Geophysical Research Abstracts, Vol. 9, 04229, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04229

Modelling of flash flood propagation in urban areas using 2-D hydraulic numerical models

K. El kadi Abderrezzak, A. Paquier

Cemagref, Hydrology and Hydraulics Research Unit, Lyon, France (elkadi@lyon.cemagref.fr / Fax: +33 478-477875 / Tel: +33-472-208611)

Flash flood inundation of urban areas due for instance to dam or levee failure happens occasionally in the world. Such an event may however cause serious loss of lives, major damage (roads, railway lines, buildings, bridges…), and socio-economic consequences. Acquiring by numerical modelling the knowledge of free surface water levels, flow velocity, and inundation extent due to flash urban flood events may help to establish an effective system to manage the risk. For this purpose, many hydraulic numerical models, mostly based on 2-D approach, have been developed and applied for computing overland flows in urbanized areas.

This study focuses on the modelling of flash flood propagation in urban areas attributed to dam break wave or to excessive rain over a short period of time that induces a quick-rising inundation. Two different 2-D numerical models with different assumptions and simplifications are tested. The first model solves the classical 2-D depth averaged momentum and continuity equations for shallow water free surface flow. The model uses a refined grid resolution composed of quadrilaterals and triangles to represent the urban area topography, the buildings being modelled as impervious boundaries. The flow governing equations are solved using an explicit second-order numerical scheme that is adapted from *MUSCL* approach. The second numerical code is a large-scale 2-D shallow water model, in which buildings are not represented. The reduction in both water storage and exchange section, due to the presence of buildings and other urban structures, is modelled by the introduction of porosity in the classical 2-D shallow water governing equations. Furthermore, a specific source term representing head losses due to singularities (obstacles, crossroads…) is added. This model allows urban flow patterns to be modelled without a need for refined mesh, reducing then the computation time and memory capacities compared to those needed

by 2-D based refined mesh model. The modified governing equations (due to the introduction of porosity and additional head losses terms) are solved by a finite-volume approach based on unstructured grids and a Godunov-type scheme and that uses a modified a modified Harten, Lax and van Leer Contact (HLLC) Riemann solver.

Both numerical model schemes are robust, shock capturing and are able to describe discontinuities such as mobile hydraulic jumps and shock waves over initially dry bed, and then particularly suitable for the simulation of flash flood in urban areas. Three cases covering experimental and real-life test examples under rapidly varying flows are used to demonstrate the potentials and limitations of each model: laboratory model city experiments performed at the Université Catholique de Louvain (Belgium), physical model of the Toce River Valley and the 1982's dam break flood in the city of Sumacarcel (Spain). Numerical results are compared to measurements and the findings of the study provide an interesting comparison of the two numerical models. It appears that the use of 2-D large-scale model leads to a significant reduction of computational effort compared to the 2-D model using refined grids, with a similar degree of accuracy in predicting water depth. However, the 2-D based refined mesh model provides detailed information on the water depth, duration and flow velocity as well as the inundation extent, thus offering the required strategic planning information necessary for mapping the flood hazard at a much finer resolution.