CHIST-ERA Projects Seminar 2022
WATERLINE PROJECT

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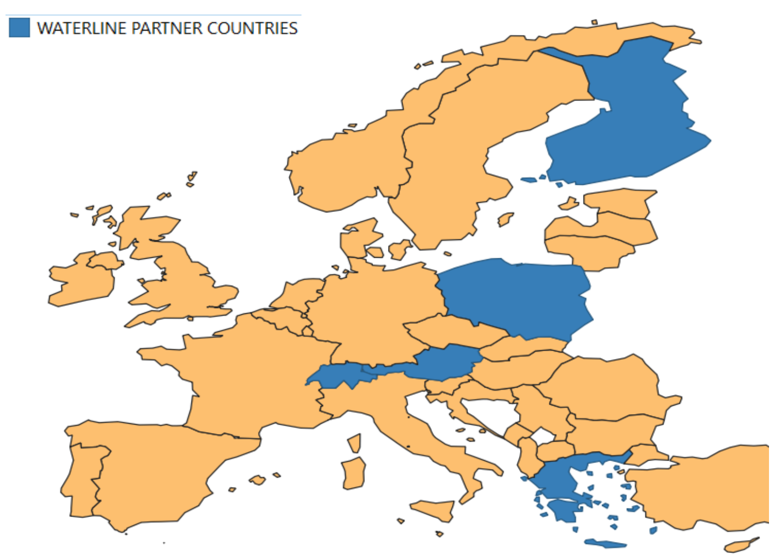
EUROPEAN UNION

Introduction: Projects of the Topic CES

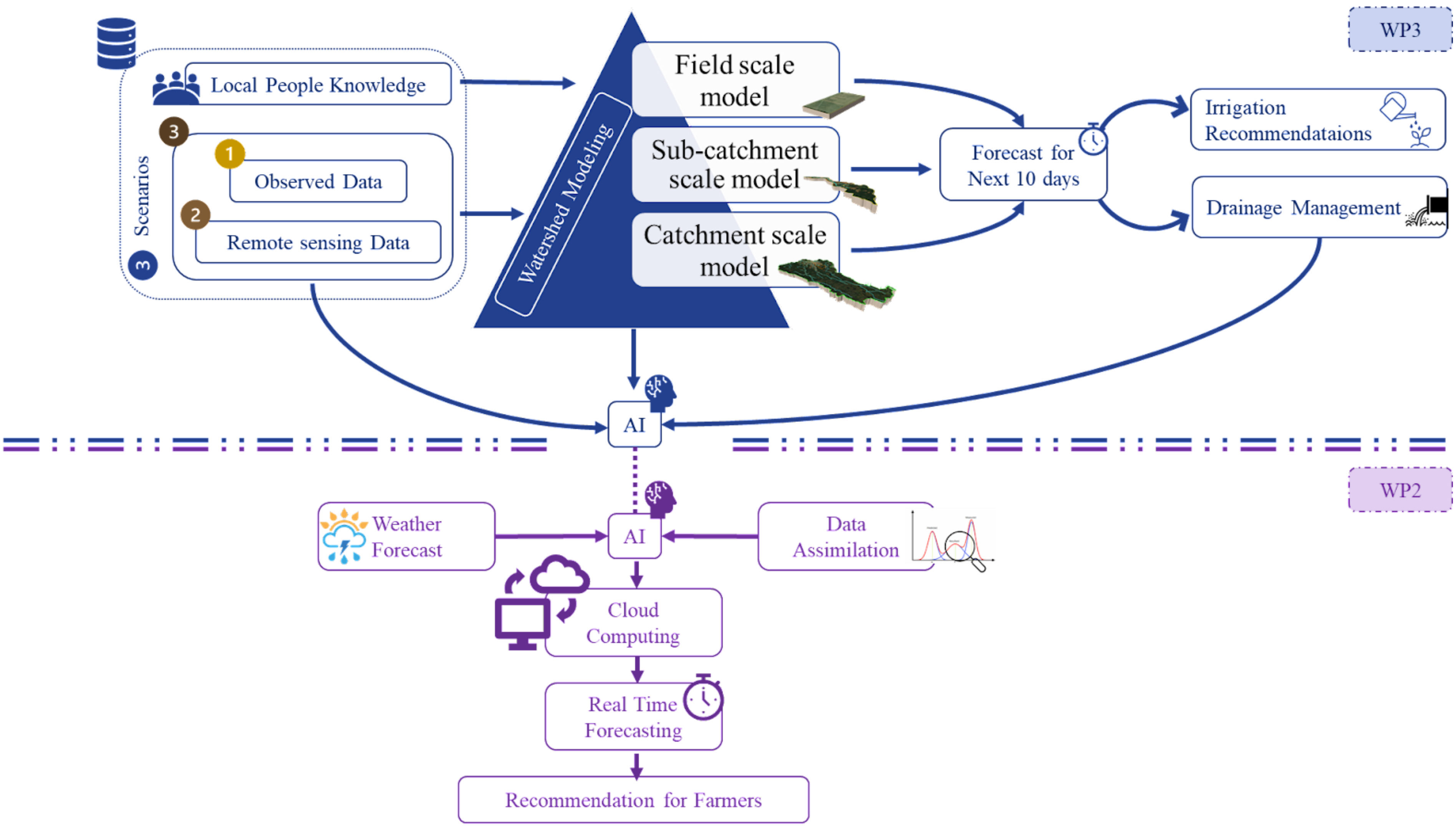
NEW SOLUTIONS FOR DATA ASSIMILATION AND COMMUNICATION TO IMPROVE HYDROLOGICAL MODELLING AND FORECASTING (CHISTERA 2019)

Participating Organizations

- Democritus University of Thrace – Greece (Coordinator)
- University of Oulu – Finland
- University of Neuchatel – Switzerland
- AGH – University of Science and Technology (Poland)
- Vienna University of Techonlogy -TU Wien – Austria
- Digital Innovations SME - Greece



WATERLINE OUTLINE



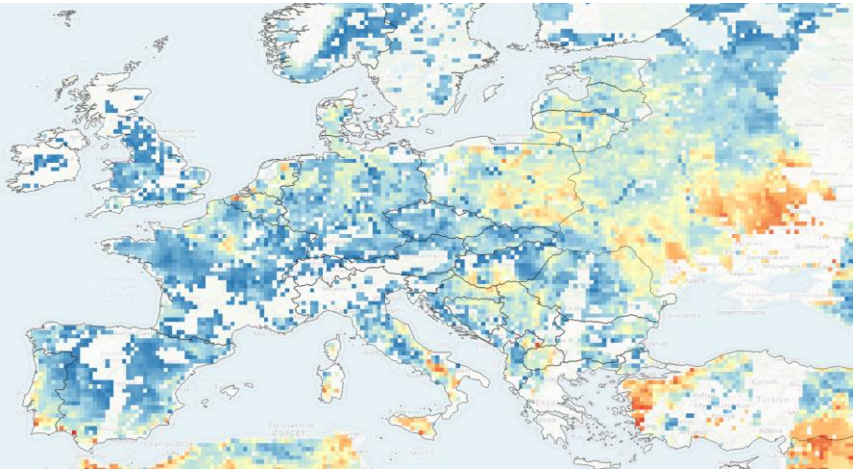
Major Achievements and Outputs

All project partners devoted their efforts during the first year to the multi source data selection and processing

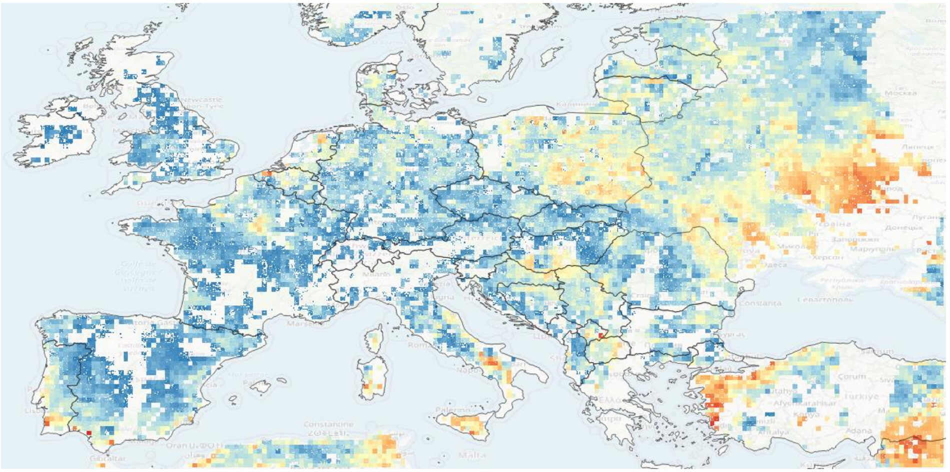
MAJOR OUTPUTS

❖ Downscaling of remotely sensed soil moisture over EU

ESA CCI (0.25°)



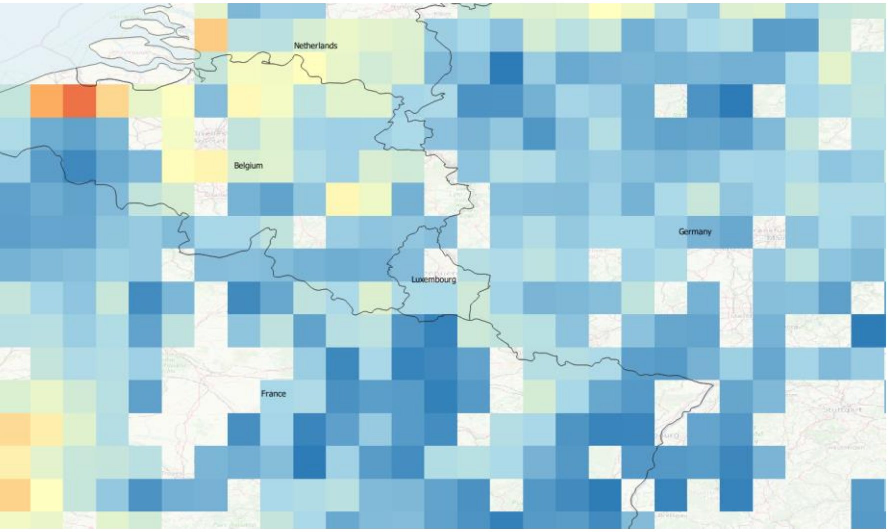
DOWNSCALED SM (0.05°)



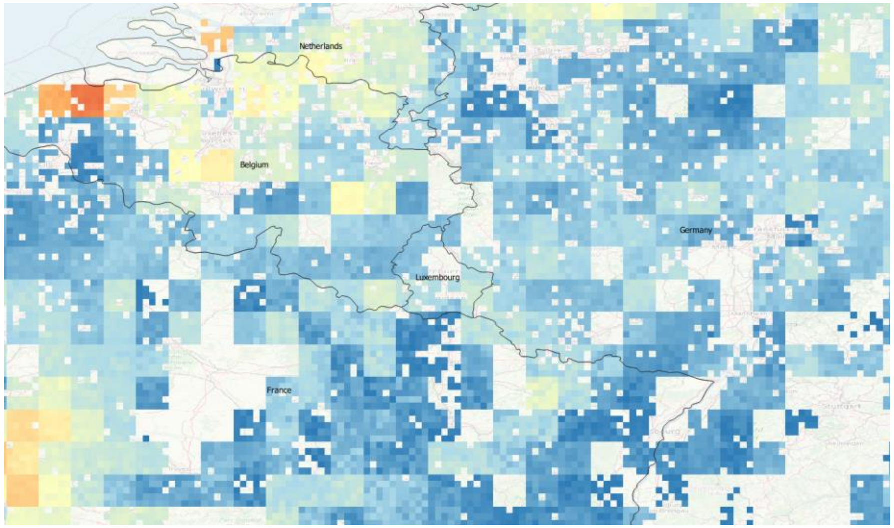
MAJOR OUTPUTS

❖ **Downscaling of remotely sensed soil moisture over EU (zoom to central EU)**

ESA CCI (0.25°)

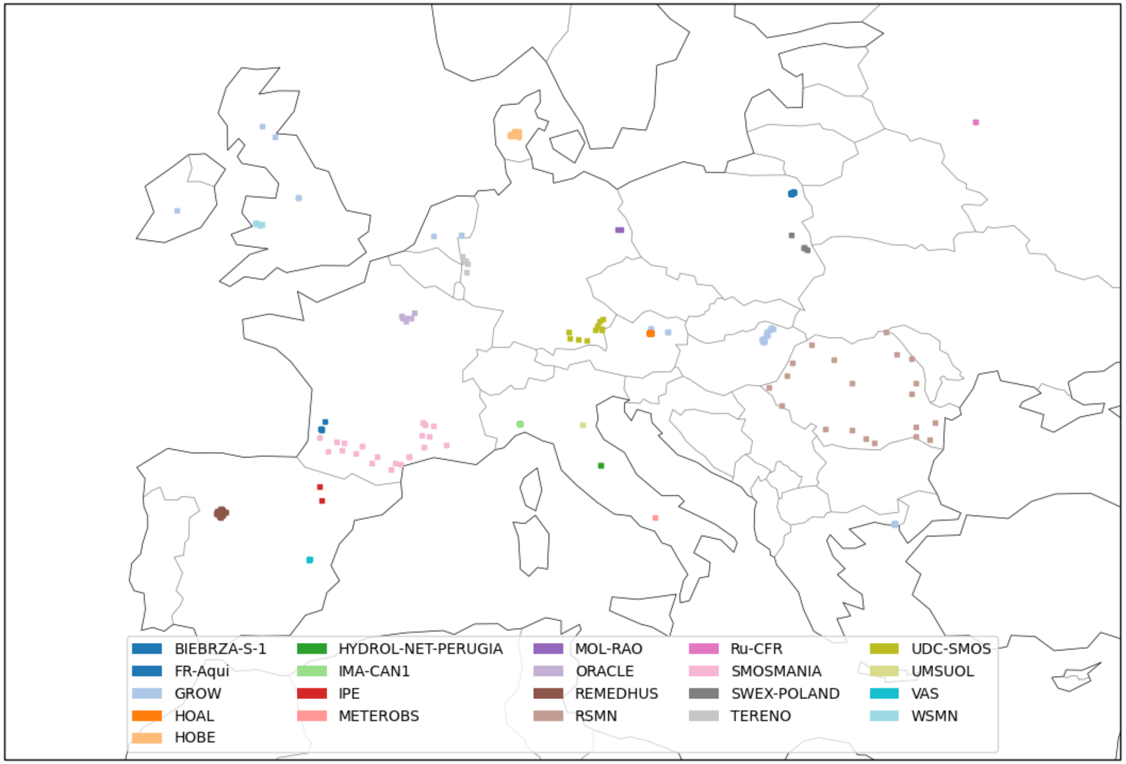


DOWNSCALED SM (0.05°)



VALIDATION

- International Soil Moisture Network (ISMN)
- Sensors in the top 10 cm
- 221 stations across Europe

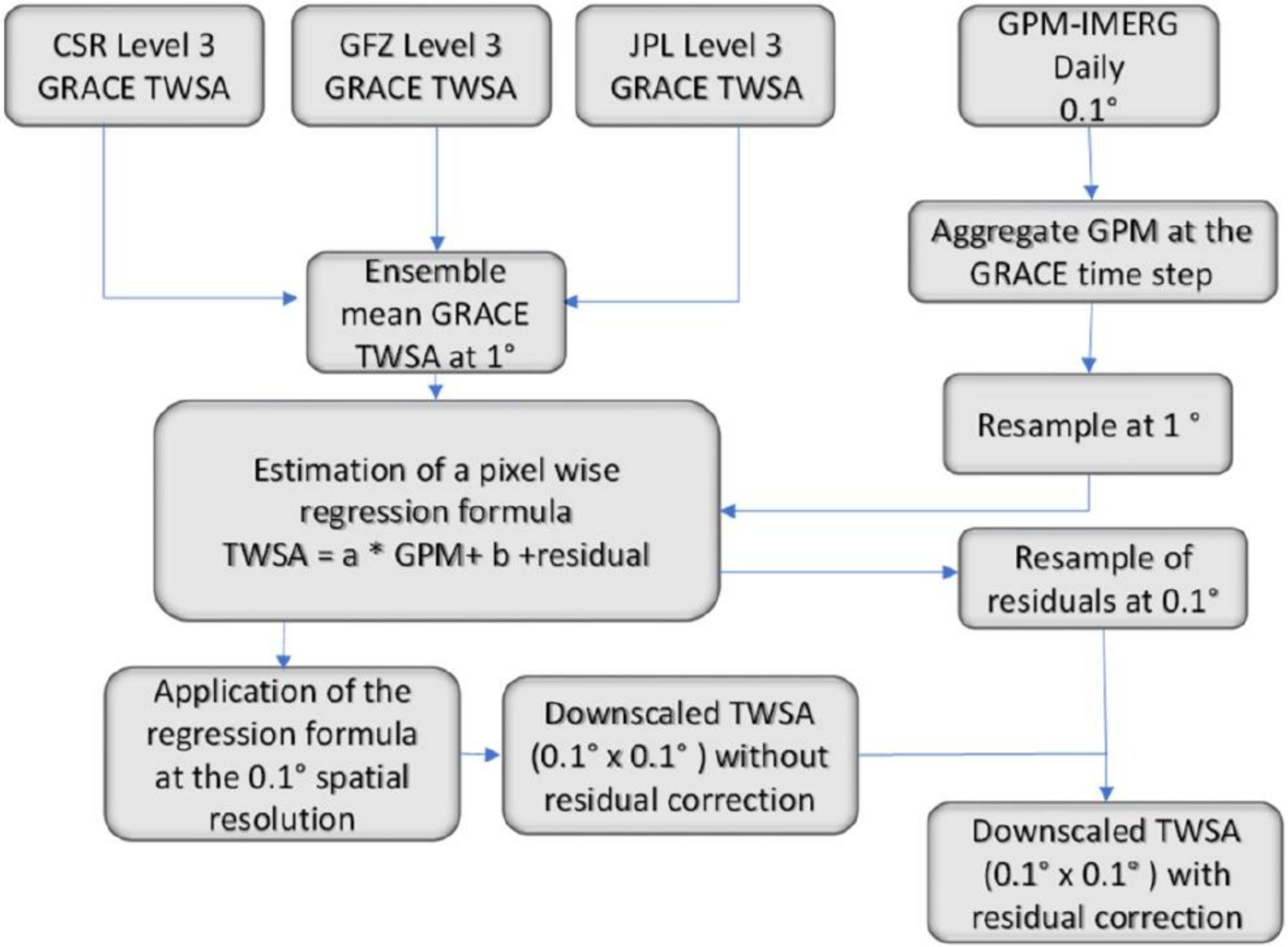


- Zappa et al (2021), Towards a long-term (> 15 years) and medium resolution (0.05°) soil moisture dataset over Europe by merging ESA CCI SM and EUMETSAT products; Talk: 7th SALGEE Workshop, Drought & Vegetation Monitoring: Energy-Water Cycle, EUMETSAT; 24-26/11/2021
- Zappa et al. (2022), Towards a long-term and medium resolution soil moisture dataset over Europe by downscaling the ESA CCI Soil Moisture, ESA Living Planet Symposium 2022 (accepted)

- We are generating a multi-scale (0.05° and 0.01°) soil moisture dataset over Europe spanning 13 years (2008-2020)
- Spatial details given by land cover, soil properties, topography, and vegetation
- Good agreement with in-situ reference
- Dataset generated as netcdf and geotiff v0 already available
- Test and inter-compare various machine learning algorihtms select the best one
- Many gaps exist in the CCI SM product fill the gaps to increase the n° of observations
- Assess the contribution of different factors affecting soil moisture spatial organization across scales

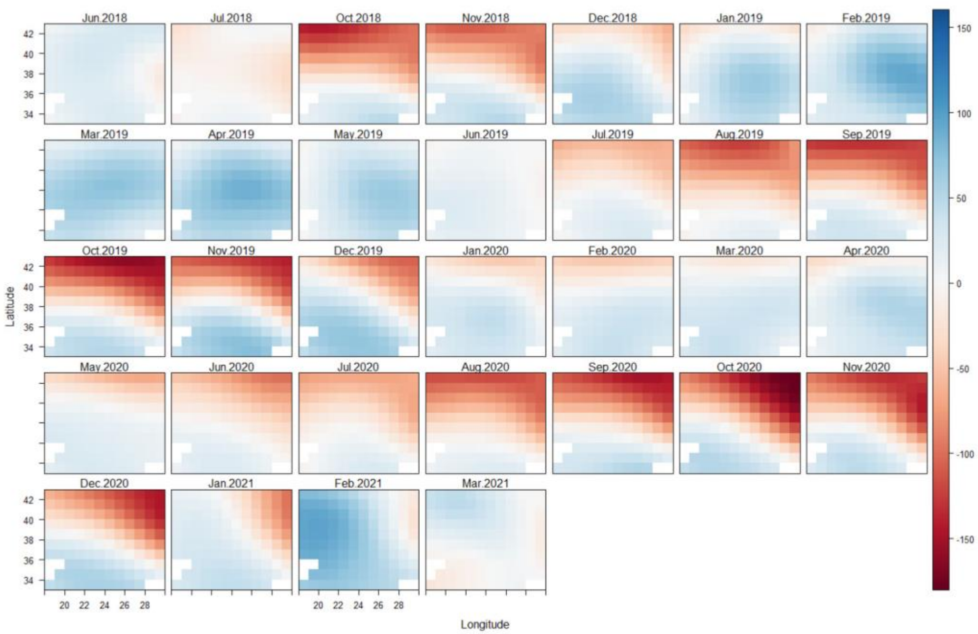
MAJOR OUTPUTS

- Downscaling of remotely sensed total water storage anomalies – GRACE total water storage anomalies

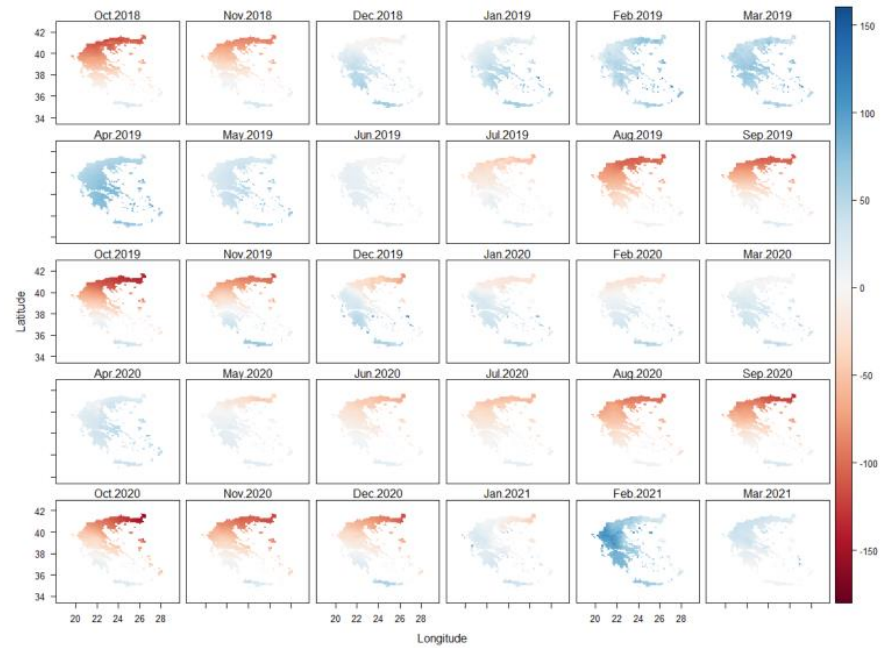


MAJOR OUTPUTS

GRACE TWSA – 1 degree



GRACE TWSA – 0.1 degree



Paper published and dataset released

Gemitzi, A.; Koutsias, N.; Lakshmi, V. A Spatial Downscaling Methodology for GRACE Total Water Storage Anomalies Using GPM IMERG Precipitation Estimates. Remote Sens. 2021, 13, 5149. https://doi.org/10.3390/rs13245149. and the associated dataset is released for Greece:

https://www.mdpi.com/2072-4292/13/24/5149

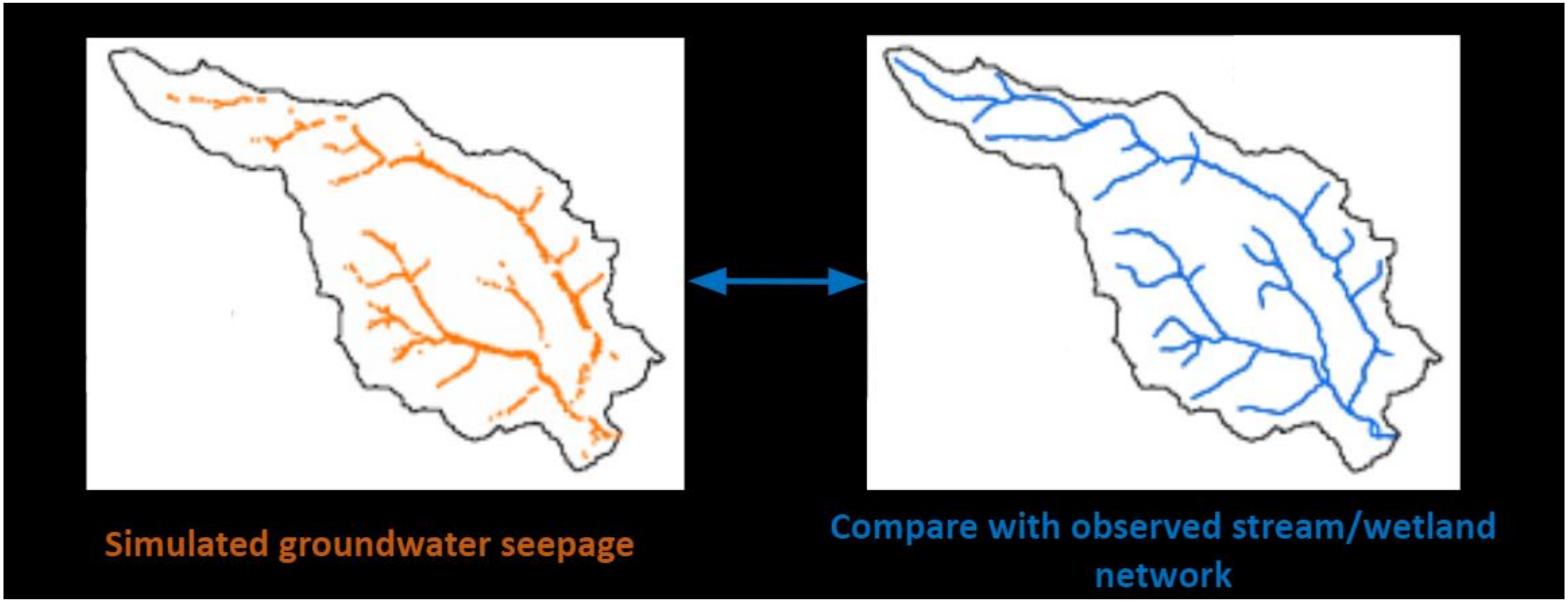
ONGOING TASKS

- Use of downscaled TWSA for hydrological model constraining
- Downscaling algorithm for GPM precipitation ready. Downscaled precipitation dataset expected by the end of April and a publication will be prepared
- A review article concerning downscaling approaches for RS precipitation has been submitted

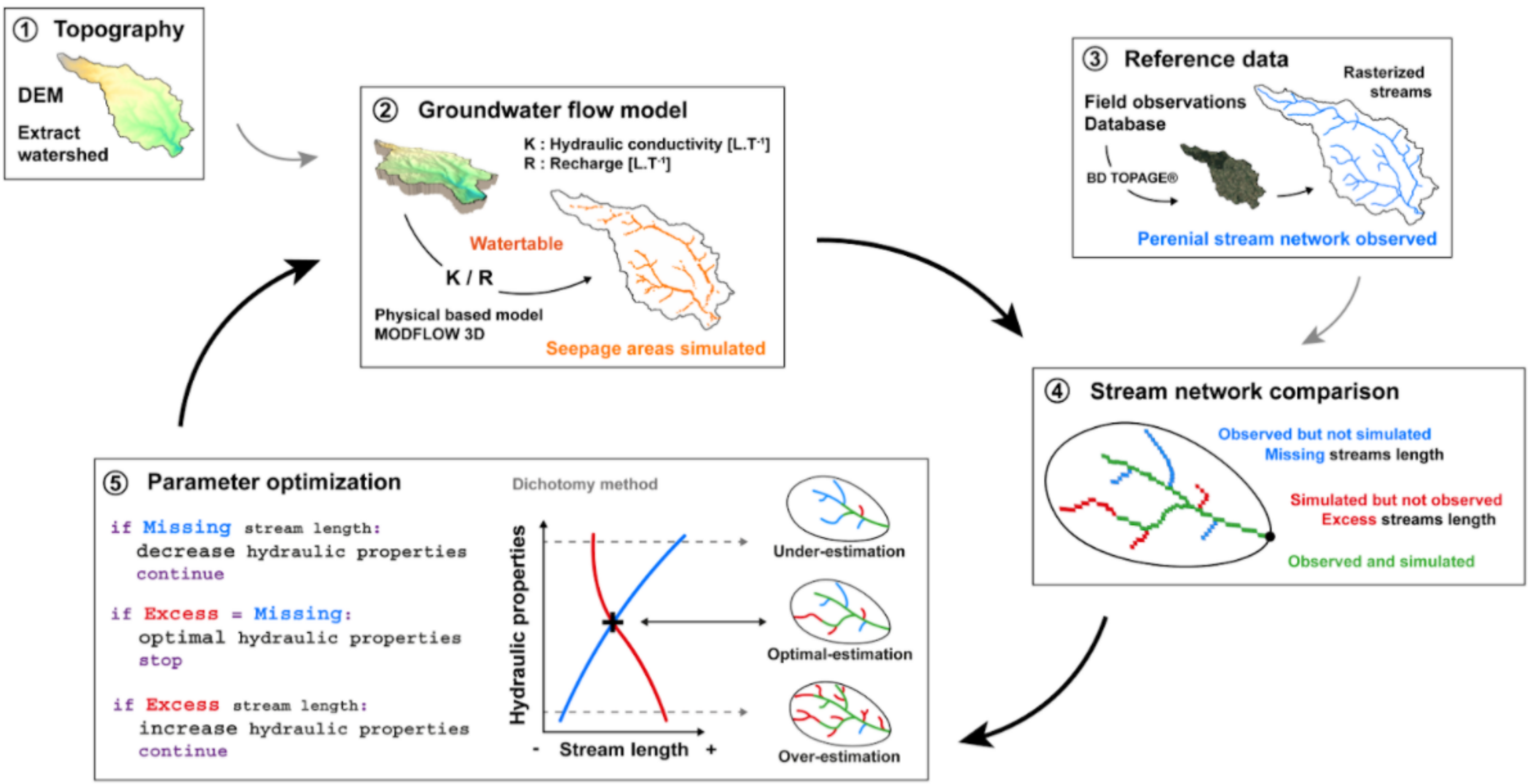
MAJOR OUTPUTS

Development of hydrological models

- Model calibration is strongly dependent on the availability and quality of discharge and piezometric data
- Stream/wetlands/soil saturation dynamics are important constraints to assess catchment-scale subsurface processes



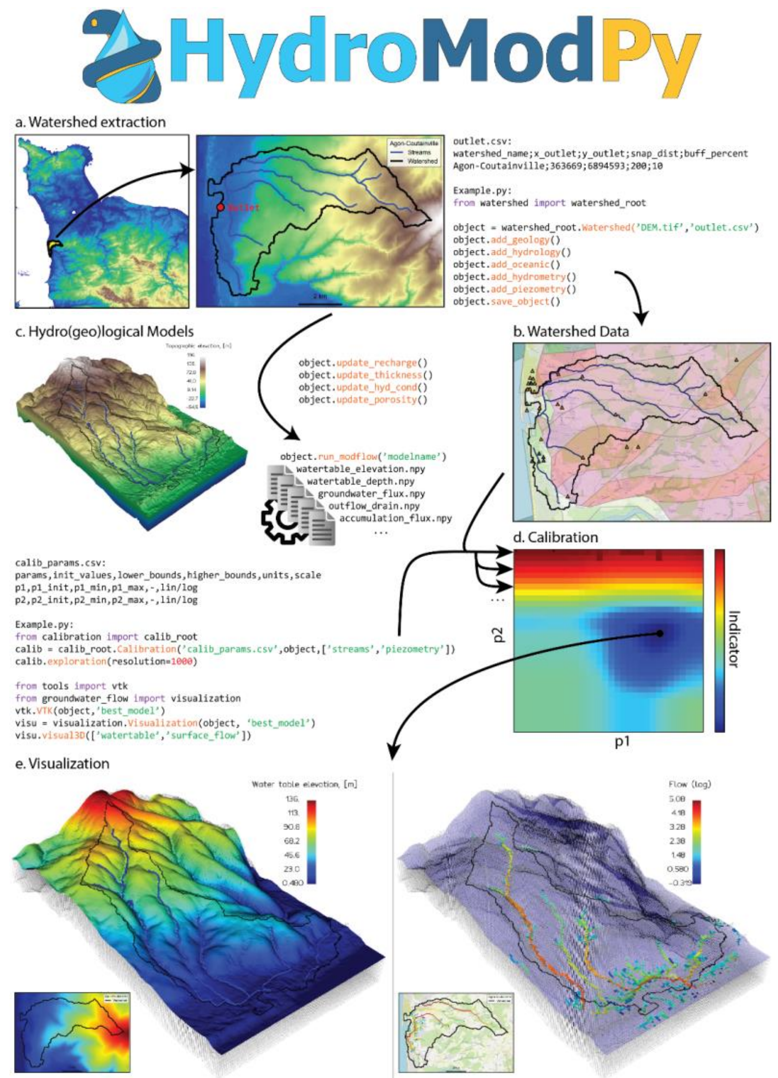
Workflow for model calibration on stream network organization



MODEL DEVELOPMENT

Development of a Python interface for building and calibrating hydrological model

Publication open for discussion in HESS (Roques et al. 2022)



Estimation of groundwater – surface water interactions Deep Learning models

Preliminary results from Kocincha river in Poland

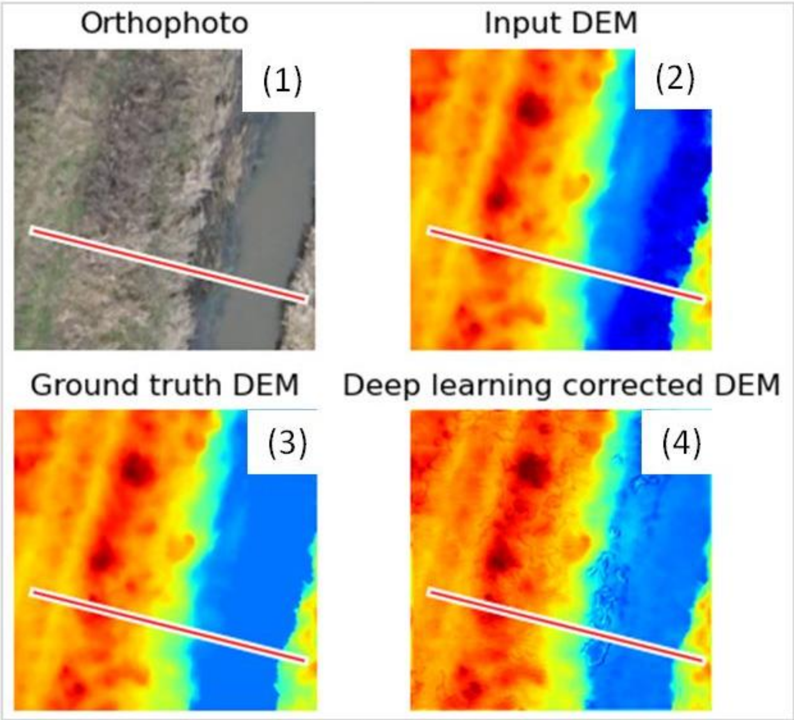


Fig. 1. Dataset sample (1,2,3) and ML model output (4).

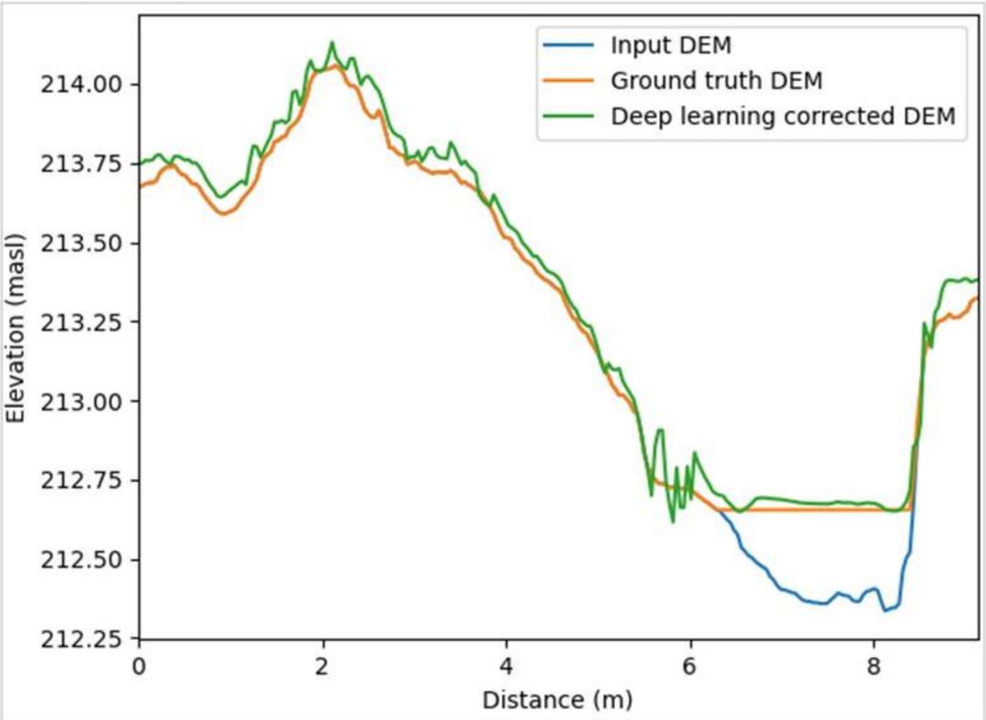
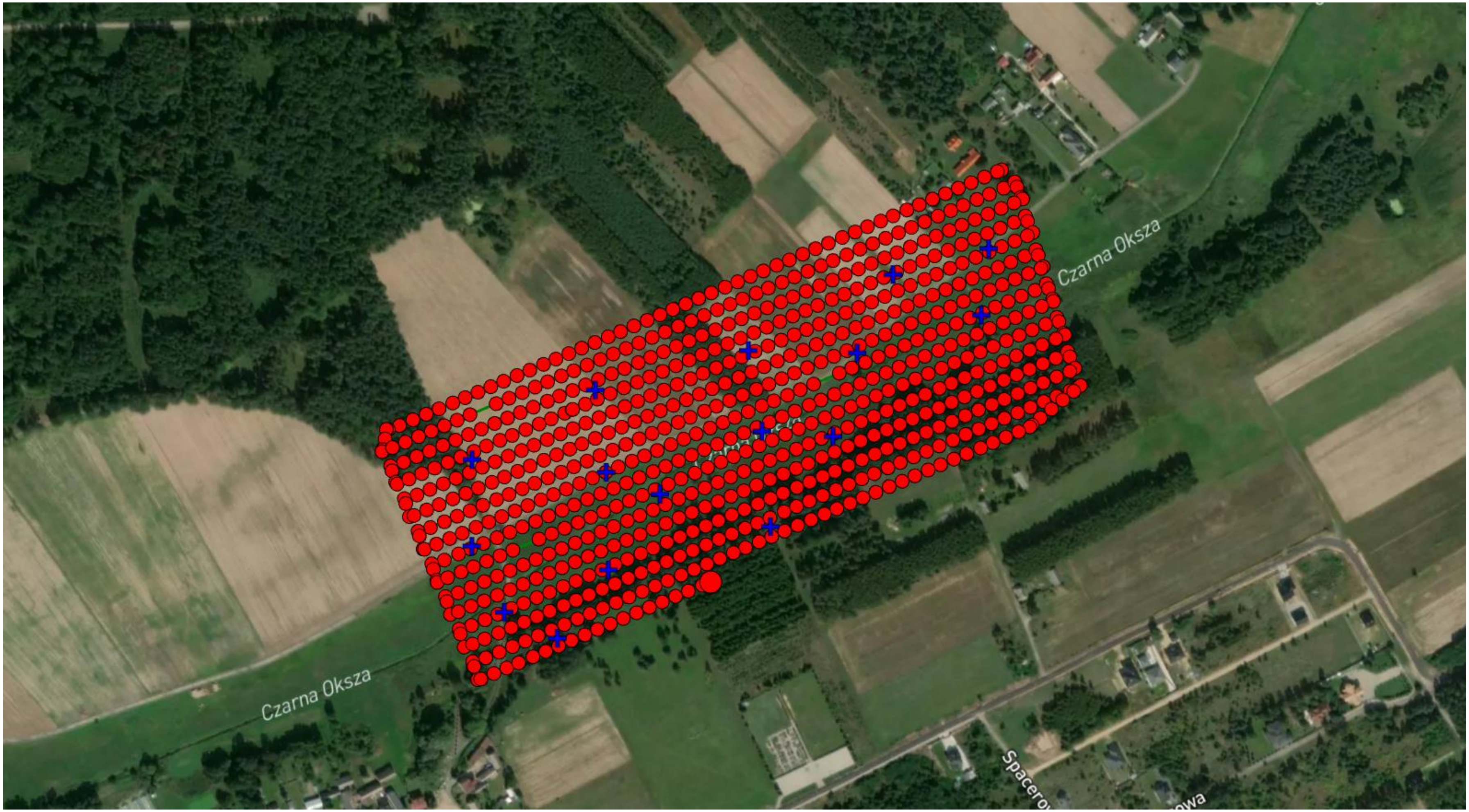
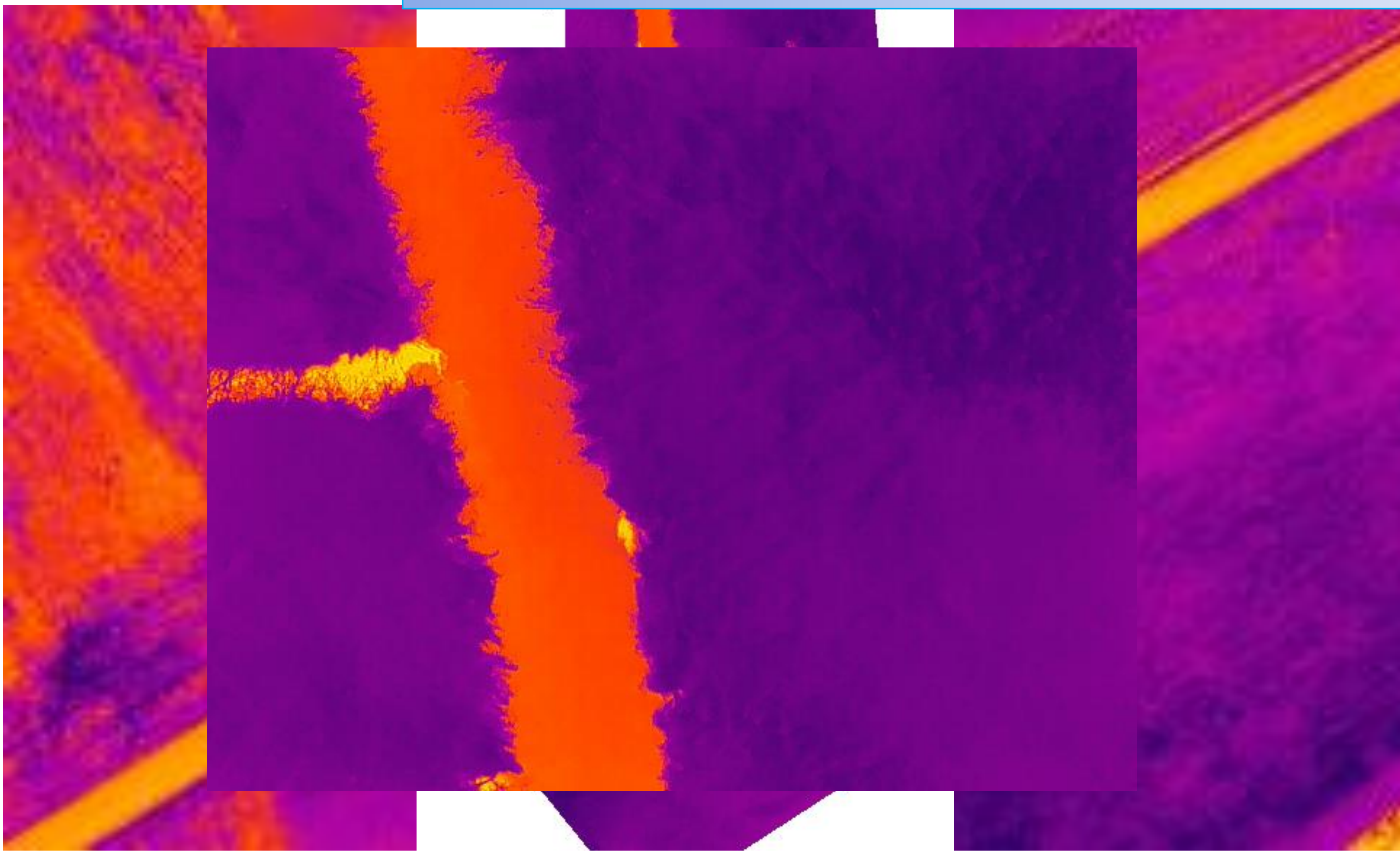


Fig. 2. Profile graphs corresponding to the DEMs in Fig.1.

IR flights



IR flights



Development of execution services and web interfaces

- AGH has worked on the architecture of the Application execution framework (T5.1) and application workflows (T5.2). The first identified application workflow was a model coupling scenario integrating Hydrus and MODFLOW models. An implementation of this application has been prepared and published (https://github.com/WaterlinePL/Hydrus-Modflow-Synergy-Engine).

- The application consists of several modules responsible for: (1) Hydrus model execution; (2) MODFLOW model execution; (3) coupling and data exchange between models; (4) web interface for configuration of the simulation.

- The implementation provides three deployment models: (1) local: application is run as a standalone program and requires separate installation of Hydrus and MODFLOW; (2) Docker: application in run in Docker containers, no additional software needs to be installed; (3) Kubernetes: application is deployed in a Kubernetes cluster (which can be hosted locally or in the cloud). In all three cases the application provides a web-based interface to configure and run the simulation.

Szostak R., Pietroń M., Zimnoch M., Wachniew P., Cwiakala P., Puniach E., 2021. Using Deep Learning for estimation of river surface elevation from photogrammetric Digital Surface Models. NeurIPS 2021 (Machine Learning and the Physical Sciences workshop.

Cloud architecture and hydrological applications

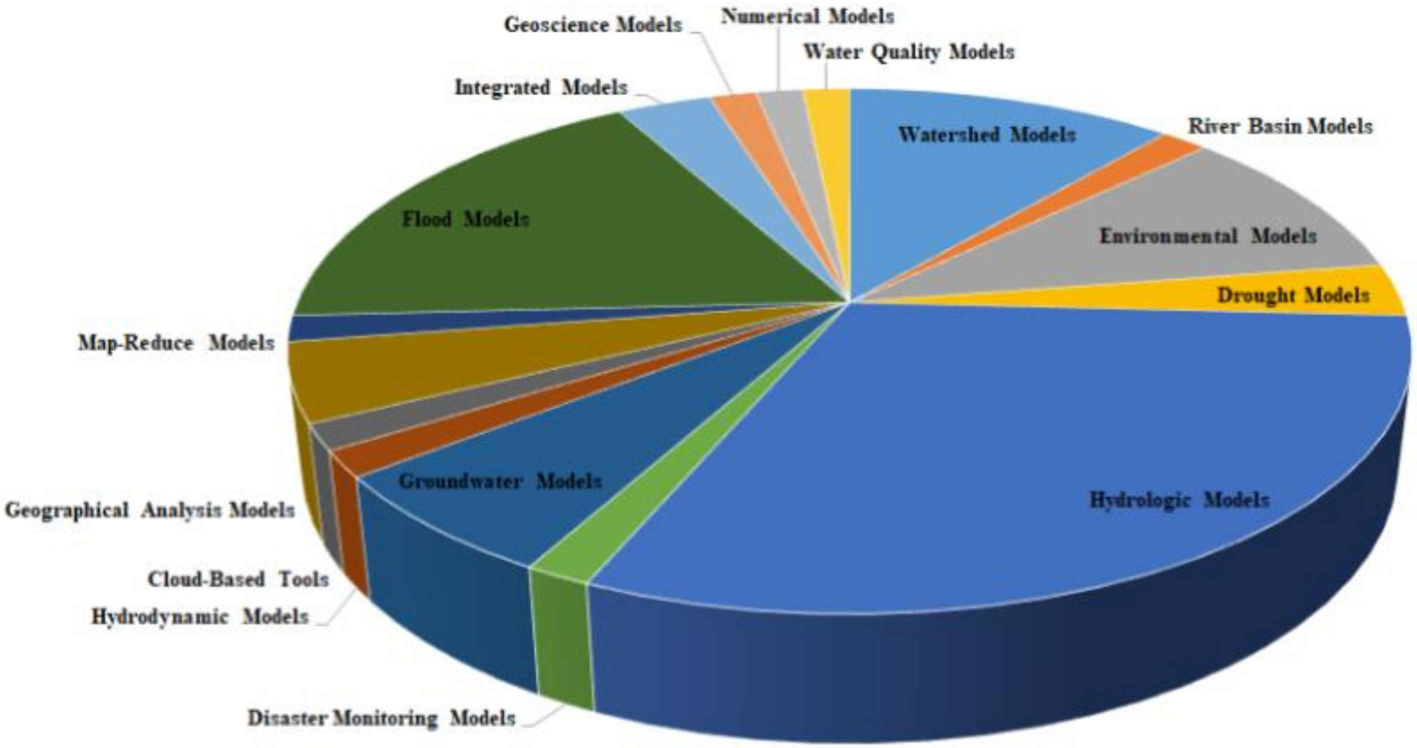


Figure 7: Classification based on types of model developed and studied using cloud computing platform.

Review of literature on cloud architecture and hydrological applications

- explore the existing cloud architecture tools and technologies developed to solve desired water resources management issues
- The efficiency and effectiveness of cloud-based hydrological applications
- Q1: How do cloud computing applications aid hydrological applications more efficiently, and what is the state of the practice?
- A: description and categorization of the existing technology
- Q2: What are the limitations associated with cloud computing to process hydrological data processing and handling?
- A: critical examination of the scope and boundaries of the dataset identified

COLLABORATION

- Up to now restrictions in travelling due to COVID pandemic did not allow for a physical meeting to take place.
- Difficult for Ph.Ds and / or Post Doc students to exchange visits among Waterline for training
- A training event was organized by AGH and DUTH on Environmental Monitoring with Remotely Sensed Data (22 April 2021).
- A short Ph.D course has been organized from OULU (11 – 13 October) titled: "Agricultural water and nutrient management: novel approaches on water retention and nutrient recycling" where Waterline Ph.Ds presented their progress and some Waterline partners presented on topics related to hydrological modeling, stakeholder involvement, access and use of RS data.
- A Ph.D. student from AGH visited during January 2022 the DUTH team and was trained on the RS techniques for environmental monitoring
- We strongly need a face to face meeting

Upcoming Challenges and Needs

- **Besides the scientific challenges and needs there is a serious problem concerning funding for the two Greek partners which is still pending due to bureaucratic issues within the funding agency (GSRT)**
- **Concerning tasks and deliverables related to WP4 (Co-development with stakeholders) lead by DUTH and WP6 (Project results dissemination and communication) lead partner DIN not much could be achieved.**
- **Serious problems for smooth project implementation as the coordinating partner has not yet joined the project officially!!!!!**
- **GSRT has posed additional obstacles to our work flow, e.g. all project tasks for the Greek partners should finish by July 2023!!!!!**

Upcoming Challenges and Needs

- Within those unprecedent constraints DUTH partner tries to do its best with no funding at all
- Project coordination tasks are accomplished
- Consortium Agreement has been signed and project meeting were organized according to the work plans
- Annual reporting is expected to be ready by end of March

Role of the CHIST-ERA Support

- CHISTE-ERA should try to enforce the smooth funding flows in all partners.
- In exceptional conditions there should be help provided to partners experiencing those adverse impacts
- All participating countries funding agencies should follow the same rules at least as far as funding flow is concerned

Questions ?