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A Satellite-based analysis of Tiber River inland-marine water connectivity

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Connectivity describes the efficiency of material transfer between the components of a system. The definition of these components varies among different disciplines and in relation to the material under consideration.

River systems are complex and dynamic environments where multiple and highly inter-correlated processes occur at various spatial and temporal scales. Because of this reason, in-situ traditional techniques for inland waters monitoring are often inadequate to the full understanding of river processes, making the evaluation of river system and inland-marine water connectivity a challenging task.

In this study, we use high-resolution multispectral satellite data acquired by the Sentinel-2 Earth observation mission of the EU Copernicus Programme to investigate the connectivity of the lower Tiber River basin (Italy) from a sedimentological and biogeochemical point of view. To this end, Level-1C satellite imagery, collected on the study area for the period 2017-2020, were processed through the ACOLITE software to perform image atmospheric correction and to obtain water turbidity (WT) and chlorophyll-a (Chl) concentration values on multiple regions of interest along the river course up to the river mouth and the adjacent coastal area. WT and Chl are indeed key parameters for both sediment transport and water quality monitoring of inland and coastal waters. River connectivity was then evaluated by analyzing the spatio-temporal variability of seasonal climatologies of the satellite-derived parameters.

The analysis showed a significant dependence of suspended sediment transport and chlorophyll concentration on hydrological conditions; however, complex dynamics arises. From a sedimentological point of view, as expected, connectivity seems to be positively correlated with the magnitude of the hydrological events, with the highest and lowest degrees of connectivity of WT during the highest and lowest discharge events respectively (winter and summer). From a biogeochemical point of view, there seems to be an optimum window during moderate hydrological conditions (spring) that, on one hand, allow for sediment resuspension and, therefore, nutrients transport along the river course, but on the other, prevent to reach critical resuspension values that would reduce and/or hinder Chl concentration along the river course.