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Impacts of Climate Change and Land Use on River Catchment Hydrology Using Model Downscaling

IMPACTS OF CLIMATE CHANGE AND LAND USE ON RIVER CATCHMENT HYDROLOGY USING MODEL DOWNSCALING

Jacques Ganoulis[1] and Charalampos Skoulikaris[2]

Competing water demand for different uses, such as water supply, agricultural irrigation and hydropower production is expected to be heavily affected by climate change and anthropogenic modification of land use. The present work is based on coupling a physically based distributed hydrological model with climate change models in order to investigate impacts of climate change and land use on the hydrological regime at the catchment scale. It is illustrated by the Mesta/Nestos river basin case study. This river basin is shared between Bulgaria (Mesta) and Greece (Nestos). The river ends in the Aegean Sea by expanding into the Nestos delta, which has a vast expanse of irrigated fields.

In this paper, results on river flow hydrology under different climate scenario, obtained through a UNESCO supported research project called HELP, are shown. Climate change studies over the Mesta-Nestos catchment are based on the output of CLM (Climate Local Model) developed at the Max Planck Institute for Meteorology, Germany KOTLARSKI *et al.* (2005). CLM uses a dynamically downscaling technique, where boundary conditions provided by global scale models are adapted to local conditions, such as the river watershed relief. The temperature, precipitation and evapotranspiration distributions obtained from this climate model were introduced as input data to the spatially distributed hydrological model MODSUR-NEIGE (*MODélisation des transferts de SURface en présence de NEIGE*, in French). MODSUR-NEIGE was developed at the Ecole Nationale Supéreure des Mines de Paris for simulating rainfall-runoff relationships at the river catchment scale. In the MODSUR-NEIGE model, the water budget is computed for each grid box using a 4- connectivity algorithm in order to define the direction of flow over a two-dimensional grid. Knowing the daily precipitation and potential evapotranspiration (PET), the production functions are used to compute the actual evaporation, infiltration and runoff, with a time step of one day. Then, infiltration is transferred to the water table, whose daily spatial evolution is simulated using the diffusivity equation LEDOUX et al. (1989).

Once adjusted, the CLM output series of rain, surface temperature and PET were fed into the MODSUR-NEIGE program. The flow values could then be extracted for any point on the river. Fig. 1 presents a comparison between the flow computed upstream of the Thissavros dam on the Nestos River for the IPCC A1B climate scenario and a reference flow series prolonging in time the climate conditions of the past 25 years. It is worth noting that this reference series contains similar dry spells to the ones experienced in the area in the early 90s. This climate stability hypothesis is sometimes referred to as “business as usual” or “baseline scenario” in the EU WFD nomenclature. Compared to climate conditions in the recent past, the A1B and B1 scenarios clearly predict a flow decrease (Fig. 1).

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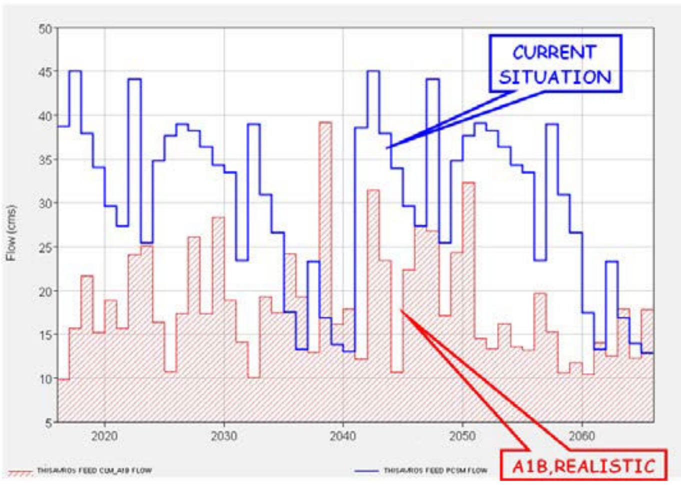

Figure 1 Flow rate time series at Thissavros site: no climate change (blue line) and under the A1B climate change scenario (realistic, shaded in red).

The effect of different climate change scenario and possible changes in land use in the mountainous area of the basin on the water flow in the delta region was analysed. Sustainability of alternative projects ensuring hydropower and irrigation needs under future climatic conditions were also investigated.

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