International Research on Flood Resilience at Imperial College London


- NWE Interreg IVB RainGain Project: Advanced observation and rainfall prediction for urban pluvial flood management

- Climate KIC Blue Green Dream Project: Integrating Blue and Green Urban Assets for the City of Tomorrow

Susana Ochoa Rodríguez and Prof. Čedo Maksimović
BRE & SMARTeST Seminar: Building Flood Resilient Communities
BRE, Garston, Watford, 14th June 2012
Flood Risk Management Via Collaborative Modelling

**DIANE-CM PROJECT**

Decentralised Integrated ANalysis and Enhancement of Awareness through Collaborative Modelling and Management of Flood Risk
(Jan 2010 – Oct 2011)

**Project Partners**

Leuphana University of Lüneburg (Germany)

Imperial College London (United Kingdom)

UNESCO-IHE Institute for Water Education (The Netherlands)
Contents

• Objectives and methodology
• Case studies
• Implementation: UK case study
• Conclusions
Main objectives

• To enhance flood risk awareness and capacity through collaborative modelling and social learning

• Supported by improved flood modelling and mapping techniques and by web-based decision support making tools

Enhance resilience of local communities to flooding
Goals and Working Steps

1. Stakeholder identification and analysis

2. Improvement of flood modelling, mapping and Near-Real-Time flood forecast

3. Collaborative Modelling for participatory and improved flood risk management

4. Enhancing resilience through training, awareness raising and dissemination
UK Case Study: Cranbrook catchment

- **Focus:** surface flooding
- **Area:** approx. 9 km², predominantly urbanised
- **Located within the London Borough of Redbridge (NE of London)**
- **Subcatchment of Roding River catchment**
German Case Study: Alster river catchment

- **Focus:** fluvial flooding
- **L=** 56 km, **A =** 587 km$^2$.
- Tributary of Elbe river
- High damage potential
- Natural and canalised parts, dammed lakes
Focus on surface flooding

- Focus on flood risk and event management
  - Planning issues with GE support

Focus on fluvial flooding
- Surface flooding with UK support
  - Focus on planning issues

Supported by web-based tools (UNESCO-IHE) and experiences of Dutch experts in planning and flood risk management
Implementation: UK Case Study
Step 1: Stakeholder Analysis

Objectives:

- To identify relevant stakeholders
- To understand interrelations between them
- To understand current situation and needs regarding FRM in the study area
Methodology

- A **common framework** for the stakeholder analysis was developed and used for both case study areas to ensure **comparability**
- Brainstorming session
- 10 structured interviews
- Summary of information in parameter table
- Categorisation of stakeholders through MCA (*Multi-Criteria Analysis*)
- Elaboration of organi and sociogram
- Flood risk awareness evaluation
Categorisation of stakeholders
(Through Multi-Criteria Analysis)

Criteria taken into account: role in FRM, responsibilities, available resources, available information, willingness to cooperate, confidentiality issues, etc.

<table>
<thead>
<tr>
<th>According to their role in FRM and their activities</th>
<th>According to their relevance in FRM and their role in the project</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Flood management professionals</td>
<td>- Local Champions</td>
</tr>
<tr>
<td>- Emergency managers</td>
<td>- Primary stakeholders</td>
</tr>
<tr>
<td>- Planners</td>
<td>- Secondary stakeholders</td>
</tr>
<tr>
<td>- General public</td>
<td>- Tertiary stakeholders</td>
</tr>
</tbody>
</table>
Flood Risk Awareness Assessment

- Access to results of survey previously conducted by the Local Council (in 2007)
- 10 flood risk assessment questionnaires submitted online

Main findings - Flood Risk Awareness Assessment

- High turnover rate
- New residents are of particular concern; they were found to have little or no knowledge of flood risk.
- Old residents are aware of flood risk, but have not adopted self-protection measures
- The public wishes for structural measures, limited recognition for self-resilience measures
Main findings - Flood Risk Awareness Assessment

• Flooding vulnerable residents have not taken any precautions to protect their properties.

• Lack of knowledge regarding whether they live in a flood risk area

• Insufficient information and training concerning what to do in case of flooding, in spite of significant efforts of Local Council

• Misunderstanding regarding the roles of the different authorities (e.g. Local Council, Police, Fire Brigade, Environment Agency)

• Flood warden scheme is considered to be a good option for improving event management

• Participants would be willing to use internet web based tools.
Step 2: Improved flood modelling

UK Case Study: focus on pluvial flooding

Extreme rainfall events exceed the capacity of the drainage system!
Model Assembly for Pluvial Flood Modelling, Forecasting and Management

Observations
Rainfall Estimation / Forecasting
Flood Modelling / Forecasting
Management (urban planning, emergency)
Deployment of monitoring system with Real-Time transmission

Observations

Rainfall Estimation / Forecasting

Flood Modelling / Forecasting

Management
- Improvement of rainfall estimates through combination of raingauge and radar data
- Development of new temporal and spatial downscaling techniques
- Setup of 1D/2D and 1D/1D models
- Development of hybrid models
Step 3: Collaborative Modelling for participatory flood risk management

COLLABORATIVE PLATFORM

- Online platform whereby information about flood risk in the study area is provided and discussed amongst participants and feedback can be provided
- Supports development of shared understanding of current flood risk
- Supports collaborative ranking of alternatives for FRM

From individual to collaborative modelling!
Steps for Collaborative Modelling (supported by platform):

1. System definition

2. Identification of flood risk management objectives

<table>
<thead>
<tr>
<th>Obj₁</th>
<th>Obj₂</th>
<th>Obj₃</th>
<th>Obj₄</th>
<th>Obj₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>To reduce the magnitude of surface flooding</td>
<td>To minimise the damage to properties</td>
<td>To minimise damage to critical infrastructure</td>
<td>To maximise the opportunity of salvaging belongings</td>
<td>To maximise ease and feasibility of implementation</td>
</tr>
</tbody>
</table>

3. Definition of flood scenarios

- 30 years return period + lower level at the Roding River
- 30 years return period + high level at the Roding River
- 200 years return period + high level at the Roding River
- 200 years return period + high level at the Roding River (base case for the CME)

4. Identification of alternatives for FRM

- **A1 (base case):** Do nothing
- **A2:** Rainwater harvesting
- **A3:** Improved and targeted maintenance regimes for the sewer system
- **A4:** Improved resistance for preventing water from entering properties
- **A5:** Improved rainfall and flood forecasting and warning

5. Joint / collaborative ranking of alternatives
5. Collaborative Modelling Exercise for Joint Ranking of Alternatives for FRM

- Developed through three modules:
  - MODULE 1: Individual module
    - Weighting of objectives
    - Evaluation of alternatives
    - Ranking (TOPSIS)
  - MODULE 2: Group module
  - MODULE 3: Collaborative module and negotiation stage
### Stakeholder name: Mike Nye

#### DECISION MATRIX

<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>Obj 1: Magnitude of surface flooding</th>
<th>Obj 2: Damage to properties</th>
<th>Obj 3: Damage to critical infrastructure</th>
<th>Obj 4: To salvage belongings inside properties and businesses</th>
<th>Obj 5: To select FRM alternatives easy and feasible to implement</th>
<th>RANKING OF ALT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(INDICATOR)/ALTERNATIVES</td>
<td>(Flooded hectares)</td>
<td>(Number of properties flooded)</td>
<td>(Damage to critical infrastructure)</td>
<td>(Opportunity of salvaging belongings)</td>
<td>(Feasibility of implementation in Redbridge)</td>
<td></td>
</tr>
<tr>
<td>Alternative 1</td>
<td>28.02</td>
<td>987</td>
<td>Medium damage</td>
<td>Very low opportunity</td>
<td>Very high feasibility</td>
<td>3</td>
</tr>
<tr>
<td>Alternative 2</td>
<td>24.06</td>
<td>616</td>
<td>Medium damage</td>
<td>Very low opportunity</td>
<td>Low feasibility</td>
<td>2</td>
</tr>
<tr>
<td>Alternative 3</td>
<td>25.8</td>
<td>904</td>
<td>Medium damage</td>
<td>Very low opportunity</td>
<td>Medium feasibility</td>
<td>4</td>
</tr>
<tr>
<td>Alternative 4</td>
<td>28.02</td>
<td>535</td>
<td>Medium damage</td>
<td>Very low opportunity</td>
<td>Low feasibility</td>
<td>1</td>
</tr>
<tr>
<td>Alternative 5</td>
<td>28.02</td>
<td>987</td>
<td>Medium damage</td>
<td>Very low opportunity</td>
<td>Low feasibility</td>
<td>5</td>
</tr>
</tbody>
</table>

#### Graph of Ranking:

![Score of Alternatives](image)

#### Reason of selection:

Most of the responsibility for property level flood protection falls on the property owner. For flooding in any form, Rainwater harvesting scores well but the feasibility of installation everywhere is highly doubtful. Improved warning and forecasting (to 30 minute lead time) will likely not have a significant effect in terms of property damage limitation. Almost everyone will seek to confirm the warning through an alternative source, which will decrease the effective lead time. Also assumes warning recipients are in the property and able to act.
Exercise for Cranbrook catchment
United Kingdom

RANKING OF ALTERNATIVES

The tools and buttons below will guide you through the different steps to evaluate the flood risk management research. For each step, please make sure you read the details about each step provided below the diagrams.

1. Weighting of the objectives
   (Click here to start)

2. Review of the Group Weighting
   (Click here to view the results)

3. Individual ranking of alternatives

Please go through the maps (below this table) to make a good assessment of each alternative.

Evaluation of the alternatives according to the objective 3 (BASE CASE SCENARIO)

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do nothing</td>
</tr>
<tr>
<td>2</td>
<td>Rainwater harvesting</td>
</tr>
<tr>
<td>3</td>
<td>Improved and targeted maintenance</td>
</tr>
<tr>
<td>4</td>
<td>Improved resilience for preventing flooding</td>
</tr>
<tr>
<td>5</td>
<td>Improved rainfall and flood</td>
</tr>
</tbody>
</table>

Legend:
- Your rank position
- Clustered positions
- Sh in Group 1: Government agencies and local councils
- Sh in Group 2: Emergency and utility services
- Sh in Group 3: General public
- Sh in Group 4: Research institution
- Sh in Group 5: Competitors and businesses
- Sh in Group 6: Other

Group Score of Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>35</td>
</tr>
<tr>
<td>5</td>
<td>32</td>
</tr>
</tbody>
</table>
Group Results for the UK Case Study:

- **A1 (base case):** Do nothing
- **A2:** Rainwater harvesting
- **A3:** Improved and targeted maintenance regimes for the sewer system
- **A4:** Improved resistance for preventing water from entering properties
- **A5:** Improved rainfall and flood forecasting and warning

![Group Score of Alternatives]

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Rank</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>16.49</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>28.35</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>29.80</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>30.83</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>29.79</td>
</tr>
</tbody>
</table>
Integrate, Consolidate and Disseminate European Flood Risk Management Research
CONCLUSIONS

• The developed tools proved to be useful for promoting interaction between stakeholders, developing shared knowledge, carrying out collaborative modelling and achieving social acceptance of new technologies for flood risk management.

• Engaging a wide variety of stakeholders in the decision-making process for flood risk management proved to make them more aware of the situation and increased their personal responsibility towards this issue.

• Having case studies of different magnitudes allowed drawing conclusions and recommendations for replication in other areas.
CONCLUSIONS

Some barriers for wider stakeholder involvement remain:

- Lack of knowledge and motivation
- Language barriers
- High residential turnover rate
- Apathy to taking part in flood risk management and towards self-resilience measures
RainGain Project:
Advanced observation and rainfall prediction for urban pluvial flood management
(Sep 2011 – Jul 2015)
RAINGAIN
Project Objective

To improve fine-scale measurement and prediction of rainfall and to enhance urban pluvial flood prediction in order to enable urban water managers to adequately cope with intense storms, so that the vulnerability of populations and critical infrastructure can be reduced.
Project Partners

1) TU Delft (NL)
2) Zuid-Holland Province (NL)
3) Gemeentewerken Rotterdam (NL)
4) KU Leuven (B)
5) Aquafin NV (B)
6) Ecole des Ponts ParisTech (F)
7) Marne-la-Vallée (F)
8) Seine-St.-Denis (F)
9) Météo France (F)
10) Imperial College London (UK)
11) Met Office (UK)
12) Local Government Flood Forum (UK)
13) Véolia (F)
Work Packages

• **WP1:** Acquisition, installation and testing of X-band radars and high-quality radar protocols in pilot locations.
  *Lead: ParisTech, Daniel Schertzer*

• **WP2:** Acquisition of rainfall data at the detailed time and spatial scales that are essential for urban rainfall and flooding prediction
  *Lead: KU Leuven, Patrick Willems*

• **WP3:** Implementation of rainfall data in existing urban water models to enhance short term pluvial flood modelling and prediction
  *Lead: Imperial College of London, Cedo Maksimovic*

• **WP4:** Implementation of detailed rainfall data and flood modelling results into enhanced urban water management strategies at the short and long term
  *Lead: TU Delft, Marie-claire ten Veldhuis*
Pilot Sites

Rotterdam (NL)

Leuven (BE)

Marne-la-Vallée (FR)
Seine-St.-Denis (FR)

Croydon (UK)
Redbridge (UK)
Torbay (UK)
Cooperative Work

- Knowledge exchange between partners
- Field visits pilot locations
- Workshops on development of common methods and training for practical application
- Demonstration tools (radar, flood model), applications (radar results, model results), solutions (early warning systems, operational control, storage basins) to other partners
Blue Green Dream

Integrating Blue and Green Urban Assets for the City of Tomorrow
Blue Green Dream

- Led by Urban Water Research Group of ICL
- 4 EU countries
- 14 partners and 24 supporters from academia, businesses (including SMEs) and local, regional and national governments
Thank you

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