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Numerically Enhanced Conceptual Modelling (NECoM) applied to the Flumendosa Plain groundwater system (SE Sardinia, Italy)

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The alluvial aquifer of the Flumendosa delta plain, in south-eastern Sardinia (Italy), is overexploited for drinking and agriculture purposes and it is subjected to ongoing sea water intrusion phenomena. In a context of progressive quali-quantitative deterioration of groundwater resources, development of a sustainable management plan and, eventually, effective remediation actions require a deep understanding of the investigated system. A systematic review of dataset collected from literature, integrated with new field hydrogeological and geochemical data, is performed to improve the knowledge of the aquifer system. Despite the large amount of processed data, many aspects require further investigations. In this frame, a fast-running steady state groundwater flow numerical model is developed as a tool for testing the preliminary assumptions, to address the main uncertainties, and to optimize the acquisition of new field data. The adopted approach follows the methodology proposed by Lotti et al. (2021) for the development of a Numerically Enhanced Conceptual Model (NECoM).

Geometrical discretization of the numerical model is based on results of the 3D hydrogeological reconstruction of the plain area (Arras et al. 2019); simulation of main inflows and outflows, water exchange between surface water bodies and groundwater, irrigation and drinking water withdrawals is performed through the implementation of general head boundaries (GHB), river (RIV), and well (WEL) packages, respectively. Results from the application of the Soil Water Balance code (Porru et al. 2020) are used as input for simulating the average recharge from precipitation. Lateral recharge from the Paleozoic basement is also simulated. More than 4000 heads observations from about 350 wells and piezometers are used as targets in the calibration process; weights are assigned to deal with the high heterogeneity of the dataset quality. RIV and GHB conductance, irrigation well yields, direct and lateral recharge, and hydraulic conductivity are set as parameters in the calibration process. Due to the high sensitivity of some parameters, different calibration cycles are performed; hydraulic conductivities and lateral recharge are then calibrated in the last cycle.

Model results show that the hydrogeological conceptualization used for implementing the numerical model can reproduce the main general features of the piezometric head field. According to field observations, the Flumendosa river shows losing conditions in the western part of the plain and next to the river mouth, while gaining conditions occur in its central part; gaining conditions are also observed along the abandoned branches of the Flumendosa river, also known as *foxi*. Moreover, mass balance analysis show that the Flumendosa river represents the main recharge input of the whole groundwater system, providing an average inflow of about 4.3 Mm^3/year. Nevertheless, several local incongruencies with the observed data were precious to highlight the effects of unknown variables such as agricultural extraction wells, the hydrogeological role of the bedrock or the water exchange between surface and groundwater bodies. The discrepancies, rather than the agreements, provided useful direction for the detection of new data to be collected to capture the salient information needed for a proper water resource management.