



Investigating the potential to reduce flood risk through catchment-based land management techniques and interventions in the River Roe catchment, Cumbria, UK

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Throughout the United Kingdom flood risk is a growing problem and a significant proportion of the population are at risk from flooding throughout the country. Across England and Wales over 5 million people are believed to be at risk from fluvial, pluvial or coastal flooding (DEFRA, 2013). Increasingly communities that have not dealt with flooding before have recently experienced significant flood events. The communities of Stockdalewath and Highbridge in the Roe catchment, a tributary of the River Eden in Cumbria, UK, are an excellent example. The River Roe has a normal flow of less than $5\text{m}^3\text{sec}^{-1}$ occurring 97 percent of the time however there have been two flash floods of $98.8\text{m}^3\text{sec}^{-1}$ in January 2005 and $86.9\text{m}^3\text{sec}^{-1}$ in May 2013.

These two flash flood events resulted in the inundation of numerous properties within the catchment with the 2013 event prompting the creation of the Roe Catchment Community Water Management Group which aims are to deliver a sustainable approach to managing the flood risk. Due to the distributed rural population the community fails the cost-benefit analysis for a centrally funded flood risk mitigation scheme. Therefore the at-risk community within the Roe catchment have to look for cost-effective, sustainable techniques and interventions to reduce the potential negative impacts of future events; this has resulted in a focus on natural flood risk management.

This research investigates the potential to reduce flood risk through natural catchment-based land management techniques and interventions within the Roe catchment; providing a scientific base from which further action can be enacted. These interventions include changes to land management and land use, such as soil aeration and targeted afforestation, the creation of runoff attenuation features and the construction of in channel features, such as debris dams. Natural flood management (NFM) application has been proven to be effective when reducing flood risk in smaller catchments and the potential to transfer these benefits to the Roe catchment ($\sim 69\text{km}^2$) have been assessed. Furthermore these flood mitigation features have the potential to deliver wider environmental improvements throughout the catchment and hence the potential for multiple benefits such as diffuse pollution reduction and habitat creation are considered. The research explores the impact of NFM techniques, flood storage areas or afforestation for example, with a view to enhancing local scale habitats.

The research combines innovative catchment modelling techniques, both risk-based approaches (SCIMAP Flood) and spatially distributed hydrological simulation modelling (CRUM3), with in-field monitoring and observation of flow pathways and tributary response to rainfall using time-lapse cameras. Additional work with the local community and stakeholders will identify the range and location of potential catchment-based land management techniques and interventions being assessed; natural flood management implementation requires the participation and cooperation of landowners and local community to be successful (Howgate and Kenyon, 2009).