The Economics of Climate Resilience: Health and Well-Being Theme CA0401

A REPORT PREPARED FOR DEFRA AND THE DEVOLVED ADMINISTRATIONS

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Context of this report

The Economics of Climate Resilience (ECR) has been commissioned by Defra and the Devolved Administrations (DAs) to develop evidence to inform the National Adaptation Programme and the adaptation plans of the DAs. The report should be read in the context of other programmes of work on adaptation being taken forward separately.

The scope of the ECR

The ECR follows the publication of the UK Climate Change Risk Assessment (CCRA) in January 2012 and differs in scope from work envisaged prior to that date. While its original aim was to consider individual climate change risk metrics from the CCRA and specific adaptation options, this evolved as the project was considered across government departments. The current ECR therefore focuses on broader policy questions, with each report covering multiple climate risks and CCRA risk metrics. In this context, the economic assessment is broader than a quantitative assessment of costs and benefits – it concerns identifying and assessing market failures and other barriers to effective adaptation action, seeking to understand drivers of behaviour which hinder or promote the adoption of adaptation actions. The framework for assessing the costs and benefits of adaptation actions is considered in a separate phase of the ECR.

Questions addressed

The questions addressed by the ECR were chosen following cross-government engagement by Defra. They ask whether there is a case for further intervention to deliver effective adaptation given the current context – i.e. the current adaptive capacity of those involved and the policy framework. Criteria for the choice of questions by policy officials include: the current and projected degree of the climate change risk; priorities for additional evidence gathering beyond that already being considered in other work-streams, and the data and evidence currently available. Questions were deliberately broad to allow the wider context to be considered, rather than just individual climate metrics. However, this approach prevents a detailed evaluation of individual risks or localised issues being made. Detailed assessments of climate thresholds and the limits of specific adaptation options have also not been possible.

Analysis undertaken

The analysis has sought to build on existing assessments of current and projected climate change risks (such as the CCRA). The context in which sectors operate has been assessed, including the current adaptive capacity of relevant actors and the policy framework in which those actors function. Categories of actions currently being taken to adapt to climate change have been explored, including those which build adaptive capacity where it is currently low, and those which limit the adverse impacts or maximise opportunities, allowing identification of barriers to effective adaptation. The case for intervention is then presented.

The degree to which an adaptation action is likely to be cost-effective requires more detailed assessment, reflecting the particular context in which adaptation is being

considered.

This report is underpinned by stakeholder engagement, comprising a series of semi-structured interviews with sector experts and a range of other stakeholders. This has enabled the experiences of those who undertake adaptation actions on the ground to be better understood. We are grateful to all those who have given their time.

Executive Summary

1 Executive Summary

This report explores whether there is a case for further intervention by government or other bodies in relation to certain climate change impacts on health and well-being. It is anticipated that individuals and organisations will adapt in various ways to particular health effects of projected climate change out to the 2050s, without further government intervention. The purpose of this report is to provide an assessment of the ability to adapt, and the barriers and constraints to effective adaptation. An assessment of the extent to which adaptation action is likely to be taken is offered. Cost benefit analysis of particular actions is not within the scope of this report and should be carried out separately on a case-by-case basis.

The potential effects from projected climate change assessed in detail by UK Climate Projections (UKCP09) are broad; therefore, this report focuses on four specific questions set by Defra and the Department of Health. These are:

"**Given current policy and the current and expected adaptation, what is the case for further intervention in relation to:**

- **The continuity of services in NHS hospitals at risk of flooding, with illustration of *Gloucestershire Royal Hospital, Worthing Hospital and Aintree University Hospital,* as case studies*;***
- **The mental health and well-being of individuals affected by floods, with illustration using the case studies of *Hull and Gloucestershire* and with additional commentary on *Toll Bar*;**
- **Community resilience to future weather events, focusing on flooding, with illustration of *Toll Bar and Great Yarmouth* as case studies; and,**
- **The health impacts of heatwaves and rising mean summer temperatures on older populations (those over 65), with illustration using case studies in *Eastbourne and Islington.*"**

The above questions were assessed using case studies to highlight key issues, which are more widely applicable.

This analysis does not seek to repeat the substantial work that has been undertaken to date on each of these areas, but rather to provide new insights on expected levels of adaptation and barriers to effective action. This analysis is based on readily available evidence and extensive stakeholder engagement. There have, however, been significant challenges in undertaking this work. The limitations are discussed in the main report but it is worth noting the lack of formal evidence in many of these areas which limits the ability to draw precise conclusions.

The continuity of services provided by hospitals at risk of flooding

Where floods occur, hospitals can be affected in a number of ways, including:

- flooding of the estate,
- infrastructure damage,
- access to the hospital may be hindered, and
- supply chains may be disrupted.

To estimate the magnitude of hospital services potentially at risk of flooding, illustrative 'what-if?' scenarios have been explored using three hospital case studies. These scenarios are intended to provide a sense of scale of the potential services at risk and are not in-depth assessments of actual costs incurred. In addition, the costs associated with a disruption to one hospital will be different to expected costs at another, depending on the number and proximity of neighbouring hospitals and their capacity.

The calculations from the 'what-if?' scenarios indicate that costs may range from relatively little up to £14 million for an individual hospital as a result of a temporary (60 day) closure of A&E, and temporary closure of inpatient and outpatient procedures over the same period.

The analysis emphasises the fact that healthcare provision is part of a system with substantial interdependencies across healthcare providers; disruption to the services at one site will affect services at another.

The evidence suggests the sector has a relatively high adaptive capacity. The Civil Contingencies Act 2004 may have helped in this regard. Within this context, the report discusses some of the key actions that hospitals themselves can take to minimise the direct impacts of flooding on hospital services. The categories of adaptation actions assessed include:

- Infrastructure (internal and external);
- Planning and early warning systems; and,
- Continuity of services.

Key barriers to effective adaptation include:

- Interdependencies of a hospital both with surrounding infrastructure (such as power, water, transport), and other organisations within the healthcare system, create a lack of transparency and understanding of the level of risk.
- There is a lack of information and evidence on the effectiveness of adaptation actions and best practice adaptation.

Executive Summary

The mental health effects on individuals affected by flooding

An increasing body of evidence suggests that there are real and significant impacts on the mental health and well-being for those affected by floods. The CCRA (Ramsbottom *et al,* 2012) estimated that approximately six million (one in six) properties in the UK are at risk of flooding, with mental health impacts among the most important implications for those affected (Hames and Vardoulakis, 2012).

This part of the report discusses two key issues when flooding occurs:

- The potential mental health effects associated with flooding; and,
- The community resilience of a flooded area.

These issues are explored using two case study areas for each issue: (Hull and Gloucestershire for the former; and, Great Yarmouth and Toll Bar for the latter).

The analysis estimates the potential costs to these communities of the mental health effects. The estimates demonstrate the uncertainty surrounding climate change impacts (as described in **Annex** 3) and therefore in estimating the potential health costs of flooding.

The analysis shows that the costs of mental illness to the individual (lower quality of life) far outweigh the costs to the NHS in terms of treatment, or the costs of lost productivity from workers being off sick. Aggregate costs to individuals could be in the range £4 million to as high as approximately £620 million in Hull and in the range £2 million to £300 million in Gloucestershire. This is compared with costs to the NHS of approximately £0.1 million to £10 million in Hull and £0.1million to £5 million in Gloucestershire. Costs to the economy from lost productivity of those affected could be in the range £1 million to £37 million in Hull, and £0.3 million to £18 million in Gloucestershire.

In addition to these high costs for individuals, the adaptive capacity of communities is very variable and is particularly low for vulnerable groups within those communities[1]. This is likely to call for specific future action to help with adaptation. While flood alleviation schemes are extremely effective in reducing flood risk, they are not discussed in this report. Instead, this report focuses on adaptation that facilitates the recovery process after a flooding event (this goes beyond the immediate emergency response). The categories of adaptation actions include:

- Planning e.g. community emergency plan, local resilience groups, warnings,

[1] The issue of climate change and vulnerability has been explored in depth by the Joseph Rowntree Foundation, (JRF, 2011a).

- Social support e.g. social networks, voluntary groups,
- Provision of and access to information after flood event e.g. websites, helpline/advice line,
- Support to reinstate/return to house after flood event e.g. insurance, loans, builders, and
- Health services available specific to mental health effects e.g. social care, GPs.

Key barriers to effective adaptation include:

- Interdependencies across healthcare providers and with other sectors (such as insurance and service infrastructure such as power and transport) lead to a lack of transparency around the risks.
- A lack of access to comprehensive recovery related information or knowledge of where to access it can increase stress and anxiety in those affected.
- Lack of incentive for insurance companies to act in the residents' best interests by increasing the speed of drying homes, cleaning rather than replacing assets, repairing properties so they are flood-resilient rather than as they were before.
- Some members of the community may not recognise they are suffering with a mental health disorder, or they may not wish to admit it. They may be marginalised from emergency and recovery plans.

Overcoming barriers to adaptation and recovering more quickly from flood events could achieve significant benefits, including reducing the mental health impacts of floods. Illustrative "what-if?' scenarios suggest:

- The relative avoided costs from lowering the duration of mental health impacts can be significant. This could be equivalent to around £8,700 per person flooded in each area in terms of their quality of life effects (assuming a reduction in the duration of mental illness from five years to six months; however, it is likely that only a small proportion of people will be this severely affected).
- The relative costs avoided to individuals from lowering the relative risk of mental health impact following a flood could also be notable. This could be equivalent to around £700 per person flooded.

The impact of heat on health

The impacts on public health from gradual rises in temperatures and heatwaves (both consequences of climate change) include heat illnesses (such as heat stroke and heat exhaustion) and related conditions (dehydration) as well as neurological conditions, renal disease, and mental illness (Kovats and Ebi, 2006) These form the focus of the analysis, though other health effects are possible such as those related to air quality or ozone.

The total impact of a heatwave event will be dependent on a number of factors including: its magnitude, timing in season, population experience of heatwave events and public health responses (Kovats and Hajat, 2007). Increased mortality (premature death) is likely to occur, with the effects of heat overwhelmingly concentrated in the elderly (Kovats and Ebi, 2006). The number of hospital admissions and visits are expected to increase, as well as the demand for other healthcare services such as visits to the GP.

Given that the older age groups suffer from the greatest share of heat-related health effects, the focus in this report is on those aged 65 and over. Premature deaths and hospital admissions are the focus of the analysis. The study specifically looks at Islington and Eastbourne to derive estimates for the potential impacts. It then discusses the adaptation actions, the barriers to adaptation and concludes with the suggested case for further intervention.

The case study analysis indicates that:

- Islington is projected to experience a higher number of cases of mortality and hospital admissions than Eastbourne, because it is has a larger population and because of the higher projected temperatures. However, excess mortality is only around 15% higher than Eastbourne, despite having double the total population. This reflects the proportionately higher number of residents over 65 years of age in Eastbourne compared to Islington. Demography and age profile are therefore key drivers of heat-related excess mortality and hospital admissions.

- The monetised (discounted) costs associated with mortality reflect the same patterns as described above. When considering London as a whole, the costs associated with heat-related excess mortality are expected to be around £7-78 million in the 2030s (473-712 heat attributable deaths). By the 2050s, this could rise to £13-149 million (1200-1838 heat attributable deaths). Note that these figures do not account for existing adaptation and acclimatisation.

- London is a useful comparator with Islington: the London mortality rates are estimated to be more than 50 times higher for London than Islington in the 2030s and 2050s. The magnitude of difference is explained in part because London comprises 33 London Boroughs, and because the demography of

Islington is younger than London as a whole (so a relatively lower impact on the health of the population would be expected).

The time-lag between onset of heat and death is very short, which is why preventative measures and quick responses are so important (Gasparrini *et al,* 2010). A primary difficulty with assessing such preventative measures is the lack of heatwaves that have occurred since 2003 and 2006 (the Plan was first developed in 2004). As a result, there is limited evidence to examine effectiveness, and some data has been drawn from experiences in other countries. The categories of adaptation measures include:

- Alert systems and summer preparedness,
- Communication with the public,
- Engagement with service providers, and,
- Engagement with communities.

Barriers to effective adaptation to address as a priority are:

- Interdependencies across healthcare providers mean that they may not be aware of actions being taken by others and how they interact.
- There is a lack of evidence on the costs and benefits of interventions and the lives that can be saved.
- Members of the community may not recognise they are at risk of heat impacts and may not heed advice.
- There is a lack of coordination and collaboration between organisations with responsibility for care.

This report develops a case for intervention to address some of the key barriers to effective adaptation within the three areas considered. Given the timeframe of this report and the fact that it is being used to inform the National Adaptation Programme, most of the case for intervention focuses on building adaptive capacity: this will allow strengthen decision-making and increase flexibility and ability to adapt to uncertain climate change impacts.

Case for intervention in response to risk of flooding to hospitals

- **Build an understanding across hospitals of the interdependencies in service provision** (e.g. with water, power and transport infrastructure) **and with other healthcare providers.** This involves mapping linkages to identify the key points of risk, and appropriate scenarios to inform decision-

makers. Share information across interdependent hospitals on resilience and planned actions to facilitate effective decision-making.

- **Assess the degree to which hospital resilience is affected by climate change risks to other sectors and the actions they are taking to adapt**. For example, this could be undertaken for particular areas as pilot studies.

- **Improve learning from past experience and embed best practice approaches to flood resilience consistently across the sector**. Build the evidence on how small-scale and low-cost actions could potentially be effective, for example, basement protection, re-locating key equipment within the hospital away from the basement. Gather detailed evidence of costs and benefits under different situations.

- **Evaluate hospital adaptation actions (ex post) to build the evidence base** – the current lack of evidence could lead to maladaptive actions being taken, particularly as hospitals are upgraded over time.

- **Carry out research to understand better ways of building resilience of emergency care outside the hospital and in the community**.

Case for intervention to address key barriers to effective adaptation to enhance community resilience and lower mental health impacts of flooding

- **Share information across infrastructure providers and those in the healthcare and resilience sectors and develop resilience plans collaboratively. Undertake analysis using scenarios** to assess which actions may be effective under particular situations, the thresholds and the limits to adaptation. Assess the costs and benefits of actions under particular circumstances.

- **Provide a single trusted hub of information for members of communities, with comprehensive cover of all aspects needed for effective recovery following a flood (such as medical advice, insurance claim handling and managing builders).** For example, a national flood website. Educate key figures in the community to share information. Use existing and trusted channels where possible.

- **Provide enhanced emotional support for individuals by** building and strengthening existing community groups and processes to share information, build trust of authorities among community etc. Undertake research into ways of sharing best practice and examples between communities e.g. information platforms, web-based resources.

- **Take action to make insurance a driver of flood-resilience,** e.g. insurance companies to use most rapid drying technologies to dry homes, and to encourage cleaning of assets rather than replacement where possible, and encourage flood-resilient repair to homes, rather than repairing them to the same vulnerable standard.

- **Provide education and training for emergency planners, local authorities, and community members** to ensure effective engagement with individuals and groups, building and applying emotional intelligence to empathise and empower communities to help themselves; and, build knowledge of risks and actions to minimise them (e.g. in Scotland, school children are taught about climate risks etc as resilience is integrated into the curriculum).

- **Investigate the feasibility of integrating voluntary groups within formal planning processes** to ensure vulnerable groups are not isolated (e.g. the Central Scotland's Memorandum of Understanding between statutory and voluntary sector responders).

To address key barriers to effective adaptation to address the heat-related risk to the health of those over 65

- **Share information across healthcare providers** and develop plans collaboratively. Undertake analysis using scenarios to assess which actions may be effective under particular situations, the thresholds and the limits to adaptation. Assess the costs and benefits of actions under particular circumstances.

- **Build the evidence base on the costs and benefits of adaptation actions to lower heat-related impacts on health**. Assess (*ex ante*) the relevant baseline against which costs and benefits can be assessed, and undertake ex post evaluations after a heatwave.

- **Provide targeted and tailored information, appropriately communicated, to those at risk so that they are able to understand their extent of risk and heed advice.** Raise awareness among vulnerable groups in particular, along with those in the community able to support them.

- **Identify vulnerable people at the local level and collaborate with voluntary groups within the community,** involve them more formally in preparedness planning processes.

2 The health and well-being theme

Climate change is expected to lead to a range of health and well-being impacts on individuals and communities. In response to this, the analysis presented in this report addresses the following question set by government policy officials:

"**Given current policy and the current and expected adaptation, what is the case for further intervention in relation to:**

- **The continuity of services in NHS hospitals at risk of flooding, with illustration of *Gloucestershire Royal Hospital, Worthing Hospital and Aintree University Hospital,* as case studies;**
- **The mental health and well-being of individuals affected by floods, with illustration using the case studies of *Hull and Gloucestershire* and with additional commentary on *Toll Bar*;**
- **Community resilience to future weather events, focusing on flooding, with illustration of *Toll Bar and Great Yarmouth* as case studies; and,**
- **The health impacts of heatwaves and rising mean summer temperatures on older populations (those over 65), with illustration using case studies in *Eastbourne and Islington.*"**

This analysis provides new insight on expected levels of adaptation and barriers to effective adaptation action. The questions selected for the focus of this study are those on which policy leads identified a need for additional evidence, while avoiding duplication with past or on-going research.

2.1 Approach

The general framework used to address the particular questions set by policy leads involves both stakeholder engagement and quantitative and qualitative analysis.

2.1.1 Stakeholders

We are grateful to the wide range of stakeholders who have provided their valuable time, evidence and expertise to this work (listed in **Annex 2**). This input has been through over 30 interviews, an online focus group and in-depth discussions with the Health Protection Agency, Department of Health, Primary Care Trusts, County Councils and other health experts across England and the Devolved Administrations.

We are especially grateful to our expert advisor – Professor Paul Wilkinson – epidemiologist at the London School of Hygiene and Tropical Medicine who has inputted substantially to the assessments and provided advice throughout.

2.1.2 Analysis

The framework for analysis to address each question involves a series of steps. The questions are each addressed by applying the framework to case studies that are used to identify issues and common learning points that can be applied to other areas and contexts across the UK. The steps of the framework are:

- **Understand the scale of the challenge**: this involves exploring the evidence on the current scale of risks posed by climate change (including extreme weather events) and understanding the potential magnitude of the consequent health impacts;

- **Understand the context in which adaptation is considered**: this includes identifying the relevant actors and understanding their adaptive capacity as well as identifying relevant policies that are likely to facilitate or hinder effective adaptation;

- **Identify and assess adaptation actions** currently being implemented by some in the sector, considering the extent of their current and likely near-term adoption and their potential effectiveness. These actions include building adaptive capacity and implementing action to limit damage or make the most of an opportunity. Barriers are then identified in terms of where uptake or effectiveness (or both) is constrained. Barriers are explored in the following categories:

  - Market failures: the degree to which there are market failures relating to pricing signals; externalities[2]; public good characteristics; and where information may not be timely, accurate, relevant or is incomplete,

  - Policy: the framework of regulation and policy incentives,

  - Governance: institutional decision-making processes, and,

  - Behavioural: short sightedness and willingness to act.

- **The case for intervention** to address those barriers is then explored through the consideration of adaptive management and illustration of 'what-if?' scenario analysis to demonstrate the potential effectiveness of actions if barriers are overcome.

[2] Where there are costs or benefits imposed on others that are not accounted for in individual decision making.

2.2 Limitations

This analysis is based on the evidence available and extensive stakeholder engagement. There have, however, been significant challenges in undertaking this work. First, the long term view of climate change taken in this report means that there are inevitable uncertainties in the estimated magnitudes of potential impacts. Uncertainty regarding the nature, scale and timing of projected climate change, and the associated variability in weather patterns, poses substantial challenges in terms of analysis (explained further in Annex 3). Analysis is therefore indicative of potential effects and would merit further detailed assessments before adaptation actions are implemented - costs and benefits of action will vary across areas and timeframes.

Second, this report assesses the degree to which adaptation actions are currently being implemented and whether they are likely in the future, given current policy and market incentives. This work is not intended to provide cost-benefit analysis on particular actions (that is for a further stage of work).

Third, there are substantial gaps in the available evidence and analysis on adaptation actions and their effectiveness.

The structure of this report is:

- Section 3 investigates adaptation in relation to the continuity of NHS hospital services, given projected climate change;
- Section 4 explores adaptation in the context of the impacts of flooding on mental health and community resilience;
- Section 5 investigates adaptation in the context of the effects of projected increases in temperature on human health; and,
- Section 6 concludes and summarises the case for intervention.

3 Flooding and the continuity of NHS hospital services

This section addresses the following question:

"Given current policy and the current and expected adaptation, what is the case for further intervention in relation to the continuity of services in NHS hospitals at risk of flooding, with illustration of *Gloucestershire Royal Hospital, Worthing Hospital and Aintree University Hospital,* as case studies?"

This section first presents an assessment of the scale of the challenge in terms of the potential magnitude of hospital services at risk if a hospital is flooded and the current and projected level of risk. It then considers the context for adaptation in terms of adaptive capacity and associated policy that facilitates or hinders adaptation. Adaptation actions being implemented by some in the sector, and are expected given current policy or market incentives, are then explored. Barriers to effective adaptation are identified.

3.1 The scale of the challenge

3.1.1 The impact of floods on hospital services

At present an estimated 7% of hospitals in England are located in flood risk areas. Hospital services are at risk of flooding in all regions of the UK, with vulnerability particularly high in the South East, South West and East Midlands (Ramsbottom *et al,* 2012).

Continuity of healthcare provision through NHS hospitals is extremely important given the UK's reliance on public health services. For example, in England there were 15.8 million attendances of Accident and Emergency Departments in 2010-11 (HES, 2011), 1.4 million in Scotland (NHS Scotland, 2012), 730,000 in Northern Ireland (DHSSPNI, 2011) and 82,000 in Wales over the year to September 2011 (Statistics for Wales, 2011). A wide range of additional services are provided by NHS hospitals on a daily basis, including inpatient and outpatient care, day cases, elective procedures, rehabilitation, non-consultant led consultations, palliative care and community care, among others.

Where floods occur, hospitals can be affected in a number of ways. These include:

- **Flooding of the estate**: flood water may penetrate the estate leading to disruption of the functioning of the hospital. This could range from relatively minor impacts up to the temporary closure of departments or even the hospital. Such disruption could lead to the potential relocation of

patients within the hospital, diversion of emergency patients, cancellation of procedures or re-location of patients to another hospital.

- **Infrastructure damage**: hospitals can experience indirect effects of flooding owing to their intrinsic interdependency with surrounding infrastructure. Interruptions to utility services can be very problematic. For example, water supplies may become disrupted or contaminated, power supplies may be interrupted and communications systems disrupted. As these are critical to the functioning of the estate, service provision could potentially also be affected.

- **Access to the hospital may be hindered**: affecting both the ability of patients to get to their appointments or to access A&E services, and the ability of staff to get to work. Many staff may simultaneously have to manage their own personal problems if their homes or families are affected.

- **Supply chains may be disrupted**: products and medication that the hospital relies on for service provision could be interrupted. It is also possible that staff may also be disrupted if the local areas and access routes are flooded.

3.1.2 The estimated cost of interruptions to NHS hospital services caused by floods

Current level of risk

The CCRA (Ramsbottom *et al,* 2012) assessed the extent to which hospitals in the UK are at risk of flooding. This report builds on the CCRA to consider the potential implications for three real hospitals in the UK, using their specific activity data and costs, to illustrate the scale of impact on services.

To estimate the magnitude of hospital services at risk of flooding, illustrative 'what-if' scenarios have been explored using three hospital case studies:

- **Aintree University Hospital** (a large teaching hospital in the North West of England);

- **Gloucestershire Royal Hospital** (a district general hospital in South West England); and,

- **Worthing Hospital** (serving Worthing and other towns and villages along the south coast of England).

These hospitals were chosen as they have all experienced the effects of flooding in the recent past- either directly (they were flooded) or indirectly (the infrastructure or other services they rely on were flooded). Importantly, this

assessment does not accurately assess in detail the costs those hospitals incurred during past events. Instead, each 'what-if?' scenario is intended to be illustrative of the potential scale of services at risk and the associated costs if they could not be provided for a period of time[3]. The 'what if?' scenarios use current activity levels of the three case study hospitals as a basis for the assessment; they do not rely on particular climate change projection scenarios.

Although the case study 'what if?' scenarios are in England, lessons and issues are highlighted where they are applicable across the rest of England and the Devolved Administrations.

Illustrative 'what-if?' scenarios

It is important to note that **the costs associated with a disruption to one hospital will be different to other hospitals owing to the types of service provided, the levels of activity and the proximity of neighbouring hospitals that could act as a substitute service provider.** For example, if all staff and patients are able to re-locate temporarily from a flooded hospital to an unaffected hospital (with sufficient capacity to cater for the increase in patient load and staff) then the impacts on patients and the NHS could be relatively low. However, the in-built capacity of hospitals is unlikely to be large enough that they can absorb the services of another hospital without some impact on patient welfare, potentially waiting times, and increases in cost to the NHS.

The 'what if?' scenarios explored, using the scale of activity of each case study hospital, are (see **Annex** 4 for further detail):

- **Scenario 1: Temporary closure of A&E**

  This explores 'what-if?' flooding forces the temporary closure of the hospital's A&E department for 10 to 60 days. Here, patients will have to be diverted to other Accident and Emergency departments, forcing these healthcare providers to absorb the costs of treatment.

- **Scenario 2: Temporary closure of A&E department and the cancellation of all outpatient appointments for the duration of the flood**

  This explores 'what-if?' the A&E department is temporarily closed so that all A&E patients are diverted to neighbouring hospitals (hence increasing the costs they face in turn); and all outpatient appointments are postponed, meaning patients must wait longer for their treatments. The duration of effect is 10 to 60 days.

[3] Note that this assumes no further adaptation actions – in practice, some level of adaptation would be likely.

- **Scenario 3: Temporary closure of all hospital services**

  This explores 'what-if?' a flood event is so severe that the entire hospital is temporarily closed for 10 to 60 days. A&E patients and inpatients are displaced to neighbouring hospitals and all outpatient and elective procedures are cancelled for the duration of the flood. Costs relate to the neighbouring hospitals from having to treat the additional A&E and inpatients, plus the costs to patients from delays to outpatient treatment and elective procedures.

Activity levels at the case study hospitals

Before describing potential costs under each 'what-if?' scenario, it is helpful to understand the nature and scale of current activity of each hospital. This indicates the magnitude of health services at risk from flooding, should it occur. These are shown in **Figure 1**.

Figure 1. Activity levels and costs at each case study hospital

Daily attendance rates* and costs** by department				
Location	Current daily A&E attendances and (costs)	Current daily inpatient attendances and (costs)	Current daily outpatient attendances and (costs)	Current daily elective procedures and (costs)
Aintree University Hospital	240 (£35,000)	295 (£295,000)	1,695 (£200,000)	30 (£60,000)
Gloucestershire Royal Hospital	145 (£15,000)	230 (£250,000)	1,645 (£225,000)	35 (£70,000)
Worthing Hospital	110 (£10,000)	190 (£215,000)	990 (£145,000)	20 (£40,000)
* attendance figures are rounded to the nearest five				
** costs are rounded to the nearest five thousand				

Source: Based on Hospital Episode Statistics and associated Reference Cost data provided by the Department of Health

It is clear that the hospitals vary in their size and location, with the costs of providing services dependent on the volume and type of services provided. More specialist services have a higher unit cost than more general healthcare, for example, and could be less amenable to being displaced to surrounding hospitals in the event of a flood.

Estimated costs of an interruption to services

To estimate the potential scale of cost of interruption to services from flooding, a range of different costs have been reflected. These are summarised as follows (with further detail in **Annex** 4)[4]:

- The monetary value of health care services provided (this could indicate the increase in cost faced by the surrounding hospitals from absorbing additional patients, beyond the level they would have otherwise treated – this is the value of services provided;
- The costs to patients' welfare from having an outpatient appointment or elective procedure delayed[5]; and,
- The cost to the surrounding hospital from providing healthcare services to inpatients from the flooded hospital.

Results are summarised in **Figure 2**.

Figure 2. Estimated costs of flooding associated with each 'what-if?' scenario

Potential scale of the threat by impact on patients* and costs of treatment (£m)**						
Location	Scenario 1: Temporary closure of A&E for 10-60 days		Scenario 2: Temporary closure of A&E and postponement of outpatient appointments for 10-60 days		Scenario 3: Temporary closure of A&E and postponement of all inpatient and outpatient procedures for 10-60 days	
	10 days	60 days	10 days	60 days	10 days	60 days
Aintree University Hospital	2,400 (£0.3m)	14,300 (£2.0m)	19,300 (£0.4m)	116,000 (£2.5m)	22,600 (£3.4m)	135,600 (£20.2m)
Gloucestershire Royal Hospital	1,500 (£0.2m)	8,800 (£0.9m)	17,900 (£0.2m)	107,400 (£1.4m)	20,600 (£2.8m)	123,200 (£16.5m)
Worthing Hospital	1,100 (£0.1m)	6,500 (£0.6m)	11,000 (£0.1m)	65,900 (£0.9m)	13,100 (£2.3m)	78,300 (£13.9m)
* attendance figures are rounded to the nearest hundred						
** costs are rounded to the nearest hundred thousand						

Source: Based on Hospital Episode Statistics and Reference Cost data provided by the Department of Health

The analysis suggests that:

[4] It is recognised that other costs are likely too, such as the cost associated with any increased risk to health from having to travel to an A&E department further away (though treatment may to some extent be available in the ambulance); infrastructure costs associated with flood damage to the premises and equipment (note that this is beyond the scope of this report – only healthcare effects are monetised here); and the costs to staff from having to be diverted to an alternative hospital to work, or take an alternative route to work, or not being able to get home. None of these costs has been possible to assess within this work.

[5] This is estimated using the patients' willingness to pay to avoid a delay.

- **Healthcare provision is part of a system with substantial dependencies within the health system and with other sectors.** Disruption to the services at one site will affect services at another as patients are absorbed and treated**.** Even a relatively short interruption of 10 days, as shown across all 'what-if' scenarios, could lead to additional costs for surrounding hospitals running into many millions of pounds. These costs are likely to be an underestimate because there would be disruption to staff, patients etc. plus, capacity constraints at surrounding hospitals could imply greater costs from lengthening waiting times. When resources are already tight, this additional un-budgeted cost is substantial.

- **Not all patient care is possible to transfer to the nearest local hospital.** Specialist care is, by its nature, only possible to deliver on some sites if specialist knowledge or equipment is required. For those patients affected, the costs and degree of disruption could be larger if they need to travel far greater distances to receive their care.

- The costs of an interruption are significantly greater at Aintree University Hospital than other hospitals, notably owing to its **size and the specialist services provided**.

- If a flood renders a hospital temporarily unable to provide inpatient care for a period of time then **this imposes potentially significant costs on neighbouring hospitals, as well as risks to the key revenue streams** of the flooded hospitals (payments are made on the basis of activity carried out).

- The **costs associated with the provision of inpatient care are found to far outweigh those in terms of providing A&E services or protecting outpatients from delays to their appointments**. This is illustrated by the £2-3 million increment in cost between the 'what-if' scenarios 2 and 3 for each hospital.

Against this analytical background, it should be noted that there are practical constraints on the ability to redistribute patients across areas. In addition to the costs illustrated here, there may be secondary costs (for example, logistical and transport costs of moving patients or managing impacts if more than one hospital is flooded in an area).

This section has explored the potential scale of cost of disrupted services associated with flooding of case study NHS hospitals. The next section considers the context for adaptation i.e. adaptive capacity, including the identification of those policies that facilitate or hinder adaptation. Adaptation actions that are already being taken by some in the sector, and those that would be expected in the future, are then assessed, along with barriers to effective adaptation.

3.2 Adaptation in NHS hospitals

3.2.1 Introduction

The framework for assessing the degree to which adaptation is occurring already and would be expected is based on two key factors:

- **Adaptive capacity** (see below)**:** Adaptive capacity is a necessary condition for the design and implementation of effective adaptation strategies, so as to reduce the likelihood and the magnitude of harmful outcomes resulting from climate change (Brooks and Adger, 2005). This is assessed to provide the context adaptation action.

- An understanding of the **adaptation actions** that individuals and organisations are already taking in some parts of the sector and those that would be expected in the future. These may be in response to an event or consequence of climate change (reactive) or as a result of government policy (planned) (see below). Adaptation actions can focus on building adaptive capacity or on reducing the climate impact or maximising the opportunity. There is a suite of actions that could form part of an effective adaptation strategy. The choice of actions will depend on the capacity of both the organisation and the sector in which it operates, and the climate change risks under consideration – these factors should be considered systematically together with non-climate risks.

The definitions of these concepts in this report are below.

Adaptive capacity: definition

For the purposes of the ECR, adaptive capacity, or the ability to adapt, is analysed using a simplified framework informed by the Performance Acceleration through Capacity Building (PACT)[6] model (Ballard *et al,* 2011) and the "weakest link" hypothesis[7] (Yohe and Tol, 2002; Tol and Yohe, 2006). Both PACT and the

[6] This model was chosen as it was used in the CCRA and because in a UKCIP review of adaptation tools it was ranked as the most robust (Lonsdale *et al,* 2010). The PACT model identifies six clear stages of development when organisations take on the challenge of climate change. These are called response levels (RLs) rather than stages as each level is consolidated before moving to the next. RLs 2 and 3 are characteristic of 'within regime' change, RL4 is characteristic of 'niche experimentation' (or 'breakthrough projects') and RL5 is conceptualised as regime transformation. RL6 would be conceptualised at the landscape level. In this report, the RLs were used very simplistically as a comprehensive assessment of the adaptive capacity of the sector using PACT could not be undertaken. It is recommended that this be undertaken in further work.

[7] The weakest link hypothesis enables assessment of the potential contribution of various adaptation options to improving systems' coping capacities by focusing on the underlying determinants of adaptive capacity. In this report, the determinants were used to assess capacity of an actor rather than an adaptation option. This was used as it provides socioeconomic indicators by which an actor's adaptive capacity may be categorised. It enables the weakest part of an actor's capacity to be shown providing an area to focus adaptation responses.

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weakest link models introduce the idea of discrete levels of an attribute and allow identification of where an actor is now and where they would like to be, and illustrate the areas that need most development to get to the desired end point (Lonsdale *et al,* 2010).

This project defines adaptive capacity using the CCRA definition:

Adaptive capacity

"The ability of a system/organisation to design or implement effective adaptation strategies to:

- adjust to information about potential climate change (including climate variability and extremes),
- moderate potential damages,
- take advantage of opportunities, or cope with the consequences"

Source: Ballard *et al,* 2011 (CCRA – modified IPCC definition to support project focus on management of future risks)

Adaptive capacity refers to both the structural capacity within the overall sector, and also the capacity of different actors in the sector. The assessment of these factors allows us to explore the ability of actors to implement effective climate change adaptation measures.

Adaptation actions: definition

For the purposes of the ECR, the adaptation actions considered are those that are already being taken or expected to be taken. The actions include adaptation which is:

- **Planned adaptation:** this tends to be (but is not exclusively) anticipatory adaptation, undertaken or directly influenced by governments or collectives as a public policy initiative. These actions tend to represent conscious responses to concerns about climate change (Parry *et al,* 2007).
- **Reactive adaptation:** is taken as a reactive response to climatic stimuli as a matter of course (without direct intervention of a public agency) (Parry *et al,* 2007).

In some cases, actions could be considered both planned and reactive (for example, a reactive response to a current risk could lead to planned adaptations to limit future exposure). Both planned and reactive adaptation actions might be

'wrong' or lead to maladaptation[8], in the long term or for wider society, and may need to be countered with further action such as building adaptive capacity and by taking specific actions to change and deal with the consequences.

In this section, both factors are explored for NHS hospitals. The information in this section has been compiled through an assessment of peer-reviewed and grey literature, in-depth stakeholder interviews, and testing of key findings with sector experts and stakeholders. The stakeholders that were interviewed are set out in **Annex** 2 and are referenced in this report by their organisation and not by name.

3.2.2 Context for adaptation: adaptive capacity

This section assesses the adaptive capacity of the sector and organisations or individuals and highlights particular policies that facilitate or hinder adaptation.

The analysis of adaptive capacity has been derived from evidence from published studies and qualitative evidence from interviews with a wide range of experts within the sector and broader stakeholders. It draws on the assessment made by Ballard *et al* (2011) for the CCRA, and further develops it. Both structural adaptive capacity (e.g. the role and size of organisations) and organisational adaptive capacity (e.g. the functions of key players and their performances) are considered.

Structural adaptive capacity

This description of structural adaptive capacity can be used to identify specific types of decisions where further assessment of climate change implications will be important. These include hospital design and infrastructure, planning procedures and business continuity.

In its day-to-day operations, experts and literature reviews (e.g. Ballard *et al,* 2011) suggest that the health sector will be able to develop quickly the necessary levels of adaptive capacity to address direct risks to health. However, where major capital expenditure is planned, a greater level of adaptive capacity at a delivery level is required.

(i) Sector complexity

In England, the healthcare structure is changing under the Health and Social Care Act 2012 (Shirley-Quirk, 2012) with focus moving away from just hospitals and GPs to including treatment at home and at community level (Department of Health (DH) interview). The structural adaptive capacity for clinical decisions to update care pathways to handle flooding and heat stress, for example, is not a significantly constraining factor. Experts and stakeholders have advised this study

[8] Action or investment that enhances vulnerability to climate change impacts rather than reducing them (UKCIP, 2012).

that the medical profession regards itself as relatively strong in this area, and therefore requires relatively little additional capacity to respond to these emerging climate challenges.

Health Boards and Special Boards in Scotland are covered by the public bodies climate change duties introduced by the Climate Change (Scotland) Act 2009. Publication of the Scottish Climate Change Adaptation Programme, being developed by the Scottish Government for publication in 2013, will bring into force the adaptation requirement of the climate change duties (s.44 of the Act) which requires that a public body must, in exercising its functions, act in the way best calculated to help deliver any climate programme laid before the Scottish Parliament.

The Welsh Health Board is a 'category one' responder in Wales along with local authorities, fire service etc. This is a requirement for the Health Board, in conjunction with other category one responders, to compile a risk register that incorporates risks from flooding heat etc. This register is reviewed every year.

(ii) Interdependencies

Health and wellbeing covers a wide range of interconnected sectors and stakeholders. Dependencies exist across other sectors including transport, power, and water provision, among others. **The adaptive capacity of hospitals is critically dependent on the adaptive capacity and actions taken by other actors**. In particular, physical infrastructure is important, such as transport providers, electricity distributers/retailers, water companies, logistics/supply chain management companies, insurance providers etc. These can lead to trade-offs between immediate service delivery and building resilience, weakening the adaptive capacity. **This highlights the need for hospitals to work with infrastructure providers in designing resilience**.

In addition, hospitals operate within a system of healthcare provision so if one hospital is adversely affected by a flood, surrounding hospitals are likely to be affected owing to the need to take action to absorb additional patients.

(iii) Decision lifetime

With respect to flooding adaptation measures within hospitals, the decision lifetimes vary across the physical infrastructure measures, which have long decision lifetimes (e.g. 30-40 years with many facilities used for longer) (Ballard *et al,* 2011), and those that are behavioural (e.g. care pathway decisions) which are frequently revisited and have very short decision lifetimes. This makes them easier to implement and iterate.

(iv) Activity levels

There is a high potential for adaptive capacity where activity levels (e.g. decision making frequency, replacement time of buildings etc) are high. When decisions are made frequently, there is the potential to build learning and bring in emerging

climate knowledge, but this only happens where there is recognition of the issues and the processes to bring this into decision-making. The short-term nature of most decisions related to management of clinical risks and to community resilience means that activity is relatively high. However, activity levels are lower in other parts of the sector such as where capital investment in hospitals or health-care facilities occurs (Ballard *et al,* 2011). Making health facilities resilient tends to be most effective when a new build or refurbishment takes place.

(iv) Maladaptation

Maladaptation refers to actions or investments that enhance vulnerability to climate change impacts rather than reducing them (UKCIP, 2012). In some cases, this can reduce adaptive capacity by devoting too many resources to actions which are not as effective as others, and by diverting scarce resources to undoing maladapted decisions (Ballard *et al,* 2011).

Maladaptation is a greater risk where capital investments occur with long lifetimes (e.g. designing hospitals without consideration of climate risks such as flooding) or where either capital investment, or short term planning, is made in relation to one climate risk, such as increased flooding, but without regard to any other climate risks (such as overheating). However, it is less of a risk where decisions are frequently made, have short lifetimes, and are of a behavioural nature (e.g. internal planning procedures). There is a moderate degree of maladaptation as climate risks have not been incorporated within the design of the majority of hospital buildings which were built before potential climate impacts were understood (Ballard *et al,* 2011).

There are important trade-offs to consider which can lead to maladaptation due to dependencies within the sector and across sectors. For example, the actions of one hospital may increase the vulnerability of another; and the actions of other sectors (e.g. power, transport) may increase the vulnerability of a hospital.

A key consideration is where to best focus resources given the uncertainty around climate change impacts (please refer to **Annex** 3 for further information). For example, what is the opportunity cost of money spent on retrofitting a hospital to make it flood resilient, if the flood risk is low? It would be "over adaptation" to spend money on making a building resilient if the cost far outweighs the risk of an event. If the risk is to grow in the future, then such spending decisions should be reviewed in the light of increasing evidence and knowledge. This concept (adaptive management, which allows for learning over time) is discussed further in Section 6.

Organisational adaptive capacity

In this section, the focus is on hospitals as the decision-makers. **Figure 3** presents a summary of the organisational adaptive capacity of hospitals. For further detail, please refer to **Annex 6**.

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Figure 3. Adaptive capacity of hospitals

Strategic Health Authority/ regional level actor	**High** HPA knows about responses that can be best engineered in times of crisis and HPA carries out longer-term planning with other facilities HPA works with Local Resilience Forums[9] to support the NHS, and coordinates local issues of preparedness, ensuring hospitals have plans while having overview of major events
Hospitals (new build and existing)	**Med – High** Hospitals have relatively high adaptive capacity in dealing with emergencies (Department of Health interview). Adaptive capacity is strengthened by flexible planning and processes embedded into decision-making Emergency culture of a hospital strengthens capacity, as does the nature of staff in a hospital and their willingness to devote resources to dealing with an emergency (NHS SDU interview; DH, 2007b) Have ability to move services around, sharing load with neighbouring hospitals (e.g. DH interview, WSH, 2012; AUSH, 2012) Specialists in the NHS understand resilience, though it is not embedded across the organisation and down to front line staff, such as carers or nurses (Ballard *et al,* 2011) Existing emergency planning procedures have allowed front line organisations to address climate risks, but less success at triggering a response appropriate for capital projects such as refurbishment or new build (Ballard *et al,* 2011) Adaptive capacity is lower for physical infrastructure due to higher costs and longer lifetimes and lead in times. However, some examples of 'breakthrough projects' e.g. De2RHECC programme (Designing and Delivering a Resilient Hospital Environment to Climate Change) Interdependencies for services and their delivery e.g. built environment and infrastructure (transport, utilities etc) significantly weakens adaptive capacity (e.g. unavailability of mains water to Gloucestershire hospitals in 2007 floods) (DH, 2007b). Interdependencies across healthcare providers could also weaken adaptive capacity where capacity and incentives differ across providers (public/private).

[9] LRFs are existing multi-agency partnerships, supported by the Department of Communities and Local Government (DCLG), to enable and build local resilience capability through planning and testing. There are currently 39 LRFs that map directly on to police areas; LRFs typically have 3 seats for health representatives, currently: Local NHS management (i.e. PCTs), ambulance services and public health (HPA).

Building adaptive capacity

There are a number of actions that are required to build adaptive capacity in order to respond to the needs identified in this section. Some actions are generic, e.g. education, training, or strengthening coordination between organisations, while others are specific to the particular climate impact e.g. access to flood resistant building design, or awareness of the flood risk, or planning for the particular risk. This report considers both types of actions in the following section on adaptation actions.

3.2.3 Adaptation actions

This section provides an overview of some of the categories of actions some hospitals are already taking, and would be expected to take to maximise opportunities or minimise risks. These categories include both actions to build adaptive capacity, and actions that reduce the particular risk of flooding in hospitals.

The categories set out here are not exhaustive, and each category contains a number of individual adaptation options, which in future, could be disaggregated and assessed individually. These categories of actions were informed by key sources of literature and discussions with health sector experts. They were then refined and verified in the stakeholder interviews to ensure that the ECR considered the key sorts of actions to address the particular risks considered.

The categories of adaptation measures described for hospitals do not include those measures that increase resilience of other sectors and therefore lower the impacts on health service provision following a flood (such as those in relation to power supply, ensuring access to clean water, enhancing the resilience of roads, among others). These are critical areas that should be considered further, as recommended by the Pitt Review (2008) and the Department of Health (2007b).

Categories considered below are:

- Infrastructure (internal and external)
- Planning and early warning systems (EWS)
- Continuity of services

The categories of adaptation actions are described in detail in **Annex 7**. They are briefly set out below with a description of the action, and a summary of the key barriers/ enablers, and potential outcomes[10]. Policy or legislative requirements

[10] The potential outcomes include extent of current and future adoption, timing, cost and effectiveness. Costs are relative to the sector. For example, high cost is major infrastructure investment or change in approach or strategy (e.g. hundreds of thousands or millions); low cost is the individual cost of a change to processes or operations, information provisions, or minor investment in equipment (e.g. thousands or tens of thousands).

that act to facilitate or hinder adaptation measures are also noted. The actions set out below are largely planned adaptation responses in response to legislation (e.g. Civil Contingencies Act 2004), although they are expected to increase in prevalence after a flood event is experienced, and given the autonomy of hospitals, many of the actions are also reactive.

(i) Infrastructure (Internal and External)

These actions relate to the external structure of a hospital, such as its design or location – much of which depends on land-use and building design planning decisions – and the internal lay out. External actions include flood resistance (diversion channels, retention areas, flood barriers) and flood resilience (elevating the facility or access routes, reinforcing the physical integrity of the building with water-resistant materials) (US DHS, 2012; National Kidney Foundation, 2006). Internal measures focus on flood resilience, such as locating essential equipment on upper floors not the basement, having gas-powered pumps, raised power switches etc (GOSH, 2012; Shroades, 2007). **Figure 4** provides a summary.

(ii) Planning and Early Warning Systems

These actions largely involve building adaptive capacity, and include existence and practice of an emergency-preparedness plan, (including staff training, warning and evacuation procedures, equipment such as sandbags); early flood warning systems (e.g. cameras on flood gauges, direct contact with emergency services); and system wide standardisation and coordination (so other hospitals can accommodate patients) (Cloutier *et al,* 1998). It is noted that in the UK, there is little centrally held data on the specific actions or their costs, so data is drawn from US examples. **Figure 5** provides a summary.

(iii) Continuity of Services

These actions include: guaranteeing the availability of essential (building and medical) services such as having back-up generators, or mobile units from third parties to carry out operations (Loosemore, 2011); providing access to and from hospital for staff and patients (including helipads on roof for critical patients (Loosemore, 2011; Rolyn Companies, n.d.); accessing options for supplies before disaster strikes e.g. considering where to obtain fuel if facilities need to operate on generators for longer than three days (Shroades, 2007); and having the ability to control all communications to entire hospitals and personnel from one single source (Loosemore *et al,* 2010; HPA, 2012b). **Figure 6** provides a summary.

3.2.4 Uncertainties and limitations

There are a number of uncertainties and limitations in the analysis of adaptation actions including;

- **Interaction across measures**: The measures discussed in this section do not occur in isolation of each other. For instance, measures to plan and

put in place early warning systems influence the approach to continuity of services.

- **Timeline**: Hospitals are continually responding to emergencies and changing conditions. While projections of flooding impacts go out to 2050s, the analysis of adaptation actions in this report is primarily based on actions occurring in the present and on the experience of experts and stakeholders today.
- **Subjective assessments**: Assessing the extent of adaptation measures and their likelihood of increasing in extent in the future is subjective and based on the views and opinions of stakeholders and experts. Such views influence and are important for the evidence base and are balanced alongside other evidence drawn upon or this study.
- **Comprehensiveness**: The work is not comprehensive in scope and is limited by the available evidence and the expertise of the experts and stakeholders that responded to the work. Given the diversity of the sector, some generalisations are necessary.
- **Nature of the evidence**: Although there is some evidence on isolated costs of specific options, there is little readily available evidence as to the costs and benefits of different options compared with others, and the cost implications of taking one option rather than another particularly when in the context of so many other options. There is little data available on the quantified impacts of adaptation decisions and whether or not, and to what extent, decisions will mitigate climate risks. Data has been drawn from evidence where readily available.

3.2.5 Cross-sectoral linkages

The categories of adaptation measures described above have both cross-sectoral dependencies and impacts. The response of a hospital is critically dependent on other services (power and water, pharmaceuticals, flood alerts), and therefore, to ensure continuity in all emergencies, hospitals should be as self-reliant as possible. The effectiveness of hospital infrastructure will be dependent on land use planning and general flood alleviation measures (Arup, 2011). Developing ways of maintaining continuity of services during a flood event will benefit continuity of services during any emergency event; and maintaining service provision by a hospital during an emergency is a key part of overall community resilience and emergency response.

Figure 4, **Figure 5** and **Figure 6** summarise key evidence on the adaptation actions explored. It should be noted that the assessments shown are intended to be a summary of the average situation in terms of levels of adoption – this masks the likely variation across individual hospitals.

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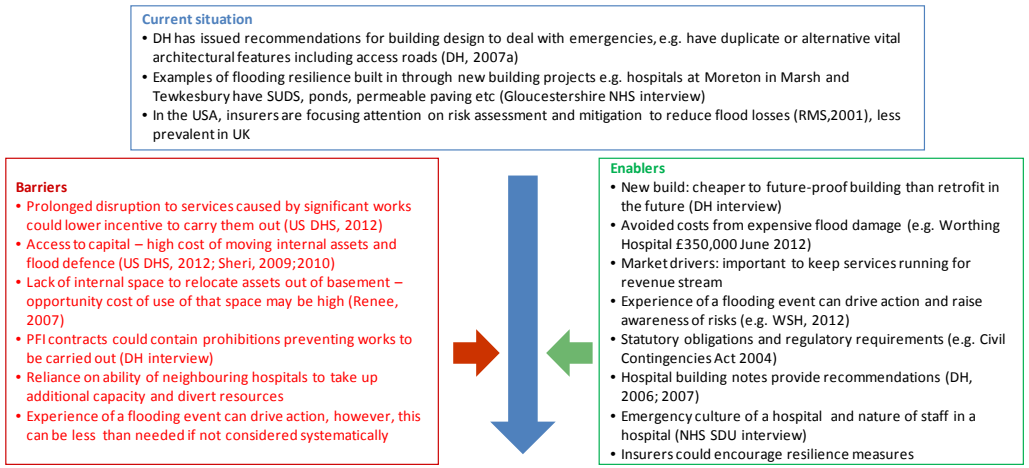
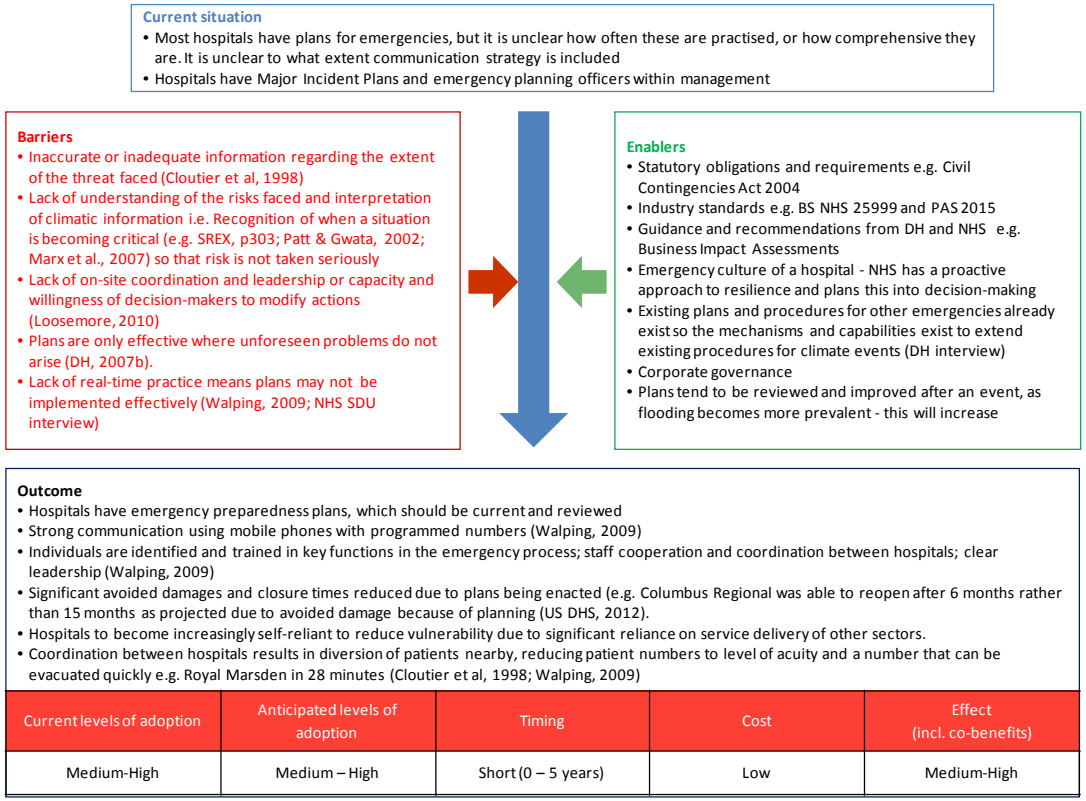
Figure 4. Summary of infrastructure-related adaptation for hospitals



Current levels of adoption	Anticipated levels of adoption	Timing	Cost	Effect (incl. co-benefits)
Low-Medium	Medium	Medium-Long	Medium – High	High

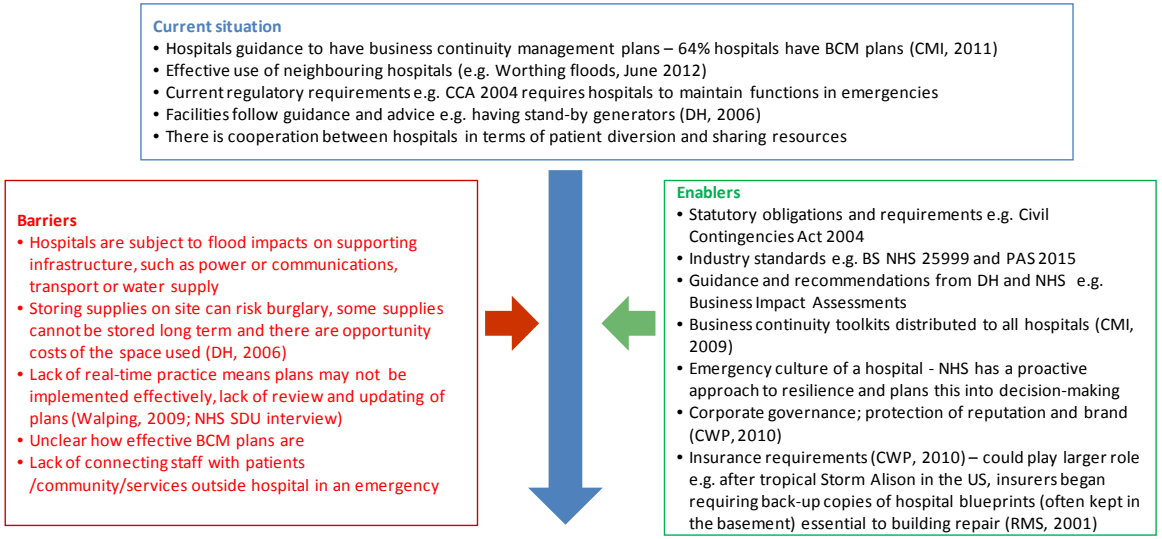
Source: Based on published information where cited and stakeholder interviews

Figure 5. Summary of early warning systems



Source: Based on published evidence where cited and stakeholder interviews

Figure 6. Summary of continuity of services



Current levels of adoption	Anticipated levels of adoption	Timing	Cost	Effect (incl. co-benefits)
High	High	Short (0 – 5 years) and ongoing	Low	Med-High

Source: Based on published evidence where cited and stakeholder interviews

3.2.6 Summary of current and anticipated adaptation

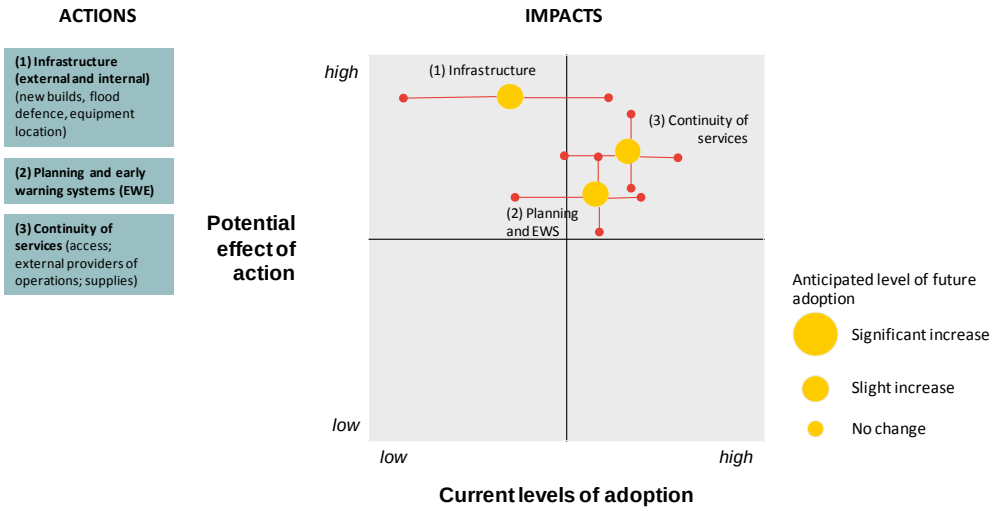
It is important to gain a general view of the current and expected degree of effective adaptation so that key barriers can be identified and addressed through intervention by government or other bodies. This is shown in **Figure 7**.

Figure 7 provides a simplified summary of the extent of adoption of the adaptation actions that are currently being taken, and those that would be expected under current policy and drivers of behaviour, along with a view about their effectiveness. The extent to which the actions are an appropriate response in a particular situation would require a detailed assessment of the costs and benefits of the action.

This approach provides a framework for summarising a substantial amount of information. The summary uses the classifications 'high, medium and low' used within **Figure 4**, **Figure 5** and **Figure 6** and as explained further in **Annex 7.** The assessment is based on the evidence presented in this section and stakeholder discussions.

The figure is intended to be an overview of the findings set out in this report. It is illustrative only, as there is no reliable data drawn from large-scale studies. **Figure 7** is intended to provide a basis for further discussion as part of future stakeholder engagement.

Figure 7. Summary of current and anticipated effects of different adaptation actions



Source: Based on the evidence presented in this report.

Note: Scales are qualitative and relative to the sectors considered. The **current levels of adoption** include decisions that are infrequent (e.g. infrastructure) as well as common practice (e.g. planning). **Effectiveness** varies, but the actions tend to be relatively effective. All the actions show limited increases in the future, essentially over the next 10 years or so. The position of each measure is based on the classification used within this chapter, but could vary considerably depending on the specific hospital

The yellow dots positioning the measures in **Figure 7** are scaled according to the expectation of future increase in uptake, in the absence of further intervention. The red lines illustrate variation in the levels of adoption and the effectiveness of the actions across hospitals.

The top right corner of **Figure 7** shows those actions where adaptation is generally working well. There may be areas where the adaptation is maladaptive or more action is being taken than would be justified by a cost-benefit analysis, but generally and in the short term, the actions are effective and widespread. Those actions in the top left corner are effective, yet not widespread, suggesting barriers to action. The actions in the bottom right are widespread, yet not effective, either because they are driven by factors other than climate change, or they may be simple to implement. Those actions in the bottom left are neither widespread nor effective.

Key findings of **Figure 7** are:

- **Most of the adaptation measures are in the top half of the chart indicating that where they are taken, the actions are expected to be effective**. However, there is significant variation in the degree of current uptake of measures, particularly early warning systems and infrastructure

defence. Some hospitals are advanced in their preparation, others are behind and experience repeated flooding. This suggests the prevalence of barriers to adaptation.

- **Hospital resilience is likely to increase and become more widespread in the future** as climate events become more prevalent and lessons are learned from experience. However, this may only happen in hospitals affected by flooding rather than in a systematic, coordinated way. This could be aided by channels of communication allowing lessons to be shared. **Resilient design, in terms of flood resistance and resilient infrastructure, is highly effective at preventing service disruption** and consistent with health objectives and procedures**.** However, it is also expensive and has long lead-in times. It may be less cost-effective to put such measures in place where strategic flood defence infrastructure is being invested in by the government.

- Hospitals have emergency plans and procedures and also business continuity arrangements in place. However, there is some **variation in how effective these measures ar**e, it depends whether they are put into practice and tested, and whether they are reviewed and revised etc. Plans are also beneficial as a means of engaging with suppliers and other collaborators/ dependents. Planning for emergencies and having continuity arrangements in place is particularly effective given the relative low costs and also the co-benefits that arise as a result of being prepared for any emergency, not only flood events.

This assessment has highlighted that there are particular barriers that either prevent measures being taken, or being effective, or both. This could be due to a range of factors, which are discussed next.

3.2.7 Barriers to effective adaptation action

The review of available evidence and input from experts in the field has identified barriers to effective adaptation.

As discussed in Section **Error! Reference source not found.**, the framework for considering barriers in this study is to consider four groups.

- Market failures: the degree to which there are market failures relating to pricing signals; externalities[11]; public good characteristics; and where information may not be timely, accurate, relevant or is incomplete;

[11] Where there are costs or benefits imposed on others that are not accounted for in individual decision making.

- Policy: the framework of regulation and policy incentives;
- Governance: institutional decision-making processes; and,
- Behavioural: short sightedness, cultural influences and willingness to act.

These are explored below.

Market failures

- **Interdependencies and external costs or benefits**: In several of the measures discussed, there are strong interdependencies and cross-sectoral linkages that can act to impede adaptation actions. Examples identified through this report include
    - **Intra-sector interdependency of measures and actors:** the reliance on surrounding hospitals to provide services in the event of an emergency means there could be value in additional or 'spare' capacity to enhance resilience that is not likely to be identified by decision-makers at the individual hospitals.
    - **Inter-sector interdependency of measures and actors**: interdependencies with surrounding infrastructure may not be understood but could pose high financial costs and prolonged service disruption if not adequately addressed. The lack of transparency around the resilience of infrastructures relied upon means that decision-making may not be able to account for such risks wen making decisions or plans.
- **Information failure** arises in two main forms:
    - **Uncertainty** over climate change, and lack of awareness of risk and its potential impacts, along with uncertainty over technology and non-climate change drivers such as socio-economic developments can hinder effective decision-making. Being able to account for uncertainty, learn over time and account for emerging information will be important.
    - **Lack of detailed evidence on the effectiveness of measures in the UK:** the lack of available evidence on the costs of action and how effective actions have been in different contexts is a barrier to effective decision-making.

Policy

- Performance targets and legislative requirements often provide solid incentives to enhance resilience (for example, BS NHS 25999 which relates to business continuity management and PAS 2015 which relates to improving and maintaining resilience). However, there is little evaluation and information relating to the effectiveness of business continuity plans.

- Although avoiding placing hospitals on floodplains would be beneficial, this may not be possible in many cases owing to the location of populations and the need to provide accessible healthcare services. Investment in flood protection is therefore paramount.

Behavioural

- Linked with the information failures above, if information is not clear or well-understood, there may be a lack of willingness to take it seriously.

Governance

- Leadership: the extent to which adaptation actions are considered and implemented is influenced by leadership. In some cases, a lack of willingness to modify actions could be a barrier. In addition, different approaches may be used, but may not be effective.

3.3 Recommended interventions

Addressing the key barriers, which includes action to build adaptive capacity, suggests a case for intervention. Recommended interventions to address key barriers have been guided by the key government criteria: effectiveness (whether they lower climate vulnerability), efficient (whether the benefits outweigh the costs) and equity(distributional impacts). Recommendations are set out below.

- **Build an understanding across hospitals of the interdependencies in service provision** (e.g. with water, power and transport infrastructure) **and with other healthcare providers.** This involves mapping linkages to identify the key points of risk, and appropriate scenarios to inform decision-makers. Share information across interdependent hospitals on resilience and planned actions to facilitate effective decision-making.

- **Assess the degree to which hospital resilience is affected by climate change risks to other sectors and the actions they are taking to adapt**. For example, this could be undertaken for particular areas as pilot studies.

- **Improve learning from past experience and embed best practice approaches to flood resilience consistently across the sector**. Build the evidence on how small-scale and low-cost actions could potentially be effective, for example, basement protection, re-locating key equipment within the hospital away from the basement. Gather detailed evidence of costs and benefits under different situations.
- **Evaluate hospital adaptation actions (ex post) to build the evidence base** – the current lack of evidence could lead to maladaptive actions being taken, particularly as hospitals are upgraded over time.
- **Carry out research to understand better ways of building resilience of emergency care outside the hospital and in the community**.

The next section explores adaptation in the context of mental health effects of flooding.

4 Potential impacts of flooding on mental health and community resilience

The questions set by policy leads that are explored in this section are:

- **Given current policy and the current and expected adaptation, what is the case for further intervention in relation to the mental health and well-being of individuals affected by floods, with illustration using the case studies of Hull and Gloucestershire and with additional commentary on Toll Bar?**

- **Given current policy and the current and expected adaptation, what is the case for further intervention in relation to community resilience to future weather events, focusing on flooding, with illustration of Toll Bar and Great Yarmouth as case studies?**

4.1 The scale of the challenge

4.1.1 Overview

The summer floods of 2007 were among the most severe weather events in the UK. Flood damage to homes and commercial properties was extensive. Insurance companies paid out approximately £3 billion in damages to claimants who in total lodged over 165,000 insurance claims. Naturally the full economic and social costs of the floods were much higher as businesses and communities were unable to function as normal and thousands of people were forced to evacuate their homes, with potential psychological implications (ABI, 2007).

An increasing body of evidence suggests that there are real and significant impacts on the mental health and well-being of those affected by floods. The CCRA (Ramsbottom *et al,* 2012) estimated that approximately six million (one in six) properties in the UK are at risk of fluvial or coastal flooding, with mental health impacts among the most important implications for those affected (Hames and Vardoulakis, 2012).

The psychological impacts of flooding include stress, anxiety and depression as well as the potential exacerbation and prolonging of physical and mental health problems (Reacher *et al,* 2007). The consequences of flooding may continue a long time after the water has receded (HPA, 2011), particularly for those evacuated from their homes (Paranjothy *et al,* 2011).

Studies have found that the long-term consequences of trauma are a predictor for Post-Traumatic Stress Disorder (PTSD). This suggests post-event stressors increase the intensity of experience or symptoms. Strelau and Zawadzki (2005)

and Tunstall et al (2006) found that high intensity scores for PTSD were concentrated in people who reported that flooding was a physical and mentally traumatic event for them. Reducing the time people are displaced from their properties is important in reducing mental disorders as prolonged periods of evacuation can result in a number of physical and mental health problems (Curtis *et al,* 2007).

Furthermore, separation from family and community members and not knowing when one can return home also adds to stress among evacuees (Curtis *et al,* 2007). Studies in the UK found that evacuation during the 2007 floods was associated with an increase in psychological distress (HPA, 2011). Furthermore, the capability to take out insurance as well as relocate post-flood are dramatically affected by wealth; consequently social inequalities play an important role in whether a group can recover from the consequences of flooding (JRF, 2011b).

Given these potential effects, this analysis addresses the two questions set by policy leads in relation to:

- The impacts of flooding on mental health and well-being; and,
- The case for intervention in relation to community resilience to flooding.

These issues are explored through case studies: Hull and Gloucestershire for the former and Great Yarmouth and Toll Bar for the latter. Each of these areas has experienced significant flooding events in recent years so they have a high level of current risk.

The key characteristics of the case study areas are first outlined, then analysis is presented on the magnitude of potential impacts on the mental health of those flooded in Hull and Gloucestershire. A discussion is then presented of the context in which adaptation is considered i.e. adaptive capacity and associated policies where relevant, before assessing adaptation actions currently being taken and the barriers to their uptake and effectiveness.

4.1.2 Estimating the scale of mental health impacts of flooding

The key characteristics of the four case study areas are outlined in **Figure 9** and **Figure 10** below. Each area has experienced at least one flood event in the past that had widespread implications across the area and affected thousands of people, either directly (flooding their homes for example) or indirectly (affecting the power or other utility supplies).

Current level of risk

In order to provide some sense of scale to the impacts on mental health, analysis has been carried out using the impact of the 2007 floods to identify the number of people flooded. These are considered to be severe events because, for example, the 2007 flood in Gloucestershire is assessed as a 1 in 200 year event

(EA, 2007b). Use of the recent event and its implications reflects the level of preparedness at the time – this is now likely to be different in these particular areas[12] but could still be representative of others areas.

Costs of mental health impacts

There are many ways in which the costs of mental health impacts could be estimated with results highly dependent on the assumptions made. Given the significant uncertainties, this analysis must be considered illustrative only.

Full details of underlying assumptions and methods used are in **Annex 4**.

This analysis estimates the prevalence of Common Mental Disorder (CMD)[13] attributable to a flood using published evidence and applying it to the case study areas. The population affected and the associated mental health burdens are estimated and monetised in terms of:

- the monetised equivalent cost to the individual from the impact on quality of life,
- treatment cost to the National Health Service, and
- estimated costs in terms of lost productivity through additional sickness absence of the working age population.

Two key studies have been used as the core basis of the assessment of the relative increase in risk of a common mental disorder (defined here to include psychological distress, anxiety, depression and probable post-traumatic stress disorder (PTSD)[14]) and the degree to which the individual's quality of life is impacted as a result. The two studies, Reacher et al (2004) and Paranjothy et al (2011), deliver broadly consistent findings. It should be noted that although the analysis focuses on these forms of mental health effects, it is likely that a far greater prevalence of distress would be likely. This has not been possible to include in this analysis owing to a lack of evidence on scale.

Ranges are used to reflect the uncertainty around:

- the relative risk of common mental disorder (i.e. the risk is assumed to be 4.1, in the range 2.6 to 6.4, times higher than the national average

[12] Such as the additional expenditure for flood defences announced by Government in the 2008 Comprehensive Spending Review (CSR), taking annual spending to £800m

[13] Definition of 'Common Mental Disorders' is taken from the National Institute of Health and Clinical Excellence and used by Paranjothy et al (2011).

[14] *Ibid.*

incidence of common mental disorder in the general population[15] (Reacher *et al,* 2004);

- duration of impact on the individual (assumed to be 6 months in the range 3 months to 5 years, therefore reflecting the potential for very long term implications); and,
- severity of impact on quality of life (assumed to range from a case of PTSD, mild depressive state or moderate depressive state).

The populations at risk of flooding used for our analysis are taken to be the size of the flooded population in Hull and Gloucestershire during the 2007 floods. This is an assumed 15,470 adults in Hull and 7,520 in Gloucestershire. On the basis of these assumptions, the estimated costs are illustrated in **Figure 8.**

Figure 8. Estimated costs associated with the mental health effects of flooding in Hull and Gloucestershire, on the basis of the scale of the floods in 2007 (2012 prices)

Monetised equivalent of impact							
Location	Range	Costs to individual (QoL)		NHS costs		Costs from sickness (GDP)	
		Total impact (£Ms) to persons	Per capita additional cost per year (£s)*	Total cost to NHS (£Ms)	Per capita additional cost per year (£s)*	Total cost to economy (£Ms)	Per capita additional cost per year (£s)*
City of Kingston Upon Hull	Central	19	67	1	2	2	8
	High	617	2243	10	36	37	133
	Low	4	14	0.1	1	1	2
Gloucester-shire	Central	9	72	0.3	2	1	8
	High	300	2402	5	39	18	143
	Low	2	15	0.1	1	0.3	2

* i.e. assuming cost per person is borne by whole population of each district

All costs rounded to the nearest million pounds, apart from when kess than £0.5 million

These estimates demonstrate the uncertainty surrounding the potential health costs of flooding.

Some key points from this analysis are:

- The costs of mental illness to the individual far outweigh the costs to the NHS in terms of treatment, or the costs of lost productivity from workers being off sick. This supports the importance of adaptation actions to address the key drivers of the higher costs: duration of impact, relative risk and severity of disorder experienced. Adaptation actions could, for example,

[15] The attributable burden of flood related CMD was calculated by application of this relative risk to the prevalence of common mental disorder obtained from the Health Survey for England. The relative risk for GHQ-12 scores of 4+ is assumed to be appropriate for the *relative* change in clinical mental health disorders after flooding.

reduce the duration of mental health impact by limiting the period of time individuals and families are displaced from their homes following a significant flood event or by reducing the severity of mental illness by monitoring or screening, or providing information to ensure help is sought early.

- The costs are higher in Hull as a larger population is affected.
- The potentially large scale of effect is clear. Estimated costs range from £4 million to £617 million for Hull and £2 million to £300 million for Gloucestershire. In addition, costs to the NHS from treatment (which could be £0.1-10 million in Hull and £0.1-5 million in Gloucestershire) as well as impacts on the wider economy, could further exacerbate the costs.

This section has presented the scale of the challenge that a severe flood can pose by impacting the mental health of those flooded.

The next section explores the context for adaptation in terms of adaptive capacity, noting the key policies that facilitate or hinder adaptation. It then investigates the adaptation actions that are currently being taken, and would be expected over coming years given current incentives and policy. The barriers to effective adaptation are identified.

Figure 9. Key characteristics of the case study areas: Gloucestershire and Hull

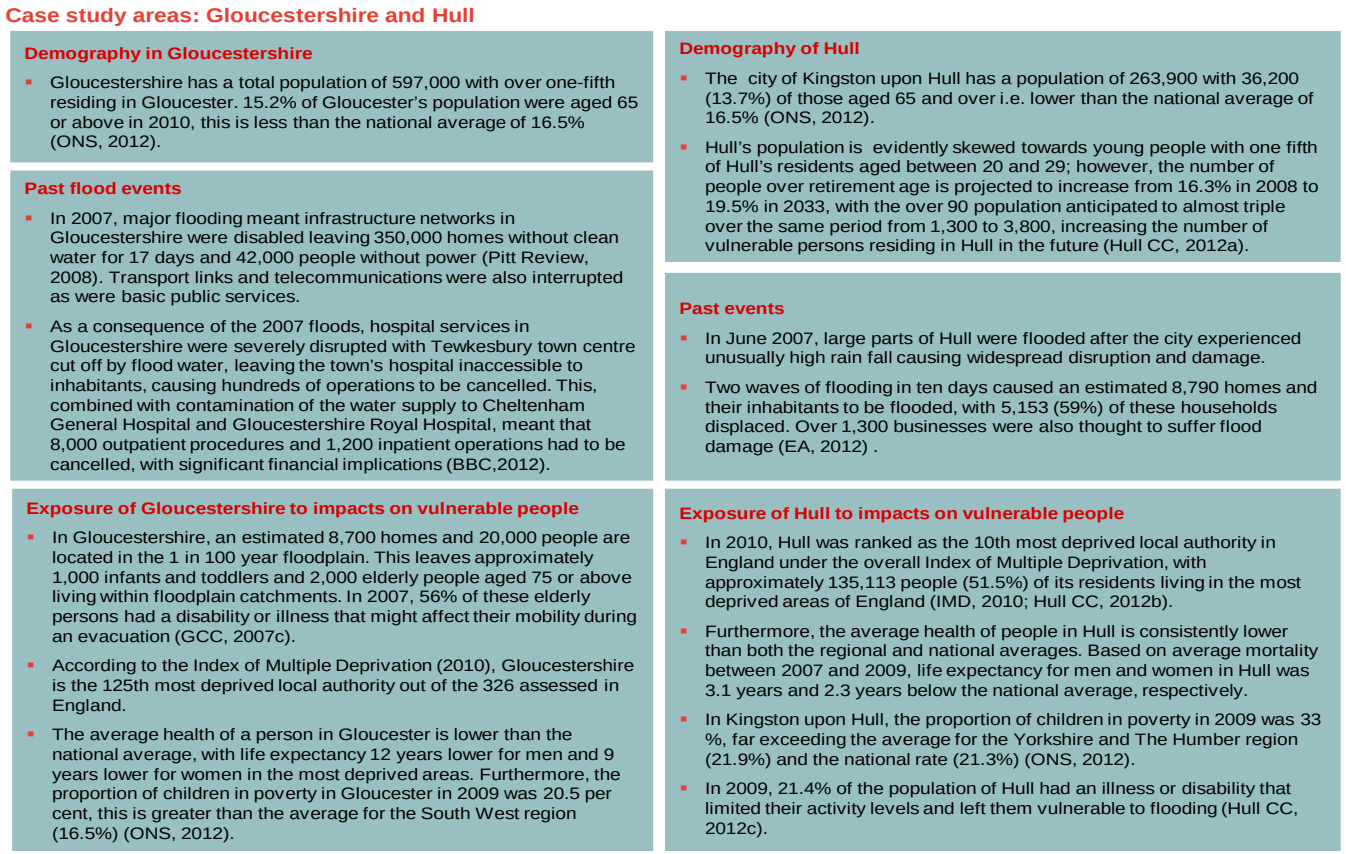
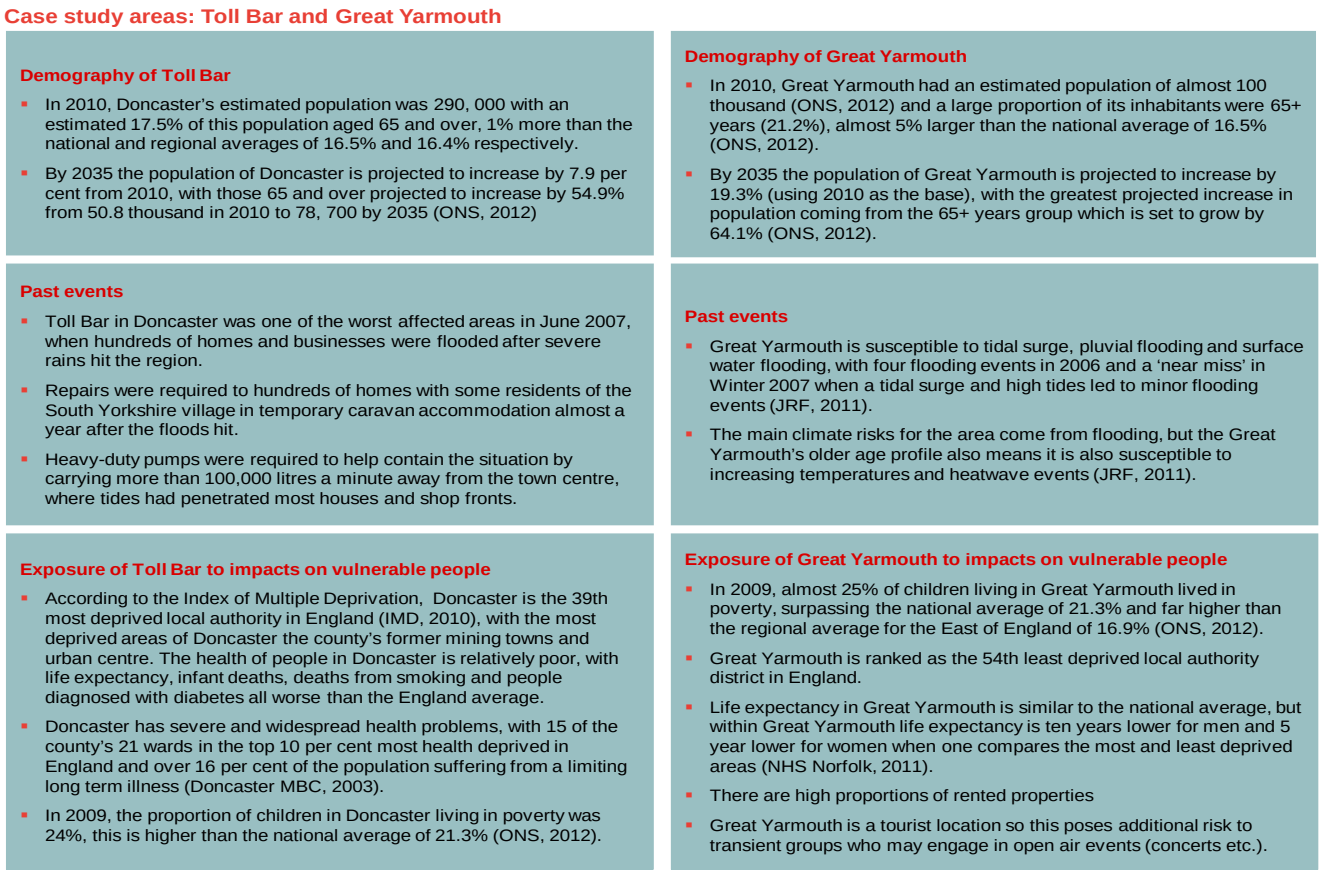


Figure 10. Key characteristics of the case study areas: Toll Bar and Great Yarmouth



Potential impacts of flooding on mental health and community resilience

4.2 Context for adaptation: adaptive capacity

Using the same framework that was used to assess the adaptive capacity of hospitals (see Section 3.2.1), this section sets out an assessment of the adaptive capacity of the main organisations and communities in relation to:

- public health: resilience to flooding and heat,
- community resilience to flooding, and
- the impacts of heat on health (the final question addressed in this report in Section 5).

These aspects are considered together as there is considerable overlap in terms of the decision-making of individuals and organisations involved.

4.2.1 Structural adaptive capacity

This description of structural adaptive capacity can be used to identify specific types of decisions where further assessment of climate change implications will be important. These include: identification of vulnerable groups; support of the recovery process after a flood; and development of community resilience to a climate event.

In its day-to-day operations, experts and reviews (e.g. Ballard *et al,* 2011) suggest that the public health sector has relatively good adaptive capacity and will be able to develop quickly to address direct risks to health. This analysis extends consideration of public health to the communities and organisations involved. Stakeholders interviewed are listed in **Annex 2**, and are referenced in this section by their organisation.

(i) Sector complexity

The current structure for the healthcare sector is changing, with more focus on treatment at home and at community level, rather than just hospitals/GPs (DH interview). The new health system, to be established by the Health and Social Care Act 2012 will create structures and functions in the NHS Commissioning Board, Public Health England, Health and Wellbeing Boards, and Directors of Public Health in local authorities[16]. There will be further changes to the way Emergency Preparedness Resilience and Response (EPRR) is managed from April 2013 (Shirley-Quirk, 2012). The healthcare sector complexity could increase substantially as a result with a potential greater variability in the context of risk tolerance (Ballard *et al,* 2011). However, public health reforms provide an opportunity to integrate the various players at the local level via Health and

[16] http://www.dh.gov.uk/health/2012/06/act-explained/

Wellbeing Boards. Cross government collaboration is also being encouraged through the multi-agency National Hazard Partnership. This offers the opportunity for better understanding of health protection and emergency responses to floods (HPA, 2012b).

While this is aimed at moving decision-making closer to service users, there is a danger that informal service provision could be overwhelmed by the complex demands imposed on local capacity (Whittle *et al,* 2010). The local response is the basic building block of response to any emergency. It is based around the delivery of individual providers' and agencies' responsibilities at the service level (as underpinned by the Civil Contingencies Act 2004[17], which is focussed on multi-agency cooperation through Local Resilience Forums (LRF)[18].

The delivery of EPRR at local through to national level will therefore depend on a large number of organisations (many of which are new) working together, which can weaken adaptive capacity. The large number of organisations makes the sector complex, and new organisations, with new roles and new responsibilities require new thinking and resources. Previously, health and social care were managed separately, but since they have been brought together, coordination will take time to develop (Shirley-Quirk, 2012). Adaptive capacity could be strengthened, once the organisations become established, if these changes provide a system for wide stakeholder involvement across sectors and if they stimulate behaviour change in communities, which should support delivery of EPRR for true incidence events (DH interview). It is not clear at this stage whether EPRR will be sufficient to address climate change risks and drive transparent adaptation. However, the EPRR is the natural place to develop this capacity beyond just plans to cope.

Without National Indicator 188 (planning to adapt to climate change) as a performance indicator[19], there is no national standard or benchmark for adaptation actions. Under the localism agenda, different approaches are likely to be taken depending on local risk and need, leading to case-specific and appropriate actions, but also fragmentation. Sector-led initiatives, e.g. Local

[17] Under the CCA 2004, emergency response organisations are classified as Category 1 (primary responders) or Category 2 (supporting agencies), Specific obligations for EPRR are assigned to each category. Local authorities, acute trusts, ambulance trusts, the Health Protection Agency (HPA) and Primary Care Trusts (PCTs) are currently Category 1 providers, Strategic Health Authorities (SHAs) are Category 2 providers.

[18] LRFs are existing multi-agency partnerships, supported by the Department of Communities and Local Government (DCLG), to enable and build local resilience capability through planning and testing. There are currently 39 LRFs that map directly on to police areas; LRFs typically have 3 seats for health representatives, currently: Local NHS management (i.e. PCTs), ambulance services and public health (HPA).

[19] NI188 is used to assess the extent to which a Local Authority and its partners have mechanisms in place for proactively managing climate risks and taking appropriate action.

Government Association's Climate Local Initiative (LGA, 2012), could help sharing knowledge and best practice.

The difficulties of promoting effective public communication and engagement have been exacerbated by a fragmentation of responsibilities between the different agencies involved in the recovery process (Pitt Review, 2008). Consequently, it is not just communication from these agencies to the resident that is a problem – it is also communication and coordination across these agencies that creates difficulties and weakens the system's adaptive capacity (Whittle *et al,* 2010).

(ii) Interdependencies

Wellbeing covers a wide range of interconnected sectors and stakeholders. Interdependencies with other sectors include transport, power, communications and water provision among others. There is significant reliance of health care on service providers with no connected plans. This can lead to trade-offs between immediate service delivery and building resilience, weakening adaptive capacity.

The adaptive capacity of communities and public health actors is critically dependent on the adaptive capacity and actions taken by other actors. In particular, physical infrastructure is important, such as transport providers, electricity distributers or retailers, water companies, pharmaceutical companies, logistics and supply chain management companies, insurance providers etc. This highlights the importance of planning policy – and the need to incorporate risk management (Great Yarmouth Council interview). It also means that local authorities should integrate organisations other than those designated as Civil Contingencies Act responders into their contingency arrangements (e.g. the insurance industry).

Individuals are also dependent on others – for example, the elderly are more vulnerable to flooding or heat impacts and are therefore dependent on the ability of others to look after them. So the capacity of carers and nurses or doctors and community residents who provide social support is very important. Furthermore, while all persons are vulnerable to the health impacts associated with flooding, the limited evidence indicates that the elderly are most at risk in the UK (HPA, 2012b).

(iii) Decision lifetime

The adaptation actions described in this report are largely behavioural[20]. These measures, such as preparedness, planning, awareness-raising, have very short decision lifetimes, e.g. the Heatwave Plan is reviewed and revised annually. This makes them flexible and allows rapid adaptation as understanding of climate

[20] For adaptation to heatwaves regarding physical measures and housing design, please refer to the ECR Report on Overheating in Residential Housing.

impacts develops (Ballard *et al,* 2011). The time for a community flood plans to be developed is about nine months (NFF interview). Even physical adaptation measures for flooding, such as flood resilient repairs, usually have a timescale of less than a year.

However, embedding planning and actions into communities and management processes can take some time.

(iv) Activity levels

Adaptive capacity is strong where activity levels (e.g. decision-making frequency) are high. The short-term nature of most decisions related to management of clinical risks and to community resilience means that activity is relatively high.

(v) Maladaptation

As explained in Section 3, maladaptation refers to actions or investments that enhance vulnerability to climate change impacts rather than reducing them (UKCIP, 2012). In some cases, this can reduce adaptive capacity by devoting too many resources to actions which are not as effective as others and by diverting scarce resources to undoing maladapted decisions (Ballard *et al,* 2011).

The changes in responsibility for public health moving to local authorities could lead to maladaptation where there is a lack of understanding of real public health knowledge at the local level (NHS SDU interview). The Health and Social Care Act 2012 introduces significant uncertainty in this regard.

Maladaptation could occur where plans are made in relation to one climate risk, such as flooding, but without regard to any other climate risks (such as overheating[21]) and whether the measures reduce resilience to those other risks. Maladaptation is less of a risk where decisions are frequently made, have short lifetimes, and are of a behavioural nature (e.g. methods of communicating the Heatwave Plan, or supporting community resilience groups). Decisions need to be made holistically and systematically.

4.2.2 Organisational adaptive capacity

Adaptive capacity of the organisations and communities in terms of public health and community resilience is variable. There are areas of strength in particular communities and local councils, but there are also areas where capacity could be improved, particularly as the new public health bodies become established.

The social and economic cost of a disaster falls unevenly on different populations (Curtis *et al,* 2007) – based on site (physical) or situation (socioeconomic). The adaptation actions in this section focus on the situation rather than the site.

[21] Please refer to the ECR report on Overheating in Residential Housing.

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Figure 11 is a summary of the organisational adaptive capacity of communities and actors in the public health sector:

Figure 11. Adaptive capacity of public health and community resilience organisations and individuals

Communities	**Very variable** Each community is different e.g. depends on physical location, characteristics of the home, personality, age, financial constraints, size, its networks and services (Morrow, 1999; Jaspers & Shoham, 1999) Capacity increases once a flood or heatwave has been experienced (Great Yarmouth Council interview, Hull, Gloucester; Cabinet Office, 2011) and actions are then taken; however, this also increases impact on mental health (Acierno *et al,* 2007) Motivated individuals can make a big difference in linking organisations and driving actions (Twigger-Ross, 2011b) Most people (excluding vulnerable groups) have capacity to cope with sudden extreme events (Coulthard *et al,* 2007). Transient communities have less adaptive capacity Self-reliance and ownership can increase capacity (Twigger-Ross, 2011b) Existing social structure and networks are key to resilience (Twigger-Ross, 2011b) No systematic mechanism for sharing information or lessons learned between communities; positive engagement when communities feel empowered (NFF interview) Lack of information or awareness of risks (floods or heatwaves) lowers ability to respond and recover (University of Lancaster interview) e.g. 14% do not know where to go to get information, 69% have not seen advice (SMSR, 2012) Recent work by HPA identifies research on health and flooding as a research priority in order to understand the impacts, as well as research on causes/outcomes of population displacement (HPA, 2012b). This suggests a current lack of evidence. Connection to decision-making processes tends to be low – distrust of authorities, but community groups can bridge the gap to statutory agencies (Gloucestershire County Council interview) Finance is constraining for individuals in terms of paying for flood repairs/ having insurance (Tunstall *et al,* 2006; Whittle *et al,* 2010) Tenants have least capacity financially, often do not have insurance, and have less connection with decision-making processes e.g. landlords deal with buildings (Whittle *et al,* 2010) In Scotland, the Scottish Government publishes a "Guide to Emergency Planning for Community Groups" [22] which provides advice to community groups on how to work with local responders to plan for emergencies. The Scottish Government has also published a Voluntary Emergency

[22] http://www.readyscotland.org/my-community/

	Responders Guide for statutory emergency responders, which contains information on the functions of voluntary sector emergency response organisations A number of models of integration of voluntary sector responders with Strategic Coordinating Groups (SCGs) exist. In the Central Scotland SCG area a Memorandum of Understanding has been signed between responders and the SCG[23]. In this area, voluntary sector deployments are managed through a single point of contact, which is currently managed by the British Red Cross
Split by vulnerable groups (>65s year olds)	**Low-Med** Variable – many over 65s have higher capacity than younger people as they may have more resources and life experience (Wistow *et al,* 2011; Tunstall *et al,* 2006); majority have lower capacity with fewer resources and are reliant on care of others (DH, 2009) Vulnerable groups (e.g. elderly) tend to be more socially isolated and can be marginalised – can feel excluded from mainstream adaptation plans (NCVO interview). Less ability to control environment and decisions (Whittle *et al,* 2010) and they can be reluctant to admit they are at risk/vulnerable Great diversity of responsibility within social housing/care home sector weakens adaptive capacity (LCCP, 2012) Vulnerable individuals can make up a large proportion of the community weakening overall capacity e.g. Hull nearly half flood properties were Gold category (over 65s, single parents with children, disabled) (Whittle *et al,* 2010) Reasons for vulnerability in certain groups are further set out in Edkins et al (2010).
Split by socially deprived	**Low** Socioeconomic groups differ in ability to cope with stresses post-disaster (Norris *et al,* 2002) – can lead to increased community resilience e.g. Hull due to history of investment in community (University of Lancaster interviews) Few financial resources to rely on (Curtis *et al,* 2007) and less education/knowledge to manage with recovery process after a flood (Whittle *et al,* 2010) Can live in social housing with less ability to adapt environment and less connection to decision-making
Local Resilience Fora/Local Health Resilience Partnerships	**Med-High** These are new organisations so it is unclear what resources they have; processes and roles/responsibilities may not be established yet Connecting resilient communities with climate change adaptation and planning can be problematic Adaptive capacity may be high longer term as multi-agency so potential for stakeholder engagement and collaboration and coordinated role in emergency planning. LHRPs established to deliver emergency planning

[23] http://www.civilsociety.co.uk/docs/emergency_services_memorandum_of_understanding.pdf

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	and resilience in local context New Health and Well-being Boards could encourage strategic resilience planning (BIOPICCC, 2012) - LRFs should provide mechanism for increased coordination and partnership between authorities Local agents take responsibility themselves, requiring response and flexible governance, not top-down (Twigger-Ross, 2011a)
Local healthcare providers (e.g. GPs)	**Med** Lack of knowledge of some GPs of heat impacts and flood impacts. Further training required at local level (Carmichael *et al,* 2012; BIOPICCC, 2012) e.g. recent guidance for GPs on heatwaves (RCGP, 2012), particularly as GPs play important part in community GPs constrained by financial and human resources (Carmichael *et al,* 2012) High adaptive capacity for responding to communities particularly in terms of identifying and monitoring vulnerable groups
Local authorities/ councils	**Med-High** Variable. Some struggle to have staff and systems in place to deal with emergency event (University of Lancaster interviews), but others have relatively high resources to respond (e.g. 700 Hull council staff went door to door in 2007) (NFF, 2009) Capacity tends to increase after an event (e.g. developments in Gloucester, Hull, etc after event) New public health role could weaken capacity as new roles and decision-making required (Shirley-Quirk, 2012). Increasing autonomy at local level provides flexibility and tailored solutions, but can also lead to disparate practices and lack of support (ARCC, 2011) Anecdotal evidence shows that not all local authorities are aware of relevant guidance available to them in dealing with the health impacts of climate change e.g. not all aware of Heatwave Plan (ARCC, 2011; BIOPICCC, 2012). There appears to be a lack of access to information of best practice and lessons learned Some communities view their local council as unprepared for further flood events e.g.5 years after 2007 floods, almost 60% people think Hull county council is unprepared (SMSR, 2012). Linking networks between communities and authorities can be weak (Twigger-Ross, 2011b)
Voluntary groups	**Variable** Some groups are well established and have high capacity (e.g. British Red Cross), others are small, informal and have lower capacity (e.g. local groups) Few financial resources which can limit service delivery e.g. National Flood Forum Agents for community learning and adaptation – act as change agents (Deeming *et al,* 2011) Valuable part to play in complementing local councils and providing link between statutory services and communities (Interviews with

	Gloucestershire County Council and Great Yarmouth County Council) Valuable part in identifying and dealing with vulnerable groups as can provide targeted services; often trusted faces in the community compared to agency/council staff Can work effectively with statutory service providers where used properly e.g. Gloucester developed computer system to match volunteer to request for help

4.2.3 Building adaptive capacity

There are many actions that can build adaptive capacity in line with the discussion above. Many of the actions are generic, e.g. education, training, developing social cohesion and provision of information, strengthening coordination between organisations, while others are specific to the particular climate impact e.g. providing support for returning to a property once it has been flooded such as insurance or codes of conduct for flood-proofing properties. Many in the sector are already implementing some of these.

The next section discusses the adaptation actions that are being taken by some in the sector including both those to build adaptive capacity and those to lower the consequence of a climate risk, or to maximise an opportunity.

4.3 Adaptation actions

4.3.1 Introduction

In response to the risk of flooding to communities, this section discusses some of the key categories of adaptation actions that are already being taken by some in the sector, and those that are expected in the near-term given current market or policy incentives. The categories set out here are not exhaustive, and each category contains a number of individual adaptation actions which in future, could be disaggregated and assessed individually. These categories of actions were informed by key sources of literature and discussions with the expert panel. They were refined and verified in the stakeholder interviews to ensure that the ECR considered the key sorts of actions to address the particular risks.

Strong flood incident management reduces the probability of flooding by controlling flood pathways and significantly reduces the damage caused, by managing losses and influencing behaviour of individuals and organisations (Dawson *et al,* 2011).

While flood alleviation schemes are extremely effective in reducing flood risk, they are not discussed in this report. The adaptation actions considered in this chapter focus on some of the ways of aiding recovery after a flooding event (this goes well beyond the immediate emergency response). They do not consider the issues of communities that have had to move location permanently after flooding. Given

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the significant impacts that this has on mental health and community resilience, it is recommended that further work be done on this topic.

The actions include both measures to build adaptive capacity and also to reduce particular climate impacts. The categories are:

- Planning e.g. community emergency plan, local resilience groups, warnings,
- Social support e.g. social networks, voluntary groups,
- Provision of and access to information after flood event e.g. websites, helpline/advice line,
- Support to reinstate/return to house after flood event e.g. insurance, loans, builders, and
- Health services available specific to mental health effects e.g. social care, GPs.

Further detail on all these adaptation actions is in **Annex 7.** They are briefly set out below with a description of the action, and a summary of the key barriers/enablers, and potential outcomes[24] presented in **Figure 12**, **Figure 13**, **Figure 14**, **Figure 15** and **Figure 16**.

4.3.2 Planning

These measures include building community resilience and lessening the impacts of flooding through advanced planning and preparedness, as well as having a register of vulnerable people. It also includes putting in place appropriate formal/informal processes and organisations (such as community flood group); awareness raising; engaging stakeholders in preparing plans as well as ensuring its dissemination (Paranjothy *et al,* 2011); and includes contributions from Local Resilience Forums. For householders, this should result in minimising the damage that leads to mental disorders, such as not keeping sentimental items in the cellar/ground floor; and encouraging individual personal planning e.g. householders can have an emergency bag with survival essentials and insurance documentation (Pitt, 2008). In Scotland, school children are taught how to prepare for emergency events such as flooding. These actions are both planned (e.g. information sharing) and reactive (e.g. communities coming together to form plans) and are largely concerned with building the adaptive capacity of the community. Key information on these actions is in **Figure 12**.

[24] The potential outcomes include extent of current and future adoption, timing, cost and effectiveness. Costs are relative to the sector. For example, high cost is major infrastructure investment or change in approach or strategy (e.g. hundreds of thousands or millions); low cost is the individual cost of a change to processes or operations, information provisions, or minor investment in equipment (e.g. thousands of tens of thousands).

4.3.3 Social support

Intervention principles that should be used to guide efforts to reduce distress include promoting a sense of self- and community-efficacy; connectedness; and hope (Hobfoll *et al,* 2007). These principles can be implemented by provision of social support, especially for maintaining normality after the event, and rebuilding a social life. It also contributes to a way of sharing experiences. It includes actions such as helping neighbours, forming voluntary local groups, and developing social networks. These actions will serve to build the adaptive capacity of a community. Three elements of social support that protect people affected by disasters from vulnerability to mental disorders are received support, perceived support and social embeddedness (Norris *et al,* 2002). This is particularly important for targeting the vulnerable. These actions are largely reactive, as people respond to flood events, but can be supported by planned actions (e.g. financial or practical help for forming networks or groups). This is summarised in **Figure 13**.

4.3.4 Provision of and access to information after flood event

Provision of information and knowing where to access it is important in helping communities recover from floods and empowering individuals to take action by providing simple practical guidance. Information can include official leaflets and provision of a national advice line or 'one-stop shop' website that has comprehensive information on every flood-related issue from the flood risk, to warnings, to help on insurance, building repair and longer-term issues, information on flood-proofing one's property, and information targeted at specific vulnerable groups. These actions are largely planned, and include actions to build adaptive capacity. Key information is summarized in **Figure 14**.

4.3.5 Provision of support (financial and practical) to reinstate or return to house after flood event

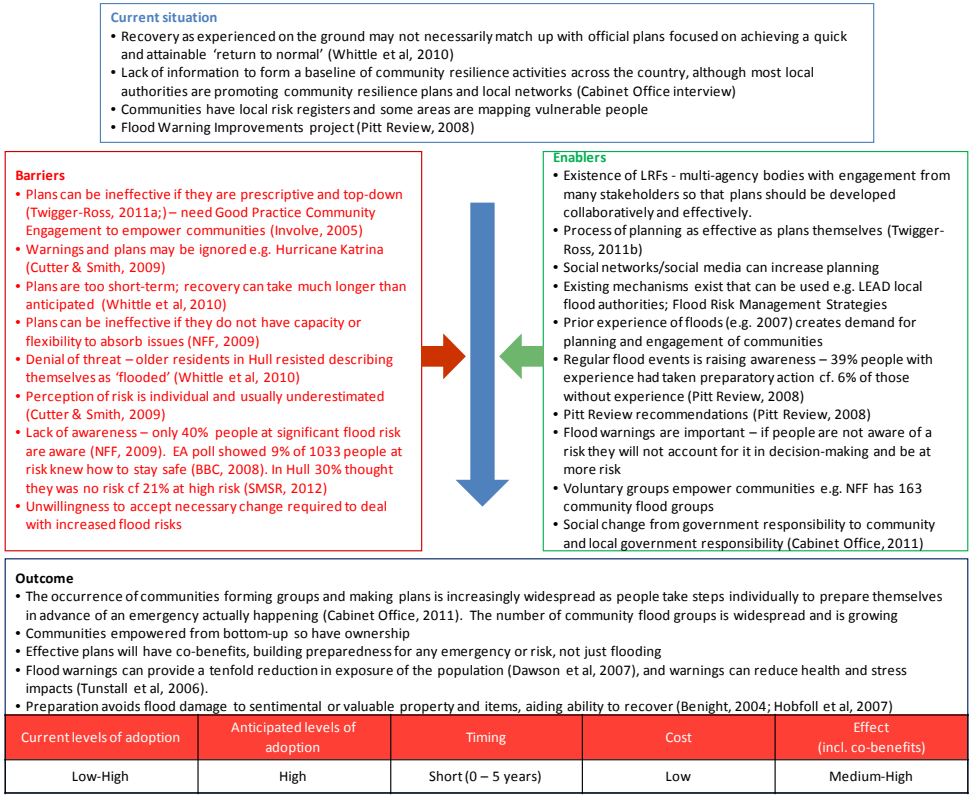
This includes formal provision of: financial support, such as insurance and flood recovery grants, and practical support, such as support services to help people do project management, contact with contractors, and standards of workmanship e.g. codes of practice for post-flooding building repairs, or lists of accredited builders (Reacher *et al,* 2004; SW HPA Unit interview). These actions are largely planned and include actions to build adaptive capacity (e.g. financial support) and also address the particular impact (e.g. building repairs). This is summarised in **Figure 15**.

4.3.6 Provision of mental health services

Flooding is a major 'life event', and it is understood that life events contribute to mental disorder (Brown and Harris, 1989). The measures described above can help to minimise this distress by reducing some of the causal factors. However, it is important that those people who are suffering have ready access to help. This

includes: provision of counselling services to those affected; ensuring local GPs have information about the floods and potential impacts, not just in the immediate aftermath, but for several years afterwards (SW HPA Unit interview); NHS Direct, insurers and local authorities should have links to HPA information (or other sources of information) that let people know the potential psychological consequences of flooding. These actions are largely planned. This is summarised in **Figure 16**.

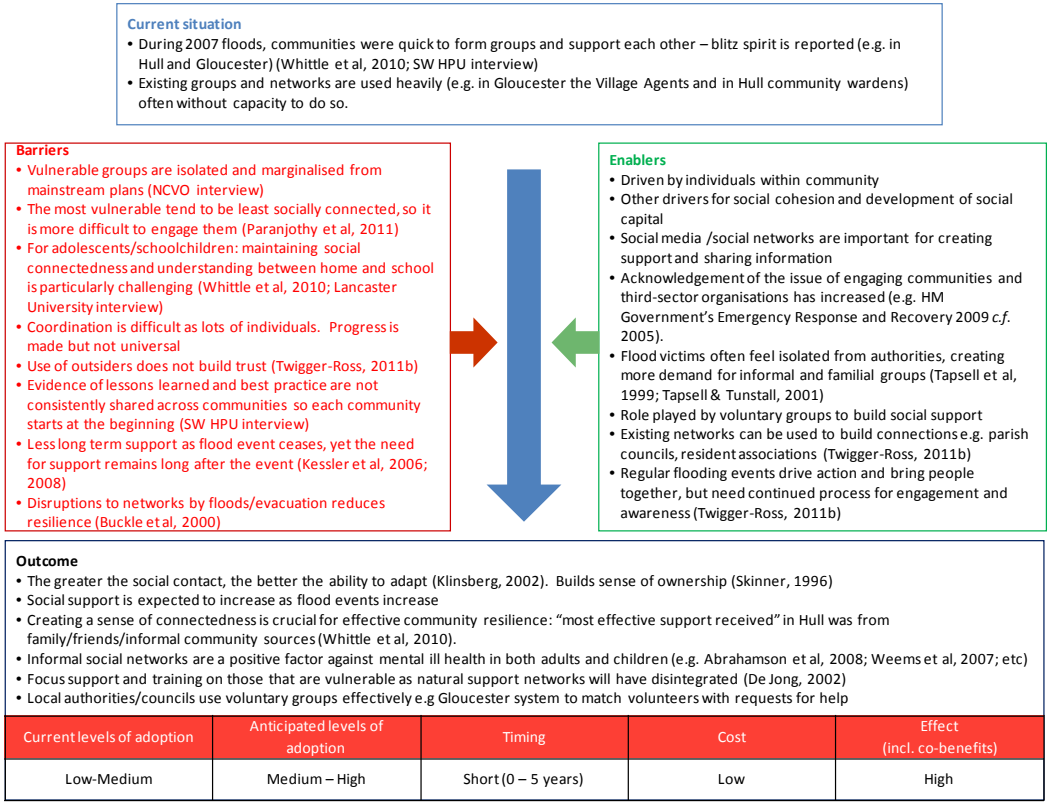
Figure 12. Summary of community adaptation through planning



Source: Based on published evidence where cited and stakeholder interviews

Potential impacts of flooding on mental health and community resilience

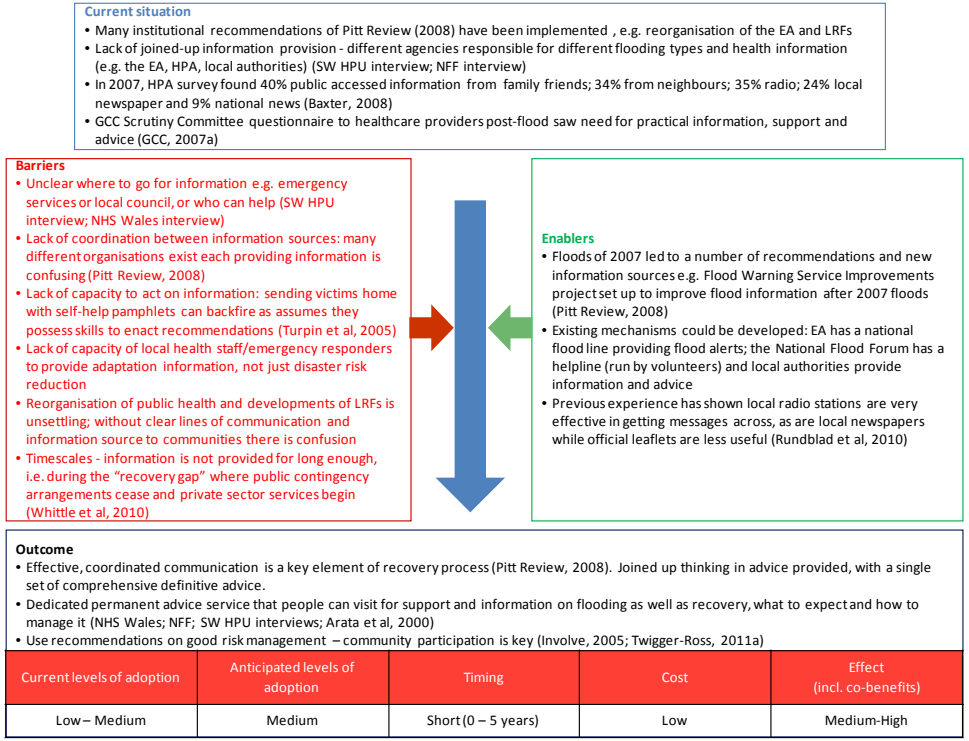
Figure 13. Summary of adaptation through social support



Source: Based on published evidence where cited and stakeholder interviews

Potential impacts of flooding on mental health and community resilience

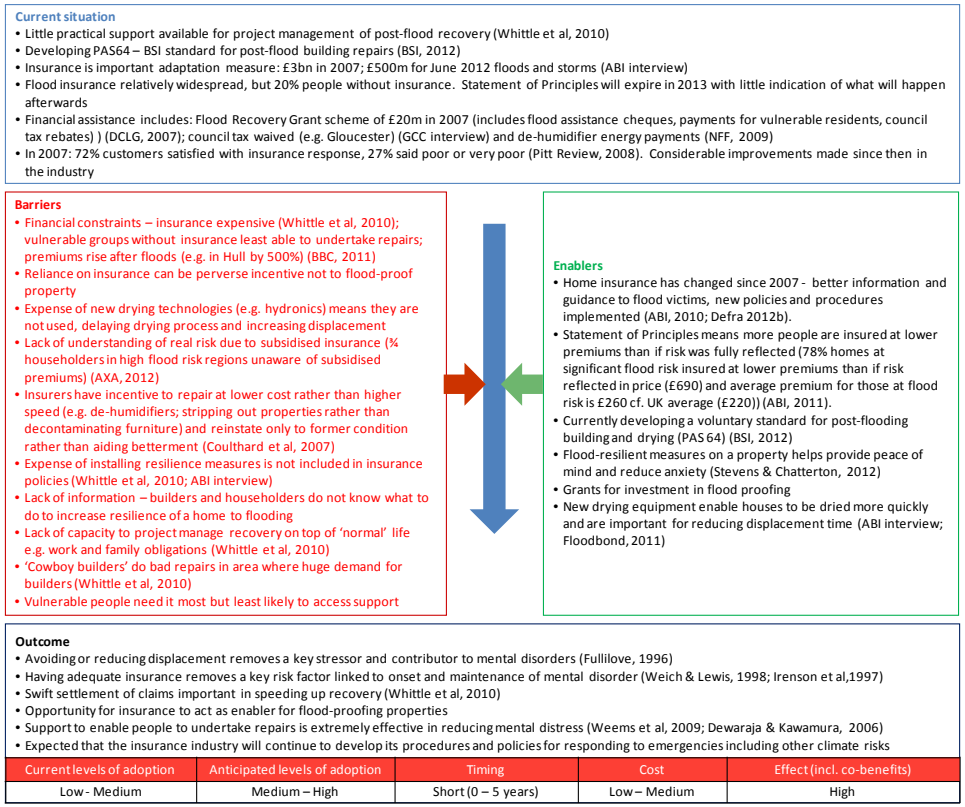
Figure 14. Summary of adaptation through provision and access to information after a flood



Source: Based on published evidence where cited and stakeholder interviews

Potential impacts of flooding on mental health and community resilience

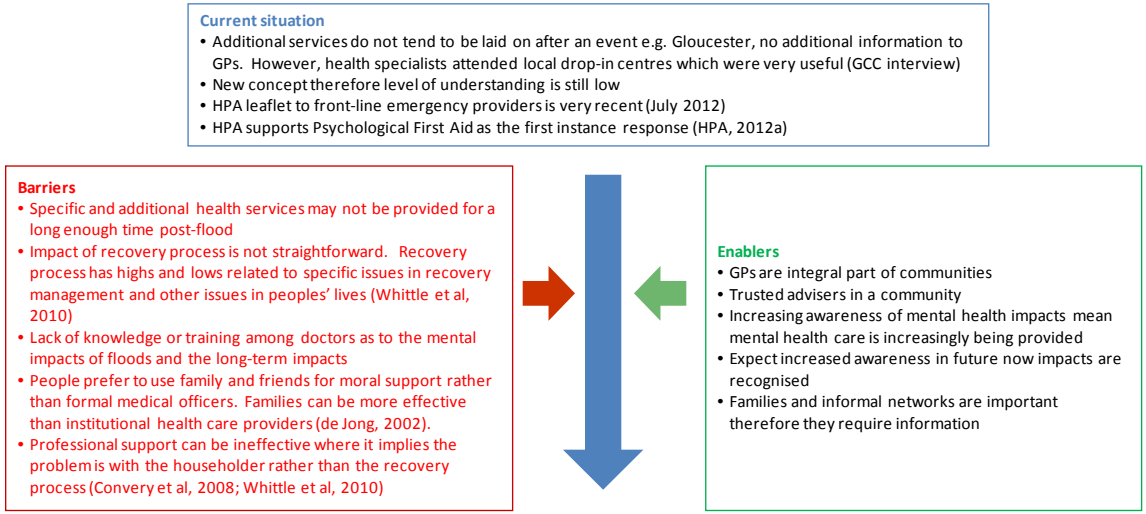
Figure 15. Summary of adaptation through support to reinstate or return home following evacuation



Source: Based on published evidence where cited and stakeholder interviews

Potential impacts of flooding on mental health and community resilience

Figure 16. Health services specific to mental health effects



Current levels of adoption	Anticipated levels of adoption	Timing	Cost	Effect (incl. co-benefits)
Low	Medium	Short (0 – 5 years)	Low	Medium

Source: Based on published evidence where cited and stakeholder interviews

Potential impacts of flooding on mental health and community resilience

4.3.7 Uncertainties and limitations

A description of the main uncertainties and limitations associated with the adaptation actions can be found in Section 2.3.4 above.

4.3.8 Cross-sectoral linkages

Many of the actions described above are both dependent on, and impact on, other sectors and the effectiveness of their adaptation. Although the adaptation measures described above focus mainly on a post-flood response, this will be significantly dependent on flood risk mitigation and alleviation measures. Community resilience should be integrated with land use planning on large and small scales, and also with building design to address vulnerability. Other sectors that will be affected include insurance. Information provision and engagement for flooding will need to be considered alongside information provision for other risks or needs.

4.3.9 Case study evidence: mental health impacts of flooding and community resilience

The adaptive capacity and adaptation actions of the case study areas are shown in **Error! Reference source not found.**. Stakeholder engagement and evidence review have allowed an assessment to be provided.

Hull Adaptive Capacity

Communities:

- History of deprivation so it had more investment in the community e.g. community wardens - became a resource to be mobilised in floods (Whittle et al, 2010)
- 5 years after floods, survey shows poor understanding of risks (30% believe high risk, 33% believe low risk/ not affected; 56% do not feel prepared for a flood (SMSR, 2012))
- Although low socio-economic status, this is counter-balanced by vibrancy of social capital: goodwill, community spirit, general proactive response (Coulthard et al, 2007)

Authorities:

- 750 staff from Hull CC did door to door knocking during floods, characterised most vulnerable so they could be targeted (NFF, 2009)
- Ran Flood Advice Service for a year after 2007, but shut down before recovery process was complete (Whittle et al, 2010)
- Some staff were overwhelmed dealing with flood response at work and their own flooding at home
- After floods, Hull CC has a dedicated flood manager and funds a local flood forum

Vulnerable people:

- Charities had lists of vulnerable people
- High numbers e.g. nearly half flooded properties were “Gold” ; and 10% had no insurance

Adaptation actions taken

In 2007:

- Network of CCTV cameras facilitated coordination of emergency services
- Diarists from Whittle et al (2010) study became forum for shared learning

After 2007:

- Biggest issue was about length of time it took for recovery
- Hull has taken many structural steps to reduce flood risk e.g. Surface Water Management Plan and flood alleviation schemes (Wragg, 2012)
- Set up projects to work with voluntary organisations and their end users
- Range of warning and informing initiatives as part of Emergency Planning Service. E.g. “Let’s Get Ready” campaign, websites, info documents
- Created community evacuation and rescue services; schools have flood resilient measures
- Information provided in info packs and post campaigns and council bills
- Council is trying to place people in properties according to their vulnerability

Potential impacts of flooding on mental health and community resilience

Toll Bar Adaptive Capacity

Communities:
- The deprived nature of the community led to a greater willingness to ask for help –the opposite is often true. Local residents saw floods etc as 'just another challenge' alongside those of living in a deprived area. Their needs went far beyond engineering solutions

Authorities:
- Limited public funds available prompted a more creative approach to helping the community based on human capital
- Multi-agency response to 2007, e.g. worked with GPs, PCTs delivered additional support
- Local Resilience Forum has 4 local authorities – allows mutual aid arrangements
- Lack of engagement and trust in authorities e.g. EA flood warning was too late – now have warning groups in the community, working on local knowledge
- 1 in 3 council officers interviewed request more information to raise awareness (DC, 2010)

Vulnerable groups:
- Relied on voluntary groups to access all individuals in community not covered directly in formal plans
- 81% flooded properties were council owned: dependent on others to invest in adaptation

Adaptation actions taken

- Suitable accommodation was sourced – this was vital for those with specific needs, for example physical disability or families with young children
- Help lines and additional support were flagged and delivered by the local PCT. In addition, they worked with GPs to ensure people were directed to the right places for help
- The South Yorkshire Community Foundation managed and distributed a hardship fund set up to help those who couldn't meet the cost of responding to the flood
- The Salvation Army offered a befriending service to help those who were maybe socially isolated or at risk
- A furniture redistribution charity managed donations of furniture from organisations and individuals
- The local authority ensured that there was a staff presence 24 hours a day to deal with any on site issues - people could be signposted to services that were available, and arranged visits to vulnerable, welfare checking; provided social interaction and evacuation services. Position of Health Emergencies Planner created
- Housing strategy seen as successful – moved to local caravan park so communities kept together
- Council put flood resilient measures into council houses
- Reliance on Red Cross: offered manicures – a way of getting people to talk
- Social support networks set up because of motivated local individuals e.g. a local resident who established the 'Monday club'
- Set up Flood Warden scheme to bridge EA and local community
- Upgraded internal systems to strengthen flood warnings
- Motivated individuals led the approach for recovery and earned community respect
- Many community activities laid on afterwards (ACL, 2008)

Great Yarmouth Adaptive Capacity

- Notable events over recent decades have prompted action to be taken
- The transient nature of the populations – both tourists and those who rent – mean that their adaptive capacity is lower.
- The voluntary sector, such as charities like the Red Cross, is important in complementing the statutory services such as supporting the health services to provide mental health counselling
- Community development workers are key to linking the community and statutory services. They have the skills to facilitate meaningful interaction
- Community resilience contacts are able to provide real-time intelligence on the impacts of weather events. For example, during a recent line squall, community resilience contacts were able to report to the Council very swiftly the extent of the damage e.g. roof tiles lifted, cars damaged, a mobile home was transported across a mobile home park and crashed into a wall that smashed it to pieces. The council were quickly made aware of the damage.

Adaptation actions taken

- Norwich, Kings Lynn, and Borough of Great Yarmouth – all have, or are developing in the case of Great Yarmouth, Surface Water Management Plans
- The Norfolk Community Risk Register logs all past events
- Northgate flooding led to a range of actions being taken. For example, Northgate Community Association was set up; a flood alleviation scheme was implemented with the co-operation of Anglian Water Services Ltd (this was commended by the Institution of Civil Engineers East of England 2010 Merit Awards)
- Community Resilience Groups have been established across Great Yarmouth and work with statutory services. Their knowledge about vulnerable groups complements that held by utilities and social services. Involving care homes is seen to be valuable.
- The North Sea tidal surge in 2007 suggested a need for a dedicated evacuation cell, and a vulnerable people cell but dynamic risk assessment is said to be called for first

Key messages

The evidence suggests some key learning points in relation to building community resilience:

- **Integration and trust:** the community must trust those that are seeking to help them. This takes time so the fact that those aiding the recovery in Doncaster stayed so long after the major flood event meant that they were more integrated into the recovery process. Dr Easthope found "Observationally it was clear to see that this led to a sense that 'recoverers' and the 'recovering' were in this together" (Easthope, 2012). In Toll Bar, trust was developed over time: "as the study developed the engagement with the council as a whole became more far reaching e.g. residents engaging in training opportunities, attending events, organising the exhibition and taking advantage of grants etc." (Easthope, 2012).

Potential impacts of flooding on mental health and community resilience

- **Recovery is a long process**: it goes months, and even years, beyond the initial emergency response. "I would assert that without the many months of relationship building that went on in 2007-8, the flood warden scheme that was initiated in 2008-9 would not have been as successful" (Easthope, 2012).

- **Collaboration is required:** the diversity in any community means that there is a need for a co-ordinated response involving a range of organisations. Each brings particular expertise which together allows a coherent and comprehensive coverage of the needs of the community. There is a clear role for voluntary groups, local Councils, emergency planners, neighbourhood teams etc (Easthope, 2012), particularly where there are vulnerable groups who may not otherwise be integrated in the community.

- **Leadership is an important issue**: the form of leadership during recovery needs to be appropriate to the situation and the timing of action required. Responsiveness to the needs of the community is important.

- **Finding the right means to engage is important**. The British Red Cross offered manicuring, for example, because there was a realisation that in a relaxed environment, people were more likely to talk about issues affecting them. Informal channels through which experiences can be shared are an important route for identifying where people may be struggling, without them necessarily wanting, or being able to, recognise it.

- **Information is key**: the impacts on individuals can be worsened by a lack of access to information because they are not aware of the options that they have to help themselves, or their possessions, following a flood. In Toll Bar, Dr Easthope found "neither the residents or local responders had access to this information and were instead dependent on 'official' risk messages" (Easthope, 2012).

- **Access to grants and financial measures** was highlighted to those in the community and were therefore more accessible.

- **Scenario planning** helps people to engage and think through what they might do and how response and recovery processes work.

- **A sense of place is important** - for example, in flooded communities, it is not necessarily a good thing to re-locate people as this can exacerbate feelings of isolation. In Toll Bar the housing strategy was important and a caravan park was set up in existing estates so that people could stay in the same communities.

- **Day to day help can play an important role as long as it is tailored to what the community needs** – for example, helping people fill in the forms they need to complete for financial assistance etc.

Having explored the evidence on adaptive capacity and adaptation actions, an overall assessment is provided next.

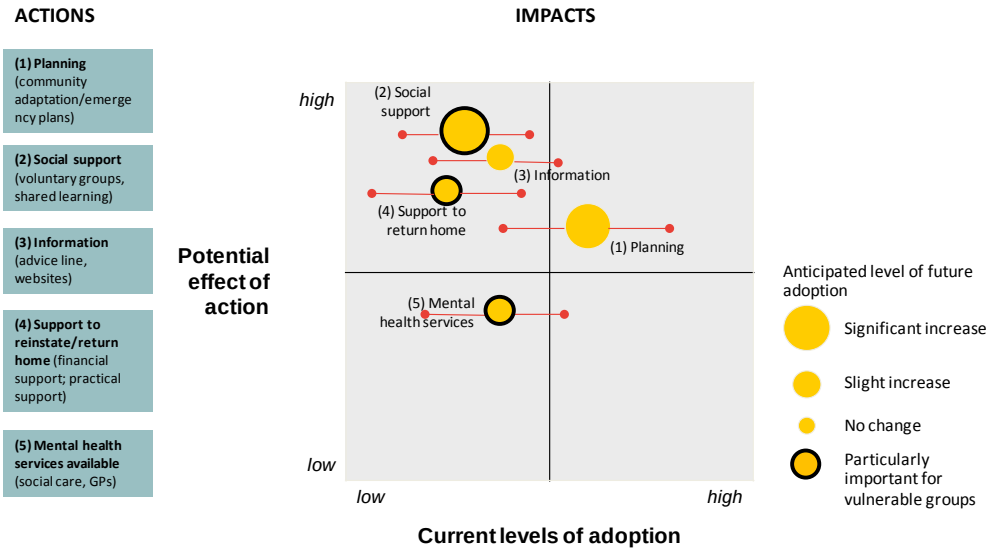
4.3.10 Summary of current and anticipated adaptation

As in Section 3, a general view of the current and expected degree of effective adaptation is required so that key barriers can be identified and addressed through intervention by government or other bodies.

Figure 17 provides a simplified summary of the current and future levels of adoption and effectiveness of the adaptation actions that are currently being taken and would be expected under current policy and drivers of behaviour. The extent to which the actions are an appropriate response in a particular situation would require detailed assessment of the costs and benefits, thresholds and adaptation limits.

The summary is based on the 'high, medium and low' classifications used within **Figure 12 to Figure 16**. The assessment is based on the evidence presented in this section and weighing up stakeholder discussions. The figure is intended to provide a basis for further discussion as part of future stakeholder engagement.

Figure 17. Summary of current and anticipated effects of different adaptation actions for communities



Note: Scales are qualitative and relative to the sectors included. The **current levels of adoption** include decisions that are infrequent (e.g. support to return home) as well as more common practice (e.g. community planning). **Effectiveness** varies from relatively limited scope (e.g. provision of mental health services) due to relatively limited impact and constraints involved, to highly effective (e.g. social support). Increases in future adaptation are shown only for actions without further intervention, essentially over the next 10 years or so. The position of each measure is based on the classification used within this chapter, but could vary considerably depending on community and region

The yellow dots positioning the measures in **Figure 17** are scaled according to the expectation of future increase in uptake, in the absence of further intervention. The red lines illustrate variation in the levels of adoption. The yellow dots circled in black highlight the actions that are of particular importance for supporting vulnerable people.

There are a number of key points:

- Most adaptation measures are in the top left hand quadrant, illustrating the relatively low levels of current adoption of effective adaptation measures. This indicates significant barriers to their uptake, including market failure.

- The red lines indicating variation are there partly because it has not been possible to gather data on every community, and also because there is significant variation across communities due to the local level of decision-making. For example, those that have been affected previously are often more likely to take adaptation actions.

- Most of the adaptation measures show expected increases in adoption in the future, due to anticipated increases in awareness as a result of flood event experiences.

- Social support and support to return flooded residents to their homes are measures that show relatively low adoption, but high effectiveness. This indicates the importance of building adaptive capacity by providing financial, practical and emotional for individuals, particularly the vulnerable to help them adapt.

This assessment has highlighted that there are particular barriers that either prevent a set of measures being implemented, or being effective, or both. This could be owing to a range of factors – and limited adaptive capacity is likely to be a major weakness.

4.3.11 Barriers to effective adaptation action

The review of available evidence and input from experts in the field has identified barriers to effective adaptation. The framework used for the assessment is the same as in Section 3.2.7. The barriers are assessed below.

Market failures

- **Interdependencies and external costs or benefits:** as with the discussion in Section 3, interdependencies both within the sector and across others are likely to influence the degree to which actions are implemented and are effective:

  - **Intra-sector interdependencies:** an effective response to a flood in terms of minimising the mental health effects requires a large number of individuals and organisations to be involved. This requires significant co-ordination and sharing of information, joint-planning etc. The actions of one party can affect the other which may not be duly accounted for when individuals take decisions.

  - **Inter-sector interdependencies:** there are many inter-sector interdependencies that have been highlighted, for example, of those affected with insurance companies. The insurance market has an incentive to keep costs low which may mean taking longer to get people back in their homes (e.g. faster drying equipment is more expensive but much more effective so it is rarely used). Other examples include interdependencies with infrastructure providers such as power, transport and communications along with land-use planning and building designers. The resilience and speed of action of each of those can have implications for the impacts on the mental health of individuals.

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- **External costs**: as highlighted above, insurance companies have the incentive to use methods and technologies to dry out homes that are low cost rather than high speed of effect. This can lead to residents being out of their homes and in temporary accommodation significantly longer than would be the case if more advanced and effective technologies are used which are higher cost. Insurance companies do not have the incentive to account for such costs in their choice of approach. As displacement from the home is a key driver of mental health effects, addressing this requires intervention.

- **Information failure**: this has been noted in several contexts:

  - **Uncertainty** over climate change, and lack of awareness of risk and its potential impacts, along with uncertainty over technology and non-climate change drivers such as socio-economic developments can hinder effective decision-making and lower the ability to respond and recover. Being able to account for uncertainty, learn over time and account for emerging information will be important.

  - **Lack of detailed evidence on the effectiveness of measures in the UK and best practice:** it has been noted how information in the costs and benefits of actions is not currently available. In addition, lessons learned and best practice are inconsistently or widely shared across communities.

  - **Lack of access to information or knowledge of where to access the required information:** this can be an important barrier as residents in a vulnerable state after a flood may not know where to seek help or how to go about co-ordinating insurance companies, builders etc. This can increase stress and anxiety.

- **Skills**: emergency and recovery planners may in some cases not be engaging the community in a way which makes their actions and advice effective (for example, by using language which they cannot relate to or understand, or by using impersonal means to engage, such as standard letters). Understanding how best to engage the community could enhance the effectiveness of action.

- **Misaligned incentives:** tenants often have less connection with decision-making processes e.g. landlords deal with buildings (Whittle *et al,* 2010) so there may be costs imposed on them that are not accounted for by the landlord.

Policy

- **Emergency and recovery planning processes** can be less effective when they are too prescriptive because they can disempower communities from being able to help themselves. Communities can become disengaged.
- **Re-organisation of the health bodies** could be a barrier if they take time to develop effective means of working together.
- **Formalised planning process may** marginalise some of the most vulnerable or disconnected members of the community.

Behavioural

- There is evidence that those at risk may not be willing to accept it or may underestimate the degree of risk they are facing. This could potentially lead them to take too little adaptation actions.
- In communities, there may be a lack of trust of those who come from outside to help. Local knowledge and engagement could overcome this.

Governance

- **Great diversity of responsibility** within social housing and care home sector weakens adaptive capacity (LCCP, 2012).

Having identified many of the key barriers, the next section explores the potential benefits of actions to lower the post-flood mental health effect of flooding.

4.3.12 Addressing barriers: illustrative 'what-if?' scenarios

There is little information available on the effectiveness of adaptation actions that could be taken to mitigate the adverse mental health impacts of floods. Illustrative 'what-if?' scenarios have therefore been developed with the following underlying assumptions:

- **Scenario 1: what-if adaptation actions are taken which reduce the duration of common mental disorder from 5 years to 6 months?** This may be action taken to reduce the time that those affected by floods are displaced from their homes, for example by placing greater weight on insurance companies to expedite drying of homes and cleaning.
- **Scenario 2: what-if community support is able to lower the relative risk of common mental disorder by over a third?**
- **Scenario 3: what-if the severity of common mental disorders associated with the flood are lowered through the provision of, and**

access to, information? (For example, lowering from mild and moderate depressive states to a case of post-traumatic stress disorder). This may for example be achieved through the provision of better and more timely information on where to get help and to raise awareness.

These scenarios suggest that the extent to which costs could be reduced if adaptations were effective in bringing these outcomes about could be as shown in **Figure 18.**

Figure 18. Estimated extent of relative costs avoided to individuals through adaptation under 'what-if?' scenarios (£m) (central relative risk and QALY assumed)

Location	Scenario 1: what if the duration of mental illness is reduced from 5 years to 6 months	Scenario 2: what if community support is able to lower the relative risk of a mental illness by over a third?*	Scenario 3: what if the stress associated with the flood is lowered through adaptation**
Hull	167	14	17
Gloucestershire	81	7	8
* This assumes the relative risk is lowered from 4.1 times the no-flood risk, to 2.6 times			
** This is assumed to lessen the severity of mental illness experienced by the individual			
All costs rounded to the nearest one million			

These illustrative scenarios suggest:

- The relative **avoided costs from lowering the duration of mental health effect can be significant.** This could be equivalent to around £8,700 per adult person flooded in each area in terms of their quality of life effects.
- The relative costs avoided to individuals from lowering the relative risk of mental health impact following a flood could also be notable. This could be equivalent to around £700 per person flooded.
- If the degree of severity of mental health effect was lowered below what it would otherwise be, then the benefits in the case study areas of Hull and Gloucestershire could be £17 million and £8 million respectively. Per person flooded, the avoided cost to the individual given their relatively higher quality of life could be around £900 per person.

4.4 Recommended interventions

The barriers to effective adaptation were discussed in Section 4.3.11. The 'what - if?' analysis above highlights the gains for adapting effectively to reduce the impacts of mental health on individuals could be significant per person. This supports a case for intervention to address key barriers.

- **Share information across infrastructure providers and those in the healthcare and resilience sectors and develop resilience plans collaboratively. Undertake analysis using scenarios** to assess which actions may be effective under particular situations, the thresholds and the limits to adaptation. Assess the costs and benefits of actions under particular circumstances.

- **Provide a single trusted hub of information for members of communities, with comprehensive cover of all aspects needed for effective recovery following a flood (such as medical advice, insurance claim handling and managing builders).** For example, a national flood website. Educate key figures in the community to share information. Use existing and trusted channels where possible.

- **Provide enhanced emotional support for individuals by** building and strengthening existing community groups and processes to share information, build trust of authorities among community etc. Undertake research into ways of sharing best practice and examples between communities e.g. information platforms, web-based resources.

- **Take action to make insurance a driver of flood-resilience,** e.g. insurance companies to use most rapid drying technologies to dry homes, and to encourage cleaning of assets rather than replacement where possible, and encourage flood-resilient repair to homes, rather than repairing them to the same vulnerable standard.

- **Provide education and training for emergency planners, local authorities, and community members** to ensure effective engagement with individuals and groups, building and applying emotional intelligence to empathise and empower communities to help themselves; and, build knowledge of risks and actions to minimise them (e.g. in Scotland, school children are taught about climate risks etc as resilience is integrated into the curriculum).

- **Investigate the feasibility of integrating voluntary groups within formal planning processes** to ensure vulnerable groups are not isolated (e.g. the Central Scotland's Memorandum of Understanding between statutory and voluntary sector responders).

A further issue in relation to the potential impacts of climate change on health as assessed by the CCRA (Hames and Vardoulakis, 2012) relates to the extent to which heatwaves and rising temperatures affect the health of those aged over 65. This issue is the subject of the next section.

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5 The potential impacts of heat on human health

The question set by policy leads explored in this section is:

"Given current policy and the current and expected adaptation, what is the case for further intervention in relation to the health impacts of heatwaves and rising mean summer temperatures on older populations (those over 65), with illustration using case studies in *Eastbourne and Islington?*"

5.1 The links between heat and impacts on human health

Climatic factors have the potential to adversely impact on the health and wellbeing of the UK population. The CCRA (Hames and Vardoulakis, 2012) identified two forms of potential threat to public health associated with rising temperatures.

5.1.1 Climate change projections

Gradual rise in projected mean summer temperatures is a potential threat to public health. By the 2050s, the southern part of England could see temperature rises of between 2.3 ºC and 2.7 ºC (medium emissions scenario, p50) (Murphy *et al,* 2009). This sits within the range of +1 ºC to +5.5 ºC between the p10 low emissions and p90 high emissions scenarios (Murphy *et al*, 2009). Although there is considerable uncertainty within the projections, all the climate scenarios illustrate a trend of gradually rising temperatures.

The regional climate model used by UKCP09 does not include influences of urban surface types on the climate. Moreover, heat storage during the day and heat release at night by buildings is not included either. As a result, the UKCP09 projections will not take into account changes to any of the factors potentially changing the intensity of the Urban Heat Island effect. This could lead to additional errors when acquiring future urban climate data from the model (HPA, 2012b). Details of the climate projections are described in **Annex 3.**

5.1.2 Implications for public health

In this report, heatwaves or 'heat episodes' refer to 10-day moving averages of the maximum daily temperature (details are provided in **Annex 4)**. The impacts on public health from both of these changes in temperature include heat illnesses (heat stroke, heat exhaustion) and related conditions (dehydration), neurological conditions, renal disease, and mental illness (Kovat and Ebi, 2006).

The total impact of a heatwave event will be dependent on a number of factors including: its magnitude; timing in season; the population's prior experience of heatwaves, and public health responses (Kovat and Hajat, 2007). Sudden increases in temperature to extreme levels – especially in early summer – have been found to have much greater impacts on health. The same temperatures can have different impacts depending on the duration of the event, or the time in the season. Heatwaves early in the summer (June/July) are associated with greater impacts on mortality than heatwaves of comparable or hotter temperatures in the same population in subsequent months (Roaf *et al,* 2009).

Increased mortality (premature death) is likely to occur, with the effects of heat overwhelmingly concentrated in the elderly (Kovat and Ebi, 2006).

Heat may also increase the number of hospital admissions and visits, as well as the demand for other healthcare services such as visits to GPs, calls to NHS Direct or through other channels. Determining the increase in demand for services that are directly attributable to heat is complex and problematic owing to the lack of data and multiple confounders that are present, such as socio-economic and emission futures. This study therefore focuses on hospital admissions.

The rest of this Section seeks to:

- Present the estimated costs of health impacts arising from rising temperatures and heatwaves out to the 2030s and 2050s. Given older age groups account for the greatest share of heat-related health effects, the focus here is on those aged 65 and over. Premature deaths and hospital admissions are the focus of the analysis;
- Discuss the adaptation actions to increase preparedness for heat events, along with providing an assessment of their potential effectiveness;
- Highlight the common enablers and barriers to adaptation; and
- Conclude with the suggested case for further action.

5.2 The scale of the challenge

The case studies used to illustrate the potential scale of impact of heat on public health are **Eastbourne** and **Islington**. These are set against **London** as a whole as a comparator. Each case study was chosen for two main reasons.

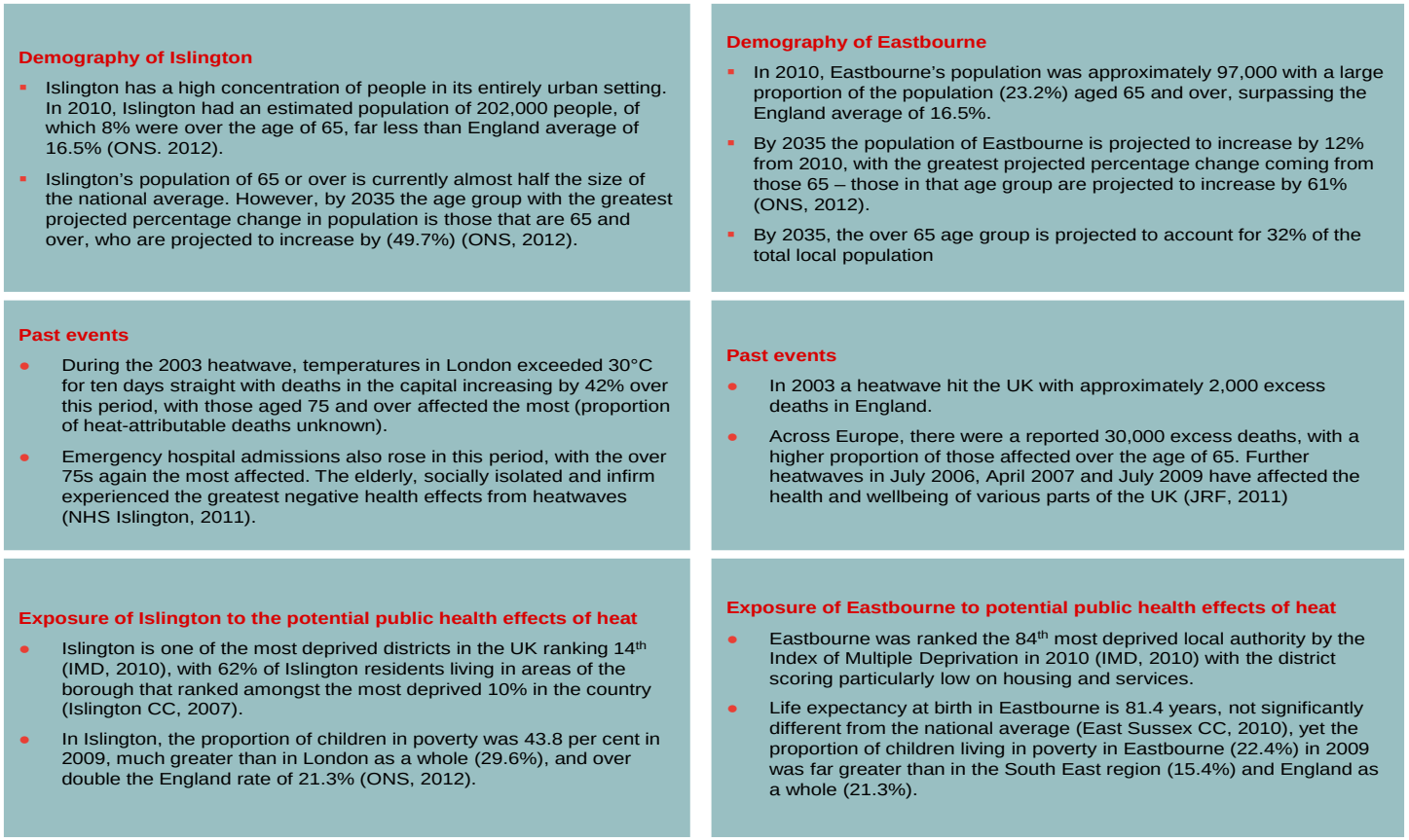
- Spatial: The locations of both Islington and Eastbourne indicate that they are projected to experience rising temperatures in the future that are higher than the national average. Although not assessed in this analysis, Islington's location in the centre of London means that it may be particularly vulnerable

to the impacts of the urban heat island effect (on top of those effects assessed in this analysis) (for further information please refer to the ECR Report on Overheating in Residential Housing).

- Demographic: Eastbourne is a small coastal town in the south east of England. A relatively high proportion of its 97,000 population is over 65 – the demographic group most susceptible to the effects of heat. This is in contrast to Islington, which has a much larger, but younger, population.

Each case study area is set out in more detail in **Figure 19**.

Figure 19. Key characteristics of case study areas of Islington and Eastbourne



5.2.1 Potential cost of heat-related mortality and hospital admissions

Current level of risk

To provide some scale to the current levels of heat-related mortality risk facing the UK from rising temperatures, the CCRA (Hames and Vardoulakis, 2012) provided the current baseline against which projections are made. The baseline does not account for the incidence of heatwaves, however.

The baseline is for the period 1993-2006. The CCRA (Hames and Vardoulakis, 2012) suggest a baseline average number of heat-related deaths per year of 1,142. At the regional level, London is estimated to have accounted for the most significant share, at 207 on average per annum (around 18%). This is followed by the South East (the county in which Eastbourne is located) with a baseline of 160 deaths per year (14% of the UK total).The analysis indicates that there is substantial variation across regions of the UK. At the other end of the extreme is Northern Ireland with baseline annual average heat-related deaths of 19 per year (less than 2%).

Accounting for heatwaves, the CCRA suggests the baseline heat-related deaths per year could be 18-33 higher (Hames and Vardoulakis, 2012).

Projected risk

Analysis in this study relies on UKCP09 weather generator simulations for the 2030s and 2050s under a high emissions scenario. This emissions scenario was chosen for illustration, though it is fully recognised that there are a range of scenarios possible, each of which would have different results. Results presented here should therefore be interpreted accordingly.

Heatwaves (of 10-day duration) and the hottest 3-month summer periods (June, July and August) were investigated by looking at weather simulations over the next 100 years[25]. Average maximum daily temperatures for the hottest 1% and 5% of summers were identified. These were roughly equivalent to a return period of 1 in 20 y.ears and 1 in 100 years respectively. Likewise, the hottest 10-day period for every 10 years and every 100 years were identified.

For each day of the heat episodes and summer period, the numbers of heat-attributable deaths and hospital admissions were calculated by using evidence from Armstrong et al (2010). Armstrong et al (2010) derived temperature-mortality relationships that could be applied to those temperatures above the threshold temperatures for Islington and Eastbourne: 24.7°C and 23.6°C,

[25] 100 sets of 100-years series of daily maximum temperature were simulated giving 10,000 years of data in total.

respectively. The relationship between mortality and temperature is not assumed to change in the future.

Hospital admissions are also expected to rise from temperature events. The relationship between temperature and hospital admissions is less well established. For the purposes of this analysis, a different approach to that used in the CCRA (Hames and Vardoulakis, 2012) has been used, with London-specific evidence based on research by Kovats *et al* (2004) used to derive a multiplier on the mortality effect[26].

Assumptions were applied to the projected populations of Eastbourne and Islington to the 2030s and 2050s to estimate the public health impact. London is shown as a comparator (using the same approach). The estimate of the future impact of high temperatures is highly dependent on assumptions of the degree to which populations acclimatise or 'naturally adapt' to future higher temperatures.

This analysis used calculations based on applying current-day temperature-mortality and morbidity relationships to (weather-generator based) estimates of future temperature distributions. Over time, however, those temperature-mortality relationships are likely to change. For example, for a given relatively high temperature, all other things being equal, vulnerability is likely to be lower in future than it is now. This is because of a range of social, environmental and other changes that in combination are likely to help to protect individuals against high temperatures. People will learn to adapt behaviourally, and there is likely to be some biological acclimatisation at individual and population levels, as people learn to cope better with higher temperatures[27]. Nonetheless, acclimatisation is imperfect (nearly all populations still show an increase in mortality at high temperatures) and under the relatively rapid climate change expected for this century, acclimatisation is likely to be less complete.

This report does not estimate the degree of acclimatisation/natural adaptation, but presents estimates that apply current temperature-mortality relationships to future temperature distributions.

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[26] This is described in **Annex 4**. In summary, the multiplier is equivalent to the ratio of the temperature-mortality gradient and temperature-admissions gradient.

[27] There is for example evidence that during the course of the 20th century (Carson et al. 2006) the seasonality of mortality in England diminished and so too vulnerability to temperature extremes (cold and high temperatures) despite a gradual ageing of the population. It would be reasonable to expect such a trend to continue into the future. There is also some evidence from comparisons between populations that the threshold for heat-related mortality is higher in those regions with warmer summer temperatures (Armstrong *et al,* 2010). This also suggests natural adaptation/acclimatization.

Policy context

One particular factor that merits comment is the role of specific health protection, and in particular the measures that have been introduced following 2003 with the Heatwave Plan for England. The Heatwave Plan forms the basis of structure of considering the range of adaptation measures discussed in this Section 5.3. The Plan has put in place a warning system for heatwaves and sets of actions that identify and help protect those who may be at greatest risk. It is likely that this Plan has some effect to diminish vulnerability to the adverse health effects of heatwaves, but as yet it has not been possible to quantify that effect with any precision. It should be noted that the temperature-mortality relationship used for calculations of the numbers of heat deaths in this report was based on an analysis that included data for the years 2004 to 2006 when the Heatwave Plan for England was first operational.

5.2.2 Estimating the cost of heat-related mortality and morbidity

Costs of mortality (premature death) in this analysis reflect the cost of life years lost. The extent to which the heat episode reflects a shortening of life is an important part of the estimate. There is much debate about the possibility that a proportion of heat deaths may represent mortality displacement (days or weeks only) in very frail populations, implying much lower relative loss of life than if members of the population with average life expectancy died of heat. To address this, UK static life tables (without any assumption of changing underlying mortality risks over time) were used to estimate the life expectancy for each year of age above 65 years assuming their underlying risk was (i) average, (ii) twice average, (iii) five times the average, and (iv) ten times the average (reflecting progressively more frail populations) and using the average loss of life that these imply. The Department of Health estimated cost per life year lost (£60,000) was applied (see Annex 4).

The costs associated with hospital admissions reflect the duration of stay in hospital (ranging from 2 to 5 days); the cost per patient per day of treatment (assumed to be £266, based on Defra (IGCB, 2007)) plus a welfare cost to the patient from being in hospital (assumed to be £625 per patient per day, based on Defra (IGCB, 2007)).

Results are shown in **Figure 20** and **Figure 21**.

Figure 20. Estimated cases and costs (£m discounted) of mortality and morbidity (hospital admissions) of a 10-day heat episode in the 2030s and 2050s

Impact of 10-day episodes (heatwaves) on mortality, 65+ years			Cases						Costs* (£m discounted)					
			Central		Lower		Upper		Central		Lower		Upper	
			Mortality	Morbidity	Mortality	Morbidity	Mortality	Morbidity	Mortality	Morbidity	Mortality	Morbidity	Mortality	Morbidity
Islington	2030s	1/10 years	9	9	8	8	10	10	0.6	0.01	0.1	0.0	1.1	0.03
		1/100 years	11	10	10	9	12	11	0.7	0.01	0.1	0.0	1.3	0.04
	2050s	1/10 years	24	23	21	20	26	25	1.1	0.02	0.2	0.0	2.1	0.1
		1/100 years	28	27	25	24	31	30	1.3	0.03	0.3	0.0	2.5	0.1
London	2030s	1/10 years	536	482	473	425	584	525	34.2	0.6	6.6	0.5	63.9	1.6
		1/100 years	652	586	574	516	712	640	41.7	0.7	8.0	0.6	77.8	2.0
	2050s	1/10 years	1370	1231	1200	1079	1501	1350	65.0	1.1	12.5	1.0	121.9	3.1
		1/100 years	1672	1503	1459	1312	1838	1652	79.3	1.4	15.2	1.2	149.3	3.8
Eastbourne	2030s	1/10 years	8	6	7	5	9	7	0.5	0.01	0.1	0.01	1.0	0.02
		1/100 years	10	7	8	6	11	8	0.6	0.01	0.1	0.01	1.2	0.03
	2050s	1/10 years	15	11	12	9	17	13	0.7	0.01	0.1	0.01	1.4	0.03
		1/100 years	18	14	15	12	20	16	0.9	0.01	0.2	0.01	1.7	0.04

* Costs are rounded to the nearest hundred thousand

Note: central case reflects the central estimated gradient of the temperature - mortality relationship from Armstrong et al (2010), the upper and lower cases reflect the upper and lower confidence intervals. 2010 willingness to pay values have been uprated at 2% per annum and Green Book discount rate applied.

Figure 21. Estimated cases and costs (£ million, discounted) of mortality and morbidity (hospital admissions) for summer-related heat impacts on health[28]

3-month summer-related mortality and hospital admissions			Cases		Costs (£ million, discounted)				
			Mortality	Hospital admissions	Mortality			Hospital admissions	
			Point estimate	Point estimate	Central	Lower	Upper	Lower	Upper
Islington	2030s	1/20 years	24	23	1.5	0.3	2.6	0.03	0.1
		1/100 years	32	30	2.0	0.4	3.5	0.04	0.1
	2050s	1/20 years	78	75	3.7	0.8	6.4	0.07	0.2
		1/100 years	104	100	4.9	1.1	8.5	0.10	0.2
London	2030s	1/20 years	1439	1293	92.0	20.1	157.4	1.8	4.5
		1/100 years	2053	1846	131.2	28.7	224.6	2.6	6.4
	2050s	1/20 years	4715	4238	223.8	49.0	382.9	4.4	10.9
		1/100 years	6924	6224	328.6	71.9	562.3	6.4	16.0
Eastbourne	2030s	1/20 years	24	19	1.6	0.3	2.7	0.03	0.08
		1/100 years	31	24	2.0	0.4	3.4	0.04	0.10
	2050s	1/20 years	53	40	2.5	0.5	4.3	0.05	0.12
		1/100 years	63	49	3.0	0.7	5.1	0.1	0.15
* Costs are rounded to the nearest hundred thousand									

Note: 2010 WTP values have been uprated at 2% per annum and Green Book discount rate applied.

[28] Notes for the table: Mortality: central costs assume 1.52 years of life lost per death, lower costs assume 4 months loss of life per death and upper assume 2.61 years loss of life per death. Morbidity: lower assumes 2 day hospital stay and upper a 5 day hospital stay. Note that for these full summer effects, evidence has allowed only one mortality-temperature gradient to be tested (3 could be tested for the 10-day heat episode) hence the number of cases is shown for illustration only.

Figure 20 and **Figure 21** show that:

- Mortality levels for a 1 in 10 year heatwave could be 8-10 in Islington in the 2030s or 21-26 by the 2050s. For London as a whole, corresponding numbers are 473-584 for the 2030s and 1200-1501 by the 2050s; and in Islington 7-9 for the 2030s and 12-17 for the 2050s. Mortality rates for a 1 in 100 year heatwave are a little higher still.

- In relation to both levels of heatwaves (1 in 10 year and 1 in 100 year), in the 2030s, Islington is projected to experience higher mortality and more hospital admissions than Eastbourne. However, mortality in Islington is only around 15% higher than Eastbourne, despite having double the total population. This reflects the proportionately higher number of residents over 65 years of age in Eastbourne compared to Islington. **The demography and age profile is therefore a key driver of mortality and hospital admissions.**

- By the 2050s, Islington is projected to experience mortality rates around 60% higher than those in Eastbourne, largely as a result of the relatively greater increase in temperatures. Although the projected increase to the 2050s in the over-65 age group is lower in Islington than Eastbourne, and the total population of that age group is lower (around 44,000 compared with 55,000[29]), the projected temperatures for Islington are far more extreme. The maximum temperature of the heat events explored is consistently higher than those projected for Eastbourne.

- The monetised (discounted) costs associated with mortality reflect the same patterns as described above. When considering London as a whole, the costs associated with mortality are expected to be around £7-78 million in the 2030s (473-712 heat attributable deaths). By the 2050s, this could rise to £13-149 million (1200-1838 heat attributable deaths). Costs at the city-level are therefore projected to be notable**.** However, these figures are not discounted and do not account for existing adaptation and acclimatisation.

- The rates for the wider London area are a useful comparator with Islington: the London mortality rates are estimated to be more than 50 times higher than Islington in the 2030s and 2050s. The magnitude of difference is driven largely by London's size – it comprises 33 London Boroughs. In addition, the demography of Islington is younger than London as a whole (so a relatively lower impact on the health of the population would be expected).

[29] Note that the ONS (2012) population projections extend to 2035 only. Indicative projections to 2055 have been formulated by assuming the same average annual rate of growth in each age-band as the previous decade continues. This is indicative only.

For example, the projected mortality increase in the over 65 age group in London is 65% over 2010-2035, compared with 50% for Islington (ONS, 2012).

For the summer-period effects, **Figure 22** shows that:

- In the 2030s, the cases of mortality and hospital admissions are broadly similar for Islington and Eastbourne, despite the population of the latter being less than half of Islington. This implies the relative costs per capita are likely to be greater in areas where there are relatively high proportions of elderly individuals. The estimated cost per capita associated with mortality in Islington in the 2030s (for the 1 in 20 year summer episode) is £1-9 compared to £2-17 per capita in Eastbourne. For comparison, the cost per capita in London under the same scenario is £1-11. This is shown in **Figure 22**.

Figure 22. Estimated mortality cost for the 2030s for the 3-month summer period heat-related effects

		Total cost (£, discounted)				cost per capita (£, discounted)			
Area	Population in 2035	Lower cost (1/20)	Upper cost (1/20)	Lower (1/100)	Upper (1/100)	Lower cost (1/20)	Upper cost (1/20)	Lower (1/100)	Upper (1/100)
Islington	263,300	0.2	2	0.3	2	1	9	1	9
London	10,320,600	14	110	20	157	1	11	2	15
Eastbourne	111,400	0.2	2	0.4	2	2	17	4	21

Source: ECR analysis

All costs in this section have been estimated assuming that no degree of adaptation action occurs. However, in practice, two particular forms of adaptation action would be likely to occur:

- Natural adaptation in the form of acclimatisation to the range and variability in temperatures in the summer months, as explained above; and,

- Planned adaptation actions taken by a range of other actors to warn individuals about potential impacts of rising temperatures or take other actions to reduce the potential adverse impacts on health (particularly the over 65s and older, or those with existing respiratory diseases for example).

Adaptation actions are explored in the next section.

5.3 Adaptation actions

5.3.1 Introduction

The context for adaptation, i.e. adaptive capacity of communities, has been discussed in section 4.2. In this report, the adaptation measures for reducing health impacts of heatwaves focus on preparedness for heatwaves, and on the behavioural and social measures that can be taken, rather than on physical infrastructure or housing, which is discussed in detail in the ECR Report on Overheating in Residential Housing.

The actions described here are largely those identified in the Heatwave Plan for England. As such, the categories of actions described below are primarily planned adaptation responses, and the actions include those to build adaptive capacity and also those to specifically reduce the heat impacts on health. The Heatwave Plan was recommended by expert advisors, and tested with stakeholders, as an appropriate framework for the ECR to use to consider practical behavioural adaptation actions to overheating. The stakeholders are listed in **Annex 2** and are referenced by organisation. A primary difficulty with assessing the Heatwave Plan measures is the lack of heatwaves that have occurred since 2003 and 2006 (the Plan was developed in 2004). As a result, there is limited evidence to examine their effectiveness, and some data has been drawn from experiences in other countries.

This report does not consider adaptation actions beyond those set out in the Heatwave Plan, as at the present time these actions have already been identified as ones to implement. Further work should consider when the effectiveness of the scheme might diminish and whether additional actions are needed, and when. At present there is no real data on the success of on-the-ground implementation of the Heatwave Plan and this will need to be done before the need for additional actions can be properly considered.

Further detail on the actions is set out in **Annex 7**, the categories of measures include:

- Alert systems and summer preparedness,
- Communication with the public,
- Engagement with service providers, and
- Engagement with communities.

5.3.2 Alert systems and summer preparedness

Heat-Health Warning Systems (HHWSs) are a public health tool to reduce the adverse impacts of excessive heat on human health by building adaptive capacity. They consist of (i) preparations and meteorology-based warning systems, rapid

and coordinated actions during heatwaves, and evaluations following the response outcomes (McGeehin & Mirabelli, 2001; Kovat & Ebi, 2007; Alberini *et al,* 2008). A summary is provided in **Figure 23.**

5.3.3 Communication with the public

This includes measures that communicate the Heatwave Plan to the public and engage with them, such as: information to the public through media before and during a heatwave; distribution of bottled water through the Red Cross to vulnerable people; and operation of a heat information line to answer heat-related questions (Adger *et al,* 2007). These are awareness-raising actions of both the risks and the responses that can be taken. This is particularly important for caregivers of vulnerable groups and parents of infants. A summary is provided in **Figure 24**.

5.3.4 Engagement with health care service providers

The measures taken by local NHS and social care organisations include: action to reduce indoor heat exposure (medium and short term) (e.g. monitor indoor temperatures; move critical patients or individuals in care homes); particular care for vulnerable population groups (help GPs and social workers to identify vulnerable patients and clients and provide them with information and good practice advice); and preparedness of the health and social care system (e.g. staff training and planning, appropriate healthcare and the physical environment). A summary is provided in **Figure 25.**

5.3.5 Engagement with the community (focus on the vulnerable)

These measures include provision of extra help, where possible, to care for those most at risk, including isolated older people and those with a serious illness or disability. This could include opening of designated cooling centres at public locations or providing cool rooms in care homes or social housing, and could come from local authorities, health and social care services, the voluntary sector, communities and faith groups, families and others. In the England Heatwave Plan, this is determined locally as part of the person's individual care plan and will be based on existing relationships between statutory and voluntary bodies. A summary is provided in **Figure 26**.

5.3.6 Uncertainties and limitations

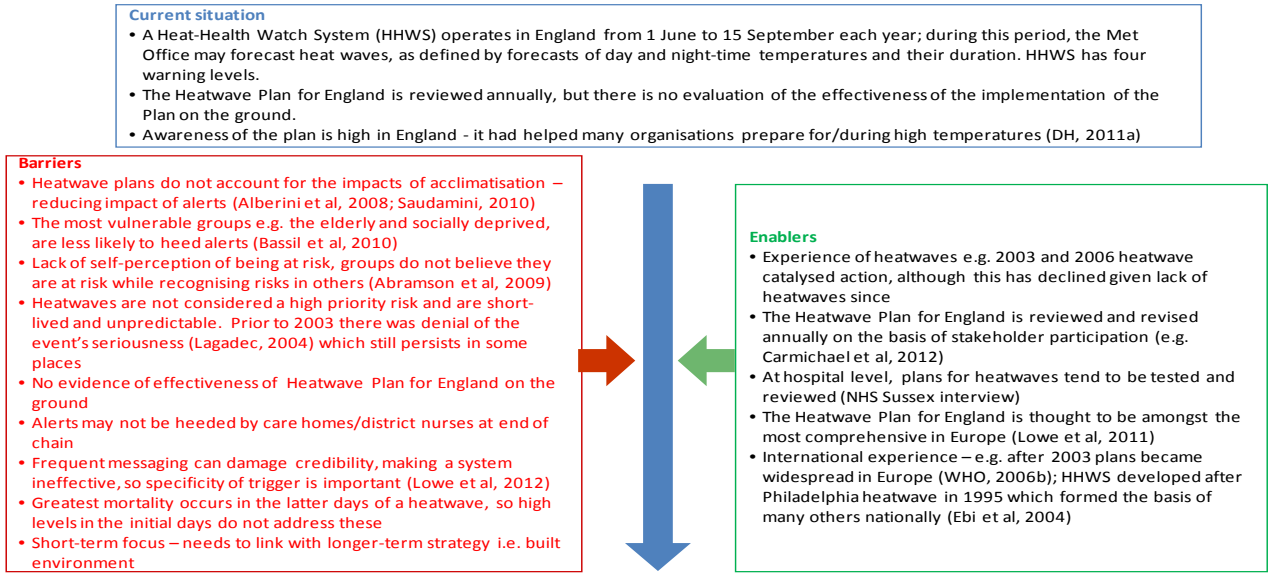
There are a number of uncertainties and limitations in the analysis of the adaptation actions, which are set out in section 3.2.4 above.

5.3.7 Cross-sectoral linkages

The adaptation actions described above are dependent on, and impact upon, many other sectors. Health care and social care are inextricably linked, and

reducing the health impacts of heat will depend in part on social care measures that can be put in place to prevent or reduce the impacts. The health and wellbeing response to overheating must be considered with the physical housing infrastructure response to overheating (see ECR Report on Overheating in Residential Housing for more information). External 'green' infrastructure can make a big difference in both impact and response such as access to green space, access to water, shading, and urban planning is important.

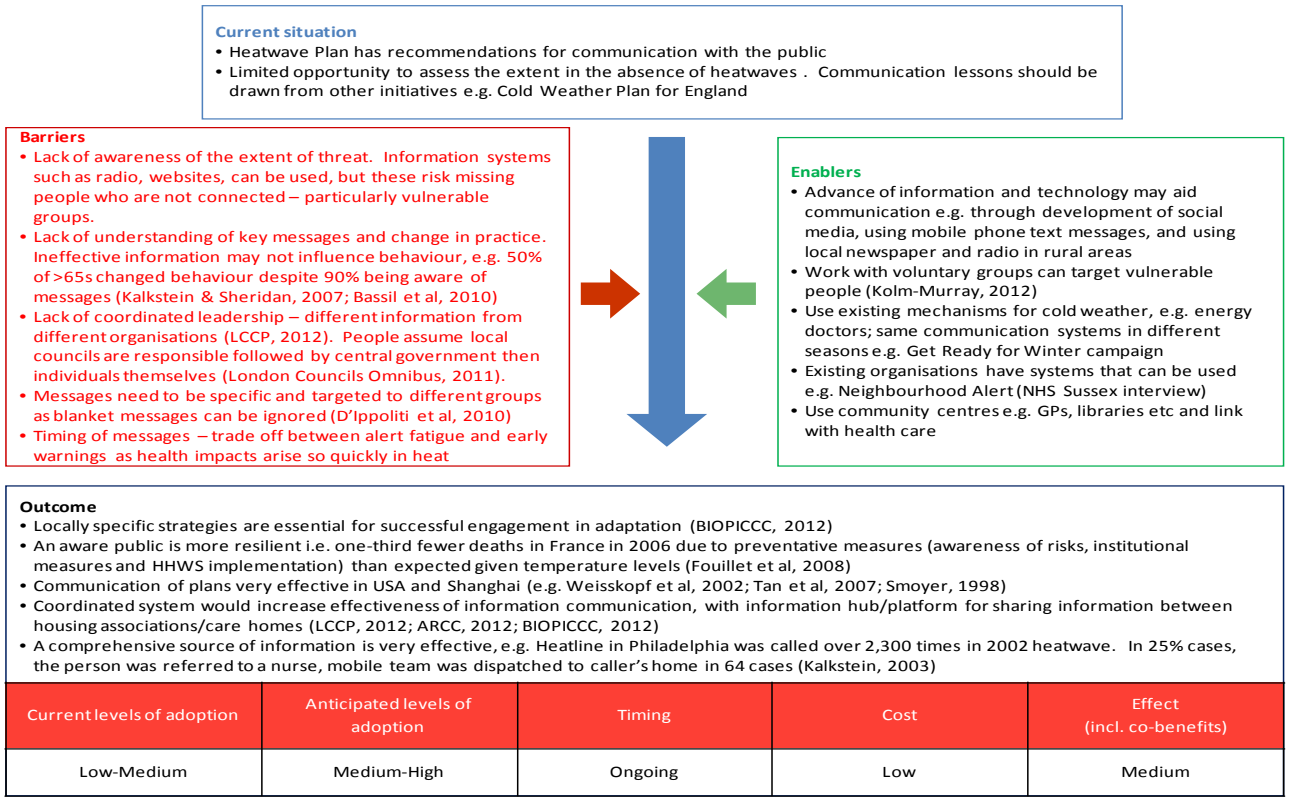
Figure 23. Summary of alert systems and summer preparedness



Current levels of adoption	Anticipated levels of adoption	Timing	Cost	Effect (incl. co-benefits)
High	High	Short/Ongoing	Low-Medium	High

Source: Based on published literature where cited and stakeholder interviews

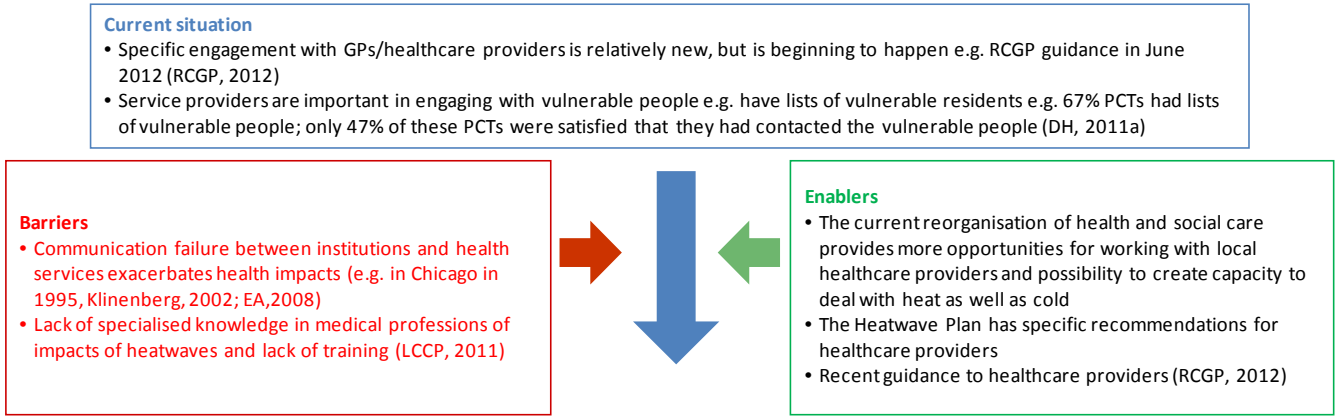
Figure 24. Summary of communication with the public



Current levels of adoption	Anticipated levels of adoption	Timing	Cost	Effect (incl. co-benefits)
Low-Medium	Medium-High	Ongoing	Low	Medium

Source: Based on published literature where cited and stakeholder interviews

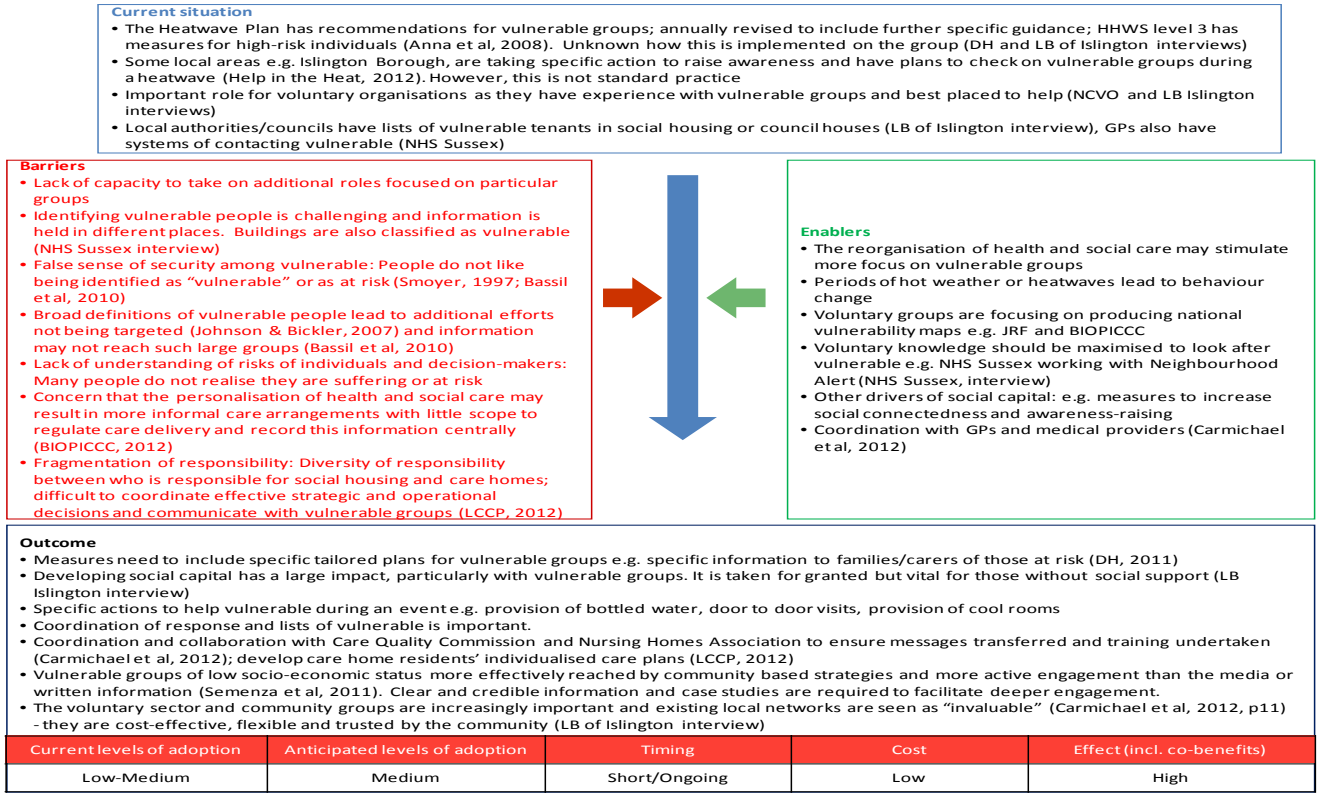
Figure 25. Summary of engagement with service providers



Current levels of adoption	Anticipated levels of adoption	Timing	Cost	Effect (incl. co-benefits)
Low-Medium	Medium – high	Short/Ongoing	Low	Medium-High

Source: Based on published literature where cited and stakeholder interviews

Figure 26. Summary of engagement with the community



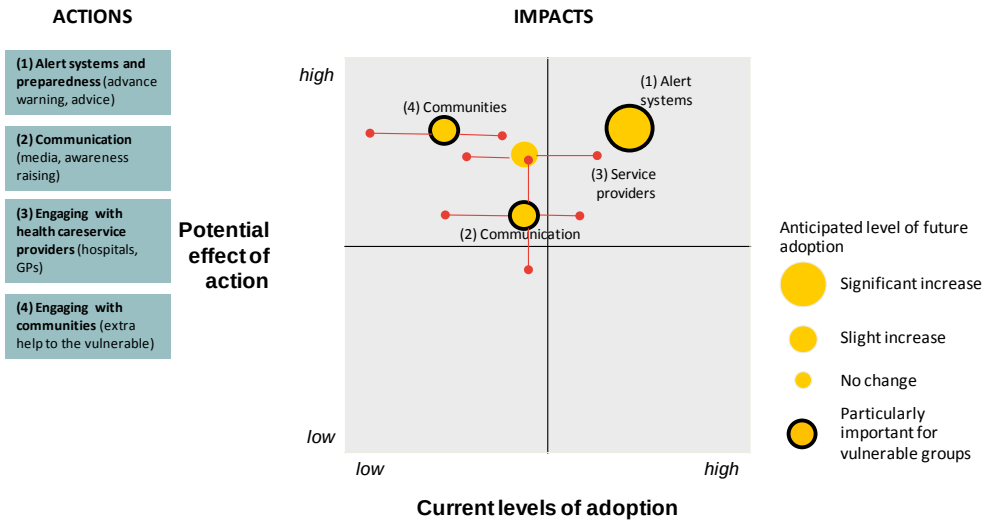
Source: Based on published literature where cited and stakeholder interviews

5.3.8 Summary of current and anticipated adaptation

To understand the degree to which there is a case for intervention, this section presents a summary of the evidence reviewed so far in the section. **Figure 27** provides a simplified summary of the current levels of adoption and effectiveness of the adaptation actions and those that would be expected without further intervention. The extent to which the actions are an appropriate response in a particular situation would require an assessment of the costs and benefits of the action, given the expected climate change.

The summary is based on the 'high, medium and low' classifications used within **Figure 23 to Figure 26** and **Annex 7**. The assessment is based on the evidence presented in this section and weighing up stakeholder discussions. The figure is intended to be an overview of the findings set out in this report, rather than a further analysis of effective adaptation. It is illustrative only, as there is no reliable data drawn from large-scale study. The figure is intended to provide a basis for further discussion as part of future stakeholder engagement.

Figure 27. Estimated uptake and effectiveness of actions to address heat risks



Source: ECR analysis

Note: Scales are qualitative and relative to the sectors included. The **current levels of adoption** include decisions that appear to be widespread (e.g. alert systems) as well as those that do not appear to be implemented (e.g. engaging with communities). **Effectiveness** is relatively high for these actions. Increases in future adaptation are shown only for actions without further intervention, essentially over the next 10 years or so. The position of each measure is based on the classification used within this chapter, but could vary considerably depending on region and community.

Figure 27 shows an assessment of the adaptation measures that can be adopted as a response to heatwaves and the effectiveness of those actions. The yellow

dots positioning the measures in the figure are scaled according to the expectation of future increase in uptake, in the absence of further intervention. The red lines illustrate variation in the levels of adoption and the effectiveness of the actions. The yellow dots circled in black highlight the actions that are of particular importance for supporting vulnerable people.

There are a number of key points arising from this analysis:

- The measures are all in the top half of the chart. This illustrates that the measures are all likely to play a valuable role in addressing the heat-related impacts on health of projected climate change.

- Many of the actions have large ranges in terms of positioning. This reflects both variation at local level, and also lack of robust evidence. These measures are designed and implemented at the local level, so the extent to which measures are implemented effectively within the community varies, and will continue to do so. Adoption of specific measures is recommended nationally under the Heatwave Plan, but it is unclear how widespread the actions are on the ground. This indicates potential barriers to uptake.

- The measures are all expected to increase in adoption to some extent – which may be incrementally driven by the Heatwave Plan. It would be expected that if hot summers increase and heatwave episodes occur more frequently, the awareness of such events would be likely to increase and uptake would increase.

- Alert systems (heatwave plans) are widespread, effective and are expected to increase further in the future. This suggests that a relatively high degree of adaptation is expected – which may be due to the importance that is beginning to be placed on heatwave resilience, and as a result of the Heatwave Plan for England, which is managed centrally. Communication is also likely to increase under the Heatwave Plan.

This assessment has highlighted that there are particular barriers that either prevent a set of measures from being implemented, or being effective, or both. This could be due to a large range of factors, including limited adaptive capacity, and these barriers are considered next.

5.3.9 Overview of key barriers to effective adaptation

The assessment of key barriers draws on the same framework as in section 3.2.7. These include market failures, policy failures, behavioural constraints and governance issues.

Market failures

- **Interdependencies and external costs or benefits:** as discussed in Section 3 and Section 4, interdependencies both within the sector and across others are likely to influence the degree to which actions are implemented and are effective:
    - **Intra-sector interdependencies**: health care and social care are inextricably linked, as described above. The adaptive capacity and adaptation actions of one part of the health system can affect another. Such interdependencies may not be generally well-understood and accounted for.
    - **Inter-sector interdependencies**: overheating and taking preparatory action to lower the impacts in the event of a sudden rise in temperatures requires actions in other infrastructure sectors, such as residential housing. The interdependencies are not likely to be accounted for by, for example, building designers as they are not likely to gain any return from doing so.
- **Information failure**: this has been noted in several contexts:
    - **Uncertainty** over climate change, and lack of awareness of risk and its potential impacts, along with uncertainty over technology and non-climate change drivers such as socio-economic developments can hinder effective decision-making and lower the ability to respond and recover. Being able to account for uncertainty, learn over time and account for emerging information will be important.
    - **Lack of detailed evidence on the effectiveness of measures in the UK and best practice:** the Heatwave Plan has been evaluated but not in terms of the extent to which it is able to actually lower the health effects of rising temperatures and save lives. This will be essential in order to inform effective adaptation strategy.
    - **Lack of accessible information relating to actions that should be taken to prepare:** information systems exist but they may not be heeded by vulnerable groups (for example, who may not access the internet, listen to the radio etc). The form of communication used could be a barrier for some.
- **Skills**: There may be a lack of training, and lack of specialised knowledge in medical professions of the impacts of heatwaves.

- **Misaligned incentives:** tenants or residents of care homes may not have the adaptive capacity to lower their vulnerability, and those who provide the shelter may not have an incentive to take appropriate action.

Policy

- The Heatwave Plan is a key tool but does not account for acclimatisation, and needs to be evaluated on the ground.

Behavioural

- There is evidence that **those at risk may not be willing to accept it or may underestimate the degree of risk they are facing**. This could potentially lead them to take too little adaptation action. People do not like being considered as 'vulnerable'.

- Warnings may not be heeded.

Governance

- **The great diversity of responsibility** within social housing and care home sector weakens adaptive capacity (LCCP, 2012).

- **Lack of coordination and communication between organisations** with responsibility for care of vulnerable people. Information regarding vulnerable people is held by voluntary groups as well as local authorities, and more support should be given to, and more use made of existing, trusted voluntary groups.

Having identified many of the key barriers, the next section explores the potential benefits of actions to lower heat-related mortality and hospital admissions through 'what if?' scenarios.

5.3.10 Illustrative 'what-if?' scenarios

The extent to which adaptation actions would allow the costs of mortality and hospital admissions to be avoided can be explored using illustrative 'what-if?' scenarios.

Fundamental to the following assessment is that **there is limited readily available evidence available on the effectiveness of adaptation actions** in lowering the mortality effects of higher temperatures. The following 'what-if?' scenarios are therefore based on expert judgement about feasible levels of attenuation – no published evidence is available on which to base assumptions. It is likely that a package of measures would be required to bring about particular levels of benefit, rather than one single action. The 'what-if?' scenarios are used

to offer the potential scale of avoided cost if adaptation actions are effective in delivering 20% and 50% attenuation of heat-related mortality effect.

The scenarios are:

- What-if natural acclimatisation (for example, behaviour change such as clothing choice, changing the time at which various activities are undertaken etc) is able to lower the relative impacts on mortality and morbidity by 20%?
- What-if the most vulnerable individuals in the community are directly targeted for help and support to minimise the risk of adverse health effects i.e. the adverse effects are 50% mitigated?

These scenarios suggest relative reductions in cost as shown in **Figure 28**.

Figure 28. Estimated lives saved and reduced costs as a result of adaptation scenarios (assumes central case temperature-mortality relationship)

Impact of adapting to a 10-day episodes (heatwaves) on mortality, 65+ years			What if a package of adaptation actions to increase preparedness is able to lower the adverse impacts on mortality and morbidity by 20%				What if a package of adaptation actions to increase preparedness is able to lower the adverse impacts on mortality and morbidity by 50%			
			Cases		Monetised effect (£m)		Cases		Monetised effect (£m)	
			Mortality	Morbidity	Mortality	Morbidity	Mortality	Morbidity	Mortality	Morbidity
Islington	2030s	1/10 years	2	2	0.4	0.01	5	4	0.5	0.01
		1/100 years	2	2	0.4	0.01	5	5	0.6	0.01
	2050s	1/10 years	5	5	1.3	0.02	12	12	1.6	0.03
		1/100 years	6	5	1.5	0.03	14	14	1.9	0.04
London	2030s	1/10 years	107	96	21.6	0.4	268	241	31.8	0.56
		1/100 years	130	117	26.2	0.5	326	293	38.7	0.68
	2050s	1/10 years	274	246	73.2	1.3	685	616	92.7	1.62
		1/100 years	334	301	89.3	1.6	836	751	113.1	1.98
Eastbourne	2030s	1/10 years	2	1	0.3	0.00	4	3	0.5	0.01
		1/100 years	2	1	0.4	0.01	5	4	0.6	0.01
	2050s	1/10 years	3	2	0.8	0.01	7	6	1.0	0.01
		1/100 years	4	3	1.0	0.01	9	7	1.2	0.02

Source: Calculations based on approach described in main text

This shows that under the assumptions of the analysis (as described above and in **Annex 4**):

- In London, for more regular heat events (10 year return period) around 100 premature deaths (mortality) could be saved through mitigating 20% of the effect of heat on health in the 2030s. This rises to more than 270 lives by the 2050s. For Islington and Eastbourne, avoided deaths would be relatively few in number (though there would be slightly more avoided deaths in Islington as it has almost double the population of Eastbourne).
- When actions are targeted to be more effective, for example by achieving a 50% attenuation of heat-related loss of life, the benefits are commensurately greater. The benefits are greater in Islington than in Eastbourne, particularly

in the 2050s. This is driven by its larger population and high projected temperature extremes for that area.

- In both Islington and Eastbourne, the relative reduction in loss of life for a 10-day heatwave in the 2050s is estimated to be as high as 12-14 and 7-9 deaths respectively.

5.4 Recommended interventions

Having identified the barriers to effective adaptation and the extent to which costs could be lowered if actions could be taken to lower the effects on mortality and hospital admissions, this section summarises the case for intervention to address those that are a priority.

- **Share information across healthcare providers** and develop plans collaboratively. Undertake analysis using scenarios to assess which actions may be effective under particular situations, the thresholds and the limits to adaptation. Assess the costs and benefits of actions under particular circumstances.

- **Build the evidence base on the costs and benefits of adaptation actions to lower heat-related impacts on health**. Assess (*ex ante*) the relevant baseline against which costs and benefits can be assessed, and undertake ex post evaluations after a heatwave.

- **Provide targeted and tailored information, appropriately communicated, to those at risk so that they are able to understand their extent of risk and heed advice.** Raise awareness among vulnerable groups in particular, along with those in the community able to support them.

- **Identify vulnerable people at the local level and collaborate with voluntary groups within the community,** involve them more formally in preparedness planning processes.

The next section seeks to bring the analysis together by suggesting roadmaps which offer packages of measures which could be taken, and when to allow effective adaptation and learning over time.

6 Developing an effective adaptation strategy

The analysis in previous sections has discussed the scale of the potential impact and costs of flooding and temperature-related risks to health and well-being. It has also explored the adaptive capacity of individuals and organisations, the adaptation actions that could be taken and their potential effectiveness, and the key barriers that may constrain adaptation actions being taken.

This section builds on this analysis by introducing the concept of 'adaptive management' in order to offer a suggested roadmap for some adaptation actions over time.

6.1 Managing uncertainty: adaptive management

The projected nature and impacts of climate change in the UK over future decades, as well socio-economics and politics, are subject to a degree of uncertainty, particularly when considering out to the 2050s and beyond (please refer to **Annex 3** for further information). Decisions affecting the resilience of organisations to potential events or changes in weather patterns must therefore be robust.

Uncertainties are particularly problematic for planning large, high cost adaptation options with long lifetimes, as such investments are costly to modify and their design is dependent on what assumptions are made today about climate over the investment's lifetime. If decisions are made without considering these uncertainties, there is a risk of over or under adaptation, wasted investments or unnecessary retrofit costs (Reeder and Ranger, 2011). Adaptation decisions must therefore be robust in the face of a fast changing and uncertain climate (Hall, 2007).

In this project, adaptive management is suggested through an illustrative roadmap as a pragmatic and effective way to allow appropriate actions to be taken (where there is a case for doing so) in the presence of uncertainty. It involves constant monitoring and reviewing of actions taken, and further steps to be taken and iterated, consistent with a strategic direction and the unfolding information about the future. Adaptive management therefore allows parties to learn over time and for new information to be reflected in decision making processes. The intention is to maintain as much flexibility as possible for future options. The essence of the approach is to be clear on the direction of travel, or the vision for the desired outcomes or the management/goals, and the uncertainties about how to achieve these outcomes (Murray and Marmorek, 2004).

In the long term, the direction of travel may need to change, and incremental changes may no longer be sufficient as the vulnerabilities and risks may be so

sizeable that they overwhelm even robust human use systems. Transformational adaptations will then be required: those that are adopted at a much larger scale, that are truly new to a particular region or resource system, and that transform places and shift locations (Kates *et al,* 2012). Anticipatory transformational adaptation is extremely difficult to implement because of uncertainties about climate change risks and adaptation benefits, high costs, and institutional and individual mindset that prefers to maintain existing resource systems and policies than create massive change. This approach allows flexibility to be incorporated into adaptation measures from the start where possible. For example, using measures that are suitable over a broad range of possible future climates or by designing the adaptation measure so it can be adjusted over time (Fankhauser *et al,* 1999). Flexibility is also incorporated into the overall adaptation strategy, by putting the adaptation in a sequence, and leaving options open to deal with a range of possible future scenarios.

6.2 Illustrative roadmaps for health and wellbeing

The roadmap developed here is intended to show "packages" of measures that can be implemented over time. The ECR considers a number of different risks and categories of adaptation actions, and these are set out in a timeframe to illustrate how the issues could be managed adaptively. This report has not developed a detailed adaptation pathway, such as the Thames Estuary 2100 Report, because the "known thresholds" for climate change risks and the relative impacts of the actions against those risks (Reeder and Ranger, 2011) have not been assessed. Future work should analyse the thresholds of individual climate risks and what the limits of specific actions may be in reducing a particular risk.

The majority of the actions described in this report are behavioural and so are less dependent on thresholds for a particular climate change risk than a decision about a physical investment might be. Prioritising adaptation options in the face of uncertainty leads to focus on those options that are:

- **No regrets:** those actions which are worthwhile (ie. they deliver net socio-economic benefits) whatever the extent of future climate change. These types of measures include those justified under current climate conditions (UKCIP, 2007). Most of the behavioural measures fall here, e.g. enhancing knowledge of effectiveness of certain actions.

- **Win-win:** actions that minimise climate risks or exploit opportunities, but also have other social, environmental or economic benefits (UKCIP, 2007). For instance, increasing social cohesion by developing social networks develops social capital as well as resilience to flooding.

- **Low-regrets/low cost:** actions with relatively low associated costs, and with relatively large associated benefits, although the benefits will primarily be realised under projected future climate change (UKCIP, 2007). These could include outsourcing services and storing supplies or existence of alert systems e.g. heat-health watch system.

- **Strategic options with long lead times**: these can include longer term decisions related to investments in new physical infrastructure.

The roadmap involves putting in place incremental adaptation options, rather than undertaking large-scale adaptation in one fell swoop. Measures are designed to allow for incremental change, including changing tack, as knowledge, experience and technology evolve. Delaying a specific measure can be part of this, where that decision is accompanied by a commitment to continue to build adaptive capacity and monitoring and evaluating the evolving risks (UKCIP, 2007).

Adaptive management aims to ensure that actions taken will not be maladaptive if climate change progresses at a rate different from expected today, and to review any and all unintended consequences.

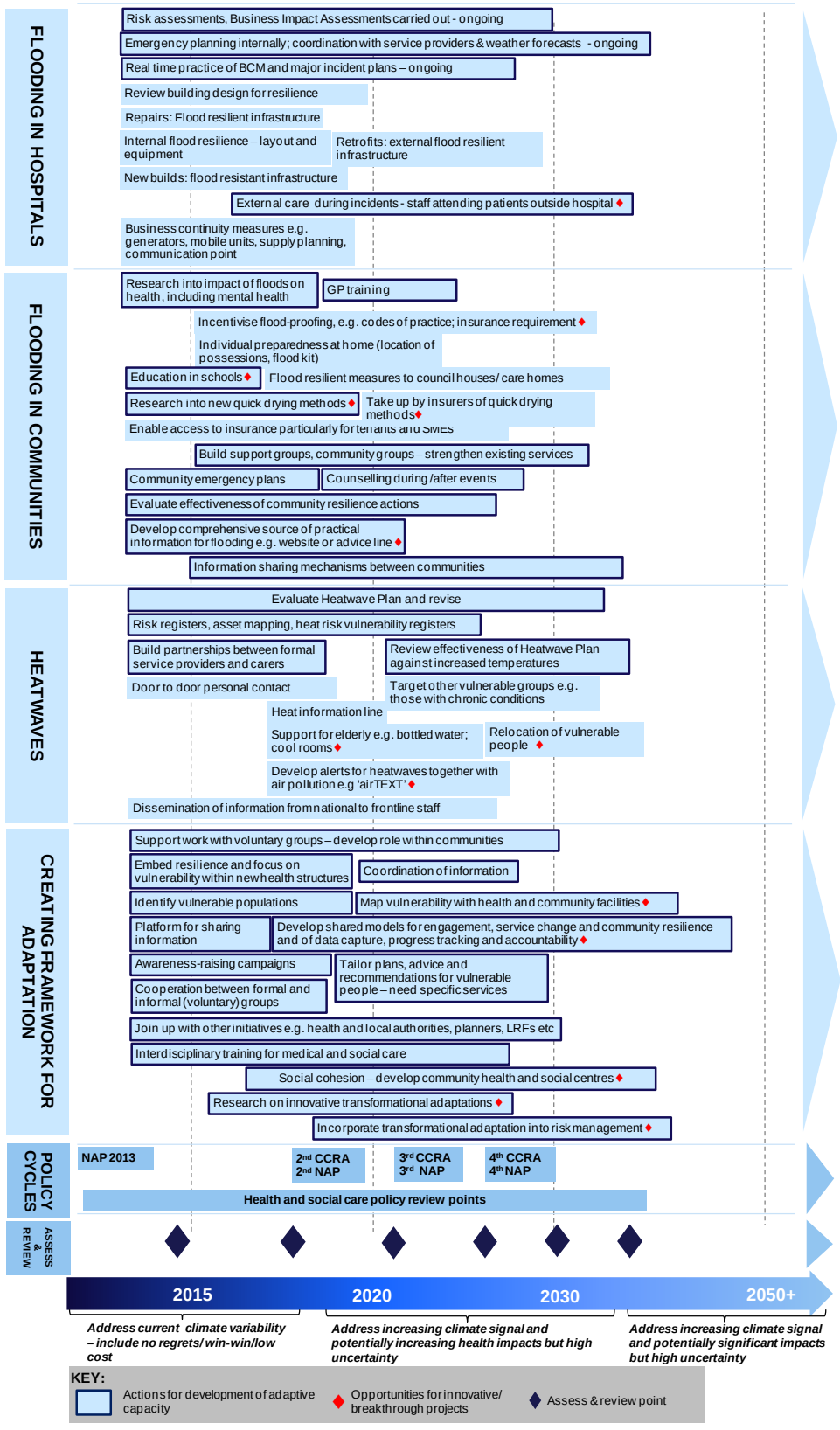
It should also be recognised that any action chosen should be taken with the engagement of stakeholders and availability of data to allow progress and emerging outcomes to be monitored and reviewed.

The roadmaps in **Figure 29** cover certain risks to health and well-being as discussed in the 'what-if?' scenarios. The roadmaps are not intended to be comprehensive or exhaustive, as there are many other roadmaps. Instead, **Figure 29** is intended to be an indicative illustration of some of the actions that could be effective up to the 2050s and when key review points will occur.

- The measures in **Figure 29** were chosen based on the key measures and highlighted actions that came out of the research (literature and stakeholder evidence as set out in sections 3, 4 and 5) and were prioritised. Building adaptive capacity is included within the actions, as illustrated.

- Some of the actions within the roadmap will continue to occur without further support, while others will require intervention by government or other stakeholders.

Figure 29. Illustrative roadmaps



Developing an effective adaptation strategy

Short-term actions would focus on research, planning and building adaptive capacity and are termed as no-regrets. The majority of the actions considered in this report are short-term as they are behavioural and do not require long lead-in time nor do they have long lifetimes.

These include:

- Undertaking systematic monitoring and review of the Heatwave Plan,
- Awareness-raising campaigns,
- Developing community emergency plans,
- Identifying vulnerable people, and
- Mapping vulnerability of risks and people.

Actions in the medium term are those which may not require early action, or need further information before they are taken. Following research activities, development of best practice actions and implementation of research findings will occur, based on the research outcomes. These processes are iterative, allowing flexibility in decision-making. Actions include:

- Developing partnerships,
- Joining up with other initiatives, and
- Develop shared models for engagement and community resilience.

Longer-term, it is likely that strategic responses may be required, for structural changes in the sector, and also for longer-term larger investments with slower immediate results. Long-term measures include consideration of building design and relocation of vulnerable people. The longer-term strategy should be developed as the risks increase.

Figure 29 shows that some actions are likely to be innovative or breakthrough. This refers to those that are significant changes to existing practice, rather than just incremental changes to current processes or decisions. These include:

- Developing community health and social centres, and
- Developing mechanisms to map staff and patients for external care during an emergency.

Where incremental adaptation is no longer appropriate, and significant changes are required, transformational adaptation may be required. In initiating transformational adaptation, supportive social contexts and resources will be key enabling factors (Kates *et al,* 2012). Innovative transformational adaptation actions should be considered in detail in future iterations of the ECR as

information and understanding develops. Early steps that should be developed include:

- Incorporating transformation adaptation into risk management, and
- Initiating research to expand the menu of innovative transformational adaptations.

Underpinning these roadmaps is the need to consider the conditions under which adaptation actions as a whole are likely to be effective. Fully mitigating the impacts of climate threats, and making the most of opportunities, requires a range of conditions to be in place, such as the policy framework and other supporting mechanisms.

6.2.1 Coordination

There are many interdependencies between the options in the roadmaps. Many of the options rely on capacity-building and the framework for adaptation. For example, embedding resilience within new health and wellbeing boards, identifying vulnerable populations and building up cooperation between formal and informal (voluntary) groups. The base must be established before other, costlier, options can be taken later on.

The adaptation responses in this report focus mainly on behavioural measures. There are many other adaptation responses to flooding and heating impacts (such flood alleviation measures, physical infrastructure design of hospitals and houses etc) that are extremely important. Some further adaptation measures regarding overheating are assessed in the ECR Report on Overheating in Residential Housing. The actions in the above roadmap must be considered within the full suite of the possible responses to flooding/ heatwaves.

In addition, there are many dependencies on actions in other sectors that need to be considered to lead to effective adaptation. For example, continuity of hospital services will depend on water and power provision, and on transport to maintain access. Hospital design for flooding will also depend on design for overheating, water and energy efficiency; and response to flooding will depend on the risk which may be mitigated or exacerbated by land use planning, and the natural environment and ecosystem services, and other needs for land use.

6.2.2 Review points

The roadmaps incorporate review points, where policy and practice can be assessed and evaluated in light of recent developments, new information and better understanding of climate risks and research outputs. The review points are designed to coincide with policy cycles (e.g. NAP and CCRA as well as developments in public health policy) and points where adaptation actions should be maturing. These frequent review points will enable adaptation actions to be

developed iteratively, with consideration of inter-dependencies and linkages between options.

Earlier review points allow analysis of short-term measures, with no-regret/win-win characteristics, and particularly those that build adaptive capacity. The review points will also allow consideration of the options in the context of developing evidence on evolving climate risks. Some options may be more or less appropriate in future time periods, depending on the level of projected change in climate risk, but also socio-economic developments. At each review point, the options should be considered as portfolios of short-term, medium-term, and long-term responses, to identify early actions to address long-term issues and ensure there is enough time for decisions with long lead-in times. There may be additional review points where major review and consultation is required e.g. if there are repeated extreme events (such as the 2003 heatwave) or if the upper end of climate projections and uncertainty ranges are approached.

6.2.3 Enhancing the effectiveness of action

Underpinning these roadmaps is the need to consider the conditions under which adaptation actions as a whole are likely to be effective. Fully eliminating the projected impacts of climate threats may not be justified – it depends on the costs of taking actions. Decisions should be informed by an assessment of all costs and benefits of action over time, duly accounting for the inevitable uncertainties.

The need for a **cross-sectoral approach** across different organisational levels is increasingly recognised by the health and social care sector. A broad approach to understanding social vulnerability is required.

Health officials should be in dialogue with urban planners and managers. **The role of community representation in forums of policy making and emergency planning is key.** There needs to be increased support for less well organised sectors (Molyneux *et al,* 2012).

It is **imperative that the more "soft" measures (i.e. behavioural) described in this report are considered at the same time as the "hard" measures (i.e. physical infrastructure)** described in the ECR Report on Overheating in Residential Housing. The external and internal environments should not be separated as they are interdependent – actions in one area affect another.

Given the range of activity already taking place in some communities and many areas of healthcare provision, **it is important that information generated and learning is shared**. Effectiveness of any action will depend on local conditions – understanding the conditions under which actions are or are not effective is valuable and would help to target action to where the benefits would be greatest.

Community resilience, land-use planning and building design, and emergency planning for climate risks must be considered together so that communities are resilient to emergencies generally, rather than specific events only.

Having explored how an effective adaptation strategy can be developed, the case for intervention as identified from the analysis in this report is summarised in the following section.

6.3 Recommendations

The case for intervention is generally present under the following conditions:

- There are significant barriers to adaptation that, unless they are addressed, are likely to significantly constrain the extent of adaptation actions;
- There are constraints on the adaptive capacity of individuals or organisations; and
- There are actions that should be avoided as they could lead to maladaptation.

There are a range of actions that could be taken including those that are 'no regret', win-win, low cost or those with long lead times. Actions to build adaptive capacity can fall into any of these categories. Given the timeframe of this report and the fact that it is being used to inform the first NAP, most of the case for intervention focuses on building adaptive capacity: this will allow strengthen decision-making and increase flexibility and ability to adapt to uncertain climate change impacts.

This report has highlighted a case for intervention to address key barriers.

Case for intervention in response to risk of flooding to hospitals

- **Build an understanding across hospitals of the interdependencies in service provision** (e.g. with water, power and transport infrastructure) **and with other healthcare providers.** This involves mapping linkages to identify the key points of risk, and appropriate scenarios to inform decision-makers. Share information across interdependent hospitals on resilience and planned actions to facilitate effective decision-making.
- **Assess the degree to which hospital resilience is affected by climate change risks to other sectors and the actions they are taking to adapt**. For example, this could be undertaken for particular areas as pilot studies.
- **Improve learning from past experience and embed best practice approaches to flood resilience consistently across the sector**. Build the

evidence on how small-scale and low-cost actions could potentially be effective, for example, basement protection, re-locating key equipment within the hospital away from the basement. Gather detailed evidence of costs and benefits under different situations.

- **Evaluate hospital adaptation actions (ex post) to build the evidence base** – the current lack of evidence could lead to maladaptive actions being taken, particularly as hospitals are upgraded over time.

- **Carry out research to understand better ways of building resilience of emergency care outside the hospital and in the community**.

To address key barriers to effective adaptation to enhance community resilience and lower mental health impacts of flooding

- **Share information across infrastructure providers and those in the healthcare and resilience sectors and develop resilience plans collaboratively. Undertake analysis using scenarios** to assess which actions may be effective under particular situations, the thresholds and the limits to adaptation. Assess the costs and benefits of actions under particular circumstances.

- **Provide a single trusted hub of information for members of communities, with comprehensive cover of all aspects needed for effective recovery following a flood (such as medical advice, insurance claim handling and managing builders).** For example, a national flood website. Educate key figures in the community to share information. Use existing and trusted channels where possible.

- **Provide enhanced emotional support for individuals by** building and strengthening existing community groups and processes to share information, build trust of authorities among community etc. Undertake research into ways of sharing best practice and examples between communities e.g. information platforms, web-based resources.

- **Take action to make insurance a driver of flood-resilience,** e.g. insurance companies to use most rapid drying technologies to dry homes, and to encourage cleaning of assets rather than replacement where possible, and encourage flood-resilient repair to homes, rather than repairing them to the same vulnerable standard.

- **Provide education and training for emergency planners, local authorities, and community members** to ensure effective engagement with individuals and groups, building and applying emotional intelligence to

empathise and empower communities to help themselves; and, build knowledge of risks and actions to minimise them (e.g. in Scotland, school children are taught about climate risks etc as resilience is integrated into the curriculum).

- **Investigate the feasibility of integrating voluntary groups within formal planning processes** to ensure vulnerable groups are not isolated (e.g. the Central Scotland's Memorandum of Understanding between statutory and voluntary sector responders).

To address key barriers to effective adaptation to address the heat-related risk to the health of those over 65

- **Share information across healthcare providers** and develop plans collaboratively. Undertake analysis using scenarios to assess which actions may be effective under particular situations, the thresholds and the limits to adaptation. Assess the costs and benefits of actions under particular circumstances.

- **Build the evidence base on the costs and benefits of adaptation actions to lower heat-related impacts on health**. Assess (*ex ante*) the relevant baseline against which costs and benefits can be assessed, and undertake ex post evaluations after a heatwave.

- **Provide targeted and tailored information, appropriately communicated, to those at risk so that they are able to understand their extent of risk and heed advice.** Raise awareness among vulnerable groups in particular, along with those in the community able to support them.

- **Identify vulnerable people at the local level and collaborate with voluntary groups within the community,** involve them more formally in preparedness planning processes.

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