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## Quantifying the hydrological responses of future climate changes on a large scale river basin in India

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The serious hydrological consequences of climate change faced by developing countries like India show regional variability. Understanding these regional hydrologic impacts has a crucial role in the management of water resources. Mahanadi river basin (MRB) is a major large-scale river basin in India that is predicted to face severe floods under future climate change scenarios. Commonly, climate change impacts are simulated for a specific decade, specific scenario, or specific climate model in the future. We, however, employed an arguably more objective, approach that would identify the impacts of all possible combinations of specific change within the possible mean annual temperature and precipitation 2-dimensional scenario space (derived from thirteen CMIP6 models) on the hydrological responses. CMIP6 is the recent generation of climate models, released to overcome the drawbacks of the previous generation CMIP5 models such as under/overestimating the monsoon characteristics over the Indian subcontinent. Our methodological approach also involves using an ensemble of VIC models, representing the overall model uncertainty due to parameter value choices, in conjunction with these climate projections, instead of using a single calibrated model to predict the hydrological responses. The climate projections show an overall change in mean annual precipitation and mean annual average temperature that ranges from -5 to +105% and 0-7°C respectively. This has resulted in significant changes in both mean annual flows and peak flows of up to 2849 and 29,776 m<sup>3</sup>s<sup>-1</sup> respectively. Uncertainties associated with the model parameters, of up to 1211 m<sup>3</sup>s<sup>-1</sup> are observed in the predicted peak flow magnitudes, which is considerably higher than in predicted annual flow magnitudes. Our findings indicate that precipitation mainly controls the future predicted flows in the basin. This study has provided a set of results on the likely future behavior of the MRB mean annual and peak flows under the CMIP6 climate projections. Future projections of hydrologic variables, along with the associated model parameter uncertainties can help with better hydrologic impact assessment and developing adaptation strategies for MRB in India.

Keywords: Climate change, CMIP6, VIC, Mahanadi river basin, flows