Adaptation Sub-Committee of the Committee on Climate Change

Analysis of How Land Use Planning Decisions Affect Vulnerability to Climate Risks

Final Report

4-05

Final | July 2011

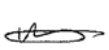
Ove Arup & Partners Ltd
13 Fitzroy Street
London
W1T 4BQ
United Kingdom
www.arup.com

Job number 216009-00

ARUP

Document Verification

ARUP

Job title		Analysis of How Land Use Planning Decisions Affect Vulnerability to Climate Risks			**Job number** 216009-00
Document title		Final Report			**File reference**
Document ref		4-05			
Revision	**Date**	**Filename**			
Draft 1	13/04/11	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Vicky Evans	Stephen Cook	Stephen Cook
		Signature			
Draft 2	20/05/11	**Filename**	Draft final report with addn analysis 200511.docx		
		Description			
			Prepared by	Checked by	Approved by
		Name	Vicky Evans/ Fiona Boden	Stephen Cook	Stephen Cook
		Signature			
Final Draft	09/06/11	**Filename**	Draft final report 090611.docx		
		Description			
			Prepared by	Checked by	Approved by
		Name	Vicky Evans/ Fiona Boden	Stephen Cook	Stephen Cook
		Signature			
Final	11/07/11	**Filename**	ASC Final report 2011 07 11.docx		
		Description			
			Prepared by	Checked by	Approved by
		Name	Vicky Evans/ Fiona Boden	Matt Verlander	Stephen Cook
		Signature			

Issue Document Verification with Document ✓

Contents

1 Introduction

1.1 Purpose

The Adaptation Sub-Committee (ASC) has identified land use planning as one of five priority areas for adaptation to climate change in the UK. In its first report on the UK's preparedness for climate change[1], it argues that land use planning is a priority for adaptation by:

- Locating buildings and infrastructure in areas of lower flood risk;
- Managing competing pressures on land in response to potential impacts of climate change; and
- Enhancing the design of urban landscape to reduce the risk of heat stress.

The report also outlines the importance of ensuring land use decisions do not restrict future options or leave future generations more vulnerable to climate change. It poses a number of questions as to how the new planning system can ensure sufficient cooperation of adaptation at a landscape scale and how capacity building can translate into tangible outputs to reduce vulnerability to climate change.

This report has been commissioned by the ASC and the study stems from those initial findings and forms the beginning of a programme of research on the effectiveness of the town and country planning system to integrate adaptation responses in the development and use of land.

Primarily, this research programme is focused on the end of the process, i.e. how planning decisions, which form the principal regulatory gateway for new development, have in the recent past affected vulnerability to climate risks.

This research project sets two key research questions:

- How have current and future climate risks and the underlying drivers of climate risk changed as a result of recent land-use planning decisions?
- Is there evidence that land-use planning is incorporating low-regret adaptation measures that increase resilience to climate change?

In addition to the planning decisions analysis, this report also includes the results of the separate but parallel review of whether, and how, local planning policy considers climate change vulnerability and adaptive measures. This work was originally undertaken by staff working within the ASC Secretariat. Latterly Arup was commissioned to complete the work by the ASC and this report incorporates the findings of both the in-house and Arup-led parts of the local planning policy analysis.

[1] How well prepared is the UK for climate change? (Adaptation Sub-Committee, September 2010)

1.2 Scope

The study sought to assess how development management decisions and land-use planning policies are affecting vulnerability to climate risks by asking the following questions based on the ASC's preparedness ladder:

Adaptation outcomes & actions

- How have development decisions affected vulnerability to climate risks?
- Is there evidence of development decisions incorporating low-regret adaptation measures?

Decision-making

- Are climate risk and adaptation measures being incorporated transparently and robustly alongside non-climate risks in setting local planning policies?
- Are local planning authorities effectively working in partnership on issues that require a strategic and co-ordinated approach to decision-making, such as along the coast or at the catchment scale?

Policy barriers

- What effect has national planning guidance had in influencing local planning policies and actual development decisions?
- Are there barriers to adaptation in the current land-use planning system that the policy framework could address more effectively?

The research applied a case study approach in order to enable analysis in sufficient detail to understand the complexities of planning decision making processes and land use and development outcomes. This research is based on understanding the planning process and development management decisions in England and therefore the findings apply to this country only.

This research is believed to be the first of its kind and a key output has been to establish a baseline upon which future iterations of the research can build a more sophisticated picture of detailed adaptation and vulnerability trends in the planning system as future national guidance and legislative reforms and development plan revisions work their way through the system.

As with any small sample analysis, the results can be used to illustrate issues which have been identified by other methods at a national scale and also to provide indications of new issues which had not been observed by wider and broader methods. The authorities selected for the research are a representative sample, selected to ensure that the key climate risks facing England were accounted for. However, the small number of case studies means that conclusions on how all local authorities in the country are adapting to climate change should be drawn with care.

1.3 Research Parameters

This section describes the overall structure of the study and identifies a number of key limitations which have affected the findings and outputs. Full details of the methodology are set out in Section 3.

1.3.1 Case Study Localities

The geography for analysis examined specific local authorities within five broad localities (north east London, Tees Valley, Hull and Humber, South Hampshire and Gloucestershire). Land cover change (spatial) analysis was undertaken for eleven local authority areas within these five localities using Geographic Information Systems (GIS).

Analysis of planning applications (statistical analysis) and case study analysis focuses on three of the eleven local authorities (London Borough of Islington, Stockton-on-Tees and East Riding).

Analysis of policy making focuses on three local authorities only (Stockton, North East Lincolnshire and London Borough of Hackney).

Stockton-on-Tees is the only local authority subject to spatial analysis, a review of planning applications/ case study analysis and analysis of policy making.

Please see **Section 3.4** for more details regarding the localities selected for assessment.

1.3.2 Timescales for Analysis

Planning applications

The planning application databases received from the three local authorities subject to the planning application analysis dates back to 2001. Therefore any mapping of planning applications onto climate risk areas will date back to 2001. However, it was not until 2005 with the advent of electronic planning application submissions that an online planning service was available. Therefore this study has been limited by the availability of planning documents online, meaning that most of applications sampled have been from 2006 or later.

Policy implementation

The national planning policy framework for climate change and its key impacts documented primarily through PPS1 (Planning Policy Statement 1: Delivering Sustainable Development) and PPS25 (Planning Policy Statement 25: Development and Flood Risk) were introduced from 2005, i.e. halfway between the two spatial data points available for the analysis (2001 and 2011). The analysis of spatial development could not therefore disaggregate development over the decade which preceded the new framework from that which has come after.

1.3.3 Major Applications

In order to highlight key trends and to work with a manageable quantum of planning applications, the study has undertaken analysis on major planning applications only. This constitutes:

- ten (10) or more units of residential accommodation;
- new commercial development over 1,000 sq m;
- change of use over 1,000 sq m;
- amendment or removal of a condition relating to a major development;

- site area exceeding 0.5 hectares where it is not known how many dwellings or how much floorspace is to be created;
- development site area is 1 hectare or more; and
- waste development.

It was agreed with the ASC at the research scoping stage that in order to gather a useful sample of planning applications which incorporate adaptation measures, major applications would provide a more appropriate population for analysis. Although minor applications constitute a large number of applications, inclusion of them within the dataset would skew the results and would be unlikely to show results on a scale as with major applications. Furthermore, "permitted development" (i.e. development permitted by the Town and Country Planning (General Permitted Development) Order 1995) such as some extensions to buildings and hard standing do not require planning permission and therefore could not be included within this analysis.

1.3.4 Data Sources

The spatial analysis undertaken within Section 4 of this study relies upon Ordnance Survey 2001 and 2011 MasterMap data. The Ordnance Survey confirmed that the two datasets use the same methods of data collection, meaning that each land use type description is comparable between the two time slices. Essentially it is the same dataset which is continuously updated. However, Ordnance Survey (OS) advised that there is some difference in TOID (Topographic Identifier) structure as the information has evolved over time, which may influence the results slightly. There are limitations with this data, and the study indicates where the data is limited to this effect.

The spatial analysis has been applied on a desktop basis only. Where anomalies have been identified, locally knowledgeable staff within Arup and the relevant local authorities have been consulted where possible, but no on-site validation was possible within the scope of the research. Where unexpected results have occurred these are highlighted in the report.

As highlighted in Section 3.2.1 there are some limitations to the data that is available for this study that have been considered and accounted for in drawing conclusions. This has limited the scope of the study to remain within the boundaries of the data that is available. For instance, the water stress maps produced by the Environment Agency are at water company level only, and do not allow disaggregation to the local authority scale.

1.4 Acknowledgements

1.4.1 Adaptation Sub-Committee Members

We are grateful to the following Adaptation Sub-Committee members for their guidance and support:

- Lord John Krebs;
- Sir Graham Wynne;
- Professor Jim Hall;

- Dr. Andrew Dlugolecki;
- Dr Sam Frankhauser;
- Professor Martin Parry;
- Professor Tim Palmer; and
- Professor Anne Johnson.

1.4.2 Sounding Board Members

We are grateful to the following study Sounding Board members for their guidance and support:

- David Thompson ASC Secretariat;
- Sebastian Catovsky ASC Secretariat;
- Graham Wynne, CBE ASC member;
- Peter Bide Department for Communities and Local Government (DCLG);
- Jenny Crawford Royal Town Planning Institute (RTPI);
- Andrew Coleman Environment Agency;
- John Silvester Planning Officers Society, Local Government Group;
- Sule Nisancioglu Planning Officers Society;
- Dominic Rowland Defra; and
- Michael Chang Town and Country Planning Association (TCPA).

We are grateful to Dr Jeremy Carter, Manchester University for undertaking a peer review of the draft report.

1.4.3 Local Authorities

We are grateful to the following eleven local authorities for agreeing to participate in the study and providing planning application data:

- East Riding of Yorkshire Council;
- Fareham Borough Council;
- Gloucester City Council;
- Gosport Borough Council;
- Kingston upon Hull City Council;
- London Borough of Haringey;
- London Borough of Islington;
- South Gloucestershire Council;
- Southampton City Council;
- Stockton- on- Tees Borough Council; and
- Tewkesbury Borough Council.

1.4.4 Data providers

We are grateful to the following other organisations for providing data for inclusion in this study:

- Defra;
- Environment Agency;
- GiGL (Green Space Information for Greater London) with permission from Natural England; and
- University College London for the LUCID data.

2 Background

2.1 Introduction

This study seeks to evaluate how the land use planning system in England has influenced vulnerability to climate risks and whether there is evidence to suggest that the land use planning system is incorporating adaptation measures. The purpose of this section is to provide:

- information to understand key terms used in the study; and
- information which has shaped the scope and methodology.

2.2 Adaptation

Adaptation can be defined as adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects. Adaptation can be carried out in response to (ex post) or in anticipation of (ex ante) changes in climatic conditions. It entails a process by which measures and behaviours to prevent, moderate, cope with and take advantage of the consequences of climate events are planned, enhanced, developed and implemented (adapted from UNDP 2005, UKCIP 2003 and IPCC 2001).

2.2.1 Adaptation Measures

This study considers whether there is evidence that local planning authorities are considering climate risks when making decisions on the location and design of new development and in doing so incorporating, or requiring, adaptation measures.

There are a number of adaptation measures that can reduce vulnerability to climate-related risks by both protecting against current damage from extreme weather and increasing resilience to future climate risks. They can also yield other benefits than those directly relating to weather and climate vulnerability, e.g. water conservation can reduce the amount of energy used in domestic heating and water treatment. This is particularly significant when it is considered that about 90% of carbon emissions in the water industry come from its end use rather than in the treatment process.

Adaptation measures can be *robust options*, which broaden the coping range from the outset, or *flexible options and strategies* that allow for potential mid-lifetime adjustments as more information about climate change becomes available.

Adaptation strategies include:

- *Strategic land use planning* e.g. ensuring new buildings and infrastructure are sited in areas that minimize exposure to climate risks such as flood zones.
- *Design and renovation* e.g. renovating buildings to enable them to cope with future climate risks.
- *Managing resources* e.g. sustainable water management, ecological preservation and extension.

Specific adaptation measures include:

- Green roofs;
- Sustainable urban drainage systems;
- Increasing flood resilience (door guards, allowing for natural changes in rivers and coasts, building design);
- Improving water efficiency (demand management, building facilities for water re-use); and
- Increasing biodiversity resilience (enhancing and extending ecological connections between habitats, establishing buffers around areas of high-wildlife value).

A table defining the adaptation measures which have been assessed as part of this study can be found in **Appendix A.**

2.2.2 Climate Related Risks

The UK currently faces a number of climate-related risks which affect both natural and human systems. The impacts of these risks can be damaging, although some can provide benefits and opportunities. In the future, many of these risks are projected to intensify with climate change. This study looks at the following risks:

- River, tidal and pluvial flooding;
- Coastal erosion;
- Heat stress;
- Water stress; and
- Further degradation of natural environment and ecosystems.

Details regarding the how climate risks have been considered in terms of formulation of indicators is set out in Section 3.

2.3 Land Use Planning

Land use planning is defined as the order and regulation of land and space in order to prevent conflicts in land use. Spatial planning is defined as going "beyond traditional land use planning to bring together and integrate policies for the development and use of land with other policies and programmes which influence the nature of places and how they can function"[2]. The planning system is the regulatory mechanism for land use planning. The planning system is the primary statutory mechanism for determining how land is used in towns, cities and the countryside. Planning decides where development should happen, where it should not and how it affects and fits into its surroundings. The planning system is essential for economic growth, in protecting the environment and promoting sustainability. Decisions about planning applications are based on the 'development plan', prepared by each local council. The planning system aims to balance competing demands so that land is used in the public long-term interest.

[2] DCLG (2005) Planning Policy Statement 1: Delivering Sustainable Development, page 12

2.4 Planning Policy and Development Management

Planning policy and development management together form the planning system. Planning policy plays an important role in ensuring future development considers climate adaptation risks.

Policies within the Local Development Framework (LDF) or Unitary Development Plan (UDP) set out what is expected of development in order for planning permission to be obtained. Policies can identify specific locations or set criteria for types of locations which are suitable for particular land uses. Policy can also stipulate particulars of the design of new development or the assessment of its effects.

Decisions on individual planning applications (development management) are normally based upon the planning policy framework although other material considerations can justify granting planning permission which does not comply with one or more policies.

Taken together, these two elements – planning policy and development management – form the planning system, and both these areas can address climate adaptation risks.

2.4.1 Planning Policy

Local planning policy can address climate adaptation by developing clear policies for the location and design of new development which mitigate risks identified for an area. For example, authorities which experience extreme river, tidal, and pluvial flooding are able to use that evidence to designate areas at risk where development will be not permitted. If the risk can be mitigated through careful design, the policy could be developed to stipulate development will only be approved where certain measures are incorporated.

Having a solid evidence base is essential for setting robust policies that will stand up at inspection. For instance, a Strategic Flood Risk Assessment should inform the Sustainability Appraisal and policies of a local plan and London boroughs that are more exposed to the Urban Heat Island effect need to demonstrate the links between increasing development and temperature to justify policies designed to mitigate that risk, such as requiring green roofs and tree planting in new development. Policy, therefore, plays an important role in laying the foundations for ensuring new development adapts to the changing climate.

2.4.2 Development Management

Development management considers national, regional (if applicable) and local planning policies to determine if a development proposal is acceptable. A planning officer may also consider ‘any other material considerations’, however with the emphasis on evidence it is unusual for an application to be approved contrary to the development plan.

With robust policies in place, the development management system would be able to ensure new proposals incorporated measures to ensure the adaptation risks were mitigated or applications refused. Likewise, if a proposal was identified to have a positive impact on adaptation, such as if it increased the amount of green surfaces, then these wider benefits would support a decision to grant permission.

Applicants are required to submit particular details and information as part of their planning submission, demonstrating that their application complies with local and national planning requirements. Submission of some documents is mandatory, and some discretionary based on local authority requirements and local context. The planning application documents of particular interest to this study include:

- Planning Statement;
- Design and Access Statement;
- Environmental Statement;
- Flood Risk Assessment; and
- Sustainability Statement;

A local planning authority granting permission can also impose planning conditions on development to ensure any potential issues are mitigated. These conditions can address adaptation risks, such as requiring green roofs, flood defences or sustainable drainage. Furthermore, applications may be approved subject to a S.106 legal agreement to provide, for example, on or off site infrastructure to mitigate against the adverse effects of climate change. As part of the planning application review, the study assessed the proportion of applications which include documents which refer to climate change risks and incorporate adaptation measures as design solutions or management measures. As highlighted by members of the RTPI Climate Change Network, the impacts of development management decisions on resilience to climate change are influenced by pressure for development, as planners can often require best practice approaches on prime development sites. Where there is less pressure, planners may have very little leverage.

2.4.3 Building Control

Parallel to development management are building control regulations which can also help to address adaptation risks. However, despite the overlap, the building control process is entirely separate to planning. The legislative framework of the building regulations is principally made up of the Building Regulations 2010 and The Building (Approved Inspectors etc.) Regulations 2010 - both came into force on 1 October 2010. In addition, the Sustainable and Secure Buildings Act 2004 introduced new powers and requirements with respect to a range of building related issues. Not all sections of the Act have been enacted and some of them would require new regulations to give them effect, but the range of subjects now includes sustainability.

2.4.4 Planning System Processes

The planning system, and its relation to climate change adaptation, can best be understood by reference to a logic chain showing the connections between different events or stages of an area of inquiry. Shown below is the logic chain for the planning system, and how different stages of the planning process (from policy through to development management) relates to reviewing the effects from land use changes on climate vulnerability.

Objectives and **inputs** can be related to formation of policy and compilation of the relevant evidence base to support assessment of the climate risks. This study

seeks to evaluate whether local authorities are formulating planning policy to take account of climate risk.

Processes, **outputs** and **outcomes** are related to the development management system. By reviewing **outcomes**, using GIS spatial analysis, it is possible to gain some understanding of how land use has changed physically as a result of the earlier links in the logic chain. Although tracking trends in land use change in GIS is effective at tracking physical changes which are in some way visible (such as development in flood risk areas), GIS does not detect detailed design interventions where many adaptation measures occur (such as underground flood storage tanks or grey water systems).

Exploring the **processes** and **outputs** related to the planning system allows us to explore whether planning decisions tend to document the relevant measures as part of the permission granted, and how the application assessment and consultation processes address key climate risks. By looking into the application process itself, the study will explore what level of knowledge planning officers and developers have on the possible measures to address adaptation risks and if planning conditions/obligations are being used to improve the resilience of future development. It is this process which will highlight the detailed design interventions proposed by the applicant where many adaptation measures appear.

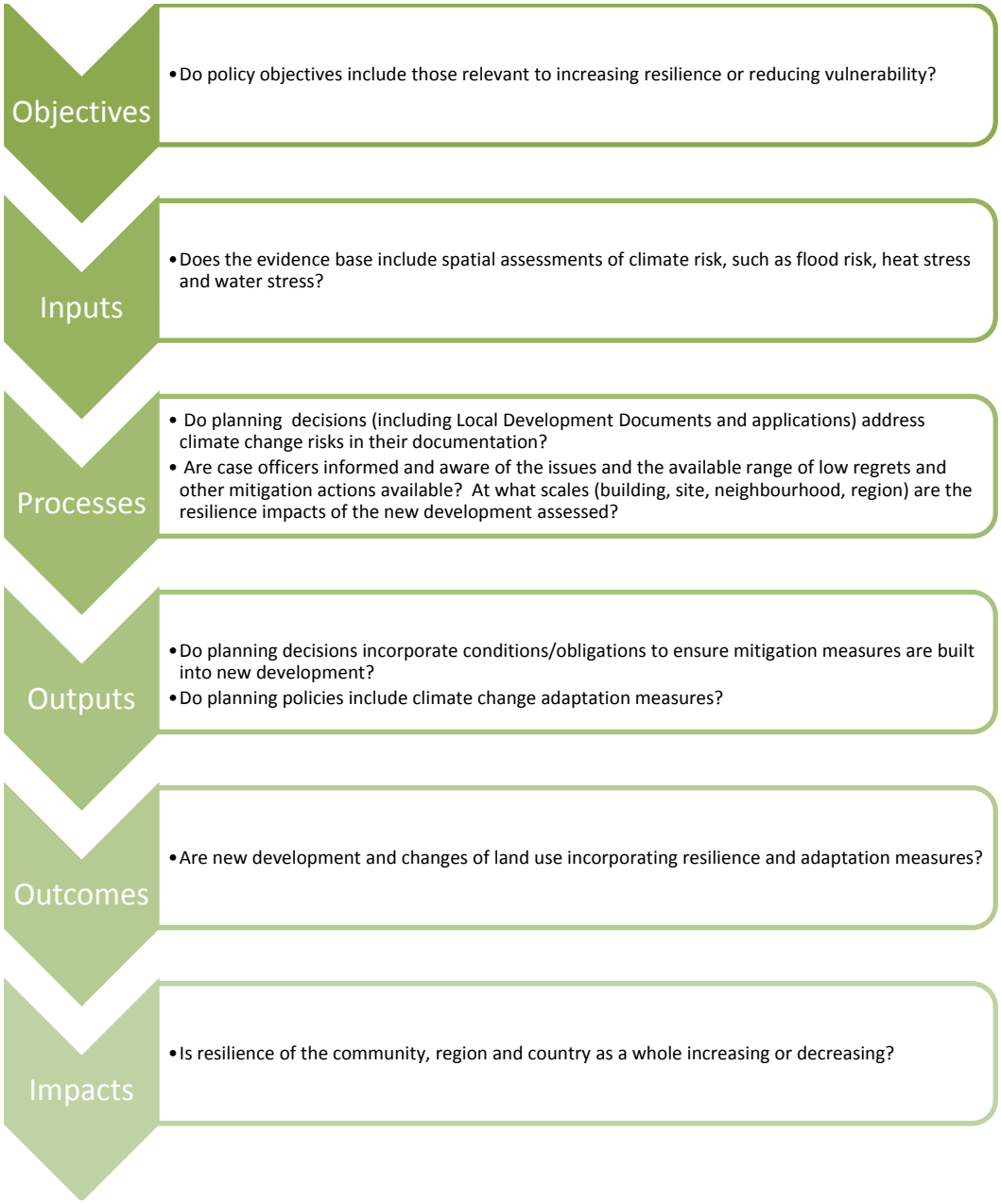


Figure 1: **Logic chain of the planning system**

2.5 Climate Change Adaptation Policy

The limitations of the timescales associated with the study are recognised, particularly with regard to the implementation of national climate change adaptation policy and subsequent planning guidance. A review of the key climate change adaptation policies highlights the increasing importance placed on the climate change agenda over the past decade, notably since 2005 and the decision making framework within which the planning system sits.

2.5.1 UK Strategy for Sustainable Development – Securing the Future (2005)

In March 2005, the UK government launched its new strategy for sustainable development, *Securing the Future*. Part 5 of Chapter 4 stresses that some climate change is already inevitable so there is a need to understand the unavoidable impacts so that we can prepare for them. Accordingly, the strategy states that 'adaptation must be brought in to all aspects of sustainable development'.

2.5.2 PPS1: Delivering Sustainable Development (2005)

Planning Policy Statement 1: Delivering Sustainable Development seeks to ensure sustainable development is the outcome of all land use planning decisions. It states that, *"Development plan policies should take account of environmental issues such as mitigation of the effects of, and adaptation to, climate change"* (para. 20).

It also states development plan policies should take account of the following issues related to climate change adaptation:

- the potential impact of the environment on proposed developments by avoiding new development in areas at risk of flooding and sea-level rise, and as far as possible, by accommodating natural hazards and the impacts of climate change;
- the protection of the wider countryside;
- the conservation and enhancement of wildlife species and habitats and the promotion of biodiversity; and
- the need for the provision of good quality open space.

2.5.3 Supplement to PPS1: Planning and Climate Change (2007)

The supplement to *Planning Policy Statement 1: Planning and Climate Change* contains key policy guidance in relation to climate change adaptation, seeking to '*shape sustainable communities that are resilient to and appropriate for the climate change now accepted as inevitable'*. PPS1 acknowledges that 'even with effective policies for reducing emissions in place, the world will still experience significant climate change over the coming decades from emissions of carbon dioxide and other greenhouse gases already released. Changes in climate are likely to have far-reaching, and potentially adverse, effects on our environment, economy and society for which we need to prepare and adjust' (para. 5). Climate change adaptation thus forms a central tenet of the policy statement.

The key PPS1 planning objectives which relate to climate change adaptation, include:

- Secure new development and shape places that minimise vulnerability, and provide resilience to climate change; and in ways that are consistent with social cohesion and inclusion; and
- Respond to the concerns of business and encourage competitiveness and technological innovation in mitigating and adapting to climate change.

2.5.4 PPS25: Development and Flood Risk (2006, revised in 2010)

Planning Policy Statement 25 updated and strengthened previous planning policy on flood risk. It seeks to facilitate and promote sustainable patterns of development which avoid flood risk and accommodate the impacts of climate change (para. 3). The strong direction of PPS25 in its policies to locate development away from areas at risk of flooding reflects a clear commitment to climate change adaptation. As paragraph 5 states:

'the aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk'.

PPS25 accordingly places great emphasis on applying a sequential approach to development in order to minimise risk (para. 14-15). This sequential approach directs the most vulnerable development to areas of lowest flood risk, gives priority to the use of sustainable drainage systems and ensures that all new development in flood risk areas are appropriately flood resilient and resistant e.g. through the incorporation of safe access and escape routes where required. This risk-based approach is strongly driven by climate change adaptation.

Adapting to flood risk through spatial planning is thus manifest in PPS25, but layout and design considerations relating to climate change adaptation are also cited as important factors. This includes the incorporation of sustainable drainage systems, for example (para. 6).

PPS25 requires Flood Risk Assessments to carried out which assess the risks of all forms of flooding to development taking climate change into account (para. 10). FRAs thereby ensure that climate change adaptation – through location, layout and design – is considered within the planning process. Additionally, PPS25 contains national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights from present to 2115 (para B9, appendix B). Taking into account these expected impacts of climate change is also a key means for adaptation to future risk to be incorporated into the planning process.

PPS25 has been complemented by changes to secondary legislation that made the Environment Agency a statutory consultee for applications in river and tidal floodplains, a 'Call-in' Direction that ensures that the flood risk implications of applications for major development in flood zones are assessed and the introduction of a 'default' requirement for porous hardstandings.

The ASC's September 2010 report states '*there is good evidence that local development control decisions are taking flood risk into account, driven by PPS 25'*. The report also states, however, that there is little evidence of other climate risks and adaptation being made integral to planning decisions. This study seeks to determine what effect national planning guidance (such as PPS25) has had in influencing local planning policies and actual development decisions and whether there are barriers to adaptation in the current land-use planning system that the policy and decision making framework could address more effectively.

The floods of summer 2007 and the recommendations set out within the Pitt Review (2008) have seen the issue of flooding rise in importance due to the

increased realisation of the consequences of flood events. Recommendations within The Pitt Review included the need to adapt to flooding and that the Government should ensure that there is proper resourcing of flood resilience measures, with above inflation increases every spending review. This also placed increased emphasis on the importance of taking account of the risk posed by pluvial flooding.

The Flood and Water Management Act (2010) provides for better, more comprehensive management of flood risk for people, homes and businesses, helps safeguard community groups from unaffordable rises in surface water drainage charges and protects water supplies to the consumer. The Act implements the Pitt Review recommendations requiring urgent legislation, following his review of the 2007 floods. The Act is central to reducing the flood risk associated with extreme weather, which takes into consideration that these extreme events are projected to occur more frequently as a result of climate change.

The Act creates clearer roles and responsibilities and instils a more risk-based approach. This includes a new lead role for local authorities in managing local flood risk and a strategic overview role for all flood risk for the Environment Agency. This placed an increased emphasis on surface water flooding, whereby local authorities were given responsibility for this issue. Furthermore, this requires developers to incorporate sustainable drainage systems into new developments.

2.5.5 PPS25 Supplement: Development and Coastal Change (2010)

The supplement to PPS25 on "Development and Coastal Change" (2010) sets out a planning framework for the continuing economic and social viability of coastal communities. The policy aims to strike the right balance between economic prosperity and reducing the consequences of coastal change on communities. The Government objectives specifically state the need to "adapt to coastal change". As such policies and decisions in coastal areas are based on an understanding of coastal change over time and prevent new development from being put at risk from coastal change. This includes avoiding inappropriate development in areas that are vulnerable to coastal change and directing development away from areas vulnerable to coastal change.

This supplement states that LPAs should identify areas likely to be affected by physical change along the coast and for these to be referred to as Coastal Change Management Areas (CCMAs). Within these CCMAs authorities should set out what is appropriate development and the circumstances in which certain types of development would be permissible. This also states where development and infrastructure should be moved out of the CCMA authorities should make provision for suitable land outside of this area.

2.5.6 Climate Change Act (2008)

In November 2008, the Climate Change Act introduced the world's first long-term legally binding framework to tackle the risks of climate change. Enhancing the UK's ability to adapt to the impact of climate change is one of the central tenets of the Act, and an Adaptation Sub-Committee of the Committee on Climate Change

was accordingly established to provide advice to, and scrutiny of, the Government's Adaptation work.

Part 4 of the Act is committed to 'Impact of and Adaptation to Climate Change', and sets out the following requirements:

- that a report containing an assessment of the risks for the UK of the current and predicted impact of climate change is produced within three years, and at least every five years thereafter (section 56);
- that objectives in relation to adaptation to climate change are formed, and proposals and policies for meeting those objectives produced. A programme containing the time-scales for introducing such proposals and polices should also be created (section 58); and
- that the secretary of state guides and advises authorities about assessing the current and predicted impact of climate change in relation to the authorities' functions, preparing proposals and policies for adaptation to climate change in the exercise of their functions and co-operating with other authorities for that purpose (section 61).

The ASC's September 2010 report represents their first national assessment of how well prepared the UK is for climate change.

2.6 Planning System Reform

The planning system has been subject to a number of reforms which are relevant to this study. As the regulatory system to determine planning applications, reform to the planning system has altered requirements for how applicants and local authorities integrate climate change to development design and resultant planning applications. These reforms include the proposed amendment of the Use Classes Order, the introduction of Enterprise Zones and a move towards the *presumption* in favour of sustainable development.

2.6.1 Planning and Compulsory Purchase Act 2004

The Planning and Compulsory Purchase Act 2004 brought major changes to the planning system in the UK, aiming to create a system which would lead to better development plans and allow planning decisions to be made more quickly.

Most notably, the Act replaced unitary, local and structure plans with regional spatial strategies (a spatial development strategy for London) and Local Development Frameworks for local planning authorities (LDF). These new statutory planning documents were required to be in line with national planning policy, including its policies relating to climate change adaptation.

The Act also introduced sustainable development as an objective of the planning system. Item 39 of the Act states that any planning body must exercise their function '*with the objective of contributing to the achievement of sustainable development*'. Both the Regional Spatial Strategy and all local development documents, under the 2004 Planning Act, are required to undertake a Sustainability Appraisal (SA)of their proposals. A report covering the findings of the SA must also be prepared.

2.6.2 Planning Act 2008

The Planning Act 2008 introduced a statutory obligation for national policy statements, regional spatial strategies and development plan documents to incorporate climate change policies, including most notably those which contribute to the mitigation of and adaptation to climate change. Accordingly, climate change adaptation, for the first time, became enshrined in statutory planning policy.

The Planning Act 2008 also contains enabling powers for charging authorities (including local authorities) to apply a Community Infrastructure Levy (CIL) on new developments in their areas to support infrastructure delivery. The Community Infrastructure Levy (CIL) Regulations 2010 came into force in April 2010. CIL is a tariff system which is applied to nearly all development in accordance with the amount of floorspace of the development. Once a CIL charging schedule is adopted in a local area (or after 2014 in any case), financial contributions from new development for infrastructure may only be collected through CIL.

The range of infrastructure to which CIL can be applied is quite wide and includes flood defences, green infrastructure and social and community infrastructure. Building-scale measures, including area-wide retrofit programmes for existing buildings, would appear not to be fundable from CIL receipts, but the system is still new and the boundaries of its scope have not yet been tested.

In March 2010 the House of Commons Environmental Audit Committee published its report on Adaptation to Climate Change which encouraged local authorities to look to CIL to fund adaptation work and to developers to introduce adaptation measures which benefit not only their schemes, but also the wider community. Very few draft CIL charging schedules have been published; as an early indicator Portsmouth City Council recently published its consultation draft CIL charging schedule which detailed contributions will be sought for coastal defence strategies and green infrastructure. The Environment Agency estimates that annual spending on flood and coastal defences will need to increase from £600m to £1bn by 2035 to protect against the risk of flooding. The national Flood and Coastal Erosion Risk Strategy was laid before Parliament in late May 2011. Its approach to funding is broadly that public expenditure should concentrate on protecting existing communities with developers being responsible for funding defences for new development.

2.6.3 Regional Scale Planning

The abolition of the regional tier within England has been a commitment of the current Government and through the Localism Bill all regional plans and regional planning bodies, Local Authority Leader's Boards, Regional Development Agencies and the Government Offices for the English Regions will be abolished. The exception to this rule is in London, where the Mayor continues to have regional planning powers through the London Plan and through the Mayor's planning call-in function.

2.6.4 Neighbourhood Planning

The Localism Bill referred to above proposes the introduction of a new neighbourhood scale system of spatial planning. Under the proposals a neighbourhood forum can prepare a neighbourhood plan which will set out specific policies and land use designations for the local area, subject to overall compliance with the adopted LDF. The plans will be able to be adopted as part of the local development plan which would give them significant weight in the determination of planning applications.

In addition, the bill would empower neighbourhood forums to designate 'Neighbourhood Development Orders' which would remove the requirement for planning permission for particular types of development in particular locations or areas where local communities are in favour of development (i.e. if more than half of those voting in a referendum have voted in favour of the order) and certain safeguards have been met.

Furthermore, the Localism Bill proposes the introduction of Community Right to Build Orders which gives communities the power to directly deliver infrastructure they believe their community needs. Under the scheme, any community which wishes to benefit from development will be able to seek the Right to Build as long as they can demonstrate that they have met various minimum criteria to ensure development is sustainable, and have the overwhelming support for the development through a referendum.

A further localism reform set out in the Bill will enable citizens to promote referenda on local issues, the results of which, although not binding, would have to be considered by the local authority in making planning decisions.

As aforementioned, the Localism Bill is currently proceeding through Parliament, and it is not expected to receive Royal Assent until late 2011 at the earliest. The practical impact of these provisions in relation to climate change adaptation remain unclear but it can be expected that the combination of local empowerment and regional dismantling will tend to lead to greater variation in approaches and priorities for planning and development across the country.

2.6.5 Implications for this Study

Climate change has been identified as an explicit driver for spatial planning since around 2005, which also marks the date from which a number of procedural reforms began to take effect. Although sustainable development has been a concept which has informed planning policy and decision making since the 1990s, explicit reference to climate change adaptation has emerged only in the past five to six years. The lags built into the system, as changes in national guidance are incorporated in to local policy, then into planning decisions and finally reflected in development, mean that some policy changes have only recently begun to gather momentum.

Documenting the impact of the planning system requires a combination of analytical approaches which examine both the physical changes brought about by new development and the changes further up the process through decision-making and policy development.

This study takes place with the prospect of a new set of reforms coming into force in the next couple of years. This study will therefore provide a useful baseline

from which to monitor the effect of those reforms from the ground-level perspective, which can complement broad national scale studies by providing a richness of detail in how local authorities are dealing day to day with the challenges of planning for climate change.

In summary, the following reflections arise from the foregoing survey of policy and legislation:

- Climate change adaptation is clearly now a key factor to be taken into account in planning. The presumption of the planning system is to enable appropriate land use and development – therefore, taking account of an area's vulnerability to climate risk should be part of this decision making process.
- In spite of the time lag in the planning system, recent decisions and development would be expected to have been informed by consideration of climate change risks.
- Climate change adaptation is an issue with implications for both policy and development management, and evidence for its influence could be sought in local plans (LDFs), planning applications and decisions, planning obligations and in development on the ground.
- The historic analysis of changes to land use provides a useful baseline to aid and assist future decision making. The current (evolving) planning regime could offer opportunities for local authorities to shape how climate change adaptation measures can be incorporated into development decisions.
- The advent of neighbourhood planning and the demise of regional planning mark a strengthening of local drivers for planning. The likely increase in variety of approaches suggests that ground-level case study based research will need to continue in order to obtain a picture of that variety.

3 Methodology

3.1 Overall Approach

In order to explore how land use planning decisions affect the UK's vulnerability to climate risks this study employs spatial, statistical and contextual analysis. The study uses Geographical Information Systems (GIS) to track physical changes and trends in land use cover over the past decade, alongside contextual analysis of planning application documents to gain an understanding of how changes in land use and development relate to the adaptation agenda. Where spatial trends of land use change are useful indicators of the physical penetration of the planning system on land use, it is the review of planning application documents and development plan policies which provide insight to the design interventions employed by applicants to address climate risks. There are five key strands to the study, as set out in **Figure 3**.

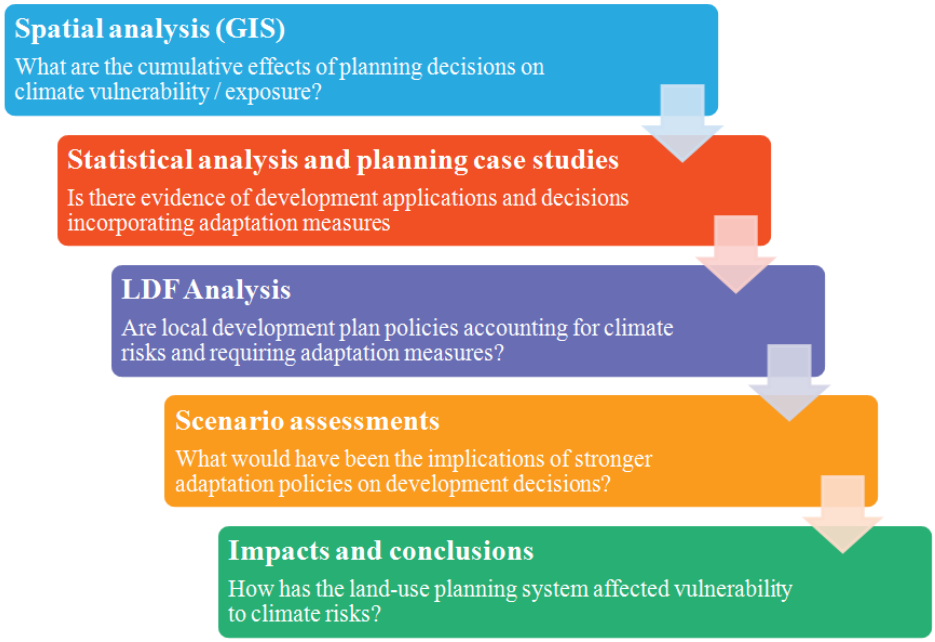


Figure 3: Approach Diagram

3.2 Spatial Analysis (GIS)

Spatial analysis uses GIS to overlay land use cover data and available climate risk vulnerability data, to provide a quantitative baseline and a retrospective view of land use change between 2001 and 2011. There are three key elements:

- Mapping of climate risk areas;
- Mapping of land cover change within climate risk areas; and
- Development of spatial indicators to enable measurement of land cover change both within and beyond climate risk areas.

3.2.1 Mapping Climate Risk Areas

Appropriate climate data layers have been gathered in GIS to allow identification of areas susceptible to climate risks, to allow analysis of land use change in particular areas, as well as defining a 'catchment' area for the planning application review. These datasets are outlined in **Table 1**:

Table 1: Data sources

Climate risk	Climate data	Source	Details	Date of data	Limitations of data
River and tidal flooding	River and tidal flood risk areas	Environment Agency	Shows the areas that could be affected by flooding from rivers or the sea. • Flood Zone 3 is the Agency's best estimate of the areas of land with a 100 to 1 (or greater) chance of flooding each year from rivers, or with a 200 to 1 chance (or greater) of flooding each year from the sea. • Flood Zone 2 is the Agency's best estimate of the areas of land between Zone 3 and the extent of the flood from rivers or the sea with a 1000 to 1 chance of flooding in any year. It includes those areas defined in flood zone 3.	March 2011 (updated quarterly)	The Flood Risk Zones show areas floodable only from river and tidal sources, ignoring the presence of defences. Flood Zones are inherently more precautionary (than the NaFRA data discussed below) as flood defences can be breached and overtopped and there is no guarantee that they will be maintained in future. They are based on current flood risk and do not take climate change into account.
	NaFRA Spatial Flood Likelihood Category (FLC)	Environment Agency	NaFRA Spatial (FLC) is a spatial data set. The NaFRA Spatial (FLC) Grid enables a comparison of the relative risks and their distribution within each of these catchments, rather than a detailed, local assessment of the risk at a specific location. The calculations provide an indication of the likelihood of flooding at the centre of each cell. These results are then placed into three risk categories as used by the insurance industry. The three risk categories are: • low - the chance of flooding each year is 0.5 per cent (1 in 200) or less	April 2011 (updated quarterly)	The NaFRA datasets show areas floodable from river and tidal sources. Land is categorised as being of low (1 in 200 chance or less), moderate (1 in 75 to 1 in 200 chance) or significant (more than 1 in 75 chance) risk of flooding from rivers or the sea

Climate risk	Climate data	Source	Details	Date of data	Limitations of data
			• moderate - the chance of flooding in any year is 1.3 per cent (1 in 75) or less but greater than 0.5 per cent (1 in 200) • significant - the chance of flooding in any year is greater than 1.3 per cent (1 in 75)		
Pluvial flooding	Areas Susceptible to Surface Water Flooding	Environment Agency	The map shows areas that are susceptible to surface water flooding. A surface water flood event that results from rainfall generated overland flow before the runoff enters any watercourse or sewer. The data provides three bandings, indicating 'less' to 'more' susceptible to surface water flooding.	January 2009	The map shows areas that are susceptible to surface water flooding. It has been produced using a simplified method that excludes: • underground sewerage and drainage systems, and smaller over ground drainage systems; • buildings. It uses a single rainfall event. Therefore, it only provides a general indication of areas which may be more likely to suffer from surface water flooding. In future studies, the Flood Map for Surface Water should be used as it is more appropriate for urban areas. In London, Drain London modelling should be used.
Coastal erosion	Shoreline Management Plan data	Various	Large-scale assessments of the risks associated with coastal processes and helps reduce these risks to people and the developed, historic and natural environments. Coastal processes include tidal patterns, wave height, wave direction and the movement of beach and seabed materials. Data on eroding and protected coastlines has been derived from here. Draft Flamborough Head to Gibraltar Point SMP2 (September 2010) (Hull and Humber Region)	September 2010	The analysis has used boundaries of 1km (East Riding) and 300m (Fareham, Gosport and Southampton) of the protected and unprotected eroding coastline within these SMP boundaries. These boundaries have been derived from the SMPs and are indicative, as they have been traced into GIS., These protected and eroding coastlines should be subject to subject to greater granularity of mapping to achieve exact results.

Climate risk	Climate data	Source	Details	Date of data	Limitations of data
			North Solent SMP2 (South Hampshire) (December 2010) (South Hampshire region)	December 2010	
Heat stress	Urban heat island map data (London only)	LUCID Project/ UCL	Data shows the effect of the urban heat island in London, mapping temperature variations across London. The data models the local climate in urban areas based on the dynamic and thermodynamic processes associated with land use and building form.	March 2011	Data is for London only. Limited information exists to measures heat island effect elsewhere. Over reliance on one dataset is a limitation for this analysis. The UHI effect is at its most intense in the early hours of the morning so impacts residential buildings and buildings occupied 24/7 (hospitals, care homes, prisons etc) but there is also an issue about overheating in buildings occupied during the day which are not designed to cope with high temperatures. Therefore UHI cannot be used as an exact representative of climate change driven heat stress risk. Its value for this study is that is way to show spatial areas at different levels of exposure to heat events.
Water stress	Water stress maps	Environment Agency	There is no single indicator of water stress. The study has used indication of relative water stress using scores for each water company area – classification is serious, moderate or low The study reviewed the use of Catchment Abstraction Management Strategies (CAMS). The CAMS 'downstream override map at	2008	The water stress mapping process takes a long-term view of the balance between water availability and the demand for public water supply, rather than a snapshot of shorter or peak periods. Disaggregation down to LPA layer is difficult owing to complex data extraction requirements. These maps are not intended for land use

Climate risk	Climate data	Source	Details	Date of data	Limitations of data
			Q95' shows downstream CAMS colours at low flows and indicates the availability of water for new unconstrained consumptive abstraction. Although the maps show current resource availability and do not consider the impacts of climate change, the geographical scale of the CAMS maps do not indicate any further detail with regards water stress at a borough level.		planning purposes. The Environment Agency is currently working on a set of maps that will use CAMS base data and climate data from UKCP09 to estimate the impact of climate change on water availability. The Environment Agency is also working to simplify messaging to make it more customer focused. Access to water consumption data is limited. Returns to OFWAT have basic consumption figures but these are at the resolution of an entire Water Resource Zone (WRZ). More specific data focussing on a Borough would only be available from water companies in the form of District Meter Area (DMA) monitoring. These can be quite large and most are cascading so getting the resolution of data required may also be difficult. **Therefore spatial analysis not undertaken for water stress at a LPA level.**
Biodiversity and open space	Extent of Biodiversity Action Plan Priority Habitats	Local Authorities	The relevant BAP habitat area for a LPA has been mapped by co-ordinating the OS MasterMap land cover data with the BAP habitats.	Relevant Biodiversity Action Plan year of adoption	In order to understand the relative pressure that the planning system is placing on biodiversity in a geographical area, extraction of habitats from BAP required – however direct comparator not always available.

Climate risk	Climate data	Source	Details	Date of data	Limitations of data
	Nature Designations	MAGIC	Various nature designations have been mapped, which include: Ramsar, SPAs, SACs and SINCs	Regular updates	Data reflects only statutory designations and not other land with biodiversity value
	Open space data (London only)	GiGL	The data set combines information from the GLA surveys with information from surveys conducted on behalf of the London Boroughs in order to provide the most up to date London-wide information on open spaces	2011	Data exists for 2011 only, therefore comparison, therefore study not able to be made with 2001 data. Also relevant for heat stress climate risk.

3.2.2 Mapping Land Cover Change

In order to understand how development decisions have cumulatively influenced land use change over a given period of time, the study has sought to measure change in land use in particular areas, using the climate data (In **Table 1**) over the time period of 2001 to 2011. The availability and temporal nature of GIS land use change data sources i.e. Ordnance Survey's MasterMap, has to some extent led the time period for analysis, as 2001 is the earliest available comparable data. In any case, the planning application data received from LPAs is over a similar timescale.

The key data source for measurement of land use change has been the Ordnance Survey's MasterMap, which records land use cover on a yearly basis. It is the same data that informs DCLG's annual Land Use Change Statistics, which maps land use change as part of the Ordnance Survey's revision process. The data layer used for this study is the Topography layer, which represents topography at a scale of 1:1250. It is subdivided into a number of themes: land area classifications, including buildings, roads, tracks and paths, rail, water, terrain and height, heritage and antiquities, structures; and administrative boundaries.

Review of the Topography data layers demonstrates that 'benchmarks' can be used as useful indicators for land use change. For instance, the change in area covered by the 'Buildings' (a permanent roofed construction) category is a good indicator of quantum and churn of land going through the planning and development system. The 'Manmade' (features that have been constructed, for example, areas of tarmac or concrete) and 'Natural' (features that are not man-made but possibly man altered, for example, cliffs, areas of water and uncultivated/cultivated vegetation) data layers are good indicators of the change in impermeable and permeable land cover – an indication that development has (or has not) taken place.

Table 2: MasterMap Data layers used

MasterMap Data Layer	Indicator
Buildings	Change in area covered by buildings
Man made surface	Change in impermeable surface
Natural surface	Change in natural areas

It should be highlighted that the 2001 MasterMap dataset was found to contain anomalies in relation to the overall quantification of land area within some of the local authority areas. This particularly affected East Riding and Stockton-on-Tees, where the total land mass of these authorities was calculated to have reduced between 2001 and 2011 by over 30%. Three other authority areas - Hull, Tewkesbury and South Gloucestershire – showed much smaller but still significant errors between 2001 and 2011.

At the more detailed and smaller area scale, such as was used for the flood risk area analysis, we found the results to be more reliable. In this report we have shown, for completeness, the results of all authorities, and have provided notes where relevant to highlight those authorities where the results may have been affected by the 2001 dataset anomalies.

It is recommended that the results of this study are not reported without reference to this data quality issue.

3.2.3 Development of Spatial Indicators

The approach to the selection of spatial indicators has taken into account the availability of climate risk data and the availability of MasterMap land cover data.

Table 3 illustrates the climate risks and supporting indicators with narrative justifying their selection.

Table 3: Spatial indicators

Climate Risk	How development affects vulnerability to risk	Selected Indicator
River and tidal flooding Significant current vulnerability and increasing risk due to climate change.	New buildings in areas at risk from flooding increases vulnerability.	***Change in coverage of buildings in areas at risk from flooding*** Data available and directly related (with good accuracy) to known flood risk. Use of EA NAFRA data, so accounting for existing flood defences.
Pluvial flooding Significant current vulnerability. Risk predicted to increase significantly due to climate change.	Increased urbanisation at neighbourhood/catchment scale generally reduces permeability, so increasing risk of pluvial flooding. New building in areas susceptible to pluvial flood risk increases vulnerability.	***Overall change in impermeable surface cover (manmade areas)across the LPA*** ***Change in coverage of buildings in areas susceptible to pluvial flood risk.*** Data available as changes in urban areas, proxy indicator for alteration of natural functioning of hydrological processes within urban context
Coastal erosion Large UK coastline with areas of significant active coastal erosion. High sensitivity of coastal locations to severe weather. Risk increasing with climate change/sea level rise.	As with river and tidal flooding, development in areas at risk from erosion increases vulnerability.	***Change in coverage of buildings in areas at risk from coastal erosion*** Data available and directly related (with good accuracy) to coastal areas using shoreline management plans.

Climate Risk	How development affects vulnerability to risk	Selected Indicator
Heat stress Current vulnerability of urban heat stress recently identified e.g. development of National heat plan, heat wave events of 2003 and 2006. Increasing urban heat island effect risk due to climate change identified as a significant issue although potential differences in risk due to location in UK, e.g. Southern England primary risk area	Increased urbanisation, density of development activity and building design will all affect vulnerability. Loss or degradation of green/blue infrastructure in urban areas can increase vulnerability.	***Change in impermeable surface cover (manmade areas)*** Data available as changes in urban areas. Using as proxy indicator for change in area of green/blue infrastructure
Biodiversity and habitat loss Current climate hazards can have negative impacts (e.g. wildfire, drought, flooding) and so be an additional pressure biodiversity. Phenological changes are now evident. MONARCH and associated impact studies suggest species range shifts.	Development can directly increase landscape fragmentation, so reducing resilience of biodiversity to respond to observed and projected changes in climate..	***Change in natural area*** ***Change in BAP habitats*** Use of MasterMap to identify BAP habitat areas. Two categories from MasterMap, 'orchards' and 'marshland', were used as a proxy to assess BAP habitat areas. Source data on protected areas (e.g. Ramsar, SPAs) is readily available (e.g. via MAGIC) and where possible spatial data on local Biodiversity Habitat Plan habitats (LBAPs) and additional habitat studies, e.g. urban habitat surveys.

Note: Definitions describing an increase/decrease in manmade surfaces are not solely as a result of planning permission and includes those activities outside the realm of planning.

3.3 Statistical Analysis and Planning Case Studies

GIS is very effective at tracking physical changes which are in some way visible (such as development in flood risk areas) but is not as effective at detecting detailed design interventions not visible from the air, where many adaptation measures occur (such as underground flood storage tanks or grey water systems). It is necessary to assess application documents to find out if these types of measures are being incorporated. This analysis of planning applications is intended to complement the spatial analysis and includes a review of:

- Decision notices;
- Committee reports; and

- Relevant assessment documents, including environmental statements, sustainability statement, flood risk assessment, and health impact assessments

Key research questions include:

- For each climate risk factor, what proportion of applications and decisions take account of the risk status of the application site?
- What proportion of all applications contained assessment documents referring to adaptation measures?
- What proportion of all permissions contained planning conditions which addressed climate related risks?
- Is there evidence of development decisions incorporating adaptation measures?

3.3.1 Sampling

The study uses planning application data received from LPAs and assesses major planning applications[3] only over the time period 2001 to 2011. It was agreed that in order to gather a useful sample of planning applications which incorporate adaptation measures, it is likely that major applications would provide the most useful evidence base for analysis. Although minor applications constitute a large number of applications, inclusion of them within the dataset would skew the results and would unlikely show results on a scale as with major applications.

The planning application data was then mapped on GIS. In order to select planning applications for review, the study has used appropriate climate related datasets to identify 'climate risk areas' (as highlighted in Section 3.2). These data layers have then been mapped and planning applications sampled from within those selected areas. The planning applications within climate risk areas only were included in sample analysis. A proportionate sample was taken for analysis, based on number of applications determined across development categories e.g. 10% office, 35% housing, 20% retail, 35% 'other' (i.e. mixed use).

[3] More than 1,000m^2 or 10 residential units

Table 4: The number of major and minor planning applications received from 2000 to present for the three local authorities

Use	East Riding	Islington	Stockton
Major retail	26	21	90
Major dwellings	682	370	446
Major manufacturing	117	6	118
Major office	46	59	90
Major (other)	275	261	282
Major (collectively)	**1,146**	**717**	**1,026**
Minor (collectively)	**12,931**	**20,578**	**6,576**

3.3.2 Analysis

The following process was undertaken to analyse planning application data:

- Analysis of the number of approvals of major planning applications within climate risk areas between 2001 and 2011.
- Sample of up to thirty five planning applications from pool of planning applications within each climate risk area[4]. The type of applications will be proportionate with the number of applications received in a particular development category e.g. 10% office, 35% housing, 20% retail, 35% 'other'.
- Review of planning application documents to determine proportions of planning applications included assessment documents referring to climate change adaptation or related concepts, and have taken account of a particular climate risk factor.
- Review of planning conditions to identify the proportion of these planning applications which addressed climate and climate change related risks, and show evidence of incorporating adaptation measures.

Analysis of the planning application data is quantitative, and provides a baseline indicating current awareness and uptake of adaptation measures.

3.3.3 Case Studies

The case studies seek to identify examples of good practice and highlight when adaptation and climate risk has been part of the application process. For each climate risk, three planning applications have been selected for further case study review. This could be where a development application has proactively considered climate risks and incorporated measures to mitigate them, or where approval was given with adaptation conditions and/or obligations added. Each case study has included phone interviews with the application case officer to understand the decision making process and to assess the relative importance of climate change risks to the design and decision making process.

[4] This is dependent on availability of application documents online, as well as the quantum of major applications within a given climate risk area.

The case study applications have been selected on the basis of achieving a good spread of issues across the identified climate change risk factors, and on the basis of practicability considerations, such as the availability of the case officer to be interviewed.

The application and decision documents have been reviewed in depth to identify how each of the climate change risk and other vulnerability drivers were considered, both in terms of the risks to the use of the development itself and in terms of the changing risks to the community as a result of the new development.

A standard proforma has been used to collect the results from the case study analysis. Please see **Appendix B** for an example case study proforma.

3.4 Localities for Assessment

The selection of localities (i.e. LPAs) for the spatial analysis and planning application parts of the study has been based on a range of criteria. These included:

- Balance of urban, semi-urban and rural localities;
- Capturing all four key climate risk areas across the local areas;
- Geographical balance across the country;
- Robust and up to date GIS systems that capture link planning decisions spatially; and
- Willingness to participate and provide data within the timescale.

The study identified five localities that met the mix of climate risks that the Study team were looking for, and which were willing to participate. Only **three** of the eleven participating local authorities underwent the more detailed review of planning applications and case studies (as well as the spatial analysis). Area profiles for these LPAs are in section 3.4.1. All other nine local authorities were subject only to spatial analysis.

Table 5: Local areas for study

Locality	Criteria for selection of locality	Planning application, Case Study and Spatial Analysis	Spatial Analysis only
NE London	• Urban (and suburban) locations; • Many large and medium urban regeneration sites with significant new development activity in recent years; • Significant climate risks include heat stress and water stress; and • Other vulnerabilities and issues include sensitive habitats and degraded landscapes and areas of high socio-economic vulnerability.	LB Islington	LB Haringey
Hull and Humber	• Mixed urban and rural areas; • Area with significant river, tidal and pluvial flooding and coastal erosion	East Riding	Hull

Locality	Criteria for selection of locality	Planning application, Case Study and Spatial Analysis	Spatial Analysis only
	issues; • Shoreline Management Plan area; and • Other vulnerabilities and issues include high socio-economic vulnerability.		
Tees Valley	• A mixed urban and rural district; • Stockton-on-Tees is a priority regeneration area focussed on low carbon industrial development; • Significant climate risks include river and tidal flooding; • Area of very high socio-economic vulnerability; and • Only authority to achieve NI188 Level 4.	Stockton	
South Hampshire	• Area with significant development constraints, and pressure • Significant climate risks include river and tidal flooding, and water stress • Coastal erosion issues; has Shoreline Management Plan in operation	N/A	Southampton, Gosport, Fareham
Gloucestershire	• Gloucestershire has significant development pressure • Significant climate risks include river and tidal/ pluvial flooding and sensitive biodiversity/ habitats	N/A	Tewkesbury South Gloucestershire, Gloucester City

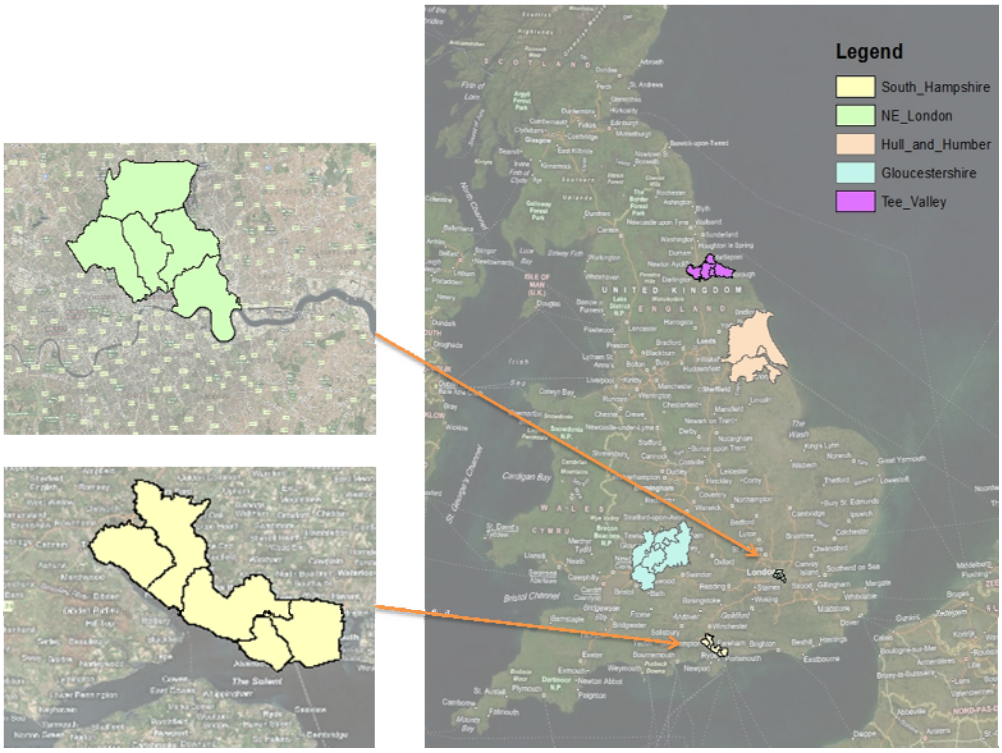


Figure 4: Localities selected for the study

The opportunity to participate in the study has been well received – most authorities approached have been very interested in participating. However, available LPA resources have been cited as a barrier to providing the data in time.

3.4.1 Area Profiles

Profiles for each LPA subject to both spatial and planning application analysis have been compiled to provide context on the following aspects:

- Geography of the locality, including population; and
- Prevalence of climate risks.

3.4.1.1 Stockton-on-Tees

Stockton-on-Tees Borough Council serves the towns of Billingham, Stockton, Thornaby, Ingleby Barwick, Yarm and surrounding areas. Stockton-on-Teesis located within the Tees Valley, along with the towns of Redcar and Cleveland, Darlington, Middlesbrough and Hartlepool. A total of 186,000 people live and work in the Borough.

The main climate risks for Stockton-on-Tees are inland and tidal flooding - issues which are likely to be increasingly severe as a result of climate change. This is due to the course of the River Tees and the coastal (North Sea) location of the authority. The low-lying nature of much of the Tees Valley means that Stockton-on-Tees is susceptible to direct climate change impacts such as rising sea levels and flooding, which will impact homes, businesses and the coastal and wetland habitats of the Teesmouth and North Tees Valley marshes. A further issue is the loss or deterioration of biodiversity and habitats in the Borough due to development and climate change.

3.4.1.2 East Riding

The East Riding of Yorkshire Council (East Riding) is a unitary authority with a number of large settlements covering a wide area. The district is within the Yorkshire and Humber Region and has a population of 337,000 people and contains 112,300 jobs. The focus for growth in the emerging Core Strategy[5] is the identified 'Principal Towns' of Bridlington, Beverley, Driffield and Goole and the Major Haltemprice Settlements. The Major Haltemprice Settlements have a strong relationship with the city of Kingston upon Hull (Hull), forming the outer edges of the city. 18% of East Riding's population live in the Major Haltemprice settlements of Cottingham, Anlaby, Willerby, Kirkella and Hessle, which are defined within the Regional Spatial Strategy (RSS) as being within the 'Regional City of Hull'.

The geology and topography of the authority mean that it is particularly to susceptible to flooding and coastal erosion. The East Riding has one of the fastest eroding coastlines in North West Europe. The average rate over the whole length is 1.8 metres per year[6]. However rates fluctuate significantly, both over time and from place to place, so accurate prediction is often difficult. The draft Flamborough Head to Gibraltar Point Shoreline Management Plan (SMP) was published in November 2009. The SMP2 aims to identify sustainable coastal defence options, taking into account the influences and needs of historic, natural and human environments. The SMP2 assesses coastal management issues over time periods of 0 to 20 years, 20 to 50 years and 50 to 100 years.

The area's low-lying topography, proximity to the Humber Estuary and the presence of several major river systems, means that a relatively large proportion of East Riding is at risk of flooding from a range of sources, including tidal, river, surface water and groundwater. The district has completed a Level 1 Strategic Flood Risk Assessment (SFRA), which shows that approximately a third of the area, including parts of South Holderness, the River Hull corridor, and the Humberhead levels around Goole, falls within Flood Zone 3. The predominant risk to the East Riding is tidal flooding and as sea levels are projected to continue to rise this problem is set to increase.

3.4.1.3 London Borough of Islington

The London Borough of Islington is a central London borough running from Farringdon in central London to Archway and Crouch Hill in North London. It consists of a varying intensity of development which becomes increasingly lower density away from central London. The surrounding boroughs are Hackney to the east, City of London to the south, Camden to the west and Haringey to the north. Islington is a densely populated borough with 191,800 people or 129 persons per hectare[7]and is within the Greater London Authority area.

The dense urban environment and central London location mean that it is susceptible to heat stress, and pluvial flooding; issues which are likely to become increasingly severe as a result of climate change. In addition, the whole of the south east region, including London, is defined as 'severely water stressed' as

[5] The East Riding of Yorkshire Core Strategy was consulted on at Preferred Options stage in May 2010
[6] East Riding Integrated Zone Coastal Management Plan towards a sustainable coast (2002)
[7] Annual Monitoring Review 2010

demand outstrips supply in the summer months. With higher rainfall in winter and longer drier summers Islington is exposed to increased risk of surface water flooding, water shortages and overheating in the respective seasons. The impact of climate change on Islington's ecosystem services (open spaces and biodiversity) is also anticipated to be severe.

LB Islington provides developers with detailed guidance on what is expected as part of the design process for major applications related to adaptation. The Council require applicants to provide a Sustainable Design and Construction statement, which should include: reducing run-off; reducing overheating by passive design and ventilation; sustainable urban drainage; biodiversity and; water conservation. Islington also provides training for its Development Management officers on what is required from developments in terms of sustainability issues. Case officers will consult with the internal sustainability team on the detail provided within the require Sustainable Design and Construction statement. On adaptation the information is judged against overheating, flood risk and sustainable urban drainage, however efficient water use is also included but not under adaptation

3.4.1.4 London Borough of Hackney

The London Borough of Hackney is a central London borough with a population of 223,171, making it a smaller London borough in terms of population size. Population density is high, with over 11,027 people per square kilometre, compared to the London average of only 4,679 people per square kilometre.

The LB of Hackney highlights that increases in extreme weather associated with climate change will create an increased risk of future flooding in the Borough. Those areas at most risk of flooding include those surrounding the River Lee, a major river running north to south along the eastern edge of the Borough. The areas most at risk of flooding are Wick ward and King's Park ward. Around 2,650 properties are at risk of flooding in zone 2, with a low to medium risk, and 1,422 properties at risk in zone 3, with a high annual risk. However, the areas deemed most at risk from flooding by the River Lea are undeveloped. Nonetheless, LB Hackney states it is likely that land use changes and climate change will lead to an increase in the number of times the river reaches and exceeds capacity.

In a similar manner to Islington, the dense urban environment and central London location mean that Hackney is susceptible to heat stress, and pluvial flooding; issues which are likely to become increasingly severe as a result of climate change. In addition, the whole of the south east region, including London, is defined as 'severely water stressed' as demand outstrips supply in the summer months.

3.4.1.5 North East Lincolnshire

North East Lincolnshire is situated on the East Coast of Britain. It has a population of approximately 157,000 and 67,900 jobs, covering a land area of 74sq miles. Grimsby and Cleethorpes together form the major urban centres of this District, and play an important role as service centres relative to other smaller settlements in the surrounding areas. Immingham acts as a compact secondary urban centre within the authority and the docks located here are important to the regional and national economy.

The Humber Bank's marine and coastal areas are internationally recognised habitats, giving them a high level of protection; and the surrounding areas of North Lincolnshire and East Lindsey feature several nature reserves. In addition, the district also includes the edge of the Lincolnshire Wolds Area of Outstanding Natural Beauty (AONB).The Initial Sustainability Appraisal (2005) states that the main anticipated effects of climate change are a rise in sea-levels and an increase in localised flooding during times of heavy rainfall. There is a significant risk of flooding on the Humber Estuary; and local spending on flood defences is twice the regional average and is the second highest rate of expenditure, after Selby, in the Yorkshire and Humber region. KP1 and CP10 of the Core Strategy help address these risks and will have a positive impact on mitigating the effect of climate change.

3.5 LDF Analysis

Alongside the planning analysis, the study assesses how climate risks and adaptation responses have been accounted for in the preparation of a sample of Local Development Frameworks. The analysis focuses on the extent to which the current local plan making process (including national guidance) encourages the assessment of climate risks and adaptation measures. The assessment takes place in the following LPAs who have recently adopted (or are close to submitting and/or adopting) their Core Strategies: Hackney, Stockton-on-Tees and North East Lincolnshire. The methodology for analysis is as follows:

- The key LDF documents were grouped into the three stages, based on the ASC assessment framework:
    - Structuring the problem;
    - Identifying options; and
    - Monitoring and review.
- Analysis of the LDF documents to identify where climate-related risks and adaptation measures have been considered.
- Analysis of references to climate change adaptation alongside the adaptation framework to ascertain whether authorities are factoring adaptation into decision making for land use planning policy.

3.6 Scenario Assessments

The purpose of the scenario assessment stage was to explore the implications of different approaches within the planning system to reduce vulnerability or to increase resilience to climate change. Specifically, the assessment considered what might have been the impacts, both adverse and beneficial, had different planning policies been in place over the past ten years.

As with the other aspects of this research, the assessments were carried out on a case study basis, with two locations in focus. The study also focused on one particular aspect of climate change risk, being river and tidal flooding. The methodology is briefly described below.

3.6.1 Study Area

Two study areas were proposed for this work, which have been selected through the incidence of river and tidal flood risk (assessed using NaFRA data) experienced in these areas. They are:

- Goole, in East Riding; and
- Central Stockton-on-Tees.

The NafRA data was used in preference to Flood Zones as it takes into consideration flood defences. Flood Zones are inherently more precautionary as flood defences can be breached and overtopped and there is no guarantee that they will be maintained in future. They are based on current flood risk and do not take climate change into account.

3.6.2 Approach

The approach taken was to identify all major applications within each case study area, granted permission between 2001 and 2011. For each application, alternative planning decision outcomes were imposed, based on the site's flood risk exposure and type of proposed development. The impact of the policies were assessed and quantified as far as possible.

The two policy approaches can be characterised as "Retreat" and "Resilience" approaches. The Retreat approach involves avoiding new development in risk areas, while the Resilience approach involves requiring all new development within risk areas to incorporate a range of risk mitigation measures to reduce the impact of flood risk events when they occur. Each approach is described in more detail below.

The value of assessing these two alternative approaches – the "retreat" approach and the "resilience" approach – is to consider the direct and indirect costs and benefits of each and to explore the tensions between potentially competing spatial planning objectives. The research also considers the impact on the legacy of existing development which preceded the adoption of each of these alternative policies.

It should be highlighted that this was a limited exercise which was not able to consider the longer term cost implications for building and/or maintaining flood defences in areas of flood risk (or the savings associated with removal or avoidance of defences). Thus to an extent the analysis is not able to provide a complete picture of all impacts of all policy options. The implications of this approach will be addressed in the report of results.

3.6.2.1 Retreat Approach

The Retreat approach was to restrict development (that is, the past 10 years of permissions for new development) in significant and moderate risk areas, utilising the NaFRA data. Those permissions which were granted in the past ten years were redistributed to areas outside of the flood risk areas. The replacement sites for both residential and non-residential development were selected based on the sites put forward within the respective local authorities' Strategic Housing Land Availability Assessments (SHLAAs) and Employment Land Reviews (ELRs). In

completing this work the same amount of development was redistributed, at the same density. This broad approach is set out in **Table 6**.

Table 6: Approach to redistribution of development for those applications within NaFRA flood risk areas

Type of development	Policy approach for each NaFRA risk level	Commentary on relocation approach
Residential	• Significant and Moderate risk areas: redistribute development to lower risk areas • Low risk areas: allow development to occur.	Initially sites already allocated within the Local Plan and shown to be available within the SHLAA were used. At a secondary level potential sites put forward within the SHLAA were used. Development would be allocated to a new site taking account of the site appraisal to identify which site would be the most suitable. If there is no clear hierarchy of what would be the most appropriate site, the nearest available site of the necessary size would be selected.
Non-residential	• Significant risk areas: redistribute development to lower risk areas • Moderate and Low risk areas: allow development to occur.	Non-residential development is considered a lower vulnerability use than residential use and therefore the policy allows these sites to remain in the Moderate risk areas Initially sites already allocated within the Local Plan and shown to be available within the ELR were used. At a secondary level potential sites put forward within the ELR were considered. The development would be allocated to a new site taking account of the site appraisal to identify which site would be the most suitable. If there is no clear hierarchy of what would be the most appropriate site, the nearest available site would be selected.

Having completed this redistribution of development the Study team sought to assess the costs and benefits of this revised approach to the spatial location of new development. This included both quantitative and qualitative results. In its simplest sense this would demonstrate how much development would not have occurred within the locations it did and the new patterns of development that would be created, which were mapped to present the results. This made it possible to begin to identify the impact (beneficial or adverse) on other planning policy objectives. For instance, would redistributing the development lead to greater urban sprawl or reduce town centre vitality and viability?

3.6.2.2 Resilience approach

The resilience approach was to consider the case of allowing new development to take place in flood risk areas but imposing a range of resilience and resistance measures in new development to reduce the risk of impacts when floods occur. This effectively allows the approved developments to remain but adds a cost factor to the development cost in order to deliver the flood risk reduction measures.

The economic impact of the Resilience approach was then considered using a similar approach as for the Retreat approach

It is noted that the research identifies that this approach has already been adopted to some extent by local planning authorities, albeit not with universal application. Therefore this study will provide a small-scale test of the possible implications of continuing in this direction or changing course to a more risk averse spatial planning strategy.

4 Spatial Analysis

4.1 Introduction

Table 7 indicates which spatial indicators have been developed for the local authority areas.

Table 7: Spatial indicators

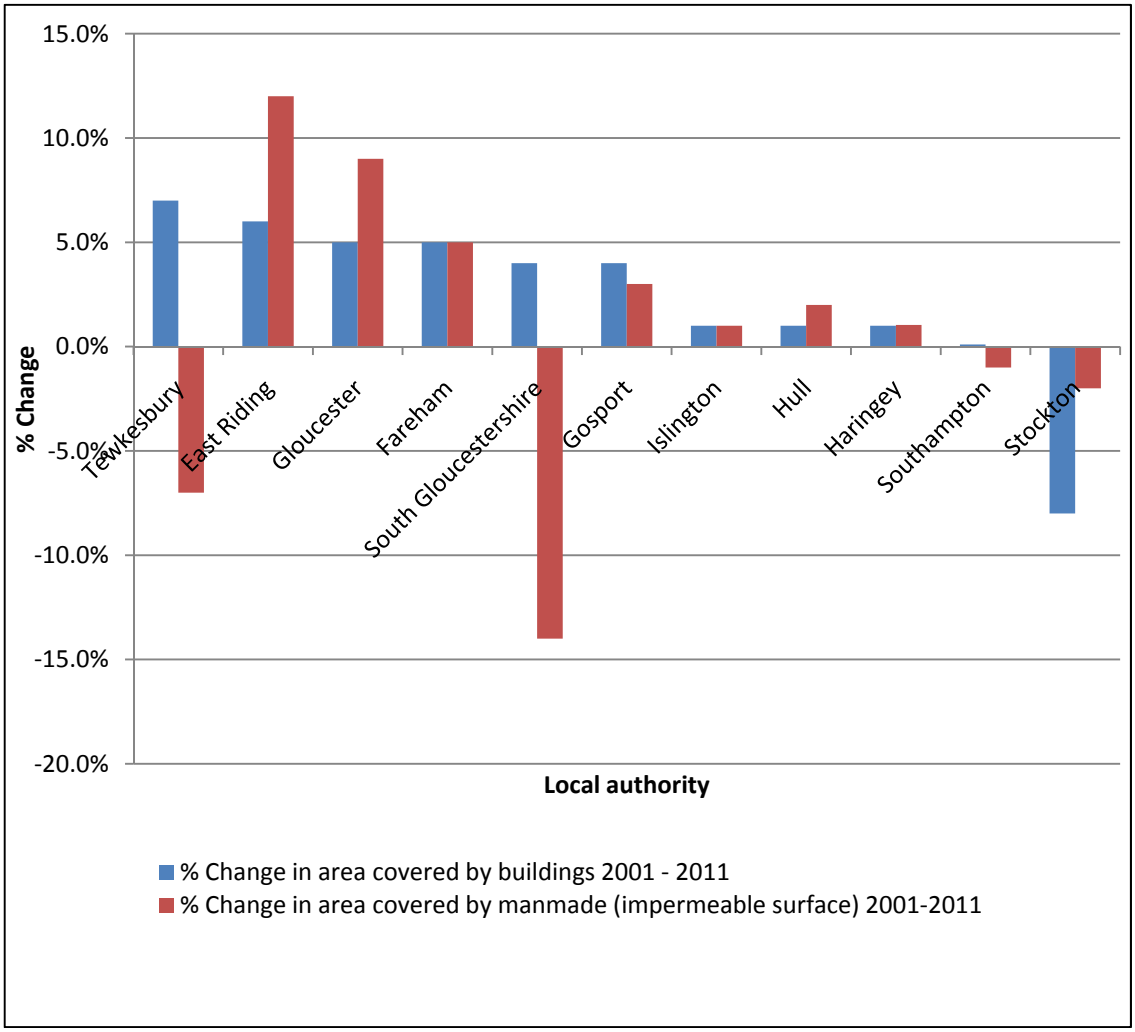
	Spatial analysis indicators – land use cover change 2001 to 2011					
	River and Tidal flooding	**Pluvial flooding**	**Coastal erosion (within x km of an unprotected eroding coastline)**	**Coastal erosion (within x km of a protected eroding coastline)**	**Heat stress**	**Biodiversity and habitat loss**
East Riding			1km	1km		
Hull						
Islington						
Haringey						
Stockton						
Gloucester						
South Gloucestershire						
Tewkesbury						
Fareham			300m	300m		
Gosport			300m	300m		
Southampton			300m	300m		

4.2 Overall Changes in Land Cover

As a benchmark, and comparator, the study has calculated overall changes in land use:

- change in area covered by buildings (m^2) 2001 to 2011; and
- change in area covered by manmade (impermeable surfaces) 2001 to 2011.

Table 8: Land use changes for localities as a whole



Note: Results for East Riding, Hull, South Gloucestershire, Stockton-on-Tees and Tewkesbury may have been affected by anomalies on the 2001 MasterMap dataset. See Section 3.2.2.

4.3 River and Tidal Flooding

River flooding occurs when rivers or streams overtop their banks, this can be due to high or intense rainfall events in some instances there may be other causes of flooding e.g. flooding cause by blockages of watercourses. This study has used GIS to map Environment Agency National Flood Risk Assessment (NaFRA) to determine which areas are at risk of flooding in nine localities. The data included the flood risk categories below:

- low – the chance of flooding each year is 0.5 per cent (1 in 200) or less;
- moderate – the chance of flooding in any year is 1.3 per cent (1 in 75) or less but greater than 0.5 per cent (1 in 200); and
- significant – the chance of flooding in any year is greater than 1.3 per cent (1 in 75).

Low, moderate and significant flood risk was mapped for 2001 and 2011 to determine the extent of flooding in each locality. These layers were then analysed against land use categories from the Ordnance Survey MasterMap topography data to assess whether the amount of development classified as 'buildings' had increased or decreased between 2001 and 2011.

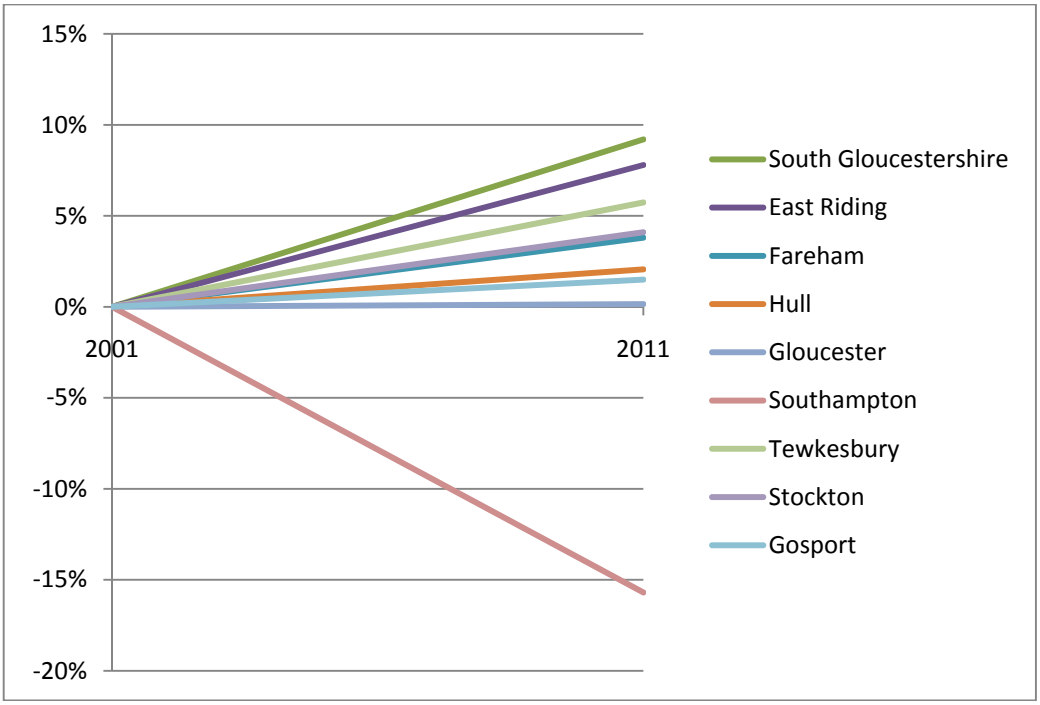


Figure 5: Absolute change in land covered by buildings within low, moderate and significant flood risk zones, 2001 to 2011

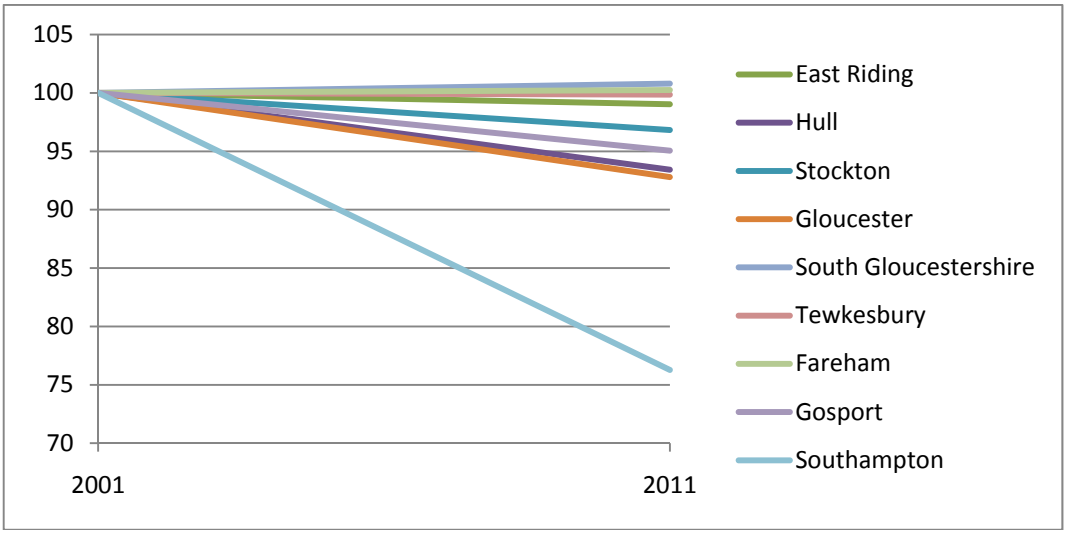


Figure 6: Change in land covered by buildings within low, moderate and significant flood risk zones, 2001 to 2011, indexed against population change 2001 to 2011

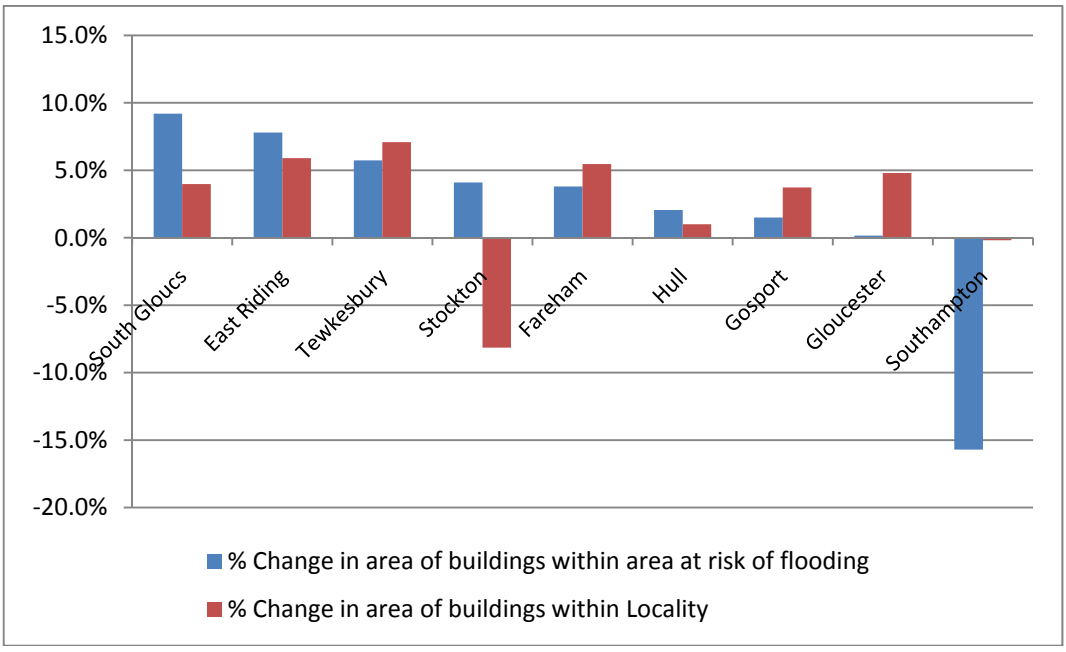


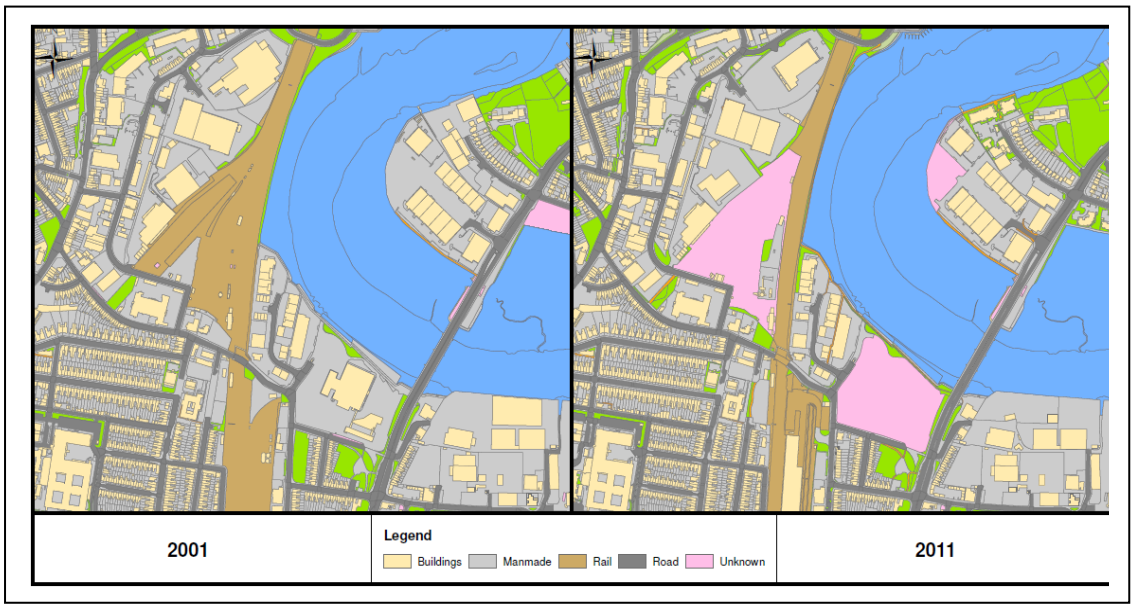
Figure 7: Change in land covered by buildings (m^2) within all three flood risk categories (low, moderate, and significant) 2001 – 2011 compared with change across the locality as a whole

In summary, the analysis above shows that in the eight of the nine authorities studied the amount of buildings in flood risk area increased between 2001 and 2011. Across these eight authorities where an increase was experienced the average increase was 4.3%; across all nine authorities the average percentage change was 2.1%. In only one authority was there a decrease in the amount of buildings. The following observations can be made:

- South Gloucestershire, East Riding, Stockton-on-Tees and Hull observed a higher quantum of land use change in areas used for buildings within Flood

Risk Zones than across the locality as a whole, demonstrating that the risk of river and tidal flooding has not prevented development being brought forward;

- Stockton-on-Tees observed an increase in land used for buildings within Flood Risk Zones but a decrease across the locality as a whole;
- Gloucester observed an increase in land used for buildings across the locality as but only a small increase (0.2%) within Flood Risk Zones; and
- Southampton experienced a decrease in buildings across the locality as a whole and within Flood Risk Zones, although the decrease in flood risk zones was much more significant. Following further investigation of the MasterMap data for 2001 and 2011, the Study team identified three large development sites within the flood areas which were classified as 'Buildings' (yellow shade in Picture 1) in 2001, but in 2011 are now classified as 'Unknown' (see pink shade in Picture 1). These are likely to be vacant or half constructed development sites, which have been classified as 'Unknown' by Ordnance Survey. The size of these three sites alone account for 60,000m² of development space. The absolute decrease is 82,000 m².



Picture 1: Screenshot from Mastermap for Southampton area within area at risk of flooding

Within the scope of this study, the study cannot establish the effect of introducing PPS25 regime on the quantum of development within river and tidal flooding areas, but the trend in development in FRZs will emerge as the study is repeated in future years. It should be noted that when new dwellings are deemed to be necessary in Flood Zone 3 that flood risks will be managed and made safe in accordance with PPS25 Guidance. The uptake of adaptation measures to manage this risk is discussed in the following chapters of this report. `

Please see **Appendix C** for maps illustrating the change in land covered by buildings (m2) within low, moderate, significant flood zones, 2001 – 2011.

4.4 Pluvial Flooding

Pluvial (surface water) flooding occurs when drainage systems overflow or where water cannot be absorbed through the ground or at a fast enough rate to dispose of surface water following rainfall. Development of new buildings and impermeable surfaces increase the risk of pluvial flooding. This study has used Environment Agency data to map areas susceptible to less, intermediate and more surface water flooding[8] in ten localities. However, the maps should not be used to identify individual properties at risk of surface water flooding. Nor can the Environment Agency surface water flood maps be used alone to show expected areas of surface water flooding; or as defining the flood extent for a specific probability/risk level. The layers were then analysed to assess whether the amount of land covered by buildings, through the use of MasterMap, had increased or decreased between 2001 and 2011.

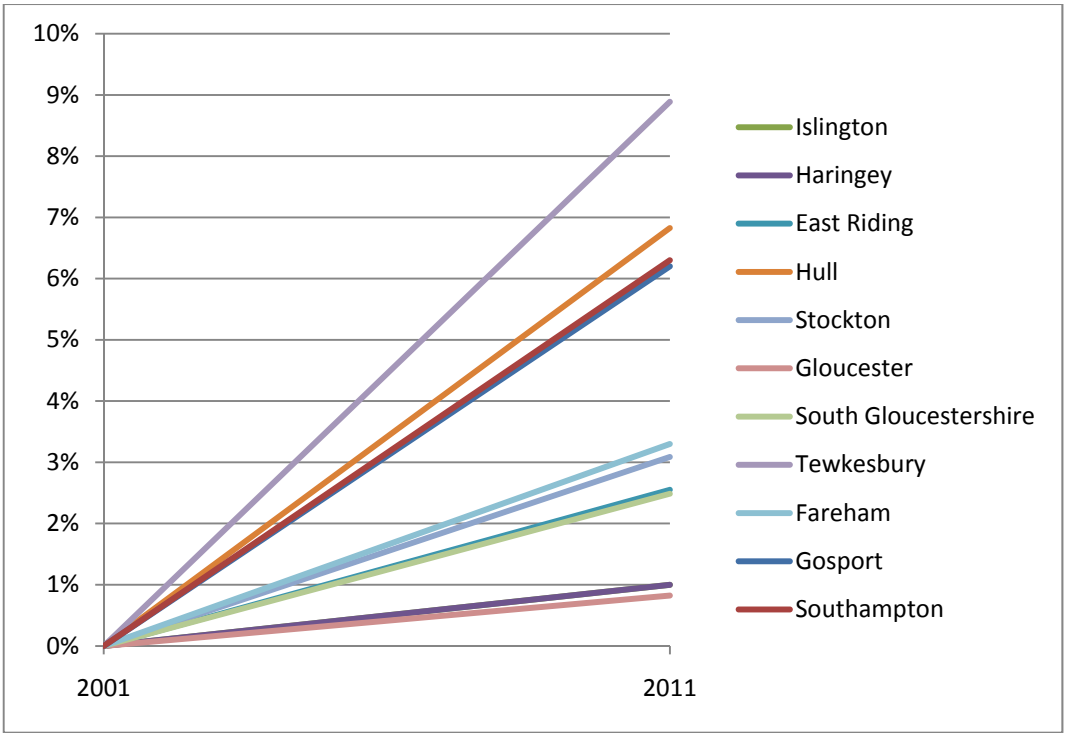


Figure 8: **Change in area of buildings within areas susceptible to surface water flooding 2001 to 2011**

[8] Data from April 2009

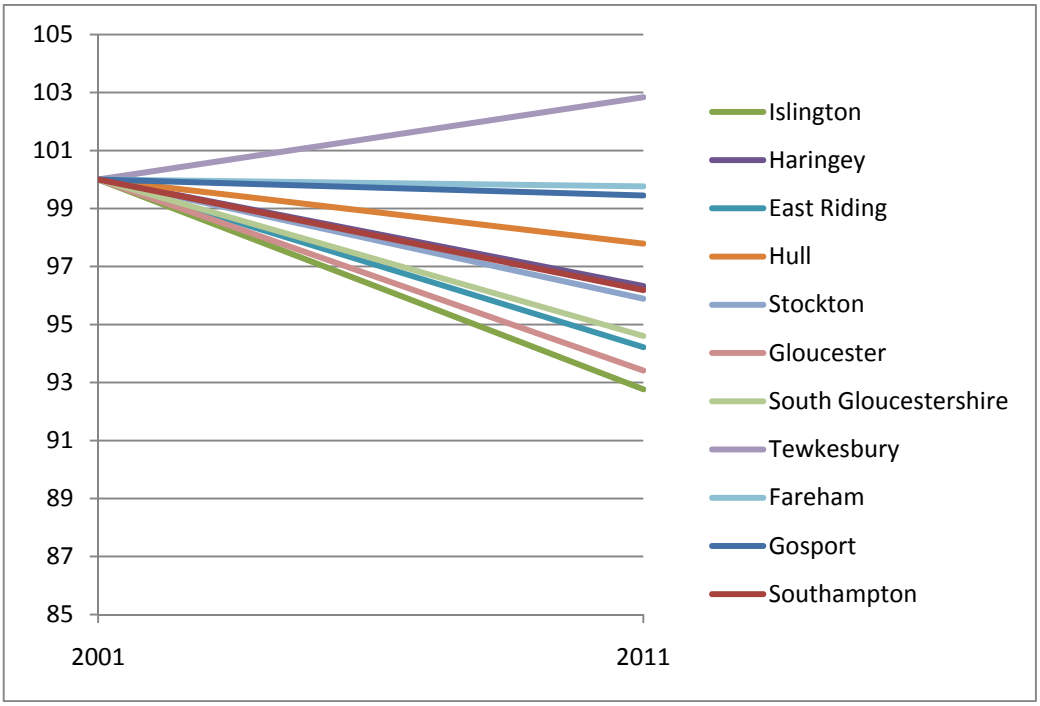


Figure 9: Change in area of buildings within areas susceptible to surface water flooding indexed against population change 2001 to 2011

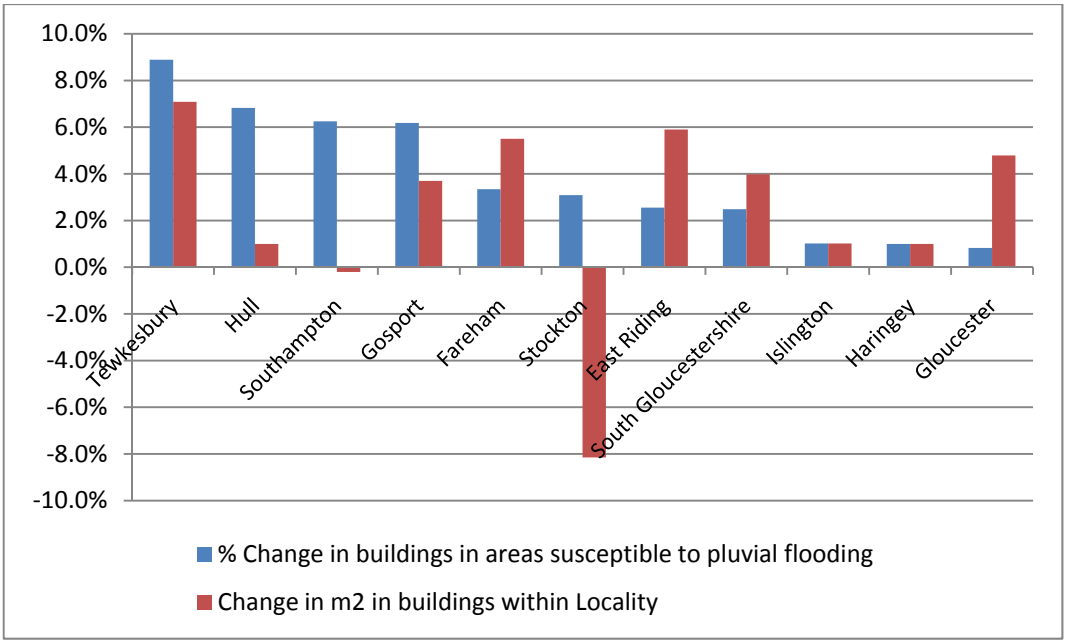


Figure 10: Change in area of buildings (m²) 2001 – 2011 in areas susceptible to surface water flooding compared with change across the locality as a whole

The initial data presented above demonstrates in all authorities there was an increase in the amount of buildings created in areas at risk of surface water flooding. Across the 11 authorities were there was an increase in the amount of buildings in areas of pluvial flood risk, the average growth rate was 3.9%. The following observations are made:

- The area of buildings in areas susceptible to surface water flooding has increased in all authorities studied.
- In Hull, Tewksbury and Gosport, land use change in buildings was slightly higher in areas susceptible to surface water flooding than in the locality as a whole.
- In both Stockton-on-Tees and Southampton, buildings area decreased over the past ten years. However, there was an increase in buildings in areas susceptible to surface water flooding.

Please see **Appendix D** for maps illustrating the change in buildings susceptible to surface water flooding between 2001 and 2011.

4.5 Coastal erosion

In order to investigate coastal erosion in South Hampshire and the Hull and Humber area the Study team utilised the areas set out in the respective Shoreline Management Plans (SMPs) for these areas:

- North Solent SMP (South Hampshire); and
- Draft Flamborough Head to Gibraltar Point SMP (East Riding).

The SMPs identify those sections of the eroding coastline currently protected by defences and the sections that are unprotected.

The analysis has used GIS to analyse the change in the total area covered by buildings within buffer zones along the two SMP areas. The depth of the buffer area was derived from each SMP, as follows:

- 1km of the protected and unprotected eroding coastline for East Riding; and
- 300m of the protected and unprotected eroding coastline for Fareham, Gosport and Southampton.

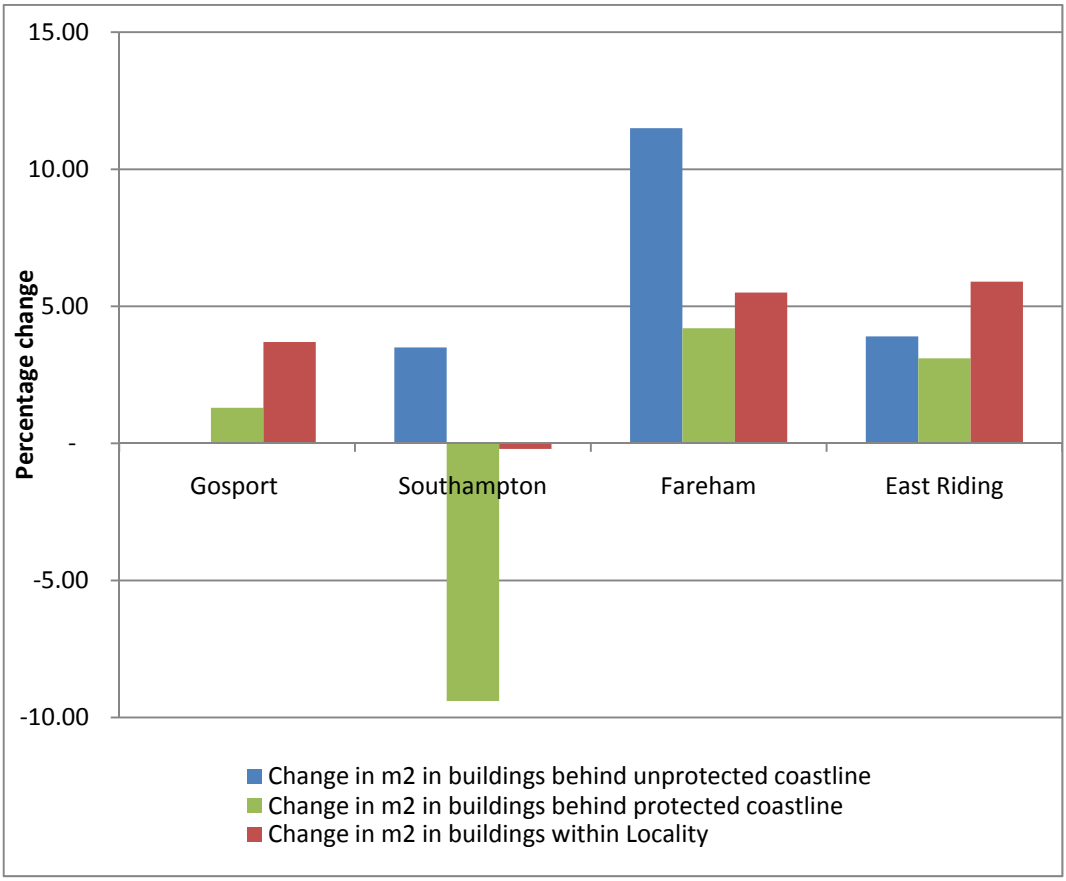


Figure 11: Change in buildings (m^2) 2001 – 2011 on eroding coastlines that is protected or unprotected, compared with change across the locality as a whole

The data in **Figure 11** illustrates the percentage changes in buildings on eroding coastlines, which are protected by defences or unprotected and across the authority area as a whole. The graph shows a variation across the localities in terms of the proportionate amount of development occurring behind unprotected coastlines. There has been an increase in buildings in all areas between 2001 and 2011, with the exception of Southampton and the unprotected eroding coastline in Gosport. It should be noted, however, that the majority of the eroding coastline in South Hampshire is protected by defences. Furthermore, in East Riding the main coastal settlements on the eroding coastline of Bridlington, Hornsea and Withernsea are protected by defences, while the more rural areas, where the proportion of buildings is much lower, are unprotected by defences. In addition, the following observations have been made:

- Fareham was the only area that demonstrated a substantial increase in buildings in unprotected coastal areas.
- In East Riding, proportionally, change in protected and unprotected coastlines was broadly the same.
- In Gosport change in the amount of buildings was significantly lower behind protected eroding coastlines, and the unprotected coastline where there was no change, than in the locality as a whole.
- The Southampton figures are surprising as they show a significant decrease in buildings near the protected coastline, compared with a slight decrease in the locality as whole and slight increase of 3.5% in the protected coastline. These

results mirror those for fluvial and tidal flooding. See explanation in section 4.3.

Please see **Appendix E** for maps illustrating the change in buildings behind protected and unprotected eroding coastlines between 2001 and 2011.

4.6 Heat stress

Heat stress as a climate risk is directly related to increased urbanisation and density of development activity. One of the main climate-related risks across London is known as the urban heat island (UHI) effect. There are several causes of an UHI, including surface heat radiation, which causes a change in the energy balance of the urban area, often leading to higher temperatures than surrounding rural areas. The effect is exacerbated by greater quantities of impermeable surfaces, unable to absorb the heat.

This research has used data provided by the 'Development of a Local Urban Climate Model and its Application to the Intelligent Design of Cities' (LUCID) which illustrates the UHI effect across London. LUCID is a three year research project funded by the UK Engineering and Physical Sciences Research Council (EPSRC) that began in June 2007. The project is researching how cities can adapt to a changing climate.

The LUCID data is based on average daily minimum temperatures. Although maxima are more frequently used, minima illustrate greater variation in the upper and lower values. The figures give a snapshot in time, between 26th May 2006 and 19th July 2006, and do not take into consideration the projected increases in temperature as a result of climate change. Across London as a whole the temperature ranges from 11 to 16.2 °C, with a very clear pattern of increasing average temperatures towards central London as a result of the increased density and lack of vegetation.

The two London boroughs identified in this study illustrate the variation in temperature by their location. The London Borough of Islington is rectangular in shape and extends towards central London, whereas the borough of Haringey is located further north and runs east to west so does not show as great a variation in temperature. The highest temperatures in Islington reach 14.6 °C to the south of the borough (nearer central London) and drop to 13.1°C to the north. In Haringey the highest temperatures are to the east of the borough at 14.4°C and also drop to 13.1°C to the west where the borough joins with the northern border of Islington.

This study has explored the changes in impermeable land use (or manmade land uses, as a proxy for hard surfaces), correlated against the UHI effect. The temperature was broken down into three heat stress bands to explore whether the increased heat risk was having an impact on development on the ground. The heat stress bands are illustrated below and the figures for the bands are:

- Low (yellow) 10.36 – 14.40°C;
- Medium (orange) 14.41 – 14.59°C; and
- High (red) 14.60 – 14.82°C.

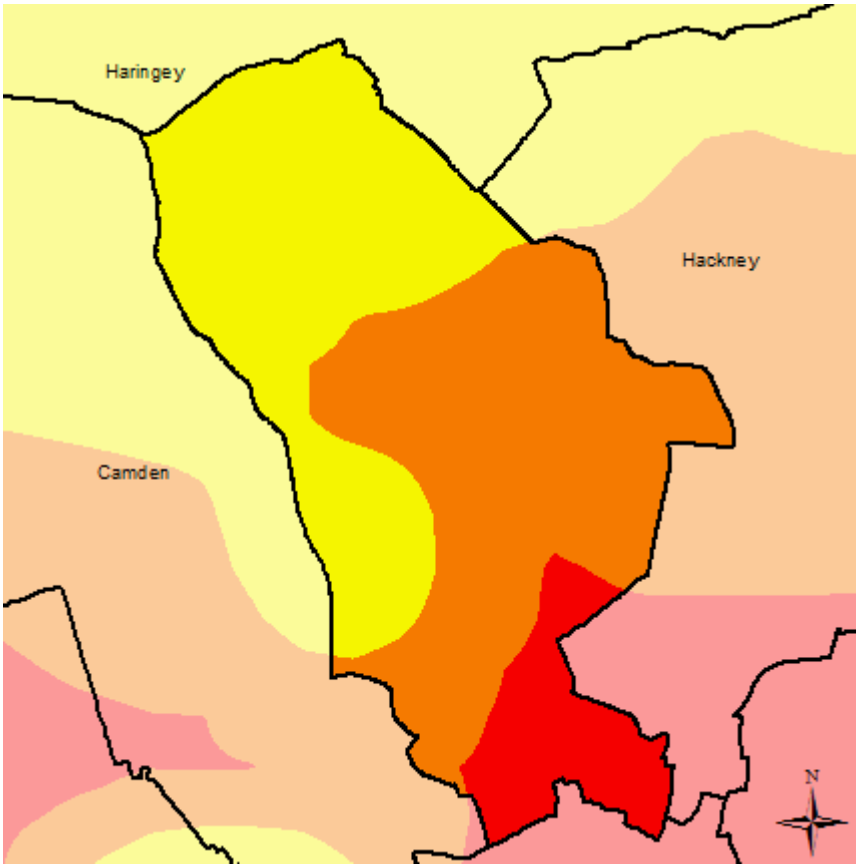


Figure 12: High, Medium and Low Risk Areas for heat stress in Islington

The same heat stress bands were used for LB Haringey, but there was a more uniform situation across the borough as illustrated in **Figure 13**.

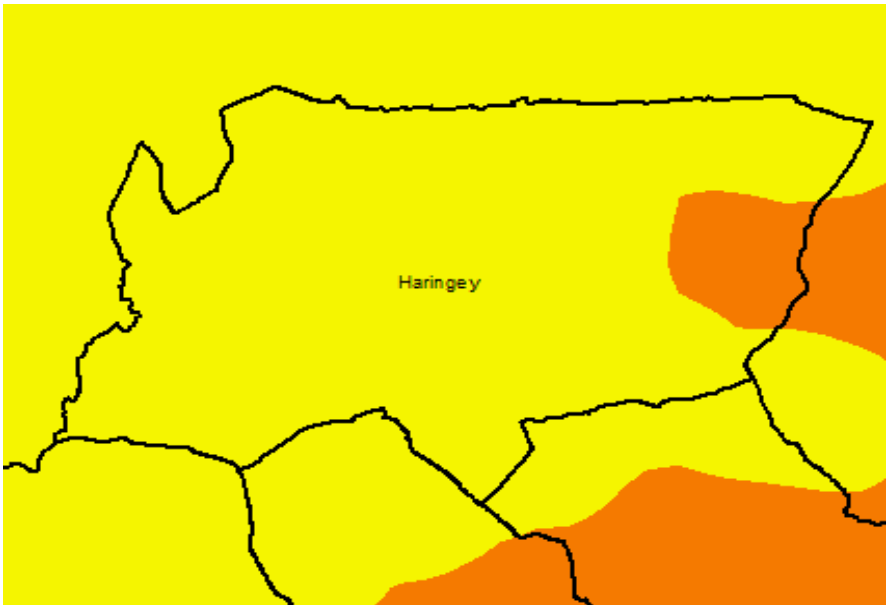


Figure 13: Medium and Low Risk Areas for heat stress in Haringey

Unsurprisingly, there has been an increase in manmade development in both Islington and Haringey in high and low heat stress areas. In Islington, there has been a 6% increase in manmade surface in areas categorised as being in high heat stress risk

4.7 Biodiversity

This study has used GIS to explore whether habitats identified in local authority Biodiversity Action Plans (BAPs) have increased or decreased between 2001 and 2011. The land use categories have been extracted from the Ordnance Survey MasterMap topography data, and form part of the "Natural" land use category[9]. The overall change in "Natural" areas between 2001 and 2011 is in Table 6:

Table 9: Change in Area of Land defined as "Natural" 2001 to 2011

	Change in total 'Natural' area 2001 to 2011
Stockton	-37.8%
Gloucester	-8.3%
South Gloucestershire	-2.3%
Tewkesbury	-7.1%

The study has assessed the change in those BAP habitat land cover typologies which corresponded with the data available in MasterMap. The four authorities and their habitat priority areas are given in Table 7.

Table 10: BAP Priority Habitat Areas

Local Authority	**BAP habitat**
Stockton	Orchards Marshland
Gloucester	Orchards Marshland
South Gloucestershire	Orchards Marshland
Tewkesbury	Orchards Marshland

[9] Defined as features that are not man-made but could possibly be man altered, for example, cliffs, areas of water and uncultivated/cultivated vegetation

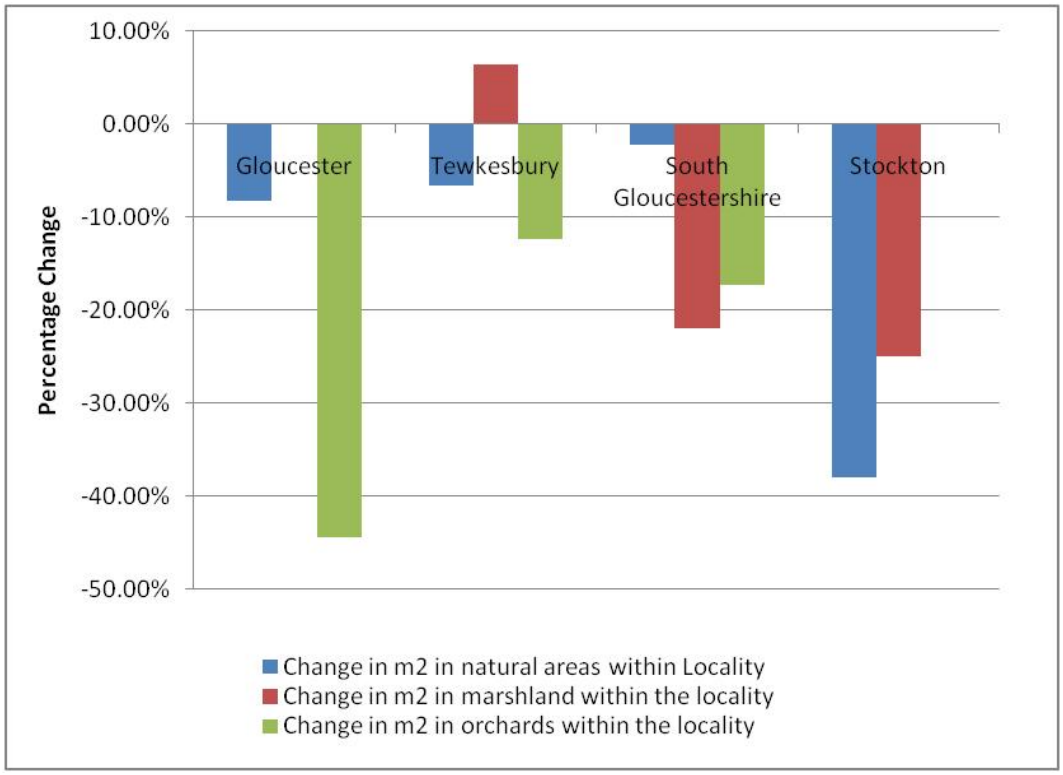


Figure 14: Change in area covered for selected BAP habitats, 2001-2011

Figure 14 illustrates the percentage change in areas of marshland and orchards, which are identified as Biodiversity Action Areas within the respective authorities, compared to the percentage change in natural areas across the authorities. With the exception of marshland in Tewkesbury, the graph illustrates that these areas have decreased in all the authorities between 2001 and 2011. The Gloucester marshland figure has been omitted as it showed an erroneous increase owing to the relatively small area of land designated as marshland increasing. In addition, Stockton-on-Tees did not identify orchards as one of their Action Areas so these figures are not shown. The following observations can be made:

- There was a significant decrease in orchards in Gloucester and South Gloucestershire compared to the percentage decrease in natural land cover;
- There was also a significant decrease in marshland in South Gloucestershire and Stockton-on-Tees relative to the percentage decrease in natural land area; and
- A countertrend was observed in Tewkesbury which showed an increase, in absolute terms, in marshland.

Please see **Appendix F** for maps illustrating the change in land covered by BAP habitat areas.

Note: Although this study has attempted to quantify the direct loss of habitat and has focused on the loss of the habitat type, this indicator is a proxy for ecological system health. The study is aware that the analysis has taken a very pragmatic proxy indicator for biodiversity effects, and that a much more focussed, fine-grain approach is required to undertake a true measures of biodiversity and ecological network degradation.

Note: Results for East Riding, Hull, South Gloucestershire, Stockton-on-Tees and Tewkesbury may have been affected by anomalies on the 2001 MasterMap dataset. See Section 3.2.2.

4.8 Conclusions

The statistical analysis of the amount of development that has occurred between 2001 and 2011 within the five localities studied reveals that there has been considerable development in climate risk areas. However, the amount of change experienced varied between different climate risks and across the study area. The main changes in relation to each of the climate risks are set out below:

- **River and tidal flooding:** in eight of the nine authorities sampled for this indicator the total footprint of buildings in flood risk areas increased between 2001 and 2011. Across these eight authorities where an increase was experienced the average increase was 4.3%; across all nine authorities the average percentage change was 2.1%. However, this total percentage change of 2.1% was below that for the average rate for the local authorities as a whole, which was 2.6%, showing that there has been proportionally less change in river and tidal flood risk areas.
- **Pluvial flooding:** in all eleven authorities studied there was an increase in the total footprint of buildings in areas at risk of pluvial flooding. Across all authorities sampled for pluvial flood risk the average change was 3.9%. This figure was above the average change in buildings in the entire local authority areas, which was 2.3%. This shows that relatively there was more change in the risk areas than in the local authority areas as a whole.
- **Coastal erosion:** of the four authorities studied the total footprint of buildings in areas of unprotected coastlines increased in three out of the four authorities. Similarly, in three out four authorities studied there was an increase in building footprint in protected coastal areas.
- **Heat stress:** there was an increase in manmade development (which mainly comprises buildings and paved surfaces) in both Islington and Haringey in high and low heat stress areas, however the amount of development in medium risk areas has decreased.
- **Biodiversity:** with the exception of marshland in one authority, the area of marshland and orchards has decreased in all the four authorities studied between 2001 and 2011.

Cumulatively, these sample studies tell a consistent story of increasing development and decrease natural areas between 2001 and 2011. The implications of this trend are significant both in terms of the increase of assets and people exposed to climate change-related risks, and in terms of the exacerbating effect of new development on these risks

5 Influence of land use planning

5.1 Overview

In order to understand the scale and influence of the planning system over time, the Study team have quantified the following metrics over the period 2001 to 2011:

- How much land is covered by planning decisions each year? What percentage of all land is this? (East Riding, Islington and Stockton-on-Tees only); and
- How many planning decisions (approvals) are taken in regards to each climate risk area, provided for the twelve local authority areas;

5.2 Influence of Planning

The quantity of land covered by major planning applications in the three local authority areas of the East Riding, Islington and Stockton-on-Tees reveals that in Islington a significant proportion of the area has received planning permission for a major development over the last 10 years. This would illustrate that the planning system is central to the facilitation of land use change over time.

This data reflects that Islington is a highly developed borough and operates as a part of the strong London property market, relative to the other two authorities. However, it is important to remember that proportionately it is a much smaller authority geographically than either Stockton-on-Tees or East Riding. Therefore, a higher percentage of the local authority area covered by development in this area does not necessarily mean that more development has been permitted here. For example, in East Riding between 2001 and 2011 almost 25 million sqm in floorspace was generated through approved planning applications. Consequently, whilst proportionately this is a lower amount of East Riding's total area it is a significant amount of consented future development.

Table 11: Proportion of local authority area within approved major planning applications

	Percent of local authority area subject to planning applications	
	2001 to 2011	**Per annum - %**
East Riding	1%	0.09%
Stockton-on-Tees	7%	0.64%
Islington	15%	1.4%

5.3 Approvals Analysis

In absolute terms the most major applications approved between 2001 and 2011 fell within areas at risk of coastal erosion and river and tidal flooding, with collectively almost 1,100 proposals within these risk areas being approved. In contrast, of the local authorities studied a smaller number of applications were approved in areas at risk of either heat or water stress. This would indicate that

pluvial flooding and coastal erosion affects a larger number of approved planning applications than the other risks studied as part of this research.

The analysis undertaken shows that the average approval rate for major planning applications in all the climate risk areas was moderately lower than the overall average approval rate of 85% for all major schemes within these authorities. This lower rate of approvals may indicate that being located in a climate risk area can slightly reduce the probability of a development being approved. Furthermore, the level of information that may be required in support of an application in a climate risk area may be greater and thus more of a challenge to the developer, therefore reducing approval rates. It would also be interesting to undertake a comparison of the time period in which applications were determined in climate risk areas as opposed to the applications sitting outside of these areas, thus further detailing whether applications were determined within a shorter time period with climate risk areas.

The table below indicates that the lowest approval rate for major applications occurred within the areas at risk of pluvial flooding, and those in proximity to areas of eroding coastlines (including both the protected and unprotected areas). This is of particular interest when it is considered that these risks contained the largest number of approvals in absolute terms. This initial analysis would suggest that these risks may be of greater significance when determining applications and consequently may result in more applications being refused. This may mean that when preparing applications in these areas sufficient adaptation measures are not included to mitigate the risks of climate change. Furthermore, this may be because of Councillor awareness and applications going to Committee rather than being decided by officers under delegated powers. In contrast, through this analysis it would appear that more appropriate adaptation measures are included for heat and water stress, although it may be a coincidence, as both heat and water stress have been analysed at a borough scale. Further discussion of adaptation measures included within approved planning applications is provided in Chapter 6.

Table 12: Analysis of approvals across climate risk areas

	Climate risk				
	Pluvial	**River and tidal**	**Coastal Erosion**	**Heat stress**	**Water stress**
Total approvals (2001 to 2011)	579	513	629	449	449
Total applications	800	687	865	575	575
Total % approved	72%	75%	73%	78%	78%

Notes: This table contains data from across all 11 authorities for which the planning application data was received. The figure in relation to coastal erosion includes applications for protected and unprotected coast.

Figures for river and tidal are based on planning applications and approvals within Flood Zones 2 and 3.

6 Statistical Analysis: uptake of adaptation measures

6.1 Introduction

Examining the process and outputs associated with the development management system allows us to explore whether planning decisions tend to document the relevant measures as part of the permission granted, and how the application assessment and consultation processes address key climate risks. Therefore to understand the degree of penetration of climate change risks and adaptation in the development management process, the following key questions have framed our approach to analysis of planning applications:

- For each climate risk factor, what proportion of applications and decisions take account of the risk status of the application site?
- What proportion of all applications contained assessment documents referring to climate change adaptation measures?
- What proportion of all permissions contained planning conditions which addressed climate related risks?
- Is there evidence of development decisions incorporating low-regret adaptation measures?

This section provides analysis on a thematic basis, with each section relating to each of the five climate risks[10]. **Table 13** indicates which climate risk is evaluated in each of the three boroughs. The sample size was limited by the availability of planning documents online, as well as the actual quantum of major planning application approvals within particular climate risk areas. The nature of the information available online means that the majority of applications were approved between 2007 and 2009, with a smaller number of applications sampled post 2002.

Table 13: Areas for analysis

Climate risk	Borough	Sample size
River and tidal flooding	East Riding, Stockton	East Riding (28) and Stockton-on-Tees (28)
Pluvial flooding	East Riding, Stockton, LB Islington	East Riding (28), Stockton-on-Tees (28), Islington (28)
Coastal erosion	East Riding	N/A
Heat stress	LB Islington	LB Islington (28)
Water stress	LB Islington	LB Islington (28)
Loss of biodiversity and functioning of ecosystem services	LB Islington, Stockton	LB Islington (28) and Stockton-on-Tees(35)

[10] Coastal erosion has been excluded from the statistical analysis however .

6.2 Climate Risks in Planning Application Documents

We measured the proportion of planning applications sampled which explicitly refer to climate change as a risk within their application documents.

Almost 90% of applicants submitting development proposals in areas of river and tidal flooding acknowledged that river and tidal flooding is a risk that is projected to increase with future climate change. Fewer (61%) applicants submitting development proposals in areas of pluvial flooding related the risk of climate change to pluvial flooding. A third of applicants associated increasing heat stress with climate change. Only 2% of applications linked the retention and enhancement of biodiversity with risks associated with climate change. Interestingly, none of the development proposals within areas of water stress discussed water stress in the context of climate change (although many applications addressed water use in their proposals).

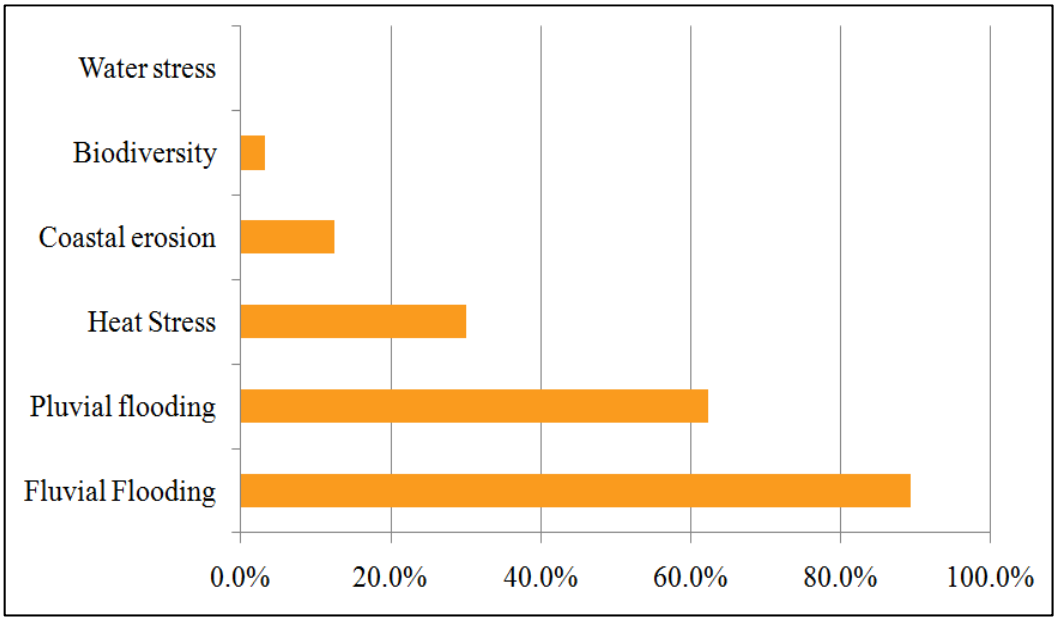


Figure 15: Proportion of applications sampled in a risk area with assessment documents explicitly referring to that risk in relation to climate change

6.3 River and Tidal Flooding

6.3.1 Statistical Analysis

Overall, 96% of approved planning applications within areas of river and tidal flood risk included one or more low regret adaptation measures as part of their planning submission or had a planning condition requiring adaptation measures. The majority of these measures were included within FRAs and often summarised within Design and Access Statements and Sustainability Statements.

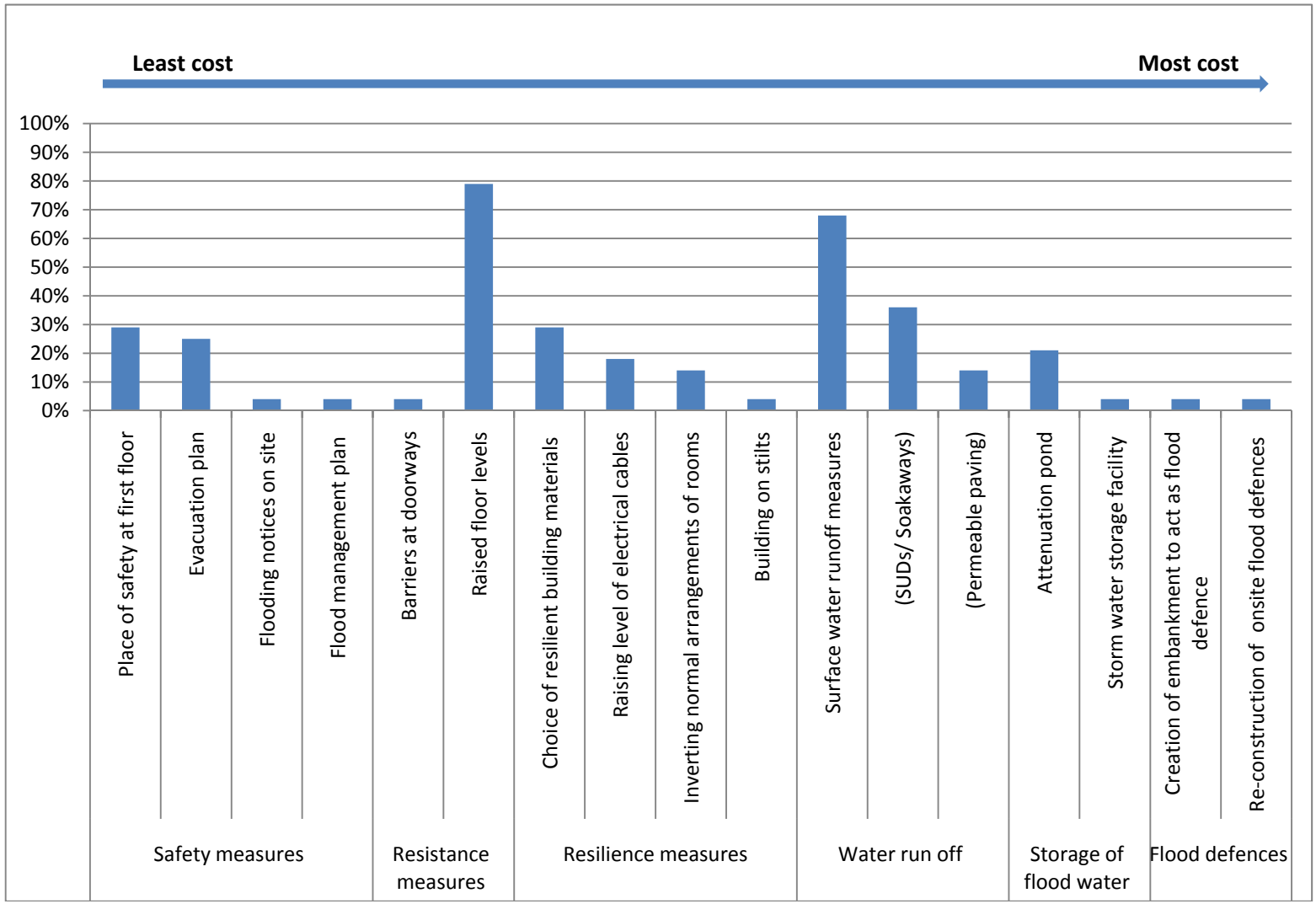


Figure 16: Proportion of sampled planning applications in areas of river and tidal flood risk containing assessment documents or planning conditions referring to adaptation measures

6.3.2 Analysis

25% of major planning applications in East Riding lie within Flood Zones 2 and 3. In Stockton-on-Tees 18% of major applications lie within Flood Zones 2 and 3. The majority (79%) of these planning applications included resistance measures of minimum floor height, which included raising floor levels or building the development on a raised platform. This is evidence that building design is taking into account mechanisms to be resistant to flooding and that there is uptake of flood resistance measures in new development. It was evident from the officer's reports reviewed that floor levels had often been raised at the request of the Environment Agency. Only 4% of applications included proposals for barriers to be placed in doorways as a resistance measure.

In terms of resilience measures, where building design takes account of the high risk of flooding, 29% of development proposals had selected resilient building materials, where materials have been selected to recover relatively undamaged from flooding e.g. solid concrete floors, which tend to suffer less damage than suspended floors and are less expensive and faster to restore following exposure to floodwater. 18% of planning applications included a planning condition which set a minimum height for critical infrastructure such as electrical/utility cables in residential developments, or IT infrastructure in commercial and office developments. 14% of applications demonstrated that building layout had inverted the normal arrangements of rooms to take account of the potential risk of flooding. 4% of planning applications were built on stilts.

Almost a third of planning applications included a place of safety within the building design and layout. This was particularly notable in residential applications, providing a place of safety at the equivalent of first floor level in all dwellings in the development. A quarter of developments had a planning condition requiring the applicant to complete a flood evacuation plan and to provide safe access and egress during flood events to land outside of Flood Zone 3 in order to reduce reliance on emergency services. 4% of applications had a planning condition requiring flood notices, to be placed on site, although this was unique to Stockton. Similarly, 4% of applications had to submit a flood management plan. These planning conditions were usually required to be discharged before the building is occupied.

The use of surface water runoff and attenuation measures such as ponds were also put forward within application supporting documents and are also evident in planning conditions. The majority (68%) of applications included surface water runoff measures as part of their development proposals, although only a third of these measures were SUDs, and fewer still, permeable paving (14%). 21% of planning applications proposed the creation of attenuation ponds and 4%, the provision of a storm water storage facility. These measures are discussed in more detail in the pluvial flooding section, as in many instances it was difficult to distinguish between how these drainage measures contributed specifically to either river and tidal or pluvial flooding.

Very few planning applications included creation of flood defences as part of their development proposals. 4% of applications proposed re-construction of on-site flood defences, and 4% proposed the creation of a new embankment to act as flood defence. Interestingly, none of the planning applications sampled either proposed or required a financial contribution to off-site flood defences.

There was a marked difference between the measures proposed for commercial and domestic properties reflecting PPS25 regarding the protection of uses which are the most vulnerable to the impacts of flooding. For example, there was more adaptation measures proposed for residential development than for commercial. For residential proposals these measures were generally more focused on measures such as the provision of a place of safety at first floor or 5m AOD.

This analysis shows that adaptation measures to ensure resilience and resistance to river and tidal flood risk are well embedded in planning system, with relatively standard measures and planning conditions being included within the design of many schemes[11]. Furthermore, in terms of river and tidal flooding it was clear that this issue could not be resolved through a single measure, but was based on a combination of adaptation measures. As more information and knowledge is ascertained on the need to adapt to climate change and specifically river and tidal flooding as part of this it will be important to address these issues holistically, so that this becomes an integral part of the building design process rather than a bolt-on (i.e. dealt with as part of a planning condition).

6.4 Pluvial flooding

6.4.1 Statistical Analysis

Overall, 55% of approved planning applications within areas of pluvial flood risk included one or more low regret adaptation measures as part of their planning submission or had a planning condition requiring low regret adaptation measures. The majority of these measures were included within FRAs and often summarised within Design and Access Statements and Sustainability Statements.

[11] See Environment Agency 'Development and flood risk in England report 2008-09'for statistics on the number of applications the EA were consulted on and the number of decisions on planning applications that were in line with the EA's advice.

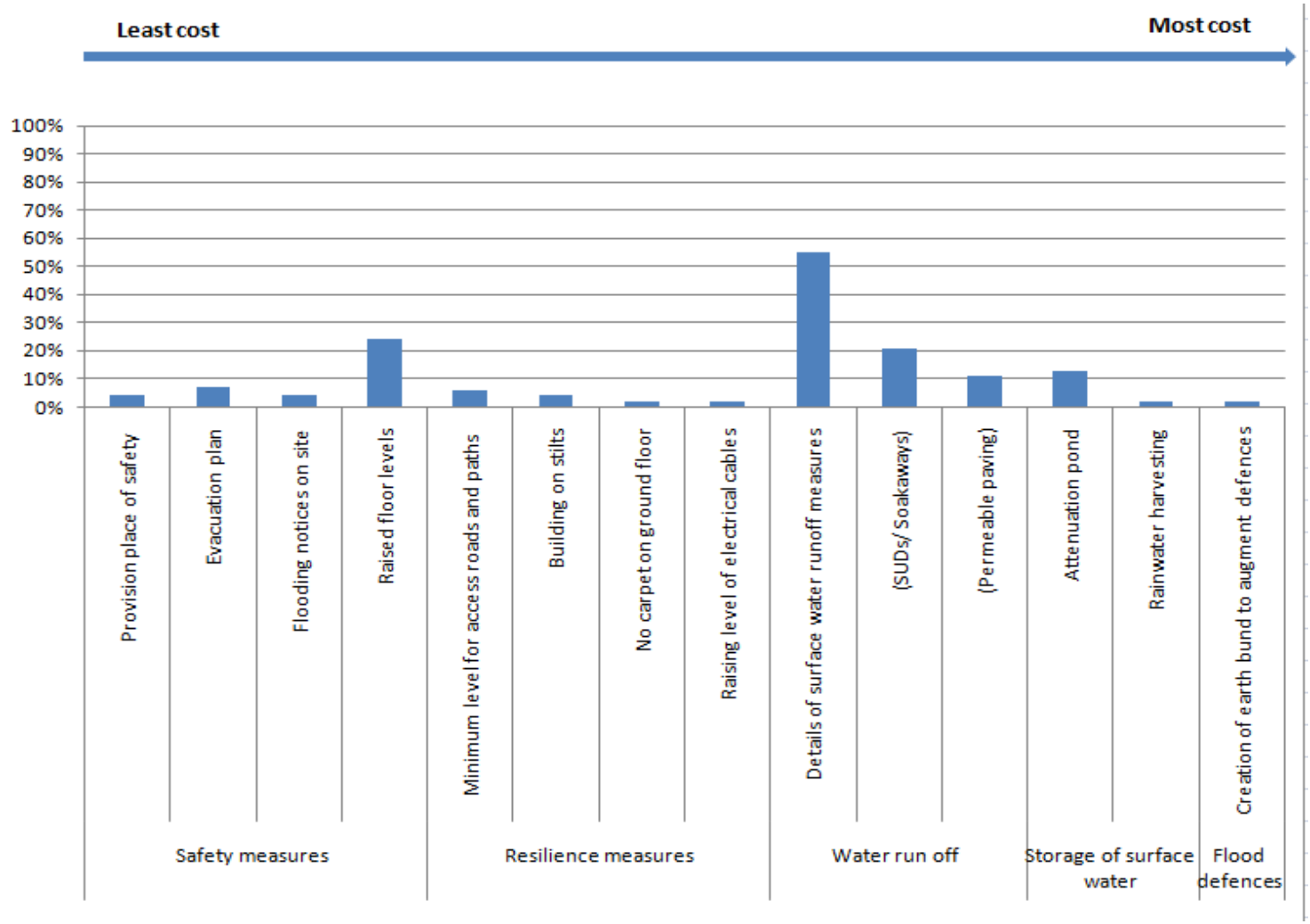


Figure 17: **Proportion of planning applications in areas of pluvial flood risk containing assessment documents/ planning conditions referring to adaptation measures**

6.4.2 Analysis

Just over half (55%) of planning applications were required to provide details of surface water run-off measures as part of planning conditions. New drainage schemes and improvements for new developments typically incorporate some consideration for climate change based on current best practice guidance. Existing systems, however, are generally managed in a more reactive sense. Where local authorities used a planning condition to ensure drainage details were submitted, it would appear that not all planning applications provide a sufficient level of information for how drainage issues and pluvial flood risk are to be managed. However, as these applications were still approved this illustrates that, whilst an important condition of development pluvial flooding was not considered to pose such a sufficient risk to refuse the application, demonstrating that adaptation measures were often anticipated to make the development acceptable.

The inclusions of measures within development proposals to adapt to the risk of pluvial flooding, mainly through sustainable drainage systems (SUDs) was evident across applications in all three localities, although only just under a quarter of applications included proposals for SUDs, and 11% permeable paving to help reduce surface water run-off. Although, in different authorities the types of drainage measures proposed varied slightly, reflecting local circumstances in each area. For instance, permeable paving and SUDs as an adaptation measure is much more prevalent amongst the applications sampled in Islington.

In terms of resistance measures, 24% of applications included proposals for raising floor levels – markedly less than in river and tidal flooding areas. It is possible that applicants are not as aware of the risk of surface water flooding to their development as river and tidal flood risk. Similarly, very few developments required safety measures such as an evacuation plan (7%) or a flood management plan/ place of safety (4%), compared with those development proposals in river and tidal flood risk zones. Adaptation measures related to increased resilience to pluvial flooding were also less prevalent in planning applications in pluvial flooding areas – only 6% of applications proposed minimum heights for access roads and paths, and 2% of applications included raising levels of electrical cables. Again, this is markedly less than proposed developments in river and tidal flooding areas.

A small quantum (15%) of applications proposed storage of surface flood water as an adaptation measure – notably within developments proposed in East Riding, where attenuation ponds (13% of applications), and to a lesser extent rainwater harvesting (2% of applications) were included as part of the development proposal to adapt to pluvial flood risk. In accordance with PPS25, many of the more recent applications made explicit reference in the FRA to the fact that these attenuation measure were designed to be able to accommodate greater rainfall events as a consequence of climate change. In this sense the building design can be seen to take into account resilience to predicted increases in future events.

Only 2% of applications proposed or were required to provide flood defence measures related to pluvial flooding. None of the planning applications sampled either proposed or required a S106 contribution to off-site reduction of pluvial flooding risk.

6.5 Heat stress

6.5.1 Statistical Analysis

Overall, 28% of approved planning applications within areas subject to heat stress included one or more adaptation measures as part of their planning submission or had a planning condition requiring low regret adaptation measures be included as part of the scheme. The London Borough of Islington was the only local authority area within this study for which increased heat stress has been explicitly identified as a climate risk, and the applications are sampled from across the borough.

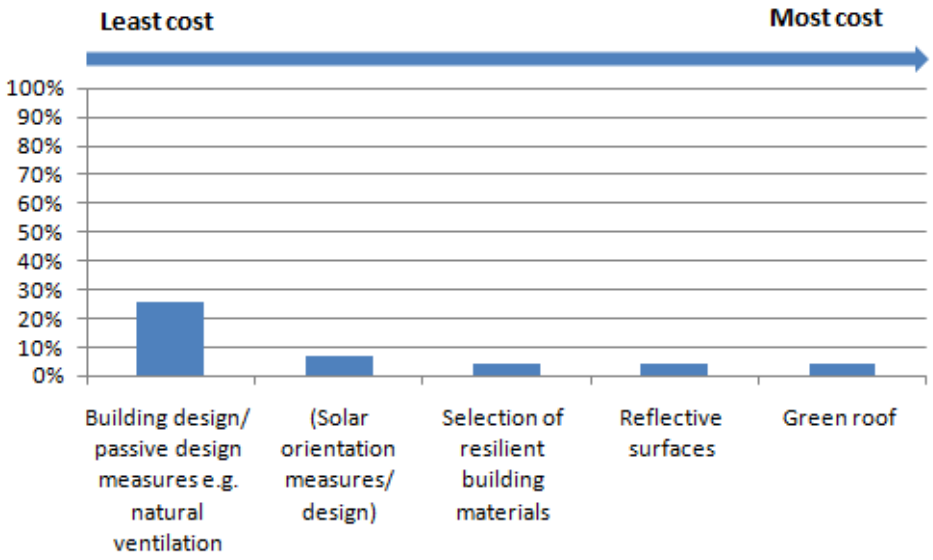


Figure 18: Proportion of sampled planning applications in areas of heat stress containing assessment documents/ planning conditions referring to adaptation measures

6.5.2 Analysis

The most prevalent adaptation measure included in planning applications to minimise the risk of heat stress were related to building design and passive design measures to reduce internal heat gains e.g. enhancing natural ventilation and awnings/ screens to protect rooms from the sun. 26% of planning applications proposed designs which were considered to reduce heat stress, and reduce internal room temperatures and overheating, particularly during the summer months. Of these applications, 7% specifically included adaptation measures pertaining to solar orientation, where applicants had designed the layout of developments to minimise exposure to the sun and solar radiation/ heat gain to reduce the risk of overheating.

Only 4% of planning applications had selected specific building materials as part of the design process to be resilient to heat stress/ overheating and to reduce exacerbation of heat stress. Similarly, only 4% of applications included reflective surface measures (painting external walls in light colours) as part of the building design in order to minimise warming of external surfaces. There were no planning

conditions imposed specifically on the applications sampled within this study which related to reducing or limiting the heat island effect

Only 4% of planning applications sampled included a green roof within design proposals, relating it specifically to reducing heat stress as a climate risk. Instead, green roofs are integrated to development proposals more for benefits relating to biodiversity, rather than heat stress. Only one application that makes the link that planting on roofs will help reduce summer overheating in buildings - although this does not go as far as to say the planting will in turn help to combat the UHI effect, only the internal room temperature. Therefore, although the majority of the sample had planning conditions requiring details of green roofs to be submitted, the stated reasons for refusal stipulated that green roofs are required to increase biodiversity rather than reduce urban heating. It is likely this is because the Islington Unitary Development Plan (UDP) has not provided the case for planning officers to impose conditions related to reducing the heat island effect, whereas the policy documents do for the importance of biodiversity. The recently adopted Core Strategy, however, states the importance of addressing the UHI effect. There will be a lag time before this effect is evident.

Often, planning applications did not explicitly state the range of benefits the adaptation measures proposed to minimise the effects of heat stress could provide at any scale wider than the building or site scale. This implies that applicants are not fully aware of the different benefits of adaptation measures, at different geographic scales (site, neighbourhood, borough etc) or the opportunities that adaptation measures can provide benefits across other climate risk effects. For instance, where green roofs were often included by applicants to provide a biodiversity benefit on site, it is widely recognised that green roofs provide multiple benefits, helping to reduce the UHI effect and also reduce surface water run-off.

In addition, one application included an area of outdoor space within its proposals and explicitly linked increasing temperatures in the borough with the importance of providing green space to counteract the UHI effect. However, in this case, the inclusion of open space as part of the application was justified in terms of improving amenity. The Greater London Authority (GLA) has published research on how to manage the intensification of London's Urban Heat Island[12], which includes a range of low regret adaptation options as part of the analysis. The research supports the need for more adaptation measures such as green roofs and street trees to dissipate the effects of increased temperature rises.

In summary, a quarter of planning applications in Islington include adaptation measures which will help to reduce or at least stabilise the UHI effect, such as green roofs, passive design and natural ventilation. However, it is clear that this is a developing area for the adaptation agenda. The recently adopted Core Strategy and emerging Development Management policies provide detail regarding requirements of future applications to reduce the UHI effect and overheating. Policies emphasis the spatial variation across LB Islington, as the Bunhill and Clerkenwell area is highlighted as a priority zone for measures to reduce overheating owing to its location close to central London. In addition, major applications in Islington within the London Central Activity Zone will soon be required to submit details of temperature modelling under projected increases in temperature to demonstrate whether passive cooling measures are sufficient.

[12] London's Urban Heat Island. A summary for decision makers. Greater London Authority. October 2006.

6.6 Water stress

6.6.1 Statistical Analysis

Overall, 70% of approved planning applications within areas subject to water stress included one or more adaptation measures as part of their planning submission or had a planning condition requiring low regret adaptation measures be included as part of the scheme. The London Borough of Islington was the only local authority area within this study for which increased water stress has been explicitly identified as a climate risk, and the applications are sampled from across the borough.

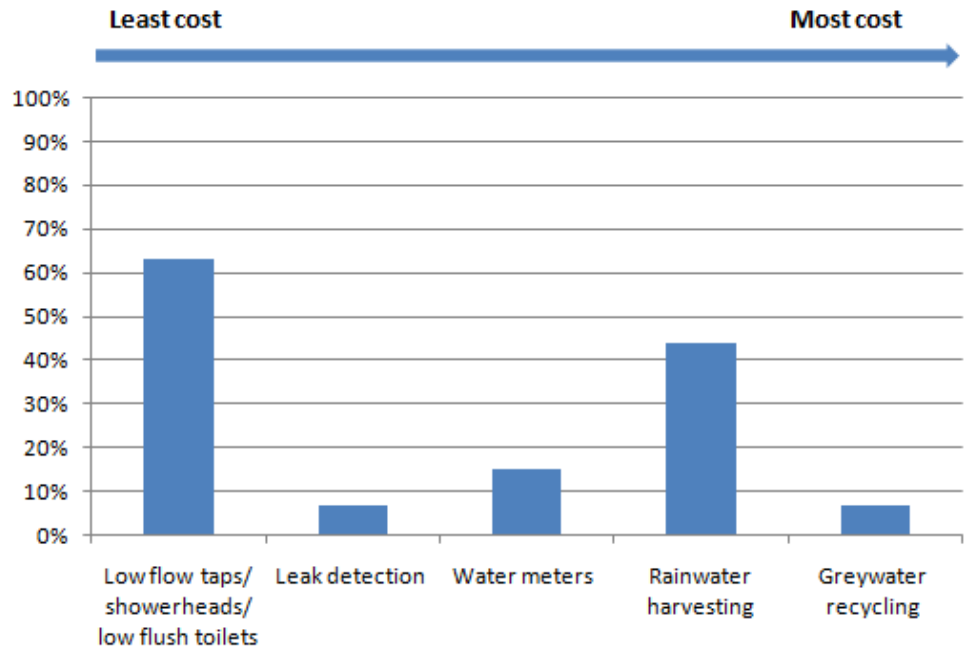


Figure 19: Proportion of sampled planning applications in areas of water stress containing assessment documents/ planning conditions referring to adaptation measures

The limitations of the data used to identify the areas of water stress within the sampled local authorities are set out in **Table 1**. These limitations should be considered in relation to this section, however, it is important to remember this data was used to select areas within which planning applications were sampled and analysed to produce the results set out below. Key limitations of the map data include:

- The water stress mapping process takes a long-term view of the balance between water availability and the demand for public water supply, rather than a snapshot of shorter or peak periods. Disaggregation down to LPA layer is difficult owing to complex data extraction requirements.
- These maps are not intended for land use planning purposes. The Environment Agency is currently working on a set of maps that will use CAMS base data and climate data from UKCP09 to estimate the impact of climate change on

water availability. The Environment Agency is also working to simplify messaging to make it more customer focused.

- Access to water consumption data is limited. Returns to OFWAT have basic consumption figures but these are at the resolution of an entire Water Resource Zone (WRZ). More specific data focussing on a Borough would only be available from water companies in the form of District Meter Area (DMA) monitoring. These can be quite large and most are cascading so getting the resolution of data required may also be difficult.

6.6.2 Analysis

The majority of planning applications sampled included details of water conservation measures in the supporting documents, clearly integrating adaptation measures into the design of the proposed development. 63% of planning applications included measures such as low flow taps, showerheads, and low flush toilets. Fewer applications included 'detection' adaptation measures: 15% of applications included proposals for water meters, and 7% proposals for leak detection mechanisms. It is interesting to note that policy ENV 39 within Islington's UDP states that the council encourages specific water conservation measures, but does not have any direct powers in this respect. The policy recognises that Islington has only very limited remit with regard to utility provision.

Rainwater harvesting and recycling was proposed and/or required in 44% of sampled applications. Greywater recycling, on the other hand, showed up in only 7% of sampled applications. In one planning application, a planning condition requiring details of rainwater harvesting is imposed in relation to policy 4A.14 of the London Plan, which specifically relates to sustainable drainage rather than water efficiency. Although this was only identified on one application it is indicative of how case officers can use policy to deliver adaptation measures. Interestingly, none of the planning application documents referred to water stress as an issue related to climate change. Indeed, some of the information provided in the planning documents does not include detail regarding the rationale for including the water efficiency measures proposed, and does not make an explicit link to climate change adaptation. Measures such as low flush taps and toilets are instead often justified on an energy efficiency basis. There were no applications sampled which included drought-resistant landscaping schemes and 'low water gardens' in open spaces requiring minimal irrigation.

LB Islington requires all applications to meet the 'Code of Sustainable Homes' rating of no less than 'Code 4' and BREEAM non-residential rating of no less than an 'Excellent' which includes a number of measures which require improved water efficiency. The Code for Sustainable Homes measures cover water stress, surface water run-off and ecology in relation to climate adaptation; Similarly, BREEAM rating covers water efficiency and ecology which relate more to adaptation measures. However, it must be noted that BREEAM is flexible with regards to water, and limited water efficiency measures are needed to achieve a BREEAM rating (water is only approximately 6% of the total BREEAM rating). Half of planning applications sampled included a planning condition to ensure compliance with the Code and BREEAM which it can be assumed may have been implicitly imposed to mitigate water stress in the borough.

6.7 Biodiversity

6.7.1 Statistical Analysis

Overall, 33% of approved planning applications included one or more adaptation measures relating to biodiversity as part of their planning submission or had a planning condition requiring low regret adaptation measures be included as part of the scheme. Details and planning conditions have been omitted regarding the protection of trees and (standard) landscaping schemes as it was felt that landscaping details would not provide any insight into how climate change adaptation risks are addressed by the planning system. Specific applications where biodiversity and open space were relevant was analysed, and this included:

- applications on (or directly adjacent to) open space areas and habitats;
- whether any of the landscaping schemes were tailored to encourage specific habitats to increase biodiversity;
- green roofs for biodiversity reasons;
- conditions relating to biodiversity action plans ;
- loss and gain of open space and whether this was related to amenity uses or explicitly climate change adaptation; and
- whether any of the applications/decisions accounted for impacts on the fragmentation of ecological/habitat networks or put in place conditions to improve connectivity.

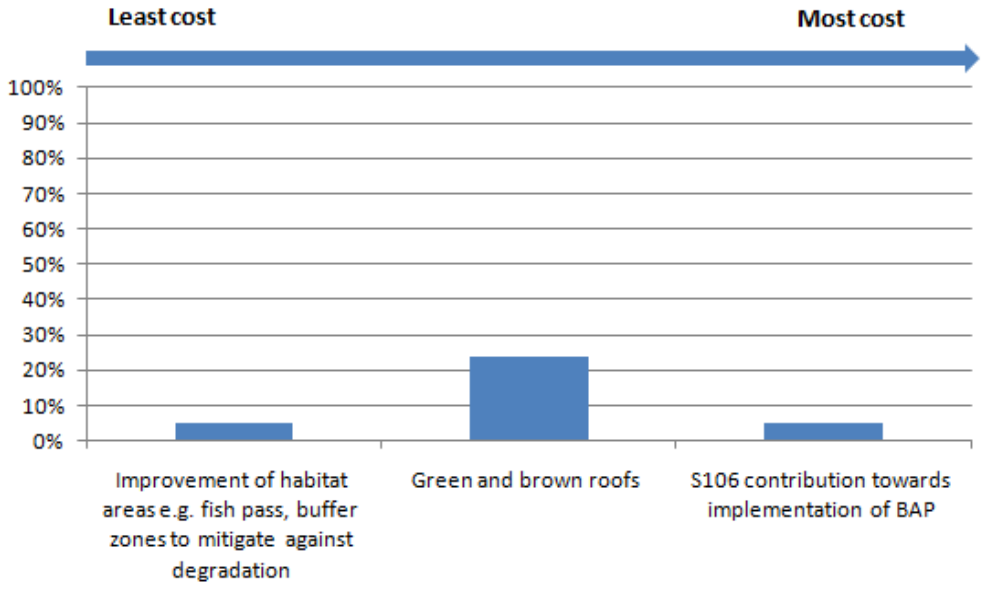


Figure 20: Proportion of sampled planning applications in areas where there is risk of loss of biodiversity and functioning of ecosystem services, where assessment documents/ planning conditions refer to low regret adaptation measures

6.7.2 Analysis

The strategic role of open space and green infrastructure in climate change adaptation has become increasingly recognised and promoted as a mechanism to deliver adaptation benefits and wider social policy objectives. Closely related, is the protection and enhancement of biodiversity and natural resources, which is also a key principle of the planning system. Delivery of green infrastructure and maintenance and enhancement of biodiversity is a key objective for the Community Infrastructure Levy (CIL), where LPAs are suggesting that a tariff approach will adequately provide requirements for green infrastructure. 5% of planning applications included a requirement to provide a Section 106 payment towards the creation of habitats, which were associated with the Biodiversity Action Plan, in the interests of enhancing and maintaining habitats. 5% of applications included a reason for approval specifically stating that an increases in biodiversity and habitat creation was a reason for approval.

24% of planning applications sampled included a green roof as part of their development proposals on the grounds of enhancing biodiversity, and encouraging habitat development. The implementation of green roofs is controlled by planning condition, and all proposals including a green roof were sampled in Islington. Fifteen out of the twenty eight applications in Islington included proposals for a green roof. The supporting documents accompanying the applications stated that green roofs had been incorporated into the design of the proposed development in the interest of biodiversity. In comparison, none of planning applications sampled from Stockton-on-Tees included green roofs as part of the scheme design, perhaps demonstrating that green roofs in Stockton-on-Tees are not considered in biodiversity terms, or at all, in terms of heat stress or pluvial flooding. This may also demonstrate that these measures are not as important in towns like Stockton, which is clearly much smaller than London or that development viability is much lower here.

A small number of planning applications (5%) included measures to improve habitat areas and reduce degradation of habitats. However, these measures were not specifically related to the risk of habitat degradation associated with climate change; instead, the applicants had highlighted the risk of degradation as a result of the development and offered adaptation options to alleviate the impact e.g. integration of buffer zones within the scheme layout, to ensure that the habitat between the development and a river is protected from degradation.

Protection of open space and habitats is enshrined in the planning system. However the link and benefits of climate change adaptation with protection of biodiversity and open spaces are not explicit. For instance, there was no evidence in the sampled applications of the role of open space to manage the urban heat island by protecting local green spaces and identifying opportunities for urban greening. Open space is still primarily seen as an amenity issue, rather than having the wider benefit of reducing the Urban Heat Island effect. Despite the cross cutting benefits of climate adaptation options such as green roofs, which cool (high albedo) roofs, reduce surface water run and can be designed to encourage biodiversity there is limited evidence of this being detailed in application documents. There are opportunities to enhance the role played by open space and biodiversity for the purposes of climate change adaptation, particularly with regard to green infrastructure, and provide benefits across other climate risks. For instance, integration of irrigation methods to developments

which use water efficiently, and introducing planting schemes that provides shade and cooling.

6.8 Conclusions

The range of risks presented by climate change means that multifaceted solutions are needed to address the challenge that this poses. This means that whilst a planning application may be within a specific risk area, such as river and tidal flood risk, a significant proportion of all applications analysed also included adaptation measures to address other risk areas. This reflects that the planning system recognises that there is no single uniformly applied measure that will resolve the challenges posed by climate change. Instead a range of adaptation measures are required to provide a locally appropriate holistic solution.

Out of the different climate risks studied, river and tidal flooding has emerged as the area where the greatest number of applications included low-regret adaptation measures. This was followed by pluvial flooding where a significant proportion of applications in risk areas included adaptation measures. The higher level of adaptation measures proposed by applicants or imposed as planning conditions would indicate that the risks surrounding this issue are potentially better understood. In areas such as East Riding and Stockton-on-Tees where a significant proportion of all planning applications submitted were in areas at risk of flooding then it would appear that there is strong understanding of the issues faced in bringing forward development. This may be as a consequence of the amount of policy and guidance that exists on flood risk at national, regional and local scale, which means that this issue is widely understood by applicants. The role of the Environment Agency as a statutory consultee is also considered a significant factor in raising awareness and ensuring compliance with policy.

In contrast, a smaller proportion of applications included adaptation measures in relation to heat or water stress and enhancing biodiversity/ecology. This may be indicative of the fact that these risks are harder to quantify and provide specific evidence, or again that the lack of a clear and mature national policy framework effectively diminishes the importance of these risks for planning authorities to address. As planning requires evidence to enforce a decision, it is more difficult for the planning system to address these less quantifiable risks. Nevertheless, there was evidence of some activity and awareness on these other risks. For instance, more than a quarter of all application in Islington (the only area in which heat stress was studied directly as a climate risk) included low-regret adaptation measures in regards to this issue.

Across the different climate change risk areas a range of low-regret adaptation measures were included. However, as the more detailed case study analysis reveals while these risks were understood as individual issues, such as pluvial flood risk, the direct link to climate change was frequently not explicitly stated. Consequently, it seems probable that the planning process is doing more to adapt to climate change than may often be recognised, as the links between low-regret measures for specific risks and the wider climate change agenda are rarely clearly stated.

The use of S106 agreements has emerged within the research as a potential means of addressing climate change risks off-site within a local authority area. This has highlighted how this can lever investment to be used to fund improvements to

open space and biodiversity. For example, in Islington there was evidence of S106 contributions being used for the Borough's Biodiversity Action Plan. The research has also found evidence of S106 being used to fund off-site flood defences. The research has to-date not found evidence of this within East Riding where flood defence schemes are often funded through the EA. The use of S106 therefore can help to reduce climate change risks across a local authority area and not just at a site specific scale.

It is important to remember that the planning system is intrinsically about balancing different and competing interests and that when a decision is made on an application has to consider all of these elements. Therefore in order to ensure that development is brought forward more stringent adaptation measures cannot always be included. The current property market conditions may complicate this issue due to the ongoing difficulties encountered in bringing development forward as a result of the recession. However, it is clear that planning applications do include a number of low-regret adaptation measures to adapt to climate change.

7 Case Studies

7.1 Introduction

This chapter presents case studies which analyse how climate change risks are addressed through the planning system and how adaptation measures are incorporated into individual applications. This aims to show at what stage in the planning process climate risks are considered and the types of adaptation measures put forward to address these risks and adapt to climate change.

7.2 London Borough of Islington

7.2.1 Case Study 1: 350 bed student accommodation

Summary:

- Application was in an area at risk of pluvial flooding, heat and water stress.
- Application was for 350 bed student accommodation which was refused at committee but allowed at appeal.
- The reasons for refusal did not relate to any climate risks and, other than the conditions, the appeal did not address adaptation measures.
- Adaptation was raised in pre-application discussions by the case officer stating by letter the development should include green roofs, bird/bat boxes, SUDS, rainwater harvesting, and BREEAM/Code for Sustainable homes measures.
- There was a confused message given in the Design and Access Statement (DAS) – as policy referenced did not cover climate change, and a "SWOT" analysis only identified greening as an opportunity for ecology (ignoring SUDs and UHI). However, in a later section it states that buildings will be designed for wetter winters and hotter summers by planted roofs and landscaping. Furthermore the Energy Statement includes a section on shading to reduce building temperatures.
- The Sustainability Statement provided additional links stating SUDs and green roofs can help with wetter winters – a link not made in the DAS. Passive design and water conservation measures are also mentioned but links are weak with adaptation.
- Limited information regarding biodiversity or open space was provided other than for amenity value, despite part of the development being on a site of nature conservation importance. The ecology report focuses on illustrating the site would not impact on biodiversity, rather than highlighting the benefits it could bring.
- Adaptation is an overarching issue that cuts across all of the applicant's submission documents; however, as they are often produced in isolation the shared benefits between adaptation measures were missed. Adaptation measures are implicitly and explicitly referenced in this application, but as a result of the separate documents the important and beneficial links are not being highlighted.

Image 1: Taken from the Design and Access Statement

This application was for a 350 bed student accommodation with commercial ground floor units and outdoor amenity space. The application included adaptation measures to address climate risks such as heat and water stress – although this was not explicitly stated in all cases.

Climate change and adaptation was first implicitly raised in pre-application discussion as evidenced in the case officer's letter to the applicant. The letter stated the council would expect the development to include green roofs, bird/bat boxes, sustainable urban drainage, rainwater harvesting, and for the buildings to reach excellent on BREEAM/Code for Sustainable homes ratings. In addition, in respect to the site of nature conservation an ecology statement was requested as well as a financial contribution towards delivery of Islington's Biodiversity Action Plan.

Low regret adaptation measures were referred to in a number of the submitted documents, including the DAS, Sustainability Statement and the Energy Statement. However, there were inconsistencies across these documents and the cross cutting benefits of the measures stated were often not highlighted.

The Sustainability section within the DAS specifically focused on three particular areas: BREEAM/Code for Sustainable, water efficiency fittings and biodiversity from green roofs and walls. However the policy section did not cover climate change and the SWOT analysis only identified greening as an opportunity for ecology (ignoring combined benefits of sustainable urban drainage and addressing the Urban Heat Island effect). Nevertheless, in a later section the DAS states that buildings will be designed for wetter winters and hotter summers by planted roofs and landscaping. Overall the main adaptation risks are highlighted at various points in this document, however the synergies between them are missed and the importance to climate change adaptation not explicitly stated.

The Sustainability Statement, under a sub heading 'adaptability', provides additional linkages of the measures proposed, in that it states sustainable urban drainage and green roofs can help mitigate wetter winters, which is a link not referred to in the DAS. This specific section also states that green roofs and passive design (such as higher mass and glass that reflects the heat) will help combat hotter summers. However the wider benefits of helping to stabilise temperatures across the borough, as heating is anticipated to increase, are not mentioned. Water conservation appears under a separate heading which breaks its important link with adaptation, however the low regret measures included: grey and rain water recycling and irrigation for landscaping. It is interesting to note that the benefits of open space are only referred to in respect of amenity value. However, the case officer confirmed that the applicant had originally proposed habitat creation in the amenity space, but the council felt this was not a realistic use given the development was student accommodation and so the management of the space would be neglected.

The Ecology Statement focussed on the non-statutory site of nature conservation importance, which is categorised as grade 1 known as 'IsBI11 Holloway Road to Caledonian Road Railsides'. The report was designed to illustrate that this area had little ecological value. However, the case officer explained that the land had been covered in hard surfacing over four years ago so the council was not in a good position to negotiate for improved biodiversity. However, £8,000 was secured through S106 towards the Biodiversity Action Plan, which will help to improve this issue across the Borough.

The Energy Statement includes a section on shading for reducing building temperatures and an introduction section on the London Plan specifically mentions passive design to minimise overheating and protection of biodiversity and green infrastructure. It is interesting to note that this is the only document that uses planning policy to state the importance of the low regret adaptation measures proposed.

Adaptation is an overarching issue which crosses all of the submitted documents, however as they are often produced in isolation the links are missed. Adaptation measures are implicitly and explicitly referenced in this application, but as a result of the separate documents the important and beneficial links are not being highlighted.

A number of conditions were imposed following the planning appeals which are consistent with the low regret conditions on other applications analysed in Islington. The conditions related to: BREEAM rating; sustainable urban drainage; bird/bat boxes; green roofs and green walls. At present none of these conditions have been discharged, however the case officer confirmed that Islington council does not have compliance officers to confirm whether work has began on site which would be a breach of planning permission.

This application was initially refused at committee in April 2010, but was then allowed at appeal in November 2010. The application was refused on account of its scale, impact on the road network and amenity. However the Inspector disagreed with these reasons, as it was felt the positive aspects of the development outweighed the issues.

This application demonstrates how a significant number of low regret adaptation measures can be incorporated into a development through the planning process. Engagement with the council during the pre-application stage provided an early indication of the types of adaptation measures that would need to be included in the application. These measures could then be incorporated into the submission documents and their delivery ensured through subsequent conditions. However, whilst these adaptation measures were featured in a number of documents there positive impact on climate change was not always explicitly acknowledged. Furthermore, by not looking at all the measures put forward in one place the scale of their cumulative impact in relation to climate change adaptation does appear to be reduced.

7.2.2 Case Study 2: Residential scheme and landscaping for approximately 40 dwellings

Summary:

- Application was in an area at risk of pluvial flooding, heat and water stress.
- Application was for 38 affordable homes and landscaping.
- Adaptation was raised implicitly at the pre-application stage, where areas such as open space, sustainable drainage, green roofs, limiting water use and rainwater recycling were discussed with the applicant.
- All the adaptation measures referenced above were also detailed in the Design and Access Statement, however the reasons for including these measures was not specified.
- A supporting document almost entirely focussed on adaptation was submitted, which followed the same headings included in Islington's online guidance.
- The applicant explored the link between the installation of a green roof and reducing heating, however this was considered on a building only scale, rather than at a neighbourhood or borough scale.
- Planning conditions were imposed in relation to ecology / biodiversity, and included green roofs and bird/bat boxes, however the reasons did not pick up the wider benefits of such adaptation measures as were detailed in the application.

Image 2: Taken for the Design and Access Statement

The planning application was for 38 affordable homes and landscaping and was approved at committee in December 2010 with a legal agreement. The site location is exposed to water and heat stress, as well as pluvial flooding and diminishing biodiversity.

The case officer confirmed that, other than green roofs, limited information on the adaptation measures was discussed during the pre-application process. The officer indicated this situation was representative of other applications as it is uncommon for information related to sustainability to be shared at the pre-application stage. However issues relating to climate change were raised by the case officer at the pre-application stage where it was stated that the application needed to retain the same amount of open space and to improve its quality. Specific details were requested at the outset of the amount of permeable and impermeable paving, permeable land and building coverage which clearly illustrates the concerns with pluvial flooding, although this was not explicitly linked with adaptation. In addition, it was stated that the council would expect green roofs, bird/bat boxes and sustainable drainage as well as consideration of landscaping to minimise water use and the feasibility of rainwater and grey water harvesting. The case officer confirmed that no significant changes to this scheme were secured as a result of the pre-application discussions because a planning brief with a preferred design option was formulated by the Council prior to the site being disposed of by the Council.

The DAS includes a comprehensive sustainability section which details the low regret adaptation measures that would be incorporated into the development, these included:

- Level 4 for the Code for Sustainable homes;
- Passive design, such as summer shading;
- Reducing water consumption;

- Sustainable urban drainage – including green roofs, landscaping and permeable paving; and
- Rainwater harvesting.

Despite a full range of measures being proposed that would address climate risks of water and heat stress and pluvial flooding the reasons for these measures were not included. Neither did the document include a policy section to highlight the national, regional and local agenda giving weight to these areas. In terms of ecology the 'trees and landscaping' section stated it would increase biodiversity on the site, however open space was within a separate section which focused solely on its amenity value.

Climate change adaptation is given prominence in the Sustainable Design and Construction statement as it appears as the first section in the report, and adaptation is the principal subject covered throughout the document. The Statement addresses pluvial flood risk by stating that SUDS and green roofs will be incorporated. To address heat gain it proposes that development would include screens on the southern side of the building and maximise natural shading from trees. In addition the application refers to natural ventilation and green roofs to help reduce heat gain. It is also stated the development will include a large area of outdoor space on account of the increasing temperatures in the borough. Water efficiency is stated as an important area on account of the likelihood of further shortages, so efficient fittings will be installed and rainwater harvesting will be used to irrigate the landscaped areas.

Sustainable drainage, biodiversity and water resources appear under separate headings where further detail of what is to be provided is covered. Rainwater harvesting, green roofs, landscaping and permeable paving are all measures proposed for sustainable drainage to reduce run-off. The biodiversity section states the redevelopment of the site will be undertaken in the winter months and bat boxes included. Furthermore, trees are to be retained (although with the caveat of 'where possible') and planting to boost biodiversity. Under the 'water resources' section, further detail of the water efficient fittings are provided

The importance of biodiversity was specifically acknowledged in the Decision Notice, which stated that the soft landscaping, bird and bat boxes and green roofs would enhance biodiversity in accordance with local and London wide planning policies.

In spite of the of the detail included in this application, in comparison to the other applications reviewed in Islington, conditions were still included in terms of the green roofs, construction outside of breeding months and bird and bat boxes. This clearly shows that biodiversity is perceived as an important area for the council and controls are needed to ensure the stated measures are delivered in developments. However, despite the beneficial links being made with green roofs of reducing run-off and stabilising temperatures these reasons are not given in the condition imposed. At present none of the planning conditions related to low regret adaptation measures have been discharged.

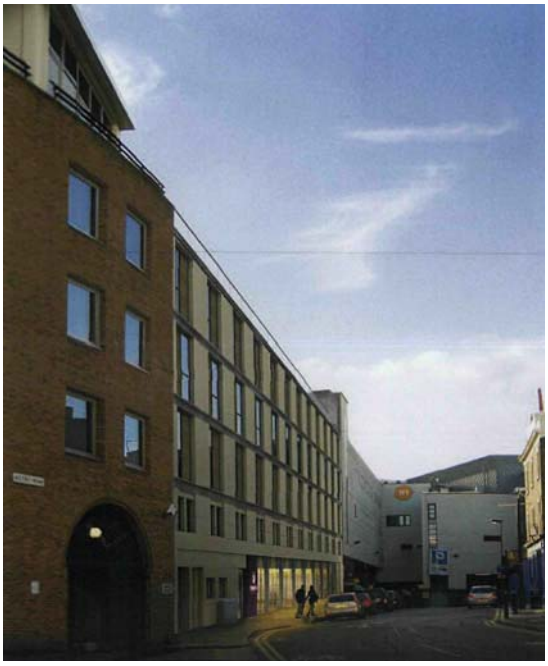
7.2.3 Case Study 3: Hotel and ancillary services

Summary:

- Application was on an undeveloped site which was being used temporarily as a car park. The site was the only substantial undeveloped site in the locality and had not contained any buildings since WWII.
- Application was for the erection of 6 storey building to develop a 96 bedroom hotel (Class C1 use) and ancillary services.
- Application was in an area at risk of pluvial flooding, heat and water stress.
- There had been five previous applications for this site, three of which have been the subject of appeals. The reasons for refusal overwhelmingly related to design and massing and issues in respect of Crossrail rather than climate change adaptation.
- Planning obligations secured almost £94,000 of financial contributions towards Islington's Biodiversity Action Plan, of which over half was put towards improving open space in the vicinity.
- Heat stress, water stress and pluvial flooding were never directly referenced within the application.
- Planning conditions secured the inclusion of a green roof within the design of the application although this was justified on biodiversity and pluvial flooding grounds rather than heat stress.
- A planning condition requiring compliance with BREEAM water saving measures were proposed within the application.
- Overall, the application deals with climate change adaptation implicitly, rather than explicitly, with the supporting documents failing to link many of the low-regret measures proposed to climate change adaptation itself.

This application, for a 96 bedroom hotel and ancillary services, represents the culmination of a 7 year process and 5 previous applications. Four of these applications were refused, three at appeal, before this application for the erection of a 6 storey hotel to provide 105 bedrooms was approved. The application site occupies a central London location within Islington, and falls within an area where water stress, urban heating and pluvial flooding issues are expected to intensify under climate change.

Reasons for refusal for the four previous planning applications related to design and massing, Crossrail and the inappropriateness of student accommodation for the site's town centre location. However, a previous application for the construction of a new building for use as student accommodation or hotel did contain a reason for refusal which implicitly related to climate change adaptation. The decision notice stated that '*the development fails to provide a Sustainability Assessment and also an Energy Statement showing that a reasonable percentage of the energy demands of the resulting building shall be met by on-site renewable energy*'. Whilst not directly relating to climate change adaptation, the reason for refusal does demonstrate that the planning system strongly defends the importance of addressing climate change issues in general.



Pre-application discussions with the applicant were undertaken, however low-regret adaptation measures were not discussed as the sustainability and energy requirements had been satisfied within the previously consented scheme, and were not being altered.

Climate change adaptation is rarely explicitly addressed within the application and its supporting documents, despite a strong emphasis on climate change more generally. Instead, low regret adaptation appears to have been an implicit consideration, although references vary across the various parts of the application and supporting documents.

The DAS does not discuss any low regret adaptation measures in detail, with only the policy section referring to such measures, when green roofs are stated as part of the design as a result of policy arising from the London Plan and the then draft LDF.

The Sustainability Assessment is brief and contains no references to the climate change risks of water stress and heat stress, despite their prominence in Islington. Although flooding is referred to within the document, it is simply stated that the site is so limited in extent that it would not present a significant risk of flooding. For the same reason SUDs are dismissed as a low regret adaptation measure required for this development. As such it seems the risk of pluvial flooding under climate change is not considered a significant issue meaning that low regret adaptation measures are considered unnecessary.

The Energy Statement, presented as an Energy and Sustainability Statement, is more detailed. Low regret adaptation measures relating to both heat stress and water stress are proposed pro- within the document. However, the climate change risks themselves are never stated as the reason behind these measures. For example, there is a large section on ‘Water Saving Measures’, wherein water saving measures such as dual flush toilets, bathroom tap flow restrictors and shower flow restrictors are proposed. The savings in water usage are clearly stated and quantified, yet the issue of water stress itself is never mentioned or linked to such measures. Similarly, ventilation incorporating a heat recovery system is also proposed, a low regret adaptation measure addressing the risks associated with heat stress. Nonetheless, the issue of heat stress is never brought up as the justification behind such a measure. This reaffirms the implicit rather than explicit consideration of climate change adaptation within the application.

Thames Water was consulted as the organisation had expressed concerns in the previous consented scheme about flow rates and surface water drainage. Although no feedback was received, information on water flow rates and surface water drainage was attached to the decision notice. This recommended that the applicant ensure storm flows are attenuated or regulated into the receiving public network

through on or off site storage, suggesting pluvial flooding considerations were taken into account.

Within the case officer's report a number of policies were referred to that are of relevance to climate change adaptation. The inclusion of these policies therefore demonstrates that adaptation to climate change and low-regret measures such as living roofs and sustainable drainage were concrete policy considerations within the report, despite its often understated status within the application's supporting documents and reports.

Twenty five planning conditions were imposed within the Decision Notice; of which two related to climate change adaptation. These two conditions are standard for Islington, and, consistent with other applications in the borough these conditions proposed low-regret adaptation measures:

- BREEAM Hotel rating of no less than 'Very Good'; and
- Green roof.

The case officer directly cites 'addressing climate change' as the reason for imposing the BREEAM condition. In relation to the green roof condition, climate change adaptation is not directly referenced, with 'the creation of habitats and valuable areas for biodiversity' being cited as the reason. Furthermore the case officer also noted that green roofs can help adaptation to pluvial flooding. However, both conditions refer to Policy 4A. 9 of the London Plan 2008 'Adaptation to Climate Change', which reflects the important contribution that such low-regret adaptation measures can play in addressing climate change.

It is interesting to note that the previous consented planning application contained a condition requesting a BREEAM bespoke rating of excellent. In this application, this condition had been downgraded to 'very good'. The case officer explained that this was because the applicant provided extra information which demonstrated that 'very good' was the best that could be achieved. At the time, the council had no clear local policy requiring achievement of BREEAM 'excellent', something which has changed since the adoption of the Core Strategy. This issue, however, reveals some weaknesses in the planning system in being able to address climate change adaptation in the face of powerful developers.

Negotiations on the proposal resulted in the applicant agreeing to make a financial contribution for general use in London Borough of Islington's Biodiversity Plan. Further investigation reveals that a contribution was made towards environmental, streetscape and community improvements within the vicinity of the site, of which more than half was put towards open space improvements within the vicinity of the site. This contribution towards the provision of open thus suggests low-regret adaptation measures can also be affected via planning obligations.

The green roof planning condition has been discharged though the submission of drawings and a landscape palette. Meanwhile, the BREEAM condition requires a post-construction assessment, and thereby still enjoys a level of ongoing monitoring.

Overall, it is clear that low-regret adaptation was not a prominent consideration within this application, but that the planning system did still add value to the application in relation to this through the imposition of relevant London Plan and local plan policies, conditions, informatives and s106 contributions. Heat stress, water stress and pluvial flooding, whilst never directly referred to as issues to be

considered when processing this application, nonetheless began to be addressed through the low-regret adaptation measures that were implicit within the proposals.

7.3 Stockton-on-Tees

7.3.1 Case Study 1: Erection of two industrial type units with ancillary offices

Summary:

- Application in an area at risk of pluvial, river and tidal flooding.
- References to flood risk were found within a number of documents, including the Planning Statement, the FRA, the Risk Assessment Report, Officers Report and the Decision Notice.
- Low-regret adaptation measures included within the application in relation to flood risk include: raised floor levels (which specifically state that extra allowance be made for climate change), raised utilities i.e. electricity sockets, and lowered car parking levels to allow for flood water containment.
- EA are satisfied that the development does not pose a significant flood risk but request conditions to be put upon the development i.e. increased floor levels.
- Interesting conditions imposed, include: the erection of flood warning notices, and details of a safe exit route to an area outside of Flood Zone 3.

This full application for the erection of two industrial type (B1, B2, B8- haulage and HGV fleet) units with ancillary offices and parking with associated works was approved with conditions in January 2010. The development was located within Flood Zone 3 and at risk of pluvial flooding and these issues were considered in this application in a number of places. These climate risks and potential adaptation measures are reflected within the decision notice, committee report, officers report and supporting documents contained with this planning application.

The EA played a role in the pre-application discussion with the developer, however it was over a short time period and the basic elements of the development did not change as a result.

The Planning Statement sets out the adaptation measures that have been integrated into the design to help reduce the threat of flood risk. The low-regret adaptation measures set out include raising floor levels, raising services and materials within 1.5m of floor level which could be affected by flood water, lowering the car park by 500mm to allow for water containment, and surface water to be discharged to the main ditch.

The Risk Assessment sets out that the site is located in an area at risk of potential flooding (combined tidal and river) and does not currently benefit from flood defences. It also states that a surface water drain is located on the site.

As the Risk Assessment demonstrated that the site was not currently protected by flood defences the FRA puts forward a number of measures to mitigate the flood risk posed by the development. These measures included:

- A floor level of 4.19AOD based upon flood predictions, with 600mm added to tide levels to allow for the effects of wind and wave action, and a further 200mm to allow for future climate change and sea level rise and the geological tilt, as recommended by PPG25.
- No services or materials within 1.5m of floor level which could be affected by flood water.
- Lowering the car park for water containment.

The Officers Report and the Decision Notice imposed a number of interesting conditions in relation to the need to manage flood risk, including:

- A condition to prevent increased risk of flooding by ensuring the satisfactory means of surface water disposal. This specifically states no development shall be commenced until a scheme for the provision of surface water drainage works (that takes in account tide locking) has been submitted to and approved by LPA.
- A condition to ensure that owners and occupiers of premises are aware that the land is at risk of flooding. This specifically states flood warning notices should be erected.
- A condition to protect the development from flooding. This specifically states floor levels should be 5m AOD.
- A condition to provide safe access and egress during flood events and reduce reliance on emergency services. This specifically states development shall not commence until details of a safe exit route, not adversely affecting the flood regime, to land outside Flood Zone 3, are submitted to and agreed by LPA. Furthermore, the route must be in place before occupancy of the building.

This application is also of particular interest as it shows how the planning process can produce a development which can reduce the threat posed by climate change. The Environment Agency (EA) had originally objected to the proposed scheme due to the information contained within the Flood Risk Assessment (FRA). The basis for the objection by the EA was considered by the applicant, and in January 2007 the Planning application was approved with conditions and granted permission provided that outstanding issues were resolved prior to the expiry date of the application, including the condition that PPS25 and EN32a of the adopted Stockton-on-Tees Local Plan were met. The EA also commented that they were satisfied that the development did not pose a significant flood risk. Furthermore, it is made clear within the Officers Report and also through the discussion with the case officer that ensuring the development does not have a detrimental impact on flood risk was a material consideration. Consequently, the EA's feedback ensured that some of the conditions set out above were attached to the development due to it being in a flood risk area. However, through the discussion with the Case Officer it was made clear that these are standard conditions which are found throughout schemes in the local area.

On the whole, climate change is an implicit as opposed to an explicit factor shaping the design of the building. The only exception to this is contained within the FRA, which specifically states that "a further 200mm [will be added to the floor level] to allow for future climate change and sea level rise". The other supporting documents, including the Planning Statement, Risk Assessment,

Decision Notice and Officers Report are implicit in their outlook, referring to flood risk rather than climate change risks.

This application demonstrates how a range of low-regret adaptation measures, can make an industrial scheme acceptable in an area at risk of river, pluvial and tidal flooding. However, in terms of the climate risks studied it is clear that the need to adapt to flooding was the issue of relevance to this application. Furthermore, whilst a number of low-regret measures were included within the application only a very small number of direct references were made to climate change.

7.3.2 Case Study 2: Residential apartment block

Summary:

- Application was in an area at risk of river and tidal flooding.
- References to flood risk were found within the FRA, the strategic FRA and the conditions of the Decision Notice. However, no references to flood risk were found within the DAS.
- The only low-regret adaptation measures included within the application in relation to flood risk included: raised floor levels and the introduction of a permeable external courtyard surface.
- EA initially raised an objection to the scheme based on an unsatisfactory FRA. The applicant addressed this by raising floor levels and increasing the amount of permeable external space and the objection was removed. This is an example of the positive influence of the planning process in addressing climate risks.

This application for a residential development comprising one apartment block (4 x one bedroom units and 8 x two bedroom units) and associated parking was approved subject to S.106 agreements in February 2008. The site in within Flood Zone 3 and river and tidal flooding was considered in this application within three main documents.

Through significant pre-application discussion mostly focused on flood risk, between the EA, the Council and the applicant, the FRA became acceptable and no major design alterations were made to the scheme.

The strategic flood risk assessment set out initial low-regret adaptation measures to manage the level of flood risk experienced at the site. Specifically this stated that due to the level of flood risk posed by Lustrum Beck finished floor levels needed to be set a minimum height of 600mm above this level.

An FRA was completed in addition to the strategic flood risk assessment. Again, set out that the application was situated in an area of river and tidal flooding but was not subject to pluvial nor groundwater flooding. Furthermore it highlighted that the site had no history of flooding. Interestingly the FRA did look at the effects of climate change on the site and estimated that there was likely to be an increase in rainfall of 20% over the next 50 years due to climate change effects, which would have led to an increase in stream flow. However, it was estimated that with this increased level of rainfall the site would not be affected and therefore no specific additional adaptation measures were required.

One of the main planning considerations of this application was the impacts of the development on flood risk. The decision notice stated that the application had been considered against Policy EN32 Development and Flood Risk and it was considered that the development did not pose any flood risk. One condition was included in the application to prevent increased risk of flooding by ensuring the provision of a satisfactory means of surface water disposal. This specifically stated that a scheme for the provision of surface water drainage must be submitted to and approved by the LPA.

This application is of particular interest as it highlights how the planning system can produce a development that is more resilient to the affects of climate change. Through discussion with the Case Officer, it can be noted that the scheme was submitted twice prior to this application, yet the applicant withdrew on the grounds of unacceptable flood risk. When the developer submitted this application for the third time in February 2008, the EA objected to the scheme on the grounds that the FRA was unsatisfactory. However, the objection was considered and the applicant made changes to the proposed development, including the raising of the floor levels and a reduction in impermeable surfaces through the creation of a permeable inner courtyard area. Furthermore, the condition attached to this application regarding the surface water drainage scheme was recommended by the EA.

No S.106 payments were negotiated for flood risk adaptation measures. Instead, a large contribution was made towards the provision of open space.

Although climate change is an important factor influencing the design of the building i.e. raised floor levels and permeable external surfaces, it is mostly an implicit factor as opposed to being an explicit factor. The decision notice refers to Policy EN32 Development and Flood Risk but does not connect this to climate change and the DAS does not refer at all to either flood risks or climate change when discussing the design of the building. The only explicit reference to climate change risks was in the FRA which included consideration of the projected increase in rainfall over the next 50 years.

What is noteworthy about this application is the process by which the application was able to prove that flood risk was at an acceptable level to permit the development. Through an ongoing dialogue between the applicant, the EA and the Council it was possible to develop a design that incorporated an appropriate range of low-regret adaptation measures in a way that had not been achieved in the previous two applications.

7.3.3 Case Study 3: Construction of new school facilities and the extension of existing school buildings

Summary:

- Application was in an area at risk of river and tidal flooding.
- References to flood risk were found within numerous documents, including: the FRA, Sustainability Statement, Design and Access Statement, Officers Report and the Decision Notice.
- Low-Regret adaptation measures included: a modified water management system, positioning of buildings to provide maximum protection against

floodwater inundation, flood warning and evacuation plans, and safe exit routes.

- A medium-regret adaptation measure included the replacement of an existing flood wall defence.
- Alongside flood risk mitigation measures, low-regret adaptation measures relating to heat stress and water stress were incorporated. These included: building orientation to make use of solar gain; renewable energies supporting the heating and hot water system; solar shading, passive ventilation and thermal mass to avoid artificial cooling; and rainwater harvesting and water conservation methods.
- Low-regret adaptation measures were also incorporated to benefit biodiversity, including: a 5m wide buffer zone alongside the River Tees which may provide networks to "help wildlife adapt to climate change".

The site is presently used for educational purposes, and contains various school buildings, car park areas, sports pitches and play areas together with open areas of green field land. This application proposed the improvement of the on-site facilities and new build structures to brownfield areas of the site, and was approved subject to S.106 agreements in June 2009.

The site is within Flood Zone 3 and the River Tees follows the eastern boundary of the site. There is an existing flood defence embankment to the northern edge of the site and part of the site sits on functional flood plain. Risk to flooding is therefore highlighted across all application documents, including the Sustainability Statement, the FRA and the DAS and the resultant Officer's Report and Decision Notice.

Through discussion with the Case Officer, it was found a pre-application discussion lasting nearly a year, which included ongoing dialogue between the EA and the developer, helped the evolution of the building's design and location. This in particular included raised floor levels and the positioning of the buildings further away from the river, so as to protect the scheme against flood risks.

River and tidal flood risk was considered within this application within a number of places, but the most emphasis was within the FRA. The FRA put forward a significant number of measures to adapt to the flood risk posed by the development. The low-regret measures included:

- A modified water management system i.e. drainage, accounting for changes to both pluvial and river and tidal capture, runoff and disposal;
- Location and positioning of new buildings chosen to afford maximum protection against floodwater inundation;
- Flood warning and evacuation plans, including a safe exit route to dry land; and
- Changing rooms being situated on the ground floor.

A medium-regret adaptation measure was also incorporated into the design and this involved the replacement of the existing flood wall defence due to the footprint of a new buildings being in line with the existing flood defence embankment. The FRA highlights the provision of this new hard defence would further reduce and limit flood defence breach occurrences. However it must be

highlighted that although a new flood defence wall has been erected, the FRA states "adequate mitigation must be allowed for the event of breach and overtopping of the defence" therefore although mitigation measures are being put in place, the development may still not be completely climate risk proof.

The DAS stated that a number of constraints had influenced the proposed buildings scale and mass, which included the EA's requirements for preserving the flood plain, an issue that had been discussed during pre-application (as set out above).

The Sustainability Statement contains low regret adaption measures for river and tidal flooding, heat stress and water stress. This Statement sets out how the incorporation of a surface water management system into design will improve the standard of protection for the majority of the school. Low-regret adaptation measures in relation to water stress included water conservation methods and rainwater harvesting. In addition, a range of low-regret adaptation measures with regard to heat stress are set out and these include:

- The orientation of buildings to make use of solar gains;
- Hot water solar panels;
- Solar shading; and
- Passive ventilation.

The Officer's Report and discussions with the Case Officer further highlighted that the EA, a statutory consultee, had no objections to the scheme subject to the application of condition in regards to the buffer the buffer zone, approved FRA and drainage, as set out below.

The Decision Notice imposed a number of conditions, to reduce flood risk and these included:

- A planning condition to reduce the increased risk of flooding to the proposed development, future occupants and users and elsewhere. This specifically stated development must have been carried out in accordance with the FRA version 3 and the design and mitigation measures detailed within.
- A condition to prevent the increased risk of flooding, improve and protect water quality, improve habitat and amenity, and ensure future maintenance of the surface water drainage system. This specifically stated a surface water drainage scheme must be submitted.

Within the Decision Notice, two planning conditions were imposed with regard to biodiversity, including a condition to enhance biodiversity, with full details of soft landscaping to be submitted to and approved by the LPA. There was only one condition which explicitly referred to climate change and this stated that prior to commencing development the applicant must submit a scheme for the provision and management of a 5m wide buffer zone alongside the River Tees. The rationale for this condition was that any development that encroaches on watercourses has a potentially severe impact on their ecological value and wildlife must be protected. Article 10 of the habitats directive stresses the importance of natural networks of linked corridors to allow movement of species between habitats, and promote the expansion of biodiversity, and "*such networks may also help wildlife adapt to climate change*". Within the Decision Notice therefore it has

been made explicit that climate change has played an important factor in governing the location of the buildings.

Whilst it is clear that climate change is an important factor in governing the design of the building and overall site, this is more implicit than explicit. Although a number of documents refer to flood risk, biodiversity loss and measures to conserve both energy and water, only once is this associated with climate change, and this has been dealt with at a late stage in the planning process through the use of a planning condition.

This application contains a wide range of low- and medium-regret adaptation measures, with regard to flood risk and biodiversity loss, which can make a site used for the purpose of education, acceptable in areas at risk of flooding and in areas which may cause biodiversity loss. The planning process has seen to have added to the value of the application in relation to climate change through the pre-application discussion, which lasted nearly a year and allowed for the evolution of the scheme to incorporate further flood protection measures. However, as noted some of the issues are being dealt with at a late stage in the process through the use of planning conditions. Furthermore, no S106 were negotiated to secure climate change adaptation measures.

7.4 East Riding

7.4.1 Case Study 1: Events Centre, Driffield

Summary:

- Application was in an area at risk of pluvial and river and tidal flooding.
- It was an aim of the applicant to make this building sustainable with a low carbon footprint, which were put forward by the applicant initially in pre-app discussions and then through the application itself.
- References to flood risk were found within a number of documents including the FRA, Design and Access Statement, architect's covering letter, Committee Report, and Decision Notice.
- Low-regret adaptation measures included within the application in relation to flood risk included: rainwater harvesting, raised building levels, SUDs, green roof, solid concrete floors with damp proof measures, solid timber doors and frames, minimum heights for electrical supplies; lime based plaster and ceramic tiles for floor, and use of permeable paving. Therefore, what was special about this application was that a very long list of adaptation measures were included, rather than just a small number as in other applications.
- EA initially raised an objection to the scheme based on the data submitted as part of the FRA – the client was able to submit further information and EA removed objection, e.g. of positive influence of planning process in addressing climate risks.

Image 3: Taken for the Scheme Layout Plan

This application for an Events Centre with associated car parking and boiler facilities was approved in 2010. The site was located within Flood Zone 3 and at risk of surface water flooding. A number of low-regret adaptation measures were included in the application including raising floor levels, flood proofing measures and surface water flooding mitigation techniques. The cumulative impact of the adaption measures ensured that the risks were reduced to an acceptable level and that therefore the proposed development would be appropriate.

The need to make this building sustainable was a central part of its overall aim and therefore it had been incorporated into the design, as indicated by the number of adaptation measures included in the FRA (discussed below). This aim came through strongly in the pre-application discussions with the local authority when the applicant stated their intention to create a sustainable building with a low carbon footprint.

Flood risks, both river and pluvial, were considered in the application in a number of documents, but the most detail was provided within the FRA. Even within the architect's covering letter for the application it was set out that the specific design for the foundations of the building had been developed to protect against flood risk and to provide a place within which to store water.

The FRA put forward a significant number of measures to mitigate the flood risk posed by the development. These measures included:

- rain water harvesting for attenuation;
- building level raised through the use of a platform;
- SUDs;
- green roof;
- solid concrete floors with damp proof membranes;
- solid timber doors and frames;
- minimum height for electrical supplies;
- lime based plaster or ceramic tiles on the floor; and
- use of porous material for paving and car parks.

Whilst some of these measures such as raising the building/floor levels, SUDs and minimum height for electrical installations appeared within many of applications within East Riding as part of this research, some of the others were more unusual. For example, of all the approved applications analysed this was the only one to incorporate a green roof. Similarly there was also detail provided on the materials to be used in the building to ensure that it would be more resilient if a flood were to occur.

The DAS sets set out that the development fell within Flood Zone 3 and provided number of adaptation measures that had been integrated into the design to help reduce the risk that this posed. The adaptation measures set out included developing the building on a raised platform, the use of SUDs, rainwater harvesting and permeable materials for the car park.

This application is of particular interest as it illustrates how the planning process can produce a scheme that can reduce the threat posed by climate change. For example, the EA, as a statutory consultee objected to the scheme initially as it did not contain information on why compensatory flood plain storage should not be provided on site. But the basis for their objection was considered and the applicant provided supplementary information to the Flood Risk Assessment initially submitted and as a result the EA removed their objection.

Whilst the majority of climate change adaptation measures were in relation to flood risk there were other factors included to promote the sustainability of the building. This included designing it to optimise natural light and ventilation, constructing it from locally grown straw, which reduce thermal loses, and incorporating renewable energy generation technologies from photovoltaic cells and a biomass boiler (which in part will be fed though on site timber). In this sense the wider design of the building can be seen to have been developed to be sustainable and reduce its carbon footprint. These measures were part of the objectives of the application for the development from the beginning of the process and were therefore discussed during pre-application.

That the low-regret measures were successful is reflected in the Committee Report. This states that the site is within a flood zone but that adequate mitigation measures have been put forward with these to be included as conditions for the application.

The Decision Notice subsequently includes a condition to manage flood risk on the site, reflecting the content of the submitted supporting documents. This specifically states that the development should be completed in accordance with

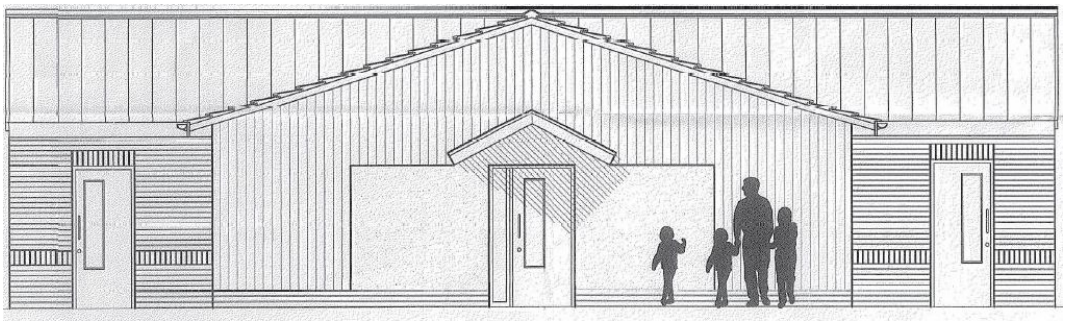
the FRA (and its addendum) including the mitigation measures of managing surface water un-off, flood-proofing measures, and finished floor levels set no lower than 17m AOD.

Whilst it is clear that climate change is an important factor in governing the design of the building this is more an implicit, rather than explicit, factor. Whilst the policy review makes reference to PPS1, there is an important factor in governing the design of the building this is more an implicit, rather than explicit, factor. Whilst the policy review in the DAS makes reference to PPS1, there are few other explicit references to climate change, instead there is an emphasis upon how the design will make the building sustainable. The other main explicit mention is in the FRA, which states that the attenuation measures put forward have been designed to ensure "that storm water from a 1 in 100 year event, plus 30% climate change, and surcharging the drainage system can be stored on the site without risk to people or property and without overflowing into the existing watercourses". Therefore while there are some explicit references to climate change the majority of the emphasis is implicit, through the need to create a sustainable building.

7.4.2 Case Study 2; Erection of a new primary school following part demolition of existing school

Summary:

- Climate risk: pluvial and river and tidal flooding
- Interesting application as site was flooded in the 2007 floods – this has been considered in the design of the new school and has led to specific features being incorporated to increase its resilience in the future.
- Particularly interesting in regards to the need to provide a place of safety at first floor level (5m AOD) for all building users – this will generate the need for a large amount of space at first floor levels i.e. is a big impact on the design of the building.
- Other low regret adaptation measures included: surface water runoff measures, SUDs, rainwater harvesting and minimum finished floor levels.



This planning application was for the creation of a new school and the partial demolition of the existing school at this site. The current school, as set out in the DAS, did not comply with national guidance in terms of the range and size of spaces provided. Furthermore, the site was extensively flooded during the 2007 floods and this contributed to the need for a new primary school. Consequently,

ensuring that the new development would be resilient to future flood events was an important part of its design.

The phasing of this proposed development would enable the new school to be built on its existing playing fields, which would be replaced through the demolition of the existing school upon completion. This loss of open space and playing fields was an issue discussed during the pre-application process and specifically with Sport England. However, it was felt that this short term loss of playing fields would be acceptable due to the need to create a new school and that this would be a short term impact during the construction of the new building and demolition of the existing. Early discussion of this issue helped to ensure that this temporary loss of green space did not pose a barrier to the delivery of the project and illustrates the value of discussing such issues with relevant stakeholders early in the planning process.

The main area that climate change adaptation measures were included within the development proposals was in regards to flood risk. The experience of the flooding in 2007 had demonstrated the scale of the risk to the current development and therefore it was a driver of the development to create a building that would be more resilient to this issue.

As the Site was located within Flood Zone 3 and as the development was for a school, which is classed as a more vulnerable use, an FRA, including a sequential test was submitted as part of the application. This set out the following low regret adaptation measures to flood risk:

- Raising floor levels; and
- The use of SUDs, including, subject to percolation tests, the use of soakaways, rainwater harvesting, permeable paving and/or the creation of a new swale and filter land system.

The FRA also calculated that the development would not pose a risk to surrounding properties.

Low-regret measures to promote biodiversity were also included within the application in terms of the need to protect bats found in the existing building. The initial mitigation measures and surveys undertaken to determine the impact on this species were not considered to be appropriate, due in part to the time elapsed between their completion and the submission of the application. However, the applicant undertook additional surveys to demonstrate that the impact on bats had been considered. Low regret mitigation measures included the provision of bat boxes and by fixing a plastic mesh to internal skylights to prevent bats accessing class rooms. In this way the development can be seen to promote the ecology of the area, however the risk posed by the development was only deemed acceptable as result of the applicant submitting additional information in response to initial objections received from Natural England and East Yorkshire Bat Group.

As noted in the Committee Report objections were not received from either the EA or Yorkshire Water, subject to the Agency stating that a condition should be applied that the development must comply with the FRA.

The Decision Notice consequently included the need to comply with the FRA as condition to the development. This made specific reference to low-regret adaption measures such as the need for raised floor levels and to reduce surface water run-off levels from hardstanding areas to Greenfield run-off rates. The Decision

Notice also included as a condition the need to provide an internally accessed place of safety at 5m AOD for all users of the building. This is particularly significant when it is considered that the new school was for 420 pupils plus staff and would therefore require space for this number of people. Other conditions in relation low-regret adaption measures for flood risk specified by the local authority included the need for separate systems for the disposal of foul and surface water drainage and for these to be approved by the local authority prior to development commencing. Furthermore, the development cannot be occupied until the scheme for surface and foul drainage have been fully completed.

Both the FRA and Decision Notice made direct reference to the fact that the level of flood risk to the area included an allowance for climate change. This demonstrates that it was directly considered how the level of flooding experienced in the area is projected to increase as a consequence of climate change.

This application demonstrates how known flood risk at a site, as a result of the direct experience of a recent flooding event can help to develop a design for a new development that reduces the risk experienced currently. The proposals for the new school sought to make the building more resilient to a flooding event and thus included a range of low-regret adaptation measures to reduce the risk experienced. The range of measures set out meant that the risk experienced was reduced to a level that made the development acceptable. This can be seen to have emerged in part through the ideas of applicant to ensure that a flood resilient building was designed, but also through the engagement of other bodies such as the Environment Agency with the local planning authority to help achieve these outcomes through the planning system. Consequently the engagement of different stakeholders, with the application and through the local authority can be seen to have helped to address the climate risks experienced at the site.

7.4.3 Case Study 3: Residential scheme for approximately 60 dwellings

Summary:

- Climate risk: river and tidal flooding
- A large number of conditions were attached to this development in order to address the level of flood risk experienced here, many of these were relatively unique in terms of the other applications sampled as part of the analysis
- Reference to climate change risks found in the supporting documents and within the Decision Notice – the adaptation measures set out in the decision notice were particularly interesting relative to other applications in the authority.
- Low regret adaptation measures included: limiting surface water run-off, not allowing sleeping accommodation on ground level, flood proofing measures such as minimum floor heights, and a requirement for the submission of a flood management plan.
- Site was protected by existing flood defences so new defences were not included within the application, with the focus instead being on improving the resilience of the building to flooding events.

This application set out proposals for a residential development on previously developed land, which was formerly used for residential and commercial uses. The development was part of a programme of housing market renewal and a central element of the design was to improve the environmental quality of the area through the design, to make it a more attractive place to live. This was in part achieved through reducing the quantum of development on the site and through the provision of open/play space for residents and the creation of a Home Zone. The application was identified as a case study as it fell within an area at risk of river and tidal flooding. However, adaptation measures were also put forward within the supporting documents and Decision Notice for pluvial flooding events.

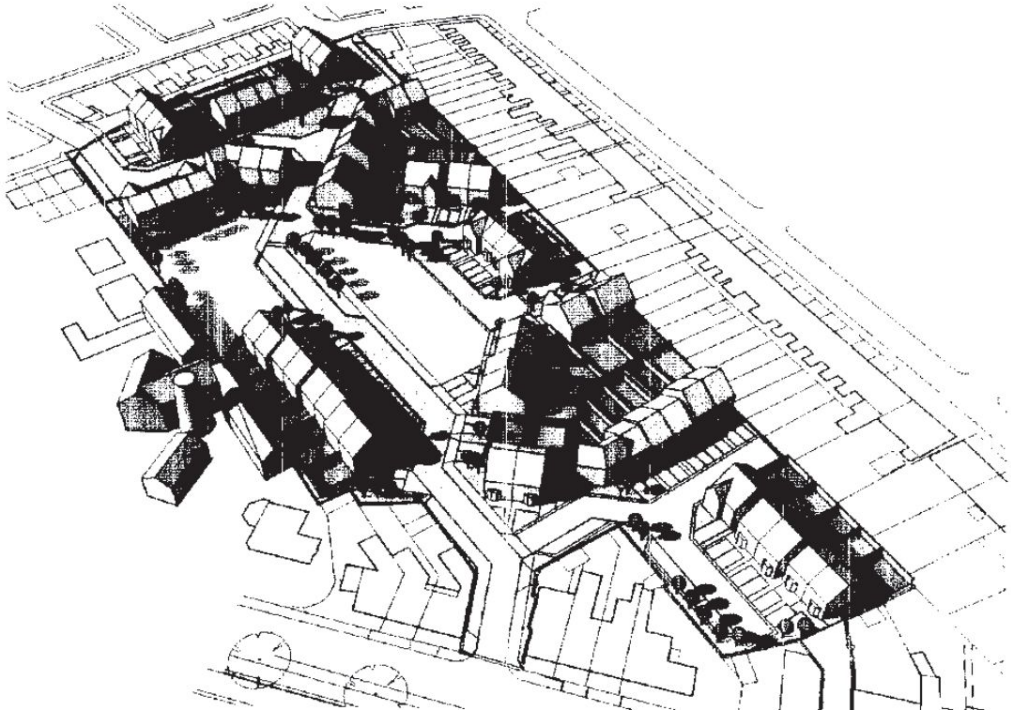


Image 4; Taken from the Design and Access Statement

The development site is situated close to the River Ouse, however a concrete wall of 6.7m AOD is located between the river and the site, which provides it with protection from river and tidal flooding events. As set out in the FRA during pre-application discussions with the Environment Agency it was agreed that this wall would provide a suitable level of protection to the development. These discussions therefore played an important part in setting out the parameters of what types of adaptation measure would be required to address flood risk posed by the development proposals.

The DAS can be seen to be proactively addressing the risk of pluvial flooding on the site by reducing the quantum of development on the site relative to the existing uses, helping to reduce the risk of surface water flooding. The Decision Notice also included a condition that stated that during a one in 100 year critical storm event the surface water generated should be limited to the level of the undeveloped part of the site. Meanwhile, the Design and Access Statement also set out that it would be likely that SUDs, and the use of soakaways, could also be incorporated into the development to reduce flood risk. Thus this inclusion of low-

regret measures, such as the proposed SUDs, could contribute to meeting this condition to reduce pluvial flooding.

As well as flood risk low-regret adaptation measures put forward in terms of ecology were included as part of the application. The Ecology Survey submitted as part of the application included adaptation measures such as bird and bat boxes and recommended the

Other conditions included in the Decision Notice specified low-regret measures that would improve the resilience of the development to flooding. This set out that the development should comply with the FRA and specifically that flood proofing measures should be implemented and that no sleeping accommodation should be provided on the ground floor. This condition was relatively unusual in that of all applications analysed as part of this report it was only used here. An additional low-regret adaptation measure was included within a condition in the Decision Notice which stated that additional evacuation measures and a Flood Management Plan needed to be provided in case the existing flood wall was over-topped during a flood event. These are examples of simple mechanism that can be applied to reduce the risk posed and vulnerability of future residents by flood risk.

Conditions also included minimum floor levels, not allowing the ground level to be raised and specifying that any spoil created must be removed outside of the flood plain. By not raising ground levels of the building this is another means of ensuring that the flood risk will not be increased for surrounding properties. This condition can be viewed as a consequence of consultation with the Internal Drainage Board, as original plans showed the levels to be raised, which would have increased the risk of flooding for surrounding properties. Its inclusion is testament to how by engaging with wider stakeholders as part of the planning process the climate change risks can be reduced.

It was recommended by the EA that the conditions related to flooding were included within the Decision Notice. It was felt by the EA and the local authority respectively that through these conditions the risk posed by flooding could be managed to an appropriate degree to make this development acceptable. However, the EA raised an objection to the application in the first instance due to insufficient information being provided. This meant that the Committee Report recommended that the application be deferred to the Chief Planning Officer on two main grounds the need to gain approval from the Agency and Internal Drainage Board (IDB) and to produce a Section 106 Agreement (in relation to the provision of open space and affordable housing). This meant that the applicant provided supplementary information for the Agency and the IDB, whereby they withdrew their objections which meant the application, was subsequently approved.

Finally, a condition was also applied to the application, which meant that prior to development commencing the applicant had to demonstrate that this proposal will reduce carbon dioxide emissions by 10%. This condition was applied to the development in accordance with Policy ENV5: Energy in the RSS.

This application is a good example as it shows how very simple low-regret adaptation measures, can make more vulnerable uses such as residential development acceptable in areas at risk of flooding. For example, not allowing sleeping accommodation on the ground floor and providing a flood management plan can help to provide protection over and above that of existing defences.

7.5 Conclusions

The study team found that the case study review corroborates many of the conclusions which emerged from the statistical analysis as to the role and relative effectiveness and awareness of the planning system across the range of risks posed by climate change.

Multiple low regrets measures means that multifaceted solutions are needed to address the challenge that this poses. This means that whilst a planning application may be within a specific risk area, such as river and tidal flood risk, a significant proposition of all applications analysed also included adaptation measures to address other risk areas. This is demonstrated most acutely in the case studies above where the majority included low-regret adaptation measures for a number of different climate change risks. This reflects that the planning system recognises that there is no single 'panacea' solution that will resolve the challenges posed by climate change. Instead a range of adaptation measures are required to provide a holistic solution to this problem.

Awareness of river and tidal flood risk stands out as greater than other risks. The case study analysis undertaken here shows the positive role stakeholders such as the EA play in both the pre-application process and when an application has been submitted in ensuring that the development is acceptable. For example, Case Studies 2 and 3 for Stockton-on-Tees illustrate how issues of flood risk formed a significant part of the pre-application process.

Although water and heat stress risks were found to be less prominent and universally address in the planning process, there was evidence from the case studies of pockets of activity, notably in Islington's work to address heat stress issues through the planning process. Discussions undertaken with officers as part of the case study research highlighted that this was an issue that was frequently discussed during the pre-application process. Furthermore, there is online guidance on this issue to inform developers of the types of measures that need to be included within an application. In all the case studies, climate change was implicitly but not explicitly referred to as the driver behind the adaptation measures proposed. Equally, policy reviews within planning applications tended to give limited attention to the topic of adaptation, despite its increasingly prominent position in national and regional planning.

The pre-application process enables climate change adaptation risks to be raised with applicants if they were not already recognised. In this manner any major issues affecting a development can be understood at the earliest possible opportunity, which means that the appropriate adaptation measures can be incorporated into the design from the beginning of the process. To this end it would appear that the pre-application stage offers an important opportunity to ensure that adaptation is embedded within the process, meaning that low regret measures help to form a more holistic development, which can address the climate change risks being experienced.

This research suggests that some planning guidance can also lead to a more confused message in relation to climate change as seen by developers following the guidance documents to the letter even when the document itself omitted linkages to adaptation. Furthermore, in the short term the uncertainty surrounding the weight to be given to RSSs may also lead to further confusion. As the case study analysis showed conditions for adaptation measures were applied as a result

of regional policy to generate energy from renewable sources. This may make it more difficult for local authorities to apply such adaptation conditions where there is not an adopted Core Strategy and the Local Plan was completed some time ago.

Once an application has been submitted, the capacity and competencies of the planning authority and its statutory consultees appear to be significant factors which affect how and whether risks are addressed in the development management process. Internal consultations with area specialists, such as the Sustainability officer in Islington, were found to be beneficial in helping to bring adaptation to the fore. Furthermore, as highlighted above, statutory consultees such as the Environment Agency, Internal Drainage Boards and Natural England play an important role in supporting local authorities with a combination of expertise and authority to ensure key policies (such as flood risk and protection of biodiversity) are reflected in planning decisions.

8 LDF Analysis

8.1 North East Lincolnshire

8.1.1 Structure the Problem

The Core Strategy Initial Draft Issues (2005) included no reference to climate change, perhaps because it pre-dates changes in national policy and the introduction of PPS1 Supplement Planning and Climate Change (published in 2007) which essentially formalised the need to take climate change into account when developing LDFs. The changes in national policy that have taken place over the period in which NE Lincolnshire has been preparing its LDF (particularly the growing emphasis on climate change adaptation and mitigation) are reflected in the changes and emerging policies relating to climate change contained within subsequent drafts of the Core Strategy.

The Initial Draft Issues document identifies that the area is at risk from flooding, but no acknowledgement is made of the impacts of climate change on flood risk. The 2007 Preferred Options Core Strategy makes reference to climate change and flood risk as a key issue, but no further reference is made to climate change in its vision or objectives. The latest draft of the Revised Preferred Options Core Strategy (2008) acknowledges the need to adapt to the uncertainties of climate change upfront in its Spatial Portrait. It also includes a specific objective relating to mitigating and adapting to the effects of climate change.

In terms of assessing the sustainability of Core Strategy policies, the 2005 Sustainability Appraisal (SA) includes a sustainable development aim which refers to *'minimal greenhouse gas emissions and a managed response to the effects of climate change'*. The 2005 SA also highlights that the Core Strategy is weak in relation to climate change, recommending that the sustainable development principles consider and respond to the causes and effects of climate change. The 2008 Sustainability Appraisal adopts the same objective as the 2005 SA, although this is accompanied by indicators relating to the reduction of greenhouse gases and the planning and implementation of adaptation measures for the likely effects of climate change. There is also an additional indicator that seeks to reduce the impact of flooding on people, property and natural environment.

With regards to current and future vulnerability to climate change, Core Strategy documents acknowledge the extent of coastal flood risk in the area. The latest draft of the Core Strategy also acknowledges that given the extent of flood risk across the Borough, raising resilience to climate change impacts is a particular issue. Several evidence base documents also identify flood risk as a particular issue for NE Lincolnshire – including the Employment Land Study and Strategic Housing Land Availability Assessment, both of which adopt the PPS25 sequential approach to identifying suitable development sites. The SFRA is however the only evidence base document to consider future vulnerability to climate change by running a scenario that includes an allowance for climate change related flood risk. There is limited reference to coastal erosion in either the Core Strategy documents or evidence base reports.

Both the Core Strategy and Sustainability Appraisal documents make reference to several other plans and strategies. Early sections of the Core Strategy – such as the

vision and objectives, are closely tied to the Sustainable Community Strategy (SCS), as required by national policy. This can have implications for the prominence of issues such as climate change, since it is dependent on whether or not the SCS identifies it as a priority. This is perhaps the case for earlier drafts of the NE Lincolnshire Core Strategy, which lifted its vision directly from the SCS. In moving climate change up the planning policy agenda it is therefore important that it is also given prominence in other related plans and strategies; the latest version of the NE Lincs SCS does make reference to climate change, although not as part of its vision or priorities.

Drafts of the Core Strategy identify several other related plans and strategies, both upfront in the documents and in connection to specific development management policies, including the Grimsby and Ancholme Flood Management Plan, North and North East Lincolnshire Strategic Flood Risk Assessment, Humber Shoreline Management Plan and the Humber Flood Risk Management Strategy/ Plan (Core Strategy Preferred Options 2007) and the Strategic Flood Risk Assessment 2007 and Humber Flood Risk Management Strategy/Plan 2008 (Revised Preferred Options 2008). Reference is also made to the RSS in connection to local targets for renewable energy and strategic decisions about the location of development. Appendix B of the 2008 SA (Relevant Plans and Programmes) identifies several related plans and strategies and their relevance to the Core Strategy, including the NE Lincs SFRA, Grimsby & Ancholme CFMP, Louth Coastal CFMP, Lincolnshire Coast SMP and Humber Estuary SMP.

With specific regard to flood risk, the local authority has confirmed that the preparation of the Core Strategy has been undertaken in close liaison with the Environment Agency, who have reviewed the various iterations of the document. The Council is also currently involved in the preparation of the Flamborough Head to Gibraltar Point Shoreline Management Plan, which is referenced in the emerging Submission version of the Core Strategy, which states that '*the Borough's coastline has a good standard of coastal defence and this standard of defence is expected to be maintained to cope with predicted sea level rise (as confirmed by the Shoreline Management Plans). The flood risk is therefore the risk from residual flooding, that is, risks posed by the overtopping or breaching of defences'*. The Submission draft of the Core Strategy will be publicly available and due for consultation in late May/ June 2011.

8.1.2 Appraise Solutions

In terms of the decision analysis undertaken to generate the plans, the lack of acknowledgement of climate change upfront in the vision, objectives or spatial portrait of the Borough in the earlier drafts of the Core Strategy could have influenced the level to which climate change is addressed in the remainder of the document, and whether it has influenced the spatial layout of development. In contrast, the 2008 Core Strategy acknowledges climate change in the Spatial Portrait, key issues and objectives, with knock on effects for the remainder of the document.

The early drafts of the Core Strategy (2005 & 2007) are light on identifying climate change adaptation options, except in connection to flood risk, where they emphasise that flood protection and coastal defences will be supported and safeguarded in accordance with the Humber Shoreline Management Plan and/ or the Humber Flood Risk Management Strategy. The 2008 Core Strategy adopts a

similar approach to adapting to flood risk, referencing the management approach adopted in the Humber Flood Risk Management Plan 2008 which will continue to protect the land, subject to funding being secured, working with the local and regional authorities, property owners and developers to make sure flood risk is taken into account at all stages of the planning process. Developers are consequently expected to make contributions towards flood defences in accordance with this Strategy.

The 2008 Core Strategy also embraces climate change adaptation in wider sense than its predecessors. Its Sustainable Development Principles contain a specific reference to delivering a built and natural environment that is adaptable to climate change, whilst policy DM10 specifically deals with adapting to climate change (although some of the policy is concerned with mitigation). Links are also made with other policy areas, such as green infrastructure which is recognised for its role in reducing surface water run-off and flooding, as well as reducing the urban heat island effect.

There is also clear evidence in the latest drafts of the Core Strategy that the issue of climate change has been taken into account in decision analysis (perhaps as a result of some consultation feedback which emphasised the need for this). The document states that '*the sequential approach to site allocation and selection is recognised as being a fundamental tool in addressing flood risk, and this Core Strategy as part of the Development Plan will set the main strategic direction. In considering the options for development in this and successive Development Plan Documents choices will nearly always be challenged with minimising the risks of flood risk, sustaining existing communities and realising opportunities. Sequentially preferred sites for development that are at the least or no risk from flooding within the Borough also have to be assessed in terms of their own impact upon climate change as they will have environmental consequences in respect of drainage systems, CO2 emissions and increased need for travel to everyday facilities.'* The Spatial Strategy also states that '*Environmental and climatic influences have a significant bearing on the future pattern of growth in the Borough.'* As a consequence, policy SP1 Spatial Strategy clearly states that emphasis will be placed on steering development away from areas of flood risk.

However, there remains evidence of a policy conflict between addressing climate change related issues such as flood risk and delivering other policy priorities – such as regeneration and economic development; in several cases a site at risk of flood risk is still proposed for development as other benefits are considered to outweigh that risk. The Core Strategy also allocates the estuary zone for continuing industrial development. Some of the decisions to locate new development in these areas can also be linked back to the RSS, which encouraged development in the urban area to support regeneration, and in the estuary area for economic development. There is however evidence of joined up thinking between the Core Strategy and Humber Flood Risk Management Plan, which has made a commitment to maintaining defences in respect of climate change for the next 100 years, subject to funding being secured.

The 2008 SA recommends that the Core Strategy could strengthen other policies relating to design, economic growth and housing by including statements relating to:

- Avoiding development on identified flood plains and land susceptible to flooding.

- An aim to build homes to the highest level of the Code for Sustainable Homes in advance of regulation (to kick in by 2016).
- Retrofitting of existing developments to include energy and water efficiency measures.
- Developments to include soft landscaping to mitigate against potential climate change effects (e.g. flooding).
- Developments to include Sustainable Urban Drainage Systems, water conservation and grey water recycling design.
- Incorporating energy efficiency designs and be adaptable to climate change

8.1.3 Implementation, Evaluation Monitoring and Review

In terms of ongoing monitoring and review, the Annual Monitoring Report 2010 (AMR) does not include any specific monitoring indicators relating to climate change adaptation or NI 188. Related indicators include:

- Number of planning permissions granted contrary to the advice of the EA;
- Flood defences NI189 Flood and Coastal Erosion risk management;
- Renewable energy generation; and
- Recycling and composting NI192.

8.2 London Borough of Hackney

8.2.1 Structure the Problem

The Issues and Options draft of the Core Strategy (2005) identifies climate change as an issue in its preamble to a Sustainable Borough. However, the document does not make any subsequent references to climate change risks in the identification of development options. Although the draft Scoping Report for the Sustainability Appraisal identifies several sustainability objectives relating to climate change, such as reducing greenhouse gas emissions, avoiding areas at risk of flooding and resource efficiency, this is not carried through into any of the indicators or targets.

The 2008 Sustainability Appraisal framework includes objectives relating to the minimisation of flood risk, SUDS, reducing greenhouse gases and promoting energy efficiency and sustainable design The adopted Core Strategy recognises the challenges of Climate Change upfront in the document, stating that '*over the next 15 years, climate change will become an increasingly critical challenge for Hackney. Tackling climate change and bringing down our carbon emissions will require a comprehensive range of interventions across housing developments, infrastructure including energy supplies, transport, town centres, employment and open spaces'*. Tackling climate change is also included as a Strategic Objective.

Reference to current and future vulnerability to climate change varies across the Hackney evidence base documents. Whereas the Employment Growth and Heat Mapping Study do not consider climate change risks, both the Housing Strategy and Regeneration Delivery Framework acknowledge the challenges of climate change, although they don't go so far as to identify specific areas of climate risk for Hackney Borough. Although the Infrastructure Delivery Plan covers related issues such as water supply, flood risk and green infrastructure, these sections do

not specifically consider the implications of climate change. The 2009 PPS25 Sequential Test accompanying the Core Strategy Proposed Submission Document specifically considers flood risk in connection to climate change, identifying the implications for Hackney Wick'. The LDF Options Map (2008) also identifies areas of flood prone land, but not those areas that are potentially vulnerable to heat or water stress. The introductory text to the chapter on Climate Change and Environmental Sustainability in the adopted Core Strategy identifies areas of Hackney that are vulnerable to river and pluvial flooding.

The adopted Core Strategy makes links to the Hackney Climate Change Strategy and Action Plan, which it states will underpin future planning policy in the borough. The Strategy is identified as being particularly important in terms of helping to deliver a combined heat and power network in key growth areas in the borough. The Core Strategy is also underpinned by the London Plan which is identified as a key driver in several policy areas, including promotion of decentralised energy, the energy hierarchy and targets for water consumption and CO2 emissions. References are also made to partnership working with the Environment Agency on flood risk, and contribution towards the long term management targets of the Thames CFMP. The Annual Monitoring Report also makes links to other relevant plans and strategies, including the Core Strategy, Sustainable Communities Strategy, Climate Change Strategy and Regeneration Framework, which are brought together in the monitoring indicators.

8.2.2 Appraise Solutions

The policy approach to climate change issues is strengthened considerably in the latter versions of Hackney's Core Strategy, where changes and greater focus on climate change in national policy and the London Plan appears to have filtered into the decision analysis to generate plans.

In terms of the identification of adaptation options, earlier drafts of the Core Strategy contain limited references to climate change adaptation. The Core Strategy Preferred Options (2008) identifies several climate change adaptation techniques, such as sustainable urban drainage and green roofs and walls and rainwater harvesting there is no specific link to their role in adapting to climate change. The document contains no policies on addressing heat island effects, water shortage or the role of green infrastructure in adapting to climate change. The 2008 Sustainability Appraisal does however make reference to PPS1, and recommend that the Core Strategy reflects its objectives in relevant sections. In particular it notes that PPS1 advocates adapting to climate change impacts likely to occur.

Consultation on the Core Strategy appears to have played an important role in strengthening the Core Strategy's approach to climate change adaptation; consultation feedback for example highlighted the role of green infrastructure in urban cooling and water stress issues, which is reflected in subsequent drafts of the Core Strategy.

The Core Strategy Submission Document (2009) (and subsequently the adopted Core Strategy) contains a specific chapter on Climate Change and Environmental Sustainability. This chapter sets out a much clearer set of policy principles aimed at mitigating and adapting to the impacts of climate change, including:

- Reducing the risk of flooding by reducing surface water and locating developments away from flood risk areas;
- Reducing water consumption;
- Boosting renewable and low carbon energy production;
- Promoting energy efficiency;
- New green infrastructure to address heating and cooling issues and reduce CO2 emissions; and
- Sustainable transport.

The document is also more imaginative and comprehensive in identifying adaptation solutions, including:

- High density urban form is identified as providing opportunities to respond positively to sustainability by providing opportunities for photovoltaic cladding, CHP, biomass and solar water heating systems and helping to kick-start decentralised energy production across the Borough.
- Green infrastructure (including living roofs) is more specifically identified as a way of reducing energy demand and moderating the urban heat island effect.
- As well as considering new development, policies for resource efficiency and carbon dioxide emissions consider opportunities to retrofit existing buildings.
- Reconciliation of the need to build new homes and flood risk within the borough (particularly in the east) through innovative solutions such as providing new flood water storage that also addresses open space deficiencies
- Maximisation of opportunities to move existing development from within the floodplain to areas with a lower risk of flooding. This includes consideration of the vulnerability of existing developments and whether there is potential for land swaps with lower vulnerability uses and identifying, allocating and safeguarding open space for flood storage.

Policy approaches are also more specific in addressing the impacts of climate change – particularly in relation to dealing with issues of flood risk in the east of the borough, the circumstances in which development will be permitted and measures expected of developers to deal with potential impacts. The policies make reference to the findings from the SA in directing changes in policy, as well as making connections to other partner organisations and documents including the Environment Agency and Thames CFMP.

Although areas of flood risk and associated climate change vulnerability such as Hackney Wick have been identified and the policy position adopted by the Core Strategy strengthened in connection to these issues, the decision analysis to generate plans indicates that other factors – such as regeneration can create a tension between responding to climate change risks and delivering other growth objectives, which can result in areas of relatively high risk still being allocated for development. This is particularly the case for an authority such as Hackney where the availability of land/ alternatives is constrained. The tension between delivering new development and minimising vulnerability to climate change is an issue that is identified in the Sustainability Appraisal, which highlights the need to align growth locations in order to deliver decentralised energy systems and thereby mitigate / adapt to climate change. The SA also emphasises the importance of making sure that strategic policies setting out the growth agenda and locations of

development take into account adverse impacts of growth, rather than leaving it to development management policies to deal with the resultant effects.

8.2.3 Implementation, evaluation, monitoring and review

The Annual Monitoring Report 2008/9 (AMR) contains a number of indicators relating to either climate change mitigation or adaptation, including:

- Net change in open space;
- % reduction in CO_2;
- Renewable Energy Generation;
- All major development rated against CSH or BREEAM;
- Number of permissions granted contrary to EA advice;
- Residual waste collected Percentage of household waste sent for reuse, recycling and composting;
- Access to services and facilities by public transport, walking and cycling;
- Working age people with access to employment by public transport; and

No reference is made to climate change adaptation or NI188.

8.3 Stockton-on-Tees

8.3.1 Structure the Problem

Early work and scene setting undertaken as part of the Core Strategy Issues and Options report (2006) does not identify climate change as a key issue, nor is it referenced in the draft vision or objectives. Flood risk is subsequently identified as an environmental issue, although no reference is made to its exacerbation as a result of climate change. The Sustainability Appraisal Scoping Report (2006) does not specifically identify climate change as a key issue, although Sustainability Objective 13 is to '*reduce the causes and impacts of climatic change'*. The indicators under this objective are however largely related to climate mitigation rather than adaptation (e.g. reducing carbon emissions, renewable energy targets etc). The SA also includes an objective relating to the reduction of flood risk, although no specific connection is made to climate change. One of the key drivers for change identified in the Preferred Options Core Strategy (2007) is realising the potential of the River Tees as a key asset whilst taking into account the impact of climate change and flood risk; which is reiterated in the adopted Core Strategy. Addressing the impacts of climate change is not however identified as a key objective within the Core Strategy, although mitigating the effects of climate change is identified as an important consideration under Objective 11: To provide a safe, healthy and attractive environment. The Environment DPD (Issues and Options 2010) however, which is intended to deliver certain aspects of the Core Strategy, focuses specifically on climate change as a key issue, which is then adopted as an overarching approach (together with green infrastructure) throughout the document.

Reference to climate change in LDF evidence base documents is limited. The Employment Land review and forecasts and the infrastructure strategy make no

reference to climate change. The Strategic Housing Land Availability Assessment (2008) does however eliminate sites within the functional floodplain, although no allowance is made for climate change. However, in relation to SHLAAs, National Planning Guidance makes clear that climate change allowance does not need to be made "the scope of the Assessment should not be narrowed down by existing policies designed to constrain development, so that the local planning authority is in the best possible position when it comes to decide its strategy for delivering its housing objectives." This does not diminish the weight that would be attached to such designations in relation to planning applications. A level 1 and level 2 SFRA have also been undertaken which take into account the effect of climate change on the spatial extent of Flood Zone 3. Both the Sustainability Appraisal and Core Strategy acknowledge that flood risk is a key issue for the Borough; however, other potential areas of climate change vulnerability are not specifically identified. Contrastingly, the Climate Change Action Plan identifies a range of areas of potential current and future potential vulnerability to climate change in Stockton, including sea level rise, coastal erosion, flood risk, temperature increases, changes in agriculture and forestry, lifestyle and the built environment (e.g. water & heat stress), tourism, business, health, transport, energy and the natural environment. The Issues and Options Environment DPD also identifies some potential areas of vulnerability, such as loss of habitat/ biodiversity, although the range of possible impacts is not as comprehensive as those identified in the Action Plan.

There are clear links between various LDF documents, such as the Core Strategy and emerging Environment DPD. The relationship between these documents is made quite clear – for example, that the Environment DPD is intended to build on certain policies form the Core Strategy – including those relating to climate change. The adopted Core Strategy also contains an Implementation Plan, which links each policy to potential implementation frameworks (largely other Borough Strategies, SPDs and DPDs), lead agencies, targets and outcomes.

The Stockton-on-Tees LDF is also supported by the Stockton-on-Tees Climate Change Action Plan. As well as reducing greenhouse gas emissions and raising awareness, the key aims of the Action Plan include the provision of a 'framework to adapt to the inevitable impacts of climate change'. The Action Plan contains separate chapters relating to Climate Change Adaptation and Climate Change Mitigation. It also makes specific reference to LDF documents in terms of the roles that they should play in delivering specific objectives, such as improving energy efficiency, reducing flood risk and developing mechanisms to adapt to extreme weather conditions (see below).

8.3.2 Appraise Solutions

The Climate Change Action Plan identifies a range of specific climate change adaptation options, including:

- Production of a Parks, Open Spaces and Countryside Strategy that promotes integrated planning and delivery of green infrastructure, recognising the role of GI in reducing the impacts of climate change on people and buildings.
- Collation of baseline data for woodland and tree cover within the Borough and setting of targets to increase % cover by 2012.

- Inclusion of a sustainable urban drainage policy to dispose of surface run-offs without enhancing the flood risk as part of Core Strategy and Environment DPDs
- Setting out a clear vision, objectives and strategy for flood protection as part of the Core Strategy.
- Developing and adopting appropriate planning polices within the environment policy element of the LDF process
- Encouraging sustainable building design to maximise natural ventilation and utilise passive solar systems and thermal mass to reduce internal temperatures.
- Promoting 'Gardening for Wildlife' to reduce the loss of biodiversity.
- Producing new and revised management plans for urban parks, country parks and other green space that take account of the need to adapt to climate change
- Identifying climate risks to local authority services
- Identifying and prioritising climate impacts requiring adaptation responses.

Some of these elements are picked up in the Core Strategy, although they are not perhaps articulated as clearly as in the Climate Change Action Plan. For example, flood risk is incorporated into a policy relating to environmental protection and enhancement, which does not appear to go so far as the Climate Change Action Plan in terms of setting out a clear strategy for flood protection. The Core Strategy also contains a policy relating to Sustainable Living and Climate Change, although the focus of this policy is more on carbon reduction and energy efficiency than adaptation options. Opportunities for climate change adaptation – such as the role of green spaces and biodiversity corridors, are however identified in supporting text to Policy 10 Environmental Protection and Enhancement. The emerging Environment DPD acknowledges that it has a key role to play in mitigating and adapting to the effects of climate change, and the Issues and Options document identifies various adaptation options for consultation, such as the identification of new sites for habitats and tree cover and restoration of natural flood plains. The Sustainable Design DPD (Consultation Draft 2010) also sets out ways of incorporating climate change adaptation options into new development, such as SUDs, green roofs and natural ventilation.

The Preferred Options and Submission Core Strategies (2007 & 2009) and accompanying Sustainability Appraisal show evidence of decision analysis to generate plans that takes into account impacts on climate change and flood risk, by identifying policy options and objectives that could have a potentially negative impact on relevant SA objectives. As a consequence of these, the SA makes recommendations for mitigating these impacts, such as avoidance of development within the flood plain, adoption of sustainable construction techniques and increasing the emphasis on sustainability throughout the Core Strategy. The SA does comment however, that given the strategic nature of the Core Strategy, the potential impacts arising from the policies in relation to climate change and flood risk are at times uncertain and would be more easily identified against site allocation policies.

Consultation feedback on the Core Strategy also highlights opportunities for climate change mitigation and adaptation to be strengthened in the Core Strategy, including in particular the role of SUDs and Green Infrastructure in adapting to climate change. The Submission Draft Core Strategy reports that more detailed

consultation comments are expected to be picked up in the Environment DPD, although greater emphasis is subsequently given to the role of biodiversity and green spaces in responding to and adapting to climate change in the adopted Core Strategy. Concerns over the location of development within the river corridor and incorporation of findings from the SFRA were also raised during consultation. The SA also recognises the potential conflict between flood risk and strategic sites and suggests options for mitigating these conflicts. The adopted Core Strategy subsequently continues to identify the river corridor as a focus for development in light of identified benefits such as reversing industrial decline, making use under-utilised previously developed land and supporting the Stockton-on-Tees Middlesbrough Initiative whose overall objective is to create a new city region within the Tees Valley.

Issues over flood risk are also raised in connection to the Boathouse SPD, where a site allocation within Flood Zone 3 had been carried forward from the earlier Local Plan, even though it predates the evidence base. This is potentially an issue that may be faced by several local authorities where Local Plan site allocations continue to apply despite changes in evidence base and to government policy in connection to issues such as flood risk that have taken place in the interim. This is important as PPS25 requires LPAs to review previous allocations in light of new policy and evidence.

Questions raised by the Inspector during the Core Strategy examination did not focus on conformity with plans and policies specifically relating to climate change adaptation. However, the examination did specifically consider the extent to which housing commitments, SHLAA sites and employment land were constrained by flooding. The Inspector concluded however that the number of dwellings and employment land requirements proposed in the Core Strategy would not be significantly compromised by flood risk, given the nature of the policies and land allocations which provide flexibility/ additional capacity elsewhere.

8.3.3 Implementation, Evaluation, Monitoring and Review

The AMR 2009/10 does not include NI188 on climate change adaptation, although it does include a range of other indicators relating to flood risk and enhancement green infrastructure. Climate change related indicators include:

- Number of planning permissions granted contrary to Environment Agency advice on flooding and water quality grounds;
- Percentage of agreed actions to implement long term flood and coastal erosion risk management being undertaken satisfactorily – linked to actions set out in the CFMP;
- Protection of strategic gaps and green wedges from inappropriate development; and
- Percentage of homes constructed to sustainable homes code levels.

Please see **Appendix E** for LDF analysis tables.

8.4 Conclusions

The review of Local Development Framework documents provides a clear illustration of how changes in national policy and guidance on climate change have influenced the content of local development plan documents. Later drafts of all three authorities' Core Strategies contain much stronger policies on climate change adaptation, which reflects its growing importance at the national level over the plan making period.

The Town and Country Planning (Local Development) (England) Regulations (2004, amended 2008) and PPS12 set out key requirements for Core Strategies, which includes their relationship to Sustainable Community Strategies (SCS), and the need for them to be founded on robust evidence bases. If Core Strategies are to meet these procedural requirements in relation to the adoption of climate change adaptation policies, there is a need to align guidance and priorities for preparing supporting documents to ensure that climate change adaptation is addressed and incorporated into the evidence gathering stage from the outset. Sustainability Appraisals are also an important tool in ensuring that climate change is appropriately addressed in adopted Core Strategies, although this is dependent on the range of indicators that they contain. They are however a good means of ensuring that national policy guidance is reflected in emerging Core Strategies, so long as SA indicators and objectives are updated during the plan making process to reflect changes in national policy.

The extent to which Core Strategies contain detailed policies on climate change adaptation also depends on the content and organisation of the wider Local Development Framework. For example whether or not there is (or is intended to be) an SPD on Sustainable Buildings, or a separate DPD on Development Management Policies may influence the level of detail appropriate for the Core Strategy. In all cases however, the Core Strategy sets the overall vision and objectives for the local authority area, and it is consequently important that it identifies climate change as a key issue and priority, as this will influence the tone of subsequent policies and DPD/ SPDs. The nature of climate risks means that this may also require local authorities and other bodies to co-operate across borders to address the challenges that this poses. It will also be important to adopt a long term approach to addressing the issue of climate change, whilst maintaining an appropriate degree of flexibility to be able to respond to new information as it emerges.

As with the development management process analysis, avoidance and management of flood risk is the most consistently identified climate change adaptation measure across all authority areas studied. This is perhaps because it is an issue that local planning authorities are familiar with dealing with as part of land use planning, it having pre-dated the climate change agenda. However, consideration of the impact of climate change on the level of flood risk is perhaps an area that could be strengthened. Whilst strategic flood risk assessments generally tend to include a climate change scenario, this is not always reflected in other evidence base documents or Core Strategy policies which consider flood risk on the basis of existing levels, rather taking account of climate change. Policy responses to heat stress, water shortages and biodiversity adaptation appear less well developed or ubiquitous, a finding which links back to the importance of both a clear national policy framework and a comprehensive evidence base which recognises the nature of the risk in each locality.

Successfully addressing climate change adaptation requires local authorities to incorporate appropriate policy actions and responses across a range of policy areas – including growth areas and targets, site designations, green infrastructure, water resources and building design. The approach to this varies across the Core Strategies studied, with some containing specific climate change adaptation policies, and others choosing to incorporate adaptation across other topic areas. Where adaptation measures are incorporated under other policy topics (such as open space), there is a need to make sure that its role in adapting to climate change is clearly recognised and explained rather than assumed.

The LDF review points to a tension between climate change adaptation and other policy priorities such as regeneration. In several instances, those areas in greatest need of new development (such as industrial riverside areas) are often those with a higher vulnerability to climate change. Decision makers are consequently faced with the challenge of balancing risks and benefits, with short term opportunities for regeneration often taking precedence over long term climate change vulnerability (particularly flood risk).

The range of climate change related monitoring indicators varies across the authorities studied. Whilst none of the Annual Monitoring Indicators had adopted NI188 (Adapting to climate change), they do contain indicators relating to the avoidance of flood risk in new development, protection of open space and achievement of sustainable buildings standards.

9 Scenario Analysis

The results of the scenario assessment are presented in this section. This section is structured as follows:

- Report on spatial analysis for the relocation of development under the Retreat scenario for each case study location (Sections 9.1 and 9.2)
- Report on the economic assessment of the Retreat and Resilience scenarios (Section 9.3)
- Summary of results (section 9.4)
- Conclusion (section 9.5)

9.1 Stockton-on-Tees

9.1.1 Overview of Areas at Risk

Figure 21 shows the planning applications in areas at Significant and Moderate risk of river flooding in the selected study area in Stockton. This demonstrates that the highest levels of risk are concentrated around the River Tees, in the centre of Stockton. Furthermore, this shows that the risk level is relatively stratified in the town, with a large area not at risk of flooding, and the next largest area being at a significant risk of flooding. In contrast, a much lower proportion of land in the town was identified as being at either a moderate or low risk of flooding.

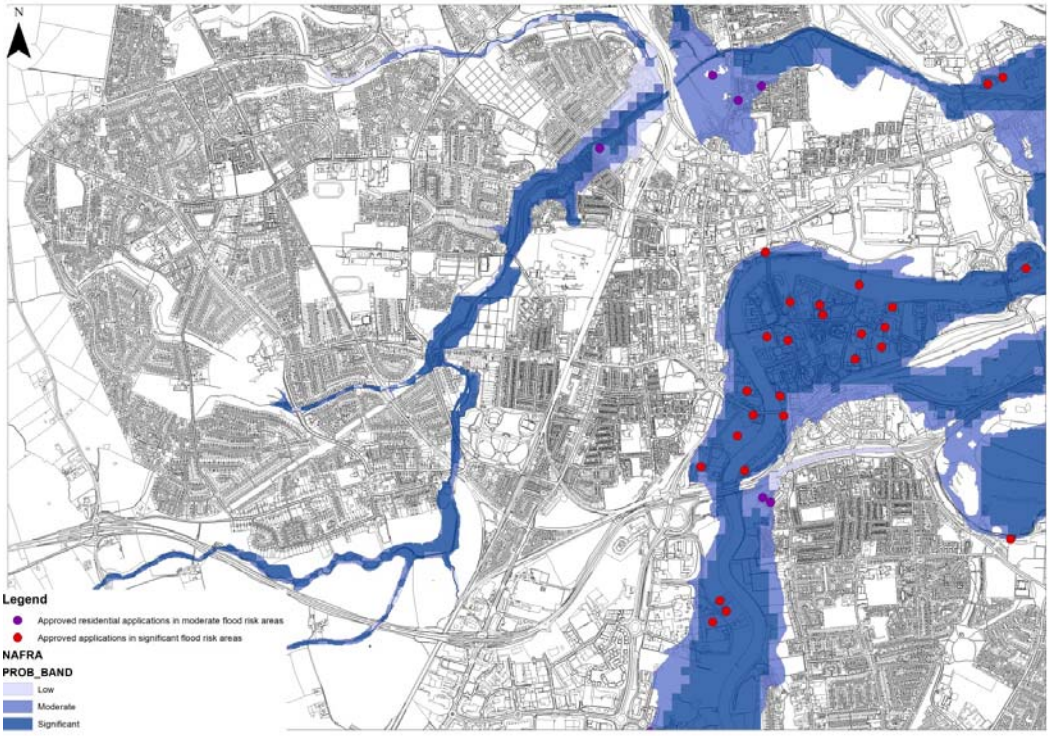


Figure 21: All major approved planning applications in areas at significant risk of river flooding and all major residential applications at moderate risk of river flooding in Stockton-on-Tees

Note: The major planning applications are shown as points on the map, rather than the shape and size of the site area

In total, 34 major planning applications were approved in Stockton-on-Tees within areas at significant risk of flooding, of which six were for residential development. Meanwhile, fifteen applications were approved within the area at moderate risk of flooding, of which seven were for residential development. Figure 22 provides a comparison of the number of applications within each risk area by development type.

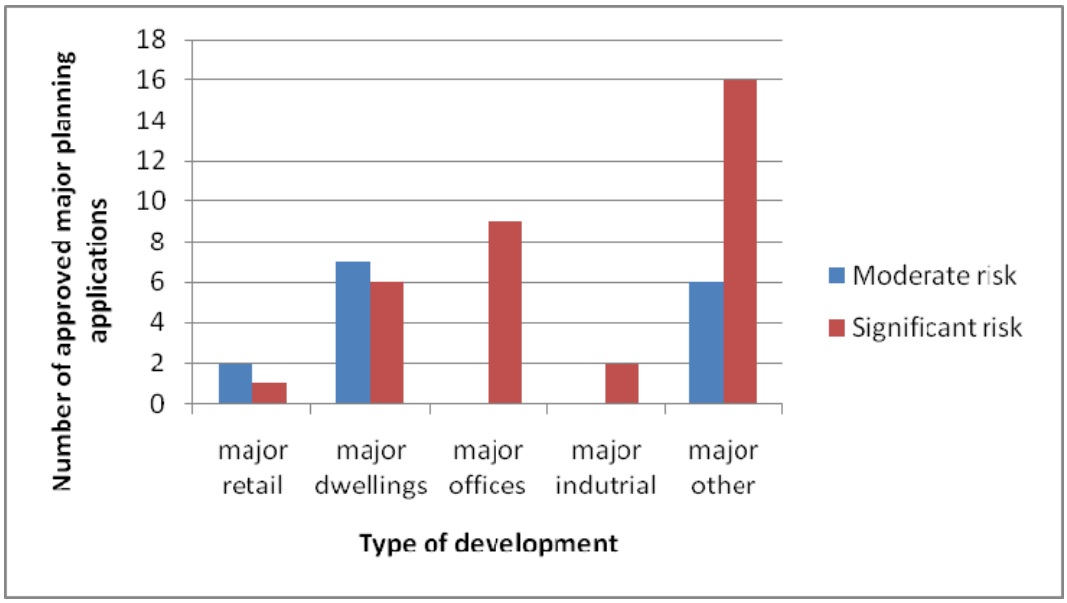


Figure 22. Major permissions, by development type and flood risk, in Stockton-on-Tees focus area, 2001-2011

Figure 23 provides an overview of the amount of development that was included within these planning applications. This shows that the average size of schemes were greater for residential development than non-residential development as a smaller number of applications generated a higher total site area (ha).

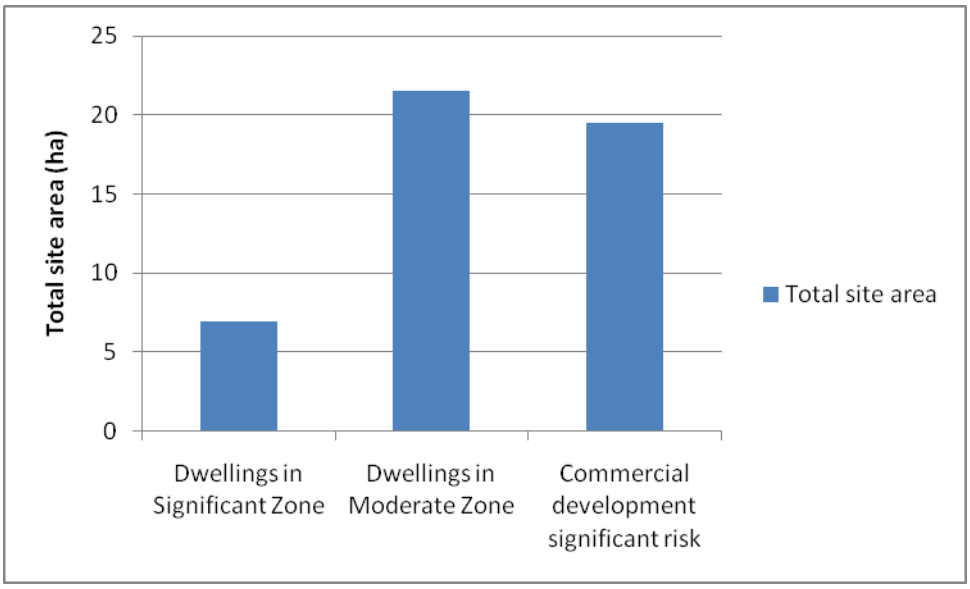


Figure 23. Total site area of applications within moderate and significant flood risk zones, by development type, Stockton-on-Tees, 2001-2011

9.1.2 Residential Applications

The analysis presented in **Figure 24** shows the location of major residential applications within significant and moderate flood risk areas and the sites where these applications would be redistributed as part of the retreat approach. This shows that all residential development would move from within the main urban area to an edge of town location. This site is identified within the Stockton-on-Tees SHLAA as being available for residential development and is not an area of flood risk. However, as set out within the SHLAA this site is outside of the current development limits of Stockton-on-Tees and is greenfield land. As a result of the coalition Government removing targets for the amount of development to occur on brownfield land and the recommendation of the Practitioners Advisory Group NPPF of the introduction of a new concept of land 'of lesser environmental value', which if adopted by Government may allow greenfield sites outside risk areas to come forward more easily. However, these policy changes will impact on development coming forward in the future rather than the development assessed as part of this research. Information within the SHLAA also highlights that the development of this site would have major implications on the highways network.

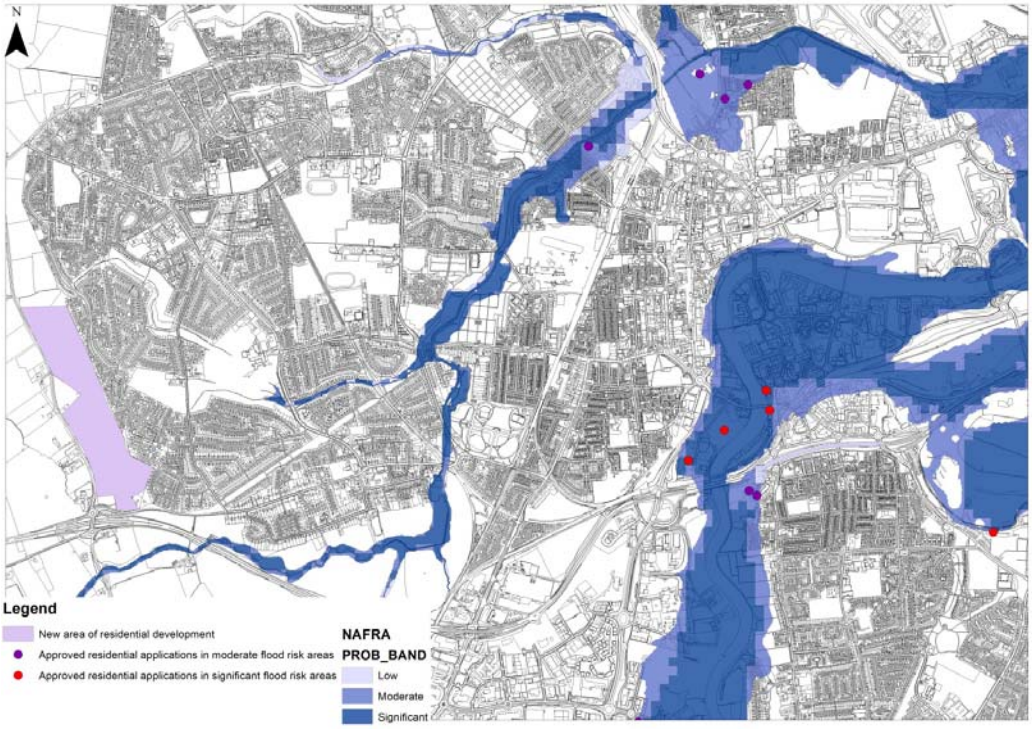


Figure 24: Where residential development in high and moderate flood risk zones could be redistributed to in Stockton-on-Tees

Note: The major planning applications are shown as points on the map, rather than the shape and size of the site area. The new area of residential development represents the total site area of these planning applications, rather than the area of development. The site selected for the residential development was the nearest developable site within the study area as set out in the SHLAA (excluding the sites with planning permissions) that was not in moderate and significant flood risk areas.

By developing in this area and reducing the risk of river flooding there is the potential for a negative impact on ecology and biodiversity through the loss of this greenfield land. Furthermore, by locating people in this edge-of-town location the distance travelled by residents by car is also likely to be higher than in the previous locations, which may have negative impact on transport-related carbon emissions. If all of the proposed developments were moved to this one site, however, this may help to minimise carbon emissions relative to what they would be if development was more widely distributed around the urban edge. This would result from having greater potential to create a level of critical mass of developments to provide improved public transport links to this area.

9.1.3 Non-residential development

Figure 25 shows the potential redistribution of non-residential development applications which were in Significant risk areas.

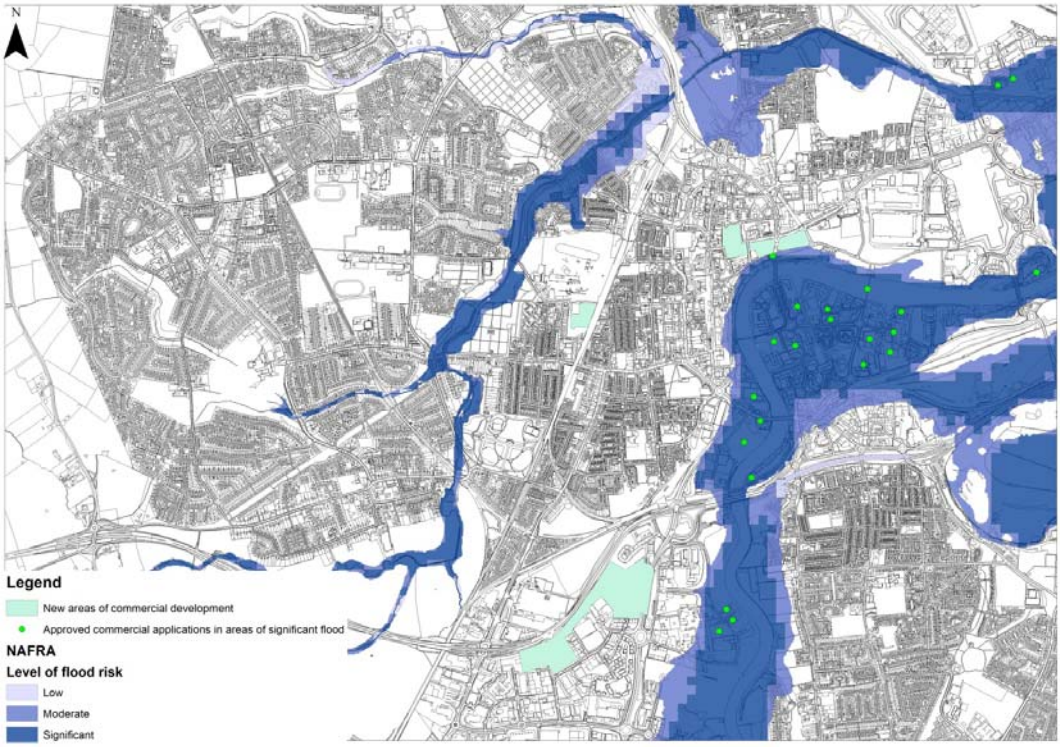


Figure 25: Where non-residential development in high flood risk zones could be redistributed to in Stockton-on-Tees

Note: The major planning applications are shown as points on the map, rather than the shape and size of the site area. The new area of non-residential development represents the total site area of these planning applications, rather than the area of development.

The redistribution of non-residential development in Stockton-on-Tees can be seen to be achieved through the use of sites within the study area of Stockton-on-Tees itself, without using land in the area at significant risk of flooding. This primarily creates land use patterns whereby development concentrated to the South East of the river is moved to the north of the river and to other out-of-centre locations. This redistribution of development would include the use of the proportion of the North Shore Site (the area of development to the north of the river) identified for employment uses[13], which was identified within the Regional Spatial Strategy for the North East as a regeneration scheme of regional significance. However, as set out within the emerging Local Development Framework[14], there are aspirations to use this site for a mixed use scheme incorporating a research based business park, expansion of the Durham University Business Park, offices and other commercial uses such as a hotel, restaurants and bars. This would from part of wider scheme; with the North shore area covering 56 acres of riverside land. Thereby, redistributing the development set out within the planning applications in areas at significant risk of flooding to this site would mean that it would be unlikely that these aspirations could be delivered. Consequently, this may have a negative impact on the ability of Stockton-on-Tees to realise its wider aspirations for employment growth.

[13] The area of the North Shore site suitable for employment uses was identified as 4.75ha as set out within table 3.3 in the Nathaniel Lichfield and Partners (2008) Employment Land Review, on behalf of Stockton-on-Tees Borough Council

[14] Stockton-on-Tees Borough Council (2007) Regeneration Development Plan Documents, Issues and Options

There is a cluster of planning applications located to the south east of the curve of the River Tees close to the Durham University Campus that is situated here. A brief review of the applications themselves highlighted that some of the applications were directly related to the university. This highlights the difficulty of applying the flood risk restriction policy where the new development is directly linked to an existing set of uses. Even for the applications which are not directly linked to the University itself, it seems probable that they have chosen this location so due to the proximity to the University. As such it may mean that it may not be appropriate to redistribute these applications away from the University, as the proposals may no longer be viable.

Fundamentally, the patterns of non-residential development that would be created by the redistribution of these planning applications would mean that more development is being distributed over a wider geographic area, which is further from the town centre. This would potentially represent less sustainable patterns of development or generate development patterns that may conflict with climate change mitigation policies, as it could encourage more people to drive to these sources of employment.

As set out in Policy CS4 Economic Regeneration in Stockton-on-Tees adopted Core Strategy, the main locations for general employment land are located outside of the study area that the Study team have used for this task. Therefore, if the total size of the site areas included within planning applications in areas at significant risk of flooding had been much greater the development could not have been accommodated within the study area and would have required the use of sites within some of the Borough's other business/technology parks or industrial estates.

9.2 Goole, East Riding

When compared with Stockton-on-Tees the number of major planning applications within significant and moderate flood risk areas was much lower in Goole. As Figure 26 shows the majority of Goole is located within the area of low risk of river and tidal flooding and the majority of planning applications were made in this low risk area.

In total six applications were submitted during the period 2001-2011 within Moderate and Significant river and tidal flood risk areas in Goole. All of these applications were for residential development and a higher number of these applications were in the Moderate flood risk area rather than the Significant flood risk area. The distribution of these applications is shown in **Figure 27**.

Figure 28 shows the total site area of the planning applications within the Moderate and Significant flood risk areas within Goole. This shows that cumulatively 4.5ha of land was included within planning applications that fell within moderate and significant flood risk areas in Goole. This represents a considerably lower figure than that for Stockton.

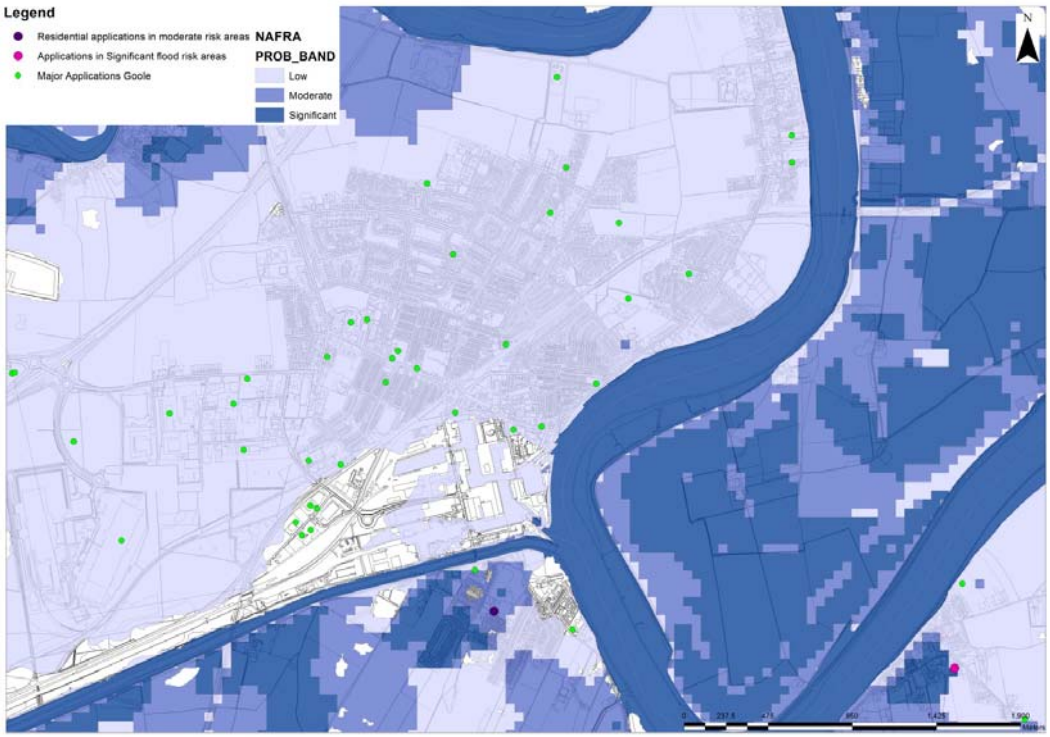


Figure 26: All major approved planning applications in areas at significant risk of river and tidal flooding and all major residential applications at moderate risk of river and tidal flooding in Goole

Note: The major planning applications are shown as points on the map, rather than the shape and size of the site area

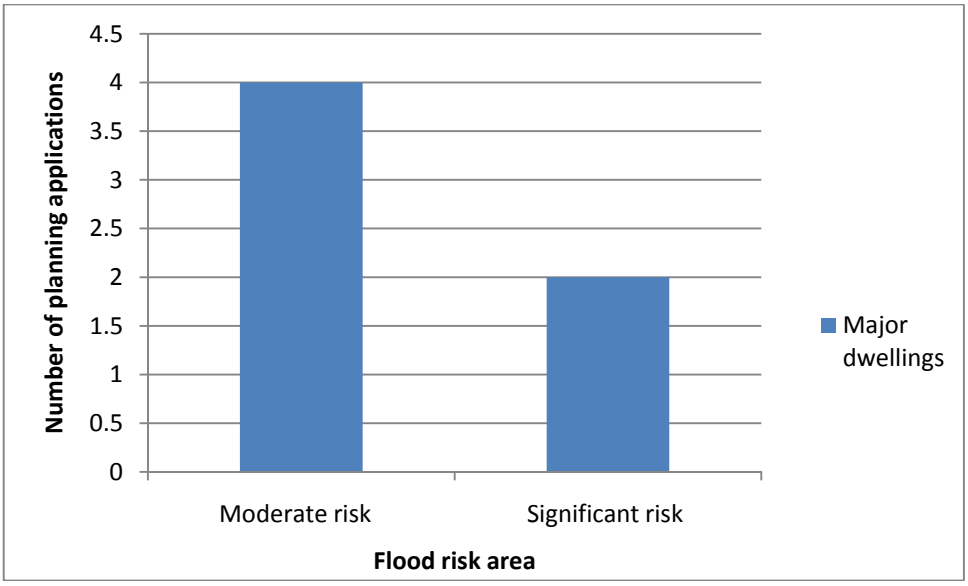


Figure 27: The number of planning applications within the moderate and significant flood risk areas

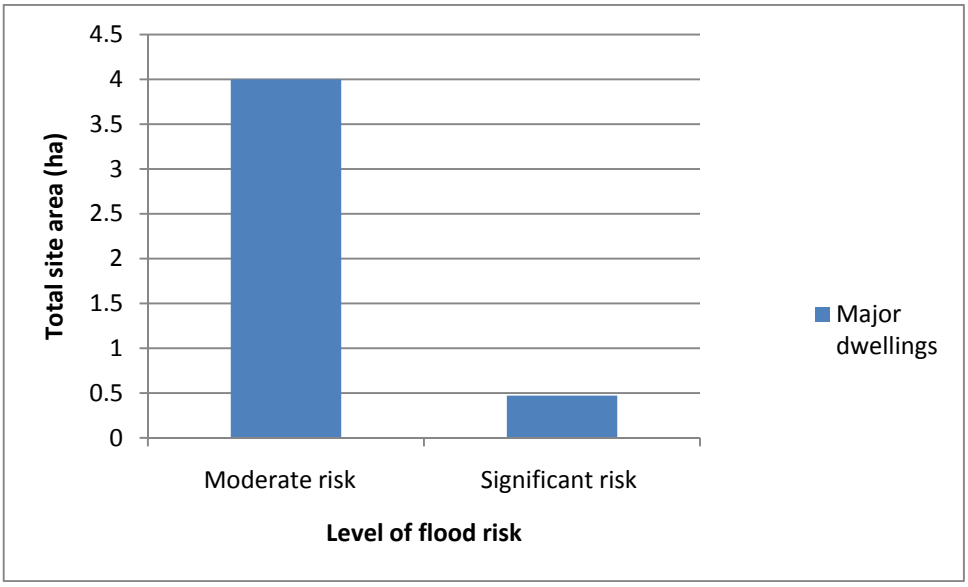


Figure 28: Total site area of applications within moderate and significant flood risk zones, Goole

Figure 29 shows the destination sites for the redistributed the planning applications from the areas of moderate and significant flood risk. In Goole the six applications would be distributed across three sites, with four of the smallest applications being located within the site to the north east of Goole.

In locational terms redistributing the growth in Goole appears to have relatively little effect as development is moved from one edge of centre location to another. Furthermore, the relatively small quantum of development involved mean that overall the effects are also relatively limited.

It is worth noting though the differences observed between the Flood Zones 2 and 3 and moderate and significant zones. The East Riding SHLAA states that all three sites where development is redistributed to, were all partly (or entirely) located within Flood Zone 3. Whilst small elements of these sites were within moderate or significant flood risk zones this was not of a sufficient scale to mean that the proposed developments could not occur. This therefore shows an interesting variation in the data on river and tidal flood risk, ultimately reflecting that NaFRA includes areas protected by defences. Therefore by removing development from moderate and significant NaFRA areas there is potentially a reduced pressure to maintain and improve flood defences, which is usually at public expense.

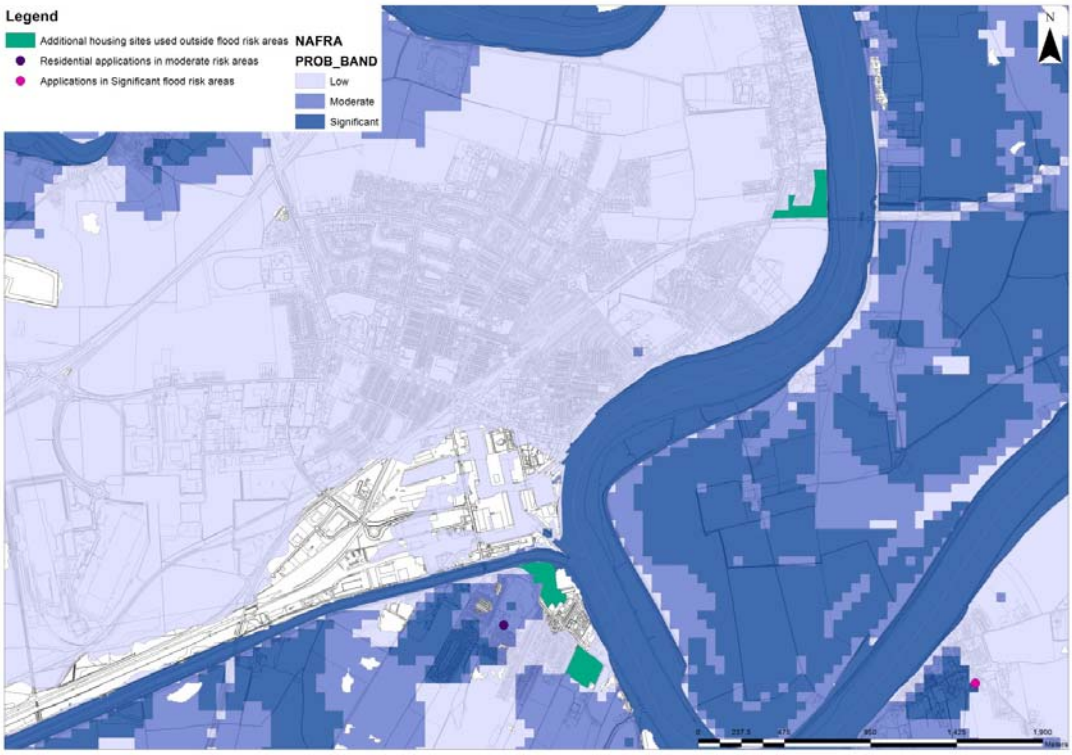


Figure 29: Where residential development in high and moderate flood risk zones could be redistributed to in Goole

Note: The major planning applications are shown as points on the map, rather than the shape and size of the site area. The new area of residential development represents the total site area of these planning applications, rather than the area of development.

9.3 Economic Assessment

This section provides a high level assessment of the economic impacts under the scenarios presented for Stockton-on-Tees and Goole. The purpose is to identify the nature and scale of potential economic impacts that may be generated by adopting the Retreat or Resilience approach to new development in areas of river and tidal flood risk. Where possible, indicative quantitative estimates of impacts are provided for illustrative purposes. However, the primary goal of the analysis is to draw out the wider economic implications of the two different approaches in the context of differing geographical locations – to stimulate thinking on how best to respond to issues arising.

For illustrative purposes, a chain of potential impacts is developed for each of the two approaches, as shown in **Figure 30Error! Reference source not found.** and

Figure 31. These identify the potential impacts of the two approaches to new development on the behaviour of key economic actors and a causal chain of economic impact.

9.3.1 Retreat

The primary implication of the 'retreat' approach is that new property development will be directed to alternative locations. The impact of this in economic terms will depend on the quantity and quality of land supply and the locational needs of the proposed new development. In areas of limited available land allocations, it may be necessary for the local planning authority to make additional allocations to accommodate demand. The existing pattern of spatial development and economic activity in a settlement and demand for floorspace will determine the scale of impacts arising from moving the location of new development. If the proposed movements of activity are of a significant order, in terms of both quantum and economic sector affected then it may be necessary to revise spatial plans for economic development.

In particular, there could be significant adverse consequences for sectors that rely on clustering effects – since the restriction on new development of commercial premises in their vicinity could act as a constraint of growth of the sector in the settlement. The financial services and creative industries are examples of sectors that demonstrate a high propensity to cluster. These are both of relatively high economic value in which local economic policy in the UK often seeks to achieve growth (along with knowledge based activities more broadly). Relocation of new economic activities in a secondary location could lead to a loss of potentially valuable future clustering effects. This would clearly depend on the distance between the established and new locations of activity and degree of connectivity between the two areas.

The nature of the alternative locations to which new development is transferred will be important in determining the impact of development restrictions on the delivery of new property development. Should the alternative locations be considered as significantly less attractive (due to local market demand, additional infrastructure costs and so forth) then the outcome may be a contraction in new development. Alternative locations may be associated with additional financial costs for developers – through potential contributions for new infrastructure in edge of town locations and reduced end values of development, at least in the short term before new locations become more established.

The impact on existing development in areas of river and tidal flood risk of no new development being permitted in the area and instead channelled to alternative locations could also be significant in some locations. It could incentivise movement of existing population and businesses from areas in which no new development is permitted. Alternatively, it could lead to an inflation of property values. Much would depend on the response of property owners to retrofit – here, there is an important distinction to be appreciated between property owners and tenants in terms of the responsibility and willingness-to-pay for flood resistance and resilience measures.

To summarise, the following potential outcomes can be identified with the Retreat approach:

- Contraction in new development
- Requirement for a revised approach to economic development spatially should the number of properties affected be significant

- Cost of disruption to business and temporary loss of economic output, should businesses in existing areas relocate as a result of the block on new development
- Inflation in property values and rents should the at risk location remain a preferred location

Clearly, whilst the focus of this analysis is on costs, adopting the 'retreat' approach would be likely to generate economic benefits in the form of reduced damage and disruption to new development caused by flood events. Evidence collated by the Environment Agency and Association of British Insurers (ABI) illustrate the scale of impact of flood events on business and residents. By forcing the relocation of new development away from areas of flood risk, the potential adverse economic impacts arising from flood events on these new properties are avoided. It is not part of the scope of this study to estimate these benefits.

Examining the two selected case study areas, it is clear that the unique characteristics of the different locations result in very different economic outcomes when the 'retreat' approach is adopted.

The findings from the Stockton-on-Tees and Goole examples lead to a suggested impact chain – i.e. the indicated sequence of effects of the policy approach of preventing future development in flood risk areas and allowing it to take place in other locations. The impact chain for the Retreat approach is shown in **Figure 30** below.

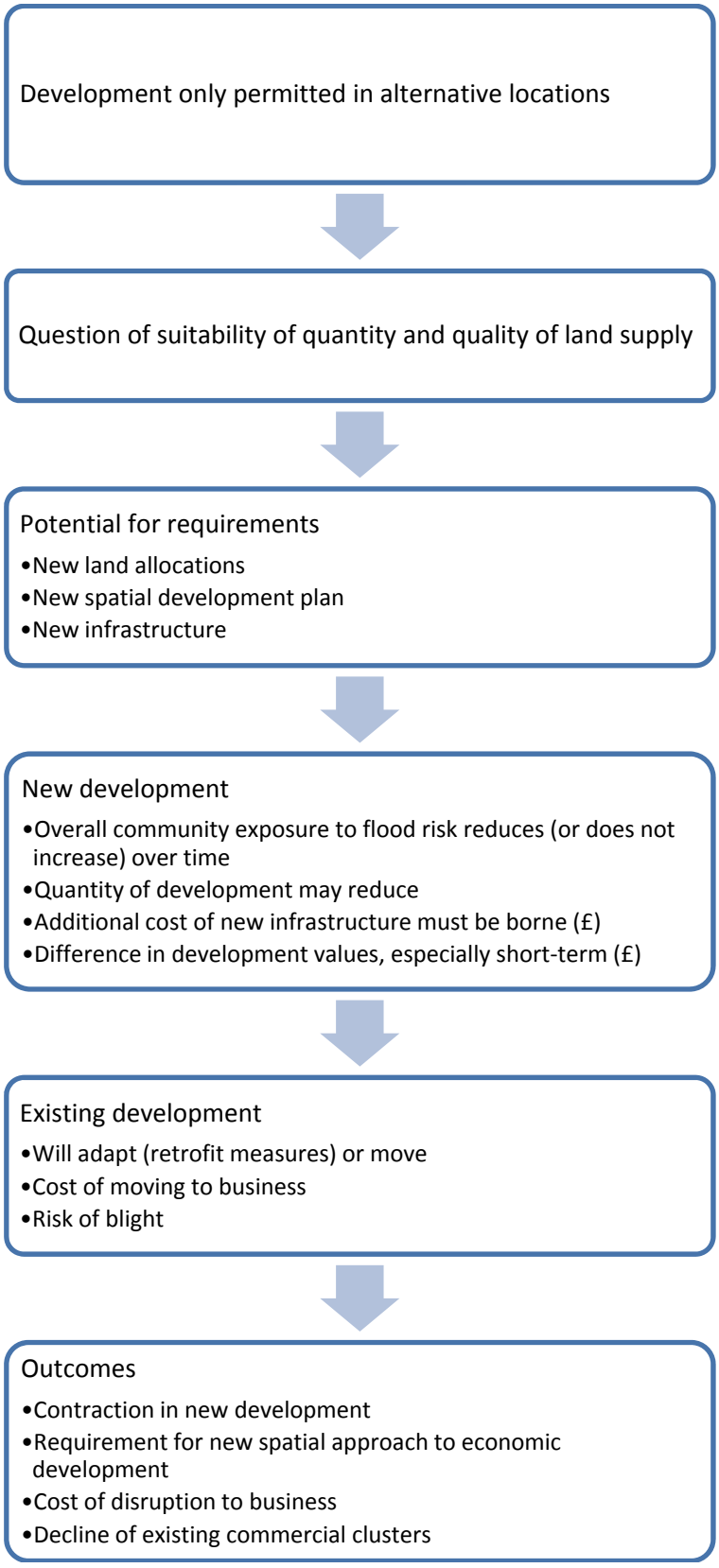


Figure 30: Impact chain for the Retreat approach

9.3.2 Resilience

The Resilience approach – requiring developers to incorporate additional flood impact mitigation measures – will enable developments to remain in the desired locations while ensuring that the impact of a flood event will be reduced. The mitigation measures will, however, result in additional development costs for developers.

If the additional costs of including resilience measures in new development are significant, the cost may impact upon the attractiveness and commercial viability of sites for developers and therefore the quantity of development coming forward. There may be a restriction on the development capacity of the site if the resilience measures require using more of the site for flood storage. Ultimately, the impact on quantity of development being delivered will depend on the degree to which the local property market enables developers to pass on additional costs in their sale or rental prices and therefore their margin of profit. In areas with a buoyant property market supported by a strong demand side, the impact on the quantity of development is likely to be relatively small. In contrast, in areas with a weaker property market where development may already be on the margins of viability the impact on the quantity of development would be expected to be much greater. The strength of the local property market is therefore fundamental in determining the impact on pursuing a resilience approach to new development.

The marginal cost of incorporating flood resistance and resilience measures into new build development is often substantially less than that associated with adding retrofit measures to existing properties. With good design, the marginal cost of measures for new development has the potential to be relatively low. One of the key challenges however, is not making a new property resistant and resilient to flood but doing so in a way that sits comfortably alongside existing properties (having properties at different levels alongside each other is one example). Unique site characteristics, level of flood risk and desired degree of protection are also important determinants of cost, and in some circumstances may result in little difference between the cost of new build and retrofit measures.

The level of impact on the supply of new build development will also have implications for existing properties in an at risk location. In an area of river and tidal flood risk that is characterised by a weak property market, a lack of new development could have a significant impact on existing activity. This may dampen the demand for space by businesses and result in a gradual leakage of businesses and population from an area. A significant knock on effect may be an adverse impact on the competitiveness of settlement, as it becomes less attractive due to higher property costs. This will depend on the nature of its competition with surrounding settlements and extent to which they suffer from abnormal costs arising from factors including flood risk.

In summary, under the Resilience approach the potential economic outcomes are a:

- Different quantity of new development;
- Upward movement in rental values; and
- Competitiveness impact on the settlement as a location for businesses – and potential adverse impact on inward investment.

Examining the two selected case study areas, as with the Retreat approach, it is clear that the unique characteristics of the different locations result in very different economic outcomes.

The findings from the Stockton-on-Tees and Goole examples lead to a suggested impact chain – i.e. the indicated sequence of effects of the policy approach of allowing future development in flood risk areas but requiring additional measures to reduce the impact of flood events when they occur. The impact chain for the Resilience approach is shown in

Figure 31 below.

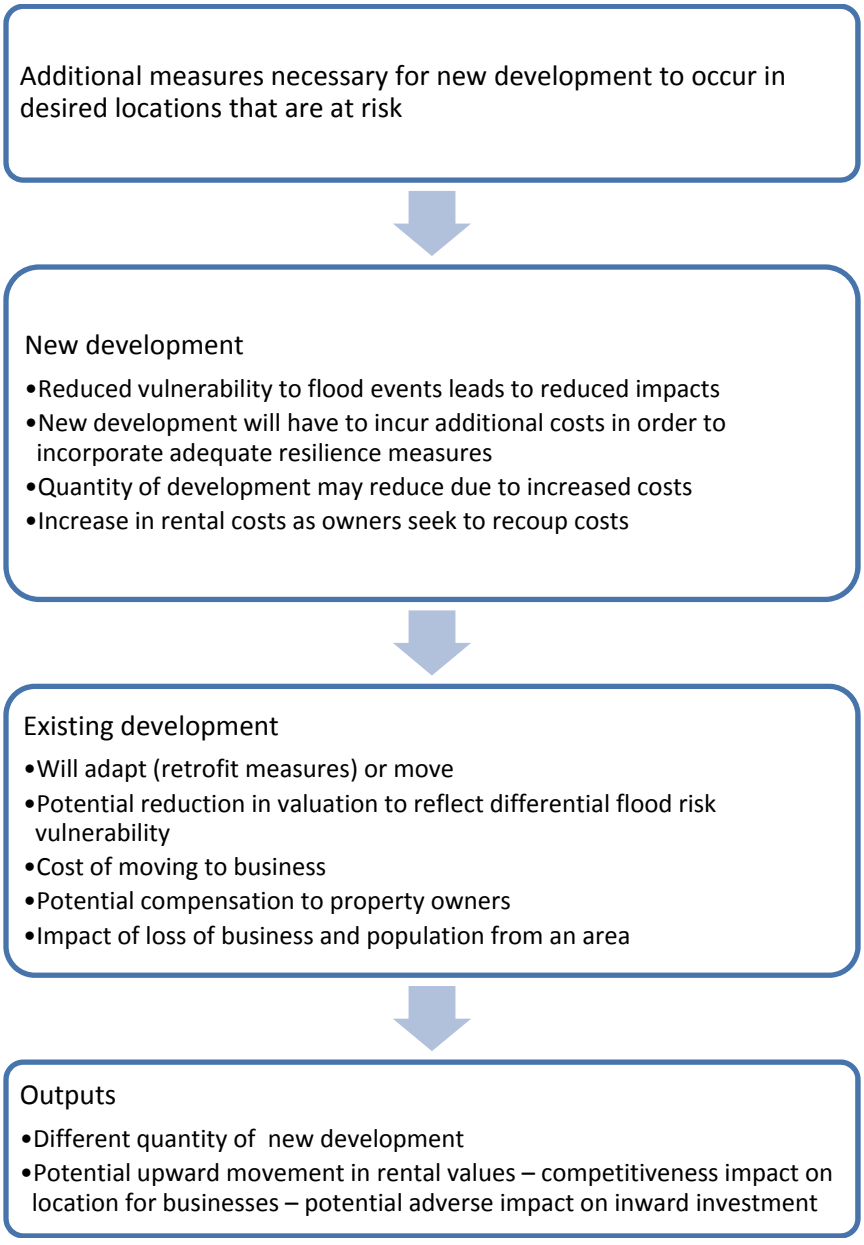


Figure 31: Impact chain for Resilience approach

9.4 Summary of findings

The scenario assessment work on Task 3 shows different patterns in what might have occurred in Goole and Stockton-on-Tees had the stronger flood risk policy been in place. In brief, there are clear differences in the scale of development affected by the policy: the amount of development relocated within Stockton-on-Tees from the moderate and significant zone was significantly greater than in Goole.

Meanwhile, the patterns of development in Goole indicated that it would move from one out-of-centre location to another out-of-centre location in a different part of the town. The residential development redistributed in Stockton-on-Tees has generated a different pattern of development, as the nearest developable site within the study area was an edge-of-town, greenfield site, which is outside the current development limits. This would redistribute development away from central locations to an edge of town location, potentially created additional impacts on open space and ecology of the out-of-centre site and overall energy consumption or carbon emissions from additional transport associated with the more dispersed spatial pattern.

Similarly, redistributing non-residential development in Stockton-on-Tees has shown that it is spread over a broader geographic area, resulting in development being pushed further from the centre of Stockton. Therefore, this may also encourage increased use of the car. Redistributing the non-residential development to other parts of Stockton-on-Tees in this manner would appear to be likely to have significant impacts on the ability of the Council to achieve specific regeneration aspirations for particular sites in the town. This may therefore have a negative impact on the ability of the Borough to realise its aspirations for employment growth and the development of specific sectors. Meanwhile, redistributing the non-residential development to other sites may also reduce the viability of the development proposals themselves. For example, there appears to have been a clustering of planning applications around the University Campus, and as such redistributing this development to other parts of Stockton-on-Tees may not be appropriate for this development.

9.5 Conclusions

The scenario assessment considered two policy approaches to the reduction of vulnerability of new development to river and tidal flood risk, being:

- A Retreat approach of preventing new development in higher flood risk areas; and
- A Resilience approach of allowing development to take place in exposed locations but requiring the incorporation of flood resilience and resistance measures within the development.

As noted in Section 3.6 above, this was a limited exercise which was not able to consider the longer term cost implications for building and/or maintaining flood defences in areas of flood risk (or the savings associated with removal or avoidance of defences). Thus to an extent the analysis is not able to provide a complete picture of all impacts and benefits of all policy options. Nevertheless,

the analysis does reveal a number of issues associated with the policy options which were assessed.

The two policy options were considered in two case study locations – Stockton-on-Tees and Goole, East Riding – where the community faces significant levels of flood risk. The two case studies showed first that different locations will have different patterns of both risk and development, which will have a significant influence on the nature and severity of economic and spatial impacts from the two policy options.

Among the impacts and complexities identified as part of the analysis are the following:

Based on these case studies, the Retreat approach clearly achieves the core policy objective, i.e. avoiding flood risk in new development, while the Resilience approach partially achieves the objective, in that flood risk exposure remains the same but the vulnerability to the flood event is reduced. Both policies bring economic and financial costs along with these benefits, however. The Retreat approach, being more radical in its nature, triggers a complex chain of impacts which affects different actors and parts of the community differently.

The Retreat approach in Stockton-on-Tees highlights the challenge of identifying alternative sites outside the flood risk zones (which coincide with the more valuable city centre area). It was found necessary to identify an area of greenfield land to replace the flood zone land, leading to significant infrastructure costs and the loss of open land with ecological value. Relocations within Goole did not appear as difficult, and relocation sites of apparent similar characteristics were identified.

There was some evidence of clustering of non-residential development in Stockton, particularly around the Durham University campus. Preventing new development would undermine the economic benefit of clustering and may put pressure on existing developments which need to expand or be altered, or else relocate.

Similarly, there appears to be a risk of blighting existing properties or communities located within the at risk area under the Retreat approach. Addressing the legacy of existing development in at risk areas is perhaps the most challenging aspect of the Retreat policy, and the example of Stockton-on-Tees suggests that this could be a very widespread issue.

Other conclusions of this case study exercise are set out below:

- There will be a wide range in impacts on any particular settlement, as a consequence of unique characteristics of each – in relation to spatial pattern, economic base, land supply and property market;
- There are both financial and economic implications of the two approaches (‘retreat’ and ‘resilience’);
- There will be a period of transition and the nature of impacts will change over time;
- There is an important distinction to be made between property owners and tenants in terms of responsibilities and bearing of costs;

- The characteristics of the local property market are a key factor in determining the extent to which additional costs can be passed on and the impact of any additional costs on the quantity of development coming forward;
- The impact on new development can be assessed in much the same way as one would assess the potential for other forms of policy-related impact assessments examining the economic viability of residential and non-residential development. One approach is residual land valuation i.e. by subtracting the costs of delivering a specific development from the revenue generated by the completed scheme;
- There is a balance of financial cost to be considered – the cost of incorporating flood resistance and resilience measures into new build development in at risk areas versus the additional infrastructure costs of moving development out to less established locations. The benefits in terms of reduced damage during flood events and reduced insurance premiums will need to be part of that balance;
- The sectoral composition of a settlement's economic base is important in determining the economic impact of relocating new non-residential development. Where there are established clusters of economic sectors that rely on proximity to other businesses in their sector, the adverse impact of relocating new development could be substantial. Clustering adds economic value and increased productivity through agglomeration effects; and
- At a broader level there is the potential for a redistribution of economic activity between different settlements. This will create economic 'winners' and 'losers' in terms of local output and employment.

The distinct advantage of this retrospective type analysis is that it provides a more precise picture of the type and quantum of development which the market sought to bring forward. This provides more firm numbers – e.g. amount of development, cost of adaptation measures – than might be available in a conventional projection-based study. On the other hand, the results are firmly grounded in the specific circumstances of each local area under scrutiny and are therefore constrained from leading to robust generalisations about the effectiveness of alternative policy options.

It is recommended that this approach be widened to incorporate a more comprehensive assessment of costs and a more extensive sample of localities. We believe that this case study approach could usefully complement the national scale Economics of Climate Resilience study to be carried out by the Government during 2011-2012.

10 Findings and Conclusions

10.1 Overview

This research has sought to understand the effect of the town and country planning system on the vulnerability to different climate risks. The results of this research confirm that the planning system plays a key role in raising awareness of risks and ensuring climate change resilience is designed in to new development as communities grow and change. This role represents an important part of the UK's efforts to effectively prepare for future climate risks.

The main findings from the work undertaken are summarised in this chapter. These findings are structured around the main research questions that were set out in section 1.1. It is also important to remember that this research has been subject to data and methodological constraints, as set out in section 1.3.4.

10.2 Adaptation Outcomes and Actions

10.2.1 How have development decisions affected vulnerability to climate risks?

The statistical analysis of the amount of development that has occurred between 2001 and 2011 within the five localities studied reveals that there has been considerable development in climate risk areas. However, the amount of change experienced varied between different climate risks and across the study area. The main changes in relation to each of the climate risks are set out below:

- **River and tidal flooding:** in eight of the nine authorities sampled for this indicator the total footprint of buildings in flood risk areas increased between 2001 and 2011. Across these eight authorities where an increase was experienced the average increase was 4.3%; across all nine authorities the average percentage change was 2.1%. However, this total percentage change of 2.1% was below that for the average rate for the local authorities as a whole, which was 2.6%, showing that there has been proportionally less change in river and tidal flood risk areas.
- **Pluvial flooding:** in all eleven authorities studied there was an increase in the total footprint of buildings in areas at risk of pluvial flooding. Across all authorities sampled for pluvial flood risk the average change was 3.9%. This figure was above the average change in buildings in the entire local authority areas, which was 2.3%. This shows that relatively there was more change in the risk areas than in the local authority areas as a whole.
- **Coastal erosion:** of the four authorities studied the total footprint of buildings in areas of unprotected coastlines increased in three out of the four authorities. Similarly, in three out four authorities studied there was an increase in building footprint in protected coastal areas.
- **Heat stress:** there was an increase in manmade development (which mainly comprises buildings and paved surfaces) in both Islington and Haringey in high and low heat stress areas, however the amount of development in medium risk areas has decreased.

- **Biodiversity:** with the exception of marshland in one authority, the area of marshland and orchards has decreased in all the four authorities studied between 2001 and 2011.

Cumulatively, these sample studies tell a consistent story of increasing development and decrease natural areas between 2001 and 2011. The implications of this trend are significant both in terms of the increase of assets and people exposed to climate change-related risks, and in terms of the exacerbating effect of new development on these risks.

Our research on the planning applications data in East Riding, Stockton-on-Tees and Islington has shown that major applications alone meant that 1%, 7% and 15% of land within each local authority area respectively was covered by planning applications between 2001 and 2011. This would suggest that a significant proportion of the change experienced in the different risk areas and discussed above will have passed through the planning system. As such it would appear that the planning system and development decisions have increased the potential vulnerability to climate risks. However, as discussed in the following section this development has been accompanied by the uptake of low regret adaptation measures, so that the proposals adapt to these risks.

10.2.2 Is there evidence of development decisions incorporating adaptation measures?

Our analysis of planning applications revealed that there was evidence of development decision incorporating adaptation measures, although the rate of uptake varied across different climate risks.

The greatest proportion of adaptation measures were applied to developments in areas at risk of river and tidal flooding. Of the applications analysed within these areas 96% contained adaptation measures. The next highest climate risk was pluvial flooding, where 55% of applications included adaptation measures, followed by heat stress with 28%. The results provide a clear confirmation that river and tidal flood risk awareness and policy maturity is much higher than for other risks. Applicants are addressing river and tidal flood risk in their applications and planning authorities are imposing planning conditions to ensure mitigation measures are undertaken. This is occurring less consistently for other risk areas.

In general the rate of uptake of adaptation measures also appears to reflect the level of risk experienced at a particular site. For example, the high uptake of adaptation measure for river, tidal and pluvial flooding would reflect that these are significant risks to those sites and therefore taken seriously as something that will have to be addressed to gain planning permission. Similarly, our results indicate that development proposals in areas most at risk of coastal erosion or that were priority habitats were likely to be avoided by developers as a result of local policy restricting development in these areas. In contrast heat and water stress are strategic (catchment scale) issues rather than site specific and this may be why the uptake of adaptation measures to address these issues was lower. Another possible explanation is that the risks are not well enough understood, or that they are perceived (rightly or wrongly) to be lower than flood risks.

The breadth of the challenge posed by climate risks means that there is no single adaptation measure that can be used to address the different risks experienced.

Instead, our analysis of sampled planning applications reflected that a range of measures are required, tailored to the challenges experienced at a particular site. Furthermore, a significant majority of the applications sampled included adaptation measures for more than one climate risk area. By addressing multiple risks, each application will help to create a more integrated and holistic solution to this problem.

An important finding that emerged through the analysis of sampled planning applications was that whilst adaptation measures to climate risks were included within applications the positive impact that this would have on climate change was generally not acknowledged. Consequently, it seems probable that the planning system is doing more to adapt to climate change than may be recognised.

The analysis of the case studies illustrated how pre-application discussions can help to embed low-regret adaptation measures within an application from the start of the process. This can mean that the headline risks facing an application are understood from the outset, providing the potential to develop a solution to any problems prior to the submission of an application.

The nature of the climate risks studied means that other statutory consultees, as well as local authorities, play an important role in the planning system and in determining appropriate adaptation measures. The Environment Agency, internal drainage boards and Natural England, for example, were shown in the case study analysis to play a vital role in understanding the climate risks experienced at a site, how a development can affect this risk, and in identifying any potential measures that could be used to reduce the level of risk. The case study analysis showed that their contribution was important in both the pre-application stage and post-submission.

The case study analysis of specific planning applications also showed the benefits of having local policy in place that set out requirements for the incorporation of adaptation measures. Such a policy was in place in Islington and the importance of this was demonstrated by the case studies. Where such local policy was not in place, the authority had much more limited scope to influence the planning applications to address this issue.

The use of planning obligations has emerged within the research as a potential means of addressing climate risks off-site within a local authority area. This has highlighted how this can lever investment to be used to fund improvements to open space and biodiversity. For example, in Islington there was evidence of financial contributions being used to support the delivery of the borough's Biodiversity Action Plan. The use of planning obligations therefore can help to reduce climate change risks across a local authority area and not just at a site specific scale.

10.3 Decision-making

10.3.1 Are climate risk and adaptation measures being incorporated transparently and robustly alongside non-climate risks in setting local planning policies?

From analysis of policy formulation, it is clear that climate change is increasingly recognised as a key issue in later stages of Core Strategy preparation - possibly as

a consequence of its growing profile and focus within national policy guidance during that time, for example, as exemplified through the enactment of the Climate Change Act in 2008. The identification of areas vulnerable to climate risks tends to focus most commonly on river and tidal flood risk, which has clear spatial implications. Evidence of consideration of climate change as part of evidence base documents such as SHLAAs and ELRs was found to be sometimes limited in the samples surveyed. For example, where flood risk was identified as an issue in site assessments, this generally did not specify if an allowance for climate change has been included. However, the Study team are aware that in some cases the evidence base documents rely upon other assessments to address such risks. For instance, where a SHLAA relies upon a strategic flood risk assessment (SFRA), the climate change factor in flood risk will have been taken into account by the SFRA and need not be explicitly covered by the SHLAA.

The extent to which Core Strategies contain detailed policies on climate change adaptation also depends on the content and organisation of the wider Local Development Framework. For example whether or not there is an SPD on Sustainable Buildings, or a separate DPD on Development Management Policies may influence the level of detail contained in the Core Strategy. In all cases however, the Core Strategy sets the overall vision and objectives for the local authority area, and it is consequently important that it identifies climate change as a key issue and priority, as this will influence the tone of subsequent policies and DPD/ SPDs.

Avoidance and management of flood risk is the most consistently identified climate change adaptation measure across all authority areas. This is perhaps because it is an issue that local planning authorities are familiar with dealing with as part of land use planning, it having pre-dated the climate change agenda. However, consideration of the impact of climate change on the level of flood risk is perhaps an area that could be strengthened. Whilst SFRAs generally tend to include a climate change scenario, other evidence base documents or Core Strategy policies we reviewed considered flood risk only on the basis of existing risk levels. Policy responses to heat stress, water shortages and biodiversity adaptation are less well developed, although this is perhaps reflective of the lack of a specific or well developed evidence base to support these policy areas.

The case study analysis showed though that climate change policy implemented in Islington has led to applicants including adaptation measures within their planning applications. This reflects how local policy can help to encourage the uptake of climate change adaptation measures.

The LDF review points to a tension between climate change adaptation and other policy priorities such as regeneration. In several instances, those areas in greatest need of new development (such as industrial riverside areas) are often those with a higher vulnerability to climate change. Decision makers are consequently faced with the challenge of balancing risks and benefits, with opportunities for regeneration often taking precedence over climate change vulnerability (particularly flood risk).

In general, policy approaches to climate change adaptation could be strengthened; climate change policies tend to be focused more on mitigation measures such as renewable energy and energy efficiency. The extent to which Core Strategies deal with climate change may be influenced by their strategic role – other elements of the LDF will eventually complement the Core Strategy and perhaps add further

detail to policy approaches and climate change interventions. Monitoring generally tends to focus on mitigation measures, and prior to its abolition NI 188 Climate Change Adaptation was not widely incorporated into AMRs.

10.3.2 Are local planning authorities effectively working in partnership on issues that require a strategic and co-ordinated approach to decision-making, such as along the coast or at the catchment scale?

This research question was largely outside of the scope of this commission. It can be noted that authorities are working in conjunction with each other in the Hull and Humber and South Hampshire, for example, on the respective Shoreline Management Plans. Furthermore, the Localism Bill introduces a duty to co-operate for local planning authorities on strategic issues, which could help to ensure effective partnership working in the future when the Bill is enacted.

It is suggested that this be a matter for further research by the ASC.

10.4 Policy barriers

10.4.1 What effect has national planning guidance had in influencing local planning policies and actual development decisions?

The research strongly indicates that where a clear national planning policy framework is in place, the uptake of adaptation measures was much greater. This is demonstrated in relation to river and tidal flood risk, for which PPS25 provides specific policy on where and how flood risk should be considered in relation to planning applications.

The analysis has shown that 96% of approved sampled planning applications within areas of river and tidal flood risk included one or more low regret adaptation measures as part of their planning submission or had a planning condition requiring adaptation measures. This was the highest uptake of adaptation measures of all the climate risks studied. Similarly, 90% of all sampled applications made reference to the fact that climate change will make river and tidal flood risk increase in the future. This can be seen to reflect the approach set out in PPS25 and thus suggests when national policy is in place, planning applications will consider these issues.

The case study analysis also indicated that having a body to enforce this guidance plays an important role in influencing development decisions. Applications analysed within these case studies showed that if, for example, insufficient information was provided, the EA would highlight such a gap and the applicant would be advised to provide additional material prior to the application's determination. This reflects that it is not only important to have national planning policy and guidance on climate risks but that there is a need for a statutory body with the capacity and competency required to support and advise on its implementation.

10.4.2 Are there barriers to adaptation in the current land-use planning system that the policy framework could address more effectively?

As identified in the previous section the presence of national policy and a body to implement this policy has had a positive impact on adaptation to river and tidal flood risk. It would appear that there is a case for similar national policy and an equivalent guardian for issues such as heat and water stress to help facilitate the process of adapting to these risks.

The nature of the policy contained within PPS25 means that developers know if they do not meet certain criteria and follow the specified process they will not be able to gain planning permission. As the EA then advises both local authorities and developers on this policy, then developers are subsequently aware of the need to provide adaptation measures. Without such policy that makes it essential to include adaptation measures it may mean that other areas are not considered as important to include for developers. By developing similar policy for heat and water stress and having a statutory consultee to advise on this policy could lead to higher levels of adaptation measures being taken up.

A barrier with the system currently would appear to be the extent to which it recognises the cross-cutting benefits that can be generated from the implementation of adaptation measures. Without the recognition of these benefits it may mean that developers do not fully understand their potential and worth and thus may limit their uptake within planning applications.

The nature of the planning system means that significant time periods are involved in collecting evidence and then consulting on draft documents before new planning policy can be published. This may mean that for issues such as heat and water stress there will be a period of time delay whilst policy catches up with the available evidence on this topic. For many boroughs the provision of better data on water and heat stress is likely to be key to driving policy development, especially as resources are constrained and commissioning of such studies can have a significant cost. This may drive more cross-borough research studies.

The number of issues that are mediated by the planning system currently means that climate change adaptation is one of the issues that need to be researched. Therefore a barrier to adaptation in the planning system may be the capacity of staff to have the time and resources to spend on this issue. This may also be compounded through being a relatively fast evolving issue, which may therefore create a greater need for ongoing training, which may be less viable in the current fiscal climate.

11 Recommendations for further research

- What proportion of local authorities do have specific policy guidance (as Islington does) on climate change/sustainability? How many require Sustainability Statements to be completed as part of the planning application validation process?
- Research to understand the uptake of adaptation measures for minor planning applications, as this research has been focused on major applications. An important element of this will to understand the role played by the local planning authorities in these applications.
- Further research into heat and water stress and to what extent these are issues considered across the country, as heat stress has emerged as a particular issue for London within this research?
- Research into if there is a need for technical guidance on heat and water stress and coastal change, who should provide it and if a body is needed to promote it in spatial plans and through development management?
- That there should be research undertaken into the potential utility of introducing heat and water risk assessments documents as documents to be submitted, in a manner similar to flood risk assessments, with a planning application. This may provide a means of increasing the uptake of adaptation measures for these risks.
- Is the economic climate and changes to council structure and staffing levels affecting the uptake of low-regret adaptation measures in planning applications and decisions? Additional research could be undertaken to determine if the recession is meaning that developers are including fewer adaptation measures and decision-makers requiring fewer conditions. Similarly this could seek to understand if the measures included have become increasingly focused on low cost options.
- To what extent has regional policy been used to include conditions in relation to climate change adaptation? How will the abolition of RSSs impact on the ability of local authorities to ensure that applicants include appropriate adaptation measures? Will it have any effect on strategic co-ordination between LPAs, for example at the catchment scale or along a shared coastline or will the Localism Bill's duty to cooperate overcome this issue?
- To what extent will the Governments removal of targets in regards to a brownfield first approach and minimum density levels mean that local authorities are able to locate more development outside of the floodplain?
- Research into the long term economic costs of building development in flood risk areas.
- Additional research into the potential to apply or amend the Community Infrastructure Levy (CIL) to fund non-infrastructure climate change adaptation measures.
- How will the emerging SUDS approval process influence how pluvial flooding is managed by local authorities? The decision taken on the sustainable drainage application is independent of planning consent, although some coordination is expected to occur (as is the case today with planning and

environmental permitting). In addition the approval may be subject to conditions or obligations to ensure the scheme is implemented.

- In future years a piece of research may be informative on to what extent and how UKCP09 data has been used by planners to inform the planning policy and development decisions.