

# **Technical and organizational aspects of climate scenarios.**

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## Summary

KNMI is in the Netherlands (Royal Dutch meteorological institute) responsible for the creation and publication of climate scenarios. Their most recent published set of scenarios are often called the KNMI06 scenarios. Future climate change is represented in the form of climate scenarios, because the many uncertainties make it impossible to attach probabilities to certain amounts of climate change. The goals of the KNMI06 scenarios is therefore to sketch a range of possible futures. The scenarios are not meant as predictions of the future. KNMI observes however that in practice they are not used to explore a range of possible futures, but that often one of the four scenarios is chosen and is used as a prediction of the future climate.

The KNMI06 scenarios give per scenario for each variable one number. In Great-Britain in 2009 scenarios were published that represent each variable as a probability density curve. These scenarios are known as the UKCIP09 scenarios. KNMI is planning to publish new scenarios in 2013. They hoped that a different scenario design could solve the problems they were experiencing with the use of their scenarios. KNMI hoped that a UKCIP scenario design would make people more aware of the uncertainties associated with climate change and that that awareness would lead to 'better' use of the scenarios. During the research it became clear that there were also significant differences in the guidance that was provided with the scenarios. The initial research question was framed as:

*What elements of UKCIP09, like for instance: scenario design choices with respect to uncertainty and guidance provided with the scenarios, should be adopted in KNMI13?*

Later it became clear that UKCIP (the organization responsible for publishing British climate scenarios) and KNMI are very different organizations and then also organizational aspects were added to the research question.

From the differences in design between KNMI06 and UKCIP09 two elements were selected that could be interesting to adopt in the new KNMI scenarios. These elements were: different driving forces and representing variables in a probability density curves. UKCIP had also published much more guidance on how to use their scenarios than KNMI, this was added as a third element. The desirability of implementation of these elements in the new KNMI scenarios was investigated with user interviews. Users came from the Dutch water management sector and the use was focused at climate change adaptation.

From the interviews it became clear that the introduction of probability density curves or different driving forces was not going to change in the direction KNMI intended it to change. The probability density curves might be used for dimensioning of engineering works or cost benefit analysis. It is however not entirely clear if the probability density curves are suitable for this. It will probably not

encourage people to use all scenarios in the set. People often choose one scenario in a design process to make decision making easier and not out of a lack of awareness of the uncertainty associated with climate change. A change in driving forces was not seen as desirable by the interviewees, because they wanted to keep the new scenario design as close as possible to the old design.

On the desirability of more guidance on how to use the scenarios the interviewees were not entirely univocal on the need of more guidance. But this can be caused, because the concept of guidance was not defined very clearly in advance.

The organizational differences were investigated with help of literature research and an interview with people from UKCIP. It turned out that KNMI and UKCIP are different organizations with different roles. Their roles in the climate scenario creation process are different. UKCIP is responsible for the publication of the scenarios and the British Met Office makes the scenarios in the sense that they deliver the data and model runs.

KNMI is a governmental agency and belongs to the ministry of infrastructure and environment. KNMI is responsible for providing the Netherlands with weather and climate data. UKCIP is a programme established by Defra (department of environment, food and rural affairs) in order to help the UK adapt to climate change. UKCIP can be considered a boundary organization as it sits between climate science and policy makers.

Deep uncertainty in science for policy causes problems for both scientists and policy makers. In policy and decision making it is often assumed that science can provide policy makers with precise numbers and certainty about what the future will bring. These hard facts and precise numbers then can help not only to determine the policy that needs to be chosen, but these facts are also used to legitimate the policy. However, because of the deep uncertainty associated with climate change it is impossible for climate scientists to provide policy makers with certain and precise numbers. This means that policy makers have to decide under uncertainty, which makes it impossible to choose one optimal alternative. Also the uncertainty can be used in a strategic way by opponents of a policy. This complicates decision making and these problems can only be solved with the involvement of both scientists and policy makers.

A boundary organization can facilitate this involvement. By bringing the parties together but also by providing guidance on how to use the scenarios. This is more easy for a boundary organization to do than for a traditional research organization, because activities associated with involving policy makers and providing guidance, require an involvement in the policy making process that is traditionally not done by a traditional research institution. When a traditional research institution shows this much involvement in the policy process it could harm the credibility of their scientific research. This is

because institutions are still judged by the normal model of science where science and policy are strictly separated. A boundary organization does not have this problem, because their scientific information is often provided by another party.

Providing scientific information for policy and thus the creation and publication of climate scenarios also requires some decision making that cannot be based strictly on scientific facts. For instance the temperature increase range for the scenarios to span cannot be solely based on scientific facts, but is also a policy decision. It is easier for a boundary organization to make these decisions because then these decisions are not intertwined anymore with the core scientific research.

There is currently no official boundary organization between KNMI and their users and this probably causes some of the problems KNMI is experiencing.

## **Preface**

This master thesis on the technical and organizational aspects of climate scenarios is the final work for my master in engineering and policy analysis. It also marks the end to my long time career as a TU Delft student. Of course this thesis would not have been possible without the help of many people, whom I would really like to thank here.

First of all my two main supervisors Tineke Ruijgh-van der Ploeg en Janette Bessembinder. Tineke, I am very grateful for your patience and extensive support, in particular during the writing of my thesis and also for the fact that you were always available for help and questions. Janette, I would like to thank you for all your help and time and for giving me the chance to work temporarily at KNMI. You were also always available for questions and help. I hope this thesis provides you with valuable insights and information.

I also would like to thank Bertien Broekmans, Bert Enserink and Wil Thissen for their help and comments during the committee meetings.

My research would not have been possible without the interviews I have conducted. I would therefore really like to thank my interviewees Erik Gloudemans, Jaap Kwadijk, Willem Ligtvoet, Marianne Linde-Kuipers, Anna Steynor and Roger Street.

Besides being the final work of my master in engineering and policy analysis, this thesis also marks the end of my long career as a TU Delft student. A career that has not been easy for most of the time. I would really like to thank my parents for their never ending support during these years.

Last but not least, I would like to thank Arjan for always standing by my side in the past years and of course for checking my thesis on grammar and spelling.

Linneke vd Veeke  
Delft, 2011

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# **Chapter 1 Introduction**

## **1.1 KNMI and Climate scenarios**

The KNMI (Royal Dutch meteorological institute) is in the Netherlands responsible for the creation and publication of climate scenarios (KNMI 2006). Because of the many and large uncertainties associated with future climate change, it is impossible to give precise predictions of the future climate. Information about future climate change is therefore represented in the form of climate scenarios (KNMI 2006). It is even impossible to attach probabilities to future climate change (Dessai and Hulme 2004). Climate scenarios are therefore meant to provide policy makers with a range of possible futures (Hulme and Dessai 2008b).

Climate scenarios are used in practice for different purposes: for instance in engineering design, policy development, issue framing and impact assessment (Hulme and Dessai 2008a). Despite attempts to mitigate climate change at least some climate change will be inevitable in the future (Christensen, Hewitson et al. 2007). This makes adaptation of society to climate change urgent and important (Hulme and Dessai 2008a). Climate scenarios inform adaptation policy analysis and also support decision making in climate adaptation. They help policy makers answer questions like: Is my system vulnerable to climate change? What are possible solutions to my vulnerabilities? Which solutions work best under a range of future climates? Decision making is the selection step in analysis and design (Walker 2000). Although analysis and decision making are in theory often represented as separate steps, in practice they can be intertwined, because policy analysis and decision making can be an iterative process. In chapter 2 decision making approaches for climate adaptation are presented.

KNMI has published their first set of scenarios in 2001. In 2006 they published their second and most recent set of scenarios. These scenarios are often called the KNMI06 scenarios. The first set (called the WB21 scenarios) was specifically created for the Dutch water management sector (Kors, Claessen et al. 2000). The second set is aimed at a wider audience, but is still very important to the Dutch water management sector (KNMI 2009; National Waterplan 2009). The National Waterplan contains the measures that need to be taken from 2009 to 2015 to keep the Netherlands safe and livable. (National Waterplan 2009). The National Waterplan prescribes the use of the KNMI scenarios for the Dutch water management sector and gives guidelines on how to use the scenarios.

The aim of the KNMI06 scenarios is to sketch a range of possible futures. Ideally all scenarios are used in decision making to make decisions as robust as possible (KNMI 2009). Robust decision making means, choosing the alternatives, which function well under a range of possible futures (Lempert and Schlesinger 2000). The perspective of KNMI on the use of climate scenarios can be seen in Textbox 1-1, where an excerpt of the 'suggestions for use' provided with their scenarios by KNMI, can be read.

*"The four KNMI06 climate scenarios are chosen in such a fashion that they span with 4 corners a large part of the possible future. Based on the goal of policy studies it is in most cases useful to use all four scenarios. By comparing the scenarios, it is possible to determine how robust different policy options are. Policy options that work well under all four scenarios are often the most interesting to policy makers."*(KNMI 2009)

KNMI observes that the use of their scenarios is not according to their expectations. In practice often only one scenario is used and this scenario is then used as a prediction of the future. Users often expect that they can use the scenario as predictions and become dissatisfied with the scenarios if this turns out not to be the case (J. Bessembinder, 2010, pers. comm., 19 March).

The use of only one scenario undermines the goal of the KNMI scenarios, because than only one future is taken into account instead of a range of possible futures. Not taking into account the range of possible futures in case of an uncertain future in decision making can lead to seriously wrong decisions (Walker, Rahman et al. 2001). This is why the choice of one scenario is perceived to be a problem by KNMI.

The WB21 scenarios consisted of three scenarios: low, middle and High. When this set was still in use often the middle scenario was chosen (National Bestuursakkoord Water<sup>1</sup> 2003). KNMI tried to solve this problem when publishing the KNMI06 scenarios by publishing a set of four scenarios without a middle scenario. (J. Bessembinder, 2010, pers. comm., 19 March). This didn't solve the problem, because now often the scenario that resembles the old middle scenario the most, is chosen (National Waterplan 2009).

In 2013 KNMI wants to present their next generation climate scenarios. They want to design these scenarios in such a way that they are used better. Better in this sense means that not one scenario is chosen and used as a prediction (J. Bessembinder, 2010, pers. com., 19 March). In Great-Britain in 2009 scenarios were published that contained probabilistic data on the scenario variables (Jenkins, Murphy et al. 2009). This means that these scenarios represent the uncertainty that is present, differently. These scenarios are called the UKCIP09 scenarios or the UKCIP09 climate projections.<sup>2</sup> A different representation of uncertainty as is done by UKCIP09 might help improve the use of the climate scenarios, because it could help making people more aware of uncertainty. In this research the differences between UKCIP09 and KNMI in terms of the representation of uncertainty are investigated. Several elements were identified that could be adopted in KNMI13.

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<sup>1</sup> The national bestuursakkoord water (agreement on national water governance). Is an agreement between different parties active in Dutch water management, on a joint approach to water problems.

<sup>2</sup> In the UK these scenarios are called projections, but in this thesis they are called scenarios, because in the Netherlands they would be considered scenarios and not projections.

Although the 2006 scenarios were targeted at a larger audience, water management is still an important user of climate scenarios (National Waterplan 2009). With a significant part of the country below sea level global warming and sea level rise have important consequences for the Dutch flood protection (Huisman 2004). Organizations in Dutch water management have a policy obligation to adapt to climate change (Nationaal Bestuursakkoord Water 2003; National Waterplan 2009). Users from the Dutch water sector are therefore in this research used as a the research target group. In the National Waterplan it is agreed that the KNMI06 scenarios will be used in Dutch watermanagement and it also prescribes how the scenarios should be used. The National Waterplan will be further discussed in chapter 4. The scenarios are in Dutch water management used for climate adaptation (National Waterplan 2009). This research will therefore focus on climate adaptation and not on climate mitigation.

This makes the main question of the research:

*What elements of UKCIP09, like for instance: scenario design choices with respect to uncertainty and guidance provided with the scenarios, should be adopted in KNMI13?*

This leads to several sub questions

1. Which different approaches are there to climate change adaptation and how does this influence the use of climate data? (Chapter 2)
2. How do the UKCIP09 and KNMI06 scenarios compare in terms of the representation of uncertainty, guidance provided with the scenarios? (Chapter 3)
3. How are climate scenarios applied in Dutch water management? And what are the reasons for this application? (Chapter 4)
4. Will a UKCIP approach in terms of scenario design or guidance change the use of the climate scenarios? And if so which elements are to be adopted? (Chapter 4)
5. How do UKCIP09 and KNMI06 compare in terms of organizational arrangements and what can be learned from this?(chapter 3 and chapter 6)

The fifth question arose later during the research when it became clear that KNMI and UKCIP are different organizations. KNMI is a governmental agency, belonging to the Ministry of Infrastructure and Environment (previously Ministry of Transportation, Water Management and Public Works). KNMI's task is to provide weather information to the general public, government (both national and regional), the aviation industry and the shipping industry. Providing meteorological information is their legal task to ensure the safety of the Netherlands and its inhabitants (wet op het KNMI)<sup>3</sup>. Climate research is conducted to be able to adequately forecast the weather in the future. KNMI is the

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<sup>3</sup> Wet op het KNMI means law on KNMI. It is the law that determines KNMI's tasks.

research institute in the Netherlands for weather, climate and seismology. However because KNMI also has a public task it is a governmental agency ( [http://www.knmi.nl/over\\_het\\_knmi](http://www.knmi.nl/over_het_knmi), 13 December 2010).

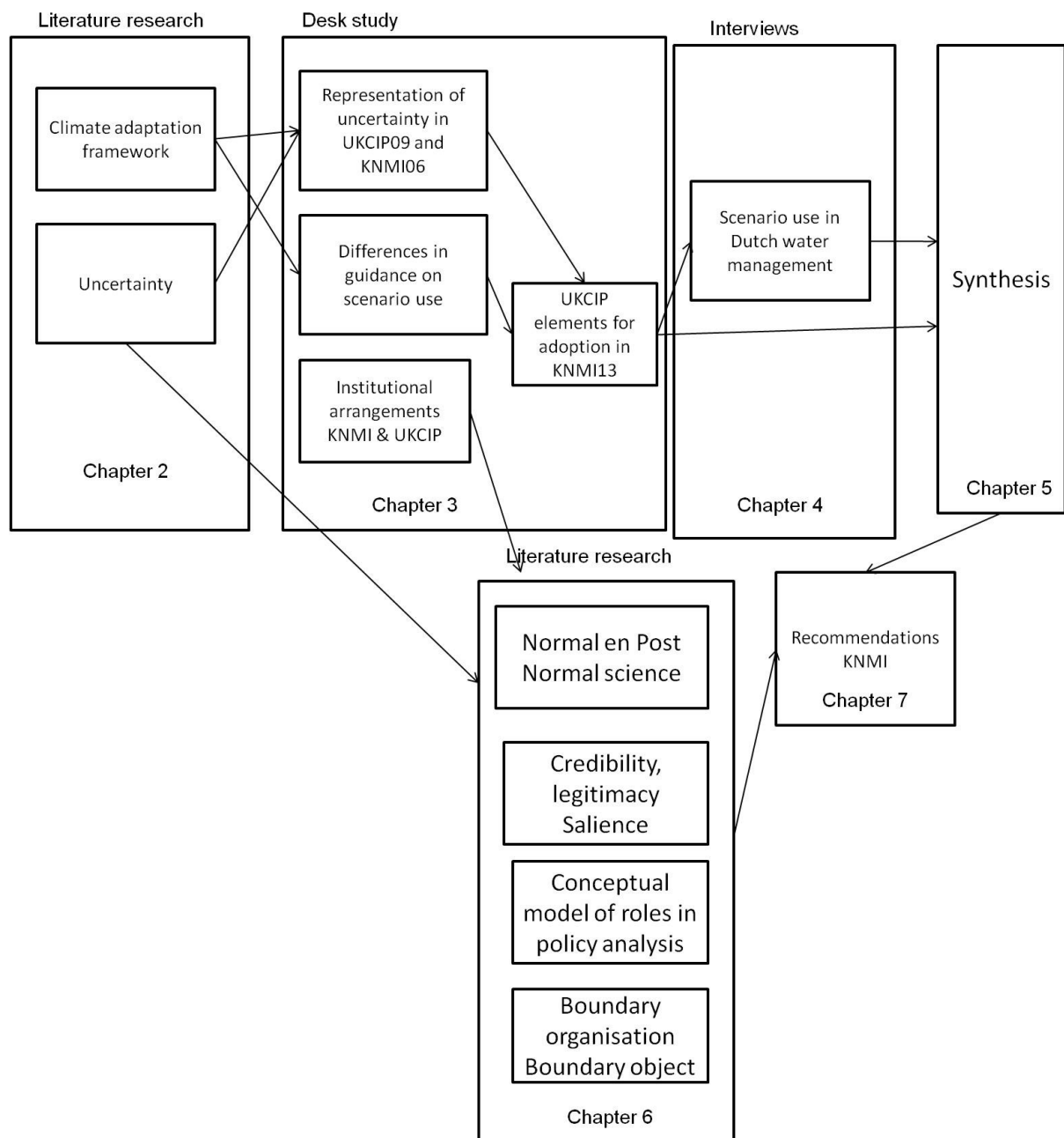
During the course of the research it became clear that UKCIP (UK Climate Impacts Programme), the organization responsible for the publication of the UKCIP09 scenarios is a different organization. UKCIP is a programme established by Defra (Department of Environment, Food and Rural Affairs). The main goal of UKCIP is to help the UK adapt to climate change and to facilitate decision making about climate change( <http://www.ukcip.org.uk>, 13 December 2010). UKCIP gets the climate data for the scenarios from the British Met Office (Jenkins, Murphy et al. 2009). They are more the publishers of the scenarios than the makers of the scenarios. The organization sits between climate science and policy makers (A Steynor and R Street, 2010 pers. comm., 22 July 2010).<sup>4</sup> During the research it also became clear that UKCIP provides more and different guidance with their scenarios.

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<sup>4</sup> See appendix A

## 1.2 Research methodology

An overview of the research is given in Figure 1-1.



**Figure 1-1 Research overview**

The research questions were answered with the help of literature research, a desk study and with interviews. The literature study was used to define the concepts of uncertainty and dealing with uncertainty in preparation of the desk study. Also the concept of uncertainty needed to be defined to investigate the role of uncertainty in conceptual models of the science policy boundary in chapter 6. Literature was also used to examine different approaches to climate change adaptation, because different approaches may place different demands on climate scenarios and can therefore influence the design of climate scenarios.

The comparison between UKCIP09 and KNMI06 was made with help of a desk study and is mainly based on documents provided with the scenarios. Additional information for the comparison between UKCIP09 and KNMI06 was acquired from a semi open interview with the publishers of the UKCIP09 scenarios. The purpose of the desk study was initially to only compare UKCIP09 and KNMI06 in terms of how they represent the uncertainty associated with climate change. Based on this comparison scenario design elements of UKCIP09, could be identified that could help in improving the use of climate scenarios in Dutch water management. Later also the guidance was included in the research and more guidance on how to use the scenarios, was also identified as an element that could be adopted in the scenario design. As mentioned in section 1.1 during the research it became clear that there were also significant other differences between UKCIP and KNMI. The comparison between these two organizations is used later to determine if organizational factors play a role.

Some questions about the use of climate scenarios in Dutch water management and the usefulness of particular elements of UKCIP09 could not be answered with literature alone. For that reason interviews were conducted with people working in Dutch water management. The interviews were used to get insight in the use of climate scenarios in Dutch water management and to answer the question if particular UKCIP09 elements could change this use. The literature research and the desk study provided additional input to the interviews, for instance the question if more guidance was desired by the users. The interviews were semi open in form. A list of open questions was used, but interviewees were encouraged to talk about issues not present in the question list. This in order to support the inductive character of the research.

The interviewees were selected on the purpose of their use of climate scenarios.(Table 1-1) Both people working on regional and on national scale were selected. A distinction was made between scenario use for analysis and for design. Organisations that use scenarios for analysis are found among the research institutions that support the government in policy analysis. Design is more common among those governments that are responsible for policy implementation and design of water works, for example waterboards.

In Table 1-1 an overview of the interviewees can be seen. In chapter 4 a more detailed overview of the organisations these people work for, and differences in purpose are given.

**Table 1-1 Overview of interviewees**

| <b>Name</b>            | <b>Organisation</b>                                                            | <b>Purpose</b>                  |
|------------------------|--------------------------------------------------------------------------------|---------------------------------|
| Jaap Kwadijk           | Deltares                                                                       | National and regional/strategic |
| Willem Ligtvoet        | Plan bureau voor de leefomgeving.(Netherlands environmental assessment agency) | National/strategic              |
| Erik Gloudemans        | UVW (Union of waterboards)                                                     | Regional/design                 |
| Marianne Linde-Kuipers | Geodan                                                                         | Regional/strategic              |

To answer the question about what could be learned from the organizational differences, a second literature research was done. Based on the outcome of the initial comparison between UKCIP and KNMI it became clear that organizations at the science policy boundary can have different roles. To clarify this two different conceptual models of the science policy boundary are introduced, namely normal and post normal science. With the help of policy analysis literature different roles of organizations and analysts at the science policy boundary are introduced to explain the differences between UKCIP and KNMI. Another approach used comes from the social studies of science in the form of the boundary organization concept. Based on these two approaches recommendations could be devised about the organizational arrangements for the making and publishing of climate scenarios in the Netherlands in relation to the problem as it is perceived by KNMI.

Related to the boundary organization concept is the boundary object concept. This concept is used to support recommendations on how to improve the design of climate scenarios. Also the normal and post normal model have implications for the quality of scientific information. With help of the concepts of credibility, salience and legitimacy these consequences are applied to climate scenarios in order to answer the question on how to improve the scenario design in general.

### **1.3 Structure of the report**

Chapter 2 defines the concept of uncertainty and describes different approach to climate adaptation. The chapter also provides a definition for the concept of uncertainty and gives information about uncertainty in climate change. These concepts will be used in Chapter 3 which describes how UKCIP09 and KNMI06 compare in how they represent uncertainty and the differences in guidance provided with the scenarios. This chapter also discusses the organizations responsible for the publication of the scenarios. Chapter 4 describes how climate scenarios are used in Dutch water management and what the reasons are for this use and what elements of UKCIP09 can help to change this use. Based on the answers in Chapter 4 it was deemed useful to devise a new research question. In Chapter 5 this research question is described together with several issues that became apparent during the course of the research. Based on the new research question additional literature research was done, which is described in Chapter 6. Chapter 7 presents the conclusions and recommendations.

## Chapter 2 Uncertainty and climate change adaptation.

This chapter defines the concept of uncertainty and describes approaches to climate change adaptation. In essence climate adaptation is always decision making under uncertainty. The uncertainty concept as it is defined here is used in Chapter 3 to explain the representation of uncertainty in UKCIP09 and KNMI06. It is also used later in Chapter 6 because uncertainty in scientific information influences the science policy boundary. The climate adaptation approaches are discussed, because the chosen strategy influences the use of climate scenarios.

### 2.1 Uncertainty

Uncertainty can be defined as: *"any deviation from the unachievable ideal of complete determinism."* (Walker, Harremoës et al, 2003, p2)

In the past years research has been done in the field of complex risks and uncertainty has provided with the following key insights (Van der Sluijs 2006):

- *"Uncertainty is partially socially constructed and its assessment always involves some subjectivity."*(Van der Sluijs 2006, p67)
- Contrary to what is often thought more research does not necessarily reduce uncertainty. It often reveals complexities that weren't foreseen before.(Van der Sluijs 2006) An example of this can be seen in Textbox 1-1.
- *"Uncertainty is more than statistical errors or inexactness: it is increasingly understood as a multi-dimensional concept involving quantitative and qualitative dimensions."* (Van der Sluijs 2006, p67)
- Most of today's uncertainty assessment methods focus on the part of uncertainty that is quantifiable. While in problems where there are high system uncertainties, knowledge gaps and high decision stakes the unquantifiable aspects may be far more important (Van der Sluijs 2006).

*"We are confident that the uncertainties can be reduced by further research"*  
(IPPC first assessment report 1990)

*"It is unlikely that uncertainties surrounding climate change will be decreased significantly in the short term future"*(IPPC fourth assessment report 2007)

#### Textbox 2-1 View on uncertainty in different IPCC reports

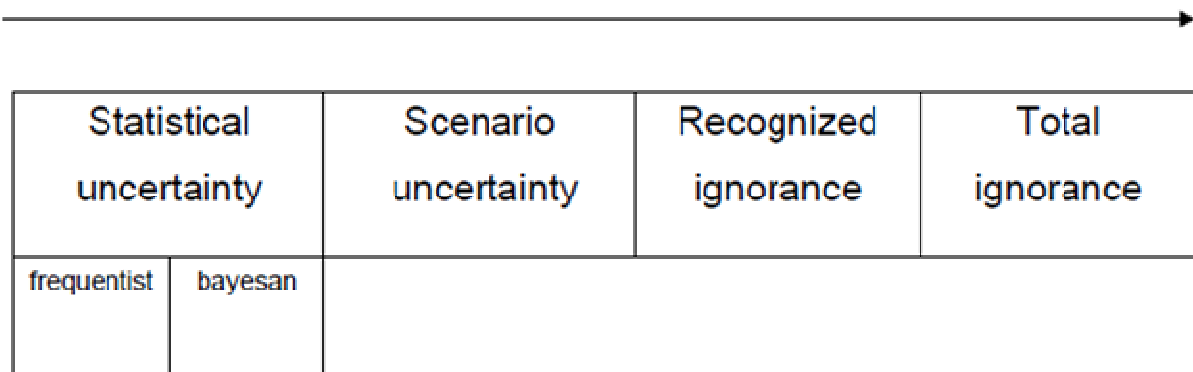
A multidimensional topology was developed by Walker, Harremoës et al (2003) to classify and investigate uncertainty from the viewpoint of policy analysis.

They classify uncertainty on three dimensions: location (where the uncertainty occurs for instance model or input data), nature (is the uncertainty caused by a lack of knowledge or by natural

variability) and level (how uncertain is the uncertainty?). For this thesis only the level of uncertainty is of real importance. Walker, Harremoës et al (2003) discern four levels of uncertainty:

1. Statistical uncertainty: *"any uncertainty that can be described in uncertain terms"*(Walker, Harremoës et al, 2003, p8), i.e uncertainty that can be described in probabilistic terms.
2. scenario uncertainty: *"there is a range of possible outcomes and mechanisms leading to this range are not well understood"* (Walker, Harremoës et al, 2003, p8)
3. recognized ignorance: *"is fundamental uncertainty about mechanisms and relations being studied"* (Walker, Harremoës et al, 2003, p8)
4. Total ignorance: is very deep uncertainty where it is unknown what is unknown.(Walker, Harremoës et al. 2003)

Although the concept of a probability seems rather straightforward it has different interpretations. There are generally two different views on probabilities: the frequentist, where it is seen as a physical property of the system and subjective (Bayesian) view, where it is more a measurement of the state of knowledge. The Bayesian probabilities, because they are more subjective, are seen as more uncertain than frequentist probabilities. Because of this and because subjective probabilities are used in climate science it is useful to subdivide statistical uncertainty in frequentist and Bayesian statistical uncertainty (Dessai and Hulme 2004).



**Figure 2-1 Overview of probabilities and other methods to present outcomes (Dessai and Hulme 2004)**

The level of uncertainty was explicitly discussed here because it has the highest consequences for the communication between scientists and policy makers. According to (van der Sluijs 2006), scientists primarily focus on statistical uncertainty, while the impacts of the higher levels of uncertainty on the success of a policy are far more profound. Uncertainty that is of a higher level than statistical uncertainty is in this thesis referred to as deep uncertainty.

## **2.2 Climate adaptation and decision making under uncertainty**

### *2.2.1 Scenario analysis*

There are different methods for the assessment of uncertainty, one of them is scenario analysis. The concept of scenario analysis comes from the field of strategic management and was made famous for helping Royal Dutch Shell profit from the first oil crisis. Scenarios are often used when it is impossible to attach probabilities to possible futures. A scenario is a plausible image of the future state of the system. It is not a prediction, but it shows what could happen. The plausibility is what distinguishes it from fiction. Scenario analysis can have different goals. It can be used to raise awareness or to make an impact assessment of for instance climate change. Because of the diversity in types of use as can be read in Textbox 2-2, there is not really a set of strict guidelines on how scenarios should exactly be used in practice (Swart, Raskin et al. 2004; Heijden 2005).

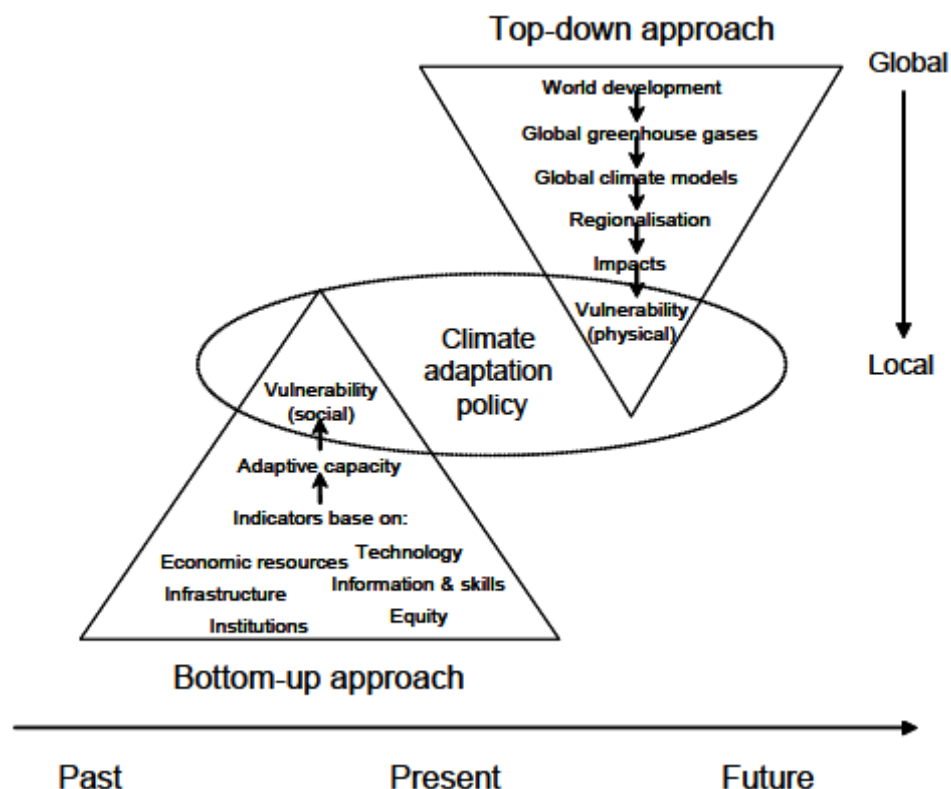
The most famous example of scenario analysis are the Royal Dutch Shell energy scenarios. In the early seventies Shell had devised several scenarios on how the energy/ oil market could evolve. Managers were encouraged to test their decisions against these scenarios and to choose options that worked best in most scenarios. This also made the company aware of its vulnerabilities to particular events. One of the scenarios included a serious increase in the oil price, because of events in the Middle-East. In particular this scenario enabled Shell to withstand the oil crisis better than most other oil companies and to even profit from it (Heijden 2005).

A second quite famous example of scenario analysis are the Mon Fleur scenarios. They were used and made during the abolishment of apartheid in South Africa and provided insight in how the country could develop. The country was at the time deeply divided. A wide range of people participated in making them. This was already a first step to overcome conflict between different groups. Only one scenario of the four led to a really desirable outcome for the country and this required cooperation between different groups. The fact that the scenario analysis highlighted that only by working together there would be a desirable outcome helped bridge the gap further between different groups (Heijden 2005).

policy makers. It is also important that the scenarios span the range of possible future as well as possible (Dessai, Lu et al. 2005).

### *2.2.2 Decision making in climate change adaptation*

Decision making in climate change adaptation is decision making under uncertainties. Two approaches have developed over time for approaching climate change adaptation. A top-down approach and a bottom-up approach (Dessai and Hulme 2004).



**Figure 2-2 Approaches to climate adaptation (Dessai and Hulme 2004)**

These two approaches deal differently with uncertainty. The top-down approach is prediction oriented and tries to reduce the uncertainty that is present, by means of quantification. The bottom-up approach accepts uncertainty more as a fact of life and tries to adapt to system in such a way that it can handle surprises. These two approaches demand different things from climate information particularly from the top-down perspective there is a strong need to attach probabilities to climate change. These methods need climate data to 'predict' vulnerabilities in the system. With the bottom-up approaches the starting point is finding first the vulnerabilities in the system (Dessai and Hulme 2004). There are also approaches that incorporate both top-down and bottom-up elements, these strategies will be referred to as mixed approaches. In the next section several examples of climate change adaptation strategies are discussed. These strategies are: risk approaches, resilience, adaptive management, robust decision making and the adaptation policy framework (Dessai and Van der Sluijs 2007).

## Risk approaches

Risk approaches belong to the top-down category. Risk approaches are "*Environmental risk management or risk assessment is the process of identifying, evaluating, selecting, and implementing actions to reduce risk to human health and to ecosystems.*" (Jones 2001 p197) The goal of risk assessment is to manage uncertainties in such a way that the risk of a particular event, in this case climate change and its consequences can be determined. When the risk a particular event poses, is identified appropriate action can be taken if necessary. The most basic definitions of risk is: the chance of a certain event occurring times the consequences of the occurrence of this event, but different professions use different.

Risk management for climate change is difficult, because there are many uncertainties about climate change. It is currently still impossible to attach probabilities to certain levels of climate change (Dessai and Hulme 2004; Dessai and Van der Sluijs 2007). Different risk approaches for climate change impacts have developed over the years. Climate scenarios often play an important role in these risk frameworks. An example of one of these risk frameworks is the UKCIP risk management framework. This framework consists of several steps (Willows and Connell 2003; Dessai and Van der Sluijs 2007):

1. Identify the problem and objectives.
2. Establish your risk tolerance level and decision-making criteria.
3. Identify and assess your risks.
4. Identify a range of adaptation options.
5. Appraise your adaptation options.
6. Make a decision.
7. Implement the decision.
8. Monitor the decision and for new information.

Climate scenarios do not form a specific step within this framework, but climate scenarios are suggested as a one tool among others in step 3. UKCIP suggests different level of analysis, based on: the level of the decision, the understanding of the impact climate change has on the decision by the decision maker. Also whether the decision is an adaptation decision or a climate influenced decision plays a role in this choice. (Willows and Connell 2003; Dessai and Hulme 2004; Dessai and Van der Sluijs 2007)

The tools to analyze and possibly quantify risk are divided into three tiers, based on this different level of analysis. The tools in the first tier are directed at risk screening. The second tier consists of tools for qualitative risk assessment and the third tier contains the tools directed at quantitative risk assessment (Willows and Connell 2003; Dessai and Hulme 2004; Dessai and Van der Sluijs 2007).

Scenarios are an important tool present in all three tiers of risk analysis. The first tier is the risk analysis phase and here the scenarios can be used to identify climate variables that could influence the decision. In the higher tiers the scenarios are used more as decision making tools. It is not entirely clear if they are used really differently within each tier (Dessai and Hulme 2004).

One of the reasons for UKCIP to publish scenarios with probabilities can be traced to the risk approach. The inclusion of probability density curves allows users to choose and determine their own level of risk. This is considered very important in their risk approach (A Steynor and R Street, 2010 pers. comm., 22 July 2010).

### Resilience

Resilience is a bottom-up approach and can be defined as the capacity of a system to tolerate disturbance without collapsing.

Six general principles of resilience have been formulated. These principles help to increase the adaptive capacity of the system and help to recover quicker from a disturbance (Barnett 2001; Dessai and Van der Sluijs 2007; Wardekker, de Jong et al. 2010).

1. *"Homeostasis (multiple feedback loops stabilize the system);*
2. *Omnivory (external shock mitigated by diversification of resources and means);*
3. *High flux (a fast rate of movement of resources through the system ensures fast mobilisation of these resources to cope with perturbation);*
4. *Flatness (hierarchical level relative to base should not be top-heavy, overly hierarchical systems are less flexible and hence less able to cope with surprise and adjust behaviour);*
5. *Buffering (systems with a capacity in excess of its need are more resilient); Redundancy (overlapping functions, if one fails, others can take over)"* (Dessai and Van der Sluijs 2007 p40)

### Adaptive management

Adaptive management is characterized by an ongoing learning process and a stepwise approach to adaptation. It is a bottom-up approach and it incorporates an experimental way of learning to deal with uncertainties. This approach tries to ensure maximum flexibility and tries to avoid lock in. According to Dessai and Van der Sluijs (2007) the main criticism to this strategy is that it is likely to fail in case of surprises and discontinuities in the system response (Dessai and Van der Sluijs 2007). The lack of evaluation frameworks is also mentioned as a problem, when using this approach in practice (Gregory, Failing et al. 2006).

## Robust decision making

Robust decision making is a mixed approach. For a policy option to be robust it must be compatible with multiple possible futures. To find robust options the entire uncertainty space should be explored (Lempert and Schlesinger 2000). For a solution to be entirely robust it should be working under the complete uncertainty space. In practice however this is not always feasible, for instance when possible futures are each others opposites. Robustness can be achieved in multiple ways for instance by over dimensioning designs or by implementing flexible solutions. Robustness is the decision method, that is more or less advocated by KNMI. It is the idea that lies behind the recommendation that all four KNMI scenarios should be used in decision making (Dessai and Van der Sluijs 2007).

## The adaptation policy framework

The adaptation policy framework starts from the vulnerabilities of a system to current climatic conditions. Often systems are not adapted very well to the current climate let alone to a future changed climate (which might be more extreme). It starts from the assumption that being well adapted to the current climate, already makes a system less vulnerable to a changing climate. UKCIP uses this approach alongside and with their risk approach framework. The adaptation policy framework is also a mixed approach. (Dessai and Van der Sluijs 2007).

### *2.2.1 Conclusions regarding decision making under uncertainty*

This chapter have discussed the use of scenario analysis and several decision frameworks for deciding under uncertainty. These frameworks differ in how suitable they are for each level of uncertainty.

Dessai and Van Sluijs (2007) have rated the suitability of the decision strategies for different levels of uncertainty as can be seen in Table 2-1.

|                             | Statistical uncertainty | Scenario uncertainty | Recognized ignorance |
|-----------------------------|-------------------------|----------------------|----------------------|
| Risk approaches             | ++                      | +                    | --                   |
| Resilience                  | ±                       | +                    | ++                   |
| Adaptive management         | ++                      | -                    | --                   |
| Adaptation policy framework | +                       | +                    | +                    |
| Robust decision making      | +                       | ++                   | +                    |

**Table 2-1 A qualitative indication how well each decision framework Works with each of the three levels of uncertainty. ++ very good, + good, ± somewhat, - bad, - very bad.**

These different framework also ask for different climate types of climate information. The fact that UKCIP reasons from a risk approach and the KNMI from a robustness approach leads them to make different scenarios.

## **2.3 Conclusions on uncertainty and climate change adaptation.**

In this chapter the concept of uncertainty has been defined as a multidimensional concept. It is more than natural variability and more scientific research will not necessarily reduce the uncertainty. There is uncertainty that cannot be expressed in probabilities anymore. This uncertainty is in this thesis referred to as deep uncertainty. The uncertainty associated with climate change is this deep uncertainty, because it is still impossible to attach probabilities to certain amounts of climate change.

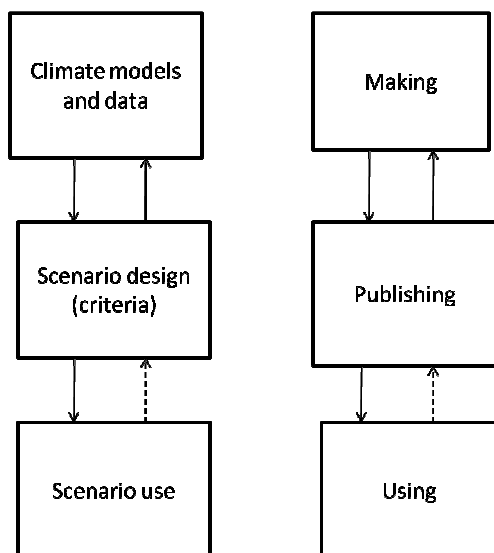
There are different approaches to climate adaptation, these approaches deal with uncertainty in a different way. These approaches can be divided into two groups top-down approaches and bottom-up. These two groups have different attitudes towards uncertainty. The top down approaches try to contain the uncertainty by quantifying it first. The bottom up approaches accept uncertainty more as a fact of life. In the Netherlands a robustness approach is used in the UK a risk based approach.

## Chapter 3 Comparison between UKCIP09 and KNMI06.

This chapter describes the differences between UKCIP09 and KNMI06 on how they represent uncertainty, the guidance provided with the scenarios and organizational differences. To be able to describe the differences between UKCIP09 and KNMI 06 adequately first the scenario creation process and the uncertainties associated with climate change are discussed. This is done in section 3.1 and in section 3.2 respectively. Also possible design choices and elements of climate scenario need to be discussed first, which is done in section 3.3 In section 3.4 the differences between KNMI06 and UKCIP09 in terms of the representation of the earlier discussed uncertainties, is described. In section 3.5 the guidance provided with the scenarios is discussed. And finally in section 3.6 the organizational differences between UKCIP and KNMI are described.

### 3.1 Climate scenarios from making to using

The complete process from climate model to scenario use can be divided in three phases.



**Figure 3-1 An overview of the scenario making and using process.**

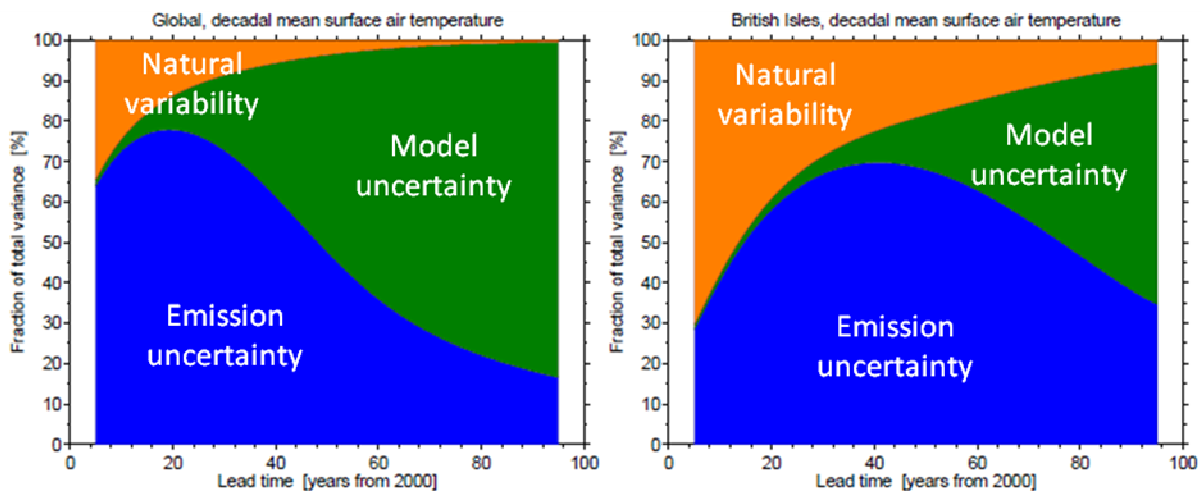
The first stage is the making stage, this is stage in which climate models are run and datasets are created with climate data for the scenarios. The next step is named the publishing step in this research in this phase the datasets are represented in scenarios and the design and design criteria of the scenarios are determined. This is of course in practice an iterative process. The next step is the use in practice of the scenarios. The design will determine partly how the scenarios are used. Ideally the use in practice could also determine some of the design criteria (Jenkins, Murphy et al. 2009).

### 3.2 Uncertainty in climate change

Uncertainty has been defined earlier *as any deviation from the unachievable ideal of complete determinism*. (Walker, Harremoës et al. 2003). There are three major uncertainties in climate change namely:

- Natural climate variability
- Incomplete understanding of the climate's system
- Uncertainty about future greenhouse gas emissions (Hawkins and Sutton 2009)

First the natural variability and uncertainties in climate models are more important later on the uncertainty about future green house gasses becomes more important. (Figure 3-2)



**Figure 3-2 Importance of different uncertainties in time (Hawkins and Sutton 2009).**

These uncertainties are presented differently in the UKCIP09 scenarios and the KNM06 scenarios.

### 3.3 Climate scenario design choices

Climate scenarios consists of two features: driving forces and climate variables. The driving forces are factors that are uncertain and serve as the starting point of the scenario. An example of different driving forces are for instance greenhouse gas emissions and temperature increase. These driving forces represent one or more of the main uncertainties in climate change, which were described in section 3.2. When emission uncertainty is the driving force of a set of scenarios, the emission uncertainty is treated separately. If temperature increase is the driving force, all the three uncertainties are captured together in the driving force (Jenkins, Murphy et al. 2009; KNMI 2009).

A scenario set consists of several scenarios with the same driving forces, but these driving forces have different values, so that the variables have different values. Based on different values for these driving forces climate variables like mean summer precipitation are calculated. In Figure 3-3 an example of a fictious set of climate scenarios is shown. The driving force is the temperature increase indicated with red the change in summer precipitation is a scenario variable that depends on the temperature increase (it is indicated in blue) (Jenkins, Murphy et al. 2009; KNMI 2009).

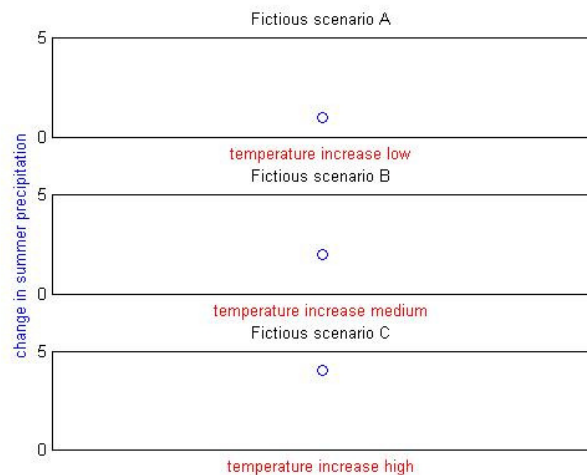


Figure 3-3 example of a set of fictitious climate scenarios

### 3.4 The representation of uncertainty in KNMI06 and UKCIP09

#### 3.4.1 KNMI06

KNMI has represented the main climate change uncertainties with the help of two driving forces. The first driving force is temperature increase and the second is a change in the air circulation pattern in Western Europe. To establish the temperature change KNMI uses the global temperature increase range established by the IPCC based on the emissions scenarios and several global climate change scenarios. The KNMI tries to cover 80 percent of that range by giving the scenarios either 2 degree increase or a 4 degree increase in 2100 (Figure 3-4) (KNMI 2009).

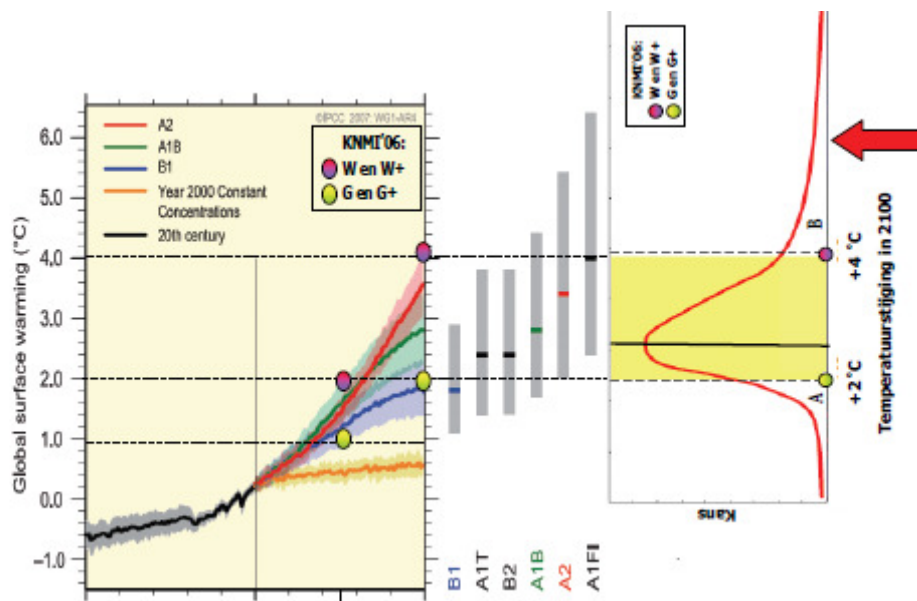


Figure 3-4 Temperature range of KNMI06 scenarios (KNMIreport:223 2009)

In the temperature driving force, they capture both the uncertainty about the future green house gas emissions and the uncertainty caused by lack of knowledge about the climate system. The second driving force is a change in the air circulation in Western Europe. This can change or it won't. With this second driving force they capture more of the uncertainty due to model uncertainty. This results in four scenarios, as can be seen in Figure 3-5 (KNMI 2009). KNMI gives one value for each variable per scenario as is indicated by the single point value in Figure 3-5.

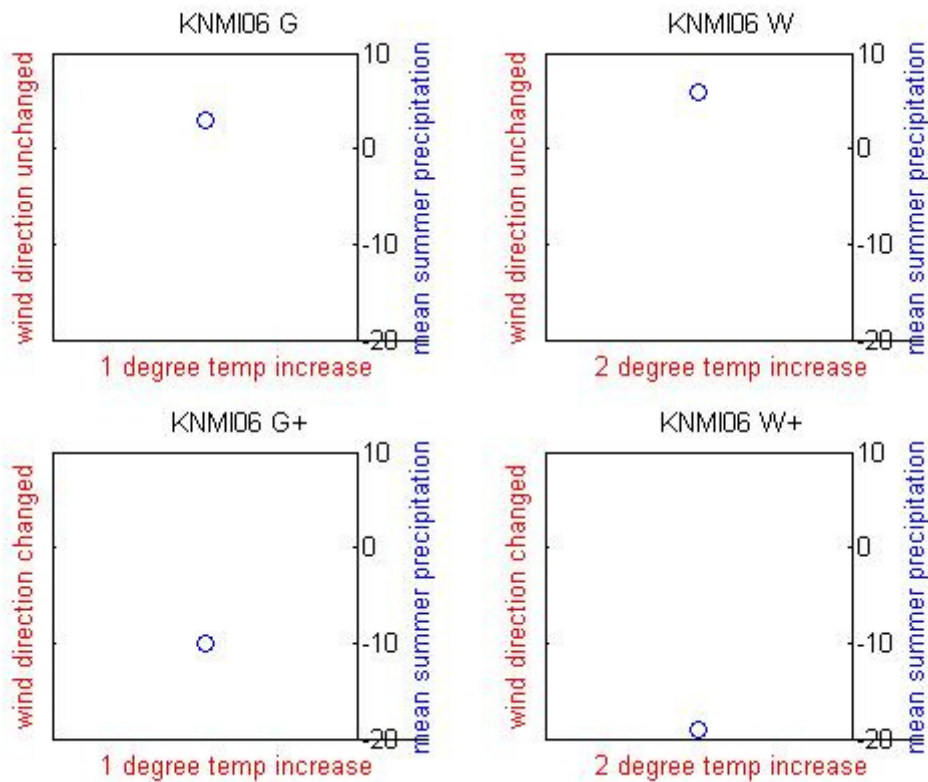


Figure 3-5 the KNMI06 scenarios adapted after KNMI 2009

As discussed earlier in chapter 2 uncertainty is a multiple dimensional concept and this chapter also presented a multidimensional topology of uncertainty by (Walker, Harremoës et al. 2003). This topology defines uncertainty in terms of location in the model, type and nature. In Table 3-2 it is indicated how the three main uncertainties in climate change are represented in terms of location in the scenarios and type. In the KNMI scenarios all three uncertainties are located in the driving forces. All three uncertainties are represented as scenario uncertainty.

Table 3-1 Location and type of the three main uncertainties in climate change as represented in KNMI06

| Emission uncertainty |                      | Natural variability |                      | Model uncertainty |                      |
|----------------------|----------------------|---------------------|----------------------|-------------------|----------------------|
| Location             | Type                 | Location            | Type                 | Location          | Type                 |
| Driving forces       | Scenario uncertainty | Driving forces      | Scenario uncertainty | Driving forces    | Scenario uncertainty |

### 3.4.2 UKCIP09

The UKCIP 2009 scenarios treat the uncertainties differently. The future green house gas emissions are the only driving force of the scenarios (indicated in red in Figure 3-6). This driving force is based on the IPCC emission scenarios. Emission uncertainty is more explicitly shown than in KNMI06. The model and natural variability uncertainty are represented by giving for each variable in the scenarios a probability density curve (as is indicated with blue in Figure 3-6). In contrast with the KNMI06 scenario where there is only one value given per scenario for each variable (Murphy, Sexton et al. 2009).

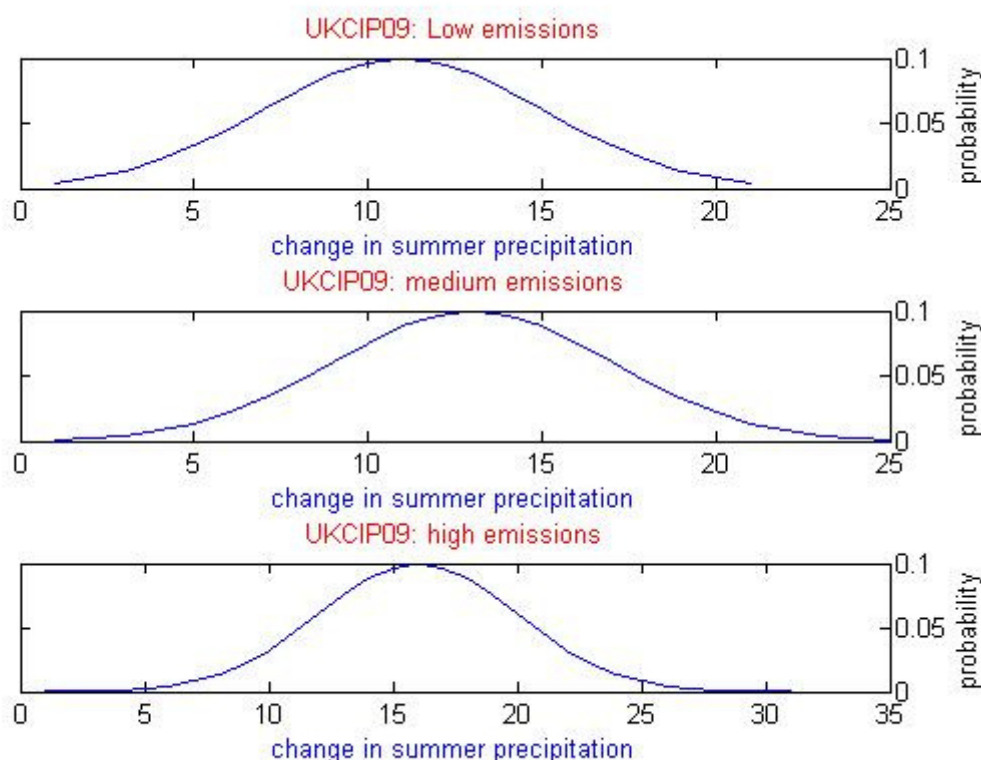


Figure 3-6 Overview of the UKCIP09 scenarios adapted after Murphy Sexton et al. 2009

UKCIP09 represents the natural variability and model uncertainty differently in terms of location and type of uncertainty than KNMI06. In UKCIP09 these two uncertainties are located in the variables instead of the driving forces. Also in UKCIP09 they are represented as statistical uncertainty instead of scenario uncertainty.

Table 3-2 Location and type of the three main uncertainties in climate change as represented in UKCIP09

| Emission uncertainty |                      | Natural variability |                                    | Model uncertainty |                                    |
|----------------------|----------------------|---------------------|------------------------------------|-------------------|------------------------------------|
| Location             | Type                 | Location            | Type                               | Location          | Type                               |
| Driving forces       | Scenario uncertainty | Variables (pdf)     | Statistical uncertainty (Bayesian) | Variables (pdf)   | Statistical uncertainty (Bayesian) |

### 3.5 What guidance is provided with the scenarios?

#### 3.5.1 The guidance provided with UKCIP09

##### Introduction

The UKCIP guidance is based on the UKCIP risk approach, which was described earlier in section 2.2.2. The guidance consists of several elements as can be seen in Figure 3-7. For most steps there are tools and documents available, these tools and documents are discussed below.

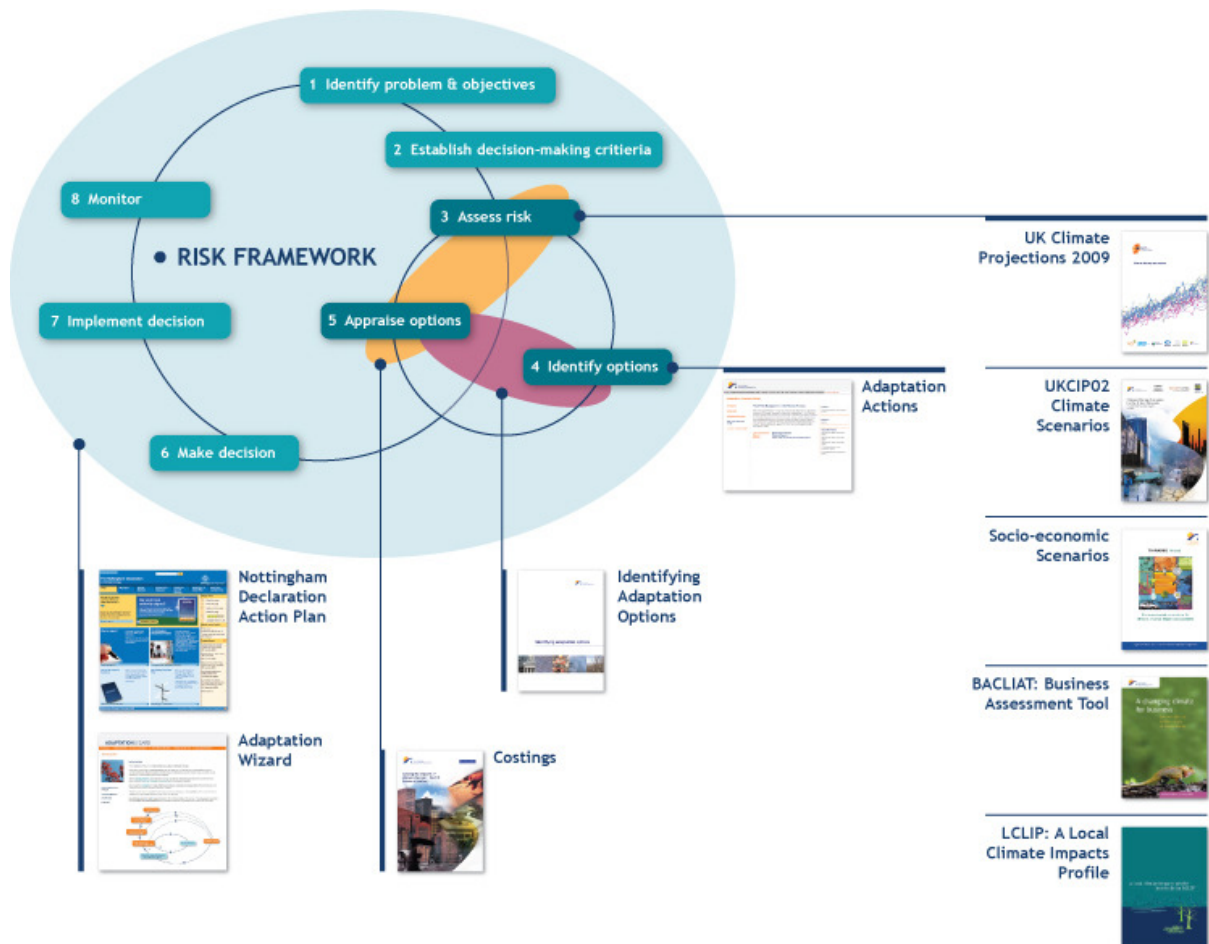


Figure 3-7 The UKCIP risk framework ([www.UKCIP.org.uk](http://www.UKCIP.org.uk), 28 December 2010)

##### Risk assessment

For the risk assessment phase several tools and documents are available. Mainly in the form of scenarios. For local authorities UKCIP has developed the local climate impact profile. Local authorities can investigate what past weather events they were vulnerable to and with the so-called threshold detector they can see how often this event is likely to occur in the future. Based on that information they can make their adaptation decisions ([www.UKCIP.org.uk](http://www.UKCIP.org.uk), 28 December 2010 ).

### Identify options

To help users identify adaptation options UKCIP has the adaptation actions database. In this database examples can be found of how organisations in the UK are adapting to climate change. The identifying adaptations options document provides more information about the characteristics of climate change adaptation. It provides guiding principles on climate adaptation, like work in partnership, understand risks and thresholds etc. It gives information on dealing with uncertainty and identifying adaptation options ([www.UKCIP.org.uk](http://www.UKCIP.org.uk), 28 December 2010 ).

### Appraise options

This guidance describes a methodology for calculating the costs of climate impacts and explains how to compare these to the costs of adaptation measures. This tool is aimed at decision makers, who will use the information resulting from the costing analysis. The methodology has been designed to be used with a decision frameworks, which takes climate risk and uncertainty into account ([www.UKCIP.org.uk](http://www.UKCIP.org.uk), 28 December 2010 ).

### Make decision

UKCIP supports the decision making with the adaptation wizard. This is a five step tool that will help with the assessment of vulnerability to climate change and supports decision making. Apart from all these documents and tools of course also personal guidance is available. ([www.UKCIP.org.uk](http://www.UKCIP.org.uk), 28 December 2010 ).

### Addressing of uncertainty in the guidance

UKCIP clearly states that climate change is uncertain. It advises its users to apply an adaptive or flexible approach to adaptation. The inclusion of probabilities also facilitates users to take their own risk averseness into account when making decisions. UKCIP tries to adress the uncertainty in multiple ways. They address it in their risk management framework and by providing probability density functions with their scenarios. Also UKCIP uses the adaptation policy framework. They help people adapt to the current climate, because than in short term a large part of the variability is covered ([www.UKCIP.org.uk](http://www.UKCIP.org.uk), 28 December 2010 ).

## *3.5.2 The guidance provided with KNMI06*

### Introduction

The KNMI06 climate scenarios aren't accompanied by a complete tools portfolio like the UKCIP scenarios. The website provides information about the contents of the scenarios and their construction. Documents are provided that mainly describe the construction of the scenarios and the world images the scenarios describe. There is briefly touched upon uncertainty. A more scientific publication is also available. Later a publication was added about an extreme scenario that had been developed for the second delta committee. This committee had the task to investigate how to adapt

the Dutch water management to sea level rise and wanted to use an extreme scenario (National Waterplan 2009). In this publication, there is also some information about extreme climate events. The only guidance that is given is a few pages suggestions for use of scenarios. This document discerns between impact, adaptation and mitigation studies and policy and strategy. And suggests some questions that should be answered when using this scenarios for one of those two purposes. Ofcourse there is also personal guidance available for users (KNMI 2009).

### Adressing of uncertainty

As mentioned before the suggestions for use touch briefly upon uncertainty. It describes which uncertainties are present in climate change and that the KNMI06 scenarios cover a large part of possible futures. It doesn't give information about what this uncertainty means for the user or how much of the possible futures is covered by the scenarios. It is not mentioned explicit how the user should deal with this uncertainty. It is suggested that it is useful to use all four scenarios. Later in the section with the questions that should be answered in a policy the document contradicts itself. The question which scenario is most likely is listed here (KNMI 2009).

## **3.6 Which organisations are responsible for making the scenario's?**

### *3.6.1 KNMI*

In the Netherlands KNMI is both responsible for the making and publishing of the climate scenarios. KNMI stands for: koninklijk Nederlands metereologisch institute (Royal Dutch meteorological institute). The KNMI was founded in 1854. It is the national knowledge and data institute for weather, climate research and seismology. The KNMI is most well known for providing weather information to the general public, Dutch government and the aviation and shipping industry. To gain insight in long term developments KNMI conducts climate research. Making data and information accessible, is one of their core businesses. Their climate research made them the right institute to publish climate scenarios. KNMI is an agency of the ministry of transportation public works and water management (wet op het KNMI; [www.knmi.nl/overhetKNMI](http://www.knmi.nl/overhetKNMI) , 28 December 2010).

### *3.6.2 UKCIP and the Met Office*

In Great-Britain two separate organisations are responsible for the making and publishing of climate scenarios. The Met Office is responsible for the models and the data UKCIP is responsible for the publication of the scenarios (Murphy, Sexton et al. 2009).

UKCIP (the UK climate impacts programme) helps organisations to adapt to (inevitable) climate change. UKCIP was established in 1997. UKCIP is primarily funded by Defra. Other contributors include: Environmental Change Institute (Oxford University) and the Government's Knowledge Transfer Partnership scheme. According to their current working programme which was approved by Defra in 2005 UKCIP has 5 main objectives:

- Understanding the impacts of climate change
- Equipping for adaptation
- Working in partnership
- Providing information on impacts and adaptation
- Learning from the international scene.
- Representation of uncertainty in the climate scenarios

In their approach to assess climate change and adaptation options UKCIP has not created an formal science driven research agenda. Instead UKCIP tries to involve all kinds of stakeholders across society in conducting adaptation research (Lorenzoni, Jones et al. 2007;[www.ukcip.org.uk](http://www.ukcip.org.uk), 28 December 2010).

### **3.7 The interview at UKCIP**

An interview was conducted with Anna Steynor and Roger Street of UKCIP. This section discusses the most important information from this interview. An important question for this research was if the inclusion of probability density functions led to different use of the scenarios than in the Netherlands and if this use was better from the perspective of KNMI. The complete interview can be found in appendix A.

UKCIP has chosen to include probability density functions in their scenarios because their users were interested and the Met Office was able to provide them. It was not out of dissatisfaction with the use of their scenarios. The inclusion of the probability density functions also fitted well with the risk approach UKCIP was using to deal with the uncertainty associated with climate change. Users can now determine their individual level of risk based on the probability density functions. It should be noted that the UKCIP09 "scenarios" are actually called officially projections because of the inclusion of probabilistic data (A Steynor and R Street, 2010 pers. comm., 22 July 2010).

UKCIP was also asked if the inclusion of probability density functions had led to people using the complete set of scenario opposed to just one. Although it is considered best by UKCIP to use all three scenario often the middle, highest or both are used in practice. This hasn't changed by the introduction of probabilistic data (A Steynor and R Street, 2010 pers. comm., 22 July 2010).

A difference between KNMI and UKCIP that became clear from the interview, is that UKCIP actively involves their users in the design of the Scenarios and that they have a permanent advisory board in which they users are represented (A Steynor and R Street, 2010 pers. comm., 22 July 2010).

### 3.8 Conclusions on the comparison of KNMI06 and UKCIP09

In this chapter several differences between UKCIP09 and KNMI06 were found. Also differences between the organisations responsible for the scenarios were found.

KNMI06 and UKCIP09 represent the main uncertainties: emission uncertainty, model uncertainty and natural variability differently. KNMI06 presents al three climate uncertainties by the range of the driving forces. UKCIP09 represents emission uncertainty in the driving forces and the natural variability and model uncertainty by the probability density curves of the variables. The most important differences between UKCIP and KNMI are therefore the differences in driving force choice and the inclusion of probability density functions with the scenarios. The desirability of these design features will be included in the interviews with users in the next section.

**Table 3-3 Difference between KNMI06 and UKCIP09 in driving forces.**

|                | <b>Driving force</b>                             |
|----------------|--------------------------------------------------|
| <b>KNMI06</b>  | Temperature increase<br>Change in wind direction |
| <b>UKCIP09</b> | Green house gas emissions                        |

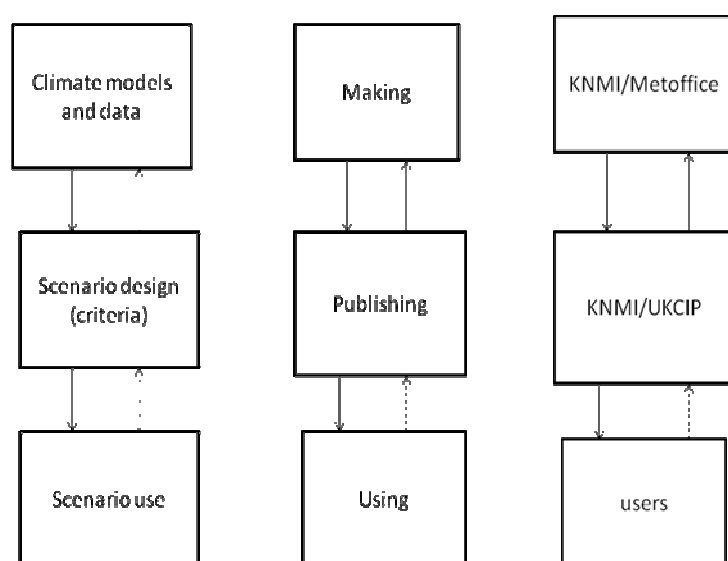
**Table 3-4 Difference between KNMI06 and UKCIP09 in representing uncertainty.**

|                | <b>Emission uncertainty</b> |                      | <b>Natural variability</b> |                                    | <b>Model uncertainty</b> |                                    |
|----------------|-----------------------------|----------------------|----------------------------|------------------------------------|--------------------------|------------------------------------|
|                | Location                    | Type                 | Location                   | Type                               | Location                 | Type                               |
| <b>KNMI06</b>  | Driving forces              | Scenario uncertainty | Driving forces             | Scenario uncertainty               | Driving forces           | Scenario uncertainty               |
| <b>UKCIP09</b> | Driving forces              | Scenario uncertainty | Variables (pdf)            | Statistical uncertainty (Bayesian) | Variables (pdf)          | Statistical uncertainty (Bayesian) |

There are also important differences in the guidance provided with the scenarios. UKCIP's guidance is far more extensive than KNMI's. KNMI of course gives support in using the data, but they give only very limited support on how to use the scenarios in a policy study. UKCIP also gives extensive guidance on this subject. This possibly can be related to the differences in tasks between the organizations. It could also be that more guidance could lead to better use of the scenarios. In the interviews with users questions about the need for more guidance will be asked. (chapter 4)

UKCIP has chosen a risk approach in its approach towards uncertainty. The inclusion of probability density functions of a variable is an important feature within this approach. KNMI has more or less chosen for a robustness approach.

KNMI and UKCIP are different organisations that have different tasks, both in general as within the scenario making process. KNMI is responsible for the making and publication phases. UKCIP is only responsible for the publication stage. The models and data are provided by the Met Office (Figure 3-8). Within society the main task is of KNMI is to provide weather data to the government, general public and the aviation and shipping industry. The main task of UKCIP is to help great Britain adapt to climate change. What the role is of this difference in tasks in the problem as it is perceived by KNMI, needs further investigation. This issue is addressed further in chapters 5 and 6.



**Figure 3-8 overview of the role of different organisation in the scenario making process.**

## **Chapter 4 The use of climate scenarios in Dutch water management.**

This chapter answers several questions. It answers how climate scenarios are used and why they are used in such a fashion. The chapter also answers if the adoption of UKCIP09 elements can change this use. These elements were defined in the previous chapter and were: greenhouse gas emissions as driving force, probability density curves of variables and more guidance on how to use the scenarios. The answers to these questions are based on interviews. This chapter begins with describing the consequences of climate change for Dutch water management (section 4.1). In section 4.2 organizations active in Dutch water management are described. The interviewees came from these different types of organizations, which could partly be an explanation for different answers and different viewpoints on scenarios. Section 4.3 describes the agreements made in the National Waterplan on climate scenario use. This is done because the Waterplan prescribes how scenarios should be used in Dutch water management and gives extra information alongside the interviews. In section 4.4 the outcomes of the interviews are discussed.

### **4.1 Climate change and Dutch water management**

Global warming threatens Dutch flood protection in several ways. First of all it will lead to sea level rise, because of the melting of ice caps and volume expansion of the seawater. A higher sea level increases the force of storm surges on dikes and dams and thereby it leads to a higher flooding risk. The rainfall pattern in the country could change into a more erratic pattern, leading to more extreme rainfall. Since in the low lying parts rainwater needs to be pumped away this may lead to flooding. Also extreme rainfall in neighboring countries may lead to dangerously high water levels in the rivers. The erratic rainfall and warmer temperatures increase the chance of water shortages (Huisman 2004; National Waterplan 2009).

### **4.2 Organizations in Dutch water management**

#### *4.2.1 Organisations responsible for the execution of Dutch water policy*

The ministry of transportation public works and water management is on the national level responsible for flood protection and water management. The water directorate of this ministry creates the water and flood protection policies. Rijkswaterstaat another directorate of this ministry supervises the execution of national policies by provinces and water boards. Rijkswaterstaat also has operational responsibility for the state managed waters and water retaining structures of importance ([www.rijkswaterstaat.nl](http://www.rijkswaterstaat.nl), 28 December 2010).

On a regional and local level most water management is conducted by so-called waterboards. Waterboards are the oldest democratic institutions in the Netherlands. The water boards are responsible for the maintenance of both sea and river dikes. They also conduct the construction of

inland dikes and they are responsible for water storage and distribution and the water quality in their area. Also the purification of waste waters is their responsibility. The water boards are united in the union of water boards (Huisman 2004; [www.uvw.nl](http://www.uvw.nl), 10 December 2010).

#### *4.2.2 Organisations responsible for spatial planning*

In the Netherlands water policy is closely related to spatial planning. Therefore also the organizations active in this field are mentioned. Even though water management is not their core business they often also use climate scenarios. The government makes the main plan. This is the responsibility of the ministry of housing spatial planning and the environment (VROM). The provincial governments make provincial spatial plans. And the municipalities make these for their territory. In this process space needs to be reserved for water management and climate scenario can have a large impact on these plans. The municipalities are also responsible for sewerage. Because the needed capacity in the future can be influenced by climate change (Huisman 2004).

#### *4.2.3 Research institutes and consultants*

The Netherlands has a rather unique knowledge infrastructure. The foundation of this infrastructure is formed by the universities. Universities use climate scenarios in their diverse research programmes. Next there are several research and knowledge institutions. These institutions often have close ties with the universities, but they also conduct research themselves. They often conduct research on project base and their research is more applied. In their research and advice they use the climate scenarios. An example of such a research institute is Deltares. The Netherlands also has three planning bureaus, from which the Netherlands environmental assessment agency is the most important in the context of climate change. These planning bureaus make policy analyses and conduct research for the Dutch government. They work closely with the universities and knowledge institutes. They also use climate scenarios in their policy analyses. There are also many more commercial oriented engineering and advice firms. They often assist provinces, municipalities and the national governments in their policy making (Huisman 2004; [www.deltares.nl](http://www.deltares.nl), 10 December 2010, [www.pbl.nl](http://www.pbl.nl) 10 December 2010).

### **4.3 The National Waterplan**

The National Waterplan describes the measures that should be taken in the Netherlands in Dutch watermanagement between 2009 and 2015 to keep the country safe. The plan explicitly deals with climate change and climate change adaptation (National Waterplan 2009). The plan gives specific guidelines on how to use the scenarios and how to deal with the uncertainties associated with climate change. The guidelines on how to use the scenarios was copied from the agreement on national water governance. These guidelines can be seen in Textbox 4-1.

"For the remaining policy themes, the more moderate climate scenarios Moderate and Moderate+ (Gematigd/ Gematigd+) are used as a starting point. The following qualifications apply:

- For regional flooding and waterlogging, the Moderate KNMI 2006 scenario is used as a lower limit.
- The design of urban locations, commercial estate and infrastructure yet to be constructed and urban renewal or development projects should be based on the climate scenarios Moderate and Warm. If well founded, Moderate+ can be chosen as the lower limit on account of significant financial, spatial or other consequences for society.
- For the short-term approach to water shortages (until 2015) the KNMI climate scenario Moderate is used, while the starting point for the long-term (from 2015) is a range between Moderate and Moderate+.
- For water quality tasks, the starting point is the KNMI 2006 Moderate scenario, except for areas that are prone to water shortages. For the latter, scenario Moderate+ will be used to determine the tasks.

Apart from the starting points listed above, the sensible course of action on the project level is to always carry out sensitivity analyses according to all four of the KNMI climate scenarios and, where applicable, the plausible upper limit. On the basis of these analyses, a well-motivated deviation can be made from the above-mentioned starting points if required."(National Waterplan 2009)

#### **Textbox 4-1 Guidelines in the National Waterplan on using the KNMI06 scenarios**

Apart from these guidelines the it is mentioned in the plan that *"Apart from the guidelines mentioned earlier it is always wise to use all four scenarios in a sensitivity analysis on a project level"*.

The plan advises the use of all four KNMI06 scenarios, but also says *"In the choice of a scenario the the societal risk plays and important role"* (National Waterplan, 2009).

This formulation makes the exact viewpoint on the use of scenarios a bit ambiguous. To deal with uncertainty the plan suggests both flexible and robust solutions. However the choice of ranges made in the guidelines does not always cover the complete range for a variable. A policy option devised under this limited range can therefore not be considered to be completely robust. This makes it unclear if the robustness approach mentioned in the National Waterplan is the same as the robustness approach described before in this thesis. The plan also speaks of an adaptive approach to uncertainties with a focus on learning which is more in line with flexible options than with robust options.

## **4.4 Interviews with users of climate scenarios in Dutch water management**

The questions that were asked were divided into three groups: the use of climate scenarios, guidance and support with the scenarios and scenarios design. The answers to these questions will be described in the following sections.

### *4.4.1 Scenario use*

#### Experience in using scenarios

Interviewees were asked about their experience in using the scenarios. How they had used the scenarios and if they had experienced problems with using the scenarios. If the way the interviewees had used the scenarios were incorrect according to KNMI it was asked what the reason was for this type of use. Interviewees had experience with the use of scenarios for both strategic and design decisions. Also they have worked both on national as regional level. Only the Dutch environmental assessment bureau is using specifically all scenarios in their analyses, but they also did not consider it wrong to use one scenario when testing an engineering design, if it is kept in mind that the future can turn out different than expected. Other users often made their choices in such a way that some form of simplification was used. This varied between using the two scenario's that comprised they entire range of the variable needed (consultant) or the choice for fewer scenarios than four (often done in cases of designing waterworks for instance within a water board).

#### Problems experienced

Many of the problems indicated had to do with the missing of particular variables in the scenarios. Also the match between economic and climate scenarios was mentioned.

The lack of a middle scenario in the KNMI06 set had been a problem, because before KNMI the middle scenario was often chosen and this had also been officially agreed in the agreement on national water governance.

The introduction of new scenarios was also mentioned as being often a problem. Because policies devised on basis of the old scenario's are often still being implemented, when new scenarios are published, new scenarios can provide (justified or not) ammunition against these policies for opponents.

### Use different than described in KNMI documents

Not using all scenarios (explicitly) is mainly done to make decision making quicker and simpler. Often money and time are limited and using 4 scenarios to test 4 alternatives leads to 16 calculations which is often deemed as too many. A distinction can be made between here between strategic analysis and engineering design of for example water works. The Netherlands environmental assessment agency for instance uses all four scenarios, but they mainly operate on a strategic level.

Another reason indicated for scenario use that would be considered incorrect according to the standards of KNMI is that scenarios are relatively new and that engineers generally did not work with them in the past. Lack of awareness of the uncertainty associated with climate change was not mentioned as a reason.

#### *4.4.2 Guidance*

All users indicated that the support KNMI provided with its data was good. The opinions about the need of extra guidance on how to use the scenarios were divided. The outcome of the interviews was not univocal on the need for more guidance. This was partly due because the concept of guidance was not very well defined in advance. The view of the interviewees on the need for more guidance from KNMI is probably influenced by how they see KNMI and what they expect from them. If they see KNMI solely as a provider of climate data, than KNMI does not have to give guidance on how to use the scenarios in decision making. Also the organizations where some of the interviewees were working for, provide climate adaptation advice themselves and have therefore a role in providing guidance themselves.

However it was indicated that scenario analysis is considered to be relatively new in Dutch water management so more information on the use of scenarios could be helpful. The deep uncertainty associated with climate change requires users to make changes in their practices, before they can use the scenarios correctly. Guidance can help facilitate making these changes.

#### *4.4.3 UKCIP elements*

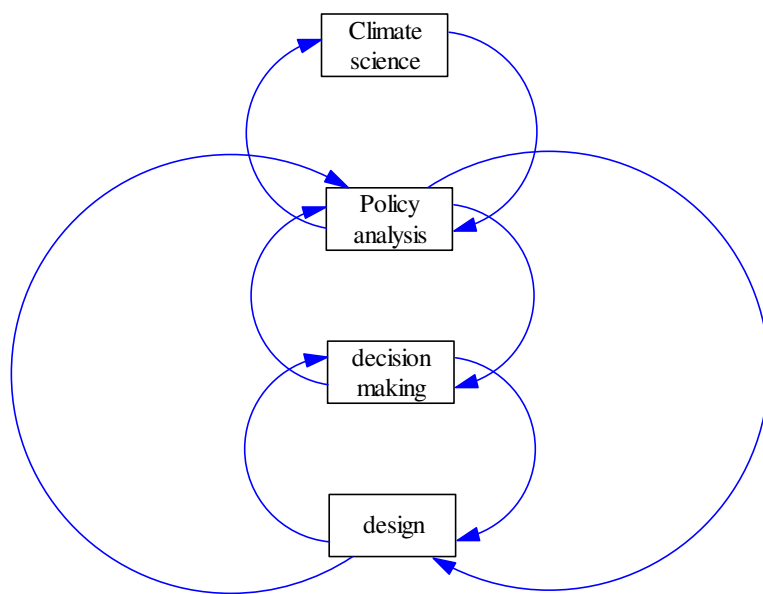
As discussed earlier the desirability of the adoption of two elements of UKCIP09 was investigated, namely greenhouse gas emissions as driving force and the inclusion of probability density functions for the variables. None of the interviewees considered the change in driving force desirable. The opinions were divided about the inclusion of probability density functions. These functions could be useful for dimensioning water works or cost benefit analysis. It is not really clear if these functions are really suitable for dimensioning or cost benefit analysis. The use of the scenarios probably will not change significantly because of the inclusion of pdf's or a change in driving force. This was already clear from experiences in the UK.(chapter 3)

As mentioned before all interviewees would like the scenarios to remain as close to the old design as possible. It should be noted that when pdf's are included and dimensioning and cost benefit analysis is done based on these pdf's. Changes in these pdf's in a new scenario set will lead to big problems and the pdf's need to be stable for it.

#### 4.5 Conclusions on the use of climate scenarios in Dutch water management.

From the interviews that were done it can be concluded that the choice to use only one scenario was often made to simplify the decision process. This particularly happens in cases where engineering design plays a role and this is perceived as not necessarily wrong. Engineering design and strategic analyses should therefore be considered as different stages.

In Figure 4-1 a conceptual model of the use process can be seen. Climate science provides information to a policy analysis process, but the use of this information can differ in each step of the process.



**Figure 4-1 Conceptual model of an adaptation decision process**

Incorporation of the two UKCIP elements will not change the use as it is intended by KNMI and is therefore not a solution to the problems. The user support provided by KNMI with the climate data is considered very good. Most interviewees agreed that more information on dealing with uncertainty and scenario analysis could be useful. It should be noted that how the scenario's should be used is also agreed in the Waterplan. If KNMI publishes guidance that contradicts the National Waterplan, this might cause problems.

## **Chapter 5 Additional considerations in scenario design**

Based on the conclusions of the past chapters it became clear that it is useful to reformulate the problem and the research question. Inclusion of UKCIP scenario design elements will probably not solve the problem KNMI is perceiving, because the problems is not caused by lack of awareness of the uncertainty associated with climate change by the users of KNMI. The question than is: what can KNMI do to solve the problem, they are experiencing. During the course of the earlier research several issues have arisen and maybe these issues can provide directions for additional research.

### **5.1 Issues in climate scenario use and design**

KNMI had framed the problem as a design issue. They hoped that a different scenario design would make people more aware of the uncertainties associated with climate change. They hoped than that more awareness of the uncertainty would lead to better use of the scenarios. From the interviews it became clear that users preferred KNMI to keep their new scenarios as close as possible in design to the old scenarios and that a UKCIP design would not change the use of the scenarios as KNMI intends them to be used.

In the case of engineering design the choice of one single scenario is not perceived as wrong. So a distinction should be made between engineering design and strategic analysis. It might be that these types of use are confused in practice. It is still not entirely clear how climate scenario are precisely used in Dutch water management. The use of climate scenario is partly prescribed in the Waterplan and this prescribed use is not entirely in accordance with use principles of KNMI. This prescribed use is not based on the theory of scenario analyses but it is a negotiated agreement and therefore quite ambiguous, but it approves choosing one scenario in case of the design. However if in that case the upper range scenario is chosen, the question if this is acceptable is not entirely a scientific question, but also a political one. If the Netherlands is willing to pay for flood defences build to withstand the highest level of climate change than in that sense it is not wrong.

It is theorized earlier if more guidance on how to use climate scenario's could help solve the problem KNMI is experiencing. However the National Waterplan prescribes how scenarios should be used, it begs the question if KNMI can even publish more guidance. It will lead to problems if this guidance says something different from the National Waterplan. The decisions made about the contents of this guidance are not purely scientific decisions, but also political ones.

Guiding others on these types of decisions is currently not the task of KNMI. KNMI provides weather and climate data, but they have no role in facilitating or implementing climate change adaptation. KNMI and UKCIP are for that matter very different organisations. KNMI is a scientific government agency, where UKCIP is more a boundary organisation as they sit between science and policy makers.

It should be noted that currently there is no Dutch equivalent of UKCIP and also no guidance like that of UKCIP. There seems to be some need for it and KNMI is providing some guidance. But it is not the task of KNMI to provide it.

## **5.2 Knowledge gaps**

It is not entirely clear how scenarios are used in practice in Dutch water management. It is therefore also not clear why they are used in a particular way and what factors influence the use. There are differences in opinion about how scenarios should be used, but it is also not entirely clear what good use is and what bad. This is also partly due to the fact that this is not only a scientific but also a political question. There are different approaches to climate change adaptation and the choice of approach partly determines the importance to climate scenarios and the correct use. The design of the scenarios themselves also determines use, but how and to what extent still needs to be investigated, but it is clearly not the only factor. Also it is not clear what constitutes a good climate scenario design. This knowledge can help very much in climate design. More research on these issues is therefore needed.

As mentioned before there are more differences than the scenario design alone. UKCIP provides more and different guidance than KNMI does and the organizations have different roles. It could be that this difference between the organizations plays a role in the problem. The problem could lie in the role of scientific information in policy processes and in the role of organizations that provide scientific information in it. A broader question to be asked is than what is good scientific information for policy making? New climate scenarios are being seen as good and useful from a scientific perspective because they are based on the most recent (and because of that better) scientific, but for a policy process they can be bad news.

## **5.3 A new research question**

A change in design is probably not going to solve the problems KNMI is perceiving, but maybe other measures can. The research question can therefore as mentioned earlier be reformulated as

*What measures could KNMI take that could help develop the use of climate scenarios in Dutch watermanagement further?*

This question can be framed based on main groups knowledge gaps. The first knowledge gap was how the scenarios are used and what factors play a role in this and the second group is about the organizational setting. From these knowledge gaps subquestions can be defined.

Questions based on knowledge gaps regarding the use of climate scenarios:

- Is it desirable for KNMI to develop the same amount of guidance as UKCIP has done?
- What is the role of climate scenarios in different stages of the policy cycle?
- If KNMI can't do it are there other organizations that can?
- What can conceptual models about the science policy boundary teach us about the standards scientific information in policy should adhere to?
- What can be conceptual models of science and policy analysis teach us about the differences in organizational arrangements of UKCIP and KNMI

The first question was already partly answered with help of the interviews in chapter 4. The second question is answered in the next section. The rest of the questions is answered in chapter 6.

## **5.4 Issues of scale**

### *5.4.1 Introduction*

Scale choices can affect the outcome and success of a policy analysis study strongly. The scale on which the decision is taken can also influence the use of climate scenarios. Karstens (2009) Distinguishes three different (interrelated scales). The temporal scale, the spatial scale and the level of aggregation. The level of aggregation. Level of aggregation is in how much detail the system and its subsystems are studied. This information is used to answer and describe the different roles the scenarios can play in different stages of the policy process. (Karstens 2009).

Scale can be defined by two components extent and resolution. The extent is how wide the system is covered. The resolution is the amount of detail that is covered (Karstens 2009). In particular the temporal and level of aggregation can influence the use of scenarios and how can be dealt with uncertainty.

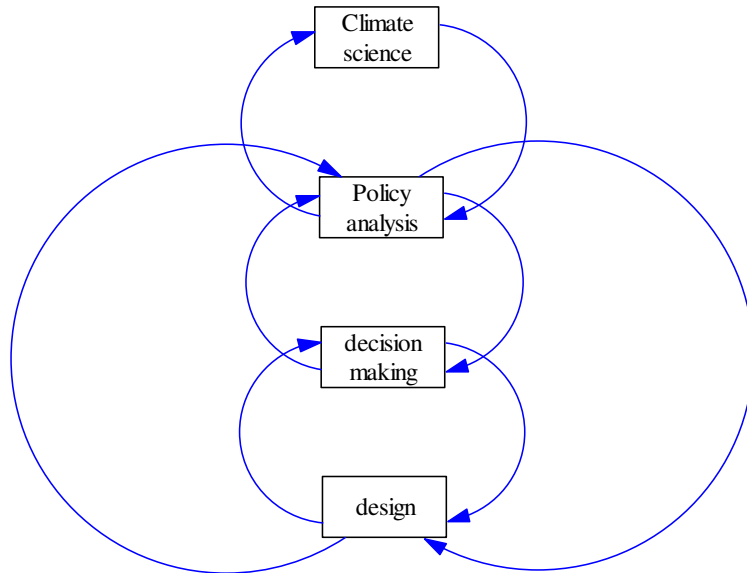
### *5.4.2 Temporal scale*

The importance of climate change for a decision in water management, depends very much on for what term the decision is taken. Decisions about new waterworks are different than about the amount of sand suppletion at the coast. The amount of sand and work needed can be re-evaluated next year a dam should last for at least 50 years. For sand suppletion decisions you do not need climate scenarios (National Waterplan 2009).

Depending on how long you want your policy to last you make different choices regarding uncertainty. This is also described in the water plan. The longer the policy should last the more uncertainty you need to take into account (Van der Sluijs 2006). In the case of climate change the nature of the uncertainty also changes in time (Hawkins and Sutton 2009).

### 5.4.3 Level of aggregation

When looking at the conceptual model for the use of climate scenarios in Dutch water management. The difference between design and policy analysis mainly comes from the difference in level of aggregation.



**Figure 5-1 Conceptual model of the use of climate scenario's in Dutch water management.**

A policy analysis study usually covers a significant part of the water system. If than is found that a waterboard needs a water storage, the designer of the storage can justify only using scenarios, where the rainfall increases or becomes more erratic. Policy analysis and design look at different levels of aggregation to the system. The policy analysis study looks at the whole water system it looks where its vulnerabilities are for climate change and than determines possible policy options. If a policy option is chosen the design phase only looks at this particular policy option and only at the subsystem the new design has to be fitted into.

## **Chapter 6 Perspectives on science and policy**

In the previous chapter it was concluded that part of the problem lies in dealing correctly with deep uncertainty, by the users of the KNMI06 scenarios. The chapter therefore begins with introducing several strategies for dealing with (deep) uncertainty in section 6.1. The reason that dealing correctly with deep uncertainty is so difficult, stems partly from the dominant conceptual model of science and policy. Section 6.2 therefore describes the dominant conceptual model of science and policy, namely the normal model and describes how it is changed by the introduction of deep uncertainty. In section 6.3 it is discussed what implications the addition of deep uncertainty in the dominant conceptual model of science and policy has for the quality of scientific information and thus for climate scenarios. In section 6.4 the roles of organizations at the science policy boundary are discussed in relation to the complication of the normal model of science and policy. This is done in order to explain the differences between UKCIP and KNMI further and to examine if further recommendations for KNMI can be derived from this.

### **6.1 Perspectives on dealing with uncertainty**

There are different styles of dealing with uncertainty. These styles apply in particular to dealing with deep uncertainty. Deep uncertainty is uncertainty that cannot be expressed in probabilities anymore. Van der sluijs (2006) distinguishes four styles in dealing with deep uncertainty:

This first coping strategy is trying to get rid of uncertainty by ordering more research or by simply ignoring or hiding the uncertainty. Often more research cannot eliminate the existing uncertainty, because more research uncovers often more complexities and uncertainties and research cannot go on for ever (Van der Sluijs 2006).

A second strategy tries to adapt the uncertainty to a level that is manageable. This usually involves quantification of the uncertainty. In this approach people for instance try to change scenario uncertainty into statistical uncertainty. People applying this approach often feel uncomfortable with anything that doesn't fit in a spreadsheet (Van der Sluijs 2006).

The third strategy that falls is the embracement of uncertainty an example of it is the denial of environmental risks by pointing at the uncertainties. This is often done strategically (Van der Sluijs 2006).

The last strategy is the assimilation of uncertainty. With this strategy people try to give uncertainty a central and deliberative place in science and in decision making and people use decision methods that do not adapt uncertainty or ignore it (Van der Sluijs 2006).

The last strategy is probably best in dealing with deep uncertainty, in a rational decision making setting. If the whole range of uncertainty is taken into account, than the most likely it is that the policy options is designed for the correct future (Walker, Rahman et al. 2001). Implementing this strategy is much more difficult as it may seem. In the dominant conceptual model of science and policy which will be discussed in the next section. In this model science can provide policy makers with the truth and it therefore completely determines policy. The scientific information also serves as legitimation for the policy. If decisions were taken rationally deep uncertainty wouldn't be that much of a problem. However as will be discussed later most decisions are not taken rationally and this often causes strategic use of uncertainty, which makes assimilation of uncertainty difficult.

Sometimes also practices within professions hamper the use of an assimilation approach to uncertainty. In engineers have difficulty using "soft" information like scenarios, because they are used to using data from which they can extract statistical probability. (Cabantous and Pearman 2006; Gawith, Street et al. 2009). Instead of assimilation the uncertainty the uncertainty is adapted by engineers. Cabantous and Pearman (2006) observe that *"the presence of a 'hard data' culture among civil engineers is a strong cultural barrier to the management of climate change"*. The choice of one scenario for design can than be seen as a form of uncertainty adaptation.

Also these four ways of dealing with uncertainty can be related to the two groups of climate adaptation decision making discussed in chapter 2. The top-down approach tries to adapt uncertainty while the bottom up approach assimilates it (Van der Sluijs 2006; Dessai and Van der Sluijs 2007)

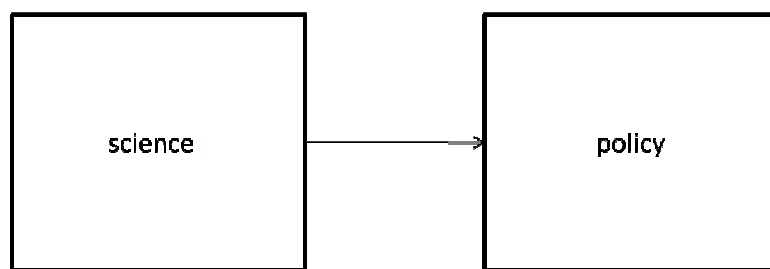
## **6.2 Conceptual models of science and policy**

### *6.2.1 Conceptual models of science*

There are two perspectives on science a constructivist and positivist view. The positivist perspective considers science to be objective. There is only one reality and science can provide understanding of this reality with certainty if enough research is conducted. Empirical research has shown that this view dominates among policy makers. The constructivist view scientific knowledge is not objective it is not removed from society but constructed by it and therefore subject to the social and cultural context in which it is constructed in. This view is more common among scientists. This difference in perspectives causes problems in the communication between policy makers and scientists. The first coping strategy of removing of uncertainty mentioned in the previous section corresponds with the positivistic view of science prevalent among policy makers. This is the reason that policy makers expect scientists to come up with precise number or at least probabilistic predictions of climate change. (Van der Sluijs 2006)

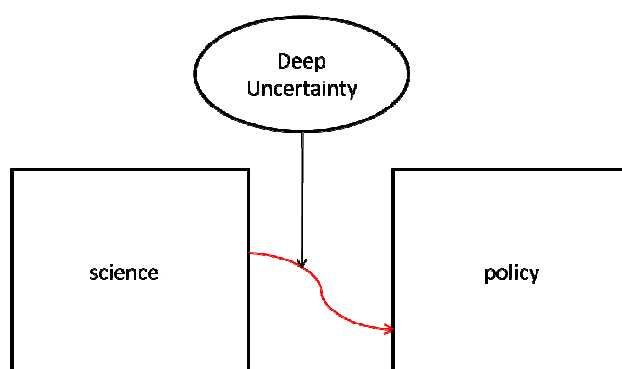
### 6.2.2 Conceptual models of the science policy interface

There are different conceptual models to describe the relationship between science and policy. The most prevalent model is the modern mode of legitimation. This model is strongly related to the positivistic view of science. It assumes that science determines policy. Developing a policy has is than a matter of retrieving the right scientific knowledge and then sort out values and preferences and determine the correct and rational policy option. Science and policy are clearly separated in this model. Science deals with facts politics with the values. This model also assumes that uncertainty can be eliminated or controlled and that science can provide the policy maker with complete information necessary to take a decision. This means that there is no room in this model for uncertainty deeper than statistical uncertainty. The model also assumes complete rational decision making by the policy maker (Funtowicz and Ravetz 1993; Funtowicz 2006).



**Figure 6-1 the normal model of science**

According to Funtowicz (2006) problems arise with this model: *"when complexities abound, when uncertainties cannot be reduced to probabilistic risks and when experts disagree, are seen to be stakeholders themselves or simply do not now."* In many problems nowadays these issues play a role and climate change is no exception to this. Society deals more and more with problems that are urgent, where the stakes are high and uncertainty is large.(Funtowicz and Ravetz 1993; Funtowicz 2006) These things may also lead to instability of the science policy boundary.



**Figure 6-2 Disturbance of the normal model**

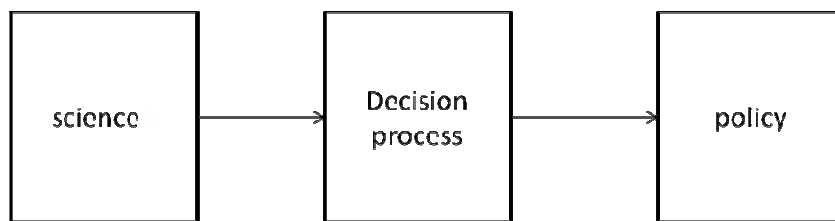
(Funtowicz 2006) presents so-called postnormal science as a solution to the problems with the normal model. It exists of the following extensions to the normal model.

- = Appropriate management of value ladenness and uncertainty
- = Extension of the peer community by other disciplines and stakeholders.

He doesn't present operationalizations of these concepts. Appropriate mapping of uncertainty and value ladenness can be tackled by science. However the inclusion of stakeholders doesn't seem really

manageable. It should also be noted that the normal model is deeply ingrained in western culture and scientific knowledge is still judged by this paradigm. Peer review is at the core of scientific credibility. The extension of the peer community can therefore jeopardize the credibility of science (Jasanoff 1994).

What seems to be ignored by Funtowicz is that there is a decision process between science and policy (Figure 6-3), where stakeholders can be involved (Van de Riet 2003). This decision process is also idealized by as being completely rational in the normal model of science and policy. Funtowicz also implicitly assumes its decision process to be rational. (Funtowicz and Ravetz 1993)



**Figure 6-3 Between science and policy there is a decision process.**

Rational decision making consists of several steps. First the problem is analyzed and identified. Then all possible solutions are listed. All these solutions are evaluated for their effectiveness and consequences and ranked. Then the optimal alternative is chosen (Drucker 1967). This model assumes that there is only one decision maker who has complete decision power. It assumes that all information is available and unambiguous and that preferences are univocal.

In reality there is not one single decision maker and decision power is divided and disputed and multiple actors are involved. There is often uncertainty and preferences are often unclear contradictory and changing. Value conflicts are also inevitable. Allison (1971) argues that outcomes of decision processes are more the outcome of a political game than of a rational decision process.

These complications to the normal model of decision making can be clarified with the following typology of (unstructured) policy problems. Problems become unstructured when they cannot be solved anymore by standardized analytical techniques and procedures (Hisschemöller and Hoppe 1995). Unstructured problems have also been called wicked (Rittel and Webber 1973) and messy (Ackoff 1974).

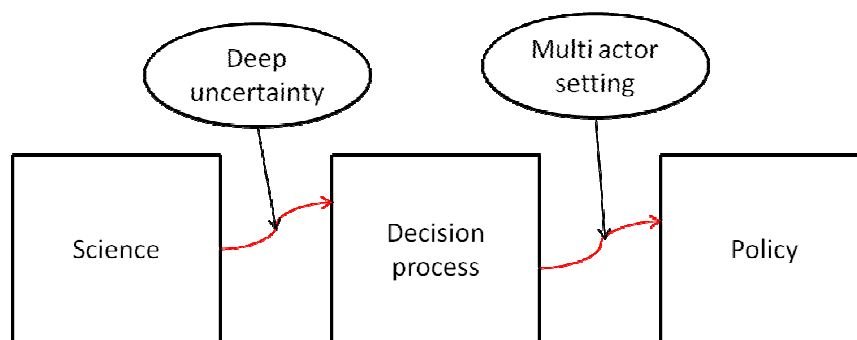
In policy problems there can be a lack of consensus on both values and knowledge. If there is consensus on both, the problem is structured and if consensus is lacking one of the two the problem is moderately structured. If consensus is lacking on both then the policy problem is an unstructured problem. (Hisschemöller and Hoppe 1995)

|                        |     |                       |                               |
|------------------------|-----|-----------------------|-------------------------------|
|                        |     | Consensus on values   |                               |
|                        |     | No                    | Yes                           |
| Consensus on knowledge | No  | Unstructured problem  | Moderately structured problem |
|                        | Yes | Moderately structured | Structured problem            |

**Figure 6-4 A typology of policy problems (Hisschemöller and Hoppe 1995)**

In particular in case of an unstructured problem the normal model becomes problematic, many policy problems including climate change adaptation fall in the unstructured problem category.

The complications to the rational (normal) model of decision making may also put different demands on scientific information and of the role of the organisation that is providing this information than is assumed in the normal model. In conclusion it is still often assumed that science can provide clear and unambiguous information and that complete rational decision making is possible. In reality deep uncertainty and a multi actor setting make this impossible.(Figure 6-5). This means that the use of climate scenarios is also more complicated than is often assumed. The scenario themselves are a way of dealing with the complications of uncertainty. It is however not clear what the implications are of deep scientific uncertainty for a multi actor decision process. Reasons from the multi actor decision process may lead to misuse of the scenarios, when people are using the deep uncertainty in a strategic way to defend their own goals. They are embracing they uncertainty making it difficult to assimilate the uncertainty in the decision process.



**Figure 6-5 Complications to the normal model of science and decision making**

### **6.3 Quality of science for post normal times.**

In the normal model of science and policy it is easy to devise a normative framework for good science and decision making. Science is good when it has found the truth and provided policy makers with all information necessary to take a decision. A good decision is a rational choice for the most optimal solution. Because the boundary object and boundary organization concept leaves room for different

perceptions, it is not easy to devise a normative framework to judge the quality of scientific information. This also makes it hard to judge a climate scenario design.

(Hulme and Dessai 2008) have used the concepts of credibility, legitimacy and salience to judge the quality of several British climate change scenarios. Cash, Clark et al (2002) have used these concepts to describe boundary work. In this thesis these concepts will be used as criteria in the creation of recommendations for solving the problem received.

Credibility can be defined as: how authoritative and trustworthy is the information?. Salience as how relevant the information is for the decision maker. Legitimacy as: how fair is the information process? Are for instance the perspectives of important stakeholders included? Usually most attention is given to credibility. In a post normal age however the other two have become increasingly important (Hulme and Dessai 2008).

These three concepts have their own dynamics at the science policy boundary. They depend on each other, but unfortunately as often in negative as in a positive way (Cash, Clark et al. 2002). Post normal times demand other things from scientific information than normal times. In Table 6-1 criteria are given for each concept under normal and post normal conditions. Post normal science adds something extra to normal science, it doesn't take things away from it. For information to be credible, legitimate and salience in post normal times it needs to fulfil the criteria from both normal and post normal science, because normal science is still the dominant mental model.

**Table 6-1 Criteria for credibility, legitimacy and salience in normal and post normal science**

|             | <b>Normal</b>                            | <b>Post normal</b>                                    |
|-------------|------------------------------------------|-------------------------------------------------------|
| Credibility | Trustworthy?<br>Scientific method?       | How well are<br>uncertainties<br>adressed?            |
| Legitimacy  | Was the right<br>authority<br>consulted? | Legitimacy<br>information<br>construction<br>process? |
| Salience    | Usefulness to the<br>problem             | Legitimation of<br>policy.                            |

In normal science the criteria for credibility are is the information credible?, was it gathered in the right way (according to the scientific method?). For information to be credible in the post normal model uncertainty should be explicitly addressed.

For the information to be legitimate in the normal model the right authority should be consulted. In the post normal model scientific information like scenarios is seen as a social construct (Funtowicz and

Ravetz 1993). The involvement of the users in the information creation process gives the information legitimacy under the post normal model.

Salience in the normal model means that the information provided is useful and suitable for solving the policy problem at hand. In the normal model the rational decision process provides legitimacy to a policy (Hulme and Dessai 2008). A decision is legitimate if it was made rationally on the basis of the right information. In the post normal model this is not completely the case anymore and scientific information can also partly be used to provide legitimacy for the policy. This is the reason users of climate scenarios fear new scenarios, because it can provide opponents of their policies with ammunition against it.

## **6.4 Organizations at the science policy boundary**

In chapter 3 it became clear that UKCIP and KNMI are very different organizations in terms of the roles they fulfil. KNMI is a 'traditional' research institute, conducting climate and weather research and providing Dutch society with climate and weather data. UKCIP is often referred to as a boundary organizations, because instead of conducting traditional climate research their task is to help Great-Britain adapt to climate change. They sit more between climate science and policy makers, than they are a traditional research institute.

This section explores the concept of a boundary organization further (section 6.4.1) and describes how it is related to post normal science. To explain the difference between a traditional research institute like KNMI and a boundary organization further different roles analysts and organizations can have is discussed in.

### *6.4.1 Boundary objects and boundary organization organizations*

The complications that are caused by deep uncertainty to the normal model of science and policy lead to changes to the science policy boundary. In the normal model there is a strict line between science and policy. Science deals with facts and policy with values. The complications to the normal model and the solution to this, in the form of post normal science leads to a blurring of the science policy boundary (Funtowicz 2006). Guston (2001) has found a blurring of the boundaries in practice, which can be to some extent constructive. Too much blurring however can lead to destabilization of the science policy boundary and can be destructive.

To restabilize the science policy boundary again Guston (2001) introduces two concepts namely boundary objects (Star and Griesemer 1989) and boundary organizations. Boundary objects sit between two social worlds, for instance between climate science and policy making. These objects can be used by actors in both worlds for each of their specific purposes without losing their identity (Star and Griesemer 1989; Guston 2001). Hulme and Dessai (2008) classify climate scenarios as being

boundary objects. Boundary objects require agreement from all of the different social worlds involved. (Fujimura 1992) Also the existence of boundary objects alone may not enough to stabilize the boundary again, sometimes more general changes in culture and practices are needed (Guston 2001). This is probably the case in the problems KNMI is experiencing. The climate scenarios alone are not enough to change the practices of the users. Instead of changing their practices they adapt the scenarios in such a way that they fit in their own practices, but by treating the scenarios as predictions they do lose their purpose and identity.

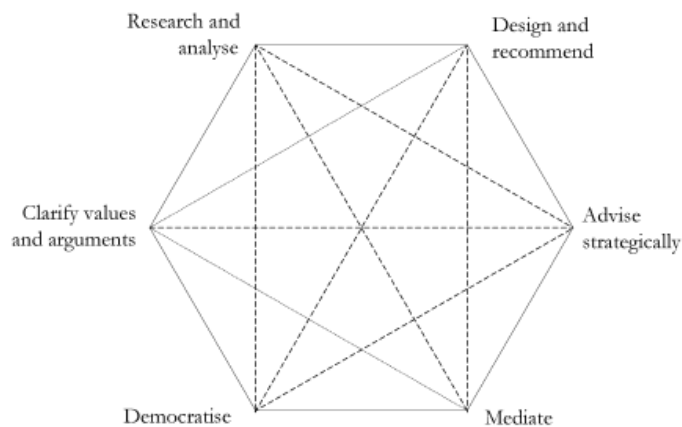
The need for the restabilization which cannot be facilitated by boundary objects alone has led to the development of a relatively new type of institutions which are named boundary organisations. These boundary organizations can help facilitate the change in practices needed to restabilize the science policy boundary again. Boundary organizations do this by meeting three criteria:

*"They provide the opportunity and also incentive for the creation of boundary objects. They can involve actors from both social worlds and can help reach consensus between the two social worlds at which boundary the organisation is working. They exist at the frontier of two different worlds, but have distinct lines of accountability themselves."* (Guston 2001).

In order to use the scenarios correctly KNMI's users have to change their practices. Instead of getting rid of uncertainty or embracing it strategically they have to assimilate it. Research has shown that a boundary organization can facilitate a change like this (Lorenzoni, Jones et al. 2007). UKCIP is an important example of a boundary organization (Hulme and Turpenny 2004). Hulme and Turpenny (2004) have observed that the climate research in the UK moves is moving closer to a post normal paradigm under the influence of UKCIP. Lorenzoni et al (2006) have observed that as a boundary organization UKCIP is a forerunner in using a post normal science approach to the adaptation to climate change. This suggests that a boundary organization can help implement a post normal approach. This post normal approach can then help dealing with the problems caused by destabilization of the normal model. In the Netherlands an official boundary organization between KNMI and the users of climate scenarios is missing.

#### *6.4.2 Perspectives on policy analysis*

The goal of policy analysis is to provide policy relevant information, in order to inform and facilitate good decision making (Walker et al 2000). Mayer van Daalen et al (2004) have tried to restructure the policy analysis discipline in one conceptual model. They have found 6 styles of policy analysis. Each of these styles has its own underlying values and each style should therefore be evaluated differently (Figure 6-6). This conceptual model is used to analyze the difference between a traditional research institute and a boundary organization further. The styles are ordered in the hexagon in figure 6-6. The top half of the hexagon is more oriented towards objectivity the lower parts is more subjective.



**Figure 6-6 Overview of the six policy analysis styles (Mayer, Van Daalen et al. 2004)**

### Research and analyze

This policy analysis style focuses on the generation of knowledge. Questions answered by this style could include: Is our climate changing? How will climate change affect rain patterns in the Netherlands? What will this change in rain pattern mean for the agricultural sector in the country? Knowledge institutes and research agency create knowledge both on demand and by their own initiative to inform policy making. The knowledge they gather is partly influenced by political demand, but also their research findings may influence political discourse.

This policy analysis style informs policy, but it doesn't design a solution. This is left to politics. For instance the KNMI provides policy makers with information about the changing climate. It doesn't provide or design specific solutions in dealing with a rising sea in water safety(Mayer, Van Daalen et al. 2004).

### Design and recommend

This style is concerned with finding and designing solutions to specific problems The knowledge gathered earlier is translated into a solution. *"Recommendations will typically be the result of comparing the effects of different policy alternatives and weighing the options based on different criteria."*(Mayer, Van Daalen et al. 2004)

### Clarify values and arguments

There are always normative and ethical issues behind every policy option. Sometimes the differences in opinion are large untamed problems. *"Policy analysis may not only make instrumental recommendations it for policy making it may also analyse the values and argumentation that underly social and political debate"*(Mayer, Van Daalen et al. 2004)

### Advise strategically

What should a government minister do to bring about acceptance for abolishing state student scholarships? Often policy analysis is a strategic client oriented activity. The policy analyst can provide the client with the best strategy to achieve his goals. (Mayer, Van Daalen et al. 2004)

### Democratise

This cluster of activities is aimed at ensuring equal access to and equal influence on the policy process for all stakeholders. It should be noted that this cluster of activities is not value free. (Mayer, Van Daalen et al. 2004)

### Mediate

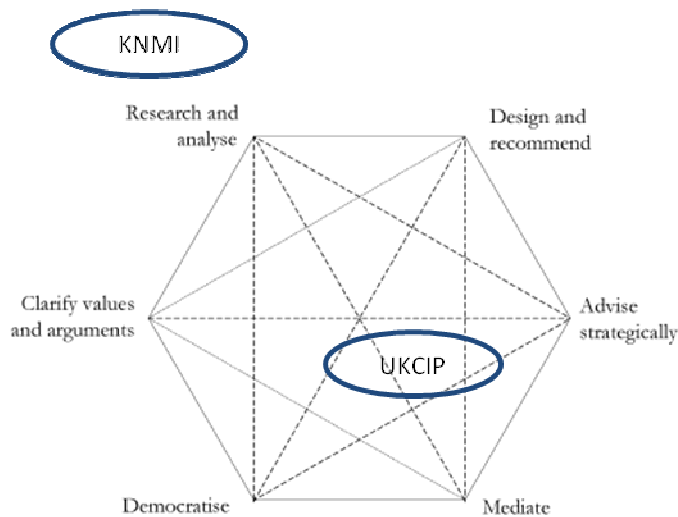
"How can industry and government agree on the moderation of their dispute about the possible harm caused by zinc emissions on the environment and health?" (Mayer, Van Daalen et al. 2004)

Sometimes resolving a policy option requires mediation. A policy analyst can design and supervise a process to arrange this. (Mayer, Van Daalen et al. 2004)

### UKCIP and KNMI and their roles

In the hexagon the activity clusters that are more alike are placed closer to each other. For instance design and recommend is a logical step after research and analyze. The further away activities the most likely they are to conflict. This does not mean that these activities are completely incompatible. Depending on the policy problem and the stage of the process one or more clusters can become important. Often multiple clusters of activity are needed, sometimes even the clusters that may seem incompatible. (Mayer, Van Daalen et al. 2004)

In the normal model of science and policy only research and analyze and some design and recommend needs to be carried out. The outcome of the research and analyze phase lead to certain information that can serve as input for a design. When science is uncertain and the problem is unstructured the other activities in the hexagon are needed. In Figure 6-7 the placement of KNMI and UKCIP is indicated. KNMI's activities are limited to research and analyze. UKCIP provides the UK with other activities from the hexagon which are needed to solve the unstructured problem of climate adaptation (Lorenzoni, Jones et al. 2007).



**Figure 6-7 UKCIP and KNMI and their placement in the hexagon by (Mayer, Van Daalen et al. 2004)**

As mentioned before the activities that are opposite of each other could be in conflict with each other. The climate research for the UK is done by the Met Office, so the Met Office has the research and analyze role in the policy problems UKCIP is involved in. This gives UKCIP the freedom to do the activities in the lower part of the hexagon, without the climate research being questioned by these activities.

## 6.5 Conclusions

In this chapter first different perspectives on dealing with uncertainty are discussed and it was found that to deal correctly with deep uncertainty it should be assimilated. In practice however this is more difficult, because decision power is often dispersed between different actors, which encourages strategic use of uncertainty. Problems also arise from the dominant mental model of science and policy: the normal science model. In this model science can provide policy makers with the truth and it therefore completely determines policy. This model is not valid anymore, but for instance research institutes are still judged by its criteria.

To solve policy problems that involve deep uncertainty about the future and a multi-actor setting other activities are needed than to purely scientific research alone. These activities (like for instance mediation and clarify values and arguments) are seen as more subjective than research and analyze activities. If a traditional research institute conducts these activities it may "threaten" their objectivity from a normal science view and therefore the credibility of their scientific research.

There are organizations that are not traditional research institute, but that "sit" between science and policy and mediate between these two world. UKCIP is an example of a boundary organization. The independence of UKCIP from climate research (the data and models are provided by the met Office)

allows them to conduct more subjective activities, that are needed in order to adapt successful to climate change.

## Chapter 7 Conclusions

### 7.1 Conclusions

#### *7.1.1 Which different approaches are there to climate change adaptation and how does this influence the use of climate scenarios?*

Approaches to climate adaptation can be divided into three groups: top-down, bottom-up and mixed. Top-down approaches start from information about possible climate change, while bottom-up approaches start from the vulnerabilities in the system for which climate adaptation plans are devised. The top-down approaches have more need to diminish the level of uncertainty present in climate change information, compared to the bottom-up approaches. (Dessai and Hulme 2004; Dessai and Van der Sluijs 2007)

In the UK, a risk management approach to climate change adaptation, was adopted by UKCIP. In the Netherlands, both KNMI and Dutch water management have adopted a robustness approach. (Willows and Connell 2003; KNMI 2009) The risk management approach adopted in the UK falls in the top down category and the robustness approach adopted in the Netherlands is a mixed approach. (Dessai and Van der Sluijs 2007)

#### *7.1.2 How do the UKCIP09 and KNMI06 scenarios compare in terms of the representation of uncertainty and guidance provided with the scenarios?*

The first and most important difference between UKCIP09 and KNMI06 is the representation of the variables in each scenario by UKCIP09 by means of a probability density function. KNMI06 gives only one number for each variable per scenario.(KNMI 2006; Jenkins, Murphy et al. 2009)

The second difference between UKCIP09 and KNMI06 is the difference in driving forces. KNMI has two driving forces namely temperature increase and change in dominant wind direction. UKCIP09 only has one driving force namely greenhouse gas emissions.(KNMI 2006; Jenkins, Murphy et al. 2009)

UKCIP provides their scenario users with an extensive amount of guidance on how to use the scenarios. This guidance can be found in the wide range of documents posted on their website. Guidance in person is also given. KNMI has chosen not to provide extensive guidance on how to use the scenarios in the documents and publications on their website. They do provide personal guidance. KNMI of course provides information on what the scenarios stand for, but in contrast with UKCIP they don't give extensive information on how to use the scenarios in a decision making process.(<http://www.ukcip.org.uk> 28 December 2010; [www.KNMI.nl/klimaatscenarios](http://www.KNMI.nl/klimaatscenarios) 28 December 2010)

### *7.1.3 How are climate scenarios applied in Dutch water management? And what are the reasons for this application?*

Climate scenarios are in Dutch water management applied both for strategic decision making and design of for instance water works. From the interviews it became clear that in a design situation it is not considered incorrect to use only one scenario, because it is not considered feasible to use all scenarios in such a situation. The reason for this is because it takes too much time and money test all design options against all four scenarios. There are however no other options to test designs for climate change than the scenarios, so that is why they are used to test designs. In contrast, in strategic decision making more often multiple scenarios are used.

Guidelines are given in the National Waterplan on how to use the scenarios and often these guidelines are followed. The Waterplan describes in a very detailed fashion how climate scenarios should be used for a particular purpose. It makes no distinction between different users, but this difference is partly made by making a distinction in purpose. Although the Waterplan advises to use all scenarios if possible it also suggests choosing one or more climate scenarios as an option.(National Waterplan 2010)

### *7.1.4 Will a UKCIP approach in terms of scenario design or guidance change the use of the climate scenarios? And if so which elements are to be adopted?*

Two design elements from UKCIP09 were identified that could be interesting to adopt in KNMI13. These elements were: greenhouse gas emissions as a driving force and representing the variables in probability density curves.

From the interviews (appendix 2) it became clear that the introduction of probability density curves in KNMI13 could change the use, but probably not as KNMI intended it to change. When probability density curves are added to the scenarios people may use them for the dimensioning of for instance waterworks and in cost benefit analyses. It is however unclear if these probability density curves are really suitable for this. It will probably not encourage people to start using all the scenarios. This is also consistent with the experiences of UKCIP, often not all UKCIP09 scenarios are used in the UK.(R street & A Steynor, 2010, pers. comm., 21 July)

Users indicated that they actually preferred the new scenarios to remain as close as possible to the old scenarios. This was the reason that the interviewees were not interested in changing to greenhouse emissions as a driving force. The reason that users want the new scenarios to resemble the old scenarios as close as (scientifically) possible is that, when new scenarios are introduced policies based on the old scenarios are still in their execution phase. Radically different climate scenarios can provide (justified or not) ammunition to opponents of these policies.

The outcome of the interviews was not univocal on the need for more guidance. This was partly due because the concept of guidance was not very well defined in advance. The view of the interviewees on the need for more guidance from KNMI is probably influenced by how they see KNMI and what they expect from them. If they see KNMI solely as a provider of climate data, than KNMI does not have to give guidance on how to use the scenarios in decision making. Also the organizations where some of the interviewees were working for, provide climate adaptation advice themselves and have therefore a role in providing guidance themselves. However it was indicated that scenario analysis is considered to be relatively new in Dutch water management so more information on the use of scenarios could be helpful. The deep uncertainty associated with climate change requires users to make changes in their practices, before they can use the scenarios correctly. Guidance can help facilitate making these changes.

#### *7.1.5 How do UKCIP09 and KNMI06 compare in terms of organisational arrangements and what can be learned from this?*

UKCIP and KNMI are different organizations and have different roles. Their roles in the climate scenario creation process are different. UKCIP is responsible for the publication of the scenarios and the British Met Office makes the scenarios in the sense that they deliver the data and model runs. (Jenkins, Murphy et al. 2009) In contrast, KNMI is responsible for both phases of the creation process (KNMI 2009). (Figure 7-1)

KNMI is a governmental agency and belongs to the ministry of infrastructure and environment. KNMI is responsible for providing the Netherlands with weather and climate data. UKCIP is a programme established by Defra (department of environment, food and rural affairs) in order to help the UK adapt to climate change. (<http://www.ukcip.org.uk> 13 December 2010) UKCIP can be considered a boundary organization as it sits between climate science and policy makers. (Hulme and Dessai 2008)

Deep uncertainty in science for policy causes problems for both scientists and policy makers. In policy and decision making it is often assumed that science can provide policy makers with precise numbers and certainty about what the future will bring. These hard facts and precise numbers then can help not only to determine the policy that needs to be chosen, but these facts are also used to legitimate the policy. However, because of the deep uncertainty associated with climate change it is impossible for climate scientists to provide policy makers with certain and precise numbers. This means that policy makers have to decide under uncertainty, which makes it impossible to choose one optimal alternative. Also the uncertainty can be used in a strategic way by opponents of a policy. This complicates decision making and these problems can only be solved with the involvement of both scientists and policy makers.

A boundary organization can facilitate this involvement. By bringing the parties together but also by providing guidance on how to use the scenarios. This is more easy for a boundary organization to do than for a traditional research organization, because activities associated with involving policy makers and providing guidance, require an involvement in the policy making process that is traditionally not done by a traditional research institution. When a traditional research institution shows this much involvement in the policy process it could harm the credibility of their scientific research. This is because institutions are still judged by the normal model of science where science and policy are strictly separated. A boundary organization does not have this problem, because their scientific information is often provided by another party. This allows them to conduct activities that are generally regarded as more subjective, but that are needed in order to solve problems involving deep uncertainty and a multi actor setting.

Providing scientific information for policy and thus the creation and publication of climate scenarios also requires some decision making that cannot be based strictly on scientific facts. For instance the temperature increase range for the scenarios to span cannot be solely based on scientific facts, but is also a policy decision. It is easier for a boundary organization to make these decisions because then these decisions are not intertwined anymore with the core scientific research.

## **7.2 Recommendations**

### *7.2.1 Recommendations for KNMI*

**Create or expand partnerships with organizations like the Netherlands environmental assessment agency (PBL) and Deltares.**

These organization can act as an “unofficial” boundary organization for KNMI, in the sense that they can help with climate scenario development and providing guidance to users. They can help in implementing the two recommendations that will follow. It is better for KNMI not to assume the boundary organization role themselves, because it can interfere with KNMI’s original activities, because it requires more political involvement and it also requires a different expertise. Waiting for an official boundary organization to be established is also not advised, since it will take too long for KNMI<sup>13</sup>.

**Communicate that KNMI scenarios are designed to function with a robustness approach towards adaptation; use of these scenarios helps to prepare for a range of futures, if the complete set is being used.** Explain that different approaches to uncertainty warrant different scenario designs. For instance a risk based approach to adaptation benefits from scenarios with probability density functions, as is the case in the UK.

**Communicate about uncertainties with users both in user meetings and in guidances**, but explain them from the viewpoint of what this could mean for the users not from the viewpoint of climate science. So do not mention that there is natural variability, emission uncertainty and model uncertainty. But tell the users that there is a range of futures possible and that looking only at one future could lead to a very wrong decision. Expand the idea of user meetings into an ongoing dialogue. This can support users in handling climate change uncertainties.

### *7.2.2 Recommendations for national policy makers*

**Make an explicit choice on how to handle deep uncertainty for different types of decision purposes.**

It is very likely that the deep uncertainty associated with climate change will not be decreased to statistical uncertainty any time soon. If climate adaptation is still a priority than it requires a clear choice in how to handle uncertainty. In the past robustness was chosen and this fits well with the KNMI scenarios. So this approach can be kept, however it should be made more explicit how policies and designs should be tested for robustness. Working with KNMI and organizations who cooperate with KNMI, on the development of these tests can help create synergy with the climate data and guidance that is provided by KNMI and the organization they cooperate with.

**Support the formation of a boundary organization structure.**

A boundary organization can mitigate some of the problems that are causes in adaptation policy making. (see chapter 6) Currently a boundary organization is lacking in the Netherlands. KNMI has been advised to set up a boundary organization structure with the help of existing organization that can fulfill the role of unofficial boundary organization. This could help users of the KNMI scenarios very much in using the scenarios correct and to come to good decision making. Facilitating the formation of this boundary organization by the national government would help.

### *7.2.3 Recommendations for users*

**Budget time and money for dealing correctly with deep uncertainty.**

The deep uncertainty associated will probably not be decreased any time soon, so dealing with it in a correct way will be necessary to come to good decision making. This requires time and money and it also may require a change in existing practices. This is not easy, but it is worth it. Planning for only one or two futures when the future is so uncertain as it is with regard to climate change, is planning for a future that will very likely not occur. So money spent now can save a lot of money in the future.

**Enlist help of other organizations if KNMI cannot help.**

Providing support in changing decision practices and deciding on how to deal with uncertainty is not something in which KNMI has expertise . Other organizations like the Netherlands environment assessment agency and Deltares (but there are also others) have more expertise in this matter. If there are problems in working with the climate scenarios, with which KNMI cannot help, these scenarios might be able to help.

**Communicate with KNMI and the boundary organizations on what is needed for you to make your decisions.**

It is very valuable for KNMI to know how you are using the scenarios, what your approach to climate change uncertainty is. This can help KNMI to design scenarios that work for you and other users.

**Remember that KNMI06 is designed from a robustness approach,** if you are using another approach the KNMI scenarios may not be suitable for this method. KNMI and other organizations can help to find out if the KNMI scenarios are suitable for your approach. If they are not suitable it might be possible to provide scenarios that are suitable.

### **7.3 Reflection on the research**

The most noticeable feature of this research report is that an additional research question was researched. This has enriched the research, because it provided much extra information that hopefully is more useful to KNMI than an answer only to the first research question.

However during the research process this shift happened gradually and has only been marked later in hindsight. This has led to a few problems. In particular writing the report took more time than expected partly because of this. Many changes were made to the structure in order to represent the research results in a good way. Tackling an extra research question itself takes also more time. Therefore the overall research project has taken longer than initially anticipated.

This also partly influenced the interviews and how they were handled in the report. No official way for structuring and representing the interviews had really been chosen before conducting them, because they were conducted during the time that the shift in research question was happening and I tried to answer both research questions. Later I took too much time in trying to structure in the interviews in an existing method for processing interviews, because this hasn't been planned in advance. In hindsight the interviews were a bit too unstructured. For instance the concept of guidance had not well be defined in advance. This made that each interviewee interpreted the concept of guidance differently.

## **7.4 Limitations**

The main limitation to this research is the small number of the interviews held and the bias this caused. From the four interviewees, three had primarily experience in use of climate scenarios in a strategic setting. The operational side of Dutch water management was not covered very well. Also no official selection method to select the interviewees was used. It could be that not all opinions on scenario use and scenario the value of a UKCIP were captured.

The conclusion that other factors play a role in the use of climate scenarios is not hampered by it, because this is also supported by literature research. This conclusion can also apply to other sectors than water management alone.

The destabilization of the science policy boundary was only discussed from the viewpoint of post normal science. The main explanation given for this destabilization is the presence of deep uncertainty. By choosing this framework, with its heavy emphasis on uncertainty it may be that other factors have been ignored.

As a solution to this destabilization the introduction of a boundary organization has been suggested. A boundary organization is the only method researched to stabilize the science policy boundary. In the UK it works well. However the institutional setting the UK has not been investigated and it hasn't been compared to the Dutch institutional setting. That a boundary organization works in the Netherlands the way it works in the UK is not entirely certain.

## **7.5 Recommendation for future research**

What became clear from this research is that there are many unknowns about climate scenario use in practice and what influences this use. This information is very useful in designing climate scenarios and in improving their use. Also more information about the wishes of the users could help in this. There are no strict rules to what constitutes good scenario use and more research into what constitute good scenario use might be helpful.

During this research it became also clear that the UK and the Netherlands have adopted different approaches to climate change adaptation. It could be interesting to research how these choices influence scenario use. Also the difference between theory and practice on this matter gives reason for extra research. For instance in the Dutch National Waterplan robustness is adopted as an approach to climate change adaptation. It is not clear however if this is the same robustness approach as described in this thesis and it is not clear if the robustness approach is really applied in practice.

The information on boundary organizations and boundary objects is rather limited. There are no criteria to what standards these concepts should adhere to. And there is not much known about

destabilization and stabilization of the science policy boundary. More research into these mechanisms and possible ways to stabilize the science policy boundary .

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[www.uvw.nl](http://www.uvw.nl), 10 december 2010

## **Appendix A: The Interview with Anna Steynor and Roger Street of UKCIP.**

22-07-2010

Anna: Let me tell you first that UKCIP is quite is unique that we are this sort of boundary organization. We sit between science and policy. We are trying to get away from it though.

### **Why Are you trying to get away from it?**

Roger: just the term

### **Does it have a negative connotation?**

Anna No I just think that nobody understands what a boundary organization really is and we didn't really understand what a boundary organization was . We tried to figure it out, but nobody could really define it. So we are thinking of other ways to describe ourselves. It is just an internal thing

Roger: the difference between us and the metservice, Even the Met Office realizes they cannot do what we do. And that is a significant added value and they recognize the legitimacy of this role, especially when dealing with users.

### **Than KNMI probably cannot fulfill that role either?**

There are a couple of reasons they cannot fulfill our role. One they do not have that close one to one engagement with users. They do not have that type of focus. The other thing is that the meth services and other types of organizations of that type often have the requirement to raise funds. Whereas we don't we don't come charging people to do what we want to do. We are not consultants.

Anna: not at the moment

Roger: at the moment we are not. This makes a big difference in terms of going to people we are trying to work and learn with them. We are not trying to gain financial benefit.

Anna: at the moment this is interesting since our contract is ending and we work on five year contracts. And it is interesting to see how much people value UKCIP and we have been doing a survey about what people value from the UKCIP service. We haven't seen the result of that yet. People say it is imperative that UKCIP goes on, because we need your type of support.

Roger: One of the thing we are doing and I was very interested when I heard you say water.

There are three different groups of users from the field of water. One of them is the water companies themselves, for whom supply is important. There is another user the environment agency, they oversee the water companies activities. They are also involved in flooding and those other aspects of water that are important in the Netherlands. And then the other user is the regulatory body for the water companies, they are quite interested in how those different users are perceiving the utility of the projections. They all three are strongly looking at it how they could use it in the water sector in particular.

**In water management these are your main users?**

Yes from a water management perspective. Defra is in there also with respect to the flood management. But those from the water community. There are always researchers. The researchers use the information too.

**What type of use do you distinguish between? In the Netherlands they distinguish between impact assessment, policy analysis etc, design?**

Anna: We narrowed it down to three groups. These are three very broad groups.

- Communications: communicate the message
- Policy makers: people who make the policy
- Decision makers: who make the decisions on the ground.

**Are decision makers politicians or is it more operational?**

Anna: More operational.

We found that most people fall into one of these groups. Consultants are a bit iffy, because they sit on the borders and we didn't know where to put them.

Roger: We did a survey and asked people what they were using them for. Some were using it for communication. They had to have these categories. Most people fit within:

- Communicate
- Research
- Decision making.

**This research is it policy related research?**

It is broader than that. It is master's and PhD research. The end result can inform policy. We try to separate people doing research and people doing assessments.

Anna: When we launched UKCIP09 in June and in September Defra asked us to do a user survey of who is using it and how they found it. If they found the website useful etc. So it is a very preliminary result.

Roger: This comes from people who log on to the website and extract information. They have to register and give information and it counts how often people extract information.

Anna: it gives quite a good indication of who is using the projections so far.

Roger: that gives us information we are also working one to one with several other organizations. We are working more than with the people that are also partially reflected in this too. This is where the added value of UKCIP comes in. We work with individuals and individual organizations. We have our purpose and they have their purpose. We learn about how they are doing it, how they are using the information, so that we can better provide guidance. And we are sharing this with other people in our case studies.

Anna: Since the launch we have worked with users. Most of them have come to us and said that they wanted to work with us, because they get advice from us on how to robustly use the scenarios. They get a sort of sign off from us that the methodology they have used is correct. The main concern of people is that they do not want to be the first to do something wrong with the projections. So they know that if they come to us and work with us they get a methodology out of it that is robust, that is scientifically credible. That is what I do currently talking to people and developing case studies. These case studies will be placed on the website to show people how UKCIP is being used. Our users are very willing to join us. I was frankly surprised by how enthusiastic they were. We have a reciprocal relationship with them. Other organizations find this far more difficult to achieve. But it is our objective to do this. It is seen as beneficial by our users to work with us. We have a lot of users that are new to working with climate projections. We really benefit from our reputation here.

**In the Netherlands it has even been put in agreements how to use the scenarios. Is that also done in Britain?**

Anna: Well UKCIP09 is different because of this new probabilistic approach and it is very difficult to tell people exactly how to use it, because each water company will have a different risk based approach. It is generally very difficult to tell people exactly how to use the scenarios, because they are vulnerable to different impacts. You can't tell people exactly how to adapt and make it the same for the whole of the UK. So the regulatory body for the water companies is looking into what advice they can give people. The UK water industry research community, but it is difficult.

Anna: Defra keeps saying that they want to tell people which probability and which emission scenario to use. And it misses the point really of this probabilistic approach, because the whole point of it is that people make a decision based on their individual level of risk rather than it just being a standard approach.

Roger: There is a lot of debate going on and I am involved just like Anna in the discussions that are going on and there are people that want a simplistic approach. "just give me the number and then I'll stick it through". these people they have limited resources have limited resources. And we have to recognize that. However they ask us to take the risk for them. That I am wrong and if I am wrong they can point to me. There is a lot of concern about that. For instance within the water companies the regulatory body for instance recognizes that and therefore is not wanting to be told what to use., but they want to understand the criteria and the methods that are available that allow someone to understand what they should be using. In other words they are more interested in guidance that allows that flexibility that is needed based on the understanding of the risk. If you look at flooding for example flooding in Rotterdam and the Hague is quite different from flooding in Maastricht. So are you going to give them the same guidance? No. You can't say regardless of the risk use 23. They do expect it though. The water companies use 20 % headroom as a way to adapt. They say 20% headroom that is how to adapt. And now with UKCIP09 they had to reassess that. Now the guidance hasn't changed yet.

Anna: I got an email the other day from a water company, asking has the guidance changed yet?. Is it not 20 % anymore? So I wrote back no it hasn't changed yet it is still 20 % but watch out.

Roger: Because they have done analyses, have been done showing that in most cases 30 to 40 percent is not enough. So you are giving people a false sense of security, by giving them the 20%. There are a couple of cases where it will be the number. If you give them a single number you are enhancing the risk that the adaptation option will be inappropriate or brittle, in other words it falls apart, if that particular projection doesn't come true. It's changing a culture that is willing to do that. We do see some examples where people are willing to do it, where they embrace and others fight very hard not to.

I talked to a number of these people and you say to them: there is also a lot of uncertainty in your demand curves for water. "oh yes we know how to deal with that". Well do you also know that there is probably less uncertainty associated with the climate. "well just give us the number". They want something simplistic

Because I talked to some of these water companies and their models to model their capacity are often black boxes, provided by consultants. To change their modeling practice will take time a couple of years. So that is a problem. They do see the advantage so they want to change, but it is going to take them time to do that.

We made a major leap here and we are now hopefully pulling people along with us. Some are very willing but others fight it and others are waiting until everybody else does it so they can do it then. It is going to take time.

There is a strong belief that the risk approach is the way to go. There is a desire to go that way. But the capacity to do so is limited.

Anna: In a way it is slightly a bad timing , having released 09, with this new risk approach and the the current bad financial situation. It is difficult for them to start and try using the projections.

Roger: I think a step backwards is inappropriate at this time. If you look at the KNMI thinking of going probabilistic. There is a lot of interest in it. We put together how much it cost us to make these projections., what the UKCIP part had cost.

Anna: Defra asked us "can you please tell us what it has cost, just for the UKCIP09 component of the UKCIP contract." So I worked out the staff time and the publication's cost and came upon a large number. And even they went wow that is a large number. But it was 5 years of work for six members of staff. But I think it was good value for money. It would have been far more expensive three times the cost if we had used independent consultants.

Roger: The thing is that a lot of time also went in the user panel and in work with specific user communities and that is going to build up as well. It is there that we see the most advantages.

### **What was the reason for going probabilistic?**

Anna: Well there is a truth and a spin on the truth. The truth is that the Met Office could do it and wanted to do it. But also the reason behind it is that consultation with stakeholders showed that they wanted more transparency in uncertainty. They wanted us to tell them how uncertain our scenario's were. The wanted us to give them the range that is were the probabilistic approach came from.

Roger: There was a lot of request for that and there was a desire to move to a risk approach even back in 2002 so the Met Office said:"we can do this"

What we are doing is trying to get this and it is a very delicate balance one in terms of what the science can do and what the users want . If you talk to users what they want to know what will happen in there back yard 15 June 2051. And you can't give them that, so you have to pull them back. What science wants is to do really interesting science and really push the information, with no real understanding whether that is going to help the decision makers. Increased accuracy or increased resolution isn't what it is all about. You have to understand what the users need and that is what we spend a lot of time doing is trying to get that balance, but also what users need. If you tell them you can give them 1 km resolution they take it, but they have to realize what they are getting. I know people who make 1 km 5 minute projections and I am sitting there and say you have to be very careful with that.

### **Most decision makers of course don't have a background in GIS modeling.**

Roger: Some of them have. And what we are doing is putting together a users advisory panel and what we do we poll the users with providers and with practitioners. And practitioners are different from users in my perspective in the sense that practitioners know how to use that information. There is a slight difference between practitioners or experts or users. We have some very good expert users.

Anna: I am going back slightly to why we did the probabilistic projections. The background of our choice is described in a paper. That was called something like UKCIP02 lessons learned and that was published in global environmental change.

Roger: I have got a presentation that I am going to refer to . It explains some of the reasons behind UKCIP09. Again it comes back to if you are going to use climate information to make decisions, you need a different type of information and climate scenarios do not provide you with sufficient in order to make decisions. The reason we changed from scenarios to projections is a very deliberative change, scenarios don't have probabilities associated with them. As soon as they have probabilities associated with them we can't call them scenarios. Scenarios are equally likely that is why we changed the name. You need that type of information we believe to make decisions under a risk framework. You have to have some indications how much risk are you willing to take.

**Are you stimulating your users to use all three emission scenarios. Because you have three of them?**

Anna: We can't give them the likelihood of which one is more likely to happen.

Roger: We do encourage them to use all three.

Anna: We encourage them to use all. In practice. Most people use medium and/ or high. In the previous scenarios most users used medium-high. Because we had a medium-high, because we had four. But now most people use medium and/or high I don't think I had anybody in the case studies using the low. It comes from the business as usual being higher than the medium

**Do you think if they use medium that they capture all information, when they are just using medium?**

Anna: No, definitely not. I had someone the other day and they had used the weather generator with arithmetic means with the medium scenario and they said they were future proof. So said no you are not. Even if they had used all the emission scenarios they wouldn't have been future proof, because there are unknowns that we don't know yet. That no one knows yet.

Roger: We don't like future proof or climate proof, since It gives a false sense of security.

Anna: For all we know emissions could be much than the highest emission scenario.

### **Have you published extreme scenarios?**

Roger: There is an extreme scenario for sea level rise and than the indicated the storm surges. It is for the marine stuff.

### **There is not a lot of demand for?**

Well there is not a very high demand for it, but a lot of people are interested in the extreme sea level scenario.

Roger: But one of the problems that we are now seeing, is that the current process of putting out snapshots every four to six years of so is no longer valid. The science is changing so rapidly and so are the needs of the users. SO what happened when we put out UKCIP at that time the only information available on sealevel rise was in the IPCC report and they added lines saying we do not understand the ice cap dynamics completely. So we added H+++. I f you look at the trend in the literature you see that H++ is no more reality than anything else. So you see that people consider the H++. It is still an apprehension and I see more and more people including it in their analysis.

Roger: That is the problem when you put out snap shots what do you do when the science is changing. How are we adding those new developments? We have some beautiful analyses that aren't in the projections and how are we going to add those.

Anna: For that reason we decided to publish UKCIP09 online and only do a limited run of hard copy publications because we knew that things were going to change and for instance the weather generator will probably change substantially soon.

### **Doesn't that goes trouble?**

Roger: See the base information is constant, we are only adding greater functionality and enhancements. We are enhancing its functionality with things that users have requested. So we got things, things that are called extras or enhancements. You have to be able to do that particularly with this type of information, primarily because we are learning new things about what our users want to do. Some are very useful. For instance people wanted to know: What are the projections associated with a 2 degree warming globally. 2, 3 and 4 degrees temperature increase globally. SO we are not changing the information we are adding extras on how we are presenting the information. That has utility for some people. The weather generator is a tool and we are increasing its capabilities.

Anna: Their previous study won't be invalid.

**No but I asked it since in the Netherlands it is always a bit of problems when the KNMI publishes new scenarios.**

Anna: That is the problem when you publish a whole new set of scenarios. People go like now I have to do it all over again.

**Is that a problem here? How did you solve that?**

Roger: A lot of discussion and preparing.

Anna: From the beginning of 2007 we started doing awareness raising workshops one in each region and we did pre launch trainings. We described the methodology and what was coming, what products and we held discussion groups on how this could be used. That worked really well and we did a lot of presentations and a lot of engagement through user panels. We brought people together and really involved them in the process. User involvement was key. They were involved in the functionality of the new projections, in the user guidance. We did a lot of user engagement. So when the projections finally came out, people were looking forward to them.

**In the Netherlands we first had three scenarios and everybody used the middle scenario. That is why the KNMI published four scenarios in 2006. It didn't stop people from choosing one scenario.**

Anna: The key to it is engaging users and tell them why you are doing what you are doing.

Roger: that is major. And you need them to buy in. If you get the users involved you get less problems. science organization that is more a problem.

It is engagement as well in the development of it. Engage the users in the development. How do you want them to look. Even address trivial issues. Talk to them about how they want to have the information presented. Do you want it in this format or in that format? Different types of things. This is really critical.

**It is an ongoing process?**

Yes it is. When the methodology was in place there were still a lot of things that needed to be decided about.

Roger: We even had discussions about what level of language are you going to use in your publications. At whom are you directing them at. For instance there is a chapter three that goes through the methodology. (this was 2 years ago) This part was focused on level three which is a high research level. Most of the other stuff was focused a little bit lower.

**So you really have different publications directed at different groups of people?**

Roger: Even within publications, different sections of publications are aimed at different people. We asked we are going to use this? And again we involved a steering group and a users panel in confirming those decisions.. We confirm any decisions that we make. That made the buying a lot easier. We see it in other countries there they do it without as much buying as we get and it is a lot more difficult.

**Could It also be a problem. I don't know if this is also in Britain, but in Dutch watermanagement people work with norms and dimensioning . Is it now so in Britain that people are using your projections to design for instance?**

Roger: There is still resistance and a lot comes from the civil engineers, but there are groups that are opening up. For example one of the things that we have done is that we went to the professional institutes, like the institute for civil engineers and in the institute for mechanical engineers and we are working with them so you are changing. You don't go to a particular engineer you go to a professional society. We had some advances along those lines.

Roger: The other thing that we do that I think is really good is for example we go to the build environment. We have fairly good connections with a standard setting group within the build environment. And with them we went to the research council. And that research council invested 5 million pounds how to use this climate information within the built environment. We will have mixed benefits, but at least there is a group looking at it and exploring that and there is a willingness to look at it and explore.

**So here the civil engineers have problems using the scenarios?**

Roger: It does complicate their job, what UKCIP09 does it challenges you to really understand your system . You have to understand it rather than it being a black box. Some people like that and some people don't. Because it is extra work and there is only so much money and so much time.. Other people see the advantage of it because they understand that there result will be much more sustainable.

Roger: Climate change is really the opportunity to move from a deterministic society to a society that is more able to deal and cope with change. Society has to learn to deal with a change that is unknown. Dealing with uncertainty we do really well unless it is not a very lot of change.

**I am I correct that it is really your task to help people to deal with this uncertainty? You have your risk framework. But you also tell people to adapt to the existing climate first, because then you have already a part of the variance covered? Is that correct?**

Anna: Yes.

Roger: yes

Anna: It is the premises of the Local climate impact profile., which is initially aimed at the local authorities. Look at the current climate and see if you are adapted to it. And that has been a really useful tool for local authorities, because it is not very labor intensive. You can hire a student to find out with newspaper clippings and so what caused trouble in the past and how to adapt best to that type of events. With the threshold detector you can find out how often this will happen in the future as opposed to in the baseline climate. If for instance a heat waver is likely to happen three times in the future opposed to once in the past they can decide which measures to take. So this is a really useful tool to them. We weren't realizing that when we were developing it, because it is in the weather generator and the weather generator was thought of as something for really sophisticated uses. But actually the threshold detector is also used by very high level users. Because it has this simple message, You have got one now this will be three in the future what are you going to do.

One of the things we are currently trying to move towards is seamless information to support adaptation. We made a major push with this to improve the current information associated with 09. We pushed further on that. In terms of making information available on the current and on trends . If you look at the publications for example there is a much more focused publication on the current climate. There is also more information that is available on the website. The move in the Met Office and climate science community, not necessarily do we see significant improvements in the future projections, but in the projections to the near term. SO you move from past, current, near future and future . And we are trying to get that seamless. So that you have similar type of information, in fact we did it with the threshold detector and some of the things available under the weather generator. It is mainly being done because what we are starting to see is that people try to deal with the current situation. Unless you are doing some major investment most people are only concerned with the next three to five years. And there aren't very good projections. Projections for 2050 are than to far away. So we are trying to push it closer to us and that is where major advances have to come. They have to come in that near term in order to support adaptation. There is a lot of need for things like the local climate impact profile.

Roger: what our advantage is over a provider of climate information is that we are also working with users on how they use that information to support decision making. We have the local climate impact profile, the risk framework, the adaptation wizard and all that . And we have that in our mind where the provider has more the climate science on its mind and how the scientific advances can be reflected. The fact that We live between those two worlds, makes it far more easier to understand and working with the users.

**So you really are a boundary organization?It is a good role since the users also need to make a step they need to think differently?**

Roger: Yes, so it is not all about getting the providers to change it is also about getting the users to change and getting them together.

If you look at some of the discussions that are going on internationally . In the Global climate services framework. There is a whole discussion going on about this it is again something you may want to link to in understanding what climate services are needed and there is a desire of going this way, but a lot of the met services are having trouble. I don't say that they cannot doing, but I am saying that they are having a lot of difficulty.

Anna: Most met services try to provide that kind of boundary role, but they can't.

Roger: They are stretching there mandate .

Roger: We have to invest in climate science, but we have to invest in the use of climate information too. But you can't do both. It is very difficult to do both I think, unless you have an organization like us.

### **What problems are experienced by users?**

Anna: unfortunately the woman that does the help desk is sick today. There are a couple of things. We ran in November a user meeting and we got together people who are using similar UKCIP09 products and the idea was for them to create a support network so they could meet similarly minded users. And so they could give back to use the things they experienced problems with. Here are the notes of the last two meetings. One is from the probabilistic projections workshop and the other is from the weather generator workshop.

### **Are you satisfied with how the information is used?**

Most of the time the once that we interacted with usually are yes. But occasionally people did it wrong. Because of the user engagement that we had and the comprehensive user guidance I haven't discovered a lot of people using it incorrectly. Which I m quite surprised about, because we did think that it was going to give u a lot of trouble. But we worked very hard on a post launch training

Roger: That did pay off, but I still get surprised every once in a while, by what peoples sometimes think they can do with the data, both in terms of the positive and the negative. Often there is misunderstanding of what the probabilities are. They don't understand what they are and we spend a lot of time showing them what they are. We even got so far that we said the information that we gave you before UKCIP02 and now we are giving you this information UKCIP 09 and people wanted to know what the differences were between 02 and 09 and we done that. And people though 09 and 02 we will just be in the middle. People will try to use the probabilistic information.

Anna: People then just use the 50 percentile and think it is the most common. And it is difficult to tell people that is not the most projected value, because you are leaving out half of what is projected. So can you justify leaving that out.

Roger: People also interpret higher resolution as higher accuracy, they try to blow it up and see where there house is and we then have to explain that it is less accurate, because it is so uncertain.

What I also found out is as soon as you get this information, we also had this with 02 and it is probably the same in the Netherlands, People get mesmerized by all these numbers. There is all this information, so you spend all your time focusing on these numbers. And I say hold on think about what you need it for. In a lot of cases they don't need to go into that.

Roger: another thing were we also have some difficulty with people sometimes go straight to numbers and don't look at the guidance.

Anna: And then they don't understand and write to the help desk.

Roger: That were things we are experiencing, but we have significant engagement with the users throughout the entire process and continue to have that as we go through. We changed the concept of a users panel to a users advisory panel. We changed that concept and what we are using it for. The community of users idea we put forward is really useful. We are starting to see some spin-offs of user communities of people working together. The online forum, the helpdesk. The helpdesk has been a really strong feature. Even though the number of requests aren't as high as you would expect each one of those has been very helpful.

Anna: Well that has been a very helpful resource for the users actually. We haven't had a huge amount of help requests, but it is a very helpful resource.

Roger: It is also helpful for us, because we use that information to enhance the guidance, enhance some of the case studies and the FAQ's, where we can often point people to. And we had an online forum.

Anna: It is a discussion forum, that the user communities requested. But no one has the time to go and check it . But having said that the Scottish user community forum is very well used, but they have quite a close knit community.

Roger: we need to push that a little more. But we have used webinars. Those have worked well.

Anna: and e learning resources.

Roger: Every problems that we have experienced we tried to address and you address it through a variety of different methods. Improving the guidance, improving the technical notes, add aditions to the reports. Trying to address problems with case studies.

Anna: The key to all of that that every time we have done a survey of what users want or need, we always publish the results with our responses. So it has been a very transparent process. They know that it is not just being filed away.

**You don't seem to be bothered by people not using all your scenarios?**

Anna: Well we can't make them

Roger: the thing that we always push is: If you tell me why you do it this way and if you understand the implications of that. Than I can say I wouldn't doing it that way, but you have to accept that they are doing it that way as long as they understand implications of it.

Anna: Every user that has come to us and said I cannot run all of these projections, we have to narrow it down. And in my mind it is better that they cut out the lowest emissions scenario than the highest. We are not saying don't use the low, but if they don't use the low and justify not doing it than that is fine.

Roger: When we do a risk assessment around here. There is a national risk assessment going on right here and we went trough the process and developing. They are now half or three quarters of the way trough and are now finally going to bring in the climate. And I can remember when we brought in some of the climate scientists. They just couldn't believe that we could go sofar in a risk assessment without bringing In the climate. You don't need the climate or the projections until that time. So you bring it in when it is the right time.

Roger: I also work with the water companies they are very concerned with drought and what it means for their resources and investments. They couldn't run and they do not have the capability of running the type of projections that we provide . All values for all three emission scenarios and that type of information. They did a detailed analysis based on where they were sensitive and where there thresholds were. And they could see where they could cut it down the amount of information and how it would affect their decision. If it doesn't change the decision Do you really need to have all that information. Again it was looking at the decision and they found that it didn't change the decision if they changed the information the brought in. Again it gets back to understanding what the climate information is doing and it is aiding people to take decisions. If the decision doesn't change by bringing in more or less information. Than what is the issue.

Roger: I was at a meeting with the water companies and I ran an activity. These are the water companies the people that supply water and I quickly realized that that community is unwilling to accept any risk of the water cannot be supplied. So they don't have to use everything if it doesn't change their decision. So again it is why did you not include that information. They aren't willing to accept any risk. Everybody has a different risk aversion

## **Chapter 8 Appendix B: The interview with Jaap Kwadijk of Deltares on.**

25-06-2010

### **U heeft uiteraard ervaring met klimaatscenario's ook in een onderzoekssetting. Heeft u ook ervaring met het gebruik van klimaat scenario's voor klanten?**

Ja dat hebben we. Deltares werkt overig ook in het buitenland en ik moet zeggen dat de KNMI aanpak daar vrij bijzonder is. In het buitenland wordt er meestal gebruik gemaakt van de uitkomst van een klimaatmodel met één of twee emissie scenario's. Wat dat betreft doet het KNMI het zorgvuldig en goed. Er zitten daar slimme mensen en wij bemoeien ons niet met hun werk.

### **U heeft ervaring met de KNMI 06 scenario's ook nog met andere scenario's?**

Meestal met 06 en wb 21. Ook wel met andere scenario's.

### **Heeft u moeilijkheden ervaren en zo ja, wat zijn de moeilijkheden die u ervaren heeft?**

Een probleem voor ons, maar dat was dan een probleem in termen van omzet was dat de KNMI 06 scenario's in tegenstelling tot de wb21 geen middenscenario bevatten. Terwijl dat in het bestuursakkoord water wel als uitgangspunt genomen was. Deze scenario's waren wel erg gericht op overlast en niet op watervoorziening. Er is ook later een droogte scenario bijgekomen.

### **Maar als je naar de theorie van scenario analyse kijkt dan, zouden alle vier de scenario's gebruikt moeten worden om een goede beslissing te nemen?**

Ik denk en dat is dan dus "expert judgement" dat er het volgende speelt. Het Nederlandse waterbeheer gaat uit van standaarden, gemeten series, herhalingstijden ontwerpcondities e.d.. Daar zijn mensen heel sterk aan gewend. Ontwerpen met scenario's is dus binnen het waterbeheer eigenlijk iets raars. Als je Han Vrijling interviewt zal hij zeggen dat er van klimaatverandering niets in de gemeten records te zien is en dat je er dan dus nog niet mee hoeft te rekenen. Men is er nog niet aangewend. Het gebruik van scenario is toch iets wat wat 'zachter' is. In de 19<sup>e</sup> eeuw is het Nederlandse waterbeheer aan normalisatie gaan doen. Daarvoor werd er maar wat gedaan en ging het goed of niet. (me dat moet je waarschijnlijk ook in opkomst van rekenmethodieken zien) klopt

### **Ik kan me voorstellen dat (sterke normalisatie) dat voor waterveiligheid erg geldt. Geld dit ook voor watervoorziening?**

Voor een deel wel. In de jaren 80 kwam het idee van integraal waterbeheer op. Dat alles dus samenhangt dus waterveiligheid en voorziening hangen samen.

Als je echter de definities van integraal waterheer nakijkt zot daar geen leren in. En langzaam aan leren hoort wel bij adaptief management.

### **Zijn mensen zich er wel van bewust dat de onzekerheid groot is?**

Ja dat denk ik wel, allen je moet mensen wel handelingsperspectief geven. Een scenario van 6 meter zeespiegel stijging heeft alleen zin voor Balkenende die kan daarmee naar de EU om te zeggen dat hij 6 miljoen mensen moet herhuisvesten.

Het is overigens moeilijk hard temaken dat je iets anders moet dan je nu al doet worden omdat er in de synthetische tijdseries eigenlijk geen echte trend te zien is.

### **Heeft het dan wel zin om scenario's te maken?**

Jawel het gaat erom dat je kijkt of je misschien iets anders moet gaan doen dan je nu doet.

Kijk we kunnen enigszins uitvissen hoe de toekomst eruit gaat zien wil je daar zinnig gebruik van maken dan moet je dat ook vergelijken met andere onzekerheden en zo wordt er nu ook naar gekeken bijvoorbeeld in het deltaprogramma. Het deltaprogramma gaat voornamelijk over waterveiligheid en watervoorziening. Die hebben bijvoorbeeld eerst gekeken gewoon naar twee assen. Eén met water beschikbaarheid en één met watervraag.

Als dan blijkt dat je kwetsbaar bent kun je altijd nog naar de klimaatscenario's kijken om te kijken of je voldoende doet. Het is pas interessant als je iets moet anders moet gaan doen. Bijvoorbeeld als de maeslantkering vaker dan de eens in 10 jaar dichtgaat, wordt het misschien interessanter om de dijken op te hogen

### **Denkt u dat een probabilistische approach als die van UKCIP het gebruik kan veranderen?**

Die probabilistische approach leidt ertoe dat mensen ermee gaan rekenen.

Bij grote lange termijns projecten (waterkeringen ruimtelijke ordening) is bijvoorbeeld ruimte voor de rivieren (5 mld) is het een enorm gedoe om alle afspraken rond te krijgen. Er moeten allerlei afspraken gemaakt worden met gemeente er moeten huizen onteigend worden e.d.. Als er dan iets uitgerekend is op basis van die scenario's en er komen scenario's met andere getallen dan is dat voldoende grond voor rechtzaken. Het KNMI moet zicht dat realiseren. Hetzelfde speelt bij het IPCC werkgroep 2. Deze groep beschreef vroeger wat er eventueel kon gebeuren als het klimaat verandert. Toen kwam het idee van adaptatie en nu worden hun resultaten gebruikt voor ontwerpen.

Dat is het gevaar van UKCIP als je die pdf's geeft gaan mensen ermee ontwerpen. Dus dan moeten ze stabiel zijn. Echter als je een ander klimaatmodel neemt of er wat in verandert, verandert ook je pdf. Je bent dan feitelijk beslissingen bij de beleidsmakers weg aan het halen over ontwerpcondities en dat vindt ik niet slim.

### **UKCIP heeft wel een framework waar die scenarios inhangen.**

Ukcip wordt nu vaak gereduceerd tot die probabilistisch. Ik vind wel dat framework er omheen van ze erg goed. Dus guidance zou kunnen helpen. Ja alleen ik denk dat die niet door de klimatologen zelf gemaakt moeten worden. Die gaan het dan over downscaling onzekerheden hebben en daar hebben beleidsmakers niet zoveel aan.

Denk u dat het voor beleidsmakers uitmaakt of er sprake is van natuurlijke variabiliteit model of emissie onzekerheid?

Voor adaptatie beleid niet. Voor mitigatie wel. Het belangrijkste is dat er een verandering in randvoorwaarden is waardoor je kwetsbaar bent en niet waardoor dat nou komt. Het probleem is meer moet je pas wat doen als je de verandering ziet of moet je ook wat doen aan veranderingen die je verwacht, maar nog niet ziet. Het kan zijn dat het nog niet zichtbaar is maar voor projecten met een zeer lange levensduur (ruimtelijke ordening grote infrastructuur projecten) wel van belang is.

Klimaatverandering wordt wel gebruikt om dingen op de agenda te krijgen Bijvoorbeeld zoals de commissie veerman gedaan heeft. We zijn een klein laag landje. De commissie heeft naar de meest extreme omstandigheden gekeken last delta standing.

### **Klopt het dat er in Nederland eigenlijk een instituut ontbreekt tussen KNMI en beleidsmakers UKCIP?**

Er zijn bij het KNMI wel mensen mee bezig .

Maar omdat het klimaat zo breed is kunnen ze niet alles zelf doen. Je moet je realiseren dat topdown makkelijker lijkt dan bottom up. Als wij een afdeling klimaatmodellen zouden beginnen verklaart iedereen ons voor gek. Een afdeling watermanagement beginnen bij het KNMI lijkt logischer. Maar ze zijn eigenlijk een v en w agentschap belast met het weer en ook met klimaat en daar zijn ze erg goed in. Maar het zijn geen beleidsondersteuners? Nee waarschijnlijk zijn ze daar niet goed in?

Wat kan het KNMI om de introductie van de 2013 beter te laten verlopen?

Het is verstandig om met de nieuwe KNMI scenarios ook een set randvoorwaarden (bijvoorbeeld rivierafvoeren). Naar buiten te brengen. Dat er gelijk een vertaling naar de praktijk is. Dat duidelijk is wat die scenarios betekenen.

### **Is een overstap service zinnig?**

Ja waarschijnlijk wel.

### **Maken beleidsmakers zich druk om de range?**

Waarschijnlijk niet zo, maar ik vind dat het wel verteld moet worden.

### **Zouden extreme scenarios zinvol zijn?**

Ja, maar wel naar beide kanten toe. Dus ook scenario's waar dan bijna niets veranderd.

En de extreme uitgangspunten moeten erbij vermeld worden.

## **Appendix C: Interview with Willem Ligtoet of the Netherlands Environment Assessment Agency**

13-7-2010.

### **Heeft u persoonlijk ervaring met het gebruik van klimaatscenario's?**

Ja Ik ben programmaleider op het gebied van klimaat, water en adaptatie en wij maken veel gebruik van klimaatscenario's.

### **Dat zijn de meest recente KNMI scenario's?**

Ja. Voor onze studie Nederland later , hier hebben we vooral aandacht besteed aan de adaptatie opgave van Nederland. Met het KNMI hebben we nog wat extra werk gedaan om de zeespiegelstijging in kaart te brengen. Dat zijn iet zozeer de klimaatscenario's zelf, maar wel de vertaling naar de zeespiegelstijging.

Wij kijken heel erg het omgaan met onzekerheden ernaar, dat is ons vertrekpunt want er is niet gewoon één scenario waarheid.

### **Jullie gebruiken ze alle vier?**

Ja,

### **Altijd?**

Ja vrijwel altijd

### **Dus dat is feitelijk het protocol?**

Ja, wij zeggen dus ook niet wat waarschijnlijker is of zo. Bijvoorbeeld nu zijn we bezig met het orject klimaatbestendig Nederland. Vooral voor de wateropgave hebben we een kruistabel gemaakt van de KNMI scenario's met de WLO scenario's. De KNMI scenario's zijn ook nog maar een deel van de mogelijke toekomst. Klimaatscenario's worden niet één op één gekoppeld aan economische scenario's.

Welke tijdshorizon?

Tijdshorizon 2040-2050 tot 2100, voor de zeespiegelstijging kijken we ook nog wel verder.

### **Heeft u weleens problemen ervaren met het gebruik van scenario's?**

Nee wij hebben geen problemen. Omgaan met onzekerheden is ons uitgangspunt en dan is het dus niet zo'n probleem. Ook de KNMI scenario's zijn niet de waarheid. Alleen de variabelen zijn niet altijd consistent. Ze geven wel zomer en winter gemiddelden maar geen jaargemiddelden. Wij zouden ook graag een jaargemiddelde hebben voor temperatuur en neerslag, omdat mondiaal alles in jaargemiddelden gaat. Wij rekenen ze in overleg zelf om naar jaargemiddelden. Maar onze wens zou zijn dat het KNMI dat zelf doet, ook voor temperatuur. In de tekst van een KNMI publicatie staat dan

dat de jaargemiddelde temperatuur tweemaal zo hard stijgt in Nederland dan mondiaal, alleen dat jaargemiddelde is dan nergens te vinden. Ook naar buiten toe is een jaargemiddelde makkelijk. Het is moeilijk uit te leggen dat je altijd met twee getallen moet komen.

Voor zeespiegelstijging zijn we nu ook in gesprek omdat daarvoor ook verschillende cijfers te vinden zijn. Wij zijn zelf ook aan het kijken hoor of we wel steeds consistente cijfers naar buiten brengen.

**Hoe kijkt u aan tegen het gebruik van klimaatscenario's in andere organisaties? Want u heeft zelf een heel duidelijk beeld van hoe ze gebruikt zouden moeten worden.**

Welke organisaties? Waterschappen enzo?. Die zijn volgens mij redelijk realistisch bezig. Die hebben maar dat was voor de wb21 scenario's voor wateroverlast problematiek gezegd we gaan uit van het midden scenario.

**Dat weet ik, maar u gaat zelf uit van alle scenario's?**

Maar goed een waterschap moet gaan dimensioneren, dus die moeten op een gegeven moment een keuze maken. Een andere organisaties? Ik denk dat er over het algemeen behalve dan door de deltacommissie goed met scenario's omgegaan wordt. Wij bevelen ook aan als je gaat ontwerpen kies een bepaald scenario, maar houd in de gaten als het harder gaat of erger wordt dan verwacht wat is dan je terugval optie. Wat doe je dan?

**In het nationaal bestuursakkoord water ligt ook vast welk scenario je waarvoor moest gebruiken. G lijkt het meest op wb21 dus dat wordt gebruikt?**

Als je gaat dimensioneren kan dat. Wij zeggen erbij het gaat om het omgaan met onzekerheden, dus ook al neem je een besluit op basis van één scenario en daar kun je best G voor nemen, maar breng in beeld wat er moet gebeuren als het een ander scenario wordt.

**Wordt dat vervolgens wel ook echt in beeld gebracht?**

Op dit moment in het onderzoeksprogramma rond het delta programma heb ik de indruk dat ze wel de totale bandbreedte in kaart willen brengen. Daar worden wij ook als adviseur steeds gevraagd om mee te denken hoe ze dat het beste kunnen doen. Dat was wel grappig ter illustratie (Arnout Feijt was daar ook bij) we waren bezig met het combineren van de WLO scenario's en de KNMI scenario's. Zij wilden een link leggen tussen bijvoorbeeld G en een lage economische groei. Toen hebben Arnout en ik gezegd: dat kun je niet doen, want op de schaal van Nederland is er geen relatie tussen economische groei en klimaatverandering. Dat hebben ze nu ook bijgesteld.

Deltacommissie deed dat verkeerd in mijn optiek. Die hebben wel wat wij ook geadviseerd hebben het worst case scenario in beeld gebracht. Je moet namelijk een beeld hebben van wat er op je af kan komen, maar je moet dat vervolgens niet automatisch als uitgangspunt voor beleid nemen. Je zegt dat is de worst case, maar vervolgens neem ik G of G+ en daarop focus ik mijn beleid, en

ondertussen ga je monitoren. Je moet dan bijstellen als dingen anders gaan dan verwacht. Dat is in feite adaptive management.

### **Is daar voldoende ruimte voor? Bijvoorbeeld in waterwetgeving , maatschappelijk bestuurlijk framework?**

Eigenlijk zitten ze in een soort transitie, wat dat betreft. Dus dat zal nog best een tour zijn denk ik.

Je kent het deltaprogramma waarschijnlijk wel een beetje ook die basiswaarden die ze daaraan verbonden hebben zoals solidariteit, flexibiliteit en duurzaamheid. Maar vooral de flexibiliteit sluit natuurlijk helemaal aan bij adaptive management. Wij zeggen altijd het is de combinatie van een stabiele lange termijnsvisie met een flexibele uitvoering. Het is niet zo dat je kunt gaan zwabberen met je beleid. En je moet ook heel goed kijken (wij geven het advies kijk naar doorlooptijden van maatregelen). Naar doorlooptijden van 2-2 jaar moet je anders kijken dan naar doorlooptijden van 30 jaar. Dat zit ook al wel in het huidige beleid ingebakken. Het is echt nog zoeken naar de optimale aanpak. En daar wordt momenteel veel onderzoekskracht tegenaan gezet. Ik heb wel de indruk dat in het nationaal waterplan in de basis een goede aanpak gekozen wordt. Ze hebben afstand genomen van de aanpak van de deltacommissie. Want eigenlijk al hun inhoudelijke voorstellen die zijn geparkeerd en die worden op nut en noodzaak opnieuw bezien afgezien van de procedurele dingen als deltawet, deltacommissaris etc. Dat lijkt mij ook verstandig , want het was een slecht advies. Teveel op het worst case scenario? Het advies van de deltacommissie was inhoudelijk slecht onderbouwd en er zijn weinig varianten bekeken. Ik vind het heel terecht dat het inhoudelijke werk opnieuw gedaan wordt.

Je ziet nu ook dat er heel veel met zeespiegel scenario's gedaan wordt. Je hebt daar eigenlijk maar drie mogelijkheden het is weinig midden of heel veel en of heel veel nu 1.30,1.50 of 1.60 is who cares. Het blijft omgaan met onzekerheden, je moet dus nadenken wat je moet kunnen doen als er iets van 1.50 aan de orde is. Je moet dus nu geen dingen doen die dat in de wielen rijden. Dat is het belangrijkste, voor de rest een gefaseerde aanpak kiezen en monitoren.

### **Julie werken natuurlijk nauw samen met het KNMI wat vind u van de ondersteuning, die gegeven wordt bij het gebruik van de scenario's?**

De ondersteuning vanuit het KNMI is erg goed. Er is altijd ruimte voor discussie. We hebben echt een driehoeksdiscussie met Deltares , het KNMI en het PBL over de zeespiegelstijging hoe zit dat nu in elkaar en we proberen op één lijn te komen. We stemmen nu ook de informatie op elkaars websites op elkaar af. Zodat je op alle drie de websites dezelfde getallen vindt.

### **Wat mist er?**

Probabilities Probabilities van scenario's (Dessai en vd sluijs, 2007) Geeft heel duidelijk de bandbreedte aan van de scenario's. Mensen denken anders dat scenarios de hele bandbreedte opspannen.

**Wilt u liever dit of zoals in groot-Brittanië?**

Liever dit (zoals in Dessai en Van der Sluijs 2007)

**Kan een pdf per scenario ook helpen?**

Wij zijn meestal niet de mensen die de dimensionering bepalen. Maar als je dat doet kan zo'n benadering wel helpen. Je kan dan een scenario kiezen en bijvoorbeeld met 80% werken. Dan heb je een stukje onderbouwing bij jouw beleid. Wij zitten echter vaak een abstractie niveau hoger en dan wil je juist die totale onzekerheid weten en die ook weer tegen andere onzekerheden aanleggen.

Hoewel dit wel te grof is, omdat er dingen inzitten die niet kunnen. Je moet dus filteren. Ze hebben dit wel gedaan, alleen hebben ze het nooit gepubliceerd. Ze zeggen dat hun klimaatscenario's ongeveer 80% van de toekomst omvatten, maar dat kunnen wij dus niet checken.

**Hebben beleidsmakers meer ondersteuning nodig bij het gebruik van scenario's?**

Ja, op zich zijn ze wel gewend aan omgaan met onzekerheden, maar hier heb je dus een bepaald gebruik van die scenario's in het omgaan met onzekerheden en dat vraagt nog wel wat ondersteuning richting beleidsmakers.

**Waarom denkt u dat ze er moeite mee hebben? Wat is uw ervaring?**

Ik weet niet of ze er echt moeite mee hebben, maar soms spelen er ook politieke dingen een rol. (103-128) In het nationaal waterplan hebben adaptive management en omgaan met onzekerheden een prominente plek gekregen. In waterbeleid heeft het wel een goede plek.

**Een beetje extra hulp zou misschien wel op prijs gesteld worden?**

Ja. Ik denk dat de totale beweging van communicatie van wetenschap naar beleid, wij zitten eigenlijk tussen wetenschap en beleid in. Het KNMI is bijvoorbeeld veel wetenschappelijker dan wij. Wij proberen wat het KNMI doet nog wat meer in een beleidsmatige context te plaatsen. (er is natuurlijk vanuit het KNMI ook direct contact met het beleid). Je moet als instituten ook een gezamenlijke lijn proberen te trekken. Soms verschil je van mening, maar dan mag de politieke het uitmaken.

**Als je naar het ontwerp van de scenarios kijkt in de rest van de wereld bijvoorbeeld in Engeland worden vaak emissiescenario's als basis gekozen? De aanpak van het knmi is redelijk uniek. Heeft u een voorkeur?**

Is het niet zo dat achter die twee assen de IPPC scenario's zitten. Zelf denk ik dat als je naar de Nederlands situatie kijkt de keuze van het KNMI terecht is, daarom gebruiken wij de wlo en KNMI scenario's onafhankelijk van elkaar. Op wereldschaal zijn ze niet onafhankelijk, maar op Nederlandse schaal wel. Als het hier slecht gaat economisch, maar in India en China goed krijg je het alsnog gewoon over je heen. Bij wijze van spreken.

Dat verhaal kan misschien nog wat beter gecommuniceerd worden. Je merkt dat dat nog niet altijd goed gaat. Het KNMI draagt heel erg uit dat ze allemaal even waarschijnlijk zijn en dat is heel moeilijk te verkopen aan de mensen die ook bezig zijn met die emissie toestanden. Op de schaal van Nederland is het onafhankelijk, maar mondiaal niet. Dat is een moeilijk verhaal, dat makkelijk munitie kan geven: allemaal waarschijnlijk het doet er dus niet toe. Het verhaal erbij vraagt aandacht.

**Zouden scenario's op basis van emissie scenario's tot ander gebruik leiden? Het dan misschien meer koppelen aan economie.**

Ja die discussie hebben we gevoerd, maar op het niveau van Nederland is er geen relatie. Dus niet doen denk ik. Ook voor het ontwerp van je waterbeheer is het ook niet zo relevant. Je opgave is het klimaat dat je over je heen krijgt en de bevolking en economie die je moet beschermen en daar zitten bij allebei onzekerheden in.

**Denkt u dat de probabilistische scenario anders gebruikt zullen worden dan de KNMI scenario's?**

Dat denk ik wel. Ik denk dat er behoefte aan is. Als je een iets moet ontwerpen dat je dan een beter onderbouwde keuze kan maken.

**Het is niet zeker of ze daar geschikt voor zijn. Ik probeer achter de aantrekkingskracht van dit type scenario te komen. Het lijkt mij dat het voorkomt uit normeringen?**

Er wordt in Nederland heel veel gewerkt met kosten baten analyse, als je aan een maatregel een probability kunt hangen of aan de noodzaak om iets te doen kun je een veel betere kosten baten analyse maken.

**Merken jullie dat er problemen zijn op het moment dat er nieuwe scenarios uitkomen, ongeacht of dat ze nu probabilistisch zijn of niet?**

Ja nieuwe scenario's is altijd lastig want iedereen moet gaan bedenken, wat betekent dit voor mij?

Het zou ook denk ik verstandig zijn als het KNMI nieuwe scenario's zou uitbrengen, dat zij zelf of bijvoorbeeld samen met ons in kaart brengen: wat betekent dit nu voor bijvoorbeeld het waterbeleid. Er betekenis aangeven. Het duiden van heeft dit consequenties voor?

**Zou een algehele pdf dingen veranderen?**

Dat is vooral een perceptie denk ik, als je zo'n curve laat zien, dan gaan mensen automatisch denken grote onzekerheid. Ik weet niet of deze bandbreedte realistisch is. Wij vonden het verrassend dat in dit plaatje de KNMI scenario's, maar een klein deel van de mogelijke toekomst opspannen, misschien valt het erg mee als je er een filter overheen legt.

Volgens mij in de perceptie als je zo'n curve laat zien is al weer een extra aanwijzing van de wereld is niet zo zeker en die klimaatscenario's zijn ook maar een uitsnede.

**Als u de klimaatscenario's zelf mocht ontwerpen, wat zou u dan doen? Hoe zouden ze er dan uitzien?**

Denk je dan in parameters?

**Zijn er bijvoorbeeld dingen die ik niet genoemd heb, die handig zouden zijn of die u anders zou doen dan het KNMI.**

Eigenlijk doet het KNMI dit wel goed. Je ziet dit ook bij het IPCC. Als KNMI kom je er niet meer mee weg om eens in de vier of zes jaar scenario's te publiceren, dat kan ook nog wel. Maar je moet ook iets op je website hebben waar je voortdurend nieuwe informatie een plek geeft. De informatie buitelt over elkaar heen. Het IPCC heeft daar ook last van, die hebben een rapport uitgebracht, maar de jaren daarna komt er zoveel informatie los, dat mensen behoefte hebben aan duiding.

Een ijkpunt eens in de zes jaar is goed, maar tegelijkertijd zou je ook die nieuwe kennis in beeld moeten brengen. Je zou op de website iets kunnen zetten van zeespiegelstijging, dat de worst case nu 1.50 is. Als er dan publicaties uitkomen dat het 2.90 kan worden, kun je dat duiden als zijnde nog in het stadium van onderzoek. En dat het voor je beleid nu nog niet uitmaakt.

**Dus het duiden van de huidige wetenschappelijke stand van zaken?** Ja daar zou je de wereld behoorlijk mee helpen..

**Maakt het verschil tussen de hoofdonzekerheden uit puur voor adaptatiebeleid?**

Als je aan besluitvorming denkt

Zijn we zover dat je we dat kunnen duiden?

**Ja er zijn wel wat publicaties over. En het KNMI noemt dat ook in hun publicaties. De Britten trekken ze uit elkaar. Zou het uitmaken?**

Nee ik denk het niet. Als tachtig procent natuurlijk is maken die energie scenario's natuurlijk niet zoveel meer uit.

Op welke graad schat u de drie hoofdonzekerheden?

Ik denk dat er nog een hoop erkende onwetendheid is. Er zijn een aantal recht toe rechtaan fysische relaties, maar de hele dynamiek van de ijskap is nog wel heel lastig

Dus de model onzekerheid is erkende onwetendheid? En de emissie scenario's? Scenario onzekerheid

En de natuurlijke variabiliteit is die statistisch? Ja dat denk ik wel. In Nederland valt dat nog wel mee.

Maar in aride gebieden, dan heb je grotere problemen, daar is het niet alleen statistische onzekerheid.

Daar is echt de natuurlijke variabiliteit aan het veranderen.

In Nederland is dat nog niet echt? Jawel in de zin van dat de buien aan het veranderen zijn. We hebben hier zoveel informatie, daar kan je wel wat mee

**Is het ook niet zo dat daar veel minder gemeten is?**

Ja absoluut.

## **Appendix D The interview with Eric Gloudemans of the union of waterboards on**

3-8-2010.

### **Heeft u ervaring met het gebruik van klimaatscenario's?**

Ja hiervoor heb ik bij een waterschap gewerkt, waarbij we veel sommen gemaakt hebben naar het functioneren van de watersystemen. Daarbij ben ik ook in aanraking gekomen met klimaatscenario's. Voor de UVW heb ik samen met V&W, KNMI, IPO en VNG een studie in 2007 gemaakt naar de toepassing van de KNMI 2006 klimaatscenarios en, deze toepassing is overgenomen in het Nationaal Bestuursakkoord Water Actueel (2008). Verder ben ik betrokken bij de ontwikkeling van de deltasenario's van RWS en Deltares in het kader van het Deltaprogramma.

### **Wat zijn de belangrijkste problemen in het omgaan met scenarios?**

Het probleem is dat door klimaatverandering de variabelen verschillende kanten uit kunnen gaan. Waardoor het lastig is in te schatten wat er moet gebeuren en wat er geïnvesteerd moet worden. Watermanagement is breed het omvat waterveiligheid, water kwantiteit (te droog en te nat) en kwaliteit en deze aspecten kunnen heel verschillende beïnvloed worden.

In 2000 kwamen de wb21 scenario's uit. Dit waren er drie. Er is toen afgesproken om voor het middenscenario te kiezen. Die bandbreedte is aangehouden zowel in planvorming als naar bestuurders toe. Waterschappen nemen bepaalde besluiten (zoals peilbesluiten) vaak voor 10-12 jaar, dus veel plannen liepen nog toen in 2006 de nieuwe KNMI scenario's al weer uit kwamen. Je kunt die plannen dan niet zomaar opnieuw gaan maken. Het was dus zaak uit te zoeken op welk punt de klimaatscenario's overeen kwamen en waar de verschillen zaten.

### **Maar gezien vanuit de theorie over scenario analyse, zouden eigenlijk alle vier de scenarios gebruikt moeten worden om een goede beslissing te kunnen nemen?**

Er bestaat de behoefte denk ik om dingen behapbaar te maken. Er moest in een kort tijdsbestek veel plannen gemaakt worden. Als alle vier de scenario's gebruikt worden duurt het plan proces ook weer veel langer. Daarom wordt er destijds (2003-2006) toch vaak één scenario gekozen. Waterveiligheid kiest dan meestal het hoogste/zwaarste scenario, maar voor wateroverlast wordt dan voor het middenscenario gekozen.

Het klimaat is ook zeker niet de enige onzekerheid, waar het waterbeheer mee te maken heeft. Het gebied en het functioneren van de watersystemen moet bijvoorbeeld ook in beeld gebracht worden. Dit gebeurt door metingen, die in een model geplaatst worden. In het model worden simplificaties gemaakt. Dit leidt ook weer tot onzekerheden. Je kunt aan de voorkant van het model met scenario's werken, maar je kunt ook aan de achterkant een bandbreedte bepalen.

**Kan het zijn dat er een clash is tussen het in normeringen denken in het waterbeheer en het gebruik van scenario's?**

In het begin was er sprake denk ik van onbekendheid met scenario's. Men zag het als een hoop extra werk. Als je 4 oplossingen hebt en die moet je voor alle vier de scenario's doorrekenen dan geeft dat een hoop extra werk. Er zit ook een bestuurlijke kant aan. Als je bestuurders vier opties geeft die alle vier even waarschijnlijk zijn dan hebben ze heel veel moeite om een keuze te maken.

**Maar hoe zit het met dimensioneren en normeringen en scenario's?**

Tot de eeuwwisseling (jaren 90) werd er veel gewerkt met standaard herhalingstijden e.d. Dat was tot die tijd het uitgangspunt. Tegenwoordig wordt er toch meer met een modelschematisatie van het gebied gewerkt, die tot stand komt o.a. dmv. metingen. Op basis daarvan wordt dan een afweging gemaakt. Deze aanpak dekt de dynamiek van een systeem aanzienlijk beter. En hier kan ook meer ruimte zijn voor scenario's.

**In de landen om ons heen worden vaak emissie scenario's als driving forces voor klimaatscenario's gebruikt in plaats van klimaatvariabelen? Zou een andere keuze hierin het gebruik kunnen veranderen?**

Zolang 2006 nog steeds robuust is blijft het goed bruikbaar voor de waterwereld. Ik denk dat de keuze voor andere driving forces niet zoveel verandert aan het gebruik in het geval van de waterwereld. Ik denk eerder dat totaal andere scenario's weerstand op zullen roepen dan scenario's die lijken op de vorige. Dan valt er namelijk weer veel uit te leggen hoe het nieuwe beleid aansluit/verschilt van het oude.

**In Groot-Brittannië zijn probabilistische scenarios gepubliceerd. Zou dat eventueel het gebruik kunnen veranderen?**

Het is voor ons vooral belangrijk dat er aansluiting is met de omliggende landen (Duitsland en België) omdat we steeds meer dingen op rivierstroomgebiedsniveau doen. Dat is belangrijker dan die curves. Als je de curves erbij gaat geven, moet je ook zorgen dat er hele goede richtlijnen voor gebruik bij gemaakt worden.

**Is er meer behoefte aan gebruiksondersteuning?**

De lijntjes met het KNMI zijn heel goed. Ik wil er ook voor pleiten om de beweging die het KNMI heeft ingezet vast te houden. De gebruikersbijeenkomsten waren erg goed.

**Als u de klimaatscenario's zelf mocht ontwerpen hoe zou u dat dan doen?**

De terugblik naar het verleden is heel belangrijk en overstappen van de oude naar de nieuwe scenario's moet makkelijk zijn. Wat beslissingen nemen ook lastig maakt zijn de natuurlijke fluctuaties. Het kan soms erg nat zijn en soms erg droog en op beiden wil je voorbereid zijn. Maar de natte en

droge kant kunnen zich verschillend ontwikkelen tegengesteld zelfs. In de 2006 scenarios komt dit duidelijk naar voren.

### **Hoe worden de normeringen in het waterbeheer vastgesteld?**

De normeringen voor waterveiligheid komen vanuit de rijksoverheid. Ik ben hier geen expert in. Voor wateroverlast worden er op voordracht van de waterschappen in de provinciale verordening zogenaamde gebiedsnormen vastgesteld. Voor watertekorten bestaat geen normering

### **Wat mist er nog in de klimaatscenarios?**

Onze belangrijkste vraag betreft de ruimtelijke spreiding van klimaatontwikkeling in Nederland. Er zijn in Nederland verschillen tussen bijvoorbeeld de kust en het zuiden of oosten en het lijkt erop dat die versterkt. We zouden hierover graag meer informatie hebben. Ook zijn er verschillen tussen stedelijke agglomeraties als Rotterdam en het landelijk gebied. Eén scenario met een beetje bandbreedte zou natuurlijk het mooist zijn. Wat ook een interessant concept is zijn knikpunten in het waterbeheer. Je gaat dan niet meer kijken wat gebeurt er tussen 2030 en 2050, maar wanneer gaat het mis in het systeem. Scenario's is voor bestuurders erg ingewikkeld, het is misschien interessant om beslissingstools te koppelen aan knikpunten.

Aanpassen aan veranderingen is onze core business, we zijn daar al lang mee bezig. Je wilt als waterschap anticiperen op veranderingen en je watersysteem zo robuust maken als nodig is. Daarbij moeten wel afwegingen gemaakt worden wat nog rendabel is. Hoeveel ruimte je in beslag kunt nemen. Er spelen natuurlijk meer belangen. Vaak is het uitgangspunt heel robuust, maar wordt dat toch in overige met belanghebbenden dat ietsje teruggeschroefd. We werken vanuit adaptief management.

### **Worden die voorzieningen ook wel echt getroffen?**

Ja er worden maatregelen getroffen om dijken te versterken en waterbergingen aan te leggen. Ook worden er bijvoorbeeld al ruimtelijke reserveringen voor de toekomst gemaakt.

Je kan natuurlijk verschillende types maatregelen nemen. Sommige heel technisch, maar vaak wordt het natuurlijk gemaakt, met veerkrachtige systemen als uitgangspunt. Stapje voor stapje worden systemen aangepast. Er is een wisselwerking met de aanwezige grondgebruikfuncties. Soms zitten de functies die een lage (grond)waterstand vereisen op de diepste plekken en de functies die veel water vereisen op de hoge plekken. Daar willen we samen met de ruimtelijke ordenaars (provincie, gemeente) geleidelijk aan verandering in brengen.

Hoe denkt u over het gebruik van klimaatscenario's in andere organisaties?

Welke organisaties? Rijkswaterstaat bijvoorbeeld? Rijkswaterstaat werkt als beheerder van het hoofdwatersysteem ongeveer hetzelfde als de waterschappen.



## **Chapter 9 Appendix E Interview with Marianne Linde-Kuipers of Geodan.**

5-8-2010

Wat is uw ervaring met het gebruik van klimaatscenario's?

Dan zal ik wat vertellen over wat wij doen. Geodan gebruikt klimaatscenario's voor het opstellen van milieueffect rapportages. En in die milieueffect rapportages voor structuurvisies, dan kijk je wat verder vooruit. Dat doen we vooral voor provincies. En de vraag die provincies hebben is, is ons ruimtelijk beleid klimaatbestendig en dan kom je eigenlijk al gauw bij de klimaat scenario's van het KNMI uit. En het lastige is als je kijkt naar de database, je hebt die vier scenario's en veel provincies willen eigenlijk niet die vier scenario's, maar zeggen we kiezen er 1. En dat is nu dat waarvan Janette altijd probeert uit te leggen dat je dat nou net moet doen.

Het alternatief dat wij bijvoorbeeld daarvoor aangedragen hebben bij de structuurvisie van Overijssel en misschien is dat ook niet goed hoor. We hebben gewoon gekeken naar de effecten, die afgeleid worden van de klimaat scenario's en dan hebben we steeds gekeken welk klimaatscenario de grootste range oplevert. En daarmee hebben we toch alle scenario's over elkaar heengelegd en we hebben dan steeds de worst case genomen.

Waarschijnlijk kan dat wel.

Misschien had ik daar methodisch wat meer over na moeten denken, maar ik denk dat dat de meest logische manier is. En omdat in beleid het werken met probability density curves, werkt al helemaal niet. Mensen zijn niet geïnteresseerd in 80%. Als ik in een rapport schrijf dit is met zo'n onzekerheid of ik geef als dat zou kunnen een onzekerheidsinterval dan wordt dat altijd geschrapt of het wordt niet gelezen, dus die informatie is niet bruikbaar in beleidsdiscussies.

Dus als ik bij ieder scenario een probability density curve geef werkt dat ook niet?

Ik ben gebruiker, dat is heel simpel. En ik maak ook gebruik van gegevens bijvoorbeeld van WUR over mogelijke schade aan gewassen. Bij het analyseren van effecten is het voor onderzoekers wel belangrijk om die onbetrouwbaarheid goed in beeld te brengen, want je doet een heleboel tussenstappen en dan kom je tot een kaart waarin bijvoorbeeld overstromingsrisico's staan of waarin potentiële schade aan landbouwgewassen staat. Die kaart is voor mij weer een nieuwe waarheid en die gebruik ik. Maar voor het maken van die kaart en het in beeld brengen van die mogelijke kansen en dat gaat vaak in een hele simpele ordinale schaal, van geen effect tot groot effect. Ik denk dat in die analyses, het werken met onzekerheid heel erg belangrijk is en dat je dus heel goed onderscheid moet maken tussen gebruikers als ingenieursbureaus en adviesbureaus die beleid adviseren en die

zullen niet werken met probability density functions en de onderzoekers, de analysten, die zullen er wel mee werken.

Voor mij zijn die 4 scenario's gewoon prima.

**Er zitten twee ideeën achter het toevoegen van die curves en dit onderzoek. Het KNMI dacht als we die curves toevoegen dan begrijpen mensen beter dat die scenarios onzeker zijn. Ik dacht dat de gebruikers dit vanuit de civiele techniek zouden willen omdat het het rekenen makkelijker maakt.**

Dat is dus een hele analytische onderzoeksgerichte aanpak, maar bij de eindgebruikers is dus dat probleem niet zo groot.

Wat erg illustratief is, ik laat wel altijd aan de eindgebruiker een plaatje zien van de berekening van de mogelijke zeespiegelstijging en daar zie je die enorme verschillen in de ontwikkeling op langer termijn. At zijn dus grafieklijnen en om elke lijn hoort eigenlijk ook weer onzekerheids curve, maar die laat ik weg. Dat plaatje is meestal voldoende om in een adviesrapport aan te geven let op deze gegevens gaan over A kennis die nog in ontwikkeling is en B een probleem dat eigenlijk niet te meten valt en niet te analyseren valt, het is dus een bouwwerk met aannames.

**Dus het probleem is, het is onzeker het KNMI kan geen kansen kan geven en dat beleidsmakers daar niet op toegerust zijn?**

Ik vind de methode waarmee het KNMI werkt, met die scenario's waar je eigenlijk 4 databases hebt. Dat vind ik een veel mooiere methode, dan dat je 1 database hebt. Wat ik als gebruiker zou doen als ik met een probability density curve moet werken, dan zou ik alle data over onzekerheid eruitgooien. En dan zou ik het gemiddelde pakken in plaats van de worst case.

**Ze hebben in Groot-Brittanie wel een curve per emissie scenario?**

Dus ze hebben daar ook verschillende scenario's?

**Dat klopt. In de praktijk pakken ze dan het midden of het hoge scenario en daarvan 80 of 90%.**

Maar eigenlijk zeg je dan dat ik met mijn worst case benadering, omdat ik het gemiddelde neem eigenlijk niet de echte worst case heb.

**Ze zijn eigenlijk niet 1 op 1 vergelijkbaar die scenario's. Het KNMI neemt wel 80 % van de bandbreedte, of althans dat proberen ze. Ik vind dat zelf wel behoorlijk. 80% van de bandbreedte zegt mij ook meer dan 80% van een emissie scenario.**

Ik denk dat de gegevens die het KNMI op de website heeft staan voldoende zijn voor 80% van de gebruikers. En de onderzoekers die het 100% betrouwbaarheidsinterval willen hebben, die komen

toch wel bij hen. Daar is toch wel 1 op 1 contact mee. Die gegevens kun je altijd opvragen. Dus ik vind het allemaal fantastisch wat het KNMI doet.

**Dat brengt me op de volgende vraag. Hoe is de ondersteuning?**

Prima, als je een mailtje stuurt, dat heb ik overigens de laatste tijd niet gedaan hoor, maar vorig jaar hebben we weleens vragen gesteld. De mensen van het KNMI zijn gewoon heel toegankelijk. Ze geven goed uitleg en hun website is prima.

**Is het misschien zo dat beleidsmakers meer hulp nodig hebben, bij het nemen van beslissingen onder onzekerheid?**

Je moet je voorstellen een beleidsmaker maakt geen gebruik van de KNMI website. Een beleidsmedewerker schakelt kennisinstituten in en die schrijven een rapport over de effectiviteit van bijvoorbeeld landbouwbeleid en daar worden die KNMI scenario's voor gebruikt.

**Dus vaak is het zo dat kennisinstituten en ingenieurs bureaus al een vertaling maken?**

Ja. Je moet niet het idee hebben dat door beleidsmedewerkers of in besluitvormingsprocessen die scenarios heel veel gebruikt worden. Ik kan je een voorbeeld noemen.

In juli heeft de provincie Zuid-Holland het nieuwe ruimtelijke beleid vastgesteld, de provinciale structuurvisie. Ik heb daarbij geholpen om het rapport te schrijven. Ik vond het belangrijk om in die structuurvisie ook de KNMI scenario's op te nemen. Ik had ze dus een prominente plek in hoofdstuk 2 gegeven, met een mooi verhaal over de onzekerheden erbij. Dat werd dus geschrapt, want wat doet dat in de structuurvisie. Ik wilde de onzekerheden laten voor een provincie waarin de wateropgave, de klimaatopgave zo groot is. Het zit nu in een bijlage. Dat geeft dus aan wat het belang is.

**Denkt u dat het hun beslissingen beïnvloed? Willen ze er niet naar kijken of weten ze het niet?**

Het is niet relevant.

**Is het uiteindelijk niet relevant of vinden ze het niet relevant, maar zou het dat wel moeten zijn?**

Nee het is ook niet relevant, want waar zij over moeten beslissen is: kan een boer over 20 jaar nog boeren in Zuid-Holland. Hebben wij over een 10 jaar enorme kosten om onze infrastructuur te onderhouden. Daarover moeten ze beslissen en die kennis is mede gebaseerd op de veranderingen in het klimaat.

**Dus andere onzekerheden spelen een grotere rol?**

Ja een heleboel andere. Bijvoorbeeld hoe gaan wij om met onze infrastructuur. Worden er technologische innovaties verwacht in het type asfalt dat we gebruiken. Hoe ontwikkelt de landbouwtechnologie zich? Kunnen we straks met hele lichte voertuigen oogsten? Dan is het niet zo erg als de grondwaterspiegel stijgt. Het is dus maar 1 parameter in een heel breed veld.

Er spelen nog veel meer onzekerheden zoals technologische innovaties in de landbouw. Klimaatverandering is er maar 1.

### **Dan is het misschien een beetje overkill?**

Ja om daar heel veel zorgen over te maken over de gegevens die het KNMI via zijn website beschikbaar stelt. Het is belangrijk dat er een goede community van onderzoekers is. En dat de klimaatonderzoekers van het KNMI gelinkt zijn aan de onderzoekers die de effecten van klimaatverandering voor allerlei andere aspecten van onze samenleving onderzoeken.

En hoe ze over die keten van onderzoek omgaan met onzekerheid, met betrouwbaarheid en onbetrouwbaarheid, dat is wel belangrijk.

### **Worden die onzekerheden dan wel makkelijk gecommuniceerd?**

IK heb vroeger bij het planbureau gewerkt en toen hebben we een richtlijn gemaakt hoe je onzekerheid kunt communiceren. En dat vind ik heel goed.

Als het getal bijvoorbeeld 30 is, maar er is een enorme onzekerheid, dan presenteert je dat getal 30 niet. Je presenteert dan bijvoorbeeld of de ontwikkeling positief of negatief is. Soms moet je helemaal geen getallen noemen. Je kan aangeven de ontwikkeling gaat zoals het beleid beoogd heeft, of het kan zijn dat het onzeker is, dat doelen gehaald worden en dan kan je aangeven dat een heleboel effecten moeten worden gemonitord, om te kijken hoe de ontwikkeling gaat. Dus ik denk dat die richtlijn al een heel goed beeld geeft hoe er met onzekerheid kan worden omgegaan. Er is ook een hele community die zich daarmee bezig houdt.

### **Misschien is het een idee om het KNMI daar wat meer mee te linken**

Ja

**In Engeland is de organisatie die de klimaatscenario's presenteert en communiceert niet dezelfde organisatie als die ze maakt. Er zit daar echt een boundary organisation tussen. Die organisatie heeft een andere rol en brengen dus ook heel veel dingen samen. IK denk dat dit in Nederland een beetje mist, maar dat de kennis er wel is.**

Volgens mij moet je heel goed onderscheid maken tussen het omgaan met onzekerheden in beleidsadviezen en omgaan met onzekerheden in wetenschappelijke publicaties. In wetenschappelijke

publicaties moet je het gewoon heel helder in beeld brengen. Want dat onderzoek moet voldoen aan bepaalde criteria.

### **Ik kijk naar het gebruik in watermanagement en dus naar de beleidskant.**

In watermanagement heb je vaak te maken met grote investeringen. Bij watermanagement is er door het planbureau nog een aanvullend richtlijn opgesteld namelijk omgaan met risico's, daar is een onderzoek naar gedaan. Bij het omgaan met onzekerheden moet je rekening mee houden wat het effect is als je in die 20% extreme gevallen zit. En als dat effect exponentieel gaat toenemen, dan moet daar een discussie over gevoerd worden. Dus ik denk wanneer je praat over investeringen in dijken je de 100% betrouwbaarheidsinterval moet pakken, maar dan gaat het puur over een heel specifiek onderwerp.

### **Ik kijk vooral naar waterkwantiteit, dus zowel droogte als waterveiligheid.**

Als je praat over verdroging van natuur, dan wijzen onderzoeken telkens uit dat de flexibiliteit van onze natuurgebieden vrij groot is, dus dat de natuur zich vrij goed kan herstellen na een periode van droogte. Als je kijkt naar watertekorten in de landbouw, dat is natuurlijk een waterkwantiteit en waterkwaliteit probleem. Bij het analyseren van de mogelijke effecten en de economische kwetsbaarheid van de landbouwsector dan denk ik dat je de hele range moet pakken. Maar dat is ook weer een kwestie van onderzoek. De landbouwonderzoekers in Wageningen moeten dan met de hele range werken.

Maar in het werkveld waar ik werk, waarin je eigenlijk geen echt onderzoek doet, maar desk research van wat zijn de resultaten van bestaande onderzoeken, daar hoeft je dat niet te doen.

### **Hoe maak je dan je keuze?**

Zoals ik eerder vertelde.

### **Dus je legt ze over elkaar heen?**

Ja en je kijkt naar resultaten van ander onderzoek en dan kijk wel altijd hoe betrouwbaar die gegevens zijn. En ik moet zeggen dat in 80% van de onderzoeksrapporten die ik lees, wordt helemaal niet gerept over de betrouwbaarheid van de gegevens. Dat is misschien wel een aandachtspunt voor de hele onderzoeksketen.

### **Zou het helpen bij het gebruik van klimaatscenario's als er een instituut is dat specifiek helpt bij het gebruiken van klimaatscenario's en het aanpassen aan klimaatverandering?**

Ik ben geen voorstander van zo'n Brits model, dat je er weer een instituut tussen gaat zetten.

### **Waarom niet?**

Het kost allemaal veel tijd en het is duur. Je maakt dan je informatieketen alleen maar langer en complexer. Terwijl we juist in Nederland behoefte hebben aan een meer simpele structuur.

### **In hoeverre een simpelere structuur?**

Nou stel dat een instituut hebt dat verantwoordelijk is voor de communicatie van alle onderzoeksresultaten van kennisinstituten van het KNMI, maar ook het RIVM TNO en dergelijke dat is toch heel onhandig.

**Zo is het in Engeland ook niet echt. Zij zijn door de Britse overheid in het leven geroepen, om het land te helpen zich aan te passen aan klimaatverandering het zijn een soort klimaatadaptatie consultants. In Nederland heb je het in feite in die vorm niet nodig, want je hebt deltares en het PBL enzo. Het zou beter gestroomlijnd kunnen worden.**

In Nederland hebben we het heel mooi georganiseerd.

We hebben de kennisinstituten, dat is eigenlijk het fundament Bijvoorbeeld TNO dat alles van de ondergrond weet. Deltares weet alles van water. En die werken heel nauw samen want in Nederland zijn Water en ondergrond zijn sterk verbonden. En je hebt een instituut dat alles weet van mobiliteit. Zo hebben we een heleboel instituten.

Dan zijn er de drie planbureaus volgens people planet profit, die de communicatie richting het kabinet en desgewenst tweede kamer verzorgen. Die gebruiken voor 90% op de kennis van de kennisinstituten.

Daaroverheen zit een laag van samenwerking met de universiteiten, die op zich die kennisinstituten weer voeden.

Als tweede laag zitten daar nog de aardgasbaten overheen om te investeren in extra onderzoek op bepaalde onderwerpen. E'n van die onderwerpen naast nanotechnologie ed is klimaat en we hebben dus heel veel geld om nog die staande structuur van wetenschap, kennisinstituten en planbureaus, om die nog extra te voeden.

Om daar nog een laag op te zetten van instituten die zich concreet bezig houden het uitwerken van de gevolgen van klimaatverandering voor de samenleving. Dat lijkt me te veel. Ik vind het nu al heel complex. Soms denk ik dat kan allemaal veel simpeler.

### **Ze hebben natuurlijk wel allemaal hun eigen rol.**

Ja

Als ik iets wil weten over een dwarsdoorsnede van de ondergrond kan ik dat via dinoloket allemaal zo krijgen en kan ik precies weten wat er allemaal in de grond zit. Als ik iets wil weten van de KNMI scenario's al die gegevens, al die kaartlagen zijn beschikbaar via GIS. Op het moment dat ik iets anders wil of ik ben onzeker over of ik het wel goed heb begrepen dan bel ik het KNMI en dan krijg ik ook nog ondersteuning. Maar als ik iets wil weten over de kabels en leidingen, die in de grond liggen. Dat is via een private organisatie geregeld, dan krijg ik geen informatie. Dat is heel raar. Voor mij ligt het probleem dus niet bij de overheidsinstituten en de kennisinstituten.

Maar is dat ik vaak ik die informatie wil combineren met informatie van wat vroeger een overheidstaak was, de kabels en de leidingen, maar wat nu een private taak is en die gegevens krijg ik niet.

Laatst wilde ik de gegevens van hoe het elektriciteitsnetwerk van de NS in elkaar zit. Dan moet ik eerst een brief van V en W hebben dat ik in hun opdracht onderzoek doe, voordat ik bij de prorail GIS database kan. Volgens Europese richtlijnen moeten die gegevens uiteindelijk wel openbaar worden. De inspire richtlijn.

Er is wel heel veel klimaatinformatie beschikbaar. Janette heeft natuurlijk ook wel eens provincies en gemeentes aan de telefoon en ik kan me voorstellen dat het lastig is om voor hen op maat gesneden informatie te maken.

Dat doen we via die laag van extra gelden. Voor gemeenten en provincies maken we klimaat effect atlassen. Dat doet eigenlijk de WUR maar Geodan mag daar aan mee helpen en het is heel goed dat het KNMI kritisch meekijkt, want die zeggen gewoon tegen de projectleider als het niet goed is en dan helpt Janette en dat vind ik echt een hele goede manier. Dus die structuur is prima zo.

### **Het uitgangspunt van mijn onderzoek is het scenario ontwerp. Maakt het voor jullie klanten, maar ook voor jullie zelf uit hoe die scenario's ontworpen zijn? Het KNMI heeft die twee assen en de vorige klimaatscenarios hadden de IPCC emissie scenarios als driving force Maakt dat uit?**

Waar wij erg mee geworsteld hebben zijn klimaat scenario's in combinatie met sociaal economische scenario's. Die zitten ook een beetje achter de IPCC scenario's. Dan gaat het erom hoe gaan we om met het gebruik van grondstoffen etc. Die twee scenario assen, in Nederland hebben de planbureaus die ook gebruikt.

### **Dat is met privaat en publiek en globalisering en regionalisering als driving forces?**

Die vier scenario's uit de CPD studies, die willen we altijd combineren met de de KNMI scenarios.

Als je dat correct doet, veronderstel je onafhankelijkheid, dat is overigens niet helemaal waar, want achter die 2 graden zit een sterke groei van de economie en een sterke toename van de uitstoot van

broeikasgassen. Dus ze zijn niet helemaal onafhankelijk. Maar als je ze onafhankelijk veronderstelt leidt dat tot 16 scenarios en dat is rampzalig. Met hulp van aardgasbaten geld is er in kvv project toen een koppeling gemaakt. De CPB scenarios zijn toen gekoppeld aan die van het KNMI. De koppeling zit eigenlijk indirect inde 2 graden, de verandering van de windrichting is daar meer onafhankelijk van.

**Dus als ze gebaseerd zouden zijn op emissie scenario's zou die koppeling wat eenvoudiger zijn.**

Ja dat denk ik wel. Maar met de koppeling die gemaakt is het probleem uiteindelijk ook opgelost en daar zijn vier nieuwe scenario's uitgekomen.

**Dus dan maakt het ook weer niet zo heel veel uit?**

Wat ze in het buitenland doen zou ook kunnen. Het probleem is die scenario's baseren zij op sociaal economische scenario's, maar de ontwikkelingen in de economie zijn zo onzeker. We dachten eigenlijk dat Europa in een gat zou vallen en dat de verenigde staten zich zou herstellen en nu blijkt ineens het omgekeerde. Op de lange termijn als de dollar daalt wordt de euro duurder en dat remt onze economie dan weer. Dus die economie is zo lastig te voorspellen dat ik denk dat het maken van lange termijns economische scenario's zich blijft herhalen en elke keer zijn de toekomst anders.

**Ja het is deels gebaseerd op zachte variabelen en dat maakt het zo lastig.**

Laat het KNMI dan maar met de best beschikbare gegevens scenario's maken en ik vind het heel goed dat ze zeggen de onzekerheid bij klimaat komt voort uit de emissies en uit het gedrag van de wind , dus laten we die onzekerheden juist zien. En op het moment dat het aannemelijker wordt dat die Co2 emissies in de hogere scenario's zitten, gaan we opschuiven naar die scenario's met twee graden temperatuurstijging, alleen dan worden de betrouwbaarheidsintervallen dagkoersen. Telkens als er nieuw onderzoek beschikbaar komt kunnen ze eigenlijk opnieuw doorrekenen. Daar kan het beleid niet mee werken dan worden ze knettergek, dus maak maar foto's en ga nu maar kiezen. En als nieuwe scenario's afwijken van de oude dan moet je heel duidelijk aangeven, waarom ze afwijken

**Is dat de vorige keer een probleem geweest?**

Het is altijd een probleem. Toen ik bij het planbureau werkte het is altijd rampzalig. Je doet voor beleid altijd ex ante evaluatie.

Bijvoorbeeld de reductie van fijnstof is belangrijk in Nederland, want overal werden die grenzen overschreden. Het is ook erg moeilijk te meten, maar dat werd gemeten en het beleidsdoel werd bij lange na niet gehaald. Dan verplicht je de overheid om maatregelen te nemen en dat kost geld. Als je dan de volgende jaren roept we hebben een foutje gemaakt in onze metingen de doelen worden wel gehaald, dan zijn er soms miljoenen geïnvesteerd.

Stabiliteit in de scenario's is belangrijk. Als echter voortschrijdende wetenschappelijke inzichten nieuwe scenario's nodig maken prima, maar leg dan wel uit waarom.

**Is het ook handig als gelijk uitgelegd wordt wat dit betekent.**

Ja

**Is er nog iets vanuit uw werk wat er mist aan de scenario's, wat eventueel handig zou zijn. Als u ze mee mocht ontwerpen, wat zou u dan veranderen?**

De belangrijkste keuze die het KNMI moet maken, is waar baseren ze hun scenario's op

Wat ik ook wel belangrijk vind is: er worden scenario's op Europese schaal gemaakt en ook op mondiaal niveau. Leg vooral uit wat de verschillen zijn, want heel naïef denken mensen, dit is de mondiale scenario set en daar een uitsnede van is de Europese set en daar weer een uitsnede van zijn de KNMI scenario's. Als dat niet zo is, dan moet je dat uitleggen hoe dat zit. Want in veel onderzoeken worden resultaten van de wereldbank gebruikt in combinatie met nationale gegevens en misschien kan dat helemaal niet. En maak 1 keuze nu is gewerkt met 4 beelden. Als er toch wordt gekozen voor een andere werkwijze, betekent dat veel voor de instituten, die jouw kennis gebruiken en je moet die afweging goed maken.

Nu wordt telkens geroepen pas op (dat heb ik ook in mijn structuurvisie gedaan) er komen nieuwe scenario's aan in 2013. De verwachting is dat die er hetzelfde uitzien. Als er dan ineens hele andere scenario's komen, omdat de wetenschappelijke aanpak anders is, moet je dat wel een tijd van tevoren aankondigen.

**Missen er nog dingen in de ondersteuning?**

Nee helemaal niet. Het KNMI doet het hartstikke goed. Hoewel ik de laatste tijd geen contact meer met ze gehad heb, maar in het verleden wel. Janette, maar ook de anderen helpen heel goed.

**Ik denk dat ze ook heel erg hun best doen, alleen dat ze niet zo gewend zijn aan politieke besluitvorming, dat daar toch andere zaken een rol spelen dan wetenschappelijke kennis alleen. Dus ik heb daarom het onderzoek wat breder gemaakt.**

Dat is natuurlijk zo kennis is maar 0.1% van de besluitvorming. Een heleboel andere factoren spelen ook een rol.

**Dus het is even zoeken aanvankelijk dachten we dat we de problemen misschien met een ander scenario op konden lossen, maar je blijft het probleem houden dat mensen maar één scenario kiezen.**

Ik vind het wel goed dat ze het gebruik in de gaten houden. Een provincie heeft de scenario's proberen te middelen en daar heeft het KNMI toen van gezegd dat moet je niet doen. En ik denk dat dat nu ook wel echt duidelijk is.

**Klopt Groningen heeft dat toen gedaan. Daar waren ze bij het KNM I ook wel van geschrokken toen.**

**Ook als zitten er pdf's bij worden de scenario's dan anders gebruikt?**

Nee alleen wat ik zei als onderzoekers ze gebruiken om hun beleidsadviezen mee te bekijken dan wel. Maar heb niet de illusie als dat door het KNMI in één keer heel sterk gepromoot wordt, dat dat ook heel erg in de besluitvorming een rol speelt.

Het is niet zo dat het onzekerheid wat meer op de kaart kan zetten?

Volgens die richtlijn moet je het wel mee laten wegen in de besluitvorming.

Gebeurt dat inde praktijk nou heel goed of niet?

Nee het is mijn ervaring dat beleidsmedewerkers die onzekerheidsmarges maar even weg laten.

**Dus dan lost je pdf dat niet op?**

Nee maar tips voor gebruik wel. Dat staat ook allemaal op de site. Ze hebben uitgelegd hoe dat je het moet gebruiken. Alleen bij watermanagement kan ik me voorstellen kan ik me voorstellen, bij berekeningen die in de vervolgstap plaatsvinden, dat je dan zegt 80% interval is onvoldoende we kijken bij veiligheid en investeringen ook naar de worst case, naar de 100%.

**Daar is inderdaad wel discussie over of dat echt moet.**

Tenzij die onzekerheidscurve zo extreem wordt, dat het een schot hagel wordt, dat je er niets meer mee kan.