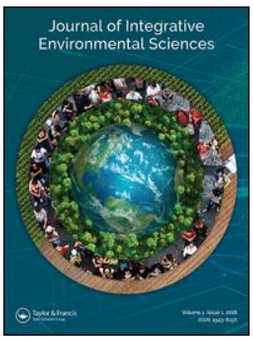

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Studying residents' flood risk perceptions and sense of place to inform public participation in a Dutch river restoration project

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ABSTRACT

Public participation is becoming increasingly important in integrative river restoration projects. However, studies show that flood risk awareness is generally low among residents of flood-prone areas, making it (more) difficult for project managers to involve the public. We contribute to understanding this generally low flood risk perception by carrying out a survey (N = 631) among residents in a Dutch floodplain and studying the connection between flood risk perception and sense of place. We found that expected damage is influenced by (collective) memory of near-floods and that residents with a high self- and group efficacy expect less damage. Against our hypothesis, we conclude that sense of place hardly influences flood risk perception, only nature bonding does. We recommend further research to study the complex relationships between flood risk perception, sense of place and self-efficacy from a theoretical need, but also because of the implications of these results for communication in flood risk management and motivations to engage in participation processes.

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Sense of agency; self-efficacy ; participatory river management; place attachment; survey

1. Introduction

As a way of adapting to climate change and reducing flood risk, the trend became to rely on rivers' natural resilience by restoring rivers instead of canalizing them (Smith et al. 2014; Speed et al. 2016). The technical approach towards reducing flood risk changed towards a more integrative approach since the 1970s. Instead of a "traditional" focus on only flood reduction, the trend arose to increasingly integrate the natural and human system, and local perspectives were included via participation processes (Agarwal et al. 2000; Smith et al. 2014), though the technical approach also remains strong in the Netherlands (Kaufmann 2018). As participation becomes increasingly common, it is also increasingly regarded as a democratic right to be able to participate (Reed 2008). As participation developed, multiple typologies of participation arose with different levels and methods (Mostert 2003; Reed 2008). Including the diverse perspectives of stakeholders also let to a rediscovery of the multifunctionality of rivers (van den Born et al. 2020). Over the last decades, there has been an increasingly holistic integrative approach

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Supplemental data for this article can be accessed here.

in river restoration to achieve ecological, aesthetic and recreational goals along with flood risk reduction (Jähnig et al. 2011; Wohl et al. 2015).

In an integrative and multi-functional approach, it is necessary to include the public and their perceptions and perspectives through "real participation", where stakeholders participate on the level of decision-making (Agarwal et al. 2000; Smith et al. 2014; Wohl et al. 2015). Participation in integrated river management leads to better quality and creative decisions, increased support and legitimacy (Carr 2015). Also, including residents' perceptions and their relationship with the area allows managers to adapt plans to residents' preferences and provides an opportunity to raise awareness among the public and river managers about the opportunities and risks restoring rivers could bring (van den Born et al.Forthcoming). For example, Krasovskaia and colleagues (2007) called for integrating public knowledge and involvement to improve flood protection. However, despite the benefits of public participation in river restoration, residents and their perceptions and local knowledge are often not included in (integrative) river management (Junker et al. 2007). River project managers perceive challenges with public participation, such as the perceived lack of public knowledge and a concern for bad decision-making (Junker et al. 2007). The common finding that flood risk perception among residents of flood-prone areas is generally low further reinforces these concerns (Krasovskaia et al. 2007; Pagneux et al. 2011; Ludy and Kondolf 2012; Scolobig et al. 2012). This low perception of flood risk (feeling of invulnerability) might lead residents to be too optimistic about potential risks in the area they live in, resulting in inaction (Bonaiuto et al. 2016). As "real participation" is important in integrative river management and restoration (Agarwal et al. 2000), potential barriers such as low flood risk perception and inaction must be overcome. Understanding residents' perceptions can guide and shape how to organize the communication and participation (van den Born et al. Forthcoming). In this light, we study why residents of flood-prone areas perceive such low levels of risk and how this inaction can be explained.

Flood risk perception is a multidimensional phenomenon and these dimensions are influenced by many variables. In this paper the main focus is on studying to what extent *self-efficacy, propensity to ignore flood risk* and *sense of place* explain low flood risk perception. Self-efficacy signifies whether residents believe they (as individuals or a group) have the capacity to act on something (Bandura 1990). Residents with a high self-efficacy, who perceive they have the ability to influence flood risk, might have a lower flood risk perception. Residents with a lower self-efficacy could also be more eager to ignore or marginalize flood risk as they perceive to have little control over them anyway. This *propensity to ignore* flood risk is a passive coping strategy, not aimed at reducing the risk but at reducing internal tension (Lemée et al. 2019).

Flood risk perception should not be studied independently but in its societal context, especially because of the importance of public participation in integrative river management. Therefore, this paper also focusses on the relation of flood risk perception with another multidimensional phenomenon, *sense of place*. Recently, there has been an increase in research on the relationship between the dimensions of flood risk perception and sense of place. Previous studies have illustrated the importance of sense of place in risk perception and have called for more empiric data (Peng et al. 2017). Sense of place describes the meaning a place holds to residents and how this bond is formed (Hernandez et al. 2014) and as such influences risk perception (Peng et al. 2017). For instance,

residents who experience benefits from living in a certain area might be more willing to accept flood risk and/or have a lower flood risk perception.

This study contributes empiric data to better understand flood risk perception and sense of place. Specifically, we examine to what extent self-efficacy, propensity to ignore flood risk and sense of place can explain why flood risk perception is low. By studying the two opposite sides of the river Meuse in the Netherlands, each with a different recent flood history, this study formulates implications for tailor-made communication and participation in integrated river management. The conceptualization of the phenomena and hypotheses will be elaborated on in Section 3.

2. Study context

In the Netherlands, a shift of focus from canalizing to restoring rivers can be seen, especially since the near floods of the rivers Rhine and Meuse in 1993 and 1995 (van Stokkom et al. 2005; van Buuren et al. 2016; Fliervoet 2017). A dyke enhancement on the south bank of the Dutch river Meuse to meet new safety norms is therefore integrated with exploring possibilities for river restoration and spatial development on both sides of the river by the responsible regional water authority *Aa en Maas*. To address these multiple goals on both sides of the river, the project is a collaboration between two water boards, three municipalities, two provinces, the ministry, Natuurmonumenten (a Dutch nature organization) and *Rijkswaterstaat* (a Dutch executive government agency) (Meanderende Maas n.d.). In this context, the water authority commissioned a perception study providing the opportunity to study residents' flood risk perception, self-efficacy and sense of place in a survey. This perception study was performed to study the perceptions prior to the start of the river restoration project and the insights were used for participation in the integrated river management project.

The study area is located in the south of the Netherlands and includes both opposite sides of the river Meuse (province of Gelderland north of the river and province of Noord-Brabant south of the river) between the A50 highway crossing the river and the sluice located near the village of Lith (see Figure 1). The study area consists of three municipalities, containing several small villages and a small city, Ravenstein. In the 1930s the river Meuse was canalized. As of 2017, the dykes (artificially constructed bodies alongside the river used as flood defence mechanism) on the southern side of the study area do not meet the new safety norms (Project team Ravenstein-Lith 2016). These Dutch safety norms have been adjusted as more people live in the areas protected by the flood defence mechanisms and because of an increased water discharge. In the new legislation, the risk of flood must not exceed 1:10,000 a year (Meanderende Maas n.d.).

Even though it is one study area, the context of the two opposite sides of the river is different in the quality of the dyke and in their experiences with high water levels. This provides the opportunity to empirically study two different contexts in a single case. Because of the new safety norms, flood safety on the southern bank has a high priority and the improvement of the flood defence mechanism must be completed by 2025. Flood protection on the northern side of the Meuse does not require improvement until after 2030 (Project team Ravenstein-Lith 2016). Secondly, even though there has not been a flood in the Netherlands for decades, during the near floods in the 1990s over 200,000 residents were evacuated as a precaution (in hindsight perhaps unnecessarily) (Fliervoet

Figure 1. Left: map of the Netherlands with the location of the study area marked in the south of the country. Right: Map of the study area. The study area consists of two opposite sides of the river Meuse between the sluice of Lith and the A50 highway that crosses the river. The northern part of the study area is the Province of Gelderland, the southern part is the Province of Noord-Brabant.

2017). This only concerned residents on the northern bank of the study area, as residents on the southern bank were not evacuated. This has resulted in different types of (collective) near flood experiences between the two sides.

3. Theoretical framework

In this section, we elaborate on the concepts flood risk perception (Section 3.1), sense of place (Section 3.2), propensity to ignore flood risk (Section 3.3) and (collective) flood experience (section 3.4). At the end of each section, we formulate hypotheses.

3.1. Flood risk perception and self-efficacy

In the literature, various conceptualizations of flood risk perception are used, encompassing a variety of (overlapping) aspects and dimensions (Raaijmakers et al. 2008; Bubeck et al. 2012; Scolobig et al. 2012; Wachinger et al. 2013; de Boer et al. 2015). They primarily concern the perceived likelihood, vulnerability and perceived magnitude (harm) of a flood (Bubeck et al. 2012; de Boer et al. 2015; O'Neill et al. 2016). However, residents' awareness of flood risk and their perception of being at risk also depend on the extent to which they feel able to (individually and as a community) prepare for and protect themselves against floods. The influence of actually being prepared has been studied in the context of flood risk perception (Raaijmakers et al. 2008; Bubeck et al. 2012; Scolobig et al. 2012; Wachinger et al. 2013; de Boer et al. 2015). But in this study, we focus on the perceived ability to prepare for or protect against flood. This is conceptualized as *self-efficacy*, which describes whether people believe they (as individuals or a group) have the capacity to act on something (Bandura 1990). Self-efficacy, in combination with high vulnerability, is crucial in preparedness behaviour (de Boer et al. 2015). We expect that residents who feel they have more control over the probability of flooding and/or in decreasing possible damage consequently have a lower flood risk perception. Therefore, we test the first

hypothesis: a higher self-efficacy predicts a lower flood risk perception (both expected chance and damage of flood).

3.2. Sense of place

The influence of sense of place on flood risk perception is increasingly studied as there is "*a complex interaction between sense of place and risk perception*" (Peng et al. 2017). According to Jorgensen and Stedman (2006) "sense of place can be conceived as a multidimensional construct representing beliefs, emotions and behavioural commitments concerning a particular geographic setting." There are various ways of conceptualizing this multidimensional construct (Jorgensen and Stedman 2006; Hernandez et al. 2014). Place identity and place dependence can be considered as its two main components (Williams and Vaske 2003). Place identity concerns to what extent people identify themselves with their surroundings (Jorgensen and Stedman 2006). Place dependence describes the benefits a specific area provides in comparison to other areas. The attachment to place consists of multiple dimensions (Scannell and Gifford 2010), and we included three forms of bonding through which residents can form attachment to place. Raymond et al. (2010) describe nature bonding, through connectedness to the natural environment in a place, and social bonding, through a feeling of belonging to a group of people, social relationships and shared history, interests and experiences in a place. Verbrugge and van den Born (2018) add a third form of bonding, narrative bonding, and describe this as bonding through "*cultural and historical meaning*" of a place.

To gain more insight into the relationship between sense of place and flood risk perception, we formulated a second hypothesis: a higher sense of place predicts lower flood risk perception because residents experience many benefits from the area and therefore do not perceive, will not or cannot imagine the possible risks.

3.3. Propensity to ignore flood risk

We study the concepts self-efficacy and sense of place in relation to residents' propensity to ignore flood risk, a passive coping strategy aimed at reducing internal tension instead of active coping strategies aimed at reducing risk or its consequences (Lemée et al. 2019). The third hypothesis we studied is that residents with a lower self- and group efficacy and/or a higher sense of place have a stronger propensity to ignore flood risk, as a coping mechanism. If a resident feels they cannot protect themselves against flood risk, they might as well ignore it instead of worry about it, and if a resident feels more connected to the flood-prone area, they are more willing to ignore possible risks.

3.4. (Collective) flood experience

Previous (near) flood risk experience is an important variable influencing flood risk perception (Zaalberg et al. 2009). Also in preparedness, direct experience is a main factor (de Boer et al. 2015). Even though the Netherlands has not been flooded for decades, in the 1990s the northern part of the project area was evacuated as a precaution because of a near flood, whereas the southern part was not, allowing us to also study the effects of

evacuation on perception of flood risk and (collective) flood risk experience and experience with evacuation. This results in our fourth hypothesis that residents who live in the evacuated area have a higher flood risk perception than those who live in the area that was not evacuated.

4. Methods

4.1. Sampling/methodology

An invitation for an online, anonymous survey was sent by mail to all addresses in the study area and their immediately adjacent neighbourhoods (see Section 2). The invitation consisted of a link to the online survey in LimeSurvey version 2.06 +. For practical reasons, we asked people to fill out the survey online; however, people who were not able to fill out the survey online could request a paper survey by phone. The invitations were sent mid-august 2017, with 2 weeks of schools' summer holiday remaining. After 2 weeks a postal reminder was sent to all households. In total, the survey was open for a month. Aiming for an equal age distribution among the respondents, we asked the person in the household over the age of 18 whose birthday was most recent to complete it.

4.2. Questionnaire structure

The survey invitation was sent to all addresses in the neighbourhood, including some entrepreneurs. After asking whether respondents were residents, entrepreneurs and/or recreationists, the residents and entrepreneurs received some specific questions on living/working in the area. Next, all respondents received questions on their use of the dyke and study area. Sense of place was measured with 21 statements on a scale of 1 (strongly disagree) to 5 (strongly agree) subdivided in place identity, place dependence, social bonding, nature bonding and narrative bonding. This was followed by questions on features of the dyke, river and floodplains. After that, we measured flood risk perception using 18 statements on a scale of 1 (strongly disagree) to 5 (strongly agree). These statements represent the perceived chance of a flood occurring, the expected damage, trust in authorities concerning flood protection, and the feeling of being valued by these authorities. These questions were followed by questions on near-flood experiences and flood risk perception. Afterwards, questions were asked about the expected effect of dyke enhancement and/or river restoration on the area. Lastly, some demographic data (including postal code) were collected and people were invited to share stories, memories and experiences in the area and the opportunities they see for the area. Personal stories or other remarks could also be sent by (e-)mail.

4.3. Data analysis

The data were analysed using IBM SPSS Statistics 21. The Likert scale statements were rescaled to −2 to 2. To compare different subgroups (e.g. residents from the north vs the south bank), we used independent t-tests. A factor analysis was carried out to analyse the statements on sense of place and flood risk perception. We chose principal axis factoring with a covariance matrix because not all items have the same variance (as indicated by

Levene's test), and used oblique (promax) rotation because of the expected relation between the factors. Factor loadings higher than 0.4 were included. To determine if the data were adequate for a factor analysis, the Kaiser-Meyer-Olkin Measure and Bartlett's test of Sphericity were interpreted. For all resulting factors, a Cronbach's alpha analysis was performed to test reliability (Field 2013).

To determine which variables have a predictive value for sense of place or flood risk perception, we used multiple regression. All predictors were entered simultaneously and bootstrapping was performed with BCa (Field 2013). Categorical predictors (including individual Likert scale items) were recoded into dichotomous categories (Field 2013). The Likert scales based on several 5 point items are included in regression analysis (Boone and Boone 2012). Durbin-Watson tests were performed to test independence of errors. If the result was either less than 1 or greater than 3, this is reported. Multicollinearity was assessed using VIF values (VIF values greater than 5 are reported) (Field 2013).

Significance levels are indicated as follows: *** = $p \leq 0.001$; ** = $0.01 \geq p > 0.001$; * = $0.05 \geq p > 0.01$. Trends ($0.1 \geq p > 0.05$) are indicated using a tilde (~).

4.4. Response – demographic composition

We included the responses of residents who completed at least one third of the questionnaire (until the questions on flood risk perception). Of those 631 responses, 547 were completed questionnaires. The response rate is approximately 14%; however, it should be taken into account that the actual response rate is unknown, as the link to the survey was also posted on the projects' website and some mail was returned to sender because of incorrect addresses. Some questions had missing values, and as a result the number of respondents for specific questions differs from the total number of respondents. Demographic data of the respondents can be found in Table 1. We have a slight over-representation of older people, male as well as higher educated residents. We have more respondents from the southern side of the Meuse, which is also more densely populated.

5. Results

In this chapter, the statistical analyses and results are described. First, the factor analyses of sense of place (Section 5.1) and flood risk perception (Section 5.2) are described. In Section 5.3 to Section 5.6 we test the hypotheses.

5.1. Sense of place

5.1.1. Factor analysis on sense of place

In order to determine if our statements on sense of place form cohesive factors and if the respondents distinguish the same factors, a factor analysis (see Section 4.3) was performed with the data of 629 respondents (Table 2). The data proved adequate for a factor analysis (KMO = 0.931; Bartlett's test $p = 0.000$).

Based on the scree plot and eigenvalues, solutions with four or five factors were considered. The solution with four factors was chosen because of high overall factor loadings and improved interpretability. One place dependence statement, "I would have difficulties missing the facilities (e.g. shops, schools, public transport, etc.) in this area",

Table 1. Demographic composition. Household composition percentages add up to over 100%, because this question allowed respondents to give multiple answers.

Living	
Time of residence (N = 629)	
Average	34.1 years
Place of birth (N = 629)	
Within study area	38.3%
Outside study area	61.7%
Home ownership (N = 629)	
Bought home	88.4%
Rental home	11.6%
Distance to dyke (N = 629)	
On or adjacent to the dyke	22.1%
Less than 10 metre	6.4%
10–50 metre	13.4%
50–100 metre	18.4%
100–250 metre	25.8%
More than 250 metre	14.0%
Distribution study area (N = 547)	
Brabant (south of the Meuse)	60.5%
Gelderland (north of the Meuse)	39.5%
Demographic data	
Age (N = 552)	
Average (years)	56.1 years
Gender (N = 553)	
Female	37.1%
Male	62.9%
Highest completed education (N = 552)	
Lower education (primary school)	1.6%
Middle education (secondary school or community college)	44.0%
Higher education (college or university)	54.3%
Household composition (N = 629)	
Alone	11.3%
With partner	79.0%
With child of younger than 14 years old	14.6%
With child of 14 years of age or up	19.4%
Other	2.4%
User type beside inhabitant	
As entrepreneur (*N* = 630)	16.7%
As recreational user (*N* = 627)	73.5%

and one social bonding statement, "*I* live in this area because my family lives here", were excluded because of low factor loadings.

The factor analysis reproduces the original dimensions nature bonding and narrative bonding in two clear factors (Table 2). Place identity and place dependence statements were mixed in one factor, which was called "place bonding". One factor, called "social bonding", consists of three social bonding items and the statement "*I feel like this area is a part of myself*", which represents place identity (albeit with a lower factor loading than the social bonding statements). Possibly the identification with the area is influenced by social bonding, or this way of identifying with the area influences social bonding. Since other studies do reproduce the mother categories (Verbrugge and van den Born 2015; Verbrugge et al. 2017), perhaps place dependence and place identity are strongly linked for the respondents in this study.

Table 2. Results of factor analysis on sense of place (N = 629) including factor loadings and level of adherences with standard deviation. For the mean, the scale ranged from −2 ("strongly disagree") to 2 ("strongly agree").

	Mother category	Factor loading	Mean	Standard deviation
Nature bonding (α = 0.874)			**1.15**	**0.811**
It would make me sad if the plants and animals from this area would disappear	Nature bonding	0.955	1.34	0.914
I think the nature in this area is important	Nature bonding	0.853	1.44	0.851
I feel strongly connected to the nature in this area	Nature bonding	0.813	1.16	0.929
Since I live here, I got more interested in the nature in this area	Nature bonding	0.569	0.67	1.098
Social bonding (α = 0.876)			**0.54**	**0.886**
Belonging to the community in this area is important to me	Social bonding	0.929	0.56	1.055
The friendships I have in this area, tie me to this place	Social bonding	0.841	0.32	1.114
I feel connected to my neighbourhood and/or the street I live in	Social bonding	0.736	0.73	0.955
I feel like this area is a part of myself	Place identity	0.406	0.58	1.017
Narrative bonding (α = 0.782)			**0.19**	**0.833**
I like to tell (folk)tales about this area	Narrative bonding	0.795	−0.27	1.099
I know (folk)tales about this area	Narrative bonding	0.750	0.30	1.050
The history and development of this area is visible	Narrative bonding	0.640	0.26	0.969
I once deepened my knowledge about the history of this area	Narrative bonding	0.597	0.45	1.159
Place bonding (α = 0.910)			**0.83**	**0.785**
There are no better places for me to live than in this area	Place dependence	0.919	0.83	1.063
I am proud of this area	Place identity	0.885	1.17	0.909
In this area, I can best do the things I love to do most	Place dependence	0.712	0.56	0.970
This area means a lot to me	Place identity	0.711	1.37	0.888
I feel strongly connected with this area	Place identity	0.593	0.86	0.959
There is no other place comparable to this area	Place dependence	0.573	0.21	1.061
This area is very special to me	Place identity	0.568	0.78	0.952

5.1.2. Adherence to sense of place factors

Nature bonding has the highest adherence of all sense of place factors (see Table 2), and levels of place bonding are also high. The respondents have a more neutral social and narrative bonding to the area. Noteworthy are the relatively large standard deviations, which indicate that the attachment to the area varies strongly among the respondents.

5.1.3. Influence of demographic characteristics

The predictive value on sense of place of recreating in the area, owning a business, being born in the area, length of residence, gender, age, education level, household composition, owning pets, distance of home to the dyke and home ownership was calculated.

For social bonding, these demographic characteristics account for 7.9% of the variation*** (N = 544). People living with children of 13 years or younger have a higher social bonding than those (living) without children**. The demographic characteristics account for 6.5% of the variation in place bonding*** (N = 545). Significantly predictive for a higher

place bonding are length of residence*, living on or adjacent to the dyke* and recreating in the area**. In narrative bonding, 5.2% is accounted for by these demographic characteristics*** (N = 545). Significantly predictive for high narrative bonding are length of residence** and owning a business in the area*. The demographic characteristics account for 8.3% of variation in nature bonding***. However, in the regression between demographic characteristics and nature bonding, the Durbin-Watson was 0.904, indicating a lack of independence of errors. This has to be taken into account while interpreting the results. The regression itself indicates that people who recreate in the area*** and women* have a significantly higher nature bonding.

5.2. Flood risk perception

5.2.1. Factor analysis on flood risk perception

A factor analysis (see Section 4.3) was performed on the statements about flood risk perception (N = 572), see Table 3. The sampling data proved adequate for a factor analysis (KMO = 0.820; Bartlett's test p = 0.000).

Two statements, "*I try to think as little as possible about flood risk*" (M = 0.24; SD = 1.107) on neglect of responsibility and "*I trust people in my neighbourhood help each other with flood problems*" (M = 0.97; SD = 0.827) on self- and group efficacy did not have a factor loading higher than 0.4 on any factor and were therefore excluded. Trying not to think about flood risk is thus not part of any factor, but is included in further analyses because it represents our third hypothesis. For the sake of legibility, this statement is referred to as propensity to ignore flood risk. The factor with perceived own responsibility has a low Cronbach's alpha. Therefore, this factor will not be used.

5.2.2. Adherence to flood risk perception factors

Generally, as can be seen in Table 3, the respondents believe chances of flood are rather small and that they do not expect a lot of damage. On average residents are neutral towards propensity to ignore flood risk (M = 0.24; sd = 1.107; N = 572) and have a low self- and group efficacy. Residents trust the authorities to protect them against flood risk. They also perceive that protection against flood risk is primarily the authorities' responsibility and that the dykes are fully protective (Figure 2). The factor of perceived own responsibility and trust in authorities show the strongest correlation in the factor correlation matrix (0.484). However, as noted before, the perceived own responsibility cannot be further included as factor due to the low Cronbach's alpha.

5.2.3. Influence of demographic characteristics

The same demographic characteristics as in Section 5.1.2 were tested on their predictability for the flood risk perception factors. Trust in authorities and their measures can be accounted for 6.0% by the factors* (N = 545). Significantly predictive for a higher trust in authorities is a higher age* and not owning a business***.

The expected damage can be accounted for 6.4% by the demographic characteristics* (N = 545). Women expect significantly more damage compared to men*. Also, residents with pets/animals expect significantly more damage than residents without*.

Table 3. Results of factor analysis on flood risk perception ($N = 572$) including factor loadings and level of adherences with standard deviation. For the mean, the item scale ranged from −2 = "strongly disagree" to 2 = "strongly agree".

	Mother category	Factor loading	Mean	Standard deviation
Trust in authorities (α = 0.860)			**0.58**	**0.698**
I trust that the authorities will help me if there are problems with high water	Trust in authorities	0.894	0.58	0.869
I have trust in the authorities' knowledge concerning water safety	Trust in authorities	0.850	0.72	0.853
I trust that the authorities protect me against water	Trust in authorities	0.753	0.70	0.840
I trust that the authorities take me seriously in the project	Trust in authorities	0.737	0.31	0.949
The authorities take measures to protect us against water	Self- and group efficacy	0.555	0.59	0.841
Expected damage (α = 0.855)			**−0.05**	**0.936**
I expect emotional damage from water problems	Expected damage	1.005	−0.09	1.108
I expect material damage from water problems	Expected damage	0.788	0.25	1.068
I expect impact on my health or the health of my family members because of water problems	Expected damage	0.732	−0.33	1.018
Self- and group efficacy (α = 0.733)			**−0.43**	**0.778**
I take measures to protect myself, my family and my home against flood	Perception of own responsibility	0.807	−0.37	1.007
The neighbourhood takes measures to protect ourselves against flood	Self- and group efficacy	0.797	−0.63	0.868
I am able to protect myself against water problems	Self- and group efficacy	0.539	−0.29	1.007
Expected chance of flood (α = 0.748)			**−0.47**	**0.853**
I am very concerned about a levee breach or flood	Expected chance of flood	0.901	−0.70	1.000
I expect that within 25 years, water will get through or over the dyke	Expected chance of flood	0.605	−0.32	1.057
I feel vulnerable to flood	Expected chance of flood	0.441	−0.40	1.084
Perceived own responsibility (α = 0.383, thus excluded as factor)			**0.68**	**0.731**
The authorities are entirely responsible for water safety (-)	Perception of own responsibility	0.626	0.94	0.925
The dykes fully protect me against water (-)	Perception of own responsibility	0.441	0.42	0.933

The demographic characteristics are altogether not significantly predictive for variation in self- and group efficacy (N = 545). However, looking at the individual characteristics, residents living on or adjacent to the dyke have a higher self- and group efficacy*.

The expected chance of flood risk can be accounted for by the demographic characteristics*** for 8.5% (N = 545). Being female***, or having a rented home** significantly predicts a higher expected chance of flood. Living on or adjacent to the dyke* predicts a lower expected chance of flood risk.

Agreeing that the authorities are fully responsible for flood safety can be accounted for by demographic characteristics** for 7.1% (N = 545). Significantly predictive for agreeing to this statement are not being an entrepreneur in the area* and being older*.

Propensity to ignore flood risk can be accounted for 6% by demographic characteristics* (N = 545). Significantly, residents who do not recreate in the area*, women*,

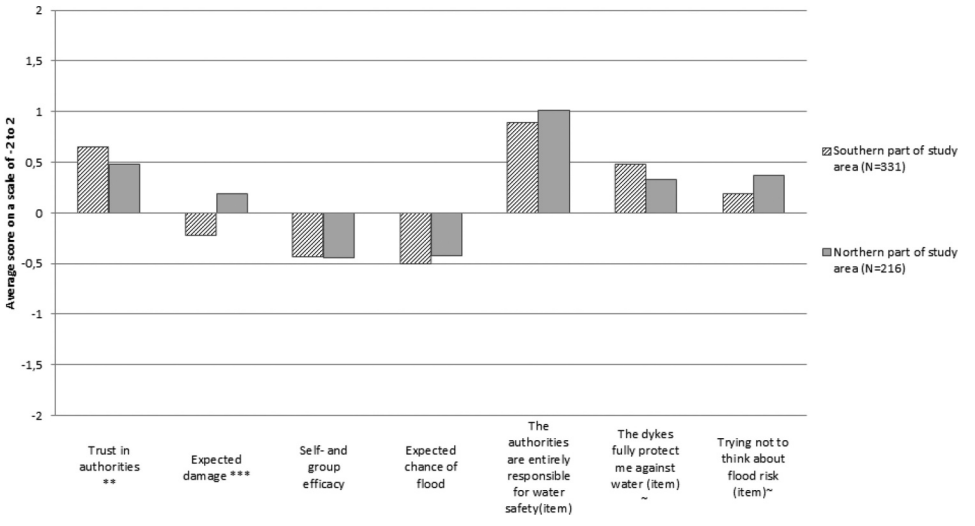

Figure 2. Differences in flood risk awareness between southern, not evacuated (N = 331) and northern, evacuated (N = 216) side of the study area.

residents with lower education** and residents with middle education* agree more with the statement that they try not to think about flood risk. It is noteworthy that our respondents are relatively highly educated. This may have introduced a bias in our results.

5.3. Does a higher self-efficacy predict lower flood risk perception (hypothesis 1)?

To test the hypothesis that self-efficacy predicts a lower flood risk perception, a regression analysis was performed. Other variables used as predictors were trust in authorities, group efficacy, agreeing that the authorities are fully responsible for flood protection and agreeing that the dykes fully protect against flood risk as predictors. The perceived self- and group efficacy influence flood risk perception. It does not significantly influence the expected chance of flood risk, but it does significantly influence expected damage.

Variances in expected chance of flood can be explained for 13.4% by these variables*** (N = 571). The self- and group efficacy is not significantly predictive for the expected chance of flood. Residents who agree that the authorities are fully responsible for protection against flood** and/or who do not think that the dykes fully protect against flood*** have a higher expected chance of flood. Also, a lack of trust in the responsible authorities significantly predicts a higher expected chance of flood***.

Variances in expected damage can be explained for 4.1% through these variables*** (N = 571). A lower self- and group efficacy* predicts a higher expected damage. Residents who do not think that dykes fully protect against flood*** expect more damage.

5.4. Does a higher sense of place predict lower flood risk perception (hypothesis 2)?

To test the hypothesis that a higher sense of place predicts lower flood risk perception, a regression analysis was performed (with all sense of place factors as predictors). We found that sense of place factors influence the expected chance of flood significantly**, and account for 2.4% of the variance. However, none of the sense of place factors is significantly predictive for the expected damage (N = 570). For higher expected chance of flood, only nature bonding is significantly predictive***. Respondents with a stronger bond with nature in the study area expect a higher chance of flood.

5.5. Do a higher sense of place and lower self-efficacy predict a higher propensity to ignore flood risk (hypothesis 3)?

To test this hypothesis, the relationship between sense of place, self-efficacy and propensity to ignore flood risk is analysed through a regression analysis (with all sense of place factors and self-and group efficacy as predictors). Variances in propensity to ignore flood risk can be explained for 3% (N = 570) by a combination of sense of place factors and efficacy**. Looking at these two concepts separately, only a lower self- and group efficacy* significantly predicts a higher attempt to ignore flood risk. Regarding sense of place, only a trend can be observed between a lower narrative bonding and a higher attempt to ignore flood risk.

Performing a regression analysis ($R^2 = 0.010$, N = 571) with agreeing with the statement that one tries not to think about flood risk as predictor for self- and group efficacy shows that propensity to ignore flood risk predicts a lower self- and group efficacy*.

5.6. Do residents who live in the north (evacuated in the 1990s) have a higher flood risk perception than those who live in the south (not evacuated) (hypothesis 4)?

The study area consists of two opposite sides of the river, only the northern side was evacuated in the 1990s. The near-flood experiences of residents are compared between the northern and southern side of the study area to test this hypothesis. It is noteworthy that there are also other (social-geographic and cultural) differences between the northern and southern part of the study area that were not included in this study.

5.6.1. Near flood experiences

The way these near floods were experienced significantly differs between the southern and northern part (see Figure 3 and supplementary data 1). Generally, respondents indicated they did not experience damage during the near floods. However, in comparison with their southern neighbours, people on the northern side more often indicated that they experienced emotional damage*** and had to work cleaning up afterwards***. They less often reported that they were prepared for high water levels* and less often reported that they expected that this could happen*. The residents on the northern side of the river report more confidence in the dykes*. Whereas the respondents are neutral towards the help of authorities during the near flood, they considerably agree with the

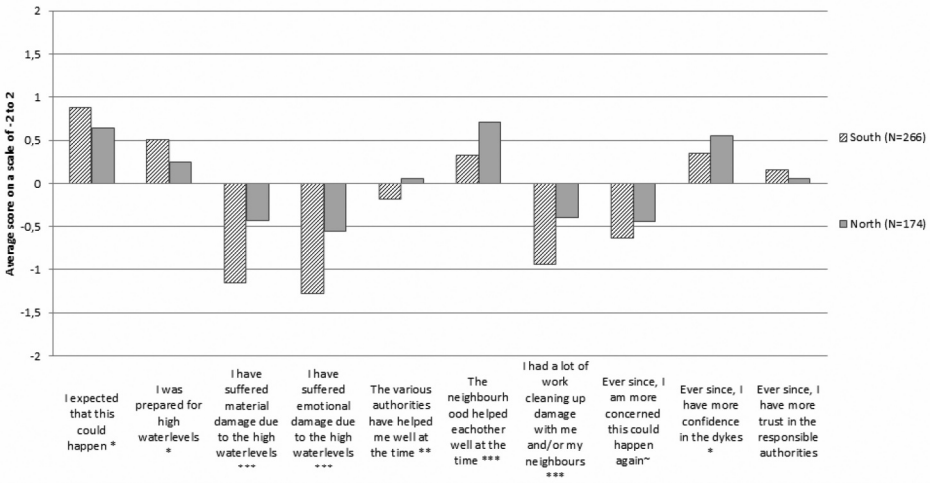

Figure 3. Difference in experiences of near flood between southern, not evacuated (N = 266) and northern, evacuated (N = 174) side of the study area.

statement that the neighbourhood helped each other well. The people on the evacuated side of the Meuse report they experienced more suitable help from authorities** and neighbours***. The trust either side has in the responsible authorities is similar, and the concern for new floods also does not differ between the two banks.

5.6.2. Difference in sense of place between northern and southern part of the study area

Of the sense of place dimensions, only narrative bonding differs between the northern and southern side of the Meuse. Statistically significant differences are found for sense of place between people who did or did not experience the near flood(s): those who experienced the near flood(s) report a higher level of place bonding** and social bonding** than those who did not (supplementary data 2; Figure 4). The results show

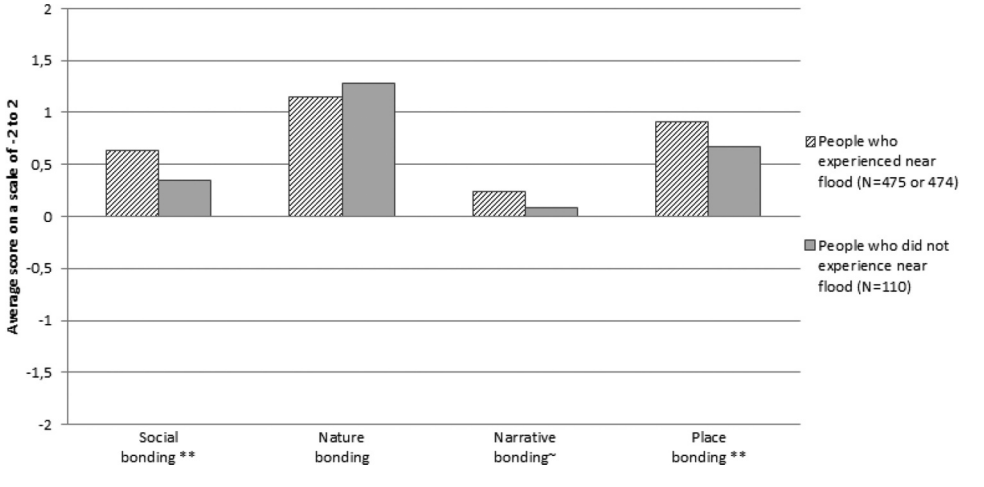

Figure 4. Difference in sense of place factors between people who did (N = 475 and for social bonding N = 474) and did not experience near floods (N = 110).

that social bonding is not significantly predicted by length of residence, but place bonding is*.

5.6.3. Influence of the collective or personal experience of near-flood on flood risk perception

Having experienced the near floods in the area significantly influences the expected damage, but not the expected chance of flood (supplementary data 3). People who did not endure the near floods expect more damage. Taking into account only residents who endured the near floods in the 1990s, differences can be found in flood risk perception between the residents living north and south of the river Meuse (supplementary data 4).

Considering residents who endured the near floods, residents south of the river expect less damage*** than residents north of the river. No difference is found in expected chance of a flood happening. Residents south of the river have more trust in the government** and their flood protection measures.

In the south, residents also agreed more with the statement that the dykes fully protect against water* than residents in the north. There is no difference in self- and group efficacy or in the question whether authorities are entirely responsible for water safety. Residents in the north are more willing to ignore flood risk*.

6. Discussion

In this chapter, our findings are summarized, discussed and reflected upon. First, we discuss adherence to the sense of place and flood risk perception factors (Section 6.1), while in Section 6 to 6.5 we discuss the hypotheses.

6.1. Sense of place and flood risk perception

The adherence to the sense of place factors (see Section 5.1) indicates that the residents have a strong bond with their residential area, especially through nature bonding and less through social and narrative bonding. This is similar to findings from another Dutch riverine area, though bonding to nature was found to be slightly weaker there (Verbrugge et al. 2017). Insight in sense of place or place attachment can be used in designing tailor-made participation which resonates with them and motivates to participate in local planning (Manzo and Perkins 2006; Verbrugge et al. 2019). Moreover, a strong sense of place, as we found in this case study, could be an opportunity for including residents in participation processes in integrated river restoration projects.

Attachment to place is both of positive and negative influence on flood risk perception (Bonaiuto et al. 2016). The low perceived chance of flood found in this study corresponds with other European research (e.g. Botzen et al. 2009; Bosschaart et al. 2013; de Boer et al. 2014). The damage our respondents expect is small in comparison to another Dutch study by Botzen and colleagues in 2009, but similar to results in, e.g. France (Rambonilaza et al. 2016). Dutch history with flood prevention has reduced residents' flood experience and their flood risk perception (de Boer et al. 2016). In other parts of the world the risk perception is considerably higher (Adelekan and Asiyanbi 2016; Bronfman et al. 2016), so caution is needed when transferring these results to non-western societies.

The results on residents' propensity to ignore flood risk are not very outspoken. Possibly, when people do not think there is a risk, there is nothing for them to ignore. We found a low score on self- and group efficacy, possibly resulting from being unfamiliar with possible actions one could take. The low levels of efficacy and perceived own responsibility may be a result of the high trust residents have in the authorities to deal with flood risk. Possibly, because residents trust they can rely on government, they feel less need to take precautionary measures themselves (de Boer et al. 2015). Residents' low perceived own responsibility is also found in other Dutch studies (e.g. Terpstra 2009) and could also result from their low flood risk perception: if people do not think they are personally at risk, they may not feel the need to take action (Terpstra 2009). Another explanation could be the low efficacy (i.e. one does not take any responsibility because one believe he/she is not able to influence the risk). Acknowledging risk perception is important for effective risk communication. Also, the heterogeneity within residents' risk perception is important to address as it is not effective to approach all residents with the same message (Kellens et al. 2013). It must be noted that in this study flood risk perception is likely affected by the current investigation into dyke enhancement on the southern side. This could have resulted in a higher flood risk perception since residents might have become more aware of the fact that the dyke does not meet the new safety norms. Alternatively, it could have decreased flood risk perception since residents witness the government investing in flood safety, reflecting the high agreement among residents that the government is fully responsibly and their high trust in the governmental bodies regarding flood protection.

6.2. Does a higher self-efficacy predict lower flood risk perception (hypothesis 1)?

We partially accept the hypothesis: self-efficacy does not predict the expected chance of flood, but a lower self-efficacy might predict a higher expected damage. This can be explained because residents cannot prevent a potential flood but are able to mitigate damage. In their review, Bubeck et al. (2012) state that the relationship between flood risk perception (expected chance and expected damage) and mitigation behaviour is often not empirically validated. Lemée et al. (2019) demonstrate that the relationship between risk perception and active coping (i.e. taking measures to reduce or master the risk) is direct and not influenced by self-efficacy. Our results indicate that the lack of empirical proof for this direct relationship could be because self-efficacy and mitigation behaviour influence damage control and thus expected damage of flood, and not the probability of flood.

6.3. Does a higher sense of place predict lower flood risk perception (hypothesis 2)?

With the exception of nature bonding, we contradict our hypothesis and findings from previous studies (e.g. Peng et al. 2017) that a higher sense of place predicts lower flood risk perception. Possibly, residents with a stronger connection to nature recognize natures' and the river dynamics, fluctuations and potential force. The other dimensions of sense of place possibly influence the willingness of residents to accept certain risks, but does not alter risk perception as much as other (moderating) factors. For instance, in our study gender proved predictive for expected damage and chance of flood. Also, the slight overrepresentation of men could give a bias in the results. Another methodological

explanation could be the relatively large standard deviation and thus large variance in adherence to the factors. Bonaiuto et al. (2016) conclude in their review that there are both positive and negative relations between place attachment and risk perception.

6.4. Do a higher sense of place and lower self-efficacy predict a higher propensity to ignore flood risk (hypothesis 3)?

We partly accept this hypothesis: propensity to ignore flood risk is not influenced by sense of place, but residents with a lower self-efficacy are more inclined to ignore possible flood risk. A lower self-efficacy could lead to feeling powerless, resulting in a propensity to ignore the risk. As low self- and group efficacy not only predicts a higher propensity to ignore flood risk, but also a higher expectation of damage (Section 5.3), propensity to ignore flood risk could be a passive coping mechanism. Possibly, anxiety towards the risk is a crucial variable in passive coping strategies (such as propensity to ignore flood risk), in which place identity is a moderator (Lemée et al. 2019). Another possibility could be that residents who do not think about flood risk do not contemplate the potential influence and control they have in protecting themselves against the consequences of a potential flood.

6.5. Do residents who live in the north (evacuated in the 1990s) have a higher flood risk perception than those who live in the south (not evacuated) (hypothesis 4)?

As is described in the study context, the study area almost flooded in 1993 and 1995, and the northern part was even evacuated in 1995. Other studies (e.g. Zaalberg et al. 2009) show that flood risk experience not only increases expected consequences, but also perceived vulnerability. In addition to testing the hypothesis, the experiences of these near floods are compared between the northern and southern side of the study area.

People from the northern side of the Meuse report having experienced more (emotional) damage, possibly because they were evacuated. They also indicate that they were less prepared for the high water levels and had not expected the events of 1995. Possibly, this is because the threat on northern side was more serious than on the southern side and therefore they could have been more surprised by the situation. The residents north of the Meuse have more confidence in the dykes, which could be a result of the near-flood not being as disastrous as anticipated.

6.5.1. Difference in sense of place between northern and southern part of the study area

Sense of place only differs concerning narrative bonding, which is higher in the northern part of the study area than in the southern part. In relation to flood risk perception, this could be explained by all the stories about the 1995 evacuation the southern side lacks. Residents experiencing the near floods have a higher social bonding and place bonding. Enduring an event like that with a group of people could tighten the social bonds and the bond to the area where that happened. However, since it happened more than 20 years

ago this result could be biased because people who experienced the near floods might also have a longer time of residence which could increase sense of place.

6.5.2. Influence of the collective or personal experience of near-flood on flood risk perception

People who experienced near floods (both south and north of the river), expect less damage than residents who did not. A possible explanation could be that the evacuation was not necessary in hindsight and the water levels and the damage were lower than anticipated. Perhaps residents feel that if this is the worst that can happen, it is still quite manageable.

When considering only residents who endured the near floods, residents in the evacuated part of the study area expect more damage. During the evacuation, residents probably realized the amount of (possible) damage caused by only the evacuation, let alone the amount of damage that can be expected during an actual flood. As residents north of the river have less trust in the government and their flood protection measures, the evacuation perhaps also reduced the trust residents have in the authorities since authorities overestimated the near floods by unnecessarily evacuating. Possibly residents have a different coping mechanism after an evacuation, as residents in the north are more willing to ignore flood risk.

We partially accept our hypothesis: the perceived flood risk is different between residents who experienced flood and residents who did not, and between residents living north or south of the Meuse. But in both cases, only expected damage is significantly different, but expected chance is not.

7. Implications

Despite the extensive body of empirical research on risk perception, the relationships between sense of place, self-efficacy and flood risk perception are still scarcely explored. In a Dutch river restoration project, we studied residents' flood risk perception, sense of place and self-efficacy as these perceptions have implications for public participation, which is essential in integrated river management. We believe two issues raised in the discussion require further attention. First, we encourage future research to study the relationship between risk perception and sense of place and the underlying mechanisms elaborately, for example, to see if this relationship could be mediated by willingness to accept flood risk. Second, as we conclude that residents with a low self-efficacy are more willing to ignore flood risk, we suggest to investigate if this could be linked to the low flood risk perception found in this study and in the Netherlands in general.

From our study, several implications follow for public participation in river restoration as an integrative approach. First of all, in communication and participation, one should take notice of the low-risk perception and low perceived own responsibility, especially when considering the high trust residents have in the government taking its responsibility. In participation and communication processes in river restoration, risk perception could be anticipated to increase the perceived responsibility and perceived need to take flood-protecting measures. Since expected flood chance and self- and group efficacy are not significantly related, but self- and group efficacy and expected damage are,

communication could focus on informing on the kind of damage that can be expected and how this can be prevented.

However, a major downside is that emphasizing the risks could cause unnecessary fear among residents, especially if a low flood risk perception stems from a feeling of powerlessness. Another way to enhance residents' perceived responsibility and efficacy without frightening them could be through narrative bonding. By sharing stories about the cultural history of a flood-prone area, and bring youngsters and new residents into contact with residents with flood experience, the propensity to ignore flood risk might decrease by being more familiar with the history and the stories about it. With a lower attempt to ignore flood risks, residents might reflect on their self-efficacy and be more receptive to get informed on ways to mitigate flood damage. This could further stimulate their perceived responsibility. Studying the social aspects, such as flood risk perception and how this is linked to the relationships residents have with the area and their perceived influence in flood protection, could thus benefit integrated river restoration projects.

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No potential conflict of interest was reported by the authors.

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