Sentinel users preparation for novel aquatic applications using CHIME and LSTM data

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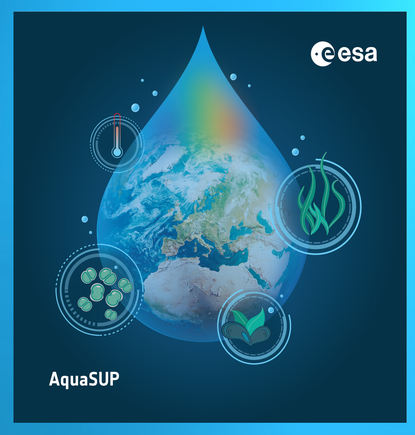


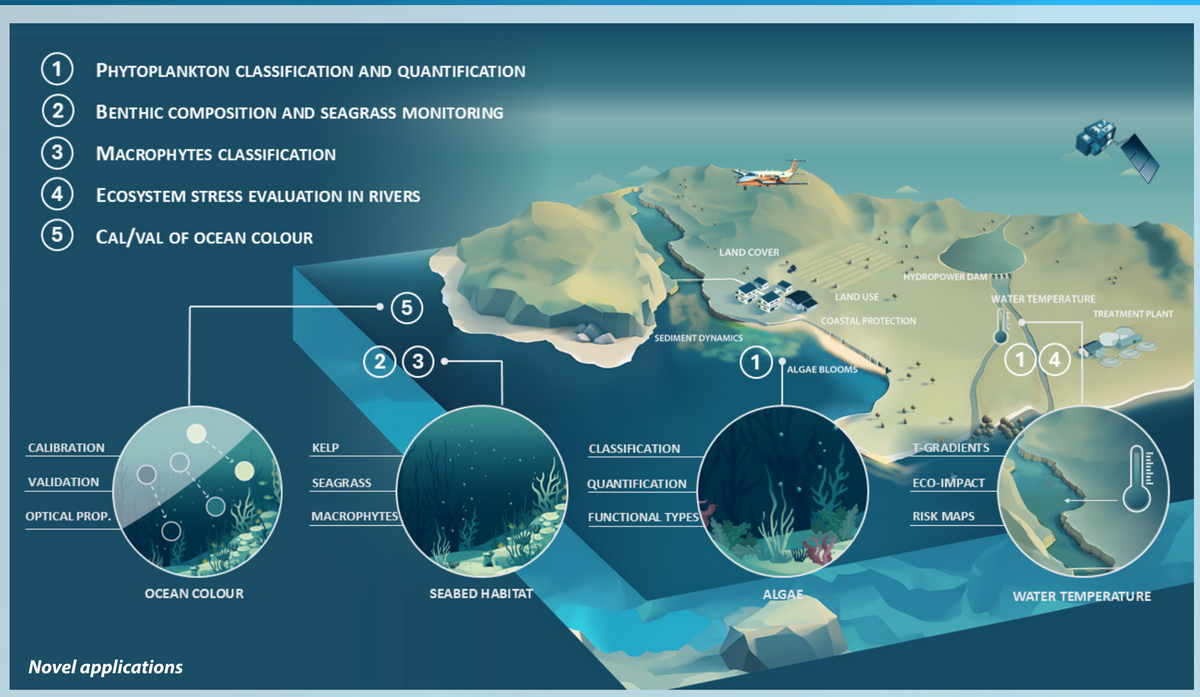
Objective

Two thirds of the planet are covered by water, the single most important element to sustain life. Preserving and promoting good water quality not only benefits the environment but also safeguards public health and ensures the preservation of water resources for future generations.

The **objective of the AQUASUP project** is to **develop and validate novel concepts for the integrated use of data from the CHIME and LSTM missions**, to **overcome prevailing information deficiencies in inland water and coastal monitoring and management,** focusing on enhanced water quality and ecosystem assessment. Combining hyperspectral and thermal imagery for advanced applications presents a promising pathway for addressing a multitude of societal challenges in the future holding the potential for understanding various impacts, such as the response of both inland and coastal ecosystems to population growth and climate change enabling to establish mitigation action plans. The combined data exploitation brings benefit to their end-users and thereby addressing EU policies and gaps in Copernicus user needs.

Applications

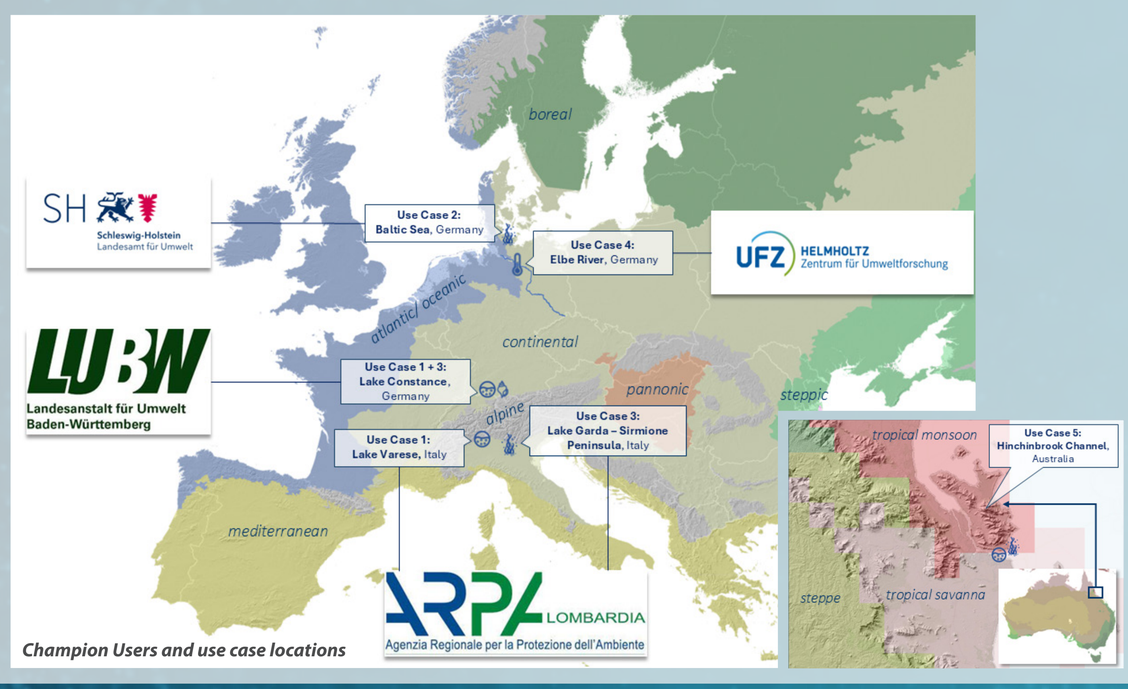
The project marks a first step in facilitating the adoption of the new Copernicus Expansion missions together with selected key stakeholders. Utilizing simulated CHIME and LSTM data, **five applications will be developed focused on mapping and monitoring both inland and coastal aquatic environments**.



Novel applications

Champion Users

The **selected champion users represent various stakeholder groups and are influential players** within their respective fields. Their participation in testing and evaluation activities ensures that the new approaches are tailored to address the stakeholders' real-world challenges, enabling the demonstration of viability and benefits concerning the Copernicus expansion missions.



Champion Users and use case locations

Benefits of the novel applications

Landesanstalt für Umwelt Baden-Württemberg
- » **Enhanced classification of algae including toxic species** and the **influence of temperature** for ecosystem shifts
- » Monitoring of quagga mussels and Potemogeton helveticus

Schleswig-Holstein Landesamt für Umwelt
- » **Spatial coverage and temporal frequency of monitoring**

ARPA Lombardia – Agenzia Regionale per la Protezione dell'Ambiente
- » **Increased accuracies for phytoplankton and macrophytes classification** including adverse situations
- » **Evaluation of temperature influence on ecosystem changes**

HELMHOLTZ Zentrum für Umweltforschung
- » **Spatially and temporally resolved thermal information** (not existing)
- » Enhancement of water quality models' results

The fifth use case will be conducted along the Northeast Australian coast in exchange with CSIRO. The goal is to develop an improved analysis of optical properties in coastal systems with high amount of dissolved substances. It will advance the analysis about the influence of both dissolved and particulate water constituents. Furthermore, XYLEM will have access to the results as Champion User.

Methods

Dataset simulation

CHIME: Three different approaches will be developed, tested and evaluated to simulate Top of Atmosphere (ToA, Level 1) CHIME data in a respective hyperspectral and spatial resolution. The simulation methods are:

I. **Full simulation of CHIME spectra** considering various parameter scenarios, defined by constant sets of inherent optical properties (IOPs) of the water constituents and albedo spectra of the benthic types, and by a min/max values of the parameters which are treated as variable.

II. **Spectral resampling** utilizing sensors with similar specifications like EnMAP and PRISMA based on a CHIME adapted transfer logic.

III. **Simulation through water constitutents** and the determination of physical paramters from EnMAP and PRISMA data.

LSTM: Spectral resampling utilizing sensors with similar specifications like ECOSTRESS and locally available airborne datasets.

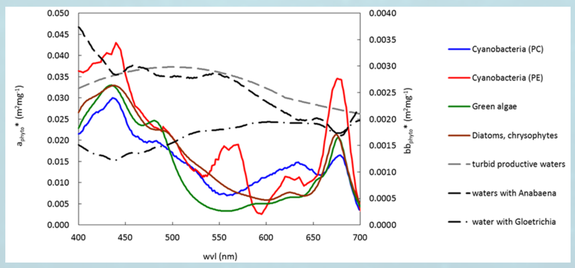
Applications

- » Adaptive semi-empirical band-ratio like algorithms
- » Bio-optical modelling inversion by using respective absorption and backscattering coefficients
- » Sun-induced Chlorophyll Fluorescence (SICF)
- » Radiometric observation on the thermal domain based on Planck Law
- » Heat flux budget based on LakeVap* tool

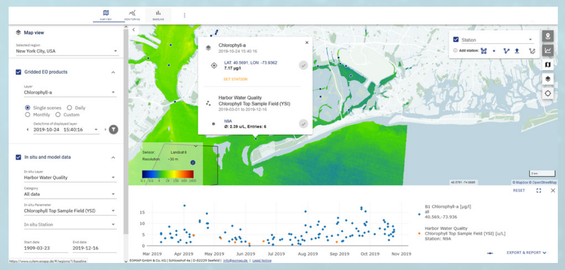
Implementation of applications

The developed applications of AQUASUP will be **showcased by a webapp based solution that integrates the derived water quality/environmental products and analytical functions for risk indicators assessing the threat potential for a given combination of spectral response and temperature measurements.** Alert warnings will be issued if specific conditions are met. Built on EOMAP's agile EOAPP platform, the webapp solution will offer a user-friendly interface that enables data analysis, visualization, and access to critical EO based information.

Users can explore relevant parameters, trigger custom analytics, and make informed decisions in relation to reporting directives.



Spectral signature of different algae classes in the visible spectral range (Source: http://www.copernicus-inform.eu/sites/default/files/ppt/13_Chla_PC_Phyto_CNR_final.pdf)


EOAPP for visualizing water information products and dedicated end-user functionalities

1. * Matta E., Amadori M., Free G., Giardino C., Bresciani M., 2022. A satellite-based tool for mapping evaporation in inland water bodies: Formulation, application, and operational aspects. Remote Sensing, 14(11), 2636

Outlook

The described applications aim to **prepare users to fulfil current and future regulations** and policies imposed by global, EU, and regional initiatives, including the **United Nations' Sustainable Development Goal (SDG) 6 on a global scale, the Water Framework Directive (WFD) - the most critical EU directive for water body protection and management - alongside the Nitrates Directive (ND) and the Drinking Water Directive (DWD) on a European level, and NATURA 2000, the Habitat Directive and Environmental Impact Assessments** on a local scale.

The AQUASUP project is funded by ESA and conducted by a consortium consisting of EOMAP, DLR, CNR and UFZ. The project has a runtime from December 2024 - December 2026.

Looking ahead, AQUASUP will

- Facilitate prompt adoption of CHIME and LSTM data through early stakeholder engagement
- Create novel applications combining CHIME and LSTM data
- Enable enhanced environmental monitoring
- Strengthen regulatory compliance and ecological sustainability

EOMAP a Fugro company · DLR · Italian National Research Council · UFZ HELMHOLTZ Zentrum für Umweltforschung