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More than a one-size-fits-all approach – tailoring flood risk communication to plural residents' perspectives

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ABSTRACT

Many urban residences are insufficiently prepared for fluvial, pluvial or coastal floods, owing to a lack of accurate information on flood risk. This article analyzes how risk communication can improve disaster risk reduction by overcoming the expert–layperson gap. Building on interviews in three cities in the Netherlands, it applies Q methodology to identify four perspectives on flood risk communication. To promote greater private residential involvement in flood risk adaptation, communication should address all four rationalities.

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Introduction

Flooding is a serious threat to urban areas, particularly to private homes. In Europe, water authorities are obligated to provide flood hazard maps and flood risk maps, due to the EU Flood Directive (EC 2007/60) (European Commission, 2007; Priest et al., 2016). Yet Europeans rarely take flood adaptation measures, even though they could reduce the costs of flood damage by as much as 80% (Fournier et al., 2016; Grothmann & Reusswig, 2006; Hegger et al., 2016; Mees, 2017; Mees, Tijhuis, & Dieperink, 2018; Thaler & Hartmann, 2016). This implementation gap leads to extensive damage from floods (Loucks, Stedinger, Davis, & Stakhiv, 2008).

Why do residents not take these measures when flood risk information is available? There are at least four possible reasons for this implementation gap. The first is a misinterpretation of the available information on flood risk. For instance, flood recurrence intervals, which are based on statistical probabilities, e.g., 'your home is protected against a 1-in-250-year flood', can be misconstrued in such a way that people count on 249 years of safety after a flood event. Second, flood risk information is often not disaggregated below the city or regional level, much less to the level of individual homes. Even more fine-grained applications (such as the Dutch flooding website overstroomik.nl) only go to the four-digit zip-code level. Third, residents often perceive flood risk management as a governmental responsibility, because the government is responsible for dike maintenance and other flood defence works (OECD, 2015) or

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because they are not aware of how to reduce flood risk on their own. Fourth, while public authorities try to raise flood risk awareness through different kinds of communication methods, these are generally targeted at a flood-expert audience instead of the general public, whose experience regarding floods and flood risk is small and knowledge likewise.

One of the root causes of the problems mentioned above is that present-day flood risk communication is still originating from an expert point of view (Patt & Jüpner, 2013). It is based on the knowledge-deficit model (Burningham, Fielding, & Thrush, 2008; Faulkner, McCarthy, & Tunstall, 2010), which assumes that providing any kind of information to the public will give rise to understanding of individual risks. In this, it is assumed that experts (e.g., scientists) are 'right' and lay people are 'wrong', or at least lack the necessary knowledge to fully comprehend expert information (Hansen, Holm, Frewer, Robinson, & Sandøe, 2003). For instance, interpreting the mentioned flood recurrence intervals typically goes beyond the lay understanding of flood risks (Everett & Lamond, 2013; Meyer et al., 2012). As a result, lay people, including area residents, tend to understand flood probability as a guarantee of flood protection (Hartmann, 2011). When a proper translation from expert to lay knowledge fails, and residents distance themselves from responsibility, they hold the government accountable for flood risk management and protection. This may lead to difficulties in governing present-day flood risk, especially in urban areas. However, a great deal of the responsibility still rightly lies with the appropriate regional authorities. Our plea is therefore not aimed at a one-on-one shift of responsibility from the government to the resident. Rather, we suggest opening up the discussion first in order to take a more inclusive and encompassing approach to flood resilience.

To better understand the limited comprehension among residents of flood risk information, their perspective is used as the starting point for this empirical study. Instead of focusing on what information experts determine is crucial for residents, we aim to understand what type of flood risk communication and what information residents themselves need in order to make informed decisions. The resident as the focal point could help with choices about the risks that are of individual concern and augment the general public's perception of their own responsibility (Renn, 2014). To meet this objective, flood risk communication needs to shift away from strategies based on one-way information supply and education towards content and processes that help residents consider the trade-offs in adapting (or not) to flood risk (Árvai, 2014). With this in mind, we aim to answer the research questions, 'How do residents who are at risk of flooding interpret flood risk information, and how can flood risk communication be better targeted towards their needs?'

The next section provides an overview of the differences between expert knowledge and lay knowledge, as well as of the knowledge-deficit model, which relates to flood risk communication, risk awareness and disaster risk reduction. Following this, the empirical research in the three case study areas in the Netherlands is described. The empirical research consisted of structured interviews and Q methodology exercises with residents. Finally, the outcomes of the case studies are analyzed. Cultural theory provides an effective theoretical framework for the interpretation of the empirical outcomes. The theory identifies four distinct rationalities (or cultures) according to which people perceive the world and from which they derive their actions: hierarchism,

individualism, egalitarianism and fatalism. These four rationalities are mutually exclusive, and they represent contradicting views of the world. As every rationality is rational and consistent within itself, it is likely that each is represented in every social situation. Cultural theory moves away from the distinction between expert and lay and initiates more differences among lay people as well as experts. Cultural theory was not part of the conceptual framework for designing the research methods in this study; therefore it will be taken into consideration in the discussion section of this article. In the end, conclusions are drawn on how to overcome the implementation gap in flood risk communication.

Persisting challenges in flood risk communication

The knowledge-deficit model was the dominant perspective on the dissemination of scientific research in the 1980s. The model assumes that lay people lack sufficient knowledge, compared to experts, and that by providing the necessary expert knowledge to them, their knowledge deficiencies will decrease, which will influence their subsequent behaviour (Dickson, 2005; Hansen et al., 2003; Wynne, 1991). The knowledge-deficit model was developed as a means to reduce 'scientific illiteracy' (Miller, 1983), considering that ignorance causes a lack of societal support for various societal issues where scientific knowledge could play a role (Simis, Madden, Cacciatore, & Yeo, 2016). Underlying the knowledge-deficit model are two (positivistic) assumptions: first, that the information formulated by experts will be identically interpreted by all individuals (Simis et al., 2016); and second, that once people are informed, they will adjust their perception and implement adaptation measures accordingly (Faulkner et al., 2010). This is not to say that the knowledge produced by experts is irrelevant and poorly translated per se, but rather that – for the reasons outlined before – residents have a very limited sense of what they should or could do with the information provided by experts. The model has been much criticized for its simplicity and its positivistic translation of scientific knowledge through a one-way, top-down communication process (Burningham et al., 2008; Faulkner et al., 2010; Goosen et al., 2014; Kirchhoff, Lemos, & Dessai, 2013; Miller, 1998; Petts & Brooks, 2006). Nevertheless, it is still implemented in present-day communication of scientific insights, including risk assessments (Dickson, 2005; Domingues, Santos, de Jesus, & Ferreira, 2018; Gustafson & Rice, 2016; Simis et al., 2016).

Over the years, risk communication in general has come a long way from the knowledge-deficit model as the main perspective on communicating research results to the public. Nowadays, a resident's perception of risk is mainly understood as a social construct (Hartmann, 2010). This means that, within communities, risk perception is formed through networks of social processes with, for instance, neighbours and friends (Cole & Murphy, 2014; Faulkner et al., 2010). Therefore, the perception of risk includes personal experience but is also determined by cultural background, values, location, and demographic characteristics (Bradford et al., 2012; Cole & Murphy, 2014; Kashefi & Walker, 2009; Maidl & Buchecker, 2015).

However, current *flood* risk communication is still closely linked to the dated approach of the knowledge-deficit model (Simis et al., 2016). This is reflected in the objectives that are allocated to flood risk communication: raising risk awareness, transferring knowledge and providing (behavioural) advice (Höppner, Whittle,

Bründl, & Buchecker, 2012). These objectives have hardly been realized over the years. This is primarily due to the one-way transmission of risk information to the lay public (Árvai, 2014; Höppner et al., 2012). Also, residents prefer to be informed regarding the likely impact and consequences of floods for their well-being and property (Bichard & Kazmierczak, 2012; Renn, 2014), instead of probabilities of flooding. It also matters that the information provided is actionable, because being informed about risks that are beyond your individual control raises anxiety rather than triggering adaptation.

Moreover, flood risk communication is expert-oriented. It remains dominated by a one-directional expert-to-lay perspective, inspired by the knowledge-deficit model, and fails to adequately communicate flood risk to residents in an effective way. The adherence to the knowledge-deficit model has not been effective in fostering behavioural change or public engagement (Moser, 2010). In other words, a translation of the expert's message should, among other things, aim to prevent misinterpretation of probabilities, communicate risk at an individual level, address individual responsibility and target the public audience. This requires transforming flood risk communication from a knowledge-deficit model perspective towards a lay perspective when attempting to communicate flood risk to the public.

Researching flood risk communication in the Netherlands

This article analyzes how flood risk communication can overcome the implementation gap by concentrating on translating expert knowledge to a lay perspective. This objective is met by studying the flood risk perception and communication preferences of residents in three locations in the Netherlands: Dordrecht, Venlo and Zwolle. The Netherlands is characterized by its downstream location in the delta area of several main European rivers (Rhine, Waal and Meuse), which discharge into the North Sea. Due to this location, 26% of the country is located below sea level, and 59% of the country is susceptible to flooding, either by a river or by the sea (PBL, 2009). The Netherlands has extensive flood protection measures, of which dikes and pumping systems are most important.

The Netherlands is interesting for analyzing flood risk communication, risk perception of residents, and their current knowledge of flood risk because of its location in relation to water and the expected consequences of climate change. The existing flood protection measures (i.e., dikes) are under pressure due to climate change prognoses, and Dutch governmental organizations are legally obliged and therefore committed to improve Dutch protection measures. However, they cannot take sole responsibility for flood risk management, as private homes will also be more susceptible to damage due to increased chances of floods. Therefore, flood risk communication is important to properly advise residents about their specific, individual situations and measures they can take. This also includes an appreciation of the types of flood people are susceptible to (e.g., fluvial or pluvial), which is illustrated in the rationale behind the case-study areas, as explained below.

Introduction of the case-study areas

Three sample areas were selected (Dordrecht, Zwolle and Venlo). They are located in the same larger delta area of the Netherlands and are roughly evenly distributed across the country (Figure 1). Dordrecht is in the south-west, close to the Port of Rotterdam;

Figure 1. The three case-study locations in the Netherlands.

Zwolle is in the north, close to the Ijsselmeer; and Venlo is in the south-east, at 20 to 35 metres above sea level. These locations differ in local context, flood return periods, and existing flood protection (Table 1), representing the range of Dutch flood risks.

The city of Dordrecht is an island within the tributaries of two of the main Dutch rivers, the Meuse and the Waal. In general, the city's land is 4 to 5 metres below sea level, but it is surrounded by a main dike ring protecting against a 1-in-1000-year (sea and river) flood. Dordrecht is vulnerable to heavy rainfall, which causes local floods because the runoff peaks are higher than the drainage system is built to withstand, surface water storage capacity is inadequate and water absorption by the clay soil is limited. The city of Zwolle is in the estuary of the Ijssel and the Vecht. The latter is a rainfed river, whereas the Ijssel is a tributary of the Rhine, which is a combination of a glacier-fed and rain-fed river. The residential areas in the city are susceptible to floods with a depth of 2 to 4 metres (Rijkswaterstaat & Ministerie van Infrastructuur en Waterstaat, 2019). Several of these neighbourhoods have experienced floods and related damage due to heavy rainfall in past years. The third case study is Venlo, which is in the

Table 1. Overview of the three case-study areas.

	Dordrecht	Zwolle	Venlo
Maximum water depth	4–5 m	2–4 m	1.5–3 m
Recent flood events	Pluvial	Pluvial	Fluvial
Scale of recent floods	Local	Local	Regional
River	Meuse and Waal	IJssel and Vecht	Meuse
Flood probability (years)	1:1000 to 1:3000	1:300 to 1:3000	1:100 to 1:300
Population	118,426	101,192	126,116

Table 2. Demographic information of the case-study areas (CBS, 2017–2018).

	Population		Education (thousands; ages 15–75)				
	Male	Female	Primary	Secondary	Tertiary	Unknown	Average disposable income per household (€)
Dordrecht	58,577	59,849	25	36	26	1	39,200
Venlo	50,350	50,842	24	32	19	1	37,600
Zwolle	62,030	64,086	21	37	37	0	40,400
Netherlands (total)	8,527,041	8,654,043	4,415	5,447	4,204	202	41,900

Meuse River basin. In 1993 and 1995 the area suffered two 1-in-200-year floods, which led to evacuations of the neighbourhoods alongside the river (van Meijgaard & Jilderda, 1996). Up to then, no large-scale flood protection measures such as dikes were in place; so for the past few decades the regional water authority and the municipality have been collaborating to protect residents by building dikes along the Meuse, although these measures restrict the streams flowing into the Meuse and can cause local floods in times of heavy rainfall.

This research was conducted in several residential areas of the case-study locations, based on their experience with floods (either river floods or the consequences of heavy rainfall) and their position relative to sea level. See Table 2 for an overview of the demography of the case-study areas.

Methodology

The focus of this research is on residents, based on the assumption that improved flood risk communication with residents can have a substantial effect. Therefore, the participants in the case-study locations are homeowners or tenants of single-family houses in residential areas. To cover a broad range of respondents in the case-study locations, we combined two methods. First, structured door-to-door interviews were held in the selected neighbourhoods, collecting the responses of 69 residents in total (20 in Dordrecht, 36 in Zwolle and 13 in Venlo). Each interview lasted approximately 20–30 minutes and consisted of questions concerning the resident's perception of floods, their experience with floods, whether they have taken adaptation measures, their awareness of the flood-probability of their homes, and the perceived responsibility for reducing flood risk. In addition, their preferences regarding flood risk communication were examined through discussing a variety of methods ranging from interactive, face-to-face methods to static media such as websites and flyers. These communication methods encompass long-term flood risk information (as opposed to early-warning systems) with an emphasis on the level of individual homes. The questions were formulated based on a literature review. The interviews were transcribed, and the data were analyzed.

Second, to acquire more in-depth insight into residents' perspective on flood risk communication, 18 of the 69 respondents also agreed to be interviewed in depth using Q methodology. Q methodology systematically reveals individual perspectives and groups them into shared perspectives using quantitative factor analysis (Raadgever, Mostert, & Van de Giesen, 2008). The factor analysis identifies the basic principal dimensions of respondents' perspectives (Kerr & Bjornlund, 2018).

By employing Q methodology, this study combines quantitative and qualitative research methods (McKeown & Thomas, 2013). Since the aim is to overcome the implementation gap by concentrating more on translating expert knowledge to a lay perspective, Q methodology can highlight the various perspectives coexisting among Dutch residents. These different perspectives on how individuals prefer flood risk communication to be dispersed could facilitate a translation from expert to lay knowledge. It is important to understand that the focus is on identifying the various coexisting perspectives rather than generalizing about how many residents hold a particular perspective.

The Q methodology adopted consisted of four steps. First, a Q-sample (or Q-set) was created. The sample is composed of statements extracted from the literature, interviews, or media. The statements in this study are formulated based on an analysis of the existing literature on flood risk communication, flood risk awareness and flood risk perception (Árvai, 2014; Bier, 2001; Bradford et al., 2012; Burningham et al., 2008; Höppner et al., 2012; Kasperson, 2014; Terpstra, 2011). The Q-sample consisted of a number of statements that covered the research issue, after which participants were selected by snowball sampling.[1] In the second step, Q-sorts were collected. Respondents ranked statements (i.e., the Q-sort) by assigning a value to each statement (Uittenbroek, Janssen-Jansen, Spit, & Runhaar, 2014). The Q-set consisted of 31 statements, and 18 interviewees performed the Q-sort. That is, they assigned each statement to one of 31 boxes in the Q-sort, which consisted of a 9-step scale from strongly agree (4) to strongly disagree (−4). Step three was a statistical analysis of the Q-sorts, namely a factor analysis. PQmethod software was used to run a principal component analysis (Schmolck, 2002). The statistical analyses run by PQMethod manually and automatically rotate the initial factors and provided the necessary outputs for step five (McKeown & Thomas, 2013). Step four was the interpretation of the factors. McKeown and Thomas (2013) refer to this as the task of distilling the core meanings hidden within the factors. We call factor groups *perspectives*, and the interpretation is explained in detail in the next section. The focus of the results section will be on the Q methodology outcomes, while the structured interviews provide context for Dutch residents' perception of floods.

Residents' preferences: four different perspectives

Overall, the respondents perceived a flood event as unlikely to happen. Of the 69 residents, only 13 had taken some sort of measure (e.g., pump, garden drainage or sand bags), and most of these 13 had experienced a flood before. Yet, residents most commonly replied that they did not know what they could do individually to prevent flood damage. Responses ranged from 'there is nothing I can do' to prevent floods (respondents 1, 22, 33, 38, 40) to trust in current flood defence: 'I expect the dikes to be properly constructed' (respondents 8, 51), and further to 'I do not know what I could do' to prevent floods (respondents 7, 35, 52, 48). This complements the assertion that most respondents do not expect a flood to occur in their living area, at least not in the coming 5–10 years. Their preferences for how they would ideally be informed about their flood risk varied greatly (e.g., newsletters, websites, flyers, neighbourhood meetings, newspapers, TV, mobile applications or e-mails). Four perspectives are distinguished as outcomes of the Q factor analysis, which helps structure these diverse

responses. Even though these four perspectives vary significantly, on some statements of the Q-sort, there was consensus among the entire sample group.

All respondents agreed to a certain extent that, in general, they personally do not need more information on flood risks (statement 18: −3, −2, −2, −1; see Table A1 in the online supplemental data). Moreover, all respondents were aware of the flood risks their properties face (statement 30: +4, +3, +4, +2). This might at first not seem in line with the tone of this article, as it could suggest that the respondents do not need more information on flood risk. However, to put these responses in perspective, first, multiple respondents commented that although they were aware themselves, their neighbours were not aware enough (respondents 1, 3, 7, 9, 10). They argued that most of their family, friends and neighbours were not as personally motivated to gather information on flood risk as they were. 'I am not the average Dutch resident on this topic', said respondent 1.

Second, statement 13 shows that all respondents are willing to use a website that informs them of flood risk (statement 13: +3, +2, +3, +3). In other words, even though the respondents claimed to be aware of their individual flood risk and did not think they needed more information on it, they were all interested in a website that would provide more information on it. And all said they would use such additional information sources to gain more knowledge of flood risk.

Beyond this consensus, the factor analysis presented four statistically significant perspectives on flood risk communication ('self-assured omniscient', 'acknowledged inexpert', 'insusceptible confident', 'insufficiently connected'). These perspectives are named after the characteristics of the empirical outcomes associated with each respondent group. A respondent defines a perspective when the loading is in excess of ±0.46 (Table A2 in the online supplemental data). The interpretation of these perspectives is based on the distinguishing statements. Table A1 shows the statements for each perspective with the corresponding scores. Some statements are unique to a factor, because they scored significantly differently compared to the other perspectives on that statement. These distinguishing statements, with a significance of $p < .01$, are shown in Table A1 (in boldface). These statements indicate a distinction between core and secondary values (Webler, Danielson, & Tuler, 2009).

Self-assured omniscient

The residents who shared this perspective on flood risk communication trusted their own knowledge of flood risks, which gave them confidence. They were also content with existing communication practices and the flood protection measures in place. They trusted that the government has taken the necessary precautions. 'I am confident the measures taken (i.e., dikes) [surrounding my home] are sufficient', said respondent 4.

They do not see any need for the involvement of an expert. Respondent 11 argued that she was definitely not going to adjust her home, so there was no need for an expert to inform her. Face-to-face communication of flood risks was also unnecessary in the eyes of the residents associated with this perspective. Moreover, they were not interested in paying for expert advice or a detailed report on their personal flood risk. They were willing to use a website to gather more information on flood risks, although they expected it to confirm what they already knew. 'Even though I am aware of the high

flood risk I am facing, I am not going to invest money to prevent a flood that could occur once every 100 years; I will worry about it then' (respondent 11).

This remark implied that they would react in the event of an acute threat of flooding. The fact that they faced, for instance, a 1% chance of flooding each year did not serve as a sufficient motivator to act now. Moreover, the self-assured omniscients were not interested in locally tailored flood risk information. They were aware of their personal flood risks and claimed to understand the current manner of flood risk communication in terms of the probabilities of flooding. They regarded flood probabilities as the best way of communicating flood risk.

Acknowledged inexpert

The residents who identified with this perspective were aware of the flood risks of their properties. In contrast to the self-assured omniscients, they did not believe that their properties were currently well protected against floods. Therefore, this view was based on the awareness of the shortcomings of their homes from a flood risk perspective, which made the owners receptive to flood risk communication. Moreover, residents who shared this view appreciated personal contact in flood risk communication. They preferred to be informed face to face rather than looking for information on an online platform, and they trusted information provided by an expert more than a website with flood risk information. They were not willing to use a website to gather more information on their personal flood risk. Related to this preference for expert information in a face-to-face manner, respondents who defended this position did not see any need for a national campaign on flood risk management. Respondent 1, for instance, specifically attached more value to the tailored assessment of an expert than the more general information available on a website. He stated that websites do not improve the flood risk awareness of most people. Instead, people generally ignore the information or do not take the time to read it thoroughly.

The acknowledged inexperts were aware of the flood risk that their property faced but acknowledged that there was more to learn. Respondent 12 questioned, for instance, whether his knowledge was adequate. In addition, this group did understand what it meant for their home to be protected against a 1-in-1000-year flood, although they did not consider flood probabilities the best way to communicate flood risk. The mention of a 1-in-1000-year probability causes people to assume they will not experience such an event. While a flood of that magnitude is possible, the question remains whether it will actually happen (respondent 1). Also, respondent 8 acknowledged that communicating a flood probability of 1 in 1000 years or even 1 in 10,000 years causes people to wait and see what will happen. The acknowledged inexpert perspective represents the respondents who would like to be more informed and who said that the probabilities make people wait and see what will happen. However, this group did not want to wait and see, because they believed their properties were not well protected at the moment.

Insusceptible confident

This third perspective encompasses the residents who were convinced of their own knowledge of flood risks and believed that enough information on flood risk is already available. They were not interested in using a website for flood risk information. Nor were they willing to spend any time or money gathering more information. Essentially, these residents knew that they live in a flood-prone area, but they were not considering taking measures in any way. As respondent 14 explained, 'In my opinion, my home is adequately protected against floods. So, I do not see the need to spend money to improve that.'

Defendants of this perspective were strongly opposed to paying for information on a website or for a detailed flood report by an expert. They were only interested in flood risk information if it was free. 'In my opinion information on floods should be free of charge. That is the way it is supposed to be, considering I already pay taxes to the regional water authority' (respondent 17).

They considered the Dutch government the sole actor that should inform residents of flood risks and anticipated that since this information would serve a common good, it should be available free of charge. Also, they did not perceive flood probabilities as the best way to communicate flood risk. They deemed probabilities too abstract to grasp (respondent 14). However, it is important to be critical in regard to the rankings respondents assigned to these statements.[2] As an example, respondent 17 claimed in the ranking of statements to be aware of the flood risk of his property and to understand what it meant to be protected against a 1-in-1000-year flood, but explained the probability as 'it will happen once'.

This perspective of the insusceptible confidents was a passive view. The residents assumed themselves to be well informed and were therefore only interested in flood risk communication if it was delivered to their homes in a brochure. 'To visit a website, you personally have to take action, but if the flood risk information is delivered via the mail, you are immediately confronted', said respondent 17.

Insufficiently connected

The residents who held this perspective were open to flood risk communication. Compared to residents who subscribed to the other perspectives, who claimed that enough information is already available, the 'insufficiently connected' residents stated explicitly that they needed more information on personal flood risk. The respondents preferred above all to be informed via a website, first, because they did not perceive a visiting expert as more reliable than a website, and second, because in their opinion insufficient information was currently provided by the government. These residents would prefer to search for flood risk information on their own time. They would also like different scales of information: from general flood risk to individual adaptation measures. More than the other perspectives, the insufficiently connected residents preferred technical information on adaptation measures, and they were interested in the benefits of adaptations. Residents associated with this perspective also had a clear need for real-time flood information.

To inform residents adhering to this perspective, flood risk information should not consist of flood probabilities, because for them a probability of 1 in 1000 years is incomprehensible. In their opinion, communicating in probabilities is not the right approach. Flood probabilities 'are actual nonsense', according to respondent 3.

This perspective strongly suggested the need for a national campaign to inform them of flood risk. They thought that the government should play an important role in dispersing more information, which was, in their perspective, not currently the case. 'I think it is essential that people are more aware of flood risks, and you can to a greater degree work together' on minimizing flood risk (respondent 3).

Discussion: pluralistic perspectives on flood risk

The objective of this article was to understand the perspective of residents in relation to existing and desirable flood risk communication. We find that, generally, residents interpret flood risk information in different ways than flood experts do. Moreover, one communication approach cannot address the disparate needs of such a diverse audience.

The most obvious finding of this study is the mismatch between residents' perception of flood risk versus that of the flood experts (water management). The latter ought to communicate flood risk in flood recurrence intervals and flood probabilities. For residents, it does not matter whether the probability is 1 in 100 years or 1 in 3000 years. Describing chances in terms of hundreds of years does not make it clear to lay people that a flood could occur tomorrow. Even the respondents who claim to understand flood probability cannot always explain it correctly. These findings are in line with Everett and Lamond (2013), Meyer et al. (2012) and Hartmann (2011), who argue that residents do not necessarily understand statistical probabilities and therefore these statistics should be avoided in flood risk communication meant for lay people.

The empirical outcomes provide insight into preferred communication methods. In general, residents are willing to visit a website for more information on flood risk, but they favour varying styles of communication. Whereas the 'acknowledged inexperts' have a clear preference for face-to-face communication, the 'insufficiently connected' desire a national campaign on floods, the 'self-assured omniscients' are only willing to take a short look at a website and prefer flood probabilities to communicate risk, and the 'insusceptible confident' residents would rather get flyers in the mail. Out of the four perspectives, the self-assured omniscient is best aligned with the current communication techniques (e.g., flood recurrence intervals). The mismatch goes beyond a juxtaposition of the 'expert' and the 'layperson', both in formulating flood risk and in the method used to inform residents. Therefore we conclude that a one-size-fits-all approach is not suitable for informing residents of flood risk.

This article is a step towards a better understanding of how floods are perceived by residents to design more tailored flood risk communication. We postulate a more bidirectional perspective on expert and lay knowledge, in which expert knowledge not only flows to the lay audience but also incorporates lay or local experience and feedback in subsequent expert judgements. This approach could increase and improve flood risk communication. However, the empirical findings reveal that this bidirectional perspective is not just a two-way communication between the two clear-cut groups of

experts and lay people; given the plural perspectives on flood risk, adequate communication requires multiple directions of communication.

Insights through cultural theory

The empirical analysis shows that risk perception is not homogeneous within the group of residents (laypersons), as four different perspectives result from the Q methodology. None of these perspectives can be proven right or wrong; all are empirically true perspectives on flood risk. These multiple perspectives on risk can be analyzed by applying the cultural theory of risk (Douglas & Wildavsky, 1992). The theory takes as a starting point four distinct rationalities (or cultures), according to which people perceive the world and from which their actions are derived: egalitarianism, individualism, hierarchism and fatalism (Hartmann, 2012; Schwarz & Thompson, 1990). These perceptions are placed in a matrix based on the level of 'grid' and 'group' (Figure 2). Group represents the level of attachment to social values such as democracy, frequency of interaction and equality, whereas grid represents valuation of autonomy, control and institutional integrity (Mamadouh, 1999).

People with an egalitarian worldview (weak grid, strong group) envision the world as on top of a hill, unstable enough that a small disturbance can destroy the equilibrium. Based on that notion, the world is constantly in danger, and it is necessary to respond quickly to possible disturbances. In addition, there is no room for experiments, because failure means the balance will be destroyed. From an egalitarian perspective, the results of an action are more important than the process, and worry or morality serve as reasons for taking action (Hartmann, 2012; Schwarz & Thompson, 1990).

An individualist's world view (weak group, weak grid) is more robust: the world seems to lie in a valley, so if a disturbance influences the equilibrium, it will always 'roll'

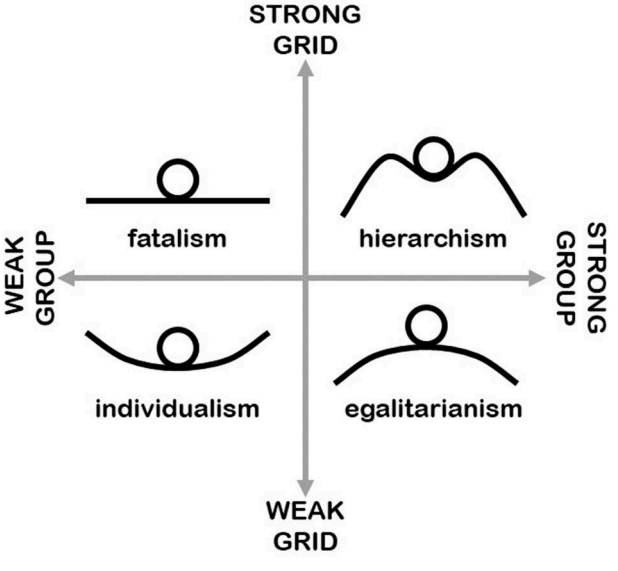

Figure 2. Grid and group scheme of cultural theory (Hartmann, 2012, p. 12).

back to the centre of the valley. Individualists can experiment, and each fault is also seen as an opportunity for benefit. They do not prefer to cooperate with others, but rather identify self-determination and individual liberty as important values.

Hierarchism (strong group, strong grid) is related to egalitarianism, as this world-view envisions the world to be on top of a hill but in a small dip, which makes for a relatively robust equilibrium. There are chances for trial and error, but only to a certain extent, because beyond the small dip, the equilibrium can be destroyed. Hierarchists prefer to determine boundaries by setting up rules and regulations, and, as the name suggests, hierarchy is important. People adhering to this perspective thrive on the notion that members of society give power to an institution and all members are equal in the process. Integrity is also essential in maintaining the equilibrium.

Fatalism (weak group, strong grid) is based on the idea that we cannot know how the world reacts and events cannot be influenced. The world can move freely both ways, and there is no 'falling down'. Fatalists do not believe in the world can be controlled. The strong grid is externally determined, and it is not possible for individuals (weak groups) to influence it. Fatalism is a passive rationality.

These four rationalities are mutually exclusive, and they represent contradicting views of the world. However, cultural theory postulates that, as each of these rationalities is rational and consistent within itself, it is likely that each rationality is represented in each social situation.

The four perspectives on flood risk communication that resulted from the factor analysis of the Q methodology match the description of the four rationalities almost perfectly, even though the methodology was not based on cultural theory. The 'insufficiently connected' perspective matches the rationality of egalitarianism, which believes in community-based solutions, common values, and trust. Residents adhering to this perspective are interested in technical information on what adaptation measures they can implement and their benefits. This relates to egalitarianism because the results are seen as more important than the process. In addition, these residents call for a national campaign on flood risks, which can be considered a consequence of their dissatisfaction with the current flood risk communication provided by the government. This situation causes them to worry and therefore to take action by acquiring information on adaptation measures.

The 'acknowledged inexpert' perspective fits individualism. The individualist believes in self-determination, which relates to the preference for face-to-face flood risk information and expert advice over non-tailored information on a website. Moreover, individualism supports individual liberty and freedom, as expressed in the acknowledged inexpert's explicit plea that no national campaign on flood risk should be initiated.

The perspective of 'self-assured omniscients' represents hierarchism, a rationality that stands for a belief in management and controllable situations. Residents associated with this perspective trust the measures taken by the government and therefore believe in (flood risk) management. They also recognize flood probabilities as the best way to communicate flood risk, as they believe that these chances can be controlled and accurately assessed. Moreover, they trust in rules and regulations; in their opinion, the government is responsible for flood risk management. Therefore, they are not willing to pay for expert advice or a detailed report and see no need for face-to-face communication. This rationality also aligns with the perception of water managers (the experts).

The 'insusceptible confident' perspective corresponds to fatalism, a passive rationality that assumes the world is too complex and messy to manage. Residents associated with this

perspective are aware of flood risk on their property and see no need for more information. This is in line with the assumption of the fatalist rationality that events cannot be influenced; the world is uncontrollable. Residents are not willing to pay for expert advice, a detailed report or the use of a website. Since the world cannot be controlled and events cannot be influenced, they are not willing to spend time or money on flood risk adaptation. They know they live in flood-prone areas but have no intention of taking measures.

Conclusion

This article aimed to analyse how residents interpret flood risk communication and how flood risk communication can be better targeted towards their needs. The empirical analysis indicates that within risk communication these four distinct perspectives prevail. These can be conceptualized through the four rationalities of cultural theory. Cultural theory explains that any solution that follows only one of the rationalities will only respond to people of one perspective. Other people will discard the solution as irrational (i.e., not matching their own rationality). A solution that deliberately considers all four rationalities has a better chance of acceptance by a larger public. But because the rationalities are mutually exclusive, it will never be perceived as a perfectly rational solution; it can only exist as an ideal to model a best-of-both-worlds solution. This puts flood risk communication strategies at a crossroads: the question arises whether to target one of the four rationalities at a time, to maximize the impact on that select group, or to try to find an ideal communication strategy that addresses all four different perspectives, knowing it will not fully appeal to any of them.

The currently dominant knowledge-deficit model in flood risk communication only responds to the 'self-assured omniscient' perspective (the hierarchism rationality). It does not respond to the other three perspectives. These results challenge the way risk communication is currently done: from an expert point of view and by appealing to one of the four perspectives. This study has emphasized the need for a deliberate choice to tailor the intended message to the targeted audience. At the same time, we should not forget that residents' perceptions, whatever the rationality may be, are influenced by aspects such as experience of floods and geographical living conditions.

This article cannot provide a recipe for what tailored bidirectional risk communication might look like; rather it provides empirical evidence for the necessity of such an approach. Further research is required to design and test risk communication methods that do not depend only on the view of experts but keep in mind the communication preferences of the egalitarian, individualist and fatalist rationales as well. This study is based on a small sample; therefore further empirical testing of these rationales is necessary to overcome possible selection bias. Most of all, we conclude that different communication styles are needed to better orient flood risk communication to the needs of residents; one approach to address all rationales is not suitable.

Notes

1. Snowball sampling has some limitations. It should be kept in mind that the respondents to the Q methodology might have more affinity with the topic than the average Dutch resident.
2. See the online appendix for a detailed overview of statements and rankings by perspective.

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