



## Integrating reservoirs in a landscape-based hydrological model to understand the impact of the reservoir on flow regime in the Cauvery river basin, India

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As economic development continues to expand, rivers resources are exploited for power generation, flood control, and irrigation, which substantially impacts the river hydrology and surrounding ecosystem. Reservoir construction is one of the major contributors to such changes. Around the world, the long free-flowing rivers are impaired due to reservoirs and their downstream propagation of fragmentation and flow regulation, which impacts the structural and functional connectivities of the entire basin. The extent of interdependence and interactions of biophysical, social, and economic characteristics determine hydrological behaviour and thus define the sustainability of the river ecosystem. In this regard, the topography driven rainfall-runoff modeling (Flex-Topo model) approximates the river landscape hydrological behaviour by delineating the catchment into three functional hydrological units (HRUs). However, these HRUs are natural and do not take anthropogenic factors into account. Therefore, the present study aims to understand the effects of the integration of reservoirs into a Flex-Topo model to assess model transferability in predicting the river flow regime in ungauged basins.

The Cauvery river basin in India is chosen as a case study. The construction of reservoirs in the Cauvery basin helped to expand irrigated areas, securing water availability during water stress conditions. Nevertheless, it aggravates the water allocation between upstream and downstream states leading to conflict among states sharing the river basin. Based on size and storage capacity, four large reservoirs are selected for the study. At first, the watershed area is delineated based on the gauge location. For adding reservoirs, two different flex-models are created for the watershed's areas upstream and downstream of the reservoirs. A separate reservoir model is created for each reservoir. The reservoir model is integrated into the flex-model following operation rule curves to simulate the reservoir based on different reservoir yield. It is assumed that the response of the upstream catchment will serve as an input to the reservoir, and the outflow of the reservoir will be an input to the downstream catchment. These three subunits are connected, and river flow is simulated at the gauge station located at the downstream of the reservoir. Three different procedures are adopted to calibrate the model. First, the integrated flex reservoir model is calibrated using the downstream gauging station. In the second calibration method the reservoir is calibrated first, then keeping the parameters of the reservoir fixed the integrated model is calibrated using downstream gauging station. Third, both the reservoir model

and flex model are calibrated separately. The modelled runoff from each parameter sets are compared using Nash-Sutcliffe Model Efficiency and Mean Absolute Error with the observed.

Results indicate that the second calibration method performed the best and improved the overall performance of the Flex-Topo model. Further, results are compared across the four reservoirs in order to develop a generalized understanding of transferring a integrated flex model to basins where data on reservoirs is unavailable. The proposed method therefore provides a way to simulate both biophysical constraint and anthropogenic modifications simultaneously in river landscape and enhance understanding of impact of reservoirs on river flow regime.