



Spatial planning for climate change adaptation: identifying cross cutting barriers and solutions

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Citation for published version (APA):

Carter, J. G., & Sherriff, G. (2011). *Spatial planning for climate change adaptation: identifying cross cutting barriers and solutions*. University of Manchester, Centre of Urban and Regional Ecology.

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Spatial Planning for Climate Change Adaptation

Identifying Crosscutting Barriers and Solutions

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University of Manchester

2011



This document should be referenced as:

Carter, J. G. and Sherriff, G. (2011) Spatial planning for climate change adaptation: identifying cross cutting barriers and solutions, Centre for Urban and Regional Ecology, University of Manchester.

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1 Introduction

There is widespread acknowledgement that climate change is with us and is set to intensify (IPCC 2007, Richardson et al 2011). Reducing greenhouse gas emissions is deemed a necessity, but there is a growing awareness of the need to adapt to the associated impacts (EEA 2008, Stern 2007). Emitted greenhouse gases such as CO₂ persist in the atmosphere for centuries before being re-absorbed back into ocean and land based carbon sinks (Pittock 2009). Even in the unlikely event that emissions ceased tomorrow, the chemistry underlying the phenomenon is inert, meaning that centuries of climate change would remain (Solomon et al 2009). What is more likely is that rapid carbon intensive development paths being followed by developing countries, particularly China and India (Anderson and Bows 2011), coupled with a general lack of political action to reduce greenhouse gases (Hamilton 2010, Hulme 2009), heightens the challenges associated with reducing emissions levels over the short to medium term. Consequently, scientists are increasingly speculating that future climate change has the potential to be rapid and severe (Betts et al 2011). Whatever future scenario we find ourselves in, adapting to the changing climate is set to become an important policy agenda. Spatial planning has a key role to play in responding to this challenge.

1.1 Spatial planning

Many sectors are important elements in responding to the challenges and potential opportunities afforded by a changing climate. Due to its role in regulating the development and use of land, spatial planning is particularly significant (Blanco and Alberti 2009, Davoudi et al 2010a). Amongst other things, it provides a forum for stakeholder engagement, a nexus for planning much of key infrastructure and the space to develop long term strategies. Each of these is important to the development of effective adaptation responses. This working paper focuses on exploring and building the knowledge base supporting the role of spatial planning in climate change adaptation.

1.2 Adaptive capacity

Adaptive capacity concerns the ability of an actor, be that a nation, an organisation or individual, to mobilise effective responses to climate change impacts (Levina and Tirpak 2006). Where adaptive capacity is high, the implementation of responses in practice, from strategy development through to those 'on the ground', is more achievable. Adaptive capacity is influenced by a

combination of issues including societal characteristics (e.g. political will to respond to climate change impacts), geographic location (e.g. proximity to the coast and access to groundwater supplies), and institutional factors (e.g. the existence of relevant governance frameworks) (Brooks et al 2005, Haddad 2005). Knowledge, awareness and guidance on different adaptation responses is also important. Although certain dimensions of adaptive capacity are static, such as geographic location, many evolve over time. Capacity can be boosted by strengthening the knowledge base around adaptation responses. This research acknowledges the centrality of spatial planning to holistic adaptation responses and directly addresses the EU Adaptation White Paper's (CEC 2009) identification of the presently weak and fragmented knowledge base around adaptation action amongst policy makers in Europe.

1.3 The Delphi survey

A two-stage Delphi survey was carried out with the aim of gaining a broader understanding of the relationship between spatial planning and climate change adaptation. The Delphi technique involves a wide range of stakeholders in a survey, usually to build knowledge of a contemporary issue or to support the forecasting of future conditions and developments. By seeking the input of academics, planners, policy makers and others working across the fields of spatial planning and climate change adaptation, our Delphi survey aimed to:

- Explore the current role of spatial planning in adaptation.
- Identify the barriers inhibiting spatial planning in bringing about effective adaptation.
- Distil a set of guiding principles for policy, practice and research.

This working paper begins with an overview of the significance of spatial planning as an adaptation response. The Delphi technique is then explained, outlining the reasons for using it and describing how the study was carried out. The Delphi results are then presented and analysed, before drawing conclusions and recommendations.

2 Climate change adaptation: the role of spatial planning

Traditionally, reactive emergency response functions offered by the 'blue light' services have been at the forefront of responses to extreme weather events such as floods and heat waves. This can help urban areas, and their residents and businesses, to deal with the aftermath of such events, but does little to instigate actions that target their root causes. Spatial planning offers one of the most widely acknowledged routes into the development of proactive long-term adaptation responses. Over recent years there has been greater activity around the role of spatial planning in the flood risk management sector. However, there is now an emerging recognition of the role of spatial planning in climate change adaptation from a broader perspective, across a range of different countries and sectors (Blanco et al 2011, Davoudi et al 2010a, Richardson et al 2011). Indeed, Blanco et al (2011: 227) note that: 'The adaptive capacity of cities fundamentally depends on urban land management systems.' Consequently, Richardson et al (2011: 401) stress that: '...mainstreaming climate change adaptation considerations into current urban development has to be a central strategy for dealing with climate change.'

Within this report, we follow the definition of spatial planning provided by Davoudi et al (2010: 14) as '...the processes through which options for the development of places are envisioned, assessed, negotiated, agreed and expressed in policy, regulatory and investment terms.' In effect, the planning system is a forum for developing plans and regulations to guide urban development, usually via a consultative and consensus seeking process.

There are a number of reasons why spatial planning is seen as having significant potential as an adaptation response. These include:

- the cross-boundary nature of spatial planning;
- long-term nature of spatial plans;
- influence over building design;
- influence over urban form;
- a forum for engagement.

Each of these issues is briefly discussed below.

2.1 The cross-boundary nature of spatial planning

Actions and events in a city's hinterland have a significant effect on the nature and extent of climate change impacts within its more densely developed and populated urban districts. For example, flood risk within Manchester is related in part to rainfall events in upland areas, prompting the need to develop strategic cross-boundary flood risk management responses. Further, green corridors running into the city, such as those flanking rivers, can contribute to the cooling of air temperatures in the urban core, as they do in Stuttgart (Kazmierczak and Carter 2010). Progressing city-wide adaptation responses requires strategic spatial planning to influence the development and use of land, for example, by protecting absorptive surfaces and existing green spaces.

2.2 Long-term nature of spatial plans

Long-term planning is essential for the growth and development of cities, especially for infrastructure due to its long life span of 75 years or more (Richardson et al 2011). Given the importance of transport, energy, communications and water for urban areas, their long term sustainability is crucial. Spatial planning, through its influence on the number and location of developments, influences the demand for infrastructure services. If climate change risks are factored into these decisions, spatial planning can positively influence the adaptive capacity of an urban area, such as linking future water demand and supply projections. Through zoning, spatial plans can ensure that infrastructure is not located in areas exposed to climate change hazards, and where this is not possible demand design features, such as raising roads in areas prone to flooding. Aside from providing a platform for infrastructure developments, spatial plans that extend 15-20 years into the future enable a comprehensive view of the design and operation of cities.

2.3 Influence over building design

As the annual rate of replacement of building stock in a country such as the UK is around 3% per annum, many of the buildings standing today will still be operational in 2050. The climate is projected to change significantly by then, which will impact on the performance and functionality of the building stock in urban areas. Adaptation of existing buildings will involve retrofitting to change buildings internally and externally. Changes to the land in the streets and neighbourhoods surrounding the building, for example, through tree planting and incorporating permeable paving will also be required. Nevertheless, through

building regulations and codes, the planning system can require certain features to be included within new developments. In the context of adaptation to climate change this may include design interventions such as requiring fitting green roofs and shading canopies, or regulations that specify heating and cooling standards.

2.4 Influence over urban form

Although spatial planning frameworks do not necessarily impact on existing buildings themselves, planners exert an influence over urban form. The local nature of many climate change impacts will mostly necessitate local adaptation responses. Spatial planning exerts its primary influence on the development and use of land at the city scale and below. In relation to adaptation responses, spatial planning's main role is to zone urban areas, permitting or discouraging certain land uses. Zoning can protect existing green spaces that provide cooling and storm water absorption functions (Gill et al 2007); discourage further densification in areas already prone to heat stress; or prohibit the building of new critical infrastructure in floodplains. Spatial planning can build a city's adaptive capacity by protecting land with significant adaptation functions and reducing the exposure of developments (and their inhabitants) to climate change hazards.

2.5 Cross-sectoral nature of planning

Extreme weather and /climate, with flood risk, heat stress and sea level rise (depending on location) are the key climate challenges facing urban areas. The causes and impacts of these events cross sectors and spatial scales. Aside from spatial planning's remit at different spatial scales, from the building to the conurbation, it is clear that the planning system also has a cross-sectoral remit. Spatial plans cover these traditionally land use, housing, transportation, public facilities and services, natural resources or environmental protection, open space and recreation, with some cities also including economic development and urban design (Blanco et al 2011: 230). The capacity of planning to integrate and coordinate different sectors gives it an important position in addressing the multi-dimensional issues that climate change adaptation raises. For example, to design and implement flood risk management responses, issues such as building design, surface cover and green space provision should be considered. The contribution that the planning system can make across these issues and more highlights its importance in developing adaptation responses

2.6 A forum for engagement

Spatial planning systems offer a number of opportunities for stakeholders to input to planning decisions, from the development of plans through to decisions on individual developments. Consultation and participation opportunities depend on the country being considered and the nature of the planning issue being addressed (some developments relating to 'critical national infrastructure' are sometimes exempt from planning controls). By providing a forum for engagement, the planning system builds adaptive capacity in areas where adaptation to current or projected future climate risk is needed. Involving individuals and organisations in decision-making increases the likelihood of plans and actions being applied effectively in practice. By creating a valuable negotiation space, the planning system can help to prioritise risk and the strategies to respond. A collaborative approach can encourage innovative approaches to governing urban areas in the context of achieving any adaptation goals.

With issues relating to the potential role of spatial planning in climate change adaptation introduced, the discussion now turns to the research method used to consider this in more detail; the Delphi technique. The Delphi technique is used as a method to explore and understand more about the role of spatial planning in adapting to the changing climate.

3 Research Approach

3.1 The Delphi technique

Although research methods are not of interest to all readers, we include this section to be transparent in our approach. Equally, we think that the method will prove a valuable and practical tool for decision-makers to address global, urgent and complex challenges. The iterative, web-based survey that we discuss below offers a cost-effective way to involve people from a range of places and institutional settings; combines a relatively 'open' mode of questioning with a 'closed' ranking and prioritisation stage; and offers anonymity in a setting in which participants may wish to be critical of current practices or comment on the particular organisations - including their own.

Developed in the 1950s, the Delphi technique has been widely used across research fields and is accepted as a method for achieving a convergence of opinion concerning real-world knowledge and for forecasting future developments (Hsu and Sandford 2007; Hung et al. 2008). Some pertinent examples include bringing together expert views on Finnish environmental policy (Wilenius and Tirkkonen 1997); summarising expert opinions on impacts on tourism (Hamilton et al 2005); evaluating options for climate change adaptation in Ontario (Lemieux and Scott 2011); understanding green space in the European built environment (James et al 2009); and surveying expert opinion on climate change (de Franca Doria et al 2009).

The technique has several distinguishing characteristics. It is an iterative process, consisting of two or more rounds. Analysis and feedback occurs at the end of each round, with the outcomes of the analysis informing subsequent round(s). There is also a level of anonymity amongst the participants, which facilitates creative thinking outside of institutional norms. This reduces the risk of a participant's views being criticised or taken to represent a particular organisation. This Delphi approach gives everyone a voice in the process. These features are not unique amongst research methods, but together they characterise the Delphi technique.

Whilst a classical Delphi is intended to be a 'forum for facts' in which unbiased experts form a consensus, a policy Delphi is a 'forum of ideas' and does not necessarily seek consensus (Crisp et al 1997). It may be used as a tool for analysis rather than decision making, aiding the development of potential solutions and helping researchers identify the roots of consensus, or

disagreement (Miller 2001). The policy Delphi approach was particularly attractive for this research for several reasons:

- The geographical spread of the people involved, together with the pressures on their time, made a physical workshop extremely difficult. Internet survey technology enabled the inclusion of a greater range of people than a more traditional workshop format.
- We wanted people to be able to express themselves freely and, if appropriate, criticise the organisations and structures within which they work. The anonymity of an internet survey offers this freedom.
- A workshop conducted in English can marginalise non-native English speakers. Although our study was limited to written English, participants were able to take their time reading the questionnaire, look up words and collaborate with colleagues.
- The iterative approach is well-suited to an enquiry looking at an emerging field, climate change adaptation. Initially, we could be open to new ideas. In the second stage, we could synthesise participants' ideas and asked them to rate these. This approach presents a distinct advantage over a straight forward single-stage survey.
- The Delphi approach proved to be a cost-effective – and low-carbon – way to survey opinion from a range of relevant individuals from across the world.

3.2 The study

Our Delphi study was carried out between May and August 2011. It consisted of two stages, both using internet questionnaire software. Box 1 provides a timeline.

Sample selection

A number of approaches were combined in order to achieve a varied participant base to involve in the Delphi. The aim was to identify people who were in some way working at the 'cross over' of climate change adaptation and spatial planning – i.e. having a working interest and involvement in both areas of activity – since these were the people who would best be able to comment on the relationship between the two agendas.

The sample included planners, policymakers, private sector consultants, academics and the non-governmental sector. A literature study of academic and 'grey' literature (e.g. consultancy reports, reports by organisations in the non-governmental sector) was conducted, which enabled identification of researchers and practitioners active in this field. A search of relevant research projects identified further key people.

Box 1 - Research Timeline	
May	Literature and Internet searches to establish participant-base; development of questions
June	(22 nd) opening of stage 1
July	(4 th) deadline for stage 1 responses interim analysis of stage 1 responses and development of stage 2 questions (19 th) opening of stage 2
August	(27 th) deadline for responses to stage 2 analysis and report writing

The research team had been working in the climate change field for around five years, and were able to draw on contacts made, not only in GRaBS and EcoCities, but also other projects. There was also an element of 'snowballing' in sample selection: each paper, project or contact linked us to further possibilities.

Through this process, 97 invitees were selected, and invitation emails were sent out. Of these, 15 declined, generally due to time pressures. The cohort of 72 people who responded to the survey, either in one or both of the Delphi stages, comprised 50 males and 22 females. The sample contained employees of

Government and agencies including planners and policy makers (28 – 39%), academics (27 – 38%), consultants (11 – 15%) and representatives of the non-governmental sector (5 – 7%). The respondents were from organisations based in Australia, Austria, Belgium, Canada, Finland, Germany, Italy, Lebanon, Netherlands, Norway, Sicily, Spain, Sweden, Switzerland, UK, and the USA, with others working in EU or international level organisations.

We asked our respondents to indicate the types of activity they do in relation to climate change adaptation planning and at what spatial scales they work. As shown in Figures 1– 4, the majority, nearly two-thirds, of the respondents had some involvement with research on related policy areas, and just over half were involved with developing policy on climate change adaptation. Fewer, 25% of the respondents, were involved in research on the science of climate change. Those working in related areas of policy, just under half, were well-represented. Around one third reported that they were involved in implementing adaptation.

Figure 1: Areas of professional activity

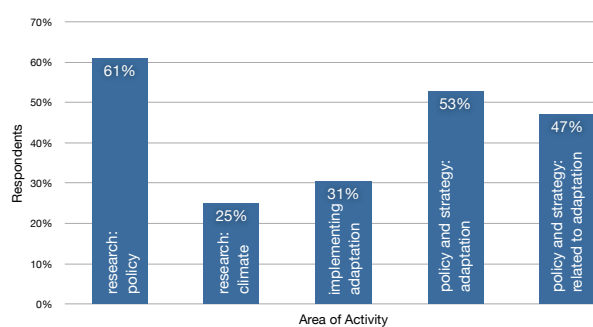


Figure 2: Spatial scales of activity

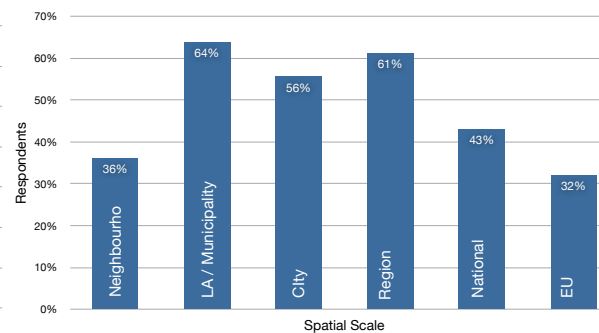


Figure 3: Percentage of working time spent on adaptation related activity

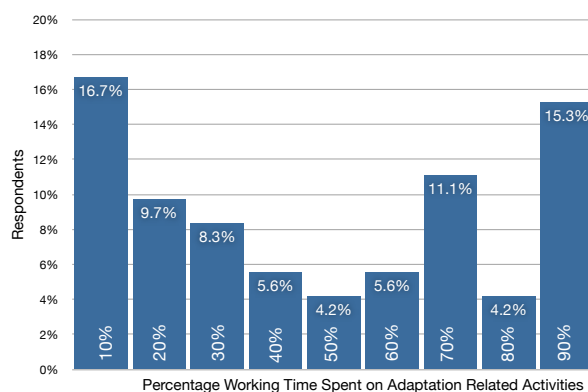
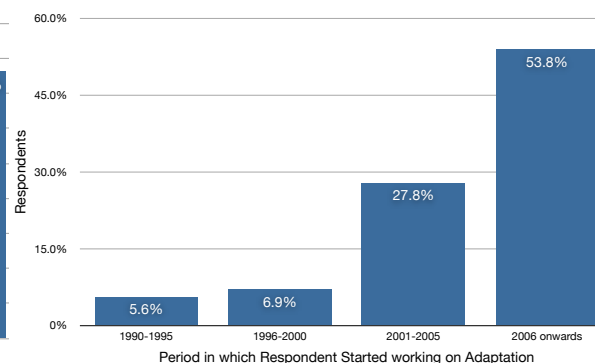


Figure 4: Year in which participants began working on adaptation



Respondents worked at a range of spatial scales, from neighbourhood to EU, with municipality and regions being most common. We also asked them what percentage of their time is taken up with activities related to climate change adaptation. Although some of the respondents reported to have been working on climate adaptation since the early 1990s, most had become involved since 2005.

3.2.1 Encouraging participation

Maximising participation was achieved through clearly stating Delphi's timescales and duration in the invitation letters to allow people to set some time aside from their other commitments. It was also important to set out the goals and subject matter of the research, highlighting the relevance to the invitees work. Finally, the invitation letters specifically referenced the reason that participants had been selected: for example, mentioning a project they had been involved with, or referring to their field of work.

3.2.2 Delphi stage 1

Questions in the first stage of the Delphi approach are commonly left relatively open. This reduces potential researcher bias and captures a wider scope of ideas from the participants. Stage 1 was structured around three key questions, designed to encourage a broad range of responses:

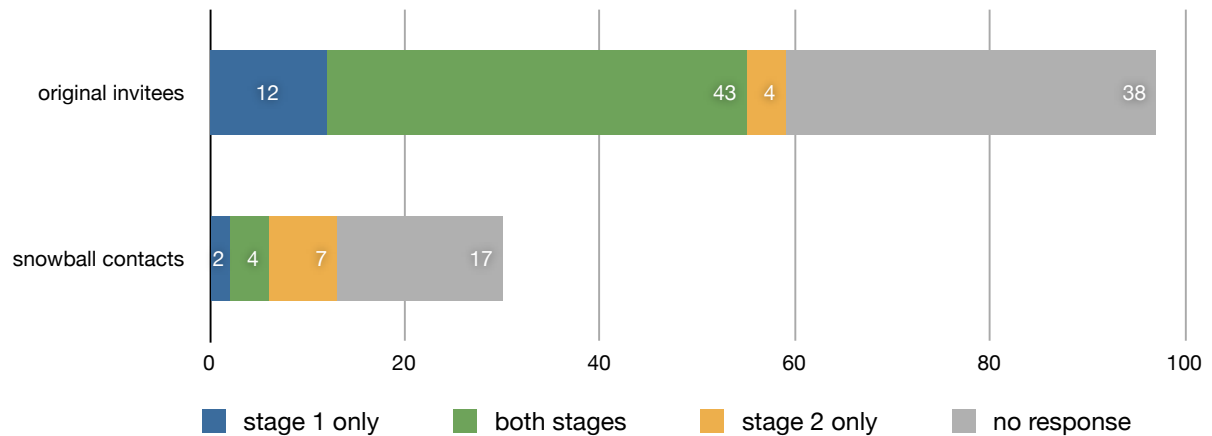
- 1) Within the field of spatial planning, please cite up to three existing initiatives (e.g. principles, policies, strategies, tools and actions) that you think play a valuable role in supporting climate change adaptation.*
- 2) What do you believe are the three most significant factors that are currently reducing the effectiveness of spatial planning in contributing to climate change adaptation? For each example, please state why you consider it to be significant.*
- 3) Please cite up to three changes or new initiatives (e.g. principles, policies, practical approaches) that you think would help to strengthen the contribution of spatial planning in supporting adaptation to the impacts of climate change. For each example, please describe the contribution it would make.*

These questions corresponded directly to the aims of the study in the context of adaptation and spatial planning: to recognise successful initiatives; to identify barriers to progress; and to highlight potential ways forward. Stage 1 also asked for suggestions for further contacts to which the questionnaire could be sent. As shown in table 1 and figure 5, this elicited 30 additional contacts. Six of these responded to stage 1 and 11 responded to stage 2.

Table 1: Delphi survey response rate

		responses				
		stage 1 only	both stages	stage 2 only	total	%
original sample	97	12	43	4	59	61
snowball contacts	30	2	4	7	13	43
Totals	127	14	47	11	72	57

Figure 5: Number of participants of the Delphi survey, by stage



3.2.3 Interim analysis of stage 1 results

Integral to the Delphi approach is a second stage that builds on an interim analysis of the first stage. The rich contribution of our stage 1 respondents allowed us to identify a wealth of current initiatives, barriers to progress, and potential ways forward regarding the role of spatial planning within climate change adaptation. Having promised our respondents that each stage would require only a small amount of their time to complete, and wanting to make the research as progressive and policy relevant as possible, we decided that the most effective use of stage 2 would be to look in more detail at potential ways forward. The findings on current planning initiatives that contribute positively to adaptation goals, and details on barriers to progress were analysed, and the findings are discussed in the results section below.

Our interim analysis of strengthening the role of spatial planning grouped all of the contributions into themes. This process resulted in the development of seven broad headline actions, under which other related actions could be grouped. The full set of headline and related sub-actions is presented in Table 3.

3.2.4 Delphi Stage 2

Our aim in stage 2 was to consolidate and verify our interim analysis of the responses to stage 1, rather than generate substantial amounts of new information. The first question assessed the sufficiency and acceptance of our headline actions list. Using a 9-point Likert scale (a widely used approach for scaling responses in surveys), we asked the extent to which the respondent agreed that the actions on our list were essential in enhancing spatial planning's contribution to climate change adaptation. To find out if our list was sufficient, we invited respondents to recommend other additional actions at this 'meta' level that did not fit into the broad categories described by the headline actions.

The second question aimed to get a sense of our respondents' priorities. Each person was asked to prioritise two headline actions. Here, two supplementary questions focused on the headline actions, and the sub-actions under them, that they had prioritised. This enabled detailed questioning without making the process too time consuming and, therefore, risking a low and poor quality response rate. Firstly, using the same 9-point Likert scale, respondents were asked to what extent they agreed that the sub-actions sitting under each of their two identified headline actions were essential in supporting spatial planning to bring about effective adaptation to climate change. This question was designed to gain a more detailed insight into the perceived importance of the sub-actions.

It was also valuable to get a sense of the timescales for progressing these sub-actions, and respondents were therefore asked whether they thought these were short-term priorities or long-term goals. For each headline action respondents were asked to suggest any additional sub-actions, and to apply the Likert scale and the short-term priority/long-term goal to these new suggestions. As in the case of the first question, this enabled us to test the completeness of the list of sub-actions that had been grouped under each headline action.

4 Results

4.1 The current contribution of spatial planning to climate change adaptation

A key aim was to understand more about the current contribution that spatial planning is making to the delivery of climate change adaptation goals and to identify initiatives that support this contribution. To explore this, we asked:

Within the field of spatial planning, please cite up to three existing initiatives (e.g. principles, policies, strategies, tools and actions) that you think play a valuable role in supporting climate change adaptation.

Table 2 groups the responses to this question. Eight overarching themes were identified, some of which included sub-themes. The right hand column of Table 1 contains the number of responses that fit under each theme or sub-theme. A more detailed version of this table, containing the names of the individual documents and policies put forward by the respondents, is available in appendix 1.

Table 2 (and appendix 1) contains examples of initiatives that support spatial planning in delivering adaptation responses, and also specific planning responses. There are many supporting initiatives that help planning to deliver on adaptation goals. Policy and strategy examples sit alongside guidance documents, data sources and research programmes. Additionally, existing planning methods and techniques are available to planners in developing adaptation strategies and responses. Table 2 (and appendix 1) highlights examples of where legislation, guidance, data and methods has led to the creation of adaptation policies and strategies at regional, city and district scales in different countries. In addition, examples of thematic adaptation planning actions developed to respond to different climate change impacts, and specific examples of adaptation actions and networks, were also cited by the Delphi respondents. It is therefore clear that, in certain locations, planning is delivering on its potential as a significant element of the adaptation response. The existence of frameworks of legislation and guidance, bolstered by relevant data and methods provides further indication that organisations are actively aiming to facilitate this response.

Table 2: Initiatives supporting and evidencing the current contribution of spatial planning to climate change adaptation.

1. City-scale adaptation progress	2
2. Planning methods and techniques	30
a. Assessment and data gathering methods	8
b. Participation and communication approaches	10
c. Adaptation plan and policy integration approaches	10
d. Building codes and regulations	2
3. Adaptation research programmes and outputs	9
4. Thematic adaptation planning responses	19
a. Flooding	5
b. Green infrastructure	4
c. Water resources	3
d. Food and farming	2
e. Other	5
5. Specific examples of policies and strategies	18
a. City and district scale	11
b. Regional scale	7
6. Specific examples of adaptation action and networks	7
7. Guidance and data sources on adaptation	29
a. Guidance documents and tools	21
b. Data sources	8
8. Policy and strategy at different spatial scales	20
a. Supranational policy and action	3
b. EU Level policy and action	4
c. National level policy and strategy	13

4.2 Barriers to planning for a changing climate

Another key goal of our research was to identify factors that currently reduce spatial planning's effectiveness in contributing to climate change adaptation. Despite the significant potential of spatial planning to support the delivery of adaptation responses (section 2) and the evident steps that are being taken to this end in some locations (section 4.1), progress is not widespread. Barriers exist, which may explain why few cities have detailed adaptation plans and strategies (Blanco et al 2011, Carter 2011). Indeed, Blanco et al (2011: 238) describe adaptation planning as a 'novelty'. Identifying barriers is an important element of improving practice. If we know more about why planners are not taking action, we are one step closer to devising strategies that support spatial planning in realising its adaptation potential. The following question was posed within stage 1 of the Delphi survey to explore this issue further:

What do you believe are the three most significant factors that are currently reducing the effectiveness of spatial planning in contributing to climate change adaptation?

We organised the answers to this question in nine broad categories (Table 3 – this also details the number of responses gathered that fitting under each category). Each barrier includes a number of associated sub-themes (Table 4).

Table 3: Groups of barriers that currently reduce the effectiveness of spatial planning in contributing to climate change adaptation.

	Barrier	Freq.
1	Legislation, regulation and guidance influencing planning and adaptation	29
2	Knowledge and awareness of climate change impacts and adaptation responses	28
3	The nature of the planning system and the planning profession	27
4	Information and tools to assess climate change impacts and adaptation responses	19
5	Availability of resources within planning authorities (time, money, human)	16
6	Planning methods and approaches	11
7	Market pressures and economic issues	8
8	Political commitment and will to address climate change	7
9	Governance of urban areas and adaptation responses	7

Table 4: Barriers currently reducing the effectiveness of spatial planning in contributing to climate change adaptation

The nature of the planning system and the planning profession	Frequency
Short term concerns and established ways of working and thinking dominate planning and policy making. This inertia reduces the scope of planning to address long-term climate change adaptation issues.	10
Spatial planning authorities suffer from organisational weaknesses, including a lack of integration and communication between departments, which limits integrated and proactive working and decision making across sectors and scales.	8
Adaptation goals can conflict with other competing planning issues and agendas such as economic development, which are often given higher priority by planners.	7
Planning education does not link sufficiently to relevant adaptation issues including environmental science and wider political processes.	2
Planning methods and approaches	
There are weaknesses in current planning instruments and approaches that limit adaptation planning. These include lack of influence over current building stock, limited focus on individual properties and emphasis on development control over policy development.	7
An emphasis on procedure brings bureaucracy into the planning process, which can limit and slow down proactive adaptation.	3
In developing countries, plans are inadequate and poorly implemented.	1
Knowledge and awareness of climate change impacts and adaptation responses	
Adaptation knowledge, awareness and expertise within the planning profession is lacking, and is not sufficient to respond to the complexity of the adaptation agenda.	10
There is a lack of awareness of climate change adaptation issues amongst different groups. In particular, the urgency regarding climate change impacts and the need to develop adaptation responses is generally not acknowledged.	9
There is a lack of targeted information, for example on the benefits and cost effectiveness of adaptation options, to convince stakeholders of the need for adaptation.	3
Politicians are not sufficiently aware of the nature of the adaptation agenda.	3
There is an overemphasis on the uncertainty of climate change projections.	2
There is some confusion over relationship between adaptation and disaster relief.	1

Political commitment and will to address climate change	
Some politicians are sceptical of both climate change and the role of spatial planning.	3
Climate change is not a main driver for politicians, who are focused on shorter term priorities (e.g. economic growth).	3
High level political commitments are not reflected at local level.	1
Availability of resources within planning authorities (time, money, human)	
Planning authorities are suffering from financial problems and funding shortages.	9
Human and financial resources are generally lacking, particularly at the local level, for planning authorities to develop adaptation responses.	4
Local authorities sometimes do not have staff with a climate change remit, and therefore lack the capacity to undertake their own analysis of impacts and adaptation responses.	2
Planners do not always have sufficient time to address adaptation issues within their work, and to encourage adaptation to be included in decision making processes.	1
Governance of urban areas and adaptation responses	
Institutions with a role to play in climate change adaptation (including spatial planning) are not sufficiently integrated, both between sectors and across spatial scales. This limits their capacity to engage in this agenda.	5
Lack of effective metropolitan governance.	1
There is a lack of clarity on responsibilities for adaptation.	1
Information and tools to assess climate change impacts and adaptation responses	
There is a lack of information, particularly at the local level, to support effective adaptation planning. This relates to issues including climate change scenarios, the cost effectiveness of adaptation options and good adaptation practice.	8
Technical tools and resources for addressing adaptation issues are lacking, and if they do exist they are not well publicised.	5
Uncertainty concerning the future impacts of climate change, and the direction of socio-economic change, constrains adaptation planning decision making.	5
Discussions on the adaptation issue are too often overly theoretical.	1
Market pressures and economic issues	
There is significant pressure for economic growth and development, particularly housing, which can counteract adaptation goals	4
There is a perception, for example amongst developers, that costs of adaptation are high. This can limit adaptation action where the planning system stresses commercial viability and has a tradition of 'predict and provide' decision making.	4

Legislation, regulation and guidance influencing planning and adaptation	
Changes to planning regulations, stimulated by change in national government, can fundamentally alter the context within which planners work to deliver adaptation responses (highlighted in a UK context).	10
Planning legislation and regulations often do not specify that adaptation issues must be addressed, which reduces the incentive for plans to include adaptation policies.	8
Guidance to support planners in accounting for adaptation issues may not be available, and where guidance exists it can be weak.	8
Adaptation is not an objective or principle in planning law.	2
Lack of formal requirement for SEA and EIA to address climate change.	1

Table 4 appears to show three broad groups of barriers, which differ according to their level of abstraction from the core workings of the spatial planning system. These are discussed in greater detail below.

4.2.1 Issues external to the planning system which influence its workings and potential effectiveness

Systemic issues that stand outside of the structure and workings of the spatial planning system exert a significant influence on the way that planners work, and ultimately on the potential effectiveness of planning processes and outcomes in delivering on climate change adaptation. The majority of barriers, identified by our analysis of the Delphi survey results, fell under this category. These encompass social, economic and political issues ranging from limited knowledge and awareness of climate change amongst different groups, a lack of political commitment and market pressures influencing land use and development. Although these issues lie beyond the scope of planning systems, they generally make it more difficult for planners to design and implement adaptation responses.

4.2.2 Broad issues concerning the overarching structure and operation of the planning system

Moving one step down from the systemic issues, certain barriers relate to the overarching structure and operation of the planning system itself. These include the nature of spatial planning, the planning profession, and also the framework of legislation, regulation and guidance influence its operation. The Delphi survey results reveal certain characteristics of the planning system that work against the delivery of adaptation responses, such as conflicting agendas that planners are asked to address and the short-term nature of aspects of the planning

system. The limited coverage of adaptation issues within legislation and regulations that structure the work of planning authorities is also relevant here. In many respects, adaptation remains a largely voluntary exercise with little mandatory action on adaptation prescribed within either the statute book or regulations guiding the development and use of land. Where adaptation responses are mandated within the planning system, or where planning authorities take steps to progress adaptation responses on a voluntary basis, there is little guidance to support them.

4.2.3 Issues related to the detailed workings of the planning system

Only when we look below the overarching structure of the planning system do we find barriers that relate largely to the detailed day-to-day workings of planners and planning authorities. The Delphi survey suggests that planners do not have sufficient resources to deliver adaptation responses. The funding for adaptation response development is limited, planning authorities often do not have staff in place with appropriate adaptation knowledge and skills, and other pressures means that planners have little time available to commit to this agenda. Procedural bureaucracy within planning processes further weakens the contribution that planners can make to the development and implementation of adaptation responses.

At each step down, the number of barriers relating specifically to the detailed workings of the planning system, as suggested by the Delphi participants, declines. We concluded that broader systemic issues are particularly prevalent when considering the barriers limiting the contribution of spatial planning to the delivery of adaptation goals. This finding should be of particular concern to the planning profession. In theory, planners have an important role to play in the development and implementation of adaptation responses (section 2). However, in practice the system within which the planners operate – encompassing issues from the dominance of free market ideologies, limited knowledge and awareness of climate change impacts and adaptation responses to lacking political commitment on climate change – puts a real break on realising spatial planning's potential as an adaptation response.

4.3 Strengthening the contribution of spatial planning to climate change adaptation

4.3.1 Approach

A key goal of the Delphi survey was to draw together the collective knowledge and understanding of the participants to develop insights to support and enhance the contribution of spatial planning to climate change adaptation. At stage 1, the following question was posed:

Please cite up to three changes or new initiatives (e.g. principles, policies, practical approaches) that you think would help to strengthen the contribution of spatial planning in supporting adaptation to the impacts of climate change.

A large number of 'solutions' were suggested in response to this question. These were analysed and grouped by the researchers into seven headline solutions, each of which also encompasses sub-categories. The seven headlines were:

1. Apply different concepts and methods to align spatial planning more closely with adaptation agenda. For example extend planning time horizons; link adaptation and mitigation and create multifunctional green spaces.
2. Strengthen institutional and organisational governance structure to facilitate connections between planning authorities, and other organisations with a role to play in adaptation, across sectors and spatial scales.
3. Increase resources (financial and human) available to planning authorities to increase their capacity to develop and implement responses to climate change impacts.
4. Enhance levels of awareness about climate change impacts and adaptation responses, and the role of spatial planning in this context, amongst politicians and the public.
5. Enhance the climate change adaptation knowledge, skills and technical capacity of planners through guidance, education, training and good practice exchange.
6. Develop responses to market pressures and economic drivers that exert a strong effect over planning and development, and that in some cases counteract the achievement of adaptation goals.
7. Build an overarching framework of legislation and regulation to strengthen the capacity of spatial planning to deliver climate change adaptation.

Stage 2 of the Delphi was dedicated to consolidating and verifying our interim analysis of the responses submitted at stage 1. The seven headline solutions were presented for evaluation using a Likert scale. The following question was posed:

For each of the following actions [the 7 solutions], please indicate to what extent you agree that they are essential in enhancing spatial planning's contribution to effective climate change adaptation.

Respondents were then asked to select two of the seven headline solutions that they perceived to be particularly important, and to then evaluate the associated sub-solutions using the Likert scale and also to decide whether they were regarded as short-term priorities or long-term goals. Table 5 summarises the consolidated findings of the two stages of the Delphi, and Figures 7-9 provide visual representations of the findings.

4.3.2 Findings

This research has provided a detailed insight into the issue of how spatial planning's contribution to climate change adaptation could be strengthened. The clear statement of priorities, which has been built by over 70 individuals from 10 countries, offers planners and decision makers additional knowledge to take this agenda forward.

There are several important messages emerging from the solutions analysis. Firstly, the whole group of seven headline solutions are regarded as important elements of a deep and wide ranging strategy to strengthen the contribution of spatial planning to climate change adaptation.

The weighted mean values of the Likert scale results for each headline solution is relatively high (see Table 5 and Figure 7). Nevertheless, when we look at several different metrics, it is possible to identify that one particular solution appears to be regarded as marginally more important than the others. This is headline solution 5; enhancing the adaptation knowledge, skills and technical capacity of planners. This has the largest number of respondents suggesting this solution at Delphi stage 1 (see Table 5), and at Stage 2 it has the highest percentage of respondents selecting the solution in their top 2 priority solutions (see Figure 8) and the highest weighted mean Likert value (see Figure 7).

It is clear that an 'up-skilling' of planners is key to making progress. If this was to occur, other solutions may become easier to achieve, such as applying

different concepts and methods to align spatial planning more closely to the adaptation agenda. Increasing knowledge and awareness of climate change impacts and adaptation responses may also stimulate the allocation of increased resources to this agenda.

In the same way that the barriers inhibiting the contribution of spatial planning to climate change adaptation differ according to their level of abstraction from the core workings of the planning systems, so do the solutions identified by the Delphi. They can be broadly categorised into those which relate to systemic issues and others that link more closely to spatial planning systems.

At the systemic level, we see the solutions relating to enhancing levels of awareness of climate change impacts and adaptation responses, and developing responses to address the market drivers and economic pressures that influence planning and development. These solutions lie largely outside the scope and remit of planners, and signal the need for broader socio-economic changes.

The five other headline solutions link more directly to spatial planning. In some cases, planning authorities may have it in their remit to implement some of the solutions at a local scale. For example, there are numerous examples of planning authorities instigating proactive adaptation responses locally (Kazmierczak and Carter 2010). This takes the commitment of resources locally, and demonstrates a certain degree of prioritisation of resources over other issues and agendas. Although positive steps can be taken locally, adaptation planning practice is not yet widespread, and it is ultimately going to be necessary for individuals and organisations with an influence over spatial planning to work to implement solutions, such as those identified by this Delphi process, to mainstream adaptation into urban planning.

Table 5: Solutions to strengthen the contribution of spatial planning to climate change adaptation

Action	Stage 1 respondents suggesting as solution	Stage 2 weighted mean
1. Apply different concepts and methods, for example extending planning time horizons, linking adaptation and mitigation and creating multifunctional green spaces, to align spatial planning more closely with adaptation agenda.	32	7.8
a) Improve understanding of the role, benefits and limitations of spatial planning in the context of adaptation to climate change.	3	7.4
b) Explore specific approaches and methods, for example scenario planning, flexible adaptation pathways, multifunctionality, cheap low-tech solutions and ecosystem services, for encouraging the delivery of adaptation goals via spatial planning	11	8.3
c) Extend the time horizon of spatial planning and project planning to enable long term climate change impacts to be addressed	3	7.3
d) Develop stronger institutional and practical linkages between climate change mitigation and adaptation within spatial planning	2	7.2
e) Promote and develop regional planning as an important element of adapting to climate change	4	7.2
f) Enhance the planning for, and investment in, multifunctional green spaces	3	6.9
g) Encourage the use of participatory adaptation planning approaches involving networks of relevant stakeholders from an early stage in the planning process.	6	7
2. Strengthen institutional and organisational governance structure to facilitate connections between planning authorities, and other organisations with a role to play in adaptation, across sectors and spatial scales.	12	7.5
a) Increase collaboration between sectors and actors working at different spatial scales to encourage a more 'joined up' approach to adaptation planning	9	8.3
b) Develop strategies to encourage joint working between local planning authorities, and the different departments within them, on adaptation issues such as flood risk management	2	8.3
c) Develop sub-regional clusters of organisations working on adaptation issues that are of particular relevance to their locality	1	7.6

3. Increase resources (financial and human) available to planning authorities to increase their capacity to develop and implement responses to climate change impacts.	6	6.9
a) Provide financial support, for example via subsidies or investment programmes, to facilitate strategic adaptation planning	6 (total for a and b)	8.1
b) Provide financial support, for example via subsidies or investment programmes, to deliver practical adaptation responses		8.3
4. Enhance levels of awareness about climate change impacts and adaptation responses, and the role of spatial planning in this context, amongst politicians and the public.	11	7.9
a) Raise awareness of climate change impacts and adaptation responses amongst politicians and the public	4	8.2
b) Aim to create political support for local and regional level adaptation planning activities	5	8.0
c) Promote the role of spatial planning as a mediator of space and an approach that can help to resolve conflicts between competing land uses	1	6.9
d) Develop methods to assess the multiple benefits of adaptation responses, and widely publicise the results of this research	1	7.6
5. Enhance the climate change adaptation knowledge, skills and technical capacity of planners through guidance, education, training and good practice exchange.	33	8.1
a) Provide clear national guidance, ideally web based, outlining adaptation goals, principles and methods for planning authorities to work towards	5	7.4
b) Enhance the availability of accessible well managed regional and local spatial data on climate change scenarios, impacts and vulnerabilities	7	7.9
c) Encourage the international exchange of a wide range of good adaptation practice through an accessible web portal	11	7.4
d) Enhance the availability of tools to assist planners (and businesses) in developing adaptation responses	3	7.8
e) Increase emphasis on climate change science, impacts and adaptation within mandatory training and education programmes for planners	7	7.9
6. Develop responses to market pressures and economic drivers that exert a strong effect over planning and development, and that in some cases counteract the achievement of adaptation goals.	6	7.0
a) Improve understanding of the financial processes underlying development and infrastructure planning	1	7.4
b) Develop whole lifecycle cost-benefit methods that go beyond assessing projects purely on economic grounds	3	8.3
c) Emphasise the causal link between climate change impacts and future economic prosperity, highlighting that the sustainability agenda does not conflict with economic growth	2	8.0

7. Build an overarching framework of legislation and regulation to strengthen the capacity of spatial planning to deliver climate change adaptation.	27	6.9
a) Develop an EU Directive on climate change adaptation	1	7.2
b) Develop national legislation and policy on adaptation, which highlights links to spatial planning	7	8.4
c) Develop legislation and regulations, supported by associated assessment methods, requiring local authorities to develop and evaluate policies and plans with adaptation goals in mind	7	8.1
d) Develop regulations, codes and standards that mandate the consideration of adaptation issues within project planning and building design	12	8.2

Figure 6: Key for interpreting the Likert scales in figures 7 and 9



Figure 7: Extent to which headline solutions are regarded as essential to strengthening spatial planning's contribution to climate change adaptation (see Tables 5 for headline solutions)

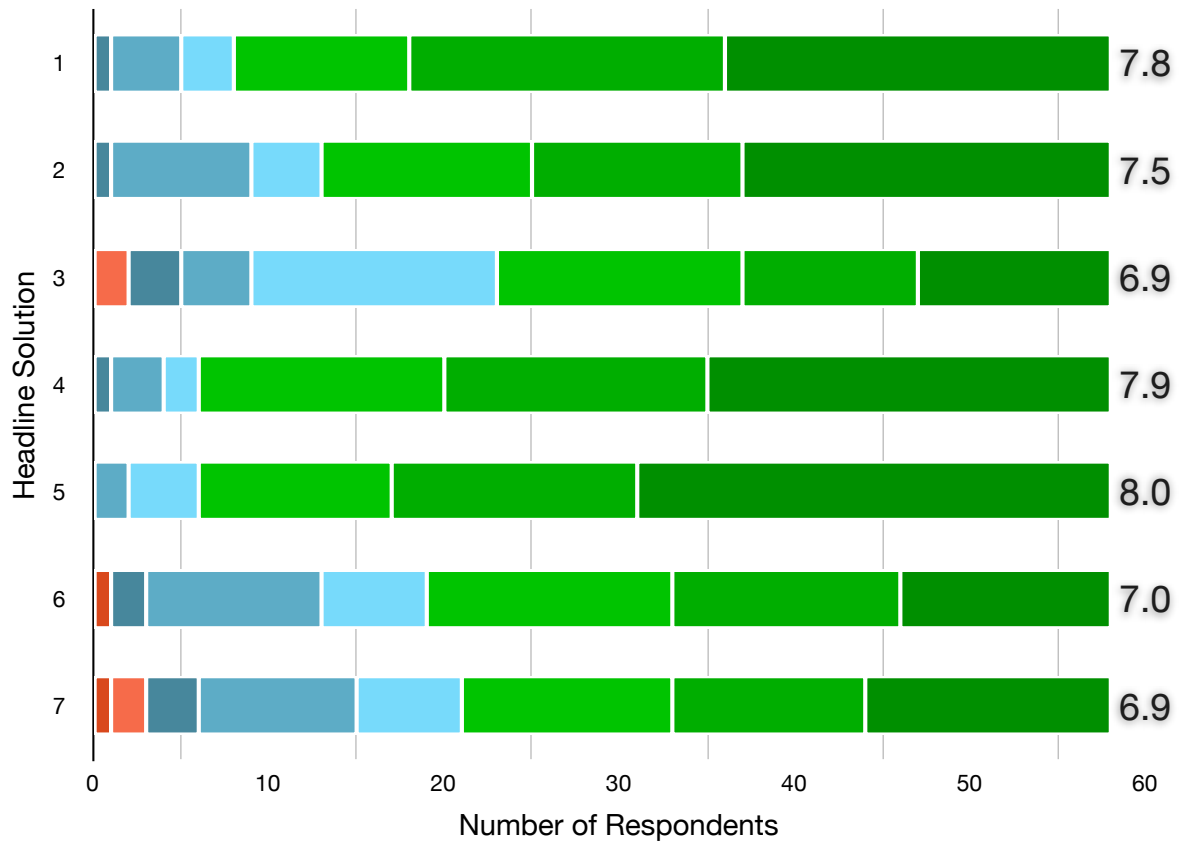


Figure 8: Percentage of respondents choosing headline solutions as one of their top 2 priorities (see Table 5 for headline solutions)

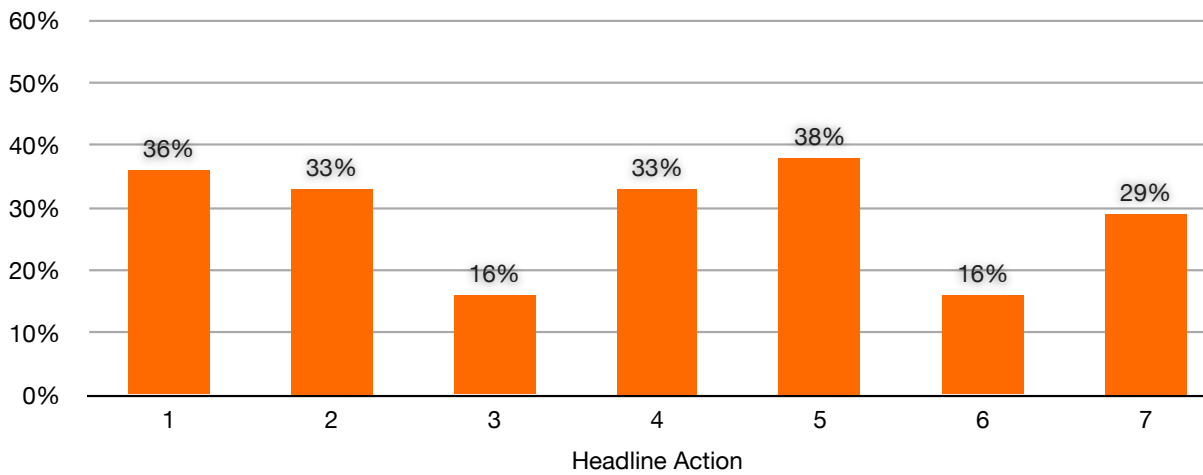
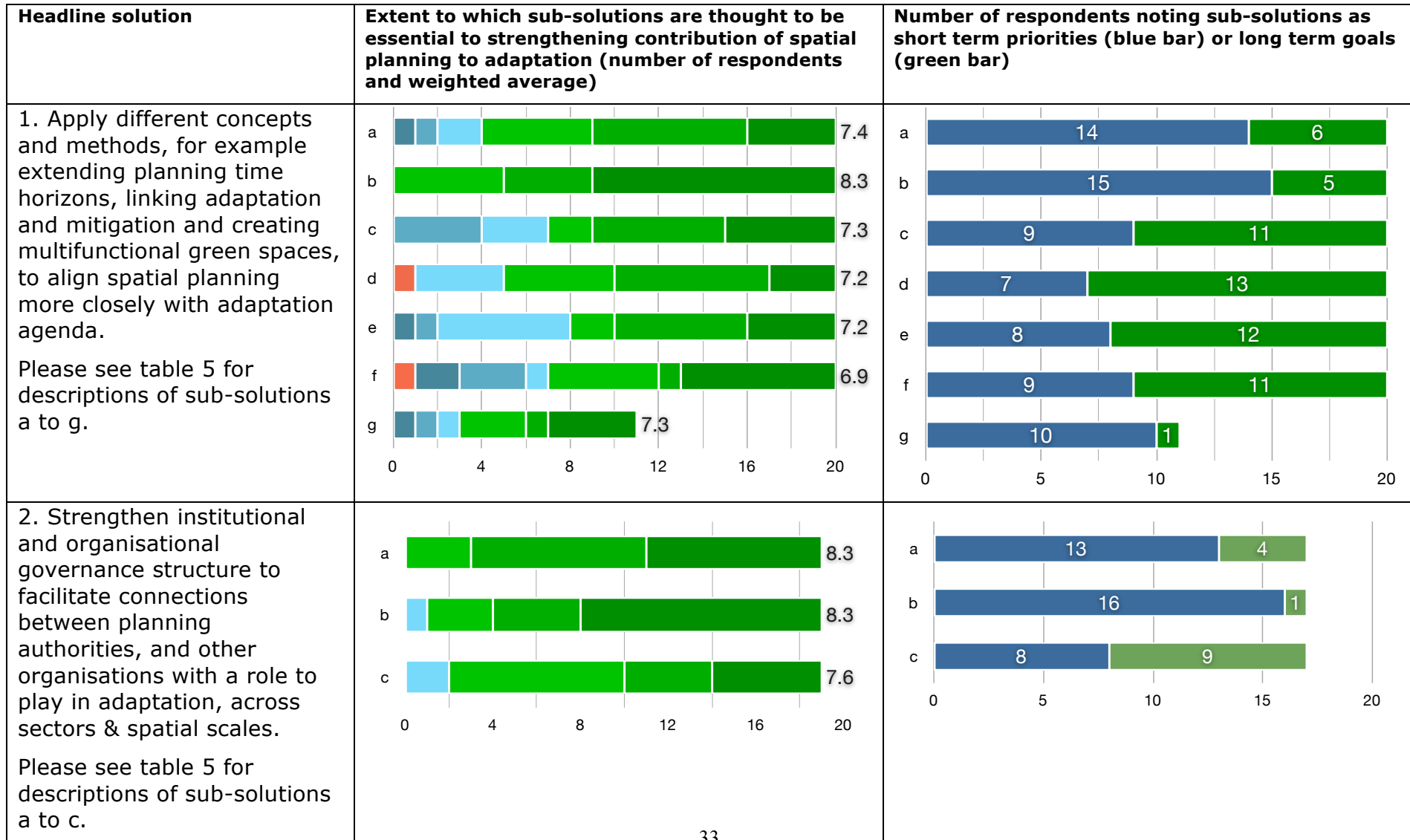
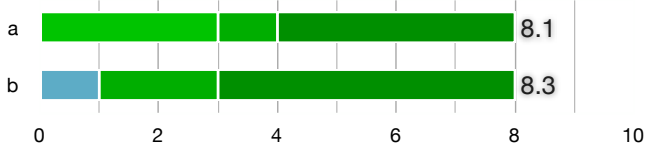
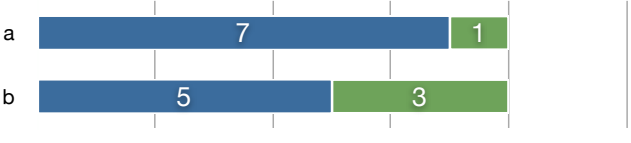

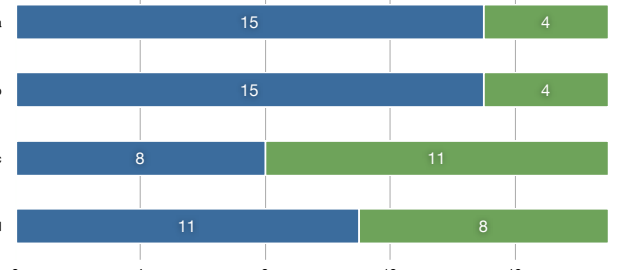


Figure 9: Findings of the analysis of the sub-solutions



Headline solution	Extent to which sub-solutions are thought to be essential to strengthening contribution of spatial planning to adaptation	Number of respondents noting sub-solutions as short term priorities (blue bar) or long term goals (green bar)																									
<p>3. Increase resources (financial and human) available to planning authorities to increase their capacity to develop and implement responses to climate change impacts.</p> <p>Please see table 5 for descriptions of sub-solutions a to b.</p>	 <table border="1"> <caption>Extent to which sub-solutions are thought to be essential to strengthening contribution of spatial planning to adaptation</caption> <thead> <tr> <th>Sub-solution</th> <th>Score</th> </tr> </thead> <tbody> <tr> <td>a</td> <td>8.1</td> </tr> <tr> <td>b</td> <td>8.3</td> </tr> </tbody> </table>	Sub-solution	Score	a	8.1	b	8.3	 <table border="1"> <caption>Number of respondents noting sub-solutions as short term priorities or long term goals</caption> <thead> <tr> <th>Sub-solution</th> <th>Short term priorities (blue)</th> <th>Long term goals (green)</th> </tr> </thead> <tbody> <tr> <td>a</td> <td>7</td> <td>1</td> </tr> <tr> <td>b</td> <td>5</td> <td>3</td> </tr> </tbody> </table>	Sub-solution	Short term priorities (blue)	Long term goals (green)	a	7	1	b	5	3										
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5 Conclusions

Blanco and Alberti (2009) indicate that the planning profession can play a vital role in every aspect of adaptation to climate change impacts. Davoudi et al (2010: 14) acknowledge this by saying that:

...recognition of the complexity, uncertainty and irreversibility demonstrated by climate science is changing the nature and framing of spatial planning, with an increasing expectation for it to play a part in mitigation and adaptation efforts.

Although an emerging body of practice demonstrates that planners can deliver adaptation responses, our research points to a number of barriers that limit mainstreaming adaptation within the planning system. Equally, the Delphi process identified some key solutions that can strengthen spatial planning's contribution to the adaptation agenda. In doing so, our research addresses the deficit between spatial planning's role in adaptation and the realisation of this potential role in practice. As information on the nature of climate change impacts emerges and the responsibility of spatial planning in reacting to this, the capacity of cities to respond will be strengthened.

Our respondents work in a range of countries, and so our outputs are not country specific. The barriers and solutions identified are crosscutting and transferable to different contexts. However, particular barriers, such as the availability of resources for planners or political commitment to address climate change, differ between countries and even local authorities in the same country. Similarly, prioritising which solutions to pursue in order to strengthen the adaptation role of spatial planning will again depend on local factors, including the current position of the adaptation agenda in the policy hierarchy and the existing availability of information on climate change impacts and adaptation responses. Nevertheless, this report highlights the scope of potential barriers and identifies solutions. This information offers planners and decision-makers a better insight into connecting the two crucial agendas of spatial planning and climate change.

Adaptation is only just beginning to be acknowledged as an important element of securing the future of urban areas (Blanco et al 2011), and cities now starting to incorporate adaptation objectives into city plans (Carter 2011). Given the severity of climate change projections, and the risk of cities being impacted by multiple intensifying weather and climate events, the limited uptake of adaptation responses within spatial planning must change. Gaining a holistic

perspective of approaches to adaptation to changing climates will help to progress this agenda.

Adaptation should be seen less as an exercise in its own right, and more as a constituent element of governing and designing the form and function of urban areas and processes. This will help to broaden the adaptation debate and move it closer to key planning policy agendas such as supporting sustainable communities and enhancing the economic competitiveness of cities. Strengthening spatial planning's role in the delivery of adaptation responses is crucial.

6 Appendices

Appendix 1: Current good practice concerning spatial planning and climate change adaptation

City-scale adaptation progress	2
• Cities implementing climate change initiatives	1
• Cities leading the way and demonstrating adaptation in their planning processes	1
Planning methods and techniques	30
Assessment and data gathering methods	8
• Strategic Environmental Assessment	2
• Identifying areas that are vulnerable to climate change impacts	1
• Vulnerability assessments	1
• Risk Mapping	1
• Hotspots Approach: select very vulnerable region, research impacts and implement adaptation strategy	1
• Evidence and intelligence gathering	2
Participation and communication approaches	10
• Scenario building	3
• Developing long term visions	1
• Participation in Planning Initiatives	2
• Panel on Adapting to the impacts of climate change (assessments , policy etc)	1
• Exchange of good practice	1
• Exchange of information	2
Adaptation plan and policy integration approaches	10
• Integrating Adaptation Action in existing spatial planning approaches (e.g. Green Infrastructure Plans - Green Nets)	3
• Integration of climate change adaptation in strategic planning frameworks and masterplans (e.g. East London Green Grid)	1
• Policy developments with LDFs	1
• Spatial action plans (especially at local level)	2
• Alignment of plans with adaptation strategy	1
• Principles translate into policy	2
Building codes and regulations	2
• Regulations	1
• Building codes	1
Adaptation research programmes and outputs	9
• Collaborative knowledge transfer across the UK (being developed to assist the local roll out of the National Adaptation Programme)	1
• GRaBS project	3
• ESPACE project	1
• Stern Review	1
• VCCCAR Scenarios Project	1
• ARCC programme	1
• Spatial Development Strategies for Climate Change' (www.klimamoro.de)	1

Thematic adaptation responses	19
Flooding	5
• Taking into account flood risk in planning	1
• Floodplain restoration	1
• Flood risk prevention plans	1
• Flood risk management through soft engineering	1
• Prescribing standards of soil permeability	1
Green infrastructure	4
• Green infrastructure and open space in cities	4
Water resources	3
• Water catchment area planning	1
• Strategic water resources management planning	2
Food and farming	2
• Local food growing schemes	1
• The protection of farmland from development	1
Other	5
• Maintaining and enhancing ecosystem services	1
• Consideration of the location of physical infrastructure in the context of climate hazard	1
• Strategies to mitigate urban heat island effect	1
• Residential street design for homezones	1
• Planned retreat	
Specific examples of policies and strategies	
City and district scale	11
• Arnhem (NL) developing new structure vision document including climate vulnerability map	1
• London: strategic profile in planning policy given to climate change adaptation	1
• Building codes in Basel and Bolzano	1
• Climate change supplementary planning document (Rochdale MBC)	1
• Energy Plan region Madrid 2004/2012	1
• Forestry plan region madrid 2000/2019	1
• Climate change strategy for region of Madrid 2006/2012	1
• Rotterdam2Waterplan and Rotterdam Climate Proof Programme (longterm strategies, short term action plans)	1
• City of Chicago Climate Action Plan	1
• London Borough of Islington Draft Core Strategy (contains exemplary policies 67)	1
• Resilient Sheffield (recently completed workshop-based approach)	1

Regional scale	7
• Regional and sub-regional scale	1
• Australian Capital Territory (ACT) planning land authority current incorporation of climate change in plan	1
• Green infrastructure North west	1
• Climate change guidelines for urban planning (Basque Country)	1
• New Climate Act of the Basque Country includes explicit mention to climate adaptation as an issue to be analysed in SEA	1
• Regional planning regulations prescribing standards to incorporate green roofs to buildings (Norway)	1
• Regional adaptation strategies in Germany (e.g. Schleswig-Holstein, Mecklenburg-Vorpommern)	1
Specific examples of adaptation action and networks	7
• City canal with 'urban floodplain'	1
• Rotterdam Water Plaza designed to control small scale flooding	1
• Planning and Climate Change Coalition	1
• ICLEI support for 'declarations' by Mayors and Local Governments	1
• Stuttgart Urban Climate Office	1
• Sydney Coastal Council Group	1
• Chicago's Green Alleyways initiative	1
Guidance and data sources on adaptation	29
Guidance documents and tools	21
• Adapting to impact of climate change on buildings' produced by centre for Construction Innovation for Climate Change NW	1
• CLASP NI188 support toolkit	1
• VCCCAR adaptation roadmap (Victoria, Australia)	1
• DSE adaptation guide	1
• Climate Change Risk Assessment Resource Pack (CLASP and CC NW)	1
• TCPA planning for CC guide	4
• Transnational Strategy for Climate Proof Planning' (CLISP 2011)	1
• Guidance for Planners to Evaluate the Climate Change fitness of Spatial Planning' (CLISP 2011)	1
• Anpassung.net German website 'competence centre for climate impacts and adaptation'	1
• PPS1 supplement on climate change	5
• UK PPS25 flood risk management	3
• National policy guidance (UK)	1
Data sources	8
• UKCIP evidence	2
• Climate Adaptation Atlas (Dutch Adaptation Programme)	1
• Climate Ateliers (stakeholder interaction formats) (Dutch Adaptation Programme)	1
• German Climate Atlas http://www.regionaler-klimaatlas.de/	1
• LCLIPS (UKCIP)	2
• Spatially represented evidence	1

Policy and strategy at different spatial scales	20
Supranational policy and action	3
• UN Habitat 'Cities and Climate Change Academy'	1
• Hyogo (UN) framework for actions on disaster management	2
EU Level policy and action	4
• EU white paper on adaptation to climate change	2
• EU floods directive	1
• European Climate Change Programme	1
National level policy and strategy (UK unless stated)	13
• National Research Programme: Climate Changes Spatial Planning (NL)	1
• Climate Change Act	1
• Climate Change Skills Fund	1
• NI188 (in some cases)	1
• 'Room for the River' project (NL)	1
• Deltaprogramme (NL government)	1
• Making adaptation compulsory issue at regional level (through Finnish national guidelines)	1
• Norwegian government Green Paper on climate change adaptation	1
• Swiss adaptation strategy	1
• Swiss Spatial Planning document 'Raumkonzept'	1
• Delta Act, July 2011 Netherlands - institutionalised long term planning	1
• UK national level recognition of adaptation in planning	1
• Obligatory Municipal CC adaptation plans and risk and vulnerability plans (Norway)	1

Appendix 2: Participants contributing to the Delphi survey

Name	Organisation
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N.B. 14 additional participants wished to remain anonymous.

7 References

- Anderson, K., and Bows, A. (2011) Beyond 'dangerous' climate change: emissions scenarios for a new world, *Philosophical Transactions of the Royal Society* 369: 20-44.
- Betts R, Collins M, Hemming D, Jones C, Lowe J, and Sanderson M (2011) When could global warming reach 4°C, *Philosophical Transactions of the Royal Society* 369: 67-84.
- Blanco, H., and Alberti, M. (2009) Building capacity to adapt to climate change through planning, in Blanco, H., and Alberti, M. (eds) (2009) *Hot, congested, crowded and diverse: emerging research agendas in planning*, *Progress in Planning* 71: 153-205.
- Blanco, H., McCarney, P., Parnell, S., Schmidt, M., and Seto, K. (2011) The role of urban land in climate change, in Rozenzweig, C., Solecki, W., Hammer, S., and Mehrotra, S. (eds) (2011) *Climate change and cities: first assessment report of the urban climate change research network*. Cambridge University Press, Cambridge.
- Brooks, N., Adger, W.N., and Kelly, P.M. (2005) The determinants of vulnerability and adaptive capacity at the national level and implications for adaptation, *Global Environmental Change* (15): 151-163.
- Carter, J.G. (2011) Climate change adaptation in European cities, *Current Opinion in Environmental Sustainability*, 2011, Vol. 3, 193-8.
- Commission of the European Communities (CEC) (2009) White paper – adapting to climate change: towards a European framework for action (COM 147 final), Commission of the European Communities, Brussels.
- Davoudi, S., Crawford, J., and Mehmood, A. (2010) Climate change and spatial planning responses, in Davoudi, S., Crawford, J., and Mehmood, A. (eds) (2010) *Planning for climate change: strategies for mitigation and adaptation for spatial planners*, Earthscan, London.
- Davoudi, S., Crawford, J., and Mehmood, A. (eds) (2010a) *Planning for climate change: strategies for mitigation and adaptation for spatial planners*, Earthscan, London.
- Doria, M. de F. et al., (2009) Using expert elicitation to define successful adaptation to climate change. *Environmental Science & Policy*, 12(7), pp.810-819.
- European Environment Agency (EEA) (2008) *Impacts of Europe's changing climate 2008 indicator-based assessment*, European Environment Agency, Copenhagen.
- Haddad, B. (2005) Ranking the adaptive capacity of nations to climate change when socio-political goals are explicit, *Global Environmental Change* (15): 165-176.
- Hamilton, C. (2010) *Requiem for a species: why we resist the truth about climate change*. Earthscan, London.

- Hamilton, J.M., Maddison, D.J. & Tol, R.S., (2005) Climate change and international tourism: a simulation study. *Global Environmental Change Part A*, 15(3), pp.253–266.
- Hsu, C.C. & Sandford, B.A., (2007) The Delphi technique: making sense of consensus. *Practical Assessment, Research & Evaluation*, 12(10), pp.1–8.
- Hulme, M. (2009) *Why we disagree about climate change: understanding controversy, inaction and opportunity*, Cambridge University Press, Cambridge.
- Hung, H.L., Altschuld, J.W. & Lee, Y.F., (2008) Methodological and conceptual issues confronting a cross-country Delphi study of educational program evaluation. *Evaluation and Program Planning*, 31(2), pp.191–198.
- Intergovernmental Panel on Climate Change (IPCC) (2007) *Climate Change 2007: Synthesis Report*, IPCC, New York.
- Kazmierczak, A., and Carter, J.G. (2010) *Adaptation to Climate Change Using Green Infrastructure: A Database of Case Studies*. GRaBS Project Paper, TCPA, London.
- Lemieux, C.J. & Scott, D.J., (2011) Changing Climate, Challenging Choices: Identifying and Evaluating Climate Change Adaptation Options for Protected Areas Management in Ontario, Canada. *Environmental Management*. Available at: <http://www.springerlink.com/content/nx7r18243m134656/> [Accessed August 23, 2011].
- Levina, E., and Tirpak, D. (2006) *Key adaptation concepts and terms*, OECD, Paris.
- Pittock, A.B. (2009) *Climate change: science, impacts and solutions* (2nd edition), Earthscan, London.
- Richardson, K., Steffen, W., and Liverman, D. (2011) *Climate change: global risks, challenges and decisions*. Cambridge University Press, Cambridge.
- Stern, N.H. (2007) *The economics of climate change: the Stern review*. Cambridge: Cambridge University Press.
- Solomon, S., Plattner, G.K., Knutti, R., and Friedlingstein, P. (2009) Irreversible climate change due to carbon dioxide emissions, *Proceedings of the National Academy of Sciences* 106 (6): 1704-1709.
- Wilenius, M. & Tirkkonen, J., (1997) Climate in the making: Using Delphi for Finnish climate policy. *Futures*, 29(9), pp.845-862.

8 Acknowledgements

The research that led to the production of this report was funded by two projects; the Interreg IVC Green and Blue Infrastructure for Urban Areas and Eco Towns (GRaBS) project and the EcoCities project (the Bruntwood Initiative for Sustainable Cities).

Further information on these two projects can be found at:

www.grabs-eu.org

www.manchester.ac.uk/ecocities

The time committed to this process by all of the participants who contributed to the Delphi survey is greatly appreciated.