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Effects of tributary inflow and sediment input on reservoir turbidity current formation and evolution

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For reservoirs built on a hyper-concentrated river, tributary inflow and sediment input may affect the formation and evolution of reservoir turbidity current, and accordingly bed morphology. However, the understanding of tributary effects on reservoir turbidity currents has remained poor. Here a series of laboratory-scale reservoir turbidity currents are investigated using a coupled 2D double layer-averaged shallow water hydro-sediment-morphodynamic model. It is shown that the tributary location may lead to distinctive effects on reservoir turbidity current. Clear-water flow from the tributary may cause the stable plunge point to migrate upstream, and reduce its front speed. Sediment-laden inflow from the tributary may increase the discharge, sediment concentration, and front speed of the turbidity current, and also cause the plunge point to migrate downstream when the tributary is located upstream of the plunge point. In contrast, if the tributary is located downstream of the plunge point, sediment-laden flow from the tributary causes the stable plunge point to migrate upstream, and while the tributary effects on discharge, sediment concentration, and front speed of the turbidity current are minor. A case study is presented as of the Guxian Reservoir (under planning) on the middle Yellow River, China. The present finding highlights the significance of tributary inflow and sediment input in the formation and propagation of reservoir turbidity current and also riverbed deformation. Appropriate account of tributary effects is warranted for long-term maintenance of reservoir capacity and maximum utilization of the reservoir.