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Searching for the hydroclimatic effects of a single impounded reservoir in a tropical hydrological basin

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The water cycle is not only a generator of ecosystem services and a critical driver of Earth system change. It is also a system subject to intense human interferences. Hydropower development is well known to modify the amount and variability of discharge in river streams around the world. Furthermore, there is growing evidence of impacts of reservoir impoundment and flow regulation on other hydroclimatic variables such as potential and actual evapotranspiration, convective energy and soil moisture. In this study, we performed a trend analysis of several hydrological variables based on the Budyko framework in a 1,630 -km^2 hydrological basin in Central Colombia and two of its upstream subbasins. Our aim was to detect any possible hydroclimatic effect of the impoundment of the Prado Reservoir within the Prado River hydrological basin. The hydroelectric project comprises a single reservoir with an installed capacity of 1,1 x 106 m^3 and a hydroelectric station that came into operation in 1973. We gathered monthly observed data for precipitation, temperature, radiation and runoff and used it to calculate initially potential and actual evapotranspiration, the aridity index and the evaporative ratio during the period of 1952-2014. We calculated change before and after the construction of the dam for all these variables, and a running coefficient of variation (CV) for both precipitation and runoff, and used statistical tests such as Pettitt and Wilcoxon significance tests to identify changes in the trend series. We found that after the commissioning of the project, precipitation and runoff simultaneously decreased in all basins. The changes in variation and magnitude of the CV of runoff in the downstream station reflected the effects of regulation, effect not observed in the subbasins upstream of the project. On the contrary, no effect of the reservoir was found on basin-scale evapotranspiration, as it has been found in other heavily regulated basins worldwide: after performing a separation technique on evapotranspiration change, we found that the residual change in evapotranspiration not related to climate variability, and attributed to other factors, was negligible. This may be explained by the fact that the construction of only one reservoir within the hydrological basin may not be sufficient to evidence an effect on net evapotranspiration from flow regulation from the entire basin.