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Regional variation in climate elasticity and climate contribution to runoff across China: estimation according to the Budyko hypothesis

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Climate elasticity of runoff is an important indicator for evaluating the effects of climate change on runoff. It can be analytically derived based on the Mezentve-Choudhury-Yang equation, with a parameter n representing the impact of the catchment characteristics. In China, both climate and catchment characteristics have large spatial variations. To understand the spatial variation of hydrologic response to climate change, we divided China into 210 catchments, further calculated the parameter n, and then estimated the climate elasticity and evaluated the contribution of climate change to runoff for each catchment. The results show that n ranges from 0.4–3.8 (with a mean of 1.3 and a standard deviation of 0.6), which has a logarithmic relationship with catchment slope; the precipitation elasticity ranges from 1.1–4.8 (with a mean of 1.9 and a standard deviation of 0.6), which shows a large regional variation, smaller values (1.1–2.0) mainly appearing in Southern China, the Songhua River basin and the Northwest, and larger values (2.1–4.8) mainly appearing in the Hai River basin, the Liao River basin and the Yellow River basin. In addition, climate contribution to runoff exhibits a large regional variation, the largest positive values (1.1–3.1%/a) occurring in the Northwest, the largest negative values ($^{-1}$.0–−0.5%/a) occurring in the Hai River basin and the middle reach of the Yellow River basin. In theory, the climate elasticity method is a first-order approximation. The approximation underestimates the precipitation (P) contribution to runoff when P increases and overestimates that when P decreases, and the relative error has a median of ∼3% and a maximum of ∼20% when 10% precipitations change in those catchments of China.