Geophysical Research Abstracts
Vol. 12, EGU2010-807, 2010
EGU General Assembly 2010

Downscaling catchment scale flood risk to contributing sub-catchments to determine the optimum location for flood management.

Ian Pattison, Stuart Lane, Richard Hardy, and Sim Reaney
Durham University, Geography, United Kingdom (ian.pattison@durham.ac.uk)

The recent increase in flood frequency and magnitude has been hypothesised to have been caused by either climate change or land management. Field scale studies have found that changing land management practices does affect local runoff and streamflow, but upscaling these effects to the catchment scale continues to be problematic, both conceptually and more importantly methodologically. The impact on downstream flood risk is highly dependent upon where the changes are in the catchment, indicating that some areas of the catchment are more important in determining downstream flood risk than others. This is a major flaw in the traditional approach to studying the effect of land use on downstream flood risk: catchment scale hydrological models, which treat every cell in the model equally.

We are proposing an alternative ideological approach for doing flood management research, which is underpinned by downscaling the downstream effect (problem i.e. flooding) to the upstream causes (contributing sub-catchments). It is hoped that this approach could have several benefits over the traditional upscaling approach. Firstly, it provides an efficient method to prioritise areas for land use management changes to be implemented to reduce downstream flood risk. Secondly, targets for sub-catchment hydrograph change can be determined which will deliver the required downstream effect. Thirdly, it may be possible to detect the effect of land use changes in upstream areas on downstream flood risk, by weighting the areas of most importance in hydrological models.

Two methods for doing this downscaling are proposed; 1) data-based statistical analysis; and 2) hydraulic modelling-based downscaling. These will be outlined using the case study of the River Eden, Cumbria, NW England. The data-based methodology uses the timing and magnitude of floods for each sub-catchment. Principal components analysis (PCA) is used to simplify sub-catchment interactions and optimising stepwise regression is used to predict downstream flood magnitude from the significant principal components. Two particular sub-catchments, the Eamont and the Upper Eden were highlighted as explaining the highest proportion of downstream flood risk, with 21.0% and 19.6% respectively. This approach uses the concept of data mining, whereby commonly available discharge data is used in an innovative way to learn about catchment behaviour.

An alternative downscaling approach is hydraulic modelling whereby the input hydrographs from each tributary are changed in turn, both in terms of the magnitudes and the timing of the flows. This basic scenario testing approach can be used to assess the sensitivity of downstream flood risk to upstream contributing tributaries. This approach also highlighted the Upper Eden and Eamont as the most sensitive sub-catchments. A 25% reduction in the flows from these sub-catchments resulted in a 33.1cm and 21.9cm stage reduction downstream respectively, while an 8 hour delay of the peak flow caused a 32.3cm and 27.4cm decrease in downstream stage respectively.

This alternative flood management approach is not a replacement to traditional hydrological modelling (upscaling), but a pre-step which allows for more focussed and informed investigation of land management scenarios, in the area where they are most likely to have beneficial impacts on downstream flooding.