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Assessing different levels of model complexity for the Liri-Garigliano catchment simulation

Maura Rianna (1), Evangelos Rozos (2), Andreas Efstratiadis (2), and Francesco Napolitano (1)

(1) Department of Civil, Construction, and Environmental Engineering, "Sapienza" University of Rome, Italy, (2) Department of Water Resources and Environmental Engineering, National Technical University of Athens, Greece

Liri is one of the principal rivers of central Italy, flowing into the Tyrrhenian Sea, under the name Garigliano. The Liri-Garigliano basin is about 4900 square kilometres and the length of the main course is 160 kilometres. The hydrological system exhibits significant heterogeneity. The mountains located in the NE area and the Apennines are dominated by carbonate platform deposits that are intensively karstified. This part of the basin is characterised by high effective infiltration, poor development of the hydrographic network and low overland flow; most of runoff derives from karst springs of relatively stable flow regime. On the other hand, there are areas lying on geological formations of low permeability, the hydrological regime of which is characterized by significant overland flow from autumn to winter. For the simulation of daily flows along the river network, we use HYDROGEIOS modelling framework. The whole basin is discretized into a number of sub-basins, so that all flow gauges are represented as outlet nodes, which allows evaluating the model performance on the basis of the corresponding multi-response data. For the representation of the hydrological processes, four parameterization approaches are tested. The simpler configuration only utilizes the rainfall-runoff component of HYDROGEIOS and follows a semi-lumped parameterization, thus assigning the same parameter values to all sub-basins. The next approach follows a distributed parameterization to account for the surface system heterogeneity, on the basis of the hydrological response unit (HRU) concept, thus taking advantage of the spatial information about the geomorphologic characteristics of the basin. In particular, four HRUs are defined, by combining two classes of soil permeability and two classes of land cover. In the third approach, a conceptual groundwater cell is introduced under each sub-basin, which receives the aggregated percolation from the overlaying soil partitions (i.e. combination of sub-basins and HRUs). This is a standard technique used by typical hydrological packages (e.g. RIBASIM), to represent the baseflow as a lumped process at the sub-catchment scale. In this hydrologic approach (the term hydrologic is used in contrast to the term hydraulic, where models of dense discretization are used, e.g. MODFLOW within MIKE SHE) the groundwater cells are isolated, thus prohibiting any exchange of flow among them. This restriction is lifted in the last approach, which enables to selectively allow hydraulic connectivity among the groundwater cells; in addition, it introduces few peripheral cells to simulate underground leakages to adjacent aquifers and the sea. Therefore, a coarse network of interconnected tanks is formulated to simulate the actual groundwater cycle and the karst system responses. This last approach provides satisfactory compromise between model complexity, data availability and computational effort, and also reveals the flexibility of HYDROGEIOS against different spatial scale requirements.