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Predictive models applied to groundwater level forecasting: a preliminary experience on the alluvial aquifer of the Magra River (Italy).

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Computer-based decision support systems are getting a growing interest for water managing authorities and water distribution companies. This work discusses a preliminary experience in the application of computational intelligence in a hydrological modeling framework, regarding the study area of the alluvial aquifer of the Magra River (Italy).

Two sites in the studied area, corresponding to two distinct groups of wells (Battifollo and Fornola) are managed by the local drinkable water distribution company (ACAM Acque), which serves the area of La Spezia, on the Ligurian coast. Battifollo has 9 wells with a total extraction rate of about 240 liters per second, while Fornola has 44 wells with an extraction rate of about 900 liters per second.

Objective of this work is to make use of time series coming from long-term monitoring activities in order to assess the trend of the groundwater level with respect to a set of environmental and exploitation parameters; this is accomplished by the experimentation of a suitable model, eligible to be used as a predictor. This activity moves on from the modeling of the system behavior, based on a set of Input/Output data, in order to characterize it without necessarily a prior knowledge of any deterministic mechanism (system identification).

In this context, data series collected by continuous hydrological monitoring instrumentation installed in the studied sites, together with meteorological and water extraction data, have been analyzed in order to assess the applicability and performance of a predictive model of the groundwater level.

A mixed approach (both data driven and process-based) has been experimented on the whole dataset relating to the last ten years of continuous monitoring activity. The system identification approach presented here is based on the integration of an adaptive technique based on Artificial Neural Networks (ANNs) and a blind deterministic identification approach.

According to this concept, the behavior of the natural system can be partly explained in terms of its impulse response, identified as an arbitrary function, optimally fitted to the behavior observed in the past time series. In the proposed method, the approximation of the natural behavior of the system derives from the decomposition of the excitation signals (input parameters) into sequences of discrete values. Data fed to the ANN are thus pre-processed according to this concept.

In the particular case study presented in this work, the proximity of the Magra River mixes the short-term effects of the hydraulic level of the river with the slower rainfall effects that diffusely feed the groundwater system, making the analysis even more challenging.

In addition to piezometric levels, also continuous conductivity data series are available for the same period, and have been taken into account separately in this preliminary experience. The availability of the electrical conductivity parameter opens the way to the modeling of the different contributions to the groundwater reservoir, and may also enable the prediction of some water quality features, as discussed in this work.

The preliminary analysis of meteorological and hydrologic data sets is discussed in this work, and goes through the following steps: a) description of the dataset, b) description of the model developed, c) model tuning, d) discussion of results and applicability as a predictor.