Adapting to extreme weather events: perspectives of social actors

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Abstract

People can be expected to perceive extreme weather events differently, but what are the differences and what explains them? And what does this imply for adaptive responses? In this paper we explore the perspectives of social actors in different sectors in the Netherlands with respect to extreme weather events and ways to adapt to projected changes in these events. The paper reports on a set of 41 interviews, using the repertory grid technique. The results were analyzed, to identify: (a) the perspectives that stakeholders hold as most important for adaptation to extreme weather events; (b) the determinants of different perspectives on extreme weather events. The results indicate that differences in perspectives were not closely related to different sectors the interviewees belonged to. The level of concern and level of informedness influenced the ways interviewees perceive adaptation priorities for extreme weather events, and especially their prior participation to related events.

Keywords: extreme weather, climate change adaptation, repertory grid, risk perceptions

Introduction

Climate change is expected to have an impact on the likelihood of the occurrence and duration of extreme weather events, such as extreme precipitation, heat waves, and extreme drought, but possibly also snow storms, tornadoes, and hail; however, the uncertainties involved in these projections are large, in particular for small-scale phenomena such as extreme precipitation (including extreme snow and hail storms), tornadoes, etc. (IPCC, 2011). For the Netherlands, the Royal Netherlands Meteorological Institute (KNMI) developed four scenarios, each describing a possible future climate within the range of climate-model scenarios of the CMIP3 project (Meehl et al., 2007; Van den Hurk et al., 2006). According to these scenarios, the following changes in extreme events can be expected: an

increase in temperature in summer and winter; a decrease of frost days and an increase in heat waves; an increase in precipitation in winter; a decrease, or an increase, in precipitation in summer, but an increase in heavy precipitation events.

The way that individuals relate to and perceive these extreme weather events is of vital importance, not only for the psychology of the individuals themselves (Adeola, 2009), but also for two additional reasons. Worldwide climate services turning towards their end-users in order to produce demand-driven weather and climate information and communicate it in such a way that the end users (different social actors) find it the most meaningful (WMO, 2011). This necessitates an understanding of the underlying perspectives of the different social actors on weather, and extreme weather events. Second, and most important, as will be discussed below, understanding the different perspectives on extreme weather events is a necessary precondition of developing robust and adequate strategies of adapting to extreme weather events. The current paper investigates the perspectives of social actors from different economic sectors in the Netherlands with respect to adaptation priorities vis-à-vis extreme weather events.

Because of uncertainties in the climate models, the focus of climate scientists has recently turned to robust adaptation measures, which are independent from different climate change scenaria, and likely to create win-win solutions (Dessai & Hulme, 2004). Individuals and economic sectors have been already dealing with the weather for ages and have developed knowledge and behavioral responses with respect to weather extremes. Hence, it is widely agreed that robust adaptation measures need to be developed together with involved social actors, as Dessai and Hulme suggest, taking into account their perspectives, needs and values (ibid.). In fact, research has been emphasizing the role of public participation in environmental hazards planning the last years (Brody, 2003). Identifying the perspectives and priorities of social actors on adaptation measures for extreme weather events is, therefore, of key importance for the success of these adaptation measures (Pahl-Wostl, 2002).

The paper aims at contributing to the knowledge on involving social actors in adaptation governance. It reports on a recent study among Dutch social actors in various relevant sectors. Starting point is the observation that, so far, we are in need of reliable data on social actors' perspectives on weather extremes as well as how these perspectives correlate with specific characteristics of these actors.

Differences in the perspectives of social actors on weather extremes can be related to the actors' affiliation to specific economic sectors. The social actors to be involved in the implementation of adaptation plans, measures and policies, must be familiar with the relevant sectors, since most measures need to be specific to each socio-economic sector (de Bruin et al., 2009). However, as yet the predictive value of actors' affiliation with specific sectors for their perspectives on the risks of weather extremes has not been firmly established (Lowe & Lorenzoni, 2007). It may be the case that differences between perspectives cannot be reduced to simple categories such as differences between economic sectors . Consequently, it may become more difficult to reach convergence on robust adaptation measures. The problems may turn out to be unstructured, i.e. featured by uncertainty or even controversy with respect to the relevance of both knowledge (scientific and practical) and values (Hoppe & Hisschemöller, 2001).

The way to find out about this is through a research approach that focuses on identifying the underlying frames that shape social actors´ views and opinions rather than focusing on (volatile) opinions and preferences (Hisschemöller & Midden, 1999). Such research approach needs to be bottom-up as to avoid *ex ante* assumptions linking stakeholder views or biases to certain groups or categories, e.g. professional affiliation, concern or level of knowledge (van de Kerkhof, Cuppen, & Hisschemöller, 2009).

This paper uses such an approach, with the repertory grid technique from construct psychology (Kelly, 1955), and reports on the perspectives on weather extremes, found among stakeholders from different sectors in the Netherlands. It addresses the following research questions:

> Which perspectives are the most important for adaptation to (changes in) extreme weather events according to different social actors in the Netherlands?
>
> To what extent do actors' perspectives correlate to actor characteristics, such as their affiliation with specific sectors, level of concern and knowledge?

Section 2 of this paper will clarify the study´s conceptual framework. Section 3 presents its methodology, and section 4 the findings on the two research questions. Section 5 discusses the results and their implications for adaptation governance.

Perspectives, social actors and actors' characteristics

By 'perspectives' we refer to underlying frames or belief systems that stakeholders use to make sense of their own observations and experiences. Perspectives structure human observations and help people to make sense of their environment. The perspectives we hold often function as filters for new information and knowledge we acquire, which has been recognized and studied extensively in studies of framing environmental (and other social) problems (de Boer, Wardekker, & van der Sluijs, 2010; Hisschemöller, 2005; Hoppe & Hisschemöller, 2001; Taylor, Stewart, & Downton, 1988).

Extreme weather events are by definition low probability but high impact weather events. We expect mostly negative perspectives, that is, that individuals associate mostly risks (and not opportunities) with such events, but do not preclude positive images as well. The perspectives that are the most important when considering adaptation, link the phenomenon under study, here extreme weather events, with possible solutions, or human preventive actions. That would provide us with different conceptions of salience of extreme weather events connected to their impacts, since adaptation options almost always refer to preventing possible impacts of extreme weather events. For instance, a relevant perspective could be the immediacy with which an intervention (adaptation) can be provided for impacts of a specific extreme weather, like flooding, or a hurricane. If this perspective of immediate action is important for stakeholders, then that would relate to concrete recommendations for a sector, for instance new decision protocols in the crisis management sector, which would reduce bureaucracy in decision processes.

Personal construct theory provides the framework within which the current study was conducted, introduced in construct psychology (Kelly, 1955). The fundamental assumption of this framework, and the method associated (repertory grid technique) is that our different perspectives on a topic, e.g., extreme weather events, can be identified as *bipolar constructs*: that is, dichotomies that we use to distinguish different types of extreme weather and relate them to our personal world (e.g. dangerous for me vs. not dangerous; wet vs. dry etc.). The bipolarity is also something that distinguishes constructs with concepts. According to the personal construct theory, we make sense of a situation like hail by noting what it is like, and at the same time what it is different to (Fransella, Bell, & Bannister, 2004). Constructs are both a result of one's experiences and examination of people and places, as well as they frame how individuals frame their world and experiences.

In an early study, van der Sluijs et al. also used repertory grid methodology, to identify the perceptions of stakeholders on climate-change related risks (van der Sluijs, Hisschemoller, de Boer, & Kloprogge, 2001), using as input different sets of impacts of climate change. In addition, the same study did a separate repertory grid analysis on the policy options to respond to climate change. In our study, we intend to capture both elements of (1) the role of adaptation, linked to the (2) impacts of extreme weather events. Because of our focus on robust adaptation, we use perspectives on adaptation to extreme weather events as a notion linking the extreme weather phenomenon, its impacts, and our strategies to cope with it.

The literature acknowledges various reasons for involving social actors in environmental policies. For adaptation governance, one major reason is that stakeholders possess the kind of knowledge that is often referred to as tacit, local or practical knowledge, which is supposed to make a contribution to policy-making in addition (or in contrast) to formal scientific knowledge (Ziervogel, Bharwani, & Downing, 2006). In practice, when social actors are consulted, it is often done through formal "stakeholders" as high level representatives of sectoral interests. Going beyond this narrow conception of stakeholders, our study addresses high as well as lower level practitioners. Thereby, the study also takes into account that social actors may face the issue of weather extremes in different roles. On the one hand, they are embedded in sectors that have to deal with climate adaptation, but at the same time, as individuals being part of latent (unorganized) groups, they may be affected by an adaptation policy. In conclusion, the stakeholder sample was identified in such a way as to guarantee a sufficiently large degree of differentiation between the interviewees and, in consequence, to identify a broad range of perspectives.

On the basis of literature, the following characteristics of social actors were included in the study as potential predictors of differences in perspectives.

Involvement in sectors: we wonder as to whether individuals from different sectors would have different perspectives on extreme weather events and priorities of adaptation. On the one hand, we may expect different assessments of e.g. long periods of heat and drought among stakeholders active in outdoor recreation that can be explained by referring to distinct ways these stakeholders relate to this particular weather extreme. On the other hand, we may find stakeholder perspectives to differ with respect to core beliefs and values that cut across sectors, such as beliefs with respect to the capacity of humans to prepare for rare and unexpected weather events.

In a series of interviews with climate change experts about their perceptions of climate change, Lowe and Lorenzoni did not find any influence of institutional affiliation on these perceptions, probably because the interviewees were multi-institutional (Lowe & Lorenzoni, 2007).

Involvement in (previous) events and workshops: We want to know whether individuals who have been involved in climate-change adaptation workshops or events, would hold similar perspectives, drawing upon formal knowledge obtained from reports and oral presentations; whereas those who did not participate would draw more upon tacit knowledge and personal experience. Low level practitioners tend to have less affinity with the science-policy interface. Therefore, their knowledge and experience may provide an authentic contribution to the identification and exploration of different and potentially conflicting adaptation strategies. A previous study found that exposure to a greater number (amount of) of relevant information sources was positively associated with some preparedness behaviors in one of the locations (Los Angeles county) but not in the other (New Orleans) (Basolo et al., 2009). The authors suggest that the role of information sources may be different (thus less important and influential) in places where the risk of extremes (hurricanes) is high and such information sources common, than in places where information sources less common (ibid.). This may also play a role in the Netherlands, where the risk of specific extreme weather events, namely flooding, has been imminent for centuries.

Level of knowledge: we like to find out as to whether different levels of knowledge among interviewees correlate to differences in perspectives on extreme weather events. According to Dessai et al. (2004), the amount of information of individuals is one of the determinants of experienced or perceived dangerous climate change (Dessai et al., 2004).

Level of concern: We want to examine whether different levels of concern among interviewees correlate to differences in perspectives on extreme weather. The (self-reported) informedness about climate change was identified as a factor influencing concern with respect to climate change(Kellstedt, Zahran, & Vedlitz, 2008), but in an unexpected way: the more individuals felt they were informed about climate change, the less concerned they were. The authors explain this by suggesting that those more informed about climate change probably also trust science and scientists to find a solution for climate change. In a more recent study, exposure to a specific information source, namely Al Gore's movie "An inconvenient Truth", resulted in raising levels of knowledge about climate change, and level of concern

about climate change (Nolan, 2010). This latter study used objective measures of knowledge about climate change, and found a positive relationship between level of knowledge and level of concern.

Method

Methodological framework

The methodology used in this paper is a non-steering open interview technique called repertory grid technique, introduced in construct psychology (Kelly, 1955), and more recently applied in environmental studies (Home, Bauer, & Hunziker, 2010; van de Kerkhof, Cuppen, & Hisschemöller, 2009; van der Sluijs, Hisschemoller, de Boer, & Kloprogge, 2001). The repertory grid technique uncovers the bipolar constructs that individuals use to understand and relate to a topic, here extreme weather events. The identification of these constructs, or perspectives, can be elicited by the interviewees themselves, using as probing devices the so called "elements": instances of the topic under investigation. As elements in the subsequent study, the team selected fifteen photos of extreme weather events and their impacts, shown in Figure 1. All of these might be relevant for adaptation governance in the Netherlands.

Previous research suggests that 15–25 interviews can bring about saturation of unique constructs (Dunn, 2001), as there is, according to the underlying theory, a limited amount of constructs individuals use for any given topic (Fransella, Bell, & Bannister, 2004). Another advantage of the method is the bottom-up elicitation of the constructs, using as only probe from the interviewer the elements (be it photos, as in our case, words, sentences etc.).

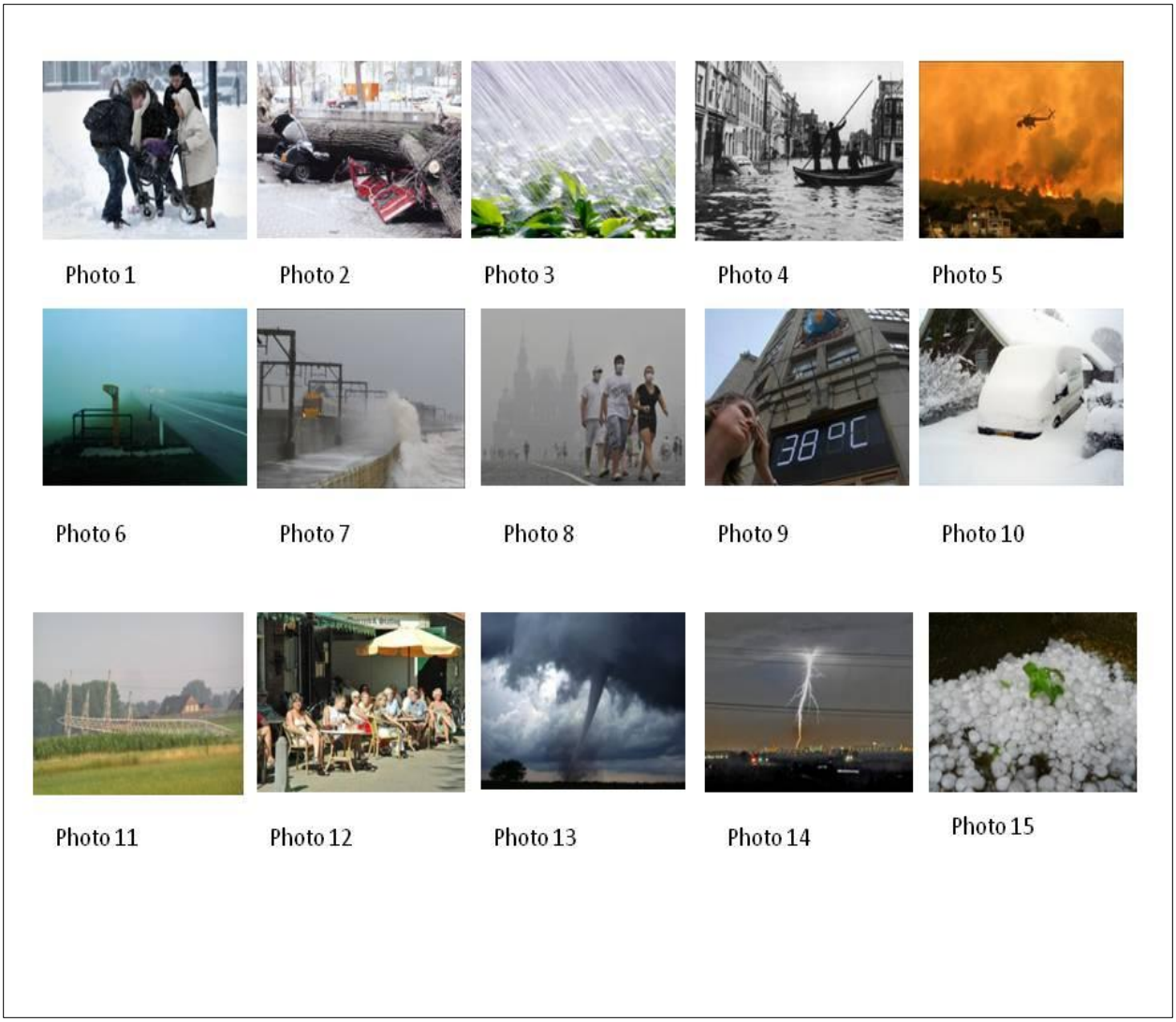

Figure 1: Photos of extreme weather and their impacts, used as elements for the repertory grid

Procedure

During the interview each respondent was asked to select three random photos (facing upside-down) and to compare them, the question being: "To what extent are two of these phenomena similar and different from the third?" The answer to this question provided a bipolar construct, such as 'no economic impact – great economic impact'. The respondents were allowed to come up with more than one answer to a particular set of photos, thus allowing multiple constructs to be identified by a single triplet of photos. This process went on until the photos were finished, and the respondent had no constructs to add. The respondent was then invited to select the three constructs that he/she

considered the most important, when focusing on adaptation to (changes in) extreme weather events[1]. Following this selection, the respondent ranked all photos (elements) on a 1–7 scale, according to their position in each of the three prioritized constructs[2]. So if the construct was "no economic impact vs. great economic impact", the scale would be 1= "no economic impact", 7= "great economic impact", and all the photos would be given a number between 1 and 7 by the interviewee.

In addition, the respondents were asked a number of additional questions on their (self-reported) level of informedness about extreme weather, as well as their involvement in prior events and workshops related to climate change or extreme weather events.

Analysis

First, we interpreted the prioritized constructs using the bootstrapping technique (Jankowicz, 2004). Thereby we identified broader categories, i.e. constructs phrased in different wording but with apparently an identical meaning [3]. To validate the results of qualitative analysis, we did a reliability test. The categories constructed were sent to a second coder, in order to re-code all 125 constructs in these categories. In total 80% of constructs were categorized consistently with the original coding. We proceeded to more detailed explanation of two categories (which created the biggest problem), and the creation of a new category (Other) to include constructs which could not be categorized. Discussion between the two coders led to re-classification of some constructs, raising the percent of agreement in categorizing to 96%.

Second, we conducted factor analysis (Principal Component Analysis-PCA) of the prioritized constructs (columns as variables) using as information the rankings of the fifteen photos (rows)[4]. PCA is

[1] The actual question was: "Taking into account adaptation to extreme weather events, which three constructs would you think are the most important?". The interviewees were also given the option to add a fourth construct which they considered equally important. A few interviewees only reported one or two constructs as priorities of adaptation.

[2] The total number of ranked constructs were 125. However, four were omitted from the factor analysis, because they were not bipolar and the ranking of the photos had no variance.

[3] We did not use the term "unique constructs" that previous literature uses, because we only categorized the constructs selected by the interviewees as most important, and not all the constructs they told us.

[4] Even though is two prior studies HOMALS was used (van der Sluijs et al, 2001; van de Kerkhof et al., 2009), our data permitted PCA: the rankings were not nominal categories, and there was sufficient variance of the variables.

the standard method suggested to analyze numerical repertory grid data[5] (Fransella, Bell, & Bannister, 2004; Jankowicz, 2004).

Third, we identified whether the sectors, the level of concern (1-7 scale), the level of informedness (1-7 scale) and participation in prior events (yes-no) were shaping the different components that came about. We used the percentages of constructs in these categories (each sector, level of informedness etc) to provide an indication of the random distribution.

Sectors and participants

We focused on the following sectors, all of which are immediately affected by extreme weather events, (number of interviewees from each sector in parenthesis): public health (6), crisis management (5), water sector (6), hospitality sector (hotels, restaurants and cafes) (6), tourism and recreation (9), urban transportation (5), vulnerable individuals (small children and older people) (4). The first three sectors were selected because of their primary role in *responding to extreme weather events,* and are thus involved in adaptation to extreme events through their expertise. The following three (hospitality, urban transport and tourism and recreation) are economically vital sectors for urban areas in the Netherlands, especially Amsterdam, that are *affected by extreme weather events*[6]. Vulnerable individuals, was selected because they are amongst the most affected in the case of any extreme weather event (young children, older citizens); yet, because of lack of formal organization, they are rarely taken into account as social actors. Previous research has suggested that a person's physical location was an important determinant of climate change risk perception, especially given the fact that climate change impacts will be highly regional (Brody, Zahran, Vedlitz, & Grover, 2008). Most of our interviewees work in, or close to, the city of Amsterdam, and thus the perspectives tend to be urban.

The selection of sectors or interviewees in the sector did not follow the logic of representative sampling. The selection of the sectors was, on one hand, related to our aim for designing adaptation strategies, as we made sure all relevant sectors were involved (e.g. crisis management). Further, we conducted theoretical sampling (Strauss & Corbin, 1990), selecting sectors with affinity to science-policy interface on extreme weather events, and sectors far away, unrelated to public policy discussions on extreme weather adaptation. In addition, we tried to ensure the "maximum variety" within each sector

[5] Varimax rotation was used.

[6] Economic sectors such as farmers were considered "usual suspects" as they participate in almost every programme related to (extreme) weather events, and thus were not included in the research. The emphasis here is on urban areas.

by interviewing directors of institutes and simple employees alike. Our strategy is similar to that in previous studies of repertory grid (Home, Bauer, & Hunziker, 2010).

Results

Here we first report on the qualitative analysis of the different perspectives that the respondents identified as most important for adaptation to extreme weather events. Section 5.2 presents the results of the statistical analyses (PCA), which aim to identify how the different constructs cluster with each other, and which factors influence this clustering. We use the qualitative analysis to understand and shed light on the results of the PCA. Section 5.3 examines the determinants of differences in perspectives.

Qualitative analysis

The 41 interviewees provided in total 125 prioritized constructs. Qualitative coding of these constructs gave us the following 19 categories (Table 1). The Table shows the summarized categories (column 2), the number of individual constructs in each category (column 3), the number of individual interviewees in each category (column 4).

Not all categories in the table above are bipolar. This results from the clustering of the individual constructs in broader categories, which may be bipolar (e.g. positive versus negative) or non bipolar (spatial distribution). For instance the category “spatial distribution” includes constructs which mentioned whether the extreme event takes place in cities or countryside (3 constructs); regional or local (2); in the Netherlands or not (1). This is consistent with previous studies, which also used broader categories that were not always bipolar (van der Sluijs, Hisschemoller, de Boer, & Kloprogge, 2001).

The most numerous category proved the positive versus negative weather event: especially probed with a photo of people sitting out in a terrace under the sun, individuals made the distinction between “pleasant” and “unpleasant/ catastrophic event” or “not dangerous versus dangerous” event. This category clusters together those constructs which referred to an event as generally positive versus negative, so not for a specific sector, or a specific activity. This category is a bit similar to the second most numerous one, on positive or negative impact on a specific sector, or specific activity, coding items such as “more tourists versus less tourists” or “bad for the movies versus good for the movies”. Thus, the impact on the sector was the second most important category for the interviewees. Expectedly, a lot

of importance was placed on the impact of the extreme events in general: categories 2, 6, 10, 12, 15 all relate to impacts, with, in total, 34 constructs coded in these categories.

	Categories	Constructs	Interviewees
1	Positive versus negative perceived phenomenon (general)	23	17
2	Negative impact on sector vs. positive/no	18	14
3	You can prepare for it vs. not	14	13
4	Extreme vs. no extreme	9	9
5	Cold vs. hot	8	8
6	Negative impact on health vs. no impact	7	7
7	Dry vs. wet	7	7
8	Spatial distribution	6	6
9	Individual vs. societal problem	5	4
10	Long vs. short duration of impact	4	4
11	Event itself vs. impact of event	3	3
12	Economic costs of impact	3	3
13	Involves people vs. not	3	3
14	Role of help	3	3
15	Negative impact on nature vs. not	2	2
16	Role of humans in causing event	2	2
17	Simple vs. complex problem	3	2
18	Degree of familiarity with phenomenon	2	2
19	Other	3	3

Table 1: Coding of perspectives on adaptation priorities for extreme weather events

Activities that come, or should come, before the event, were also important: category 3 on the preparation for the event (e.g. constructs such as "you can insure against it versus you cannot insure against it" or "it is generally taken into account when we design infrastructure, versus it is not taken into account"); and category 16 on the extent to which an event is human induced or not[7].

There were quite a few descriptive constructs (21 in total) e.g. hot versus cold; wet versus dry; wind versus no wind; has people in vs. doesn't have people in; presents the event vs. presents its impact; these were categories 7, 11, and 14.

[7] This mostly referred to the photo of a fire, where some interviewees suggested that such an event is human induced.

The interviewees created, therefore categories separating the event itself (descriptive categories), the feelings that an event induces (general positive or negative), the impacts, and the adaptation or preparation measures. As discussed in section 2, we are interested in perspectives which *link extreme weather events, with possible adaptation solutions,* as they would provide us with different conceptions of salience of extreme weather events connected to their impacts, since adaptation options almost always refer to preventing possible impacts of extreme weather events. For this reason we proceed to the factor analysis, which uses one additional level of information (the rankings) and thus deepens our understanding on these broad categories.

Factor analysis

The analysis in this section was conducted with PCA on the 121 ranked constructs against all 15 photos (elements). We focus on the first six components out of the total fourteen, which explain for 73% of the variance. Table 2 shows the labels we give to these components. The story lines are given below, based on the constructs that loaded high on each component. Each story line (component) includes the following elements: (a) typical character of the event; (b) typical kind of impact, and (c) some notion of (need for) action to be taken.

Component	% of variance[8]	Interpretation
Component 1	16%	Very disastrous, rescue needed
Component 2	15%	New versus old weather extremes
Component 3	12%	Prepare for (material) damage
Component 4	12%	People involved
Component 5	12%	Beyond imagination
Component 6	6%	Natural resources management

Table 2: Typology of perspectives on extreme events, based on PCA

Component 1, "Very disastrous, rescue needed", contains 21 constructs[9] that were brought up by 12 interviewees. The typical event in this component is sudden, very disastrous and dangerous. It is

[8] Rotation sums of Squared loadings.

[9] We take into account constructs that load 0.6 or higher in each component.

described as “violent”, something you cannot do anything about, as opposed to peaceful and calm. Such an event is likely to have a short duration and its impacts are typically local; it is more disastrous and long-lasting when it affects a city rather than the countryside. Its victims are in despair and afraid; they don´t see a solution. This is not a nice place to visit and the local hospitality sector is expected to lose a lot of customers. Interestingly, this type of events does not relate to serious (long term) health risks. Its focus is on sudden catastrophe with victims in need of urgent help (rescue). Exemplary constructs in this component are: “very disastrous vs. least disastrous”; “rescue needed fast vs. help can wait”; “violent vs. peaceful and calm”, “short term event vs. long term event”.

Component 2, labeled as “New versus old extremes”, contains 16 constructs, mentioned by 13 interviewees. This component turns out to be very stable in the analysis, by which we refer to the fact that in case we manipulate (e.g. diminish) the number of factors, this component comes out again. The component concentrates on the differences between extreme hot (summer, dry) and extreme cold (winter, wet) weather. The typical feature of annoying winter weather is its impact on transportation, namely, that it gets slippery. This impact may be long-lasting, but people normally won´t need help. We are acquainted with this type of weather extremes. On the contrary, extreme heat is (as for the Netherlands) a relatively recent phenomenon, which people are not familiar with and which causes drought and health problems, especially during summer. It is the type of event where help is needed. Moreover, whereas extreme cold is associated with just one array of problems (constraints on transport), extreme heat is associated with ´multiple themes´. The interviewees did not come up with specific examples of measures or options that would address ´multiple themes´ weather extremes. Typical constructs in this component are: “high temperatures, heat vs. low temperatures, cold”; “no impact on transportation vs. maximum impact on transportation”; “happens the recent years vs. happens since long”.

Component 3 is labeled “Prepare for (material) damage”, and includes 12 constructs, brought up by 8 interviewees. In some ways it contrasts with component 2 as it focuses on typical Dutch weather extremes, especially storms. Storms and many other weather extremes are caused by nature rather than humans and they can have dangerous consequences, as they cause damage to infrastructure and buildings. Many of the impacts cannot be dealt with at personal level, some of them can. Hence, preparatory measures need to be taken in so far this is possible, e.g. the protection of infrastructure or stronger building regulations. Exemplary constructs in this component are: “damage to electricity vs. no

damage to electricity"; "we need to prepare in advance vs. no need to prepare"; "cases maximal damage vs. causes no damage".

Component 4, labeled as "People involved", consists of 10 constructs, mentioned by 4 interviewees. This component is different from the others as it does not concentrate on any particular type of event, e.g. (sudden) storm or heat wave, nor on any particular type of human reaction (e.g. fear). It focuses on extreme events that occur infrequently and are dangerous in terms of their impacts. In contrast to component 3, this component acknowledges that many weather extremes or their impacts are more or less induced by humans. The involvement of persons is central in this argument, even though in different roles. Although it recognizes persons in their capacity of bringing help, it considers people primarily as victims. In fact, it distinguishes different types of impacts on (groups of) people like health risk, people threatened in their home environment, social disruption and, simultaneously, severe impact on nature. Exemplary constructs here are: "health impacts vs. no health impacts"; "induced by humans vs. not induced by humans"; "people respond with help vs. no response with help".

Component 5, which we labeled "Beyond Imagination", includes 13 constructs mentioned by 8 interviewees. Like component 4, it focuses on extreme events that happen infrequently. They are supposed to be catastrophic disasters, because of their dangerous consequences, i.e. their impact on the daily lives of people and the huge costs of material damage. Some of the weather extremes are not (yet) known (in the Netherlands). But even if they are known, people hardly take them into account in their daily outdoor activities. In a sense it is difficult to interpret the unique message hidden in this component. On the one hand, we learn that people might try to prepare themselves, if they would be aware of the things going to happen. In this respect, the concept of ´knowing´ may imply ´signaling´ or ´warning´, but these concepts have not come up during the interviews. On the other hand, however, it maybe anyhow impossible to intervene in an event that is beyond imagination. Typical constructs in this component are: "extreme vs. not extreme"; "complete disaster vs. pleasant circumstances"; "not possible to intervene vs. possible to intervene".

Component 6, "Natural resources management" includes 5 constructs brought up by 3 interviewees. Neither of these specifies the extreme weather events themselves. Three relate to problems that extreme events can cause as regards natural resources, i.e. water shortage, flooding and threat to food production. In these cases, spatial planning requires complex (as opposed to simple) adaptation measures. Exemplary constructs in this component are: "related to water (shortage) vs. not

related to water (shortage)"; "threat to food production vs. no threat to food production"; "spatial management needed vs. no spatial management needed".

Perspective	Ranks the highest	Ranks the lowest
Perspective 1	photo 13; photo 5	photo 12; photo 9
Perspective 2	photo 9	photo 10; photo 1
Perspective 3	photo 11; photo 13; photo 2	photo 6; photo 12
Perspective 4	photo 8; photo 5	photo 12; photo 14
Perspective 5	photo 5; photo 4	photo 12; photo 1
Perspective 6	photo 4	photo 11; photo 2

Table 3: Photos ranked high and low for each perspective

Table 3 present the photos that ranked the highest, and the lowest in each perspective: these help contextualize the perspectives.

Determinants of perspectives

We tested as determinants of these perspectives the sector, level of concern, level of informedness, and the prior participation to events. Concern and informedness were measured on a 1–7 scale; we re-coded both variables as BA (=Below Average, and Average) values 1–4; and AA (=Above Average) values 5–7. In the cells we indicate the percentage of constructs mentioned by respondents which had above average level of concern, and above average level of informedness.

Table 4 presents the additional analyses. Column 3 shows the sectors of the respondents that mentioned constructs which loaded higher than 0.6 in each component. Column 4 shows the percent of constructs brought up by interviewees with above average level of concern, which were in total 44%. Column 5 shows the percent of constructs mentioned by interviewees with above average level of informedness, which were in total 55%. Column 6 shows the percent of constructs mentioned by interviewees with prior participation in events related to climate change or extreme weather events, which were in total 41%. In the last three columns we use bold typeset to indicate the numbers well above or below the percentage expected.

	Sectors	Relation to extreme weather	Concern (AA=44%)	Informedness (AA=55%)	Prior event (Yes=41%)
Perspective 1	tourism 7; hospitality 5; vulnerable 6; crisis 2; water 1	Affected 18 Responding 3	57%	**29%**	**14%**
Perspective 2	hospitality 2; transport 4; tourism 4; health 3; crisis 2; vulnerable 1	Affected 11 Responding 5	**71%**	59%	**24%**
Perspective 3	tourism 4; transport 3; health 1; water 2; crisis 2	Affected 7 Responded 5	**25%**	42%	**8%**
Perspective 4	crisis 4; water 3; tourism 3	Affected 3 Responding 7	**0%**	**80%**	**100%**
Perspective 5	water 5; hospitality 3; tourism 3; transport 1; health 1;	Affected 7 Responding 6	**62%**	**77%**	**78%**
Perspective 6	health 4	Responding 4	**0%**	**60%**	**60%**

Table 4: Components per determinants

Table 4 suggests that all four variables (sectors, level of concern, level of informedness and prior participation in events) play a role in the identified components, albeit to a different extent. With respect to the different sectors, most components are cross-sectoral, but some sectors are represented more than others. Component 4, which relates to the involvement of people, either as victims, or in their capacity to provide help, is, expectedly, comprised mostly by constructs from individuals in the crisis and water sectors, whose jobs related to saving human lives (crisis), and health risks (water sector). Surprisingly enough, constructs from the public health sector are absent in that component. The sixth component, related to impacts on natural resources management is comprised exclusively from constructs of interviewees in the health sector, which makes it the only component from one sector. In components 1, 3, and 5 sectors do not seem the defining factor shaping the components identified.

More informative than the actual sectors is the distinction whether individuals are primarily affected by extreme weather, or have to respond with professional action. In the first two perspectives

individuals who are mostly affected by extreme weather are over-represented: we can imagine that for vulnerable individuals and sectors, the extent to which rescue is needed (perspective 1) is of vital importance, whereas professionals who respond with rescue in such cases, probably feel that this is not priority for adaptation, because they already have a role in responding and rescuing during these circumstances. For the second perspective, we can also understand that professionals who have to respond to extreme weather are probably more knowledgeable with respect to "new, more recent" extremes, such as heat waves, and thus did not prioritize this perspective. However, these professionals responding to extreme weather events were, naturally, over-represented in perspective 4, about the role of humans involved, as well as the last perspective on natural resources management.

With respect to the level of concern, interviewees with above average level of concern for extreme weather events score a lot of constructs on the components related to "New versus old weather extremes" (component 2) and "Beyond imagination" (component 5). The high level of concern would relate, in that case, to extreme heat waves (component 2) and to unimaginable disasters (such as flood, fire because of heat wave and hurricane). The components "People involved" and "Natural resources management" are comprised exclusively of constructs from interviewees with below average level of concern. It can be the case that people with low degree of personal concerned focus on the importance of "impersonal" adaptation measures (related to natural resources management). But the fact that these individuals also score low on focus on personal involvement and impacts on people, (component 4), makes us think that the personal impacts of extreme weather events in component 4 are mentioned in a somewhat professional and detached manner from individuals with a lot of knowledge and prior participation to dedicated events, as we can see from the last two columns.

The level of informedness seems to play a less important role in the shaping of components. Highly informed individuals are overrepresented in the components "People involved", as discussed above, and "Beyond imagination". It could be the case that these two components are more related to better knowledge about an event. "Very disastrous, rescue needed", "Unknown and known extremes" and "Prepare for (material) damage" can be also identified by individuals with low level of informedness, as they are somewhat common-sense dimensions related to extreme weather. It could also be the case that level of concern and informedness are linked in a different way: people who focus on impacts on human lives and health (component 4) will inform themselves better than people who mainly worry about less-far-reaching consequences.

Finally, participation in prior events seems to be the most influential factor in the shaping of components. Interviewees with prior participation in previous workshops are underrepresented in the first three components, comprised of relatively common-sense categories, whereas they are overrepresented in the last three components which go beyond common knowledge and ways of thinking about extreme weather events. It is, however, noteworthy that they are also underrepresented in the component which is mostly concerned with the need to prepare (component 3). Events and workshops on climate change and extreme weather events have the implicit intention of mobilizing for adaptation and preparedness to extreme weather events. Yet individuals who participate in such events were underrepresented in this category.

Discussion

In this study, we found six broad perspectives to be the most prevalent in describing adaptation to extreme weather events. These perspectives link specific events, or types of event, with their impacts, as well as with human action that is, or is not, needed (i.e. preparation, rescue). The priorities for human action for adaptation, coming out of these components, are primarily: immediate help and crisis management, in the case of very disastrous and catastrophic events, such as intense storms (perspective 1); addressing heat waves and drought, which we know little about and they are relatively recent (perspective 2); preparing infrastructure such as buildings as much as possible for extremes (perspective 3); addressing events that endanger human lives and have victims (perspective 4); and complex adaptation measures related to water (shortage) as changes in natural resource management and spatial planning (perspective 6).

Once we link these perspectives to changes in extreme weather events projected for the Netherlands by the KNMI, which were outlined in the introduction of this paper, we can identify which socio-economic sectors need to be involved in adaptation planning and management. Our starting point is that different social actors need to be involved in adaptation governance, ensuring implementation of measures, as well as inclusion of their local and tacit knowledge in adaptation decisions. Since more intense precipitation events are likely, both crisis management and rescue operations and preparation of the infrastructure are in order. Therefore, for adaptation measures, the crisis management sector, as well as the building sector, and infrastructure (transportation, electricity etc) need to be involved in adaptation planning. Further, with more heat waves and hotter summers, adaptation measures are

needed for dealing with heat, especially with respect to human health and lives. This necessitates involvement of public health organizations, and addressing vulnerable individuals, such as older people and children. Events that endanger human lives, such as intense precipitation, as well as extreme heat are also more likely. Preparation of the transportation sector to increased precipitation in winter (snow) or frost is considered important, but the interviewees perceive mobility hindrance more as nuisance and annoyance and less as danger which needs to be addressed. Finally, for different extreme events, the need for changes in spatial planning and natural resource management are important, highlighting the need to engage with the water sector, the spatial planning sector, and the food sector, in order to identify concrete adaptation measures and strategies.

Individuals with high level of concern tend to prioritize with respect to more descriptive components (cold vs. hot; level of extremity) and not prioritize according to more elaborate categories (i.e. health and societal impacts; level of complexity of adaptation measures). It could be the case that individuals, who feel more than average concerned, feel concerned because they lack more elaborate knowledge on extreme weather events. In a previous study it was found that the number of information sources one is exposed to is positively linked to perceived level of preparedness (Basolo et al., 2009). Individuals who participate thus in such events may feel more prepared, and thus less concerned, than individuals who do not participate in such events.

The level of self-reported informedness seems to play a less important role in the shaping of components than the level of concern. Highly informed individuals are overrepresented in the components related to societal and health impacts, as well as level of extremity, and economic costs. It could be the case that these two components are more related to more elaborate knowledge about extreme weather. Finally, participation in prior events seems to be the most influential factor in the shaping of components. Interviewees with prior participation in previous workshops are underrepresented in the first three components, comprised of more descriptive, common-sense categories, whereas they are overrepresented in the last three components, which go beyond common knowledge and ways of thinking about extreme weather events. Our original expectation that individuals with prior participation to such events would tend to draw on formal knowledge and prioritize more elaborate perspectives seems to be confirmed.

With respect to the role of education, organization of workshops and dissemination of knowledge about extreme weather events, the results point to some interesting insights. It is interesting

that individuals who participate in events, workshops or lectures etc. on climate change or extreme weather events are underrepresented in some components and especially the component related to the need to prepare in advance for the possibility of extreme weather. This could be linked to the increased sense of preparedness that additional information sources provide, as found by previous studies (Basolo et al., 2009). Many such events have the implicit intention of mobilizing for adaptation and preparedness to extreme weather events. This, however, should not be taken for granted.

The results of the study should be read with care. Our interviewees could be more concerned or knowledgeable about extreme weather events, than a random sample of the Dutch population. In the invitation for the interviews we indicated the topic of the research, and one could expect that those agreeing to participate may have had some interest in extreme weather events, either by having knowledge about it, or either by feeling concerned about it. This does not invalidate our results, however, because close to half of our individuals reported above average level of informedness and above average level of concern. While the sample cannot be considered representative, it was not our intention to have a representative sample for the Dutch population; rather the intention was to focus on selected sectors, and to identify their priorities with respect to adaptation to extreme weather events. The number of interviews we conducted ensures a saturation point of constructs, since 15-25 interviews are enough to capture the entirety of different constructs, according to previous repertory grid analyses.

Conclusion

In this paper we report on 41 interviews taken with repertory grid technique, with social actors in the Netherlands, and identify six prevalent perspectives which interviewees prioritise for adaptation to extreme weather events. The perspectives are: Very disastrous, rescue needed; new versus old extremes; prepare for (material) damage; persons involved; beyond imagination; and natural resource management. The results indicate that differences in perspectives were not closely related to different sectors the interviewees belonged to. The level of concern and level of informedness influenced the ways interviewees perceive adaptation priorities for extreme weather events, and especially their prior participation to related events. Implications are drawn for adaptation planning and management, as well as communication of extreme weather events.

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