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Climate Change Impacts on the Marine Environment: Research Results and Public Perception

# CLAMER Deliverable 2.3

# Understanding public engagement with marine climate change impacts: Literature review and report of qualitative study

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# Executive Summary

This report comprises two parts. The first is a review of the academic literature on public engagement with climate change impacts on marine environments (CCIME) and climate change more broadly. The second contains a report of an in-depth qualitative study on the same topic that brought together members of the public and scientists in a participatory workshop in the United Kingdom in June 2011. Both these components complement other work based on the CLAMER project's European-wide public poll (summarised in Buckley et al's (2011) 'Report on European public awareness and perception of marine climate change risks and impacts', and subject its findings to further interpretation. The unique outputs contained in this document help to build understanding of how members of the public understand, perceive, and engage with CCIME by exploring some of the underlying psychological, social and other factors. Adding to existing knowledge in this area is crucial to securing public support for climate mitigation policies and incentivising changes in individual behaviour designed to mitigate climate change, adapt to its impacts and support environmental resilience.

Prior studies of public engagement with marine climate change impacts in Europe have often been framed in terms of risks from sea-level rise and coastal flooding to vulnerable coastal communities, so by their nature they are concerned with adaptation to CCIME. In this context, deliberative and participatory processes have been successful in exploring public views on the risks and the range of alternative responses. However, risk perceptions are only one aspect of possible public engagement with CCIME. The literature review shows that other types of public engagement, for instance based on personal morality, are as yet under-researched. In particular, there is an important need to explore the factors that foster interest and concern in impacts such as ocean acidification or sea temperature rise, which at present seem remote and irrelevant to many members of the public. The key message of several studies reviewed here is that scientific information about CCIME needs to be presented in such a way as to create engagement, rather than merely to increase public knowledge. There is a rich seam of research highlighting both how this might be done and what is counterproductive. Future CCIME communications should take account of these valuable insights.

The findings of the qualitative study indicate that visibility and personal experience are important factors in both the salience of CCIME for individuals and their degree of concern.  For some individuals, concern does seem to be driven by risk perception. Other individuals however see CCIME as a moral issue, because of their effects on vulnerable people and species; they engage with CCIME in a different way.  Both the findings of this study and the literature review highlight the need to acknowledge such diversity among the public and target communications accordingly.  In addition, the qualitative study suggests that some members of the public have integrated and holistic views of marine climate impacts and tend to frame CCIME and climate change as aspects of the wider problem of unsustainable societies rather than as discrete scientific issues. This further suggests that attempts to engage the public need to start from an understanding of how they view, experience and engage with marine climate change issues in their own terms.  Public campaigns on marine environmental issues, such as the UK's 'Fish Fight', suggest that there may be considerable latent interest in CCIME, which communications could tap into.

The high costs of some environmentally beneficial behaviour, the lack of infrastructure to support environmentally sustainable behaviour, an absence of guidance and information other than very basic mitigation actions, perceived personal inefficacy and the perception of free riders were all highlighted as disincentives to acting in an environmentally responsible manner and mitigating climate change. As for adaptation, it was seldom mentioned.  In particular, there was little evidence that participants who lived in vulnerable coastal locations had given much thought to protecting themselves against flood risk.  The evidence suggests that they are indeed aware of the risks, but do not see themselves, or the actions they can take as individuals, as effective in dealing with them.

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# PART 1: Public engagement with marine climate change issues: A review of the literature

# 1 Introduction

## 1.1 Project context

This review is a unique attempt to map and synthesise research findings concerning public engagement with climate change impacts on marine environments (CCIME). There has been a considerable attempt within the scientific community to understand natural and physical processes relating to CCIME (see the CLAMER Synthesis of European Research on the Effects of Climate Change on Marine Environments, Heip et al., 2011). There is also increasing recognition of the need for mitigation programmes, action plans and adaptive management systems that address climate impacts on marine environment, all of which depend on public engagement (Higgason and Brown, 2009). Attempts to engage the public depend on a sound understanding of how individual citizens connect with marine climate change, yet the evidence base in this area is yet to be synthesised. To this end the following review seeks to further our knowledge of how publics understand, perceive, engage with and respond to CCIME and the associated psychological and social factors. It is intended that this review will provide a sound foundation for future communication and engagement initiatives.

## 1.2 Method and scope of the literature review

A systematic search of relevant databases and academic journals was undertaken. Appendix 1 lists details of the sites and search terms. The 'snowball' technique was used to lead from article to article, and in a few cases, colleagues and authors were

contacted directly.  The analysis of papers identified through the search enabled a synthesis of empirical research findings either directly concerned with, or highly relevant to, public engagement with marine climate change impacts.

The sources analysed belong to several distinct academic disciplines, in particular various branches of psychology and sociology.  There are a few surveys and qualitative studies focussing specifically on public engagement with CCIME.  Most of these consider risk perceptions concerning sea-level rise and associated coastal flooding and erosion.  There is also a much wider body of work on public engagement with climate change in general, the most relevant of which are analysed here.[1]  In addition, the review looks at a handful of studies investigating public engagement with marine environments in general; in some cases the findings of these studies touch on CCIME.  Lastly, a small number of studies investigating public reactions to climate change mitigation initiatives in or under the sea, such as tidal energy and carbon capture and storage, are included.  The premise is that while the latter three strands of research do not have a direct focus on CCIME, their findings still offer useful insights.

The main geographical focus is Europe, but articles from other industrialised countries, mainly the USA, are also included.  Within Europe, the majority of relevant articles emanate from the UK, and to a much lesser extent, Scandinavia.  Literature on climate change in developing countries falls outside the remit of this review.

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[1] Throughout the review, the term 'climate change' is used rather than the less scientifically accurate term 'global warming', except when the findings of studies (usually American) which use the term 'global warming' are reported.

## 1.3    Review structure

Before starting the review proper, it is necessary to discuss and define what we mean by the terms we use throughout the document, in particular the terms 'public understanding', 'public perceptions' and 'public engagement', so the review begins with an exploration of these concepts and how they relate to each other (Section Two).  In Section Three, various types of evidence on how the public engages with CCIME are reviewed.  This section also includes insights from related studies concerning public perceptions of marine environments more generally and climate change mitigation efforts involving the seas and oceans.  Section Four looks at various aspects of public engagement with climate change in general, including patterns and trends of knowledge and concern, evidence on constraints to public engagement and findings regarding the most effective ways to communicate climate change issues to the public.  A brief conclusion is given in Section Five.

## 2    Exploring 'public engagement'

### 2.1    Definition and context

Before embarking on the review it is necessary to clarify some terms that are used in it and explain how they are related, namely; 'the public', 'public understanding', 'public perceptions' and 'public engagement'.  The 'public', in this context, refers to individuals who do not have an expert scientific knowledge of CCIME.  Wolf and Moser (2011:548) define the term 'public understanding', which recurs throughout this document, as the knowledge held by the public.  They also provide another useful definition, that of *perceptions*, defined as 'views and interpretations based on beliefs and understanding' (2011:548).  Both public understanding and public perceptions are aspects of 'public engagement' with CCIME (Lorenzoni et al., 2007: Wolf and Moser, 2011).  'Engagement' refers to the personal connection that individuals make with an issue, and includes their behaviour in relation to it.  In the case of CCIME, such behaviour might involve mitigation of climate change or adaptation to CCIME. For Ockwell et al. (2009), engagement also refers to proactive involvement in policy-making or activism.

Why is public engagement with climate change important? While some environmental problems appear to be more amenable to purely technical solutions, in democratic societies public engagement is vital for policies and programmes to mitigate and adapt to climate change. For instance, stronger public engagement is a pressing priority in order to foster individual-level energy conservation, enable people to take an active role in public debates and foster public support for climate protection policies (Lorenzoni and Pidgeon 2006; Lowe et al., 2006; Moser and Dilling, 2007; Shwom et al., 2010). Yet it is well known that certain characteristics of climate change may discourage public engagement. For one thing, responding to the challenge of climate change will require far-reaching changes to lifestyles in industrialised countries, and many people find this daunting or unacceptable (Lorenzoni et al., 2007). The problem is compounded by scientific uncertainty over climate change impacts, the wide diversity of interests and perspectives, and the fact that, for many people in industrialised countries, climate change seems a remote, intangible issue. These and other problems mean that climate change can seem an intractable problem (Lorenzoni et al., 2006, Etkin and Ho 2007; Hulme, 2009). In order to foster public engagement, scientists, practitioners and policy-makers need to learn about the factors that underlie and influence public engagement.

## 2.2 The role of knowledge in engagement

There is a considerable body of literature concerning the public's knowledge of the causes, impacts and mitigation of climate change, rooted in the wider 'public understanding of science' research tradition. In keeping with this tradition, some studies have deployed the so-called 'deficit model', assuming that what members of the public need in order to become engaged is more information, on which they will then act (Irwin and Wynne 1996). Indeed, the influence of this model is detectable in the CLAMER project itself, as in this extract from the project home page: "The project builds upon the concept that there is a gap between what is known through research and what policy makers and the public know and understand about the impacts of climate change on the oceans; and that this gap needs to be filled to help catalyse formulation and acceptance of the necessary mitigation and adaptation measures for the marine environment" (see www.clamer.eu).

However, the link between knowledge on the one hand and engagement on the other is contested by many social scientists. For instance, a study aimed at understanding people's attitudes and aspirations towards the marine environment in Scotland developed nearly 15 years ago showed how concern about pollution, coastal zone management, tourism and fisheries was not linked to the respondents' level of knowledge (Cobham Resource Consultants, 1997). The authors highlight that regional variations in responses were noted and that these were probably related to the respondents' history and type of engagement with the coast.

Several studies, especially in the USA, have found adults' mental models of the *causes* of climate change to be misconceived or inaccurate (Bostrom et al., 1994; Kempton et al., 1995; Poortinga and Pidgeon, 2003; Sterman and Sweeney, 2007; Reynolds et al., 2010). Some UK studies have found that members of the public generally have a poor technical understanding of how climate change works (Lorenzoni and Pidgeon, 2006; Lorenzoni et al., 2007) or what they can do about it (Whitmarsh, 2009). Lorenzoni et al. (2007) call for the provision of basic information on its causes and implications, as well as better science education to improve the public's grasp of the scientific concept of uncertainty. However, these authors also argue that although public understanding may seem confused, it nevertheless reflects 'valid ways of seeing the world' (p.451) and so should not be dismissed by climate experts. Räthzel and Uzzell (2009) argue that discrepancies regarding public and expert understanding of climate change are not as great as they are often portrayed, and the findings of the CLAMER survey on public attitudes to CCIME tend to support this (see Buckley et al., 2011).

A separate strand of research frames public engagement with climate change in terms of risk perceptions; often, researchers are attempting to find out how knowledge of climate change impacts affect these risk perceptions. In Sweden both cognitive risk judgements (judgements of the probability of serious negative consequences) and affective risk judgements (degrees of worry) are positively correlated with knowledge of the potential health consequences of climate change (Sundblad et al., 2007). This straightforward association needs to be considered alongside the findings of several studies which indicate more nuanced and sometimes surprising relationships. In what they call a 'sharp contrast with the knowledge deficit model', Kellstedt et al.

(2008:120) found that survey respondents who think they are well-informed about global warming tend to feel less concerned about it than other people as well as less personally responsible.   Another US study found that, for individuals with a conservative ideology, college education was associated with lower concerns about global warming, while science literacy did not affect levels of concern one way or the other (Zia and Todd, 2010).   Similarly, in the UK Whitmarsh (2011) found no significant relationship between climate change scepticism and either levels of science education or self-reported knowledge about climate change; her evidence indicates that more information will not win over the most sceptical groups (Whitmarsh, 2011).[2]  Put at its simplest, more knowledge or information about climate change does not always lead to more concern and citizen action.

Turning now to the role of public knowledge in climate change *mitigation,* a lack of knowledge has been identified as a major constraint to reducing carbon emissions at the individual level.  Only a tiny proportion (0.5 per cent) of UK citizens mentioned domestic energy consumption as a cause of climate change (Whitmarsh, 2009), and among residents of two American cities, not knowing how to change one's behaviour was the most commonly cited reason for not acting to reduce personal carbon emissions (Semenza et al., 2008).  However, although acknowledging that improving the public's knowledge regarding their use of fossil fuels may be one element of the public engagement agenda, Whitmarsh et al. (2011) argue that efforts to this end need to be based on a sophisticated understanding of existing knowledge, concerns and the institutional context.

In their critiques of the knowledge deficit model, many social scientists argue that expert knowledge interacts with the public's knowledge in complicated ways, and that various influences shape the way individuals interpret expert knowledge.   Some of

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2  As a caveat, these authors point out that self-reported and objective measures of informedness often bear little or no relation to one another.

these diverse influences crop up repeatedly in the quantitative and qualitative studies that are discussed next.


## 2.3   Beyond knowledge: other influences on public engagement

This section looks at studies concerning the complex interactions among different types of knowledge and a variety of other influences on individuals' understanding and engagement with climate change.  The most significant of these other influences appear to be trust in scientific information; political ideology; affect and emotions; values and worldviews; and finally, perceived personal efficacy.  Although they tend to be interrelated, for clarity's sake they are considered separately here.


*Trust in scientific information*

Sturgis and Allum (2004) argue that public trust in scientists and scientific information partly depends on individuals' understanding of the institutional framework in which scientists operate.  The more sophisticated this contextual understanding, the more favourably people are likely to view scientific information. Several other researchers also draw attention to the key role that trust plays in promoting public engagement with climate change (Poortinga and Pidgeon 2003; Malka et al., 2009; Whitmarsh, 2009).  However, in the USA, trust sometimes affects public engagement in surprising ways.  Kellstedt et al. (2008:121) found an inverse relationship between individuals' trust in climate change scientists and their concern about climate change.  The higher the trust, the lower the concern, suggesting that some members of the public believe scientists will develop technological solutions to the problem.  Studies that investigate the mediating influence of political ideology on trust are cited below.


*Political ideology*

In the USA, the public discourse on climate change has been sharply polarised along political party lines since the late 1990s (Dunlap and McCright, 2008; Pew Research Center, 2010).  Associated with this party split, political ideology affects trust in scientific information on climate change and, indirectly, levels of concern (Malka et

al., 2009; Zia and Todd, 2010). Among people who trust scientists to provide reliable information about the environment, and among Democratic and Independent voters, more knowledge is associated with more concern. Conversely, among individuals who are sceptical about scientists and among Republicans, more knowledge is associated with no change in, or reduced, concern (Malka et al., 2009). For Americans with a conservative ideology, college education is associated with lower concerns about global warming (Zia and Todd, 2010); these authors speculate that the effect might be due to 'enhanced belief in the capacity of human societies to adapt to change' (p.751). Moreover, science literacy has no effect on concern levels. A UK survey produced broadly comparable results. Respondents with right-of-centre political views tend to be most sceptical about climate change, again mediated by views on the trustworthiness of climate change evidence and the people behind it (Whitmarsh, 2011).

*Affect and emotion*

It has long been known that 'affect', the instantaneous positive or negative valuation of an object, idea or image, is a strong influence on risk perceptions in general (e.g. Slovic, 2000). More specifically, affect plays an important role in risk perceptions regarding climate change (Leiserowitz, 2006; Lorenzoni et al., 2006). For the British and American respondents of two separate surveys reported by Lorenzoni et al. (2006), the images and associations they mentioned in connection with climate change generally had negative affect; images of sea-level rise in the USA and melting ice in Great Britain were marked with strongly negative affect.

Specific emotions, such as fear, also play an important role, not just in risk perceptions but in public engagement with climate change more broadly (Lorenzoni et al., 2006; Lorenzoni et al., 2007). Sometimes they militate against strengthened public engagement by triggering denial rather than positive responses (O'Neill and Nicholson-Cole, 2009), with important implications for communications (see Part 1, Section 4.4).

*Values and worldviews*

Several studies explore the influence of values on public engagement with climate change (Ockwell et al., 2009; Wolf et al., 2009). Perceived personal efficacy, which is critical to engagement (see below), is associated with pro-environmental values (Kellstedt et al., 2008). Whitmarsh (2011) found that beliefs about climate change are closely linked to existing values as well as political affiliation. The concept of worldviews was originally developed by anthropologist Mary Douglas (e.g. Douglas and Wildavsky, 1982). Worldviews are a set of general orienting social, cultural and political attitudes such as egalitarianism or individualism. Depending on their particular worldview, individuals perceive climate change impacts and related public policies in fundamentally different ways (Leiserowitz, 2006; Verweij et al., 2006; Etkin and Ho, 2007; Kahan et al., 2010; Shwom et al., 2010; Whitmarsh, 2011). Some of the implications for communications are explored below.

*Perceived self-efficacy*

Individuals' sense of being able to do something about climate change, in other words their perceived self-efficacy, is critical to their engagement (Lorenzoni et al., 2007). For instance perceived self-efficacy plays a part in risk judgements (Brody et al., 2007) and individuals' capacity to adapt (Grothmann and Patt 2005; Harvatt et al., 2011).

The articles cited above provide considerable evidence that, while knowledge and information are important components of individuals' engagement with climate change, so are various qualitative, social and psychological factors. Depending on circumstances, these may act to prevent or constrain engagement (see Part 1, Section 4.3). This brief overview of the key components of public engagement provides a useful starting point for interpreting the studies in the next section, which specifically concern how individuals connect, or fail to connect, with marine climate change issues.

# 3 Public engagement with climate change impacts on marine environments

## 3.1        Introduction

There is a dearth of studies that directly address public understanding of and engagement with CCIME. Of these, most focus on risk perceptions related to sea-level rise and coastal flooding in certain vulnerable locations, almost all in the UK. This section begins with these risk perception studies, before going on to look at the even smaller number of studies that explore public engagement more broadly.

## 3.2    The salience of sea-level rise/coastal flooding

Sea-level rise/coastal flooding are the associated impacts of climate change that individuals in the UK and USA tend to mention most frequently when asked about climate change impacts in general (Lorenzoni and Pidgeon 2006; Brody et al., 2007; Whitmarsh, 2009). Studies that investigate public engagement with these issues are usually framed in terms of risk perceptions, in other words they explore people's perceptions of risk to humans and the communities they live in rather than non-human impacts. Risk awareness is the first step in adapting to climate change, (Dolan and Walker, 2004; Grothmann and Patt, 2005), so this is an important body of work for climate change adaptation. The theme that dominates such studies is perceived personal salience, or its absence.

Despite the CLAMER survey findings of high levels of concern about sea-level rise, the findings of some other studies indicate that, on the contrary, this issue has little salience in the minds of members of the public in Sweden, the UK and the USA. Lorenzoni et al. (2006) and Sundblad et al. (2007) analyse the findings of smaller-scale national surveys in the UK, USA and Sweden. When asked to think of associations with climate change and then rate them for affect, similar proportions of survey respondents in both countries mentioned sea-level rise/coastal flooding (Lorenzoni et al., 2006). However, their associations tended to be generic, with little or no immediate or tangible relevance to the respondents' lives. In Sweden, knowledge of climate change impacts on the sea and glaciers had no effect on people's risk judgements concerning climate change, whereas knowledge of the potential health risks did, indicating the role of personal salience in risk perceptions (Sundblad et al., 2007).

Perhaps surprisingly, sea-level rise/coastal flooding risks seem to have low personal salience even for individuals in especially vulnerable communities. For instance, residents of a UK town vulnerable to extreme weather events and coastal erosion failed to connect climate change impacts to their own lives and community in contrast with other risk issues such as radioactive waste. In contrast, they saw the benefits of climate change, such as the conveniences associated with modern life-styles, as personally and culturally immediate. The authors argue that the salience of a risk is not just a matter of physical exposure or proximity but also requires individuals to make cultural connections to that risk (Bickerstaff et al., 2004).

Similarly, Harvatt et al. (2011) also found that, despite living in high risk areas, the majority of their survey respondents did not perceive themselves as being personally at risk from sea-level rise/coastal flooding.[3] This is particularly the case for people who have no direct personal experience of floods, stemming from the 'inability of individuals to conceptualise a hazard that has not yet happened' (p.73). Moreover, individuals tend not to distinguish between flooding caused by naturally occurring processes and flooding caused by sea-level rise due to anthropogenic climate change. In line with this, the residents of four disadvantaged coastal communities in the UK have very low awareness of climate change risks, except in communities where there has been recent flooding (Zsamboky et al., 2011). Even in such areas, though, awareness of climate change impacts is limited to the specific CCIME of coastal flooding. Many individuals see daily concerns, such as low income and unemployment, as a much greater priority than climate change, especially in the most disadvantaged of the four communities. The authors also report certain socio-demographic variations within these vulnerable populations. For instance, migrants who had settled in one of the communities, Llanelli, are said to be less aware of

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3 Although this is true of the three survey locations overall, in one location a majority of respondents did perceive themselves to be at risk, which researchers attribute to that community's clearly visible proximity to both the sea and a river estuary.

climate change related risks than longer term residents, due to language and cultural barriers as well as a lack of experience of local risks, whether direct or vicarious.

Although concerned with the impacts of cyclones in Australia rather than flood risks in Europe, Li's study of residents' attitudes to risk in the city of Darwin (2007) is also relevant here. She found that residents who lack personal experience of cyclones tended to underestimate the risks. More specifically, long-term and short-term residents had very different risk perceptions in relation to the wind damage, storm surge and safety risks associated with tropical cyclones, with the long-term residents' memories of a powerful cyclone in 1974 the chief dividing factor. Conversely, Myatt-Bell et al. (2002) highlight how, where individuals *do* have either first- hand or vicarious experience of disastrous events, such experience can heighten risk perceptions. Residents of a UK coastal town affected by a government coastal 'managed realignment' initiative drastically overestimated the probability of flooding compared with government risk assessments. The authors attribute their exaggeration of the risk to local memories of the notorious North Sea flood of 1953 that killed 300 people on the UK's east coast, as well as to more recent flood events. Although in this case it led to misperceptions, such local knowledge is critical to the adaptive capacity of vulnerable coastal communities (Dolan & Walker, 2004).

Even when individuals do have personal experience of coastal flooding, they do not necessarily connect it to climate change (Whitmarsh, 2008; Zsamboky et al., 2011). For instance, victims of recent severe floods in the UK differ little from other individuals in their perceptions of, and responses to, climate change. They are no more likely to mention flooding as a potential impact of climate change than non-flood victims, and are less likely than non-flood victims to agree that the effects of climate change would be 'catastrophic'. Moreover, both flood victims and others were sceptical that climate change had caused the floods that affected them (Whitmarsh, 2008).

The Netherlands is a special case with respect to risk perceptions of sea-level rise/coastal flooding. In general, members of the Dutch public are less concerned about climate change than citizens of other European countries, despite the country's vulnerability to sea-level rise. This apparent paradox is associated with the shaping of

the country's coastline by flood protection and water management practices over the centuries; not only has the Dutch population learned to live with coastal flooding risks, but their history means they trust their water management institutions to protect them (Van Koningsveld et al., 2008).

The studies cited so far here support the idea that perceptions of sea-level rise/coastal flooding risks are often clouded by lack of experience. However, a survey in the USA did find a significant correlation between physical vulnerability to sea-level rise/coastal flooding and individuals' climate change risk perceptions (Brody et al., 2007). In other words, people living on relatively high ground and far away from the coast perceive a significantly lower level of risk from climate change than those who are most vulnerable to coastal flooding, who perceive climate change as a greater personal risk. On the other hand, the authors report that socio-economic factors and attitudes are much more important variables in explaining risk perceptions than physical proximity. A previous US survey produced the finding that people living with a mile of the coast and at lower elevations are less likely to support climate protection policies than others (Zahran et al., 2006), which Sandvik (2008) interprets as an example of 'wishful thinking', a form of denial.

In summary, these studies indicate that individuals' perceptions of the risks from sea-level rise/coastal flooding are strongly affected by personal experience or the lack of it, and even where individuals have had such experiences, this does not necessarily foster an engagement with climate change. Although risk perception studies are valuable, they tend to be concerned solely with threats to human beings. There is more to engagement than risk perceptions. Rather than adopt a risk perspective, the studies discussed next explore other forms of connection with, interest in, and emotional responses to CCIME.

## 3.3    Beyond risk: wider engagement with marine climate change impacts

A survey of 138 visitors to the UK's National Maritime Museum (Fletcher et al., 2009) indicates that climate change is high in people's minds in relation to the ocean. Climate change in general came second only to pollution when respondents were

asked an open question about the most pressing problems facing the ocean. It was also frequently mentioned as an 'interesting' marine environmental topic, as were the specific CCIME of coastal erosion and sea-level rise/coastal flooding. More generally, respondents demonstrated 'reasonable factual knowledge about specific marine environmental issues' (p.374), although the authors do not claim that their sample was representative of the population as a whole.

O'Neill and Hulme (2009) provide insights into the motivations that underlie headline findings such as these. Their study is especially valuable because of the lack of other research on these issues. The study, which was based on a range of qualitative methods, explored individuals' reactions to 'icons' of climate change, defined in this context as 'a tangible entity worthy of respect' (p.403). Although the researchers did not set out to explore engagement with CCIME specifically, in practice all the icons used in the study were related to CCIME in one way or another. Of these six icons, three were chosen by climate change 'experts' and three by members of the public. The experts' icons were thermohaline circulation shut-down, the collapse of the West Antarctica Ice-Sheet, and ocean acidification. The non-experts' icons were polar bears, the effect of sea-level rise on the Norfolk Broads (a local wetlands area popular for leisure and an important wildlife habitat) and the effect of sea-level rise on London.

In general, study participants were 'most drawn to' the non-experts' icons, citing various reasons such as personal relevance or emotional appeal. With regard to the role that knowledge plays in public engagement, it is striking that even participants with scientific qualifications were more likely to choose a non-expert's icon; only 45 per cent of this group chose an expert icon. Participants were both 'least interested in' and 'least drawn to' ocean acidification. In fact, the authors suggest that the expert's icon of ocean acidification may have provoked the disengagement of study participants, who perceived it as complicated, scientific and impersonal, with impacts that were neither immediate nor geographically specific, invoking feelings of helplessness and boredom. Although study participants saw all three experts' icons as irrelevant to themselves and their families, they simultaneously judged them to be the most relevant icons for people in other countries. This resonates with other studies

that have highlighted the 'psychological distance' of climate change for many individuals (see Part 1, Section 4.3).

Finally in this section, Tribbia and Moser (2008), in their study of the CCIME information needs of Californian coastal managers, ask not how marine and climate scientists can get their information across, but rather what kind of CCIME information coastal managers need from scientists.  Many of the challenges coastal managers mentioned in a survey are related directly or indirectly to climate change. But while the managers are concerned about the implications of climate change, they face many constraints that restrict their capacity to improve their knowledge in this area.  Scientists, on the other hand, lack incentives to make information available and accessible to decision-makers, and there are no connections between California's academic institutions and those responsible for managing the coastline.    The establishment of 'boundary organisations' within the state could bridge the two groups, facilitate participatory knowledge production processes and in so doing build trust in scientific information.   The authors stress that coastal managers need interactive forms of learning and examples that are oriented towards the exigencies of professional practice.

The findings of these studies can be supplemented with research findings concerning public knowledge and attitudes towards marine environments in general.   For instance, in a survey of the US public, Steel et al. (2005) investigated levels of policy-related knowledge concerning the ocean and coastal management, and the variables that affect such knowledge.  Less than half of all respondents were familiar with commonly-used ocean and coastal management terms and could answer quiz questions correctly. While respondents who lived in a coastal state had higher levels of self-assessed knowledge of ocean and coastal policy issues, in general they performed no better than other respondents when their knowledge was tested.  People who had frequent interactions with the ocean, on the other hand, had higher levels of objectively assessed knowledge, as did respondents who held pro-environmental values.  Based on these findings, Steel et al. (ibid) argue that actual experience of the ocean is more important than information conveyed via the media in fostering public engagement with ocean and coastal issues. To this end, they advocate public outreach visits to the coast and participatory ocean science initiatives. The theme of active

engagement as a means to foster public engagement recurs in Section 3.5 below, which reviews articles reporting participatory initiatives involving stakeholders and members of the public.

Wester and Eklund (2011) studied and compared the views of male and female owners of leisure boats in the Baltic Sea on the state of the marine environment, leisure boats and responsibility for the marine environment. They found that both male and female owners saw their boats as having a low impact on the marine environment, although they did accept responsibility for such impact as they perceived. Women tended to 'express more environmentally friendly attitudes than men in their views and their behaviour' as boat owners (p.76). While the male boat owners in general perceived that the Baltic marine environment was improving, female boat owners tended to see it as deteriorating.

It is also possible to glean some insights into potential public attitudes to CCIME from public reactions to marine-based climate change mitigation activities, the subject of the next section.

## 3.4   Insights from public reactions to climate change marine mitigation initiatives

Studies of public perceptions of climate change mitigation initiatives using marine resources or the seabed may yield insights into how the public perceives marine environmental change, and so indirectly how they might view CCIME.

Shackley et al (2005) explored public attitudes to carbon capture and storage (CCS) under the seabed. Some Citizens' Panel members thought storing carbon under the seabed was preferable to storing it underground because it was 'not in anyone's back yard'. Others took the view that CCS under the sea was morally wrong, but they still perceived it as an environmental issue concerning 'Mother Earth' rather than the marine environment. The researchers comment that, as there seems to be no strong public opinion either for or against CCS, there is the potential for stakeholder groups such as NGOs to shape public opinion on the issue, a point that may hold equally well for CCIME. In the USA, a majority of participants in a small interview-based study

had strong negative reactions to the idea that oceanic CCS might have adverse effects on aquatic life (Palmgren et al., 2004:6442).

Haggett (2008) and Devine-Wright (2011) explore public perceptions of different forms of marine energy production, namely near-shore wind farms and tidal energy respectively. In the UK, offshore wind farms are often seen as a better alternative to on-shore wind farms because it is thought they will not attract the same public opposition, but Haggett questions this. Based on the example of a large proposed scheme which was opposed on the grounds that it would detract from the beauty of the coast and so deter tourists, she argues that the problems of visual and environmental impact, planning issues and public opinion that have dogged many onshore schemes may also apply to near-shore schemes.

Devine-Wright (2011) highlights the symbolic and affective associations that particular locations, including marine and coastal environments, have for the public. Some community members living near a new tidal power project in Northern Ireland saw it in positive terms, because it made their locality more distinctive and was seen to be in keeping with the character of the locality. However there were objections on the grounds that it would interfere with local marine wildlife and fishermen's livelihoods.

Although Shackley et al.'s (2005) findings are mixed with regard to possible public engagement with CCIME, Haggett (2008) and Devine-Wright (2011) indicate that members of the public have strong personal connections to local marine and coastal environments that will be affected by CCIME.

## 3.5    Participatory and deliberative processes on CCIME

The studies reviewed in this section mainly analyse participatory deliberative processes connected with CCIME, specifically impact assessment and decision-making. There is likely to be a wide range of legitimate stakeholder perspectives on coastal and marine issues such as CCIME and these need to be given a voice in decision-making processes (Ritchie and Ellis, 2010; Van Koningsveld et al., 2008). As well as recognising the obvious stakeholders, such as groups who derive their

livelihoods from the sea, Ritchie and Ellis (2010) put forward the concept of a 'sea interest' which is as yet largely unidentified and intangible. They argue that developing this concept of a sea interest would involve developing a sophisticated understanding of diverse opinions, interests and knowledges, something that deliberative processes, such as those described here, have the potential to do. Other researchers advocate increased use of participatory deliberation in order to foster people's sense of self-efficacy (Brody et al., 2007) or move beyond the entrenched positions associated with different values and world views (Verweij et al., 2006:822; Shwom et al., 2010; Whitmarsh, 2011). While the initiatives reported here are primarily aimed at government staff and members of special interest groups, some of them did also involve members of the public, and so they may point the way forward for more inclusive deliberative processes that foster public engagement with CCIME specifically.

*The ATLANTIS project; planning for the collapse of the West Antarctic ice-sheet*

Researchers working on the ATLANTIS project (Atlantic sea-level rise: adaptation to imaginable worst case climate change) investigated how decision-makers perceived and responded to the risk of extreme sea-level rise due to the collapse of the West Antarctic Ice Sheet (WAIS), using scenario-based participatory impact assessments and policy exercise games conducted in three European regions. Project experience is reported and analysed in a group of four articles (Lonsdale et al., 2008; Olsthoorn et al., 2008; Poumadère et al., 2008; Toth and Hiznyik, 2008). Toth and Hiznyik (2008) claim that research on the social perceptions of unstoppable risks like this, which they liken to an asteroid on a collision course with Earth, are virtually non-existent. While the participatory exercises are not designed with the public in mind, the authors maintain that the project offers useful insights into how to engage the public with scientific information on any psychologically distant risks associated with climate change, such as the possible collapse of the thermohaline circulation in the North Atlantic.

The regions selected for the ATLANTIS participatory exercises were the Rhone delta in France (Poumadère et al., 2008); the Thames estuary in the UK (Lonsdale et al., 2008); and the Rhine delta in the Netherlands (Olsthoorn et al., 2008). They vary in

character and so would be affected in different ways by extreme sea-level rise. The exercises were a combination of simulation gaming and scenario-based policy exercises, and used techniques such as games and focus group discussions. In each case participants were presented with a scenario involving the collapse of the WAIS. The main response options were also presented to the participants, together with their pros and cons, and they were then invited to decide on response strategies (Toth and Hiznyik, 2008).

There were marked differences between individual participants' views before the exercises and the collective outcomes of the workshops, illustrating the potential of deliberative processes to resolve conflicts of interest (Toth and Hiznyik, 2008). Poumadère et al. (2008) comments that the scenarios made WAIS, initially a psychologically distant risk, seem much more real, overcoming the problems of uncertainty, complexity and ambiguity. As well as facilitating the exploration of various adaptation strategies, Toth and Hiznyik (2008) comment that such exercises can 'foster learning about the perceptions of those affected' (p.95). They identify competent organization, high quality scientific input and productive interaction procedures as key ingredients for successful deliberation on similar issues, and give practical advice on designing and running similar participatory exercises in this context.


*Using scenarios to engage stakeholders in coastal planning in the UK*

Tompkins et al. (2008) report on the use of scenario-based stakeholder engagement (SBSE), to explore people's preferences regarding responses to sea-level rise/coastal flooding. SBSE involves identifying and engaging local stakeholders, scoping the likely climate change impacts on the local coastline and facilitating workshops to discuss them. Stakeholders covered a range of interest groups including coast/flood protection experts, businesses, local government, academics, conservationists and local residents.

Participants initially expressed three main concerns: how to minimise the risks of future damage from climate change; how to keep down the costs of responding; and how to ensure that local priorities were reflected in decisions. Workshop discussions centred on the tradeoffs to be made among these three criteria. The authors conclude

that SBSE can help to communicate complex scientific issues such as the impacts of climate change on coastal environments, because the process of deliberation helps stakeholders to decide their preferences regarding alternative adaptive responses. A key point is that stakeholders accepted high levels of uncertainty and were comfortable working with 'an envelope of possibilities' (p.1589). The outcomes of the two workshops were different in terms of the type of coastline protection governance that stakeholders opted for, showing the importance of conducting such processes at local levels.

*Using a software tool to improve stakeholder understanding of long-term coastal management issues*

Coastranger MS has been designed to raise awareness of the flood and erosion risks associated with sea-level rise, as well as the need to balance different interests and perspectives (Pontee and Morris, 2011). A simulator predicts the impacts of climate change on coasts under different management scenarios chosen by users. Animations showing the effect of defending or not defending sections of coast over a 100-year timeframe have been found to be especially useful. The authors recommend that the tool is most useful in a workshop context. It is hoped that CoastRanger MS will help to educate the public and other stakeholders on the complexities of shoreline management, enabling better informed debate and more effective consultations. To this end, the Environment Agency has bought copies for coastal community liaison officers to use in exercises involving the public.

*'Localize, spatialize, visualize': using scenarios of sea-level rise/coastal flooding in British Columbia*

Climate change scenarios and visualisations have been used to raise awareness of sea-level rise/flooding in Canada and to build capacity to respond through both mitigation action (such as reduction in energy use) and adaptive action Canada (Shaw et al., 2009; Burch et al., 2010; Sheppard et al., 2011). During the first phase of the initiative, academics, government and NGO stakeholders scaled down global climate change scenarios to regional and local levels, focussing on well-known locations vulnerable to sea-level rise(SLR)/flooding. The scenarios were based on climate projections and a range of social responses to them. For each scenario, impacts in the

four specific locations were projected out in steps to 2100 and presented using a combination of narratives and visuals.

The visioning process provided a way to communicate scientific information and uncertainty in a local context and resulted in raised awareness and an increased sense of urgency among participants; it also enabled various community options to be articulated.  The authors report that the effectiveness of the scenario exercises owed a great deal to the compelling visuals, which maintained high engagement from the public participants.  As well as raising levels of concern among public participants, the workshops resulted in a significant increase in the numbers of participants who said they planned to reduce their fossil-fuel energy use. Willingness to support climate change mitigation and adaption policies also increased substantially. However Shaw et al. (2009) point out that the members of the public who took part were self-selected.  They also highlight ethical issues, in particular the duty not to alarm participants with overly-fearful, scientifically inaccurate scenarios or visualisations.


## 3.6    Involving the public in marine science

As well as the kind of deliberative processes described above, CLAMER's own review of marine science outreach initiatives in Europe ('Marine climate science outreach programmes: an evaluation of their success and lessons learnt', Pinnegar and Buckley, 2011) highlights many relevant examples.  For instance, members of the public have been involved in observing specific marine organisms in European waters, for instance the marine mammal strandings and sightings database of MUM/RBINS in Belgium.  These projects tend to focus on unusual or charismatic species and offer a useful service by summarising records that would otherwise be lost to the scientific community. Information is also collected by sea anglers, in particular information on record sizes of sea fish (e.g.www.anglerstimes.co.uk/ britishrecords.htm).  Such data can sometimes be used to generate useful indicators of population status and change.  Both the deliberative processes and 'citizen science' initiatives cited above can be conceived as 'spaces' to which members of the public and stakeholders are invited, sometimes being specially selected for the purpose.  But

there are also 'uninvited spaces' (Wynne, 2007; Chilvers, 2010), in which members of the public respond to marine environmental issues either on their own initiative or through civil society organisations and NGOs. These are the subject of the next section.

## 3.7 Uninvited spaces for public engagement with marine environmental change

Voluntary and political action in response to marine environmental change and CCIMEs appears to be an under-researched area. While a comprehensive mapping of such initiatives throughout Europe is beyond the scope of this review, the following examples of initiatives, mainly drawn from the UK, give an idea of the diversity of public engagement currently under way.

*Beachwatch project*

The UK Marine Conservation Society's 'Beachwatch' project is now in its eighteenth year. It aims to monitor the amount of litter on UK beaches through volunteer surveys and a beach clean-up programme. In 2009, 4,665 people helped to clean 397 beaches (see CLAMER Deliverable 2.1, Pinnegar and Buckley, 2011).

*Save Our Shoreline (Overstrand in Norfolk)*

In reaction to the government's 2005 publication of a draft shoreline management plan (SMP) for the area which recommended 'managed retreat', residents of Overstrand banded together to oppose the plan, which they brand a 'threat to the security of the village and similar communities throughout the United Kingdom' (www.overstrandonline.org.uk).

*Fish Fight*

Television celebrity Hugh Fearnley-Whittingstall is leading a campaign, Fish Fight, for more sustainable fishing with reduced by-catches, and to date almost 700,000 people have indicated their support (fishfight.net). One of the campaign's successes

has been to persuade Princes, a large fish-canning company, to adopt a policy of more sustainable fishing practices.

*Greenpeace: Defending our Oceans*

The Greenpeace Defending our Oceans campaign sets out to establish a global network of marine reserves covering 40 per cent of the world's oceans. The organisation lists 'global warming' as one of the main threats to life in the ocean, alongside other issues such as industrial fishing (www.greenpeace.org).

*Northern Flood Conference*

Following severe floods across the north of England and southern Scotland in recent years, various community-based flood action groups have been established in affected areas. Several of these organisations joined together to host a Northern Flood Conference in May 2011,with the objective of empowering flood action groups to address common issues through one voice in order to protect their communities (www.the-eps.org/events).

Several of these examples of public campaigning and advocacy around marine environments and CCIME, which are merely the tip of the iceberg, offer a glimpse of a 'sea interest', a section of the population that is likely to be interested in CCIME from pro-environmental motives.

# 4    Widening the focus: Public engagement with climate change in general

## 4.1    Introduction

While there is only a small amount of research on how the public engages with marine climate change impacts, fortunately there is a much larger literature on public engagement with climate change in general. The findings of the studies cited above in Section Three can be supplemented and complemented by this wider body of work, which in many cases has produced findings that are directly applicable to CCIME. Data collected through surveys provide insights into large-scale patterns and trends

(as detailed in Section 4.2 below). The findings of small-scale, context-specific qualitative studies complement such data because they have the potential to provide more fine-grained and nuanced insights and explore the psychological and social factors that underlie the patterns. Social science researchers in this field often frame their studies as investigations of how best to communicate climate change to the public in order to improve understanding and engagement.


## 4.2    Patterns and trends

This section is based mainly on survey data regarding levels of knowledge and concern about climate change in Europe and, to a lesser extent, other industrialised countries, particularly the USA. There is also an overview of various types of active public engagement with marine environmental issues in Europe. Survey data are drawn from the Special Eurobarometer surveys on attitudes to climate change conducted in 2008 and 2009, CLAMER's own 2011 survey, Climate Change Impacts on the Marine Environment, and a small number of surveys carried out at national or lower levels in individual European countries. The Special Eurobarometer and CLAMER survey findings are not strictly comparable, because whereas Eurobarometer respondents are drawn from all EU member nations, the CLAMER survey drew respondents from only ten countries within the EU. Differences in the formulation of questions and the methods used also affect survey findings. Nevertheless, it is possible to compare headline findings to reveal general patterns and trends.


*Knowledge and concern*

Recently, Mee et al (2008) reanalysed results from the Eurobarometer survey of citizens' attitudes towards the environment, with specific emphasis on the ranking of major environmental worries. They grouped responses by regional seas (i.e. north-east

Atlantic, Baltic and Mediterranean) and determined that levels of concern of particular importance within the marine environment were as follows; water pollution (1st concern overall), natural resource depletion (9th) and biodiversity loss (11th).[4] The authors highlight differences in perceptions regarding engagement with environmental matters between regional seas and also state that the relatively low priority given to natural resources depletion and biodiversity loss contrasts with strong scientific evidence that these issues are critically important.

More than half of Europeans feel informed about the causes (56 per cent) and consequences (56 per cent) of climate change and ways of fighting it (52 per cent), although the proportion of citizens that feel poorly informed about the subject remains significant, at 9 per cent (Special Eurobarometer 313; 2009). However, the CLAMER survey shows that self-assessed knowledge levels for specific CCIME are much lower than this; 48 per cent feel well-informed about 'melting sea ice', the specific CCIME about which Europeans feel they are best informed, and only 14 per cent about ocean acidification, which has the lowest ranking in this regard.

As for knowledge about the *causes* of climate change, most Europeans disagree with the statement that carbon dioxide emissions have only a marginal effect on climate change, 30 per cent agree with this statement and 12 per cent say that they do not know. These findings indicate a tendency for citizens to overrate their own knowledge levels, a common finding in surveys of this type. The findings on objectively-assessed knowledge of climate change hardly changed between 2008 and 2009 (Special Eurobarometer 300, 2008; Special Eurobarometer 313, 2009).

Most Europeans declare high concern about climate change overall; according to Special Eurobarometer 313 (2009); 67 per cent see climate change as a 'very serious issue'. Several much smaller surveys within individual EU nations also indicate that a

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4 The original questionnaire did not explicitly focus on the marine environment but results may serve as a proxy for a wider discussion.

large proportion of people are concerned about climate change (e.g. Paeth and Otto, 2009; Spence et al., 2010; Whitmarsh, 2011). In general there is an overall positive correlation between the extent to which people feel informed and the extent to which they see climate change in general as a serious problem. However the UK and the Netherlands differ from other EU nations, in that they have high proportions of both citizens who see themselves as well-informed about climate change and citizens who see it as 'not a serious problem'. The case of the Netherlands in this regard has already been commented on (in Section 3.2 above).

These European survey findings on knowledge and concern are broadly comparable with data from other industrialised countries. In the USA, Semenza et al. (2008) found that most of the 92 per cent of survey respondents who had heard of global warming were 'very' or 'somewhat' concerned. In Australia, over 62 per cent of the population think global warming is likely to get worse, and over 56 per cent expressed concern that they or members of their family would be adversely affected (Agho et al., 2010).

On the other hand, although climate change is viewed as an important issue it is generally perceived as less important than certain other global problems. In 2009, the proportion of people who chose climate change as one of the world's three most serious problems was 50 per cent, fewer than for "poverty, the lack of food and drinking water" or "a major global economic downturn" (Special Eurobarometer 313, 2009). However, 18 per cent saw it as the most important problem facing the world (Special Eurobarometer 313, 2009). CLAMER's own survey (2011) also showed that 18 per cent viewed climate change as the most serious problem facing the world as a whole, compared with 31 per cent who took the view that poverty, lack of food and drinking water are the most important issues.

Support for climate protection policies is a critical dimension of public engagement, and here the evidence suggests that the publics of both Europe and USA are no more than lukewarm in areas that would affect them financially. Forty-nine per cent of European citizens express a willingness to pay a premium for energy from sources with low greenhouse gas emissions, although about half of these people were not prepared to pay more than an extra five per cent (Special Eurobarometer 313, 2009).

In the USA, Leiserowitz (2006) found that despite supporting national and international climate protection policies, 78 per cent of survey respondents were opposed to taxes on gasoline or an 'energy tax' on businesses. This finding resonates with another US survey showing that 58 per cent of respondents took personal economic considerations into account when considering possible policy approaches to climate change (Shwom et al., 2010).

*Some socio-demographic differences*

Public engagement with climate change is patterned along socio-demographic lines such as age, gender, ethnicity and socio-economic status, which are in turn associated with the various influences on engagement already discussed (in Section 3.2 above). Socio-demographic patterns are complex and can vary from context to context, and sometimes the findings of different surveys are inconsistent. Commonly, women perceive climate change as a more serious problem than men do (Leiserowitz, 2006; Sundblad et al., 2007; Semenza et al., 2008; Agho et al., 2010, McCright, 2010). This is accompanied by a tendency for women to underestimate their climate change knowledge compared to men (Special Eurobarometer 213, 2009).

Education appears to affect public perceptions of climate change in different ways in the USA compared to some other industrialised countries, including in Europe. In Europe overall, people who have studied until the age of 20 or beyond are considerably more likely to say that climate change is a serious problem than individuals whose education ended before that age. Surveys in Sweden and Australia also indicate a positive correlation between education levels and levels of concern (Sundblad et al., 2007; Agho et al., 2010) In the USA, though, higher education levels are correlated with perceptions of lower risk from climate change (Brody et al., 2007). This finding reflects a stratum of mainly white, high-income, well-educated and conservative men in the USA who perceive climate change as a very low or non-existent risk (Leiserowitz, 2007, 2009), and is in turn bound up with the bipartisan nature of attitudes towards climate change in the USA (Section 3.2). One corollary is that lower income individuals in America often report greater concern about climate change than higher income individuals (Semenza et al; 2008).

Evidence regarding the influence of age on individuals' attitudes is hard to generalise. While older respondents (aged 55+) in Special Eurobarometer 313 (2009) were less likely than those in other age groups to mention climate change as a serious problem, older respondents of a survey in two German towns saw climate change as more important than younger people (Paeth and Otto, 2009).

*A downward trend in concern?*

The two Special Eurobarometer surveys of 2008 and 2009 provide evidence of a fall in concern about climate change in the intervening year, linked to fears about the global economic recession. The percentage of European citizens who chose climate change as one of the world's three most serious problems in 2009, 50 per cent, was considerably lower than the 62 per cent of the previous year, with concerns about "a major global economic downturn" demoting climate change to third place. Between 2008 and 20009, Sweden was the only country where there was an increase in mentions of climate change as an important issue (Special Eurobarometer 313, 2009).

Some smaller-scale surveys provide findings that supplement this data. A survey conducted in the UK during the height of the UEA emails controversy showed that levels of concern had declined since 2005 (Spence et al., 2010). More specifically, the proportion of respondents who agreed or strongly agreed that climate change posed risks to UK citizens fell from 77 per cent to 66 per cent between 2005 and 2010. Conversely, the proportion that agreed or strongly agreed that there were benefits to people in Britain from climate change rose from 13 to 18 per cent. Although most people (71 per cent) were either fairly or very concerned about climate change, this is lower than the 82 per cent in this bracket in 2005. This survey also shows that, in addition to concern levels falling, more people have become sceptical about climate change. Seventy-eight per cent of those polled in 2010 considered that the world's climate is changing, a fall of 13 per cent since 2005, and 15 per cent considered it was not changing, an increase of 11 per cent since 2005. Despite the intense media coverage of the 'Climategate' story at the time of the survey, 57 per cent of UK residents recognised the scientific consensus that humans are causing climate change. For a comprehensive review of patterns and trends in public perceptions in the UK see Upham et al. (2009).

Whitmarsh (2011) cites several surveys in UK showing that around 10 per cent of the UK public completely reject the idea of anthropogenic climate change. Comparing the findings of postal surveys in two UK counties in 2003 and 2008, she found that the proportion of outright sceptics did not change much during that period, but the proportion of people who thought claims about climate change were exaggerated almost doubled, from 15 to 29 per cent. Levels of scepticism have risen in the USA (Pew Research Centre, 2009; Leiserowitz, 2010; Gallup, 2011). Only 49 per cent of Americans think that global warming is already impacting the planet compared with 60 per cent in 2008, and some American analysts speculated that the downward trend in concern is linked to the economic recession, which may have 'crowded out' climate change as a perceived problem (Gallup, 2011). As Lorenzoni and Pidgeon (2006) point out, the social context of public perceptions of climate change is constantly changing, depending partly on fluctuating media coverage.

In Europe, the CLAMER survey provides evidence that the decline in public concern about climate change that marked the inception of the global economic recession may have been halted. The proportion of CLAMER respondents who said that climate change was 'the most serious problem currently facing the world as a whole' was 18 per cent, the same as in the Special Eurobarometer survey of 2009.

In the next section, studies that explore barriers that prevent or constrain people from engaging with climate change are reviewed to add depth to the quantitative data that surveys such as those cited here provide.


## 4.3    What are the main barriers to public engagement?

It is clear from much of the literature that there are various obstacles to public engagement with climate change, a generalisation also likely to apply to CCIME specifically. Lorenzoni et al. (2007) list such barriers and divide them into two classes; individual psychological barriers and those that operate at social or institutional levels; 'the degree of people's engagement relates to their individual underlying knowledge, values, experiences and lifestyles; and these in turn are affected by the wider social landscape' (p.449). Beginning with individual-level

barriers, these authors and others have identified several interlinked tendencies that commonly constrain engagement.

*Psychological distance and low prioritisation*

People tend to associate climate change with large-scale, distant and generic impacts such as melting polar ice; socio-economic impacts are perceived as affecting other countries and people, and overall the problem is seen as one for the far future, (Nicholson-Cole, 2005; Leiserowitz, 2006; Lowe et al., 2006; Lorenzoni et al., 2006; Norgaard, 2006, 2010; Lorenzoni et al., 2007; O'Neill and Nicholson Cole 2009; Räthzel and Uzzell, 2009; Whitmarsh, 2009; Morton et al., 2011). For instance, participants in two UK studies told researchers that while in general they thought climate change was an important issue, it had no personal salience for them because it seemed remote from their everyday experiences (O'Neill and Nicholson-Cole, 2009). Young people in Sweden and the UK perceive climate change as 'serious, but produced and happening elsewhere' (Räthzel and Uzzell, 2009: 331). At the same time, people tend to view psychologically distant environmental or climate change impacts as more severe than local or personal ones (Räthzel and Uzzell, 2009; Spence and Pidgeon, 2010). Also, climate change projections are usually out to many years, while many people in the UK find it hard to imagine impacts even in the 2050s (Lorenzoni et al., 2007). Ryghaug et al. (2010) interpret Norwegians' perceptions of remoteness as a way of alleviating their concerns and overcoming the dissonance between awareness of climate change and personal behaviour. This theme of 'denial' also crops up in several other studies (see below).

Although study participants told researchers O'Neill and Nicholson-Cole (2009) that they would be more concerned about climate change if it began to impact adversely on their lives and localities, studies cited above in Section 3.2 suggest that even where there are already tangible local implications people still find it hard to make a personal connection with the issue. One of the consequences is that climate change often falls behind other problems in terms of perceived priority. These include both global problems (Special Eurobarometers 300 and 313, 2008 and 2009; Paeth and Otto, 2009; Ryghaug et al., 2010) as well as personal and domestic matters such as health and finances (Lorenzoni et al., 2007). In Norway, some people interpret

politicians' inaction over climate change as a signal that the problem is not very serious (Ryghaug et al., 2010). Residents of disadvantaged coastal communities in the UK showed little interest in climate change and generally gave it a low priority far behind 'economic security and providing for themselves and their families' (Zsamboky et al., 2011:47). Evidence such as this may illustrate the 'finite pool of worry' effect (Linville and Fischer, 1991, cited in O'Neill and Nicholson-Cole, 2009) whereby preoccupation with one risk reduces anxiety about others.

*Externalising responsibility*

People often underestimate their own contribution to carbon emissions, preferring to blame other groups and nations (Lorenzoni and Pidgeon, 2006; Whitmarsh, 2009; Räthzel and Uzzell, 2009; Whitmarsh et al., 2011). There is also a tendency for people to see mitigation as the responsibility of industry and governments rather than themselves (Stoll-Kleemann et al., 2001; Nicholson-Cole, 2005; Lorenzoni et al., 2007; Räthzel and Uzzell, 2009; Harvatt et al., 2011). Stoll-Kleemann et al. (2001) see this attribution of responsibility to other people or institutions as one of the ways that Swiss citizens justify their own inaction, although paradoxically in this case it is accompanied by scepticism that the government will indeed take the required action. In the USA, Leiserowitz (2006) found that although the majority of survey respondents support climate protection at national and international levels there is strong opposition to raising prices for fossil fuel-based energy: 'they hope the problem can be solved by someone else' (p.63). In contrast, Canadian individuals characterised as 'ecological citizens' take the view that, in industrialised countries, it is everyone's duty to take action (Wolf et al., 2009).

The tendency to see reducing carbon emissions as someone else's responsibility is linked to the well-known problem of the 'tragedy of the commons', whereby individuals deplete a shared resource even though it is not in their long-term interest to do so. With this perspective, it is not rational for individuals to take action unless there is also collective action (Stoll-Kleemann et al., 2001; Etkin and Ho, 2007; Milinski et al., 2008). But as well as constraining individual-level mitigation activities such as energy conservation, this perception limits micro-level adaptation. In an English community vulnerable to SLR/coastal flooding, residents saw it as

governments' role to curb carbon emissions, mentioning the USA's decision not to sign up to the Kyoto Protocol at the time of the study. This led to a low level of active responses to the flooding threat, such as buying insurance or moving house (Harvatt et al., 2011).

*Lack of trust in governments and media*

The critical part that trust plays in engagement with climate change was briefly discussed in Section 3.2. A lack of trust in governments and the media has been identified as an obstacle to engagement, although the CLAMER survey (Buckley et al., 2011) indicates that levels of trust vary quite widely within Europe. In the UK, the public tends to distrust scientists working for government agencies (Lorenzoni and Pidgeon 2006), the Hollywood film industry (Lowe et al., 2006) and media coverage of climate change in general, which they often see as alarmist (Lorenzoni et al., 2007; Whitmarsh, 2009; Whitmarsh 2011). Dunlap and McCright (2008) also found that members of the US public feel that the media there exaggerates the climate change problem. In Norway, the public's distrust of news media in relation to climate change reporting has ambiguous effects, with some individuals claiming that the risks are exaggerated and sensationalised, and others expressing the view that the media does not pay enough sustained attention to the issue (Ryghaug et al., 2010).

Information obtained through social networks, on the other hand, appears to have a strong influence on people's perceptions of climate change (Brody et al., 2007; Harvatt et al., 2011). In the vulnerable coastal communities studied by Harvatt et al. (2011), information from friends, relatives and local interest groups was perceived as more important than information from government risk warnings or media reports (Harvatt et al., 2011). This reflects the findings of an earlier UK survey that friends and family were the most trusted source of information on climate change, while national government was considered the least trustworthy (Poortinga and Pidgeon, 2003).

*Perceptions of personal powerlessness*

Feelings of powerlessness, or perceived inefficacy, come up frequently in the literature as a constraint to engagement (Nicholson-Cole, 2005; Lorenzoni et al.,

2007; Semenza et al., 2008; O'Neill and Nicholson-Cole 2009; Paeth and Otto, 2009; Räthzel and Uzzell, 2009; Ryghaug et al., 2010).  People commonly think that any mitigatory action on their part, such as energy conservation, would have such a negligible effect as to be futile.  Through a simple manipulation of self-affirmation in a laboratory situation, researchers were able to reduce individuals' levels of climate change denial and boost their perceptions of personal involvement in the issue (Sparks et al., 2010).

*Multiple forms of denial*

The socio-psychological barriers mentioned above are often characterised as varieties of denial (Stoll-Kleemann et al., 2001; Moser and Dilling, 2004, O'Neill and Nicholson-Cole, 2009).  For instance, Ryghaug et al. (2010:14) regard expressions of personal inefficacy as an 'excuse' for continuing habitual lifestyles, a form of denial that serves to absolve individuals from responsibility.  In a cross-national study, Sandvik (2008) finds a negative correlation between nations' gross domestic product and aggregated levels of concern about climate change, which he interprets as a manifestation of mass denial in industrialised countries.  Forms of denial such as scepticism and apathy serve the psychological purpose of enabling people to control their fears (Nicholson-Cole, 2005; Lowe et al., 2006).

The gist of these papers, taken as a whole, is that various socio-psychological obstacles combine to severely limit the extent of public engagement with climate change.  Even individuals who are strongly motivated to do something about it, for instance by reducing their own energy use, are confronted by interlocking contextual barriers (Lorenzoni et al., 2007; Ockwell et al., 2009; Wolf et al., 2009).  Some of these external barriers are practical, part of the 'high carbon infrastructure within which we live, travel and work' (Ockwell et al., 2009:308).  For instance, a lack of adequate public transport services makes it hard for individuals to give up using their car (Nicholson-Cole 2005) and pro-environmental behaviour sometimes costs more or is more time-consuming than the alternatives (Howell, 2011; Whitmarsh et al., 2011).  In such situations, old habits and routine behaviour often reassert themselves.

There are also subtle and pervasive socio-cultural norms and structures at play (Stoll and Kleemann et al., 2001; Norgaard, 2006).  Norgaard (2006) explores how members

of a small Norwegian community 'manage to produce an everyday reality in which this critically serious problem [climate change] is invisible' (364). This study is unusual in that its unit of analysis is a community and society more widely, rather than individuals. Norway's citizens derive considerable economic benefits from oil production, so their way of life is intimately bound up with carbon emissions and climate change. Rather than stemming from an absence of knowledge or awareness, Norgaard argues that the lack of personal engagement she observed was a matter of 'socially organised denial' (p.350), whereby individual-level barriers to engagement are supported and produced by the social, cultural, economic and political context. Similarly, in their comparison of young people's environmental attitudes in UK and Sweden, Räthzel and Uzzell (2009) argue that, rather than focussing solely on individuals, researchers need to take into account the social, political and historical context in which their perceptions are rooted.

The diverse contextual barriers that currently make it hard for the public to practise low energy lifestyles lie outside the remit of this review. Rather, the next section is an attempt to answer the question: 'how can communications on CCIME overcome apparently formidable socio-psychological barriers to engagement?' based on applicable research.

## 4.4 Overcoming barriers to engagement through effective communications

Based on research findings, it is possible to identify guidelines for improving the effectiveness of communications on climate change, and by extension CCIME, in order to foster public engagement.

A recommendation arising from several studies is that communications should acknowledge that there are 'multiple publics' (Lowe et al., 2006:454). This means moving away from generic, mass communications and instead developing strategies and messages for specific communities, interest groups, worldviews or types of individual (Bray and Shackley, 2004; Ereaut and Segnit, 2006; Lowe et al., 2006; Featherstone et al., 2009; Nisbet and Myers, 2009; O'Neill and Hulme 2009; Harvatt et al., 2011; Zia and Todd 2010). For instance, as ideologies have a strong influence

on individuals' perceptions of climate change science, Zia and Todd (2010) suggest matching communications strategies to known ideological predispositions, changing the framing as appropriate. Ereaut and Segnit (2006) recommend targeting groups of people who share the same values and behaviours so that mitigation behaviour is perceived as 'the kinds of things that people like us do' (p.8).

Targeting and tailoring communications in this way would involve localising messages rather than representing climate change in terms of its global impacts; giving them a strong visual element (Lorenzoni et al 2007; Shaw et al., 2009; Harvatt et al., 2011); and avoiding experts' conceptualisations in favour of representations likely to appeal to non-experts (O'Neill and Hulme, 2009). Messages should involve an element of co-construction, whereby local publics are actively involved, rather than being seen as passive 'targets' to whom information is transferred (O'Neill and Hulme 2009). Evidence already cited (in Section 4.3 above) also indicates that disseminating messages through social networks is likely to be more effective than routing them through governments, businesses or the media (Ereaut and Segnit, 2006; Brody et al., 2007; Harvatt et al., 2011).

Engagement requires some emotional involvement (Ereaut and Segnit, 2006; Lorenzoni et al 2007), but appeals to fear are, at worst, counterproductive (O'Neill and Nicholson-Cole, 2009) and at best have only a short-lived effect (Lowe et al., 2006). Yet according to Ereaut and Segnit (2006:7), much media coverage of climate change is alarmist, depicting climate change as 'awesome, terrible, immense and beyond human control' People commonly feel overwhelmed by shocking images (Nicholson-Cole, 2004; Petts et al., 2004; Lowe et al., 2006) and so may well reject such messages (Lowe, 2006). Although alarming images and narratives may grab attention, they can also cause confusion (Lowe et al., 2006; Jennings and Hulme, 2010) or produce feelings of helplessness. O'Neill and Nicholson-Cole (2009) recommend using images showing simple personal actions like fitting a low energy light-bulb in order to stimulate feelings of personal efficacy. Joining images of global doom to apparently trivial injunctions, such as switching the light off, may provoke derision and the very feelings of powerlessness that need to be overcome (Ereaut and Segnit, 2006). Moser and Dilling (2004:41) point out the value of 'teachable moments': that is, relevant news or media events to which appropriate messages can

then be linked.  In such situations timeliness is crucial, because although such moments produce spikes in public interest or concern, these quickly flatten out again (Lowe et al., 2006; Hart and Leiserowitz, 2009).

The question of whether communicators should use 'a gain 'or 'loss' frame adds further complexity to the composition of messages. When highly uncertain climate change predictions are expressed with a gain frame (such as 'there is a 60 per cent chance that we can avoid catastrophic effects from climate change') people feel that mitigatory action will be more effective and so are more willing to consider taking such action.  Expressing the same probability in negative terms, (e.g. 'there is a 40 per cent chance that we cannot prevent catastrophic effects from climate change') inclines people to accept the risk (Morton et al., 2011).  There may be a dilemma here though, because although messages based on gain frames foster positive attitudes to mitigation, people forget them more easily than fearful messages (Spence and Pidgeon, 2010).

# 5  Conclusion

This review highlights a substantial research gap.  Existing studies of public engagement with CCIME are mainly concerned with the risk perceptions of people in communities exposed to SLR/coastal flooding, which is also one of the climate change impacts that the public are most aware of.  By their nature, these studies relate to the imperative of adaptation.  In this context, participatory deliberative processes have been successful in raising awareness both of the risks and the range of alternative responses.

But risk perceptions are only one aspect of public engagement with these issues, and other aspects are relatively neglected in the academic literature.  This is despite the success of some recent public campaigns concerning the marine environment which indicate that there is substantial public concern about marine environmental problems; concern that is not necessarily based on perceptions of risk to humans.  Constituencies of people who are already engaged with marine environmental issues have only been fleetingly glimpsed here, although they certainly exist and in some cases have been influential in policy circles.  As well as these already-active groups, the public interest

in other marine environmental issues that is documented here suggests there is likely to be considerable latent interest in CCIME. There is a need to explore the factors that foster such interest and concern. In addition, public engagement with the lesser-known CCIME, such as ocean acidification, has been very little studied. What evidence there is suggests that some of these lesser known CCIME may be perceived as extremely 'psychologically distant' by many members of the public. The rather limited body of directly relevant work can be supplemented by reference to other, closely-related, literatures.

The gist of several studies reviewed here is that the links between knowledge of CCIME and engagement with them is contested. The implication is that scientific information about CCIME needs to be presented in such a way as to create engagement rather than merely to increase knowledge. A rich seam of research highlights how such information might be targeted and crafted in order to avoid or overcome common socio-psychological barriers such as fixed worldviews, fear and perceived helplessness. Future CCIME communications should take account of these valuable insights.

# PART 2: Public understandings of and responses to marine climate change impacts: The results of an in-depth qualitative study

## 1  Introduction

In this second part of the report, the findings of an in-depth qualitative study are used to explore public understanding and engagement with marine climate change impacts in more detail and to complement, interpret and reflect on the results of the 10 country survey analysed in CLAMER Deliverable 2.2 (Buckley et al., 2011).  This study took the form of a participatory workshop that brought together 20 members of the UK public along with several climate change and marine environmental specialists in a day-long programme of discussions, presentations and a beach walk held in a coastal location in North Norfolk on 25th June 2011.  The main aims of the research were to deepen understanding of how publics perceive, engage with and respond to marine climate change issues and investigate the underlying factors that shape their understandings and responses.  The following research questions guided the design and analysis of the study:

- How do publics frame and understand marine climate change impacts?

- Does the public engage with marine climate change issues?  If so, how?

- What is the relationship between public understanding and engagement?

- To what extent do publics support different responses to CCIME in terms of individual, policy and research commitments?

- What difference does connecting with CCIME - through direct experience, taking on information, and interacting with scientific expertise - make to public understanding and engagement?

The rationales and justifications for developing an in-depth participatory study as part of the CLAMER project that addresses these questions are threefold.  First, while the European-wide CLAMER survey has generated new evidence into what publics think about marine climate change issues it offers us limited insight into why this is the case

and what underpins perceptions. Our in-depth study therefore plays a valuable role in investigating the underlying factors that shape understandings and responses in order to complement, verify and further explain patterns and insights emerging from the wider survey (cf. Lorenzoni, 2006; Wolf and Moser, 2011). This study therefore represents a new addition to a small but growing body of work that looks for detail, difference, nuances and complexity in developing deeper insights into the factors that shape perceptions of climate change and its impacts at the level of individuals.

Second, in the CLAMER survey public respondents were asked to offer 'top-of-mind' and relatively uninformed opinions, concerns and judgements about what are inherently complex and often scientifically-defined marine climate issues. While offering far less geographic coverage, the participatory and deliberative nature of our in-depth study has the advantage of eliciting more informed and considered public views on marine climate impacts. It has done this through providing time and space for participants to explore, learn about, and reflect on the issues in hand, not least through dialogue and interaction with experts and fellow citizens (cf. Webler et al. 1995; Bohman, 1996; Chilvers, 2008).

Third, our in-depth study offers an alternative way of exploring one of the main focuses of the CLAMER project – i.e. relations between scientific and public understandings of climate change impacts on marine environments. Rather than comparing a review of the scientific evidence base with responses to a large-scale survey to gauge the knowledge 'gap' between scientists and the public, our in-depth study took the opposite approach. It sought to actively develop opportunities for interaction, challenge and debate between scientists (or scientific information) and public participants in order to explore relations between and transformations in their respective knowledges, expertises and identities in greater depth (cf. Davies and Burgess, 2004). In addition to exploring how such interaction may influence public understanding of marine science and climate change issues, this has allowed us to explore how scientists understand of the public and whether this is transformed through their participation.

Given the clear strengths, added value, and complementary of this in-depth participatory approach, ideally similar studies would have been held in each of the 10

countries surveyed, but project resources were insufficient to allow this. Based on a comparison of the CLAMER survey results and the debates that took place during the one-day event, there are some important commonalities linking the sample of people who took part in the discussions, the 1,000 or so UK survey respondents and the approximately 10, 0000 respondents from all 10 countries surveyed, although there are certain differences too. The insights afforded by the in-depth study cannot be transferred uncritically to larger populations, whether in the UK or in Europe. Rather, they may be considered as useful for interpreting and explaining some of the results produced by the CLAMER survey and other quantitative studies interested in public engagement with climate change, as well as being an important form of evidence in their own right.

Workshop discussion yielded unique insights into what certain members of the UK public know about CCIME, their perceptions of marine climate change impacts, and their engagement with these issues, as well as with marine environmental problems more widely. The data that the study yielded, namely transcripts of discussions lasting the best part of a day, is, like all qualitative data, context-specific. This particularity of the data is part of its richness. In Section 4 of this second part of the report an analysis of certain key aspects of this group's understanding of, and engagement with, marine climate change is set out, covering; the salience of these issues in people's minds and influences on concern; knowledge, framings and perspectives; responsibilities and trust, and fourthly, changes in understanding, attitudes and intentions arising from participants taking part in the process. These themes will be explored in turn, after first describing the participatory method and the outcomes of the workshop.

## 2 Design and method

The design of the participatory process developed in this study took the form of a workshop that brought together public participants and specialists on marine climate change issues in a day-long deliberative process. A hybrid methodology was used inspired by and drawing on several traditions. Focus group/in-depth group approaches (e.g. Burgess et al. 1998) were used to explore participants open framings of the issues in question at the beginning of the process and elicit differences as well

as similarities among participants. Deliberative mapping (Burgess et al. 2004; 2007) influenced how participants were enrolled into the process and the way in which citizen-specialist interaction was organised. Participatory rural appraisal (PRA) and participatory learning and action (PLA) techniques were used to encourage participants to take an active role through brainstorming and voting on a list of priorities in their own terms (e.g. Chambers, 1994).

## 2.1 Recruiting participants

A local market research firm was contracted to recruit twenty members of the public, which they did through community organisations, local radio stations, social networks and social networking media such as Twitter. The recruiters were instructed to seek participants in equal numbers from the City of Norwich, which has an estimated 132,000 inhabitants and lies about thirty kilometres from the nearest coast, and coastal parishes in North Norfolk.

A brief information note was disseminated to interested individuals (Appendix 3), as well as an enquiry form for any who wished to take part in the event (Appendix 4). A total of 38 completed enquiry forms were received in the first instance, and a further two individuals approached us later wanting to take part. Based on the information in the completed forms the eventual participants were carefully selected with respect to gender, age and socio-economic class, as defined by the UK Office of National Statistics, in order to broadly reflect the socio-demographic composition of the two sample areas. Data from the 2001 census carried out by the UK's National Statistics Office were used to establish the socio-demographic makeup of the two areas sampled. This is the most recent census of which the results are yet available, as the results of the 2011 national census have yet to be published.

The completed forms were also used to check for prior environment-related interests and affiliations. During the recruitment process, our event was advertised as 'a discussion of environmental issues', although no mention was made of either climate change or the marine environment. That was because researchers' previous experience suggested that participants might prepare in advance if they knew the topic, which would have distorted the study findings concerning their knowledge of

the issues. Nevertheless, there was still the potential that a disproportionately large number of would-be participants might have prior affiliations to environmental campaigning organisations or charities. In order to guard against this, details of such affiliations were checked during the sampling process. The final group; of participants included one individual who was a member of several environmental campaigning groups as well as the Green Party. A few other participants were members of, or did occasional voluntary work for, charities and other organisations whose remit touched on environmental matters (see Appendix 7). Most participants did not declare any such interests or connections.

The three experts who took part were drawn from the School of Environmental Sciences at the University of East Anglia and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS), one of the partners in the CLAMER project.

## 2.2 Programme, approach and practical arrangements

The venue for the day-long event was a hotel on the North Norfolk coast, about one kilometre from the sea. Transport was provided to and from the venue for the Norwich participants, as an incentive to participation, and one of the facilitators contacted all the participants by phone or email a few days before the event, to confirm their attendance and answer any queries they might have. Although experience of similar events has shown that it is common for a few participants to withdraw at the last moment, in this case all the invited participants turned up for the event. The provision of a reasonably generous honorarium (£50), lunch and refreshments, the attractive venue and location, the mention in publicity materials of 'walking on the beach' as part of the day's programme, and the personal contact with a facilitator, probably all contributed to this high turnout.

The programme for the day comprised plenary sessions interspersed with concurrent small group discussions for the North Norfolk coast and Norwich participants (see Appendix 2 for a detailed outline of the participatory workshop programme). Plenary sessions were used to; create an environment in which participants could feel comfortable about taking an active involvement, present scientific information on marine climate change, and at the end of the process draw out general reactions both

to the information presented and the experience of taking part in the event. The parallel discussions for the North Norfolk coast and Norwich sub-groups reflects the separate sampling of coastal and inland dwellers for the CLAMER survey, which was in turn driven by the hypothesis that coastal dwellers might demonstrate different understandings and experiences compared with other members of the public.

During the morning tea break, after participants had been given the opportunity to think about marine environmental issues and CCIME in their own terms, a set of posters covering various marine climate change impacts were displayed (see Appendix 8), as a preliminary to the expert presentation. In the middle of the day, a picnic lunch was provided and participants were taken to a nearby beach, where they ate lunch, listened to very short presentations from several specialists in climate change and/or marine environments, and took a short walk, before returning to the hotel for the afternoon sessions. This visit to the beach was seen as a key part of the programme both because of: the importance of site visits and direct experience to participatory learning (e.g. Webler et al., 1995); and evidence that being able to interact with the sea heightens engagement with marine environmental issues (Steel et al., 2005).

## 2.3    Capturing and analysing the data

All plenary and group sessions were audio recorded and notes taken as back-up and to help identify which participants were speaking at different points in the recording. The discussions were professionally transcribed and then coded using NVIVO8 software. Coding was based on a straightforward list of the topics discussed, themes developed in the literature review (given in Part 1 of this report), and themes that emerged from a preliminary analysis of the transcripts.

# 3   Overview of process and outputs

In essence the deliberative process had three stages. During the first stage, in the early morning, the public participants' initial understanding, perceptions of and engagement with the marine environment and CCIME were explored. The second stage consisted of presenting information on the CCIME covered in the CLAMER

survey.  This was done through a poster exhibition which participants were encouraged to look at during the mid-morning break (see Appendix 8), followed by a presentation from a CEFAS scientist and a question and answer session.  This second stage culminated in a walk on the beach.  The same CEFAS expert who had made the presentation used the walk as a short 'field trip' to relate the scientific information he had presented to the actual environment of West Runton beach, using the local landscape, seascape and found objects.  On the beach, post-graduate researchers from the School of Environmental Sciences, who were assisting the facilitation team on the day, also talked briefly about those CCIME that fell within their areas of expertise.  A picnic lunch provided a further opportunity for the public participants to talk to the experts and researchers.

A key objective during the afternoon was to explore public participants' concerns around CCIME, after looking at the posters, hearing from the experts and going to the beach.  Public participants were asked if and how their perceptions had changed since the morning.  They were also asked to deliberate on their own priorities regarding various responses from different actors, and at different levels.  As for the experts, they were asked to reflect on their experiences of the day.

This programme was closely adhered to throughout the day, without serious over-runs and with no adjustments.  The atmosphere throughout was brisk but informal and, after the initial 'ice-breaking' session, quite relaxed, although some participants expressed nervousness on arrival.  Discussions were always lively and several participants showed a willingness to engage with the marine and climate change experts who were also present.

As has already been explained, the aim of this study was to investigate the diverse influences on individuals' understanding of, and engagement with, CCIME, rather than to present data on the participants' knowledges, views and attitudes in themselves.  However, the substance of the West Runton participants' understanding and engagement with CCIME needs to be understood, if only as a backdrop to the analysis of findings contained in the next section.  Appendices 9 and 10 contain data from the visual outputs of the West Runton discussion event concerning marine environmental matters in general and CCIME in particular.  For the participants, those

marine environmental issues that were local and visible tended to predominate. When asked to think about CCIME, they tended to talk about the local impacts of coastal erosion and flooding associated with sea-level rise. However several participants also articulated awareness of remote and less tangible impacts. For instance, one participant even mentioned the issue of ocean acidification before this was presented, which was done through posters and the expert presentation.

# 4 Analysis of findings

Analysis of the discussion transcripts pointed to four broad areas where the data illuminates the public participants' understandings of climate change and marine environments. Firstly, there are the factors that underlie the salience of the issue for individuals, and their degree of concern. Secondly, the discussions throw light on the kind of knowledge individuals have about these issues, the way they frame them and their specific perspectives, which in some cases are very different from scientific perspectives. Third, individuals discussed the responsibilities of various actors, including themselves, to respond to CCIME, and their levels of trust in the different actors. Fourthly, reflections of both public participants and experts on their deliberations, their interactions with each other, and the opportunity to directly experience these issues through a beach walk, provide insights into the value of these processes and the extent to which they lead to transformations for the individuals involved.

## 4.1    Influences on salience and concerns

In this section, the workshop discussions are analysed to explore the factors that influence both the salience and importance of CCIME for individuals who took part, and the extent of their concerns about specific CCIME. Before analysing what the

discussion tells us about these influencing factors, it is useful to overview some of the findings of the qualitative study and place them alongside the relevant CLAMER survey results.

When participants were asked which, if any, marine and coastal environmental issues sprang to mind, pollution and erosion came up as priorities, followed by overfishing.[5] The primacy of pollution and beach rubbish in people's minds closely reflects the CLAMER survey findings, both for all 10 countries polled and the UK in particular. Across all 10 countries surveyed, 24 per cent of responses to the relevant question mentioned pollution and an additional 10 per cent mentioned oil pollution specifically. In the UK, 29 per cent of responses named pollution and a further 4 per cent named 'oil pollution'. In sum, those marine environmental issues that were most salient for participants in the discussion group were also salient for these two wider populations. Further evidence of the salience of pollution is provided by Howard and Parsons (2006) who documented levels of public concern for various marine issues. Their results show that oil spills, chemical and sewage pollution are considered to be the most serious threats in Scottish waters by urban residents. The public showed significantly greater levels of concern for pollution and related issues than a test group of experts did (Howard and Parsons, 2006).

When workshop participants were asked without prompting which, if any, coastal or marine climate change impacts sprang to mind, sea-level rise/flooding and erosion dominated. This reflects survey findings for the UK, where erosion came first with 18 per cent of all responses to the relevant question, and sea-level rise came a close

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[5]That was in answer to Question 7 of the CLAMER survey: 'When you think about the coastline or the sea, what are the three most important environmental matters that come to mind?' The survey did not include a separate option for 'beach rubbish and litter' under Question 14, regarding concerns, although the option 'pollution at the coast or in the sea' could be construed to include it. With hindsight it would have been a good idea to include rubbish and litter as a distinct option, so that it could be readily distinguishable from sewage and oil, the two types of marine pollution commonly mentioned.

second with 17 per cent.[6]  Erosion is a much more salient issue for the UK population than for most other countries surveyed, although it also comes high in the public mind in Ireland.

UK levels of concern over many marine environmental issues are very similar to average concern levels across all 10 nations surveyed.[7]  For instance, 70 per cent of UK respondents claimed high levels of concern about SLR, compared with seventy one per cent of total respondents.  The figures for coastal flooding concerns were also very similar; 73 per cent of UK respondents claimed high levels of concern regarding coastal flooding, compared with 71 per cent of respondents from all 10 countries.  On the other hand, the survey also indicates that the UK public is less concerned than the 10-country average about nine out of 15 marine environmental and climate change issues, and more concerned than the 10-country average about; coastal erosion, jellyfish and the impacts of aquaculture.

The literature suggests that many factors help to shape the salience of climate change and its impacts for individuals, as well as their associated degree of concern.  These include relative visibility, immediacy and proximity, perceptions of personal risk, and moral arguments relating to impacts on other peoples and species.  The concept of 'psychological distance' helps to explain why climate change in general can be a difficult issue for the public to engage with.  As discussed in the literature review (Part I), studies have found that for many people, climate change impacts seem remote and irrelevant to their own lives (Nicholson-Cole, 2005; Leiserowitz, 2006; Lowe et al., 2006; Lorenzoni et al., 2006; Norgaard, 2006, 2010; Lorenzoni et al., 2007; O'Neill and Nicholson Cole 2009; Räthzel and Uzzell, 2009; Whitmarsh, 2009; Morton et al., 2011).  In the paragraphs that follow, extracts from the discussion

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[6]  Question 11 of the CLAMER survey: What three things come to mind when you think about the impacts of climate change on the coastline or the sea?

[7]  Question 14 of the CLAMER survey: And now please indicate to what extent do you feel concerned about each of the following?

transcripts are used to illuminate and explore some of these aspects of CCIME, and how they may influence salience and concern.

*Visibility*

Unsurprisingly, where the manifestations of marine environmental problems are visible to members of the public, this tends to contribute to relatively high salience. For instance, during workshop discussions the problems of flotsam, sewage and beach litter emerged as marine environmental issues that individuals prioritise at least in part because they are easy to see.

> Tanya, Norwich
> I've noticed that the beaches are dirtier, there's more stuff washing up that is clearly what people have put down toilets, that hasn't actually disintegrated.

The issue of plastic rubbish came up several times. One participant pointed out that people tend to notice plastic flotsam and rubbish because it does not rot down and so remains visible over long periods of time. The effects of coastal erosion are also highly visible, either at first hand or in the television and print media, as are the effects of extreme weather events.  In contrast, sea-level rise was characterised as a manifestation of climate change that is hard to grasp partly because it is not visible;

> Donald, Norwich
> [Sea level rise] is less visible than erosion and in some ways is more difficult to get your head around, and I wondered to what extent, with a lot of these issues, it just feels too big, can't conceive of it somehow.

> Tanya, Norwich
> When you walk along a beach after ...a storm...you can see the damage that's been done, but with rising sea levels ...you're not really aware of it, are you?

*Proximity*

Coastal flooding and erosion tended to dominate the CCIME concerns of people from both Norwich and the North Norfolk coast.  Several participants from the coast live in areas vulnerable to coastal flooding.  According to the CLAMER survey findings, coastal dwellers throughout all 10 countries are more concerned about erosion than respondents who live inland (71 per cent of coastal dwellers claimed high levels of

concern, compared with 59 per cent of respondents living inland). They are also somewhat more concerned about coastal flooding than people living inland (75 per cent compared with 69 per cent) although the difference is not as great as might have been expected. The greater concern of the North Norfolk coastal sub-group over these two threats only really became apparent when both groups were asked to prioritise a list of public policies and research priorities relating to CCIME; during that exercise, policies and research relating to erosion and flooding emerged as more important for the North Norfolk participants than for the Norwich participants.

In the next comment, the salience of coastal erosion and flooding is attributed to the physical proximity of vulnerable coastline and the consequent local media coverage, and the speaker contrasts it with the much lower salience of ocean acidification;

> Carrie, Norwich
> Because of where we are near the coast and we are in relatively low lying lands ...it's something that is higher up in our consciousness than the acidity of the sea, we don't really hear that on the news in the evening...It's local and immediacy that make you more concerned about something.

However, this comment by a Norwich resident, when asked to name CCIME during one of the first sessions, shows that, although coastal flooding is a relatively salient climate change impact for people in Norfolk, even so the threat can be hard to grasp;

> Michael, Norwich
> Flooding, I think that's an issue. They have said in about 100 years' time, Norwich is going to be under water and if you go through Great Yarmouth and you go down one of the roads near the coast, you wouldn't think no water come here at all, if you look 2/3 years ago, it was like 2/3ft under water, so the effects of flooding, when it's not [flooded] it's unbelievable and when it is [flooded] it's like a shock and it's like, I can't think of the word, you wouldn't have imagined it.

*Risk perceptions*

Studies of risk perceptions tend to dominate the UK literature on climate change adaptation. The studies of perceived climate change risks that were cited in Part I (e.g. Harvatt et al. 2011) focus on the direct threats that people perceive to themselves and their own homes, families and communities. Certain participants in the

discussion based their perceptions of CCIME wholly, or largely, on appraisals of personal risk. In the case of Michael, who is quoted next, that was quite explicit;

Michael, Norwich
If it's miles away, I'm not that bothered, as I say the closer to home it is, the more it hurts.

Jessica also gave the absence of perceived risk as a reason for her relatively low concern about ocean acidification and changes in the frequency of extreme weather events compared to erosion and coastal flooding;

Jessica, Norwich
[Coastal erosion and flooding] are the ones that directly affect us...whereas changes in extreme weather is not quite so much for us, we don't get tornadoes and hurricanes particularly.

Other participants were aware that they indirectly shared some climate change risks with other people even where they themselves were not directly affected. For instance, this woman is talking about sharing risks from extreme weather events (one of the CCIME identified in the survey and included in the discussion);

Tanya, Norwich
We've had that really freak storm where the hailstones were the size of golf balls and they were damaging property and a lot of people lost their Perspex roofs on their very expensive conservatories, therefore the economic or financial aspect of that was insurance shot up for everybody, whether you had a conservatory or not.

Several other participants based their perceptions on considerations quite other than personal risk, however, whether direct or indirect. Concerns about remote CCIME, based on moral values and ideas of social justice, are discussed next.


*Sense of morality and social justice*

As Simone made clear, not everyone based their perceptions of CCIME on assessments of personal risk;

Simone, North Norfolk coast
These things don't have to directly affect us personally for us to be concerned about them.

Several individuals expressed concerns about CCIME in distant places, such as Bangladesh, showing that she was not alone in this view. In the following comments, a member of the Norwich sub-group compares severe climate change impacts for people in developing countries with the relative privileges and protection of inhabitants of industrialised countries, using the blue flag beach designation as an example of the latter.[8] He is followed by another participant, Tanya, who talks about the need to take personal responsibility for distant impacts:

<u>Donald, Norwich</u>
Most of us are in a privileged position, whereas 75 to 200 million people by 2020 will be experiencing shortages of fresh water. That's a real impact, they'd be worried, we've got blue flag beaches so we're all right, do you see what I'm getting at?... That's where I think it's as much a moral issue as anything.

<u>Tanya, Norwich</u>
David's point about we're quite fortunate here, it doesn't really impact us, in a sense that is such a moral thing because we can all say that, it doesn't affect us... it's getting people to take personal responsibility and that personal responsibility is the thing that will flow out and help communities be communities as such, but how that impacts with climate, I can't quite marry the two at the moment.

Tanya's remarks provide evidence to support Stern (2000) in his argument that personal moral norms are the basis for environmentally responsible behaviour. In the North Norfolk coastal sub-group, Inuits and polar bears were mentioned as examples of populations and species which would be seriously affected by climate change, despite their lack of responsibility for the problem. The second comment also demonstrates the potency of iconic images (O'Neill and Hulme, 2009) to influence public perceptions:

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[8] Blue Flag designations are awarded to coastal destinations which have achieved the highest quality in water, facilities, safety, environmental education and management (www.blueflag.org).

Zahra, North Norfolk coast

> They haven't done anything wrong and neither have the Eskimos...so I feel really bad now for the polar bears and the Eskimos!

> <u>Bill, North Norfolk coast</u>
> I can remember seeing just a picture of a single polar bear floating on a small block of ice, when the whole area would have normally been ice...and I thought that was just awful.

One of the youngest participants, Jed, aged 19, expressed a rather different reaction to images of melting polar ice, one based on the emotion of fear rather than moral concerns:

> <u>Jed, Norwich</u>
> I think the Arctic melting is quite bad, that just doesn't seem like a good sign. I just think that's a bit dodgy to be honest but I can't put it into formal wording; it just freaks me out that it's melting.

Based on their remarks, it seems likely that Zahra, Bill, Jed and other participants who made similar observations about impacts in distant countries and on other species hold 'egalitarian' worldviews according to the cultural theory developed by Mary Douglas (e.g. 1997) and used by some social science researchers to explain differences among individuals' views on climate change (Verweij et al., 2006). The contrast between their perceptions of climate change impacts with those of Michael, who articulated a perception of CCIME based on risk perceptions, was striking.

Inevitably, this analysis of the factors that shape degrees of salience has touched on the diverse kinds of knowledge that members of the public rely on when forming their judgements. In this way it anticipates the next section, where these sources of knowledge are analysed in their own right and non-scientific framings of marine climate change are also discussed.

Several members of the coastal group who live in locations vulnerable to flooding appear to take this risk rather lightly. Marion, asked if she had been concerned about the risk of coastal flooding when she and her husband recently moved into a vulnerable area, replied with a smile; 'We just didn't consider [it]'. At first sight this seems surprising, because parts of the North Norfolk coast are a paradigmatic case

(Flyvbjerg, 2001) of an area that is vulnerable to CCIME. However, several studies cited in Part I show that coastal flooding risks seem to be of low concern for many individuals in vulnerable communities (Bickerstaff et al. 2004; Harvatt et al. 2011).

*Place attachment*

Recently, researchers such as Adger et al. (2011) have begun to discuss the powerful influence of 'place attachment' in adaptation decisions, although this is a very new area of work. Place attachment might have been expected to figure in participants' views on coastal erosion and flooding. Comments were made about the loss of the Norfolk Broads due to sea-level rise and the realignment of the coastline due to flooding; during these parts of the discussion a sense of pragmatic acceptance seemed to prevail within the group, including among members from North Norfolk. On the other hand, one participant, Carrie, expressed sadness over the damage caused by climate change to the Great Barrier Reef, which she had visited on holiday, showing that place attachment is not restricted to place of residence. The loss of coastal property to erosion was deplored by two members of the Norwich sub-group although they themselves are not affected. One, Michael, had been struck by television images of houses falling into the sea, while the other, Jessica, was presumably influenced by the experience of her friend on the Suffolk coast.

Although the local impacts of erosion and flood risk were often mentioned, they did not completely crowd out physically distant environmental and climate change issues, although one of the CEFAS experts who took part in the day predicted that this would happen.

*Remoteness in space and time*

As well as discussing CCIME that impinge locally such as coastal erosion and flooding, some participants raised CCIME that will affect remote locations and the people living in them. The point was made more than once that climate change will affect poor people in vulnerable locations, such as Bangladesh, much more seriously than it will affect people in Norwich and North Norfolk. This is in line with a study by Räthzel and Uzzell (2009). However, whereas these researchers found that young people in Sweden and the UK saw climate change as primarily both produced by and

affecting people elsewhere, there was a strong consensus in both the Norwich and North Norfolk groups that distant impacts were the responsibility of people in industrialised countries (see below). In other words, while perceptions that CCIME are more of a threat to people in faraway lands than in the UK reduce their salience and concern for some individuals, for other people in the group they raise uncomfortable moral issues (see below).

The idea that some climate change trends will only have an impact in the remote future, if at all, also contributes to psychological distance (Lorenzoni et al., 2007). This is exemplified in the following brief exchange, where two middle-aged participants are discussing why their group showed relatively low concern about changes in sea currents:[9]

> Ralph, North Norfolk coast, followed by Marion, North Norfolk coast
> I think that's a gradual change and if it does happen, it will be gradual and we'll slowly go – it could be 100 years …Hopefully it doesn't affect us! [Laughs]
>
> Maybe that's it; we're not going to be here.

## 4.2    Public knowledges and framings

In this part of the report, the evidence from the West Runton event is analysed with a view to illuminating debates on the public's knowledge about climate change. In particular, diverse types and sources of knowledge of CCIME are discussed, and the argument is made that some members of the public frame climate change differently from scientists. Most studies in this area belong to a tradition of studying public understanding of science, and so they are concerned with a particular type of knowledge: scientific knowledge. As discussed in Part I of this report, evidence has

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[9] This marine climate change impact is mentioned in Q. 14.1 of the CLAMER survey.

been put forward that many adults' mental models of the causes of climate change are misconceived or inaccurate (e.g. Poortinga and Pidgeon, 2003; Reynolds et al., 2010), but social scientists have critiqued this approach (e.g. Lorenzoni et al., 2007: Räthzel and Uzzell, 2009). The findings of the CLAMER survey support this latter position, because they show that public judgements on sea level and sea temperature rise are consistent with mainstream scientists' projections (Buckley et al., 2011).

The survey results also show that on all issues apart from coastal erosion, the mean UK score for self-reported 'informedness' is lower than for the 10 countries as a whole.[10] The biggest difference concerns self-reported informedness regarding jellyfish swarms (a UK mean of 2.2 compared with a mean of 2.6 for the 10 countries surveyed) which might reflect a lower exposure to this particular threat compared to respondents in other countries. Conversely, self-reported informedness on coastal erosion is higher among UK respondents than in the 10 countries as a whole (a UK mean of 3.2 compared with a mean of 3.0 for the 10 countries surveyed), which might reflect the fact that some parts of the UK coastline are highly vulnerable to erosion. It needs to be borne in mind that self-reported informedness is known to be an inaccurate proxy for actual knowledge or awareness, and in a multi-country survey such as this one, differences in country scores may reflect national cultural characteristics as well as, or even rather than, actual informedness. In short, it is hard to draw any firm conclusions from these particular results. A more definitive indicator of lower levels of scientifically-defined knowledge in the UK is the fact that UK respondents also scored lower on two of the 'ocean literacy' questions included in the CLAMER Survey.[11]

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[10] Question 13 of the CLAMER survey: How informed do you feel about each of the following?

[11] The UK has the lowest proportion (36 per cent) of respondents scoring correctly on the likely amount of global average sea-level rise over the next 100 years, based on projections in the 2007 IPCC report of a likely rise of 19-58 centimetres (Question 16). Also, slightly fewer UK respondents than the 10-country average think that sea temperatures will rise by 2 degrees over next 100 years, which according to the CLAMER WP1 synthesis report is likely (Question 19).

As might be expected, workshop participants varied widely in their scientific knowledge on marine climate change. Some individuals did articulate misconceptions about climate change and its links to other phenomena. A small number of participants articulated basic misapprehensions, for instance mistakenly attributing tsunamis to climate change, ocean acidification to sewage and sea-level rise to melting polar ice. On the other hand, the discussions also provided evidence that some participants had a very sophisticated understanding of CCIME and frame them in a more integrated and holistic manner than marine and climate scientists. In general, levels of awareness seemed quite high, apart from the issue of ocean acidification, an issue that has come to light comparatively recently and as yet has received little media attention.

In some cases, knowledge seems to equate in a straightforward manner with concern and ignorance with lack of concern, as this remark about ocean acidification illustrates:

> Barbara, Norwich
> Because I understand it less, I don't really see what the direct impact is on me, so I'm not as concerned.

With respect to knowledge about the *causes* of climate change, the CLAMER survey shows that 53 per cent of UK respondents think it is partly caused by human and partly by natural processes. This is higher than any for other country surveyed and much higher than the 10-country average of 42 per cent. The UK also has one of the lowest national percentages of respondents who think climate change is caused entirely by human activities. During the discussion two male participants, one from Norwich and one from the North Norfolk coast, argued strongly that scientific claims regarding anthropogenic climate change overlook natural climatic cycles playing out

over many millennia. The impression was given that these participants saw mainstream climate change science as an orthodoxy that they were keen to challenge.

Although another participant, Donald, did not challenge mainstream climate change science, he expressed the view that more scientific knowledge would not necessarily help to build public understanding:

> Donald, Norwich
> Logic would suggest that yes, wouldn't it be helpful that we know, but we seem to have done a fair amount and we're still uncertain. [One of the marine climate change experts] was saying; 'Here's some graphs and some will say it will be there, some will say it will be here'... in terms of the public and our response to it, we all get jumbled.

On the other hand, this participant did see scientific knowledge as the key to changing public behaviour:

> Carrie, Norwich
> I think an individual's response can only be as good as the individual's understanding of the situation...we've been quite lucky today, we've had the privilege of listening to people who really know what they're talking about. But there's all this amazing scientific research being done, but unless that's disseminated properly to the general population, people can't respond properly individually because they don't quite understand what they're responding to and why they're doing it.

When discussing research priorities, another participant suggested that it is not so much knowledge of marine climate change itself but rather knowledge about how best to communicate these issues to the public that should be a priority:

> Tanya, Norwich
> If you can look at ways of …actually understanding how best to educate people – do you start younger in schools or are they just going to ignore you? Do you go older? – That sort of research would probably be quite beneficial.

One further point needs to be made about public views in relation to scientific knowledge. Following the CLAMER synthesis report (Heip et al., 2011) and the CLAMER survey, marine climate change impacts were presented to workshop participants as separate and discrete issues, for example in the information provided in the posters (see Appendix 8) and in expert presentations. This reflected the scientific tendency to break phenomena down into their constituents, and the consequent

specialisation that tends to ensue. However, several participants pointed out that CCIME tend to be interconnected and interacting, as here:

Barbara, North Norfolk coast
'It's all linked, isn't it?'

Donald, Norwich
Everything that we've talked about today and everything I feel I know on the subject would suggest that all those are interrelated.

These comments are consistent with the findings of Howard and Parsons (2006). Eighty per cent of their survey respondents agreed with the proposition that more education about the marine environment as whole, rather than on discrete marine environmental issues, would be a good way to engage the public. This is a good example of how surveys that frame issues in scientific terms may fail to capture, or may actually misrepresent, individuals' understanding of climate change and its impacts. In this case, it is arguable that some of our participants' understanding was more sophisticated than the survey design allowed for.

*Sources of knowledge*

From where do participants gain or develop their knowledge on CCIME? During discussions, television was the most frequently mentioned source of information on climate change and environmental matters. Television documentaries seem to be the most important sources of information on distant impacts and their outcomes, while the local news is an important source of information on local impacts such as erosion. Indeed, spectacular television images of houses threatened by erosion clearly contributed to the salience of coastal erosion as an issue for some members of the group:

Michael, Norwich
On the news recently, the local news, you see coastal erosion and over the last decade you see there was a house and it had a massive big garden and a shed, then you see where the shed falls into the sea, half the garden's fallen into the sea and so on and coming up to the present day, the house is right on the edge of the cliffs and that, so coastal erosion in 10 years has been 100-200 metres or something like that, 10-20 metres a year has been falling into the sea.

One member of the group (Adrian) said he derived information from popular science titles such as National Geographic magazine, while another (Carrie) joked that she read academic journal articles on issues such as climate change, because her scientist boyfriend thought it was important that she learn about such things. For the North Norfolk coast group, local networks of friends and relations seemed to be an important source of anecdotal information on marine environmental issues such as changes in fish species distribution, EU quotas on fishing and the alleged impacts of a wind farm under construction off Sheringham, all of which impact on local people in one way or another.

Several participants gave examples of how their own personal experiences had shaped their understandings of climate change, which has been shown to be a key aspect of lay knowledge on environmental issues (Irwin, 1995). For instance a seaman described how he had noticed an increase in maximum wave heights over the years, while other participants mentioned that they had experienced increasing variability and intensity of weather events in recent years. Such experiential and anecdotal knowledges were downplayed or excluded in the CLAMER survey, given the nature of the method, but were important features of workshop discussions thus highlighting the value of the in-depth participatory approach taken. Hulme (2009) alludes to the tendency of scientific practitioners to exclude or discount experience as a valid source of knowledge, and the survey unwittingly perpetuated this tendency.

Another environmental issue that may owe its salience to visibility and personal experiences is marine sewage. The first comment relates to the English county of Cornwall, the second to a Turkish holiday resort:

> Zahra, North Norfolk coast
> I was chased, basically chased by somebody's sanitary towel, I'm talking proper disgusting litter, not fisherman lines, not those types of things, it's actually people's [sewage].

> Bill, North Norfolk coast
> Boats would come in close to the shore where people were bathing in the sea, effluents from the boat right onto the coast, absolutely vile.

Incidentally, these two comments also show how the ability to take holidays in other parts of the country or abroad mean that personal experience of marine environments is by no means limited to one's area of residence.

One reason that scientists might distrust personal experience as a source of knowledge about climate change is that, in the case of inhabitants of high latitude countries, it can sometimes contribute to a sense of ambiguity with regard to the outcomes. For instance, Zahra, who frequently expressed great concern about marine climate change, nevertheless explained that, because of her experience as a surfer and lifeguard she welcomed one particular trend:

> Zahra, North Norfolk coast
> I'll be honest, I quite like the idea of the sea warming, it means you can go swimming more and you don't have to wear a wetsuit as much. Sounds good to me. I know that's *really* selfish of me, but that's against all the other ones.

Her remarks may shed light on why UK CLAMER survey respondents are less concerned than the average about changes in sea temperatures (54 percent of UK respondents reported high concern levels on this topic compared with 59 per cent in the 10 countries overall). Again based on their own experience, other participants were enthusiastic about the opportunity to enjoy cheaper lobster and sea bass due to marine climate change:

> Daniel, North Norfolk coast, followed by Zahra, North Norfolk coast
> Sea bass are becoming more popular: where I live at Sea Palling, there's a lot more sea bass there. People do like sea bass. It's cheaper as well, it used to be a luxury and now you can afford to get it, and it's beautiful fish, as well.

The marine climate change specialist who gave a presentation at one of the morning sessions emphasised the ambiguity of some CCIME for the UK. This appealed to several participants, who linked this ambiguity to a view of nature as self-correcting or balancing; this was a recurring theme during discussions of both coastal erosion (which several participants argued was balanced by accretion elsewhere) and changes in marine species distribution:

> Daniel, North Norfolk coast
> There are places that were on the coast but are now four or five miles inland, especially down around the South Coast and ...is it just the shape of the

country changes over hundreds and hundreds [of years] and maybe we should just accept that.

Ivy, North Norfolk coast (on changes in marine species distribution)
We heard that although various fish that are disappearing, there are others that are coming in. It's an equation that stays solid; the fish are there, they're just a different species.

Ivy, North Norfolk coast (on coastal erosion and accretion)
Does the earth find a self balancing mechanism? It feels like it.

But not all participants subscribed to this idea of equilibrium. For instance, in response to Ivy's remarks another participant retorted that changes in species distribution, although in some cases bringing benefits for humans nonetheless should be recognised as consequences of human interference, and therefore 'unnatural'.

*Framing climate change as part of a wider problem*

One possibility that tends to be overlooked in the 'public understanding of science' literature is that the public may frame the climate change problem differently from scientists. Analysis of the discussion provides clear evidence for this. Specifically, rather than conceiving of climate change as a stand-alone issue, several individuals articulated a framing that sees it as an integral aspect of a wider problem, environmental unsustainability:

Joseph, Norwich
Humans, as a rule, we should just live by the fact that you don't mess up your own backyard, so let's go … with the actual stuff that people can focus on. If you clean up the pollution, generally you'll go back through the chain of all the other things that pollute, possibly pump out the carbon dioxide etcetera, which would then hopefully reduce these issues, if they exist, that we're actually going through. So I personally think the whole concept and term is wrong and we need to go back to basics in terms of what the environment is and what we need to do with it.

The fact that people often mention issues such as ozone depletion or recycling alongside climate change is sometimes seen as a symptom of confusion about the causes of climate change (e.g. Whitmarsh, 2009). However, based on comments such as those above, an alternative interpretation is that people see climate change as part

of a much bigger environmental problem, to which they are trying to respond as well as they can as citizens and consumers.

Having explored the nature of public knowledge about marine climate change impacts and how workshop participants framed and defined these issues in their own (non-scientific) terms, the next section looks at individuals' views on the responsibility for dealing with the problem and the degree to which they trust actors at different levels.

## 4.3    Responsibilities and actions

In this section, the discussion is analysed in order to throw light on the responses to Questions 23 to 28 of the CLAMER survey, all of which concern different aspects of responding to the challenge of marine climate change.   Such responses may be directed at mitigating climate change impacts, for instance by reducing energy consumption or by adapting to them.   The in-depth study yielded several insights into participants' views on these matters.   The section begins with a debate about the responsibilities of individuals and the factors that act as disincentives to individuals taking action.   Views on the effectiveness and trustworthiness of institutional actors, namely national and local governments, the EU and the private sector, are then briefly discussed.

*Individual behaviour*

At both the beginning and end of the day's programme, participants debated the responsibility of individuals for mitigating and adapting to climate change, and the problems they face when trying to act in an environmentally responsible manner. Although the facilitators asked them specifically about responses to marine climate change, in fact the discussion tended to be about environmentally responsible behaviour more generally.   This is in line with responses to the relevant survey question across all 10 countries. According to the survey results, large proportions of respondents buy environmentally friendly products (74 per cent), have reduced domestic water consumption (83 per cent) and buy locally sourced food (72 per cent) but far fewer see these actions as effective as ways of either mitigating or adapting to climate change. Although reducing water use at home may bring financial benefits,

this is not true of the other two actions. The findings suggest that, across Europe, many people are responding to the challenge of living more sustainably, although they do not see these actions as ways to reduce or deal with climate change mitigation.

At the beginning of the discussion in West Runton, participants were asked if they were already doing anything in response to the environmental and climate change problems they had identified. Several people said they had, and their examples included picking up litter on the beach, giving up their car or reducing car usage, reducing energy and water use in the home and using sustainability criteria when buying fish: e.g. 'I stay away from cod already' (Jessica, Norwich). At the end of the day-long discussion, when asked about individual responsibilities for dealing with CCIME, some indicated that they would step up their efforts as a result of what they had heard from marine climate change experts and the process in general (see Part 2, Section 4.4). Many disincentives to such actions were identified during the discussion, namely the high costs of some environmentally beneficial behaviour; infrastructural barriers, particularly concerning the lack of public transport; an absence of guidance and information; perceived personal inefficacy and the perception of free riders, all of which are discussed in this section.

*Financial considerations as incentives and disincentives*

Whitmarsh (2009) found that members of the public are more likely to reduce their energy consumption for financial reasons than for environmental ones. Comments made during the workshop discussions, on the other hand, indicate that although financial considerations may be paramount, individuals' motives for energy conservation may be mixed. For instance, talking about reducing car usage and time spent in the shower respectively, these two men indicated that although environmental concerns were a factor in their behaviour, financial considerations were even more important to them:

> Daniel, North Norfolk coast
> It's fuel costs, but I also feel I'm contributing.

> Joseph, Norwich
> Most of mine are primarily financial first, then environmental...the main thing
> I've done: three minute showers. I timed myself with a kitchen timer and that

knocked £100 off the water bill and as I say, about 25% saving on the gas bill too...you're giving money to the power companies, so a three minute shower.

However, while cost considerations act as an incentive to some environmentally friendly actions, the high cost of taking certain other environmentally beneficial actions, such as buying sustainably produced food, was identified as a deterrent:

Becky, Norwich
Okay you can educate me [about the environment], but I might have a family of how many and I haven't got the money to feed them, so I have to go to Tesco's and buy what I can, so [sustainably produced food] has to be accessible.

In fact, the proportion of UK CLAMER survey respondents who reported buying locally sourced food was 69 per cent, only slightly lower than the 10-country average of 72 per cent.[12] Complaints about the high cost of acting in an environmentally responsible manner help to explain some other UK CLAMER survey findings though. For instance, only 12 per cent of UK respondents reported using energy from sustainable sources, by far the lowest proportion of any of the 10 countries included and considerably lower than the 10-country average of 28 per cent.[13] In the UK, energy from sustainable sources is more expensive than the alternatives. And while 66 per cent of UK respondents indicated that reducing energy use at home was an effective action that people should take to tackle climate change, a much higher proportion (88 per cent) reported actually reducing their domestic energy consumption. In the UK, reducing energy consumption has considerable financial benefits, so cost considerations may well be an important influence. This UK figure

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[12] Question 25.4 of the CLAMER survey: Please indicate whether or not you have taken any of the following actions to reduce and cope with the impacts of climate change – Buying locally sourced food.(is this the whole question? and in the next footnotes – it says 'any of these' and you give only one, just needs adjusting to make sense)

[13] Question 25.6 of the CLAMER survey: Please indicate whether or not you have taken any of the following actions to reduce and cope with the impacts of climate change. – Using energy from sustainable sources.

of 88 per cent is very close to the 10-country average of 89 per cent who report reducing their energy consumption.[14]

Infrastructural barriers, in particular the unavailability of a good public transport system, were also pinpointed as important deterrents to environmentally friendly behaviour. 'Are you going to take two buses in the pouring rain or are you going to drive in your BMW?' asked one man (Michael) rhetorically, while a young woman from a small rural village said this about having to rely on a car for getting around:

> Zahra, North Norfolk coast
> I'm conscious of the fact that I am harming the environment but there's nothing I can do about it, because I have no other choice.

These and other similar comments on car dependency may help to explain why the proportion of UK CLAMER survey respondents who say they use environmentally friendly transport is lower than the 10-country average; 41 per cent compared to 56 per cent.[15]

The following comments, from two participants who were among the most committed to being environmentally responsible indicate that for this kind of person an absence of information may be an important practical obstacle to changing behaviour:

> Tanya, Norwich
> I try to do something every year to improve what I'm doing to help the environment etcetera, but I'm running out of ideas now because I don't have the level of education, there's nobody telling me; 'why don't you do this?' Because I've done all the obvious things.

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[14] Question 25.6 of the CLAMER survey: Please indicate whether or not you have taken any of the following actions to reduce and cope with the impacts of climate change. – Reducing energy use at home.

[15] Question 25.1 of the CLAMER survey: Please indicate whether or not you have taken any of the following actions to reduce and cope with the impacts of climate change. – Choosing an environmentally friendly way of transportation.

> ### Carrie, Norwich
> You can only do as much as you know, but if you want to improve, you need the specific input.

On the other hand, Donald, who was also committed to taking environmental responsibility, argued that more knowledge was unlikely to result in changed behaviour at individual level if people were not concerned about environmental issues in the first place:

> ### Donald, Norwich
> Tanya said 'I've given up knowing what else to do' but a lot of people won't bother thinking what to do and that's not meant as a criticism, it's just if they haven't the interest in the first place, why?

Although no-one expressed a lack of concern or a downright unwillingness to act in an environmentally responsible manner, a few individuals articulated a sense of personal inefficacy, as illustrated by this short exchange during a discussion of ocean current changes:

> ### Barbara, North Norfolk coast
> What can you do if the current does change? There's not much you can do!

> ### Bill (North Norfolk coast)
> Mmmh, how can we change the current?

Another disincentive that was mentioned was the perception of 'free riders', although as the following dialogue shows, there was a divergence of thinking on this point:

> Michael Why should I try when my mate next door's not doing anything? Why should I recycle day in, day out, turn my lights off, turn off the tap when I brush my teeth and next door is watering the garden 24/7, chucks all his rubbish into one bin and then drives to work in a Range Rover?

> Siobhan: Because it makes you feel good.

> Michael That's not good enough though, is it?

> Tanya: It is for me.

*Adaptation actions*

During the final session, Bill, who lived in an area vulnerable to coastal flooding, expressed a desire for information that would enable him to plan appropriate adaptive actions:

> Bill, North Norfolk coast
> I haven't heard anybody mention about extent, severity, how long it's going to be, nobody seems to be able to have their finger on the pulse to know those questions, is it going to be 10 years, 20 years, 50 years, 500 years? …Because I live by the coast, if it's going to be 10 years, I need to start making provision now to get away, to go somewhere else.

This was one of very few comments that concerned personal intentions to adapt to coastal flood risks. In fact, apart from this remark, there was no evidence that members of the North Norfolk coastal sub-group had given much thought to protecting themselves from this risk, despite the fact that at least three individuals in the North Norfolk group live in vulnerable locations and two of these are volunteer flood wardens. Rather, the discussion of individual responses to climate change focussed on actions to contribute to environmental sustainability, and to a lesser extent mitigate climate change. In other words, the need to mitigate climate change was much more salient for individuals than the need to adapt to it. Broadly speaking this is consistent with the findings of other UK studies in communities vulnerable to coastal flooding (e.g. Harvatt et al., 2011 and Zsamboky et al., 2011) which also found that individuals did not regard flood risk as important or urgent.

The low priority given to adaptation actions was also apparent when participants were asked to prioritise policies and research priorities. Individuals were asked to distribute votes to reflect the importance of taking the following types of action at individual and policy levels; mitigating climate change, adapting to its impacts and supporting the resilience of marine environments. Both the Norwich and North Norfolk coastal sub-groups prioritised government policies and individual actions designed to mitigate climate change over promoting environmental resilience. Adaptation policies and actions regarding coastal erosion and flooding came a long way after these two priorities for the Norwich sub-group. Participants from North Norfolk gave *individual actions* to cope with erosion and flooding an even lower priority than participants from Norwich. However, they gave a much higher priority

than the Norwich sub-group to *government policies* to combat these threats.  In other words, the coastal residents look to government to protect them rather than considering taking individual protective actions, such as moving to a safer area or protecting homes against flooding.  The finding is consistent with the findings of Harvatt et al. (2011), who also found that residents of a vulnerable coastal community tended to look to government for protection against flooding.  In the light of Grothmann and Patt (2005) it also suggests that although they are aware of flood risk, they do not see themselves, or the actions they can undertake, as effective in reducing their vulnerability.

Much of the literature on climate change adaptation is highly technical and relates to governmental policy-making (e.g. Yohe and Tol, 2002).  In contrast, the following remarks articulate a different concept of adaptation, one that sees adaptation as a matter of everyday decisions made by individual members of the public:

Tanya, Norwich
I would assume that everybody here knows about the areas on the Norfolk coast which are in most danger of erosion and therefore would not probably look at buying a property there, so that's adapting because you're not thinking I'm going to live here ... I suppose we're all doing that, we're all making choices every day about what we do so we are adapting.

Another person was concerned that adaptation might be seen as an easier alternative to mitigation:

Donald, Norwich
It's interesting to even think of these as being in any way mutually exclusive because you could certainly do either, and then because of the way things are going, you'll probably be required to do the adaption bit anyway.  It's just worrying to think that you might go to adaption as a way of not doing anything else.

The low salience of flood risk for North Norfolk coastal participants seems puzzling when it is compared with the UK responses to the relevant survey questions.  Thirteen per cent of UK respondents chose 'moving to an area less prone to flooding' as an effective way of coping with climate change, almost double the 10-country average of 7 per cent who chose this option, and 16 per cent chose 'preparing homes against flooding', again considerably higher than the 10 country average (in this case 9 per

cent).[16]  That suggests recent flood episodes have raised awareness of this problem.[17] On the other hand, the proportion of UK survey respondents who claim they have already moved 'to an area less prone to flooding', 12 per cent, is less than the average for the 10 countries overall (15 per cent) but still a surprisingly high proportion.[18]

The public's current reluctance to adapt to changes in marine species distribution by changing fish purchasing and eating habits was identified by one participant as something that was already damaging local fishermen's livelihoods, as they find it hard to sell species of fish that the public are as yet unfamiliar with (Zahra, North Norfolk coast).  Zahra's remarks on this, which were based on what a local fisherman had told her, belied the complacency of certain other participants who seemed to think that some forms of adaptation, for instance changes in fish consumption, would be a relatively easy matter.  Later in the day and during a separate discussion, one of the experts pointed this out:

> Somebody in the Norwich sub-group said 'It's just very easy isn't it, you just eat what's available locally so if new fish come along, you change to eat that', as if that was a simple process ... [but] that's not what people do, people are averse to making these adaptations actually.

In the next section, the discussion is analysed to throw light on levels of public trust in various institutions and media where information about climate change is concerned. This is followed by an analysis of discussions about the extent to which government, at various levels, the private sector and individuals can be trusted to take effective action themselves to reduce or adapt to climate change.

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[16] Question 24: From the list below, please select the three most effective actions you feel individuals should take to reduce and cope with the impacts of climate change.

[17] The wording of CLAMER survey Question 24 asked respondents both to make judgements of 'effectiveness' and judgements about what people 'should' do, that is normative judgements.  That makes it rather difficult to interpret the findings, because it is not clear which part of the question respondents were reacting to.

[18] Question 25 of the CLAMER survey: Please indicate whether or not you have taken any of the following actions to reduce and cope with the impacts of climate change.

*Trust in information*

The discussion was concerned with trust in information on environmental sustainability in general, rather than climate change impacts on the coast or sea, or even climate change more widely.  This is consistent with the general tendency of participants to frame CCIME as aspects of environmental unsustainability rather than discrete issues.   While several participants talked about media reports they remembered, their comments indicate that they did not question their accuracy or balance; see the relevant comments above concerning local and national television coverage of coastal erosion and melting Arctic ice.   As for information from government, this hardly featured at all in discussions.  Participants did, however, have quite a lot to say about information from companies and the scientists who are funded by them, as well as research scientists more generally.

On the basis of the CLAMER survey findings, the UK population has slightly higher levels of trust than the 10 surveyed countries overall in both industry and scientists working for industry.  For instance, thirty five per cent of UK respondents reported low levels of trust in industry, which is less than the 42 per cent average across the 10 countries surveyed.   Also, the proportion of UK respondents who reported low levels of trust in scientists working for industry, 30 per cent, is slightly less than the 10-country average of 33 per cent.[19]  In other words, the UK population is cynical with regard to these actors, but not as cynical as the other countries overall.  UK citizens are far less cynical than Germans, 61 per cent of whom report low levels of trust in industry and 50 per cent of whom report low levels of trust in scientists working for industry.

During workshop discussions, participants expressed considerable distrust in advertising and public relations initiatives that make claims about companies'

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[19] Question 22 of the CLAMER survey: To what extent, if at all, do you trust each of the following individuals or organisations when providing information about climate change impacts on the coastline or the sea?

environmental sustainability. This was based in some cases on participants' personal experiences as company employees. For instance, Barbara, (North Norfolk coast) had worked in a local fish packing factory that supplies a large High Street retail chain. She described a disparity between the company's 'green' claims about packaging and their actual practices. Her story provoked a lively and derisive debate within the North Norfolk coast group. The point was made that companies' lack of transparency, over matters such as sourcing, packaging and 'embodied energy' prevents consumers from making informed choices (Marion, North Norfolk). Both in the North Norfolk coast and the Norwich sub-groups there were calls for government to force companies to be transparent about their policies and practices relating to the environment (e.g. Zahra, North Norfolk coast).

The cynicism extended to research funded by the private sector, and in some cases this too was derived from personal experience:

Tanya, Norwich

I've worked in companies where I've pulled off reports and the big guy at the top has said; 'I don't like those reports, manipulate the figures'.

Simone, North Norfolk coast

Research is dependent on where the funding is coming from.

Moving now to scientific research more generally, the next comments indicate that disagreements among experts and changes in scientific opinion contribute to public scepticism about research findings:

Joseph, Norwich

You come across a lot of discussions on these sort of things, you just see this never-ending battle of; 'The figures say things are getting cooler, look at this graph' and then someone will come back; 'Yes, but if you look at this study by Professor So and So, it's going that way.'

Barbara, North Norfolk coast

You'll have a survey going on, one year like people got told coffee was bad for them, two years later coffee's good for you so, there's all this rubbish going on isn't there? One minute something's good for you, the next minute it isn't!

Adrian, North Norfolk coast
Peer review journals are probably more accurate, but maybe in ten years' time they'll say; 'That's not right, we've changed our minds about it'. You can only go on what they believe at the moment, but it is often contradicted later.

## 4.4    Judgements on effectiveness of responses to climate change

In this section the discussion is analysed with reference to participants' trust in other actors, notably different levels of government and the private sector, to respond to the challenge of climate change in an effective manner.[20]

*Government at various levels*

The discussion regarding governments centred on national governments, and to a lesser extent local authorities. However one participant did have this to say about international climate change governance:

Jessica, Norwich
We keep having these international conferences and they make all these points and then they don't stick to them, so what's the point? They should be held accountable... So far I haven't been very impressed.

Also, during a debate on fishing quotas and discard in the North Norfolk group, it became apparent that the EU policy on 'discard' was unpopular because it is seen to encourage overfishing. Conversations with local fishermen were an important source of information on the issue (e.g. Zahra, North Norfolk coast). However the EU was not discussed with reference to climate change policies, perhaps indicating that the EU is not seen as an important actor by this group of people.

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[20] Specifically, Question 22 of the CLAMER survey: To what extent, if at all, do you trust each of the following individuals or organisations when providing information about climate change impacts on the coastline or the sea? And Question 23: How effective are the following in tackling climate change impacts at the coastline or in the sea?

With reference to national governments, several workshop participants expressed the view that there is little political will to tackle climate change. One person (Marion, North Norfolk coast) thought that the short-termism of governments who have to seek re-election every few years was a factor in this. However it was more common to attribute government inaction to their preoccupation with economic issues, especially now, at a time of global recession. The point was made more than once that governments respond best to economic arguments, so unless a strong economic case is made for tackling climate change, little action can be expected from governments. This comment is typical of this point of view within the group:

Bill, North Norfolk coast
Unless environmentalists and the people who are concerned about global warming make an economic argument that it will save money, I really think it won't be addressed.

In the North Norfolk coast group there was a short debate between two participants about developing countries' responsibilities to mitigate climate change by controlling deforestation:

Ralph, North Norfolk coast    What's the point of planting a tree if we're pulling up thousands of trees in the rainforest?    We've got to stop governments; I know governments have to be told.

Facilitator    What governments have you got in mind?

Ralph, North Norfolk coast    Any government, the Brazilian government, the Papua New Guinea government...because they're not only breaking up the eco structure, they're also breaking up the homelands of Indians, animals and things like that.

Marion, North Norfolk coast    It's not fair to tell them they can't tear their trees up when we've been doing it over centuries.

Turning now to views on local authorities, these mainly concerned local authorities' policies and actions regarding coastal erosion, sea defences and keeping beaches clean. Disparities in policies and priorities among different local authorities came up several times. Where the policy differences concern sea defences that protect people's homes, some members of the group implied that they see them as unjust (e.g. Daniel, North Norfolk coast). Also, local authorities, and more particularly their

officers, were perceived as weak when it comes to enforcing regulations on beach cleanliness (e.g. Zahra and Daniel, both North Norfolk coast).

*The private sector*

With regard to the effectiveness of business and industry in tackling CCIME, UK survey respondents reported trust levels that were slightly higher than for the 10 survey countries in general. For instance, sixty six per cent of UK survey respondents think that 'business and industry' are ineffective at tackling CCIME, somewhat less than the 10-country average of 69 per cent.

Several discussion participants expressed distrust in business and industry to act in an environmentally responsible manner or support the public's efforts to do so. Underlying these criticisms was the perception that the private sector is driven entirely by profit motives. This is in line with the argument, noted above, that governments have to provide economic incentives for environmentally responsible behaviour. The survey had divided actors into several categories, which were also used by facilitators during the discussion. However one participant, Carrie, rejected this distinction between individual actors and private companies, based on her own experience:

> Carrie, Norwich
> All big businesses and politicians, they're all individuals at the end of the day. So splitting between individual responsibility and that, we only need one person in a corporation to be really passionate about something to get things done. I used to run the Odeon [cinema in Norwich], a million pound business and one person says we should be more interested in keeping our carbon footprint down, so we started every day recording the electricity consumption, the gas consumption every day, our water consumption every day, so we could literally look at it and say; 'It spiked on Saturday, why, what can we do to stop it?'. And that huge policy change came from one person being passionate about it. So it makes a real difference, one person can actually make a change.

Although Zahra (North Norfolk coast) and some others argued that it was the duty of companies to set an example for the public through environmentally responsible policies and practices, other people rejected the idea that individuals should expect companies to 'do the right thing'. Simone was typical of participants who preferred to stress individual responsibility rather than waiting for the private sector to act:

Simone, North Norfolk coast
Should we be trusting [companies] anyway? These choices are based on your own behaviour.

Of more direct relevance to marine climate change was Bill's criticism of insurance companies. He had experienced difficulty finding a company that would insure his home near the sea, although there are sea defences in place. Only 6 per cent of UK survey respondents indicated that they had bought flood insurance, compared with 27 per cent in France and Czechoslovakia, and a 10-country average that is almost double the UK proportion (13 per cent).[21] Perhaps the reluctance of UK companies to insure in such circumstances explains these disparities; this may be a subject for further comparative research.

## 4.5   How did involvement in the process affect participants' perspectives?

Previous studies indicate that taking part in a deliberative process to consider and plan for CCIME heightens engagement among members of the public (e.g. Shaw et al., 2009). Still other studies have found that scientists' own views tend to change when they are involved in a deliberative process with members of the public (e.g. Davies and Burgess, 2004). In this section, the effects of the workshop process, group deliberation, and the beach visit on participants' engagement with CCIME are analysed, based on data derived from plenary and group discussions. The views of the experts are discussed as well as what the public participants said about the process.

*Public participants*

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[21] The CLAMER survey included 'purchasing flood insurance' as an option for respondents answering Question 25: 'Please indicate whether or not you have taken any of the following actions to reduce and cope with the impacts of climate change'.

During the last two sessions, facilitators asked the public participants to reflect on whether the day's activities and debates had changed their understanding of CCIME, and if they would do anything differently thereafter. Participants were also asked to provide anonymous written feedback on the event as a final activity before leaving. The vast majority of the comments were positive. It was clear that most, perhaps all, of the public participants had found the day's discussion and activities interesting, stimulating and enjoyable.

More specifically, several participants talked about feeling more motivated than before to take action to reduce their energy consumption, as in this example:

> Jed, Norwich
> Even though I knew that leaving the lights on was bad for the environment, I guess I have decided I should definitely start turning them off a bit more, it's not just my mum's bills, it is about the environment.

Other participants reflected on changes in their understanding and engagement with climate change, which in some cases were quite subtle. Different individuals identified the following aspects of the day as having influenced them in positive ways; taking an active part in a discussion rather than passively absorbing information (e.g. Becky), and having the opportunity to apply the new information to an actual environment during the walk at lunchtime (e.g. Michael and Tanya). Several participants were influenced by the expert presentation in the morning, which tended to stress the ambiguity of CCIME outcomes in the UK. Becky, whose comment is included next, was not alone in saying that her views on climate change had become more nuanced as a result of that presentation, and she also mentioned that hearing a range of different views had affected her own thinking;

> Becky, Norwich
> Just hearing [experts'] views in some of the talks, they're just observing what's going on and they don't actually know what's going to happen. And different people speaking in this group have had goods and bads about things, got different views, and so it would be helpful to stand back. You could say 'global change' or whatever the word is and I'll go 'Aaargh', but actually it breaks it down a bit and puts it into more perspective.

For Michael and Tanya at least, the visit to the beach helped to make sense of abstract issues like ocean acidification; this corroborates the argument of Steel et al. (2005)

that experience of the ocean can foster public engagement with ocean and coastal issues.

*Marine environmental and climate change experts*

The three marine environmental and climate change experts involved in the process were interviewed together at two points in the day's programme; first, in the morning, to elicit their expectations of the day and second, near the end of the day's programme, to find out what they thought of the process and whether or not their expectations had been fulfilled.

Although all three UEA and CEFAS experts had had some involvement in public outreach via various media, their previous opportunities to interact with the public on these issues had been limited or non-existent.  One participant made this comment:

> I tend to operate in a slightly more rarefied, elite world and I think it's good to be here and get a bit of reality as well. I think it's been a valuable experience for us to see these things not from the perspective that we normally come from because we live in a lot more of a narrow world, within the policy/science community.

One of the experts saw talking to the public as more challenging than dealing with other scientists or policy-makers, particularly with regard to communicating scientific uncertainty:

> When we're dealing with scientists and policy makers, [it's] a challenge in many ways but this is potentially harder, to try and explain the why and the why and the why again I guess, which can be quite difficult, and trying to explain why we don't know lots of things.

The expectation that public participants might focus exclusively on local issues, in particular coastal erosion and flooding, was repeated several times by one of the experts from CEFAS.  Although he saw this as a potential problem, he also hoped it might produce a discussion based on actual experience:

> If people have lived along the coastline here and seen eroding landscape and things like that, what they've experienced over the past 50 years, I think it will be interesting to see their first hand perspectives of things rather than just some vague idea of what might happen in  the future.

Some of the experts' expectations at the beginning of the day turned out to be accurate, at least in part. The CEFAS expert quoted above was correct in his prediction that coastal flooding and erosion would be dominant issues, but his fears that they would crowd out other issues of less immediate relevance turned out to be misplaced, because participants also brought up remote CCIME, as previous sections show. Two other expectations from experts did prove to be correct, firstly that very few of the public participants would have heard about ocean acidification, and secondly that polar bears would be mentioned during the discussion. At the end of the day, when the experts were brought together again, it became clear that some had been impressed by the levels of knowledge and engagement displayed by certain public participants, despite some misapprehensions on the part of a few participants. One of the CEFAS experts admitted:

> They probably know more about some of the local scale issues than we do. Some people are very well informed …and put me to shame in terms of the actual actions that they've been doing. I think most climate scientists are absolutely hopeless at doing anything… But equally there were some people who had completely got the wrong end of the stick on some issues, like on ocean acidification.

## 5 Conclusion

Analysing the West Runton workshop discussions against the backdrop of the CLAMER survey results produces useful insights into some of the factors that influence how individual members of the public understand, perceive and engage with CCIME.

The analysis indicates that visibility and personal experiences are important factors in the salience of CCIME for individuals and their degrees of concern. For some individuals, concern seems to be driven by risk perceptions. Other individuals though see marine climate change impacts as moral issues, because of their effects on vulnerable people and species; these people engage with CCIME in a different way. This is in line with the literature review in Part I, which showed how some researchers stress that there are multiple publics, and communications need to be tailored to fit these different segments. Those interested in communicating about climate change to

the public should find these insights useful in helping to develop strategies, target, select and frame effective messages.

In addition, our in-depth study shows diverse understandings of climate change among the participants; while some were well-informed, others articulated serious misconceptions or ignorance in relation to established scientific knowledge. However, most participants also expressed other, non-scientific, ways of knowing about climate change, rooted in their own personal experiences. Some participants demonstrated a sophisticated grasp of the interconnections among CCIME and a holistic perspective of the issues involved. Others showed that they frame climate change not as a discrete scientifically-defined issue, but as an aspect of a much wider problem; unsustainable societies. These findings too may be an important pointer towards how to communicate more effectively with certain sections of the public on climate change mitigation.

Participants tend to distrust business and industry in relation to climate change, reflecting the CLAMER survey results. They showed understanding of the institutional contexts in which scientists working for various bodies operate, and this reflects the degree of trust they place in scientific research from different quarters.

Many disincentives to acting in an environmentally responsible manner were highlighted, in particular the high costs of some environmentally beneficial behaviour, infrastructural constraints (e.g. the lack of public transport), an absence of guidance and information apart from on very basic mitigation actions, perceived personal inefficacy, and the perception of free riders. As for adaptation, this was seldom emphasised, despite the fact that several people were very knowledgeable about the local issues of coastal erosion and flooding. In particular, there was little evidence that members of the North Norfolk coastal sub-group had given much thought to protecting themselves against flood risk. The fact that North Norfolk residents saw government-led adaptation measures such as coastal defences as more of a priority than the Norwich sub-group suggests that they are aware of the risks, but do not see themselves, or the actions they can take as individuals, as effective. This suggests that focussing on lessening this sense of inefficacy, through practicable 'action' messages, is a good strategy for adaptation communications in such contexts.

Participants' remarks about how the process had affected them reflect previous studies indicating that being able to take part in discussions and planning exercises related to climate change adaptation heightens individuals' engagement. As for the marine and climate change experts, they were surprised at the nature and level of knowledge demonstrated by the public participants, especially on the locally salient impacts of erosion and coastal flooding.

This study was unique in that it drilled down to explore the factors that influence European individuals' understanding of CCIME. Although small in scale, it has yielded rich, detailed and nuanced data, and its findings are a valuable complement to the CLAMER survey.

**Appendix 1: List of databases and journals searched for literature review**

| Sources | |
|---|---|
| *Databases* | *Search terms* |
| World of Knowledge (Social Sciences category) | Climate change + marine environment |
| | Climate change + ocean |
| | Climate + sea |
| | Perceptions + ocean |
| | Public perceptions + sea |
| | Climate change + public |
| | Climate change + understanding |
| | Climate change + perceptions |
| | Global warming + public |
| | Global warming + understanding |
| | Global warming + perceptions |
| Google Scholar | Climate change + marine environment + perceptions |
| | Climate change + ocean + perceptions |
| | Climate change + perceptions |
| | Climate change + public |
| | Climate change + understanding |
| | Global warming + public |
| | Global warming + understanding |
| | Global warming + perceptions |
| *Academic Journals* | *Search terms* |
| Marine Policy | Climate |
| | Global warming |
| Journal of Environmental Psychology | Climate |
| | Global warming |
| Global Environmental Change | Climate change + public |
| Climatic Change | Public understanding |
| | Public perceptions |
| Journal of Environmental Psychology | Climate change + perceptions |
| | Global warming + perceptions |
| Risk Analysis | Climate change |
| | Global warming |
| Journal of Risk Research | Climate change + perceptions |
| | Global warming + perceptions |
| Public Understanding of Science | Climate |
| | Global warming |
| | Marine environment |
| | Sea |
| | Ocean |
| Science Communication | Climate change |
| | Global warming |
| | Marine environment |
| | Sea |
| | Ocean |

**Appendix 2: Programme and process design for CLAMER citizens' workshop, Saturday 25th June 2011, Links Hotel, West Runton**

**AIMS**

- To explore and substantiate some of the CLAMER survey findings in more depth.

- To explore how publics understand, perceive and engage with marine environments, climate change, and CCIME.

- To provide access to information and experts on CCIME and bring together citizen and specialists in constructive and interactive dialogue.

- To explore public concerns in relation to CCIME and what difference interaction with CCIME information and expertise makes to public views on these issues.

- To consider public views on and priorities for different courses of action for managing and responding to CCIME, both in terms of individual engagement and policy responses.

- To reflect on the experience of participating in the process (including changes in participants' views and understandings), evaluate the process, and explain next steps.

**PEOPLE**

- Public participants: 10 Norwich sub-group; 10 North Norfolk coastal sub-group

- Specialists from School of Environmental Sciences and Centre for Environment, Fisheries and Aquaculture Science (3)

- Facilitators: (2)

- Support facilitators/scribes/secondary experts: (3)

**9:15-9:30 Participants arrival**

Whole research team to meet and greet citizens as they arrive; tea and coffee provided

Give each participant a workshop pack with name badge, pad, pen, and programme for the day.

**9:30-10:00 Session 1: Introduction**

*Objectives*

- Embed the group (through ice-breaker, introductions to facilitators; domestic information)

- Explain the process and what people have volunteered to do; answer any questions/queries

- Establish some basic ground rules for participation and interaction

- Introduce the specialists to the process and to the citizens

All, plenary

- Welcome and introduction to the day. State the aim and purpose, including how the information be used. Check everyone is OK with us recording discussions.

- Go over programme and deal with any queries.

- Housekeeping information.

- Elicit 3-5 ground rules, or introduce if necessary (Suggestions; respect for other people's contributions; listen to what other people have to say; allow other people to make their points without interruption or criticism; punctuality for all sessions; take an active part; mobile phones off/on silent)

**9.45 ICE BREAKER** – include all participants in this.

Instructions: Everyone asked to line themselves up by birthday day and month (not year). Pair off with the person next to you; spend 2-3 minutes introducing yourselves and try to discover one interesting/unusual thing about the other person and also what they hope to get from day. Bring everyone back into the large group sitting with their partner. Each introduces the other partner, including the interesting thing about them. (This will take c.15 minutes, maybe a little more.)

**10:00-11:15 Session 2: Exploring Initial Understandings**

*Objective:* To explore how participants understand, perceive and engage with marine environments, climate change, and CCIME.

In separate sub-groups; North Norfolk coast, Norwich, Experts

*Citizen discussi*ons

For 1 hour – whole focus group discussion around the following points/themes:

- When thinking about the coastline or the sea, what are the most important environmental matters that come to mind?  [Participants reflect individually and write one thought per post-it note. Tina/Helen collects and put up on chart. Quickly organize them by topic.]

- Why is this case?

- Which environments are you thinking of and how do you experience/connect with them (e.g. local / European seas; holiday, leisure, work)? *[Possibly mark on a map of Europe]*

- What comes to mind when thinking about the term 'climate change'?

- Do you think that the climate is changing?

- What things come to mind when you think about the impacts of climate change on the coastline or the sea? *[Open discussion/brainstorm. Tina/Helen to list on flipchart.]*

- Where have you found out about or seen information about climate change impacts on the coastline or the sea? (or climate change and marine environments more generally)

Probe different sources (e.g. newspapers, television, internet, friends/family, direct personal/sensory experience).

- To what extent do you trust these different sources?

- Are you personally doing (or have you done in the past) anything to take action on issues relating to climate change impacts at the coastline or the sea?

Probe what actions and why/why not (e.g. reducing energy use in the home, sustainable forms of transport, buying environmentally friendly products, taking part in a campaign/protest, protecting against flooding)?

Final 10-15 minutes – identify questions / information needs

Get participants to work in pairs/threes to reflect on the discussion and consider what questions they would like answers to and what further information they need

Each participant to write down in their pad (at least) 3 questions or things to ask the specialists.

*Specialists' sub-group discussion*

(Rob to facilitate, take 30-40 minutes and then invite specialists to observe citizen group discussions)

Engage the specialists in an informal discussion of the following:

- Have you done anything like this before?

- What previous experience do you have of public engagement on environmental / scientific issues?

- What are your expectations of the process?

- What do you hope to learn from / get out of interacting with public participants today?

- What do you currently know about public understandings/perceptions of climate change impacts on marine environments (or environmental issues more generally)?

- How do you expect the public will relate to these issues in this process?

**11:15-11:30 Break (information posters on marine climate change on view – encourage participants to look at them)**

**11:30 – 2:15 Session 3: The nature of the proble**m

(Citizen-specialist interaction)

*Objective:* To provide access to information and experts on CCIME and bring together citizen and specialists in constructive interaction and discussion

All, full plenary

15 minutes - open space for participants and specialists to take in posters in their own time

30 minutes – expert presentation (John), followed by questions and answers (in open plenary)

15 minutes contingency time prior to minibus departing for beach

**12:30 Picnic lunch and beach walk**

Guided walk and talk (lead by specialists in turn, identifying different aspects)

Open interaction between citizen and specialists during the picnic (plenary picnic) – citizens prompted to ask questions developed in Session 2

**2:15pm SESSION 4: Concerns**

Objective: To explore public concerns in relation to CCIME and what difference interaction with CCIME science and experts makes to public views on these issues.

Back at the hotel, participants in their 2 sub-groups (specialists available to answer any questions but not directly involved in discussion)

Discussion around the following questions;

- What do you think about the possible climate change impacts on marine environments that we have just heard about? [*Begin with open discussion and initial views.*]

- Which of these impacts are you most / least concerned about? Why? [Draw a Likert scale (5 point spectrum) for each of the 9 CCIME on a flipchart sheet (V concerned at one end and Not at all concerned at the other, as in CLAMER survey). Participants come up and place dots/crosses on the scale. Use this as a basis to discuss the above question and explore for reasons.]

- Are there other marine and coastal issues that you feel are equally or more important? *[Assistant to list on flipchart sheet]*

- Thinking back to your discussion in this morning's session - has finding out more about these issues and interacting with the specialists changed your view on these issues (if at all)?

**3:15pm Session 5: Responses for addressing climate change impacts at the coastline or in the sea**

Objective: To consider views on and priorities for different course of action for managing and responding to CCIME, both in terms of individual engagement, policy responses, and research.

All, plenary

10 minutes - Brief presentation introducing options for responding to and managing CCIME (Paul to talk through PPT). Handouts of slides to be distributed to participants. Outline the task for this session.

Citizen participants break into their 2 sub-groups

5 minutes – Brief discussion of possibilities for individual responses taken by the participants themselves;

- Reflect back on personal actions highlighted in the morning's session

- Are you more or less likely to act in response to CC impacts at the coastline or the sea?

- What individual responses are you realistically likely to take action on?

25 minutes – Discussion of possible responses to be taken by government, industry, scientists and wider society. – The key question here is: 'To what extent would you support these different options for managing CCIME?'

Focus discussion on options at each level of action in turn (individual responses by others, policy, research);

- What are the strengths and weaknesses of this option in responding to climate change impacts at the coastline or the sea?

- Are there any other options for responding to climate change impacts at the coastline or the sea that might be important? *[Ask this for each category. Assistants to write in addition options on the matrix]*

10 minutes - Prioritise options

Participants to vote for which options they support. They have ten votes each to distribute across all options (free to put all on one option or 1 on each option).

When participants are doing this check reasonings / criteria for the judgments made (e.g. 'effectiveness', 'social justice', 'feasibility').

All, plenary (move participants back into plenary)

15 minutes – Citizen sub-groups feedback to each other on priorities for action followed by open plenary discussion.

**Specialists sub-group discussion (to start at 3:15pm)**

Specialists to reflect on the process (referring back the morning conversation):

- What has been your own experience of the workshop today?

- How did it relate to your expectations:

  - Of the process?

  - Of how the public will relate to issues of CC impacts on marine environments?

- Was anything particularly easy or challenging for you? Please explain?

- What have you learned?

Short break (or go straight through with tea and coffee available if we are short of time at this point.)


**4:30-5:15pm Session 5: reflections and conclusions**

Objective: To reflect on the experience of participating in the process (including changes in participants' views and understandings), evaluate the process, and explain what next steps

All, plenary

Identify any changes in participants' attitudes since the morning, and reasons.

5 minutes individual reflection (including experts)…

- Have knowledge and views on CCIMEs changes since this morning?  If so, what has made the difference?

- Reflect on strengths and weaknesses of the process. [Use anonymous post-it notes for comments – place on simple chart under '+' and '-' signs as appropriate, or smiley and frowning faces. Invite everyone to look at these as they leave. Facilitators read out a selection, if time and if appropriate. If so, start with the negatives and end with the positives.

- Explain what happens next. Explain how views will be analysed & presented. Sum up, round off, thank.

# Appendix 3: Information sheet for potential participants

**Discussion of environmental issues**

**Saturday 25<sup>th</sup> June 2011, West Runton, Cromer**

This discussion is designed to give participants a chance to discuss environmental issues and put any questions they may have to experts. It will be conducted by staff from the University of East Anglia (UEA) and the Department of Environment, Food and Rural Affairs, as part of a European research programme into public views and attitudes.

Participants must be willing to attend for the whole day on Saturday 25<sup>th</sup> June, starting at 9.30 (registration and coffee) and finishing at 5.30. Discussions will be recorded, but all comments will be confidential and no individuals will be identified in any report.

The event will be held at The Links Country Park Hotel in West Runton. Refreshments and a picnic lunch will be provided. The day will include a short walk on the beach (weather permitting), so participants need to be reasonably mobile.

At the end of the day an honorarium of £50 will be paid, and transport costs from Norwich will be covered by UEA

# Appendix 4: Enquiry form for interested members of the public

Name

Address

Telephone

Mobile

Email

Please tick your answer, and write in extra information where relevant.

| 1. Your gender | |
| --- | --- |
| Male | |
| Female | |
| 2. Your age group | |
| 18 – 29years | |
| 30 – 59 years | |
| 60 plus | |

| 3. Your education (please tick the highest qualification you have) | | | |
| --- | --- | --- | --- |
| GCSE / O-level / CSE | | Masters / PhD or equivalent | |
| Vocational qualifications (NVQ1+2) | | No formal qualifications | |
| 'A' level or equivalent (NVQ3) | | Other (please write in details) | |
| Bachelor Degree or equivalent (NVQ4) | | | |

| 4. Your work and childcare responsibilities (please tick all that apply to you) | | | |
| --- | --- | --- | --- |
| Full time paid work | | Retired | |
| Part time paid work | | Full time care of child / children | |
| Self employed | | Part time care of child / children | |
| Unemployed, seeking work | | Other (please write in details) | |
| Unemployed, not seeking work | | | |
| Student | | | |
| If you are in paid work please give information about what you do: | | | |
| 5. Mobility I am reasonably mobile and can join in a 30 minutes' walk on the beach. | | | |

| | |
|---|---|
| Yes | |
| No | |
| 6. Do you have any special dietary requirements? | |
| Yes | |
| No | |
| If 'Yes' please write in details: | |
| 7. Do you have any special or professional interest in environmental issues in Norfolk? | |
| Yes | |
| No | |
| If 'Yes' please write in details: | |
| 8. Are you a member of an environmental charity or campaigning organisation? | |
| Yes | |
| No | |
| If 'Yes' please write in details: | |
| 9. Your ethnic background | |

| | | | |
|---|---|---|---|
| White British | | Pakistani | |
| Irish | | Bangladeshi | |
| White European | | Chinese | |
| Afro-Caribbean | | Gypsy / Roma / Traveller | |
| African | | Mixed Heritage (please write in details) | |
| Indian | | Other (please write in details) | |
| | | | |
| | | | |

# Appendix 5: Sampling strategy and information on participants (pseudonyms used)

**Norwich public participants(10)**

| Gender | Women (Sub-total = 5) | | | | Men (Sub-total = 5) | | | |
|---|---|---|---|---|---|---|---|---|
| Age-group | 18 -24 (13%) | 25-44 (29%) | 45 -64 (21%) | 65+ (17%) | 18 -24 (13%) | 25-44 (29%) | 45 -64 (21%) | 65+ (17%) |
| NS-SEC 1-3 or student (43%) | | Carrie | | | Jed | Joseph | Don* | |
| NS-SEC 4-9 (57%) | Siobhan | Rebecca | Tanya Jessica* | | | Michael* | | Reg |

**North Norfolk public participants (10)**

| Gender | Women (Sub-total = 5) | | | | Men (Sub-total = 5) | | | |
|---|---|---|---|---|---|---|---|---|
| Age-group | 18 -24 (6%) | 25-44 (22%) | 45 -64 (28%) | 65+ (25%) | 18 -24 (6%) | 25-44 (22%) | 45 -64 (28%) | 65+ (25%) |
| NS-SEC 1-3 or student (31%) | | Simone | | | | Adrian | Ralph* | |
| Chief household earner in NS-SEC 4-8 or unclassified (69%) | Zahra* | | Marion | Barbara Ivy | | | Derek Bill* | Daniel* |

NS-SEC = National Statistics Socio-economic classification (see Appendix 6)

*See Appendix 7 for information on these participants' voluntary activities or membership of organisations that are concerned with aspects of the environment.

# Appendix 6: Office of National Statistics NS-SEC analytic classes

*Class 1*        Employers in large organisations, higher managerial occupations and higher professional occupations

*Class 2*        Lower professional and higher technical occupations

*Class 3*        Intermediate occupations

*Class 4*        Employers in small organisations and own account workers (non-professional and agricultural)

*Class 5*        Lower supervisory occupations

*Class 6*        Semi-routine occupations

*Class 7*        Routine occupations

*Class 8*        Never worked and long-term unemployed

*Unclassified*        Occupations not stated or inadequately described, or not classifiable or other reasons

Notes

The Office of National Statistics treats students as 'unclassified'. However, for the purposes of this study we treated students as members of NS-SEC 1-3.

For more details of these categories, see

 http://www.statistics.gov.uk/methods_quality/ns_sec/downloads/NS-SEC_User_2005.pdf

## Appendix 7: Participants' declared memberships of organisations concerned with the environment

*NORWICH*

| | |
|---|---|
| Jessica | Member, National Trust |
| Michael | Member, British Trust for Conservation Volunteers |
| Donald | Member, Green Party, Friends of the Earth, Sustrans |

*NORTH NORFOLK*

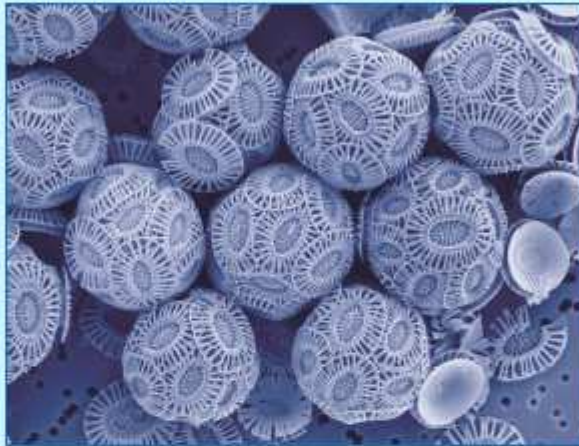| | |
|---|---|
| Zahra | Volunteer beach lifeguard (Royal National Lifeboat Institution) |
| Ralph | Voluntary lifeboat operations manager (Royal National Lifeboat Institution) |
| Bill | Volunteer flood warden (Parish Council) |
| Daniel | Senior volunteer flood warden (Parish Council) |

**Appendix 8: Posters used to provide information on CCIME during the workshop**



What we know about climate change and marine environments

## Seas becoming more acidic

- The oceans take up about 1/3 of the carbon dioxide that human societies emit into the atmosphere

- Carbon dioxide is a weak acid, so when large quantities dissolve this makes the seas and oceans more acidic.

- In the last 200 years, ocean acidity has increased by 30%.

- More acidic oceans will affect plant and animal species that use calcium carbonate to form their shells, such as the microscopic *coccospheres* pictured. Corals and mollusc populations will be harmed.

- Acidification may pose a serious threat to marine ecosystems and cause the extinction of some marine organisms. However, there is still considerable uncertainty on what the precise effects will be.

*(Information from CEFAS and CLAMER project)*

**UEA University of East Anglia**

## *What we know about climate change and marine environments*

# Coastal flooding



- Over the last century, changes in land use and the movement of people and services to coastal areas has increased vulnerability to coastal flooding.

- It has been estimated that a 40 cm rise in sea-level, which is in line with government projections for 2100, will increase the number of properties at risk in eastern England from 270,000 to 400,000.

- Coastal flood events in the future will be more affected by sea level rise than by changes to wave height or storm surges.

*(Information from CEFAS and CLAMER project)*

UEA University of East Anglia

# What we know about climate change and marine environments

# Changes in the frequency of extreme weather events



- There is no scientific consensus on how climate change will affect storm frequency and wave height around Northern Europe.

- There is high natural variability, so it is hard to see whether climate change has had any effect up to now.

- Some scientific projections show lower wave heights to the north of the UK and higher waves in the south-west, and the government has accepted these projections.

*(Information from CEFAS and CLAMER project)*

**UEA University of East Anglia**

## What we know about climate change and marine environments

## Coastal erosion



- The causes of coastal erosion are complex. Sea level rise is a contributing factor.

- Storms often produce the most dramatic erosion events, although coasts often recover in time.

- In areas likely to experience more frequent storms due to climate change, increased erosion is expected.

- However the outcomes will also depend on how humans respond. Basically there are two options; defend the coastline or retreat and allow erosion to occur.

- Hard sea defences and the replacement of lost beach sand ('beach recharging') can protect coastal property. However these options are expensive and they may damage or destroy natural habitats.

*(Information from CEFAS and CLAMER project)*

**UEA** University of East Anglia

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## What we know about climate change and marine environments

# Sea level rise



- Sea level rise poses significant risks to European coastlines.

- It is driven mainly by the expansion of seawater due to heat, and to a lesser extent by the melting of ice sheets and glaciers.

- Around the UK, sea levels are rising at about 1.4 mm per year. Low-lying areas and their populations are most at risk.

- In such areas, the consequences of sea level rise include; flooding, increased coastal erosion, the contamination of groundwater by seawater and the loss of farming land.

- The Thames Barrier (pictured) was built in to protect London from flooding caused by tidal surges. Since the barrier was officially opened in 1982, it has been raised over 100 times to protect the capital from flooding. After 2070 the standard of protection will slowly decrease over time, due to rising sea levels and increasingly frequent and large surges.

*(Information from CEFAS, CLAMER project and the Environment Agency)*

**UEA** University of East Anglia

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## What we know about climate change and marine environments

# Changes in ocean currents



- The ocean current known as the 'Gulf Stream' or the 'Atlantic Heat Conveyor' increases temperatures on the western edge of Europe by several degrees.

- This vast current is driven by differences in the densities of seawater due to salinity and temperature. Cold, dense seawater sinks in the North Atlantic, drawing warm water northwards from the tropics. The cycle is completed when this cold dense water flows back to the tropics, warming as it goes.

- Some scientists are concerned that the current may shut down, leading to a dramatic cooling of the UK and Scandinavia.

- It is very likely that, during this century, the current will slow down by about 25% compared to its strength before the Industrial Revolution.

*(Information from CEFAS and CLAMER project)*

**UEA University of East Anglia**

## What we know about climate change and marine environments

# Melting sea ice
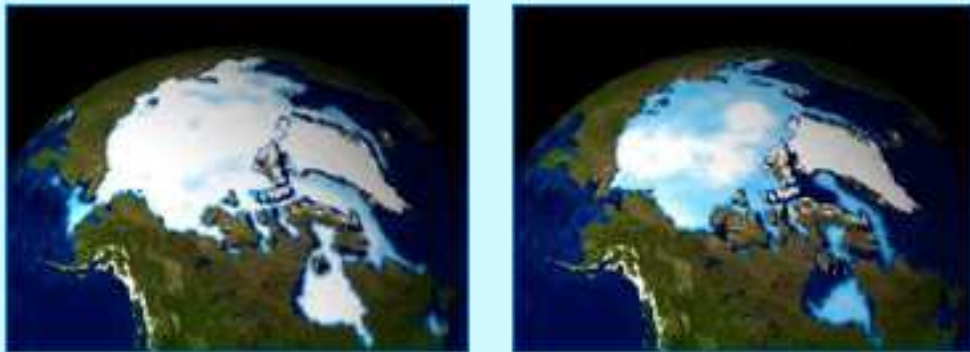


- These two NASA satellite images show how Arctic sea ice cover reduced between 1990 (left) and 1999 (right).

- Over the last 30 years, Arctic summer sea ice cover has reduced by 11% every 10 years, with an apparent speeding up of the decline in recent years. Winter sea ice is reducing more slowly.

- As well as reducing in extent, Arctic winter sea ice has decreased in thickness from 3.65 metres in 1980 to about 1.89 metres today.

- Arctic winter sea ice acts as a 'lid' preventing carbon dioxide from returning to the atmosphere, so as more ice melts this will accelerate global warming.

- The reduction in Arctic sea ice is affecting species such as polar bears, which depend on it for their survival. The total number of polar bears is predicted to fall substantially.

- The retreat of the Arctic sea ice is opening up the 'Northern Sea Route' between Europe and Asia for a limited part of the year. This might reduce shipping costs in the future.

*(Information from CEFAS and CLAMER project)*

**UEA University of East Anglia**

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# What we know about climate change and marine environments

# Rising sea temperatures
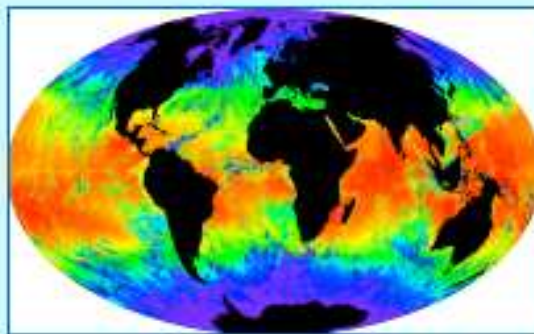


- This map shows the differences in temperature across regions of the world's oceans.

- In general, there has been a rapid warming up of Europe's seas over the last 25 years, especially in the North Sea and the Baltic.

- For instance, the winter temperature at the bottom of the North Sea has increased by 1.6 degrees centigrade over the last 25 years.

- Climate change is one of many factors that influence sea temperatures.

- The warming has led to a northward shift in the distribution of plankton, which in turn has affected species higher up the food chain.

- In general, smaller species of fish from the south have increased in the North Sea, while larger species have declined in number.

*(Information from CEFAS and CLAMER project)*

**UEA University of East Anglia**

# What we know about climate change and marine environments

# Changes in the distribution of marine species



- Climate change has already caused changes in plankton and fish distribution. Due to warming sea temperatures, the North Sea is now more suitable for species such as sardines and anchovies, and it is possible that these will replace traditional North Sea fish stocks in the near future.

- Together with fishing, climate change is probably involved in the marked decline of sand eel populations in the seas around the UK.

- Sand eels are the main food source for most seabirds. Along with changing weather patterns and fish distributions, the decline in sand eel numbers has also led to a decrease in the numbers of several species of seabird in the last 10 years, such as black-legged kittiwakes, terns and skuas.

- Around the UK, most non-native marine species, such as the Chinese mitten crab in the picture, were introduced by human intervention. However climate change has allowed some non-native species to extend their range. Colonisation by Chinese mitten crabs has greatly increased in the UK in recent years due to warmer temperatures.

- Non-native marine species have caused damage to the aquaculture industry, but on the other hand some non-native species may represent new economic opportunities.

*(Information from CEFAS and CLAMER project)*

**UEA University of East Anglia**

**Appendix 9: Environmental issues relating to the coastal and marine environment: workshop participants' associations**

- Impact of wind farms

- Increasing wave action

- Beach cleanliness (litter and dogs fouling the beach)

- Pollution and sewage (including plastics)

- Coastal erosion

- Sea-level rise

- Overfishing

- Rising sea temperatures

- Tsunamis

## Appendix 10: Climate change in relation to the coast and sea: workshop participants' associations

- Erosion

- Changing seasons (at sea)

- Acidification

- Currents changes (Thermohaline circulation/El Niño)

- River flooding

- Loss of Norfolk Broads due to rising sea level

- Consequent impact on local economy (tourism)

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