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Application of the ANIN Drought System for Integrated Drought Monitoring in the Berg-Olifants and Breede-Gouritz Water Management Areas, South Africa

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South Africa Drought Monitoring ANIN

Outline

1. Introduction
2. ANIN Approach to Integrated Drought Monitoring in South Africa
3. Case Study Results: Breede-Gouritz Water Management Area (South Africa)
4. Case Study Results: Berg–Olifants Water Management Area
5. Conclusion
6. Recommendations

Introduction (Background)

- Droughts have significant **Social, Economic, Environmental, and Political impacts** globally, and South Africa is no exception.
- Historical data shows that droughts are a **recurring** event, and climate projections suggest that their **frequency and intensity will likely increase** in the near future.
- Extensive research has been conducted on the performance of EO (Earth Observation) Satellite-based products globally and specifically in South Africa.
- **Point-to-pixel correlation** between CHIRPS and SAWS In-Situ Rainfall data ranges from 82% to 84% across South Africa.
- At the **District level** (SAWS rainfall Districts), CHIRPS and In-Situ data show a high correlation of 92% to 94% across South Africa.

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Introduction (Goal)

- **The goal of the ANIN Drought System for Integrated Drought Monitoring in South Africa is to leverage existing knowledge of Earth Observation (EO) to create a practical and simple drought monitoring system for effective drought risk management.**

- **The system aims to integrate EO satellite-based products with current in-situ and satellite-based drought monitoring systems in South Africa.**

- **By utilizing EO products, the ANIN Drought System will improve access to drought information and facilitate near-real-time decision-making across South Africa.**

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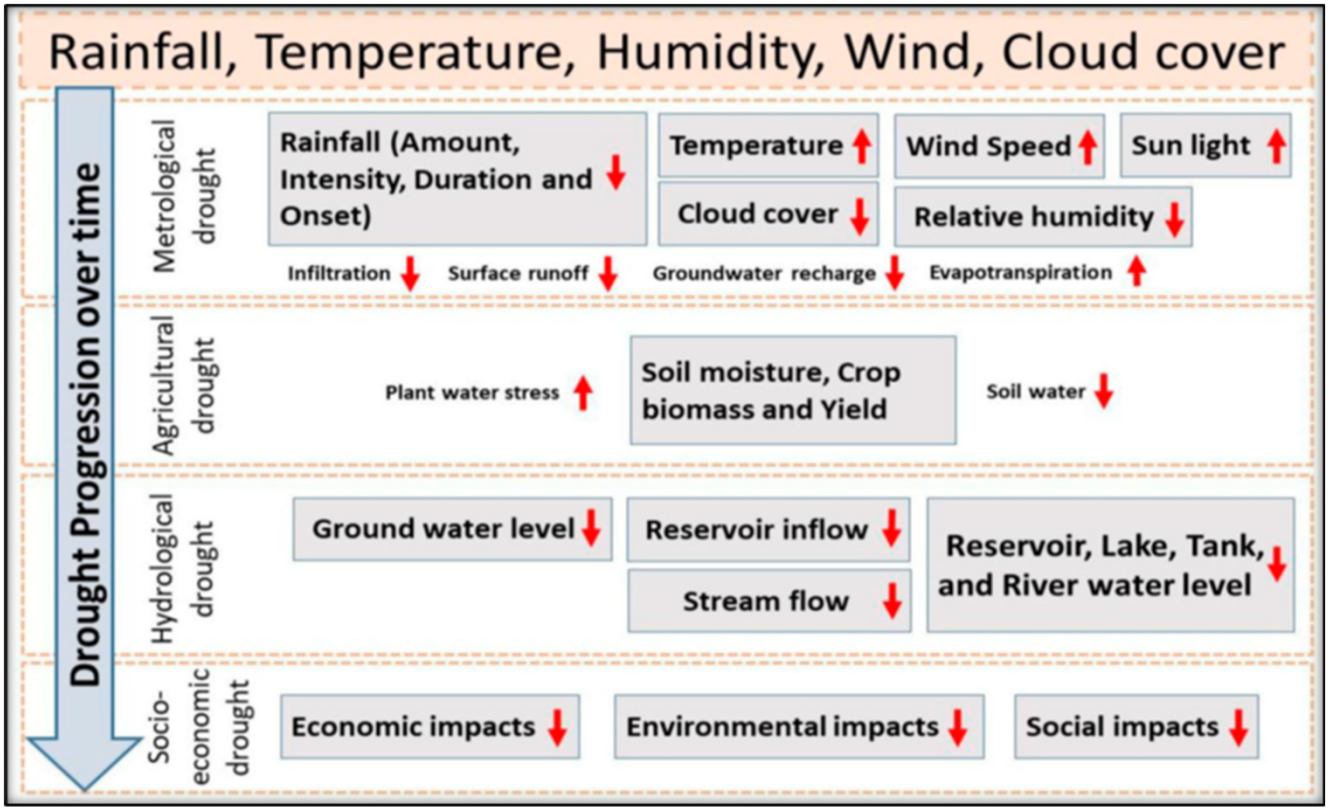
ANIN Approach to Integrated Drought Monitoring in South Africa

No single Index can account for all Meteorological, Agricultural, Hydrological, Socio-economic aspects of droughts.



Safdar et al. (2023) *https://doi.org/10.3390/ASEC2023-16602*

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Review

Review of In-Situ and Remote Sensing-Based Indices and Their Applicability for Integrated Drought Monitoring in South Africa

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- Standardize Precipitation Index (SPI)
- Standardised Precipitation-Evapotranspiration Index (SPEI)
- Vegetation Condition Index (VCI)
- Standardized Soil Moisture Index (SSI)
- Standardized Groundwater level Index (SGI)

Due to the scarcity of groundwater data, the study recommends that research be carried out to investigate the assimilation of GRACE information to generate GRACE-based groundwater drought indices in SA.

Hence, when combined, and with suitable best fitting distributions used, and informed choice between parametric and/or non-parametric approaches, the combination of the SPI, SPEI, VCI, SSI, and SGI have the potential to produce comprehensive and integrated drought monitoring and early warning information system in SA. Hence, this study calls for an improved approach for monitoring of droughts in SA, which is the integrated approach, using the combination of the SPI, SPEI, VCI, SSI, and the SGI. To achieve this, this review study recommends that investigations be carried out to evaluate the performance and applicability of both the linear ADI and the non-linear BDI to combine the SPI, SPEI, VCI, SSI, and the SGI for integrated drought monitoring in SA. It

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ANIN Approach to Integrated Drought Monitoring in South Africa

Integration of Remote Sensing and In-Situ-based Meteorological, Agricultural and Hydrological Drought Indices

SPI $= \frac{\mathrm{P-MeanP}}{\sigma_p}$ [**P** ≡ Precipitation for the given period: σ_p ≡ Standard Deviation] **[Meteorological]**

SPEI uses water balance method ≈ $D = P - PET$ [**PET** ≡ Potential Evapotranspiration] **[Meteorological]**

VCI $= \frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}}$ [$NDVI$ ≡ Current NDVI $NDVI_{min}$ ≡ Minimum NDVI $NDVI_{max}$ ≡ Maximum NDVI] **[Agricultural]**

CDI monitors regions that are either experiencing or prone to agricultural drought [Resolution ≈ 300m] **[Agricultural]**

SPI SPEI	ERA5-Land	TAMSAT	VCI	Base line- MOD13Q1 (Terra MODIS)	Copernicus Global Land Service Sentinel-3 OLCI
Spatial resolution	9 km	4 km	Spatial resolution	250m	300m
Temporal resolution	Monthly	Monthly	Temporal resolution	16 days	10 days
Temporal coverage	1980 - Present	1983 - Present	Temporal coverage	2000 - 2020	2020 - present
Data format	NetCDF	NetCDF	Data format	hdf	Geo tiff

Parameter Index Data sources	Parameter Index Data sources	Parameter Index Data sources
Precipitation	SPI	Precipitation: ERA5-Land
Soil Moisture	SMA	JRC (Joint Research Centre)
Vegetation Condition	FAPAR Anomaly	FAPAR: GLASS (historical) / Copernicus (Real time)

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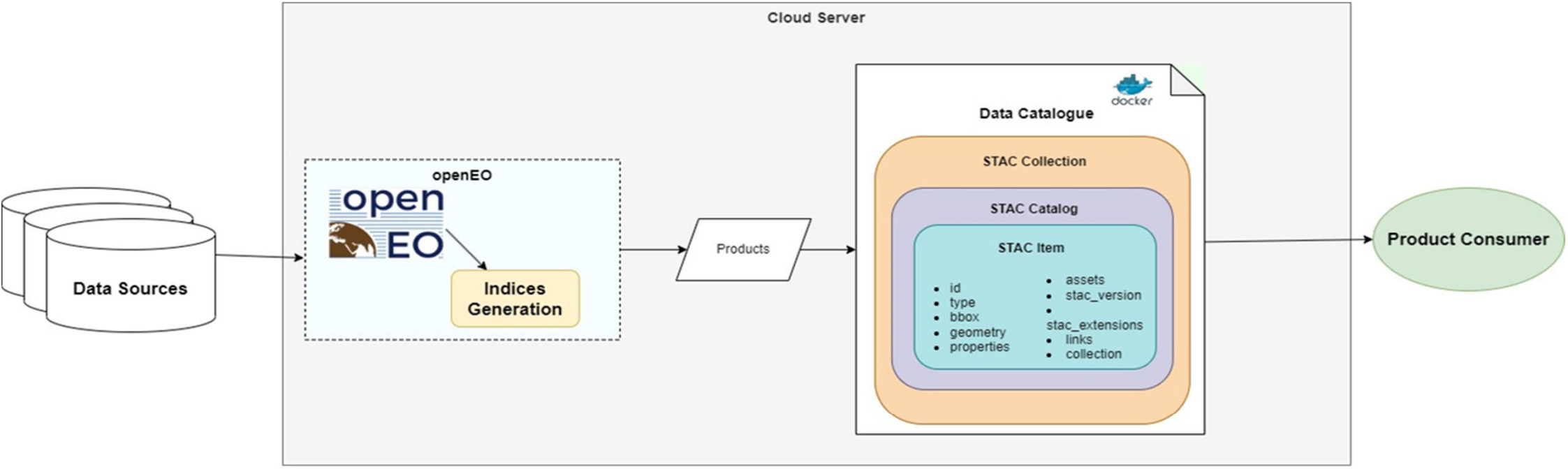

- Cloud based architecture
- OpenEO for data processing
- Data Catalogue for data hosting

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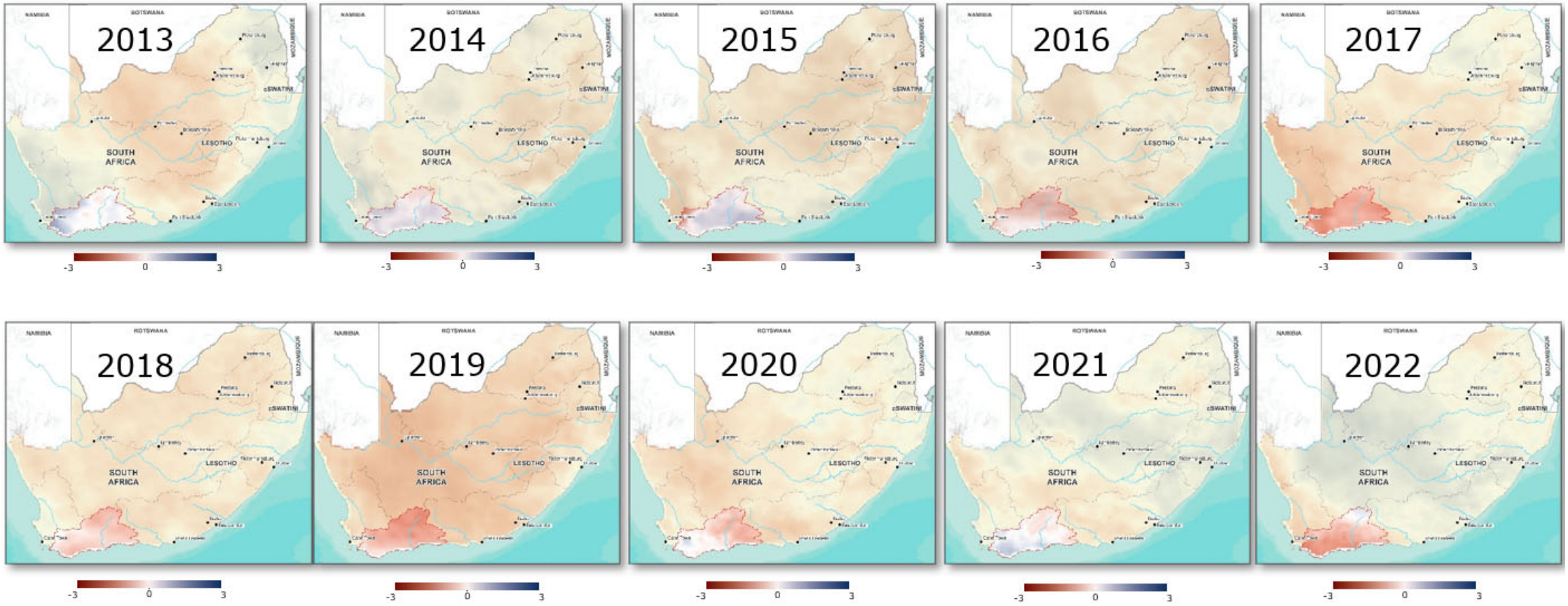
Case Study Results
SPI Breede-Gouritz WMA (2013-2022)



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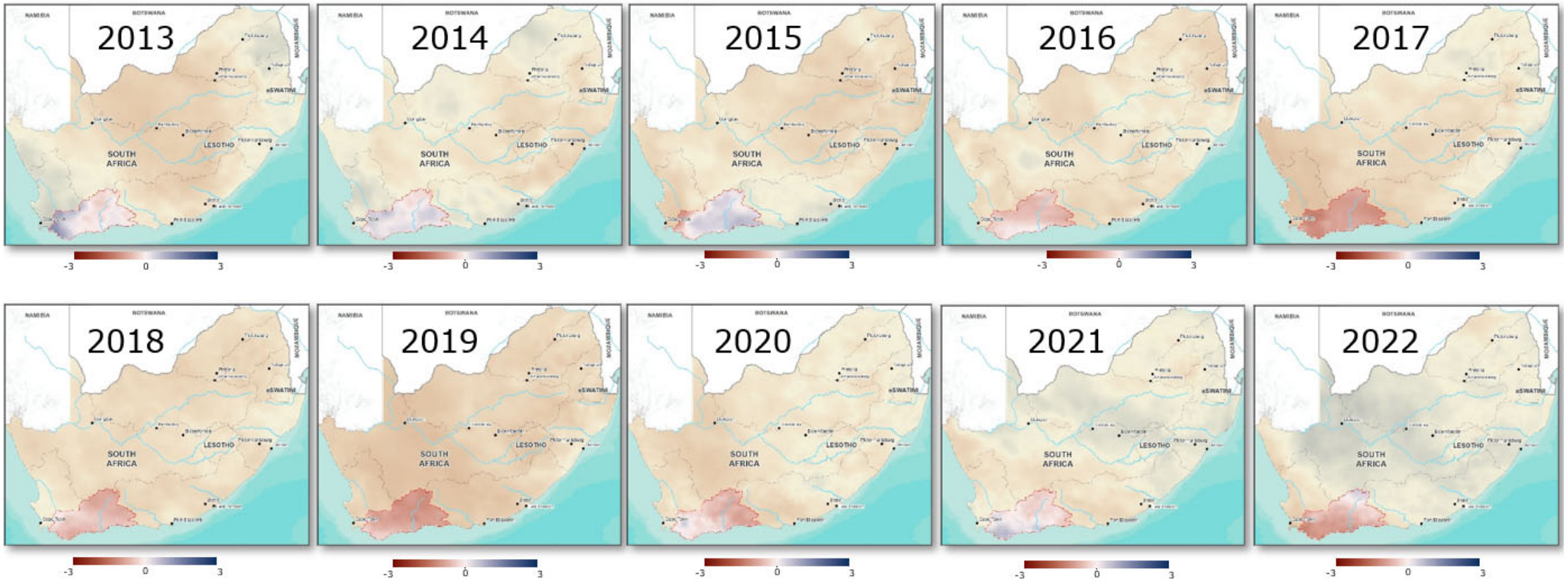
Case Study Results
SPEI Breede-Gouritz WMA (2013-2022)



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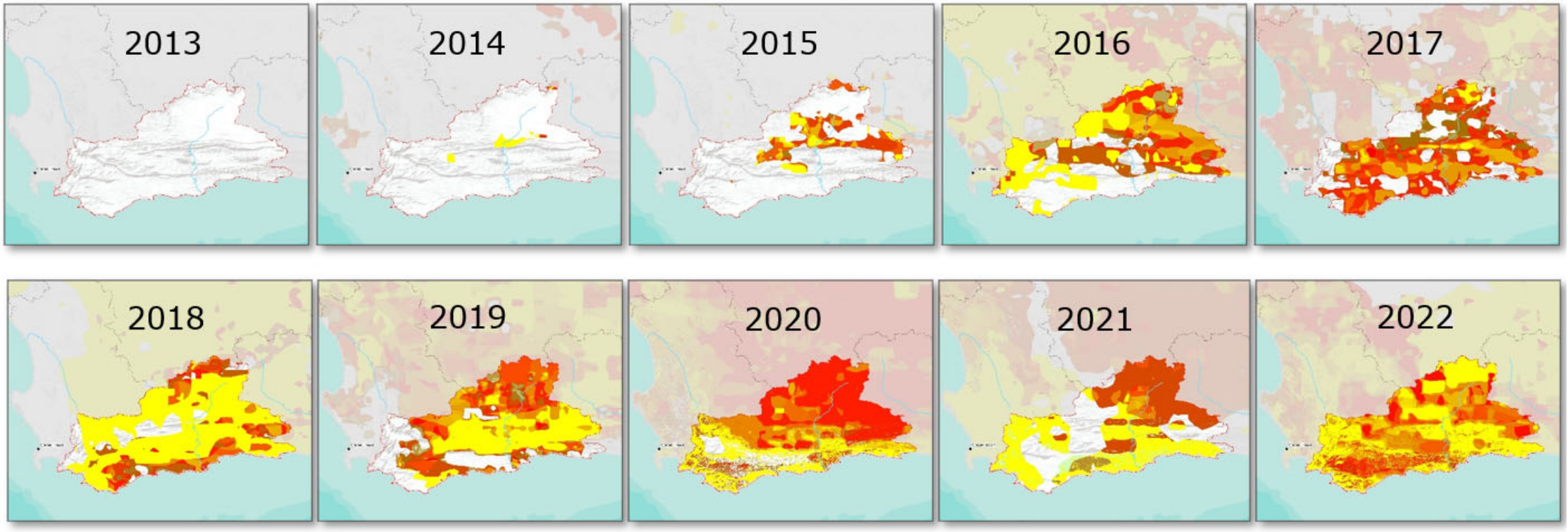
Case Study Results
CDI Breede-Gouritz WMA (2013-2022)



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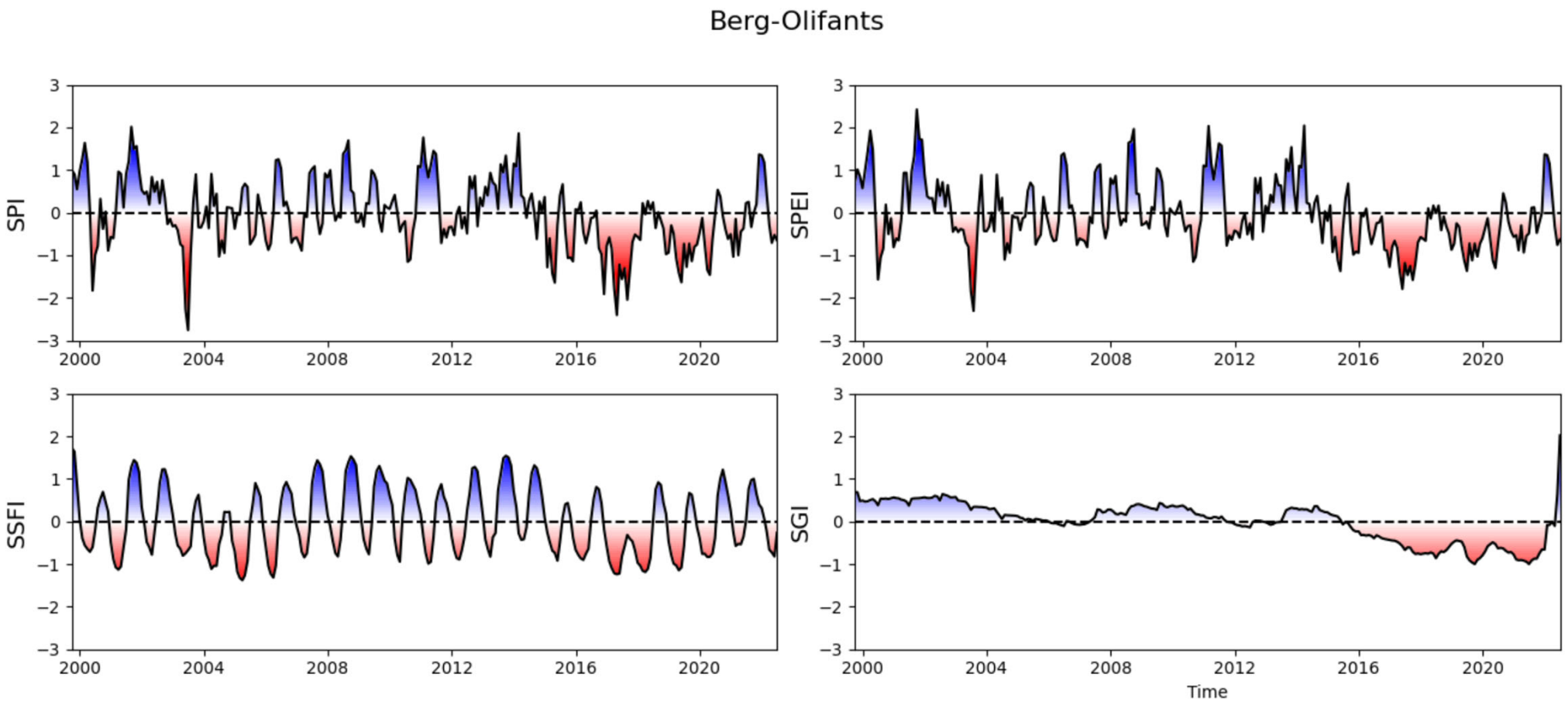
Case Study Results
Berg–Olifants WMA (2000 – 2022)



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Conclusion

- **Correlation between the SPI, SPEI, CDI, SSI, and SGI suggest that the EO Satellite-based products may be used to identify and monitor Meteorological, Agricultural, and Hydrological drought prone (hot-spots) in South Africa.**
- **It also implies that EO Satellite-based products may be used to generate early warning drought information for surface and groundwater-based droughts in South Africa.**
- **Groundwater resources appear to be more resilient to climate induced droughts compared to surface water resources.**
- **Research conducted indicates that the groundwater-based droughts in the Berg-Olifants and Breede-Gouritz MWAs were exacerbated by increase in groundwater abstractions during the 2015 and drought events in the Western Cape province of South Africa.**

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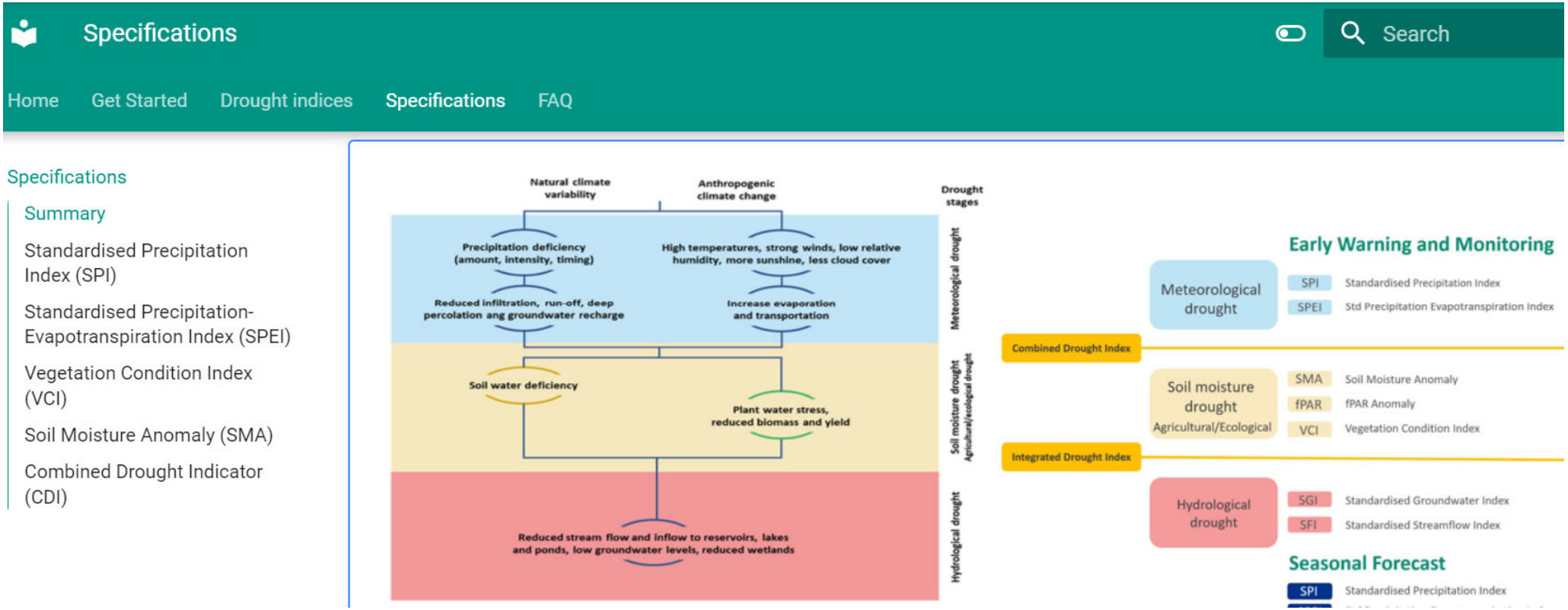
Recommendations

- **Up-to-date ANIN Drought Handbook**



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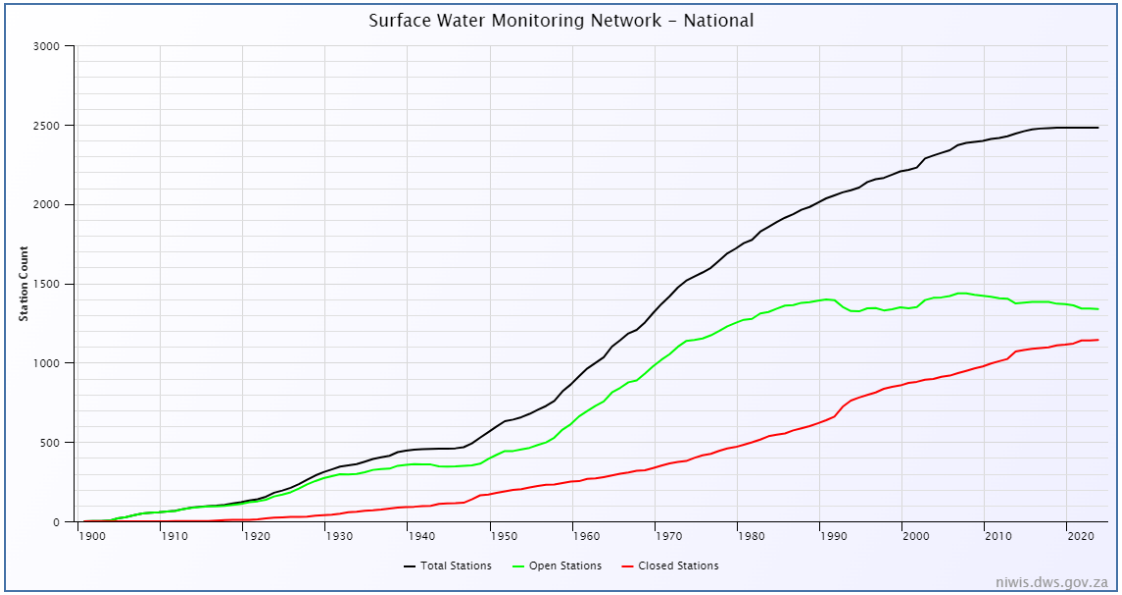
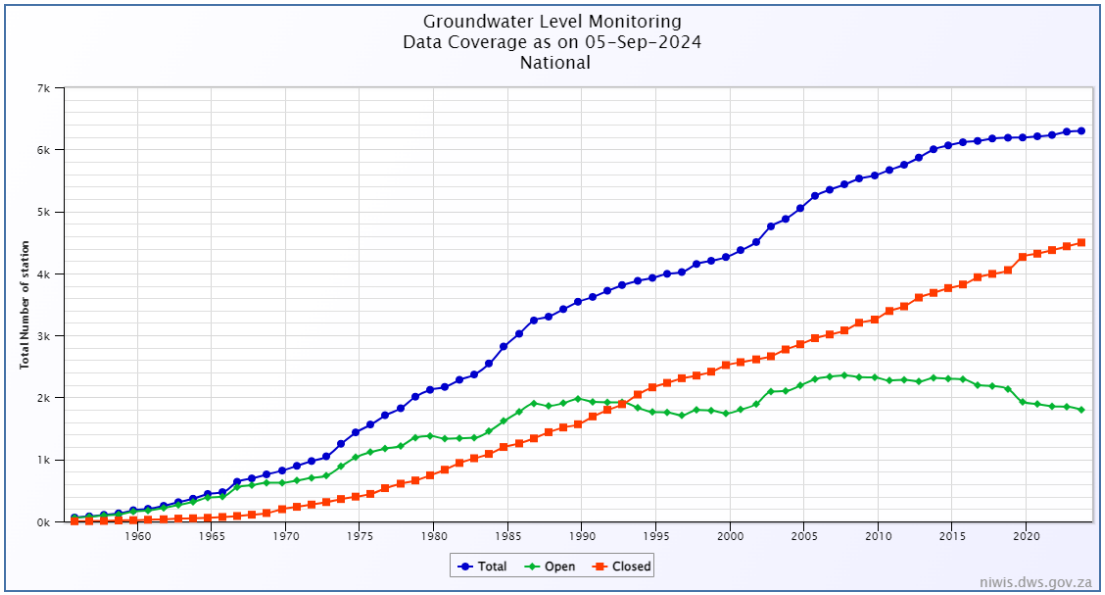
Recommendations

- **Research on EO Satellite-based products to generate streamflow-based drought information?**
- **Research on EO Satellite-based products to generate groundwater-based drought information?**
  - ***To mitigate data scarcity due to vandalism, remoteness, insufficient spatial distribution of streamflow and groundwater monitoring networks.***





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END

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