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Awareness among users of a public space of its multifunctionality as green infrastructure: driving factors and awareness development strategy

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Summary

Cities must adapt to the effects of climate change and increase their resilience to them. Green infrastructure (GI) aids urban adaptation and resilience building efforts. Citizens' attitudes to GI determine its uptake, while citizens with awareness of resilience initiatives have more engagement with and commitment to resilience. Awareness can be increased through awareness-raising strategies. The case of Westersingel urban floodplain, an example of a GI public space in Rotterdam which provides a flood protection function, was chosen for this research. This research assessed the public space users' awareness of its resilience functions, as well as the driving factors of this awareness. Lastly, an awareness-raising strategy was designed for this case. The awareness of Westersingel urban floodplain users was assessed using a structured interview, along with information regarding the driving factors of awareness determined in the literature. Correlation analysis was done to determine the effect of different driving factors. Lastly, these results were used to design strategy for Rotterdam to raise awareness of the benefits of GI for climate adaptation and resilience. Only 4.4% of the sample was aware of the space's flood protection function, while a further 2.9% were aware of other, specific resilience functions of the space. The largest category of respondents (48.5%) was not aware of any functions which the space could provide. Awareness is therefore assessed to be very low, which indicates a low engagement with urban resilience and ways to increase it. Factors with a significant relationship with awareness were a perception of flooding as a personal problem, a perception of flooding as a problem for Rotterdam, and environmental project involvement, though no strong relationship was found. There are likely further unknown factors with an effect on awareness. Low awareness indicates low engagement with resilience within the citizens surveyed for this study. Given the driving factors for awareness, this means that cultivating a perception that flooding is a problem which affects people personally, as well as the city, could increase people's awareness towards solutions for it, as well as engagement with other environmental projects. An awareness-raising strategy could also be used, focusing on the benefits which GI can provide, such as improvement to the neighbourhood aesthetic, more natural areas and flood protection. This would lead to higher awareness and urban resilience.

Keywords

Resilience, Green Infrastructure, Multifunctionality, GI Function Awareness, Awareness-Raising

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Chapter 1: Introduction

1.1 Background

As climate change moves more into public consciousness, cities around the world are beginning efforts to adapt to its effects. As a port city, 80 percent of which lies below sea level (Khader, 2021), Rotterdam has an intimate relationship with water. The city has developed a system of dikes to protect the city, which lies on the river Nieuwe Maas, from flooding. The threat which water poses is not limited to the river and rising sea (only 50 kilometres away), but equally in the weather patterns which climate change brings about. For the Netherlands, climate change is projected to bring, among other effects, increased intense rainfall (van den Hurk et al., 2007) which increases the risk of pluvial flooding. Pluvial flooding can be very disruptive to the normal functioning of the city by damaging or rendering unusable crucial infrastructure, such as roads, tunnels, public transport services and sewer systems.

In recent years, Rotterdam has been planning and acting to increase its resilience to climate change impacts such as flooding. Resilience is "the ability of a city … to resist, absorb, adapt to and recover from … shocks … to keep critical services functioning" (Bång & Rankin, 2016). One way in which Rotterdam increases its resilience is the use of multifunctional urban design and green infrastructure (GI), which has resulted in multiple different water-related resilience projects. Some of these are the Museumpark parking garage, which doubles as underground stormwater storage, the Benthemplein Watersquare, which acts as a stormwater detention pond during heavy rains, and the Westersingel urban floodplain, which provides a scenic canal walking route and simultaneously acts as a stormwater retention pond (see Figure 1), preventing the surrounding areas from flooding. These multifunctional designs are so seamlessly integrated into the urban fabric that their resilience function could be entirely overlooked by their daily users, such as pedestrians on a stroll. Such integration into the urban fabric is desirable and partly enables the multifunctionality of these projects, as otherwise they would not be usable for other purposes such as a parking garage or an open public space. However, with this level of integration comes invisibility of the functional aspects of these projects to those who are not educated in urban resilience. It can be beneficial, however, for citizens to be conscious of the resilience efforts of their city, both to build trust in the city's ability to care for its citizens and for citizens to see that climate adaptation is being tackled successfully, in their city. It can inspire hope, showing that climate adaptation is possible, and

inspire further ideas which citizens may use within their own everyday lives. In the long-term, this could help initiate a cultural shift in which citizens are more conscious about climate change and proactive about adapting to it, incorporating ideas of resilience and adaptation in their everyday lives.

Figure 1: Westersingel Urban Floodplain under normal conditions and flooded

Sources: Author's photos and *https://unfccc.int/files/adaptation/cancun_adaptation_framework/application/pdf/rotterdam_climate_proof.pdf*

The Rotterdam Climate Change Adaptation Strategy predicts several climate change impacts for the city. Winters will become wetter with increasingly intense rainfall, while summers will experience more frequent and severe rainfall events, along with other extreme weather conditions which could all lead to more frequent and intense episodes of flooding (Rotterdam Climate Initiative, 2013). The strategy recognises the risks of disruption and damage caused by flooding, especially in areas with lower water storage capacities and dense, paved urban areas (Rotterdam Climate Initiative, 2013). The Rotterdam Climate Change Adaptation Strategy proposes a solution to the problems brought by intense rainfall: "Where possible, in

all parts of the city, rainwater must be captured and retained where it falls and drainage delayed" (Rotterdam Climate Initiative, 2013, p. 80). One of the ways to achieve this is to increase the water storage capacity of public areas, 'waterproofing' them to "temporarily [store] water on the streets without causing any damage" (ibid, 2013, p. 80). The Westersingel Urban Floodplain embodies these principles in its design and function and is used as an example of a water storing public space in the strategy.

1.2 Problem Statement / Motivation

Urban climate adaptation and resilience is a much-discussed scientific topic with a large body of research behind it, both in terms of broad theory and specific adaptation and resilience measures. In relation to resilience to flooding, stormwater retention ponds, such as the Westersingel urban floodplain in Rotterdam, have been researched extensively. Most research focuses on the technical level in their ability to regulate stormwater flows and provide ecosystem services (Flynn & Davidson, 2016; Kopp & Preis, 2019; Moore & Hunt, 2012; Ramos et al., 2017). Where research is still lacking, however, is citizens' needs and beliefs regarding the benefits they can derive from GI (Derkzen et al., 2017) such as an urban floodplain and park. To successfully implement GI-based climate adaptation initiatives, citizens' awareness of, and way of thinking about, GI and its benefits needs to be better understood. This way, adaptation strategies can be fit to the local context in which they need to be implemented (Derkzen et al., 2017).

How aware the public is of the multifunctional resilience initiatives in their city is an underexplored area of research. There are still many unknowns regarding people's understanding of climate impacts, and the degree to which they are aware of and acknowledge the benefits of GI in climate adaptation (Derkzen et al., 2017). However, awareness among the public has known effects. Awareness in the context of climate change means consciousness about risks and knowing how to act to reduce hazard exposure (Iturriza et al., 2020). When citizens are aware of and understand the purposes of resilience initiatives, they can see that there are ways to effectively tackle the impacts of climate change, which results in more engagement with and commitment to resilience (Iturriza et al., 2020). This ultimately makes a city more resilient.

One of the ambitions for the city of Rotterdam laid out in the Rotterdam Climate Change Adaptation Strategy is to "increase the involvement of the inhabitants of Rotterdam with their city" (Rotterdam Climate Initiative, 2013, p. 22). Furthermore, some concrete objectives include minimizing the disruption from extreme rainfall patterns, making the city's inhabitants aware of the effects of climate change and their role in the city's adaptation efforts, and providing a comfortable and attractive urban environment. These objectives are in line with the functions of the Westersingel canal urban floodplain and may be addressed through a strategy to raise citizens' awareness of these functions.

1.3 Research Objectives

The research objective is to assess the levels of awareness of the resilience initiative within the users of the public space. How aware are people of the fact that the public space they are using has been designed with multiple functionalities which, among other things, increase the city's resilience to flooding? What proportion of users is aware and what proportion is unaware? What differences in their awareness levels can be determined, and what factors explain these differences? This research will bridge the gap identified in the research by directly assessing the general public's awareness of a resilience initiative near them. This research can help progress climate adaptation and resilience by gaining a more complete understanding of how these initiatives are received by the public and how they exist in their consciousness. It furthermore enables gauging how engaged the public is with this piece of resilient GI in their city.

A second objective of this research is to design an awareness building strategy. The understanding of the public's awareness of resilience gained through this study will be used to tailor this strategy to the area being researched. Further input will be taken from academic literature about awareness-building strategies.

1.4 Research Question

This research is guided by the research question "How aware are users of Westersingel Urban Floodplain, a multifunctional design urban public space in Rotterdam, of its flood resilience function?". This research furthermore investigates two sub-questions: "Which factors drive this awareness?" and "How can awareness be developed in this context?".

1.5 Significance of this study

This study can help in addressing the questions in the literature about what factors drive awareness of GI functions by testing different factors' correlation with awareness. It furthermore uses a more direct approach to measuring awareness by using a target population of GI space users who are somewhat familiar with the space. Respondents therefore can answer more accurately about the functions they perceive as they are in the space while they respond to the survey questions than if the survey were conducted, say, door to door. Furthermore, this study aims to combine the data gathered about awareness of GI functions with a strategy to raise awareness, thereby taking the next step in increasing urban resilience in the context of this Rotterdam neighbourhood. This study furthermore aims to provide stepping stones for small-scale GI awareness-raising efforts elsewhere.

1.6 Structure of the Thesis

The thesis is structured as follows: In the next chapter, the current academic literature on the subjects of stormwater and drainage, green infrastructure and awareness are evaluated and synthesised into a conceptual framework. In Chapter 3, the methodology and research design are laid out in detail, as well as the operationalisation of key concepts. In Chapter 4, the survey results are presented, analysed and discussed. These results are then used to inform the awareness-raising strategy, before concluding the Thesis in Chapter 5.

Chapter 2: Literature Review

The following literature review was conducted using the Google Scholar search engine with the following key search terms: urban stormwater retention ponds; sustainable urban stormwater management; blue-green infrastructure; stormwater ponds climate adaptation; multifunctional urban design; green infrastructure awareness. Further papers were found by following the references of other authors.

2.1 Stormwater and Drainage

When areas urbanize, their land use changes: vegetation is removed and natural soils become covered with impervious surfaces (such as asphalt roads), which changes the area's surface runoff characteristics. When it rains in large quantities, the water can no longer infiltrate as quickly and more stormwater runs off in a shorter amount of time (Barbosa et al., 2012), creating flood risks. In most urban areas in developed countries, stormwater is managed through the use of grey infrastructure, such as sewer pipes, deep storage facilities and regional treatment facilities. Despite the high costs of investment in these grey stormwater infrastructure solutions, urban areas continue to experience problems in managing water, such as flooding and sewer overflows (Flynn & Davidson, 2016) when capacities of the drainage system are overwhelmed and water accumulates at the surface (Moore et al., 2016). This points to the fact that these systems are not sustainable in the long run, as they are not easily nor affordably adaptable to the changing weather patterns which climate change is foreseen to bring, nor sufficiently resilient to avoid damages at high costs to the public (Flynn & Davidson, 2016). Furthermore, impervious surfaces around grey infrastructure contribute to the problem of increased stormwater runoff (Ramos et al., 2017), the problem which the infrastructure was built to solve.

One of the key limitations of traditional urban drainage design is the specification to previously static precipitation patterns. Due to the effects of climate change, these are no longer static. The IPCC predicts that northern and central Europe will experience more frequent and increasingly extreme rainfall events, but also more rainy days with higher rainfall for non-extreme weather (Christensen et al., 2007). The effect of this change in view of the increasingly inadequate design standards of the drainage system is an increased risk of flooding, property damage and threats to human safety (Moore et al., 2016). The increase in this risk is dependent on the local context, as some drainage systems will remain adequate in the face of the changes,

whereas others will be overwhelmed by the new precipitation patterns (Moore et al., 2016). For this reason, urban managers must consider ways of increasing the resilience of the urban drainage systems. While blanket upgrading of the stormwater drainage systems is prohibitively costly, other solutions can be integrated into the system, such as more natural vegetative cover in place of impervious surfaces.

2.2 Green Infrastructure

Green infrastructure (GI) is providing an alternative to the traditional stormwater management paradigm (Derkzen et al., 2017). GI has been defined as "all natural, semi-natural and artificial networks of multifunctional ecological systems" (Tzoulas et al., 2007, p. 169). In fact, multifunctionality is one of the concept's key aspects, as GI can perform several functions and provide several benefits in the same area (Madureira et al., 2015). If carefully designed and implemented, GI can contribute to climate adaptation (Derkzen et al., 2017). Well-designed GI can play crucial roles in stormwater management while providing co-benefits, "such as ecosystem restoration, air quality improvement, and urban heat reduction" (Flynn & Davidson, 2016, p. 1). As part of GI, stormwater retention ponds "are engineered ecosystems designed to provide runoff … regulating services", and can reduce peak runoff rates (Moore & Hunt, 2012). They can therefore reduce the likelihood of flooding and the disruption which it can cause. In a small, urban case study site in the USA, a "distributed network of ponds and hydrologic connectivity to the regional green infrastructure system seems to have compensated for insufficient pipe conveyance capacity" (Moore et al., 2016, p. 501), meaning that green infrastructure can help prevent flooding where the existing grey infrastructure may not be able to cope with the more intense rainfall events. The literature reviewed shows a breadth of research on the technical aspects of stormwater retention ponds, ranging in focus from their ability to regulate stormwater runoff flows (Ramos et al., 2017), their removal of pollutants (Moore & Hunt, 2012) to the ecosystem services which they provide (Flynn & Davidson, 2016; Moore & Hunt, 2012). Moore et al. (2016) discuss multiple studies in which computer modelled traditional drainage systems show enhanced climate and flood resilience when augmented through infiltration-based approaches, which furthermore can reduce adaptation costs. Even in the case study site where infiltration retrofits to the drainage system were not the most cost-effective option, "preserving the hydrologic connectivity of green infrastructure was a more robust adaptation approach than engineered infiltration approaches" (Moore et al., 2016, p. 502).

Ecosystem services are understood as the benefits which humanity derives from the (healthy) functioning of the planet's ecosystems (Costanza et al., 1997). The following ecosystem services could in theory be provided by stormwater retention ponds: regulation of hydrology, water quality, greenhouse gases, air quality, and climate; provision of food and raw material; providing cultural services with recreational, educational and aesthetic values; and providing biodiversity benefits through habitat provision (adapted from de Groot, 2006 and MEA, 2005; cited in Moore & Hunt, 2012). The actual quality and quantity of the provided services depends on the specific characteristics of each pond. Carbon sequestration is best achieved when there is dense vegetation in and around the ponds (Moore & Hunt, 2012) which can be achieved with shallow-water plants along pond shores. These also maximise the biodiversity services which the pond can provide. The provision of cultural services may be determined by the pond's integration into broader urban park features and open spaces with cultural features such as trails (Moore & Hunt, 2012).

2.3 The Awareness of Green Infrastructure

GI is still facing multiple barriers to implementation in municipalities, most often due to the lack of funding allocated to these measures. This is due to limited economic resources of public bodies in charge of stormwater management, as well as a lack of information and understanding of the adaptation cost and cost-effectiveness of GI solutions (Flynn & Davidson, 2016; Moore et al., 2016). Local perception of unknown or unwanted impacts can also be a barrier (Barnhill & Smardon, 2012). If the (co-)benefits of GI solutions were more easily quantifiable in a way comprehensible to policy makers, they would be more likely to adopt a GI approach with its co-benefits in, for example, reducing urban heat island effects or promoting recreational opportunities (Flynn & Davidson, 2016). Furthermore, green infrastructure solutions to climate adaptation are often part of a 'no regrets' adaptation approach – they can lead to broad social, ecological and economic benefits irrespective of the severity of climate impacts (Byrne et al., 2015). However, the adaptation benefits of GI are not always clear nor predictable in terms of cost: Moore et al. (2016) show for two case study sites in Minnesota, USA, that GI upgrades to the drainage system – in the form of areas where water can naturally infiltrate – would, in a more rural case, decrease adaptation costs and, in a more urban case, increase adaptation costs compared to purely grey infrastructure upgrades. Just as knowledge can be a barrier to GI adoption, it can also be a factor which enhances it. Tayouga and Gagné list 'education' as one of the most important factors influencing GI adoption, using the term to encompass "awareness,

knowledge, and understanding of the types and uses of green infrastructure … by the general public, stakeholders, and policy- and decision-makers" (2016, p. 9). They furthermore hypothesise that GI use in an area increases awareness among the general public and other stakeholders, which in turn can influence GI adoption through changes in the policies and planning recommendations around GI. They backed their hypothesis with findings from a literature review that this factor is considered important by scholars regardless of geographical location (within North America). Awareness and knowledge of GI seem to have a positive feedback on GI adoption, as investment in GI increases public knowledge and support of GI, which in turn leads to more investment in it (Tayouga & Gagné, 2016).

Venkataramanan et al. (2020) emphasise a lack of understanding of people's existing knowledge about flood risk and GI and call for more social science research on this topic. New knowledge in this field would "enhance designs and reduce barriers to GI implementation" (Venkataramanan et al., 2020, p. 3). To help prioritise GI, there should be studies which address people's needs and beliefs regarding GI benefits, which can be used to inform successful implementation of GI-based climate adaptation, which benefit the city and its residents (Derkzen et al., 2017). Properly educating citizens about the functions of GI can help prevent conflicts which may arise between planners, managers and residents, as urban green space amount and quality are finally a political question which can be steered by citizens' engagement with them (Madureira et al., 2015).

In a survey of citizens of two Rotterdam neighbourhoods, Derkzen et al. (2017) found that flood protection was a highly valued benefit of GI, especially of water rich parks, green roofs and grass strips. Flood protection was also the second most important ecosystem service to respondents' livelihood. When asked about their GI preferences, respondents only infrequently chose water plazas, which often have a more grey and engineered appearance, yet people who had perceived flooding to be a problem were more favourable towards these. Lastly, canals were the most popular option of GI. Furthermore, residents' preferences for GI shifted to effective adaptation measures once they were informed about their adaptation effect (Derkzen et al., 2017). In a study of two Syracuse, USA neighbourhoods, Baptiste et al. (2015) found a high level of environmental knowledge around stormwater management and the use of GI to tackle it, with only limited variation in the population based on socio-demographic factors. The authors instead propose lived experience with stormwater as a factor driving knowledge of this topic. Some studies indicate that citizens are more likely to highly value GI functions which

relate directly to individual and family interests, such as health (Derkzen et al., 2017; Madureira et al., 2015). Venkataramanan et al. (2020) note in their literature review that overall knowledge and awareness of GI is low, while attitudes towards it are varied. An interesting finding of Byrne et al. is that green space users' awareness and concern of climate change impacts did not increase the likelihood that they would "recognise the related adaptive functions of urban trees" (2015, p. 140). Some variables which other authors identified as having a relationship to perceptions of GI are the following: disconnect between urban residents and their environment; access to green space; involvement in other environmental projects; lived experience with stormwater (Baptiste et al., 2015; Barnhill & Smardon, 2012).

2.4 Developing Awareness

Once data on citizens' awareness of GI functions has been gathered, it can be used to help raise awareness. Awareness-raising is informing and educating people about a topic, aiming to influence their attitudes and behaviours, mobilise public opinion and influence the political will of decision-makers (Cardinal et al., 2019). Awareness can be a useful tool in transforming people's behaviour from passive to proactive, and can enhance city stakeholders' communication and engagement, which leads to a higher resilience level for the city, thereby furthering adaptation to climate change (Iturriza et al., 2020). Developing awareness therefore results in more commitment to and engagement with resilience (Iturriza et al., 2020). Developing awareness and reconnection of nature to residents are also perceived to be critical to overcoming barriers to GI implementation, a finding which is consistent in studies across continents (Barnhill & Smardon, 2012). A lack of awareness, on the other hand, is one reason why city climate change plans are not as effective as hoped; the information they provide is too abstracted from people's daily lives (Iturriza et al., 2020). As Iturriza et al. (2020) state: "awareness is not only the first step prior to developing any resilience-building process, but it is also a requirement that must be met during the development process because it serves as a driver", as awareness can increase the public's consciousness about risk and hazard exposure.

While information about the state of the environment on a planetary scale is routinely communicated via mainstream media – news articles about environmental issues are common, the IPCC Assessment Reports are covered in news segments – information about the state of the environment on a small, local scale is rarely brought to our attention. Information about local conditions or local efforts to improve environmental conditions is not easily found nor

widely made available. Tayouga and Gagné (2016) suggest that government agencies at all levels should invest in public education programs to positively influence GI adoption, as well as coupling any GI development with a public education component to increase awareness and understanding. This would help change the focus from vague, planetary-level information about the environment, climate change impacts and adaptation to local-scale information being disseminated to local residents. Information campaigns aimed at individuals can have goals ranging from raising awareness and knowledge about a particular topic to fostering behavioural. Campaigns which target communities or societies hope to change public opinion, public policy or social norms, to name a few (Maibach, 1993). Environmental change at the level of broader society can be fostered through communication campaigns aimed at the general public, as the public has the power to pressure governments and corporations with enough will and coordinated action (Maibach, 1993). Furthermore, for a mid-sized social network, such as a neighbourhood or local community, it can be very helpful to enlist the help of those community leaders who have the reach and recognition within the community to influence people's opinions (Maibach, 1993). Maibach (1993) states that a good information campaign must reflect the target audience's orientation towards a topic to effectively reach them. Some factors which influence their orientation are involvement with the topic, recognition of the problem, knowledge about the topic and past experience with it. There is some overlap between these factors and the data gathered in this research, which therefore can be used to gauge the audience's orientation towards this topic, a process known as formative research. Lastly, a campaign should always aim to minimise the (perceived) negative costs and maximise the positive benefits and incentives of any advocated change (Maibach, 1993).

2.5 Conceptual Framework

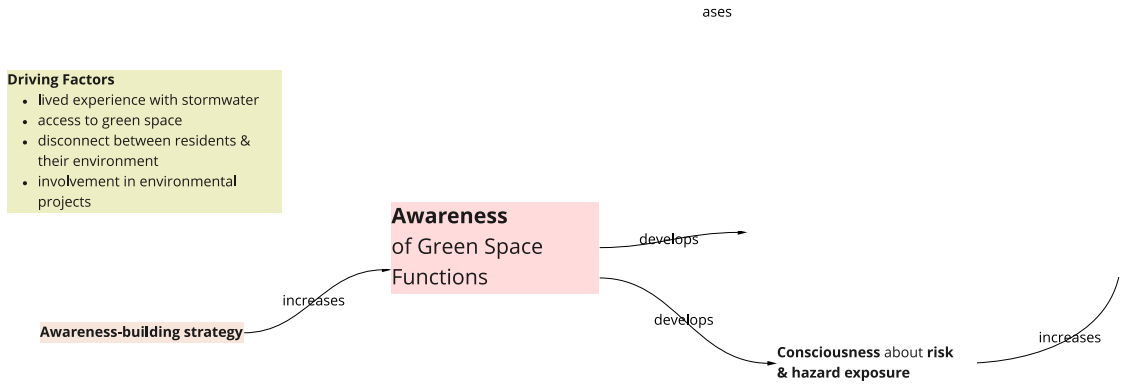

Figure 2: Conceptual Framework

Source: Author's graphic

The main concepts identified in the literature and their relationships are synthesised into the conceptual framework (Figure 2). Awareness of Green Infrastructure and its functions is the central concept in this research. It is influenced by driving factors but in turn influences critical aspects of urban resilience. First, the factors identified as driving awareness of green infrastructure functions are lived experience with stormwater, access to green space, the disconnect between residents and their environment, and citizens' involvement in environmental projects (Baptiste et al., 2015; Barnhill & Smardon, 2012). An awareness-building strategy is furthermore assumed to have an overall positive impact on citizens' awareness of green infrastructure and its functions. This awareness in turn reduces the amount of conflicts between stakeholders, specifically residents and urban planners and managers (Madureira et al., 2015). It furthermore fosters more GI-focused planning recommendations (Tayouga & Gagné, 2016). Both of these effects increase the adoption of urban GI initiatives, which should theoretically have an impact on resilience. GI adoption furthermore positively feeds back into GI awareness, as citizens have more opportunity to see effective climate change adaptation through GI initiatives. Separately, awareness has the potential to develop citizens' commitment to and engagement with resilience ideas and initiatives and consciousness of risk and hazard exposure (Iturriza et al., 2020), which in turn have positive effects on urban resilience. Awareness, therefore, is positively linked with urban resilience.

Chapter 3: Research Design and Methodology

In this chapter, the research design and methods are explained. The study uses mixed methods, with an initial gathering of primary data which was quantitatively analysed, before using the results of this analysis in parallel with desk-based research to formulate an awareness-raising strategy. In the first section, the research objectives are reiterated, before the second section elaborates on research design, sampling, quantitative analysis methods as well as desk-based research methods. Following this, the key concepts are operationalised, before validity and reliability are discussed. A brief description of the challenges and limitations of this research concludes this chapter.

3.1 Research Objectives

The objectives for this research are to assess the levels of awareness of the Westersingel green space's multiple resilience functions, the distribution of this awareness and the factors explaining this awareness. A further objective is to design an awareness-raising strategy which can help increase the citizens' understanding of the contribution which multifunctional green spaces such as the Westersingel can bring to climate change adaptation and thereby help increase the city's resilience. The approach to completing these objectives is to identify factors which influence awareness through the literature review and design a survey questionnaire which can identify different levels of awareness within respondents and measure the identified influencing factors (independent variables). The data is then collected at the study site by conducting short, structured interviews with the users of the space. After the data is collected and analysed, it is used to inform an awareness-raising strategy tailored to the Westersingel space and its users to raise their awareness of its multiple resilience functions.

3.2 Methodology

3.2.1 Research Design and Sampling

This research collected primary data using a survey questionnaire (see Appendix 1). The data collection method is a short, fully structured interview wherein the researcher approached public space users within the study area (see Yellow Square, Figure 3) and read the questionnaire to respondents, filling in their answers on a response form. In the case of multiple respondents willing to take part in the research at the same time, the questionnaire forms were

distributed to the respondents so they could fill them in themselves. The survey form is attached in Appendix 2. The questionnaire survey method was chosen to get an overview of broad levels of awareness within the population of interest, rather than in-depth opinions. Furthermore, it was designed to elicit the most responses, by keeping contact with respondents as short and non-invasive as possible. To this end, no personal data of any kind was asked of the respondents (such as age, area of residence, etc.). Furthermore, this is adequate given that demographic variables often do not explain differences in environmental knowledge well (Baptiste et al., 2015).

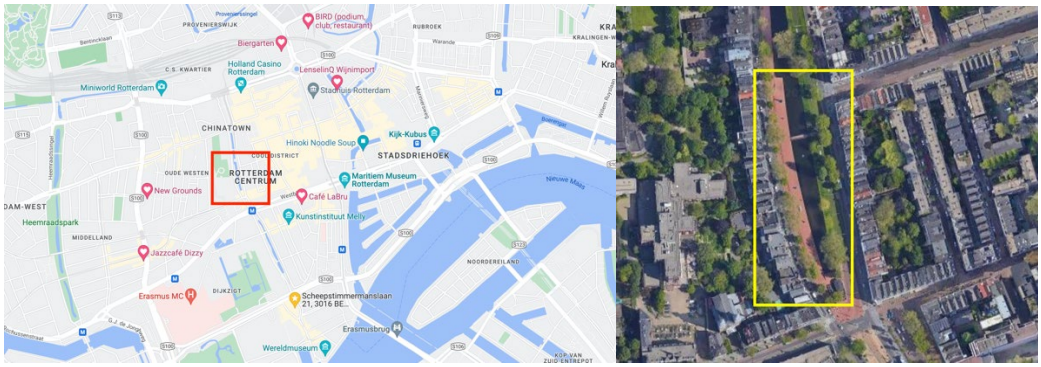

Figure 3: Map and Aerial Photo of Study Area

Source: Google Maps. Note: Red Square shows extent of satellite photo, Yellow Square denotes the part of the Westersingel which makes up the study area where responses were collected

Questions 1 and 2 of the survey are designed to elicit responses from which a respondent's awareness of the space's functions can be determined. They are open-ended and ask for a description of benefits which the space provides to the respondent individually and the surrounding area more broadly. By using two questions this way, respondents have a chance to describe the functions which they perceive as beneficial to them while they are using it (such as a calming effect of the natural setting), as well as the functions which can help the neighbourhood (such as cooling and flood protection). The responses are then evaluated based on the levels of awareness described in section 3.1. The remaining questions are closed-ended and rely on the respondents' self-assessment of a given indicator, such as their perception of flooding as a problem for the city, or the frequency of their visits to the space. While respondents were initially asked to choose from a range of answers on a scale similar to a Likert scale, the data was later aggregated in the analysis (see below).

The population of interest are the users of the public space of the Westersingel canal walk. The population of interest was chosen to assess the general public's, rather than experts', latent awareness of GI multifunctionality, since it is primarily the public who benefits from GI. This research therefore used non-probability purposive sampling of this population by repeatedly visiting the study area and asking the users to complete the survey on the spot. The users of this public space were chosen as the population of interest to ensure that the respondents were familiar with the space in question, which minimises useless responses (if the respondent does not know the space). Aiming to find the largest number of users, visits were conducted on days with sunny or overcast weather conditions, avoiding rainy days as fewer people are assumed to be spending time in the uncovered public space exposed to the elements. Time spent collecting data on a given day ranged between one and two hours. The data collection was conducted during several different visits between 24.5.2022 and 28.6.2022, mostly during lunch hours and afternoons, with some effort to include weekends; the largest use of the space is assumed to be during these times. The final number of responses collected is 68.

3.2.2 Statistical Analysis using STATA

The results from the survey were recorded on the survey form during the structured interview and later digitised on an excel sheet, which was imported into STATA. All variables were recorded as ordinal variables, as the questions were answerable through a selection of prescribed answers with gradually changing values, similar to a Likert scale. The .do-file containing the code for the statistical analysis is included in Appendix 2.

The number of responses is too low to conduct statistical analysis of each variable by answer category. Instead, to maintain an adequate number of observations for each independent variable, the response data was recoded into dummy variables for each independent variable based on a logical cut-off point determined by the researcher, excluding "I don't know" responses. For example, the variable *having experienced problems with flooding* was recoded into a dummy variable with value "0" for the response "never" having experienced problems with flooding, and value "1" for any other response (different frequencies of experiencing problems with flooding; excluding "I don't know" responses). The cut-off points for the other independent dummy variables are as follows: for perceiving flooding as a personal problem and as a problem for Rotterdam, anyone who answered "Yes, somewhat" or "Yes, very much" considers flooding a problem (therefore value "1"), while any other response means they do

not consider it a problem (value “0”). Frequency of visits was recoded into monthly visit or more frequent, whereby anyone who indicated their frequency of visiting as monthly, weekly or daily was coded “1” and all other answers as “0”. For Access, all those who indicated they could access the space “Easily” or “Very easily” were coded “1” and all others “0”. For Connection to the Environment, those who indicated “Connected” or “Very connected” were coded “1” and all others “0”. For involvement in environmental projects, all answers were coded as “1” with the exception of “Never” being involved, thereby splitting the sample between those who are currently or have been involved and those who have never been involved. For all recoding operations, “I don’t know” responses were excluded from the new dummy variables.

Recoding the independent variables into dummy variables was done as the data was analysed as categorical data rather than continuous, with no way of quantifying the differences between the individual response categories to enable analysis as if the data were continuous. Furthermore, due to the small sample size, every response was recorded within the variable so as to maximise the statistical power and minimise the number of variables with low statistical significance. The next step was to correlate the individual dummy variables for each independent variable with the awareness levels. This is adequate given the nature of the data analysed (several dummy variables) and as the sample size is more than double the recommended minimum sample size of 30 observations for correlational analysis to achieve meaningful results (Fraenkel & Wallen, 2009). Pearson’s *r* was used as a measure of correlation, as the correlations estimated are between an ordinal dependent variable and binary independent variables. This means that the correlation coefficient can be computed using Pearson’s *r* equation as long as the sample size is above 30 (Chen & Popovich, 2002).

3.2.3 Awareness-Raising Strategy

The second part of this research was to design an awareness building strategy around GI in Rotterdam, and more specifically around Westersingel urban floodplain. The survey results were used to inform the strategy and tailor it to the target demographic, the users of the public space. Academic literature surrounding environmental awareness and marketing strategies was analysed in desk-based research and applied to this case to lay out the beginnings of an awareness-raising strategy.

3.3 Operationalisation of Key Concepts

The key concept investigated in this research is awareness, specifically of the functions of the Westersingel canal urban floodplain. Awareness was measured by testing respondents' understanding of the functions of the space while differentiating between different levels. These levels represent, in order: (i) not recognising any function of the space; (ii) understanding that the space has a function unrelated to resilience and sustainability (e.g. attracting tourism or providing a meeting point); (iii) understanding and listing specific functions of the space in relation to resilience and sustainability for personal benefit (e.g. recreational ecosystem services) but not for the area; (iv) understanding and listing specific functions in relation to resilience and sustainability for the area (e.g. cooling, carbon sequestration, etc; this level indicates a more environmental scientific understanding of the space); (v) understanding and listing the space's specific stormwater control function. These levels are assumed to be ordinal, with higher levels of awareness including the lower levels. The highest level of awareness which a respondent shows in their answers is considered to be their inherent awareness of resilience and sustainability functions within the space.

The lower four levels of awareness may be sufficient to assess users' awareness of the sustainability and resilience function of the public space around them. The fifth level was included as flood resilience was the function in the focus of this research. There is some nuance to the levels of awareness. Respondents may indicate a personal benefit they derive from using the space; however, this does not necessarily indicate that they are aware of its functions. For the purposes of this research, to consider a respondent aware of the space's functions their answer had to indicate an awareness of the connection between an aspect of the space and the benefit they, or the area, derive from it. Formulating the questions to ask for "personal benefits" or "benefits to the area" which the space could provide was done specifically to avoid leading respondents to an answer which they would not have answered independently. For example, asking which functions the space could provide would move respondents to consider the space through a more technical and functional lens than they would have latently, without the leading question. It is precisely the latent awareness which this research was designed to test.

To illustrate this point, take the following example: A respondent may indicate that the benefit they derive from the space is relaxation and calmness. This is an important benefit of open space and natural settings, one which many respondents listed. On its own, however, this does

not constitute awareness of the space's functions and translates to awareness level (i). Instead, an awareness of the sustainability function is only recorded if this benefit, for example relaxation, is connected to the natural setting which includes trees, grass, open water and bird life (which would be recorded as awareness level (iii)).

The factors expected to drive awareness of the space's stormwater control function have been operationalised to fit the specific context of the space on which this research focuses. Experience with stormwater is assumed to be the most important factor in driving awareness of stormwater control functions. Therefore, it is given the most attention, with three separate ways of assessing it. Most directly, respondents are asked whether they have experienced problems with flooding before. More indirectly, respondents are asked whether flooding is a problem which affects them personally, and whether it is a problem for the city of Rotterdam, presumed to be the city of residence for most respondents. Second, access to green space is assessed directly, asking respondents whether they feel they can access the space in question easily. Furthermore, respondents are asked how often they visit the space to get a second way of assessing access to the space. Disconnect between urban residents and their environment is also assessed directly, asking respondents to rate their connection to their environment on a Likert scale. Lastly, involvement in projects about the environment and nature is assessed by frequency of involvement. The theoretical framework and its variables were operationalised into measurable indicators, which are shown in Table 1.

Table 1: Operationalisation Table

Concept / Variable	**Definition**	**Indicators**	**Data Source**
Awareness	Understanding of the functions of a multifunctional public green space	- Functions recognised when asked about benefits	Survey Responses
Experience with stormwater	Having experienced and/or understanding the threat of stormwater	- Having previous experience with stormwater - Perceiving flooding as a personal problem - Perceiving flooding as a	Survey responses

		problem for the city	
Access to the space	Ease of accessing and using the space, in terms of logistical and social barriers	- Ease or difficulty accessing the study space - Frequency of visiting the space	Survey responses
Connection to one's environment	Experiencing a personal connection to the surrounding space on an everyday basis	- Self-assessed connection or disconnection	Survey responses
Involvement in Environmental Projects	Current or past involvement in projects about the environment or nature	- Frequency of involvement in such projects	Survey responses

3.4 Validity and Reliability

This research has limited measurable validity, as there is only one source of data, namely the survey results. This is due to the fact that there is limited information on awareness of GI functions in the academic literature and writing about this topic outside academia is practically non-existent. Furthermore, this research was conducted around one single green space in the city of Rotterdam, therefore the results are not generalisable beyond this case.

Second, if there are unknown factors which influence awareness which have not been identified through the literature, they will not be measured or identified through this research. This research only assesses the degree to which the factors identified in the literature are correlated to the awareness of the respondents. Previously unknown factors which may influence awareness can therefore not be identified through this research.

This research is reliable, as the process of obtaining and analysing the data has been fully documented. The study area, questionnaire and data analysis methods are detailed in various parts of the thesis and appendices, which makes this study replicable by other researchers. One

factor limiting reliability is the language in which the survey was conducted, as the number of English speakers visiting the space may fluctuate and thereby influence the results.

3.5 Challenges and Limitations

As this study used non-probability sampling, the results are not representative of the entire population of interest. The results can therefore not be generalised beyond this specific case. Furthermore, the research design is cross-sectional, meaning that these results do not indicate trends or evolution over time but simply an assessment of current conditions.

There are some biases expected to be present in the sample. Since the survey was conducted in English, the sample is biased towards people who speak English and are willing to speak to a stranger in English. There were multiple instances of people not being willing to partake in the survey as they considered their English language skills to be insufficient. This selects for people who either speak English as a first language or have received a sufficient level of education in it as a foreign language. This could imply a bias towards people with a higher level of education than the average of the general population, or those who more recently completed their education (assuming that their education included English language and they felt comfortable using it). Derkzen et al. (2017) report that residents of Rotterdam with higher education levels were more aware of flooding. This study may therefore over-estimate the awareness of flooding to a slight degree.

Second, there is a double bias towards younger people in the sample. From observations in the field, most users of the public space (during the time in which responses were collected) appeared to be younger than the age of 40, with a particular overrepresentation of people in their 20s (as a rough estimate). This is likely due to the fact that most people of working age would be working during the time that responses were being collected, with the exception of lunch hours (12h00 – 14h00). An effort to correct this bias was made by collecting responses on weekends and during lunch hours, where working people would also be able to visit the space and have a higher chance of being included in the survey. The other aspect of this bias is that younger people seemed to be more willing to take part in the research, while more potential respondents over the age of 40 (as a rough estimate) were not willing to partake in the research. Barnhill and Smardon (2012) report that younger people were more likely to help work on GI facilities. This is the only effect of age reported in the reviewed literature, which may indicate

a higher awareness among younger people and therefore an upward bias in the awareness levels recorded through this research.

Lastly, given the limited study area, the sample is likely biased towards people who live in comfortable walking or cycling distance to Westersingel canal, so nearer the centre of Rotterdam. However, this bias may not be very large, as there are multiple different modes of public transport which stop very near the study area. This is confirmed by the result that most respondents felt they could access the study area very easily (see results section for more detail).

Chapter 4: Results, Analysis and Discussion

The following chapter describes the results of the survey, including awareness levels and the results of each survey question in turn. Following this, the results of the correlation analysis between awareness and the independent variables are laid out, before analysing the correlations between the independent variables. In the following section, the discussion begins by tackling the awareness levels, following with the factors driving said awareness. In the last section of this chapter, a broad awareness-raising strategy is laid out.

4.1 Results

4.1.1 Awareness

Assessing public space users' awareness of the study area's flood resilience function produced the following results (see Figure 4).

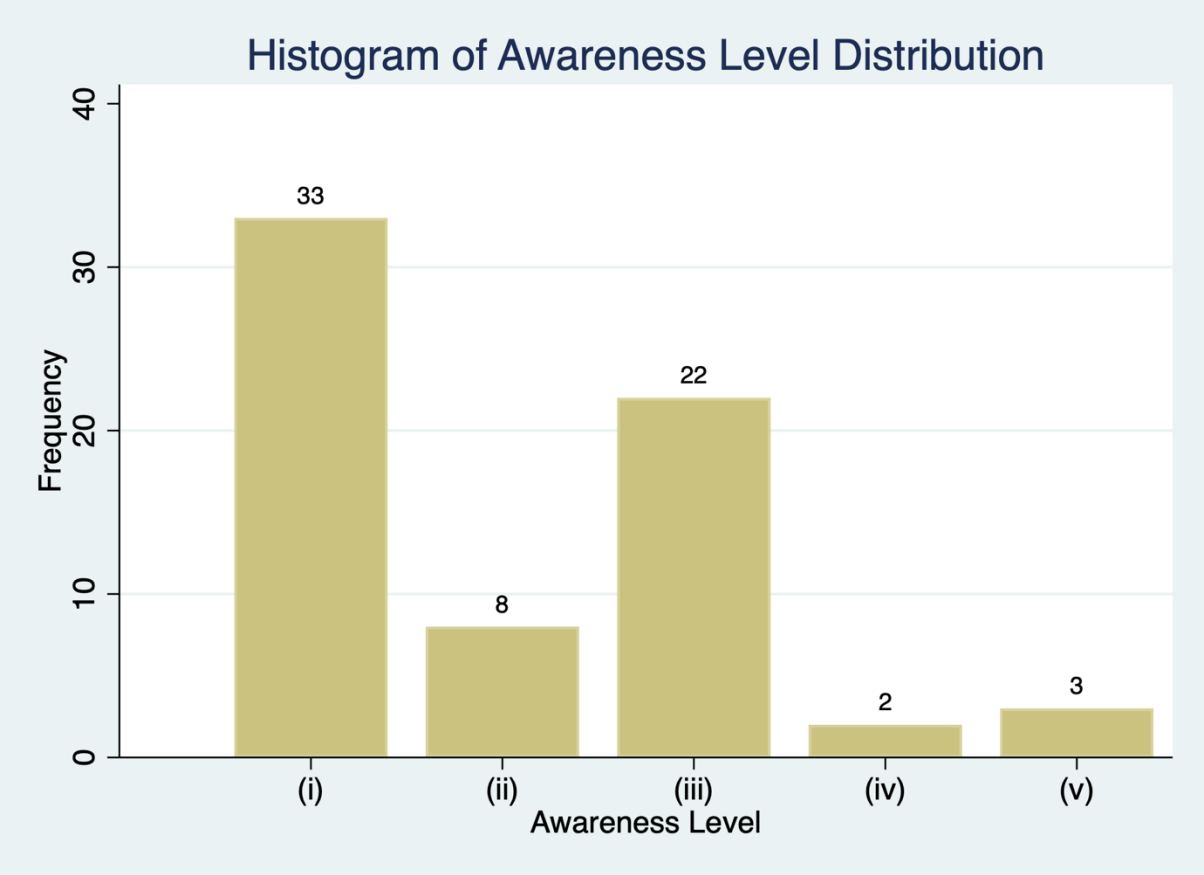

Figure 4: Histogram of Awareness Level Distribution

Note: Awareness level definitions (see Chapter 3.1):

(i) not recognising any function of the space
(ii) understanding that the space has a function (unrelated to resilience and sustainability)
(iii) understanding and listing specific functions of the space in relation to resilience and sustainability for personal benefit (e.g. recreational ecosystem services) but not for the area
(iv) understanding and listing specific functions in relation to resilience and sustainability for the area (e.g. cooling, carbon sequestration, etc.)
(v) understanding and listing the space's specific stormwater control function

Given the classification of awareness into five ordinal levels, as described in Chapter 3.1 Operationalisation of Concepts, respondents' awareness clusters in two levels, namely *(i) having no awareness of the space's functionality of any kind* and *(ii) having an awareness of a sustainability function for personal benefit*. Together, these two response categories make up 80.9 per cent of all responses, or 55 out of 68. In other words, the vast majority of respondents were either unaware of the functionality of the space or could only see how the space has a function related to their personal benefit. The awareness level with most responses (33 responses, 48.5 per cent) is level *(i)*, representing respondents who have no awareness of the functionality of the space. These were respondents who expressed an opinion towards the space but did not indicate a function. For example, they may have responded that they found the space nice or calming but did not consider this benefit a function of the space, therefore their awareness was classified as the lowest level. Eight responses were recorded for level *(ii)*, or 11.7 per cent of the total. These were respondents who indicated a function of the space, but not in relation to resilience or sustainability. Such functions included bringing tourism to the area, providing a meeting point for friends or displaying artwork (various sculptures are displayed in the space, see Figure 1 for photos). Level *(iii)* is the second most common awareness level with 22 responses, or 32.4 per cent of the sample. These were respondents who clearly indicated an understanding of the functions which the space can provide, in the sense that respondents connected the characteristics of the space to a benefit. A common response of this type would be the recognition of the space's natural setting providing relaxation or stress relief.

The two highest levels of awareness together only account for five responses, or 7.4 per cent. Only two respondents had a more scientific, level *(iv)*, understanding of the space's functions, such as the cooling benefit of the trees and water. Lastly, only three respondents (4.4 per cent) were aware of the space's designed function as an urban floodplain which provides stormwater storage and flood protection functions to the surrounding area.

4.1.2 Driving Factors: Independent Variables

The following section describes the distribution of the independent variables. The results are presented by survey question with histograms (see Figure 5 – Figure 11) providing a visual representation of the response distribution. The result of recoding the independent variables into dummy variables during analysis as described in Chapter 3.2 is displayed in Table 2.

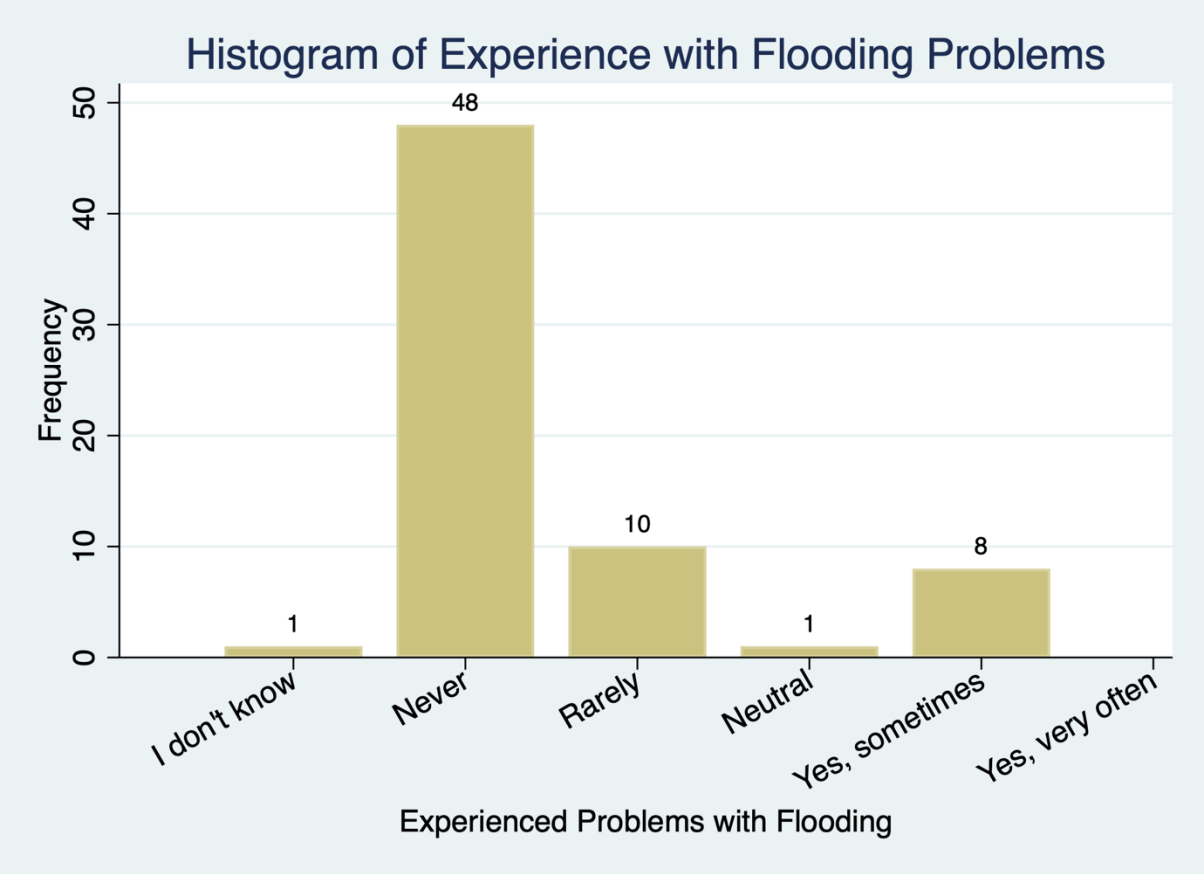

Figure 5: Histogram of Experience with Flooding Problems

Figure 5 shows the majority of respondents (70.6 per cent) have never experienced problems with flooding. 14.7 per cent of respondents have rarely experienced problems, while 11.8 per cent of them have sometimes experienced problems with flooding. After recoding the responses into a dummy variable differentiating between those with experience with flooding and those without, 27.9 per cent of respondents have experienced problems with flooding, a factor theorised to increase respondents' awareness.

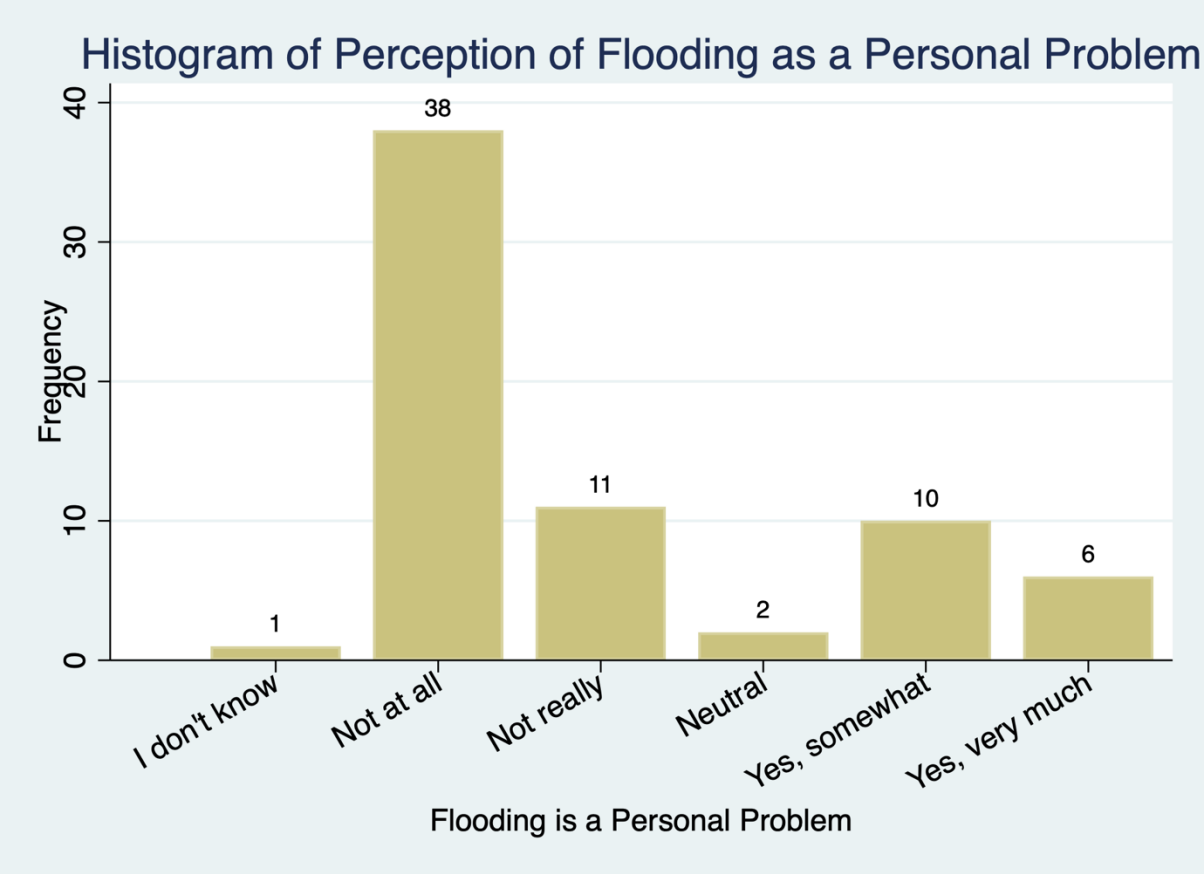

Figure 6: Histogram of Perception of Flooding as a Personal Problem

As shown in Figure 6, more than half of respondents (55.9 per cent) considered flooding as a problem which does not affect them personally at all, with another 16.2 per cent thinking it does "not really" affect them. After recoding the variable, those who considered flooding as a personal problem made up 23.9 per cent of the sample. This finding is very similar to the finding of Derkzen et al. (2017, p. 112), who assessed the same variable among residents of two neighbourhoods in Rotterdam and found that 25.5 per cent of their sample considered flooding as a personal problem. This suggests some reliability within the measurement instruments used for this research.

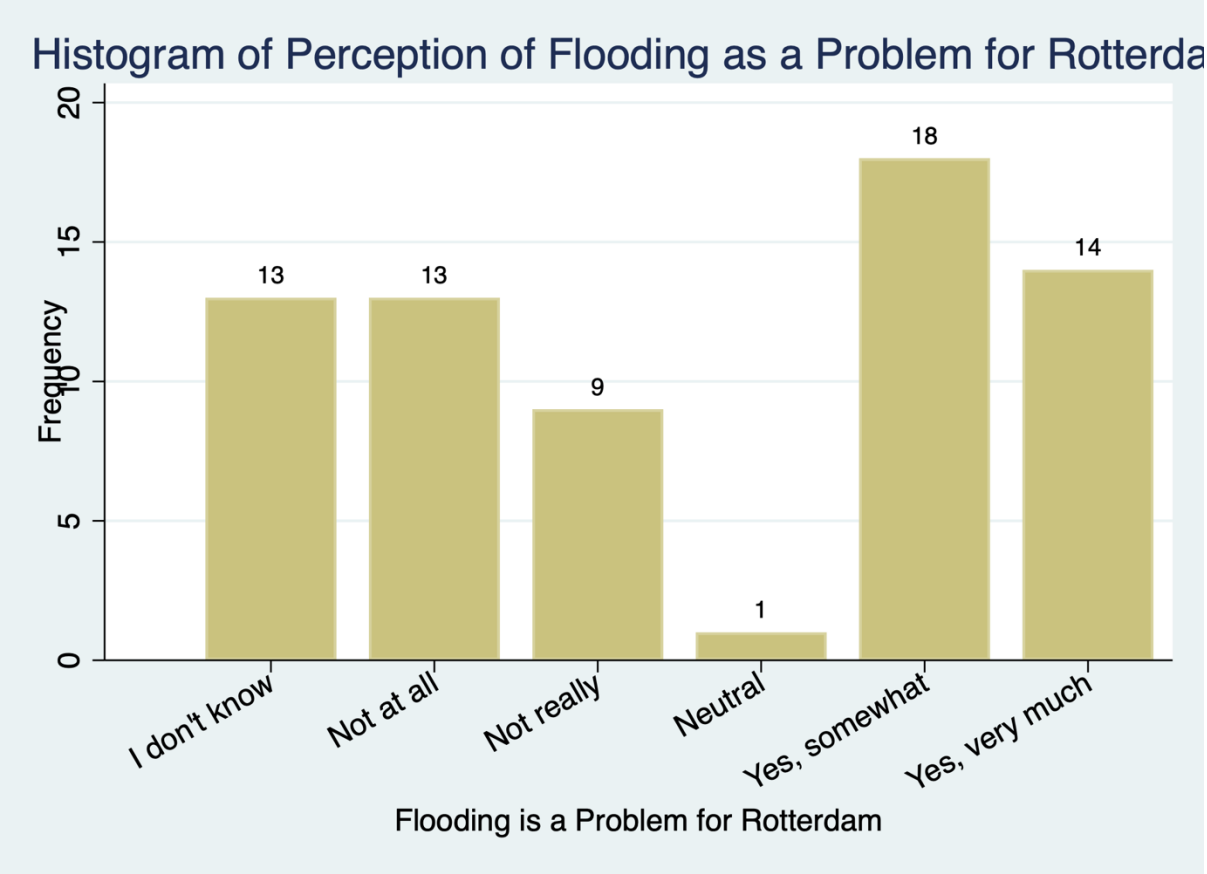

Figure 7: Histogram of Perception of Flooding as a Problem for Rotterdam

The distribution of responses for the perception of flooding as a problem for the city of Rotterdam differs significantly from how respondents perceive it as a personal problem (see Figure 7). All answers (except "Neutral") have a similar number of responses, with the most common answer being "Yes, somewhat" (26.5 per cent). An initial observation is a much higher number of "I don't know" responses compared to the other questions. This is likely due to two reasons: first of all, any tourists visiting the study area who answered the survey would not feel confident in answering this question about a city they are not familiar with, let alone know the flood risks for. This is in contrast to the previous question, which ask them about their personal circumstance and is therefore more easily answerable even as a person unfamiliar with the city. Therefore, tourists would systematically answer this question differently compared to residents of Rotterdam. Second of all, based on observation during the collection of responses, there seemed to be some confusion and uncertainty about the precise meaning of the question for some respondents. As is widely known, many areas in the Netherlands –

including Rotterdam – are below sea level, which some interpret as a persistent problem which needs to be dealt with continuously. On the other hand, the government of the Netherlands is effectively protecting its citizens from this threat through a series of dikes and other flood protection measures, leading some to answer that flooding is not a problem for the city. Yet other respondents would not be able to make a choice between these two arguments and respond with "I don't know". As the wording of the question does not specify which type of flooding is concerned, most people thought about flooding as a problem which stems from the sea and sea level rise, which in turn influenced their answer. This indicates a general awareness of the Netherlands' land below sea level and the threats inherent in settling this land, which, however, does not translate to awareness of other, such as fluvial or pluvial, forms of flooding.

After recoding the variable, those who considered flooding to be a problem for the city of Rotterdam made up 58.2 per cent of the sample. A clear majority considered Rotterdam to have a problem with flooding, more than twice as many as considered flooding to be a personal problem. This result is lower than the finding of Derkzen et al. (2017, p. 112) that 75.5 per cent of their sample of Rotterdam residents considered flooding to be a problem for the city. A key difference in the measurement instrument here is that their question explicitly asked about people's concern for future conditions, whereas in this study it was left ambiguous whether the question pertains to the current moment or the future. This likely explains the difference in results, as some respondents in this study thought of the current conditions in Rotterdam and did not consider flooding to be a problem for the city at this time.

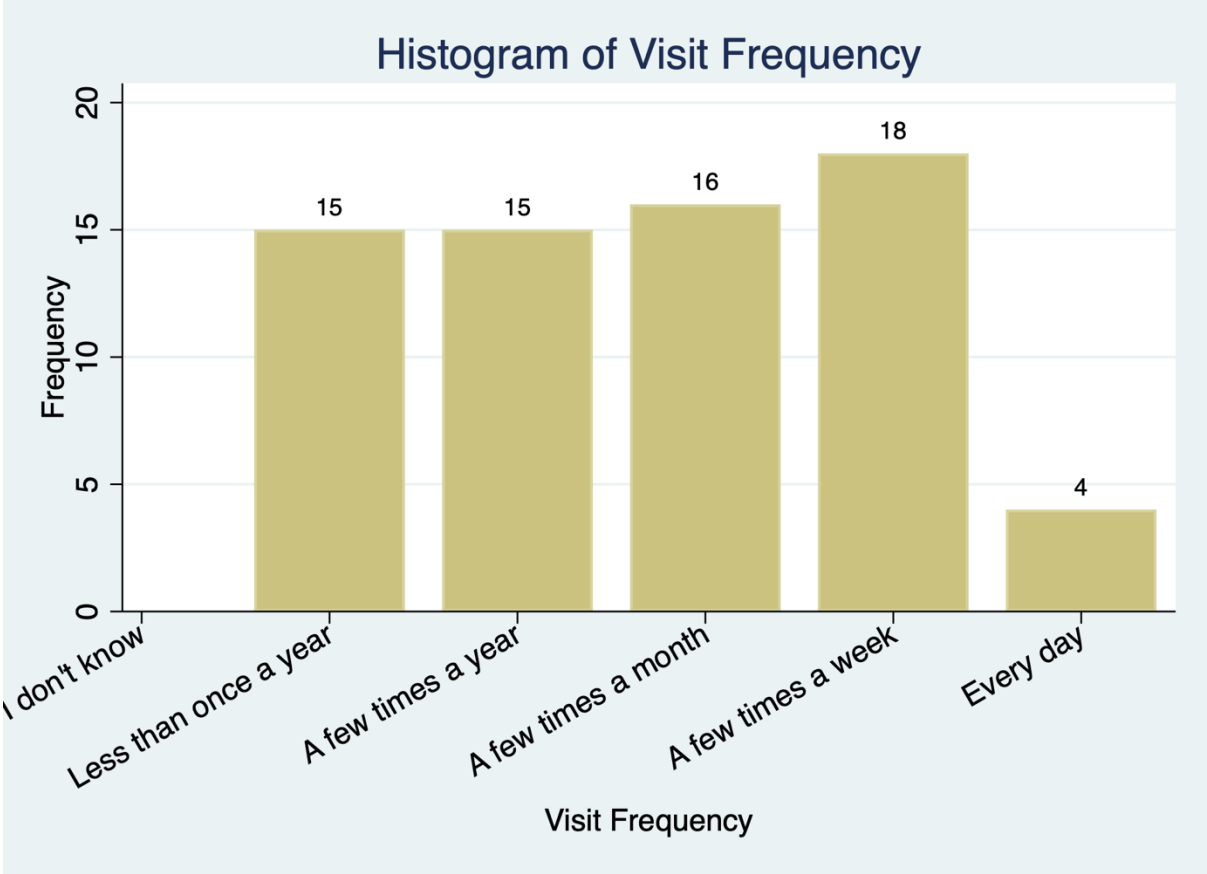

Figure 8: Histogram of Visit Frequency

The distribution of visit frequency is very consistent across all answers, with the exception of those who visit the space "Every day" (see Figure 8). The most common answer is "A few times a week" (26.5 per cent). After recoding the variable, 38 respondents or 55.9 per cent of the sample said they visit the space monthly or more often. This suggests a good spread within the sample between people who visit the space often and are very familiar with it, and people who visit the space less often and are less familiar with it.

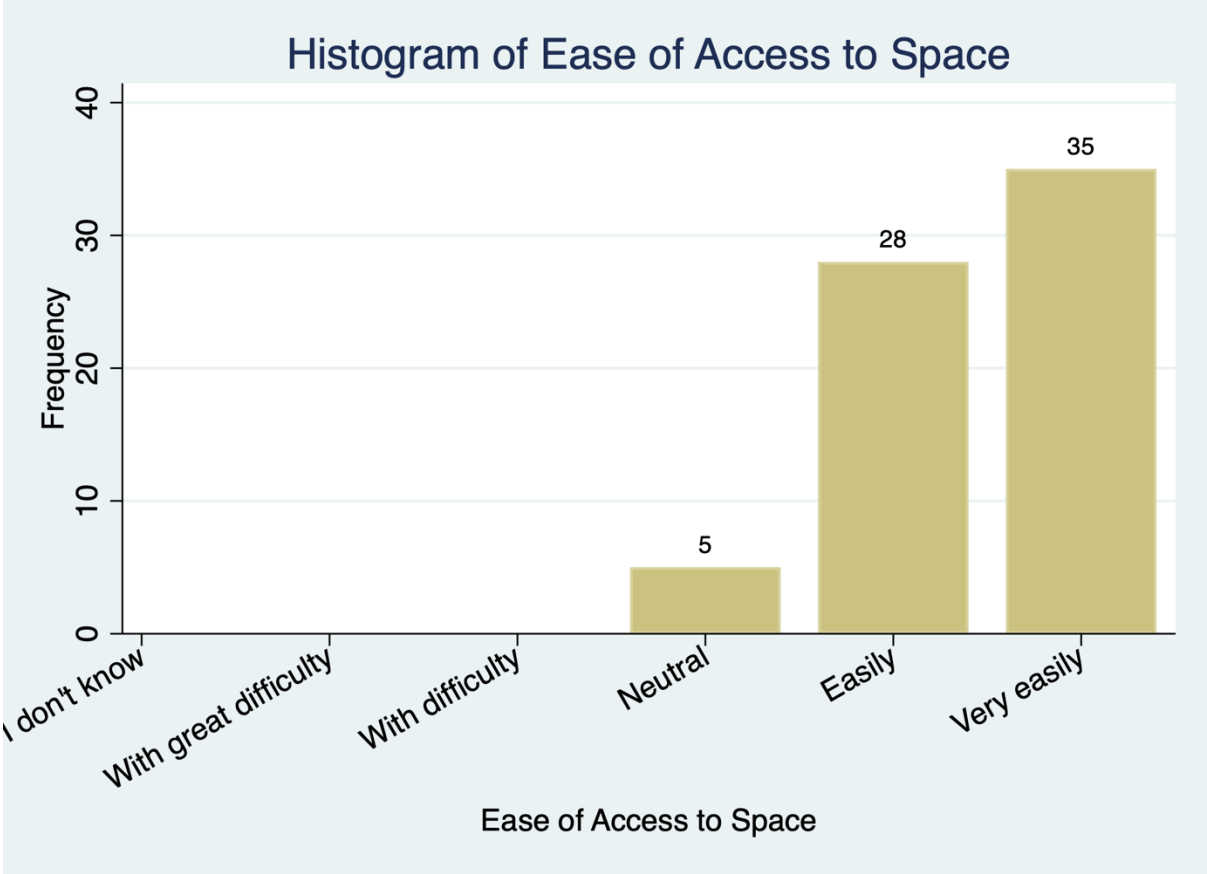

Figure 9: Histogram of Ease of Access to Space

Figure 9 indicates that almost every respondent felt they could access the space "Easily" or "Very easily", with only five answering "Neutral". This is likely due to the fact that people who have difficult access to the space would not be visiting it often, if at all, and therefore would have a low chance of being included in the survey. After recoding, 92.6 per cent of the sample had easy or very easy access to the space.

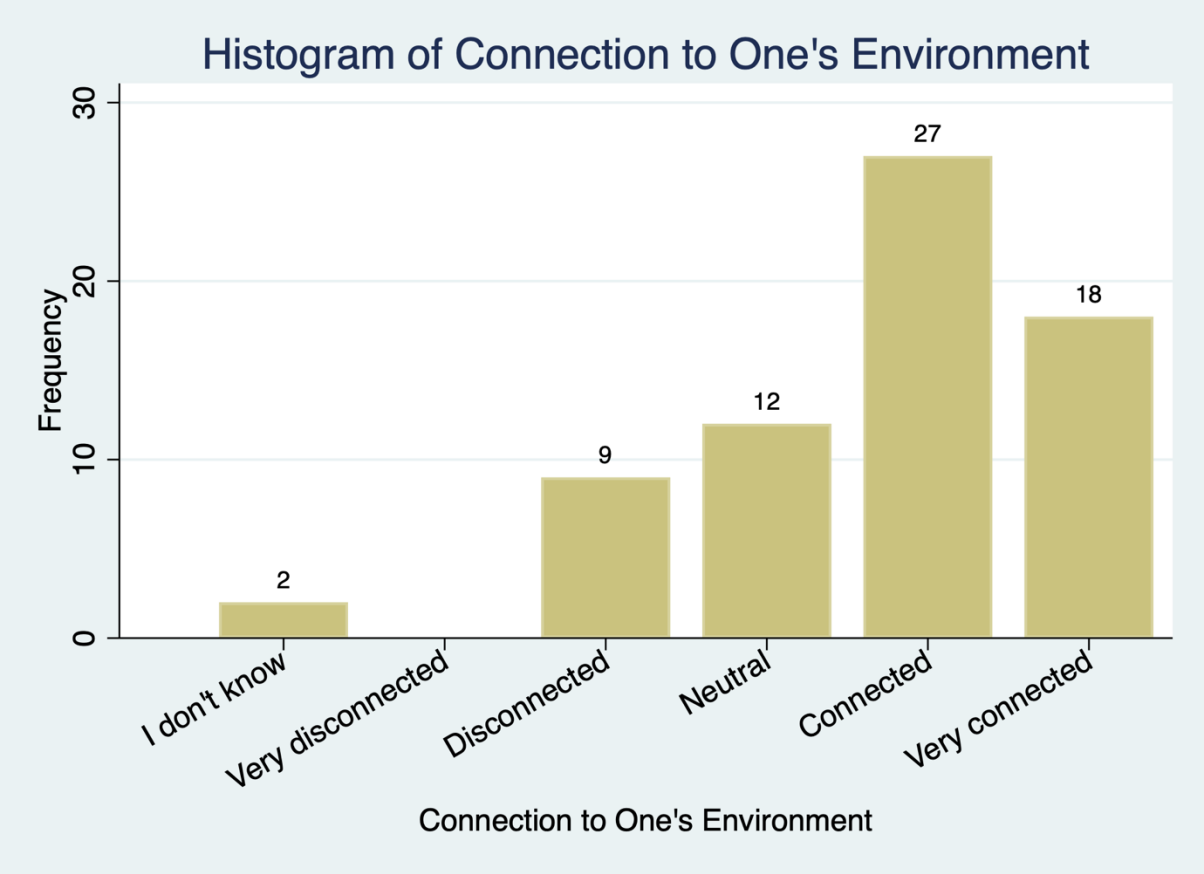

Figure 10: Histogram of Connection to One's Environment

Figure 10 shows that most respondents (39.7 per cent) consider themselves "Connected" to their environment, with a further 26.5 per cent of respondents considering themselves "Very connected". Only nine respondents (13.2 per cent) felt disconnected from their environment. The difference between these two categories is merely whether the respondents assess their connection to their environment to be moderate or very strong. After recoding, 68.2 per cent of the sample was connected to their environment, with the remaining 31.8 per cent not considered connected due to their response being "neutral" or "disconnected".

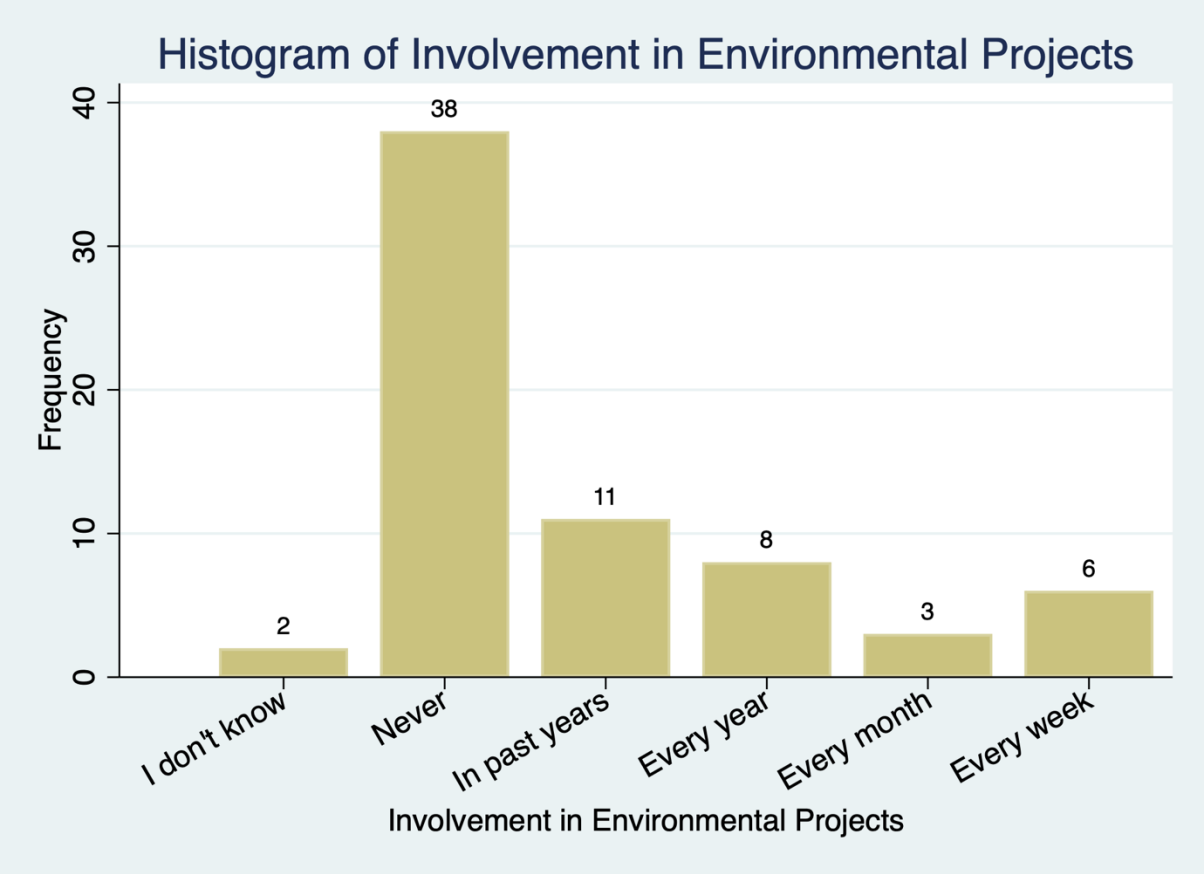

Figure 11: Histogram of Involvement in Environmental Projects

Regarding the involvement in environmental projects, Figure 11 shows the majority of the sample (55.9 per cent) has never been involved in environmental projects, with the rest of the sample being somewhat evenly distributed among the other responses indicating frequency of involvement. After recoding, this means that 42.4 per cent of the sample has been or is involved in Environmental Projects of some kind.

The distribution of the dummy variables created through the recoding of the survey response data can be seen in Table 2 below. While the questions were initially designed to elicit more nuanced responses, for example differences in involvement in environmental projects, the small sample size made it more adequate to recode the variables and drop the nuance from the responses in favour of binary observations which could be analysed with more statistical power due to all responses being encoded within one variable. For a more detailed discussion of this, please see Chapter 3.2, Section *Statistical Analysis using STATA*.

Table 2: Dummy Independent Variable Distribution

Independent Variable	No (0)	Yes (1)
Experience with flooding	48 (71.6%)	19 (28.4%)
Flooding is a personal problem	51 (76.1%)	16 (23.9%)
Flooding is a problem for Rotterdam	23 (41.8%)	32 (58.2%)
Visit space monthly or more often	30 (44.1%)	38 (55.9%)
Easy access to space	5 (7.3%)	63 (92.7%)
Connection to environment	21 (31.8%)	45 (68.2%)
Environmental project involvement	38 (57.6%)	28 (42.4%)

4.1.3 Correlation Analysis

To assess the effect of the various driving factors on awareness, the awareness level data was correlated with each of the dummy variables. The correlation coefficient and associated p-value for each correlation can be seen in Table 3 below.

Table 3: Coefficients and Significance values for Correlations between Awareness and independent variables

Independent Variable	Correlation Coefficient (Pearson's r)	p-value (statistical significance)
Experience with flooding	–.025	.844
Flooding is a personal problem	.282**	.021
Flooding is a problem for Rotterdam	.271**	.046
Visit space monthly or more often	–.106	.389
Easy access to space	.154	.209
Connection to environment	.008	.951
Environmental project involvement	.217*	.081

*Note: * represents statistical significance at p<0.1 level; ** represents statistical significance at p<0.05 level*

The first observation when looking at these results is that there are no strong correlations between any independent variables and awareness. No correlation coefficient goes above 0.3, which would indicate a moderate to weak correlation. The correlation coefficients instead

indicate weak or even negligible relationships between the independent variables and awareness levels. Second, only three independent variables have statistically significant correlations with awareness levels. These are *perception of flooding as a personal problem*, *perception of flooding as a problem for Rotterdam*, and *environmental project involvement*. This means that for these three variables, the correlation coefficients are meaningful and can be interpreted. *Perception of flooding as a personal problem*, *perception of flooding as a problem for the city of Rotterdam* and *environmental project involvement* have statistically significant relationships with awareness and are all weakly positively correlated with awareness levels. This means that, as one variable shows a positive change, so does the other. For example, people who perceive flooding as a personal problem are more likely to have a higher awareness level than those who do not perceive flooding as a personal problem. An important caveat to these results is that correlations do not indicate causality or causal direction. Therefore, these relationships may work in one direction or the other, or are both influenced by a third, unknown, variable. Keeping this in mind, it may be awareness of the space's resilience functions which has an effect on the perception of flooding as a personal problem, for example. As the variables *perception of flooding as a problem for Rotterdam* and *environmental project involvement* are also weakly positively correlated with awareness, these relationships equally hold true for these variables. The remaining independent variables do not have statistically significant linear relationships with awareness. It is therefore not possible to infer any relationship between these variables and awareness with an acceptable degree of confidence.

Given the similar coefficients and p-values for the correlations between *perception of flooding as a personal problem* and awareness, and *perception of flooding as a problem for Rotterdam* and awareness, the independent variables were correlated with each other to test whether some indicators are measuring the same thing, which would be indicated by a high correlation coefficient and statistical significance. The results can be seen in Table 4.

Table 4: Dummy Independent Variable Correlation Coefficients

Independent Variable	1.	2.	3.	4.	5.	6.	7.
1. Experience with flooding	1						
2. Flooding is a personal problem	.036	1					
3. Flooding is a problem for Rotterdam	.038	.472***	1				
4. Visit space monthly or more often	–.099	–.481***	–.090	1			
5. Easy access to space	–.121	–.007	.229*	–.023	1		
6. Connection to environment	.053	.007	.185	–.166	–.037	1	
7. Environmental project involvement	.064	.301**	.303**	–.263**	–.039	.003	1

*Note: * represents statistical significance at p<0.1 level; ** represents statistical significance at p<0.05 level; *** represents statistical significance at p<0.01 level*

Perception of flooding as a personal problem and *perception of flooding as a problem for Rotterdam* are indeed highly statistically significantly ($p<0.01$), moderately positively correlated ($r = .472$). This indicates that these variables may in fact measure similar underlying opinions in people, or that people who consider flooding to be a personal problem are also more likely to consider flooding as a problem for Rotterdam, or vice versa. Perceiving flooding as a personal problem is also moderately negatively correlated with visiting the space monthly or more often, a highly statistically significant finding. This means that people who perceive flooding as a problem are less likely to visit the space monthly or more often. While this may suggest a relationship whereby people who perceive flooding as a problem are reluctant to visit the space more frequently, or that those who visit the space more frequently consider flooding to be less of a personal problem, there is no further evidence to confirm either relationship, and a direct causal connection seems unlikely and would need to be investigated experimentally. There are four more statistically significant relationships between the dummy variables, however these are all weak relationships.

4.2 Discussion

4.2.1 Westersingel Public Space Users' Awareness of its Flood Protection Function

As shown by the results of the awareness level data, only a very small fraction of the sampled respondents was aware of the flood protection function of the Westersingel canal urban floodplain. With only three respondents clearly stating the flood protection function as a benefit of the space, this means only 4.4 per cent of respondents are aware at the highest level of the space's flood protection functions. This equally means that 95.6 per cent of the sample were *not* aware of the space's flood protection function, even though they are, as users of the space, presumably at least superficially familiar with the space. This result shows that the latent awareness within the space's users of the space's flood protection function is, on average, very low, which is congruent with Venkataramanan et al. (2020), who found that overall knowledge and awareness of GI is low. This result contradicts Derkzen et al. (2017, p. 111), who found that "[o]verall, [residents of two Rotterdam neighbourhoods] acknowledged GI's capacity to mitigate local flooding" and rated flood protection very highly among services which GI can provide. It also contradicts Baptiste et al. (2015), who found that residents in Syracuse, USA, had a high level of environmental knowledge around the use of GI to manage stormwater. The commonality of those two studies is that they surveyed neighbourhood residents, not the users of GI public spaces. A key difference between surveying residents and public space users is the familiarity which they have with the GI around them. While this study was consciously designed to survey public space users to ensure some degree of familiarity with the space, this familiarity may still be lower than that of residents who see GI in their neighbourhood every day.

This study assessed latent awareness (see Chapter 3). This means that there was no material presented to the respondents to get them to think about certain GI measures or their functions. In contrast, Derkzen et al. (2017) used a survey form which included information on the benefits and functions of certain GI measures, including canals and their rainwater retention benefits. Similarly, Baptiste et al. (2015) used a survey where GI measures were presented to respondents for assessment of their efficacy in controlling stormwater runoff. This would explain the difference in results, as in other studies the respondents were *made aware* of GI measures and their benefits and asked to rate them, while in this study they were *not made aware* before asking them for their perceived benefits.

Two respondents, or 2.9 per cent of the sample, had an understanding of the space's other resilience functions, such as cooling. These respondents were able to point to specific aspects of the space and list their functions in terms of creating a more resilient city. This means that all together, only 7.3 per cent of the sample were aware of the benefits which the space could provide to the city in terms of urban resilience, sustainability and climate adaptation. While this result cannot be generalised to any wider population, it may be indicative of the order of magnitude in which awareness of these functions exists within the general population.

A larger number of respondents (32.4 per cent) were aware of the functions which the space could provide for individuals, such as the mental health benefits of green space in a city which is built-up and mostly covered by man-made asphalt and concrete surfaces. Many respondents did in fact describe the benefits and necessity of natural settings within the city. This makes sense as these benefits are more likely to be directly felt by respondents when they enter the space, whereas a higher level of awareness requires thinking in more abstract terms about how an area or city can benefit from the functions the space provides. While this mode of thinking is cultivated in, say, educational courses about sustainability, it is not prevalent within the general public, as evidenced by these results. What these results do show, however, is a substantial awareness within the surveyed sample of the ecosystem services which have benefits for mental and physical health. These may be recreational and aesthetic services. This is consistent with the findings of Derkzen et al. (2017) that residents of two Rotterdam neighbourhoods can better understand those benefits which more directly relate to their health and wellbeing than less direct benefits.

What does it mean that most people are not aware of the space's flood protection function? Following the line of reasoning laid out in the literature review (Chapter 2), this would mean that most respondents are not fully engaging with resilience and climate change adaptation. Based on observation during data collection, when asked about flooding problems many respondents did in fact comment that flooding does not seem to be a problem for them nor for Rotterdam, as they see it as being taken care of by the government. They do not see themselves as active components within the city's adaptation effort and leave adaptation to flooding, and perhaps also other climate change impacts, in the hands of the government. This shows that climate change adaptation and urban resilience are not on people's minds and that they are taking a passive approach. This could be a problem in the future as climate adaptation would be most effective when all levels of society are engaged with it, given that the implementation

of resilience measures can be steered by political processes and the votes of the general population (Madureira et al., 2015). If awareness is the first step to building resilience and a driver of the resilience development process, as Iturriza et al. (2020) state, then a lack of awareness implies that the first step to building society-wide resilience has not been taken.

4.2.2 Factors Driving Awareness

As Fraenkel and Wallen (2009) note, correlation coefficients below 0.35 have little value in a predictive sense. With this in mind, it is not possible to use the results of this study to predict a respondent's awareness of the Westersingel urban floodplain's flood protection functions based on their responses to other questions. Furthermore, all correlation coefficients being below 0.35 indicates that the relationships between these variables and awareness are slight at best.

Furthermore, an important consideration to keep in mind when looking at these results is that the correlation coefficients describe the relationships between the independent variables and the awareness levels as a whole, and not merely a high level of awareness of the space's flood protection function. Analysing the correlation between these factors and the highest level of awareness is not possible due to the very small number of respondents who are categorised within awareness level (v). A (statistically significant) positive relationship may exist between, for example, perceiving flooding as a personal problem and awareness. This does not mean that perceiving flooding as a personal problem predicts high level awareness of Westersingel's flood protection function, but rather higher average awareness levels for those who perceive flooding as a personal problem than for those who do not perceive flooding as a personal problem. People who perceive flooding as a personal problem are then more likely to be aware of some functions of the space, even if they are not necessarily fully aware of its flood protection function.

Even though experience with flooding was considered the most important factor driving awareness of flood protection benefits during the design phase of this study, the results show a very different picture. A very low correlation coefficient ($r = –.025$) and a very high p-value ($p = .884$) suggest no linear relationship between these two variables as they are measured in this research. This is in direct contradiction to the findings of Baptiste et al. (2015) that residents have a high level of environmental knowledge around stormwater management and the role

that GI can play in it, and that lived experience with stormwater is a driving factor of this knowledge. While there is a slight difference in the indicators, namely this study asking about experience with flooding as a whole and not just with stormwater, this difference should not be enough to yield completely different results when determining driving factors of knowledge and awareness about GI. One reason for this may be the contrast between a high number of residents having lived experience with stormwater in the study of Baptiste et al. (2015), while only 28.4 per cent of the sample in this study had experienced problems with flooding.

Perceiving flooding as a personal problem and as a problem for Rotterdam both have a statistically significant relationship with awareness. Since the correlation does not indicate causality nor causal direction, there are multiple explanations for this relationship. People who consider flooding to be a problem for themselves or Rotterdam may spend more time thinking about flooding and its impacts, and therefore would be more likely to think about solutions to these perceived problems, which include GI and the functions GI can fulfil. This, in turn, would make them more aware of flooding functions of GI. Even if they are not fully aware of flood protection functions, respondents who think about flooding may also think more about the impact which nature can have on humans, which includes the functions of green spaces in the city. On the other hand, if the causal direction is in fact reversed, then people who are more aware of a space's functions, including flood protection, may also be more inclined to think about flooding and consider it a problem for themselves and for Rotterdam. The latter relationship seems less likely, as it would require an intricate understanding of GI and its functions before consideration of flooding as a problem. It is, however, perceiving flooding as a problem which is much more widespread as indicated by the results of this study.

Visiting the space monthly or more often does not have a statistically significant relationship with awareness. A possible explanation for this result may be that this space does not include any informational material to educate users of its functions. If a visitor is unaware in the first place, their frequency of visiting the space would have no effect on their awareness, as there is nothing in the space that would increase their awareness (no matter how often they visit the space). This further suggests that the mere existence of the function is not enough to be noticed by the users of the public space, even if they visit it frequently and are therefore assumed to be more familiar with it. If the function is not easily visible, the majority of respondents will not see it. This further underscores the need for a formal approach to raising awareness with a strategy behind it.

Having easy access to the space also does not have a statistically significant relationship with awareness of its functions. This is to be expected given the result that visiting the space monthly or more often has no detectable relationship with awareness, as the largest effect of ease of access would be more frequent visits to the space. If visiting the space more frequently has no effect, however, then any effect of having easy access to it would also be negated. Furthermore, the distribution of the dummy variable is very uneven, such that the overwhelming majority of respondents (92.7 per cent) have easy access to the space. This makes correlational analysis difficult due to limited variation in the sample which could obscure the relationship between the variables.

Having a connection to one's environment is the independent variable with the lowest correlation coefficient ($r = .008$) and highest p-value ($p = .951$), which together indicate that there is no linear relationship with awareness. While in Barnhill and Smardon's (2012) research this factor was an important barrier to GI implementation and a limitation to local residents' engagement with resilience, their study assessed people's attitudes towards GI by neighbourhood, such that their attitude and connection to their environment both related to their neighbourhood. This study, on the other hand, did not control for neighbourhoods, which means that people from any neighbourhood were included in the survey. Whether or not they are connected to their environment in their neighbourhood, then, has no impact on their attitude towards the Westersingel GI as it is not connected to their neighbourhood. This result would seem to suggest that residents' connection to their environment is an important factor in determining engagement with GI and resilience locally, but that this factor loses salience as GI implementation and resilience measures move outside of the neighbourhood which residents live in. This reinforces the need for climate adaptation and resilience development to be conducted at local scales (Adger et al., 2005) within the local context (Derkzen et al., 2017) to take advantage of the connection which the local community feels towards their environment. This makes space for the development of community-based adaptation, which allows for the "participatory identification and implementation of community-based development activities that strengthen the capacity of local people to adapt to climate change" (Archer et al., 2014, p. 346). This relationship between residents' connection to their environment and the scale of adaptation would need to be investigated further.

Environmental project involvement is the third variable with a statistically significant weak positive relationship with awareness levels. Respondents who are involved in environmental

projects are inherently more interested in the environment, which drives them to take part in such projects. This means they are more likely to think about the environment in their city, and how it affects the living conditions of the residents. Through their involvement in environmental projects, they are also more likely to engage with information about environmental solutions to urban problems, such as the Westersingel urban floodplain and similar initiatives. In other studies, environmental project involvement predicts residents' willingness to partake in the maintenance of GI, which implies that they are interested in and informed about the functions of said GI, which would translate, in this study, to higher awareness levels. The precise mechanisms of this relationship would need to be investigated further. On the other hand, an awareness of the functions of GI may in fact drive environmental project involvement, as such an awareness could translate into more interest in environmental projects. As correlation does not imply causation nor causal direction, it is not possible to exclude either explanation based on these results.

A final consideration to keep in mind with these results is that the correlations show at best weak relationships between awareness and the independent variables. This suggests that, while a perception of flooding as a personal problem, a perception of flooding as a problem for Rotterdam and environmental project involvement are factors driving awareness, there are other factors which drive awareness and the observable differences in awareness which would need to be explored through further research.

4.3 Awareness-Raising Strategy

The results of this research can help Rotterdam policymakers identify the levels of awareness of their multifunctional GI initiative within the users of the Westersingel canal and urban floodplain. This can further help them design awareness campaigns to inspire the public to think about climate adaptation and urban resilience. The design of an awareness building strategy based on the results of this research will allow policy makers to have a starting point for the development of a more comprehensive awareness building campaign.

An awareness-raising strategy should have the following components: a goal or problem to be addressed; objectives to be achieved; target groups; clear and simple messages; methods, tactics or activities; and a monitoring and evaluation plan (Cardinal et al., 2019).

The goal of this awareness-raising campaign is to increase the general public's understanding that a public space with the right design features can have flood protection and other beneficial functions for the local area. Through raising awareness, it aims to contribute to implementation of such initiatives within communities, thereby increasing the urban resilience of the area.

Objectives for this campaign should centre around awareness and the uptake of such GI climate adaptation solutions. One objective, for example, could be to increase high awareness of such solutions and their functions within target areas. A second objective could be the implementation of such solutions in a certain number of target areas.

The target group for this campaign is the general public but can be segmented into the residents of specific neighbourhoods. The residents of an area are the most important to achieve the goals of the campaign, as they must give their approval to any implementation of green infrastructure in their area, but they can also be the initiators if they are sufficiently persuaded that it would be a positive development for them. They may then influence their local politicians to work towards these goals. Furthermore, it is property owners along the sites where such solutions could be implemented – given the physical layout of the neighbourhood – who are important to be targeted through this campaign.

The messages of this campaign are simple and based on the benefits which the initiative, an urban canal and floodplain, can bring to an area, while being oriented by the needs and desires of the population. Benefits should be maximised and emphasised (Maibach, 1993). These can be a more aesthetically pleasing area, more accessible natural recreational setting for residents and their children and pets, a cooler place to enjoy hot summer days, protection from flooding during rainstorms, lower flood insurance premiums and increased property values for the whole area due to the aesthetic improvement. Costs should be minimised (Maibach, 1993). This can include framing initial construction costs as investments which return lower flood insurance costs and higher property values. This is especially helpful if the government offers financial assistance to the project (in the form of investment in urban GI) and advertises it. Furthermore, as the driving factors of awareness identified in this research suggest, the campaign should emphasise the potential for flooding, its increasing likelihood due to climate change, and the damages which flooding can cause. There should be a focus on the problems flooding can cause for residents personally (personal damages and health impacts) and for the city (infrastructure damage and disruption). Simultaneously, the campaign should focus on the ways in which GI

can alleviate these problems. If there is a deeper consciousness about flooding within the residents, they should be more receptive to the proposed solution. Furthermore, the messaging should emphasise the capacity of residents to act in the climate adaptation of their own neighbourhoods. This would be helped by information on how much these initiatives can help achieve the resilience goals of the city. Short messages presented to the audience should lead them to resources with more detailed and elaborated content to expose them to richer information (Rice & Atkin, 2013). Through more detailed formative research of the target audience, these messages should be refined fit to the residents' specific needs and desires, while using the language they use to speak about the matter (Maibach, 1993). The public should be educated about the efficacy of the GI adaptation measures, so they may influence institutional leaders to enable such developments (Rice & Atkin, 2013).

A mix of media channels is generally advised when designing a campaign. As suggested by Tayouga and Gagné (2016), GI development should be coupled with public education. Westersingel urban floodplain should therefore be outfitted with educational materials that showcase the space's specific functions. This will help connect abstract information on resilience functions to the real world and to places which residents can see with their own eyes. These educational materials should include short informative texts and intuitive visual representations of the space's flood protection, cooling, carbon sequestration and wildlife habitat provision functions (for example, a line on the wall showing the flood height on a certain date). Similar approaches are already being used at the Rotterdam Benthemplein Watersquare, where the mechanism of the water retention function is explained in detail (De Urbanisten, n.d.). Furthermore, engaging content can be disseminated through neighbourhood associations and community centres, targeting the communities directly. Due to the focus on Rotterdam communities, the choice of traditional media most likely falls to local newspapers and/or local radio stations, as well as local social media groups. Media channels such as television and radio reach a national audience and would be too broad and not cost-effective. Lastly, the campaign could make use of community leaders who have personal influence over the community's attitudes towards development as a whole (Rice & Atkin, 2013).

Monitoring and evaluation should take place on multiple fronts. One aspect could be to repeat this study after the campaign has been running for some time and compare the awareness levels of public space users to those measured in this study. To assess the progress of the objectives mentioned above (increasing awareness of GI and its functions; and increasing the

implementation of GI in neighbourhoods), the research could be adapted to assess the awareness within target areas and compare these. For the second objective, the development and implementation of GI adaptation measures in target areas should be monitored.

Chapter 5: Conclusion

5.1 Social and Scientific Contribution

This study used a survey to assess public space users' awareness of the Westersingel urban floodplain's resilience functions as GI. The results show that only 4.4 per cent of respondents were aware of the space's flood protection functions. This shows a very low awareness of said function among the people who spend time in the space. A further 2.9 per cent of respondents were aware of the space's other functions in a scientific sense, such as cooling or carbon sequestration. This means that the vast majority of respondents (92.7 per cent) were unaware of the specific resilience functions which the space can provide for the surrounding area, laying bare a lack of engagement with potential ways to address urban resilience in the general population.

A substantial portion of the sample, 32.4 per cent, was aware of the benefits which the space could have for individuals in the sense of mental health and recreation. This shows that people can in fact think about the functions which a space can provide but are more likely to recognise these if they relate to their own personal benefit. It is the next step in this thought process which needs to be cultivated within the population, the consideration of how well-designed spaces can provide functions for residents more broadly and for whole areas. By far the most frequent awareness level (48.5 per cent of the sample) was the lowest level, which shows no awareness of any functions which the space can provide. This indicates a substantial lack of awareness of beneficial functions of the Westersingel public space within its users.

This research has shown that, while some factors driving awareness could be identified in the literature, not all of these had a measurable relationship with awareness in the investigated sample. The main factors with a significant relationship with awareness are a perception of flooding as a personal problem, a perception of flooding as a problem for the city of Rotterdam, and environmental project involvement. The results further imply the existence of unknown factors with a relationship with awareness, which were not identified through the literature and therefore not included in the analysis of this study. They thus should be investigated further.

5.2 Practical Implications

The low awareness levels measured in this research are evidence to suggest that the general population is not engaging with urban resilience and climate adaptation, even when they are in a public space which functions as a GI adaptation measure. They are furthermore taking a passive approach to adaptation and leaving it in the hands of their government, rather than thinking about the contribution they could be making. This may present issues if full-scale adaptation requires the involvement of all segments of society and no action is taken to raise the general public's engagement with this topic. This research suggests that considering flooding as a problem, and not necessarily experiencing problems with flooding, is linked to higher awareness levels. In practical terms, this means cultivating a sense of flooding as a problem personally and for the city which residents live in could raise awareness levels and thereby engagement with resilience. Furthermore, involvement in environmental projects is also linked to higher awareness levels, suggesting that a culture of environmental thinking and acting could lead to higher levels of awareness and more engagement with resilience. Environmental projects should therefore be supported and encouraged to cultivate resilience thinking in the population and help increase urban resilience to adverse effects of climate change.

The awareness-raising strategy laid out in this thesis has identified the target audience as the city's residents, segmented into targeted neighbourhoods, and the subject matter of the core messages: aesthetic improvement of the area; better accessibility of natural areas; cooling on hot days; flood protection during rainstorms; and higher property values. Its main goal would be to increase awareness, with a secondary, more long-term goal of increasing the use of GI multifunctional resilience initiatives throughout the city.

5.3 Limitations and Future Research Needs

This research would benefit from better integration with the culture of the study area. Specifically, a survey conducted in Dutch would allow for respondents to feel more at ease and comfortable answering in their own language, which at the same time may reduce confusion about concepts raised in the questions, as well as increase the number of respondents by including people who do not speak English. Furthermore, as it was outside the scope of this research, future research could conduct a larger survey in multiple different green areas around

Rotterdam at once, in order to gain a more complete understanding of the awareness levels throughout the city and have a means of comparison across green spaces or areas, as well as take advantage of a larger sample size to increase statistical power.

Moreover, this research only showed weak relationships between awareness and the independent variables investigated in this study. This likely means that there are other variables driving awareness and the observable differences in awareness within the sample which have not been touched upon by this research. These variables would need to be explored through further research.

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Appendix 1: Participant Information & Survey Form

Thank you for taking the time to fill out this survey. This survey is part of research I am conducting for my Master of Science Thesis in Urban Management and Development.

The research concerns the awareness of users of a public space of its multifunctional uses. Some spaces in the city have multiple functions built into their design. For example, a car park can act as water storage, or a green area with trees can cool down the surrounding area. This research assesses people's awareness of multifunctionality in the Westersingel canal walk.

This short survey will take no longer than 5 minutes to complete.

Your answers will be used FOR ACADEMIC PURPOSES ONLY.
This survey will NOT record any personal information (e.g. Name, Address, etc.)**.**
You will remain ANONYMOUS and your answers CANNOT be traced back to you.

If you choose not to take part in this survey, please inform the researcher and the form will be destroyed immediately.

If you have already answered the survey and decide that you do not want your answers included in this research, please contact the researcher and your answers will be removed from this research.

For this purpose and any other questions you may have please contact the researcher or supervisor at the contact provided below.

Researcher: Yasha Pilarsky 627488yp@eur.nl

Supervisor: Qian Ke ke@ihs.nl

Respondent No. _____ **Date ___ / ___ / 2022**

1: Do you feel like this space we are in gives you any personal benefits? If yes, which benefits?					
2: Do you feel like this space gives any benefits to the area or neighbourhood? If yes, which benefits?					
3: How often do you visit this space?[d]					
Every day	A few times a week	A few times a month	A few times a year	Less than once a year	I don't know
4: How easily do you feel you can access this space?[e]					
Very easily	Easily	Neutral	With difficulty	With great difficulty	I don't know
5: In general, how connected or disconnected do you feel to your environment, the space around you every day?[f]					
Very connected	Connected	Neutral	Disconnected	Very disconnected	I don't know
6: Are you involved in projects about the environment and nature?[g]					
Every week	Every month	Every year	In past years	Never	I don't know
7: Do you think flooding is a problem for the city of Rotterdam?[c]					
Yes, very much	Yes, somewhat	Neutral	Not really	Not at all	I don't know
8: Have you experienced problems with flooding?[b]					
Yes, very often	Yes, sometimes	Neutral	Rarely	Never	I don't know
9: Do you think flooding is a problem for you personally?[a]					
Yes, very much	Yes, somewhat	Neutral	Not really	Not at all	I don't know

Appendix 2: STATA .do file

```
clear

set more off

cd "/Users/Yasha/Documents/MSc UMD18/Thesis/STATA"

capture log close

log using "log.log", replace

use "survey68.dta"
************************************************************
*** renaming variables & values ***
************************************************************
rename Awareness awareness
label variable awareness "Awareness"
label define Awareness 1 "(i)" 2 "(ii)" 3 "(iii)" 4 "(iv)" 5 "(v)", replace

rename FloodingPersonalProblem floodprob
label variable floodprob "Flooding is a Personal Problem"
label define floodprob 0 "I don't know" 1 "Not at all" 2 "Not really" 3 "Neutral" 4 "Yes,
somewhat" 5 "Yes, very much", replace

rename FloodingExperience floodexp
label variable floodexp "Experienced Problems with Flooding"
label define floodexp 0 "I don't know" 1 "Never" 2 "Rarely" 3 "Neutral" 4 "Yes, somewhat" 5
"Yes, very often", replace

rename FloodingCityProblem floodcity
label variable floodcity "Flooding is a Problem for Rotterdam"
label define floodcity 0 "I don't know" 1 "Not at all" 2 "Not really" 3 "Neutral" 4 "Yes,
somewhat" 5 "Yes, very much", replace

rename VisitFrequency freq
label variable freq "Visit Frequency"
label define freq 0 "I don't know" 1 "Less than once a year" 2 "A few times a year" 3 "A few
times a month" 4 "A few times a week" 5 "Every day", replace

rename AccesstoSpace access
label variable access "Access to Space"
label define access 0 "I don't know" 1 "With great difficulty" 2 "With difficulty" 3 "Neutral"
4 "Easily" 5 "Very easily", replace

rename ConnectedDisconnectedtoSpac connection
label variable connection "Connection to Space"
label define connection 0 "I don't know" 1 "Very disconnected" 2 "Disconnected" 3 "Neutral"
4 "Connected" 5 "Very Connected", replace
```

```
rename EnvironmentalProjectsInvolveme envproj
label variable envproj "Environmental Projects Involvement"
label define envproj 0 "I don't know" 1 "Never" 2 "In past years" 3 "Every year" 4 "Every
month" 5 "Every week", replace

***

codebook

***

tab awareness

*************************************************************
* GRAPHS *
*************************************************************

histogram awareness, discrete barwidth(.8) xti(Awareness Level) xlabel(1 "(i)" 2 "(ii)" 3
"(iii)" 4 "(iv)" 5 "(v)") frequency addlabels title(Histogram of Awareness Level Distribution)
graph export "graphs/hist_awareness.png", replace

histogram floodexp, discrete barwidth(.8) xti(Experienced Problems with Flooding) xlabel(0
"I don't know" 1 "Never" 2 "Rarely" 3 "Neutral" 4 "Yes, sometimes" 5 "Yes, very often",
angle(30)) frequency addlabels title(Histogram of Experience with Flooding Problems)
graph export "graphs/hist_floodexp.png", replace

histogram floodprob, discrete barwidth(.8) xti(Flooding is a Personal Problem) xlabel(0 "I
don't know" 1 "Not at all" 2 "Not really" 3 "Neutral" 4 "Yes, somewhat" 5 "Yes, very much",
angle(30)) frequency addlabels title(Histogram of Perception of Flooding as a Personal
Problem)
graph export "graphs/hist_floodprob.png", replace

histogram floodcity, discrete barwidth(.8) xti(Flooding is a Problem for of Rotterdam)
xlabel(0 "I don't know" 1 "Not at all" 2 "Not really" 3 "Neutral" 4 "Yes, somewhat" 5 "Yes,
very much", angle(30)) frequency addlabels title(Histogram of Perception of Flooding as a
Problem for Rotterdam)
graph export "graphs/hist_floodcity.png", replace

histogram freq, discrete barwidth(.8) xti(Visit Frequency) xlabel(0 "I don't know" 1 "Less
than once a year" 2 "A few times a year" 3 "A few times a month" 4 "A few times a week" 5
"Every day", angle(30)) frequency addlabels title(Histogram of Visit Frequency)
graph export "graphs/hist_freq.png", replace

histogram access, discrete barwidth(.8) xti(Ease of Access to Space) xlabel(0 "I don't know"
1 "With great difficulty" 2 "With difficulty" 3 "Neutral" 4 "Easily" 5 "Very easily",
angle(30)) frequency addlabels title(Histogram of Ease of Access to Space)
graph export "graphs/hist_access.png", replace

histogram connection, discrete barwidth(.8) xti(Connection to One's Environment) xlabel(0 "I
don't know" 1 "Very disconnected" 2 "Disconnected" 3 "Neutral" 4 "Connected" 5 "Very
```

```
connected", angle(30)) frequency addlabels title(Histogram of Connection to One's
Environment)
graph export "graphs/hist_connection.png", replace

histogram envproj, discrete barwidth(.8) xti(Involvement in Environmental Projects) xlabel(0
"I don't know" 1 "Never" 2 "In past years" 3 "Every year" 4 "Every month" 5 "Every week",
angle(30)) frequency addlabels title(Histogram of Involvement in Environmental Projects)
graph export "graphs/hist_envproj.png", replace



* NOTES *
* for any table or graph, label awareness with levels "i" thru "v" and use notes under graph to
show full name of value

**********************************************************
* CREATING DUMMY VARIABLES *
**********************************************************

* floodexp
* NOTE: cutoff point is at never experienced flood problems

generate floodexp_d = 0 if floodexp == 1
replace floodexp_d = 1 if floodexp >= 2 & floodexp <=5

* floodprob
* NOTE: cutoff point is neutral

generate floodprob_d = 0 if floodprob >= 1 & floodprob <= 3
replace floodprob_d = 1 if floodprob >= 4 & floodprob <= 5

* floodcity
* NOTE: cutoff point is neutral

generate floodcity_d = 0 if floodcity >= 1 & floodcity <= 3
replace floodcity_d = 1 if floodcity >= 4 & floodcity <= 5

* freq
* NOTE: cutoff point is a few times a year -> dummy variable: minimum monthly visits?
yes/no

generate freq_d = 0 if freq >= 1 & freq <= 2
replace freq_d = 1 if freq >= 3 & freq <= 5

* access
* NOTE: cutoff point is neutral. since there are only 5 respondents who said neutral and all
others said easy or very easy, significance of the correlation is impacted

generate access_d = 0 if access >= 1 & access <= 3
replace access_d = 1 if access >= 4 & access <= 5
```

```
* connection
* NOTE: cutoff point is neutral

generate connection_d = 0 if connection >= 1 & connection <= 3
replace connection_d = 1 if connection >= 4 & connection <= 5

* envproj
* NOTE: cutoff point is never being involved in environmental projects

generate envproj_d = 0 if envproj == 1
replace envproj_d = 1 if envproj >= 2 & envproj <= 5

**********************************************************
* TABS *
**********************************************************

tab floodexp_d
tab floodprob_d
tab floodcity_d
tab freq_d
tab access_d
tab connection_d
tab envproj_d

**********************************************************
* CORRELATING NEW DUMMY VARIABLES *
**********************************************************

pwcorr awareness floodexp_d floodprob_d floodcity_d freq_d access_d connection_d
envproj_d, sig
```