SESAME

Small businesses and flooding – operational responses and long-term preparedness

Modelling Small and Medium Enterprises to assess ways that they can improve their response to flood events

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Aim

Within the EPSRC-funded SESAME project, the aim of our computer modellers is to develop a modelling and simulation approach to allow us to investigate how the behaviours of Small and Medium Enterprises* (SMEs) influence their business continuity during and in the aftermath of flood events. Given that SMEs account for 99.9% of all private sector businesses and approximately 47% of annual turnover (2014 figures), this could provide information of significant benefit to the United Kingdom's economy. In terms of losses to UK businesses, the Environment Agency has estimated the financial cost of the 2007 and 2012 floods at approximately £740 million and £600 million respectively.

*SME are classified according to number of employees (micro (<10), small (<50), medium-sized (<250)) and turnover or balance sheet total.

Approach

We are achieving this aim by using agent-based modelling, coupled with flood modelling, to simulate the behaviours of small businesses when they respond to flooding (see Figure 1). In our work, agent-based modelling involves capturing and representing the attributes, actions, interactions and dynamic behaviours of SMEs, and related organisations, such that simulation can be used to assess ways in which SMEs can improve their response to flood events. Put simply, we are developing computer programs that represent and simulate the actions and interactions of agents, such as individuals and organisations, in order to enable investigations of the consequences of different behaviours for business continuity.

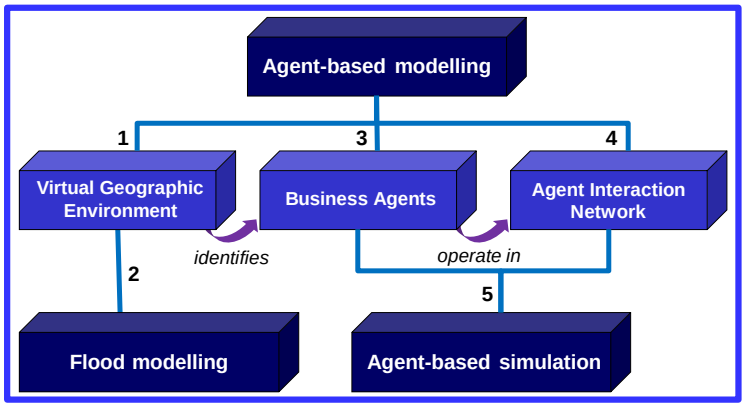

Figure 1: Approach to computer modelling and simulation

- **Stage 1** of our approach involves developing the virtual geographic environment in which the SME agents in the model will operate. To accurately represent the geographic environment of any location in the United Kingdom, three layers of Ordnance Survey's OS MasterMap® have been used: the 'Topography Layer' provides information on individual buildings; the 'Integrated Transport Network (ITN) Layer' provides information on the road network; the 'Address Layer 2' provides information on commercial properties including the precise location and the associated identification of the building in the Topography Layer and road link in the ITN Layer.
- **Stage 2** couples the virtual geographic environment with flood model output in order to identify the SMEs affected by the flood event that is being simulated dynamically. Two-dimensional hydrodynamic modelling of different

flood scenarios has been used to estimate flood inundation depths at regular time intervals in two case study areas: Sheffield and Tewkesbury. Figure 2 illustrates this with a map from the Lower Don Valley in Sheffield; this illustrates how the flood model's output (top) is fed into the virtual geographic environment (bottom) which, in turn, leads to the identification of which SMEs are affected at different time-points in the flood event.

- **Stage 3** involves writing computer programs that simulate the behaviour of individual agents, i.e. SMEs, related businesses and organisations. These programs use rules to govern the behaviour of agents and give them attributes relevant to a flood event being modelled. The content of these computer programs draws on a range of sources including semi-structured interviews with SMEs that have been flooded, the academic literature, Environment Agency guidelines, and the requirements of business continuity management systems (ISO 22301).
- **Stage 4** involves setting-up an agent interaction network to represent the different types of relationships existing between SME agents and other businesses/organisations modelled as agents such as customers, suppliers and service companies. This network, which is illustrated in Figure 3, will allow all agents to communicate and interact with one another in the simulations in Stage 5.
- **Stage 5** comprises a range of simulations that will assess the business continuity of SMEs when they employ different combinations of 'typical' and 'enhanced' behaviours. These simulations will provide data that can help small businesses when they review their behaviour in order to be better prepared for future flood events.

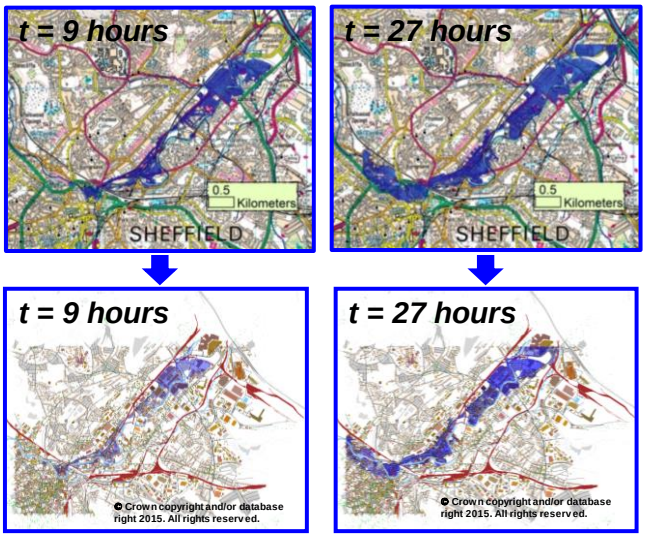

Figure 2: Identifying businesses in a flooded area

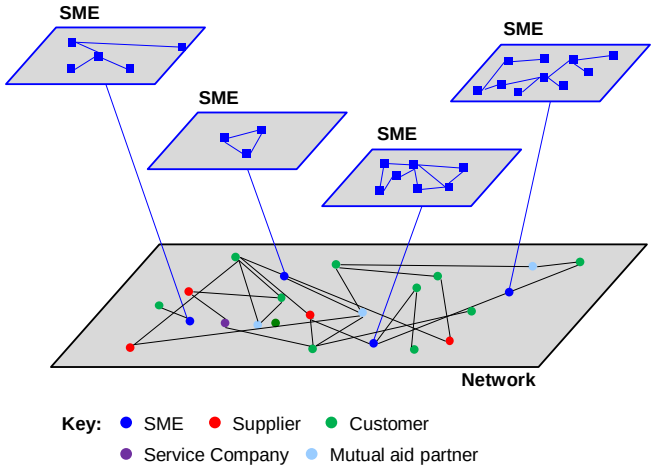

Figure 3: Agent interaction network

Current and future work

Current work is focused on modelling typical behaviours of SMEs in response to flooding and enhanced behaviours aimed at improving their response.

Future work will focus on the design of experiments to simulate SMEs during and in the aftermath of flood events to allow the investigation of the impacts of changed behaviours on operational response and business continuity.

Benefits to users

The computer modelling and simulation aspect of the SESAME project aims to investigate how SMEs' behaviours during and in the short-term aftermath of flood events influence their business continuity. This assessment of ways in which SMEs can improve their response to flood events will provide simulation based evidence which will inform guidance on how these businesses may better prepare for and respond to future events.

More information

Please visit our website at http://sesame.uk.com or contact Dr Graham Coates (graham.coates@durham.ac.uk).

Funding source

The authors gratefully acknowledge the funding provided by the UK's Engineering and Physical Science Research Council under grant EP/K012770/1.