An open surface Water Quality Emergency Monitoring Service (WQeMS) to the water utilities' industry leveraging on the Copernicus products and services. Target is an optimized use of resources by gaining access to frequently acquired, wide covering and locally accurate water-status information.

Newsletter II

Copernicus Services Evolution

Ioannis Manakos, project coordinator
(on behalf of the consortium)

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

Contents

Highlight:

WQeMS was presented at

- the GEO Week 2021 in the session "A water quality emergency monitoring service evolution and the generation of a roadmap for future Copernicus water services: WQeMS meets Water-ForCE"; and
- the CEMS Week 2021 in the evening session of the 25th of October, where experts, users and policy makers got involved in a discussion about the future of our service (a presentation was given) towards the user community.

Editorial

Dear Reader,

we kindly welcome you to get acquainted with a Copernicus Service Evolution project within the Research and Innovation Action program of the H2020 framework. Being part of the cluster of projects for Space Research by the European Commission our working team is honoured to inform you about the Copernicus Assisted Lake Water Quality Emergency Monitoring Service (WQeMS).

In this issue you may enjoy interesting articles about the services, which are under development in relation with the pilot areas and use cases of the project.

Follow us at our social media accounts and visit our website for more information: https://wqems.eu/.

Ioannis Manakos

Project Coordinator

Principal Researcher @ CERTH

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WQeMS Services

There is the need to provide water quality data for the drinking water reservoirs according to the Drinking Water and the Water Framework Directives. The continuous monitoring of the water quality nowadays is achieved via sensors that are placed on key points of its route and most commonly in the water provision channels and that can measure several physicochemical properties of water including pH, conductivity, color, dissolved oxygen, turbidity and others. Therefore, in case of an alert coming from a sensor, specific procedures of communication are initiated with the water management authorities in order to take the necessary measures.

Although the sensors provide very accurate and on time measurements, they are able to capture the quality of the water only in very specific and limited places of the route, excluding usually the source itself, which is quite extensive and thus not possible to cover. Moreover, existing in-situ sampling campaigns can only provide limited information at specific points within the reservoirs. So far estimations of water quality features by analysis of the satellite observations are utilized in rare cases. This creates a gap in the water quality monitoring system.

WQeMS will enrich the portfolio of supporting monitoring services for water utilities, respective governmental and local authorities' agencies, and service providing companies. WQeMS offers an extended and frequent coverage monitoring of open surface water reservoirs that are utilized for the production of drinking water. It allows site specific time series analyses to monitor water quality features' values.

Additional information on seasonal trends for important water quality variables from past decades can be generated from archived satellite data to provide a baseline of water quality features. From this baseline, further analyses can be undertaken. The main results can be summarized in monthly reports with user-defined specifications, such as specific visualizations or evaluations.

Water reservoir in Eibenstock, Saxony, DE

User requirements are taken into consideration for the development of the services within WQeMS. These are

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initially applicable at the each of the pilot areas and use cases. However, they may become transferrable to further regions of interest, as framework bio-geo-climatic conditions vary at each of the pilot service-test-and-development areas. The following WQeMS core services may be used as such or bundled to provide added value support to Decision Support Systems of the water utilities:

1. Water quality features estimation;
2. Bloom events detection;
3. Extreme events detection;
4. Land-water transition zone change monitoring;
5. Alerting through reporting and crowdsourcing;
6. Capacity building through the provision of training material and tools.

Depending on the pilot area, different products and services are employed. These are adapted towards local conditions and resources, which results to variable adjusted workflows for the monitoring services.

In this newsletter, the services directly related with increment of substances dissolution/ concentration in the water (1., 2., 3.) will be presented. The rest services (4., 5., 6.) will be highlighted in the forthcoming Newsletter 3.

Water quality features

Water quality features that can be estimated through this service are the following:

- Chlorophyll-a;

- Turbidity;

- Water Surface Temperature;

- Secchi Disc Depth; and

- Coloured Dissolved Organic Matter.

This service is developed by applying and improving existing processing chains, such as the proprietary Modular Inversion and Processing system (MIP) by EOMAP or the open access processors by SYKE, such as C2RCC, Polymer, Acolite and FUB WeW for water quality estimation in the Finnish lakes.

Water quality variables are generated by operationally using Copernicus satellite data missions from Sentinel-2A/B and -3A/B, while not excluding the possibility to take advantage of commercial very high resolution (VHR) spaceborne or airborne data, as well. An increased spatial resolution allows for a more detailed observation

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of study areas that is not yet available with current services. This added value due to VHR data can be seen in the image (Figure 1.). The eoHAB indicator can depict the spatial pattern in the WorldView-3 image at 2m spatial resolution, while the pattern is not as clearly visible in the Sentinel-2 image at 10m spatial resolution.

Co-utilization of images acquired by various spaceborne sensors (e.g. Sentinel-2 MSI and Landsat-8 OLI) may also lead to the increment of the frequency of sensing; thus, to a higher temporal resolution. Radiometric issues have to be considered, as well as the difference in scale.

Water quality features service comprises of:

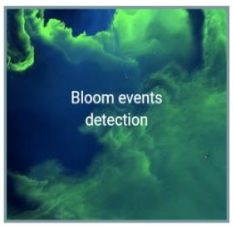
- the acquisition of EO data;

- processing, generating and validating added-value products with higher spatial and temporal resolution;

- utilization of advanced internal quality measures as well as standardized metadata descriptions;

- customized reporting output through the WQeMS platform; and/ or

- integration as input into existing Decision Support Systems.



Bloom events detection

Usually, the information that water managers have on algal blooms and cyanobacteria evolution in the catchment is generally limited to some in-situ sampling every few weeks. Satellite-based data of the open surface water reservoirs can be used to identify and track the (evolving) algal blooms, which can cause problems by potentially influencing taste and odor of the water, as well as toxin concentrations produced by species, such as cyanobacteria microcystins.

The bloom events detection service line is focused on identifying and monitoring of harmful algae blooms (HAB) formed by cyanobacteria with potential of producing toxic compounds. Latest developments in HAB monitoring are adopted along with the user requirements to answer directly to water utilities needs. The HAB indicator developed by EOMAP as well as the HAB indicator developed by SYKE are used in order to increase the applicability of WQeMS at various bio-geo-climatic conditions.

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Figure 1. HAB indicator by utilizing different spaceborne images (i.e., Sentinel-2 (top) vs. WorldView-3 (bottom)).

Selected remote sensing techniques will bring more frequent and complete information on the state of the different open surface water reservoirs and ponds. Existing workflows will be improved through field measurements at the pilot areas. A weekly monitoring will become feasible and would allow to early alert for HAB changes, and to plan in-situ analyses more efficiently.

This can lead to a better understanding of the local conditions to develop water quality forecasts, serving as the link between physical and chemical parameters of importance for water treatment. This frequently updated information will lead to faster decision making about the risks induced by HAB changes and tuning of the treatment accordingly; towards

a) a better environmental footprint by adjusting doses of chemical reactive agents; thereby,

b) leading to a more economical use of resources and reducing costs.

Risk management will be thus enhanced, become more cost-effective, and reduce vulnerabilities of the treatment plants through a better forecast and control of the hazards exposure.

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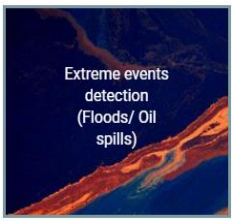

Extreme events detection

The past decades several events have been recorded that showcase the necessity of developing a service that identifies hydrocarbon formations on water surface. To minimize the consequences of the pollution events and in order to provide early warnings to the involved stakeholders for taking the necessary mitigation actions, regular collection and analysis of data is required. At the same time, there is a need for the water utilities to reduce the need for monitoring efforts by additional sampling. This can achieved by the continuous monitoring of the area of interest.

WQeMS will develop a service that aims at identifying hydrocarbon formations on the surface of open surface water reservoirs. The novel algorithm is specifically developed to target small-scale oil spill events observed for the first time in inland waters, a fact that is more challenging compared to large-scale oil spills in open sea and coastal waters.

The detection of hydrocarbon formations is done by a custom deep neural network, which receives as input a set of selected bands provided by Sentinel-2. The outcome of the service includes

a) a raster file that can be easily input on any Geographical Information System (GIS) program and allows its visualization, and

b) a metadata file, which contains information about cloud coverage of the initial Sentinel-2 image, accuracy of the service, and number of the pixels annotated as hydrocarbons over the total number of pixels of the area of interest.

This service allows existing DSSs to map and monitor high-risk and remote areas, and increase the efficiency of substance detection in big areas that cannot be monitored traditionally with sensors.

Hence, drinking water supply is expected to become more resilient to unexpected external contamination incidents, increasing safety and security of the drinking water production procedures.

At the same time, WQeMS will reduce the cost of water quality monitoring network given that it is based on satellite data, which are freely distributed by Copernicus.

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wqems_dissemination@iti.gr

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