Impact of fluvial discharge on water properties variability in the Tagus Estuary: A numerical modeling approach

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Understanding estuarine hydrodynamics is vital for managing coastal ecosystems under changing forcing conditions. Estuaries, as dynamic interfaces between rivers and the ocean, are critical for maintaining ecological balance and supporting socio-economic activities. The Tagus Estuary, one of the largest in Europe, is a key ecological and socio-economic resource and a highly dynamic system influenced by tides, river discharge, and meteorological conditions [1]. This study focuses on the impacts of fluvial discharge on estuarine water properties, including salinity, heat (temperature), and suspended sediment transport.

Using the 2D hydrodynamic numerical model MOHID, we aim (1) to evaluate estuarine gradients under varying fluvial discharge scenarios, (2) assess the combined influence of tidal and fluvial forces on water property distribution and (3) analyze hydrodynamic simulations for sustainable management insights [2,3]. The study area includes distinct marine, mixing, and fluvial zones of the Tagus Estuary, covering the whole area of the estuary-coastal continuum. Simulations were conducted for three scenarios representing different flow regimes: no discharge, average discharge (283.3 m^3/s), and high discharge (1000 m^3/s) [4].

Results show that tidal forces dominate estuarine circulation, while fluvial discharge significantly alters salinity, temperature, and suspended sediment dynamics. High discharge scenarios reduce salinity, enhance stratification in the upper estuary, and lead to pronounced horizontal gradients in the mixing zone. These conditions also increase suspended sediment transport, emphasizing the critical role of freshwater inputs in shaping estuarine patterns. This study provides a comprehensive understanding of the fundamental hydrodynamics of the Tagus Estuary, highlighting the MOHID model's capability to simulate estuarine responses to natural and anthropogenic changes. The findings offer valuable insights for long-term management strategies to preserve the estuary's ecological and socio-economic functions.

Keywords
Numerical Modelling; MOHID; Tagus Estuary; Hydrodynamics; Sediment Transport; Tidal Forces