

## COUPLED HYDRODYNAMIC AND BIOGEOCHEMICAL MODELING FOR THE ORBETELLO LAGOON: ASSESSING CLIMATE CHANGE & EUTROPHICATION EFFECTS

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### Abstract

The Orbetello Lagoon (26 km<sup>2</sup>, ~1 m mean depth) is a shallow Mediterranean transitional ecosystem affected by recurrent eutrophication crises, dystrophic events, and summer fish mortality due to limited water renewal and strong anthropogenic pressures [1]. Effective management requires understanding the interplay between wind-driven circulation, sea-lagoon exchange and artificial pumping. In this work, the two-dimensional hydrodynamic model SHYFEM [2] was implemented and applied to the Orbetello lagoon. The first modeling phase aims to establish a robust hydrodynamic framework, simulating water levels, temperature, salinity and circulation patterns under realistic physical forcing.

A high-resolution triangular mesh (~3935 elements, 2233 nodes) was built, covering the lagoon and its three connection channels (Fibbia, Nassa and Ansedonia) with the Tyrrhenian Sea. A full-year simulation for 2019 was performed on the CINECA-Galileo100 HPC platform, with extension to 2022 in progress. Forcing data include water level, salinity and temperature at the open boundaries, atmospheric parameters from meteo stations, and artificial pumping at Nassa and Fibbia channels. All inputs were quality-controlled and pre-processed into SHYFEM-ready format. Model results were verified against the ARPAT continuous monitoring system (6 CTD stations inside the lagoon, see Figure 1) and tide gauges of the Tuscany Region.

Initial results show that the model reproduces the main hydrodynamic features and the seasonal behavior of temperature and salinity, with circulation patterns dominated by wind and the pumping system [3], consistent with previous studies of the lagoon.

This validated hydrodynamic framework provides the basis for the next phase of the PhD project: coupling with the EUTRO biogeochemical module [4] to simulate water quality and eutrophication dynamics, followed by climate-change and management scenarios [5]. The integrated tool aims to support both scientific understanding and adaptive management of vulnerable Mediterranean coastal systems like the Orbetello lagoon.

## References

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Figure 1. Map of the Orbetello lagoon with the finite element grid of the hydrodynamic model SHYFEM, the position of the tide gauges (in red) and the continuous monitoring stations.

