An open surface Water Quality Emergency Monitoring Service (WQeMS) for 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 III

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 General Assembly Meeting. CERTH & EYATH welcomed their Partners & the Advisory Board Members of WQeMS for the first hybrid meeting on 17-19 May 2022.

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 evolution of WQeMS services, their results in the pilot areas, and the benefits offered to the user and end user.

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

Ioannis Manakos

Project Coordinator

Principal Researcher @ CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

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WQeMS Services Evolution

As already presented in previous volumes the following WQeMS core services may support Decision Support Systems of water utilities:

1. Water quality features changes;

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.

In the previous newsletter (newsletter II) the services were presented, which are directly related with the increment of substances dissolution/ concentration in the water (1., 2., 3.) and their assets.

In this newsletter we are going to present the evolution of these services and their results in the pilot areas. The rest of the services (4., 5., 6.) will be highlighted in Newsletter IV.

Water quality features

Service description:

The water quality in open surface water reservoirs in the pilot areas needs to be monitored in order to support and optimize the operational management of the reservoirs. The traditional in situ measurements can only be done at selected points. This information can be supported by frequently monitoring the entire surface of the water body by using satellite-based services, providing an additional data source for evidence based WFD reporting. Topics of this service are the identification of long-term seasonal trends or increase of yellow substances through main indicators such as Chlorophyll-a, Secchi Disk Depth, Colored Dissolved Organic Matter (CDOM), and Water Surface Temperature.

Service results:

The water quality features' changes service is providing results for different open surface water reservoirs in the pilot areas in Spain, Greece, Germany, and Finland. For all selected pilot areas, first results are

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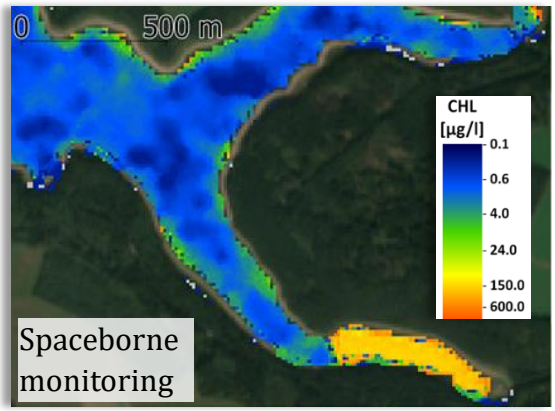
generated, and currently being validated to show the estimation accuracy with in situ data. Different features are approximated depending on the water body properties. While the chlorophyll-a content is of interest for all reservoirs, the CDOM content is not required for each one, but only at specific locations, such as the Carlsfeld reservoir in Saxony.

With the abundance of in situ data there are different analyses being undertaken. Directly estimated features are compared, e.g. remotely sensed Chlorophyll-a data compared to in situ measurements of Chlorophyll-a or the Turbidity. Moreover, there are proxy analyses undertaken for the Saxony pilot case. In this use case, available in situ data for features, such as Phosphorous or Nitrogen, are correlated to the water quality features, which were indirectly approximated from the satellite imagery, due to missing optical spectral signal of Phosphorous or Nitrogen.

Additional work in the scope of service development is conducted regarding hyperspectral data. Data from the Italian PRISMA satellite is employed. First tests have shown great potential. Aim is to increase the potential of the physics-based water quality algorithms applied by EOMAP. For example, the differentiation of algal species can possibly be enabled by using the additional spectral features of this type of imagery. Future tests will reveal the potential of the hyperspectral methodology in water quality features estimation, e.g. for Chlorophyll-a estimation.

Gain for the users:

The added value of remote sensing data becomes apparent when looking at the images from 2018-09-19 shown below. The images show a part of the Saidenbach reservoir in the Saxony pilot region.



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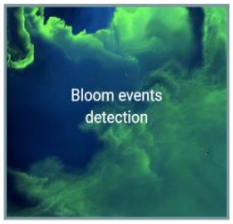
In the German pilot case -the so-called 'Vorsperren' or pre-reservoirs – have an important role in decelerating the entry of nutrients into the open surface water reservoirs used for drinking water production. The status of these reservoirs can be frequently observed from space for their whole spatial extent. This provides a time advantage for managing the inflow based on evidence and real time conditions.



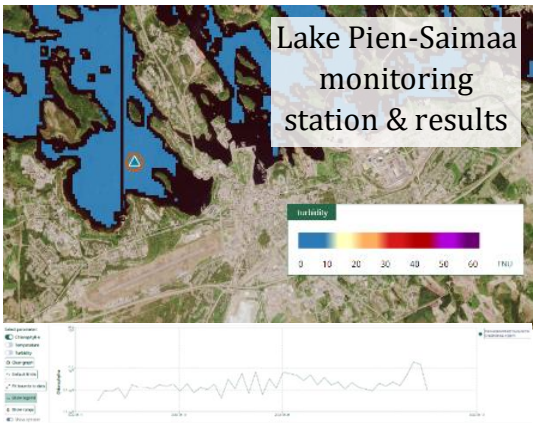
Bloom events detection

Service description:

The Bloom Events Detection service covers for the emergence of potentially harmful algal blooms in open surface water reservoirs used for drinking water production. Satellite-based data of the reservoirs can be used to identify and track evolving algal blooms. They can cause problems by potentially influencing taste and odour of the water, as well as the concentration of toxin producing species, such as cyanobacteria microcystins.

Service results:

The latest update included the visualization of the automated water quality measurements done in Lake Pien-Saimaa in Finland. The instruments installed on an in situ measurement platform estimate Chlorophyll-a (Chl-a), temperature and turbidity. Below is an example showing a turbidity map and the timeseries of automated Chl-a measurements.



EO and in situ water quality information will be provided to professional users and the general public through WQeMS and SYKE's TARKKA service. SYKE is developing the next version (TARKKA+) and its beta version is now available. More content and functionalities are being added weekly.

After receiving in situ data for the German pilot case the results of a study with relevant satellite images was conducted with eoHAB from EOMAP and are shown below. Quitzdorf reservoir showed no indication of a

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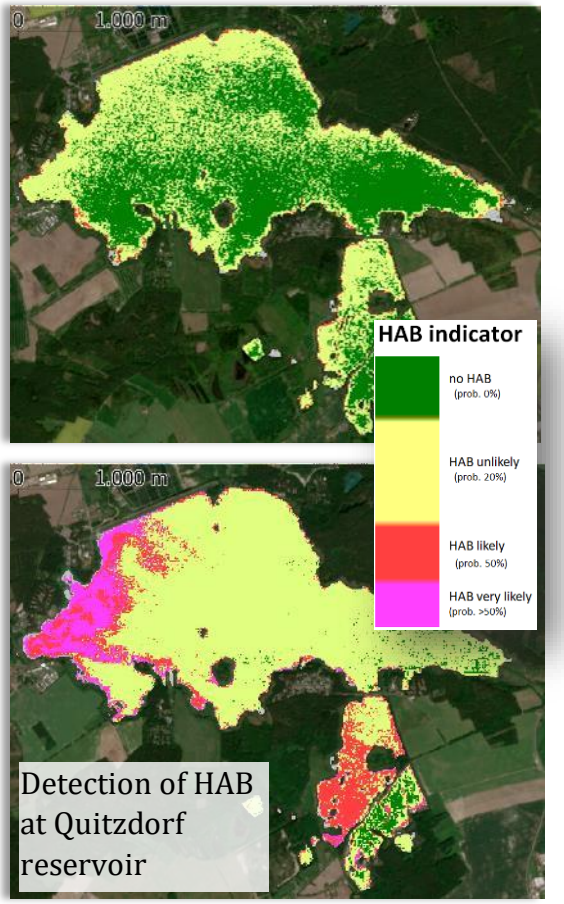
harmful algal bloom on 2016-05-09 (up), but there was a strong indication for an algal bloom on 2018-05-14 (down). Observations from the satellite images agree with the registered in situ data.



Detection of HAB at Quitzdorf reservoir

While the early date shows barely any cyanobacterial cell count, the cell counts for the second date are very different. While for the earlier date, the cell count is less than 1 Mio. cells per liter, the bloom date shows around 200 Mio. cells per liter. Therefore, it confirms the data already visualized in the satellite imagery. Additional dates will be checked for a comparison of satellite imagery and in situ data.

The application of hyperspectral imagery is still in the testing phase, but first results are promising. Additional spectral bands allow for a more detailed observation of the spectrum, which helps the physics-based algorithms applied by EOMAP.

For the hyperspectral imagery, the Italian PRISMA satellite is employed. Due to the early stage of this satellite mission, no regular image captures over the same area could be accessed. Additionally, no imagery of pilot case regions with a visible algal bloom could be detected so far, since the number of images for each region is still limited, and these bloom events are highly dynamic events.

EOMAP is monitoring closely PRISMA's acquisitions versus real events and chances of capturing an algal bloom event in the time of hyperspectral imagery acquisition increase. Furthermore, the EnMAP satellite is in the process of calibration after it was launched earlier this year. Hopefully, this satellite increases the frequency of spaceborne hyperspectral data takes.

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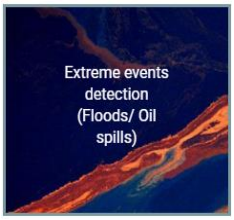
Gain for the users:

The service allows anyone to get access to water quality information in a convenient manner. In the Finnish use case, the latest values in May indicate increasing trend in algal biomass. This is expected as the algal bloom season was approaching.

In the German use case, the focus now lies on validating past events, such as the one shown before, before looking into the future in the form of the operational (monitoring) service for the water authorities.



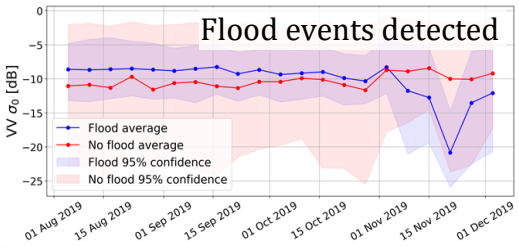
Extreme events detection

Service description:

Flash floods are fast-evolving phenomena that have become more frequent for more than a decade as a result of the climate crisis. Frequent monitoring and mapping of such phenomena is of high importance to the water utility users, among others, since they impose a direct and indirect threat to the water quality of drinking water reservoirs. WQeMS develops an extreme flood event detection service by exploiting ONDA DIAS data provision and infrastructure. The service is based on Copernicus data, whose discovery, pre-processing, analysis, as well as micro-service architecture takes advantage of top-notch open-source software and technologies.

Service results (flood detection):

Extreme flood mapping service is currently applicable on the Italian pilot use case (PUC), where time series of Sentinel-1 data are used. The latter are preprocessed and are used as input to a custom deep neural network model. The model inherently exploits temporal information in order to learn temporal patterns that are mostly characteristic under the presence of an extreme flood event (see figure below).



As a result extreme flood maps can be generated every time Sentinel-1 passes over the PUC. At the same time several statistics that are indicative of the magnitude of a flood event are calculated and will be available to the user.

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Service results (Hydrocarbon formation detection):

The existence of hydrocarbon formation in water resources compromise the quality of the water we drink. WQeMS develops an oil spill detection module that identifies hydrocarbon formations in inland waters based on Copernicus Sentinel-2 high resolution data derived from ONDA DIAS. A novel deep learning algorithm targets small-scale oil spill events observed for the first time in inland waters, which is more challenging compared to coastal and open sea waters.

Gain for the user:

Since produced flood products are based on Synthetic Aperture Radar data, which are not prone to weather and sun illumination conditions, they can be seen as an integrative tool for the user and end users for monitoring and mapping floods in open surface water reservoirs used for drinking water production with high temporal and spatial resolution. The reader can find further information in the open-access version of the IGARSS2022 conference research paper or attend its presentation (physically or online) on July 21st, 2022.

The hydrocarbon formation mapping service is useful to the users, since it minimizes human labor and cost that would be needed in the business as usual scenario, where in situ measurements have to be collected and analyzed in the laboratory. Although these observations are acquired frequently, they cannot accurately track the source of pollution, remote areas or the spatial pattern, factors which are important to take mitigation actions.

Participation in Conferences:

WQeMS actively participated this period in

1) Living Planet Symposium 2022, Thursday 26th of May, Bonn Germany, with 2 oral presentations and 3 poster presentations.

Oral Presentations:

- 'Water Quality Mapping for emergency application in drinking waters using high and very high resolution satellite data', oral Presentation at the session A7.06 EO for monitoring water quality and ecological status in inland

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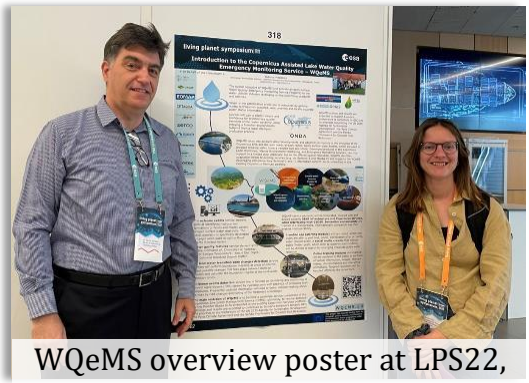
waters by P. Bauer (EOMAP), K. Schenk (EOMAP), L. Pouget (CETAQUA).

- 'Fusion of Sentinel-1 and Sentinel-2 data for inundation mapping in service of the water utilities', oral Presentation at the session A7.01.3 Inland Water Storage and Runoff: Modeling, In Situ Data and Remote Sensing by A. Kita (CERTH), M. Sismanis (CERTH), I. Manakos (CERTH), C. Kalogeropoulos (CERTH), C. Christodoulou (EYATH), I. Lioumbas (EYATH).

Living Planet Symposium 2022 poster presentations:

- 'Water Quality Emergency Monitoring Services for Lake Pien-Saimaa in Finland', poster presentation at poster session Day 4 by E. Bruun & S Koponen (SYKE);
- 'Detection of oil spills in an inland lake using Multi-Spectral Satellite Images', poster presentation at poster session Day 4 by D. Mantsis, M. Bakratsas, K. Vlachos, A. Moumtzidou, I. Gialampoukidis & S. Vrochidis (CERTH);
- 'Introduction to the Copernicus Assisted Lake Water Quality Emergency Monitoring Service – WQeMS', poster presentation at the poster session Day 4 by I. Manakos (CERTH).



WQeMS overview poster at LPS22, I. Manakos (left) & A. Kita (right)

2) EGU General Assembly 2022, Monday 23rd of May, in Vienna Austria, with an online oral presentation: 'Applying water requirements into metadata in the era of SDGs and Essential Variables: semantics, quality parameters and discoverability in the GEM+', at session ESSI2.9. Software tools and semantics for geospatial research by I. Serral (CREAF), J. Maso (CREAF), N. Julia (CREAF), L. Pesquer (CREAF), I. Manakos (CERTH), G. Milis (PHOEBE).
3) SCERIN-8 Virtual Workshop, Tuesday 31st of May 2022: 'Overview of the Copernicus Assisted Lake Water Quality Emergency Monitoring Service – WqeMS', oral presentation by I. Manakos (CERTH).
4) DATAWEEK 22, Wednesday 01st of June 2022: "Data over troubled in water sector" by Anastasia Moumtzidou (CERTH).

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wqems_dissemination@iti.gr

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