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® Integrating WRF and Hydrology Models for Improved Urban Flood Forecasting in Pune using HPC: A Comprehensive Approach for the Indian Metropolis

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Pune is the second largest city in the Indian state of Maharashtra, situated over a complex topographical region on the leeward side of the Western Ghats, India. Recently, Pune City has been experiencing frequent heavy to extreme rainfall events, causing urban floods, threatening lives, and heavy socio-economic damage. The recent decade has witnessed the adverse effects of urban floods on daily life by destroying infrastructure, water-logging that triggers floods, disrupting transportation, and resulting in the loss of lives and property. An efficient early warning system is a crucial requirement that remains challenging using a high-resolution numerical weather prediction (NWP) model. The complexity increases manifold, particularly if the forecast has to be made on an urban scale to mitigate its adverse impacts.

An attempt is made to develop a coupled modelling system that integrates the Weather Research and Forecasting (WRF) model with Hydrological to enhance urban flood forecasting capabilities for an Indian city. Extensive work has been done to set up the WRF model through sensitivity analysis of domain setup, parameterisation schemes, land-use information, and initial conditions for rainfall event forecasting over Pune. Model performance has been validated against various observations available through ground-based and satellite measurements. The rainfall forecast obtained from the WRF model at a very high resolution of 0.5 km has been provided to the hydrology model to simulate surface runoff, stormwater discharge, and depth in urban regions. The developed coupled system was calibrated against past rainfall flood events over Pune. This calibration ensured that the model represented the actual behaviour of the system and the rainfall distribution in the sub-catchments. This coupled system was used for simulations of recent floods of 2022 and showed a good agreement with observations. Such coupling of hydro-met systems can be a helpful tool to enhance urban flood forecasting. For this work, WRF model simulations were performed on HPC (PARAM series) using around 1900 processors.

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