A MULTILAYERED APPROACH TO TWO-DIMENSIONAL URBAN FLOOD MODELLING

Submitted by Barry Evans, to the University of Exeter as a thesis for the degree of Doctor of Philosophy by Research in Engineering, June 2010

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted for the award of a degree by this or any other university

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Abstract

With urbanisation continuing to encroach upon flood plains, the constant replacement of permeable land with impermeable surfaces and with the changes in global climate, the need for improved flood modelling is ever more apparent. A wide range of methods exist that simulate surface flow; most commonly in one-dimensional (1D) or two-dimensional (2D), and more recently on smaller scales in three-dimensional (3D) models. In urban flood modelling, 2D models are often the preferred choice as they can simulate surface flow more accurately than their 1D model counterparts; they are, however, more computationally demanding and thereby usually require greater simulation time. With the vast amount of information used in flood modelling, generalisation techniques are often employed to reduce the computational load within a simulation.

The objective of this thesis is to improve 2D flood modelling in urban environments by introducing a new and novel approach of representing fine scale building features within coarse grids. This is achieved by creating an automated approach that data-mines key features such as buildings and represents their effects numerically within a multiple layer grid format. This new approach is tested in comparison to two other, already established generalising techniques which are single layer based. The effectiveness of each model is assessed by its ability to accurately represent surface flow at different grid resolutions and how each copes with varying building orientations and distributions within the test datasets. The performance of each generalising approach is determined therefore by its accuracy in relation to the fine scale model and the difference in the computational time required complete the simulation. Finally the multilayered methodology is applied to a real case scenario to test its applicability further. Overall it revealed, as predicted, that the multilayered approach enables far greater accuracies at routing surface flow within coarse grids whilst still greatly reducing computational time.

As a further benefit in urban flood modelling, this thesis shows that using a multilayered data format it is possible to simulate the influence of features that have a grid resolution finer than the initial terrain topology data, thus enabling, for example, the routing of surface water through alleyways between buildings that have a width less than one meter.

Contents