10 years of monitoring and empirical analysis on the Eddleston Water NFM project

The Eddleston Water Project was established as a long-term empirical study to detect change in runoff dynamics. The catchment is 69 km2 in area, is almost wholly rural, covered by a mix of grazing and forestry with an altitude range from 190 to 600 m OD and mean annual rainfall of ~900 mm, making it not dissimilar to catchments in many parts of the UK and large enough to allow investigation of scaling effects. Two years of baseline monitoring were undertaken before interventions began in ~2013.

Results to date have identified the tributary catchments generating the highest rates of runoff, variations in baseflow contributions, and substantial variability in travel times down the main stem of the Eddleston Water. As an indicator of the attenuation provided by woody flow restrictors and on-line ponds, median hydrological lag in headwater catchments increased by more than 2 hours at gauging sites with up to 25 km2 in area, while no change in lag was detected in tributaries treated only with riparian planting and fencing. Further downstream, no significant changes were found in hydrological lag times.

The Eddleston study over 10 years has revealed a great deal of complexity in terms of runoff generation and hydrograph characteristics. It provides a rich source of data from now more than 20 water level monitoring sites, with which to explore the interplay between attenuated and unmodified flows in a catchment characterised by varying geology and land uses. In particular, the growing data set provides a valuable resource for the testing of hydrological models of runoff attenuation.

This rich dataset has been used to undertake multi-scale calibration of a whole catchment 2d hydrodynamic model (HEC-RAS 2D) driven by direct rainfall and losses based on ReFH2 with calibrated initial soil-moisture. Two models were calibrated with pre-NFM and post-NFM schemetisation to represent the leaky barriers and an appraisal of flood risk was undertaken to understand the average annual damages avoided - or benefits of the NFM measures. Different model representations of the leaky barriers were investigated and compared and a user-guide was developed to help modelling NFM in other catchments based on the Eddleston water findings.

Alongside the focus on surface water and groundwater hydrology, a second parallel aim of the project is to assess the impact of NFM measures on riparian habitats and the ecology of the catchment, so taking an integrated whole catchment approach to river restoration. Much of this focussed on the impact of NFM remeandering of the channel and its impact on hydromorphology, aquatic macroinvertebrates, macrophytes and fish population in the Eddleston. Using a BACI approach with upstream and downstream control stetches, the remeandering (after 200 years!) of the channel at Cringletie and Lake Wood form the basis for the work. Detailed survey by SEPA, Dundee University and others show the impact on geomorphic units in the channel and demonstrate the linkages to ecological response to these morphological changes over time.

A final part of the study has been to assess the costs and benefits of undertaking these NFM works. Working with JBA and Mott MacDonald, we demonstrate the value of the (voluntary) implemented NFM measure to date to reduce flood risk in terms of Net Present Value (NPV) for flood damages avoided (some £950k over 100 year period) to be considerable, but much less than the extra £4.2million net benefits derived from a wide range of other ecosystem services delivered by these same measures, including carbon, water quality, biodiversity, recreation, etc. Scaling this up, we show even greater benefits with £2.85m from flood damages avoided complemented by £17.7m from other benefits.