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Towards Improved Coastal Flood Assessments through Hydrodynamic Modelling and Digital Twins.

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Coastal urban areas face increased risk from storm surge induced flooding due to accelerating sea level rise and continued urban expansion, without adaptation leading to exacerbated flood damages in the future. Thus, enhanced preparedness is essential to minimize damages, especially for coastal cities that have not yet adapted to the increasing risk. Despite their computational demands hydrodynamic models are an essential tool to simulate flood propagation and quantify flood exposure, due to their ability to accurately predict flood characteristics.

We have successfully validated a set of hydrodynamic models for several cities along the German Baltic Sea coast, using tide-gauge data and flood measurements collected during the storm surge in October 2023. In combination with synthetic but physically plausible storm surge hydrographs, available along the entire German Baltic Sea coast, our results can provide comprehensive insights into flood characteristics that support decision-making. For example, an automated set-up allows high resolution simulations of many events in relatively short time. Resulting flood characteristics can be compiled into probabilistic or digital portfolios of flood maps, helping identify areas at risk for multiple events, reducing uncertainties. Moreover, with the ability to simulate a large number of scenarios, we can support the evaluation of various adaptation strategies offering essential information on their effectiveness. Last, near real-time simulations enhance early warning capabilities and emergency planning. Integrating the above elements into digital twins and combining those with visualization techniques or AI models offers a promising foundation for operational frameworks in the face of increasing flood hazards.

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