Participatory modelling

Using Bayesian networks to involve stakeholders in flood risk decision making in Hebden Bridge

FACTSHEET

Project area: *Stakeholder communications*
Intended readership: *practitioners, academics, interest groups*

Over the last nine months, a group of stakeholders have attended a series of workshops to design, build and test a conceptual model of flood risk in their town, as they understand it.

The aims are threefold. Firstly, to investigate whether modelling in this participatory way could be used to actively involve stakeholders in decision making, something that had previously been limited in most cases to consultation. Secondly, to capture local knowledge and experience about flood consequences, that currently has very little consideration in flood risk modelling. Thirdly, to trial a technique that whilst well established in other areas of environmental management, has yet to be applied to flood risk, and to see whether that technique could structure local knowledge and allow assumptions to be challenged.

The workshops were based in Hebden Bridge, West Yorkshire, which experienced flash flooding from fluvial and pluvial sources in July 2012. Despite a history of regular flood events that are becoming more frequent, the town is struggling to meet the cost-benefit requirements to secure the funding required for a flood alleviation scheme. The town's reliance on the tourism industry further makes flood defences similar to those installed at upstream Todmorden an unpopular option.

The modelling group

Modelling took place over six workshops, each roughly two hours in length, with interviews before and after to investigate stakeholder views on the process and what they feel it has achieved in terms of their understanding of local flood risk, and the social learning that resulted directly from participating. The workshops have been attended by roughly 12-15 stakeholders from a range of organisations, both local and regional, as well as residents and academics. Key partners include the Environment Agency, Calderdale Metropolitan Borough Council, Pennine Prospects, Treesponsibility, The National Trust, Calder Future, Moors for the Future and the Hebden Bridge Flood Action Group (Figure 1).

Figure 1: Stakeholders meet at the town hall

Figure 2: Formulating system variables (inc. interventions) based on the catchment objectives

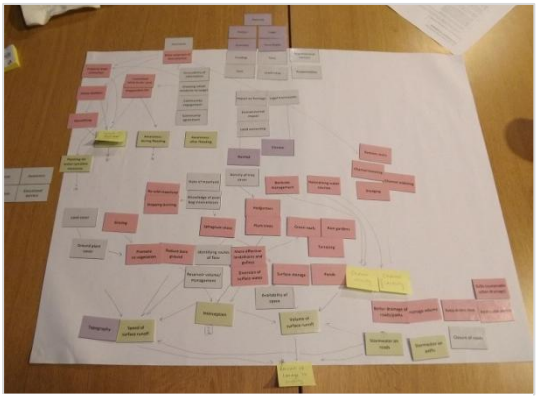

Figure 3: Organising system variables into a network structure of cause and effect

EPSRC Engineering and Physical Sciences Research Council
EP/K013661/1

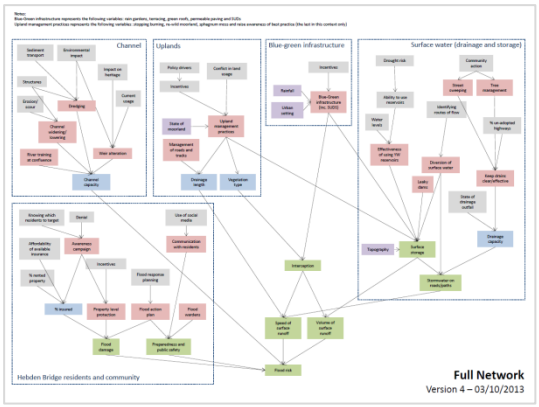

Figure 4: The completed network

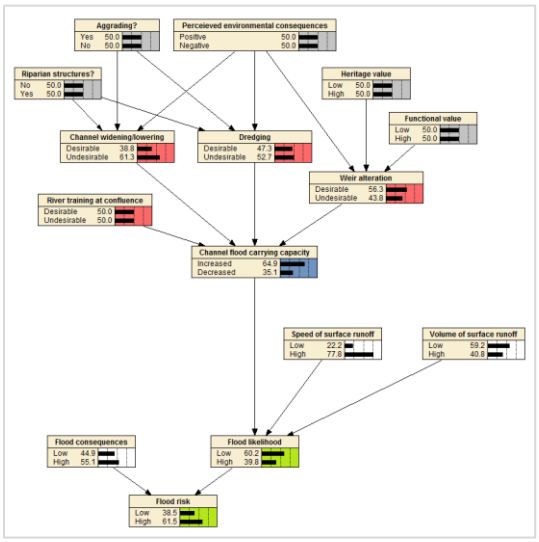

Figure 5: A portion of the network in Bayesian network software Netica™

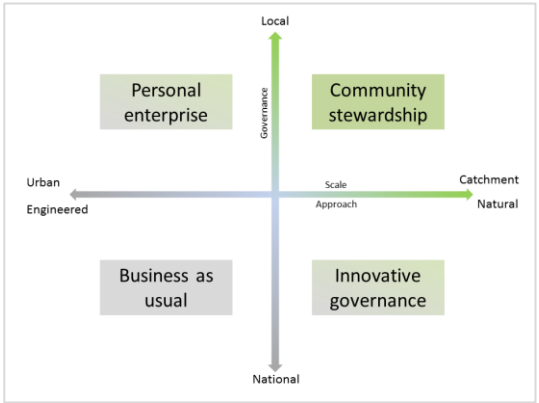

Figure 6: Socio-economic futures for managing flood risk in Hebden Bridge

The workshops

Prior to the first workshop, key stakeholders were interviewed to identify what they understood to be the main catchment objectives with regards to reducing flood risk. These formed the starting point for workshop one, where participants worked in two groups firstly to identify interventions that could be implemented to achieve the objectives, and second to identify factors that affect whether these interventions would be a) implemented and b) successful (Figure 2). These became the system variables.

At the second workshop, these system variables were organised into a general network structure of cause and effect. Generally speaking, implementation factors and drivers would affect interventions which would in turn affect objectives. A conceptual model of stakeholder understanding was already taking shape (Figure 3). These networks were then systematically refined throughout the third workshop (Figure 4), and formed the basis for the network to be built in Bayesian networking software.

At the fourth workshop, stakeholders were asked to define the relationships between the variables (i.e. each of the arrows in the network) by stating the likelihood that a variable would take each of its potential states, given the states of other variables which directly affect it. These numbers then populated the conditional probability tables that underlie the network, and allow it to perform predictive and diagnostic tasks. The model was then ready to be constructed in a piece of freely available Bayesian networking software called Netica™ (Figure 5). Netica™ was then used at the fifth workshop to allow stakeholders to experiment with the model that they had created, and see whether the initial results it gave match their existing understanding.

This started a process of model testing, which was concluded in the sixth workshop by using four future socio-economic scenarios to identify recommendations for reducing flood risk (Figure 6). Stakeholders did this by identifying which interventions were most likely to be realised under each scenario, and then observing the effect of the combination of these interventions on their multiple catchment objectives. The workshop culminated in a discussion over what form the outputs from the workshop series should take, and how these will be disseminated, both to agencies charged with reducing flood risk and the general public.

The future

Moving forwards we will continue to work with Calderdale Council and the Environment Agency to disseminate our findings to the wider public.

Research team:
University of Nottingham: *Shaun Maskrey (shaun.maskrey@nottingham.ac.uk), Dr Nick Mount and Professor Colin Thorne*

Blue-Green Cities in an interdisciplinary research consortium made up of partners from UK and international universities, government bodies and practitioners supported by:

bluegreencities.ac.uk
@BlueGreenCities

EPSRC
Engineering and Physical Sciences Research Council
EP/K013661/1

Environment Agency
RIVERS Agency
NATIONAL SCIENCE FOUNDATION