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Climate change implications on maximum monthly stream flow in Cyprus using fuzzy regression models

A. Loukas and M. Spiliotopoulos
University of Thessaly, Dept. of Civil Engineering, Volos, Greece (aloukas@uth.gr, +30 24210 74169)

Maximum stream flow data collected from Cyprus Water Development Department and outputs of global circulation models (General Circulation Models, GCM) are used in this study, to develop statistical downscaling techniques in order to investigate the impact of climate change on stream flow at Yermasoyia watershed, Cyprus. The Yermasoyia watershed is located in the southern side of mountain Troodos, northeast of Limassol city and it drains into Yermasoyia reservoir. The watershed area is about 157 km2 and its altitude ranges from 70 m up to 1400 m, above mean sea level. The watershed is constituted mainly by igneous rocks, degraded basalt and handholds. The mean annual precipitation is 638 mm while the mean annual flow is estimated in 22,5 millions m3. The reservoir water surface is 110 hectares and has maximum capacity of 13,6 million m3. Earlier studies have shown that the development of downscaling methodologies using multiple linear fuzzy regression models can give quite satisfactory results. In this study, the outputs of SRES A2 and SRES B2 scenarios of the second version of the Canadian Coupled Global Climate Model (CGCM2) are utilized. This model is based on the earlier CGCM1 (Flato et al. (2000), but with some improvements to address shortcomings identified in the first version. Fuzzy regression is used for the downscaling of maximum monthly stream flow. The methodology is validated by independent historical data and used for the estimation of future maximum stream flow time series. From the 30 years of observed data representing the current climate, the first 25 years (1968-1993) are considered for calibrating the downscaling model while the remaining 5 years (1994-1998) are used in order to validate the model. The model was first developed using the logarithm of observed maximum monthly streamflow as the depended variable and 36 output parameters of GCM as the candidate independent variables. Then, five (5) independent GCM parameters were selected, namely, mean daily maximum screen temperature, precipitation, 850 hPa geopotential height, 500 hPa specific humidity and screen specific humidity, using stepwise linear regression. Finally, fuzzy rules were applied to the multiple linear regression coefficients, indicating the uncertainty of the model. The results indicate that the developed model can predict maximum monthly stream flow quite satisfactory. The developed model was, then, applied to estimate the effect of climate change on maximum monthly stream flow for a medium term future period (2030-2060) and a long time future period (2070-2100). These results indicate the significant effect of climate change on the frequency and temporal distribution of maximum stream flow.