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Nationwide flood risk assessment using large ensemble climate change dataset and the Rainfall-Runoff-Inundation model

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Floods pose significant threats, particularly in the context of climate change. This research focuses on a comprehensive analysis of river flooding nationwide in Japan. We utilize the latest dynamic downscaling data, d4PDF-5km, for the entire country, feeding this information into the Rainfall-Runoff-Inundation (RRI) model with a spatial resolution of 150 meters. The objective is to efficiently estimate the probability discharge of all rivers by developing a new method for extracting rainfall events from long-term ensemble data.

The proposed method involves extracting heavy rainfall events from 720 years (12 ensembles of 60-year records) of downscaled data for each present, 2K and 4K scenarios and inputting them into the RRI model. This approach allows for the estimation of quantiles by analyzing peak flow as non-annual data with the peak-over-threshold method. When applied to the Shikoku region, the results demonstrate the effectiveness of the method, with the ability to estimate probability flows exhibiting a bias of 10% or less compared to a comprehensive calculation of all rainfall events.

Furthermore, the research identifies variations in the increase of peak flow under climate change, particularly emphasizing differences between the main river and its tributaries. Notably, smaller rivers in the upper reaches are more significantly influenced by changes in rainfall patterns than the lower reaches of the main river.

The implications of this research extend beyond hydrologic science. The estimated probability flows and corresponding hydrographs serve as crucial boundary conditions for assessing local flood risk. This information is fundamental for informed river management by governments and local authorities. Additionally, private companies, residents, and other stakeholders can utilize this data for robust risk assessments. In conclusion, our research provides valuable insights and a practical methodology for understanding and mitigating flood risks in Japan, taking into account the complexities introduced by climate change.