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Large scale evaluation of the reservoirs regulation impact on environmental flow

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Environmental flow is an essential variable to sustain riverine biodiversity and ecosystem. While due to the intervention of human activities especially the reservoirs regulation, the environmental flow has been altered to different degrees in space and time. In this study, a few criteria relevant to environmental flow are analyzed and compared between two scenarios with and without reservoirs regulation. The scenario-based simulations are conducted by a fully distributed land surface model-ORCHIDEE, within which a new human regulation module was developed to describe the human interventions on the water cycle including the water usage and reservoir regulation.

The new human regulation module is developed on the current routing module in ORCHIDEE. It adds the calculation of the human water consumption (including irrigation, industrial and domestic water, hydroelectricity water demands). The optimal path with the least cost from the water consumption location to the water abstraction points is estimated according to the topographic information. A set of simplified reservoir regulation rules are applied to the dams located on the river system. The new routing module considers the water consumption and regulation at a high spatial resolution (less than 10km), which increases the currency of the water management.

Results show that the reservoir regulation does help to increase the water usage especially the irrigation, thus decreases the water volume in the river system. Moreover, the regulation exerts more significant impacts on the inter-annual cycle through the impoundment-release regulation. Environmental flow criteria change as a response while in different magnitudes and tempo-spatial patterns due to their various definitions. Generally, the criteria based on percentile are more sensitive than those based on percentage and the criteria alter more significantly for dry conditions (seasons or regions). All the alteration magnitude of criteria decreases from the reservoirs site to downstream. Therefore, previous studies based on site evaluation underestimated the dam regulation as the major sites were always far downstream the major reservoirs. Whereas, simulation based on the ORCHIDEE and a developed regulation module can draw full pictures in a large scale of the reservoir regulation impacts on environmental flow as well as other hydrological variables if interested.