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Stochastic modelling of aquifer level temporal fluctuations using the Kalman filter adaptation algorithm and an autoregressive exogenous variable model

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Reliable temporal modelling of groundwater level is significant for efficient water resources management in hydrological basins and for the prevention of possible desertification effects. In this work we propose a stochastic data driven approach of temporal monitoring and prediction that can incorporate auxiliary information. More specifically, we model the temporal (mean annual and biannual) variation of groundwater level by means of a discrete time autoregressive exogenous variable model (ARX model). The ARX model parameters and its predictions are estimated by means of the Kalman filter adaptation algorithm (KFAA). KFAA is suitable for sparsely monitored basins that do not allow for an independent estimation of the ARX model parameters. Three new modified versions of the original form of the ARX model are proposed and investigated: the first considers a larger time scale, the second a larger time delay in terms of the groundwater level input and the third considers the groundwater level difference between the last two hydrological years, which is incorporated in the model as a third input variable. We apply KFAA to time series of groundwater level values from Mires basin in the island of Crete. In addition to precipitation measurements, we use pumping data as exogenous variables. We calibrate the ARX model based on the groundwater level for the years 1981 to 2006 and use it to successfully predict the mean annual and biannual groundwater level for recent years (2007-2010).