Case study 5

River Frome desk-based study - Stroud District Council

Chris Uttley (Stroud District Council)

1. Catchment summary

Study location

River Frome catchment (252km2), Gloucestershire

Catchment summary

The Stroud Valleys suffered extensive flooding during the summer of 2007 and every year since has seen flooding in some parts of the area. Most recently, Chalford (middle Frome) and Bridgend and Eastington (lower Frome) have experienced flooding. Localised flooding occurs not just on the lower Frome but within Stroud itself. In addition, the Slad Valley has been designated as a rapid response catchment at risk of flash flooding. Poor soil permeability throughout the catchment exacerbates surface water run-off.

The catchment also suffers from diffuse sediment pollution, whereby land use change can release large quantities of sediment into watercourses. Water quality in receiving watercourses is also poor, with phosphate levels exceeding Water Framework Directive (WFD) standards. There are also rising levels of artificial chemicals such as pesticides and industrial chemicals in groundwater systems.

Study summary

The purpose of this study was to review and understand the issues within the catchment and the potential use of Working with Natural Processes (WwNP) measures to reduce flood risk and improve water quality. There was less focus on modelling than the other case studies.

The project aims to create a river catchment where water and land management practices are fully integrated. Working closely with the community and private companies to manage drainage within the catchment, thus reducing flood risk downstream, was seen as crucial.

Stroud District Council explored the feasibility and potential flood risk benefits of implementing rural sustainable drainage systems (SuDS) throughout the River Frome catchment. The main objective was to see if these measures could help reduce flood risk and improve water quality by trapping sediment and diffuse pollutants. Stroud District Council have produced a video which describes the project (http://www.stroud.gov.uk/docs/environment/rsuds/video.asp).

The following WwNP measures were considered:

- In-channel: hurdles, bunds, berms, on-line pools, woody debris
- Land-based: ponds, basins, wetlands, swales, stone dyke, hedgerows, headlands and buffer strips, contour bunds, shelter belts and woodland
- Farmyard: Rainwater harvesting, cross-drain, swales, green roof, sediment traps, permeable surfaces, soakaways, filter trenches and drains

Community involvement

As part of the project there was extensive engagement across Gloucestershire County Council, Stroud District Council, the Environment Agency, the Severn and Wye Regional Flood and Coastal Committee (RFCC) and local communities.

2. Data summary

Datasets and analysis techniques used

The following data were used:

- 2 field visits
- desktop study
- drainage characteristics
- Digital Terrain Model (DTM) analysis

- Flood Zone datasets
- geological data
- land use data
- soil data
- surface water maps
- records of fluvial (river) flooding
- outputs from river models (ISIS, TUFLOW)

The Updated Flood Map for Surface Water and the Environment Agency's Flood Zone maps were used to identify surface flow pathways.

Information was also obtained from the following:

- Severn Tidal Tributaries Catchment Flood Management Plan
- Severn Vale Catchment Abstraction Management Plan
- Stroud District Council Local Plan
- Stroud Strategic Flood Risk Assessment for Local Development Framework

Data restrictions

The Environment Agency's Woodland for Water dataset was discounted as being too broad scale for this study.

3. Model summary

Catchment processes investigated

This study explored the following catchment processes:

- run-off generation mechanisms and patterns
- sediment sources, pathways and receptors
- mobilisation and inputs of diffuse pollutants from the land

Model assumptions

No modelling was carried out. Instead, the study analysed existing reports and conducted desk-based reviews of existing geographical information system (GIS) data.

Flood Zones datasets, updated Flood Map for Surface Water and geological maps were used to highlight areas where WwNP may be appropriate and have a positive impact.

Existing flood management plan policy units and available flow and gauge data records were also consulted.

The desktop GIS review divided the catchment into 3 basic land forms:

- Upland areas – elevated, generally flatter ground areas above the edge of the river valleys
- Upper river valleys – steep river valleys cut into the landscape with steep or shallow 'V' forms, steep channel slope and relatively little or no permanent floodplain area
- Floodplain river valleys – where the channel slope and valley bottom open out to form continuous, wide floodplains where flooding occurs

Data and model outputs

The types of WwNP measures compatible with the 3 land forms were identified and a long list of

influences was compiled to narrow down potential locations where WwNP measures could be implemented. The following areas were identified as not being suitable for implementing WwNP measures:

- areas of high permeability in upland areas
- a lack of substantial floodplain features
- the presence of mill structures and interactions with groundwater in the upper river valleys
- a lack of ground area and extensive development across floodplain river valleys
- multiple spring sources adding water to rivers along all watercourses making single-point flow management difficult
- severe conflicts from inserting new barriers and excavating storage areas with WFD objectives or existing habitats

Understanding the hydrological characteristics was essential in looking for opportunities to reduce flood risk. For example, the response in river levels to heavy rainfall events clearly differs across the catchment according to the underlying geology and the degree of surface water or groundwater influence.

This study showed that, in the Frome catchment, it is likely that a significant number of WwNP measures would need to be applied to have a measurable flood risk benefit. The desk study considered the applicability of each WwNP measure within each subcatchment and according to the landscape types identified within each of these areas relative to land use, topography, geology and drainage characteristics.

It is recommended that woodland is planted across the catchment at locations agreed through engagement with landowners and farmers. Two pilot locations were recommended to implement WwNP measures.

Model performance

The proposed locations of the WwNP measures were largely opportunistic. They were based on the desktop study, information gained during a catchment walkover and the willingness of landowners to allow WWNP measures to be installed on their land.

To measure potential WwNP benefits, specific pre-installation, baseline condition, flow and water quality monitoring is required. However, measuring improvements to groundwater quality or quantity would be extremely difficult as the two systems beneath the Frome catchment are hydraulically linked to other adjacent drainage catchments which are likely to contribute to the current rising trend of pollution

4. Lesson learnt

Choice of tools

It was considered easier to go out into the field and conduct a catchment walkover, combined with knowledge obtained from desktop studies, than use some of the available detailed modelling tools for this particular project. This may influence future investigations of a similar nature as detailed models may not always be appropriate for various types of work involving looking for opportunities to install WwNP measures.

There were uncertainties within available existing models, especially with regard to the assumed catchment drainage/soil types and model outputs were therefore questionable. However, without modelling, it was not possible to make an assessment of scheme benefits to analyse results and add confidence to the generic approach.

Catchment scale and typology

Many of the constraints that were listed restricted the application of WwNP measures to localised features. In addition, measuring catchment scale benefits of such dispersed features was considered likely to be difficult.

A desk study of the catchment provided an understanding of the baseline geology, topography, land use, environmental condition and flood risks.

Scale issues within the study were not tackled due to the small scale of the study. Without further implementation of WwNP measures across different areas of the catchment, it was impossible to assess the overall impacts on flood risk.

Wider benefits

While the scope of the project identified water quality as being important, detecting the changes was considered too difficult to measure and assess. However, the principles of restoring natural drainage pathways and slowing downstream transfer of water through WwNP measures were seen to be vital for future environmental management and potentially mitigate the impacts of climate change.

Additional benefits of the measures considered were the creation of a variety of habitats for wildlife to colonise, many of which are Biodiversity Action Plan (BAP) habitats such as wet woodland, wetlands, moorland, peatlands, ponds and hedgerows.

Future research needs

It would be useful to know when it is necessary and not necessary to model WwNP measures, enabling a risk-based approach to be taken.

5. Bibliography

ATKINS, 2013. Rural SuDS – River Frome Catchment (Gloucester). Scoping Study (Final Report). Report for the Environment Agency. Birmingham: Atkins.

CREW, 2014. Stroud RSuDS project [online]. Edinburgh: Centre of Expertise for Waters. Available from: http://www.crew.ac.uk/casestudies/stroud-rsuds-project [Accessed 11 January 2016].

ENVIRONMENT AGENCY, 2009. Severn Tidal Tributarues: Catchment flood management plan. Available from: https://www.gov.uk/government/collections/catchment-flood-management-plans

[Accessed 18 January 2016].

HALCROW GROUP, 2008. Stroud District Council. Strategic Flood Risk Assessment for Local Development Framework. Available from: http://www.stroud.gov.uk/localplan/sfra.asp [Accessed 11 January 2016].

ENVIRONMENT AGENCY, 2009. Severn Tidal Tributaries Catchment Flood Management Plan. Summary Report December 2009. Solihull: Environment Agency.

STROUD DISTRICT COUNCIL, 2015. Stroud Rural Sustainable Drainage Project [online]. Available from: http://www.stroud.gov.uk/docs/environment/rsuds/index.asp [Accessed 11 January 2016].

STROUD DISTRICT COUNCIL, 2015. Stroud Local Plan [online]. Available from: http://www.stroud.gov.uk/docs/planning/planning_strategy.asp [Accessed 11 January 2016].

Project background

This case study relates to information from project SC120015 'How to model and map catchment processes when flood risk management planning'.

It was commissioned by the Environment Agency's Evidence Directorate, as part of the joint Flood and Coastal Erosion Risk Management Research and Development Programme.

Project manager: Lydia Burgess-Gamble, Evidence Directorate

Research contractors: Barry Hankin (JBA), Sebastian Bentley (JBA), Steve Rose (JBA), Keith Beven (Lancaster University), Trevor Page (Lancaster University), Mark Wilkinson (James Hutton Institute), Paul Quinn (Newcastle University) and Greg O'Donnell (Newcastle University).

For more information contact: fcerm.evidence@environment-agency.gov.uk