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The costs of the summer 2007 floods in England

Project: SC070039/R1

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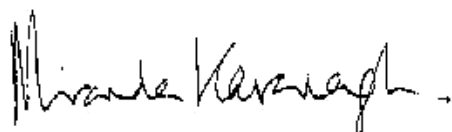
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Miranda Kavanagh
Director of Evidence

Executive summary

Exceptional rainfall in the summer of 2007 caused extensive flooding in parts of England, especially in South and East Yorkshire, Worcestershire, Gloucestershire and Oxfordshire. As a consequence there was unprecedented flooding of properties and infrastructure in some areas. The resultant disruption, economic loss and social distress turned the summer 2007 floods into a national catastrophe. Broad-scale estimates made shortly after the floods put the total losses at about £4 billion, of which insurable losses were reported to be about £3 billion. On behalf of the Environment Agency, this study set out to produce a plausible, transparent and comprehensive monetary estimate of the total economic cost of the summer 2007 flood events.

Approach

The impacts of flooding on assets, service flows, and incomes and expenditures were identified and classified accordingly for each category of impact. The approach draws on a number of sectoral and regional studies of the impacts of the summer 2007 floods commissioned by the Environment Agency, by Local Government Authorities (LGAs), by corporate organisations such as utility and transport companies, and by insurance companies.

Information was derived from reports produced by a range of organisations for internal purposes and for the purpose of claiming compensation/grant aid. In others, damage costs were constructed from records of physical damage and disruption using estimated quantities of impacts and standard rates for estimating costs. For example, road user impacts were based on Department for Transport (Dft) COBA (cost-benefit analysis) appraisals, and Department for Energy and Climate Change (DECC) estimates were used to value the disruption of electricity supply.

The methods used here to derive economic costs are consistent with Project Appraisal Guidance (PAG) for flood risk management used by the Department for Environment, Food and Rural Affairs (Defra). Economic costs consider those costs that are borne by the national economy. These can be different from financial costs that are borne by private individuals and businesses. For example, estimates of financial damage costs based on insurance claims have been adjusted to economic values by removing value-added tax, basing property damage on 'old' remaining values rather than 'new' replacement costs, and allowing for a degree of under-insurance. Disruption to utility supplies has been estimated at compensation rates used by the industries concerned and those derived in customer surveys.

Results

Total economic costs of the summer 2007 floods are estimated at about £3.2 billion in 2007 prices, within a possible range of between £2.5 billion and £3.8 billion. Overall, about two thirds (£2.12 billion) of total economic costs were incurred by households and businesses. Power and water utilities accounted for about 10 per cent (£0.33 billion) of total costs, communications (including roads) about 7 per cent (£0.23 billion). About 4 per cent (£0.14 billion) of total costs were incurred by LGAs, excluding road damage, rising to 7 per cent (£0.24 billion) if road damage funded by LGAs is included. Emergency services, involving the police, fire and rescue services and emergency response by the Environment Agency accounted for about 1 per cent (£27 million) of total economic costs. Damages to agriculture, associated with inundation of over 40,000 hectares, accounted for about 2 per cent (£50 million) of the total economic costs of the flood events.

Impacts on public health (including school education) accounted for about 9 per cent (£287 million) of economic costs. £260 million of this comprises the mental health cost

associated with flooding based on estimates of people's willingness to pay to avoid exposure to the distress caused by flooding. It is possible that this figure fails to adequately value the negative impact of the flood on the psychiatric health of those affected. 400,000 pupil days were lost due to school closures. Valued at the cost of a pupil day, together with parental work days lost, this accounted for about £12 million, but this probably underestimates the disruptive effect on the education of children.

It is estimated that the financial 'out of pocket' expenses attributable to the 2007 summer floods were about £4.0 billion, of which £3.2 billion (84 per cent) related to impacts on domestic and commercial properties. This share is £3.5 billion (90 per cent) if damage to motor vehicles, temporary accommodation and business disruption are also included.

It is estimated that about 75 per cent of the financial costs of £2.5 billion borne by households (that is, property damage, motor vehicles and temporary accommodation), and 95 per cent of the £1.0 billion financial costs borne by businesses (excluding utilities and transport businesses) were recovered through insurance. It is noted that insurance payouts in financial terms were typically about 40 per cent higher than estimated economic costs once adjustments are made for the effects of value-added tax and for replacements valued at remaining rather than new values.

About 63 per cent of the total economic costs identified here were covered by insurance or other forms of compensation, including grant aid to Local Government. About 56 per cent of total economic costs were covered by private insurance. Local Authorities and emergency services were able to claim about 45 per cent of their extra costs from central government or other sources.

The summer 2007 flooding caused damages of about £674 million to important national infrastructure and the operation of essential services. Total damage costs were greatest, in order of magnitude, for water supplies and treatment, roads, electricity supply, agriculture and schools. National food supplies were not put at risk, although the floods made things worse in a year of general food shortages and high prices.

There was variation amongst regions in the type and magnitude of flood damage costs. Although the flooding was concentrated in three main areas, namely Yorkshire and Humberside, Gloucestershire and Worcestershire, and Oxfordshire, impacts were dispersed throughout England and Wales, including places where all the major categories of effects were evident, albeit at a smaller scale.

Uncertainties

There are uncertainties and gaps in the data and estimation methods. Information obtained from the audited accounts of Local Authorities is considered robust and comprehensive. There remain moderate uncertainties regarding estimates of damage costs to households and businesses based on aggregated insurance data. There is considerable uncertainty in estimates of costs borne by users of services that are curtailed or disrupted, such as for water and electricity consumers, especially as these use broad estimates transferred from other sources. There is particular concern about the considerable uncertainty surrounding the impact of the 2007 floods on public health, particularly regarding psychological and emotional stress.

Conclusions

The scale and seriousness of the summer 2007 floods were sufficient to classify them as a national disaster. Analysis confirms the very significant economic costs associated with flood events of this magnitude. However, it is recognised that the impacts on the lives and livelihoods of those caught up in the summer 2007 floods cannot be expressed in monetary values alone. For many people affected, the floods were a personal tragedy from which full recovery may be very slow or not possible.

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1. Introduction

1.1 Context

Exceptional rainfall in the summer of 2007 caused extensive flooding in parts of England, especially in South and East Yorkshire, Worcestershire, Gloucestershire and Oxfordshire. Following a sustained period of wet weather starting in early May, extreme storms in late June and mid-July resulted in flooding from heavy surface flows, overloading and surcharging of surface and subsurface drainage systems, and overtopping of river flood defences. As a consequence there was unprecedented flooding of properties and infrastructure in some areas. The events were associated with 13 fatalities. Thousands of people were evacuated from properties, and many more were in fear of evacuation. Public water and power utilities were disrupted, with threat of power blackouts at the regional scale. The resultant disruption, economic loss and social distress turned the summer 2007 floods into a national catastrophe. Broad-scale estimates made shortly after the floods put the total losses at about £4 billion, of which insurable losses were reported to be about £3 billion.

Given the severity of the floods and the lessons to be learned for dealing with future extreme events, the Environment Agency felt the need to compile a comprehensive estimate of the cost of the summer 2007 floods. This had to recognise the diversity of the impacts on assets, economic activity, incomes and costs, as well as the disruptive effect on services such as energy, water, and transport. This study is set in this context.

1.2 Aims and objectives

The broad aim here is to produce a plausible, transparent and comprehensive monetary estimate of the total economic cost of the summer 2007 flood events.

Specific objectives are as follows:

- To determine the type, the magnitude and, where possible and relevant, the plausible monetary value of the impacts of the summer 2007 flood events across a range of sectors and impact categories, and in aggregate for the entire summer 2007 events. Where quantitative assessment is not possible, a qualitative assessment of magnitude of impacts will be provided.
- To identify and explain variations between the estimates for insured and non-insured losses, and between financial and economic costs.
- To identify, where information allows and in broad terms, variations in the spatial and temporal distribution of impacts and costs, and the distribution of impacts and costs amongst different social and economic groupings.
- To identify main uncertainties, broad confidence limits, and the main gaps in data and methods that constrain estimation.

A subsidiary objective will be to compile and apply a framework for estimating the cost of floods, drawing on actual event data and the various methods used for predicting the costs of flooding.

1.3 Overview of methods

The impacts of flooding on assets, service flows, incomes and expenditures were identified and classified accordingly for major category of impact. The approach draws on a number of sectoral and regional studies of the impacts of the summer 2007 floods commissioned by the Environment Agency, by Local Government Authorities (LGAs), by corporate organisations such as utility and transport companies, and by insurance companies.

More specifically, valuations of damage and loss were based on:

- Insurance claims, such as damage to property, contents and motorcars adjusted to remove tax, remaining values of assets, and uninsured losses.
- Audited accounts of local authorities and public services, including those produced to claim compensation from insurance, Government and EU sources, including damages and loss of income.
- Surveys of damages and extra costs incurred by businesses and companies, such as utility and transport companies, supported by personal interviews with managers, supplemented by internal management records and specialist reports, and internet sources.
- Surveys of a sample of farm businesses, supported by secondary regional farm business data, grossed up according to flooded areas.
- Costs of disruption in services to users, based on previously derived estimates of willingness to pay/accept compensation to secure/tolerate disruption of services such as water and electricity supplies.
- Standardised unit rates for estimating damages or loss, for example with respect to fatalities, health costs, and travel disruption.

Thus, a sequential approach was adopted, involving:

- Describing the impacts qualitatively.
- Quantifying impacts.
- Deriving monetary valuations for these impacts.

The estimated flood damage costs here are expressed in economic rather than financial terms in order to reflect the cost to the national economy. This involves making a number of adjustments to the financial 'out of pocket' expenses and lost income borne by individuals and organisations as a result of the flood, such as:

- Taxes on goods and services, such as VAT, are excluded because these are not real resource costs. They are transfers from the payee to the exchequer.
- Goods damaged or lost by households and businesses are valued at their remaining value (typically at half life) rather than at the full replacement cost which is usually compensated by insurance under 'new for old' policies.
- Loss of trade for businesses is not included where this is replaced by businesses elsewhere. Disruption of businesses which results in increased costs for business operations is included where known.

- Curtailment or deterioration of services to people as a result of flooding is valued at rates used in Government appraisals such those applied by Department for Transport (Dft) for transport disruption, Department of Business, Enterprise and Regulatory Reform (BERR)/Department of Energy and Climate Change (DECC) for loss of electricity supply, and OFWAT for reduced water services.

These methods are consistent with Defra's Project Appraisal Guidance (PAG) for flood risk management (Defra, 2009) and guidance such as that contained in the *Multi-Coloured Manual* (Penning-Rowsell *et al.*, 2005). The costs of disruption to businesses are not currently included in PAG – they amounted here to about £160 million, about five per cent of total costs.

Estimates of flood impacts for major categories of impact were aggregated to compile an estimate of the total economic costs of the 2007 summer flood for England and Wales, though most of the impact occurred in England.

1.4 Structure of the report

The report comprises a main report containing a summary of flood damage costs by category, supported by summary statements of impacts for each. Details of the estimates and the data and methods used to derive them are given in a supporting Appendix..

2. Summary of aggregate costs of summer 2007 floods

2.1 Overview

Table 2.1 contains a summary of the costs of the summer 2007 flood events, classified by category of impact. More details are provided in tables contained in the Appendices at the end of this main report and in supporting Annexes which are contained in a separate volume.

Total economic costs are estimated at about £3.2 billion in 2007 prices. Overall, about two thirds of the total economic costs of the summer 2007 floods were incurred by households and businesses, including the cost of temporary accommodation and damage to vehicles. Power and water utilities accounted for about 10 per cent of total costs, and communications (including roads) about 7 per cent. About 4 per cent of total costs were incurred by Local Government Authorities (LGAs), excluding road damage, rising to 7 per cent if road damage funded by LGAs is included. Emergency services, involving the police, fire and rescue services and emergency response by the Environment Agency accounted for less than 1 per cent of total economic costs.

Impacts on public health (including school education) accounted for about 9 per cent of costs. This mainly comprises the mental health cost associated with flooding based on estimates of willingness to pay to avoid exposure to the distress caused by flooding. It is possible that this figure fails to adequately value the impact of the flood on the psychiatric health of those affected, and the disruptive effect on the education of children. Damages to agriculture account for about 2 per cent of total flood costs.

The total financial 'out of pocket' costs estimated here are £4.0 billion, almost 90 per cent accruing to residential and commercial property and related costs.¹

¹ Financial costs based on estimates here, billions rounded: Domestic and business: £3.52; LGA £0.12; Emergency £0.01, Environment Agency £0.02, Utilities £0.11; Communications £0.13; Agriculture £0.04. Total £3.95

Table 2.1 High level summary of estimated economic¹ costs of summer 2007 floods in England.

Impact	Best estimate £ million	% of total	Possible range £ million	% insured	Basis for estimates	Uncertainty score (see text)
Households (buildings and contents)	1,200	38%	1,010-1,430	76%	Adjusted Insurance estimates	2
Businesses (buildings, contents and disruption)	740	23%	550-800	95%	Adjusted insurance estimates	2
Temporary accommodation	94	3%	85-103	95%	Insurance claims	2
Vehicles (motors)	80	3%	72-88	95%	Adjusted insurance estimates	2
Local Government – infrastructure (excluding roads (£83 million)) and non-emergency services	134 (219 incl roads)	4% (7%)	123-151 (198-242)	45%	Audited accounts of LGAs	1
Emergency services, (LGA, police, fire and rescue)	8	<1%	7-9	45%	Audited accounts of LGAs, police and fire/rescue	1
Environment Agency (23% of costs for emergency)	19	1%	17-21	?	Audited accounts	1
Utilities (electricity, gas, water)	325	10%	253-436	32%	Company accounts, user WTP/A for services	2-3
Communications (roads (including LGA), rail, telecom)	227	7%	151-303	50% Mainly LGA road damage	Company sources, extra travel costs	2-4
Public health and fatalities (including distress, impact on education and fatalities)	287	9%	187-387	n/a	Research Literature, standard estimates, LGA accounts	3-4
Agriculture	50	2%	30-66	5%	Farm survey	2
Unquantified costs:, tourism, nature conservation, community services, Military services	n/a	n/a	n/a			
Total	3,164	100%	2,521-3795	63 %		2 overall

¹ This table is based on the tables contained in the Appendix at the end of this main report. Economic costs are borne by the national economy and may differ from financial costs borne by individuals and organisations.

Damages to property and contents, both residential and commercial, are clearly the most important categories in terms of the magnitude and severity of impacts. The degree of confidence in the estimates varies according to the perceived robustness of data and estimation methods. Table A in the Appendix to this main report lists data types and sources. It also classifies the degree of confidence in the estimates on the scale of one to four used in the *Multi-Coloured Manual* (Penning-Rowsell *et al.*, 2005) for data quality assessment, namely: 1: Best of Breed; 2: Limiting Assumptions; 3: Gross Assumptions; and 4: Heroic Assumptions. These confidence classes for data were combined with an assessment of the robustness of estimation methods to determine the likely range in estimates as shown in Table 2.1.

For example, confidence is high, rated Best of Breed at '1', for estimates of local authority related costs, and the range of estimates here is set at about +/-10 per cent of the best single estimate. The overall confidence rating for domestic and commercial damage is '2', namely Limiting Assumptions. Here, the range in the estimates is based on possible variations in critical assumptions on inventories, remaining values and proportion insured. The possible range is about +/-20 per cent. Where confidence is lower, the range is about +/-25 per cent to +/-35 per cent. In some cases, specific ranges for estimates have been identified or calculated. For example, the range for agricultural damage costs is a statistically derived estimate based on survey data, rated '2'. The range for impacts on communications reflects variations in modelled assumptions about the number and type of journeys disrupted and is rated '4'. The estimate for public health costs is considered a minimum estimate with a very high degree of uncertainty, rated '4'.

Table 2.1 shows that the best estimate of economic damages associated with the summer 2007 floods is £3.2 billion, ranging between £2.5 billion and £3.8 billion.

Table 2.1 also shows that about 63 per cent of total economic costs were covered by insurance or other forms of compensation, including grant aid. About 56 per cent of total economic costs were covered by private insurance. As explained below, an estimated 81 per cent of financial (out of pocket) costs borne by households and businesses were covered by insurance.

2.2 Impact on critical infrastructure

The summer 2007 floods caused damages to important national infrastructure, such as roads and schools, and the operation of essential services, such as water and electricity supplies (Table 2.2). Total economic costs here are estimated at £674 million, greatest, in order of magnitude, for water supplies and treatment, roads, and electricity supply. Schools were also seriously affected, with the loss of 400,000 pupil days of education. Over 42,000 hectares of farmland were flooded.

A distinction can be made between the share of the immediate burden of costs on service providers and on users of services (although eventually most burdens pass to users in some way or other). In the case of water utilities, for example, 65 per cent of total costs were borne by water companies in terms of damage and extra operating costs, and 35 per cent by water users as 'costs' of disruption to supply. For example 140,000 houses were without clean water for up to 17 days in Gloucester. In the electricity sector, supply companies bore only 6 per cent of total costs whereas consumers incurred 94 per cent of total economic costs due to loss of value associated with disruption of supply. Supply companies were able to switch supply sources to avoid lengthy power cuts; otherwise cost to users would have been much higher. Nevertheless, 42,000 homes were without power in Gloucester for up to 24 hours.

Table 2.2 Economic costs of the summer 2007 floods associated with impacts on important national infrastructure and essential services.

Sector	£ million	% of total	% of cost associated with property/infrastructure damage¹
Utilities			
Water (and waste water)	186	28	65
Electricity	138	20	6
Gas	<1	0	6
Communications			
Roads	191	29	45
Railways	36	5	29
Telecommunications	<1	0	90
Services			
Police, fire, LGA	8	1	10 ²
Schools	49 ³	7	76
Community leisure centres	14	2	30
Health service, hospitals	n/a		
Agriculture and food supplies	50	8	15
Total	674	100%	

n/a not available.

¹Items show cost of damages to property and infrastructure – the balance mainly relates to impacts on goods and services provided.

²Police and fire shows damage/repairs to equipment with the balance for provision of extra services, includes £4 million police and fire and £4 million LGA emergency responses.

³Assumes loss of pupil days at average costs of education per pupil day.

3. Summary of impacts by category

The following section contains summaries of selected key points on methods and results with respect to particular categories of flood damage. Details of data sources and estimation methods are contained in the Appendix.

3.1 Impacts on agriculture

The estimated total agricultural damage cost caused by the summer 2007 floods in England amounts to about £50 million (Table 3.1). This estimate is based on the results of detailed farm visits and personal interviews at 78 flooded farms in the three main regions affected, namely Yorkshire and Humberside, Worcestershire and Gloucestershire, and Oxfordshire (Posthumus *et al.*, 2008, 2009). Average flood damage cost were about £1,150 per flooded hectare when weighted by land use. This estimate is higher than that derived by the reconnaissance level study by ADAS (2008) because more detailed and comprehensive estimation methods were applied. There appear to be regional differences in flood damage costs per hectare, depending on land use and dominant farm type, but these were not statistically significant given the considerable variation within regions.

Average cost per hectare of flooding was multiplied by the total flooded area of 42,000 hectares reported by the Environment Agency, allowing for regional distribution of land use and farming systems. A mean estimate of £48.4 million was derived, with a 95 per cent confidence interval between £31 million and £66 million. An estimate of £50 million is used here. Reflecting regional differences in the areas flooded and land use, about 50% of total damage costs were borne by farms in Yorkshire and Humberside, 28% in Worcestershire and Gloucestershire and 22% in Oxfordshire (and their respective adjacent areas).



Flooding on the River Avon, near Tewkesbury, in July 2007 caused extensive damage to high value crops.

Over 90 per cent of flood damage costs were associated with losses of farm output and additional production costs. The remainder involved damage to farm level assets

such as machinery, property and infrastructure. Only about five per cent of flood damage costs (excluding damage to household property) were insured. The floods did not have a major impact on total food supply, but probably contributed to further price increases during a year of general commodity deficit at the global scale.

Table 3.1 Estimated economic costs to agriculture of the summer 2007 flood events.

	Area flooded, ha *	Loss, £ million**	Average loss £/ha flooded**
Arable	26,500	34.3 (±9.2)	1,293(±347)
Grassland and livestock	15,600	10.1 (±6.5)	647(±416)
Other costs	42,100	4.2 (±2.0)	100(±48)
Total	42,100	48.5(±17.7)*	1,153 (±422)

* based on ADAS, 2008 using Environment Agency sources,
 ** 95% confidence intervals shown in brackets

3.2 Houses and belongings

Damage to residential property, both buildings and contents, was the largest category of costs by value associated with the 2007 summer flood events. In order to assess the property damage and losses, it is necessary to know the number of properties affected and the average damage or loss² incurred. Both variables are difficult to determine. The approach employed here obtains data on insurance claims to quantify both aspects. However, in both cases – property numbers and average losses – there are data problems and inconsistencies. These are discussed below.

The number of domestic properties flooded

The numbers of properties flooded³ in June and July 2007 is not fully known and therefore remains uncertain. Initial estimates following the floods were between 46,000 (Efra, 2008) and 48,000 flooded homes (Pitt, 2008).

² Damage is when the building fabric of a house is adversely affected or inventory items are lost or broken. There can be other losses such as the cost of clean-up.

³ “Flooded” here (and in the *Multi-Coloured Manual*) means flood waters inside the property or, for those with suspended floors, water within 30cm of the ground floor level.

In terms of insurance claims, however, the Association of British Insurers (ABI) report 130,000 separate claims from domestic households, a figure also quoted by Pitt (2008).

It appears that many insurance claims were made for separate policies covering contents and building fabric repairs (that is, two or more claims per property) and some for properties that were not deemed as 'flooded' but may have suffered damage belatedly from basement and foundation flooding. The damage and losses implied by the insurance claims appear to be real enough, and therefore they are used here as a basis for estimating total damage costs.

Flood damage costs

Data on insurance claims were used to derive estimates of damage costs to residential properties. There are discrepancies between different sources of data, partly due to failure to distinguish between number of insurance claims and the number of properties (addresses) to which these claims relate.

Early estimates by RMS (2007) and Carpenter (2007) made shortly after the floods, based on ABI sources, suggest that the average domestic claim was some £30,000 for the June event and £40,000 for the July event (the latter in the more affluent south of the country). It is not clear, however, whether these amounts refer to the average value of individual claims on different insurance policies, or the average total amounts claimed per household.

The most recent estimates obtained in June 2009 from ABI show that 132,000 insurance claims had been lodged for damage to domestic property associated with the summer flood events at a total value of £1.72 billion, equivalent to about £13,000 per claim. ABI's view is however, that multiple claims are made per household and that 'depending on height, length and velocity of the flood as well as property type we estimate that the average spent per domestic property is between £23k and £30k'. This equates to between 57,000 and 74,000 (average 65,000) individual households making claims, which is higher than the 48,000 homes that were reported by Pitt (2008) as actually 'flooded'.

A review of 18,000 aggregated claims submitted by households for the summer flood events derived from the Weathernet insurance validation database shows an average claim of £24,303 for residential properties, although the estimate is highly skewed by a small number of very large claims. This source, given its purpose, tends to focus on the larger claims. The estimate of average claims at the household scale is consistent with that referred to by ABI above.

Table 3.2 contains a range of estimates for the damages to domestic properties (and also to commercial properties as explained below). Three estimates of economic costs are derived for residential properties drawing on a variety of data sources. Estimates A and B assume average claims per property and numbers of flooded properties. Estimate C assumes an average value for separate insurance claims and numbers of insurance claims made.

Table 3.2 also shows the effect of adjusting the financial value of claims to derive an economic value which gives a better indication of the real costs incurred from the view point of the national economy. This adjustment includes the removal of Value Added Tax (VAT) at 17.5 per cent because tax is not a real cost but rather a transfer of monies to Government.

Adjustments are also made to the financial value of insurance claims to allow for the fact that most goods replaced under 'like-for-like' policies are not new. On average, they have a remaining value equivalent to half of their original value, and hence half their replacement cost. Thus, the economic cost of damage is taken to be half of the financial replacement cost under an 'old' for 'new' policy.

It is also assumed that 75 per cent of claims are for household inventories (for which the remaining value adjustment is made) and the balance is for building structures and fixtures (for which no remaining value adjustment is made). Adjustment for VAT and replacement costs at remaining values mean that economic costs are 53 per cent of the financial value of insurance claims. Further adjustment is made because, according to ABI estimates, about 76 per cent of potential flood damage costs for domestic properties are not insured. This is because some households do not have policies at all, some are under-insured, and because some policies require the holder to cover some of the losses themselves in the form of 'excess' charges. These assumptions can be varied for the purpose of sensitivity analysis.

The resultant estimates of economic damages to domestic property range between £1.01 billion and £1.2 billion. This is about 70 per cent of the reported £1.72 billion financial value of insurance claims in the domestic sector for the reasons given above. The most reliable estimate is considered to be estimate C at £1.2 billion.

Additionally, ABI data show that claims of about £90 million were made for motor vehicle damage incurred mainly by private individuals. Adjusted for VAT and under-insurance at 5 per cent, this gives an economic cost of £80 million.

Table 3.2 Estimated economic damage costs of the summer 2007 floods to residential and commercial properties and contents using alternative estimation methods.

	Average insurance claim £ per property (A,B) or per individual claim (C)	Properties affected (A, B) or claims (C)	Total insurance claims £ bn	Economic adjustment factor % *	Economic losses £bn	% covered by insurance	Total economic losses £bn	Econ as % of insurance claims
Residential - A	£30,000	48,000	£1.44	53%	£0.77	76%	£1.01	70%
Residential - B	£24,303	65,000	£1.58	53%	£0.84	76%	£1.11	70%
Residential - C	£13,000	132,000	£1.72	53%	£0.91	76%	£1.20	70%
Commercial - A	£90,000	7,300	£0.66	66%	£0.43	95%	£0.46	69%
Commercial - B	£55,652	8,000	£0.45	66%	£0.29	95%	£0.31	69%
Commercial - C	£24,000	35,000	£0.84	66%	£0.55	95%	£0.58	69%
Total A			£2.10				£1.46	70%
Total B			£2.02				£1.41	70%
Total C			£2.56				£1.78	70%
DATA SOURCES								
	source of unit cost		source of number of claims					
Residential - A	Pitt/Efra		Pitt/Efra households					
Residential - B	Weathernet		ABI estimate households					
Residential - C	ABI av claim		ABI claims					
Commercial - A	Pitt/Efra		Pitt/Efra businesses					
Commercial - B	Weathernet		ABI estimate businesses					
Commercial - C	ABI av claim		ABI claims					
Economic adjustment								
* residential adjusted for VAT at 17.5% and assuming '75% of claims for inventory with 50% remaining value								
*commercial adjusted for VAT at 17.5% and assuming '45% of claims for inventory with 50% remaining value								

3.3 Businesses

Many business properties were flooded during the summer 2007 floods, resulting in damage to premises, equipment and fittings, and loss of stock. They also suffered disruption of business. The method of cost estimation is similar to that used for domestic properties, namely identifying the number of properties affected and the average cost of damage. There are similar challenges interpreting available data.

Estimates of the number of commercial properties flooded ranged between 7,100 and 7,300 according to Efra (2007) and Pitt (2008) respectively. The ABI subsequently estimated that 8,000 business premises had been affected.

There were, according to the ABI in June 2009, 35,000 insurance claims by businesses associated with the summer 2007 floods, far exceeding the number of commercial properties that were reportedly flooded. This is presumably because businesses submitted claims against more than one insurance policy, and possibly because multiple claims were made on individual policies.

Table 3.2 contains a range of estimates for the damages to commercial properties drawing on a variety of data sources. Estimates A and B assume average claims per commercial property and number of flooded commercial properties, whereas estimate C is based on the average value of separate insurance claims and the number of insurance claims made.

Adjustments were made, as described above for domestic properties, to derive an economic value for flood damages for commercial properties by removing VAT payments, allowing for replacement costs based on the remaining value of inventories and allowing for a proportion of uninsured properties. Estimated economic damage costs range between £0.31 billion and £0.58 billion. This is about 69 per cent of the financial value of insurance claims. Estimate C in Table 3.2 at £0.58 billion is considered to be the most reliable estimate of damage to commercial property.

In addition to damage costs, some businesses claimed compensation from insurance for disruption to businesses where this involved extra costs and lost income. Based on ABI sources, for the latter part of 2007, £160 million was claimed for this purpose. This is probably an underestimate. It is known, for example, that disruption was acute in many locations, such as in Sheffield where disruption to business was reported at £50 million. It is assumed here that the disruption to and loss of trade was not made good by domestic businesses that were not flooded.

Total economic costs associated with business impacts are therefore £740 million.

3.4 The geographical distribution of property flooded and damages

It is commonly thought that the June floods only affected South Yorkshire and Humberside, and particularly Sheffield and Hull Cities, and that the July events affected only Gloucestershire, Worcestershire and Oxfordshire. Figure 3.1 shows the distribution of the number and average value of claims, based on the post codes of insurance claims, confirming that the effects of both extreme events were widely spread throughout England and Wales.

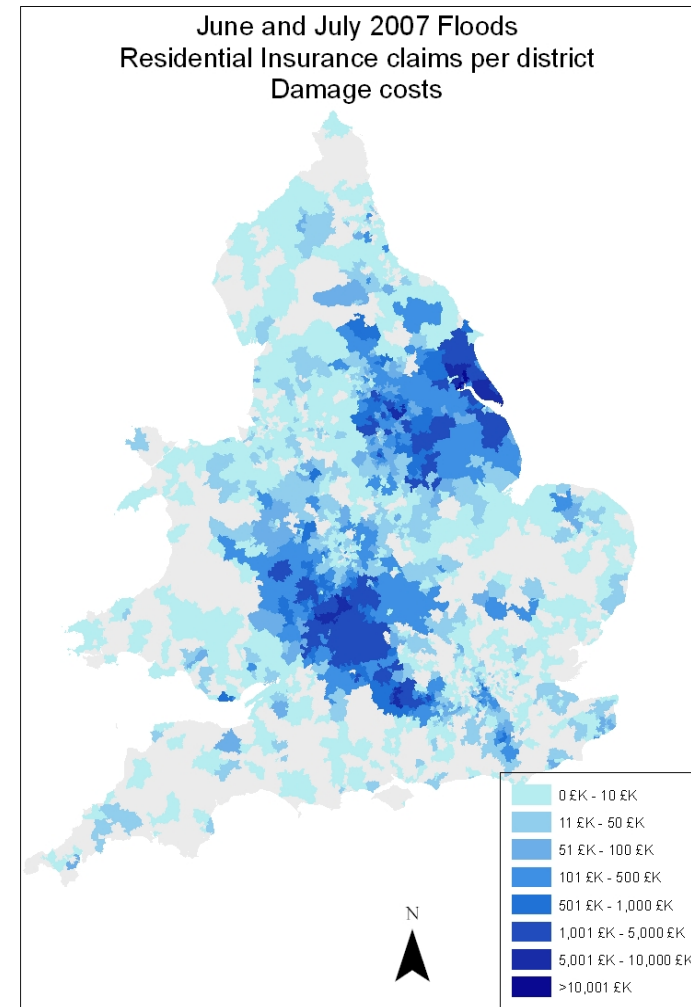
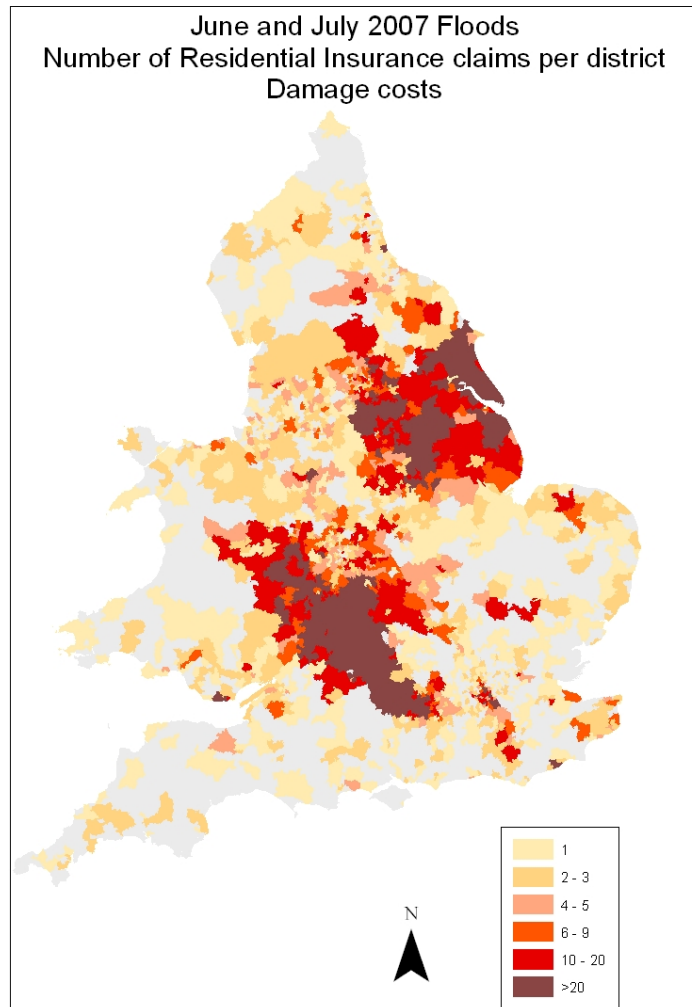


Figure 3.1 Spatial distribution of numbers and value of insurance claims associated with the summer 2007 floods.

3.5 Temporary accommodation

Many people were evacuated from flooded areas during the summer 2007 events. According to Pitt, approximately 14,500 households were provided with alternative accommodation. Some of this was short stay. However, at the end of May 2008, local authorities estimated that 4,750 households were still not back in their homes (Pitt, 2008). These costs are estimated here at just under £100 million.

The methods used here estimate:

- The incidence of flood impacts in terms of the number of people affected.
- The periods during which they were provided with temporary accommodation.
- The average cost per person per day of temporary accommodation.

The number of people affected and length of stay were based on Pitt's estimates of evacuation and temporary accommodation. The average cost was based on mean Weathernet £ values for claims. The resultant estimate of total loss is regarded as reasonably accurate.

Weathernet insurance-based data showed that for a subset of 5,800 households in temporary accommodation, the mean cost was £6,695. Applying this to the total number of households affected as reported by Pitt above, and deducting VAT, gives a total of £82.5 million in losses.

The number of non-residential properties in need of alternative accommodation is not known. An average cost of £5,461 was recorded for a subset of businesses according to Weathernet. It is assumed that a similar proportion of temporary accommodation is required for business as for residential occupants. Using Pitt's ratio of 14,500 evacuated to 48,000 flooded homes (that is 30 per cent of the total) suggests that about 2,400 businesses (0.30×8000 businesses flooded) required accommodation at £5,461. Deducting VAT, this yields a total of £11.2 million. Thus, the estimated total cost of alternative accommodation is £93.7 million.

3.6 Combined impacts on domestic and commercial property and related costs

Table 3.3 summarises the estimated costs incurred by domestic households and commercial entities. The total financial insurance claims for the 2007 floods for domestic and commercial property (excluding vehicles, temporary accommodation and business disruption) based on the most recent evidence were £2.56 billion. Allowing for under-insurance, this estimate of total 'out of pocket' adjusted financial cost rises to £3.15 billion.

Estimated total economic losses for domestic and commercial property (excluding vehicles, temporary accommodation and business disruption), after adjustments for tax and remaining values, were £1.78 billion, equivalent to 70 per cent (£1.78 billion/£2.56 billion) of the value of insurance claims and 57 per cent (£1.78 billion/£3.15 billion) of estimated total financial costs allowing for under-insurance.

Table 3.3 also shows that all damage costs attributed to domestic and commercial property, inclusive of damage to vehicles, the cost of temporary accommodation and business disruption, amount to: £2.92 billion of financial insurance claims; £3.52 billion of adjusted financial costs (allowing for under insurance); and £2.11 billion economic costs.

Table 3.3 Summary of costs incurred by domestic households and commercial entities due to the 2007 floods.

£'000	Property	Vehicles	Temp accom	Business disruption	Total
Insurance Claims					
Domestic	1720	90	97		1907
Business	840		13	160	1013
total	2560	90	110	160	2920
Financial adjusted					
Domestic	2263	94	97		2454
Business	884		13	168	1066
total	3147	94	110	168	3520
Economic					
Domestic	1200	80	83		1363
Business	580		11	160	751
total	1780	80	94	160	2114

These estimates are sensitive to assumptions about the correct estimates of unit costs and number of properties and claims, about the proportion and remaining value of inventories and about the proportion of non- or under-insurance. A +/-1 per cent change in assumptions regarding inventories and remaining value each results in a relatively small change in total economic damage costs (+/-0.3 per cent). A +/-1 per cent change in the proportion insured has an equal proportionate response (+/-1 per cent).

3.7 Public health

The Pitt Review reported that the summer floods had a significant effect on the public health and welfare (GfK NOP, 2007). A survey in April 2008 of 647 people who had experienced the summer floods reported that over 70 per cent felt that their physical or emotional health had been affected (GfK NOP, 2008). Real time surveillance by the Health Protection Agency (HPA) (2008a) did not find evidence of significant adverse impacts on health. However, follow up surveys by HPA (2008 b, c) of flood victims reported that between one third and a half of over 2,200 respondents in areas affected by flooding reported health concerns, especially relating to depression and anxiety. A comparative survey within and adjacent to flood areas, suggested that flood victims were about six times more likely to exhibit psychiatric distress than those who had not experienced flooding. Surveillance of flood victims in Hull (Sims et al, 2008) showed that many of the mental health impacts of flooding were due to people being treated badly by the various companies and agencies involved in flood recovery. Thus, the way the recovery process is managed has an effect on the costs of distress.

There are currently no agreed methods for estimating the monetary value of ill health and stress on those affected by flooding. Two methods were considered: one based on willingness to pay to avoid intangible impacts of flooding, including health impacts, and one based on days absence from work due to ill health.

With respect to the appraisal of flood defence schemes, a study commissioned by Defra (RPA/FHRC, 2004) suggested that households were, on average, willing pay £200 per year to avoid the negative intangible, mainly health related impacts of flooding. This payment was deemed to provide the protection against flood to the

minimum design standard typically provided by urban flood defence schemes, namely that flooding will not occur more frequently than 1 in 75 years (and typically no more frequently than between 1 in 75 and 1 in 200 years (Environment Agency, 2009)). The 2007 floods were extreme events with an estimated return probability of about 1 in 200 years.

On this basis, £200 per year per household can be regarded as an annual 'insurance' payment to avoid the distress associated with infrequent flooding events (that might happen in any given year but with a probability of occurrence of no more than 1.3%)⁴. Expressing this as an equivalent capital sum (discounted at 3.5% over 50 years, the typical design life of a flood defence scheme) gives about £4,700 per household, which is an estimate of the willingness to pay upfront to avoid the distress of flooding that might occur over a 50 year period. (Note, this relates to distress not property damage avoidance). Applying this estimate to the 48,000 households that were flooded gives a capital sum attributable to psychological stress of about £225 million. If, in the absence of other information, it is assumed that occupiers of business premises would be willing to make similar payments to avoid distress, a further £34 million is attributable to the 7,300 affected businesses. Thus, a total cost for flood induced distress of £259 million is derived for the 2007 flood events.

A number of researchers and health professionals, however, consider that an annual value of £200 per household (and per business premise) seriously underestimates the true willingness to pay to avoid the distress associated with flooding, and indeed the true value of stress caused by flooding when it occurs. It is clear that this is an important topic for future research.

Health costs can also be based on estimates of working days lost due to ill health induced by flooding. Using data on work absences from Pitt (2008) scaled up to the national level at average wage rates, assuming one day lost per flooded household due to ill health results in 32 years of loss of production associated with paid employment, equivalent to about £0.5 million. This probably underestimates the true cost due to considerable under reporting of work absences.

Media reports attributed 13 deaths directly to the summer 2007 floods. The circumstances and the characteristics of these fatalities were broadly consistent with evidence from European studies of flood fatalities. For the summer 2007 floods, however, there were no victims of property collapse or inundation. The fatalities were males attempting to cross or clear away flood waters. The value placed on a human life by the Treasury for the appraisal of public investments in health and safety is used here. At £1.15 million per fatality, this equates to £15 million. It is noted that this valuation is an accounting procedure used to derive an estimate of costs for the summer 2007 flood events. This value for a life protected is used by the Government to justify the commitment of public funds to reduce the probability of fatalities. It is not in any way intended that these sums are a measure of the value of the lives of those individuals who were tragically lost in the summer events and the enduring impacts on their families and friends.

In summary, a total cost of £275 million is used here to represent impacts on public health, recognising that this is likely to be an underestimate of true costs.

⁴ £200 /property/year is used to represent intangibles costs in guidance on flood risk management appraisal: Penning-Rowsell et al, 2005

3.8 Local government and emergency costs

The summer 2007 floods resulted in additional costs for Local Government Authorities associated with damage to property, disruption to services and post flood recovery. Emergency services were provided by Police, Fire and Rescue and Ambulance organisations as well as the Environment Agency. A distinction is made here between the impacts of the 2007 floods on

- Local government infrastructure and non-emergency services.
- Expenditure by the emergency services.

Expenditure by the Environment Agency. Total costs in this category are about £223 million, including about £85 million road costs (allocated to communication/roads in Table 2.1) and £4 million expenditure on emergency services (allocated to emergency services in Table 2.1).

Local government infrastructure and non-emergency services

The broad approach here involved identification of flooding incidents and associated costs, for the most part drawing on data recorded by Local Government Authorities and other official bodies and contained in special 'incident' reports and audited accounts. These data sources were often compiled to apply for compensation under Government schemes for grant aid or other forms of financial assistance. Data are regarded as robust.

The floods of June and July affected over 100 local authorities. Table 3.4 shows the distribution of additional costs attributable to the 2007 summer floods from a review of 16 LGAs with the highest flood related costs.

Table 3.4 Additional expenditure by 16 Local Authorities with the highest costs associated with the 2007 floods.

	£ million	% of total
General Expenditure:	41.8	22
Highways	73.4	37
Recovery	11.0	6
Schools	37.6	19
Social Services	3.7	2
Housing	27	14
Waste	0.9	<1
	£195.4	100%

Source: LGA audited reports

From Table 3.4, for the most affected 16 LGAs, it is apparent that:

- Increased General Expenditure accounted for 22 per cent of total additional costs. About 33 per cent of this 22 per cent relates to damage to sports and leisure facilities, over 25 per cent to lost revenue associated with reduced income from council tax, and car parks and sports facilities, and about 15 per cent for additional temporary staffing. About 8 per cent of extra general

expenditure, (equivalent to about £3.4 million for this group of LGAs) involved emergency supplies and services, including safeguarding non-road infrastructure at risk.

- Damage to roads and highways was the main burden on Local Authority resources (37 per cent of total costs), especially within rural County Councils. It was noted that rural roads in particular incurred relatively high infrastructural damage compared to more robust and better maintained major highways that were less exposed to flooding.
- Damage to schools (19 per cent) was a significant category of infrastructural damage, often requiring temporary classroom accommodation during repair works. This affected rural and urban authorities alike.
- Housing costs comprised mainly repairs to council houses, as well as temporary accommodation for displaced council tenants.

It is noted that the majority of the damage and disruption were associated with four local authorities (Hull City, Gloucestershire CC, East Riding of Yorkshire and Sheffield City).

A review of Local Authority audited claims obtained through the Department for Communities and Local Government (CLG) shows that total estimated costs were £223 million for the 80 LGAs that incurred costs above the eligible threshold for making claims for compensation. All of these LGAs were in England.

About £100 million of these LGA costs were reimbursed through central Government support payments such as the Bellwin Scheme (whereby abnormal conditions justify expenditure above threshold targets) and Grants from EU Solidarity Funds (Table 3.5). Other funds were also committed by LGAs with support from the Department for Schools and Families (DFSF) for improvements to schools and recreation facilities to help reduce future flood risks. These are not included here because they comprise enhancement rather than reinstatement. The remaining £123 million has been met out of financial reserves, savings on other accounts, or, as a last resort, borrowings.

Total costs allocated to LGA infrastructure (non-roads) and non-emergency services are £134 million (ie £223 million, less £85 million roads and less £4 million emergency services).

Table 3.5 Grants and support provided to English Local Authorities and emergency services as compensation towards the costs of summer 2007 floods.

	EU Restoration Fund £ million	Payments under Bellwin £ million	DSCF Grants for schools £ million	Dft payments for roads £ million
Local Authorities	30.2	17.0	9.0	40.9
Police	0.3	1.0		
Fire and Rescue	0.1	0.8		
Total	30.6	18.8	9.0	40.9

Source: audited accounts

Emergency services

The floods placed an extra burden on police, fire and ambulance services for staff overtime, emergency supplies and provisions. Six police authorities reported costs above their normal operational costs, with two (Gloucestershire and South Yorkshire) claiming under the Belwin reimbursement arrangements. The total audited extra spend was £2.57 million, of which £1.3 million (40 per cent) was refunded (see Table 3.5).

Nine Fire and Rescue Authorities reported above normal operating costs, totalling £1.17 million, South Yorkshire alone accounting for nearly 50 per cent of this. South Yorkshire, Humberside and Worcestershire between them claimed £0.77 million under Bellwin (65 per cent of the total as shown in Table 3.5). Information was not available on additional ambulance service and related paramedic costs.

Taken together, the identified additional costs for emergency services come to £3.74 million, equivalent to less than two per cent of that spent by Local Authorities on infrastructure and non-emergency services.

About 1,000 personnel from the Royal Navy, Royal Marines, Army and Royal Air Force were involved in assistance during the floods and immediate post-flood recovery, mostly in Gloucestershire. 350 personnel were used at any one time as requested by Environment Agency for search and rescue, construction of flood defences and distribution of bulk and bottled water. Although their costs could be theoretically recharged under Military Assistance to the Civil Community Scheme, no such costs were separately reported by the 16 LA top damage contributors. The use of military resources provided training opportunities and did not impact on either pre-deployment preparation or support to current operations.

Environment Agency costs

The summer 2007 flood incidents placed an additional burden on the Environment Agency in its role as the lead organisation for flood risk management in England and Wales. 500 flood watch and severe flood warnings were issued. Floodline, a telephone information service, handled some 206,000 requests for recorded messages. The National Customer Contact Centre handled some 55,000 calls. 700 media interviews were given along with 2,600 media enquiries. Some 1,200 flood risk management staff and 1,000 other Environment Agency staff were involved in managing the event, and additional support was drafted in when required.

Accounts provided by the Environment Agency show additional emergency response costs of £4.43 million, mainly for extra manpower (65 per cent) and hire of equipment and contractors (24 per cent). There was considerable damage to Environment Agency flood defence infrastructure, estimated at about £15 million, one third of this involving immediate emergency repairs and the balance scheduled for urgent repairs to permanent structures. Thus total costs were £19.3 million, of which 22 per cent were for emergency, non-structural items.

Disruption to Schools – impacts on pupils and parents

In addition to impacts on school buildings and contents, there was considerable disruption to school services. 467 schools were flooded or were affected in some way in the June floods in Humberside and Yorkshire. About 390 schools were affected by the July floods in Gloucestershire and Worcestershire. 91 of Kingston upon Hull's 99 school sites were affected with 65 primary schools, 13 secondary schools, 10 special units and three nurseries temporarily closed. According to a UK Resilience Report (Cabinet Office, 2008), 170, 000 pupils lost a total of 400,000 pupil days in the

Yorkshire and Humberside floods alone. A minimum estimate of the value of school days lost can be based on the equivalent cost of a school day. An average expenditure per pupil day of £24.5 was derived for the schools affected in Hull based on Education Authority budgets for 2007 (assuming an adjusted Age Weighted Pupil Unit (AWPU) of £3000, 70 per cent pupil-led funding and 190 school days per year). This gives a cost-based estimate of the value of 400,000 school days lost at £9 million. An alternative estimate could use the value of lost benefits associated with unauthorised absences (National Audit Office, 2005) at £275 per pupil per day. This would amount to about £110 million, which is thought to be unrealistically high. £9 million is used here, but is likely to underestimate the true loss of the value of school days.

The closure of schools also forced some parents to take time off work with resultant loss of earnings and of the value of output associated with work days. This was estimated at average wage rates, net of national insurance, at £2.4 million in Hull alone. On this basis, the total cost of disruption to schools is estimated here at about £11.4 million, but this is probably an underestimate.

3.9 Electricity and gas

Cost to electricity and gas include the direct costs of curtailed supply, the costs of redirecting supplies to avoid curtailment and, where supplies were cut off, the loss of value to users. Information was obtained from supply company records and personal communication with utility supply managers. Total estimated costs to electricity and gas are about £139 million, over 90 per cent of this associated with the cost of disrupted supplies to customers.

For the most part the electricity supply system remained intact during the flood events. Supplies were maintained by switching power distribution through different parts of the network where this was possible. This flexibility meant that major costs of disruption were averted. Estimated infrastructural damage was around £9 million.

Fortunately, a number of potentially very damaging incidents did not happen. The possible breaching of Ulley dam near Rotherham posed significant risk to National Grid's Above Ground Gas Installation at Guilthwaite and the electricity substation at Brinsworth. The consequences of failure would have been very serious, placing the electricity and gas distribution networks of Sheffield City and surroundings at risk.

The greatest estimated cost for power utilities is associated with the impact of deprived supply to customers and losses incurred due to curtailment in the value derived from using power, over and above the price (£0.07/kWh) normally paid for it. Based on surveys of electricity consumers, BERR (2007) use an average willingness to pay estimate of £10 per kWh per customer to represent the value of avoiding electricity disruption, confirming the considerable 'consumer surplus' (benefit obtained above price paid) for security of electricity supply.

Two major power cuts occurred. Curtailment of supplies in Yorkshire and Lincolnshire in June affected 130,000 households experiencing in total 1.9 million hours of interruptions to services spread over a five day period. This involved a loss of 10,000 MWh and an equivalent cost of disruption of £100 million. The failure of Castle Meads substation in Gloucestershire cut electricity off from 12,000 households for about 20 hours at an equivalent cost of about £25 million. Additional rota cuts in some areas resulted in a further £5 million loss of value to users. This gives a total of about £130 million for affected parties, mainly in Yorkshire, Lincolnshire and Gloucestershire. Thus the loss of value to users accounted for more than 90 per cent of the total economic costs of flooding in the electricity sector.

A number of critical locations on the gas network in Yorkshire came close to inundation but fortunately this did not occur.

3.10 Water, waste water and water quality

The water industry incurred extra costs associated with damage to property and for providing alternative supplies to customers. For their part, customers incurred costs associated with disrupted services. Information was obtained from water companies and OFWAT, the water industry regulator. Total estimated costs are about £186 million.

Though the effect on water services was widespread throughout England and Wales, Severn Trent and Yorkshire Water companies were by far the worst affected. The flooding of Mythe water treatment works in Tewkesbury created one of the worst post-World War II national emergencies. Outside Gloucestershire and Hull, water supplies were maintained for most communities, although some were affected by short-lived reductions in water services.

Flooding of Severn Trent's Mythe Water Treatment Works led directly to the loss of piped potable water supply to 350,000 consumers (138,194 properties) in the Gloucester area from 22 July 2007 for up to 16 days. Overall costs to Severn Trent Water as a result of flooding at Mythe were estimated by the company at £29.6 million. This included the operational distribution of tankers and bowzers and quality testing some 23,000 samples after connection was resumed. The cost of bottled water supply and distribution to 350,000 consumers was estimated at £25 million. The deployment of 1,400 bowzers to 1,100 locations was the largest of any incident of its kind in UK. This incident illustrates the extreme scale of damage and disruption when a major single source of supply utility serving a wide hinterland of users is flooded.

With respect to loss of value to water users, in the exceptional circumstances, compensation payments under OFWAT regulations were not paid. Using OFWAT (2008) guidance on the cost imposed on households when water is cut off, at £10/household/day, this equates to a cost burden of £23.5 millions. Payments of about £3.5 million were made by the water industry to a number of organisations associated with flood relief, in recognition of the burdens imposed by disrupted supplies.

Although there were failures of sewage treatment plant and pumping stations (300 suffered some degree of flooding) most of the repairs were not large enough to show up in the water company's accounts. Yorkshire Water suffered worst from the flooding of waste water treatment plant and associated infrastructure. £50 million of the £70 million estimated costs incurred by Yorkshire Water were within Hull City, where much of the plant is located below high tide level. As a result of flooding, water treatment for services for 2,500,000 people (just over a million homes) was affected for an average of two days. No standard rate is available for disrupted sewage services. Assuming half of OFWAT's rate for curtailments of supply, that is £5/home/day, this equates to about £11 million. Severn Trent reported disruption of water treatment services for 125,000 households for about 2 days, equivalent to £1.3 million.

Annual assessments of water quality in water courses by the Environment Agency suggests that water quality impacts were probably localised and short lived. However, river sediments and debris were deposited in some flood plain areas. Contamination occurred on a number recreation and nature conservation sites, such as at Tewkesbury Ham (Gowing, 2009). These impacts have not been valued here.

3.11 Railways

The floods resulted in damage to railway infrastructure and disruption to services. Information was obtained from railway company records and personal communication with operations managers. The estimated costs are about £36 million.



Flooding of the Cotswold line at Adlestrop (21 July) flooding from River Evenlode.

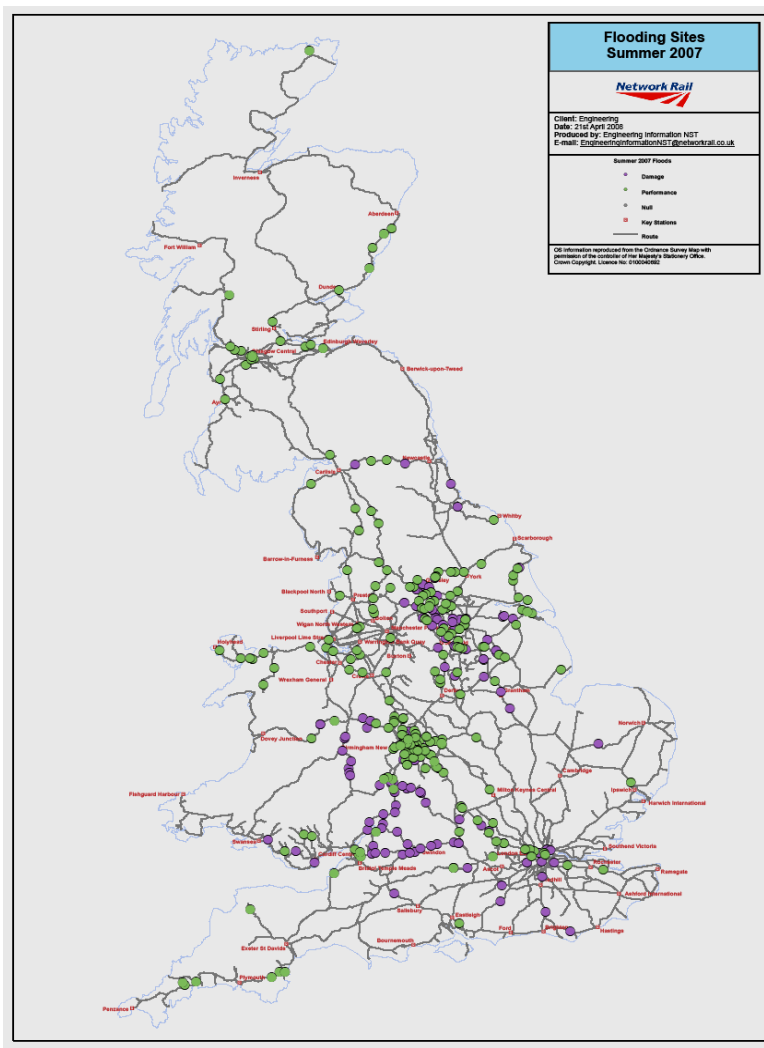


Figure 3.2 Locations of damage (violet) and performance problems (green) on the rail network, June and July 2007 (source: Network Rail).

Fluvial flooding and surface water excesses affected the railway in 265 places, although only 42 sites within 10,200 route miles in Great Britain were subjected to significant damages (Figure 3.2). Many of the disruptions were associated with accumulation of surface water. It is noted that only 12 per cent of flooding incidents were associated with fluvial flooding.

Most flooding was attributable to surface runoff and/or inadequate drainage. The worst infrastructure damage was in Network Rail's Western territory with closures at Oxford, Cheltenham and Gloucester stations. In June, both Sheffield and Rotherham stations were closed with passengers accommodated by local authorities. The longest track closure was the Manchester airport to Cleethorpes line at Kiveton which was closed for six weeks.

Total costs in June and July were £10.5 million for infrastructure damages. Estimated passenger minute delays, charged at standard rates for the value of travellers' time, gives a total £25.6 million for passenger delays. These delays and disruption also affected marginal revenues to train operators, but estimates of this loss are not available.

3.12 Road traffic

The floods caused damage to roads and related infrastructure, requiring capital expenditure and rescheduled extra maintenance. The closure of roads resulted in extra costs due to congestion, and increased travel time and distances. Information was obtained from a variety of sources: mainly insurance companies, the Highways Agency and LGAs. Estimated costs are about £191 million, about half due to damage and half to traffic delays. There is much uncertainty about the estimate of traffic delay and redirections.

16 local authorities accounted for 86 per cent of the total road damage costs of about £75 million out of a total of about £85 million cost of road damage to all LGAs. Gloucestershire roads were worst affected with repairs of some sort necessary at 420 locations. These include 30 bridge repairs, 15 slope stabilisation works and 135 major surfacing repairs. An early and detailed estimate made at 303 locations in Gloucestershire suggested an estimated total repair bill of £34.2 millions. Fifty per cent of emergency capital maintenance work in Gloucestershire related to unclassified rural roads, of which 42 per cent of this total related to grouped small schemes. Road damage costs in Sheffield alone were about £15 million. It is noted that motorways suffered proportionately less damage due to higher standards of design and maintenance compared with minor roads.

Thus, virtually all costs associated with damage to roads and related infrastructure such as bridges and culverts were incurred by Local Government Authorities, and identified from LGA accounts. These costs are charged here to the roads impact category, at about £85 million. The Highways Agency reported extra costs of only £33,000.

With respect to disruption, six motorways (M1, M4, M5, M18, M40, and M50) were closed. The M1 (Junction 31 to 34) closed for 40 hours because of the danger of dam breach at Ulley reservoir (Rotherham).

Disruption costs are difficult to assign but have been estimated by the Highways Agency at £2.3 million for the M1 incident alone. Data on the type and magnitude of traffic flows were used to determine the cost of the extra time and distances travelled due to blockage at given 'nodes' on the road network. Interpretation of flood maps suggested blockages at 200 flood/transport nodes. This gave a mean of direct traffic disruption of £98 million, but the range in this estimate is very large, between £22 million and £174 million depending on assumptions. Thus there is considerable uncertainty in this estimate.

3.13 Telecommunications

Additional costs incurred by providers of telecommunication services relate to increased repair and maintenance, and extra operating costs during the emergency. There were few reports of telephone exchange and network equipment affected by flooding. Unless flood water enters property, resilience of telecommunications equipment to flooding was high. Telecommunications companies worked with security and emergency services to provide extra cover. Damage and disruption to telecommunications are considered to be less than £1 million.

4. Insured and non-insured losses

Previous broad-scale estimates of flood damage costs for the summer 2007 flood events were about £4 billion, of which £3 billion was assumed to be insured (Pitt, 2008). The estimates here suggest that financial 'out of pocket' expenses were about £4.0 billion, of which £3.5 billion (90 per cent) related to impacts on domestic and commercial properties. It is estimated that about 75 per cent of the financial costs of £2.5 billion borne by households estimated here (that is, property damage, motor vehicles and temporary accommodation) were recovered through insurance, and insurers covered 95 per cent of the £1.1 billion financial costs borne by businesses (excluding utilities and transport businesses), based on available information and informed judgement.

Economic costs to the nation were about £3.2 billion. Of this total economic cost, about 63 per cent (£2.0 billion) was insured or compensated in some way, about 56 per cent of it (£1.8 billion) through private insurance. Insurance payouts in financial terms were about 40 per cent higher than economic costs due to the removal of VAT and the valuation of damaged items at their remaining value rather than their new replacement cost. Local authorities and emergency services were able to claim about 45 per cent of their extra costs from central government or other sources.

5. Impact on regions and social groups

It is clear that there is variation between the regions in terms of the type and magnitude of flood damage costs. Three main areas were affected, namely Yorkshire and Humberside, the Gloucestershire and Worcestershire, and Oxfordshire. This is verified by the analysis of insurance claims, and the impact on LGAs, utilities, transport networks and farming. Most damage in these areas was associated with the flooding of residential and industrial urban areas, although the impacts on farming and rural communities were also significant, especially where flood waters remained for long periods. This analysis shows however that while impacts were focused in these areas, flooding and consequences were also geographically dispersed. There were pockets of serious effects where all the major types of impacts revealed here were evident, albeit at a smaller scale.

It has not been possible here to quantify and explain the distribution of impacts amongst different social groups. It may be possible to do this by undertaking a detailed analysis of insurance claims by post code for residences and businesses. It may be possible to assess the particular impacts on occupants of local authority and social housing further drawing on surveys undertaken by Local Authorities and agencies such as the Health Protection Authority. A review of rural impacts showed the vulnerability of small farm and other rural businesses to extreme floods of this kind (Morris *et al.*, 2009). These aspects go beyond the main purpose here.

6. Main uncertainties, gaps in data and deficiencies in methods

There are uncertainties in the estimates associated with the limits of the data available and estimation methods. Data sources and estimation methods were graded on a scale 1, high confidence, to 4, low confidence.

The greatest confidence (rated 1) is held in costs reported by local authorities and emergency services that have been subject to auditing procedures and used for submitting claims for grant aid and other assistance.

There is moderate uncertainty (rated 2) concerning the estimate of damage costs borne by household and businesses based on insurance claims. The recording and classification of insurance claims appear to be incomplete and in some cases inconsistent, such that potentially limiting assumptions were required. These in particular relate to uncertainty about the relationship between number of claims and number of properties affected. Assumptions were also required regarding the proportion and remaining value of inventories at risk. Only detailed analysis of insurance claims would fill this gap in information. Furthermore, the proportion of total losses that were covered by insurance is not known for sure. In the case of businesses, the cost of disruption to businesses (based on insurance claims) is likely to be an underestimate, given the dispersed and wide ranging nature of these impacts.

There is moderate to high uncertainty (rated 2-3) regarding the estimates of cost borne by utility and some transport service providers, depending on the availability of internal management accounts and whether these were used to inform insurance claims.

Uncertainty is particularly high (rated 3-4) in the estimates of costs borne by users of services that are curtailed or disrupted, such as for water and electricity consumers. Here, standard rates are used to reflect willingness to pay to avoid curtailment or to accept compensation for curtailment for services for which people have 'entitlement'. It is assumed that these rates were correctly assessed in the first place and can be transferred and used for the purposes here.

There is considerable uncertainty about the impact of the 2007 floods on public health, particularly as this affects psychological and emotional stress (rated 4). Estimates here are based on expressed willingness to pay to avoid the health impacts of flooding rather than the costs of distress when floods occur. The costs are considered significant, but there are currently no robust and accepted methods for estimating the equivalent monetary value of these impacts.

There is also much uncertainty about the impact of flooding on non-market public goods such as impacts, both during and after the floods, on nature conservation, sites of special scientific interest and access to the countryside (Gowing, 2009). These could be nationally and locally significant but they have not been quantified here

7. Conclusions

In accordance with the aim of the study, the following conclusions are drawn.

Total economic costs of the summer 2007 floods to the nation are estimated at about £3.2 billion in 2007 prices, within a possible range of between £2.5 billion and £3.8 billion. Economic valuation here removes VAT from the estimate of damage costs, values the cost of replacing damaged items at remaining values, and includes values for loss of essential services such as water and electricity. This differs from the financial out of pocket expenses and losses incurred by people and businesses, which are estimated at about £4.0 billion, of which £3.5 billion (90 per cent) related to impacts to households and businesses.

Overall, about 67 per cent of total economic costs of the summer 2007 floods were incurred by households and businesses. Other major categories related to power and water utilities, communications (including roads), and Local Government Authority expenditure. The proportion of total costs committed to emergency and other supporting services was relatively small. Public health costs, mainly based on an estimate of the willingness to pay to avoid the distress associated with major flood events, account for about 9% of total economic costs, but there is considerable uncertainty in this estimate. Damages to about 42,000 ha of farm land accounted for about two per cent of total flood costs.

About £2.56 billion of insurance claims were made for damages to residential and commercial properties, rising to £2.92 billion when motor vehicle damage, temporary accommodation and business disruption are included. Assuming that 81 per cent of losses were covered by insurance, the total financial value of residential and commercial damages was probably about £3.1 billion and £3.52 billion respectively.

About 63 per cent of total economic costs (£2.0 billion) were covered by insurance or other forms of compensation, including grant aid. About 56 per cent of total economic costs (£1.8 billion) were covered by private insurance. It was estimated that insurance payouts in financial terms were typically about 40 per cent higher than economic costs due to adjustments for tax and remaining values. Local authorities and emergency services were able to claim about 45 per cent of their extra costs from central government or other sources.

The summer 2007 floods caused economic damages of about £674 million to important national infrastructure and the operation of essential services. Total damage costs were greatest, in order of magnitude, for water supplies and treatment, roads, electricity supply and agriculture. Almost 800 schools were affected by flooding, with a loss of 400,000 pupil days.

It is clear that there was variation between the regions in terms of the type and magnitude of flood damage costs. Although the flooding was concentrated in three main areas, namely Yorkshire and Humberside, Gloucestershire and Worcestershire, and Oxfordshire, analysis showed that flooding and consequences were dispersed throughout England and Wales. There were pockets of serious effects where all the major categories of impacts identified here were evident, albeit at a smaller scale.

There are uncertainties and gaps in the data and estimation methods. Information obtained from the audited accounts of Local Authorities was regarded as robust and comprehensive. There remain moderate uncertainties about the estimates of damage costs to households and businesses based on aggregated insurance data. It is felt that this is a potentially rich source of information which could be further drawn on to inform and explain variations in estimated damage costs.

There is considerable uncertainty in estimates of costs borne by users of services that are curtailed or disrupted, such as for water and electricity consumers as these use standard estimates transferred from other sources.

There is a great deal of uncertainty about the possibly large impact of the 2007 floods on public health, particularly regarding psychological and emotional stress. A better understanding of these impacts and potential economic consequences is required.

The scale and seriousness of the summer 2007 floods were sufficient to classify them as a national disaster. Analysis confirms the very significant economic costs associated with flood events of this magnitude. However, it is recognised that the impacts on the lives and livelihoods of those caught up in the summer 2007 floods are not fully reflected in these monetary valuations. For many people affected, the floods were a personal tragedy from which recovery is a slow and difficult process.

References

ADAS, 2008. Impacts of 2007 Summer Floods on Agriculture. Report to Department for Environment, Food and Rural Affairs. ADAS, Cambridge.

Cabinet Office, 2008. UK Resilience Reports. Floods - Damaged School Buildings.

Available at:

http://www.cabinetoffice.gov.uk/ukresilience/response/recovery_guidance/case_studies/b1_yh_floods.aspx, accessed 24 April 2009.

Carpenter, G., 2007. Wrong Type of Rain: Impact and Implications of 2007 UK Floods December 2007. Guy Carpenter, London.

Department of Business, Enterprise and Regulatory Reform (BERR), 2007. Electricity Priority Users Arrangements, Department for Business, Enterprise and Regulatory Reform. Available at: <http://www.berr.gov.uk/files/file40466.pdf>, accessed 24 April 2009.

Department for Environment, Food and Rural Affairs (Defra), 2009. Valuation of Agricultural Land and Output for Appraisal Purposes. FCDPAG3. May 2008, Department for Environment, Food and Rural Affairs, London

Efra, 2008. Flooding. Fifth Report of Session 2007-8, Environment, Food and Rural Affairs Committee, House of Commons, London.

Environment Agency, 2007. Review of 2007 summer floods. December 2007. Environment Agency, Bristol.

Environment Agency, 2009. Flooding in England: A National Assessment of Flood Risk. Environment Agency, Bristol..

GfK NOP, 2007. The Pitt Review: Learning Lessons from the 2007 floods. Qualitative research undertaken during October 2007 in areas affected by the 2007 summer floods. Cabinet Office, London.

GfK NOP, 2008. Pitt Review survey on impact of flooding – insurance and health.

Available at:

http://archive.cabinetoffice.gov.uk/pittreview/_media/assets/www.cabinetoffice.gov.uk/flooding_review/evidence/pitt_review_insurance_survey_incl_renters%20pdf.pdf, accessed 25 September 2009

Gowing, D.J.G., 2009. Impact of summer flooding on floodplain biodiversity via nutrient deposition. NERC Urgency Application . NE/Foo9232/1. Available at:

<http://www.floodplainmeadows.org.uk/pics/d96462.pdf>, accessed 25 September 2009.

Health Protection Agency (HPA), 2008a. Draft Final Report of the floods and health survey. Health Protection Agency, London.

Health Protection Agency (HPA), 2008b. Flooding – Frequently Asked Health Questions. Health Protection Agency. Available at:

http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1213686561005?p=1213686561915, accessed 24 April 2009.

Health Protection Agency (HPA), 2008c. Sources of Information on Health and Social Effects of Flooding in England and Wales. Draft Report, December. Health Protection Agency, London.

Morris, J., Posthumus H., Trawick P., Hess T.M., Neville D., Phillips E., Wysoky M., 2009. Impacts of summer 2007 floods on rural communities in England. Cranfield University. Report to the Commission for Rural Communities, Cheltenham.

National Audit Office, 2005. Improving School Attendance in England. Available at: http://www.nao.org.uk/publications/0405/improving_school_attendance.aspx, accessed 24 April 2009.

OFWAT, 2008. Guaranteed Standards Scheme. Available from: http://www.ofwat.gov.uk/consumerissues/rightsresponsibilities/standards/gud_pro_gss08.pdf, accessed 24 April 2009.

Penning –Rowse, E., Johnson, C., Tunstall, S., Tapsell, S., Morris, J., Chatterton, J. and Green, C., 2005. The Benefits of Flood and Coastal Risk Management: a Manual of Assessment Techniques. Flood Hazard Research Centre, Middlesex.

Pitt, M., 2008. Learning Lessons from the 2007 Floods. Cabinet Office, London.

Posthumus, H., Morris, J., Hess, T., Neville, D., Phillips, E. and Wysoki, M., 2008. Agricultural Damage caused by the Summer 2007 Floods in England. Report to the Environment Agency, Cranfield University, Bedford

Posthumus, H., Morris, J., Hess, T., Neville, D., Phillips, E. and Baylis, A., 2009. Impacts of the summer 2007 floods on agriculture in England, Journal of Flood Risk Management, 2009: 1-8.

RMS, 2007. UK Summer 2007 Floods. RMS, London. Available at: http://www.rms.com/publications/uk_summer_2007_floods.pdf, accessed 24 April 2009.

RPA and FHRC, 2004. The Appraisal of Human Related Intangible Impacts of Flooding. R&D Technical Report FD2004/TR. Defra, London.

Sims, R., Medd, W., Mort M., Watson, N., Walker G. and Twigger-Ross, 2008. Perspectives on resilience from households in Hull– response to Defra consultation on policy options for promoting property-level flood protection and resilience. Available on www.lec.lancs.ac.uk/cswm/hfp accessed 24/04/09

Weather.net. <http://www.weather.net.co.uk/>. Accessed 24 April 2009.

Appendix to Main Report

Appendix Table A

Summary of Statistics, Sources and Uncertainties

For damages/losses see summary in main report or appendices

Uncertainty scoring - 1: Best of Breed, 2: Limiting Assumptions 3: Gross assumptions, 4: Heroic Assumptions.

Receptor Class	Damage/Loss Statistics	Source	Uncertainty Score
Houses /residential	Insurance claims, adjusted – 45, 000 households flooded, 130,000 claims	ABI statistics	2
Businesses	Insurance claims, adjusted, 8,000 businesses flooded, 35,000 claims	ABI statistics	2
Agriculture	42,000 ha flooded in Humberside/Yorkshire , Gloucestershire and Worcestershire, and Oxfordshire	Visits survey of impacts on 79 farms in affected areas	1
Local authority	117 English affected 22 Welsh affected	Full audit by Communities and Local Government and Welsh assembly Government	1
Public Health	48,000 households , 7300 businesses flooded: WTP to avoid intangible costs of flooding Work days lost to ill health	Research WTP study Data on work absences from Pitt Review	3-4
Schools	407 flooded in June in 26 LGAs 390 flooded in July in 22 LGAs 400,000 pupil days lost	Audited data from Department for Schools and Families. Complex presentation of data for grant applications. Cabinet Office review of school closures. Age Weighted Pupil Units (AWPU) Budget allocations.	2
Fire Authority	12 English authorities involved	Full audit by Communities and Local Government and Welsh Assembly Government	1

Police Authority	7 English authorities involved 4 Welsh authorities involved	Full audit by Communities and Local Government and Welsh Assembly Government	
Water	Mythe WTW Tewkesbury with loss of supply to 138,194 properties; 23,000 water quality samples taken, 1,400 bowzers sent to 1,100 locations; 50 million litres of bottled water distributed Fulstow WTW (Cleethorpes) 2,500 properties Holmesford (Derbyshire) 0 properties Ewden (Sheffield) 0 properties Grimsbury (Banbury) 0 properties Whitbourne (Hereford) 3,800 properties	Data from water companies affected.	1
Waste water	Yorkshire Water: 35 WWTW and 100 PS with 2.5 million in some way compromised by loss of service Key PS in Hull did NOT fail Severn Trent Water: 110 WWTW and 85 PS failed Anglian: 56 WWTW and 109 PS failed 1 customer service centre flooded	Data from water companies and Ofwat; No data for Thames Water but proportionately far less impact.	1

Environment Agency	<p>55,000 calls</p> <p>206,000 requests for recorded messages</p> <p>2,200 staff gave significant time</p> <p>500 flood watch and severe flood warnings</p>	From Environment Agency Final 2007 flood report	1
Electricity	<p>Sheffield ring Neepsend flooded</p> <p>48,000 customers affected</p> <p>Safety closures at Brinsworth and Thorpe Marsh</p> <p>55 secondary, 4 primary substations and 4,300 service terminations lost in Yorkshire/Lincolnshire affecting 130,000 customers</p> <p>Near miss at Wallham with no customer loss</p> <p>Timberdene, Worcestershire substation flooded with loss to 12,670 customers</p> <p>Castle Meads plus 5 over substations flooded with loss to 33,400 customers</p> <p>20,000 flooded properties in Glos/Worcs checked for electrical safety</p>	Data from Distribution Network Operators and National Grid. Not available from Scottish and Southern.	1 where available
Gas	<p>1 AGI lost</p> <p>2 gas supply lines severed</p> <p>Limited customer loss</p>	Personal communication with National Grid, but information patchy and incomplete.	2
Telecoms	No geographical breakdown of losses but assumed low	BT Openreach data only; More research required on the resilience and redundancy of the network.	3

Road damage	<p>16 LGAs suffered 86 per cent of the damage</p> <p>Gloucestershire roads damaged at 420 locations</p> <p>1,5900 tonnes of debris deposited on roads in Don valley</p> <p>Superficial road damage in Hull</p> <p>Little substantive damage to HA roads</p>		1
Traffic disruption	<p>7 Motorways closed</p> <p>Up to 41 road closures in Sheffield</p> <p>M1 closed from 3 days</p> <p>10,000 vehicles stranded overnight on M5/M50</p> <p>A conservative estimate of 4 million car journeys were disrupted in Gloucestershire alone with over 90 per cent attributed to the A46</p> <p>HA disruption costs conservatively range from £22 million to £174 million</p>	<p>Gross assumptions on traffic disruption costs to Highways Agency based on an unsubstantiated 200 road closures identified from flood maps.</p> <p>Gloucestershire estimates based on good closure data with some limiting assumptions.</p> <p>Likewise M1 closure data.</p>	<p>3</p> <p>2</p> <p>2</p>
Railway damage and disruption	<p>Rail network affected in 265 locations</p> <p>42 sites were severely affected</p> <p>Several railway stations including Rotherham, Sheffield, Oxford, Cheltenham and Gloucester were closed</p>	<p>Standard delay costs per minute per train are assigned depending on the type of train affected (commuter versus regional etc.), the operator (Virgin versus Arriva) and where the incident was reported and at what time (peak or off peak).</p> <p>National damage costs derived from Network rail.</p>	<p>1</p> <p>1</p>

Appendix Table B: Summary of provisional estimated costs of summer 2007 floods in England by main and subsidiary impact categories, and source and reliability of estimates.

Cost Item:	Description	Sub sectors	Costs £ million	Data sources and estimation methods	Comments: confidence/uncertainties
Agriculture	Output losses, additional costs, damage to farm assets and infrastructure	All	£48.4 (95% confidence: £30-£60)	Sample survey of 78 farms in three flood regions, estimates at field and farm scales, grossed up according to land use and flooded areas.	Detailed, statistically based estimates at field and farm scale. Possible errors in grossing up according to distribution of land use within the flooded areas, and the area flooded in each region.
Houses and belongings	Damage to structures, fittings and contents (excluding vehicles)	All	£1,,200	Assessing the numbers of properties flooded and the average insurance claim, reduced by VAT and then increased by the % of people/properties with insurance cover. Sources: ABI; Weathernet; Pitt and Efra reports.	These figures are based on ABI figures of 130,000 claims.
Businesses premises, stock, equipment	Damage to structure and fittings ,damage to stock/ work in progress, supply chain impacts	Damage	£580	Assessing the numbers of properties flooded and the average insurance claim, reduced by VAT and then increased by the % of people/properties with insurance cover. Source: ABI.	These figures are based on ABI figures of 35,000 claims.
		Disruption	£160		
Motor vehicles	Damage to private cars	Household related	£80	Insurance claims ; 18,000 flood related motors claims at average £5,000 incl VAT.	Based on reported flood damages, based on remaining values, assumed 95% cover.
Temporary accommodation	Alternative accommodation, and relocation costs	All	£93.7	Assessing the numbers of people provided with temporary accommodation, and the average claim. Sources: Weathernet £ values. Pitt evacuation / temp. accom. . numbers.	Estimates based on Pitt , from local authority sources on temp accommodation.
Public health	Cost of work absences , medical treatment. Value of 'loss of life'	Psychological stress ,	£259	Health Protection Agency of incidence, WTP to avoid flooding .: Defra research	Considerable uncertainty .based on WTP to avoid exposure to flood related health costs – payments towards protection – rather than based on costs of flooding once it occurs Economic value of a life
		13 fatalities	15	Recorded fatalities	
		Other	£0.5	Pitt Review : work absences	

Cost Item:	Description	Sub sectors	Costs £ million	Data sources and estimation methods:	Comments: confidence/ uncertainties
Local Authorities infrastructure and recovery	Total cost of immediate emergency and longer term recovery	All	137 (excluding roads) 223 (including roads)	Total cost reconciliation for application to EU Solidarity Fund	Fully comprehensive certified accounts from Local authority Finance Department. No better data
Emergency					
Police Authorities	Total cost of immediate emergency and subsequent recovery	All	2.6	Total cost reconciliation for application to EU Solidarity Fund	Fully comprehensive certified accounts from Police authority Finance Department. No better data
Fire and Rescue Authorities	Total cost of immediate emergency costs and subsequent recovery	All	1.2	Total cost reconciliation for application to EU Solidarity Fund	Fully comprehensive certified accounts from Fire and Rescue Authority Finance Department, No better data
Environment Agency	Additional manpower, equipment and emergency and more permanent works	All	19.3	Environment Agency Finance Department	Reconciled figures for Flood Risk Accountancy Department. No better data
Schools Closures	School pupil days lost and parent work days lost	Schools by type	9.0 2.4	Reported school closures/pupil days lost. AWPU adjusted by pupil led funding. Parent work days lost	Cost of a school day based estimate for pupil days lost, plus proportion of parents work days lost. Probably underestimates true cost of disruption
Electricity/Gas –Direct	Costs to power Infrastructure:	National Grid Central Networks CEE Electric Gas	2.3 1.3 5 ,<1	Web trawl and estimates from Power supply and distribution companies	Based on costs extracted from operational data and personal communication, difficult to verify
Electricity/Gas – Indirect	Willingness to pay to avoid loss electricity supply	Rota cuts, Sheffield Timberdine, Worcestershire Castle Meads CEE Electric	4.3 0.16 25 100	Literature review by department for Business, Enterprise and Regulatory reform	£10 (midpoint) per kwh lost (range £5 to £30) MW hours outage based on detailed demand calculations

Cost Item:	Description	Sub sectors	Costs £ million	Data sources and estimation methods:	Comments: confidence/ uncertainties
Water - Direct	Physical damage to water infrastructure and cost of additional manpower associated with bowzers etc	Mythe WTW Manpower Ulley Reservoir (event) Ulley Repairs	29.6 1.6 1 4	Web trawl and detailed discussions with 4 water companies and Annual reports	Mythe is actual cost; manpower estimated from numbers involved factored by mean daily wage. Other sites outside Severn Trent Water minimal loss
Water – Indirect	Cost of alternative supply of drinking water. Nominal Compensation for lost supply Moneys paid by Severn Trent Water to voluntary organisations providing relief to help with the extra costs incurred	Gloucestershire, Cheltenham, Gloucestershire and Tewkesbury	25 23.5 3.5	Scrutiny Report OFWAT compensation rate at £10/home per day	Supply and delivery at 50p per litre NOT PAID, but £2.6 million paid to Glos flood victims by Government. Other sites outside Severn Trent Water no losses; re-zoning possible
Waste Water – Direct	Costs to sewage treatment facilities	Severn Trent Water Yorkshire (Y): of which Ings Lane (Y) Sewers (Don) Water treatment works Hull upgrading/repairs Anglian	10 <u>70</u> 2.9 0.6 12 10 5.1	Annual Reports. Web Trawl, Scrutiny Reports	No data yet available , estimated at £10 million, based on reported flooding of sites Yorkshire Water's 2007/08, accounts indicated insurance claims of £33m and £15.5 against written off assets – hence at least £50m plus other identified costs Assumed 50% proportion of full cost is for damage restoration, based on experience elsewhere

Cost Item:	Description	Sub sectors	Costs £ million	Data sources and estimation methods:	Comments: confidence/ uncertainties
Waste Water – Indirect	Willingness to pay for lost service	Yorkshire	11	Half value of water @ £5 /day/home, over 1 million homes affected homes for 2 days	Little direct loss to facilities outside Hull. Sewage plant largely resilient
		Severn Trent Water	1.3	125,000 homes affected for 2 days	
Telecommunications	Costs to telecommunications infrastructure		<1	BT Openreach and BT 2007/08 accounts	Limited costs; within normal reactive costs for BT
Road – Direct	Costs to Roads, Bridges and Highways Infrastructure	Highways Agency	<1	Interoute JV	Disruption but little damage to HA roads (only £33,000 in Area 2) Audited data
		County/Local roads	50.4		
		Gloucestershire	18.7 or 21.6	Estimated by WS Atkins on behalf of Dft	LGA road costs at £83 million based on audited accounts GCC overall estimate could be as high as £34.2
		Sheffield CC	13.5	Ditto (but reconciliation at different times. (EU) Reconciliation from EU solidarity claim	Early estimate was £9.9 million Certified accounts submitted to CLG equal £72.4 for top 16 flooded local authorities.
		Street Furniture	2.2		
Road – Disruption	Cost of delays (extra time and extra distance) through longer more circuitous routes	M1	2.3	Calculation by HA	Inferred but uses COBA traffic model Dependent on number of roads flooded, congestion, extra journey length, traffic flows etc.: estimates ranged from £22 to £174 mn depending on assumptions. Grossing to national figure difficult. Suggest Yorkshire floods at least equal this range. Probably more with City/town grid lock
		HA roads	98	Inferential model based on cost to UK plc Based on lost wages for 10,000 stranded motorists	
		M5/M50 grid lock			
		Gloucestershire Highways	0.91 2.5 to 6.3	COBA VoT/VOC calculations	

Cost Item:	Description	Sub sectors	Costs £ million	Data sources and estimation methods:	Comments: confidence/ uncertainties
Railways – Direct	Cost to track, stations and signalling equipment etc	All	10.5	Network Rail	Sums paid to TOCs as compensation for disruption
Railways – Performance	Performance related delays	All	25.6	Network rail	Sums paid to TOCs as compensation for disruption

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