***Master Thesis (30EC)***

***Sustainable Development, Environmental Governance***


# Climate proofing municipalities with usable information

*Improving the usability of climate information to support local adaptation planning through an evaluation of the Climate Adaptation Atlas by municipal practitioners in medium-sized municipalities in the Netherlands*

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# Preface & Acknowledgements

As part of the Master *Sustainable Development Environmental Governance* at Utrecht University, I performed this research for my graduation project. The past six month I researched a particular science-policy interface regarding climate change research and its application in local adaptation planning. While the science-policy interface is a concept that cannot be simply observed, interviewing scientists, consultants, municipal practitioners and boundary workers allowed me to gain an understanding on this science-policy interface and its dynamics. In this thesis I aimed to put these understandings on paper.

From Utrecht University, Dr. ir. D. Hegger supervised my research. Dries, thank you for providing me with usable feedback and taking the time to discuss both my general and very specific questions. Moreover, I much appreciated how you made time available to think along with me to find an interesting practical case to study. Also I would like to thank my second reader, Dr. C. Dieperink, who provided me with valuable feedback on the research design of this thesis.

This research I performed at boundary organization Climate Adaptation Services (CAS), which did not only provide me with a timely case study, but also offered me a pleasant and professional workspace. I experienced the CAS team – Arjen Koekoek, Hasse Goosen, Kim van Nieuwaal, Marit Heinen, Menno van Bijsterveldt, Onno Piek and Rahel Laudien – as very dedicated to their work and everybody was very helpful to answer my questions. In particular, thank you Arjen for engaging me in the update process of the Climate Adaptation Atlas and thinking along with my thesis project. In addition, towards the end of the thesis writing process, I was given the opportunity to contribute to writing a paper at CAS that included findings of this thesis research. Thank you Rahel, Kim and Hasse for giving me this opportunity. I much appreciated our discussions on usable climate information and co-production processes.

Eva Boon
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# Summary

Municipal practitioners are challenged to plan for climate adaptation. Access to climate vulnerability information is critical, yet the usability of this information is easily compromised by inherent complexities and uncertainties. Science-policy interfaces aim to address this issue, yet the influence of contextual factors on the performance of science-policy interfaces to produce usable climate information is little studied. To address this knowledge gap a specific case of a science-policy interface in The Netherlands was studied: The Climate Adaptation Atlas (CAA). The CAA is an interactive vulnerability map to support local adaptation planning. In practice, Dutch municipalities are currently challenged to formulate an integrative environmental vision as part of a substantial spatial planning reform. This provides an opportunity to institutionalize adaptation. Therefore, this research addressed the question:

*Which factors determine the usability of the CAA climate information tool to support municipal practitioners in local adaptation planning and how can this be expected to develop anticipating the environmental vision?*

An embedded case study design was applied, studying the CAA science-policy interface for five user cases: medium-sized municipalities. In-depth semi-structured interviews with both the CAA producers(n=9) and municipal practitioners(n=10) were performed to describe the actors' contexts and to evaluate the usability of the CAA. Results were validated with experts(n=4). The analysis revealed six factors that determined the usability:

| | |
|---|---|
| 1.Visual overview: | the CAA provides a visual, understandable overview of climate vulnerabilities |
| 2.Tailor-able: | the CAA can be contextualised by adding local geospatial information |
| 3.Cross-sectorial: | the CAA fits the favoured 'systems approaches' |
| 4.Freely available: | the CAA is freely available |
| 5.Co-developed: | policy-makers and scientists co-produced the CAA |
| 6.Co-(prod)used: | municipal practitioners further co-produce the CAA with intermediaries |

Facilitating cross-sectorial planning approaches, the CAA appeared a promising tool to support the integration of climate adaptation in the environmental vision. Yet the great organizational changes in municipalities resulting from the spatial planning reform demand further guidance on *how* this integration can be achieved. This research affirms the importance of contextual factors by revealing how *inter alia* the organizational structure of municipalities and prevailing accountability culture influence the type of climate information that is needed, adopted and used. Furthermore, since the absence of incentives for municipal practitioners and scientists to interact did not compromise the usability of the CAA, the widely advocated process of science-policy co-production was reconsidered. It is suggested to regard co-production on multiple levels and engaging diverse actors. Directions for future research and practical recommendations are provided.

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# 1 Introduction

## 1.1 Scientific Knowledge gap

Municipalities are challenged to formulate sensible policies to the risks of climate change impacts such as flooding from sea, rivers and downpours or heat and drought impacts. Climate adaptation is a response to mitigate these risks and can be defined as (IPCC, 2014, p. 8):

*"The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects"*

Municipalities are key actors in climate adaptation as it is at these levels where climate change risks manifest and where the risks are addressed (Hoppe, van der Vegt, & Stegmaier, 2016; Mees, 2014; van den Berg & Coenen, 2012; Wilson, 2006). Moreover, on the local level a large potential for solutions for adaptation is present, as many local decisions affect the local vulnerability (Cutter, 2003). There are two pre-conditions for successful adaptation, being access to information on what to adapt to and how, and access to the resources needed for adaptation action (Füssel & Klein, 2006). A key function of this information is the vulnerability assessment (Füssel & Klein, 2006, p. 304):

*"The collection of information about the vulnerable system and the stressors that it is exposed to (in terms of scientific research, data collection, or model experiments), and the transfer of resources to vulnerable societies (in terms of financial means, technologies, or expertise) in order to help them to prepare for and cope with un-avoided impacts of climate change are thus necessary elements of a comprehensive climate policy"*

Yet for municipalities it is not straightforward that they have access to information that is usable to generate policies. Especially, the actors in local governments that address climate adaptation and formulate policies, 'municipal practitioners', need this information. Municipal practitioners are the actors that can plan for longer time scales, foster deliberation among stakeholders, facilitate implementation, coordinate capacity and manage consistency among the adaptation planning process (Graham & Mitchell, 2016). Since climate adaptation has a strong orientation to the spatial environment (Goosen et al., 2014; Hurlimann & March, 2012), the municipal practitioners that work on the spatial environment, such as city planners and environmental managers (e.g. sewerage managers, vegetation management etc.) are important practitioners for local adaptation planning. Yet, planning for adaptation is not easy, and many barriers have been identified that constrain adaptation planning at the municipal level such as lacking political support, little awareness, little budgets and lacking (usable) information (Porter, Demeritt, & Dessai, 2015; Räsänen et al., 2017; Runhaar, Mees, Wardekker, van der Sluijs, & Driessen, 2012).

Moreover, managing the societal risks of climate change is a risky exercise for municipalities themselves, as the management of societal risks bring risks for the institutions that manage these risks and for the legitimacy of regulations that they apply (Rothstein, Huber, & Gaskell, 2006). In the pursuit of 'good governance' (e.g. by aiming for coherence of regulations through increased accountability and scrutiny) the role of risk management in regulating institutions has become more dominant. The central role of risk management may positively contribute to mitigate societal risks, as in the shift towards multi-actor governance systems (Driessen, Dieperink, van Laerhoven, Runhaar, & Vermeulen, 2012) the management of risks may be effectively executed through a network of 'risk managers' instead of single institutions (Rothstein et al., 2006). However, a negative consequence may be that managing institutional risks becomes prioritized over managing societal risks (ibid).

Especially the risk of climate change impacts is a complicated societal risk that is not easily comprehended and managed. The climate system is characterised by feedback mechanisms among different temporal and spatial scales, making the system complex in nature. Moreover, the 'behaviour'

of the climate system is yet understood to a limited extent and future climate is uncertain (Houghton, 2009). Motivated by strong evidence for a changing climate, scientists research *what will happen*, *what can happen* and *how specific targets can be achieved* (Börjeson, Höjer, Dreborg, Ekvall, & Finnveden, 2006; Moss et al., 2010), resulting *inter alia* in reports describing a range of plausible futures (e.g. see IPCC, 2007, 2013). However, these future climate projections are concerned with large uncertainties, that emerge from for example multi-model outcomes, different scenarios and perturbed physical uncertainty (Kaye, Hartley, & Hemming, 2012; Stephens, Edwards, & Demeritt, 2012). These uncertainties affect projections with regard to *what* happens, *where* and *when*. Consequently, many aspects of (future) climate are not simply uncertain but fundamentally unknown and moreover depend on society's choices (Stephens et al., 2012). Such systemic risks cannot be described in simple cause-effect models and need different approaches than simple risks (Renn, Klinke, & Van Asselt, 2011) and different types of uncertainties need different interpretations to guide adaptation decision-making (e.g. see Brugnach, Dewulf, Pahl-Wostl, & Taillieu, 2008; Walker, Marchau, & Swanson, 2010).

Thus, supplying municipal practitioners with information that they can use to formulate sensible adaptation policies is not an easy task and often problems emerge; science-policy interface problems. Science-policy interfaces aim to enrich the decision-making through decisions that are well informed on the issue and the associated interests as well as the potential solutions (Van Enst, Driessen, & Runhaar, 2014). Generally, three problems in environmental science-policy interactions are (ibid):

1) The strategic use of knowledge from the side of policy-making
2) The strategic use from the side of science
3) An operational misfit between demand and supply of knowledge

Multiple studies describe how these problems manifest in the production, understanding and use of scientific climate information. For example, a study on the use and production of scenarios in the Netherlands showed how uncertainty and complexity of climate information led to misunderstanding by both users and producers (Enserink, Kwakkel, & Veenman, 2013). In another study, selective and strategic use of uncertainty information on future climate was reported, as well as unnecessary discussions delaying decision-making (Wardekker, van der Sluijs, Janssen, Kloprogge, & Petersen, 2008). Moreover, the study showed how different manners of expressing uncertainty (e.g. verbal and numerical) of the likeness of future events, were associated with significantly different interpretations. Finally, policy-makers reported the urgent need for information that is policy-relevant (ibid). While the strategic use of climate information may be a concern in local policy-making, finding access to and using climate information for adaptation planning can be regarded as the first step towards the formulation of sensible policy options, therefore is focused on the problem of 'operational misfit'.

Responding to science-policy interface problems, studies focus on improving this interface through creating an understanding of how climate information is produced, perceived and understood (e.g. Cash et al., 2003; Lemos, Kirchhoff, & Ramprasad, 2012; McNie, 2007). While information can be theoretically useful to policy-makers, this may not be perceived useful by policy-makers, therefore Lemos et al. (2012) argue that not all useful information is *usable* (see also chapter 3). Moreover, to be usable to decision-makers, information must be perceived in line with their "value demands", referring to the perceived policy-relevance ('saliency'), accuracy and quality of information ('credibility') and the perceived 'legitimacy' of the information producing institution (Cash et al., 2003 see chapter 3). From literature different processes, strategies and actors are suggested that may contribute to improving the usability of climate information in science-policy interfaces:

Firstly, a process that is widely reported to increase the usability regards interactions between the users and producers of information. Participatory approaches towards knowledge production, in which scientists and decision-makers jointly produce knowledge (or: co-production) may increase the saliency, credibility and legitimacy of information (e.g. see Hegger & Dieperink, 2014; McNie, 2007). These processes may both be oriented to the formulation of science policies (e.g. definition of research agendas) and to the inclusion of scientific information in decision-making processes (McNie, 2007). Through co-production processes is aimed to achieve iterative mechanisms, in which information flows within and between the scientific and policy communities are focused on exchange and participation (ibid). Overall, interactions between scientists and decision-makers may improve the

usability when their relations are strengthened in terms of trust, cooperation and respect (ibid). However co-production is also a costly process, and demands substantial time and efforts (Lemos et al., 2012; McNie, 2007).
Secondly, two strategies that are often reported to increase the usability of climate information are tailoring and visualisation. Tailoring climate information recognises that different audiences have different perceptions, capacities and characteristics that impact comprehension (Lemos et al., 2012; Lorenz, Dessai, Forster, & Paavola, 2015). Processes of interactions may help to identify user-demands and tailor climate information (McNie, 2007), however care should be taken as user preference for information does not necessarily matches user comprehension (Kinkeldey et al., 2014; Lorenz et al., 2015). User needs may be determined by user characteristics but also depends on the phase of the adaptation planning process (Lorenz et al., 2015). Moreover, information needs for adaptation may differ for different locations, sectors, climate change risks, existing knowledge and the decisions to be made (Kiem, Verdon-Kidd, & Austin, 2014). Hence to meet the user-demands the specific decision-making process of the policy community and its processes need to be understood (McNie, 2007). Tailoring may be accomplished through 'customization', in which climate information is adjusted to specific users' needs, such as the selection of a specific climate parameter and framing this parameter in a desired unit, for example the occurrence of a precipitation event with a specific repetition time at a certain location. Another form of tailoring is 'value adding', in which a certain message is communicated, for example by selecting and analysing specific climate parameters to a certain field of application, hence combining climate information with other relevant information (Lemos et al., 2012). Other relevant information may include geospatial information on vulnerable objects and populations as well as local objectives. Then, climate information can be understood as that it includes parameters that describe the current or future state of the climate. The strategy of value adding has been promoted by various authors who suggest that local non-climatic information should be added to improve the usability of climate information, such as local geospatial information on tasks with a spatial orientation 'spatial tasks' or 'spatial priorities' (Goosen et al., 2014; Räsänen et al., 2017).

A second strategy is to use visuals in communicating climate information. Visualisation tools are known for their explanatory power and they are widely developed to increase insight in physical processes, impacts and to support decision-making (Grainger, Mao, & Buytaert, 2016). Visualisation tools can serve a variety of aims, such as increasing urgency among policy-makers (e.g. see Brown et al., 2006) and supporting participative local decision-making for climate adaptation (Burch, Sheppard, Shaw, & Flanders, 2010; Shaw et al., 2009). A key finding on effective uncertainty communication of geospatial visualised data is task-dependency (Kinkeldey, Maceachren, & Schiewe, 2014; Kinkeldey, MacEachren, Riveiro, & Schiewe, 2015). The authors suggest considering categories of tasks such as communicational, analytical and exploratory tasks. Hence, as brought forward with the tailoring of information, visualisation tools should be matched to the aims of use. However, communicating deep uncertainty with visualisations for policy-making remains difficult (Spiegelhalter, Pearson, & Short, 2011), posing the challenge to balance saliency, richness and robustness of climate information (Stephens et al., 2012).

Finally, specific actors that may play a role in increasing the usability of climate information are boundary organizations. Boundary organizations recognize the divide between science and policy and aim to manage this boundary through efforts of translation, mediation and effective communication (McNie, 2007). By facilitating learning processes among science and policy actors, boundary organizations can solve issues between these actors that the actors could not have solved alone (Crona & Parker, 2012). Yet to perform such a role and be perceived as a legitimate actor, boundary organizations must be accountable to both the scientific and the policy-making community in that they deliver climate information that is credible to the scientific community and relevant to the policy standards (Graham & Mitchell, 2016). Boundary organizations could deliver climate services (Räsänen et al., 2017), applying for example the strategies as explained above.

Inspired by processes and strategies as stated above, among others, many climate information tools have been established and more recently, climate (adaptation) services have been developed to narrow the gap from the production of scientific climate information to its application in the policy field (Goosen et al., 2014; Räsänen et al., 2017). However there is little understanding of how social,

economic and political dynamics as well as other contextual factors influence the performance of the science-policy interfaces (Van Enst et al., 2014). Subsequently, little is known on how the performance of these science-policy interfaces can be influenced and how these deliberately can be improved for diverse problems in specific contexts (ibid). What makes that usable climate information is produced, and why is it usable? There is especially little knowledge on how this usability manifests for policy-makers at the municipal scale; the role of information in adaptation planning in municipalities is little studied (Archie, Dilling, Milford, & Pampel, 2014). This research addresses this gap and takes into account the contextual factors in the scientific community and the local level policy-making community.

## 1.2 Practical knowledge gap

As introduced in the previous section, due to the orientation of climate adaptation towards the physical environment, spatial planning is a relevant policy domain for addressing climate adaptation. A development in the Netherlands is the reform of the spatial planning laws into an integrated environmental planning act, expectedly put into force in 2019. The establishment of this act is motivated by the plurality of laws and procedures that complicate 'passing the legal desks' for planning projects (Altes, 2016). Basic principles to the act are: less and clear rules, more space for initiatives, local tailoring and trust ("aandeslagmetdeomgevingswet.nl," n.d.-a). The act has a large impact on municipalities, not only since they have to redesign their procedures but also because all relevant sectors must be integrated, including water, infrastructure, nature, environmental and space.

Currently the act is further specified through experimentation and learning processes with governmental bodies and citizens. A key instrument of the act is the 'environmental vision'. This vision comprehends a long-term strategic vision for the physical living environment ("aandeslagmetdeomgevingswet.nl," n.d.-b), and is mandatory for all governmental levels. The format of the vision instrument is not fixed, attributing the municipalities with freedom towards the ambitions, time-horizon, level of abstraction and themes (Ministerie van Infrastructuur en Milieu, 2016). The development of an integrated vision on the environment is a challenge for municipalities, but also a "window of opportunity" to include adaptation. The question is whether municipalities exploit this opportunity to institutionalise adaptation into spatial planning. Especially the municipal practitioners working on spatially relevant policy domains, such as green managers or urban planners, are the individuals that may be seeking for usable climate information to address climate adaptation. Moreover, it regards these municipal practitioners that are confronted with new ways of working: integrating policies while reducing regulations. These changes may influence the climate information needs.

A climate information visualisation tool that can potentially support municipal practitioners to integrate climate adaptation in the environmental vision is the "Klimaat Effect Atlas" (Climate Adaptation Atlas, CAA). This is an interactive map of the Netherlands where current and future climatic risks and vulnerability can be plotted. The tool is developed to increase the understanding of the climate change impacts and vulnerability of the Netherlands and is intended for local and regional policy-makers (for more details on the CAA see section 3.2.1 and 5.1.1). The CAA will be updated in 2017 to include the latest scientific insights. This moment allows for reflecting the usability so far and the identification of improvements to support adaptation planning in context of the environmental vision. Hence from the above emerges that there is a practical knowledge gap on how the reform of the spatial planning laws may influence the climate information needs of municipal practitioners to address adaptation planning, and the extent to which current available climate information, such as the CAA, can fulfil this need.

## 1.3 Research goal & Research question

Following the scientific and practical knowledge gap, this research aims to gain insight in how the science-policy interface between climate change research and local adaptation planning can be improved, by evaluating and understanding the usability of the Climate Adaptation Atlas (CAA) for

Dutch municipal practitioners in support of local adaptation planning and the formulation of the environmental vision. Thereby this research contributes to scientific research on the performance of science-policy interfaces to produce usable climate information and the role of contextual factors. In addition this research provides insight in how the climate information needs may develop in context of a changing environmental law in the Netherlands.

The following research question and sub-questions are leading in this research:

*Which factors determine the usability of the CAA climate information tool to support municipal practitioners in local adaptation planning and how can this be expected to develop anticipating the upcoming policy instrument 'the environmental vision'?*

1. What evaluation criteria for the usability of climate information can be identified from literature on the science-policy interface?

2. What factors can be used to analyse the contexts of the producers and users of climate information and can potentially explain the usability of climate information?

3. How do the CAA producers develop climate information and how do the municipal practitioners pursue adaptation planning and the environmental vision in the CAA case?

4. To what extent is the CAA usable for municipal practitioners for adaptation planning and how can this be explained?

5. What conditions for usable climate information can be identified for addressing climate adaptation in the municipal environmental vision and to what extent are these conditions met by the CAA?

Corresponding with these questions, Figure 1.1 represents the research framework indicating the steps to achieve the research objective. The numbers in the small grey circles correspond with the sub-questions, the boxes indicate the sections in which the sub-questions are addressed and answered. The blue and red lined boxes refer to the actors of the science-policy interface; throughout this thesis red colours are used to indicate the users, while blue colours refer to the producers.

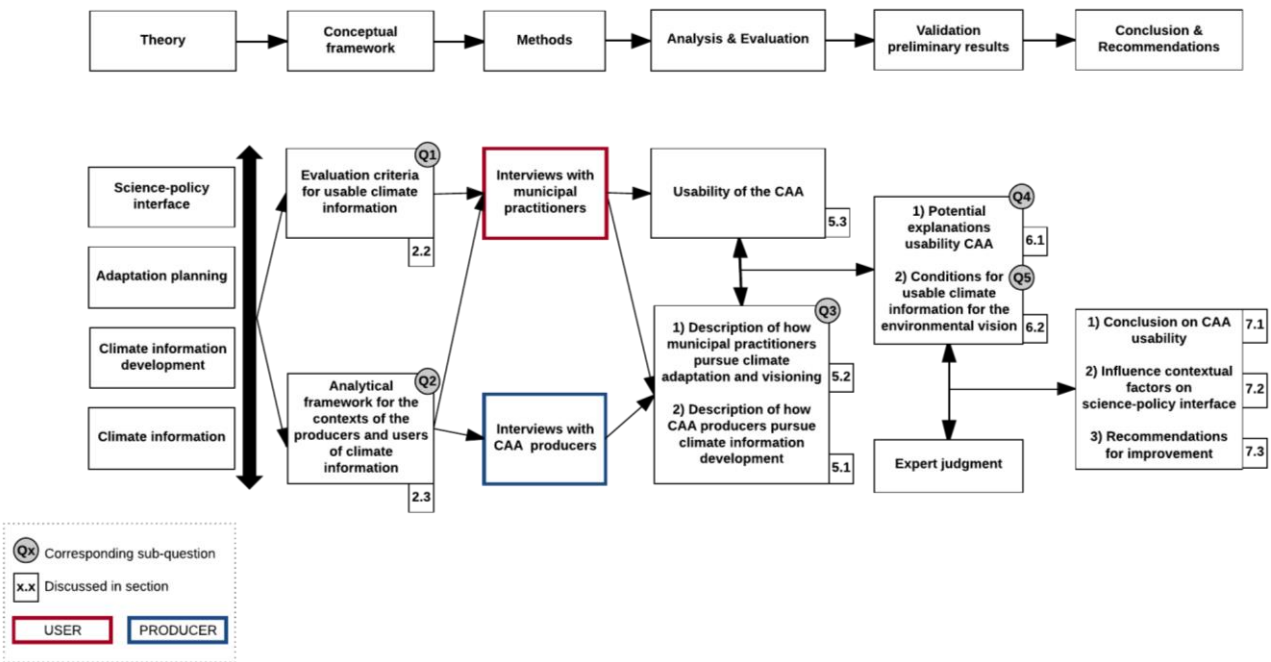



**Figure 1.1: Research Framework**

Describing the science-policy interface interactions of the CAA is timely, since there are little empirical cases that expose both sides of the science-policy interface to evaluate the usability and

moreover take research contextual factors. Gaining insight in the factors that influence the usability of climate information of a specific context may yield lessons on how the production and use of climate information may be improved to mitigate the risks of climate change. Moreover, the specific evaluation of the CAA for the environmental vision may provide insights for municipal practitioners that aim to address climate adaptation.

## 1.4 Reading guide

*Thesis structure*
Having introduced the scientific and practical knowledge gaps, goal and questions, this thesis continues as follows: Chapter 2 discusses literature on usable climate information and the science-policy interface. This results in a framework to evaluate the usability of climate information in section 2.2 and a framework to analyse the contexts of the producers and users of climate information in section 2.3. The chapter concludes with answering sub-question 1 and 2.

Subsequently chapter 3 presents the methods applied in this research and elaborates on the case studied in the research: the CAA. Chapter 4 provides a brief introduction into the policy context of adaptation and spatial planning in the Netherlands, which allows to better understand the results presented in chapter 5. The results chapter comprises of three parts. First, section 5.1 describes the CAA producers' context, thereafter section 5.2 describes the municipal practitioners' context. These two sections answer sub-question 3. Thirdly, the usability of the CAA as evaluated by the municipal practitioners is presented in section 5.3.

Continuing, chapter 6 discusses the interpretation of the results by relating the findings from the three sections in chapter 5 to each other. First section 6.1 proposes explanations for the usability of the CAA, answering sub-question 4. Subsequently, section 6.2 discusses to what extent the (future) information needs for the environmental vision can be met the CAA. This section provides an answer to sub-question 5.

Finally, chapter 7 concludes on this research in three sections. First, section 7.1 answers the central research question. Thereafter section 7.2 discusses the findings of this research in relation to existing literature, reflects on the research approach and provides suggestions for future research. Finally, section 7.3 provides practical recommendations that may improve the usability of the CAA and the science-policy interface regarding local adaptation in The Netherlands in general.

*When reading this thesis…*
While also explained elsewhere in this thesis, the next three points may help the reader when reading this thesis: Firstly, throughout this thesis a colour scheme was applied to indicate what part of the science-policy interface was discussed. Blue colours were used to indicate the producers of (scientific) climate information, and red colours were used to indicate the users of climate information. The usability of climate information, which can be understood a when users and producers align, were indicated with purple colours.

Secondly, often-used concepts that comprise of double terms were for readability reasons often indicated with single terms. For example, the following terms were frequently used interchangeably: [municipal practitioner] – [practitioner] and [climate adaptation] – [adaptation].

Thirdly, the term 'climate information', a central concept in this thesis, was used to refer to information that includes parameters on the state of current or future climate. Alternatively, terms like 'geospatial information' and 'local knowledge and information' do not include climate components. Yet, climate information may include geospatial information, for more explanation on this see section 2.3.2.1.

# 2 Conceptual framework

Following the first two sub-questions, this chapter discusses literature on the science-policy interface (Cash et al., 2003; Lemos et al., 2012; McNie, 2007; Van Enst et al., 2014) and literature to analyse the contexts of the producers and users of scientific climate information for local adaptation planning (Eikelboom & Janssen, 2013; Füssel & Klein, 2006; Goosen et al., 2014; John, Keeler, Wiek, & Lang, 2015; Sarewitz & Pielke, 2007; Uittenbroek, Janssen-Jansen, & Runhaar, 2013; Vogel & Henstra, 2015). Inquiry on this literature yields two frameworks; an evaluative framework and an analytical framework.

This chapter is structured as follows; First is shortly explained how literature was searched and selected for both frameworks (section 2.1). Subsequently, section 2.2 provides a conceptual understanding of a successful science-policy interface for climate information, and presents a framework to evaluate the usability. Thereafter, in section 2.3 a framework is proposed to understand both producers' and users' contexts, by introducing factors to analyse how scientists pursue the development of climate information, and how municipalities pursue adaptation planning and spatial vision development. The chapter concludes with answering sub-question 1 and 2.

## 2.1 Literature review

Relevant literature was identified by searching search engine *Scopus* using the following keywords:

[climate change], [climate change research], [climate information], [local adaptation policy], [local spatial planning], [policy integration], [municipal adaptation], [science-policy interface], [vision development], [usable information].

Articles were selected on the criteria that they were relevant for learning on 1) the criteria that influence the performance of the science-policy interfaces to produce usable climate information, 2) how climate information is developed for policy applications, and 3) how municipal practitioners pursue adaptation-planning and spatial vision development. Selecting most cited and most recent articles narrowed the search results down to the most relevant literature.

## 2.2 Evaluative framework

In this research, a successful science-policy interface is understood as when science supplies potentially *useful* information to policy-makers that is adopted. Hence, to improve the science-policy interface, the goal is to generate information that policy-makers need and use (McNie, 2007, p. 17):

*"Useful scientific information improves decision-making by expanding alternatives, clarifying choices and enabling decision-makers to achieve desired outcomes"*

However, clarifying choices may also reduce alternatives in contrast to expanding alternatives, depending on the role scientists take towards policy-making (Pielke, 2007). Based on the scientists' view on science and democracy, four roles of scientists in decision-making can be distinguished (ibid), see Table 2.1. Of the four roles, the 'honest broker' aims to both provide a complete range of alternatives as well as providing possible criteria for decision-making to clarify choices and reduce alternatives (ibid). The 'issue advocate' is in favour of a particular political agenda and focuses with research on promoting the interest at hand (ibid). Both roles may produce useful information according to the definition stated above, depending on the decision-making context and needs. Alternatively, the 'pure scientist', who doesn't take in consideration the use or usability of research, and the 'science arbiter', who doesn't want to be involved in political considerations whatsoever (Pielke, 2007), are in the above definition not suitable to produce useful information to policy-makers.

Rather, useful information is more likely produced by scientists that take into account decision-making needs.

**Table 2.1: Four idealized roles of scientists** (adapted from: Pielke, 2007)

| | | View of science | |
|---|---|---|---|
| | | Fundamental research and freedom of scientists best serves society, e.g. by reducing uncertainty. | Users of science should have a role in it's production. |
| View of democracy | Experts can offer specialised knowledge for a particular interest in the political debate. | Pure Scientist | Issue Advocate |
| | Experts should inform on the implications of expert knowledge for decision-making. | Science Arbiter | Honest Broker |

To be of use to policy-makers, information must be perceived in line with their "value demands", which are met if the information is perceived salient, credible and legitimate (Cash et al., 2003; McNie, 2007; Van Enst et al., 2014). Saliency is the perceived relevance to users. Credibility refers to the perceived accuracy, validity and quality of information. Legitimacy refers to that the information producers are perceived as free from political bias and that they are respective to the users' interests (McNie, 2007).

Beyond the perception of the legitimacy of the information producers, the transmission process of information from the scientific community to the decision-making community in general influences the potential usefulness of information (McNie, 2007, 2013). In improving science-policy interactions it is widely reported that the application of participatory and collaborative approaches can support this (e.g. see Armitage et al., 2009; Cash, Borck, & Patt, 2006; Hegger & Dieperink, 2014; van Buuren & Edelenbos, 2004).

While climate information can be theoretically useful as perceived by scientists, it is not always perceived useful, i.e. *usable*, by policy-makers (Lemos et al., 2012). This gap between scientific information and policy-making emerges from either scientists who think they produce useful information while in reality it is not used, or from users that are not aware of the available information or how it can support their decision-making (ibid). This corresponds with how Sarewitz and Pielke Jr. (2007) reason that the usability gap may emerge when the internal logic of the scientific community on 'usable' climate information does not fit the decision-makers' needs, which strongly depends on the decision context and the broader social setting. Lemos et al. (2012) conceptualise three broad factors that influence the **usability** of climate information for users:

- The perceived **fit** of information to the decision-making needs.
- The **interplay** of climate information with other (existing) kinds of knowledge of decision-makers. Problems with the usability of information emerge when information conflicts with existing knowledge, for example with regard to organizational routines or expertise.
- The quality and level of **interaction** between scientists and policy-makers. The willingness to use information is influenced by the process of transmission of information.

Table 2.2 lists the drivers for each of these factors; these factors are operationalized in Table 2.3.

**Table 2.2: Factors that contribute to the usability of information** (adapted from: Lemos et al., 2012)

| Factor | drivers that contributes to the factor |
|---|---|
| **Fit of information to decision-making needs** | Perceived accurate<br>Perceived credible<br>Perceived timely<br>Perceived salient |
| **Interplay with other kinds of knowledge of potential users** | Flexible decision-making structures<br>Human and technical capacity<br>Positive experiences with innovation<br>Decision-making culture to mitigate climate change risks<br>Public pressures<br>Perception of vulnerability<br>Triggering events<br>Users valuing research: information-seeking<br>Organizational incentives<br>Technocratic insulation<br>Commitment to planning |
| **Interaction between scientists and policy-makers** | Two-way communication<br>On-going relationship between science and policy community<br>Co-production<br>Trust<br>Legitimacy<br>Iterative |

Figure 2.1 illustrates how fit, interaction and interplay influence whether potentially useful climate information 'crosses the channel' and is adopted and used by the user. The double arrows indicate that the three variables may shape each other. For example, when policy-makers and scientists have many interactions, the perceived credibility (fit) may increase.

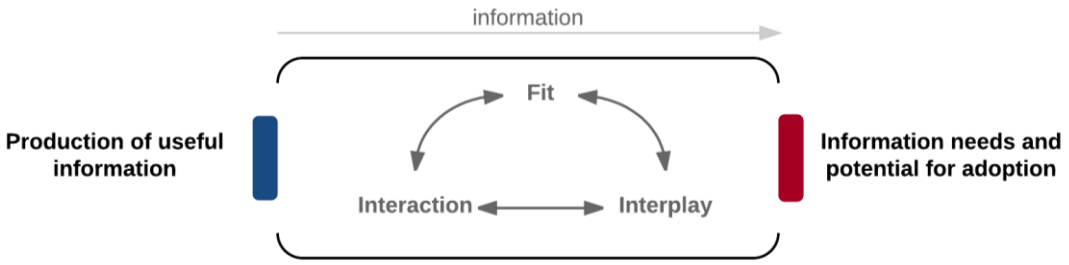



**Figure 2.1: Conceptual model usable information** (adapted from: Lemos et al., 2012, p. 791)

The conceptualisation of Lemos et al. (2012) was chosen as a starting point to evaluate usability, as it explicitly regards the actual use of climate information in the decision-making process, which suits the approach to regard the problem within the science-policy interface of an operational misfit. Moreover, using the factors from Lemos et al. (2012) seems to come with benefits with regard to often used approaches to discuss and evaluate usability.

Many studies regard the usability of (climate) information as a function of salient, credible and legitimate information, (e.g. see Bauer, Pregernig, & Reinecke, 2016; van Voorn, Verburg, Kunseler, Vader, & Janssen, 2016), based on the influential paper by Cash et al. (2003). Other studies have used similar criteria but emphasized the importance to regard in addition iterative mechanisms between users and producers, by the inclusion of decision-making needs into research (e.g. see Ford, Knight, & Pearce, 2013; Sarkki et al., 2015). Also organizational factors such as dispersed organisational units were found as a factor that strongly influenced information uptake (Soomai, 2017). Hence, evaluating usability demands a broader perspective, in which also the interactions and contextual factors make up the function of usability. This resonates with the knowledge gap that this research addressed, by taking into account the contextual factors. The reasons motivated the use of the framework of Lemos et al. (2012). Moreover, as the framework is based on literature from diverse perspectives (including institutional, organizational, cultural, congenital and behavioural factors that influence the information uptake and use), it is expected that this allows better for the localisation of problems in the science-policy interface and hence the allocation of potential improvements.

**Table 2.3: Operationalization of the evaluative framework**

| Criteria | Drivers | Operationalization/Definition | Indicator, interviewee refers for example e.g. to.. | Based on source |
|---|---|---|---|---|
| Fit/ Product | Perceived accurate by user | The perceived precision and exactness of information is perceived good, regarding the temporal and spatial dimensions of information | …appropriate/good quality temporal and spatial resolution | |
| | Perceived credible by user | The perceived authoritativeness of scientific community and the extent to which the information is perceived as of good quality | …peer reviewed, scientific logic, description of assumptions and simplifications, the quality of the institute | (Cash et al., 2003; Kirchhoff, 2010) |
| | Perceived timely by user | The production and dissemination of information is perceived timely | …the availability of information with regard to the planning phase | (Kirchhoff, 2010) |
| | Perceived salient by user | The climate information is perceived as relevant to the needs of the policy maker, by increase understanding and/or assists in solving a policy issue at hand. | … the policy issues is clearly framed and regarded relevant by policy-makers, the content is perceived relevant: themes (drought, flooding), prospects for action, temporal and spatial scales etc. | (Cash et al., 2003; van Voorn et al., 2016) |
| Interplay/ Context | Flexible decision-making structures are in place | The flexibility of decision-making structures to introduce new knowledge into decision-making processes | …openness to change organizational routines, culture of risk | (Lemos, 2008) |
| | Human and technical capacity is sufficient | The human and technical capacity in the organization to introduce and adopt new knowledge/information, or to find access to it | …sufficient expertise and skills and technical systems (e.g. software) present to introduce new knowledge or access it (e.g. external) | (Lemos, 2008) |
| | Positive experiences with innovation have been gained | The positive experience of the introduction of new knowledge/information | …positive experiences with change in knowledge, routines. | (Lemos, 2008) |
| | Decision-making culture to mitigate climate change risks is in place | The use of climate information is perceived as a strategy to mitigate risks, rather than a risky practice itself | … climate change is a risk that needs to be managed and prevented, referring to uncertainties of climate information and its usability | (Lemos et al., 2012) |
| | Public pressure of addressing issue have been raised | The pressure on policy-makers from citizens to addressing climate change (adaptation) in their long-term planning | …calls from the public, newspapers, articles, or interest groups pressuring the municipality to take action | |
| | Perception of vulnerability is present | The perception of present risk climate change risks | … past experiences, expressing concern on risks and impacts etc. | (Lemos et al., 2012) |
| | Triggering events have occurred | The occurrence of climate change related events such as droughts and flooding, and the related impacts. | … past or current climate change related events: such as flooding, heat, casualties etc. | |
| | Users value (scientific) research | The value a policy-maker attributes to scientific research, and strives for use | … the importance to consult scientific information and experts | (Kirchhoff, 2010) |
| | Organizational incentives are in place | Support from upper management to use (scientific) information and expertise | … managerial support, mandate and means to collaborate with research institutes and to address climate change adaptation | (Kirchhoff, 2010) |
| | Technocratic insulation is in place | Relying on high technical expertise to guide decision-making, which is not or limited understood by the wider public | … decision-making, using models to guide decision-making, rational decision-making, referring to calculations etc. | (Lemos, 2008) |
| | Commitment to planning is present | The extent to which for climate change related risks is planned. | … a preparation/evaluation plan is present etc. | (Kirchhoff, 2010) |
| Interaction/ Process | Two-way communication takes place | The users and producers communicate from both initiatives on climate information | …(face-to-face) contact moments of policy-makers with research institutes, in which both parties inquire on mutual needs and possibilities. | |
| | Co-production takes place | Both users and producers cooperate in the exchange, production and application of knowledge. | …information is tailored in workshops, meetings, knowledge and research programmes | (Hegger, Lamers, Van Zeijl-Rozema, & Dieperink, 2012) |
| | Users trust producers | The belief that someone or an organization is reliable, good, honest, effective etc. | …past experiences from which appears that an actor is reliable, honest and good and trustworthy | |
| | Producers are perceived legitimate by user | Climate information production is perceived as open and free of political bias | …transparency in process of production, independently research, and taking into account the divers interests and perspectives | (McNie, 2007) |
| | Iterative mechanisms are in place | The extent to which interactions between producers and users influence how research pursue science and how users understand the possibilities and limits of science | …producers taking into account practical questions from municipalities in formulating their research projects, alternatively municipalities are aware what research and what research answers are plausible to expect | (Lemos & Morehouse, 2005) |
| | On-going relationship is in place | Frequent, or standard knowledge exchange between users and producers | …frequent meetings, e.g. on seminars, workshops, collaborations, contracts | |

## 2.3 Analytical framework

Why it is that certain climate information is more usable to policy-makers than other types of climate information? As explained in the introduction, different users have different characteristics, capacities and perceptions that all may affect comprehension of climate information; moreover the objectives of use are different for different tasks and different phases in the policy-process (Lorenz et al., 2015). Hence, knowing the user and its objectives may help to understand why certain information is perceived salient (fit), or why it is that certain information does not match the kinds of knowledge the user is familiar with (interplay). Additionally, the extent to which producers and users have a mutual understanding of each other's needs and possibilities by interacting (interaction), may influence the usability of information (Sarewitz & Pielke, 2007). Users may have expectations on what science can offer, but also the producers may have expectations on what users need and are capable of with regard to adopting and using climate information. This brings forward that explanations for the usability can also be sought in the production side of climate information: also producers are concerned with certain capabilities and perceptions that may influence the decisions made in the development of climate information. Understanding both users' and producers' contexts allows to gain insight into why municipal practitioners are in need of certain climate information, and why producers develop certain climate information.

The next sections introduce factors that allow to describe both the users' and producers' contexts, and that potentially can explain the usability of climate information. The identified factors can be understood as 'sensitizing concepts', meaning that factors potentially explain the usability of climate information, yet the factors may also appear to be background variables. At any case, all factors are regarded relevant for generating an understanding of the science-policy interface and the mechanisms that take place in climate information production and use. Provided the focus of this research, the factors describing the users' context is oriented on local adaptation planning and spatial vision development (section 2.3.3), and the producers' context focuses on climate information development (section 2.3.1). The analytical descriptions of the users' and producers' context can be situated in the figure on usability, as presented in Figure 2.2. In addition, to allow discussing the concept of 'climate information' in a systemic way, general factors are identified that may be relevant for the usability of the information, corresponding with the information arrow in Figure 2.2 (section 2.3.2). The factors are treated as 'background' variables, as they are derivatives of the decisions that are made by producers of climate information.

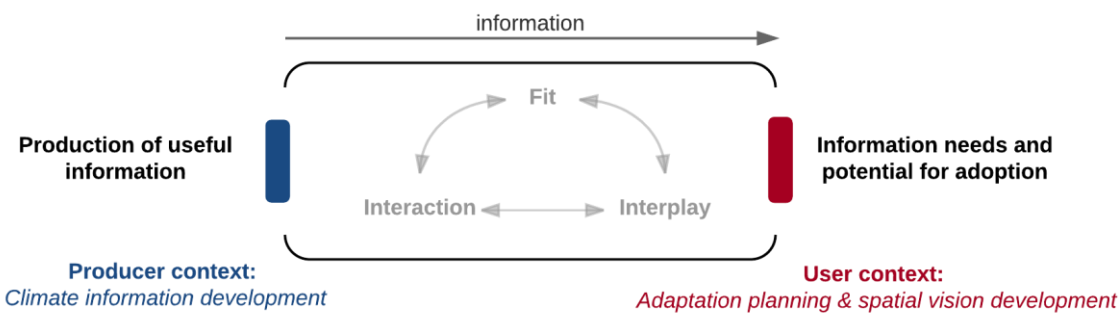



**Figure 2.2: Situation of analytical factors in the conceptual model of usable information**

### 2.3.1 Producers' Context

Starting at the producers' side of the science-policy interface, the manner in which climate information is developed may explain why the produced information is usable to policy-makers or not (e.g. Lemos et al., 2012; Sarewitz & Pielke, 2007). The next paragraphs introduce three broad analytical factors that may help to analyse how climate information is developed and that moreover may contribute to

explaining whether the developed information is usable to policy-makers. The three factors are not meant to be all encompassing; rather they aim to provide a general characterization of how climate information development is pursued and how this may influence usability. Moreover, the factors do not stand-alone; rather they are likely to shape each other.

#### *2.3.1.1 Actors*

The first factor concerns the actors that are engaged in the development of climate information and how they shape the process and outcomes. Climate information may be solely produced by scientists from research institutes, or with engagement of external actors such as boundary organizations, policy-makers, citizens or companies. Moreover, the actors may have a smaller or larger influence on the process of information development and the decisions with regard to the end product. The 'modes' of engagements may range from contractual (in which scientists test the applicability of their research outcomes) to 'consultative' (in which research is conducted to solve societal problems) and 'collaborative' (in which scientists and the engaged actors are equal partners in defining for example research questions) (Meadow et al., 2015). Hence different modes are concerned with different roles of actors that influence the decisions made in the development process. Broad coalitions of actors with diverse backgrounds and perspectives may leverage the production process by yielding more salient and credible knowledge through a legitimate development process, hence increasing usability (Hegger et al., 2012).

#### *2.3.1.1 Capabilities*

The second factor accounts for the contextual factors in which the climate information producers operate and that may influence the decisions made in the information development process (section 2.3.2 elaborates on these decisions). The setting in which producers operate may be characterised by particular incentives, constraints, opportunities, funding sources and cultures (Sarewitz & Pielke, 2007). To understand how this shapes the production of climate information insight is needed in the organizational, political, technical and cultural capabilities of climate information producers (ibid). The usability of climate information may increase when science policies in research institutes aim to produce actionable science, dispose of sufficient (human and financial) resources to live up to this ambition and dispose of the technical capabilities to model the climate information needs of users. For example, when in a particular research institute there is a culture or science policy that favours increasing fundamental understanding over the generation of societal benefits, it is less likely that policy-making needs are included in the research design.

#### *2.3.1.2 Beliefs*

In developing climate information, producers dispose of certain beliefs on what comprises of 'good' climate science and how it can best benefit society (Pielke, 2007; Sarewitz & Pielke, 2007). These beliefs may be shaped by experiences and expectations on user capabilities, user information needs and the users' patterns of information use. Moreover, as explained in section 2.2, scientists may have different beliefs on their roles as a researcher in relation to society and policy-making. Evidently, the extent to which the producers' beliefs and the following climate information match the users and their needs, influences the usability of the information. For example, if producers expect that users dispose of the analytical skills to read, interpret and analyse geospatial information, climate information may be disclosed in GIS formats. Alternatively, if producers' expectation is that policy-makers aim to discuss climate change risks with a larger group of practitioners with divers backgrounds, they might offer information that can be easily communicated to divers individuals. However, the extent to which the beliefs actually match the users and their needs, only comes to light when the producers' beliefs are compared with the user capabilities, information use patterns and information needs. Hence, looking for explanations requires an understanding of the users' contexts (on the users' context is elaborated in section 2.3.3). Comparative overlay of the producers' beliefs with the users' context can provide insight in the performance of the science-policy interface and may explain the usability of the developed climate information (Sarewitz & Pielke, 2007). In Figure 2.3 is such a comparative overlay visualised. To provide an example, when scientists have the belief that by increasing fundamental understanding policy-making is helped while policy-makers need concrete decision-support tools, there is a mismatch in rationales.

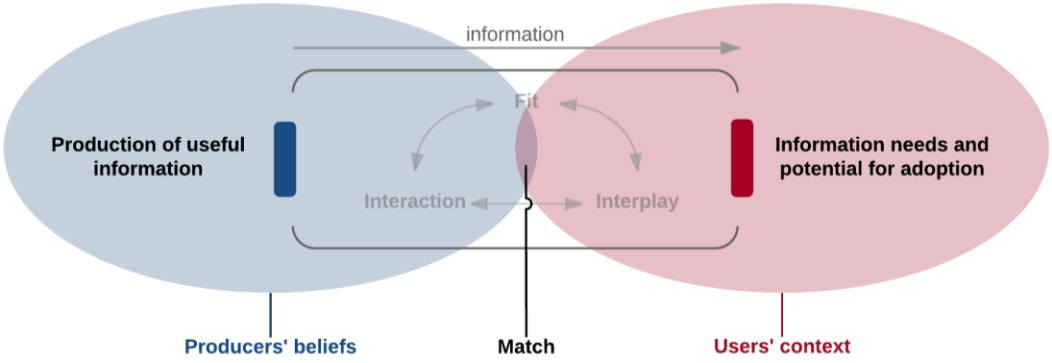



**Figure 2.3: Comparative overlay of rationales**

The above-introduced factors, which can be used to describe the producers' side of the science-policy interface and that can potentially explain the usability of the developed climate information, are operationalized in Table 2.4.

**Table 2.4: Operationalization analytical factors producers' context: climate information development**

| | Factor | Operationalization: Description and potential for explanation | Indicators, the interviewee refers e.g. to.. | Reference |
|---|---|---|---|---|
| Climate information development | Actors | The actors that are engaged in the development of climate information and how these actors influence the process and outcomes. The usability of climate information may increase with the inclusion of a broad coalition of actors and the extent to which actors can influence the development process. | …engagement of individuals with diverse backgrounds and roles, e.g. research institutes, companies, policy-makers (national, regional, local) and citizens, the extent to which actors influenced decision-making on e.g. relevant climate change indicators or information format etc. | (Hegger et al., 2012; Meadow et al., 2015) |
| | Capabilities | The context in which the producers operate and how this influences the development of climate information. The usability of climate information may increase when there is a culture that pursues the development of actionable climate science; there are sufficient (human and technical) resources to live up to this ambition and the technical capabilities to model the climate information that users need. | …available budgets, capacity to perform specific climate model calculations, ability to communicate science in understandable language, the extent to which research is focussed on the practical application etc. | (Sarewitz & Pielke, 2007) |
| | Beliefs | The producers' beliefs of how the development of climate information fits to the needs of the policy-making community, in terms of information use patterns, user capabilities and user information needs. The usability may increase when the producers' beliefs match the users' context. | …the structures of policy processes and how information is used by policy-makers, the capabilities to adopt and use climate information, the need of users in terms of specific climate change indicators or a specific format, perception of usable information etc. | (Sarewitz & Pielke, 2007) |

### 2.3.2 Climate information

The previous section showed how the producers' context may influence the decisions made in the climate information development process and thereby potentially influence the usability of climate information. However, there is much more to say on how exactly the decisions made in developing climate information yield usable information or not. Various studies show how different aspects of climate information are worthwhile to consider when aiming for the production of usable climate information (e.g. Füssel & Klein, 2006; Goosen et al., 2014; Rozum & Carr, 2013; Wardekker et al., 2008). In the next paragraphs is elaborated on three considerations that may be typical for establishing climate information and that may influence the usability: climate information content, expression of uncertainties and the functionalities/format of the information. This section corresponds with the information arrow, as indicated in Figure 2.4.

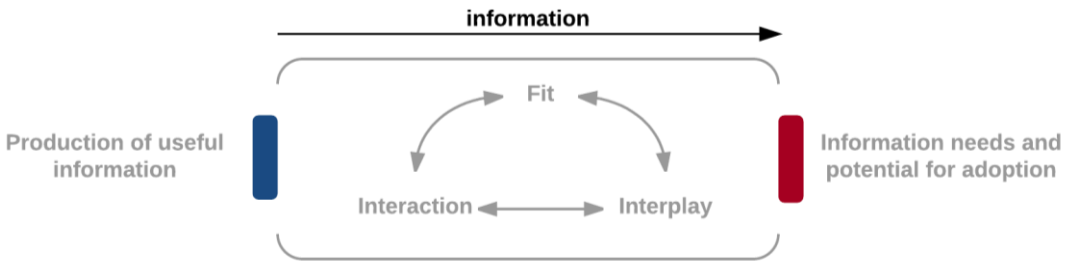



**Figure 2.4: Situation of climate information in the science-policy interface**

#### *2.3.2.1 Type of climate change information content*

First of all, a decision must be made on what information for adaptation is disclosed exactly. The content of climate information to inform adaptation considerations can be diverse, as climate information can take into account a variety of concepts: The simplest form regards changes in climate parameters (such as temperature and precipitation), more complex forms try to estimate potential impacts based on specific geospatial information including functions important to humans (e.g. river levels for shipping, or hospitals locations), the sensitivity of those functions, as well the ability to respond (Füssel & Klein, 2006). Broadly, three types of climate information content can be distinguished (ibid):

1) Impact assessments
2) Vulnerability assessments
3) Adaptation policy assessments

The different types of information are appropriate to inform different types of decision-making contexts (Füssel & Klein, 2006), see Table 2.5. Impact assessments regard the climate change processes and assess the impacts on climate parameters. Vulnerability assessments are extended impacts assessments, that include non-climatic factors, to determine for example secondary en tertiary impacts as well as the potential to adapt (Goosen et al., 2014). Alternatively, adaptation policy assessments examine the available policy options to implement adaptation measures to minimize the vulnerability and/or increase the adaptive capacity (Füssel & Klein, 2006).

**Table 2.5: climate information and decision-making context** (based on Füssel & Klein, 2006; Goosen et al., 2014)

| **Information** | **Description** | **Decision-making context** |
|---|---|---|
| Impacts assessment | Impact assessments take into account the nature and degree to which the system is exposed to climate variations (exposure) and the degree to which the system is affected by exposure (sensitivity), the assessment yields the consequences for the natural and human system (impacts). These impacts are 'primary impacts' and refer to changes in primary climate variables, such as changes in temperature and precipitation. | Specification of long-term targets for the mitigation of global climate change. |
| Vulnerability assessment | Vulnerability assessments are impact assessments that take into account the potential of the human system to adapt (1st generation vulnerability assessment) or also the feasibility of the human system to adapt, by regarding the adaptive capacity (2nd generation vulnerability assessment). Moving from an impact assessment to a vulnerability assessment includes taking into account secondary and tertiary impacts as well as the adaptive capacity. Secondary impacts take into account hydrological and geomorphological area characteristics, e.g. changes in river discharge. Tertiary impacts take into account land use and economic sectors, yielding impacts that may be positive or negative, e.g. flood damages, health effects. | Identification of particular vulnerable regions and/or groups in society to prioritize resource allocation for research and for adaptation. |
| Adaptation policy assessment | Adaptation policy assessments are extended vulnerability assessments that also include available response options, taking into account their feasibility and coherence with other policies. Policies may be about the concrete implementation of activities to avoid negative impacts and/or to increase the adaptive capacity of the system. | Recommendation of adaptation measures for specific regions and sectors. |

#### *2.3.2.2 Expression of uncertainty*

A second consideration in disclosing climate information is the communication of uncertainties. As explained in chapter 1, the projections and forecasts on future climate are uncertain by nature, and the expression of this in climate information is a frequent recurring characteristic that affects comprehension and usability of information. It regards the certainty and confidence there is with regard to future climate processes and states. Many policy-makers are unaware of the uncertainties associated with environmental information and what underlies these uncertainties, rather presented

numbers are often interpreted as facts (Wardekker et al., 2008). Hence, proper communication on uncertainties of climate information is important to prevent misunderstanding and misuse. Policy-makers may be mostly interested in uncertainty information when it is concise, policy-relevant and when explicitly is communicated on the implications, providing the policy-makers with a perspective of action. Yet, the interest and need for uncertainty information is not uniform, and may differ among policy-makers and their specific needs (ibid). The usability of uncertainty disclosed in climate information depends on the specific context, and users' interests in uncertainties may range from none, to interest in the sources of uncertainties, the uncertainties of effect sizes and on temporal and spatial scales and uncertainties in relation to taking action.

#### *2.3.2.3 Information format, functionality and tasks*

Finally, with regard the 'format' of information, communicating climate information to policy-makers can be done using different means such as scenario and projection reports, (spatial) tools and serious games, moreover expert's sessions, or dialogues are possible ways of transferring information. This research focuses on the climate information tools for local policy-makers, to support adaptation planning. From literature emerges that different types of information format are appropriate for different types of adaptation tasks as they provide different functionalities. Often is spoken of 'tools'. In their practical guide for coastal adaptation planning, Rozum and Carr (2013) list and discuss tools to support adaptation planning projects:

1) Visualisation tools
2) Modelling tools
3) Decision-support tools.

Visualisation tools may help to understand and envision current and future conditions and processes by means of graphics and simulation. Generally they are easy to use and don't need special software to run them (Rozum & Carr, 2013). Many studies have researched how visualization can be done best to transfer geospatial (climate) information and the related uncertainties for (Kaye et al., 2012; C Kinkeldey et al., 2014; Spiegelhalter et al., 2011; Stephens et al., 2012). Modelling tools are generally more complex and technical, requiring specific expertise as well as specific software (Rozum & Carr, 2013). Finally, decision-support tools help to develop storylines of future conditions based on climate change as well as decisions-made (ibid). These tools exhibit different functionalities, which can be more or less appropriate for certain adaptation planning activities. For example, visualisation tools may be more appropriate for stakeholder engagement, while modelling tools can better facilitate data management. In the same vein, Eikelboom & Jansen (2013) discuss how different interactive spatial support tools for adaptation: drawing, simulation and evaluation tools, can be linked to different adaptation tasks in generating and ranking policy-alternatives: analysis, validation, exploration, design, evaluation and negotiation. For example for the tasks of design and validation, simulation tools may be appropriate, while drawing tools may be appropriate for a broader set of tasks being validation, exploration, design and negotiation (Eikelboom & Janssen, 2013). While many types of information formats and functionalities may exist and policy-makers may have a diversity of tasks to perform, rather than providing a comprehensive overview of all possible combinations, the point is here that functionalities and format need to match the tasks and objective to be performed.

**Table 2.6: Operationalization of factors describing climate information**

| | Factor | Operationalization: Description and potential for explanation | Indicators, the interviewee refers e.g. to.. | Reference |
|---|---|---|---|---|
| Climate information development | Type of climate change information content | The type of climate information content: impact assessment, vulnerability assessment of adaptation policy assessment. | …changes in climatic parameters, information on non-climatic factors, course of action etc. | (Füssel & Klein, 2006; Goosen et al., 2014) |
| | Expression of uncertainties | The extent to which uncertainties are expressed on the climate information: these may regard the uncertain nature of climate change and the related impacts, the uncertainties in the natural, technical and social system. | …climate scenario's, uncertainty bands, credibility of climate information etc. | (Wardekker et al., 2008) |
| | Information format, functionalities and tasks | The policy-making tasks for which the information format and functionalities are appropriate. | …visualisation of climate impacts, performing vulnerability analysis, engaging stakeholders etc. | (Eikelboom & Janssen, 2013; Rozum & Carr, 2013) |

### 2.3.3 Users' Context

Continuing to the users' side of the science-policy interface, the manner in which climate information is (desired to be) used may explain the usability of climate information. As explained in the previous section, the climate information, comprising of certain content, uncertainties and functionalities may match the user demand to a larger or smaller extent. An understanding is needed of what characterizes the users and their context in terms of for example user attributes, capabilities and information sources (Sarewitz & Pielke, 2007). In line with the scope of this research is focussed on two categories to describe the users' context: local adaptation planning and spatial vision development. The two categories are disparate in the extent to which they describe the users' context. While local adaptation planning regards in general the users' approach towards climate adaptation, spatial vision development is about a specific strategic policy-making process. The two categories may be integrated, depending on the extent to which adaptation is integrated in the vision, hence the analytical distinction here is artificial, but allows analysing the status of both categories. The next paragraphs discuss the identified factors of both categories and how they may potentially explain the usability of climate information. The factors are operationalized in Table 2.7.

*Users' context: Adaptation planning*

Analysing how local policy-makers pursue adaptation planning is not a straightforward task for several reasons as adaptation planning is not widely institutionalised in municipalities (Hoppe, van den Berg, & Coenen, 2014; Vogel & Henstra, 2015). Hence no universal approach can be expected: Municipalities may not address climate adaptation at all, address it in separated plans and policies, or address it in existing policy domains. Moreover, there is a debate on where adaptation should fit, ranging from a separate domain to integrated (mainstreamed) with existing policy domains such as spatial planning, mobility and other related domains (Termeer et al., 2011; Uittenbroek, Janssen-Jansen, Spit, Salet, & Runhaar, 2014).

Vogel & Henstra (2015) propose a set of general themes that can be used to analyse both policy content and processes of adaptation planning, based on the general policy-making functions (Wu, Ramesh, Howlett, & Fritzen, 2012). These general themes recognize and allow for describing the heterogeneous contexts and approaches of municipalities. Finally, understanding how and why certain policy-processes take place and why decisions are made on adaptation, the general themes are complemented with insights on the influence of how climate adaptation is presented and understood in municipalities on how it is addressed (de Boer, Wardekker, & van der Sluijs, 2010). The next paragraphs discuss these factors to describe the users' context regarding local adaptation planning.

#### *2.3.3.1 Frame of problem and solution*

The manner in which an issue is framed influences the urgency that is assigned to the issue, the related interests that are activated, and the type and range of policy options that are available to the problem (Vogel & Henstra, 2015). Framing can be a political choice as certain frames may be more in lines with favoured courses of action than others (ibid). A manner in which frames of climate change issues can be analysed is by differentiating between distal or proximate views on the problem of climate change and promotional or prevention views towards goal achievement (de Boer et al., 2010). The manner in which the problem of climate adaptation and solutions to it are framed is expected to influence the perceived usability of available climate information, as some information may better serve certain frames than other. For example it is reasoned that if a municipalities' frame is concerned with a proximal focus (e.g. addressing pluvial flooding in the street) with a preventive orientation (e.g. increasing sewages systems capacities), this may require more detailed and technical climate information on norm exceeding. Alternatively, a municipality that is concerned with a distal focus (e.g. addressing the safety of current and future generations) with a promotional orientation (e.g. formulation of the ambition to be climate robust) may need different information that includes more non-climatic information to allow for indicating opportunities.

#### *2.3.3.2 Agenda-setting*

Local decision-makers can focus on limited issues due to limited time and resources (Vogel & Henstra, 2015). Bringing issues to the agenda can be initiated from the outside, e.g. through public pressure, or may be initiated internal to the local authority. The issue of climate change tends to be outrun by more pressing issues, for example due to the uncertain nature of climate change and the long-term time span

it addresses. Bringing climate adaptation to the agenda is often an internally initiated affair, e.g. because it was recognized as important by a municipal practitioner (Vogel & Henstra, 2015). Moreover, the degree to which climate adaptation is on the municipal agenda may be expressed by the ambition formulated towards climate adaptation. This ambition may be again characterized by a promotional or prevention and a proximal or distal view, as explained in 2.3.3.1. The extent to which climate adaptation is on the municipal agenda may explain the usability of certain climate information. Assuming that climate adaptation is mostly an internal initiated affair, it can be reasoned that when the issue is not yet on the agenda, information that addresses in-depth explanations on climate change mechanisms and it uncertainties is of less use to practitioners than for example information that stresses the urgency to address climate adaptation. Alternatively, when the issue is on the agenda, more specific information may be needed for formulating policy-options.

#### *2.3.3.3 Generating political support*

Political will refers to the willingness to take a certain approach or action. Political will is a condition for local adaptation policy success, especially with regard to authorities that have the power to approve, implement and enforce policies. A lack of political will for a local adaptation policy may emerge from the limited public interest, uncertain benefits of adaptation action and the perception of more pressing issues (Vogel & Henstra, 2015). The political will that is present for addressing climate adaptation may explain the usability of climate information in a similar fashion as agenda-setting. If there is political will, that is administrational support within the municipality, climate information that allows to analyse and generate policies can be expected to be of more use than information stressing the impacts in absence of adaptation action. Rather, the latter may be of use to policy-makers that aim to generating political support from the municipal council by shocking them with damage costs.

#### *2.3.3.4 Engagement of stakeholders/public*

Stakeholders can be individuals or groups that have the power or resources to affect the policy-making process and implementation, or that can be affected by the policy objectives (Bryson, 2004; Vogel & Henstra, 2015). The engagement of stakeholders is argued to enhance the policy-making process, for example to increase the perceived legitimacy of policy alternatives, and moreover to prevent policy failures, however this function is not necessarily found in the adaptation planning process (Vogel & Henstra, 2015). For local adaptation planning, stakeholder engagement may offer specialised knowledge and expertise on climate change, trust and increased legitimacy of policies as well as the increased political support as stakeholder support for adaptation may leverage the will to address adaptation (ibid). The inclusion of stakeholders and the public is expected to be relevant to explain the usability of climate information in several ways. For example, if information is to be used in larger groups, information that supports such settings, such as (interactive) visualizations are potentially more usable than extensive reports. Moreover, the inclusion of different types of audiences may require different types of complexity of information, for example participation with local experts may require other information than participation with citizens.

#### *2.3.3.5 Setting priorities*

Policy-makers must set priorities witch regard to what aspects of the issue, in this case climate change risks, they aim to address as confronted with limited time. Often risk management is proposed as a decision-support framework to identify and prioritize climate change risks as well as formulating responses (Vogel & Henstra, 2015). The IPCC (2014) for example proposes the iterative risk management as a useful framework (Figure 2.5) for decision-making under the on-going uncertainty of timing and intensity of climate change impacts.

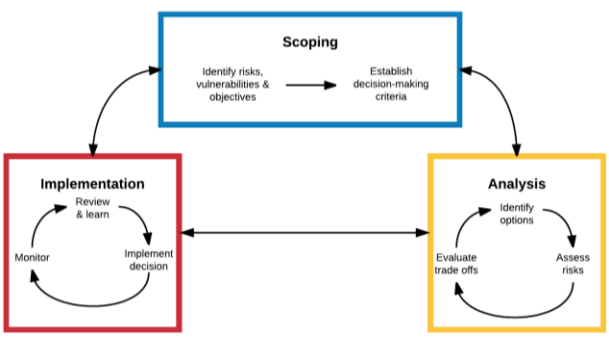



**Figure 2.5: Climate change as an literature risk management process** (adapted from: IPCC, 2014)

However, in practice strategies to deal with climate adaptation in municipalities are not necessarily inspired by such risk management circles. De Boer et al. (2010) suggest that strategies within municipalities can be differentiated on the extent to which the involved actors needs more scientific knowledge or need more deliberation on preferences in the political context, recognizing that selected strategies are shaped by the perceived (un)certainty of science and politics. Dependent on the extent to which politics (preferences regarding possible outcomes) and science (beliefs about cause/effect relations) are certain, De Boer et al. (2010) suggest potential strategies and appropriate decision support tools. For example, if a municipal strategy is characterized by a perception of large certainty on both science and politics, a computational approach, using cost-benefit analysis tools and physical analysis tools are appropriate means. However, in case of large perceived uncertainty on both politics and science, an inspirational strategy using for example cognitive aids and the development of learning-scenarios are more appropriate. Hence, the usability of climate information may increase when the information is aligned with the adopted strategy for dealing with climate information, taking into account the (un)certainty in science and politics. For example, for a computational strategy, more detailed information may be useable, while explorative tools that facilitate deliberation may better fit inspirational strategies.

#### *2.3.3.6 Formulating policy options*

Formulating policy options includes the generation and evaluation of potential policy alternatives (Vogel & Henstra, 2015). Shaped by the political and financial conditions, evaluation may include data analysis, stakeholder consultation and legal scans to gain insight in the acceptability and the feasibility. Often for local adaptation, policy options are formulated by a small group of public administrators: formulating the policy content of the adaptation policy and defining the goals, targets, agents and instruments (ibid). The manner in which policy options are formulated influences the usability of information in a similar way, as the 'priority setting function', since the manner in which priorities are set can be expected to steer how policy options are formulated. However, the usability of climate information for formulating policy options may be further influenced by the specific context in which decisions are made and the extent to which financial and social feasibility can be demonstrated. For example when there are only little budgets available for climate adaptation, climate information that needs expensive thorough analyses are of little help. Rather climate information that provides insight the social benefits can be of use to increase the social acceptability. Alternatively, can be reasoned that if policy-makers are in favour of certain policy instruments, such as citizen engagement for maintaining public green space, information that explains on social mechanisms and generating public support may be more useable than detailed and technical information on climate parameters.

#### *2.3.3.7 Policy integration*

Policy integration refers to the implementation of climate adaptation as an overarching perspective against which proposed policies and programmes are evaluated (Vogel & Henstra, 2015). The policy integration (or: mainstreaming) of adaptation refers to the extent to which adaptation is integrated in other policy-domains to increase coherence of policies (ibid). Policy integration may increase effective and efficient policy-making, through combining climate adaptation with other objectives (Uittenbroek et al., 2013). Policy integration can be expressed by the integration of adaptation principles in for example vision statements, strategic plans and regulations (Vogel & Henstra, 2015). Due to a strong orientation to the spatial environment, urban planning, water management, green management and soil management are relevant policy domains for policy integration. However, also non-spatial domains such as public health are relevant for climate adaptation. The extent to which adaptation is integrated in existing policy domains may explain the usability of climate information; The more climate adaptation is integrated in existing domains, the more usable climate information is that is translated to the context of the specific domain. For example when integrating climate adaptation in green management plans, climate information that is clearly related to the vegetation at hand may be more usable than the general climate scenario's on precipitation patterns.

*Users' context: Spatial vision development*

Since no literature specifically addresses the role of climate adaptation in local spatial visioning processes, insight from related fields of literature (sustainable vision development and urban vision development) are used to analyse how local policy-makers pursue spatial vision development.

Generating and establishing (sustainability) visions is important in research, planning and decision-making as they pose key reference points for formulating strategies (Wiek & Iwaniec, 2014). Vision development regards the formulation of desired future states, and allows for guidance of strategic operational planning as well as monitoring, and can be used (John et al., 2015):

- To engage divers publics, perspectives and expertise in planning
- In diverse collaborative settings
- Using different media to facilitate engagement
- Generate target knowledge to guide strategies
- To communicate vision target in diverse ways to the broader public.

Vision development can provide tangible and intangible outcomes. Tangible outcomes of vision development are salient and legitimate vision documents that can be related to government administration and documentation in support of implementing strategies (John et al., 2015). Intangible outcomes for process participants are generating consensus on planning targets among large diverse groups and support for and willingness to participate in operationalized strategies.

John et al. (2015) discuss themes with attributes that can be used to describe general processes and structures under which vision processes take place, that may enable or constrain the inclusion of 'sustainability' into urban vision development. For the purpose of this research, sustainability is replaced with 'climate adaptation'. Two factors are distinguished to describe how visions may manifest in local authorities: the process and organization of the vision ('visioning') and participation.

#### *2.3.3.8 Visioning*

Visioning is the process and organization of the vision development. The development visions are concerned with a certain time frame for which the vision is laid out. A far away time-horizon may support the inclusion of measures to adapt to upcoming developments and trends. The vision may be organised around certain 'main themes', along which the vision process is started. These starting themes may be preselected (e.g. by the council) or more open to public steering. Moreover, the project team may be drafting the vision self, or be facilitated by an external actor. Performing a situation analysis and formulating clear outcome objectives for the visioning process may guide the process and facilitate understanding and common ground on the main issues. With regard to the integration of climate adaptation, it may be considered as an integrative starting point or marginalised as a separate topic. Finally, the practicality of the vision may be determined by the extent to which the vision is integrated into the daily use, for example by translating the vision objectives in strategic and operational plans (John et al., 2015). The usability of climate information to support the inclusion of climate adaptation may increase when the information is aligned with the manner in which the vision process is organized. For example, climate information that concerns projections that are in line with the time frame may be usable to support analysis and define objectives.

#### *2.3.3.9 Participation*

Vision development processes may be concerned with stakeholder involvement. Consequently, who is engaged in the vision development at what point, influences the process and outcomes. Participants may be carefully selected, for example when a municipality is pursuing a diverse set of participants, or participation is organised for the general interested public. Moreover, participation may take place at specific points; higher levels of participation may take place through participation on multiple points in the vision development process or when they have larger influence on the decisions made. The participation may range from one-way communication to bilateral and multilateral approaches towards participation (John et al., 2015). The usability of climate information may increase if the information is aligned to the participants and the manner in which the participation process is organized. For example, if general interested citizen engagement is an important part of the vision process, information that is easily understood and can be communicated to a diverse public may be more usable than detailed and technical information, including broad uncertainty information.

**Table 2.7: Operationalization analytical factors users' context: climate information development**

| | Factor | Operationalization: Description and potential for explanation | Indicators, the interviewee refers e.g. to.. | Reference |
|---|---|---|---|---|
| Adaptation planning | Frame of problem and solution | The manner in which the problem of climate adaptation is framed as well as the solutions to it. Climate adaptation may be framed as an abstract and long-term issue (distal), or short-term and contextualised (proximal). Furthermore, action on climate adaptation may be oriented on achieving positive outcomes (promotional) or focussing on preventing negative consequences (prevention). The usability of climate information may increase when the information is aligned with the frame. | …positive outcomes of climate adaptation measures, coupling of objectives etc. (promotion frame) …versus…increasing norms for the sewage system capacity, extensive risk calculations etc. (prevention frame)… climate adaptation for future generations (distal frame)… versus…making the municipality climate robust etc. | (de Boer et al., 2010; Vogel & Henstra, 2015) |
| | Agenda-setting | The extent to which adaptation planning is on the municipal agenda and how internal and external actors have influenced this. The usability of climate information may increase when the information is aligned with the extent to which it is on the agenda. The more the issue is on the agenda, the more precise vulnerability information and policy assessment may be needed. | … external or internal pressures, leadership, management support, other pressing issues, aim to be frontrunner, or being follower, the ambition to be climate robust etc. | (de Boer et al., 2010) |
| | Generating political support | The present political will for addressing climate change adaptation and the will to take a certain approach. The usability of climate information may increase when the information is aligned with the extent to which there is political will. The less political will is present, the more information may be needed to demonstrate the urgency. | …administrational support, uncertain benefits of adaptation, public pressure, allocation of budgets etc. | (de Boer et al., 2010) |
| | Engagement of stakeholders/ public | The extent to which and how stakeholders/public are engaged in adaptation planning. The usability of climate information may increase when the information is tuned with the amount of participants and the expertise and backgrounds of participants. | …stakeholder consultation or public engagement for specialised knowledge (e.g. local knowledge), engagement to increase legitimacy of policy options etc. | (de Boer et al., 2010) |
| | Setting priorities | The aspects of the problem that are addressed and the way in which these aspects were chosen. The usability of climate information may increase when the information is aligned with the adopted approach, taking into account uncertainty on politics and science. | … what climate stress(es) where chosen to address (e.g. addressing pluvial flood risk, but not addressing drought), and how these were selected (e.g. through integrative vulnerability assessment versus through sewage maps, through calculating flooding risks or discussing risks with partners). | (de Boer et al., 2010; Vogel & Henstra, 2015) |
| | Formulating policy options | How policy options are formulated and evaluated and how organizational and financial constraints influence this. The usability of climate information may increase when the information is aligned with the adopted approach (setting priorities) and the available resources and capacities. | …. available budget, evaluation tools such as legal scans and cost-benefit analysis, who was involved in generating and weighing options, evaluation of social acceptability and financial feasibility of policies etc. | (de Boer et al., 2010; Vogel & Henstra, 2015) |
| | Policy integration | The degree to which adaptation is integrated in relevant policy domains such as spatial planning, and how this integration is expressed. The usability of climate information may increase when the information is aligned with the field of integration. | … the policy domains in which adaptation is addressed (e.g. green management, sewage plan etc.), to adaptation principles, documentation, tools to integrate adaptation in policy domains, integration of adaptation in vision, strategies and/or regulations etc. | (Vogel & Henstra, 2015) |
| Spatial vision development | Visioning | The manner in which the vision development process is organised in terms of time-frame, project team, starting themes, situation analysis and specification of outcome objectives, the role of climate adaptation and the integration of the vision into the daily use. The usability of climate information may increase when the information is aligned to vision development process. | … Time Frame: up to e.g. 2030, 2050 etc. Project Team: team size, expertise of actors, function of actors, collaboration with advice organizations. Starting themes: council decisions and regulations that are leading for the vision. Situation Analysis and Outcome Objectives: the purpose of the vision, the extent of common ground on process of visioning. The Role of Climate Adaptation: adaptation is an integrative theme; climate adaptation is integrated in a specific policy domain. Integration Into Daily Use: translation into strategic plans (such as the environmental plan), the role/mandate of the vision in relation to plans and measures etc. | John et al.(2015) |
| | Participation | The extent to which what actors are engaged in what stage of the vision development process and how. The usability of climate information may increase when the information is aligned with the participation process(es). | … who is engaged (public, organizations etc.), how (workshops, brainstorm etc.) and when in the process etc. | John et al.(2015) |

## 2.4 Conclusion Q1 & Q2

With the evaluative and analytical frameworks presented in the previous sections, sub-question 1 and 2 can be answered.

Recalling sub-question 1:

*What evaluation criteria for the usability of climate information can be identified from literature on the science-policy interface?*

The usability of climate information can be evaluated with the criteria of fit, interplay and interaction. The fit regards the perceived fit of the information to the decision-making needs of policy-makers. The interplay refers to the extent to which the policy-makers are willing and able to search for, adopt and use new knowledge. The interactions refer to the quality and level of interactions between scientists and policy-makers. The extent to which these criteria contribute to the usability of climate information depend on the extent to which the corresponding drivers are present, the drivers are operationalized in Table 2.3.

Recalling sub-question 2:

*What factors can be used to analyse the contexts of the producers and users of climate information and can potentially explain the usability of climate information?*

In Table 2.8 the factors are listed that can be used to analyse the contexts of the producers and users of climate information. The factors of the producers' context regard the process of climate information development and may influence the *fit* of the information to the users' needs, the extent to which information is accessible for the users' *interplay* and the *interactions* between the producers and users. It is expected that the analytical factors are interrelated, for example when producers engage users in the development process (factor: actors), this may shape the producers' beliefs on the users' needs. The analytical factors are operationalized in Table 2.4. Furthermore, especially three decisions with regard to the product of climate information in the development process can be expected to influence the usability; the expression of uncertainties, the type of climate information content and the format through which the information is disclosed. These background factors are operationalized in Table 2.6.

The factors of the users' context regard adaptation planning and spatial vision development and may influence the users' capabilities, needs and patterns of information use. Consequently, these factors may influence the specific needs, the interplay, and the extent to which interactions take place. The factors are operationalized in Table 2.7.

**Table 2.8: Summary of analytical factors**

| Analytical factors users' context | Analytical factors producers' context |
|---|---|
| - Actors | - Framing of problem and solution |
| - Capabilities | - Agenda-setting |
| - Beliefs | - Generating political support |
| - | - Engagement of stakeholders/public |
| - Decisions that may affect usability | - Setting priorities |
| - Climate information content | - Formulating policy options |
| - Expression of uncertainties | - Policy integration |
| - Format and functionalities | - Visioning |
| | - Participation |

# 3 Methods

## 3.1 Research strategy

This research aimed to gain insight in how the science-policy interface between climate change research and local adaptation planning can be improved. Elaborating on literature on usable climate information in the context of a science-policy interface as described in chapter 2, a research strategy was adopted that allowed to gain an in-depth understanding of both the production and use of climate information in practice.

One of the notions that literature brought forward is that the usability of information depends on the perception of the user, the interplay of the user, and the interactions between users and producers (Lemos et al., 2012). Moreover, the way in which climate information is used and how it is produced may explain the usability. Another insight from literature is that adaptation planning is not uniformly addressed within in municipalities, i.e. no standard approach to adaptation can be expected (Vogel & Henstra, 2015). Moreover, a great diversity is found in the 'advancedness' of Dutch municipalities with regard to addressing climate adaptation (Tijhuis, 2015). Adaptation may be addressed as a separate topic, integrated with other policies or it may be addressed to a limited extent. Similarly, the formulation of the environmental vision is new to municipalities and moreover is free of format, thus no standard approach can be expected.

Hence, to gain insight in how the science-policy interface could be improved, a strategy was needed that accommodated for the collection of the perceptions and taken approaches of both the producers and users. Moreover, the new and non-uniform context of adaptation planning and the environmental vision demanded an exploratory and flexible research approach using qualitative methods. To accommodate for these conditions, it was chosen to study one particular case of a science-policy interface in-depth: the Climate Adaptation Atlas (CAA). This case is an example of an interface between climate change research and local adaptation planning in the Netherlands for a specific type of climate information: a tool to map the climate vulnerability of local and regional areas. The CAA is intended to support local and regional authorities with adaptation planning. As the CAA was updated along with the time horizon of this research, the CAA was a particular interesting case to study.

Case studies are appropriate to examine a "*contemporary phenomenon, especially when the boundaries between the phenomenon and context are not clearly evident*" (Yin, 1981, p. 59). Hence a case study approach fits the exploratory research aim by gaining in-depth insight in the object of study (Verschuren & Doorewaard, 2010). Moreover, provided that heterogeneous approaches may be found in municipalities, a strategy was needed that would allow sketching the diversity as well as potential similarities. Therefore an embedded case study design was applied, researching five (potential) user-cases within the CAA case: municipal practitioners in five municipalities. Comparative research on local policy-making processes can provide insights in conditions that enable or constrain policy-making as well as implementation (Vogel & Henstra, 2015). To accommodate for the producers' side, the CAA producers that comprise of consultants, scientists and a boundary organization were studied. Data was collected through in-depth semi-structured interviews, complemented with grey literature. Interviewing allows to gain a holistic description of the system; here, the science-policy interface, and to learn on how a system works or fails to works (Weiss, 1994); in this case, the extent to which usable information is produced and used.

Consistent with the research framework in Figure 1.1, the following steps were taken:

1) Semi-structured interviews with CAA producers were conducted to gain insight in how the CAA was established and how it was aimed to produce usable information. Interviewed CAA producers included individuals from research institutes (n=3), boundary organization CAS (n=2), and consultants that are part of the CAA consultant feedback group (n=4).

2) Semi-structured interviews with municipal practitioners (n=10) from five medium-sized municipalities were performed to evaluate the (potential) usability of the CAA for local adaptation planning, and to describe how the municipalities approached adaptation planning and the environmental vision. If possible, interviews were complemented with grey literature.

3) Interviews were recorded, transcribed, coded and analysed using the frameworks presented in chapter 2. The usability of the CAA was evaluated on the perceived *fit*, the *interplay* of the municipal practitioners and the *interactions* between municipalities and research institutes. Subsequently, the producers' perspectives on 'usable climate information' as well as their approach to develop climate information were analysed to identify potential explaining factors for the usability of the CAA. Similarly, the municipal approaches on adaptation planning and the environmental vision were analysed to identify potential explaining factors for the usability of the CAA (sub-question 3 & 4). In addition the municipal approaches towards the vision development and the associated information needs were analysed to identify conditions for usable climate information to support the vision. These conditions were contrasted with the CAA to evaluate to what extent these conditions were met (sub-question 5).

4) The preliminary results were discussed with experts to validate findings. Recommendations were made to improve the CAA as well as the science-policy interface in general.

Next sections elaborate on how participants were selected and how data was collected and analysed.

## 3.2 CAA Case: data collection

### 3.2.1 The CAA science-policy interface

The CAA Case is a climate information tool that was developed within the knowledge programme Climate Change Spatial Adaptation in 2008 and that aimed to bridge the gap between climate research and local adaptation planning. The tool is offered at the knowledge web-portal www.ruimtelijkeadaptatie.nl. The CAA was not only developed by scientists, but also by two types of intermediaries: a boundary organization and consultants, together 'CAA producers'. In addition to inspecting the CAA tool on the knowledge portal in a web-viewer, the data can be requested (for more details on the CAA tool see section 5.1.1). Municipal practitioners, who are potential users, from five different municipalities were studied. Figure 3.1 visualises the CAA case study.

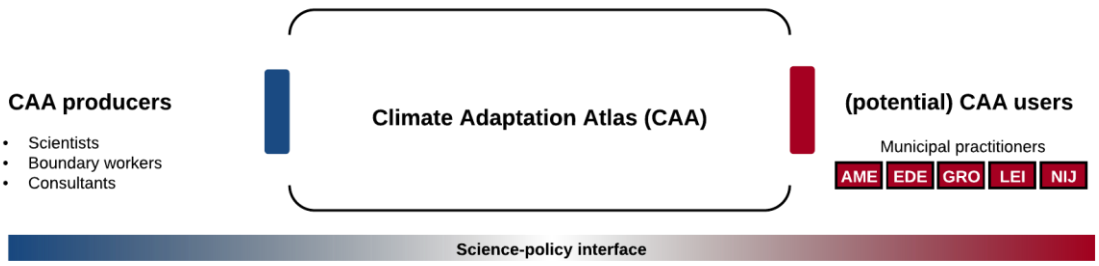



**Figure 3.1: CAA case study**

The next sections elaborate on the actors that were studied in the CAA case, and how data was collected through interviews. In addition to the formal interviews, several meetings were attended to get acquainted with the diverse actors of the specific case and to learn on the context in general, see Appendix 9.2 for a list of attended meetings.

### 3.2.2 CAA producers

In total 9 semi-structured interviews were performed with actors engaged in the establishment and further development of the CAA, albeit from different roles:

- Boundary organization (CAS): coordination and maintenance CAA (n=2)
- Research institutes: climate information supply CAA (n=3)
- Consultants: feedback groups CAA and/or user CAA (n=4)

Abovementioned 'producers' were interviewed to identify how the CAA tool came about and to explore experiences and perceptions from the producers on the usability of the CAA and the usability of climate information in general. Moreover, the first interviews with producers were used to further specify the interviews with the municipal practitioners. In addition to the interviews, reports and web material on the CAA was consulted (e.g. www.ruimtelijkeadaptatie.nl). In Appendix 9.1 more details on the interviewed CAA producers can be found.

### 3.2.3 (potential) Users of the CAA

In total 10 interviews were performed with municipal practitioners from 5 municipalities. Municipalities were selected strategically on that they were of medium size (between 100.000 and 250.000 inhabitants), expressed commitment to deal with climate adaptation planning and expressed to be exploring the role of adaptation in the environmental vision. Medium-sized municipalities are especially interesting as these municipalities often perform a central role in their region and can be expected to be important actors for adaptation planning, yet these municipalities are concerned with less resources and capacities than the large municipalities. It was chosen to only consult municipalities that expressed affinity with adaptation planning and integration adaptation in the vision due to the new nature of both policy themes. Among the municipalities that would meet these criteria was aimed to gain a diverse sample both in geographical location, advancement in the environmental vision process and familiarity with the CAA. Table 3.1 lists the characteristics of the selected cases.

**Table 3.1: Studied cases and case characteristics**

| Municipality | Inhabitants (CBS, 2015) | Location Netherlands | Stage environmental vision | CAA use | KANS network | # Interviews |
|---|---|---|---|---|---|---|
| Amersfoort (AME) | 152481 | Middle | Preparing/pilot environmental plan | Yes | Yes | 1 |
| Ede (EDE) | 111575 | Middle | Preparing | No | Yes | 1 (duo interview) |
| Groningen (GRO) | 200336 | North | Preparing/ start participation process | No | Yes | 1 |
| Leiden (LEI) | 121562 | West | Formulating vision | Yes | No | 5 |
| Nijmegen (NIJ) | 170681 | East | Preparing/pilot environmental plan | No | Yes | 2 |

Municipalities were recruited via contact persons of boundary organization Climate Adaptation Services (CAS). One municipality was selected based on the fact that they requested CAA data for the formulation of the environmental vision. The other four municipalities were recruited from a network for medium-sized municipalities 'KANS'. The KANS network is a bottom-up initiative that unifies members from the platform medium-sized municipalities (PMG) who aim to explore, research and exchange experiences with regard to climate adaptation in the spatial environment. Prior to the interviews, informal conversations were held by telephone of through attending network meetings to learn whether the municipalities would meet the case selection criteria as introduced above. While the sample of participating municipalities was largely dependent on the willingness to cooperate, it seemed that all municipalities were comparable in size and expressed commitment to both climate adaptation and exploring its application in the environmental vision. Moreover, municipalities were confronted with different climate change risks due to their diverse geographical location, found themselves in different stages of the environmental visioning process and the familiarity of the CAA ranged from unknown to extensive usage.

The four cases recruited from the KANS network were studied with a similar intensity: an interview with 1 or 2 individuals from the municipality (the 'municipal practitioners'). The case of Leiden was studied more extensively: 5 interviews were conducted with project participants of the environmental vision project. This case was far progressed in the process of the vision development compared to the other four cases. It was decided to further look into this case as it allowed collecting experiences and perspectives on the use of climate information in the new environmental vision. The interviewees of this case included municipal practitioners and individuals from the drinking water service, the water board and a constancy firm, together these actors were referred to as 'project participants'. 'Municipal practitioners' specifically refers to the individuals that work at the municipalities (often policy-makers or advisors). For details on the interviewees, see Appendix 9.1.

The municipalities were studied independently, as if it were single-case studies (Verschuren & Doorewaard, 2010). In addition to the interviews, the municipalities were asked for complementing material such as reports, documents and websites explaining their approaches, to triangulate methods and sources. However, it appeared that there was little grey literature available on the practices of municipalities; while material was available of practical examples of concrete projects including adaptation measures, these sources did not inform on how adaptation planning and the environmental vision were approached within the municipality. In one municipality a document was shown that described the status of adaptation in the policy processes, yet since this document was not an official document that was approved by the council, it was not allowed to use it for this research.

### 3.2.4 Interview guides

Interview questions were based on the concepts of the evaluative and analytical frameworks as presented in chapter 2. Rather than inquiring on all possible evaluative criteria and analytical factors, it was aimed to collect data on all main themes of the frameworks; inquiring on all possible factors would make the interview static, time consuming and would counteract the aim of retrieving users' and producers' perspectives on the usability of climate information. While fixed open questions seem attractive as they may yield data in a systemic way, it is largely given in on the quality of data: it tends to be rather general than concrete, moreover, interviewees may be directed by the interview schedule rather than the associations of the interviewees (Weiss, 1994). Therefore it was decided to perform the interviews based on interview guides.

The interview guides were established as follows. First a list of interview topics was identified from the evaluative an analytical framework; the 'topics to learn about'. Each topic is associated with more specific topics and questions that together make a 'line of inquiry'. For example, in the interviews with municipal practitioners, for the topic 'perception of CAA usability ' a line of inquiry was:

*What information was used? What are the experiences of using this information in adaptation planning? What are strong and weak points of the information? What characteristics make that the information was usable or not?*

Subsequently, for the lines of inquiry, overarching questions were formulated that together made up the interview guide. For the above example, the overarching question was:

*Could you tell me on the information that is used to deal with climate change adaptation, and to what extent has this information supported you?*

During the interviews was aimed to keep in mind what with each question for the interviewee was intended to learn about. This would allow adjusting the question, or think of new questions that might better invited the interviewee to tell about the topic. After all there is no one good question; a question is good depending on the extent to which it produces the material that is needed (Weiss, 1994). Moreover, as the interview unfolded it was allowed to deviate from the interview guide when it potentially contributed to the aim of understanding the science-policy interface and its mechanisms. Three interview guides were established; a guide for the research institutes, consultants and municipalities. The complete interview guides (in Dutch) can be found in the Appendices 9.3, 9.4 and 9.5. Below the 'topics to learn about' for each of the guides are presented.

**Topics to learn about: research institutes**

- Process and involvement in the development of the CAA
- Interactions with municipalities
- Perception of the usability of the CAA for municipalities
- Perception of what drives or constrains municipalities to use (scientific) climate information
- Vision on climate information needs for the municipal environmental vision

**Topic to learn about: consultants**

- Experiences on how municipalities address climate adaptation and use climate information
- Experience and perception on the usability of the CAA for municipalities

- Experiences and perception on interactions between municipalities and research institutes
- Experiences on how municipalities address the environmental vision
- Vision on climate information needs for the municipal environmental vision

**Topic to learn about: municipalities**

- Approach to adaptation planning (e.g. ambition and processes)
- Climate information use and perceived usability
- Experiences and perception of how the municipal context influences the use of (scientific) climate information.
- The interactions with research institutes and consultants, and how this is experienced
- Approach to the environmental vision (e.g. engaged actors and process)
- The role of adaptation in the environmental vision
- Vision on climate information need for the municipal environmental vision

Before the start of the interviews, interviewees were introduced to the aim of the research and interviews. It was explained that their responses would be treated anonymously, in that their personal perceptions and experiences would remains unrecognizable.

To make the discussions with the municipal practitioners on the usability of climate information more concrete, a list of 'applied' CAA indicators was discussed with the practitioners (see Table 3.2 and appendix 9.6 for list in Dutch). 'Applied' indicators refer to indicators in which climate change parameters are related to spatial characteristics and mechanisms to illustrate the impacts; e.g. drought stress crops refers to the impact of drought on a specific crop in terms of water deficiency. Moreover, comparing these indicators with other spatial information may provide insight into the relationship with other spatial tasks and objectives. For each of the indicators is indicated to which climate change risk theme they apply – drought, heat, pluvial flooding and flooding from see and rivers -, and whether they apply to a specific area or sector. Discussing the list of indicators allowed moreover for better discussions on the usability of the CAA with the practitioners that had not used the CAA.

The practitioners were asked which of the indicators they perceived most relevant, and which indicators they were potentially missing, this allowed evaluating the 'saliency' of the CAA in specific. Some indicators would potentially be included in the update of the CAA, the list allowed for testing whether these indicators were indeed evaluated as relevant and usable.

**Table 3.2: List of potential relevant indicators of the consequences of climate change**

| Risk theme | Indicators: | Sector/area: | Spatial characteristics: | Sector/area: |
|---|---|---|---|---|
| Drought | Land subsidence | Urban area | Agricultural area | Rural area |
| | Paalrot (rotting foundation houses) | Urban area | Natura 2000 area | Rural area |
| | Drought stress crops | Rural area | | |
| | Feasibility nature objectives | Rural area | | |
| | Salt intrusion | Health/Safety | | |
| | Decreased navigability | Industry/Mobility | | |
| Heat | Excess mortality | Health/Safety | Movable bridges | Industry/Mobility |
| | Decreased labour productivity | Health/Safety | Area green/paved | Urban area |
| | Blue-green algae | Health/Safety | Care institutions | Health/Safety |
| | Allergy days | Health/Safety | Insulation houses | Health/Safety |
| | Ticks/ Oak processions | Health/safety | Share of elderly people (65+) | Health/Safety |
| | Growing season | Rural area | Swimming pools (outdoor) | Health/Safety |
| Pluvial Flooding | Flooding: downpours | Urban area | Tunnels | Industry/Mobility |
| | Flooding: prolonged precipitation | Rural area | Sewage capacity | Urban area |
| | Water erosion | Divers | Planned replacement of infrastructure | Industry/Mobility |
| | Oxygen stress crops | Rural area | | |
| Flooding | Flooding: rise rate | Divers | Dry areas in case of flooding | Divers |
| | Maximum flooding depth | Divers | Networks/Utilities | Divers |
| | Fraction of evacuation | Health/Safety | | |
| | Risk of death | Health/Safety | | |

## 3.3 Interview analysis

Interviews were recorded, transcribed, analysed and translated. The written interviews were analysed using Nvivo software and applying a coding system corresponding with the evaluative criteria and analytical factors as operationalized in Table 2.3, Table 2.4 and Table 2.7. The interviews were treated anonymously, in that names of the interviewed practitioners and scientists, consultants and boundary workers were numbered to guarantee secrecy. The analysis process included the translation of the interview from Dutch to English. As the 19 interviews (lasting often 1.5 to 2 hours) yielded rich data, much effort was put in translating the interview results to maintain the quality of the data and to be able to 'quote' the interviewees' expressions to illustrate and underpin the analysis. When interviews were coded, data was structured by describing:

1) How the different CAA producers pursue climate information development (comparison)
2) How practitioners from different municipalities pursue adaptation and visioning (comparison)
3) The usability of the CAA for municipal practitioners and the vision information needs

Subsequently was sought for explanations for the usability of the CAA by comparing the outcomes of the evaluation with the outcomes of how the producers pursue climate information development and how the municipal practitioners approach adaptation and visioning (see Figure 3.2). The factors to describe specific climate information characteristics (Table 2.6) were treated as background variables, which allowed understanding how the findings may relate to specific climate information characteristics.

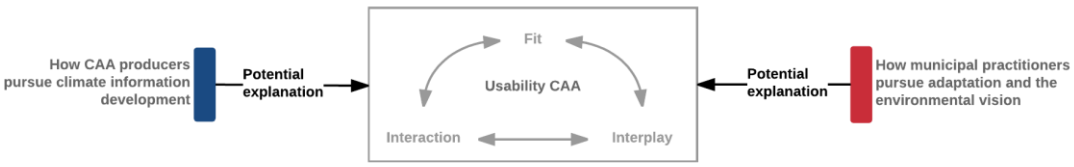



**Figure 3.2: Data Analysis**

Moreover, from the approaches towards the environmental vision, as well as from the municipal practitioners' expectation on their information needs for integrating adaptation in the environmental vision, conditions for usable information were identified to support the vision development. The analytical distinction between adaptation planning and the environmental vision enabled to describe how municipalities approached both themes. However, the more adaptation planning was found already to be an integrated part of the environmental vision, a more integrated description was needed to characterize the municipalities' approaches.

The preliminary findings from the analyses were tested with four experts from diverse relevant fields of expertise; see Table 3.3. Statements were prepared and proposed to the experts to find out to what extent they recognized these statements. The discussions with the experts on local climate adaptation (expert II & III) were focussed on finding out to what extent the findings on the use and usability of climate information in adaptation planning were specific for the researched cases, or valid for a larger set of Dutch municipalities. With an expert on climate change research and environmental governance (expert IV), the discussion was oriented to revealing whether the findings on how climate information is produced by scientists, boundary organizations and consultants could be generalized to how these actors pursue the development of climate information in the Netherlands and beyond. Finally, with an expert on the environmental law (expert I), the findings on the implications of the environmental law for municipalities were discussed to find out to what extent these findings could be generalized. The expert discussions were documented in short reports, see Appendix 9.7, 9.8 and 9.9.

**Table 3.3: Validation of interview results and analysis: consulted experts**

| Expert | Role and expertise |
|---|---|
| Expert I | Professor environmental law |
| Expert II | Junior assistant professor: local level adaptation policy mainstreaming |
| Expert III | Assistant professor: local climate adaptation responsibilities |
| Expert IV | Professor environmental governance, former director Climate change research programme |

## 3.4 External validity

The application of an embedded case study design to research five municipalities in the science-policy interface between climate change research and municipal adaptation planning is concerned with strengths and weaknesses. The collection of data via extensive interviews with municipal practitioners, scientists, consultants and boundary workers, allowed to gain an in-depth understanding of how climate information is developed, used and evaluated, while the expert discussions increased insight in the external validity of the findings. Testing findings with experts was especially relevant to gain insight in the extent to which the findings from the case are applicable for other municipalities and science-policy interfaces in The Netherlands. After all, the studied science policy-interface, concerned a specific case of climate change research and its application in local adaptation planning:

Firstly, the studied case regards a specific type of climate information: a climate vulnerability tool, other types of climate information, such as impact assessments and adaptation policy assessments may flourish in yet somewhat different interplays of the municipal organization; For example the (technical) skills to analyse primary climate impacts may be more important to use and interpret impact assessments. Secondly, the studied case applies to a science-policy interface in The Netherlands that is associated with a specific policy context and regulations. Such a context may influence the extent to which municipal organizations are willing and able to adopt new climate information, and how they pursue climate adaptation in general. Similarly this may influence how scientists pursue the development of climate information. In other countries, such context may be different, for example due to different funding structures for research or the political attention for climate adaptation. Thirdly, the studied case applies to medium-sized municipalities. Municipalities of smaller or larger sizes may have different organizational structures, power and resources. While small municipalities are expected to have little resources, and have a less beneficial interplay to adopt and use information, large municipalities can be expected to more easily access the needed resources. Moreover, since all municipalities were recruited on the criteria to express efforts to deal with climate adaptation and integrating adaptation in the environmental vision, it can be expected that the findings of are biased towards more beneficial attitudes to adopt and use climate information. Finally, the case of Leiden was studied more extensively than the other four cases. While this allowed to learn on the environmental vision, this case should be treated as a single example when it comes down to describing Dutch municipal approaches towards the environmental vision.

# 4 Climate adaptation in the Netherlands: a brief introduction

This chapter provides a brief introduction about climate adaptation in the Netherlands; explaining the general policy context on adaptation and spatial planning, climate change research efforts and local adaptation practices. Thereby this chapter puts the results as presented in the next chapter (5) into context.

**Climate change research in the Netherlands**
Over the past two decades two large research programmes on climate change have been performed in the Netherlands: 'Climate Changes Spatial Planning' (CCSP) and 'Knowledge for Climate' (KfC). CCSP took place from 2004-2011 and focussed on the opportunities of climate change for the Dutch society by adapting the use of the spatial environment and establishing an operational infrastructure for the public and private sector on the relationship between climate change and variability and the use of space ("Klimaat voor Ruimte," n.d.). Research was conducted by a public-private network of research institutes, governments, non-governmental organizations and the private sector focussing on five themes: climate scenarios, mitigation, adaptation, integration, communication and sectors. In CCSP was worked closely together with the governmental programme 'Adaptation to Climate Change' ('ARK'), which started in 2006. In this initiative, ministries worked together with the umbrella organizations of the municipalities, provinces and water boards, to develop a strategy for the next 100 years to climate proof spatial planning. Central themes included flood protection, living environment, biodiversity, economy and health. Moreover, making use of the mechanisms of the natural system became an important strategy (ibid).

KfC took place from 2007-2014, and focussed on developing applied knowledge that can support decision-making, taking into account the impacts of climate change ("Kennis voor Klimaat," n.d.). In the research programme was collaborated between research institutes and universities (such as Utrecht University, Free University Amsterdam, the Dutch National Meteorological Institute KNMI, Deltares/TNO and Wageningen university), Dutch Governments (national government, provinces, municipalities and water boards) and the private sectors. The aim was to develop knowledge that could be applied to evaluate investments in spatial planning, infrastructure and institutions on their 'climate robustness'. Research was conducted for diverse general themes (e.g. climate robust cities, flood safety and decision-making support) and for specific 'hotspot' areas (e.g. airport Schiphol, Rotterdam Region and the Southwest Delta's). Towards the end of these programmes also research was conducted that provided the buildings blocks for the National Adaptation Strategy, which was launched in 2016.

In addition to these two large research programmes, recently (2016) the research programme 'National Water and Climate Knowledge and Innovation' (NKWK) was initiated, and will last until 2020. Similar to CCSP and KfC in NKWK is aimed to perform research projects on climate change and the act of 'becoming a climate proof', with governments, private actors and research institutes. Yet, the difference is, that for this programme no budgets are available. Rather, the actors themselves have to bring together budgets. This programme is closely linked to the national governments' ambition to become 'climate robust and water resilient'.

**National policy context**
The political attention for climate adaptation in the national government increased in parallel to and influenced by the national research programmes. In 2008 the Dutch Delta Commission presented an advice to the Dutch Cabinet which motivated the national government to start a Delta Programme in 2009/2010, which included a decision dedicated to adaptation. This decision regarded the formulation of a policy framework for the (re) development of space while managing risks of flooding, pluvial flooding, drought, salt intrusion, land subsidence and heat stress (Delta commission, 2011). In the subsequent years, this decision developed into the Delta Decision Spatial Adaptation, DDSA (Delta Commission, 2015a).

The DDSA comprises of a collaboration between governmental bodies, the private sector and civil society to establish a 'climate-proof and water resilient Netherlands' (Delta commission, 2017). The decision supports adaptation efforts by providing guidelines, sharing research results and experiences and encouraging pilots throughout the country. As part of this, an incentive programme is performed from 2015 to 2017, facilitating meetings and disclosing knowledge. The knowledge web-portal www.ruimtelijkeadaptatie.nl is an important tool for sharing knowledge, experiences and guidelines. Furthermore, a 'stress test light', was developed, which is relative simple method for decentralised governments to gain insight in the vulnerability of their area with regards to the main four climate risk themes that are differentiated in the Netherlands: pluvial flooding, heat, drought and flooding. Moreover, 'climate ateliers' are proposed as an appropriate method to generate a shared image on adaptation within local governments. This bottom-up method concerns an interactive setting in which municipal ambitions, climate change vulnerability and landscape characteristics are combined to establish a vision on the area of the authority (Masselink, Goosen, Grond, Vellinga, & Leemans, 2017).

With the efforts from the DDSA is worked towards an ambition and an approach for climate adaptation. The ambition comprises that The Netherlands' spatial design is climate robust and water resilient by 2050, and that this is integrated in policies on all governmental levels by 2020. The approach includes that governments address this goal in three steps (Delta Commission, 2015b):

1) **Analysis** of the spatial planning area.
2) Formulation of an **Ambition** and an adaptation strategy, based on the identified challenges and opportunities from the analysis.
3) **Acting** upon the ambition by securing this in policies and regulations.

In the end is worked towards a Delta Plan on Spatial Adaptation, which will determine how to proceed to achieve these goals, what tools and measures will be used and how the progress will be monitored. The plan will be launched in 2018 (Delta commission, 2017). As a result of the national attention and incentive programmes, on the municipal level diverse adaptation efforts are made.

**State of climate adaptation in local spatial planning**

Climate adaptation action in local spatial planning has yet manifested in diverse local policies, concrete construction projects and initiatives in the Netherlands. Within municipalities a diversity of instruments are deployed such performing stress tests, climate ateliers, appointing climate adaptation ambassadors and supporting citizen adaptation initiatives (de Graaff et al., 2017). Other instruments include the formulation of roadmaps and 'green-blue' structures for the municipal area. Green-blue structures are about the configuration of rivers, creek and channel as well as parks, trees, perk and forests and may contribute to the climate robustness of the area. Furthermore, many municipalities joined the initiative 'operatie steenbreek', which can be translated as 'mission de-pave', that aims to engage citizens to replace paved areas with green space in their private gardens (ibid). A more broad trend towards spatial planning is that municipalities aim to adopt an 'area-oriented' perspective ('gebiedsgericht werken'). In this approach an area is regarded as an coherent system of the physical characteristics and the identity and networks in place; subsequently, the specific tasks, stakeholders and objectives in an area guide the spatial decisions. Such integrative approaches towards spatial planning get a less voluntary nature with the introduction of a new spatial planning law, the environmental law, in which integration is a key objective.

**Spatial planning reform: the environmental law and the implications for municipalities**

The upcoming enforcement of the environmental law (expected 2019) takes a broader perspective towards spatial planning, and bundles the laws and regulations on the physical living environmental and the activities that may have an impact on the physical environment (see Table 4.1). According to article 1.2 from the law, the physical living environment at least includes ("Omgevingswet.nl," 2015): Constructions, Infrastructure, Water systems, Water, Soil, Air, Landscapes, Nature and Cultural heritage. The key instruments of the law are

1) The environmental vision
2) The environmental plan
3) Environmental programmes

**Table 4.1: Acts integrated into the planning** (adapted from: Altes, 2016)

| Acts fully integrated into the environmental law | Selection of acts partly integrated in to the environmental laws |
|---|---|
| Spatial Planning Act | Environmental Management Act |
| Act on General Provisions in Environmental Law | Water Act |
| Extractions Act | Nature Protection Act |
| Plan Act Traffic and Transport | Historic Buildings and Ancient Monuments Act |
| Infrastructure Trajectory Act | Mining Act |
| Expedition Act on Road Broadening | Housing Act |
| Restrictions on Property Act | |
| Crisis and Recovery Act | |
| Soil Protection Act | |
| Noise Nuisance Act | |
| Interim Act City-and-environment Approach | |
| Odour Nuisance and Livestock Breeding Act | |
| Act on Health and Safety of Bathing Establishments and Swimming Facilities | |

The environmental law demands municipalities, provinces and the national government to formulate an environmental vision. This vision comprehends a long-term strategic vision for the physical living environment ("aandeslagmetdeomgevingswet.nl," n.d.-b), and is guiding for the environmental plan and environmental programmes. The environmental vision replaces the former 'spatial development strategy'. The format of the vision instrument is not fixed, attributing the governmental bodies with freedom towards the ambitions, time-horizon, level of abstraction and themes (Ministerie van Infrastructuur en Milieu, 2016).

In contrast to the vision, the environmental plan has a legal status. The environmental plan includes regulations for the physical environment, which can be coupled to specific locations or functions. In the plan also the 'environmental values' are determined, which are norms that the municipality aims to accomplish for the physical living environment. This can be a performance requirement, effort requirement or other requirement (e.g. with regard to air quality, flood safety and swimming water quality). The environmental values are concerned with large obligations, since when such a norm is formulated, its progress must be monitored, evaluated, and action is to be taken in case of unfulfillment. Finally, the environmental programmes include concrete measures for maintenance, protection, use and development of the physical living environment. The environmental programmes include the measures with which an environmental value or other objective can be accomplished. For example a programme can concern a management plan for Natura 2000 areas. For more details on the environmental law and the implications for municipalities see also Appendix 9.7

In preparation of the implementation of the law, 10 pilot projects for the environmental vision were performed by municipalities in 2014/2015. From the evaluation report was learned on the implications of the environmental vision for municipalities; revealing both challenges and opportunities. The main findings included (Ministerie van Infrastructuur en Milieu, 2016):

- The challenge is how to achieve integration among sectors and disciplines.
- Integration demands, or may facilitate a change of culture in organizations and among sectors and disciplines.
- There are high expectations of participation and multiple methods for participation are present, however how to best organise participation remains a challenge.
- Digitalisation is identified as an instrument to counteract fragmentation of information and facilitating flexibility and keeping the environmental vision up to date. However, there are no information standards (yet).
- The focus of the vision can be diverse and pluriform, e.g. the vision can be built up based on themes, on physical regions, target groups and based on trends. Despite this diversity, the focus is on abstract guiding and oriented towards the long-term.
- The process of formulation is also divers in approach, steps and roles. This process needs to be coordinated well with internal and external stakeholder to generate and maintain 'momentum'.
- There is a tension between the vision and 'issues of the day'. For example, close-by changes speak more to the imagination that for example long-term developments like climate change.

# 5 Results

This chapter discusses the results of the application of the analytical and evaluative framework to the CAA case. First, section 5.1 describes how CAA producers pursue climate information development and section 5.2 describes how municipal practitioners pursue climate adaptation planning and spatial vision development. These two sections answer to sub-question 3. Finally, section 5.3 evaluates the usability of the CAA to municipal practitioners. This answers the first part of sub-question 4.

## 5.1 CAA producers

Starting with the producers' side of the science-policy interface, this section discusses the producers' context, by describing how boundary organization CAS, scientists and consultants pursue the development of climate information. This is done by analysing the actor engagement in the development of the CAA (section 5.1.1), the producers' capabilities (section 5.1.2), and the beliefs on the production of usable climate information (section 5.1.3). Section 5.1.4 ends with a sub-conclusion to sub-question 3.

### 5.1.1 Actors engaged in the development of the CAA

This section discusses the actors engaged in the development process of the CAA, and how this has shaped the development process, according to the analytical factor 'actors' as explained in section 2.3.1.1. Figure 5.1 summarizes the actors that were engaged in the development of the CAA, the next paragraphs elaborate on how this influenced the development process.

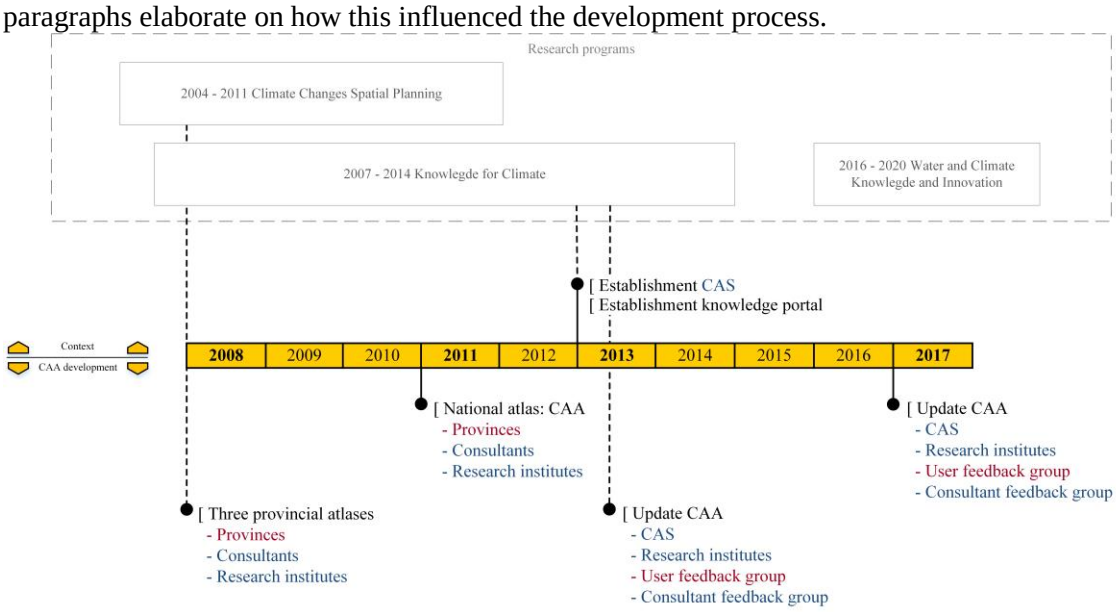



**Figure 5.1: Engagement of actors along the timeline of the development of the CAA**

- 2008: Three provincial atlases

On request of three Dutch provinces, research institute Wageningen Environmental Research (WER) initiated a project to create atlases for climate change effects to support the provincial spatial development strategies. The project was supported by the research programme 'Climate Changes Spatial Planning' (CCSP) and 'Knowledge for Climate' (KfC) and was performed by individuals from WER, the national meteorological institute (KNMI) and consultancy firm Royal HaskoningDHV, together with the provinces. This resulted in (non-digital) atlases, embedded in a report describing the climate effects for each of the provinces.

- 2011: National Atlas

The project with the provinces gave rise to the idea that also other provinces might be interested. This idea was well received at the interprovincial organisation (IPO) and resulted in the up-scaling of the provincial atlases to a national atlas. This project was co-financed by IPO, the provinces and CCSP.

Again individuals from WER, KNMI and Royal HaskoningDHV performed the project. In addition, individuals from diverse research institutes and companies contributed, including research institute Deltares and GEO-ICT firm Geodan. Since the research institutes do not have an information disclosure task, one of the researchers stated that a motivation to participate in the project was:

*"For the research institutes participating in CCSP, this project provided an opportunity to bundle research outcomes and disclose it to society"*

The researchers, consultants and provinces together determined the design and content of the national atlas. Firstly, all provinces were interviewed on their needs. It appeared, that sometimes the provinces had expectations that could not be met by the scientists. For example they would like to have maps indicating the potential damages in Euros per hectare in future climate, or the provinces explained that they needed maps on drought, but it remained unclear what impacts of drought were relevant for the provinces. This resulted in some friction between the research institutes and provinces. As was stated in a report on the initial development of atlas (Goosen, Bessembinder, & Stuyt, 2009, p. 60):

*"the end-users were interested in a drought map. Hydrologists however, need to know which parameters they need to visualize: water availability in the root zone, ground water levels, in what period of the year, for a standard year or in cases of severe drought periods etc."*

Therefore, much time was invested in gaining insight in the underlying questions of the provinces in multiple 'Climate Ateliers' sessions, along themes such as 'agriculture' and 'spatial development strategy'. From these sessions mutual understanding increased; e.g. the province gained insight in that some of their questions couldn't simply be answered by the research institutes, and needed to be addressed in a different way. Based on the input from the sessions and the available knowledge from the research programme CCSP, indicators were selected for the atlas. No maps were established specifically for the CAA, rather the available knowledge and information was selected and tailored to fit the provinces' needs. In 2011 the national CAA was published in an online web-viewer.

- 2013 establishment CAS and update CAA

Climate Adaptation Services (CAS) was established in 2013 as an independent foundation to maintain and further promote the CAA, as a spinoff from the research programme KfC. The provinces commissioned CAS to update the national Atlas with the latest knowledge. At the same time, the Ministry of Infrastructure and Environment commissioned CAS with the development of the knowledge portal 'www.ruimtelijkeadaptatie.nl' as part of the incentive programme in the Delta decision on spatial adaptation (DDSA). With the establishment of the knowledge portal was aimed to facilitate, support and promote climate adaptation in the physical environment. Moreover, the portal was regarded as a good approach to secure the efforts and outcomes of the DDSA. The CAA web-viewer was integrated in the knowledge portal.

The knowledge portal was developed by CAS together with research institutes, landscape architects, a user group and the advisory board of the Delta Plan. The engaged actors influenced the development of the portal by bringing forward that climate adaptation efforts are rather combined with other spatial objectives, and often do not start from climate adaptation objectives only. As a result, the knowledge portal was structured with modular units of knowledge and information that can be separately used. Moreover, the user group, comprising of provinces, municipalities, water boards and housing associations, evaluated that CAA as part of the portal, and provided input on both the content (e.g. missing indicators) and visualisation (e.g. colours of legenda).

Moreover, for the CAA specifically, a consultant feedback group was established to collect their experiences on the use of the CAA with for example municipalities. From the feedback group was *inter alia* learned which indicators were less usable and needed improvement. A round by all KfC research tracks allowed for identifying relevant new climate information for the atlas. In 2014 the updated CAA was published online and was updated to a web-viewer that maps out the current and future climatic risks for the four risks themes of: fluvial flooding, drought, pluvial flooding and heat, see Figure 5.2. For each of these risk-themes a list of relevant indicators was made available which are spatially represented when ticked on. The indicators may be relevant climate change impacts or

relevant functions. For example, under the risk theme pluvial flooding, the indicator groundwater flooding can be selected. Moreover, different basic maps can be selected, such as landscape types. The indicators can be viewed for the current situation, and for the year 2050 for an extreme climate scenario. An instruction manual is available in which users are guided through the functionalities of the tool. As a service of the knowledge portal, questions on the CAA can be posed through a 'help desk' and the GIS data underlying the maps is freely available on request.

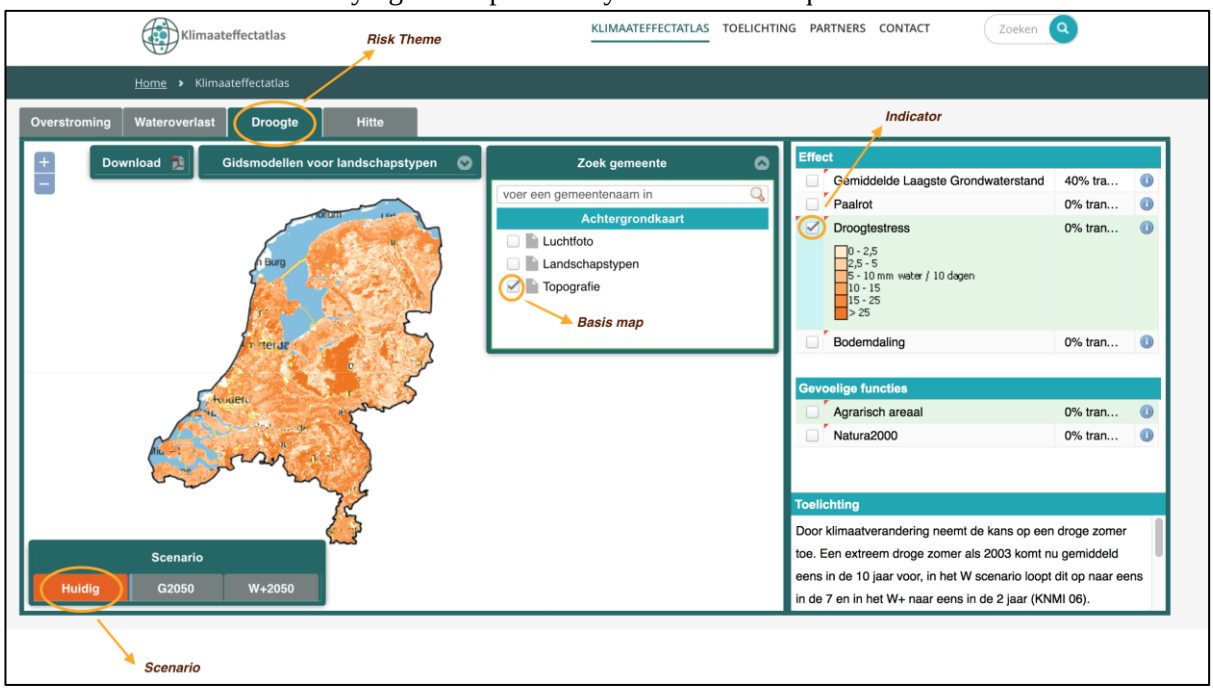



**Figure 5.2: Screenshot web-viewer Climate Adaptation Atlas** (source: Climate Adaptation Services, n.d.).

- 2017: Update CAA

For 2017, The Ministry of Infrastructure and Environment commissioned CAS to update the CAA, *inter alia* by including the latest KNMI climate scenarios. CAS coordinated the update and had a one-year access to financial subsidies for the update. In the update process, CAS defined the issues that would be updated, based on the needs and possibilities that came forward from consultations with the consultant feedback group and the research institutes. This resulted for example in the inclusion of the suggestion of the consultant feedback group, to provide more explanation on how the CAA data can be used. CAS therefore explores the possibility to embed the CAA in a story map, which is a web format in which texts, figures and interactive maps are combined to provide a narrative. Moreover consultation with the consultant feedback group and research institutes focussed on the identification of more 'applied' indicators, which show the impacts of climate change risks to functions and sectors relevant to the potential users. This resulted for example in the identification of an indicator that shows the pluvial flooding on the neighbourhood level, taking into typical neighbourhood structures.

When CAS identified the 'update tasks' in January 2017, the research institutes were subcontracted for data modelling in February and April. In turn, in May 2017 CAS visualised the provided data on maps, and made a first start with embedding the maps in a story map. The texts with explanation of the data and the suggestions for potential use were formulated together with the scientists of the research institutes. For June, it was planned to present and discuss the primary results with a group of (potential) users. Thereafter adjustments could be incorporated so that the CAA can be launched in November 2017.

Taken together, throughout the development of the national atlas much effort was done to engage users (provinces) in the development process to collectively shape the content and design of the CAA. Moreover, through the entire development of the atlas, a broad coalition of actors were engaged comprising of local and regional authorities, research institutes, consultants and boundary organization CAS. Yet, it seemed that the provinces had most influence on the initial atlas. Furthermore, the consultants appeared an important intermediary in exchanging experiences with CAS on the use of the CAA in projects with municipalities.

### 5.1.2 Capabilities

This section discusses the capabilities of the CAA producers and how it affects the development of climate information for municipal practitioners, according to the analytical factor 'capabilities' as discussed in section 2.3.1.1. Table 5.1 summarizes the findings.

**Table 5.1: Summary of capabilities of CAA producers**

| CAS | Research institutes | Consultants |
|---|---|---|
| - The objective of foundation CAS is to promote the adoption and use of climate information to support local and regional climate adaptation.<br>- CAS performs diverse climate adaptation projects, focussed on translating climate information (often using maps) and stakeholder engagement, which are usually commissioned by governmental bodies.<br>- Commissioned by the national government, CAS supports climate adaptation on the regional and local level by disclosing knowledge and experiences on a national web-portal: the knowledge portal<br>- Interactions with municipal practitioners take place through the knowledge portal user feedback group, consultant feedback group, helpdesk questions, regional meetings and participation in projects. | - The primary objective of the research institutes it to develop knowledge by conducting research.<br>- Projects are commissioned from both public and private actors.<br>- The research institutes have little structural interactions with municipalities. Performing projects together on climate adaptation is not common, due to financial and institutional constraints.<br>- The NKWK research programme aims to bring together research institutes and private and public actors, to increase the applicability of knowledge.<br>- In contrast to the research institutes, consultants can provide applied climate information, by developing their own products. | - Primary goal is to fulfil user needs, not knowledge development.<br>- Most interactions of consultants with municipalities take place in projects on in stress tests in which a variety of actors participate, focus on creating awareness |

It was found that the diverse CAA producers operate from diverse organizational contexts, and consequently pursue different objectives that are concerned with different incentives and constraints in developing climate information. Where the research institutes are primarily focussed on developing climate knowledge in research projects, the consultants aim to supply applied products in projects to fulfil user needs. In turn, foundation CAS acts as a boundary organization by aiming to make scientific climate information accessible to local and regional authorities. Consequently, the incentives to produce usable climate information for municipal practitioners differ; especially CAS and the consultants have the incentive to collect input from practitioners and take their needs into account in (further) developing climate information.

These differences in objectives are reflected in the interactions that take place between the CAA producers and municipal practitioners. While CAS and Consultants have many interactions with municipalities, the scientists usually don't perform projects with municipalities. A scientist explained that since research institutes do not have a general information disclosure task, no budgets are available to communicate on climate research and make it more applicable. Projects from the interviewed scientists emerge mostly from European and national research budgets, or from private and public parties (e.g. for branch research). Yet, if projects with municipalities take place, it usually concerns the larger municipalities with high climate adaptation ambitions. These municipalities generally also have the resources to analyse and research information on top of their primary tasks and moreover have better access to European subsidies. In contrast, for smaller municipalities it is difficult to get involved in research projects due to small budgets and human capacity. In addition, while two of the interviewed research institutes act independently, the meteorological institute is a governmental agency. This brings the implicating that only projects can be performed if it concerns research or when the institute is the only party that can bring in specific knowledge. This requirement constrains the institute to perform projects with municipalities. However all scientists indicated that interaction outside of projects take place with municipal practitioners; most often when the scientists are invited to join sessions and to provide input based on their expertise.

Furthermore, one of the scientists explained that with the research programme NKWK is aimed, to improve the applicability and accessibility of scientific research (e.g. for climate adaptation). The rationale of the project is that if municipalities with similar problems together perform projects with research institutes they can bundle budgets. Yet the scientist doubted the feasibility of formulating such projects. Especially for smaller municipalities, spending even a small budget on research is a big investment while outcomes are unknown. The same budget spent on a consultant yields with bigger certainty climate information that is usable and specified for the municipal area. While the consultants

themselves do not dispose of the capabilities to generate information on future climate impacts as the research institutes can, consultants can create derived products with which for example land subsidence or pluvial flood risks can be modelled. Yet for private actors as the consultants, the incentive is always to use their own in projects. The scientist stated on the role of the consultants:

*"it is the tasks of consultants to shape the rough diamonds produced by research institutes, and transform it into applicable products"*

In contrast to the scientists, consultants have many interactions with municipalities in projects. Projects with municipalities on climate adaptation often include facilitating sessions such as stress tests or climate ateliers. The consultants explained that they are the actors that can translate the climate information that is produced by the research institutes, by offering supplied products such as pluvial food risk maps and heat stress maps. Also CAS participates in projects with municipalities, however since CAS performs a role for the national government to support adaptation on the local level (knowledge portal, see section 5.1.1.), CAS doesn't take an active role in acquiring local projects themselves but rather participates next to another initiating party; usually consultants. Yet other interactions take place with municipalities, e.g. through the feedback group and the helpdesk.

The consultants explained that projects with municipalities on climate adaptation usually include the establishment of vulnerability maps and discussing these vulnerabilities as well as a potential course of action with the practitioners. A common way of doing this is that consultants collect municipal maps and overlay it with climate information (e.g. CAA data). The climate data may be tailored to the municipality, e.g. by changing legend classes to better show variation in the specific municipal area. In interactive sessions the maps are discussed with municipal practitioners from different departments (e.g. green policy, soil management, water management and spatial development). The practitioners complement the maps with local knowledge and identify if more specific relevant data is present to complement and specify the maps (e.g. with infrastructures and vulnerable objects). The local knowledge and information is incorporated in the maps. In a second session, the municipal practitioners draw-in threats and challenges on the updated maps and discuss potential solutions.

The interviewees of CAS explained that the role of CAS in projects is often about translating complex climate information to simple and understandable information and facilitating climate adaptation projects that are centred on stakeholder engagement. Whereas within the organization there is much expertise on maps and visualisation, most of the translation efforts manifest in the creation of maps. With the task to support local and regional adaptation, and the ambition to support the adoption and use of climate information, CAS has the incentive to interact with both scientists and (potential) users. One of the boundary workers explained that the independent role of CAS allowed to freely tailor the scientific information to the user needs, while having good connections to both the science an policy-making community One of the interviewees explained that the interactions provide insight in the state of knowledge on climate adaptation among municipalities as well as their potential information needs. In turn interactions with the scientific community provided insight on the latest climate knowledge.

From the above appears that the research institutes dispose of the technical capabilities to develop climate information, while CAS and consultants dispose of the human and technical capabilities to make the information applicable for municipal practitioners. Financial as well as institutional factors seem to constrain that research institutes participate in projects with municipalities. Alternatively, both CAS and the consultants have many interactions in the use and application of climate information (e.g. CAA data), and aim to include what is learned from these interactions in the development of climate information. Yet, where consultants have the financial incentive to promote the use of their products, CAS has the incentive to support local and regional adaptation and moreover to link back the user needs to the research institutes.

### 5.1.3 Beliefs on users and their needs

This section discusses the beliefs of the CAA producers and how it affects the development of climate information for municipal practitioners, according to the analytical factor 'beliefs' as discussed in

section 2.3.1.2. First the producers' beliefs on municipal adaptation planning, vision development and information needs are discussed; subsequently the beliefs on the usability of the CAA are discussed.

### *5.1.3.1 Beliefs: municipal climate adaptation and information needs*

Table 5.2 summarizes the beliefs of CAA producers on municipal processes on climate adaptation and the formulation of the environmental vision, and the corresponding information needs.

**Table 5.2: Beliefs: climate adaptation and environmental vision by municipalities and information need**

| | CAS | Research institutes | Consultants |
|---|---|---|---|
| Adaptation information needs | - There is a variety in ambition and perceived urgency within and between municipalities on addressing climate adaptation.<br>- Municipalities rarely take measures solely for climate adaptation, rather is aimed to couple objectives.<br>- Addressing climate adaptation is constrained by unclear responsibilities towards addressing climate adaptation and limited available budgets. | - There is a variety in ambition and perceived urgency within and between municipalities on addressing climate adaptation.<br>- Adaptation efforts manifest rather loose projects in integrated policies.<br>- For addressing climate adaptation, political support is critical, however this is not easy accomplished due to the divide between the municipal council and practitioners.<br>- To make scientific climate information usable to municipal practitioners, it must be translated to the local situation. | - There is a variety of ambition and perceived urgency within and between municipalities on addressing climate adaptation, but ambitions and approaches are pragmatic and iterative in nature.<br>- Municipal practitioners need concrete and understandable climate information that provides insight in the risks, the course of action and the associated investments.<br>- Addressing climate adaptation is constrained as being perceived as complicated and expensive and being misunderstood. Bringing climate adaptation further within the municipality requires multiple efforts to overcome organizational and financial barriers; more is needed than climate information only. |
| Environmental vision & information needs | - To integrate adaptation in spatial planning, climate adaptation should be integrated in the environmental vision. | - Integrating climate adaptation in the municipal environmental vision demands the establishment of new and adjustable spatial planning norms.<br>- Coupling climate adaptation to other spatial objectives is an opportunity to integrate climate adaptation into the vision.<br>- Climate vulnerability information needs to become basis information, along with other integrative themes.<br>- To establish an integrative vision, municipal organizations may need to reorganize.<br>- Climate change uncertainties should be regarded in drafting spatial visions and concrete plans. | - While stress tests are available to gain insight in the climate vulnerability, a method/support for taking the next step in climate adaptation is lacking.<br>- A green-blue vision may serve as a building block for integrating adaptation in the environmental vision.<br>- Adaptation needs to be framed as an integrative societal goal, so that it can be addressed in the vision along with other goals such as health and can be coupled to other objectives.<br>- The environmental vision may be more influenced by the political climate, than by the available (climate) information. |

All CAA producers expressed the belief that there is a variety in ambition and approach towards climate adaptation within municipalities, and that municipal practitioners are often concerned with increasing internal awareness while disposing of little budgets. Consequently, all producers indicated that climate information should take into account this diversity by tailoring the scientific climate information to the local needs and relate to other municipal objectives. The interviewees of CAS indicated that the diversity in the priority given to adaptation can be explained with that the responsibilities on climate change risks are unclear at the local level: municipalities may expect that adaptation is addressed by the national government (e.g. flooding) and by the water boards (e.g. pluvial flooding), while the other climate change risks may lack awareness (e.g. heat). Furthermore, two scientists explained that the diversity in ambition emerges from differences in political support. It was indicated that there is often a huge divide between the municipal practitioners and the council. Consequently, climate adaptation efforts often come down to individuals that promote the issue. However, often climate adaptation only really gains attention, political support and budgets when the municipality is confronted with climate change impacts, it was stated:

*"Sometimes municipal practitioners reveal that it would be good if something happened, just to bring the issue forward"*

Furthermore, two scientists indicated that climate adaptation is often not yet an integrative theme within municipalities; adaptation is addressed in specific projects but badly secured in policies or only specific departments may include adaptation considerations within the municipality, making them loose efforts. In addition, one scientist explained that criteria to evaluate climate adaptation considerations in procurement processes are lacking. For example, currently in constructing drinking water pipelines, it is not taken into account that climatic temperature increase may cause that critical values are exceeded and can cause health issues. To make climate information usable to municipal

practitioners, all scientists indicated that scientific climate information should be translated to the local situation, and offered in information formats that users recognize. In addition, the interviewees of CAS explained that as municipalities rarely implement measures solely for climate adaptation, the information should facilitate that practitioners can combine adaptation with other objectives.

While the beliefs of the consultants on how municipal practitioners approach adaptation are in line with the beliefs of CAS and the scientists, the consultants elaborated in most detail on the municipal context influences the information needs of practitioners. Like the scientists, two consultants explained that the motivation to address climate adaptation is often driven by the occurrence of recent climate problems. Both consultants provided examples of the recent initiation of projects as a reaction to extreme precipitation events. These events gave rise to that municipal budgets were made available to perform a stress test. The consultants explained that during the stress test sessions, municipalities are pragmatic and in search of concrete measures, couple them to other objectives and realise them as cheap as possible. This contrasts with the rationale of the national government adaptation to perform the subsequent steps of analysis, ambition and action, a consultant stated:

*"Municipalities want to know what is going on, what they can do, and dependant on the price tag, what they want to do"*

Consequently, the consultants explained that easy and understandable information is needed that can answer these questions of municipalities. Moreover, this information should be offered in a concrete product that is understandable and fits the pragmatic and iterative processes of the municipalities.

Yet, the specific needs of municipalities may differ, depending on the ambition and specific context. A consultant explained that among the 'frontrunner' municipalities it still varies whether they aim to make policies to decrease 'specific climate change risks' or aim to be 'climate robust'. For example for pluvial flood risks, some municipalities just increase the norm of the sewerage capacity, while others also regard over-ground solutions. Another consultant indicated that also some climate adaptation efforts are not based on a vulnerability analysis at all; Citizens may be just encouraged to disconnect drainpipes without indications of flood risks; and in all new neighbourhoods disconnected sewage systems are implemented, while in some cases combined sewage systems may be cheaper. Yet another consultant explained that there are also municipalities that don't do much on adaptation yet, more often this concerns smaller municipalities. In these municipalities climate adaptation is often a theme that is inferior or badly understood; e.g. not all municipalities understand the difference between mitigation and adaptation, it was stated:

*"a municipality argued that they where doing well on climate adaptation and then exemplified this with their efforts of promoting the use biogas for transport"*

Moreover, municipal practitioners often perceive climate adaptation as a complicated and expensive effort. One consultant explained that addressing climate adaptation within the municipality often emanates from individual practitioners that feel responsible for climate adaptation. The practitioners are concerned with increasing awareness within the municipality, on the practitioners was stated:

*"People often feel as lonely wolfs"*

This observation partly motivated one of the consultants to start the KANS network; to allow practitioners to exchange experiences and identify if shared needs can be addressed together. Two consultants indicated that promoting adaptation within the municipality is not only about supplying good climate information; it is also much about overcoming organizational and financial barriers: Firstly, organizational and financial factors may constrain addressing climate adaptation. Often it is unclear how and by whom climate adaptation should be financed. For example, when more green space is implemented as an adaptation measure, the maintenance costs increase, while benefits often express in other domains such as public health. In general, the manner in which the municipalities are structured may constrain addressing adaptation, e.g. as budgets are made available for different sectorial departments, rather sectorial solutions are promoted.

Secondly, municipal practitioners from the spatial development department sometimes lack awareness on climate adaptation, while this department has the largest mandate in spatial planning decisions. Still, if climate adaptation is taken into account, often it is only regarded in the end of the planning process. Thirdly, geospatial information is often not well organized within municipalities. This was exemplified with a project in which an atlas for a municipality was established with both local geospatial information and climate information. All available maps for different themes (e.g. on green policies and water management) were collected. For the water theme only, more than 80 different maps were found. Bringing this information down to one main map with them most relevant and up-to-date information required much time and deliberation.

With regard to the **environmental vision** it appeared that none of the CAA producers had a clear perspective on the implications of the environmental law for municipalities, how municipalities would shape the environmental vision and how this might affect their climate information needs. From CAS was indicated that it was expected that to fulfil the objective of integrating climate adaptation in spatial planning, it should be at least integrated in the vision where the long-term spatial goals are formulated. From the consultants, none had concrete experiences with this environmental vision yet, and from the scientists, two had not heard of the environmental vision before. Yet when explaining on how the environmental law demands municipalities to integrate sectorial planning policies and formulate a vision, all CAA producers referred to the vision as a promising instrument for adaptation, however the expectations on the implications for climate information needs remained rather general:

From the research institutes, all scientists indicated that for integrating adaptation into spatial planning, dynamic norms must be established that take into account climate change and that can be adjusted as the future climate unfolds. Secondly, coupling adaptation objectives to other objectives was seen as a promising manner to integrate adaptation into the vision. For example, a scientist explained that there is great potential to combine adaptation objectives with biodiversity, environmental quality and recreation. To be able to identify such combinations, it was suggested that climate change information should become part the basis information; just like maps on e.g. soil conditions and socio-economic developments. This would allow municipalities to base spatial decisions on climate vulnerability (e.g. relocating residences to areas with low risks of groundwater nuisance). Finally, one of the scientists stated that on all levels of spatial planning, from vision to plan, climate change uncertainties should be regarded, as using a certain climate scenario is a political choice; effectiveness of adaptation measures may differ for different scenarios, hence knowing the uncertainties is important for decision-making.

From the consultants, two interviewees indicated that to integrate climate adaptation into the vision, both the vulnerability of the municipal area and a potential course of action must be known. While for mapping municipal vulnerability clear methods are available (e.g. stress tests), there is no clear support for taking the next step and integrate adaptation into spatial planning. Yet, one of the consultants suggested that the formulation of a green-blue vision that includes adaptation measures for vulnerable areas, could be an appropriate building block to integrate climate adaptation into the environmental vision. Finally, one consultant indicated that often the link between information and municipal policy is weak; it can be expected that the political context has a large influence on an important policy instrument such as the environmental vision, more than 'good' scientific information.

While all producers recognized a potential for integrating adaptation in the vision and suggested general ways forward, both the research institutes and consultants also expressed concerns on how the integration among divers policy domains could be accomplished. One consultant explained that the environmental vision is an opportunity for addressing climate adaptation as well as other societal goals; however for this climate adaptation needs to be framed as a societal goal, just like health and energy. The challenge is to break through the current sectorial analyses on soil, water or health in spatial planning, and rather generate maps on the systems on which the relations between all societal objectives can be shown. Yet, for this needs to be recognized that climate adaptation links to the natural system, so that there is an incentive to increase system knowledge. In the same vein, one of the scientists indicated that because municipalities are currently sectorial organized; the establishment of an integrative environmental vision might require reorganizations, as currently different municipal departments have their own separate budgets, which constrain collaboration among and integration.

From the above appears that all CAA producers are familiar with how municipalities differ in their approaches and prioritization of adaptation, and that climate information should be adjusted to the heterogeneous needs. Yet especially the consultants have most feeling with how addressing climate adaptation, and consequently the patterns of climate information use are constrained by financial and organizational factors. Furthermore, the consultants recognized that the capabilities to complement climate information with local geospatial information may be constrained with that information is not well-organized within municipalities. Finally, while all producers indicated the potential for the integration of adaptation in the vision, the expectations on the implications for climate information needs remained rather general. Moreover, from both the consultants and scientists was indicated establishing integration among sectorial domains is a big challenge.

#### *5.1.3.2 Beliefs: usability of CAA for municipalities*

Table 5.3 summarizes the beliefs of CAA producers on the usability of the CAA

**Table 5.3: Beliefs CAA producers on the usability of the CAA for municipalities**

| CAS | Research institutes | Consultants |
|---|---|---|
| - The CAA can be used to support regional and local policy-making on the strategic level by mapping the climate change vulnerability.<br>- For formulating adaptation measures, the CAA cannot be used, rather more specific and local and information is needed.<br>- While it sometimes is criticized that the CAA is too coarse, decision-making doesn't' necessarily improve with more detailed information.<br>- The usability of the CAA to municipal practitioners may increase when more applied indicators are used, and additional explanations are provided in a story map.<br>- Ultimate goal is to make local /regional governmental bodies look a head to 2050 and 2100 | - It is difficult to judge the usability of the CAA when not involved in projects in which the CAA is used.<br>- The CAA is usable for identifying climate change risks and agenda-setting<br>- The CAA is usable as it is freely available and thereby provides municipalities, which are often concerned with small budgets, with climate information.<br>- The CAA is not usable for defining policies and measures: more detailed climate information is needed.<br>- CAA data alone may be limited usable because municipalities are used to work with detailed maps. By combining the CAA data with geospatial information, the usability may increase.<br>- The CAA data may be more usable to consultants who can edit and tailor the information than to municipalities<br>- Some indicators are too complicated for municipalities to interpret and need explanation. | - The CAA is usable as a starting point for climate adaptation: do we have a problem, and subsequently for pushing adaption forward on the municipal agenda and generate a sense of urgency.<br>- Combining CAA data in stress test session with local spatial information creates a shared knowledge base that facilitates collaboration and integrative thinking, and knowledge dissemination among the municipal organization. Moreover, it matches municipal practitioners' need to use their own known maps, which they recognize.<br>- The CAA is usable for consultants as it is editable and can be combined with private products.<br>- The CAA is not usable for the next step: local and detailed info is needed as well as explanation.<br>- The ready-made CAA data is usable to municipalities as they are concerned with little budgets and little time to inquire on climate information.<br>- The four CAA climate themes are defined from a theoretical perspective, which does not match topical issues addressed in municipalities.<br>- Generally CAA data is trusted and recognized it should be clearer what value could be attributed to the information. |

All CAA producers evaluated the CAA as usable for increasing awareness and pushing adaptation forward on the agenda, yet while CAS and the consultants explain this from their experiences on using the CAA data with municipalities, the scientists had not used the CAA with municipalities and knew the web-viewer superficially. The interviewees of CAS explained that the CAA was indented to meet the de demands of provinces; to support regional and local policy-making on the strategic level. Moreover was aimed to counteract the fragmentation of available climate information by supplying national covering vulnerability information.

Also all consultants evaluated the CAA as usable to start with adaptation: analyse the vulnerability and use this analysis to push adaptation forward on the municipal agenda. One of the consultants explained that heat stress is often a big eye-opener among municipal practitioners; while it is generally known that temperature increases, the implications for the urban area and how is spatially dispersed are often unknown. Yet, two consultants reported that heat is also a difficult issue since it is not straightforward what measures should be taken. While three consultants had used the CAA data in projects, one consultant explained that rather the climate information products from the consultancy firm itself were used since with this more detailed information could be provided. Also the scientists explained that the CAA is a first filter to gain insight in the vulnerability and assist agenda-setting. Finally, both the scientists and consultants indicated that the freely available CAA web-viewer provides ready-made

information and therefore fits well to the limited budgets and time available at municipalities to inquire on climate information.

However for taking 'the next step', all producers evaluated the CAA as less usable; more detailed information is needed to formulate policies. In addition, both the consultants and scientists indicated that explanation is needed to understand the data and know the (im) possibilities of the data. From CAS was explained that for formulating concrete measures, more detailed climate information and other geospatial information is needed. Similarly, the scientists explained that for formulating spatial plans, the maps are too coarse to regard the heterogeneous municipal area and to formulate a course of action on the street level. The consultants explained the practitioners regard the maps with a rather pragmatic lens and are in search for a course of action.

Moreover, while the CAA municipal practitioners generally trust the data, two consultants indicated that it should be clearer what value could be attributed to the data. It was explained that practitioners generally recognize that the CAA data represents the best available information. However as they cannot judge the quality of the data themselves it must be better communicated to what extent the CAA data can be trusted, as potentially decisions are based on this information. Also from CAS was indicated that an often-heard critique is that that the national CAA data is too course, and the resolution is not suffice to take action. Yet one of the boundary workers argued that it is questionable whether decision-making on climate adaptation would improve when more detailed climate change vulnerability information is available; establishing high-resolution vulnerability maps are still associated with large uncertainties that emanate from the climate scenario inputs.

Beyond the trustworthiness of the data, three consultants explained that additional explanation is needed along with the maps; usually practitioners have many questions on what the data means. The consultants see it as their task to present and explain the map layers in digestible units. Also one of the scientists indicated that some of the CAA indicators are too complicated: It was doubted whether sufficient in-house knowledge is present to interpret the indicators of for example oxygen and drought stress, municipal practitioners may be more interested in the specific resulting impacts. More generally, one of the consultants indicated that the four risks themes – drought, heat, pluvial flooding and flooding – are argued to be too abstract, and difficult to relate to the policy and planning process in municipalities. To link the risks themes to spatial planning processes, the consultant suggested to present better recognizable risk themes: such as flooding, water nuisance, heat stress, drought, wildfire, water quality, biodiversity, erosion, paalrot, wind damage and land subsidence.

In the above context, all producers indicated that tailoring the maps increase the usability of information. For example, from CAS was indicated that in the update process of the CAA was aimed to included indicators that are more applied, as these may be better recognized by practitioners. Moreover, by embedding the CAA in story maps is aimed to increase the understanding of the CAA by providing simple explanations on the climate information and how it can be used. Consultants are regarded as performing an important role in further tailoring the CAA information, while municipal practitioners can also use the CAA directly.

Like CAS, both the scientists and consultants explained that the CAA is usable for consultants as they can further tailor the CAA to the municipal needs. Moreover, combining the CAA data with local knowledge and information and providing additional explanation in sessions facilitates collaboration among sectorial domains and integrative thinking. One of the scientists explained that while the CAA is usable for a rough analysis, municipal practitioners are generally used to work with detailed maps (e.g. sewerage maps), therefore the CAA may be too coarse. Yet, as consultants further tailor this general information by adding local knowledge and their own more detailed products, consultants increase the usability of the maps. Similarly, the consultants themselves explained how they could use the CAA data as a starting point, and further tailor the maps to the practitioners needs, e.g. by editing the data (e.g. define new legend classes, change colours), or adding geospatial information (e.g. adding information green structures to the heat stress maps). The consultants stressed that it is important that the practitioners recognize the information, after all the practitioners know every street by hart. Furthermore three consultants explained that combining CAA data with geospatial information on maps, supports collaboration between stakeholders and integrative thinking: collecting information

from municipal practitioners with diverse backgrounds and from diverse departments and combining this with the CAA creates a shared knowledge base; brining not only together information but also stakeholders. Moreover, the visualisation of the diverse information on maps allows stakeholders to think and talk on the same thing. In turn, provided the diversity of information this facilitates integrative thinking among the practitioners. Finally, since usually larger groups of practitioners are engaged, knowledge is disseminated through the organization easily, and maps are an appropriate mean for this.

From the above appears that all CAA producers evaluated that the CAA fulfils the needs of municipal practitioners to increase awareness on the climate change vulnerability and pushing adaptation further on the municipal agenda. Moreover the consultants indicate that combining climate information with geospatial information in climate sessions (e.g. stress test), facilitates collaboration among sectorial domains and integrative thinking among stakeholders. Yet all producers agreed on that the CAA was not usable for defining measures. Moreover, all producers indicated that explanation is needed to guide the understanding of and use of the data, as the capabilities of municipal practitioners are limited and they cannot judge the quality themselves. While from the consultants was indicated that more clarity is needed on the extent to which the data can be trusted to be able to support decision-making with good information, from CAS was indicated that decision-making does not necessarily improve with more detailed climate information, given the inherent uncertainty of the climate projections.

### 5.1.4 Conclusion Q3 (part I)

With section 2.3.1 the first part of sub-question 3, can be answered. Recalling sub-question 3:

*How do the CAA producers develop climate information [….] in the CAA case?*

The CAA producers' context was described by analysing the development of climate information with regard to the engaged actors, the producers' capabilities and their beliefs. The analysis showed that scientists, consultants and provincial policy-makers were the actors that collectively developed the CAA. The development process was centred on matching and tailoring available climate information to the provinces' needs. Multiple sessions were organized to identify relevant climate (vulnerability) indicators for policy-making. The coalition of actors remained the same in the further development and update process of the CAA, yet boundary organization CAS was established to coordinate process.

Differences were found in the capabilities of the CAA producers. Only the scientists dispose of the technical capabilities to run climate models and produce information on future climate, while the consultants and boundary organization CAS have the capacities to supply municipalities with applied and practical climate information. This resonates with the intermediaries' incentives to interact with municipalities and to include user needs in the development process. The intermediaries regularly interact with municipalities, yet from different incentives; CAS aims to support local adaptation by supplying usable information to the municipal practitioners and providing feedback to the scientists, and the consultants aim to promote the use of their commercial products. In contrast, the scientists have the primary task to conduct research, and financial and institutional factors constrain the scientists to interact with municipalities in projects.

Consequently, the beliefs of the intermediaries on usable climate information were most inspired by practical experiences. Yet in general, all producers believed that usable information should consider the heterogeneity of the practitioners. Surprisingly, none of the producers had a clear view on how the environmental vision may influence information needs. Regarding the CAA, all producers believed that the CAA is usable for creating awareness and agenda-setting. Additionally, the consultants believed that combining the CAA data with local knowledge from diverse stakeholder facilitates collaboration and integrative thinking. To improve the usability of the CAA all producers suggested additional guidance on the use of the CAA. Moreover, the consultants emphasized the need to communicate on the trustworthiness of the data and provide detailed information to be able to formulate policies options. Alternatively, from CAS was doubted whether providing detailed climate information would improve decision-making, provided the inherent uncertainty of future climate.

## 5.2 (Potential) Users of the CAA

This section analyses the users' side of the science-policy interface, by discussing how municipal practitioners pursue adaptation planning and the development of the environmental vision. This is done by analysing the factors to describe the users' context as discussed in section 2.3.3.1 to 2.3.3.9. Factors that appeared to be closely related where discussed together. This section concludes with answering the second part of sub-question 3.

### 5.2.1 Frame, priority setting and formulating policy options

It was found that the practitioners from all municipalities expressed similar frames towards climate adaptation, and pursued similar ways of setting priorities and formulating policy options.

#### *5.2.1.1 Frame of problem and solution*

The five cases showed similar frames on the problem of and solutions to climate adaptation. A frame can be characterised by proximal or distal and promotional or preventive views to adaptation as explained in section 2.3.3.1. All municipal practitioners expressed a promotional and proximal view towards adaptation, by referring to the ambition and need to couple adaptation objectives to other (spatial) objectives to yield multiple benefits, and to make the adaptation objectives concrete for different scales within the municipality.

For example, all project participants of Leiden referred to that the region must be prepared for specific climate change risks (e.g. land subsidence) by taking these risks into account in spatial planning decisions. The practitioners of Nijmegen explained that the 'vague' concept of adaptation must be translated into concrete and understandable objectives, for example by stressing the benefits of adaptation for other objectives such as an increase of health when implementing green space. The practitioners explained that such translations are necessary, as the term 'climate adaptation' does not appeal to people. Similarly the practitioners of Amersfoort, Groningen and Ede indicated that climate adaptation should be 'coupled' to other objectives; the practitioner of Amersfoort explained that since many interests must be taken into account, every spatial intervention must contribute to a better living environment. The practitioners of Ede expect that there are potentially many synergies, yet the question is yet how the general climate trends can be translated to the municipal area: while the main threats are known, what does, for example temperature increase, exactly mean for this municipality? Finally, both the practitioners of Amersfoort and Groningen indicated that the general vulnerability analyses must be translated to the neighbourhood level, the practitioner of Groningen stated:

*"The rough information is present; it is now time to make it more specific"*

#### *5.2.1.2 Setting priorities.*

In line with the proximal and promotional frame towards adaptation, the practitioners expressed similar ambitions towards setting priorities for climate adaptation, which is about the aspects of the problem that are addressed and the way in which these aspects are chosen, as explained in section 2.3.3.5. All municipal practitioners expressed the adoption of a systems perspective towards spatial planning in which spatial decisions are based on, or strongly influenced by, the (im) possibilities of the natural system. Coupling climate adaptation objectives to other spatial objectives is central to this approach. While pluvial flooding and heat stress seem to be prioritised in the municipal context, the practitioners are promoting to regard broader range of risks.

The priorities given to climate change risks and adaptation differed among the municipalities. In the municipality of Leiden, the practitioners emphasized that a range of climate change risks is regarded, such as pluvial flooding, heat, drought, land subsidence and salt intrusion, to analyse the vulnerability of the region. In the municipality of Amersfoort and Groningen was aimed to improve the pluvial flooding and heat maps and to translate them to the neighbourhood level to be able to formulate more concrete adaptation objectives. In the municipality of Nijmegen was indicated that yet the pluvial flooding risks were best analysed and secured in policies, while heat and drought needed better analyses. The practitioners explained that this prioritisation is mainly a matter of unevenly distributed

budgets and capacities among sectorial policy domains. Also the practitioners of Ede indicated that pluvial flooding has gained most attention. Furthermore, both the municipalities of Groningen and Ede indicated that climate vulnerability analyses mostly focus on the inner city of the urban area, while the outer areas are less well known with regard to climate vulnerability. Despite the concentration of priorities on pluvial flooding and heat, all practitioners aimed increase their knowledge on a boarder set of risk themes for the complete municipal area. For example one of the practitioners of Ede stated:

*"I want to get insight in the effects of climate change in the broadest possible way"*

Continuing, both the practitioners of Leiden and Amersfoort indicated a clear application of a systems approach for strategic spatial policy-making. In Leiden the systems approach was applied for the environmental vision, to explore and analyse how climate risks relate to spatial characteristics, policies and tasks, by collecting information on both climate vulnerability and spatial priorities on maps. These maps were created by an external consultant that used an 'urban metabolism'[1] systems perspective to increase coherence among spatial themes. In applying this approach, the municipality collaborated with local parties to increase systems knowledge, gain insight in the issues and associated spatial claims, couple objectives and find collective solutions (see also section 5.2.4.1). While the participating actors agreed on this collective approach, the municipal practitioners explained that this was not an easy task; To gain insight into the 'water issue' of climate adaptation, the drinking water service and water board need to signal on the problems that they are confronted with, yet these parties are traditionally used to 'fix their own problems'. In the municipality of Amersfoort the systems approach was applied in the formulation of a green vision. The applied systems perspective is based on a framework that integrates soil, green, and water for spatial planning and climate adaptation (Natuurlijke Alliantie, 2017). A climate vulnerability map was used to support the formulation of the green vision by indicating for example vulnerable areas for pluvial flooding and heat stress. The practitioner explained that the perspective supports the deliberation among a variety of spatial interests and objectives, as it can be used to analyse how divers objectives can be best achieved provided the many demands on the physical living environment. For example, when pursuing the objectives to have access to both green spaces and good infrastructure, analysing the system's characteristics and possibilities assists spatial decision-making. It was stated:

*"what is optimal for a specific area, depends on what is in the area"*

Also the practitioners of Nijmegen, Groningen and Ede expressed the ambition to apply a systems approach, yet these municipalities seemed to be exploring and preparing for the application of this approach. In Nijmegen, the practitioners explained that the application of a systems perspective was prescribed in a plan, that was integrated in the water plan. This plan suggested the formulation of a development perspective for climate adaptation, by collecting and analysing all relevant maps on climate vulnerability as well as other maps from the different environmental policy domains. An external consultant was engaged to increase the system knowledge of the municipal area. Also the municipality of Groningen expressed the ambition to apply a broader perspective towards spatial planning and regarding climate adaptation through a systems lens. However the best method to apply this method was yet to be found, but similarly might include the collection of maps on climate vulnerability and spatial priorities. Finally, also the practitioners of Ede explained that is aimed to apply a systems approach, to be able to identify potential synergies and conflicts between climate adaptation objectives and other spatial priorities. Yet, the practitioners indicated that first system knowledge must be increased. Therefore performing a stress test is on the agenda.

#### *5.2.1.3 Formulating policy options*

In line with the systems perceptive to set priorities with regard to climate adaptation and spatial planning in general, the municipal practitioners expressed similar approaches towards the formulation of policy options, which is about how policy options are formulated and evaluated and how organizational and financial constraints influence this, as explained in section 2.3.3.6. All practitioners referred to the ambition to apply the systems perspective to identify potential synergies (potential for

[1] The model of Urban Metabolisms regards cities as consumers of materials and energy, and allows to gain an understanding of the social and biophysical processes and relations (e.g. see Barles, 2010).

coupling) or conflicts between diverse objectives, to support decision-making. Finding opportunities to couple adaptation objectives to other objectives can be identified as a strategy to increase the social acceptability and financial feasibility of adaptation measures. Moreover, was aimed to give more decisive power to environmental interests emerging from the water and green policy domains, which have usually lower mandates in spatial planning projects.

For example, in the municipality of Leiden was aimed to work towards a decision-framework that support decisions on spatial planning, through incorporating and weighing interests such as biodiversity, energy and climate adaptation. Moreover, the practitioners indicated that a decision-framework is necessary to facilitate deliberation, as with the environmental vision process many and diverse interests are activated. With this the municipality aims to justify spatial decisions by generating insight in the desirability of alternatives. Yet to establish a decision-framework, the practitioners explained that knowledge for all spatial themes and interests must be equal, and especially for climate adaptation knowledge needs to be increased. For example more insight is needed in the options for spatial planning emanating from the potential of soil, which can be identified from the system characteristics and mechanisms.

In the same vein the municipality of Ede, Nijmegen, Groningen and Amersfoort referred to the goal to gain insight in how diverse interests go together or compete. The acceptability and feasibility of climate adaptation increases when it is associated with multiple benefits. Yet in order to do so, the practitioners of Ede and Amersfoort indicated that more detailed climate vulnerability information is needed. For example, the practitioners of Ede explained that the acceptability and feasibility of climate adaptation policies depend on how concrete adaptation objectives compete or go together with other spatial objectives. The challenge is to make general adaptation objectives concrete, it was stated:

*"while everybody can easily agree on qualitative objectives such as 'protecting cultural history' and 'becoming climate robust', how can these objectives be quantified and translated to maps?"*

Subsequently was explained that it must be known what it means for the municipal area if those objectives are to be realised: will the interests match or conflict? Given the diversity of interests and objectives, practitioners expected that this can be a tensile exercise. Similarly, the practitioner of Amersfoort explained that the desirability of policy options are considered by evaluating the impact on for example the beauty of the landscape and the impact on nature. While, this is already done for mitigation objectives (e.g. exploiting geothermal energy) to deal with climate adaptation in a similar manner, more detailed vulnerability analyses are needed. However, the practitioner indicated also that adaptation action not always has to emanate from extensive vulnerability analyses, but can take place regardless of systems' structure, such as in 'operatie steenbreek': It was stated that:

*"if implementing green space in a specific area is not needed to prevent pluvial flooding, it still contributes to green neighbourhoods or may decrease heat"*

Moreover, to better balance the diverse interests, the practitioners of Ede explained that within the municipality is explored how integrative objectives such as health or climate adaptation and mitigation, can be attributed with more decisive power in the spatial planning process. In the same vein, from the municipality of Nijmegen and Groningen was indicated that the practitioners were exploring how they could attribute the interests that emerge from the green, water and soil policy domains with more power, for example, by integrating climate adaptation earlier in the planning process.

### 5.2.2 Agenda-setting, generating political support and policy integration

With regard to agenda-setting and generating political support for climate adaptation, differences among the municipalities were found. Where in the municipality of Leiden adaptation had obtained significant support and was taken up as an integrative part of the strategic planning process of the environmental vision, the other municipalities seemed to be yet more concerned with (further) increasing awareness on climate adaptation, generating political support to obtain for example budgets and/or making it an integrative part of spatial planning efforts. Consequently, the extent to which climate adaptation was integrated and secured in policies was found diverse. While the practitioners

indicated that climate adaptation action takes place (e.g. decoupling projects), securing adaptation in policies seemed more difficult. Climate adaptation appeared best integrated in water policies (pluvial flooding), in addition it was found to be integrated in a green vision (all risks themes).

#### *5.2.2.1 Agenda-setting*

Both differences and similarities were found for agenda-setting, which is about the extent to which adaptation planning is on the municipal agenda and how this is influenced by internal and external actors as explained in section 2.3.3.2. With regard to how adaptation is brought to the agenda, especially the practitioners of Leiden indicated that climate adaptation was a prominent theme, while the other four municipalities were more concerned with (further) increasing awareness among municipal colleagues and council as well as among citizens. And while climate adaptation was mostly an internal imitated affair, also some references to external influences.

The practitioners of Leiden explained that climate adaptation was brought to the agenda from (inter) national signals on the urgency to address climate adaptation as well as the climate problems that local and regional actors were confronted with. Both the project participant from the drinking water service and water board referred to that they were confronted with problems of drought, salt intrusion and downpours, which need to be addressed adopting a broader perspective. From the drinking water service was explained that they actively proposed themselves as a partner for the regional environmental vision. This suggests that pushing adaptation forward on the municipal agenda was not only an internal initiated matter, but influenced by local parties.

In Amersfoort, climate adaptation was pushed on the municipal agenda through climate ateliers and the calculation of damage costs – of €60 to €140 million - in the scenario that climate adaptation was not addressed by the municipality. This supported the generation of awareness among the organization and council, and generated an understanding for the need to apply a systems approach.

The practitioners of Nijmegen explained that the start of climate adaptation efforts in the municipality could be traced back to the year 2000. At that point a water plan was formulated from a sustainability perspective resulting in not only concrete implementation plans but also a long-tong term vision up to 2050. The plan included the objective to separating sewage water and rainwater, decrease purification efforts and lower pluvial flood risks, however these efforts were not yet labelled as adaptation. While this provided a basis for addressing climate adaptation, the practitioners explained that bringing climate adaptation further within the municipality depends on the efforts of individuals that promote adaptation among colleagues and the municipal council. As stated by one of the interviewees:

*"It is a continuing process of pushing it forward to the agenda, also to gain administrational support"*

In contrast to pluvial flooding which found a place in the water plan, the risks of heat and drought were difficult to push on the agenda, as the responsibility for these risks is unclear. As explained by the practitioners, pushing climate adaptation on the agenda is a bottom-up effort; first the urgency must be proved by demonstrating the vulnerability of the municipality.

In both Groningen and Ede was indicated that awareness among the municipal organization was increasing. The practitioners of Ede explained that climate adaptation is becoming a more common theme within the department, for example by the recent organization of a climate atelier, led by the 'climate adaptation ambassador' from the regional water platform Vallei & Eem (see also section 5.2.3). Especially, within the water department adaptation is a theme (e.g. decoupling). The practitioner of Groningen indicated that while adaptation was appointed as an integrative theme in the new policy programme 'living environment', to further push the topic on the agenda concrete adaptation objectives are needed. Finally, the practitioners of Amersfoort, Nijmegen, Ede and Groningen indicated that a reason to participate in the KANS network was to exchange experiences on how to (further) increase awareness among colleagues as well as external to the municipality.

With regard to the extent to which adaptation is on the agenda, all practitioners indicated that it is difficult to formulate an ambition for climate adaptation. Both the municipality of Leiden and Amersfoort indicated that it is more difficult to formulate objectives for adaptation than for mitigation,

for which a clear objective is set: being energy neutral by 2030. For example, the practitioners of Leiden explained that objectives for adaptation are rather formulated in terms of 'maintaining and protecting', such as maintaining biodiversity and guaranteeing safety under climate change.

Furthermore, both the municipalities of Amersfoort and Groningen aimed to improve the vulnerability analyses to further shape adaptation objectives. For example, the practitioner of Amersfoort explained that is aimed to establish clear vulnerability analyses for pluvial flooding and heat stress on the neighbourhood level by 2020. The practitioner of Groningen explained that more detailed vulnerability analyses are needed to formulate an ambition on climate adaptation and to identify the associated costs, to be able give substance to the climate adaptation theme in the programme 'living environment'. Next, the challenge is to demonstrate the urgency of addressing climate adaptation to both colleagues and the administration; no budget was assigned yet to the programme, hence the practitioner explained that a well-underpinned analysis is necessary.

Finally, both in Nijmegen and Ede the ambition was formulated that adaptation should be addressed. While for Nijmegen this included the formulation of plan for formulating a development perspective for climate adaptation, for Ede no concrete objective was yet formulated. Only the water plan included the general objective to be 'water robust by 2050'.

#### *5.2.2.2 Generating political support*

Differences were found in generating political support, which is the present political will for addressing climate change adaptation and the will to take a certain approach, as explained in section 2.3.3.3. Especially the practitioners of Leiden and Amersfoort explicated political support for addressing climate adaptation, while the other practitioners more often referred to efforts to increase political support for integrative ways of working and budgets to address climate adaptation.

In the municipality of Leiden, climate adaptation was found as a prominent topic in the environmental vision, of which the process was oriented to increasing system knowledge and analysing spatial tasks. The practitioners explained that the entirety of the vision development process had gained substantial political support from the municipality of Leiden (inter alia two supportive aldermen) as well as from the participating municipalities. Moreover, as the vision formulation serves as a national pilot the municipality had support from the national government. However, the practitioners also indicated that in the end the vision must communicate a clear story that is based on true (climate) information to maintain this support, as it will guide spatial decisions. Also the practitioner of Amersfoort indicated that there is substantial political support for addressing climate adaptation. The politicians expressed their ambition to integrate adaptation in the projects of the municipal organization itself; moreover the politicians participated in the formulation of the green vision in which adaptation was addressed.

The practitioners of Ede, Nijmegen and Groningen often referred to efforts to generate and increase political support for adaptation, inter alia to obtain budgets. The practitioners of Nijmegen explained that this requires many efforts, yet there is support to address the topic; the practitioners for example explained that there are regular consultations with the alderman on the topic of climate adaptation. In Ede, the practitioners explained that while climate adaptation had gained some political support, yet it appeared that the topic remains inferior to the topic of climate mitigation; solving climate change problems is often about mitigation: energy use and clean energy. On climate mitigation, a clear sustainability programme was formulated, and this programme crosses all sectorial domains within the municipal organization. Such an integrated programme does not exist for climate adaptation in Ede; rather climate adaptation is addressed in specific sectorial domains. However, the practitioners explained that the policy department in general aims to work more along integrated themes. Yet, for this new approach political support is still to be obtained. In the same vein, the municipal practitioner of Groningen explained that while adaptation was appointed as theme in the programme 'living environment', not budget was yet made available. Therefore the vulnerability analyses are improved to demonstrate the urgency and obtain budgets. Similarly, one of the practitioners of Nijmegen indicated that practitioners may be in a vicious circle: detailed vulnerability analyses are needed to obtains budgets, however firs budgets are needed to perform detailed vulnerability analyses.

#### *5.2.2.3 Policy integration*

In line with agenda-setting and generating political support differences were found in policy integration, which is about the degree to which adaptation is integrated in relevant policy domains such as spatial planning, green management and water management, and how this integration is expressed as explained in section 2.3.3.7. Climate adaptation appeared best integrated in water policies (pluvial flooding), in addition sometimes a broader range of climate risks was integrated in strategic policies (e.g. visions). In policies, climate adaptation was often integrated as 'an integrative theme', or more specific, adaptation was integrated into policy through a 'green-blue structure'.

Firstly differences were found in *where* climate adaptation was integrated in policies. In Leiden, adaptation was secured on the strategic level as a prominent theme in the environmental vision. However, how the vision will translate into policies in the plan is not clear yet. One practitioner explained that the issue of adaptation needs further clarification by increasing system knowledge. In Ede and Nijmegen climate adaptation was secured in the water policy, addressing water related risks. Moreover, in Nijmegen a plan for formulating a development perspective for climate adaptation was secured in the water plan, addressing not only water-related risks but for example also heat. Yet this plan describes only how the municipal vulnerability should be analysed, the policies that follow have yet to be explored and determined. Furthermore, the municipality of Ede and Amersfoort indicated that that climate adaptation was integrated in visions on green (vision on trees and 'green vision' respectively). Moreover in Amersfoort, in spatial projects more often climate adaptation objectives are coupled to other objectives, since the application of the systems approach. For example, a climate robust hospital was realised where all vital facilities are located on higher floors, anticipating flooding risks, while realising nature objectives. From Groningen no references were made on policy integration.

Secondly, with regard to *how* climate adaptation was (aimed to be) integrated in policies, it appeared that adaptation was either labelled as an 'integrative theme' or addressed by the inclusion of a 'green-blue' structure. The municipality of Leiden, Groningen and Ede referred to addressing climate adaptation as an integrative theme. In the municipality of Leiden, climate adaptation was integrated as an 'integrative topic' in the environmental vision, along with the themes of 'energy' and 'biodiversity'. Also, in the municipality of Groningen, climate adaptation was appointed as an integrative topic in the new programme living environment, along with the themes of 'health' and 'attractive'. While climate adaptation was appointed as a theme, the urgency to secure it into policies needs to be demonstrated, so that budgets will be allocated. Similarly in Ede, the policy department had been working on the identification of integrative themes, of which climate adaptation will potentially be appointed as such a theme; other integrative themes are 'climate mitigation' and 'health'. The practitioners explained that within the policy department, which includes all advisors for the physical environment (e.g. archaeology, cultural history, nature, waste, traffic, energy, roads, green, air and sound), a transition is taking place in which the sectorial domains are adopting a more integrated perspective. This perspective includes a coherent view towards the natural system of the physical environment. However, also within the municipality of Ede first political commitment is to be obtained to work according to integrated structures.

Alternatively, the municipality of Nijmegen and Amersfoort referred to the formulation of green-blue structures to integrate climate adaptation into policy, and potentially into the environmental vision. The practitioner of Amersfoort explained that since 2002, as a counterpart for the growing city, the municipality analysed the green-blue structure of the municipality, and established a plan for creating green connections in the growing city. More than 20 projects where implemented up to 2015, including green corridors, cycling paths, nature areas. As a follow up, the 'green vision' was established together with politicians and citizens, to further built on the green-blue 'skeleton'. Similarly, the municipality of Nijmegen had been working on a green-blue structure to deal with climate adaptation in an international research and innovation project to create climate robust cities.

### 5.2.3 Engagement of public/stakeholders

Both differences and similarities were found for the engagement of public/stakeholders, which is about the extent to which, when and how stakeholders/public are engaged in adaptation planning, as

explained in section 2.3.3.4. While participation was central in climate adaptation for all municipalities, there were differences in the levels on which actors were engaged.

The practitioners of Nijmegen, Amersfoort and Groningen referred to the importance of citizen participation in climate adaptation action. The municipality of Nijmegen aims to engage citizens in 'operatie steenbreek' and 'lead by example' by adopting the 'greening' rationale in municipality projects to generate enthusiasm and promote citizen engagement. Also the municipalities of Groningen and Amersfoort participated in 'operatie steenbreek'. The practitioner of Amersfoort explained that citizens and active associations (e.g. nature associations) are important stakeholders that are engaged for climate adaptation on the municipal level. It is aimed to create coalitions of local actors and to orient those coalitions to the issues that need action. An example project is 'measure your city', in which citizens measure the impacts of climate change. This project creates awareness among citizens and in turn provides the municipality with local knowledge. Yet, the practitioner explained that it is a big challenge to engage citizens in establishing climate robust neighbourhoods, as most citizens don't make active considerations on climate adaptation in their private areas, therefore also citizens must be provided with knowledge on the local vulnerability.

On the regional level, the practitioners indicated to engage with a diversity of stakeholders on climate adaptation. Especially the municipality of Leiden, Amersfoort, Nijmegen and Ede indicated higher levels of participation. For example, the municipality of Nijmegen was engaged in formulating a regional adaptation strategy with partners like the water board, the province and other municipalities. Similarly, the municipality of Leiden addresses climate adaptation in collaboration with regional partners such as the water board and drinking water service.

The practitioner of Amersfoort explained how is aimed to deliberately engage the relevant stakeholders on the appropriate scale of action. On the regional level is aimed to engage with the water board, farmers and nature organisations, to exchange experiences, collect local knowledge and information and to support taking action. Both the municipality of Amersfoort and Ede participate in a regional water platform led by the water board, in which is collaborated with other municipalities that are located along the river. Climate adaptation is an important issue in the platform, which is for example addressed through knowledge exchange and monitoring activities to increase insight in the water chain's functioning. On the website of the water platform, diverse reports are available on climate adaptation, ranging from the results of a stress test of the entire region, to a report describing the lessons learned on decoupling projects with citizen participation (PWVE, n.d.). Moreover, recently a climate adaptation ambassador was appointed to further promote the issue among the municipalities. Finally, the practitioner of Groningen indicated that little collaboration takes place yet with local actors. While some interactions took place with the water board to establish flood maps, the practitioner had the impression that adaptation is not yet a common theme within the region.

### 5.2.4 Environmental vision development

With regard to the development of the environmental vision it appeared that only the municipality of Leiden had progressed in the formulation of the vision, the other municipalities were yet exploring and preparing the vision development process. While the application of an area-oriented approach and participation seemed central to the environmental vision as well as the application of a systems perspective towards adaptation, the first focus of the vision development processes differed, ranging from starting with an extensive citizen participation process to starting with the formulation of the environmental plans. The implementation of the environmental law seemed to be characterised by fuzzy and explorative processes.

#### *5.2.4.1 Visioning*

Differences were found in the process and organization ('visioning') of the environmental vision, which is about the manner in which the vision development process is organised in terms of time-frame, project team, starting themes, situation analysis and specification of outcome objectives, the role of climate adaptation and the integration of the vision into the daily use, as explained in section 2.3.3.8. Only the municipality of Leiden was progressed in the process of developing an environmental vision, the other four municipalities were yet exploring the formulation of the vision.

The municipality of Leiden formulates the environmental vision in collaboration with nine neighbouring municipalities, local water parties, and citizens. The collective of municipalities, called 'Hart van Holland', was initiated from the recognition that the municipalities are highly connected and confronted with similar challenges, for example, risks of land subsidence and an urbanization challenge to accommodate 30.000 to 40.000 more residents in the upcoming years. With the collective environmental vision is aimed to discuss and address such challenges in a collaborative fashion; taking into account for example that the municipality of Leiden itself has many facilities but lacks a landscape, while the surrounding municipalities do have such landscapes and nature.

In the report 'Agenda Environmental Vision' the historical developments of the main physical structures in Hart van Holland and the main tasks that can be expected in the region are discussed (Het Hart van Holland, 2016) this indicates how a situation analysis was performed. Three sustainability tasks and five spatial tasks were identified. Energy, biodiversity and climate adaptation were identified as integrative sustainability tasks. The task 'climate adaptation' was soon labelled as 'water', as it emerged that most climate risks in the region are linked to the water system (e.g. land subsidence, downpours, groundwater flooding). Based on the requirements of the environmental law, five spatial tasks (together spatial framework) were abstracted (Het Hart van Holland, 2016):

- Clean air
- Urbanisation along the Old Rhine
- Strengthen open and robust landscapes up to the riverbanks of the Old Rhine
- Excellent accessibility, without suffering of the physical environment
- Powerful soil

The three sustainability tasks are connected to multiple of these spatial tasks. In the process of the vision development, the project team analysed the spatial tasks and sustainability themes by collecting knowledge on each of the themes and representing the information on maps. An external consultant facilitated this process. In addition to analyses, the maps were used for 'designing research', meaning that hypotheses for spatial developments are suggested in the maps, which provide input for discussion. For the climate impacts the consultant used CAA data complemented with information from the municipality, municipal partners and available reports. The consultant explained that bringing the information and knowledge together is sometimes slowed down because parties must be convinced that information sharing serves a common goal. People may hesitate to share information in fear of others putting claims on 'their' land; this sometimes inhibited the possibilities to freely explore hypotheses. The consultant explained that the goal of the maps is to provide insight in spatial claims and support agenda-setting, rather than facilitating a (scientific) discussion on these tasks.

In the end is aimed to regard the themes water, biodiversity and energy integratively, and confront them with tasks such as urbanization: this may yield synergies and/or conflicts of spatial claims. The practitioners explained that the above discussed tasks and spatial framework are more or less set: and with this the first spatial decisions have been made on which all participating municipalities agreed. For example, in the municipalities with beautiful landscapes no more houses will be built, this will be done in the already urbanized areas. The municipality characterises these points of departure as:

*"a good agreement among good neighbours"*

The municipality is working towards a decision framework in which the effects of spatial plans are revealed based on the themes indicated above. The regional vision will be the foundation for the distinct municipal visions. Finally, the practitioners explained that with the 'far away' time-horizon of 2040, is aimed to stimulate free and open thinking, and preventing the collaborating parities to make spatial claims upfront.

In contrast to Leiden, the other four municipalities were yet exploring the formulation of the vision, which included the clarification of many issues. Two main issues were indicate. Firstly the practitioners indicated to the issue of integration: both the integration of environmental policies mutually as the integration of adaptation in other policies. The practitioners of Nijmegen explained that it is a big question how all the interests from both the physical and social domain can be integrated, how connections or conflicts among policies can be identified and how it can be secured

that interests from water, green and soil are well included in spatial decisions. In the end it is aimed that decision-making is not only based on financial costs and short-term impacts, but on societal benefits. Similarly, the practitioners of Amersfoort and Ede explained that their municipalities are exploring how a diversity of interests can be integrated: how can it be secured that diverse interest are secured and that the spatial development department represents not the only leading interests in the spatial decisions? Finally, the practitioner of Groningen explained to be in search of appropriate instruments to integrate climate adaptation into the vision. Both the practitioners of Groningen and Ede indicated that learning on how adaptation can be addressed and secured in the environmental vision motivated to participate in the KANS network.

A second issue that the practitioners referred to was the relation between the environmental vision and plan. The practitioners of Nijmegen explained that an appropriate level of detail for the vision must be identified; if the vision is too abstract it doesn't mean anything and doesn't direct the plans. In the same vein, the practitioners of Ede explained that the level of detail of the vision is an issue; should the environmental vision only include qualitative ambitions, or is it better to translate the ambitions in spatial terms specific for the municipal area? Moreover, what should be stated in the environmental vision and what in the environmental plans? Similarly the practitioner of Groningen indicated that a question is how adaptation objectives can be integrated in the vision, and how these subsequently can be translated into the plans. Also the municipality of Amersfoort indicated that it is a challenge how the adaptation objectives of the vision can be translated to concrete measures for a specific area.

Yet, despite the issues to be clarified, all practitioners indicated central approaches to start the vision with, such as the ambition to apply systems approaches to achieve integration. Moreover, both the practitioners of Amersfoort, Groningen and Nijmegen indicated that an area-oriented approach would be central to the environmental vision; regarding coherence among objectives on the neighbourhood level. Furthermore, both the practitioner of Amersfoort and Nijmegen indicated that a green-blue structure might be an important instrument to integrate climate adaption in the environmental vision. This structure may guide choices on spatial developments by suggesting a desired green-blue structure.

Furthermore, both the municipality of Nijmegen and Ede explained how performing vulnerability analyses may be input for the environmental vision; Nijmegen aims to formulate a development perspective and Ede aims to make a start by performing a stress test. Both the practitioners indicated that this might result in an atlas of maps, indicating climate change vulnerabilities like pluvial flood risks, heat islands and bottlenecks for agriculture and nature. These maps can then be combined with maps on other spatial objectives, to identify matches or conflicts. Yet, the practitioners indicated that it is difficult to make the step from the general vulnerability maps to costs and spatial claims.

A practitioner of Nijmegen explained to be promoting the topic of climate adaptation among the vision project team. For this, the practitioner rather referred to objectives such as a 'green spaces' and 'safe environments' than to the term 'climate adaptation', as this is more appealing to both colleagues and citizens. Moreover, the practitioner indicated that when connections between, for example, climate adaptation and health can be clarified, social acceptance increases. In order to do so, specific indicators are needed that show how diverse benefits relate.

Finally, both the municipality of Nijmegen and Amersfoort started with the formulation of the environmental plan. The practitioners of Nijmegen explained that two pilots, one for a neighbourhood and one for a hospital, are performed for environmental plans in which is experimented with more freedom in rules. These pilots run parallel to a pilot for the environmental vision. In Amersfoort, the practitioner explained that the visioning has not started yet, rather first will be looked into the environmental plans spatial development department is exploring how the 'structural plans' can be transformed into an environmental plan. For this the municipality is performing two pilots that will provide input for the environmental plan for all neighbourhoods. In the end, is aimed to establish a neighbourhood agenda for both the short and long term, so that for every spatial project can be identified how objectives can be coupled.

#### *5.2.4.1 Participation*

Similarities were identified in participation, which is about the extent to which what actors are engaged in what stage of the vision development process and how, as explained in section 5.2.4.1. Most practitioners indicated that participation processes with local actors, both citizens and local private and public actors, are or will be central to the vision development. Mostly citizens are engaged to identify general relevant themes vision, and local experts are engaged to contribute with local knowledge and information.

Both Leiden and Groningen performed extensive participation projects with citizens to support the environmental vision development. In Leiden, a participation project was organized to collect input from citizens and local professionals. The aim was to complement the 'technical knowledge' from the 'makers' of the environmental vision, with 'bottom-up knowledge'. First, discussions were held with groups of citizens on societal trends, subsequently local professionals translated the results into usable terms for urban planners and policy-makers. One of the conclusions was that the local professionals were most concerned with collaboration that is needed for the development of a collective vision (see Het Hart van Holland, 2015). Also in Groningen an extensive participation project was started to collect input from citizens for the vision. The practitioner from Groningen explained that in the project a set of questions and statements were proposed to citizens. The citizens' perspectives were being analysed and will serve as input for the vision. Both the practitioners of Groningen and Leiden indicated that it was difficult to mobilize citizens to participate the 'abstract' visioning process. Moreover, citizens themselves did not bring up climate adaptation as a theme to be addressed.

Furthermore, the practitioners of Leiden, Groningen Amersfoort and Nijmegen referred to participation with diverse local stakeholders. For example the municipality of Leiden collaborated with the water board and the drinking water service, which were official partners in the environmental vision process. These actors often participated in expert sessions to contribute to the vision maps. The consultant that established these maps explained that it was a challenge to decide on what to incorporate in maps, given the many opinions and diverse expertise that come to table. Also in the municipality of Nijmegen sessions were organized to prepare the vision development. In those sessions diverse topics were discussed with a broader public. Similarly, the municipality of Groningen and Amersfoort indicated to engage with local actors such as entrepreneurs and citizens to support the visioning process. From the municipality of Ede no references were made to participation.

### 5.2.5 Conclusion Q3 (part II)

With section 5.2 the second part of sub-question 3 can be answered, recalling the question:

*How do the [….] municipal practitioners pursue adaptation planning and the environmental vision in the CAA case?*

The context of municipal practitioners from five municipalities was described by analysing how the practitioners frame the problem and solution of adaptation, set adaptation priorities, formulate adaptation policy options, pursue adaptation agenda-setting, generate political support for adaptation, engage the public/stakeholder in adaptation, pursue adaptation policy integration, organize the vision process and participate with stakeholders in the vision process.

The analysis showed that all municipal practitioners expressed a promotional and proximal **frame** to adaptation, by referring to the ambition and need to couple climate adaptation objectives to other objectives and making adaptation objectives concrete for different spatial scales. Related to this frame, all practitioners (aim to) **set priorities** by applying a systems perspective towards spatial planning. In this perspective spatial decisions are based on the (im) possibilities of natural physical system. Subsequently, in **formulating policy options**, practitioners aimed to identify potential synergies (potential for coupling) or conflicts between diverse objectives. Coupling adaptation objectives to other objectives was regarded as a strategy to increase the social acceptability and financial feasibility of adaptation measures. Moreover, in order to achieve this, practitioners were exploring how environmental interests could have more decisive power in spatial planning processes.

With regard to **agenda-setting** and generating **political support** for climate adaptation, differences among the municipalities were found. Where in the municipality of Leiden adaptation had obtained substantial support for the vision process in which adaptation was taken up as an integrative topic, the practitioners of the other municipalities seemed to be yet more concerned with (further) increasing internal and external awareness on climate adaptation, generating political support for budgets and/or making adaptation an integrative part of spatial planning. However, the practitioners of all municipalities indicated that it is difficult to formulate concrete objectives. Consequently, the extent to which climate adaptation was **integrated** and secured in policies was found diverse. While the practitioners indicated that climate adaptation action takes place (e.g. decoupling projects), securing adaptation in policies seemed more difficult. Often adaptation is yet best integrated in water policies mitigating (pluvial) flood risks. On strategic levels of policy-making, often also a broader range of climate risks was regarded. Finally, **stakeholder/public engagement** was found central to climate adaptation, however there were differences in the extent to which and how stakeholders were engaged. For example, practitioners aimed to engage citizens to take action at the neighbourhood level, while the water board was appointed as an important actor on the regional scale.

With regard to the development of the environmental vision (**visioning**) it appeared that only the municipality of Leiden had progressed in the visioning process. The other municipalities were yet exploring and preparing for the vision development. The implementation of the environmental law in general appeared a fuzzy and iterative effort, characterized by processes of experimentation and learning. Consequently, operational plans (environmental plan) were explored in parallel to the strategic environmental vision. Despite the newness and uncertainties associated with the new law, it appeared that applying a systems perspective and an area-oriented approach were central points of departure. Also **Participation** appeared a central theme. Often was aimed to engage citizens to identify general relevant vision themes and to engage local experts to provide local knowledge and information.

## 5.3 Evaluation of the CAA and potential future information needs

Having discussed the contexts of the producers and (potential) users of the CAA, this section presents the usability of the CAA for the (potential) users. The findings on each of the three criteria of usability (fit, interplay and interaction) are presented, by discussing to what extent the corresponding 'drivers' were found. The section concludes with a preliminary answer to sub-question 4. Yet, this chapter starts with introducing what climate information is used by the (potential) users: the municipal practitioners.

### 5.3.1 Climate information use

The CAA was used by two of the five studied municipalities: within the municipality of Leiden the CAA data was used for the environmental vision and in the municipality of Amersfoort the CAA data was used to calculate the damage costs if no climate adaptation action would be undertaken. The other three municipalities had not used the CAA web-viewer or data. Of these municipalities, the practitioner of Nijmegen knew the CAA, the practitioners of Ede had heard of the CAA before, and the practitioner of Groningen was not familiar with the CAA.

All municipal practitioners disposed of heat stress maps and pluvial flooding maps that where often established by consultants, for example see Figure 5.3 (left) for the vulnerability maps of Groningen. The heat stress maps of Nijmegen were developed in a transnational research programme that was oriented on establishing climate proof cities (Figure 5.3, middle). Both Ede and Amersfoort established the vulnerability maps for pluvial flooding themselves based on national height data. These maps did not include future climate impacts, but were indicted bottlenecks might occur in events of extreme precipitation. The maps were used in combination with products of consultants; a precipitation model that could be used to analyse and explain events of pluvial flooding and formulate measures. In the municipality of Leiden, a consultant combined the CAA data with other information on maps, such as heat stress and concentrations of young and elderly people, see Figure 5.3 (right).


Groningen Nijmegen Leiden

**Figure 5.3: Heat stress maps of Groningen, Nijmegen and Leiden** (Fabric, 2016b; Future Cities, 2013; "Geo-Portaal Gemeente Groningen," 2016).

Finally, no specific alternative climate information sources were mentioned except for in the municipality of Ede, where a regional glossy was used that was established by meteorological institute for the regional water platform. The glossy includes changes in precipitation patterns and evaporation values for the specific region; for example showing how temperature in the region has increased with 1,9 degrees since 1901 (Figure 5.4). This information was for example used in a climate atelier.


**Figure 5.4: Screenshot climate information tailored to the region Vallei & Eem** (source: Platform Water Vallei & Eem, 2017)

### 5.3.2 Evaluation fit

The **fit** regards the perceived fit of the climate information to the municipal practitioners' adaptation planning needs. All practitioners evaluated the CAA. The practitioners that were not familiar with the CAA, evaluated the CAA based on a list of indicators of the CAA (see Table 3.2, section 3.2.4) and/or by inspecting the CAA web-viewer. In addition, the municipal practitioners evaluated how their climate information needs might develop anticipating the formulation of environmental vision. This section describes the fit as perceived by the interviewees along three drivers of fit: saliency, accuracy and credibility. No references were made to the timeliness of the information.

#### *5.3.2.1 Saliency*

Recalling, climate information is perceived *salient* when the information is perceived relevant to the municipal practitioners' needs by increasing the understanding and/or assisting in solving a policy issue at hand. Table 5.4 summarizes to what extent the municipal practitioners evaluated the CAA as salient by specifying for what needs the CAA was perceived relevant or not. All practitioners evaluated the CAA salient for the specific goals of increasing awareness, generating a sense of urgency and pushing climate adaptation forward on the municipal agenda. Additionally, the project participants of Leiden explicated that the CAA allowed to gain system knowledge and to connect climate information to multiple spatial themes. Alternatively, all municipal practitioners evaluated the CAA as less relevant for the needs of taking 'the next step'. Moreover, the project participants of Leiden indicated that the CAA did not fulfil the need to understand the mechanisms of the climate change indicators. The next paragraphs elaborate on these findings and present what vulnerability indicators were valued as most relevant (Table 5.5) and how the information needs might develop anticipating the environmental vision (Table 5.6).

**Table 5.4: Summary of saliency of CAA according to municipalities**

| The CAA is relevant for… | The CAA is less relevant for… |
|---|---|
| Increasing awareness among the municipal organization | Taking 'the next step' |
| Generating a sense of urgency | Policy-making |
| Gaining system knowledge | Gaining insight into the mechanisms of climate change risks |
| Identifying climate risks on the regional level | Climate change risks at the neighbourhood level |
| Gaining a first impression of the climate change risks | Using the climate information on the operational level |
| Fulfilling a signalling function | To identify bottlenecks (e.g. for pluvial flooding), the CAA is too abstract. |
| Connecting climate change risks to geospatial information and spatial tasks (e.g. in the environmental vision) and bringing together stakeholders | |

*Creating awareness, generating a sense of urgency and pushing forward on the agenda*

All practitioners indicated that the CAA assisted or may assist in increasing awareness, fulfilling a signalling function and pushing adaptation forward on the agenda. The project participant of Leiden for example explained how the maps provided insight in the climate change risks at hand; before using the CAA not all participating municipalities were aware of its land subsidence task and didn't recognize it as a climate related problem. Furthermore the practitioner of Amersfoort indicated that calculating the damage costs for a 'doing-nothing' scenario with the CAA helped to push climate adaptation on the agenda. Finally, the practitioner of Nijmegen explained that the CAA is usable to municipalities to demonstrate the urgency to address adaptation and generate administrational support.

*Not usable for 'the next step', determining a course of action*

All municipal practitioners indicated that the CAA is not usable for taking 'the next step' due to the level of detail of the data (see also 'accuracy' below). This 'next step' was often about the exploration, ranking and implementation of policy options. All practitioners expressed the need for more detailed climate information and local geospatial information to define a course of action. For example, the project participants of Leiden explained that if the CAA provided detailed pluvial flooding information, appropriate pavement heights could be calculated to create retention areas. In the same vein, the practitioners of Ede, Amersfoort, Groningen and Nijmegen referred to the need for detailed climate information and geospatial information to translate the climate risks to the neighbourhood level to support the neighbourhood plans. The practitioner of Ede exemplified this with that there is especially little knowledge on the course of action for heat stress. While much knowledge is available to decide on the acceptance of a certain flood risk (e.g. information on the sewerage capacity and future precipitation patterns), for heat stress the actual impact is difficult to determine. The

practitioners explained that it is unclear if it would be a calculation exercise, and if so, what information would be needed for this. Finally, both the practitioners of Nijmegen and Leiden explained that the CAA does not support taking 'the next step' because there was no guidance on how to continue when the general vulnerabilities are identified. The practitioner of Nijmegen stated:

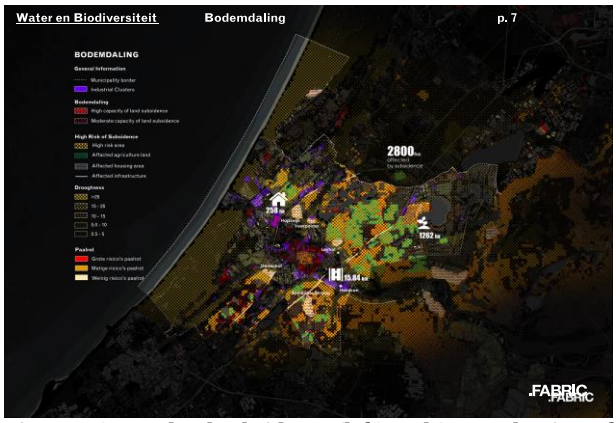
*"..one of the main challenges is to get the climate information to the workplace and to make people enthusiastic; this gap is difficult to close. The CAA maps are too little concrete to provide the needed specific information."*

In the same vein, the project participants of Leiden indicated that to make climate change adaptation really 'come alive', more detailed information is needed; the level where adaptation action takes place. Both the practitioners of Nijmegen and Leiden referred to how the tailored CAA, as established for the province of Zuid-Holland, better meets this need.

*Usable for gaining system knowledge and connecting spatial themes and stakeholders*
The project participants of Leiden indicated that the CAA assisted to increase system knowledge, connect climate change vulnerability to spatial tasks and bring together stakeholders. The CAA data was usable for understanding and analysing the diversity of information on the environmental vision themes (see also section 5.3.1), as the CAA data could be overlaid on the maps representing information on spatial tasks and themes (e.g. urbanization task, accessibility and soil composition). This allowed the identification of the magnitude of divers spatial claims for certain tasks, and moreover the identification of both problems and opportunities. It was explained, that if addressing certain problems or exploiting certain opportunities could be coupled with other objectives, such as climate adaptation, the social acceptability of climate adaptation action would increase. The project participants brought forward that how the consultant edited the CAA data and geospatial information on maps, and analysed the spatial tasks and suggested design solutions, provided insights ("eye openers") in the magnitude of spatial claims, which in turn stimulated discussion. For example it appeared that if all roofs would be covered with solar panels, this could only provide for 6% of the energy demand (Figure 5.5, left). Moreover, some maps represent "what could be" and serve as input for discussions, for example the exploration of different designs and constellations of windmills (Figure 5.5, right). The aim is to similarly identify spatial claims that include climate adaptation. All project participants expressed that obtaining these collective insights in the spatial claims of the diverse tasks in the area, supported a more open attitude among the participants (municipal practitioners, water board, drinking water service) on discussing the problems and opportunities at hand. Moreover, this increased the willingness of the participants to supplying local information.

**Figure 5.5 Energy potential with solar panels on all roofs (left) and windmill constellation (right)** (source: Fabric, 2016a)

Furthermore, the project participants of Leiden indicated that the CAA doesn't clearly tell the story on the mechanisms underlying the climate change vulnerabilities. The consultant therefore created additional 3D visualisations to explain for example the mechanisms of land subsidence, see Figure 5.6.



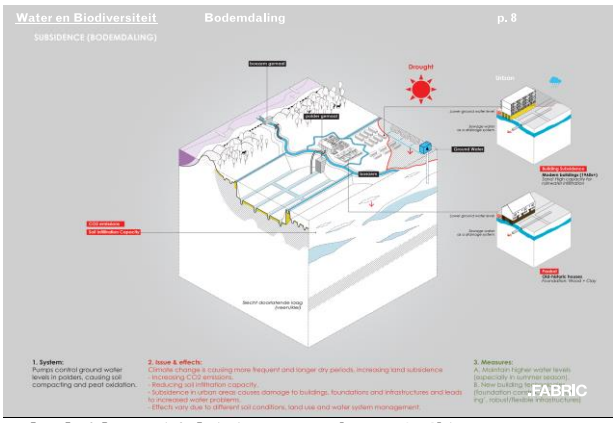



**Figure 5.6 Map land subsidence (left) and 3D mechanism of land subsidence (right)** (source: Fabric, 2016b)

*Relevant indicators*

Table 5.5 presents the indicators that the practitioners indicated as most relevant or as missing. A diversity of indicators was valued, covering all the four risk themes and all of the distinguished areas and sectors. It stands out that all practitioners evaluated 'prolonged precipitation' and 'downpours' as relevant, suggesting that pluvial flooding both in urban and rural areas is a high priority. Furthermore, often was referred to the indicators: 'feasibility of nature objectives', 'drought stress crops', 'land subsidence' and health related indicators such as 'excess mortality' and 'decreased labour productivity', these indicators mostly emergefromthe risk themes heat and drought. From the geospatial information, the distribution of green and paved areas was valued. Several practitioners evaluated an entire cluster of indicators as relevant. While practitioners may be interested in all the indicators of a cluster, it could also be that practitioners are interested in just any of the indicators that are proposed to them, indicating that they don't know well what indicator is exactly relevant to them. An argument for this can be found in the list of missing indicators; except for the indicator on temperature increase, the suggestions are rather broad and don't inform on specific parameters to use.

**Table 5.5: Evaluation of CAA indicators**

| | Indicator | Risk theme | Sector/ Area | LEI | NIJ | AME | GRO | EDE |
|---|---|---|---|---|---|---|---|---|
| Most relevant | Prolonged precipitation | PF | Rur | X | X | X | X | X |
| | Downpours | PF | Urb | X | X | X | X | X |
| | Feasibility nature objectives | DR | Rur | | | X | X | X |
| | Flooding (cluster) | FL | He/Saf | | | X | X | X |
| | Drought stress crops | DR | Rur | | | X | X | X |
| | Excess mortality | HE | He/Saf | | X | | X | X |
| | Land subsidence | DR | Urb | X | | | X | |
| | Blue-green algae | HE | He/Saf | | X | | | X |
| | Decreased labour productivity | HE | He/Saf | | X | | | X |
| | Ground water flooding | PF | Div | | | | X | X |
| | Allergy days | HE | He/Saf | | X | | | |
| | Salt intrusion | DR | He/Saf | X | | | | |
| | Heat (cluster) | HE | He/Saf | | | X | | |
| | Water erosion | PF | Div | | | X | | |
| | Drought (cluster) | DR | Div | X | | | | |
| | Area paved/green both private and public | SP | Div | | X | X | | |
| Missing | Impacts on ecology/ landscape/urban green/ biodiversity | AL | Div | X | X | X | X | |
| | Small water courses: impacts of drought and flooding | DR, FL | Div | | X | | | X |
| | Damage costs/financial consequences | All | Div | | | | X | |
| | Quality of stay due to heat | HE | He/Saf | | | | X | |
| | Temperature increase: day above 40 degrees | HE | He/Saf | X | | | | |

Risk theme: PF= Pluvial Flooding, DR= Drought, HE= Heat, FL=Flooding, AL= All risk themes, SP= Spatial information, no risk theme.
Sector / Area: Rur= Rural area, Urb=Urban area, He/Saf=Health/Safety, Div= Diverse areas/sectors.
Municipalities: LEI= Leiden, NIJ= Nijmegen, AME= Amersfoort, GRO=Groningen, EDE=Ede.

The diversity of indicated relevant indicators can be partly related to the specific geographical location of the municipality, for example, land subsidence is an issue in the region of Leiden, while it doesn't manifest in the more eastern located municipalities such as Nijmegen, Ede and Amersfoort. Among the missing indicators, especially the vulnerability of vegetation and species to climate change was appointed as an important theme. Furthermore, the practitioners were interested in the financial consequences of climate change and the impacts on smaller watercourses, indicating both to indicators to further understand the vulnerability and to demonstrate the urgency.

*Future climate information needs: Environmental vision*
Aside from the CAA, the practitioners were inquired on their expectation on their climate information needs for developing the environmental vision. The findings are summarized in Table 5.6.

**Table 5.6: Environmental vision (climate) information needs**

| Municipality → | LEI | NIJ | AME | GRO | EDE |
|---|---|---|---|---|---|
| Gaining insight in the spatial claims for all tasks (magnitude), the conditions of the area and potential course of action for fulfilling the tasks | X | | | | |
| Adaptation (e.g. in the environmental vision) what works when and why? When can what instruments be applied? | | X | | X | X |
| What is the relationship between climate adaptation objectives and other objectives (e.g. health)? | | X | | X | X |
| Information on multiple levels of scale: from street and neighbourhood level, to the municipality level, and the municipality in relation to its regional environment | X | | X | | |
| Information to support creating awareness on climate adaptation for citizens and local stakeholders | | | X | | |

Municipalities: LEI= Leiden, NIJ= Nijmegen, AME= Amersfoort, GRO=Groningen, EDE=Ede.

From Table 5.6 emerges that indicated information needs are rather general and broad, ranging from needs that may be met with more specified climate vulnerability analyses, to needs that regard the best practices and experiences on the process on integrating climate adaptation in the environmental vision. Yet what this information exactly should entail remained unclear. The most specific need seems to be the need for indications of how diverse objectives can be coupled to climate adaptation objectives, which allow the practitioners to get insight in how a certain spatial decision contributes to diverse objectives and ambitions. For example, if an area of green space with a certain size is implemented, how much does it contribute to the goal of creating a healthy environment en and how much does it contribute to minimizing climate change vulnerability?

#### *5.3.2.2 Accuracy*

Recalling, climate information is perceived *accurate* when the perceived precision and exactness of the information (e.g. temporal and spatial dimensions) is perceived good. In line with the points mentioned by the municipal practitioners on taking 'the next step', all practitioners referred to that the CAA data is usable for the regional and municipal area, but when zooming in on the municipal area, more detailed climate information and geospatial information is needed (e.g. on current practices and policies) to align be able to align with the neighbourhood level and engage citizens. For example, the project participant of Leiden indicated that to take 'the next step' the CAA needs to be further specified with concurrent interventions and practices. On a drought map that was discussed during an expert sessions, was stated:

*"A strange map was created; Drought stress was visualised on the urban areas, while the drought stress indicator only applies to agricultural lands. Additionally, the dunes appeared to be highly vulnerable for drought while the current water level management would prevent this to occur. It is important that municipalities can make 'the next step', this cannot be done with the atlas alone"*

Moreover was explained by a project participant, that if the CAA maps are used to pile-up different layers of climate information and local geospatial information, the uncertainties associated with this information add up. Consequently, simply concluding on problems or opportunities that are identified when combining different map layers may be unwarranted. This was exemplified with the land subsidence map; this map is based on rough estimates and while this provides a good indication on the

regional scale, on the local scale care should be taken when making decisions. Continuing, the practitioner of Amersfoort emphasized the need to regard climate adaptation on multiple scales and levels of detail. For example, in addition to regional information on pluvial flooding, more detailed information is needed to inform and engage citizens and to match the level of detail to the formulation of neighbourhood plans. Moreover, for a detailed pluvial flooding map, information is needed on for example the green and paved areas. Similarly, the practitioners of Nijmegen indicated that the CAA maps need to be translated to the local situation, for example by adding maps on soil type.

#### *5.3.2.3 Credibility*

Recalling, climate information is perceived *credible* the perceived authoritativeness of the scientific community and the extent to which the information is perceived of good quality. The municipal practitioners made no explicit references to the quality of the information and the authoritativeness of the scientists. Only a practitioner of Leiden referred to that the clarity on the extent to which the CAA data can be trusted could be improved. It was explained that it is important to know to what extent can be relied on the climate information as currently assumptions are made for, for example, green policies. It is important to the practitioners to know that the information is correct, so that it can be presented to the alderman. For example for the heat stress map some doubts were expressed on the reliability of the data and it was presumed that this emerged from a rough satellite analysis. Moreover the practitioner expressed that the impression prevails that the scientists knows climate change effects 'more or less'; while this is fine for the signalling function, this is problematic for when the climate information is used and secured in the more detailed policy programmes. Using the CAA data in decision-making may result in go's or no-go's for a certain land use in a specific area, hence the information needs to be reliable. The practitioner explained that when experts are invited from professional organizations and research institutes, experts don't always agree on the CAA climate information, so it is difficult to know what is true. Knowing to what extent data can be trusted would be an improvement, yet it was recognized that this is difficult for the uncertain future climate, it was stated:

*"It is much easier to make a map with a signalling function, than a map on which can be zoomed in to identify the course of action."*

### 5.3.3 Evaluation interplay

The **interplay** refers to how existing knowledge influences the adoption of new knowledge by municipal practitioners, i.e. scientific climate information. Problems with the usability of information emerge when information conflicts with existing knowledge, for example with regard to organizational routines or expertise. This section describes what the practitioners explained on the context they operated in along six interplay elements that drive the usability of climate information: flexible decision-making structure, human and technical capacity, decision-making culture to mitigate climate change risks, perception of vulnerability, triggering events and users valuing research. No references were made to the drivers on the commitment to planning, technocratic insulation, organizational incentives, positive experiences with innovation and public pressures, this does not mean that the drivers were absent, rather there was no time available to inquire on all drivers.

#### *5.3.3.1 Flexible decision-making structures*

Recalling, *flexible decision-making structures*, such as open and flexible organizational routines, facilitate the adoption of new knowledge in the decision-making structures. The municipality of Leiden organised the vision development process around the adoption of knowledge on diverse spatial priorities (e.g. climate adaptation) to analyse the system, indicating a rather high flexibility. The practitioners of the other four municipalities referred to be working according to, or towards an organisational structure in which the sectorial policy domains on green, water, soil and often also spatial development, are working more closely together. This suggests a transition towards more flexible decision-making structures. This transition was expressed in different ways. In Amersfoort the sectorial domains had been working more closely together since the formulation of the spatial development strategy in 2013, and since the departments were located more closely. Similarly, municipality of Nijmegen had started working with more flexibility among three departments: the policy department, the engineering department and the maintenance department. All practitioners from those departments can sign up to an assignment, allowing the practitioners to work on a task outside

their primary field of expertise. Finally, both the practitioners of Groningen and Ede indicated that they were heading towards working according to clustered themes instead of sectorial domains.

#### *5.3.3.2 Human and technical capacity*

Recalling, the presence of *human and technical capacity* in the organization enable municipal practitioners to find access to, adopt and use new knowledge. Practitioners from three municipalities indicated that it is difficult to find time and budget to search for and analyse climate information. Moreover often budgets and power are unevenly distributed among the sectorial domains and the capacities to adopt and use new climate information seemed to be concentrated to the water/sewage departments. Alternatively, it appeared with a collective of municipalities, more easily sufficient resources can be collected. Still, all municipalities disposed of pluvial flooding maps and/or heat maps, often established by consultants. However, in translating climate information to the specific municipal context, it seemed that the process of combining climate information with local geospatial information was constrained by that this information if often not uniformly organised within the municipalities.

The practitioners of Ede, Groningen and Nijmegen expressed that there is little time available to inquire on climate information or to participate networks while the willingness to learn and exchange experiences is present (see also 'users valuing research' below). Moreover, a practitioner of Nijmegen indicated that especially for the smaller municipalities, commissioning consultants to establish vulnerability maps is expensive; hence first the urgency needs to be demonstrated. This starts a negative circle; as to demonstrate the urgency, time and budgets are needed. Another constraining factor mentioned was how budgets and power are unevenly distributed among departments. At the municipality of Nijmegen for example, the water department disposes of a substantial budgets, while for green management little budgets are available. Consequently, climate adaptation could only be secured in the water plan. Moreover, both the municipality of Nijmegen, Groningen and Ede indicated that often the spatial development department has most power in decisions on spatial tasks, while awareness and integration of climate adaptation considerations are often lacking.

The project participants of Leiden explained that the collective of municipalities provided sufficient capacities and resources as well as a 'workable' region to regard spatial planning problems and opportunities. The collective allowed the smaller municipalities with less resources and capacities to participate in the comprehensive spatial analyses. Yet, a project participant also indicated that local geospatial information is often not well-organised and up-to-date among and within municipalities. For example, information on the sewage system is often fragmented among municipalities. This problem also emerges in using the CAA indicator for 'paalrot'. This indicator only indicates the expectation for a potential risk of paalrot based on building period of residences. The municipalities themselves have to do research to track whether the houses were indeed built on wooden poles, however such information is often not ready-made available within the municipalities.

#### *5.3.3.3 Decision-making culture to mitigate climate change risks*

Recalling, an organization is characterised by a *culture to mitigate climate change risks*, when municipal practitioners perceive the use of climate information as a strategy to mitigate risks, rather than a risky practice itself. All practitioners seemed to regard that collecting new climate information may benefit them in addressing climate risks. The project participants of Leiden, clearly explained how they aim to pick up the signals that go around on climate change, and translate these to their situation to see if they must be addressed without having direct solutions ready. This suggests an approach that is focussed on increasing climate knowledge while recognizing the complexity of climate impacts. However, also the other municipalities were pursuing the adoption of new climate information to improve vulnerability analysis and identify potential combinations of objectives.

#### *5.3.3.4 Perception of vulnerability*

Recalling, when the *vulnerability* to climate change risks is *perceived* high this may support the adoption and use on climate information. All municipal practitioners indicated an interest in a broad range of climate change vulnerabilities, as was shown in Table 5.5, suggesting an awareness of the (potential) vulnerability of the municipal area. However, except for the municipality of Leiden, which disposed drought stress and land subsidence maps, the other four municipalities only referred to

disposing of heat stress and pluvial flooding maps. This may have the implication, that the perception on the vulnerability within the municipal organization is concentrated on heat and pluvial flooding.

#### *5.3.3.5 Triggering events*

Recalling, *triggering events* refer to the occurrence of climate change related events, such as drought and flooding, and the related impacts. All municipal practitioners referred to some (almost) triggering events, which often concerned flooding and once heat. For example, the municipality of Amersfoort explained how they are located in the 'pit' of the area, being vulnerable to flooding from both the lake in the north and the river in the south. Another example was given from the municipality of Nijmegen, which was confronted with two casualties at the yearly hiking event 'Four days marches', in 2006. The practitioner indicated that then (political) attention increased.

#### *5.3.3.6 Users valuing research*

Recalling, users *valuing research* refers to the value a municipal practitioners attributes to scientific research and pursues to use it. The value the practitioners attribute to research was found high for two municipalities; in Leiden was aimed to collect and analyse scientific climate information and the municipality of Nijmegen participated in an international research programme on climate proof cities. For example, a project participant from Leiden expressed a thorough ambition towards research:

*"we gave ourselves carte blanche to research climate change impacts and the relation to spatial themes and tasks and continue until the organisational or administrative support fails. New knowledge can strengthen the stories told in the environmental vision"*

The other four municipalities more often attributed value to collecting and exchanging knowledge and experiences through platforms or through commissioning consultants. An important reason for the four municipalities to participate in the KANS network was to exchange experiences; the practitioners of Nijmegen explained that scientific climate information in general is not sufficiently applicable. The municipalities of Ede and Amersfoort participated in yet another network; a regional platform of the water board. In addition, the practitioner of Amersfoort explained that the municipality collects knowledge from research performed by citizens in the project 'measure your city'.

### 5.3.4 Evaluation interaction

**Interaction** refers to level and quality of interactions between scientists and municipal practitioners, and may influence the willingness and ability to use climate information. This section discusses the interactions of municipal practitioners with scientists and how they experience this. Due to the little interactions, only the findings for the drivers of co-production, two-way communication and interactivity are discussed. No references were made to trust, legitimacy and on-going relationship.

#### *5.3.4.1 Co-production*

Recalling, co-production refers to when municipal practitioners and scientists cooperate in the exchange, production and application of knowledge. In general was found that little interactions take place between research institutes and municipalities, and more specifically, no interaction took place between the research institutes and municipalities in the use of the CAA data. Some interactions were indicated with boundary organization CAS (see section 5.3.4.2). In all municipalities, climate information was established by and together with consultants, moreover local knowledge was collected bottom-up in Amersfoort and Nijmegen.

Apart from the absent interactions with research institutes in using the CAA, the municipality of Leiden indicated to be participating in a project on climate change with research institutes, to research the impact of climate change on biodiversity in the area. For the other four municipalities, rather interactions with consultants and/or networks took place to inquire on climate knowledge. For example, in most municipalities, the pluvial flooding maps and heat stress maps were created by or in collaboration with consultants.

#### *5.3.4.2 Two-way communication*

Recalling, *two-way communication* refers to that on both the initiates of the municipal practitioners and scientists is interacted on the (use of) climate information. Among the municipalities no direct

interactions with research institutes took place in using CAA data, only some interactions with boundary organisation CAS were mentioned in the use of the CAA.

The project participants of Leiden had some interactions with boundary organization CAS, to discuss the available CAA data. On both the initiative of the collective of Leiden and CAS there was communicated on how the data could be best used and interpreted. The interactions included some written contact as well as participating in meetings. Furthermore Amersfoort and Nijmegen had some interactions with CAS on the CAA data and using it in projects some time ago.

#### *5.3.4.3 Iterative*

Recalling, iterative refers to that interactions between scientists and municipal practitioners influence how scientists pursue science and how users understand the possibilities and limits of science in decision-making. The practitioners of the municipality of Nijmegen explained that despite the little interactions, there is a to a certain extent mutual understanding on each other possibilities and needs; still research institutes mostly fail to make their research more applicable. The practitioner explained this with the efforts that were done with the NKWK research programme (see for explanation NKWK chapter 0); The NKWK efforts fail to provide what is needed: knowledge and best practices that can directly be inserted in the processes of municipalities. The practitioners explained that to supply this knowledge, budgets from the national government and know-how from the research institutes are needed to translate the climate information into a local and applied form: for example a plan of action. While other municipalities may be able to solve the problems, the municipalities don't have the time to exchange knowledge. The practitioners observed that among the research programmes, such as NKWK, that aims to support the local level, the same questions keep popping up: for example what is the importance of green-blue structures on the environmental quality of the city? From this the practitioners conclude that the research efforts do not succeed to supply applied information. Despite this the gap between research and application, the practitioners explain that scientists know the municipal needs, yet it is difficult to find a practical application for their research. Moreover is observed that it is not an easy time for research institutes and that they are in a 'surviving mode'.

The above suggests that while there are little interactions between municipal practitioners and scientists, municipal practitioners access, interact and co-produce climate information with other actors such as colleague municipalities or intermediaries, like consultants and boundary organization CAS, allowing them to access applied and contextualized climate information. Yet, the little interactions seem to inhibit the progression of climate change research that is actionable.

### 5.3.5 Conclusion Q4 (preliminary)

With section 5.3 the first part of sub-question 4 can be answered, recalling sub-question 4:

*To what extent is the CAA usable for municipal practitioners for adaptation planning [….]?*

The usability of the CAA was evaluated on the criteria of fit, interplay and interaction. The evaluation showed that the CAA *fits* two needs of municipal practitioners: creating awareness and generating a sense of urgency, and relating climate vulnerabilities to other spatial priorities on the regional/municipal level with diverse stakeholders. The CAA could not meet the need to take 'the next step', such as formulating policy options. The municipal practitioners revealed a moderate beneficial *interplay* to adopt climate information. While all municipalities expressed a positive attitude towards collecting and using new climate information, the culture and capabilities to do so seemed especially present in the municipality of Leiden. Finally, none of the municipal practitioners *interacted* with the scientists that contributed to the development of the CAA. And while only two of the cases used the CAA, in general the municipal practitioners reported little interactions with the scientific community. However, interactions did take place between the practitioners and other CAA producers; the practitioners further co-produced the CAA with consultants or boundary organization CAS. Also in the municipalities that did not use the CAA, consultants fulfilled an important role in supplying climate information. Section 6.1 explains and discusses the implications of these findings.

# 6 Explaining usability and identifying future conditions

This chapter first introduces explanations for the usability of the CAA in section 6.1. Thereafter, section 6.2 discusses conditions for usable climate information to support environmental vision.

## 6.1 Towards explanations for the usability of the CAA

This section explains the fit, interplay and interaction as found in section 5.3. This was done by summarizing the main findings for each of the three criteria, and linking these to the findings from the analyses of the CAA producers (section 5.1) and the municipal practitioners (section 5.2). By linking the analytical factors to the evaluative criteria was aimed to identify how contextual factors from the CAA producers and municipal practitioners influence the usability of the CAA.

The resulting 'lines of explanation, are visualised in figures to provide insight in how the analytical factors relate to the evaluative criteria. Consistent with the colour scheme applied in this thesis, red boxes refer to the descriptions on the municipal practitioners and blue boxes indicate when it concerns a description of the CAA producers. Moreover is indicated for which of the user cases (municipalities) or producers (boundary organization CAS, research institute or consultants) a certain factor was found. The purple boxes refer to the criteria of the evaluative framework. With this, the purple boxes represent the dependent variables, and the blue and red boxes the independent variables. It appeared that often the municipalities of Amersfoort, Nijmegen, Groningen and Ede had commonalities in contrast to the municipality of Leiden. In some cases, to increase readability, those four municipalities are referred to as 'the four'.

### 6.1.1 Explaining the fit to 'the first step' of local adaptation planning

Recalling, the **fit** refers to the perceived fit of information to the adaptation planning needs of the municipal practitioner and was evaluated with the drivers of **saliency**, **accuracy** and **credibility**. The evaluation showed that the CAA was perceived salient, accurate and credible for two adaptation-planning needs: creating awareness and relating climate vulnerabilities to other spatial priorities, both on the regional level. This can be explained with how the municipal practitioners **frame** adaptation, aim to **set priorities** and **formulate policy options**, as well as the extent to which adaptation is on the **agenda,** has gained **political support** and is **integrated in policies**. The CAA could not meet the adaptation planning need to assist in taking 'the next step'. This can be explained with how the **visioning** process is shaped and how far it is progressed, the extent to which adaptation has gained **political support,** the role of **participation** in adaptation and vision development processes and the **actors** engaged in the CAA development. Finally, the **beliefs** of the CAA producers matched the perceived fit by the municipal practitioners, yet the producers appeared to have little knowledge on how the development of the environmental vision influence climate information needs. The next paragraphs elaborate on how these findings explain the perceived fit.

#### *6.1.1.1 Mapping municipal vulnerability supports agenda-setting*

Figure 6.1 summarizes the factors that can explain why the CAA was evaluated salient and accurate by all municipalities for creating awareness on the climate change risks and vulnerability of the municipal/regional area and demonstrating the urgency to address climate adaptation.

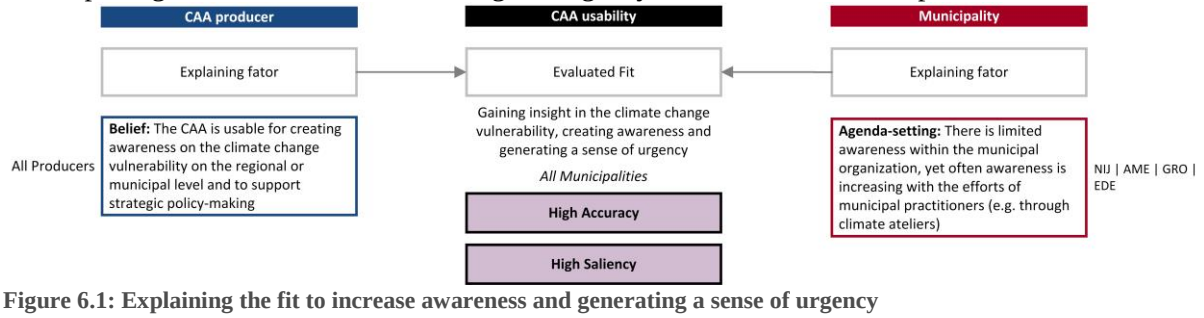



**Figure 6.1: Explaining the fit to increase awareness and generating a sense of urgency**

The **saliency**, which is the perceived relevance, can be explained with that the awareness on adaptation among the municipal organization was often limited and that adaptation was yet addressed to a limited extent; consequently, municipal practitioners had to do much effort to push the topic further on the **agenda**. Moreover, the **accuracy** of the CAA, which is the perceived precision and exactness of information, was sufficient to indicate the risks on the municipal or regional level and generate awareness. When contrasting the perception of the municipal practitioners with the **beliefs** of CAA producers on the usability of the CAA, the users and producers rationales agree on that the CAA is of use for regional and local policy-making on the strategic level, and support creating awareness and agenda-setting through gaining insight in the climate change vulnerability.

It appears that how the CAA maps out the general climate vulnerability for a specific regional or municipal area, allows municipal practitioners to gain an understanding of the complex problem of climate change risks for their region. Moreover, it allows them to communicate on the problem within the municipal organization. Hence the CAA succeeds to communicate on climate vulnerability in an understandable manner, by visualising the imminent climate change risks in the area of interest.

#### *6.1.1.2 Overlaying municipal vulnerability over spatial maps facilitates integrative approaches*

Figure 6.2 summarizes the factors that can explain why the CAA was evaluated by the municipality of Leiden as salient and accurate for connecting climate change vulnerabilities to other spatial priorities and bringing together stakeholders, and why the CAA was evaluated as moderate credible for spatial decision-making.

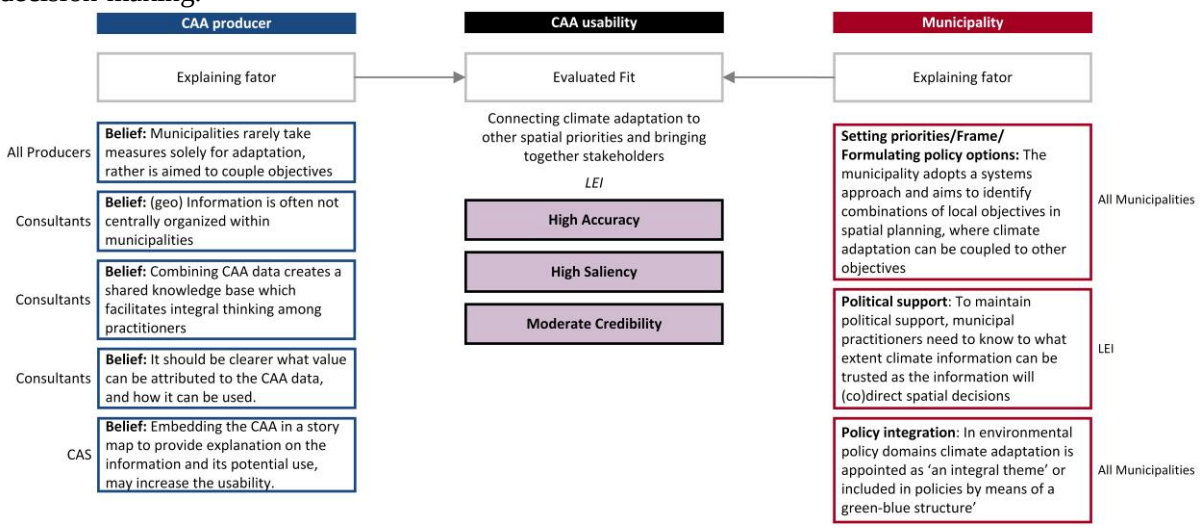



**Figure 6.2: Explaining the fit to connect climate change information to other spatial priorities**

The **saliency,** which is the perceived relevance, can be explained with that the municipality of Leiden aims to **set priorities** for spatial planning by applying a systems approach in the formulation of the environmental vision. While the other four municipalities similarly expressed to pursue such an approach, not all municipalities had yet a clear application of this approach in spatial planning, or had only applied it in specific projects. This may explain that these municipalities had not recognized the relevance of the CAA for this application, provided the detail of the CAA data. With the systems approaches is aimed to align spatial planning decisions with the characteristics and mechanisms of the natural physical area (e.g. soil conditions, water system). Operationalizing this approach includes that the municipal policy domains of soil, water and green, as well as spatial planning are linked and aligned (e.g. by using maps). Within these systems approaches, climate adaptation was (aimed to be) **integrated in policy** as an 'integrative theme' crossing the sectorial domains (Groningen, Leiden, Ede) or climate adaptation was addressed through the development of integrative 'green-blue' structures (Amersfoort, Nijmegen). Other integrative themes included for example biodiversity, energy and health. It appeared that the municipalities are searching for the best way to integrate climate adaptation in the sectorial domains and seek for more integrative ways of working. In line with the systems approach, all municipal practitioners expressed a rather promotional and proximal **frame** towards adaptation, by seeking for opportunities to combine concrete and local objectives (e.g. combining climate adaptation objectives with nature objectives). This frame was again reflected in the manner the practitioners aimed to steer the **formulation of policy options**. For example, the

municipality of Leiden aimed to create a decision framework that provides insight in the impacts of spatial decisions on a variety of spatial objectives (e.g. what does the decision mean for biodiversity, climate adaptation etc.), the other four municipalities similarly expressed the ambition to identify combinations of objectives to increase social acceptability and financial feasibility of spatial plans and measures.

Taken together, the positive and nearby frame towards adaptation, the application of a systems approach and the favoured decision-making approach to identify combinations of objectives, explain that the CAA was valued relevant to increase system knowledge and connect climate information to multiple spatial themes and tasks. By overlaying the CAA data with data of other spatial priorities, (e.g. maps on soil conditions or urbanization objectives) the municipality of Leiden could make the first strategic spatial decisions in the environmental vision (see 5.2.4.1). Yet, the maps could not fulfil the need to gain insight in the mechanisms of the climate change risks. The relevance of that the CAA can combined with other information was also reflected in the **beliefs** of all producers, who recognized that municipalities rarely take adaptation measures for adaptation objectives solely, and that practitioners are rather pragmatic and aim to find combinations of multiple objectives. However, as was recognized by a consultant and was also indicated by a project participant of the municipality of Leiden, geospatial information, to combine with climate information is not always well organized within municipalities.

In addition to connecting climate information and other geospatial information, the practitioners of Leiden indicated that the CAA was **salient** for bringing together the divers stakeholders that were involved and contributed by adding information (e.g. water board, drinking water service and participating municipalities). This matches with the **beliefs** of the consultants, who explained how the using the CAA and combining this with geospatial information as well as their own products in for example stress tests, creates a shared knowledge base of information that is recognized by the municipal practitioners and that facilitates integrative thinking and collaboration among practitioners from divers disciplines.

Finally, the moderate **credibility**, which refers to the extent to which the information is perceived as of good quality, can be explained with the need to maintain **political support** when using the CAA data to guide spatial decisions as explained in the case of Leiden. To maintain the broad political support, the practitioners that use the information for analyses are accountable to the Alderman and need to know to what extent the CAA data can be relied upon, since the climate information will (co)direct spatial decisions. Similarly, the consultants expressed the **belief** that it should be clearer what value can be attributed to the CAA data and how decisions can be made, yet the consultants indicated that municipal practitioners generally recognize that climate data is concerned with uncertainties. Hence, rather than doubting the credibility**,** there seems to be a need for the explication of the extent to which the data can be trusted. Therefore, CAS adopted the belief that the usability of the CAA may increase when the CAA web viewer is embedded in a story map where the data and its potential use are explained.

It appears that how the CAA data is available in a GIS format in which the CAA data is compatible with and can be easily combined with other geospatial information, assists municipal practitioners to relate climate vulnerability to spatial planning tasks, and identify potential problems and opportunities for adaptation planning. In addition, including geospatial information of engaged stakeholders may facilitate collaboration. Moreover, when consultants perform projects with municipalities on climate adaptation, they can use the CAA data, and combine it with local geospatial information as well as with their own products. Hence the CAA succeeds to supply both practitioners and consultants with climate vulnerability information that can be further tailored with local detailed knowledge and information, dependent on the municipal needs. Yet, in interpreting the climate vulnerability and the resulting problems and opportunities, the CAA doesn't succeed to guide the municipal practitioners in how the information should be used in decision-making; how should be dealt with uncertainties.

#### *6.1.1.3 General vulnerability information is not enough for 'the next step'*

Figure 6.3 summarizes the factors that can explain why all municipal practitioners evaluated the CAA as not salient and accurate for taking 'the next step'.

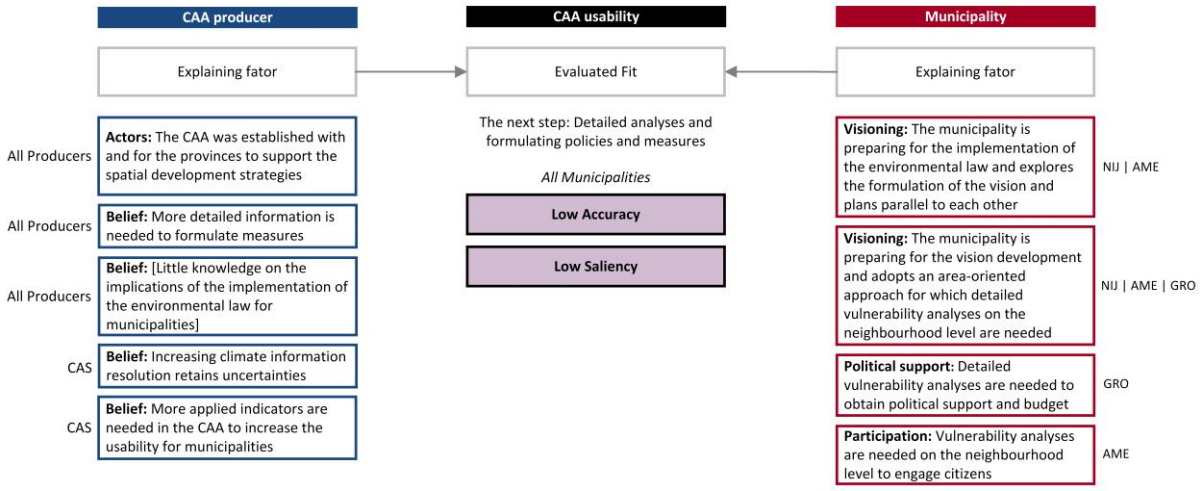



**Figure 6.3: Explaining the unmet need to take the next step**

The lacking **saliency,** meaning that the CAA was not perceived relevant, can be explained with how the **environmental vision** is developed in context of the implantation of the environmental law. While Leiden has started a comprehensive process for the vision development, in the other four municipalities, the process towards the implementation of the environmental law is about clarifying a diversity of issues, such as exploring what should be in the environmental vision and plans, identifying the appropriate themes, and determining how the process should be organized. To clarify these issues, different factors of the environmental law are regarded and explored parallel. Two municipalities started with the formulation of the environmental plans along with the preparation of the vision development (Nijmegen, Amersfoort). This suggests that the implementation of the environmental vision is a rather fuzzy process, where the vision and the plans shape each other in an iterative fashion, as the implementation of the environmental law proceeds. This may explain the need from the municipal practitioners for information that assists in taking 'the next step' and formulating concrete policies and measures for the environmental plans, which is cannot be done with the CAA as it only indicates the general climate change risks and vulnerable areas.

In line with that the municipal practitioners' need for more than only general climate vulnerability information, CAS **beliefs** that the usability of the CAA could be improved with more applied indicators. When proposing the list of applied indicators to the municipal practitioners, it appeared indeed that they showed particular interest in more applied indicators that were not yet in the CAA, such as the feasibility of nature objectives, the drought stress for particular crops and the impact on urban green, biodiversity and landscapes (see Table 5.5). Moreover, the consultants expressed the **belief** that especially climate information is needed that not only provides insight in the risks but also in supporting the exploration of a course of action and the associated investments. While the CAA producers seemed well informed on the limitations of the CAA for formulating measures, none of the CAA producers had a clear idea on the implications for municipalities of the implementation of the environmental vision. Especially for the consultants, it is surprising that there is little knowledge and experience with how the policy processes in the environmental law will look like, as it can be expected that it are those actors that will support municipalities in assisting to shape such policies.

The **inaccuracy** of the CAA for taking 'the next step'**,** meaning that the CAA data was perceived as not exact and precise, can be explained with the levels of analysis in the **vision** development**.** From the 'first approaches' for the vision development as indicated by the four municipalities that were preparing for the vision development, three municipalities emphasized that the application of an area-oriented approach will be central (Nijmegen, Groningen Amersfoort). This approach includes regarding (spatial) development on the neighbourhood level and connecting to the stakeholders in the area and formulating neighbourhood plans. This level of analysis explains that the accuracy of the CAA was evaluated of limited use to the four municipalities, in contrast to the municipality of Leiden where an area of 10 municipalities combined was regarded. In addition to the formulation of neighbourhood plans, two municipalities gave additional reasons for the need for more detailed information to take the next step. Firstly, more detailed information was needed to increase **political support** and obtain budgets, as with more detailed information better analyses can be made to identify

possible solutions and associated costs which in turn can further shape ambitions (Groningen). This was supported by another municipal practitioner who explained that in efforts to increase political support, municipal practitioners may be in a vicious circle: budgets are needed to perform sophisticated vulnerability analyses, however sophisticated vulnerability analyses are needed to demonstrate the urgency to address climate adaptation and obtain budgets (Nijmegen). Secondly, one municipal practitioner explained that neighbourhood level information is needed to be able to communicate to citizens and engage them to **participate** in adaptation action (Amersfoort).

The fact that the CAA was initially developed for and with **actor** engagement of the provinces to support their spatial development strategies (see section 5.1.1) could explain that the CAA better fits the regional level and municipal level, and was perceived as inaccurate to perform local analyses and formulate measures. Moreover, the nationwide CAA was established from the motivation of boundary organization CAS to counteract fragmentation of climate information and to provide a central location of information. Developing nationwide climate information means that only national models could be used, which come with a limited resolution. However, from boundary organization CAS the **belief** was expressed that while the spatial resolution of the CAA data is limited, it is questionable whether decision-making would improve when more detailed climate model runs would be included, provided that the uncertainties remain the same as the input from the climate scenarios is concerned with quite a bandwidth of uncertainty.

It appears that the CAA does not succeed to provide climate information that provides insight in the vulnerability on the neighbourhood level and information that support the formulate policy options; the practitioners indicate the need for more detailed vulnerability analysis and adaptation policy assessments. This information in turn may be needed to engage citizens, further shape ambitions and obtain political support. It seems that municipal practitioners are hesitating to use the CAA for more than identifying general vulnerable areas in the municipality and are occupied with the idea that detailed climate information is needed to take the next step. This suggests that if the producers of the CAA aim to make the CAA usable for taking the next step, explanation and guidance is needed for the municipal practitioners to be able to do so.

### 6.1.2 Explaining a moderate but improving interplay

Recalling, the **interplay** refers to how existing knowledge influences the adoption of new knowledge, and was evaluated with the drivers of the flexibility of decision-making structures, the human and technical capacities, the decision-making culture to mitigate risks, the value attributed to research, the perception of vulnerability and triggering events. The evaluation showed a moderate beneficial interplay to adopt new climate information within the municipalities, where all municipalities expressed a positive attitude towards collecting and using new climate information, however the culture and capabilities to use the scientific information seemed especially beneficial in the municipality of Leiden compared to the other four municipalities. The similarities can be explained with how the municipal practitioners **frame** adaptation, aim to **set priorities**, **formulate policy options** and the extent to which adaptation is **integrated** in policies, while the differences emerge from the extent to which these ambitions are on the municipal **agenda** and have gained **political support**. Moreover, the **capabilities** of the consultants may direct the focus of municipalities adopting information towards the consultants' expertise. The next paragraphs elaborate on how these findings explain the similarities and differences in interplay.

#### *6.1.2.1 Scientific research beyond primary tasks demands political support*

Figure 6.4 summarizes the factors that can explain the finding that all municipalities expressed a beneficial interplay in terms of an ambition that is oriented towards the adoption and use of scientific climate information, while especially in the municipality of Leiden these ambitions were expressed in a culture of doing so.

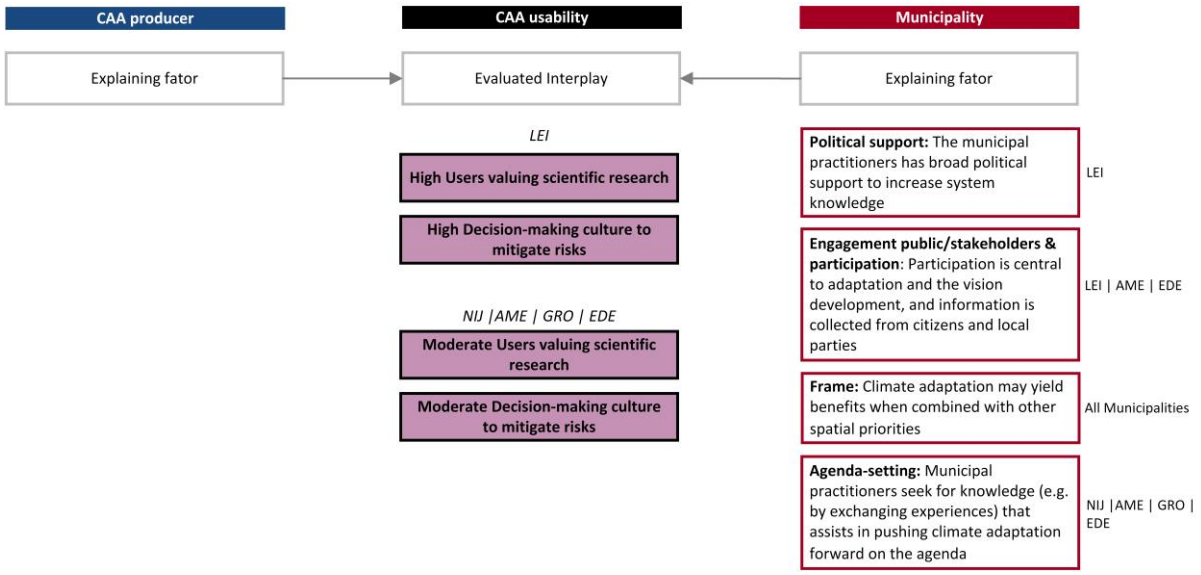



**Figure 6.4: Explaining an interplay that is characterized by a (moderate) beneficial culture**

All municipalities expressed a moderate positive **value towards scientific research** and the presence of a **decision-making culture to mitigate risks**. This refers to the value that that is attributed to scientific research, and the perception that the adoption and use of climate information is a beneficial strategy to deal with climate change risks, respectively. The similarity in positive attitude can be explained with the positive **frame** of all municipalities towards adaptation. All municipal practitioners **framed** climate adaptation as an effort that may yield benefits when it is combined with other spatial objectives, and for which opportunities can be identified through increasing system knowledge. This explains the willingness to seek and adopt new climate information among the practitioners of all municipalities. However, the fact that the municipality of Leiden had broad **political support** for increasing systems knowledge for the environmental vision, collecting information and participating in scientific research, explains that the municipality could afford a culture that accepts that, no straightforward and clear answers become available.

Continuing, the more beneficial interplay of Leiden in contrast to the other four municipalities can be explained with the extent to which adaptation is on the **agenda** and has gained **political support**. The municipal practitioners of the four municipalities were more concerned with pushing climate adaptation forward on the municipal agenda, and therefore rather inquired on climate information via platforms, consultants and citizens. An important motivation for joining the KANS network, in which all practitioners of the four municipalities participated, was to exchange experiences on how internal and external awareness on climate adaptation could be increased. This indicates that municipalities are also seeking for knowledge that assists them to shape the conditions to address climate adaptation within the municipal organization. In contrast, Leiden had yet broad political support for and already applied the systems approach. In addition to pushing climate adaptation further on the agenda, the effort of collecting climate information from local parties seems to be driven by the central role that is attributed to **participation** in both climate adaptation and the environmental vision in all municipalities. For example, the municipality of Amersfoort aimed to collect climate information from citizens, and the municipality of Leiden collected climate information from the parties involved in the visioning process (water board, drinking water service). Moreover, two municipalities exchanged knowledge and experiences through a network initiated by the water board (Ede, Amersfoort).

It appears that the CAA accommodates for an interplay that is characterised by seeking for scientific climate information to increase system knowledge that is easily understandable and can be used to perform general analyses in participatory settings. The CAA does not accommodate an interplay that is focussed on exchanging experiences and learning on pragmatic solutions. Hence the CAA succeeds to accommodate for a municipal interplay that supports the use of scientific climate information.

*6.1.2.2 Political support for integrated process facilitates the capacity to adopt climate info*

Figure 6.5 summarizes the factors that can explain the finding that the municipality of Leiden disposed of excellent capacities to adopt new climate information, while the other four municipalities were more constrained but working towards a more beneficial interplay.

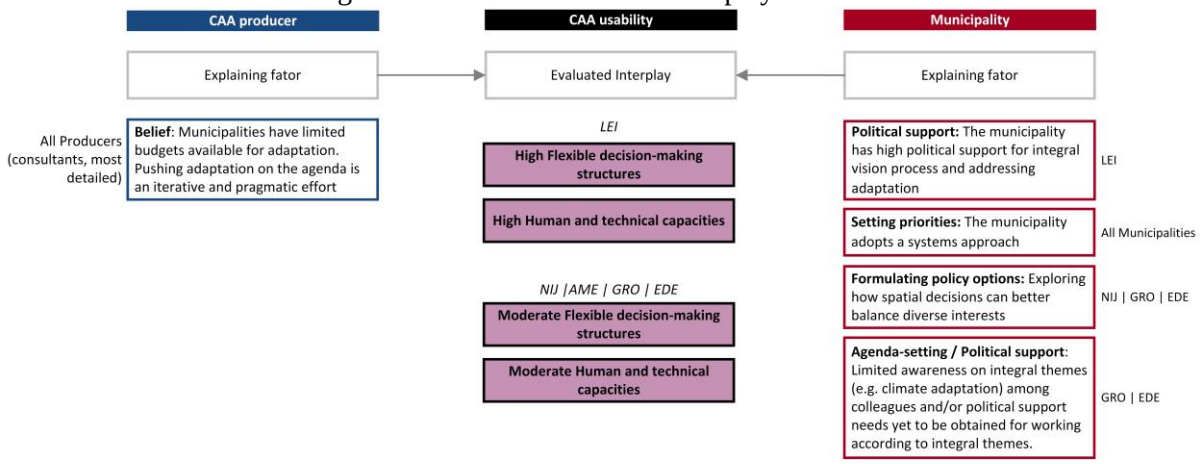



**Figure 6.5: Explaining an interplay that is characterized by (moderate) beneficial capacities**

Especially the municipality of Leiden expressed a high **flexibility of decision-making structures** and excellent **human and technical capacities.** This refers to the openness of organizational routines to introduce new information and the ability to introduce and adopt new information respectively. In contrast, in the other four municipalities municipal practitioners were making efforts to overcome constrained capacities. This difference in interplay can again be explained with the extent to which adaptation is on the **agenda** and has gained **political support**, while the manner in which **priorities are set** seem to drive the transition within the constrained municipalities.

The beneficial capacities of Leiden were expressed in that the environmental vision process was organized around the adoption and use of new knowledge on spatial priorities, including climate adaption. Moreover the collaboration with nine other municipalities brought together sufficient resources and capacities. The formulation of the environmental vision had high **political support**, from both the participating municipalities and the national government. This support allowed the municipal practitioners to adopt new information in the vision development process. Alternatively, in the other four municipalities was found that within the municipal organization efforts were done to introduce more flexible structure in the organization, through intensifying collaboration between the sectorial domains and thereby easing the ability to adopt new information (especially information that applies to multiple sectorial domains such as for climate adaptation). This transition can be explained with that the municipal practitioners aim to **set priorities** by using a systems approach for spatial planning. Despite the upcoming transition, from three municipalities, the municipal practitioners indicated to be yet concerned with limited capacities in terms of budgets and time. Budgets and power were found unevenly distributed among the domains policy domains of soil, water, green and spatial development. The human capacities and budgets to adopt new climate information seemed to be concentrated in the water and spatial planning departments. However due to the often-lacking awareness in the spatial planning departments, adaption was only addressed in sewage policies (e.g. see Nijmegen, Ede).

In establishing the above-mentioned ‘transition’ municipal practitioners referred to overcoming two barriers; Firstly two municipal practitioners indicated that colleague practitioners need to become aware of the integrative nature of themes such as climate adaptation (**agenda-setting**), and that there needs to be **political support** for the new integrative ways of working. Secondly, three municipal practitioners explained that spatial decision-making must be steered differently, therefore they were exploring how interests emerging from the water, green, and soil policy domain could have more decisive power in the planning process, for example by bringing in objectives from those domains early in the planning process and thereby balancing the manner in which spatial **policy options are formulated**. In making progress in this transition, the capacities of practitioners to address climate adaptation in all relevant domains may increase, for example by adopting climate information and perform vulnerability analyses.

When contrasting the **beliefs** of the CAA producers with above findings, it seems that all producers are aware of the contexts in which the municipal practitioners operate. It stands out that especially the consultants have most feeling with how municipal practitioners have to make efforts to push climate adaptation on the agenda with limited capacities. Furthermore, all CAA producers recognized that there are limited budgets available at municipalities and that there is diversity in ambition and perceived urgency as well as diversity in approaches towards addressing climate adaptation. From the consultants in more detail was explained how climate adaptation within municipalities is often a pragmatic and iterative effort, in which municipal practitioners have to manoeuvre through sectorial structured organizations with uneven distributed budgets and power, where especially the spatial development department is often unaware of climate adaptation issues, and where geospatial information to apply in vulnerability analysis is often not well organized. This shows that especially the consultants are well informed on how the municipal context influences the municipal practitioners to adopt climate information and address adaptation.

It appears that the freely available CAA data that can be used to support integrative approaches across sectors, by overlaying the data on maps from the environmental policy and spatial planning domains. This accommodates for an interplay that is characterised by limited resources and (transforming to) working according to integrative organizational structures. Hence, the CAA succeeds to supply accessible information in a format that facilitates integrative approaches.

#### *6.1.2.3 Vulnerability perception driven by capabilities of consultants and awareness*

Figure 6.6 summarizes the factors that can explain the finding that the municipal practitioners expressed interest and awareness into a broad range for climate change risks, but disposed mostly of climate information and experiences with risks of heat stress and pluvial flooding.

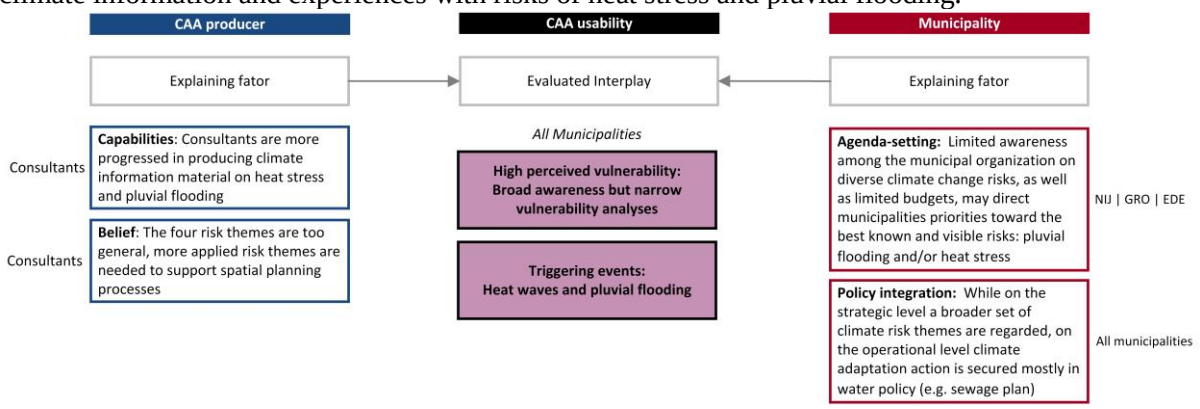



**Figure 6.6: Explaining an interplay that is characterized by a broad interest but little vulnerability maps**

While all municipal practitioners perceived their municipal area as **vulnerable to climate change impacts,** referred to **triggering events** and showed interest into a broad range of climate change risks indicators, the available vulnerability information was mostly focussed on pluvial flood risks and heat stress. Only the municipality of Leiden also disposed of maps on drought and land subsidence. A possible explanation is that the four municipalities commissioned consultants that only disposed of the **capabilities** to make applied heat stress maps or pluvial flooding maps. Another explanation is that these risks are highest on the **agenda** and were recognized as most important to allocate the limited budgets to. For example, in the municipality of Nijmegen the municipal practitioners explained how the theme of heat and drought was more difficult to push forward, as it is unclear whose responsibility it is. A general observation was that a range of climate change risks was regarded on the strategic level (e.g. environmental vision, green vision), yet on the operational level, climate adaptation was often only **integrated** in water policies. Another argument is that, as was indicated by one of the consultants (**belief**), that the four risk themes are too general, and do not automatically relate to spatial planning process. Refining the list of risks/vulnerabilities with more applied ones (see 5.1.3.2), may be better recognized and adopted by practitioners and increase the chance that they will regard the total range of possible risks.

It appears that the CAA presents for all the four risk themes a broad range of relevant impacts for municipalities to inquire on and thereby accommodates for an interplay that is focussed on inspecting

on the entire spectrum of climate change risks that the municipality may be confronted with. However, the general risk themes provide only a weak links to spatial planning processes.

### 6.1.3 Explaining lacking interactions with the scientific community

Recalling, the **interaction** refers to the level and quality of interaction between scientists and municipal practitioners, and was evaluated on the drivers of **co-production**, **two-way communication** and **iterative**. The evaluation showed that none of the municipal practitioners interacted with the scientists from the research institutes engaged in the development of the CAA. And while only two of the cases had used the CAA, in general the municipal practitioners reported little interactions with scientific community. The limited interactions can be explained with the extent to which adaptation was on the **agenda** and had gained **political support**. Moreover, the **capabilities** of the CAA producers seem to influence what kind interactions take place on climate adaptation. The next paragraphs elaborate on how these findings explain the interactions.

#### *6.1.3.1 Interactions with scientists inaccessible and irrelevant*

Figure 6.7 summarizes the factors that can explain the finding that none of the municipal practitioners interacted with the scientists from the research institutes engaged in the development of the CAA.

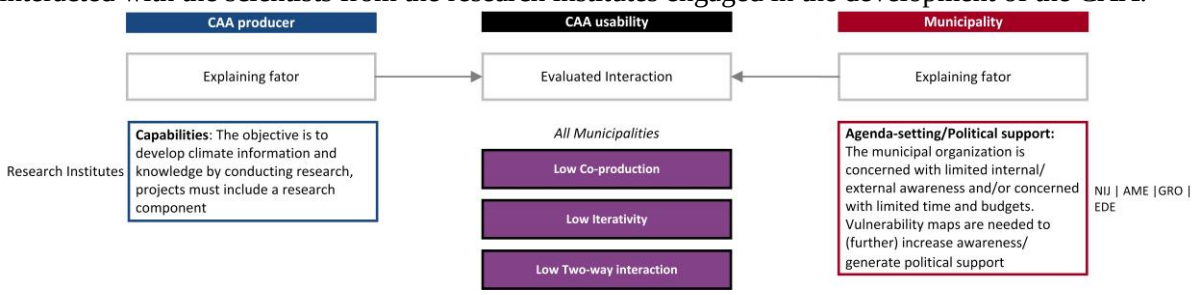



**Figure 6.7: Explaining the lacking interactions between municipal practitioners and scientists**

In absence of interactions between the municipal practitioners and scientists, there were also no processes of: 1) co-production, where users and producers cooperate in the production, exchange, and application of information, 2) iterativity, where the interactions between users and scientists influence how scientists pursue science and how users understand the (im)possibilities of science, and 3) two-way interaction, where both users and scientists take initiative on the production and use of climate information. However, also no disadvantages of the lacking interactions were indicated such as perceiving the scientific community as illegitimate, or the absence of trust in which the users and scientists perceive each other as good and reliable. It seems that the limited interactions do not so much emerge from a lack of trust or legitimacy, rather municipal practitioners seek for interactions with actors that can provide them with more applied and understandable climate information, as will be discussed in the following section (6.1.3.2).

The lacking interactions of municipal practitioners with scientists can be explained with that adaptation is at many municipalities still to a limited extent on the municipal **agenda** (lacking awareness among both the internal organization and among citizens) and **political support** is needed to make budgets available for addressing climate adaptation. Moreover the **capabilities** of the research institutes seem to constrain the interactions of scientists with the policy community. For example, one of the research institutes could only participate in projects with municipalities if the projects included a clear research focus, moreover commissioning research institutes for projects would be too expensive and yield to little applied outcomes. The primary task of research institutes is to develop knowledge, and while the research institutes expressed efforts to generate an understanding of the users' contexts and needs (through expert-municipality interactions, or via the CAA consultant feedback group, see 5.1.2) no actual instances were indicated that showed that municipal needs (co)directed scientific research.

Yet, together with boundary organization CAS and the consultants feedback group, the scientists aimed to better tailor the available climate information to the municipalities' needs. Also in the establishment of the CAA, rather available relevant climate information was collected and tailored to the provinces, than that research agendas were adjusted to the specific needs of the provinces. However, in the development of the CAA, the process of identifying the relevant climate information

and tailoring it into usable indicators was done together with the provinces and scientists. This shows that the CAA was in a way co-produced, albeit with provincial policy-makers. In this co-production process, instances of mutual learning were indicated on the relevance of specific climate information indicators for policy-making and the (im) possibilities of climate research (see 5.1.1). It seems that from this co-production process the scientists had learned on the context of users, as was described in the previous sections on explaining the fit and interplay. Moreover, the provinces at that time could access this co-production process as the provinces as well as the research programme CCSP could bring together sufficient financial resources.

It appears that how the CAA was co-produced by scientists and provinces resulted in the selection of relevant indicators to support regional strategic spatial policy-making. Hence the co-production process succeeded to establish a climate information tool with indicators that are generally relevant to support strategic policy-making. However, the co-production did not allow the collective definition and direction of research agenda.

#### *6.1.3.2 Interactions with intermediaries*

Figure 6.8 summarizes the factors that can explain that despite the lacking interactions with scientists, all municipal practitioners interacted on climate information with intermediaries.

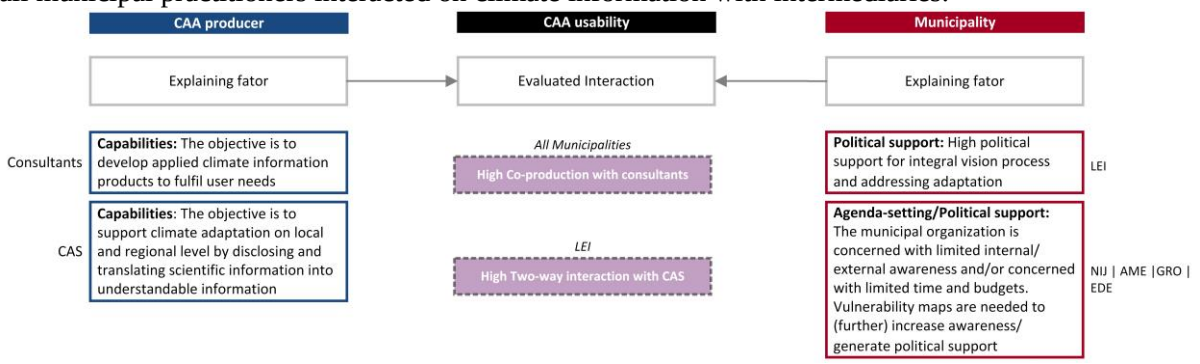



**Figure 6.8: Explaining the interactions with intermediary actors**

All municipal practitioners indicated interactions on climate information with consultants, and the municipality of Leiden and Amersfoort had interactions with boundary organization CAS in using the CAA data. When municipalities obtain climate information from consultants, a **co-production** can be identified, as in the stress test sessions or climate ateliers for example, maps are produced in which climate information (potentially from the CAA) are combined with local and specialised knowledge of the municipal practitioners. Such co-production process were indicated by both municipalities that referred to having organized climate ateliers (Amersfoort, Ede) or aimed to perform a stress test (Ede), and the consultants explained how the stress test sessions assisted to create a shared knowledge base. Furthermore, on both the initiative of Leiden and CAS interactions took place on the interpretation and use of the CAA data to support the vision development, indicating **two-way interactions**. The co-production processes and two-way interactions can be again explained in with the **capabilities** of the intermediaries in the context of yet limited awareness on adaptation, among both citizens and within the municipal organization (**agenda-setting**), and the often-limited **political support** to address climate adaptation. Consultants operate from the objective to fulfil their clients' needs, in this case municipalities, and are incentivised to develop applied products of climate information that can be commercialised. Consultants often dispose of products with which they develop detailed change vulnerability maps for municipalities. The freely CAA data allows the consultants to use and or combine their own products with future climate data. Moreover, in the interactions with the municipalities they can further guide and explain the use of the data.

Boundary organizations CAS operates from an ideal to translate climate information to local and regional actors, and moreover performs an assignment for the national government to disclose relevant knowledge and climate information to these actors through *inter alia* the knowledge portal and the CAA. This provides CAS with an incentive to perform two-way communication. The capabilities of CAS and the consultants, in contrast to the capabilities of the scientists, explain that municipal practitioners are inclined to interact with especially these actors, which are accessible and dispose of (more) applied climate information.

It appears that because the CAA was co-produced with policy-makers, general policy-making relevant climate information is disclosed through the CAA. Yet, when municipalities use the CAA, the usability seems to be leveraged when the practitioners further co-produce the climate information with intermediaries (consultants /CAS), by adding local geospatial information and providing guidance and explanation. Hence the CAA succeeds to supply general usable information that can be further co-produced. Only, the CAA, and the mechanisms of production and use, do not allow for direct interactions between scientists and policy-makers to formulate actionable research agendas.

### 6.1.4 Conclusion Q4

With the analysis in section 6.1, sub-question 4 can be answered. Recalling sub-question 4:

*To what extent is the CAA usable for municipal practitioners for adaptation planning and how can this be explained?*

By analysing the findings about how the CAA producers pursue climate information development (producers' context) and how municipal practitioners pursue adaptation planning and spatial vision development (users' context), explanations were found for the usability of the CAA as evaluated by the municipal practitioners. The usability is discussed along the three criteria of usability; fit, interplay and interaction.

Regarding the **fit**, it appeared that the need to increase awareness among colleagues and the council, and obtaining political support (e.g. for budgets), could explain that the visual overview provided by the CAA fitted the need to demonstrate the municipal vulnerability in an easily understandable manner. This corresponded with the beliefs of the CAA producers on the usability of the CAA. Continuing, the adoption of a systems perspective to spatial planning and the ambition to couple concrete adaptation objectives to other objectives (to increase the social acceptability and financial feasibility of climate adaptation efforts), could explain that the CAA fitted the need to relate climate vulnerability to other spatial priorities and bring together municipal practitioners and other stakeholders. The CAA accommodates for this need since the CAA data is available in a GIS format and can be easily combined with other geospatial information. Also the consultants, who tailored the CAA in projects with municipalities, referred to how the usability of the CAA is leveraged when it is used in participatory settings and combined with local geospatial information.

The findings that spatial planning is developing towards taking an area-oriented approach (emanating from the coherence of the social and natural system on the neighbourhood level) and the central role of (citizen) participation in adaptation, could explain that the CAA did not fit the need to take 'the next step'. Indeed, the CAA does not offer detailed (e.g. neighbourhood level) vulnerability analyses nor does it support the formulation of concrete adaptation objectives and measures. In addition, a strong accountability culture within the municipalities seemed to direct the information needs of municipal practitioners towards detailed climate information. This could explain that the practitioners needed to know to what extent the CAA data can be trusted to guide spatial decisions. The CAA producers recognized that these needs remained unmet. Moreover, the fact that the CAA producers engaged regional policy-makers in the development of the CAA, explained that the CAA is most relevant for the regional/municipal scale. However, from CAS was also believed that increasing the level of detail of climate information does not necessarily improve decision-making, provided the inherent uncertainties of climate information. Finally, the finding that the CAA producers had little ideas on the implications of the environmental law for municipalities could explain that application of the CAA for the environmental vision was not propagated and explicated.

Regarding the **interplay**, it appeared that the substantial political support for addressing adaptation and increasing system knowledge as found in one municipality, could explain that this municipality was characterised by a beneficial interplay in terms of seeking for, adopting and using scientific climate information. The CAA accommodates for this interplay as the CAA can be used in cross-sectorial approaches, combining CAA climate information with local geospatial information of diverse

policy sectors. Alternatively, the fact that the other practitioners where concerned with creating awareness among colleagues and the council as well as generating political support for budgets, could explain that these municipalities were characterised by a more moderate interplay. In this interplay, the practitioners expressed the willingness to adopt scientific climate information but in practice adopted and used climate information mostly by exchanging experiences with other practitioners or by commissioning consultants. It appeared that municipal practitioners need substantial political support as well as a clear application for the systems perspective, to be able to inquire on and analyse scientific climate information beyond their primary tasks. Finally, the finding that pluvial flooding, and often also heat stress, had gained most attention within the municipalities, together with the finding that consultants have most expertise on these themes, could explain that the practitioners' perceptions of vulnerability were concentrated on pluvial flooding and heat stress. However, all municipal practitioners expressed interest in a broader set of climate risks. Finally, the CAA producers recognized how the interplay of municipalities is often constrained by little budgets. The CAA accommodates for this interplay since the CAA is freely available.

Regarding the **interactions**, it appeared that when creating awareness on climate adaptation (both internal and external to the municipal organization) as well as obtaining budgets were main concerns of municipal practitioners, this could explain the lack of interactions with scientists. This in turn hesitated the co-production of actionable research agendas. More in general, interactions with scientists cannot provide the practitioners with applied information. In contrast, the intermediaries (consultants/CAS) could provide tailored and (more) detailed versions of the CAA through co-production processes with the municipal practitioners. Moreover, the objective of CAS to support local climate adaptation action, could explain that two-way interaction took place between municipal organizations and CAS. Finally, the fact that the CAA was initially co-produced by provincial policy-makers, scientists and consultants, could explain that the CAA included indictors that were generally relevant for strategic policy-making. Implications of these findings are further discussed in the discussion, section 7.2.1.

## 6.2 Usable information: anticipating the environmental vision

This section proposes conditions for usable climate information to address adaptation in the municipal environmental vision. These conditions were identified from the municipal practitioners' approach towards the environmental vision (section 5.2.4), the expectation of practitioners on their climate information needs (section 5.3.2.1), and the general finding on how the context of the CAA producers and municipal practitioners influences information usability (section 6.1). In addition, the outcomes of a discussion with an expert on the environmental law were included (see also Appendix 9.7).

From the above listed sections appeared that how municipalities approach the formulation of the environmental vision is diverse and yet uncertain. While the municipality of Leiden was progressed in the development, and shaped the vision trough collecting a diversity of geospatial information together with regional stakeholders, the other four municipalities were yet exploring and preparing for the vision development; addressing fundamental questions like how should the process be organized and what should be stated in the vision and what in the environmental plan. Some municipalities started with the development of the plan, others started with a participation process. It appeared that the implementation of the environmental law is an iterative and fuzzy process, in which diverse instruments are explored and formulated simultaneously and shape each other. More in general, municipalities have to redesign their (policy-making) processes and are challenged with increased responsibilities; with the implementation of the environmental law municipalities are concerned with increased freedom on environmental and spatial regulations while they need to integrate environmental and spatial policies and lower the amount of regulations. This may put the municipal organization upside down. The practitioners' expectations on the climate information needs to integrate adaptation in the vision were centred on gaining insight in how multiple objectives can be coupled. This corresponds with that the practitioners referred to that applying a systems perspective and an area-oriented approach, as well as engaging citizens and stakeholder are central to the vision development. Since it is highly uncertainty how the implementation of the environmental law influence the climate information needs, no straightforward answers are present. Yet, when taking into

this account uncertainty and the change processes within municipalities to achieve integration, general conditions can be identified for what climate information is usable for the vision according to the usability criteria fit, interplay and interaction. The next sections discuss these conditions and the extent to which these are met with the CAA.

### 6.2.1 Fitting climate information to the environmental vision

#### *6.2.1.1 Facilitate an integrative approach*

As all municipalities adopted or aimed to adopt a systems approach to integrate climate adaptation into the vision, it can be expected that climate information is needed that facilitates these integrative approaches. In the systems approach is aimed to increase knowledge on the natural system. More in general, the environmental law simply demands increased integration of sectorial policy domains. In this context, the practitioners explicated the information need to gain insight in how spatial decisions can contribute to diverse objectives: for example how much does the implementation of green space contribute to the objectives of 'climate adaptation' and 'biodiversity'. Moreover, in context of a strong accountability culture within municipalities there seems to be a need for the quantification of the societal benefits to increase the financial feasibility and social acceptability of adaptation measures. Such information may be needed to gain political support and budget to address adaptation. It thus can be expected that climate information is needed that facilitates an integrative approach that allows for gaining insight in the relations of diverse characteristics of the physical environment.

- Does the CAA facilitate an integrative approach?

The CAA can be expected to facilitate an integrative approach as the CAA data can be combined with other geospatial information on maps.

#### *6.2.1.2 Concurrent climate information for strategic and operational planning*

As the environmental vision is developed in parallel to the plans, and the two instruments shape each other, it can be expected that both climate information to support strategic and operational adaptation planning is needed. Moreover, when it comes to securing adaptation in spatial planning, especially the environmental plan is relevant since the plan includes the legal regulations on the use and development of the municipal area. Hence, climate information to support strategic and operational policy-making are needed at the same time; so that the parallel processes can be provided with information and can strengthen each other in exploring risks and analysing and ranking policy options (e.g. with adaptation policy assessments). Climate information to support the environmental plan may help to sharpen the vision, for example, when knowing the effectiveness of how certain measures contribute to goals of adaptation and other objectives, more concrete climate adaptation ambitions can be formulated on the vision level. Alternatively, when on the vision level is found that specific areas of the municipality are vulnerable to land subsidence, in the plan may be focussed on exploring the implications for the municipal objectives and the associated spatial claims.

- Does the CAA supply climate information for strategic and operational planning?

The CAA can be expected to assist strategic planning since it maps out the climate change vulnerability of the municipal/regional scale. Municipalities can use this information to inspect on the climate change vulnerability and formulate general climate adaptation objectives. For the operational level, the CAA does not provide information to develop a course of action.

#### *6.2.1.3 Climate vulnerability information on multiple levels of scale for stakeholder engagement*

As spatial planning is developing towards applying area-oriented approaches and municipalities aim to engage different stakeholders for climate adaptation on different spatial levels, it can be expected that climate vulnerability information is needed on multiple spatial scales: from region to neighbourhood. More detailed vulnerability analyses are for example needed to support the application of an area-oriented approach, which is based on the specific stakeholders, tasks and objectives of a specific area to guide spatial decisions. Given the rather broad range of potential engaged stakeholders, the specific usability of the information depends on the engaged stakeholders and the goals/tasks to be performed.

- Does the CAA supply climate vulnerability information on multiple levels of scale?

The visual overview that the CAA offers on the climate vulnerability is usable on the regional/municipal level and to engage stakeholders for strategic policy-making. The CAA does not provide neighbourhood level climate vulnerability information.

### 6.2.2 Accommodating for interplays in transition

#### *6.2.2.1 Accommodate for a diversity of interplay*

Due to the heterogeneity in the willingness and ability to search for, adopt and use (scientific) climate information among municipalities, it can be expected that climate information is needed that accommodates for this diversity in interplay. Where in one municipality a beneficial interplay was present to adopt and use system knowledge and climate information, other municipalities seemed yet to be in a transition towards applying integrative working structures. This can be expected to improve the willingness and ability to search for, adopt and use climate information. However the transition does not necessarily mean an increase in scientific climate information demand. Rather, it can be expected that for this transition to happen, municipal practitioners are in search for pragmatic solutions and exchanging experiences on how integrating climate adaptation can be best organised. This need may be further pressured by the more general trend in The Netherlands, where Dutch municipalities are attributed with increased responsibilities. Recognizing that approaches towards adaptation planning and vision development are divers as well as the extent to which political support and financial resources are available, it can be expected that climate information is needed that can support a diversity of interplays. For example when a municipality that aims to increase system knowledge and is exploring how policy domains should be integrated, while concerned with little time and budgets, this municipality may be better served with exchanging experiences with other municipalities to learn how adaptation can be integrated and how organizational and cultural barriers can be overcome.

- Does the CAA accommodate for diverse interplays?

The CAA especially accommodates for municipalities that are willing and able to search for, adopt and use (scientific) climate information and perform general analysis, for example to increase system knowledge. Also as the CAA is freely available, the climate information is accessible for municipalities with little financial resources. However, the CAA does not accommodate for an interplay that is more concerned with determining where and how climate adaptation should be addressed in policy-making. While the knowledge portal, in which the CAA web-viewer is embedded, provides practical examples of climate adaptation and supports exchanges between the users, this concerns formal exchanges while practitioners may benefit from more informal exchanges.

### 6.2.3 Interactions with scientists and consultants

#### *6.2.3.1 Information that is tailor-able and usable for consultants*

As intermediaries, such as consultants, often play an important role in increasing the usability of climate information by tailing the information to the specific municipal context, it can be expected that information should be usable for consultants. In contrast to scientists, consultants can provide the practitioners with pragmatic climate information that is tailored to their specific municipal area, including local geospatial information representing for example municipal objectives. Simultaneously, in the implementation of the environmental law and the associated challenges, consultants may become even more important actors to support the formulation of the instruments of the law and/or to guide the organizational change process. For climate information to be usable, it can be expected that it is important that consultants have access to climate information that they can tailor.

- Is the CAA tailor-able and usable for consultants?

The CAA is tailor-able and can be used by consultants, as it is editable and can be combined with other products and geospatial information.

#### *6.2.3.2 Designing actionable research agendas for 'integrative spatial planning'*

Due to the lack of interactions between municipal practitioners and scientists, it can be expected that the formulation of actionable research agendas is constrained, while knowledge is needed for policy-makers to deal with the challenge of integrating divers sectors and objectives (including adaptation). It

was found that municipalities are challenged not only to address climate adaptation in spatial planning, but to balance and weigh a wider set of objectives that are promoted by a diversity of stakeholders in spatial planning. While municipal practitioners expressed the need to quantify objectives and impacts to remain legitimate authorities, many of these (often social) objectives are difficult to measures (e.g. environmental quality) or need extensive calculation (e.g. how many trees to decrease urban heat stress?). The finding that little interactions take place between municipal practitioners and scientists, hesitates mutual learning on the concurrent climate information needs of municipalities and the (im) possibilities of science. Interactions are needed to allow that research agenda include the issue of how the objective of integration in spatial planning can be operationalized, and for the practitioners to gain insight into the limits of quantification.

- Does the CAA facilitate the formulating of actionable research agenda?

The use of the CAA does not facilitate the interaction between scientists and municipal practitioners. While the CAA producers are informed on user needs through boundary organization CAS, no direct exchanges take place.

### 6.2.4 Conclusion Q5

With section 6.2, sub-question 5, can be answered. Recalling sub-question 5:

*What conditions for usable climate information can be identified for addressing climate adaptation in the municipal environmental vision and to what extent are these conditions met with the CAA?*

Six conditions were identified that may increase the usability of climate information for the environmental vision. Contrasting these conditions with the CAA revealed to what extent the CAA could fulfil these conditions; the findings are summarized in Table 6.1.

**Table 6.1: Summary sub-question 5**

| Condition for usable climate information to support the formulation of the environmental vision | Does CAA meet the condition? |
|---|---|
| Facilitate an integrative approach | Yes, the maps can be easily combined with spatial information from divers policy domains. |
| Concurrent climate information for strategic and operational planning | Partly, the CAA only provides climate vulnerability information for strategic planning. |
| Climate vulnerability information on multiple levels of scale for stakeholder engagement | Partly, the CAA provides a visual overview of the vulnerability on the regional/municipal scale, which allows engaging stakeholders in strategic policy-making. |
| Accommodating for a diversity of interplays | Partly, the CAA accommodates especially for municipalities that are willing and able to use climate information and perform general vulnerability analyses, e.g. by increasing system knowledge. Moreover, the freely available CAA accommodates for municipalities with little financial resources. The CAA does not accommodate exchanging practical experiences. |
| Climate information that is tailor-able and usable for consultants | Yes, CAA is tailor-able and can be used by consultants, as it is editable and can be combined with local geospatial information and products of consultants |
| Designing actionable research agendas for 'integrative spatial planning' | No, the CAA does not facilitate interactions between scientists and municipal practitioners. |

# 7 Conclusion, discussion and recommendations

## 7.1 Answering the research question

Recalling the research question:

*Which factors determine the usability of the CAA climate information tool to support municipal practitioners in local adaptation planning and how can this be expected to develop anticipating the upcoming policy instrument 'the environmental vision?*

This question can be split up into two parts, starting with answering the first part:

*Which factors determine the usability of the CAA climate information tool to support municipal practitioners in local adaptation planning […]?*

Literature review revealed that the factors of *fit*, *interplay* and *interaction* determine the usability of climate information for municipal practitioners. The usability can be explained with how municipal practitioners pursue adaptation planning and spatial vision development and how the CAA producers pursue the development of climate information. In the studied municipalities divers levels of awareness and political support were found for adaptation planning, in which most practitioners had to make substantial efforts to push adaptation (further) on the agenda. In doing so, the prevailing accountability culture directed the perceived climate information needs of the practitioners towards specific and detailed information; not only to map the municipal vulnerability but also to identify potential solutions, costs and (co) benefits of taking action. All practitioners adopted or aimed to adopt a systems perspective towards spatial planning and integrating climate adaptation. This ambition was reflected in efforts to restructure different policy sectors (water, soil, green, spatial development) according integrative themes. However, the municipalities were yet exploring how they could best integrate adaptation in spatial planning and were concerned with limited time and resources.

The municipal context could explain that the CAA was especially usable for 'the first step' of addressing adaptation, where the practitioners could gain insight in the climate vulnerability and demonstrate the urgency to address adaptation. Moreover, the CAA could support the adoption of systems approaches that are focussed on increasing system knowledge, since the CAA could easily be combined with other local geospatial information on maps. The CAA producers, comprising of scientists, consultants and later on boundary organization CAS, co-produced the CAA with provincial policy-makers, which could explain that the CAA maps were mainly usable on the regional and municipal level. And while all CAA producers were familiar with the municipal context and the corresponding information needs, especially the consultants and CAS played an important role in the adoption and use of the CAA by municipalities. These intermediaries dispose of the right capabilities to interact with municipalities and offer applied and tailored information; consequently this explained the lack of interactions between practitioners and scientists. Taken together, six (interrelated) factors were identified that determine the usability of the CAA:

**1) Visual overview of municipal vulnerability *(fit)***
The CAA maps out the general climate vulnerability for a specific regional or municipal area, which allows municipal practitioners to gain an understanding of how the complex problem of climate change manifests in their municipal region. Moreover, it allows the practitioners to communicate on the problem within the municipal organization, increase awareness and generate a sense of urgency. Hence the CAA succeeds to communicate on climate change vulnerability in an easily understandable manner by visualising the imminent climate change risks of the specific area the practitioner is interested in. Using easily accessible visuals at relevant scales is as a critical way to build capacity for adaptation planning on the local scale (Shaw et al., 2009). Yet, the CAA does not succeed to supply climate information that provides insight in the vulnerability on the neighbourhood level or support the formulation of policy options. Such information is necessary to engage citizens, further shape climate

adaptation ambitions and obtain political support. Having access to action-oriented information is an important factor to support adaptation on the municipal level to be able to advocate for adaptation resources and funding (Graham & Mitchell, 2016). Also, the CAA does not provide insight in the mechanisms that underlie the climate change risks neither does it provide guidance on the extent to which the data can be trusted for (spatial) decision-making. Users often perceive that reducing uncertainties and/or better communication of uncertainties improves the usability of climate information, yet this is problematic since uncertainties are inherent to climate information and the effectiveness of adaptation strategies (Kiem et al., 2014). The municipal practitioners hesitated to use the CAA for more than identifying general climate change risks and were occupied with the belief that detailed climate information is needed to take the next step. This suggests that if the producers of the CAA aim to make the CAA usable for taking 'the next step', explanation and guidance is needed for the municipal practitioners to be able to do so. Yet this is not easy, taking into account a strong accountability culture within municipalities. Kiem et al. (2014) suggest that users should be better educated on the uncertainties in climate research.

**2) Tailor-able *(fit)***
The CAA data is available in a GIS format, which allows that the CAA data can be easily combined with other (local) geospatial information, which in turn supports municipal practitioners to relate climate vulnerability to spatial planning tasks and identify potential problems and opportunities for adaptation planning in their specific area. This results in tailored information that is relevant to the practitioners at hand. Making general global climate change information tangible and relevant to the local context and the specific user needs is important to make the information usable to the user at hand (e.g. see Kiem et al., 2014; Lemos et al., 2012; Räsänen et al., 2017; Shaw et al., 2009). Consultants and boundary organization CAS are important actors in this process, where they facilitate the tailoring process by collecting and combining CAA data, local geospatial information as well as specialised products of the consultants. Hence the CAA succeeds to supply practitioners and/or consultants with climate vulnerability information that can be further tailored with local knowledge and information.

**3) Cross-sectorial *(interplay)***
The CAA provides comprehensive and scientific climate information that can be used to perform vulnerability analyses. This accommodates for an interplay that is characterised by working according to integrative structures crossing sectorial policy domains. Such municipal organizations may have political support for the application of integrative planning processes and the ambition to increase system knowledge of the municipal area. The CAA presents for all the four risk themes (drought, heat, pluvial flooding and flooding) a broad range of relevant impacts to inquire on. By combining the CAA data with local geospatial information from the sectorial policy domains, the practitioners can relate the climate risks to a diversity of policy domains. For example the risk theme of 'heat', may be relevant to both green management and water policies. A barrier that may need to be overcome to achieve integrative ways of working and analysing information from diverse sectors is that local geospatial information in and among municipal organizations often is not well organized. Furthermore, for municipalities that seek for pragmatic insights on *how* to integrate climate adaptation into spatial planning, the four risks themes provide only a weak link to the policy processes. Hence, practitioners may not recognize how these risk themes relate to the municipal planning processes. Also, the CAA does not accommodate an interplay that is focussed on exchanging experiences and learning on pragmatic solutions with regard to adaptation and overcoming organizational barriers. Taken together, the CAA succeeds to supply climate information that can be applied in cross-sectorial approaches towards adaptation and spatial planning.

**4) Freely available *(interplay)***
The CAA data is freely available and with this accommodates for an interplay that is characterised by limited resources. A lack of financial resources is a main barrier to access climate information for the purpose of adaptation planning on the local level (Archie et al., 2014). Moreover, access to climate information on what to adapt to, is one of the pre-conditions for successful adaptation (Füssel & Klein, 2006), as was stated in the introduction.

**5) Co-developed *(interaction)***
The CAA was co-produced by scientists and provincial policy-makers, which yielded maps that were relevant to support the formulation of spatial development strategies. In the co-production process, the scientists and policy-makers gained mutual understanding on the (im)possibilities of climate information development and its use, which allowed to identify climate (vulnerability) indicators that are generally relevant for strategic spatial policy-making. Co-production processes may increase the chance that the climate information is accepted and used by the policy-makers, for example because the legitimacy of the information increases and more relevant information is selected (Meadow et al., 2015). However, the co-production process did not allow for the collective formulation of scientific research agendas, rather the best available climate information was translated to the policy-makers' needs. Hence there was no direct feedback to climate change research and it relevance for local policy-making, hesitating the chance that actionable science is produced (Meadow et al., 2015; Sarewitz & Pielke, 2007). The discussion (section 7.2) elaborates on this point.

**6) Co-(prod)used *(interaction)***
In the use of the CAA by municipal practitioners, the CAA was often further co-produced together with intermediaries (CAS or consultants). This allowed the practitioners to be supplied with scientific climate information that is specified for the municipal area and that is accompanied with explanation and guidance. This co-production process leverages the usability by increasing the legitimacy of the produced information, not only with regard to the scientific climate information, but the entirety of information that is brought together by diverse municipal practitioners or other engaged stakeholders. Combining the general climate information with local geospatial information of diverse stakeholders facilitates collaboration among these stakeholders by the creation of a shared knowledge base. Co-production processes of climate information can increase the perceived legitimacy and relevancy through the creation of a sense of ownership (Robinson & Tansey, 2006). Moreover, decision-making processes that include diverse stakeholders may increase the legitimacy of the decision and improve the cost effectiveness of the decision (McNie, 2007). Hence the CAA allows to be tailored through co-production processes between municipal practitioners and intermediaries.

Continuing to answering the second part of the question:

*[…]and how can this be expected to develop anticipating the upcoming policy instrument 'the environmental vision?*

In general, the CAA is a promising tool to support the inclusion of adaptation in the environmental vision by providing insight in the climate vulnerability, yet municipalities also need support on *how* climate adaptation can be integrated in (strategic) policies. This research revealed how there is yet a great diversity in progression and starting themes of the environmental vision among municipalities. More in general, the implementation of the environmental law is a process that is associated with many uncertainties and demands large organizational efforts. Municipalities are attributed with increased freedom and responsibilities in spatial planning and environmental policies. In the preparation of the law, municipalities are exploring different instruments of this law simultaneously. While the environmental vision is meant to steer the environmental plans and programmes, strategic (environmental vision) and operational plans (environmental plan) are developed in parallel and moreover shape each other. Exploring and shaping the different instruments is accompanied with processes of reorganization, in which municipalities are seeking to integrate divers policy sectors mutually as well as to integrate adaptation in diverse policy domains. Furthermore, participation and applying an area-oriented approach are central to the vision development. Taken together, it is highly uncertain how information needs will develop and this may moreover differ among municipalities. Yet, general implications can be identified for the *fit*, *interplay* and *interaction* and thereby the usability of the CAA to support the integration of adaptation in the vision:

**Integration, stakeholder engagement and concurrent strategic and operation planning *(fit)***
For the environmental vision, it can be expected that climate information must fit cross-sectorial policy-making processes, the simultaneous processes of strategic and operational policy-making, and the engagement of stakeholders on diverse spatial scales. The CAA can be expected to fit these needs to a certain extent. As the CAA can be applied for cross-sectorial approaches the CAA fits the

formulation of integrated policies. Yet due to the level of detail, the CAA can only support strategic levels of adaptation planning, consequently the CAA is mostly appropriate for engagement of stakeholders in strategic processes; for example the engagement of local institutes such as the water board, or engaging citizens in the formulation of the environmental vision. Furthermore, the usability of the CAA for the environmental vision may depend on the extent to which also usable climate information is available for the environmental plans, since the two instruments are formulated in parallel and shape each other. More detailed vulnerability information to support the analysis and ranking of policy-options may be needed for this. A strong accountability culture within municipalities directs the information needs towards detailed and quantified indications of climate vulnerability and the potential (integrative) solutions.

**Organizational change *(interplay)***
The interplay of municipal organizations is divers, yet municipalities are transforming towards more integrative organizational structures, which may increase the willingness and ability to adopt and use climate information in general. The CAA can accommodate for such integrative working structures as it can be tailored and applied in cross-sectorial settings as explained above. Yet, the transition towards integrative organizational structures is accompanied with increased responsibility and freedom with regard to spatial planning, while the amount of regulations must be reduced. Therefore it can be expected that practitioners are especially interested in information or knowledge that assists them in *how* the integration of policy sectors can be achieved best, and how climate adaptation can be included in integrative policies. Such needs may be met for example by exchanging experiences on organizational change processes, for example how cultural and financial barriers can be overcome to accomplish cross-sectorial structures. For the exchange of such knowledge the CAA does not accommodate, rather the tool can be used to facilitate strategic and cross-sectorial policy-making processes. Furthermore, it can be expected that with the challenges that municipalities are confronted with, the time and budgets available to inquire on climate information will be even more pressured; hence the fact that the CAA is freely available may become increasingly important.

**Co-production for spatial planning and actionable science** *(interaction)*
With consultants playing an important role in supporting municipalities to address climate adaptation, it can be expected that with the implementation of the environmental law, consultants may maintain performing an important role. Consultants may not only support municipalities to address climate adaptation by gaining insight in the climate vulnerability, but may also support the process of integrating climate adaptation in the diverse policy sectors. As the CAA is tailor-able and usable for consultants, the CAA may be a relevant input of climate information in the development of the environmental vision. Furthermore, the municipal practitioners' needs for climate information may develop towards more guidance and support on how adaptation can be integrated in diverse policy domains and how policy options can be formulated. Therefore research is needed on how this can be accomplished: how can diverse objectives be coupled and how can spatial decisions be made while balancing a diversity of interests. The CAA does not facilitate for interactions between scientists and municipal practitioners that lead to the formulation of actionable research agenda to address this issue.

## 7.2 Discussion

Science-policy interfaces aim to bridge the gap between science and policy by enriching decision-making with decisions that are well informed on the issue at hand, the associated interests and the potential solutions (Van Enst et al., 2014). This research aimed to gain insight in how the performance of the science-policy interface between climate change research and local adaptation planning to produce usable climate information can be improved. Therefore the usability of the Climate Adaptation Atlas (CAA) for Dutch municipal practitioners was evaluated and explained for two applications: local adaptation planning and the formulation of the environmental vision. The findings of this research do not only contribute to the identification of the factors that determine the usability of the CAA, but also yield more general insights about the usability of climate information and how the usability is influenced by the dynamics in the science-policy interface. Firstly, this section discusses how this research contributed to the debate on the performance on science-policy interfaces. Thereafter is reflected on the research approach and the extent to which it helped to achieve practical and theoretical insights. Finally, suggestions for future research are provided.

### 7.2.1 Reflecting on science-policy interface literature

This research addressed the knowledge gap indicated by Van Enst et al. (2014) regarding the influence of social, economic and political dynamics and other contextual factors on the performance of science-policy interfaces to produce usable climate information. Exposing both sides of the science-policy interface, this research shed light on an empirical case of climate information development and its application by local policy-makers: the usability of the CAA tool for Dutch municipal practitioners. The next paragraphs discuss the four main contributions to the knowledge gap and regard:

1) The influence of the organizational structure of municipal organizations on the ability to adopt and use (scientific) climate information.
2) The tension between the desire of municipal practitioners to apply a systems perspective and the present accountability culture.
3) The interrelatedness between often-found barriers in municipalities to address climate adaptation and the ability to adopt and use climate information.
4) The interactions between diverse actors in the science-policy interface and how these interactions contribute to the usability of climate information. A suggestion is made to advance the understanding of co-production processes.

*Integrated organizational structure*

A first contribution is that the organizational structure of municipalities may be determining for the type of knowledge or information that is used as this structure influences the willingness and ability to search for, adopt and use certain knowledge (*interplay*). By evaluating the interplay of municipal organizations, this research showed that municipalities that work according to integrated organizational structures have a beneficial interplay to search for, adopt and use climate information. The aim for integrated (or 'cross-sectorial') working structures is to increase collaboration between diverse sectorial domains (e.g. spatial planning and environmental departments) and to couple objectives among these domains. For example, when climate adaptation objectives are coupled to biodiversity goals. Integration is especially relevant for the adoption of climate information, since adapting to climate change relates to many sectors such as water management, green management and health. Having political support for integrative ways of working is critical since it demands the reorganization of sectorial budgets. The ambition for integration between sectorial domains is a broader trend among Dutch municipalities, yet this 'integration' is also recognized as a 'buzzword'; municipal practitioners are struggling with how this integration can and should be achieved (expert I & II, Appendix 9.8). Moreover, the ambition to couple multiple objectives resonates with a strong 'efficiency rationale' that prevails in (local) governmental bodies. Efficient coupling increases the chance that climate adaptation gains political support (ibid).

The aim and efforts for integrating adaptation in diverse policy domains is not only a trend in Dutch municipalities, but is found in municipalities all over the world. A survey among 350 municipalities in

Canada, Europe, Australia & New Zeeland, Africa, Asia and the U.S. showed that adaptation is being increasingly integrated in existing policy domains (Aylett, 2015). Moreover, building collaborative networks between different municipal departments was found as one of the most effective tactics to integrate adaptation into different sectors (ibid). Also the need for political support for integrated ways of working was demonstrated in other studies. A study of Norwegian municipalities showed that cross-sectorial ways of working requires efforts of diverse municipal practitioners and substantial resources, hence approval and support from 'above' is needed (Rauken, Mydske, & Winsvold, 2015). However, it was also found that among municipalities around the world only specific policy sectors are making efforts to integrate adaptation, such as the environmental agencies and planning departments. Other domains are lacking behind, such as wastewater and health (Aylett, 2015). In the Netherlands, the environmental law demands the integration of a diversity of spatial and environmental regulations, including for example wastewater. Hence in the Netherlands, integration is not only a voluntary objective but also a requirement by the national government. This increases the chance that if adaptation is integrated in the instruments of environmental law, adaptation is integrated in diverse sectors. Moreover Dutch municipalities are concerned with increased responsibilities and decision-making power when it comes to the use and development of the spatial environment (Expert I, Appendix 9.7). Spatial planning reforms that include decentralisation of responsibilities, simplifying planning regulations and area-based development are not are not unique for the Netherlands, but are found in other European countries (Roodbol-Mekkes & van den Brink, 2015).

*Tension between applying a systems approach and the prevailing accountability culture*

A second contribution is that a promotional and proximal frame towards climate adaptation seems to constrain the practitioners' desire to apply an integrative systems perspective. This point builds further on the first discussion point, since the transition towards applying cross-sectorial working structures resonates with the desire of municipal practitioners to apply a systems perspective. This research showed that all practitioners revealed a *proximal* (hence not *distal*) and *promotional* (hence not *preventive*) view on climate adaptation, which are characterised by regarding adaptation as a nearby and context specific issue, focussing on gaining positives outcomes respectively (de Boer et al., 2010). Apart from this 'frame', the practitioners aim to address adaptation by applying a systems perspective. The systems perspective regards the dynamics and characteristics in the natural and social system as one coherent system. Hence, applying a systems perspective may be focussed on identifying relationships among sectorial policy domains, to understand the natural system and its relations to objectives from the social system. However, the complexity of this system is unlikely to be comprehended and understood in detail as there are large uncertainties in both science (cause-effect relations) and political (agreement of preferences among stakeholders). The application of a systems approach could therefore be best operationalized using an *inspirational strategy* as discussed by De Boer et al. (2010), focussing on stakeholder engagement and learning.

However, here the discrepancy emerges. Inspirational strategies are especially appropriate for promotional but *distal* views to adaptation (ibid). Yet, the accountability culture within municipalities as found in this research, drive practitioners to a *proximal* view and direct their information needs to 'detail' and 'quantification'. For example, the practitioners explicated the need to know the climate impacts on the street level. Or the practitioners needed to now how much a certain intervention exactly contributes to the objectives of health, climate adaptation and nature. This accountability culture may relate to what Rothstein et al. (2006) refer to as 'the risks of risk management', as discussed in the introduction. Municipal practitioners are accountable the municipal administration (aldermen and mayor). The administration is accountable to the municipal council; the municipal council is in turn accountable to the citizens. Hence the application of an inspirational strategy is new and is associated with risks for the municipal practitioners as well as local level political actors. Municipalities are challenged to seek for new ways of collaboration and policy-making. The mismatch between frame and strategy, suggest that either climate adaptation should be framed differently or that another strategy should be applied.

*Relations between barriers to address climate adaptation*

A third contribution is that the prioritization of climate adaptation within municipalities may influence the willingness and ability to search for, adopt and use (scientific) climate information. Literature identified a range of barriers to address climate adaptation on the local level, often including little

awareness, limited budgets, lacking political support and a lack of relevant information (e.g. see Archie et al., 2014; Runhaar et al., 2012; Uittenbroek et al., 2013). However, the dynamics in the organizational context, such as the relationships between these barriers have not been well researched. This research suggests that there is a relationship between a lack of political support, little awareness and limited budgets to search for, adopts, and use climate information. Municipal practitioners need detailed climate vulnerability analyses to increase awareness and demonstrate the urgency to obtain budgets, while in the first place budgets are needed to perform detailed vulnerability analyses. While Archie et al. (2014) found that practitioners often perceive the lack of financial resources to be the main barrier when concerned with little political support, the practitioners in this research explicitly appointed the relation between the two. Moreover, this research showed that the municipal practitioners that were occupied with increasing the prioritization of adaptation within the organization, rather inquired on information by interacting with local stakeholders and networks (e.g. with the water board or other municipalities). Mechanisms of exchanging on climate information for adaptation through local networks were also found among local level officials in the U.S. (Archie et al., 2014).

*Reconsidering science – policy interactions and co-production processes*

The fourth and final contribution is that usable climate information may be produced despite the lack of incentives of the local policy-making community and the scientific community to interact. This research showed how both municipal practitioners and scientists do not have the incentives to perform projects on climate adaptation together. Scientists have the primary task to perform research and may even be constrained to participate in projects by the requirement that all projects should include research. Municipalities on the other hand, have only little budgets and research projects are associated with uncertain outcomes that are unlikely to be specific and directly applicable for their municipal area. This lack of incentives is present for other science-policy interfaces in the Netherlands that regard climate adaptation (expert IV; see Appendix 9.9). Yet, problems in producing usable climate information are attributed to lacking interactions between the scientific and policy-making community all over the world (e.g. see WMO, 2011). While this insight is not new, the specific incentives (or disincentives) may be context dependent and differ across countries, for example due to different funding structures. Even though national research grants in The Netherlands are increasingly demanding scientists to connect their research to practice, this 'use-inspired' research is often formulated from a scientist's perspective rather than that research questions emerge bottom-up from policy-makers (expert IV; see Appendix 9.9). The lack of (incentives for) interactions between scientists and municipal practitioners are problematic for the widely advocated strategy of knowledge co-production to produce usable information (e.g. see Cash et al., 2003; Hegger & Dieperink, 2015; McNie, 2007, 2013). While literature on science-policy interfaces appoint interactions between scientists and policy-makers as a factor that determines success (Lemos et al., 2012), the study of the CAA showed that usable information can be produced despite (direct) interactions between the municipal practitioners and scientists.

The CAA was developed in a participatory process by scientists, regional policy-makers and consultants and resulted in a climate information tool with relevant climate impacts and vulnerability indicators to support strategic spatial planning. Through the years, the CAA was further developed and updated by a boundary organization that was established to continue to guide the participatory development process. This increased the usability of the tool for local and regional policy-making. In the use of this tool by municipal practitioners, consultants or boundary organization CAS further co-produce the general climate information from the tool by adding local knowledge and information as well as commercial products from the consultants. Through this co-production tailoring process, the usability of the general climate information of the CAA is leveraged. By engaging consultants as well as municipalities in the update process of the tool, experiences were back linked to the boundary organization and the scientists.

Hence, when municipal practitioners use the CAA, the information is further co-produced, yet not with scientists but with intermediaries. Thereby this research does not only show how science-policy interfaces can be enabled or constrained by their specific contexts to interact or adopt and use information. It also enhances the understanding of how specific co-production processes can produce usable climate information. Reconsidering the 'interaction' factor as a criterion for usability, a better

explanation can be found for the usability when differentiating between levels and actors of co-production processes.

Based on the findings of this research, the concept of co-production can be conceptualised along three levels and including four types of actors as depicted in Figure 7.1. While the first level corresponds with the prescribed interactions between scientists and policy-makers to generate usable climate information, the second and third levels are descriptions of interactions that were found in this research that produced usable climate information. All levels of co-production may contribute to the usability of climate information to policy-makers. The conceptualisation is suggested as better way to co-produce usable information and hence also as a better way to evaluate the extent to which interactions lead to usable climate information. This conceptualisation better accounts for the context in which both the scientists and policy-makers operate. Rather than propagating the process of co-production between the actors that generally have little incentives to co-produce information in projects, the existing and well-working infrastructures of information and knowledge are exploited.

The levels of co-production comprise of:

1) Determining research agendas
2) Translating research outcomes to (generally) relevant policy-making units
3) Tailoring the general units to the specific user needs.

The actors comprise of scientists, policy-makers and two types of intermediaries: consultants and (a) boundary organization(s).

The first level of co-production concerns the formulation of research agendas, in which decisions are made on research topics, designs and outcomes. The inclusion of policy-makers in this process may advance that decisions are made that in general yield more actionable science, for example because it takes into account specific sectors or mechanisms that the policy-makers are interested in. This co-production process may be leveraged if policy-makers with diverse backgrounds are engaged as well as other local actors that have demands for actionable climate information such as insurance companies, health officials, farmers and nature organizations. Especially in the formulation of research agenda this may be important, as single policy makers may have restricted ideas of what kinds of policies would be necessary to deal with climate change (Sarewitz & Pielke, 2007).

On the second level of co-production, climate change research outcomes are further co-produced by scientists and policy-makers, by exploring how the outcomes may be relevant for developing policies. Such efforts involve for example the selection of appropriate indicators to analyse climate vulnerability or to monitor the effectiveness of climate adaptation efforts. In this co-production process, the focus is on increasing mutual understanding. Scientists may learn on the policy-making context and the specific functions that are to be fulfilled. Policy-makers on the other hand, may learn on the manner in which climate information can be used in decision-making taking into account the limits of science. The outcomes are climate information tools or decision-support methods that can be regarded as generally usable to the policy-making context. The process of co-production may be guided by boundary organizations. Moreover, the boundary organization can disclose the tools and decision-support methods to society, for example through a knowledge portal.

On the third level of co-production, the generally usable climate information produced on the second level is further co-produced by the policy-makers that aim to use the information, together with intermediaries. For example, combining general climate information with geospatial information on local spatial characteristics, experiences and local objectives may tailor the general climate information to the users' needs. Consultants may moreover combine the general climate information with their own applied products.

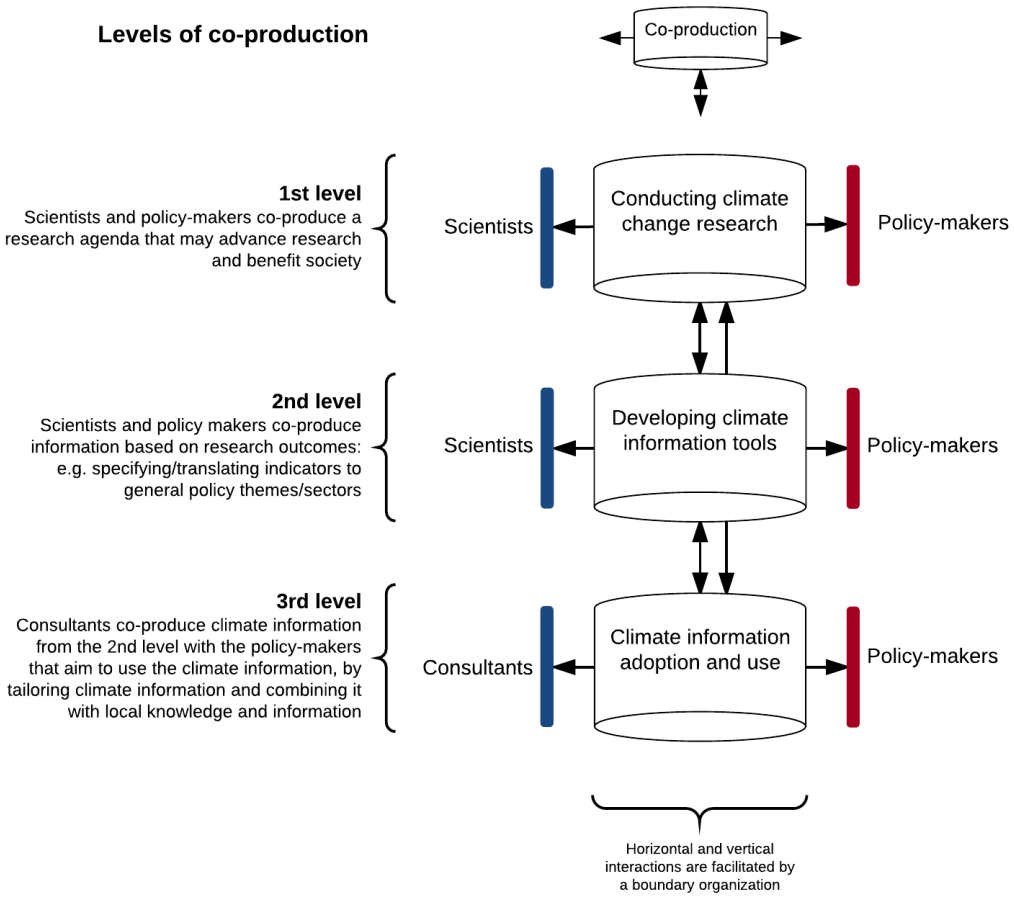



**Figure 7.1: Levels of co-production**

On the first two levels, interactions between scientists and policy-makers take place, while in the third stage scientists are not involved. In the third level rather consultants and boundary organizations play an important role. Boundary organizations may fulfil an important role in securing that the co-production processes take place (horizontal arrows). As independent actors, yet accountable to both the scientific and policy-making community, boundary organizations can moreover secure that insights from co-production processes are exchanged mutually among levels (vertical arrows). To perform a role as suggested above, a critical success factor is that the scientists, consultants and policy-makers perceive the boundary organization as a legitimate actor. Indeed, successful co-production processes benefit from trust among participants. Moreover the willingness to participate in co-production may depend on the extent to which the scientists perceive the disclosed climate information as credible, and the extent to which the policy-makers perceive the climate information as relevant (Graham & Mitchell, 2016). Yet, operating at the boundary between science and policy, and being perceived as a legitimate actor may be a challenge. It includes careful considerations with regard to when what role is taken. Moreover obtaining funding for boundary organizations is not straightforward (expert IV, see Appendix 9.9). Hence, a legitimate boundary organization with sufficient funding is necessary to facilitate and secure the co-production processes.

The conceptualization above suggests that the beneficiaries of co-production processes in the science-policy interface can be accomplished by diverse ways of co-production processes and with diverse actors. The three levels of co-production, and the vertical exchanges between them, may contribute to building trust and legitimacy between the policy and scientific community. This in turn increases the chance that these interactions direct research agenda in more applied directions, and yield more applied climate information tools. Moreover, users can learn on what research has to offer, and how the outcomes can be used. Increasing mutual understanding on possibilities and needs of science and policy can be direct or indirect through boundary organizations and consultants. Especially by attributing consultants a more explicit role in these processes, allows to benefit from the present infrastructures on information development and exchange.

While not indicated in the figure, consultants may also interact with scientists, as consultants aim to use scientific insights to develop applied products and fulfil their clients' needs. Such processes do not need to compete with the second level of co-production, but rather may complement each other. Co-production processes between policy-makers and scientists may be oriented towards the identification of relevant sectors and areas to relate future climate parameters to. Consultants on the other hand may be inclined to develop the models and methods to use such insights in making specific and detailed calculations for specific areas. However, providing consultants with an intermediary role in science-policy interfaces also comes with some implications as they have a significant influence on what and how climate information is used within municipalities. While especially consultants are the actors that are driven to fulfil the municipalities' needs, consultants are also driven to promote the use of their own commercial products. This does not need to be a bad thing. However, when municipalities have little budgets and limited awareness on the range of climate risks, the used climate information may be biased towards the consultancies' expertise and the municipal practitioners' awareness on climate change risk themes. This research showed how risks related to extreme precipitation and heat were often were best mapped out. Hence the objectives of scientists to provide rather comprehensive information may be lost in the consultants' application.

It can be expected that the co-production of generally usable climate information between scientists and policy-makers (2nd level), that can be further tailored to the specific and concurrent user needs (3rd level), is relevant for climate information development in other parts of the world. While climate change impacts can be similar in different regions, the vulnerability is inherently divers at the local level where climate adaptation action must take place. This is mainly because the vulnerability depends on the specific spatial structure and characteristics of the area, the local population and the objectives that are being pursued. Moreover, apart from the content of the climate information, usability remains dependent on the specific actors aim to use the information. Hence co-producing climate information that is tailor-able, flexible and can be supplied in modular units, corresponds with the general insights of literature on usable climate information, that tailoring climate information accommodates for the diversity in perceptions, capacities and characteristics that impact comprehension (Lorenz et al., 2015).

### 7.2.2 Reflecting on the research approach

*Internal validity*
As explained in the previous section, by studying the scientists, intermediaries and (potential) users of one case of a science-policy interface, much was learned on the interactions between those actors and the usability of climate information. Visiting these actors in their organizations and speaking with them in interviews that often lasted 1.5 to 2 hours provided rich data about their approaches, experiences and perceptions. In studying both sides of the science-policy interface, especially the municipal contexts appeared to be rather complex. While the extensive evaluative and analytical framework appeared helpful to start structuring the diverse and rich information that the interviews yielded, it also appeared that the contexts of municipalities are not easy to capture. This was reflected in the description of the users' context, where the distinct analytical factors were often closely related.

Using the factors of fit, interplay and interaction appeared useful to connect contextual factors to the found usability, as illustrated in the previous section. Measuring the usability criteria through interviews appeared especially appropriate for evaluating the fit and interactions. Fit could simply be evaluated through inquiring on the practitioners' perceptions of the usability of the CAA, and interactions could be evaluated through inquiring on how often and in what kind of relationships the actors would interact. However, the criterion of interplay, which is about the willingness and ability to adopt new information, is not only about individual perceptions, but relates to the context in which the practitioners operate. Instead of interviewing the practitioners on how they perceive this context, ideally a more objective way of measuring is applied. For example, the driver 'flexible decision-making structures' - which refers to the extent that organizational routines are open to change - may be better measured by interviewing a larger amount of practitioners for each municipality, which now ranged from n=1 to n=5. Yet interviewing more practitioners was outside the scope of this research.

Furthermore, a setback was that there was little grey literature available on the municipal approaches to adaptation and the environmental vision, except for some showcases that explained how climate adaptation was taken into account in a specific planning project. However, since the focus of this research was on sketching how practitioners evaluate the usability of climate information, it can be argued that it was more important to gain insight in the practitioners' perceptions and knowledge on how the municipality deals with adaptation and climate information, than aiming for a factual representation of the municipalities' processes. However, it was aimed to sketch a truthful picture of a set of practitioners in their municipal context.

*External validity*

The findings of this research apply to the CAA science-policy interface, which is a specific case of a science-policy interface that regards scientists from national research institutes and municipal practitioners from five medium-sized municipalities, as well as consultants and a boundary organization. Moreover, the studied case concerned a specific type of climate information: a tool to map regional or local climate vulnerability. Expert discussions provided insight into the generalizability of the findings for other (medium-sized) municipalities in the Netherlands. In general, the experts recognized the findings on the municipal practitioners, the scientists and the mechanisms in the science-policy interface as found in this research; for example that finding that municipal practitioners are often concerned with increasing internal awareness and obtaining political support was widely recognized. The outcomes of the expert discussions were integrated in section 7.2.1, reports of the discussion can be found in see Appendix 9.7, 9.8 and 9.9.

While the findings may be valid for this specific case, it can be expected that the findings on the importance of contextual factors on the production and use of climate information is also relevant for municipalities in other countries (as discussed in section 7.2.1), for other types of science-policy interface problems such as the strategic use of climate information (Van Enst et al., 2014), for other types of climate information (e.g. policy assessments), and for other stages in the adaptation process (e.g. implementation and monitoring). Yet, how the specific contextual factors influence the performance of the science-policy can be expected to remain, unsurprisingly, context-specific. Still, certain mechanisms between contextual factors may be more generally applicable. And gaining insight into the contextual factors and the mechanisms is crucial for understanding why certain climate information is usable (or not) and how this can be improved. For a further discussion on the external validity of this research see the methods chapter; section 3.4.

*How conducting research at CAS influenced this research*

This research was performed at boundary organization CAS, to evaluate the CAA tool and to research how the usability of this tool may develop anticipating the new spatial planning law in the Netherlands. However, this research was not simply commissioned by CAS, rather the research topic was determined by the researcher. Through several explorative meetings with diverse research institutes and organizations, an appropriate case study was found for this research at CAS. The suggestion from CAS to regard the implementation of the environmental law helped to narrow down the scope of this research. Both the researcher and commissioning party could benefit from this research. On the one hand, evaluating the CAA provided an empirical case for the research, on the other hand it could yield practical insights for the update process of the CAA, which was performed in the same period as this research. The parallel process of the update and this research allowed the researcher to attend a diversity of meetings and informal discussions, which in turn supported to generate a feeling of how the interactions between divers actors in the science-policy interface take place (see Appendix 9.2 for an list of attended meetings). Also, the parallel processes allowed for exchanges of preliminary findings and for testing expectations that developed along the update process. For example, one expectation that emerged was that municipal practitioners need especially more applied indicators to value the CAA as usable. To test such expectations a list of indicators was established and included in the interviews to direct the discussions towards the usability of specific indicators. Finally, since organization CAS is responsible for maintaining the knowledge portal on spatial climate adaptation, much knowledge was available on climate adaptation projects and the political context. Performing this research at CAS allowed that this knowledge could be easily accessed which otherwise would not have been possible.

### 7.2.3 Future research

This research provided insight into how contextual factors the performance of science-policy interfaces influence to produce usable climate information for adaptation planning. Several suggestions for future research can be made. Firstly, to further increase an understanding of the diversity of contextual factors that influence the performance of science-policy interfaces more empirical case studies of science-policy interfaces are needed that expose both communities' contexts. Yet also other analytical frameworks than used in this research may be helpful to gain insight in the contextual factors. Echoing Sarewitz and Pielke (2007), using analogous terms to analyse both the scientific community and policy-making community and their capabilities allows for systemic comparison of the extent two which rationales agree on what comprises usable information. To advance the understanding of the influence of contextual factors potential follow-up questions are:

- What other frameworks can be used to analyse the contextual factors of the science-policy interface to explain the usability of climate information?
- To what extent are barriers to address climate adaptation in municipalities interrelated?
- To what extent do the contextual factors that influence the performance of science-policy interfaces differ across countries, for specific science-policy interface problems and for different fields of research?

Secondly, this research showed how the prevailing accountability culture within municipalities directs the frame on adaptation to a narrow and nearby view, which in turn directs the climate information needs to 'detail' and 'quantification'. Yet, the desire to apply a strategy that is centred on stakeholder engagement and identifying system relations, conflicts with this frame. Detailed and quantified information may be more likely to support 'risk-oriented approaches' (*proximal* and *preventive* views) while 'system-oriented approaches' (*distal and promotional views*) may be better served with information and tools that facilitate deliberation. Research is needed to further explore these hypotheses. More in general understanding is needed on the extent to which different approaches contribute to effective and legitimate adaptation action. Potential follow-up questions are:

- To what extent are systems approaches reconcilable with cultures of accountability and scrutiny?
- What are the advantages and disadvantages of risk-oriented and system-oriented strategies to address climate adaptation in municipalities in terms of legitimacy and effectiveness and what determines the usability of climate information for both strategies?

Thirdly, the suggestion to differentiate between levels and actors in co-production processes demands further research. Collecting experiences on empirical cases of science-policy interfaces managed by boundary organizations are key in this. Future research could apply the conceptualisation as presented in Figure 7.1 to evaluate the interactions and regard whether this framework indeed can better explain the usability of climate information. Yet also arranging deliberate co-production processes according to the conceptualisation and evaluating the usability of information would be a valuable contribution. Furthermore, it is particularly interesting to learn about how the diverse actors contribute to the processes. Potential follow-up questions are:

- To what extent do the co-production processes on diverse levels take place in practice and how are they enabled or constrained?
- What capabilities of the actors in the science-policy interface constrain or enable the production and/or use of usable climate information, and to what extent can the roles of the actor be complementary?
- How can boundary organizations secure and facilitate co-production processes on different levels and secure the exchange of insights between the levels?

## 7.3 Recommendations

Based on this research four recommendations were formulated to increase the usability of climate information in the Netherlands to support local adaptation planning, the recommendations regard:

1) To make the potential uses of the CAA explicit and recognizable to (potential) users.
2) To set up a knowledge infrastructure to exchange experiences on the integration of adaptation in the environmental law.
3) To facilitate interactions between local policy-makers and scientists to co-produce knowledge on how integration across policy domains can be achieved and how 'the next step' regarding adaptation planning can be taken.
4) To educate the scientists and policy-makers of tomorrow on the challenges of today.

While the first recommendation may be easily accomplished, the other three recommendations need more time and efforts before they yield benefits. Yet, with all recommendations could be started today. Moreover, while the first recommendation is specifically addressed to CAS, the other recommendations are also addressed to and demand efforts of scientists and municipal practitioners.

*1) Explicate the potential uses of the CAA*

A recommendation that may be easily executed is to sketch out and explicate the diverse potential uses (applications) of the CAA. After all, it was found that one of the factors that determines the usability of the CAA is that it is tailor-able to diverse needs and contexts. Since the municipal practitioners are concerned with little time and budgets, it is important that they easily recognize that the usability of the CAA is increased when it is combined with local geospatial information and local objectives. This could minimize the chance that practitioners evaluate the CAA as too general.

A practical way to do this is to write a 'white paper' that explains the potential applications of the CAA. A white paper describes how a product solves a certain problem. Explanations should inform the potential user on how the CAA can be tailored to a diversity of needs. Tailoring can be done by the municipal practitioners themselves or together with intermediaries. It is key to sketch out the diversity of potential uses. For example the CAA can be tailored for the goal to demonstrate the urgency (e.g. calculating damage costs), the task to analyse the vulnerability (e.g. stress test) or the application in policy-making (e.g. the environmental vision). To make the explanations tangible, lively and recognized as feasible by the practitioners, practical examples could be provided. While material on tailored CAA's is available on the websites of CAS and the knowledge portal, the point is here that explicating the tailor-ability and relating it to practitioners' needs is needed for the municipal practitioners to recognize the usability.

*2) Setting up a knowledge infrastructure for adaptation in the environmental law*

A second recommendation is to set up an infrastructure for information and knowledge exchange on how adaptation can be integrated in environmental law. Due to the newness of the environmental law and the uncertainties with regard to how climate information needs develop, it is important that learning processes are facilitated. Setting up a knowledge infrastructure may include both formal and informal structures. The aim is to explore the approaches and experiences within municipalities and learn on the extent to which these are usable. Moreover, this may reveal the needs for climate information. Such a knowledge infrastructure is both relevant to the municipalities and the knowledge purveyors (e.g. boundary organization CAS).

A practical way to do this is to collect experiences of municipalities on how they deal with integrating adaptation in the diverse instruments of the environmental law, and disclose these experiences to the larger population of municipalities. This can be done through the knowledge portal. It is especially relevant to communicate on the applied methods and approaches and the extent to which this helped the practitioners. For example, experiences may be collected on the use and usability of the CAA in the environmental vision. Yet, especially also appropriated methods and processes should be regarded for integrating adaptation in the environmental plan. After all, it is this instrument that sets the legal regulations and hence determines whether adaptation action takes place.

Additionally, attention may be given to the organizational change processes that are in progress within municipalities and the implications for knowledge and information structures. To illustrate this,

municipal organizations are reorganizing policy sectors to increase integration; this is accompanied with reorganizing and restructuring relevant information and knowledge of the policy sectors. The availability and accessibility of relevant local geospatial information is necessary to perform for example climate vulnerability analyses. Practitioners may be looking for how information and knowledge can be best organized and exchanged. Such processes are accompanied with overcoming cultural and organizational barriers and are likely to need support. Exchanges on these learning processes may be done best through more informal exchanges. Organizing seminars or network events that are centred on discussing encountered problems can facilitate such informal exchanges. Also providing contact details on the knowledge portal of municipalities that apply certain approaches can support informal exchanges.

*3) Co-production to explore and clarify the information needs to take the next step*
A recommendation that demands more time and effort is to, together with municipal practitioners and scientists explore and clarify what climate information is needed for the - by the practitioners so often referred to - 'next step' (e.g. see section 5.3.2.1, 5.3.2.2 and 6.1.1.3). While practitioners recognize the usability of the CAA to map out the general vulnerabilities of the municipal area, quickly thereafter the practitioners are concerned with the question how to continue: what methods and information are available to take the next step. Special attention may be paid to the practitioners' needs for more detailed climate information, information on the effectiveness of adaptation measures, and the relation of climate adaptation objectives to other objectives - and the extent to which these needs can be met from the scientific community. Further clarification of the specific needs and possibilities to fulfil this need may be done best through interactions between the scientists, municipal practitioners and boundary organization CAS. A practical way to do this is to organize workshops at conferences and network events. It seems important that a discussion is started on the accountability culture within municipalities and the extent to which this leads to sensible adaptation planning. When creating awareness on the tension between the accountability culture and the ambition to reduce climate change risks, both the limits and possibilities of science may be better clarified.

Furthermore, specifically for the environmental vision, knowledge is needed on how integrated approaches of policy-making can be operationalized, including how adaptation can be integrated in diverse sectorial or integrated domains. This may be obtained when scientists and policy-makers collectively define research agendas. Yet, the lack of budgets seems problematic in this; there are no incentives for scientists and municipal practitioners to interact, and current research programmes such as NKWK do not have budgets available. Boundary organizations may play an important role in this. Yet, the challenge is to facilitate such interactions in a way that the divers parties recognize that participation is worth investing effort and budgets.

*4) Educate the scientists and policy-makers of tomorrow*
A final recommendation is to educate the students on the challenges that are encountered in information and knowledge production and exchange. Observing the transitions that take place within and among municipal organizations to accomplish more integration and collaboration, and the implications for the organization on knowledge flows to accomplish this, large changes must be made in practices and cultures. Yet these transitions are not unique for municipalities; governments of all levels as well as research institutes and private actors are exploring new forms of collaboration, and seek for ways to better account for a diversity of interests. The transition takes place over a longer time scale and demands processes of experimentation and learning. Yet, provided that the scientists and policy-makers of tomorrow are being educated today on 'good policy-making' and 'good scientific research', it is relevant that the students are educated on the present challenges.

An inspiring and engaging way to do this is to present practical examples in guest lectures on challenges that are encountered in science-policy interfaces. With this students are educated how trends such as increased collaboration and integration are associated with implications on information and knowledge structures. For example, how to deal with digitalization and how to manage information among networks of actors? Providing students with practical examples of both success stories and less successful stories, may give students insight in the skills that are needed in their future jobs. Teaching students the skills to make societal contributions are important goals of universities and universities of applied science, in addition to providing them with (specialised) knowledge.

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# 9 Appendices

## 9.1 List of interviewees

**Table 9.1: Interviews with climate information producers and users**

| # | Organization | Type organization | Role interviewee | Relation to CAA | |
|---|---|---|---|---|---|
| 1 | Deltares | Research Institute | Water and soil expert | Input CAA | |
| 2 | KWR | Research Institute | Researcher | Input CAA | |
| 3 | KNMI | Research Institute | Advisor climate data use | Input CAA | |
| 4 | Hydrologic | Consultancy | Advisor water | Feedback group | |
| 5 | Sweco | Consultancy | Advisor water and environment | Feedback group | |
| 6 | Tauw/HvA | Consultancy/Education | Expert water/lector | Feedback group | |
| 7 | Grond RR | Consultancy | Advisor spatial planning | Feedback group | |
| 8 | CAS | Boundary organization | Director foundation | Initiator CAA | |
| 9 | CAS | Boundary organization | Advisor/GIS expert | Initiator CAA | |
| 10 | Municipality Leiden | Municipality | Urban planning supervisor | User CAA data | Case 1 |
| 11 | Municipality Leiden | Municipality | Strategic policy maker | User CAA data | |
| 12 | Rijnland | Water board | Strategic policy advisor | User CAA data | |
| 13 | Fabrications | Consultancy/Design | Advisor urban and regional planning | User CAA data | |
| 14 | Dunea | Drinking water service | Manager environment | User CAA data | |
| 15 | Municipality Nijmegen | Municipality | Policy advisor water<br>Policy advisor green/soil | No user CAA data | Case 2 |
| 16 | Municipality Nijmegen | Municipality | Policy advisor green/soil | No user CAA data | |
| 17 | Municipality Amersfoort | Municipality | Advisor environment (soil) | User CAA | Case 3 |
| 18 | Municipality Groningen | Municipality | Policy-maker (green) | No user CAA data | Case 4 |
| 19 | Municipality Ede | Municipality | Advisor water<br>Advisor soil | No user CAA data | Case 5 |

## 9.2 Additional meetings

In the Table 9.2 the meetings that were attended were indicated that were aimed to increase understanding of the practices in the science-policy interface and more specific in the update process of the CAA. Figure 9.2 gives an impression of one of the attended meeting: the stress test session of the region of Eindhoven.

**Table 9.2: Attended meetings**

| Date | Type of meeting | Focus/Goal meeting |
|---|---|---|
| 09/01/2017 | Meeting CAS & consultant group CAA | Update CAA |
| 10/01/2017 | Meeting KANS network & NKWK | Role KANS in NKWK |
| 16/01/2017 | Meeting CAS & National Meteorological Institute | Update CAA |
| 30/01/2017 | Meeting CAS & municipality of Leiden | Use of CAA in environmental vision |
| 13/02/2017 | Meeting CAS, Deltares & TNO on land subsidence | Update CAA |
| 09/01/2017 | National Conference Spatial adaptation | State and way forwards of spatial adaptation in the Netherlands |
| 02/02/2017 | Meeting KANS network I | Network meeting KANS municipalities |
| 13/03/2017 | Stress test light region Eindhoven | Stress test workshop with 20 small municipalities |
| 19/04/2017 | Meeting KANS network II | Network meeting KANS municipalities |

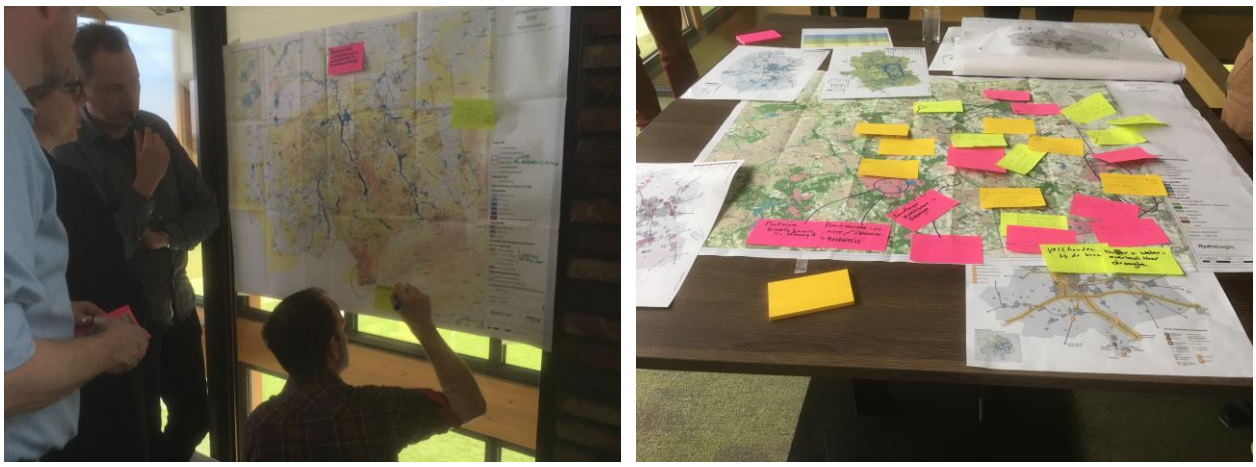


**Figure 9.1: Impression stress test light region Eindhoven**

## 9.3 Interview guide Research institute

*Interview Kennisinstelling*

*Hartelijk dank voor het meewerken aan dit interview. Ik onderzoek de bruikbaarheid van klimaatinformatie voor klimaatadaptatie in gemeenten, en meer specifiek in de context van het formuleren van de omgevingsvisie. Perspectieven van kennisinstellingen zijn belangrijk om te begrijpen hoe klimaatinformatie tot stand komt en wordt gebruikt. Hierom ben ik geïnteresseerd in uw ideeën/visie en ervaringen over de klimaateffect atlas (KEA), en klimaat informatie in het algemeen. Ten behoeve hiervan heb ik een aantal vragen geformuleerd. Het interview duurt +/- een uur. Antwoorden zullen anoniem behandeld worden.*
*Vindt u het goed als ik het gesprek opneem? Het zou mij helpen me beter te richten op het gesprek.*

**0) Introductie (5 min)**
i. Hoe staat u tegenover dit interview?
ii. Kunt u uzelf kort introduceren en iets vertellen over uw achtergrond en uw organisatie?

**1) Kunt u me vertellen hoe de KEA tot stand is gekomen en wat uw rol / de rol van uw organisatie hierin was? (10 min)**
i. Kunt u beschrijven hoe u/uw organisatie betrokken was bij de KEA?
ii. Kunt beschrijven hoe het proces is gegaan van het selecteren van informatie/indicatoren voor de KEA? (b.v. hoe is dit besloten en door wie?)

*De KEA is bedoeld om lokale overheden kennis te laten maken met klimaatverandering.*

**2) Kunt u me wat vertellen over de interacties tussen uw organisatie en gemeenten als het gaat om klimaat informatie, wat zijn uw ervaringen hiermee? (10 min)**
i. Hoe zou u de relatie tussen gemeenten en uw organisatie beschrijven? (b.v. intensiteit, samenwerkingen, wederzijdse uitwisseling)
ii. Hoe ervaart u deze relatie? (b.v. transparantie, en wederzijds begrip van mogelijkheden en behoeften)

**3) Kunt u me wat vertellen over wat u denkt dat de KEA heeft opgeleverd? Sterke/zwakke punten? (10 min)**
i. Wat zijn uw ervaringen met het gebruik van de KEA door gemeenten - is de KEA toegepast genoeg?
ii. Welke elementen/functionaliteiten van KEA, maken dat de KEA bruikbaar is of niet bruikbaar?
iii. Wat vind u zelf van de bruikbaarheid van de KEA voor adaptatie planvorming

**4) Wat zijn uw ervaringen m.b.t. wat gemeenten ertoe aanzet en/of juist van weerhoudt om klimaatinformatie te gebruiken? (10 min)**
i. Wat zijn uw ervaringen met betrekking tot de capaciteiten en de houding van gemeenten om klimaatinformatie (van uw expertise) te gebruiken?
ii. Wat zijn uw ervaringen/gedachten over hoe gemeenten nu met adaptatie aan de slag zijn (b.v. ambitie en aanpak)

*In de omgevingsvisie moeten gemeenten een integrale visie formuleren voor de ruimtelijke omgeving. Klimaatadaptatie heeft een sterke oriëntatie op/toepassing in de ruimtelijke omgeving.*

**5) Wat is uw visie op hoe klimaatinformatie het best bruikbaar is ten behoeve van klimaatadaptatie voor de ruimtelijke omgeving en wat is daar voor nodig? (10 min)**
i. Welke kansen en bedreigen kunt u bedenken voor het voor ruimtelijk maken en integreren van informatie, ten behoeve van klimaatadaptatie?
ii. Wat zijn uw gedachten omtrent de aanpak die het beste genomen kan worden om bruikbare informatie tot stand te laten komen, en welke bouwstenen/functionaliteiten moeten hierin zitten?

**6) Slotvraag: Zijn er belangrijke onderwerpen die we niet hebben besproken // Heeft u suggesties voor mijn volgende interviews? (5 min)**

*Hartelijk dank voor uw tijd! Wanneer ik in het vervolg nog vragen bedenk, mag ik u dan opnieuw benaderen*

## 9.4 Interview guide consultant

*Interview Consultant*

*Hartelijk dank voor het meewerken aan dit interview. Ik onderzoek de bruikbaarheid van klimaatinformatie voor klimaatadaptatie in gemeenten, en meer specifiek in de context van het formuleren van de omgevingsvisie. Perspectieven van adviesorganisatie en kennisinstellingen zijn belangrijk om te begrijpen hoe klimaatinformatie tot stand komt en wordt gebruikt. Hierom ben ik geïnteresseerd in uw ideeën/visie en ervaringen over de klimaateffect atlas (KEA), en klimaat informatie in het algemeen. Ten behoeve hiervan heb ik een aantal vragen geformuleerd. Het interview duurt +/- een uur. Antwoorden zullen anoniem behandeld worden.*
*→ Is het voor u goed als ik het gesprek opneem? Het zou mij helpen me beter te richten op het gesprek.*

**0) Introductie**
i. Hoe staat u tegenover dit interview?
ii. Kunt u uzelf kort introduceren en iets vertellen over uw achtergrond en uw organisatie?
iii. Kunt u me vertellen hoe u (of: uw organisatie) betrokken bent geweest bij de KEA

*De KEA is bedoeld om lokale overheden kennis te laten met klimaatverandering en adaptatie. Consultants ondersteunen gemeenten vaak in dit type opgaven.*

**1) Kunt u me vertellen over uw ervaringen met de aanpak van gemeenten omtrent adaptatie?**
i. Wat zijn uw ervaringen met het ambitieniveau van gemeenten, de stappen die gezet worden (b.v. stresstest?) en betrokken actoren?
ii. Wat zijn uw ideeën over en ervaringen met wat er bij gemeenten aan bijdraagt, of wat hen juist tegenhoudt om wetenschappelijke klimaatinformatie te gebruiken? (b.v. houding, capaciteit)?

**2) Kunt u me vertellen over wat u denkt dat de KEA heeft opgeleverd? Sterke/zwakke punten?**
i. Wat zijn uw ervaringen met het gebruik van de KEA door gemeenten – is de KEA toegepast genoeg?
ii. Welke elementen/functionaliteiten van de KEA, maken dat de KEA bruikbaar is of juist niet?
iii. Wat vindt u zelf van de bruikbaarheid van de KEA voor adaptatie planvorming?

**3) Wat is uw ervaring met de kennisuitwisseling tussen kennisinstellingen en gemeenten over klimaatverandering?**
i. Hoe zou u de relatie tussen de kennisinstellingen en gemeenten beschrijven?

*In de omgevingswet moeten gemeenten nu een integrale visie formuleren voor de ruimtelijke omgeving.*

**4) Kunt u me wat vertellen over uw ervaringen met gemeenten en hun aanpak met de omgevingsvisie?**
i. Wat is uw ervaring met het ambitie niveau voor de omgevingsvisie, de stappen die genomen worden, en de betrokken actoren?
ii. Wat is uw ervaring met de rol die adaptatie krijgt in de omgevingsvisie?

*Klimaatadaptatie heeft een sterke oriëntatie op/toepassing in de ruimtelijke omgeving.*

**5) Kunt u me vertellen over uw ideeën t.a.v. de plek die adaptatie zou moeten krijgen in de omgevingsvisie?**
i. Wat is uw visie op de kansen en bedreigingen voor het ruimtelijk maken van informatie?
ii. Welke informatie is er nodig om adaptatie in de omgevingsvisie te borgen?

**6) Slotvraag: Zijn er belangrijke onderwerpen die we niet hebben behandeld // Heeft u suggesties voor mijn volgende interviews?**

*Hartelijk dank voor uw tijd! Wanneer ik in het vervolg nog vragen bedenk, is het dan goed als ik opnieuw contact met u opneem?*

## 9.5 Interview guide municipality

*Interview Gemeente*

*Hartelijk dank voor het meewerken aan dit interview. Ik onderzoek de bruikbaarheid van klimaatinformatie voor klimaatadaptatie in gemeenten, en meer specifiek in de context van het formuleren van de omgevingsvisie. Ervaringen en perspectieven zijn belangrijk om te begrijpen hoe klimaatinformatie tot stand komt en wordt gebruikt. Hierom ben ik geïnteresseerd in uw ideeën/visie en ervaringen over de klimaateffect atlas (KEA), en klimaat informatie in het algemeen. Ten behoeve hiervan heb ik een aantal vragen geformuleerd. Het interview duurt +/- een uur. Antwoorden zullen anoniem behandeld worden.*
*→ Is het voor u OK als ik het gesprek opneem? Het zou mij helpen me beter te richten op het gesprek.*

**0) Introductie**
i. Hoe staat u tegenover dit interview?
ii. Kunt u uzelf kort introduceren, en iets vertellen over uw rol binnen de gemeente?

**1) Kunt u me wat vertellen over hoe de gemeentes bezig is met klimaatadaptatie?**
i. Kunt u me wat vertellen over de prioriteit die wordt gegeven aan klimaatadaptatie), en wat wordt gezien als het belangrijkste probleem rondom dit thema?
ii. Kunt u me wat vertellen over hoe adaptatie binnen de gemeente wordt aangepakt: welke stappen worden ondernomen, wie is er betrokken?
iii. Kunt u me wat vertellen over in hoeverre adaptatie een plek heeft in verschillende beleidsdomeinen/afdelingen?
iv. Kunt u met wat vertellen over hoe er beslissingen worden genomen over adaptatie?

**2) Kunt u me wat vertellen over de informatie die wordt gebruik om aan de slag te gaan met klimaatverandering en adaptatie, en in hoeverre dit heeft geholpen?**
i. Kunt u me vertellen welke informatie wordt gebruikt?
ii. Wat zijn uw ervaringen met de bruikbaarheid voor adaptatie van deze informatie voor uw gemeente? Is het toegepast genoeg?
iii. Wat zijn sterke en zwakke punten? Welke functionaliteiten maken dat het bruikbaar is en welke niet?

**3) Kunt me wat vertellen over wat uw gemeente ertoe aanzet of juist van weerhoudt om met klimaatinformatie te werken?**
i. Wat is uw ervaring met de capaciteit en middelen om met klimaatinformatie aan de slag te gaan?
ii. Wat zijn uw gedachten omtrent de houding binnen uw gemeente om met klimaat informatie aan de slag te gaan?

**4) Kunt u me wat vertellen over de interactie tussen uw gemeente en kennisinstellingen/adviesbureaus over klimaatinformatie, en wat zijn uw ervaringen hiermee?**
i. Hoe zou u deze relatie karakteriseren?
ii. Hoe ervaart u deze relatie? (b.v. openheid, wederzijds begrip van mogelijkheden en behoeften t.a.v. informatie)

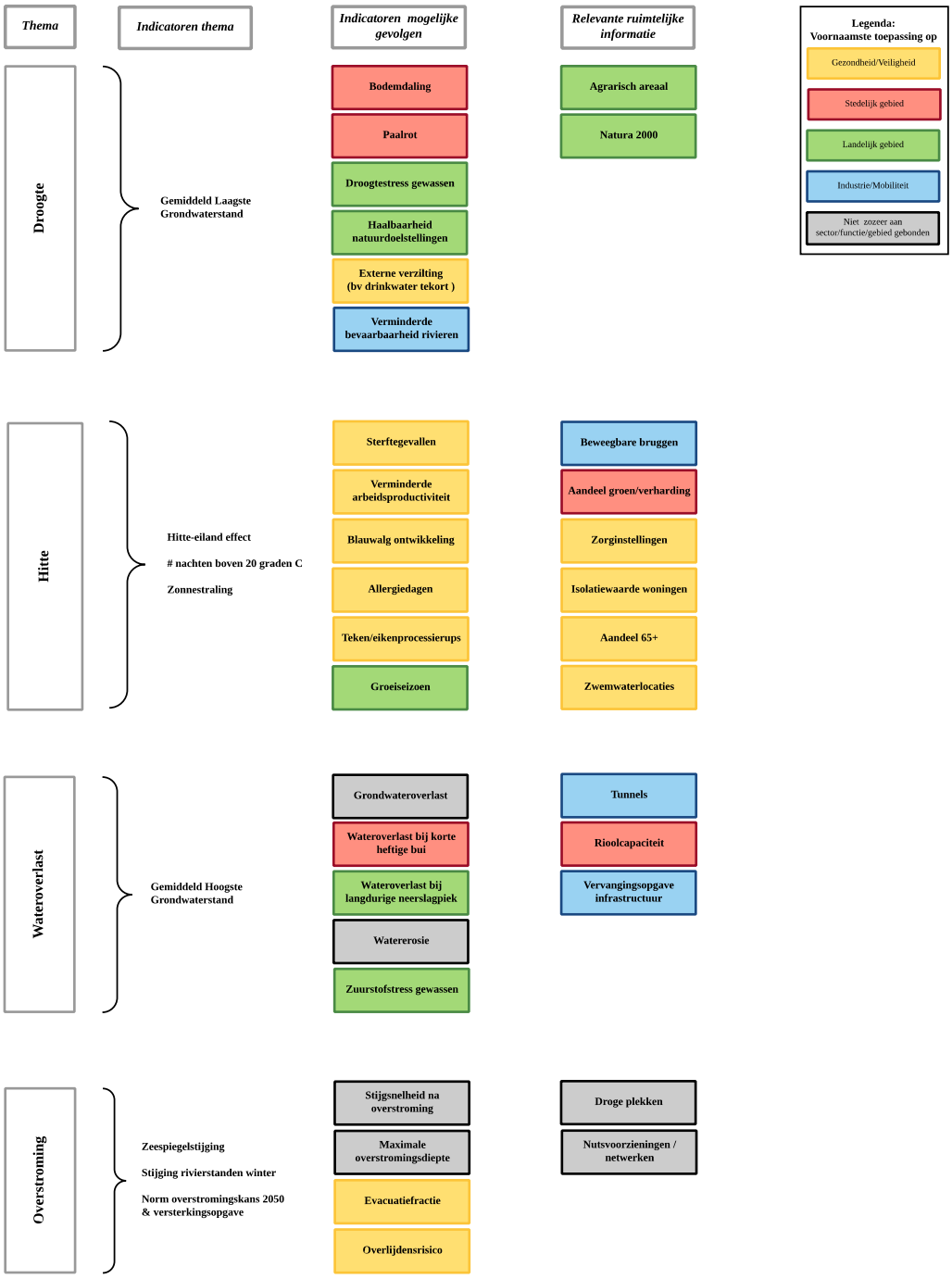
**5) Kunt u me wat vertellen over de aanpak van de gemeente ten aanzien van de omgevingsvisie?**
i. Kunt u me wat vertellen over het proces de omgevingsvisie binnen uw gemeente en hoe de visie eruit gaat zien? (stappen, team)
ii. Kunt u me wat vertellen over de rol die klimaatadaptatie heeft in de omgevingsvisie? En hoe andere ontwikkelingen worden opgenomen in het omgevingsvisie proces?

**6) Kunt u me wat vertellen over uw gedachten op welke klimaatinformatie het meest bruikbaar is om adaptatieplanvorming te ondersteunen binnen de omgevingsvisie?**
i. Wat zijn uw gedachten over de functionaliteiten van klimaatinformatie en de inhoud die aanwezig zouden moeten zijn?

**7) Slotvraag: Zijn er belangrijke onderwerpen die we niet hebben behandeld // Heeft u suggesties voor mijn volgende interviews?**

*Hartelijk dank voor uw tijd! Wanneer ik in het vervolg nog vragen bedenk, is het dan goed als ik opnieuw contact met u opneem?*

## 9.6 Interview municipality: list of indicators



## 9.7 Report expert discussion I: Environmental law expert

Expert I: Professor Environmental Law

Date: 23/05/2017
Duration 30 minutes

A legal expert was interviewed on the implications of the environmental law for municipalities and addressing climate adaptation objectives. The expert explained on the different instruments of the environmental law, and the implications for addressing climate adaptation were discussed. The emphasis of the discussions was mainly on the legal aspects of the law and the implications than on validating the findings in practices. Below the discussion is summarized. The expert validated this test.

**Implications of the environmental law for municipalities and addressing climate adaptation**
The environmental law provides municipalities with increased freedom in spatial decision-making. Where previously environmental norms, such as those regarding noise were centrally determined, municipalities are now equipped with the freedom to adjust such norms and redefine the acceptability. With this, the municipalities are provided with a 'mixing panel' on spatial norms in which municipalities can more flexible assign functions and regulations to specific areas. Only for the environmental requirements that follow from European law, the norms remain fixed (e.g. with regard to water and air quality). This creates a field of tensions between legal certainty and flexibility. More flexibility is at the expense of the legal certainty for citizens and companies. Furthermore, whereas municipal organizations are concerned with limited financial and human resources while equipped with larger freedom and responsibility, shaping spatial policies and regulations may be a big task. Especially since the law aims to better facilitate initiatives from diverse actors for the use and development areas, many interests are activated that may pressure municipalities in managing, using and developing the physical environment.

From a legal perspective, especially the **environmental plans** are relevant, as it is this instrument that is concerned with legal protection, meaning that the public can object to a decision that follows from the plan, and appeal to court. The environmental plans regard the legally binding rules regarding the protection of the physical environment, such as land use, which are established by the municipality. Yet, higher authorities can impose legally bindings instructions or regulations on the lower authorities. Also the formulation of '**environmental values'**, which are goals/norms, is concerned with a legal implication: When a municipality defines an environmental value they have to monitor and evaluate the achievement of the objective. The environmental values are the goals for the municipalities themselves, these values can be expressed by an obligation of result, or an obligation of effort. These values are not legally binding for legal subjects, such as land users, but they impose a duty of care on the authorities. When the goal is not achieved, the municipality has to set-up a programme with actions to manage the achievement of the goal after all. Some environmental values are centrally determined (e.g. water quality and air quality), however municipalities could also set other goals and provide them with the status of an environmental value. Hence in doing so, municipalities put themselves under the obligation of achieving this value. Alternatively, setting environmental goals can also be done without the legal status of an environmental value, by drafting an environmental programme dedicated to the objective. **Environmental programmes** itself don't heave the obligation to be monitored. While environmental programmes can not be objected, stakeholder may influence the environmental programmes in participation processes.

The **environmental vision**, in contrast to the environmental plan, is a policy instrument with no direct legal implications. Rather, the environmental vision sets out the objectives of the municipality, which guides and justifies the decisions made in the environmental plans and programmes. Consequently, the more abstract the goals in the vision are formulated, the more freedom the municipality can afford in making decisions in the environmental plans and programmes.

The environmental law differentiates between policy (non- binding only self-binding for authorities, like visions and programmes) and regulations (binding rules, permits, etc.). Visions are established on

every governmental level, but there is no hierarchy between visions. They are not binding for other authorities, but to the authority that establishes a vision. Visions can provide a building block for the substantiation of decisions of authorities that are legally binding; hence the visions are indirectly relevant for taking legally binding decisions.

To achieve climate adaptation objectives, either goals in the spatial development can be accomplished with measures such as creating retention areas, however also legal measures could be imposed such as making it obligatory to build on mounds or obligations to compensate for constructing paved areas, and decoupling rainwater from the sewage system. In the above context, when aiming for the integration of climate adaptation in spatial planning several implications can be identified:

- Including climate adaptation as an objective in the **environmental vision** may guide and justify taking certain climate adaptation measures (e.g. through programmes) or assigning specific areas with specific functions and requirements (e.g. in plans). However, as the vision itself does not have legal implications, vision statements on climate adaptation do not guarantee actual climate adaptation action. Furthermore, the more abstract adaptation goals are formulated on the vision level, the more freedom decision-makers have in the environmental plans and programmes. Hence the more concrete climate adaptation objectives are defined on the vision level, the larger the chance is that such objectives are expressed in actual spatial decisions, measures and regulations. Alternatively, the more abstract the climate adaptation objectives are formulated on the vision level, the larger the chance that the inclusion of climate adaptation measures is influenced by the concurrent political climate.

- Including climate adaptation as an objective in the **environmental plan** may be expressed in for example regulations on the use and development of specific areas, and implies actual compliance to the set objectives. In the environmental plans for example, measures could be included to increase water retention areas or minimize heat island effects by implementing green space. Also the environmental plan could include regulations for legal subjects for the use and development of space. However, the environmental plan is subjective to public objection. Furthermore, higher authorities may have legally binding instruments to influence and stir decision-making on the lower levels.

- Labelling climate adaptation objectives as an **environmental value** requires the municipality to monitor and evaluate the achievement of the objective. Consequently, it is the instrument in which it is most certain that climate adaptation objectives are pursued and fulfilled. However, due to the significant obligations environmental values are concerned with, municipalities may be hesitating to formulate environmental values voluntarily. Rather, municipalities may choose to design a **programme** dedicated to climate adaptation, in which is strived to achieve certain climate adaptation goals. While goal accomplishment in the programme is less strict than when it is labelled as an environmental value, the public cannot object the programme, however may be influenced by public participation processes.

## 9.8 Report expert discussion II & III: Local adaptation experts

Expert II: Junior assistant professor: local climate adaptation responsibilities
Exert III: Assistant professor: local climate adaptation responsibilities

Date: 29/05/2017
Duration 45 minutes

Two experts were interviewed that are experienced researchers in the field of local climate adaptation. The researchers have specialised knowledge on policy mainstreaming and public and private responsibilities with regard to climate adaptation. Statements were proposed to the experts, and invited to comment to them. In specific was asked whether the experts could explain to what extent they recognized this from their experiences. Below the statements and comments of the experts are summarized.

**Statement 1:**
Awareness/urgency regarding adaptation within the municipal organisation is limited, often addressing adaptation depends on individual municipal practitioners that promote adaptation and seek to obtain budget from the Alderman. It seems that there is a vicious circle: detailed vulnerability analyses are necessary to obtain budgets, however to perform detailed vulnerability analyses budgets are needed.

Expert reaction: Indeed climate adaptation often depends on single individuals addressing climate adaptation that are struggling to obtain political support and budget, and increase the limited awareness within the municipal organization. The experts do not know about the relationship between the lack of perceived urgency and obtaining budgets as suggested with the vicious circle, however could imagine that such mechanisms take place. The experts explain that the barriers of limited awareness, limited recourse and limited political leadership are widely recognized from literature yet, the relationships between those barriers are not researched.

**Statement 2:**
Municipalities apply a systems approach, in which is aimed to organise the policy domains of green, water, soil and spatial development in such a manner that:

- Collaboration among sectorial domains increases
- The relationships among domains can be identified
- Spatial decisions are based on a consideration that takes into account both problems and opportunities of the natural system.

Moreover is aimed to achieve as many goals as possible simultaneously: coupling. If coupled, adaptation is perceive to yield benefits. Also, municipalities are seeking for ways for how they can steer spatial decision-making in a balanced manner. It seems that municipal departments related to the physical domain are reorganising.

Expert reaction: Indeed municipalities are working towards more integrated structures. However this is also because integration is currently a 'buzzword'. The experts expect that it is difficult for municipalities to determine how this should be organised since it is difficult to determine to what extent such integration should take place. This touches the debate on specialization versus integration, in which too much integration may come with inefficiencies. Expert I expects that the perspective on that everything should be integrated may develop again towards more specialised sectors, following a cyclical wave.

Moreover, expert II indicate that municipalities are confronted with being responsible for more tasks, without being provided with larger budgets. This further pushes and strengthens the yet existing 'efficiency rationale' that prevails within municipalities, in which, in this neo-liberal society, it is all about costs and benefits, hence coupling is interesting: you only address climate adaptation, if there is

already planned for refurbishment. Moreover, explaining that a measure also contributes to another environment objective, increases the chance that budgets become available. Making the efforts and benefits visible is important to sell the idea of 'climate adaptation' to the Alderman. E.g. such as the efforts in Rotterdam have resulted in rather visible squares and floating objects.

**Statement 3:**
Citizen participation is central to climate adaptation for municipalities

Expert reaction: Often the people that the experts talk to aim to achieve adaptation in participation with local actors, however within municipalities there is diversity among the municipal practitioner on the perspective towards participation. There are two reasons indicated why municipal practitioners are hesitating to apply participation in adaptation actions: 1) Participation includes the exploitation of the resources of the participating actors, due to financial inequality among actors and areas, participation projects on climate adaptation may increase the social inequality of areas. 2) Participation of local actors may be spontaneous, and short term; the continuity of adaptation action may be compromised.

**Statement 4**
Climate adaptation is best secured in water policy.

Expert reaction: Yes, this is absolutely true. It is most often about pluvial flooding. Heat is often not recognized as a problem, or secured in policies. Drought is sometimes is recognized for the risk of 'paalrot'.

**Statement 5**
Little interactions take place between municipalities and research institutes.

Expert reaction: Yes, however efforts are done to improve this. For example the experts participate in the climate adaptation city deal where experiences and insights are mutually shared. However generally, scientists do not have the time and incentives to formulate applied recommendations of their research, and municipal practitioners do not have the time, knowledge and capacities to adopt and use the knowledge. They are rather looking for pragmatic information such as stress tests that consultants can perform. There is a gap between science and policy, this could be improved.

## 9.9 Report expert discussion IV: Climate Change research expert

Expert IV: Professor environmental governance, former director climate change research programme

Date: 30/05/2017
Duration 60 minutes

An expert in the field of climate research programmes was interviewed, that was involved in the research programme Knowledge for Climate. The expert was asked to explain on the experiences with regards to the knowledge use and production concerning to climate change research and the application by municipalities. Statements were proposed to the expert, who was invited to comment to the statements and explain to what extent this was recognized. Below the statements and comments of the experts are summarized.

**Statement 1:**
There are little interactions between municipalities and research institutes.

Expert: The experience from Knowledge for Climate is that interactions between municipalities and research institutes are difficult. Especially the smaller municipalities have practical questions, which usually consultants address. Moreover, municipalities find it difficult to make their practical questions more abstract, which is necessary for conducting scientific research: often there are more general questions behind the practical questions. This was also the idea of boundary organization CAS, that they can collect practical questions, and bundle them to translate scientific information and translate this to answer the practical questions. Furthermore, municipalities often think climate adaptation is too abstract. Framing the problem in more concrete terms may be improving this: e.g. water nuisance, increasing green spaces etc.

Also from the scientists' side there are barriers to interact with municipalities. There are some incentives from the research funding agency NWO for example; They pose the requirement that research has to contribute also to practice. As a result, researchers may perform research with municipalities, however this is then still researcher's perspective, rather than that practical questions from municipalities are collected to perform research.

**Statement 2:**
There is an accountability culture within municipalities. Provided this culture, the gap between science and policy can not be improved through interaction.

Expert: There is a tension between detailed information and municipalities. For example, for the politicians the interests may not be to know on street level to know all the risks, since citizens may start making appeals to actions. Furthermore its not possible and necessary to make everything measurable with regard to climate adaptation objectives as well as other objectives. Rather it may be looked at how 'lines of reasoning' can be used to list how certain spatial decisions/interventions contribute to values such as climate adaptation, health and economics.

Furthermore the expert explains that with the decentralisation of tasks, for, for example environmental policy, the knowledge infrastructure that was governed and maintained by the national government is being lost. The local governmental bodies are not investing in such knowledge infrastructures.

Finally a preliminary model on co-production is presented and discussed in Figure 9.2. The expert recognizes the idea of the model, and explains that this is something that is discussed before, yet there are some implications. The expert comments the following:

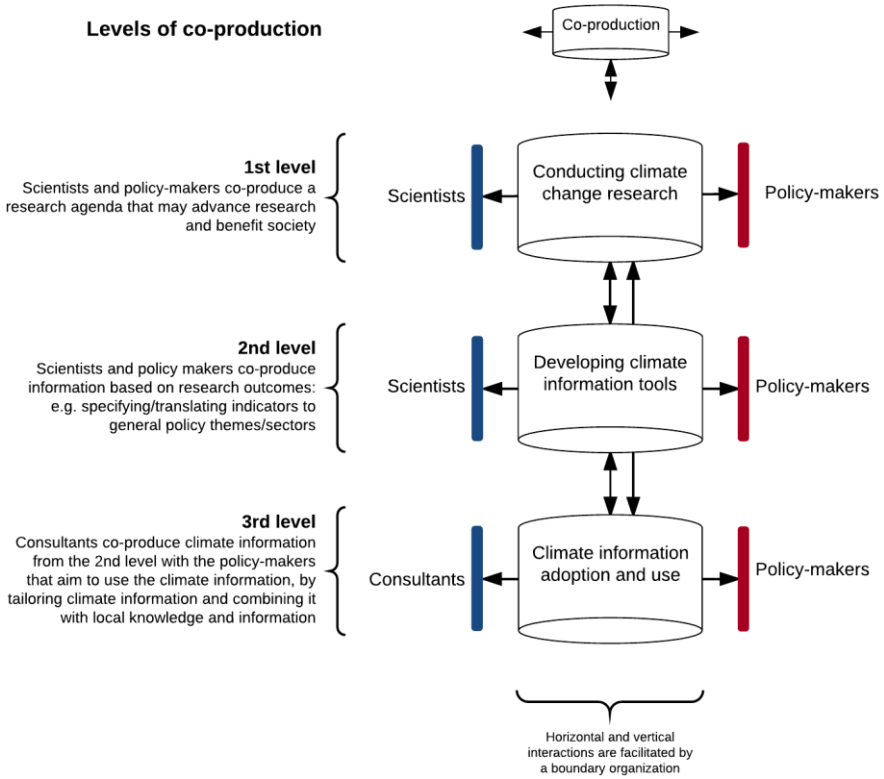



**Figure 9.2: multiple levels of co-production**

→ Level 1: The expert explains that this level is financed by research funds. This level is thus financed by public money. Furthermore, the inclusion of policy makers on this level may include mostly policy-makers from more national levels.

→ Level 2: This level is now coordinated by CAS, and financed with special governmental subsidies, such as subsidies for the maintenance of the knowledge portal and updating the CAA. Thus this level is again financed by public money. A question is how the continuity of this level can be guaranteed; what is the business model of CAS, and how can it be a legitimate actor for coordinating the co-production processes: how do you make sure that practical questions from level 1 are used to shape the co-production processes on level 2, and how can these insights also be back linked to the scientists. And alternatively, how do you make sure that the research outcomes from level three are used and translated. How are all these processes financed? By moving up in the column towards level 1 through participating in research projects, CAS makes use of public funds, yet if is moved downwards to level 3 by performing projects for e.g. municipalities, it becomes a commercial project. Then what is the role of CAS, and how can it remain legitimate

→ Level 3: This level is between policy-makers and consultants and involves a commercial level. Now, public money is used to finance level 1 and 2. Only the consultants benefits. Resources need to be directed back to level 1 and 2.