SALINITY DYNAMICS IN THE UPPER TAGUS ESTUARY

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Abstract

The influence of freshwater discharge and sea level rise in the salinity in the upper Tagus estuary is assessed using a numerical model. Results suggest that the river flow is the main driver of the salinity in the upper estuary and that salinity intrusion increases with the duration of the droughts. For the analyzed scenarios, salinity reaches concentrations that are inadequate for irrigation during some periods, which can harm the agricultural activities.

Key words: Estuary; River flow; Sea level rise; SCHISM

1.   Introduction

Salt water intrusion in the upper Tagus estuary can have negative social, economic and environmental impacts by affecting the uses and activities in this area (e.g. agriculture, water supply). The salinity propagation in this estuary is mainly controlled by the tides and the river flow (Rodrigues and Fortunato, 2017). A reduction of the freshwater discharge entering the Tagus estuary or sea level rise promotes the landward intrusion of saltwater. To assess the salt water intrusion in the upper reaches of the estuary a process-based model was implemented, calibrated and validated (Rodrigues and Fortunato, 2017) and is used herein to explore different scenarios of freshwater discharge and sea level rise, providing information to help end-users cope with future changes.

2.   Model application and results

The three-dimensional model of the Tagus estuary (Rodrigues and Fortunato, 2017) was implemented using the system of models SCHISM (Zhang *et al.*, 2016). The model was forced by tides at the oceanic boundary, river flows at the riverine boundaries (Tagus and Sorraia) and atmospheric data at the surface. The validation of the salinity model for drought conditions was done for July 2017. Given the uncertainty on the river flow data, two alternative input flows were used: data from Almourol and the sum of the outflows from Belver and Castelo de Bode dams (data from SNIRH). See BINGO (2018) for further details.

To evaluate the salinity propagation during droughts five scenarios were established for the summer season – July (Figure 1). The river flow scenarios were based on the climatological data available in SNIRH and taking into account that the Tagus river flow is mainly controlled by decisions on the operation of dams. The Sorraia river flow was taken as 5% of the Tagus river flow. To allow the comparison between the scenarios, the tidal and atmospheric forcing were similar in all the simulations and aimed to represent average conditions. A sea level rise (SLR) of 0.5 m was considered at the oceanic boundary in S5. Simulations were performed for 30 days using similar initial conditions. See BINGO (2018) for further details.

Validation assessments suggested that, using the Almourol flow data, the model tends to overestimate the salinity by about 2 in the upper reaches of the estuary (Conchoso) and that the

river flow data used to specify the boundary conditions is a major source of uncertainty in the model results (BINGO, 2018), which should be taken into account when analyzing the results.

Time series of surface salinities were extracted and analyzed at four locations (Figure 1). Results suggest that for climatological conditions salinity does not reach the Conchoso, Rio do Risco and Valada stations, which is consistent with empirical knowledge. For the recent drought scenario (S2), salinity reaches about 10 at Conchoso and exceeds the threshold acceptable for irrigation. For the remaining river flow scenarios (S3 and S4) salinity increases and aggravates the consequences for irrigation. Salinity differences for the SLR scenario are small when compared with the differences between the various river flows. The tidal signal present in the salinity time series suggests that during droughts water should only be abstracted from the river at low tide, in order to provide fresher water. Results also show that salinity intrusion in the upper estuary depends not only on the river flow alone, but also on the duration of the droughts, as the tidally-averaged salinities display a rising trend.

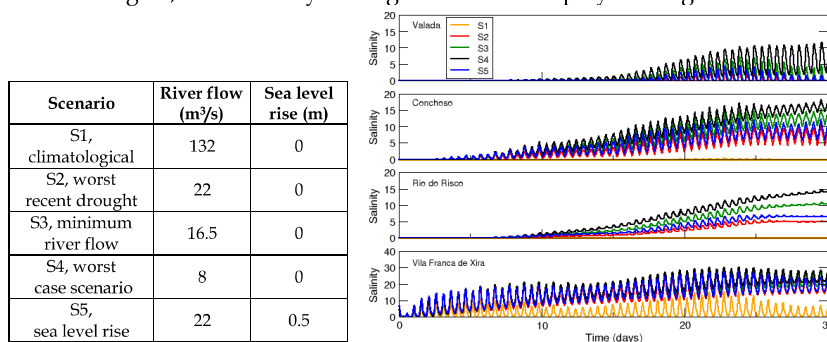| Scenario	River flow (m³/s)	Sea level rise (m)
S1, climatological	132	0
S2, worst recent drought	22	0
S3, minimum river flow	16.5	0
S4, worst case scenario	8	0
S5, sea level rise	22	0.5

Figure 1. Scenarios simulated and time series of surface salinity at the four virtual stations. For scenario S1, salinity at Rio do Risco, Conchoso and Valada is approximately 0.

3. Conclusions

The numerical assessment of the salinity dynamics in the upper Tagus estuary suggests that the river flow is the main driver of the salinity in this area. For the analyzed scenarios, salinity reaches concentrations that are inadequate for irrigation during some periods and increases with the duration of the droughts. These results can contribute for the management of the agricultural activities in the upper Tagus estuary.

References

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