Integrating modelling approach to study the relations between stressors and indicators

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Introduction

Watersheds are subject of multiple stressors resulting from urban and agricultural land use, water power generation and climate change. Reservoirs used to irrigation promote land use changes and can influence all water balance and water quality in the watershed.

According with EC (2014) drivers such as agriculture promotes diffuse pressures, increasing nutrients (nitrate and phosphate) in the river promoting the decrease of water quality in all basin. Reservoirs promote flows (Figure 1) and water level regime changes , as well as water abstraction from the river that is used to the irrigated areas. The flows and nutrients variability resulting from the reservoir are indirect stressors to the fish, changing the biotic state in the river.

Figure 1 Left: Reservoir implementation in rivers. Right: Maranhão and Montargil reservoirs in Sorraia (Source: Google).

Climate change is another concern in the river water management. In the Mediterranean countries is expecting an increasing of temperature and the decreasing of the annual amount of precipitation (van Vuuren et al 2011).

The hypotheses of this work is to use an integrated modelling approach to assess all the processes and scales, to quantify reservoir inputs and outputs and agriculture impacts..

Case study

The case study in this work is the Sorraia river basin, located in Portugal (Figure 2). In the 1957 and 1958 years two reservoirs were built in the two mainstreams of the Sorraia River basin, with the aim of supply water for the main channel created to irrigation. The increase of water availability allowed the Sorraia Valley to increase the irrigated area for the one of the biggest now in Portugal.

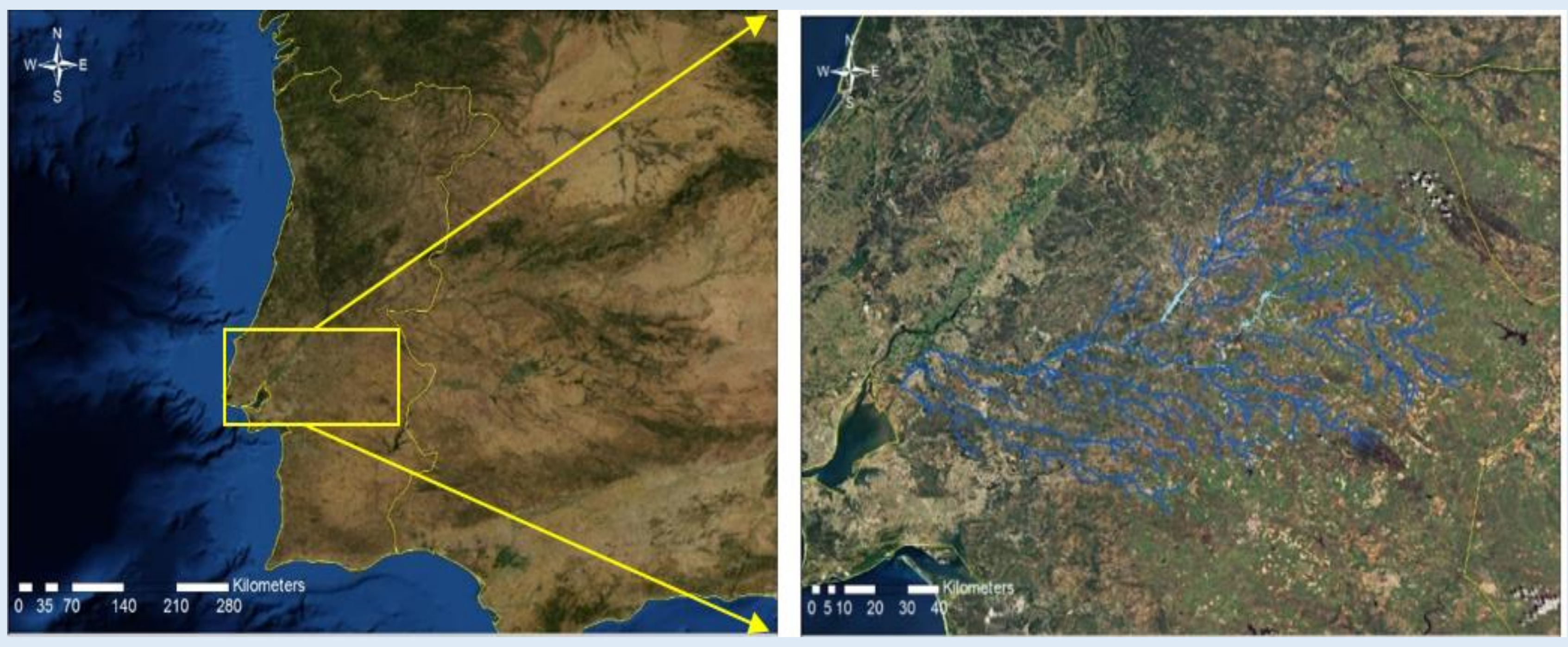

Figure 2 Sorraia Valley location (left). Sorraia River and reservoirs (right). (Source: Google earth)

Integrating modelling

In this work a methodology based on fully distributed catchment modelling and 3D reservoir modelling (MOHID) will be showed (Figure 3 left). The catchment is divided into 3 parts (Figure 3 right), one above each reservoir and the downstream part. Upstream, the sub-catchment models compute loads to reservoirs as a function of land use/land cover and of irrigation water availability.

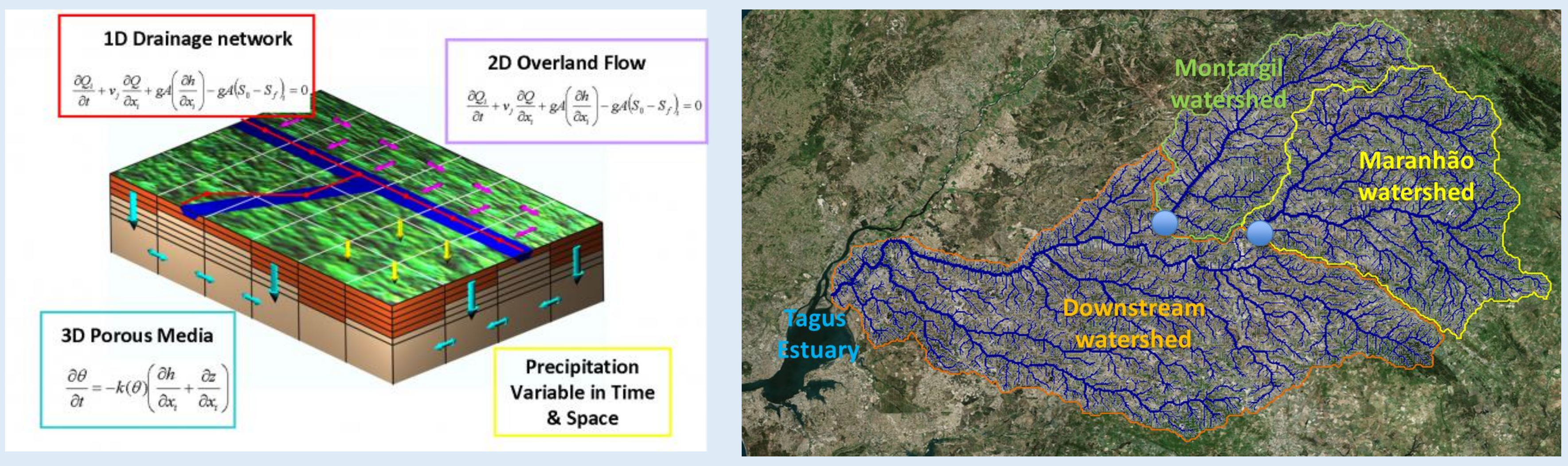

Figure 3 MOHID Land geometry and equations (left). Modelling approach (right).

Reservoir models compute biogeochemical processes in the reservoirs (Figure 4), assessing the relation between their trophic status and upstream loads. Loads discharged by reservoirs are computed as a function of each reservoir discharge and of the abstraction depth and are added as loads to the downstream catchment model, while flow regime is modelled, at a daily basis. Based on this modelling system, local stressors are computed along the whole river system and used to assess ecological status using empirical correlations obtained from site data. Calibration uses an independent set of empirical data (Figure 5 and Table 1), thus enabling to explain ecosystem's status at a large scale, and to bring evidence of the impact of changing land management. Modelling tool can show as well the impact of the reservoir in the discharge control (Figure 6).

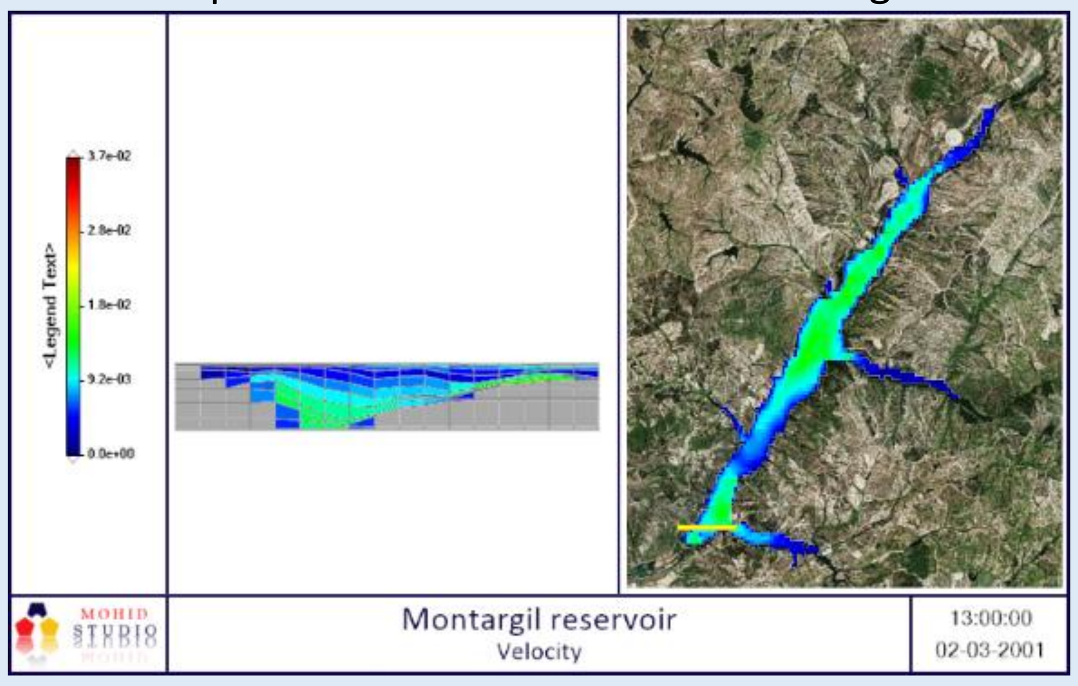

Figure 4 Reservoir model result (velocity modulus m3/s)

Table 1 MOHID Land modelling results. Statistic analyses

		Montargil	Maranhao
Flow daily average (m3/s)	Measurements	6.4	8.26
	Model	6.6	9.36
Model efficiency		0.65	0.87
Correlation		0.8	0.84

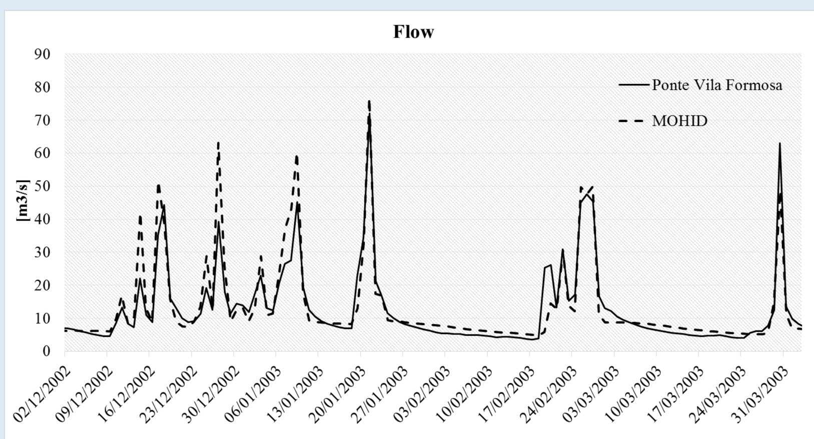

Figure 5 Flow river calibration

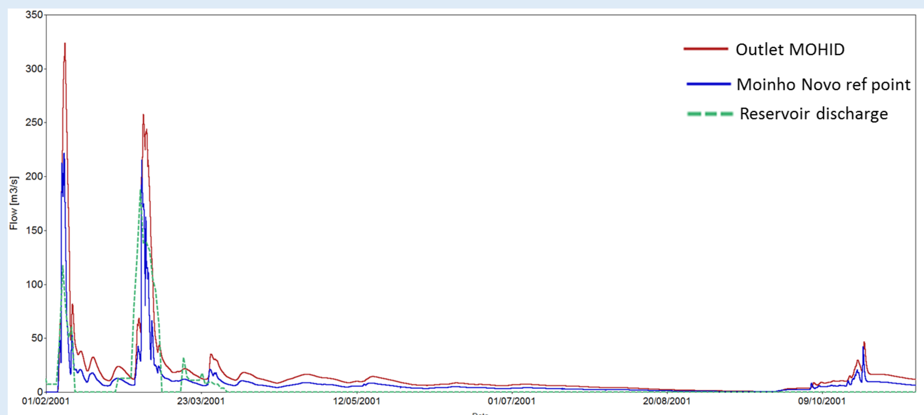

Figure 6 Comparison between discharge from Montargil reservoir (green) and in the Outlet (red), and "Moinho Novo" reference point (blue)

Conclusions

The multiple events occurring in the basin are subject of research to understand the state of the system under study (biological, hydro-morphological, physic-chemical), as well as the impact resulting from this changes in the environmental state with relevance for ecosystem processes as well as ecosystem services (irrigation, water supply…).

In this context, integrated assessment of catchment functioning is essential to quantify their effect as stressors of ecological systems. Modeling is essential to allow multiple stressors scenario assessment. Actual data is essential to validate the actual scenario.

Acknowledgements

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