Yield Prediction and Estimation from Earth observation (YIPEEO)

- Challenge: The threat of hunger and food insecurity for several hundred million people worldwide is being exacerbated by more frequent extreme weather events resulting from changing climate conditions.
- Solution: Minimizing the impact of extreme events and changing climate on agricultural production through the use of monitoring and forecasting of crop growth and yield for more informed decision making.
- Project goal: YIPEEO aims to improve field-scale crop yield forecasts through the usage of high-resolution remote sensing data and cutting edge scientific methods

Project consortium

Vienna University of Technology

Global Change Research Institute CAS

EODC Earth Observation Data Centre for Water Resources Monitoring GmbH

Funded by

European Space Agency

Objectives

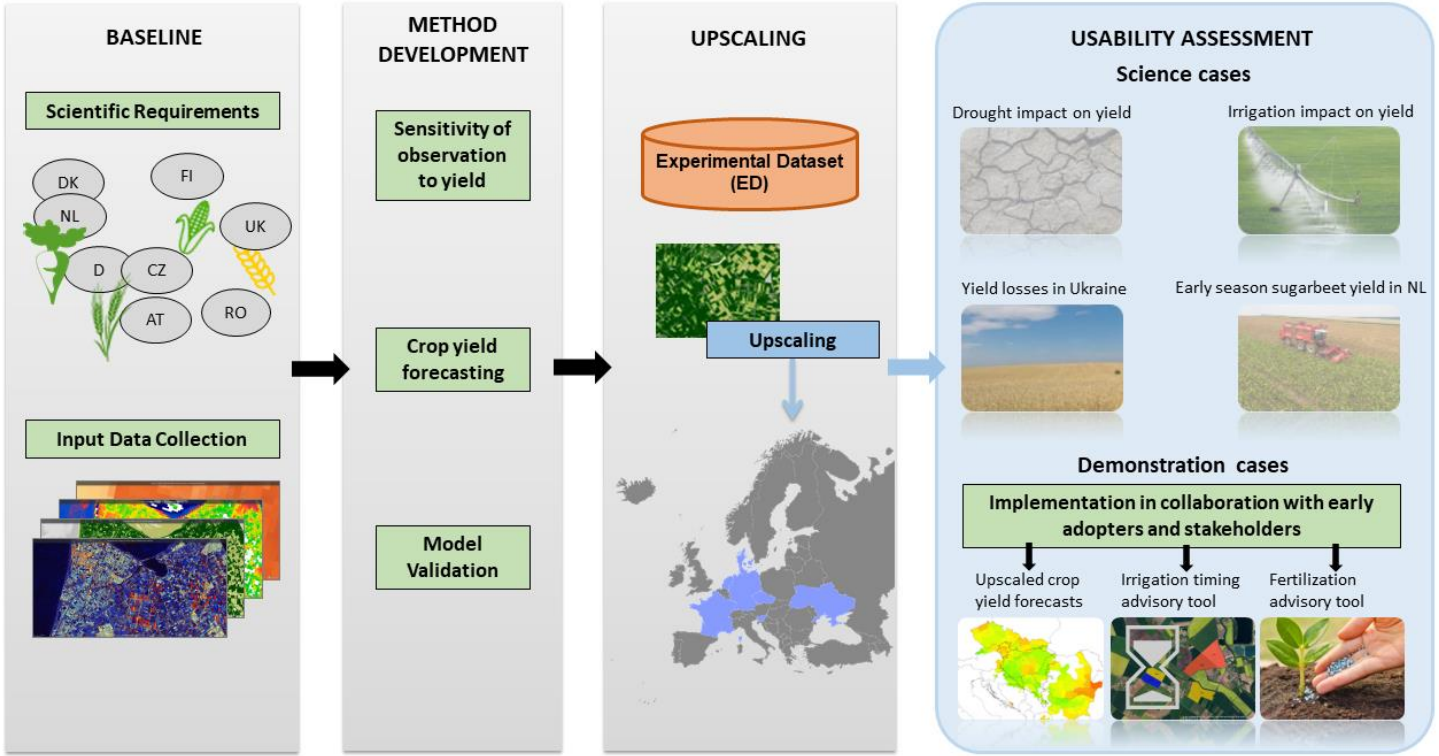
[1] Providing inputs for the development of the next generation of “fit for purpose” observation systems for agricultural monitoring

[2] Setting the bases for enhanced cooperation between ESA and EC, **working towards a Common Science Agenda** addressing the grand agriculture-related challenges

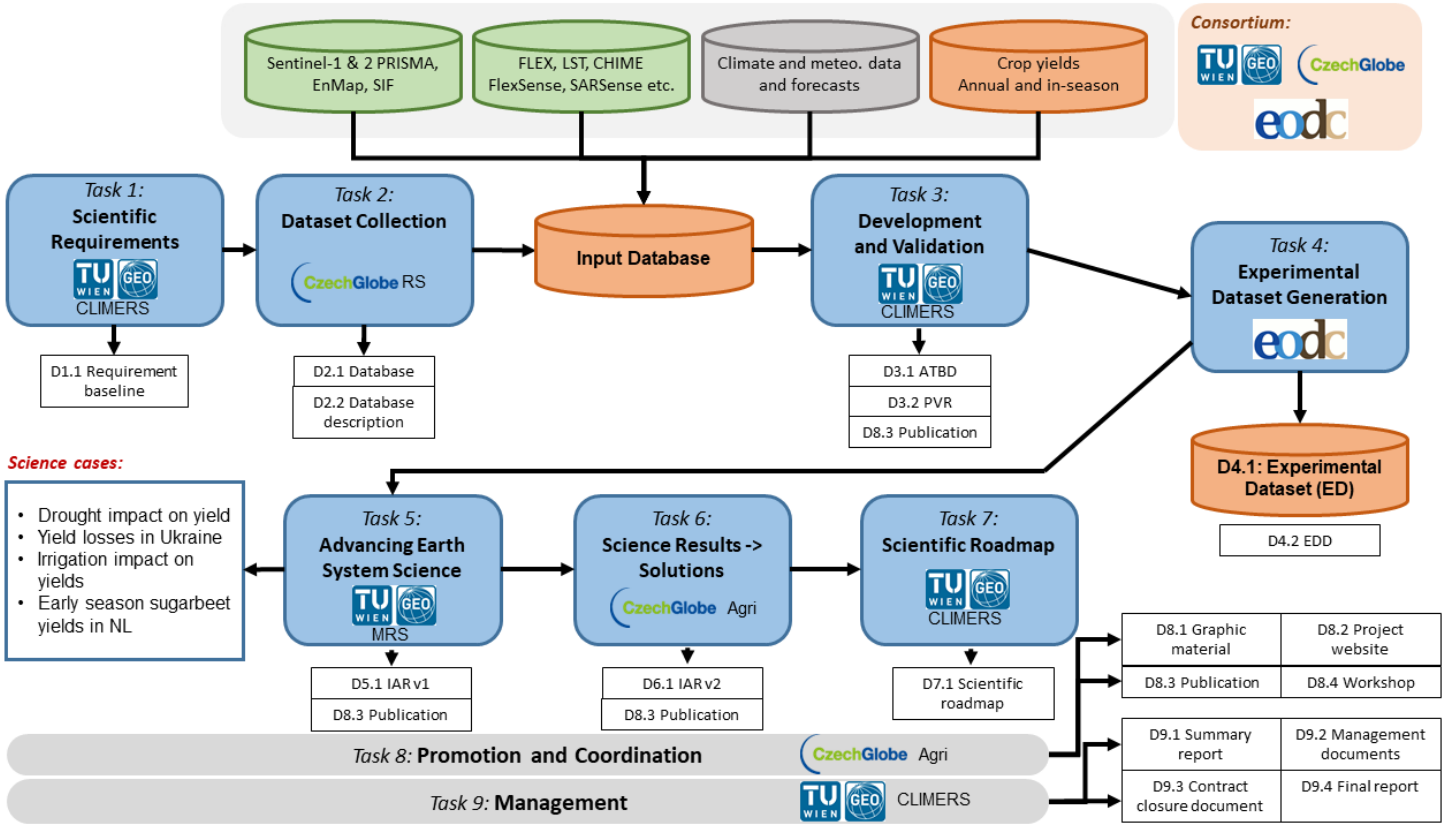
[3] A proper Science-Society interface & dialogue resulting in a **transfer of science & technology results into practical solutions for farmers** and other food system actors

[4] Establishing a sound scientific basis for **developing a Digital Twin of crop areas** and agricultural activities

Project conceptual approach



Proposed technical implementation

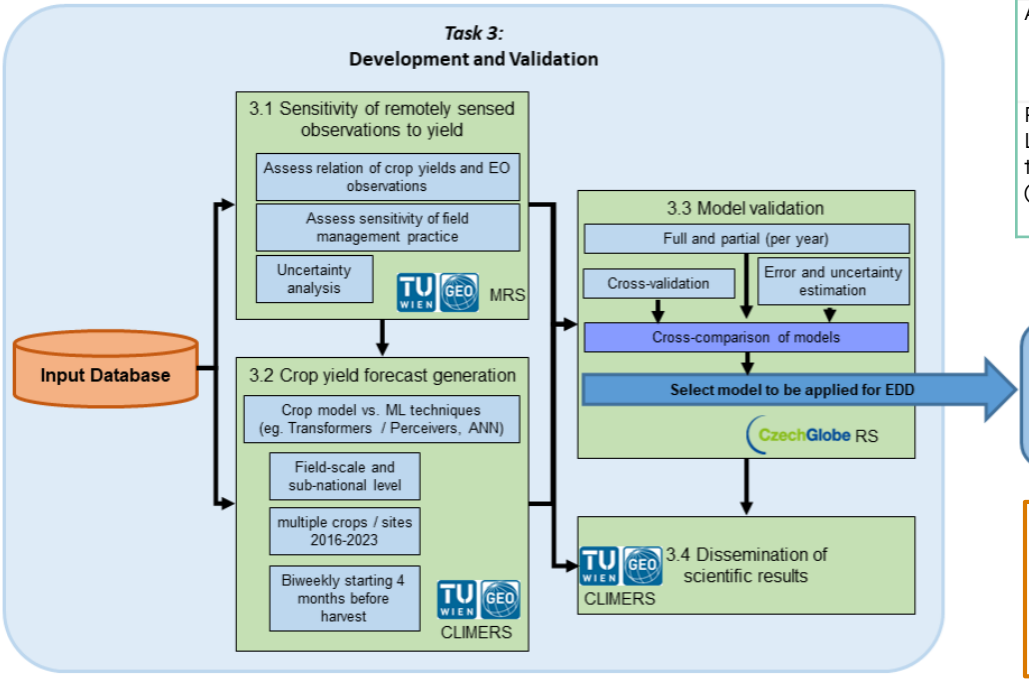


Datasets for project database

Dataset	Variable	Spatial resolution and coverage	Temporal resolution and coverage	Responsible partner
Earth observation data				
Sentinel-1 SAR	SSM, VH/VV, phenology metrics	1km Europe, 20m regional	1.5-4 d 2016* to present	EODC
Sentinel-2 MSI	Spectral reflectance, vegetation indices, LAI, phenology metrics	20m global	5 d 2015* to present	EODC
Sentinel-3 OLCI	Spectral reflectance, vegetation indices, LAI, phenology metrics	300m global	2 d 2018* to present	EODC
Sentinel-3 SLSTR	Thermal, LST	1km global	2 d 2018* to present	CzechGlobe A/RS
PRISMA	Spectral reflectance	30 m, tasking	Tasking 2020 to present	CzechGlobe RS
EnMap	Spectral reflectance	30 m, tasking	Tasking from 2022	TUW CLIMERS
HLS	Spectral reflectance	30 m global	3-5 d 2016 to present	CzechGlobe RS
Landsat	Spec. Reflectance, temperature	30 m global, 90 m global	16 d 1984 to present	CzechGlobe RS
ECOSTRESS	Thermal, LST	70 or 30 m tasking	1-7 d 2018 to present	CzechGlobe A/RS
Sentinel-5p TROPOMI	SIF	3.5x7.5km global, 3.5x5.5 km since 2019	Daily 2017 to present	CzechGlobe RS
C3S Soil Moisture	SSM	0.25° global	Daily 1978 to present	TUW CLIMERS
CGLS	LST, Albedo, LAI, TOC reflectances	0.05°	Hourly/Daily min 2014 to present	CzechGlobe A/RS
Airborne campaigns				
FLEXSense	Spectral reflectance, SIF, temperature	< 5 m local	2018, 2019	CzechGlobe RS
Local hyperspectral campaigns for sites in Czechia	Spectral reflectance, temperature	< 2 m local	Since 2016, a few times per season	CzechGlobe RS
Meteorological data				
ERA5(6)-Land	Precipitation, air temperature,radiation, humidity, etc.	0.1° global land	Daily 1950 to present	CzechGlobe A
C3S seasonal forecasts	Precipitation, air temperature, radiation, humidity, etc.	1° global	Subdaily 2017 to present (1993-2016 hindcasts)	CzechGlobe A

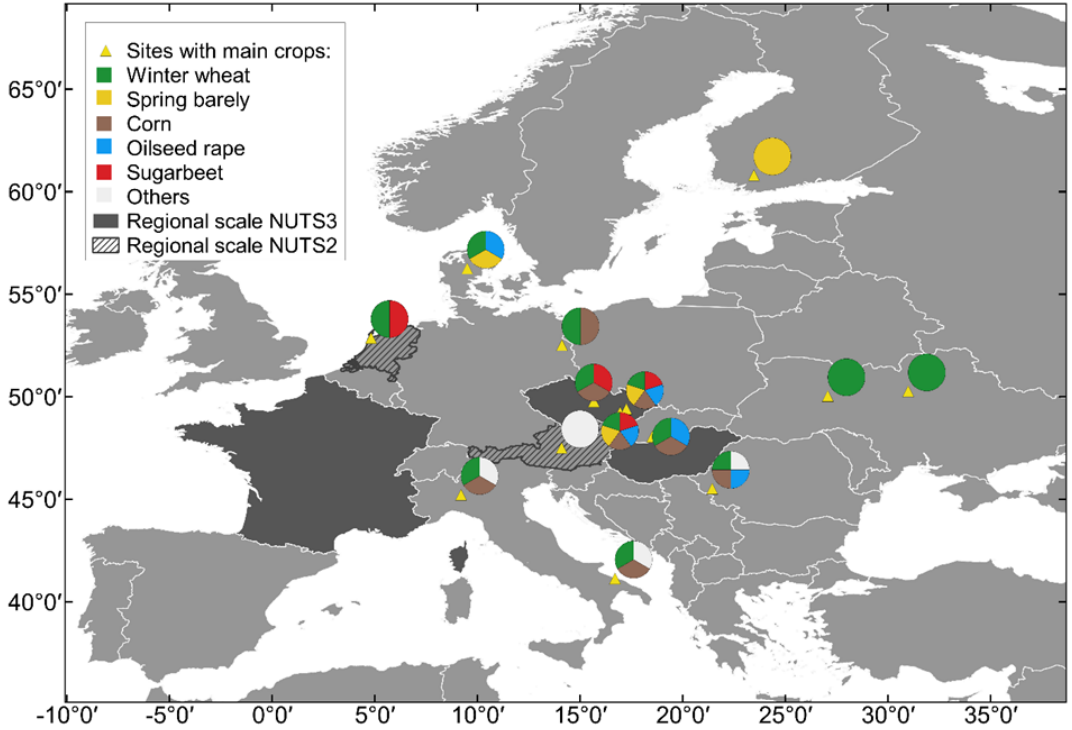
Model development and validation

Model	Required data	Responsible partner
Process-based crop models: Monica, Daisy, Hermes	Meteorological forcing	CzechGlobe A
Crop model GRAM	Available EO, climate data,	CzechGlobe A
Artificial Neural Network	Available EO, climate data, ancillary data on land cover, soil characteristics	CzechGlobe A
Random Forests, Deep Learning, LTSR, Gradient-boosted decision trees, Attention-based methods (Transformers, Perceivers)	Available EO, climate data, ancillary data on land cover, soil characteristics	TUW CLIMERS



The newly generated experimental dataset will be applied to larger spatial and temporal scales

Field level sites



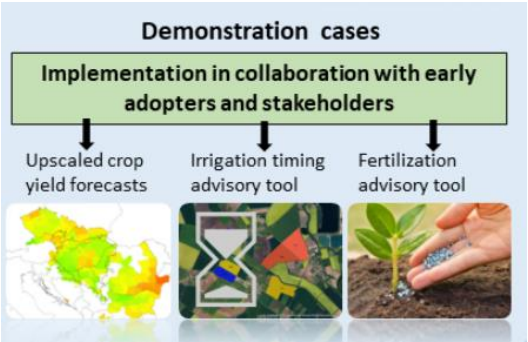
Overview of proposed and confirmed study sites with field level crop yield data. The yellow triangles depict the (sub)field level yield data while the dark grey polygons the NUTS3 and NUTS2 yield data at the national level

- A network of **collaborating farms** representing north-south and west-east geographic gradients will serve to supply in-situ observed (sub-)field level yield data for various crops.
- Four science cases will be carried out to **assess the merit** of the generated experimental dataset.

Transferring science into solutions for society

- **The prototype demonstration cases will be implemented with a range of relevant stakeholders**, early adopters, institutions, initiatives and projects (e.g., ministries, local governments, farmers, farmer associations, traders, insurance companies, universities, and higher education establishments)

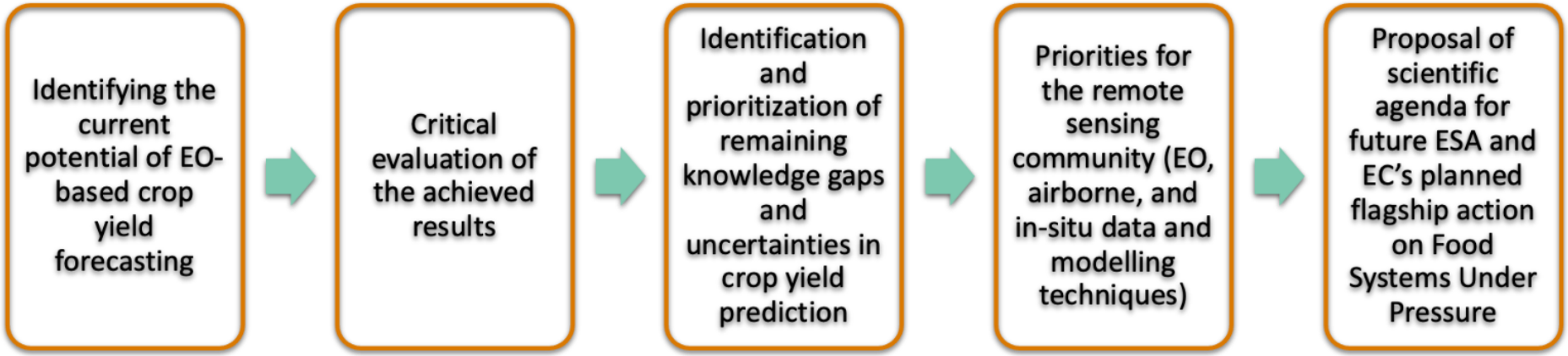
- **Goal is to demonstrate the benefit of the project results** for creation of actionable information used **in more informed decision-making** and ultimately benefiting sustainable agricultural practices



Tools

- Involvement of the early adopters in the project
- Webinar series
- Targeted “advertisement” of the results through web
- Social platforms
- Farmer newsletter

Scientific roadmap for future explorations



Promotion and coordination

Collaboration with relevant networks and projects

User workshop for early adopters

International conferences

Peer-reviewed, high-impact, open-access journal publications

Project website and other promotion materials