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HYDRODYNAMICS INFLUENCE ASSESSMENT ON MONDEGO ESTUARY EUTROPHICATION PROCESS

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ABSTRACT: The south arm of Mondego estuary is stressing by an eutrophication process due to massive nutrient loading from urbanised areas and diffusive runoff from intensively agricultural areas. The consequence is a structural change of the ecosystem, where the turnover of oxygen and nutrients is much more dynamic and macroalgae play an important role in the nutrient pathways of the ecosystem. A sampling program was carried out and available field data analysis allows concluding that the occurrence of green macroalgal blooms is strongly dependent on the hydrodynamic conditions, precipitation and salinity gradients.

The aim of this work is to assess the role of estuarine hydrodynamics on the non-attached macroalgae control and the magnitude of nutrients tidal balance. Residence times estimation can provide essential information about estuarine hydrodynamic behaviour, considering different scenarios, in order to select the better water quality management practises.

Keywords: **Estuarine environment management; eutrophication; hydrodynamics; mathematical modelling; Mondego estuary**

STUDY AREA

The Mondego river basin is located in the central region of Portugal. The estuary (40°08'N, 8°50'W) is divided into two arms (north and south) with very different hydrological characteristics, separated by the Murraceira Island (Figure 1).

The north arm is deeper and receives the majority of freshwater input (from Mondego river), while the south arm is almost silted up in the upstream area.

Figure 1 – Location, aerial view of Mondego estuary and south arm bathymetry

METHODS

A sampling program was carried out at three benthic stations (1,2 and 3) and at three other points (RP, EA and Gala bridge) for water column monitoring. Two different years summer campaigns are compared (July 2000 and July 2001), attempting mainly on the mass balance returned by different amplitude tides.

The benthic stations were selected considering eutrophication gradient in the estuary south arm, since a non-eutrophicated zone (site 1) up to a strongly eutrophicated zone (site 3), in the inner and shallower areas (Figure 2).

Figure 3 shows the variation of salinity, water level and water speed during the tidal cycles. Hour samplings of water, Suspend Particulate Matter (SPM) and drifting vegetation were collected, to evaluate water nutrients transported, besides measuring of water environmental parameters.

Residence times (RT) can be a key parameter to assess hydrodynamic influence on estuarine eutrophication vulnerability. Figure 4 presents the finite element mesh considered in the estuary hydrodynamic modelling, based on *RMA2 model.*

Figure 2 – Sampling points location

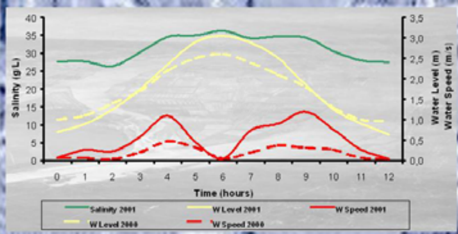

Figure 3 – Environmental parameters during tidal cycles

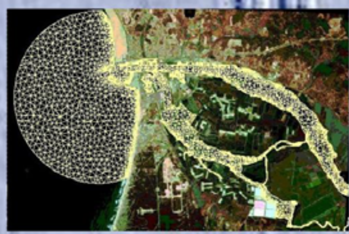

Figure 4 – Finite element mesh (2D-H)

RESULTS

The spring blooms could occur when freshwater inputs into the system are little, because salinity remains high, current velocities, turbidity and N/P ratios decrease, enhancing macroalgal growth and their fixation availability and reducing biomass losses to the ocean.

Figure 5 shows the water column transported material due to different water velocities and presents the contributions of water dissolved, suspended particulate matter (SPM) and vegetation tissues nutrients on tidal nitrogen and phosphorus balance.

Figure 6 presents hydrodynamic modelling (2D-H) results of Mondego estuary, concerning to maximum velocity magnitude, and surface water elevation (flood tide).

Residence time values obtained for different tracer discharge duration (one and six hours, respectively) are depicted in Figure 7.

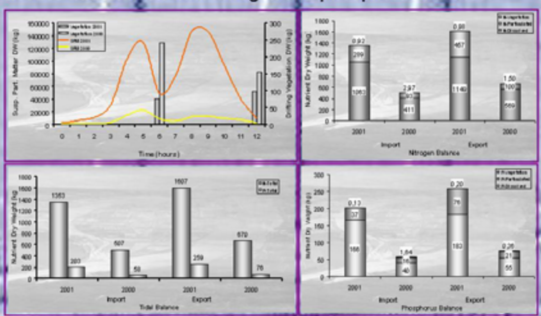

Figure 5 – SPM, vegetation drifting and nutrients tidal balances

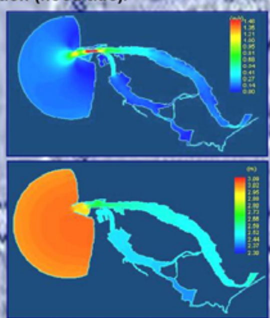

Figure 6 – Velocity magnitude and surface water elevation

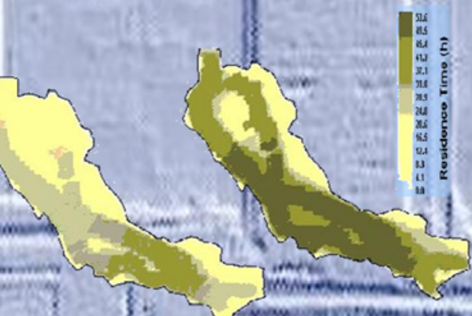

Figure 7 – Residence time spatial variation

CONCLUSIONS

- The time of rising tide decreases at points farther inland and is much smaller than that of the fall, due to the estuary south arm shallow waters. Hydrodynamic modelling has shown the occurrence of a noticeable delay between the beginning of seawater entrance into the two arms of this estuary.
- The fraction more representative on the nutrients transport was the one dissolved on water, followed by the suspended particulate matter fraction. The former is also the most important factor on the eutrophication phenomena since represents the nutrients immediately accessible to the macroalgae tissues incorporation on the growing process.
- Water quality modelling results confirm the eutrophication gradient measured in the south arm of the river Mondego estuary, validating the methodology applied. RT obtained from different simulated scenarios allow to establish the most sensitive zones to this estuarine eutrophication process.

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