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Towards long-term forecasts of agricultural droughts in Africa

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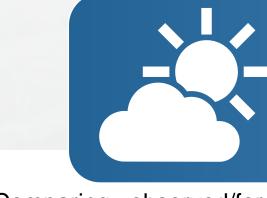
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OBJECTIVES

⚙ Developing a method to **forecast agricultural droughts** well in advance, so local farmers can **anticipate** in a timely manner

❗ Providing an **early warning system** which generates alerts for agricultural droughts in Africa at different time horizons

🌱 Strengthening the resilience and preparedness of local African communities to the occurrence of potential food security crises.

Meteorological Drought
Lower precipitation than expected
→ Forecasts regularly provided by national weather forecasting services

Comparing observed/forecasted precipitation (SPI) or potential evapotranspiration (SPEI) values with those of multi-year observations for the same moment in the year.

e.g. SPI = -2 → The observed precipitation is 2 standard deviations below the multi-year average precipitation at this moment in the year
→ exceptionally dry conditions

$$g(x_t) = A + \frac{K - A}{(C + Q e^{-B x_t})^{1/v}}$$

→ a fitted generalized logistic function was used to describe SPI distribution

Agricultural Drought
Lower vegetation productivity than expected
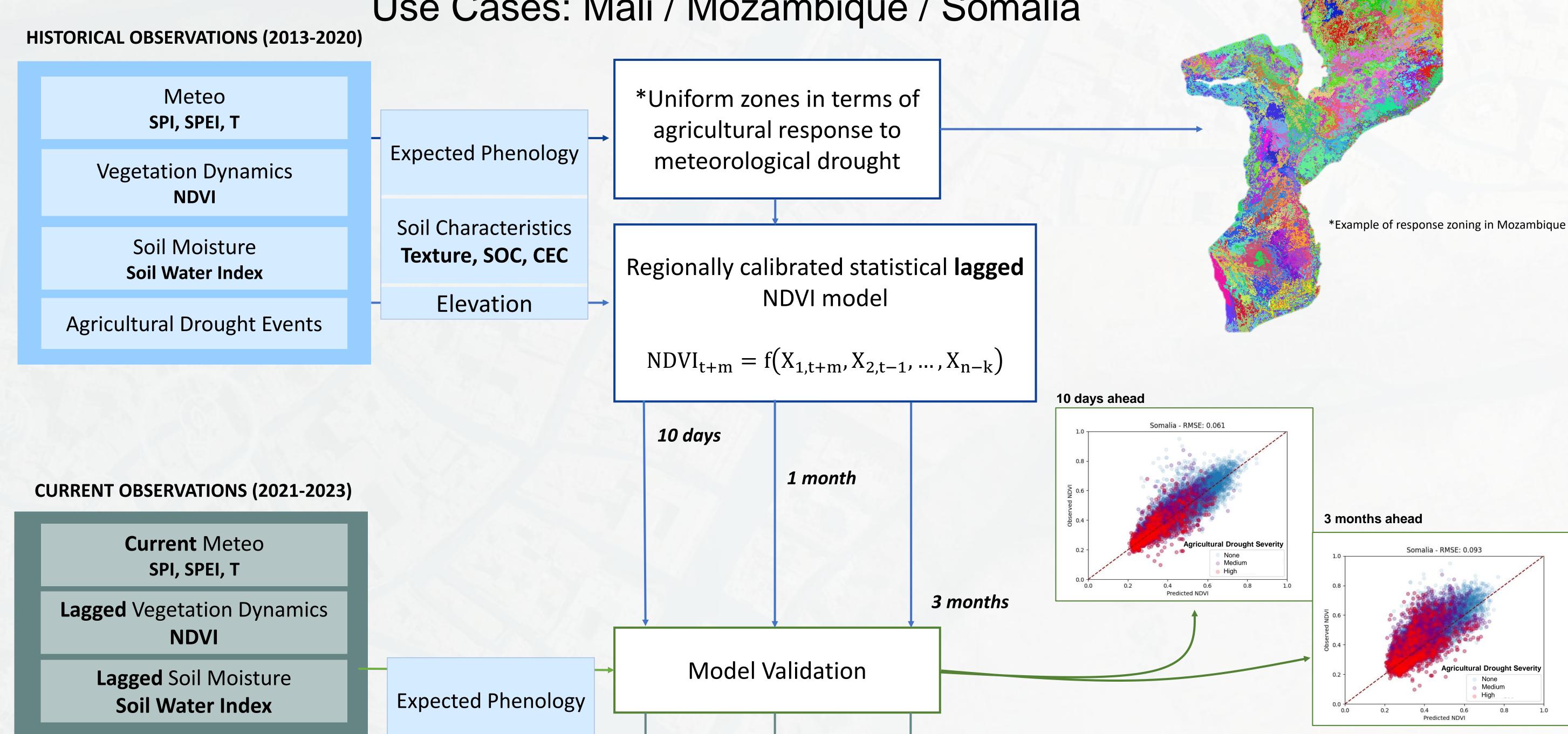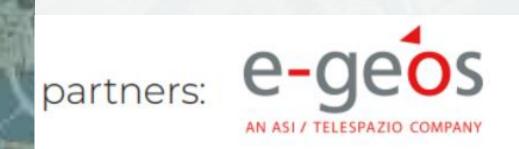→ Currently only applications exist that describe historical events

Comparing observed NDVI values with those of multi-year observations within the same crop production zone* for the same moment in the year

NDVI ≤ p15 → Mild Drought

NDVI ≤ p05 → Severe Drought

Use Cases: Mali / Mozambique / Somalia

HISTORICAL OBSERVATIONS (2013-2020)

- Meteo **SPI, SPEI, T**
- Vegetation Dynamics **NDVI**
- Soil Moisture **Soil Water Index**
- Agricultural Drought Events

- Expected Phenology
- Soil Characteristics **Texture, SOC, CEC**
- Elevation

*Uniform zones in terms of agricultural response to meteorological drought

*Example of response zoning in Mozambique

Regionally calibrated statistical **lagged** NDVI model

$$NDVI_{t+m} = f(X_{1,t+m}, X_{2,t-1}, \dots, X_{n-k})$$

10 days

1 month

3 months

10 days ahead

Somalia - RMSE: 0.061

Agricultural Drought Severity
None
Medium
High

3 months ahead

Somalia - RMSE: 0.093

Agricultural Drought Severity
None
Medium
High

CURRENT OBSERVATIONS (2021-2023)

- **Current** Meteo **SPI, SPEI, T**
- **Lagged** Vegetation Dynamics **NDVI**
- **Lagged** Soil Moisture **Soil Water Index**

- Expected Phenology
- Soil Characteristics **Texture, SOC, CEC**
- Elevation

FORECASTS (2024-…)

- Meteo **SPI, SPEI, T**

Model Validation

Future drought impact on vegetation productivity

Integration into Copernicus Early Management System (CEMS)