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Hydrologic impacts of reservoir operation on flood inundation pattern in a highly flood-prone deltaic region of Mahanadi River Basin, India

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The construction of dams and reservoirs on large rivers pose a myriad of serious long and short-term human implications over downstream river flows and the adjoining floodplains. Whilst such structures aid in reducing socio-economic losses caused by floodwaters, the natural river ecology (aquatic and riparian) is greatly hampered, especially the biodiversity- enriched deltaic region of the river basins. Thus, there is a need to assess the environmental impacts of dams/ reservoirs on the downstream river and floodplains during high flow conditions. Here, a case study of a highly flood-prone deltaic region in Mahanadi River Basin, India has been explored to quantify changes in monthly and seasonal streamflow simulated using Soil and Water Assessment Tool (SWAT). In our analysis, we have performed hydrological simulations at stream gauge stations located in the downstream of Hirakud dam under 2 scenarios: (1) not considering Hirakud reservoir operations; (2) considering reservoir operations in the model. The results show that a significant bias persists in the simulated streamflow in case of no reservoir scenario, leading to the poor simulation of low flows. We find that the operation of Hirakud Dam is responsible for the broad changes in watershed's hydrology (in terms of runoff and streamflow) at the lower reaches of Mahanadi River. The study also shows an improvement in the simulation of extreme flows during flood season after inclusion of dam/ reservoir operation. Further, the near-future changes in streamflow under different climate change scenarios, i.e. RCP 4.5 and RCP 8.5 to the baseline period (1981-2005) are demonstrated using statistically downscaled GCM simulations. The outcomes of this study demonstrate how a reservoir operation can influence the river flows at the lower reaches and can be used to quantify impacts on the environment over space and time for devising and evaluating alternative basin management strategies in future.