Challenges for integrated catchment-to-coast modelling in the context of science-policy interface: the Ria de Aveiro coastal lagoon

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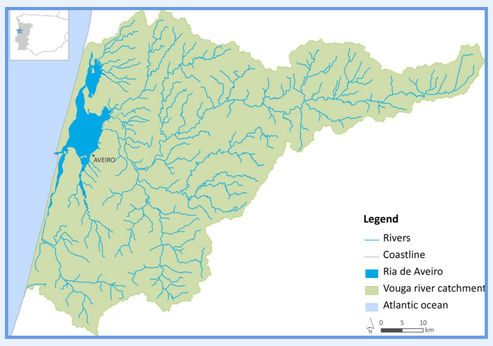
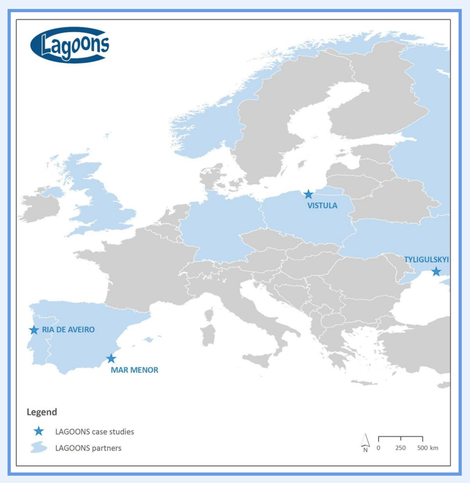
Abstract

Ria de Aveiro is one of the European "hotspot" coastal lagoons being studied within the EU-FP7 LAGOONS project. Regarding the water quality status of Ria, the main policy context of relevance is the EU-Water Framework Directive and the activities related to its implementation. The considered anthropogenic deterioration may be affected by changing climate, land use and water use in future. The aim of the modelling effort within LAGOONS is to project the Ria's response to climate change and land use change scenarios. For the climate impact assessment the sets of existing regional climate scenarios from the ENSAMBLES project are used. The use of modelling tools to assess the spatial impacts in the context of the EU-policies pose some additional challenges, namely due to the gaps in data sets and the lack of effective information-sharing systems.



CASE STUDY AREA: Ria de Aveiro

- is a shallow coastal lagoon located on the north-west coast of Portugal (40º38'N, 08º45'W) and integrated in the Vouga River catchment area;
- the catchment area has approximately 3362 km2 whilst the lagoon corresponds to a complex wetland area that varies approximately from 66 km2 to 83 km2 according to the tidal cycle;
- the main tributaries of the Vouga river are the rivers Sul, Caima, Antuã and Águeda;
- is under the influence of a temperate maritime climate with a warm period between July and September and a cold period between December and February;
- rainfall occurs mainly between October and May, with higher precipitation periods in December and January;
- the Vouga river catchment area covers 31 counties, with a total population of 961316 inhabitants (2011 census), and is mostly occupied by forest and farmlands;
- is part of the Natura 2000 network, has the designation of Special Protection Area, and includes several areas classified as Sites of Community Importance;
- is managed within a complex policy and legislative context, with a wide variety of entities and actors engaging in the use and management of the lagoon.



SWIM model: Vouga Catchment

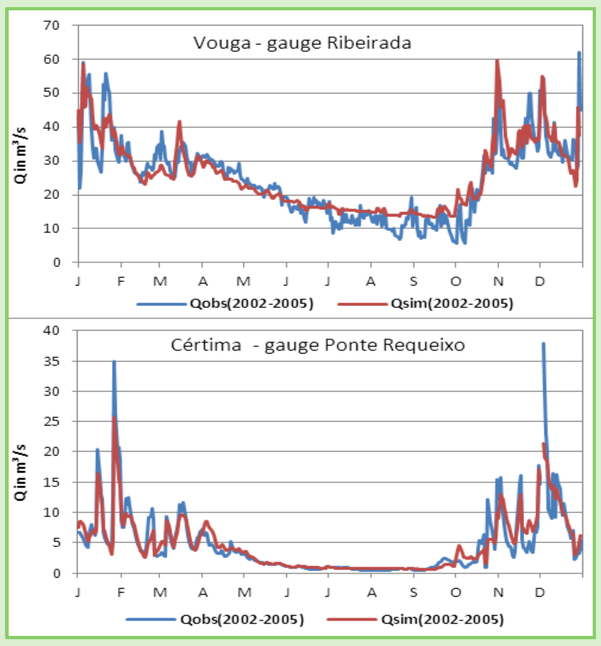
- is being used for ecohydrological modelling of the catchment areas of the case study lagoons.

SWIM is a continuous-time spatially semi-distributed model, integrating hydrological processes, vegetation growth (agricultural crops and natural vegetation), nutrient cycling (nitrogen, phosphorus and carbon), and sediment transport at the river basin scale. The model is coupled to GRASS and MapWindow open source geographic information system project, and has modest data requirements. Its spatial disaggregation scheme has three levels: 1) basin, 2) subbasins and 3) hydrotopes within subbasins.

Objectives:

- to evaluate water discharge and nutrient (Nitrogen, N, and Phosphorus, P) inputs from the drainage area under climate change and land use change scenarios, and
- to estimate related uncertainty from different sources.

Comparison of simulated and observed mean daily flows at gauges Ribeirada and Ponte Requeixo.



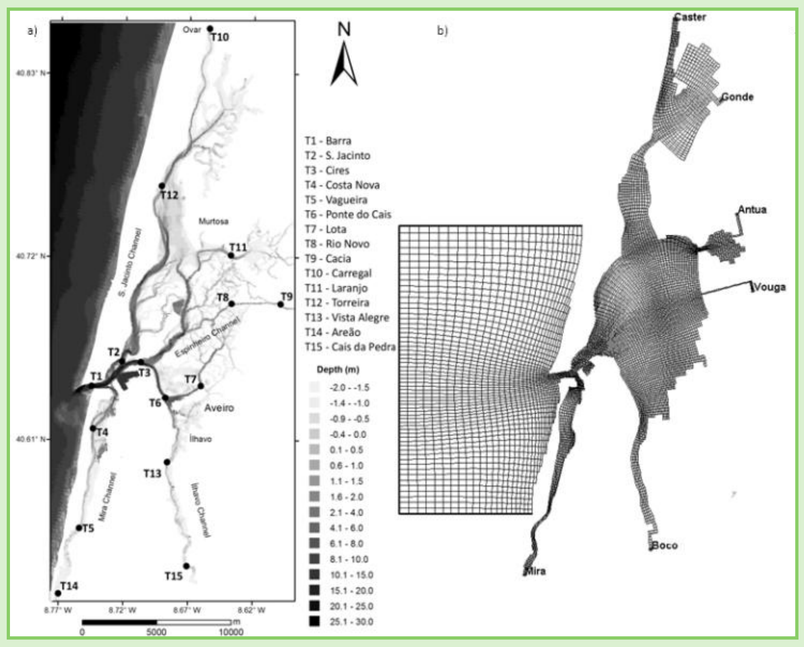
The graphs show satisfactory agreement between the modelled and measured discharges. However, some peak flows, especially during winter are underestimated. This can be caused by mainly two reasons: (i) insufficient climate data, and (ii) inaccuracy of the flow curve equations. Most of the gaps in precipitation data occur during winter, which could lead to an underestimation of rainfall, and consequently discharge for this period.

Delft3D-Flow model: Lagoon

- is a three-dimensional, finite differences hydrodynamic and transport model which simulates flow and transport resulting from tidal and meteorological forcing.

The Delft3D-Flow model was used for its ability to support curvilinear grids allowing the timely calculation of the several model configurations needed for the calibration, validation and scenario simulation with the necessary resolution in the relevant areas of the lagoon. This model allows for the simulation of hydrodynamic and biogeochemical quantities at the tidal, fortnightly, seasonal and event scales.

(a) Study area, bathymetry and stations used in the hydrodynamic model calibration (b) Numerical grid, discharge locations and open boundary (thick line).



Main challenges are:

- the old bathymetry (1987 – 1988) in the intricate net of channels and salt pan areas in the lagoon central zone;
- the high uncertainty of the position of the top limit of the intertidal;and
- the absence of an up-to-date synoptic survey of the lagoon's sediments

Modelling for the 2041-2100 interval poses additional challenges such as:

- the dependency of the sediment nutrient and fines content on the long term evolution of the lagoon's bed; and
- the unavailability of projected oceanic conditions for the ipcc (intergovernmental panel for climate change) story lines adopted and for the variables needed, such as nutrients, chlorophyll and dissolved oxygen.

Discussion

Taking Ria de Aveiro as an example it has been pointed out that there are data gaps regarding the catchment area and the lagoon that need to be addressed to improve the integrated catchment-to-coast modelling in the context of climate change. The cooperation between LAGOONS team and ARHcentro has resulted in the sharing of data, information and knowledge. In the context of science-policy interface an additional challenge is posed - it is necessary to improved dialogue between the scientific and policy-making communities and between the scientific and stakeholders communities. Science-policy interface is only a part of the challenge facing integrated lagoon management. The demands made for increased stakeholder and public participation provide other important interactions, the science-stakeholder and the policy-stakeholder interfaces. In this way scientific knowledge and the quantitative modelling results produced by the LAGOONS team will be combined with the local knowledge and perceptions of the stakeholders at all stages of the project.

References:

LAGOONS 2012a. The Ria de Aveiro Lagoon – Current knowledge base and knowledge gaps. LAGOONS Report, D2.1b, 52p.

LAGOONS. 2012b. Hydrodynamic and water quality models. LAGOONS Report D6.1. 71 pp.

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