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**EUCLEIA**

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**EUropean CLimate and weather Events: Interpretation and Attribution**

**Deliverable D4.2**

*Empirical working paper: analysing stakeholders' needs and understanding*

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## 1. Executive Summary

Work task 4.2 aims at conveying an understanding of user needs and the value of extreme event attribution for regional stakeholders in the Baltic Sea Region and in the greater Paris area. The study builds on Cash et al.'s (2013) concept for evaluating climate and extreme event attribution (EEA) services and follows a harmonised methodology as proposed in M2. Empirical evidence from interviews and a workshop are thereby meant to advance the current state of knowledge in terms of mapping potential users of EEA and their requirements. The empirical results of WT4.1 about scientists' articulation of EEA and about the perspectives of the media on Baltic storm surges allow comparing and complementing the findings of WT4.2.

In WT4.2, we have assessed the needs and requirements of a rather diverse set of user groups. Building on our existing dialogue with stakeholders in Northern Germany and in the greater Paris area and on the assumption that EEA is relevant to governing climate change- and storm surge-related (Baltic) or heat waves (Paris) risks (see D4.1), we consulted, beside scientists and the media (assessed in WT4.1), stakeholders from politics, public administration, civil society, associations, and the private sector in fields, which might be able to make use of EEA, namely: spatial planning, coastal protection, climate mitigation and adaptation, nature protection, tourism, maritime/port industry, and emergency management in the Baltic Sea case; emergency health care, health planning, mass transit, collective provision of temperature regulation (cold), urban planning, local and regional climate planning, land use planners, local and regional climate offices, forestry, agriculture in the Paris case.

The consulted stakeholders, particularly in the Baltic Sea case study, perceived EEA as a complex scientific endeavor attached to large uncertainties. Most of them never used or even heard of the possibility of EEA before. This seemed to cause a lack of understanding and misunderstandings of EEA. Stakeholders particularly in the Paris case study were, however, more expert in climate change related processes and may therefore be able to take up complex information such as the ones provided by event attribution – once these are actually available and more established. The fact that there is no appropriate term for attribution in German language further complicated discussions and the articulation of EEA needs and requirements (see also D4.1). These aspects and difficulties might also hold true for many other stakeholders at a regional level who are far from being expert on EEA-related topics. The consulted stakeholders did not only think that EEA is a highly complex and abstract topic but were skeptical that it is even possible (see also D4.1). Overall, a suitable product of EEA for regional stakeholders should accordingly be explicit with respect to what a EEA system as developed in EUCLEIA is, mention how it is different from related concepts, explain these aspects in an understandable way, and be able to translate scientific language into mother-tongue language. To make implicit expectations explicit, an EUCLEIA product therefore needs to build upon a regular and context-specific stakeholder consultation and proactive engagement.

Despite of the assumption that EEA is of relevance to all phases of risk governance (see D4.1), most stakeholders found that it would not change their own motivation or way of taking action. They told to be rather in need of information about vulnerability, potential impacts and promising adaptation options; such information was not perceived to be

enhanced by EEA results. Nevertheless, most stakeholders thought that EEA could be able to change the risk perception of others. Particularly the overall societal debate and public awareness-raising in terms of climate change were perceived to be potential fields of application. In the Paris case study, event attribution information might, in addition, be particularly interesting for political leverage. Litigations, loss and damage discourses, or geo-engineering, all fields which were listed in previous EEA studies, were named by none of the stakeholders. Also, the assumption that EEA facilitates a more effective resource distribution, planning and implementation of climate adaptation could not be confirmed. Comparing our stakeholder mapping with stakeholder identifications in previous EEA studies accordingly demonstrates that it is not possible to compile *one* generic stakeholder typology or identify only one set of potential EEA users. It is important to conduct case-specific stakeholder mappings and reflect the results against the background of context-, hazard-, or region-specific factors.

We also looked at the specific requirements to make EEA relevant, reliable and expedient for regional stakeholders. The interviews and workshop discussions reveal that the tolerance of uncertainty is rather low. Credibility is often linked to the designation of small statistical uncertainties and is commonly ensured by relying on information from trusted sources, people or institutions. The time of availability is, in contrast to what previous studies and also the media analysis show, rarely mentioned to be of relevance. This might be owed to the fact that most of the stakeholders are engaged in long-term preparedness or continuous awareness-raising campaigns. Saliency is most commonly attached to the fact that EEA is linked to the consequences of extreme events or stakeholder-specific problems. This has been emphasised in both case studies. Accordingly, a suitable EUCLEIA product should be tailored to the specific concerns of the particular stakeholder, received from a trusted “honest broker”, and published rather at a later stage but with smaller uncertainties than vice versa. This demands an understanding of stakeholder needs from scientists and an understanding of what science can/should provide from stakeholders. Regional climate service providers can serve as an interface for creating such mutual understanding.

In the following work tasks, it will be necessary to take a closer look into the specific requirements and potential fields of application. This will be done in WT4.3, in an in-depth analysis at the example of the insurance sector and in WT4.4 in a representative survey of the general public. This is meant to not only reveal in-depth insights into commercial and public interests but might also convey a more representative picture and profound understanding of some of the aspects which remained largely uncovered for the stakeholder groups assessed in WT4.2.

## 2. Project Objectives

With this deliverable, the project has contributed to the achievement of the following objectives (DOW, Section B1.1):

**Table 1: Contribution of the deliverable to the achievement of EUCLEIA's objectives.**

No.	Objective	Yes	No
1	Derive the requirements that targeted user groups (including regional stakeholders, re-insurance companies, general public/media) have from attribution products and demonstrate the value to these users of the attribution products developed under EUCLEIA.	X	
2	Develop experimental designs and clear ways of framing attribution studies in such a way that attribution products provide a fair reflection of current evidence on attributable risk.	X (for the « framing part »)	
3	Develop the methodology for representing the level of confidence in attribution results so that attribution products can be trusted to inform decision-making.		X
4	Demonstrate the utility of the attribution system on a set of test cases of European weather extremes.	X (for the cases of Baltic Sea storm surges and heat waves/ cold spells in the Greater Paris Area)	
5	Produce traceable and consistent attribution assessments on European climate and weather extremes on a range of timescales; on a fast-track basis in the immediate aftermath of extreme events, on a seasonal basis to our stakeholder groups, and annually to the BAMS attribution supplement.		X

### 3. Detailed Report

#### 3.1. Introduction

##### 3.1.1. Deliverable 4.2 as it appears in the DOW

In the Description of Work (DoW), Deliverable 4.2 (D4.2) is described as “Empirical Working Paper analysing regional stakeholders’ needs and understanding in terms of attribution for two cases”:

- a) In the greater Paris area, dealing with the climatic extreme of heat waves and the their challenges for public health; and
- b) Along the German Baltic Sea coast, dealing with the threat of storm surges and their challenges for public safety and coastal erosion.

The target groups are meant to comprise sector specific regional stakeholders (See DoW part B, p. 5). Deliverable 4.2 will mainly build on the work undertaken in task 4.2. It presents the findings of the stakeholder identification according to an attribution-relevant typology and displays the main findings from the stakeholder interviews and workshops with selected focus group. The methodology for stakeholder identification, interviews and workshops was aligned with the harmonized methodology presented in Milestone 2 and the theoretical framework outlined in Deliverable 4.1.

##### 3.1.2. Deliverable 4.2 against the background of work package tasks and overall project objectives

Deliverable 4.2 is a cornerstone for reaching the overall goals of the EUCLEIA project. EUCLEIA aims to “provide to targeted groups of users, well verified, well understood assessments on the extent to which certain weather-related risks have changed due to human influences on climate” to facilitate climate change mitigation and adaptation activities (DoW part B, p. 4). *Extreme Event Attribution (EEA)* studies provide the basis for these assessments by developing a system which is able to judge the relative contribution of human influence on a specific extreme weather-related event with an assignment of statistical confidence. EEA builds on detection studies which identify the changes in extreme event occurrences [Hegerl et al., 2010].

Deliverable 4.2 aims at conveying an understanding of who the ‘targeted groups of users’ are and how to reach them, how they define ‘well verified’, what, why the results are ‘understood’, and how this information might feed into governance processes in ‘climate adaptation and mitigation’.

More specifically, the work task contributes to achieving some of the central objectives stated in Table 1 (see also DOW part B, p. 4). Addressing what and how regional stakeholders evaluate the quality of a climate service like extreme event attribution facilitates deriving the requirements that one of the listed targeted user groups have (objective No. 1). This provides a basis to understand how to frame attribution studies so that they find attention in the general public (objective No. 2 – only the framing part, though). Both aspects

are demonstrated on a set of test cases of European weather extremes, i.e. Baltic Sea storm surges and heat waves/ cold spells in the Greater Paris area (objective No. 4).

Work task 4.1 has developed a context-specific conceptual framework to assess regional stakeholder needs and requirements at the example of these test cases. It is meant to convey an understanding of how extreme events, attribution, and climate services are perceived and articulated. Interviews with scientists and a media analysis have already revealed first insights on how extreme events, climate change and extreme event attribution is understood and communicated. The conceptual framework also sets a preliminary basis for assessing extreme event attribution as a climate service for stakeholders particularly in the fields of climate change adaptation and mitigation. Milestone 2 (*“Harmonised methodology for the focus group organisation and results analysis for the regional level stakeholder needs and understanding analysis”*) outlined an expedient methodology to answer the given research questions along the lines of this conceptual framework. It describes why and how qualitative interviews and stakeholder workshops with identified focus groups are relevant to WP4.2 of the EUCLEIA project. Milestone 1 (*“Suitable description of the envisaged product of event attribution”*) fed into the development and conduction of the stakeholder workshops in particular. Providing a hypothetical EUCLEIA event attribution report to stakeholders in the workshops, it is meant to be a better and more tangible basis to evaluate the quality of potential climate services based on probabilistic extreme event attribution studies than if talking about extreme event attribution in general.

### 3.1.3. *Report outline*

In the following report, we will first introduce the underlying concepts and the contextual background drawn from a review of the relevant literature. In the following section, the overall methodology and the process of data collection in the German Baltic Sea and the Greater Paris area is described. These sections explain how and in what context, the empirical findings emerged which will be outlined in the following sections. First, the results from the case of Baltic Sea storm surges will be described; second, the findings from the case of heat waves in the Greater Paris area are presented. In a common discussion and conclusion section, we reflect the empirical findings against the background of the existing literature and the previous work task and thereby aim at answering the key research questions of WT4.



### 3.2. Literature review – relevant concepts and contextual background

#### 3.2.1. Conceptual basis

##### Risk governance and risk perception concepts as proposed in D4.1

In Deliverable 4.1, we assumed that risk perception and risk governance research as proposed by Renn and his co-authors [see e.g. *Renn, 2008*] provides a preliminary conceptual framing for gaining an understanding of stakeholder needs and requirements with respect to extreme event attribution services. **Risk governance** is defined to comprise all “structures and processes for collective decision making” regarding risks [*Renn, 2008*] (see D4.1 for more details). In order to understand how stakeholders perceive, understand and articulate extreme event attribution within an overall risk governance context, we refer to Renn’s [2008] integrative framework for **risk perception** as also applied by Kane et al. [2014], Touili et al. [2014] and Vanderlinden et al. [2015]. To be able to grasp stakeholder needs and requirements, we conceptualized risk perception and the social articulation of Extreme Event Attribution against the background of evidence-, material-, and value-based considerations of stakeholders (see D4.1 for more details).

Work package 4 is, according to the DOWs, meant to deal particularly with **stakeholders’ perceptions and evaluation of extreme event attribution**. We thereby assume that the stakeholder needs and requirements with respect to EEA depend on stakeholders’ appreciations of how the world (e.g. extreme events, attribution) functions, on their understanding of whether and why extreme event attribution matters, and on how EEA services are judged on moral or normative grounds (see Deliverable 4.1 for more details).

##### Concepts explaining the usefulness of scientific (climate) knowledge in stakeholders’ decision-making

In order to understand why stakeholders may find scientific knowledge relevant to their decision-making and to ensure that they are able to take up this knowledge, key stakeholder requirements are to be identified. Cash et al. [2003] identifies ways or criteria for assessing information and information services. They are a good basis to complement the value considerations proposed in D4.1. It is argued that information is most likely to influence decision-making if the boundaries between knowledge and action are managed in ways “that simultaneously enhance [their] salience, credibility, and legitimacy [...]” [*Cash et al., 2003*]. **Salience** refers to “the relevance of information for an actor’s decision choices, or for the choices that affect a given stakeholder” [*Cash et al., 2002*]; **credibility** involves, according to Cash et al. [2003: 8086], “the scientific adequacy of the technical evidence and arguments”; **legitimacy** reflects, according to Cash et al. [2003: 8086], that research has considered stakeholders’ needs and interests. This is often based on the judgement of who participated in what way in knowledge production, assessment and dissemination.

Pielke [2007] argues, in this context, that a responsible scientist should function as an “honest broker” who is able to explain complex processes and research results and facilitate identifying expedient ‘solutions’ also in case of high uncertainties. Policy-makers, on the other hand, should only pose scientifically solvable problems to scientists and not make them provide the most accepted or appropriate ‘solution’ to problems [see also *Storch, 2010*]. McNie [2013] found that climate science has to be not only credible and trusted, but is

most salient to users if it is contextual and well understood in order to feed into decision-making and enhance adaptation efforts. Storch, Meinke, et al. [2011] argue, in this context, that scientific knowledge about climate change may only influence society's risk perception, if it fulfills a number of key requirements; i.e.:

- "regional experiences, memories and values have to be understood and analyzed";
- information needs to be presented in an understandable manner
- scientific findings should be targeted towards relevant region-specific impacts
- scientists should rather than convey an illusion of static and universal truths, embed it in the overall political and societal decision-making context

The requirements named by Pielke [2007], McNie [2013], and Storch, Meinke et al. [2011] seem to reflect the criteria which were named to be important by Cash et al. [2003] and add a more specific understanding to Cash's criteria in terms of climate-related knowledge for regional decision-makers. Accordingly, salience can be better ensured by providing understandable information targeted particularly to region-specific impacts to facilitate finding expedient solutions; credibility is more likely to be achieved if scientists honestly communicate uncertainties and dynamics; legitimacy is reflected in the requirement for a consideration of regional stakeholders' perspectives. Legitimacy can also counteract another common problem for creating knowledge that is useful for decision-making, i.e. that neither the users nor the producers of knowledge 'own the problem' of producing usable knowledge [Dilling and Lemos, 2011].

Due to this, an institution is needed which makes producing useful and applicable knowledge to 'its problem' and feels responsible for it. Such an institution is also needed to enhance salience, credibility and legitimacy. Cash et al. [2003] argue in this context that we need institutional mechanisms which enable and foster communication, translation and mediation across related boundaries between knowledge and action. This can be, according to Dilling and Lemos [2011], information brokers, collaborative group processes, organization-internal or embedded capacities, and boundary organisations. Climate service providers can thereby function as boundary managers by standing in a mutual dialogue with stakeholders, the general public, and knowledge producers.

Several scholars like Storch [2009], Krauss and Storch [2012], or Bray and Martinez [2015] argue that this mutual science-stakeholder dialogue has increasingly gained importance and has been the answer to a so-called 'post-normal situation'. In a 'post-normal situation', it is no longer only scientificity, methodological profoundness, or scientific validity which is sufficient for making science 'useful', but its relevance to decision-making and its social acceptance [Bray and Martinez, 2015; Storch, 2009]. Scientifically legitimized knowledge is, according to Storch et al. [2014: 3], just one knowledge type which competes with other forms of knowledge. Lemos et al. [2014] and Kirchhoff et al. [2013] argue that the usability of new knowledge, also that from science, depends on its interaction with the types of knowledge which are in use by the stakeholder at that moment. In order to produce 'useful' information, science therefore needs to comprehend these 'other' knowledges and vice versa [Storch et al. 2014: 3]. Understanding general public and stakeholder needs on the one side and scientists' perspectives and capabilities on the other side is thereby also the basis for enhancing salience, credibility, and legitimacy, balancing the trade-offs between these criteria, and making advantage of the evident complementarities.

### 3.2.2. Literature about stakeholder needs in terms of EEA information and a potential operational system

#### Identified requirements regarding EEA information for stakeholders' decision-making

Cash et al.'s (2002, 2003) understanding of information services may provide an expedient conceptualization **for achieving the goals of WP4**, i.e. to provide to targeted groups of users, well verified, useful, and well understood assessments on the extent to which certain weather-related risks have changed due to human influences on climate (DoW part B, p. 4). The requirements for creating useful *climate* information for *regional* stakeholders, formulated by Storch, Meinke et al. [2011] and McNie [2013], fit and indicate foci within the categories suggested by Cash et al. [2002, 2003]. In combination, they may therefore well serve an encompassing assessment of EEA-based information for the EUCLEIA project.

- Assessing the credibility of extreme event attribution information will indicate in how far '*targeted groups of users*' perceive to receive '*well verified*' information and how scientists can honestly communicate associated uncertainties.
- Addressing the salience of extreme event attribution services accounts for what and why the results are '*well understood*' and '*useful*' to the decision-making of the relevant stakeholders. For instance, whether a focus on or links to region-specific impacts might also be demanded in case of EEA information.
- Including legitimacy as important quality criterion of extreme event attribution services adds a very specific normative dimension to the evaluation, i.e. that information is not only '*well understood*', '*useful*' and '*well verified*' but also produced, assessed and disseminated in participation with stakeholders.

The review of extreme event attribution literature reveals that the **credibility** of results is a major concern and yet there is little known about stakeholder perspectives on it. In the EUCLEIA proposal, it was, for instance, stated that there is only little known about the "tolerance of potential decision-making processes to uncertainties and possible errors in attribution assessments" (DoW part B, p. 9). Most people concerned with climate change and extreme events seem to think that it is not possible to attribute specific events to anthropogenic climate change. This appears to be not only the case in science, as James et al. [2014] argue, but also in the public and media perception [Stott et al., 2013]. This is assumed to be caused by the facts that there is yet little information available about the contribution of anthropogenic climate change to specific extreme events and that the information which is provided is often contradictory and highly uncertain [Stott et al., 2013]. In the group discussions undertaken by Stott and Walton [Stott and Walton, 2013], robust extreme event attribution information with little uncertainties involved was among the most important requirements mentioned by the participants [Stott and Walton, 2013]. Hulme argues that extreme event attribution information which lacks credibility may "open up new spaces for political contestation, but now hidden in the language of science" [Hulme et al., 2011]. These are arguments which can be found in the context of most climate change related debates [see e.g. Koerth and Sterr, 2012; Patt and Weber, 2013].

Also **salience** is acknowledged as relevant criterion in extreme event attribution studies. Stott et al. [2013], for instance, states that the relevance and interest in such information is largest during or right after an extreme event. This might even compensate for the larger uncertainties which are to be expected if results have to be produced timely. They also argue, that such information should be available on a regularly basis similar to weather forecasting services. Moreover, the results themselves seem to influence the relevance of

information about the anthropogenic forcing of extreme events. Adam [2011], for instance, argues that lawyers would only get interested in such information if the contribution of climate change would be large enough. If the probability of an extreme event only increases by five percent due to anthropogenic climate change, he could most likely not make use of it in court.

The review of the literature has shown that **legitimacy** is a rarely named criterion in extreme event attribution studies. According to Stott et al. [2013], most extreme event attribution studies have not met the requirement of producing research results in consultation with relevant stakeholders, i.e. they have not explicitly considered legitimacy concerns in their research. Scientific rigour and innovative research methodologies have been at the centre of interest instead. Thompson and Otto [*Thompson and Otto, 2015*] somehow touch this question by considering the ethical and normative dimension of EEA within the context of loss and damage. The EUCLEIA project has committed itself to move beyond the current state of the art by “engaging with targeted groups of stakeholders in a systematic and comprehensive fashion from start to finish of the project” and therefore intends to put also legitimacy criteria to the fore.

How extreme event attribution research is effectively translated, mediated and communicated by boundary managers like climate service providers has not been studied so far. And also questions like: “How important are these criteria to different stakeholder groups? In how far influence quality judgements of extreme event attribution risk perception? And how do these perceptions feed into governance processes for climate change mitigation and adaptation?” have not been addressed so far in extreme event attribution literature. This deliverable will address these questions by taking a closer look at the relevance of credibility, salience and legitimacy for stakeholder evaluations.

#### Potential stakeholders and users of an EEA operational system

In order to understand the needs and requirements of ‘targeted groups of users’, potential target groups for extreme event attribution services have to be identified. Most attribution studies – also extreme event attribution studies - argue that the interest in this field of research is continuously growing among stakeholders ([see e.g. [Hegerl et al., 2010; James et al., 2014]).]. It is stated that attribution results are fundamental to decision-making. Hulme [Hulme, 2014] finds that one of the most common questions asked to climate scientists after a meteorological extreme event is: ‘Was this weather event caused by climate change?’. This ‘extreme weather blame’ question, as he calls it, reflects “an enduring quest across all human cultures”. Studies which go beyond the understanding that EEA is important for stakeholders and which empirically identify potential groups of users or map possible needs of different sectors, institutions and agents are still rare [Stott and Walton, 2013].

Stott et al. [2013] identify four major groups of EEA service users based on their experiences from the test cases where EEA attempts have previously been made. These are: the general public, the legal sector, actors engaged in climate change adaptation, and the geo-engineering sector. In other studies, also the insurance sector and the media have been named as potential users of EEA information [Hulme, 2014; James et al., 2014; Stott and Walton, 2013].

Extreme event attribution information may serve an already long-lasting **public interest** in the ‘extreme weather blame’ question. In the past, this question has commonly been

answered by blaming god, evil spirits or witches [Hulme, 2014]. In recent decades, where climate change is a frequent topic in public debate, man-made greenhouse gas emissions are often made responsible for extreme weather events. EEA information could, in this respect, increase scientific rigour in the debate and add probabilities to such assumptions. In addition, it could ease the frustration with and the argument about the invisibility of climate change because extreme events are more visible than creeping climate changes [Hulme, 2014; Stott and Walton, 2013]. However, there is also another point of view shaping the debate, i.e. that EEA statements confuse the public and may reduce rather than increase the trust in science and anthropogenic climate change. This is because the probabilistic statements are loaded with uncertainties and the public often associates uncertainties with opposing scientific views on the feasibility and results of EEA [Hulme et al., 2011; James et al., 2014].

A large public interest is naturally linked to an interest in the **media** and vice versa. The 'extreme weather blame' question is also among media representatives the most commonly asked question to climate scientists according to Hulme [2014]. Stott and Walton [2013] found in a workshop discussion with journalists, that the media thinks that EUCLEIA information would allow them to serve the big public "appetite for explanations" of extreme events by revealing in how far man-made greenhouse gas emissions bare responsibility. However, scientists' lack of capability to communicate complex statements is a major concern which might inhibit the application of EEA information in their point of view. Media representatives have also voiced misgivings with respect to the large uncertainties attached to EEA information. They were concerned that the public might take such information as "not known" facts [Stott and Walton, 2013].

Several authors argue that EEA information can also be utilized in court as part of "climate **litigations**" [see e.g. Adam, 2011; Faulk, 2012; Stott and Walton, 2013]. As of today, there were a few cases of private actors trying to enforce claims against greenhouse gas emitters. In the Mississippi federal court, 14 victims of Hurricane Katrina made eight oil companies, 100 oil and refining entities, 31 coal companies and numerous insurance and mortgage companies responsible for damages to their homes because of their contribution to climate change. The case was, however, not permitted to go forward [Faulk, 2012]. Also nations could demand compensation from each other after an extreme event happened [Adam, 2011]. This is, for instance, highly relevant to the *loss and damage* debate where less-developed countries claim compensation from developed countries because they are the ones who emitted most of the greenhouse gas up to date [Hulme, 2014]. EEA results might increase the chances of such claims to be successful. Nevertheless, in order to really make use of EEA information in this context, Stott et al. [2013] argue that some key questions have to be answered such as "what a court might consider as natural climate, over what time scales are damages relevant, or what levels of reliability, neutrality and acceptability are required". And above all: how can you single out one defendant's emissions and therefore his contribution to climate change? [Adam, 2011].

Also from an **insurance** perspective, EEA information might be of relevance according to Stott and Walton [2013]. Insurers and large re-insurers can factor the man-made contribution to extreme events into their contracts and improve long-term planning. The workshop of Stott and Walton [2013] has shown that insurers might raise their premiums due to an increased probability of extreme events due to climate change [Vanderlinden et al., 2015]. This might increase private incentives for seeking alternative strategies and invest in climate resilience.

House owners might, for instance, move to another place rather than paying the expensive insurance premiums and relying on insurance companies to pay in case of loss [Vanderlinden *et al.*, 2015]. Nevertheless, long-term developments and specific patterns of an event are still more relevant to insurers than assessing single events. Moreover, the tolerance of uncertainty is very low in this sector. Participants in the workshop have stated that insurance companies are reluctant to use data with uncertainty levels as high as in case of EEA [Stott and Walton, 2013]. Whether and in what way, insurers are interested in EEA results will also depend on the nature and type of extreme event. For storm surges in Germany, or for the impact of heat waves in the Greater Paris area, for instance, there is in most cases no insurance available to date.

Also in the **adaptation** debate, information about the contribution of anthropogenic climate change to single extreme events is said to be of importance. EEA results could, for instance, indicate that a specific event is and will be extremely rare. It should therefore not be prioritized in the adaptation agenda [Stott and Walton, 2013]. EEA might, in contrast, also show that a specific extreme event is a signifier of the future to which society should better adapt. In this case, EEA information would not only enhance the justification for taking action and facilitate more effective resource distribution but would also improve planning and implementation of climate adaptation [Stott *et al.*, 2013; Stott and Walton, 2013]. Hulme and his co-authors [Hulme *et al.*, 2011] speak to the contrary. They argue that EEA information might allocate adaptation funds to places where hazards are most attributable to anthropogenic climate change and not to where people are most vulnerable to meteorological hazards. Moreover, information about the causes of the hazard per se does not facilitate more appropriate adaptation planning. They find that the large uncertainties attached to EEA results increase the complexity of the adaptation debate and support climate sceptics and re-open debates about unresolved uncertainties which had already occurred in the past [Hulme *et al.*, 2011] rather than enhancing the argument for taking adaptation actions.

In the EEA literature, also the opportunities for **geo-engineering** have been named. Stott *et al.* [2013] state that “attribution should be an important component of any research and development of such technologies”. EEA results are required for evaluating whether a geo-engineering intervention is/has been necessary and will/has delivered the intended benefits. It might answer questions such as: ‘was the extreme typhoon event caused by the geo-engineering solution, was it consequence of anthropogenic greenhouse gas emissions, or was it simply a natural variability?’. Others argue that it rather exacerbates political and social conflicts around geo-engineering than giving a definite answer to whether it is a promising mitigation option [Hulme, 2014].

The identification of these sectors mainly builds upon EEA studies which have been undertaken so far, in particular on studies about the contribution of anthropogenic climate change to extreme events like heat waves, cold spells, heavy rainfall or flooding - mainly in the UK and the US. The identification of potential stakeholders has, however, not been reflected against the background of context-, hazard-, or region-specific factors. Potential users of EEA in the context of, for example, storm surges in the Baltic Sea or heat waves in a region like Greater Paris might well be substantially different to those interested in EEA for flooding in the UK. WT4.2 looks at two test cases of different regions, hazards and context. It is therefore able to shed light on such aspects while at the same time allowing for identification of potential regularities.

So far, work package 4 has assessed the potential needs and requirements of the media in work task 4.1. The insurance sector will be assessed in WT 4.3 and the general public is at the centre of WT4.4. In WT4.2, sector specific regional stakeholder needs and requirements are to be assessed. We'll therefore focus in this deliverable on other regional stakeholders encompassing public, private and legal entities.

### **3.3. Methodology and materials**

#### **3.3.1. Methodology in light of the underlying work package goals and proposed concepts**

The review of the existing literature related to extreme event attribution has shown why assessing stakeholder needs with respect to EUCLEIA information is essential and it indicated who potential stakeholders might be and how they might evaluate information and related services. Despite of the evident relevance to the development of novel extreme event/climate information and services, there are no empirical studies or longer-term stakeholder dialogues which aim at understanding stakeholder needs and requirements with respect to extreme event attribution services in more depth. The following section will elaborate on ways of empirically assessing stakeholder needs for EUCLEIA products and will describe the methods used for this study. More details about the harmonized methodology developed for this work package can be found in Milestone 2 (M2) of the EUCLEIA project.

As proposed in the DOWs of the EUCLEIA project, this empirical study is undertaken in two test cases:

- 1) Storm surges at the German Baltic Sea coast
- 2) Heat waves and cold spells in the greater Paris area

In Milestone 2, we identify content-related and regional foci, outline the leading questions, propose an appropriate stakeholder typology, and aligned the methodology with the conceptual framework developed in WT 4.1 (see section 3.2.1 of this report for more details). For WT4.2, we conducted interviews with regional decision-makers and organised a workshop with different focus groups.

#### **3.3.2. Qualitative Interviews with key stakeholders**

Qualitative interviews with key stakeholders were conducted for four main reasons: First, qualitative interviews are able to convey an in-depth understanding of needs and requirements. Second, interviews with key stakeholders have facilitated a specification and validation of the preliminary set of focus groups identified in Milestone 2. Third, the interviews with regional decision-makers who have an extensive network in the region have facilitated the sampling for further interviews and the workshops. Fourth, the interviews have facilitated organizing a stakeholder workshop which is useful and interesting for the participating stakeholders. The interviewees were selected, as proposed in the harmonized methodology (see M2 for more details about the motivation to conduct stakeholder interviews).

Building on years of stakeholder dialogues and aligned with the conceptual framework and main research foci, we identified guiding questions for the interviews – these coincide widely with what was proposed in M2. The interviews were conducted in an open and flexible way with little interference from the interviewer (see text box 1 for a list of guiding questions and M2 for more details about the linkages to the concept and foci of the work package).



## Textbox 1: Guideline for the in-depth interviews with key stakeholders

### I. Introduction – institutions, people, context

*The interviewer introduces the own institution and him-/herself and explains the goals of the interview. The interviewee is asked to introduce him-/herself and the institution:*

1. Personal background and Institution
2. Key topics and actors around climate change & storm surges/heat waves in the region

### II. Role of regional climate services

*Interviewee is asked to tell about the role of regional climate and extreme event services, in specific about:*

3. Work tasks and high priority topics
4. Role of extreme event related information in the different fields of work
  - a. general (*short-, medium- and long-term / strategic-institutional*)
  - b. *sources of information*
  - c. *additional demand*
5. Role of climate change-related information in each of these tasks
  - a. general (*short-, medium- and long-term / strategic-institutional*)
  - b. *sources of information*
  - c. *additional demand*

### III. Definition and potential relevance of extreme event attribution-related information

*Interviewer introduces extreme event attribution to the interviewee. The interviewee is asked to tell about:*

6. General interest in such information (private and in a work context)
7. Meaning of such information in the context of storm surges

*Interviewer explains extreme event attribution in more detail and gives examples of statements.*

8. Potential value/use of this information for own fields of work
  - a. for which of the fields of work is it relevant
  - b. which specific information would be relevant
9. Other potential users of this information in politics, private sector and general public
10. Contacts interested in these products

### IV. Quality criteria which determine the value of climate and extreme event-related information in general and extreme event attribution information in particular

*Interviewee is asked about the usefulness and applicability of the most relevant climate and extreme event-related information in general and extreme-event attribution-related information in particular*

11. *Quality criteria*
  - a. when / why is information judged trustworthy, reliable, convincing?
  - b. when / why is it judged relevant to the case/context ? when is the information needed?
  - c. how to assure that information is accessible and applicable for the user

### IV. Workshop concept and planning

*The interviewer outlines the overall goals of a workshop with different stakeholder groups:*

- *conveys an understanding the usefulness and requirements of information products*
- *improves the accessibility of information products for the participants*
- *creates a field of interaction for different stakeholders*

*The interviewee is asked how such workshops can be of use to him/her, particularly with respect to the following aspects.*

12. General interest in a workshop about this topic
13. Contacts which might be interested in such a workshop
14. Relevant and interested focus groups
15. Personal need for interaction with particular stakeholder groups
16. Topics to be addressed in the workshop
17. Workshop format

For the Baltic Sea case study, we tried to cover all stakeholder groups which have been identified to be of relevance to work package 4.2 in Milestone 2, i.e. civil society organizations, ministries, authorities and administration, political actors and parties, education, and economic/private sector actors. The interviews revealed that, in addition to these, also associations are potential users of EUCLEIA information product. They were therefore included in the sampling list.

In M2, also relevant fields of work or sectorial foci of these stakeholder groups were identified. Based on a literature review and first expert interviews, two main areas of interest in the context of climate change and Baltic Sea storm surges were identified: urban centers and periphery - each dealing with a specific set of problems. In the urban centers, it is mostly coastal and flood protection, emergency management and urban planning with which people are concerned when it comes to climate change and storm surge risks. In the periphery, tourism and nature protection are, beside coastal protection, of relevance. The first interviews have shown that it is also important to address climate change mitigation and the maritime/port industry. These have therefore been included in the sampling list.

Regionally, we tried to cover most of the key urban centres at the German Baltic Sea coast and some of the rural Hinterland. We found that the cities and regions around Flensburg, Kiel, Lübeck and Rostock are interesting study regions for the identification of stakeholder needs with respect to EUCLEIA information products (see Map 1).

**Map 1: Selected interview regions at the German Baltic Sea Coast**



The selection of interviewees within the identified stakeholder groups and regions followed a snowball sampling approach “through referrals made among people who share or know of others who possess some characteristics that are of research interest” [Biernacki und Waldorf 1981, p. 141]. We decided for this approach because it helps identifying people in charge of topics relevant to the study objective and raises the motivation and thereby the likelihood of potential interviewees to participate in an interview or workshop.

In total, HZG conducted nine interviews with various stakeholder groups (see Table 2 for an overview of the conducted interviews). The variety of interviewees allowed gaining insights into a broad range of potential EUCLEIA user groups and thereby facilitated understanding many differences and similarities in needs and requirements. Moreover, it allowed selecting

the most relevant focus groups for the planned workshops. Given the broad range of stakeholder groups and sectors covered by the interviews, we decided not to conduct a second round of interviews as proposed in M2.

**Table 2: Conducted interviews linked to the type of stakeholder group, sectorial focus and region addressed for the Baltic case study.**

Stakeholder groups	No. of interviews conducted	Sectorial foci	No. of interviews conducted	Region	No. of interviews conducted
civil society	2	emergency management	1	Flensburg	3
authorities & admin.	4	spatial planning	2	Kiel	1
politics & parties		tourism	1	Lübeck	2
education	1	nature protection	1	Rostock	3
private sector	2	climate change mitigation	2		
		coastal protection	1		
		maritime/port industry	1		
	<b>Total: 9 interviews</b>		<b>Total: 9 interviews</b>		<b>Total: 9 interviews</b>

The interviews were conducted between January and March 2015 and followed the guidelines presented in text box1. In addition to the questions listed in text box 1, we decided to include questions about the relevance and usability of regional climate services provided by the Northern German Climate Office. This allowed embedding the findings about user needs and requirements into an overall framing of climate services as boundary management (see section 3.2.1).

For the **Paris case study** site, the sectors that were targeted are those given in Milestone 2 : emergency health care, health planning, mass transit, collective provision of temperature regulation (cold), urban planning, local and regional climate planning, land use planners, local and regional climate offices, forestry, agriculture. Interview participants were identified by (1) using the invitee list of the June 2014 stakeholder workshop, (2) using snowball sampling following the interview that were conducted, and (3) mobilizing individuals within our network in order to fill in gaps remaining. This allowed for the identification of stakeholders. 10 persons accepted participating in the interview process. Some of the participants of the June 2014 Paris Stakeholder workshop explicitly felt that they had conveyed all they had to convey during the workshop and declined the invitation for an interview.

**Table 3: Conducted interviews linked to the type of stakeholder group, sectorial focus for the Paris case study**

Stakeholder groups	No. of interviews conducted	Sectorial foci	No. of interviews conducted
civil society	2	health care, health planning, mass transit, collective provision of temperature regulation (cold).	0
authorities & admin.	2	urban planning,	1

Private/public partnership	<b>2</b>	local and regional climate planning, regional climate office	<b>5</b>
private sector	<b>1</b>	Rural planning agriculture	<b>1</b>
	<i>Total: 7</i> <b>interviews</b>		<i>Total: 7</i> <b>interviews</b>

The interviews were conducted between April and June 2015. In order to address gaps in the health and temperature regulation sectors we are, for this report, using the data collected in the course of the June 2014 Paris stakeholder workshop. In order to address other gaps (mainly mass transit, and rural operators) we will be furthering interviews in September and October 2015. For this report we use the interview corpuses that we were in a position to collect at this stage.

### 3.3.3. *Focus group workshops*

Focus group discussions were meant to convey a better understanding of selected stakeholder groups' perceptions and needs with respect to climate services and extreme event attribution information. The in-depth stakeholder interviews facilitated the selection of these focus groups (see previous section). We asked during the interviews, which focus groups would need a better access to climate and coastal information, could be interested in extreme event attribution products, and/or would benefit from a communication platform for an exchange with colleagues or with people from other sectors or institutional backgrounds. The interviewees gave us contact details of colleagues which might be interested in a workshop. The list was amended by own contacts and an internet-based research of people potentially interested in climate and extreme event attribution information (see M2 for more details).

The in-depth interviews included questions which helped developing a workshop concept which does not only serve the project objectives but also create utility for the participants of the workshop (see text box 1). Most of the interviewees, for instance, found that a focus on only event attribution, storm surges or climate change will not generate much interest in the workshop. Many people also expressed their need for networking and exchange of experiences, particularly with respect to interregional cooperation, connections between providers and users of climate services, as well as a participation of people who are usually not part of the debate. These aspects were considered in designing the workshop. A work package meeting attended by researchers from HZG and UVSQ in March 2015 in Hamburg facilitated specifying the workshop concept and harmonizing it to be appropriate for both test cases and therefore better comparable. Based on the interviews and the project-internal discussions, the concept proposed in M2 was modified and complemented.

We decided that the workshops should start with presentations to outline the overall context of climate change, extreme events and EEA. These are followed by two breakout group sessions and a result gallery (for more details see text box 2). Before the workshop starts, each participant receives a participant workbook. It includes information about the workshop, regional climate change and extreme events, and an evaluation and comment sections for each part of the workshop.

## Textbox 2: Guideline for the focus group workshops

### **Breakout group (part 1) – „Regional climate services – how to transform scientific results into credible, legitimate and relevant information products?“**

- 1) Introduction and explanation of the breakout groups (3 minutes)
  - 2) Each participant writes on the post-its in his/her work book the following aspects (5 minutes):
    - a. most important fields of work where climate-related information is needed
    - b. most important information which is needed in these fields of work
    - c. answer whether the information is available or not
    - d. answer for each information “what makes this information useful for your work?”
  - 3) Short presentation of each participant and his/her information needs while putting the prepared cards on the table (10 minutes)
  - 4) The group tries to order the cards and link them with each other (5 minutes)
  - 5) Open discussion about the usefulness and availability of data (10 minutes)
  - 6) Moderator asks for quality criteria of information which have not been mentioned before (5 min.)
  - 7) Each participant writes in his book whether aspects of relevance to the topic were not mentioned in the discussion (2 minutes)
  - 8) Each participant writes the information products which are not available yet on post-its (3 minutes)
- 45 minutes

### **Breakout group (part 2) – “Quantifying the contribution of anthropogenic climate change to storm surges/heat wave events as an example for ‘good’ regional climate services”**

- 1) Moderator asks: “What if we could inform you about the extent to which man-made climate change is responsible for a specific storm surge/heat wave event in the recent past?”
  - 2) Discussion: “Do you think this is possible?” (5 minutes)
  - 3) Each participant writes on post-its from the work book (5 minutes):
    - a. how and why this information can be useful for his/her work
    - b. how and why this information can be useful for other peoples work
  - 4) Discussion: “Is there a need for such information?”. During the discussion, participants attach the post-its to the fields of work identified in the first part of the break out group session (7 minutes).
  - 5) Moderator presents the fake fact sheet about extreme event attribution (EEA) results (3 minutes)
  - 6) Moderator distributes potential probabilistic extreme event attribution statements and the participants fill out the assessment table for each probabilistic statement (7 minutes)
  - 7) Discussion “is this what you imagined would be needed?”. During the discussion, participants remove EEA information cards previously attached to a field of work or add probabilistic EEA statements (8 minutes)
  - 8) Each participant fills out an information assessment table for each of his information needs and attaches it to the information card. The information assessment tables are not distributed beforehand (10 minutes).
- 45 minutes

### **Networking & Result Gallery– “where and how can we get ‘good’ information?“**

- 1) Each group presents the results of their discussion (as posters on the wall) (15 minutes)
- 2) Each participant presents his information needs/information products which are not available yet on a “searched and to be found wall” (5 minutes)
- 3) Participants have the opportunity to get back to the “searched and to be found wall” to fill information gaps and for networking and exchanging experiences (20 minutes)
- 4) Moderators list the information cards which have not been filled during the session

To evaluate the required climate information and potential extreme event attribution statements, assessment cards were distributed to the participants in the working groups (see e.g. Table 3 and Table 4). The assessment tables were developed based a literature review on information evaluations and the criteria named in the previous interviews. The evaluation

of extreme event attribution was done by referring to a scenario and potential probabilistic statements made in the fact sheets developed for milestone 1.

**Table 4: Assessment questions for an extreme event attribution statement**

Front

<i>Extreme event attribution information</i>	
<b>Question Nr. 2)</b> By how much has the water level increased due to anthropogenic climate change?	
Is an answer to this question useful for you?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Why?	

Backside

<b>Question Nr. 2)</b>		
By how much has the water level increased due to anthropogenic climate change?		
From which value would an answer be relevant to your decision-making?	<input type="checkbox"/> No change detectable. <input type="checkbox"/> It did increase. <input type="checkbox"/> By 3 cm. <input type="checkbox"/> By 15 cm. <input type="checkbox"/> By 50 cm.	<u>Explanation:</u>
With which of the statements could you work best?	<input type="checkbox"/> Between 40 and 60 cm <input type="checkbox"/> Model 1: 40 cm // Model 2: 60 cm // Model 3: 50 cm <input type="checkbox"/> 50 cm with a probability of 85% <input type="checkbox"/> It doesn't matter.	
Evaluate the following statement:	<i>The quay was protected up to a water level of 2.50m → it would not have been overflowed without the 50 cm climate change supplement</i> <input type="checkbox"/> It is credible that such a statement can be made. <input type="checkbox"/> The statement is relevant for my work. <input type="checkbox"/> The statement is more useful than the mere information about the change of water levels.	

HZG conducted a stakeholder workshop on the 29<sup>th</sup> of April in Lübeck. Based on a stakeholder mapping, which was developed by conducting an internet-based research and complemented by contact details received during the stakeholder interviews, 51 stakeholders were selected and invited. The selection was based on a quota sampling, i.e. contact were selected which represent the regions, stakeholder groups and sectorial foci which were identified to be most relevant to the research goals (see tables 3-5). In total, 14 people registered for the workshop and 12 attended it. The participants represented nearly all of the regions, stakeholder groups and sectorial foci which were identified to be most relevant to the research. Only stakeholders from the tourism sector were not present. However, some of the other participants were also concerned with tourism-related topics. For that reason, it was decided that a second stakeholder workshop is not necessary for achieving the goals of WT4.2. The agenda, format and guiding questions of the workshop in Lübeck were aligned with the proposed concepts described above (see Table 6).

**Table 5, 6, 7: Invited stakeholders and workshop participants linked to the region they are responsible for, the type of stakeholder group, and their sectorial focus.**

Region	No. invited	No. participants
Flensburg	7	2
Kiel	5	2
Lübeck	8	5
Rostock	9	
Other region	14	
State-level	8	3
	<i>Total: 51 invited</i>	<i>Total: 12 particip.</i>

Stakeholder groups	No. invited	No. particip.
civil society	8	
authorities	4	3
commune/city administration	12	6
political actors	7	
education	3	
private sector	10	3
association	7	
	<i>Total: 51 invited</i>	<i>Total: 12 particip.</i>

Sectorial foci	No. invited	No. participants
<i>Urban centers:</i>		
- emergency management		
- <b>spatial planning</b>	9	4
<i>Periphery:</i>		
- <b>tourism</b>	8	
- <b>nature protection</b>	8	3
<i>Both:</i>		
- <b>climate mitigation</b>	11	1
- <b>coastal protection</b>	9	4
- maritime/port industry		
- <b>other/no specific focus</b>	6	
	<i>Total: 51 invited</i>	<i>Total: 12 particip.</i>

**Table 8: Agenda of the stakeholder workshop in Lübeck on the 29<sup>th</sup> of April 2015**

11:30 – 12:00	<i>Registration</i>	
12:00 – 12:30	Presentation of Dr. Insa Meinke (Northern German Climate Office/ HZG)	„Climate change and storm surges at the Baltic sea coast - state of research, mandate of the Northern German Climate Office, and goals of the workshop“
12:30 – 12:50	Presentation of Jens Riemer (Schleswig-Holstein state agency for coastal protection)	„New coastal protection regulations for the state of Schleswig-Holstein “
12:50 – 13:00	Plenary discussion	„Climate change and storm surges at the Baltic Sea Coast – Perspectives from Science and Practice“
13:00 – 13:40	<i>Lunch break</i>	
13:40 – 14:20	Discussion and exchange in two breakout groups	„Regional climate services – how to transform scientific results into credible, legitimate and relevant information products?“
14:20 – 15:00		„Is this already climate change – how and why are information about the contribution anthropogenic climate change to Baltic Sea storm surges useful?“
15:00 – 15:15	<i>Coffee break</i>	
15:15 – 15:55	Networking & Result Gallery	„Access to useful climate and coastal information – which information products are needed and who is able to provide them?“
15:55 – 16:00	Closing words Dr. Insa Meinke (Northern German Climate Office/ HZG)	<i>Wrap-up and outlook</i>

UVSQ was not in a position to conduct a supplementary stakeholder workshop in the Paris area in a timely manner for this report. UVSQ has planned this workshop for late September 2015.

Yet, the data collected in the course of the June 2014 stakeholder workshop are used. In this corpus we focus on the participants that are relevant for this deliverable (e.g., regional level, health sector, cold provision and city planners). The workshop description, process and associated corpus are described in deliverable 4.1 as this dataset has also been used in the course of that deliverable.

### 3.3.4. Analysis methods

The data drawn from the evaluation tables filled out during the stakeholder workshops are analysed with quantitative statistical methods. Given the content and structure of the data, mostly descriptive statistics are thereby applied. The data drawn from the qualitative interviews and focus group discussions are analysed along the lines of qualitative content analysis (see Milestone 2 for more details).

Building on grounded theory, a continuous dialogue between the scientist, existing theories, and the data from these different empirical corpuses was fostered. The coding system for the data analysis has emerged from theories and concepts developed for deliverable 4.1 and the concepts proposed in section 3.2.1 as well as from the conclusions drawn from the interviews and workshops. The coding system does therefore fit the specific research



context and facilitates a specification of the underlying theories and concepts (see e.g. cf. Glaser and Strauss 1998, Mayring 2000).

### **3.4. Results Part 1: Results of the empirical work undertaken at HZG**

#### **3.4.1. User needs with respect to regional climate and coastal information**

Years of stakeholder dialogues with Northern German decision-makers in the fields of climate change and storm surge risks as well as a review of the literature provided a basis for identifying a preliminary list of potential users of information on climate, extreme events, and extreme event attribution (see section 3.3 and M2). We thereby found that the following stakeholder groups - which are also identified as users of the Northern German Climate Office - might be particularly interested in information services around the above mentioned issues, i.e.: civil society organizations, ministries, authorities & administration, political actors & parties, education, economic/private sector actors, and associations.

The fields of work which have been identified to be most relevant in this context are: emergency management, spatial planning, tourism, nature protection, climate change mitigation, coastal protection, and maritime/port industry. The interviews and workshops showed that climate and coastal information or services are needed in nearly all of these sectors and institutions. Only for the maritime/port industry and civil protection/emergency management such information plays merely a minor role, according to interviews with stakeholders in these fields. We have therefore concentrated on the other sectors for our further research (see section 3.3 and M2).

The interviews and workshop revealed that climate change and Baltic Sea storm surges play a role in the work of all interviewees and participants, however, for some particularly storm surges in the Baltic Sea was not a high priority topic. This was often linked to the fact that there were only few or no events perceived to be severe in the past few decades. Therefore, mainly people who were directly concerned with storm surge risks like stakeholders in emergency management and coastal protection attached higher priority to Baltic Sea storm surge risks. Several interviewees with a spatial planning and emergency management background felt that only after an extreme event happens, the public and relevant decision-makers get interested. One interviewee engaged in climate change adaptation in urban planning, for instance, said:

*I-3<sup>1</sup>: [...] ich GLAUBE, dass Menschen häufig nur DANN aufwachen, wenn mal irgendwie gerade wieder so eine Katastrophe war, wie eine Überschwemmung an der Elbe oder so, DANN, DANN fangen die Menschen an, sich damit zu beschäftigen. Es ist zwar bedauerlich, aber es ist häufig so, [...].<sup>2</sup>*

Various interviewees and workshop participants stated that regional coastal information and climate services are particularly important for public awareness-raising activities. This was most commonly mentioned by people from city administrations and by stakeholders in the field of climate change mitigation. Regional climate and coastal information services were also named to be of relevance for raising public funds and institution-internal awareness. In

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<sup>1</sup> I-# stands for the anonymised ID of interviewees

<sup>2</sup> I-3: [...] I believe that normally people only wake up when a catastrophe just happened, like a flood at the river Elbe, THEN, THEN do people start dealing with it. It is sad but that is commonly the way it is [...].

the group discussions, participants engaged in climate change adaptation in urban planning and coastal protection also mentioned that they commonly use regional climate and particularly coastal information. Among urban planners, climate information is also needed for climate and vulnerability analyses. In addition, coastal information for planning coastal protection strategies is also needed.

The information and data used by the workshop participants and interviewees who conduct own data analyses, particularly for spatial planning, infrastructure development and coastal protection, was commonly received from scientific networks, consulting agencies, and data services within and outside of the own organisation (e.g. German Meteorological Service, Federal Maritime and Hydrographic Agency). Regional climate and coastal information services, like those of the Northern German Climate Office, were commonly used for institution-internal, political and public awareness-raising. Two interviewees also used regional climate services in their analyses for adaptation planning in urban development and the maritime sector. Mainstream media were mentioned several times, particularly by people working in local administration, but were not explicitly discussed in light of their role as information source for the daily work of interviewees and workshop participants.

In terms of the content, many stakeholders mentioned that they need data or information about physical parameters like sea level, wind, temperature, fresh air supply, or waves. Such parameters were mainly named in the context of climate and vulnerability analyses for urban planning and for coastal protection regulations. Also, information about extreme events was commonly used by interviewees and workshop participants, particularly in climate mitigation for awareness-raising, and for assessing implications of extreme events or worst-case scenarios for coastal protection and urban planning. In the workshop, the utilisation of information about multiple-hazard situations was discussed as well, i.e. people wanted to know more about situations in which more than one hazard affects the region within a short period of time. This was most interesting to the workshop participants engaged in urban climate and vulnerability analyses. Some stakeholders who were engaged in public awareness-raising and educational activities also argued that they rather need to know more about potential climate change and storm surge consequences than having data on the physical parameters.

Content-related needs which are not met to date were discussed to be mostly about climate change consequences and adaptation measures like best practices and alternative adaptation options (e.g. alternatives to dike building measures). These information needs were expressed by many of the interviewees and workshop participants— particularly by the ones concerned with either public awareness-raising or adaptation measures in spatial planning and coastal protection. On the other hand, most of the interviewees and a few people in the group discussions stated that there is no need for more information. These people said that they rather need more reliable information with less uncertainty than novel or different information. It was also discussed that it is difficult to express your information needs if you do not know what you could ask for, like this workshop participant from a state authority said:

*WP-12<sup>1</sup>: Aber was ich nicht weiß, das kann ich auch nicht erfragen. Das ist so ein bisschen das Schwierige<sup>1</sup>.*

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<sup>1</sup> WP-# stands for the anonymised ID of workshop participants

### 3.4.2. *Understanding and potential relevance of Extreme Event Attribution information*

Most of the interviewees and workshop participants mentioned that extreme event attribution (EEA) information is generally interesting but not relevant to their work. In the interviews, some people working in the fields of emergency management, maritime industry and spatial planning said that they would not need EEA information at all while other stakeholders in the city administration dealing mainly with climate mitigation and coastal protection told that their need for such information is rather low. In the workshops, the majority of participants told that they would not need EEA information for their daily work. Only stakeholders from the private sector and city administration who are working in climate adaptation, mitigation and coastal protection mentioned that they might need EEA information. The utility of such information was, however, estimated to be rather low.

In the workshop, the participants also discussed why they do not need EEA information. Stakeholders from city administrations and state authorities explained, for instance, that only the consequences and not the causes of extreme events matter to them and their planning for the future. This reason was named by people from all fields, except for climate change mitigation where the causes could be linked to the emissions of greenhouse gases, i.e. the focal point of all climate change mitigation efforts. Workshop participants with a coastal protection and spatial planning background also said that EEA information is simply not relevant to their planning and implementation of measures. Another workshop participant who works in a city administration in the field of flood and environmental planning told that the contribution of anthropogenic climate change might be too small to be of relevance. It was supposed that this information would therefore not raise the awareness of other stakeholders or the public. The participant also argued in this context the following:

*WP-4: Also ich glaube, für meine Arbeit wäre das auch nicht relevant, wer dann da so Schuld dran ist, dass es so stark regnet zum Beispiel. Das ist einfach Tatsache und dann muss man sehen, wie man mit diesen Wassermengen umgeht. Gut, man kann natürlich über die Landschaftsplanung den kleinräumigen, regionalen Wasserhaushalt beeinflussen. Und das ist dann natürlich planerisch, wenn da irgendwas schiefgeht, ist das natürlich menschengemacht. Aber das ist nicht der Anteil am CO2 oder am Klimawandel, sondern einfach durch Zupflastern Hitzewellen in der Stadt erzeugt oder so, Stadtklima beeinflusst durch ungeschickte Planung [...].<sup>2</sup>*

The quote indicates that people are rather interested in the contribution of anthropogenic drivers of exposure and vulnerability than the contribution of anthropogenic climate change to certain extreme events. This is particularly relevant to urban and infrastructure planners who wittingly or unwittingly influence climate-related risks by changing exposure and vulnerability patterns. Some stakeholders interested in spatial planning have therefore also argued that it is good and enough to know *that* climate change is partly man-made - there is

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<sup>1</sup> WP-12: But the things that I don't know, these are also the things that I cannot ask for. That is the difficulty in this respect.

<sup>2</sup> WP-4: Well, I think that this would also not be relevant to my work, i.e. who is responsible for the heavy rainfall for instance. It is simply a fact and we have to see how to deal with the mass of water. Alright, we could of course influence the small scale regional water balance with spatial planning. And then, from a planning perspective, if something goes wrong, it is of course man-made. But this is then not due to the contribution of CO2 or climate change, but simply because of sealing, heatwaves were caused in the city, or something like that; urban climate influenced by inapt planning [...].

no need for knowing whether a particular extreme event is man-made. On the other hand, one person interested in urban adaptation strategies mentioned (and obtained approval from several other workshop participants) that the region-specific nature and the link to extreme events make the information that climate change is man-made more relevant and tangible for the people.

In the interviews and workshops, more people expressed the importance of EEA for other stakeholders than for themselves. Its relevance for awareness-raising was, in this context, most commonly mentioned, particularly in relation to climate change mitigation. One workshop participant interested in coastal protection argued in this context:

*WP-7: Ich glaube, es wäre dann auch eher für die öffentliche Meinungsbildung wichtig, dass man sich denkt, hmm, na ja, wenn das jetzt tatsächlich ein Meter weniger gewesen wäre und weniger überflutet hätte, wenn wir uns mal am Riemen gerissen hätten und weniger Klimagase ausgestoßen hätten, dann schafft das vielleicht auf längere Sicht eher eine Erkenntnis und eine Änderung im persönlichen Verhalten eines jeden, aber ich glaube, ich weiß nicht, ob das jetzt für Bauleitplanung oder Küstenschutz eine Relevanz hätte. Das sehe ich eigentlich spontan nicht. Also es ist mehr vielleicht der Ansporn, doch mal ein bisschen mehr zu tun und den Klimawandel aufzuhalten, vielleicht auch politisch und persönlich, aber jetzt nicht für die Anpassung<sup>1</sup>*

In the interviews and workshop, also the relevance to political decision-makers and city administration was mentioned. Insurance companies were also named by some interviewees and workshop participants. It was not further elaborated how insurances would be able to use such information, though. Interviewees engaged in educational activities for the general public mentioned, in addition to this, that EEA information is so complex that it might be more something for experts than for the general public. In the workshops, EEA information was found to be particularly relevant to the general societal discourse about climate change. One interviewee engaged in urban adaptation planning explained it as follows:

*WP-1: Aber auf der anderen Seite finde ich auch ist es so gesellschaftspolitisch oder es ist eine gesellschaftliche Frage, wie gehe ich mit dem Klimawandel um und wie ändere ich für mich persönlich meinen Umgang mit dem CO<sub>2</sub>-Verbrauch, wie verhalte ich mich in der Umwelt, wie heize ich und was für Produkte verzehre ich und trage ich und so weiter und so fort<sup>2</sup>.*

The other participants of the workshop seemed to widely agree to this point of view. EEA information was accordingly perceived to rather be of use to the general climate change discourse than directly to the work of the stakeholders. Education was only named in the context of academic training, for instance, for a novel Master programme. One stakeholder engaged in coastal protection mentioned that it might be relevant to coastal protection, despite an initial hesitation. It was explained as follows:

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<sup>1</sup> WP-7: I think it would rather be important for shaping the public opinion – so that one thinks, hmmm, well, if this had actually been lower by one meter and had therefore flooded a smaller area, if only we had pulled ourselves together and emitted less greenhouse gases - then this could maybe have created recognition and a change of the personal behavior of everyone in the long-run, but I think, I don't know, whether this would actually be of any relevance to urban land-use planning or coastal protection. For now, I cannot really see that. So it is maybe more the incentive to do a bit more and stop climate change, maybe also on a political and personal level, but not for adaptation.

<sup>2</sup> WP-1: But on the other hand, I think, it is also a socio-political or a general societal question; how do I deal with climate change and how do I personally change my way of dealing with the CO<sub>2</sub> consumption, how do I encounter the environment, how do I heat, and what products do I eat, and so on.

WP-7: [...] okay, wenn wir nachweisen können, dass wirklich ein Anteil, ein großer Anteil, menschengemacht ist, dann müssen wir es ernst nehmen und damit rechnen, dass es weitergeht mit diesem Anstieg<sup>1</sup>.

A stakeholder from a state authority for coastal protection also mentioned spatial planning as potential user of EEA information. He thought that it could be used to promote more climate-proof land-use patterns. Adaptation was generally, however, rarely mentioned to be a relevant field of application. Some interviewees and workshop participants from city administrations and state authorities even argued that it is not relevant to adaptation at all.

**Table 9: Stakeholder groups and fields where EEA could be needed according to interviewees and workshop participants** (Source: key stakeholder interviews, workshop discussion)

Potential fields of application	...mentioned
Climate change mitigation Societal / Public CC discourse Public awareness-raising Politics	Frequently
Insurances Compensation mechanisms	Few times
Civic participation Political leverage Administration Universities Basis for better scenarios General education Coastal protection Spatial planning Internal awareness raising	Rarely
Geo-engineering Litigation	Never

Some people thought that EEA would hinder rather than foster climate change mitigation and adaptation. In the workshop, a discussion emerged where several stakeholders from a state authority, a consulting firm and city administrations, all of them engaged in spatial planning, discussed that it could well be that such information strengthens the arguments of climate sceptics. EEA might either show that the contribution of anthropogenic climate change is too small to be acknowledged, or it adds more uncertainty to the debate like this workshop participant engaged in urban planning argues:

WP-6: *Ich hätte sogar Angst, dass man sich damit einen Bärenienst erweist. Das ist schon schwer genug zu argumentieren, die Klimaänderung ist anthropogen verursacht. Das glaubt man mittlerweile Gott sein Dank und das ist auch ganz gut wissenschaftlich nachgewiesen. Und anstatt an diesem*

<sup>1</sup> WP-7: [...] okay, if we could prove that there is really a man-made contribution, a large contribution, then we would have to take it serious and have to take into account that the increase continues.

*doch jetzt recht soliden/ diese recht solide Erkenntnis zu nutzen, um die Köpfe der Politiker zu gehen, machen wir jetzt quasi noch ein Experiment weiter, versucht jetzt, noch weiter zu spekulieren.*<sup>1</sup>

This opinion might, be linked to the fact that most of the workshop participants thought it is methodologically not possible to make such statements. In a discussion around the practicality and feasibility of EEA analyses, most workshop participants found it unrealistic that there exist methodologies which are able to produce results with acceptable levels of uncertainty. The others told that they did not know it. In the interviews, these aspects were not discussed in detail.

A lack of understanding or misunderstanding of EEA might have also influenced the perceived need or relevance of it. In the workshops and interviews, most people seemed to understand the general idea behind EEA. Nevertheless, it was several times mistaken for general detection and attribution research. Two interviewees concerned with spatial planning and coastal protection also thought of it as being able to predict future changes in extreme events rather than the contribution of anthropogenic climate change to a given likelihood of a recent event. Based on such assumptions, people linked it to potential fields of application or needs which might not need EEA information indeed.

### *3.4.3. User requirements with respect to climate, coastal and extreme event attribution information*

During the interviews and workshop, numerous requirements of information were mentioned and discussed, particularly with respect to coastal and climate information. Given that most of the interviewees and workshop participants have not used or even heard of the possibility to attribute the probability of extreme events to anthropogenic climate change, it was very difficult for them to judge what requirements they would have in the context of such information. Moreover, people often did not know in which fields they might be able to apply EEA information or did not think that they could use it at all. Due to this, it was even harder for stakeholders to express their requirements, many points were raised in the workshop but did not lead to further discussions, and real interest in such information could rarely be raised. In the group discussions, this was even more the case when people with a strong scepticism or objection against the relevance of EEA information were able to influence the other participants' opinion and the readiness to discuss.

**Credibility** of information was among the most commonly named concerns in the context of coastal and climate information. In this respect, several interviewees working in infrastructure planning mentioned that the designation of small statistical uncertainties indicates that information is credible and therefore useful to them. In the workshop, this was also discussed principally in the context of long-term infrastructure planning where uncertain research results with large margins of potential changes were said to inhibit the process notably. An interviewee from a private consulting firm in the maritime sector stated in this context:

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<sup>1</sup>WP-6: I would even be afraid that we would do us a disservice. It is difficult enough to argue that climate change is anthropogenic. People believe this today, thank god, and it is well proven by science. And instead of making use of this quite solid/these quite solid results for changing the minds of politicians, we go kind of one experiment further, now trying, speculating even more.

*I<sup>1</sup>-7: Nein, also das einzig wichtige sind verlässliche Informationen, also wirklich VERLÄSSLICHE Hochrechnungen, die sagen, es WIRD definitiv der Anstieg so und so stattfinden<sup>2</sup>.*

Small statistical uncertainties were also the most critical credibility criterion named in the context of extreme event attribution. In the workshops, this topic was taken up by participants engaged in public awareness-raising and urban adaptation planning. They found that this was the key argument whether it benefits or rather inhibits mitigation and adaptation efforts. One workshop participant with an urban planning background argued in this context:

*WP-6: Ja, weil wenn es sicher wäre, könnte man jetzt darüber nicht mehr diskutieren [ob Klimawandel existiert oder nicht], müsste sich dem Thema stellen und wenn es unsicher ist, dann fängt jeder an, der das eigentlich nicht hören will, wieder zu überlegen, ach, das ist ja Szenario x; und wird Szenario y genommen/ dann nimmt man es nicht als Fakt, sondern als Spekulation [...]<sup>3</sup>.*

During a workshop discussion about potential uncertainties of EEA results, some participants argued that not only little uncertainty but also transparency with respect to uncertainty is important. A stakeholder from a private spatial planning agency, for instance, argued that the perceived credibility of information would be low if the assigned uncertainties are too low to believe that it is methodologically sound. Such aspects were discussed particularly in the context of EEA information where people knew little about potential methodologies. In the workshop debate about uncertainties and in interviews with spatial planners, credibility was also coupled with the requirement that the methodology behind the information is reliable and solid. More concrete requirements were not expressed given that most interviewees were not expert on this highly complex matter. A workshop participant working in coastal protection also raised that EEA results might be more trusted, if they would be done continuously for every major event. This aspect was, however, not discussed in more detail or taken up by other participants.

The interviewees and workshop participants linked credibility also to the requirement that information should be received from a reliable source or a renowned institution. The topic emerged mainly in the context of climate and coastal information and not of EEA information. It was addressed in most of the interviews, only in the interviews with private urban planners and a maritime consultant, was this aspect not explicitly mentioned. They seemed to have established data services which they trust and might therefore not have mentioned it. In the assessment cards, where people were asked to select from a list of sources which indicate high quality coastal and climate information, mainly scientific sources were ticked. Politicians or colleagues were, in contrast, not ticked. In the workshop, a discussion about the reliability of different sources emerged particularly among different stakeholders engaged in coastal protection where large infrastructure projects require reliable information. One workshop participant engaged in public coastal protection, for instance, said:

*WP-11: Ich glaube, wenn [wir / unsere Institution] alleine mit solchen Ideen kommt, würde man auf relativ schwierigem Boden stehen, wenn es da alle nötigen Fachinstitute gibt, wie das Helmholtz, das*

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<sup>1</sup> I-# stands for the anonymised ID of an interviewee

<sup>2</sup> I-7: No, the only important thing to have is reliable information, really RELIABLE projections which state that the increase will take place definitely in this and that way.

<sup>3</sup> WP-6: Yes, well if it would be certain [whether climate change exists or not], people would not be able to discuss about it anymore, they would have to face the topic and if it is uncertain then everyone who does not want to hear it starts thinking again, well, this is scenario x; and what if we assume scenario y - then they would not take it as a fact but as speculation.

wäre eigentlich die Alternative, dann ist es auch für [uns / unsere Institution] einfacher, das zu argumentieren und in die Planung zu kommen. Und so was bräuchte ja schon auch eher größere raumordnerische Planung<sup>1</sup>.

This quote also shows that information from *independent* institutions is perceived to be more credible than from institution-internal, potentially biased informants. In the workshop, a discussion about the reliability of information provided by public authorities evolved in this context. Participants who provide and those who potentially use this information argued that it is important to consider findings from independent scientific sources. The articulation of implausible extremes is another commonly named argument indicating that information is not credible. According to an interviewee in emergency management:

*I-8: Es ist aber nicht immer förderlich das Worst-Case Szenario anzuführen. Der Schuss kann auch nach hinten losgehen und das Risikobewusstsein eher verringern, da man als Worst-Case Maler verurteilt wird<sup>2</sup>.*

In addition to the previous credibility criteria, the workshop participants and interviewees found that information needs to be based on facts and, more specifically, that the data basis is reliable. These criteria were named in interviews and in workshops by stakeholders with an urban planning, maritime consulting, coastal protection and emergency management background in city administrations, state authorities and private consulting. Discussions about a reasonable argumentation and a scientific review process only rarely emerged (see Figure 5). A reasonable argumentation was only mentioned once in an interview with a stakeholder in a coastal protection authority. This does, however, not mean that these criteria are not of importance to the people. When being directly asked for these aspects, like in the assessment cards, they were ticked by nearly all of the workshop participants who filled them out.

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<sup>1</sup> WP-11: I believe that if [we/our institution] alone come up with such ideas, we would stand on rather difficult grounds; if there would be all relevant technical/scientific institutes, like Helmholtz, this would be *the* alternative, then it would be easier also for [us/our institution] to argue and get into planning. And something like that would need rather larger spatial planning.

<sup>2</sup> I-8: It is not always conducive to come up with the worst-case scenario. That could also backfire and rather reduce the risk awareness because you are denounced to be a worst-case prophet.



**Table 10: Credibility-related requirements named by stakeholders** (according to interviewees and workshop participants, order of criteria based on number of mentionings)

Credibility-related criteria	
Coastal / climate information	EEA information
Small statistical uncertainties	Small statistical uncertainties
Reliable source/ institution	Transparency regarding uncertainty
Plausible results/extremes	Solid process/ methodology
Reliable data basis	Reliable source/ institution
Based on facts	Reliable data basis
Solid process/ methodology	EEA for all major extreme events
Independent source/ institution	
Other	

The **relevance** or salience of information was another very common criterion which was perceived to determine the usability of information. The relevance criteria differed notably between coastal / climate information and EEA information. In the context of coastal and climate information, the spatial scale, type of quantitative data, level of data processing, comprehensibility, and the time horizon were the most frequently mentioned characteristics determining the relevance of required information (see Figure 8). None of these criteria were directly mentioned in the context of EEA, except for comprehensibility.

*I-8: Es ist aber nicht immer förderlich das Worst-Case Szenario anzuführen. Der Schuss kann auch nach hinten losgehen und das Risikobewusstsein eher verringern, da man als Worst-Case Maler verurteilt wird*

In terms of spatial scale, people asked most commonly for data and information on a local level (see Figure 8a). This was often discussed with stakeholders who conduct or plan to conduct climate and vulnerability analyses for urban planning in both the interviews and the workshops. The type of quantitative result was another commonly stated requirement. Most people in the workshop and interviews said that they need concrete or distinct values to work with, most notably in terms of infrastructure planning for coastal protection and harbours. One interviewee engaged in coastal protection, for instance, said:

*I-11: Also wenn Sie uns etwas vom Meeresspiegelanstieg erzählen von bis, dann ist das für den Ingenieur recht schwierig damit umzugehen. Weil der braucht natürlich ein Maß für die Errichtung eines Deiches und keine Spanne<sup>1</sup>.*

Several stakeholders also expressed to be in need of extreme values and worst-case scenarios. In the interviews and workshops, this was mainly a topic in the context of people's tasks in emergency and flood planning where they needed extreme values or worst-case scenarios to be prepared for the worst. In an interview with a stakeholder engaged in public education extreme values or scenarios were used to raise the attention of the public. Scenario-based statements were, on the other hand, also often perceived to be difficult to work with, particularly in case of larger infrastructure investments. It was, for example,

<sup>1</sup> I-11: Well, if you tell us something like sea level rise will be 'from – to' then this is difficult for an engineer to deal with it; because he, of course, needs a measure and not a range for constructing a dike.

extensively discussed in an interview with a maritime consultant. In this interview, the relevance of having one concrete value rather than results depicting large margins was named to be the most relevant criterion in infrastructure planning. The main reason was, similar to the argumentation in the quote above, that the cost difference in an investment based on a value at the one end of the margin to the one at the other is substantial in large infrastructure project. For this reason, most engineers might rather decide for the lower end of the margin than for the worst case.

Several interviewees and workshop participants had specific requirements with respect to the level of processing. Most stakeholders need filtered and well-bundled information, particularly in city administrations, because they told not to have the time and capability to thoroughly select the most important information. One interviewee with a spatial planning background described why there is a need for filtered and bundled information as follows:

*I-14: Und das ist ja scheinbar kein Problem, dass da noch Informationsmangel vorherrscht. [...] Das ist ja eher ein Problem [...] dass man eher also von der Masse erschlagen wird (lacht) [...] Was glauben Sie, was ich oben an Fachliteratur habe zu dem Thema. Und das ist ja die Region - das ist nur ein Ausschnitt. Also, wenn ich mich damit mehr befassen würde [...], dann würde man mich gar nicht mehr sehen unter dem Berg von Broschüren und Büchern und was auch immer, die da irgendwie relevant sind<sup>1</sup>.*

The time horizon of climate data or information was another commonly mentioned criterion determining its relevance. Several stakeholders mentioned that it is difficult to work with long time horizons of 100 years or more. It was argued that even most of the long term-oriented infrastructure planning does not deal with time horizons longer than 30 years. Projections until the end of the century are therefore often not considered. The up-to-dateness or the timing when climate and coastal information should be available was addressed by only one interviewee engaged in public education. He told that IPCC information is sometimes not up-to-date; it was not mentioned, however, that more recent data would raise the effectiveness of public awareness-raising. In the group discussion, a discussion about whether the often out-dated sets of regulations or standard data services can be of real relevance and are credible enough to work with. This point was taken up by stakeholders from city administration and seemed to be addressed also to the present stakeholders from state authorities. In the context of EEA information, only an interviewee engaged in raising public awareness mentioned that it is more effective to provide such information soon after an extreme event happens. It was argued that people who have the event and the severe consequences of it still in mind are probably more interested in the topic. This stakeholder also found that:

*I-6: [...] wir haben da eine gewisse Verantwortung gegenüber der nächsten Generation und dann muss ich nicht NOCH mal 20 Jahre FORSCHEN, ob es nun 60 oder 70 Prozent Einfluss sind<sup>2</sup>.*

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<sup>1</sup> I-14: And it seems to be no problem that there is still a lack of information. [...] It is more of a problem [...] that you are overwhelmed by the mass [of information] (laughs) [...] You would not believe how much scientific literature I have on this topic. And this is about the region – it is only one segment. So, if I would deal with it more thoroughly [...], you wouldn't see me anymore under a whole mount of brochures and books and whatever is somehow relevant.

<sup>2</sup> I-6: [...] we are somewhat responsible for the next generation so that we should not RESEARCH ANOTHER 20 years if it is a contribution of 60 or 70%.

In the workshops, in contrast, several participants engaged in spatial planning and coastal protection responded frankly to the same question that is of no relevance *when* EEA information is provided. In this discussion round none of the participants argued for the contrary. Some urban planners also said that it is important that a processed spatial data set is available, particularly in form of thematic maps. Raw data was only explicitly mentioned to be needed by a private engineering office that processes raw data as climate information service for other stakeholders. A requirement mentioned by many of the interviewees and workshop participants was that information needs to be understandable, more specifically, that it is not too complex, intuitively accessible, descriptive, or in native language. These aspects were named mainly in the context of civic participation and public awareness-raising. One interviewee engaged in regional coastal protection also expressed the need for comprehensible information in the context of his own work. He argued that :

*I-11: [...] Also (...) es ist ja nicht so, dass man sagen müsste, ja sie können auch lesen, lesen sie sich doch den IPCC durch. Nicht? Den haben hunderte von Wissenschaftlern geschrieben, LESEN sie sich das durch. Ja (...) kann man machen. Aber ich verstehe das nicht, was (...) zum einen kann ich kein fließend Englisch, zum anderen, wenn ich es könnte, würde ich es trotz/ das Fachvokabular ja auch nicht wirklich verstehen. (...)<sup>1</sup>*

**Table 11: Saliency-related requirements named by stakeholders** (according to interviewees and workshop participants; order of criteria based on number of mentionings)

Saliency-related criteria	
Coastal / climate information	EEA information
Type of quantitative results	Link to relevant problems
Spatial scale	Kind of results
Level of data processing	Regional proximity
Comprehensibility	Intuitive accessibility
Time horizon	Comprehensibility
Other	Practicality
	Time of availability

The legitimacy of information was rarely mentioned as a requirement for climate and coastal information services. In the context of EEA, it was not named or discussed at all. In fact, mainly stakeholders who also provide climate service to others mentioned that it is important to create and process information in dialogue with the users of this information. One interviewee from a private consulting firm providing climate services particularly to urban planners in administration explains it as follows:

*I-5: Also zunächst erst mal ist das wichtig, sich mit der Verwaltung zu unterhalten oder den Akteuren in der Verwaltung, WAS für sie überhaupt eine Rolle spielen KANN und WIE Informationen überhaupt von ihnen AUFGENOMMEN werden können. Das hat also sehr viel damit zu tun, ja, Gespräche zu führen und festzustellen, welche, was für Informationen ÜBERHAUPT von Nutzen sind. Auf der*

<sup>1</sup> I-11: [...] Well (...) one could say, just read the IPCC. No? Hundreds of scientists wrote it, just read this through. Yes (...) you can do this. But I do not understand it which is (...), on the one hand, owed to the fact that I do not speak English fluently, on the other hand, even if I could do so I would not understand it due to the technical vocabulary.

anderen Seite müssen die entsprechenden Personen in der Verwaltung dann eben auch erst mal überhaupt WISSEN, WAS sie sich auch wünschen können<sup>1</sup>.

### 3.4.4. *The perceived role of climate services for meeting information needs and requirements*

Requirements with respect to climate services were mainly named in the context of climate and coastal information. The workshop participants and interviewees did not or only rarely discuss the role of climate services against the background of EEA information. As mentioned earlier, the stakeholders have never used EEA information before, were not sure whether and in which of their work-related task such information might be needed, and were often not able to articulate concrete requirements with respect to EEA-based information. Climate services in the context of EEA were more often discussed in the interviews than in the workshops. In the workshops, it was not only rarely addressed, but did also not lead to more in-depth discussion. This might be related to the fact that fewer stakeholders in the workshop relied on climate services in their daily work than among the interviewees.

Climate services were perceived to be important in light of translating scientific findings for stakeholders. Most of the related requirements were, in one way or the other, linked to credibility concerns. One interviewee from a state ministry explained the need for a quality control as follows:

*WP-11: [...] weil ehe man dort wieder im Internet recherchiert, hat man immer keine Wahrnehmung der Qualität dessen, was dort dargestellt wird. Also deswegen ist das, glaube ich, gut, wenn man das vor so einem wissenschaftlichen Hintergrund auch irgendwo sozusagen noch verdeutlicht zusätzlich, dass hier und dort/ also da wäre es gut, irgendwie so eine Art Anlaufstelle zu bieten, zu sagen, Leute, da könnt ihr mal solche Projekte auch mal anmelden und wir greifen sie auf und wir schauen vielleicht noch mal kurz drauf, auf welcher Basis sind sie so entstanden<sup>2</sup>.*

The interviewed stakeholders perceived climate services, for instance, as means to receive credible information which is filtered and bundled. This was most commonly addressed when explaining the needs of city or commune administrations. One interviewee with an urban planning background argued that climate service providers should function as “scouts”:

*I-14: Sprich: Wenn alles vorliegt - also, ich sage mal so, wenn ich jetzt den Arbeitsauftrag bekäme: So, nun regel das mal -, dann bräuchte ich einen Scout - vielleicht passt das Wort ganz gut -, der sozusagen das für mich aus den vorliegenden Informationen heraus filtert und mir in einem kurzen überschlägigen Dokument zusammenstellt. Das ist eigentlich das, glaube ich, was wir brauchen und was die Kollegen wahrscheinlich auch - zumindest als Einstieg in das Screening sozusagen - verstehen<sup>3</sup>.*

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<sup>1</sup> I-5: Well, first of all, it is important to talk to the administration or to the actors in administration. WHAT matters to them and HOW are information taken up by them. It is therefore very much linked to having conversations with the people to ascertain which information are useful AFTER ALL. On the other hand, people in administration need to, first of all, know WHAT they can WISH for.

<sup>2</sup> WP-11: [...] because if I start searching online again, I do not know about the quality of the things which I find there. I think, it is therefore good to ascertain, from a scientific background, that here and there, this would be good - provide something like a platform where you can show people where projects are or can be registered and we just take them up and take a short look at how they were produced.

<sup>3</sup> That is to say: if everything is there – meaning if I’d receive a work task: So, please deal with it – then I would need a ‘scout’ – maybe the word fits here quite well - who could sort of filter the existing information for me

Interviewees engaged in public awareness-raising and regional coastal protection planning also expressed that they need information which is translated in a way that they can understand scientific information or information in foreign language. Most relevant seemed to be services which transform scientific data into context-specific information. An interviewee working in public awareness-raising and education was, for instance, interested in information which is tailored to the interests of different target groups like: an easy-to-understand and inter-active presentation of information for school students and more advanced and detailed information for a more expert audience like university students. In terms of EEA information, one workshop participant engaged in climate change mitigation demanded for a positive formulation of EEA-related statements and related claims to ensure a more effective presentation:

*WP-3: [...ich] finde es eigentlich ganz schön, das auch möglichst zu versuchen, positiv zu formulieren, also den Leuten Lust da drauf zu machen, mal neu, anders/ ‚umparken im Kopf‘ ist ja auch so ein Slogan [...] dass man das Ganze einfach mal versucht für sich selber aus einer anderen Perspektive zu betrachten und sich mal neu einzulassen auf dieses Thema und dass man nicht immer das Gefühl hat, man muss jetzt Verzicht üben [...]*<sup>1</sup>.

Another aspect discussed in light of climate services was communication of scientific findings. Several people stated that it is important to ensure a reliable and continuous communication of findings in order to establish that this information feeds into the work of people on a regular basis. This was discussed in the context of public awareness-raising for storm surge risks as well as in the general context of communal spatial planning activities, like this interviewee argues:

*I-5: und wichtig ist ansonsten aber auch eine gewisse Kontinuität bei den Informationen, dass man dort eben auch einen regelmäßigen Kontakt dann auch HAT, sodass das Thema dann nicht vom Alltag dann wieder aufgefressen wird. Sondern dass es eben einen gewissen Stellenwert bekommt*<sup>2</sup>.

Also, the way of communication was discussed. Many stakeholders found that information should be communicated personally either by a presentation or consulting. This was perceived to be most important to city and commune administrations who want to raise public or institution-internal awareness. In an interview with urban planners, it was, for instance, argued that communication via personal interaction is better able to convey an understanding of complex issues because people can receive a thoroughly selected set of relevant information and can ask context-specific questions. These communication channels were also most commonly ticked in the assessment cards. In addition, webtools and reports were frequently ticked in the assessment cards. Also mainstream media like the press and social media were mentioned as pertinent means of communication by some employees of a city administration and authority. These aspects were not discussed in more detail, however. The type or format in which findings are presented played an only minor role in the workshop

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and summarise it in a rough document. I think, this is what we essentially need and what colleagues can probably also understand – at least for a preliminary screening so to say.

<sup>1</sup> WP-3: [...] think it is kind of nice to try formulating it positively, to make people fancy making something different, new, ‘repark in your head’ is such a slogan [...] so that you try to look at it all from a different perspective and get newly involved with the topic and that you do not always have the feeling that you need to practice self-denial.

<sup>2</sup> I-5: ...and, other than that, it is also important to ensure a certain continuity of such information, that you have a regular contact, so that the topic is not eaten up by daily routines. But that it receives a certain value/priority.

and interviews. Apps, mail circulars and newsletters were mentioned to be good media by stakeholders working in a city administration and a local authority. This was not discussed in more detail. In the assessment cards, people stated that they preferred tables, maps and diagrams rather than schematic figures and mere text-based presentations of findings.

Some interviewees and workshop participants also demanded that climate services should deliver information pro-actively, particularly to city administrations, and present findings inter-actively and emotional to raise public awareness. In the context of EEA, one workshop participant who is engaged in spatial planning expressed that it is important to communicate scientific EEA findings in a way that is able to grasp people's attention:

*WP-1: Also ich frage mich tatsächlich, wie man in einer informationsüberfluteten Welt tatsächlich diese Informationen an die Menschen heranbringt und damit dann auch was bewirkt. Ich glaube, [...] dass, wenn man tatsächlich irgendwo bildgewaltige Beispiele schafft, die tatsächlich dann bei den Menschen auch was auslösen. Warum auch immer, aber auch zum Thema Rauchen gab es ja eine Anti-Raucher-Kampagne; ich habe den Eindruck, dass die sehr viel Effekt gehabt hat. [...] vielleicht ist das etwas, wo das Bundesumweltministerium oder so tatsächlich Geld investieren könnte und den Menschen zeigt, was der anthropogene Anteil am Klimawandel ist<sup>1</sup>.*

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<sup>1</sup> WP-1: Well, I indeed ask myself how to deliver such information in a world of information overload and still achieve something. I think [...] that if you do create visually stunning examples which actually trigger something inside people's mind... For whatever reason... but also in the context of smoking there was an anti-smoking campaign; I had the impression that it was very effective [...] maybe this is something where the Federal Ministry for Environment or something like it could actually invest money in and show the people what the anthropogenic contribution to climate change in fact is.

### 3.5. Results Part 2: Results of the empirical work undertaken at UVSQ

#### 3.5.1. User needs with respect to regional climate information in an urban and mixed rural- urban contexts

The salience of climate change as a policy issue both in terms of mitigation and in terms of adaptation, in the greater Paris area, has led to fairly specialized job positions within the sectors that we have identified. The interviewees and workshop participants were thus all “climate change” reference persons within the various sectors that we targeted: emergency health care, health planning, mass transit, collective provision of temperature regulation (cold), urban planning, local and regional climate planning, land use planners, local and regional climate offices, forestry, agriculture.

It is thus evident that the interviewees and the participants to the workshop have a fairly precise idea of the type of climate information that is needed for their respective structures and associated mandates. This information is closely associated to the specifics of the potential impacts of climate change in their work environment.

*J-1<sup>1</sup>: L'intérêt de chacune de ces informations climatiques : ilots de chaleur, inondation, ... etc. c'est d'avoir les données et informations les plus précises possible pour apporter les réponses les plus adaptées possibles au contexte<sup>2</sup>.*

Central to these concerns are heat waves, the memory of 2003 being still vivid:

*J-1: On a été le 2ème département le plus touché en France pendant la canicule de 2003 et quand je dis le plus touché je parle en termes de décès prématuré chez les personnes âgées<sup>3</sup> (adaptation planer, “département” level)*

Some interviewee (regional level land use planning) felt quite vehemently that there was enough climate information as it stands.

*J-4: ça suffit comme information, je crois pas qu'il y a besoin d'informations supplémentaires<sup>4</sup> (climate planning director at a regional level having both adaptation and mitigation mandate)*

The most critical priority is to connect climate information with impacts on issues that are politically relevant. These interviewees and workshop participants stressed the fact that somehow climate information should be connected to their economic impacts:

*J-6: Si on veut faire un saut qualitatif il faut travailler sur l'interface des données pour caractériser une augmentation potentielle des tempêtes de tant de coûts, sinon on n'arrive pas à convaincre les élus<sup>1</sup>*

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<sup>1</sup> I-# stands for the anonymised ID of interviewees

<sup>2</sup> The value of each of these climate information: heat islands, flood, etc ... is to have data and information as accurate as possible in order to make the most appropriate context specific responses.

<sup>3</sup> We were the 2nd most affected department in France during the heat wave of 2003 and I mean the most affected in terms of premature death in the elderly

<sup>4</sup> [we have] enough information, I do not think there is a need for additional information

*J-4: Une donnée qui légitimise une action est une donnée qui rend intelligible les impacts. Le langage universel aujourd'hui c'est les Euros<sup>2</sup>*

Other interviewee (local climate offices mostly) saw science-based information as a fundamental key to the legitimacy of their work. These participants stressed the fact that without robust climate information their recommendations will not reach the political agenda.

*J-1 [talking about science-based climate information] Ce rôle est fondamental dans le sens ou a partir du moment où le risques est clairement défini on va avoir des outils plus puissants pour embarquer nos élus et décideurs dans nos structures sur ces problématiques<sup>3</sup>*

Yet when pushing the conversation further two key elements are central to their needs (all interviewees). First the participants expressed the fact that high levels of uncertainty are “unmanageable” at the operational policy level. Second the geographical scale at which they work is much finer than what they understand as being accessible in terms of climate information.

*J-2 On a une étude où on a étudié les prévisions climatiques sur notre territoire, mais ce sont des prévisions où il y a pas mal d'incertitudes et où ils sont assez larges. Il n'y a pas d'informations précises au niveau d'une ville<sup>4</sup>*

*J-5 Les informations climatiques ne peuvent être utiles que si elle décrit des choses perçues par les gens comme des certitudes<sup>5</sup>*

The interviewees, being climate resources persons within a variety of regional entities, clearly framed climate information through the needs of their institutions. As stated above, most saw it as a source of reinforcement of their action; many saw the current large geographical scales and high uncertainties as a weakening factor. The dominant use of climate information that is mentioned by the interviewees is climate forecast in order to plan for the next decades. Climate information is thus perceived to be part of a continuum that goes from climate change to its impacts; this serves two objectives: mitigation and adaptation. Another use that is mentioned often is the contribution of robust climate information to outreach and public engagement. Interviewees stress that in terms of quantity the current information offer is sufficient but that its geographical scales and high uncertainties were somehow limiting factors in order to build public support.

Currently the respondent who are mentioning climate information source pointed to the DRIAS portal. “Drias - Futures of climate –“ is the main, sometimes only, climate information portal that aims to provide regionalized climate projections computed by several French laboratories involved in climate modeling (IPSL, CERFACS, CNRM-GAME). Some of interviewees stressed the fact that while these data are available they feel that the portal is

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<sup>1</sup> If we want to make a qualitative leap we must work on the data interface to characterize a potential increase in storms associated to this level costs, otherwise we can not convince elected officials

<sup>2</sup> Datas that legitimize action are datas which makes intelligible impacts. The universal language today is Euro

<sup>3</sup> This role is fundamental in the sense that from the time the risk is clearly defined we will have more powerful tools to mobilize our elected officials and policymakers on these issues

<sup>4</sup> We have a study where climate predictions on our territory have been analyzed, but these are forecast where there is a lot of uncertainty and they are wide enough. These are not precise information for a city .

<sup>5</sup> Climate information can be useful only if it describes the things perceived by people as certainties



not sufficiently known. They insist on the need to publicize this portal. Its user friendliness, or rather lack thereof, is sometimes mentioned as a source of reduced usage.

Content-wise, and this is directly connected to what is said above, interviewees are looking for climate information that goes beyond climate conditions “stricto sensu”. When focusing on climate information in terms of average meteorological variables, interviewees and workshop participants stress the importance of having short and mid-term forecast with the smallest uncertainties and a high resolution. Temperatures, especially potential heat waves are mentioned, extreme rainfall event are mentioned as well.

### 3.5.2. *Extreme Events, climate information and the relevance of event attribution*

When moving explicitly to the connections between extreme events and climate information, interviewees do not mention the added benefits of attribution. Detection is more often mentioned as information that may be of interest. Nevertheless they stress the fact that extremes may raise much more interest than other impacts of climate change.

*J-7 Si vous me dites évènements extrêmes, canicule, santé, impacts tels impacts tels impacts tout le monde ira chercher les informations<sup>1</sup>*

Regarding extreme events detection and attribution, a central elements that is present in most of the interviews lies again in the difficulties of communicating figures that are uncertain.

*J-5 Il y a le tendancielle et La variabilité climatique normale : il est normal d'avoir tous les X temps un été froid ou un hiver chaud. Là c'est les scientifiques ne sont pas capables de se prononcer. Aujourd'hui on a une culture de chiffres, si je vous dis que ça c'est 50 plus que 50% d'incertitude, l'élu va te dire que ta donnée ne sert à rien<sup>2</sup>*

Also stakeholder mentioned repeatedly the relative nature of the concept of extreme. They stressed often that it made little sense to disconnect impacts, vulnerabilities and meteorological events and to disconnect the related information.

*J-7 Parfois ce n'est pas des évènements extrêmes mais c'est des conditions extrêmes par rapport à ce que les infrastructures ont l'habitude de gérer. Les trains ne circulent plus à 23°, C'est ahurissant, et on annonce que à cause de fortes chaleurs les trains sont annulés et ça pendant tout l'été. Ça, c'est des évènements de vulnérabilité liés à un événement pas du tout extrême mais qui deviennent extrêmes pour des conditions de sensibilités<sup>3</sup>*

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<sup>1</sup> If you tell me extreme events, heat wave, health impacts such as impacts, more impacts, everyone will fetch information

<sup>2</sup> There is the trend and the normal climate variability: It is normal to have every N period a cold or a warm winter. Scientistis are not able to precisely describe the situation. Today we have a culture centered on figures, if I tell you that things will increase by 50 with 50% of uncertainty, elected officials will tell you that your data is useless

<sup>3</sup> Sometimes it's not really an extreme event, it is rather extreme conditions for what infrastructures are designed to withstand. Trains no longer run at 23 °, It is amazing, and it was announced that due to high temperatures trains are canceled and it all summer. That's vulnerability related events, not at all an extreme meteorological event. It simply extremely impacting sensitive objects.

Interviewees involved at local level risk prevention expressed frustrations at the fact that the only “data” that they really had to engage the population are the heat waves of 2003 and 2006 as well as the storm of 1999. Yet today already some places are overwhelmed by more “normal” situations. When confronted with the question of attribution they did not see it as central. What they stressed is that such extremes are used as potential memory anchors in order to prepare to what the future may have in store. That these past events are attributable to anthropogenic climate change is not central to their concerns.

Being coherent with the results above, when causal statements are envisioned the respondents are much more focused on vulnerabilities and associated impacts. This is reinforced by the nature of the job description of most of them: they are tasked with the development of the plans that will allow their region/city to face climate change – their central operational interest lies in reducing exposure.

Finally, when asked directly what could be the use of EEA, interview participants mentioned the potential for outreach, which may help them at reducing exposure, and its potential importance, as long as impacts are quantified, to mobilize politicians. Workshop participants on the other hand mentioned the insurance sector as potential beneficiaries of extreme event attribution – yet as a mean to improve forecast - as well as outreach agencies.

**Table 12: Stakeholder groups and fields where EEA could be needed according to interviewees and workshop participants in the greater Paris area**

Potential fields of application	...mentioned
Societal / Public CC discourse	Frequently
Public awareness-raising	
Political leverage/Internal awareness raising	
Insurances	Few times
Basis for better scenarios	
Compensation mechanisms	Not mentioned
Administration	
Universities	
Civic participation	
General education	
Climate change mitigation	
Spatial planning	

### **3.6. Discussion and Conclusion**

#### **3.6.1. Discussion and conclusions based on the findings from the Baltic Sea case study**

##### How do regional stakeholders understand extreme event attribution?

In deliverable 4.1, we argue that an understanding of how stakeholders conceptualise and articulate extreme event attribution facilitates identifying the specific needs and requirements of different decision-makers. Despite of the potential relevance to extreme event attribution studies, it is an issue which has not been grasped by the literature around EEA so far.

The general idea behind EEA appeared to be widely understood by the interviewed stakeholders and workshop participants in Baltic Sea region. Methodological details and potential results have, however, been perceived to be rather abstract and complex. Some stakeholders misunderstood EEA, for instance, as being equivalent to detection and attribution, or as being able to predict future extreme event characteristics or consequences. A lack of understanding can be explained by the technical or professional background of the stakeholder sample. Having selected interviewees and workshop participants who are, in contrast to the interviewed scientists in WT4.1, neither expert nor familiar with extreme event attribution, it was not surprising that misunderstandings occurred. Also a more in-depth analysis of how EEA is understood was accordingly not possible. This may also be linked to the fact that a guideline or more details about how EEA is conducted has not been available. The fact that even scientists engaged in detection and attribution studies are not aware of an appropriate term for EEA in German language might further complicate conveying an understanding of EEA (see D 4.1, p. 62). Also the stakeholder consultation in the Baltic Sea case was complicated by the lack of an appropriate German term for EEA. Regional stakeholders, particularly the ones who are engaged in public awareness-raising and civic participation, are likely to also struggle with this “eloquent speechlessness” as it was described in D4.1.

The unacquaintedness with the concept of EEA made it also very difficult for the consulted stakeholders to identify potential fields of application for EEA and express specific and concrete requirements to EEA information or services (see chapter 3.4.2 and 3.4.3). Some of the identified fields of application may therefore, indeed, not be relevant and several expectations may rather be owed to a misunderstanding of or a lack of knowledge about EEA. Moreover, stakeholders were, similar to many scientists interviewed in WT4.1, rather sceptical that EEA is actually possible or is able to produce reliable results. Stott and his co-authors (2013:337, see chapter 3.2.1) argue that the scepticism towards EEA might also be caused by the fact that uncertain and contradictory information about EEA has been provided in the past. This could not be observed in the interviews and the workshop because most of the consulted stakeholders in the Baltic Sea case have rarely heard of EEA-related information before (see chapter 3.4.1).

The perceived complexity, misunderstanding and scepticism regarding EEA might not only occur among the selected stakeholder groups but might also hold true for many other stakeholders at a regional level to date. EEA is a novel and at the same time complex field of research making it unfamiliar and abstract to most stakeholders not engaged in related

sciences. The understanding of EEA may be substantially different in case of other stakeholders, however.

#### How do stakeholders perceive the usefulness of extreme event attribution information?

In the EEA-literature, it has been argued that the results of extreme event attribution are fundamental to decision-making and raise large interest among stakeholders (see e.g. [Hulme, 2014; Stott and Walton, 2013] in section 3.2.2). In D4.1 we argue that it allows for a better understanding of the extreme event, renders risk perception and feeds into all processes of risk governance as these were described by Renn [2008]. In WT 4.2, we accordingly selected interviewees and workshop participants engaged in regional governance of the case study-specific risks.

The empirical results of the German Baltic Sea case study show that there is a general interest in EEA. However, EEA-based information seemed to have little significance for rendering the risk perception of the consulted stakeholders in terms of the hazard, i.e. the perceived likelihood and severity of storm surges. None of the selected regional decision-makers in the German Baltic region was a climate change sceptic and all were well-aware of the fact that also extreme events are likely to change due to anthropogenic climate change. They therefore also found that it would not change their own motivation to take action. Renn's [2008] approach for risk perception and governance was therefore not an appropriate approach for describing the usefulness of event attribution. Nevertheless, many stakeholders argued that such information might change the risk perception of the public or other decision-makers not directly concerned with climate change-related topics in their daily work. EEA could therefore be of use to awareness-raising activities. This is in line D4.1 where we assumed that awareness-raising activities may benefit from EEA information.

Similar to what the media analyses already indicated (see D4.1, p. 62), the consulted stakeholders in the German Baltic Sea region often rather needed information about the causes of increased exposure, vulnerabilities or risk management capacities for their daily work than about the contribution of anthropogenic climate change to certain extreme events (see section 3.4.2). Such information might render their risk perception in terms of perceived capacities to act and their knowledge about potential risk management options. According to the assumed social articulation of attribution as proposed in Deliverable 4.1, EEA might be able to provide a better idea of the options available to reduce unwanted consequences of extremes. The stakeholders in the Baltic Sea case study did not perceive that this could be the case, however.

In the literature, it is argued that the need for EEA is particularly evident for litigations, actors engaged in climate change adaptation, and decision-makers concerned with geo-engineering (see e.g. [Stott et al., 2013] in section 3.2.2). These sectors were rarely or not at all identified to be potential users of EEA information by the regional stakeholders selected for this study. Litigations like the ones discussed in the US or at the international scale (see e.g. [Adam, 2011; Faulk, 2012; Stott et al., 2013]) have not fed into the general societal and technical debate about climate change in Germany – particularly not at the regional scale. This might explain why the consulted stakeholders in the Baltic Sea region did not mention the relevance of EEA to litigations. Geo-engineering might not have been named by stakeholders in the Baltic Sea case study because none of the stakeholders was directly or

indirectly concerned with it. It is a topic which is debated at the national if not international scale rather than by regional decision-makers - which were at the centre of this study.

Out of the three sectors suggested by Stott et al. [Stott et al., 2013], in fact, only climate change adaptation was mentioned by some of the consulted stakeholders. In line with the conclusions drawn for potential fields of application in D4.1, they found that adapting large infrastructures might benefit from EEA-based information. Stott et al. (2013) argue, in this context, that EEA might facilitate a more effective resource distribution and would improve planning and implementation of climate adaptation. Several stakeholders consulted in the Baltic Sea case study, however, argued to the contrary saying that they need to know how extreme events occur and change rather than knowing why extreme events change in order to be able to improve adaptation planning. This has been interpreted differently for climate mitigation where knowing about the causes of the changes in extreme events can provide motivation to act. Also at the international scale, it might be of larger relevance to adaptation, where, for instance, compensation for adaptation is negotiated between the large emitters of the past and the ones most affected by climate change today and in future. Some of the consulted stakeholders also follow a similar line of argumentation as Hulme and his colleagues, i.e. that EEA results “open up new spaces for political contestation, but now hidden in the language of science” [Hulme et al., 2011], meaning that highly complex and uncertain scientific EEA results rather weakens the argumentative basis for climate adaptation (see section 3.4.2). Stakeholders have often encountered the problems of communicating uncertain storm surge or other climate change related projections already today so that they were hesitant towards information which may be associated to even higher uncertainties.

Climate change mitigation has, in contrast to adaptation, named to be a potential beneficiary of EEA information by a larger number of the consulted stakeholders in the Baltic Sea region. In this test case, the relevance of EEA-based information was perceived to be more an issue to awareness-raising activities in terms of climate mitigation than for informing the technical implementation of it or political lobbying for international compensation mechanisms. Many of the consulted stakeholders found that EEA-based information can benefit, particularly the societal discourse about climate change. This is in line with Stott et al.'s (2013) argumentation that the general public and the media are potential users of EEA information due to their “long lasting interest in the extreme weather blame question”.

#### What makes extreme event attribution-based information relevant, reliable and expedient for stakeholders and related decisions?

The interviews and stakeholder workshops conducted in the Baltic Sea case study revealed that the most commonly named requirements with respect to EEA information can be linked to either salience or credibility concerns. These categories represent two of the three most essential quality criteria for information services identified by Cash et al. (2002, 2003) (see section 3.2.1). Legitimacy, which was proposed as third category, has not been named to be of larger relevance by the consulted stakeholders in the Baltic Sea case study. Generally, it appeared that the consulted stakeholders had difficulties expressing and discussing EEA-specific requirements. As argued above, they were not acquainted with the concept and potential results (see previous sections on how this could be overcome).

Similar to what has been found by other EEA studies [see e.g. Stott and Walton 2013 in section 3.2.1] and also other climate information-related literature concerned with stakeholder needs [see e.g. McNie 2008], credibility concerns ranked prominently among the requirements of the consulted stakeholders in the Baltic Sea case study. Among the most commonly named credibility-related criteria for climate/extreme event information were: designation of small statistical uncertainties, a reliable and independent source of information, plausible results, a reliable data basis and a reasonable methodology. This seemed particularly important to the planners of large and expensive infrastructures. The credibility of extreme event attribution information appeared to be judged by similar criteria. In this context, particularly small uncertainties and a solid methodology seemed of relevance to the stakeholders. This indicates a rather low tolerance of the selected decision-makers to uncertainties and thereby attaches particular relevance to the skepticism reflected in the articulation of EEA which was outlined in the previous section. The small tolerance to uncertainties does, however, not mean that a suitable EEA-based product should not designate the inherent uncertainties. To the contrary, it seems that the consulted stakeholders rather demanded an “honest broker” [Pielke, 2007; Storch, Meinke et al. 2011] who is transparent with respect to uncertainties and the underlying methodologies.

Many of the consulted stakeholder in the Baltic Sea case study told that they ensure credibility by relying on information from sources they trust. This appears to be more important if stakeholders are not expert in a certain field as will be particularly the case for EEA. Such sources can be climate service providers as well as scientists. Only few of the consulted stakeholders in the Baltic Sea case study mentioned that they trust and use information from the mainstream media. Other authors who surveyed regional decision-makers and their perceptions with respect to climate change related aspects in the Baltic Sea found, in contrast to this, that the media is the most essential source of information [see Bray et al., 2011]. This mismatch indicates how different perceptions and knowledge production of different regional decision-makers are. Bray and Martinez (2011) selected only political decision-makers indirectly concerned with climate change whereas we also included other actors like e.g. private sector actors or decision-makers focusing on climate change-related aspects. These have a different educational or academic background and therefore use different information sources for their daily work.

A further group of criteria was linked to the perceived relevance or salience of information. In contrast to the credibility-related requirements, aspects linked to the relevance of EEA information were significantly different from those for climate and extreme event information in general (only comprehensibility was of importance in the context of both types of information). This can be explained by the very specific nature of EEA. The spatial scale, which is essential in terms of climate information, has for instance not been named to be of relevance in the context of EEA-based information by any of the consulted stakeholders. Other aspects appeared not to be mentioned in the context of EEA because it is novel information which has not been used by the consulted stakeholders before. It seemed, for instance, difficult to judge what specific type of quantitative results might be needed - an aspect which was key to climate/extreme event information in general.

In the reviewed EEA literature which dealt with stakeholder needs, particularly the time of availability was named as key criterion determining the salience of EEA for stakeholders. Stott et al. [Stott et al., 2013] (see section 3.2.1, p. 9), for instance, argue that the relevance of EEA is largest during or right after an extreme event. Also in D4.1 it is stated that “the

timing of the decision to launch an attribution exercise may very well influence its reception by society". Accordingly, the requirements of stakeholders may very well be different depending on the timing of a product launch (D4.1, p. 60). The consulted stakeholders in the Baltic Sea case study did not attach larger relevance to the time of availability. It was mentioned in the general context of extreme events but did not raise much interest in the EEA context. This might be linked to the specific background of the stakeholders which are mainly concerned with long-term preparedness or continuous awareness-raising campaigns. They argue, for instance, that a memorable extreme event can also serve as an illustrative example after a longer period of time and does therefore not need to be published right after the event. For these stakeholders, a suitable product of EEA should rather produce information at a later time but with smaller uncertainties than vice versa. Stakeholders who need information at a time when the interest for this event is still high, like for example the mainstream media, might attach larger importance to the timing when information is launched. In this case, it might also confirm Stott et al.'s (2013) assumption that an earlier launch can compensate for higher uncertainties attached to them (see section 3.2.1, p. 9).

In D4.1 we argued that it is important to know whether an attribution service should "limit itself to climate attribution or should encompass the issue of attributing consequences and judging the responsibility for climate change". In case of the consulted stakeholders in the Baltic Sea region, this was indeed one of the most commonly named requirements. It was expressed that EEA information should be linked to the specific problems and particularly to the consequences of extreme events. This reflects the requirement of linking climate information to region-specific impacts, identified by Storch, Meinke et al. [2011]. Linking, for example, probabilistic EEA statements to losses and damages which occurred due to an extreme event were perceived to be more relevant than without. Also the kind of results produced by EEA mattered to the consulted stakeholders in the Baltic Sea region. Similar to Adam's [Adam, 2011] argument for EEA in litigations, also several workshop participants found that EEA-based results should not be communicated if they do not indicate a significant contribution of anthropogenic climate change. These stakeholders were mainly referring to a presentation of such results to the general public or climate sceptics and to an utilisation for political leverage.

Legitimacy was hardly ever mentioned explicitly by the consulted stakeholders in the Baltic Sea case in the context of climate and extreme event information and not at all in the context of EEA. In fact, only climate service providers said that it is important to interact with and involve the users; the users did not require that information needs to be produced in a "legitimate" way. This might be caused by the fact that science is still perceived to be an endeavour isolated from stakeholder needs and this in turn coincides with the findings of the interviews with scientists conducted in WT4.1. Accordingly, stakeholders and their possible interests are largely unrecognized by scientists (D4.1, p.8). For the stakeholders, legitimacy seems to be rather an implicit requirement cached in their requests for context-specific and -relevant information. Having not mentioned legitimacy does therefore not mean that a suitable product of EEA does not need to be concerned with legitimacy concerns. On the contrary, legitimacy is the basis for being able to meet stakeholder-specific needs particularly in terms of salience. It might therefore be a criterion which is rather nested within the other two main requirements for producing useful knowledge as proposed by Cash et al. [2003] than being a separate category of its own.

### 3.6.2. *Discussion and conclusions based on the findings from the Greater Paris case study*

The findings associated with the greater Paris case study points toward several specificities that, while being more contextual, will have a direct bearing on the potential use of extreme event attribution services.

a) Climate information in the greater Paris area caters to an emerging category of climate professionals. As such they are quite educated in climate change science and its peculiarities. This may play as a double-edged sword. First, climate services do have knowledgeable partners, which have clear sense of what they need. Second, and this may lead to an information bias; these professional have relatively narrowly defined mandates, generally centred on operational matters associated with impact mitigation. As such they are much more focused on the impacts that they have to manage and may filter out innovative climate services that are emerging provided that they do not see the relevance of the information to their work. They show the potential to simultaneously connect climate services to policymaking, even in terms of information as complex as EEA, yet, they show the potential to reduce information flow when they feel that this information does not serve directly their mandate.

b) Potential relevance and users of event attribution do not appear to stand out. Most of the stakeholders did, similar to stakeholders in the Baltic Sea case, not express a direct need for event attribution information. Particularly its relevance to political leverage may play a role when such information is available. Some of the other potential fields of application for event attribution were also named in the storm surge case, i.e. awareness raising or societal discourse. Climate mitigation was, in contrast, not mentioned; and also most of the sectors identified in previous event attribution studies were not named here.

c) Climate information for the greater Paris area stakeholders is not limited to the kind of climate science-based information generally associated with climate services. Climate information includes for these stakeholders most if not all the causal connections associated with climate change – from greenhouse gases, to climate change, to impacts, the latter as function of vulnerabilities and exposure. This is important for extreme event attribution and its potential uses – EEA could be part of more integrative statements where anthropogenic climate change is one of the factor explaining shifts in impacts. Similar to what has been found in the Baltic Sea case study, extremes are, for Paris area stakeholders, conjoint manifestations of a meteorological event, a set of vulnerabilities, and impacts, the latter giving saliency to an event.

d) Within Paris area structures, to simultaneously conduct outreach towards the general public AND convince elected officials seems most important to the interviewees. In light of this policy relevance and considering (a) and (b) above, our interviewees felt that climate information needs to be salient for policy makers. They clearly felt that their success with their superiors is conditional to being able to translate climate change into “euro figures”.

e) Critical to the action of our interviewees was the relevance of climate information to their local contexts. This is associated with a need for as small uncertainties as possible. This leads to a “Catch 22” situation where simultaneously requests are made for local scale



climate information AND reduced uncertainties – while this was not mentioned in direct connection with EEA, it must be taken into account as a potential challenge.

### 3.6.3. *Common conclusion*

In conclusion, it has been shown that a suitable product of EEA for stakeholders should be explicit with respect to what EEA is, mention how it is different from related concepts, explain these aspects in an understandable way, and translate scientific language into the mother-tongue language of regional stakeholders. This cannot be done in the same way for all stakeholders and irrespective of time and place. It needs to be, for instance, known which aspects or methodologies need in-depth technical details, context-specific examples, or rather intuitive explanations and transparent communication of uncertainties. This demand for a regular and context-specific stakeholder consultation which accounts, amongst other things, for the level of experience or expertise with respect to EEA. If stakeholders are, for instance, not acquainted with such information at all, it is important to assess not only the need and requirements with respect to extreme event attribution information but with respect to climate and extreme event information services in general. Only in that way, it is possible to make implicit expectations explicit for a rather abstract science-based information product which has not been used before.

The reflection and comparison of the empirical results from two case studies and against the background of the existing literature highlights that it is not possible to compile *one* generic stakeholder typology or identify only one set of potential EEA users. It has been shown that potential users of EEA for storm surges in the German Baltic Sea region are substantially different to those interested in EEA for heat waves in the Greater Paris area or for flooding in the UK (see e.g. Stott et al. 2013). It is therefore important to conduct case-specific stakeholder mappings and reflect the results against the background of context-, hazard-, or region-specific factors. Accordingly, a suitable EEA-based information product should not only be hazard-specific with respect to its methodology for developing probabilistic statements but also needs to be hazard- and region-specific in identifying its user-groups and their needs.

A detailed analysis of user requirements in terms of EEA and climate services in general results indicates that the stakeholders want EEA-based products tailored to their specific concerns from a trusted “honest broker” who presents only information that he or she can be honest about. These are requirements which cannot be met by science alone. It demands for an understanding of stakeholder needs from scientists and an understanding from the side of stakeholders in terms of what science can/should provide. Climate service providers can serve as an interface for creating such mutual understanding. They should not be misunderstood as being a one-directional communicator from science to the stakeholders but facilitate and make use of a continuous dialogue. The consulted stakeholders requested in this regard that they need someone translating scientific information into salient and understandable information. They emphasized that they preferred information from a trusted institution or person and a communication based on an active and personal exchange. This seems to be of particular importance to stakeholders which are not engaged in scientific activities themselves, like in the Baltic Sea case, and lack time and expertise to deal with complex information as they might be produced by EEA.

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## 4. Lessons Learnt

The methodological concepts and its implementation have not only facilitated answering key questions posed in WT4.2 but demonstrated critical lessons to be learned for the proceeding work tasks. Work task 4.3 aims at understanding specific stakeholder needs and requirements, in particular commercial interest, by assessing it at the example of insurances and re-insurances. In WT4.3, the general public will be polled by a representative telephone survey in order to comprehend their interests in information based on extreme event attribution.

### 4.1. *Methodological lessons learned*

Lessons can be drawn from the overall methodological setup, selected foci and the data collection process in WT4.2.

Having proceeded with **in-depth interviews** which followed rather open and flexible guidelines, was expedient from both an exploratory and explanatory point of view. It provided first insights into what mattered to a broader set of stakeholders and explained why that was the case. Dealing with a novel information product and a diverse group of actors, these aspects were key to achieving the research goals. Also in case of the insurance sector, such aspects might be important. There is little known about potential interests of insurers in EEA to date, particularly not in the selected case studies; and by what is known and to be expected, these stakeholders have similar interests in some respect but also substantially different interests than the stakeholders consulted in WT4.2 in others. It is therefore important to start with in-depth interviews to get a better idea of these similarities and differences. Also for WT4.4, it might be helpful to start with in-depth interviews. Before conducting a quantitative survey, it is helpful to know what to focus on or how to formulate questions in a way that it is understandable for the public. The interviews and workshops in WT4.2 indicated that people have problems understanding, for instance, complex probabilistic statements, misunderstand it or mistake it for something else. This has already been the case for stakeholders which deal with climate change/extreme event-related issues in their daily work and was therefore also less the case in the Paris case study. For the general public who is rarely familiar with these topics, it might be even more difficult to formulate understandable and relevant questions. The complexity of the topic is particularly critical to a telephone survey, as intended in WT4.4, where room for explanations is restricted.

In the **selection of interviewees** and workshop participants in WT4.2, it was very helpful to start with identifying a preliminary set of potential stakeholder groups but be at the same time not limited to this set. It appeared to be expedient to specify and modify the stakeholder mapping in the course of the interviewing period. The information received in the interviews helped adapting the stakeholder mapping, identifying people in charge, and increasing the likelihood of receiving an appointment for an interview (see section 3.3 for more details). A similar approach may also be helpful for identifying relevant decision-makers in the insurance sector and in the general public, at least for developing an appropriate stakeholder mapping. For the public, however, a stratified random sampling might be more expedient given the larger basic population.

The **interview guidelines** used for the interviews have proven to be suitable to the research context. Addressing not only the role of and requirements with regard to EEA information but also with regard to regional climate and extreme event information in general was very helpful given the unacquaintedness of the consulted stakeholders with the concept of EEA (see section 3.6.1 for more details). Also decision-makers in the insurance sector and the general public have probably not dealt with such information before, at least not in case of storm surges where EEA information does not exist yet. In the general public, there may be a larger number of people who do not deal with climate and extreme event information in their daily life at all. Embedding EEA requirements in the more general context of climate and extreme event information might therefore also be advisable for the following work packages.

The **workshops** with selected stakeholder focus groups in WT4.2 helped grasping the needs and requirements of stakeholders not only in isolation from each other but in a mutual and interactive exchange. Having invited different focus groups made it possible to highlight, for instance, the differential priority setting of different stakeholder groups better than the interviews could do and allowed grasping how opinions are changed or enforced in an exchange with stakeholder groups. It did, however, also show that aspects which might have been decisive for some groups were not addressed in sufficient detail because the other groups were not concerned with it or did not possess the expertise to question or debate it in more depth. WT4.3 provides an opportunity to conduct workshops with only one focus group and can thereby facilitate more thorough discussions.

A difficulty encountered when **planning the workshop** was gathering enough relevant regional decision-makers with a diverse background. Using snowball-sampling and focusing in the preceding interviews on stakeholders' information and networking needs raised the motivation for participating (see section 3.3.2). The interviews before the workshop have, for instance, indicated that a focus on only event attribution would not raise the interest of stakeholders in the workshop. We did therefore not focus solely on EEA but embedded it in the overall context of climate and coastal information/services. Most important to many stakeholders seemed to be the networking opportunity during the workshop. It was therefore very helpful to ask for and consequently invite stakeholder groups which necessitate a platform for exchange. Incorporating a "Networking and Result Gallery" session could encourage such an exchange during the workshop. Similar issues and problems to the ones in WT4.2 might also be encountered when planning and conducting workshops with other stakeholders, like decision-makers in the insurance sector. If a stakeholder workshop in WT4.3 is envisaged, it is therefore advisable to include questions about how to improve the usefulness of workshops in preceding interviews as suggested before.

The **information assessment cards** used in the workshops have proven to be understandable and cover key evaluation criteria. In terms of EEA-based information, the fake EUCLEIA fact sheet, i.e. a description of the envisaged product of event attribution developed as EUCLEIA Milestone 1, provided a good basis to understand stakeholders' articulation and evaluation of potential EUCLEIA information products. To formulate a suitable fact sheet, however, required a first understanding of stakeholder needs and requirements. It was therefore developed only after having consulted stakeholders and not beforehand as initially intended in the DOWs. The fake fact sheet was used to develop assessment cards for evaluating EEA results in form of statements which might be made by EUCLEIA as an answer to three exemplary questions. This showed stakeholders how EEA

results might look like and facilitated expressing more concrete requirements with respect to such information. In the workshops, however, filling out quantitative survey-like assessment cards interrupted discussions and made people write for themselves where they could better discuss in a group. They might therefore provide a better basis for quantitative survey methods, as intended in WT4.4, than for further interviews and workshops in WT4.3 and WT4.4.

The most important lesson learned from the work conducted in UVSQ is the real need to face stakeholder fatigue when conducting climate research. Mobilizing individual for interviews and workshops becomes increasingly challenging. Somehow the connections with the world of science and the world of stakeholders may soon need to be reinvented. This seems urgent if we want stakeholders to be closely associated with the development of climate services. The work conducted in the course of WT3 and 4 are steps in the right direction but may not be sufficient.

#### *4.2. Empirical findings in light of the following work tasks and the overall project goals*

The empirical findings of work task 4.2 provided a further cornerstone towards reaching an understanding of user needs and the value of extreme event attribution for regional stakeholders. The concepts provided in WT 4.1 built a good basis to develop an appropriate methodology for WT.2. The empirical research about the perspectives and articulation of scientists and the media in WT4.1 created a foundation to compare and complement the findings of WT4.2.

We have now achieved a good overview of the needs and requirements of a rather diverse set of user groups comprising beside the media and scientists also stakeholders from politics, public administration, civil society, associations, and the private sector. We have in this respect identified and covered some of the most relevant sectors who could make use of EEA information in the case of Baltic Sea storm surges and heat waves in the Greater Paris area. Particularly the workshops have, nevertheless, shown that there are aspects which need a more in-depth assessment and understanding. Specific requirements with respect to extreme event attribution were, for example, addressed but did, at times, not receive enough attention. This was principally the case due to the explorative character of the interviews and the diverse stakeholder interests represented in the workshop. The following aspects should, for instance, be addressed in more detail: how and why are probabilistic EEA statements understood? What are threshold values of an anthropogenic contribution making an EEA finding useful? When and why should EEA findings be linked to the impacts of storm surge events? What level of uncertainty is tolerable? What role should climate service providers play in an operational EEA system? Which communication channels can be used in what way?

To answer these and further questions, it is, on the one hand, necessary to take a closer look into one of the potential fields of application. This will be done in WT4.3 for the insurance sector and in WT4.4 for the general public. This may not only reveal in-depth insights into commercial and public interests but might also convey a better understanding of some of the aspects which remained largely uncovered for the other stakeholder groups. On the other side, a survey of a larger population would help creating a basis for drawing more

representative conclusions and might reveal aspects which were not found among the smaller sample before. This will be done in WT4.4 with a representative survey of the public.

With these findings, we hope to provide a good basis for the other work packages to develop methodologies for extreme event attribution in general and for Baltic Sea storm surges and heat waves in the Greater Paris area in particular.



## 5. Links built

We worked closely together within our work package on the two test cases. We had a WP4 meeting in Hamburg in March 2015, discussed and harmonized our empirical data collection and analysis, and aligned our findings in this deliverable D4.2. Work task 4.2 has also provided a basis for extreme event attribution in the pre-defined case study areas which will be conducted in WP7. We have therefore started to get in contact with the project partners involved in the attribution of heat waves in the Greater Paris area and with the partners concerned with event attribution for storm surges in the German Baltic Sea area. Our work is also linked to what has been done in WP3 (stakeholder engagement). We have benefited from the stakeholder workshop in July 2015 in Paris and contributed our experience in the regional test cases there. In addition, we presented our work to all work packages at the EUCLEIA General Assembly Meeting in Paris in July 2015.