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Extracting flood defence information for the entire continental US from high-resolution elevation data

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Large-scale flood hazard models underpin risk assessments where local data is lacking in quality and quantity and have yielded a step-change in our understanding of flood risk at continental to global scales. Yet by necessity, these physical models are simplified to make them computationally practicable. One such simplification involves reducing the volume of topographic information input via coarsening the resolution of the Digital Elevation Model (DEM) employed. This means a single elevation value represents 10^3– 10^6 m^2 of terrain in common academic and industrial flood hazard models. In reality, floodplain topography can be highly heterogenous across such spatial scales, with crucial flow-controlling structures, such as levees, effectively being "smoothed" out of the terrain model. Solutions to this issue currently employed by large-scale modellers involve: (i) using auxiliary databases containing flood defence information, which are known to contain only a small proportion of such structures, to ensure defended areas remain dry in the simulation; (ii) employing largely unsubstantiated defence standard assumptions relating to socio-economic information (e.g. wealth, population, development); or (iii) ignoring the problem entirely. Here, we propose a new solution to this problem in the US. We collate high-resolution topographic information for the entire continental US from the US Geological Survey, where single elevation values represent 10^1 – 10^2 m^2 of terrain, and run a highly efficient geomorphic algorithm to extract levee-like features. The algorithm selects pixels which: (i) are elevated relative to their neighbours, (ii) have steep neighbours with opposing aspects, (iii) exhibit profile convexity and no planform curvature, and (iv) are linear in shape when connected. The parameter values to drive this are derived from sampling these characteristics from the DEM at known levee locations based on information from the US Army Corps of Engineers National Levee Database. The algorithm is run 1000 times, using different plausible parameter sets based on this sampling, meaning a probabilistic surface of likely levee locations is constructed. The high-resolution elevation values of these levee crests is then burnt into a coarser DEM used for large-scale hydraulic simulations, meaning flood defences are more adequately represented.