15th International Conference on Environmental Science and Technology

Rhodes, Greece, 31 August to 2 September 2017

Space assisted water quality forecasting platform for optimized decision making in water supply services

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Extended Abstract

Drinking water accounts for around 18% of the total fresh water abstractions in the EU (Eureau, 2009), managed by almost 70,000 utilities (EurEau, 2015). The frequency, intensity and distribution of long standing water quality and supply challenges are expected to increase alongside climate change (European Commission DG, 2014), posing challenges for water treatment plant operators.

In response to such increasing pressures, SPACE-O is catalysing innovation with an operational service platform designed to increase interoperability among Earth Observations (EOs) and modelled services to optimize water treatment plant (WTP) operations, reduce resources and energy required to treat water, and enhance water management at the catchment level. By catalysing innovation in the use and access to satellite data by water utilities, SPACE-O aims to offer a powerful Decision Support System (DSS) and risk assessment tool for WTP operators. Such tools will optimise WTP operations through the use of accurate short-term forecasted water quality and quantity information and a better understanding of environmental challenges through integration of satellite, in situ, modelled data and citizens' observations.

SPACE-O products and services are being tested and validated at two water utility case study locations in Greece (Aposelemis dam in Crete) and Italy (Mulargia dam in Sardinia) in order to reflect the requirements of water utility operations and management processes. Key functionalities and products (i.e. assimilation of EOs and use of high resolution numerical weather prediction systems) are being refined at two scientific case study locations in Sweden (Umeälven river) and Italy (Lake Garda). First EO-based historic data sets for the years 2013-2016 have been produced for the case studies using high resolution satellite data from Sentinel 2 and Landsat 7/8 (Fig. 1 and 2). In addition, early warning algorithms for cyanobacterial blooms in the SPACE-O reservoirs using MERIS for historical condition and Sentinel 2 and 3 for actually condition are being developed and tested on large time series. As part of scientific experiments, water temperature and water leaving reflectances have been generated for Lake Garda to develop a new algorithm on heat fluxes and evaporation rate.

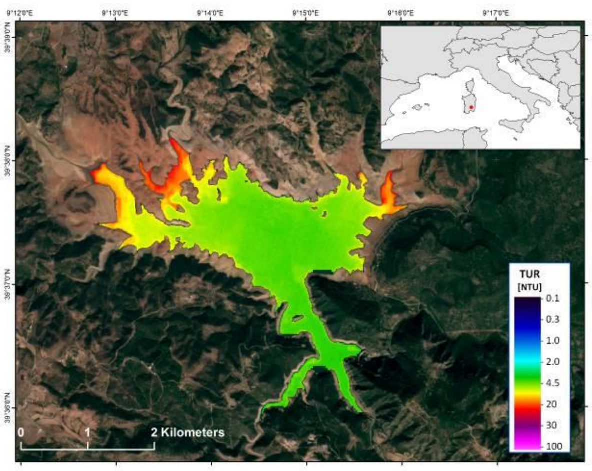

Figure 1. Satellite derived turbidity in the Mulargia reservoir (operated by ENAS, data source: Sentinel-2A recorded on 2016-10-16 © ESA, processed with EOMAP MIP-EWS, Heege *et al*. 2014).

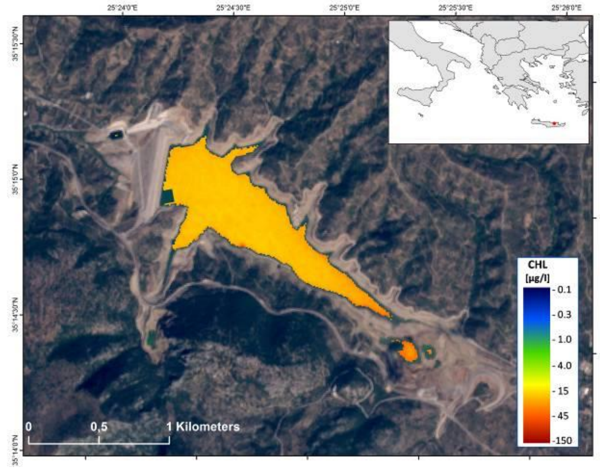

Figure 2. Satellite derived chlorophyll-a in the Aposelemis dam (operated by OAK, data source: Sentinel-2A recorded on 2016-10-15 © ESA, processed with EOMAP MIP-EWS; Heege *et al*., 2014).

SPACE-O also provides the opportunity to produce water information systems that are based on near real-time EO products. This is a step ahead in scientific and operation efforts. In this project, we are taking advantage of two setups of the HYPE hydrological model (Linström *et al*., 2010) at the continental and national scale. The HYPE model has been setup both for the pan European region and Greece (Hundecha *et al*., 2016) allowing its applicability for water services (Fig. 3). Apart from using EOs in these services, we also take advantage of SMHI's Global Forcing Dataset (GFD) system for generating corrected re-analysis fields of precipitation and temperature, with the primary focus to produce forcing data for our continental and regional hydrological applications. One flavor of the GFD system is running operationally at SMHI, and collects global model data from ECMWF, observations of precipitation from GPCC and of temperature from GHCN-CAMS (Fig. 4).

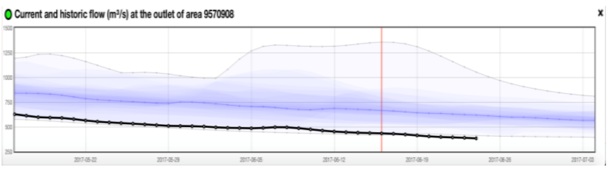

Figure 3. SMHI's hydrological forecasting service.

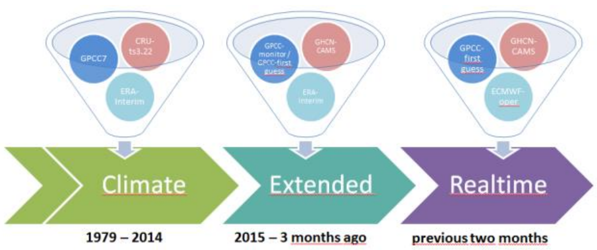

Figure 4. Time line of the GFD-system running operationally at SMHI to produce forcing data for the HYPE model.

Water quality forecasting is performed with Delft3D-FLOW and DELWAQ, two open-source hydrodynamic and water quality models respectively. The whole water quality forecasting workflow is driven by the ASH system developed by EMVIS, which automates and manages the different components and tasks that have to be performed in order to provide an operational forecast of water quality characteristics in water reservoirs. The coupled hydrodynamic and WQ models are fed on a daily basis with updated hydrological information from the HYPE model, related to the inflows as well as to the pollution loads (e.g. phosphorus, nitrogen, sediment) entering the reservoir. When EO products of chlorophyll, turbidity and temperature, or datasets from in-situ monitoring stations are available, a data assimilation technique based on the Ensemble Kalman Filter is engaged, in order to adjust the model state and avoid error accumulation. Finally, a post-processing algorithm integrated into the ASH system, is employed for calculating various water quality indicators for the SPACE-O Early Warning Functionality as well as for providing tailored operation strategies and actions for the Water Treatment Optimisation Functionality of the SPACE-O platform.

Keywords: SPACE-O, earth observations, hydro-meteorological forecasting, water quality forecasting, water supply services, decision support systems

Acknowledgements

SPACE-O has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 730005.

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