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A deep learning-based super-resolution DEM model for pluvial flood simulation

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High-resolution Digital Elevation Model (DEM) data provides essential information for pluvial flood simulation. Although the increased accessibility and quality of publicly available DEM datasets can facilitate geospatial analysis at various scales, existing DEM datasets with global coverage mostly lack sufficient spatial resolution for pluvial flood simulations, which require detailed topographic information to be included in the simulation. Simulating flood scenarios with low-resolution DEMs (>30m) can result in substantial deviations from real cases. This issue becomes even more severe for flood-prone areas in data-scarce developing countries.

Image super-resolution is a technique for reconstructing low-resolution information into high-resolution data. Various deep-learning models have been employed for this task, primarily focusing on generating high-resolution natural-colour images. However, the effects of these deep learning models on enhancing the resolution of DEM data have not been extensively investigated. One of the state-of-the-art super-resolution models, the Residual Channel Attention Network (RCAN), has gained popularity due to its accuracy and efficiency. Leveraging publicly available low-resolution global DEM data and high-resolution regional DEM data, this study assesses the performance of RCAN models in a DEM super-resolution task. The experimental results suggest that, compared to conventional interpolation methods, the tested RCAN model exhibits superior performance in constructing high-resolution DEM data. The generated super-resolution DEM data were then tested in pluvial flood simulations and achieved substantially higher realism in modelling floodwater distribution. The proposed method for constructing super-resolution DEMs opens up the possibility of simulating flooding at hyper-resolution globally.