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# SESAME

*Organisational Operational Response and Strategic Decision Making for Long Term  
Flood Preparedness in Urban Areas*

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**Annual Report  
2015**

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## Introduction

In 2015, all four Work Packages of the EPSRC-funded SESAME project have made important progress with each working towards their respective goals. Collectively, the achievement of these goals will deliver the project's aim of creating a unified framework of academic knowledge that can be used to influence the behaviours of small businesses faced with flooding and flood risk. As a reminder, the achievement of this aim is being pursued via four interdisciplinary research objectives:

- (1) achieve a better understanding of business continuity processes and how private and public sector organisations behave and interact with each other in the immediate and longer term aftermath of flood events;
- (2) establish how agent based modelling and simulation can improve organisational business continuity by means of representing attributes and simulating actions, interactions and the dynamic behaviours of different types of at-risk organisations and the consequences of these for both the short-term response to flooding and longer-term preparedness;
- (3) assess the impacts of flooding on economic systems both within and beyond the immediately affected urban area and explore how changed behaviours could influence these impacts;
- (4) develop and critically evaluate innovative approaches to the promotion of organisational behaviour change and adaptive organisational learning throughout the flood cycle.

In 2015, Work Package 1 (Durham) has focussed on (i) the continued development and implementation of software agents to model the behaviours and attributes of small and medium

enterprises (SMEs) in terms of responding to and recovering from flood events, along with models of related organisations such as suppliers, customers and service companies, and (ii) conducting preliminary agent-based simulations involving manufacturing-engineering SMEs. Also in Work Package 1, De Montfort and Leeds have used hydrodynamic modelling to simulate the 2007 flood event in the case study area of Tewkesbury. Work Package 2 (Sheffield) has made progress in relation to collecting further case study data, engaging with stakeholders, organising SESAME dissemination events, and reviewing social media for flood data collection. In Work Package 3 (East Anglia), work has focussed on economic modelling at the city scale level leading to a flood footprint model of the City of Sheffield and an analysis of the 2007 floods. Colleagues related to Work Package 4 (West of England and Kingston) have focused on developing and evaluating the co-production research processes in the development of the prototype e-learning tool.

In 2015, there has been further integration across the various work packages. Such activities include establishing the details of the small business behaviours modelled, implementing the e-learning tool.

At the end of this report, a list of publications and engagement activities is given, which provides an indication of the increased dissemination of the different strands of research being undertaken by colleagues from the work packages of the SESAME project.

### Dr Graham Coates

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# Work Package 1

## Agent-based modelling and simulation at an organisational level

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

Professor Nigel Wright (School of Engineering and Sustainable Development, De Montfort University)

Dr Sangaralingam Ahilan (School of Civil Engineering, University of Leeds)

### Aims

Work Package 1 is aimed at developing an agent based modelling and simulation (ABMS) approach, coupled with flood modelling, to enable the investigation of small businesses' behaviour in the face of flood events. Achieving this aim involves developing:

- the agent-based model's (ABM's) virtual geographic environment, which is able to combine Ordnance Survey information with flood model output, to identify the businesses affected by flooding;
- agents to model businesses in terms of their attributes, behaviour, actions and interactions in response to flood events;
- an agent interaction network to enable simulations to be performed thus informing longer term preparedness.

### Progress

In 2015, Work Package 1 has focussed on a number of areas of work. For the purpose of this report, Figure 1 provides an overview of the areas in which progress has been made.

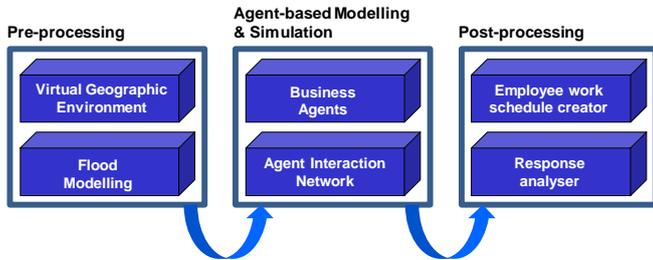


Figure 1: Overview of progress in Work Package 1

Durham has concentrated its efforts on: (a) 'pre-processing' which has involved using the ABM's virtual geographic environment (VGE) to identify and classify the businesses and organisations within the case study areas considered, and based on inundation data for the particular flood scenario modelled, which of these businesses is flooded and to what extent in terms of depth of water and length of time; (b) 'agent-based modelling and simulation' which has been directed toward the further development of software agents to model SMEs in terms of their behaviour and attributes relevant to responding to and recovering from flood events and, at the same time, the development of the interaction network containing agents representing other related organisations such as suppliers, customers and service companies; (c) 'post-processing' to analyse the operation and performance of SMEs during and in the short-term aftermath of flooding. De Montfort and Leeds have performed hydrodynamic modelling of the July 2007 flood event in Tewkesbury, Gloucestershire. As in the previous case study area of Sheffield's Lower Don Valley, hydrodynamic modelling has provided estimated water depths at regular time intervals during the simulated flood event which, after an analysis via the VGE software, is used as input for ABMS.

### Pre-processing

#### Using the VGE to classify businesses and organisations

The ABM's VGE software classifies businesses and organisations according to the National Land Use Database (NLUD) code, which consists of 41 groups, within the Address Layer of OS MasterMap®. For the two case study areas of Sheffield's Lower Don Valley and Tewkesbury, an analysis has been performed by Durham using the VGE software to identify the types of businesses in these areas as shown in Figure 2. Within the Sheffield and Tewkesbury case study areas, the VGE identified 5570 and 692 business/organisations respectively. Further, as shown in Figure 2, retail (U091 for shops, U092 for financial and professional services) along with industry and business (U101 for manufacturing, U102 for offices) are shown to

dominate in both case study areas modelled. Furthermore, the percentage of businesses in the NLUD groupings is shown to be similar in both case study areas.

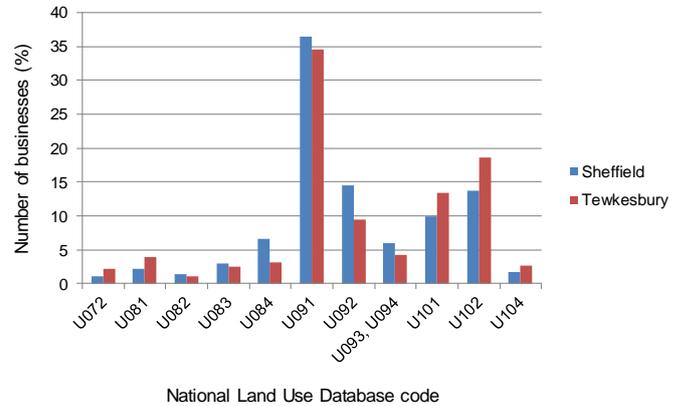


Figure 2: Breakdown of business/organisation by type (>1% share)

This analysis represents an important step within Work Package 1's modelling framework as it provides input for the ABM in terms of identifying the precise geographic location of each SME along with their type and, based on inundation data for the particular flood scenario considered, which of these businesses experiences flooding and to what extent in terms of depth of water and length of time.

### Flood modelling

As reported last year, Leeds has performed simulations of one in 200 year and one in 1000 year flood events of the River Don at the Lower Don Valley region of Sheffield. This year, progress has focused on the simulation of the July 2007 flood event in Tewkesbury which was severely affected when the combined pluvial and fluvial floods hit the city. The heavy rainfall overloaded drainage systems due to the influx of surface water, and very high water levels in two main rivers, namely the Severn and Avon, led to flooding in most areas of Tewkesbury which lasted about two weeks. Simulation results of the July 2007 event, based on the 2D LISFLOOD-FP model of Tewkesbury at 10m resolution developed by Bristol University, are shown in Figure 3.

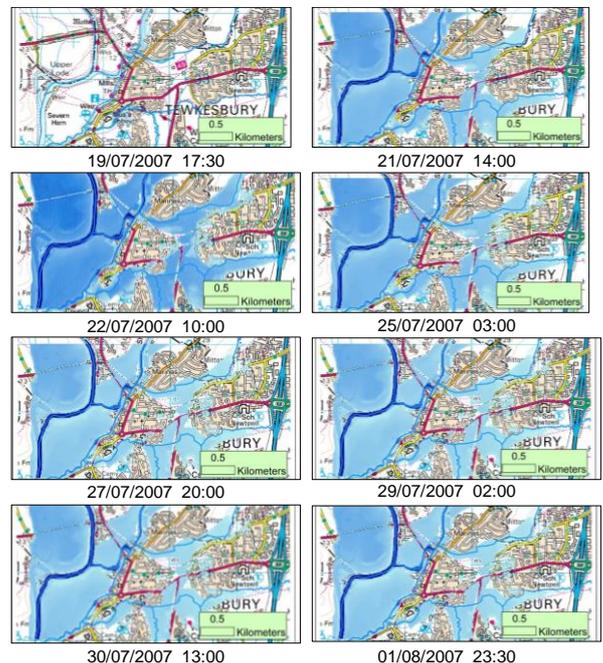


Figure 3: 2007 flood simulation results for Tewkesbury

# Work Package 1

## Agent-based modelling and simulation at an organisational level (continued)

As shown in Figure 3, essentially, Tewkesbury becomes an island, particularly in the high street area. The same observation was recorded by team members in Work Package 4 during their interviews with SMEs from the flood affected area.

### Using the VGE with inundation data from flood modelling

For the Tewkesbury case study, the inundation data associated with the maps shown in Figure 3 provide the input for the ABM's VGE, which, in turn, provides input for agent-based simulations. As an example, based on inundation data for Tewkesbury, VGE output is shown in Figure 4 which corresponds with 10.00 a.m. on 22 July 2007. In agent-based simulations, the provision of dynamic inundation data enables agents representing flooded businesses to act accordingly in light of the depth of water at their respective premises at different times throughout the flood event modelled.

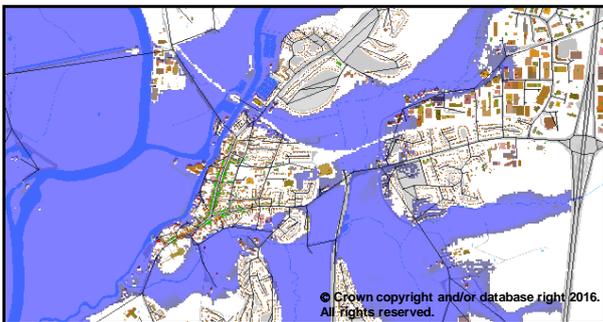


Figure 4: VGE output - Tewkesbury flood, 22/07/07 (10.00 a.m.)

In preparation for carrying out agent-based simulations, in addition to the VGE analysis of the inundation data for Tewkesbury, an analysis has been performed for a one in 1000 year flood event of the River Don at the Lower Don Valley region of Sheffield.

### Agent-based modelling and simulation

#### Attributes and behaviours of businesses modelled as agents

Throughout 2015, effort has primarily been directed at implementing the code for *existing* and *potential behaviours* for SMEs in the engineering-manufacturing sector. As indicated in last year's report, business agents' attributes and behaviours have been derived from a number of sources: (a) information extracted from transcripts of semi-structured interviews conducted by colleagues from Sheffield, UWE and Kingston (Work Packages 2 and 4) with SMEs at risk of flooding and/or which have experienced flooding; (b) discussions with colleagues from Sheffield, UWE and Kingston to ensure the attributes and behaviours, and the relationships between behaviours, being used to model SMEs are appropriate and relevant; (c) Environment Agency literature providing advice for businesses preparing for flooding; (d) literature detailing business continuity management (BCM) systems' requirements (ISO223301). In this work package, we refer to SME behaviours extracted from interview transcripts as *existing behaviours* whereas those found in EA and BCM literature are referred to as *potential behaviours*. This distinction is made as it provides the basis for a comparative analysis in our modelling environment in terms of what SMEs did when flooded in the past and what they may do in the future.

#### Agent interaction network

Simulations of the behaviours of business agents during and in the short term aftermath of a flood event has required the development of other agents to model organisations such as suppliers, customers and service companies. In addition, relationships between SMEs and these organisations have been modelled since some of them will influence the response and recovery of an SME when a flood event occurs. For, example, the existence of a pre-agreed priority relationship between an SME and a service company may lead to preferential treatment thus expediting recovery and resumption of normal operations. Similarly, the existence of a pre-existing mutual aid agreement between SMEs may enable the flood affected SME to

resume some degree of production operations, in the case of engineering-manufacturing SMEs, thus enabling customer demands to be met to a greater degree than if such an arrangement was not in place.

### Preliminary simulations and design of experiments

As part of the process of developing and implementing the code for SMEs' *existing* and *potential behaviours*, preliminary simulations have been conducted in order to assess the functionality of the software. For illustrative purposes, sample output from a preliminary simulation is shown under 'post-processing'. In terms of future simulations, we are currently designing experiments for simulations which will enable us to assess the effect of different combinations of behaviours in terms of the performance of the small businesses modelled.

### Post-processing

#### Analysis of preliminary simulations

Simulating small businesses during and in the short-term aftermath of flood events enables what-if scenarios/experiments to be performed in order to investigate the effect of different behaviours in terms of operational response and business continuity. As alluded to earlier, for illustrative purposes, output from a preliminary simulation for a manufacturing-engineering SME with a mutual aid agreement in place is shown in Figure 5. In this particular simulation, the SME operates normally until an EA warning is received (green arrow) at which point employees undertake activities such as lifting up equipment and sealing doors. Subsequently, employees evacuate the premises once the flood water approaches then enters the SME's property (amber arrow). During the flood, a proportion of the SME's machines are damaged and raw materials ruined due to the water depth reached. With some machines inoperable and raw materials lost, the SME's ability to manufacture products once the flood water has receded (amber arrow) is degraded. However, in the recovery period, due to a pre-existing mutual aid agreement with another SME, some agreed level of production at the other site is possible while recovery takes place at the flood affected SME's own premises. Simultaneously, those employees not re-located to the mutual aid partner's site work on recovery tasks including fixing machinery and eventually some become available for production once it is able to be resumed. As shown in Figure 5, as machines become available, production capacity increases.

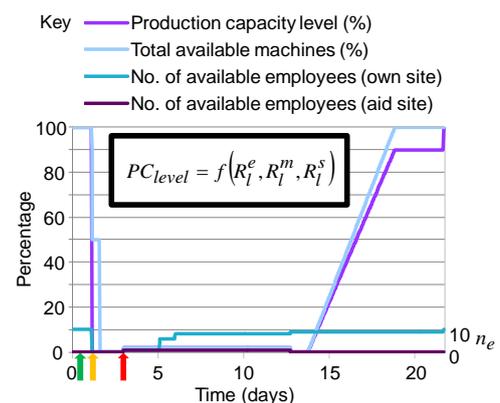


Figure 5: Sample output for an SME with mutual aid

### Future plans

In 2016, in addition to disseminating the research by preparing conference and journal papers, Work Package 1 will focus on making progress in a number of areas of agent-based modelling and simulation.

- Implement behaviours and attributes for retail sector SMEs.
- Perform benchmark simulations of SMEs for *existing behaviours*.
- Design experiments of simulations to investigate the effects of different combinations of *potential behaviours* for an SME.
- Commence simulations based on SMEs exhibiting *existing behaviours* and *potential behaviours*.

# Work Package 2

## Business continuity processes

Dr Martina McGuinness and Dr Noel Johnson (Management School, University of Sheffield)

### Aims

The aims of Work Package 2 are:

- to gain an understanding of businesses' response to flood events within their local, regional and national context, and behaviours of SMEs from their experiences of responding to flood events;
- to gather data which will help to inform ABMS (Work Package 1), feed into economic impact analysis (Work Package 3), and complement organisational learning and related e-learning initiatives (Work Package 4).

### Progress

Building on activities over the past two years of the project, progress has been made across a number of key areas: case study data collection; data analysis; research outputs; stakeholder engagement; dissemination events. There have also been further developments in collaboration and integration across the different work packages. Scoping has also been carried out for the final data collection activity using social media.

### Case studies

Six case studies have now been undertaken as part of this work package, comprising of 80 interviews. In order to best capture a range of organisational experiences and behaviours, efforts have been made to identify case studies for investigation which: (i) represented different types of flood event i.e. fluvial, pluvial and coastal; (ii) included businesses from a variety of sectors; (iii) spanned different time periods. Table 1 summarises this information.

Case study	Year	No. interviews	Flood type
Sheffield	2007	28	Fluvial
Tewkesbury	2007	17	Pluvial/Fluvial
Tyneside	2013	6	Coastal/Pluvial
Warwickshire	2007	17	Fluvial
Wirral	2013	6	Coastal/Pluvial
Romsey	2014	6	Pluvial/Fluvial

Table 1: Case studies

In doing this, our aim is to capture both commonalities of experience but also to capture any points of difference arising from different sectoral paradigms. We report on some interesting data in this regard in our emerging findings.

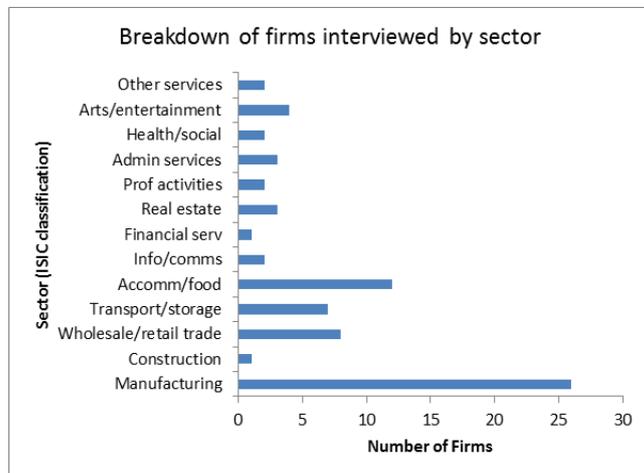


Figure 6: Sectoral breakdown of participant firms

Our approach also optimises the potential to capture the impact of a changing institutional landscape upon flood response and recovery. So, for example, the most recent case study of Romsey provides data on response and recovery from businesses which were able to access central government funds for flood recovery; monies not available to businesses in other case studies. Similarly, our work in Sheffield has been more extensive than in other case studies to permit the investigation of novel public/private collaboration undertaken in the city in the wake of the 2007 flood. This includes the establishment of a Business Improvement District (BID) to support flood resilience in the Lower Don Valley. As set out in previous reports, our approach has been based upon semi-structured interview as the primary method of data collection.

As part of collaboration with the ABM being carried out in Work Package 1, we have also gathered some additional data from participants in the form of a brief survey to provide inputs for the modelling. We are now moving forward with the final stage of data collection, from social media. This has been left until the later stages of the SESAME project to allow us to capture data from more recent flood experience (extending the temporal boundaries of the data).

### Emerging findings

A significant trend to emerge from the data is that whilst there is a range of guidance available to SMEs, from organisations such as the Environment Agency, we find that few small businesses have formal planning and preparedness for flood risk. Reasons that businesses cite for limited formal planning include a lack of knowledge about how to do this planning, even though they may be aware that the guidance exists, as well as resource limitations such as time and cost. Even after the, often traumatic, experience of being flooded, many businesses we interviewed have not implemented formal preparedness measures as recommended in guidance aimed at their sector.



Figure 7: Sectoral breakdown of participant firms

Nonetheless, the businesses that we have spoken with have all demonstrated, to some degree or another, resilience to a flood event. Our data suggests that this resilience has some foundation in the fundamental nature of the firms themselves. Small businesses' day-to-day experience is often characterised by resource limitations as they do not have the scale of assets available to their larger counterparts. Thus, we find many businesses have developed capabilities, over time, to optimise the limited resources that they have for running their normal operations e.g. flexibility, quick decision making and innovative approaches to problem solving. These are powerful tools in aiding resilience to a flood event.

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## Work Package 2

### Business continuity processes (continued)

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More specifically, we find that this skill set is also strongly influenced across different levels, such as, the industry or sector paradigm and the firm's own past experience. In other words, key attributes such as innovation and flexibility can be highly path dependent. As an example, the picture opposite shows how one engineering/manufacturing firm fixed a high tension wire across a flooded street adjacent to their premises to enable stranded staff to make their way to safety. Firstly, this illustrates the way in which one business brought their engineering approach to problem solving. It also shows them utilising their product in a novel way to solve the problem faced by some of their employees. The latter arguably reflects the firm's pre-existing mind set of searching for new ways to deploy their products in order to unlock new markets for the business.

Insurance for flooding emerges as a major issue for SMEs at all stages of the flood cycle. Some businesses, which had not previously perceived themselves to be vulnerable to flooding, were not sure whether they had cover for losses arising from flooding until they spoke to their broker, or insurer, in the immediate aftermath of the event. The speed of claims settlement and how soon insurance payments are received is important in the length of time that it takes for the firm to return to normal operations. A flood event typically impacts upon a number of businesses in a locale at the same time. This can create pressure upon brokers and insurers due to the volume of inquiries and claims within a short time frame, and some businesses felt that this impacted upon their ability to recover as rapidly as possible. A number of firms cited good relationships with insurance brokers as key in facilitating quick and fair claims settlement whilst others experienced delays arising from their inability to quickly provide evidence required by their insurers.

These findings have important implications for the guidance that we aim to produce to assist business resilience to flooding. Firstly, given that pre-existing informal competences and networks can underpin effective resilience to a flood event, guidance should be explicitly focus upon helping business to optimise that resource base in a way in which they find accessible and easy to understand. Secondly, our data indicates that there are certain practical measures in the response phase of a flood that can have important ramifications for business recovery and financial sustainability in the longer-term. These issues shall be incorporated into the proposed guidance for small businesses.

#### Research outputs and related activities

Work has continued on academic focussed outputs with two papers at an advanced stage (a systematic review of business continuity management; adaptive capacity in SMEs). A third paper, in collaboration with Work Package 4, on flood insurance is in development. A paper has also been accepted for presentation at FLOODrisk 2016.

Findings from work undertaken as part of the SESAME project have also fed into applications for additional interdisciplinary projects, which funding has been successfully obtained. These include:

- 'Increasing Civil Society's Capacity to Deal with Changing Extreme Weather Risk: Negotiating dichotomies in theory and practice', ESRC seminar series programme £29,811, 2016-19. Grant reference: ES/N008944/1 (McGuinness Co-Investigator);
- 'TWENTY 65: Tailored Water Solutions for Positive Impact', funded by EPSRC Grand Challenges programme £3,917,265, 2015-20. Grant reference: EP/N010124/1 (McGuinness Co-Investigator).

#### Stakeholder engagement and dissemination activities

We have also continued to engage with national and international audiences which span academe, policy and practice. During 2015, McGuinness fed findings from the project into UK based projects involving the UK Water Partnership (Action Group on Floods and Drought) and Business in the Community (Forces for Change: Global Megatrends). The former published its report in July and Business in the Community launched the new framework at its annual conference (May). McGuinness was an invited speaker at a workshop for academics and practitioners held in Miami in February (UK-US Social Responses to Emergencies) whilst Johnson won funding for participation in a Development of Disaster Resilient Coastal Communities workshop in Bandung, Indonesia in October/November. Details of these activities are included at end of this report.

#### Future plans

Over the final months of the project, work will focus on the following:

- dissemination event to be held in Sheffield (April 2016);
- drafting of guidance for SMEs on flood resilience;
- submission of papers (i) systematic review of business continuity management and (ii) adaptive capacity the two papers;
- completion of case study interview data utilising Nvivo software
- cross work package collaborative outputs, including completion of a paper on insurance;
- completion of the data collection from new technologies.

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## Work Package 3

### Business continuity processes

Dr Dabo Guan and Mr David Mendoza  
(School of International Development, University of East Anglia)

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#### Aims

Analysis of the economy and society is central to understanding the broad impacts of flooding and identify cost-effective adaptation and mitigation measures. Assessments of flooding impacts have traditionally focused on the initial impact on people and assets, which are useful in understanding the immediate implications of damage, and in marshalling the pools of capital and supplies required for re-building post event. Since different economies and societies are coupled, especially under the current economic situation, any small-scale damage may be multiplied and cascaded throughout wider economic systems and social networks. Work Package 3 sets out to gain an improved understanding of the economic impacts of floods on SMEs, and the knock-on effects on the wider economy. Taken together, these can be described as the *flood footprint* - a measure of the total direct and indirect economic impacts caused by a flood event to the area that is flooded and to wider economic systems. To quantify the economic impact of flood events beyond the immediate local urban area affected, a flood footprint model is to be constructed based on adaptive input-output analysis. Work Package 3 involves:

- adapting the city scale Adaptive Regional Input-Output (ARIO) model to quantify the cost-benefit of adaptation measures for case study cities from a macroeconomic perspective.
- linking the city scale ARIO model with national input-output tables (for each case study city) to estimate the cost of local flooding to the national economy.
- integrating the ARIO model with results produced by Work Packages 1 and 2 to study the flood impact on SMEs and the economic benefits of SMEs' preparedness and adaptation.

## Work Package 3

### Assessment of flooding impact on urban areas and wider economic systems (continued)

#### Progress

##### City scale modelling

As the model is based on Input Output (IO) tables, i.e. a compendium of national economic transactions among industrial sectors/agents, the 'regionalisation' of the data was needed. The process of scaling down the national tables was done using statistical techniques, which consider the region's economic structure and the regional share of the national economy. The data for the regionalisation of the IO tables comes from the Cambridge Econometrics' Multi-sectoral Dynamic Model, which provides regional disaggregation at 46 industrial sectors. Also, we developed the ARIO model at monthly intervals based on seasonal production data from the National Statistics Office.

##### Case study

Flood footprint modelling requires substantial amounts of data concerning the behaviour of producers and consumers. Given the SESAME project's study of the consequences of small businesses responses to previous flood events, it offers unique access to data for the calibration the flood footprint model. The information comprises the characterization of each interviewed business, the damage suffered in previous flood events, their response to allocate remaining resources to different client categories, labour reaction and adaptation. This information defined the behavioural parameters of the model for assessing the total economic impact of past flooding in the City of Sheffield.

##### Results

The model estimates that after the 2007 flood it would have taken at least 17 months for Sheffield's economy to fully recover to the pre-disaster level. The flood footprint is £511 million, or 6.2% of the city's annual gross value added. As shown in Figure 8, the direct and indirect footprint ratio is almost 1:1, i.e. £286 million and £225 million respectively. The recovery path shows a tendency for recovery to be fast in the first months of the aftermath, whereas it slows down when the economy approaches its pre-disaster level.

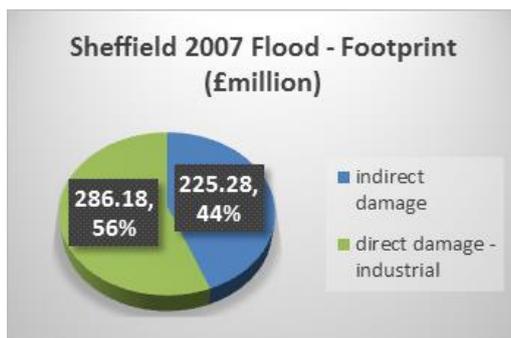


Figure 8: Relation direct/indirect damage

The direct damage is concentrated in three sectors: electricity and gas; land transport, and warehousing and postal. The direct damage in these sectors accounts for over half of the total direct damage. Electricity and gas account for £76 million or 26% of total damage. The remainder of the direct impact was more uniformly distributed among manufactures (e.g. food, metals, chemicals, etc.) and some services sectors with a range of damage between £4.5m and £16m. Among those sectors which were almost unaffected are professional and businesses services (e.g. legal and accounting, architectural and related, and other professional services). In the case of indirect damages, the most affected sectors were the businesses and support services with £15 million (7% of total indirect damage) and financial and insurance services with £13 million (6% of total indirect damage).

## Work Package 4

### Adaptive e-learning and behaviour change throughout the 'flood cycle'

Professor Lindsey McEwen and Dr Amanda Wragg (Dept of Geography and Environmental Management, University of the West of England)

Dr Tim Harries (Business School, Kingston University)

#### Aims

This work package has two aims. The first is to understand what influences whether and how small businesses make long-term adaptations to flood risk. The achievement of this first aim has fed into the development of the agent based model (ABM; WP1), and is helping achieve the second aim of the work package. This is the development of a prototype intervention for the promotion of business adaptation; this could, eventually, be made available across the UK.

The academic literature suggests that the best way to change SME behaviours around flood risk is by embedding learning within relationships of trust and respect, and to take care to couch all communications in a way that is familiar to businesses. The development of the tool therefore needs to take place alongside the building of relationships and trust between SMEs, other businesses, and the organisations that work with them in resilience building. The tool will also provide a virtual space in which SMEs can engage with flooding issues in terms that are familiar to them, so that they can recognise and address their own priorities for adaptation. The final intervention tool is currently emerging from a process of co-production – i.e. iterative engagement between the team, SMEs and national/regional stakeholders in business resilience.

#### Progress

Over the past year, the WP4 team has focused on developing and evaluating the co-production research processes in the development of the prototype e-learning tool to a stage where the tool can be piloted with specific business groups. This has involved working with businesses, and those organisations that support businesses with their resilience planning. The aim has been twofold: to explore the processes of 'co-production', and to research and develop a prototype tool. This phase of the work built on several sources of information: a literature review of the international literature on business learning (from Phase 1); the Phase 1 interviews with small businesses in Tewkesbury, Sheffield, Swindon and Tyneside; consultations with groups of stakeholders from a wide range of flood risk management/ business resilience organisations and with small businesses from Tewkesbury; and engagement with businesses at the Sheffield Festival of Ideas (ESRC) (two workshops co-run by WP1, WP2 and WP4).

Co-production within the research process has involved the development of two separate groups:

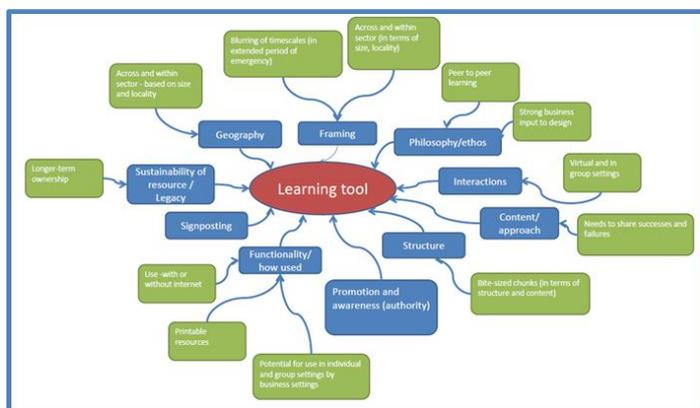
- *The Stakeholder Competency Group (SCG)* comprising national and regional organisations (15 people) that work with small businesses for increased resilience. The organisations included: Business in the Community; Federation of Small Businesses; local government (flood planners); the National Flood Forum; local resilience fora; and rural community councils (business advisers). This group has progressively increased its number of participants to 15, and has provided opportunities for new and rich exchanges about business resilience between different organisations.
- *The Business Research Partnership Group (BRPG)* comprising businesses from Tewkesbury, UK (10 people; including representation from the retail sector, transport, catering, leisure, health and manufacturing). Many of these businesses had been interview respondents in Phase 1 of the project. At the outset, the group had not previously met together to discuss the 2007 floods. This group was observed to undergo a transformative process as the co-production process progressed. This is being researched.

## Work Package 4

# Adaptive e-learning and behaviour change throughout the 'flood cycle' (continued)

In the development of the e-learning tool, we used a process known as co-production, whose aim is to engage a range of partners, and to integrate the contributions of representatives of all those with a stake in the project aims and outcomes. To this end, we first engaged all our partners in developing the framework for the e-learning tool – i.e. the concept, structure, design, content, media and messages. We used a range of different media to deliver the content: text; digital stories (2-3 minute audio recordings played over personal images selected by the storyteller); interactive process flow-charts that explored business decision-making priorities and processes; and films of academic experts discussing technical issues with businesses. In addition, we used social media to promote business-to-business communication

The meetings with the SCG and BRPG formed an important stage in the development of the research process by providing information that informed the specification of the tool. For example, Figure 9 shows a mind map generated from the first SCG meeting.



**Figure 9:** Mind-map generated from discussion of the tool design with organisations that support businesses

The prototype tool is now being developed around the following themes: customer and supplier relationships; financial strategy before, during and after floods; understanding local flood risk and flood-building interactions; resistance/resilience strategies for reducing physical flood impacts; relationship building between the business and the 'community'; working differently as a business; and building individual strength and developing coping strategies. As suggested in discussions with the SCG and BRPG, a variety of media are being incorporated into the tool to contribute to these themes including:

- *Written narratives* that draw on stories of business adaptation captured in the Phase 1 interviews.
- Six *digital narratives* that capture the different adaptations of businesses after the 2007 floods (all co-produced with business people from Tewkesbury).
- *Interactive learning activities* that focus on decision-making for property resilience, financial strategy and rethinking business processes. (Data from these interactive games will be shared with the users of the tool and with the wider SESAME team.)
- *Films of business people in discussion with scientists* about local flood risk and property-level resilience. Taking a different approach to science communication from the traditional 'talking head podcast', these co-produced films were created in the spirit of two-way Business and Science Exchanges that showcase the value of integrating local/lay knowledge and scientific knowledge.

Since July 2015, the team has been working with Hot Pepper Design, Swindon, on the specification and design of the e-learning tool. This process will be complete in February 2016. Particular attention is being given to strategies to ensure the sustainability of the tool, and to how to keep it dynamic after the funded lifespan of the project.

The prototype tool was reviewed with the Stakeholder Competency Group and Business Research Partnership Group at a combined workshop in December 2015. This meeting had three aims: to review current progress with the e-learning tool and gain feedback for the final stages of the development; to celebrate local contributions to the tool; and to collect research data on the co-production process by reflecting on the experiences of being involved in the development of the tool.

### Future plans

We plan to trial the tool within Tewkesbury and Gloucestershire business communities from February to May 2016 in collaboration with Tewkesbury Borough Council. At the same time, additional research will explore the effectiveness of the narrative approach taken in the tool. A final inter-professional dissemination workshop for the full SESAME project will take place in Tewkesbury in May 2016.

### Dissemination

The dissemination plan for research and knowledge exchange for WP4 is provided below. Attention is given to maximising impact across several different communities - disciplinary, professional, practitioner and business audiences. The Taunton event (detailed below) involved giving a presentation about the SESAME project to local businesses in Somerset, and delivering a workshop. A member of the research team also attended a workshop in Bournemouth which involved interacting with, and learning from, local businesses from Dorset.

- Refereed journal articles
  - Paper on issues influencing SME adaptation to flood risk – e.g. Journal of Risk Management
  - Paper on knowledges and learning for SME resilience – Environment & Planning C
  - Paper on SMEs and flood Insurance (working with WP2) – e.g. International Small Business Journal, Journal of Flood Risk Management
  - Paper on the co-production process – e.g. in Journal of Flood Risk Management
  - With WP1 and WP2, paper on involving social science in the generation of an agent based model – in a modelling journal
- Conference presentations
  - European Geophysical Union, Vienna – May 2015
  - Presentation - FCERM Conference, Edinburgh, May 2015
  - International Water Congress – Heriot Watt, May 2015
  - FLOODrisk 2016 – Lyons, France
  - Defra/EA Flood and Coastal Erosion Risk Management conference, 2016
- Contributions to webinars/workshops
  - Presentation to SW stakeholders (University of Exeter Climate Change event, Taunton) – June 2014
  - Contribution on co-production to FCERM Webinar series (July 2014)
- Web media
  - Public blog following the development of the e-tool - [blog4Sesame.press.com](http://blog4Sesame.press.com) – has involved contributions from SCG; listserv for WP4's collaborators;
  - Twitter feed: @Resilient\_SME

### Legacy

A key consideration in ensuring a legacy for this project is finding a home/adopter for the embryonic learning tool. Current possibilities include the Federation of Small Businesses and the National Flood Forum (both of which are represented on the SCG). We are also in discussion with the Business Emergency Resilience Group (which sits within Business in the Community and is funded by the Prince of Wales) and the Cabinet Office, both of whom are in the early stages of developing their own web-based crisis resources for small businesses.

## Publications

### Forthcoming in 2016

- Coates, G. et al. 'SESAME: Exploring new ways of modelling organizational behaviour to enhance resilience to flooding', In Proceedings of the 3rd European Conference on Flood Risk Management, Lyon, France, 17-21 October 2016.
- McEwen, L.J., Wragg, A., Harries, T. Increasing business resilience to flood risk: Developing an effective e-learning tool to bridge the knowledge gap between policy, practice and business owners. 3rd European Conference on Flood Risk Management, Lyon, France, 17-21 October 2016.
- McGuinness, M., Johnson, N. 'Flood resilience in the context of shifting patterns of risk, complexity and governance: An exploratory case study', 3rd European Conference on Flood Risk Management, Lyon, France, 17-21 October 2016.
- Coates, G., Li, C., Wright, N.G., Ahilan, S. 'An investigation into the flood responsiveness of Small and Medium Enterprises using agent-based modelling and simulation', In Proceedings of the 5th International Conference on Flood Recovery, Innovation and Response (FRIAR 2016), Venice, Italy, 29 June – 1 July, 2016.
- Wragg, A., McEwen, L.J., Harries, T. Barriers and motivators to flood risk adaptation for small business owners: sense-making within localised contexts within the UK. European Geosciences Union General Assembly 2016, Vienna April 17-22nd April 2016.

### 2015

- Harries, T., Coates, G., McEwen, L., McGuinness, M., Guan, D., Johnson, N., Li, C., Wragg, A., Wright N.G., Ahilan, S. 'The SESAME project on small businesses: understanding flood impacts, evaluating the effects of adaptation and promoting resilience', World Water Congress XV, Edinburgh, Scotland, 25-29 May 2015. (Abstract only)
- Johnson, N. 'SME adaptive capacity to flooding: Findings from the UK', presentation to 'Development of Disaster Resilient Coastal Communities to Enhance Economic and Social Welfare Workshop', 28 October-1 November 2015, Bandung, Indonesia.
- Li, C., Coates, G. 'Design decisions in the development of an agent-based model for business operations when faced with flood disruption', In Proceedings of the International Conference on Complex Systems in Business, Administration, Science and Engineering, New Forest, England, 12-14 May 2015.
- Li, C., Coates, G., McGuinness, M., Johnson, N.J. 'Designing an agent-based model of SMEs to assess flood response strategies and resilience', In Proceedings of the International Conference on Flood Resilience (ICFR 2015), Zurich, Switzerland, 13-14 January 2015.
- McGuinness, M. (2015) 'Flooding in the UK' invited presentation to 'UK-US Social Responses to Emergencies Workshop', 5-6 February 2015, Miami, Florida, USA.
- UK Water Partnership 'Floods and Droughts: Towards a more holistic approach', the UK Water Partnership, July 2015.

### 2014

- Coates, G., Hawe, G.I., Wright, N.G., Ahilan, S. 'Agent-based modelling and inundation prediction to enable the identification of businesses affected by flooding', In Proceedings of the 4th International Conference on Flood Recovery, Innovation and Response (FRIAR 2014), Poznan, Poland, 18-20 June, 2014.
- Coates, G., Guan, D., Wright, N.G., McGuinness, M., McEwen, L., Harries, T. 'SESAME: Finding ways of promoting SME adaptation to flood risk', In Proceedings of the 11th International Conference on Hydroinformatics (IHC 2014), New York, USA, 17-21 August, 2014. (Abstract only)
- Ahilan, S., Wright, N.G., Coates, G., Sleigh, P.A. 'Using Agent-based Modelling with Inundation Predictions to Enhance the Resilience of Small Businesses', In Proceedings of the 6th International Conference on Flood Management (ICFM6 2014), Sao Paulo, Brazil, 16-18 September, 2014. (Abstract only)
- McGuinness, M., Johnson, N. 'Exploring multi-level capacity building for flood resilience', International Workshop 'Resilience: Just Do IT?!

Governing for resilience in vulnerable places.' University of Groningen, 9-10 October, 2014.

- McGuinness, M., Johnson, N. 'Exploiting social capital and path-dependent resources for organisational resilience', 4th International Conference on Building Resilience, MediaCity UK, Salford Quays, 8-11 September 2014.

### 2013

- Coates, G., Hawe, G.I., McGuinness, M., Wright, N.G., Guan, D., Harries, T., McEwen, L. 'A framework for organisational operational response and strategic decision making for long term flood preparedness in urban areas', In Proceedings of the 3rd International Conf on Disaster Management, A Coruña, Spain, 9-11 July 2013.
- McGuinness, M., Johnson, N. 'Responding to changing paradigms of risk: managing flood risk and enhancing organisational resilience', In Proceedings of the Association of Geographical Societies in Europe (EUGEO) 2013 Congress, 'Changing Geographies and Geographies of Change', Rome, Italy, 5-7 September 2013.

## Other publications

- Briefing paper to the Environment Agency on SMEs and flooding, 14 February 2014 (McGuinness & Johnson).

## Engagement

### Invited presentations

- EPSRC-LWEC Flood and Coastal Erosion Risk Management Network, Birmingham, 20 November 2013 (Coates).
- Agent-based Modelling and Simulation in Flood Risk Management Workshop, Newcastle, 26 February 2014 (Coates).
- Adaptation and Resilience in the Context of Change (ARCC) Network Assembly, Birmingham, 11 June 2014 (Coates).
- FCERM Annual Assembly, Edinburgh, 19 June 2014 (McGuinness, Wragg).
- Institute of Insurers (Newcastle) Seminar, Newcastle, 26 June 2014 (Coates & McGuinness).
- Institute of Insurers (Middlesbrough) Seminar, Stockton, 02 July 2014 (Coates & McGuinness).
- Exeter University Centre for Business and Climate Solutions knowledge exchange event, Taunton, 10 July 2014 (Wragg).
- ESRC Festival of Social Science 'Business as (un)usual: flood risk and SMEs', Sheffield, 04 November 2014 (McGuinness, Coates, McEwen & Wragg).
- Institute of Hazard, Risk and Resilience Seminar, Durham, 08 December 2014 (Coates).

### Media interviews

- Yorkshire Evening Post, 10 January 2014 (Wright).
- LBC Radio, 10 February 2014 (Wright).
- BBC Inside Out West, 11 February 2014 (Wright).
- Radio 5 Live, Victoria Derbyshire, 14 February 2014 (Wright).
- BBC Inside Out West Midland, 25 February 2014 (Wright).
- Sky News, 11 & 16 February 2014 (Wright).
- BBC Radio Cambridge, Naked Scientist, 09 March 2014 (Wright).

### Webinars

- EPSRC-LWEC Flood and Coastal Erosion Risk Management Network, SME resilience to flooding – a resource-based perspective', 12 May 2014 (McGuinness).
- UK Environment Agency staff on SMEs and Flooding, 'Flood resilience for SMEs: barriers to adaptation', 20 May 2014 (McGuinness).

