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Participatory modelling for stakeholder involvement in the development of flood risk management intervention options

Shaun A. Maskrey [a, *], Nick J. Mount [a], Colin R. Thorne [a], Ian Dryden [b]

[a] School of Geography, University of Nottingham, UK
[b] School of Mathematical Sciences, University of Nottingham, UK

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ABSTRACT

Advancing stakeholder participation beyond consultation offers a range of benefits for local flood risk management, particularly as responsibilities are increasingly devolved to local levels. This paper details the design and implementation of a participatory approach to identify intervention options for managing local flood risk. Within this approach, Bayesian networks were used to generate a conceptual model of the local flood risk system, with a particular focus on how different interventions might achieve each of nine participant objectives. The model was co-constructed by flood risk experts and local stakeholders. The study employs a novel evaluative framework, examining both the process and its outcomes (short-term substantive and longer-term social benefits). It concludes that participatory modelling techniques can facilitate the identification of intervention options by a wide range of stakeholders, and prioritise a subset for further investigation. They can help support a broader move towards active stakeholder participation in local flood risk management.

Software availability

Netica (CoGF) 4.16 for Windows ©1992–2015. Norsys Software Corporation, 3512 West 23rd Avenue, Vancouver, BC, CANADA, V6S 1K5. Available online from http://www.norsys.com/netica Cost US$285.00(academic)/US$585.00(commercial) (both include technical support and updates for one year). Free demo version available for download at above website (full-featured but limited model size supported).

1. Introduction

The identification of intervention options is a key component of a local flood risk management (FRM) decision-making process. Considerable national and/or regional variation exists in how it is conducted (*cf.* EA, 2010), but at a high-level it can be summarised into six, generic steps (Fig. 1): a) problem definition; b) objective setting; c) benchmark development and setting; d) intervention option scoping and identification; e) intervention option appraisal and; f) intervention option recommendation/selection.

Feedback and iteration is usually employed to help inform and refine options appraisal (steps d–e). However, options identification (steps a–d) is structured more sequentially (although a planning cycle in which objectives and benchmarks are reviewed is commonly included). The sequential structuring of options identification steps means the framing of a local flood risk problem is particularly critical because it constrains the set of FRM objectives that drive the remainder of the process. Incomplete or inaccurate framing may produce poorly formulated objectives which, in turn, may result in incomplete or inappropriate identification of options for appraisal. Thus, the specific local contexts (both physical and socio-economic) that frame a local flood risk problem must be fully understood and explicitly represented within local FRM decision-making processes (Johnston and Soulsby, 2006; Prell et al., 2007). There is, therefore, a strong imperative for FRM practitioners to include the elicitation and integration of situated, stakeholder knowledge (Wynne, 1996; Evans and Plows, 2007) within the options identification steps of local FRM decision-making (RELU, 2010; Haughton et al., 2015).

* Corresponding author.
E-mail address: shaun.maskrey@nottingham.ac.uk (S.A. Maskrey).

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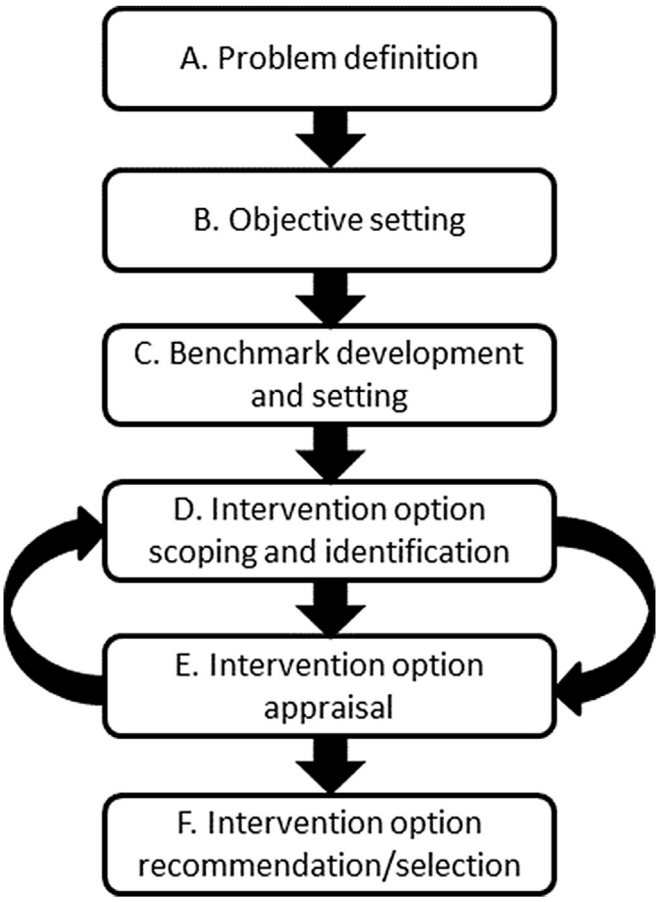

Fig. 1. Generic steps in flood risk decision-making.

In response, formal planning for stakeholder engagement has become a requirement in many FRM options identification and appraisal policies (e.g. USACE, 2000, 2005; EA, 2005, 2006, 2010; DEFRA, 2011) and stakeholders are increasingly seen as full partners rather than consultees in FRM decision-making process (White et al., 2010). However, guidance for practitioners on how stakeholder knowledge can and should be integrated into local FRM options identification, and the benefits that it can deliver, is underdeveloped. Considerable uncertainty about the methods and tools that can be used to engage local stakeholders exists, resulting in wide variation in the nature and scale of engagement across different local FRM projects (e.g. AECOM, 2012; NCC, 2013). The objective of this paper is to improve the guidance that is available by exemplifying how a participatory modelling approach (*cf.* Greenland and Brumback, 2002; Voinov and Bousquet, 2010), coupled with a simple Bayesian network model (BNM), can help to support enhanced options identification in local FRM contexts. The approach taken is particularly novel in the context of FRM in the respect that participants were involved in all stages of model development. In this respect, it represents a considerable departure from previous attempts at participatory flood risk modelling (e.g. Lane et al., 2011) where models have been informed and directed by participation but developed by expert modellers.

The remainder of the paper is structured as follows. Section 2 briefly outlines the principal arguments for and against the adoption of stakeholder participation and participatory modelling in local FRM decision-making. Section 3 presents a case study in which participatory modelling is used to support a local FRM options identification process. The principles and goals of the approach, along with the three-stage structure by which it was organised, are outlined. The methodology is presented in Sections 4 and 5. Details of the stakeholder analysis methodology employed to identify participants, and to inform the local FRM objectives, are provided in Section 4. The participatory modelling methodology (including the approach, tools used and the co-development process) is described in Section 5. In Section 6 the local FRM intervention options identified by the participatory model are presented. Section 7 provides a comprehensive evaluation of the participatory modelling process and its outcomes. Finally, lessons for using participatory modelling in local FRM are synthesised in Section 8.

2. Stakeholder participation in flood risk decision-making

The participation of stakeholders throughout environmental decision-making (including FRM) is an established principle, underpinned by a comprehensive statutory framework (e.g. ICWE, 1992; UNEP, 1992; UNECE, 1998; EC, 2000, 2003, 2007). Expert knowledge *per se* is increasingly seen as insufficient for informing decisions concerned with specific local contexts (e.g. Wynne, 1992, 1993; Robbins, 2000; Cinderby and Forrester, 2005; Eden et al., 2006; Douglas et al., 2010). Instead, it is recognised that in many decision-making processes the adoption of a participatory paradigm (Brown and Damery, 2002; Reed, 2008; Barreteau et al., 2010) is needed so that those possessing both certified expertise and situated knowledge (which need not be mutually exclusive) can be

Fig. 2. Hebden Bridge town centre (left) and surrounding landscape (right).