An iconic approach to representing climate change

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ABSTRACT

In order to meet the UK Government's 60% greenhouse gas emissions reduction target, there is a need for non-experts to be meaningfully engaged with the issue of climate change. This thesis investigates the value of engaging non-experts with climate change at the individual level. Research demonstrates that individuals perceive climate change as temporally and spatially remote, and not of personal concern. There are psychological, social and institutional barriers to meaningful engagement with climate change.

More effective methods for engaging the public with climate change are needed which address the psychological barriers to change. An 'iconic' approach was developed to harness the emotive and visual power of climate icons with a rigorous scientific analysis of climate impacts under a different climate future. 'Icons' are defined as tangible entities which will be impacted by climate change, considered worthy of respect by the viewer, and to which the viewer can relate to and feel empathy for. Such icons already exist: for example, melting of the West Antarctic Ice Sheet or Thermohaline Circulation shutdown. However, these 'expert-led' icons have failed to engage non-experts. The selection of non-expert icons enables individuals to engage with climate change through their personal perceptions and values.

A robust sourcing for 'non-expert icons' was carried out using focus groups and online survey methodologies. A suite of icons representative of the reasoning behind individuals' non-expert icons was selected. Expert-led icons were identified from 'Sleeping Giants' emerging from the Exeter Avoiding Dangerous Climate Change conference. Impact assessments were then carried out for the suite of expert-led and non-expert icons under a specified greenhouse gas emissions scenario and to an imaginable timescale. Methodologies used to investigate climate impacts on the icons included a survey of expert opinion, quantitative modelling and spatial analysis using a Geographic Information System (GIS).

The cognitive and affective impact of the non-expert and expert-led icons upon individuals was investigated through an evaluative pre/post test workshop. The expert-led icons generally disengaged individuals. Expert-led icons had little personal impact and invoked emotions such as helplessness or boredom, and were considered too scientific or complex. Conversely, non-expert icons tended to impact upon the individual, the local area or nature; and invoked affective and cognitive engagement with climate change.

TABLE OF CONTENTS

LIST OF ACRONYMS

AR4 – Assessment Report four from the IPCC (2007)
CaCC – Campaign against Climate Change
CNS - City of Norwich School
COP – Conference of the Parties
cp.net – *ClimatePrediction.net*
DEFRA – Department for Environment, Food and Rural Affairs
DETR – Department for Environment, Transport and the Regions
FoE – Friends of the Earth
GCM – General Circulation Model
IAM – Integrated Assessment Model
IPCC – Intergovernmental Panel on Climate Change
LEAD - Leadership for Environment And Development International network
MORI – Market and Opinion Research International
NGO – Non-Governmental Organisation
OST – Office of Science and Technology
rSLR – Relative Sea Level Rise
SCC – Stop Climate Chaos
SLR – Sea Level Rise
SRES – Special Report on Emissions Scenarios
THC – Thermohaline Circulation
UKCIP – United Kingdom Climate Impacts Programme
UNFCCC – United Nations Framework Convention on Climate Change
WAIS – West Antarctic Ice Sheet
WWF – World Wide Fund for nature

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CHAPTER 1:
CLIMATE CHANGE FROM A SCIENTIFIC TO A SOCIETAL ISSUE

"Is the mean temperature of the ground in any way influenced by the presence of the heat-absorbing gases in the atmosphere?" Svante Arrhenius (1896)

"Our mission is, in truth, historic and world changing - to build, over the next fifty years and beyond, a global low carbon economy. And it is not overdramatic to say that the character and course of the coming century will be set by how we measure up to this challenge"
PM Gordon Brown (2007)

"Preservation of the environment, promotion of sustainable development and particular attention to climate change are matters of grave concern for the entire human family. No nation or business sector can ignore the ethical implications present in all economic and social development." Pope Benedict XVI (2007)

The idea of global climate change emerged in the nineteenth century, through the scientific academic study of John Tyndall, James Croll and Svante Arrhenuis. But climate change has now evolved from a purely scientific endeavour to an issue with political, social, cultural and moral facets. The Stern Review (2006) reported a 'simple conclusion': that the economic cost of not acting on climate change far outweighs the disadvantages of strong and early action. A myriad of actors urge society to cut their carbon dioxide emissions to change their behaviour in relation to climate change (for example, see DEFRA 2007c, Marks and Spencer PLC 2007; and Rising Tide 2007). Yet, UK carbon emissions are rising slightly, not falling (DEFRA 2007b) with climate change communications approaches generally failing to engage individuals.

1.1 CLIMATE CHANGE AS A SCIENTIFIC ISSUE

1.1.1 Evidence and impacts

Some amount of climate change[1] is attributable to variations in the natural cycles of the Earth's system. These natural variations are caused by changes in solar output, by volcanic

[1] In this research, the term 'climate change' is used, as it has no direct connotation to increase in temperature, unlike terms such as 'global warming'. 'Climate change' is perceived as including other climate impacts such as species change, rather than just temperature change and, indeed, to allow for suggestions of cooling temperatures. See Whitmarsh (in press) for further discussion of perceptions of both terms.

eruptions, by the internal variability of the climate system and on millennial timescales, through variations in the Earth's orbit. Global mean surface temperature has increased by 0.74°C from 1906 - 2005. Additionally, eleven of the twelve years between 1995 and 2006 rank as the twelve warmest years in the instrumental record of global surface temperature (IPCC, 2007a). Yet these trends cannot be explained by natural cycles alone. The IPCC (2007a) states *'warming of the climate system is unequivocal'*, citing evidence from increases in global average air and ocean temperatures to the widespread melt of snow and ice to rising global mean sea level rise (SLR). Only by considering anthropogenic forcing can the increasing temperature trend since the industrial revolution be finally accounted for. Anthropogenic forcing is the result of combustion of fossil fuels and land use changes, leading to increased greenhouse gas (GHG) and aerosol emissions. Global GHG emissions due to human activities have increased by 70% between 1970 and 2004 (IPCC, 2007a). From herein, the phrase 'climate change' is used to refer to *anthropogenically induced* climate change.

The IPCC developed the Special Report on Emissions Scenario (SRES) to explore the impact of increasing GHG emissions (Nakicenovic *et al.* 2000). The IPCC state *'high agreement and much evidence'* that under current policies and practices, GHG emissions will continue to grow over the next few decades, by as much as 90% from 2000 to 2030. These scenarios lead to a range in projected increase of global mean temperature of between 1.1 - 6.4°C by 2090 - 2099 relative to 1980 - 1999. Climate change is projected to increase the frequency and intensity of certain categories of extreme weather events, and to increase mean sea level rise (SLR; IPCC 2007a). The SRES scenarios lead to a projected range in global mean SLR of 18 - 59cm by 2090 - 2099 relative to 1980 - 1999. Impacts of climate change are projected to be many and varied, but range from changes in ecosystems (Leemans and Eickhout 2004) to impacts on human systems such as water resources (Arnell 1999), to potential forced human migrations (Barnett and Adger 2003), to widespread acidification of the oceans (Caldeira and Wickett 2003), to insurance and re-insurance difficulties (Munich Re 2004). Whilst the transition to a warmer world is often forecast as a smooth, linear progression, Lenton *et al.* (2008) warn of the dangers of non-linearities within the Earth's system. Lenton *et al.* elucidate via an expert elicitation potential 'tipping elements' of the Earth system; where a tipping element refers to a component of the Earth's system that can be switched – under particular conditions – into a different state by a small perturbation. Such tipping elements include Arctic sea ice melt, Amazon dieback and changes to the Indian summer monsoon (Lenton *et al.*, 2008).

The UKCIP02 emissions scenarios delivered information on possible changes to the UK climate and to potential changes in extreme events at a regional level (Hulme *et al.* 2002). This report is currently being updated[2], but projected climate changes in the 2002 report included average annual temperatures in the UK southeast warming by up to 5°C in summer by the 2080s, seasonal shifts of one to three weeks by the 2050s to earlier springs and later onset of Autumn, and up to 20% heavier winter rainfall by the 2080s as precipitation events become more extreme.

1.1.2 Managing the challenge of climate change

Both mitigation and adaptation actions are needed to appropriately manage the challenge of climate change. Mitigation refers to the reduction of GHG emissions through the reduction of fossil fuels use (for example, increasing product energy efficiency) or through capturing and storing emitted carbon (for example, through carbon geo-sequestration). Adaptation actions are those which reduce the adverse impacts of climate change (for example, species acclimatisation to warmer temperatures or policy interventions to build better coastal defences to guard against SLR, or those which exploit new opportunities offered by climate change such as changes in agricultural products).

Global efforts have thus far concentrated largely on mitigating climate change. In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was signed in Rio de Janeiro, framing much of the future debate on climate change around the notion of ‘danger’. It stated the ultimate aim of the Convention was to achieve:

> *Stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. (UNFCCC 1992)*

All signatories to the Convention agreed to aim voluntarily to reduce their GHG emissions to 1990 levels by 2000. The Kyoto Protocol was adopted in 1997 and entered into force in 2005, becoming the first legally binding national commitment to GHG emissions reduction. The major GHGs subject to emissions reduction under the Kyoto Protocol are carbon dioxide, methane, nitrous oxide and three groups of fluorinated gases. Although criticised for setting emissions reductions targets too small for significant benefits

[2] The UKCIP08 report will be available from October 2008

(Lomborg 2005), the Kyoto Protocol provides only a first step in reducing emissions (O'Neill and Oppenheimer 2002). A roadmap to GHG emissions reduction beyond the Kyoto Protocol has been negotiated at the Conference Of the Parties (COP-13) held in Bali in 2007.

Sir David King (2004), Chief Scientific Advisor to the UK Government stated how Great Britain is attempting to show leadership on climate change beyond that of international negotiations. The UK government is currently in the process of drafting the Climate Change Bill, which states a UK GHG emissions target far more stringent than the Kyoto Protocol. The Climate Change Bill states the UK's target to reduce GHG emissions through domestic and international action by between 26-32% by 2020, and by at least 60% by 2050, against a 1990 baseline (DEFRA 2007d).

1.2 CLIMATE CHANGE AND SOCIETY

Despite the UK's commitment to the Kyoto Protocol and development of the Climate Change Bill, there has been a slight increase in UK carbon emissions during the last few years rather than the radical emissions reductions needed to reach national targets. As this suggests, in order to meet the UK Government's 60% mitigative emissions target society must be meaningfully engaged with climate change in order to begin to undertake decarbonisation behaviours (Nicholson-Cole, 2004; Whitmarsh, 2005; Lorenzoni *et al.*, 2007). This thesis recognises that individuals have an important role to play in the reduction of emissions, and investigates the value of engaging at the individual level with climate change. On one hand, individuals are citizens responsible both for influencing policy through elections in a democratic society and for driving consumption patterns and trends through their purchasing power - regardless of the power an individual may or may not hold through occupation or background. On a more pragmatic note, domestic emissions through car use, heating, lighting and appliances represent around a third of UK total emissions (DEFRA, 2005). Research such as the '40% house' demonstrates that significant cuts in domestic emissions *are* possible to achieve within the Government's 2050 timeframe, but that such emissions cuts represent a significant challenge to society (Boardman *et al.* 2005).

1.2.1 Societal response to climate change in the UK

The public increasingly recognise climate change as a reality. For example, a survey by DEFRA (2007) found 99% of the UK public recognised the term 'climate change'.

DEFRA (2007) claim that within the UK, being 'green' is now seen as a social norm, rather than an 'alternative' way of life: although this statement is called into question somewhat when examining current environmental practices. Yet rrecognition of the language of climate and even recognising climate change as a risk issue represents a fairly superficial engagement with climate change, rather than the meaningful engagement which is needed. Risk research indicates that the public rank climate change as lower priority than other risk issues such as genetically modified foods or nuclear power (Poortinga and Pidgeon 2003). Without prompting, over a third of the UK public state crime, health, economic concerns or education as issues the government should deal with. Just one percent of the public without prompting states climate change or global warming an issue the government should deal with (DEFRA 2007).

Several government information campaigns have been run to inform the public about climate change. For example, the *'Are you doing your bit'* campaign was launched by the DETR in 1998. The £7 million campaign was designed to reach a mass public audience through television adverts showing many different individuals all taking small actions to help the environment. The campaign focussed on the personal and economic benefits to energy reduction. Although the DETR claim success in that the campaign generated recognition of the campaign brand amongst particular target audiences, they note only small consequent changes in personal attitudes or behaviour (DETR 2000). Information campaigns such as this have generally been unsuccessful in securing decarbonisation behaviour.

During the period in which the research for this thesis research was completed, considerable change occurred in the field of communicating climate change. In 2005, DEFRA announced plans for a new £12 million climate communication strategy, based upon recommendations from Futerra (2005). Futerra's '*Rules of the Game*' report outlined a new approach to climate communication in the form of an evidence-based strategy aimed at changing public attitudes towards climate change in the UK. The approach challenged some traditional tenets of sustainability communication, such as the use of scare tactics to engage the public (see Section 3.4.4 for further discussion). The adoption of the guidelines by DEFRA formed the *'Tomorrow's Climate, Today's Challenge'* climate communication campaign (DEFRA 2007c). Whilst significant changes to climate communication are in progress on some practitioner-led levels, this thesis provides empirical academic evidence of the need to engage individuals more meaningfully with climate change in order to promote attitudinal change.

1.2.2 Communication and engagement

Thus far, much effort has concentrated on climate change *communication*. Communication is defined as the provision of ideas, knowledge or information (OED online 2007). This thesis argues for approaches going further than simply information provision. Instead, the thesis examines climate change *engagement.* Engagement is defined by Lorenzoni *et al.* (2007) as a state of connection comprising the three co-dependent spheres of cognition, affect and behaviour. They state that:

> *"It is not enough for people to know about climate change in order to be engaged; they also need to care about it, be motivated and able to take action."* Lorenzoni *et al*., (2007: p 447)

Cognitive engagement is imperative in climate change; as if the public do not have an adequate understanding of the issue, any mitigation policy risks being ineffective or being rejected. Effective engagement refers to how an individual understands the issue through an emotional connection. Whilst the emotional processing system has been much maligned in Western society as inferior to a more analytic risk processing, the risk literature demonstrates that a significant proportion of our ability to assess risk stems from experiential rather than analytical processing (Slovic *et al.* 2004: see also section 5.4.1.2). The behavioural sphere of engagement refers to the actions an individual may take. There are two types of barrier to engagement with climate change: individual-level and social-level barriers (Lorenzoni *et al.* 2007). Individual barriers include a lack of desire to find out information and a lack of locally and personally relevant information. Social barriers include a lack of political substantive action and the difficulties of 'free riders' and social norms (Chapter 3 considers this further). This thesis explores an approach to overcome individual-level barriers to engagement with climate change.

The term engagement is used in this thesis to refer to the three inter-related and co-dependant facets of cognition, affect and behaviour. These three facets to engagement may work independently of each other. For example, climate mitigation strategies can be successful through 'piggybacking', or the promotion of other messages besides carbon reduction, whilst also achieving decarbonisation. Thus, Stern (2000) argues that energy conservation does not require a knowledge of climate change. However, Whitmarsh (2005) notes how these sorts of messages based on a 'rational actor' model are not always effective (see also Section 3.3). For example, widely used money-saving or 'thrifty' engagement approaches have limitations. Unless a new behavioural habit has been formed, when the stimulus of the piggyback is removed – in this example, if the new pattern of behaviour becomes more expensive for instance – the individual is likely to revert to the original behavioural pattern (Dobson 2003). Furthermore, consideration of the affective aspect to engagement is needed. Individuals enact particular behaviours not only due to economic factors but because of social norms, habitual behaviours or because the behaviour represents a cherished activity (Whitmarsh 2005). In the money-saving example, the very engagement approach used may act to disengage some individuals, as the 'thrifty' behaviour is perceived as 'penny-pinching', a negative behavioural attribute. Thus, approaches promoting behavioural change without a connection to individuals' underlying cognitive and affective values in relation to climate change is unlikely to lead to meaningful and long-lasting behavioural change.

This thesis explores individual engagement with climate change within a UK context. The thesis is interdisciplinary, crossing the disciplines of geography, psychology, sociology, climate sciences, marketing and communication studies. The objective of this research is to increase understanding of meaningful individual-level engagement with climate change, in order to encourage attitudinal change towards mitigative and adaptive action. The originality of the thesis rests in the interdisciplinary linkages made between natural and social scientific knowledge, through the investigation of an 'iconic approach' to individual-level engagement with climate change. With this context in mind, the following research questions are answered:

Stage 1. What makes an engaging 'climate icon'?

- What do participants select as their climate icons?
  - On what spatial scale(s) are icons chosen?
  - What reasoning lies behind icon choice?
- Are there commonalities and differences in the icons selected?
  - Does this vary across spatial and cultural contexts?
  - Is there such an entity as a globally engaging icon of climate change?

Stage 2. Examining non-expert and expert-led icons

- What constitutes an expert-led icon?
- What is the impact of a future climate scenario upon selected icons?
  - What is the impact on the non-expert icons?
  - What is the impact on the expert-led icons?

Stage 3. Does the iconic approach engage non-experts with climate change?

- How do non-experts engage with the expert and non-expert icons?
- Does the iconic approach alter cognitive or affective aspects of engagement with climate change?

The thesis schematic diagram (Figure 1.1) illustrates the relationship between each stage of the thesis research: from the methodologies used, to the aims of each stage, along with a timeline of the research process.

1.3 ROADMAP

An overview of the contents of each Chapter is provided here. The thesis is a detailed and sequential document, with each Chapter building on the conclusions of the previous Chapter. Firstly, Chapters 2 and 3 discuss the wide-ranging literature upon which this research is based. Chapter 2 explores the emergence of the discourse of 'dangerous climate change' and the agents and methods involved in this discourse. Chapter 3 then reviews the literature on public engagement with climate change. This Chapter specifically focuses on barriers to effective engagement, models for exploring behavioural change and approaches to improve engagement with climate change. The reasoning behind the use of an 'iconic approach' to climate engagement is then set out.

This thesis is interdisciplinary in that it applies methodologies from both the physical and social sciences. Thus, Chapter 4 provides a brief overview of the theoretical and methodological foundation to the thesis. Chapters 5, 6 and 7 provide details of the methodologies, results and analysis used in each of the three stages of the primary research of the thesis. Chapter 5 discusses the focus groups and online survey methodologies used in icon selection. The three emerging overarching themes from the icon selection data of spatial scale, pragmatic and intangible reasoning are discussed. Chapter 6 reports on the results of the icon modelling of the non-expert icons: the polar bear expert elicitation, the London Atlantis research and the Norfolk Broads Coastal Simulator research. The Chapter also reviews the literature on the expert icons of the West Antarctic Ice Sheet, ocean acidification and the Thermohaline Circulation. Chapter 7 reports on the icon evaluation workshop, specifically commenting on participants' knowledge and perceptions in relation to climate change. This Chapter then provides a detailed investigation into participants' intra- and inter-relationships with the expert and non-expert icons.

Finally, Chapter 8 brings together the analyses from each of the three stages of the thesis and discusses the conclusions in terms of individual engagement with climate change. The Chapter considers what makes both an engaging and a disengaging climate icon, and the benefits of a climate engagement approach rather than a climate communication approach is discussed. The final Chapter concludes with some methodological reflections and thoughts for potential avenues for future research.

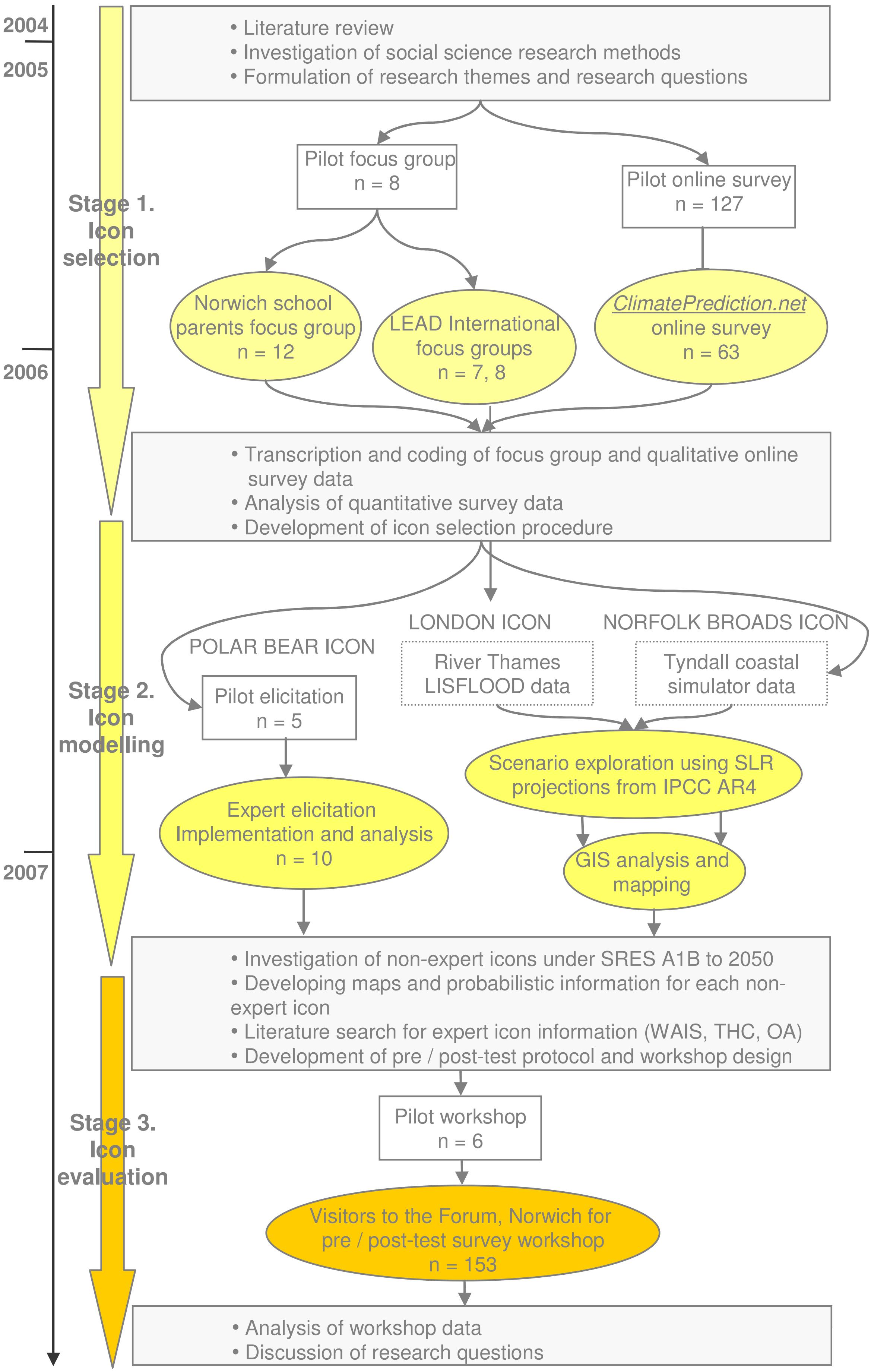

Figure 1.1 Thesis schematic diagram

CHAPTER 2:
EXPLORING PERCEPTIONS OF 'DANGEROUS' CLIMATE CHANGE

> *"Radical new methods of participatory research are necessary to truly elicit what level of climate change might be regarded as dangerous by different cultures, communities and constituencies. Much more needs to be done to recognise the importance of the social, cultural, institutional and contextual in the definition of danger."* (Dessai *et al.*, 2004: p 21)

The avoidance of 'dangerous' climate change is at the centre of international climate negotiations, forming a frame around which discourses on climate change are built. Thus it is necessary to review the concept of 'dangerous' climate change. First, the Chapter explores the concept of 'dangerous' climate change from the origin of the term to how it has been negotiated, and the influence of the concept on the non-expert discourse of climate change. A review of the metrics used so far to categorise 'dangerous' climate change is presented with the conclusion that 'danger' can not be categorically defined; and how new and socially relevant methods of engaging with the concept of 'danger' are needed. After this review, the term 'dangerous' climate change is not expressed explicitly, but it is used implicitly to frame the thesis research which follows. The Chapter then focuses on the tools used for engaging individuals with climate change. Lastly, the Chapter examines the agents that employ these tools.

2.1 UNDERSTANDING 'DANGEROUS' CLIMATE CHANGE

The following Section investigates the notion of 'dangerous climate change' and its context within non-expert perceptions. Before investigating 'dangerous climate change', the following Section consists of a necessarily brief review of the literature specifically relevant to this thesis on how the concept of 'danger' itself may be defined.

2.1.1 What is 'dangerous climate change'?

Danger may be one of the oldest concepts relating to threat to oneself, dating at least from Sumerian times (Ingles, 1991). Danger is typically defined as:

> *'Exposure to harm or injury; the condition of being exposed to the chance of evil, risk or peril'* (OED online, 2007)

It has been argued that danger is inherently linked to disorder (Douglas, 1966). Disorder implies disarray and disorganisation. Order implies that a restriction has been made from all possible options, and thus this limited selection infers less danger. Danger can be defined as that simply which disrupts normality (Lorenzoni, 2004), alternatively, it can be defined as an *'unacceptable risk'* (Hulme, 2000). It is noted that the determination of what constitutes danger is deeply normative (Schneider and Lane, 2005).

The use of the two terms 'danger' and 'risk' has become interchangeable in modern parlance (Douglas, 1980). Here, it is argued that the terms do have distinct meanings, but that the definition of these terms poses conceptual, logical and epistemological difficulties. One may categorise the difference between danger and risk as the difference between unrecognised and perceived risk (Luhmann, 1993). There are features which threaten humans but are not recognised, and thus are defined as danger; whereas conscious recognition of threat constitutes a risk (Pidgeon *et al.*, 2003). But, if danger is distinct from risk, in that risk comprises a recognised threat, does this make danger a phenomenon of unperceived threat? This makes the conditions under which danger is identified problematic. The overriding problem is that there is no clarification of the real-world conditions that can specifically define danger; 'risk' and 'peril' are simply semantic substitutions. Further definition of these substitution terms leads in turn to the same predicament (Pidgeon *et al.*, 2003).

Douglas (1966) defines danger in two forms, external and internal. An internal definition works subconsciously; she defines it as the 'psyche'. External definitions of danger must work consciously. These definitions also define controlled and uncontrolled power over danger. Internal danger cannot be controlled, but external danger can be wilfully manipulated. Dessai *et al.* (2004) define danger in the context of climate change using this external and internal demarcation. External definitions of danger are based on risk analysis of physical or social features, and so link to the definition of risk. Internal definitions rely on the danger being perceived or experienced in order to be appreciated as real, and thus relate to the categorisation of danger offered by Pidgeon *et al.* (2003). Barnett and Adger (2003) define danger in terms of the internal definition offered by Dessai *et al.* (2004), as a perception of insecurity - whether or not the threat is real or imagined. Lorenzoni and Pidgeon (2005) concur that a definition of danger must include that of danger as a perceived threat, and cannot be restricted to simply technical or risk-based criteria.

Perceiving danger involves recognising both the context in which the danger appears, and the processing of this information relative to other previous encounters with danger and their subsequent consequences (Barnett and Adger, 2003). Some have argued against the definition of danger as perceived, as one can perceive a threat when there is no real danger: our perception of danger is frequently incorrect[3]. Understanding what is perceived as dangerous also involves knowledge of what is valued by individuals. If an entity is greatly valued by an individual, the individual may consider the entity 'in danger' at a lower threshold than if the entity is less valued.

Different publics perceive different risks as more or less dangerous. An individual's perception of danger will determine how likely that person is to take a particular risk (Lorenzoni and Pidgeon, 2004). An individual's assessment of danger is not a rational process, but involves emotional aspects (Joffe, 2003): there are biases and heuristics inherent in risk estimation. As discussed in Section 2.1.2.3, for example, the 'availability heuristic' - the ability of the hazard to be recalled or imagined - can affect how dangerous a particular scenario is. Greater danger is often associated with risks which have not been experienced (Whitmarsh *et al.*, 2005). In addition, there appears to be a limit to how concerning a suite of potentially dangerous situations can be. A mechanism known as the 'finite pool of worry' effect (Linville and Fischer, 1991) illustrates that as concern for one issue rises, concern for another will decline.

2.1.1.1 The emergence of 'dangerous climate change'

Why is the concept of 'dangerous climate change' so important for the scientific and policy communities? The answer lies within the wording for the United Nations Framework Convention on Climate Change (UNFCCC), signed in May 1992 in New York. In the policy wording of Article 2, the Convention's objective is set out in Box 2.1.

[3] Comment made by anonymous discussant in an online discussion forum titled 'Dangerous climate change' initiated by S. Dessai (2004). See www.tyndall.ac.uk/forum/messages/archive/dangerous.html (accessed 11/11/04).

Box 2.1 The United Nations Framework Convention on Climate Change: Article 2

'The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to:

- *allow ecosystems to adapt naturally to climate change*
- *to ensure that food production is not threatened*
- *enable economic development to proceed in a sustainable manner.'*

(UNFCCC, 1992)

With the wording *'preventing dangerous interference'*, the signatory Parties agree that anthropogenic influence can affect the climate in ways that can be detrimental to society and ecosystems. By recognising that atmospheric greenhouse gas concentrations needed to be stabilised in order to avoid danger, article 2 legitimised climate change as a problem of international concern (Bodansky, 1993). The Convention also implies that international climate policy must anticipate the inevitable inertia in the climate system and deal with all the complex interactions involved, in order to find a common notion of 'dangerous' (Coffee-Morlot and Hohne, 2003). The wording above has angered some Parties to the Convention, who argue that the three focus points concentrate overly on Small Island States and on food security in Africa, whilst ignoring other priorities (Lorenzoni, 2004).

Several parts of Article 2 link with Article 3.3: the application of the precautionary principle when confronted with scientific uncertainty (Hare, 2003). Ott *et al.* (2004) states that when there are threats of serious damage from climate change which cannot be adequately compensated or that which is irreversible, lack of scientific certainty cannot be used as an excuse for avoiding commitment by any Party committing to the Convention under Article 3.3. Yet, the precautionary principle is not yet being applied in the context of dangerous climate change: mitigation targets such as the Kyoto targets finally ratified in February 2005 are merely a small step in an ongoing process, and as yet adaptive action has not been widely adopted. Even though 'dangerous' is not defined, this should not become a reason for inaction (Barnett and Adger, 2003).

Almost immediately from the publication of the Convention, the legal significance of 'dangerous' was questioned and the UNFCCC stabilisation objective queried as not legally watertight (Bodansky, 1993). Although some early proposals relating to reducing emissions phrased the Convention as a collective commitment, and the Secretariat categorised the proposals on objectives as 'general obligations' in a compilation document, when finally adopted Article 2 used declarative language and therefore compels no country to commitment (Bodansky, 1993). However, Bodansky (1993) asserts that Article 2 may be contained within the category of 'object and purpose' contained in the Vienna Convention on the Law of Treaties. If this is so, then those agreeing to the Convention would have a legal duty not to defeat the stabilisation objective.

More recently, Risbey (2004: p 1) has questioned why the term 'dangerous' was used in Article 2:

> *'What role has this concept to play? Is it as a form of placeholder or does it play more of a pernicious role as a kind of Protocol Trojan horse?'*

Risbey argues that 'dangerous' is probably a placeholder for a particular level of climate change not yet agreed by the convention: either due to a useful definition appearing unwarranted due to a lack of research, or because it was not politic at the time to do so, or for both reasons. The lack of definition of dangerous has been described as creating a 'zone of ambiguity' (Lorenzoni, 2004), from which many vested interests seek to gain.

Defining 'dangerous' in the context of climate change remains a *'critical international challenge'* (O'Neill and Oppenheimer, 2002). However, there is still widespread international agreement for preventing dangerous climate change according to Article 2 (Ott *et al.* 2004). Policy progress on this may be slow due to the complexity of understanding a system such as the global climate, and due to the uncertainties involved (Corfee-Morlot and Hohne, 2003). Nevertheless, negotiation of Article 2 is essential for future policy dialogue (Corfee-Morlot and Hohne, 2003; Yamin *et al.*, 2005).

2.1.1.2 The IPCC and 'dangerous climate change'

One of the aims of the IPCC Third Assessment Report (TAR) was to consider the evidence for Article 2 and assess the new scientific information and evidence as an input for policymakers, to aid determination of what constitutes ‘dangerous anthropogenic interference’ with the climate system (Smith *et al.,* 2001).

The TAR stresses that it is not the task of the IPCC to decide upon what metric, at which level, constitutes a dangerous level of climate change. Danger is defined by the IPCC as a *‘function of the degree to which effects are negative and the degree to which those effects are unacceptable’* (Smith *et al.*, 2001), i.e. at which point danger implies an unacceptable risk (Hulme, 2000). At which point the danger becomes unacceptable is what the IPCC terms a ‘value judgement’, and as such, is outside of the remit of the IPCC. The IPCC states its objective as reviewing the current climate scientific literature so as to provide information that is policy relevant, whilst being impartial to the knowledge presented, and presenting no recommendations or bias in its reports (Patwardhan *et al.*, 2003). However, some do maintain that no conclusions on dangerous climate change can be reached whilst the IPCC avoids the value-ridden debate surrounding dangerous climate change, citing a need for an ‘interactive forum’ between science and policy (Moss, 1995).

Instead of providing a definition for ‘dangerous’, the IPCC provided five ‘Reasons for Concern’ developed from the scientific literature. The Reasons for Concern were designed to aid the reader in making their own individual value judgement on what constitutes dangerous climate change. Smith *et al.* (2001) state that the Reasons for Concern (Box 2.2) can be used singly, or in combination. There is no attempt to combine them to generate a single ‘bottom line’.

Box 2.2 The Five Reasons for Concern

1. *‘Damage or irreparable loss of unique and threatened systems*
2. *The distribution of impacts*
3. *Global aggregate damages*
4. *The probability of extreme weather events*
5. *The probability of large-scale singular events such as the break up of the West Antarctic Ice Sheet or the collapse of the North Atlantic Thermohaline Circulation*

(Smith *et al.,* 2001: p 958)

The IPCC presents three caveats when using the five reasons for concern:

1. There is still substantial uncertainty about how effective adaptation will be (and could be) in ameliorating negative effects of climate change and taking advantage of positive effects
2. The effects of changes in baseline conditions, such as economic growth and development of new technologies, that could reduce vulnerability has not been adequately considered in most impact studies
3. Most impact studies assess the effects in a stable climate, so our understanding of which rates of change may be dangerous may be limited

Corfee-Morlot and Hohne (2003) advocate building on the reasons for concern, using 'benchmark indicators of risk' for every area, through local and regional climate impact information. They maintain that these could be used to help guide policy decisions about mitigative actions for the longer term. Nevertheless, the concept of 'danger' itself will not be categorically defined by the IPCC.

2.1.1.3 Exploring the concept of 'dangerous climate change'

The IPCC has so far taken a natural science focussed approach to exploring what 'dangerous' climate change means. Yet Parties may use the lack of agreement on what constitutes dangerous climate change as justification for inaction such as the US:

> *"No-one can say with any certainty what constitutes a dangerous level of warming, and therefore what level must be avoided."* US President George W. Bush (11th June, 2001)

'Certainty' may only increase gradually over time, and whilst waiting for scientific certainty to emerge, a lack of emissions regulation may indeed lead to dangerous climate change. The value judgement imposed by using the term 'dangerous' was recognised by Moss (1995). Whilst the natural sciences have a key role to play in estimating climate risks, it has been argued that a full understanding of Article 2 will need to draw on the social sciences, psychology, law, and ethics (Oppenheimer, 2005) as well as appreciate societal and individual perceptions of danger (Dessai *et al.*, 2004). It has been suggested that gaining societal support for emissions regulation whilst a dangerous emissions limit cannot be categorically defined would be difficult. However, the public currently accepts imposed limits for unknown risks such as car safety, cancer and nuclear power far lower than what is currently accepted for the probability of dangerous climate change

(Mastrandrea and Schneider, 2004). Risbey (2004) expands on the different perspectives that impact on how dangerous climate change is perceived (Box 2.3).

Box 2.3 Circumstances leading to different definitions of 'dangerous'

1. *Points of view (attitude to risk, compassion, political commitments etc.)*
2. *Points of stance (manifest as different impacts in different places)*
3. *Impact selection and metric (impacts both human and natural systems, measurement?)*
4. *Impact timeframe (generally increase the danger as the longer the time frame)*
5. *Uncertainty (allows disagreement over fairly large range of potential dangers)*
6. *Ignorance (we may have no comprehension of what is to happen, we cannot put thresholds up to dangers we are not yet aware of)*

(Risbey, 2004: p 2)

Before discussing what could be considered dangerous, it is constructive to consider the different types of danger associated with climate change. Dessai *et al.*, (2004) argue that understanding of both the internal and external definitions of danger is needed in order to fully comprehend dangerous climate change as stated in Article 2:

- External definitions are usually based on scientific risk analysis, performed by experts, of system characteristics of the physical or social world.
- Internal definitions of danger recognise that to be real, danger has to be either experienced or perceived - it is the individual or collective experience or perception of insecurity or lack of safety that constitutes the danger.

External risks present an expert view of risk, whereas internal definitions are more personally centred. Dessai *et al.* (2004) argue that for non-experts to recognise danger, it must be either experienced or perceived. This is corroborated by Leiserowitz (2004) who found American non-experts were highly unlikely to undertake personal actions until they perceived climate change as a situated risk.

The occurrence of internal and external definitions of danger leads to two different paradigms. The first, a top-down, linear approach, uses future socioeconomic scenarios as inputs to a series of hierarchical models. These assessments typically define danger in terms of physical measures, threats to the function of the non-human world, or in terms of people at risk or reduction in economic welfare. These assessments often assume no adaptation (Dessai *et al.*, 2004). According to Hare (2003) a top-down approach typically focuses on avoiding changes of a greater magnitude than have been discovered in the palaeoclimatic record of the last few interglacial periods. A bottom-up approach investigates the vulnerability of societies or individuals to present-day climatic variability and possible future climate changes by investigating their ability to adapt (Dessai *et al.*, 2004). Scenarios can then be assessed in regard to the adaptive capacity of the examined system (Hare, 2003).

If a particular level of climate change exists which is deemed 'dangerous', then it logically follows that there must also be a level deemed 'safe'. Brooks *et al.* (2004) maintain that defining any level of climate change as dangerous is unethical, as it condones all deaths under this threshold – presumably occurring under a 'safe' climate change. An extension to this would imply that if a dangerous (and thus a safe) climate change exists; it should follow that a dangerous, or safe, climate exists. Yet this does not appear to be the case: the lack of a safe climate is demonstrated with respect to current climatic conditions and hurricanes. Is a hurricane ever 'safe'? Kovats *et al.*, (2004) also argue a similar case for climate change and health, as even current climate variability is not adequately dealt with by current healthcare systems. Hulme (2004) maintains that climate has always been 'dangerous' and will continue to be so. The lack of a safe limit to emitting greenhouse gases makes avoiding dangerous climate change increasingly urgent (Allen and Lord, 2004).

Ethical considerations are paramount in exploring dangerous climate change. Schneider and Lane (2005) recognise three areas in which there is likely to be inequity, and hence difficult ethical decisions to be made; inter-country, intergenerational, and inter-species inequity. One's cultural values and knowledge of climate change will have impact on how dangerous climate change is perceived. Also, the ability to adapt to change, either personally, or collectively - for example as a country - may contribute to how one defines dangerous (Vlek and Steg, 2004).

Although it may be widely recognised in the scientific community that an understanding of dangerous climate change involves value judgements - and thus is outside of the scope of science – politicians still look to scientists to aid in defining dangerous climate change. Prime Minister Tony Blair commissioned a symposium in Exeter, UK, in 2005 to encourage scientific debate on Avoiding Dangerous Climate Change. Yet scientists at the symposium saw the defining of 'dangerous' as principally a political task (Pearce, 2005). PM Blair structured the symposium debate around three considerations of 'danger':

1. Incremental changes in average climatic conditions to which either migration or adaptation is a possible option
2. The effect of changing extreme conditions, such as the 2003 heat wave in Europe
3. Waking the 'sleeping giants' e.g. melting of the Greenland Ice Sheet (GIS) or the West Antarctic Ice Sheet (WAIS)

Blair asked scientists to consider *'exactly how much climate change was self-evidently too much'*: language used to echo the American Constitution and thus appeal to the US. Attempting to use a scientific symposium to answer this question has been challenged, however. Yamin *et al.*, (2005) argue that what an individual comes to regard as self-evident is in effect completely dependant on how the individual interprets dangerous climate change, and how this fits with their world view.

2.1.1.4 Measuring 'dangerous' climate change

Deciding what constitutes 'dangerous climate change' may involve formal or informal assessments of risk. This risk can be assessed through impact measures, and on different aggregations of social, cultural or natural systems (Oppenheimer, 2005). These risk assessments are referred to here as metrics: defined as an environmental objective which is stated in terms of some measure of climate damages and their distribution (Oppenheimer and Petsonk, 2004). Possible metrics include monetary cost, number of people affected or social costs like the loss of a unique culture. Risbey (2004) recognises that dangerous can be defined in many ways (Box 2.3), and the choice of metric - or measurement of the impact – has a significant impact on how danger is defined.

A Cost/Benefit Analysis (CBA) approach has been used to try and estimate the costs of mitigation and adaptation to climate change against a Business-As-Usual trajectory (Lomborg, 2005). However using CBA for climate impact analysis is controversial, as it works on a purely economic basis. Climate, by its global nature, has social and environmental as well as economic impacts (Schneider *et al.* 2000). Some impacts such as irreversible damages through species loss cannot be given an economic value (Oppenheimer and Petsonk, 2004). In addition, ethical problems occur when using metrics such as the Value of a Statistical Life (VOSL) for a CBA. VOSL is based on a willingness to pay for increased safety. For example, using this purely economic tool, poor developing countries have a VOSL 15 times less than a developed country.

The principal underlying a CBA is an aggregated market power form of utilitarianism i.e. the greatest good for the greatest number of dollars in benefit/cost ratios (Schneider and Lane, 2005). Climate impacts will manifest themselves differently in different parts of the globe, and is likely to add to greater disparity between the rich and the poor: hence global averages can be deemed meaningless (Schneider *et al.*, 2000). For example, an economically neutral, but ethically unacceptable situation could occur where more developed countries get richer and less developed, poorer.

Integrated assessment models (IAMs) are increasingly used within the climate modelling community. It has been argued that as IAMs provide a numerical output, they can be directly used in considerations of what may be 'dangerous' (Smith *et al.* 2001). However, imaginable climate surprises, let alone those not even known about, are not adequately represented in IAMs (Schneider, 2001). IAMs also only use select measures of impacts which are in no way comprehensive (Smith *et al.* 2001). Also, IAMs do not solve the problem of not knowing future socioeconomic and physical changes (Brooks *et al.*, 2004).

Schneider and Lane (2005a) propose that in contrast to CBA approaches, a different type of metric, or group of metrics, should be implemented (Box 2.4).

Box 2.4 The 'Five Numeraires'

1. *Monetary loss*
2. *Loss of human life*
3. *Degraded quality of life*
4. *Species or biodiversity loss*
5. *Mal-distribution / equity*

(Schneider and Lane, 2005b)

The Five Numeraires are examples of justice-orientated metrics. Lane *et al.* (2005) suggest that not only should absolute costs be examined in the case of the five numeraires, but also that relative costs – for example, relative to a country's GDP, or species loss relative to the number of species in that family - should be examined (Schneider and Lane, 2005).

A possible method of measuring ‘dangerous’ climate change is through utilising impact metrics, with those that contributed least to the climate change problem probably the ones facing the worst consequences (Schneider and Lane, 2005). An impact metric may explore physical, social or cultural thresholds of danger. For example, physical thresholds may investigate danger in relation to GIS ice sheet collapse (Oppenheimer and Alley, 2005), social thresholds the migration from small island states (Barnett and Adger, 2003) and cultural thresholds the impact of climate change on Inuit traditions (Rosentrater *et al.*, 2004). Some impact studies have started to use several metrics together in an analysis. A broad-based, multiple metric approach provides a preferable approach to those focusing solely on market damages (Schneider and Lane, 2005). Integrated approaches to investigating dangerous climate change through impact metrics have been used by Parry *et al.* (2001) in the ‘Millions at Risk’ framework, where a set of global change scenarios were used to investigate the impact of climate change on ecosystems, food security, water resources, malaria and coastal flooding.

A common impact metric is the level of warming required to melt the GIS or WAIS, causing eustatic sea level rise of 4-6m and 7m respectively (Oppenheimer and Alley, 2005)[4]. Impact metrics investigating species loss, ecosystem loss and landscape change have also been used (e.g. Leemans and Eickhout, 2004). For example, a mean global increase of 2˚C would cause mass devastation of coral reefs through bleaching (O'Neill and Oppenheimer, 2002). This level of warming may also be used to define danger in the context of Arctic sea ice melt, with associated impacts on seals and polar bears, and on Inuit culture (Rosentrater *et al.*, 2004). Climate change is likely to have a deleterious effect upon global forests, especially areas such as the Brazilian rainforest (White *et al.*, 1999). At present, these forests provide carbon storage, if not carbon sinks. So therefore, a threshold could be reached where these forests are no longer viable; in itself perhaps ‘dangerous’ in the context of species loss, but also because the forests may then become sources of carbon - a potentially ‘dangerous’ feedback mechanism.

High altitude glaciers have been used as impact metrics for exploring dangerous climate change. The UN warned in 2002 that 40 Himalayan glacial lakes were dangerously close to bursting after large volumes of water had been released from the glaciers upstream (Reuters, 2005). There is a lack of monitoring on these rivers and lakes, so it is not known how close to a dangerous climate change we are (FoE, 2004). There is also a large social

[4] The implication of this commonly-used impact metric is that melting of either ice sheet is self-evidently dangerous but this assumption is questioned, as the social and cultural context is not taken into consideration.

cost associated with this glacial retreat, as millions in India and Bangladesh rely on Himalayan rivers such as the Ganges. In addition, the Ganges is a holy river for Hindus, and thus any threat to its glacial source has cultural as well as economic and social consequences.

Definitions of ‘danger’ less frequently focus exclusively on possible social impacts of climate change. A novel impact metric approach to calculating the effect of climate change upon tourism has been developed (Viner and Amelung, 2005). Barnett and Adger (2003) investigate how sea level rise, sea surface warming, and an increase in extreme weather events is likely to put human inhabited coral atoll islands at risk of climate change. This poses a risk to the inhabitants of the islands by challenging their national sovereignty. The threshold may be recognised when international migration from the atolls reaches a certain ‘dangerous’ level.

There are a number of inherent difficulties when using impact metrics. The impact metric provides only the catalyst for an exploration of what is considered ‘dangerous’ climate change. For example, with respect to water availability (from Parry *et al.*, 2001) questions arise such as: how large must a region be before a water deficit “counts”? How do multiple but less severe water deficits rate against each other? How does a water deficit risk stand in relation to the examined population’s vulnerability? And importantly, are the impact metrics weighted so they can be compared? (Oppenheimer, 2005). An inherent difficulty with using impact metrics is simplification of the real-world situation, occurring even from the outset when deciding on the individual metrics to be used. Therefore, whilst impact metrics provide a useful method of exploring ‘dangerous climate change’, the negotiation of a definition of ‘danger’ still requires recognition that the process involves value judgements, as other embedded values are lost.

The literature reviewed above suggests that ‘dangerous’ climate change can never be categorically defined. Thus, the process of negotiation is more important than the definition itself. If this is the case, then leaving ‘dangerous’ as a placeholder in the UNFCCC negotiations was a politic move designed to encourage space for dialogue and negotiation rather than to produce a definitive classification of the term. Any negotiation of ‘dangerous climate change’ will need to account for a balance between different types of danger (Ott *et al.*, 2004). For example, a danger to the climate may be offset by reducing emissions, but in the short term, this may lead to an economic threat. Parry *et al.* (2001) wrote that economic threats might be more politically accepted should one know the potential climatic threat that would be avoided, in order to calculate the 'pay off'. The Stern Review (2006) explored this, investigating the economics of climate change for the UK and calculating the cost for inaction. Yet the Stern Review has not galvanised action on climate change, despite the Review's conclusion that inaction is more costly than action on climate change. Impact metrics provide a more explorative method of investigation, but may fall short of engaging perceived or internal definitions of risk. It is suggested here that this is due to a lack of holistic understanding of what individuals consider 'dangerous'. Instead of purely natural scientific, or risk-based criteria, a post-normal approach is needed which would allow different social, cultural, institutional and contextual interpretations of 'dangerous' climate change to be considered.

From this point, the term 'dangerous' climate change is not used explicitly. However, the notion of 'dangerous' climate change is used implicitly as a frame around which the review of public engagement with climate change is based. The next Section considers individuals' conceptualisation of climate change, and the tools and agents which influence an individuals' engagement with the issue.

2.2 TOOLS AND AGENTS FOR ENGAGING INDIVIDUALS WITH CLIMATE CHANGE

2.2.1 Tools for engaging individuals with climate change

Four tools which have been used in the communication of climate change are examined here: imagery, narratives, probabilities and scenarios. Images and narratives are argued to have a powerful impact on the experiential processing system as they are emotionally engaging and represent events in a similar manner to how they are experienced in everyday life (Epstein, 1994). Probabilities and scenarios are the communications tools typical of the communication of climate science. The four approaches are investigated with respect to their impact on the non-expert's conceptualisation of climate change.

2.2.1.1 Imagery

The advantages of using images are documented by Nicholson-Cole (2004). Imagery is eye-catching, and may provoke an emotional response. Images are easier to remember than text, and can condense complex information into a simple format. For example, global temperature changes can be easily signified through a coloured map, with red indicating hotter and blue, cooler temperatures. Images avoid the need for scientific jargon and expert language often associated with climate change (Leggett and Finlay, 2001). Imagery can still be used as a communications device when there are difficulties with literacy or language barriers exist (Nicholson-Cole, 2004). Using imagery for climate change communication has a long history. Early in the 20th Century, palm trees juxtaposed onto glacial scenes were used to provide a dramatic illustration of climate change (Bronnimann, 2002). Most forms of mass communication are now saturated with images (Deacon *et al.*, 1999).

Climate change imagery is often intended to provoke an emotional response such as fear or dread. Alarmist climate change imagery was a central part of the pictography used for the Green Party in their 2005 election campaign. A pamphlet for the Norwich area showed a flooded local street, whilst the caption read: *'Want urgent action on climate change?'* (Ramsay, 2005). This message was reinforced in national level campaigning, where a pamphlet showed 'the British Isle' [sic] with Ireland completely inundated and a much flooded coastline around Britain. The text read: *'sea levels are predicted to rise at alarming rates due to global warming'* (Wootton, 2005).

As discussed in 2.1.1.1, environmental NGOs frequently use alarmist imagery. Doyle (2007) notes that since 2002, two distinct campaign strategies can be identified from Greenpeace's climate change literature. The first utilises imagery of glacial habitats and their vulnerability to climate change, whereas the second promotes renewable energy by focusing on local or national level imagery of flooding and heat waves. Doyle argues that despite these two different threads, glacial images have come to dominate the symbolic imagery of climate change. This dichotomy of glacial, distant and alarmist imagery set against positive, local and solutions-led imagery may undermine Greenpeace's efforts to communicate effectively with the public. Similarly, the media also favour alarmist climate imagery despite the lack of saliency that this imagery lends to the climate narrative. Media interest tends to focus on the photogenic (Yearly, 1996). An example of this is provided by imagery of polar bears which have been viewed as the *'poster boys of global warming'* (Garfield, 2007).

Catastrophic images of climate change have become common. Weingart *et al.*, (2000) demonstrate that the image of the half-submerged Cologne cathedral has become iconic of the threat of climate change in Germany. This scenario is very unlikely under the timescales the public can conceptualise. Baldwin and Charter (2005: p 9) argue that imagery of glaciers melting or sea levels rising are *"about as interesting as watching paint* *dry"*, indicating a lack of saliency when using these images for communication with the public. Baldwin and Charter suggest imagery of famine and disaster carry far more impact. However, as is argued in Chapter 3, these groups of images are also likely to lower saliency, by increasing a feeling of alienation from climate change.

Nicholson-Cole (2004) investigated the types of images that promoted feelings of saliency and efficacy. Her results mirror that of Macnaghten (2003). Participants were found to have much to contribute to the mental imagery of climate change, yet most had little sense of personal salience or efficacy. The images that strongly communicated the importance of climate change were seen as disempowering. Images that encouraged action did not promote feelings of saliency. Macnaghten (2003) found pristine natural images such as whales and natural forest illustrated with captions such as *'it's in our hands'* produced an instant emotional response, but the feeling was largely superficial and did not lead to greater involvement with the issue. Nicholson-Cole (2004) argues that overexposure to emotional imagery such as this can lead to 'issue fatigue'. Issue fatigue may not necessarily mean that people are tired with interacting with the material. Often, it is because of these emotional appeals that people feel a sense of powerlessness, and it is this which may cause disengagement. Nicholson-Cole found that the most empowering imagery was a combination of the images that promoted feelings of salience and efficacy.

2.2.1.2 Narratives

Narratives provide a powerful communication method, defined here as an account of a series of events or facts, given in order and with the establishing of connections between them, as in the form of a story (OED online, 2007). This Section focuses on written and spoken narratives.

Much has been made of the film *The Day After Tomorrow* (Emmerich, 2004) as a vehicle for communicating climate change. For example, Friends of the Earth hoped it would *'create a sense of urgency to fight climate change in the real world'* (FoE, 2004). The narrative depicts an abrupt and catastrophic climatic change into an ice age, through the mechanism of Thermohaline Circulation shutdown. The plot focuses on the dramatic, even on the apocalyptic. Characters are forced to flee their homes in a fight for survival. Climate change as a dramatic vehicle for a narrative is also utilised in fiction. *Floodland* (Sedgwick, 2001) is a novel aimed at young teenagers. Teenage Zoe, abandoned by her parents, is left to survive amidst lawless chaos after a catastrophic sea level rise floods England. The narrative is bleak and the ending suggests society has broken down under this particular vision of climate change. *Ivan's Appeal* (Drury, 2007), a children's book aimed at 8-11 year olds, follows a more positive story of Ivan the talking iceberg. Ivan successfully appeals to two children visiting Antarctica to change their lifestyles and convince wider society of the need for action on climate change.

Lowe *et al.* (2006) examined how cinema-goers were impacted by *The Day After Tomorrow*. The public's attitudes were affected, as viewers were significantly more concerned about climate change immediately after seeing the film. Yet, whilst anxiety increased, viewers' beliefs in the likelihood of extreme events through climate change were reduced. Cinema-goers also experienced difficulty in distinguishing scientific facts from the dramatised science fiction narrative. This suggests that whilst disaster-focused climate narratives engage and concern the public on a superficial level, they may cause confusion between science fact and science fiction, and distance the public from a more meaningful engagement with the issue.

The use of language is of great importance in narratives:

> *'The greenhouse effect, global warming, global climate change: the environmental phenomenon so important that it needs three names.'* (Trumbo and Shanahan 2000: p 199)

Each description carries different associations. The 'greenhouse effect' and 'global warming' are powerful metaphors (Carvalho and Burgess, 2006). Whitmarsh (in press) carried out a public attitudes survey investigating flood risk. Half the sample used a questionnaire using the term 'climate change'; the other half completed the survey with the term 'global warming'. Significant qualitative and quantitative differences were found between the two samples, with more concern over 'global warming' worded surveys than 'climate change'. Importantly, a significantly higher proportion of respondents mentioned rising temperatures as a response to the survey worded 'global warming' than 'climate change' in Whitmarsh (in press). Public reaction to information worded 'global warming' rather than 'climate change' may also evoke a higher response rate. Whitmarsh also notes how although media coverage uses both terms, 'global warming' is most often used. This contrasts with the scientific and political communities, where 'climate change' is the preferred term. It should be recognised that the use of terminology is not neutral. The terms 'greenhouse effect', 'global warming' and 'climate change' invoke different responses from individuals, and thus the terms should not be used indiscriminately.

The use of language in narratives is not restricted to naming of the overall issue: the same effect has been found when investigating the use of terms in sustainability studies. 'Alternative energies' had negative implications, with an insinuation of opting out, and there was public mistrust of the term 'sustainable' (Leggett and Finlay, 2001). As has been discussed, narratives in the media and from environmental NGOs often focus on the use of dramatic words or phrases. For example, a month-long series of climate change programmes from the BBC termed the *'Climate Chaos Season'* ostensibly was aiming to *'engage and inform viewers about climate change'* (BBC, 2006). However, it is argued here that these sorts of narratives do little to engage, and instead prevent the public from more meaningful engagement. It is imperative that these issues around narrative construction are recognised, and that narratives which promote a more salient involvement with climate change are used in their place.

2.2.1.3 Probabilities

Probabilities are defined as a numerical representation of the extent to which a particular event is likely to occur (OED online, 2007). Sarewitz *et al.*, (2004) note how the provision of climate change probabilities could lead to more informed decision making. The non-expert is increasingly provided with risk information presented in probabilistic terms. This implies that individuals actively receive risk information, and use a rational, logical system to discriminate between different risks. However, research indicates that risk is 'socially constructed' (Douglas, 1966). That is, how individuals perceive and respond to risk is due to personal interests, cultural and moral values, and social and institutional differences. Because of this transformation due to the social construction of risk, risk as expressed through a probabilistic framework will be interpreted differently by each individual.

Using probabilities in climate change communication poses particular challenges. An individual's assessment of risk will be subject to 'heuristics' or cognitive shortcuts used to process the risk information presented. These can introduce biases into the public's assessment of risks, which then differ from official risk estimates (Whitmarsh *et al.*, 2005). Heuristics can affect the types of risk that the public are prepared to accept, and those which are deemed unacceptable. The public tend to find risks that are involuntary and out of one's own control more worrying and less acceptable. This may explain why individuals accept risks around smoking and driving, but are concerned about flood risks (Whitmarsh *et al.*, 2005).

Individuals tend to under-estimate their chance of experiencing negative events. This phenomenon is known as the 'availability heuristic'. If individuals regularly experience a beneficial risky activity without harm, such as driving without wearing a seatbelt, then this can act to reassure the individual, decreasing the perceived probability of harm. The probability of being injured in an accident whilst not wearing a seatbelt on one trip is very small. Whilst the probability remains so low, together with the availability heuristic mechanism, individuals may discount the risk entirely (Slovic *et al.*, 1978).

There is evidence that a significant proportion of people have difficulty understanding numerical risk (see Lipkus and Hollands, 1999). For example, Gigerenzer *et al.*, (2005) found when asked what the simple probabilistic statement 'a 30% chance of rain tomorrow' meant, a majority of participants were incorrect. Cognitive biases and a lack of probabilistic understanding can also affect how an individual reacts to an opportunity to reduce numerical risk. For example, it may be more difficult to convince individuals of the worth of reducing one risk from 45% to 30%, than another risk reduction of 0.01% to 0.005% (Patt and Schrag, 2003). Very small probabilities present other difficulties. Individuals are more sensitised to small changes in probability, such as the difference between 0 and 1 deaths, than larger changes further away e.g. the difference between 500 and 600 deaths (Slovic *et al.*, 2004).

Scientifically accepted standards of probabilistic communication may not be of use when communicating with a lay audience. It can be difficult to communicate the probability of a 1 in a 100 year flood, or what the differences in inundation between a 1 in 100 year and a 1 in 20 year flood would be (Hulme, 2004). Conceptualisation of these types of probability may mean that non-experts assume the flood will not happen for 20 years, and will only happen once during that time.

The language used to describe uncertainty can greatly influence the way risk information is conceptualised, particularly whether it is framed in either epistemic or stochastic terms (Dessai and Patt, 2005). When describing high frequency events, people offer probability estimates along the full interval from zero to one, whereas for epistemic uncertainty, risks are much more likely to be expressed as an estimate of 0.5, as in 'a fifty-fifty chance' (Bruine de Bruin *et al.*, 2000). An attempt to provide a useful communication method using probabilities has been developed by the IPCC (IPCC 2001, 2007b). A Table is provided in each report which specifically links probabilistic language (e.g. 'very likely') with a numeric probability of occurrence (e.g. more than 90%). This allows readers to choose the scale, numeric- or language-based which they prefer, whilst providing a reference for distinguishing risk probabilities in both methods.

The manner in which probabilities are phrased can also act to increase or decrease concern. Slovic *et al.* (2004) asked two groups of people to assess the attractiveness of purchasing new equipment to aid in the crash landing of an aeroplane. One group was told that the new equipment would save 150 lives, the other were told that it would save 98% of 150 lives. Though the first option saves more lives, support was higher for the second option. Slovic *et al.* concluded that this is because saving such a high percentage of something is clearly very good, whereas saving 150 lives is diffusely good, and hence only weakly evaluable.

An examination of the difficulties of using probabilities when communicating climate change to the non-expert may suggest it wise not to use probabilistic information at all. Yet, the public may distrust a lack of probabilistic information. Whilst studies such as Stott *et al.* (2004) have attributed a very likely human influence at least doubling the risk to a heat wave such as that in Europe 2003, probabilities cannot be attributed to particular weather events. The Sun newspaper (The Sun Online, 2007) attempted to attribute a month of exceptionally heavy and prolonged rainfall to climate change when interviewing a climate scientist. The scientist noted that it is impossible to attribute global warming to specific events. Whilst this is common practice in scientific discourse, it can cause communication difficulties with the public. Public comments posted online after this newspaper article suggested that scientists were too arrogant to state that they didn't know the probabilistic basis for the suggestion.

Whilst new methods for communicating climatic probabilistic information such as Probability Density Functions (IPCC, 2007b) are being developed, these are of limited use for communicating with the public. Quantitative probabilities are used in climate communication as it is believed they provide more precise, useful information to the public that qualitative risk statements (Gigerenzer *et al.*, 2005). This is only the case when probabilistic information is carefully considered. Presenting probabilities as the chance of occurrence experienced over a long time period may help trigger concern (Slovic *et al.*, 1978). Additionally, probabilities need to be 'infused with affect': i.e., probabilities need to be given emotional meaning, or the public may not act upon even the simplest probabilistic information (Slovic *et al.*, 2004). Lastly, the influence of common heuristics must be taken into account when using probabilities for communicating climate change.

2.2.1.4 Scenarios

A 'scenario' may be defined as an outline or description of an imagined situation or sequence of events (OED online, 2007). A 'climate scenario' is more thoroughly defined as:

> *"A plausible and often simplified representation of the future climate, based on an internally consistent set of climatologically relationships, that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change'*
>
> (IPCC, 2007c: p 872)

A 'climate change scenario' is thus the difference between a climate scenario and the current climate. Most climate change scenarios combine elements of both a qualitative storyline and quantitative modelling (Doll 2004). They provide a top-down, linear approach (Dessai and Hulme, 2004) to communication. Groups of scenarios are often used to explore a range of possible climate futures.

There are four possible ways to construct future climate scenarios (Carter *et al.*, 1994):

1. Spatial analogues
2. Historical analogues
3. Incremental changes
4. Quantitative scientific modelling

Spatial analogues involve comparing a present-day climatic regime to another and through this constructing a possible future climate scenario, such as comparing the future climate of London to present-day Bordeaux. Historical analogues work in much the same way. Instead of spatial comparisons, inferences are made to climate regimes from the past, say comparing the global mean temperature of the present Holocene interglacial to the last interglacial, the Eemian (e.g. Imbrie and Imbrie, 1979). The third method involves exploring the impact of incremental changes on the climate regime. This can be examined through sensitivity analysis and by investigating different thresholds. Quantitative scientific modelling comprises several methods for exploring different forcing conditions including using General Circulation Models (GCMs) and regional modelling, downscaling and weather generated models.

Spatial analogues can be weak as many other factors may play a part in creating the climatic conditions, and physical and cultural connotations, experienced at a particular site. It is also difficult to find a historical period which provides a meaningful analogue for another. If analogues are carefully made they may be of some use in the communication of potential climate futures to the public. Hallegatte *et al.*, (2007) used several well-defined temperature and precipitation criteria to search for analogues to 17 European cities. They selected the scenarios from two climate models. Analogues, such as the comparison between present-day northern coastal Portugal and London, were designed to be used as a 'heuristic tool' to investigate adaptation to climate change. It does still presents a simplification of the impacts of climate change: the UK public may notionally welcome the prospect of the Portuguese climate, for example, but this may be countered if information is also provided on the costs for adaptation. Whatever additional information is provided though, this approach is considered of limited use as it heavily discounts the relationship between climate and culture.

The Special Report on Emission Scenarios (SRES) (Nakicenovic *et al.*, 2000) were designed to inform climate policy through the provision of emissions scenarios. Each scenario provides a study of a particular set of forcing conditions and their possible effect upon future climate (Hulme *et al.*, 2002). The SRES develop along four pathways, or 'families' with the scenario development dependant upon the inputs of demographic, social, economic, technological, and environmental factors (Nakicenovic *et al.*, 2000). Within each family, there are a variety of different emission scenarios. The SRES storylines were designed to represent very different socio-economic and environmental attitudes (Viner and Turnpenny, 2002). Feedbacks or extreme events are not accounted for in the storylines. Because of the different demographic, social, economic, technological, and environmental factored into each scenario, policymakers can more fully explore the impacts a future policy may have. The scenarios were purposely designed to be 'agnostic'. No probabilities are attached to the different scenarios; scenario A1 is simply the 'first among equals' (Nakicenovic *et al.*, 2000).

The IPCC justify the use of the SRES as providing an exploration of potential future climates which are easily understood by non-experts. As stated, the purpose of the SRES was to inform policy, rather than to inform the public. Whilst the SRES provide a well developed example of scenarios as a communication tool, it is argued that the SRES themselves do not provide an easily understood communication method for the public. There is some superficial attraction in the analogue approach taken by Hallegatte *et al.*

(2007), although as noted, this approach also has inherent difficulties. Providing the implication of these factors are carefully considered for communication, scenarios can provide a more scientifically robust method for imagining future climate change then narratives or imagery and may provide an important tool for exploring decision-taking (Hulme, 2004), but remain of limited use for engaging individuals with climate change.

2.2.2 Agents engaging individuals with climate change

This last Section examines why different agents are involved with the climate change issue, how they mediate the climate discourse, and how the public responds to the information they provide. There are many agents involved in influencing the public perception of climate change, whether this act of communication is undertaken knowingly or not. This Section focuses on five main agents: environmental Non-Governmental Organisations (NGOs), education, government, business, and the media. Environmental NGOs and the UK government have invested considerable resources in the communication of climate change, and climate change is now becoming a part of mainstream geography education. Businesses are increasingly seeing climate change as both a business risk, and a marketing opportunity. The media have a slightly different role. They interpret climate information provided by other sources, and reframe the discourse according to a particular world view; influencing citizens' awareness, attitudes and actions towards climate change (Slovic, 2000).

2.2.2.1 Environmental NGOs

Environmental NGOs have played a significant role in the communication of climate change to the public. NGOs are in a privileged position for communicating climate change, as the public place more trust in NGO scientists than in either industry or government scientists (Farrow, 2000). Established NGOs such as Greenpeace, Friends of the Earth (FoE) and the World Wide Fund for nature (WWF) have incorporated climate change into a central tenant of their campaigns. Greenpeace (2007) state they have:

> *"identified global climate change as one of the greatest threats to the planet"*

WWF (2007) have stated that:

> *"humanity is facing the biggest threat to our planet"*

and similarly, FoE (2005) call climate change the:

“single biggest environmental threat facing the planet”

In common to all the established NGOs is the framing of climate change around the rhetoric of threat and implied global danger.

Farrow (2000) reports of the past difficulty in engaging the public in climate change. She states that NGOs have had to relate climate change to the non-expert in order to promote engagement with the issue. However, there is a tendency for NGOs to continue with old-style communication methods which have been previously found effective. For example, the FoE climate change homepage (FoE, 2005) has as its central image three people fleeing a falling timber house as it is swept away with the force of Hurricane Katrina. Mike Childs, the Campaign Director for FoE (pers. com. 2005) maintains that the public must be ‘shocked’ into acting on climate change. However, as discussed by Moser and Dilling (2007) and in Section 5.4.1.1.3, such appeals are likely not lead to the intended behavioural or attitudinal change but to denial or apathy.

Established NGOs attempt to motivate behaviour change through commitment changes, such as signing pledges to reduce energy usage. WWF (2007) states on its website:

“*make a commitment, sign a pledge*”

whilst FoE (2005) suggests energy saving solutions in

‘*brainy ways to beat climate change*’

These NGOs also encourage lobbying for political commitment. FoE (2005) state:

“*much can be done to stop catastrophic climate change but decisive action is needed from governments and industry now*”

FoE (2008) have also implemented ‘the big ask’ campaign. Whilst FoE recognise the UK as a frontrunner in implementing a climate change law with legal binding targets for reducing emissions, the big ask encourages individuals to add their voice to a campaign for a law that also includes emissions from aviation and shipping. They state that this would lead to a ‘ground-breaking […] fantastic climate law’.

In some cases, NGOs have been involved in corporate initiatives, such as the Ben and Jerry's and WWF Climate College (Ben and Jerry's, 2007) and the WWF and Marks and Spencer CO2 footprint calculator (WWF, 2007).

From 2000 onwards, established environmental NGOs have been joined by one-issue climate change NGOs. These groups, such as Campaign Against Climate Change (CACC), Rising Tide and the coalition Stop Climate Chaos (SCC) often have a more radical agenda than the established NGOs. The rhetoric of fear is taken to the extreme, with stated aims such as (emphasis added):

> *"push for the urgent and radical action we need to prevent the **catastrophic** destabilisation of global climate"* (CaCC, 2007)

> *' [to] mobilise public concern, and through this the necessary political action, to stop **climate chaos**"* (SCC, 2007)

Action already taken on climate change is rejected by the climate change NGOs as inadequate. For example, Rising Tide argues that the Kyoto Protocol will fail as the emissions cuts are too low and market mechanisms are unable to support the change required. SCC state that through their campaign "*nothing on this scale has been attempted before on climate change, but anything less is unlikely to be successful*". More marginal groups such as Rising Tide have also disregarded large corporate events which are supported by other NGOs e.g. Live Earth, for what it sees as a "*fatal flaw*": recognising the issue, but then suggesting what it views as inappropriate mitigative actions such as technological change and carbon offsetting (Rising Tide, 2007). These newer groups endeavour to bring about action on climate change through more radical social change. They aim to mobilise public concern, through awareness raising and pushing for political action, often in the form of public protests.

Common to many NGOs campaigning on climate change is a language of fear, and of urgency. Increasingly however, this approach is dismissed as unhelpful by climate communicators (see Futerra 2005: this issue is discussed in more detail in section 3.1.2). Farrow (2000) suggests that NGO members have become disillusioned with '*doom scenarios'* and that NGO policies are becoming more pragmatic and less confrontational. Whilst this may be the case with the more established NGOs, this is not evident with the newer climate-orientated NGOs. Especially with newer NGOs, climate change may be viewed as an issue to be solved through a much wider and more radical social change, to be achieved through awareness-raising in political protests. More established NGOs have supported corporate initiatives, which may act to raise the status of climate mitigation behaviours amongst non-experts. Such approaches may be disregarded as corporate greenwash by grassroots NGOs however [5].

2.2.2.2 Education

> "*It is inconceivable that young people growing up today should not be taught about issues like climate change: it has enormous relevance to their lives.*"
>
> Alan Johnson, UK Education Secretary (quoted in Smith 2007)

Climate change has now become part of the UK key stage 3 Geography National Curriculum (Smith 2007). Climate change narratives are also now appearing in young peoples short stories (Sedgwick, 2001; Drury, 2007). Factors such as these may become important in driving youth public perceptions of climate change.

The importance of young people in influencing perceptions of climate change is recognised by the UK government, with a copy of the film *An Inconvenient Truth* issued to each secondary school in England and Wales (DEFRA, 2007). Others have recognised the potential impact this film may have in changing young people's perceptions, with a High Court review challenging the issuing of the film in process in the UK (BBC News Online, 2007). It is evident that the film's distributors also appear to value young people's perception of climate change, investing resources in a free educational resource kit available to download from the film website (Paramount Pictures, 2007).

Climate change is cited as young people's biggest concern for the world's future (DEFRA, 2006a). With the growth of the internet, young people are able to make contact with a global community through networking websites such as Bebo, Facebook and YouTube[6]. Young people increasingly believe that they are part of a global community, which can decrease their isolation from global issues such as climate change (DEFRA, 2006a): perhaps in contrast to adults, who can find the global scale of the issue paralysing (Futerra, 2006). If this is the case, engaging young people with climate change both personally and as influencers will become more important.

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[5] Greenwash' is defined as the selective disclosure of positive information about a company's environmental performance, without a full disclosure of negative information on these dimensions (Lyon and Maxwell, 2007).

[6] Websites as follows: www.bebo.com, www.facebook.com and www.youtube.com

Education can also be less formalised than that received through schooling. For example, the Interdependence Day project (Smith, 2007) provoked individuals to acknowledge and respond to the ecological, economic and social interconnections in the world, and to think creatively about how the world could be in the future. The project aimed to invite new people into the conversation about issues such as climate change and poverty. Importantly, the project also aimed to ask new questions of individuals already familiar with such issues.

2.2.2.3 Government

The UK Government has cited climate change as a policy priority, as seen at the G8 and during the British presidency of the EU (Giles, 2004). However, whilst the Government is on track to meet international Kyoto greenhouse gas reduction targets (due in part to the 'dash for gas' in the 1980s rather than Labour specific energy reduction policy achievements), Britain is very unlikely to make the domestic targets it has set (Maslin *et al.*, 2007). The Labour government states it has:

> *"displayed leadership at home and internationally, and has a track record of action, not just words"* (Watt, 2007)

This action on climate change is often framed in the context of energy rather than environmental issues: apparent from Labour's website where climate change policy is outlined partnered in the context of energy concerns (see Watt, 2007).

Climate change messages communicated through the government may be received rather sceptically by the public, especially with the growth of political 'spin' (Collins *et al.*, 2003). The UK public distrusts both the national government and the EU, and tends to think that government is not interested in the views they personally hold. The UK public also tend to agree that the government does not provide all the relevant information about climate change to the public (Poortinga and Pidgeon, 2003). This theme has been highlighted by a review of government communication of climate change (Futerra, 2005) where it is emphasised that government policy and communications on climate change must be consistent in order to be successful.

The Government has traditionally held an information-provider role on the issue of climate change, such as attempting to reduce energy consumption through the advertisement series titled *'Global warming: are you doing your bit?'* (DETR, 1999). However, this ‘information deficit’ model has been argued as inadequate for the communication of climate change (Moser, 2006), with such approaches unlikely to be successful unless paired with appropriate contextualised attitudinal change messages. Instead, interpretations of climate change are contextualised by societal values and personal experience (Lorenzoni *et al.*, 2007). An indirect ‘influencing’ role is difficult for the Government to achieve (Collins *et al.*, 2003), as it relies on a sophisticated understanding of these contextual values and experiences. Such viewpoints have shaped more recent climate communication campaigns funded by the Government, such as the *‘Tomorrow’s Climate, Today’s Challenge’* climate communication campaign (DEFRA 2007b). Central to this initiative is the £6 million ‘Climate Challenge Fund’. Individuals and groups could bid for funding from the Fund to carry out targeted, community-level climate engagement exercises. Importantly, the UK Government has attempted to minimise issues of trust, by funding localised peer-to-community communications projects instead of attempting to forge direct government-to-public communication channels. Also, the government in this case is not attempting to influence behaviour, but to achieve changes in public attitudes towards climate change.

2.2.2.4 Business and advertising

There has been movement within industry towards the issue of climate change. Whilst in the past climate change was seen as a threat, it is in many cases now seen as a business opportunity (Farrow, 2000), and even as a business priority (Barclays Bank PLC, 2007). Farrow argues that since British Petroleum and Shell announced increasing investment in renewables, the political atmosphere has changed and the business debate has been transformed. Indeed, in May 2005, business leaders from 13 major UK and international companies offered to support the government in drawing up new, longer term climate policies (The University of Cambridge Programme for Industry, 2005), creating political space on the issue. By 2006, almost 80% of the FTSE 100 considered climate change to be a business issue (The Carbon Neutral Company *et al.*, 2006). Marketing theory has also undergone change during the last twenty years from simple information provision towards focusing more on product ‘brand’, and on the need to create an identity that resonates with the consumer (Collins *et al.*, 2003). The change in attitude towards climate change in both the business and advertising spheres has implications for the public perception of climate change.

The public trust in climate change information from business sources is low. Ninety percent of UK and US consumers are unsure about business claims on climate change, and have concerns over greenwash, and 70% of US and UK consumers want climate change claims to be independently verified (AccountAbility and Consumers International, 2007). A majority of the UK public also distrust scientists working for private businesses (Hargreaves *et al.*, 2003).

Governmental regulation goes some way to reducing business emissions, such as the Integrated Pollution Prevention and Control framework, which aims to minimise pollution from industrial sources across a variety of sources. Increasingly though, businesses are aware of the value of communicating their own environmental credentials. Consumers are becoming more demanding of the products and services they purchase with regard to ethical issues. As this demand increases, it becomes more important for businesses to develop products and services in a low carbon way: in a manner *'that delivers value to both society and the business'* (British Telecommunications PLC, 2007). Public perceptions of businesses action on climate change is likely to be influenced by this: businesses are unlikely to undertake change unless they will see some benefit: either in terms of increased product awareness, or through tangible business benefits. For example, Richard Branson has received both positive publicity for pledging $3 billion over the next ten years to "*combat global warming*" (e.g. Daily Mail Online, 2006) and a new business venture, as this investment will be channelled into a new company, Virgin Fuels, developing biofuel.

Business may attempt to state altruistic justifications for action on climate change:

> "*My test is that our children should look back at what I and Barclays did [and say we] 'really made a positive difference'*" John Varley, Group Chief Executive (Barclays Bank PLC, 2007)

However, as outlined above, the public have concerns over business greenwash, and so may be unlikely to respond positively to statements such as these from a corporate source. Some businesses have attempted to address public concerns over greenwash, such as Marks and Spencer PLC with its stated targets incorporating climate neutrality, zero-landfill and ethical trading. The company makes clear:

> "*we're doing this because it's* ***what you want us to do****. It's also the right thing to do.*" (Marks and Spencer PLC 2007, emphasis added).

Marks and Spencer PLC have attempted to increase brand value over competitors who have not stated similar policies:

> *"we're calling it Plan A because we believe it's now the* ***only way to do business****. There is no Plan B." (emphasis added)*

It is interesting to note the language of decisive action in the second sentence. Proctor and Gamble have attempted to add 'ethical' value to their Ariel brand through their advertising encouraging consumers to:

> *"do a good turn to 30°, and reduce your energy use by up to 40%"* (Procter and Gamble, 2007)

whilst still receiving the same results from using their washing products.

Advertisements are as much as about what is not said than what is actually represented (Williamson, 1992). In the Ariel advertisement, there is an underlying association between the imagery of the cool, white icebergs and the association of clean washing at lower temperatures (and of course with melting sea ice under climate change): perhaps an image more likely to engage than the website video imagery depicting enzymes working at lower temperatures in a washing machine. Indeed, advertisements may completely avoid stating obvious climate messages, and instead subvert the rhetoric towards an ironic reading of the issue: often for the aim of promoting greater consumption (Linder, 2004). To date, this discourse, coined 'British comic nihilism' by Ereaut and Segnit (2006) is only found only in middle-class press and radio.

If brand value does increase as a result of including climate change messages, other businesses are likely to follow this lead. In doing so, businesses are likely to increase the public awareness of climate change. It will be interesting to see how an increasing discourse around climate change originating in the business and advertising spheres impacts on public conceptualisation of climate change: whether an increase in the acceptance of climate change occurs due to increasing exposure to the issue, or if an increasingly brand-aware public is more sceptical of such approaches.

2.2.2.5 Media

The complex nature of climate change allows the media opportunities to heavily influence public perceptions of the issue: Carvalho and Burgess (2006) referred to the media as the *'map makers of the 21st century'*. The media are reflexive, both in shaping public opinion, and being in turn influenced by it. The contextual framing of climate change differs between media sources and across time. In the US print media between 1987 and 1990, there was an overwhelming frame of using technology to 'fix' the problem (Wilkins, 1993), whereas the UK print media between 1997 to 2003 saw a framing through which the dangers of climate change were realised in particular geographical places and events (Carvalho and Burgess, 2006). The media discourse is largely shaped by the agency of top political figures and by the ideological standpoints of the medium concerned (Carvalho and Burgess, 2006).

The majority of the public claim they distrust scientific information received from the media (Hargreaves *et al.*, 2003). Whitmarsh (in press) found a significant proportion of participants agreed that the media was often too alarmist about issues like climate change. However, this scepticism is not clear cut. The public still tend to trust the media that they personally use (Hargreaves and Thomas, 2002). The media can influence both how informed, and how concerned the consumer of that medium is. Generally, the media appears to make a positive contribution to the public understanding of climate change, although it can also aid in perpetuating popular misconceptions (Stamm *et al.*, 2000). An increase in climate change coverage by newspapers has been found to be correlated to how concerned its readers become (2003). There are ebbs and flows within climate change reporting, with peaks in UK and US reporting in 1988, 1997, and 2006-7. A dramatic increase in reporting of climate issues occurred in both the US and UK between 2006-7 (Boykoff, 2007).

The media has been blamed for inaccuracies, bias, sensationalisation (Carvalho and Burgess, 2006) and under-reporting of climate change (Brown and McDonald, 2000). Journalistic best practice can influence how issues are handled and presented. Documentary and news formats encourage a balanced presentation between two opposing 'sides'. Because of this, competing views which scientists may view as very unequally matched may be presented as views with a similar balance of merit (Yearly, 1996). This has contributed to accusations of bias in climate change reporting. For example, Boykoff and Boykoff (2004) found there existed a significant divergence of popular discourse from scientific discourse in the US prestige press because of the rigid following of these journalistic norms. Farrow (2000: p 196) notes:

'For a time, an important time in the climate negotiations - more than 2000 scientists had a smaller voice than the 15 paid for by the oil lobby!'

The media has also been criticised for the sensationalism surrounding climate change (Ereaut and Segnit, 2006). Specifically, the media has been criticised around the reporting of the results of the Climateprediction.net experiment. The media was provided with a press release that mentioned the upper global mean temperature change as 11°C: the ensuing headlines were all *'predictably apocalyptic'*, focusing on this upper limit (Cox and Valdon, 2005). Ereaut and Segnit (2006) have termed the sensationalisation of climate reporting as *'climate porn'*, and warn against its use in engaging the public with climate change. It has been argued that some newspapers take an alarmist line on climate change because of commercial motives (bad news sells) rather than ideology: a claim strongly denied by *The Independent*, who stress their commitment to behavioural change reporting as well as more 'alarmist' coverage of climate issues (Black, 2006).

There is now developing an ironic take on the reporting of sensationalised climate issues. Instead of sensationalising climate change as an apocalyptic vision (e.g. Arlidge, 1999; Buncome & Carrell, 2005), climate change is presented as a conspiracy theory, thoroughly 'debunked' by the reporter (Murray, 2004). Scientists adhering to scientific norms such as the precautionary principle can find their views unintentionally edited to those of a climate change sceptic. This style of reporting could be very important in shaping the views of the public: when what is seen as 'sound science' is presented to the audience, the public may use it as a reason for inaction, or disengage with the debate altogether. The public and institutional response to the documentary *'The Great Global Warming Swindle'* (Durkin, 2007) screened in March 2007, demonstrated this clearly. Several prominent UK organisations saw a need to provide an online response to the documentary, such as DEFRA (e.g. see Milliband, 2007) and the Royal Society (Rees, 2007), whilst one of the scientists involved in the programme later wrote '*I should never have trusted Channel 4'* (Wunsch, 2007).

Whilst in some cases the media provides a public service through information provision, the media also have their own demands to publish particular themes and narratives (Yearly, 1996). Narratives concerning abstract global issues are increasingly hard to publish - *'the key is to keep the human interest in order to write about issues'* in order for an article's editorial acceptance (Brown and McDonald, 2000). This may mean that particular issues – those with a human angle, or a photogenic species, are highlighted; and other, less editorially amenable, issues are not addressed. Narratives also have to vie for attention with other news stories, becoming sidelined if they are not deemed sufficiently newsworthy (see for example, the time taken to print for an article on the environmental consequences of the Kosovan War in Brown and McDonald, 2000). Few news reporters have a scientific background, and there is a routine under-reporting of environmental narratives in the media (Smith, 2000). However, Smith states that this under-reporting should not necessarily be blamed on the media. Political friction often stifles environmental debate, particularly at election time. Climate change reportage may also be influenced by other factors such as the weather: there is some evidence that local temperature affects the frequency of such features (Shanahan and Good, 2000).

An interesting emerging academic review centres on the role of celebrities as agents for the issue of climate change. Boykoff (2007) discusses how an issue can wind its way to the top of the media's agenda, reaching 'celebrity status' as a social problem. Through the media, celebrities can act to normalise particular attitudes or behaviours towards climate change. For example, Leonardo DiCaprio is seen as one of the most visible advocates of the Toyota Prius hybrid car (Forbes, 2007), acting as an agent for change by influencing particular social norms of consumption and the environment.

2.3 CONCLUSIONS

There currently exists a lack of holistic individual-level understandings of 'danger'. Current definitions of danger do not allow for, or do not account for, different perceptions or values within the issue of climate change. This thesis argues for a post-normal approach to defining danger: where social, cultural, institutional and contextual interpretations can be taken into account. The tools and agents which mould public perceptions of climate change were then examined. Many different agents are involved in the communication of climate change. Each agent uses a variety of tools to communicate with their target audience. The next Chapter examines public engagement with climate change in more detail, assessing the social psychological literature on attitudes and behaviour. The barriers to effective engagement and theoretical models for understanding behavioural change are considered. An approach is then suggested which addresses some of the individual-level barriers to engagement, and allows for a more holistic individual-level conceptualisation of climate change than the approaches presented thus far.

CHAPTER 3:
EXPLORING ENGAGMENT WITH CLIMATE CHANGE

As stated in Chapter 1, in order to meet the UK Government's 60% greenhouse gas emissions reduction target, there is a need for non-experts to be meaningfully engaged with climate change in order to begin to undertake decarbonisation behaviours. This Chapter investigates engagement with climate change: from general UK trends to individual-level and societal barriers to engagement. Engagement is defined here (as Chapter 3) as an individual's state regarding the three inter-related and co-dependent facets of cognition, affect and behaviour (*c.f.* Lorenzoni *et al.* 2007). The Chapter finishes by proposing an 'iconic' approach to engaging individuals with climate change in order to decrease some of the individual-level barriers to engagement with climate change.

3.1 PUBLIC ENGAGMENT WITH CLIMATE CHANGE

Many US and UK studies have focussed on revealing what the layperson knows about the issue of climate change, ranging in scale from over a thousand risk-orientated mail surveys (Fisher *et al.,* 1999) to small-scale, in-depth focus groups (Nicholson-Cole 2004a). A majority of the UK public recognise the main causes of climate change and say that they are concerned about it as an issue (DEFRA, 2007). There is widespread awareness of climate change, with 99% of the public recognising the term 'climate change' (DEFRA, 2007). Yet, the public has serious misunderstandings about climate change (Trumbo & Shanahan, 2000). When compared to other risk issues, climate change is of low priority (Poortinga & Pidgeon, 2003): this is the case even when compared to other environmental issues (DEFRA, 2007). Only a minority of the public translates their concern about climate change into taking measures to reduce their own energy consumption (DEFRA, 2007; Norton & Leaman, 2004) Additionally, whilst awareness of climate change may be high, awareness of the international framework for action is low (Norton & Leaman, 2004).

Lorenzoni *et al.* (2007) conclude that it is not enough for individuals to know about climate change. In order to be meaningfully engaged on the issue, the public needs to care about it, be motivated and be able to take action. Mitigation policies are unlikely to succeed unless there is a widely held feeling that climate change is a personally relevant and salient issue, and that individual actions can make a difference to the climate future (Nicholson-Cole, 2004a). Moser and Dilling (2004: p 43) call for:

> *'believable, positive, open-ended, problem-solving and meaning-giving visions […] to offer a lasting motivation to participate in conversation and partake in communal action'.*

for effective climate communication. Developing constructive visions is seen as key to engaging the UK public (Futerra, 2005).

3.2 BARRIERS TO EFFECTIVE ENGAGMENT

Hobson (2003) describes the 'plethora of barriers to action' which act to stop individuals from engaging with climate change. These barriers range from individual circumstances to adherence to public norms and structures. Lorenzoni *et al.* (2007) elaborate that past behaviour, knowledge, emotions, social networks, trust issues and demographic background can all present barriers to engagement and influence an individual's connection with climate change.

Moser and Dilling (2004) identified five potential barriers to meaningful climate change engagement with the public (Box 3.1). Although this is a US-based critique, engaging the UK public in climate dialogue encounters similar difficulties.

Box 3.1. Barriers to engaging the (US) public in climate change dialogue

- *The creeping nature of climate change*
- *Complexity and uncertainty*
- *System lags*
- *Human perception limits*
- *Communication failures on the part of scientists*

(Moser & Dilling, 2004: p 34-36)

Whilst the creeping nature of climate change and system lags are inherent difficulties of engaging individuals with a macro-environmental issue such as climate change, there are methods of minimising the problems these may present. A successful engagement approach can address the difficulties in human perception limits, and can restrict the perceived complexity and uncertainty associated with the issue.

Lorenzoni and Pidgeon (2005) state that climate change is not a problem viewed in isolation by individuals, but is instead contextualised in the reality of their lives. This contextualisation in everyday reality may reveal barriers to engagement. Barriers to engagement can be divided into two types, external and internal (Ajzen, 1985). External barriers consist of those relating to time and opportunities for change, and dependence on others in order to complete a particular behavioural change. Internal barriers incorporate the information, skills and abilities needed in order to enact change; and willpower, emotions and compulsions. Internal definitions also encompass the extent to which individuals perceive themselves, as opposed to environmental factors, controlling events in their lives. Section 3.2 investigates the perceived social, psychological and institutional barriers to change cognition, affect and behaviour which an individual may experience in regard to climate change.

3.2.1 Psychological barriers

The psychology of denial surrounding climate mitigation measures has been investigated by Stoll-Kleemann *et al.* (2001), who report that individuals implement psychological barriers in order to justify why they should not change their behaviour. Barriers such as blaming the inaction of other individuals and governments, doubts over the contribution of personal actions, and the costs of changing comfortable lifestyles were used as justification for inaction. Whilst participants may have been concerned about climate change, behavioural change was often not achieved because alternative options were seen as unacceptable.

Psychological barriers to behavioural change also exist when individuals feel helpless or are not interested (Lorenzoni, 2003). Kaplan (2000) also suggests that feelings of helplessness or powerlessness will influence how likely an individual is to make behavioural changes. Other psychological barriers are individuals feeling they are the 'wrong type of person' to carry out particular actions; or that it is not their responsibility to act, but instead the responsibility of business or governments (Blake, 1999). A lack of saliency may also be linked to the magnitude of the problem. The non-expert may expect the issue to be dealt with by the government: or else expect technology to fix the problem (Wilkins, 1993).

Individuals may also not undertake behavioural changes because of scepticism in climate predictions. A news items interviewing participants living in Winterton-on-Sea, a coastal village in the UK, found participants did not connect the cliffs experiencing serious coastal erosion with climate change:

> *'I'm not at all convinced the sea will continue to rise at this rate, and I'm sceptical about making decisions for the next 100 years when we don't know what'll happen next year'.*
>
> (Robin Chenery: quoted in Dear, 2005)

Residents had not heard of the Kyoto Protocol, did not make any connection between energy use, climate change, sea level rise (SLR) and the erosion of their village, and thought the problem was not linked to any global environmental issue (Dear, 2005). Indeed, residents are in some sense correct: there are other factors which perhaps lead to erosion on the Norfolk coast but are unconnected with climate change (offshore dredging, for example). This example serves to highlight the complexities of engaging individuals with a macro environmental issue.

Stehr and von Storch (1995) state that the physics of climate change is largely incomprehensible to non-experts, and that anticipated climatic changes occur on timescales much longer than the 'time horizon of everyday life'. Individuals are able to distance themselves from climate change because it remains a psychologically 'un-situated risk' (Lorenzoni & Pidgeon, 2005). For engagement to be effective, climate change needs to be situated in knowable temporal and spatial dimensions, otherwise it can be relinquished to other places and future times.

Mechanisms for psychological denial for action on climate change are investigated by Stoll-Kleemann *et al.* (2001). Denial barriers are created when individuals need to overcome the dissonance of their attitude towards climate change and the daunting prospect of making meaningful behavioural changes (Stoll-Kleemann *et al.* 2001). The attitude may be changed by displacing the responsibility for change or rejection of blame (Lorenzoni 2003; Stoll-Kleemann *et al.* 2001). Box 3.2 outlines potential denial and displacement mechanisms. A reoccurring theme throughout this displacement processing is that of the 'tragedy of the commons'[7].

[7] The 'tragedy of the commons' (Hardin, 1968) refers to a situation where behaviour that makes sense from an individual point of view ultimately proves disastrous to society when repeated by enough individuals. In the case of environmental issues, each individual sees little harm in consuming the natural resource since it is so huge and their impact on it individually is so small (Gardner and Stern, 1996).

Box 3.2. Nine methods of psychological denial for personal action on climate change

• *Metaphor of displaced commitment*	*"I protect the environment in other ways"*
• *To condemn the accuser*	*"You have no right to challenge me"*
• *Denial of responsibility*	*"I am not the main cause of this problem"*
• *Rejection of blame*	*"I have done nothing so wrong as to be destructive"*
• *Ignorance*	*"I simply don't know the consequences of my actions"*
• *Fabricated constraints*	*"There are too many impediments"*
• *'After the flood'*	*"What is the future doing for me?"*
• *Comfort*	*"It is too difficult for me to change my behaviour"*
• *Powerlessness*	*"I am only an inxnitesimal being in the order of things"*

(Stoll-Kleemann et al. 2001: p 112)

If an individual is confronted with cognitive dissonance[8] (for example, they profess to be concerned about climate change, yet still carry out carbon-intensive behaviour such as driving rather than using public transport) the individual is more likely to change their attitude than their actions (for example, would be more likely to justify driving by emphasising the disagreeable features of public transport than changing that behaviour in future) (Futerra, 2005).

3.2.2 Social and institutional barriers

Even if an individual is engaged in a psychologically meaningful way, the individual may not undertake a particular behaviour. Social networks and institutions can have a powerful hold on preventing such behaviours being enacted, regardless of intentions (Blake, 1999). For example, Nicholson-Cole (2004a) investigated the power of imagery to enhance participants' engagement with climate change. Even when imagery was considered salient, individuals were unlikely to feel more than trivially engaged because of the perceived significant barriers to personal commitment. Bulkeley (2000) considers public understanding of climate change to be tied into more complicated questions of the relationship between society and nature. Hence, rather than communications simply investigating what is known, and then filling the knowledge gap with more climate change

[8] The discomfort experienced when there is a mismatch between attitude and behaviour is known as 'cognitive dissonance' (Festinger, 1957).

science, engagement approaches should start to investigate what the social and institutional barriers to involvement are, and act to decrease these.

The power of social networks to affect an engagement approach is demonstrated by Kurz *et al.* (2005), who investigated domestic water usage in maintaining the appearance of participants' gardens in Perth, Australia. The participants reported a strong social obligation to maintain a high standard of appearance to uphold the aesthetic appeal of the suburb in which they lived. Participants justified their large water usage reporting that they did not want to upset the social status quo, despite a reported personal desire for a more environmentally sustainable approach to maintaining their gardens. Perceived institutional barriers can also have an impact on whether a behavioural change is enacted. Sarewitz (2004) argues that science is inherently and unavoidably becoming politicised in environmental enquiries. This can act to undermine public trust, and create a perceived barrier to change. Individuals may also perceive behavioural actions such as energy reduction as largely ineffective in the context of inertia from institutions such as businesses and government (Bulkeley, 2000).

It has previously been considered that individuals with strong environmental concerns would be likely to translate this concern into behavioural change (Poortinga, 2002). However, even these individuals do not necessarily adapt their behaviour (Lorenzoni 2003; Stoll-Kleemann *et al.* 2001). Individuals are only likely to change their behaviour if the change is easy (Norton & Leaman, 2004), and are unlikely to take action if they feel their lifestyle is threatened (Lorenzoni, 2003).

The potential impact of social and institutional barriers on a potential behavioural change (regardless of whether the underlying attitude may have changed, or how strongly these views are held) indicates that attitudinal engagement approaches should be supported by wider structural change in order to enable the public to successfully implement mitigative and adaptive behaviours in relation to climate change (Lorenzoni *et al.* 2007).

3.3 MODELS FOR EXPLORING ATTITUDE-BEHAVIOUR CHANGE

Attitude-behaviour change models are attempts to model and predict behavioural changes. The theories of reasoned action and of planned behaviour, the Attitude Behaviour Constraint model and the social practices approach are examined below in order to provide insights into effective engagement approaches.

3.3.1 The Theory of Reasoned Action

The Theory of Reasoned Action (TRA) was developed by Ajzen and Fishbein (1980). The TRA is based on the assumption that individuals usually behave in a sensible manner: that they take account of available information and implicitly or explicitly consider the implications of their actions. The theory postulates that an individual's intention to perform (or not to perform) a behaviour is the immediate determinant of that action (Ajzen, 1985). The TRA demonstrates how attitudes towards an issue may be mediated into behavioural intentions and behavioural change. The TRA takes into account individuals beliefs and value systems about the potential behavioural change, and also the beliefs about how others may view the potential behaviour. Although the TRA accounts for personal and societal attitudes towards a potential behaviour, these are associated in the literature with only negligible intention to act.

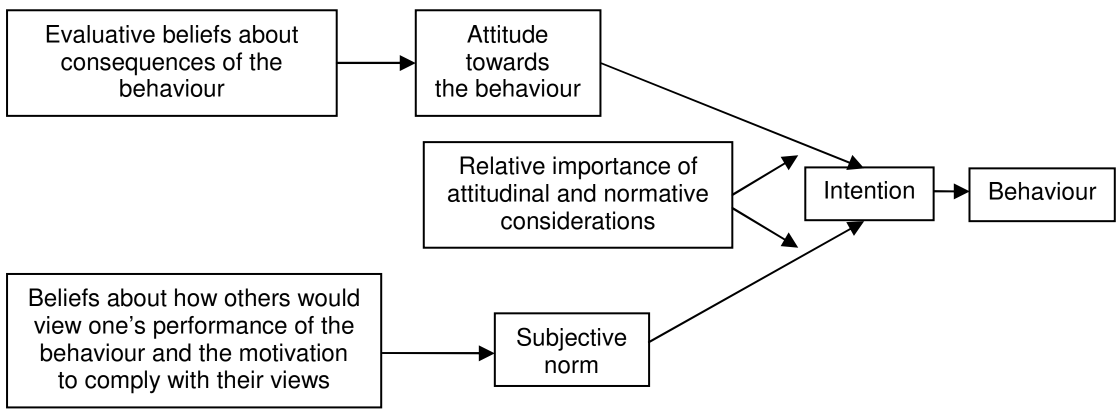

Fig. 3.1 The Theory of Reasoned Action (adapted by Eiser, 1986)

3.3.2 The Theory of Planned Behaviour and the value-action gap

Ajzen (1985) expanded on the TRA with the Theory of Planned Behaviour (TPB). Ajzen recognised that factors such as external obstacles like time, opportunities or dependence on others, or personal limits such as a lack of willpower, could obstruct the relationship between intention and behaviour. Together, these factors are termed the perceived behavioural control (PBC). The TPB therefore postulates that individuals act in accordance with both their intentions and perceptions of control over a behaviour (Ajzen, 1985). Potter (1996) notes that within the TPB, an individual's judgement about whether they are able to enact a particular behaviour takes priority over any intention they may have to enact that behaviour. He also notes that the influences between attitudes, subjective norms and perceived behavioural control can work in either direction (see Figure 3.2).

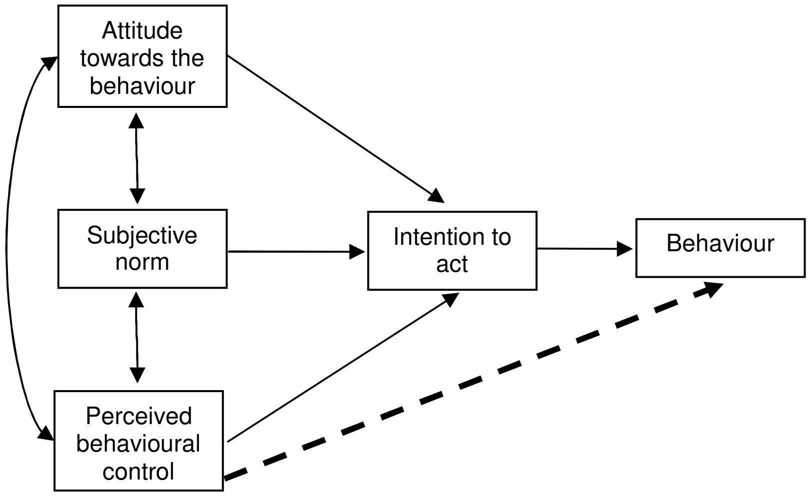

Fig. 3.2 Theory of Planned Behaviour (from Potter, 1996)

The TPB can make impressive predictions of how people might act in situations such as voting polls and public health campaigns (Potter, 1996). However, the TPB may struggle to explain complex attitude-behaviour change around climate change.

The TPB and TRA attempt to model the 'value action gap': the difference between what people say, and what people actually do (Blake, 1999). Blake explores the history of investigations into the value-action gap from the TRA and TPB. Blake argues that whilst attitude-behaviour models are becoming increasingly sophisticated by considering a more socially constructed nature of environmental values, this research still portrayed theories of behaviour based on individuals forming their attitudes and planning their behaviour based on a rational thought processing system. Instead, Blake asked respondents to identify the barriers or reasons which prevented them from carrying out particular environmental actions, despite a general concern for the environment. Three categories of barriers were coded from the responses arising from this barrier between concern and action. These were individuality, responsibility and practicality; confirming that psychological, institutional and social barriers all existed as barriers to behavioural change (Figure 3.3).

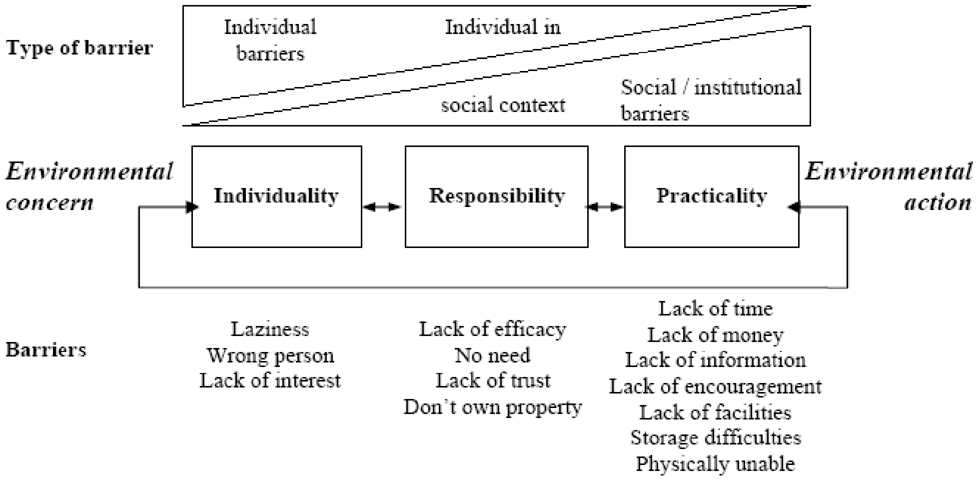

Figure 3.3 Barriers between environmental concern and action (Blake, 1999)

3.3.3 The Social Practices Approach

Understanding attitudes and behaviour continues to be researched through attitude research through the types of models discussed above. However, some have argued for a constructionist approach to exploring attitudes. Rather than seeing individuals as simply perceiving (or misperceiving) their social worlds it treats those worlds as socially constructed (Potter, 1996). The Social Practices Approach (SPA) developed by Spaargaren (2003) is one such approach. It is stated that the SPA offers an integrative model to analyse and understand environmentally sustainable behaviour. Spaargaren argues that the SPA (fig. 3.4) differs from attitude-behaviour models in three ways.

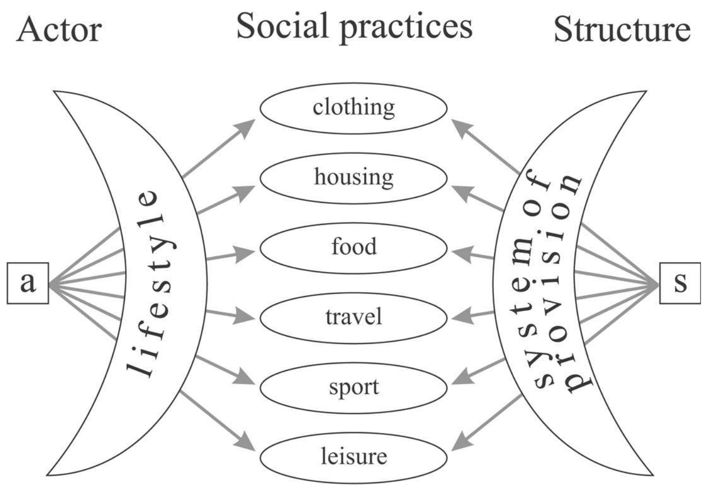

Fig. 3.4 The Social Practice Approach (from Spaargaren, 2003)

Firstly, at the centre of the SPA is the behavioural practice situated in time and space, rather than the unsituated individual attitude or norm. Secondly, the SPA does not focus on individual, isolated behavioural practices but instead looks at groups of actors who may help the individual to enact behavioural change. Lastly, the SPA aims to provide power to individuals through providing both knowledge and the social structure in which to enact a behaviour (Spaargaren, 2003).

It is stated that attitude-behaviour models are flawed, in that they suppose individual behaviour to be responsive to either social, economic or psychological stimuli (Shove, 2003). Shove also maintains that attitude-behaviour models rely on the isolation and analysis of relative factors, and that they assume behaviour can be modified through information, incentives or education. Shove reflects that changing behaviour cannot be enacted through attitude-behaviour models or through finding particular ‘levers’ to pull; instead, behavioural change is enacted by challenging dominant ways of thinking about behaviour and lifestyle.

The SPA itself also invokes criticism however. It can be viewed as ambiguous or too complex. Qualitative research utilising the SPA can also be seen as too open-ended to be reliable. Whilst the SPA criticises attitude-behaviour models for looking for that elusive ‘lever’ to pull, the SPA itself does not offer a clear alternative.

3.3.4 The Attitude Behaviour Constraint model

This Chapter has explored two types of barriers to change: psychological (or individual) and societal (or social and institutional). Stern (2000) developed a model to integrate both types of barriers to environmental change. He terms what this thesis calls individual barriers as ‘attitudes’ and societal barriers as ‘external conditions’. Stern notes that when individuals have very positive attitudes, the individual is likely to carry out a pro-environmental behaviour even when external conditions are also high. For example, an individual would probably recycle if they have very positive attitudes towards recycling even if carrying out the recycling behaviour was inconvenient to the individual (Figure 3.5). Conversely, if societal conditions are high (for example, recycling was very convenient and it was the social norm to recycle), individuals are likely to recycle even if they personally hold a negative attitude towards recycling.

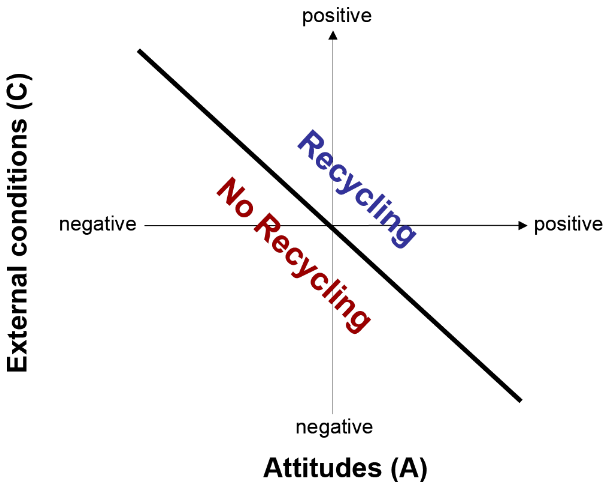

Figure 3.5 The Attitude-Behaviour-Constraint model for recycling behaviour (Jackson, 2005: based on Stern, 2000)

The approach taken in this thesis is based on Stern's ABC model. It is concluded that if personal attitudes towards climate change are increasingly positive, individuals will be more likely to carry out decarbonisation behaviours.

3.4 IMPROVING CLIMATE ENGAGEMENT

Within any engagement approach, particular methods and practices improve effectiveness. Many of these are based on overcoming known psychological or social barriers to change. These practices for improving effectiveness in climate engagement are expanded upon below.

3.4.1 Knowing the audience

Past climate engagement approaches have used mass communication methods, but have failed to communicate to specific audiences (Moser, 2006a). These sorts of approaches, may have provided information on the science and impacts of climate change, but have failed to engage the public in a more profound way and engage the public in a more meaningful dialogue (Moser, 2006a). Futerra (2005) call targeting information to particular audiences a *'classic marketing rule'*. Mass communication approaches attempt a 'blanket' style to communication, which is unlikely to engage meaningfully with individuals. One form of communication may be successful in motivating some sectors in the public, and yet not be effective with others. Nicholson-Cole (2004b: p 269) reports that, with climate imagery:

> *'No single image will appeal to everyone and different messages and influences will be taken away, because of prior perceptions and expectations of climate change and the future'.*

Whilst traditional communications approaches may have targeted specific demographic groupings, Ereaut and Segnit (2006: p 8) state that for effective communication on climate change targeting groups by shared values and behaviour can be more effective. These sorts of approaches can engender the desired attitudinal change by making the new attitude feel like *'the kinds of things that people like "us" do'*.

For communications to be effective, communication approaches must be aware of the 'mental models[9]' through which the audience conceptualises climate change. The causes, effects and solutions of climate change must be effectively linked (Moser & Dilling, 2004) so that the individual can enact useful change. Investigations of the layperson's perception of climate change are likely to reveal great diversity, confusion, and often, ignorance (Vlek & Steg, 2004) Bostrom *et al.* (1994) investigated public understanding of climate change through mental model interviews with laypeople. They found that many participants confused stratospheric ozone depletion with the greenhouse effect and weather with climate. The 2002 British Social Attitudes Survey found that a majority of the UK public are unaware of the relationship between home energy use and climate change, and that ten percent of the UK public believe that mobile phones are a major cause of global warming (Park *et al.* 2002). Bord *et al.* (2000) found participants thought CFC aerosols were the major contributor to climate change. Many other participants in this study believed insecticides, nuclear power generation and depletion of ozone to be major contributors to climate change.

Bord *et al.* (1998) argue that lay audiences may view climate change through a 'general pollution model' and thus may believe that if general pollution causes climate change, then good environmental pollution controls will prevent it. Failure to recognise, and to work with, these lay mental maps of climate conceptualisation (which differ significantly from the scientific expert mental models linking climate cause and effect) may lead to ineffective engagement approaches.

3.4.2 Climate confusion

Climate change is a highly complex, elusive and global hazard, making the issue difficult to understand, and difficult to communicate (Moser & Dilling, 2004). For each argument or perspective on climate change, there is one declaring its opposite: climate change discourse in the UK looks confusing, contradictory and chaotic (Ereaut & Segnit, 2006).

[9] A mental model has been defined as a 'representation of knowledge' (Niewöhner, 2001).

Scientists emphasise the complexities and uncertainties associated with climate change. Whilst this is accepted practice in academic publications, this way of framing climate change may be less appropriate for public communications, being viewed as uninteresting or esoteric (Moser & Dilling, 2004).

More confusion arises due to the prominence gained by climate contrarians. Provocateurs such as Bjørn Lomborg have argued that resources used for tackling climate change could be better used elsewhere, on global problems such as poverty or AIDS (Lomborg, 2005). Media climate contrarians also add to the cynicism, with derisive narratives of climate change:

> *The Vanishing Gulf Stream, Millions Dead of Malaria in the Midlands, the Parboiled Polar Bear…*' (Righter, 2005: p 35)

Darley (2000) states that climate change is often reported as a balance between two equally opposing sides: those 'pro' and those 'against' the science of climate change. This 50/50 split is commonly used as it provides a simple and editorially-accepted reporting procedure (Darley, 2000). This mechanism has been used despite the majority of scientific opinion resting towards one 'side' (Smith, 2000)[10]. This has been stated as 'balance as bias' by Boykoff (Boykoff & Boykoff, 2004). Boykoff (2004) maintains that the historical balancing of narratives for and against within the climate change issue is the result of journalistic norms. Moser and Dilling (2004) suggest dealing with contrarians by becoming familiar with contrarian tactics; by emphasising the value-laden debate that is climate change, instead of disguising it as 'science'; and marginalising provocateurs by calling them their correct name – e.g. naysayers or doomsayers.

Non-experts try to understand the confusing issue of climate change through their own mental model conceptualisation, although these may not adequately capture the complex relationships between causes, impacts and solutions. Engagement approaches can seek to influence the audience's mental model framework in order to aid the audience in making sense of the issue (Moser & Dilling, 2004). Additionally, public-science initiatives on

[10] The media - notably in the UK, the BBC - appears to be addressing this somewhat, with the portrayal of climate change now occurring in a more considered way. See for example: http://www.bbc.co.uk/blogs/theeditors/2007/02/how_green_should_we_be.html [accessed Sept 2007], where Newsnight editors discuss in an online blog how climate sceptics are given an amount of airtime relative to their minority opinion.

climate change could be used so as to build greater public engagement and confidence in dealing with the conduct of climate change science (Abbasi, 2006).

3.4.3 'Empty vessels'

Methods used to communicate climate change in the past have principally focussed on the 'deficit model': assuming that participants take the given scientific information and rationally make a decision based on weighing up the risks involved (Office of Science and Technology & The Wellcome Trust, 2001). The deficit model views human thinking as analogous to erroneous information processing (Joffe, 2003). This approach implicitly assumes that the public does not act on climate change because they do not understand the issue (Lorenzoni *et al.* 2007). However, Collins *et al.* (2003) state that it is important not to overestimate the power of providing information. More information does not necessarily lead to more awareness, or increased awareness to behavioural change (Collins *et al.* 2003). In fact, 'science for science's sake' – increasing the presence of science related narratives in the media appears unlikely to generate engagement (Hargreaves *et al.* 2003).

Engagement approaches are now beginning to recognise that the deficit model of engagement is outdated (Moser 2006a). Climate change is increasingly viewed as a risk that is 'socially constructed', i.e. affected not only by rational informational input, but by the individual's worldview, beliefs and cultural situation (Wilsdon & Willis, 2004). An individual's response to such a risk is a highly social, emotive and symbolic entity (Joffe, 2003). An 'engagement model' involving two way dialogue between experts and non-experts is deemed more appropriate than the deficit model (Office of Science and Technology & The Wellcome Trust, 2001).

It is important to note that providing scientific information on climate change is not what is challenged here[11] but that the notion of simply providing scientific information and expecting attitudinal change is disputed (Futerra, 2005). When provided, even the communication of scientific information itself has been subject to a number of pitfalls which should be addressed (Box 3.2). Engagement approaches require useful solution information, specific to the particular audience, rather than *'an extended lesson in climate science'* (Moser, 2006a). Abbasi (2006) warns against the *'yawn factor'*: he argues that whilst scientific information is critical to telling the climate change story, it should be translated into an accessible or entertaining way for non-experts.

[11] For example, Bord *et al.* (2000) found that caring about the environment is not in itself enough for effecting change: knowledge of the causes and effects of climate change is needed too.

Box 3.3 Perceived individual barriers to engagement with climate change

- *Lack of knowledge about where to find information*
- *Lack of desire to seek information*
- *Perceived information overload*
- *Confusion about conflicting evidence or partial evidence*
- *Perceived lack of locally relevant information, for example about impacts or solutions*
- *Format of information is inaccessible to non-experts*
- *The source of information is not credible or trustworthy (particularly the media)*
- *Confusion exists about the links between environmental issues and their respective solutions*
- *Information conflicts with values or experience*

(Lorenzoni *et al*. 2007: p 450-451)

3.4.4. Shock tactics

There is an increasing trend to attempt to make climate change more salient by using threats such as fear and guilt as motivators (Moser & Dilling, 2004). For example, Pearce (2005: p 8) wrote in New Scientist:

> *'Time is running out, and fast. Rising carbon dioxide levels and higher temperatures will soon set in motion potentially catastrophic changes that will take hundreds or even millions of years to reverse. […] Act now, before it is too late.'*

Whilst some emphasise that fear is essential to create urgency, there is a growing literature that generalised appeals and a rhetoric of crisis can be counterproductive (Myers & Macnaghten, 1998) or even that it is not possible to provoke fear for an issue like climate change given the time lag until serious impacts are realised (Abbasi, 2006). Guilt appeals are used in a similar way. Macnaghten (2003) notes how these approaches do cause a fleeting sense of guilt, but how the appeals lack reach, and fail to engage on a meaningful level.

The rhetoric of fear is widespread, found from broadsheets to tabloids, campaign literature to government initiatives (Ereaut & Segnit, 2006). The rhetoric used is extreme, has an urgent tone, and implies death and doom through a language of acceleration and irreversibility (Ereaut & Segnit, 2006). Investigating the reporting of the IPCC Working Group I report, Hulme (2007a) found that the four UK prestige newspapers all ran front-page headlines utilising a language of fear and anxiety. All UK newspapers examined used one or more of the adjectives 'catastrophic', 'shocking', 'terrifying' or 'devastating' within the narrative. Hulme (2007a) notes how none of these words came from the original IPCC report. However, individual scientists have used this language. In discussing the communication of climate change, Sir Crispin Tickell (2002) suggested that *'perhaps a useful catastrophe or two'* would help illuminate the issue.

Threats such as fear used as a motivator should be used with caution (Futerra, 2005) as these sorts of rhetoric are unlikely to lead to meaningful engagement. If fear is overused as a communication and motivation device, the audience is likely to avoid the approach because of its associated negative emotions of apprehension, feeling overwhelmed and feeling a lacking personal control of the situation (Moser, 2006a). It is likely the audience will avoid these negative emotions using denial, paralysis, apathy or even maladaptive responses as coping mechanisms (Moser & Dilling, 2007).

3.4.5 Spatial and temporal dissonance

Moser and Dilling (2004) discuss how human perception limits and priorities may mean that climate change does not rank highly as a personal concern. Although individuals consider climate change socially relevant, the consequences are seen as spatially and temporally distant; i.e. affecting other more vulnerable communities or future generations (Lorenzoni & Pidgeon, 2006). In the UK, 52% of people believe climate change will have 'little' or 'no effect' on them personally (BBC News Online, 2004), whilst the Energy Savings Trust (2004) found that 85% of UK residents believe the impact of climate change will not be seen for decades. The impact of climate change in the UK is seen as far less alarming than the impacts in the third world (Hargreaves *et al.* 2003).

Despite the warnings such as those from the Chief Scientific Advisor to the UK Government, Sir David King (2004) warning that *'delaying action for decades, or even years, is not a serious option'* climate change remains a temporally distant risk. Drottz-Sjöberg (2006) found that when thinking about the future, individuals tended to think about 30 years ahead, and could conceive of emotional relationships stretching to maximum of around 60 years. Individuals found it difficult to imagine the future beyond this point: so it is perhaps unsurprising that climate change impacts over greater timescales than these carry little saliency. Whilst climate change remains an un-situated risk, individuals will tend to psychologically distance themselves from the issue (Lorenzoni & Pidgeon, 2005). This may explain why even if the causes of climate change are correctly identified by individuals, the risks may still be seen as minimal (Bord *et al.* 2000).

The literature increasingly demonstrates that local or regional examples ensure saliency. Gupta (2004) declares that communications should *'think local before global'*, and Futerra (2005) believe that it is essential when communicating climate change to make climate change a 'home' rather than an 'away' issue. Saliency on climate change is much more likely to improve when an audience can perceive a local connection to the issue, and when it connects to the personal domain of everyday life (Macnaghten, 2003). Therefore communications seeking to minimise spatial and temporal dissonance should connect climate change with the everyday life of the individual (Office of Science and Technology & The Wellcome Trust, 2001). The OST maintain that this will attract the layperson's attention and ensure that the information given is retained. Thus, finding methods of making global climate change a local issue in ways unique to particular audiences can aid in connecting individuals to what may otherwise be viewed as remote and impersonal (Moser, 2006a).

3.4.6 A lack of agency

Climate communications frequently rely on fear or guilt appeals. Extreme and dramatic climate events are communicated as they sell better than those of slowly ongoing climate change (Bronnimann, 2002). Yet such engagement approaches do not encourage efficacy. To encourage agency, engagement approaches should be believable, understandable and personally relevant (Moser & Dilling, 2004).

Non-experts found that when connections are made to climate change with everyday life, approaches are more thought-provoking than conventional methods (Macnaghten, 2003). Utilising emotions and visual imagery are also key ways to engage and promote agency (Futerra, 2005). This is also emphasised by Abbasi (2006), who states that climate communications would be more effective at engaging the public if the human interest in narratives was emphasised, and emotional hooks for the specific audience were sought. Novel approaches that seek to engage audience and provoke conversations amongst peers by inspiring curiosity are needed (Collins *et al.* 2003). Macnaghten (2003: p 80) maintains:

> *'A different iconography of the 'global environment' needs to be set out in terms of its human dimensions, through focussing on the kinds of experience in the course of which people come into bodily contact with the environment.'*

By focussing more on individuals and their immediate social networks, greater significance can be found between macro-scale global environmental issues and everyday life.

Recent reports on communication strategy have followed a trend towards 'social marketing'[12] i.e. using marketing principles to influence the way in which climate change is communicated; for example, the *'Rules of the Game: the principles of climate change communication'* by Futerra (2005). It is argued that models of public service or campaigning communications are outdated, and that climate change should be approached as a *'brand that can be sold'* (Ereaut & Segnit, 2006) – something positive and desirable, in order to encourage agency. Ereaut and Segnit (2006) emphasise that a large proportion of the public have esteem-driven needs. The public expects advertising approaches focussed on making individuals feel special through what they do and what they buy. Climate engagement approaches could perhaps learn from this and attempt to enact change by also emphasising positive esteem-driven attitudes, rather than focussing on negative communication.

3.4.7 Meeting the challenge of effective climate engagement

Although information has a role to play, relying on the information deficit model is ineffective for overcoming the value-behaviour gap. Social, psychological and institutional norms and beliefs may instigate barriers to effective behavioural change, preventing individuals from feeling that they can take action and engage meaningfully with the issue. Behavioural models attempt to explain and predict behavioural change. The more traditional attitude-behaviour models such as the TRA and TPB have been criticised for not situating behavioural change in a specific place and time. The SPA has been postulated as a more socially constructed solution, although itself is subject to a number of difficulties. Investigating effective engagement approaches can be informed by understanding barriers to change, and the values and limitations of these behavioural models. It is argued that for a engagement approach to be effective (defined as facilitating a social change), it must accomplish two things. First, the approach must elevate and

[12] Social marketing is defined as the use of marketing principles and techniques to influence a target audience to voluntarily accept, reject, modify, or abandon behaviour for the benefit of individuals, groups, or society as a whole (Kotler *et al.*, 2002).

maintain the motivation to change a particular behaviour, and second, the approach must contribute to lowering the barriers and resistance to making that change (Moser, 2006b).

3.5 ICONS FOR ENGAGEMENT

> *"If people in their communities, in their families, in their local landscapes identify something that is precious to them, and you can point out to them how that is going to be threatened by uncontrolled climate change, they then will have an incentive to mobilise, to try to protect that thing, whether it is a feature of the landscape, a building or whatever. In that process I think people are then empowered at the community level and at the local level and indeed the individual level by the notion that there are things that they can do which will have traction [on climate change]"* (Steve Rayner, 2005: p 340)

It is maintained that a bottom-up approach to engagement is needed, focussing on approaches which non-experts can relate to and empathise with. The research in this thesis investigates a method in which individuals identify things which are precious to them, but that are threatened by climate change. The impact of climate change upon this precious entity is presented, so these people in the communities and families that Steve Rayner refers to in the quote above can be empowered - and find saliency in the issue of climate change.

3.5.1 Icon history

The icon is the most enduring element in any writing system. It is unique in that in can impart direct understanding, overcoming language barriers and, within certain limits, become universally understood (Sassoon & Gaur, 1997). The word icon is derived from the Greek word eikon, meaning 'an image' (OED online, 2007). The earliest record of using icons as graphic representations to signify thoughts and ideas goes back to the Stone Age. Examples of notches cut into stone or bone have been found, perhaps representing an early form of tally counting (Sassoon & Gaur, 1997). Later, abstract geometric shapes were introduced to represent physical objects such as water holes. More complicated representations of animals and Figures started to appear around 30 000 BC. Narratives of occasions such as hunts, celebrations and warfare are detailed through more complex frescos such as that in Altamira, Spain, and only appear much later between 10 000-8 000 BCE. Cave paintings became more advanced as time progressed, as did the use of icons. Modern times have seen the use of icons continue. The Dakota Indians used iconic representation of the main event of the year as a form of calendar. Between 1801-02, smallpox killed many of the Indians, and thus this year is represented as an icon of a stylised head and torso filled with small scratches to represent the dead (Sassoon & Gaur, 1997). Icons continue to be used now, with current uses such as road signs providing a widely understood pictorial system of recognising dangers and illustrating rules.

3.5.2 Defining an icon

Some ancient icon representations have been found with almost universal usage, before times of global travel and trade. Evidence has been found in places as diverse as Scandinavia, Russia, Italy, North America, and even to the present day in some parts of Africa for a system of using a notched stick as a reminder for a traveller to deliver a message to a recipient (Sassoon & Gaur, 1997). However, more complex messages often form part of the cultural makeup from where they originated. Therefore, the icon cannot be understood, or 'read' outside of that particular culture or tradition. Gathering the same message from the icon may depend upon the readers of the icon having similar cultural values, world views and sense of place.

Since ancient Greek times, the term 'icon' has been used to represent a range of meanings. In Eastern Orthodox Christianity, icons hold religious significance. In this context, an icon is a wooden block, on which is painted a representation of a sacred person in the Greek or Russian Byzantine style. The icon images are painstakingly copied from one image to the next. There is little freestyle artistry involved: each modicum of imagery has great religious significance in the painting, from the folds in clothing to the sometimes unusual shapes of the facial features (Ramos-Poqui, 1990). After the painting is completed, the icon is blessed, and then is itself regarded as sacred. These icons are used as an aid to worship. Byzantine iconography has had a convoluted history, falling into disfavour and indeed being prohibited during the crisis of Iconoclasm. During this period it was argued that the icons, rather than what they represented, were being worshipped. This period ended when it was accepted that veneration of the icons, and not worship of them, was acceptable.

An icon may also be defined as:

> *'a small symbolic picture of a physical object on a VDU screen'* (OED online, 2007)

This may be a familiar definition for more technologically minded individuals. Although not the rich definition of 'icon' that is exemplified in this thesis, this definition is of some relevance: the icon in this definition is an abstract representation of a function that can be investigated in order to provide further knowledge.

A further definition of ‘icon’ is a recent addition to the English language. This modern definition may have most relevance with the layperson. An icon is thus:

> *‘A person or thing regarded as a representative symbol, especially of a culture or movement, and considered worthy or admiration or respect’* (OED online, 2007)

This definition of the word ‘icon’ is heavily used in the popular media. For example, Marilyn Monroe may be seen as an icon of modern culture, whereas Mt. Everest may be an icon of the natural world.

A further definition for an icon is found in the field of semiotics, where an icon is *‘a sign which resembles the object it signifies’* (OED online, 2007). Understanding semiotics and the semiotic definition of ‘icon’ is most relevant to this research. The use of semiotics in the understanding and communication of ideas has been recognised by fields as diverse as philosophy to advertising (Wright, 2000). Saussure (1974) defined semiotics as *'the science of the life of signs in society'*. Understanding and communication is not just conducted through spoken language. Many other methods can be used to communicate, such as signals, signs and symbols, which could be conveyed in noise, and through the pictures, shapes and colours of imagery (Wright, 2000). It is argued that signs transcend all other devices as the basic building blocks of communication, either signifying meaning, or making things mean something (Tomaselli, 1996). Semiotics investigates not only how things come to mean, but how these meanings are a product of the cultures and worldviews from where they originated. If semiotics is understood in this way, then everything in a culture can be seen as a form of communication, organised in a way similar to spoken language, to be understood in terms of a common set of principles (Hodge & Kress, 1988).

Saussure (1974) argued that in non-verbal communication there is no inherent relationship between the signifier i.e., the symbol, and the signified i.e., the actual meaning of the symbol. Thus, a symbol of three parallel wavy lines has from Ancient Egyptian hieroglyphics to modern day British road signs come to represent water. However, this may not always be the case, and an icon will not necessarily carry the same meaning for everybody who views it. As an icon is only an abstract representation; decoding the message of the icon requires a common understanding. This is echoed by Tomaselli (1996) who notes that signs are unstable, and their meanings change depending on who is speaking or using the icons and for which purpose or in what context.

In the semiotics of Pierce, there are three basic categories of sign: symbols, indexical signs and icons. Symbols have no obvious association to the idea to which they connect apart from through a convention which it is taken for granted is accepted. For example, a triangular traffic sign symbols danger, though there is no obvious connection between a triangle shape and the concept of danger. Indexical signs draw attention to the thing to which it refers. Hence a weathercock is an indicator of wind direction. Icons resemble the object which they signify (Peirce 1931-35, 1958).

In semiotics, the more a sign looks like the object it is representing, the more motivating it is said to be. Thus icons are more motivating than indexical or symbolic signs, as they have a physical correspondence to the 'reality' referred to (Tomaselli, 1996). As icons are motivating a common ‘decoding’ method may not need to exist in order for the viewer to understand the real entity from the icon sign, as Saussure would suggest. Instead, viewers of the icon may be able to visualise and imagine the entity represented directly from the icon.

A project titled ‘Icons of England’ launched in 2006 asked the public to vote for and to share what they considered to be English icons. The project first asks how exactly an icon should be defined:

> *What is an icon? What makes something an icon? Is it to do with being famous or important? Is an icon beloved or somehow symbolic? Why is a cup of tea iconic and not a glass of orange juice? Do we include the Humber Bridge as well as Tower Bridge? Wimbledon or Wembley?*
>
> (Icons Online, 2006)

The project states that icons have to be uniquely important to life in England, and to the people that live in England. The project also states that agreement has to be reached on what is iconic: some icons are obvious, some controversial. The project set up a number of ground rules for what was considered an icon. First, it was considered that icons are symbolic: that they represent something in the culture, history or way of life. Second, the project considered that icons are recognisable in a crowd: if no-one has heard of it or knows what it looks like, it is not considered an icon. Last, icons were entities judged to be fascinating and surprising, with hidden depths and unexpected associations (Icons Online, 2006).

3.5.3 Engagement with climate change through icons

A climate change icon would demonstrate the effects of increasing atmospheric greenhouse gas emissions upon a particular entity. Some have already used the term ‘icon’ for describing an entity impacted by climate change. For example, ecologist Daniel Fagre based in Glacier National Park, Montana, US, stated that *‘glaciers are an icon for climate change’* as they are symbolic of change across ecosystems, and as they are an easy to identify physical phenomenon (Nussbaum, 2006). Another entity described through the concept of a climate icon has been the glaciers on Mt. Kilimanjaro. Mabey (2006) writing online for *The Times* newspaper commented:

> *“The snow-cap of Mount Kilimanjaro will soon vanish into the heavens. Will the loss of that iconic image of the Earth’s grandeur stir consciousnesses?”*

The concept of ‘climate icons’ is used frequently even if this particular terminology is not used. For example, UNESCO has named several World Heritage Sites threatened by climate change: entities which could be viewed as ‘climate icons’. These include the Tower of London, the Belize Barrier Reef and Sagarmatha National Park in the Himalayas (Black, 2006). Climate icons portrayed in the media range across a wide variety of entities; from impacts on individual buildings to impacts on specific cultures. For example, McCarthy (2006) writing for *The Independent* newspaper, cited 16 entities likely to be impacted if climate change reaches a tipping point: entities which could be named ‘icons’. These included impacts on the Arctic tundra, crop yields in Africa, water shortages, the Inuit, Coral reefs and Alpine skiing. Climate icons also occur in campaigning literature. NGOs have utilised icons to carry their climate change message. Greenpeace is typical, using retreating glaciers from the Arctic and Antarctic, and species such as polar bears and walruses (Doyle, 2007) as icons to carry messages of a changing climate.

The concept of icons of climate change is not limited to non-expert discourses. Indeed, it could be argued that many climate icons originate from the scientific literature. Icons found in the scientific literature range from the impacts of climate change on niche ecosystems, to the West Antarctic Ice Sheet (WAIS) and the Greenland Ice Sheet (GIS) (O'Neill & Oppenheimer, 2004), to impacts on atoll countries (Barnett & Adger, 2003) and to climate impacts on water availability in Egypt (Conway *et al.,* 1996).

The Avoiding Dangerous Climate Change conference held in Exeter, 2005, provides an interesting example of how icons evolve. The conference defined ‘three dangers’, the third of which was waking the six ‘sleeping giants’[13]. The wasting of the West Antarctic Ice Sheet (WAIS) is one of the sleeping giants. If the WAIS were to completely disintegrate, then there would be a eustatic SLR of between 4-6m (O'Neill & Oppenheimer, 2002). The melting of the Greenland Ice Sheet (GIS) was the second sleeping giant. A complete melt of the GIS could, eventually, cause a eustatic SLR of 7m. The third sleeping giant involves soils giving up their carbon stores. Much of the world’s carbon is stored in soils and swamps, particularly at high latitudes. Climate change and their impacts on soils have been modelled by White *et al.* (1999) who find that after 2050, shifts in temperature and precipitation become large enough to adversely affect growth, causing a declining trend in forests and a loss of carbon from vegetation and soils. The fourth sleeping giant was a weakening of the Thermohaline Circulation (THC). It has been predicted that a shutdown of the THC could cool UK temperatures by an average of 5˚C, with winter temperatures regularly reaching below -10˚C (Jenkins *et al.* 2005). Increasing natural methane emissions are cited as the fifth sleeping giant. Lastly, the sixth sleeping giant is acidification of the ocean by CO2. Increasing the amount of CO2 released into the atmosphere leads to an equilibrium uptake reaction by the surface ocean. The action of carbon dioxide with water produces carbonic acid. Increasing the concentration of atmospheric CO2 will cause an increase in this reaction, and hence a decrease in ocean pH.

These six sleeping giants could be defined as ‘expert’ or (science-led) ‘climate icons’.
The media picked up on these ‘sleeping giants’ and brought them into public discourse (for example, see the Guardian Unlimited 2005)[14]. However, these top-down ‘expert climate icons’ may have done little to engage the public with climate change as they do not connect with individual’s everyday experiences. Although it is recognised that this was not the aim of this conference, the use of ‘expert climate icons’ more generally indicates a top-down approach which is at odds with the views expressed by Dessai *et al.* (2004) as reviewed in Section 2.1, and the increasing socio-psychological literature as examined in this Chapter, demonstrating that non-experts require non-technical, locally salient engagement approaches that promote efficacy.

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[13] ‘Sleeping giants’ are so called because they are processes that have the potential to accelerate the rate of warming beyond that attributed to human emissions of greenhouse gases (Field *et al.*, 2004)
[14] This process was also aided by the ‘tipping points’ metaphor entering public discourse from the conference.

Some ‘climate icons’ currently in the public sphere (for example, polar bears) may at first glance appear to be ‘non-expert’ climate icons, rather than ‘expert’ climate icons as they have gained public understanding and connection to the issue of climate change. However, it could be argued that icons in non-expert discourse are still essentially defined through a top-down approach by experts. So it may be that whilst ‘non-expert’ climate icons such as the polar bear originated as ‘expert climate icons’, these types of icons were considered to have greater saliency and be more amenable to public dissemination than others: and hence occur more in public discourses, becoming a ‘pseudo’ non-expert icon. So far a public participatory approach has not linked the ‘climate icons’ which promote non-expert engagement with a scientific analysis of the impacts of climate change upon these ‘non expert climate icons’. This is the central idea that lies behind this thesis.

3.6 AN ‘ICONIC APPROACH’ TO ENGAGING NON-EXPERTS WITH CLIMATE CHANGE

Using climate icons (hereafter referred to as ‘icons’) is designed to overcome some of the barriers to involvement with climate change as discussed earlier in this Chapter. An iconic approach to engaging non-experts with climate change aims to engage through a participatory bottom-up approach where individuals express what they consider icons of climate change to be. Icons could be entities as diverse as natural systems, indigenous communities, communities and landscapes, cultural entities and species at risk. In this research, the definition of ‘icon’ will relate to all the definitions discussed above:

- Icons as represented through religious artistry
- Icons as representations in IT
- Icons as symbolic representations considered worthy of respect
- Icons as representations through semiotics
- Icons as recognisable entities
- Icons as fascinating, surprising entities with hidden depths and associations

An icon is therefore more than an image or symbol. In common with the definition of an icon as a religious artefact, or as the definition of entities with hidden depths and associations, a climate icon as defined here is a symbolic representation of more than what is immediately apparent. As explained by the semiotic definition of an icon, an icon is motivated and therefore a common decoding method is perhaps not needed in order for the viewer to grasp the icon. Viewers are able to visualise and imagine the icon as viewed from their individual cultural values, world views and sense of place. Thus, a climate 'icon' in this thesis is defined as:

> *A tangible entity which will be impacted by climate change, considered worthy of respect, and to which the viewer can relate to and feel empathy for.*

The 'iconic approach' investigated here aims to harness the emotive and visual power of icons as defined by non-experts with a rigorous scientific analysis of possible changes under a different climate future.

The next Chapter sets out the methodological foundations to the development of an iconic approach to engaging non-experts with climate change. Chapters 5,6 and 7 then detail the methodologies, results and analysis in developing the iconic approach, with each Chapter building successively on the last.

CHAPTER 4:
INTERDISCIPLINARITY IN SHAPING THE RESEARCH

The thesis research is sequential, with each methodological stage building upon the conclusions of the previous stage. It is therefore more practical and comprehensible to document each stage in a separate chapter. Each of the Chapters 5, 6 and 7 therefore discusses the methodologies used in Stages 1, 2 and 3 respectively. This chapter sets out the overall theoretical framework to the thesis. First, Section 4.1 provides an insight into the necessarily interdisciplinary nature of research into climate change engagement through a discussion of post-normal science and interdisciplinarity. Section 4.2 then investigates possible theoretical frameworks for such interdisciplinary research including a brief survey of how positivist and constructivist epistemologies influence research questions, design and methods. The section concludes by stating the pragmatic epistemology underlying the thesis research. Section 4.3 summarises the approach taken in this thesis, and states the relationship between the research questions posed in Chapter 1 and the methodologies used. Section 4.4 provides a summary of the chapter.

4.1 POST-NORMAL SCIENCE AND INTERDISCIPLINARITY

Undertaking research in climate change engagement necessarily integrates disciplines from both the social and natural sciences, with influences from geography, psychology, sociology and from the physical, chemical and biological sciences. This thesis is not conventional in the sense that it does not use a single methodology. The thesis combines both quantitative and qualitative methodologies through adopting a pragmatic epistemology. The thesis is interdisciplinary and was completed in a post-normal science setting. After briefly examining the notion of post-normal science, the following section addresses the different methods of between-discipline working and the concept of interdisciplinarity.

4.1.1 Post-normal science

When systems uncertainty and decision stakes are low Kuhn's (1962) model of science as puzzle-solving (i.e., 'normal') is an adequate description of the practice of science. Funtowicz and Ravetz (1993) developed the concept of post-normal science to describe a situation where either or both systems uncertainty and decision stakes are high, and traditional methodologies ineffective (Figure 4.1). In this situation, applied science or professional consultancy is ineffective.

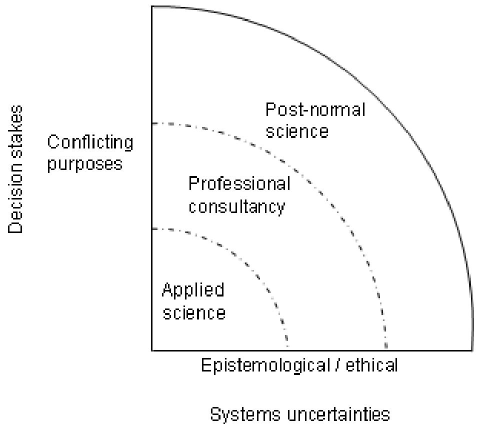

Figure 4.1 Post-normal science (Funtowicz & Ravetz, 1993)

Within post-normal science, an 'extended peer community' exists of all those with a stake in the question under scrutiny. This community comprises advocates and guardians of local knowledge and consultancy as well as the traditional peer-reviewed literature, and holds 'extended facts' on the issue under question (Funtowicz & Ravetz, 1993). Post-normal science embraces complexity and uncertainty on the understanding that complex issues will never be fully understood before action is taken to manage them (McCarthy, 2003).

Funtowicz and Ravetz (1993) state that their post-normal science model is distinctive in that it allows explicitly for the interaction of epistemic (knowledge) and axiological (values) aspects of scientific problems. Climate change is traditionally seen as a normal scientific issue, with associated 'facts' and objective truth seeking (see for example PM Blair's request to scientists at the Exeter Conference on Dangerous Climate Change in 2.1.1.3). In 1999, Bray and von Storch suggested that there is a socio-scientific construction of the climate change issue. It is increasingly recognised that climate change encompasses social, cultural and politic beliefs and norms as well as the 'facts' of normal science (as discussed by Hulme, 2007). Thus climate change cannot be seen simply as applied science: the climate issue as it now stands is not value neutral and therefore falls within the realm of post-normal science.

4.1.2 An interdisciplinary approach

As discussed, a key part of a post-normal science is the recognition of an extended peer community, and an acceptance of the value and belief systems inherent in the research. An approach is needed which recognises this.

Disciplines are constructs borne out of historical processes involving both objects and methods of study, providing frames of reference, topics of study, theoretical approaches, methodologies and technologies. Beyond this, each discipline also has shared social and cultural dimensions (Petts, Owens & Bulkeley *in press*) evident in the language and tools used, and in epistemological foundations.

There are numerous typologies given to working between disciplines, from cross-, pluri-, multi-, inter- to trans-disciplinarity (Pohl, 2007). Each has different connotations for the level of integration between disciplines. In brief, cross-, pluri- and multi-disciplinary processes are considered here to involve knowledge transfer between disciplines, but with the new knowledge created in the process formed within just one of these strands. In contrast, inter- and trans-disciplinary research is found occupying the spaces between the disciplines (see Petts, Owens & Bulkeley *in press*). It has been argued that transdisciplinary research reaches beyond interdisciplinary research by literally transcending traditional disciplinary boundaries, challenging and renegotiating them and perhaps even re-drawing the interdisciplinary map (Petts, Owens & Bulkeley *in press*). Pohl (2007) defines transdisciplinary research into two types. Type one reorganises knowledge that is produced after consideration of the perceived audience and its demands. Pohl's definition of type two transdisciplinary research goes further than a reorganisation of knowledge, and further than the bounds of academia, to a co-production of knowledge between the academic, bureaucratic, economic and civic policy cultures.

It is considered here that a continuum exists with weak inter-disciplinary 'cooperative research' at one end, and transformation of disciplines at the other, rather than the classification of research as either inter- or trans-disciplinary (as Petts, Owens & Bulkeley *in press*). Using this broad definition, the term interdisciplinary is used in this thesis to describe the research process whereby the final knowledge obtained is more than the sum of its disciplinary components (Lawrence & Després 2004).

A shortcoming of traditional scientific research is that topics are viewed isolated from their societal context (Lawrence & Després 2004). An issue such as climate change requires an interdisciplinary approach which is problem focussed, integrated, interactive and reflexive; and involves collaboration and partnership (Robinson, 2005). Thus, the approach needs to find ontological frameworks which embrace the complexity of the natural and human environment; find epistemological positions that value the complex and inter-related spheres of human and natural ecosystems; support collaborative research efforts between related disciplinary knowledge and expertise drawing upon appropriate methods; and acknowledge professionals, politicians, interest groups and the public as knowledge users and creators (adapted from Lawrence & Després 2004).

4.2 THEORETICAL BACKGROUND

The paradigmatic foundations of the research in this thesis were considered before the methodology was explicitly defined. It was important that the research was placed in an ontological framework recognised and valued the complex and inter-related spheres of human and natural ecosystems. Although different paradigms may foster very different understandings of the world, an appreciation of other paradigmatic ontologies, epistemologies and methodologies would appear a prerequisite for well-grounded research. Guba and Lincoln (1994: p 105) define a paradigm as:

> *"The basic belief system or worldview that guides the investigator, not only in choices of method but in ontologically and epistemologically fundamental ways."*

Thus, the choice of paradigm plays of primary importance over and above choices of method.

4.2.1 A pragmatic framework

It is easier to conceptualise different paradigms if imagined that they lie along a spectrum rather than as individually aligned, easily definable separate entities. The four main paradigms along this axis are defined by Guba and Lincoln (1994) as positivism, post-positivism, critical theory and constructivism, the extremities at each end of the axis being positivism and constructivism. Positivism lies within a realist tradition. The ontology in this case employs realism. Experimental methodologies are frequently used in positivist research, and the epistemology assumes that findings are universally true, or at least converging approximations to what is universally true. In constructivism, reality is thought of as being locally constructed: an interplay between the material, the cultural and the psychological. The methods used in constructivist paradigms are typically explorative and interpretative. Findings are considered created, rather than universally true. Knowledge is always situated – in a time, in a place and in a culture.

Risk research is traditionally centred in a positivist paradigm, drawing from disciplines such as engineering and the physical sciences. However, this approach has raised concerns about the social understanding of risk: for example, involving issues of dimensions of trust. Consequently, understanding the conceptualisation of such dimensions of risk often occurs through using a more constructivist paradigmatic frame because social science methodologies can be more adept at dealing with '*messy background noise*' (Baum, 1995). Therefore, it can be seen that it may be beneficial for risk research to combine elements of both positivist and constructivist paradigms.

Each paradigmatic stance has its own advantages and limitations and although it may be thought a goal is to combine the different approaches through an interdisciplinary approach, these paradigmatic frameworks may be in conflict (Day, 2004). Much has been made of the 'paradigm wars'; the polarisation of paradigms - typically positivist versus constructivist - into opposing factions. Gage (1989: p 5) defines the paradigm wars as:

> *'Competition between the disciplines - competition manifested in derogation of the concerns of the other disciplines and glorification of one's own.'*

This quantitative versus qualitative debate came to the fore in the 1970s and 1980s (Sale, Lohfeld & Brazil, 2002), ultimately exploding in the science wars of the 1990s as positivist and constructivist clashed head-on in the 'Sokal affair'[15]. Guba and Lincoln (1994) however state that the paradigm wars have been overdrawn and represent the situation as more confrontational than is necessary. Debating simply quantitative versus qualitative, or positivist versus constructivist, often just devalues the contribution of both paradigms and contributes little (Baum 1995; Gage 1989). Baum (1995) maintains that attempts should be made to explore, rather than deny, the diversity of the different paradigmatic frameworks. An honest and productive cordial relationship between the different paradigms should be encouraged (Gage, 1989).

One way around the polarisation of the realist/constructivist debate, and encouraging the development of this cordial relationship between the differing ontologies could be through pragmatism (Cherryholmes 1992; Reichardt & Rallis 1994; Tashakkori & Teddlie 1998). Pragmatism may be defined as a middle ground between positivism and constructionism (Day, 2004). It uses both inductive and deductive logic, and employs both subjectivity and objectivity (Lincoln & Guba, 1985). A pragmatic framework assumes that an external

[15] Alan Sokal is a physicist who submitted a paper titled 'Transgressing the Boundaries: Towards a Transformative Hermeneutics of Quantum Gravity' to the cultural studies journal *Social Text*. As the article was published, Sokal submitted an article to *Lingua Franca* where he announced the first article was a parody designed to test whether *Social Text* would publish an article 'liberally salted with nonsense if (a) it sounded good and (b) it flattered the editors' ideological preconceptions'.

reality does exist but denies that truth can be totally determined (Cherryholmes, 1992). Pragmatists recognise that the researcher plays a large role in conducting the research and in drawing conclusions – thus endowing 'knowledge with personality' – but pragmatists do not dwell overly on this characteristic (Cherryholmes, 1992). A pragmatic framework has been defined as *'what works'* (Tashakkori & Teddlie, 1998).

4.2.2 A multimethodological research design

Pragmatism often employs a mixed methodology research design, combining both quantitative and qualitative approaches in different phases of the research process (Tashakkori & Teddlie, 1998). A mixed methodology has been defined as follows:

> *'Those that include at least one quantitative method (designed to collect numbers) and one qualitative method (designed to collect words), where neither type of method is inherently linked to any particular enquiry paradigm.'* (Greene *et al.*, 1989: p 259)

Interdisciplinary research gains its strength from the different methodological structure it employs, and offers the possibility of breaking out of the traditional divide and composing new methodological strategies (Day, 2004).

The strength of a multimethod approach is that the bias inherent in any particular research method is to some extent neutralised by the other methods also used in the research process (Creswell, 2003; Denzin, 1970). Brinberg and McGrath (1985) argue that the full research endeavour requires the pursuit of multiple paths; no one path is correct, and no one path is sufficient. A multimethod approach is not only advantageous in data collection. The use of data analysis strategies within a mixed research methodology enables the researcher to integrate qualitative and quantitative data, and for the strategies to complement each different data set (Caracelli & Greene, 1993). The use of multiple methods allows the research problem to be examined from different viewpoints. When many strategies are used, data may be discovered that monomethod research may not reveal (Denzin, 1970).

4.3 THE APPROACH TAKEN IN THIS THESIS

It is postulated by some that pragmatism has overcome the paradigmatic differences of positivism and constructionism to produce a new paradigm combining the strengths of both: yet pragmatism itself has been criticised. Some have expressed concern that there has been a lack of awareness of the ontological and epistemological differences associated with the different theories underlying the methods used (Blaikie, 1991) and also that the contrasting epistemological assumptions associated with quantitative or qualitative methods cannot be reconciled (Caracelli & Greene, 1993). Particularly, Sale *et al*. (2002) state that parts of the positivist and constructivist approach are incompatible, and thus cannot be combined in one theoretical approach. For example, constructivists believe that objectivity is an illusion, whereas objectivity (whether one believes it may exist or not) is a cornerstone of positivist epistemology.

However, Sale *et al.* (2002) state that there are some cases where combining both paradigms in a single study can be methodologically and philosophically successful: when quantitative and qualitative work is carried out sequentially in a series of investigations. Thus, they can be combined for well-demarcated, complimentary purposes. The thesis research has been designed around a sequential, exploratory pathway (Creswell, 2003), and therefore fulfils this criteria.

Some thought should also be given to Miles and Huberman's comment (1984) that the quantitative-qualitative debate will not be resolved in the near future and thus researchers should not be overly concerned about it – epistemological purity does not get research done. It is important that paradigmatic issues are considered, but also recognised that for a study such as this into climate change engagement, there is some merit in this very practical statement.

A pragmatic epistemological standpoint is taken in an attempt to avoid the polarisation of the realist/constructivist debate. As is common within a pragmatic approach, this thesis utilises both quantitative and qualitative methodologies. As Tashakkori and Teddlie (1998) state, most researchers now use whichever method is most appropriate in their research rather than relying on one method exclusively. In the thesis research presented here, the choice of methodology has relied more on gaining insight into the research questions posed than the determined use of one particular method. Using a multimethodological approach within the pragmatic framework provides both the depth and the breadth needed to address the interdisciplinary research questions posed in this thesis.

The three main research questions addressed by the thesis (see also Chapter 1) and their relationship with the research methods is illustrated in Table 4.1. During Stage 1, focus groups and an online survey were utilised. Stage 2 encompassed quantitative modelling and GIS, as well as an expert survey and a literature search. Stage 3 used a pre / post-test survey design through a workshop format.

Table 4.1 The relationship between research questions and methods

Stage	Research questions	Research methods
Stage 1	*What makes an engaging 'climate icon'?* • What do participants select as their climate icons? ○ On what spatial scale(s) are icons chosen? ○ What reasoning lies behind icon choice? • Are there commonalities and differences in the icons selected? ○ Does this vary across spatial and cultural contexts? ○ Is there such an entity as a globally engaging icon of climate change?	focus groups online survey
Stage 2	*Examining non-expert and expert-led icons* • What constitutes an expert-led icon? • What is the impact of a future climate scenario upon selected icons? ○ What is the impact on the non-expert icons? ○ What is the impact on the expert-led icons?	quantitative modelling GIS expert survey
Stage 3	*Does the iconic approach engage non-experts with climate change?* • How do non-experts engage with the expert and non-expert icons? • Does the iconic approach alter cognitive or affective aspects of engagement with climate change?	pre / post-test survey workshop

4.4 SUMMARY

This chapter first discussed the interdisciplinary nature of the thesis. Section 4.1 discussed how climate change as an issue encompasses social, cultural and political beliefs as well as normal scientific ‘facts’, and hence how it has become a post-normal scientific issue. The theoretical basis for the thesis was then set out, with a brief survey of the literature into positivist and constructivist epistemologies and the relationship of epistemology to influence research design and methods. The chapter concluded by stating the thesis research was carried out within a pragmatic framework, using both quantitative and qualitative methods in a multimethodological approach.

CHAPTER 5:
ICON SELECTION

This Chapter explores the research questions posed in Chapter 1 (stage 1) around what makes an engaging ‘climate icon’. Sections 5.1 and 5.2 document the process undertaken for selecting the non-expert climate icons. In Chapter 3 it was argued that although some climate icons already exist in public discourse, they largely originate from expert perspectives. The literature explored in Chapter 3 examined the need for more ‘bottom-up’ approaches for engaging non-experts with climate change. Section 5.1 thus explores the views from a culturally and spatially diverse non-expert participant sample, using the methodologies of focus groups and an online survey. The coded results and analysis from these methodologies are then discussed in Section 5.2. Section 5.3 provides the rationale behind selection of the expert icons. The reasoning for selecting a suite of comparative expert icons is presented. Section 5.3.1 then details the icon selection methodology for the ‘expert’ climate icons. Lastly, the conclusions to both the expert and non-expert icon selections to take forward to Stages 2 and 3 (discussed in Chapters 6 and 7 respectively) is reported in Section 5.4.

5.1 NON-EXPERT ICON SELECTION METHODOLOGY

This research was not intended to provide a representative view of the UK public as regards the iconic approach to engaging with climate change. Instead, it was designed to gather rich, exploratory data. The non-expert icon selection procedure was opened to a wide and diverse audience in order to investigate cultural and spatial commonalities and differences in icon selection, and to investigate whether a ‘globally engaging’ icon of climate change exists. Also, this first stage of the thesis research sought to investigate on which spatial scales individuals selected their icons, and the reasoning behind icon choice.

The rationale for the choice of participant groups is outlined in Table 5.1. The three participant groups were deliberately selected as they represented very different social groups which would provide interesting data for comparison of icon selection across participant groups. The participant groups were of differing background and life stages, so it was postulated that the participant groups would have different priorities which may impact on icon selection. The LEAD Fellows are successful leaders working on complex environmental and developmental issues, and form a professional and mainly young network. The CNS parents were largely representative of a UK middle class population, and all lived in the local (Norwich, UK) area. Before the online survey started, the *cp.net* community makeup was a relative unknown. However, it was known that participants were computer literate and were interested in either (or both) computer processing or climate change.

The type of interaction between participants in their discussion and selection of climate icons was also different between participant groups, as each participant group represented a different form of community. The LEAD participants form a network of Fellows who meet infrequently to attend conferences, but maintain a strong identity through their shared mission of sustainable leadership. The CNS parents represent a community sharing the commonality of their children's' education, but none of the CNS parents had met before the focus group was carried out. The *cp.net* participants represented an opportunity to explore perceptions of climate icons with a different kind of community, through an online forum. Several *cp.net* participants had interacted informally with each other through the forums before the online survey was initiated.

Table 5.1 Rationale for participant selection

Method	Group	Rationale
Focus group	Parents with children at CNS high school	• Participants have high-school age children at the City of Norwich School (shortened to CNS in text). • Postulated that the parent's outlook on climate change may be influenced by concern for their children's future. • The school's catchment area is the city of Norwich, UK, so provided a local (Norwich, UK) perspective. • The school had a higher than UK average GCSE/A level attainment in 2004[16].
	LEAD International fellows	• Fellows of the Leadership for Environment and Development International (shortened to LEAD in text) network, designed to inspire leadership for a sustainable world. • Sustainability (but not climate change) experts. • Work in diverse fields e.g. media, government, NGOs • Fellows of many different nationalities, so represented a spatially and culturally diverse sample. • Participants have expertise in meta-environmental issues forming valuable discussion for the research.
Online survey	*Climate Prediction.net* forum participants	• Participants of *ClimatePrediction.net* (shortened to *cp.net* in text) contribute spare computing power to an online climate prediction model. Specifically, these participants take part in online forums discussing issues related to the project (forum discussions are more related to computing issues than climate science) • Participants expected to have some knowledge of climate change due to involvement in the forum, but not anticipated to be climate experts. • A spatially diverse sample as *cp.net* reaches a global, online audience • Investigation into newer forms of 'community' through exploration of an online forum.

[16] See http://news.bbc.co.uk/1/shared/bsp/hi/education/04/school_Tables/secondary_schools/html/926_gcse_lea.stm [accessed January 2006] for full Norfolk school listings

Two different methodologies, focus groups and online surveys, were utilised in the non-expert icon selection process. Parents of high school children and fellows of LEAD international participated in focus groups (Section 5.1.1). The focus groups were designed to allow in-depth discussion of climate change icons, leading into a participatory exercise where participants named their personal icons. An online survey was used (Section 5.1.2) where participants were part of an 'online' community and could not attend a central focus group discussion. Moreover, the *cp.net* group were specifically asked for their views on icon selection because of their status as an online community. The online survey protocol was thus specifically designed in order to access such an online community. The online survey protocol followed the same path as the focus group protocol, and discussion boards were set up to allow participants to discuss their personal icon selections.

5.1.1 Icon selection methodology 1: Focus groups

A focus group is a small structured discussion group held with selected participants, and led by a moderator. Focus groups are set up to explore specific topics within the individual participants own views and experiences through the medium of group interaction (Litosseliti, 2003). Kamberekis and Dimitriadis (2005) define a focus group as little more than quasi-formal or formal instances of many of the kinds of everyday speech acts that are part and parcel of unmarked social life, such as conversations, group discussions and negotiations.

Focus groups were first postulated as a research method in the 1930s. Researchers were beginning to find the structured, closed-ended questions of interviews and questionnaires too rigid to gain the sort of rich, qualitative data that they needed. However, the method was not embraced by the social sciences as a whole, and focus group discussion methods lay more or less unused for twenty more years. In the 1950s post-war era, market research began to take hold, and borrowed much of its methodology from these original ideas for focus groups. Market researchers realised that focus groups could provide information on product marketing, success and failure - and at a reasonable cost - that simply couldn't be carried out using other methods. The 1980s saw a resurgence of the use of focus groups in academic research, often borrowing skills and techniques from market research. However, this was not always successful in the new setting. Academics turned to the original sources of focus group methodology proposed earlier, but still using techniques from market research (Krueger and Casey, 2000). It is from these roots that the modern concept of focus group discussions has come to be realised in the academic environment.

The idea of a focus group is to promote self-disclosure among participants (Krueger and Casey, 2000) concerning a specific issue or idea. The method will produce rich, qualitative data that can be analysed as a form of discourse (Kamberekis and Dimitriadis, 2005), and produces data that are both inductive and naturalistic (Krueger and Casey, 2000). The discussion in a focus group around the question will allow the participants to relate the topic to their everyday '*lived realities*' (Kamberekis and Dimitriadis, 2005). It enables participants to answer questions in their own vocabulary, and allows an altogether deeper discussion than say, through interviewing, through the questioning of the participants own priorities. The research uncovers not only what participants think, but how and why their thinking is framed in this way (Kitzinger, 1995). Paultikof (2004) maintains that only through such rich data collection methodologies such as focus groups can knowledge be gained of the social processes of opinion formation. Unlike self-completion surveys or questionnaires, the method does not discriminate against a lack of literacy. With careful moderation, it also allows the views of all - including those who are shy or think they have nothing to contribute - to enter the discussion (Kitzinger, 1995). Focus groups are useful for exploring complex issues, for brainstorming and for generating ideas, with participants discussing different sides to the issue (Litosseliti, 2003). Focus groups have been widely used in a variety of settings around the issue of climate change (for example, see: Jenkins *et al.* 2005; Myers & Macnaghten 1998; Nicholson-Cole 2004; Palutikof *et al.* 2004; Stoll-Kleemann, O'Riordan & Jaeger 2001).

The group discussion is normally held for between one and two hours. The location of the focus group should have a neutral and permissive environment. Although the discussion has structure and is led by a moderator, the underlying notion is that participants contribute their views, and a skilled moderator should have little input into the actual discussion. The moderator should be careful not to make judgements: either overtly through the use of approving or disapproving language, or through more subtle means such as body language. The moderator appears neutral on all issues raised, yet encourages further discussion through the use of prompts. Essentially, the role of the moderator is to ask questions of the participants, to listen, to keep the conversation on the topics to be covered, and to ensure that every participant has a chance to share their views (Krueger and Casey, 2000).

Before a focus group initialises, the researcher must decide what kind of information they wish to obtain from the group. A protocol is then devised, which covers the topics the researcher wants discussed. Discussion is kept conversational, clear, and to the point.

Krueger and Casey (2000) suggest a format with opening questions, followed by introductory, transition, key and ending questions. Questions are kept open-ended. The format is designed to introduce the participants first to each other if they are not already known to each other and in all cases to introduce the participants to the ground rules of the group, not to interrupt others, and to be non-judgemental. The introductory questions introduce the topic to the participants, but are not designed to elicit particularly meaningful data. Transition questions lead the participants into thinking more deeply about the issue. The key questions provide just that - key data - much of the information in which will be of use in analysis. Finally, the ending questions should be designed to wrap up the topic and allow participants to voice any other thoughts they may not have already covered in the group. Following a protocol allows the moderator to keep structure to the group and to easily spot participants wandering off topic. It also allows an element of cross-comparability between different focus groups on the same discussion topics.

A focus group is run with between five and twelve participants. Too small a group, and the thought pool of the participants would be too small and inhibit discussion, whereas too large a group and the participants cannot take part as freely as they should. There is also a tendency for large groups to fragment into mini groups rather than discuss between the group as a whole. In all cases, a compromise will have to be made in the selection process for participants between possible bias (or the perception of possible bias), and the cost of recruiting a suitable group. Group composition depends on the discussion sought by the moderator, but should generally aim to include a range of age groups and a gender balance.

Incentives can be used to maximise attendance. Although there is controversy over soliciting responses with a reward, it is generally agreed that such gifts should be given to make participation agreeable without bribery. It is likely that giving an incentive would have an effect on participation, both of the type and amount of people attending, though it is also likely that there may be little uptake with no incentive. It may also be the case that giving no incentive would encourage the participation only of those with more time or those with strong views on the issue to be discussed. Krueger and Casey (2000) suggest that incentives should not be a reward, an honorarium or a salary, but should be a stimulus to attend a session.

During the focus group, a recording of the discussion should be made, with an assistant to the moderator noting the time on the recording that important points were made, to facilitate transcription. Transcription should ideally occur as soon as possible after the focus group by the moderator in order to record as fully and as accurately as possible the discussion. It is generally agreed that note taking by the moderator should be avoided in order to fully concentrate on the group discussion. Of course, the participants consent for recording the session must be obtained, and if refused, taking notes may be the only option. The moderator should write reflective notes as soon as possible after the end of the group on such issues such as whether the protocol was followed exactly, and observations on the group dynamic – including issues such as body language and noting overtly loud or noticeably quiet participants.

Despite the successes of focus groups, there are some pitfalls. Although these should be considered, they can be avoided in the main through careful moderation and planning. The moderator should be careful to avoid bias and manipulation: there is a possibility that the moderator can encourage participants into responding to their own prejudices (Litosseliti, 2003). There is also a danger of participants saying what they think the moderator wants to hear, rather than what they actually feel. This can be minimised by the use of neutral verbal and body language throughout the discussion, and the setting of a permissive environment. Finally, a 'false' sense of agreement or disagreement on issues may be obtained as some members of the discussion group with strong personalities can dominate the group, whilst others are silent (Litosseliti, 2003). Again, this can be overcome in part by careful moderation of the group dynamic.

5.1.1.1 Focus group protocol design

The protocol used in this thesis was designed in five main parts as recommended by Krueger and Casey (2000) and discussed above. The first part involved introductions and the establishment of ground rules, and the second to fifth involved introductory questions, transition questions, key questions and end questions. The protocol was structured to provide a logical thought process, from imagining what climate change is and how it is communicated, to what a climate icon might be and participant's views on their personal climate icons. The key data question involved asking the participants to write down their ideas for climate change icons on record cards. These cards were then collected at the end of the group for analysis. Each participant was asked for their suggestions for possible climate change icons, to check that all participants had contributed to this most important part of the discussion. The protocols were designed to answer the first set of research questions as set out in Chapter 1. An example of the protocol used can be seen in Appendix 5.1. After each focus group, a fieldwork diary was written noting participant behaviour and body language, an assessment of the moderation needed and first impressions of the themes arising from the discussion.

5.1.1.2 Piloting the protocol

A pilot focus group was carried out with a group of environmental science researchers at the University of East Anglia. This gave the opportunity to test the protocol and the subject matter with a group of researchers who had no expertise in the area of focus group research, but some climate change knowledge. The pilot allowed for the practice of focus group moderation. Several questions were reformatted and rephrased after the pilot exercise, but the overall framework was considered clear and concise. The pilot group also allowed for testing of the recording equipment and the overall timing of questions. A final run-through was arranged with a group of colleagues after reformatting the protocol for final testing of the questions, content and the questioning route.

One focus group was carried out with the CNS participants, and two with the LEAD participants. Two groups were held with the LEAD group due to both the time restrictions imposed on the groups and the smaller numbers of participants in each group. It was felt that two groups would be needed in order to gain breadth in the data. In total, the three groups were deemed a sufficient size for the diversification of opinions needed, as preliminary analysis of the groups showed that similar themes had developed in each of the groups. The same focus group protocol was followed in all three groups. In each case, a moderator led the session with a note-taker also present. All sessions were followed with brief reflective notes detailing any changes in protocol themes and sub-themes (e.g. due to time restrictions), participant enthusiasm, body language and group dynamics (as Marczak and Sewell, 2006).

5.1.1.3 Implementation: the City of Norwich focus group

Participants for the CNS focus group were recruited from a local school via the CNS Community Learning Officer. The session was advertised on the school website and in the weekly newsletter. The group was held in the school Learning Centre, a neutral environment where the discussion could take place freely and without interruptions. It was convened at 7.30pm on a Monday evening. The time, date and location took into account parents' likely commitments and how best to avoid prior engagements. Participants were over-recruited as it was assumed that some would drop out, although this was actually only the case for two of those responding to the advert. Thus, the focus group involved twelve adults. This large group was of initial concern, but not wanting to turn away participants, the group continued as planned. Ultimately, after the ground rules for participation were discussed, the group interacted well and the rather large number of participants did not affect the group dynamic. It was ensured that everybody contributed to the discussion. A note-taker was available to annotate the proceedings and to organise the recording equipment. This was invaluable considering the large size of the group, which required especially thoughtful moderation.

No incentive was offered, which is likely to have affected the type of people attending: many had environmental concerns and, as a whole, it may be that this group was more environmentally perceptive than a cross-sectional sample of the school parent community may have been. However, as previously stated, this investigation was focussed on obtaining rich exploratory data on participant icon selection rationale from a wide cultural and spatial range of participant backgrounds, and was not focussed on obtaining a representative sample of the general population. Indeed, the parents that did attend seemed very motivated by the discussion. It was advantageous that within the short period available, little time was needed to probe the participants on their experiences of climate change because of their prior knowledge, as this was not the aim of the focus group. All CNS parents were willing and enthusiastic to share their views.

5.1.1.4 Implementation: the LEAD focus groups

All recruiting for the LEAD participants went through a contact at the LEAD International Office in London. It was suggested that the focus groups should be carried out at the annual training event, to be held on the theme of Environmental Governance in February 2006 in Bhopal, India. Fellows first heard about the focus group events through an email to the LEAD list serve and were invited to register their interest. Secondary contact was established once in Bhopal, when Fellows were handed out information packs on the focus groups at registration. In all, 21 Fellows were interested in taking part and eighteen of these actually participated.

The participants were asked to sign up for one of a possible three different time slots, arranged around the LEAD timetable to fit in during lunch breaks and before dinner. The first group was delayed from starting by an hour due to the late running of the previous conference session. Subsequently, only three participants turned up and the group could only be convened for twenty minutes. It was deemed good practice to carry out a discussion with the three, if only because they were still keen to know what the research involved, so a very short introduction to the project and discussion around the possibility of using icons for climate engagement was held. However, the group was too small and far too short for a meaningful discussion to develop fully and so this group was not transcribed or analysed. The second group was held before dinner and the third in a lunchtime slot. These were the only times available to hold the group and were a little shorter than ideal, but the participants gave their full focus during the discussion and so in all this was of little consequence. Both these sessions were transcribed and analysed.

All sessions were held in a quiet outdoor courtyard away from the main conference, in order to minimise disruption from other conference Fellows. The location was neutral and in a peaceful setting. A note-taker was available in order to annotate the protocol with comments and timings to facilitate the transcription process. This was incredibly useful given that the protocol in all three cases had to be modified somewhat to fit with the time constraints imposed and thus full attention was needed to direct the content of the discussion.

An incentive of Rs. 750/ (£10) was given for attending the focus group. It was thought that an incentive would be needed to attract the Fellows, considering the busy conference timetable commitments they already had. There was no noticeable difference in the recruitment of participants because of the incentive: a wide range of Fellows of different nationalities and backgrounds took part.

5.1.2 Icon selection methodology 2: Online survey

Online surveys have a shorter history in social science research. They are very similar in design and aim to postal surveys (see Arksey and Knight, 1999), but have fundamental differences in data collection methods and analysis. Surveys provide a quantitative social science methodology which is of use for collecting specific data on particular issues. The data obtained is often factual, often closed-ended and may allow statistical analysis. However, survey methodologies may limit the researcher in gathering richer discussion-led data. Although the online survey in this research had a number of closed-questions, opportunities to elaborate or comment on questions were provided after several questions and at the end of the survey. There exists only a limited literature on the use of the Internet in gathering data for academic research as it forms a relatively new method of conducting social science research. Discussions of the use of the World Wide Web (WWW) in qualitative research exist in both Nesbary (2000) and Dillman (2000), although it should be noted that both of these sources are several years old, and thus may be likely to contain some outdated concepts due to fast progress in technological advances.

The Internet started as a military strategy tool, but quickly crossed into commerce, education and communication channels as its potential began to be realised (Nesbary, 2000). Its use as a research tool in the social sciences is only starting to be recognised (Dillman, 2000). The use of the Internet as a research tool has been compared to the revolutions of both random sampling in the 1940s and telephone interviewing in the 1970s. Dillman has gone as far as to say the revolution may be '*even more profound*' than both of these developments. Nesbary (2000) recognises the '*tremendous practical application*' of the use of the internet for organisational surveys.

The WWW offers several options for data collection. Of all methods, the two most obvious are email surveys and web surveys. The former offers a direct approach to known email applicants, is often easy to set up and distribute, and allows for easy access to see who has completed the survey. The latter allows much more complicated surveys to be set up, often unseen to the participant, who can be directed through a particular questioning route depending on previous answers. Web surveys can also contain more attractive graphics and often a more refined appearance and have the ability to allow the data collected to be downloaded straight into a spreadsheet. However, web surveys may not load identically through different web browsers and more complicated graphics can take longer to download than simple text-only email approaches.

5.1.2.1 Online survey protocol design

The survey was designed to be easy to complete and to be jargon-free. No more than two questions appeared on the same page (apart from drop-down boxes for the participant's personal information on the last page) in order to promote a clear structure and allow participants to think fully about one question before completing the next. The graphics were relatively basic and were designed to be quick to download even on a standard dial-up modem. The answers to the questions either appeared in a drop-down Box in standard 'open' form (see Dillman, 2000) or were to be completed in a text Box of the approximate size of the expected answer. The survey design allowed participants to go both backwards and forwards through the survey questions, and to allow questions to be skipped, ensuring participants did not feel they had to answer any particular question before they proceeded. The survey was designed to work with both Netscape and Microsoft Explorer. An email address and phone number were provided in case of any difficulties in completing the survey, but these were not utilised by any participant. A password was provided on the forum thread that had to be inputted to the survey's first page in order for it to load. So, it would have been difficult to complete the survey had it been accessed through a search engine rather than via the *cp.net* thread. This ensured to a high a degree as possible security that the survey participants were *cp.net* forum visitors, and hence the participant sample pool could be controlled.

The questions were designed to lead the participants through a logical enquiry process. The first two questions focussed on the potential impacts of climate change, and the potential sources of information available to the participant. The following questions were designed to encourage the participant to think about current climate communications and how effective they found them. Then the participant was introduced to the idea of 'icons' with the following statement:

> *"At the moment, communications tend to use representations of climate change, or 'icons' that I think may not be relevant to everyday life. Instead, I would like you to think about icons that you would find interesting, and would make you want to know more about what happens to it in regard to climate change. For example, the Houses of Parliament could be an icon of the British Government - but what would make a good icon of climate change?"*

Participants were asked to consider which they thought were more effective: local, national or global icons, and personal or famous icons – or indeed, if they think thought an icon should possess all or none of these qualities. Finally, participants were asked to select their personal climate change icons bearing all their previous answers in mind. Participants were asked several demographic questions at the end of the survey. The demographic questions were strategically positioned to encourage participants not to drop out after they had completed all of the survey questions and were not positioned at the start so as to not discourage them with personal questions at the beginning of the survey. The participants were not asked for their name or address, but were invited to input their email address if they wanted to receive a report summary or to be involved in possible further research with the project.

At the end of the survey, participants were invited to discuss the issues the survey had brought up at a second *cp.net* discussion board solely for those who had completed the survey. This board was not well attended, although some discussions did appear. The idea of the second discussion board was more to air views of the survey in a public arena to which I had access to, in case any participants had found a problem with the survey, as a form of ethical check. It was not designed in order to carry out a content analysis for example, so its low attendance was not of concern.

5.1.2.2 Piloting the protocol

A pilot online survey was carried out within the School of Environmental Sciences at UEA. As well as containing the survey questions designed for *cp.net* participants, the pilot survey also included an open-ended question at the very end of the survey where applicants could comment on the survey structure and design. One hundred and forty three responses were received in 24 hours, at which point the survey was shut down as the content of the comments was reaching saturation. Overall, the survey appeared to be easily understood, though some useful comments for adapting the survey were taken into account. These included suggestions for the wording of the 'icon' question, as well as suggestions for making the demographic questions clearer.

5.1.2.3 Implementation through the ClimatePrediction.net forum

Potential *cp.net* participants were first introduced to the research in late November 2005, via a forum posting from a senior board member. Participants from *cp.net* were invited to the forum discussion board via a link from the main *cp.net* discussion forum. A note was repeatedly posted within the survey thread to keep the thread current and in a prominent viewing position so those logging on to the general discussion board would see the thread without needing to scroll down. The survey itself went online with a posting in early December 05. Once on the thread explaining the survey, forum participants were given a brief description of the project aims and a link to the survey.

The survey was originally to be run for three months, but in mid-February 2006 the BBC ran a 'Climate Change Chaos' season of programmes (BBC News Online 2006), highlighting the work of *cp.net* and asking the British public to sign up to the experiment. It was thought worthwhile to leave the survey active in case this publicity caused a surge in participation on the forum board. This did not occur however, so the survey was deactivated in early April, having been hosted for four months. *Cp.net* web authors estimated that they had 5,970 participants signed up to the forum at the time of the survey[17], although it is unlikely that these members were all still current forum-goers at the time of the survey.

[17] http://www.climateprediction.net/board/, accessed Feb 2006

5.2 RESULTS AND ANALYSIS FOR NON-EXPERT ICON SELECTION

This Section details the analysis procedure for all focus group transcripts and the open-ended online survey responses and the results from the transcript coding. The results of icon selection are discussed in regard to three emerging themes. Finally, the icon selection process, and the icons chosen to take forward to the second stage, are described.

5.2.1 Coding of focus group and online survey data

The focus group discussions were fully transcribed noting participant age, name, nationality and occupation. All qualitative open-ended answers from the online survey were also entered into a text file. The formatting '[…]' was used to remove time fillers and moderator prompts, but only when it did not affect the meaning of the overall sentence. Spelling for the open-ended *cp.net* answers was not altered. These data files were then inputted into NVivo (QSR International 2002), a qualitative data management programme. In NVivo, categories in the data are called 'nodes'. Groups of nodes can be classified into 'node trees'. There are concerns that using such software enables the creation of too many codes and that it can distance the analyst from the data. However, such software has many advantages: NVivo provides a useful tool for organising large amounts of qualitative data and enables a 'wide angle view' to be taken, allows quick searching of large amounts of data, as well as providing some kind of audit trail of the classification method used (Richards, 1999; St John and Johnson, 2000).

The generation of categories was approached using four different methods (Box 5.1)

Box 5.1. Resources for generating coding categories (from Dey, 1993: p 100)

- Inferences from the data
  such as the emergence of the node 'global village'
- Initial or emergent research questions
  such as 'what reasoning lies behind icon selection?'
- Substantive, policy and theoretical issues
  such as 'do disaster narratives influence icon selection as may be expected from the theoretical literature?'
- Imagination, intuition and previous knowledge
  such as an intuition in the reflective fieldwork diary from the CNS focus group that a sense of 'appreciation of nature' was an important icon selection theme

These were either coded 'bottom-up' or 'top-down'. Bottom-up coding (also called open coding, see Strauss and Corbin, 1990) involves taking ideas for categorising the data directly from the data itself. Top-down coding requires the analyst to pre-define codes before starting to code the data either from their own preconceptions or from the literature. Here, a 'middle-order' approach (Dey, 1993) was taken to code the reasoning behind icon selection, where some preliminary categorisations were made (such as codes 'economic impacts), and then the majority of codes were categorised through a bottom-up approach (for example, patriotism). Within the bottom-up categorisations, some were coded 'in-vivo' (in-vivo codes use a phrase in the document to name the code directly from the data). These can be identified by the single quotation marks around the code (such as 'global village'). Codes were assigned direct to quotations in the text. Often, quotes would be assigned to more than one code, reflecting the different processes and themes drawn from the data. The data was coded iteratively and the transcripts of the focus groups and online survey re-reading and revising the coding system until no new codes were generated. Whilst the reviewing process could conceivably continue ad infinitum, it was felt that no new themes would emerge from the data, although the grouping and classification of nodes may change between analysts. The codes presented here thus are a reflection of the richness and complexity of the datasets.

Throughout this procedure, codes were organised into node trees so the emerging themes of the data could be clearly seen. Codes that did not fall under the theme of a node tree were left as free nodes. No weighting was given to the different node types as the research was designed to be exploratory rather than representative. Attached to each node was a description note of how the node was conceptualised and how it had evolved throughout the coding process. This process enabled a record to be made of the insights into the development of the coding process and ensured transparency.

Data coding allowed the large amount of rich, qualitative data to be investigated against seven different criteria (Box 5.2). As well as the actual words used, the frequency of comments from a particular participant and the extensiveness of comments from all participants on a theme; the context, internal consistency, intensity and specificity of comments was also considered in the analysis to expose the main themes of the data.

Box 5.2 Analysis considerations for qualitative research adapted from Krueger (1997)

1. *Words:* The actual words used and the meanings of the words.
2. *Context:* Responses are triggered by a stimulus (moderator question or other participants). Interpret in the light of the context.
3. *Internal consistency:* Consideration of any views that may have changed in the duration of the research.
4. *Frequency of comments:* The number of times a participant raises a theme.
5. *Extensiveness of comments:* How many different participants mentioned a particular theme.
6. *Intensity of comments:* Any special intensity, passion of depth of feeling.
7. *Specificity of comments:* Responses based on specific experience are given more weight than impersonal and vague responses.

(adapted from Nicholson-Cole, 2004; originally based on Barry and Proops, 2000)

Coding qualitative data provides a rigorous method of analysing large amounts of rich data. Ideally to ensure repeatability and reliability of the analyst's coding, it should be carried out by two separate analysts. As a complete review of the coding was not possible a Section of each document, the code set and a description of the research aims and methodology was made available to a reviewer. The reviewer was asked to independently code the data using the codes provided, but also to add or comment on these codes if they were felt insufficient. The reviewer was also asked to comment on the structure of the tree and free nodes with reference to the research objectives. The review process led to a number of nodes being combined, as the data coded within them was felt to essentially contribute to the same code categorisation. A number of nodes were also restructured to make the themes of the data appear more clearly. The reviewer felt that each code (especially those coded 'in-vivo') described accurately what the node contained and that the notes attached to these nodes contained a thorough description of the reasoning and development behind each node.

5.2.1.1 Reasoning behind participant icon selection

The three focus group transcripts and the online survey open-ended question responses provided a rich resource from which to explore participants reasoning behind different icon selections. The nine main categorisations coded from the data are discussed below.

5.2.1.1.1 'Affects me'

There were many icons coded in the 'affects me' node. The reasoning attached to this node coded both for climate impacts affecting participants directly and for impacts on others that they could empathise with and conceptualise. The node 'affects me' was coded in-vivo from the statement from Beverly, discussing the possibility of flooding in Norfolk:

> *"When you realise just how much of your own county would flood, and just disappear, I think it does make you a little bit more 'oh gosh, I've got to do something, because this affects me'. That you start to act."* (Beverly, CNS)

The theme of 'affects me' also included icons where participants thought they and their peers would be able to relate to it and find it a salient icon of climate change. For example, a LEAD participant considered water supply issues in Nigeria a salient icon:

> *"If… one of the major dams dried up… by increasing temperature, then everybody will be able to relate to it and less electricity."* (Abiodun, LEAD).

Within the sea level rise (SLR) icon group, there were a number of different reasonings. They ranged from direct statements about SLR and its impact on participant's countries:

> *"I live in Gothenburg, Sweden and grew up close to the sea. We do have landrise since the Ice Age but if the sea rises faster than that everyone living close to the sea will be affected."* (cp.net 17)

to more indirect reasonings:

> *"Beaches of Brazil. Because it's a very important thing in peoples lives. And we love beach, and then maybe we can say about, uh, with climate change there will be no more place to…" (Maria Izabel C, LEAD) "… to go and lay!" (Teresa, LEAD)*

As in the literature, participants emphasised that icons had to be targeted at particular audiences. For example, whilst icons in the SLR grouping resonated with the participants above from Sweden and Mexico, Wang disputed their salience for many Chinese:

> *"For example for China … sea level is rising. But, for the major area, and the major people in China, it is, how to say, is a terrestrial, terrestrial country."* (Wang, LEAD)

Many participants noted that climate change as a global environmental issue is seen as remote and impersonal. Participants stated how they grappled with choosing icons that had saliency to them and their peers. For example, *cp.net* participant 13 almost chose a photo of an extreme high tide on Tuvalu, before abandoning the icon as it would only be immediately identifiable to those familiar with Tuvalu's situation. The perceived distance from the issue of climate change (or at least from the impacts) is also demonstrated by a CNS participant:

> *"But it's* [climate change] *far more obvious in other countries, isn't it, like nearer the Arctic Circle, where Polar Bears aren't being able to cross the water, because it's not freezing and they… was an article… an article on the news, oh, a few weeks ago, about some Eskimos…"* (Janet H, CNS)

A LEAD participant noted that until climate change was a situated risk, she felt individuals could not conceptualise the issue. This theme is also found in the literature (as discussed in Chapter 3):

> *"People do not get involved in... global environmental issues until they have the consequences of that issue in their house, in their most precious dimensions... which is your house, and your children." (Fritzea, LEAD)*

5.2.1.1.2 'The everyday'

Linked to the issue of icons as salient if they affected individuals (either physically or psychologically) was the theme of 'the everyday'. The reasoning coded here also sheds some light on whether participants consider there to be such an entity as a 'global' icon of climate change. Unravelling this theme from the discussions revealed that generally participants felt that local icons were more salient. However, perhaps some icons existed which could induce salience at a global level? Huang summed up one focus group discussion thus:

> *"I think because* ***different cultures have different cultural backgrounds and er, for different countries people icons for them are different****. For China maybe people are familiar with er, maybe this is not a good example, maybe for us is panda? But, um, in other countries, like in, in Australia people familiar with koala. But I think maybe the climate change icon at I think at a local level, or at a national level, they will have some difference. And some,* ***maybe in the universal level, or the world level, there also have some icon that has got common, a common sense, like the Olympics everybody knows the five circles*** *resemble all those things.*

So I think um, different, ***maybe different countries have their own icons that are of climate change****." (Huang, LEAD)*

Huang uses the analogy of the Olympic symbol[18] as a recognisable 'icon' throughout the world and infers that perhaps a global icon does exist. Despite this recognition, many of the participants argued strongly for icons that connected with individuals' daily experiences. Indeed, even in this statement Huang then concludes that different countries perhaps do have their own icons. The limitations of past communication approaches was discussed in some detail by LEAD focus group 3, with suggestions made for icons that connected more in people's daily lives:

> *"…how it affects people in their daily life. I mean, people don't feel it. Sometimes we are always using this, this um, this stories of, of polar bears, of, of um, low-lying island, and all these things are in distant with peoples daily lives. So, I mean, how do you make it real, how do you make this linkage strong enough that people can feel it? is the key."* (Liming, LEAD)

Several others in the group backed up this claim, as this quote demonstrates:

> *"I think that icons have been ineffective because they are far away of most of the people in the world. […] So, I think if we use er, some icon more related with our human life, or with mega city life, it could be useful, to, to communicate the problem. Something that everyday affects the, the life of most people in the world."* (Maria Isabel R, LEAD)

> *"If you want to make some many as people as possible to know the sensitivity of climate change you should talk with the example influence their normal daily lives." (Wang, LEAD)*

The importance of finding icons that connect with everyday experiences and engender saliency is demonstrated by a *cp.net* participant.

> *"To trigger a change in my everyday life, a personally important icon on local scale would be probably the best. However, most of the impacts of climate change are on global scale, e.g. "somewhere else" on the world." cp.net 58*

[18] The five coloured rings represent the five populated continents of the world, united by Olympism and willing to accept healthy competition. The six colours that are used representing all the colours that were used on nation flags when the emblem was designed in 1913. Source: http://en.wikipedia.org/wiki/Olympic_symbols (accessed August 2007)

5.2.1.1.3 Disaster and fear

A minority of participants thought an icon with a disaster or frightening message would be an effective communicator:

> *"Something conveying the full threat i.e. death of world, human extinction"* (*cp.net* 59).

> *"The icon should cause some fear that the daily comfort that we are so often be used is gone by the effects of climate change."* (*cp.net* 42)

> *"Something dramatic like gondolas in New York!"* (*cp.net* 50)

It is interesting that all quotes coded in this node came from *cp.net* participants, which was a well educated and knowledgeable[19] sample group. This focus on frightening messages could be due then to this participant group being more aware of past communications approaches which have often attempted to use fear as a motivator and thus repeating this idea through the icon selection approach. Participants across the other participant groups (LEAD and to a lesser extent CNS) disagreed strongly with using fear as a communications tool, instead citing examples of icons that engaged with peoples everyday life as inducing a sense of saliency (see above). Also, the climate communications literature also reinforces this view that frightening or disastrous scenarios are likely to promote disengagement (e.g. see Nicholson-Cole, 2004 and Chapter 3).

5.2.1.1.4 Economic impacts

Another very pragmatic reason for icon selection was the impact of climate change on economic issues. Whilst all the groups and some online participants mentioned economic issues in respect to climate change in general, only Fritzea (LEAD) specifically cited the reason for her icon's importance as a source of income:

> *"As it's tourism in the Pacific, is one of the most important sources of income for the country. So a climate change would directly affect this patches of beaches."* (Fritzea, LEAD)

However, many of the other participants mentioned impacts on their icon which included economic impacts. For example, Stephen (LEAD) alluded to the importance of London as an economic force within Britain and thus London as a powerful icon, by first stating that East Anglia does not hold this same economic power and so cannot, in his eyes, be an icon.

[19] 79% of the sample held an undergraduate degree (The UK national average is 27%) and the majority of participants considered they were 'well informed' about climate change.

Frequently these allusions to economic impacts were through tourism, of which most of these came from participants from developing or emerging countries:

> *"So prime properties on the coastline of Nigeria if you show these, people connect with it, […] and when prime lands are being threatened, then I think it's a very suggestive view. They can relate, they can understand, because there social conditioned to it […] they see property being threatened […] and also the beaches too for tourism."* (Abiodun, LEAD)

5.2.1.1.5 Dramatic imagery

The codes behind this node tree included 'powerful imagery' and 'extreme impacts'. Common to the thread was the participant perception that an entity obviously impacted by climate change would form an effective icon. Those quotes coded within this node were often concerned with imagery where feelings or emotion were not attached to the entity: the potential icon is simply seen as a provider of striking pictures. Icons that did link emotion and imagery are discussed under the 'touches you' node. The icons occurring in this node often coded for ice-based imagery, and were mainly cited as icons by *cp.net* participants[20].

> *"A polar bear, because it lives in polar regions that are melting very fast. The global warming is clearly visible in these areas."* (*cp.net* 14.)

> *"An iceberg calving. It is climate related, it is immediate, it is powerful / dynamic."* (*cp.net* 56.)

> *"A melting arctic glacier breaking apart and dramatically plummetting into the ocean."* (*cp.net* 46.)

5.2.1.1.6 Emotion and 'touches you'

Particularly in the LEAD focus group 2, some participants were keen to state that to be an effective icon, it must *'touch you'* (Liming, LEAD).

> *"But if it* [icons] *for the purpose of really touching people to, to trigger peoples' empathy on it, you should have a localised thing, icon."* (Liming, LEAD)

[20] It is noted that polar icons are a popular form of dramatic imagery. See for example, the Cape Farewell project (Buckland *et al.*, 2006) intended to instigate a cultural response to climate change by bringing together artists, writers, scientists, educators and the media for a series of expeditions to the Arctic.

> *"So I think, if the icon can touch the hearts of people then it can you know, have some good impressions."* (Huang, LEAD)

For example, Thea (CNS) tried to elaborate on why she had chosen an oak tree as an icon of climate change:

> *"Um, it's it's the English countryside, it's too corny to put into words. It's what, what gives you pleasure… when you are passing thought the countryside."* (Thea, CNS)

However, it would appear that emotion as a communications tool would need to be used thoughtfully. As appeared in the CNS group, Janet felt upset that tigers may disappear (whether this is to do with climate change is irrelevant), but the reason it has an emotional impact upon her is because she feels she is powerless to do anything:

> *"…in 50 years, there will be no tigers. I'm not quite sure why that is. I don't know it's anything to do with climate change, but* ***that sort of thing, that really upsets me*** *really." […]* ***I feel there's probably nothing really that I can do*** *about that."* (Janet H, CNS)

Therefore, it would appear that emotion can be a powerful tool, but only if it is used in such a way as will still induce saliency.

<u>5.2.1.1.7 The 'global village'</u>

The 'global village' node was coded in-vivo from a comment by Ang (LEAD). It is interesting as it adds to the discussion on whether an entity such as a global icon exists. Ang argues that there should be compassion for other cultures and places, regardless of whether this is local or not.

> *"But icons should be a very deep example, not uh, all the world.* ***It cannot be good. One person or one animal. Or one country****. Because if Japan was flooded by 1/5 of the land, then maybe it would produce a disaster to this country. But* ***we are, have live in the global village****. So we should care about one country and not only the…"*

This reasoning reoccurred in particular reference to penguins – in that, as a global community, we should care about the possible impact of climate change on penguins even though it may not affect us directly.

> *"Penguin - it comes from an unpopulated area and therefore belongs to no-one in particular but to everyone in general."* (<u>cp.net</u> 23.)

A member of the CNS group also expressed such altruistic ideals:

> *"It's not 'what's in it for me, what's in it for me locally', I'm more interested in the third world countries […] I've got a, you know, a picture of the world and the effect on the whole earth is what I'm interested in."* (Janet C, CNS)

In these cases, justification for a global (or at least, a non-local) icon exists.

5.2.1.1.8 Appreciation of nature

Some participants, particularly those from CNS found species-orientated icons particularly salient, with over half choosing icons related to this theme. This may be due to several factors, although perhaps the most likely is that the CNS group may have been a more environmentally-conscious group of individuals (perhaps more willing to come to a group on climate change with no incentive as they had an interest in environmental issues) and hence perhaps more likely to choose 'ecological' icons.

Reasoning for choosing ecological-type icons were along the theme of an appreciation for the fragility of nature, and that humans should minimise their impact upon species.

> *"Great Barrier Reef. […] The biggest coral reef in the world represents the richness, beauty and diversity of a healthy ocean to me."* (cp.net 24.)

> "[loss of the Broads and Broadland] *It would be a tragedy to the natural world"* (Beverly, CNS)

> *"Plants, flowers, things like that, the interaction of all the insects and nature. If climate change is too quick then it upsets the ecosystems…. And that, that bothers me."* (Janet C, CNS)

5.2.1.1.9 Patriotism

Lastly, a number of icons were chosen due to reasons of patriotism:

> *"It's also iconic for England, isn't the rose"* (Thea, CNS)

> "[loss of the Broads and Broadland] *it would be… a loss to people of Norfolk."* (Beverly, CNS)

[the robin] “*It’s a very British bird.*” (Alex and Martin, CNS)

Participants found it difficult to fully express why they found this reasoning theme valuable. The icon was overall felt to be important and to be salient to them because it was deemed part of their cultural heritage and national identity.

5.2.1.2 Pragmatic and intangible themes in icon selection

Two overarching strands of reasoning are apparent from these nine codes. Here they are defined as ‘pragmatic reasoning’ and ‘intangible reasoning’. Pragmatic codes were those that involved factual assertions involving practical cause-and-effect situations. Intangible reasoning codes were those which involved deeper, emotional or spiritual understandings that cannot necessarily be measured physically (Table 5.3).

Table 5.2. Pragmatic and intangible reasoning nodes

Pragmatic reasoning codes *matter-of-fact assertions involving practical cause-and-effect situations*	**Intangible reasoning codes** *deeper, emotional or spiritual understanding that cannot necessarily be measured physically*
‘affects me’ ‘the everyday’ disaster / fear economic impacts dramatic imagery	‘touches you’ / emotion ‘global village’ appreciation of nature patriotism

There is a connection between the pragmatic and intangible sets of codes found in this data and the two ‘modes of thinking’ as proposed by Slovic *et al.* (2004), which in turn stems from Epstein’s (1994) argument that individuals understand reality via two interactive, parallel processing systems: the rational system which is deliberative and analytical and functions using logic and evidence, and the experiential system which understands reality as perceived in images, metaphors and narratives to which feelings have become attached. Slovic *et al.* named the two modes of thinking as the ‘experiential system’ and the ‘analytic system’ (Table 5.4). These name sets could well be used to describe the two icon code sets. The only apparent exception to the similarity with the modes of thinking approach is the code ‘dramatic imagery’. This first appears as if it should fall under ‘intangible reasoning’. However, the reasoning for icon selection coded under this node were related to imagery which participants saw as good communications tools, as opposed to *‘images […] to which feelings have become attached’* (Slovic *et al.* 2004).

Table 5.3. Comparison of the experiential and analytic systems (from Slovic *et al.* 2004)

Analytic system	Experiential system
Analytic	Holistic
Logical: reason orientated (what is sensible)	Affective: pleasure-pain oriented
Logical connections	Associationistic connections
Behaviour mediated by conscious appraisal of events	. Behaviour mediated by "vibes" from past experiences
Encodes reality in abstract symbols, words, and numbers	Encodes reality in concrete images, metaphors, and narratives
Slower processing: oriented toward delayed action	More rapid processing: oriented toward immediate action
Requires justification via logic and evidence	Self-evidently valid: "experiencing is believing"

5.2.2 Defining the criteria for modelling icons

The previous Section sought to illuminate the icon selection rationale that participants used when choosing their personal climate icons. Overall, 141 diverse icons were chosen by the participants.

This thesis research is sequential, with each stage of the research building on the last. The research questions in Stage 2 of the research (see Chapter 1) investigate the impacts of climate change upon the expert and non-expert icons. Each icon was required to have some form of research base as in-depth quantitative impact assessments upon each icon were not feasible within the timescale of the PhD. The research questions in stage 3 explore non-expert engagement with expert- and non-expert icons. In order to answer the questions posed in Chapter 1 for Stage 3, a comparative evaluation between expert and non-expert icons was needed. This evaluation was to be carried out with non-experts, and so needed to be straightforward and quick to complete. Thus, only 3 non-expert icons could be taken forward to the modelling and evaluative stage due to these methodological and time constraints. The criteria in Box 5.1 were considered to ensure that the suite of three icons selected represented a cross-Section of icon selection choice approaches.

Box 5.3 Criteria for non-expert icon selection*

I. Ease of modelling
II. Sensitivity to climate change by 2050
III. Spatial scale of icon
IV. Pragmatic reasoning
V. Intangible reasoning
VI. Frequency of selection

* note that the criteria numbering system is also used for Figures 5.1 to 5.3

This method was designed to provide a valid, rigorous and transparent semi-quantitative method of comparing the different icons using the large volume of both qualitative and quantitative data available. The method is based on the IPCC 'reasons for concern' diagram (IPCC 2001b) and contains six criteria. Apart from criteria VI which plots the occurrences of chosen icons, the diagram values are not absolute. The trajectories are designed to be viewed as comparable to each other rather than viewed as stand-alone values.

Criterion I illustrates the results of a scan of the literature for each potential icon. Icons were scored depending on whether much academic literature was available and a judgement was made on how straightforward the icon modelling stage would be. As previously stated, the icon modelling stage was not designed in order that new icon models would be developed, so it was important that at least a basic scientific literature was available for the selected icons[21]. Whilst this could be argued to be an 'expert' construction on the deliberately non-expert participatory choice exercise, this information needs to be investigated in order to see if it is viable to continue with this icon in the selection procedure within the constraints of the thesis. If the iconic approach is adopted beyond this PhD, it would be feasible to instigate primary research into icons lacking a scientific research base and remove this constraint. Similarly to criterion I, criterion II illustrates the results from this literature scan of how sensitive to climate change this icon would be to 2050.

[21] Forty nine icons were excluded from this literature scan and subsequent analysis on the basis of being unmodellable, as they were related to abstract ideas or concepts and were not spatially located for example the 'natural environment' and 'biodiversity'. Other icons abandoned included 'George Bush' and 'gardening programmes'.

Criterion III illustrates where the individual icon or icon group lies on a spatial scale. For example, SLR ranks highly as an impact which will affect the entire globe, whereas the species group ranks lower - as the loss of a species would be a fairly localised event. How the icon ranked for both pragmatic and intangible themes is plotted in criteria IV and V. Lastly, criteria VI plots the frequency of selection for the icon group or individual icon.

Icons that were not modellable or spatially referenced (i.e., did not fulfil criterion I) could not be carried forward to Stage 2 (icon modelling) of the thesis research were discarded. This research was specifically interested in investigating the reasoning behind icon selection. So whilst Nancy (CNS) wrote ‘birds, toads, frogs, butterflies’ on her icon report card, did not give any justification for the choice of these icons and did not volunteer these icons to the group discussion. Thus any icons which did not have any associated reasoning (i.e., did not fulfil criteria IV or V) were also abandoned from further analysis.

An icon shortlist was then drawn up classifying each individual icon into groups, and colour-coding each icon by participant nationality to reduce the complexity of the data. This shortlist of icon groups condensed the previous list by reducing individual icons chosen more than once into one icon group. Although certain icon groups were more dominant than others, the actual individual icons coded into these groups varied. For example, although ‘species’ as an icon group choice was popular, with 29%, 8% and 19% from CNS, LEAD and *cp.net* participants respectively, the individual icons within these groups were quite different. In particular with this icon group, it was interesting to note that for the *cp.net* participants (arguably the most ‘climate expert’ of the participants) polar bears and penguins accounted for 33% of the species group; whereas with the LEAD and CNS participants these species accounted for just 8% of the individual species chosen.

5.2.3 Comparing and contrasting icon trajectories

The remaining 35 icons were then subjected to analysis under these six different criteria I to VI. Figure 5.1 plots the trajectories of all the icon groups. Columns I and II will vary significantly depending on the type of individual icon. For example, there may only be a small volume of literature describing the impacts of climate change on ladybirds in Norfolk, but a range of literature exists on the impacts of climate change upon polar bears.

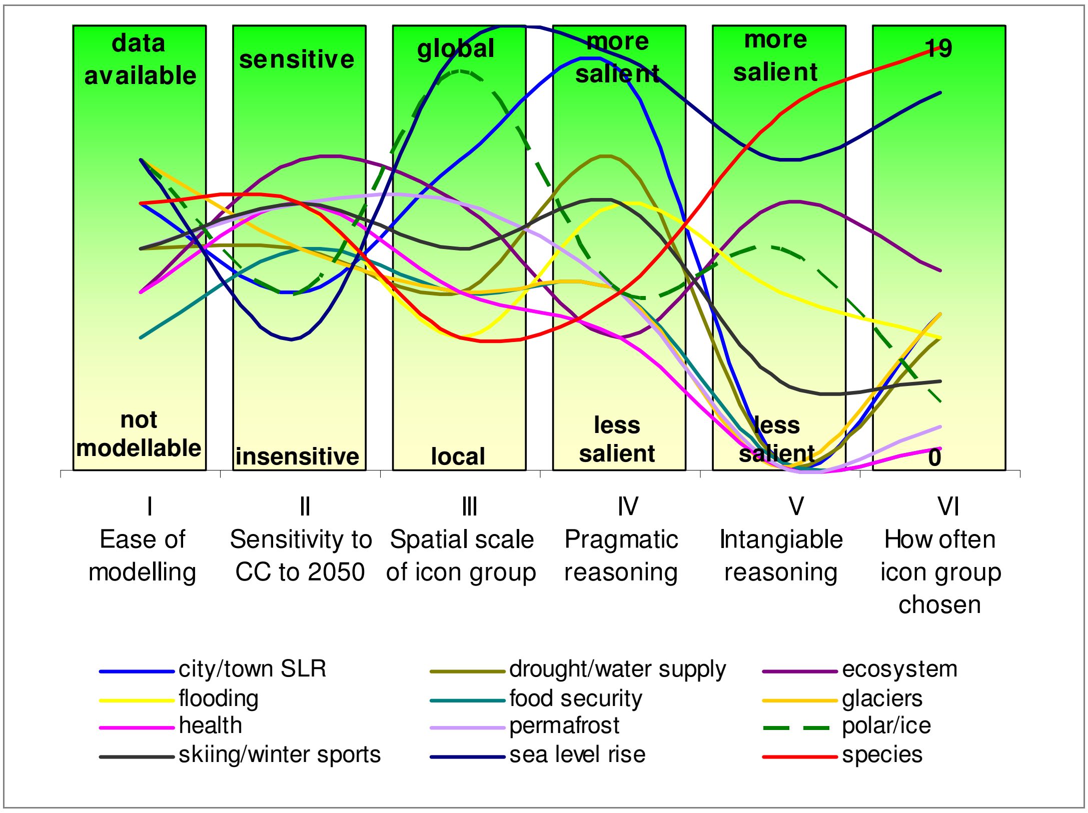

Figure 5.2 Icon selection by icon group

The trajectory that SLR (SLR icons which did not mention particular cities or towns) follows is consistently high, apart from in column II. Other trajectories that remain fairly high include city/town SLR (SLR icons specific to named towns or cities) and species. However, the species icon group fares fairly poorly on the pragmatic reasoning, but well on intangible reasoning. The city/town SLR is the opposite, with much pragmatic reasoning coded to this group, but no intangible reasoning. There are a possible 34 icons from these icon groups which could be used in the non-expert icon suite. However of these, there are a number of icon groups which follow very low trajectories and hence are rejected at this stage. For clarity, these icon groups are not shown in Figure 5.1. The icons rejected are listed in Appendix 5.2.

Eighteen modellable icons with at least a reasonably high trajectory now remained. These individual icons should also be considered in conjunction with the associated group icons (Figure 5.1), because although some individual icons may rank fairly low for criteria IV and V, the group overall may rank highly, and thus the group as a whole holds salience for a range of people even though many different specific individual icons may have been chosen within the group. Half of the eighteen icons were in either the SLR or SLR in cities / towns group. These nine icons are shown below in Figure 5.2 . It can be seen that the SLR icons generally follow a medium to high trajectory for criteria I to IV, but few SLR icons rank at all for intangible reasoning.

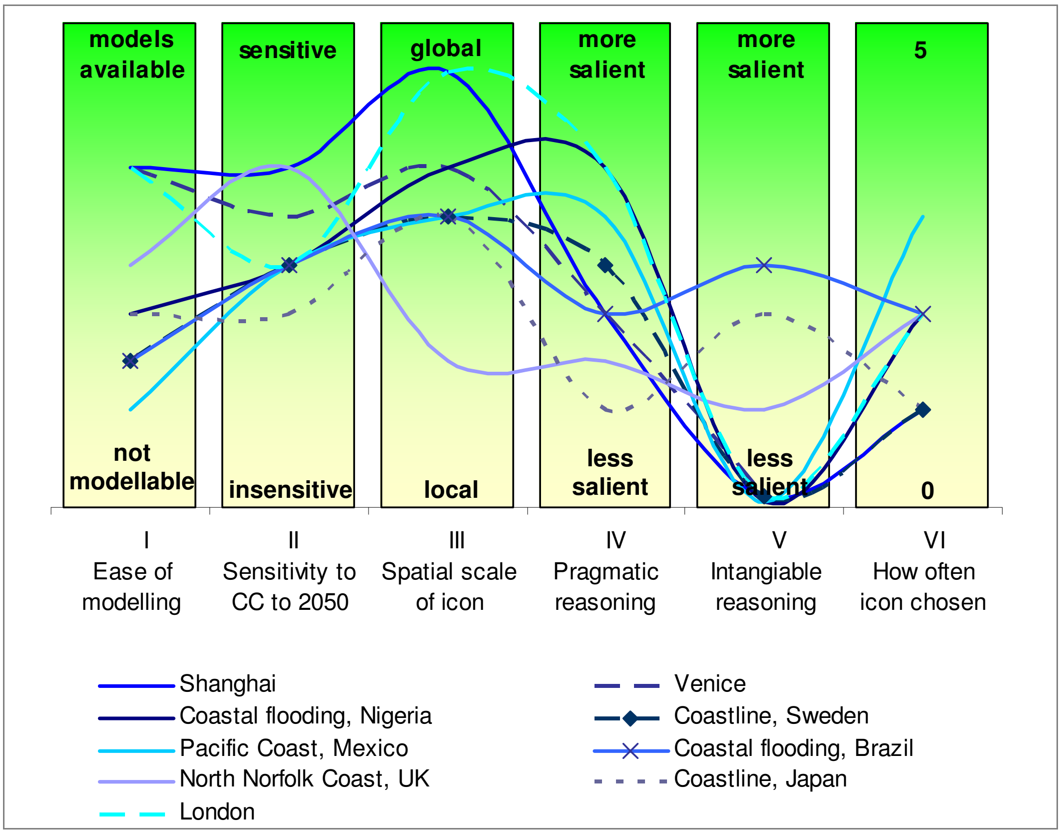

Figure 5.3 Icon selection by individual icon (SLR group icons)

The further nine individual icons (Figure 5.3) are from a variety of different icon groups. The trajectories followed are varied with no obvious pattern. Icons maintaining fairly high trajectories throughout include Broadland, UK and polar bears. Again, there are several icons which did not have any associated intangible reasoning.

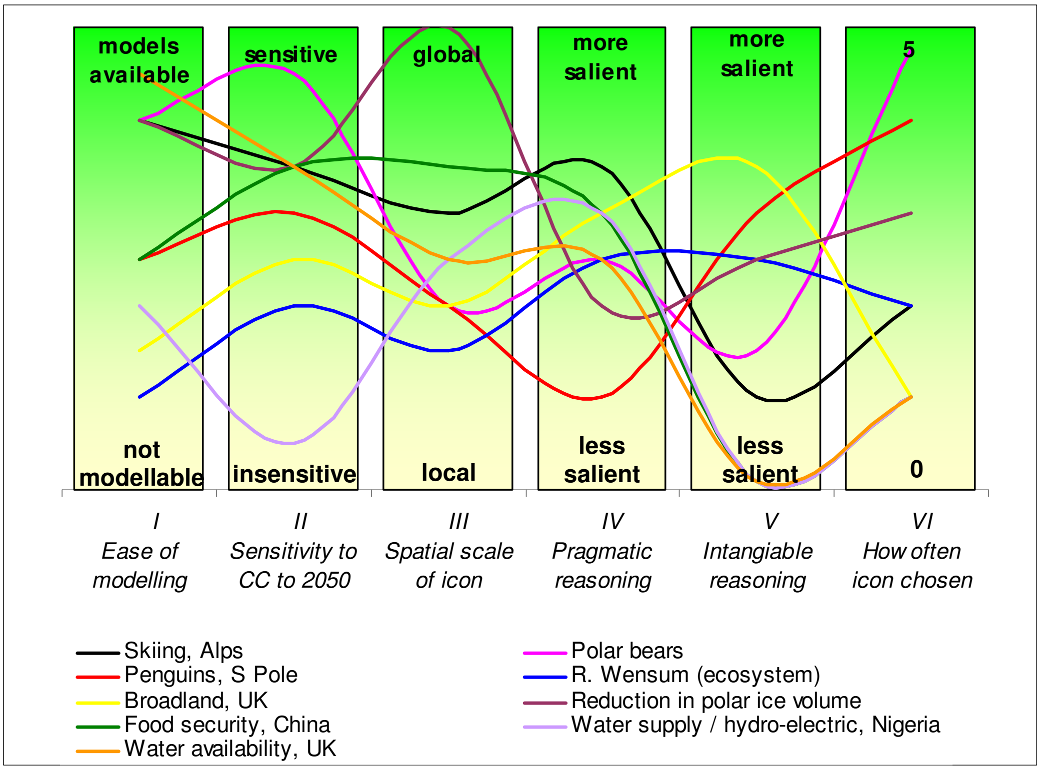

Figure 5.4 Icon selection by individual icon (all icon groups excluding SLR)

5.2.4 Selection of the non-expert icons

Making a choice of icons to model from the eighteen candidate non-expert icons was a difficult process. All ranked highly on either pragmatic or intangible reasoning and in some cases on both. Many icons were selected more than once, so were salient with different people, perhaps for different reasons. Also, all the candidate icons reaching the final selection stage were potentially modellable, either via quantitative modelling or via more qualitative means.

The final stage of this research (reported in Chapter 7) was designed to evaluate how the non-expert and expert icons connected with individuals from a local Norwich audience. Thus, taking into account the literature discussed in Chapter 3 it was decided that to maximise the impact of the icons with a local audience a suite of three icons would be chosen which would be likely to resonate with a Norfolk audience. Also, the icons chosen needed to reflect the emerging themes from the first stage of the research - that icons are selected by individuals through their connection with the three different axes of spatial scale, pragmatic reasoning and intangible reasoning. Therefore, three icons were selected which would be salient with a Norfolk audience and which reflect the diversity in the icon selection procedure. A short discussion for each trajectory of the icons not selected for further analysis is available in Appendix 5.3.

- *Non-expert icon 1: the Norfolk Broads*

The first icon selected was the Norfolk Broads, an icon which ranked highly on both pragmatic and intangible reasoning, and provides a salient and tangible local icon to Norfolk residents. This icon was cited by one participant, but similar icons were coded into the SLR group. SLR and flooding found salience with several members of the CNS group, who appeared to be very concerned about the future of Norfolk and potential flooding with climate change.

- *Non-expert icon 2: London and the Thames Estuary*

London was the second icon selected, ranking very highly on pragmatic reasoning but with no associated intangible reasoning. It was considered that using London as an icon provided a contrast to the Broads through differences in both spatial scale and icon selection reasoning.

- *Non-expert icon 3: Polar bears*

Lastly, polar bears as an icon followed a fairly high trajectory through the pragmatic reasoning, but was slightly lower for intangible reasoning. Polar bears were the most frequently cited of all the individual icons mentioned[22], although it is interesting to note that polar bears and penguins accounted for 33% of the stated icons within the species icon group with *cp.net* participants, but only 8% with the LEAD and CNS groups. Polar bears as an icon also links with the reasoning for the icon 'reduction in polar ice volume' and 'penguins'. Using polar bears as an icon provides an interesting case through which to investigate the disagreement in participant views found in the first stage of research around global-scale icons.

5.3 EXPERT ICON SELECTION METHODOLOGY

As discussed in Section 5.2.2, the research questions in stage 3 explore non-expert engagement with expert- and non-expert icons. In order to answer the questions posed in Chapter 1 for Stage 3, a comparative methodology to evaluate the commonalities and differences between the expert and non-expert icons was needed, and so a limited number

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[22] This may be due in part to the western media (of whom a large proportion of participants would have been exposed to) frequently choosing the polar bear as their 'icon' for illustrating news stories involving climate change. Between 5th November 2005 and 5th April 2006 (the month before and the duration of the *cp.net* survey; and the time all the focus groups were carried out) regional and national UK newspapers mentioned polar bears in 106 articles related to climate change and/or global warming. Contrast that with coral reefs - another icon which may be considered an icon of climate change, which occurred in 35 articles when used with the same search criteria.

of icons could be taken forward in the research. Three expert icons were taken forward to the modelling and evaluative stage due to these methodological and time constraints to balance the three non-expert icons.

Chapter 3 concluded by defining a climate icon as:

> *A tangible entity which will be impacted by climate change, considered worthy of respect, and to which the viewer can relate to and feel empathy for.*

Therefore an expert icon is defined as an entity impacted by climate change, to which climate experts consider worthy of assigning prominence to: i.e., the entity takes on iconic significance. Chapter 3 summarised the six 'sleeping giants' arising from the Avoiding Dangerous Climate Change conference (Hadley Centre 2005). The six 'sleeping giants' provide good examples of expert, 'top-down' climate icons. These 'expert icons' are also frequently cited in the media: perhaps due to the 'tipping point' metaphor associated with the sleeping giants. These 'expert icons' provide an interesting comparison for evaluation against the non-expert icons originating from the primary research in this thesis.

The three 'sleeping giants' occurring most frequently in the media were used as 'expert icons' to be carried forward to the next methodological stages of the thesis, based on the reasoning that these would carry the most salience with a non-expert audience in stage 3 (icon evaluation, Chapter 7). Obtaining UK-wide media data (e.g. from local, regional and national TV coverage, as well as radio and newspaper coverage) was not possible. However, database searches were accessible through the Lexis-Nexis portal for all UK national and regional newspapers excluding the *Financial Times*. As a first approximation, it was considered that although the amount of coverage given to environmental narratives varies between media sources, the ratio of occurrence in narratives on each 'sleeping giant' would likely be unchanged across sources (for instance, *The Independent* newspaper may carry more environmental items than Sky News, but the ratio of narratives on the West Antarctic Ice Sheet compared to that of ocean acidification would likely be similar from both sources). Thus, the Lexis-Nexis database, together with a search of the BBC News Online archives, was used as a proxy for the ratio in media coverage for each 'sleeping giant'.

5.3.1 Selection of the expert icons

A search was carried out to find how frequently each ‘sleeping giant’ was mentioned in any article in the month preceding the Avoiding Dangerous Climate Change conference. All searches looked for ‘climate change’, ‘global warming’ or the ‘greenhouse effect’ occurring in any part of a newspaper article, together with any of the key search terms for each ‘sleeping giant’. The BBC Online archive was also searched using the same criteria (Table 5.2).

Table 5.4. Media reporting of the ‘expert icons’ arising from the Avoiding Dangerous Climate Change conference, Exeter, UK from 01/02/05 – 01/03/05

Search terms	‘Expert icon’	Added icon search terms	Count* UK local/regional newspapers	Count* BBC online
“climate change” OR “global warming” OR “greenhouse effect”	WAIS	“Antarctic”	21	1
	Ocean acidification	“acid”	6	1
	GIS	“Greenland”	7	0
	Methane burps	“methane”	3	0
	Soils giving up their carbon stores	“Soil”	2	0
	THC slowdown	“conveyor” “current” “Gulf Stream” “ocean” “thermohaline”	22	0

* Mentioning the term ‘sleeping giant’ or a reference to the Avoiding Dangerous Climate Change conference. ‘Expert icons’ highlighted in grey were those selected to take forward to Stage 2 of the thesis research.

There was wide variation between reportage of the six ‘sleeping giants’. The ‘sleeping giants’ of methane burps and soils giving up their carbon stores appeared in just 3 and 2 articles respectively, with neither appearing in any BBC Online articles. Ocean acidification and melting of the GIS received coverage in a small amount of articles. The ‘sleeping giants’ of melting of the WAIS and THC slowdown received the greatest coverage with over 20 newspaper articles making some reference. The BBC Online archive returned only two articles referring to the ‘sleeping giants’; one reporting on the WAIS and the other on ocean acidification.

The WAIS and THC were taken forward as comparative examples of ‘expert icons’ as they occurred far more frequently in the media than the other ‘sleeping giants’, and thus it was reasoned would carry more salience. Although there were marginally more articles reporting on the GIS than ocean acidification, the information provided for the icon evaluation stage for the WAIS would be similar to that on the GIS. In order for a diversity of icons to be presented in the evaluative stage, ocean acidification was chosen as the third ‘expert icon’.

5.4 EXPERT AND NON-EXPERT ICON SELECTION CONCLUSIONS

This Chapter discussed the methodology, results and analysis behind the selection of the expert and non-expert icons. First, the Chapter concentrated on the non-expert icons, considering the rationale behind participant selection and the methodologies utilised of focus groups and an online survey. The results from the coding of the qualitative data arising from these two methodologies was then discussed. This Section concluded by stating the three non-expert icons as the Norfolk Broads, London and the Thames Estuary and polar bears. Each of these three non-expert icons ranks differently across the emerging themes of icon spatial scale, pragmatic reasoning and intangible reasoning. Second, the Chapter gave the rationale behind choosing three expert icons, for use in the comparative evaluation stage (Chapter 7). These expert icons were stated as the WAIS, ocean acidification and the THC. The next Chapter is concerned with the modelling of these six icons under a specified timeframe and emissions scenario in order to maximise saliency to a non-expert audience.

CHAPTER 6:
ICON MODELLING

The first Section of the thesis primary research (Chapter 5) discussed the icons selected by participants, and presented a method for selecting a suite of expert and non-expert icons. The aim of this second Section of the thesis primary research was to gather climate impact information in order that coherent and consistent assessments of the impacts of climate change on each icon could be presented back to non-experts participants (the collation of results illustrating climate impacts on the icons are presented in Chapter 7).

The 6 icons are explored for the Special Report on Emissions Scenario (SRES) A1B, to 2050, under an assumption of 'no adaptation' to climate change. The reasoning for these assumptions is discussed in Section 6.1. A range of methodologies were needed to investigate the suite of icons with climate change. For the expert icons, impacts were explored by undertaking a review of published literature and assessments (Section 6.2: Thermohaline Circulation, ocean acidification and West Antarctic Ice Sheet icons). The methodologies used to examine the non-expert icons were an expert survey (Section 6.3: polar bear icon) and quantitative modelling (Sections 6.4 and 6.5: Norfolk Broads and London icons respectively). As discussed in Section 5.2.2, one of the selection criteria (IV) for choosing non-expert icons stated that the icon should already have some form of research base, reasoning that in-depth quantitative impact assessments upon each icon were not feasible within the timescale of the PhD. This did not necessarily imply that quantitative modelling of each icon had previously been carried out, but that there was a scientific or social-scientific literature basis for assessing the impact of climate change upon each icon. The methods discussed below recognise and draw upon past research.

6.1 ICON MODELLING ASSUMPTIONS

The reasoning behind exploring climate impacts on the icons to 2050 under SRES A1B assuming 'no adaptation' is discussed. The rationale behind the thesis was that once non-expert icons had been selected, it would be informative to explore how participants responded to both non-expert and expert icons. Thus, in order to minimise the information to be shown to the participants in stage three of the research, each icon was investigated using only one emissions scenario and under one timeframe. Both the timeframe and emissions scenario were carefully considered from both a scientific impact assessment and a social psychological viewpoint, as discussed below.

6.1.1 Timeframe

The discussion here which examines difficulties in conceptualising long timescales, links back to the discussion on psychological barriers to change in Chapter 3 and to understanding of 'dangerous' climate change in Chapter 2. As noted by Stehr and von Storch (1995), climate change occurs on timescales much longer than the time horizon of everyday life, and so responses are needed to a danger which is not yet experienced. As discussed in Chapter 3, for effective engagement climate change needs to be situated in knowable temporal dimensions. Choosing a specific timescale thus represents some difficulties for an interdisciplinary thesis such as this. The timeframe must be sufficient to illustrate impacts on the icons of anthropogenic changes in climate, yet must not be so distant that the icons lose potential saliency. There is little research on which timeframes lay publics find more salient, although Lorenzoni *et al.* (2000) state that it is 'self-evident but rarely acknowledged' that non-experts think on the basis of extremely short time horizons compared to that on which scientists project climate change.

Few studies have explicitly considered the effect of timeframes on public perception of climatic information. When presented with global scenario models extending to the end of the century, participants in the ULYSSES project (van der Sluijs, 1999) commented that *'they would not be around in 2100'* and thus knowing what would happen in the near future was more important than impacts in the long term. Tonn *et al.* (2006) used a snowball internet survey to obtain responses on understanding 'the future'. They found participants thought of a point around 15 years ahead when thinking of the future, and that respondents' ability to imagine the future went 'dark' after around 15-20 years. Milligan *et al.* (2006) and Lorenzoni *et al.* (2000) claimed participants found it difficult to conceptualise change over 50-year timescales. Drottz-Sjöberg (2006) found when investigating the perceptions of long-term radwaste in Sweden that the public generally envisaged a point around 30 years time when thinking of 'the future'. Participants could imagine emotional relationships stretching only around 50-60 years into the future.

Despite the need for an easily conceptualised timeframe, there is also a need for a sufficient timescale to illustrate climatic impacts on the icons examined. For example, when investigating the impact of climate change on polar bears, the IUCN red list criteria states that any projecting of climate change impacts on biodiversity must be over a minimum ten years or three generations, whichever is longer (Akçakaya *et al.*, 2006). Since polar bears live to an average of between 15-18 years (Polar Bear Specialist Group, 2006) there is a need to look over a timescale of at least 45 years.

There is obviously then a dichotomy between the timescales over which the public can conceptualise (relatively short) and the potential loss of saliency when using long timescales, and a sufficient timeframe needed to illustrate climatic impacts on the icons (relatively long). From the few studies that investigate this phenomenon it would appear that 50 years forms an upper limit of the ability to conceptualise distant times. A preliminary exploration of the climatic impacts on the icons revealed that there was little noticeable climatic impact on the icons before the 2050s. Considering impacts to 2050 is therefore a compromise between these two opposing factors.

6.1.2 Emissions Scenario

The climate impacts on the icons were examined for anthropogenic emissions scenario[23] SRES A1B (Nakicenovic *et al.* 2000b). Although it is generally good practice to use several emissions scenarios when assessing consequences of potential climate change (Nakicenovic *et al.* 2000a) this set of impact assessments were carried out with a specific communications exercise in mind for stage three of the research. SRES A1B was chosen as it presents a middle-range scenario, although it is noted that there is little divergence in the SRES scenario projections to 2050. The SRES A1B scenario storyline is of sustained future economic growth, a global population that peaks mid-century and declines thereafter, and a rapid introduction of new and more efficient technologies. The main themes are economic convergence amongst regions, techno-scientific capacity building and increased social and cultural interactions. There is a substantial reduction in regional differences in per capita income. Energy use is balanced across all sources, not relying on any particular energy source too heavily (see Nakicenovic *et al.* 2000b).

6.1.3 No adaptation

An assumption for all icon impact assessments undertaken within the thesis is that of ‘no adaptation’. It is extremely difficult to project adaptive response, especially over such a wide-ranging set of icon impact assessments and out to 2050. Whilst research that ignores or assumes no adaptation is likely to overestimate residual or net impacts and

[23] A scenario is defined as ‘a projections of a potential future, based on a clear logic and a quantified narrative description, highlighting the main narrative characteristics and dynamics, and the relationships between key driving forces’ (Nakicenovic *et al.*, 2000b).

vulnerabilities, studies that assume full and effective adaptation are likely to underestimate residual impacts and vulnerabilities (IPCC 2007c). However, issues around adaptation are not the primary focus of this thesis so whilst limits to this approach are acknowledged, the assumption of 'no adaptation' was adopted as it is a baseline that can easily be projected for all icon impact assessments, and thus could allow effective comparison between the six icons in stage three of the research.

6.2 INVESTIGATING CLIMATE IMPACTS ON THE EXPERT ICONS

The expert icons had a significant associated body of scientific literature (of course, this was part of the reasoning in selecting these icons as 'expert' icons). Thus, the relevant literature is simply summarised here, in order that an impression of the impact of climate change upon the expert icon under this timescale and scenario can be considered.

6.2.1 The Thermohaline Circulation

What is referred to as the 'Thermohaline Circulation' (THC) or 'short-hailed' as the 'Gulf Stream', are both colloquial terms for the Meridional Overturning Circulation (MOC) (Schmidt, 2006). The THC is the term of choice for scientific parlance in public spheres (for example, it was referred to as such in the Exeter Conference on Avoiding Dangerous Climate Change, 2005; from which these expert icons were selected). Indeed, until the IPCC Fourth Assessment Report (4AR) (2007) the term MOC was not widely used in non-scientific discourses. The term THC is used instead of the MOC as it is more accessible to non-experts, being named as such in some popular narratives (e.g. Hawkes and Nuttall 1997; Righter 2005; McCarthy 2006) unlike the MOC[24]. It is acknowledged that the term THC is not used as extensively as the term 'Gulf Stream'. Here though, the term THC is used instead of the Gulf Stream as it represents a more scientifically defensible term.

When the term THC is used in this way, it refers to the inflow of warm, saline upper-ocean water from the southern oceans which gradually increase in density due to cooling as they move northwards into the North Atlantic. This water body also freshens, which reduces the density increase. As the water body reaches the Nordic and Labrador Seas, it is subject to deep convection, sill overflows and mixing. Through these processes, North Atlantic Deep Water is formed which constitutes the southward flowing lower limb of the MOC (IPCC 2007b). The transport of heat and freshwater by ocean currents can have an important

[24] see Jennings, N. (2008) From laboratory to policy: the case of the collapse of the Thermohaline Circulation. PhD Thesis, University of East Anglia, UK.

effect on regional climates: there is evidence for a link between the MOC and abrupt climatic changes over the past 120 000 years. A number of abrupt oscillations, such as the 8.2 ka cold event found in palaeoclimatic records, may have been caused by changes in the ocean circulation (IPCC 2007b).

The concern over the impact of climate change on the THC refers to the likelihood of this circulation weakening or 'collapsing'. The public may be aware of the phenomenon through popular narratives such as the film *The Day after Tomorrow* (Emmerich , 2004). However, the IPCC state that although it is likely that the MOC will reduce over the 21st century, it is very unlikely to undergo an abrupt transition over this period. Nevertheless, the occurrence of an abrupt ocean circulation change such as this does becomes more likely as the climate system is increasingly perturbed (IPCC 2007b).

6.2.2 Ocean acidification

Ocean acidification has only recently emerged as a phenomenon of serious scientific study, but has the potential to affect a wide range of marine biogeochemical and ecological processes in potentially non-linear and complex ways (Turley *et al.* 2006). The process of ocean acidification refers to the uptake by the ocean of anthropogenic carbon in the atmosphere in an equilibrium reaction, leading to the ocean becoming more acidic with an average decrease of 0.1pH[25] in surface waters being observed since pre-industrial times (IPCC 2007b). Dissolved CO_2 forms a weak acid, so as more CO_2 is emitted into the atmosphere, the ocean contains greater amounts of dissolved CO_2 and hence the pH of the water decreases.

The oceans represent an enormous reservoir of carbon, greater than either the terrestrial or atmospheric systems (Turley *et al.*, 2006). Fluxes between atmosphere and oceans are relatively rapid, such that the oceans have taken up around 50% of the total CO_2 released to the atmosphere over the last 200 years (Turley *et al.*, 2006). Calderia and Wickett (2003) conclude that if CO_2 emissions continue unabated, the ocean may experience pH changes that are greater than any experienced in the past 300 million years, with the only possible exception relating to rare, catastrophic events in Earth's history.

The acidification process has changed the saturation state of the oceans with respect to calcium carbonate ($CaCO_3$) particles (Feely *et al.*, 2004). At present, the surface ocean is

[25] Acidity is a measure of the concentration of H^+ ions and is stated in pH units, where pH = -log(H^+). A pH decrease of 1 unit therefore indicates a 10-fold increase in the concentration of H^+, or acidity (IPCC, 2007a)

saturated with respect to $CaCO_3$, but decreasing ocean pH is impacting on the level of $CaCO_3$ saturation (Orr *et al.*, 2005). Key marine organisms such as corals and some plankton build their exoskeletons from $CaCO_3$. If under-saturation occurs, these organisms will have difficulty maintaining their exoskeletons as their shells begin to dissolve in the more acidic waters (Orr *et al.*, 2005). Most living organisms reside near the surface where the greatest pH changes would be expected to occur, although deep-ocean biota may be more sensitive to pH changes (Caldeira and Wickett, 2003). Southern Ocean surface waters are predicted to become undersaturated in aragonite, a form of $CaCO_3$, by 2050. By 2100 this undersaturation could extent throughout the entire Southern Ocean and into the subarctic Pacific Ocean (Orr *et al.*, 2005). Simulations of the North Sea suggest that by 2050 some areas will experience a pH range completely distinct from current levels. By 2100, much of the North Sea will have a distinct pH range from today (Blackford and Gilbert, 2007).

6.2.3 The West Antarctic Ice Sheet

Palaeo-records indicate that ice sheets shrink in response to warming and grow in response to cooling, and that shrinkage can be much faster than growth (IPCC, 2007). Ice core data indicates that ice sheets can respond to changes over very long timescales. A rise in temperature now could take more than 10,000 years to penetrate to an ice-sheet bed. Mercer (1978) first proposed that anthropogenic climate change could eventually lead to a rapid deglaciation of a large part of the West Antarctic Ice Sheet (WAIS). If WAIS were to melt, it would add about 5m to sea level (IPCC 2007b). WAIS is vulnerable because it rests on a bed which is mostly below sea level. If the ice sheet were to lose contact with the bed, then there would be a reduction in the force that restrains ice-flow. Ice-flow could then accelerate and leave an imbalance between outflow and replenishment by snowfall. The imbalance would also cause thinning of WAIS at the point where it begins to float, allowing this point to retreat inland. At present, the ice sheet is anchored to the bed because it is too thick to float (see Vaughan, 2007).

There is much uncertainty associated with the impact of climate change on the WAIS, due both to a scarcity of observational data and to incomplete knowledge of ice dynamics physics (Rapley, 2007). An expert elicitation undertaken by Vaughan and Spouge (2002) indicated that only a few glaciologists consider it likely that a complete collapse of WAIS could occur within a few centuries. Most considered it was possible over a thousand-year timeframe. Current models suggest that the WAIS will remain too cold for widespread melting and the Antarctic Ice Sheet may indeed gain mass through increased snowfall (IPCC, 2007).

6.3 Investigating climate impacts on polar bears

Polar bears (*Ursus maritimus*, Phipps) are the biggest species of bear in the world, with males up to 3m long and weighing up to 1000kg. They are at the top of the Arctic food chain, having no predators except humans. Their primary food is ringed seal (*Phoca hispida,* Schreber), although they also prey on bearded seal (*Erignathus barbatus,* Erxleben) (Amstrup, 2006). Polar bear populations are located throughout the Arctic (Figure 6.1). Their range is limited to areas in which the sea is ice covered for much of the year, and are most abundant in shallow-water areas near the shore and at polynya[26] where currents and upwellings increase productivity and stop the ice cover from become too thick (Stirling, 1997). Because polar bears hunt marine prey, the population extent varies with sea ice cover.

Polar bears rarely venture onto land except in regions such as Hudson Bay. Here, where the sea ice melts and the bears are forced onto land for several months they may forage for berries, but are generally not adapted to life on land, being unable to efficiently digest these different nutrition sources. When denning, female bears fast for a period of up to four months whilst they give birth and feed their young. Bears that come ashore such as those in the Hudson Bay area also fast for up to four months until the ice sheet has reformed (Derocher *et al.*, 2004). In the recent past, the main threat to polar bears was over-harvest, but this has been largely corrected through management regimes involving all countries with polar bear populations. The biggest threat to polar bears is now climate change (Polar Bear Specialist Group, 2006).

There six main population groups are the Chukchi Sea group on Wrangel Island and western Alaska, the Northern and northwestern Alaska and northwestern Canada group (also referred to as the Beaufort Sea population), the Canadian Arctic Archipelago group, the Greenland group, the Spitzbergen-Franz Josef Land group and the Central Siberian group (Amstrup, 2006). They are more common in the Chukchi and Beauford Seas, Baffin Bay and in the Canadian Arctic Archipelago. Of these six main groups, several are studied more intensively than others. For example, linkages between climate change and polar bear populations were first proposed for the Hudson Bay population, which has been intensively studied for thirty years or more.

[26] A polynya is a space of open water in the midst of ice, found especially in Arctic seas (OED Online, 2006)

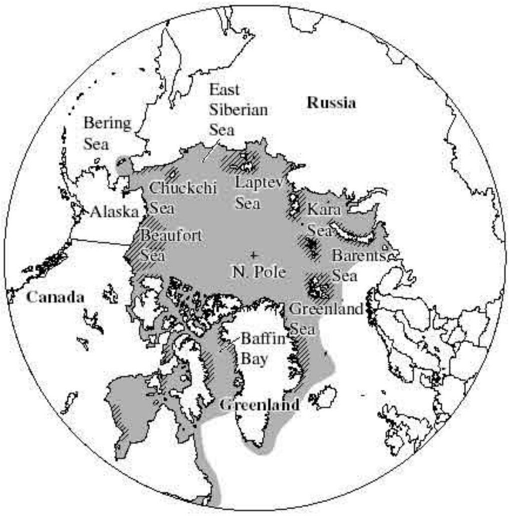

Figure 6.1 Winter polar bear distribution (light grey) and denning areas (hatched) (Amstrup, 2006)

Polar bears *Ursus maritimus* are frequently used as an iconic species in the communication of climate change by the media (e.g. Debnam 2007; Pearce 2006). Popular articles frequently suggest a rapid and alarming decline in polar bear populations under climate change. It is not clear, however, that these articles represent the range of views held by the expert community. Current scientific evidence indicates that most populations of polar bears are either stable or increasing, and that the likely extent of the population declines under climatic warming is uncertain (Stirling & Derocher 1993; Stirling and Parkinson 2006). Only in certain regions such as in western Hudson Bay (Stirling & Parkinson 2006) and Svalbard, Norway (Derocher, 2005) have relationships been drawn between bear populations and climate change, although it has been established that there is a highly significant relationship between the date of sea-ice break-up and the condition of bears when they go ashore (Derocher *et al.*, 2004).

6.3.1 Sea ice and the relationship to polar bear ecology

Climatic warming is predicted to impact on the timing of sea ice break-up and formation as well as its distribution in the Arctic. All climate models used in the Arctic Climate Impact Assessment predict a decrease in Arctic sea ice extent and sea-ice thickness over the 21st Century (ACIA 2005). A rapid acceleration in Arctic warming has also been detected in recent satellite data (Comiso 2003) with the annual mean and summer minimum ice extent declining respectively from 1978/79 at a rate of 2.7 and 4.7% per decade (Lemke *et al.*, 2007). It has been projected that by 2050, except for the most northerly parts of the Canadian Arctic Archipelago and Greenland, the average minimum extent of sea ice will be several hundred kilometers north of continental coastlines (Comiso, 2003). This has important implications for polar bears, who favour habitats on ice over the continental shelf rather than over the deeper waters of the polar basin where there is a lower biological productivity (Derocher *et al.*, 2004). In more southerly areas such as Hudson Bay, ice cover may disappear by mid-century (Gough and Wolfe, 2001).

Possible changes in sea-ice include variables such as reduced total sea ice area, reduced sea ice duration, thinner ice, smaller ice floes, a greater area of open water, altered snow cover and increased rates of ice drift (Derocher *et al.*, 2004). A continuing decrease in sea-ice distribution and thickness can be expected to impact negatively on polar bears, as the sea-ice provides a platform for travel and hunting, mating and in most cases, for maternal denning, so changes to its distribution, characteristics and timing have the potential to have profound effects (Stirling and Derocher, 1993).

Polar bears are particularly abundant on the near shore annual ice over the continental shelf where biological productivity is highest and it is these sea-ice habitats that are, in particular, projected to be impacted by climatic warming. This will affect polar bears through the availability of seals, their main prey (Derocher *et al.*, 2004). Decreases in the amount of snow, or an increase in winter rain, could mean there is not enough snow for the construction of seal pupping lairs, or that lairs collapse. Although this initially leads to an increase in easily-available prey to the polar bears, the seal pups are not mature and lack the nutritional value of an adult seal, and will likely lead to an increase in the number of starving bears later in the season (Rosing-Asvid, 2006). So whilst warming could briefly increase seal numbers in the short term, the reduction in sea ice will eventually lead to a decline in seal populations, a reduction in the fat intake of the polar bears and a lowering of their fecundity. Confounding problems of fasting for longer on land, bears also have less time on the ice in order to hunt for seals as the sea ice breaks up earlier during the most important feeding time of late spring and early summer (Derocher *et al.*, 2004), also leading to a lowering of bear fecundity. It is postulated that this could happen in Hudson Bay by 2012 if the linear decline on body mass and ice break up continues (Derocher *et al.*, 2004).

Radio-tracked female polar bears have shown a high degree of fidelity to a particular area, continuing to hunt in areas of disintegrating sea ice, rather than travelling to areas where ice still remains (Stirling *et al.*, 1999). This will lead to an increase in the expenditure of energy on swimming to maintain contact with preferred habitats (Derocher *et al.*, 2004). Similarly to seal lairs, polar bear denning could also be adversely affected. Rain and increased air temperature could cause snow dens to collapse. Thus, dens may become opened to ambient conditions causing a loss of the thermal insulative properties of the den to the litter within (Polar Bear Specialist Group, 2006).

Despite the ability of bears for adaptive behaviour, the specialised nature of polar bears coupled with the rapid changes projected for the Arctic puts the bears at risk (Derocher *et al.*, 2004). Changes in the sea-ice distribution, characteristics and length of the ice-free season could have 'profound impacts' on bears (Stirling & Derocher, 1993).

6.3.2 Exploring the impact of SRES A1B to 2050 on polar bear populations

A range of modelling techniques are available to predict the impacts of environmental change on species distribution and abundance (see Sutherland 2006). Of the range of modelling approaches available, phenomenological models and, in particular, stochastic population viability analysis (PVA) has been used most extensively to determine the likelihood of future polar bear population decline for particular subpopulations (Aars *et al.*, 2006). PVA relies on the availability of recent quantitative estimates of abundance, density-dependence, as well as survival and reproduction parameters. Reliable estimates of these parameters are not available for all populations, such as the Barents and Chukchi Seas. Furthermore, it is difficult to extrapolate to novel conditions, especially a long time into the future, as it is not known how the parameters will change (Aars *et al.*, 2006). Consequently the predictions of PVA models are often contentious (Brook *et al.*, 2000).

The projection of polar bear population dynamics under climatic warming is an ecologically complex issue involving many unknown variables, and is associated with considerable uncertainty. In such cases, conventional approaches to modelling polar bear population dynamics such as extrapolation, PVA or climate envelope modelling are not satisfactory, both because the required data are not available, and due to the long time periods involved. With a lack of available data and considerable uncertainty surrounding all aspects of the problem, expert opinion is perhaps the only available method for assessing future risks to polar bear populations.

Expert judgement is not intended to be a substitute for definitive scientific research (Morgan *et al.* 2001), but to define the ranges of uncertainty surrounding a given response. Expert opinion combines scientific information with judgement, intuition, belief or gut-feeling, in common with other predictive fields such as weather forecasting or economic prediction (Vaughan & Spouge, 2002). Expert opinion is of value for management decisions where uncertainty is high and where there is a lack of empirical data to assess uncertainty. It can make knowledge available that may not be easily accessible otherwise (van der Sluijs *et al.*, 2004). Expert opinion can illustrate the state of current knowledge, illuminate areas of greater or lesser agreement and help to drive future applied research.

Expert opinion is increasingly used as a method for assessing evidence and uncertainty. There are numerous examples of surveys of expert opinion, both investigating non-contingent and contingent phenomena. A non-contingent investigation (i.e. where the phenomena under consideration is unaffected by human activity, and where one particular response is 'correct'; whether this number is eventually known or not) includes studies such as investigating aerosol forcing (Morgan, 2006) and the possibility of West Antarctic ice sheet collapse (Vaughan & Spouge, 2002). Surveys of expert opinion have also been undertaken for contingent phenomena (i.e. where the phenomena under consideration will be influenced by human activity, and hence where there is no 'correct' response because the outcome for the phenomena in question depends on human influences which have not yet occurred). Population response to climate change is such a contingent phenomena. Examples of expert surveys investigating contingent phenomena include forest ecosystem change (Morgan *et al.*, 2001) and the risk assessment of herbicide-tolerant oilseed crops (von Krauss *et al.*, 2004).

A survey of expert opinion was undertaken in order to investigate the trends, variance and consensus (or lack of it) in current expert opinion on polar bear population dynamics, using a robust and systematic methodology[27]. This survey of expert opinion was the first undertaken for assessing risk to a particular species.

6.3.3 Expert survey design

Members of the IUCN Species Survival Commission Polar Bear Specialist Group (PBSG) were approached to take part in the expert survey through an email sent by the PBSG chairman in December 2006. A cover letter (Appendix 6.1) and information sheet (Appendix 6.2) were attached to the email. Attempts to increase participation were made using follow-up emails and telephone calls. Experts were not asked to contribute views on climate change, but for contributions on polar bear population dynamics under a specified climate future. The survey was designed to gather responses on eight issues (Appendix 6.3). Experts were asked to identify the three greatest threats to polar bear populations over the next fifty years. The body of the survey then obtained responses on the direction of change in polar bear populations and the associated uncertainties. Experts were asked to

[27] Much of what follows is based on O'Neill *et al.* (2007, Journal of Applied Ecology: submitted).

provide responses as a percentage change in range and population across the Arctic as a whole and in five specific regions. Lastly, experts were asked for their definition of 'best conservation practice' and its potential impact on population change across the Arctic. Participants were also asked to assess their own expertise in both climate science and population ecology.

Experts were asked to provide their responses with reference to supporting material on sea-ice change. This comprised two maps of projected sea-ice cover change for March and September, the months of maximum and minimum Arctic sea-ice extent respectively, a map of the change in the length of the 'ice-free season' and a map defining the regions under consideration (see Appendix 6.3 for all Figures). The 'ice-free' season was defined for each grid cell of the climate model's sea-ice component, as the maximum monthly sequence for which monthly mean sea-ice concentration remained below 50%, a threshold chosen as polar bears are known to abandon sea ice under such conditions (following Etkin, 1991).

The sea-ice information used to construct the maps and time series was diagnosed from the large database of general circulation model (GCM) based climate models from phase 3 of the World Climate Research Programme's Coupled Model Intercomparison Project (CMIP3; http://www-pcmdi.llnl.gov). This database of model simulations has been used extensively in the IPCC 4AR (see IPCC 2007). All of the GCMs for which monthly sea-ice concentration data were at the time available for the historic period and for the 21st century under the A1B scenario were used, except for one model that exhibited an unaccountable step-change in sea ice between the 20th and 21st centuries. For most GCMs, an ensemble of simulations under the same scenario was available; in these cases, an average of all ensemble members was used. Finally, a multi-model average of all 16 models was taken (Appendix 6.4 for GCMs used).

Polar bears are long-lived species (DeMaster & Stirling, 1981): whilst one or two years with reduced sea ice extent may impact survival, reproduction or body condition during those particular years, such small-scale variation would be unlikely to have an effect in the long run on overall population dynamics. Thus five time-series of projected changes to 2050 were embedded in the survey for each of the five specific regions to incorporate plausible inter-annual variability. The ECHAM5/MPI-OM GCM (Max Plank Institute for Meteorology, Hamburg) was chosen to provide the regional time-series on the basis of three criteria: first, because of its faithful simulation of the present-day annual cycle of

Arctic ice extent; second, because it simulates a change in Arctic sea-ice extent close to the multi-model mean of the change in Arctic ice extent (i.e. the model is not an outlier); and third because of the model's relatively high horizontal resolution (1.5° latitude and longitude) of the sea-ice component. The regions were defined to be as closely aligned, as the GCM grid allowed, to specific populations as described by the PBSG.

6.3.4 Piloting and implementation of the expert survey

The survey was iteratively refined, and was piloted with four researchers specialising in population ecology. No major changes were made to the protocol after piloting. Participants were given three weeks during January 2007 to complete the first iteration of the questionnaire. Experts were asked to give responses using a Box-plot question format, based on an expert survey instrument devised by Granger Morgan *et al.* (2006).

The Box-plot questions first requested participants to provide the 5% upper and lower confidence bounds first, rather than the best estimate. This was to minimise 'anchoring and readjustment' (Morgan *et al.*, 2001) whereby participants first provide their best estimate, and then draw outer bounds narrowly around this best estimate, rather than first imagining the range that their uncertainty estimate may fall between.

There is a general tendency towards overconfidence when providing estimates for probability distributions (Morgan *et al.*, 2001). The distributions given tend to be too narrow, and do not encompass the true range of uncertainty that may exist. Even if calibration questions are used in a survey to demonstrate this overconfidence, or if participants are thoroughly briefed on the relevant psychological literature, participants may continue to be overconfident in their predictions (Morgan *et al.*, 2001). Given the time constraints and the lack of evidence that either of these approaches are particularly successful, an attempt to de-bias the responses was made by briefly explaining the routine bias towards overconfidence before the survey began. After the experts had given upper and lower 5% confidence bounds for the first Box-plot question, they were again reminded of the tendency towards overconfidence, and asked to reconsider their responses and adjust them if they considered their previous responses range too narrow.

Absolute population totals, especially in some of the regions examined, are quite uncertain. For this reason, participants were asked to give their responses as a percentage change in range or population relative to today, rather than in hectares or absolute numbers of bears. Five confidence bounds were requested:

E1 lower confidence bound (corresponding to the 5% confidence bound)

E2 mid-lower confidence bound (corresponding to the 25% confidence bound)

E3 best estimate (corresponding to the 50% confidence bound)

E4 mid-higher confidence bound (corresponding to the 75% confidence bound)

E5 upper confidence bound (corresponding to the 95% confidence bound)

Absolute lower and upper bounds were not requested as polar bear population dynamics are contingent upon so many other factors apart from climate change. Experts were therefore requested to quantify only 'reasonably extreme' outcomes, rather than 'absolutely extreme' ones.

Selecting experts for a survey of expert opinion can be a controversial procedure, as the choice of participants will invariably affect the results. However, in this case, a pre-defined group of experts was already available through the PBSG. Experts were offered an honarium of £50 donated to a polar bear charity if they participated. Recruitment was via email with an endorsement by the PBSG Chairman to seventeen permanent members or researchers closely affiliated to the work of the PBSG. Eleven experts (Box 6.1) agreed to participate (with one later withdrawing due to time commitments). Two experts did not respond and four experts declined to participate. Reasons for non-participation were time constraints, or because of a self-stated lack of expertise.

Box 6.1. Participants in the polar bear expert survey*

Participant	*Institute*
Andrei Boltunov	All-Russian Institute for Nature Protection
Andrew Derocher	University of Alberta, Canada
Aqqalu Rosing-Asvid	Greenland Institute of Natural Resources
Erik Born	Greenland Institute of Natural Resources
Jon Aars	Norwegian Polar Institute
Lily Peacock	Government of Nunavat, Canada
Martyn Obbard	Ontario Ministry of Natural Resources, Canada
Mitch Taylor	Government of Nunavat, Canada
Øystein Wiig	Zoological Museum, University of Oslo, Norway
Stanislav Belikov	All-Russian Institute for Nature Protection

* Note that the expert numbers used in the Chapter text are randomly assigned

None of the experts expressed doubts regarding the validity of using expert judgement, which contrasts with other studies (e.g. Vaughan & Spouge, 2002). It could be hypothesised that this is because expert judgement has played a significant, but informal, role to date in the ecological field (Sutherland, 2006), and thus ecologists may feel more comfortable than experts from other disciplines with combining judgement and intuition with scientific information.

The Delphi method[28] is being used here as a technique for combining expert judgements for a risk analysis (Vaughan and Spouge, 2002). It was not the aim to reach consensus on each of the eight questions posed. Rather, the Delphi method was used so that participants could view their responses to each specific scenario anonymously against others in the research community, allowing the chance to reflect both on the information given and other expert responses.

Once the first round of responses had been received from all participants, results were collated. Each expert was allocated a participant number so they could identify the Box-

[28] The Delphi Method is a systematic method of obtaining projections from a group of independent experts. Results from each round are collated by a facilitator and re-sent to participants. Participant identities remain anonymous throughout. Often, the process is stopped when consensus is reached on a particular issue. For the polar bear expert survey, the process was halted once no new responses were received from participants.

plot of their individual response for each question against those of the group (as for Figures 6.2 to 6.6, but without the group median Box-plot). The collated results were then sent back to the experts and everyone was asked to view their answers in the light of those of the group as a whole, and reply via an online form if they wished to reassess any of their responses. Only one expert chose to do this; many of the others e-mailed to express interest in the collated results, stating that whilst they had reviewed their responses they were satisfied with their contributions and did not wish to change them. The results were again collated and re-sent to the expert group for a third round. None of the experts chose to change their responses in the third round and thus the survey closed.

Combining expert judgements is controversial, since the percentage of experts holding a given view is not proportional to the probability of that view being correct (Keith, 1996). Although a number of methods of combining judgements exist (Sutherland, 2006) simpler aggregation methods generally perform better than more complex methods such as weighting individual views (Clemen & Winkler, 1999), and provide a useful overview of the current state of expert opinion and associated uncertainties. It is the aim in aggregating the results to display the diversity and commonalities of opinions on polar bear population dynamics. Therefore, the collated results are shown as individual expert Box plots (Figures 6.2 to 6.6), which demonstrate the trends, uncertainty and variance in opinion. The final Box plot is the median value from all expert responses. The mean is not used in order to avoid the skew that may be introduced by a minority of extreme individual views.

6.3.5 Expert survey results

The three main threats to polar bear populations over the next fifty years were viewed as climate change, hunting and pollution. Many of the specific concerns listed could also be linked to climate change, for example the future availability of permafrost for maternal denning. Other salient concerns included the increasing frequency of human-polar bear interactions due to climatic warming, perhaps leading to an increase in ‘defence kills’.

It is evident from all Box plot responses that although the range of uncertainty varied, most experts were willing to express wide uncertainty bounds.

The experts indicated a negative trend in polar bear range across the Arctic as a whole by 2050 (Figure 6.2). The median best estimate for range change across all experts was for a 33% decline, relative to 2007. Individual expert best estimates ranged from no change, to a 70% decrease, with half the experts projecting at least a 30% decline. There was a large amount of uncertainty surrounding the projections of polar bear range, evidenced by expert responses between the absolute upper and lower confidence bounds spanning 125%. Although responses from experts 1 and 10 are significantly different to the main body of expert responses, their responses do overlap in at least part of the range of experts 2-8.

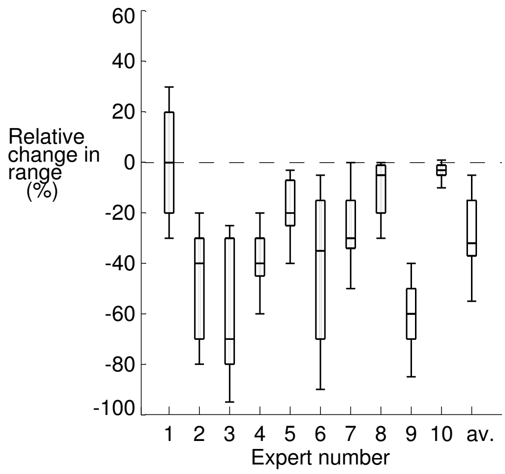

Figure 6.2 Projected change in polar bear range relative to today under current management practice. Projections were undertaken for SRES emissions scenario A1B to 2050. Each 'Box-plot' represents the views of an individual expert; the error bars indicate the expert's 5% and 95% confidence bounds, the Box spans the 25% and 75% confidence bounds, and the central line the expert's 'best estimate'. An average Box plot of all the expert views is given on the right.

In considering where there was most likely to be a change in range, experts specifically named Hudson Bay, the Beaufort Sea, Baffin Bay, the Davis Straight, the Barents Sea, the Chukchi Sea and the Laptev Sea. Of these, the Barents Sea was mentioned by six experts and the Chukchi Sea by four. Five experts either specifically named Hudson Bay, or discussed range changes in more southerly populations.

Projections on changes in total polar bear population size were very similar to projections regarding changes in total habitat area (Figure 6.3a). Experts identified a potential negative trend in polar bear population across the Arctic, with a median best estimate of a 28% decrease, relative to 2007. Eight of the ten best estimates were a 20% decrease or more in polar bear population size. As with estimations of polar bear range, there exists a large amount of uncertainty surrounding projections of population. Expert 1 projected an upper confidence bound of a 30% increase in population size relative to today. In contrast, expert 3 suggested a lower confidence bound as a 95% decrease in population: an overall uncertainty range of 125%. Changes in population size were considered to be most likely in the same areas as those experiencing changes in range, with the Barents and Chukchi

Seas both named by five experts, and Hudson Bay and the Beaufort Sea named by four experts.

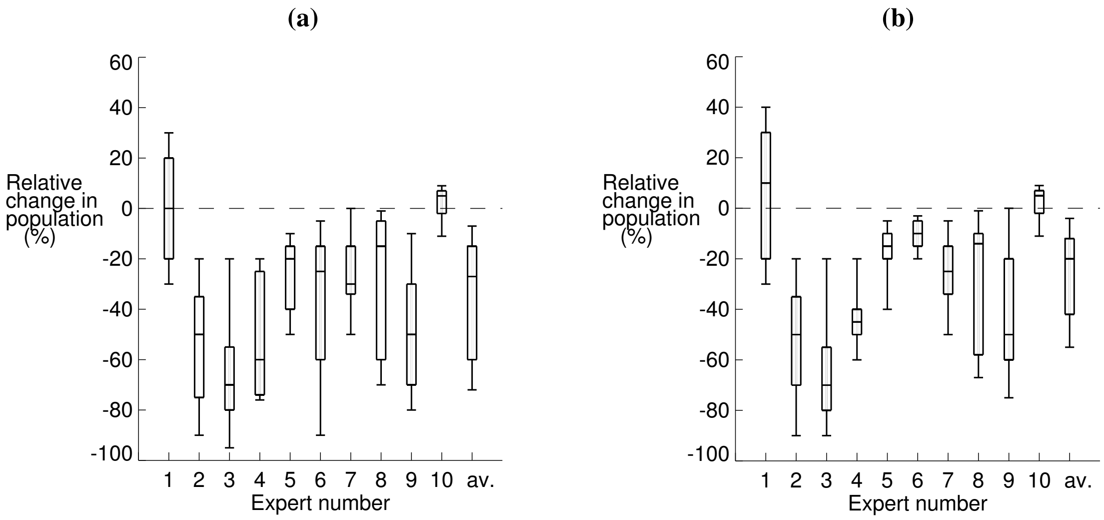

Figure 6.3 Projected change in total polar bear population relative to today under (a) current management practice (b) expert-defined 'best management practice'

Figure 6.4 reports expert judgements for five specified regions: the Barents, Chukchi and Beaufort Seas, Hudson Bay and the Canadian Archipelago. For each of the five regions, the median best estimate from all expert responses shows a projected decrease in population. This projected decrease is greatest in Hudson Bay and the Beaufort Sea, and smallest in the Canadian Archipelago.

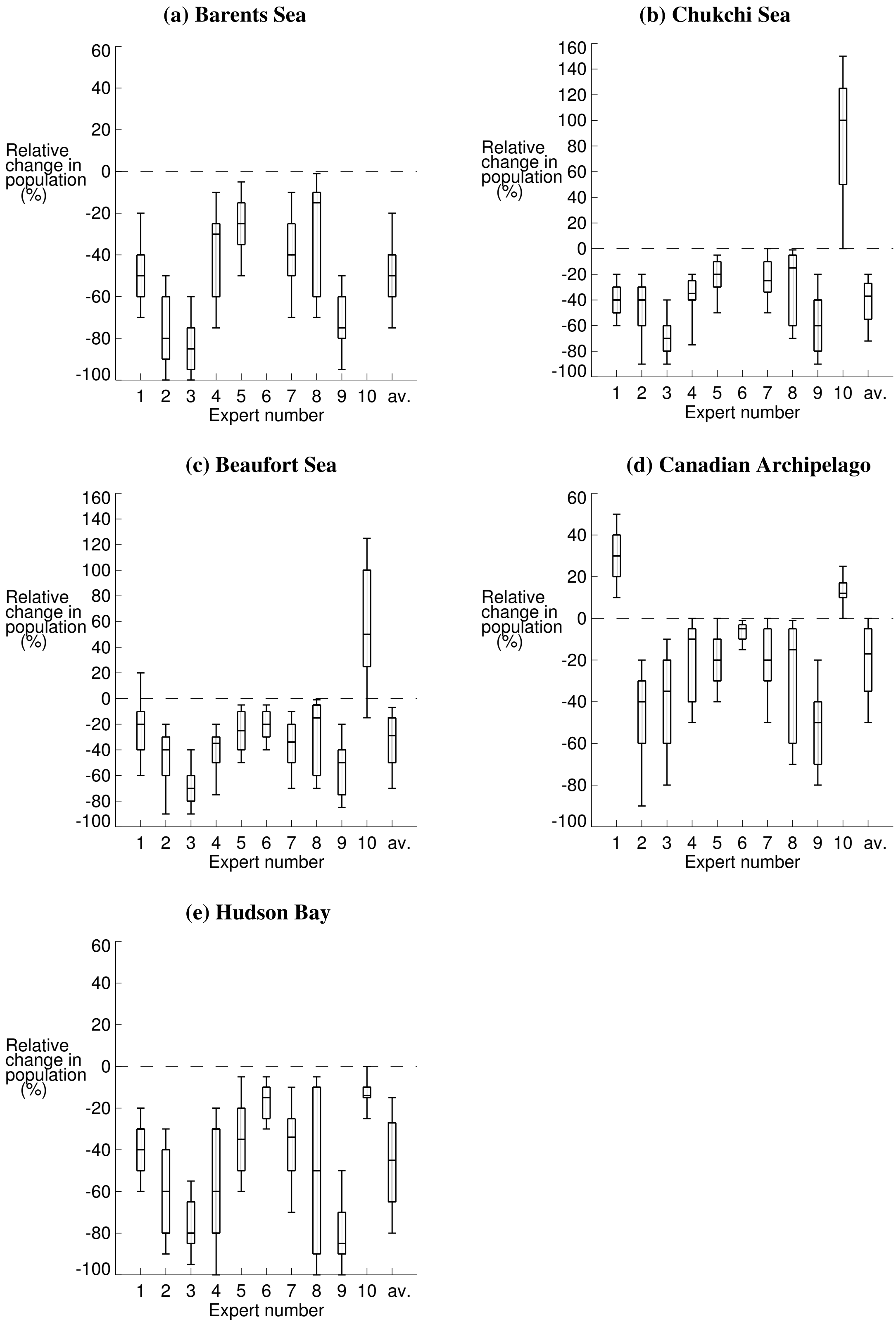

Figure 6.4 Projected change in polar bear population in five regions, relative to today under current management practice.

Experts 6 and 10 declined to give responses for population change in the Barents Sea, stating a lack of knowledge of polar bear dynamics in these regions. Although little literature exists on Russian polar bear dynamics, the remaining participants gave responses for population change in the Barents Sea (Figure 6.4a). Of the eight experts, all projected a decrease in population for the Barents Sea, with a median best estimate of a 63% decline in population relative to the 2007 population. The range of responses given was the narrowest from any of the questions asked, but still spanned 99% between the upper and lower confidence bounds.

Expert 6 also declined to give responses for the Chukchi Sea for the same reasons as detailed above. The median best estimate for the Chukchi Sea region is a decrease of 38%, relative to 2007 population levels (Figure 6.4b). Although there is a general consensus in the expert opinion of population decrease, expert 10 considered that the Arctic basin and southern populations will be impacted more severely during the timescale presented than those further north. Consequently this region has the greatest range (250%) between the upper and lower confidence bounds.

All experts gave projections for the Beaufort Sea, with estimates (Figure 6.4c) similar to the Chukchi Sea region. Again, expert 10 provided a very different estimate. The median best estimate for the region is a 30% population decrease by 2050 compared to 2007 levels.

Eight experts project a decrease in population in the Canadian Archipelago (Figure 6.4d), while experts 1 and 10 both project an increase. The reasoning behind expert 10's views is stated above, whereas expert 1 considered a loss in population likely to occur in Russian regions around Svalbard and Novaja Semlja rather than in the Canadian Arctic. The median best estimate for the Canadian Archipelago is an 18% decrease in population, the smallest population decrease of any of the regions.

Lastly, the experts all projected a population decrease for Hudson Bay by 2050, relative to the population in 2007 (Figure 6.4e). This was the only situation where responses were gathered from all ten participants, and where all responses showed a decrease in population. The median best estimate is a 45% decline in population relative to 2007 levels.

Experts were asked to reassess their projections regarding changes in total polar bear population size across the Arctic under their own definition of 'best management practice' rather than current practices (Figure 6.3b). Nine experts considered a precautionary approach to hunting was needed, with some stating hunting should be eliminated altogether. Some experts questioned the current situation of a 'sustainable harvest' as not practical, as detailed population data on which to base sustainable harvest estimates is only available for a few specific populations. This uncertainty is likely to worsen in a warming climate and with associated changes in sea ice. Only three experts mentioned the issue of climate stabilisation as being important in polar bear conservation. The statement from expert 8: *'it [climate stabilisation] is unlikely to happen at a significant level within this time frame'* may be insightful: perhaps other experts considered it too low a likelihood for climate stabilisation before 2050 to impact on their projections. No experts commented that if no action is taken to abate climatic warming within this time period, there will be an even greater climate commitment beyond 2050, with increasing longer-term impacts upon polar bear populations.

One expert stressed that, with climatic warming, bears may increasingly be crowded on land and come into contact with human settlements. Education could be key in reducing 'nuisance kills', or kills in defence of lives or property (expert 7). Lastly, several experts stated the importance of intensive monitoring and research into polar bear populations and the relationship of these populations to climate change, with facilitation of co-management initiatives using both scientific and traditional knowledge.

Most experts considered that under scenario A1B, considerable population loss by 2050 is inevitable, regardless of management technique (Figure 6.3 a, b). For half of the participants, responses to each confidence bound E1 to E5 changed no more than 5%. However, the responses from expert 4-6 were impacted rather more by implementing best management, with at least one response E1-E5 changed by 20% or more. In the case of expert 6, implementing best management practice raised the lower confidence bound by 70%: from a 90% decrease to a 20% decrease in the total Arctic polar bear population. Changes in expert responses were evenly spread over the confidence bounds E1 to E5, with no more pronounced change in either the upper or lower confidence bounds.

6.3.6 Analysis of the expert survey

The IPCC states polar bears will face a *high risk of extinction* with warming of 2.8°C above pre-industrial, associated with a *62% decline in sea-ice* calculated from the multi-model mean (Box 4.3 and Table 4.1, Fischlin *et al.*, 2007). This IPCC statement is compared to the expert survey undertaken for this thesis research by extrapolation. In the expert survey, experts were asked for projections based on a projection of 47% loss of summer sea-ice extent. In order to compare the results from the expert survey, a temperature rise of 0.4°C is assumed from pre-industrial to 1961-90. Subtracting this from the 1.9°C pre-industrial to 2050 A1B multi-model mean (Table II.4: IPCC, 2001) gives a temperature rise of 1.5°C relative to 1961-90. An assumption of a linear relationship between sea-ice and temperature is made, although the limits of this assumption are acknowledged. Under this assumption, there is a sea-ice decline of 60% by 2050 relative to pre-industrial. Therefore, when presented with this summer *sea-ice decline of 60%*, the median expert projection was a total *population decline of 28%*, amid considerable uncertainty and regional variation.

The IPCC statement of population risk was agreed amongst the authors of Working Group II Chapter 4 based on the available literature and on modelled sea ice decline, in itself forming a process of expert assessment. This thesis research sought to provide a more in-depth and transparent analysis of the current state of expert knowledge. There is a considerable difference between the risk statements of the IPCC (62% decline in sea ice, high risk of extinction) and that from the expert survey participants (60% decline in sea ice, population decline of 28%). However, caution is urged in interpreting the extrapolated statement from the expert survey. It is based on the median of the experts mean values and thus does not demonstrate the full range of expert projections (though neither does the IPCC statement) and, second, in order to compare the two statements an assumption of a linear relationship between sea-ice and temperature was made.

Best management practice does not greatly impact on projections of future polar bear populations according to the experts surveyed, with the projected median decline decreasing from 28% to 20%. It is clear from the suggestions given for 'best management practice' that no expert considers current management across the Arctic of polar bear populations as optimal; a number of methods, and in particular the reduction of hunting, could be used to help conserve populations. It has been suggested for a range of habitats that the resilience of communities and taxa to climate change could be increased if other stresses are decreased (Fischlin *et al.*, 2007). However, the rather small differences between the projections of the experts under current and optimal management indicate that the scope for this in the case of polar bears is limited. The impacts of the climate change driver are seen as increasingly dominant in the future and global mitigation efforts are, therefore, seen as key for future conservation.

6.4 INVESTIGATING CLIMATE IMPACTS FOR THE NORFOLK BROADS

The main threat to the Norfolk Broads from climate change is in Upper Thurne catchment, part of the northern Broads network. The catchment is situated around 30km from Norwich

(Figure 6.5a). The catchment area is broadly defined as the area between Potter Heigham, Eccles and Winterton (Figure 6.5b), with most of the area lying under 5m OD.

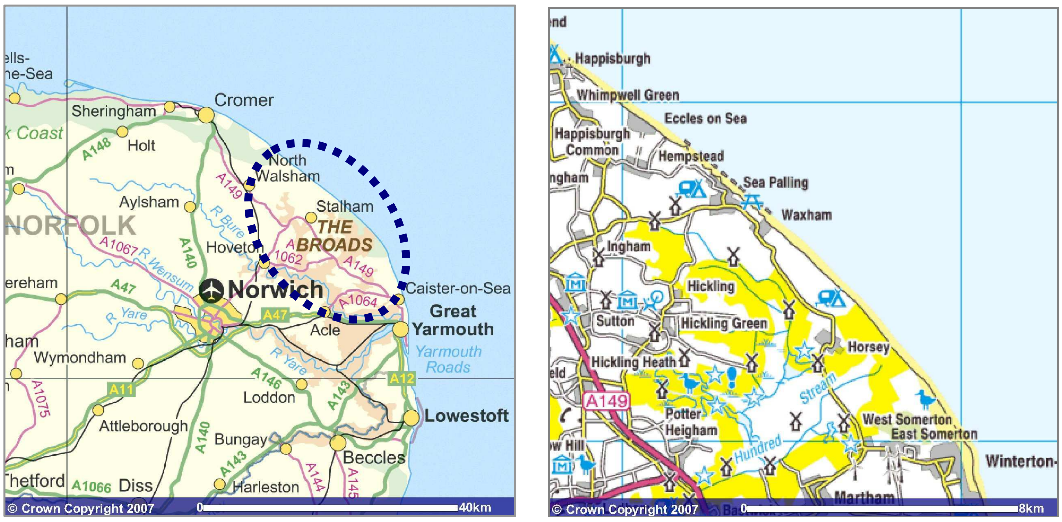

Figure 6.5 (a.) Location of the Norfolk Broads and (b.) Location of the Upper Thurne Catchment[29]

Geomorphic evidence suggests that northern Broads has been tidal during the Holocene (English Nature and the Environment Agency, 2003). During this time, the River Thurne flowed directly into the sea via the course of the present Hundred Stream (Figure 6.6 a, b). Now, the River Thurne receives drainage from only a small area of the catchment and has a very low natural discharge. There is a slight tidal influence at Hickling Broad, but saline water rarely proceeds sufficiently along the River Bure to enter the Thurne system (Holman and Hiscock, 1998).

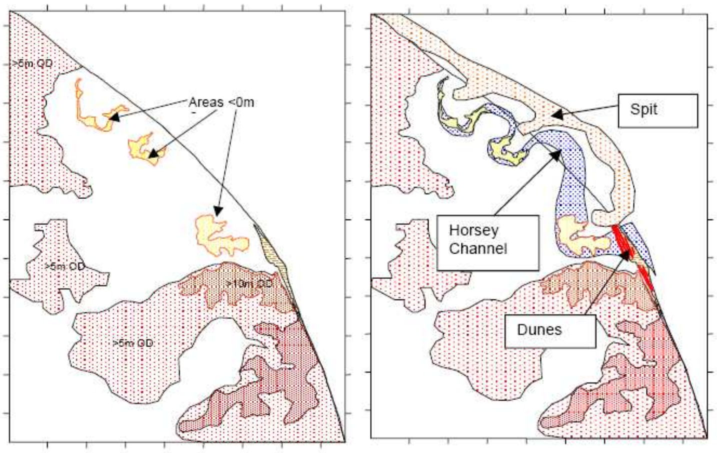

Figure 6.6 (a.) Topographic evidence for geomorphic change in the northern Broadland area and (b.) Reconstruction of mid-Holocene geomorphology (English Nature and the Environment Agency 2003: p 7)

[29] Image reproduced with kind permission of Ordnance Survey and Ordnance Survey of Northern Ireland.

Low-lying areas are protected from inundation from the sea by an extensive belt of sand dunes that extend for over 30km, with heights of up to 10m OD and a width of about 100m (Holman and Hiscock, 1998). However, the Winterton and Sea Palling Gap has always been vulnerable, evidenced from historical records of the flood of 1287 recorded by William of St Benet's Abbey, to the last inundation in 1953. The 1953 'Great Flood' surge tide flood broke through the dunes at Sea Palling covering a large area with sea water. Seven people drowned and there was significant damage to property and the environment (English Nature and the Environment Agency, 2003).

After the 1953 floods, a concrete sea wall was built to protect the 14km stretch of coastline. Construction was finally completed by 1989. However, a combination of sea level rise (SLR), increased storm surges and water extraction threaten to further undermine the current defences. Strategies including groynes, rock revetments and reef-building are now being pursued to keep the integrity of the sea wall (English Nature and the Environment Agency, 2003).

It is estimated that breaching of the sea wall could entail flooding of over 6 000 hectares of the northern Broadland area of Horsey, Martham and Hickling Broads, including six large villages and numerous isolated houses and farms (English Nature and the Environment Agency, 2003). Nicholls (2002) found that under the UKCIP98 'high' emissions scenario there were significant local flooding impacts in the Norfolk Broads by 2050. A flood of this kind would have a large negative impact on the ecology of Hickling Broad national nature reserve (K. Turner, Chair of the Broads National Park Authority; pers.comm., 26/06/06).

Changes in rainfall patterns due to a changing meteorology under climate change (Hulme *et al.*, 2002) coupled with SLR will have a large impact on the coastal aquifer (Tanaka, 2006) although the process may take many years to become apparent (Holman and Hiscock, 1998). SLR would increase the speed of groundwater flow, and so the interface between saltwater and freshwater can travel further inland. Saline groundwater would therefore underlie at a shallower depth many of the adjacent inland marshes, increasing the salinity of the inland drainage systems. As summer rainfall is projected to decrease in this region, it is likely that the need for groundwater abstraction for agriculture irrigation will also increase. More extensive saline intrusion would be expected if this were the case (Tanaka, 2006). Abstraction also impacts on the land level relative to the sea, as the peat on which the marshes are situated shrinks due to water extraction. Also, sea level relative to land is increasing due to long-term isostatic change (Shennan and Horton, 2002).

Although the long-term impact of saline intrusion through groundwater should not be underestimated, it is of lesser importance over the timescale examined here than the potential for seawater to overtop the Winterton dunes and flood the low-lying area with saline water during severe winter storms (English Nature and the Environment Agency, 2003).

Tidal surges present the greatest threat. These surges occur when an area of low pressure moves south or southwest over the North Sea, creating a bulge of water that can be up to 100 miles wide. Under certain meteorological conditions, this water mass is forced between the UK and the European coasts where the sea is shallow. This water mass can increase tide height by up to 1.5m (Lonsdale *et al.*, 2005). The worst case scenario is such a tidal surge combined with a spring tide, when the increase in sea level can be large enough to overtop defences, as seen in the 1953 flooding event. As the mean sea level rises, the mean height of storm surge heights is also increased. There is therefore also an associated change in the magnitude and occurrence of extremely high sea level events. This depends not only on the mean rise in sea level, but also on the changes in the variability around the new mean. Thus, expert knowledge was sought to investigate the impact and risk of saline flooding due to climate change on the Norfolk Broads.

Uncertainty exists in the projection of SLR. Thermal expansion and ice cap melt will result in increased SLR, although Antarctica's growth and the increased storage of water by society could act to reduce SLR (IPCC, 2007b). A great deal of uncertainty surrounds regional projections of SLR in particular. Regional variations exist because the warming of ocean water is not uniform, and therefore neither is the thermal expansion of ocean water. Ocean circulation and atmospheric pressure changes will also cause regional variation in SLR. In addition, regional vertical land movement can act to increase or decrease the relative SLR (Shennan and Horton, 2002). Regional variations are not satisfactorily represented in Atmosphere Ocean Global Climate Models (AOGCMs) with significant differences in the projected spatial pattern of relative SLR (IPCC, 2007). Regional variations can be quite substantial, varying up to +/- 50% of the global mean SLR (Hulme *et al.* 2002).

6.4.1 The Coastal Simulator

An integrated assessment of both flooding and erosion risk has been carried out for the East Anglian coastline for sub-cell 3b[30], which covers the area between Sheringham and Lowestoft. The study area includes the Thurne Catchment. Flooding and erosion risk were examined in conjunction with each other, as the two processes interact to regulate the risk of coastal defence breaching and subsequent flood risk: i.e., as beach sediment levels fall, the flood risk in adjacent low-lying coastal areas increases and vice versa (Dawson *et al.* 2006). The study investigated a range of relative SLR (rSLR) scenarios under a range of socio-economic conditions. Overtopping and / or inflows through breaches were simulated in 20,000 separate model runs, with a spatial resolution of 250m. The research is part of a wider project called the 'Tyndall Coastal Simulator' (referred to as the 'Coastal Simulator'. See Dawson *et al.* 2006 and Nicholls *et al.* 2005 for a full description of the project). The Coastal Simulator research provided an in-depth impact assessment that would not have been possible to recreate during this PhD research. However, the Coastal Simulator research was based on SLR scenarios from the IPCC Third Assessment Report (TAR) and the UKCIP02 scenarios, rather than on more recent IPCC 4AR projections[31]. It was important that the same emissions scenario was used across all six expert and non-expert icons. Thus, the projected SLR for SRES A1B was calculated from the IPCC 4AR and compared to the three SLR scenarios presented in Nicholls *et al.* (2005).

6.4.1.1 Adaptations of the Coastal Simulator for icon investigation

The Coastal Simulator project used three scenarios of SLR together with a regional subsidence rate through isostatic change of 0.7mm yr^{-1} (from Shennan and Horton, 2002). The 'low' scenario represented no anthropogenic influence and thus a continuation of the recent historic rSLR of 1.5mm yr^{-1}. The 'medium' scenario followed the UKCIP02 medium-high scenario and resulted in an increase of 45cm by 2100. The 'medium' scenario also includes a scaling factor for offshore winter wave heights. As wind increases, offshore winter wave heights are increased linearly up to a maximum of 3.5% by 2050. The 'high' scenario was based on the IPCC TAR high limit plus an additional regional sensitivity of 50%, following Hulme *et al.* (2002) to allow for spatial variability in thermal expansion. Current meteorology is imposed on future sea levels for all three scenarios.

[30] In UK coastal management planning, a costal sub-cell indicates a reasonably self-contained system of sedimentary interactions with neighbouring coastlines (DEFRA, 2006)

[31] The 4AR states that SLR projections would have had similar ranges to the TAR if it had treated uncertainties in the same way. For each scenario, the midpoint of the range is within 10% of the TAR model average for 2090-2099 (IPCC, 2007c)

Relative SLR (rSLR) is the sum of global mean SLR, regional factors and vertical land movement (Hall *et al.*, 2005). Thus, the global mean SLR for SRES A1B, a regional addition and an estimate of isostatic change were summed in order to calculate the rSLR projection for the Broads region using SRES A1B. The Figure for global mean SLR to 2050 under SRES A1B was taken from the model mean of 17 Atmosphere Ocean Global Climate Models (AOGCMs) in the IPCC 4AR (IPCC, 2007b). SLR in the north Atlantic region is often under-represented in AOGCMs (IPCC, 2007b). The single most important factor in driving sea level variability in the region is the North Atlantic Oscillation (NAO) (Osborn, 2003); although the NAO-sea level relationship and the inter-annual variability in the winter NAO index are assumed to remain applicable under a different climate state. So, a regional SLR component sourced from the IPCC (2007) was added to the global mean SLR Figure. The final component of rSLR is for regional subsidence due to isostatic readjustment (Shennan and Horton, 2002). The rSLR was thus calculated as shown in Table 6.1.

Table 6.1 Calculation of rSLR for the Norfolk region using IPCC 4AR projections

NORFOLK BROADS	yr^{-1} (mm)	2050 relative to 2000 (mm)	2080 – 2099 relative to 1980 – 1999 (mm)
Isostatic change (Shennan and Horton, 2002)	**0.61**	30	
Global mean SLR (IPCC 2nd order draft, FAR: 03/03/06 suggests global average SLR with respect to 2000 of 120 ± 60 mm by 2050 projected under scenario SRES A1B by 2050)		**120**	
Regional addition (IPPC 2007b: Figure 10.32 suggests between 50-100mm addition to global mean SLR for this region from 1980-1999 to 2080-2099 for SRES A1B. Upper limit used).		50	**100**
Total (mm rSLR)		200	

Figures in bold are taken directly from source reference: rSLR for 2050 is then calculated for comparison with low, medium and high SLR trajectories in Nicholls *et al.* (2005).

The rSLR of 200mm by 2050 most closely resembles that of the medium SLR scenario used in the Coastal Simulator (Figure 6.6). The 'medium' SLR scenario from the Coastal Simulator research therefore gives the best approximation to projected rSLR under SRES A1B.

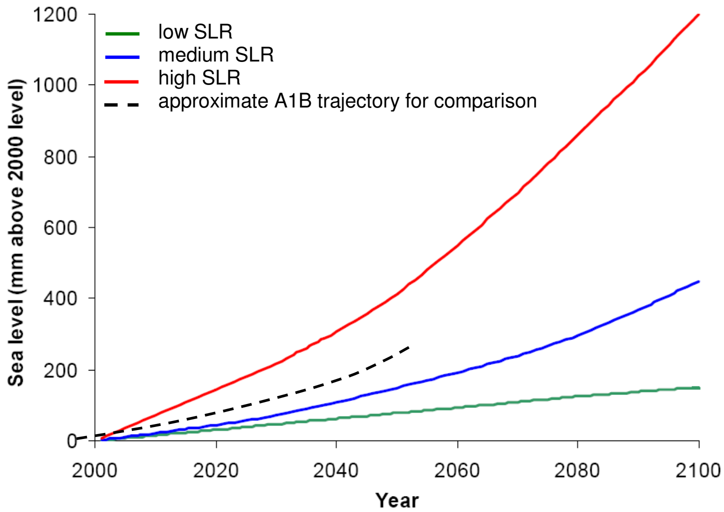

Figure 6.7 Comparison of rSLR trajectories calculated for the Norfolk region from Nicholls *et al.* (2005). Black dashed line shows approximate trajectory under SRES A1B as calculated in Table 6.1.

The East Anglian coastline is current managed with around 71% of the coast protected. This management is in the form of seawalls, groynes or palisades.

Therefore, data was taken from the 'medium' rSLR scenario, with 71% coastal protection (Table 2 in Dawson *et al.*, 2006: this rSLR and coastal protection percentage are named as 'scenario 14'). This scenario most closely fulfils the conditions for icon examination of 'no adaptation' under SRES A1B for the Norfolk region.

6.4.2 Visualising climate impacts on the Norfolk Broads using GIS

A Geographical Information System (GIS) was used in order to produce a map of the spatial variability in flood risk and flood cost damages within the Coastal Simulator scenario 14.

Non-experts appear to identify more readily with aerial photographs than with traditional cartographic maps (Haynes, 2005), and an attempt was made to source free access aerial photographs for the area. However, free access data was not available. Instead, tiles from the Meridian2 dataset were obtained from the Digimap datacentre[32]. The Meridian2 files were converted from .ntf files for manipulation in ArcView 9.1 (ESRI, 2003) using MapManager (ESRI, 2007). The results from Coastal Simulator scenario run 14 were extracted as an ASCII file and imported into ArcView 9.1. The scenario information was then converted to a raster map using the Spatial Analyst extension. Typical 'roadmap' features were added from the Meridian2 dataset within the GIS in order that participants in stage three could identify more easily with the area. Five categories were used for the symbology of the flood risk, so the participants in stage three could easily distinguish the spatial pattern of flood risk.

Figure 6.9 gives an indication of how beach volume fluctuates in a 'ripple effect' (the image is given for illustration only as it is not produced from scenario 14). Lighter areas represent higher beaches, and hence areas where defence structures are less likely to fail (Figure 6.7 illustrates this process occurring near Winterton). The x-axis shows projected beach movement through the 21st century. Towards 2050, the ripples indicating low beach sediment move down the coast. This effect can be seen in Figure 6.7.

Figure 6.8 Build up of sediment in front of a seawall defence near Winterton lessens flood risk

As sediment builds in front of a sea defence, the area behind the defence is subject to a lowering of flood risk, and vice versa. So, flood probabilities within sub-cell 3b show much variation year to year. Because of this wide annual variation in relative flood risk, a 10-year average was taken for both the present day (2002 to 2012) and for the future (2045 to 2055). Change in flood probability and flood risk were calculated by subtracting present day cell values from the future scenario values using the ArcView 9.1 raster calculator function (ESRI, 2003).

[32] All Meridian2™2 Digimap data © Crown Copyright / EDINA right 2007. An Ordnance Survey / EDINA supplied service

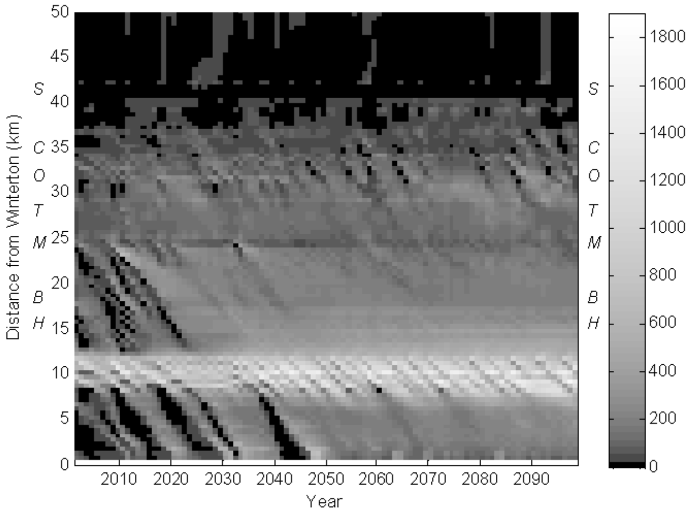

Figure 6.9 The 'ripple effect' of sediment movement down coast of sub-cell 3b. Darker shading represents lower beaches, and thus beach defence structures more likely to fail; lighter shading represents higher beaches and thus those less likely to fail. The letters on the Y-axis indicate major settlements north of Winterton: Happisburgh, Bacton, Mundesely, Trimingham, Overstrand, Cromer and Sheringham. (Note, this image is not for scenario 14 but for a scenario of lesser coastal protection: so sea cliffs are able to erode and later start to offset the ripples. In scenario 14, this cliff erosion is not present so the ripple effect continues throughout the 21st century).

6.4.2.1 Flood probability

The change in the flood probability expressed as a change in the return period[33] of a flood event is illustrated in Figure 6.9. The spatial pattern of flooding is fairly complex, especially in the low lying area between Eccles, Potter Heigham and Winterton. The greatest change is seen around Hickling Broad, where saline flood return periods increase, in some cases, by over 1000 years. The lightest blue cells around the coast and along the Hundred Stream indicate areas already at considerable risk of saline flood inundation now, and in which saline flood event return periods increase by a more modest 30 – 100 years.

[33] A 'return period' is defined as the average length of time between events (in this case, the occurrence of a saline flood event). If a particular flood event has a return period of 20a this means that there will be a 1 in 20 chance that a flood will occur in any one year and that *on average* there will be one such flood every 20a (adapted from Summerfield, 1991: p 10)

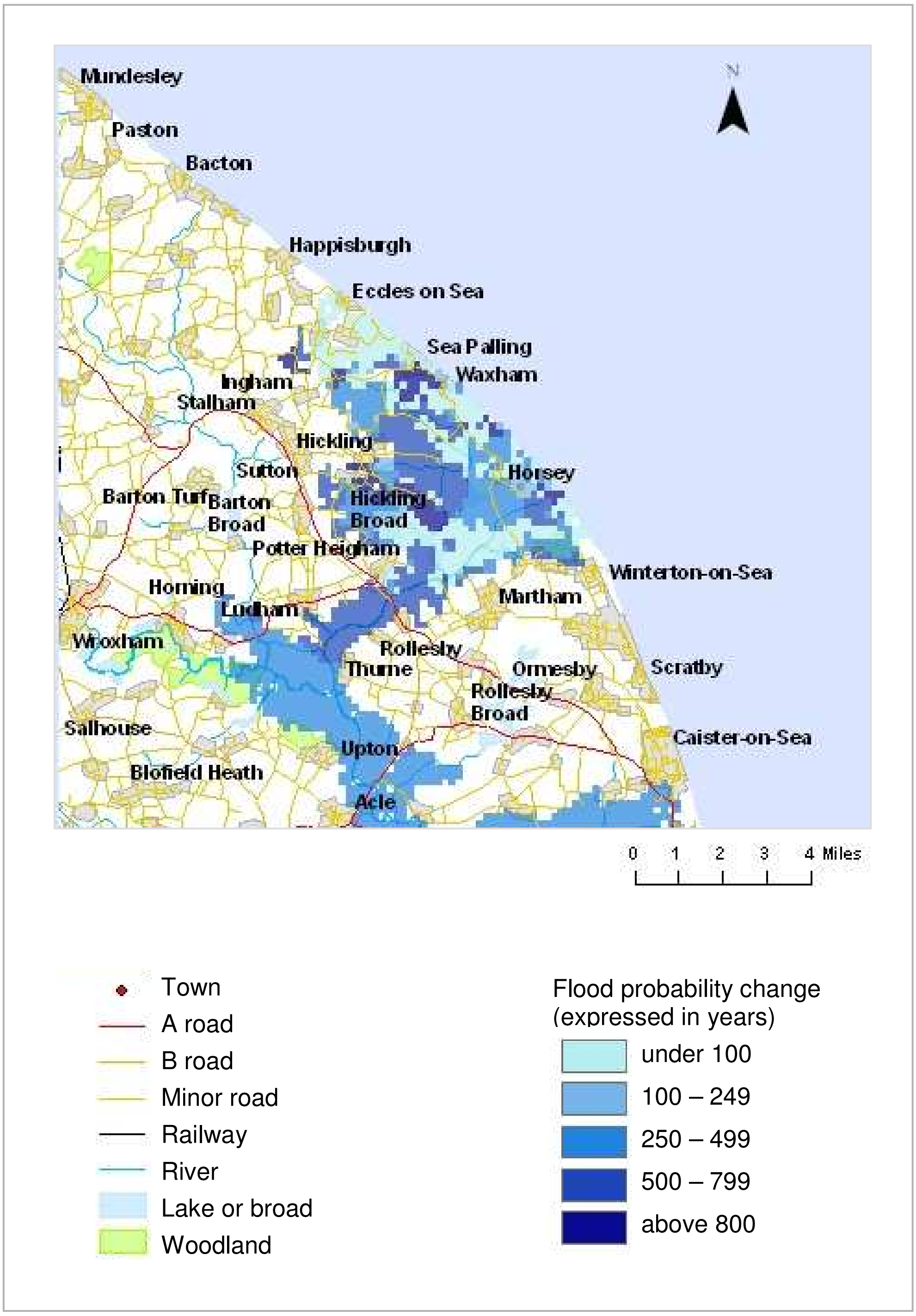

Figure 6.10 Change in the saline flood probability expressed as a change in the flood return period

6.4.2.2 Flood cost damages

The change in flood risk is expressed as a change in the expected annual damage[34] in £UK per 250m × 250m cell based on 2003 valuations. The pattern of expected annual damage is estimated by calculating a value per cell based on the agricultural value of the land and the

[34] The 'expected annual damage' is defined as the average damage cost per year calculated from all flood event simulations.

value of property within each cell. Six agricultural band valuations were available, with inundation losses ranging from arable land at £1,160, to unfarmable land valued at £20 per hectare; and erosion losses of arable land at £5,683, to unfarmable land valued at £4,571 per hectare. Properties lost through cliff top erosion were assigned an average market value of £150,000 per residential postal address, as determined from average market valuations and the UK Land Registry. Discounting was carried out to 2003 levels at a rate of 3.5% for the first 30 years and 3% for the subsequent 20 years (Dawson *et al.* 2006).

The spatial pattern of flood risk is not as complex as that of flood risk. Necessarily, the greatest losses occur nearest the coast, with the area around Horsey and between Sea Palling and Eccles experiencing the greatest change in expected annual damage. The maximum change occurs near Horsey, with nearly £1.3 million expected annual damages in one cell by 2050. In contrast, much of the area experiences a change in expected annual damage of less than £100 per cell.

Some areas experience a negative change in flood risk. This is due to a trough in the expected annual damage occurring over the 2050-centred time span, and is a consequence of sediment build up as illustrated in Figure 6.11 (and as discussed in 6.3.3, and in Figures 6.7 and 6.8). Figure 6.8 indicates that there is a general trend of increasing expected annual damage under scenario 14, and that the expected annual damages from saline flood risk are anticipated to increase in this region, especially towards the end of the century.

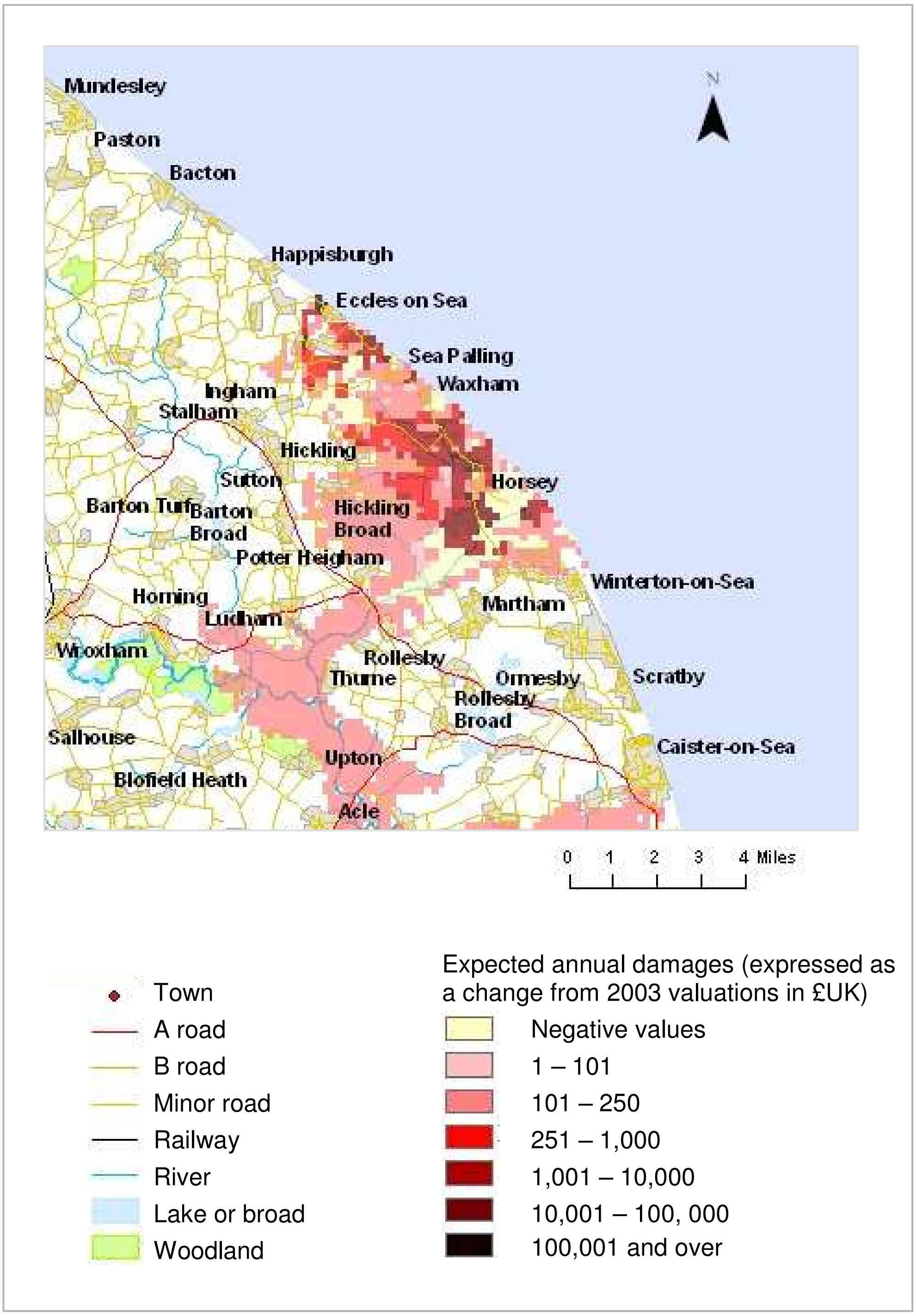

Figure 6.11 Change in the expected annual damage of saline flood risk

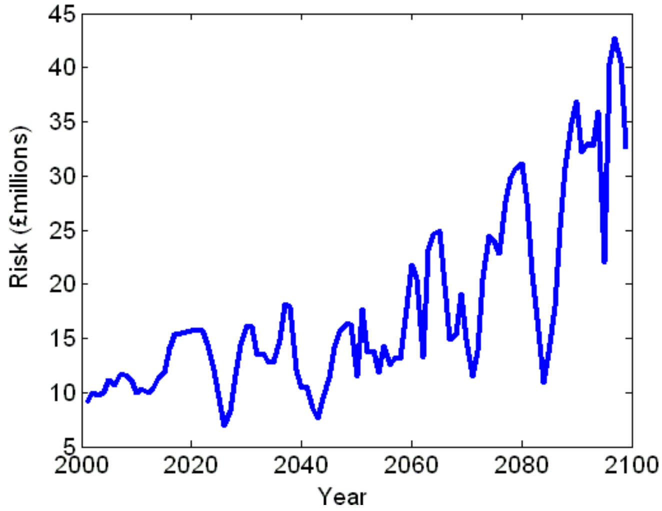

Figure 6.12 Projected trajectory of expected annual damages of saline flood risk for coastal sub-cell 3b under scenario 14

6.5 INVESTIGATING CLIMATE IMPACTS ON LONDON

Much of London lies within the 5m contour of the River Thames (Figure 6.12) on what was originally low-lying marshland. Thus, London has always been vulnerable to flooding. The first written record of a flood was from the Anglo Saxon Chronicle in 1099, and extends to the Great Flood of 1953. This last flood event was the catalyst for building the Thames Barrier, which became fully operational in 1982. The Thames defences are the UK's most costly and complex flood defence system and are of global significance in terms of the value of assets protected from flooding (Hall *et al.*, 2005). Since 1982 the Barrier has provided reliable flood defences for London, so much so that should the defences be breached, there is now very little appreciation of the consequences of tidal flooding (Lavery and Donovan, 2005). Redevelopment of housing and industry continues apace in the Thames Gateway Regeneration Area, including potential flood-risk regions such as Shellhaven, Stratford and Havering riverside (Figure 6.13). New business and finance areas in Canary Wharf are very vulnerable to increasing flood risk (Lonsdale *et al.*, 2005).

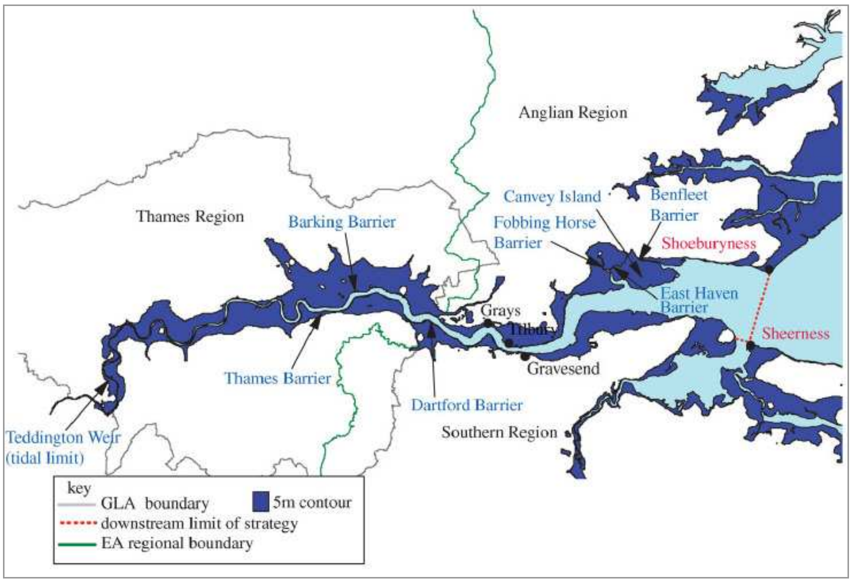

Figure 6.13 The defended Thames tidal flood-plain (from Lavery and Donovan, 2005)

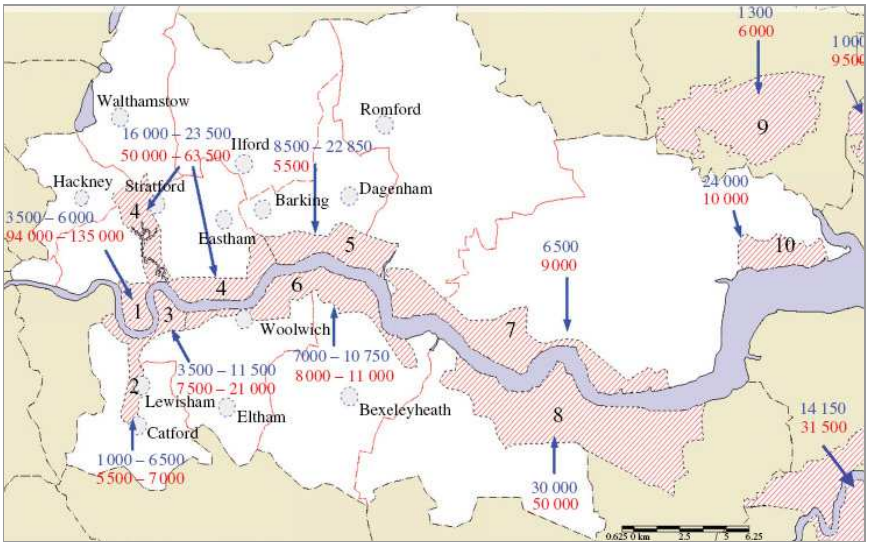

Figure 6.14 Thames Gateway Regeneration Area new homes (blue) and new jobs (red) from 2001–2016 and beyond. Zones of change are: 1. Isle of dogs 2. Greenwich, Deptford and Lewisham 3. Greenwich Peninsula 4. Stratford, Leaside and Royals 5. London Riverside 6. Charlton and Crayford 7. Thurrock 8. Ebbsfleet/North Kent 9. Basildon 10. Shellhaven (from Lavery and Donovan, 2005)

London is vulnerable to climate change through flooding in a similar way to the Norfolk Broads. Because of the position of the city on the eastern coast of Britain, London is susceptible to storm surges. As the mean sea level rises, the mean height of storm surges is also increased. Therefore there is also an associated change in the magnitude and occurrence of extremely high sea level events. This depends not only on the mean rise in sea level, but also on the changes in the variability around the new mean. There is also a smaller influence from potentially high fluvial flows flowing downstream from the River

Thames catchment. Extreme sea levels as experienced during storm surges could be 1.2m higher by the 2080s in the London area (Hulme *et al.* 2002). London is also vulnerable to local flooding when the drainage network is overwhelmed by intense rain storms (Lavery and Donovan, 2005) which are likely to become more significant under a projected 15% increase in winter precipitation by 2050 (Hulme *et al.* 2002). London is also undergoing isostatic subsidence (Shennan and Horton, 2002).

Even without climate change the Thames Barrier and associated structures will come to the end of their design life at similar times (Environment Agency, 2003). By 2030 the Thames Barrier will be 50 years old and although the structure itself should last much longer, the operating infrastructure will require overhauling to ensure a high operating reliability (Lavery and Donovan, 2005). The Thames Barrier and associated London flood defences are now undergoing extensive review in light of potential SLR through the Thames Estuary 2100 Project, or TE2100 (ThamesWEB, 2006). The Thames Barrier engineering is based on calculations made during the design period of the 1960s and 1970s. This does include an allowance for isostatic change of 8mm yr^{-1} (Lavery and Donovan, 2005), but not for projected changes due to climatic warming (and SLR).

Within the Thames Estuary area, there are approximately 500 000 properties at risk of flooding, including 420 000 properties at risk of tidal flooding in the estuary and 85 000 at risk from fluvial flooding , with 1.25 million people resident in this vulnerable area. Also at risk in the floodplain are 400 schools, 16 hospitals, 8 power stations, London City airport, and most of the central part of the London Underground. This could entail property damages of £80 billion without even considering valuation of other infrastructure and the impact on the UK and ultimately the worldwide economy (Lavery and Donovan, 2005) The losses from a serious flood would push insurance premiums out of the reach of those on low incomes. In some areas, insurance cover could be withdrawn entirely, leading to property market collapse and associated urban decay (Lonsdale *et al.*, 2005). The international nature of business would mean the impact of a serious flood event in London would be likely to have global economic repercussions (Munich Re, 2004).

6.5.1 The Thames LISFLOOD-FP model

A quantified analysis of the probability of extreme high sea levels overtopping the Thames Barrier and associated defences has been carried out (see Dawson *et al.*, 2005). The research sought to model the impact of extreme high water scenarios to examine the probability of flooding in London. Whilst this research investigated imaginable worst-case scenarios, lower SLR scenarios were also included in the modelling exercise. Simulation of inundation of the River Thames with its significant associated flood defence structures requires a two-dimensional (2D) modelling approach with a relatively high spatial resolution of 250m cells or smaller. However, full 2D modelling is computationally prohibitive at this scale (Dawson *et al.*, 2005). Dawson *et al.* (2005) instead used LISFLOOD-FP to model the extent of flooding. The LISFLOOD-FP model has been shown to perform as well as 2D codes for costal and fluvial flood modelling, whilst reducing the computational burden a 2D model would require. Whilst LISFLOOD-FP does not simulate the fine details of wave propagation it adequately captures the maximum flood extent of a simulated SLR input (Dawson *et al.*, 2005). Although London is susceptible to inundation by water from the River Thames and local flooding when drainage systems are overwhelmed, tidal surges represent the greatest flood threat (Lonsdale *et al.*, 2005). Thus, although LISFLOOD-FP does not take into consideration fluvial flows from the River Thames catchment, the model is still a reasonable first approximation for gauging maximum flood extent (R. Dawson, University of Newcastle, pers.comm., 02/03/07). The Thames LISFLOOD-FP model was run for 90 different scenarios. These 90 scenarios spanned those with current flood management strategies in place, to those with additional flood barriers added. The project also investigated rSLR scenarios of no change, to what was considered the imaginable worst case scenario of a 6m increase in sea level by 2100.

6.5.1.1 Adaptations of the LISFLOOD model for icon investigation

As for the Norfolk Broads icon (Section 6.4.1.1), rSLR had to be calculated in order to select the scenario to investigate further. The LISFLOOD-FP model required a rSLR input in mm yr^{-1} rather than an absolute rSLR total. The Figure for global mean SLR to 2050 under SRES A1B was taken from the model mean of 17 Atmosphere Ocean Global Climate Models (AOGCMs) in the IPCC 4AR (IPCC, 2007b). SLR in the north Atlantic region is often under-represented in AOGCMs (IPCC, 2007b). The single most important factor in driving sea level variability in the region is the NAO (Osborn, 2003). So, a regional SLR component sourced from the IPCC (2007b) was added to the global mean SLR Figure. The final component of rSLR is for regional subsidence due to isostatic readjustment (Shennan and Horton, 2002). The annual rSLR in mm yr^{-1} for input into the LISFLOOD-FP model was calculated as shown in Table 6.2.

Table 6.2 Calculation of rSLR for the Thames region using IPCC 4AR projections

LONDON AND THE THAMES ESTUARY	yr^{-1} (mm)	2050 relative to 2000 (mm)	2080 – 2099 relative to 1980 – 1999 (mm)
Isostatic change (Shennan and Horton, 2002)	**0.74**		
Global mean SLR (IPCC 2nd order draft, FAR: 03/03/06 suggests global average SLR with respect to 2000 of 120 ± 60 mm by 2050 projected under scenario SRES A1B by 2050)	2.4	**120**	
Regional addition (IPPC 2007b: Figure 10.32 suggests between 50-100mm addition to global mean SLR for this region from 1980-1999 to 2080-2099 for SRES A1B. Upper limit used).	1.0		**100**
Total	4.14		

Figures in bold are taken directly from source reference: annual rSLR is then calculated for comparison with scenarios of the Coastal Simulator

As for the other icons, a scenario of 'no adaptation' was assumed. The annual rSLR was then inputted into an Excel spreadsheet containing macro links to output files of each Coastal Simulator scenario run. The results for the 1:1000 year flood and a 1:10,000 year flood can be seen in Figures 6.15 and 6.16 respectively.

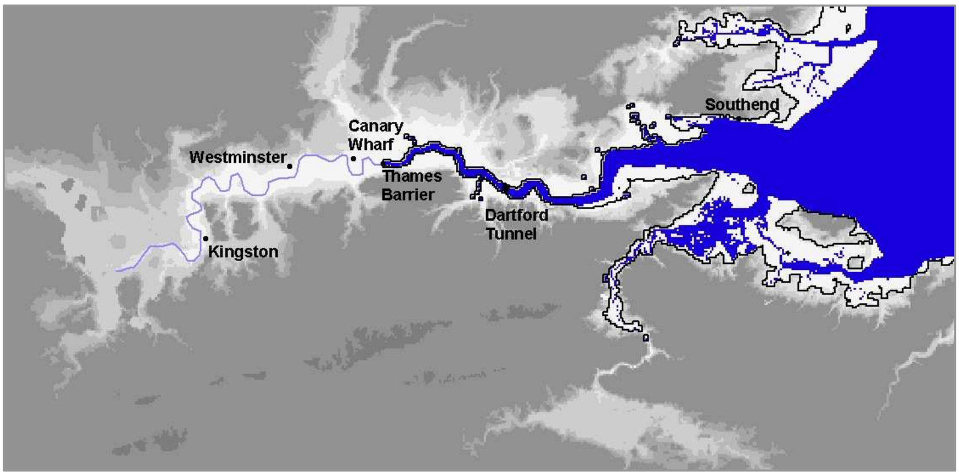

Figure 6.15 The 1:1,000 year flood (black line) after 4.14mm yr^{-1} rSLR for 2050 assuming no adaptation. The blue shading indicates the current River Thames extent, the white shading indicates flooded land. Grey shading shows higher ground (lighter shades indicate lower ground).

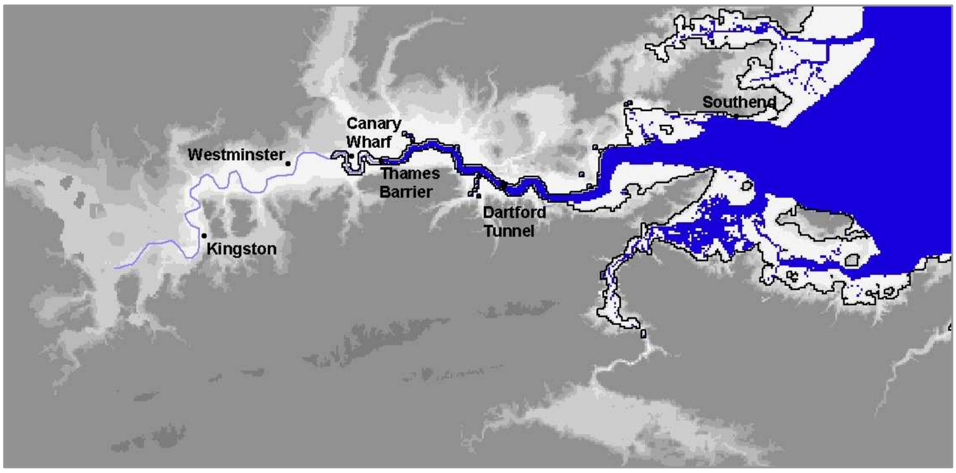

Figure 6.16 The 1:10,000 year flood (black line) after 4.14mm yr^{-1} rSLR for 2050 assuming no adaptation. The blue shading indicates the current River Thames extent, the white shading indicates flooded land. Grey shading shows higher ground (lighter shades indicate lower ground).

6.5.2 Visualising climate impacts on London using GIS

A Geographical Information System (GIS) was used in order to produce a map of the 1:1,000 and 1:10,000 flood limits for London and the Thames estuary. Tiles from the Meridian2 dataset were obtained as for the Broads icon (see footnote 10, p 28). The Meridian2 files were converted from .ntf files for manipulation in ArcView 9.1 (ESRI, 2003) using MapManager 8 (ESRI, 2007). Again, typical 'roadmap' features were added from the Meridian2 dataset within the GIS in order that participants in stage three could identify more easily with the area. The results from the 1: 1,000 and 1:10,000 year flood were obtained and imported into ArcView 9.1. The contour function was used in order to define the flood extent limits. Although the flood outline appears 'blocky', smoothing of the contour resulted in a considerable loss of spatial detail. Flood extents can be seen in Figure 6.17.

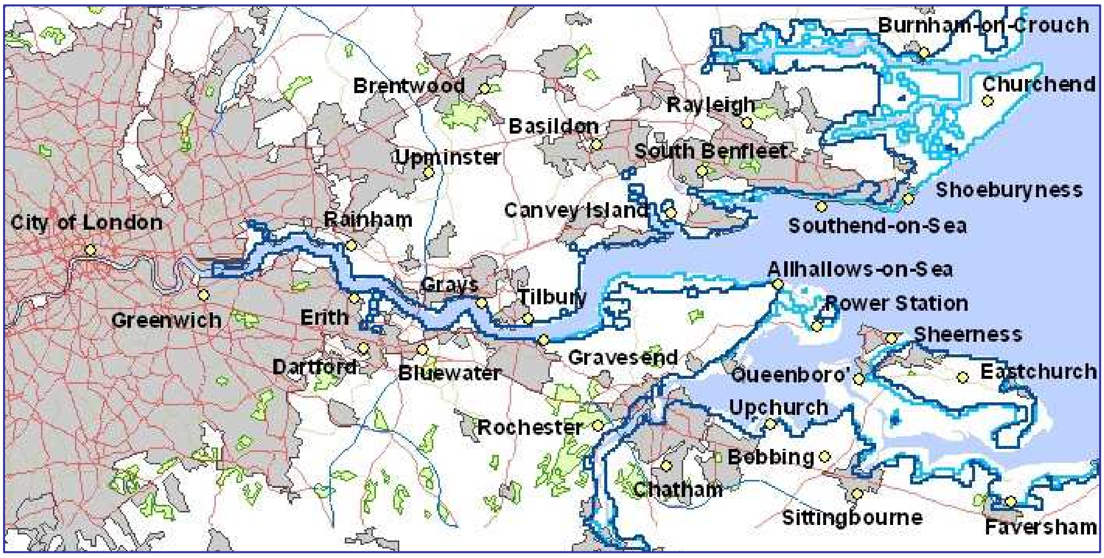

Figure 6.17 Flood extent for today and the 1:1,000 year flood event for London and the Thames Estuary

The flood risk to central London and the upper estuary increases only very slightly under this scenario of SLR, as the Thames Barrier and associated defences are designed to cope with SLR of this magnitude within its design specification. There are greater impacts for the Essex coastline, particularly around Churchend, Southend and Shoeburyness, where parts of urban centres would be inundated by the 1:1,000 year flood. Parts of urban settlements in Kent such as Sheerness and Chatham, as well as the Grain Power Station on the Isle of Grain (near All-Hallows-on-Sea) would also experience flooding with the 1:1,000 year event under this scenario.

6.6 SUMMARY

This Chapter covered three areas. First, it began by justifying the timeframe and scenario choice for investigating the six icons. The reasoning behind investigating climate impacts under 'no adaptation' was also discussed. Second, the impact of climate change on the three expert icons of the THC, ocean acidification and WAIS was explored using published literature and assessments. Third, impacts on the three non-expert icons of polar bears, the Norfolk Broads and London were explored using an expert survey, the Coastal Simulator research, the LISFLOOD-FP model and through using GIS. The next Chapter examines the emotional and cognitive reactions of non-experts to the impact of SRES A1B to 2050 on both expert and non-expert icons through a pre / post-survey test design.

CHAPTER 7:
ICON EVALUATION

An evaluation workshop was designed to explore research question 3 (Chapter 1): namely, does the iconic approach engage non-experts with climate change? This question will be answered by considering how non-experts engage with both the expert and non-expert icons, and by assessing whether the iconic approach alters non-experts cognitive or affective spheres of engagement with climate change. The evaluative workshop comprised three parts: a pre-test questionnaire to investigate current cognitive and affective engagement with climate change, viewing of a set of icon information sheets derived from the modelling research in Chapter six, and a post-test questionnaire. The pre- and post-test questionnaires contained both qualitative and quantitative questions. The workshop data was analysed using a combination of statistical and coding tools to investigate the influence of the iconic approach on participants' engagement with climate change.

7.1 EVALUATIVE WORKSHOP DESIGN

A three part pre/post-test workshop was designed to investigate participant engagement with climate change through the iconic approach. Pre/post-test methodologies are used throughout the medical, psychological and behavioural sciences for exploring changes after an input, referred to as the 'treatment'. A pre-test examines participants' views prior to any treatment, and provides a baseline on which to observe the impact of the treatment. The post-test questionnaire contains identical questions so changes in participants' views after treatment can be examined. This workshop was based on a similar pre/post-test study by Lowe *et al.* (2006) investigating climate change engagement with the film *The Day After Tomorrow* (Emmerich, 2004); and a pre/post-test study investigating cognitive change through a museum visit by Henriksen & Jorde (2000). The impact of the treatment was assessed through the use of two questionnaires, where the post-test questionnaire repeated many of the questions posed in the pre-test questionnaire.

The use of pre/post-test methodologies to self-report measures can potentially be contaminated by response shift bias, a change in respondents' understanding of the phenomena being tested between pre- and post-tests[35]. Retrospective pre-tests in these

[35] For example, consider the following pre-test question *'how large is your carbon footprint compared to the UK average?'* The participant may think that as they recycle and care about the environment, their footprint would be low (though they actually have a high carbon lifestyle). The participant then takes part in an exercise about carbon footprinting and energy reduction. In the post-test a month later the participant states

cases can be useful for assessing response shifts (Robinson and Doueck, 1994). However, the workshop described in this Chapter concentrated on exploring participants' cognitive and affective engagement. Whilst some questions in the pre-test investigated participants' self-stated current behaviour in relation to climate change, participants were not asked to re-evaluate this information and state future behavioural intentions based on the icon treatment. Behavioural elements of engagement would be overly influenced by social desirability bias using this survey methodology and thus changes in question responses investigating behavioural engagement may have referred more to participants' desire to change behaviour, rather than an actual change in behaviour (behavioural aspects could be more successfully researched by using a longitudinal interview study, for example). As stated in Chapter 2, this research focused on the exploration of changes in attitudes towards climate change rather than behavioural change. Therefore, as the workshop methodology was specifically used to explore participants' cognitive and affective engagement before and after the icon treatment, rather than behavioural change, it was not necessary to conduct a retrospective pre-test.

The workshop format used a pre- and post-test questionnaire to detect attitudinal changes towards climate change after seeing the icon information. The post-test questionnaire also explored participants' engagement with the icons in more depth using qualitative open-ended questioning. The collection of qualitative data was particularly important for exploring the reasoning behind participants' choice of which icons they found most engaging or disengaging.

The considerations for questionnaire design are analogous to those for designing an online survey (as discussed in Section 5.3.2). Reference was made to the methodologies and structure of similar questionnaires (Lorenzoni *et al.* 2006; Lowe 2006; Lowe *et al.* 2006; Poortinga & Pidgeon 2003; Whitmarsh 2005). As suggested by Dillman (2000), the questionnaires were presented in a non sans-serif font in least 12-point type. Questions were evenly spaced and shading was used to distinguish the more extreme responses at each end of the attitude statements. All attitude scales were evenly spaced and covered the same area on the page.

A logical flow of questions was designed to lead participants through both questionnaires. The questions specifically investigating which icons participants considered most and least

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that their footprint is higher than average as they can validly answer the question. It would appear that after the intervention, their carbon footprint has increased, although it may be the same, or even have decreased - because the participant did not have the knowledge to answer the pre-test question previously.

engaging were penultimate to the demographic questions. Whilst this could have affected response rate because of participants dropping out of the survey before completion, the question structure was designed so that participants could consider a multi-faceted response to their engagement with each icon before selecting the icon to which they were most engaged overall. For example, participants were asked for their responses on their understanding, emotional response and perceived relevancy of all the icons viewed, *before* providing a response to which icon they were most engaged with. In the same way, participants were asked to consider separately the map and imagery elements of the icon information sheet before being asked for which icon they were most drawn to overall. This last structural consideration was designed to compel participants to imagine the icon entity, and to somewhat filter responses such as an attachment to a particular photographic or cartographic representation.

7.1.1 Part one: pre-test questionnaire

The pre-test questionnaire protocol began with a statement that the workshop was designed to gather participants' opinions and feelings, and was not a 'test'. Participants were reminded that the facilitators could help with understanding the survey questions but could not answer queries about climate change. The pre-test questions were designed to investigate the prior levels of cognitive, affective and some aspects of behavioural engagement before the treatment was carried out. The pre-test questionnaire (Appendix 7.1) involved four Sections over four pages:

- *General impressions of 'climate change'.* An open-ended question requested the participants write down the first three things that came to mind when hearing the phrase 'climate change'. The question was placed to focus participants on the workshop topic. It also provided a check that participants had some knowledge of the term 'climate change' before the main survey questions.[36]
- *Level of concern over climate change.* These questions were taken from Lowe (2006), and Leiserowitz (in prep.). In some cases, the question wording has been slightly adapted to make questions clearer. Some of the original questions were also augmented with an additional category by adding a 'neither/nor' mid-range value. These questions provide a tool for assessing participants' views about the seriousness of climate change on a variety of spatial and temporal scales. Participants also stated their level of interest and worry over climate change. Lowe (2006) investigated the impact of two

[36] A study by Defra (2007) found 99% of the UK public had heard of 'climate change'. No participants in this sample required clarification of the term.

interventions on risk perceptions and behaviour using both terms climate change / global warming on undergraduate students, compared to a control group who were not subject to any intervention. Lowe's (2006) study also took place in Norwich, UK. The results from the control group are shown here for comparison. Leiserowitz (in prep.) undertook a nationally representative poll investigating American opinions on global warming, administered through Gallup and the ClearVision Institute. This thesis explores in detail attitudes towards climate change in the UK rather than internationally. Also, the icon pre-test questionnaire used the terminology 'climate change' rather than the term 'global warming' used by Leiserowitz. Noteworthy comparisons with the US study are highlighted.

- *General attitudes towards climate change.* A battery of 12 statements on a 'strongly agree' to 'strongly disagree' five-point Likert scale was drawn up to investigate prior perceptions of cognition, interest, scepticism and engagement. Some of these questions were taken from Whitmarsh (2005), a study investigating public understanding and response to climate change and flooding in the UK through a survey methodology. Comparisons can therefore also be made with this study, although it is noted that whereas the attitude scale in Whitmarsh (2005) uses the same 1-5 Likert scale, it is measured from 'strongly disagree' to 'strongly agree'. As this is the reverse of the pre- and post-tests scale, (which measured 1-5 from 'strongly agree' to 'strongly disagree') the scaled results from Whitmarsh (2005) have been inverted. A question was also included on how likely participants were to talk to family, friends and colleagues about climate change. Poortinga and Pidgeon (2003) found the public trust information about climate change from friends and family more than any other source: above university scientists and well above national government[37]. Thus, until climate change is seen as a topic of everyday conversation with information received through trusted sources, rather than as a narrative of scientists and policy makers, the public may be unlikely to take action to address the issue (Ereaut & Segnit, 2006).
- *Perceived personal vulnerability.* Both quantitative and qualitative questions were used to investigate participants' current attitude and behaviour towards climate change as a risk issue: whether they considered climate change would affect them personally, and if they currently took action out of concern for the issue.

[37] Trust in various sources to tell the truth on a 1-5 scale from 'distrust a lot' to 'trust a lot': friends and family 4.12, scientists working for universities 3.87, national government 2.66 (Poortinga and Pidgeon, 2003).

7.1.2 Part two: icon information sheets

The second stage of the workshop involved the treatment of viewing the icon information sheets. An icon information sheet was prepared for each of the six icons (appendices 7.2a-f). The information sheets were designed to summarise the impact assessment information gained in stage two of the thesis research for each of the icons under SRES A1B to 2050, as discussed in Chapter 6.

Significant divergence in information perception can occur through the use of differing communication devices (Sanfey & Hastie, 1998). In order to minimise apparent differences in icon engagement because of communication devices, each icon information sheet used the same format The icon information sheets consisted of an obvious and informative title, an image, three short text paragraphs and a map arranged in the same layout throughout.

As discussed in Chapter two, there is evidence that a significant proportion of people have difficulty understanding numerical risk (see Lipkus & Hollands, 1999). For example, a majority of UK participants could not identify the correct probabilistic statement when asked to clarify the statement ‘a 30% chance of rain tomorrow’ (Gigerenzer *et al.*, 2005). Likewise, communications difficulties exist when presenting information such as the probability of a 1 in a 100 year flood, or the difference in inundation between a 1 in 100 year and a 1 in 20 year flood (Hulme, 2004). In addition to difficulties in identifying scientific statements of probabilistic risk, an individual’s assessment of risk is subject to heuristics, used to process the risk information presented. These can introduce biases into an individual’s assessment of risk, which may differ from the probabilistic information presented. Therefore, for the icon information sheets, probabilistic information was minimised. For example, the London icon showed a 1:1000 year flood extent for the present day and 2050 (as depicted in Figure 6.14) but this return period was referred to for the London icon sheet as an ‘extreme’ flood. A 1:1000 year value was chosen as it represents the timeframe to which the Thames Estuary 2100 Project / Espace considers a baseline flood risk (Reeder, 2007). Similarly for the Norfolk Broads icon sheet, the flood cells with a higher flood risk probability are indicated by increasingly dark blue colouring rather than the flood return periods expresses in Chapter 6.

Particular care was taken to select icon images that did not depict the impact of climate change upon the icons, so that a particular impression of potential impacts on the icon entity was not forced on the participants. For example, the polar bear image did not show a polar bear struggling to mount a melting ice floe, the ocean acidification icon did not show a dissolving coccolithophore, and the London icon did not show a flooded Southend. The icon pictures were also all manipulated so they all covered an area of ~40cm^2. As with the images, each map was adjusted to cover the same area, in this case ~70cm^2. Clear captions were provided for the maps and images. The icon sheets were not numbered so no ranking or order to the icons was apparent to participants. The maps and images were labelled 'a' and 'b' only with no numerical identifier, for similar reasons. The three text paragraphs were divided into a short introduction to the icon, an assessment of the vulnerability of the icon to climate change, and a statement regarding how the icon could be impacted due to climate change by 2050. The icon text was limited to a maximum of 300 words[38]. Technical language was avoided where possible.

7.1.3 Part three: post-test questionnaire

The final part of the workshop involved a longer post-test questionnaire (Appendix 7.3). Participants were first asked to complete all questions even if they were repeated, as the first eight questions were the same as those posed in the pre-test questionnaire. The post-test questionnaire involved the same four Sections as the pre-test plus three further Sections, grouped over eight pages.

- *Focussed icon engagement investigation.* This Section asked participants to rate the icons they had seen on a 7-point Likert scale. The Section examined specific responses to the icons in regard to understanding, interest, concern, fright and the future. A question was also included investigating which icon was most relevant on a personal to an international level.
- *Open-ended icon engagement investigation.* This Section provided an option for a more qualitative, open-ended exploration of engagement with the icons. Participants were asked to state which icon picture and map they were most and least drawn to, before stating which icon they were most drawn to overall. As previously discussed, the questions were subdivided in this way in order to separate more trivial engagement with the icon communication device (e.g. a particular image) as opposed to a more meaningful engagement with the icon entity.
- *Demographic questions.* These were placed last to maximise response and discourage questionnaire abandonment (Dillman, 2000). These questions asked for responses on gender, age, number of children in the household, postcode, highest qualification, highest scientific qualification, political affiliation, car ownership, income, newspaper

[38] On the basis that the average reading speed is around 250 words per minute (Symonds and Nicholson, 2007) each icon information sheet would take less than 2 minutes to read fully.

readership and membership of an environmental organisation. Space was provided for participants to make any additional comments on any aspect of the workshop.

7.2 PILOTING AND IMPLEMENTING THE EVALUATIVE WORKSHOP

The workshop was designed so it could be completed within 30 minutes. This was implemented to maximise completion and attendance at the workshop, considering participants would be recruited to take part directly. Completion of the pre- and post-test surveys as well as reading and responding to the six icon information sheets would be difficult within this timeframe. Therefore, the workshop was designed instead so participants viewed a 'set' of two expert and two non-expert icon information sheets, instead of all 6 information sheets. Nine sets of all possible combinations of 2 non-expert / 2 expert icons were devised. Each set had a corresponding post-test survey, where the questions related only to the icons which that participant had viewed. The same pre-test survey was used throughout. In order that similar numbers of participants completed each set, the post-test sets were ordered into groups. So, the first 10 participants completed set 1, the second 10 completed set 2, and so on. In this way, it was expected equal numbers of participants would complete each set.

The icon information sheets went through many iterations with colleagues in environmental science, in order that the information presented was considered clear, concise and scientifically defensible. The workshop was then piloted with six participants from different demographic backgrounds recruited through a snowball sample. This gave the opportunity to test the pre- and post-test survey protocol, the content of the information sheets, and the timing of the workshop. The information sheets and the pre- and post-test survey wording were considered clear, although slight changes were made to the formatting of the survey Likert-scale questions. Although participants differed in the time taken to complete the workshop, no participant took longer than 30 minutes.

The workshop was held in the atrium of The Forum situated in Norwich city centre. The building houses the city library, a restaurant, cafés, and a museum. The Forum attracts a footfall of approximately 50,000 people per week (The Forum Trust, 2007), with the highest footfall occurring on Saturdays. The workshop was held on a Saturday in May 2007. Thus, a large cross-Section of the public was accessible for participation in the workshop.

The workshop was open between 9am and 5pm, so participants were able to join the workshop at any convenient time during the day. Individuals were randomly approached as they entered The Forum atrium and were provided with a minimum of information before they participated in the workshop. They were told that the workshop would take around 30 minutes, that it was about 'the environment', and that the first 100 participants allocated on an age/gender basis[39] would be given an honorarium of five pounds. The workshop facilitators identified themselves as from the University of East Anglia rather than from the Tyndall Centre for Climate Change Research.

A tape barrier was set up around Tables and chairs in a quiet Section of The Forum atrium. Participants were asked to contribute their views and opinions, and not to consider the workshop a 'test'. Participants were able throughout to ask one of the three facilitators if they required assistance. Participants were seated and handed the pre-test survey and given as much time as they wished to complete it. Participants generally took between 5-10 minutes to complete the pre-test. When participants had finished, the pre-test was collected and they were given the icon sheets corresponding to their set number and given around 10 minutes (or longer if they wished) to look over the four information sheets. After this time, the participants were given the post-test corresponding to their set number, but retained the icon information sheets. Participants were then given as long as they needed to fill in the post-test; on average taking between 10-15 minutes.

7.3 RESULTS AND ANALYSIS OF THE EVALUATIVE WORKSHOP: PART ONE

A total of 153 participants completed the workshop with 147 participants completing both pre- and post-test surveys, a usable response rate of 96.1%. Pre-test surveys without accompanying post-test surveys were omitted from the analysis. The results were analysed using means, ranges and standard deviations to describe the central tendencies and variance of the data. The impact of the icon information tests was analysed using Wilcoxon matched-pairs signed-rank test, in order to compare participants' engagement before and after seeing the icon information.

[39] An incentive budget of £500 was available. In order to encourage both male and female participation across the seven age groups, the first seven male/female participants' from each age range received an incentive. Recruiting females aged 65+ proved very difficult; recruiting males 25 or under straightforward. Thus this system helped to encourage participation across gender and age groups.

7.3.1 Statistical considerations

Nine sets of icon data were used in the analysis. In all, 53 participants took part with no incentive, over and above the 100 participants receiving an incentive. In addition to this, there were six unfinished post-test attempts. Thus, unequal numbers of post-test surveys were obtained for each of the nine sets.

This does not affect analysis of the pre-test data, as all the pre-tests were the same. It also does not affect questions 1 to 8 of the post-test, as the questions are identical in all sets. However, this could present two difficulties with using the different icon data from questions 9 to 20 of the post-test sets. First, it is not statistically defensible to weight ('gross up') the data based on the number of participants per set, as some set participant sizes are too small. For example, although more participants saw the polar bear icon than the ocean acidification icon, it is not defensible to gross up the ocean acidification data based on the smaller total viewing participants (or, conversely, to lessen the weight of the polar bear icon). This is countered here by reporting participant responses as a percentage of the participants that saw the icon, rather than as a percentage of the total number of participants. In the majority of cases this distinction would not change the ranking of icons for each question, but the convention is followed for statistical thoroughness. Note that percentages across a question will not therefore sum to 100%.

The second statistical difficulty is more subtle and could still apply with a larger participant sample size. The combination of icons seen could affect how likely it is that particular icons are chosen. In essence, is there a fixed ratio between the selection of each of the six icons (even if this ratio is not known) that stays the same, regardless of which two icons are removed to form the set? The presence of a fixed ratio was tested for using the Alymer test. Monte-carlo sampling revealed that there was no statistically significant relationship between the icons removed from a set and the likelihood of the participant selecting a particular icon[40].

All potential changes in attitudes between pre- and post-test questionnaires were tested for statistical significance. A statistical test was required that compared data from a study design that featured within subject variation of a matched pairs type. The parametric test requirements (in this case, a *t*-test) cannot be satisfied here. The *t*-test requires that data are interval-level. All the data used in the pre- and post-test questionnaires are measured on an

[40] Collaboration is ongoing in developing the Alymer test. See:
West, L.J. and Hankin, R.K.S. (in prep.) A generalization of Fisher's exact test. *Journal of Statistical Software*.

invented assessment scale (of the type 'mark on a scale from 1 to 5') and so are ordinal level data. Thus, a non-parametric matched-pair test, the Wilcoxon matched-pairs signed-rank test, was used. The non-parametric Wilcoxon matched-pairs signed-rank test carries at least 95% of the statistical power of the parametric equivalent (Coolican, 2004). Wilcoxon matched-pairs signed-rank test investigates the null hypothesis that the two populations from which the scores are sampled are identical. More specifically, Wilcoxon matched-pairs signed-rank tests if the medians from these two populations are equal. Of importance here is that it is only the *direction* of any change which is considered, rather than the *strength* of any change. With an ordinal style ranking system, one cannot justify that a change of 2 places (say, from scale rank 2 'quite worried' to scale rank 4 'very worried') is worth double that of a change of 1 place (say, from scale rank 1 'not at all worried' to scale rank 2 'not very worried').

Non-response rates for specific questions are not reported here. Any percentage values given in the following Sections are calculated only from participants who gave a response. In no case was the non-response rate to any one question higher than 6.5%.

7.3.2 Participant knowledge and perceptions of climate change

The pre-test questionnaire results are discussed first, before comparison of the pre- and post-test in the following Section. Results of both the pre- and post-test questionnaire are provided in Appendix 7.4.

A majority of the participant group viewed climate change as a serious threat to either themselves or the natural world (Figure 7.1). Just 8% of participants stated climate change as 'not at all serious' a personal threat. Participants' viewed the threat of climate change on animals and plants as more serious than the threat to humans (on a 1-4 scale with 1 representing 'very serious' and 4 representing 'not at all serious', the mean score for threat to animals and plants was 1.71, SD 0.71; the mean score for threat to humans 2.00, SD 0.78). The threat to the individual participant was seen as least serious (mean score 2.11, SD 0.80), with the threat to animals and plants in other countries considered most serious (mean score 1.36, SD 0.53). Participants also viewed the threat to other people in the UK and people in other countries as more serious than to themselves personally (mean scores of 2.08 and 1.59, and SD of 0.71 and 0.73, respectively). Lowe (2006) found similar results. His participant group were slightly less personally threatened by climate change than the icon participant group (mean of Lowe's control study participants was 2.51 on the same 1-4 scale for 'you and your family'). Lowe's study also found participants considered people in other countries slightly less threatened by climate change than found in the icon participant group (mean of Lowe's control study participants 1.55 on the same 1-4 scale for 'people in other countries')[41].

Participants generally thought climate change would be dangerous to them personally in around 25 years time (on a 1-6 scale with 1 representing climate change as dangerous 'now', 2 'in 10 years', 3 'in 25 years', 4 'in 50 years', 5 'in 100 years' and 6 as 'never', the mean score was 2.80, SD 1.43, Figure 7.2). Participants considered climate change would be dangerous to animals and plants before humans (mean score for humans 2.51, SD 1.31, mean score for animals and plants 2.02, SD 1.12). As with the question examining the threat of climate change, participants considered climate change would be dangerous to others – in their local communities, the UK and to people in other countries - sooner than to themselves personally. This is in agreement with the risk perception literature on 'unrealistic optimism' (Weinstein, 1980). Lowe (2006) asked the student sample when they considered climate change would be dangerous for 'people around the world'. He found the mean participant response considered there would be slightly longer until dangerous impacts were felt than the icon participant group (mean of Lowe's control study 2.49 on the same 1-6 scale for 'people around the world', compared to a mean score of 1.87 for 'people in other countries' in the icon participant group)[42].

The pre-test results revealed a participant group that was quite interested in climate change (mean score 3.37, SD 0.67, on a 1-4 scale from 'not at all interested' to 'very interested') and quite worried about climate change (mean score 3.04, SD 0.75, on a 1-4 scale from 'not at all worried' to 'very worried')[43].

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[41] Leiserowitz (in prep) posed a very similar question. Global warming was considered a very serious personal threat by a similar proportion of participants in each study (19% stated it was a 'very serious threat' in the US poll when asked 'how serious a threat is global warming to you and your family' compared to 22% asked 'how serious a threat is climate change to you' in the icon participant sample. The US sample considered global warming a less serious threat to people in other countries than the icon participant sample (US poll stating the threat 'very serious' 40%, the icon participant group 54%).

[42] Leiserowitz (in prep) again posed a very similar question. The proportion of participants considering global warming / climate change was already having dangerous impacts on people around the world was considerably larger in the icon participant sample. (US poll 30% compared to 51% of the icon participant group).

[43] Leiserowitz found when asked *'how much do you personally worry about global warming'*, Americans worried less than the icon participant sample (US mean 2.43, icon participant sample mean 3.04).

Figure 7.1 How serious a threat is climate change?

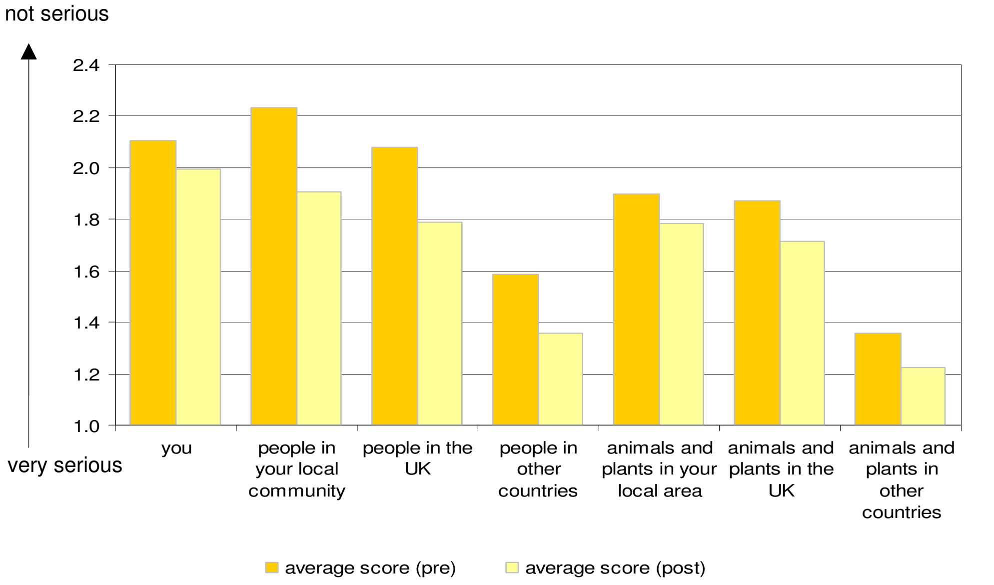
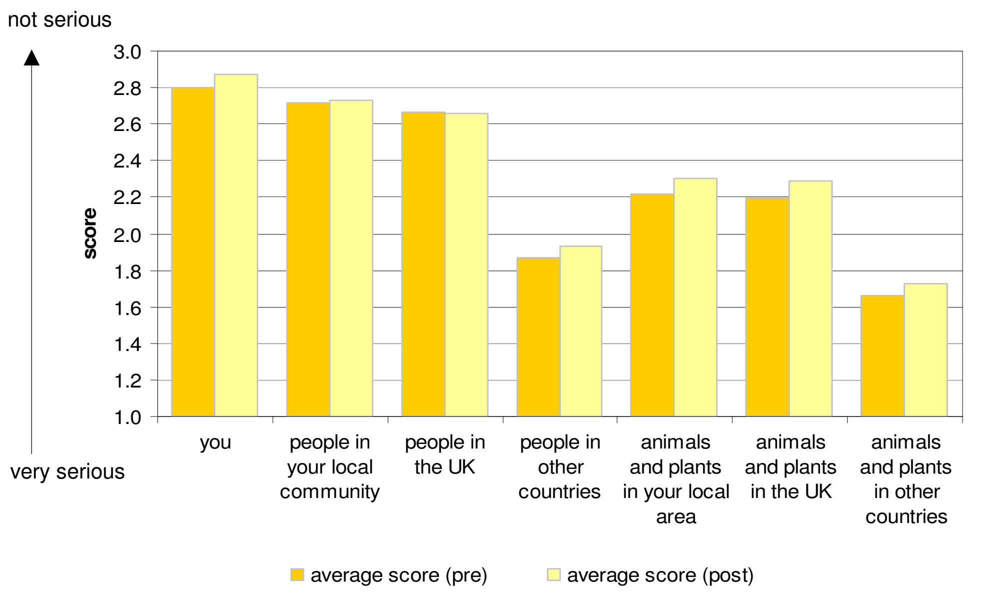


Figure 7.2 How dangerous a threat is climate change?



A battery of 12 questions examined participants' general attitudes towards climate change on a 5-point Likert scale, from 1 'strongly agree' to 5 'strongly disagree'. There was fairly strong recognition across the sample of anthropogenic climate change as an issue, with participants' tending to agree with the statement *'human activities are altering global temperatures'* (mean 1.68 SD 0.96) and tending to disagree with *'I don't think climate change is a real problem'* (mean score 4.19, SD 1.06). This contrasts with the findings of Whitmarsh (2005), where participants were far less inclined to think climate change was a real problem (Whitmarsh study mean score 2.74, SD 0.89).

Participants tended to disagree that too much fuss was made about climate change, although there is some considerable variation around the mean (3.78, SD 1.26). Lowe (2006) asked the same question and also found participants also somewhat disagreed that too much fuss was made about climate change (mean of Lowe's control study participants 3.37 but on a 1-4 scale from 'strongly agree' to 'strongly disagree' with no 'neither agree nor disagree' category'). There was some weak agreement amongst the icon participant group that the effects of climate change are likely to be catastrophic (mean score 2.27, SD 1.13).

It would appear that the participant sample felt at least slightly empowered to take action to abate climate change, with participants tending to disagree with the statement *'nothing I do makes any difference to climate change one way or the other'* (mean score 3.89, SD 1.13). Participants tended to agree that they personally felt a moral duty to do something about climate change (mean score 2.06, SD 1.04). This contrasts with the findings of Whitmarsh (2005), where participants were rather more inclined to feel a moral duty to address climate change (mean score 1.38, SD 0.83 on the same 1-5 scale). However, Whitmarsh found participants a little more ambivalent about whether anything they did would make a difference to climate change compared to the icon participant sample (Whitmarsh study mean 2.68, SD 0.81).

Participants were somewhat ambivalent about the statement *'I am well informed about climate change'* (mean score 2.50, SD 0.98). Lowe's (2006) sample perhaps considered themselves a little less informed about climate change (mean of Lowe's control study participants 2.79 but on the 1-4 scale with no 'neither agree nor disagree' category').

Participants in both the icon participant sample and Lowe's (2006) student sample were also somewhat ambivalent about whether the thought of climate change filled them with dread (mean score of this icon participant sample was 2.67 on the 1-5 scale; Lowe's control study participants mean score 2.79 but on the 1-4 scale from 'strongly agree' to 'strongly disagree', with no 'neither agree nor disagree' category').

Participants were inclined to agree that if they came across information about climate change, they would tend to look at it (mean score 1.97, SD 0.90). Whitmarsh (2005) found participants slightly more inclined to look at information on climate change than the icon participant sample (Whitmarsh study mean score 1.25, SD 0.66). Participants in the icon sample group were unlikely to think climate change was *'too complicated for me to understand'* (mean score 3.99 SD 0.96).

Participants were unlikely to think that *'talking about climate change is boring'* (mean score 3.91 SD 1.13). The sample were quite likely to talk to their family about climate change (mean score 1.99 on a 1-5 point scale from 'very likely' to 'very unlikely', SD 1.11). Similar values were obtained for how likely participants were to talk to friends and to colleagues. Relatively few participants were either 'very unlikely' or 'quite unlikely' to talk to friends, family or colleagues about climate change (the highest value obtained for participants considering they were 'very' or 'quite unlikely' to talk about climate change was that of 12% of participants to their colleagues). Within this sample at least, participants already appear to consider climate change a potential topic of conversation.

A majority (70%) of participants thought climate change was going to affect them personally. Twenty percent of participants thought climate change would not impact them, and nearly 10% of the sample said they didn't know if climate change would affect them personally.

7.3.3 Comparisons and conclusions of the pre-test

The comparison with Lowe (2006) indicates that his student sample considered climate change slightly less threatening. Lowe's (2006) sample also considered there would be a slightly longer timeframe until climate change was 'dangerous'. The student sample stated similar responses to the icon participant group for the attitudinal questions on 'fuss' and 'dread'. Some interesting contrasts were found with the participant sample of Whitmarsh (2005). Participants in Whitmarsh's sample were far less inclined to think climate change was a real problem, and were a little more ambivalent about whether anything they did would make a difference to climate change compared to the icon participant sample. However, Whitmarsh (2005) found participants slightly more inclined to look at information on climate change than the icon participant sample, and rather more inclined to feel a moral duty to address climate change. Several differences were found when comparing the icon participant sample to the nationally-representative US poll by Leiserowitz (in prep.). The US sample considered the threat of global warming to people in other countries a less serious threat than the icon participants. A significant proportion of the US poll also thought dangerous impacts of global warming were not yet being experienced around the world compared to the icon participant sample. However, a similar proportion of participants considered global warming / climate change a very serious personal threat.

A majority of the participants considered climate change a threat to either themselves or the natural world. On average, climate change was considered a personal threat in around 25 year's time. Climate change was considered more dangerous for animals, plants and other people, in agreement with the risk perception literature on 'unrealistic optimism' (Weinstein, 1980). Participants were generally quite interested and quite worried about climate change.

The pre-test questionnaire results indicate a participant group who generally recognise climate change as an important issue. The participants are ambivalent about how much they know about climate change, but as a sample group are somewhat inclined to further their knowledge of the issue. The participants tended to consider there was a moral duty to act on climate change. Participants were ambivalent about whether climate change filled them with dread, but there was some agreement that climate change impacts would likely be catastrophic. Participants were slightly empowered to take action to abate climate change, and were already likely to consider climate change a potential topic of conversation.

7.4 RESULTS AND ANALYSIS OF THE EVALUATIVE WORKSHOP: PART TWO

7.4.1 Participant knowledge and perceptions of climate change

Participants thought climate change was a more serious threat after viewing the icon information (Figure 7.1) significant at $P < 0.05$ for all categories except 'you' (on a 1-4 scale, where 1 = very serious, 4 = not at all serious). It is noted that participants considered climate change fairly serious even before the intervention (see previous Section). This change in attitude towards the seriousness of climate change was particularly strong for 'people in your local community' and 'people in the UK' (Wilcoxon matched-pairs signed-rank test, $Z = -5.024$, $P < 0.001$, $n = 144$; and $Z = -4.193$, $P < 0.001$, $n = 144$ respectively). Similarly to the pre-test, participants considered climate change a greater threat to other people than themselves. The personal risk category also experienced the smallest change in attitude after treatment, although the change is significant at $P < 0.10$.

The threat of climate change on nature and to humans was considered more serious after viewing the icon information. The threat to animals and plants in other countries was considered the most serious, with the mean concern of the sample on the 1-4 point scale, where 1 represented 'very serious' and 4 'not at all serious', increasing to 1.23 (SD 0.46) (Wilcoxon matched-pairs signed-rank test, $Z = -3.037$, $P < 0.01$, $n = 143$).

There was no statistically significant relationship between the pre-test and post-test scores across any of the human or animals and plant categories when examining the temporal 'danger' scale. There was also no statistically significant relationship between pre- and post-tests when examining how interested or how worried participants were about climate change or the proportion of participants who considered climate change would affect them personally. It is noted here too that participants were already quite interested and concerned about climate change before the intervention took place.

The repetition of the *general attitudes towards climate change* statements allows investigation into the use of icons generally[44] (both non-expert and expert) for climate change communication. Attitudes towards each statement were measured using Likert scale, from 1 'strongly agree' to 5 'strongly disagree'. Some statistically significant changes in attitudes were observed (Table 7.1)

[44] An interesting extension to this research would be to test the cognitive and affective impact of the expert icons against the non expert icons specifically: i.e. half of all participants' view the expert icons, the other participants' the non-expert icons. Wilcoxon matched-pairs signed-rank test could then be used to investigate the statements examining general attitudes towards climate change under each treatment.

Table 7.1 Wilcoxon matched-pairs signed-rank test on general attitudes towards climate change

Statement	*Direction of change after viewing icons*	n	Z	P
The thought of climate change fills me with dread	agree more	142	-1.089	0.276
Too much fuss is made about climate change	disagree more	143	-3.192	0.001*
I feel a moral duty to do something about climate change	agree more	143	-1.186	0.235
I don't think that climate change is a real problem	disagree more	143	-1.748	0.081
Nothing I do makes any difference to climate change one way or the other	disagree more	143	-0.711	0.477
The effects of climate change are likely to be catastrophic	agree more	141	-2.365	0.018*
If I come across information about climate change I will tend to look at it	agree more	142	-2.863	0.004*
I am well informed about climate change	agree more	143	-1.368	0.171
It is already too late to do anything about climate change	disagree more	143	-1.489	0.137
Climate change is too complicated for me to understand	disagree more	143	-0.478	0.633
Talking about climate change is boring	disagree more	143	-0.999	0.318
Human activities are altering global temperatures	agree more	143	-0.365	0.715

* significant to at least $P < 0.05$

Icons are a useful tool for climate change communication. Participants agreed more strongly after viewing the icon information that if they came across climate information, they would tend to look at it (Wilcoxon matched-pairs signed-rank test, $Z = -2.863$, $P < 0.01$, $n = 142$); the participant sample mean increased from 1.97 (SD 0.90) to 1.83 (SD 0.80). Although this is a fairly small mean increase in score, it is a statistically significant change. This goes some way to demonstrating that an iconic approach utilising communications theory for icon presentation, as well as an imaginable timescale and mid-range emissions scenario (not even considering the impact of non-expert or expert icons) engaged this non-expert sample in viewing climate information.

There was a significant change in participants' views towards climate change as an issue after viewing the icon information. Significantly more participants disagreed that too much fuss was made about climate change (Wilcoxon matched-pairs signed-rank test, $Z = -3.192$, $P < 0.01$, $n = 143$; the sample mean decreased from 3.78, SD 1.26 to 4.01, SD 1.18). There was a slight change in the score of participants ranking the statement *'I don't think climate change is a real problem'* with participants tending to disagree more after viewing the icon information, although with lower statistical significance and greater disagreement for this statement than in the pre-test (mean pre-test score 4.19, SD 1.06, to post-test mean 4.33, SD 0.91, Wilcoxon matched-pairs signed-rank test, $Z = -1.748$, $P < 0.1$, $n = 143$). Taking these two results together, the use of climate icons for this sample group appears to increase the level of engagement with climate change.

Despite the careful use of language avoiding emotive statements and the 'fear rhetoric' (for reasons as outlined in Section 3.4.4) within the icon sheet narratives, participants were more likely to agree after seeing the icon information that the effects of climate change are likely to be catastrophic (Wilcoxon matched-pairs signed-rank test, $Z = -2.365$, $P < 0.05$, $n = 141$; the mean of the sample increased from 2.27, SD 1.13 to 2.06, SD 1.11). This result taken singularly may be of concern, especially if this impact is found to originate within the 'non-expert' icons as the iconic approach was intended to reduce the potentially paralysing impact of fear inducement, in order to promote meaningful engagement (as suggested by Nicholson-Cole, 2004). However, this does not appear to be the case, as illustrated through the examination of the qualitative responses to each icon (Section 7.4.4).

There was no statistical significance between the pre- and post-test data when investigating how likely participants were to engage in conversation with different groups of people.

7.4.2 Focussed icon engagement investigation

Participants' responses were gathered on five quantitative scales of understanding, interest, concern, fright and feelings about the future (Table 7.2). This data is also displayed in Figure 7.3.

Figure 7.3 Focussed icon investigation mean results

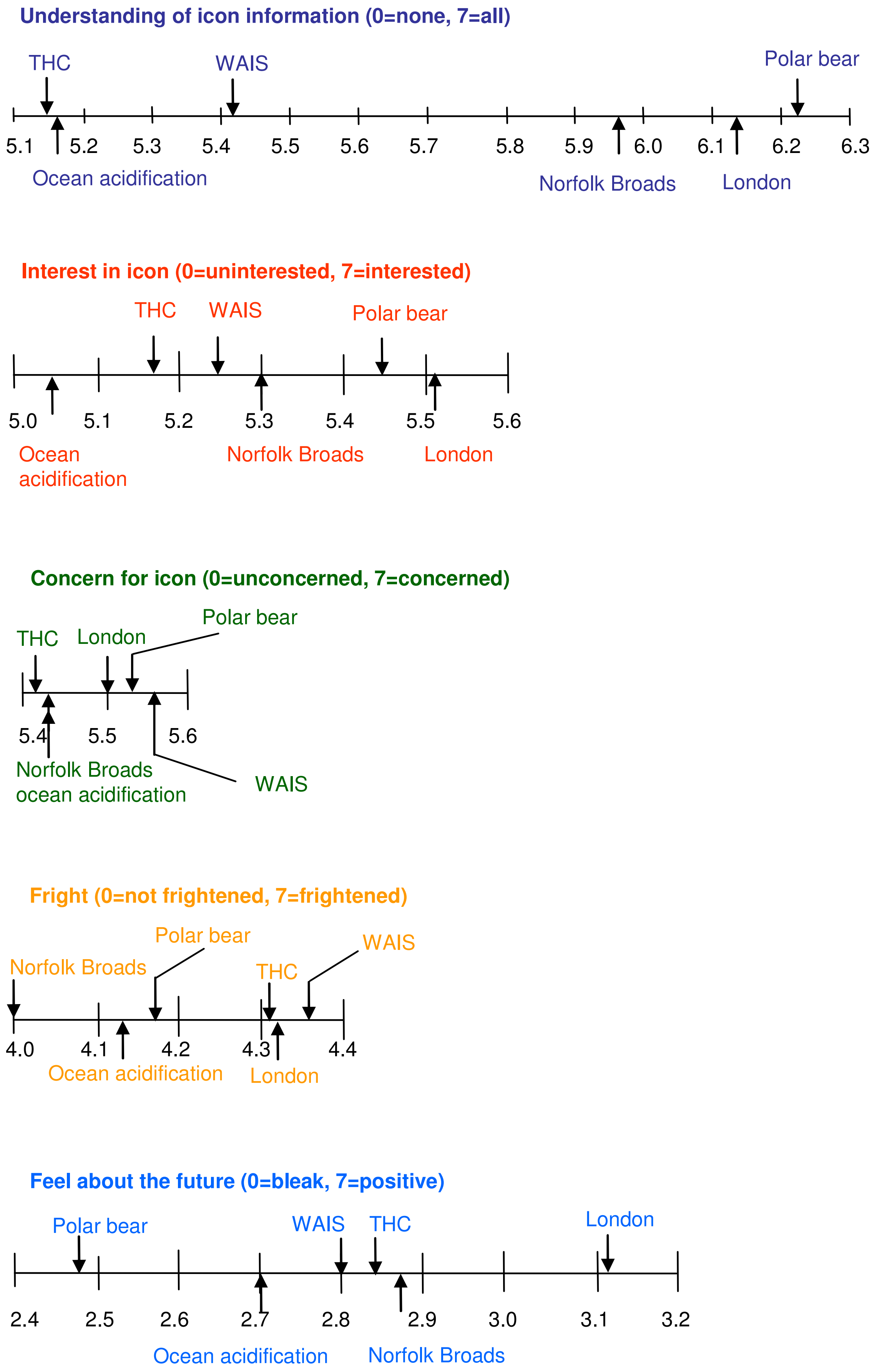


Table 7.2 Focussed icon engagement investigation responses

Icon	Understanding		Interest		Concern		Fright		Future*	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Norfolk Broads	5.96	1.20	5.30	1.73	5.43	1.71	4.00	2.01	2.88	1.57
London	6.13	1.10	**5.51**	1.67	5.50	1.71	4.32	2.09	**3.11**	1.67
Polar bear	**6.22**	0.91	5.45	1.50	5.54	1.51	4.17	2.04	2.48	1.79
THC	5.14	1.53	5.17	1.85	5.41	1.09	4.31	1.94	2.84	1.58
Ocean acidification	5.16	1.48	5.04	1.63	5.43	0.93	4.13	1.93	2.70	1.52
WAIS	5.41	1.41	5.24	1.80	**5.57**	0.99	**4.36**	2.17	2.80	1.72

* Mean from pre-test 'how do you feel generally about the future?' was 6.11

Results for understanding, interest, concern and fright on a 1-7 scale where 1=smallest, 7=greatest; results for future on a 1-7 scale where 1=bleak and 7=positive. Figures in bold highlight the highest mean per question.

Participants first stated how well they felt they had understood the icon information sheets (Figure 7.4). Overall, the icon information sheets appeared quite well understood (mean 5.67, SD 1.27 on a 1-7 scale from 1 'understood none of it' to 7 'understood all of it'). There was some variation between the icons. Most obvious is the difference between expert and non-expert icons; with the non-expert icons better understood (mean 6.10, SD 1.07) than the expert icons (mean 5.24, SD 1.48). The most well understood icon was polar bears.

Participants were asked to rate how they felt on three scales of uninterested to interested (Figure 7.5) unconcerned to concerned (Figure 7.6) and frightened to not frightened (Figure 7.7). Participants were most interested in the three non-expert icons (non-expert icons group mean 5.42, SD 1.63 on a 1-7 scale from 1 'un-interested' to 7 'interested') London, polar bears and Norfolk Broads. Participants were less interested in the expert icons (group mean 5.15, SD 1.76), and least interested in ocean acidification. The mean level of concern was fairly consistent across all icons (range 0.16).

There was no trend between the feeling of fright experienced when viewing an expert or non-expert icon (overall between-icons mean range 0.36 on a 1-7 scale from 1 'not frightened' to 7 'frightened'). The most frightening icon was WAIS, followed by London and THC. The least frightening icon was the Norfolk Broads. There was considerable variation in response to this question as evidenced by the larger standard deviations.

Figure 7.4 How much of the icon information sheet did you understand?
Score based on a 1-7 rank scale

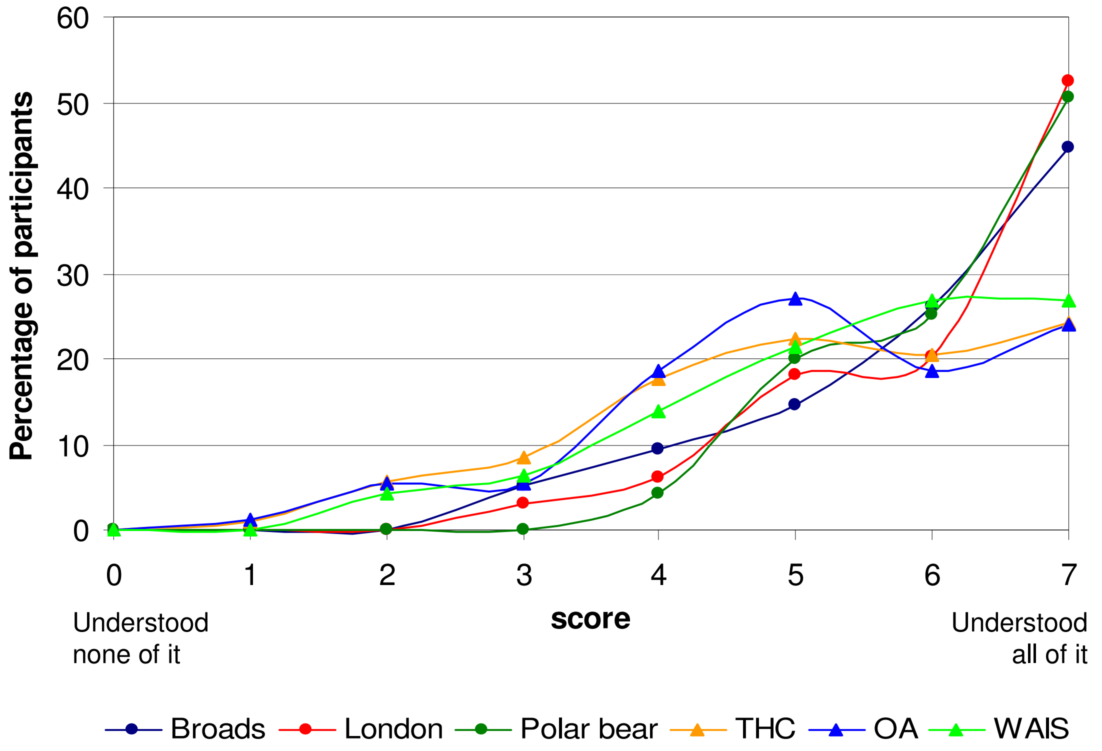


Figure 7.5 How did the icons make you feel: interest
Score based on a 1-7 rank scale

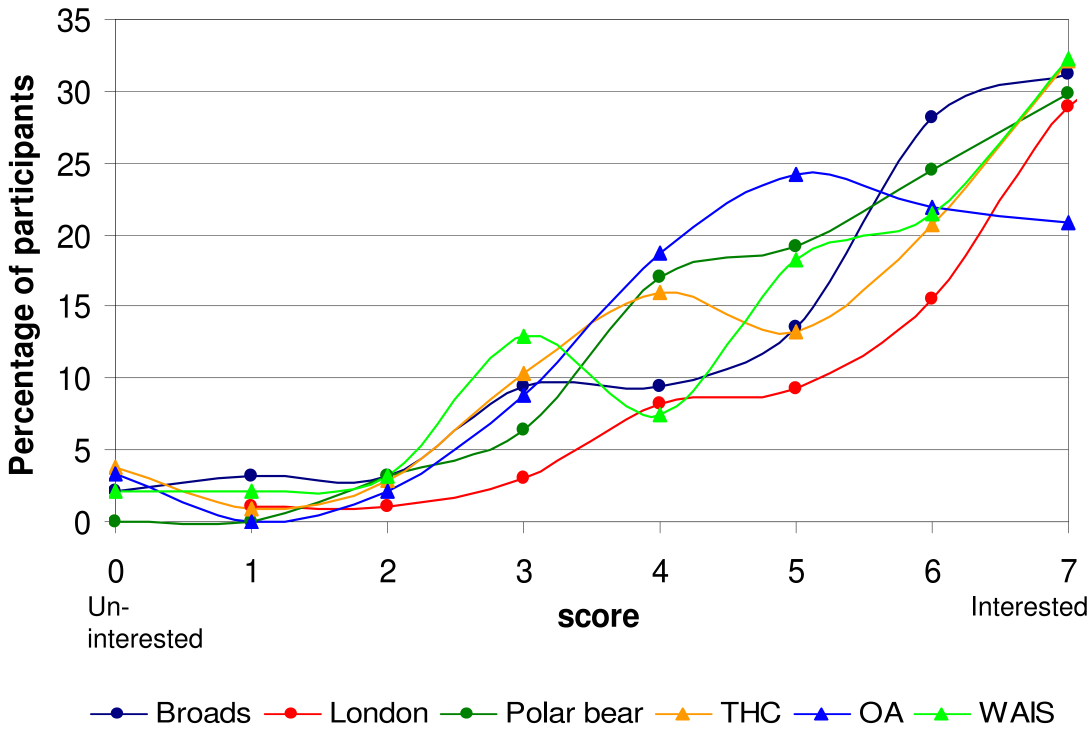


Figure 7.6 How did the icons make you feel: concern
Score based on a 1-7 rank scale

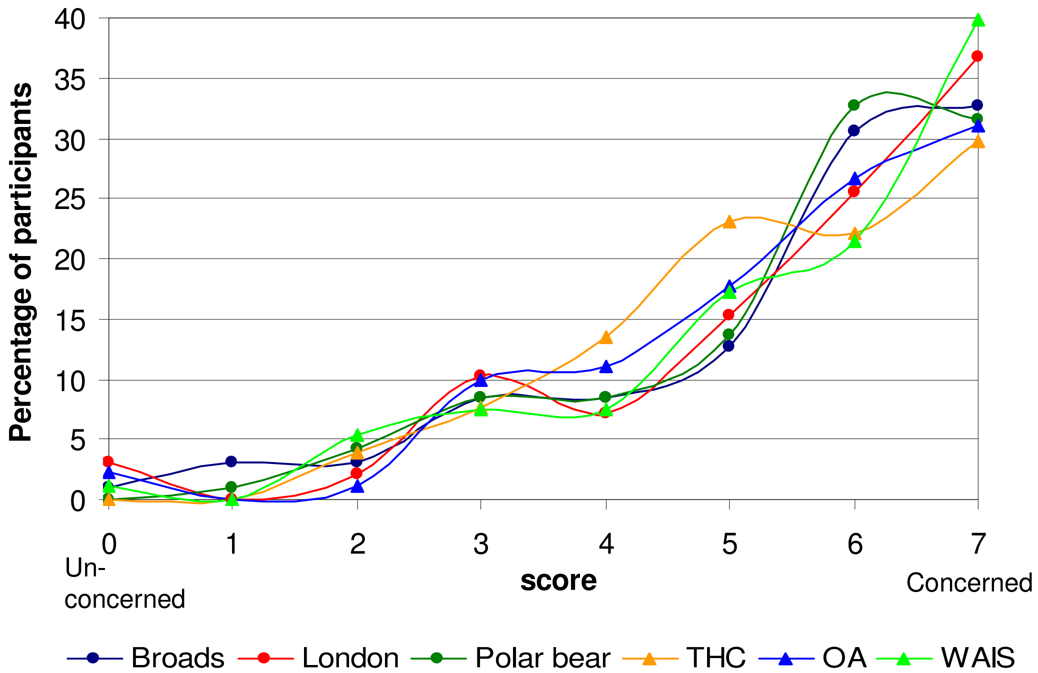


Figure 7.7 How did the icons make you feel: fright
Score based on a 1-7 rank scale

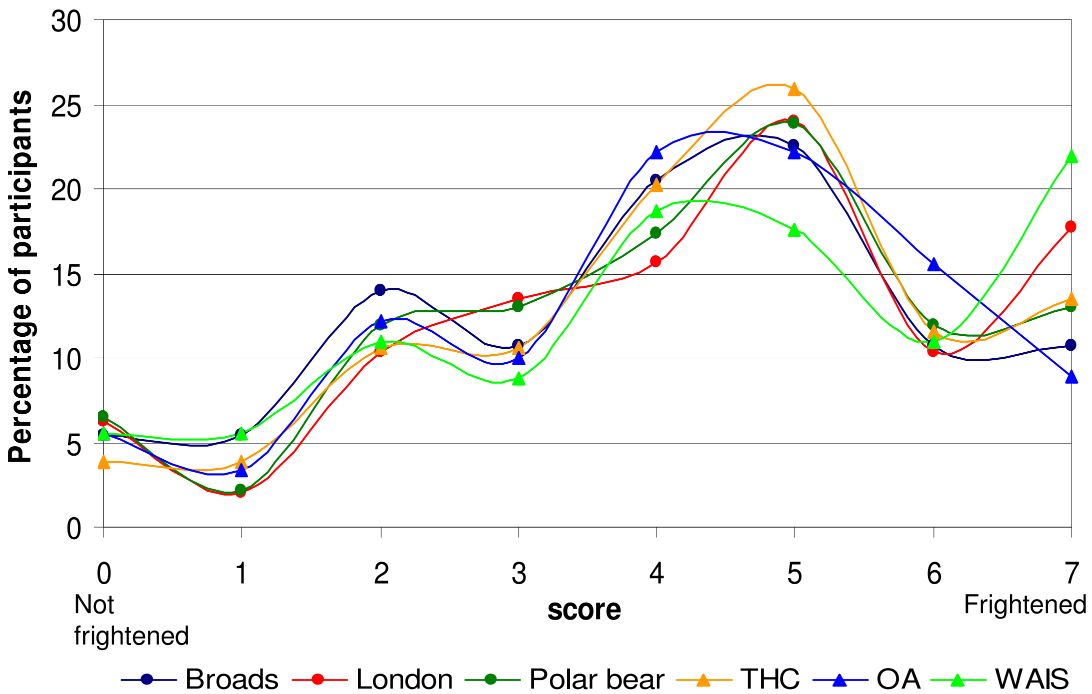
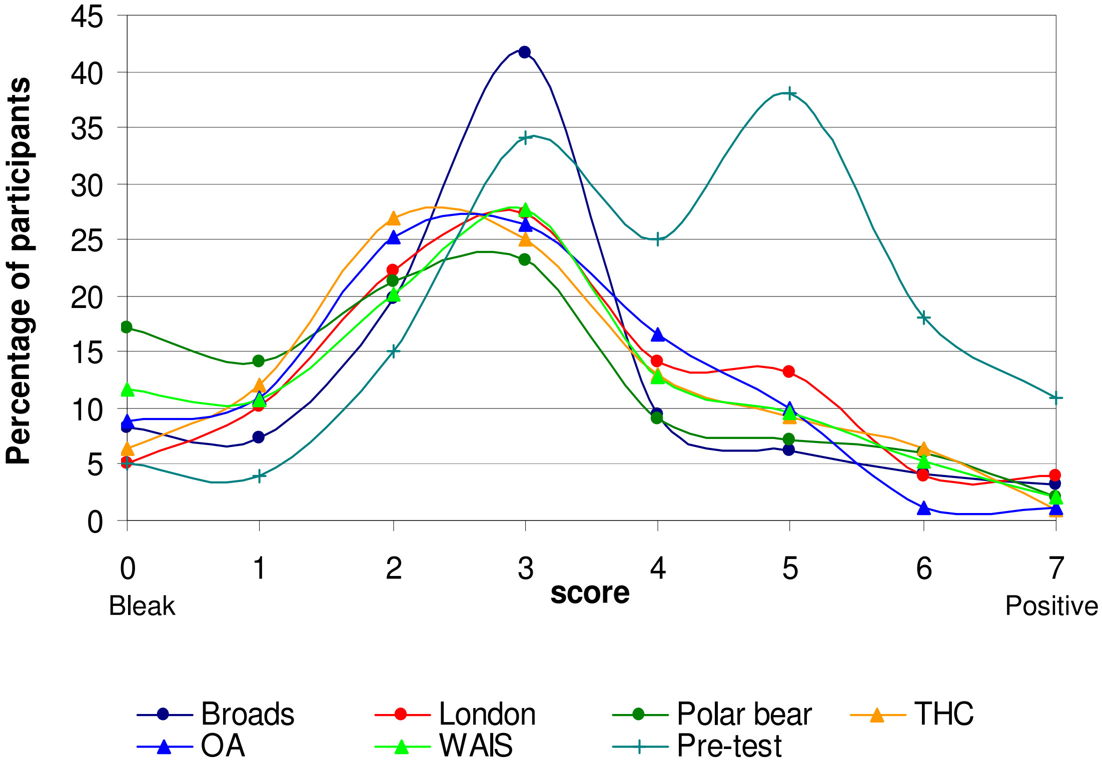


Figure 7.8 How did the icons make you feel generally about the future?
Score based on a 1-7 rank scale



The majority of participants felt generally quite positive about the future in the pre-test (mean 6.11, SD 1.68 on a 1-7 scale from 1 'bleak' to 7 'positive'). When asked in relation to the icons, participants felt much less positive about the future (mean of all icons 2.80, SD 1.64). There was a relatively large score range between icons (range 0.63, SD 1.67) with polar bears causing the bleakest response, and London the most positive[45]. The positions of the non-expert icons on the 'future' scale (Figure 7.8) are intriguing. A hypothesis is considered that participants feel they have greater control over the two more local non-expert icons (Norfolk Broads and London) and hence felt a greater efficacy for the future of these icons. A smaller degree of personal control may be perceived over the future of the more spatially distant non-expert icon (polar bears) and hence lead to less positive feelings about the future in light of this icon. This corresponds to research on non-expert risk perceptions and attitudes within a dread risk / unknown risk factor space (Slovic, 1987; see Figure 7.9). Factor one 'dread risk' is the most important factor. The

[45] Although London scored highest on the 'fright' scale, as stated above, there was a substantially smaller range between icons on this scale compared to the 'future' scale. Additionally, there was considerable variability on the 'fright' scale responses. Thus, the 'fright' scale was not considered further in relation to the 'control' hypothesis discussed for the 'future' scale.

higher a hazard scores on this factor (i.e., the further to the right it appears in the space), the higher its perceived risk, the more people want to see its current risks reduced, and the more they want to see strict regulation employed to achieve the desired reduction in risk (Slovic, 1987). Factor one is defined at its high end by a lack of perceived control and dread, amongst other risk factors. Factor two 'unknown risk' is defined at its high end to be unobservable and unknown amongst other risk factors. A third factor observed in several studies quantifies the number of people exposed to the risk (Slovic, 1987). This third factor is not depicted in Figure 7.9, but it is apparent in some participants' icon selection reasoning.

Figure 7.10 illustrates which icon participants felt is most relevant to four different peoples: themselves, their local community, people in the UK and people in other countries. There was some variation in participants' choice of the most personally relevant icon, though the most popular choices were the non-expert icons Norfolk Broads and London. The least popular choices were the non-expert icon polar bears and the expert icon ocean acidification. A majority of the participants considered the most relevant icon for their local community to be the Norfolk Broads. There are two clear selections for the icon most relevant to people in the UK, London and the Thermohaline Circulation. The icons considered most relevant to people in other countries are the three expert icons the THC, ocean acidification and the West Antarctic Ice Sheet. There are two interesting conclusions within these results. First, participants generally considered the non-expert icons most relevant to them and their local community, and the expert icons more relevant for people in other countries; and second, polar bears were considered the least relevant icon across all groups scoring a maximum of just 7% in the personal and international categories.

Figure 7.9 Location of hazards on Factors 1 and 2 derived from the interrelationships among 15 risk characteristics as detailed at the end of each axis. From Slovic (1987).

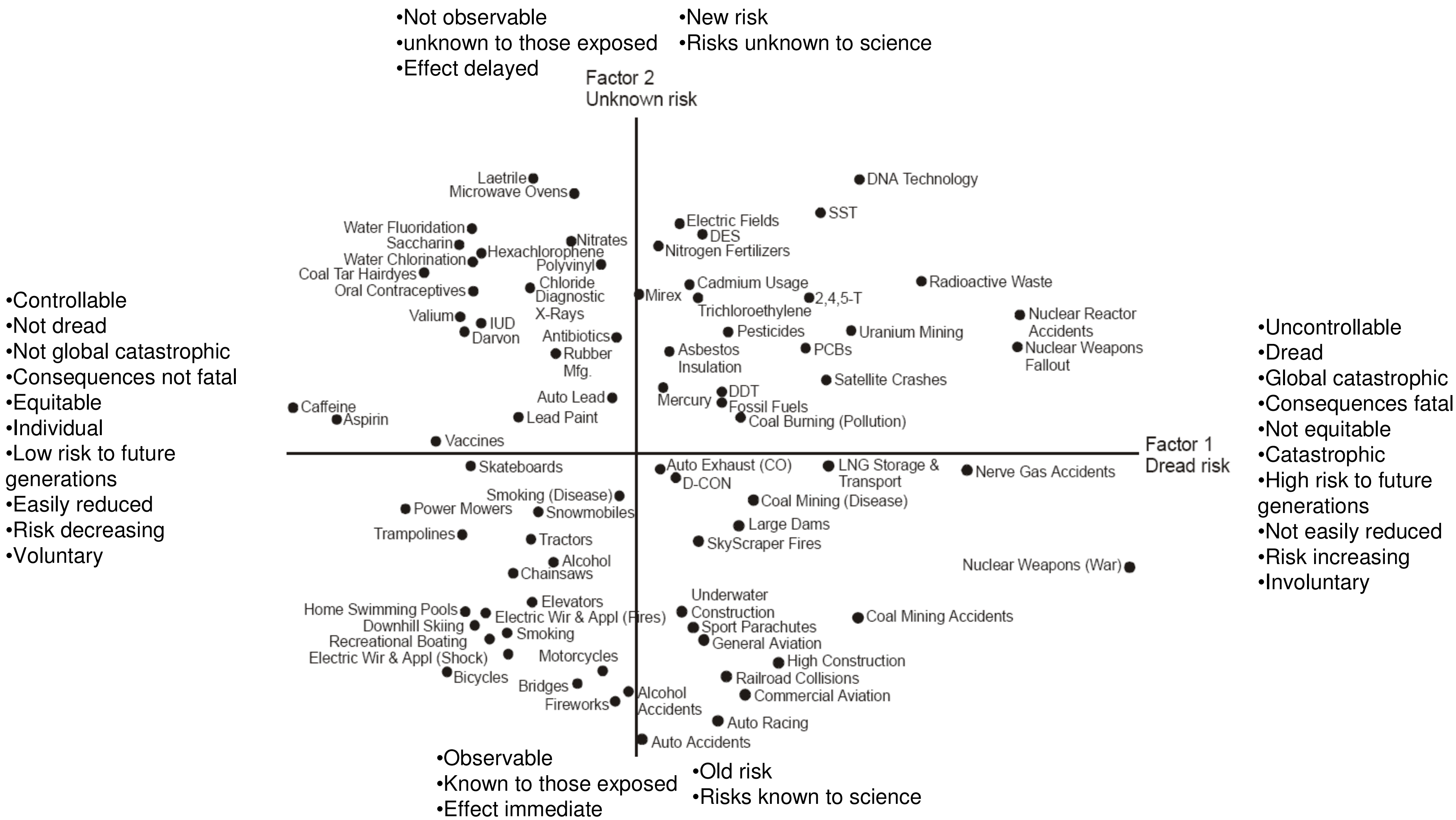
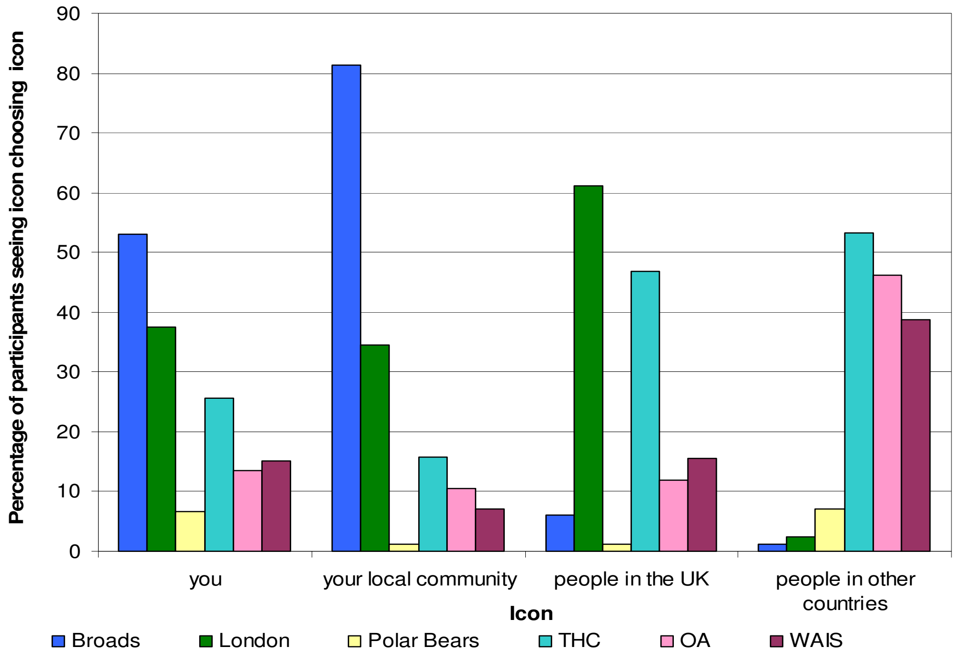


Figure 7.10 Which icon do you feel is most directly relevant?



7.5 OPEN-ENDED ICON ENGAGEMENT INVESTIGATION

The previous Section provided an insight into the quantitative closed attitudinal perceptions for each of the icons. Also of interest, though, is participants' open-ended qualitative reasoning behind icon selection. When presented with both expert and non-expert icons, which icon were participants most drawn to? More importantly, why were participants drawn to some icons and not to others? First, icons participants found they were most and least drawn to are examined, then the methodology for exploring the qualitative responses is explained. Lastly, the qualitative data are discussed in the context of icons for promoting engagement, and icons which may disengage.

7.5.1 Open-ended icon engagement investigation: quantitative responses

The quantitative responses to the most and least engaging icons are presented in Table 7.3. The polar bear was the icon picture participants were most drawn to. The Norfolk Broads and London icons were also selected by participants substantially more times than the three expert icons. The Norfolk Broads was the map which participants were most drawn to, followed by the London and THC map. Overall, participants were most drawn to the Norfolk Broads icon, followed by the polar bear icon. Participants selected the THC and ocean acidification icons substantially more than any of the other icons as the picture to which they were least drawn. The WAIS icon was selected considerably more than any of the other icons as the map to which participants were least drawn. Overall, participants stated they were least drawn to the ocean acidification icon, followed by WAIS. The qualitative reasoning behind icon selections is explored in the next Section.

Table 7.3 Responses to icons 'most drawn to' and 'least drawn to'

%	Norfolk Broads	London	Polar bears	THC	Ocean acidification	WAIS
Most drawn to:						
Picture	34	31	**42**	10	16	18
Map	**47**	35	13	30	17	5
Overall	**36**	27	34	24	17	11
Least drawn to:						
Picture	18	18	11	**41**	40	21
Map	16	15	28	22	25	**46**
Overall	25	23	18	12	**40**	32

Figures in bold highlight the highest icon percentage per category

7.4.4 Open-ended icon engagement investigation: qualitative responses

The qualitative responses to each icon selection response were fully transcribed and were entered into a spreadsheet containing participant details. NVivo (QSR International, 2002) was not used in this case as the volume of data was relatively small, and the spreadsheet design allowed easier comparison between question responses. Categories were generated both 'bottom up', with code names taken directly from the data; and 'top down', where certain categories were pre-defined before the coding took place (Section 5.4.1 provides a more in-depth discussion of the coding methodology used in this thesis). The data was coded iteratively until no new code names were generated. The qualitative responses obtained were necessarily brief owing to the space allocated on the questionnaire form. Responses ranged from one word answers to one or two sentences. Again, as for the coding performed for icon selection (Chapter five), a reviewer was asked to independently code the overall 'most' and 'least drawn to' qualitative icon data. The reviewer stated some codes could be combined if categories were to be condensed, but there was deemed no advantage to combining the categories and thus they were kept separate.

7.4.4.1 Icons which engage

The most common reasoning for selecting an icon picture when asked which they were most drawn to was because participants felt they could personally relate to the icon. Many participants who selected the Norfolk Broads used this form of reasoning:

> *'realising how vulnerable we are in Norfolk'* (participant 75) or:
> '*local and relevant to here'* (participant 120)
> *'because I live in Norfolk and this is my area'* (participant 16)

Similarly, many participants felt that they were drawn to the London icon:

> *'because [I] am familiar with the area'* (participant 38) and as it is:
> *'very identifiable, helps to understand enormity'* (participant 40)

Participants also stated an emotional connection with the icon as their reasoning. For example, several people stated the Broads as the icon picture they were most drawn to as it depicted an *'idyllic scene'* (participant 132) to which they could relate. Polar bears were cited most as the icon image participants were drawn to, for the participants that saw this icon. Two rather different strands of reasoning were attached to this choice. One line of reasoning was empathy with this charismatic mega fauna, for example:

> *'because it is a big fluffy polar bear'* (participant 46)

Others reasoned that they selected polar bears because they represented:

> *'the idea of pure environment and fragile environment most affected by change'* (participant 56)

Of the participants' that saw the Broads information sheet, almost half chose it as the icon map they were most drawn to. Typical reasons for choosing this map were:

> *'I can imagine these areas water covered'* (participant 56) and
> *'it is of local interest and concern'* (participant 6)

Similar reasons existed for participants choosing the London map as that which they were most drawn to. It is of note that a significant proportion of respondents were most drawn to the THC or ocean acidification maps, despite them both representing expert-led icons (both maps are from the Fourth Assessment Report; IPCC 2007b). A small proportion of participants selected the map as it demonstrated the global impact of the icon, using reasoning such as it represented a *'clear world effect'* (participant 129). However, the majority of explanations were due to both maps' red colours:

> *'looks so hot, really really bad'* (participant 13) and because:
> *'it seems the most dramatic / scary possible change'* (participant 101)

This reasoning demonstrates why the survey protocol asked for opinions on the image and map first, and why participants were asked to explain why they chose particular icons. In some cases, participants responded directly to the presentation device of the icon information (in this case, red signalling 'danger') rather than to what the icon may represent to the participant, despite attempts to minimise the impact of the communication devices.

Generally, participants were more drawn to the non-expert icons, although a proportion of participants were drawn to the expert icons. Participants who chose the Broads and London followed similar lines of reasoning to that seen in the earlier responses:

> *'because it is our home and one day it will affect my children and my friends' children'* (participant 2) or:
> *'because it is so local'* (participant 14) and because it:
> *shows people how climate change will directly impact on their lives'* (participant 55)

Participants chose polar bears again for similar reasons: because the icon is:

> *'easily understandable, tangible'* (participant 89)

The THC was chosen because:

> *'it seems "global" rather than specific'* (participant 148)

Again, the THC was chosen because of the dramatic nature of the icon as perceived through the map.

7.4.4.2 Icons which disengage

The majority of participants were least drawn to the expert icon pictures, in particular the ocean acidification and THC icons. The reasoning for this coded into fewer categories than seen with the previous questions. Participants felt that the icons were difficult to understand:

> *'too scientific'* (participant 150)
> *'more complicated'* (participant 58)

Of note is that the icons:

> '*doesn't tell so much of a story* (participant 83)

Participants felt these icons were:

> '*too vast and global, feels remote and impersonal'* (participant 31) and:
> *'more schematic, less real'* (participant 31)

Participants also commented directly on the imagery used:

> *'couldn't work out where map is – strange, unfamiliar angle'* (participant 132)

Of those that saw the WAIS information sheet, almost half of them chose it as the icon map they were least drawn to. Participants commented that the WAIS map was

> *'boring'* (participant 11) and individuals:
> *'found it more difficult to understand'* (participant 106)

Some participants commented that it was difficult to distinguish any difference between the two timescale maps. Participants also commented for all three expert icons that it was harder to engage with the icon because it was not perceived in a knowable spatial dimension:

> *'you can always put it to the back of your mind because of the distance'* (participant 105) or:
> '*it is not specific to a place I recognise'* (participant 41)

Some participants also found the polar bear icon map difficult to understand, commenting it was:

'hard to understand immediately' (participant 89)

There is less variation in icon selection for the icon participants were least drawn to compared to the icon participants were most drawn to. The majority of participants stated an expert icon as the one to which they were least drawn, in particular, stating ocean acidification and WAIS. Reasoning was similar to that previously cited. Participants stated:

'complicated to understand' (participant 50) or:
'most technical' (participant 84) or
'don't see the immediate impact' (participant 70)

Again, participants commented that there was:

'nothing on the article to really connect people with the problem' (participant 151)

In correspondence with the literature (Lorenzoni and Pidgeon, 2005), it appears many participants' feel an icon needs to connect them in knowable spatial dimensions in order to engage their interest. However, this reasoning was also used by participants to state why the icon was disengaging. A proportion of participants felt they were least drawn to the non-expert icons the Broads and London, with similar reasoning to this participant:

'will only effect locals, and is not as much as a global issue' (participant 141)

Participants also commented that their selected non-expert icon:

'seemed more manageable' (participant 71)

This links back to the hypothesis proposed on the 'controllability' of icon futures. Here, a perception of control over the non-expert icon exists, which acts to make this icon less engaging for this participant.

Though some commented that the loss of polar bears was sad, it called for an emotional response that sometimes did not appeal:

'Works on sentiment (or not!) (participant 45)

'Sorry to lose them, but there are many more serious impacts to worry about' (participant 112)

7.4.5 Open-ended icon engagement investigation analysis

When coding was complete, codes were sorted into groups, as illustrated in Figure 7.11. Three overriding themes emerged from the data:

- *Understanding*

The 'most drawn to' responses coded here illustrated how participants felt the icon aided in their understanding of climate change. This increased understanding was in some cases attributed to the particular graphics (image or map) in the icon information sheet. In other cases participants noted how the icon was novel to them and thus increased understanding. The 'least drawn to' responses often stated the icon was too scientific or complex to understand. In some cases, participants who had already had knowledge of the icon stated it did not add to their understanding of climate change (i.e. the icon was not novel).

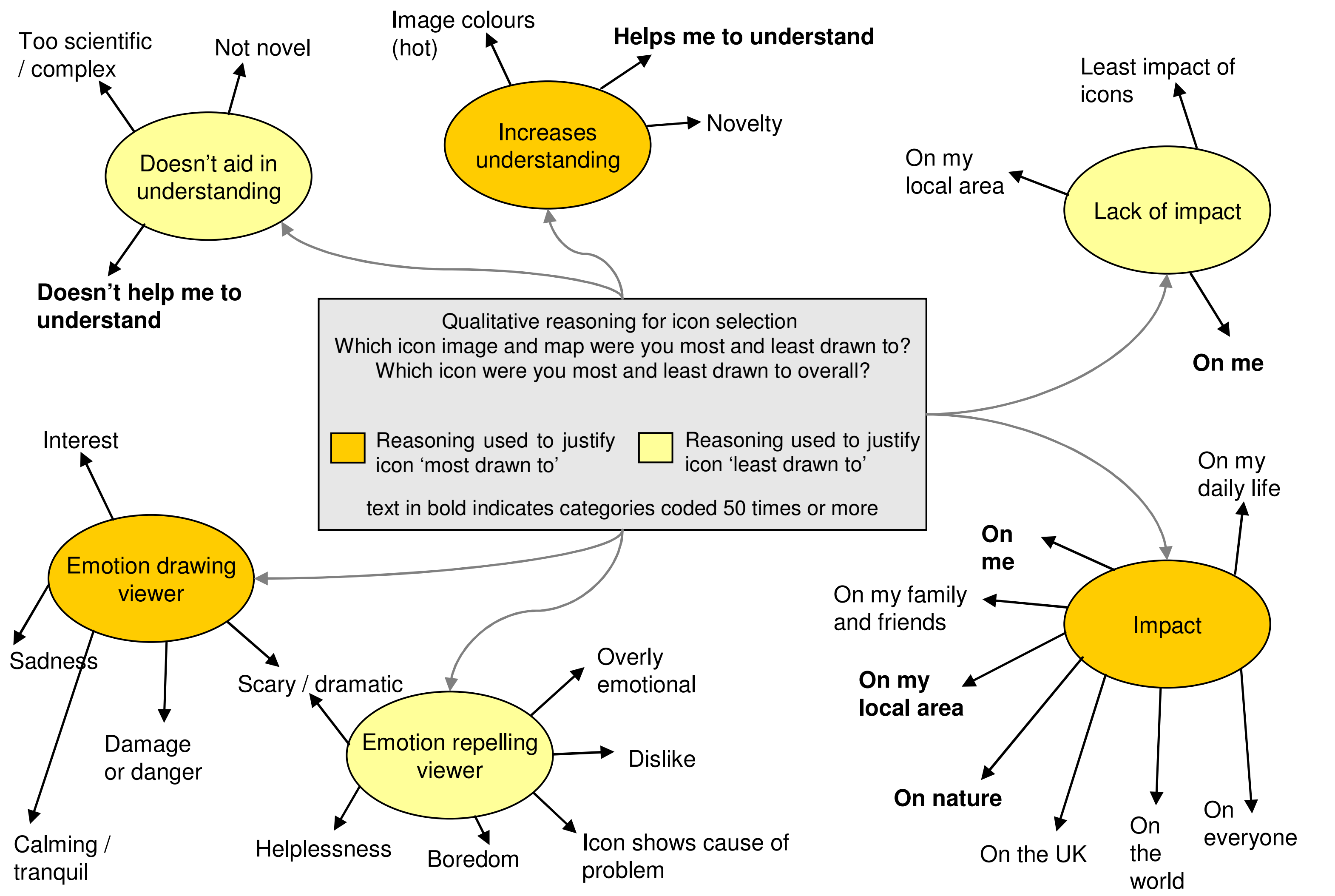
- *Emotion*

The 'most drawn to' responses under this code exemplified how an emotional response such as sadness or danger connected participants with the icon. The 'least drawn to' responses stated how participants felt emotions such as helplessness or boredom in response to the icon. Some participants stated that they simply disliked the icon. The one code that contained both 'most' and 'least' drawn to responses was 'scary / dramatic'. Some participants felt this drew them towards the icon, others found it disengaging.

- *Impact*

This group coded for the greatest number of responses. In particular, important connections for participants in the 'most drawn to' responses were for icons which impacted on them, their local area or on nature. The lack of impact on individuals was also important for responses in the icons participants found they were least drawn to. Also noteworthy is the proportion of responses that stated there was the smallest impact on the icon (at least, under this timeframe and emissions scenario) and so engaged them the least.

Figure 7.11 Coding categories from the qualitative icon engagement investigation analysis



7.5 DEMOGRAPHIC INFLUENCES

The workshop recruitment design sought to recruit participants from a wide demographic. This was achieved, with 48.4% males and 45.1% females taking part, (6.5% non-response rate); and a spread across the age ranges from a minimum of 14.0% participation in the 65+ age group to a maximum of 19.6% in the 35-44 age range (6% of participants declined to answer this question). Participants were mainly Norwich residents (73.2%), with 82.5% residing in the Eastern region (with a 13.7% non-response rate). Over half of all respondents earn £19,999 or under, which is somewhat less than the 2006 UK average of £23, 224 (National Statistics, 2006). The sample represents a fairly educated cross-Section, with over 40% of participants holding an undergraduate degree, although this dropped to under 20% holding a degree in a science-related subject. Just under a quarter of participants were members of an environmental organisation, with the RSPB supported by the largest proportion of participants. Only two participants cited support for the climate change specific environmental organisations Rising Tide or Campaign against Climate Change. Those taking the survey, especially those who took part despite not receiving an incentive, may have been a more environmentally-conscious group[46]. This may impact the data for the non-icon questions such as participant concern, but it was not the aim of the survey to assess overall attitude to climate change. Pre- and post-test surveys were undertaken to investigate any potential change in participant attitudes, rather than to examine their perceptions of climate change *per se*. For the full demographic breakdown, refer to Appendix 7.4.

The demographic data was not collected to statistically examine differences in icon selection specifically: climate communication methods increasingly value the targeting of population 'segments' (where a segment is as a group of individuals bound by a shared range of values, beliefs and behaviour) rather than population demographic details *per se* (Ereaut and Segnit, 2006; Moser and Dilling, 2007). However, some of the demographic data was examined in conjunction with the open-ended icon investigation questions to investigate general trends[47] across the gender, age range and highest science qualification categories. Generally, there appeared few trends across the demographic groupings when examining expert and non-expert icon selection. For example, there were no trends

[46] Indeed, this statement is corroborated by the response to question 27 'which political party are you most likely to support?' Support for Labour, Liberal Democrat and Conservative Parties in the sample was between 13% and 17%, but there was over 30% support for the Green Party. It is unclear whether this is local and/or national-level support. Norwich has a strong Green Party presence (10 of 39 City Councillors in 2007) but the Green Party impact was less pronounced at the 2005 General Election (taking just 2.7% and 7.4% of the vote in Norwich North and South respectively).

[47] Specific research questions, such as 'are males under 25 years old drawn to expert icons rather than non-expert icons?' cannot be investigated here as sample sizes are too small.

apparent when examining the icon data by gender. Two trends that may warrant further investigation are discussed below:

- *Age and selection of local icons*

The Norfolk Broads were selected by 40% of the 16-24 age group as the icon they were least drawn to. For this age group, the other icons each received between 10-15% of the sample. This result is surprising because the Broads was selected by the greatest number of participants overall as that to which they were most drawn to. Whilst the Broads is a salient icon to many, it may not resonate so well with younger participants.

- *Highest scientific qualification and selection of expert icons*

The icon data was examined in relation to participants' highest science qualification. As the reasoning behind icon choice has demonstrated, the expert icons are often dismissed by participants as 'too complicated' or 'too technical' to engage. A hypothesis could therefore be considered: participants with a lower level of science education may be less likely to choose the expert-led icons as those to which they find most engaging.

Participants with no formal science qualifications were likely to pick a non-expert icon as the one they were most drawn to (73% of participants chose a non-expert icon). This participant group were also fairly likely to choose an expert icon as that to which they were least drawn to (63% selecting an expert icon). In contrast, participants with an NVQ or vocational degree or higher in a science-related subject (including undergraduate and postgraduate degrees) were not as likely to pick a non-expert icon as the icon they were most drawn to as those with no formal scientific qualifications (55% selected non-expert icons, 45% expert icons). Also, the trend for choosing an expert icon as the 'least drawn to' icon was reversed for the participant group with an NVQ or higher in a science-related subject compared to those with no formal scientific qualifications (63% selected a non-expert icon).

7.6 CONCLUSIONS

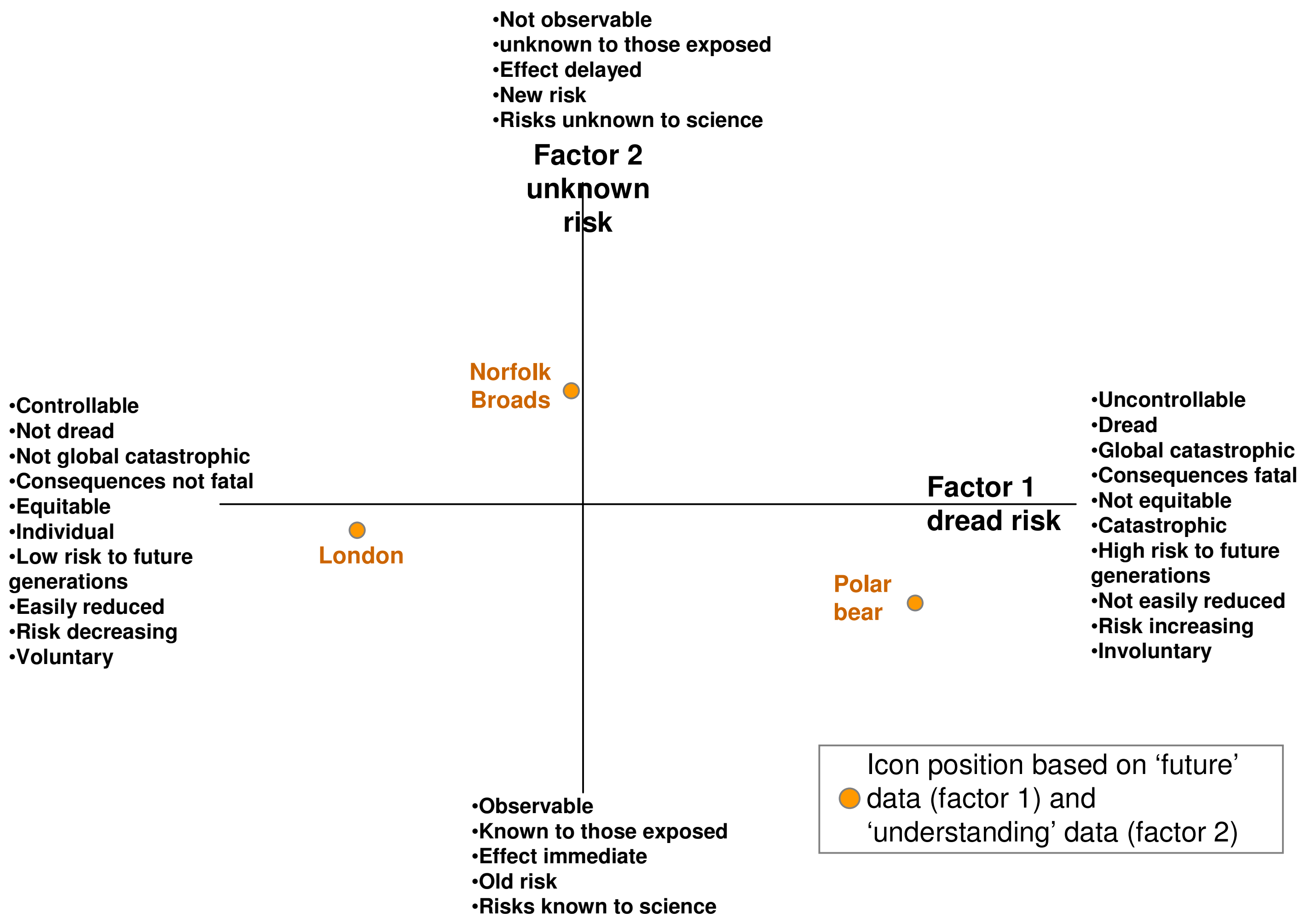
The iconic approach itself provides a useful tool for communicating climate change. Participants were more engaged with climate change after viewing the icon information. They viewed climate change as a more serious issue, they were more likely to engage with information about climate change, and they were more likely to consider climate change a real problem.

Interesting intra- and inter-relationships were found within the non-expert and expert icons. All the icons were well understood by participants, with the non-expert icons all substantially better understood than the expert icons. Interest in all the icons was also reasonably high, again, with the non-expert icons ranked higher than the expert icons. Concern was consistently high across all six icons. There was no discernible trend in the perceived fear across the non-expert and expert icons.

Participants ranked the more local non-expert icons, the Norfolk Broads and London, as making them feel less bleak about the future than the more global icon of polar bears. This could be linked to feelings of control (Slovic, 1987) over possible futures for these icons: the more distant an icon is perceived, the less participants feel they have control over the icon, and the greater the negative feeling about the future it produces. Control can either act to engage or disengage participants. Many participants felt that in order to be engaged the icon needed to be perceived as controllable (i.e. local), but others felt that in order to shock into action the icon needed to be less controllable (i.e. global). An illustration of the possible placement of the non-expert icons, using the scales of ‘future’ and ‘understanding’ as proxies for factors one and two (see Slovic 1987, and section 7.4.2) is proposed in Figure 7.12. This theme of control, and its relationship with fear and the unknown, is considered further in Chapter 8.

Of the non-expert icons, the polar bear icon is particularly intriguing. Throughout this thesis research the debate over the power of global-scale icons has proved controversial (see Chapter five). The disparity in perceptions of polar bears as either an engaging or disengaging climate icon was again revealed in the evaluative workshop. When asked which icon was most relevant, polar bears scored very low across all categories, from the personal to the global. Yet, participants cited it the greatest number of times as the icon to which they were most drawn to. This disparity is considered further in Section 8.3.1.

Figure 7.12 Non-expert icons plotted in the dread risk / unknown risk factor space using data from 'future' and 'understanding' icon scales. Adapted from Slovic (1987).



Three themes emerged from coding the qualitative responses to icon engagement selection: impact, emotion and understanding. Much of the reasoning for selecting icons which engaged participants was connected to the perceived impact of an icon: personally, locally or on nature. Conversely, icons which disengaged had little impact on individuals. Icons which affected emotions such as sadness, danger, or calmness drew participants towards some icons. Icons which disengaged through this emotional sphere affected helplessness or boredom. The only coded data participants found they were both most *and* least drawn to was that of frightening or dramatic imagery. Some perceived it as a positive icon attribute, whereas others felt it was disengaging. Reasoning coded under the understanding theme was largely related to perceptions of the maps and images. Participants found icons which engaged them most were those which they could understand best, or which were novel. In contrast, disengaging icons were too scientific or too complex, or were not novel.

Lastly, the influence of several key demographic influences was investigated. Relationships were found between the age of participants and how likely they were to choose a local icon, and the highest scientific qualification of participants and how likely they were to choose an expert icon. These represent further avenues to explore regarding icon selection.

This Chapter examined the data from a pre/post test workshop, evaluating engagement with the iconic approach to communicating climate change. In the final Chapter, the results of the evaluative workshop are explored in regard to the research questions posed in Chapter one.

CHAPTER 8:
DISCUSSION AND CONCLUSIONS

This Chapter first considers individual barriers to climate engagement and how the iconic approach overcomes these difficulties. The iconic approach is then examined in more detail, investigating what makes a climate icon engaging through considering the impact of pragmatic and intangible reasoning, and the impact of icon spatial scale. The concept of 'control' and icon (dis)engagement, and demographic and sectoral differences are also considered. A brief review of the literature discussed in Chapter 2 on 'dangerous' climate change leads to a proposal for the use of icons as tools to overcome difficulties in the selection of 'danger' metrics. The broader concept of climate engagement is then explored in the context of addressing cognitive and affective spheres within a participatory approach. The Chapter concludes with a reflection on the methodological process and consideration of future research opportunities arising from the thesis.

8.1 INDIVIDUAL BARRIERS TO ENGAGEMENT

Chapter 3 discusses the evidence that whilst the public respond to economic and other incentives intended to induce carbon reducing behaviour, there are limitations to the 'rational actor' models of behaviour such as the Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB). Providing economic incentives is an unsustainable engagement strategy, for if the economic incentive is removed behaviours revert to those in place before the incentive was given (Dobson, 2003). Additionally, individuals are motivated by values and attitudes as well as by economics (Dobson, 2003). Engagement strategies which address purely economic concerns, but do not hold an appreciation for personal or societal norms and values, risk being unenforceable (Whitmarsh, 2005). As individuals with pro-environmental values are more likely to be cognitively, affectively and behaviourally engaged with climate change (DEFRA, 2007; Stern, 2000; Whitmarsh, 2005) approaches seeking to explore attitudes and values towards climate change are needed which go further than simple information-providing communication approaches.

Lorenzoni *et al.* (2007) have identified a series of barriers to engagement with climate change. They elaborate on the individual and social barriers that the UK public perceive to engaging with climate change. These barriers to meaningful public engagement with climate change have serious implications for the UK's efforts to reduce emissions. Lorenzoni *et al.* argue that whilst information on the causes, impacts and solutions of climate change is available, on its own it may not lead to meaningful engagement. The individual-level barriers are discussed below (Box 8.1). Social barriers are discussed in Section 8.4.

Box 8.1 Perceived individual barriers to engagement with climate change (from Lorenzoni *et al.*, 2007)

1. Lack of knowledge about where to find information
2. Lack of desire to seek information
3. Perceived information overload
4. Confusion about conflicting information or partial evidence
5. Perceived lack of locally-relevant information, for example about impacts or solutions
6. Format of information is not accessible to non-experts
7. Source of information is not credible or trustworthy, particularly the mass media
8. Confusion about links between environmental issues and their respective solutions
9. Information conflicts with values or experience and is therefore ignored

The iconic approach seeks to minimise many of these barriers. Within the iconic approach information overload and the accessibility of information format was expressly considered (Section 7.1.2) by limiting the amount of information provided, using non-technical language and considering factors such as average reading speed.

Whitmarsh (2005) suggests that the provision of more information, particularly scientific information, is unlikely to foster public engagement. Whilst the deficit model is acknowledged here to be an unsatisfactory model for promoting public engagement with climate change, participatory approaches such as the iconic approach that provide scientific information *in conjunction* with an appreciation of non-expert values and experience can be effective. Indeed, Whitmarsh (2005) comments that engagement with climate change relates to broader cultural beliefs and moral concerns rather than with narrower expert understandings of the phenomenon. The iconic research has shown that by presenting information in a clear manner, and by taking into account the communications literature (for example, on the timescales of which individuals can reasonably imagine), the desire to seek further information about climate change is increased.

Participants in Stage 1 of the research indicated that the spatial scale of icons was an important consideration in icon selection. Thus, locally-relevant icons were included in the analysis. Stage 3 (Section 7.4.4.1) demonstrated that local icons were indeed more engaging for a large proportion of participants, although there were exceptions (this is discussed further in Section 8.1.1). An extension to the fifth statement (Box 8.1) could be considered: that there is a need for personally-relevant information. Whilst locally-relevant information is often engaging, the iconic research presented here demonstrates that knowledge about the impacts that resonate in the intangible and pragmatic spheres is also important. This links to the ninth barrier considered by Lorenzoni *et al.* (2007). A two-way, participatory approach to climate engagement was performed, taking into consideration non-expert understandings as well as both natural- and social-science expert knowledge. Thus, the non-expert iconic information did not conflict with participant values.

The next Section explores the major themes arising from investigation of engagement and the iconic approach by considering icon selection reasoning, the concept of control and demographic and sectoral variability.

8.2 WHAT MAKES AN ENGAGING CLIMATE ‘ICON’?

8.2.1 Exploring engagement through icon selection reasoning

The icon selection data was categorised both by top-down codes generated from the research questions and by bottom-up codes arising from the data itself. Three overarching themes emerged from the icon selection reasoning. These were defined as pragmatic reasoning, intangible reasoning, and reasoning concerning the spatial scale of the icon’s impact.

8.2.1.1 The impact of pragmatic and intangible reasoning on icon engagement

Reasoning coded into the pragmatic category involved factual assertions about practical cause-and-effect situations. Within this theme, there were five sub-themes. These were ‘affects me’[48], ‘the everyday’, disaster/fear, economic impacts and dramatic imagery. Icons

[48] Code names taken directly from the data are presented in quotation marks.

that were coded into this theme included London, coastal flooding in Nigeria, Alpine skiing and food security in China. Intangible reasoning codes were those which involved deeper, emotional or spiritual understandings that cannot necessarily be measured physically. Within this second theme, there were four sub-themes. These were 'touches you' / emotion, the 'global village', appreciation of nature and patriotism. Icons that were coded into this theme included the Norfolk Broads, penguins and the reduction of polar ice.

There is a connection between the pragmatic and intangible sets of codes found in this data and the two 'modes of thinking' proposed by Slovic *et al.* (2004; based on Epstein, 1994). Slovic *et al.* propose that individuals understand reality via two interactive, parallel processing systems: the rational system which is deliberative and analytical and functions using logic and evidence, and the experiential system which understands reality as perceived in images, metaphors and narratives to which feelings have become attached. Slovic *et al.* named the two modes of thinking as the 'experiential system' and the 'analytic system' (Table 5.4); categorisations that well describe the 'intangible' and 'pragmatic' system within the icon data. The only apparent exception to the similarity with Slovic's modes of thinking approach is the code 'dramatic imagery'. This first appears as if it should fall under 'intangible reasoning'. However, the reasoning for icon selection coded under this node were related to imagery which participants saw as practical communications tools, as opposed to *'images […] to which feelings have become attached'* (Slovic *et al.*, 2004).

Slovic *et al.* argue that analytic reasoning has been placed on a pedestal and portrayed as the epitome of rationality, and that affect and emotions have been seen to negatively interfere with the perceived 'superior' analytic reasoning. Slovic *et al.* contend that affective reasoning has played an important part in human evolution, and that the two systems work in partnership to assess risk. Although analytic reasoning is important in some circumstances, reliance on affect and emotion is quicker and easier and more efficient way to navigate in complex, uncertain and sometimes dangerous world. In some situations, individuals may knowingly 'suspend' the analytic system, allowing the emotional / affective system to wholly process information. For example, Leiserowitz (2007) commented when exploring the impacts of engagement for the film *'The Day after Tomorrow'* (Emmerich, 2004) that cinema-goers are asked to leave their rationality at the door and suspend belief, thereby creating an opening for the affective system. It is clear that affective (intangible) reasoning for icon selection exerts a powerful hold over certain participants, and can be just as effective for climate engagement as analytic (pragmatic) reasoning.

KEY INSIGHT 1: Pragmatic and intangible reasoning both provide important approaches to engagement with climate change. Affective reasoning may provide an effective shortcut to engagement, bypassing the analytical system.

8.2.1.2 The impact of spatial scale on icon engagement

Spatial scale was concerned with the local to global extent of the impact of climate change upon the icon. Local icons selected included the River Wensum ecosystem and the North Norfolk coastline, national icons London and water supply in Nigeria, and global icons included the reduction of polar ice. The theme of icon scale is apparent throughout much of the icon selection data. For example, participants in a LEAD focus group were adamant that icons distant in peoples' daily lives like polar bears and low-lying islands were not engaging (Section 5.4.1.1.1). It was stated that making a linkage with an individual's everyday locality and climate change was key to effective engagement.

The evaluative stage (Chapter 7) also demonstrated that spatial scale provided a strong basis for distinguishing particular icons as more engaging than other icons. In many cases, the Norfolk Broads was cited as a particularly salient icon because of its local scale and its relevancy to local people. To a lesser extent, the London icon provoked a similar response. This is in accord with the literature. Nicholson-Cole (2004) states that a 'global' emphasis is not an adequate stimulus for engagement. A global perspective can lead to a state of being overwhelmed and unsure about a distant issue, and to feelings of issue ambivalence. Individuals engage in environmental problems that threaten local areas and resonate with their personal experiences (Macnaghten, 2003). Whitmarsh (2005) states that trust, personal concern and efficacy are highest at the local level, and that engagement is likely to be most effective at this level.

However, local is evidently not always more engaging. A participant in the CNS focus group told of how polar bears as a spatially distant icon meaningfully engaged her and her young daughter in the issue of climate change more successfully than a local icon. A small proportion of participants in stage three (Chapter 7) stated that they were least engaged with the local icons, and were instead drawn to the global scale icons such as WAIS because of their potential global impact, or because the local icons lacked novelty. Also of note here is the icon selection reasoning in stage one (Chapter 5) on the 'global village'. Some participants stated altruistic factors for engagement. These participants were likely to be more interested in the impacts of climate change on developing countries, and with climate change on a planetary scale.

KEY INSIGHT 2: Local icons are often more engaging, but icons on different spatial scales can also be effective at engaging if they invoke strong pragmatic or intangible engagement.

8.2.2 Exploring engagement through the concept of 'control'

In Chapter 7 it was proposed that participant ranking of non-expert icons when investigating feelings about the future could be linked to the concept of 'control' as proposed by Slovic (1987). Participants ranked local non-expert icons as inducing a less bleak feeling about the future than the more global non-expert icon.

KEY INSIGHT 3: The more distant an icon is perceived to be, the less an individual may feel they have control over the icon and the greater the negative feeling about the future this icon induces. If this is the case, then for more effective engagement feelings of control should be maximised.

A minority of participants were more engaged by icons that stimulated shock or fear and thus lessened this feeling of control. One participant specifically mentioned that the icon seemed more manageable, and thus the icon was less engaging. Yet, the literature on risk perception states that inducing feelings of fear, or a lack of control, is not an effective engagement tool (see also section 5.4.1.1.3; Hastings *et al.*, 2004; Moser and Dilling, 2004 and Hulme, 2007). Research also carried out in Norwich found that dramatic imagery sometimes conveyed a sense of issue salience, but it was disempowering and decreased issue efficacy (Nicholson-Cole, 2004). This would be interesting to investigate in the context of icons; in particular whether fear appeals are effective for stimulating and maintaining climate engagement for particular sectors.

8.2.3 Exploring engagement through demographic and sectoral variability

This research was partly provoked by the frequent use in public discourse of particular climate icons. For example, polar icons are more frequently found in the media than other icons (see Figure 5.5). Therefore, a research question was posed concerning whether a globally engaging climate icon existed.

The diversity in icon selection demonstrates that individuals hold very different views about which icons best engage them with the issue of climate change. In all, 145 icons were cited by participants in the focus groups and online survey. Even when condensed into categories, fourteen icon groups remained ranging from sea level rise (SLR) to individual species to agriculture. There was little agreement on which icons promoted engagement across participants of different nationalities, with participants in the LEAD focus groups specifically commenting that individuals from different cultural backgrounds will select different icons (Section 5.4.1.1.2). Indeed, there was still considerable diversity in icon selection from participants of the same nationality and locality. The evaluative workshop is further evidence that an overarching icon of climate change that encourages engagement does not exist. Each icon, both expert- and non-expert, engaged at least some participants. Equally, each icon also disengaged a proportion of participants (Table 7.3).

Because of the emerging consensus from stage one that no overarching global climate icon existed, and taking into consideration communication literature on targeted communication approaches (Section 3.4), three non-expert icons likely to resonate with a Norfolk audience were chosen to take forward to the icon modelling and evaluation stages. The icons chosen reflected the emerging themes from the first stage of the research - that icons are selected by individuals through their connection with the three orthogonal axes of spatial scale, pragmatic reasoning and intangible reasoning.

This research illustrating the diversity in icon selection and engagement supports more recent public engagement literature where it is argued that engagement approaches need to move away from the ‘one size fits all’ approach exemplified by past climate campaigns (such as those run by environmental NGOs, Section 2.1.1.1) and recognise the heterogeneity in attitudes and values of the public. Futerra (2005) state that communications approaches should follow more mainstream marketing rules in targeting particular groups, an approach also advocated by former Greenpeace campaign coordinator, Chris Rose (2005).

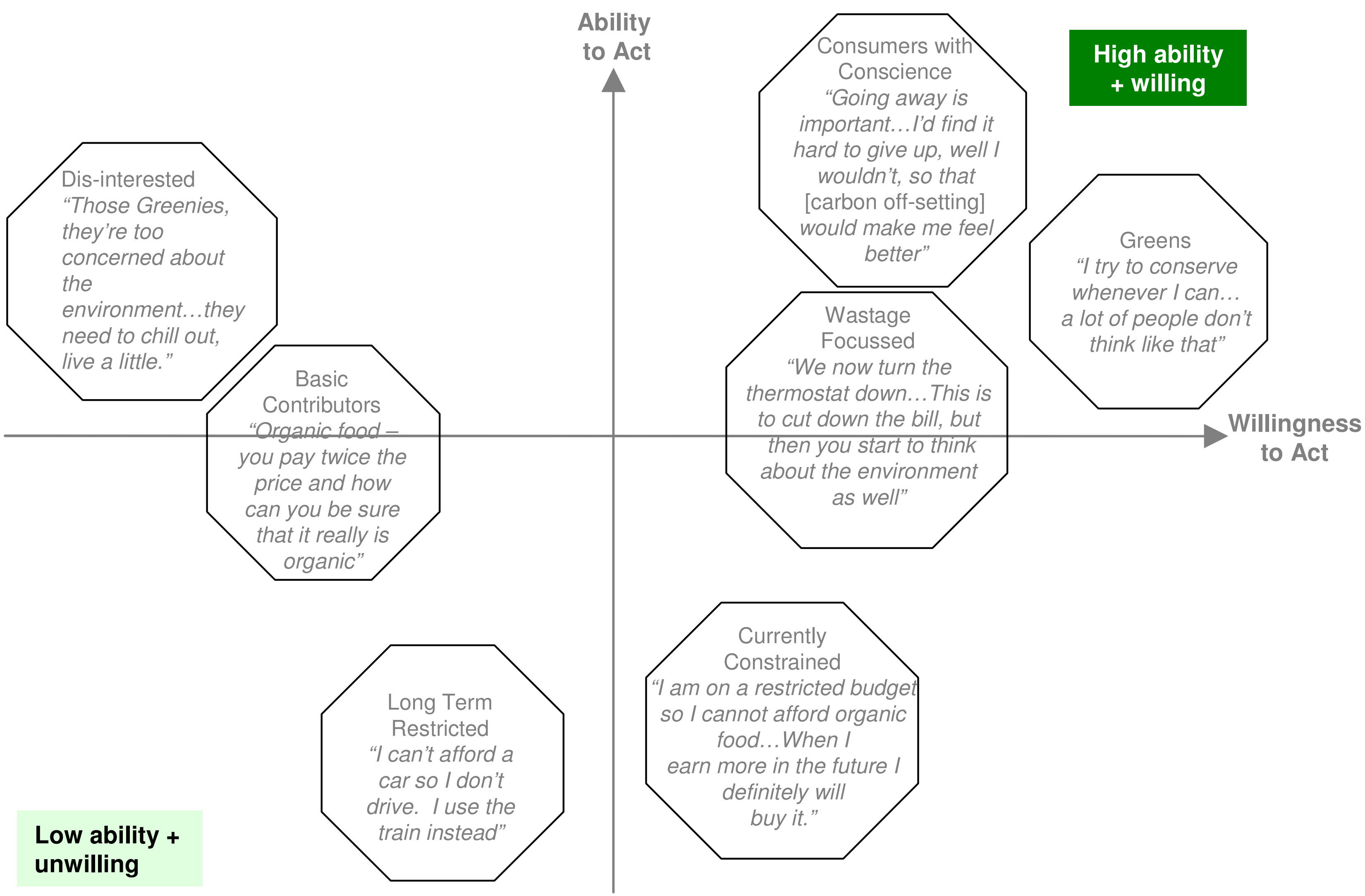
Further avenues relating to population demographics from this research are identified in Section 7.5. In this sample at least, it appears that participants’ age may have some impact on the icons they select. Younger participants found the most local icon, the Norfolk

Broads, far less engaging than any of the other icons. An additional affect which could be further investigated is the impact of participants' level of education upon the icons they are most engaged with. In the evaluative workshop, participants with no formal science qualifications were more likely to engage with a non-expert icon. Conversely, participants' with an NVQ or higher in a science related subject were more likely to engage with an expert icon.

In addition to recognising demographic variability, climate communication methods increasingly value the targeting of population 'segments' (where a segment is as a group of individuals bound by a shared range of values, beliefs and behaviour) rather than population demographic details *per se* (Ereaut and Segnit, 2006; Moser and Dilling, 2007). For example, the pro-environmental behaviour framework (Muckle, 2004) recognises seven different groups identified by their current engagement with environmental issues, ranging from 'greens' to 'basic contributors' (Figure 8.1). The use of this type of model could inform future work investigating engagement and disengagement with climate icons. Engagement through demographic and sectoral variability is discussed further in Section 8.5.

> *KEY INSIGHT 4: There is great diversity in individuals' engagement with climate icons across geographical and cultural contexts. Engagement approaches should seek to recognise and connect with differences in demographic and sectoral groups.*

Figure 8.1 Development of a pro-environmental behaviour framework (from Muckle, 2004)



8.3 USING ICONS TO OVERCOME THE DIFFICULTIES IN SELECTING 'DANGER' METRICS

Different metrics have been used to quantify a value for when climate change becomes 'dangerous' (Section 2.2.2.4). These metrics have not provided a holistic method of investigating 'dangerous' climate change. To come to a full understanding of 'dangerous' climate change, the role of danger both in societal and individual perceptions must be recognised (Dessai *et al.* 2004). Lorenzoni and Pidgeon (2005) define danger as a perceived threat.

> *KEY INSIGHT 5: A definition of danger cannot simply be restricted to technical or risk-based criteria; individuals are not rational actors acting on risk information alone. Within the iconic approach, individuals can impose their own perceptions of 'danger' upon the icons consistent with their personal values and attitudes.*

The suite of icons deliberately prevented a reduction to the lowest common metric.

The impact of climate change to 2050 under A1B under an assumption of 'no adaptation' was explored for each of the icons (Chapter 6). A literature review was conducted to investigate impacts on the expert icons of the THC, ocean acidification and WAIS (Section 6.2). Impacts on the three non-expert icons of polar bears, the Norfolk Broads and London were explored using an expert elicitation, the Coastal Simulator research, the Atlantis project research and through using a GIS (Section 6.3 to 6.5). This information was presented to participants in stage three of the research (Chapter 7).

8.4 ENGAGEMENT AS MORE THAN COMMUNICATION

8.4.1 Addressing cognitive and affective spheres for meaningful engagement

It is not enough for people to know about climate change in order to be engaged; they also need to care about it, be motivated and be able to take action. Lorenzoni *et al.* (2007) define three elements of engagement as cognitive, affective and behavioural. This definition of engagement is also used in this thesis (Chapter 1).

> *KEY INSIGHT 6: This research has shown that connecting with the affective and cognitive elements through using icons leads to meaningful public engagement with climate change.*

A research question posed in Chapter 1 was whether this participatory icon selection methodology would enable enhanced cognitive engagement with climate change. The empirical data supports this hypothesis. The iconic approach engaged through the cognitive sphere. The iconic approach (the influence of both expert- and non-expert icons) stimulated participants to find out more about climate change, to consider climate change a serious issue and to view climate change as a real issue. The non-expert icons were selected under consideration of several criteria (Section 5.3). The non-expert icons were perceived by participants to be considerably better understood than the expert icons. In addition, interest was higher across the non-expert icons than the expert icons. Additionally, the 'understanding' meta-themes which emerged from coding the qualitative responses to icon engagement selection (Section 7.4.5) closely relates to the notion of cognitive involvement proposed by Lorenzoni *et al.* (2007).

A second research question posed in Chapter 1 was whether a participatory icon selection methodology would enable enhanced affective engagement with climate change. The empirical data also supports this hypothesis. The 'emotion' theme which emerged from coding the qualitative responses to icon engagement selection links with the affective element proposed by Lorenzoni *et al.* (2007). Reasoning coded into the 'impact' meta-theme was the most common: reasoning where icons engaged participants because the icon had an impact personally, locally or on nature. This theme included icons engaging through both affective and cognitive elements.

The power of the affective element to engage individuals in climate change is well demonstrated by the polar bear icon. There was general agreement in stage 1 of the research that a global icon of climate change did not exist, and that local icons were more engaging (see Section 8.1). However, the polar bear icon appears to override this finding. In the icon selection stage, polar bears were the most frequently cited of all the individual icons, but participants were divided over whether polar bears constituted an engaging icon of climate change. This dichotomy was seen again in the evaluative stage. Polar bears scored the lowest of any of the icons when asked which icon was most relevant across any of the individual to international categories, yet it was the icon the greatest proportion of participants was most drawn to. Examining the qualitative reasoning behind icon selection clarifies this dichotomy (Section 5.4.1.2). Those most drawn to polar bears as an icon did not do so because they felt it was 'relevant' in a logical or analytical sense, but because it connected through the affective sphere.

KEY INSIGHT 7: Polar bears were an engaging icon despite a lack of analytical reasoning, because they connected through the experiential system. This finding empirically demonstrates the power of the affective state for engaging the public with climate change.

8.4.2 Integration of expert and non-expert knowledge in a participatory approach

Much evidence suggests that information deficit models of public perception, understanding and action are inadequate. Owens (2000) does not argue for an abandonment of the dissemination of the relationship between environmental risks and consumption: Owens considers it better to be informed than ignorant even if behavioural change does not necessarily follow from information provision. However, she argues that the information deficit model is at best insufficient. Instead, a more participatory process which integrates scientific analysis with deliberative communication is called for. A participatory form of engagement is appropriate in the context of climate change, where the public are included as a social actor as able to contribute to agenda setting as other actors (Wilsdon and Willis, 2004). A participatory approach does not infer that 'anything goes', but neither does it uncritically accept 'objective truths' about the physical world given by experts (Owens 2000). This thesis has presented a participatory approach where scientific and non-expert knowledge have been integrated to produce a new method for encouraging public engagement with climate change.

The public is given ownership of issues through a participatory approach. By including the public as vital actor in decision making, workable solutions are more likely to emerge. The public knowledge is given legitimacy, and the importance of non-expert knowledge is acknowledged. A public perspective may also define, or reframe, what the issues may be (Burgess *et al.* 1998). In this thesis, it is clear that 'expert led' icons prevalent in climate science on the whole fail to meaningfully engage with non-experts, whereas icons chosen by non-experts engender a much stronger pragmatic and intangible connection with other non-experts.

Climate change can no longer be defined as a scientific 'problem' waiting for a 'solution'. Hulme (*in prep.*[49]) contends climate change is a cultural and political phenomenon which

[49] Hulme, M. (in prep., publication 2008/9) *Why we disagree about climate change.* Cambridge University Press, Cambridge, UK.

reshapes the way individuals think about themselves and about society. As discussed in Section 2.2.2.2, the IPCC has refused to define ‘dangerous climate change’ as to do so would be a value judgement and is therefore outside the scope of science. As climate change has become a social, moral, cultural and political issue, including public knowledge and ethics in the negotiation of climate change is imperative.

Defined ‘experts’ hold non-expert knowledge that will influence them in a decision-making situation. This was demonstrated to the author through the examination of the expert elicitation literature in this thesis (Section 6.2.2). Even after experts are educated on the problem of overconfidence, overconfidence often still exists in expert responses. In common with non-experts, the interviewed experts are still subject to heuristics and biases in their responses. Indeed, Jasanoff (1997) states that many risk assessment exercises expose uncertainties and unacknowledged expert assumptions which much reduce the perceived distance between expert and non-expert knowledge. Further, it is recognised that the reach of expert knowledge is limited. Blake (1999) defines the ‘public’ in terms of *‘alienation from dominant political or knowledge regimes in a particular context’*. Owens (2000) states that this implies that most individuals, on any issue of particular complexity, fall into this ‘non-expert’ category.

As climate change becomes a social, moral, cultural and political issue as well as an academic scientific field of study, conflict between science and society becomes more frequent. As discussed in Section 3.4.2, a minority of climate contrarian voices are disproportionately heard in the public arena, often challenging the predictions and probabilities provided by science. Together with perceived individual and social barriers, this creates a potent recipe for inaction on climate change. Providing more information, whether in the form of increased public information communication or an increased precision in climatic research (for example, scientific endeavour to reduce errors in sea ice projections in climate models) is unlikely to quieten these voices. A participatory approach aids in addressing this issue. A more inclusive approach to decision making and knowledge creation which builds trust and understanding between the different actors is increasingly appropriate (MORI, 2005). Communications approaches to facilitate engagement and knowledge creation are moving away from mass public campaigns and towards more targeted, community-led endeavours: an example being the UK’s Climate Challenge Fund discussed in Section 2.2.2.3.

The urban lifestyles sustainability and integrated environmental assessment (ULYSSES) project developed tools to facilitate citizen participation in integrated environmental assessment. The project successfully integrated computer modelling with citizen deliberation on climate change through a participatory approach. Participants supported both technological and behavioural change strategies to reduce energy consumption. However, van der Sluijs (1999) states how individuals were still reluctant to make personal sacrifices after taking part because of the 'free rider' effect. This emphasises the importance of consideration of both individual and social barriers to engagement, as discussed next.

8.4.3 Overcoming further barriers to engagement

The iconic approach to engaging the public with climate change has successfully addressed many of the individual barriers to engagement as explored in Section 8.1. The iconic approach did not seek to address social barriers to engagement. Previous research suggests that tackling social barriers is key to allowing individual decarbonisation of lifestyles. Nicholson-Cole (2004) found a lack of action from even the most engaged individuals. She explains this through the many social barriers that affect an individual's sense of self efficacy, and which obstruct the links between concern, intention and action. Similarly, Whitmarsh (2005) states that attempts to change values without changes to social barriers such as physical infrastructures is unlikely to produce sustainable changes. She states that climate mitigation policies must provide opportunities for an individual to change their behaviour, using tools such as incentives. Lorenzoni *et al.* (2007) state the following social barriers to change (Box 8.2):

Box 8.2 Perceived social barriers to engagement with climate change (from Lorenzoni *et al.*, 2007)

1. Limited political activity by local, national and international governments (especially the US government, and the lack of substantial British action)
2. Lack of action by businesses and industry
3. Inaction by others in society ('free riders' and the tragedy of the commons)
4. Lack of enabling infrastructure and mechanisms
5. Social norms and expectations

Jackson (2005) describes the complex dependency and feedbacks between economic constraints, institutional barriers, inequalities in access and restricted choice together with habits, routines, social norms and values as consumer 'lock in'. Lorenzoni *et al.* (2007) cite one participant's view of this lock-in as a 'strangle hold'.

The relationship between attitudes and external conditions is discussed in the context of the Attitude Behaviour Constraint model (Stern, 2000) in Section 3.3.3. The model is adapted below (Figure 8.1) to show a generalised behavioural change model, where the two axes are modified to 'individual attitudes' and 'societal conditions'. The iconic approach to engaging the public with climate change increases positive individual attitudes and thus increases the potential of an individual towards decarbonisation behavioural change. For widespread behavioural change, engagement approaches to modify individual attitudes towards climate change need to be paired with much wider changes positive changes to societal conditions such as policy, infrastructure and mechanisms.

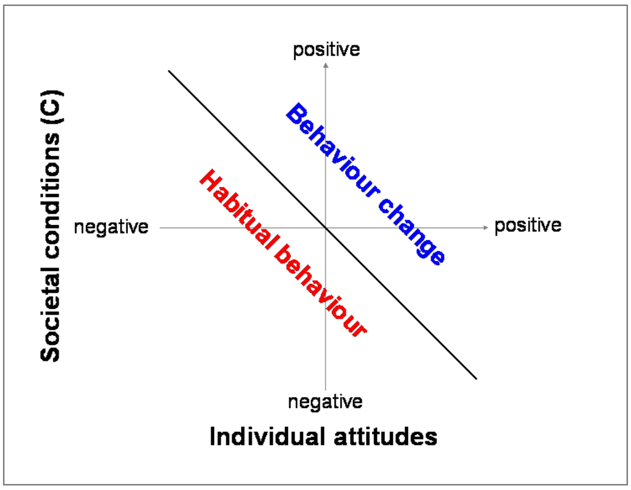


Figure 8.2 Increasing the likelihood of decarbonisation behavioural change by changing attitudes through the iconic approach (adapted from Jackson, 2005: originally based on Stern, 2000)

KEY INSIGHT 8: The iconic approach positively changes individual attitudes and increases the potential for decarbonisation behaviour. For widespread behavioural change, societal conditions also need to be addressed.

8.5 METHODOLOGICAL REFLECTIONS

8.5.1 Post normal science and interdisciplinarity

The concept of interdisciplinary in shaping this research was discussed in Chapter 4. As with Dessai (2005), it could be argued that this is not a thesis in the tradition of 'normal' science (*c.f.* Kuhn, 1962). Instead of a narrowing of knowledge and specialisation with a clear methodology linked to neat results and conclusions, this research has followed an exploratory and interdisciplinary path in the realm of post-normal science requiring an 'extended peer community' and 'extended facts' (Ravetz, 2004). This research investigation of the iconic approach as a tool to engage individuals in climate change has crossed the disciplines of geography, psychology, sociology, climate sciences, marketing and communication. This has been the most challenging and yet the most satisfying aspect of the research.

Petts *et al.* (in press) recognise the challenges of interdisciplinary research. Of note for this thesis research are two related difficulties of interdisciplinary endeavour. Discussed first is the difficulty of interdisciplinary research defined purely as real-world problem solving and second, the difficulty of integrating social science into interdisciplinary research. Petts *et al.* argue that interdisciplinary research is persistently sold as a tool for tackling real world problems. Whilst not in itself a difficulty, it can lead to the research being viewed with suspicion by those within disciplinary 'silos'. The author has attempted to address these concerns by basing knowledge contributions to the research from within the disciplinary literature (such as grounding the findings of intangible and pragmatic reasoning within psychology literature on experiential and analytic systems in Chapter 5), whilst recognising that the original contribution of the thesis is from the interdisciplinary linkages between each stage of the research (see Chapter 1).

Petts *et al.* (in press) also explore the difficulty of integrating social science into interdisciplinary research. Social science may be viewed as 'soft science': offering simplistic insights, and open to competition from 'common sense' worldviews. This has resonance with the author who has experienced such opinions expressed by colleagues in the undertaking of this research. Thus, attempts have been made to clarify the different methodologies used so as to be intelligible to different disciplinary audiences (for example, see Section 5.3.2 on focus groups as a methodology). Similarly, consistency checks were performed and validity of each method is discussed (see individual Chapters and Section 8.4.2)

Lastly, Petts *et al.* (in press) state that success in interdisciplinary research must recognise that there are different ways of framing the issue. Selecting a timescale for the icon modelling provides an example of the framing and balancing of knowledge between disciplines. The choice of timescale was carefully considered (Section 6.1) as a dichotomy exists between the timescales non-experts can conceptualise together with the potential loss of saliency when using long timescales, against a sufficient time period needed to illustrate climatic impacts on the icons. The literature examined in Section 6.1.1 indicates that 50 years forms an upper limit of the ability to conceptualise distant times. A preliminary exploration of the climatic impacts on the icons revealed that there was little noticeable climatic impact on the icons before the 2050s. Considering impacts to 2050 was therefore a compromise between these two opposing factors.

8.5.2 Research validity

This research was not intended to provide a representative view of the UK public as regards the iconic approach to engaging with climate change. Instead, it was designed to gather rich, exploratory data. The validity, meaningfulness and insights generated from qualitative research are more concerned with the richness of the information, and the observational or analytical capabilities of the researcher, than with sample size (Patton, 2002). The icon selection reasoning was from a culturally and spatially diverse participant group. Insights from this methodological stage were then used to inform the further two methodology stages, with each stage building on the underlying data. Thus, specific results are not generalisable to the UK population. However, there are reoccurring themes that appear through different participant groups throughout the different stages of the research. These themes are discussed in Section 8.1.

The validity of the data was increased through consideration of the methodology used. For example, pre-testing was carried out for all protocols. The protocols for the online survey (Section 5.3.2.1) focus groups (Section 5.3.1.1), expert elicitation (Section 6.3.4) and workshop questionnaires (Section 7.2) were pre-tested for question comprehension, question flow and timing.

A combination of complementing qualitative and quantitative questioning was used throughout the individual methods. Quantitative responses allowed statistical tests to be used to directly compare participant responses, as qualitative data on attitudes is often not amenable to statistical methods. Statistical tests were carried out on the quantitative workshop questionnaire Likert scale responses, but are inappropriate for measuring qualitative reasoning. Nevertheless, some quantitative mention is made of the frequency and extensiveness of comments as one of the seven methods for assessing qualitative data (see Box 5.2). Open-ended questions in the online survey, expert elicitation and workshop questionnaires allowed participants to elaborate on fixed-choice questions, providing a deeper and richer data source. Qualitative data was examined using the seven criteria as described in Box 5.2.

Attempts to increase data reliability were made by making a summary of the data collected as perceived by the author available to participants. In the focus groups, a summary was made of the main themes at the end of the focus groups and participants were asked to add to this as they wished. In the online survey, expert elicitation and workshop questionnaires, participants were asked a final question requesting additional thoughts not covered elsewhere. For the online survey and workshop questionnaires, participants could request a report of the results. For the expert elicitation, participants were explicitly requested to adjust responses after the first iteration as they saw fit.

Digital recordings were made of the focus groups to maintain a full and accurate record of the event, and to facilitate moderator focus on event facilitation. Full transcripts were made for the focus groups. Time fillers and moderator prompts were only removed when they did not affect the overall meaning of the sentence. Qualitative responses from the online survey, expert elicitation and workshop questionnaires were also recorded and analysed in full. Spelling and grammar was not altered for these files in order to keep true to the data.

The reliability of the data is also increased through consideration of data analysis. Reliability checks were carried out for the coded data. An independent analyst checked samples of qualitative coded data for consistency and theme categories (Sections 5.4.1 and 7.4.4). Additionally, appropriate statistical tests were used in data analysis. The statistical tests used considered assumptions in the data source. For example, the expert elicitation data used medians, not means (see Section 6.3.4) and the Likert scale analysis for the workshop questionnaires used the Wilcoxon matched-pairs signed-rank test rather than the *t*-test. Additionally, to ensure statistical thoroughness grossing-up of the sets in the evaluative workshop was not performed due to some small set numbers, but comparison of sets was made through the Aylmer test (see Section 7.3.1 for further discussion of the Wilcoxon and Aylmer test).

8.6 FURTHER RESEARCH

This research has opened several possibilities for further research both investigating the icons defined here, and identifying other icons salient for different audiences.

The impact on engagement of three non-expert and three expert icons has been addressed in this research. Further research could track engagement with these six icons over time. Of particular interest is public engagement with the polar bear icon. As this thesis research has progressed, media attention has become ever-more intense over the potential impact of climate change on polar bear populations (see Arlidge, 1999; Buncome and Carrell, 2005; Winter, 2005; Black, 2006; Joling, 2006; McCarthy, 2006; Pearce, 2006; Ashford, 2007; Debnam, 2007; Garfield, 2007; Langan and Leonard, 2007; New Scientist, 2007; Pennisi, 2007). In 2007, Garfield wrote an article in the broadsheet newspaper *The Observer* naming polar bears the *'poster boys of global warming'*. It could be that media activity intensifies engagement with the icon, as it becomes better known and increasingly associated with climate change. Conversely, it may decrease icon novelty (see Section 7.4.5) and hence decrease engagement.

An obvious extension to this research is to investigate the differences between the different demographics in icon selection. Further avenues relating to population segmentation from this research are identified in Section 7.5. First, in this participant sample at least, it appears that participants' age may have some impact on the icons they select, with younger participants finding the most local icon far less engaging than other icons. The importance of engaging young people lies not only with their status as the future electorate, but also as individuals in a transition period of their lives. Research by Verplanken and Wood (2006) has demonstrated that transition periods are very effective periods to instigate attitude and behavioural change. An additional avenue which could be further investigated is the impact of an individual's highest level of scientific education in regard to the icons they find most engaging. The iconic research found participants with no formal science qualifications were more likely to engage with a non-expert icon, whereas participants' with an NVQ or higher in a science related subject were more likely to engage with an expert icon.

Further to demographic factors, attitude/behaviour categories such as the DEFRA Segmentation Model (Dresner *et al.*, 2007) could be used to identify key icons for particular groups. This approach holds appeal, for it categorises sectors based on their current environmental attitudes and behaviours. Thus, icons may be identifiable that would help to connect with specific target sectors such as those currently least engaged with climate change; for instance, the 'basic contributors' in Figure 8.1. Or, engagement approaches could aim to reach those who are only superficially engaged through invoking more affective engagement, such as the 'wastage focussed' (see Figure 8.1).

An extension to the above could be to specifically focus on social networks bound by shared world views. Approaches through social networks are significant in influencing an individual's behaviour as people are far more likely to trust family and friends than the media or politicians (Poortinga and Pidgeon, 2003; Future Foundation, 2006). For example, it has been suggested that religious institutions could hold great influence over their congregations in regard to engagement with climate change (McNamara, 2007). Indeed, as discussed in this thesis and elsewhere (Whitmarsh, 2005; Hulme, 2007; Moser and Dilling, 2007), there is a strong moral aspect to the issue of climate change. In this respect, it would be very interesting to investigate the iconic approach to engagement with climate change through several different religious lenses; investigating commonalities and differences in the conceptualisation and selection of icons for engagement.

8.7 CONCLUDING REMARKS

This thesis has demonstrated that an iconic approach to representing climate change engages individuals through invoking affective and cognitive change. It has shown that pragmatic and intangible reasoning, as well as icon spatial scale, are important in the selection of particular non-expert climate icons. When these non-expert climate icons were tested against expert-led icons, the expert-led icons were generally found to disengage. Expert-led icons had little impact on individuals and invoked emotions such as helplessness or boredom. The expert icons also disengaged as they were too scientific and complex. Conversely, non-expert icons tend to impact upon the individual, the local area or nature and invoke emotional responses and increased understanding. Thus, non-expert icons move individuals to feeling more engaged with climate change. However, social barriers to engagement also need to be overcome before individuals will make significant behavioural changes to a low-carbon lifestyle.

Date: ____

Participants: ____

Hi.

Thanks for taking the time to come to this discussion group. As you're probably aware, we're going to be talking about climate change and ways in which it is communicated. The discussion shouldn't take any longer than 1 ½ to 2 hours. Please help yourself to tea and coffee which has been provided by CNS. Hopefully you've also had a chance to look at the information and consent form [*check*]. I'll collect these in at the end of the session.

I'm recording the session because I don't want to miss any of your comments. This is so I can transcribe the session so I don't miss anything. The tape will be destroyed after transcription. No names will be included in any write-ups of the research, and your comments are confidential, unless you specifically want to be named.

I've asked all of you to wear a name tag to help me remember names, but they can also help you. If you want to follow up on what somebody has said, you want to agree, disagree, or give an example, feel free to do that. Don't feel like you have to respond to me all the time. Feel free to have a conversation with one another about these questions. I am here to ask questions, listen, and make sure everyone has a chance to contribute. I'm interested in hearing from all of you.

There are some basic ground rules I'd like to go through before we start the discussion. First, please don't talk over anyone. You'll all get a chance to speak and I'd like to hear everyone's voice clearly when I come to transcribe the tape! Second, this is designed to be a comfortable atmosphere - consider other peoples opinions, and feel free to oppose them but please do so in a respectful way. I'm sure there will be some times when you'll all agree - and other times when you'll all have a different opinion, and that's fine! There are no right or wrong answers. I'm not here to answer any particular questions on climate change, but to find out what you think about the issue. If you have any particular questions about climate change that you want directed to me, please ask me at the end of the group when I'd be more than happy to talk to you about them.

Opening Question: 5-10 mins

If we could just go round the circle to introduce ourselves to each other now. OK… to start… Let me introduce myself. I'm working as a researcher at UEA - the University of East Anglia. My research is looking at ways in which climate change is communicated now and possible ways it could be communicated in the future. I'm really interested in listening to your ideas about what you know about climate change and whether you feel it's relevant or irrelevant. Particularly, I'm interested to know what you know about climate change and how you feel about the communications you've come across.

- introduce Sian (technical assistant)

OK, just tell us your name and how you heard about this focus group – whether you're a teacher here, or if your child goes to CNS…

Introductory Questions: 5 -15 mins

(1.) What is the first thing that comes to mind when you hear the phrase 'climate change'?

- Do you know climate change by any other words or phrases? (e.g. global warming)
- Does climate change mean anything in your everyday life? (recycling, using car less, getting hotter…)

(2.) I'd like to discuss what you think about the way climate change is communicated (e.g. media, education, government - through TV, radio, magazines, newspapers, movies)

- What do you think about it / them?
- Do they affect the way you think?
- Are they relevant to you / your life?
- Tell me how they make you feel.
- Tell me how they make you act.

OK, now we're going to move away slightly from how you have seen climate change communicated in the past to start thinking about a way that it may be communicated in the future. I'm calling this approach the 'iconic' approach.

Transition Questions: 5 – 20 mins

(3.) Can you tell me what the word 'icon' means to you?

- Where have you heard the word 'icon' before? (e.g. pictures, semiotics, on a PC, a famous entity / person)
- What do you consider to be iconic, or an icon?
- Can you think of something you think is 'iconic' or someone you think is 'an icon'?

OK, the way I'm thinking of using this 'iconic' approach combines elements of all the things we've just discussed. An icon could be a famous person or thing that you might consider representative of a particular culture or way of life, and which you admire. Examples of icons might be the Houses of Parliament as an icon of the British Government, Marilyn Monroe might be an icon of American filmmaking, a red telephone box might be an icon of England.

At the moment, communications tend to use representations of climate change, or 'icons' that I think may not be relevant to everyday life - think back to our discussion on how climate change is communicated in the media. Instead, I would like you to think about icons that you would find interesting, and would make you want to know more about what happens to it in regard to climate change.

(4.) What kind of factors do you think would make an engaging icon – one that is easy to communicate and a lot of people care about?

- Maybe think about location – would it be better to have a local/global icon?
- What about the relationship individuals would have with the icon - would it be better for it to be a personally important or famous icon?
- Think back to the Marilyn Monroe example – do you agree she become 'iconic' – why? E.g. can personally identify with her struggle for success, lowly beginnings etc.

Key Questions: 30 – 50 mins

OK, remember that example of the Houses of Parliament being a possible icon of the British Government. Well:

(5.) What do *you* think would make a good icon of climate change? I really value your input into what you think would be relevant and interesting icons for you.

- The icon you choose should be valuable to you
- you may be concerned about what happens to it in the future with climate change
- perhaps you value that this icon is still there for future generations to appreciate

Your climate change icon can be:

- a place
- something from the natural world
- a culture
- a species
- a city
- a building
- an indigenous community… the choice of icon is limited only by your imagination!

I'd like you to all take a minute to think about all the issues we've been discussing. Consider what we've discussed an icon is, and which icons you feel are most effective for communicating climate change.

OK, draw up a list of several icons that you would like to know more about, in relation to future climate change? What would make a useful icon of climate change to you? (i.e. one that excites your interest and makes you want to know more about climate change?)

(6.) So, what icons did people come up with?

Prompts: Who / what is the icon?
Where is the icon?
What are your reasons for choosing your icons?
Why is it important?
How do you think your icon will alter with climate change?

Ending Questions*:*

Summarise discussion:

- talked about climate change and how it's communicated
- then we discussed what an icon was
- we talked about what makes a good / bad icon and discussed what icons you might want to know more about in respect of climate change

- emphasise that those who want to be will be kept informed if they want: report or further discussion groups - need contact details

(7.) How well does that capture what was said in our discussion? Are there any points you think I've left out or overemphasised?

(8.) Is there anything you would have liked to have talked about, but didn't get the chance?

(9.) Could you all please fill in the consent form and give one copy back to me

OK, thanks for taking part! I'll wrap up the discussion now, but if anybody wants to talk about anything we've discussed this evening, I'll be around for a few minutes more.

Thank you!

APPENDIX 5.2
ICONS REJECTED FROM FURTHER ANALYSIS

Icons following a low trajectory in IV, V and VI and excluded from further analysis

Amsterdam	New York
Cairo	Droughts, Brazil
Coast, UK	Floodplains, UK
Glaciers, Alps	Glaciers, Arctic
E.Anglian coast, UK	Health, Brazil
Ladybirds, UK	Oak trees, UK
Whales	Permafrost melt, Russia
Robin, UK	Small island states, Pacific
Eastern spine-billed honeyeater	

APPENDIX 5.3
DISCUSSION OF ICONS NOT SELECTED FOR FURTHER ANALYSIS

(1.) Venice (city / town SLR)

Venice was chosen by Eros (LEAD group 3) and Ang (LEAD, group 2).

> *"So immediately I will say, the Venice Lagoon. Because the temperature will go up, actually so will the level of the water go up and with the consequence that you can imagine."* Eros, Italian, living in Luxemburg

Venice rates moderately highly on pragmatic reasoning. As an icon, there is a variety of literature available surrounding the issue of Venice and SLR, and it would be quite sensitive to climate change over the timescale modelled. However, Venice does not code under any of the intangible nodes.

(2.) Shanghai (city / town SLR)

Shanghai was chosen only once, by Wang (LEAD).

> *"Shanghai city, the most important city in China."* Wang, China

Shanghai ranks on pragmatic, but not on intangible reasoning. There has been a significant quantity of research on SLR on this area of coastline, although some of it is in Chinese and as such may be more difficult to access. Shanghai was also chosen by the BBC (BBC 2006) in a programme titled ' 5 disasters waiting to happen', so it could be assumed that Shanghai may already be seen as an icon of climate change. The impact of negative climate change impacts upon Shanghai as a major finance and population centre would be felt across the globe, hence it scores highly on III. However, there is little reasoning attached to this icon.

(3.) North Norfolk Coast, UK (SLR)

The North Norfolk Coast (including Happisburgh and Cromer chosen as individual icons) was chosen by Janet and Alison, both CNS participants. Janet did not provide any reasoning for this particular icon choice.

> *"So Happisburgh, I often think of [...] And then Dunwich, you know, in Suffolk, which actually did go, didn't it. You know, which was drowned. So I do think about the East Anglian coastline and I do think that is a very clear image." […]*
> *"...and then…Happisburgh… you know. Because I get that picture in my mind of the houses, right on the edge… and you know it's gonna go…"* Alison, Norfolk, UK

Although this icon ranked on both pragmatic and intangible reasoning, it was not particularly high in either. It ranks as a regional icon on criteria III. Models are available to quantify the effects of climate change upon the icon. The icon would be particularly sensitive to climate change over the timescale examined.

(4.) Coastline, Japan (SLR)
Japan was chosen by Ang (LEAD).

> *"Japan. Something you can imagine a picture that after the sea level rising maybe two or three centimetres and maybe 1/5 or 1/6 of lands in Japan will be flooded."[…]*
> *"Because if Japan was flooded by 1/5 of the land, then maybe it would produce a disaster to this country. But we are, have live in the global village. So we should care about one country and not only the…"* Ang, China

It scored fairly low on pragmatic reasoning, and little higher on the intangible reasoning. Overall, though, this icon did not seem to resonate with Ang's group and was not mentioned by any other participants.

(5.) Pacific Coast, Mexico (SLR)
Several of the participants in the LEAD groups were able to relate to this icon, and added their own icons in a similar vein (see icons 7 and 8).

> *"...our Pacific beaches. Uh! As it's tourism in the Pacific, is one of the most important sources of income for the country. So a climate change would directly affect this patches of beaches."* Fritzea, Mexico

> *"It is the same thing. Er, beaches… "* [see Abiodun's comment: beaches for tourism, and property being threatened] Maria Isabel, Mexico

This icon ranks highly compared to many of the others on pragmatic reasoning, although nothing was coded under intangible reasoning. This icon was chosen three times (although a large proportion of the LEAD participants were Mexican so this would have influenced icon selection). However, there may be difficulties in modelling as a preliminary review found very little research in this location.

(6.) Coastal flooding, Nigeria (SLR)

This icon was chosen by Abiodun (LEAD). It ranked highly on pragmatic reasoning, but again, didn't code on intangible reasoning.

> *"So prime properties on the coastline of Nigeria if you show these people connect with it, […] They can relate, they can understand, because there social conditioned to it, so when they see some ocean surge, and they see property being threatened, […] and also the beaches too for tourism."* Abiodun, Nigeria

The literature provided a few examples of research at this location, and it would be somewhat sensitive to climate change over the timescale examined.

(7.) Property flooding on the coast, Brazil (SLR)
This was chosen by two participants, Marcelo and Maria Izabel (LEAD). Teresa from Mexico also found this theme salient though, finishing off Maria Izabel's explanation:

> *"I thought about the beaches of Brazil. Because it's a very important thing in peoples lives. And we love beach, and then maybe we can say about, uh, with climate change there will be no more place to…"* Maria Izabel, Brazil
> *"…to go and lay!"* Teresa, Mexico

> *"People who has, who have houses by the beach which normally in Brazil are the richest people, they would be very touched by losing their house."* Marcelo, Brazil

Thus, this icon ranked in a middle position for pragmatic reasoning, and coded under several nodes in intangible reasoning - more than any other individual SLR icon. However, again, this may be a difficult icon to model as not much research appears to have been carried out in this location.

(8.) Coastline, Sweden (SLR)
This was chosen by one of the cp.net participants.

> *"Rising seas. I live in Gothenburg, Sweden and grew up close to the sea. We do have landrise since the Ice Age but if the sea rises faster than that everyone living close to the sea will be affected."* Participant 17, Sweden

The icon was placed in an average position for pragmatic reasoning, but did not rank at all for intangible reasoning.

(9.) R. Wensum (ecosystem)

This was chosen by two participants, both in the CNS group.

> *"...and my house is under water too, as I live quite near there… (laughter) and half way up the Cathedral, and Mercy nightclub up on Prince of Wales Rd is (laughter) [...]and you've got crocodiles in the river. And various other tropical plants.[...] I thought it would be quite nice to show people what they are going to lose."*
>
> Tom, Norfolk, UK

> *"I've got the rivers Yare and Wensum, and further salinity creeping up the rivers… and the different species that would be displaced because of that."* Tiny, Norfolk, UK

This icon has an average trajectory, through both intangible and pragmatic reasoning. However, there is a lack of models for this particular river so it may prove hard to quantify. The literature search also did not predict this river to be greatly affected by climate change, especially on the relatively short time scale chosen.

(10.) Skiing, Alps (Winter sports)

Although winter sports as a group were chosen twice, only one of the participants gave a spatial location for their activity. However, both reasonings are included here and both are accounted for in the icon trajectory.

> *"Winter sports. If climate change would lead to snow free mountains, there is now change to do winter sports any longer. […] it would directly effect one nice activity which many people are looking forward to over the whole year."*
>
> Participant no. 42, Germany

> *"…it's probably doomed anyway, um, but I did think of, of a visual, cause I mean, I think, you know, you need striking visual images. And I do think people would respond to the, the, and it's one of the few areas where you can show people an immediate negative payoff. […] 'this is a ski slope, you know, as it is now, and this is what you can expect it to be, perhaps in only ten or twenty years time."* Alison, Norfolk, UK

> *"You know, will your kids be skiing down the same piste that you're off to?"*
>
> Alison, Norfolk, UK

Skiing ranks fairly highly for pragmatic, but low for intangible reasoning. There has been much research in this area, so modelling for this icon could probably be carried out in a fully quantitative manner. Snow cover in the Alps is also very sensitive to changes in climate, as has already been seen over the last few decades (e.g. Scherrer & Appenzeller, 2004). This icon ranks at beyond a national level (but not global) as effects would be felt over several nations, and would also heavily impact the tourist market of western Europe.

(11.) Penguins, S Pole (species)

Penguins were chosen as an icon by four participants, two from LEAD and two from CP.net. The icon does not rate particularly highly on pragmatic reasoning. The reason given here is on the same lines as for polar bears – as they are "easily recognisable" (Participant 23, UK). More intangible reasoning is coded:

> *"Penguin […] because it comes from an unpopulated area and therefore belongs to no-one in particular but to everyone in general."* Participant 23, UK

> [Talking of 'March of the Penguins' movie and penguins as an icon] *"it's how people felt about it, people very touched by the film […] WWF was very, was very successful in choosing like, the, the, panda as their, as their symbol because it is like round, and round eyes, and all the people identify with that. So, that's why I decided that the penguin would be a good icon to work on that, working, humanising a penguin suffering from the climate change."* Marcelo, Brazil

Interestingly, though, although Marcelo considers the reasoning behind using penguins here makes a good icon for other people, he thinks they are not a good icon for him:

> *"because they humanise the Penguin's life, so this is like in the media, so people kind of relate, I didn't even watch because I think it's bullshit"*

It would probably be possible to model this icon quantitatively, though preliminary results from the literature suggests that penguins might not be sensitive to climate change over the period to be modelled.

(12.) Food security, China (food security)

This icon was only cited by one participant in a LEAD focus group, but the icon did provoke discussion throughout the group, appearing particularly to find salience with the other Chinese participants. It does not rate for intangible reasoning, but for pragmatic reasoning this icon scores highly. The icon would be quite sensitive to climate change over the period modelled and it would probably be possible to model it quantitatively.

> *"Chinese is very focussed on food" […] you have some impacts on food. It's…*
> (Zhen, China)
> *"…for the sensitive countries"* (Ang, China)
> *…because it's highly populated, so… food security and all these issues that matters"*
> (Liming, China)

(13.) Water supply / hydro-electric, Nigeria (drought or water supply)
Although this icon scored fairly highly for pragmatic reasoning, the literature review revealed that this icon is not likely to be affected by climate change in the timescale examined. (Water availability in Nigeria is predicted to stay the same or slightly increase, Arnell).

(14.) Water availability, UK (drought or water supply)
This icon is likely to be impacted by climate change over the timescale examined, and it is very likely that this icon could be quantitatively examined. It was chosen by one participant from a LEAD focus group. It does not rank on the intangible, although does rate on the pragmatic reasoning:

> *"Water availability where it is running out, would be the most effective communications for the UK because the loss of East Anglia is not going to happen as rapidly as sort of saying, 'yes, this is another year where we are running out of water', because with water availability there is actually potentially a crisis this year with um, maybe parts of the southeast where they will have no water."* Stephen, UK

This reasoning is interesting as it notes that for an icon to be effective, the effect of climate change may need to be visible in the near term. This has implications for the timescale used to model the icon: a longer timescale would have a greater effect on the icon, but would decrease issue saliency, whereas a shorter timescale may not produce as dramatic effect on the icon but would be more salient.

(15.) Reduction in polar ice volume (polar / ice)
This icon was chosen by three people, two from CP.net and Tiny from the CNS groups. It ranked fairly low for pragmatic reasoning, as the reasoning was coded into just one node – that the icon was a good communicator:

> *"A melting arctic glacier breaking apart and dramatically plummetting into the ocean Dynamic dramatic change."* Participant 46, nationality unknown

The icon did code a little higher for intangible reasoning though:

> *"The polar regions [...] because they're pretty much unexplored places. And to have them disappear before we have a chance to go and have a look at them in all their beauty, that would be a shame."* Tiny, Norfolk, UK

However, depending on both the location and timescale chosen, this icon could prove insensitive to climate change – although if the Arctic was chosen, then the icon is extremely sensitive.

Tyndall°Centre
for Climate Change Research

Professor Mike Hulme
Director
direct line 01603 593162

Dear PBSG member

You are warmly invited to participate in an expert elicitation to investigate potential polar bear population dynamics under climate change over the next fifty years.
This expert elicitation forms part of a PhD researching 'An iconic approach to communicating climate change' (if you would like to know more, please see the attached information sheet). It is our hope that results from this elicitation are also published in the scientific literature. Our research has shown that polar bears are an icon of climate change for many people. Although investigations into polar bear population dynamics under climate change are currently in progress, we are investigating what the expert views and associated uncertainties in this area currently are.

Expert elicitation is well established technique using a structured process to elicit subjective judgements from experts. It is widely used to quantify risk where there is a lack of empirical data to assess uncertainty, and it can make available knowledge that may not be otherwise easily accessible. Participants in the elicitation are asked to draw on all forms of knowledge available to them.

Should you accept this invitation to participate, we ask that you examine 3 sea-ice maps we have provided. We will then ask for your response to 9 questions. Once views have been collated from all experts, you will be invited to review your answers in conjunction with those from the expert group and resubmit should you wish to alter your responses. You can choose to participate online via a web link or offline via an email attachment. The elicitation will commence on Monday 8th January. Participants are asked to complete and return their elicitations by Sunday 28th January. We anticipate the elicitation should take about an hour. The second round, should you wish to participate further, will be carried out between Friday 2nd February and Sunday 11th February. A detailed timetable can be found on the attached information sheet. If you would like to participate but cannot make these dates, please do contact us and we will try to accommodate you.

You will remain anonymous throughout the procedure as your responses will be identified by a code letter only. You can modify your answers after seeing the group responses if you wish, but you will not experience pressure to do so. It is your choice whether you would like your name to be listed in any published work. If you prefer, you can remain anonymous throughout. In *no* case will responses be linked to individual experts.

In recognition of your time, the Tyndall Centre will contribute £50.00 per participant completing the elicitation to the charity Polar Bears International.
If you would like to know more and perhaps view examples of research in this area, please refer to the information sheet attached. We very much hope you will be able to assist us in this undertaking. If you have any questions before you decide whether to accept this invitation, please do not hesitate to contact us.

If you would like to take part, please email: s.o-neill@uea.ac.uk before Monday 8th January 2007.

Yours faithfully,

Ms Saffron O'Neill and Prof Mike Hulme
s.o-neill@uea.ac.uk +44(0) 1603 593911

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UEA NORWICH

Tyndall°Centre
for Climate Change Research

Information for potential expert elicitation participants

'Expert views and associated uncertainties of Polar Bear (Ursus maritimus) population dynamics under climate change to 2050'

APPENDIX 6.2
INFORMATION SHEET FOR PBSG PARTICIPANTS

Dear PBSG member

Thank you for taking the time to read this information sheet. The information sheet contains details of the submission of elicitation questions, time frame for the elicitation, some examples of the use of expert elicitation in the field of climate change and the abstract of the PhD research this elicitation forms a part of.

Submission of elicitation questions
We would like to gather your responses to 9 questions in the elicitation. There are two ways in which you can complete the elicitation form. You can either complete the elicitation entirely online via an invitation email to our survey site, or you can choose to open an email attachment form, print it out and fax it back when completed.

Time frame for the elicitation
The elicitation will be sent out on Monday 8th January and participants will have until Sunday 28th January to complete and return it. The results of the elicitation will then be collated by the team here at the Tyndall Centre. We will send out the collated results on Friday 2nd February, and participants will have until Sunday 11th February to make adjustments to their answers if they would like, after viewing the responses from the group as a whole.

Any amendments made by participants to the elicitation will be collated with the original results and re-sent on Friday 16th February. Participants can make further adjustments if they so wish: in which case, a further round of elicitation with these participants will ensue until all are satisfied with their contributions. Participating in second or further stages is completely voluntary even if the first stage has been completed. The literature in this area suggests that more than one iteration is unusual.

In recognition of your time, the Tyndall Centre will contribute £50.00 per participant completing the elicitation to the charity Polar Bears International.

Activity	*Dates*	*Approximate time for completion*
First round of elicitation responses collected	Monday 8th January - Sunday 28th January	1 hour
Responses collated by Tyndall Centre team	Monday 29th January - Friday 2nd February	
Second round of elicitation responses collected	Friday 2nd February - Sunday 11th February	15 minutes *(if you so wish)*
Responses collated by Tyndall Centre team	Monday 12th February - Friday 16th February	

Table 1. Elicitation timetable

Examples of the use of expert elicitation
Morgan, G.M., Pitelka, L.F. and Shevliakova, E., 2001. Elicitation of expert judgments of climate change impacts on forest ecosystems. Climatic Change, 49: 279–307.

Riseby, J.S. and Kandilkar, M., 2002. Expert assessment of uncertainties in detection and attribution of climate change. Bulletin of the American Meteorological Society, 83: 1317-1326.

Vaughan, D.G. and Spouge, J.R., 2002. Risk estimation of collapse of the West Antarctic Ice Sheet. Climatic Change, 52: 65–91

PhD to which this elicitation contributes:

‘An iconic approach to communicating climate change’

Article 2. (UNFCCC, 1992) states *‘stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system’* as its ultimate objective: sparking a controversy surrounding the true nature of ‘dangerous’ climate change. This research is designed to encourage climate change understanding in non-climate experts. It will argue that it is impossible to reduce a system with the complexity of the global climate to a single common metric. Instead, icons will be utilised. An icon is defined as a tangible global representation considered worthy of admiration or respect, which one can relate to and feel empathy for.

There is some evidence of the usage of such icons already e.g. the melting of the West Antarctic Ice Sheet or potential thermohaline shutdown. Yet, these icons used by climate experts are likely to discourage efficacy in the non-expert as they are too remote from everyday life. This iconic approach aims to harness the emotive and visual power of icons already in the public eye with a rigorous scientific analysis of possible changes under a different climate future. The research is divided into three consecutive sections:

1. *What makes an ‘icon’, and how will the icons be chosen?*

One of the most fundamental questions to this project concerns how to choose the icons to be modelled. The icons must fulfil their role in providing an empathetic tool for climate communication. A robust sourcing for representative icons has been carried out with three diverse groups, with contributions from participants of LEAD International, climateprediction.net forum members, and Norwich residents. The methodologies used included focus groups and an online survey. The icons investigated are flooding and the North Norfolk Coast, London and the Thames Barrier and Polar Bear population dynamics.

2. *What are the effects of modelling a potential climate future upon the chosen icons?*

Quantitative models (Lisflood, and the Tyndall Coastal Simulator) and qualitative techniques (expert elicitation) will be used to ascertain the impact of climate change for the icon under the middle-range projection SRES scenario A1B. Results will be presented as impact assessment studies in the thesis and as icon information sheets combining narratives, maps and probabilistic information, utilising communication theory, for the evaluative stage.

3. *Does this method of communicating climate provide saliency to policy-makers, the layperson and stakeholders?*

It is anticipated that using non-expert icons will aid in providing saliency of climate change to the layperson, encouraging attitude change towards mitigative and adaptive action. This last stage will evaluate if the iconic approach modifies participants’ knowledge, emotional involvement and behaviour in relation to climate change. It will utilise a semi-quantitative approach, through a comparative study of the ‘expert-led’ icons arising from the ‘Avoiding Dangerous Climate Change’ conference held in Exeter, UK in 2005 against the non-expert icons defined in this thesis.

Again, if you have any further questions, please do not hesitate to contact us. Yours faithfully,

Ms Saffron O’Neill and Prof Mike Hulme
s.o-neill@uea.ac.uk   +44(0) 1603 593911

Tyndall°Centre
for Climate Change Research

Dear Participant.

Thank you for taking the time to take part in this elicitation. The elicitation should take around an hour to complete.

The elicitation will be available for completion until Sunday 28th January 2007. Results will then be collated. On Friday 2nd February, you will be sent an email allowing you to view the collated group response in regard to your own (anonymous) answers. You will have the opportunity to change any of your answers, if you so wish, until Sunday 11th February.

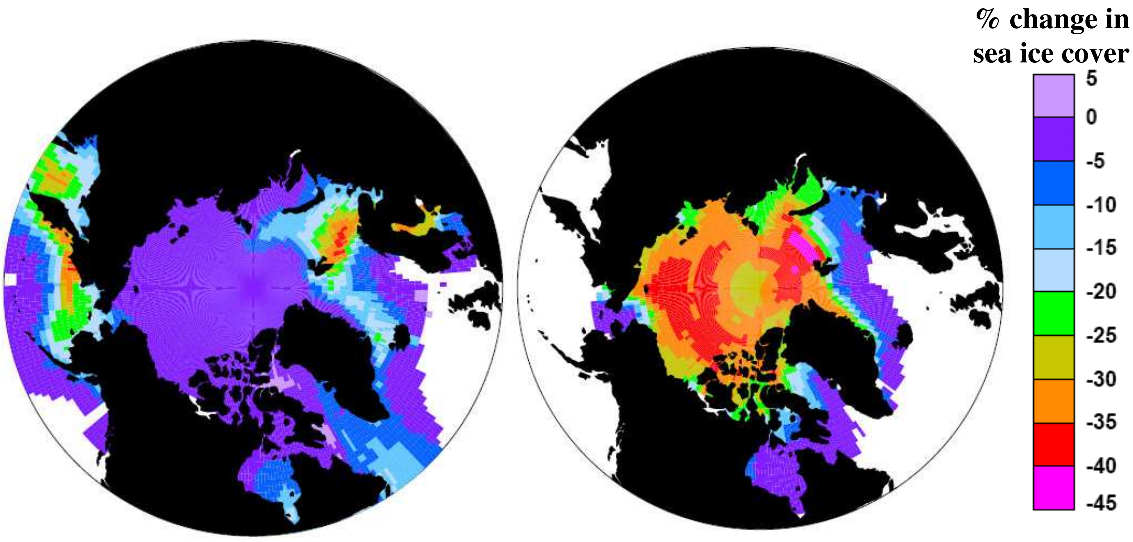
When you have finished the elicitation, please fax it to: +44 (0) 1603 593 901

If you have any questions, please do not hesitate to contact us. Thank you for participating in this elicitation. Your time is very much appreciated.

Saffron O'Neill and Mike Hulme
(s.o-neill@uea.ac.uk)

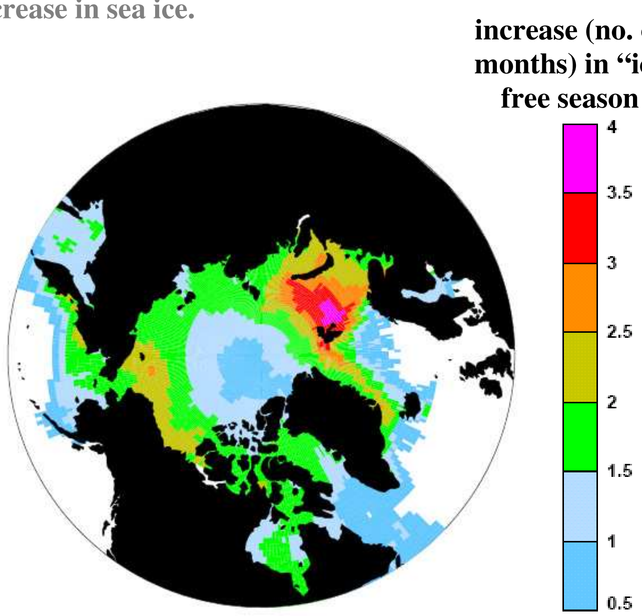
Sea ice model information: ***Please read this before you start the elicitation***

We appreciate your expertise is in polar bear dynamics and not necessarily climate science. Therefore we are providing you with simulations of sea ice from the most recent climate model experiments. These were undertaken for the forthcoming 4th IPCC report and relate for the year 2050 under the middle-range climate scenario of the IPCC SRES A1B. Please refer to this selection of ice modelling plots to aid you in the elicitation. This elicitation is designed to gather your thoughts on polar bear dynamics, *not* on climate change science itself. It is important you familiarise yourself with the following information before completing the elicitation.



(a.) (b.)

Change in sea-ice extent by 2050 for (a.) March and (b.) September. Colours indicate change in the percentage of sea ice cover for each grid cell. Negative values indicate a decrease in sea ice.



(c.) Change in "ice free" season by 2050. Colours indicate the change in the length (in number of consecutive months) of the "ice free" season. "Ice free" season is defined as that with sea-ice concentration less than 50%

There are three parts to the elicitation. The first part will ask you for your thoughts on polar bear population dynamics under current management regimes and current conditions - you should assume as a baseline that conditions of any other impacts upon polar bears (other than climate change) stay the same as today. The second part will ask for your opinions of polar bear dynamics under what you consider 'best conservation practice' and lastly, we will ask a few brief demographic questions.

To complete the elicitation, you should draw on all knowledge, information, literature, models, advice, beliefs and gut feelings available to you. If you feel you cannot answer a particular question, or part of a question, please continue to the next. Each answer you provide is important to us. At the end of the elicitation, you will have a chance to tell us why you felt you couldn't answer.

Both experts and laypeople are routinely overconfident in their predictions[50], whether it is an assessment of some defined scientific uncertainty or a simple probabilistic prediction of an everyday occurrence. Because of this, the questions asked here will first probe you for an absolute upper and lower bound, before you provide a best estimate.

Part One: Polar bear population dynamics under climate change with current management regimes

(1) What do you consider to be the three main concerns facing polar bears over the next 50 years? Please write these concerns in rank order of importance (a = most important, c = lesser importance)

a)
b)
c)

Before the next question, we would like you to follow this example through. The example demonstrates the question style we'll be using for the rest of the elicitation.

Example: Price of oil in 2050
Please refer to the example box plot below (fig. 4) when reading the example question.

The price of a barrel of oil is $61.53 today. There is no way of knowing exactly what the price of a barrel of oil will be in 2050. However, there are those who work with this sort of information every day, and thus have a better chance of estimating what this figure might be - the experts in the elicitation process.

[50] If you would like to know more about overconfidence in predictions, or designing an expert elicitation, please see Morgan, G.M. and Henrion, M. (1992) *Uncertainty*. New York: Cambridge University Press.

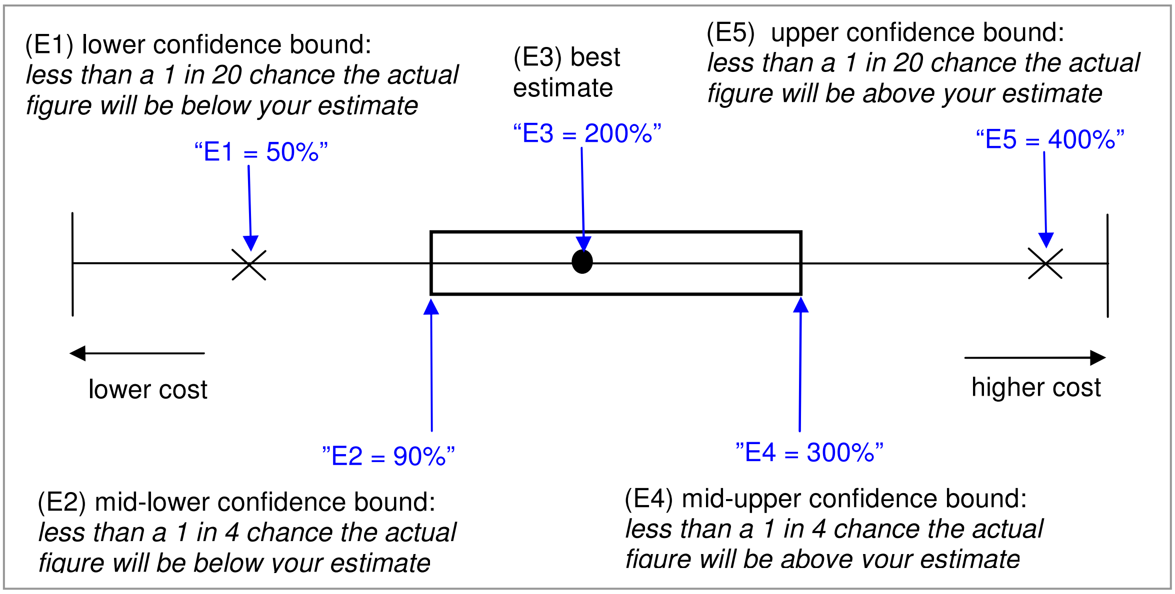


Figure 4. 'Price of a barrel of oil in 2050' example box plot showing the expert's estimations in blue

Asking for an oil price directly may be difficult, as the expert may not wish to give their estimations in US dollars. Also, it may give a false sense of accuracy if the expert is asked to quote an exact price in dollars and cents in their elicitation. To avoid these problems, we want to know what the expert's estimations are as a percentage, relative to today's oil prices. For example:

- if the expert thinks the price will be half of today's price, they will answer '50%'
- if they think the price will be double today's price, they will answer '200%'
- If they think the price will remain the same relative to today's price, they will answer '100%'.

The expert cannot give a definitive answer to what price of a barrel of oil might be in 2050, but there are ranges of uncertainty surrounding this figure. We want to know what the bounds of possibility surrounding this estimate are, as well as what the expert considers their 'best estimate'.

We want to investigate the lower range of possibility, or the plausible "lower cost" scenario. For this, we want to know what price for which the expert considers there is only a 1 in 20 chance that the cost in 2050 will fall below (E1 on the box plot diagram). The expert considers that there is a 1 in 20 chance - i.e. that it would be *very unlikely* - that the cost of a barrel of oil in 2050 will be less than halve of today's price, so they answer '50 %'.

We also want to investigate the upper range of possibility, or the plausible "higher cost" scenario. For this, we want to know what price for which the expert considers there is only a 1 in 20 chance that the cost in 2050 will rise above (E5 on the box plot diagram). The expert considers that there is a 1 in 20 chance - i.e. that it would be *very unlikely* - that the cost of a barrel of oil in 2050 will be greater than four times today's price, so they answer '400 %'.

These figures are useful to know the outer bounds of what the expert considers plausible, but these figures represent a wide range of uncertainty. We would also like to know a narrower range which the expert considers more likely. So, we want to know what price for which the expert considers there is a 1 in 4 chance that the cost in 2050 will fall below (E2 on the box plot diagram). The expert considers that there is a 1 in 4 chance - i.e. that it would be *unlikely* - for the cost of a barrel of oil relative to today's price to be less than '90 %'.

We also then want to know what price the expert considers there is a 1 in 4 chance that the actual cost change in 2050 will rise above (E4 on the box plot diagram). The expert considers that there is a 1 in 4 chance - i.e. that it would be *unlikely* - that the cost of a barrel of oil in 2050 relative to today's price will be greater than '300 %'.

Finally, once the expert has defined the range of uncertainty in their answer, we would like to know what they consider their best estimate of the price of a barrel of oil in 2050 (E3 on the box plot diagram). The expert thinks their *best estimate* is that the price will double relative to today's price, so they answer '200 %'.

(2) In this next question, we will walk you through the steps we would like you to take to complete your own expert elicitation, in the same style as the example above. You will need to refer to Figure 5, the box plot diagram below. You will also need to refer to the sea ice information at the beginning of the elicitation.

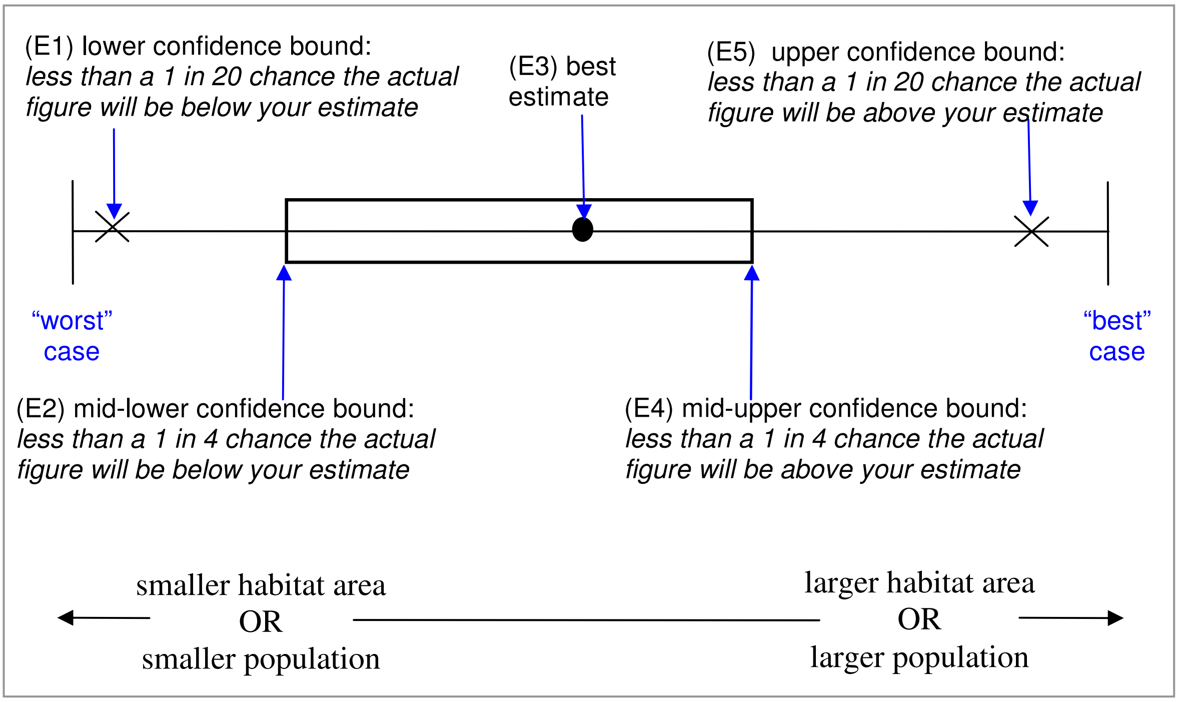


Fig. 5 Box plot diagram

Please look at the box plot and the sea-ice model data now. We will be asking for your estimate for each of the points shown on the box-plot diagram above (Figure 5). We will start with your outer bounds (E1 and E5), then your mid-outer bounds (E2 and E4), before ending with your best estimate (E3).

This question is asking about the change in the area of the polar bear range across the Arctic in 2050, compared to the current situation. We would like you to estimate the range in 2050 (with the sea-ice change shown in the maps) expressed as a percentage of today's range, under current management regimes.

For example:

- if you think the range will be half of today's size, you should answer '50%'

- if you think the range will be double today's size, you should answer '200%'
- if you think the range will stay the same, you should answer '100%'

a) Look towards the "worst case" end of the scale. We would like an estimation of the first 'cross', the lower confidence bound (E1 on the box plot diagram). This is the plausible "worst case" scenario.

Could you estimate the range, less than which is **very unlikely** to occur by 2050, based on the evidence you have seen. (By this, we mean an estimate of the range below which you think there is only a 1/20 chance of occurring).
Please estimate the change as a percentage of today's range.

(E1)	%

b) Look towards the "best case" end of the scale. We would like an estimation of the second 'cross', the upper confidence bound (E5 on the box plot diagram). This is the plausible "best case" scenario.

Could you estimate the range, greater than which is **very unlikely** to occur by 2050, based on the evidence you have seen. (By this, we mean an estimate of the range above which you think there is only a 1/20 chance of occurring).
Please estimate the change as a percentage of today's range.

(E5)	%

Please look over your confidence intervals E1 and E2 now. Remember, everyone tends to underestimate uncertainty and be overconfident in their predictions, so feel free to alter your lower and upper bounds if you think they are too narrow.

c) Look towards the "worst case" end of the scale again. We would like an estimation of the left-hand edge of the 'box', the mid-lower confidence bound (E2 on the box plot diagram).

Could you estimate the range, less than which is **unlikely** to occur by 2050, based on the evidence you have seen. (By this, we mean an estimate of the range below which you think there is only a 1/4 chance of occurring).
Please estimate the change as a percentage of today's range.

(E2)	%

d) Look towards the 'best case' end of the scale again. We would like an estimation of the left-hand edge of the 'box', the mid-higher confidence bound (E4 on the box plot diagram).

Could you estimate the range, greater than which is **unlikely** to occur by 2050, based on the evidence you have seen, as a percentage of today's range. (By this, I mean an estimate of the change that there is a 1/4 chance of being less than).
Please estimate the change as a percentage of today's range

(E4)	%

e) Finally, could you give your **best estimate** (E3 in the box plot diagram) of change by 2050, based on the evidence you have seen, as a percentage of today's range.
Please estimate the change as a percentage of today's range.

(E3)	%

h) How did you arrive at these estimates?

i) Where, if anywhere, do you see this change in range mostly occurring?

3.) The question format here will be the same as question 2. You will need to refer to the sea ice information and the box-plot diagram (polar bears). To avoid having to go through the time-consuming and detailed procedure of answering the box plot elicitation questions, we'll provide you with a simpler way of answering from now on.

Please look at the box plot and the sea-ice model data now. We will be asking for your estimate for each of the points from E1 through to E5 on the box-plot diagram (Figure 5), but this time we are asking about the change in the polar bear population across the Arctic in 2050, compared to the current situation.

We would like you to estimate the population in 2050 (with the sea-ice change shown in the maps) expressed as a percentage of today's population, under current management regimes. As before:

- if you think the population will be half of today's size, you should answer '50%'
- if you think the population will be double today's size, you should answer '200%'
- if you think the population will stay the same, you should answer '100%'

a) Please estimate the lower confidence bound (E1) for total polar bear population by 2050:

(E1)	%

b) Please estimate the upper confidence bound (E5) for total polar bear population by 2050:

(E5)	%

c) Please estimate the mid-lower confidence bound (E2) for total polar bear population by 2050:

(E2)	%

d) Please estimate the mid-higher confidence bound (E4) for total polar bear population by 2050:

(E4)	%

e) Could you give your best estimate (E3) for total polar bear population by 2050:

(E3)	%

h) How did you arrive at these estimates?

i) Where, if anywhere, do you see this population change mostly occurring?

We would now like to investigate your views on specific populations of polar bears over five regions, as defined in figure 6 below. We have defined regions using the gridding system in the sea-ice models. We have tried to match these regions as closely as possible to the PBSG defined population regions. Some regions are amalgamations of PBSG-defined regions.

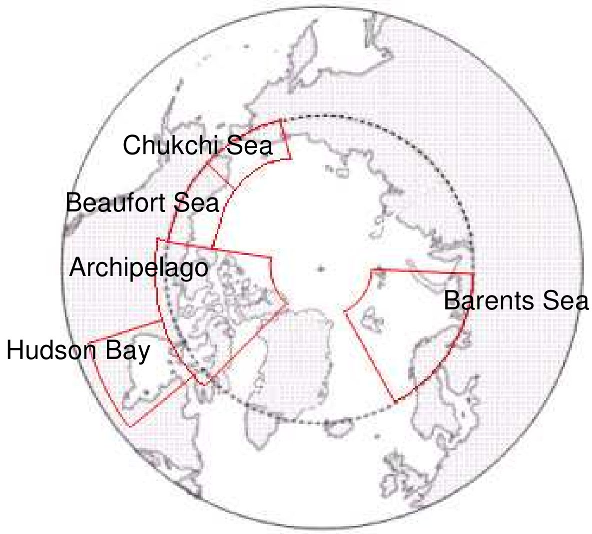


Figure 6. Geographic locations of the 5 regions

Amalgamations are:

Hudson Bay *(includes Southern Hudson Bay, Western Hudson Bay and Foxe Basin)*
Archipelago *(includes Gulf of Boothia, M'Clintock Channel, Lancaster Sound, Viscount Melville Sound, Norwegian Bay, Queen Elizabeth, Kane Basin)*
Beaufort Sea *(includes Southern and most of Northern Beaufort Sea)*

A time series is provided for each region to demonstrate the variability in the "ice free" period each year. You may also like to refer to the sea ice information maps you have already seen.

We defined "ice free" as when the decline in the total cover of the melting sea ice reached 50% or below (this value is biologically meaningful for polar bears in these analyses[51]). Polar bears can probably handle a single short ice season, but as the ice-free seasons increase in length, the bears will be subject to increasing stress[2].

Please look at the box plot and the sea-ice model data now. We will be asking for your estimate for each of the points from E1 through to E5 on the box-plot diagram (Figure 5), but this time we are asking about the change in the polar bear population across the Arctic in 2050, compared to the current situation.

The next five questions are asking about the change in the polar bear population over five different regions in 2050, compared to the current situation. We would like you to estimate the population size in 2050, with climate change, as a percentage of today's population.

[51] Stirling and Parkinson (2006). Possible Effects of Climate Warming on Selected Populations of Polar Bears (Ursus maritimus) in the Canadian Arctic. *Arctic*: 59 (3) 261-275

(4) This question is asking for elicitations on populations within the Barents Sea region as defined in question 4. Please refer to figure 7 when answering this question.

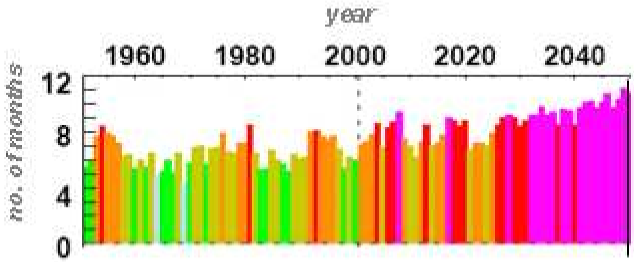


Figure 7. Time series of length (in number of consecutive months) of the "ice free" season from 1950 to 2050 for the Barents Sea region.

a) Please estimate the lower confidence bound (E1) for the Barents Sea population by 2050:

(E1)	%

b) Please estimate the upper confidence bound (E5) for the Barents Sea population by 2050:

(E5)	%

c) Please estimate the mid-lower confidence bound (E2) for the Barents Sea population by 2050:

(E2)	%

d) Please estimate the mid-upper confidence bound (E4) for the Barents Sea population by 2050:

(E4)	%

e) Please provide your best estimate (E3) for the Barents Sea population by 2050:

(E3)	%

(5) This question is asking for elicitations on populations within the Chukchi Sea population as defined in question 4. Please refer to figure 8 when answering this question.

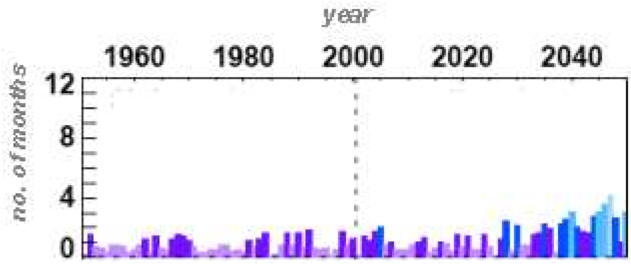


Figure 8. Time series of length (in number of consecutive months) of the "ice free" season from 1950 to 2050 for the Chukchi Sea region.

a) Please estimate the lower confidence bound (E1) for the Chukchi Sea population by 2050:

(E1)	%

b) Please estimate the upper confidence bound (E5) for the Chukchi Sea population by 2050:

(E5)	%

c) Please estimate the mid-lower confidence bound (E2) for the Chukchi Sea population by 2050:

(E2)	%

d) Please estimate the mid-upper confidence bound (E4) for the Chukchi Sea population by 2050:

(E4)	%

e) Please provide your best estimate (E3) for the Chukchi Sea population by 2050:

(E3)	%

(6) This question is asking for elicitations on populations within the Beaufort Sea population as defined in question 4. Please refer to figure 9 when answering this question.

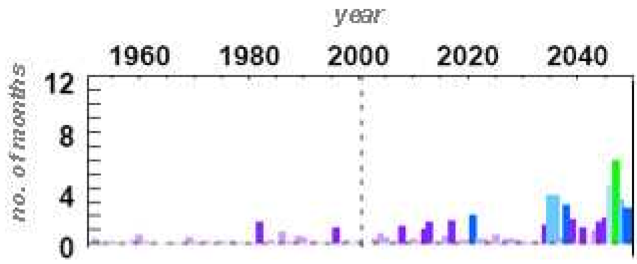


Figure 9. Time series of length (in number of consecutive months) of the "ice free" season from 1950 to 2050 for the Beaufort Sea region.

a) Please estimate the lower confidence bound (E1) for the Beaufort Sea population by 2050:

(E1)	%

b) Please estimate the upper confidence bound (E5) for the Beaufort Sea population by 2050:

(E5)	%

c) Please estimate the mid-lower confidence bound (E2) for the Beaufort Sea population by 2050:

(E2)	%

d) Please estimate the mid-upper confidence bound (E4) for the Beaufort Sea population by 2050:

(E4)	%

e) Please provide your best estimate (E3) for the Beaufort Sea population by 2050:

(E3)	%

(7) This question is asking for elicitations on populations within the Canadian Archipelago population as defined in question 4. Please refer to figure 10 when answering this question.

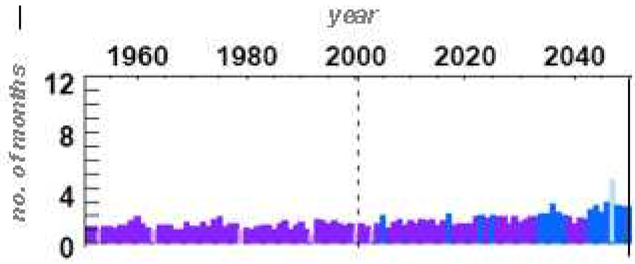


Figure 10. Time series of length (in number of consecutive months) of the "ice free" season from 1950 to 2050 for Canadian Archipelago region.

a) Please estimate the lower confidence bound (E1) for the Canadian Archipelago population by 2050:

(E1)	%

b) Please estimate the upper confidence bound (E5) for the Canadian Archipelago population by 2050:

(E5)	%

c) Please estimate the mid-lower confidence bound (E2) for the Canadian Archipelago population by 2050:

(E2)	%

d) Please estimate the mid-upper confidence bound (E4) for the Canadian Archipelago population by 2050:

(E4)	%

e) Please provide your best estimate (E3) for the Canadian Archipelago population by 2050:

(E3)	%

(8) This is the last question on population change in specific regions. This question is asking for elicitations on populations within the Hudson Bay population as defined in question 4. Please refer to figure 11 when answering this question.

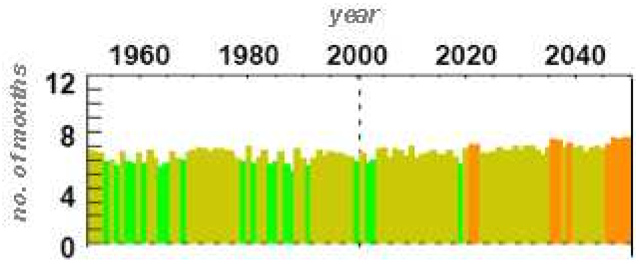


Figure 11. Time series of length (in number of consecutive months) of the "ice free" season from 1950 to 2050 for the Hudson Bay region.

a) Please estimate the lower confidence bound (E1) for the Hudson Bay population by 2050:

(E1)	%

b) Please estimate the upper confidence bound (E5) for the Hudson Bay population by 2050:

(E5)	%

c) Please estimate the mid-lower confidence bound (E2) for the Hudson Bay population by 2050:

(E2)	%

d) Please estimate the mid-upper confidence bound (E4) for the Hudson Bay population by 2050:

(E4)	%

e) Please provide your best estimate (E3) for the Hudson Bay population by 2050:

(E3)	%

Part Two: Polar bear population dynamics under climate change with 'best conservation practice'

For the last question, we would like to investigate your views on polar bear population for the Arctic as a whole with climate change to 2050, under best conservation practice, in contrast to the previous questions which have been under current management techniques.

9) What would you define as 'best conservation practice'?

As with question 3, we will be asking for your estimate of the total Arctic polar bear population in 2050, compared to today. But this time, we would like to know your opinions with your definition of the 'best conservation practice' in operation.

a) Please estimate the lower confidence bound (E1) for the total Arctic population under best conservation practice by 2050:

(E1)	%

b) Please estimate the upper confidence bound (E5) for the total Arctic population under best conservation practice by 2050:

(E5)	%

c) Please estimate the mid-lower confidence bound (E2) for the total Arctic population under best conservation practice by 2050:

(E2)	%

d) Please estimate the mid-upper confidence bound (E4) for the total Arctic population under best conservation practice by 2050:

(E4)	%

e) Please provide your best estimate (E3) for the total Arctic population under best conservation practice by 2050:

(E3)	%

Thank you for all your answers. Please could you briefly provide an overview of your background by answering the following questions. These will *not* be used without your consent in any communication of these results: you can remain anonymous throughout the process. Any personal details will not be shared and will be deleted at the end of the elicitation exercise.

Part 3: your expertise

10) Please enter your name:

11) Please enter your email address:

12) How would you describe your disciplinary or professional background?

13) Please could you provide us with a self-evaluation of your expertise in the following areas *(Please cross* 'X' *the appropriate box)*

	Not familiar with this area	Little knowledge of this area	Some knowledge of this area	Well informed in this area	Among the top experts in the world in this area
a) Polar bear life cycle dynamics	☐	☐	☐	☐	☐
b) Polar bear management practice (hunting quotas etc.)	☐	☐	☐	☐	☐
c) Sea ice dynamics modelling	☐	☐	☐	☐	☐
d) Climate modelling	☐	☐	☐	☐	☐
e) Climate policy	☐	☐	☐	☐	☐

14) Please could you tick the regions in which you have expertise in polar bear population dynamics:

Hudson Bay (includes Southern Hudson Bay, Western Hudson Bay and Foxe Basin)	☐
Archipelago (includes Gulf of Boothia, McClintock Channel, Lancaster Sound, Viscount Melville Sound, Norwegian Bay, Queen Elizabeth, Kane Basin)	☐
Beaufort Sea (includes Southern and most of Northern Beaufort Sea)	☐
Chukchi Sea (region boundaries defined by sea-ice model not PBSG)	☐
Barents Sea (region boundaries defined by sea-ice model not PBSG)	☐

15) Do you have any final thoughts on the elicitation? (you can include any reasoning behind unanswered questions, or additional information on specific questions):

☐ I consent to my name being listed as a PBSG participant in this elicitation in any publications which may arise from these results *(specific responses will NOT be attributed to any member, nor will code letters be linked to any respondent)*

OR

☐ I would like to remain anonymous (identified by random code letter only) in any publications which may arise from these results,

That's it! Thanks for contributing to this research - your time is very much appreciated.

You will be emailed both your individual results and those of the group on Monday 15th January. You will then have a week to make adjustments to your answers if you wish, after viewing the responses from the group as a whole.

Please fax this to: +44 (0) 1603 593 901, marked:
'FAO: Saffron O'Neill (Tyndall)'

GCMS USED TO CONSTRUCT SEA ICE INFORMATION

BCCR-BCM2.0
CGCM3.1(T47)
CGCM3.1(T63)
CNRM-CM3
CSIRO-Mk3.0
GISS-AOM
GISS-ER
INM-CM3.0
IPSL-CM4
MIROC3.2(hires)
MIROC3.2(medres)
ECHO-G
ECHAM5/MPI-OM
MRI-CGCM2.3.2
CCSM3
UKMO-HadCM3

Participant number:

This is the first part of the mini-workshop

We are interested in your opinions and your feelings. There are no right or wrong answers; it is your personal views that are important. This is not a test!

If you would like any help with the surveys, please don't hesitate to ask- but we cannot help with any particular questions on climate change until the end of this workshop. Once you've finished going through the mini-workshop, we will be more than happy to answer any questions you may have. Remember, this workshop is about what you personally think and about your views.

1. How do you generally feel about the future? *(please circle the number below the line to indicate your opinion)*:

I feel bleak about the future							**I feel positive about the future**
0	1	2	3	4	5	6	7

2. What comes to mind when you hear the phrase "climate change"? *Please write down the first three things that come to mind:*

1) ____

2) ____

3) ____

3. How serious a threat do you think climate change is to: *(Please tick the box that applies on each row)*

	Very serious	Fairly serious	Not very serious	Not at all serious
a.) You	☐	☐	☐	☐
b.) People in your local community	☐	☐	☐	☐
c.) People in the UK	☐	☐	☐	☐
d.) People in other countries	☐	☐	☐	☐
e.) Animals and plants in your local area	☐	☐	☐	☐
f.) Animals and plants in the UK	☐	☐	☐	☐
g.) Animals and plants in other countries	☐	☐	☐	☐

4. When do you think climate change is / will be dangerous for: *(Please tick the box that applies on each row)*

	Now	In 10 years	In 25 years	In 50 years	In 100 years	Never
a.) You	☐	☐	☐	☐	☐	☐
b.) Your local community	☐	☐	☐	☐	☐	☐
c.) People in the UK	☐	☐	☐	☐	☐	☐
d.) People in other countries	☐	☐	☐	☐	☐	☐
e.) Animals and plants in your local area	☐	☐	☐	☐	☐	☐
f.) Animals and plants in the UK	☐	☐	☐	☐	☐	☐
g.) Animals and plants in other countries	☐	☐	☐	☐	☐	☐

5. How interested are you in climate change?

Not at all interested	Not very interested	Quite interested	Very interested
☐	☐	☐	☐

6. How worried are you about climate change?

Not at all worried	Not very worried	Quite worried	Very worried
☐	☐	☐	☐

7. Please indicate to what extent you agree or disagree about the following statements:

	Strongly agree	Tend to agree	Neither agree nor disagree	Tend to disagree	Strongly disagree
a.) The thought of climate change fills me with dread	☐	☐	☐	☐	☐
b.) Too much fuss is made about climate change	☐	☐	☐	☐	☐
c.) I feel a moral duty to do something about climate change	☐	☐	☐	☐	☐
d.) I do not believe that climate change is a real problem	☐	☐	☐	☐	☐
e.) Nothing I do makes any difference to climate change one way or another	☐	☐	☐	☐	☐
e.) The effects of climate change are likely to be catastrophic	☐	☐	☐	☐	☐
f.) If I come across information about climate change I will tend to look at it	☐	☐	☐	☐	☐
g.) I am well informed about climate change	☐	☐	☐	☐	☐
h.) It is already too late to do anything about climate change	☐	☐	☐	☐	☐
i.) Climate change is too complicated for me to understand	☐	☐	☐	☐	☐
j.) Talking about climate change is boring	☐	☐	☐	☐	☐
k.) Human activities are altering global temperatures	☐	☐	☐	☐	☐

8. How likely are you to talk to the following people about climate change? *(Please tick the box that applies on each row):*

	Very likely	**Quite likely**	**Neither more or less likely**	**Quite unlikely**	**Very unlikely**
a) Family	☐	☐	☐	☐	☐
b) Friends	☐	☐	☐	☐	☐
c) Colleagues	☐	☐	☐	☐	☐

9. Do you think climate change is going to affect you personally?

☐ Yes (go to question 10)
☐ No (go to question 11)
☐ Don't know (go to question 11)

10. In which way(s) is it going to affect you? *Please state the first three things that come to mind:*

1) ______________________________

2) ______________________________

3) ______________________________

11. Have you ever taken any action out of concern for climate change?

☐ Yes (go to question 12)
☐ No (survey 1 finished. Thank you. Please hand this form back to the facilitator)

12. If yes, what did you do?

____

____

Thank you for completing the first stage of the workshop.
Now please hand this form in to the facilitator

We have been looking at using 'icons' to help communicate climate change. An icon is something that you may care about, or empathise with. It is something that you may consider worthy of respect.

Now we will hand out information sheets on four different 'icons' to look through. This should take around 10 minutes. When this time is up, one of the facilitators will provide you with the final part of the mini-workshop.

The Norfolk Broads

Picture a.

The Norfolk Broads are Britain's largest protected wetland, with the status of a national park. It is home to some of the rarest plants and animals in the UK (picture a).

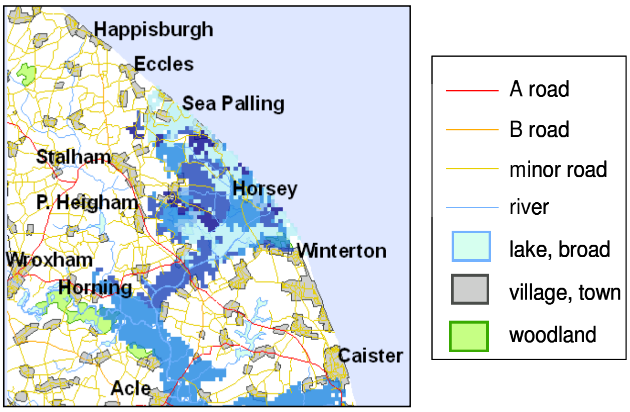
The northern Broads are not tidal, and seawater generally does not enter the rivers - even though much of the land in this area lies below sea level. In the past, the northern Broads were open to the sea via the Hundred Stream. This stream does not reach the sea today because it is blocked by sand dunes, but it means the area is vulnerable to flooding from the sea. The area between Sea Palling, Eccles and Potter Heigham (map b) has been flooded several times in recent history. The last flood was in 1953. A 14km-long sea wall was then built which has stopped flooding in this area. If the sea did break through this barrier over 9 000 hectares, 6 large villages and several farms could be flooded with salty water. A salt water flood would be negatively affect the rare freshwater plants and animals in Hickling Broad.

The Norfolk Broads and climate change

The sea wall is being damaged by the sea. Groynes, rocks and reefs are being used to try and protect the sea wall from further damage. Sea level will rise with climate change. Storm surges such as those seen in 1953 could also increase. This will cause further damage to the sea wall. The chance of the sea breaking through the Sea Palling / Winterton sand dunes will increase.

What will happen by 2050?

The likelihood of a flood continues to increase throughout the flood plain, but especially in Sea Palling and around Hickling Broad. There is also an increase to the expected cost of flood damages. Much higher costs are expected in Sea Palling, and also around Horsey. The expected annual damage cost in 2050 is about 25% greater than today.



Map b. Changes in the likelihood of a salt water flood to 2050: the blue squares indicate areas with increasing flood likelihood (darker blues indicate a greater flood likelihood than lighter blues)

London and the Thames Estuary

London has been an important settlement for over 2,000 years. It is now a leading business, financial and cultural centre, and is home to more than 7 million people.

Picture a.

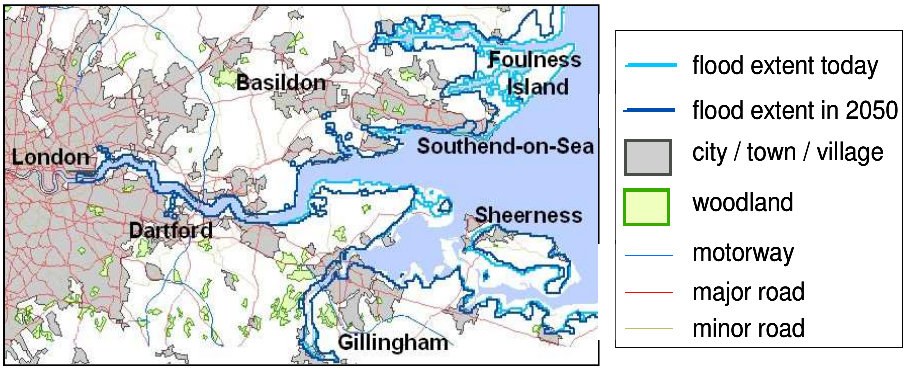
London is located on the River Thames, and has always been at risk of flooding. Much of the City is no higher than 5m above the River (picture a). The first recorded flood was in 1099; the last was the Great Flood of 1953. The Thames Barrier was built after the Great Flood to guard London against such events in the future. It is the most complicated and expensive flood defence system in the UK. Since the Thames Barrier was completed, it has been very reliable. Developments such as the Thames Gateway Regeneration Area rely on the flood defences. The flood defence system protects around 1.25 million people, 420 000 properties (worth over £80 billion), 400 schools, 16 hospitals and 8 power stations. A flood in London could have an impact globally.

London and the Thames Estuary and climate change

Sea level will rise with climate change. Storm surges such as those seen in 1953 could also increase. There is also a threat of increased river water flowing down the Thames into the sea. The Thames Barrier already has to close more often to protect London from flooding than it did when it opened in 1982, and it is likely it will be closed more in the future. Low lying coastal areas in the Thames Estuary are at greater risk of flooding.

What will happen by 2050?

An extreme flood from the sea in 2050 would impact the Essex and Kent coastlines, especially around Foulness Island and Sheerness (map b). Southend would experience more severe flooding. There are no estimates of how much this might cost. It is expected that the Thames Barrier would still protect central London from flooding.



Map b. The extent of an extreme flood from the sea today (light blue) and in 2050 (dark blue)

Polar bears (*Ursus maritimus*)

Polar bears (picture a) live in five main population groups in the Arctic (map b). Polar bears are at the top of the Arctic food chain. This makes them a good indicator for the health of all animals, fish and plants in the Arctic.

Sea ice is essential for polar bears. They use it as a platform for travel, to hunt, for mating, and for birth dens. They are most common at the ice edge, as they catch prey either in shallow water near the shore, or in open water pools out on the ice. Polar bears are not well adapted to life on land, so rarely venture off the ice.

Picture a.

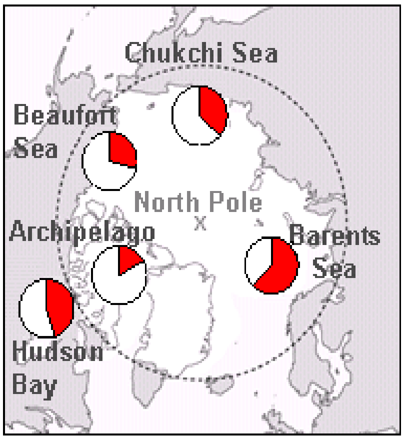
Polar bears and climate change

Polar bears in some areas are threatened by pollution and hunting. All polar bears are also threatened by climate change.

The area of the Arctic covered in sea ice varies from year to year. It also varies through the year - there is more sea ice in winter than in the summer. In the last 50 years, much sea ice has melted and not refrozen. Polar bear survival depends on sea ice. When there is less ice, bears find it harder to survive and to reproduce. If sea ice disappeared completely, it is unlikely polar bears would survive.

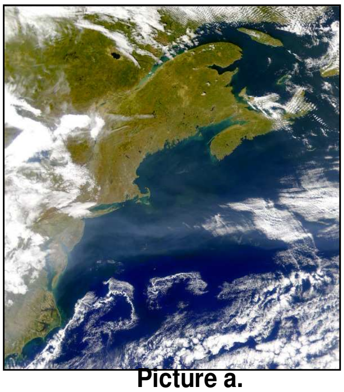
What will happen by 2050?

Arctic sea ice is predicted to melt even more in the next 50 years. Polar bear habitat is predicted to decrease. The total number of polar bears is also predicted to decrease substantially; for example, the number of polar bears in the Barents Sea region is predicted to decrease by about 60% (map b). The Hudson Bay population is also at great risk. The largest numbers of polar bears live in the Archipelago, Chukchi and Beaufort Sea regions, whose numbers may reduce less. Even after adopting best conservation practices, numbers of polar bears are predicted to drop substantially.



Map b. Polar bear population decrease by 2050 (red segment shows percentage of bears lost)

Thermohaline Circulation



Picture a.

The thermohaline circulation (THC) is the flow of seawater around the world's oceans. The THC is mainly controlled by the density of seawater. Warm, salty water at the equator is less dense than colder, less salty water towards the North Pole.

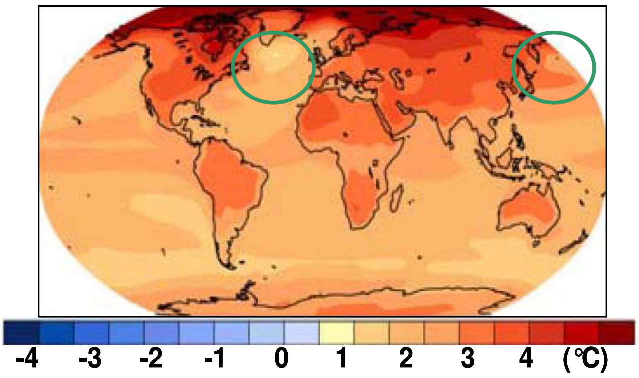
The North Atlantic Ocean is very important in driving the flow of the global THC. Seawater travels across from the Caribbean towards Iceland, partly pushed by winds known as the Gulf Stream (picture a). This warm water flows past Britain, keeping temperatures mild. As this seawater travels further north towards Iceland, it becomes colder and denser, and eventually sinks towards the ocean floor near Greenland. This cold water then flows back at depth towards the equator.

The THC and climate change

Climate would be affected if the THC was to 'weaken' i.e. to transport less seawater from the equator to the poles. The THC would weaken if ice melted (e.g. Greenland) and flowed into the North Atlantic. In the distant past, the THC has weakened rapidly, causing large changes in climate over a century or less. If the seawater flowing past Britain is colder, average temperatures on land are also colder. However, even if the THC did weaken, temperatures in Britain would still be warmer than today because greenhouse gases are warming the atmosphere.

What is predicted to happen to the THC by 2050?

The flow of seawater near Greenland appears to be getting weaker. It is very likely that the flow of the THC in the North Atlantic will weaken in the next 40 years (map b) but it is very unlikely that the flow will stop. However, the chance of a large weakening in the THC beyond 2050 would be more likely if greenhouse gas emissions were not significantly reduced by then.



Map b. Possible change in air temperature by 2050. As the THC weakens, the North Atlantic warms less than the North Pacific at a similar latitude (see green circles)

Ocean acidification

Picture a.

Seawater can absorb large amounts of carbon dioxide from the atmosphere. Carbon dioxide is constantly exchanged between the atmosphere and the ocean. In the ocean, carbon dioxide dissolves to form a weak acid. As more carbon dioxide dissolves into the ocean, the ocean becomes more acidic. As seawater becomes more acidic, it changes the amount of carbon, oxygen and nutrients in the ocean. Particularly important is how much carbonate (a compound made of of calcium, carbon and oxygen) exists in the ocean, since many marine creatures use carbonate to help make their shells and skeletons.

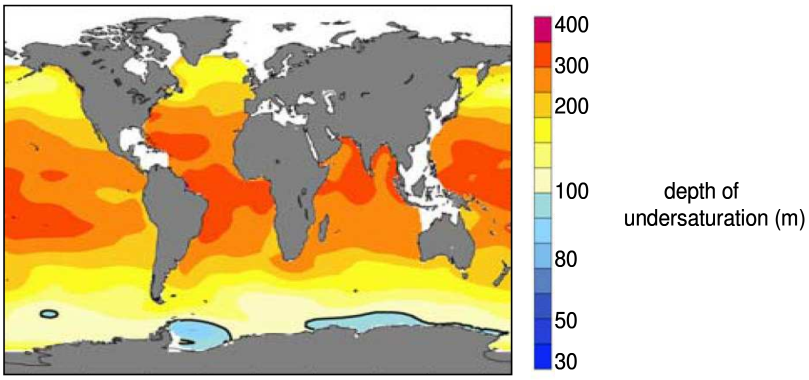
At the moment, the surface layers of the ocean are ‘super-saturated’ with forms of carbonate, and only ‘under-saturated’ below a certain depth. When the ocean becomes under-saturated, the shells of marine creatures start to dissolve. Different areas of the ocean becomes under-saturated at different depths.

Ocean acidification and climate change

The ocean can absorb small increases in atmospheric carbon dioxide, but the current increase is about 100 times faster than natural variation. Over the past decades, the ocean has become more acidic, so carbonate starts dissolving at shallower depths. The under-saturated layer rises closer to the surface. Coral reefs in tropical regions (picture a) and polar regions are particually affected. The microscopic plants and animals which use carbonate to build their shells will be impacted first. This can then cause changes higher up in the food chain.

What will happen by 2050?

It is predicted that at least one type of carbonate will begin to be under-saturated in the Southern Ocean by 2050 (see map b). By 2050, some areas in the North Sea will have a totally different acidity range from the levels observed today. Many marine processes, plants and animals are thought to be vulnerable to a change in ocean acidity.



Map b. The predicted under-saturation depth of a carbonate in 2050. Under-saturation is shallowest in the blue areas. (There is a minimum under-saturation depth now of about 150m).

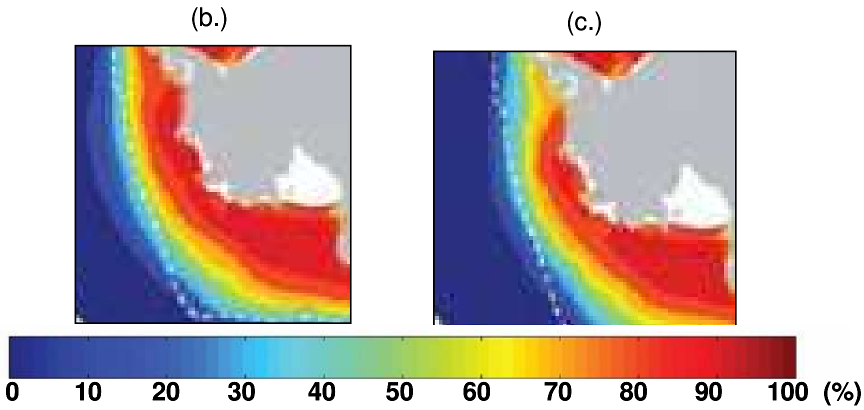
West Antarctic Ice Sheet

Picture a.

An ice sheet (picture a) is a thick body of ice, mainly formed from compressed snow. Because of the weight of the ice sheet above, the ice sheet flows very slowly towards the ice sheet edge. The West Antarctic Ice Sheet (WAIS) mainly rests on ground that is below sea level. It is kept from slipping into the ocean by ice shelves at its edges, which float in the ocean. Ice sheets grow when there is a cooler climate, and shrink in warmer climates, but shrinking of ice sheets can be much faster than growth. The WAIS contains 13% of all the ice found on the Antarctic continent.

The WAIS and climate change
Even a small amount of warming could melt some ice and cause an increase in sea level. The WAIS has been flowing faster in recent years, and this may be because the ice shelves bordering the WAIS are thinning as the ocean warms (maps b and c). This could mean that in the future, much more ice from the WAIS could be lost, although it would take centuries to melt completely. A complete melt would raise global sea level by about 5 metres.

What is predicted to happen to the WAIS by 2050?
It is predicted that there will continue to be warming in Antarctica, and some reduction in ice shelves (maps b and c). However, the WAIS will remain too cold for widespread melting. The physics of ice sheets are not well understood. This limits the ability to make accurate predictions of the impact of climate change for the WAIS.



Maps b. and c. The WAIS (grey) and its ice shelves (colour).
The colour scale shows the amount of frozen ocean in (b.) 1990 and (c.) predicted in 2050

Set 1 *Participant number:* ☐

This is the third part of the mini-workshop

This final part of the mini-workshop asks you some of the same questions as the first survey. Please answer all the questions, even if they are repeated.

13. How serious a threat do you think climate change is to: *(Please tick the box that applies on each row)*

	Very serious	Fairly serious	Not very serious	Not at all serious
a.) You	☐	☐	☐	☐
b.) People in your local community	☐	☐	☐	☐
c.) People in the UK	☐	☐	☐	☐
d.) People in other countries	☐	☐	☐	☐
e.) Animals and plants in your local area	☐	☐	☐	☐
f.) Animals and plants in the UK	☐	☐	☐	☐
g.) Animals and plants in other countries	☐	☐	☐	☐

14. When do you think climate change is / will be dangerous for: *(Please tick the box that applies on each row)*

	Now	In 10 years	In 25 years	In 50 years	In 100 years	Never
a.) You	☐	☐	☐	☐	☐	☐
b.) Your local community	☐	☐	☐	☐	☐	☐
c.) People in the UK	☐	☐	☐	☐	☐	☐
d.) People in other countries	☐	☐	☐	☐	☐	☐
e.) Animals and plants in your local area	☐	☐	☐	☐	☐	☐
f.) Animals and plants in the UK	☐	☐	☐	☐	☐	☐
g.) Animals and plants in other countries	☐	☐	☐	☐	☐	☐

15. How interested are you in climate change?

Not at all interested	Not very interested	Quite interested	Very interested
☐	☐	☐	☐

16. How worried are you about climate change?

Not at all worried	Not very worried	Quite worried	Very worried
☐	☐	☐	☐

17. Please rate how you feel about the following statements: *(Please tick the box that applies on each row)*

	Strongly agree	Tend to agree	Neither agree nor disagree	Tend to disagree	Strongly disagree
a.) The thought of climate change fills me with dread	☐	☐	☐	☐	☐
b.) Too much fuss is made about climate change	☐	☐	☐	☐	☐
c.) I feel a moral duty to do something about climate change	☐	☐	☐	☐	☐
d.) I do not believe that climate change is a real problem	☐	☐	☐	☐	☐
e.) Nothing I do makes any difference to climate change one way or another	☐	☐	☐	☐	☐
e.) The effects of climate change are likely to be catastrophic	☐	☐	☐	☐	☐
f.) If I come across information about climate change I will tend to look at it	☐	☐	☐	☐	☐
g.) I am well informed about climate change	☐	☐	☐	☐	☐
h.) It is already too late to do anything about climate change	☐	☐	☐	☐	☐
i.) Climate change is too complicated for me to understand	☐	☐	☐	☐	☐
j.) Talking about climate change is boring	☐	☐	☐	☐	☐
k.) Human activities are altering global temperatures	☐	☐	☐	☐	☐

18. Do you think climate change is going to affect you personally?

- ☐ Yes (go to question 7)
- ☐ No (go to question 8)
- ☐ Don't know (go to question 8)

19. In which way(s) is it going to affect you? *Please state the first three things that come to mind:*

1) ____________________

2) ____________________

3) ____________________

20. How likely are you to talk to the following people about climate change? *(Please tick the box that applies on each row):*

	Very likely	Quite likely	Neither more or less likely	Quite unlikely	Very unlikely
a) Family	☐	☐	☐	☐	☐
b) Friends	☐	☐	☐	☐	☐
c) Colleagues	☐	☐	☐	☐	☐

21. Please indicate how much of the information on each icon sheet you understood, based on the scale below *(circle the number below the line to indicate your opinion)*:

	understood none of it							understood all of it
a) The Norfolk Broads	0	1	2	3	4	5	6	7
b) London and the Thames Estuary	0	1	2	3	4	5	6	7
c) Thermohaline circulation	0	1	2	3	4	5	6	7
d) West Antarctic Ice Sheet	0	1	2	3	4	5	6	7

22. We would now like to know how the icons made you feel on three different scales of interested/uninterested, concerned/unconcerned, and scared/not scared. Please rate how the icons made you feel **about climate change** on this scale. We take 'interested' to mean that you would like to know more about the impacts of climate change on the icon. *(circle the number below the line to indicate your opinion)*:

	un-interested							**interested**
a) The Norfolk Broads	0	1	2	3	4	5	6	7
b) London and the Thames Estuary	0	1	2	3	4	5	6	7
c) Thermohaline circulation	0	1	2	3	4	5	6	7
d) West Antarctic Ice Sheet	0	1	2	3	4	5	6	7

23. Now, please rate how the icons made you feel **about climate change** on this scale. By 'concerned', we take it to mean that you are worried about the impacts of climate change on the icon. *(Circle the number below the line to indicate your opinion)*:

	un-concerned							**concerned**
a) The Norfolk Broads	0	1	2	3	4	5	6	7
b) London and the Thames Estuary	0	1	2	3	4	5	6	7
c) Thermohaline circulation	0	1	2	3	4	5	6	7
d) West Antarctic Ice Sheet	0	1	2	3	4	5	6	7

24. Please rate how the icons made you feel **about climate change** on this scale. By 'frightened', we take it to mean that this information scares you. *(Circle the number below the line to indicate your opinion)*:

	not frightened							**frightened**
a) The Norfolk Broads	0	1	2	3	4	5	6	7
b) London and the Thames Estuary	0	1	2	3	4	5	6	7
c) Thermohaline circulation	0	1	2	3	4	5	6	7
d) West Antarctic Ice Sheet	0	1	2	3	4	5	6	7

25. Finally, please could you rate how the icons made you feel **generally about the future**? *(circle the number below the line to indicate your opinion)*:

	It made me feel bleak about the future							**It made me feel positive about the future**
a) The Norfolk Broads	0	1	2	3	4	5	6	7
b) London and the Thames Estuary	0	1	2	3	4	5	6	7
c) Thermohaline circulation	0	1	2	3	4	5	6	7
d) West Antarctic Ice Sheet	0	1	2	3	4	5	6	7

26. Which icon do you feel is most directly relevant for:

	The Norfolk Broads	**London and the Thames Estuary**	**Thermohaline Circulation**	**West Antarctic Ice Sheet**
a) You	☐	☐	☐	☐
b) Your local community	☐	☐	☐	☐
c) People in the UK	☐	☐	☐	☐
d) People in other countries	☐	☐	☐	☐

27. a.) Now, looking at the icon sheets, which icon **picture** ('a') do you find yourself **most** drawn to? ____________________

b.) Could you explain why? ____________________

____

28. a.) Looking at the icon sheets, which icon **picture** ('a') do you find yourself **least** drawn to? ____________________

b.) Could you explain why? ____________________

____

29. a.) Now, looking at the icon sheets again, which icon **map** ('b') do you find yourself **most** drawn to? ____________________

b.) Could you explain why? ____________________

____

30. a.) Which icon **map** ('b') did you find you find yourself **least** drawn to?

____

b.) Could you explain why? ____________________

____

31. a.) Finally, looking at the icon sheet pictures, maps and text, which icon do you feel **most** drawn to **overall**? ____________________

b.) Could you explain why? ____________________

____

32. a.) Again, looking at the icon pictures, maps and text, which icon do you feel **least** drawn to **overall**? ____________________

b.) Could you explain why? ____________________

____

Thanks for answering those questions.

Finally, just so that I can compare the views of different people, please could you tell me about yourself? Your details will not be passed on and these data will only be reported in summary statistical form, so that no one individual will be identifiable.

33. Are you:
- ☐ Male
- ☐ Female

34. Please indicate your age:
- ☐ 16-24
- ☐ 25-34
- ☐ 35-44
- ☐ 45-54
- ☐ 55-64
- ☐ 65-74
- ☐ 75 or over

35. How many children (under 18) live in your household?
- ☐ None
- ☐ 1 child
- ☐ 2 children
- ☐ 3 children
- ☐ 4 or more children

36. What is the first part of your postcode? (e.g. NR1):

postcode: ____________

37. What is your highest qualification?
- ☐ No formal qualifications
- ☐ GCSE / O-Level
- ☐ A-level / Higher / BTEC
- ☐ Vocational / NVQ
- ☐ Degree or equivalent
- ☐ Postgraduate qualification
- ☐ Other *(please write in ______________________)*

38. What is your highest qualification in a **science-related subject?**
- ☐ No formal qualifications
- ☐ GCSE / O-Level
- ☐ A-level / Higher / BTEC
- ☐ Vocational / NVQ
- ☐ Degree or equivalent
- ☐ Postgraduate qualification
- ☐ Other *(please write in ______________________)*

39. Which political party are you **most likely** to support? *(please tick one box only)*
- ☐ Labour
- ☐ Conservative
- ☐ Liberal Democrats
- ☐ Green
- ☐ Other

40. Do you regularly drive a car / van?
- ☐ Yes
- ☐ No

41. Please indicate your own approximate income per year (before tax):	☐ Up to £9,999 ☐ £10,000 - £19,999 ☐ £20,000 - £29,999 ☐ £30,000 - £39,999 ☐ £40,000 - £49,999 ☐ £50,000 - £59,999 ☐ £60,000 - £69,999 ☐ Above £70,000
42. Which of these newspapers do you read at least once a week? *(tick as many as apply)*	☐ Sun / News of the World ☐ Daily Mail / Mail on Sunday ☐ Daily Telegraph / Sunday Telegraph ☐ Times / Sunday Times ☐ Express / Sunday Express ☐ Guardian / Observer ☐ Independent / Independent on Sunday ☐ Other (please state) ______________________ ☐ None
43. Are you a member of any environmental organisations (e.g. RSPB, Friends of the Earth)?	No ☐ Yes ☐ if so, which one? ____________________
44. If you would like to receive a copy of the results of this research, please enter your email address here:	____
45. If you have any comments about this mini-workshop, please write them here:	____ ____

Thank you!
The mini-workshop is complete. Please hand this form back to the facilitator.

Non-response rates are not reported here. Any percentage values given are calculated only from participants who provided a response. See pre-test questionnaire (Appendix 7.1) and post-test questionnaire (Appendix 7.3) for examples of the full questions asked.

46. How serious* a threat do you think climate change is to:

	Pre	Post	Diff
a.) You	2.11	1.99	0.11
b.) People in your local community	2.23	1.91	0.33
c.) People in the UK	2.08	1.79	0.29
d.) People in other countries	1.59	1.36	0.23
e.) Animals and plants in your local area	1.90	1.78	0.11
f.) Animals and plants in the UK	1.87	1.71	0.16
g.) Animals and plants in other countries	1.36	1.23	0.13

* 1 = very serious, 2 = fairly serious, 3 = not very serious, 4 = not at all serious

47. When do you think climate change will be dangerous* for:

	Pre	Post	Diff
a.) You	2.80	2.87	-0.07
b.) People in your local community	2.72	2.73	-0.01
c.) People in the UK	2.67	2.66	0.01
d.) People in other countries	1.87	1.93	-0.06
e.) Animals and plants in your local area	2.22	2.30	-0.08
f.) Animals and plants in the UK	2.19	2.29	-0.10
g.) Animals and plants in other countries	1.66	1.73	-0.07

*1 = dangerous now, 2 = in 10 years, 3 = in 25 years, 4 = in 50 years, 5 = in 100 years, 6 = never

48. How interested* are you in climate change?

Pre	Post	Diff
3.37	3.33	0.04

* 1 = not at all interested, 2 = not very interested, 3 = quite interested, 4 = very interested

49. How worried* are you about climate change?

Pre	Post	Diff
3.04	3.08	-0.04

* 1 = not at all worried, 2 = not very worried, 3 = quite worried, 4 = very worried

50. Rate* how you feel about the following statements:

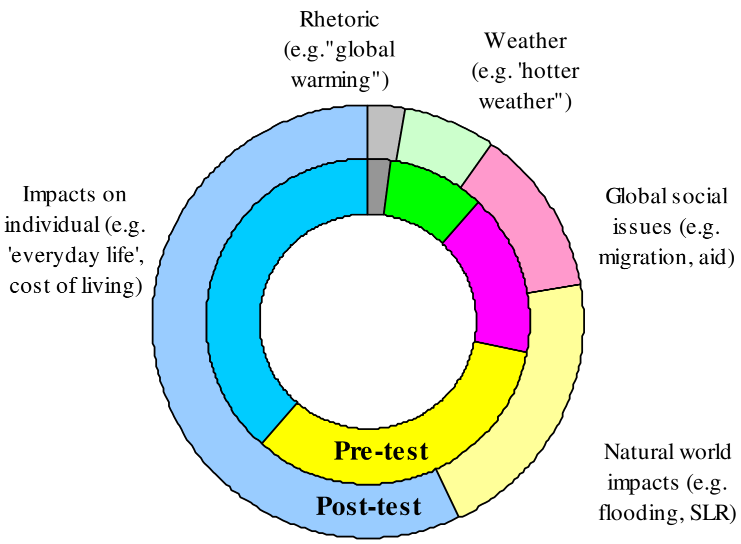
	Pre	Post	Diff
a.) The thought of climate change fills me with dread	2.67	2.61	0.06
b.) Too much fuss is made about climate change	3.78	4.01	-0.24
c.) I feel a moral duty to do something about climate change	2.06	1.97	0.09
d.) I do not believe that climate change is a real problem	4.19	4.33	-0.14
e.) Nothing I do makes any difference to climate change one way or another	3.89	3.93	-0.05
e.) The effects of climate change are likely to be catastrophic	2.27	2.06	0.20
f.) If I come across information about climate change I will tend to look at it	1.97	1.83	0.14
g.) I am well informed about climate change	2.50	2.42	0.08
h.) It is already too late to do anything about climate change	3.84	3.94	-0.11
i.) Climate change is too complicated for me to understand	3.99	4.01	-0.02
j.) Talking about climate change is boring	3.91	3.99	-0.07
k.) Human activities are altering global temperatures	1.68	1.75	-0.08

* 1 = strongly agree, 2 = tend to agree, 3 = neither / nor, 4 = tend to disagree, 5 = strongly disagree

51. Do you think climate change is going to affect you personally?

	Pre (%)	Post (%)	Diff (%)
Yes	68.0	70.3	2.3
No	21.3	20.0	-1.3
Don't know	10.7	9.7	-1.0

52. In which way(s) is it going to affect you?



Participants were asked to state the first three things that came to mind. All participants gave at least one response.

53. How likely are you to talk to the following people about climate change? *(Please tick the box that applies on each row):*

	Pre	Post	Diff
a) family	1.99	2.00	-0.01
b) friends	2.09	2.04	0.04
c) colleagues	2.22	2.17	0.06

54. Indicate* how much of the information on each icon sheet you understood:

Icon	Mean score	Rank
Norfolk Broads	5.96	3
London	6.13	2
Polar bear	6.22	1
THC	5.14	6
Ocean acidification	5.16	5
WAIS	5.41	4

* On a scale of 0 (understood none of it) to 7 (understood all of it).

55. Rate how the icons made you feel about climate change on this scale of interested to uninterested.

Icon	Mean score	Rank
Norfolk Broads	5.30	3
London	5.51	1
Polar bear	5.45	2
THC	5.17	5
Ocean acidification	5.04	6
WAIS	5.24	4

* On a scale of 0 (uninterested) to 7 (interested). Question included the wording: 'we take 'interested' to mean you would like to know more about the impacts of climate change on the icon'.

56. Rate how the icons made you feel about climate change on this scale of concerned to unconcerned:

Icon	Mean score	Rank
Norfolk Broads	5.43	4
London	5.50	3
Polar bear	5.54	2
THC	5.41	6
Ocean acidification	5.43	4
WAIS	5.57	1

* On a scale of 0 (unconcerned) to 7 (concerned). Question included the wording: 'we take 'concerned' to mean you are worried about the impacts of climate change on the icon'.

57. Rate how the icons made you feel about climate change on this scale of frightened to not frightened:

Icon	Mean score	Rank
Norfolk Broads	4.00	6
London	4.32	2
Polar bear	4.17	4
THC	4.31	3
Ocean acidification	4.13	5
WAIS	4.36	1

* On a scale of 0 (not frightened) to 7 (frightened). Question included the wording: 'by 'frightened' we take it to mean that this information scares you'.

58. Rate how the icons made you feel generally about the future:

	Pre-test mean score	Mean score	Diff	Rank (diff)
'How do you feel generally about the future?'	6.11			
Norfolk Broads		2.88	3.24	5
London		3.11	3.00	6
Polar bear		2.48	3.63	1
THC		2.84	3.27	4
Ocean acidification		2.70	3.41	2
WAIS		2.80	3.31	3

* On a scale of 0 (it made me feel bleak about the future) to 7 (it made me feel positive about the future)

59. Which icon do you feel is most relevant for:

	% choosing icon					
	Broads	London	P Bear	THC	OA	WAIS
a) You	53	38	7	26	13	15
b) Your local community	81	34	1	16	11	7
c) People in the UK	6	61	1	47	12	15
d) People in other countries	1	2	7	53	46	39

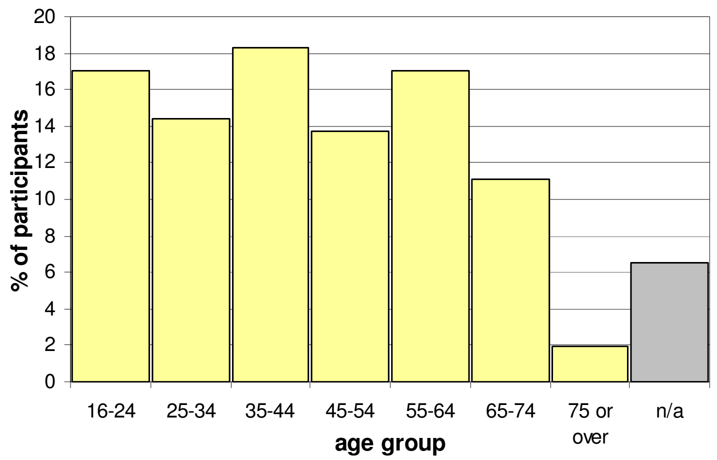
Questions 15-20 quantitative results displayed and qualitative responses discussed in chapter 7.

Demographics of sample

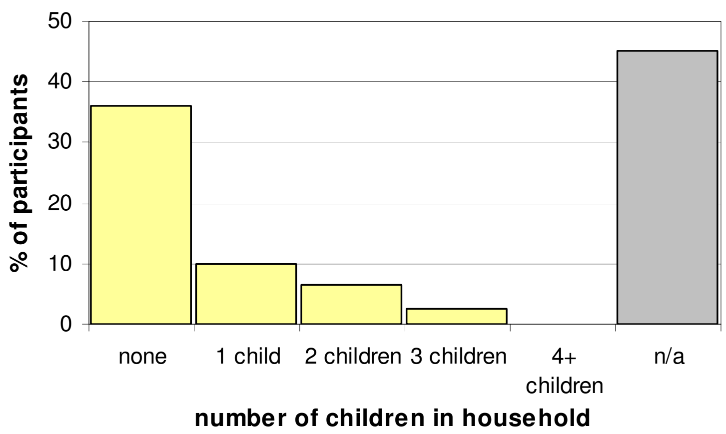
60. Gender:

	%
male	48.4
female	45.1
n/a	6.5

61. Age:



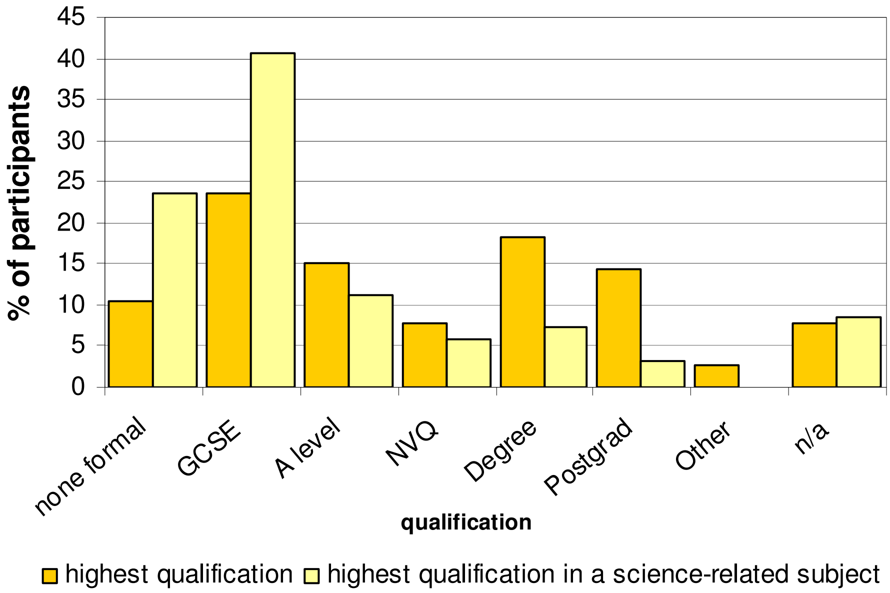
62. Children (under 18) living at home:



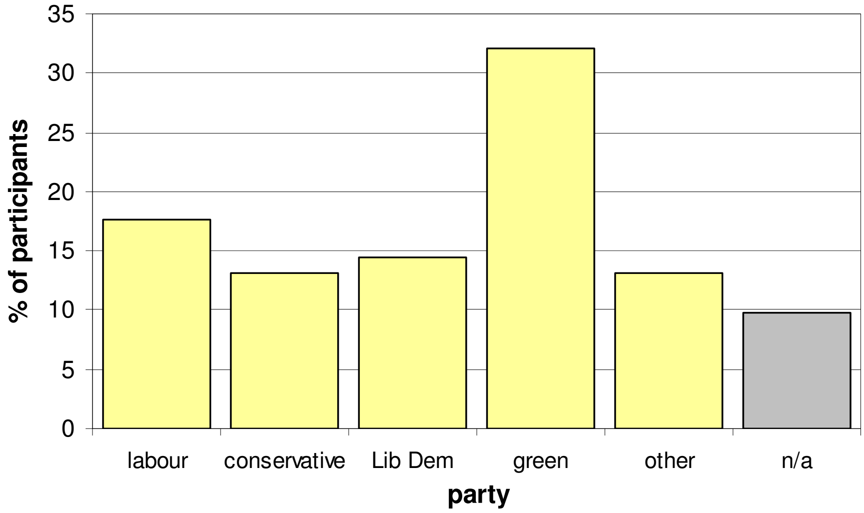
63. Postcode:

Postcode / town	%
NR1-13 (Norwich central)	63.4
NR14-34 (Norwich outskirts)	9.8
CB (Cambridge)	2.0
IP (Ipswich)	4.6
RG (Newbury)	1.3
CM (Chelmsford)	1.3
SS (Rayleigh)	0.7
PE (Swaffham)	0.7
OX (Oxford)	0.7
EN (Potters Bar)	0.7
n/a	15.1

25 / 26. Highest qualification / highest qualification in a science-related subject:



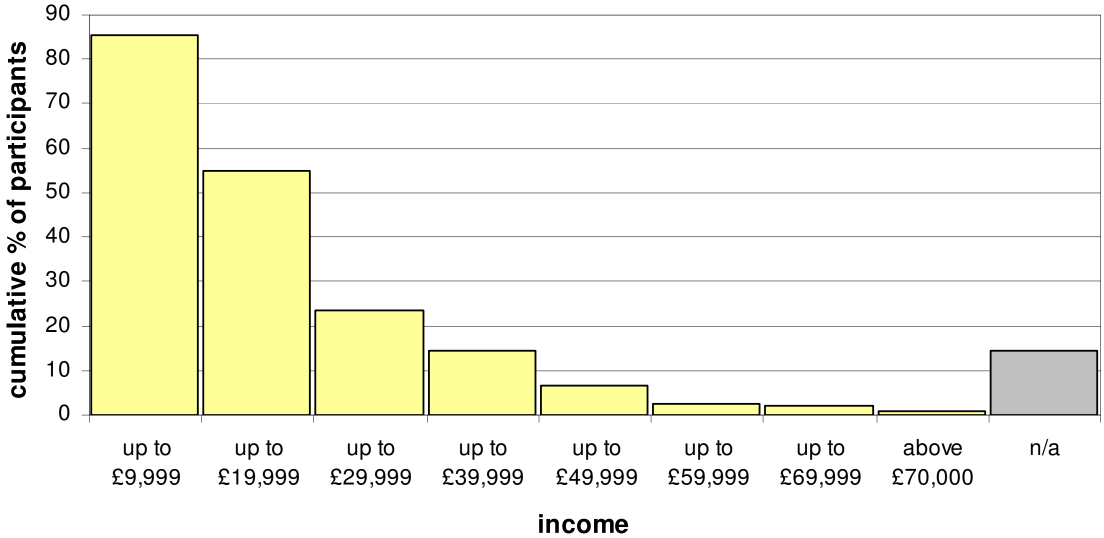
27. Most likely to support (political party):



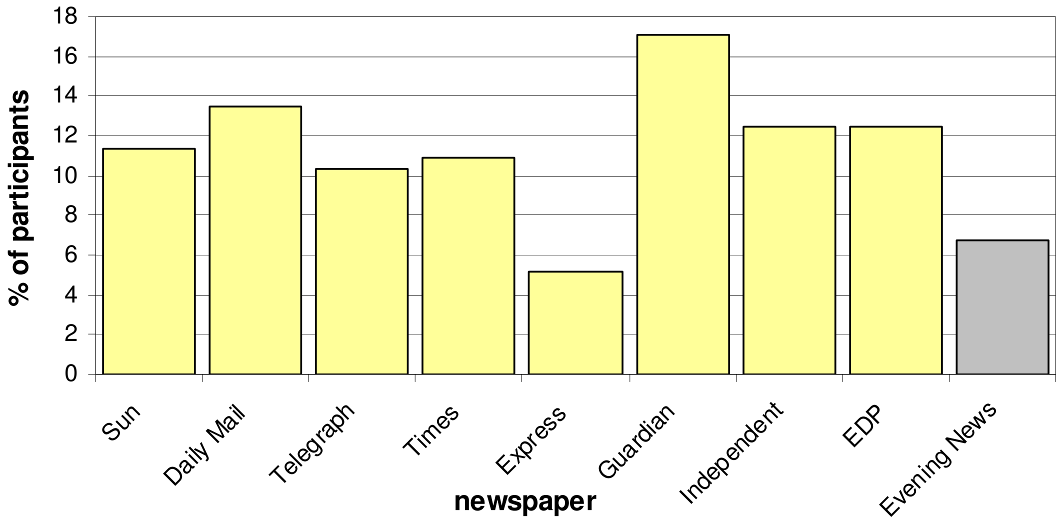
28. Regularly drive a car / van:

	%
yes	48.4
no	41.8
n/a	9.8

29. Income:



30. Newspaper readership:



31. Member of environmental organisation:

	%
No	62.1
Yes *	24.2
n/a	13.7

*RSPB 10.5%, Friends of the Earth 6.5%, WWF and Greenpeace both 2.6%. Rising Tide and Campaign against Climate Change only one mention each.

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