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The Water Quality Prototype exploiting PRISMA hyperspectral data for aquatic ecosystems mapping

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Abstract. A prototype processor for aquatic ecosystems mapping exploiting PRISMA satellite hyperspectral images has been developed in the framework of the Italian Space Agency (ASI) project "Sviluppo di Prodotti Iperspettrali Prototipali Evoluti" (Contract ASI N. 2021-7-I.0). The main objective of the project is the prototyping of a subset of Level 3 / Level 4 value-added products to be retrieved by means of hyperspectral data processing. The 'Water Quality' Prototype (WQP) is a combination of state-of-the-art techniques for the retrieval of optical parameters useful for the characterization of inland and coastal waters. The prototype processor ingests at-surface reflectance products and implements adaptive, semi-empirical and semi-analytical methods for parameters retrieval. In details, the WQP includes an adaptive band ratio algorithm for the retrieval of the concentration of phytoplankton primary photosynthetic pigment (Chlorophyll-a (Chl-a)) and the cyanobacteria accessory pigment (Phycocyanin) [1, 2]. Moreover, the prototype processor implements a semi-empirical algorithm to retrieve Total Suspended Matter concentration and water turbidity exploiting different wavelengths in the visible or near-infrared range [3]. A bio-optical model inversion [4] is applied to derive Chl-a concentration in optically deep oligotrophic waters and to provide bottom substrate fractional coverage (e.g. macrophytes, sand) in case of optically shallow waters [5]. The model parameters for the calibration of both semi-empirical methods and bio-optical models are selected based on a priori-knowledge of the optical properties specific for the case studies investigated in the project.

The WQP processor has been tested on PRISMA L2D data over some Italian lakes (i.e. Garda, Mantua, Varese and Trasimeno) with waters spanning significant ranges of trophic status and turbidity as well as in transitional and coastal areas (Venice lagoon and northern Adriatic Sea). The preliminary results of the prototype products validation show a good agreement respect to the in-situ data, both for water quality parameters and bottom substrate products. In some of the maps produced, it was possible to highlight some critical issues of the aquatic environments, for example a high blooming of cyanobacteria with high concentration of Chl-a and phycocyanin (>100 mg/m^3) on

16/10/2021 in Lake Varese (Fig. 1.), and high TSM concentrations in Lake Trasimeno (> 50 g/m^3) on 30/11/2020 (Fig. 1).

Water quality maps derived from satellite observations could support and be complementary to conventional water sampling methods. Therefore, they could potentially enhance the assessment of ecological status by achieving much improved spatial and temporal coverage of medium (several square kilometers) and larger waterbodies. They will offer a standardization of water quality assessment, improving both protection solutions and the collection of sustainability development indicators.

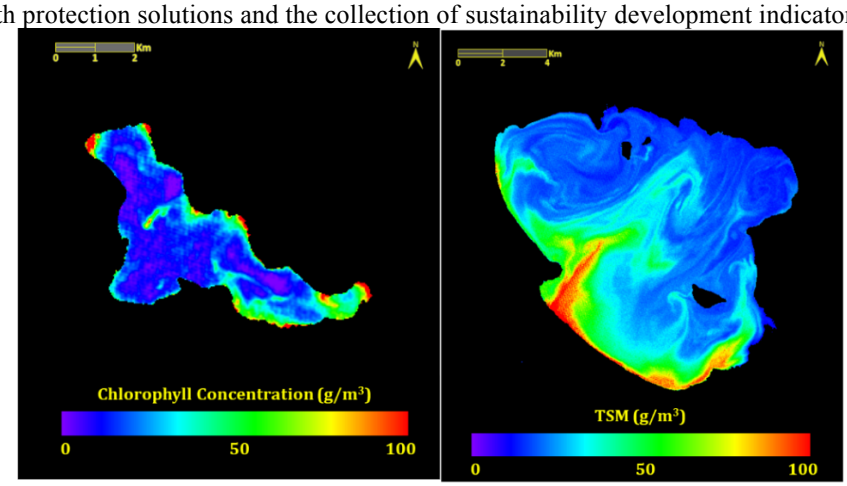

Fig. 1. Chlorophyll and Total Suspended Matter (TSM) concentrations retrieved with the WQP applied to the PRISMA images of Lake Varese acquired on October 16, 2021 (left) and Lake Trasimeno acquired on November 30, 2020 (right), respectively. Data generated under an ASI License to Use; Original PRISMA Product - © ASI – (2021).

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