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Education and Health

Estimating the potential losses due to the flooding of Schools and Hospital Services

Schools

Estimating the potential losses due to the disruption of education in schools

OVERVIEW

This sub-section provides a methodology for assessing the potential losses owing to the flooding of schools. There is a high potential for schools to be impacted by flooding. HR Wallingford (2012) estimated that there are over 1,600 schools in areas of flood risk; 740 of which are at moderate or significant risk with over 200,000 enrolled pupils. The floods in 2007 had widespread impacts with schools in Kingston-upon-Hull and East Riding of Yorkshire being particularly badly affected with the total costs of the repair and replacement of school buildings being estimated at £12.2 million (Chatterton et al., 2010). Environment Agency (2024) estimates that 21% education facilities are located in areas risk of flooding from multiple sources.

Direct damages occur due to the flooding of school buildings, the cost of temporary classroom accommodation and additional costs such as student counselling. The methodologies presented here to assess the potential losses caused by the disruption to education are based on estimating the likely number of pupil days lost due to the closure or part closure of a school. Estimates of losses are then based upon accounting for assessing the 'value' of those education days lost as well as any losses that may occur due to parents' absenteeism from work while they care for children who are unable to attend school.

LESSONS FROM EXPERIENCE

- A school does not have to be directly flooded to be impacted by flooding. Due to access issues (both by teachers and pupils) schools close to, as well as within, a benefit area should be considered within an appraisal.
- Schools are likely also to be closed due to the disruption to essential services such as electricity, water or waste water.
- It may be proportional in most cases to enumerate the losses for those schools which are likely to be closed for more than two days. However, if there are several schools which suffer only minor flooding or disruption the cumulative losses at these multiple sites may be significant.
- The duration of disruption should be minimised by school or Local Authority contingency planning to source temporary or alternative classroom accommodation and therefore the maximum time a school is closed is estimated to be 5 days. After this period it is likely that alternative or temporary accommodation would be secured.

ESTIMATING DIRECT DAMAGE TO SCHOOLS

Readers are referred to Chapter 5 for guidance on accessing direct damages to schools.

Other direct costs which appraisers may need to include are the:

- Costs of additional temporary classrooms and/or other accommodation costs.
- Costs to the school/Council of added support services to pupils affected by flooding (e.g. the cost of additional counselling services).

These costs are difficult to estimate and will vary depending on the severity of the flooding experienced and the length of time pupils need to be taught elsewhere. Where available it is recommended that appraisers should use local estimates for the costs of mobile classrooms or alternative buildings.

There are some lessons however, that can be learnt from the experiences in Hull in 2007 where the average cost for classroom accommodation was £15,000 per school. This is calculated by taking the total alternative accommodation estimate of £700,000 (Chatterton et al., 2010) and dividing it by the 46 most severely impacted schools. However, in all likelihood the most severely affected three schools should be assigned a much higher proportion of these temporary accommodation costs. Despite this, this estimate does provide a starting point for appraisal and might be considered to be a minimum estimate.

An average cost of approximately £150 per pupil for additional counselling might also be adopted as a crude estimate. This is based upon the Chatterton et al. (2010) estimate of total additional costs of £514,000 spent in the Hull case in 2007 divided by the estimate of 3,000 pupils most directly impacted by flooding (Coulthard et al., 2007).

ESTIMATING LOSSES DUE TO THE CLOSURE OF A SCHOOL

Losses from a school closure may include:

- The loss of parents' earnings (or number of staff days lost) due to the need to take time off to care for dependent children.
- The value of the loss of a pupil's education.
- Additional travel costs to alternative schools or temporary school locations (this is very difficult to establish as it would require knowing the additional journeys of all pupils/staff).

An estimation of each of these losses is a function of the duration of closure and subsequent disruption to the school and assessment of the number of pupils affected (and in particular younger pupils).

The following steps should be followed to assess the disruption losses due to the flooding of schools:

Step One: Identify the location of schools within and close to the flood risk area

Schools directly adjacent to the flood risk area should also be considered within this process. These schools may be impacted by flood warnings, any emergency actions and transport problems. Assess whether there are alternative flood-free routes to access the schools. Use this information to create a shortlist of schools for consideration for appraisal.

Step Two: Identify the type of each of the schools on the shortlist and the number of pupils enrolled

Information about every school (including mapped schools, school type and numbers of pupils) is available within the Department of Education's Performance Tables (<https://www.compare-school-performance.service.gov.uk/>)¹ (Department of Education (DoE), 2024a). Alternatively, the average figure for the number of pupils in a primary school in England is 275 and a secondary school is 1063 (DoE, 2024a) and these may be used as indicative estimates, however actual values should be collected and used where possible.

Step Three: Assess the likely impact of flooding on each school under different flooding likelihoods

This assessment needs to focus on the severity of the impact and the duration. This should address the following questions:

- Will the school be directly flooded or is it only likely to be impacted by access issues?
- Is the entire school site impacted by flooding? Or would it be possible to continue to educate children in other school buildings once flood waters have receded and while buildings are being repaired?
- How long is the school likely to be closed or partially closed? Note that half of all schools affected in Hull were able to open after one week.

As described in the lessons from experience it may be appropriate and proportional only to enumerate the losses for those schools which are likely to be closed for more than two days. However, if there are several schools which suffer only minor flooding or disruption the cumulative losses at these multiple sites may be significant. The maximum disruption time for a school to be closed should be assessed at five days. After this period it would be expected that a school would be re-opened or alternative accommodation secured (whether in another location or temporary classrooms).

Step Four: Calculate the number of pupil days lost due to flooding for each school

This can be achieved by multiplying the number of pupils in each school likely to be impacted (i.e. this will be all pupils if the whole school is closed or only a proportion if a school is partially closed) by the number of days the school is likely to be impacted.

Step Five: Quantifying the value of the loss of education

The first loss to calculate is a value attributed to the loss of a day of education (Equation 6E&H.1). This step provides a minimum estimate of the value of the school days lost. It is based on estimating the equivalent daily costs to the Local Authority to educate a pupil as adopted by both the National Audit Office (2005) and Chatterton et al. (2010). Values of annual pupil expenditure for every school in England and Wales can be found at the Department of Education's Performance Tables (<https://www.compare-school-performance.service.gov.uk/>) (DoE, 2024a) and/or via the Schools Financial Benchmarking data (<https://financial-benchmarking-and-insights-tool.education.gov.uk/>).

¹ NB: The 2023-2024 data are the latest released by the Department of Education as of April 2025.

Alternatively, national averages can be used, which for 2023/2024² are calculated at £32.02 for primary schools and £38.36 for secondary schools per pupil per day, based on median values for all national (England) schools and 190 school days a year³.

The following equation should be applied to all pupils irrespective of age.

Equation 6E&H.1

$$LD = PD * E$$

where:

LD is Estimate of the value of school days lost (£)

PD is Number of pupil days lost due to flooding

E is Average daily expenditure per pupil (£)

Step Six: Quantifying the paid productivity loss from parental absenteeism from work during the period of school closure

This second loss utilises estimates of the costs of parents missing work days due to the closure of school (based on Coulthard et al. (2007) and Sadique et al. (2008)). This method also utilises the estimate of the total pupils days lost due to closure; however we must adjust this value to account for various mitigating factors which reduce the overall number of pupil days lost due to flooding.

Firstly, not all school-age children will require supervision if a school is closed. Therefore, secondary schools should be excluded from an analysis of the parent work days lost as it would be expected that the majority of children at these schools would be able to remain at home without parental supervision. Schools which educate a mixed range of children should be included but only an appropriate percentage of the pupil affected days should be taken to represent primary-aged children.

Secondly, there is also the need to account for the following:

- The presence of siblings within a school population (i.e. to avoid double counting a parent's work days missed);
- That one parent may already be at home looking after younger siblings;
- That one parent may be unemployed;
- That some parents may choose to take annual leave (and therefore will not cause an economic loss);
- The fact that some parents may have alternative childcare arrangements (i.e. grandparents or childminders).

Indeed, the longer a school remains closed the increased likelihood that many parents will be able to find alternative arrangements and a reduction in the wider impact on the economy through work days lost.

Sadique et al. (2008) provide a more in-depth and complex way of analysing the percentage of the workforce that would be impacted by a school closure. This approach may be adopted if a more

² NB: As stated above the 2023/2024 data are the most recently released data as of April 2025. Averages have been calculated using the School Funding Statistics dataset (<https://explore-education-statistics.service.gov.uk/find-statistics/school-funding-statistics/2024-25>). It is suggested that users check at time of appraisal for their school(s) of interest most up to date and specific data (<https://www.find-school-performance-data.service.gov.uk/>).

³ NB: Data are also available for more specialist types of school such as Pupil Referral Units.

comprehensive analysis is required. However, Coulthard et al. (2007) divides the number of pupil days by two to account for the presence of siblings at the same school. However, we suggest that this is insufficient to account for all of the conditions described above and therefore dividing by a factor of three is recommended here.

The following equation can be adopted to calculate the potential loss of work days due to the closure of a school.

$$VL = (PPD / 3) * W$$

Equation 6E&H.2

where:

VL is Value of loss (£)

PPD is Total number of primary age pupil days lost

W is Value of a day's wage (£)

There are various values which could be attributed to the loss of a working day and appraisers may wish to provide estimates based on local information about average wages. A minimum estimate might use the value of a day's wage lost at minimum wage or an average wage in the UK and current estimates are provided in Table 6.20. Economic values have been provided to give daily wage estimates net of income tax and National Insurance contributions.

REFERENCES AND DATA SOURCES

Cabinet Office (2008) *Floods - Damaged School Buildings*, UK Resilience Reports, Cabinet Office, London.

Chatterton, J., Viavattene, C., Morris, J., Penning-Rowell, E.C. and Tapsell, S. (2010) *The costs of the summer 2007 floods in England*, Project: SC070039/R1, Environment Agency, Bristol.

Coulthard, T., Frostick, L., Hardcastle, H., Jones, K., Rogers, D., Scott, M. and Bankoff, G. (2011) *The June 2007 floods in Hull*, Final Report by the Independent Review Body, 21st November 2007, <http://www.coulthard.org.uk/downloads/floodsinhull2.pdf>, accessed 17 April 2025.

Department of Education (2024a) 2023/24 School Performance Tables, <https://www.compare-school-performance.service.gov.uk/>, accessed 17 April 2025.

Department of Education (2024b) 2023/24 School funding statistics, <https://explore-education-statistics.service.gov.uk/find-statistics/school-funding-statistics/2024-25>, accessed 17 April 2025.

Environment Agency (2024) *National assessment of flood and coastal erosion risk in England 2024*, (first published 17 December 2024 and last updated 22 January 2025) Environment Agency, Bristol, <https://www.gov.uk/government/publications/national-assessment-of-flood-and-coastal-erosion-risk-in-england-2024/national-assessment-of-flood-and-coastal-erosion-risk-in-england-2024>, accessed 14 April 2025.

HR Wallingford (2012) *Development of spatial indicators to monitor changes in exposure and vulnerability to flooding and the uptake of adaptation actions to manage flood risk in England: Results 2012*, Report EX6739 R4 for the Committee on Climate Change, August 2012, HR Wallingford, Wallingford, Oxfordshire, UK.

National Audit Office (2005) *Improving school attendance in England*, report by the comptroller and auditor general, HC212, Session 2004-2005, 4th February 2005.

Sadique, M.Z., Adams, E.J. and Edmunds, W.J. (2008) 'Estimating the costs of school closure for mitigating an influenza', *BMC Public Health*, London, vol 8, no 135, <http://www.biomedcentral.com/1471-2458/8/135>, accessed 17 April 2025.

Hospitals

Estimating the potential losses due to the flooding of hospital services

OVERVIEW

The flooding of hospitals can have social widespread impacts. This section describes approaches to the assessment of potential losses including the direct impact of flooding on hospital buildings, as well as due to the disruption and/or cancellation of hospital services. In 2007 there were only two instances of direct flooding to hospitals reported. The 2007 floods highlighted the high interdependency of hospitals on other services (including power and water supply) and transport networks; all of which can be impacted by flooding. Environment Agency (2024) estimates that 25.5% of medical facilities are located in areas risk of flooding from multiple sources.

Despite very minor direct damage being experienced, the flooding led to the cancellation of some hospital services with over 1,200 surgery operations and approximately 8,000 outpatient appointments being cancelled in Gloucestershire alone, primarily due to the disruption in water supply (Gloucestershire Hospitals, 2008).

It is therefore dependency and the interconnectivity of services which makes hospitals particularly susceptible to the impacts of flooding as disruption may not occur directly to the hospital site; but to one of the essential services. This dependency on external services and service providers which may be located off-site, coupled with the complexity of NHS funding arrangements, means that it can be extremely difficult to appraise any potential losses due to flooding. Therefore, the methodologies presented here include a qualitative description of potential losses as well as quantification. Quantification is proposed to estimate the potential losses due to the redundancy of a particular service or piece of equipment and utilises the cost of running that service as a proxy to loss. Additionally, in the cases where evacuation of patients will be necessary, appraisers should quantify the additional costs of transporting patients.

- A site survey and discussion with hospital managers is strongly recommended when appraising any hospital sites. This is due to the complexity and range of hospital services as well as the wide variation in hospital layout. It is likely that a hospital's administration will have investigated particular risks and identified potential contingencies which may assist in loss appraisal.
- Understanding the dependency (and redundancy in the system) of the hospital services is critical to a decision about whether a hospital needs to be investigated further and whether the potential flood related losses are significant. Hospitals close to, as well as within a benefit area, should therefore be considered for appraisal. Hospitals are likely also to be closed due to the disruption to essential services such as electricity, water or waste water and the knock-on impacts of traffic disruption.
- Assessing losses due to the closure/disruption of services is difficult as in some instances a closure of a facility will mean just a transfer within the NHS system (and therefore no net increase in cost) or even a reduction in overall running costs.
- In the absence of complex economic modelling, in many situations a qualitative description of the potential losses is recommended at least initially, to recognise and capture the complexity.

- One of the key elements is whether flooding will critically affect services, such as those for medical emergencies (e.g. Accident and Emergency and other critical care) as alternative provision will be necessary in these cases.

DIRECT DAMAGES TO HOSPITALS

The complexity of the layout of hospital buildings and assets means that a site survey is highly recommended to attribute both direct damages and disruption from losses. However, readers are referred to Chapter 5 for guidance on assessing direct damages to hospitals.

LOSSES DUE TO THE FLOODING OF HOSPITAL SERVICES

Hospitals are complex facilities to investigate. As discussed above they often comprise a number of buildings and/or sites and can have unique footprints. As well as being dependent upon the usual range of services and networks (i.e. electricity, water, sewerage, communications and transport) hospitals are also dependent on a range of other services which are critical to the running of a hospital and the continuity of care. These include amongst others: catering; waste disposal services; clinical waste disposal; laundry and various different stores services (including pharmaceutical, general stores, equipment, sterile goods). The situation is further complicated by the fact that in some instances these services are performed on site and directly by the NHS Trust and in other circumstances they rely upon external private-sector organisations and are located off-site.

In theory, there are a number of different ways in which the services of a hospital may be impacted, each of which may have economic cost implications. Some of these losses are direct in nature (such as the direct flooding of hospital infrastructure), whilst others are indirect (such as flooded roads leading to staff shortages and patients unable to reach their appointments). The total losses will also depend upon the scale of a closure (i.e. where a part or all of a hospital site is affected) and the duration of any impacts.

Potential losses/costs:

- Direct damage to the building and fabric of the hospital.
- Damage to equipment and the closure of wards and other facilities (operating theatres, scanners, etc.) due to the direct flooding of hospital buildings.
- Costs of evacuation/transfer of patients, to other hospitals or, in the case of some long-term care elderly patients to temporary alternative accommodation.
- Losses attributed to the redundancy of hospital infrastructure (e.g. scanners and other equipment which is not able to be used).
- Increased costs due to the transfer of services elsewhere (some of these may be transferred within the NHS and therefore only the increased cost should be included, whereas others may be provided by private hospitals).
- Increased staff and out-patient travel costs to alternative sites.
- Increased staff costs – if flooding prevents some staff from getting to work it is likely that agency staff may be required to cover positions, with an increased cost.
- Closure of wards/equipment and the cancellation of appointments due to staff shortages.

Assessing the losses to a hospital is in itself very complex. Although there will be social costs to individuals through the cancellation of services or operations and a general reduction in the total available hospital resources, quantifying these impacts is complicated. In some situations, for instance where acute care is closed (such as Accident and Emergency departments or emergency operations), other health care facilities will need to cover these activities and so the direct costs will be transferred to these providers. In the most part these costs remain within the NHS and so there may be little

increase to the UK as a whole. Also, strictly speaking in the short-term the closure of a ward may lead to an overall reduction in the direct costs to a hospital trust as running costs will be avoided. The difficulty of assessing losses due to flooding is compounded by the complexities of the NHS funding. For instance, the cancellation of services may have longer-term implications for an NHS Trust as it may fail to reach performance targets; thereby affecting their next period's government funding. As a result however, a Strategic Health Authority or Primary Care Trust may choose to cover this shortfall, resulting in no net decrease in funding due to the flooding disruption. In addition, although hospitals may save money through a reduction in running costs, there may be many capital assets (such as scanners, theatres, etc.) lying idle and so there will be an overall loss to the country due to the non-operation of this equipment. It is this redundancy in equipment that we aim to quantify for closed or disrupted services.

Understanding the dependency (and redundancy in the system) of the hospital services is critical to a decision about whether a hospital needs to be investigated further and whether the potential flood-related losses are significant. This includes the size of the hospital and the likely numbers of patients impacted as well as the presence and location of alternative service providers.

One of the key elements is whether flooding will impact the NHS providing a service for emergencies (e.g. Accident and Emergency and other critical care), as these are the services which need to be maintained and transferred to alternative providers. Impacts are therefore proportional to those key services which are being provided as well as the transferability of those services.

The following illustrates the basic steps that might be followed in order to appraise losses to hospitals:

Step One: Identify the location of hospitals

Hospitals (and hospital services) located within the floodplain and close to the periphery of the floodplain need to be identified (as these may also be impacted if major transport routes are cut). It is strongly advised that this is undertaken in consultation with the Hospital Trust to fully understand the interdependencies of services as they are likely to have already identified critical infrastructure at risk.

Step Two: Assess the assets likely to be affected by flooding

For quantifying direct damages, identify the footprint of the hospital and those services at ground and basement level that may be impacted directly by flooding (i.e. number of wards and potentially numbers of beds impacted that may be closed at different flood return periods). Readers are then referred to Chapter 5 for guidance on assessing direct damages to hospitals. These data should be refined where possible through discussion with hospital authorities; especially if the hospital Present Value Damages (PvD) constitutes a significant proportion (e.g. greater than 10%) of the total potential losses.

Step Three: Assess the likelihood that wards will need to be closed

This should identify how many patients these wards care for and therefore the numbers that might need to be transferred to alternative hospital/nursing home/hospice providers (e.g. if there is some redundancy on site, some patients may be moved to unaffected areas).

Step Four: Estimation of losses due to care service closure

Where possible, enumerate the loss in value through the closure of a ward (i.e. the loss of bed space) or other service/facility. This method of enumeration utilises the average cost of that asset per day to the NHS. Although not strictly an economic loss; it can provide a proxy value for the loss of use of a particular asset.

Based on the level of care and staffing required, different NHS beds have different associated costs, examples of which can be found in Table 6.21. So for ward closures, identify the number of beds of a particular type that might be affected and utilise the following equation to estimate the costs due to the redundancy of beds. Where possible it is also preferable to divide the number of beds not able to be used between general and surgery and critical care as the costs are quite difficult.

Equation 6E&H.3

$$CR = N * CB$$

where:

CR is Costs due to the redundancy of beds (£)

N is Number of beds not available to be used

CB is Average cost per bed (divided if possible by the type of bed)

The same procedure can be applied if whole procedures or other out-patient procedures are cancelled. NHS Reference Cost information is provided annually and provides an average cost of a procedure in England and Wales. These can be accessed via the government's website (<https://www.england.nhs.uk/national-cost-collection/>) and if appropriate used to enumerate the cost of cancelled services. For instance, the average unit cost of Treatment in Accident and Emergency (A and E) in 2023-2024⁴ is approximately £273, taking account of the numbers attending A and E and the total cost of treatment in A and E Departments. A figure such as this might be used to give a very approximate loss estimate to the closure of this emergency service if multiplied by the number of people usually treated over the period a service is likely to be closed.

Step Five: Patient Transportation Costs

If evacuation of patients would be necessary, quantify the transport costs of transferring the patients to alternative healthcare providers.

Equation 6E&H.4

$$CT = (P - BR) * CPT$$

where:

CT is Cost of transporting patients (£)

P is Number of patients to be evacuated

BR is Number of beds available elsewhere in the hospital (bed redundancy)

CPT is The average cost of a patient transfer (£)

⁴ NB: From 2023/24 National Cost Collection. 2023/24 data is the most up to date as of April 2025.

Some indicative values for the cost of patient transfers are provided in Table 6.22.

Step Six: Qualitatively investigate other impacts

Discuss with the Hospital Trust the likely effects of flooding on the continuity of services. The continuity of the following essential services needs to be included within the narrative:

- Electricity supply
- Water supply
- Sewerage services
- Laundry services
- Catering services
- Waste disposal services
- Clinical waste services
- Sterile services

In addition, investigate other aspects such as whether sufficient staff are able to access hospital buildings.

Step Seven: Identify what the hospital will do under different scenarios and how long disruption is likely to last

Learning from 2007 the likely impacts include:

- The closure of wards which are threatened with flooding
- The closure of Accident and Emergency services
- The cancellation of operations
- The pre-emptive cancellation of outpatients and cancellation of other non-urgent treatment

Broad annual statistics for hospitals in England and Wales can be found at NHS Digital (<https://digital.nhs.uk/>). This includes information such as the annual number of inpatients/outpatients, the numbers of hospital admissions and the total number of annual patient contacts. These can be used to calculate average daily contacts and be used to contextualise the level of likely disruption. Target and performance statistics (such as at how close to capacity a hospital runs) can also be used to understand broadly the level of redundancy in the system and the ability of the services to be transferred.

REFERENCES AND DATA SOURCES

Environment Agency (2024) *National assessment of flood and coastal erosion risk in England 2024*, (first published 17 December 2024 and last updated 22 January 2025) Environment Agency, Bristol, <https://www.gov.uk/government/publications/national-assessment-of-flood-and-coastal-erosion-risk-in-england-2024/national-assessment-of-flood-and-coastal-erosion-risk-in-england-2024>, accessed 14 April 2025.

Gloucestershire Hospitals NHS Trust (2008) 'Annual Report and Accounts 2007-2008', presented to Parliament pursuant to Schedule 7, paragraph 25 (4) of the National Health Service Act 2006.

Whiteley, D. (2008) *Report on the lessons learned from the Summer 2007 flooding experiences from an Estates & Facilities perspective*, Department of Health, DH Gateway Reviews and Estates & Facilities Division, Crown Copyright, London.