GIS BASED ADAPTIVE GRID SOLUTION TO FLOOD INUNDATION

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Worldwide, almost all of countries and regions are suffering from flooding. Floods may lead to severe loss of human lives and damages to properties and other assets. Flooding is a natural process that can never be entirely prevented. Moreover, with the ongoing climate change, the risk of disastrous flooding is expected to significantly increase during the 21st century. Therefore, to effectively manage flood risk has become a more and more important task for governments and authorities at different levels throughout the world, and hydraulic modeling is an indispensable tool in facilitating effective flood risk management.

During the last decade, due to the rapid advancement of computing technology and wide availability of rich data sources, 2D high-resolution hydraulic models have been widely used and become dominant in flood modeling. However, floods may commonly take place in relatively large domains with different land covers and very complex topographic features. Performing high-resolution flood simulation over a large scale remains to be a challenging issue even with the latest computational power. Research effort has been devoted to develop more efficient computational methods to resolve this bottle-neck and adaptive mesh refinement (AMR) may provide an effective way. The basic idea of AMR is to optimizationally allocate the computational resource by changing the local mesh resolution during a simulation.

Recently, a simplified adaptive grid system was developed by the author for efficient shallow flow modeling (Liang 2011). Based on the simplified approach, an initial non-uniform grid can be easily generated by specifying subdivision level to each cell on a coarse background mesh. Therefore it does not involve complicated grid generation as those traditional grid techniques (e.g. unstructured grid and quadtree grid) do. Furthermore, the resulting computational grid is structured and does not need a data structure for neighbor-finding. Dynamic grid adaptation can be simply performed by changing the subdivision of a cell when necessary. In this work, this new grid system is improved by combining with a GIS tool for grid generation. Starting from the floodplain DEM, a raster grid with only values of 0 and 1 can be created using a GIS tool, e.g. ArcMap, where value 1 is given to those regions that should be represented by high-resolution mesh. During grid generation, high subdivision level is only given to those cells containing value 1. This leads to a high-quality initial mesh accurately representing the domain features, on which the fully 2D shallow water equations are solved using a finite volume Godunov-type scheme implemented with an effective wetting and drying condition (Liang 2010). The model tested by idealized benchmarks and realistic cases and is ready for practical flood simulation. In terms of CPU time, the adaptive grid based model is found to be many times (up to 18 times depending on applications) more efficient than a similarly constructed uniform grid based counterpart.

References:

Liang Q. Flood simulation using a well-balanced shallow flow model. J Hydr Engrg 2010; 136(9):69–675.

Liang Q. A Simplified Adaptive Cartesian Grid System for Solving the 2D Shallow Water Equations. Int J Numer Meth Fluids 2011; DOI: 10.1002/fld.2568.