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The Communication of Scientific Uncertainty in European National Adaptation Strategies

Susanne Lorenz, Suraje Dessai, Jouni Paavola and Piers M. Forster

January, 2013

ICAD Project
Working Paper No. 2

European Research Council
Established by the European Commission
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ICAD Project, Informing Climate Adaptation Decision Making, is funded by the ERC and began April 2012.

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© Susanne Lorenz, Suraje Dessai, Jouni Paavola and Piers M. Forster

Email: ee08sl@leeds.ac.uk,

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Abstract

Many European countries have developed National Adaptation Strategies (NAS) to guide adaptation to the expected impacts of climate change. There is a need for more structured communication of the uncertainties related to future climate and its impacts so that adaptation actions can be planned and implemented effectively and efficiently. We develop a novel uncertainty assessment framework for comparing different countries' approaches to the inclusion and communication of scientific uncertainty, and use it to analyse ten European NAS. The framework is based on but modifies and integrates the notion of the "cascade of uncertainties" and the NUSAP (Numeral Unit Spread Assessment Pedigree) methodology to include the overarching assessment categories of Numerical Value, Spread, Depth and Substantiation. Our assessment indicates that there are marked differences between the NAS in terms of inclusion and communication of scientific uncertainty. We find that there is a bias towards the communication of quantitative uncertainties as opposed to qualitative uncertainties. Furthermore, through the examination of the UK and German NAS, we find that similar stages of development in adaptation policy planning can nevertheless result in differences in handling scientific uncertainty. We propose that the degree of transparency and openness on scientific uncertainty is linked to the wider socio-politico context within which the NAS are framed. Our methodology can help raise awareness among research users about the explicit and embedded information on scientific uncertainty within the existing NAS and would help to design more structured uncertainty communication in new or revised NAS.

Keywords*: climate change adaptation, National Adaptation Strategies, Europe, uncertainty, communication*

Submission date 14-01-2013; Publication date 25-01-2013

About the Authors

Susanne Lorenz, Sustainability Research Institute, Institute for Climate and Atmospheric Science and ESRC Centre for Climate Change Economics and Policy, School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK, Telephone: +44(0) 113 34 39085, E-mail: ee08sl@leeds.ac.uk

Suraje Dessai, Sustainability Research Institute and ESRC Centre for Climate Change Economics and Policy, School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK E-mail: S.dessai@leeds.a.c.uk
Climate Change Impacts, Adaptation and Mitigation (CC-IAM) Research Group, Faculty of Sciences, University of Lisbon, Portugal.

Jouni Paavola, Sustainability Research Institute and ESRC Centre for Climate Change Economics and Policy, School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK E-mail: j.paavola@leeds.ac.uk

Piers Forster, Institute for Climate and Atmospheric Science and ESRC Centre for Climate Change Economics and Policy, School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK E-mail: p.m.forster@leeds.ac.uk

1 Introduction

Climate change adaptation has gained importance on the climate change policy agenda in the past decade. For example, a number of European countries have published their National Adaptation Strategies (NAS) since 2005. It is now realised that even if stringent mitigation targets are set and achieved, Europe and the wider world will experience substantial climate change and impacts related to it due to the inertia in the climate system. Therefore, understanding the risks of climate change (and adaptation) and uncertainties associated with them is important.

Due to the transboundary nature of weather and climate impacts and the European countries' political and economic closeness through the European Union (EU), the EU has developed an adaptation framework (Commission of the European Communities, 2009), which aims to establish a European adaptation strategy and to encourage greater coordination and integration of adaptation across the member states. The framework encourages, but does not mandate, member states to prepare and implement their own NAS and non-compliance by member states is not punished. Several studies have examined different aspects of climate change adaptation in Europe (e.g. Hanger et al., 2012; Juhola and Westerhoff, 2011; Termeer et al., 2009). Studies that have examined NAS have typically focused on their content, context of their development, their dissemination, policy integration, and monitoring and evaluation (Biesbroek et al., 2010; Swart et al., 2009). Both the question of how different countries deal with the question of uncertainty within adaptation planning (Hanger et al., 2012) and the role and inclusion of scientific information and uncertainty in NAS is sometimes addressed (Biesbroek et al., 2010), though no detailed analysis has been conducted on the inclusion and communication of science and uncertainty and potential variations between them across countries.

Traditionally, risk communication was considered to improve understanding of the world people live in and the risks they face (Fischhoff 1987). In the area of climate change, the risks people face, however, can be geographically and temporally removed and somewhat mismatched with necessary actions. Therefore, there is a need for scientists to provide usable information on the risks associated with climate change and its impacts to inform the decision-making process (Pidgeon, 2012). Ad-hoc communication cannot be relied on to address this high-stake problem: a more structured and organized approach is needed (Fischhoff, 2011).

There are many uncertainties related to climate change and many studies have tried to classify them (e.g. Curry and Webster, 2011; Stainforth et al., 2007). The communication of uncertainty is therefore becoming an increasingly debated subject (e.g. Budescu et al., 2009; Fischhoff, 2007; Moser and Dilling, 2011; Rabinovich and Morton, 2012). A key finding of this research is that a 'one-size-fits all' approach to communication does not yield a desired response.

Audience-specific communication (Moser and Dilling, 2011) and an awareness of the fact that the production and processing of knowledge are deeply rooted within the practices and traditions of individual nation-states (Jasanoff, 2011) are needed.

A number of studies have examined the link between adaptation planning and decision-making on the one hand and uncertainty on the other hand (e.g. Dessai and van der Sluijs, 2007). This research has focused on mapping and matching theoretical methods, tools and decision frameworks on adaptation and uncertainty in the policy making sphere. That is, they have focused on the link between the two in the theoretical *process* of decision-making. We propose to examine empirically to what extent scientific uncertainty *is* considered and communicated in the *outcomes* of these processes, such as in the National Adaptation Strategies, by using a novel uncertainty assessment framework.

There is an increasing demand for coordinated uncertainty communication in the adaptation field (Lourenço et al., 2009). However, it has to date not been studied to what extent the different European NAS consider and communicate scientific uncertainty, even though they are the most important currently existing policy documents in Europe, which aim to provide decision-relevant information for national adaptation planning. By analysing them, we can consider a number of questions that arise from existing research in an empirical way. Firstly, considering that substantial uncertainties do exist regarding climate change and adaptation, to what extent are they communicated transparently in the NAS? Secondly, do different NAS use similar communication approaches or are they influenced by the political, economic and cultural traditions and contexts within which they have been developed? Thirdly, what implications do answers to the previous two questions have for the future development of the European adaptation strategy? This paper presents an uncertainty assessment framework which provides a tool to compare the different levels of information disclosed on scientific uncertainty in the NAS. The insights gained from this research will be useful in both the development of NAS and will also add an extra dimension to the knowledge base for the European Adaptation strategy.

In what follows, we will first analyse how NAS communicate their scientific underpinnings. We then introduce an uncertainty assessment framework based on the integration of the notion of the “cascade of uncertainty” (e.g. Schneider, 1983; Wilby and Dessai, 2010) and a modification of the NUSAP (Numeral Unit Spread Assessment Pedigree) methodology (Funtowicz and Ravetz, 1990; van der Sluijs, 2005). This framework enables us to assess and compare the NAS in terms of how they include and communicate science and uncertainty. In the discussion, we will take a more in-depth look at the British (focusing on England) and German contexts to understand how differences in practices across countries relate to country-specific socio-political frameworks.

2 Methodology

We employed qualitative content analysis in a systematic review of the coverage of physical science uncertainty in the NAS. Most countries plan to publish both NAS (overarching guidance document) and National Adaptation Plans (specific adaptive measures and delivery responsibility). By June 2012, 14 NAS have been adopted in Europe. Of these, we have considered only those available in English. The NAS covered are for: Belgium, Denmark, England, Finland, France, Germany, Hungary, Netherlands, Scotland and Wales (see Table 1 for more details on these NAS). The NAS of Scotland, Wales and England are considered separately because of the UK's devolved legal system.[1] The progress and implementation of the adaptation strategy and delivery frameworks vary across countries and their strategies vary substantially in terms of their level of detail. Yet they can be considered sufficiently comparable in all important respects.

We developed a novel uncertainty assessment framework for comparing the different countries' approaches to the inclusion and communication of uncertainty and science. The framework is based on the integration and modification of the concept of the "cascade of uncertainties" and the NUSAP methodology. The NUSAP method (Funtowicz and Ravetz, 1990) was originally designed to combine quantitative assessments of uncertainty (the Numeral, its Unit and the Spread) with qualitative judgements (Assessment and Pedigree). It thus allows for a systematic consideration of the different dimensions of uncertainty (van der Sluijs et al., 2005).

Our uncertainty assessment framework considers ***Numerical values*** (Do strategies assign numbers to the climate projections and uncertainties they mention?), ***Spread*** (Do strategies use ranges to convey the climate information rather than one deterministic number?), ***Substantiation*** (To what extent are NAS transparent about the foundation of the science communicated within them?) and ***Depth*** (To what extent do NAS take account of the various sources of uncertainty using the outcomes from the cascade of uncertainties?). ***Substantiation*** was assessed in terms of *source of information* (extent of references to other information sources within NAS), *climate scenario* (extent and clarity of specific information on climate scenario used) and *model projections* (level of explicitness about which climate model was used to create projections in NAS). Each category was scored to facilitate comparison as follows: 2 Points - information has been included in detail in the strategy, 1 Point - required information for a given category has been mentioned, but without further detail or explanations possibly also containing inconsistencies or lack of clarity. 0 Points - no information at all has been provided. The scores were then averaged firstly for the three criteria under Substantiation and then for all of the four main categories of the framework to generate an overall score for each NAS. ***Depth*** incorporates the concept of the cascade of uncertainty as described by Wilby and Dessai (2010) which helps to assess identified sources of uncertainties in the NAS. The uncertainties multiply as they pervade different

[1] To date Northern Ireland does not have a NAS and can thus not be included.

levels of the cascade from future society, greenhouse gas (GHG) emissions, climate model, regional scenario, impact model, local impacts to adaptation responses (Wilby and Dessai, 2010). We decided to omit the final level in the cascade, adaptation responses, as they will be more central to the National Adaptation Plans than to the NAS.

Table 1 Key features of European NAS analysed in this study

1	**Country**	**Title**	**Year**	**Coordinating Body**	**Number of pages of strategy document**	**Action plans**
BEL	Belgium	National climate change adaptation strategy	2010	Flemish Nature, Environment and Energy Department	51	National adaptation plan expected end of 2012
DEN	Denmark	Strategy for adaptation to a changing climate	2008	Danish Energy Agency	47	National action plan expected during 2012
ENG	England	Framework for action for adapting to climate change in England	2008	Department for Environment, Food and Rural Affairs	51	National adaptation plan for the UK expected in 2013
FIN	Finland	National strategy for adaptation to climate change	2005	Ministry of Agriculture and Forestry of Finland	280	*Action plan published in 2008*
FRA	France	National climate change impact adaptation plan	2006	Ministry of Ecology, Sustainable Development, Transport and Housing	72	*Strategy already contains very detailed actions and delivery partners*
GER	Germany	Strategy for adaptation to climate change	2008	Federal Ministry for the Environment, Nature Conservation and Nuclear safety	73	*Adaptation action plan published in 2011*
HUN	Hungary	National climate change strategy (NCCS) (extensive chapter on adaptation)	2008	Ministry for Environment and Water Department of Environmental Development	114 (20pp on adaptation specifically)	National adaptation strategic framework is planned as part of the first revision of the NCCS in 2013
NEL	Netherlands	National adaptation strategy	2007	Ministry of Housing, Spatial Planning and the Environment	Inter-administrative policy paper (16), Policy memorandum (42)	Action plans are currently being undertaken
SCO	Scotland	Climate change adaptation framework	2009	The Scottish Government	34	National adaptation plan for the UK expected in 2013
WAL	Wales	Climate change strategy (extensive chapter on adaptation)	2010	Welsh Assembly Government	110 (22pp on adaptation specifically)	*Welsh adaptation delivery plan* National adaptation plan for the UK expected in 2013

The cascade of uncertainty draws attention to the multitude of uncertainties that affect the climate adaptation planning and delivery process. It is thus a useful tool to assess to what extent the NAS are explicit about the different uncertainties present. We used a scoring system (explained below) to facilitate the comparison of NAS. Scores were given for each source of uncertainty and an average score calculated for each NAS.

3 Results - The inclusion or exclusion of science and uncertainty

Before analysing in detail the communication of scientific uncertainty, a number of more general observations on the communication of science in the NAS can be made. Firstly, there is a tendency to communicate physical science in the text of the NAS, rather than by using visual means such as graphs, tables or figures. Different countries communicate projections differently in text, some using numbers with or without decimal points, others using ranges rather than absolute numbers, and still others using proxy statements (e.g. number of frost days (Marttila et al., 2005: 26) or not quantifying statements at all ("more mild winters and hot summers" (VROM, 2007b: 8).

Visual communication of science also varies substantially in the NAS. For instance, the NAS of Scotland explicitly explains how to understand the used probabilistic projections whereas the NAS of Germany uses graphs in a similar way as the Intergovernmental Panel on Climate Change (IPCC) does in its Assessment Reports without detailed explanation. These different choices regarding visual communication may be indicative of different expectations placed on the audience, and different contextual frameworks within which these strategies have been developed.

There are also marked differences in the coverage of uncertainty between countries. Germany and the Netherlands mention uncertainty more than the other NAS. However, the acknowledgement of uncertainty itself often does not result in the provision of further details and explanation. There seems to be a gap between the amount of information included on the science and the amount of information given on uncertainty in most NAS. This leaves the impression that although a lot of emphasis is placed on communicating science, communication of uncertainty is considered less important. We now move to more detailed analysis of the NAS.

3.1 Uncertainty assessment framework

We present our qualitative comparison of the ten NAS in Table 2. The quantitative categories (***Numerical Values*** and ***Spread***) in the uncertainty assessment framework show higher scores compared to the qualitative categories (***Substantiation*** and ***Depth***). Furthermore, the majority of the countries have the same score across the two quantitative categories showing a predominantly consistent approach in the different countries in the quantitative representation of scientific uncertainty. The Finnish and Scottish NAS achieve the highest scores in both quantitative categories as their numerical projections are very clearly presented and the potential spread/ range in the numbers is well explained. Due to their preference for qualitative descriptors (e.g. mild winters and hot summers), the English and Dutch NAS score lowest in these categories.

Within the qualitative categories we notice a stark difference between the ***Substantiation*** and ***Depth*** category. The average scores for ***Substantiation*** are only marginally lower compared to the scores in the quantitative categories. Within this category, we notice that scores for *Source of information* and *Climate scenario* are highest, whereas the scores for *Climate model* are substantially lower. Only the German NAS achieves top scores for all three categories. All other NAS show inconsistent scores across the ***Substantiation*** categories. For the second qualitative category, ***Depth***, we used the concept of the cascade of uncertainties to examine which sources of uncertainty are explicitly included in the NAS. Table 3 indicates how the six sources of uncertainty are covered in the NAS and the resultant average score is then included in Table 2. The NAS of Germany and Finland cover most of the sources of uncertainty but they do not do so extensively. The other eight NAS include a few sources of uncertainty at most and half of the strategies barely acknowledge uncertainty in their communication.

Table 2 Qualitative assessment framework for the comparison of the coverage of science and uncertainty across the different NAS

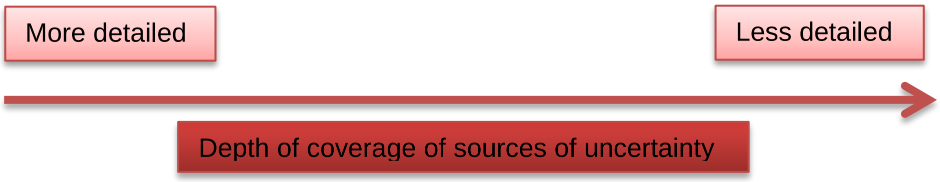
	BEL	DEN	ENG	FIN	FRA	GER	HUN	NEL	SCO	WAL
Numerical values (NV)	NV used in main body of the text	NV used in main body of the text, detailed table on projections is included	NV only given for selective variables	NV used in main body of the text, detailed table on projections is included	NV used in main body of the text	NV used in main body of the text	NV used in main body of the text, detailed table on projections is included but assumed average global warming by 1°C is not justified	NV only given for selective variables	NV included in tables	NV used in main body of the text but are given for different timescales for temperature and precipitation
NV Score	**1**	**2**	**0**	**2**	**1**	**1**	**1**	**0**	**2**	**1**
Spread	Values with very specific uncertainty ranges are used but not explained	Error margins and ranges for variables are inconsistent	No ranges are given for any values	Range of variation between the minimum and maximum value of the different scenarios included and explained	Model outputs for two regional models used are visualised -> spread is visualised, confidence intervals explicit	Model outputs for four regional models are visualised -> spread is visualised for one scenario	Mean, median and standard deviation are stated but not explained	No ranges are given for any values	Central estimates and probability ranges are explicitly stated and explained	Central estimates and probability ranges explicitly stated for some variables but not explained where ranges come from
Spread Score	**1**	**1**	**0**	**2**	**2**	**2**	**1**	**0**	**2**	**1**
Substantiation										
Source of information (SOI)	References included in the main body of the text and reference list included at the end	No references included	Includes references both within the main body of the text and the footnotes	References included in relevant sections within main body of the text, sector specific reference list is included at the end	Very few references included in the document	References included in the main body of the text and reference list included at the end	Very few references included in the document	No references included	References included within footnotes	Very few references included in the document
SOI Score	*2*	*0*	*1*	*2*	*1*	*2*	*1*	*0*	*1*	*1*
Climate scenario (CS)	High, low and middle scenario	IPCC SRES[a] A2, SRES B2, EUC2 (European target of maximum global temperature of 2C)	No specific details on scenarios	SRES A1FI, A2, B2 and B1	SRES A2, SRES B2	IPCC SRES A2, A1B, A1 for mean temperature, A1B for more detailed projections and Germany maps	No specific details on scenarios	Four scenarios but no specifications on details	Three scenarios but only medium and high emission scenario are mentioned (based on IPCC scenarios)	Medium emission scenario (based on IPCC scenarios)
CS Score	*1*	*2*	*0*	*2*	*2*	*2*	*0*	*1*	*2*	*2*
Climate model (CM)	Global and regional, but no further specifications	No specifications	No specifications	Multitude as different studies are used to summarise projections for Finland, PRUDENCE[b]	French regional climate models: ARPEGE-Climat and LMDZ	Global model: ECHAM5, and German regional climate models: REMO, WETTREG, STAR, CRM	PRUDENCE	No specifications	No specifications	No specifications
CM Score	*0*	*0*	*0*	*1*	*2*	*2*	*1*	*0*	*0*	*0*
Average Substantiation Score	**1**	**1**	**0**	**2**	**2**	**2**	**1**	**0**	**1**	**1**
Depth	See Table 2 for details on the scores									
Depth Score	**1**	**0**	**1**	**2**	**1**	**2**	**0**	**0**	**0**	**0**
TOTAL SCORE	**1**	**1**	**0.25**	**2**	**1.5**	**1.75**	**0.75**	**0**	**1.25**	**0.75**

[a] SRES - Special Report on Emissions Scenarios

[b] PRUDENCE - Prediction of regional scenarios and uncertainties for defining European climate change risks and effects

Table 3 The cascade of uncertainties in the NAS[a]

	GER	FIN	FRA	BEL	ENG	DEN	NEL	SCO	WAL	HUN
Future society	✓	✓✓			✓					
GHG emissions	✓✓	✓✓	✓	✓	✓		✓	✓	✓	
Climate model	✓✓	✓✓	✓	✓	✓	✓	✓			✓
Regional scenarios	✓✓	✓								
Impact model	✓		✓							
Local impacts	✓✓	✓✓		✓		✓				
Total score	10	9	3	3	3	2	2	1	1	1
Average score	**2**	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**



[a] The table shows the different levels of the cascade of uncertainty and gives a qualitative assessment of the inclusion/ exclusion of each one in the different NAS. ✓✓ type of uncertainty mentioned and some more detail/explanation given (2 points), ✓ type of uncertainty mentioned (1 point), blank cells signify that the type of uncertainty was not mentioned (0 points).

The most frequently mentioned sources of uncertainty are GHG emissions and climate models. This may reflect a perception that research is closer to being able to quantify uncertainty originating from these sources (e.g. Majda and Branicki, 2012; Smith et al., 2009) than it is able to do so with uncertainty originating from other sources. Many NAS do not even acknowledge regional climate projections as a potential source even though there is wide agreement that they are marked by a number of uncertainties (e.g. Foley, 2010; Stainforth et al., 2007). Furthermore, the uncertainties within the category 'Future society' encompass socio-economic uncertainties, demographic developments and technological advances, which are very difficult to project and yet are the main initial impetus into the cascade as they determine the level of GHG emissions upon which climate and resultant impact projections are based.

The results show that most NAS have shortcomings regarding the qualitative categories of assessment and perform better in quantitative terms. That is, they include quantitative values when talking about climate projections but are not explicit about where those numbers come from. There is a lack of explicitness about the underlying future socio-economic uncertainties that will resonate throughout the cascade. There are also marked differences between the NAS in terms of their score patterns across categories of assessment. There can be many reasons for this, including different policy frameworks and drivers, target audiences, scientific and cultural traditions, levels of knowledge and public acceptance of climate change. We will explore the links between broader socio-political frameworks and the design and style of the NAS in more detail in the next section.

4 Discussion - Contrasting discourses

We examined the inclusion and communication of scientific uncertainty across ten European NAS and analysed the patterns between different categories in the uncertainty assessment framework and between countries. Our framework has also revealed salient differences in the communication of uncertainty in the different countries' NAS, reinforcing the call for a much needed more systematic communication of uncertainty (Biesbroek et al., 2010; Lourenço et al., 2009). Across all countries a bias emerges towards communicating uncertainties that are perceived to be more quantifiable at the cost of communicating more qualitative uncertainties such as future socio-economic conditions. This bias however, leads to the question of how countries can justify quantifying and communicating uncertainty further down the cascade, when those at the top are barely mentioned. Past research explains that according to the stage of adaptation planning there are different ways of dealing with uncertainty in different countries such as hiding, or embracing uncertainties and including uncertainties in decision-making (Hanger et al., 2012). Our framework reveals that some of these different ways of dealing with uncertainty can also be seen in the different categories in the framework with the quantitative uncertainties being more 'embraced' and the 'qualitative' uncertainties being generally more 'hidden'. Uncertainty thus should not be regarded as one entity communicated in the NAS but can be broken down and assessed at a finer level.

Hanger et al.'s (2012) research, for example, showed that British policymakers recommend that uncertainty should be embraced in the adaptation planning process. It is surprising, therefore, that the textual communication of uncertainty in the English NAS is rather limited and seems to be in contrast with a) the statements made by the policymakers in past research and b) with the adaptation planning development stage the England is at; the UK and Germany have often been framed as being amongst those countries furthest advanced in the adaptation planning process in Europe (Juhola and Westerhoff, 2011; Massey and Bergsma, 2008). The UK has invested considerable resources in its research on climate change projections, impacts, risks and uncertainty since the 1990s through the UK Met Office Hadley centre, the UK Climate Impacts Programme (UKCIP) and more recently the Climate Change Risk Assessment (CCRA). So why is the picture that our framework paints of the English NAS in such stark contrast to this context?

We were interested in developing a framework that would allow us to qualitatively analyse and compare the communication of scientific uncertainty in NAS across Europe. By its very nature this methodology does not take into account the foundations on and the contexts within which these NAS have been developed, the available knowledge or the perception or status quo of uncertainty within adaptation decision making in these countries; nuances which could be achieved through more in-depth research. However, what this methodology enables is to use it as a diagnostic tool to highlight that the communication of scientific uncertainty is not just contingent on the stage of adaptation planning within the different countries. Instead, there are most likely also other reasons for why countries communicate scientific uncertainty differently. We will explore this hypothesis further through a more in depth analysis of the UK and Germany, as though neither of them is at the extreme ends of the assessment scale, they provide us with an interesting comparison to explore this point a little further.

The two countries share a number of commonalities: they have often been considered leaders in climate change adaptation in Europe (Juhola and Westerhoff, 2011), they are at the cutting edge of climate science, they show similarities in the agenda setting process of climate adaptation (Keskitalo et al., 2012; Stecker et al., 2012) and following the research set out by Hanger et al.(2012) they should be dealing with uncertainty in a similar fashion as their journeys along the adaptation planning path are at a similar point. Yet their NAS differ in terms of the style of communication and transparency on scientific uncertainty. The differences between the two countries warrants a more in-depth analysis and an exploration of the broader contexts within which these strategies were developed. We chose the English NAS from the UK for further analysis and comparison with the German one.

4.1 The German context

Germany has a strong tradition of environmental politics and a societal environmental consciousness that goes back to the 1980s (Beck, 2012; Krueck et al., 1999). Climate change started gaining political attention in 1986 when several influential scientists framed climate change as a ‘climate catastrophe’ (Beck, 2004; Krueck et al., 1999; Weingart et al., 2000). The German parliament established the Enquete Commission (a politico-scientific parliamentary enquiry) on ‘Preventative Measures to Protect the Earth’s Atmosphere’ the following year quickly succeeded by a second (Beck, 2004; Krueck et al., 1999; Weingart et al., 2000). These commissions involved a cross-section of stakeholders from industry, NGOs, the scientific community and politics (Beck, 2004).

The Enquete Commissions first embarked on fact-finding and assimilation of the scientific evidence in order to establish a consensus on the knowledge, resonating with the German consensus-oriented political culture (Beck, 2012; Krueck et al., 1999). This consensus not only legitimised the centrality of scientific expertise in the policy-making process (Beck, 2012), but also stabilised and institutionalised climate change as an issue (Beck, 2012; Krueck et al., 1999). The commissions managed to avoid the politicization of climate science and achieved closure on its legitimacy early on (Beck, 2004; Krueck et al., 1999; Weingart et al., 2000). The Commissions also defined climate change as a research problem, which stresses scientific uncertainty inherent in the issue and influences the public discourse on the subject (Krueck et al., 1999). The Commissions ensured that scientific uncertainty was regarded as a dynamo for instant action rather than an excuse for inaction and controversy (Beck, 2004). This acceptance of climate science and uncertainty related to it was mirrored in the public which hardly challenged climate science (Jasanoff, 2011). The transparency and detailed treatment of uncertainty in the German NAS thus reflects the politico-scientific tradition of accepting and understanding the inevitability of uncertainty in climate science.

4.2 The English context

The UK Climate Impacts Programme (UKCIP) was set up in 1997 and has played a leading role in adaptation nationally and internationally, inspiring others including

Germany to follow suit (Stecker et al., 2012) and is leading the way with its latest probabilistic UK Climate Projections 2009 (UKCP09). Developments on the climate impacts side were followed by a report on energy and the environment in 2000 by the Royal Commission on Environmental Pollution which was followed by a Government Energy White Paper in 2003 (Owens, 2010). Although the White Paper may resemble the expert knowledge driven policy action in Germany, it remains unclear whether expert advice inspired the UK government action on climate change. Geopolitical factors and a desire to distance the UK from the US in climate policy have also been argued playing an important role (Owens, 2010).

In 2008, the Climate Change Act came into force. Although the UK was the first country to make action on climate change legally binding, political consensus on what to do about climate change in the UK remains elusive (Carter, 2008). Austerity measures taken during the economic crisis have also had a significant effect on the environmental and climate change agenda in which party politics bind for public support (Carter, 2008).

While the UK is at the forefront of ground breaking climate research, cultural preferences continue to reside with trusting empirical observations opposed to conceptual models (Jasanoff, 2011). Scientists – with some exceptions (e.g. Pall et al., 2011) – and the UK media are often reluctant to link specific weather events to climate change (Gavin et al., 2011). Thus the majority of people do not think that there is empirical evidence of climate change and its impacts (Clements, 2012). In contrast, the German parliament and the German media have been explicit in making a link between extreme events and climate change (Stecker et al., 2012; Weingart et al., 2000). Although the scientific knowledge base on climate change has been importantly formed by the UK scientists, model projections and associated uncertainties simply do not sit comfortably with a tradition of evidence-based policy making, and thus do not find a place in the English NAS.

4.3 What do these two cases tell us?

The two case studies give a snapshot of the broader socio-political context within which the NAS have developed and are nested. They suggest that the traditions of environmental policy, the level of societal and political consensus on the credibility and salience of scientific knowledge on climate change and its associated uncertainties and the actions required, and the extent of politicization of climate change affect the openness and transparency of NAS regarding scientific uncertainties. Dominant framings of climate change (de Boer et al., 2010), different governance regimes (Rothstein et al., 2012), different civic epistemologies (Jasanoff, 2011), and different risk management cultures also underpin differences in NAS. What is, and importantly what is not, included with regards to information on uncertainties in the adaptation planning process is very interesting and reflective of wider cultural traditions. Other factors such as the susceptibility to change, or the perceived role of the state in risk management, are also arguably important and point to the need for further research.

Both case studies point to the different styles for communicating uncertainty in the UK and Germany. While exploratory in nature, they do highlight:

a) similar adaptation development stages between countries do not necessarily result in similar communication approaches,
b) even if policymakers support the ‘embracing’ of uncertainties this does not mean that these are communicated comprehensively in the NAS and
c) the NAS may serve different functions and different audiences which will affect the level of communication of scientific uncertainty within them.

5 Conclusion

Our analysis has shown that there are marked differences between European NAS regarding the level of detail they provide on climate science and uncertainty related to it. The methodology we used to assess the treatment of science and uncertainty in NAS proved clearly useful and it could help raise awareness among research users about explicit and embedded information on scientific uncertainty within documents. European countries have called for ‘structured communication about […] uncertainties […] to correctly develop adaptation actions’ (Lourenço et al., 2009: 15). Our assessment not only provides an insight into the communication of uncertainties in already published NAS but it could also be used in the development of future adaptation strategies as a guide to structured communication on scientific uncertainty. Different politico-scientific cultures and traditions may make it difficult to design a single European one-size-fits-all approach for communication (Beck, 2012). However, the framework can highlight areas in the strategies where policy makers may need to seek additional information. With the European Adaptation Strategy due to be published in 2013 we will have to wait-and-see how, and in what ways, considerations for different knowledge preferences affect its advice.

Acknowledgements

This research has been conducted with funding from the UK Natural Environment Research Council (NERC). Suraje Dessai is supported by the UK Natural Environment Research Council (NE/ H003509/1) and the European Research Council under the European Union¹s Seventh Framework Programme (FP7/2007 2013)/ERC Grant agreement no. 284369. We would also like to thank James Porter for his comments.

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