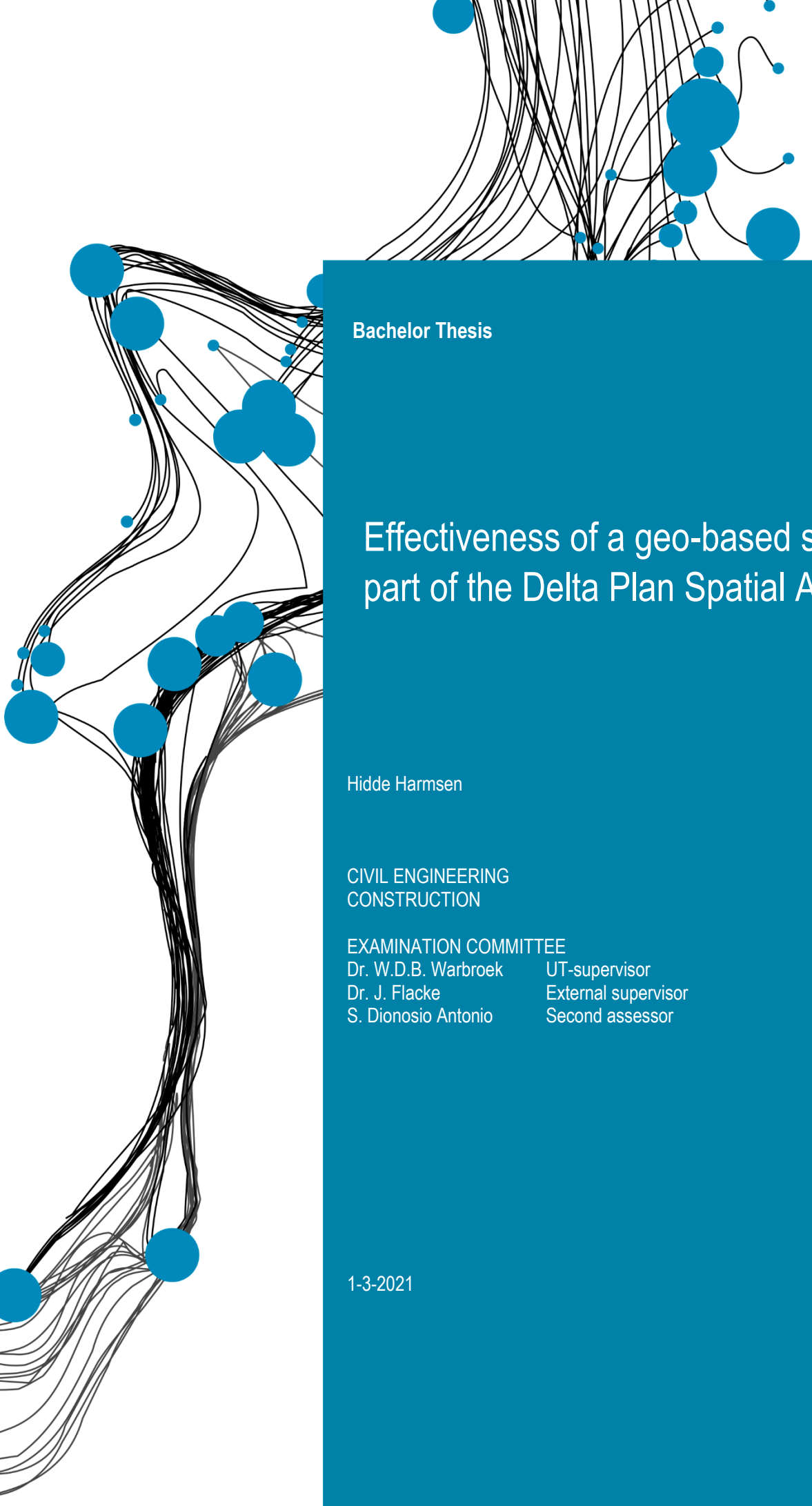

Bachelor Thesis

Effectiveness of a geo-based survey as part of the Delta Plan Spatial Adaptation

Hidde Harmsen

CIVIL ENGINEERING
CONSTRUCTION

EXAMINATION COMMITTEE

Dr. W.D.B. Warbroek	UT-supervisor
Dr. J. Flacke	External supervisor
S. Dionosio Antonio	Second assessor

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Abstract

Climate change is a widely recognized problem for which no simple answer exists. The Dutch Delta Plan on Spatial Adaptation (DPRA) is a framework for municipalities to lead the adaptation in the right direction. This plan consists of seven ambitions and typically starts with a stress test to map the challenges, a risk dialogue with stakeholders to give value to the results of the stress test and finally a composition of the adaptation strategy. The stakeholders involved are rarely residents. At the same time is there a rise in the use of Public Participation GIS to increase the participation of the general public in spatial planning. This study aims to determine if such a PPGIS in the form of a geo-based survey is of added value to the process steps outlined in the DPRA.

The hypothesis is that a geo-based survey yields information about the current climate change effects in a neighbourhood to validate the stress test and provide information for the risk dialogue. To test this hypothesis, a geo-based survey was distributed among residents of a part of a neighbourhood in the municipality of Enschede. Respondents were asked to appoint the locations where they experience waterlogging, groundwater nuisance, and which locations need protection against waterlogging. Responses were analysed using the software of Maptionnaire and compared with the results of the Climate Impact Atlas.

Results showed that a geo-based survey is a good method to use as first step in the risk dialogue. Despite a low response rate due to inefficient dispersion, the geo-based survey yielded additional information on the project area and showed great potential for informing residents and validating the results of the stress test.

Contents

1. Introduction

1.1. Background on climate adaptation

The Earth's climate is changing. Mostly due to the release of greenhouse gasses which trap the heat of the sun. Despite agreements to reduce the emission of these gasses (UNFCCC 2015), the earth is warming up. This warmer climate has as effect longer and heavier droughts, intensified precipitation, rising sea levels and heat stress (Hardy 2003, WWF 2020). Climate adaptation focusses on tackling these effects. Logically, the severity of these effects is strongly spatial dependent. A coastal city is strongly affected by the rising sea level, while farmland suffers due to the longer droughts. The adaption strategy is thus executed by local governments and is more of a short-term strategy.

1.2. Climate Adaptation in the Netherlands

An interesting case is the Netherlands. This small country is especially vulnerable due to its placement in a river delta, where 26 percent of the land area lies beneath sea level and in total 59% of the land area is prone to flooding (either due to the sea or due to rivers) (Planbureau voor de Leefomgeving 2007). Droughts are, on the other hand, quite common in the higher laying sand grounds. To get a better view of the problems at hand, municipalities, regional water authorities and the Dutch government has defined a Delta Plan Spatial Adaptation (in dutch: Delta Plan Ruimtelijke Adaptatie; therefore abbreviated as DPRA). This plan consists of seven ambitions to make the Netherlands climate-proof and water-resilient, according to the "weten, willen, werken" principle, which translates to "know, want, do". The ambitions will be explained below:

Figure 1 – the seven ambitions (De Graaff, Kloosterman et al. 2018)

- **Mapping out vulnerabilities.** All governments are obliged to map the vulnerabilities of their region regarding the four climate themes waterlogging, heat, drought and flooding before 2019. This is done by so-called stress tests. The Climate Impact Atlas (Klimaat Effect Atlas; CIA) (Stichting CAS 2020) is a good starting point since it provides a bird's eye view on the climate threats in every region.
- **Conducting risk dialogues and drawing up strategies.** Once the results of the stress tests are available, the local governments will organise risk dialogues. They serve two purposes: raising awareness of a regions vulnerabilities to weather extremes, and discussing specific measures to reduce such vulnerability. The risk dialogues are planned for 2021.

- **Drawing up implementation agendas.** After drawing up the adaption strategy based on the risk dialogues, an implementation and investment agenda will be made. This agenda features agreements on who is going to do what. Every municipality and governmental body should aim to have these finished by 2022.
- **Capitalising on linkage opportunities.** This ambitions emphasize the need to search for synergies.
- **Promotion and facilitation**. All stakeholders need to share their expertise, instruments and experience whenever possible to give impetus to spatial adaptation, so that it becomes standard practice in every project.
- **Regulating and embedding**. An ambition to boost the DPRA by legislation, visions, plans and standards.
- **Responding to disasters.** The DPRA recognise that disasters can happen, despite all measures. Special attention will be focused on emergency provisions and rapid restoration of vital and vulnerable infrastructure.

Important to notice is that the first three ambitions are more or less linear, while the other four need to be tend to continuously. This thesis focusses on the stress test and the risk dialogue. The goal of these ambitions is to make the Netherlands climate-resilient and water-proof by 2050. However, due to the ever changing insights and predictions the plans need to be evaluated every six years .

1.3. Problem description

The CIA data is rather coarse (Laudien, Boon et al. 2018) and requires enrichment, interpretation and scaling down. This is the function of the stress test and risk dialogue. The DPRA greatly benefits from the input of stakeholders, because they have the most knowledge about their own region. Not only the support for measures increases, also new threats are being identified during risk dialogues. However, out of a survey by Hofland and Boon (2019), conducted on 17 may 2018, it becomes clear that there are different views on the goal of a risk dialogue between municipalities, but also between civil servants from the departments of Water and Spatial Planning. Furthermore, they demonstrate that municipalities are not yet ready for the risk dialogue, and that more than 60% would like to have a guide. De Graaff, Kloosterman et al. (2018) state however that the term ‘guide’ is misleading. It implies that a general approach is available, which is not the case due to the diversity of the dialogues. They state that practical experience shows that experiences of frontrunners seem to inspire and give an idea what works and what not. By bundling these experiences they come to the conclusion that a guide has no added value and that the risk dialogue develops itself in practice. The challenges are threefold and turn out to lie in the field of: (1) Involving the right stakeholders at the right time in the right way. (2) Working towards spatial adaptation as a logical step of spatial development. (3) Deciding what acceptable/unacceptable risks are and the making of trade-offs and possible measures. These challenges are comparable with the challenges when organising a participatory process, namely: (1) effective arrangements of public participation; (2) ability to reach a broad spectrum of people and (3) the production of high quality and versatile knowledge (Kahila-Tani, Kytta et al. 2019).

Using the techniques-oriented matrix of public and participation (over which more in chapter 2.2) by Schlossberg and Shuford (2005), it becomes clear that the survey technique is not yet consistently used in the DPRA. That while a survey can efficiently tackle some of the abovementioned challenges. A survey has a great ability to reach a broad spectrum of people. It can also make an inventory of the relevant stakeholders, after which involving the right stakeholders at the right time will be easier. Knowing your stakeholders makes it easier to involve them in the right way and to come to effective arrangements of public participation. Last but not least, a survey is a great way to enrich the data from the stress test by validating those with the residents. Since every Dutch municipality needs to do this, a survey has good potential to serve as a guide to start with the risk dialogue.

1.4. Research objective and questions

Therefore, the question arise if a Public Participation GIS (PPGIS) in the form of a geo-based survey, which increases the participation and improves the knowledge production, can be used in the Delta Plan Spatial Adaptation. The research objective is to answer the main question:

"*Is a geo-based survey an effective measure to introduce as an additional step in the seven ambitions of the DPRA?"*.

This question will be answered with help of the following sub-questions:

1. What are the advantages and disadvantages of a geo-based survey and in which process step in the DPRA can it be used?
2. To what extent do the outcomes of the geo-based survey overlap with the output from the Climate Atlas?
3. To what extent do the perspectives of residents on climate change effects differ?

1.5. Overview of the structure

First will be started with a literature review to define where a geo-based survey could be of use, and what the actual advantages and disadvantages are. This literature review takes a better look in the current Delta Plan Spatial Adaptation and the different ambitions in this plan. Furthermore, current public participation practices and public participation geographical information systems (PPGIS) are explained. Hereafter the benefits of a geo-based survey are summed up. These will be used to define some goals a geo-based survey can achieve, and these goals will be tested by designing and executing such a survey. First the methodology behind the survey will be explained before diving into the results of this survey. The results will be compared with the Climate Impact Atlas in the results chapter. The extent in which the survey succeeds in its goals defines the usability of the survey. The conclusion reflects on the earlier mentioned research question: "*Is a geo-based survey an effective measure to introduce as an additional step in the seven ambitions of the DPRA?"*. Hereafter the methodology and conclusion will be discussed in the discussion, after which some recommendations will be made regarding the geo-based survey as measure for the Delta Plan Spatial Adaptation.

2. Literature Review

In this chapter the existing literature on the implementation of the DPRA and the current PPGIS practices will be reviewed. First a more detailed explanation will be given about the different steps in the DPRA. Then the need for public participation and origination of PPGIS is explained and how this can contribute to the DPRA. Lastly the advantages and disadvantages of a geo-based survey are analysed.

2.1. Delta Plan Spatial Adaptation

The first two ambitions of the DPRA will be explained below in a little more detail, according to 3 steps: (1) what is the goal? (2) How is it executed? (3) Who participates? Hereafter the interrelatedness of these ambitions will be explained in more detail. The stress test is namely not always the first step to take.

Mapping out vulnerabilities

As stated before, the goal of this ambition is to find out how vulnerable certain locations are to extreme precipitation, drought, heat and flooding, without a judgement about value. This is done by so called stress tests. Which entails collecting and creating data which describes the potential effects of climate change (the stress on the system) in the future, and comparing this data with information about the sensitivity of objects and functions for these effects. Points of interest are where, when and which bottlenecks emerge, among a variety of climate developments with a specific interest in vital and vulnerable functions, energy, water and telecom (Stichting CAS 2020). A good starting point of the stress test is the Climate Impact Atlas, which provides a bird's eye view on the challenges at hand. This tool is based on models and national data and provides an indication of the order of magnitude of the potential impact on a region. The atlas focusses on the themes urban flooding, waterlogging, drought and heat. For each of these themes several map layers are available. Furthermore, it is possible to compare current climate with the expected climate in 2050 (Stichting CAS 2020). With an overview of the challenges at hand, the organizer of the stress test shall expand these data with help of professional knowledge of the area, measurements and better suited models. For this the standardized stress test can be used as provided by Stichting Climate Adaptation Services to decide on which topics need further research (Stichting CAS 2020), consultants can be hired to map the challenges (Stichting CAS 2020), or local experts and stakeholders can be involved to get a better view of the challenges at hand. The participants in this phase are thus the initiator of the stress test, consultants and local experts, in practice this translates to municipal servants and a consultancy firm (Benders 2018).

Conducting risk dialogues and drawing up strategies

The risk dialogue acts as a place for discussion and giving values to certain risks. Measures shall be defined and ambitions will be formulated. The risk dialogue is about finding synergies, determining the necessary commitment, action perspective and making strategic choices. But the risk dialogue can be broader and discuss other subjects, or can be narrower and solely create awareness. The starting point is mostly the results of the stress test, but can also be a calamity, such as flooding due to heavy precipitation. The risk dialogue consists most of the times out of multiple dialogues on multiple levels, which is dependent on the available time and capacity. The risk dialogue is thus always customized (Stichting CAS 2020). It can be performed in many ways depending on the goal, such as work sessions, workshops, ateliers, masterclasses or conversations. De Graaff, Kloosterman et al. (2018) state that, after analysing 15 risk dialogues, a classic guide for the risk dialogue has no added value, but that it develops itself in practice. The definition they give to the risk dialogue is "*an interactive dialogue with all relevant stakeholders, in which combined ambitions, assessment frameworks and possible measures for spatial adaptation are drawn up, on a basis of information about the effects of climate change*".

Out of this definition it can be concluded that everyone, as long as they have a stake, should be able to participate. When considering the stakeholders government, public parties, private parties and individual civilian, this is achieved according to the analysed risk dialogues. Salient detail is that the most common participant in risk dialogues with the goal to raise awareness, was the government.

Interrelatedness of the different ambitions

The ambitions follow the principle of "weten, willen, werken". Weten is achieved by doing the stress test and mapping the vulnerabilities. The risk dialogue is the step from 'weten' to 'willen'. The implementation agenda covers the step from 'willen' to 'werken'. However, there is some interrelatedness between these ambitions. De Graaff, Kloosterman et al. (2018) describe this cyclical approach (figure 2), which implies that with any step can be started. The learning process will optimize and improve the results.

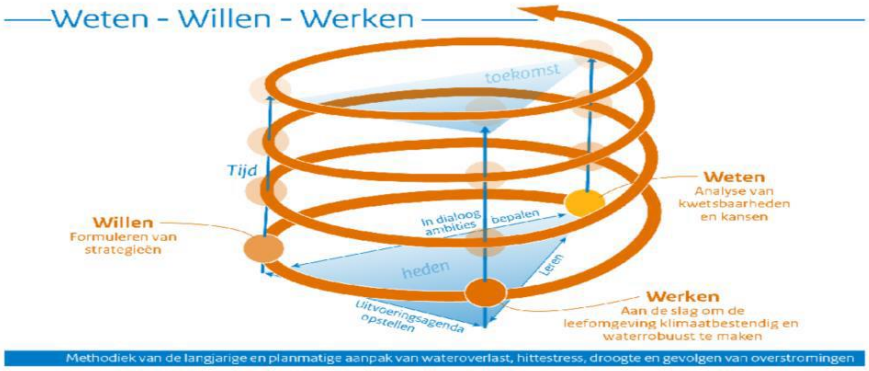


Figure 2 - "weten, willen, werken" principal of the DPRA (De Graaff, Kloosterman et al. 2018)

An overlook feature is that the process between risk dialogue and stress test is also iterative. Hereby is the stress test, as said before, the logical first step. However, when little is known about a certain area, then a risk dialogue can also be a good first step to get to know the area. Hereafter more detailed information can be created, which can be discussed as well. Only when the information about the climate change effects is detailed enough, measures can be discussed in the risk dialogue. This process is displayed in figure 3 (Stichting CAS 2020).

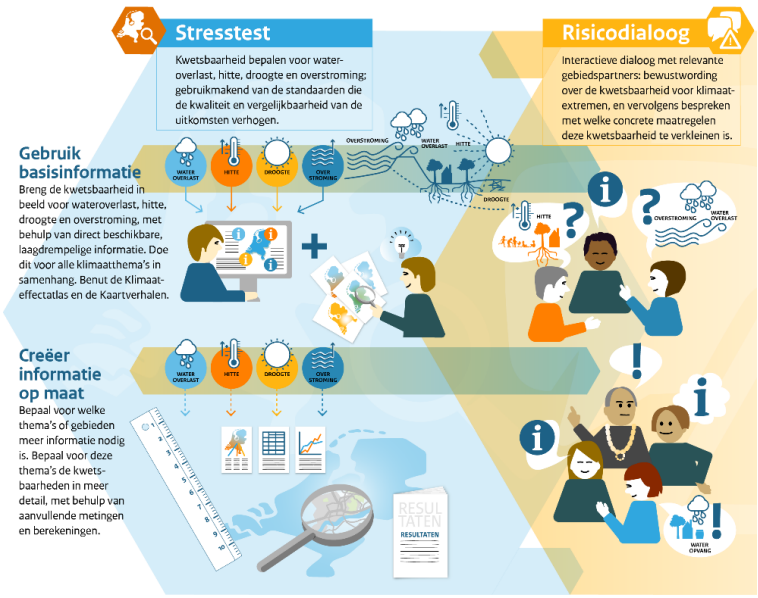


Figure 3 - interrelatedness between the stress test and the risk dialogue (Stichting CAS 2020)

2.2. Public Participation Geographic Information System (PPGIS)

Public participation plays a large role in the DPRA, and in western societies in general (Beierle 2002). This is also propagated by the United Nations in their sustainable development goals 11 ("*By 2030, enhance inclusiveness and sustainable human settlement planning and management in all countries"*) and 16 (*"Ensure responsive, inclusive, participatory and representative decision-making at all levels"*) (United Nations 2015). These goals are directly applicable to the DPRA and realised by the risk dialogue. The DPRA greatly benefits from the input of stakeholders, because they have specific knowledge about their own region. Not only the support for measures increases, also new threats are being identified during risk dialogues.

On the other hand there is a rise in the use of online tools due to the digitalisation of society. This led to the development of the field of GIS (geographical information systems), an information support system where data has a geographical dimension. Ideal for maps and thus spatial planning. Combining this technology-based spatial analysis with the participatory democracy let to the field of Public Participation GIS (PPGIS) (Schlossberg and Shuford 2005). PPGIS has proofed to be a useful contribution to participation in planning processes (Kahila-Tani, Broberg et al. 2016). Since the DPRA is a spatial problem which greatly affects the public, and asks for participation in the process, it makes sense to study the added value of PPGIS in the context of the DPRA.

Schlossberg and Shuford (2005) state that *"Understanding how specific publics are linked to certain types of participation is an important effort to undertake so that users of PPGIS ideas can appropriately characterize, utilize, implement and evaluate their PPGIS efforts."* after which they propose a matrix (table 1) to link public to participation. This provides a basic context for users and researchers of PPGIS ideas to be clearer about what they are doing and hoping to achieve by integrating GIS into a public participation process. Added to this matrix are already available methods provided by the DPRA. It becomes clear that a survey is not yet consistently used in the DPRA. This while a survey, especially a digital one, can easily be dispersed over all domains of public. It can also be used to define which part of the random public are affected individuals, who need to be taken into account in the risk dialogue.

Table 1 - Techniques-oriented Matrix of Public and Participation (Schlossberg and Shuford 2005) with methods implemented in DPRA.

		Domain of Public: simple → complex				
		Decision Makers	Implementers	Affected Individuals	Interested Observers	Random Public
Participation Techniques: simple	Static Web Page					Ruimtelijkeadaptatie.nl
	Interactive Web Page	NAS Adaptatie Tool			Climate Impact Atlas	
	Mail Survey					
	Personal Survey					
	Public Meeting	Risk dialogue				
	Charrettes					
	Citizen Juries					
complex	Collaboration					

2.3. Benefits of a geo-based survey

A geo-based survey is a form of PPGIS where a survey is used to request spatial information of a specific focus group by using maps. These maps can take different forms depending on the information necessary, but mostly it consists of either a roadmap which is easily readable for participants, or a map with future spatial plans. The goal of a geo-based survey is to ask feedback from participants on spatial plans or to gather data from participants regarding spatial features, such as beautiful, dangerous, vulnerable or important locations. The participants in these questionnaires are mostly residents of the area, since their opinion is the most valid (Jankowski, Czepkiewicz et al. 2016).

A study by Kahila-Tani, Kytta et al. (2019) outlines the key advantages and disadvantages for PPGIS methods regarding three topics: the effective arrangements of public participation, the ability to reach a broad spectrum of people and the production of high quality and versatile knowledge. These are found by analysing PPGIS and experts. The advantages and disadvantages which are applicable to the DPRA are:

Table 2 - Advantages and disadvantages of PPGIS

Advantages	Disadvantages
- Easy to implement by planners, residents or other actors - Relatively high number of participants can be reached with reasonable effort - Reaching new resident groups - Localized information related to planning situations	- Digital methods are seldom sufficient - Poor geographical and socio-economic representativeness - Digital divide - Frustration of participants if nothing changes

2.4. How to put the geo-based survey to use?

It can be concluded that a geo-based survey is a promising method to use in the DPRA. First of all due to the benefits already mentioned for surveys. Secondly, because of the easiness to gather opinions of residents regarding vulnerable locations and problems in neighbourhoods. Based on these benefits and disadvantages, it can be concluded that a geo-based survey can best be used when a large group of residents need to be addressed, where the demographics of the response group are not that important. This means that the geo-based survey is of best use in the risk dialogue.

There is something to be said to use the geo-based survey in the risk dialogue, because the survey can produce data according to 'weten'-principle. For example, data about groundwater nuisance, which is not effectively covered in the CIA. However, it is presumed that a geo-based survey has more effect when executed after the stress test. Especially because the survey can then also be used to validate data produced by the stress test. It serves the step from 'weten' to 'willen', since it validates the things known and provides information on what we want to preserve (by specifying vulnerable locations). Combined with the knowledge that municipalities like to have a guide for the risk dialogue and the knowledge that the way to go with the risk dialogue reveals itself once started (De Graaff, Kloosterman et al. 2018), it would be advised to start the risk dialogue with a geo-based survey. In other words: the geo-based survey is best put to use as first step in the risk dialogue.

3. Method: Design of the survey

The research objective of this study is to investigate if a geo-based survey is an effective measure to introduce as an additional step in the seven ambitions of the DPRA. The method chapter can be diverted into three sections: Preparation, Execution and Analysis. In the first section the design choices to construct the survey will be further discussed. Also, the project area will be introduced. In the execution section the method of dispersing the surveys is highlighted. Lastly, the analysis section outlines the methods used to analyse the results and come to conclusions.

3.1. Preparation

In the following subsections the design choices to construct the survey will be further discussed. First the goal of the survey is specified, then the scope of the survey is further explained. This entails both a description and analysis of the area in which the survey is distributed, but also the topics the survey will address. Lastly, the questions in the survey are derived by breaking down the topics into questions which will yield relevant information. This section assumes that the stress test is executed by the municipality and that the survey focusses on residents of part of a neighbourhood. When talking about functions, this indicates locations, buildings and infrastructure for people and/or services (thus from hospitals to the energy network and drinking water). Furthermore the survey only considers the climate change effect of waterlogging, more of that will be explained in the scope.

3.1.1. Goal

As stated before, the geo-based survey is best put to use when implemented as first step in the risk dialogue. This means that the survey will be implemented just after the stress test, in which vulnerable locations are defined without a judgement of value. This information is created with models which predict the climate change effects in combination with data about the sensitivity of objects and functions for these effects. These models need validation, which the survey can provide. Furthermore the survey can cover some of the goals of the risk dialogue, such as providing additional information not yet, or wrongfully covered by the stress test. The main goal of the risk dialogue is giving value to certain risks. This can be achieved with the survey in different ways, such as asking for vulnerable functions or letting participants rank different waterlog scenarios from acceptable to unacceptable. To conclude, the survey has four goals namely:

1. To validate the results of the stress test.
2. To gather additional information to complement the stress test.
3. To gather additional information about vulnerable functions.
4. To give value to the results of the stress test.

3.1.2. Scope

The scope of this project will be a part of a neighbourhood in which waterlogging plays a large role. The criteria for waterlogging as defined by Stichting CAS (2020) are:

- Change in frequency and amount of precipitation
- Water depth during short heavy precipitation
- Sensitivity of neighbourhoods for waterlogging
- change on groundwater nuisance.

This topic is chosen because the direct effects are immediately visible and two thirds of the Dutch experienced waterlogging (Ons Water 2017). The location selected is depicted in **Error! Reference source not found.**. It entails two vertical streets, Kortenaerstraat and Prinsestraat, located southwest of the city centre of Enschede. The project area is approximately 200 by 130 meters. This location is chosen due to expected waterlogging by the stress test (**Error! Reference source not found.**). On the one hand, this waterlogging was neither recognized by the municipality of Enschede, nor by participants of the first risk dialogue. On the other hand, this risk dialogue did not consider residents. Therefore, this location is ideal to test the geo-based survey.

Figure 4 - Project area within the red circle

Figure 5 - results of the stress test for the project area

3.1.3. Questions

The survey consist of several questions to satisfy the goals. To come up with relevant questions an operational scheme is used (Benders 2018, Poortinga 2020). This scheme helps breaking down the goals of the survey to questions. For each goal a dimension is defined. This dimension is one way in which the goal manifests itself. Hereafter the indicators are thought of. These indicators are the quantifiable phenomena per dimension. These indicators are used to devise the questions. The indicator for groundwater nuisance is derived from Stichting CAS (2020). Due to the distribution of the survey over Dutch residents, the questions are given in Dutch. The goal “to give value to the results of the stress test” is not fully analysed in this thesis. On the one hand is value given to the stress test by indexing the vulnerable locations, which is done in this thesis. On the other hand could the stress test extensively be analysed to come to certain different scenarios on which the respondents could give their opinions. This is a more adequate way of value giving to the results of the stress test. However, due to a lack of time and no full co-operation with the municipality this aspect is not covered in this thesis.

Table 3 - Operational scheme of the survey

Topic	Dimension	Indicator	Question
Validate results of the stress test	Waterlogging on the street	Puddles on the Road Flooded streets	Kunt u aangeven waar in uw buurt plassen ontstaan na een regen bui? i. Follow up: hoe vaak ervaart u hier een plas? Meerkeuze: eens per tijdsperiode Kunt u aangeven waar in uw buurt straten blanks staan na een regenbui? i. Follow up: hoe vaak ervaart u hier een stroompje? Meerkeuze: eens per tijdsperiode
To gather additional information to complement the stress test.	Groundwater nuisance	Hoge luchtvochtigheid in huis en schimmelvorming door natte kruipruimtes of optrekkend vocht in muren Doorslaand vocht in kelders Drassige tuinen en langdurige natte groenstroken Schade aan stedelijk groen en omwaaien van bomen door verdrinking van wortels Schade aan panden als gevolg van wijziging in de opwaartse waterdruk onder de fundering Spoorvorming en ongelijkmatige verzakking van wegen en straatverharding	ervaart u een van onderstaande indicatoren? (een of meer keuzes mogelijk)
To gather additional information about vulnerable functions.	Vulnerable location	Places with a social or cultural interest. Places which improve the liveability	Kunt u aangeven welke plekken beschermd moeten worden tegen hoogstaand water? (Gebruik van polygoon/marker) i. Follow up: Waarom deze plek?
To give value to the results of the stress test.	Not covered	Not covered	Not covered
Validation	Location dependent	Location of house	Wilt u aangeven waar u woont?

Before respondents start with the questionnaire, there is an introduction page which explains the idea of the survey (figure 6). Thereafter are several pages with the questions from the table above. The one but last page gives respondents the option for any additional remarks.

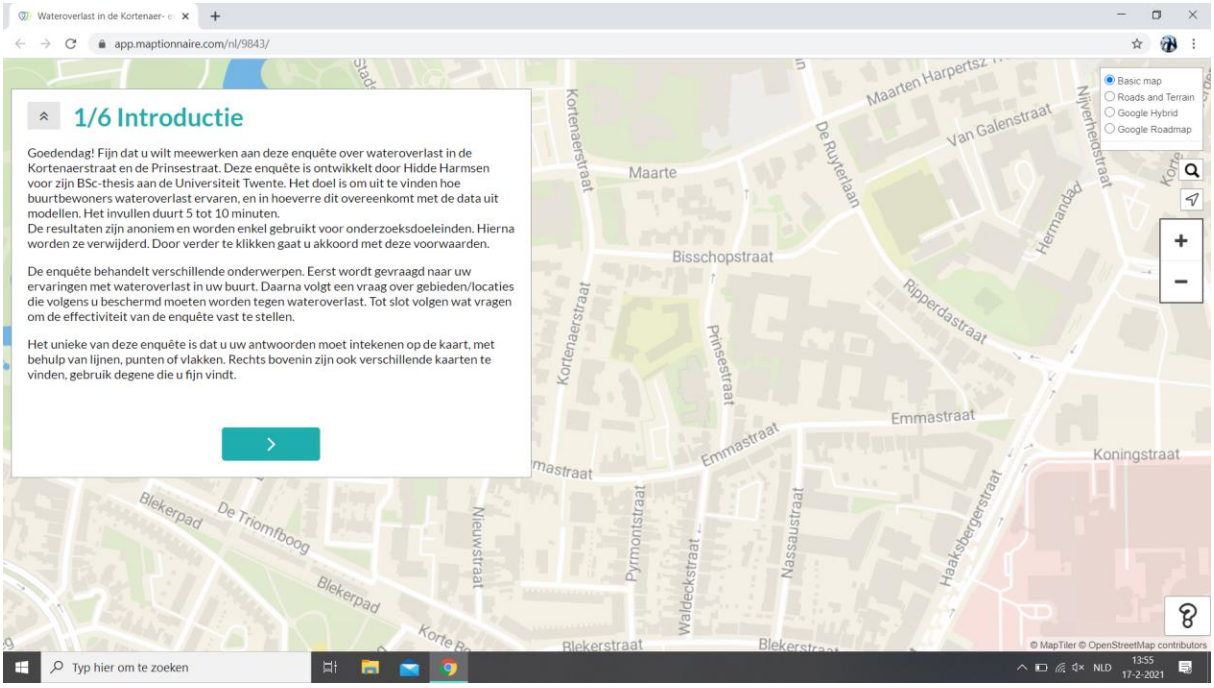


Figure 6 - Introduction page of the geo-based survey

To give respondents a better understanding about what is meant with puddles on the road and waterlogged streets, pictures are included. This is done such that respondents interpret the questions in the same way (figure 7).

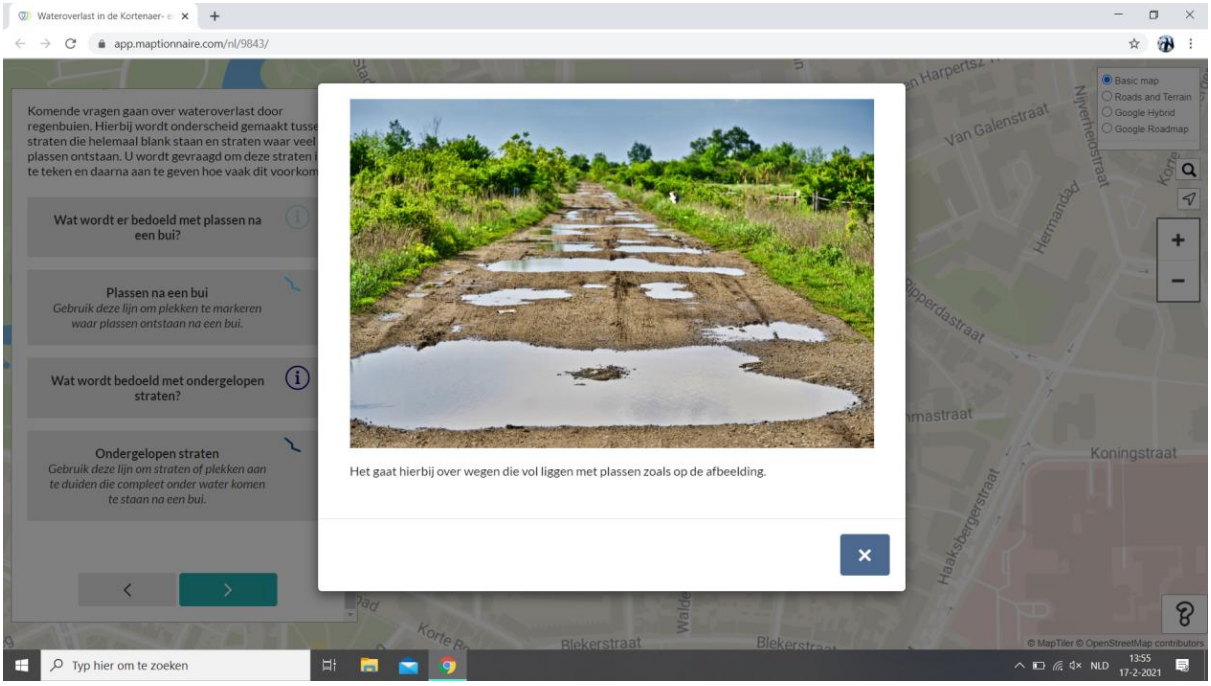


Figure 7 - exemplar of puddles on the road

Lastly, Hazansadeh and Laatikainen (2017) indicated that some user groups face greater difficulty with mapping than other user groups. When home location markings were compared to the actual home

coordinates, it was found that 86.8% of markings had an average error distance smaller than 100m and 75.1% smaller than 50 m. To get more accurate results, the respondents have the option to search for their address (figure 8). Furthermore, the project area itself is quite small (only 200 by 130 meter). This means that respondents immediately recognize the map of the area, which decreases chances on errors.

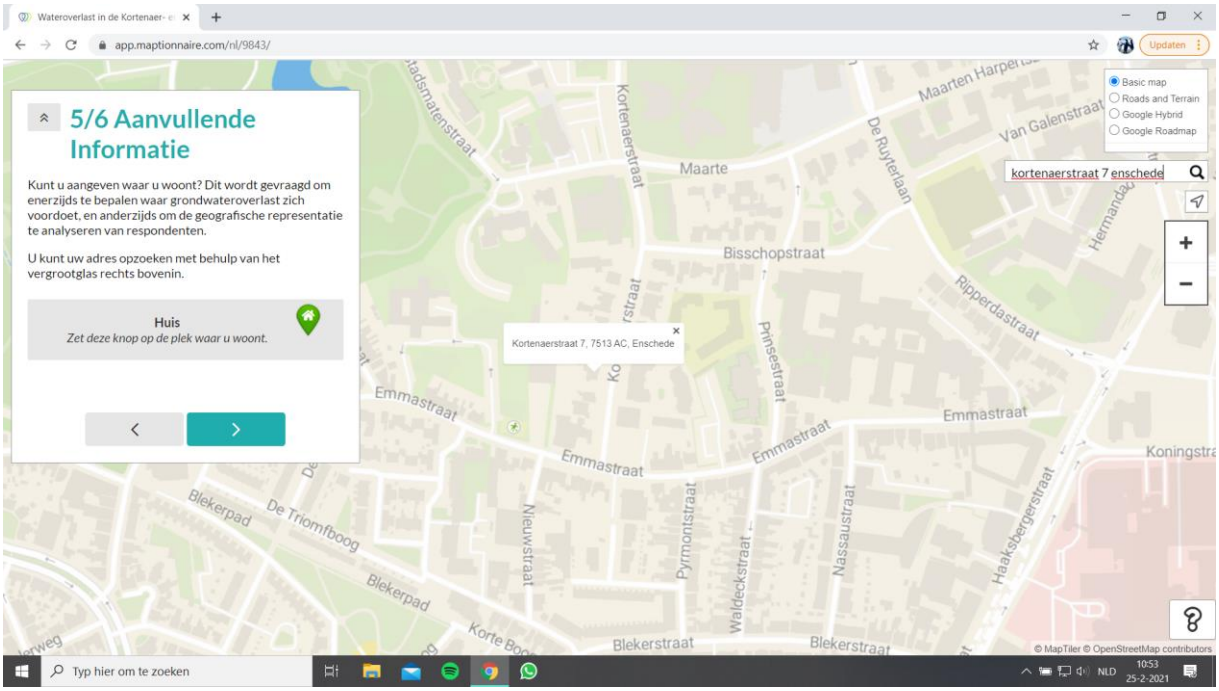


Figure 8 - Search by address in the survey

3.2. Execution

In this section the dispersion method of the survey is highlighted. An online survey has as greatest benefit its distribution, since only an html-link needs to be dispersed. Optimal would be to send this link to the residents by mail or use a social media such as Facebook, Hoplr or WhatsApp. Unfortunately, the existence of such infrastructure is unknown in this project area. Therefore, the survey is distributed using a folder (appendix B). This folder contains some general info about the research and the html-link. This folder was printed 40 times, approximately enough to deliver one to each household living in the square formed by the Kortenaerstraat, Bisschopstraat, Prinsestraat and Emmastraat.

3.3. Analysis

The goal of this thesis is twofold: (1) to what extent do the outcomes of the geo-based survey overlap with the output from the climate atlas? And (2) to what extent do the perspectives of residents on the climate change effects differ? Additional to these two questions are the four goals which can be satisfied by the geo-based survey as mentioned in chapter 3.1.1.

To answer these questions an analysis needs to be done. At first ArcGIS seemed relevant to analyse the locations plotted by the respondents. However, due to few responses, an elaborated GIS analysis seemed superfluous. Maptionnaire itself presents the results of the survey in such a way that extended analysis is unnecessary. The results are of such kind that visual inspection is adequate. Data out of the CIA and the results of the survey will be presented next to each other and compared with each other.

An extra point of attention is representativeness. This entails both the response rate as well as the spatial representativeness of the response group.

4. Results

In this chapter the results will be analysed. This will start with an analysis of the representativeness of the sample group. Next the results found by the survey will be discussed. For those topics possible, it will immediately be compared with the Climate Impact Atlas to see where it complements to data and where it deviates from the Atlas. Finally, the answers of respondents will be compared with each other to see where mutual differences occur in perspectives.

4.1. Representativeness

The representativeness of the survey needs to be analysed regarding two subjects: the sample group and the results. First it needs to be determined if the sample group is an accurate representation of the population. This will be done by assessing the response rate and the spatial distribution of the respondents. Then the certainty of the results is computed.

Out of the 40 folders distributed throughout the project area, 7 people have visited the survey, and 7 people have filled in the survey, so called respondents. This comes down to a response rate of 17.5%. This seems low, most surveys aim for a response rate around 60 till 80% (Bailey 1987, Schutt 1999, Fowler 2002). However, Leslie (1972) states that researchers surveying issues directly related to homogeneous groups should not be overly concerned about percentage of questionnaire returns, as long as enough responses are gained to meet statistical assumptions. This is the case in this survey, since it surveys residents regarding neighbourhood nuisance. This means that the survey's response rate is adequate.

The spatial distribution is analysed by looking at the location of the houses of the respondents. Out of the 7 respondents, 6 have also indicated their house (figure 9). Out of this figure can be concluded that a correct picture can be sketched of the Kortenaerstraat due to a higher amount of responses. The Bisschopstraat and the Emmastraat on the other hand are underrepresented. The Prinsestraat has just a few households, therefore one respondent is representative enough.

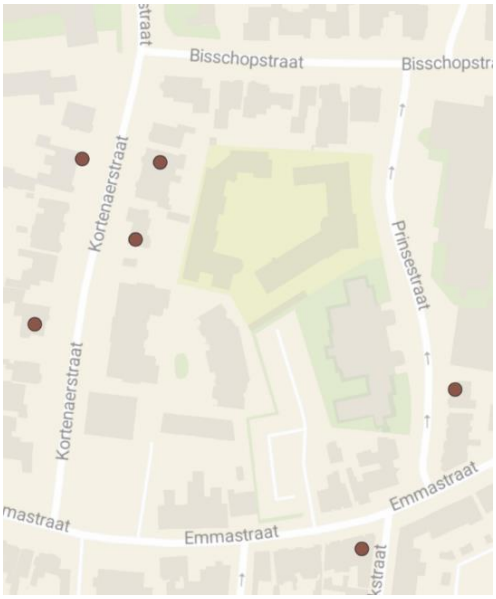


Figure 9 - houses indicated by respondents

Lastly, the representativeness of the results needs to be analysed. This entails determining the margin of error at a specified confidence level. This information tells us how much we can expect the survey to reflect the views from the overall population. The margin of error is defined using the formula:

$$margin\ of\ error = z * \frac{\sigma}{\sqrt{n}}$$

Where:

- z = the z-score, a value determined by the confidence interval
- σ = population standard deviation
- n = sample size

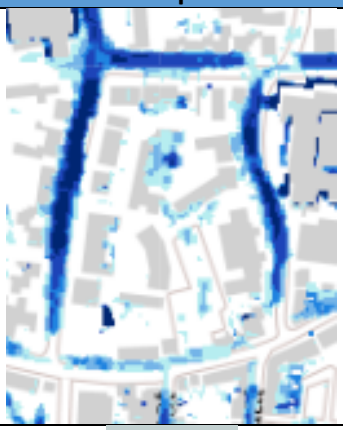
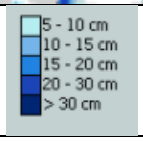
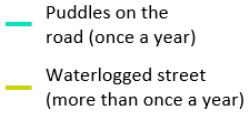
With a confidence level of 95% this yield an margin of error of 34% for our survey (Survey Monkey 2021). Usual accepted values for the margin of error are maximal 10%. To achieve such a value the sample size needs to be increased towards 28 respondents. It can be concluded that the survey yields statistically insignificant results. Luckily the survey mostly gathers soft data in which the margin of error plays a smaller role.

4.2. Results of the survey

4.2.1. Waterlogging

The data derived from the climate impact atlas and the stress test both consider a 70mm heavy rains shower which occurs once every 100 years. The survey gave the respondents a multiple choice option to indicate how many times they experienced waterlogging. Only 2 out of 7 respondents indicated that they experienced waterlogging, with intervals within a year.

Table 4 - waterlogging according to CIA, stress test and the survey

climate impact atlas	Stress test	survey
		
		

It is noticeable that the unit of measurement differs a factor hundred between the models and the survey (respectively once in a hundred years and annually). This can be explained by the problem of recall from respondents. Recalling the date of an event is the most difficult part of recall. Furthermore, the event needs to be noticed to be able to get recalled. Forgetting increases with the passing of time due to decay of memory traces and interference from new, similar events. Lastly, respondents tend to forward telescope events. This means that events tend to be recalled as happening more recently than they actually did (Martin 2006). These factors make that respondents tend to forget waterlog events due to interference with new events and thus only recall waterlog events which happened not so long ago. This corresponds with the results out of the survey. Finally, three respondents specifically indicated that they had no experience with waterlogging in the project area.

4.2.2. Groundwater nuisance

Six out of seven respondents experienced groundwater nuisance. Some respondents experienced multiple results of a high groundwater level. These results are given in figure 10. It became clear that the groundwater nuisance occurs all over the neighbourhood. Due to absence of green spaces in the project area and most households having a small or no garden, it is logical that the effects regarding these functions are almost not reported.

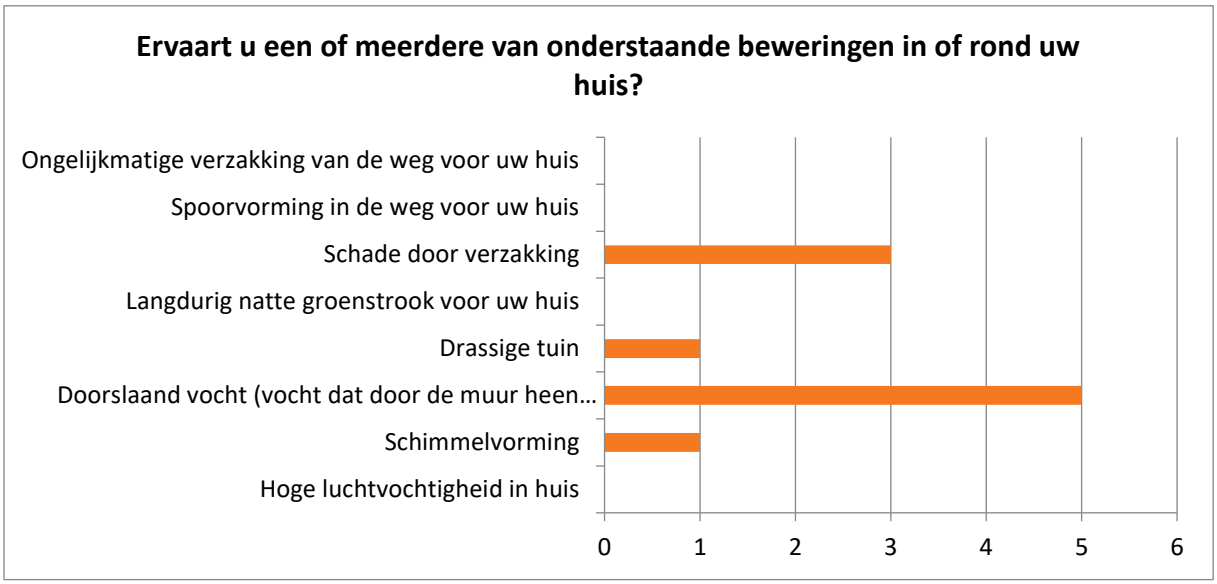
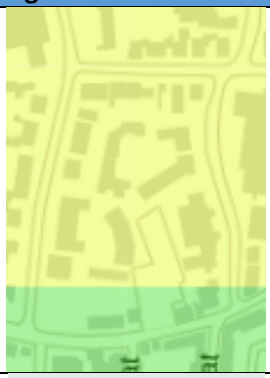
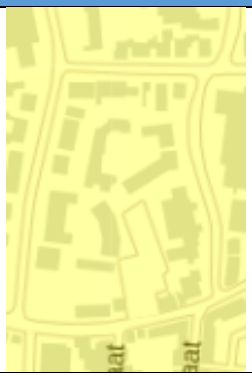
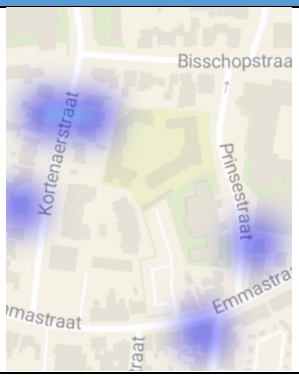
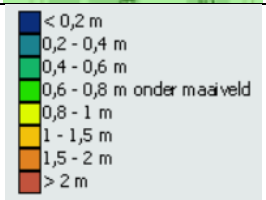
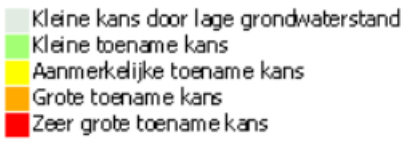


Figure 10 - Groundwater nuisance experienced by respondents

These findings are difficult to compare with data from the Climate Impact Atlas. The CIA only reports the average highest groundwater level and a expectation of the development of groundwater nuisance. These findings are given in table 5. It can be concluded that a geo-based survey is a good way to map the effects of groundwater nuisance.

Table 5 - groundwater nuisance according to CIA and survey

Average highest groundwater level	Chance on development of groundwater nuisance	Results of survey on groundwater nuisance
		
		

4.2.3. Vulnerable locations

The survey yielded two vulnerable locations reported by two different respondents. One is a park with a social and cultural value, the other one is a synagogue in a monumental building. The survey thus gives insight in what important locations are according to respondents. These locations are not considered important in the stress test (Twents Waternet 2020). Therefore the survey succeeds in its goal to provide additional information regarding vulnerable functions.

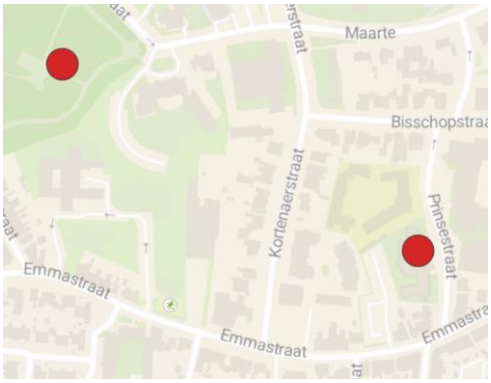


Figure 11 - Vulnerable locations as marked by respondents

4.3. Remarks from respondents

The last question in the survey gave respondents the opportunity for remarks, questions or to share something. Three respondents used this field to explicitly indicate that they have no experience with waterlogging. One even indicated that waterlogging on the street stopped since the construction of a new sewer several years ago.

4.4. Mutual differences in perspectives of respondents

As widely recognized, there are usually a lot of differences in the perspectives of respondents. This is not different in this survey. There are two topics in this survey where this reveals itself: waterlogging on the streets and groundwater nuisance. It is somehow logical that respondents experience groundwater nuisance different. The most logical explanation is that households are built differently such that nuisance does not discloses itself. A more striking difference between perspectives reveals itself when asked for waterlogging experiences. Out of seven respondents, two experience waterlogging as problem and three indicate that they have never experienced waterlogging in this area.

5. Discussion

The goal of this thesis was to define if a geo-based survey is an effective measure to introduce as an additional step in the seven ambitions of the DPRA. This was done by analysing the advantages and disadvantages of such a survey and by comparing the outputs of a self-designed survey with itself and with the output of the climate impact atlas. To design the survey three subgoals where defined. The survey succeeded partially in these subgoals. The survey is a good way to gather additional unknown information of the area. Validating the results of the stress test however proved to be more difficult due to the low response rate. Furthermore, the data indicates that perspectives of stakeholders differ drastically.

Contrary to the hypothesized association that a geo-based survey, or PPGIS in general, can reach a broad spectrum of people, this survey did not achieve that goal. It can be deduced that this is not due to the complexity of the survey, because all who visited the survey have finished the survey. A more logical explanation for the low response rate is the dispersion method. By distributing the survey on paper, due to absence of an entrance into the electronic infrastructure, the threshold to participate in the survey increased. Instead of merely clicking a link, residents needed to willingly type over the link from a folder, if they at least even read the folder.

Due to the low response rate, there is a large uncertainty in the perceived waterlogging problems. Two people indicated that they experience waterlogging, however just on a really small scale. Three people explicitly took the time to explain that they have no experience with waterlogging in the project area. To come to any conclusions regarding this problem, the response rate need to be increased, such that conclusions can be drawn with more certainty.

An explanation for the large difference in the perceived waterlogging lies with perception and interpretation. Different respondents could interpretate the question differently, despite pictures to clarify the meaning of the question. Respondents could also perceive the meaning of waterlogging differently. This could mean two things: Respondents interpretated the question differently; or respondents perceive waterlogging not as problem, but as necessary evil. This could lead to an unrecallable memory, since the waterlogging event was never encoded (Martin 2006).

Despite the high uncertainty rate, the survey does provide high-quality data on groundwater nuisance. This problem was not yet registered in this area, although groundwater nuisance is a frequent occurrence in Enschede (Gemeente Enschede 2012, Redactie Tubantia 2016, Van Toog 2021).

Furthermore, the data gathered by the survey marks two locations as vulnerable. It is interesting to see how respondents look at their own area and their reasons to mark the location as vulnerable. Respondents were asked to map cultural/social important locations, but also locations which are necessary to guarantee a quality of life. Interesting to see is that both locations mapped are only indicated as culturally/socially important. This means that either residents have no knowledge about functions which improve their quality of life such as important roads or electrical boxes; or residents do not consider these functions vulnerable; or meaning of the question regarding this part was incomprehensible.

Lastly, the survey as designed in this thesis did not test all functions such a survey could be used for. A geo-based survey can also be used to inform residents on certain matters concerning their neighbourhood. Already made plans can be validated or criticized. Certain aspects of the stress test can be validated more thoroughly by presenting specific results. This thesis did not consider these topics due to the specific nature of those questions which did not fit the more general approach used.

6. Conclusion

The aim of this thesis was to define if a geo-based survey is an effective measure to introduce as an additional step in the seven ambitions of the Delta Plan Spatial Adaptation. Based on a qualitative and quantitative analysis of a geo-based survey regarding knowledge production, it can be concluded that a geo-based survey is an effective method to use as first step in the risk dialogue. A geo-based survey as first step in the risk dialogue serves as a guide for most municipalities, after which it becomes more clear where residents experience problems and thus where the municipality needs to focus. A geo-based survey gives value to the results of the stress test by providing data on vulnerable locations and can provide additional information to complement the image of climate change effects in a neighbourhood. Furthermore, the concerned residents have revealed themselves by answering the survey. Thus, after executing such a survey, municipalities can start better prepared with the actual risk dialogues, since they know more about the neighbourhood, have a better view on what the residents want, and could even invite specific concerned residents. While the low response rate limits the generalizability of the results, this approach provides new insights into the knowledge of residents of their own neighbourhood regarding waterlogging. This knowledge of their neighbourhood hold most certainly also true when asking questions about other topics such as the energy transition. Further research is needed to determine whether such a survey can also serve as a way to inform residents on results of the stress test or on spatial plans for their area. This research should also address a different methodology for respondents to recall waterlogging on the street, which could be used to validate the stress test.

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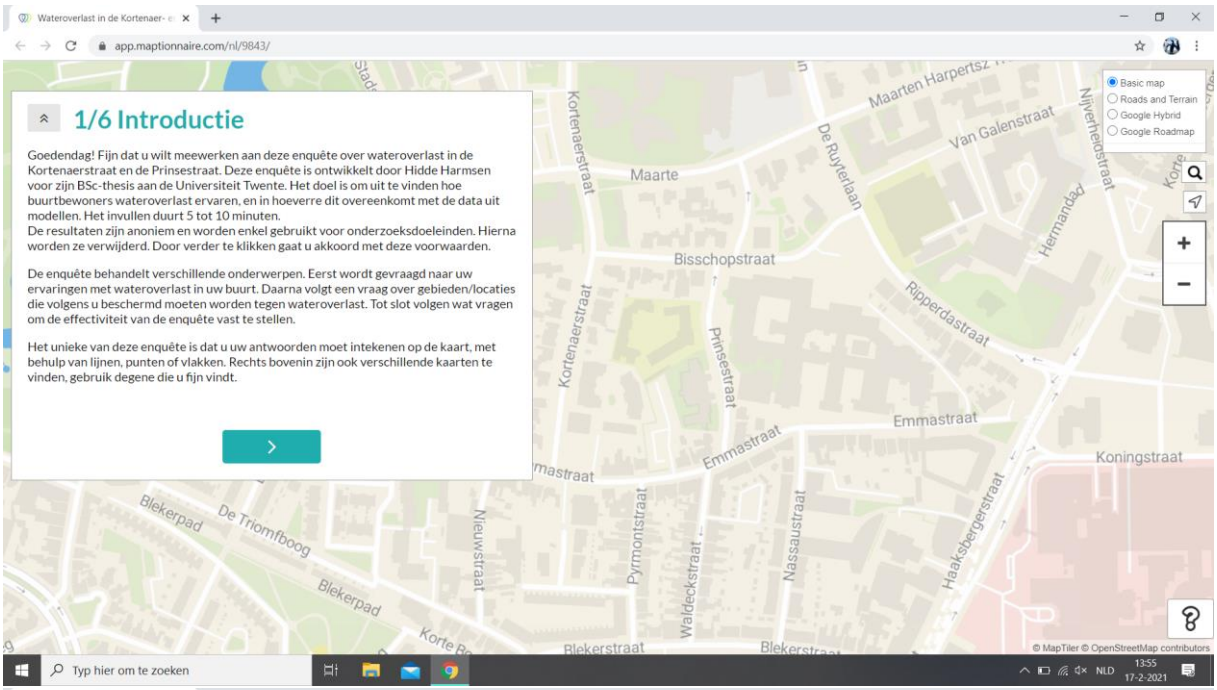
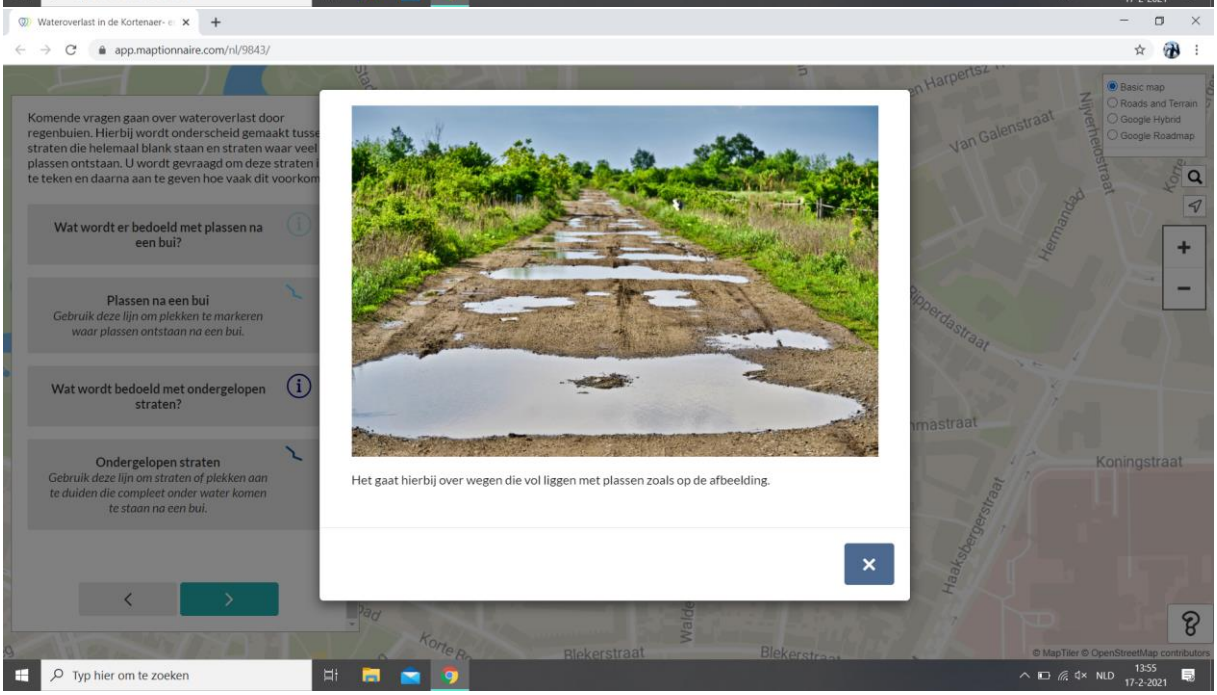
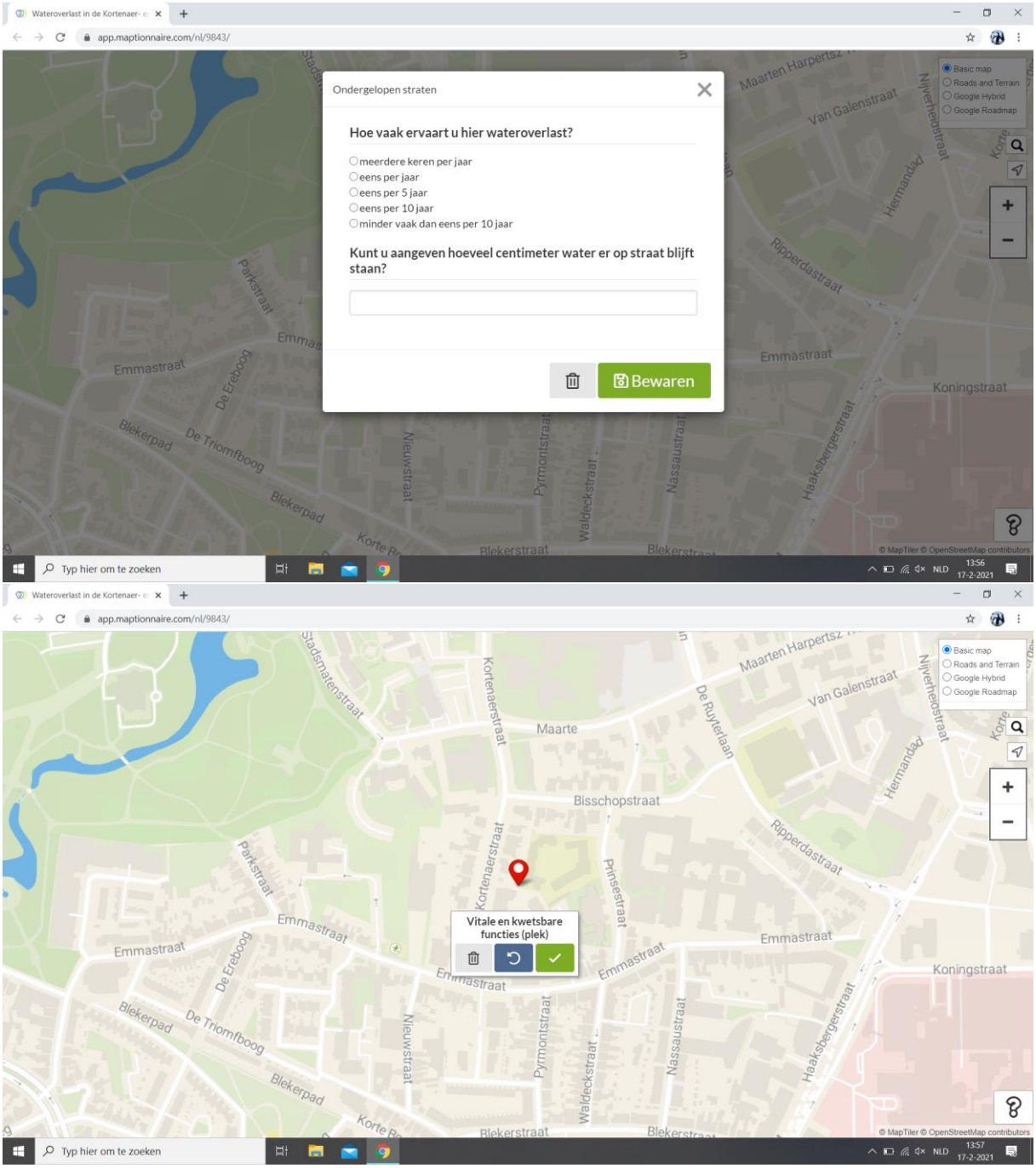
Appendices

A: Screenshots of the online survey






Wateroverlast in de Kortenaer-
app.maptionnaire.com/nl/9843/
Ondergelopen straten
Hoe vaak ervaart u hier wateroverlast?
meerdere keren per jaar
eens per jaar
eens per 5 jaar
eens per 10 jaar
minder vaak dan eens per 10 jaar
Kunt u aangeven hoeveel centimeter water er op straat blijft staan?
Bewaren
Basic map
Roads and Terrain
Google Hybrid
Google Roadmap
Maarten Harpertsz
Van Galenstraat
Nijverheidstraat
Hermandad
Ripperdastraat
Emmastraat
Koningstraat
Parkstraat
De Ereboog
Blekerpad
De Triomfboog
Nieuwstraat
Pyrmontstraat
Waldeckstraat
Nassaustraat
Haaksbergerstraat
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© MapTiler © OpenStreetMap contributors
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Wateroverlast in de Kortenaer-
app.maptionnaire.com/nl/9843/
Basic map
Roads and Terrain
Google Hybrid
Google Roadmap
Maarten Harpertsz
Van Galenstraat
Nijverheidstraat
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Ripperdastraat
Stadsmatenstraat
Kortenaerstraat
Maarte
De Ruyterlaan
Bisschopstraat
Prinsestraat
Vitale en kwetsbare functies (plek)
Emmastraat
Koningstraat
Parkstraat
De Ereboog
Blekerpad
De Triomfboog
Nieuwstraat
Pyrmontstraat
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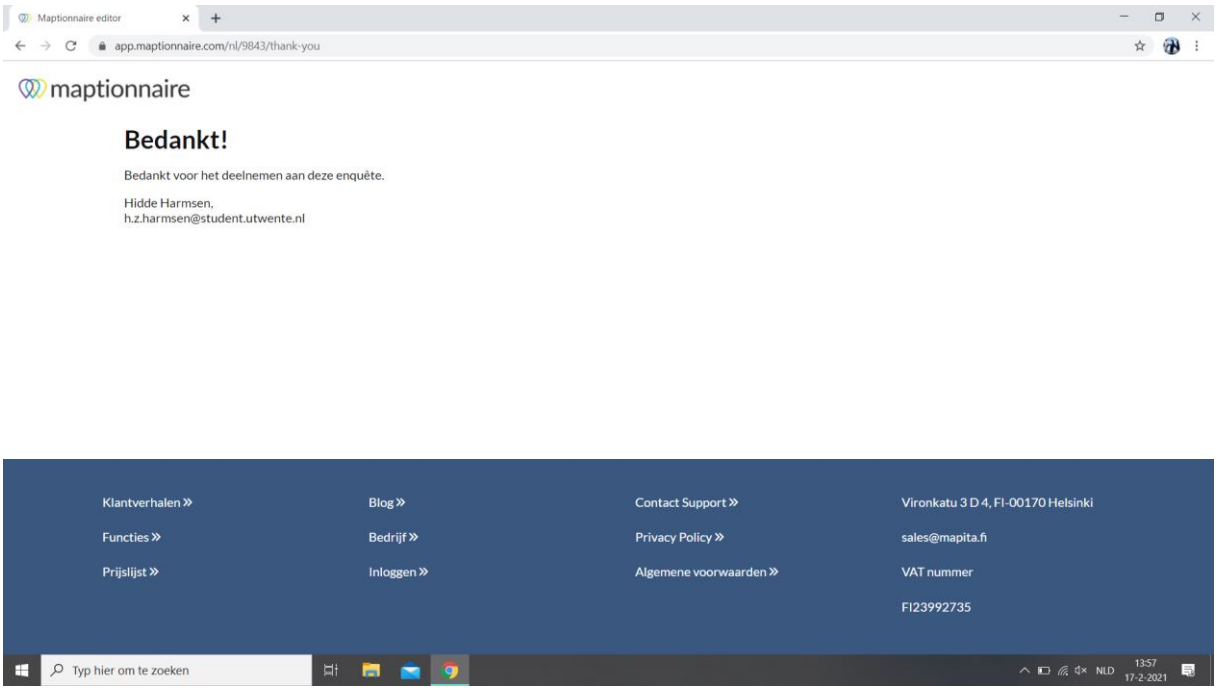
Maptionnaire editor
app.maptionnaire.com/nl/9843/thank-you
maptionnaire
Bedankt!
Bedankt voor het deelnemen aan deze enquête.
Hidde Harmsen,
h.z.harmsen@student.utwente.nl
Klantverhalen »
Functies »
Prijslijst »
Blog »
Bedrijf »
Inloggen »
Contact Support »
Privacy Policy »
Algemene voorwaarden »
Vironkatu 3 D 4, FI-00170 Helsinki
sales@mapita.fi
VAT nummer
FI23992735
Typ hier om te zoeken
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17-2-2021

B: Folder to distribute the survey

Enquête naar wateroverlast in uw buurt

www.app.maptionnaire.com/9843

Mijn naam is Hidde Harmsen en voor de studie Civiele Techniek aan de Universiteit Twente heb ik een enquête ontwikkelt die snel en effectief in kaart brengt waar buurtbewoners wateroverlast ervaren.

Er is voor deze wijk gekozen, omdat uit modellen blijkt dat hier waterproblemen voor komen, maar deze problemen worden niet herkend door de gemeente. Uw bijdrage zorgt voor een beter beeld van de wijk. De enquête invullen duurt slechts 5 minuten. Ga hiervoor naar www.app.maptionnaire.com/9843

Bij voorbaat dank!

UNIVERSITY OF TWENTE.