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Modeling the hydrodynamics of a wetland under strong anthropic pressures (Torbiere del Sebino, Italy)

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The Natural Reserve "Torbiere del Sebino" is situated on the southern bank of Lake Iseo and is one the most meaningful wet zone for extension and ecological importance of northern Italy, belonging to the Natura2000 network.

Torbiere occupies an area of 3.60 km^2 within a 14 km^2 watershed where almost 12000 inhabitants live and where agricultural activities, mostly vineyards, cover almost 40% of the area; this leads to a significant anthropic pressure that over the last 50 years has compromised the system and changed the equilibria between species, enhancing eutrophication.

Despite the ecological relevance of the area, one of the most important in northern Italy, very little quantitative information is available regarding its current state and evolution in terms of water quality and hydrodynamics. Given the critical environmental condition of the habitat, it is necessary to address the consequences of human impact on the trophic state of Torbiere.

Torbiere consists of a system of shallow lakes or ponds (average depth 1.5 m) whose main affluent is a creek (called Rì) entering from the South. A secondary occasional affluent enters the system from the East and consists of a combined sewer overflow (CSO). Finally, the main effluent is an artificial channel located in the North connecting Torbiere directly with the subalpine Lake Iseo. Although originally subdivided into a set of many interconnected ponds, the separation levees have been demolished over the last decades to enhance internal circulation, under the assumption that this would decrease the residence time and improve the water quality. However, no rational argument was used to support this decision that led to a system where similar characteristics (Secchi's depth, turbidity, specific conductivity) are found all over the study area and where the expansion of invasive species was easier; now there is some evidence that a separate set of ponds would be better manageable to contrast the eutrophication process. To understand this process, a 3D hydrodynamic model has been set up using Delft-3D, an open source, finite difference package.

Given the great extension of the system, the inner circulation of the water is not driven by the momentum of the affluents, instead the wind plays a major role. This forcing term presents a daily pattern: it blows from the North in the mornings and shifts to the opposite direction in the late afternoon. The water mainly flows from the South to the North. However, preliminary results by

Delft 3D showed that the circulation is made complex by the wind. The model shows that opposite directions of horizontal flow velocities are found at the surface and at the bottom of the water column, showing that only the upper layers follow the direction of the wind.

By comparing the actual and previous conditions of separation of the ponds, the model aims to give an answer to whether the choice of demolishing the banks was positive or negative for the water quality of Torbiere. Once the role of the banks will be clarified, the effects of their possible restoration will be addressed.