Surface Water Flooding Hazard Impact Model – Phase 2

Case Study Selection – Summary

The Surface Water Flooding Hazard Impact Model (SWF HIM) Phase 2 project is a Development and Testing programme.

Project Work Packages 3 and 4 will conduct sensitivity analysis, verification, evaluation and performance summaries based on a series of case studies. This analysis will further develop and test the hazard and impact aspects of the SWF HIM. This document sets out the protocols and framework for case study selection.

Protocols

1. The case study dataset will, as much as possible, reflect the whole range of the Flood Forecasting Centre (FFC) flood risk matrix impact categories. These categories are minimal, minor, significant and severe. See Annex A for a description of the flood risk matrix categories.
2. Both urban and rural cases will be considered.
3. Winter and summer surface water flooding cases will be used. The winter cases will reflect saturated or near saturated antecedent ground conditions and saturation excess driven surface water flooding. The summer cases will reflect unsaturated antecedent ground conditions and infiltration excess driven surface water flooding.
4. If possible cases will be selected that will allow analysis of hazard modelling over chalk geology; a known potential weakness. It is recognised, however, that other aspects of the geology such as, overlying superficial deposits, may make this aspect a challenge. The considered opinion is that this aspect of the hazard modelling will be better addressed in a longer period assessment.
5. Ideally, a 'false positive' case should be analysed, where the SWF HIM forecast impacts when no impacts occurred.
6. During the course of the Phase 2 project any relevant and interesting new surface water flooding events or 'false positive' cases will be analysed subject to the availability of data and project resource.
7. For the sensitivity analysis, cases should be chosen where a range of impact categories occur over a single county. This does not necessarily need to be from a single meteorological event.
8. For each event the hazard modelling will be conducted across the whole of the relevant domain(s). This may help to reveal 'false positive' episodes.
9. As a minimum a total of 10 'meteorological events' will be used, with a practical upper limit of 15.

Limitations and constraints

1. The number of archived events in the case study dataset is limited to those events that have been verified by the FFC. The majority of these cases are in the minor and significant categories, with relatively few in the minimal and only one case in the severe category.
2. Due to the computational expense of modelling the impact library module of the SWF HIM, the phase 2 case study domains will be restricted to regional, rather than national domains.
3. It is recognised that there is a large subjective element to the assessment of impacts. However, within the FFC these assessments have been conducted as objectively and consistently as possible and are benchmarked against the flood risk matrix. Further work between King's College London (KCL) and the Health & Safety Laboratory (HSL) is generating an independent set of impact data. See below:

Impact Validation

Funded by a NERC grant to the SINATRA project awarded as part of the Flooding from Intense Rainfall Programme, Professor David Demeritt from King's College London (KSL) is exploiting the Lexis-Nexis digital archive of ~650 regional newspapers, call-out records from the fire service and other administrative data to generate an independent set of impact data against which HIM forecasts can be validated. These digital sources are mined and the resulting impacts then geo-located, categorized by type, and scored using the criteria set out in the FFC impact matrix.

Phase 2 Case Study Domain Selection

In the FFC surface water flooding event archive, there are circa 24 separate 'meteorological events' that have recorded surface water flooding impacts, spanning from June 2012 to November 2014. These meteorological events are mapped geographically in figure 2 and this highlights a 'cluster' of events in the east of England. In addition to the two regional domains used in phase 1 (figure 1), it is proposed that a third domain is used that encompasses the south-east of England. Also outlined red in figure 2 are the initial proposed counties for phase 2 case studies.

Figure 1 – Phase 1 Case Study Domains

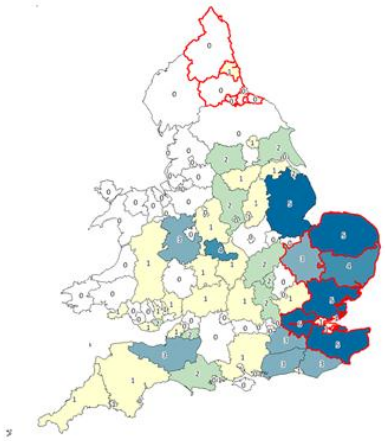


Figure 2, – events per county and selected counties.

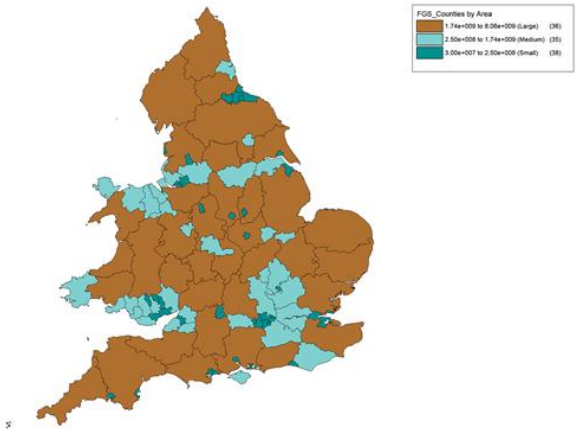


Figure 3, Counties by area.

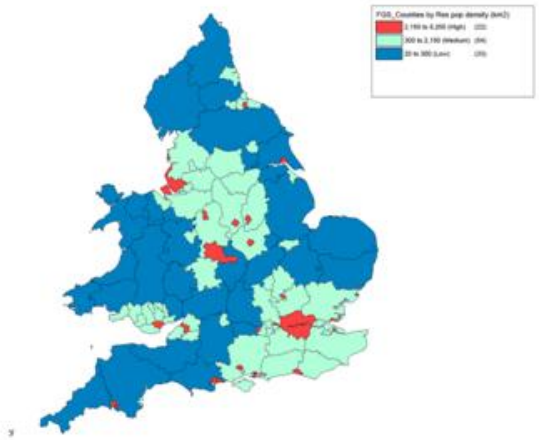


Figure 4, Counties by residential population density (km2).

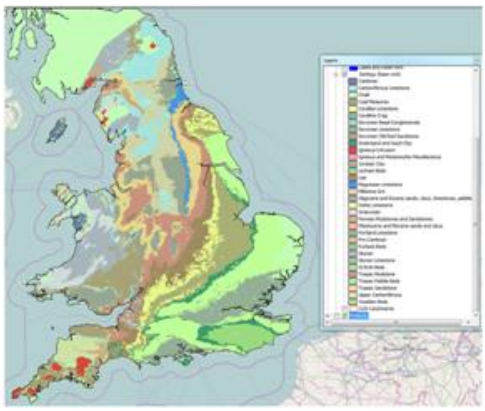


Figure 5, Geology (base rock)

Consideration of county characteristics

In selecting cases, consideration has been given to the broad characteristics of counties in terms of size (area), population and a subjective assessment of rural/urban extent. Figure 3 above shows that for the selected counties there is a mix of small, medium and large counties. In figure 4, counties by residential population density are considered (this may be applied as a proxy measure for urban/rural extent). For the selected counties there is a broad mix of low, medium and high population densities. Figure 5, is an overview of base rock geology and some of the selected counties are coincident with chalk geology, which is a consideration of case study selection.

Phase 2 selected case studies

An initial set of archived surface water flooding events from the FFC have been analysed by HSL and mapped according to county size (figure 3) and residential population density (figure 4), and an assessment of the rural or urban nature of the county or unitary authority. An initial choice of events for the phase 2 analysis is shown in table 1.

The final selection for an initial 11 case study events are shown in Table 2. These events have been selected and agreed after consideration between the FFC, CEH, HSL and KCL, taking into account the protocols outlined above.

Table 3 highlights the characteristics of the selected event counties in terms of urban/rural extent, size (area) and residential population density. Table 4 shows a count of the selected counties' characteristics and categories of impacts.

Supporting data

The supporting NWP/MOGREPS UK data is stored at the Met Office on the MASS system. CEH have been granted external access to MASS and they will use the JASMIN system to access MASS. The JASMIN system is a fast link to MASS and is part of the NERC infrastructure. CEH having a 'workspace' on JASMIN with 5 Terabytes of storage.

Table 1, case study event archive

Event	Counties	Impact category
28 June 2012	Northumberland	Significant
	Tyne & Wear	Severe
4 August 2012	Northumberland	Minor
5 August 2012	Tyne & Wear	Significant
6 & 7 August 2012	Darlington	Significant
	Durham	Significant
	Northumberland	Significant
	Tyne & Wear	Significant
6 July 2012	Norfolk	Significant
	Suffolk	Minor
	Northumberland	Significant
5 July 2012	Durham	Significant
	Northumberland	Minor
	Stockton-on-Tees	Minor
9 July 2012	Suffolk	Minor
10 July 2012	Greater London	Minor
13 July 2012	Cambridgeshire	Minor
	Kent	Minor
25 August 2012	Cambridgeshire	Minor
	Greater London	Minor
11 October 2013	Kent	Minor

20 July 2014	Essex	Significant
	Norfolk	Significant
	Kent	Significant
	Greater London	Minor
28 June 2014	Norfolk	Minor
	Suffolk	Significant
	Greater London	Minor
8 August 2014	Cambridgeshire	Significant
	Essex	Minor
	Kent	Minor
21 May 2014	Cambridgeshire	Minimal
	Essex	Minimal
	Norfolk	Minimal
	Southend-on-Sea	Minimal
	Suffolk	Minimal
	Thurrock	Minimal
	Kent	Minimal
	Medway	Minimal
	Greater London	Minimal
14 August 2014	Essex	Minor
	Suffolk	Minor
	Greater London	Significant
28 July 2014	Cambridgeshire	Minor
	Essex	Significant
	Greater London	Significant
27 June 2014	Norfolk	Minor
12&13 July 2014	Norfolk	Significant
	Suffolk	Minor
	Kent	Minor
30 June 2014	Kent	Minimal
8 July 2014	Tyne & Wear	Significant
25 July 2014	Greater London	Minor
7 February 2014	Cambridgeshire	Minor
	Essex	Significant
	Suffolk	Significant
23 November 2014	Cambridgeshire	Minor
	Essex	Minimal
	Norfolk	Minor
	Suffolk	Minor
	Thurrock	Minor
	Greater London	Minor

Table 2, Final selection of initial 11 case study events

Event	Counties	Impact category
28 June 2012	Northumberland	Significant
	Tyne & Wear	Severe
6 July 2012	Norfolk	Significant
	Suffolk	Minor
	Northumberland	Significant
5 July 2012	Durham	Significant
	Northumberland	Minor
	Stockton-on-Tees	Minor
20 July 2014	Essex	Significant
	Norfolk	Significant
	Kent	Significant
	Greater London	Minor
28 June 2014	Norfolk	Minor
	Suffolk	Significant
	Greater London	Minor
21 May 2014	Cambridgeshire	Minimal
	Essex	Minimal
	Norfolk	Minimal
	Southend-on-Sea	Minimal
	Suffolk	Minimal
	Thurrock	Minimal
	Kent	Minimal
	Medway	Minimal
	Greater London	Minimal
14 August 2014	Essex	Minor
	Suffolk	Minor
	Greater London	Significant
28 July 2014	Cambridgeshire	Minor
	Essex	Significant
	Greater London	Significant
8 July 2014	Tyne & Wear	Significant
7 February 2014	Cambridgeshire	Minor
	Essex	Significant
	Suffolk	Significant
23 November 2014	Cambridgeshire	Minor
	Essex	Minimal
	Norfolk	Minor
	Suffolk	Minor
	Thurrock	Minor
	Greater London	Minor

Table 3, County Characteristics

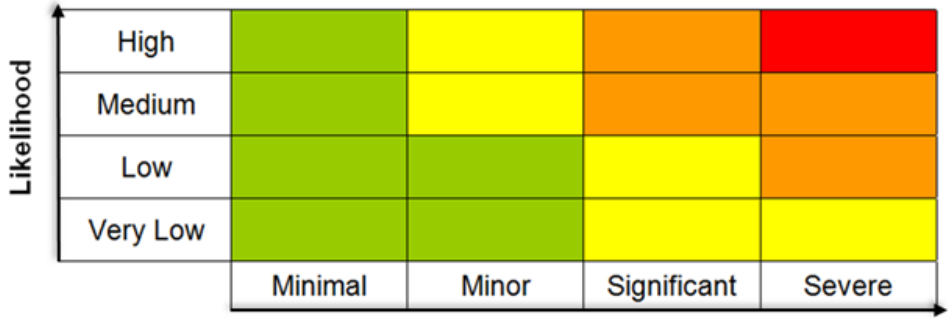
Counties	**Characteristics (urban/rural, size, population density)**
Northumberland	Rural, Large, Low
Tyne & Wear	Urban, Medium, Medium
Durham	Rural, Large, Low
Norfolk	Rural, Large, Low
Suffolk	Rural, Large, Low
Stockton-on-Tees	Urban, Small, Medium
Greater London	Urban, Medium, High
Cambridgeshire	Rural, Large, Low
Kent	Rural, Large, Medium
Essex	Rural, Large, Medium
Southend-on-Sea	Urban, Small, High
Thurrock	Rural, Small, Medium
Medway	Rural, Small, Medium

Table 4, category counts

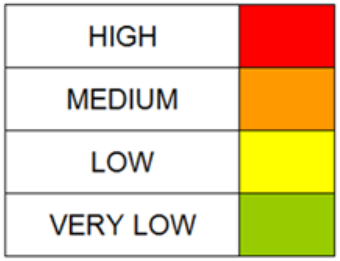
Category	Count
Counties	13
Counties Urban	4
Counties Rural	9
Minimal Impacts	10
Minor Impacts	15
Significant Impacts	14
Severe Impacts	1
Size- small	4
Size - Medium	2
Size- Large	7
Pop Density - Low	5
Pop Density - Medium	6
Pop Density - High	2
‘Summer’ events	9
‘Winter’ events	2

ANNEX A Flood Risk Matrix and Impact Table

Flood Risk Matrix
(river, tidal/coastal, surface water & groundwater flooding)



Overall Flood Risk



FLOOD IMPACTS TABLE

to be used by FFC (FGS), EA and Met Office (weather alerts / warnings of heavy rain) as an optional link on websites

	Minimal Impacts	Minor Impacts	Significant Impacts	Severe Impacts
Typical impacts	**Minimal disruption** • Generally no impact, however there may still be • Isolated and minor flooding of low-lying land and roads • Isolated instances of spray/wave overtopping on coastal promenades • Little or no disruption to travel although wet road surfaces could lead to difficult driving conditions	**Minor disruption** • Localised flooding of land and roads – risk of aquaplaning • Localised flooding could affect individual properties • Individual properties in coastal locations affected by spray and/or wave overtopping • Localised disruption to key sites identified in flood plans (e.g. railways, utilities) • Local disruption to travel – longer journey times	**Significant disruption** • Flooding affecting properties and parts of communities • Damage to buildings/structures is possible • Possible danger to life due to fast flowing/deep water/ wave overtopping/ wave inundation • Disruption to key sites identified in flood plans (e.g. railways, utilities, hospitals) • Disruption to travel is expected. A number of roads are likely to be closed	**Severe disruption** • Widespread flooding affecting significant numbers of properties and whole communities • Collapse of buildings/structures is possible • Danger to life due to fast flowing/ deep water/ wave overtopping/ wave inundation • Widespread disruption or loss of infrastructure identified in flood plans (e.g. railways, utilities, hospitals) • Large scale evacuation of properties may be required • Severe disruption to travel. Risk of motorists becoming stranded