"Recent terrestrial ecosystems LCLU changes and driving forces - challenges for remote sensing and sustainable management"

CERTH
CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

WQeMS: A Copernicus assisted water quality monitoring service in support of the water utilities for drinking water production

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WQeMS project
coordinator

This project has received funding from the European Union's Horizon 2020 Research and Innovation Action programme under Grant Agreement No 101004157

WQeMS complenenting Copernicus and the market

Users & End Users

WQeMS

Sustainable Services

EMS Copernicus Services

Ethics & Copyrights

Marketable Services

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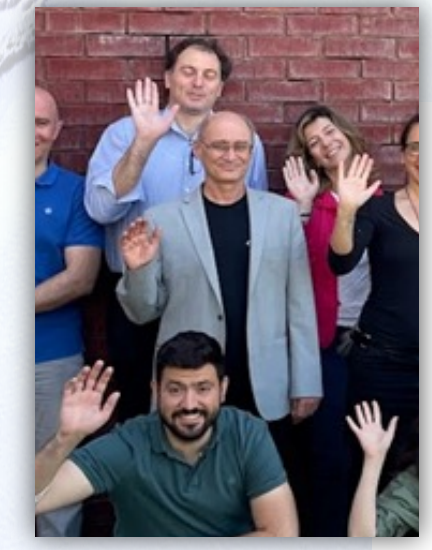
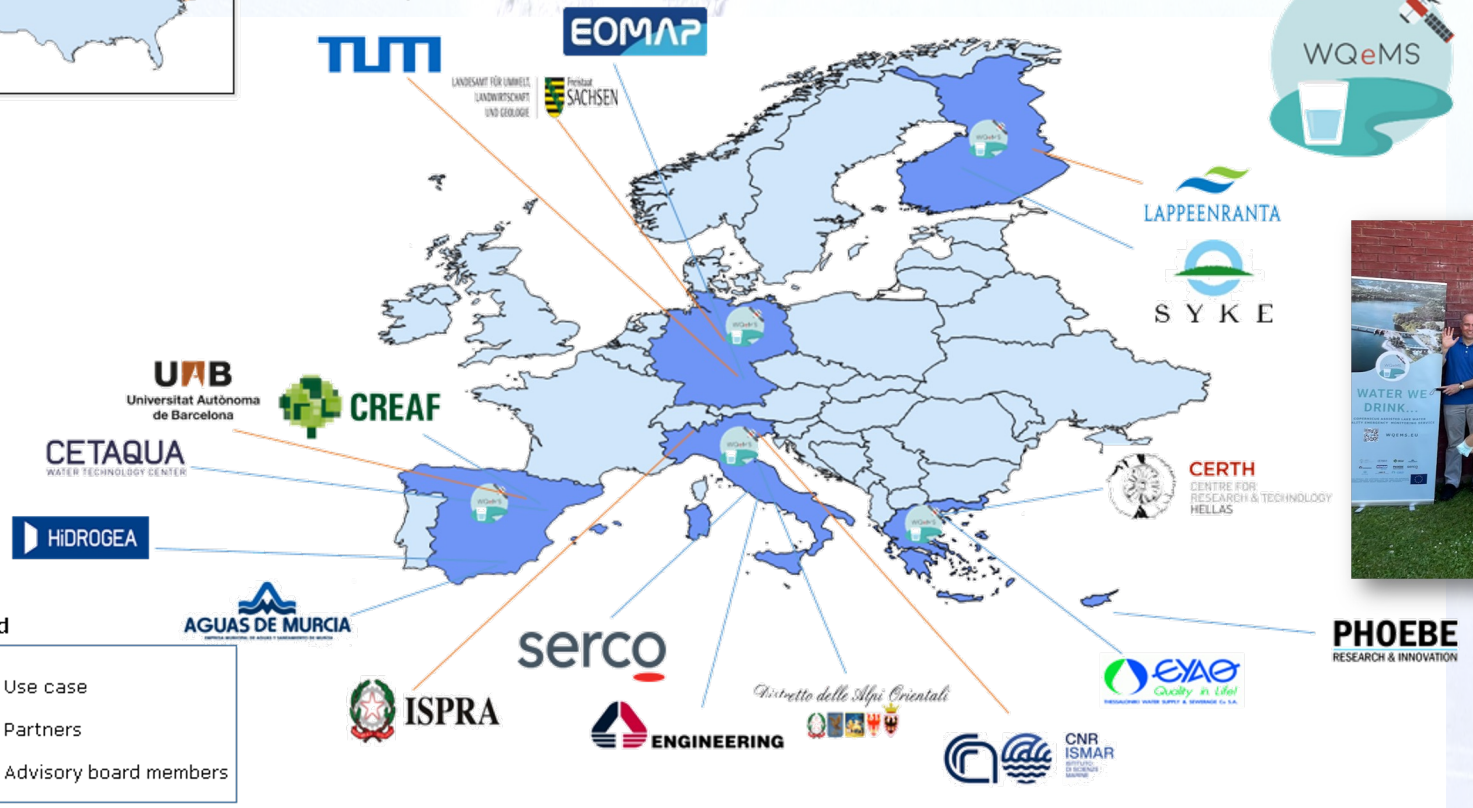
WQeMS team





End users involved (inhabitants directly served = ~2.690.000)

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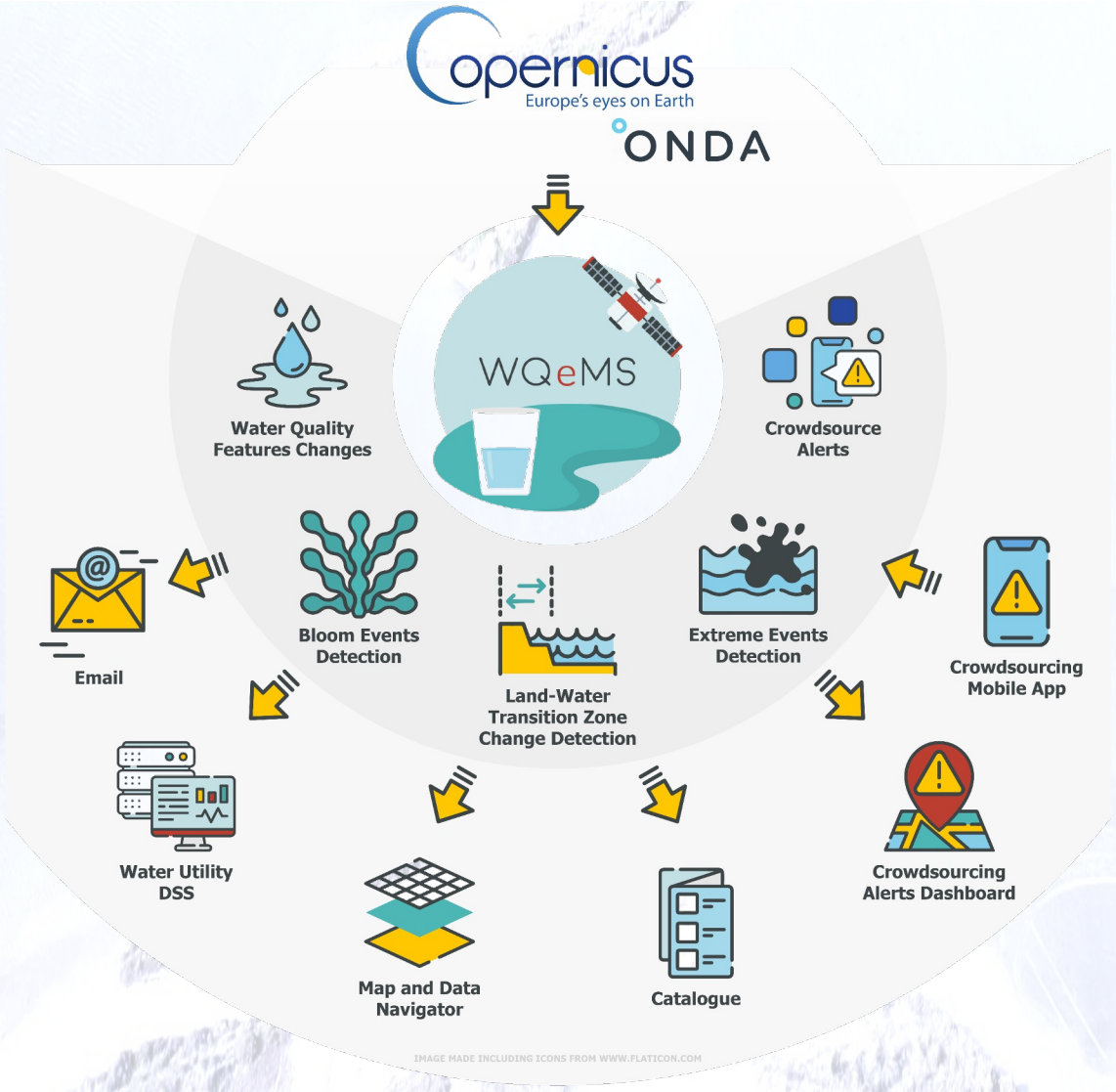
WQeMS offer to water utilities



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WQeMS for the user

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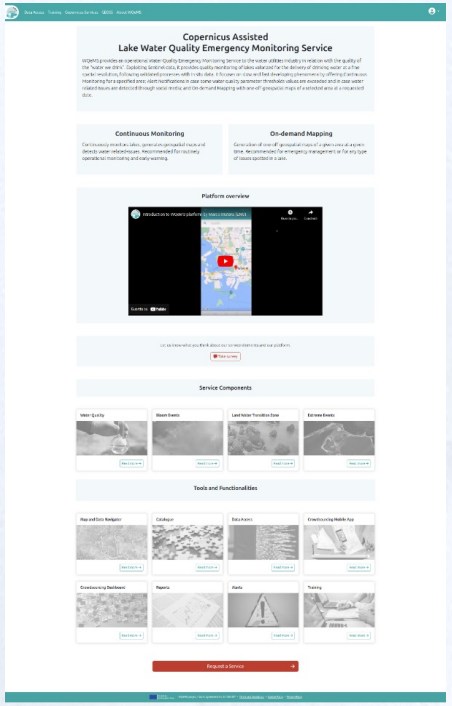
1 Send requests for data products on dates interval (on demand or continuous monitoring)

2 Access the generated data products (both GeoTIFF and metadata)

3 Get statistical data (i.e. time-series) obtained analysing the tiff files generated for the area of interest

4 Request a PDF report for a water body to be sent by email

5 Configure the platform to send alert notifications by email or to HTTP API of an external system

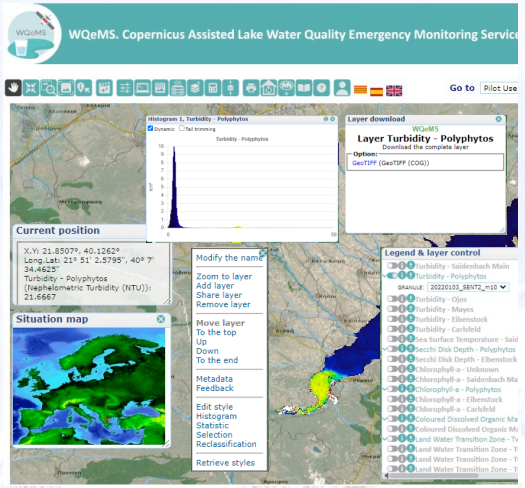


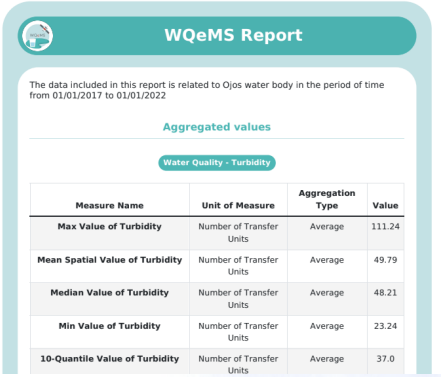
OGC WMS

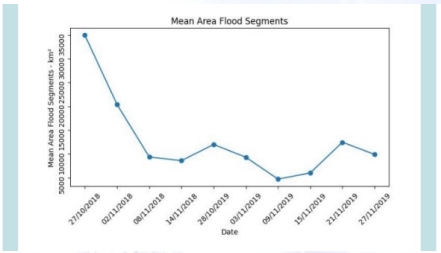
GeoServer

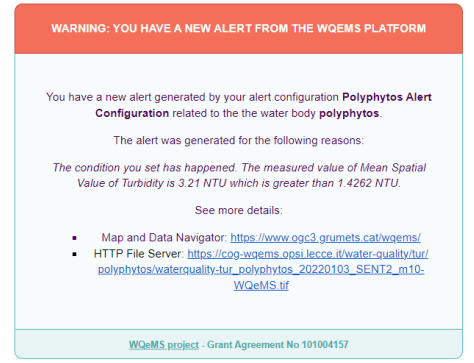
HTTP File Server

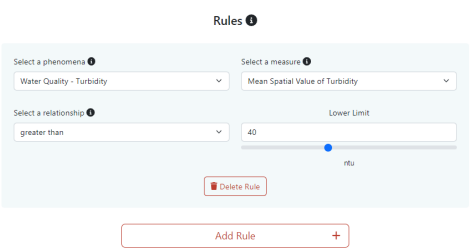
FTPS Server











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WQeMS innovation

- **Facilitate the adoption of EO monitoring services in the water utilities' operations**
- **Increased awareness of the water utilities** in relation to water-related issues (early warning, fast response to phenomena)
- Fast and automated services: The platform is realized adopting **cloud micro-services approach**, **ensuring scalability and extensibility**
- **Federated approach –** enable new service providers to easily extend the WQeMS platform service portfolio
- **Adopting both standard and modern protocols for the interconnection of systems (i.e. APIs, OGC Web Services)**

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WQeMS service components (SC)

Service	Sub-service
Water Quality	Turbidity
	Chlorophyll-a
	Coloured Dissolved Organic
	Secchi Disk Depth
	Sea Surface Temperature
Bloom Event Detection	Harmful Algae Bloom Indicator
Land Water Transition Zone	Two Dates
	Hydroperiod
Extreme Event Detection	Oil Spill
	Muddy Water
	Flood

There are three different types of output data (for each service component) managed by the platform: **GeoTiff** files, **statistical data** in json format, and **metadata** in xml format

Metadata

An XML file describing the metadata of each GeoTiff image.

For example, some parameters are: the file size, the HTTP link to the file, the Data Provider, and so on.

GeoTiff

A raster layer that contains data about a specific feature monitored by each service.

Statistical Data

A JSON that contains some statistical values associated with the GeoTiff image,

such as mean value, maximum value, median, and so on

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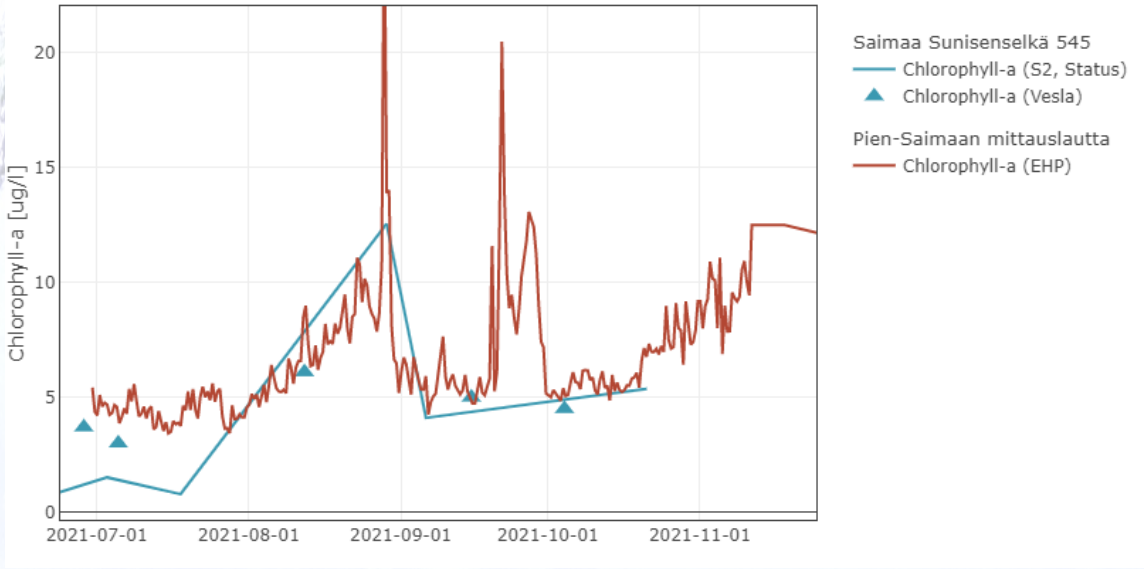
SC 1 – Water Quality Features

- Comparison of in situ and satellite observations about water quality

- Knowledge generation from the free and open water quality information through Syke's TARKKA web application and EOMAP's Modular Inversion Processor

Location of the automated water quality monitoring station



Chl-a values observed at the location of the automated station with Sentinel-2 satellite (S2, blue line), laboratory samples (Vesla, blue triangles) and automated instruments (EHP, red line)

Innovation: Expansion of known workflows and techniques for the needs of the water utility industry.

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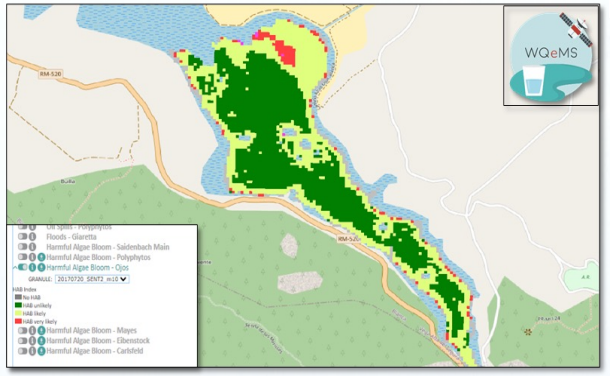
SC 2 – Harmful Algal Blooms

- In situ sampling (Azud de Ojós and DWTP Reservoir) to adjust the values detected in the Sentinel-2 images.

- Historical data of algal monitoring are used to test performance of hyperspectral images.

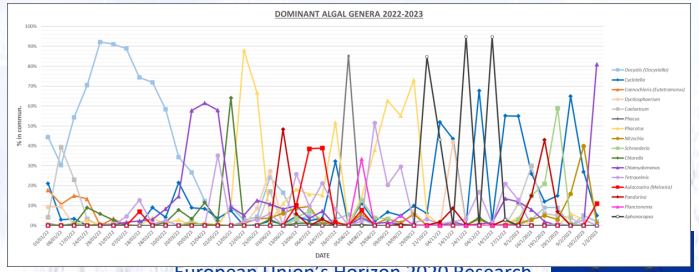


Same workflow result with WorldView, 0.5m

Innovation:

- Detection of potentially harmful cyanobacteria blooms
- Worldwide data even for small water bodies (> 1ha)
- For emergency and baseline scenarios

- Tested (in GR, DE, FI) and in an operational DSS in Spain
…using **different type of sensors and data sources** (it combines data from satellite and in-situ online monitoring station; data from regional water basin agency and national weather agency, etc.)
…able to provide **forecast of cyanobacteria risk from coupled models** based on machine learning methods
…in a form that has been **co-created with and for the Drinking Water Plant Operator** that is using it since 2021



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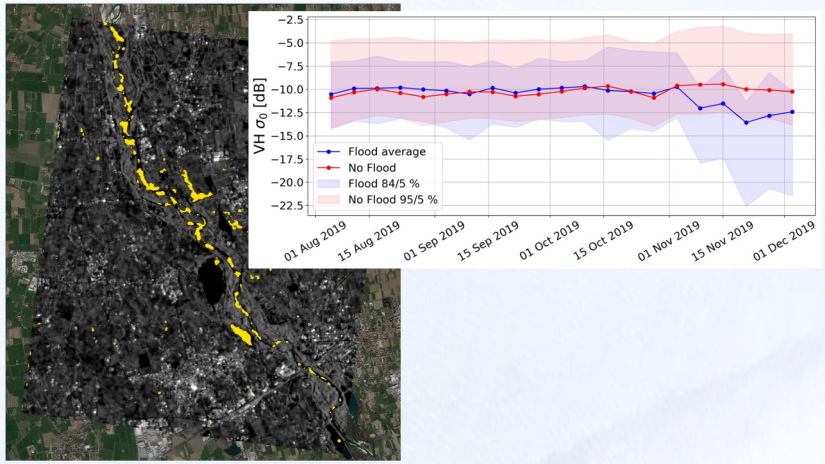
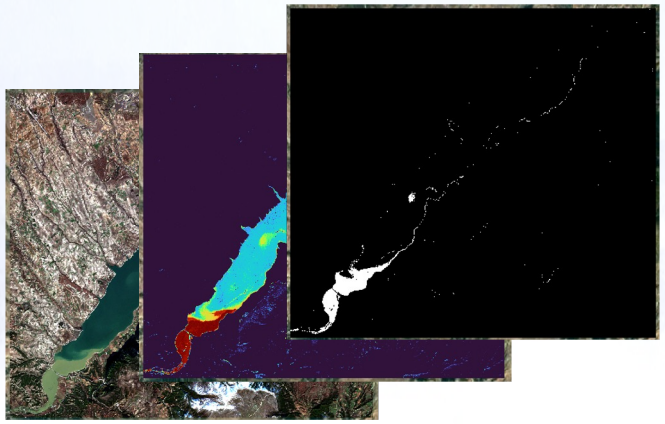
SC 3 – Extreme events

Flood sub-service maps extreme flood events using **Sentinel-1** every **~6 days** (both satellites) with a **10m** pixel size based on **Deep Learning**



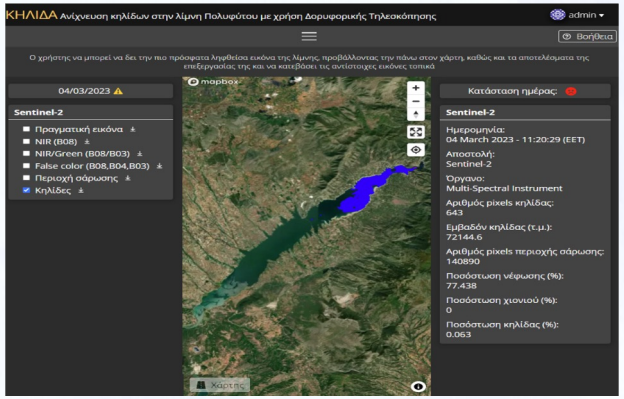
Innovation:
- **Explicitly exploits time series patterns**
- Uses deep learning
- **AOI-invariant model**

Muddy water sub-service maps muddy waters (extreme suspended sediment values in the water) using **Sentinel-2** every **~5 days** with **10m** pixel size based on **Ensemble Machine Learning**



Innovation:
- **Unique muddy water mapping service** using machine learning

Oil spill sub-service maps potential hydrocarbons using **Sentinel-2** every **~5 days** with **10m** pixel size based on **Deep Learning**



Innovation:
- **Unique hydrocarbon mapping service for inland waters using deep learning & optical data**

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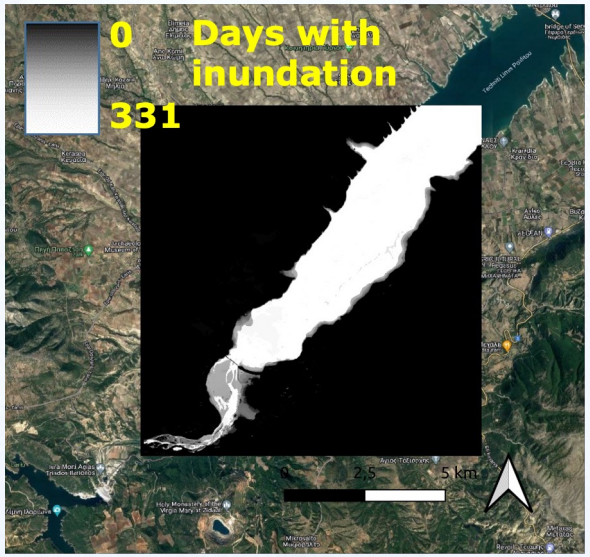
SC 4 – Land-Water transition zone



Polyphytos Lake (subset), land to water change detection between: 21-10-2017 and 02-12-2017

Three modes for two-dates service:

- S2 mode: Only Sentinel 2 data
- S2-S1: Based on the user dates, the products (either S2 or S1), whose acquisition date is the closest to the user preference, will be used for the processing.
- S1 mode: Only Sentinel 1 data

Two modes for hydroperiod service:

- S2 mode
- S2-S1 mode

Innovation:

- **Proven and adapted workflows at multiple sites across Europe** reaching up to **98% accuracies** (multiple alternative methods for various scenery types)
- Exploitation of **both optical and radar data to enhance frequency of information** retrieval with proven credible results
- **Fully unsupervised performance**

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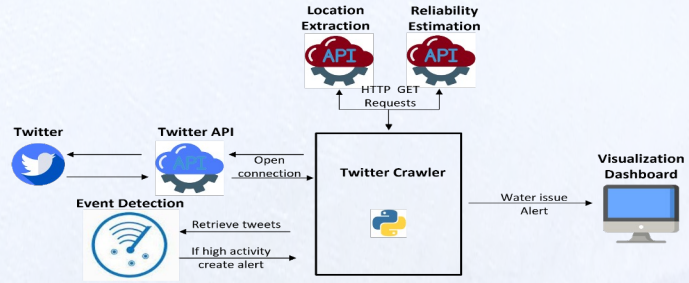
SC 5 – Alerts Generation

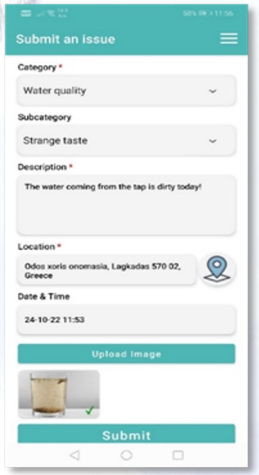
The Social Media Crawler collects water related tweets from Twitter in real time.

- Analysis of each retrieved tweet:
  1. Extract tweet location from text
  2. Estimate whether tweet is fake or not
- Detect water related events based on Twitter activity and location.



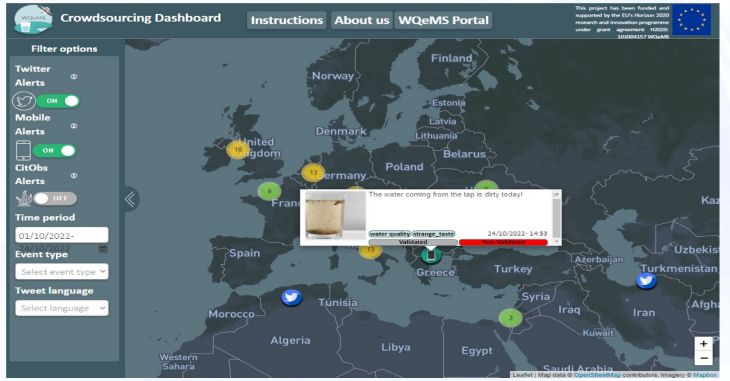
Innovation:
Analyzes **large volumes of crowdsource water related information in real time** and provides potential water issues that need to be investigated.

The Crowdsourcing Mobile App allows citizens to post water related complaints through their smartphone.



Innovation:
Enables a more efficient and **streamlined way for water utilities to receive and handle complaints** and improving the quality of service and customer satisfaction.

The Crowdsourcing Dashboard visualizes the alerts collected from multiple sources including alerts generated by social media crawlers and complaints submitted through the crowdsourcing mobile app



Innovation:
The crowdsourcing Dashboard combines and **visualizes data from multiple sources,** enabling quick identification and responding to emerging issues.

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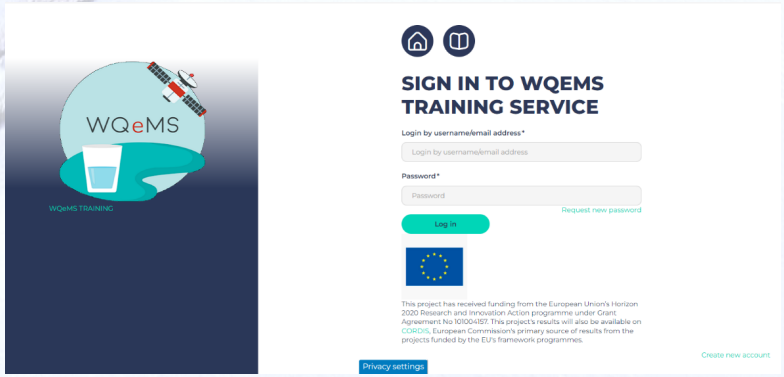
SC 6 – Capacity Building



WQeMS e-Training Platform

(https://wqems.phoebeinnovations.com)

Content

- **Understanding Copernicus data and services**
- **Technical aspects in earth observation services**
- **Inland water features' estimation services enabled by earth observation**
- **Use-cases and applications**

Training guidance

- **Training Pathway 1: Full-range training**
- **Training Pathway 2:** Familiar with background knowledge; Requiring **strong WQeMS-related skills for specific services**
- **Training Pathway 3:** Training to **attract interest of domain experts**
- **Training Pathway 4:** Focusing on **Academia**
- **Training Pathway 5:** Focusing on **Industry**

Innovation:

- **Dedicated training pathways** through the material per level of competence and target audience..
- **Facilitate the acquisition of required skills and competences** by WQeMS users, related to the operation and **content interpretation of the developed solutions.**
- Help **sustain the operation of the WQeMS platform beyond project duration.**

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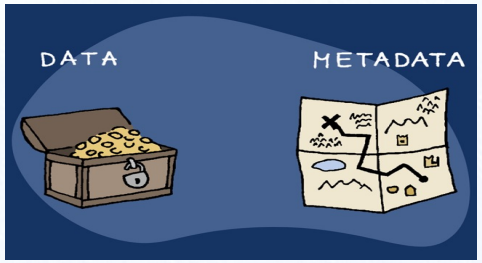
SC 7 – Metadata & Feedback



WQeMS follows the FAIR pronciples: Data should be **Findable, Accessible, Interoperable and Reusable** to the greatest extent possible

- How to decide that a dataset is useful for our purposes (fit per purpose)?
- How to choose the best dataset in terms of the quality of the data?
- How policy makers can know better the results of policy and monitoring?

METADATA!

Innovation:

- New keywords that describe the dataset in a way to bring it closer to management, monitoring and policy, following the GEO Essential Water Variables, i.e. "Lakes/reservoir levels", "Water Quality", "Water use/demand", "Evaporation", etc. and the UN Sustainable Development Indicators, i.e. Target 6.3.

- Quality parameters included in the metadata based on QualityML dictionary.

```
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</gmd:errorStatistic>
```

- All Metadata is **uploaded to the GeoNetwork catalogue and also allows connection to the GEO yellow pages**

- Metadata is also available through **the interoperable WQeMS Map and Data Navigator, by which feedback to the dataset can be provided.**

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WQeMS – Main innovative elements

- Use of multi-sensor-fusion technologies
- Spatial and temporal resolution, and product consistency
- Treatment of small (also uneven shaped) open surface water reservoirs
- Minimization and documentation of uncertainty
- Ontology and semantics of water quality supporting regulations
- Metadata tool documentation
- Interoperability with existing Decision Support Systems and multiple DIAS
- Cloud based micro-services structure
- Federated approach, enabling further service providers to expand WQeMS service portfolio

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Water we drink...

Copernicus Assisted Lake Water Quality Emergency Monitoring Service

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https://wqems.eu/

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EYAO Quality in Life! THESSALONIKI WATER SUPPLY & SEWERAGE Co S.A.

PHOEBE RESEARCH & INNOVATION

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