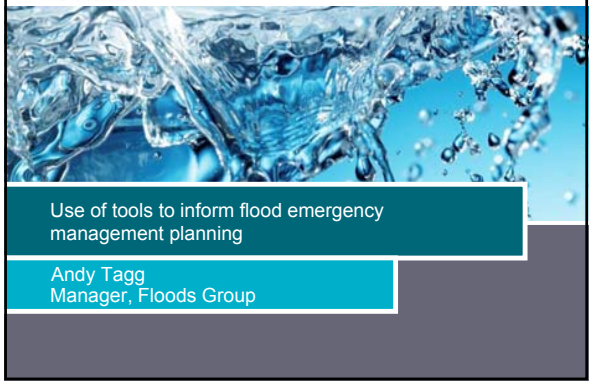


Use of tools to inform flood emergency management planning

Andy Tagg
Manager, Floods Group

Overview

Role of flood emergency plans

Analysis of flood plans

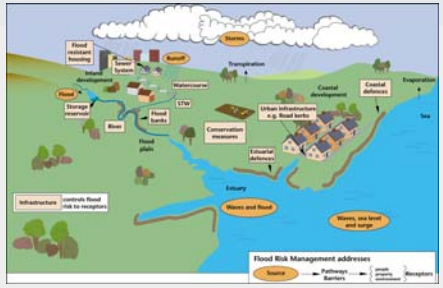
Development of a framework for assessing & improving plans

Use of tools to assist in plan development

The Life Safety Model

Make sense of the complexity

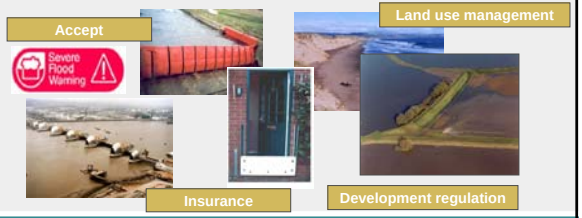
The flooding system exhibits spatial complexity



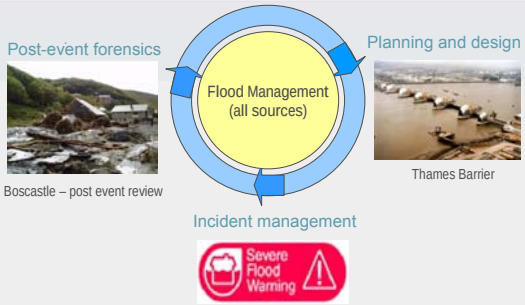
Making sense of the complexity

Portfolios of responses are now recognised as fundamental to effective FRM where:

> The advantages of one option compensates for the disadvantages of another

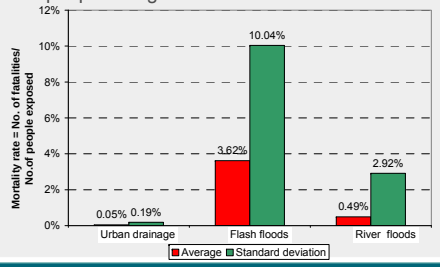


Floods: assessment cycle



Loss of life from floods

> About 1,900 flood disasters, which occurred between 1975 and 2002 resulting in 180,000 deaths and 2.27 billion people being affected



Flood incident management

Flood detection

↓

Flood forecasting and interpretation

↓

Flood warning dissemination

↓

Flood warning and emergency response

UK emergency plans - issues

- Lack of communication to public
- Identification of evacuation routes
- Identification of safe refuges
- Vulnerable areas and people
- Limited assessment of loss of life for dam breaks and flood defence failures

Objectives of the research

- To assess the effectiveness and robustness of current flood event management plans
- Evaluate the current tools that are used for flood event management planning
- To establish how currently available tools can be used to improve emergency management plans for floods
- To provide a framework by which flood incident management can be improved
- Test the approach in case studies in France, The Netherlands and the UK

Emergency planning for floods

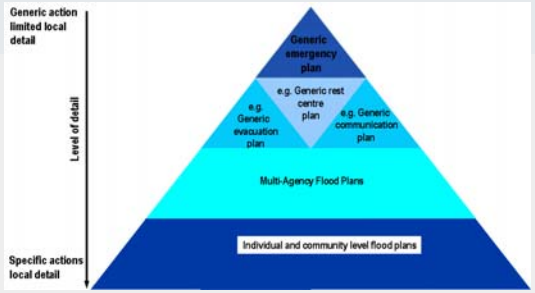
England and Wales

- Emergency planning governed by the Civil Contingencies Act 2004
- Multi-Agency Flood Plans (MAFPs) produced by Local Resilience Forums
  - 47 Resilience Forums in England and Wales
- Higher the risk the more detail is required in the MAFPs

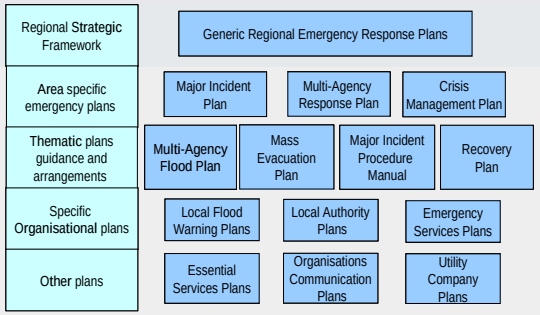
Similarities in the three countries

- All three countries have passed legislation in the past seven years - in some cases has acted as a catalyst for the production of plans
- Hierarchy of emergency plans exists in all three countries (local, regional, national)

Plan hierarchy



Plan hierarchy



Effectiveness of emergency plans

Little in the way of metrics via which the "fitness for purpose" of emergency management plans for floods can be assessed

Twenty-two metrics were developed to assess flood emergency plans. These fall into six categories as follow:

> 1. Objectives, assumptions and target audience
> 2. Organization and responsibility
> 3. Communication
> 4. Flood hazard
> 5. Flood risk to receptors (e.g. people, buildings, critical infrastructure)
> 6. Evacuation

Effectiveness of emergency plans

Metric	Level of detail		
	Low	Medium	High
Objectives, assumptions and target audience			
Aims and objectives of plan	Not detailed	Aims and objectives included but could be clarified further	Clearly stated aims and objectives including the area covered, types and sources of flooding
Target audience and updating of the plan	Not detailed	Audience defined and plan dated	Audience defined and how they will be notified of updates and modifications to the plan included
Assumptions made by the plan	Not detailed	Covers some aspects	Covers all aspects including: flood warning lead time; method by which rescue will be undertaken; implications of the failure of critical infrastructure

Effectiveness of emergency plans

Flood risk to receptors			
Flood risk to people	Not detailed	Number of people potentially affected included	Potential injuries and loss of life included and mapped for a range of scenarios
Flood risk to vulnerable people (e.g. elderly or disabled)	Not detailed	Areas where elderly/sick people live mapped	Numbers of vulnerable people defined with a response strategy
Flood risk to residential property	Not detailed	Number of properties defined	Number of properties defined together with those at risk of collapsing during an extreme flood
Flood risk to businesses	Not detailed	Number of businesses defined	Number and type of businesses defined together with potential losses
Flood risk to critical infrastructure (e.g. water supply, gas, electricity, police, fire brigade)	Not detailed	Number of pieces of critical infrastructure shown on the flood map(s)	Number of pieces critical infrastructure shown on the flood map(s) and an assessment of their likelihood of failure during a flood
Potential for NaTech hazards at industrial facilities (if present)*	Not detailed	Potential NaTech sites shown on map	Potential NaTech sites shown on site and brief details of the response

Effectiveness of emergency plans

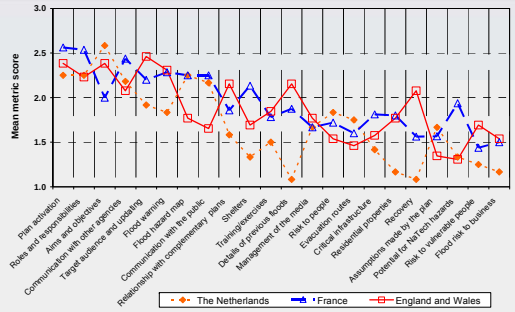
> Thirty-eight flood emergency plans in England and Wales, France and the Netherlands were assessed using these metrics. The development of the metrics allowed the plans to be "scored" in a quantitative manner

> An online survey was carried out in England and Wales, France and the Netherlands. The questions focused on the requirements for information in the plan development stage, and its usefulness and required level of detail

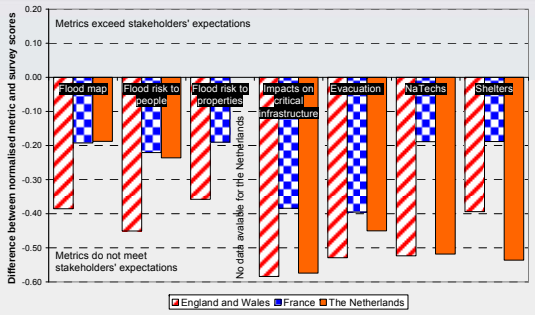
Example of scoring a plan

Metric	Room for improvement	Acceptable	Good	Score
Aims and objectives of plans			•	3
Target audience and updating			•	3
Details of previous floods		•		2
Flood hazard map		•		2
Flood Warning			•	3
Risk to people		•		2
Risk to vulnerable people			•	3
Flood risk to residential properties		•		2
Flood risk to business		•		2
Flood risk to critical infrastructure		•		2
Potential for NaTech hazards	•			1
Evacuation routes		•		2
Shelters/Safe havens		•		2
Relationship with complementary emergency plans			•	3
Communication with other agencies			•	3
Communication with the public		•		2
Management of the media		•		2
Assumptions made by the plan	•			1
Plan activation			•	3
Actions, roles and responsibilities			•	3
Recovery			•	3
Training and exercises		•		2
			Average score	2.3
			Rating	"Above average"

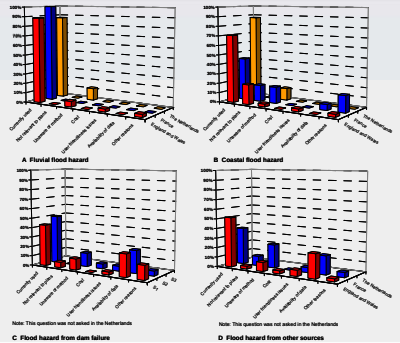
Assessment of emergency plans



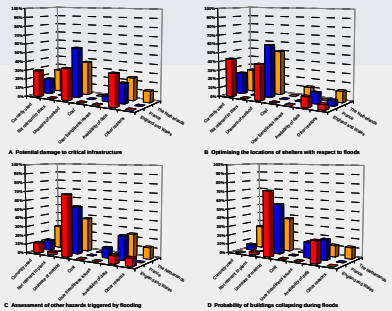
Information gap



Results of flood manager surveys



Results of surveys



FIM-FRAME Proposed framework

Objectives

> Assist in preparing flood emergency management plan

> Enhance existing flood emergency plans

The framework was designed to be:

> Simple, to be applied by anyone without specific training.

> Transportable, to be applied independently anywhere and by any flood emergency management team.

> Generic, to allow it to be adapted by the user for their specific purpose.

FIM-FRAME Proposed framework

Information management

The five principles

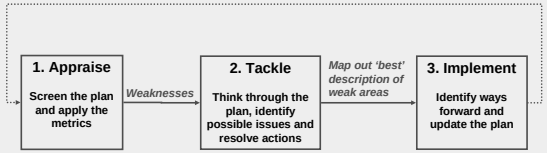
Information and data requirements	Roles and responsibilities	Processes, procedures and guidance	Enabling technologies	Audit and control
- What is needed?	- Who provides it?	- Where does it come from?	- How is it provided	- Is it good enough?

Three stages

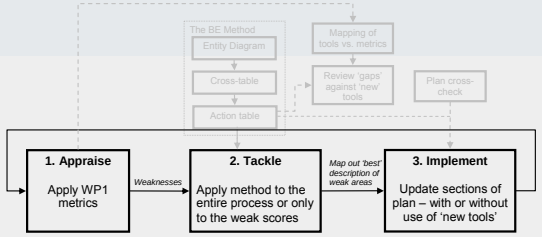
> 1 Appraise

> 2. Tackle

> 3. Implement



Final framework



Entity Diagram

Boxes

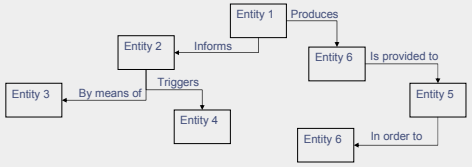
> Specific entities

- abstract (e.g. the warning, plan activation, the recovery, the evacuation..) or
- physical (e.g. the police, the resources, the SGC, the flood maps..).

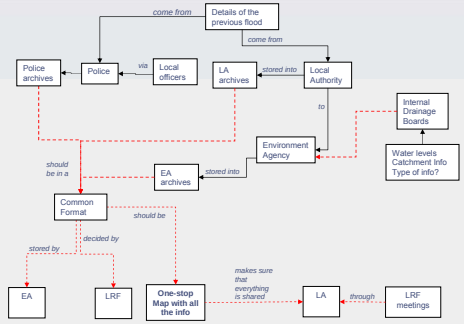
Arrows

> Relationship between such elements

Tackle stage (1)

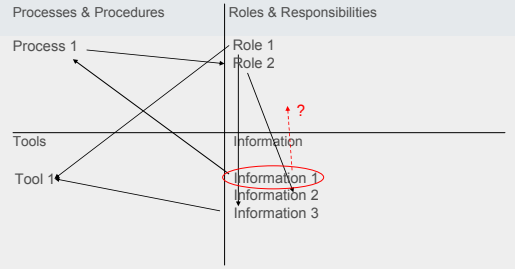


Example of Entity Diagram



Tackle stage (2)

Cross-Table



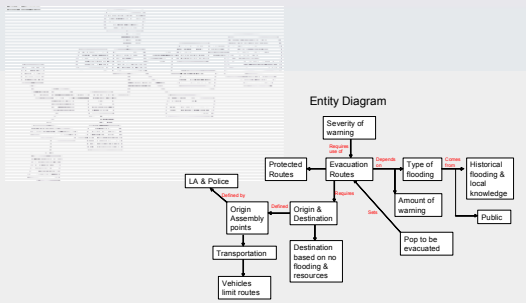
The Action Table

Issues	Tackling actions					Implementation			
	How to address it? Actions	Who should bring it forward? Responsibility	What information is needed?	Is any tool needed?	Who checks this is done? Audit	Priority	Resources	Timeline	Plan to be updated?

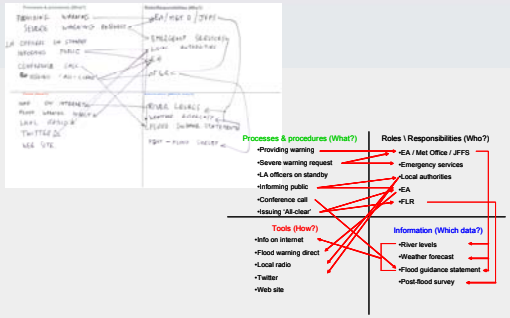
Metric scores - Sheffield MAFP

Communication					
Communication with other agencies		●		2	
Communication with the public		●		2	
Management of the media			●	3	**Media management well signposted**
Flood warning (if available)			●	3	**Clear signposting to location of other maps**
Relationship with complementary emergency plans detailed		●		2	
Evacuation					
Evacuation routes	●			1	**Consider how to determine 'optimum' evacuation routes, and impact of flood on access**
Shelters/Safe havens			●	3	**Scored High because policy is not to include this information in MAFP**

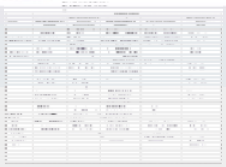
Entity Diagram



Cross Table for 'Evacuation Routes'



Action Table for 'evacuation routes'



Issues	Tackling actions				
	How to address it? Actions	**Who should bring it forward? Responsibility**	**What information is needed?**	**Is any tool needed?**	**Who checks this is done? Audit**
Informing public	Media Message	EA M.Ag.	River levels Fluvial forecast	River model	TCG
	FWD	EA to M.Ag	Request from M.Ag partners		EA
	Door-knocking	LA / E.S.	Preferred Destinations	GIS System	TCG
	WEB	M.Ag	Preferred Destinations		TCG
	Signage	LA	Preferred Routes		TCG
Where do they go?	Rest centres	LA	Fluvial forecast	Y	
	Get address details	LA / Police	Suitable locations	GIS / Local knowledge	TCG
				Co-operation	LA

Application of tools

Hydrodynamic modelling – TUFLOW

Breach development

'Flood risks to people'

Life Safety Model

Loss of life estimates

		Flood Risk to People		Life Safety Model no warning		Life Safety Model with warning	
Population		13,836		13,836		13,836	
Deaths	Total	8.5	0.1%*	240 (153)**	1.73% (1.11%)	35 (35)**	0.25% (0.25%)
	Drowning	-	-	150	1.08%	35	0.25%
	Exhaustion	-	-	3	0.02%	0	0.00%
	Building collapse	-	-	87	0.63%	0	0.00%
	Vehicles swept away	-	-	0	0.00%	0	0.00%
Injuries		64.2	0.5%				

*percentage evaluated on the total population
**in brackets, the total deaths and percentage if building collapse is not considered.

Stakeholder feedback

Framework

> Assess plans in an objective way

> Logical & complete

> Ensures no gaps between organisations

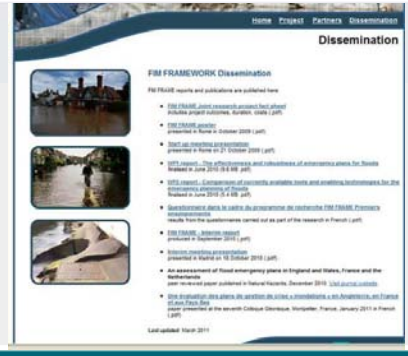
Entity diagram

> Good visualisation of processes

> Somewhat academic

> Can be time-consuming, but experience and examples improves the understanding

www.fimframe.net



Loss of life modelling and evacuation

Role of loss of life modelling and evacuation in the UK

Flood detection

Flood forecasting and interpretation

Flood warning dissemination

Flood warning and emergency response

The role of loss of life and evacuation modelling to support and improve flood incident management

Loss of life and evacuation times

Why model the loss of life and evacuation times for extreme floods?

> How the number of victims is affected by:
- the closure of roads
- the efficiency of the dissemination of warnings
- the use of safe havens
- the understanding of the risk by people who live in the flood zone

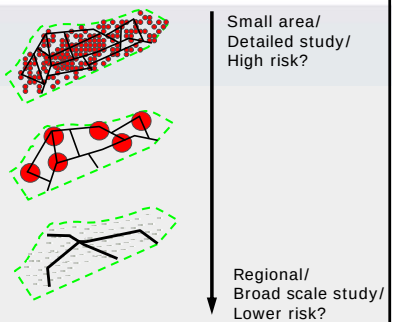
Loss of life and evacuation times

> To estimate
- fatalities and injuries
- vehicles swept away
- buildings destroyed

> To calculate the evacuation time

> Results can help to improve Flood Risk Management and emergency plans

Typical scale of application?



Life Safety Model (LSM)

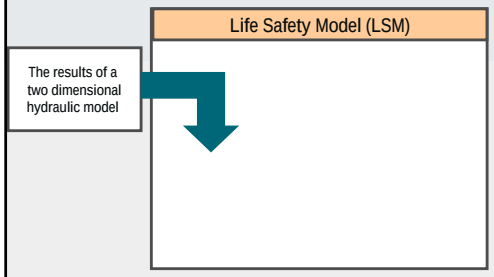
> Permits a dynamic interaction between people, vehicles, buildings and the flood wave

> Estimates of the loss of life from:

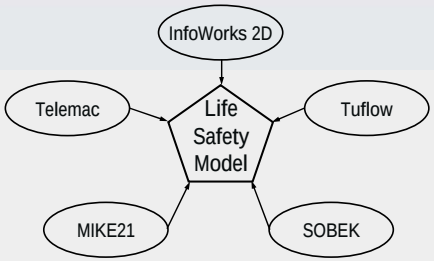
- Drowning
- Exhaustion
- Buildings collapsing
- Vehicles swept away by the flood wave

> Permits the assessment of management interventions

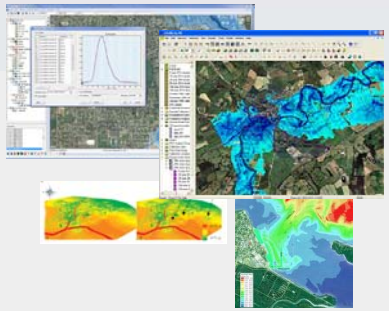
LSM – Modelling process



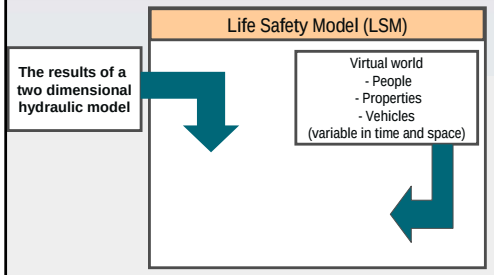
LSM – 2D hydraulic models



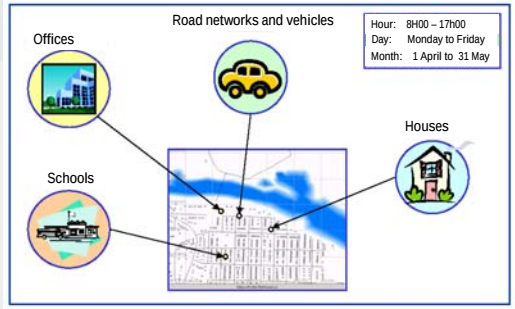
LSM - 2D hydraulic models



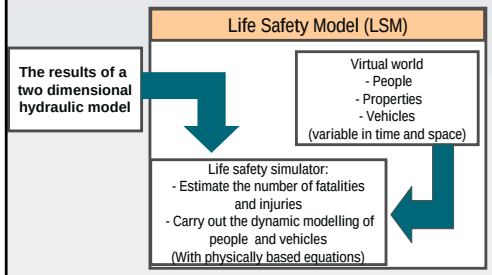
LSM– Modelling process



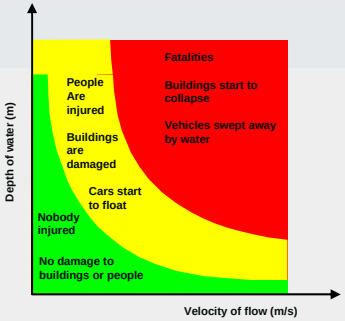
LSM – Creation of a virtual world



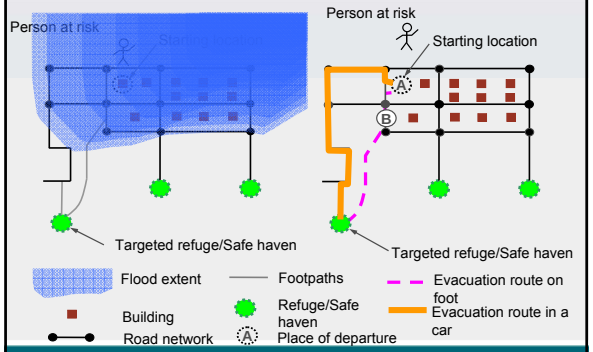
LSM – Modelling process



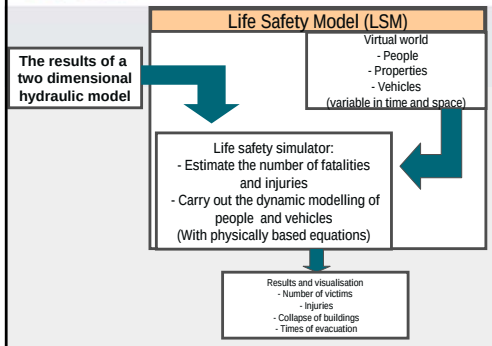
LSM – Process of modelling



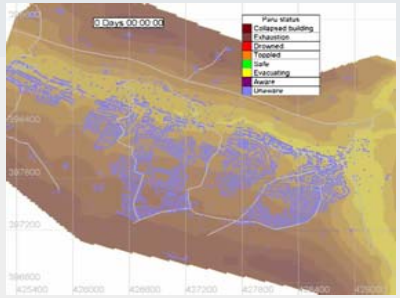
Evacuation in the Life Safety Model



Life Safety Model – Modelling process



Life Safety Model - Visualisation



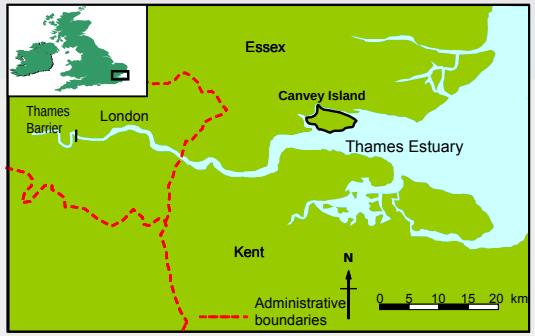
Life Safety Model – Data required

- Demographic data
- Number of vehicles
- Topographic data
- Depth and velocity of the flood wave at a suitable time step
- Building data (geo-referenced)
- Road networks and paths used for evacuation
- Historical data for validation

Case studies

- France – Validation of the model against a dam failure (Malpasset)
- England – Coastal flooding as a result of a flood defence failure
- Canada – Emergency planning for a tsunami

LSM in the Thames Estuary



Canvey Island

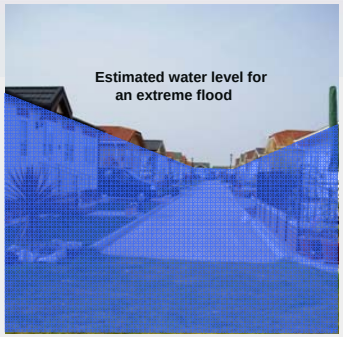
Canvey Island

Canvey Island

Flood Zone 3

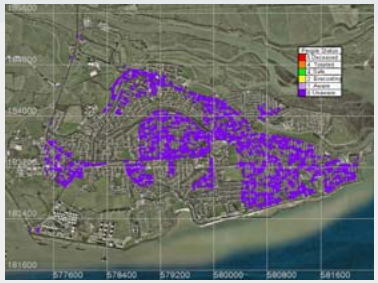
Canvey Island

The buildings



Canvey Island

Modelling of the 1953 flood event



LSM modelling for 1953 - Results

> The results agree “well” with the historical data (58 fatalities)

> The model indicates that between 55 and 150 people died

> The model shows 55 people died as the result of drowning and 150 people as the result of buildings collapsing

Conclusions

> The Life Safety Models provides a scientifically, evidence based method to model evacuation and loss of life for floods

> The Life Safety Model is sufficiently well developed to assist with emergency planning for floods

> The Life Safety Model provides better estimates of the loss of life than methods previously used in the UK, France and Canada

www.lifesafetymodel.net

www.lifesafetymodel.net/publications.html

www.hrwallingford.com

HR Wallingford
Howbery Park, Wallingford, Oxfordshire OX10 8BA, United Kingdom
tel +44 (0)1491 835381 fax +44 (0)1491 832233 email info@hrwallingford.com