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Hydrologic behaviour of the Lake of Monate (Italy): a parsimonious modelling strategy

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The Lake of Monate (province of Varese, Northern Italy), is a unique example of ecosystem in equilibrium. The lake water quality is deemed excellent notwithstanding the intensive agricultural cultivation, industrial assets and mining activities characterising the surrounding areas. The lake has a true touristic vocation and is the only swimmable water body of the province of Varese, which counts several natural lakes. Lake of Monate has no tributary and its overall watershed area is equal to c.a. 6.6 km2 including the lake surface (i.e. 2.6 km^2), of which 3.3 out of c.a. 4.0 km^2 belong to the topographical watershed, while the remaining 0.7 km^2 belong to the underground watershed. The latter is larger than the topographical watershed due to the presence of moraine formations on top of the limestone bedrock. The local administration recently promoted an intensive environmental monitoring campaign that aims to reach a better understanding of the hydrology of the lake and the subsurface water fluxes. The monitoring campaign started in October 2013 and, as a result, several meteoclimatic and hydrologic data have been collected up to now at daily and hourly timescales. Our study focuses on a preliminary representation of the hydrological behaviour of the lake through a modified version of HyMOD, a conceptual 5-parameter lumped rainfall-runoff model based on the probability-distributed soil storage capacity. The modified model is a semi-distributed application of HyMOD that uses the same five parameters of the original version and simulates the rainfall-runoff transformation for the whole lake watershed at daily time scale in terms of: direct precipitation on, and evaporation from, the lake surface; overall lake inflow, by separating the runoff component (topographic watershed) from the groundwater component (overall watershed); lake water-level oscillation; streamflow at the lake outlet. We used the first year of hydrometeorological observations as calibration data and the second year as validation data and we compared two calibration strategies which maximize two different objective functions: (1) Nash-Sutcliffe efficiency of simulated daily water-level fluctuations, NSE, and (2) linear correlation coefficient between daily series of simulated groundwater inflow and observed water table elevation multiplied by NSE. The validation exercise seems to point out the value of incorporating groundwater measurements for improving the reliability and robustness of the conceptual model.