WATELINE PROJECT

CHIST-ERA Projects Seminar

12 – 14 April 2021

WATERLINE

NEW SOLUTIONS FOR DATA ASSIMILATION AND COMMUNICATION TO IMPROVE HYDROLOGICAL MODELLING AND FORECASTING

Project's webpage:

http://www.waterlineproject.eu/

CHISTERA call 2019
Project topic CES:
Novel Computational Approaches for Environmental Sustainability

Why do we need hydrological modeling?

- **Hydrologic modeling is as old as human need to construct a shelter in a dry place.**
- **Humans have developed an ability to identify and avoid places where water will flow or accumulate when it rains.**

- **But sometimes disasters happen….**

Computational hydrologic modeling

Hydrological modeling deals with the quantification of the likelihood and extent of observing phenomena like inundation, drought, erosion, salt water intrusion etc

The nowcasting and forecasting of hydrologic states is what it is termed computational hydrologic modeling.

A short list of analytical or predictive use of hydrological models

Groundwater (quantity/quality)	Surface water (quantity / quality)	Land atmosphere interactions
Groundwater / surface water interactions	Geochemistry / weathering	Soil erosion/deposition
Contaminant transport	Land use / land cover change effects	Earth system / landscape evolution and geomorphology
Riparian / hyporheic flow analysis	Channel hydraulics / floodplain interactions and flood inundation	Water management
Water availability/budget	Drought forecasting	Aquatic habitat analysis
Compound coastal / inland flooding	Saltwater intrusion	Flood risk prediction / fire risk prediction / risk of spread of vector borne diseases

Scientists usually need to answer tricky questions while dealing with hydrological modeling

- **What really society needs from my model?**
- **Which is the best model for my case?**
- **Are there enough data for model development and calibration?**
- **Does my model accurately describe the natural phenomena?**
- **What is the uncertainty of my predictions?**

Some facts from previous research

- **The hydrologic modeling has, in general, included too much reliance on mathematics at the expense of true knowledge, and suffers from a need for more rigorous evaluation of appropriateness (Klemeš, 1997).**
- **Typically, model selection tends to be more a function of familiarity than appropriateness (Addor and Melsen, 2019).**
- **The practice of hydrologic modeling is greatly hampered by uncertainties in process and the overwhelming influence of heterogeneities (Troch et al., 2009) and other poorly understood and ill-described natural phenomena.**
- **Except in extremely data rich environments, simpler modeling approaches with highly uncertain prediction confidence limits are often considered superior to complex approaches with highly uncertain inputs and process descriptions (Hrachowitz et al., 2014).**

Source: Encyclopedia of Geology. Editors-in-Chief: David Alderton and Scott A. Elias
Reference Work • Second Edition • 2021. ISBN
978-0-08-102909-1

Main objectives

To improve hydrological forecasts exploiting recent advances in information, communication and remote sensing technologies

To combine various sources of hydrological information

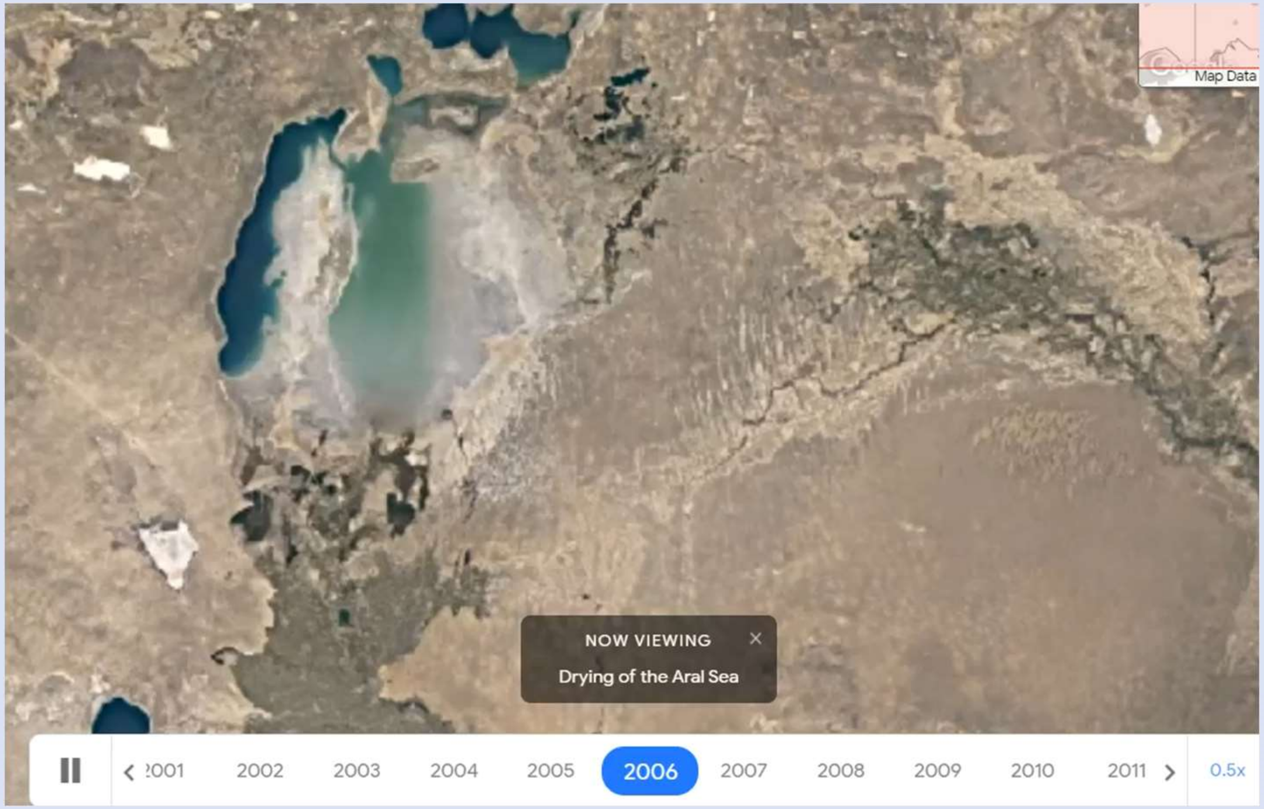
To engage citizens in environmental monitoring

To bring various stakeholders closer to scientific results

Remote sensing and hydrology

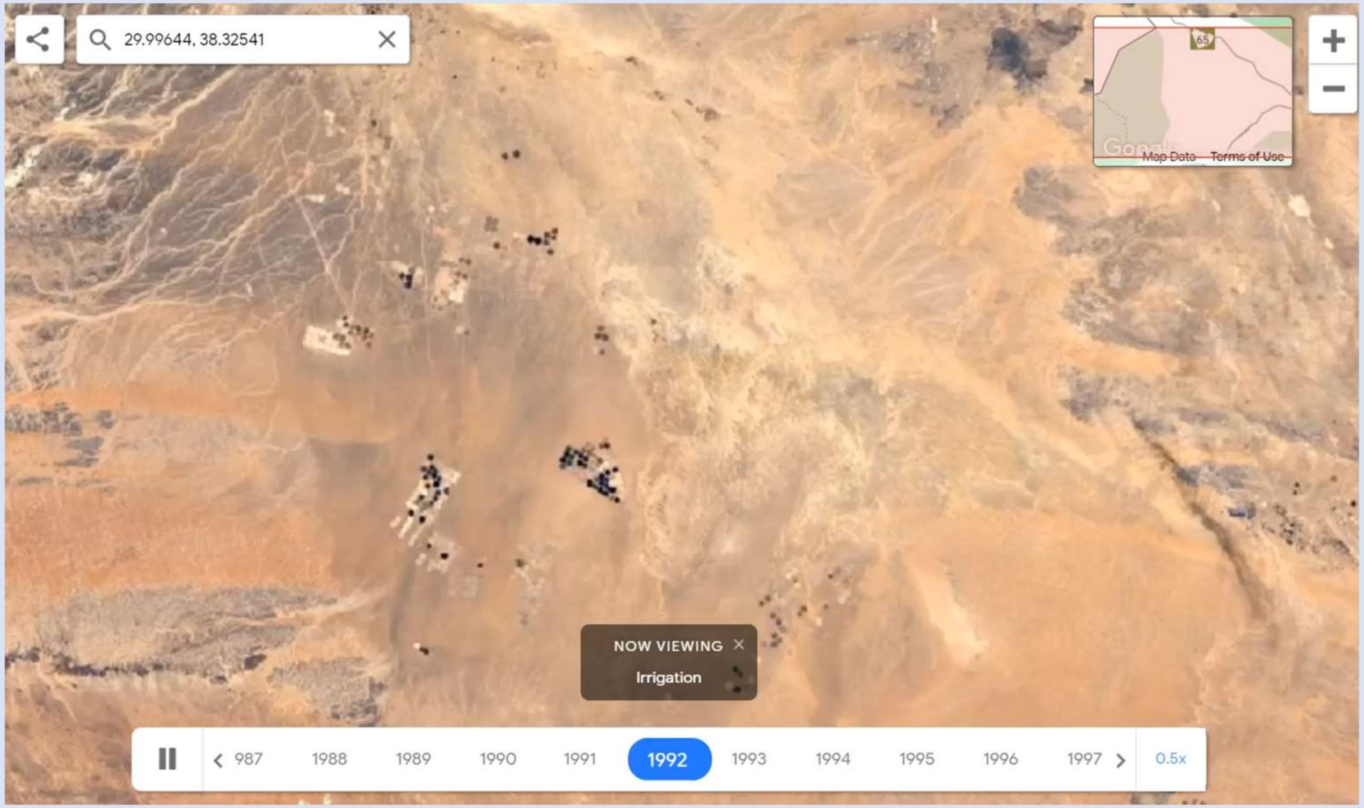
- It has been 60 years since man managed to have the first global observations of Earth.
- Ever since, satellite remote sensing has offered a wealth of environmental information precious in many scientific applications, but most of all in hydrological modeling and prediction and climate change.

Drying of the Aral Sea



Source: Google Earth Engine Time Lapse
https://earthengine.google.com/timelapse/

Irrigation in Saudi Arabia



Source: Google Earth Engine Time Lapse
https://earthengine.google.com/timelapse/

Problem definition

Typically hydrological models rely on in situ monitoring networks

Problems encountered:

- **Costly maintenance and operation**
- **Cannot reach remote areas**
- **Difficult to provide adequate coverage**
- **Difficult to keep operating for long periods**

Problem definition

Lack of adequate in situ monitoring results in poor hydrological nowcasts and forecasts.

Hydrological models usually run using meteorological data generators providing thus a rough approximation of the hydrological regime.

Problems using other data sources

Remote Sensing and Citizen science data may provide alternative sources of information

Problems encountered:

- **Different types of resolution (in time and space)**
- **Different formats**
- **Lack of expertise to process remotely sensed data**
- **Lack of ground data sets to bias correct and/or downscale RM data**
- **High uncertainty**
- **Difficult to homogenize data**

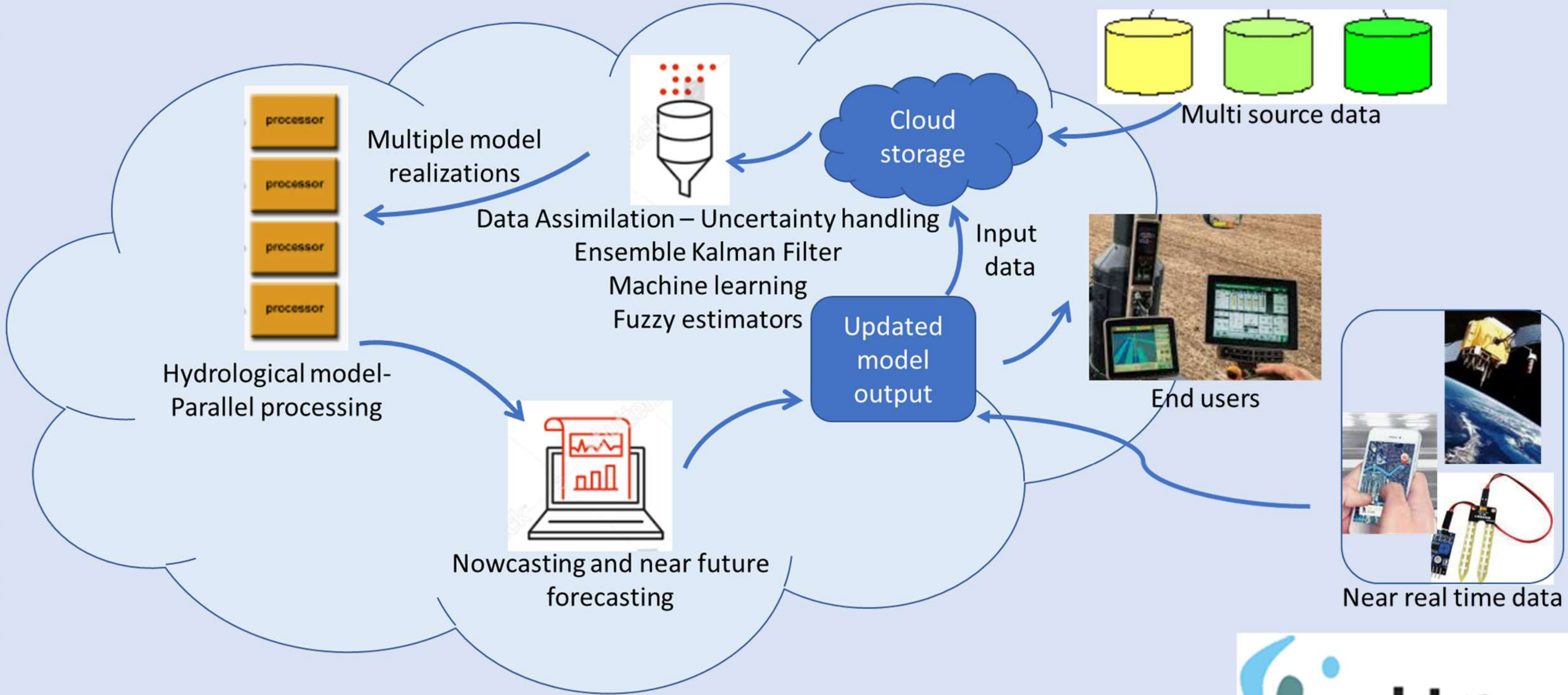
Up to now only limited coupling of hydrology and remote sensing or citizen science data has been achieved

But this can also be a challenge…

AIMS OF WATERLINE

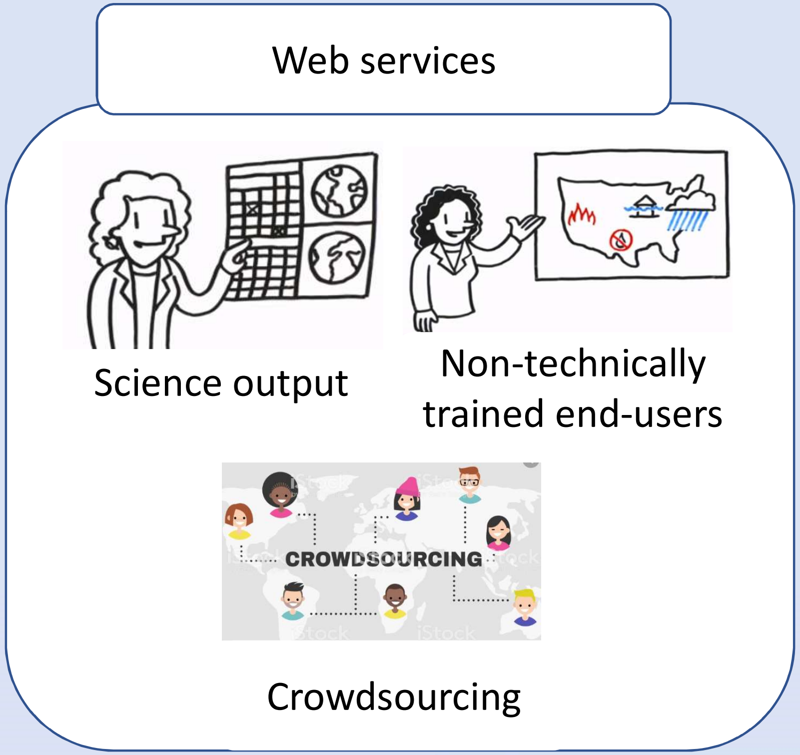
1. **WATERLINE aims to employ multi-source information from remote sensing, historical data, in-situ data from meteorological networks as well as citizen science data to improve hydrological models and their predictions**
2. **WATERLINE will take advantage of recent advances in ICTs and remote sensing technologies to improve hydrological models' output**

WATERLINE IN A FIGURE



Expected Outcomes

- A web services tool with three modular applications: scientific, societal, citizen science data
- Communication tools in the form of VR and AR applications highlighting hydrological indicators and risk maps



WATERLINE will contribute to…

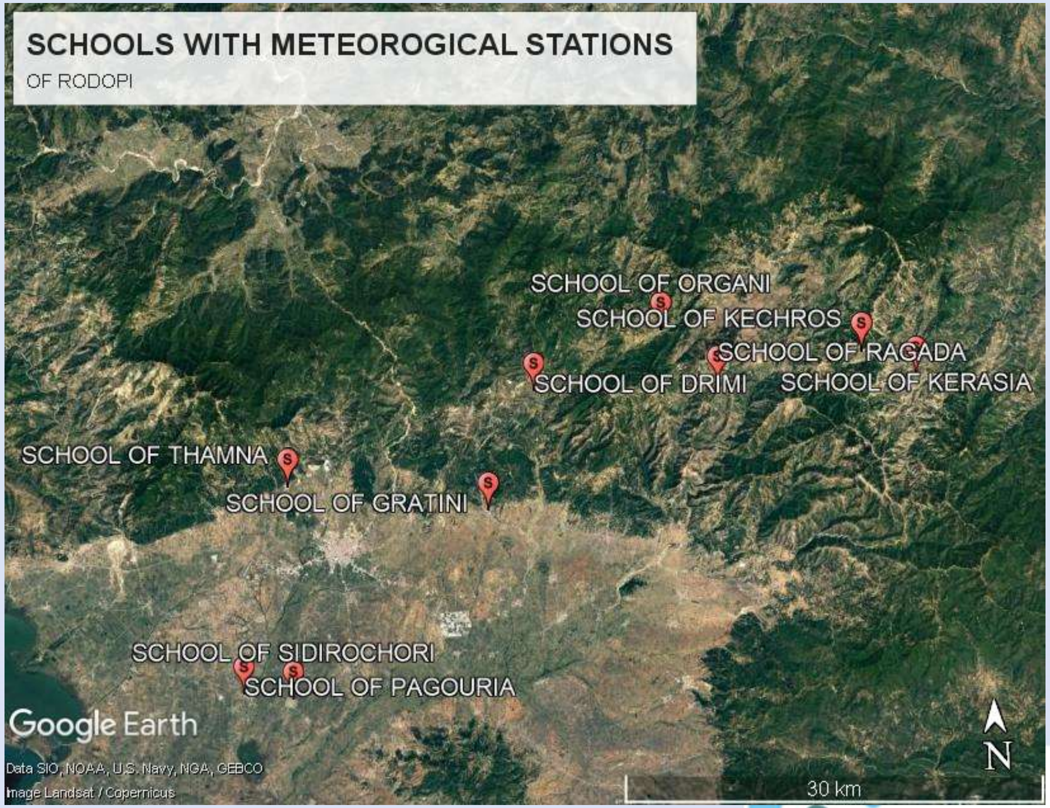
- the promotion of sustainable agriculture
- the accurate prediction and anticipation of extreme natural disasters: drought and flood prediction, monitoring, fire risk assessment
- the improvement of weather forecasts: cooperation with nation-wide meteorological groups
- the promotion of scientific research related to environment, water resources, and impacts of climate change
- new career opportunities for new scientists that will work in this project
- stakeholder engagement: farmers, school pupils and teachers, people in industry, people in fire brigade services, wide public

Co development with Stakeholders

- Farmers
- Industry processing agricultural products
- Entrepreneurs (e.g. tourism, energy)
- Public authorities (water agencies, fire brigade, hydrological monitoring),
- Decision makers, regional EPA, FMI, WFD support groups. NGOs, forest managers
- Schools – education system
- Local municipalities
- Society overall

An example of engagement of the education system

WATERLINE will engage schools in environmental monitoring



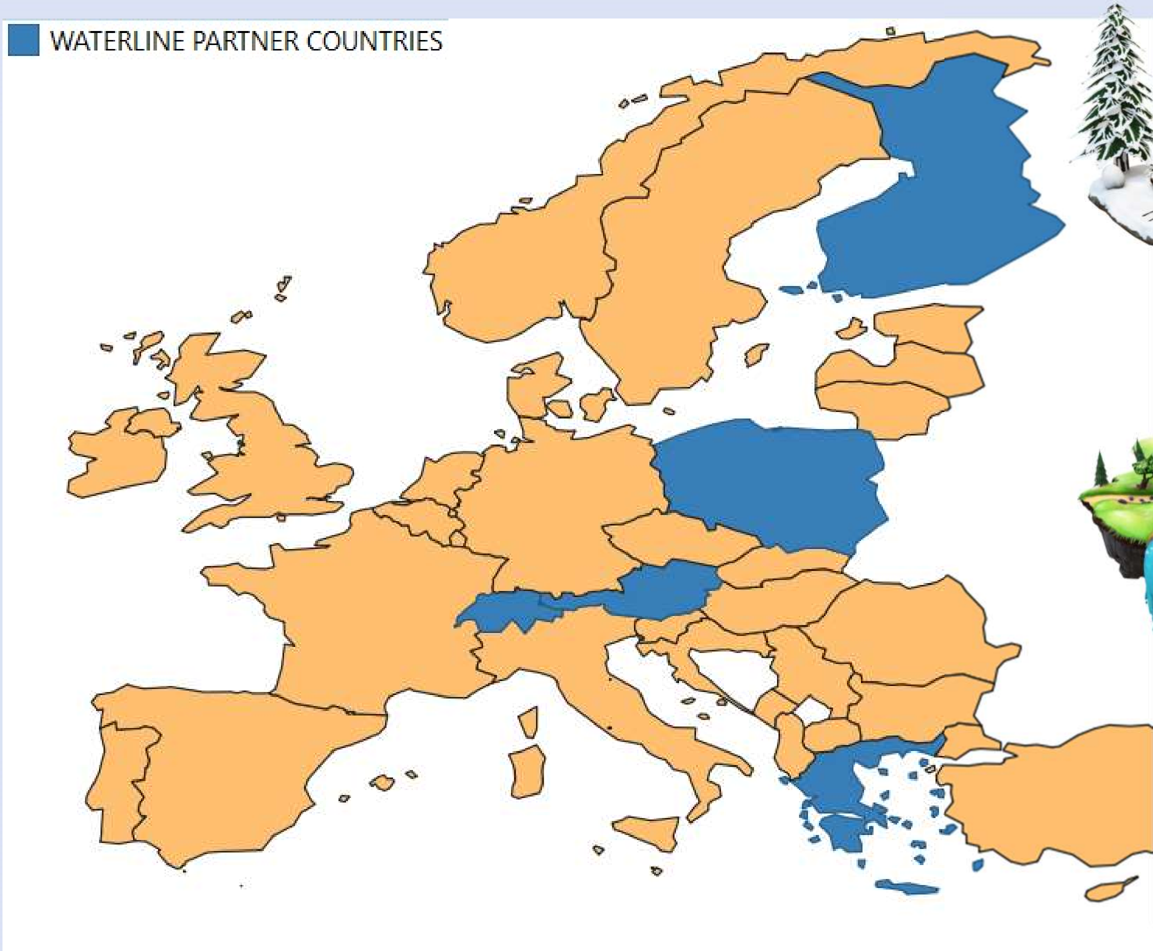
Young students will learn on environmental monitoring

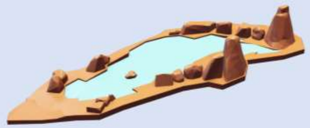
They will create their own monitoring equipment

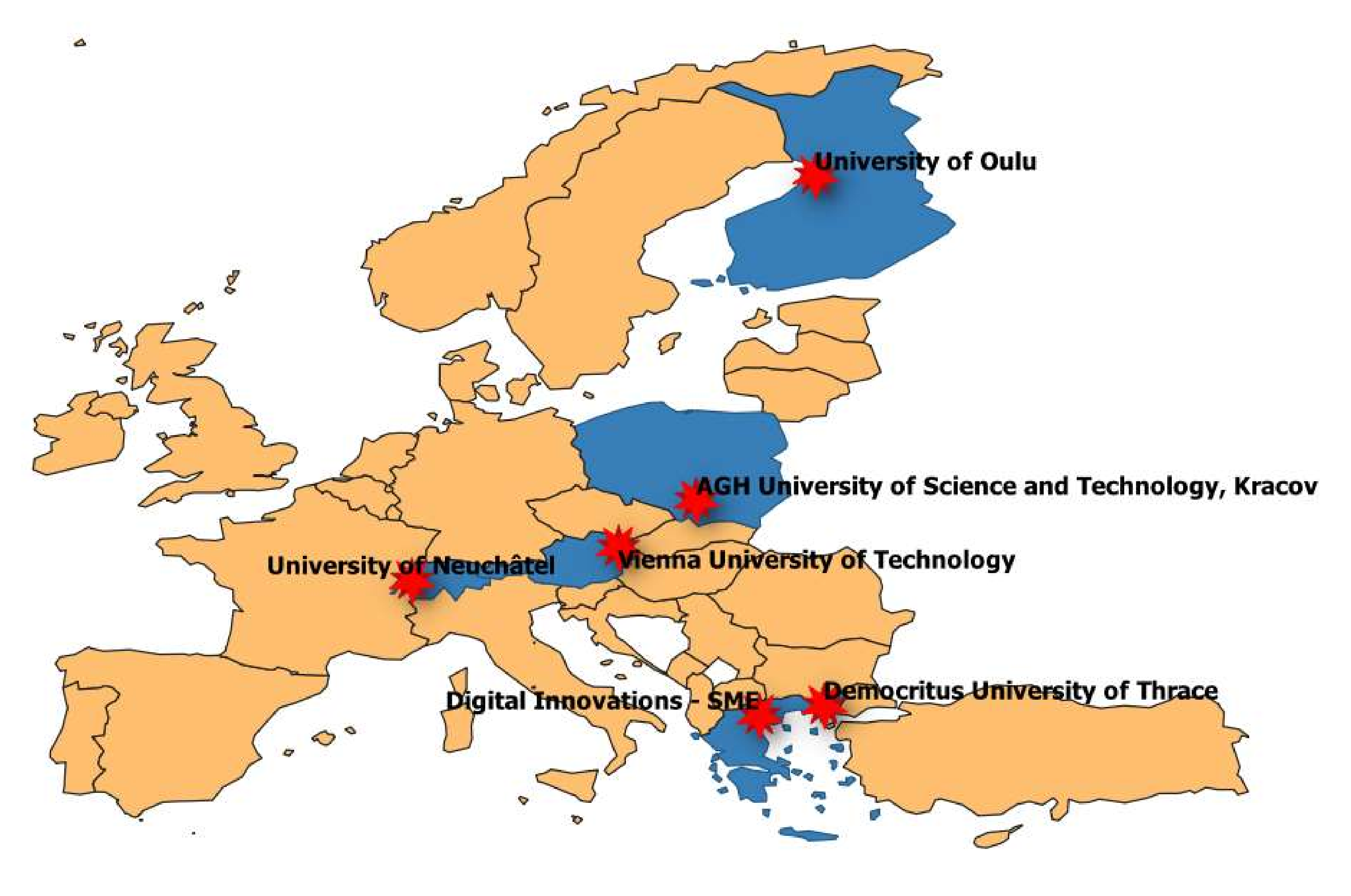
They will learn about environmental threads

WATERLINE PARTNERS

- Countries across various hydroclimatic conditions
- Different case studies
- Different problems addressed
- Diverse stakeholders' groups
- Coupling of ICT and hydrology experts
- Multi sectoral cooperation







University of Oulu
AGH University of Science and Technology, Kracov
University of Neuchâtel
Vienna University of Technology
Digital Innovations - SME
Democritus University of Thrace

Participating institutes

- Democritus University of Thrace – Greece – Coordinator

Hydrology – climate change – remote sensing applications

- University of Oulu – Finland

ICT – data assimilation – hydrology

- Vienna University of Technology – Austria

Downscaling of remotely sensed information – Citizen Science data

- AGH University of Science and Technology – Poland

Web-based solutions, hydrology

- University of Neuchatel – Switzerland

Hydrological / hydrogeological modeling – Coupling of various system processes

- Digital Innovations – SME – Greece

Virtual and augmented reality applications - Communication

Dissemination strategy

- **Authorities:** We will inform authorities about the new research developments on hydrological monitoring
- **Managers and policy makers**: The WATERLINE team will organise peer-to-peer meetings with managers from industrial sector (e.g. Uros in Finland), water authorities, policy makers in each participating country
- **Academic community**: continued success publishing in highly reputable geoscience and ICT journals
- **Stakeholders:** WATERLINE focuses on acquiring information and co-developing of tools and services with various stakeholders' groups including industry (technology/business forums).
- **Education system**: The WATERLINE project team will organise various activities targeting education system. It should be highlighted that schools, especially those in remote and mountainous parts are potential environmental monitoring points, which may easily provide precious information.
- **Public:** Press releases, news articles, social media announcements, public speeches, blogs, describing scientific advances of the project

Exploitation of WATERLINE tools and services

- During WATERLINE's implementation:
  - Open data and products under appropriate license e.g. CC
- After the end of project WATERLINE
  - Commercial license for commercial use only
  - Free license for non-commercial use (e.g. educational, research, etc).

Thank you for your attention