Leibniz Centre for Agricultural Landscape Research (ZALF)

# Earth Observation Based Digital Twin for Resilient Agriculture Under Multiple Stressors

*ESA Living Planet Symposium*

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# INTRODUCTION

EO.AGRI.TWIN

To create a comprehensive **virtual replica of agricultural systems,** at multiple scales, with a focus on agriculture under **multiple stressors,** and to deliver **Digital Twin** to support monitoring of crop condition, simulation of growth dynamics and production under different conditions and stress factors.

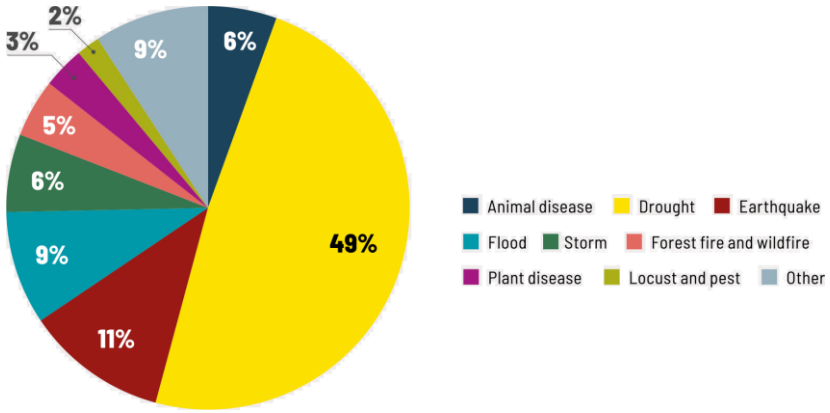
**Project Duration:** November 2024 - November 2026

# INTRODUCTION

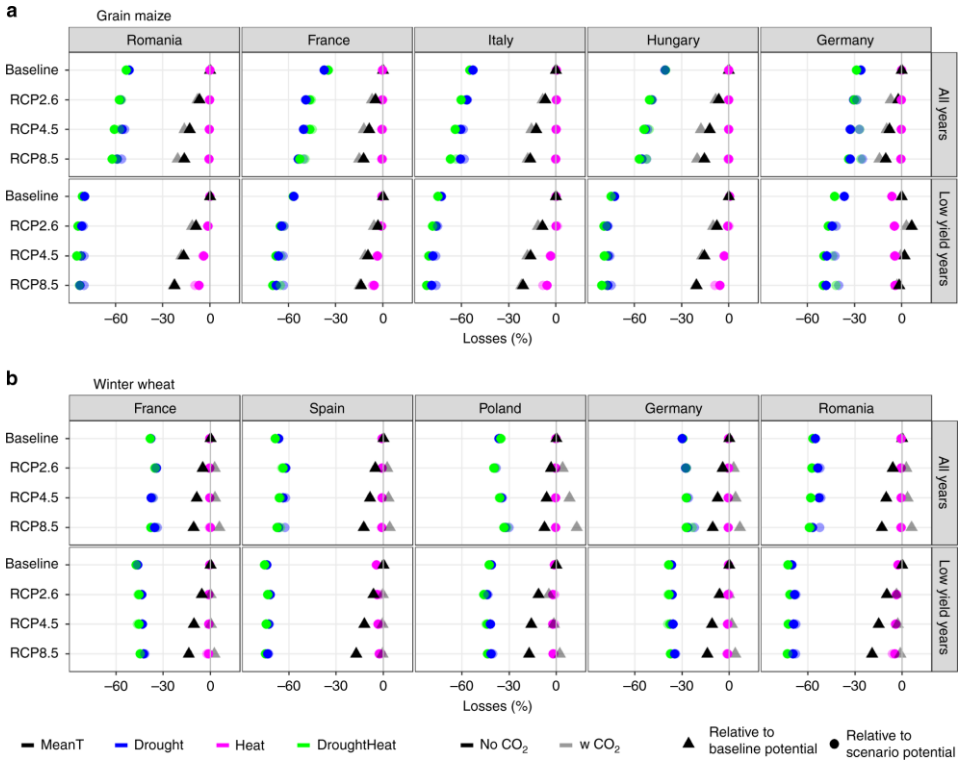

**Thematic Focus Points:**

- Drought and Heat Stress impact monitoring and modelling
- Pest and Disease Assessment
- Drought impact under different management (e.g. irrigation)
- Impact of stressors on yield, resilience and sustainability

# BACKGROUND

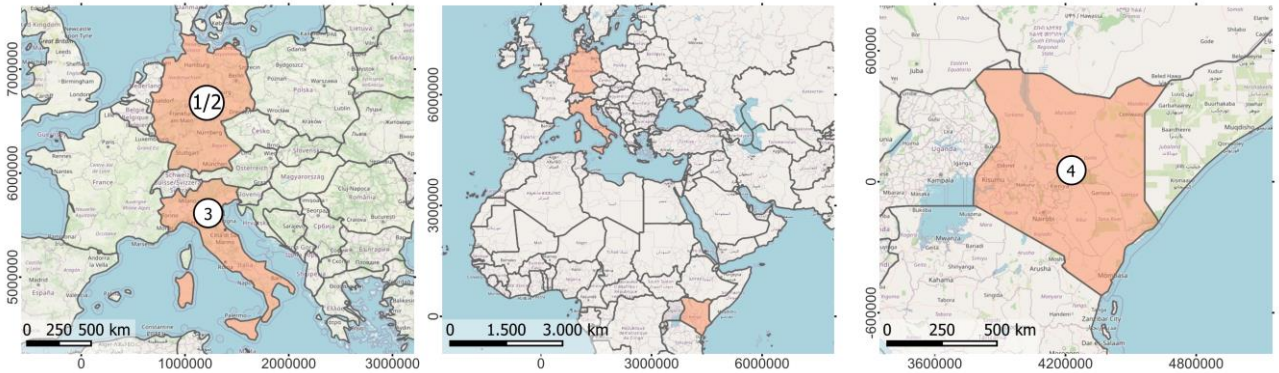



*Share of impact on agriculture by hazard type declared under Sendai framework (2015-2022)* *(FAO,2023)*




Drivers of yield losses in average and low-yielding years for rainfed systems *(Webber et al., 2018)*

# WHAT-IF SCENARIOS




1. Crop specific drought and heat risk
2. Field-level crop water consumption
3. Drought and disease impact assessment
4. Push-pull and alternatively controlled cereal-based cropping systems


## What if

**Rainfall patterns and dry spells affect disease spread and yield?**
**Irrigation is applied?**
**Droughts become more intense?**
**Heat waves occur earlier?**

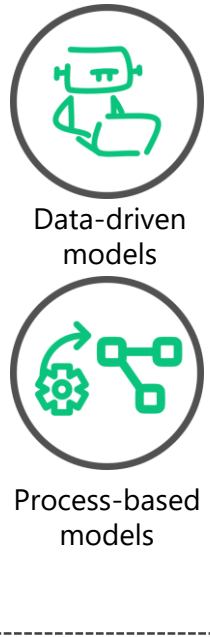
Stakeholder needs, feedback, and integration drives the development.

# MAIN COMPONENTS

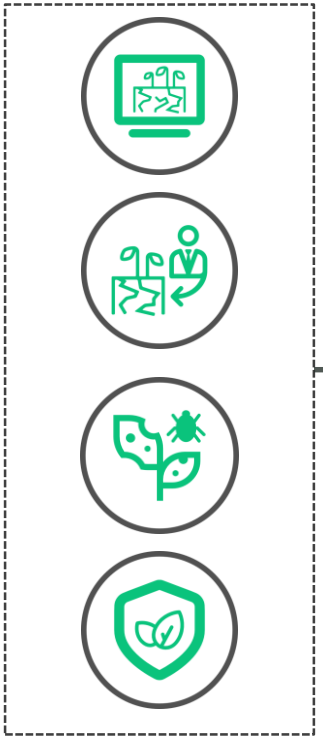
Sentinel-1/2
Sentinel-3
Landsat
MODIS
EnMap

Yield, irrigation, management, pests and disease






HPC & Cloud



Impact assessment
Validation and
Uncertainty assessment



Visualization Dashboard

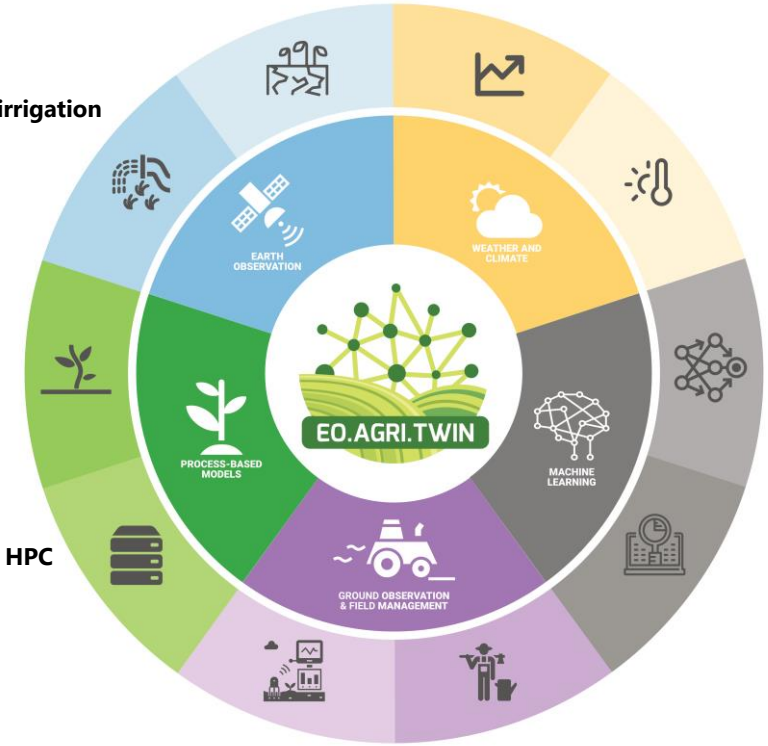
Users

Drought and heat

Impact of irrigation

Maize, Wheat,
Tomato, Potato

HPC

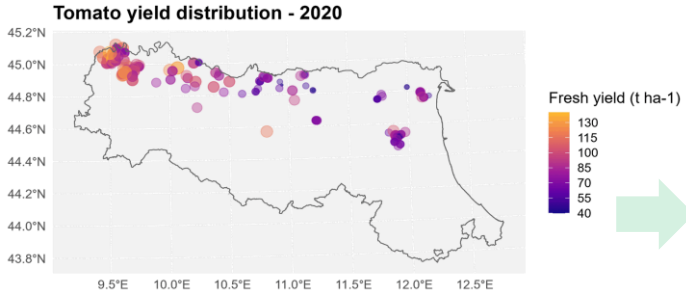



Impact of management: intercropping


Destination Earth

# FIELD LEVEL MAPPING

Early crop mapping



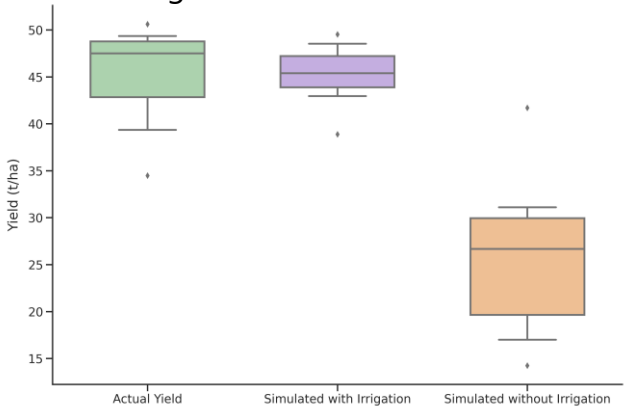

Biomass and crop condition monitoring using Light Use Efficiency

Field delineation with preliminary prediction from PTAViT3D model

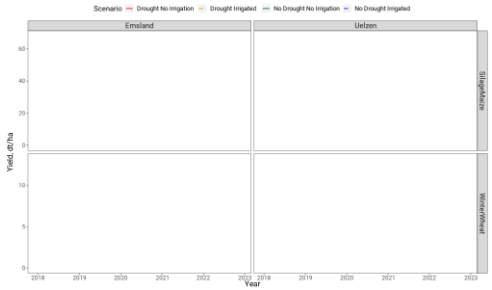
Water consumption at the level of individual management units

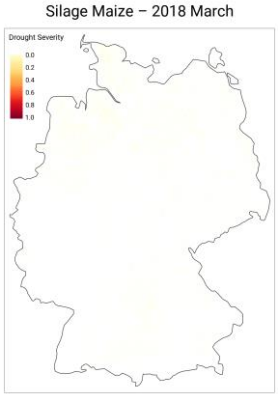
# INTEGRATION WITH DIFFERENT MODELLING APPROACHES

## Informing models with EO-based data

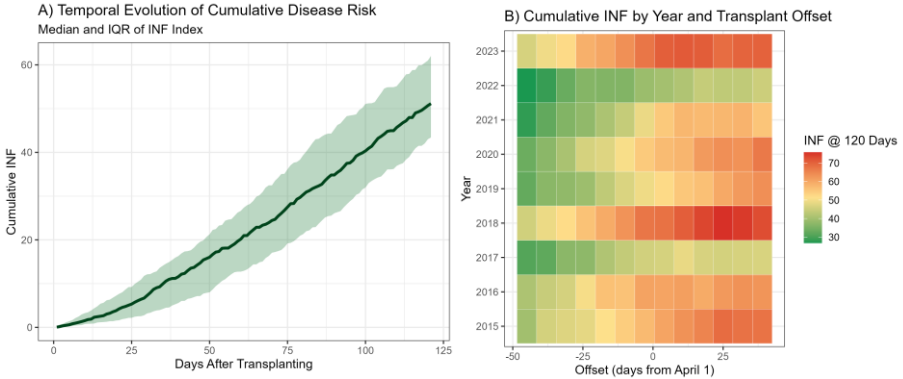



## Scenarios/Risk assessment

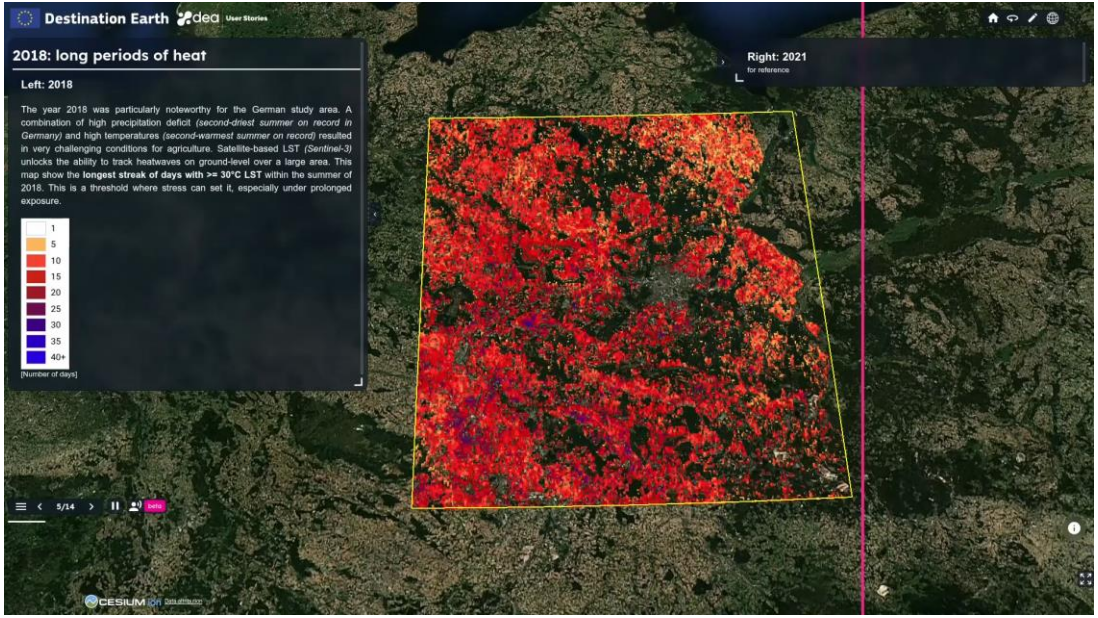


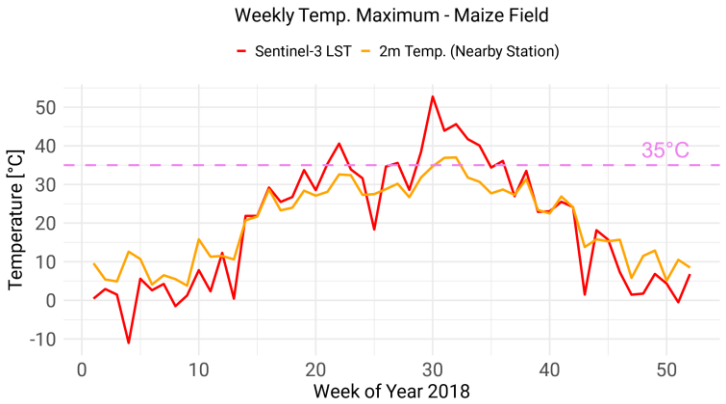




## Plant Disease risk

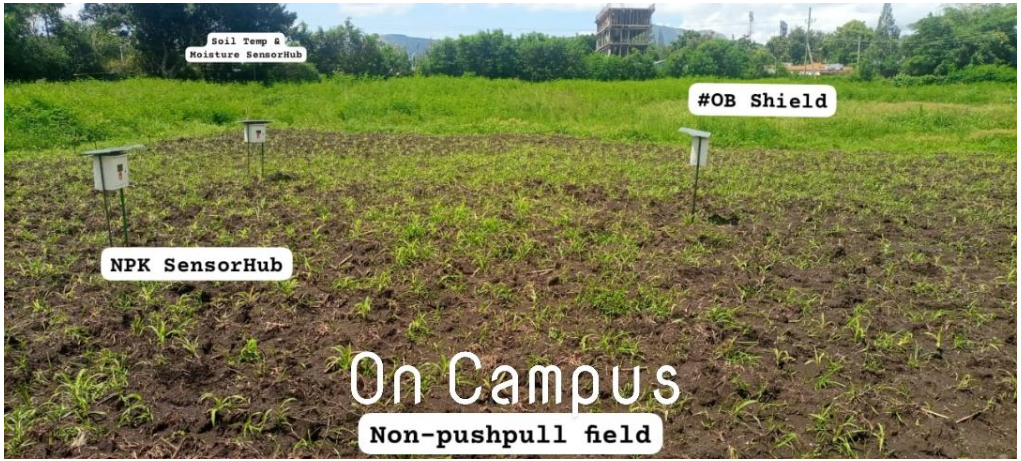


# HEAT STRESS ASSESSMENT AND WATER USE

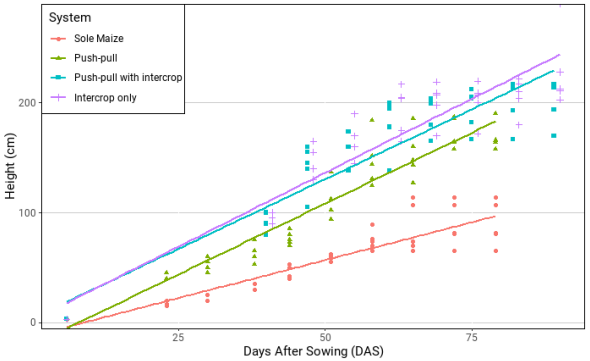


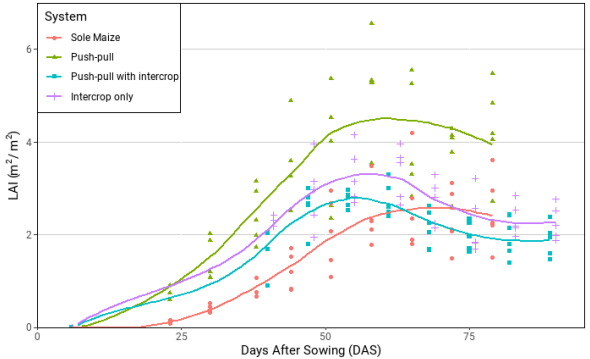



# PUSH-PULL CROPPING SYSTEMS AND ASSESSMENT OF PESTS IN KENYA

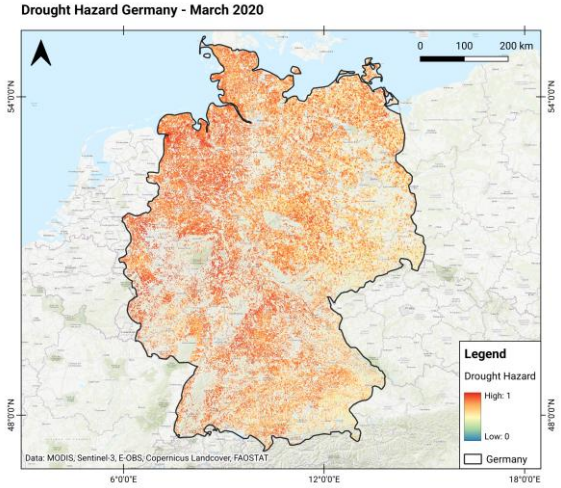


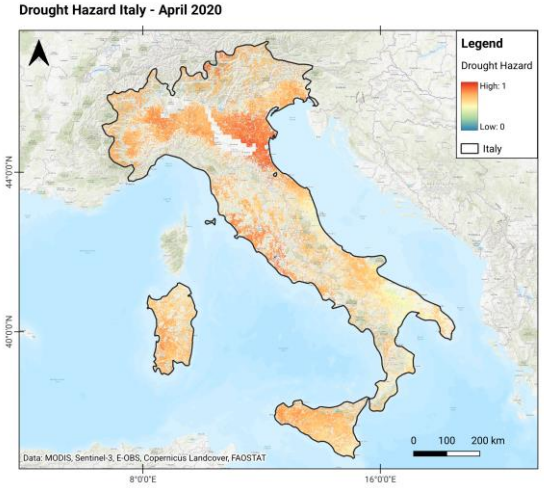


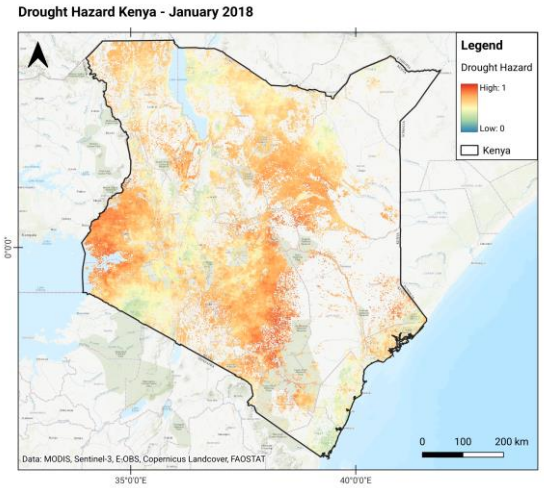



# DROUGHT HAZARD




Based on Sentinel-3 and MODIS observations combined with precipitation data
20+ years of time series

# KEY NOVELTIES AND INITIAL FINDINGS

- Use of multisource information
- Multiple stressors, use cases with different agro-climatic conditions
- Development of advanced methods and several modelling approaches
- Include local scale management information
- Demand-driven products

**Initial findings**

- Spatial patterns from EO data improve the modelling
- Management practices strongly influence crop responses and must be accounted for
- Iterative stakeholder engagement strengthens usability and trust

# THANK YOU FOR YOUR ATTENTION.

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**Booth Demos**

- Wednesday 25th of June: 13:30-14:00 and 14:30-15:00
- Thursday 26th of June: 9:30-10:00 and 10:30-11:00

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