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Integrated OpenMI modelling and management of Lake Karla aquifer under climate change

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Lake Karla basin is located in central Greece. The drainage of the original natural lake Karla back in 1960's has led to overuse of groundwater and serious declination of the water table among other serious environmental problems. In 1980's a political decision has been taken to restore Lake Karla by constructing a smaller reservoir and other complementary water works. The reservoir and the complementary water works are now under construction. This study evaluates various water resources management scenarios of Lake Karla acquifer through integrated surface-groundwater modelling. Firstly, the future timeseries of monthly precipitation and mean monthly temperature have been produced through downscaling techniques using the results of the Canadian Centre for Climate Model Analysis General Circulation Model (CGCMa2). A methodology has been developed to downscale the outputs of GCM and produce future precipitation timeseries. The methodology combines a multiple regression (MLR) model and a timeseries model for the precipitation residuals between the observed and the downscaled precipitation through the MLR model. The mean monthly precipitation was downscaled by a simple MLR model. The downscaling methods have been developed and validated for the historical base period 1960-2002, and, then, used for the generation of the timeseries for the period 2002-2044 for the SRESA2 and SRESB2 socioeconomic scenarios. Various management scenarios of Lake Karla basin aquifer have been simulated using an integrated modelling surface-groundwater system. This modelling system has been developed through the Open Modelling Interface (OpenMI) and includes a surface hydrology model (UTHBAL) which calculates, among others, the groundwater recharge, a reservoir water balance model, a reservoir operation model (LAK3) and a model for the groundwater simulation (Visual Modflow). The generated meteorological timeseries have been used as input data to the modelling system along with the estimates of water demands for irrigation and urban water supply. The component models of the system have been calibrated against observed data. The simulated management scenarios of the aquifer have been analysed and evaluated indicating that the restoration of the over-exploited aquifer is achieved only with the minimization of groundwater pumping, whereas the groundwater recharge by the reservoir is minimal.