Using time series of satellite SAR images to calibrate channel depth and friction parameters in the LISFLOOD-FP hydraulic model

Melissa Wood (1,2), Jeff Neal (1), Renaud Hostache (2), Giovanni Corato (2), Paul Bates (1), Laura Giustarini (2), Marco Chini (2), and Patrick Matgen (2)

(1) School of Geographical Sciences, University of Bristol, University Road, Bristol, BS8 1SS UK., (2) Centre de Recherche Public – Gabriel Lippmann, Departement Environnement et Agro-biotechnologies, Belvaux, Luxembourg.

Synthetic Aperture Radar (SAR) satellites are capable of all-weather day/night observations that allow discrimination between land and smooth open water surfaces over large scales. Because of this there has been much interest in the use of SAR images to estimate flood extent and flood elevation in order to improve understanding of fluvial flood inundation processes. In past studies it has been proven that integrating SAR derived information with hydraulic models can improve simulations of flooding mechanisms.

A repository of River Severn at Tewkesbury flood images from the ENVISAT satellite (wide-swath mode) have been processed and catalogued for events between 2005 and 2012. Information such as flood extent is taken from these images for floods occurring in 2007, 2008 and 2011 as the focus of this study. The flood events are simulated within a 2D LISFLOOD-FP Sub-Grid hydraulic model of the River Severn covering an area of 50x70km. The Sub-Grid capabilities of this particular version of LISFLOOD-FP allows any size of river channel below that of the grid resolution to be represented thus allowing improved hydraulic connectivity within the flooded area.

The objective of this study is to calibrate the parameters of the LISFLOOD-FP Sub-Grid 2-D model that govern channel depth and channel roughness using SAR derived images of flood extent. Parameters 'r' and 'p' are variables used in the Sub-Grid model to define depth of channel at full bank. The equation estimates bank full depth D being equivalent to rWp¬¬, where W is bank full channel width. By varying the parameters 'r' and 'p' around an initial estimate we can create a number of unique models with ranging channel depth. It follows that models with differing channel depths generate results of differing flood levels and extent. The model calibration is achieved by selecting those models results with simulated flood extent which fit best with the observations of flood extent derived from the SAR images. A similar experiment was carried out to vary Manning's value 'n' (associated with channel roughness) with the channel depth parameter 'p' to determine whether the method would also work with pairings of two unrelated parameters.

The study first compared the model simulations with a single SAR derived flood extent, then compared model results against a time series of images acquired over multiple flood events. This was to determine whether it is more useful in this method of calibration to use a time series of SAR derived extents.

Validation is accomplished by use of surveyed cross sections of the Severn riverbed and aerial photographs, together with gauged records of discharge and water level located inside the limits of the model.