Representation of Dam-Breach Geometry on a Regular 2-D Mesh Using Quadtree Local Mesh Refinement

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Using a regular, square-cell, two-dimensional mesh for representing ground elevations in surface water flow calculations offers many benefits over an irregular mesh, including simple mesh preparation and fast computational times. However, certain fine-scale features such as dam-breach geometry may not be accurately or adequately captured by the typical mesh resolutions used in these types of simulations, especially if the dam axis and dam body are not aligned with the grid lines. In 2D simulations where the reservoir and breach are modeled, an accurate description of the breach geometry is critical in order to correctly model the flow hydrograph through the breach. To avoid refining the entire mesh to correctly represent the changes in the bottom elevations as the dam breaches, which would result in increased computational burden, a local refinement can be used near the areas of interest. To address this issue, a technique using quadtree mesh refinement was implemented into an existing 2D finite-volume shallow water equation program called CCHE2D-FLOOD. This program is used to simulate dam break and levee breaching floods, and due to the wide-spread area of impact of such floods, a coarse mesh is usually used during the simulation. The process of dam or levee breach enlargement is done at the cell level, which causes difficulties when the cell size is on the same order or larger than the breach size. Using the method described in this paper, cells representing such dam or levee features are refined locally until the breach geometry can be represented with sufficient level of detail. The results from this method compare well with hydrographs from known dam break cases as well as semi-empirical equations of breach discharge compiled from dam break studies. Local mesh refinement using quadtree can also be applied to represent other types of features requiring fine mesh size.