REPORT

Flood Risk Damage Methodology

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1 Economic Assessment

1.1 Introduction

This report sets out the economic assessment undertaken to derive the flood risk economic damages of the 'Do Nothing' and 'Do Something' scenario.

1.2 Input data

1.2.1 Property data

The National Receptor Dataset 2014 (NRD) was obtained from East Devon District Council and this forms the basis of the assessment of damages to property. This dataset provides the necessary information on location, type and floor area of each property in most cases.

1.2.2 Elevation data

LiDAR topography used in the TuFLOW model was used to determine the ground level and threshold levels of the properties included within this economic assessment.

1.2.3 Flood extents and water depths

The flood propagation modelling discussed Appendix E was used for this assessment. The modelling covered the 'Do Nothing' and 'Do Something' scenario for present day (year 2017), and 20 (2037), 50 (2067) and 100 (2117) years with climate change. The modelling included the 1 in 1, 10, 20, 50, 75, 100, 200 and 1000 year return period for both present day and climate change events.

1.3 Data preparation

1.3.1 Property data

A dataset of properties was created by extracting those within the study area using ESRI ArcMap. Each data point was checked to ensure that the dataset contained sufficient information for the calculation of flood damages. The required data for each property is a valid Multi-Coloured Manual (MCM) code that determines the type of property and a flood area for non-residential properties.

1.3.2 Property type

A number of properties were listed in the NRD with an MCM Code of 999 (unclassified). In these cases, the most appropriate property type has been applied based on analysing properties using Google Street View. Also, where properties have clearly been classified incorrectly, the MCM Codes and House Types have been revised.

1.3.3 Flood area

A proportion of the non-residential properties may not have had a defined floor area in NRD. Floor area is required to determine a market value and flood damage of such properties. Any non-residential properties that did not have a floor area and identified as being upper floor properties had a default value of 50m² entered. This allowed the property to be processed so that at least conservative damages could be estimated. The remaining ground floor properties were investigated individually and, depending on the actual property type and what could be seen using aerial photos and Google Street View, were either removed from the assessment or a floor area was calculated using ESRI ArcMAP.

1.3.4 Property threshold

The ground level at each property was obtained through extracting the elevation of the filtered LiDAR topography. The NRD property point was used as the location for extracting the ground level using ESRI ArcMap.

Thresholds of properties (i.e. height water would have to rise up the side of a building before it could get inside) vary between properties. When no threshold survey data is available, the general assumption used in economic assessments is that residential properties have a threshold of 100mm (i.e.one step up to the front door) and non-residential properties have a threshold of 0mm (i.e. street level access directly into shops and community facilities). The adjustments applied to the property threshold levels for different types of properties are outlined in **Table 1-1**.

Table 1-1: Property Threshold Adjustments

Property Type / Floor Level	Threshold Adjustment
Residential Property – Ground Floor	LiDAR Elevation +100mm
Residential Property – Upper Floor	LiDAR Elevation + 3.0m
Non-Residential Property – Ground Floor	LiDAR Elevation
Non-Residential Property – Upper Floor	LiDAR Elevation + 3.0m

1.3.5 Property market value

The market value of a property is required for the calculation of flood damages as the total direct property damage attributed to each individual property cannot exceed its market value. The process of limiting property flood damages to its market value is known as capping.

There are residential properties of various types within the area at risk. The MCM Handbook indicated that the market value for residential properties should be obtained based upon the average for each property type for the region involved from the Land Registry website. Market values for the South West of England were obtained and the market values are presented in Table 1-2. These values were used as the capping values for the direct property damages for residential properties.

Table 1-2: Estimates residential property market values

MCM Code	Property Type	Market Value	Total Value
1	Average	£252,737	£252,737
11	Detached	£391,042	£391,042
12	Semi-Detached	£254,839	£254,839
13	Terraced	£210,225	£210,225
15	Flat	£166,654	£166,654

In addition to the residential properties, there are non-residential properties in the area at risk for which no market prices are readily available. Where a bulk class has been allocated to the property type by the Multi-Coloured Manual (Penning-Rowsell et al, 2013) the market value has been calculated using the value in the Communities and Local Government's "Commercial and Industrial Floor Space and Rateable Value Statistics 2008" for local authorities. This value has been multiplied by 10 to get a rate/m² and then multiplied by the floor area of the property to get the market value. For all other non-residential properties, a rate/m² has been calculated using data from the UK Government Valuation Office Agency (VOA) and SPON'S Architects and Builders Price Book. The market value rates for the different property types within the study area are summarised in Table 1-3.

Table 1-3: Estimates non-residential property market values

MCM Code	Property Type	Bulk Class	Market Value Rate
2	Retail	Retail	£1,606/m²
3	Offices	Office (Commercial)	£1,376/m²
4	Distribution/Logistics	Warehouse	£584/m²
6	Public Buildings	Non-bulk	£1,326/m²
8	Industry	Non-bulk	£572/m²
51	Leisure	Non-bulk	£1,836/m²
523	Sports and Leisure Centres	Non-bulk	£2,274/m²
525	Football Ground and Stadia	Non-bulk	£2,905/m²

1.3.6 Flood water depths

The flood water depths for each property have been obtained from the results of the flood propagation modelling by extracting the water depths from the model results at the NRD property point locations using ESRI ArcMap.

1.4 Damage calculation methodology

The calculation of damages has been undertaken using the Royal HaskoningDHV Flood Risk and Economic Damages (FRED) Tool, in accordance with the Flood and Coastal Risk Management Appraisal Guidance (FCERM-AG) (Environment Agency, 2010) using approaches set out by the Multi-Coloured Manual 2013 (Penning-Rowsell et al, 2013). The economic assessment has been carried out over a 50-year appraisal period and has a base date of 1st October 2017. All data used in the calculations has been adjusted to this date using the Consumer Price Index (CPI) as recommended in the Multi-Coloured Manual (Penning-Rowsell et al, 2013). Damages have been discounted in accordance with the recommendations of the HM Treasury 'Green Book' (HM Treasury, 2016) to provide the present value damages with discount rates starting at 3.5% and reducing to 3.0%.

The damage assessment has been carried out in line with the Multi-Coloured Manual (Penning-Rowsell et al, 2013) and HM Treasury 'Green Book' (HM Treasury, 2016 guidance on economic assessment using the Royal HaskoningDHV FRED Tool and includes the following categories:

- Direct Property Damages
- Direct Vehicle Damages
- Indirect Evacuation Costs
- Indirect Emergency Services Costs
- Intangible Health Damages
- Road Surface Damage
- Risk to Life

Damages due to flooding were calculated in accordance with the Multi-Coloured Handbook 2016 (FHRC, 2016):

- Flood depths were determined at all properties in the flood risk area for a range of return periods, based on the flood levels determined by the modelling and the threshold levels of the individual properties;

- Flood damages were then calculated for each property based on the flood depths for each return period using the short duration flooding depth damage data included in the 2016 version of the Multi-Coloured Handbook.
- The flood damages were used to calculate the equivalent average annual damages (AADs) for each property;
- Cumulative present value damages were then determined over a 100-year appraisal period, based on the AADs and the appropriate annual discount rate applied according to Treasury guidance;
- Property write-off was then applied at the point in time they become flooded above threshold by a 33.33% AEP (1 in 3yr) event. Present value damages (PVd) were then updated so that no damages were accrued following write-off.
- Following the advice in the Multi-Coloured Manual 'capping' was applied to the write-off and direct property damages, to ensure that they were not overestimated.

1.4.1 Direct property damages

Flood event damages for the individual return periods were calculated using the depth damage datasets given by the Multi-Coloured Handbook 2016 (FHRC, 2016). It has been assumed that non-residential properties do not have basements and therefore are not flooded until the water crosses their threshold.

1.4.2 Direct Vehicle Damages

Direct vehicle damages have been applied using the 'initial appraisal' methods from the Multi-Coloured Handbook 2016 (FHRC, 2016). This assumes the average value of a car is £3,100 (Penning-Rowsell et al., 2013) and on average the average number of vehicles per household is 1.15 (DfT, 2011). Damages only occur if the water depth above ground level (not above property threshold level) at the property location is greater than 0.35m. Upper floor residential properties were also included if the water depth above ground level was greater than the threshold for vehicle damages to occur.

The Multi-Coloured Handbook 2016 (FHRC, 2016) advises that it should be assumed that 25% of the residential properties in the benefit area will not have a vehicle present if a warning has been issued. To allow for this the direct vehicle damages included in the summary tables have been reduced by 25%.

1.4.3 Indirect Evacuation Costs

Indirect evacuation costs have been applied to all flooded residential properties using the 'initial appraisal' methods from the Multi-Coloured Handbook 2016 (FHRC, 2016) based on the property type and water depth above threshold. It was assumed the properties would be evacuated for one week, giving a value of £448.24/household based on the data extracted from the Multi Coloured Manual in Table 1-4 below:

*Table 1-4**: Additional Evacuation Costs (MCM 2013)***

Item	Cost £/household
Mid-range potential extra food costs per household evacuated to hotels/B&B for up to 1 week	£337.00
Mid-range extra travel costs per household evacuated	£83.97
Mid-range extra time costs per household evacuated	£27.27

1.4.4 Indirect Emergency Services Costs

The Multi-Coloured Handbook 2016 (FHRC, 2016) advises that an allowance should be made for costs incurred by various organisations in tackling flood incidents and in the recovery process. The Multi-Coloured Handbook 2016 (FHRC, 2016) suggests this varies between 5.6% and 10.7% of the total property damages. The value should be lower in urban areas to reflect the economies of scale in emergency services. The value used for each property by the FRED Tool is based on the Rural - Urban Classification dataset as shown in Table 1-5.

Table 1-5 ***Emergency Services Uplift Factor***

Rural - Urban	Description	Emergency Services Uplift Factor
A1	Major Conurbation	5.6%
B1	Minor Conurbation	5.6%
C1	City and Town	5.6%
C2	City and Town in a Sparse Setting	5.6%
D1	Town and Fringe	10.7%
D2	Town and Fringe in a Sparse Setting	10.7%
E1	Village	10.7%
E2	Village in a Sparse Setting	10.7%
F1	Hamlets and Isolated Dwellings	10.7%
F2	Hamlets and Isolated Dwellings in a Sparse Setting	10.7%

1.4.5 Intangible Health Damages

Intangible health damages were calculated using the £290 per household per year value from the Multi-Coloured Handbook 2016 (FHRC, 2016).

1.4.6 Electricity Costs for Clean Up

Currently the Multi-Coloured Handbook 2016 (FHRC, 2016) data excludes the costs of electricity in the drying out process to run blower heaters, air movers and dehumidifiers. The relevant data is shown in **Table 1-6** for flood depths of 0.6m to 1.0m.

Table 1-6: Clean-up Electricity Costs

Clean up Component	Electricity Usage (kW/hr)	No. Units Required	No. of Days
Blower Heater	3	2	36
Air Mover	3	6	36
Dehumidifier	3	3	21

Following a short review of current energy prices, a figure of 10p per kWh has been adopted, giving a conservative estimate of electricity costs for flood depths over 0.6m of £3,632 per event. For flood depths of less than 0.6m an estimate of £1,815 was used to reflect the need for less drying out.

1.4.7 Road surface

Damages to road surfaces have been calculated by applying the ‘Surface damage urban road’ cost based on length of road (m), not area (m2). The rate used was£188,061/km from the Weather Extremes: Assessment of Impacts on Transport Systems and Hazards for European Regions document as outlined in

Table 1-7 to the total length of road flooded. This was calculated within ESRI ArcMAP 10 by extracting the lengths of the road network that fall within each flood extent.

The method and values were combined with the information in Section 6d (Losses Due to the flooding of Roads) in the Multi-Coloured Handbook 2015.

Table 1-7– European average road damage costs (Weather Extremes: Assessment of Impacts on Transport Systems and Hazards for European Regions, Claus Doll, Niklas Sieber, 2011)

Damage	Cost £/km
Surface damage motorway	470,152
Surface damage trunk Road	352,614
Surface damage urban road	188,061
Substantial damage motorways	470,723
Substantial damage trunk road	353,042
Substantial damage urban road	188,289
Total loss motorway	6,800,411
Total loss trunk road	3,212,704
Total loss urban road	2,326,132

This provides a conservative estimate when compared with the Multi-Coloured Handbook 2015 which gives unit reconstruction costs for resurfacing a local road range between approximately £15/m² for a quiet road to up to approximately £50m² for a busier road (which require a thicker surface layer and road works may need to occur at night or off-peak and thus incurring overtime costs).

A sensitivity check to see how this fitted with the MCM £15-50 /m^2 range gave £25.76 /m^2. This assessment used an average road width of 7.3m which is common for single carriage roads in urban areas. In reality, this is likely to be higher as the promenade road is wider. A wider road would reduce this £25.76/m^2 even further. Given that this is less than a third along the range from £15 to £50, and the roads being damaged are by no means quiet roads, it is felt this is a conservative approach in the context of the area.

1.4.8 Risk to Life

This assessment utilised the Defra methodology from the report 'Flood Risks to People' (Defra, 2006) to analyse risk to life and applied a risk to life score for residential properties only. The methodology is commonly applied at a zone or regional level; however, for this assessment it was applied at a property level to retain consistency with other receptor assessment approaches.

The hazard rating was calculated using the following equation within the TuFLOW model runs:

HR = d * (v + 0.5) + DF

Where:
HR = hazard rating
d = depth of flooding (m)
v = velocity of floodwaters (m/s)
DF = debris factor

1.5 Flood risk damages

The Sidmouth and East Beach Management Plan provided an update of the amenity benefits providing a conservative estimate of the amenity benefits that could be realised along the Sidmouth frontage. The assessment within the BMP was based upon a previous assessment in 1992 and has been inflated to present day prices and extended from a 50 year to a 100 year appraisal period.

The results of applying these two updates is presented in Table 1-8. The table shows that the potential Present Value losses from visitors to the Sidmouth seafront under a 'Do Nothing' scenario is likely to be in the order of over £31,431,000 over 100 years allowing for the application of discount factors. If defences are maintained and improved there is a potential PV gain over 100 years of about £15,181,000 on top of avoiding the loss of £31,431,000 (i.e. the total benefit is £46,621,000 over 100 years).

Table 1-8: Amenity benefits (BMP, 2017)

Visitor Type	No. of visitors per 150 days summer season	Loss per 150 day summer season (£k)	Total PV loss over 100 years (£) (A)	Gain per 150 day summer season (£)	Total PV gain over 100 years (£k) (B)	Total PV benefit over 100 years (£k) (A + B)
Day	100,837	468.40	13,988	129.67	3,872	17,860
Staying	50,500	549.25	16,402	355.76	10,624	27,026
Local	11,250	34.85	1,041	22.93	685	1,726
Totals	162,587	1,053	31,431	508.36	15,181	46,612

1.6 Flood risk damages

Table 1-9 presents the PV flood risk damages for the 'Do Nothing' and 'Do Something' scenario and PV benefit.

Table 1-9: PV damages breakdown

Category	PV Damage Do Nothing Scenario	PV Damage Do Something Scenario	PV Benefit
Direct Property Damage (Non-Residential)	£12,186,473	£246,844	£11,939,629
Direct Property Damage (Residential)	£22,762,184	£302,983	£22,459,201
Direct Vehicle Damage*	£5,223,947	£26,118	£5,197,829
Indirect Emergency Services Cost	£1,465,020	£30,789	£1,434,231
Indirect Evacuation Cost	£2,810,115	£26,924	£2,783,191
Intangible Health Benefit	£1,076,668	£497,355	£579,313
Damage to Road Surface	£22,534,142	£211,095	£22,323,047
Risk to Life	£24,575,781	£270,654	£24,305,127
Amenity	£31,431,000	£0 (+£15,181,000)	£46,612,000
Total PV Damages	**£124,065,330**	**£1,365,918**	**£137,880,412**

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