PhD Progress Report

Urban pluvial flood risk reduction through non-structural measures

(start date: November 2011)

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1. Introduction

$$Risk = Hazard \times Exposure \times Vulnerability$$

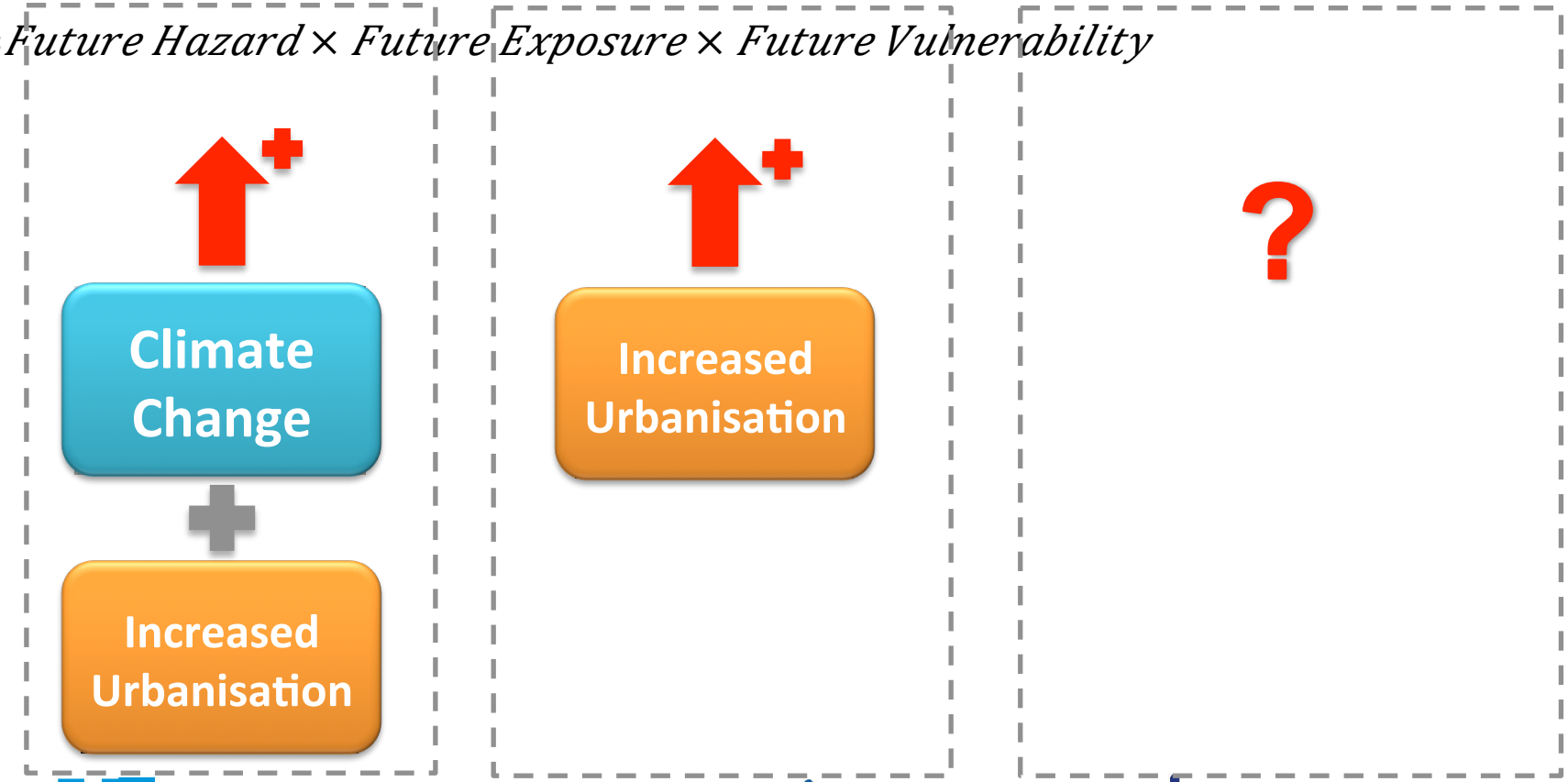
Hazard: likelihood or probability of occurrence of a flood event of certain magnitude and characteristics (e.g. depth and velocity of water, duration of the flood and its load).

Exposure: people, property, systems, or other elements present in hazard zones that are thereby subject to potential damage.

Vulnerability: characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of flood hazard; it can be considered as a combination of susceptibility and value

1. Introduction

$$\text{Future Urban Pluvial Flood Risk} = \text{Future Hazard} \times \text{Future Exposure} \times \text{Future Vulnerability}$$



1. Introduction

$$\textit{Future Urban Pluvial Flood Risk} = \textit{Future Hazard} \times \textit{Future Exposure} \times \textit{Future Vulnerability}$$

Climate Change

+

Increased Urbanisation

Increased Urbanisation

This is where my thesis aims at contributing!

Raising awareness, engaging stakeholders

Improving forecasting

2. PhD Objectives

1. **Uncertainty estimation and reduction:** To develop and test a methodology for estimating the overall uncertainty in urban pluvial flood modelling and forecasting (considering different sources and their propagation to final impact variables), in such a way that an indicator of the quality/reliability of the forecast can be provided. Also, explore techniques for reducing main sources of uncertainty.

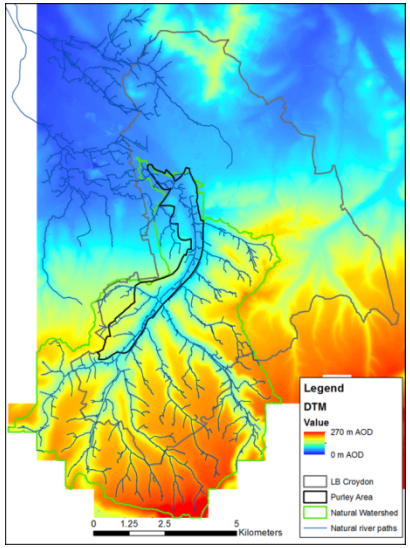
2. **Implementation of full-scale urban pluvial flood forecasting system:** To implement and test in full scale a pilot urban pluvial flooding forecasting system, which uses as input the improved rainfall estimates and forecasts produced in WP1 and WP2 of the RainGain Project.

3. **Development and testing of tools for stakeholder engagement in local flood risk management:** these tools aim at complementing the modelling and forecasting tools mentioned above.

3. Activities to date

1. Setup of case studies (will present them tomorrow!)

   - Data collection, revision, processing

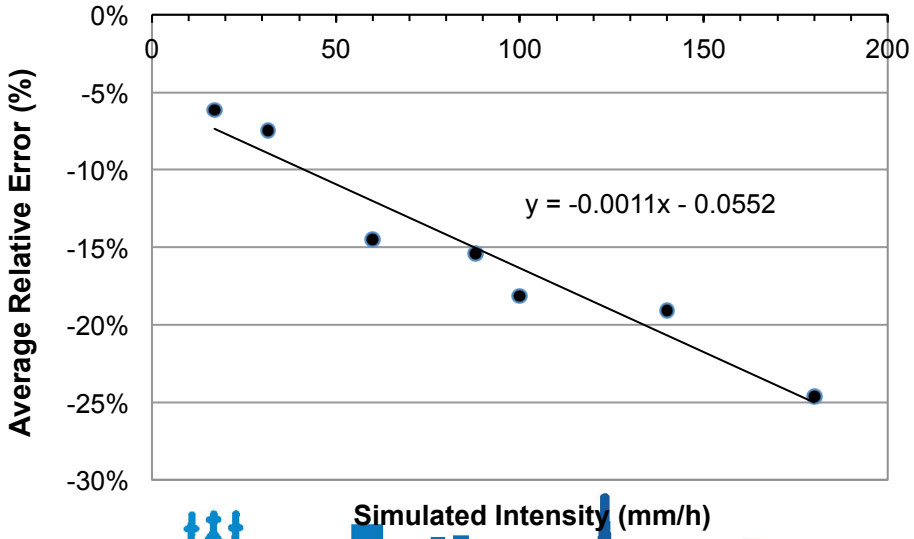


   - Fixing and upgrade of monitoring system in Cranbrook

3. Activities to date

1. Setup of case studies (will present them tomorrow!)

- Static & dynamic calibration of raingauges of London Grid for Learning and new raingauges to be soon installed in Purley, Croydon

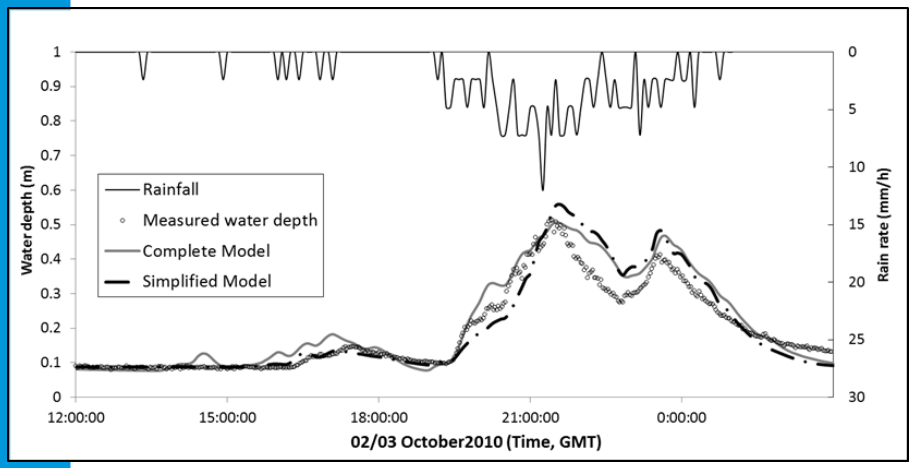


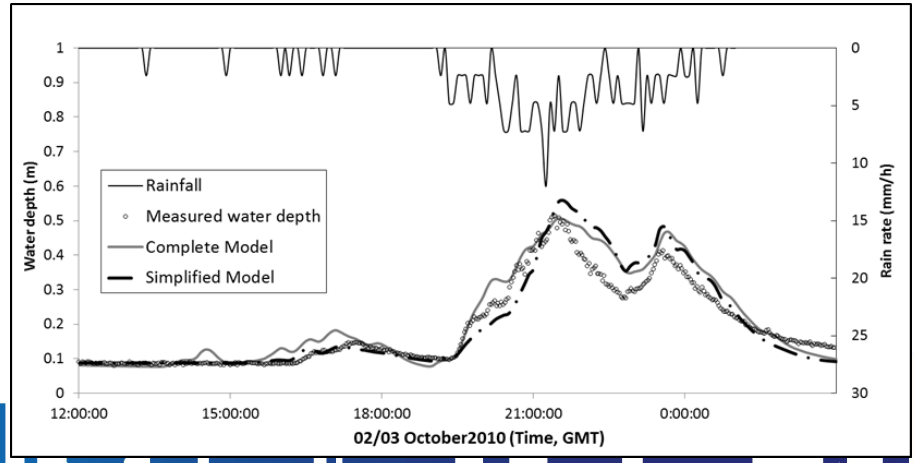
3. Activities to date

1. Setup of case studies (will present them tomorrow!)

- Meetings with local authorities of three pilot locations to assess current situation, needs and expectations

- Model setup, testing, manual calibration





3. Activities to date

2. Literature review

- Understanding of statistical likelihood, Bayesian inference and maximum likelihood method
- Review of sources of uncertainty in urban pluvial flood models and ways in which these are treated
- Review of current situation in the UK with regard to surface water flood risk, including related legislation and detailed analysis of current forecasting and warning system
- Review of surface water flood risk mitigation options and methodologies for ranking and selection of options

Development of Surface Water Flooding related legislation in the UK

Investing in Opportunities
This project has received European Regional Development Funding through INTERREG IV B.
INTERREG IVB

2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012

2005
- Making Space for Water

2006
- PPS25

2007
- Integrated Urban Drainage Pilots
- Future Water Strategy
- Summer 2007 Floods

2008
- Statement of Principles
- ERAs
- Pitt Review
- Update - PPS25

2009
- FLOODFORECASTINGCENTRE
- Government's Response to Pitt Review
- UK CLIMATE PROJECTIONS
- Flooding in England: National Assessment of Flood Risk
- 'AREAS SUSCEPTIBLE TO WATER FLOODING MAPS' 1st Generation Maps
- Cumbria Floods
- The Flood Risk Regulations 2009

2010
- Flood and Water Management Act 2010
- 'FLOOD MAPS FOR SURFACE WATER' 2nd Generation Maps
- SWMP Technical Guidance
- Drain London Forum
- PFRAs
- exercise Watermark

2011
- Flood Guidance Statement
- SWF warnings
- FLOODFORECASTINGCENTRE
- National Flood & Coastal Erosion RM Strategy

2012
- Draft Water Bill
- UK 2012 Climate Change Risk Assessment
- National Planning Policy Framework

Surface Water Flood Forecasting and Warning in the UK

July 2008 – Launching of Extreme Rainfall Alert Service

- Indication of the probability of rainfall heavy enough to cause flooding somewhere, particularly in urban areas
- Issued to category 1 and 2 emergency responders; e.g. local authority highways and emergency response departments, and utility companies
- Issued at county level
- 3 phases of alert:

	Extreme Rainfall Alerts		
	Advisory	**Early**	**Imminent**
30 mm/h or 40 mm/3h or 50 mm/6h	Very low but prob >= 10%	Low with prob 20-40%	Moderate with prob >= 40%
Issued	14LT valid for the 24h starting from the next midnight	Lead time of 8 – 11h	Lead time of 1-3h

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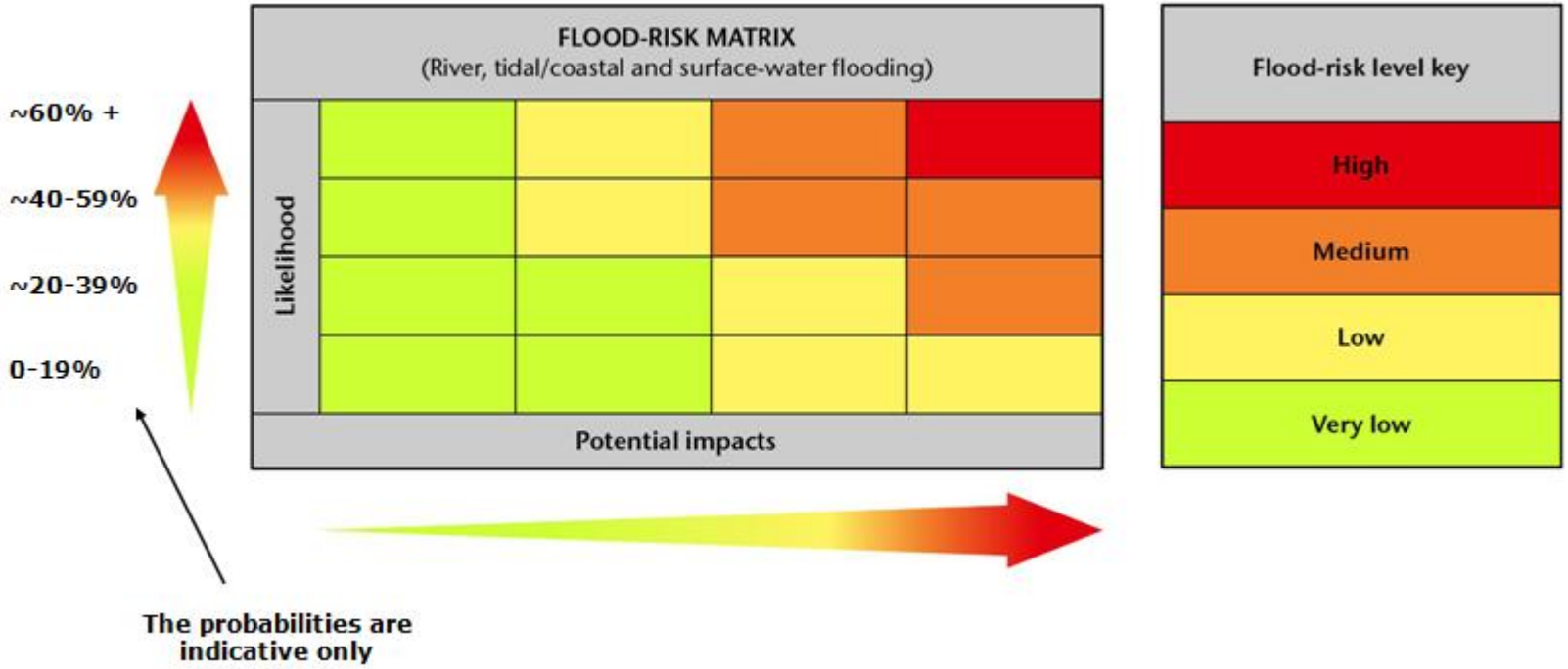
October 2011 – ERA's superseded by Surface Water Flood Warnings, included in the daily Flood Guidance Statement

- Probability of surface water flooding estimated with new "Surface Water Decision Tool"
- Factors taken into account:
  - Probability of rainfall thresholds being exceeded
  - Spatial extent of rainfall
  - Potential impacts (using 'blue squares')
  - *Subjectively:* antecedent weather, catchment conditions on the ground and operational issues

Surface Water Flood Forecasting and Warning in the UK

ID	County / Unitary Authority	Blue Square (%)	Blue Sq. Category	Spatial Category Weight 0.25 Data	Score	Prob. Excd. 3Hr30 Weight 0.375 Column F Data	Score	Prob. Excd. 6Hr30 Weight 0.375 Column G Data	Score	Total weighted score	Risk Category
0	Merseyside	17.64	3	widespread	1	20	3	20	3	2.50	High
1	S Yorkshire	10.63	2	widespread	1	5	1	5	1	1.00	Very Low
2	Tyne and Wear	19.60	3	localised	3	20	3	20	3	3.00	High
3	W Midlands	44.47	3	no rainfall	0	30	3	20	3	2.25	High
4	W Yorkshire	18.09	3	localised	3	5	1	5	1	1.50	Very Low
5	Gtr London	62.27	3	no rainfall	0	30	3	20	3	2.25	High
6	Gtr Manchester	28.84	3	no rainfall	0	30	3	20	3	2.25	High
7	Bedfordshire	5.96	2	organised	2	20	3	20	3	2.75	High
8	Buckinghamshire	7.22	2	organised	2	20	3	20	3	2.75	High
9	Cambridgeshire	1.96	1	organised	2	20	3	20	3	2.75	High
10	Cheshire	3.51	1	no rainfall	0	20	3	20	3	2.25	Low
11	Cornwall & Isles o	3.03	1	no rainfall	0	20	3	20	3	2.25	Low



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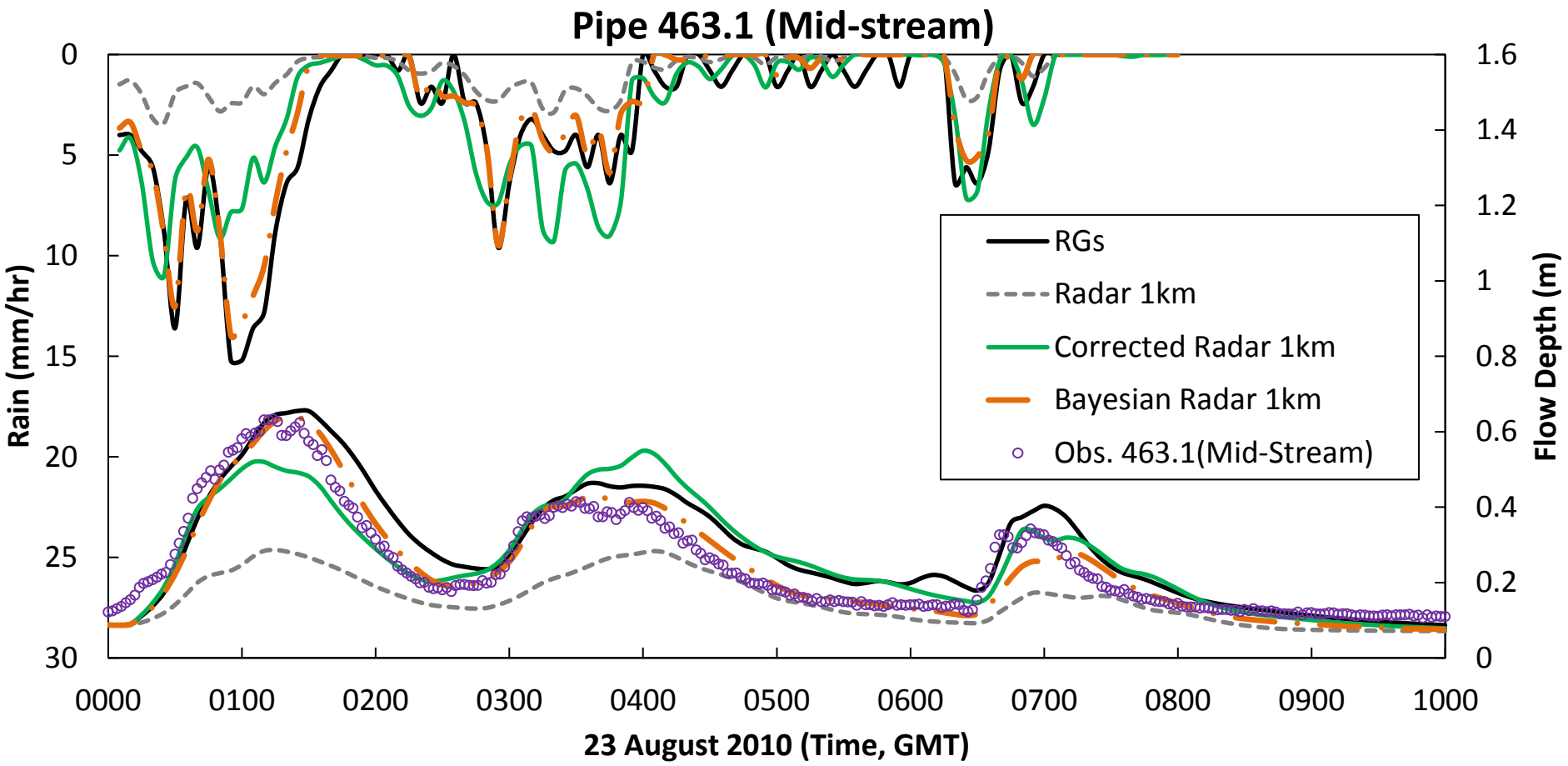
Conclusions of recent analyses and consultations

- Need for stronger connection between rainfall intensity/duration and local flooding
- Low reliability of forecast could be partially overcome by providing automated telemetry alarms (e.g. upstream of culvert trash screens, rainfall intensity) directly to the public in surface water hot spots.
- Need for standardised collection of data which can be used to validate models
- Community ownership must be at the heart of any future surface water flood warning service, including raising awareness, encouraging self-help, promoting property-level protection, and expectation management
- Two possible schemes for SWF warnings: (1) Single national service vs (2) **two-tier (national/local) approach.**

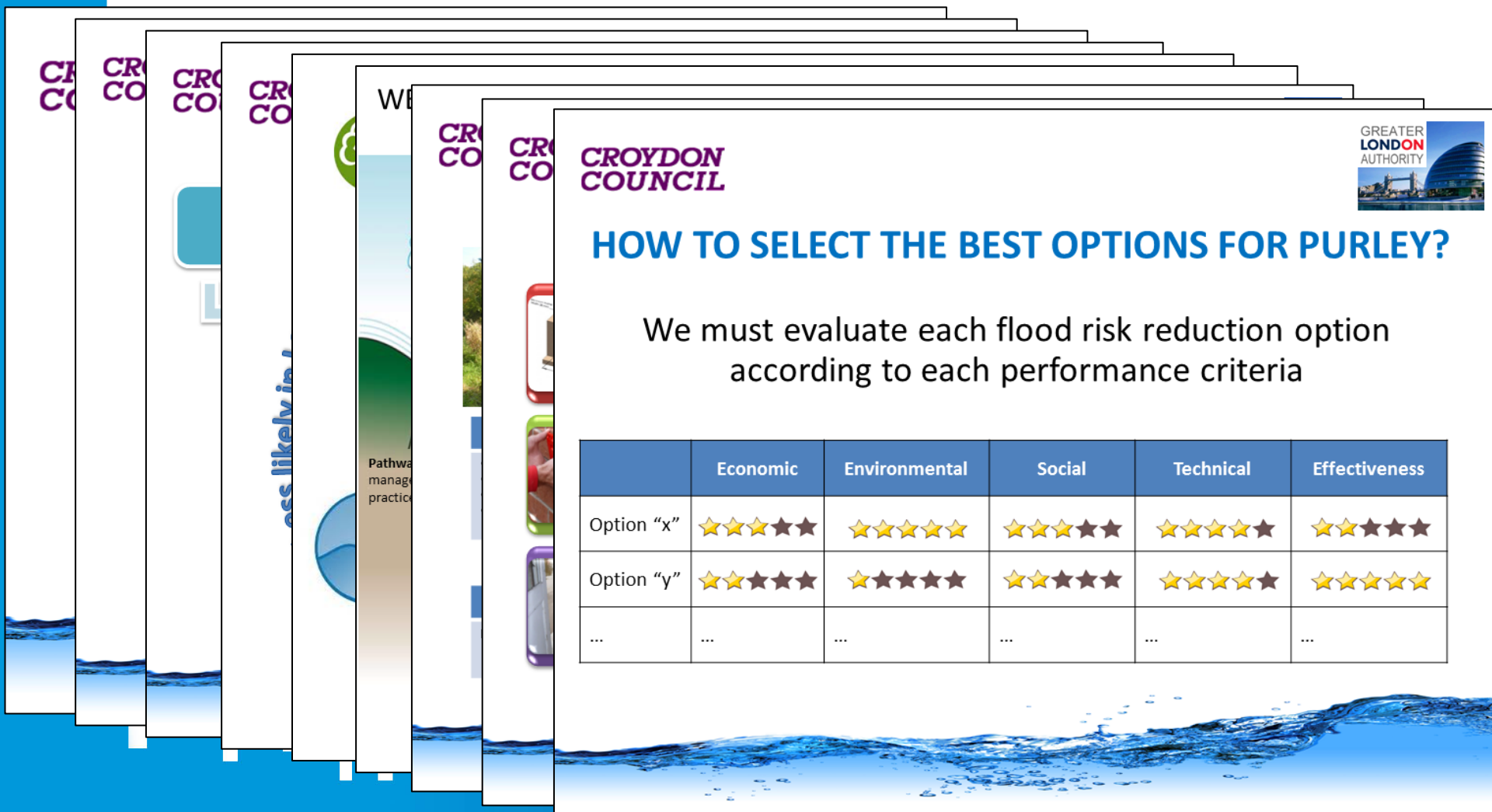
3. Activities to date

3. Testing of radar-raingauge merging (with Lipen)



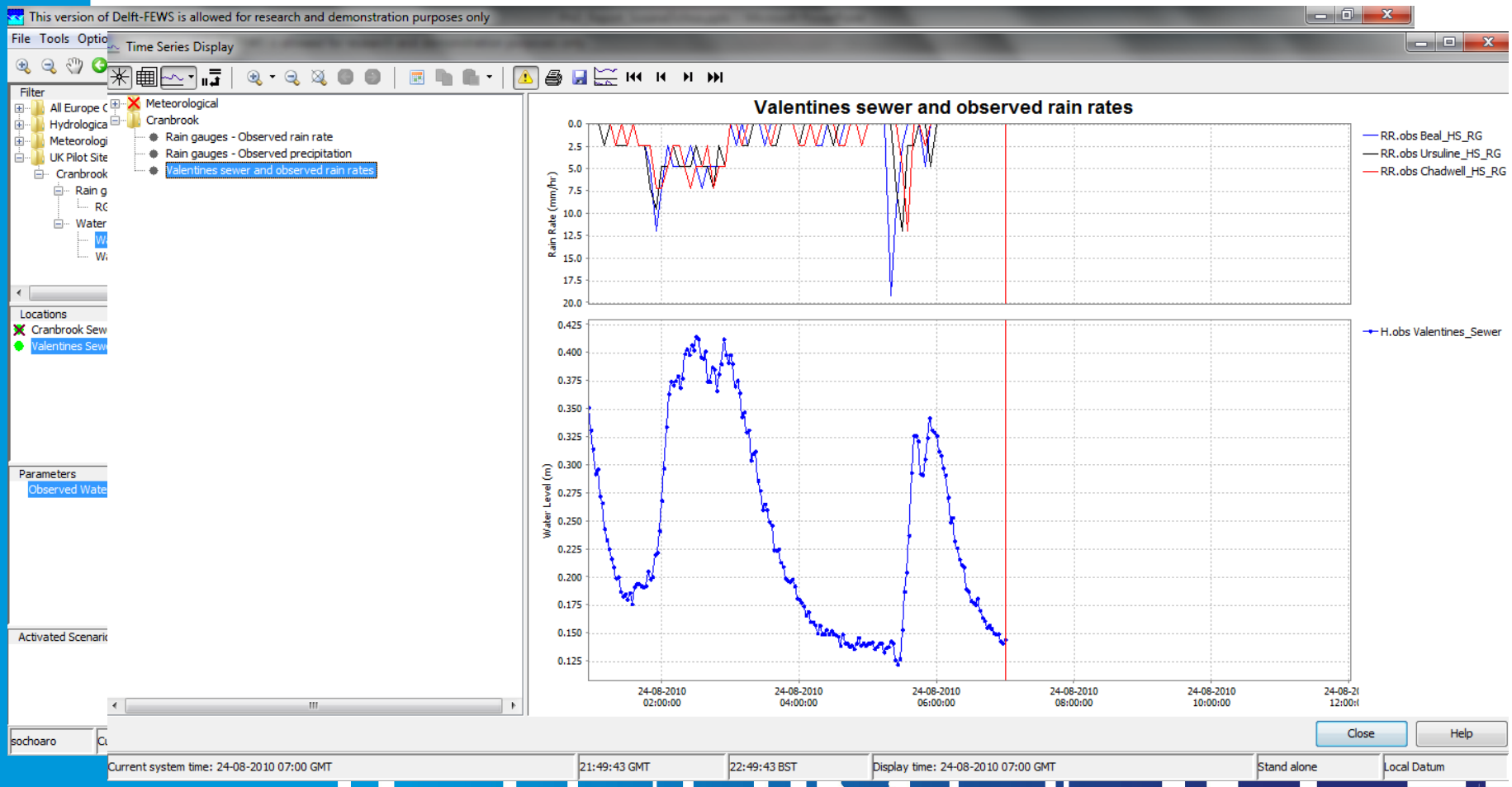
3. Activities to date

4. Development of workshop pack for participatory management of local surface water flood risk



3. Activities to date

5. Setup of pilot forecasting platform for Cranbrook Catchment (will be presented separately)



4. Next activities

1. Finish and test workshop pack for stakeholder engagement in local flood risk management

2. I'm working on the reconstruction of 4 heavy rainfall events for assessing benefits of gauge-based radar adjustment in nowcasting

3. Calibrate model of Cranbrook catchment using different rainfall inputs (raingauge only, radar only, merged radar-raingauge), determine how calibration is affected by the rainfall data used and how to best represent uncertainty in rainfall when doing calibration

4. Analyse propagation of parametric uncertainty of the model of the sewer system to surface flood depth and extent & analyse sensitivity of model results to parameters of surface model

5. Further analyse effect of spatial variability of rainfall on flow and flood estimates

4. Next activities

6. Determine local flood triggers for 3 pilot locations and analyse effect of boundary conditions in these triggers

7. Further develop pilot forecasting platform for Cranbrook and implement it in other case studies

8. Develop methodology for analysing total error in flood modelling and forecasting (possibly using Bayesian inference)

9. Possible: compare forecasting methodologies: (1) running models in real time using NWP and nowcasting as input; (2) artificial intelligence forecasting system (e.g. ANN) train with model results for a number of storms (input parameters would be: antecedent precipitation, specific boundary conditions of each catchment, expected rainfall depth and duration, type of storm).

5. Problems / Constraints

1. Difficulty in obtaining data, especially models of sewer system
2. Lack of funding for monitoring
3. Infoworks
4. Linking sources of uncertainty to quantify the overall error/ uncertainty seems rather challenging, I'm still thinking of how to best do it. Will probably follow BATEA approach, but need more reading and analysis.
5. Time needed for administrative tasks