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

Researchers

Dr Graham Coates and Dr Chunhui Li, School of Engineering and Computing Sciences, Durham University;

Prof. Nigel Wright, School of Engineering and Sustainable Development, De Montfort University;

Dr Sangaralingam Ahilan, School of Civil Engineering, University of Leeds;

supported by Dr Tim Harries (Kingston University), Dr Martina McGuinness and Dr Noel Johnson (University of Sheffield) and Prof. Lindsey McEwen and Dr Amanda Wragg (University of the West of England).

Aim

As set out in the SESAME project's previous modelling factsheet, the aim of our research is to develop a computer modelling and simulation approach (see Figure 1) to allow us to investigate how the behaviours of Small and Medium Enterprises (SMEs) influence their business continuity during and in the short term aftermath of flood events. In the United Kingdom (UK), SMEs (companies with less than 250 employees) account for 99.9% of all private sector businesses, 60% of employment and 47% of annual turnover. Given their importance, this investigation could provide information of significant benefit to the nation's economy.

Simulation experimental design

As reported in the previous modelling factsheet, our first step had been to develop software able to generate a virtual geographic environment of any area in the UK and integrate this with flood model output to obtain water depths at different times in the area considered. For a flood event modelled, this enabled us to identify the SMEs affected and to what extent. Next, our attention turned to the development of business agents and an interaction network so that we could simulate how businesses would behave within this model and how they would interact with each other and with other organisations. In collaboration with project partners we defined the *typical behaviours* governed by the actions of SME agents in response to flooding, and in addition the actions that reduce the impact of flooding (what we call *enhanced behaviours*); we wrote computer software to implement these. Subsequently, we designed a set of simulation experiments to assess the impact of different combinations of *enhanced behaviours* on business operations.

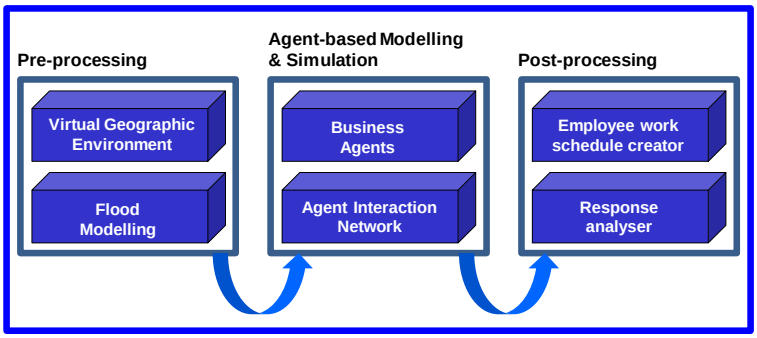

Fig 1: Computer modelling and simulation approach

In our model, 26 *enhanced behaviours* were defined. These were categorised as being *physical* (x14) or *social* (x12). Physical behaviours were then sub-divided into those we felt were relatively *easy to implement* (x6 - e.g. raising the level at which raw materials are stored), and those that were *harder to implement* (x8 - e.g. raising the levels of electrical sockets and consumer boards). Similarly, social behaviours were sub-divided into *internal* social behaviours (x6 - e.g. performing emergency flood exercises) and *external* social behaviours (x6 - e.g. identifying mutual aid partners after a flood). In addition to enhanced behaviours, our model includes a range of variables such as the number of electricians and cleaning service companies available to meet the demands of flood affected SMEs, the number of employees returning to work shortly after a flood and the likelihood of SMEs establishing mutual aid agreements. Combinations of these variables and enhanced behaviours constitute a rich data set from which we will identify those behaviours, or combinations of them, most likely to help SMEs better prepare for and respond to future flood events.

Preliminary simulations

In the two case study areas considered in the modelling aspect of the SESAME project, namely Sheffield and Tewkesbury, our agent-based modelling has focused on manufacturing SMEs since this type of business is amongst the most prominent in these geographical areas and many of them were severely affected by the significant flooding in 2007.

Figure 2 shows, for one flood scenario, the estimated effects of different combinations of *enhanced behaviours* on the production capacity of flood affected SMEs. The figure shows how production capacity would change hour by hour (with each tick signifying half an hour), given the number of employees and machines available for production, if there were a power supply to the premises and sufficient raw materials available for this level of production.

The scenario associated with Figure 2 is a one in 1000 year flood event as it would affect micro-sized SMEs (less than 10 employees) in Sheffield's Lower Don Valley. This size of company accounts for 95.5% of all SMEs according to the UK Government's 2015 figures. Simulations are also being considered for larger sized SMEs.

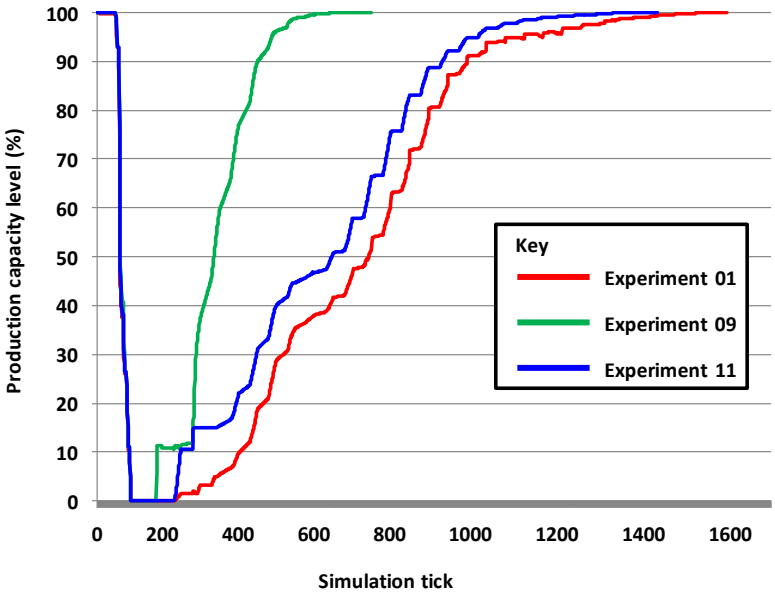

Fig 2: Production for manufacturing micro-sized SMEs

Figure 2 compares the production capacity level of micro-sized SMEs with: (a) no enhanced behaviours (Experiment 01); (b) the most common of the physical enhanced behaviours (Experiment 11); (c) all of the (physical and social) enhanced behaviours (Experiment 09). In the simulation, the flood event modelled started at tick 60 (day 2) and ended at tick 140 (day 3). As shown, for SMEs that had implemented all physical and social enhanced behaviours, production capacity level, on average, returned to 100% at approximately tick 600 (9.5 days after the flood water receded). This did not occur until approximately tick 1550 (29.3 days) for SMEs that had not implemented any enhanced behaviours.

Current work

Current work is focussing on conducting experiments that simulate the impact of enhanced behaviours on the operational response of SMEs during and in the short term aftermath of flood events.

Benefits to users

SESAME's computer modelling and simulation research aims to enable an investigation into how SMEs' behaviours during and in the short-term aftermath of flood events influence their business continuity. This assessment will identify ways in which SMEs can improve their response to flood events and will thereby provide simulation-based evidence to inform guidance on how these businesses may better prepare for and respond to such events in the future.

More information

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

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