PERCEIVED FLOOD RISK IN HIGH FLOOD RISK AREAS AND LOW FLOOD RISK AREAS

A comparative study between Zandvoort and Zierikzee.

Canva (2024)

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Abstract

The purpose of this study is to explore whether there is a difference in perceived flood risk between low and high flood risk coastal areas of the Netherlands. The central research question is: "*To what extent does perceived flood risk of people differ between high flood risk and low flood risk areas in coastal regions of the Netherlands?"* Zierikzee has been selected as a high flood risk area and Zandvoort has been selected as a low flood risk area. Preparedness, worry, awareness, experience, and trust have been identified as key elements of risk perception through literature research. The impact of these elements on perceived flood risk were measured through quantitative research. Quantitative data was collected by spreading surveys among residents in Zierikzee and Zandvoort through both digital and physical means. Results shows that people living in high flood-risk areas have a higher risk-perception since they are more worried, prepare more for potential flooding, and have more experience regarding prior flooding compared to low flood-risk areas. Results also show that, in Zierikzee, there is a relation between the theory about preparedness, awareness, worry, and experience. In Zandvoort a relation has been found between the theory about worry and trust. Future research can dive deeper into the strength and direction of these relations and see whether a relation is positive or negative and whether a relation between variables is strong.

Key words – perceived risk, high flood risk, low flood risk, preparedness, awareness, worry.

Table of Contents

1. Introduction

1.1 Background of research

The Netherlands has been dealing with water safety issues throughout history (PBL, n.d.). 70% of the Netherlands is sensitive to flooding and 26% lies below sea level (PBL, n.d.). Most of these areas are inhabited and thus are people residing there exposed to potential water safety hazards, such as floods. These floods can have disastrous consequences for society (Botzen *et al.*, 2009; Mol *et al.*, 2020; Sneijder, 2017). To reduce flood risk in these areas, protection by dikes, creation of retention areas, and water management regulations are implemented (Brody *et al*, 2022; Raadgever & Hegger, 2018). The future prospect of a rising sea level, a change in precipitation pattern, and an increase in river flow has an influence on several areas in the Netherlands and its inhabitants (Bomers *et al.*, 2019; Kennisportaal Klimaatadaptatie, 2023; KNMI, 2023; Verheggen, 2023).

Flood risk can be defined as a combination of flood probability and consequences of the floods (GOV.UK, 2024). The expected flood risk is not always in line with the perceived flood risk, and misperceptions regarding water safety may occur (Khalid *et al.*, 2019; Mol *et al.*, 2020). "Risk perception is defined as an assessment of the probability of hazard and the probability of the results (most often—the negative consequences) perceived by the society" (Lechowska, 2018, p.1343). People living in areas located below sea level or characterized by sensitivity to floods have a certain perception to how safe they feel regarding water, whether this safety perception be high or low (Botzen *et al.*, 2009; Mol *et al.*, 2020). The purpose of this study is to compare people's perceived flood risk in high flood risk areas to people's perceived flood risk in low-risk areas.

1.2 Research problem and relevance

By means of this study research is conducted on the perceived flood risk in coastal areas of the Netherlands. This research will gain new insights into people's awareness with regards to their water safety. These insights can be gained by looking at new relevant regions, different causes of natural hazards, and methods of collecting data from participants. Additionally, this research provides governmental bodies with information to improve or invent policies regarding water management. Moreover, by better understanding how people perceive safety regarding the potential flood risk in an area, public awareness can be increased where necessary (Botzen *et al.*, 2009).

Research up until this point has mainly focused on perceived flood risk in river deltas in both the Netherlands and other countries (Baan, 2004; Botzen *et al.*, 2009; Bullen & Miles, 2024; Mol *et al.*, 2020). In various studies, research has been conducted on floods in the Netherlands. Most of these studies focuses on technical aspects and less on the perception of people. Although research performed in the past is relevant when talking about flooding and/or perceived flood risk, it does not focus on Dutch coastal areas. As a result, this study aims to conduct research on people's perceived flood risk in a coastal area of the Netherlands.

The aim of this research is to determine whether there is a difference between people's perceived flood risk in high flood risk areas and low flood risk areas. Both areas are located near the coast in the Netherlands. To investigate this the following research question has been proposed:

> "*To what extent does perceived flood risk of people differ between high flood risk and low flood risk areas in coastal regions of the Netherlands?"*

To answer the proposed primary research question, the following 2 sub-questions have been stated:

1. *What are the disparities in perceived flood risk between Zierikzee and Zandvoort?*
2. *Is there a relation between different key elements that form perceived flood risk?*

1.3 Structure

This paper is divided in 6 chapters. Chapter 1 includes an introduction to the topic, relevance of this study, a problem statement, and the aim of this research. The second chapter consists of the theoretical framework. This will provide an overview of the main literature findings related to the relevant key elements and a conceptual model to give an overview of the research structure. The third chapter provides the methodology. This consist of the area selection, data collection and analysation, and ethical considerations. Chapter four presents the results. The fifth chapter consists of the discussion which concludes the outcome of this study shows the limitations of this research. Chapter 6 consists of the conclusion, which provides recommendations for future research. The appendixes consist of the reference list, tables and graphs, and further SPSS outputs.

2. Theoretical framework

The Netherlands is serving as a relevant case study because of a high flood vulnerability in certain areas, which forces the country to come up with flood prevention measures (Duijndam *et al.*, 2023; Raadgever & Hegger, 2018). Measures are being taken in the form of for example raising dikes, policies, creating retention areas (Brody *et al*, 2022; Raadgever and Hegger, 2018). These strategies must ensure that inhabitants of flood-prone areas are kept safe. "Their statistical analysis indicates that households are more likely to invest in self-protection measures, the higher they perceive their risk of flooding" (Botzen *et al.*, 2009, p.3). According to Botzen *et al.* (2009), this implies that individuals have control over what the amount of impact of floods. It highlights the importance of understanding the perceived flood risk of people.

2.1 Perceived risk

"Perceived personal risk has been found to be related to the recency, frequency, and intensity of people's personal experience with hazard events" (Lindell and Hwang, 2008, p. 542). Perceived risk is related to proximity to the source of danger and whether people experienced a hazard before (Bustillos Ardaya *et al.*, n.d.; Lindell and Earl, 1983; Yin *et al.*, 2019). Perceived risk can be described as a subjective reality consisting of emotions and opinions and the way people perceive risk can make them more vulnerable to being exposed to risk-taking (Franssen & Reichard, 2009; Khalid *et al.*, 2019; Ruiz & Hernández, 2014). Perceptions regarding flood-risk affect the willingness of people to support public investments in flood protection measures (Mol *et al.*, 2020).

The first objective of this study is to see whether there is a difference in perceived flood-risk in the low flood-risk and high flood-risk areas. To be able to achieve this objective, factors which determine or influence perceived flood-risk need to be established. For this study, perceived flood-risk consists of the preparedness, awareness, worry, trust, and place attachment.

2.2 Preparedness, awareness, and worry

Preparedness could be defined as the ability of people to be able to cope with floods while they are happening and how to deal with the consequences after the floods are over (Raaijmakers *et al.*, 2008). There are multiple dimensions when it comes to preparedness are technical, economic, social, and institutional (Raaijmakers *et al.*, 2008). For this research the focus lays on the social dimension which consists of actions taken by individuals, personal skills, and knowledge about how to deal with floods (Raaijmakers *et al.*, 2008). Awareness is the knowledge about floods or the consciousness of flood risk to which a person is exposed (Raaijmakers *et al.*, 2008). According to Raaijmakers *et al.* (2008), the three levels of awareness are expert, underestimation, and ignorance. Worry is depending on how aware people are of the frequency of floods in their area (Raaijmakers *et al.*, 2008). The more severe floods are, the more individuals will worry about the consequences of these floods (Cox *et al.*, 2002).

2.3 Trust

"The concept of trust is commonly understood and applied as a tool for assessing the legitimacy and social position of institutions" (Malesic, 2019, p. 604). Trust in institutions and measures taken by those institutions to prevent hazardous events influence the risk perception of a person (Bustillos Ardaya *et al.*, n.d.). According to Malesic (2019), trust in the government becomes higher during disaster conditions. People trust the information institutions give before, during, and after hazards which is important when it comes to reacting to these events (Malesic, 2019). High trust from people towards the government regarding providing information and taking appropriate measures decreases the impact of hazardous events (Bustillos Ardaya *et al.*, n.d.). The willingness of people to listen and act become higher which is necessary during these events (Bustillos Ardaya *et al.*, n.d.).

2.4 Place attachment

Repeated interaction with a certain place has an influence on the feelings towards to this location and to what extend a person is attached to this place (Bonaiuto, 2016; Krien & Guillou, 2018). Place attachment can have both a positive and negative impact on risk perception of people (Bonaiuto, 2016). In case of a positive impact, a change in the environment to which people feel attached can make them no longer feel safe and making them want to escape the situation or take measures (Bonaiuto, 2016; Ruiz & Hernández, 2014). Connection with a place can also give people the feeling of control over the situation and it reduces stress since they feel secure in their surroundings (Bonaiuto, 2016; Krien & Guillou, 2018). In case of a negative correlation, acknowledgement of risk is reduced because of the feeling of being secure. Consequently, it can endanger inhabitants when there is an underestimation of risk (Bonaiuto, 2016; Ruiz & Hernández, 2014).

2.5 Relations between mentioned theory

The second objective of this study is to see whether there are significant relations between the factors that determine or influence perceived flood-risk. For this study, perceived flood risk consists of multiple factors including preparedness, awareness, worry, trust, and place attachment. Relations between general theories are relevant to be able to compare these relations to potential relations present in the case-studies.

According to Dooley et al. (1992) and Stevens et al. (2012), there is a positive relation between preparedness and worry for hazardous events. People with a high concern towards hazards are significantly more likely to prepare for them (Lawrence et al., 2014; Stevens et al., 2012). According to Dooley et al. (1992), there is also a strong relation between preparedness regarding hazardous events and the years of residence. Additionally, research has indicated that there is a positive relation between preparedness towards future hazards and prior experience of hazardous events (Castañeda et al., 2020; Coulston & Deeny, 2010.; Oral et al., 2015). Moreover, people who are considered to have more knowledge about a hazard are more likely to prepare themselves for the potential hazard. This means that there is a relation between preparedness and awareness of people (Coulston & Deeny, 2010; Thomas et al., 2015).

As mentioned earlier, prior experience with floods influences the perceived flood-risk. Research shows that people living in high flood-risk areas have more prior experience with flooding than people living in low flood-risk areas (Coulston & Deeny, 2010). Additionally, there is a significant relation between anxiety towards floods and prior experience in dealing with floods (Dwi Rahmah Fitriani et al., 2019).

Paton, D. (2008) states that there is a significant relation between the amount of knowledge someone has about a hazard and the amount of trust in measures being taken to prevent this hazard. Trust in risk management of a hazard decreases the worry people have for this potential risk (Nakayachi, 2011).

An overview of the different relations between the theories can be seen in figure 1, 2, and 3.

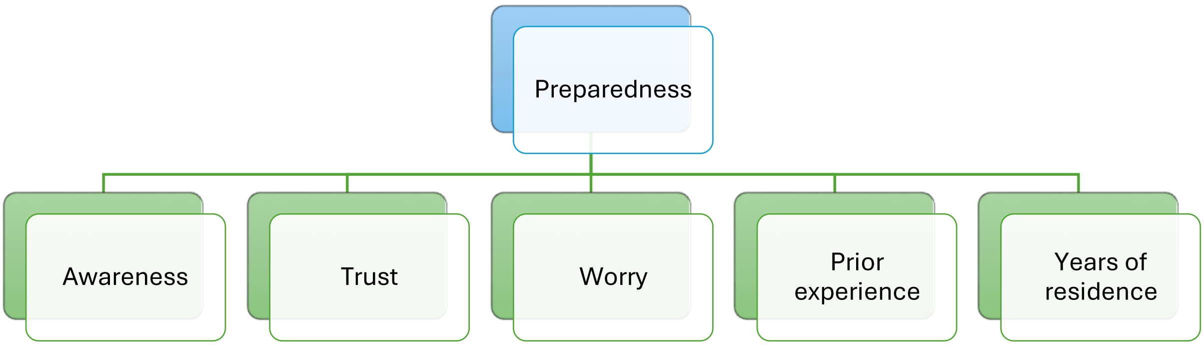


Figure 1: Overview relations between variable "preparedness" and other variables.

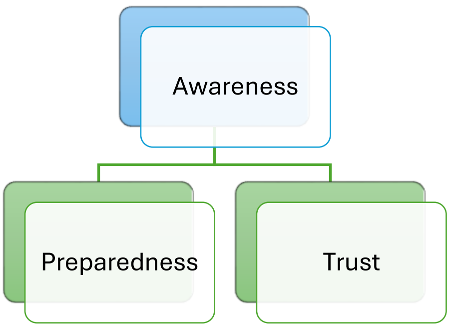


Figure 2: Overview relations between variable "awareness" and other variables.

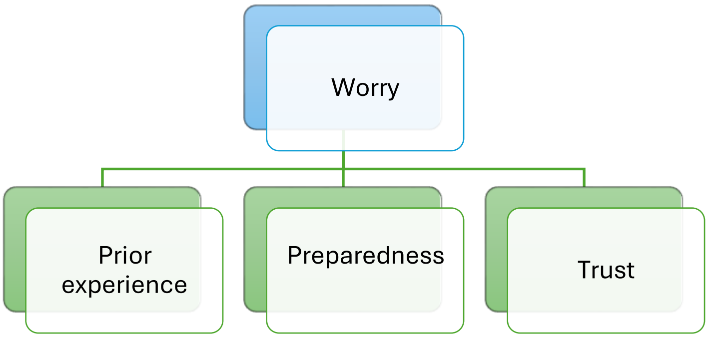


Figure 3: Overview relations between variable "worry" and other variables.

2.6 High-risk and low-risk areas

To compare perceived flood risk in high risk and low risk areas, the analyzed flood risk must be established. Ministerie van Infrastructuur en Waterstaat (2018) has analyzed and collected data about the consequences of flooding in different areas in the Netherlands. The number of people affected by the flooding have been calculated and visualized in maps based on the chance of flooding once every 100 years (figure 4) and once every 1000 years (figure 5) (Ministerie van Infrastructuur en Waterstaat, 2018). From these two maps it can be concluded that there is a difference in severity of floods. In figure 4, the probability of floods is higher since the chances of it happening are once every 100 years. Nevertheless, the floods in figure 5 will be more severe. Although the probability of floods happening in figure 5 are lower the potential impact is higher. Floods with a probability of it happening once every 1000 years will probably be more catastrophic. Another difference is that over 1000 years the chance of people being affected by floods is higher than over 100 years. This is supported by the fact that in figure 5 more people are affected.

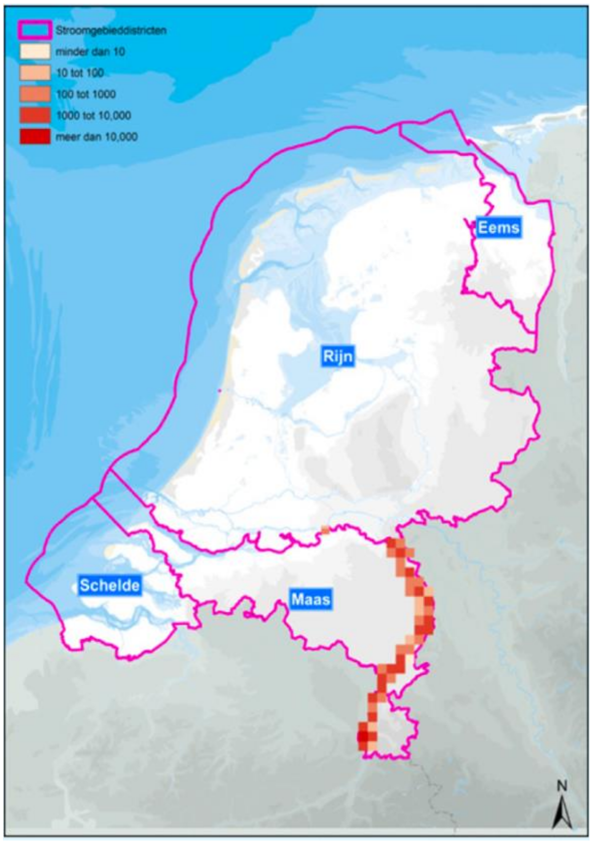


Figure 4: People affected because of flooding caused by breakage of primary flood defence alongside the head water system, chance 1/100 years (Ministerie van Infrastructuur en Waterstaat, 2018).

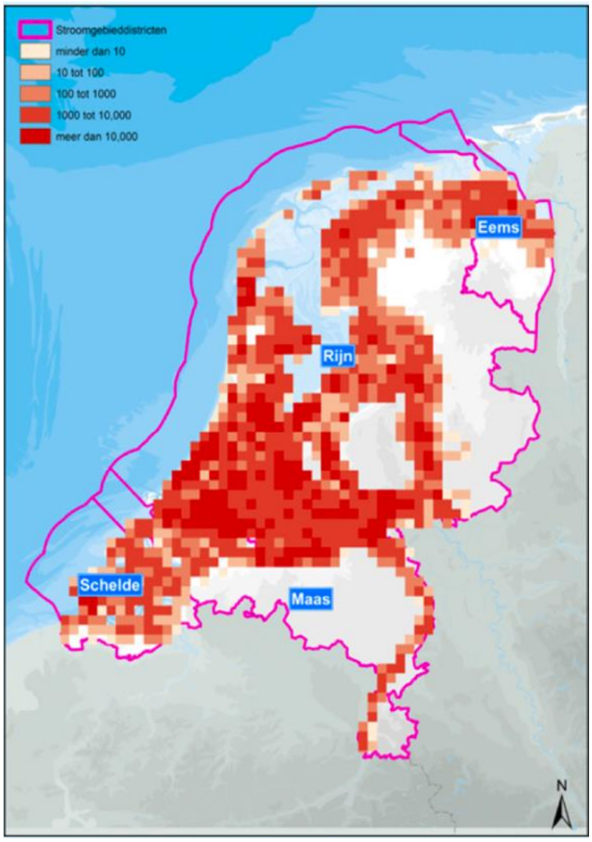


Figure 5: People affected because of flooding caused by breakage of primary flood defence alongside the head water system, chance 1/1000 years (Ministerie van Infrastructuur en Waterstaat, 2018).

2.6 Conceptual model

In this research the perceived flood risk in high flood risk and low flood risk areas has been compared. To determine perceived risk of people following conceptual model was established:

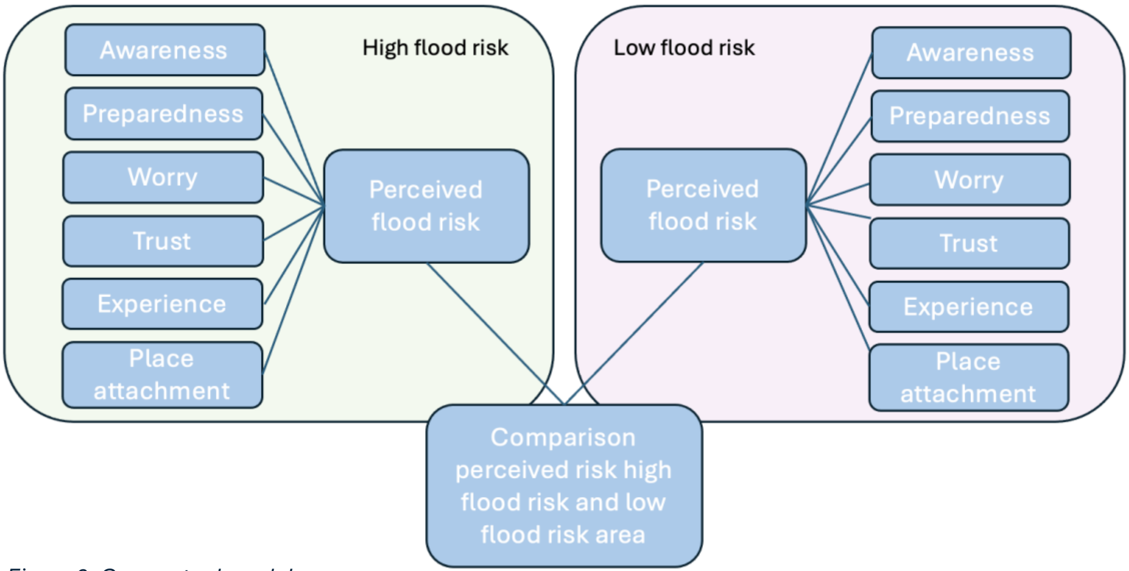


Figure 6: Conceptual model.

2.7 Hypotheses

According to Raaijmakers *et al.* (2008), the frequency and severity of floods happening in a certain area has an influence on how high the flood-risk of people is. Zierikzee has a history with floods caused by the sea in the past and Zandvoort does not (Goudbeek, 2021). This proposes the following hypothesis:

> "*The perceived flood risk of people living in a high flood risk area is higher than the perceived flood risk of people living in a low flood risk area.*"

3. Methodology

3.1 Research area

The areas that have been selected for this research are the town Zierikzee in the province of Zeeland and the town Zandvoort in the province of North-Holland. Zierikzee has a population of 12.015 inhabitants and lies in the south of Schouwen-Duivenland (see location in figure 7). Between Zierikzee and the first contact with the sea is located approximately 1.5 kilometres. This location provides a suitable case study to gather data since it lies below sea level and flooded in the past (Goudbeek, 2021; Zeeuws Archief, n.d). The average height of the surface in this town is between 1.0 metres below sea level and 1.5 metres above sea level (figure 8). The reason why this town is partially located below sea-level is because Zierikzee is located in a polder, a piece of low-laying land reclaimed from the sea and protected by dikes (Zeeuws Archief, n.d). Zierikzee has been exposed to flooding throughout history which creates an extra dimension to knowledge and memories people have regarding flooding (Brader *et al.*, 2011; Goudbeek, 2021; Zeeuws Archief, n.d). The targeted population of this research are the inhabitants of this town.

The other selected location is Zandvoort which has a population of 16.505 inhabitants. Contact between Zandvoort and the sea is less than 1 kilometre. The town lies between 3 and 5 metres above sea level. Zandvoort is located above sea level is because of tidal sedimentation caused by the sea. During the Holocene, sand accumulated along the west coast and created dune complex (Gemeente Zandvoort, 2021; Griede & Kasse, 2005). Zandvoort has been exposed to flooding caused by rain in the past, but the sea does not have an influence in these floods and people are also aware of that (NHA, 2021).

It is important that potential flooding in the chosen areas is not caused by influence of rivers. Research has been conducted on perceived flood risk in river deltas in the past already (Baan, 2004; Botzen *et al.*, 2009; Bullen and Miles, 2024; Mol *et al.*, 2020).

Figure 7: Land-height of Zierikzee in relation to sea-level in metres (AHN, 2024).

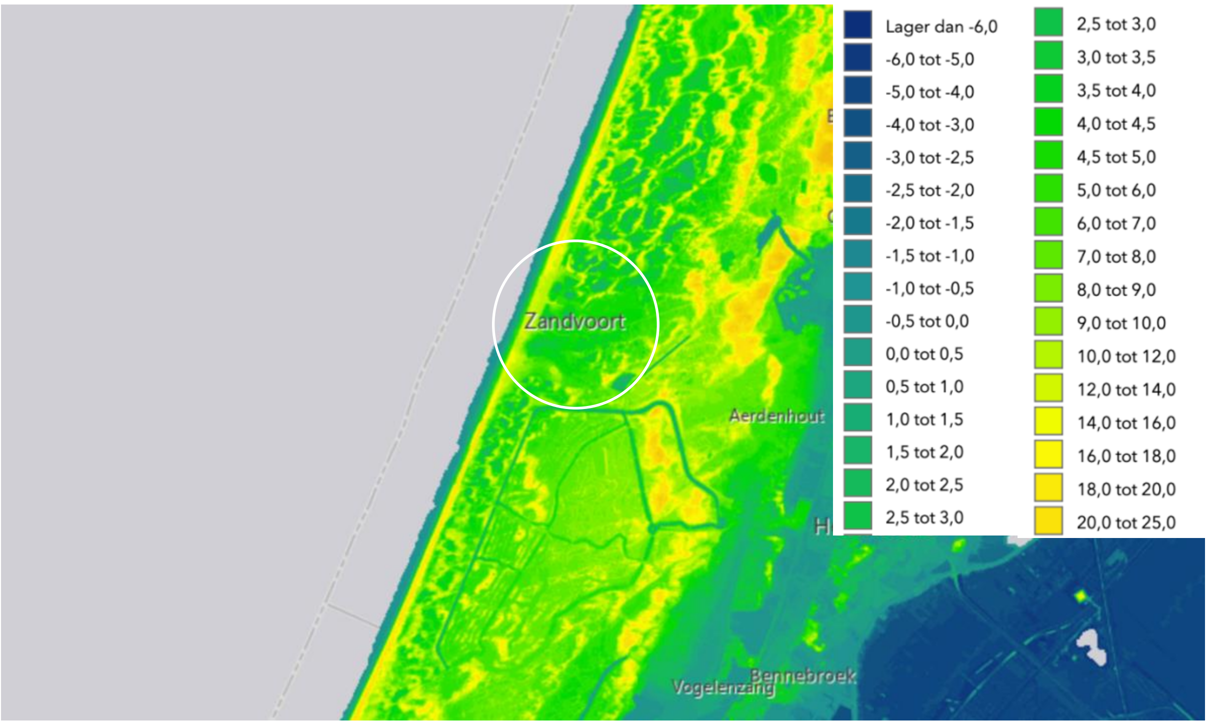


Figure 8: Land-height of Zierikzee in relation to sea-level in metres (AHN, 2024).

3.2 Data collection

Data has been collected via a quantitative research method. Quantitative research was chosen since it provides numerical data suitable for comparative analysis. It allows for making general claims about a broader population by collecting data from a representative sample. Quantitative research gives the possibility to perform a statistical analysis on data and quantify relations or patterns between variables. Data has been collected via surveys distributed among the inhabitants of Zierikzee and Zandvoort both through digital and physical means. In both cases convenience sampling was used. Convenience sampling involves selecting participants who are easily accessible and available, in this case based on a geographic location. There are some elements of volunteer sampling since a person who receives an invite to participate in the research can decline.

The survey consists of basic questions to create a better picture of the participants demographics and questions related to perceived flood risk. First, questions go more in depth about floods and the awareness, worry, trust, and preparedness of participants regarding floods. After that, questions are related to age, sex, occupation, and number of years living in the village. Questions about these aspects give a better insight into how people perceive the flood risk in their area. Most of the survey consists of closed questions but at the end of the questionnaire participants are given the opportunity to give suggestions or elaborate on given answers in the form of an open question.

Data collection in Zierikzee has been done by spreading the questionnaire via Facebook. An invitation to provide data by filling a questionnaire and a short explanation about the research was shared in Facebook groups related to Zierikzee, these groups consist of people who either live in Zierikzee or are related to Zierikzee. Examples of these groups are “prikbord Zierikzee”, “Zieriknieuws 2.0”, and “Zierikzee tijdens en na de ramp”. In Zandvoort the questionnaire has been spread via Facebook groups related to Zandvoort. Examples of these groups are “prikbord Zandvoort”, “de Zandvoorter”, and “je bent Zandvoorter als”. Both in Zierikzee and Zandvoort, the questionnaire was open for a period of four weeks.

Due to a small sample in Zandvoort, data needed to be collected on location as well. On the 18th of April flyers were distributed in Zandvoort with information about the research and invitation to fill out the questionnaire. Flyers were handed out to people walking in the city centre, working in shops, or sitting on terraces. Participants who have filled out the form online are more likely to be active online and this must be taken into consideration when processing data. Since there was no significant difference between the sample collected via online platforms and data collected at location, the two samples were combined to one.

3.3 Comparing perceived flood risk in high-risk and low risk-areas

To derive results for this research, perceived flood risk in high-risk areas needs to be compared to low-risk areas. Figures 9 and 10 show the flood probability in Zierikzee and Zandvoort translated in a flood happening in a certain number of years. As mentioned in chapter 2, the higher the number of years for a flood to occur, the lower the probability of floods and vice versa. At the same time, the potential impact becomes higher when the flood probability decreases. Figures 8 and 9 show the maximum water depth during a dike breach in the area which gives an inside into how severe flooding would be in Zierikzee and Zandvoort. Zierikzee has a relatively high flood risk and water will have a depth of 1.5 to 5.0 meters during dike breaches (figure 9 and 11). In Zandvoort the water depth during floods is 0.0 meters and there is a very low flood risk (figure 10 and 12).

Both areas have been compared by comparing the data from the quantitative data collection. By looking at the factor’s awareness, preparedness, worry, trust, experience, and place attachment the same factors of Zierikzee and Zandvoort can be compared with each other. Since the factor proximity to potential flood source is similar between the two locations, this does not form a potential influence on results.

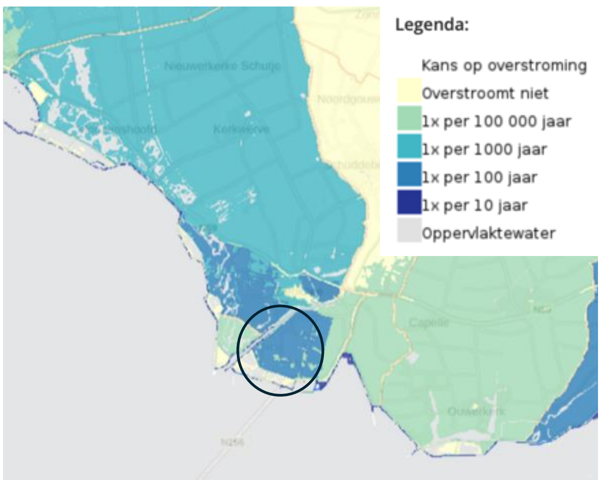


Figure 9: Flood probabilities in Zierikzee (Atlas Leefomgeving, 2024).

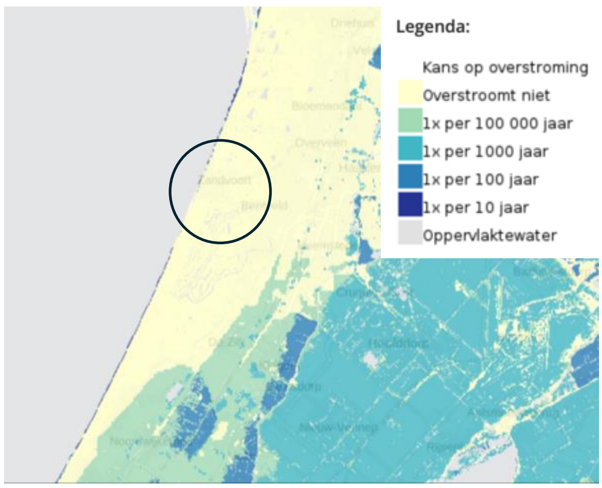


Figure 10: Flood probabilities in Zandvoort (Atlas Leefomgeving, 2024).

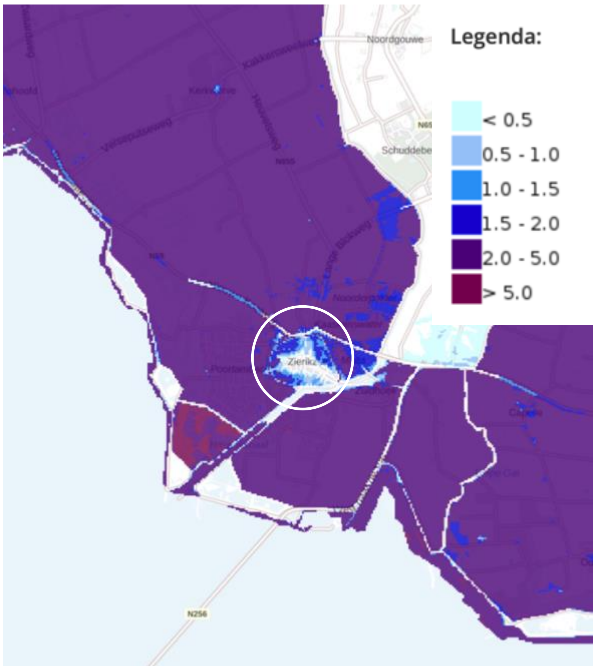


Figure 11: Maximum water depth during dike breach in Zierikzee (Atlas Leefomgeving, 2024).

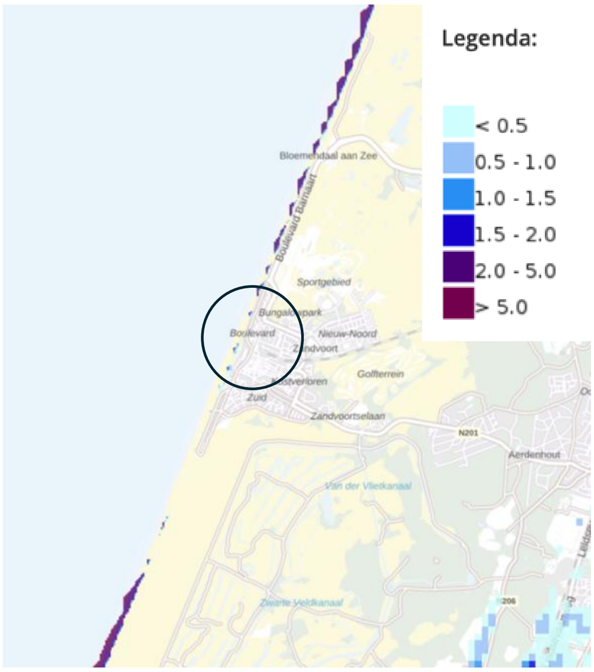


Figure 12: Maximum water depth during dike breach in Zandvoort (Atlas Leefomgeving, 2024).

3.4 Data analyses and SPSS

The collected data consists of nominal, ordinal, interval, and ratio. For the first part, the frequencies of nominal variables have been calculated and compared between Zandvoort and Zierikzee. For the interval and ratio variables, the mean and frequencies of answers have been calculated and compared between Zandvoort and Zierikzee. Descriptive data and visualizations were created in excel. In table 1, the different variables of the questions are explained. The questions related to this table can be found in appendix 1 and a more extensive explanation of the variables used in the questionnaire is shown in appendix 2.

The collected data has been analysed by using SPSS. Table 2 presents an overview of the variables and which statistical tests have been used during the data analysis. An independent samples t-test is suitable for this research since it tests whether there is a significant difference between two variables. To test whether there is a relation between the mentioned variables, a multiple linear regression has been used. A multiple linear regression is suitable for this research since it tests whether there is a relation between multiple variables.

Questionnaire	**Main factors**	**Main variables**
General demographic data	1. General demographic information 2. Geographical locations	1. Gender, age, and education level 2. Geographical locations in the form of postal code
Preparedness	1. Preparation	1. Has a person taken measures to prevent potential flooding
Awareness	1. Height of water 2. Knowledge about flooding 3. Previous experiences with risk event	1. Number of meters of water level during potential floods 2. Scale to value knowledge about flooding 3. Has a person experienced flooding in the past
Worry	1. Worry	1. Scale with level of worry regarding potential flooding
Risk perception	1. Trust 2. Place attachment	1. Scale to value trust in measures taken to prevent flooding 2. Quantity of years having lived in the selected areas

Table 1: General data of questionnaire explained.

Question	**How?**	**Data variable**	**Test**
Is there a difference in mean “worry”?	Compare question 3.	Interval x interval	Independent samples t-test
Is there a difference in mean “preparedness?	Compare question 6.	Nominal x nominal	Independent samples t-test
Is there a difference in mean “awareness”?	Compare question 7.	Interval x interval	Independent samples t-test
Is there a difference in mean “age”?	Compare question 8.	Ordinal x ordinal	Independent samples t-test
Is there a difference in mean “time of residence”?	Compare question 11.	Ratio x ratio	Independent samples t-test
Is there a difference in mean “trust”?	Compare question 4.	Interval x interval	Independent samples t-test
Is there a difference in mean “water-height”?	Compare question 5.	Ratio x ratio	Independent samples t-test
Is there a significant relation between “awareness” and “worry”, “preparedness”, “time of residence”, “trust”, and “water-height”?	Find relation between question 6 and question 3, 4, 5, 7, and 11.	Binary x interval/ratio	Multiple linear regression
Is there a significant relation between “preparedness” and “worry”, “awareness”, “time of residence”, “trust”, and “water-height”?	Find relation between question 7 and question 3, 4, 5, 6, and 11.	Interval x interval/ratio/binary	Multiple linear regression
Is there a significant relation between “worry” and “preparedness”, “awareness”, “time of residence”, “trust”, and “water-height”?	Find relation between question 3 and question 4, 5, 6, 7, and 11.	Interval x interval/ratio/binary	Multiple linear regression

Table 2: Overview of statistical tests being used.

3.5 Ethical considerations

When gathering data from participants it is important to consider ethical considerations. Before starting data collection informed consent for participants is important. Participants will receive a paper with a short introduction about the research and what conditions they are agreeing to. To provide privacy to the participants no data will be collected that can be related to specific individuals. Data that has been collected needs to be secured and protected from misuse. To prevent misuse data will remain in the hands of the two researchers, the two supervisors, and two correctors. No third party will be able to access the data gathered in this research. Data will be stored on the laptops of the two researchers secured by passwords, so other persons are not able to access it. After this research is completed and officially graded, data will be removed from all laptops, so data won't be used with wrong intensions in the future.

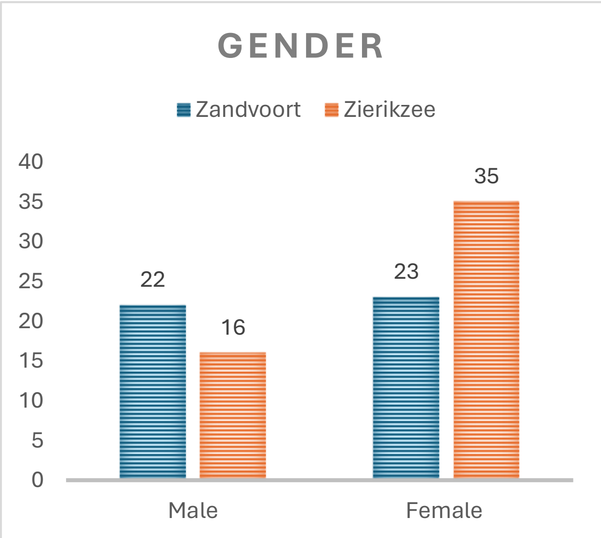
The steps of research need to be transparent to make sure it is trustworthy and future research can reproduce certain parts. Participants who agree on participating in the research are at any time able to refuse or withdraw from it without any consequences.

4. Results

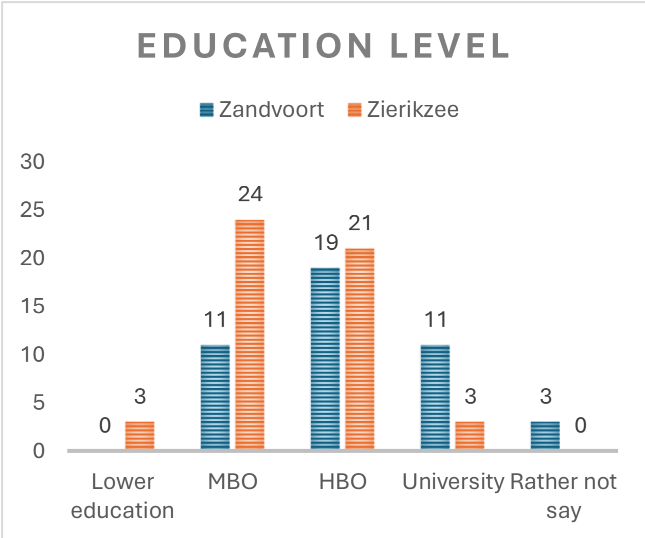
This chapter is divided in two parts. In the first part of this chapter, representativeness of samples is tested, the descriptive data is presented, and it is tested whether there are disparities between Zanvoort and Zierikee. In the second part it is tested whether there are relations between the outcomes of the research and theory discussed in chapter 2.

4.1 Demographics and representativeness

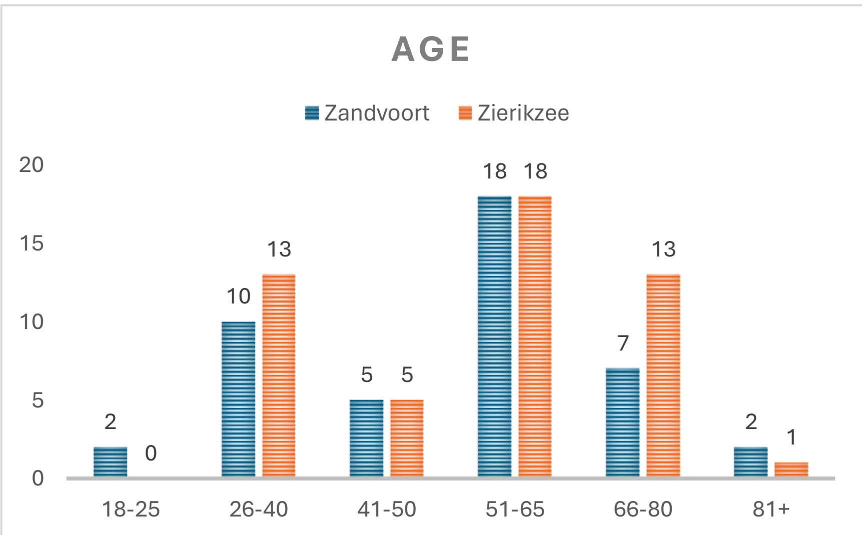
Below, the demographics of Zandvoort and Zierikzee can be seen in graph 1, 2, and 3.



Graph 1: Gender comparison between Zandvoort and Zierikzee.

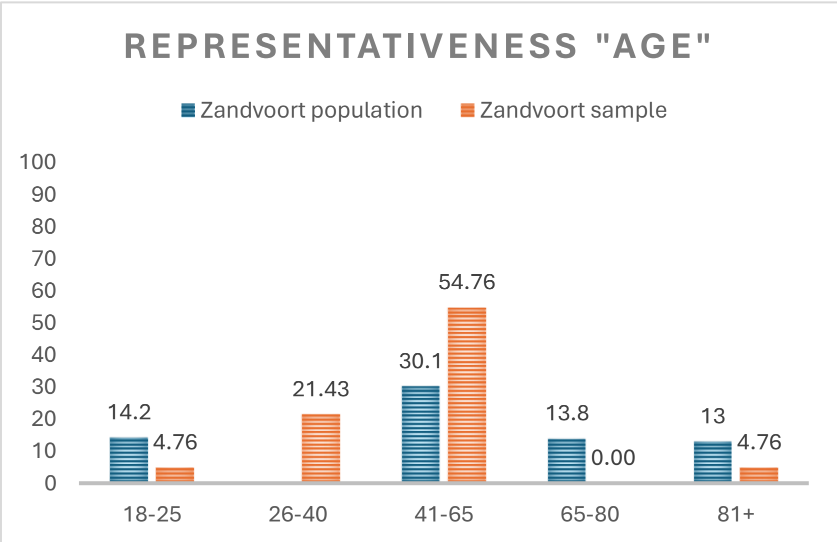


Graph 2: Education level comparison between Zandvoort and Zierikzee.

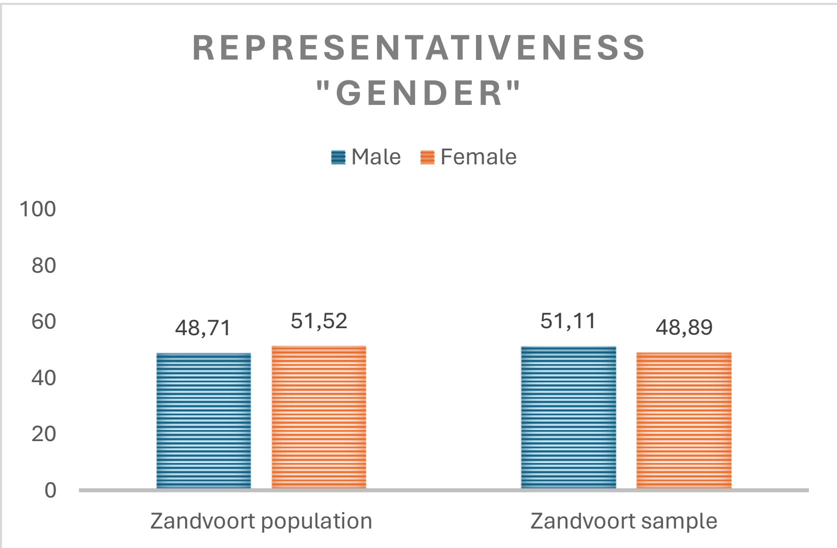


Graph 3: Age comparison between Zandvoort and Zierikzee.

The number of inhabitants of both cities have been mentioned in chapter 3 and were used to determine the representativeness of both samples. The key characteristics of the samples and populations of Zandvoort and Zierikzee were examined to assess the representativeness of the sample population. When comparing the variable "*age*" between the population and sample of Zandvoort there is a difference in all age categories (graph 4). This might imply that there is sampling bias since there is overrepresentation of the age groups "*26-40" and* "*41-64*", and underrepresentation of the other age groups. The sample of Zandvoort has a good representation for the population regarding gender since the percentages are nearly the of the sample and population are nearly the same.

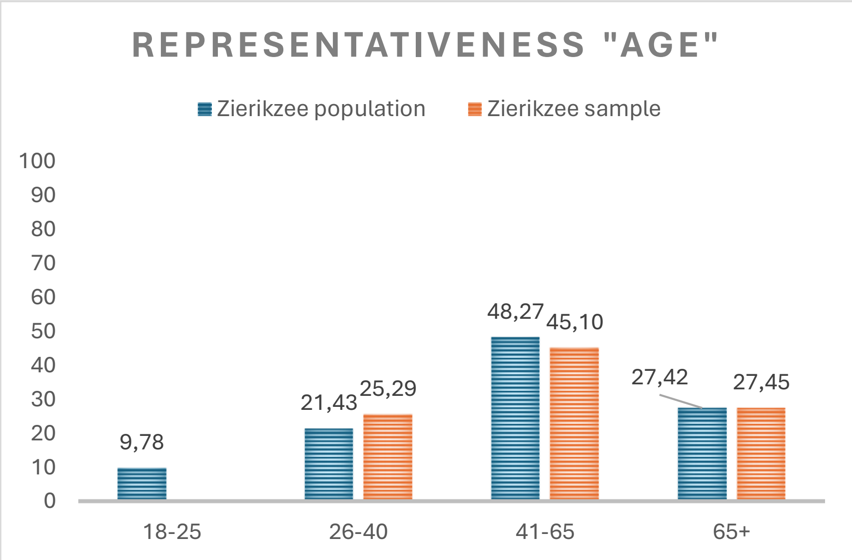


Graph 4: Comparison category "age" between population and sample of Zandvoort in percentages (AlleCijfers.nl, 2024).

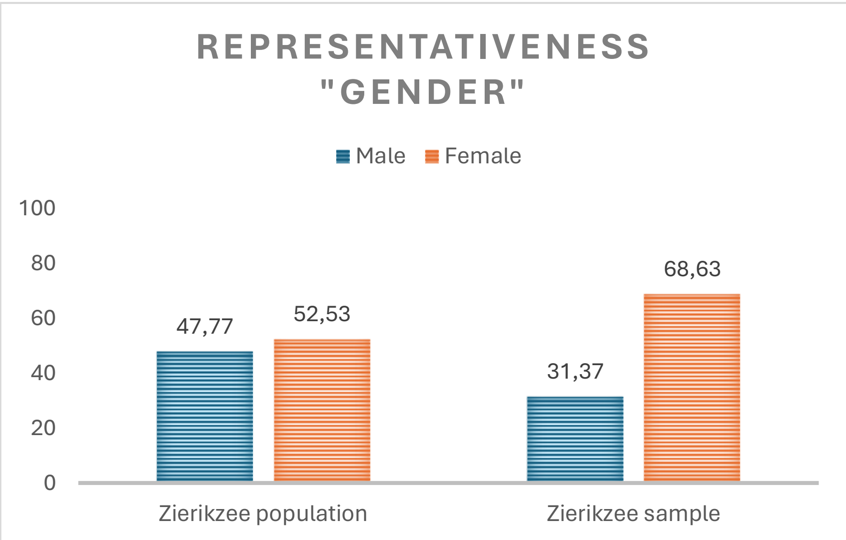


Graph 5: Comparison category "gender" between population and sample of Zandvoort in percentages (AlleCijfers.nl, 2024).

For Zierikzee, there is also a difference between the population and sample when comes to "*age*". There is an underrepresentation of the category "*18-25*" in the sample (graph 6). When looking at "*gender*", there is an overrepresentation of the category "*females*" in the sample of Zierikzee (graph 7). This once again implies there might be sampling bias.



Graph 6: Comparison category "age" between population and sample of Zierikzee in percentages.



Graph 7: Comparison category "gender" between population and sample of Zierikzee in percentages (AlleCijfers.nl, 2024).

4.2 Descriptive data

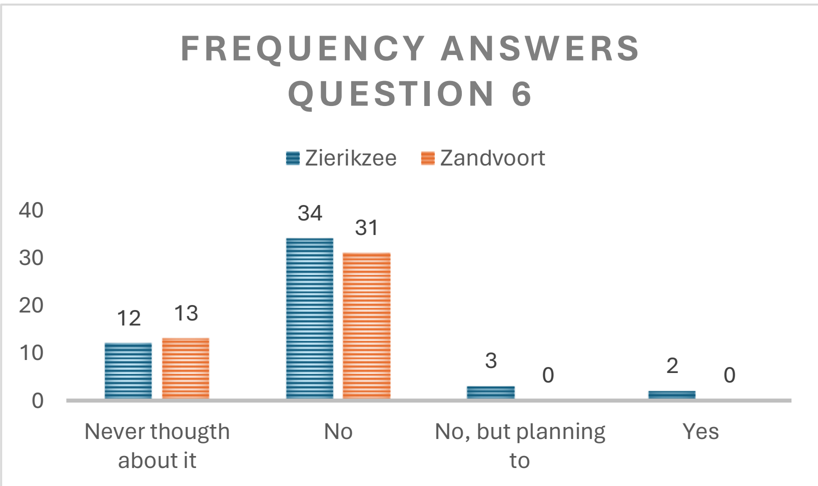
After removing the invalid responses there is a sample of 97 responses. Table 3 shows a summary of the descriptive statistics for both Zandvoort and Zierikzee.

	Zandvoort (n = 45)	**Zierikzee (n = 52)**	**Significance**
Frequency category "preparedness"	No (n = 32) Never thought about it (n = 13)	No (n = 34) Never thought about it (n = 12) No, but planning to (n = 3) Yes (n = 2)	p = 0,017*
Mean category "awareness"	5,068	5,294	p = 0,676
Frequency category "experience"	No (n = 2) No, but someone in my social circle (n = 40) Yes (n = 2)	No (n = 8) No, but someone in my social circle (n = 36) Yes (n = 7)	p < 0,001*
Mean category "worry"	2,500	3,588	p = 0.010*
Mean category "trust"	7,636	7,098	p = 0,216
Mean height of water	0,646	2,164	p < 0,001*
Mean category "time of residence"	27,036	32,098	p = 0,203

Table 3: Descriptive data for Zandvoort and Zierikzee (means significant).*

4.2.1 Preparedness

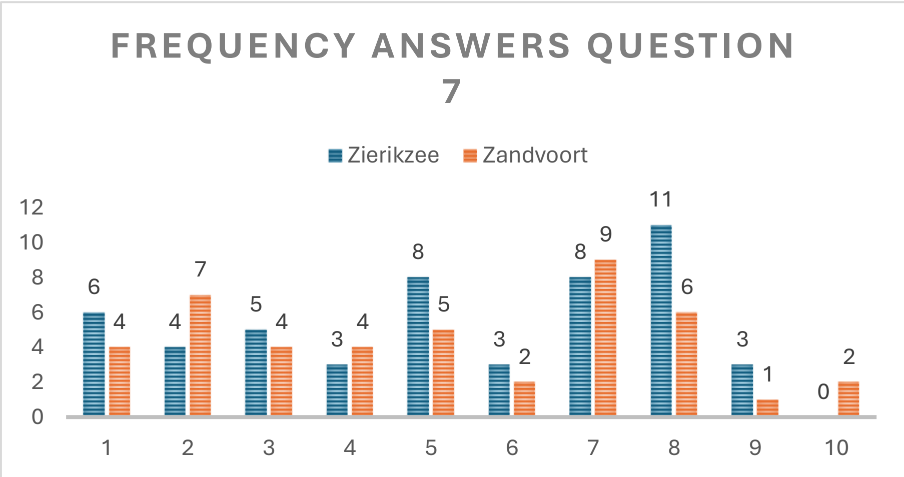
Graph 8 shows that, apart from the categories "no, but planning to" and "yes", the difference in preparedness between residents of Zierikzee and Zandvoort is little. The only clear difference is that 5 residents of Zierikzee have already taken measures or are planning on doing so while none of the people in Zandvoort have taken measures nor are planning to. This indicates that Zierikzee might be more prepared when it comes to flooding compared to Zandvoort. The independent samples t-test shows that there is a significant difference in preparedness between Zandvoort and Zierikzee (table 3).



Graph 8: Frequency of answers preparedness for both Zierikzee and Zandvoort.

4.2.2 Awareness

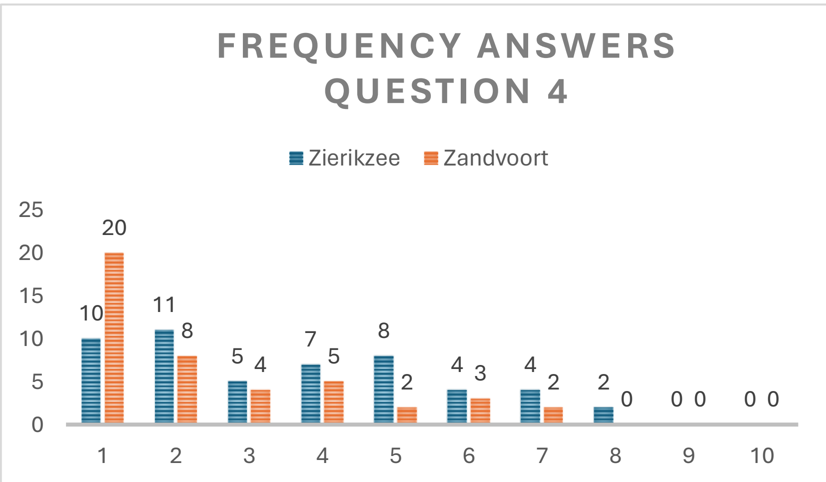
As can be seen in table 3, the average awareness for Zandvoort and Zierikzee is almost the same. The only clear difference is the higher frequency of answers at value 8 (graph 9). The answers for Zandvoort are more equally distributed throughout the scale. Still, the indication is that there is no difference in awareness between the two cities. The independent samples t-test shows that there is no significant difference in awareness between Zandvoort and Zierikzee (table 3).



Graph 9: Frequency of answers awareness for both Zierikzee and Zandvoort.

4.2.3 Worry

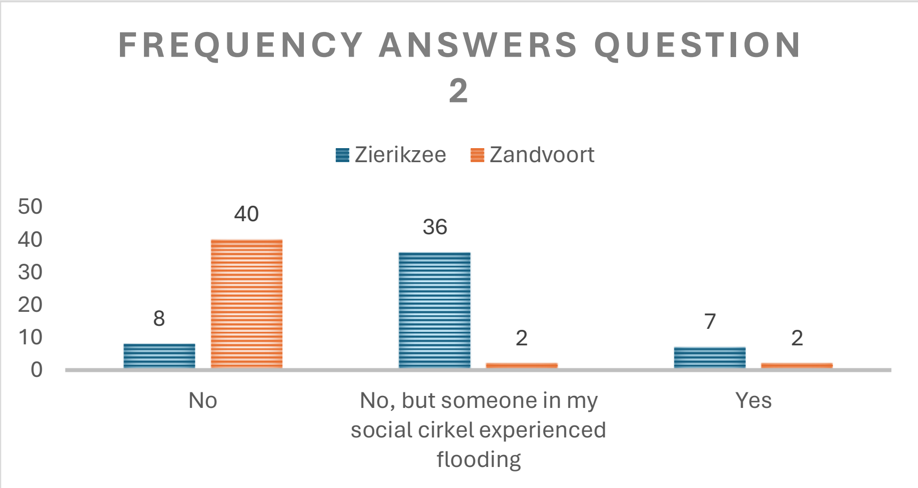
Table 3 shows the calculated means of Zandvoort and Zierikzee. The average mean in Zierikzee is higher according to table 3, which might be an indication that people are more worried in Zierikzee than in Zandvoort. Graph 10 shows that the frequency of value 1 is higher which might indicate that a higher number of people are not worried at all in Zandvoort. The answers of Zierikzee are more equally distributed throughout the scale. The independent samples t-test shows that there is no significant difference in awareness between Zandvoort and Zierikzee (table 3).



Graph 10: Frequency of answers worry for both Zandvoort and Zierikzee.

4.2.4 Experience

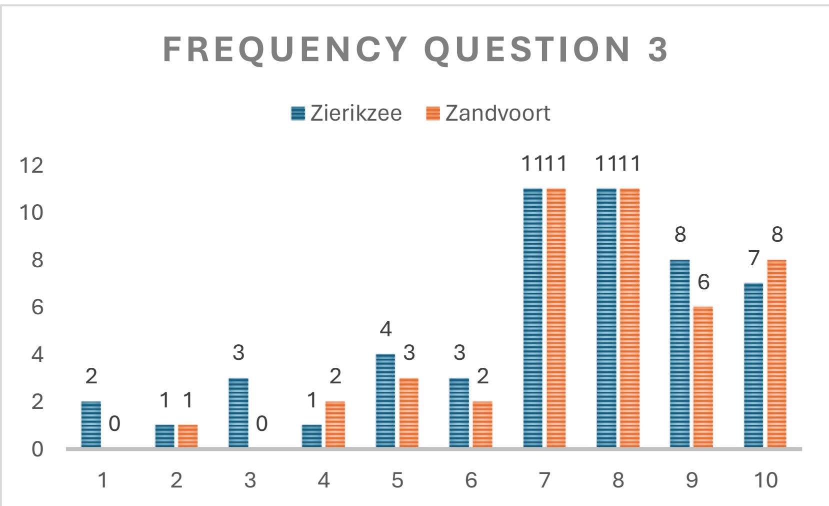
Graph 11 shows that people in Zandvoort have rarely experienced flooding, both themselves and in their social circle. According to graph 11, in Zierikzee, a higher number of people have experienced flooding themselves or through someone in their social circle. The independent samples t-test shows that there is a significant difference between Zandvoort and Zierikzee (table 3).



Graph 11: Frequency of answers prior experience for both Zierikzee and Zandvoort.

4.2.5 Trust

In graph 12 it is shown that there is no clear difference in trust between Zandvoort and Zierikzee. For most of the values, the frequencies of the two cities are similar or the same number. The independent samples t-test shows that there is no significant difference in awareness between Zandvoort and Zierikzee (table 3).



Graph 12: Frequency of answers trust for both Zierikzee and Zandvoort.

4.3 Relation between theories

4.3.1 Change of labels

The labels for the answers in the category "*experience*" and "*preparedness*" have been changed. Originally, the categories for "*experience*" were: "no", "no, but someone in my social circle has", and "yes". The categories for "*preparedness*" were: "no", "no, but planning to", "yes", and "have never thought about it". To be able to perform a multiple linear regression test in SPSS, the variables need to be a numerical variable instead of a string variable. By categorizing the answers in two categories instead of multiple categories, the variable becomes binary.

A chi-square test has been performed to see whether the categories could be decreased to two. For both variables the chi-square was significant for Zierikzee (appendix 4). The chi-square test was only necessary for the category "*experience*" in Zandvoort and is significant (table 5). This is because only the category "no" was present in the variable "*preparedness*". This means that the categories for "*experience*" were decreased to: "no" and "yes". The same applies to "*preparedness*".

4.3.2 Preparedness

The relation between the dependent variable "*preparedness*" and the independent variables "*experience*", "*trust*", "*water height*", "*awareness*", "*time of residence*", and "*worry*" has been tested with the help of a multiple linear regression. In Zierikzee, a significant relation was found between "*preparedness*" and "*awareness*" (table 4). The relation between "*preparedness*" and "*worry*" in Zierikzee is considered significant as well (table 4). The number of people in Zierikzee who have prior experience with flooding is high, nevertheless the number of people in Zierikzee who prepared for potential flooding is low. A potential explanation of this might be the fact that after the floods in 1953 measures to prevent future floods were improved. People might be less worried for potential floods because of the improved measures.

In Zandvoort, there is no relation found between the dependent variable "*preparedness*" and independent variables. The only answer that has been given by the respondents is "no" and consequently, the multiple linear regression could not be carried out.

4.3.3 Awareness

The relation between the dependent variable "*awareness*" and the independent variables "*experience*", "*trust*", "*water height*", "*preparedness*", "*time of residence*", and "*worry*" has been tested by means of a multiple linear regression. In Zierikzee, a significant relation was found between "*awareness*" and "*trust*" (table 4). The relation between "*awareness*" and "*preparedness*" is significant (table 4).

In Zandvoort, no significant relation has been found between "*awareness*" and the independent variables (table 5). An explanation could be the fact that people are less worried in Zandvoort compared to Zierikzee (graph 7). Also, people in Zandvoort have less experience regarding flooding compared to Zierikzee (graph 8).

4.3.4 Worry

The relation between the dependent variable "*worry*" and the independent variables "*experience*", "*trust*", "*water height*", "*awareness*", "*time of residence*", and "*preparedness*" has been tested by means of a multiple linear regression. In Zierikzee, a significant relation was found between "*worry*" and "*experience*" (table 4). There is also a significant relation between "*worry*" and "*preparedness*" (table 4).

In Zandvoort, there is a significant relation between "*worry"* and "*trust"* (table 5).

4.3.5 Overview relations

	Preparedness*	**Awareness***	**Worry***
Preparedness	-	Relation (p = 0,016)	Relation (p = 0,011)
Awareness	Relation (p = 0,016)	-	
Worry	Relation (p = 0,011)		-
Experience			Relation (p = 0,040)
Trust		Relation (p = 0,008)	
Place attachment			
Water height			

Table 4: Overview relations between dependent and independent variables in Zierikzee (is dependent variable).*

	Awareness*	**Worry***
Awareness	-	
Worry		-
Experience		
Trust		Relation (p = 0,015)
Place attachment		
Water height		

Table 5: Overview relations between dependent and independent variables in Zandvoort (is dependent variable).*

5. Discussion

5.1 Discussion of results

In summary, this research aimed at deriving the answer to the question: "*To what extent does perceived flood risk of people differ between high flood risk and low flood risk areas in coastal regions of the Netherlands?"* By means of comparing results gathered from primary research to theories found during literature research.

In the first part, it has been tested whether there are disparities between Zanvoort and Zierikee. Results show disparities in preparedness, worry, experience, and expected water height during floods between Zandvoort and Zierikzee. This implies that living in a high flood-risk area has an influence on preparedness, worry, and prior experience of inhabitants. This is line with theory that high flood-risk areas experience more worry, are more prepared regarding flooding then low flood-risk areas (Botzen *et al.*, 2009; Lindell and Hwang, 2008). The disparity in prior experience regarding flooding between Zandvoort and Zierikzee shows that living in high or low flood-risk areas influences the prior flood experience. This is supported by the theory that people living in high flood-risk areas have more prior experience with flooding than people living in low flood-risk areas (Coulston & Deeny, 2010). According to Lindell & Earl (1983) and Yin *et al.* (2019), perceived risk is related to whether people experienced a hazard before. This means that when a person experienced flooding before either through themselves or through people in their social circle, the personal perceived risk is influenced.

In the second part, the relations between different theories regarding variables that influence perceived flood-risk were tested. Findings show that, in Zierikzee, preparedness is influenced by awareness and worry and the other way around. This is in line with the theory that people with a high concern towards hazards are significantly more likely to prepare for them there is positive relation between preparedness and worry for hazardous events (Dooley et al., 1992; Lawrence et al., 2014; Stevens et al., 2012). The results are also supported by theory that states that people who are considered to have more knowledge about a hazard are more likely to prepare themselves for the potential hazard (Coulston & Deeny, 2010; Thomas et al., 2015). Results also present that awareness in Zierikzee is influenced by preparedness and trust. Theory by Paton, D. (2008) supports that there is a significant relation between the amount of knowledge someone has about a hazard and the amount of trust in measures being taken to prevent this hazard. In Zierikzee, worry is also influenced by experience. This is in line with the theory that states that anxiety towards floods is influenced by prior experience in dealing with floods (Dwi Rahmah Fitriani et al., 2019).

In Zandvoort, worry is only influenced by trust. This is in line with theory by (Nakayachi, 2011) which states that trust in risk management of a hazard decreases the worry people have for this potential risk.

For both Zandvoort and Zierikzee, no relation was found between "*preparedness"* and *"place attachment".* This is contrary to the theory by Dooley et al. (1992), which states that there is a strong relation between preparedness regarding hazardous events and the years of residence. In Zandvoort the potential reason for this outcome is the fact that the category "*preparedness*" could not be used in testing relations between variables since only one answer category was given. In Zierikzee, it was necessary for the variable "*preparedness*" to be re-labelled for it to be used in a multiple linear regression. The statistical test showed that there is no significant difference in the two options of labelling. Nevertheless, it cannot be ruled out that the choice for combining the categories "*no, but I am planning to*" and "*yes*" shows a falsely depicted picture of the given answers. The highest frequency of answers falls in the category "*no, but I am planning to*" so the impact on the frequency after re-labelling is high. To prevent such a situation in future research it is important to have an interval, ratio, or binary variable from the moment a questionnaire is made.

5.2 Reflection

The way data was collected and analyzed for this research caused some limitations. The first limitation is the fact that the labels of the variables "*preparedness*" and "*experience*" were changed from nominal to binary. It is necessary to have numerical variables in order to perform a multiple linear regression and thus were the categories combined which changed the value of the categories. This might have influenced the results in a negative way. In future research all the variables in the questionnaire need to be interval or binary to be able to perform correct multiple linear regressions.

The second limitation is the fact that the samples are not completely representative for the population of Zandvoort and Zierikzee. Not having a representative sample for the population might give results that were initially not expected for the population and cannot be explained. For future research, a larger sample could correct for this problem.

A different way of data collection in the two locations poses the third limitation. In Zierikzee, all data was collected via digital ways, while in Zandvoort data was collected through both digital and physical ways. Data analysis showed there was no clear difference in the samples collected via digital or physical ways. Nevertheless, due to a difference in data collection between the two locations the demographics of the samples might be different.

6. Conclusion

In conclusion, empirical evidence shows that people living in Zierikzee have a higher risk-perception since they are more worried, prepare more for potential flooding, and have more experience regarding prior flooding compared to Zandvoort. The conclusion can be drawn that people living in high flood-risk areas have a higher perceived risk than people living in low flood-risk areas. Thus, it supports the hypothesis made in chapter 1. Furthermore, empirical evidence shows that, in Zierikzee, there is a relation between the theory about preparedness, awareness, worry, and experience. In Zandvoort, there is a relation between the theory about worry and trust. The difference between the two cities regarding the relations between theories might be caused by the fact that preparedness could not be considered.

There are several recommendations for future research to continue this topic. This study is focused on the question whether there are relations between a variety of variables. Research can dive deeper into the strength and direction of these relations and see whether a relation is positive or negative and whether a relation between variables is strong. Future research can also focus on the qualitative side of perceived flood risk by interviewing people and discover more about the thoughts behind the quantitative data.

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Appendixes

Appendix 1

Questionnaire translated in English.

Question for survey to collect quantitative data:

1. To make sure you live in …, please give the four numbers of your postal code.
2. Did you ever experience flooding caused by …?
   1: Yes
   2: No, but someone in my social circle did
   3: No
3. On a scale from 1 to 10, how concerned are you about the possibility of sea-floods caused by … occurring in …?
4. On a scale from 10 to 10, to what extent do you trust current sea-flood measures in your area?
5. In case of flooding caused by …, how high do you think the water level will be in the street you are living in? (Answer in meters).
6. Have you taken any steps to prepare yourself for a potential flooding caused by … in …?
   1: Yes
   2: No, but I am planning to do so
   3: No
   4: I have never thought about it
7. On a scale from one to 10, how much knowledge do you consider yourself to have regarding sea-flood risk and sea-flood risk measures against floodings caused by … in …?
8. What is your age?
   1: 19 – 25
   2: 26 – 40
   3: 41 – 50
   4: 51 – 65
   5: 66 – 80
   6: 81+
   7: Prefer not to say
9. What is your gender?

   1: Male

   2: Female

   3: Other

   4: Prefer not to say.

10. What is your level of education?

    1: Lower education

    2: MBO

    3: HBO

    4: University

5: Prefer not to say

11. How many years have you lived in …?
12. Do you have any remark, suggestions, or elaboration regarding the question or sea-flood in general?

Appendix 2

Overview of variables present in the questionnaire and what has been measured with these variables.

Question	Type of variable	What has been measured?
1	Binary	Confirming whether someone lives in the required area.
2	Nominal	
3	Interval	This question shows how worried someone is regarding flooding, and this is compared between the two areas. There was also looked at a possible significant relation between question 3 and question 4, 6, 7, and 11.
4	Interval	This question shows the trust someone has in flood prevention measures, and this is compared between the two areas. There was also looked at a possible significant relation between question 4 and question 3, 6, 7, and 11.
5	Ratio	This question shows the prediction of how high water will come during a flood. The data can be compared between the two areas.
6	Nominal	This question shows the preparedness of a person when it comes to flooding and it was also compared between the two places. There was also looked at a possible significant relation between question 6 and question 3, 4, 7, and 11.
7	Interval	This question shows knowledge of a person when it comes to flooding and it was also compared between the two places. There was also looked at a possible significant relation between question 7 and question 3, 4, 6, and 11.
8	Ordinal	The age, which is used to look at whether the sample is representative for the population.
9	Nominal	The gender, which is used to look at whether the sample is representative for the population.
10	Nominal	The education level, which is used to see whether there is a significant relation between question 10 and question 7.
11	Ratio	This question can show place attachment. There was looked at whether there is a significant relation between question 11 and question 3, 4, 6, and 7.
12	Open question	Can give a deeper understanding to certain aspects of this research in case people give an elaboration of their thoughts. But is not necessary to use in case there is no relevant information.

Appendix 3

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Time_of_residence	Equal variances assumed	,213	,645	-1,284	89	,101	,203	-5,87245	4,57505	-14,96298	3,21808
	Equal variances not assumed			-1,286	87,377	,101	,202	-5,87245	4,56801	-14,95131	3,20642
Trust	Equal variances assumed	1,713	,194	1,224	93	,112	,224	,53832	,43969	-,33481	1,41146
	Equal variances not assumed			1,247	92,144	,108	,216	,53832	,43184	-,31932	1,39597
Water_height	Equal variances assumed	6,838	,011	-5,303	86	<,001	<,001	-1,51770	,28619	-2,08663	-,94877
	Equal variances not assumed			-5,451	67,507	<,001	<,001	-1,51770	,27841	-2,07334	-,96206
Worry	Equal variances assumed	1,631	,205	-2,647	93	,005	,010	-1,08824	,41115	-1,90470	-,27177
	Equal variances not assumed			-2,671	92,944	,004	,009	-1,08824	,40737	-1,89720	-,27927
Prepared_or_planning_to	Equal variances assumed	23,574	<,001	-2,164	93	,017	,033	-,09804	,04531	-,18801	-,00806
	Equal variances not assumed			-2,331	50,000	,012	,024	-,09804	,04205	-,18251	-,01357
Awareness	Equal variances assumed	,093	,762	-,419	93	,338	,676	-,22594	,53865	-1,29559	,84372
	Equal variances not assumed			-,418	90,050	,338	,677	-,22594	,53993	-1,29859	,84672
Personal_or_social_experience	Equal variances assumed	3,855	,053	-10,942	93	<,001	<,001	-,75223	,06874	-,88874	-,61572
	Equal variances not assumed			-11,131	92,359	<,001	<,001	-,75223	,06758	-,88644	-,61801
Gender	Equal variances assumed	6,942	,010	-1,862	93	,033	,066	-,18627	,10003	-,38491	,01236
	Equal variances not assumed			-1,852	88,522	,034	,067	-,18627	,10060	-,38618	,01363

Appendix 4

Test Statistics

	Personal_or_social_experience	Personal_experience
Chi-Square	29,455[a]	36,364[a]
df	1	1
Asymp. Sig.	<,001	<,001

a. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 22,0.

Table 3: Results chi-squares test the category "experience" in Zierikzee.

Test Statistics

	Prepared	Prepared_or_planning_to
Chi-Square	43,314[a]	32,961[a]
df	1	1
Asymp. Sig.	<,001	<,001

a. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 25,5.

Table 4: Results chi-squares test category "preparedness" in Zierikzee.

Test Statistics

	Personal_or_social_experience	Personal_experience
Chi-Square	29,455[a]	36,364[a]
df	1	1
Asymp. Sig.	<,001	<,001

a. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 22,0.

Table 5: Results chi-squares test category "experience" in Zandvoort.

Appendix 5

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-,263	,233		-1,131	,265
	Worry	,059	,022	,395	2,667	,011
	Awareness	,046	,018	,376	2,524	,016
	Personal_or_social_experience	,050	,143	,061	,352	,727
	Trust	-,030	,022	-,206	-1,386	,174
	Water_height	,024	,027	,124	,889	,380
	Time_of_residence	,002	,002	,105	,700	,488

a. Dependent Variable: Prepared_or_planning_to

Table 3: Output multiple linear regression dependent "preparedness" in Zierikzee.

Appendix 6

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	,983	1,956		,502	,618
	Worry	-,146	,197	-,120	-,741	,463
	Prepared_or_planning_to	3,144	1,245	,382	2,524	,016
	Personal_or_social_experience	2,239	1,128	,331	1,986	,054
	Trust	,471	,169	,390	2,781	,008
	Water_height	-,129	,222	-,082	-,580	,565
	Time_of_residence	-,018	,018	-,152	-1,010	,319

a. Dependent Variable: Awareness

Table 3: Output multiple linear regression dependent variable "awareness" in Zierikzee.

Appendix 7

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	5,161	2,393		2,157	,038
	Worry	-,262	,247	-,184	-1,063	,295
	Personal_or_social_experience	1,523	1,563	,147	,975	,336
	Trust	,142	,247	,099	,576	,568
	Water_height	-,922	,529	-,286	-1,744	,090
	Time_of_residence	,002	,019	,015	,098	,923

a. Dependent Variable: Awareness

Table 3: Output multiple linear regression dependent variable "awareness" in Zandvoort.

Appendix 8

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	6,257	1,239		5,049	<,001
	Prepared_or_planning_to	2,690	1,008	,399	2,667	,011
	Awareness	-,097	,131	-,119	-,741	,463
	Personal_or_social_experience	-1,946	,914	-,351	-2,128	,040
	Trust	-,177	,149	-,180	-1,191	,241
	Water_height	,204	,179	,159	1,136	,263
	Time_of_residence	,003	,015	,030	,197	,845

a. Dependent Variable: Worry

Table 3: Output multiple linear regression dependent variable "worry" in Zierikzee.

Appendix 9

Testing significance of the variable "preparedness" when combining the 3 categories into two categories.

Zierikzee

Worry is dependent variable:

- Phase 1: Preparedness is significant.
- Phase 2: Preparedness and awareness are significant.
- Phase 3: when adding experience, awareness and preparedness are not significant.
- Phase 4: when adding trust, awareness is still insignificant, experience has become significant. Trust is insignificant.
- Phase 5: when adding water height, awareness and trust are still insignificant. Experience and preparedness is still significant. Water height is insignificant.

- Phase 6 (lisa): when adding place attachment, awareness trust and water height are still insignificant. Experience and preparedness still significant. Place attachment is insignificant.
- Fase 7 (Karlijn): when adding gender, awareness trust and water height are still insignificant. Experience and preparedness still significant. Gender is insignificant.

Preparedness is dependent variable:

- Fase 1: Worry is significant.
- Fase 2: Worry and awareness are significant.
- Fase 3: when adding experience, worry and awareness are significant. Experience is insignificant.
- Fase 4: when adding trust, awareness and worry still significant. Experience and trust insignificant.
- Fase 5: when adding water height, awareness and worry still significant. Experience and trust and water height insignificant.
- Fase 6 (lisa): when adding place attachment, awareness and worry still significant. Experience and trust and water height insignificant. Place attachment is insignificant.
- Fase 7 (Karlijn): when adding gender, awareness and worry still significant. Experience and trust and water height insignificant. Gender is significant.

Awareness is dependent variable:

- Fase 1: Worry is insignificant.
- Fase 2: Worry and preparedness are significant.
- Fase 3: when adding experience, preparedness is significant. Experience and worry insignificant.
- Fase 4: when adding trust, preparedness and trust significant. Experience and worry insignificant.
- Fase 5: when adding water height, preparedness and trust significant. Experience, water height, and worry insignificant.
- Fase 6 (lisa): when adding place attachment, preparedness and trust significant. Experience, water height, place attachment and worry insignificant.
- Fase 7 (Karlijn): when adding gender, preparedness and trust significant. Experience, water height, gender and worry insignificant.

Zandvoort

Worry is dependent variable:

- Phase 1: awareness is significant.
- Phase 2: awareness is significant. Experience is insignificant.
- Phase 3: when adding trust, awareness and experience are insignificant. Trust is significant.
- Phase 4: when adding trust, awareness, water height, and experience are insignificant. Trust is significant.

- Phase 5 (lisa): when adding place attachment, water height, place attachment, and experience are insignificant. Trust is significant.
- Fase 6: (Karlijn): when adding gender, water height, gender, and experience are insignificant. Trust is significant.

Awareness is dependent variable:

- Fase 1: Worry is significant.
- Fase 3: when adding experience, worry significant. Experience insignificant.
- Fase 4: when adding trust, worry, experience, and trust insignificant.
- Fase 5: when adding water height, worry, experience, water height, and trust insignificant.
- Fase 6 (lisa): when adding place attachment, worry, experience, water height, place attachment, and trust insignificant.
- Fase 7 (Karlijn): when adding gender, worry, experience, water height, and trust insignificant. Gender is significant