Annex D

Flood Risk in Hampshire risk assessment methodology

Annex D

D.1 INTRODUCTION

D.1.1.1 This document outlines the process followed to identify areas within Hampshire which have a high risk of local (groundwater and surface water) flooding.

D.1.1.2 The aim of the assessment was to provide a consistent means to compare the economic risk of flooding between wards in Hampshire. This can then act as a guide to indicate where investment in flood risk management may be most affectively focused.

D.1.1.3 The outcome of the assessment is a map which expresses the risk of flooding as an economic value. To produce the map we have made use of publicly available guidance to establish standardised costs of flooding of different features. The map does not and should not be used to express the actual cost of flooding, it is merely a means by which to standardise the comparison of the risk of flooding between boroughs in Hampshire.

D.1.2 IMPACT OF FLOODING

For this assessment, the overall economic cost of flooding includes the costs related to:

- The number of residential properties which flood internally
- The number of non residential properties (such as shops and factories) which flood internally
- The number of properties which are critical infrastructure which floods internally (such as schools, hospitals, electricity sub stations)
- The length of motorway and A-roads which flood

D.1.2.1 DATA SOURCES

D.1.2.2 Two forms of data are required for the assessment: information on flooding (where it is, how often it occurs, how deep it is) and information on what is susceptible to flooding (location, building type, road type, floor area).

We gathered the first set of data (about flooding) from the following sources:

- The Environment Agency Flood Map for Surface Water
- Hampshire County Council flooding records
- Report on the Groundwater flooding in the winter of 2000-2001
- Water company records

D.1.2.3 For data about properties and roads at risk we used the Environment Agency's National Receptor1 Dataset (NRD), Mastermap data produced by Ordnance Survey, and critical infrastructure data provided by HCC.

D.1.3 CALCULATING RISK

D.1.3.1 Risk is a factor of likelihood and consequence.

Risk = Consequence x likelihood

D.1.3.2 To establish the consequence of flooding we have identified the economic cost of a flood to each type of receptor flooded (eg. Property, road, infrastructure).

D.1.3.3 The economic cost of flooding is not the actual cost of damages to the receptor. Many factors combine to cause actual cost of damages, many of which can only be determined in detail after an event. The economic cost of flooding, in contrast, uses a number of assumptions to produce a comparative value that can be used for strategic assessments.

D.1.3.4 Using the Environment Agency Flood Defence Grant in Aid (FDGiA) we have applied a value of £30,000 cost per residential property which is flooded internally and calculated equivalent costs for other types of receptors.

D.1.3.5 The other component of risk, likelihood, is expressed in terms of a frequency, probability, or a return period. For example a flood which is said to have a 1 in 200 year return period, has a 1 in 200 chance of occurring in anyone year, or a 0.5% probability of occurring in any one year.[2]

D.1.3.6 We want to be able to compare and combine the costs of floods of different frequencies so we express the potential cost of flooding to a ward on an annual basis, to do this you divide the cost by the return period or frequency (or multiply by the probability). For example if 1 house is flooded by a 1 in 200 year flood, the total cost is £30,000 over that two hundred year period. The annual cost of damage caused by that flood is actually £150 (£30,000 divided by 200).

D.1.3.7 Some properties which are flooded by an infrequent or severe flood (e.g. 1 in 200), may also be flooded by more frequent floods. Therefore we cannot just sum all of the costs of different frequencies of floods to establish the annual

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[1] A receptor is anything which could be affected by flooding such as a house, road, school or park

[2] It is important to remember that a 1 in 200 year return period flood can occur more often than once every 200 years.

cost of flood damage: this would lead to an overestimate of damages. To combine the costs of different probability events we need to plot a graph which plots the probability (likelihood) of different floods against the damage (consequence) each of those floods cause. The area under the curve is then equal to the annual damages of flooding. This is shown in Figure D.1.

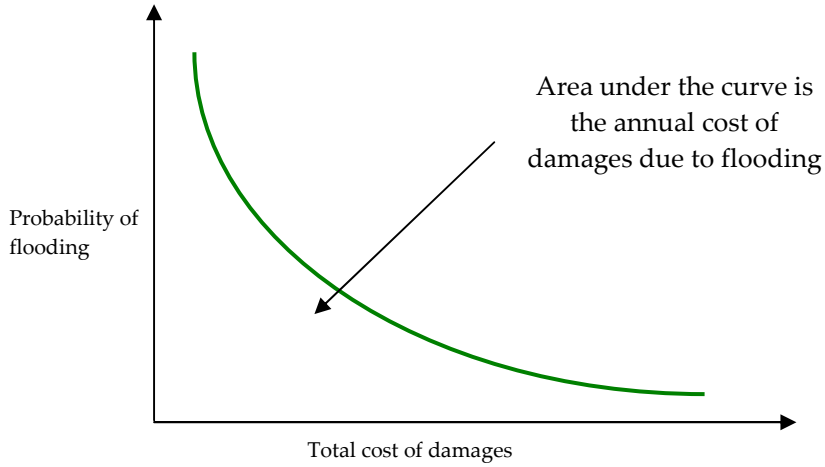

Figure D.1: Calculating annual cost of flood damage

D.2 DETAILED METHODOLOGY

D.2.1 Quantifying consequences

D.2.1.1 Defining a flood

A property is assessed to flood internally if:

- It is specified within the HCC database as having done so
- It is listed within the groundwater report as having done so
- Any part of its floor plan (taken from Ordnance Survey Mastermap) lies within 1 metre of the 'deep' (flooding greater than 0.3m depth) extent of the Environment Agency Surface Water Flood Maps[3].

D.2.1.2 For this study a road is deemed to flood if it is covered by either the shallow or deep extent in the Environment Agency Surface Water Flood Maps.

D.2.1.3 Using geospatial analysis we have counted the number and types of properties and the length of a-road or motorway that lie within the flood extents. These were then categorised by the type of property and by the ward in which they are located.

D.2.2 THE COST OF SURFACE WATER FLOODING TO RESIDENTIAL PROPERTY

D.2.2.1 The cost of internal flooding from surface water to residential property is based on standard assumptions used by the Environment Agency when populating the FDGIA calculator which values the damages to a residential property caused by internal flooding as £30,000. This value has been applied to all residential property irrespective of location, size or type.

D.2.3 THE COST OF SURFACE WATER FLOODING TO NON-RESIDENTIAL PROPERTY

D.2.3.1 The cost of internal flooding from surface water to a non-property is based upon its ground area and the bulk class of the property as defined in the Multi-coloured manual[4]. We have calculated the cost per metre relative to residential

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[3] The Environment Agency Surface Water Flood Map is buffered by 1 meter to overcome issues with the precision of the flood extents as a result of differences in grid sizes used when developing the map.

[4] The Benefits for Flood and Coastal Risk Management: A Manual of Assessment Techniques, Flood Hazard Research Centre, 2005; The Benefits for Flood and Coastal Risk Management: A Manual of Assessment Techniques 2010

property by calculating the average ratio of Weighted Annual Average Damage (WAAD) for each bulk class (type) of non-residential property against that for residential properties. This factor is then applied to the £30,000 cost of flooding to a residential property. Table D.1 illustrates the resulting cost per m^2 of floor area.

Table D.1: Cost (£) per m^2 of flooding for non residential property by Bulk class (assuming cost of flooding to residential property is £30k)

	Factory Bulk class	Retail Bulk Class	Warehouse Bulk Class	Office/other Bulk Class	Non-Bulk
Cost (£k/m2)	0.23	0.27	0.22	0.21	0.21

D.2.4 THE COST OF SURFACE WATER FLOODING OF CRITICAL INFRASTRUCTURE

D.2.4.1 Critical infrastructure is contained within the non-residential property bulk classes, and we have included these costs within the non-residential property calculations. However, these costs are costs to the physical fabric of the buildings or structure and does not account for indirect costs and costs of failure of service. These costs are not readily available, and much of the data behind these costs will be commercially sensitive. Therefore we have not directly accounted for these indirect costs in the consequence assessment. The impact of flooding on critical infrastructure will therefore be assessed qualitatively following the quantitative cost assessment.

D.2.5 THE COST OF GROUND WATER FLOODING

D.2.5.1 The number of flooded properties during the 2000-2001 groundwater flood event are shown in section 4.1 of Environment Agency report (September 2002)[5]. The report states that the estimates of the return period for total rainfall for the year (April 2000 – March 2001) range between 1:50 to 1:200. Most GW level data for the winter exceeded previous records.

[5] Environment Agency – Southern Region. Hampshire and Isle of Wight Area. Winter 2000-2001 Flooding in Hampshire Final Overview Report September 2002.

D.2.5.2 In the absence of further information, we have assumed that the GW flooding which occurred in the Winter 2000-2001 was a 1 in 100 year return period. However, local evidence and the known occurrence of repeat flooding from groundwater in some locations have led us to believe that the frequency of groundwater flooding is different to the rainfall return period. To allow for this, we have assumed a return period of flooding for the 2000/01 event of 1 in 25, or an annual probability of 4%.

D.2.5.3 A report prepared the Flood Hazard Research Centre at Middlesex University[6] concluded that a flood duration of 1 week resulted in losses which are 240% of the building fabric damages expected using Multi-Coloured Manual (MCM) data; for a flood lasting three months, the building fabric damages increased to 360% of those estimated using MCM data. For the purposes of this strategic assessment we have assumed an average flood duration of one week for all groundwater flooded properties.

D.2.5.4 Therefore to calculate the economic cost of GW flooding we have used the same base cost per receptor type used in the surface water flooding consequence assessment, multiplied by a factor of 2.4.

D.2.5.5 We do not have event flood extents for the 2000/01 event, therefore we are unable to apply a groundwater flood consequence to any receptors other than properties.

D.2.6 THE COST OF SURFACE WATER FLOODING OF ROADS

D.2.6.1 The Multi-Coloured Manual indicates that the cost of a road flooding is a function of the number of vehicles delayed, the cost of that delay and the length of time the disruption lasts:

Cost = Number of vehicles delayed x additional cost per vehicle x number of hours that the flood disruption lasts.

D.2.6.2 where the value for the additional cost per vehicle is dependent upon the additional distance that is travelled to avoid flooding.

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[6] Colin Green, Theresa Wilson, Trevor Masterson and Neil Boothby (2006) An assessment of the additional flood losses associated with groundwater flooding: a report to Hampshire County Council and Winchester City Council FHRC.

D.2.6.3 For this study we have assumed that all modelled surface water flooding causes 1 hour of disruption due to flooding. We have used the length of the road that is flooded as a substitute for the additional distance travelled to avoid flooding.

D.2.6.4 We have simplified tables from the Multi-Coloured Manual chapter 6, into three categories of road types; Motorway, A road, minor road (i.e. we have not distinguished between urban and rural roads). The tables below show the values taken from the MCM tables and highlight assumptions made.

Table D.2:Average hourly motor vehicle flow (from table 6.2 – South East)

Motorway	A Road*	Minor road*
3900	759	86

* The values are an average of rural and urban values given in the MCM table.

Table D.3 Average speed per road type km/h (from table 6.3)

Motorway*1	A Road*2
95	73

*1 *This is the average speed for the motorway for all time periods*

*2 *This is the average speed for 'A-roads All' for all time periods.*

D.2.6.5 We have assumed that for all other minor roads the speed is 35mph = 56 km/h. This is not based on any values within the MCM but is merely a gross assumption to enable calculation. Given that the ultimate aim is to provide a means of comparing relative costs rather than establishing absolute costs of flooding, this assumption is thought appropriate.

Table D.4 The percentage of road traffic by type of vehicle and road class (adapted from MCM table 6.4)

	Cars	LGV	OGV1	OGV2	PSV
Motorways	74.8	12.4	4.1	8.1	0.6
A roads*1	80.7	12.7	3.2	2.3	1.1
Minor road*2	81.1	15.1	1.9	0.3	1.5

*1 *Average of rural A-roads All and urban A-roads*

*2 *Average of rural and urban minor roads*

Table D.5 Total cost of travel as function of speed (pence) (from MCM table 6.6)

	Speed km/h		
	50	80	100
Car	25	17	15
LGV	32	23	20
OGV1	37	29	27
OGV2	50	40	37
PSV	178	124	106

D.2.6.6 The speeds provided within table D.5 do not match those within Table D.3, therefore we have used 50km/h for minor roads, 80km/hr for A-roads and 100 km/hr for motorways.

D.2.6.7 Combining the information and assumptions listed above, the cost of disruption per hour, excluding the length of flooded road can be estimated and is shown below.

Table D.6 The cost of disruption per hour (excluding length of flooded road) (£)

Motorway	A-road	Minor road
719.16	150.68	24.62

To estimate the economic cost of road flooding the appropriate value in Table D.6 is multiplied by the length of road.

D.3 Total economic damage

D.3.1.1 To provide a total economic damage, the sum of the annualised damages for each receptor is calculated and expressed by ward.

D.3.1.2 These calculated annualised cost of flooding values are then displayed on map, with the ward with the highest damages having the darkest colour.

D.4 Summary of key assumptions

- The impact of a 1 in 200 year flood is no more damaging to any individual property affected by that event than a 1 in 30 year flood.[7]
- Every property flooded internally has the same cost of flooding (for its property type) regardless of that depth of flooding, i.e. If a property has 2 meters of internal flooding, this costs no more 50 cm of internal flooding.
- No allowance has been made for confidence of modelled results in the initial assessment. Therefore reported flood incidents have the same confidence as the modelled flood extent.
- The 2000/2001 ground water event has been used as the only complete and fully analysed information on groundwater flooding.
- An average flood duration of 1 week has been applied across all flooded properties in the 2000/01 event
- An event return period of 25 years has been applied to the 2000/01 GW event.
- The impact of groundwater flooding on receptors other than properties has not been included.
- The total annualised cost of damages per ward has not been normalised against either the number of properties in the ward, or the area of the ward.

[7] We have not assumed that that the total cost of damages is the same for the 30 year and the 200 year event. What we have assumed that any property that floods has the same cost of damages for the event, independent of what the frequency is of that event. Therefore a property that floods in a 200yr event suffers £30k damages. A property that floods in a 30 year event has £30k damages. The fact that less properties flood during a 1 in 30 year event is understood and is accounted for in the methodology.

Table D.7: Summary of data sources and associated risks

Data source	Data risk	Mitigation applied
The Environment Agency Flood Map for Surface Water	Modelled data identifies where it may flood, not where it has flooded. The data series is a national scale dataset therefore suitable for strategic assessment over wide areas, but may not be accurate at a local scale.	Consultation on flood risk areas
The Environment Agency Flood Map for Surface Water	Only two return periods modelled	Consultation on flood risk areas
The Environment Agency Flood Map for Surface Water	Only shallow and deep flooding identified, therefore not suitable for quantifying differential damage of deeper flooding.	Consultation on flood risk areas
The Hampshire County Council flooding records	Reported data only includes where it has flooded and where people have reported. Does not provide any indication of where it may flood in future.	Consultation on flood risk areas
The Hampshire County Council flooding records	Data record is short, therefore reliable for frequent and regular events, unreliable for high return period, low probability events. Difficult to estimate the frequency (short record).	Consultation on flood risk areas
The Hampshire County Council flooding records	Reviewed data set, removed anything which is shallow or does not flood properties internally. Have had to 'clean' data set to categorise it into the number of flooded houses and the frequency of the event. Risk of this data cleansing mis-reporting reality	Data cleansing undertaken in partnership with HCC officers
Groundwater flooding records	Shows the location of GW flooding in one of the most severe events.	Consultation on flood risk areas
Groundwater flooding records	May not show all areas at risk from GW	Consultation on flood risk areas
Groundwater flooding records	Difficult to provide a return period for GW, so have assumed 100 year (1% probability)	Consultation on flood risk areas