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Attribution analysis based on the water balance model for detecting the causes of runoff variation in Lancang River Basin

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With the impact of climate change and frequent human activities, especially the hydropower development, the mechanism of runoff yield and flow concentration has changed due to the variability in hydrological cycle and underlying surface of the basin. Observations show that annual runoff had variations during the past several years in Lancang River Basin of southwestern China. Among five sub-basins of the Lancang River Basin, which are determined by five different hydrological stations, namely Changdu, Liutongjiang, Jiajiu, Gongguoqiao and Yunjinghong, the runoff process of Changdu and Yunjinghong have abrupt change points in 1969 and 2004, respectively. In order to analyze major causes for these variations, the hydrological series of these two sub-basins are segmented into sub-series corresponding to different time periods: before and after the abrupt change point. Under this circumstance, the two-parameter water balance model is used to determine the relationship between runoff and precipitation, evaporation and other factors in the two different periods. With the precipitation and evaporation series as input condition, the water balance model parameters which represent the formation conditions of runoff at the same period, are first regulated using the optimization method of human-machine cooperation. Then, according to the simulation of the runoff series in different time periods based on the determined model, factors contributed to runoff changes, including climate change (i.e. precipitation and evaporation) and human activities can be further separated and quantified. Result shows that the contribution rate of human activities changes from 10.94% in Changdu to 64.57% in Yunjinghong, while the contribution rate of climate change varies from 89.06% in Changdu to 35.43% in Yunjinghong. It is consistent with the fact that great dams are mainly constructed in the lower reach of the Langcang River.