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Attribution analysis based on the Budyko hypothesis for streamflow change in the Baiyangdian catchment, China

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The effects of climate change and catchment changes on the long-term water balance are of considerable interest at a range of spatial scales. The Budyko framework has been widely used to attribute changes in streamflow to the effects of climate and catchment changes. In this study, we used the elasticity method based on the Budyko framework to examine the sensitivity of streamflow to climate and catchment variables, which indicated that a 1-mm decrease in precipitation would induce a 0.3546-mm decrease in streamflow, a 1-mm decrease in potential evapotranspiration would induce a 0.1045-mm increase in streamflow, and an increase of 1 in the catchment characteristic coefficient would induce a 79.6711-mm decrease in streamflow. The absolute sensitivities of streamflow to climate variables decreased with increases in the aridity index, which indicates that the streamflow was more sensitive to climate change in wet regions. Among the total changes in streamflow (-43.41 mm), the effect of climate change was +3.86 mm (accounting for 7.55%), and the effect of the catchment characteristic changes is -45.99 mm (accounting for 89.95%) based on the sensitivity analyses. The results indicate that streamflow changes in the Baiyangdian catchment are mainly caused by catchment changes. Theoretically, $\partial Q/\partial P$ and $|\partial Q/\partial E_0|$ (the absolute value of $\partial Q/\partial E_0$) both decrease with decreases in the aridity index (φ=E_0/P) for all values of ω (1, ∞), which indicates that streamflow is more sensitive to precipitation or potential evapotranspiration change in a region with lower values of φ. Thus, our theoretical analyses indicate that hydrological responses to climate change are more sensitive in wet regions.