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A hierarchical Bayesian model for decomposing the impacts of human activities and climate change on water resources in China

Xu Zhang (1), Qianjin Dong (1), Veber Costa (2), and Xianxun Wang (1)

(1) State Key Laboratory of Water Resources and Hydropower Engineering, Wuhan University, Wuhan, China (whuzhangxu@whu.edu.cn), (2) Department of Hydraulic and Water Resources Engineering, Federal University of Minas Gerais, Brazil

Human activities and climate change are two key factors influencing the variation of the total amount of available surface and groundwater, hereafter termed water resources. Quantitatively separating their impacts remains a challenge. To this end, we used time-varying Budyko-type equations and a hierarchical Bayesian model in this paper to separate their impacts in 31 provincial-level divisions of China. The time-varying Budyko-type equations treat the Budyko equation parameter w as a variable, which depends on human activities (represented by per capita gross regional production) and climate change (represented by temperature and precipitation). The hierarchical model quantifies the uncertainty of parameters and the interrelation between covariates across regions in China. The results show that the time-varying Budyko-type equation can improve the fitting capability for water resources in China. The hierarchical Bayesian model, which considered spatial dependence, reduced the uncertainty of the parameters compared to spatially independent counterparts. For most regions of China, human activities reduce water resources while climate change increases them. Southeastern China is the most influenced area, and its water resources decreased approximately 50 mm because of human activities. This study can provide a basis for water resource management under climate change and human activity constraints in China.