Flood risk perception: a case study in Dordrecht

(Own source)

Astrid Herwig
S2580624
June 2017

Supervisor
H. Höckner

Thesis Technische Planologie

university of groningen
faculty of spatial sciences

Abstract
Due to climate change the chance of a flood rises. This results in a rising sea-level and intense precipitation. Many cities struggle with these changes, among which is Dordrecht, a city in South Holland. Statistically speaking Dordrecht has a flood once every 2000 years, making it one of the riskiest areas in the Netherlands. Due to the higher flood risk because of the threats, cities should become more resilient by minimalizing the consequences of a flood. To become more resilient awareness must be created. Awareness of flood risk can change when the perception of flood risk becomes different. The perception of flood risk is linked to four different factors: cognitive factors, risk factors, socio-demographic factors and context factors. This paper focusses on the socio-demographic factors and tries to answer the following question: In what way is there a difference in the perception of flood risk of citizens with different socio-demographic backgrounds compared to the actual flood risk in Dordrecht? The case study of Dordrecht tries to illustrate what kind of effect different socio-economic factors have on the perception of flood risk and which factors change the perception of flood risk. The case study suggests that the examined socio-demographic factors, age, gender and level of education do not affect the perception, which is contrary to the literature found on this subject. The citizens of Dordrecht have partly an inaccurate perception of floods. The speed of the water approaching the city in case of a flood was overestimated and underestimated by 70,2% of the citizens. The height of the water in case of a flood was guessed too high or too low by 85% of the citizens. A wrong perception of flood risk could be dangerous in case of a flood. These results indicate that the perception of flood risk of the citizens of Dordrecht needs to be changed to become a more resilient city.

Abbreviations

CBS	Centraal Bureau voor de Statistiek
HBO	Hoger beroepsonderwijs
NAP	Normaal Amsterdams Peil
MBO	Middelbaar beroepsonderwijs
OECD	Organisation for Economic Cooperation and Development
PBL	Planbureau voor de Leefomgeving
UNISDR	United Nations Office for Disaster Risk Reduction
WO	Wetenschappelijk onderwijs

Table of contents

1. An Introduction to flood risk perception

The Dutch history with floods influenced the water management in the Netherlands. The big flood in 1953 which began with by a dike breach caused many deaths and resulted in a big infrastructure project: The Delta Works (Van der Geest et al., 2008). The Delta Works resulted in a smaller risk of death due to flooding. As a result of the absence of great floods after 1953 the sense of security increased (OECD, 2014). Due to climate change the sea level rises and more heavy rainfall will occur, which causes a higher risk of flooding (Restemeyer et al, 2015). Another problem is the ongoing development in economically important areas even though there is an increasing chance of flooding. The economic impact of a flood will be higher in economically growing areas, like in cities for example (Zevenbergen et al., 2008).

Due to the higher flood risk a more resilient approach is needed. A resilient approach considers there is possibility a flood occurs, which chance recently increased due to the higher flood risk. Resilience has as a goal to minimalize the consequences of a flood in contrast to the traditional resistance strategy. The traditional approach aims to prevent flooding by physical prevention of floods, like rising the embankments (Restemeyer et al., 2015). Resilience had a more physical meaning, but over the years the concept changed to a broader meaning state Restemeyer et al. (2015). Resilience is according to Restemeyer et al. (2015, p. 46) now more commonly “applied to ecology (Holling, 1973, 1996) as well as to the social sciences”. The risk management approaches are more centered around the damage which could be caused by flood hazards than the traditional approaches.

In case of a flood citizens should know how to react to reduce casualties and damage to possessions. Urban areas must adapt to these changes and citizens need to be aware of the flood risks. Raising awareness affects the resilience of communities (Restemeyer et al, 2015) and therefore the resilience of a city. According to Działek et al. (2013) different communities with different socio-demographic backgrounds (for example: age or education level) perceive the chance of flooding, ways to reduce risks or damage also differently. This means different communities need different approaches to make them aware of flood risk. Creating awareness is crucial to change someone’s behavior or attitude towards flood risk (Restemeyer et al, 2015).

The flood risk management in the Netherlands has impact on the citizens. It is expected citizens have prepared themselves in case a flood takes place. Also, citizens should take measures and evacuate in a proper way (De Wit, 2009). It is unknown how active the average citizen is, what is expected from citizens and what their perspective on flood risk is. Even though the Dutch have a long water history the OECD (2014) is of the opinion in a report about the future water policy that the Dutch citizens are not aware enough about the possible flood risks. In the report, it is described how the citizens do not have the feeling they need to participate as flood risk is more a problem of the government. This could result in wrong estimations by citizens of flood risk which could lead to great consequences. According to the OECD (2014) the awareness gap is one of the most difficult jobs of the Dutch water policy. Public participation could involve people in the decision making. According to Wachinger et al. (2012), participation results in raising the awareness, which could result in citizens taking more measures. This could protect them and therefore lower the casualties in case of flooding.

Dordrecht is a special case compared to the rest of the Netherlands. The dike ring area Island of Dordrecht is enclosed by rivers and is due to the flood risk perceived as one of the riskiest areas in the Netherlands according to Planbureau voor de Leefomgeving (2017). In this area 100.000 people could be affected by a flood including a damage of 5 billion euro if a breach in the dike in the east of Dordrecht will occur and flood the whole city (UNISDR, 2014) The probability of exceedance of the water level is once per 2.000 years in Dordrecht (Hoss et al., 2013). Climate change will only reinforce the problems according to urban planners of Dordrecht, but they do not actively recognize the impacts of climate change (Runhaar et al. 2012). The municipality of Dordrecht shows how high water is common in Dordrecht. In the past, there was always a chance of flooding in Dordrecht. In 1421, the Sint Elisabethsvloed made sixteen villages disappear around Dordrecht and made Dordrecht an island. Floods were common for the citizens in the past, most of the times there were no victims, but only damage to buildings and agriculture. The past forty years dozens of times water was on the embankment of the city center of Dordrecht and reached. The water reached more than two meters above NAP (Normaal Amsterdams Peil) (Gemeente Dordrecht, 2017a). Dordrecht is suitable for this case study, because of its long history with flooding and the fact there is still a great chance of flooding. The perspective of the citizens of Dordrecht could be very different than the perspective of other cities because of the unusual history of Dordrecht, which makes this an interesting case study.

Due to climate change, crowded cities and the reduced awareness of citizens since 1953, many problems with water arose for urban planners. As the Netherlands has this long history with floods, it is important to build resilient cities to deal with these problems. Especially Dordrecht, due to its vulnerable position, cannot ignore this problem. The resilience of a city can be influenced by changing the attitude and behavior towards flood risk of citizens, which is influenced by the awareness (Restemeyer et al., 2015). Creating awareness can thus create a more resilient city. First, to change the awareness, it must become clear what the current perception is. Afterwards a fitting way can be found to change the perception if this is necessary. According to Działek et al. (2013) creating a resilient community can be done by implementing collaborative strategies. Therefore, a full image of the community and thus the community's perception is needed. This research aims to give insight in the perception of flood risk of citizens. With this information, a more resilient community can be created in Dordrecht. This results in the following main research question: *In what way is there a difference in the perception of flood risk of citizens with different socio-demographic backgrounds compared to the actual flood risk in Dordrecht?* In the end, this research also clarifies what influences people's perception. This will make a base to explore what possible ways there are to change citizens perception of flood risk for future research. Eventually, this research advises how to consider different backgrounds and how to change the perception of citizens. It contributes to a more resilient approach to make citizens aware of flood risk. Thus, the following sub questions are answered: *Do different socio-demographic backgrounds of citizens change their perception of flood risk? What kind of factors change the perception of flood risk of citizens? How well can citizens predict the flood risk in their area? Are citizens willing to change their perception of flood risk?* The last sub question is of importance because it shows if citizens with little awareness are willing to change their perception. The reason Dordrecht is chosen is because of their history with water damage and its still vulnerable position.

In chapter 2 the theoretical background is discussed, which consists of explanations about the perception of flood risk, resilience, the multilayered safety approach and social capacity. In this chapter, an overview is created. In chapter 3, the methodology of the research is explained and thus the methods of data collection and the methods to analyses the data. In the analyses, chapter 4, the data is examined and discussed. In the last chapter, chapter 5, the results are discussed and the main question and the sub questions are answered. Furthermore, recommendations are given for further research.

2. Theoretical background

2.1 Introduction

According to Pieterse et al. (2009) flood risk can be divided in three groups: the chance of a flood, the vulnerability of an area and the exposure of the area to the flood. Vulnerability is for example the value of the objects and the amount of people in the area. Exposure is the runoff, the rising speed of the water and the height of the area. These factors determine the intensity of the flood (Pieterse et al., 2009). Planbureau voor de Leefomgeving (2017), a Dutch institute in the field of space, nature and environment focusing on strategic policy analyzes, indicates that the safety standards range from 1:250 till 1:10.000 in the Netherlands. The flood risk in Dordrecht, the probability of exceedance of the water level, is once per 2.000 years (Hoss et al., 2013). According to Hoss et al. (2013), the dike ring area of central Holland has a flood risk of 1:10.000, which is a smaller chance than in the dike ring area of Dordrecht (1:2.000). This indicates the big differences between areas in the Netherlands. According to PBL (2017), Planbureau voor de Leefomgeving, Dordrecht is one of the areas most at risk in the Netherlands. The average life expectancy of a Dutch citizen born in 2017 is around 79 years (CBS, 2017), therefore a citizen's chance to experience a flood is 3,95% in their lifetime. To protect the citizens from this threat, more awareness must be created. Raising awareness affects the resilience of communities (Restemeyer et al., 2015). Resilience will be discussed in chapter 2.2. If citizens do not perceive an area with flood risk as dangerous or only expects the government to protect them, a person becomes more vulnerable. For this reason, the perception of flood risks of citizens is important to know as the perception of flood risk has impact on the vulnerability of a person. Knieling et al. (2009) state that casualties and damage to belongings can be reduced if citizens are well-informed. Awareness and perception go hand in hand and cannot be seen separately. Playing an important role in creating awareness are universities, schools, media and family (Rydén et al., 2003). Understanding the risk perception of citizens threatened by flood risk is important for policy and decision making.

2.2 Resilient city

Restemeyer et al. (2015) distinguishes three characteristics for resilience that could be applied on a resilient city:

- Robustness: Reduce the chance of a flood.
- Adaptability: Minimalize the exposure.
- Transformability: 'Foster societal change' (Restemeyer et al., 2015, p. 49).

Robustness is the way an area, in this case Dordrecht, can withstand a flood event, by having strong water protection systems, like dikes. Adaptability can be interpreted as the adjustment of an area, which reduces the damage in case of flooding. Transformability, the last one, is the change in the idea from 'fight the water' to 'live with the water'. According to this idea, projects should be more involved with the water and water should be implemented in an adaptive manner. This contrasts with the old water policies, which mostly only focusses on withholding the water. According to Restemeyer et al. (2015) transformability fosters societal change by raising awareness and risk communication to change the attitude and behavior towards flood risk. This reduces the vulnerability of a community, by making the citizens more involved, by increasing the knowledge of citizens and informing citizens about flood risk. Raising the awareness has impact on robustness and adaptability, because before implementing measures, responsibility must be created. Citizens are more willing to invest in flood risk measures if the awareness is high and if the social capital is good (Restemeyer et al., 2015).

Multilayered safety approach (Meerlaagsveiligheid) consists of three layers (figure 1) that increase together the safety of citizens and reduce the damage that could be done by floods (Atelier GroenBlauw, 2015). This approach is a part of flood risk management. The multilayered safety approach could be compared to resilience of Restemeyer et al. (2015). The first layer focusses on the prevention of floods by dikes and dunes, thus could be seen as robustness as defined by Restemeyer et al. (2015). The second layer includes sustainable spatial planning and can be compared to adaptability as defined by Restemeyer et al. (2015), because they both try to minimalize the exposure. The third layer focusses on disaster management. Disaster management becomes important in case a flood appears. Disaster management tries to reduce the damage to objects and casualties among the citizens by providing them with information beforehand and by creating disaster and evacuation plans (Atelier GroenBlauw, 2015). Disaster management has the most in common with transformability (Restemeyer et al., 2015). All the layers are important to become more resilient. Citizens cooperate differently in every layer and the level of participation depends on their awareness of flood risk. Eventually all the three layers combined result in a resilient city.

Figure 1: Multilayered safety approach (Gemeente Dordrecht, 2017b).

2.3 Perception flood risk

It is difficult to define the perception of flood risk of citizens because many factors play a role. A numerical value like an exceedance of the water level once per 2.000 years often do not apply in risk perception, as people estimate risks every day without models or graphs and is described as a pre-scientific process (Samuels, P. and Gouldby, B., 2009). Experience, intuition, expectations, values, attitudes, knowledge and feelings play a part in how citizens perceive flood risks (Samuels, P. and Gouldby, B., 2009; Wachinger & Renn, 2010). There is no perfect model for risk perception as it is hard to figure out how perception is applied in the real world. Wachinger & Renn (2010) distinguish four factors of risk perception:

- **Risk factors** were defined as how a hazard is perceived or experienced. This is what is researched in the thesis.
- **Informational factors** are the ‘source and level of information’.
- **Personal factors** are mostly the characters of a person, like age, gender, educational level, involvement.
- **Context factors** are not related to the personal factors, for example economic situation, were the house is situated, family status of a person. Also, social capacity is part of the context factors.

Another explanation is done by van der Linden (2015) in a model made for the perception of citizens on flood risk and climate change. Van der Linden (2015) argues that this model explains around 70% of the flood risk perception of a person. The model is similar to the model of Wachinger & Renn (2010). The following factors in the model of van der Linden (2015) are used:

- **Cognitive factors**, which includes mostly the knowledge of flood risk.
- **Experience**, especially personal experience and how a citizen emotionally judge
- **Social demographic factors** include for example age, gender and education level.
- **Social cultural factors** norms and values

In this research 'personal factors' corresponds with socio-demographic background and it is for that reason important for the research. Experience is a part of the risk factor; therefore, risk factor is more of importance. If comparing both models, the cognitive factors seem to be more of interest than information factors. Because the focus lies in case of the cognitive factors more on the knowledge of the citizen than the government and the available information (informational factors). Context and social cultural factors do have a resemblance as norms and values are projected in the context people are living in. For this research context factors are better to use as norms and values are difficult to define. Combining the two models results in the next factors which are fundamental for the research:

- Cognitive factors
- Risk factors
- Socio-demographic factors
- Context factors.

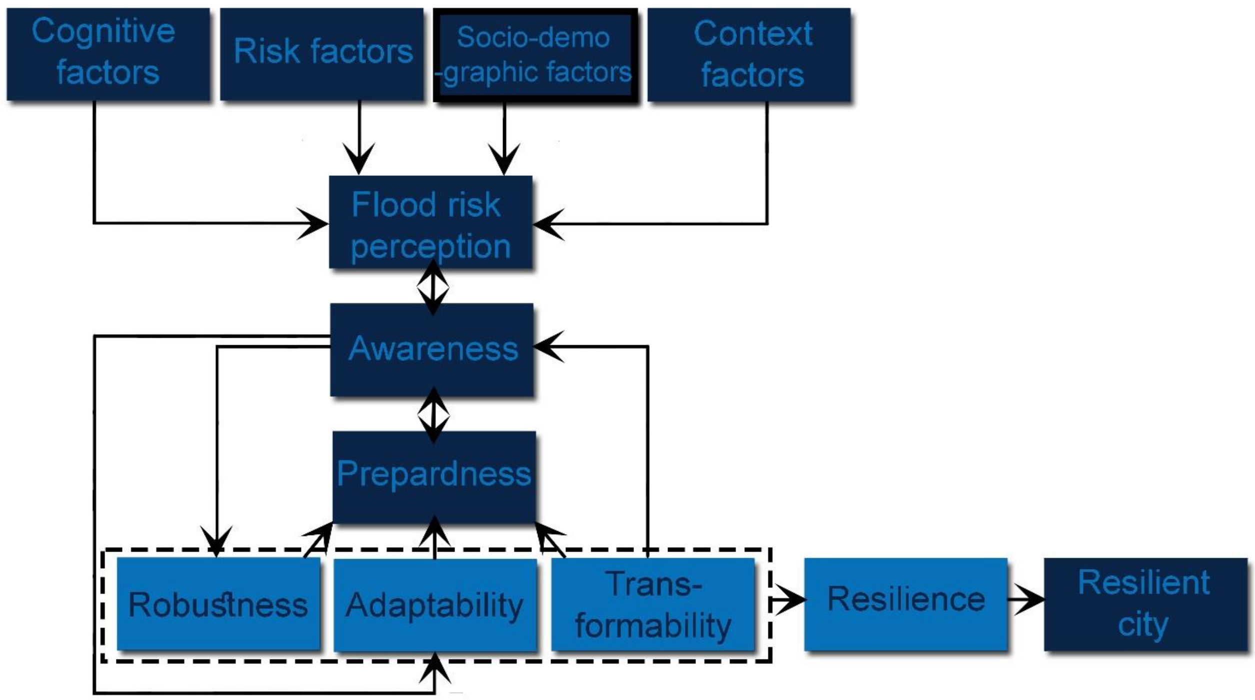
2.4 Social capacity

Działek et al. (2013) focus on keywords like: social capacity and flood affected areas. The social aspect is divided in five social capacities: knowledge, motivational, network, economic and governance capacities and can be divided in levels (individuals, organizations, communities). A more resilient community can be formed by implementing collaborative strategies and therefore recognizing lacks in different kinds of abilities and recourses is important (Działek et al., 2013; Kuhlicke et al., 2011). Consequently, these five social capacities are important as they are guidelines of what must be examined to get a full image of a community. This research mostly focusses on knowledge and governance capacities.

2.5 Conceptual model

Due to climate change and the spatial planning in economical important areas, a more resilient city should be developed in order to deal with the threat of the water. The theories already described are shown in the conceptual model in figure 2. The light blue part shows the theory of Restemeyer et al. (2015). Restemeyer et al. (2015) distinguishes three factors for resilience that could be applied on a resilient city. To call a city resilient, the city must become more robust, adaptive and transformable and thus must be better protected against floods. This results in more preparedness (dark blue box) in case of flood risk. To make citizens more prepared, awareness must be created, which can eventually result in a change of behavior. Awareness influences the preparedness, because citizens who are more aware and well-informed about flood risk are better prepared, which reduces casualties and damage to citizens' belongings. This works both ways as better prepared citizens are more aware of flood risk. Transformability influence the awareness, due to the fact transformability exist of 'risk communication and awareness raising' (Restemeyer et al., 2015, p. 49). The awareness affects the robustness and adaptability, because before implementing measures, responsibility must be created by awareness. Influencing the awareness can change the perception on flood risk. Factors changing the perception are: cognitive factors, risk factors, socio-demographic factors and context factors. The socio-demographic factors are important for the research, because the research especially focusses on this factor. To indicate the socio-demographic factor is important, the factor has a black border around it in the conceptual model. The perception can change if one of the factors changes in the model, because all the factors are connected to each other. Change can be created by transformations in the experience a person already had (risk factor) or the knowledge a person has about the subject. To change an individual's perception the cognitive factors, risk factors, socio-demographic factors and context factors should be altered. Działek et al. (2013) confirm this and state: different communities with different socio-demographic backgrounds, like age, education level and the time living in the affected area, perceive the change of floods, ways to reduce risk or damage also differently. Because of this research the next hypothesis is created: *Different socio-demographic backgrounds results in different perceptions of flood risk in Dordrecht than the actual flood risk.* The research mostly focusses on the different factors of the socio-demographic background, like age and level of education. According to Wachinger & Renn (2010) and van der Linden (2015) these factors could change the perception of flood risk.

Figure 2: Conceptual model based on Restemeyer et al. (2015); Wachinger & Renn (2010); Van der Linden (2015).



3. Methodology

First, the fundamental knowledge about flood risk perception was researched in the theoretical background, which resulted in a conceptual model. The received information is implemented in the further research, including finding the primary data (Clifford et al., 2010) on the Island of Dordrecht. A quantitative research method is used in this research. This resulted in the following research approach: face-to-face surveys and online surveys. The survey was performed on the Island of Dordrecht and therefore only citizens living in this area are approached. To find out if there is any relationship between the socio-demographic background of citizens and their perception of flood risk the primary data is afterwards processed in a statistical test. The main question and sub questions will be answered by combining the theory and the research in the upcoming chapters. The main question is as follows: *In what way is there a difference in the perception of flood risk of citizens with different socio-demographic backgrounds compared to the actual flood risk in Dordrecht?* Furthermore, the sub questions originating from the main question are answered: *Do different socio-demographic backgrounds of citizens change their perception of flood risk? What kind of factors change the perception of flood risk of citizens? How well can citizens predict the flood risk in their area? Are citizens willing to change their perception of flood risk?*

3.1 Data collection: survey

There are two possible ways to research the question in science: qualitative and quantitative research (Clifford et al., 2010; Creswell, 2014). Creswell (2014) also noted that there are many ways to collect data. Qualitive research is subjective and is done with a small amount of people. Quantitative research, identified as objective, is performed on a bigger scale and the data is tested by statistic tests (Clifford et al., 2010; Creswell, 2014). To demonstrate that there is indeed a difference in perception it must be statistically proven by statistical tests, therefore quantitative research is performed. According to Wachinger & Renn (2010) the socio-demographic background of a citizen can influence the perception. The socio-demographic background consists of age, gender and education level and are objective. This means it could be researched with a quantitative method: a survey. In the research, it is interesting what moves certain people to an answer. In an interview, it is possible to hear the opinions and motivations for certain answers. Since there was a short amount of time available for both surveys and interviews, the research focusses on surveys. The following research approaches are used: a face-to-face survey and an online survey. The face-to-face survey and the online survey are both a quantitative approach, as the data is numeric or can be transformed in useable statistics (Creswell, 2014). The face-to-face survey seems to have some qualitative elements in it, as it is possible to acquire some extra information, like opinions and motivations of the respondents. A face-to-face survey resemble somewhat an interview, but it is qualified as a quantitative research method. Therefore, a quantitative research method is used in this research (Clifford et al., 2010).

The survey consists of four parts based on the factors which influences the flood risk perception (Wachinger & Renn, 2010). The first part consists of simple questions about the personal factors of the citizen. The questions are about their socio-demographic background and consist of the age, gender and education. The second part is based on the context factors and is about the residence of the person. The context factors indicate were and how the respondent lives and for how long. The context factors compared to the perception of the citizens can show if the context factors influence the perception. The context factors questions can be compared to the socio-demographic factors question to see if there is a difference between the different flood risk perception factors as described by Wachinger & Renn (2010). The third part tries to figure out the perception of flood risk of a citizen, the risk factors. A flood risk of 1:2.000 is a vague number, which is hard to explain. The perception is therefore measured on a Likert scale. In this way, they can indicate how they perceive flood risk, for example by indicating how often they are worried about flood risk or in what kind of speed the water rises in case of a flood. In the last part of the survey, cognitive factors are used to discover if the respondents are willing to become more aware of flood risk and change their perception. Also, it tries to discover if citizens are already active by participating in flood risk activities or by taking measures at their residence. These citizens are more aware of flood risk. The cognitive and risk factors are mainly used to get an overview of the perception of flood risk of the citizens of Dordrecht.

3.1.1 Face-to-face survey

A face-to-face survey is a relative short personal interview at the respondent's location (Doyle, 2005). The face-to-face method is a scientific credible and validate research because of all the benefits. The following benefits are there for a face-to-face survey according to Doyle (2005) and O'leary (2004):

- The interviewer could clarify extra questions of the respondent
- The interviewer could establish rapport, build trust and motivate the respondent
- The interviewer can record the answers and read body language
- People with difficulty with email (or social media) could be reached
- The length of the interview is shorter, which result in more people allowing to be interviewed
- More questions could be asked
- Extra answers can be written down and used

Maybe the most important benefit mentioned by Doyle (2005) is the fact that the respondents rate is much bigger than if you have a telephone interview or an internet survey. The disadvantage is for the researcher as the researcher must go to the location and travel around questioning people, which takes a serious amount of time and money (O'leary, 2004). Fowler and Floyd (2014) note another disadvantage: people are less willing to give personal information in an interview. Also, the interviewer could ask questions in a way that it pushes the respondent to a certain direction (Clifford et al., 2010). This last point must be kept in mind while doing the interview.

Eventually by asking the extra questions more qualitative data was collected, which is the goal of doing a face-to-face survey. As it took on average more time to do a face-to-face survey an internet survey was made available on social media. With social media, more data could be collected, which especially includes quantitative data. The face-to-face surveys have been held in the northern part of the dike ring area Island of Dordrecht, in other words: the city of Dordrecht, as there are the problems as explained in chapter 2 and it is the most inhabited area with the biggest risk of flooding (Rijksoverheid, 2015; Gemeente Dordrecht, 2009). The surveys were collected at supermarkets and shopping streets on different parts of the day on Sunday the 23rd of March and Saturday the 6th of May 2017. These days are chosen as it is busier in the city center at weekends. The face-to-face survey used convenience sampling because it depends on who walks by, is interested and suitable to take the oral survey (Moore & McCabe, 2006).

3.1.2 Internet survey

Surveys with the same questions as the face-to-face survey were posted on social media: Facebook. This, together with the surveys taken on the street, created a higher response rate (Fowler & Floyd, 2014). The answers were both qualitative and quantitative, because the answers were based on opinions (for example: perception) and on facts (for example: year of birth) (Clifford et al., 2010; Creswell, 2014). It was expected that the surveys on the computer result in more personal information being received as respondents feel more comfortable to give personal information on computers (Fowler & Floyd, 2014). For online surveys, it is hard to determine how many respondents will fill in the form (Hesse-Biber and Johnson, 2015). The disadvantage of this research was that mostly young people use social media, which results in less information of older people (Doyle, 2015).

The internet-survey was made after the first face-to-face survey in Dordrecht. The internet-survey answer options were partly based on the answers collected during the first face-to-face surveys. During the face-to-face survey, it was easier to ask extra questions to get some more information, but during an internet survey that was impossible. Therefore, there was chosen for already existing answer options for some questions, which made it for the respondents on the internet more attractive to take the survey.

During the face-to-face surveys on the street there was also a chance that a person did not have time for a face-to-face survey. Due to this reason papers were distributed with the link and the QR-code for the online survey. To make people more interested in the survey, three prizes of 10 euro were divided between the respondents. After the survey, there was a possibility for the respondent to fill in their email and by doing this getting a chance to win one of the prizes. This approach was chosen as the respondents for the survey were low in the beginning. There seemed to be a rise in the number of respondents after the prize was announced on Facebook, which indicated there was a positive effect of the prizes on the number of respondents.

3.3 Case: Island of Dordrecht

De Rijksoverheid (2015) is concerned about the Drechtsteden, a region in the province of South Holland existing of Dordrecht, Alblasserdam, Papendrecht, Hendrik-Ido-Ambacht, Sliedrecht and Zwijndrecht. They try to find spatial solutions for the exceeded safety standards in these cities. According to the Rijksoverheid (2015) the upper part of the Island of Dordrecht in South Holland (figure 3 & 4), half of the city of Dordrecht, is in danger of flooding. It is predicted that in case of a flood the water will rapidly approach the parts of Dordrecht that are normally not covered in water. The Rijksoverheid (2015) also expects the water level to be high in case of flooding. These are most dangerous floods, which could lead to the most damage (Rijksoverheid, 2015).

Figure 3: Dordrecht suited in the Netherlands (own source).

In the Waterplan of Dordrecht (Gemeente Dordrecht, 2009), the oldest trading city of Holland, the municipality emphasizes how important it is that they protect themselves from water and at the same time become a resilient city. The Island of Dordrecht is enclosed by four rivers: Nieuwe Merde, Beneden Merwede, Oude Maas and the Dortsche Kil and therefore an extra dangerous zone. Climate change is one of the municipality of Dordrecht greatest fears according to the Waterplan of Dordrecht.

Figure 4: The Island of Dordrecht and the city of Dordrecht (Waterplan Dordrecht, 2009).

In figure 5 (Waterplan Dordrecht, 2009) it is possible to see how the elevation in the northern part is much lower. This is a densely-populated area as seen in figure 4. The center of the city is almost everywhere lower than 4 meters below NAP (figure 5). The rest of the city is at least lower than 1 meter below NAP, except the roads.

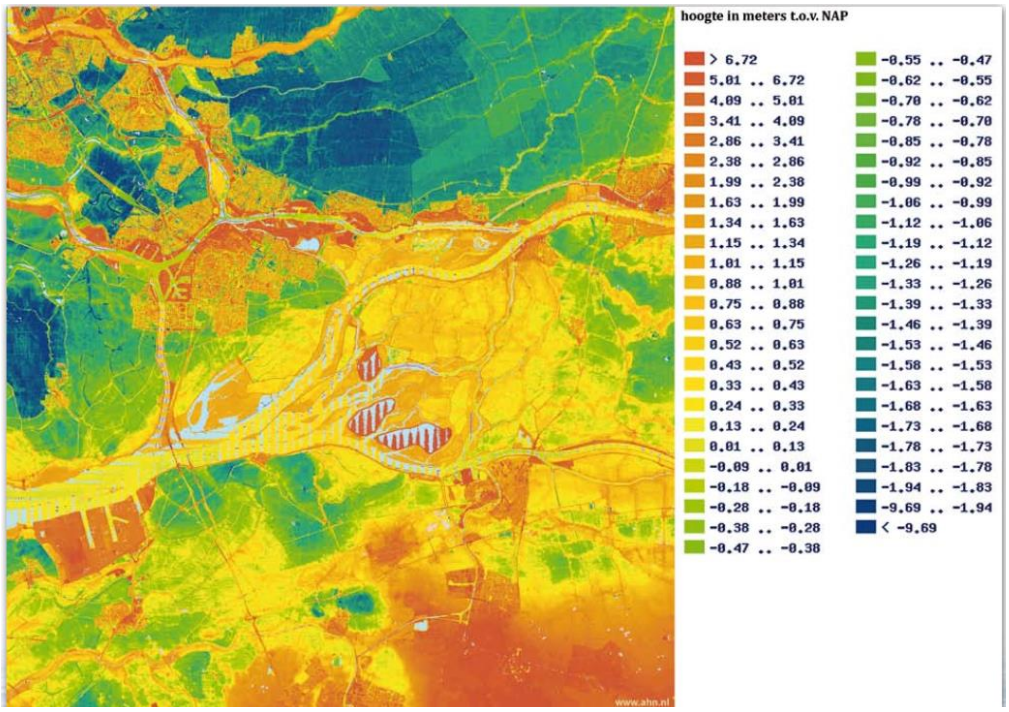


Figure 5: Elevation map of the Island of Dordrecht (Gemeente Dordrecht, 2009).

3.4 Analyzing results

The test which is used depends on the amount of surveys received and if the answers are nominal, ordinal or binary (Moore & McCabe, 2006). Analyzing the result was done with the program SPSS. After recording everything, a file was created with all the collected information. At first, descriptive statistics were used to create an overview of the data. Afterwards the answers were tested statistically by comparing them. Regression analyses, ordinal logistic regression, were used on the answers of the respondents on the water perception questions (risk factors) compared to the socio-demographic factors and context factors. The ordinal logistic regression is the only test fitting well with the Likert-scale used to indicate the perception of the citizen. The test is ideal for an ordinal dependent variable (flood risk perception) and one or more independent variables (age, gender and education). If the result is statistical significant it means that there is a correlation between the two variables.

The website overstroomik.nl (2017) was applied together with the postal codes to see how much the water really rises in the area the respondents live. The website is meant to make people more aware of flooding and to the effect of flooding in their living environment. Overstroomik.nl (2017) indicates for every postcode filled in on the website how far the respondent’s residence will be under water in case of a flood. This results in different water levels for every postcode filled in on the website. These results were compared to the level the water will rise in case of a flood, estimated by the citizen. The difference is explained as descriptive statistics.

The postal codes, received during the surveys, were used in the programs ArcGIS and Photoshop to make maps. The maps were created with this data and new insights were received. The postal codes were also used to determine where the respondents live to figure out how fast the water rises.

Besides the information received by doing the surveys, extra useful information was given by the respondents. This extra information is important, because it offers insight into the opinions and motivations of the respondents.

3.5 Ethical considerations

In this research, some ethical issues appeared. The question emerged if it is a problem if a respondent is asked for the postal code. The question is in the surveys, because it is an important part of the research and the question has a connection to other questions, such as the level of the water in case of a flood in a certain area. The respondents have been assured their data is only used in this research and not be distributed to someone else.

4. Results

4.1 Socio-demographic factors

The survey had 64 respondents of which 36 are face-to-face respondents and 28 are online respondents. The factors, age, gender and education were researched. The results of the statistical tests show that age, gender and education do not have a significant relation with the perception of flood risk. Therefore, age, gender or education do not have any effect on the perception of flood risk.

4.1.1 Age

The year of birth of the respondents differs from 1940 till 1996. The average year of birth is 1973. Converting the year of birth into ages result in an average age of 44 years old. As a person life expectancy is 79 years (CBS, 2017), which means the average age of a person met on the street is about 39 or 40 years old. The average age of the respondents of 44 is therefore higher than expected. This could be because ages under 18 were not questioned. The ages were divided in three groups (18-29, 30-59, 60+) and in four groups (18-29, 30-44, 45-59, 60+). The reason for performing the test two times with different groups is to see if the results would be different for different groups and different age classes. In the ordinal regression analyses, there was no significant relation (table 1 & 2) between the age of a person and their perception on flood risk, which means different ages do not have a different perception of flood risk.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[RisicoPerceptie = 0]	,076	,532	,020	1	,887	-,967	1,118
	[RisicoPerceptie = 1]	1,252	,561	4,991	1	,025	,154	2,351
	[RisicoPerceptie = 2]	2,502	,689	13,185	1	,000	1,152	3,853
Location	[LeeftijdCat=0]	-,693	,670	1,073	1	,300	-2,006	,619
	[LeeftijdCat=1]	,060	,645	,009	1	,926	-1,205	1,324
	[LeeftijdCat=2]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Table 1: Ordinal regression analyzes with as dependent variable the perception of flood risk and as independent variable age (3 groups).

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[RisicoPerceptie = 0]	,080	,532	,023	1	,880	-,962	1,123
	[RisicoPerceptie = 1]	1,243	,560	4,934	1	,026	,146	2,341
	[RisicoPerceptie = 2]	2,484	,688	13,029	1	,000	1,135	3,832
Location	[LeeftijdCatVier=0]	-,614	,739	,689	1	,406	-2,063	,835
	[LeeftijdCatVier=1]	-,197	,695	,080	1	,777	-1,560	1,166
	[LeeftijdCatVier=2]	-,154	,702	,048	1	,826	-1,531	1,223
	[LeeftijdCatVier=3]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Table 2: Ordinal regression analyzes with as dependent variable the perception of flood risk and as independent variable age (4 groups).

4.1.2 Gender

The survey was completed by 24 men (37,5%) and 40 women (62,5%). According to the regression analyses shown in table 3 men and women do not have a different perception in flood risk as the result was not significant. Therefore, we can conclude women and men have the same kind of perception of flood risk.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[RisicoPerceptie = 0]	-,012	,311	,001	1	,970	-,621	,598
	[RisicoPerceptie = 1]	1,174	,353	11,055	1	,001	,482	1,866
	[RisicoPerceptie = 2]	2,451	,533	21,128	1	,000	1,406	3,497
Location	[Geslacht=0]	-,835	,530	2,481	1	,115	-1,873	,204
	[Geslacht=1]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Table 3: Ordinal regression analyzes with as dependent variable the perception of flood risk and as independent variable gender.

4.1.3 Education

Out of 64 respondents, 35 (54,7%) were higher educated and completed educations at HBO or WO level, 25 respondents (39,1%) received a MBO degree and the other four respondents (6,3%) passed high school. Also in the case of education there was no significant difference, therefore there is no difference in perception of flood risk in the different levels of education. This is shown in Table 4.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[RisicoPerceptie = 0]	,151	,332	,206	1	,650	-,501	,803
	[RisicoPerceptie = 1]	1,322	,380	12,089	1	,001	,577	2,067
	[RisicoPerceptie = 2]	2,568	,555	21,431	1	,000	1,480	3,655
Location	[Opleiding=1]	-,720	1,288	,312	1	,576	-3,245	1,805
	[Opleiding=2]	,736	1,838	,161	1	,689	-2,865	4,338
	[Opleiding=3]	-,389	,517	,566	1	,452	-1,403	,624
	[Opleiding=4]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Table 4: Ordinal regression analyzes with as dependent variable the perception of flood risk and as independent variable education.

4.2 Context factors

In figure 6 the distribution of respondents is displayed together with the postal codes. Out of 64 respondents 10 respondents have been in contact with a flood at home. Of these 10 respondents six had damage to their belongings created by the flood. Out of 10 respondents eight are living in Dordrecht for longer than 20 years. Nine of the 10 respondents are living in an old house, a house older than 30 years. Four of the respondents had a little bit of damage done to their home and one declared the damage done to her home as very severe. This person lives in the postal code area of 3311. One of the respondents indicated damage to a wooden floor because of water rising through the ground. Another respondent was interested in buying a house and choose to not buy a house in the postal area of 3311 (the area with no dike), as it is perceived by him as a more dangerous area. Eventually five out of 10 respondents lived in the area 3311. No statistics were eventually used, as the group of 10 respondents is too small for a scientific correct answer. A test could have been used but because of the small group of respondents the outcome is not valid. It seems to appear people living in Dordrecht for a longer time in an old house in the area of the postal code 3311 have a bigger chance to experience a flood, but no real conclusion can be drawn out of these results. Still postal code

3311 is not significant different compared to the other postal codes with the perception of flood risk as shown in table 5. Inhabitants of postal code area 3311 do not have a different perception of flood risk.

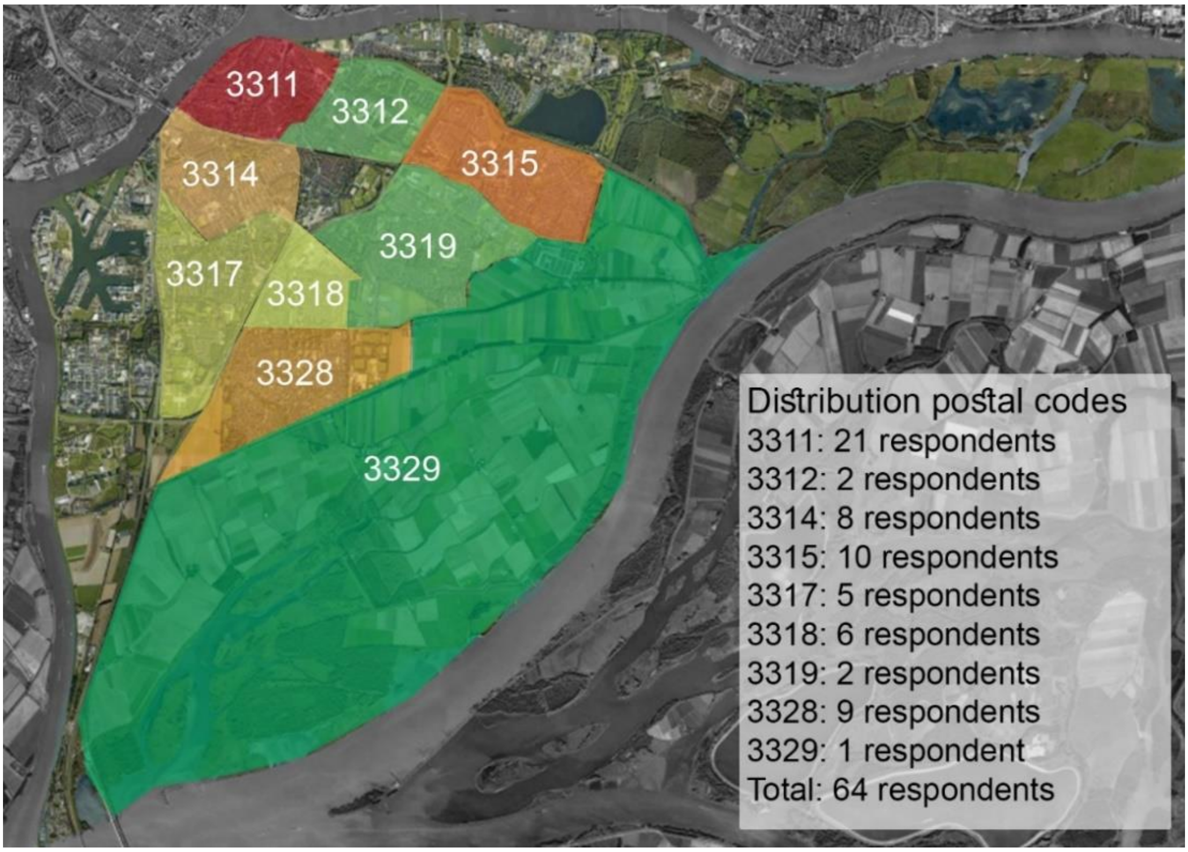


Figure 6: Distribution of postal codes on the Island of Dordrecht (own source).

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[RisicoPerceptie = 0]	-,284	,418	,461	1	,497	-1,103	,536
	[RisicoPerceptie = 1]	,904	,436	4,291	1	,038	,049	1,759
	[RisicoPerceptie = 2]	2,187	,584	14,001	1	,000	1,041	3,332
Location	[PostcodeBinnendijks=1]	-,869	,511	2,889	1	,089	-1,871	,133
	[PostcodeBinnendijks=2]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Table 5: Ordinal regression analyzes with as dependent variable the perception of flood risk and as independent variable living in postal code area 3311/not living in postal code area 3311.

The following context factors were researched:

- Rent/bought residence (table 6)
- Time of construction residence (table 7)
- Living on the ground floor (table 8)
- Time living on the Island of Dordrecht (table 9)

All these factors were not significant in the ordinal regression analyses, which is shown in tables 6, 7, 8 and 9. Therefore these factors do not influence the perception of the citizens of flood risk.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[RisicoPerceptie = 0]	,018	,327	,003	1	,957	-,623	,658
	[RisicoPerceptie = 1]	1,195	,368	10,518	1	,001	,473	1,917
	[RisicoPerceptie = 2]	2,448	,543	20,296	1	,000	1,383	3,512
Location	[Huurkoop=0]	-,713	,507	1,978	1	,160	-1,706	,281
	[Huurkoop=1]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Table 6: Ordinal regression analyzes with as dependent variable the perception of flood risk and as independent variable rent/bought residence.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[RisicoPerceptie = 0]	,418	,312	1,802	1	,179	-,192	1,029
	[RisicoPerceptie = 1]	1,578	,374	17,805	1	,000	,845	2,311
	[RisicoPerceptie = 2]	2,818	,554	25,861	1	,000	1,732	3,904
Location	[Bouwtijd=0]	,275	,508	,293	1	,588	-,721	1,271
	[Bouwtijd=1]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Table 7: Ordinal regression analyzes with as dependent variable the perception of flood risk and as independent variable year of construction of the residence.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[RisicoPerceptie = 0]	,874	,434	4,057	1	,044	,024	1,725
	[RisicoPerceptie = 1]	2,060	,497	17,198	1	,000	1,087	3,034
	[RisicoPerceptie = 2]	3,309	,648	26,071	1	,000	2,039	4,579
Location	[Begane=0]	,864	,529	2,661	1	,103	-,174	1,901
	[Begane=1]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Table 8: Ordinal regression analyzes with as dependent variable the perception of flood risk and as independent variable if respondent lives on the ground floor or not.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[RisicoPerceptie = 0]	,129	,332	,150	1	,698	-,522	,780
	[RisicoPerceptie = 1]	1,299	,379	11,770	1	,001	,557	2,041
	[RisicoPerceptie = 2]	2,558	,552	21,474	1	,000	1,476	3,640
Location	[Tijdwonen=0]	,304	,769	,156	1	,693	-1,204	1,812
	[Tijdwonen=1]	-,597	,807	,548	1	,459	-2,180	,985
	[Tijdwonen=2]	-,790	1,139	,481	1	,488	-3,022	1,443
	[Tijdwonen=3]	-,635	,741	,734	1	,391	-2,088	,818
	[Tijdwonen=4]	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Table 9: Ordinal regression analyzes with as dependent variable the perception of flood risk and as independent variable the time living in Dordrecht.

4.3 Risk factors

4.3.1 Cause of floods

According to the respondents (figure 7) mostly precipitation, climate change, failure to retain water (example: failure of a dike) and the location of the residence is the reason of a flood. The isolation of a residence, the sewerage and the capacity of it plays a less important role according to the respondents. Climate change has the most important role according to the respondents. In the face-to-face survey, a few respondents were of the opinion other factors play a role. The following factors were mentioned in the face-to-face survey:

- Living on the first floor (1 respondent)
- Insufficient drainage by the rivers (2 respondents)
    - For example: danger due to the wind from the west
- Too much tiled and asphalted area which lower the permeability of the area (2 respondents)

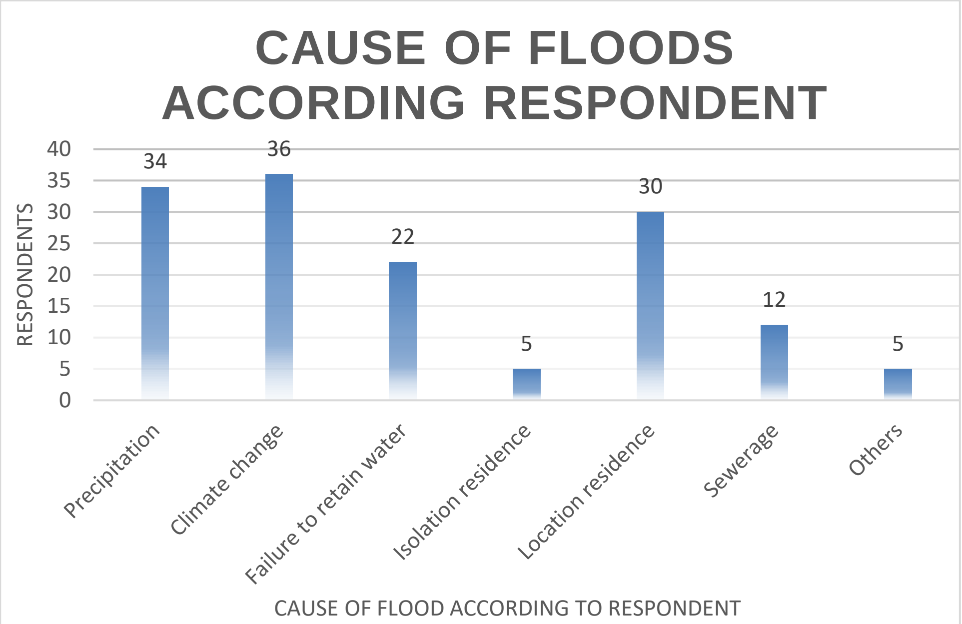


Figure 7: The cause of floods according the respondents (own source).

It is assumed that climate change is chosen because it is often in the news. Dordrecht is known as one of the riskiest areas of the Netherlands, location of residence is therefore a predictable choice. Sewerage and isolation are less chosen. Sewerage is something residents cannot see and probably for this reason this option is not chosen that often. The quality of houses is very well in the Netherlands, this could be a reason isolation is a less popular choice than climate change, location or precipitation. These past statements are all not based on scientific knowledge, but are mere assumptions.

4.3.2 Flood risk respondents

Out of 64, 60 respondents could be used in the research of rising water levels, as overtroomik.nl could not judge outside the dike ring area, where the remaining four respondents live. Table 10 shows the difference between perception of the water level and the real water level in the respondent's postal code. The 'Difference' in table 10 represent the amount of answer categories the respondent answered too high or too low. If the difference is zero the respondent got the right water level in case of a flood for his or her postal code. A negative number shows the respondent underestimated the water level. A positive number shows the respondent overestimated the water level. As seen in the table 10 only 8,3% of the respondents was right and 61,7% was wrong with more than two answer categories lower. In case of a flood, 85% of the respondents underestimate the level of the water in their postal code area. Only five respondents overestimated the water level. Underestimating the water level can be dangerous because people will not know how to estimate the effect of a flood and therefore how to act. None of the respondents experienced a flood, expect of 10 respondents. For the other respondents, it is hard to estimate the effects of a flood because they never experienced one (van der Linden, 2015). Most of the 10 respondents only experienced a small flood, with no or almost no damage. One respondent experienced the 'Waternoodsramp', the big flood and was a national disaster and created much damage to the respondent's home at the time.

Difference	Frequency	Valid Percent
-3	13	21,7
-2	24	40,0
-1	14	23,3
0	5	8,3
1	4	6,7

Table 10. Difference perception of the water level during a flood and the real water level (own source).

According to overstroomik.nl (2017) the chance of a flood is around 10% for almost every house. In figure 8 this seems to be guessed quite well by the respondents because most of the respondents are on the left and middle side of the chart. If a respondent chose 'no chance' they thought there was no chance of a flood in their lifetime.

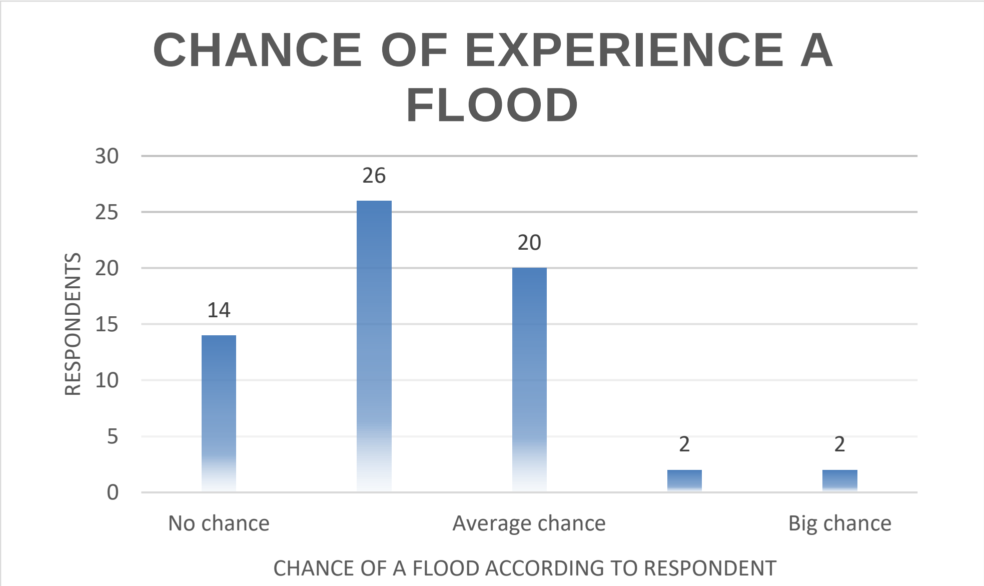


Figure 8: The chance the respondent will experience a flood according to the respondent (own source).

The respondents also estimated how fast the water would rise. A map from the PBL (2013) in appendix 1, is used to estimate the real speed of the water rising. The water rises fast if it rises in less than nine hours and slow if it rises in more than nine hours. In the most parts of Dordrecht, the water rises slow. Exceptions are an area in the postal code of 3329 and the area outside the dike ring area. Outside the dike ring area there is no indication on the used map of PBL (2013) of the speed the water will rise, therefore the respondents living in the dike ring area are not included.

Difference	Frequency	Valid Percent
-1	1	1,8
0	17	29,8
1	12	21,1
2	27	47,4

Table 11. The differences in estimating the speed the water rises by the respondents and the actual speed (own source).

Table 11 shows the differences between the estimations of how fast the water rises and the actual speed the water rises. Table 11 works the same way as table 10. Zero in 'Difference' means the respondent estimated the rising speed of the water in case of a flood right. A positive number indicates the respondent overestimated the rising speed of the water in case of a flood and a negative number shows the respondent underestimated the rising speed of the water in case of a flood. Seventeen of the respondents estimated it right, which is 29,8%. 47,4% (27 respondents) thought the water would rise rapidly, but in reality, it rises slow and therefore it is more than two answer categories difference. Only one person lives in an area where the water rises in less than nine hours. It is expected that for the respondents, it is positive they overestimate the effect of a flood than underestimate it, as the flood is less dangerous than the citizens imagine.

4.4 Cognitive factors

4.4.1 Role of the different authorities

One of the cognitive questions was about the role of the different authorities, the neighborhood and the respondent in flood risk. The role of the different authorities was divided in the municipality, province, government (Rijksoverheid) and the Waterschappen. The answers of the respondents differ a lot, which means it is hard to make a conclusion out of it. Most of the respondents had no idea what every authority exactly does. The same problem happens with the questions about how well the different authorities operate. All the authorities play according to the respondents a pretty big/ big role:

- Municipality: 71,9%
- Province: 67,2%
- Rijksoverheid, government: 89,1%
- Waterschappen: 85,9%

In the question about the role of the different authorities, it was discovered during the face-to-face survey that most respondents had no idea what to fill in on the form, because they had little knowledge about this subject. In the following question, which was about how the different authorities function, the same problem appeared. Because the first question was hard to answer, the answer to this question is too difficult to be considered true. One of the participants also perceived the municipality as an authority doing a bad job as she had some problems with them in the past.

The role of the neighborhood was seen by 40,6% (26 respondents) as a small role/no role and 28,1% (18 respondents) thought the neighborhood had a little role. A pretty big/ big role is checked on the survey 14,1% (nine respondents) of the times. This is a huge difference compared to the authorities. The quality of how the neighborhood performs its role in flood risk changes a lot. The question was refused to be answer by 22 respondents (34%) as they thought the neighborhood did not have any role at all in participating in flood risk. 26 of the respondents thought they had a small or no role and only nine people thought the neighborhood played quite a big/big role in protection against floods.

In figure 9 it is clear that citizens do not have a big role according to the respondent. They mostly give the responsibility to the authorities. According to the respondents the authorities play a much bigger role in flood risk. One of the respondents was of the opinion the government is completely responsible for reducing flood risk. Eventually only 12,5% (eight respondents) thought a person has a big role protecting themselves against floods. Of the respondents 75,0% (48 respondents) believes a person has no/almost no role in protecting against floods.

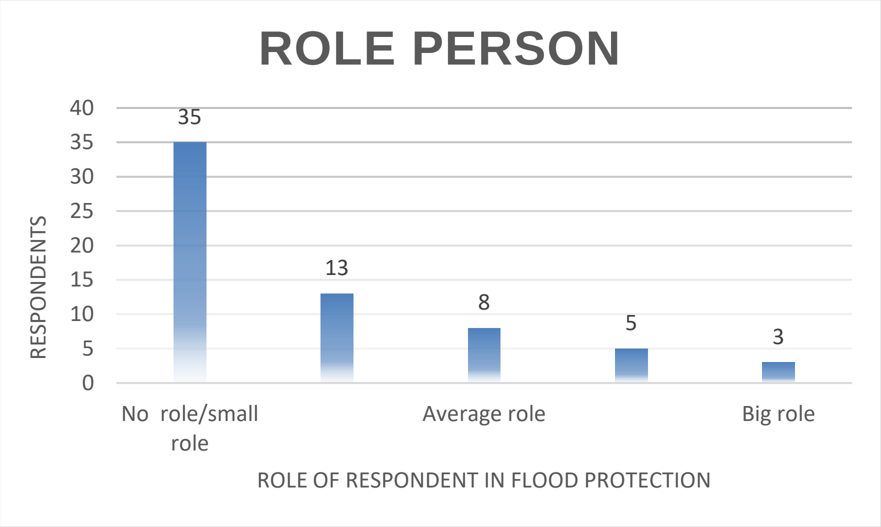


Figure 9: Role of the respondent/person in protection against floods (own source).

4.4.2 Participation

Out of the 64 respondents 16 (25%) are willing to participate in activities concerning flood protection, like attending a meeting with this theme. In the present only five respondents are active in this area, four of them check the internet regularly. One respondent indicated to be active by participating by attending meetings with the government. Overall no one is active except on the internet. This will make it hard to create awareness of flood risk, because the participation is low. Seventeen respondents (26,6%) declared that they take measures against flooding. These measures differ from no important belongings in the basement to owning sandbags or a water barrel. Also improving the permeability of the ground, by taking a green garden where water can infiltrate in the ground was mentioned by a respondent. Some owners also own planks and baffles, to stop the water from infiltrating the house if there is a flood.

4.4.3 Knowledge of measures taken by government

Out of the 64 respondents only 46 (71,9%) indicated that they know a measure/more measures taken by the government. This is a low response as there are many answer possibilities for the respondents. During the face-to-face some respondents indicated they did not want to take much time for this question. This could be a reason for the low response rate.

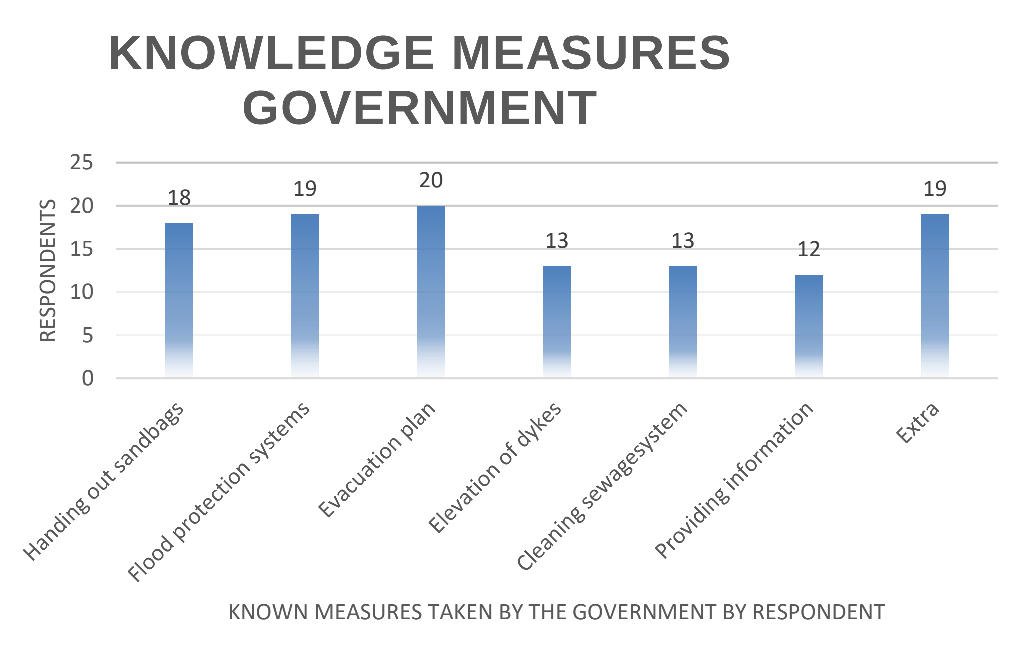


Figure 10: The knowledge of the respondents of measures taken by the government to protect the area of Dordrecht from water (own source).

The 'Extra' in figure 10 means the extra knowledge gained in the face-to-face surveys by the respondents. In the internet survey, it was possible to add extra measures, but none of the 28 respondents did this. An alternative measure mentioned by the respondents during the face-to-face was a general emergency number of Dordrecht maintained by the government, which warns the citizens in case of a flood. Another measure mentioned by a respondent is how new streets are constructed in a way the impact of flooding is reduced the most, for example by raising the street. Furthermore, a respondent mentioned water storage places, improvement of the river flow and a warning provided by the municipality each year of flood risk to each citizen (providing information). The discussed flood protection systems are the Maeslantkering and a protection system in the Biesbosch. In Dordrecht also exists a compensation for citizens living in houses with rotten posts due to water damage according a student of 22 years old, living in such a house.

These measures are mostly known by the citizens by television or a journal with 46,9% of the respondents. Other ways to know of the measures is by a newspaper (34,4%), the website of the municipality (31,3%), family or friends (21,9%), the internet (18,8%), an information brochure (14,1%), work (14,1%) or school or university (3,1%). None of the respondents checked the box presenting a meeting of the municipality. The internet includes social media, like Facebook. One of the respondents sees it as something she just 'feels'. She explained how she gains knowledge by looking around her in the city. Another respondent learned a lot of floods because of the previous house of the respondent, which was located in a zone with high flood risk. Furthermore, the municipality of Dordrecht sends every year a letter, with information about flood risk to people living in risky areas. According to Rydén et al. (2003) information is mostly received by the citizens due to universities, schools, media and family. According to the results schools and universities only play a small part in it. Media play a big role just as the municipality. A reason for this could be the change in popularity of the internet. Still television and journals are the biggest shareholders. More research on these subjects is recommended.

5 Conclusion

5.1 Conclusion and discussion

Dordrecht is one of the riskiest areas of the Netherlands in case of floods and becomes due to climate change even riskier. Cities should try to minimalize the consequences of a flood and therefore become more resilient. To become a more resilient community, awareness must be created and the perception of the citizens must be changed. First, to change the perception, it must become clear what the current perception is. Afterwards a fitting way can be found to change the perception if this is necessary. This research wants to discover the reason for different perceptions among citizens by answering the following main question: *In what way is there a difference in the perception of flood risk of citizens with different socio-demographic backgrounds compared to the actual flood risk in Dordrecht?* The following hypotheses was used: different socio-demographic backgrounds results in different perception about flood risk in Dordrecht than the actual flood risk. There was no significant difference between the socio-demographic factors and the perception of the respondents. Therefore, there is no difference in factors like age, education level and the perception of the citizens in Dordrecht. Different socio-demographic backgrounds do not affect the perception of flood risk in Dordrecht according to the research. The hypotheses can be rejected. This result in questioning if the articles of Wachinger & Renn (2010) and Van der Linden (2015) are right about flood risk perception. They state that socio-demographic factors (or personal factors) influence the (flood) risk perception. Still it is not simply falsified because socio-demographic factors also consist of income level, occupation, religion or marital status and more. Therefore, a city can still be more resilient depending partly on socio-demographic factors, as they create awareness and thus preparedness. In summary, there is no clear answer for the first sub question: *do different socio-demographic backgrounds of citizens change their perception of flood risk?* But*, what kind of factors change the perception of flood risk of citizens?* The other factors changing the perception are cognitive factors, risk factors and context factors (Wachinger & Renn, 2010; Van der Linden, 2015). The following context factors were researched: rented or bought residence, time of construction residence, living on the ground floor and the time living on the Island of Dordrecht. All these factors did not affect the perception even though it was expected because of the theories of Wachinger & Renn (2010) and Van der Linden (2015). These results again cause doubts about the theories in the articles. Van der Linden (2015) claims the factors only cover 70% of the flood risk perception. The results from the ordinal regression analyzes indeed show that the theories of the article are not perfect, because 100% of the researched variables of the context and socio-demographic factors did not have effect on the perception of flood risk. The risk factors were mostly used to calculate the perception of citizens.

How well can citizens predict the flood risk in their area? The citizens of Dordrecht could estimate the flood risk quite closely. But in case of how far the water will rise they could not estimate the right height and only four respondents guessed it right. Of the respondents, 61,7% was wrong with more than two answer categories. This wrong perception of how a flood works and how to deal with it could be dangerous in case of a flood and the evacuation accompanying it. The awareness of the citizens of Dordrecht seems to be low. Restemeyer et al. (2015) describe in the article how transformability can change the attitude and behavior of citizens by promoting societal change. Creating awareness and risk communication promotes this societal change and reduces the vulnerability of a community. Public participation could involve people in the decision making. Participation should result in raising the awareness, the city becomes because of these measures more robust and adaptive. But *are citizens* even *willing to change* *their perception of flood risk?* Considering the cognitive factors, it was remarkable that only 26,6% of the respondents wants to participate in activities concerning flood risk or is participating in any of these activities. People do not want to get involved with the government because 26,6% is a low number of citizens willing to participate and change their perception. Most of the respondents did not consider flood protection as their task. They thought the government has full responsibility of flood risk. This is curious because most of the respondents have no clue what the tasks are of the different government institutions. It seems the citizens are not at all that willing to protect themselves against floods. This confirms the research performed in the report by OECD (2014). As stated in the article of Wachinger et al. (2012) participation can raise the awareness of a citizens, which could result in citizens feeling more responsible and taking more measures which could protect them (OECD, 2014). But only 25% of the respondents are willing to participate. This does not seem to be the best option to create awareness. According to Działek et al. (2013) to create a resilient community can be done by implementing collaborative strategies and therefore get a full image of the community. As this research is small and did not research all the factors, it was impossible to create a full image of the community. Working together with all kind of institutions can make the city more resilient. But this is impossible if the citizens do not want to participate. As reported by the OECD (2014) the awareness gap is one of the hardest jobs of the Dutch water policy. In chapter 5.2 recommendations are made to create more awareness.

5.1 Reflection

The biggest problem of this research the lack of respondents, which makes the research less representative even though there is a lot of variation in the population (age, men/women etc.). This also caused a lack of respondents in each neighborhood. The lack of respondents was mainly caused by the face-to-face survey. This kind of survey takes a lot of time and energy. Luckily the face-to-face survey provided the research with more information. Which is comparable to information received during the interview. This also means that the internet survey provided the research with less extra information as it seemed that respondents got lazier to write extra information down. Another problem which occurred during the face-to-face survey is the lack of knowledge of some respondents of words regarding flood risk. One of the respondents did not know the word ‘waterkering’, which means flood protection system. In a face-to-face survey, it is easy to explain this word, but that is not possible with internet surveys, therefore it is good to keep the language as easy as possible or use some examples to explain the word. Sometimes the respondents asked for an answer during the face-to-face survey, which made it difficult to not push them in a certain direction. During the statistics, it was hard to find the right statistical test for the Likert scale, which was certainly needed to explain the perception. The ordinal logistic regression used is not perfect for this kind of data, but at the same time the best test available for this data. Furthermore, it is expected that citizens who experienced a flood or are living in a risky area do have a different perception. This is not proven, but it can be assumed, because the experience can change the perception according to Van der Linden (2015).

5.2 Further research and recommendations

To make the research more representative, more respondents are needed and throughout the whole island of Dordrecht. Another research in another city, will make it easier to compare and find out if there is a different perception in Dordrecht, because Dordrecht has a long water history. It was furthermore demonstrated that different ages, genders and educations do not change the perception of citizens. Nevertheless, other socio-demographic factors, like income level, occupation, religion or marital status can have effect on the perception of flood risk. It is interesting to examine this in future research.

To change the perception of people or give them more knowledge, the television, the journal, the municipality website and the newspaper play an important role. These media promote knowledge and can be used by the municipality inform its citizens. Schools or universities do not provide the respondents with information on flood risk, thus a change can be made by implementing more flood risk in education. As one of the respondents spoke about how her knowledge of measures against floods is caused by her feelings and mostly how she looks about. If we use this idea, it could be possible for citizens to gain more knowledge by making the measures more visible in citizens their surroundings, so they can ‘experience’ flood protection. For example, by marking flood protection measures. It is the question if this will really work, but further research can explore different possibilities and their effects.

Public and government can work together to create a more resilient city. As there was not much interest in participating in meetings or other activities, there is a small chance this will happen. Of course, the government can help the citizens of Dordrecht by handing out extra information or by providing subsidy for a water barrel to retain water. Or by promoting greener gardens to improve the permeability of the ground, to reduce flooding. Collaborative strategies can be successful if the citizens are motivated enough to participate, but this is a tough job for the future.

6 References

Atelier GroenBlauw (2015). *Multi-layer safety and water robust building.* Viewed on 29-02-217 via http://www.groenblauwenetwerken.com/water/flood-risk-management/. Delft: Atelier GroenBlauw.

CBS (2017). *Levensverwachting; geslacht, leeftijd (per jaar en periode van vijf jaren)*. Viewed on 25-05-2017 via http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA=37360ned&D1=a&D2=a&D3=0-1,11,21,31,41,51,66&D4=0,10,20,30,40,50,56-l&HD=120427-1726&HDR=G1,T&STB=G2,G3. Den Haag: Centraal Bureau voor de Statistiek.

Clifford, N., Shaun, F. and Valentine, G. (2010). *Key methods in geography.* 2nd edition. London: SAGE.

Creswell, J. (2014). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. 4th edition. London, Sage.

De Wit, M.S., van der Most, H., Gutteling, J.M. and Bocˇkarjova, M. (2008). Governance of flood risks in The Netherlands: interdisciplinary research into the role and meaning of risk perception. *Wageningen universiteit.*

Doyle, J. K. (2005). Face-to-face surveys. In B.S. Everitt and D. Howell, eds., The Encyclopedia of Statistics in Behavioral Science. New York: Wiley.

Działek J., Biernacki W., and Bokwa A. (2013). Challenges to social capacity building in flood-affected areas of southern Poland. *Natural Hazards and Earth System Sciences*, 13(10), 2555-2566.

Fowler, Floyd, Jr. (2013). Survey research methods. *Center for survey research*, university of Massachusetts. 5, 50-70

Gemeente Dordrecht (2009). *Waterplan Dordrecht 2009-2015*. Dordrecht: Gemeente Dordrecht.

Gemeente Dordrecht (2009). Figure, viewed on 08-06-2017 via https://cms.dordrecht.nl/Dordrecht/up/ZgsnisrIU_Waterplan_II.pdf. Dordrecht: Gemeente Dordrecht.

Gemeente Dordrecht (2017a). *Water en veiligheid*. Viewed on 24-03-2017 via https://cms.dordrecht.nl/inwoners/natuur-en-milieu/water-en-veiligheid/hoogwater-is-van-alle-tijden. Dordrecht: Gemeente Dordrecht.

Gemeente Dordrecht (2017b). Figure, viewed on 08-06-2017 via https://cms.dordrecht.nl/inwoners/natuur-en-milieu/water-en-veiligheid/meerlaagsveiligheid. Dordrecht: Gemeente Dordrecht.

Hesse-Biber, S.N. and Johnson R.B. e. (2015). Mixed Methods and Multimodal Research and Internet Technologies. In: *The Oxford Handbook of Multimethod and Mixed Methods Research Inquiry,* 1st edition. Oxford: Oxford university press.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, 4(1), 1–23.

Holling, C. S. (1996). Engineering resilience versus ecological resilience. In P. C. Schulze (Ed.), Engineering within ecological constraints (pp. 31–43). Washington, D.C: National Academy Press.

Hoss, F., Jonkman, S.N. and Maaskant, B. (2013). A comprehensive assessment of multilayered safety in flood risk management – The Dordrecht case study. *Floods: From Risk to Opportunity (IAHS*), 357,57-65.

Knieling, J., Schaerffer, M., & Tressl, S. (2009). Climate change and spatial planning — Land use and risk management of flood prone areas exemplified by the Elbe Island Hamburg. *Coastline Reports*, 14, 1–98.

Kuhlicke, C., Steinführer, A., Begg, C., Bianchizza, C., Bründl, M., Buchecker, M., De Marchi, B., Di Masso Tarditti, M., Hoppner, C., Komac, B., Lemkowe, L., Luther, J., McCarthy, S., Pellizzoni, L., Renn, O., Scolobig, A., Supramaniam, M., Tapsell, S., Wachinger, G., Walker, G., Whittle, R., Zorn, M., and Faulkner H. (2011). Perspectives on social capacity building for natural hazards: outlining an emerging field of research and practice in Europe. *Environment Science & Policy*, 14 (7), 804–814.

Linden, S. (2015). The social-psychological determinants of climate change risk perceptions: Towards a comprehensive model. Journal of environmental psychology. 41,112-124

Moore, D.S. & G.P. McCabe (2006). *Statistiek in de praktijk: Theorieboek*. 5th edition. Den Haag: Academic Service.

OECD. (2014). *Water Governance in the Netherlands: Fit for the Future?* OECD Studies on Water. OECD Publishing.

O'leary, Z. (2004). *The Essential Guide to doing research.* London: SAGE Publications.

Overstroomik.nl (2017). *Overstroom ik*? Viewed on 20-05-2017 via http://overstroomik.nl/overstroom-ik.html?adres=&latitude=&longitude=. Den Haag: Rijkswaterstaat.

Pieterse, N., Knoop, J., Nabielek, K., Pols, L., Tennekes, J. (2009). *Overstromingsrisicozonering in Nederland. Hoe in de ruimtelijke ordening met overstromingsrisico's kan worden omgegaan*. Den Haag: Planbureau voor de Leefomgeving.

Planbureau voor de Leefomgeving (2013). Gevarenkaart van IJsselmonde, Hoekse Waard en Eiland van Dordrecht. Viewed on 24-03-2017 via http://www.pbl.nl/infographic/overstromingsgevaar-0. Den Haag: Planbureau voor de Leefomgeving.

Planbureau voor de Leefomgeving (2017*). Hoe beschermen we ons land tegen het water?* Viewed on 10-06-2017 via http://www.pbl.nl/nieuws/nieuwsberichten/2013/hoe-beschermen-we-ons-land-tegen-het-water. Den Haag: Planbureau voor de Leefomgeving.

Samuels, P. and Gouldby, B. (2009). Language of risk-project definitions, 2nd edition. Floodsite project report T3204-01.

Restemeyer, B., Woltjer, J. and van den Brink, M. (2015). A strategy-based framework for assessing the flood resilience of cities – A Hamburg case study. *Planning Theory & Practice*, 16(1), 45–62.

Rijksoverheid (2014). *Nationaal Waterplan 2016-2021*. Rapport 2. Den Haag: Rijksoverheid.

Runhaar, H., Mees, H., van der Sluijs, J. and Wardekker, A. (2012). Adaptation to climate change-related risks in Dutch urban areas: stimuli and barriers. *Reg Environ Change* 12(4), 777-790.

Rydén, L., Migula, P. and Andersson, M. (2003). *Environmental Science - Understanding, Protecting and Managing the Environment in the Baltic Sea Region*. Uppsala, The Baltic University Press.

Van der Geest, L., Berkhof, M. and Meijer, M. (2008). *'Het hoofd boven water' - Tweehonderd jaar investeren in waterwerken*. Utrecht, NYFER.

Wachinger, G. and Renn, O. (2010). *Risk Perception and natural hazards*. CapHaz-Net WP3 Report. Stuttgart: DIALOGIK Non-Profit Institute For Communication And Cooperative Research.

UNISDR (The United Nations Office for Disaster Risk Reduction) (2014). *Local Government Profile -Dordrecht - Netherlands, the*. Viewed on 24-03-2017 via http://www.unisdr.org/campaign/resilientcities/Home/cityprofile/City%20Profile%20Of%20Dordrecht/?id=1298. Dordrecht: The United Nations Office for Disaster Risk Reduction.

Zevenbergen, C., Verbeek, W., Gersonius, B. and van Herk, S. (2008). Challenges in urban flood management: travelling across spatial and temporal scales. *Journal of flood risk management.* 1(2), 81-88.