation Index (SPI) images at various time scales are being utilized in an online Drought Monitoring Tool on a GIS portal hosted by the NDMC. The intuitive color coding, with warmer colors indicating various drought intensities, makes the maps easier to interpret. This assists the NDMC in tracking the evolution of drought in various locations to enhance preparedness.

The NDMC further utilizes the information from the Umlindi newsletter in their decision-making to declare states of local disaster in the provinces affected by natural disasters such as droughts and floods. Additionally, other products within the newsletter (monthly rainfall and fire observations) are being utilized in analytical processes for situational awareness and quantification of significant events. For example, during the 2015/2016 drought, the products packaged in the Umlindi newsletter assisted in informing policy. The drought and vegetation maps were used extensively by the Provincial Departments of Agriculture, the Portfolio Committee on Water and Sanitation, the Department of Water and Sanitation (DWS), and the NDMC to delineate the most significantly affected areas. Several workshops were also held during this time, and the rainfall-based drought monitoring products of the Umlindi newsletter were used during such workshops to identify the most severely affected areas at national, provincial, and municipal levels.

Using the Umlindi products, the Portfolio Committee on Water and Sanitation as well as the DWS were also able to put in place short- and long-term drought interventions and strategies, including signing off a municipal declaration on long-term water security for the affected provinces. The declaration had seven key points for enhanced water demand management and conservation. Furthermore, the National Agrometeorological Committee, under the Department of Agriculture, Land Reform and Rural Development (DALRRD), the Directorate: Climate Change and Disaster Risk Reduction, as well as the Crop Estimates Committee, utilize information from the newsletter to contextualize the ground-based information obtained from the provinces.

6. Conclusions

The Umlindi newsletter developed by the ARC provides climate-related monitoring products obtained from an integration of remote sensing and in situ data from weather stations. Remotely sensed vegetation monitoring products (based primarily on the NDVI) are used to complement the purely meteorological products (based on rainfall), as well as other products such as information on drought and the occurrence of wildfires. This sample overview of the drought conditions in South Africa demonstrates the application of the developed indicators and indices for decision-making in the disaster management and agricultural sectors. These indices have been largely useful for informing decisions to South African society as a whole; however, there is a need for further improvement, particularly through the following: (1) forecasting future environmental conditions to strengthen coping mechanisms by local governments, farmers, and communities; (2) incorporating a monitoring element for other natural disasters such as floods and heatwaves; and (3) incorporating a validation element of the remote sensing-derived indices through collaborative efforts with existing users.

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