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# High-resolution drought monitoring with Sentinel-1 and ASCAT data: A case-study over Mozambique

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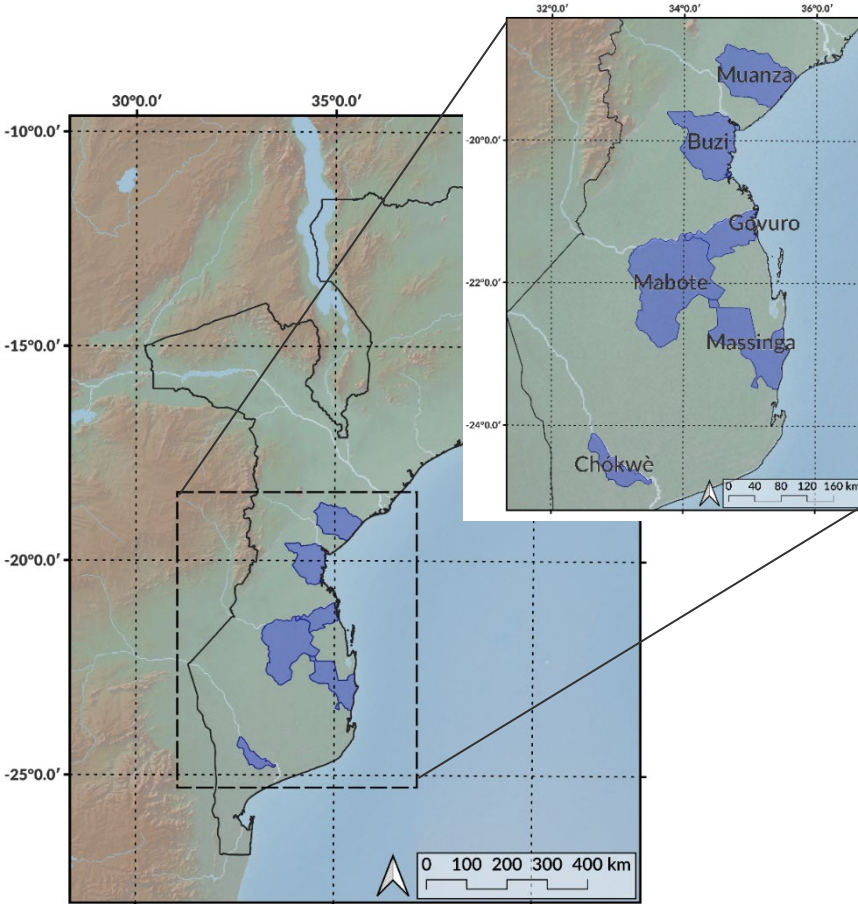


Programme  
Alimentaire  
Mondial

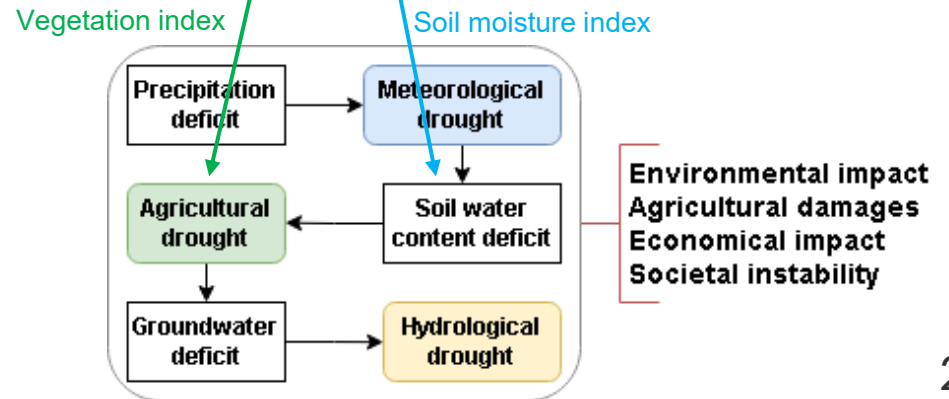


Austrian  
Development  
Agency

# Introduction: The DrySAT project



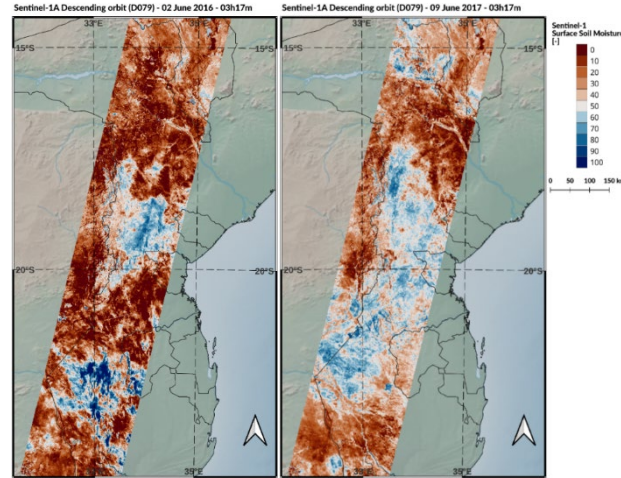
- Objective: Developing satellite **drought** indicators at a **kilometer** scale resolution over **Mozambique**
- Satellites: Sentinel-1 and ASCAT
- Spatial extent: Chokwé, Massinga, Mabote, Govuro, Buzi, Muanza



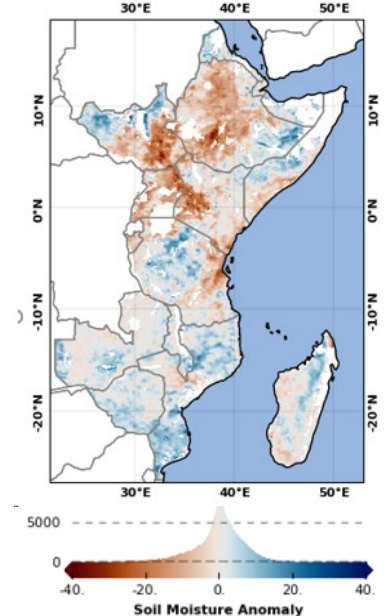
# Surface soil moisture products [%] [0-5cm]

- Sentinel-1
  - 500 m sampling
  - Change detection model
- Metop ASCAT
  - 6.25 km sampling
  - Change detection model
- **Validation dataset**
  - ERA5-Land
    - surface soil moisture
    - 9 km resolution
    - 0-7 cm top-soil layer
  - SMAP
    - Passive microwave satellite
    - 9 km resolution at daily revisit time

Comparison of Sentinel-1 SM for two scenes in 2016 and 2017 in June

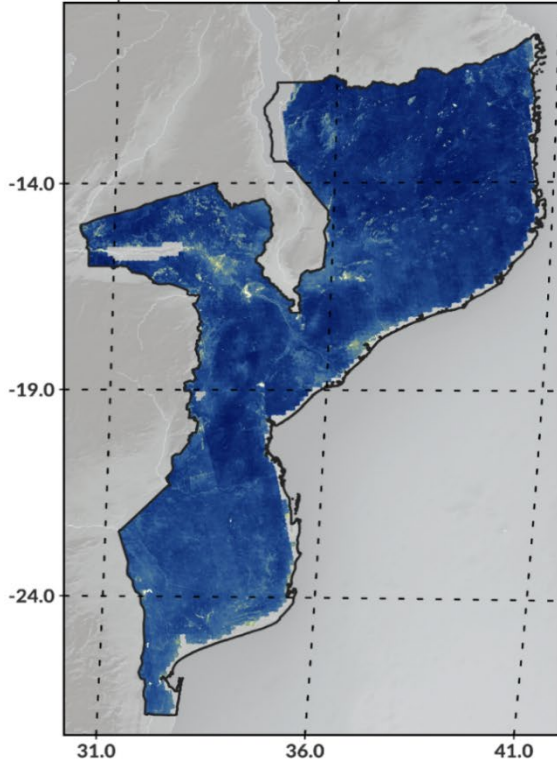


Example of ASCAT ssm anomalies

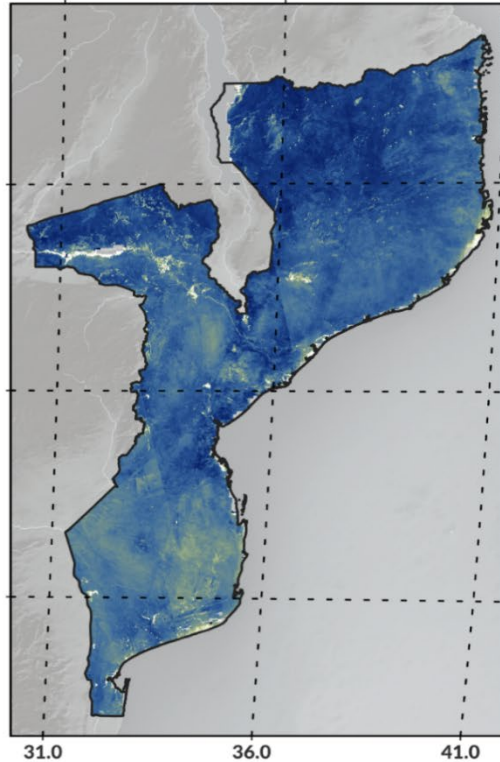


# Surface soil moisture analysis

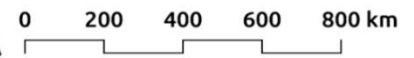
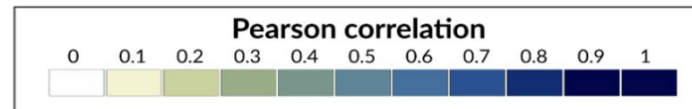
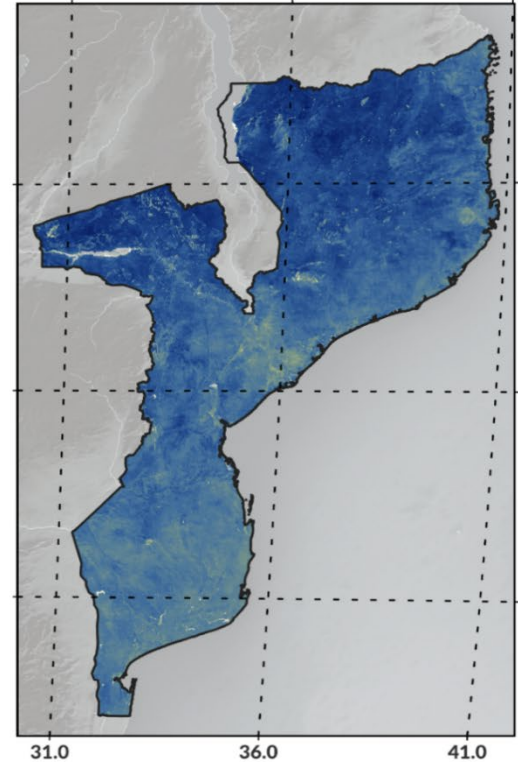
Correlation S1 - ASCAT



Correlation S1 - SMAP



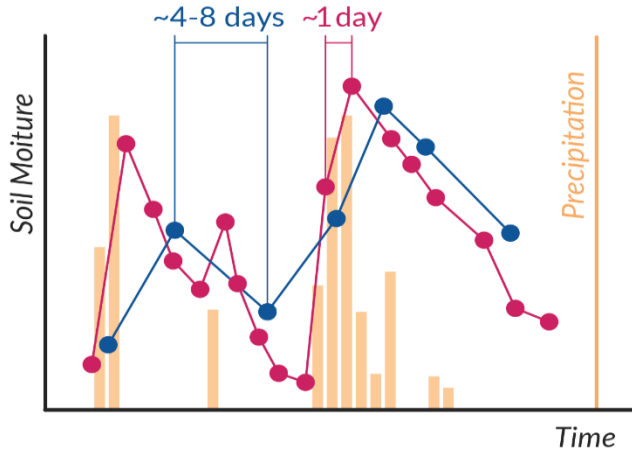
Correlation S1 - ERA5



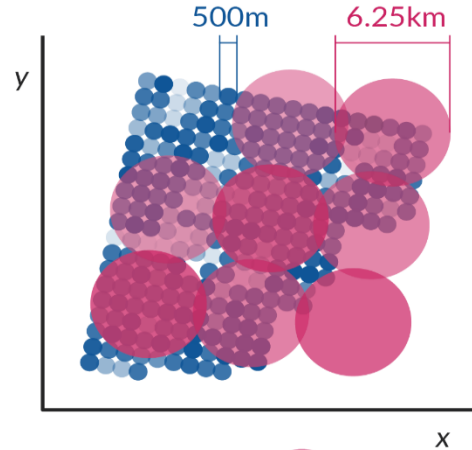
# From soil moisture to S1/ASCAT anomalies

## Scale Gap in Soil Moisture Remote Sensing

a) Temporal Scale Gap



b) Spatial Scale Gap



$$\Delta^{S_1} = SSM_{S_1} - \overline{SSM_{ASCAT}}$$

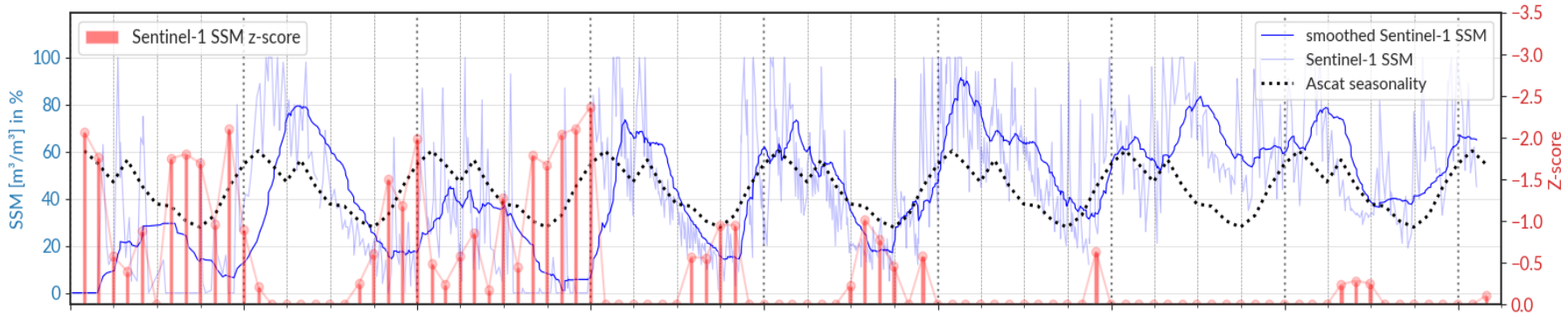
$$Zscore^{S_1} = \frac{\Delta^{S_1}}{\sigma^{S_1}}$$

- $\overline{SSM_{ASCAT}}$  : ASCAT SSM seasonality
- $SSM_{S_1}$  : Sentinel SSM
- $\Delta^{S_1}$  : SSM anomaly
- $\sigma^{S_1}$  : SSM<sub>S1</sub> standard deviation

\*(Adapted from Bauer-Marschallinger et al. 2018)

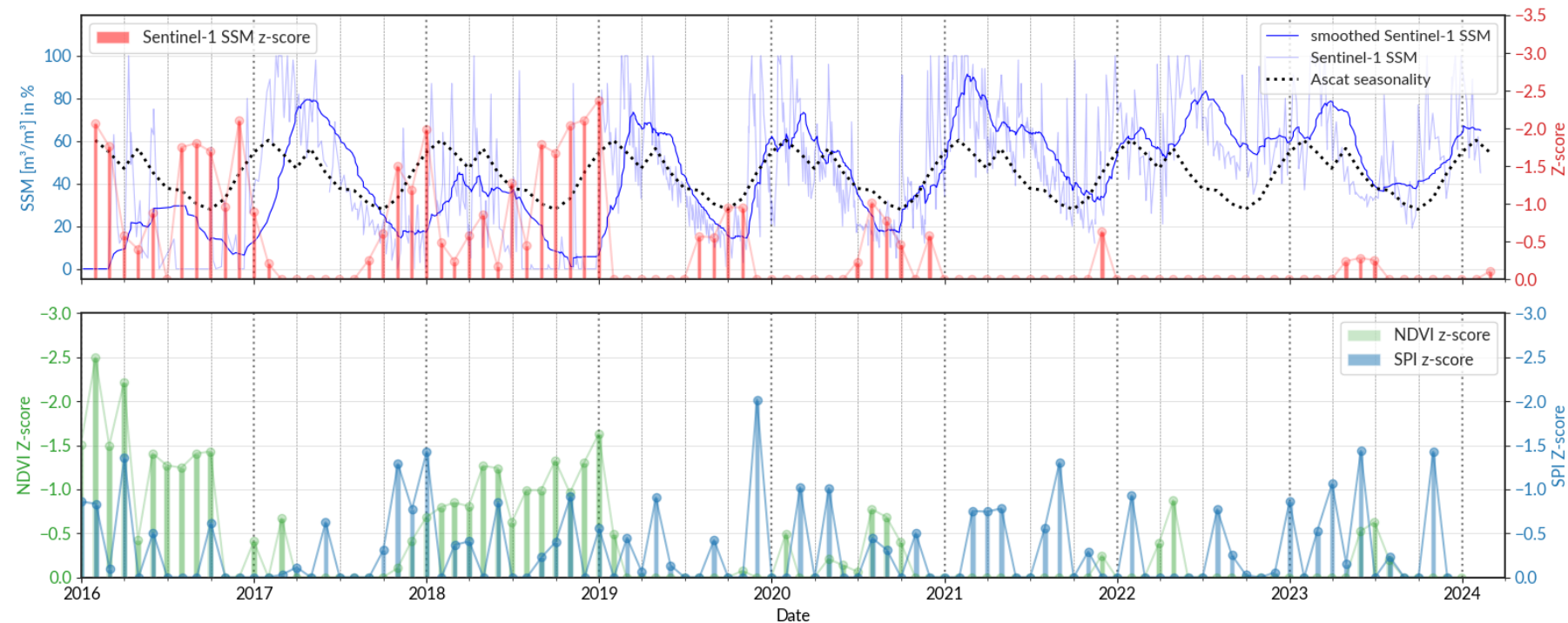
- Combination of Sentinel-1 and ASCAT
  - Rely on **ASCAT SSM seasonality**
  - Independent of auxillary data

# Example for a pixel over Chokwé



- Monthly climatology are derived from the long term **ASCAT** timeseries
- **S1SSM** is temporally smoothed and averaged monthly
  - Negative Z-score values means the observed **S1SSM** is lower than the expected values from the climatology for a given month

# Comparison to precipitation and vegetation anomalies

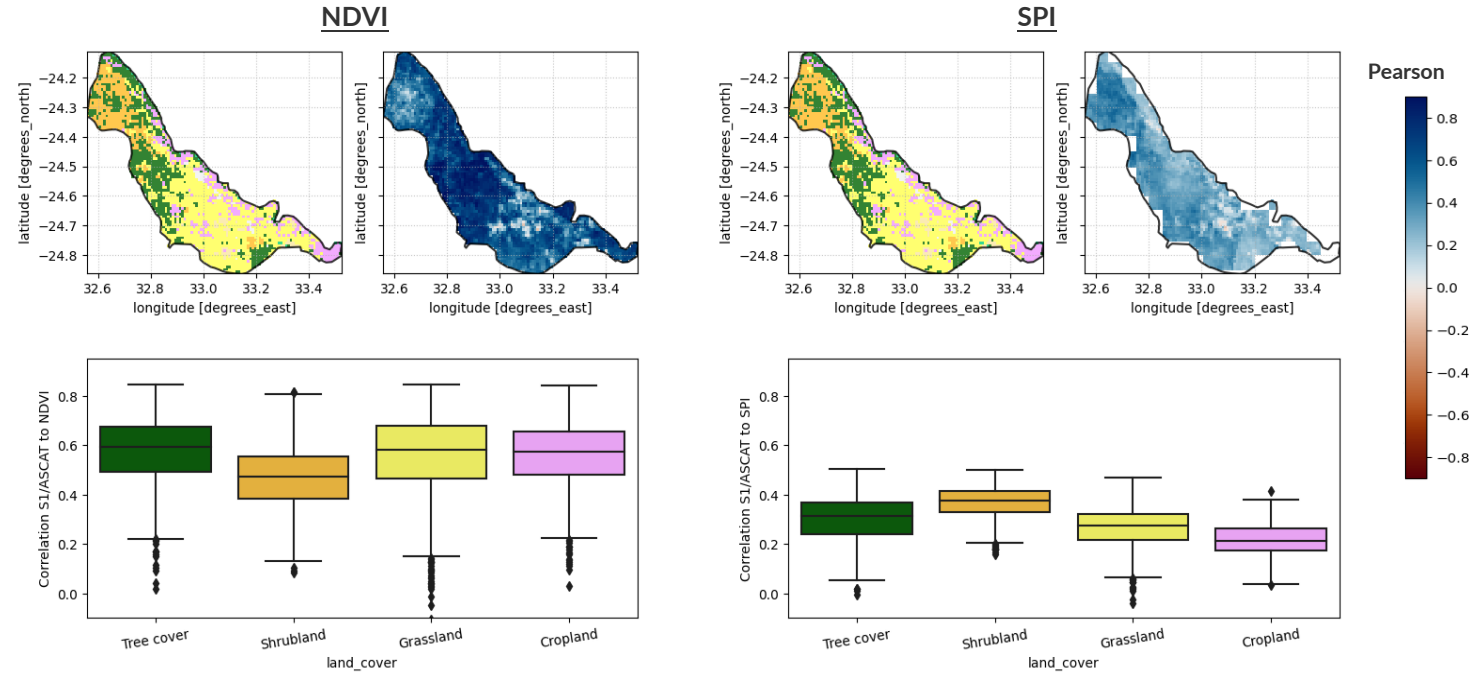


## ■ Datasets

- Z-score based on **NDVI** anomalies (From Copernicus Global Land Service - CGLS)
- Z-score based on **standardized precipitation index** (Climate Hazards Group InfraRed Precipitation with Station data – CHIRPS)

# Correlation between S1/ASCAT Z-scores and NDVI/precipitation Z-scores

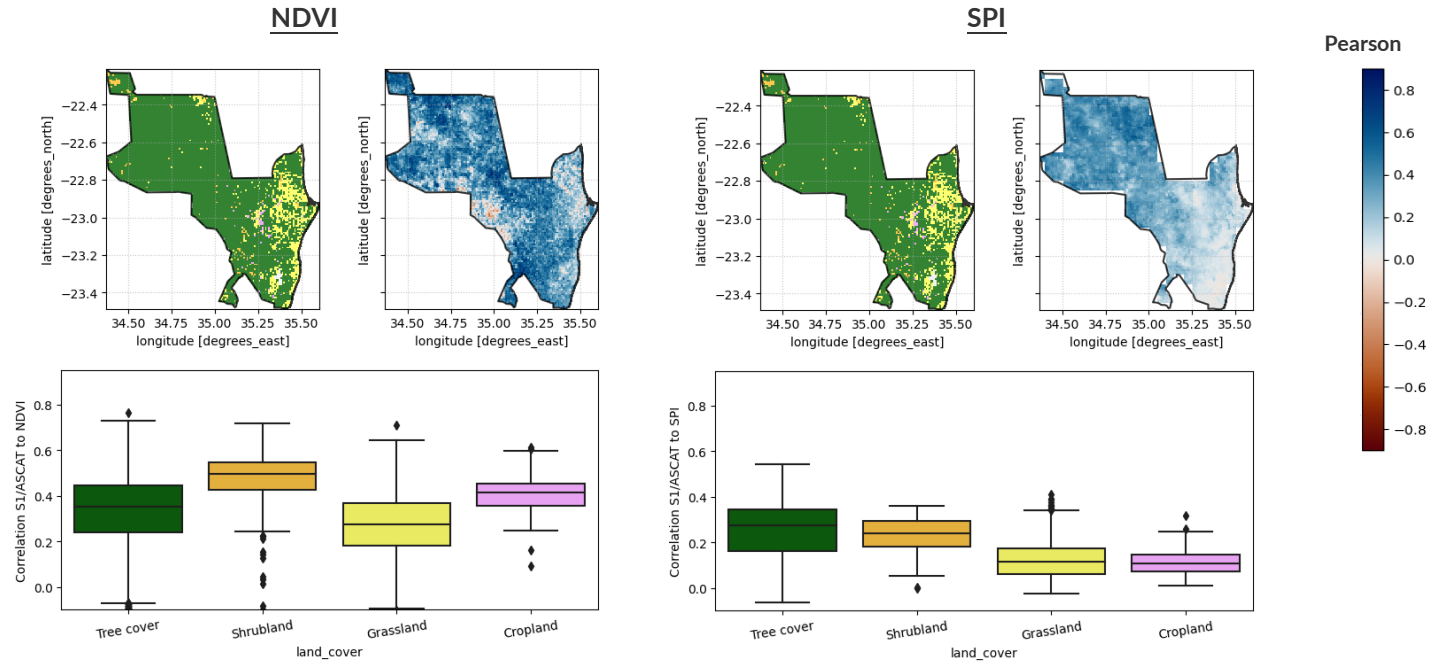
Chokwé



- Correlation between soil moisture anomalies, vegetation anomalies and precipitation anomalies during the growing season:
  - NDVI and Sentinel-1/ASCAT Z-scores have high correlation
  - SPI and Sentinel-1/ASCAT Z-scores are lower but still positive



Massinga

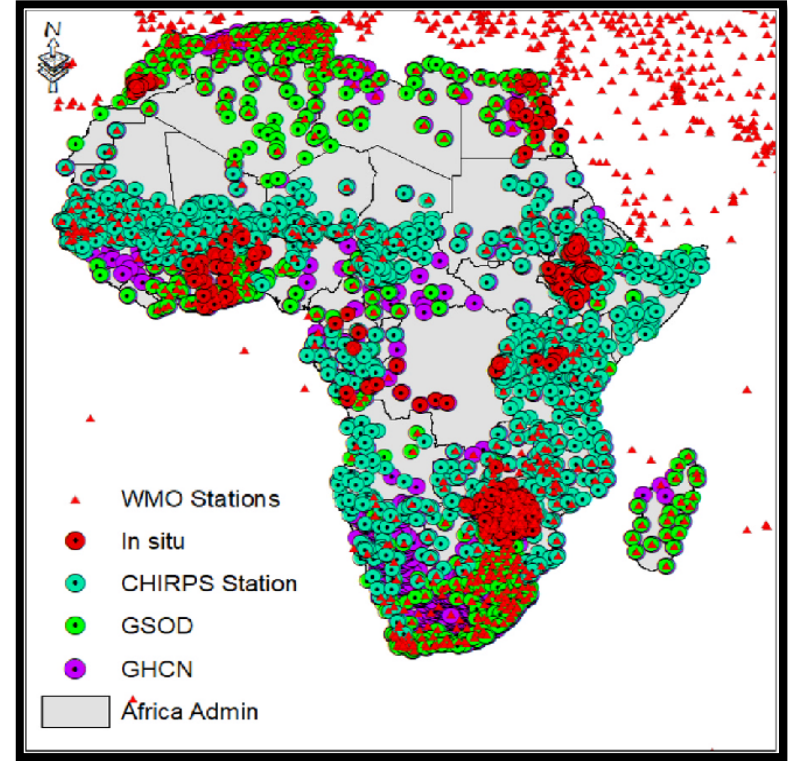


- Correlation between soil moisture anomalies, vegetation anomalies and precipitation anomalies during the growing season:
  - NDVI and Sentinel-1/ASCAT anomalies have high correlation
  - SPI and Sentinel-1/ASCAT anomalies are lower but still positive

# Lack of in-situ data



“**Soil moisture** stations in Africa over the last 30 years (International Soil Moisture Network)”



Available **precipitation** stations in Africa over the last 30 years

# In-situ validation

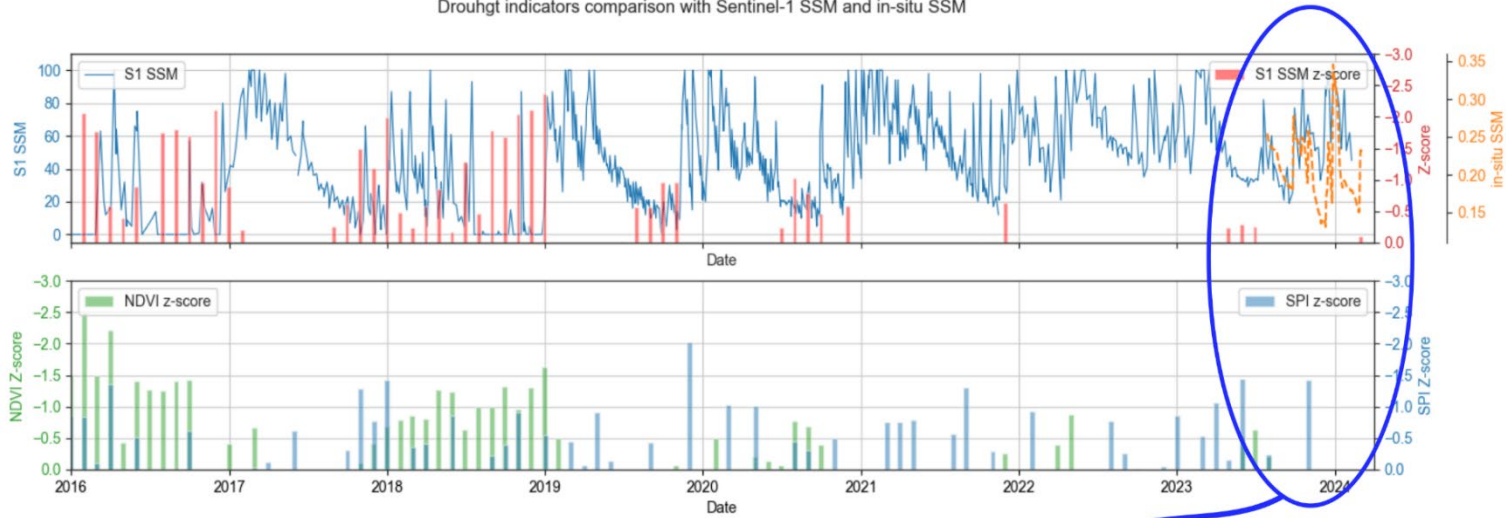
## 5 soil moisture stations

- 3 different depths:
  - 10 cm
  - 20 cm
  - 50 cm

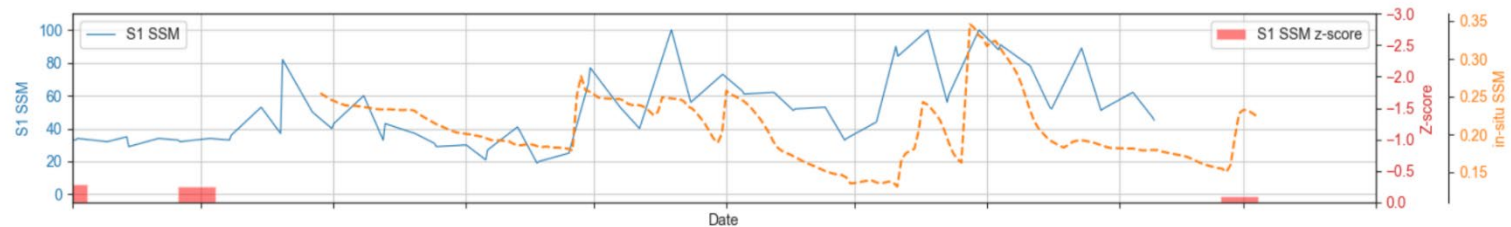


# Early comparison

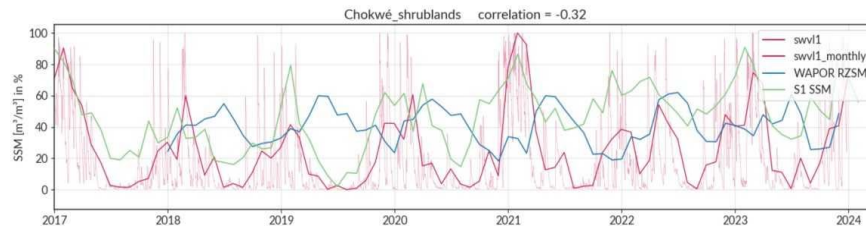
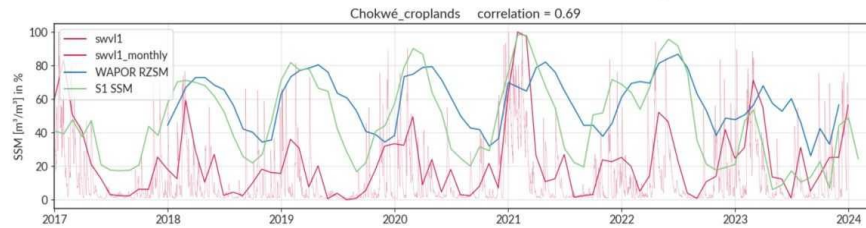
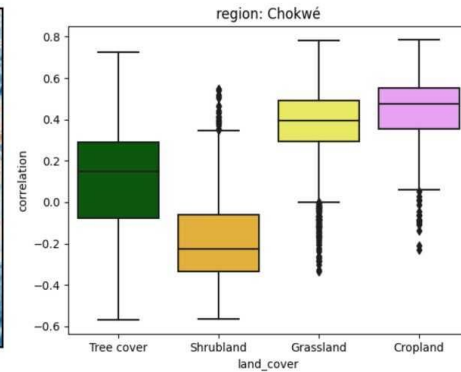
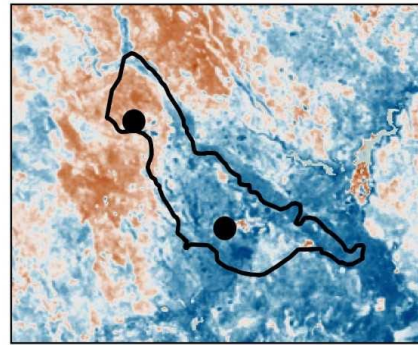
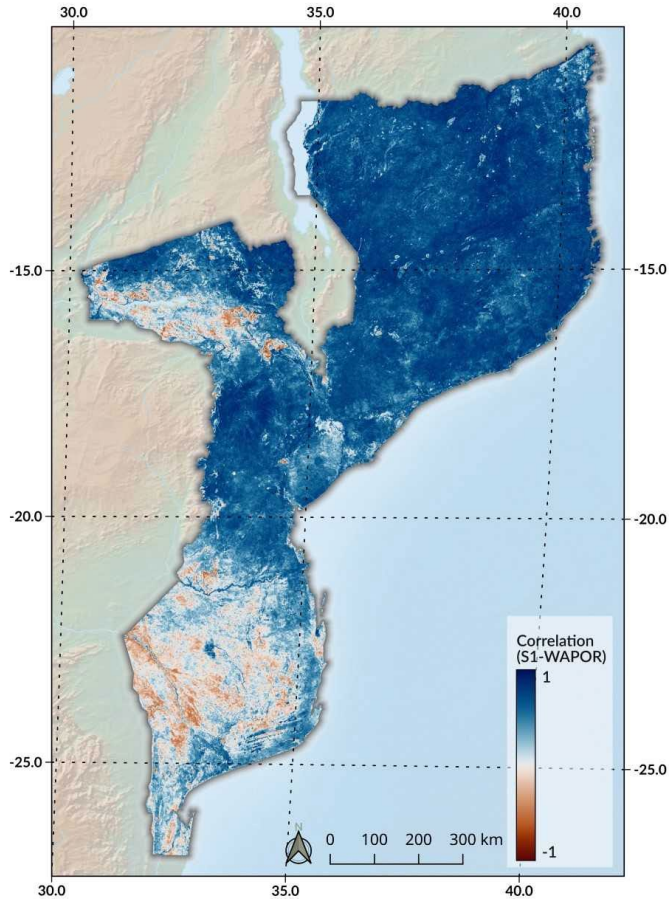
Drought indicators comparison with Sentinel-1 SSM and in-situ SSM



Drought indicators comparison with Sentinel-1 SSM and in-situ SSM

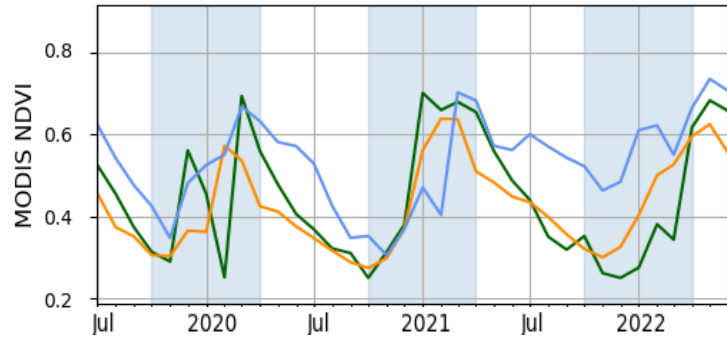
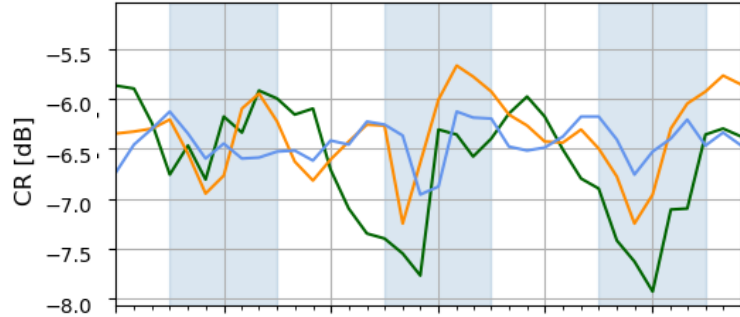


# Alternative validation with WaPOR



# Sensitivity of S1 Cross Ratio (CR) to vegetation dynamics

Cropland



— Govuro — Mabote — Massinga — Typical rain and cyclone season



Govuro



Massinga



Mabote

Google Earth view from plotted pixels in right figure. Retrieved [September 2, 2024] from <https://www.google.cn/maps/vt?lyrs=s@189&gl=cn&x={x}&y={y}&z={z}>

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## Thank you for your attention !

**Link to the viewer**