SPLIT-SAMPLE TESTING OF CLASSICAL AND ADAPTIVE TIME STEP STORAGE CELL CODES FOR FLOOD MODELLING

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Since 1962 storage cell codes have been developed to simulate flow on fluvial and coastal floodplains. These models treat the floodplain as a series of discrete storage cells, with the flow between cells calculated explicitly using some analytical flow formulae such as the Manning equation. Recently these codes have been reconfigured to use regular Cartesian grids to make full use of widely available high resolution data captured from remote sensing platforms and stored in a raster GIS format. Such raster-based storage cell codes have many of the advantages over full two-dimensional depth averaged schemes but without the computational cost, and have been used successfully in a number of flood inundation modelling studies.

However, with this class of model the propagation speed of the inundation front over the floodplain can be shown to be highly dependent on the model grid scale and insensitive to floodplain friction. To overcome these problems adaptive time step techniques have recently been proposed (for a full description see Hunter et al. in press), however to date these have only been tested against highly idealised analytical solutions. In this paper we compare for the first time fixed and adaptive time-step storage cell codes for flood inundation modelling against a real world data set which includes independent calibration data from hydrometric and satellite sources. The data consist of synoptic views of flood extent from radar remote sensing satellites at ~12.5m spatial resolution taken during flood events in 1998 and 2000 on the upper River Severn in the UK, gauged flows at the upstream and downstream ends of an approximately 60km reach of the river and a Digital Elevation Model developed from channel survey and an airborne laser altimeter survey of the floodplain topography. The two models are calibrated, using floodplain and channel friction as free parameters, against both the observed inundated area and records of downstream discharge. The predictive power of the models calibrated against inundation extent or discharge for one event can thus be measured using independent validation data for the second.

Both models are shown to be capable of reproducing flood extent and travel times to a high degree of accuracy at optimum calibration, with the new adaptive time step scheme providing better absolute performance in most cases. Unlike the fixed time step model, the adaptive version showed sensitivity to variations in floodplain friction that appeared both intuitively realistic and in line with the sensitivity behaviour of full 2D solutions of the shallow water equations applied to this test site (Horritt and Bates, 2002). Whilst parameter sets could be identified for both models that simultaneously provided acceptable simulations of flood wave travel time and inundation extent, these occurred over a broader region of the parameter space for the adaptive time step model. Gradients of the chosen performance measures over the parameter space were also steeper for the fixed time step model than for the adaptive scheme, indicating that the latter code may be easier to calibrate. The observed differences in predictive performance between the two models appear to be due to the different model responses to friction parameterisations. If we are forced to use a calibration methodology due to lack of parameterisation data, the best model will be the one with the most useful response surface. The work presented here indicates that the new adaptive time step version of the LISFLOOD-FP model is the best model for this reach when assessed in these terms.

REFERENCES

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