Hydrological and rating curve modelling of Pinios River water flows in Central Greece, for environmental and agricultural water resources management

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ABSTRACT

The aim of the present study is a hydrological approach on streamflow modelling, in order to investigate flow velocity, discharge rate, stage, river bed variations and the hydraulic properties (water depth, flow area, wetted perimeter, hydraulic radius and depth, Manning’s coefficient of roughness, Froude Number, etc.) of the Pinios River at P145 Giannouli-Larissa monitoring station (Central Greece). Also, the study aims to the compilation–validation of a rating curve (RC) from a series of stage $h(t)$–discharge $Q(t)$ pairs measurements, in order to use them as tools to assist environmental and agricultural water resources management, support environmental flows estimation, monitoring and irrigation planning in local basin scale. The results and statistical analysis, showed that Froude number during the measurement period oscillated from a minimum 0.109 to maximum 0.283 (mean $Fr = 0.172$). Therefore, in all cases, $Fr < 1$ which means that streamflow of the River Pinios, at P145 station is classified as subcritical. The segment's maximum water velocity measured from a minimum 0.452 to maximum 1.693 m s$^{-1}$ (mean 1.247). The mean monthly river discharges of years 1978, 1979 and 2014 were found to be 35.91, 57.52 and 50.37 m$^3$ s$^{-1}$, respectively. The summer months (June–August) of recent and also of historic years presented low to zero discharges, which are below the environmental flow lower (critical) limit. Moreover, based on the parameters’ measurements from 2013 (July) up to 2014 (December), on the modelling analysis, on classification results and on the proposed model performance index (MPI) for each of the eight models tested, the power model was selected as the best to use for the compilation and best fit of the flow RC for this monitoring station. The results of model’s validation using two different statistical methods, model simulation, error statistics criteria and the proposed MPI index, were converge to the same output that the data fitting the selected power model for the curve RC$^{(2013–2014)}$ was very satisfactory.

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and the stability of the developed relationship was robust. The resulted streamflow RC and the extrapolated parts, the rainfall vs. discharge and environmental flows analysis, the river bed variation analysis and the performed hydraulic properties estimates are proposed to serve as hydrological assisting tools for environmental water resources and irrigation management at the study area. These assisting tools will help water authorities accurately and quickly estimate river’s water quantities and variation with a minimum cost and effort, and they could be used for irrigation management, environmental flow estimation, groundwater recharge, flood protection and other purposes.

Keywords: Rating curve modelling; Streamflow measurements; Water resources engineering; Water velocity and discharge; Froude number; Hydraulic properties; Model validation; Simulation and error estimation