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Evaluating the Role of Building Representation in Flood Dynamics: Insights from the 2021 Ahr Valley Flood

Shahin Khosh Bin Ghomash, Nithila Devi Nallasamy, and Heiko Apel

German Research Centre for Geosciences (GFZ), Potsdam, Germany

The growing flood risk in urban areas, driven by urbanization and climate change, underscores the need for accurate building representation in flood hydrodynamic models. This study examines the effects of three representation methods—Building Block (BB), Building Hole (BH), and Building Resistance (BR)—on flood modeling during the 2021 Ahr Valley flood, analyzing their impact on flood extent, water depths, and flow velocities across different model resolutions.

Our findings reveal that building representation significantly influences flood dynamics. The BB and BH methods generally result in larger flooded areas, deeper water, and faster flows, while increased resistance or omitting buildings leads to smaller extents, shallower water, and slower flows. The choice of representation is especially critical at coarser resolutions, where the BH method yields the most accurate flood extents, while increased resistance performs better at finer scales. Although all methods achieve reasonable flood extent predictions, variations in water depths and velocities emphasize the importance of selecting the right approach for accurate flood impact assessments, particularly in dense urban areas. Finally our results highlight that tailoring building representation to model resolution is crucial for improving urban flood modeling and impact accuracy.