WQEMS PLATFORM FOR INLAND SURFACE WATER BODIES' MONITORING: SERVING USER COMMUNITIES AND SUPPORTING EXPERTS' ANALYSES

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ABSTRACT

The Copernicus Assisted Lake **W**ater **Q**uality **Emergency M**onitoring **S**ervice platform (**WQeMS**) is an outcome of the H2020 WQeMS project. It leverages on experimentation and service development relatively to lakes and open surface water reservoirs located in Finland, Germany, Greece, Italy, and Spain. Four service lines have been realized concerning ‘Water Quality Features Changes’, ‘Bloom Events Detection’, ‘Land-Water Transition Zone Change Detection’, and ‘Extreme Events Detection’. Furthermore, a crowdsourcing mobile app allows for collecting timely in-situ information, crucial during crisis' management. WQeMS flexibility and interoperability are advantageous for interfacing with Copernicus Services and the Group of Earth Observation System of Systems (GEOSS) platform. These features support proposing WQeMS as an evolution element of the Copernicus Emergency Management Service (CEMS). In addition, WQeMS modularity makes it possible to test its services with new satellite data and improve the processing chains. Finally, WQeMS platform can serve both, expert users wishing to test alternative methods, and users non familiar with Earth Observation data. Access to some water utilities and water domain engaged parties will be considered towards the end of the project (June 2023) in view of service commercialization. WQeMS sustainability should be attained by providing commercial services, still leaving room for research studies.

Keywords: lakes, reservoirs, turbidity, blooms, inland surface water quality, inland surface water extreme events, CEMS

1. INTRODUCTION

The Copernicus Assisted Lake **W**ater **Q**uality **Emergency M**onitoring **S**ervice platform (WQeMS) (portal-wqems.opsi.lecce.it), developed in the homonymous H2020 Project (European Union’s Horizon 2020 RIA Programme, Grant Agreement No 101004157), encompasses four water quality related geospatial services (service lines): ‘Water Quality Features Changes’, ‘Bloom Events Detection’, ‘Land-Water Transition Zone Change Detection’, and ‘Extreme Events Detection’. It is a federated platform, whose main characteristics are its interoperability and flexibility. These characteristics reduce the effort to interface existing systems. The choice of a federated approach has allowed for the exploitation of existing solutions, easing the assessment and integration of each service component. Interoperability is a pre-requisite for sharing knowledge, thus easing collaboration across various domains, such as research, geospatial services, environment, and risks’ management.

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WQeMS pursues service provision in the framework of Copernicus, while targeting water utilities with potential for commercialization. Service elements and workflows have been developed in a variety of biogeographical, climatological, and management conditions, as these are expressed across five pilot areas, where use cases have been experimented (i.e., the Pilot Use Cases - PUC, located in Finland, Germany, Greece, Italy, and Spain). This process has enabled the adaptation to the needs of water utilities and enhanced the transferability of the proposed knowledge generation methods, hence, facilitating wider applicability of the WQeMS services.

2. WQEMS PLATFORM

2.1 WQeMS Overall concept

WQeMS service lines are the main platform's components. In addition, in-situ data and information are collected from crowdsourcing (i.e., social media and a dedicated mobile app) through an alerting module, to detect water quality issues. On such occurrence, data processing chains are activated, and notifications are issued. User communication channels are configurable, and data and information can also be sent to users' Decision Support Systems (DSS), based on adaptable interfaces. Data products are accessed through a catalogue and visualized through the Map a Data Navigator tool. Crowd sourced information is accessed through a dedicated alert dashboard. (Figure 1)

WQeMS main features and functionalities are illustrated in the following subsections while the service lines and selected results are briefly described in section 3. Data products' descriptions, including metadata information, are available in the project website[1].

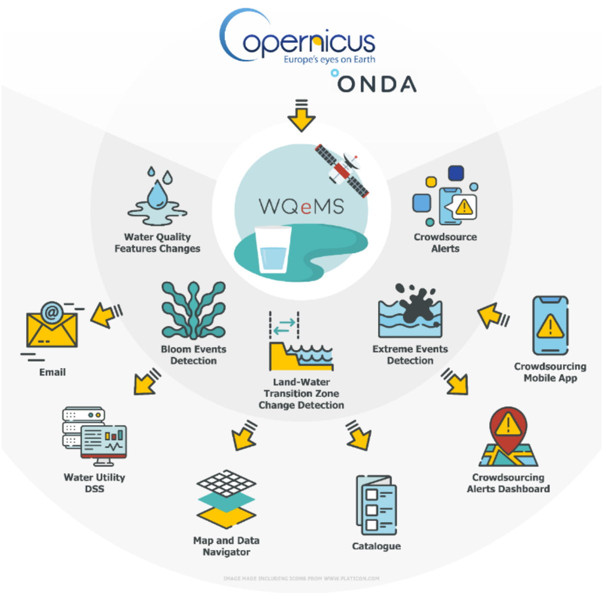

Figure 1. WQeMS Overall concept

2.2 Interoperable federated solution

The WQeMS platform includes a set of features allowing water experts, developers, and researchers, to integrate its functionalities into existing DSSs as well as to improve current methods and test alternative solutions. Functionalities include APIs for service execution requests, alerts configuration and retrieval, generation of reports, and data product and associated statistics. Moreover, the platform provides Open Geospatial Consortium (OGC) Web Services endpoints (e.g., WMS/WCS) to access data using popular, well-established standards. Thanks to them, the platform has been connected to the systems used in pilot areas, namely, in the Spanish PUC and the Italian PUC, to automatically disseminate up-to-date geospatial maps and related statistics.

[1] https://wqems.eu/services

WQeMS can also interface existing Earth Observation (EO) systems, such as the Copernicus Services and the Group of Earth Observation System of Systems (GEOSS) platform; the latter is being exploited as a dissemination channel of the WQeMS information data products. A similar approach could be adopted to interface WQeMS with the Copernicus Emergency Management Service (CEMS) in view of providing an additional service element.

The context diagram below (Figure 2) shows all actors and systems interacting with the platform.

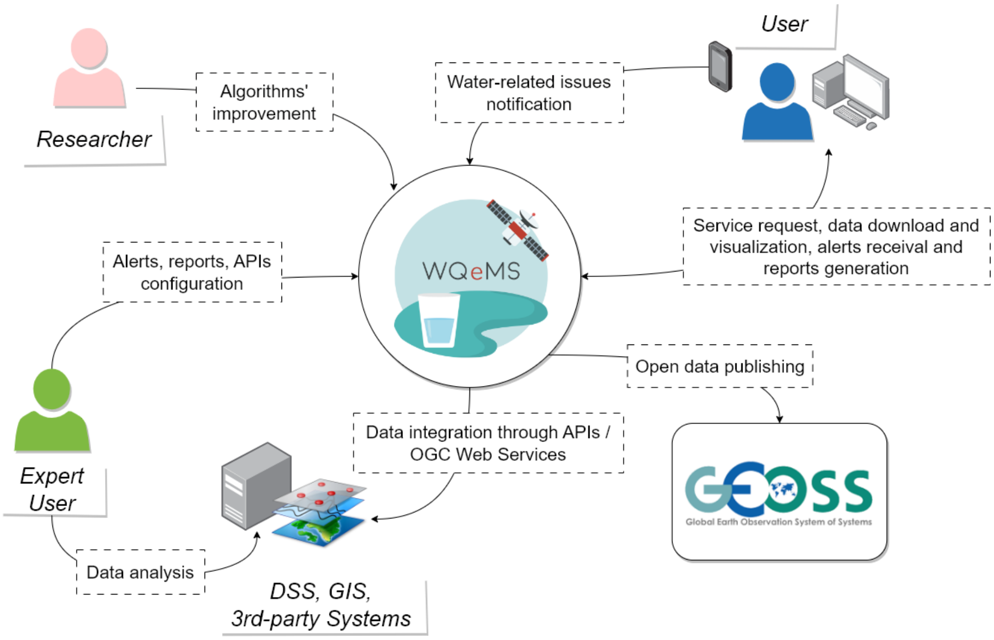

Figure 2. WQeMS Context diagram

The four service lines, mentioned in the previous section, are managed by two main partners: CERTH and EOMAP, exploiting, respectively, ONDA - DIAS[2] and CREODIAS[3] to access Copernicus (Sentinel) data and leveraging on their cloud infrastructure. The overall WQeMS platform is hosted in ONDA-DIAS (Figure 3). Such federated approach could be extended to include additional data providers, and to connect to future third-party commercial or non-commercial services.

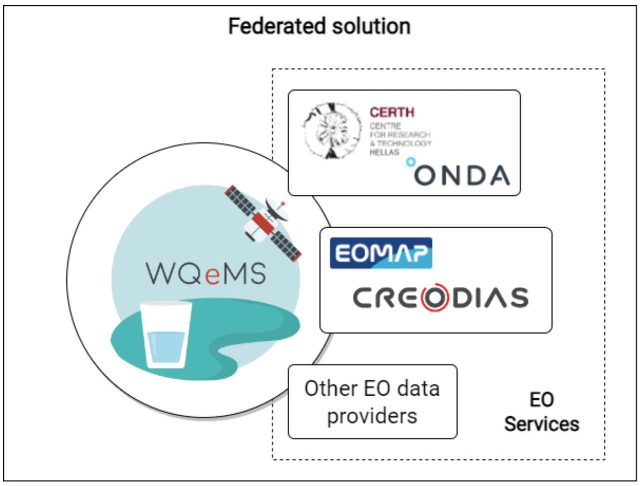

Figure 3. WQeMS Federated solution.

[2] Data and Information Access Service (DIAS) - ONDA - DIAS: https://www.onda-dias.eu/cms/about/
[3] https://creodias.eu/

More information is available in the Platform web-portal homepage where an introductory video and a hands-on guide are also provided[4].

2.3 Flexibility and user-friendliness

In designing the platform, a microservices approach has been adopted, by implementing many small components, each responsible for a specific task. Such a choice has resulted in an easily scalable, deployable, and evolvable platform. The use of containers (Docker technology) makes each component independent of the environment in which it runs, thus allowing its upgrading (e.g., for ingesting new satellite data types) without interfering with other components. Moreover, new services can be added without modifying the overall system.

The WQeMS Web Portal access page presents functionalities and tools in an intuitive way (Figure 4). From there, the user can specify the water surfaces to be monitored and select the services. Each service can be requested in two modalities: On-Demand or Continuous. In the Continuous service mode, data products are generated daily (as soon as new satellite data is available); moreover, in the Continuous mode, the Alerting Module is continuously running and can activate product generation, upon detection of a water quality issue, related to a given service line (see 2.4)). In the On-Demand service mode, data products are generated on request, over a given area, at a given time, upon verification of their feasibility (e.g., satellite data availability).

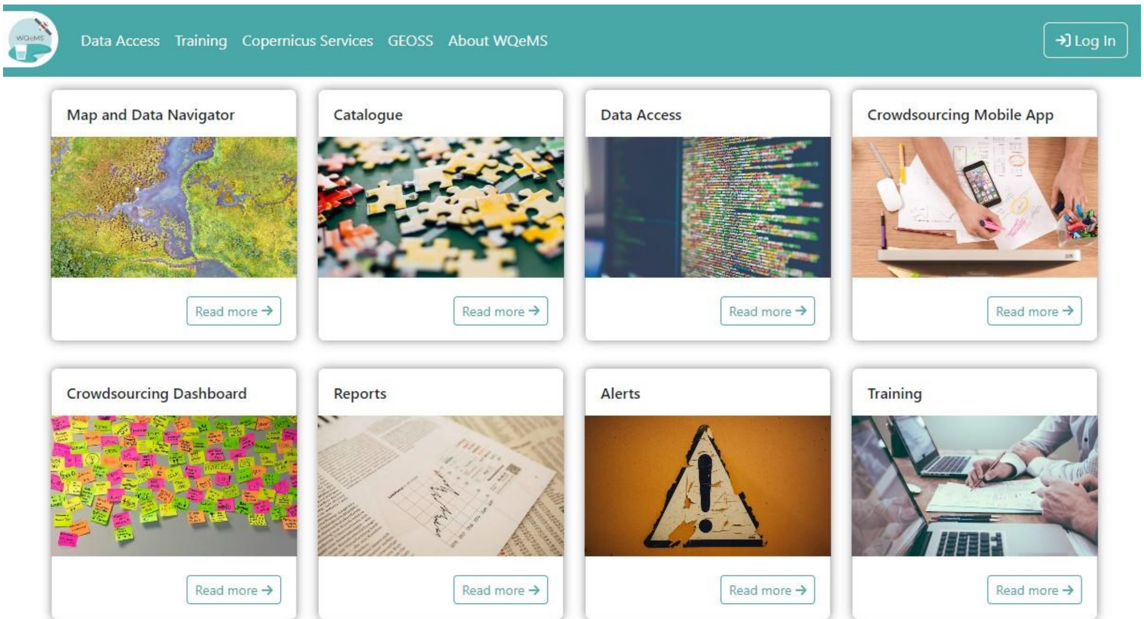

Figure 4. WQeMS Platform Tools and Functionalities

[4] portal-wqems.opsi.lecce.it

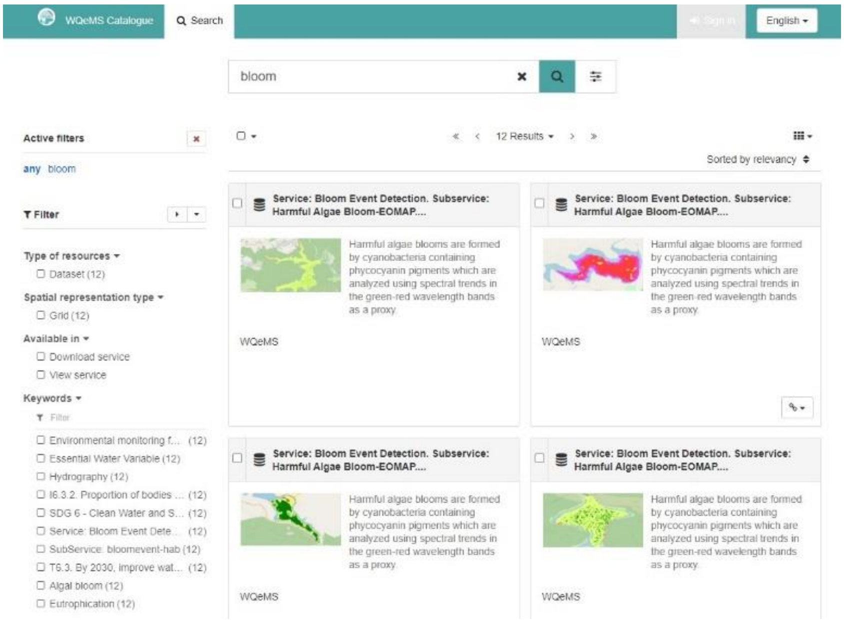

Figure 5. WQeMS Catalogue

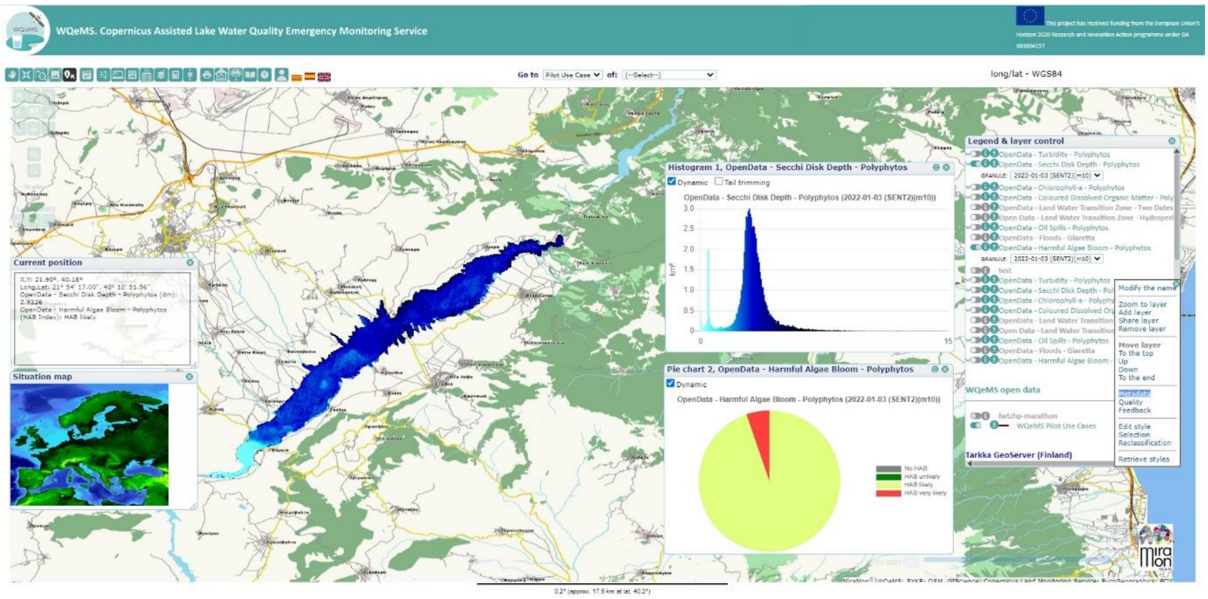

Figure 6. WQeMS Map and Data Navigator

Data products can be accessed and browsed using several tools. A catalogue (Figure 5) allows to search the data products through an open view of the metadata, depending on the service line and the monitored water body. A Map and Data Navigator (Figure 6) allows to navigate on a world map and visualize the data products, modifying visualization, performing analyses (e.g., statistics) or building time series directly in the browser. This tool allows also to receive comments, ratings, questions, etc. on specific data layers through the adoption of the OGC Geospatial User Feedback standard. Geospatial maps and related metadata are also exposed and available through a web File Server and, alternatively, through a FTPS directory, for file downloading.

2.4 Alerting module

Special attention has been devoted to the generation and notification of alerts related to water quality issues which are a key component of an emergency service such as the one prospected in the WQeMS project. Alerts can be generated, based on data collected from social media and a crowdsourcing mobile app, or by checking pre-defined threshold's values of some water quality indicators, in the data processing modules.

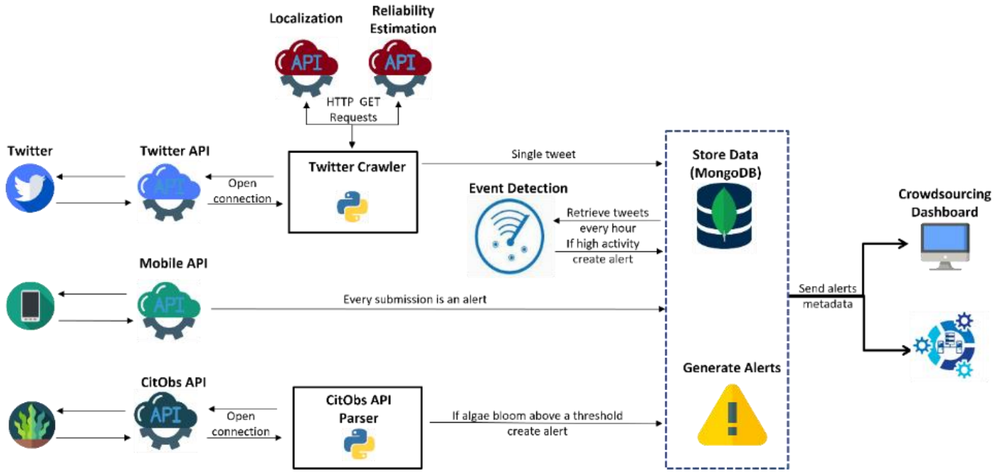

Figure 7. WQeMS Alerting module

Alerts from social media and Crowdsourcing Mobile App

Crowdsourcing data have recently become a complementary source of information in water management, being used by environmental agencies, water authorities and water utilities. WQeMS explores the usage of widely used social media to obtain crowdsourced data relevant for water quality. To this end, WQeMS Alerting module (Figure 7) collects and pre-processes crowdsourcing information related to water quality. The retrieved data are analyzed to discover water quality issues, by using, among others, an event detection algorithm. For every water quality issue found, the module generates an alert, which is then pushed to the Crowdsourcing Dashboard[5] and to the WQEMS platform Middleware layer. Crowdsourcing data are collected from three different sources, namely, Twitter, an android Crowdsourcing Mobile App, and the citizen observation database CitObs[6] of the Finnish Environment Agency (SYKE[7] - Finnish pilot area). In the following some hints about the procedure to derive information from such data are provided.

• The Twitter API is used by the Social Media Crawler to collect tweets in real time, based on user-defined keywords and certain twitter accounts relevant to water utilities (e.g., @EUEnvironment, @EUClimateAction, @EU_ENV etc.) and newspapers reporting water-related issues. For every new collected tweet, a two-step analysis is performed by calling the Localization web service to automatically find the location of the tweet mentioned in the text content, and the Reliability Estimation web service that analyses tweet-based features and estimates if the tweet is real or fake. When the analysis is concluded, the tweet is stored in the database. Afterwards, every hour an event detection algorithm is applied to discover water quality related incidents, by scanning for unusually high activity in Twitter during this hour. When a water quality incident is recognized by the event detection algorithm, it is forwarded to the Alerting module.

• The Crowdsourcing Mobile App (Figure 8) is an Android application that offers an intuitive way to report water-related issues, by filling in a simple form to report a water quality issue. The reported issues are pushed to the mobile API that sends a confirmation to the mobile app that the data were received. Then, the API stores the complaint data in the database and forwards them to the Alerting module as alerts.

• The citizen reports from CitObs are gathered by a parser that queries the CitObs API at given time intervals for algae bloom related reports. The CitObs API Parser checks the values of every fetched algae bloom observation, and if it exceeds a certain threshold, it stores the algae bloom report in the database, and pushes the data to the Alerting module.

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[5]m4d-apps.iti.gr:8007/WQeMS_Crowdsourcing_Dashboard
[6] www.syke.fi/fi-FI/Kansalaishavainnot/SYKEn_kansalaishavainnot
[7] www.syke.fi/en-US

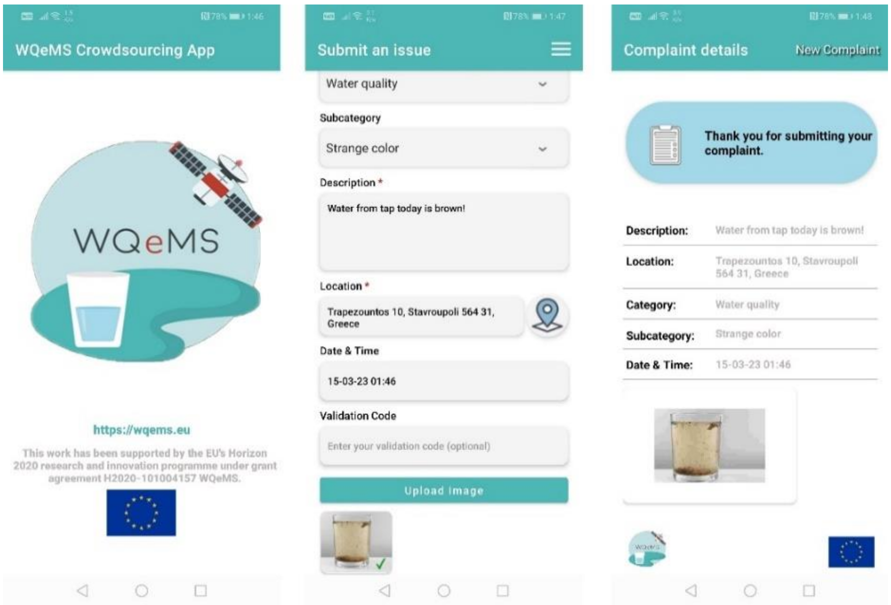

Figure 8. Crowdsourcing Mobile App

All the created alerts are also retrieved by the Crowdsourcing Dashboard and visualized in map as popups (Figure 9).

Figure 9. Crowdsourcing Dashboard web application

Alerts from data product processing modules

As mentioned above, alerts can also be generated by the data processing modules in case some water quality indicator exceeds some predefined threshold's value. It is also possible to configure the alerts by providing threshold's values and by specifying how to receive notifications (e.g., through HTTP API endpoints). Figures 10 and 11 show, respectively, an alert message, received via email, and the form to set threshold's values.

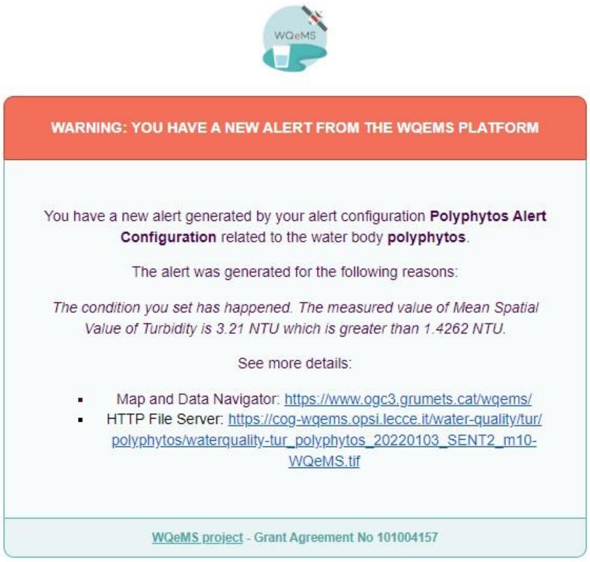

Figure 10. Alert notification (email)

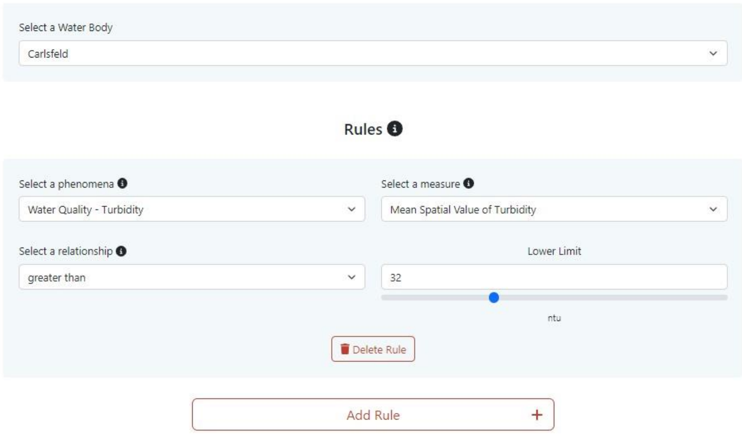

Figure 11. Alert threshold configuration form

3. WQEMS SERVICE LINES: RATIONALE AND APPLICATIONS

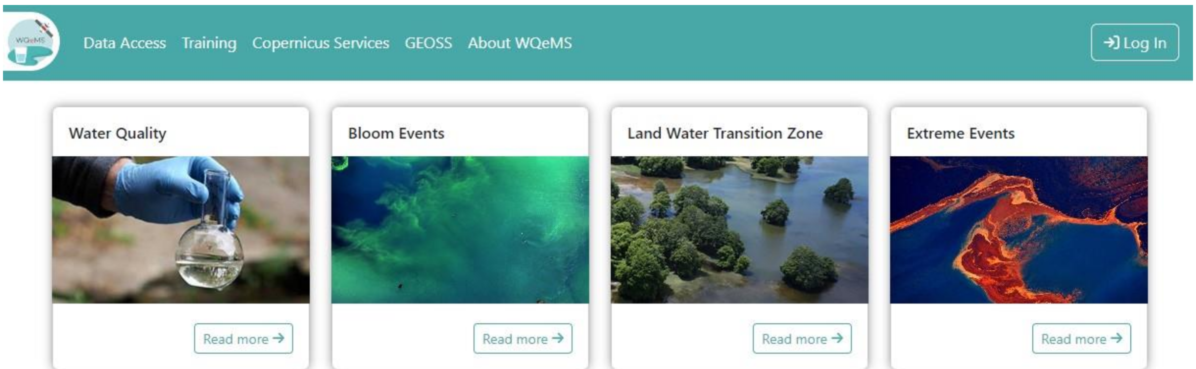

Figure 12. WQeMS Platform Service Lines

In the following sections the rationale at the basis of the WQeMS service lines (Figure 12) is briefly illustrated and selected results obtained in the pilot areas are presented, highlighting their usefulness for both, user communities and water experts.

3.1 Water Quality Features Changes - Service Line 1

Remote sensing data derived products have great potential to provide water quality information with large spatial coverage for inland and coastal waterbodies. This is particularly beneficial in places where in-situ monitoring is missing or lacking due to practical or financial constraints. For the retrieval of water quality parameters, multi -or hyperspectral satellite sensors are used, which allow to derive water quality parameters by measuring solar radiation mainly (but not exclusively) in the visible region of the spectrum. Solar radiation penetrating the atmosphere is absorbed and scattered by the particles and the compounds of the atmosphere and in the waterbody, and the reflected spectrum, detected by the satellite sensors, can be used to derive water and atmospheric properties. These are then related to relevant water quality parameters, such as turbidity and suspended matter, phytoplankton and its main pigment Chlorophyll-a, or colored dissolved organic matter or water clarity[1-2-3]. Existing algorithms for the derivation of the water constituents follow different approaches: from empirical methods[4], to neural networks[5] or physics-based approaches that are based on an inversion of the satellite measured radiance or reflectance back-spectra to derive water optical properties and constituents[6]. An overview of the most important water related variables in relation to EO-based indicators for lakes and use cases worldwide can be found in Dörnhöfer et al.[7], highlighting the potential of both, actual monitoring as well as historical analyses. Advanced analysis of water quality parameter time variations has been carried out for example, by analyzing the start and duration of the algal bloom seasons (phenology) in different pre-alpine lakes[8-9] or by analyzing their ecological status, based on satellite data collected for complying the water framework directive[10]. Different kinds of EO data have been successfully applied for mapping the main water quality parameters in waterbodies over several decades[11-12]; also, recent high-resolution multispectral missions such as Landsat 8 and Sentinel-2 have proven to produce reliable water quality products based on advanced retrieval algorithms[13-14-15].

An example of product from the Service Line 1 is shown below (Figure 13).

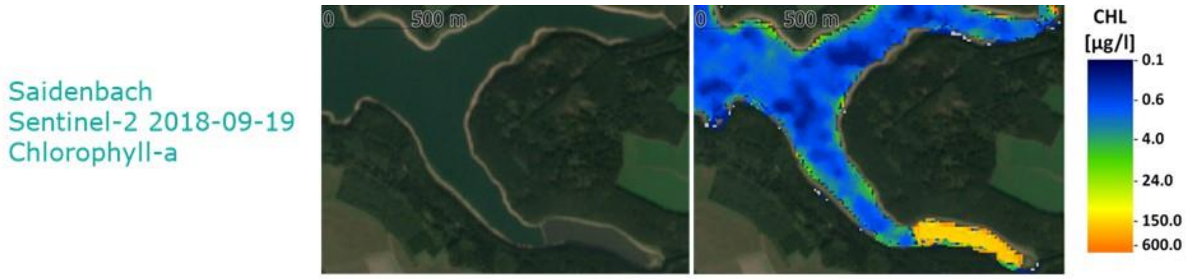

Figure 13. True Color Image and Chlorophyll-a product, derived from Sentinel-2 data. The pre-reservoir with the high Chlorophyll values is easily identified, in line with its function of reducing the Chlorophyll content in the actual reservoir.

3.2 Bloom Events Detection - Service Line 2

Algal blooms (e.g., phytoplankton) occur because of eutrophication which is the process of the nutrient enrichment of a water body leading to excessive algae growth. Their occurrence is usually associated with major changes in aquatic community structure ranging from the benign feeding of higher trophic levels to harmful effects, like preventing the sunlight from reaching other organisms, causing a depletion of oxygen in the water, and causing toxins' secretion into the water, affecting the rest of the aquatic life. From a socioeconomic point of view, the proliferation of algal blooms may have dramatic consequences for drinking water sources, fisheries, and recreational water bodies[16] due to the deterioration of water quality. Harmful algal blooms (HABs) are primarily caused by dinoflagellates, diatoms, and cyanobacteria. Each of these phytoplankton groups can produce toxins that are harmful to aquatic and terrestrial species[17].

Cyanobacterial algal blooms can be challenging to monitor due to their ubiquitous nature (i.e., high heterogeneity both in space and time). This algal group can replicate quickly, as well as move vertically within the water column[18]. Thus, a single bloom can occur over a few days or persist for extended periods (e.g., several months). Their widespread occurrence, especially in drinking and recreational waters, and the associated health effects due to their ability to produce toxins (CyanoHabs), make their frequent screening and monitoring imperative[19]. Moreover, climate change scenarios suggest that their spatial extent and intensity are expected to increase in the following decades due to higher temperatures and stability of the water column[20]. Conventional sampling with a high frequency and at an appropriate spatial scale, to properly monitor such events, has shown to be prone to limitations as being costly and time-consuming[21-22].

As an alternative to more traditional sampling methods, remote sensing has increasingly shown its applicability for the screening of such events. This methodology, while not as costly as the more traditional methods, allows for the identification of various algal blooms in both inland and coastal waters at large spatial and temporal scales. In addition to the actual monitoring of the development of an algal bloom, remote sensing can aid in identifying regions more prone to potentially harmful algal blooms[23-24-25]. Remote sensing data usage for the monitoring algal blooms and especially HABs has proven to be an effective tool[26-27], which will further increase with increased satellite data availability, especially from hyperspectral satellite missions.

The WQeMS algae bloom event detection service encompasses the identification and monitoring of algae blooms; especially, harmful algae blooms (HABs). Both, the HAB indicator developed by EOMAP[28], and the bloom indicator developed by the Finnish Environment Institute (SYKE) are used - the latter in the Finnish Use Case TARKKA service[8].

Spanish Pilot Use Case - Bloom Event Detection VHR data usage

In the Spanish Use Case, EO data analysis water experts, water utilities and water authorities (CETAQUA, EMUASA, HIDROGEA and the River Basin Agency of Segura) have been collaborating with the service provider (EOMAP) to apply the developed service to some Spanish reservoirs[9]. In-situ data of algal bloom events as well as EO data analyses were also available from previous studies. In the framework of the project activities several satellite data types, with varying spatial resolution have been used. Figure 14 shows the HAB indicator derived, respectively, from Sentinel-2 and from WorldView-3 images, over the Ojos reservoir during an algal bloom event occurred in August 2020.

Figure 14. Comparison of Harmful Algal Bloom Indicator for Azud de Ojós, calculated from Sentinel-2 (left) and WorldView-3 imagery (right).

In the Sentinel-2 image, with a spatial resolution of 10 m (left), no clear HAB is derived. The mixed pixels at the edge of the reservoir can be explained as adjacency effect. However, in the WorldView-3 image, with a spatial resolution of 2 m (right), the algal bloom is detected by the HAB with details, thus proving the usefulness of using this data in this context.

In Figure 15 the validation of the satellite based HAB with in-situ measured abundance of cyanobacteria blooms shows a good agreement in the investigated time period, over Embalse de Judio, with a peak in mid-October showing the highest HAB risk as well as a high amount of cyanobacteria cell counts.

[8] syke.atlassian.net/wiki/spaces/SYKEEOEN/pages/792657921/Syke+s+TARKKA+service+and+WQeMS+project. Products exposed in TARKKA can be also visualized in WQeMS Map and Data Navigator.

[9] wqems.eu/pilot-areas/murcia

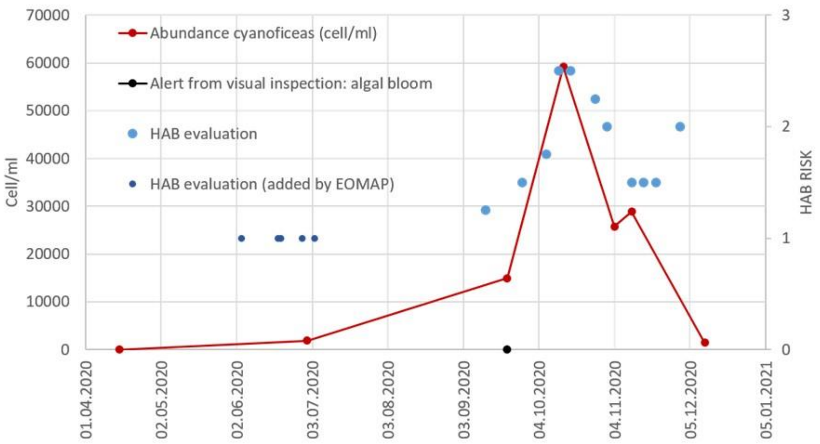

Figure 15. Validation of HAB indicator with in-situ measured Cyanobacteria in Embalse de Judio, Spain. The in-situ data is shown in red (left ordinate). The harmful algal bloom indicator is shown as HAB blue points (right ordinate). The HAB was evaluated in a manual process over a multi-pixel area by CETAQUA (reference partner for the Spanish pilot area) (light blue), complemented by EOMAP (dark blue), leading to values between 2.5 (maximum, harmful algal bloom likely, based on EO data) and 1 (minimum, no harmful algal bloom observed in the EO data).

German Pilot Use Case

The Algal Bloom Detection service line was applied to the Quitzdorf reservoir (located in the same federal state as the

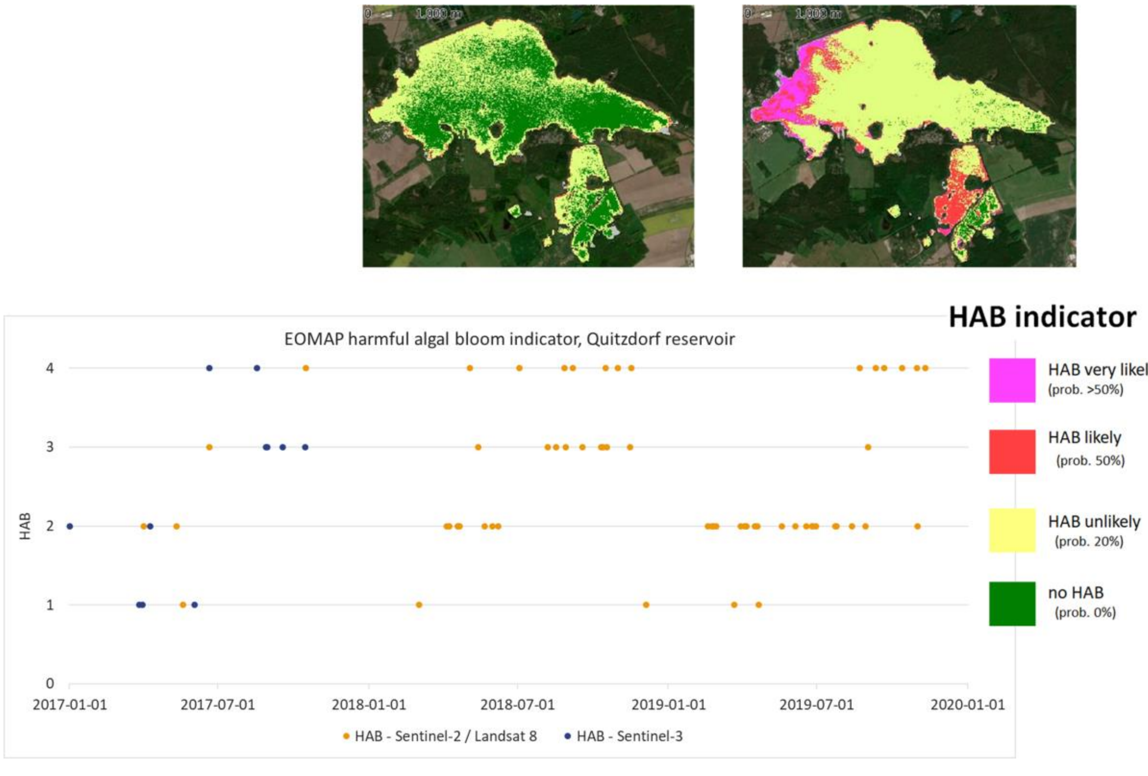

Figure 16. Satellite-derived HAB at the Quitzdorf reservoir over the period from 2017 to 2020. The right ordinate shows the HAB indicator, calculated in the service line, using, respectively, Sentinel-2 and Landsat-8, and Sentinel-3 data. The color's scale on the right refers to the Sentinel-2 images shown at the top. The left image, acquired on 2016-05-09, shows no HAB, while the right image, acquired on 2018-05-14, shows a HAB in some areas of the reservoir.

original pilot lakes), showing its effectiveness for algal blooms detection (Figure 16). In-situ data comparison with the satellite-derived HAB shows very good agreement (due to data protection restrictions, the in-situ data could not be published in the scope of this paper[10]).

3.3 Land-Water Transition Zone Change Detection - Service Line 3

The monitoring of inland surface water extent variations is one of the tasks demanded to water authorities and environmental agencies, and to water utilities, in the case of drinking water reservoirs. Monitoring on a yearly basis and over short time intervals are both relevant: the former for an efficient management of the water resources, while the latter for the prompt detection of changes, in case of unexpected events, in view to take appropriate actions.

An abrupt increase in the water extent of reservoirs not only affects the concentration of the solid material and of the substances in water, but also acts as entry path of potential pollutants. On the other hand, a significant decrease in the water extent may have an impact on the concentration of the dissolved matter and the inflow or speed of water. For these reasons, a Land Water Transition Zone Change Detection service has been devised, focused on the water extent fluctuations of open surface water reservoirs. It utilizes freely available satellite data, such as the ones from the Copernicus Sentinel-1 and Sentinel-2 missions with a relatively high temporal coverage; thus, providing a consistent and cost-effective monitoring of the water surfaces.

In order to map both, changes over given time intervals and periodic phenomena (e.g., on an annual basis), two different service products have been developed, namely: a Two-dates product, which depicts the transition zone between land and water (and vice versa) between two instances in time; and a Hydroperiod product, which maps the number of inundation days for a pixel in a given period. Unfavorable atmospheric conditions (e.g., clouds) led to the parallel utilization of Sentinel 1 data, where required. The processing chains can use both data types (multispectral and radar), which can be also specified when requesting a product, with the possibility to select the usage of Sentinel-1 or Sentinel-2 only, or both types of data. In the case of the Two-dates service product, the choice of the input data depends on the time interval between the dates indicated by the user, and the available satellite data acquisition dates. In the case of the Hydroperiod service product, Sentinel-1 data is used if the interval between two consecutive Sentinel-2 available (usable) images is longer than 25 days.

Land water transition zone map production is based on upgraded modules, initially developed, or conceptualized in the Horizon 2020 RIA ECOPOTENTIAL project[11] (2015), to produce inundation maps, as follows:

a) The WaterMask module[29-30], based on an unsupervised thresholding approach, that leverages Sentinel-2 multispectral data to predict the open surface water, open surface water with emerged vegetation, and land classes. Credible results were obtained in various areas, such as Camargue, Doñana, and Kerkini lake[31].

b) A machine learning approach[32], which jointly uses Sentinel-1 and Sentinel-2 data to ultimately produce inundation maps in persistent cloudy periods. The suggested pixel centric approach proved to be robust enough to train random forest classifiers and generate credible results for targeted dates solely using Sentinel-1 input data, mitigating the effect of cloudy conditions and the lower performance of inundation mapping when utilizing solely Sentinel-1 data.

[10] In case of interest in the comparison between the two data sources, contact the author.
[11] www.ecopotential-project.eu/

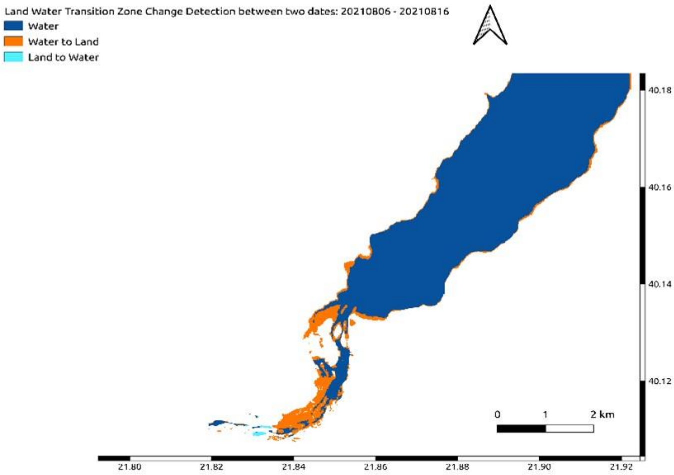

Figure 17. Rymnio Region, Polyphytos Two-dates service product showing the area where the water retreats in a period of 10 days (6-16 August 2021).

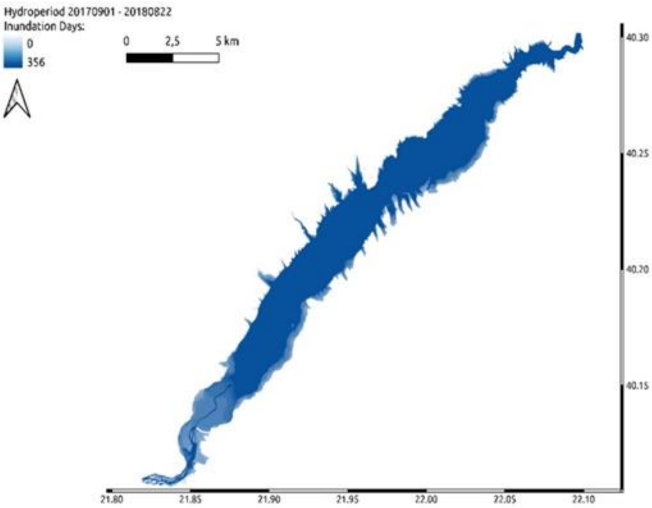

Figure 18. Hydroperiod service product of the whole area of the Polyphytos reservoir over the years 2017-2018.

c) The HydroMap module, which calculates the days that a pixel was inundated in a given period by interpolating pixel values between the inundation maps generated from the (a) and (b) modules.

The adaptability of the modules has been investigated in the framework of WQeMS, by applying the algorithms to the pilot areas of WQeMS, namely, the Polyphytos (Figures 17-18) and Giaretta open surface water reservoirs. The transferability of the algorithms has been also tested over additional areas (i.e., Marathon open surface water reservoir, Greece; and SMAT Lagoon, area of Turin, Italy. The results generally show that land water transition zone maps can be produced with high accuracy and the algorithms can be effectively applied in areas with various land-cover characteristics with minor modifications.

3.4 Extreme Events Detection - Service Line 4

WQeMS Extreme Events Detection service line provides a set of sub-services for detecting and monitoring extreme events occurring in inland surface water, such as lakes and open surface water reservoirs. It contributes to water quality monitoring and assists in the mitigation of the impacts of water quality degradation. Moreover, it can reduce costs related to in-situ measurements. Extreme events and related phenomena, such as i) extreme floods ii) muddy waters, and iii) hydrocarbon/oil spills, are fast-developing phenomena that can significantly lower the water quality and cause problems to water utilities, among others. The service utilizes Copernicus Sentinel data, Artificial Intelligence (AI) models, and state-of-the-art open-source software and technologies, as briefly described below.

Flood events

Flood events are becoming more frequent because of the climate crisis. The flood sub-service is based on a time series of properly preprocessed Sentinel-1 images. A trained temporal deep convolutional neural network model has been adapted to generate a flood map to depict flooded areas[33] for a given date (Figure 19). Moreover, several statistics, which can be related to the intensity of a flood event, are also available to the users. The purpose of this service is to provide indirect information regarding water quality, which is relevant to water utilities.

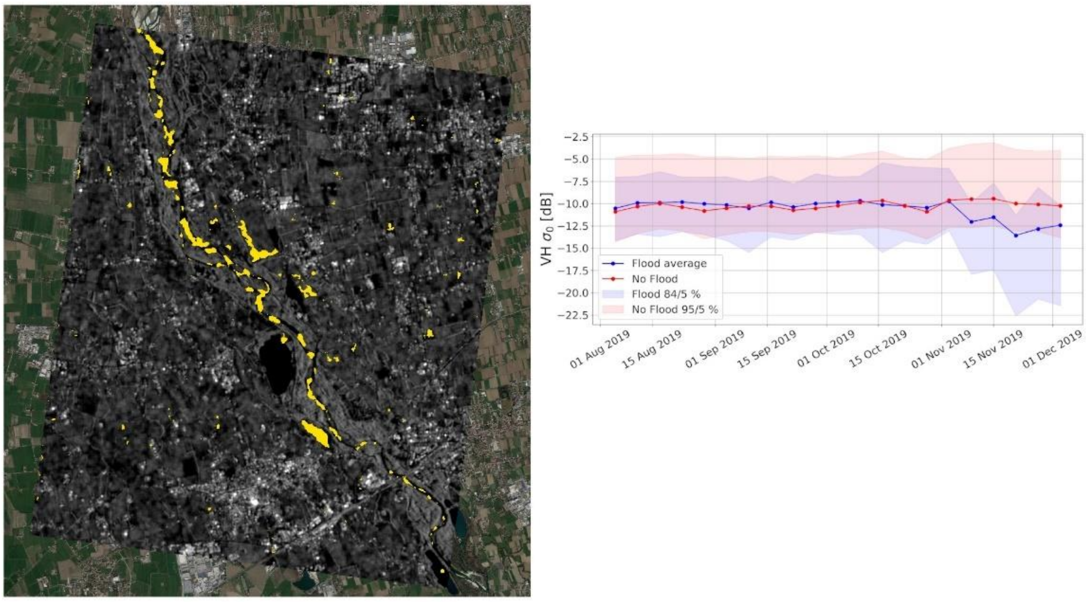

Figure 19. Areas predicted as ongoing extreme floods (yellow) with Google Earth and Sentinel-1 image used as basemaps (left). Time series of average Sentinel-1 pixel values predicted as ongoing extreme flood (blue line) and non-flood (red line) along with 84th/5th (light blue) and 95th/5th (light red) percentiles, respectively (right).

Muddy waters

Heavy rainfall, landslides, and erosion are leading causes of significant muddy water presence, which can degrade water quality. Muddy water contains sediment particles, and it can have negative implications on lake ecosystems, human infrastructure, and the local economy. The muddy water sub-service utilizes properly preprocessed Sentinel-2 data, to detect the presence of sediment-laden water. An ensemble machine learning model is trained and applied to generate a muddy water presence/absence map for a given date. The final map shows areas in the water body that contain a significant amount of suspended sediment, as well as a per-pixel pseudo-probability map (Figure 20), supporting the identification of presence/absence, frequency, and spatial extent of muddy water. As a result, it can also provide an indirect indication of the presence of other pollutants, or large sediment concentrations, which is useful, both, for emergency management and domain research.

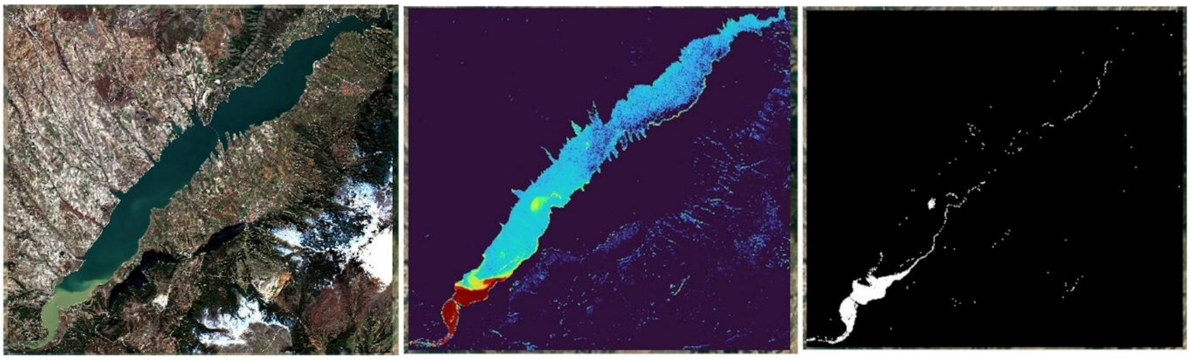

Figure 20. Sentinel-2 RGB map with muddy water at south of Polyphytos (left). Pseudo-probability (model prediction probability) map - red to blue colors denote 1 to 0 probability, respectively (center). Classification map with probabilities over 0.5 are mapped with white color (right).

Hydrocarbon/oil spills

Oil spills significantly threat water quality, especially in drinking water reservoirs. The oil spill sub-service identifies potential hydrocarbon formations in inland waters using properly preprocessed Sentinel-2 data. It is based on an adapted trained deep neural network model to identify small-scale oil spill events, which can be challenging to detect in inland waters[34], contrary to open waters. The generated oil spill map, at a given date, shows the areas, where hydrocarbon formations are present (Figure 21). Moreover, this service can provide information on the presence/absence of oil spills, which can be related to an indicator of water quality. It can also provide metadata such as size estimation of the oil spill, providing end-users useful information to take timely mitigation actions.

Figure 21. Potential hydrocarbon presence in Polyphytos lake (red); Google Earth used as basemap.

4. CONCLUSIONS

The functionalities of the WQeMS platform as well as the provided services have been illustrated, showing its potential for supporting water quality monitoring and reducing the risks related to water quality issues. Product generation automation, both, in the case of continuously monitored water surfaces, and in the case of on-demand service requests, is being pursued, as crucial for operating a service. Moreover, service assessment, which is mandatory to guarantee the service quality, is facilitated by the platform architecture, leaving room for further testing and synergies with other initiatives. Service sustainability is being pursued by targeting a variety of end users, either participating to the consortium or engaged through dissemination activities. In addition, European initiatives are being explored as framework for promoting the service. A joint exploitation plan, involving partners from, both, industry, and research, seems a suitable approach for operating the future service. In this regard, a service offer is being elucidated, aimed at identified potential users, foreseeing, both, free testing periods and promotional prices.

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