Working together to manage local flood risk

LANDF♦RM event: E11507

Report of a workshop organised by LANDF♦RM held at CIRIA, Classic House, 174-180 Old Street, London EC1V 9BP, on 5th October 2011.

Speakers	Hazel Faulkner	Middlesex University
	Meghan Alexander	Middlesex University
	Lorna Fewtrell	Aberystwyth University
	Mervyn Pettifor	Flood Management Support Services Ltd
Chairman	Colin Berghouse	Environment Agency

INTRODUCTION

This event introduced research that is exploring the impacts of flooding, particularly in urban environments in the UK, and how they can be managed. As well as the damage to homes and buildings, there are the lasting effects on the health and well-being of those affected. Additionally, the complexity of the urban environment poses challenges for those professional groups with the responsibility to respond to the events in real time, as well as to plan ahead to reduce the risk and enhance preparedness between events. Research is increasingly able to proactively quantify and model some of the impacts of floods. These include, not only the impact on the physical infrastructure of urban areas, but also increasingly the psychosocial and health effects of an extreme hazard on a vulnerable community.

From the perspective of the professional engineer, in times of severely limited budgets, the measures that might be put in place to lessen flood risk have to be considered carefully. The Flood Hazard research centre's "Multi-coloured Manual" is a source book for the myriad options that are available. While in some cases changes in infrastructure or hard engineering solutions are necessary, there are also 'softer' solutions, including Sustainable Drainage Systems (SuDS), and other means of reducing overall risk, such as improvements to the issuing and uptake of flood warnings, and community engagement. The latter (Non-Structural Responses, or NSRs) have greater uncertainty associated with their costs and outcomes. Analysis has been carried out to assess the validity of carrying out a whole lifecycle costing of such measures, or a suite of measures. We finished with a case study of Lincolnshire and the work there to increase community resilience to flooding.

THE ISSUES

While academic work is being carried out to understand the risk and potential solutions for flood risk in the UK, the researchers must also share their findings with practitioners. In this event, we learnt about the tools they are creating that take complex science and make it useful and accessible to practitioners. In this way, practitioners can be engaged with the subject and given means of communicating their work, as well as finding useful interventions in the management of flood risk in the UK. The emphasis in all the work discussed is on increasing resilience to urban flooding and managing its effects, rather than attempts to keep the flood waters away.

LEARNING POINTS

1. Keeping water out of communities, away from people, at all costs is no longer viable
2. Increasingly, flood management means allowing water into the community but managing it and the associated risks
3. Stakeholder engagement/communication is vital to increasing resilience; the role of 'local champions' in particular is important
4. There needs to be simplification of user-experience of flood models and management tools without removal of scientific subtlety or technical content

5. SuDS can be located within urban areas by utilising simple GIS-based software, and the effect on flood flows can be demonstrably reduced
6. Vulnerability, as well as hazard modelling, should be incorporated into the risk assessments
7. Social/human response is part of the risk assessment ($R_t = H_t \times V_t$ – ie risk is the product of Hazard and Vulnerability at time t)
8. Flooding poses numerous risks to health and well-being. Death may be the most dramatic consequence but physical illness attracts media attention and public anxiety, and mental health issues can be widespread and long-lasting, yet overlooked.

COLIN BERGHOUSE, ENVIRONMENT AGENCY

Colin has been working for approximately 8 years in flood risk management. Currently he works for the Environment Agency with national responsibility for flood response and recovery issues. He has had involvement in the Cabinet Office for National Preparedness since the Civil Contingencies Act was enacted.

Background
Risk from rivers and in flood plains is understood, based on well-established knowledge. Less is known of that posed by urban surface water, and interactions with ground water and other sources, such as reservoirs; mapping activities are still going on. In 2007, Hull was badly affected by a combination of river flooding and surface water. This led to complexities, akin to those seen in New Orleans affected by Hurricane Katrina.

Planning for risks
In the UK, the Cabinet Office and Defra are responsible for flood risk planning. In the National Security Strategy, two identified hazards are coastal flooding and flooding in two or more inland areas, with potential impact and likelihood justifying their status.

Vulnerability and social behaviour both influence the risks due to flooding. There are 30 million homes and businesses registered in the UK; 5.5 million of those are in low-lying, flood risks areas; 3.9 million are at risk of surface water flooding. The surface water flooding in 2007 led to the production of rough, indicative maps to plot where this was a risk over the country. There are now more detailed versions and these are available to local authorities. Rainfall prediction is difficult, especially pinpointing location. Broadcasting meaningful, accurate warnings can be difficult and the response of people to these can vary, with mixed results. This is further discussed below.

HAZEL FAULKNER, MIDDLESEX UNIVERSITY

Some New Approaches for Planning and Response to Urban Flood Risk

Hazel is a Professor at the Flood Hazard Research Centre, Middlesex University. She also sits on the Flood Risk Management Research Consortium Management Committee and is on the editorial Board of the Journal of Flood Risk Management.

Hazel described the work of her colleague and collaborator, Dr Christophe Viavattene. Christophe was unable to attend today at short notice.

Challenges for Urban Water Management
There is an ethical context: any changes to infrastructure need to be wholly sustainable. The *Water Framework Directive* sets the legislative context. Flooding in the UK in the summer of 2007 focussed attention on urban surface water management and the *Flood and Water Management Act* requires local authorities to have plans in place for surface water. The emphasis has moved away from keeping water out of communities and instead managing and planning for what water may intrude. Those plans must have a long-term water management and flood risk strategy. Potential infrastructure changes include retrofitted SuDS (sustainable drainage systems). The *Pitt Report* suggests stakeholder involvement as a key element of any strategy.

The Contribution of Science and Social Science
Stakeholder engagement, through improved communication, is one important area in which to reduce or manage flood risk but the chances of losing some of the focus on science is an increasingly challenging possibility. A further challenge is the need for a general appreciation of the inherent uncertainties in models, forecasts, and any scientific knowledge. There are also the uncertainties associated with climate change and the financial crisis. There needs to be transparency on these and joint ownership of the arising issues by all professionals involved.

Scientists can offer :

- forecasts and nowcasts
- hazard inundation mapping and modelling
- SuDS – design effectiveness and location
- assets – location design and fragility

However, local authorities, for example, can find it difficult to take forward that science for practicable purposes.

On the other hand, social science can offer:

- improved communication models and tools
- improved professional interface
- improved psychological models of response; behaviour and vulnerability assessments
- health impact assessments.

The value of these contributions was discussed as follows.

Challenges of Urban Water Scientists
The challenges to urban water scientists therefore include the obligation to inform other professionals about the new tools they are able to offer. **Urban storm water models** tend to be very technical, as they must include a good representation of the physical phenomena (or potential hazard). This renders them not particularly user-friendly. These need to be simplified without compromising the technical content. **SuDS** constitute a wide range of structures. Urban water scientists can assist in making decisions on where these are best placed in terms of the quality, as well as the quantity, of water attenuation that can be achieved through their use, and also as an assessment of their overall costs and benefits.

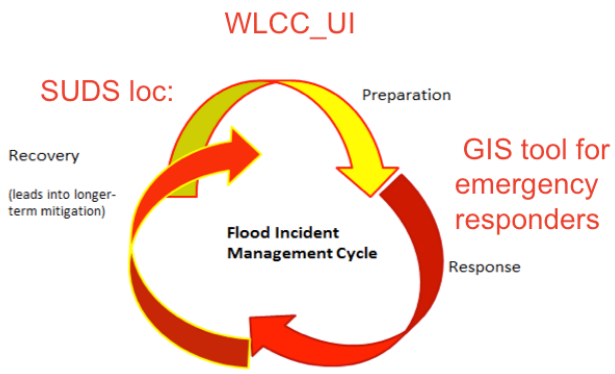
Middlesex University's Flood Hazard Research Centre aims to 'trial improved methodologies for urban flood risk assessment and response'. The novelty of the approach there is manifested through:

- retaining some of the subtlety of the available scientific models of the 'hazard' while simplifying the user experience
- incorporating social vulnerability into risk assessments
- revisiting and tailoring tools to maximise the match to professional needs, using stakeholder-held knowledge wherever possible.

Three tools have been developed for trial, to improve the use of the science:

1. **SUDSLOC** – a method of identifying the sites where the retrofitting of SuDS can be introduced, and assessing their hydrological functionality, maximising improvement in a particular area
2. **WLCC_UI tool** – to assess the feasibility of undertaking Whole Life Cycle Costing of non-structural measures in urban flood risk assessments
3. **GIS-based flood risk mapping tool –** coupling vulnerability metrics with local-scale inundation models for use by emergency response professionals. This is described in Meghan Alexander's presentation (see below).

This diagram shows when these tools may be deployed within the so-called 'emergency cycle':



1. SUDSLOC

SUDSLOC is a GIS support system for SuDS implementation at a local scale. It emerged from a EU-funded project known as SWITCH (Sustainable Water for Tomorrow's Cities and Homes – www.switchurbanwater.eu). It is a joint project between the Flood Hazard Research Centre and Urban Pollution Research Centre, both at Middlesex University.

The aims of the project are:

- the integration of qualitative and quantitative data from a variety of sources to enable investigation of the potential benefits of SuDS
- incorporation of a user-friendly tool to ensure simplicity and ease of communication
- the creation of a useable tool for stakeholders in planning and management positions who have just a few skills in GIS
- to 'bolt onto' existing local storm modelling.

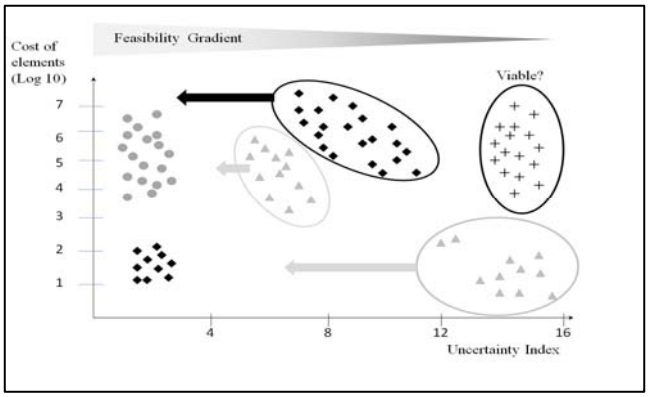
The **benefits of SUDSLOC** include:

- accurate, robust methodologies for identifying and quantifying local hotspots and 'critical drainage areas' for surface water associated with extreme storm events
- methodological basis for preparation of emergency flood planning (eg safe access and escape routes, evacuation etc)
- a basis for selecting and locating appropriate SuDS drainage controls for the mitigation of extreme event surface flooding as well as pollution impacts
- flexible communication tool for stakeholder and public consultation.

2. WLCC_UI

WLCC_UI is an uncertainty index to measure the feasibility of a whole lifecycle costing (WLCC) approach to flood risk management where WLCC is defined as 'the systematic consideration of all relevant costs and revenues associated with the acquisition and ownership of an asset.' The WLCC_UI tool was developed under the auspices of FRMRC2, an interdisciplinary research consortium.

The usual economic appraisal of urban flood risk management has been dominated by a traditional approach, CBS (Cost Breaking Down Structure), to flood defences and engineering strategies. In 2000, UK policy was changed to use Integrated Urban Flood Risk Management (IUFRM), which is a risk-based approach. A wider range of options needs to be costed: both hard and soft structural options as well as non-structural measures include deploying sandbags, flood warnings, community engagement, green roofs, etc. Whole lifecycle costing is recommended in order to evaluate both hard and soft structural responses to flood risk. Both the Treasury and Defra support this sort of appraisal. Costs for soft measures are harder to be certain of than the engineering strategies (refer to *The Multi-Coloured Manual*). Can this approach allow economic appraisal of all the IUFR options? What could we do about insufficient data on elemental costs and uncertainty in costs?



The aim of WLCC_UI is to review the feasibility of calculating the 'true overall cost' of different structural and non-structural strategies and interventions in urban flood risk assessments. The output of WLCC_UI is

a tool that embodies a methodology for costing all response strategies. It enables flood risk managers to assess whether there is sufficient data and knowledge to support a robust economic appraisal of an IUFRM project. Having identified the most important elements in the project, the tool assesses the confidence with which these can be costed against the element's own cost. A CBS approach is taken to put all project elements into a hierarchy according to the uncertainty associated with their cost. A two-dimensional uncertainty index is calculated using the confidence level in available knowledge of the costs and the behaviour of the costs through time. This is mapped against the cost of each element on a $\log_{10}$ scale, each ringed cluster representing an entire project.

The viability of costing a project on the right of the graph is questionable. Finding out more about the costs of elements in the project will move the project to the left and therefore increase the feasibility of costing the project. Trial projects are being sought and interested parties should contact Christophe at c.viavattene@mdx.ac.uk. Please refer to www.floodrisk.org.uk for more information or read the reference[1].

MEGHAN ALEXANDER

A Tool for the Assessment and Visualisation of Flood Vulnerability and Risk

Meghan is in the final year of her PhD programme at Middlesex University.

Context
Mapping is a cornerstone of flood risk management (as required by the EU Floods Directive 2007). The UK's Flood and Water Management Act 2010 has assigned new responsibilities to lead local flood authorities. This has led to a broader base of practitioners who need to understand flooding but have little training in the science and technical detail. Researchers therefore must meet a number of challenges, as described by Hazel. They must translate complex science into something useful and useable, enabling practitioners to engage with the subject and take ownership of their increased responsibilities, and facilitate the communication of knowledge within the scientific community, mixing expertise to cover all aspects of FRM.

Designing the Tool
The objective of Meghan's project is to develop a GIS-based flood risk mapping tool, coupling vulnerability metrics to local-scale inundation models. Vulnerability is identified as key facilities such as schools, hospitals and care homes, and people found through local authority data, for example covered by adult and social care, and other databases held by the NHS and utility companies. The tool is tailored to emergency response professionals. Contrasting case studies (Cowes, the Isle of Wight and Keighley, near Bradford) have been used to test the tool.

The research included semi-structured interviews and questionnaires, gauging perceptions of vulnerability, its indicators and assessment and to gather suggestions for her tool. She constructed the tool by building on the stakeholder feedback and exploring ways to engage end-users including interactivity and incorporation of user subjectivity, then presented it to the potential users for their feedback and ideas for future developments.

Within the initial round of stakeholder feedback, the vulnerable were defined as 'those that are less able to help themselves in the circumstances of an emergency'. Potential users' views on the vulnerability assessment were given particular attention. Key considerations are the elderly, long-term illness and disability. Vulnerability is, however, complex and difficult to assign a value. Risk was calculated as a function of this vulnerability and hazard. In the feedback, the relationship between these two factors was found to be subjective and varied between phases of the flood event (preparation, response and recovery).

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[1] Viavattene C. and Faulkner H. (2009). An uncertainty index to measure the feasibility of whole life cycle costing approach in flood risk management. Cost Action C22 **Road Map Towards a Flood Resilient Urban Environment** Paris 26/27.11.2009

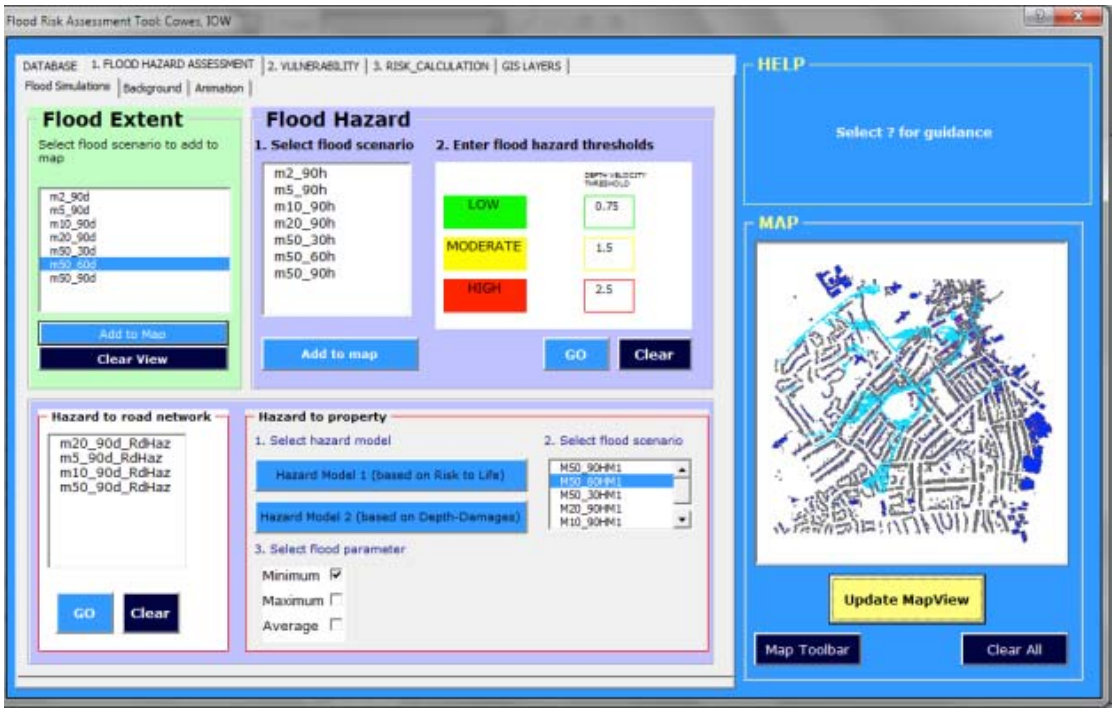
The end-user 'wish list' included:

1. A desire to "Keep it Simple and Stupid" [2](K.I.S.S.)
2. View a series of potential flood scenarios, showing extent and hazard posed
3. Animation of flood hazard. Option to produce static maps
4. Option to view key indicators for vulnerability (with rationale), to understand the make-up of a vulnerability index
5. Option to shift between spatial scales.

Constructing the tool

The Data Protection Act (1998) prevents vulnerability being mapped at the household scale, so the focus was on community vulnerability mapping. Existing census data has been used. Users are able to add and remove layers and perform calculations on layers to produce hazard, vulnerability and risk profiles. There are three views, or faces, one for vulnerability, one for hazard, and one for risk.

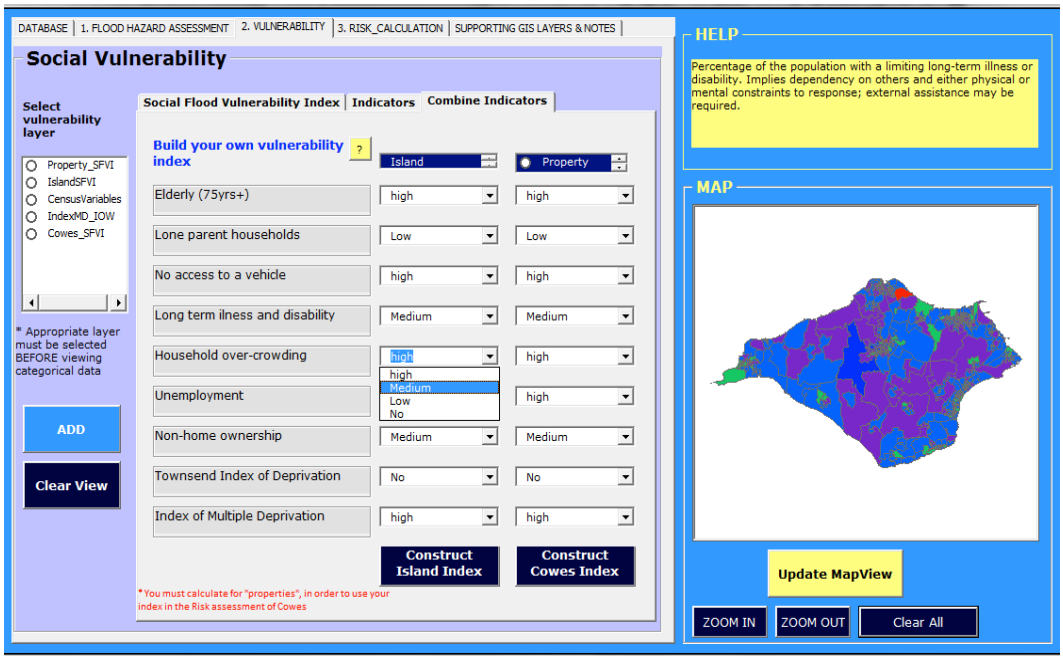
The flood hazard face allows the user to choose a flood scenario, pick the level of risk to life they are concerned with, isolate flooding to roads or properties, and colour the map produced according to the depth-damage thresholds or depth-velocity thresholds, the former being more useful for planning recovery and the latter for response planning.



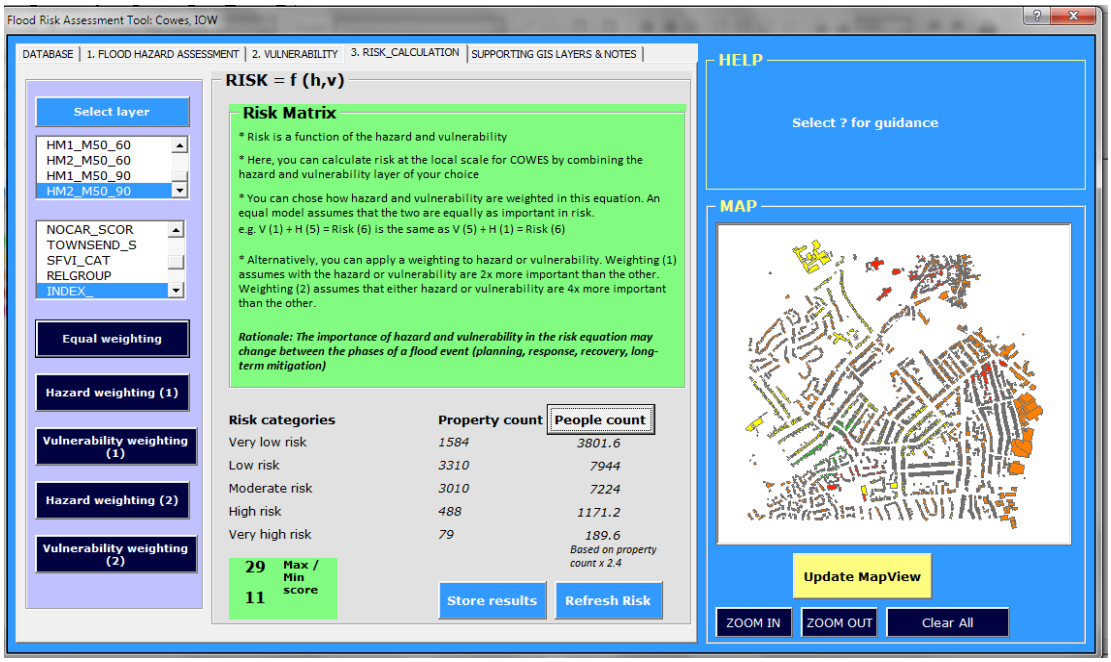
The image above shows the 'Hazard' face. The user can then choose to animate the results, thus allowing them to see how the flood progresses over a period of time on the map and allowing them to monitor the effects they are interested in.

The vulnerability face (below) utilises the existing Social Flood Vulnerability Index. It allows a user to construct his or her own vulnerability index, weighting individual indicators, enabling them to use personal professional knowledge and priorities. They can view vulnerability in relation to the nation or pick to view hotspots in the local vicinity.

[2] The issue was discussed in terms of a desire for 'user-friendliness' rather than a dumbing down of the science involved. It was concluded that accessibility and ease of use do not mean the same thing and ;simple and stupid'.



The image below shows the 'risk face', which brings together the information of the previous two faces, considering risk as a function of both the hazards posed and vulnerability of those in the vicinity ($R_t = H_t \times V_t$). For different levels of risk, the number of properties and people affected is estimated.



The tool was demonstrated with a sample of the original interviewees. They were asked to rate certain features and propose ideas for a future tool. Observations on the project included:

- since the tool was successful as a means to communicate where and when risk was present, it can support planning, responding and carrying out exercises. Users valued the interactivity – being able to view isolated vulnerability indicators and adjust spatial scales'
- however, the output gives the impression of certainty – even though a written statement explains the inherent uncertainties in the data and models used, this may be ignored. Visual interpretation and representation needs to be given to help understand the uncertainties
- combining hazard and vulnerability created some confusion amongst users, although some could see the potential scope for weighting hazard/vulnerability details in risk estimation,

arguing that there are difficulties associated with using census-sourced data which can be out-of-date;
- there is a desire for user-friendly tools that do not over-simplify the knowledge and data behind them (see footnote 2). This will give confidence to potential users, who may have a myriad of other responsibilities.

The challenges that remain in assessing vulnerability were presented. In emergency responses, the spatial scale and age of the vulnerability data (up to 10 years for census data), severely limit any possible role for such a tool. Combining this with more dynamic hazard assessments is not straightforward. Vulnerability is arguably subjective and dependent on context. A tool might hide the construction of indicators and create a 'blind' user. However, census-driven data is valuable for community-scale (around 200 households) vulnerability assessments. Potential applications of this would be:

- a prioritisation tool for broad scale events
- for response planning, an indication of scale and nature of response required
- targeting and tailoring mitigation strategies
- exercising and training emergency professionals
- user-defined vulnerability assessments, allowing a user to chose the appropriate vulnerability indicators and their relative weighting, are needed to engage professionals with vulnerability; introduce flexibility that will make such assessments relevant for different professionals and different needs, and integrate professional knowledge.

LORNA FEWTRELL, ABERYSTWYTH UNIVERSITY

Health And Environmental Impacts Following Flooding

Dr Lorna Fewtrell works at the Centre for Research into Environment and Health, Aberystwyth University, studying flooding since 2003. Her presentation today gave an overview of 8 years' research on the impacts of flooding on health and well-being.

Death from drowning is an obvious and catastrophic danger in a flooding event, and deaths have occurred in recent incidents in the UK. There is, however, a broad array of risks to health and well-being during flooding. These include gastric problems, asthma, injury, anxiety and general unhappiness. Individuals will respond in different ways for various reasons. Media reports, concentrating on the most dramatic effects, can cause anxiety. Socio-demographic factors have an influence. For instance, the inability to afford flood insurance will have repercussions. The age and existing health of people, and what they do during the flood, will change the dangers which they are exposed to.

Lorna's research has covered four areas:

- contamination profile
- media analysis
- mental health study
- flood withdrawal and clean-up behaviour.

Contamination profile
The effect of water on health will partly depend on what is in the water. Following flooding in Cumbria in 2005, the river Caldew was studied. Contamination was found to include pollution directly from animals and their urine, from slurry tanks and from human sewage, even if this has been partially treated.

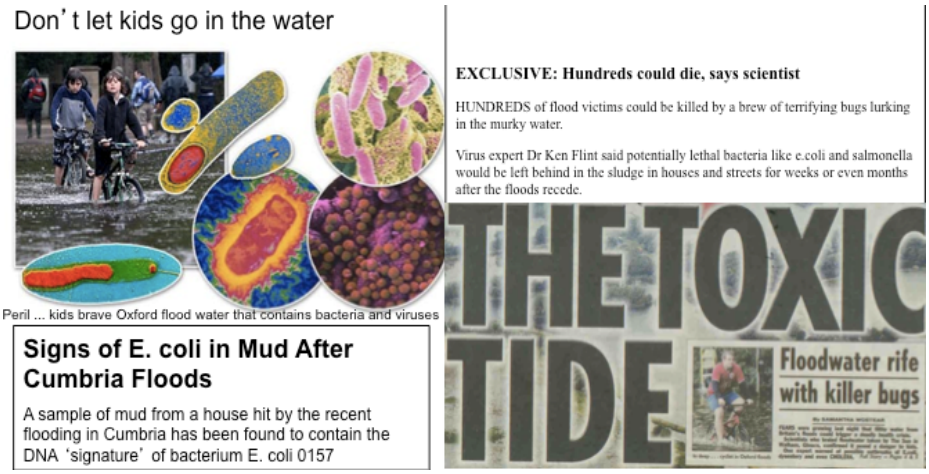
Flood withdrawal and clean-up behaviour
Some people will take care in the flood water, covering up and endeavouring to remain dry. Others will stand barefoot and work with no gloves on, apparently oblivious to any dirt and pollution in the water and mud they are standing in.

Mental Health Study
Building on a large scale survey carried out by the Health Protection Agency following flooding in the UK in 2007, Lorna undertook another survey in 2010. A number of standard instruments were used to assess:

- psychological stress
- anxiety
- depression
- probable post-traumatic stress disorder.

Though it was three years on from the incident, these effects were seen on a small scale.

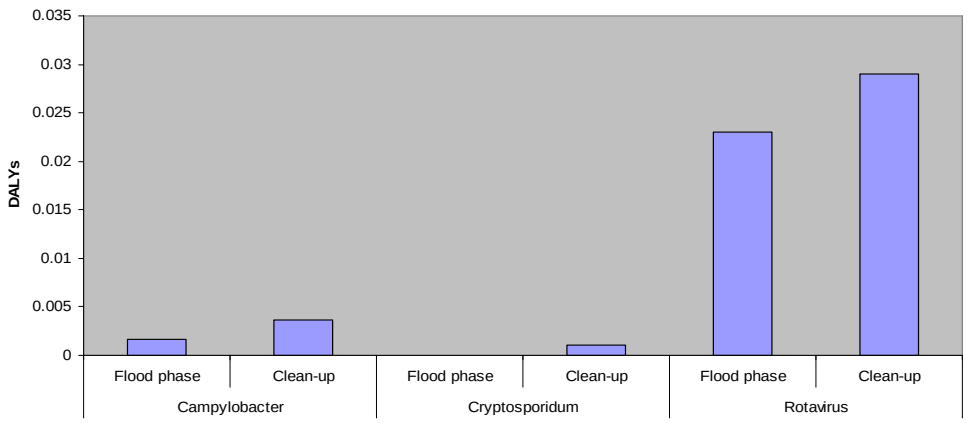
Media analysis
Press stories can be dramatic, focusing on the worst incidents and possibilities, such as cholera and typhoid. The actual, related outcomes tend to be small but the media does take an interest and the public becomes concerned.



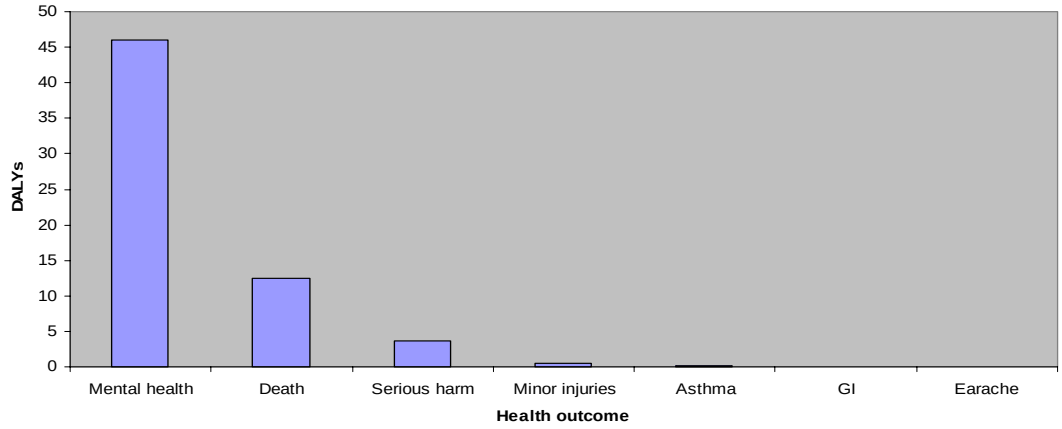
A **Quantitative Microbial Risk Assessment** (QMRA) was undertaken as part of the research. The standard method is to use reference pathogens: bacteria, protozoa and a virus (what the media might call a 'killer virus'). The dose-response relationships with these are found from controlled tests (on students and prisoners). The pathogen levels in the floodwater are considered, as are the exposure scenarios, including flood phase and clean-up phase. The result of the QMRA is a measure of Disability Adjusted Life Years.

Disability Adjusted Life Years (DALYs) are a summary of measures of health. They combine the length of time lived with a disability of (if applicable) years of life lost through premature death. Different levels of disability are accounted for using severity weighting. In this model, 3 days of sickness, for example, is factored in and well as extreme cases of premature death resulting from infection.

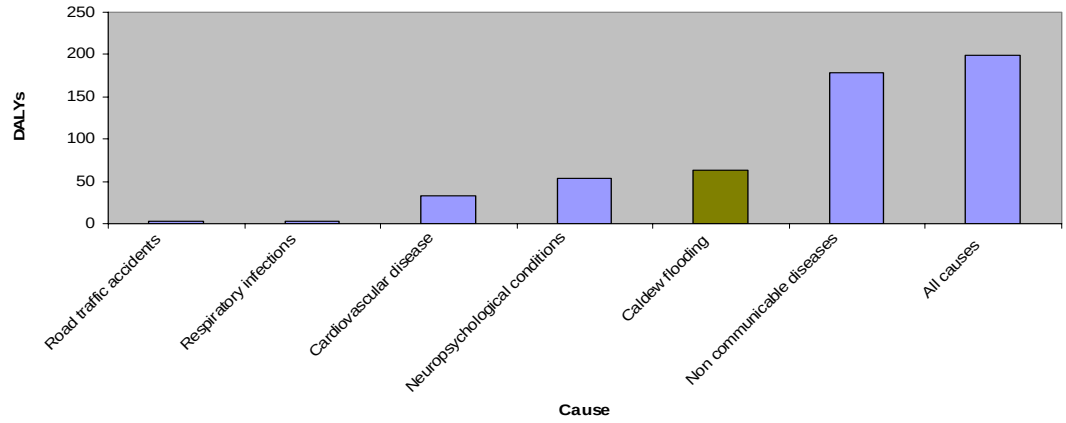
Results are shown below, with the pathogen types marked along the horizontal axis. In a population of roughly 1500, 41 are affected by the rotavirus and 50 in total are sick.



Lots of health impacts from flooding can be identified. Some, but not all, are quantifiable. Only those that are considered in the health impact assessment. This has been carried out retrospectively on the 2005 flooding in Carlisle from the river Caldew in the Denton Holme area. Mental health is significantly affected:



To put this is context, here is the effect of other health risks in the same community:



Thoughts to Consider

The impacts and their level will depend of the nature of the specific flood: its velocity, depth, duration and contaminants present. Lorna's work shows that flooding does make people ill, both during flooding and in the recovery procedures. Deaths are obvious but mental health issues are significant (insidious, private, stigmatic, delayed). People have various 'coping' strategies but it is a subject often ignored. Gastrointestinal illness incidents number around 50 and induce media interest and public anxiety. Lorna suggests it doesn't matter what the levels of significance actually are; we do need to prepare for the impacts she has revealed. Preparation would include:

For deaths:

- education/raise awareness?
- possibly difficult to influence.

For gastrointestinal illness:

- not a big problem in the scheme of things but easily (and best) avoided
- timely hygiene advice.

For mental health:

- good advice at the withdrawal phase – the media tends to omit this
- It is normal to be depressed after flooding – let people know this

- manage expectations, for example of the response of insurance companies.

To avoid disaster in the recovery phase:

- train staff who will come under a lot of strain, such as in insurance companies
- create a standard method for assessing flood damage?
- devise an accreditation system for builders?

The presentation concluded that flooding is a complex process and its impact of people is not reduceable to the inundation of water in their property. Though they might be dried out and cleaned, the loss of a perceived safe haven and distruption to life's routine can be significant.

MERVYN PETTIFOR, FLOOD MANAGEMENT SUPPORT SERVICES LTD

Increasing Community Flood Resilience In Lincolnshire

Mervyn is director at FMSS Ltd. He has almost 40 years experience in flood risk and drainage management and his work has involved policy and process development at a national level, and as a practitioner; much of the time spent working with the Environment Agency. His approach to science is pragmatic, proportionate and appropriate to risk. In this presentation, Mervyn focused on his work in Lincolnshire on community resilience in a broader context of planning for and mitigating flood risk.

In Lincolnshire, flooding is high on the Community Risk Register; primarily, this is due to coastal flooding but closely followed by inland flooding. There are also major rivers in the county and it is generally a low-lying area, with many internal drainage boards helping to manage flood risk and drainage. The Lincolnshire coast is extensive and popular with tourists. In the peak holiday season, it is estimated that up to 40 000 caravans could be sited along the coast. Though there are good sea defences, waves from high surge tides can overtop these and have been seen to reach the roofs of houses and bungalows immediately behind the sea defences. Mervyn showed us an aerial photograph illustrating how closely the caravans can be packed into sites close to the coast. It is difficult to know how many are occupied at any one time, and the local geography and road system, make the safe and effective evacuation of such sites challenging.

The Local Resilience Forum in Lincolnshire has responded to many of the challenges of coastal flood risk by establishing the East Coast Inundation Group. The focus of the group is on effective emergency planning, response and recovery, including communicating and mapping identified flood risks. The group's *Outcomes Project* was set up with seven key aims:

1. We have planned for it
2. Coastal communities know the risk
3. People (communities) know what to do when it happens
4. We are well resourced
5. We are well practiced
6. We develop best practice
7. We deliver a joint integrated response and recovery.

Examples of specific projects include:

A coastal flooding publicity campaign saw posters in public places and on refuse collection lorries etc, drawing people's attention to local flood risk, the message from relevant local authorities being 'We're prepared for coastal flooding. Are you?'

A study was undertaken into the 'Effective Use of Roads in Lincolnshire and Norfolk to Evacuate People'. The capacity of the road system along with recognised "vehicular pinch/congestion points" were sought and emergency response decision dilemmas and challenges were identified. Within Lincolnshire there are many minor roads and very few motorways, and this makes the mass evacuation of people away from coastal areas difficult. The study identified that approximately 30 hours lead time may be needed to achieve an effective mass evacuation of coastal communities, before a storm surge tide hit the coastline.

A useful source of learning has been from the French experience of responding to the storm "Xythia", and the devastating tidal surge that occurred in 2010. Due to the similarity of the coastline, topography and other coastal features with that in Lincolnshire, exchange visits have been made with responders affected on the south west coast near La Rochelle, in order to share experiences, lessons learned and good/best practice.

Lincolnshire's Multi Agency Flood Response Plan is almost complete and this is a valuable tool for helping to increase community resilience, and deliver an effective emergency response. Coastal flooding probability and consequence maps have been produced and have assisted the identification of indicative evacuation zones and the location of critical infrastructure. Communities, vulnerable assets and critical infrastructure have been charted by Flood Warning Area, and by parish, along with historic surface water flooding hotspots. This information was successfully used in Exercise Watermark and the national report on the lessons learned from this exercise is available on the Defra website.

Community resilience is a key consideration in terms of spatial planning and opportunities exist to increase resilience through Local Development Frameworks and Core Strategies.

As Lead Local Flood Authority, Lincolnshire County Council has set up a Flood Risk and Drainage Management Framework Partnership bringing together all the risk management authorities across the county. The framework comprises a Strategy group, led by the Environment Agency, a Management Group led by the Lead Local Flood Authority and, in addition, there are four Local District Flood Risk and Drainage Management Groups based on Local Development Framework areas. A willingness to work together is vital. Risk management authorities are encouraged to share data and have a duty to cooperate. Wherever possible, data should be gathered once and used many times within the partnership organisations for numerous uses. The partnership has delivered a Preliminary Flood Risk Assessment and is now developing a joint local flood risk management strategy. Further information may be found on www.lincolnshireprepared.co.uk and www.lincolnshire.gov.uk/residents/environment-and-planning/flood-risk-management/

GENERAL DISCUSSION SESSION

The following points were made:

- there has been a move away from defence towards management and resilience. There is greater tolerance of living with the risks of flooding and concentration of mitigating its effects rather than trying to prevent it within communities
- further research is needed on the impact of providing warnings that may appear to be unnecessary in hindsight
- studies show that sign-up to receive flooding warnings has generally been low, even where flooding has occurred in the past

- it is tricky to communicate warnings quickly in urban areas where people move around a lot in their daily lives
- scientists and modellers sometimes downplay important, insightful local knowledge. It should be used to help calibrate and verify models
- some residents are not reporting low level flooding for fear of increased insurance premiums and decreasing property values. This may be affecting data and intelligence
- local knowledge may be less readily available when communities are more transient
- denial can be a major problem. There needs to be improved communication of the potential for retrofitting flood resistance and resilience measures in order to achieve improved take up and acceptance
- developers are still being permitted to build in areas at risk of flooding and yet they are not obliged to inform their customers of the risk or possible need to pay increased insurance premiums.