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Integrated assessment framework for quantifying multi-hazard risk in large cities

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To better understand the integrated disaster risk in the region exposed to multiple natural hazards, there is a need for quantitative assessments that comprehensively consider all the regional major natural hazards and their interactions and correlations. This study developed an integrated assessment framework for quantifying water-related multi-hazard risk in costal cities, taking into account the possibility and outcome of the concurrence of river flood, heavy rain and storm surge. As the first part of this framework, copula theory is applied to measure the dependence between the three hazards and fit their joint probability distributions, which are used to simulate the concurrent events under different scenarios of probability. For each of the simulated events, a GPU-accelerated hydraulic model based on 2D Shallow Water Equation is operated to calculate the the flooding area and water depth. Vulnerability curves that illustrate the possible loss of different exposures as a function of hazard (flooding area and water depth) are generated and then applied to calculate the probability of loss at various level. London, which is a typical area threatened by pluvial, fluvial and costal floods, is selected as the study case in this framework. Compared with single-hazard risk, the integrated and quantitative assessment of disaster risk due to the three water-related hazard can provide more scientific reference for regional land-use planning, disaster prevention and emergency management.