Assessing Framing of Uncertainties in Water Management Practice

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Abstract Dealing with uncertainties in water management is an important issue and is one which will only increase in light of global changes, particularly climate change. So far, uncertainties in water management have mostly been assessed from a scientific point of view, and in quantitative terms. In this paper, we focus on the perspectives from water management practice, adopting a qualitative approach. We consider it important to know how uncertainties are framed in water management practice in order to develop practice relevant strategies for dealing with uncertainties. Framing refers to how people make sense of the world. With the aim of identifying what are important parameters for the framing of uncertainties in water management practice, in this paper we analyze uncertainty situations described by decision-makers in water management. The analysis builds on a series of "Uncertainty Dialogues" carried out within the NeWater project with water managers in the Rhine, Elbe and Guadiana basins in 2006. During these dialogues, representatives of these river basins were asked what uncertainties they encountered in their professional work life and how they confronted them. Analysing these dialogues we identified several important parameters of how uncertainties get framed. Our assumption is that making framing

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of uncertainty explicit for water managers will allow for better dealing with the respective uncertainty situations.

1 Introduction

Dealing with uncertainties in water management is an important issue and is one which will only increase in light of global changes, in particular climate change. So far, uncertainties in water management have mostly been assessed from a scientific point of view with the aim of representing them in an objective and quantifiable way (cf. review by Walker et al. 2003 or Klauer and Brown 2004). Scientific assessment and analysis of uncertainty is often complex and technical and not always easily understandable, accessible or usable for water managers (cf. Brugnach et al. 2007; McCulloch 2007). An increasing number of contributions to the literature therefore aim at understanding how scientific evidence of uncertainty analysis is received and being dealt with by practitioners (e.g. Xu and Tung 2008). In this paper, we would like to go one step further and investigate how practitioners themselves frame uncertainties that is how they make sense of a situation in terms of uncertainty.

In recent years, the importance of the human dimension of uncertainty has been more and more acknowledged and emphasized. Instead of regarding uncertainties as merely external and objective phenomena, the role of people involved in producing and using uncertainty assessments should be considered as well (e.g. Klauer and Brown 2004; van Asselt and Rotmans 2000; Friedmann et al. 1999; Pahl-Wostl et al. 1998). This introduces a subjective element into uncertainty assessments. However, going further than the notion of uncertainty as a subjective property where the focus resides on the uncertainty attached to a person, e.g. uncertainty as a "*state of mind*" (Einsiedel and Thorne 1999), in the relational approach we follow in this paper, the emphasis is on the relation between the subject and the object (Brugnach et al. 2008). That means an uncertainty arises out of the interaction between actor and object and may hence be framed differently according to changes in the relation between actors and objects. In that it is important that the aim is not to identify how an uncertainty really is and get to a universally valid description of it, but understand how people relate to it, how they frame it (cf. Table 1) and what changes in that relationship entail for dealing with an uncertainty.

There are approaches which aim at addressing the issue of dealing with uncertainty in management practice in a more structured way. Einsiedel emphasizes that it is important to understand what uncertainty is, how it is framed by actors in a social system and what people do with it (Einsiedel and Thorne 1999). Her focus is on how the public deals with science and scientific knowledge. She suggests eight dimensions of uncertainty to 'catalogue public uncertainty' that refer to different kinds of lack of knowledge (e.g. "*I don't know about X; I will leave it to experts to tell me what I need to know*"). Those dimensions can be categorized by individual factors (such as personal skill level, interest and motivation) and social-structural factors (e.g. access to information) which "*shape perceptions of uncertainty and subsequent coping strategies*" (*ibidem*). But what is it that shapes the framing process? Einsiedel's dimensions

Table 1 Uncertainty categorization of the Uncertainty Matrix by Brugnach et al. (2008)

Type of knowledge relationship	
Unpredictability	Unpredictable system behaviour
Incomplete knowledge	Lack of information
	Unreliable information
	Lack of theoretical understanding
	Ignorance
Multiple knowledge frames	Different and/or conflicting ways of understanding the system
	Different values and beliefs
	Different judgement about seriousness of situation, growth potential of problems, priority of actions or interventions

only partly give hints as to how somebody arrives at conclusions regarding either of the dimensions or what makes somebody frame an uncertainty as she or he does.

Building on the importance of framing in relation with environmental problems highlighted in various scientific contributions (cf. e.g. Gray 2003; Dewulf et al. 2005; Pahl-Wostl et al. 2007) we here relate the concept of framing to the issue of uncertainties in water management. Our aim is to identify parameters that shape the process of framing uncertainties in water management practice (Table 2).

As a theoretical basis for the analysis of framing of uncertainties we give a short introduction to the concepts of framing and uncertainty as used in this paper. Based on situations of uncertainties reported by practitioners in water management, we then analyze the narratives of those uncertainty situations and derive parameters that are of importance in the framing of uncertainties in water management practice. In the final section we discuss aspects of usefulness and applicability of the identified parameters of uncertainty for water management.

The examples from practice this paper draws on stem from the 'Uncertainty Dialogues' that were held in several case studies of the project NeWater (New

Table 2 Parameters for framing uncertainties

Parameter	Definition	Actor frames uncertainty as…
Positioning	Positioning as the evaluative quality actors attach to uncertainties	Positive: fun, challenge, risk
		Negative: threat, risk, doubt, problem, difficulty
Urgency	Urgency related to the point of time for taking a decision in the uncertainty situation or to the time frame within which a decision is supposed to have an effect	Urgent
		Long-term issue
Responsibility	Responsibility for having caused and/or dealing with the uncertainty	Own responsibility
		The responsibility of others
		The responsibility of scientists
		Being caused by/ having to be changed by rules/regulations
Trustworthiness	How trusting actors are towards components of an uncertain situation, e.g. towards data, methods or other actors	An issue of trustworthiness: Trustworthy
		Untrustworthy
		Danger of loss of trust

Approaches to Adaptive Management under Uncertainty, www.newater.info) in early summer 2006 (Dewulf et al. 2008).

2 Conceptual Frameworks on Framing and Uncertainties

Due to their personal, educational and cultural backgrounds people have a specific and restricted view on the world around them. That means they cannot and do not consider all details and information relevant to a specific situation but observe selectively according to their interest and concern (cf. e.g. Denzau and North 1994; Doyle and Ford 1998; van Ass-elt and Rotmans 2000). Consequently people tend to focus selectively on those aspects to which their attention is drawn, which are most relevant for their current activities or to the aspects they want to put on the foreground (Dewulf et al. 2009). This process of giving meaning to things is captured differently in various disciplines and referred to with concepts such as frames, mental models, perceptions, perspectives or world views. The definitions vary and often the terms are used in an overlapping and interchangeable way (cf. e.g. Dewulf et al. 2009; Kickert et al. 1997; Schön and Rein 1994; van Ass-elt and Rotmans 2000). A common denominator is the idea that situations can be understood or portrayed in different ways and that these different meanings are not neutral, because they direct the search for solutions or the type of actions or strategies that are considered. Making sense of a situation in terms of a threat rather than an opportunity, for example, will have consequences for the action strategies that are considered.

For our analysis of how people make sense of uncertainties we focus on the concept of 'framing' because it better captures the active aspect of sensemaking involved, as compared to e.g. the concept of 'perception'. We conceive of individuals as active sense-makers (Weick 1995) rather than passive perceivers of the world. In the research on framing two approaches can be differentiated: 'cognitive framing' and 'interactional framing' (Dewulf et al. 2009). Where the 'cognitive framing' approach studies how cognitive structures or mental models of a person are related to a situation, 'interactional framing' refers to a discursive process involving social interaction where meaning is produced interactively over a certain time. Mental models we understand as "*a relatively enduring internal abstraction of an external system to aid and govern activity*" (after Doyle and Ford 1998: 17). Mental models may be created in a non-interactive process what Kaufmann and Smith call "*adopting a frame*" (1999). However, usually framing does not start from zero but most often is related to a certain outcome of an interactive framing process (e.g. Weick 1995; Dewulf et al. 2009). So the two concepts can not be strictly separated but imply a different focus when analyzing framing. In the cognitive framing approach, the criterion for assessing mental models and change is located in the individual mind, while in the interactional framing approach the criterion is located in the interaction context.

The uncertainties we analyze have been framed by practitioners in water management, within the respective dialogue session, but also through prior interaction with other actors in their daily practice. Hence, in this study we are not able to analyze that preceding interactive framing process but consider only a snapshot of how the reported uncertainties are framed in the studied interaction contexts in the water management practice.

Uncertainty in this paper is defined as a situation in which there is not a unique and complete understanding of the system to be managed (following Brugnach et al. 2008). This relates to an individual actor's understanding of an event or action as well as of the behaviour and interest of other actors that are possibly involved in the situation. It may simply refer to a lack of knowledge or to an ambiguous situation where different approaches and solutions may be conceived. A third category and type of uncertainty is unpredictability due to variability and complexity of the system. This threefold categorization is reflected in the Uncertainty Matrix (UM) developed by Brugnach et al. which was used in the Uncertainty Dialogues (cf. Table 1).

In terms of assessing framing of uncertainty, these categories or 'types of knowledge relationships' give a fist clue as they allow to distinguish basic kinds of somebody's relation towards an uncertain situation. That is uncertainties may be framed as unpredictability, incomplete knowledge or multiple knowledge frames.

For any attempt at changing or improving the way uncertainties are dealt with in water management practice, it is crucial to understand how water management actors understand uncertainties. Identifying relevant parameters or dimensions of how uncertainties get framed in water management practice makes an important contribution to this end. In this paper parameters beyond the categories of the UM are presented which may shed light on how uncertainties in water management are framed and render a more comprehensive picture. As for practical implications, the parameters are expected to be accessible and easily applicable for practitioners in water management as they have been deliberately derived from examples from practice and may hence be of more use in water management practice than complex scientific computational models.

3 Methods

The empirical evidence on which this paper is based are the "Uncertainty Dialogues" carried out in case studies of the project NeWater, New Approaches to Adaptive Water Management under Uncertainty, in May 2006 (Dewulf et al. 2008). Participants were water managers, mostly representatives of the water departments of public administration or water management associations in the river basins of the Wupper (Germany) and the Kromme Rijn (Netherlands) as sub-basins of the Rhine, the Guadiana (Spain), and the Elbe (Germany and Czech Republic). In the dialogues they were asked to identify uncertainties they encountered in their professional work life and to explain the way they dealt or would deal with them.

Where possible the dialogues were held as focus groups with about three to five participants (Wupper and Kromme Rijn). Where this was not possible (Guadiana and Elbe) semi-structured individual interviews were conducted with representatives of the respective water management organisations. Participants for the focus groups were selected from amongst those responsible for water management decisions in their river basin and involved in current decision making processes. The main focus was on governmental organisations and water board members at local and regional level.

A discussion among people from a common work area helps the purpose of assessing framing of real life situations since it is likely to capture interaction (and framing) similar to the interaction and framing going on in day to day business. The

discussions lasted about 2 h on the average and were conducted in a semi-structured way along the Uncertainty Matrix by Brugnach et al. (2008). The discussions were led by scientists from the team with moderation skills. While introducing the UM they acted as experts, but during the discussions their role was limited to moderation. The meetings mostly took place in the participants' native language with exception of the Elbe where the meetings were held in English.

The Uncertainty Dialogues are evaluated in qualitative terms in a discourse analytic approach. We do not aim to make claims about the relative importance or frequency of the different framings. The evaluation is based on audio files, transcripts and notes taken during the Uncertainty Dialogues, particularly those of the Wupper, Kromme Rijn, Guadiana and the Czech Elbe basin. These were all recorded and fully transcribed. Notes were taken during all of the dialogues. For the analysis the transcript and the notes for the full duration of the meeting were analysed. Where necessary, quotations have been translated into English for presentation in this paper. All quotations were cross-checked with the respective stakeholders. They do not necessarily reflect the opinion of the related organisation but their personal views (NeWater internal reports 2007).

4 Results

In an ex-post analysis of the narratives about uncertainties in the different case studies we identified parameters of importance in the framing of uncertainties. The Uncertainty Dialogues allowed for detecting commonalities and differences in the water managers' framing of the uncertainties, rendering details on how the uncertainties were conceived which went beyond the initial distinctions by the use of the UM. We analyzed the way in which the participants of the Uncertainty Dialogues reported on their examples of situations of uncertainty in water management.

The text analysis of the respective recordings, transcripts, and notes of the Uncertainty Dialogues (cf. above) revealed many potential parameters. We chose to focus on those that were salient as recurrent issues across different countries, cases and examples of uncertainty, and thus are likely to be of more general importance. The four most important parameters we identified on this basis were: positioning, urgency, issues of responsibility and of trustworthiness. Among the others identified were: the relevance or importance of an uncertainty, the expected consequences of an uncertainty, the difficulty of dealing with an uncertainty or the perceived dynamics of uncertainties. These were not analysed further as they were not present or equally important in each case study.

Often the parameters were interlinked and could not be looked at strictly separately. In the following the four salient parameters are illustrated along the examples from the case studies.

4.1 Positioning

The different kinds of positioning towards uncertainty situations we encountered in the Uncertainty Dialogues varied according to the case studies and the participants of the dialogues. With positioning towards uncertainty we mean the evaluative quality people attach to the uncertainties, in other words whether they frame the uncertainty

as something positive or negative (Levin et al. 1998). This does not necessarily reflect deeper routed and more general beliefs and attitudes, but it does indicate how uncertainties get framed in the specific interaction contexts studied. These positive and negative framings of an uncertainty situation can have different manifestations, such as framings of uncertainty as risk, fun, challenge, essential part of life, threat etc. It may as well be quite ambiguous as an example in the Kromme Rijn case study shows. "*Uncertainty has a little bit negative connotations. Uncertainty, that's what you cannot grasp and that is annoying*" (NeWater Uncertainty Dialogue,[1] HDSR,[2] May 17, 2006); but then the speaker goes on that in fact her work is positively influenced by uncertainties, "*I live so to speak from uncertainties, and I enjoy it. The moment it gets certain it's not my work anymore*" (*ibidem*). One interviewee in the Elbe case study takes up a similar stance. He is very enthusiastic about water as an element and about rivers since they do not care about political boundaries. He sees the related uncertainty as something vital to life, "*I think that is the life. (…) and still there will be uncertainties. And to have a dream not to be [uncertain], wouldn't be life.*" (UJEP,[3] May 15, 2006). The same interviewee later makes another comment which may show his enjoyment in dealing with uncertainties and certainly his experience of uncertainty as a challenge in the work area of water pollution, "*you must be very smart, sometimes it is a detective story, to detect the pollutant, or the polluter*" (UJEP, May 15, 2006). Among the positive framings we encountered in the case studies the most frequent in fact was that uncertainty was framed as a challenge that people enjoyed.

Throughout the dialogues the participants used terms other than 'uncertainty' as well to express situations that implied uncertainty. These terms may include a certain positioning towards the uncertainty situation, e.g. a negative framing. Terms that came up in several case studies in this regard were 'risk', 'doubt', 'problem' or 'difficulty'. A lot of other expressions which display uncertainties were used in addition. Many of the examples were related to the issue of (not) knowing something which most participants experienced as something negative, e.g. for the task of internalizing external costs due to the cost recovery requirements of the EU Water Framework Directive, "*I do not know if we are able to evaluate environmental costs*" (CHG, May 25, 2006), or the assessment of the danger of drought: "*we do not know when it will happen; even the meteorologists do not tell us*" (CHG,[4] May 25, 2006). Evidence of uncertainty was also obtained through references to the contrary of uncertainty, that is certainty, "*the only certain thing is that some time the water pollution will come. You don't know where, you don't know which type, (…) which polluter, which amount (…) it is always an individual case*" (Elbe case study, about accidental water pollution by complex organic material, UJEP, May 15, 2006). Uncertainty was expressed with regard to rather technical issues, for instance concerning measuring systems in the Guadiana. The participants of the meeting were worried about not getting direct and accurate data from indirect measuring

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[1]Where not referred to differently all further quotations from oral communication (with exact date) refer to the NeWater Uncertainty Dialogues (project internal documents).

[2]Hoogheemraadschap De Stichtse Rijnlanden (Dutch regional water board).

[3]University of Jan Evangelista Purkyně, Usti nad Labem, Czech Republic.

[4]Confederación Hidrográfica del Guadiana (Guadiana Water Authority).

systems such as remote sensing (CHG, May 25, 2006). But the political sphere was also referred to: "*a large part of the unpredictability is political. This is the total unpredictability*" (*ibidem*).

In our case studies we observed a certain predominance of negative framings though there were also some positive examples and other rather neutral ones that showed the acceptance of uncertainties as a fact without however really evaluating the uncertainty as positive or negative.

As pointed out earlier, the parameters often are interlinked. Positioning for instance also plays a role in connection with time frame and urgency. In the Wupper case study one interview partner pointed out the difficulties and uncertainties that came along with the passing of a new legal framework. "*I just wanted to emphasize how difficult it is for the execution of a legal system to suddenly get the Water Framework Directive*" (WV,[5] May 18, 2006).

4.2 Urgency

The time factor seems to play an important role in all investigated case studies with regard to framing of uncertainties. Some uncertainties are framed as urgent, requiring an action within the short term, while others are framed as long-term issues, requiring attention in or over a few years. This may relate to the perceived urgency of taking a decision as well as to the time frame within which a decision will be implemented or is supposed to have an effect.

Concerning the time frame within which a decision has to be taken, lots of examples in the case studies showed that dealing with an uncertain situation would optimally require a lot of time. This is due to the fact that often more or deeper time-intensive analysis, modelling and scenario building were considered as necessary for addressing the need to reduce or overcome an uncertainty, as illustrated by the case of accidental water pollution, "*to analyse the complex cyanide [i.e. the behaviour of a pollutant in the river after an accidental spill] it is not so easy, it takes time*" (UJEP, May 15, 2006). Here the need for sufficient time for analysis clashes with the need for urgency since decisions have to be taken in a relatively short time once an accident has happened. In this example the short-term pressure relates to the danger of the pollutants in the water which are spreading quickly. In administrative planning, long-term considerations and goals also typically have to be evaluated against short-term pressures. However, often the relation there is different. Short-term pressures in water administration are current problems to be solved, whereas what is impeding the implementation of longer-term policies is the (lack of) required resources and investments rather than the complexity of the problem as in the water pollutant case above. In the Wupper case study an employee of an administrative body expressed this view with regard to the tension between recognising the value and benefit of the ecosystems and the long-term goal to maintain them, and, on the other hand "*(…) the decision is short-termed considering the financial straits we have in North-Rhine-Westphalia*" (StUA[6] Düsseldorf, May 18, 2006). Time here plays a role with regard to the uncertainty associated with the unpredictability of the future—the more

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[5]Wupperverband (German water association).

[6]Staatliches Umweltamt (former German regional state authority for environment).

distant the more uncertain. However, planning administration often has to take long-term decisions. Hence, the situation in the example above is difficult since "*these time concerns are related with high uncertainty and as a planning administration I can only think in a long-term time frame*" (*ibidem*). Another participant of the Wupper Uncertainty Dialogue frames the uncertainty related to short-term versus long-term planning in the following way: "*To what extent do we manage to meet the zeitgeist of 20 years ahead with the decisions we take today and that will still be important in 20 years?*" (municipality of Wuppertal, May 18, 2006).

An example of rather low urgency is the balancing of the economic versus ecologic and social benefits of a wetland ecosystem in the Guadiana case study. They are seen to play a role in the long run, "*the maintenance of an ecosystem such as the Tablas de Daimiel against the economic or social benefit that the agricultural use might bring—at a certain moment we will have to do this balance*" (CHG, May 25, 2006) which is not now.

Overall, the examples with high urgency and short-term pressures prevail, often outweighing the long-term goals, which are associated with increased uncertainties due to the difficulty of making predictions for the distant future.

4.3 Responsibility

Responsibility issues refer to different aspects of an uncertain situation. They may relate to the question of who is perceived as responsible for solving an uncertain situation and they also give an idea about the perceived range of options for taking decisions in a situation marked by uncertainty.

In the dialogues, the issue of who is responsible for dealing with an uncertainty situation came up most often. We would suggest that it may also be interesting to investigate who or what is perceived as responsible for having caused an uncertain situation. This may have implications in terms of who is perceived to be responsible for dealing with it as well as with regard to actual strategies for dealing with uncertainty. In the following, some examples from the case studies will illustrate how responsibilities got framed as part of dealing with uncertainty.

The question of responsibility for solving an uncertainty situation is quite delicate. The participants of the dialogues reported that they themselves as well as other people often refer to rules when taking a decision thus placing the responsibility on something external to them. Especially in administration, there are usually rules to be followed in an uncertain situation. This becomes explicit for instance in the Wupper case study in the issue of flood protection where the interview partner of the regional water board reports that the water administration personnel refer to rules, i.e. in this case standards for flood protection, "*the experts have developed state-of-the-art technology for a 100 year flood. Then the administration says, I have to meet the state-of-the-art technology*" (WV, May 18, 2006). These regulations are then difficult to by-pass, "*this [the regulation] is very difficult to turn back*" (*ibidem*). Administration generally needs to build its decisions on rules and regulations. Administration staff may consider stakeholders' suggestions but cannot necessarily build their decision on that. "*If the citizen says I do not need this [measure; here dike] and in 15 years, if something really happens, and the citizen says, "so, now I claim damages", then this goes back to the administration and I think this really is an uncertainty that gets in the way of many things and also of sound solutions*" (StUA Düsseldorf, May 18, 2006).

The pressure from the administration to comply with rules and regulations renders it difficult for individuals, in this case administration personnel, to take responsibility for dealing with an uncertain situation—in the example above, uncertainty about flooding. With hindsight, sticking strictly to the rules may not have been the best solution for the problem under consideration, but regardless of this it is usually seen to be the safest option in terms of formal or legal accountability.

An interviewee of the Guadiana case study makes a similar point for the case of the surveillance of groundwater extraction in the catchment area, "*the administration has to comply with the law*" (CHG, May 25, 2006), and makes similar references about the options for stakeholders influencing decisions of the state, "*there is a limit which is the law*" (*ibidem*). Consequently the solution is perceived in terms that the law should change, "*if you want the situation to be changed then the law has to be changed in the parliament*" (*ibidem*). Another example from the Guadiana basin is related to uncertainty related to drought. Decisions there are highly rule-based as well. There is a system of drought indicators consisting of different categories which each imply a different level of alert and corresponding actions to take in the respective situations (CHG, May 25, 2006). So, in general, following rules is adopted as a means to deal with the responsibility issue and thereby circumvent explicitly addressing the uncertainty. Sometimes however, rules or regulations can be even more confusing and increase rather than decrease uncertainty as is the case for the implementation of the EU Directives on Nitrate and Water which are partly contradictory and hence difficult to implement in an integrated way (MLU S-A, May 22, 2006).

A big concern in terms of responsibility during the Uncertainty Dialogues was that the participants felt they did not have the final decision in a situation of uncertainty. The responsibility often is at a higher level than those of the interviewees in the dialogues, "(…) *we are technicians. Technicians at a high level but we do not have the final decision*" (CHG, May 25, 2006). This implies that communication and coordination among actors involved in an uncertainty situation is of high importance.

Another aspect in (at least partly) getting around the responsibility for dealing with an uncertain situation is that tasks are usually clearly distributed, "*floods are not my field*" (UJEP, May 15, 2006), or at least perceived as such. In the Guadiana case study, for certain issues politicians are perceived as having duties towards taking a decision. The final decisions, e.g. on the issue of control of ground water extraction, are said to lie at the 'water commissar' from the Water Authority and the politicians in the region. "*The ones who have to wipe off the mortgage are the politicians, through their political decision. A political decision based on the actual reality*" (CHG, May 25, 2006). For the case of the threat of droughts due to climate change in the Guadiana case study the responsibilities are perceived differently for different parts of the problem. For the case of estimations of future precipitations the responsibility is perceived to be at the level of the national climate change office (as part of the National Ministry of Environment), "*(…) they are working out at the moment to define us what is the variation in the estimations*" (CHG, May 25, 2006). For helping out with uncertainties due to lack of knowledge scientists are perceived as responsible in the first place, "*with regard to the lack of knowledge (…) or the development of methodologies, technical systems, technologies etc.., this is a matter where there are universities to help and investigate*" (CHG, May 25, 2006).

In most examples in the investigated case studies the responsibility for dealing with uncertainty was external to the interviewee. That is the uncertainty gets framed as something which others are responsible for.

4.4 Trustworthiness

Components of an uncertain situation, such as actors or data, are framed as trustworthy (or rather not). This relates to the quality of relationship of actors between each other as well as to the reliability of data, both being possible triggers for or against uncertainty. In some situations one could even say that the uncertainty in fact consists in full of the perceived untrustworthiness.

There is evidence of the importance of trust towards certain information or people in all case studies, e.g. the Kromme Rijn: "*Also the state has been an unreliable partner once when they had regulations for subsidies (…) and from one day to the next they ended*" (municipality Wijk-bij-Duurstede, May 17, 2006). This remark may be extended to collaborative work in general, though usually not referring to daily work, when one of the parties stops its commitment without any prior notification. Such behaviour may then cause uncertainty (municipality Wijk-bij-Duurstede, October 16, 2007). This is an example of unpredictability in the social system behaviour.

Concerning framing of trustworthiness of information, trust in data in the Guadiana case study for instance is high, because, amongst other reasons, data are officially certified by the National Institute of Meteorology. Only in case of a wider time span, like in series of data, there could be some doubts, but in principle the data is considered as highly reliable. "*The measuring [of precipitation] usually is direct and from relatively trustworthy data, (…) moreover it is officially certified data of the National Institute of Meteorology. (…) We trust them, (…) they are also from the existing official network and therefore deserve full guarantee. These data maybe may have errors (…) in a certain moment in the meteorological series, in the series of precipitation, but in principle they have full reliability*" (CHG, May 25, 2006). In the Kromme Rijn case study, loss of trust was expressed as a potential result and risk of bad uncertainty management. The example related to the fact that sometimes possible negative side effects of plans during or after implementation are not being taken into account as possible risks beforehand: "*The side effect might then be that (…) trust in the State or the planners goes down*" (municipality Wijk-bij-Duurstede, May 17, 2006).

Framing of trustworthiness between actors or groups of actors is a delicate issue. It is an interesting issue as well in terms of who frames whom as trustworthy or not in a multi-actor constellation, most likely having implications for approaches how to deal with the uncertainty.

As shows the case of the Elbe on accidental water pollution, issues of organization and communication of data may aggravate or alleviate the uncertainty and related trustworthiness, "*there [in the Czech Republic] is a lot of data [on accidental water pollution], it is very good. In Germany it's not so easy, because nobody tells you the proper information. Nobody collects centrally, in Czech Republic yes.*" (UJEP, May 15, 2006).

In general, the trustworthiness of data or people in the case studies seems to be highly dependent on previous experiences with situations or people.

5 Discussion

In the previous chapter we illustrated the most important parameters that play a role in how the participants of the Uncertainty Dialogues framed uncertainties.

The focus of the analysis is on the relation of a person towards an uncertainty. The aim is not to assess objective boundary conditions but how people relate to those and the possibly uncertain issues. This gets clear through the identified parameters. Uncertainty gets framed in terms of positioning as positive or negative, as an urgent or a long-term issue, as an issue for which the actor herself versus other actors are responsible and as untrustworthy (or not). Many of the examples in the Uncertainty Dialogues are related to the issue of not knowing something, which most participants experience as something negative. In total, negative framings slightly dominate throughout our case studies. Among the positive framings we encountered, the most frequent was uncertainty framed as a challenge. There were also rather neutral framings that show the acceptance of uncertainties as a fact without however evaluating the uncertainty as positive or negative. Time proves to play an important role in all case studies with regard to framing of uncertainties. Recurrent evidence from the Uncertainty Dialogues is that the participants conceive of dealing with an uncertain situation as a long-term issue, optimally requiring substantial amounts of time. This is a challenge in face of the short term pressures that prevail in practice. Concerning responsibility issues mainly the issue of who is responsible for dealing with an uncertainty situation came up in the dialogues. In most examples in the investigated case studies responsibility is shifted to others (or to rules and regulations). That is the uncertainty gets framed as something others are responsible for. In that, questions of hierarchy and level of decision-making play a critical role. Typically, the responsibility for taking the final decision was referred to by the participants as not being in their hands since they were depending on decisions at a higher hierarchical or legal level. Issues of trustworthiness show through certain parts of the uncertain situations and are highly dependent on previous experiences, i.e. (un)trustworthiness regarding actors involved or towards data. Framing of trustworthiness between actors or groups of actors is a delicate issue and information and perceptions of actors involved is not easy to access. In the Uncertainty Dialogues it mostly shows through generalized opinions about actor groups.

Our analysis does not explain why an uncertainty situation is framed as it is but what is getting framed and how. This is important to understand in order to find adequate ways for dealing with uncertainties. Uncertainty in water management can no longer be ignored or trivialized given the increasing pace and dimension of changes and future challenges. Nowadays complex non-linear and multi-layered problems make the need to acknowledge different framings and to deal with them constructively more pressing (Bouwen and Taillieu 2004; Pahl-Wostl et al. 2007). To be able to confront these challenges in a constructive way it is important to make people and organizations aware about how they frame uncertainties such that they can consider possible ways of action. For a first assessment and broad distinction of framing of uncertainties the categories of the UM can be used. The parameters identified in this paper take this process further, and aim to capture the character of how an uncertainty gets framed. The parameters provide the option to further differentiate facets of the uncertainty situations distinguished through the UM.

Furthermore, the parameters have potential to be used for the development of more structured strategies to deal with uncertainty. An uncertain situation typically is a non equilibrium state that is likely to change or even requires change the actor needs or wants to perform but is uncertain how to put in practice. In water management, decisions are hardly ever taken by single actors in a disconnected way. Especially in situations with multiple actors as in water resources management it is important to arrive at connections between different ways of framing uncertainties in order to achieve joint action (Gray 1989). Normally in such multi-actor constellations the involved actors do not agree on everything. Thus learning is required to achieve a change in framing by at least some of the actors involved. Becoming aware of each other's framings, interests and needs is a first step towards (social) learning and reframing. This counts as well for framing of uncertainties. A setting where several actors are making their framings of uncertainty explicit enables social learning and constructive dealing with framing differences (Pahl-Wostl et al. 2007).

At an individual level, the assessment of framing parameters of uncertainty renders a better picture of one's own assumptions and action options including a clearer division of tasks as well as showing options for reframing by questioning one's own point of view. When dealing with various situations of uncertainty the assessment of the parameters allows for comparing the situations and prioritizing amongst them.

Commonly, uncertainties in management practice are dealt with intuitively (e.g. Einsiedel and Thorne 1999; Friend and Hickling 1997: 6). We suggest that making framing of uncertainty explicit will allow for better dealing with the respective uncertainty situations, particularly in multi-actor constellations. Mismatches in framing of uncertainties can block effective solutions. Not being aware of or not taking into account that uncertainties may be framed differently by different actors may cause problems in communication between the involved actors, and therefore also in dealing with the uncertainties.

While this is a first attempt to identify parameters of importance in framing of uncertainties, work in another context would be required to make this concept more general.

6 Conclusions

In this paper we discussed how practitioners in water management in three European river basins frame uncertainties by analyzing dialogues on uncertainty where water managers reported on their work experiences with uncertainty. From the analysis we derived a set of parameters that are important in the framing of uncertainties and illustrate the character of uncertainty.

We have argued that analyzing the framing of the context where an uncertainty arises together with the way that the uncertainties are framed (through both the type of knowledge relationship of the UM and the new parameters) makes differences in the framing of an uncertainty situation visible. Assessing framing parameters is relevant for water management practice as it forms a basis for developing strategies for dealing with uncertain situations and reaching a more structured way of dealing with uncertainty which eventually allows for more informed decisions. This is important for practice in water management where most often decisions are taken based on

experience or intuition and where scientific uncertainty analyses are difficult to deal with for practitioners.

The practical cases show that uncertainties in water management are framed in different ways. Concerning dealing optimally with uncertainty, one cannot draw general conclusions of what would be an ideal framing of an uncertainty. One could assume a negative framing to be a source of resistance but it can also be a trigger to change things. Likewise, differences in framings of actors are more likely to trigger learning and change than homogeneously sharing points of views. Nonetheless, one can conceive barriers for learning with regard to the framing of uncertainties. A rather disadvantageous starting point for learning would for instance be a framing in which actors frame other actors as untrustworthy, themselves as not responsible for dealing with the uncertain situation and the uncertainty at hand as not urgent to deal with.

In this paper, we used the four identified parameters in an ex-post analysis. The identified dimensions (both parameters and types of uncertainty from the UM) provide a set of potentially relevant aspects, whose relevance and relative importance can be assessed for a specific situation in future cases, and which can be complemented by contextual factors that are new, locally relevant dimensions in that specific situation. They could also be used as a checklist for active analysis in assessing uncertainty situations in a structured and systematic way to obtain a basis for developing strategies to deal with uncertainty and make better informed decisions. More research is then needed to conceive possible strategies according to the items of the checklist.

But one has to be aware that this would imply a considerable intervention and therefore might distort the findings if the aim is to elicit people's framing of uncertainties. For the latter we see a less structured approach as more promising. This may be achieved by eliciting important parameters directly from the practitioners—rather than through ex-post analysis. Conceivable methods for that would be card sorting techniques or similar (cf. e.g. Hare and Pahl-Wostl 2002) whereby participants themselves identify the parameters that have relevance for them.

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