MASTER THESIS

Mobilising Private Houseowners to Implement Blue-Green Infrastructure through Framing

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Abstract

Climate change is a threat to planet earth and all beings and habitats. Blue-Green Infrastructure (BGI) is one way of alleviating the effects of climate change by adapting the built environment. Especially urban and peri-urban areas are in need for a shift from grey to green infrastructure, because of the growing urban population, the intensity of grey infrastructure in place, and the expected severe effects of climate change. BGI provides several Ecosystem Services (ESS), such as regulating the climate and water, acting as habitat for animals, and providing recreational and educational opportunities. Financial incentives are the most commonly used tool to mobilise implementation and up until this point there is little research on socio-cultural and political-institutional factors which may influence the perception and behaviour of individuals. Also, the conscious framing, spotlighting an issue in a certain way, is still to be research within this field.

Focussing on the Netherlands, this research contributes to understanding factors that can mobilise private houseowners to implement BGI and to assess the potential of framing as a tool for changing private houseowners' perception. A total of 69 houseowners participated in a survey that elicited their opinion on climate change, flooding, heat stress and BGI. The analysis show that a positive opinion on climate change adaptation and heat stress have a positive influence on their opinion on BGI. Framing climate change as a loss, if no adaptation measures are taken, resulted in a slightly more positive opinion on BGI; compared to a frame on the gains from climate change adaptation, and a frame about a subsidy, which refers to no losses or gains, and. Four actions were identified to mobilise houseowners: Providing reliable and accessible information about BGI, offering financial incentives for implementing BGI, raising awareness about the urgency of climate change adaptation, and framing flooding as a current issue. These insights are useful for municipalities to design measures for mobilising residents, particularly private houseowners, to take part in the climate change adaptation process.

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List of Acronyms

BGI	Blue-green infrastructure
ESS	Ecosystem services
HBO	Technical college degree (Hoger beroepsonderwijs)
IPCC	Intergovernmental Panel on Climate Change
KW	Kruskal-Wallis
M	Mean value
MBO	Vocational level of education (Middelbaar beroepsonderwijs)
N	Number of answers
SD	Standard deviation
WO	University degree (Wetenschappelijk onderwijs)

1 Introduction

Climate change is showing its effects all over the world. The current and expected impacts are putting a burden on many regions of the world. The altering conditions of the environment call for mitigation of climate change's effects, for example by transitioning from fossil fuels to renewable sources to reduce the percentage of greenhouse gases in the atmosphere, and/or for an adaptation of lifestyle and new practices in order to live with the changing environment. Building houses in a heat resilient way, is an example for a possible small-scale adaptation to climate change (IPCC, 2014).

For urban areas in particular, heat stress, storms, extreme precipitation, flooding, droughts, water scarcity and storm surges are classified as risks and are more severe than in rural areas. The traditional way of planning without taking great shifts in climate into account and the fast influx of residents cause a major threat for cities. Extreme weather events have even more extreme effects in cities. Cities easily turn into heat islands without the ability to cool down quickly and they are not retaining enough water for all ecosystems throughout the year (IPCC, 2014). We are in an era of urbanisation. By 2050, 68% of the world population is expected to live in urban areas and are thus subject to the risks mentioned above (United Nations, Department of Economic and Social Affairs, Population Division, 2019).

In the Netherlands, the rising sea level and an increase of flooding events are high risks, but hard to objectively perceive for the public. Negative impacts, such as too much water, a diminished quality of water and biodiversity, as well as heat stress due to hot and long summers, are already noticeable. However, more summer days are also perceived as an advantage for agriculture and recreation (Planbureau voor de Leefomgeving, 2012). The urgency and strategies to mitigate and adapt to climate change are explained in the Delta Programme by the Dutch government (Ministerie van Infrastructuur en Waterstaat et al., 2019). This programme focusses on anticipating risks linked to water, finding solutions, and implementing these within the coming three decennia. The government's awareness of the needed change is an important starting point. Nevertheless, participation of stakeholders and translation in all sectors is also needed to create change leading to positive outcomes. Such a translation could involve holding industries accountable for sound environmental practices or stimulating the housing sector towards a green future. Municipalities, water authorities, provinces, as well as non-governmental and private sector organisations are identified as key actors in this process.

Grey infrastructure represents the modern way of managing natural resources, aiming at risk reduction in certain hotspots, which may cause problems in other parts. This way of using ecosystem services (ESS), tries to limit and control natural conditions, so that the services are easy to access. ESS are defined as advantages humankind gains from ecosystems (Bolund & Hunhammar, 1999). For instance, water is banked and channelled, so rivers do not meander in the natural way. This does make the ESS 'water supply' easier to access but may also cause more severe floods. The use of dams, for example, can be beneficial for one area, providing water as an ESS, but also cause a drought or a flood in downstream areas as a negative consequence. Further, grey infrastructure leads to less groundwater recharge, pollutants from stormwater runoff and heat stress, to name a few. A potential solution for adapting to climate change is the implementation of blue-green infrastructure (BGI), which enhances ESS by managing water resources in a more natural way and increases the ability of dwellings to adapt to changing conditions and prosper at the same time. Examples of BGI include green roofs, rainwater gardens, bioswales, trees or rainwater collectors (Brears, 2018).

1.1 Research problem

Climate change is a serious threat to human well-being and all habitats. However, the actions currently undertaken are underwhelming when compared to the great risks that humankind is facing (European Comission, 2008). Although the intention of living in harmony with natural resources is widespread as well as the knowledge of a sound outcome from a global to individual levels, reflective thinking and actual change of behaviour can only be found in few individuals (Carrington et al., 2014; Kollmuss & Agyeman, 2002). Research, so far, has mainly contributed to understanding the biophysical dimension of green solutions but failed to consider socio-cultural and political-institutional factors that affect individuals' perceptions and behaviour (Matthews et al., 2015). A shift in lifestyle and the implementation of solutions, such as BGI for private houseowners, are often only financially incentivised. Other ways of incentivising and influencing perception and behaviour have been studied in fields of environmental concern, such as flood management and climate change, and for various stakeholders, such as private housing associations and urban planners (Boezeman & Vries, 2019; Bubeck et al., 2013; Runhaar et al., 2012; Spence & Pidgeon, 2010). However, there is a research gap on non-economic factors that influence the perception and behaviour of private houseowners regarding BGI. Additionally, the houses owned by individual persons, hereinafter referred to as 'houseowners', make up a high percentage of buildings in the Netherlands. It is a group of people that can almost freely decide what to do with their homes. This leads to a good understanding of mobilising factors and views.

1.2 Research objectives

The objectives of this thesis are twofold: 1) to improve the understanding on factors that can mobilise private houseowners to implement blue-green infrastructure, and 2) to assess the potential of framing as a tool for changing private houseowners' perception. The research project contributes to the Dutch government's goal of making cities climate resilient and water-robust by 2050 by understanding how houseowners opinion differ and may be influences positively in order to implement more climate friendly infrastructure (Ministerie van Infrastructuur en Milieu & Ministerie van Economische Zaken, 2014) and the EU Biodiversity Strategy for 2030 “Bringing nature back into our lives”, which tries to improve biodiversity in urban areas (European Comission, 2020).

1.3 Research questions

To achieve the research objective, the following main research question and sub-questions are formulated and answered in the following chapters.

Main research question: How can private houseowners be mobilised to implement blue-green infrastructures?

SQ 1: Why do private houseowners’ opinions on blue-green infrastructures differ?

SQ 2: How does different framing of green roofs influence the opinion of private houseowners on blue-green infrastructures?

The questions will be answered by using empirical data from the Netherlands and the focus will be on green roofs as an example of BGI that can be implemented by houseowners in order to adapt to climate change.

1.4 Thesis outline

The second chapter presents the scientific, theoretical background of blue-green infrastructure, factors that influence perception and behaviour, the psychological theory of framing, and illustrates the theoretical framework. In the methodology chapter the design of the research and its realisation is laid out. Thereafter, the results are represented in chapter four. Chapter five focuses on discussing the results, comparing these with expected outcomes on the basis of the literature. Finally, chapter six draws conclusions based on the answers to the research questions, also providing indications on how to use the gained knowledge in future socio-political contexts.

2 Theoretical Background and Framework

This chapter reviews the scientific literature on ecosystem services and blue-green infrastructure, the concepts of framing and perception, and methods of influencing the perception and behaviour of individuals through psychological inducement. Besides specifying the main concepts of the research and giving an understanding of their interplay, the relevant aspects of the concepts for the research project will be presented in the end of this chapter in a theoretical framework.

2.1 The role of ESS and BGI in climate change adaptation

In order to maintain human life on earth with the current standards of welfare, living in harmony with nature is inevitable to keep up the ESS provided by it and adapt to climate change (Costanza et al., 1997). Daily (1997) defines ESS as "conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life". Even though it seems like an easy concept at first, it is hard to grasp all processes that interact to provide a single ESS. Bees are a good example. It is clear that humankind need bees for the pollination of crops. But the number of other species needed to provide good living conditions (e.g. providing a suitable habitat or pest protection) for bees cannot be easily measured and is often unknown. More examples of ESS specifically for the Netherlands can be found in Figure 1.

Figure 1: ESS in the Netherlands
Source: Koetse et al. (2018)

A systematic review of the scientific literature on different approaches of stormwater management by Prudencio and Null (2018) has shown that grey infrastructure leads to less ESS by stormwater in comparison to green infrastructure. Especially in urban areas, where more grey solutions can be found, green solutions can be a great asset. It could be an opportunity for the Netherlands considering the huge volumes of water the country is dealing with on a daily basis. Instead of only protecting the country from a surplus of water, the ESS provided by the water could be used. Targeting the benefits of the ESS for each sector and region, is an important component for climate change adaptation (Prudencio & Null, 2018).

BGI provide multiple social, economic, environmental, and ecological benefits and are often times even cheaper than traditional grey solutions. The infrastructure can be implemented on public or private space. An example on public space are water retention areas, which can be used for different recreational purposes when they are dry or filled with water, store a surplus of water, and return it to the environment when needed. On private property, green roofs are a prominent example of BGI. The vegetation on the roof cools down its surroundings, retains water, provides habitat for small animals and has social benefits, such as a relaxing atmosphere for the inhabitants (Foster et al., 2011).

Foster et al. (2011) classify five groups of environmental protection benefits of BGI, being land-value, quality of life, public health, hazard mitigation, and regulatory compliance. Each of these groups provide benefits to humans and can partly be found back in the definition of ESS by Costanza et al. (1997).

A significant financial incentive for all stakeholders may be the increased *land-value*, as described by Foster et al. (2011). Green roofs, for example, which are identified as one of the 155 climate change adaptation measures by the Dutch Ministry of Infrastructure and Environment, are expected to be as expensive as conventional roofs and require less maintenance. Further, the value of the house will increase with this investment (Roders et al., 2013).

Many benefits of BGI directly lead to an improved *quality of life*. More charming neighbourhoods invite citizens to slow down and enjoy their surroundings, instead of rushing from one place to another, providing a recreational ESS. Especially in periods without inundation BGI lead to an improved air quality, cooler surroundings, and a reduction of heat islands. Heat is already identified as a current problem and heat stress as a future problem by citizens of Rotterdam. Measures including recreation and air purification were rated the highest by the same group of people. Recreation and visual attractiveness were named as most important benefits. Further, noise reduction is a great advantage in urban areas. Vegetation can reduce noise and provide other EES, such as climate and water regulation, at the same time. Carbon sequestration, groundwater infiltration, and improvement of habitat and biodiversity are further factors which influence the quality of life in a positive way but are not noticed easily, due to their indirect effect (Derkzen et al., 2017; Foster et al., 2011).

The *public health* benefit and its entailing financial impact for the population and national governments are not easily recognised but play a major role. BGI have an indirect influence on public health through better environmental conditions and less pollution as well as better socio-economic conditions, which could reduce the high stress level of many people. Framing the health impact and its entailing financial impact could increase awareness in the population and be an incentive to implement BGI. Besides citizens, institutions should take an interest in improving the health of their associates (Bowen & Lynch, 2017). ESS with a direct effect on health and well-being were rated as important in a Dutch case study by Derkzen et al. (2017).

Hazard mitigation plays a key role for the Netherlands and worldwide. In case of a flooding event, the risk of damage to inhabited areas and its inhabitants is reduced by BGI. This entails reducing the pollution of water by stormwater runoff as well as socio-economic impacts by minimising the financial hazard due to damages, loss of houses, health impacts, less business opportunities and the loss of economic assets (Foster et al., 2011).

Due to the manifold of benefits provided by BGI, it becomes easier to comply with environmental regulations (*regulatory compliance*). Water can, for example, be recycled and improved in quality through wetlands and air can be purified by vegetation, in the form of urban roof top gardens or simply trees in urban areas. Not only environmental regulations can be met with BGI, also reduced crime and educational potentials were found as advantages of BGI, serving as cultural ESS. One could think of a small garden on top of a school, illustrating the lifecycle of a vegetable plant and all processes involved much better than any school book (Foster et al., 2011).

In the Netherlands both, houses with and without a flat roof, are present. Due to the mostly unused spaces and the possibility to implement BGI in the form of green roofs on them, without sacrificing public or private spaces and the multiple advantages of green roofs, it appeared to be a fruitful subject. Green roofs regulate gases, the climate, as well as water in their close proximity, they supply water in dry periods, act as refugia for small animals, can provide food, can be used recreational and have a cultural aspect. These eight ESS, according to the list by Costanza et al. (1997), shown above, are considered most important. Additionally, a combination of photovoltaic with green roofs can be an asset. Studies have shown that the energy yield can be increased by the cooling effect of the vegetation and the green roof nevertheless provides all initial benefits to its environment. Research is still continuing but the first results show a promising nexus (Chemisana & Lamnatou, 2014; Scherba et al., 2011).

In order to make use of all of these benefits and implement more BGI, good policy and involvement of all stakeholders is needed. Housing associations could play a major role in climate change adaptation through BGI. It is the responsibility of housing associations in the Netherlands to provide and maintain quality housing. Nevertheless, it is not upon the associations to decide on their own; the Dutch civil code states that housing associations must ask for consensus of the tenants for changes on the property that are not urgent. This is one factor that hinders large-scale implementation. The most widely recognised barrier, despite that, is the financial cost. Interviewed planners asked for an increased awareness of the benefits of BGI by the national government and in resulting policies in order to clarify responsibilities and support the process (Roders et al., 2013).

In the Netherlands private actors are less involved in climate change adaptation and therefore they are less aware of the issue and urgency. Nevertheless, citizens are willing to take measures at building level, whereas governmental actors, such as municipalities, act with caution and tend to be concerned about drawing attention to their responsibilities (Runhaar et al., 2012). In order to reach participation of as many stakeholders as possible, the role of public participation has become increasingly important, and governments consulted more citizens in different levels of their decision making (Uittenbroek et al., 2019). A new model by Mees et al. (2019) introduces "g*overnment participation"* as a transition of governments from a regulating towards a facilitating position. This may be implemented through *stimulation* of grassroot movements, which can increase awareness, create educational benefits, and improve social cohesion. An example of this is the nationwide initiative *Steenbreek*, which is funded by the government and coordinated in local groups to stimulate property owners to replace their tiles in the yard by green infrastructure. More common than this way of government participation in the Netherlands, is *network steering*. Hereby, governments organise the collaborative process, meditate conflicts, and build trust amongst each other. Water squares are a well-known example of this rung of participation. Municipalities are still experimenting, and the model may also lead to negative effects, such as inequality due to neighbourhoods with "skilled" residents getting stronger in contrast to neighbourhoods with residents that are more concerned about their basic needs. Regarding flooding, the Dutch government has a high responsibility to prevent pluvial flooding, whereas the responsibilities of fluvial flooding are increasingly transferred to the citizens (Mees et al., 2019). In order to achieve implementation in a short time span, enforced regulations are the only promising way, else postponing until the urgency is indisputable is to be expected (Bubeck et al., 2013).

2.2 Factors influencing perception and behaviour regarding BGI

This section summarises some of the most common theories about pro-environmental behaviour and how it is influenced by different factors. For further insights, the overview by Kollmuss and Agyeman (2002) is recommended.

A **positive environmental attitude** was found to influence environmental behaviour positively. The **Theory of Planned Behaviour** assumes a behaviour to be influenced by the attitude, subjective norms and perceived behavioural control, as shown in *Figure* 2. The subjective norm represents the (dis)approval of significant others, such as friends, family, colleagues, or neighbours. The appraisal of the own ability to perform a behaviour is referred to as perceived behavioural control. So even though the person and its environment perceive a behaviour as beneficial, it will still not be executed, if the person does not think he or she is capable of doing so (Ajzen, 1991). In a more detailed model, Ajzen and Fishbein (1980, Theory of Reasoned Behaviour) added 'behavioural intention' as a milestone that needs to be reached before a behaviour can be executed (Kollmuss & Agyeman, 2002).

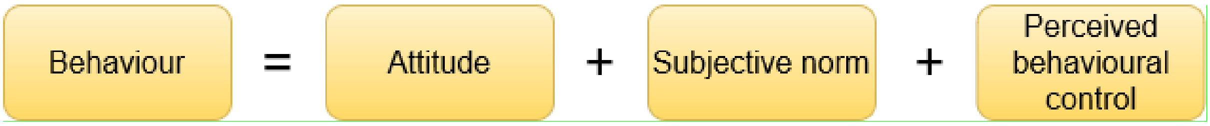

Figure 2: Theory of Planned Behaviour
Source: (Ajzen, 1991)

For the Netherlands, the aspects of the Theory of Planned Behaviour apply as follows. The perceived behavioural control and awareness of heat stress in the Netherlands is low. Houseowners do not perceive it as an issue they could influence directly. For them it can be an additional reason to invest into climate change adaptation measures, but it is not likely to be the crucial factor (Hegger et al., 2017; Runhaar et al., 2012). Even though the country has a history of devastating flood events, the construction of more dwellings in flood-prone areas indicate that flooding is not perceived as a current and serious issue. The last major flood occurred almost 70 years ago and a reliance on collective measures (e.g. dykes) leads to a low subjective norm and low perceived behavioural control in the population, and thus more and more dwellings are being built in flood-prone areas (Hegger et al., 2017).

As another model to predict health-related behaviour, the **Protection Motivation Theory** was proposed by Rogers (1975) and has been applied to environmental risk research as well. The cognitive process when facing a threat can be divided into two phases: threat appraisal and coping appraisal. The threat appraisal is defined as the perceived vulnerability and the perceived severity of an event and analyses the probability and consequences of a threat. The coping appraisal is evaluating possible responses to the threat and the own ability to avoid or avert the risk. This theory leads to the following factors, which are expected to positively influence the attitude about BGI, as they showed their effect in other environmental studies (Bubeck et al., 2013).

First of all, only financial response costs show a significant impact, which leads to the conclusion that the **income matters** significantly. Time and emotional costs as costs of responding to a threat did not play a role for the flood-coping appraisal in a study of residents along the river Rhine (Bubeck et al., 2013; Kollmuss & Agyeman, 2002).

The study by Bubeck et al. (2013) further found that even though issues are perceived as important they are being postponed until there is a **sense of urgency**. A sense of urgency may be created when residents personally feel affected by a risk. If there, for example, was a recent flood in the area, residents are expected to be more positive about implementing measures protecting themselves against floods. It was shown that, even though aware of the issues, postponing is a common strategy until the necessity of implementation is perceived as urgent. In the case of housing owners in the Netherlands it is also expected, as described earlier, that the urgency to adapt to climate change is not high enough and the perceived behavioural control rather low, leading to postponing of implementations. This postponing leads to implementation as a way of damage control instead of preventive measures (Boezeman & Vries, 2019; Bubeck et al., 2013; Everett et al., 2016; Everett et al., 2018; Runhaar et al., 2012).

Interviews with residents in Portland, USA indicated a lack of understanding of the purpose of the locally installed bioswales for climate change adaptation. The interviewees started to understand the advantages and reasons after getting more information about it and positively changed their attitude towards it. **Access to information and practical advice** are generally expected to positively influence the attitude of residents (Bubeck et al., 2013; Everett et al., 2016; Everett et al., 2018).

The residents of the same study in Portland also expressed the wish for earlier insights in the process, to gain a better understanding as well as having a voice in the process and choices made. Even though the results of this study are about BGI on public grounds, having a voice in the process and knowing about the plans of the municipality about certain districts could have a positive influence. By **improving the communication**, advice as well as (non)financial governmental support could be tailored to the needs and wishes of a neighbourhood (Everett et al., 2016; Everett et al., 2018).

Another psychological effect, which influences the perception and behaviour of citizens, is **mainstreaming.** Everett and Lamond (2014) suggest to not only look at current behaviour, but also the natural change of behaviour within a changing environment, assuming that more blue-green infrastructure in an urban area would positively influence perceptions and attitudes of the residents and lead to more implementations by them. It is expected that the attitude towards BGI is higher in a neighbourhood with existing BGI in contrast to grey infrastructure (Everett & Lamond, 2014).

Besides financial, and non-financial compensation, the **pleasure of giving** has been identified as a motivation of private actors to contribute to a public good in the Netherlands. Regarding BGI this could be the idea of investing more in infrastructure on private ground, knowing that it will have a positive effect on the environment in the whole neighbourhood and make it a joy for everyone to look at (Hegger et al., 2017).

Flood protection efforts are mainly influenced by **the self-efficacy and response-efficacy** as part of the coping appraisal. A case study about flood protection measures along the river Rhine in Germany in 2013 found that private houseowners are more likely to implement BGI if they consider their self-efficacy and their response efficiency as high. This is a trivial mechanism for every task; if a being does not view itself as capable of doing something, it will be very unlikely to do it either way (Bubeck et al., 2013).

A case study in Rotterdam has shown that citizens would be **willing to pay** a share for the implementation of BGI (Derkzen et al., 2017). Two third of the respondents considered 15€ a year per household an acceptable amount to pay for green infrastructure. The ones that were not willing to pay this amount stated that current taxes were already too high, they were not satisfied with the current policies or they did not consider the levy cost-efficient. A small group also mentioned voluntary involvement as a replacement for monetary involvement. Informed people were willing to pay slightly more than average. Overall, the willingness to pay was there especially for multifunctional infrastructure.

2.3 Influencing individuals' perception through framing

When creating a picture about a subject or an object, a frame is created by spotlighting certain characteristics or describing their value. Frames give meaning to the environment and can change the perception of a subject or object. For instance, describing a neglected path as an 'adventure path' to others can increase the likelihood of taking that path with a feeling of bravery and without complaints, because of the way it is framed. This being sad, a world without frames does not exist and the use of frames is inevitable. In order to understand our complex reality, frames are automatically and mostly subconsciously used in everyday life (Rein & Schön, 1991).

In 1993, Entman defined framing as follows: "To frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described.” (Entman, 1993, p. 52). The latest version of the four possible functions of framing, described by Entman (2003), are defined as follows:

- Defining effects or conditions as problematic,
- Identifying causes,
- Conveying a moral judgment of those involved in the framed matter, or
- Endorsing remedies or improvements to the problematic situation (Entman, 2003, p. 417).

All functions may be found in a frame, but do not have to be. Commonly, at least two functions are used when creating a frame (Entman, 2003).

General studies about decision frames have shown three major effects for participants being in a situation of choice (Tversky & Kahnman, 1981). First of all, choices involving gains lead to risk averse decisions, whereas choices involving losses lead to risk taking behaviour. Secondly, responses to losses tend to be stronger than responses to gains. Losing an amount of money, for example, will bring greater displeasure than the pleasure of receiving the same amount. In this case the framing of losses through climate change should provoke a stronger reaction than the gains. This overestimating of losses and underestimating of high gains can be seen in *Figure 3* (Tversky & Kahnman, 1981).

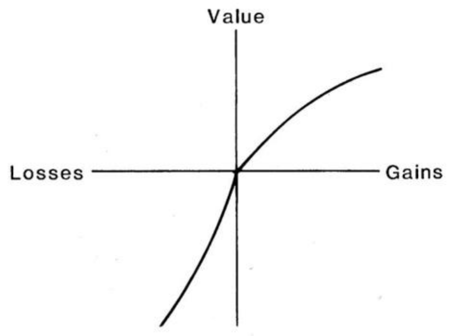

Figure 3: Value function of decision frames

Source: (Tversky & Kahnman, 1981)

Thirdly, the reference outcome should be noted; a decision is always judged compared to its loss or gain in comparison to the reference. By setting the reference the risk perception can be altered (Kahnman & Tversky, 1984). Further, the value ratio and weight ratio differ decision maker’s perceptions. The subjective value of the gain or loss of 10€ for a reference amount of 20€ is perceived greater than for a reference amount of 120€. It can be concluded that not the purchasing price itself but the comparison to other options and putting the gain or loss in relation to the purchasing price, explain the judgement of a decision and thus the decision itself (Tversky & Kahnman, 1981). Looking at the possible gain or loss through BGI in a changing climate, the gain is not likely to be perceived as a gain, but rather as the reference outcome, which in turn makes the loss frame even stronger.

In the context of climate change adaptation, Fünfgeld and McEvoy (2011) distinguish between explicit frames used in strategies, policy documents or guidelines, and implicit frames, which are used in discussions. They consider explicit frames as indispensable for establishing a community adaptation process and identify four main frames for this purpose. The first one, the hazards approach, focusses on the negative effects and risks of an object or subject. It is commonly used within the climate change discussions. The risk management approach is used for uncertainties in governments as well as for private stakeholders. It is closely connected to the hazards approach, combining hazards, exposure, and vulnerability. The vulnerability approach takes a different perspective, focussing on the people or environments that may be affected. With a spotlight on social, political, or environmental change, the resilience approach makes use of the ability to cope with external stresses and disturbances (Fünfgeld & McEvoy, 2011).

A study on gain vs loss frames and local vs distant frames about climate change adaptation in a group of university students has shown that the overall positive feeling about climate change adaptation was even greater when addressing social factors instead of personal factors (Spence & Pidgeon, 2010). The gain frame resulted to show slightly more positive responses and the local frame significantly more positive responses. In contrast to the local frame, the gain frame also resulted in a more severe judgment of climate change impacts and a more positive attitude towards climate change adaptation.

Table 1 shows two possible concepts of framing green infrastructure. Whereas the capital concept uses frames to promote the well-being and focusses on socio-economic assets, the risk-based concept takes on a frame of negative effects. Planners can choose the appropriate approach by either way listing public 'bads' or pointing out the possibility of public 'goods' (Matthews et al., 2015).

Table 1: Capital and risk-based frames of green infrastructure adapted from Matthews et al. (2015)

	Capital concept	*Risk-based concept*
Problem framing and role	Well-being - promotion of public health, recreational and social uses.	Impeding threats - heat stress alleviation and hazard mitigation.
	Deliver discrete benefits and fulfill social and economic needs (public goods).	Cope with irreducible uncertainties and minimize adverse impacts (public 'bads').

The personal connection to risk events was further analysed by Fünfgeld and McEvoy (2014). They conclude that any kind of **experienced disaster** will have a high impact whenever this frame is being activated and will lead to a high level of awareness. Using emotions of fear and stress can lead to powerful policies with a high likelihood of adaptation. A risk of 'avoiding disasters' frame is the approach of using short-term solutions instead of long-term solutions, which are needed for climate change (Fünfgeld & McEvoy, 2014).

Frames to test (dis)incentives for adaptation intentions towards sustainable farming were tested in Germany in 2018. The reference frame presented rewards and penalties as in current European law. The frame, which performed the best, concentrated on moral standards and the wish to be seen as a person acting according to moral norms. Communicating the risks also showed good effects. No significant, positive effects in comparison to the baseline was found by the frame explaining all technological benefits. They conclude that, in line with the Protection Motivation Theory, a protection motivation will be reached if threat as well as coping appraisal are found and may be reached through framing. The study further shows that non-financial frames are useful and needed (Buelow & Cradock-Henry, 2018).

Combining all of the presented theories, it is to be expected that the loss frame will lead to a more positive opinion on BGI. Responses to losses tend to be stronger and the gains from BGI will not be perceived as equally influential as the losses; it will rather be considered as keeping the current standards, i.e. the reference outcome.

2.4 Theoretical framework

From the theories and models presented above, the following theoretical framework was developed. *Figure 4* illustrates, in a simplified way, that there is a 'black box' influencing the mobilisation of houseowners to implement BGI. Mobilisation is defined by the Oxford English Dictionary as follows: "The action of organizing and encouraging a group of people to take collective action in pursuit of a particular objective." (Oxford English Dictionary). This definition clarifies that mobilisation is about the whole process, with all influencing factors, to get others to reach a certain goal. Thereby, perception and attitude are part of the influences in the mobilisation process that show an effect on behaviour. As discussed earlier, it is not scientifically proven which factors have a reliable effect on pro-environmental behaviour, such as the implementation of BGI.

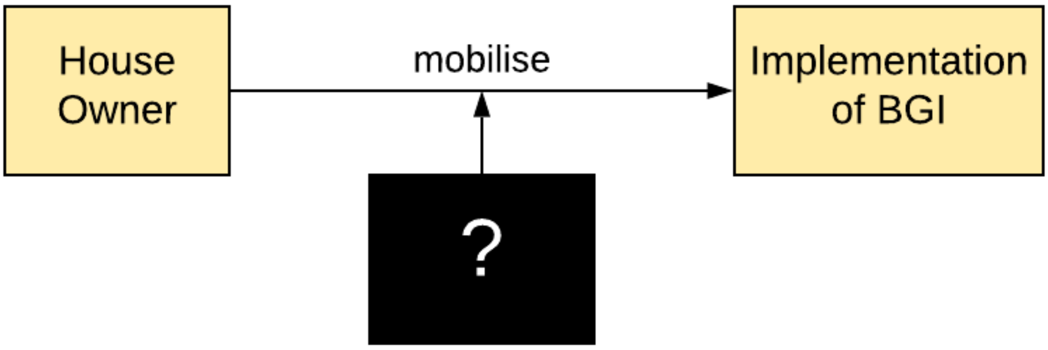

Figure 4: Theoretical framework

This thesis will analyse internal and external factors, characteristics, and opinions of the houseowners and influences from their environment, which may lead to a different opinion on BGI. Additionally, the different framing of BGI is expected to have an influence on the mobilisation of houseowners as a moderating variable.

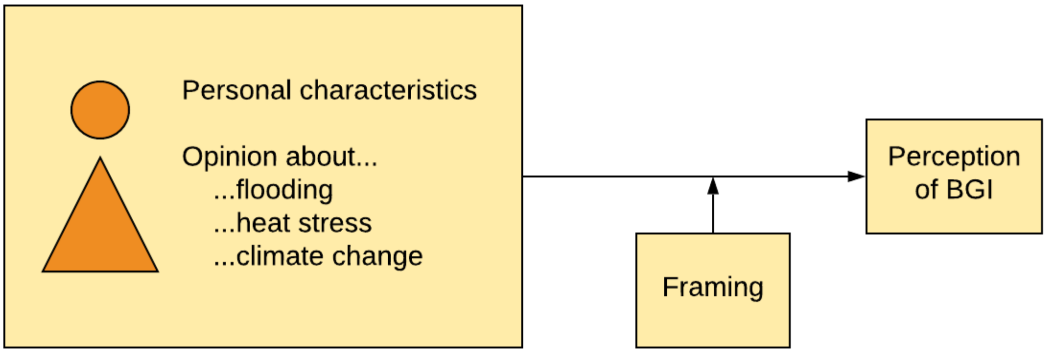

Figure 5: Theoretical framework of expected influences on the perception of BGI

The previous sections gave an overview of the factors that influence pro-environmental behaviour. There are multiple scientific models, which describe the way of mobilisation - from the opinions of individuals about certain topics and their own capabilities, the environmental conditions and the framing of topics to reach an intention to change, which may lead to action. Due to this complex process, this work only focuses on factors, which influence the opinion on BGI and does not measure if it actually comes to an implementation. If mobilisation is viewed as an arrow towards implementation, this thesis focuses on the first part of the arrow. *Figure 5* illustrates the main factors being tested, and an extensive overview of the elements are presented in the next chapter.

3 Research Methodology

In this thesis, quantitative statistical analyses were used to gain insight into the incentives for implementing BGI and to assess the effect of differently framed texts of green roofs. For this purpose, primary data was collected by conducting a survey. By talking to possible participants and analysing the free text fields, qualitative insights were gained as well. The empirical research was carried out in the Netherlands in June 2020.

3.1 Survey design

A seven-block survey was designed and distributed both online and in person. Participants were selected by considering if they own a house and the house has a roof with a slope of less than 45 degrees, so that a green roof would be possible to implement. The researcher personally contacted participants who fit the two criteria for this cross-sectional research. The survey asked personal information from the participants; information about their house, and their opinion on climate change, heat stress and flooding, incentives, obstacles and needs for implementing blue-green infrastructure at home, and about green roofs in particular. An overview of these seven question blocks can be seen in *Figure 6*. The original survey in Dutch as well as an English translation are provided in *Appendix I* and *Appendix II*.

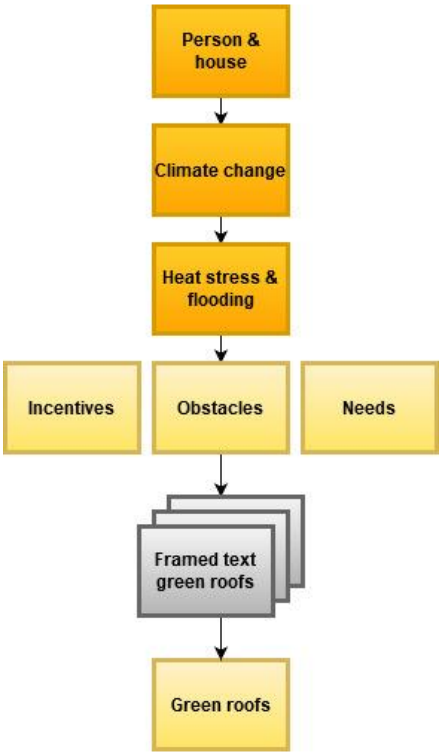

Figure 6: Survey blocks and flow

Orange: independent variables
Yellow: dependent variables

The items for the question blocks were adapted from previous studies about BGI and framing within the scientific literature. The items about climate change and the loss and gain frames were adapted from Buelow and Cradock-Henry (2018), the text about BGI from Voskamp and van de Ven (2015) and the question block about BGI from Runhaar et al. (2012), Mees et al. (2019) and (2013), and the papers discussed within the Theoretical Background and Framework section. The first block of questions asked age, gender, and level of school education from the participants as well as the year their house was built, when the last renovation took place and the angle of the roof. *Table 2* lists the Likert items that were used to measure the participants' opinion on climate change, flooding, heat stress, and green roofs. All of these items were measured on a 1-5 Likert scale from 'strongly disagree' to 'strongly agree'.

Table 2: Variables to measure the opinion on climate change, water and heat stress, and green roofs

Question block	Abbreviation	Likert item
Climate change	cc.risk	Climate change is a serious risk to humanity.
	cc.urgency	There is a need to adjust for climate change.
	cc.personal_risk	My life is affected by climate change.
	cc.personal_impact	Actions by individuals have an impact on climate change.
	cc.cost	Timely adaptation to climate change costs less than paying the damage afterwards.
	cc.personal_safety	Adapting to climate change increases my personal safety.
Flooding	f.risk_close	I consider flooding to be a major risk to my environment.
	f.vulnerability	I feel vulnerable to waterlogging.
	f.house_safety	My house is well protected against flooding.
	f.experience	I have experienced flooding in the past five years.
Heat stress	h.future	Heat stress will become more serious in the coming years.
	h.health	Hot summers are a public health problem.
	h.house_vulnerability	I am concerned about keeping my home cool in the summer.
	h.house_insulation	My house is well insulated to withstand hot summers.
	h.experience	I have experienced heat stress in the past five years.
Green roof	g.existence	I have a green roof.
	g.plans	I am considering installing a green roof.
	g.need	We need more green roofs in our country!
	g.policy	More policies are needed to promote green roofs.
	g.useful	Green roofs are useful for reducing heat in cities.
	g.waterstress_country	Green roofs contribute to reducing flooding in our country.
	g.house_value	A green roof increases the value of my house.
	g.heatstress_personal	I will personally benefit from a cooler home in the summer.
	g.profit_neighbourhood	Our neighbourhood would benefit from more green roofs.
	g.waterstress_neighbourhood	If there were more houses on my street with green roofs, we would have less water in the street after heavy rainfalls.

In *Figure 7* an overview of the elements about the incentives, obstacles and needs to implement BGI can be found. The incentives were judged for whether they are perceived as motivating, not motivating or neutral. For each obstacle, the participants responded if it appears as an obstacle for themselves. For the factors about possible needs, a maximum of two out of four could be chosen as the most important. Further, an open text field was provided to give the possibility to mention additional points.

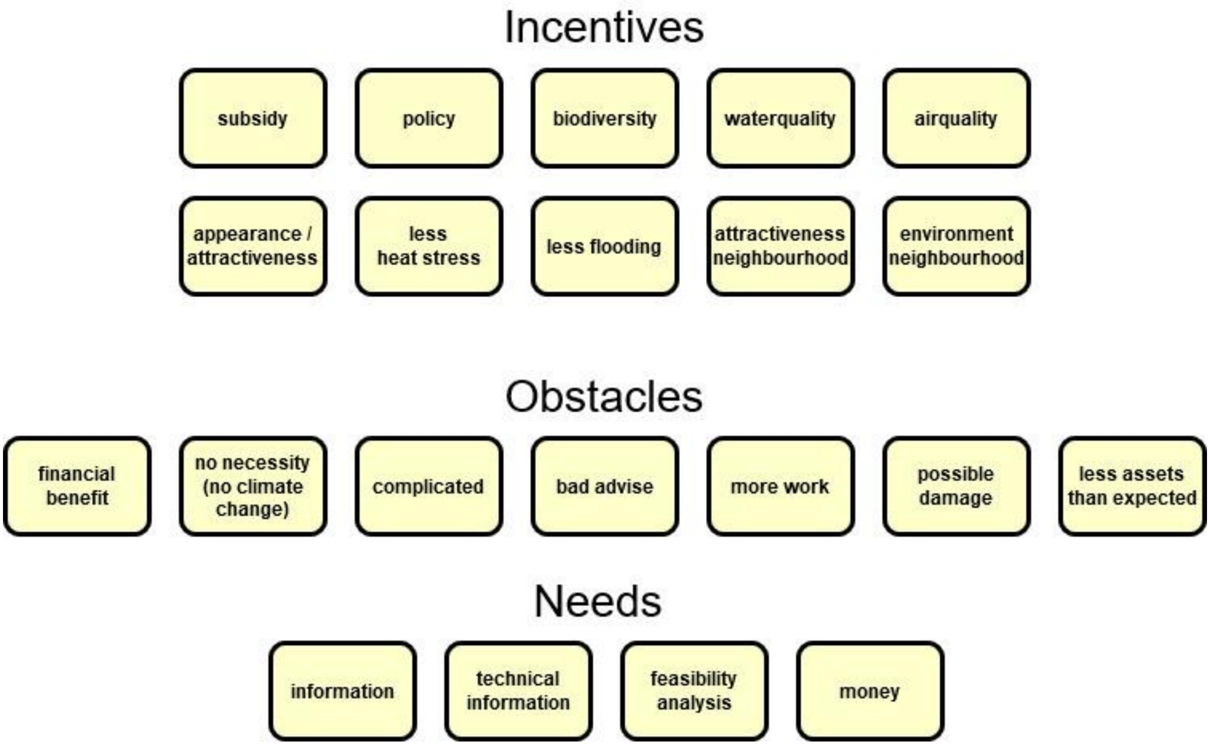

Figure 7: Question blocks about incentives, obstacles and needs for installing BGI

To analyse the possible influence of three differently framed texts about green roofs, a photograph of a house with a green roof was used for all texts, so that the reader has a visual image right away and the texts could be limited to the important information. Similar to Matthews et al. (2015), the framed texts about green roofs focus on impeding hazards (loss frame; also described by Fünfgeld and McEvoy (2011) as 'vulnerability approach') and the well-being or capital gained through green roofs (gain frame; also described by Fünfgeld and McEvoy (2011) as 'resilience approach'). One text neutrally explained the subsidy which the municipality is giving to houseowners (subsidy frame), another one framed the risk of climate change and the negative effects of heat stress and flooding if no action takes place (loss frame) and the third text focussed on the gain of a green roof, framing it in a positive way to adapt to climate change and resist heat stress and flooding (gain frame).

3.2 Data collection

The survey was conducted using the software *Qualtrics* and could be accessed via a weblink or by scanning a QR code from a handout. The research units are owners of a single unit house, living in the house themselves, and having a suitable roof for implementing a green roof (less than 45° roof slope). In total a number of 69 private houseowners with a suitable roof participated in the survey. To ensure an improved readability, the term 'houseowner' will be used to refer to the private houseowners consulted. Out of the 69 participants, 23 people (33.3%) identified themselves as women and 46 people (66.6%) as men. For the text about green roofs, the three options were randomly allocated to all participants, resulting in 23 participants per frame.

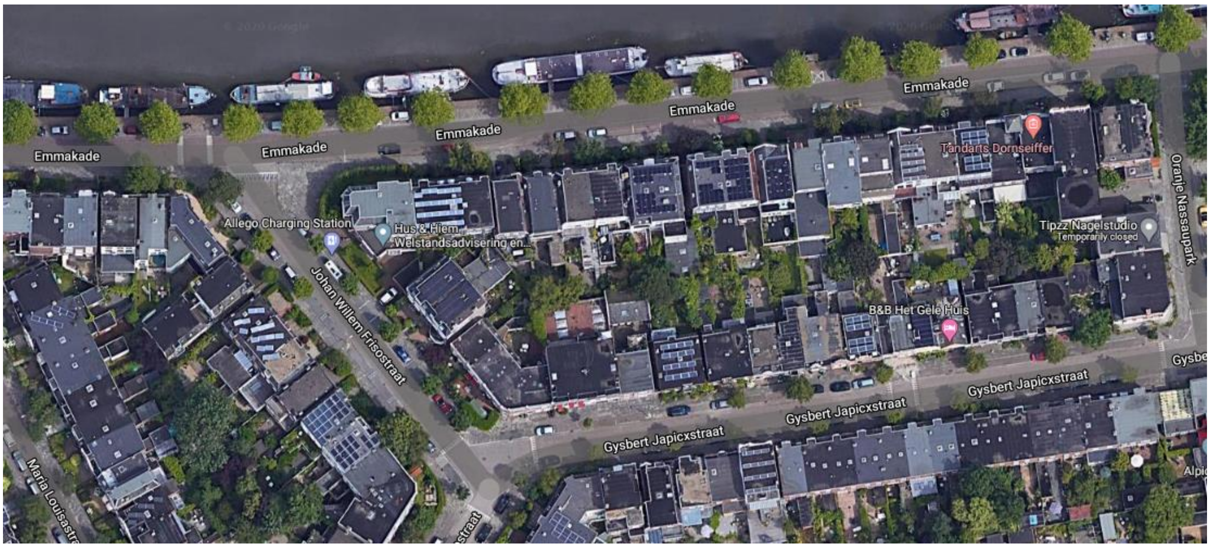

Figure 8: Typical neighbourhood for data collection
Source: Google Maps (n.d.)

The data collection mainly took place in two neighbourhoods in Leeuwarden. The first neighbourhood has many houses that are about 120 years old, mostly in private hands and have a flat roof, as can be seen in *Figure 8*. The close proximity to the centre and the channel in front of the door make it a very expensive neighbourhood. As can be seen in the picture, some houseowners already use their rooftops for photovoltaic energy production. Owners of house boats were not consulted, due to their special conditions. The second neighbourhood is located in the outskirts of Leeuwarden. It is also a pricy neighbourhood with houses built in 2001 with a main roof angle of 22.5° and a small flat roof. All houses have access to a lake through the backyard.

Table 3: Number of participants by educational level and the year their house was built.

p.education			p.house_year		
MBO	HBO	WO	< 1970	1970 - 2000	> 2000
9	38	22	37	9	23

Table 4: Number of participants by the year their house was built and the last renovation.

	p.house_year		
p.house_renovation	< 1970	1970 - 2000	> 2000
never	3	4	13
< 10y	22	5	10
< 20y	12	0	0

The level of education within the sample is high (see *Table 3*). 22 participants have a university degree (WO), 38 participants have a technical college degree (HBO) and 9 participants finished the vocational level of education (MBO). Due to the two neighbourhoods with very old and very new houses respectively, the number of houses built between 1970 and 2000 is only 9. Nevertheless, *Table 4* shows that there have already been renovations in the houses built within the last 20 years. Further, 2 participants declared that they have a green roof. 19 participants (28.4%) are planning to implement a green roof in the future.

Neither advantages nor disadvantages of BGI were mentioned while talking to the participants. It was also not mentioned that they will only be shown one of three possible texts about green roofs. If asked for the purpose of the research, the opinion on and perception of green infrastructure and green roofs in particular were mentioned. The handout further mentioned heat stress and flooding as a topic.

The Netherlands was going through a comparably dry first half of the year during the research. In the 10 days of the data collection the country faced its first short heat wave of the year with temperatures up to 30°C and humid days, followed by cooler, more rainy days (Accuweather, n.d.).

3.3 Data analysis

Data management and analysis were performed using the statistical programme *jamovi*. Reliability for combining several items was calculated using Cronbach's α and can be seen for the three grouped items in *Table 5*.

Table 5: Scale reliability statistics using Cronbach's α

	Cronbach's α
Climate change (6 items)	0.802
Flooding (2 items)	0.714
Heat stress (4 items)	0.749

As recommended by Lance et al. (2006) the combination of statistical items is viewed as reliable if Cronbach's α is bigger than 0.7.

Table 6 shows the definition of the measure of effect size used in this work. The effect size represents the magnitude of a phenomenon and is an important measure with the statistical probability suggesting a phenomenon is showing a statistically significant difference or relation.

Table 6: Definition of the effect size
Source: Cohen (1988)

	Cohen's d	Pearson's r
Small	0.2	0.1
Medium	0.5	0.3
Large	0.8	0.5

For the data analysis, the opinion on climate change, water, and heat stress as well as green roofs of the whole sample was analysed and is reported in the first section of the Results chapter. Besides these descriptive statistics, the different question blocks were tested for dependencies or correlations, respectively. The selected tests are shown in *Table 7*. Thereby, the t-test tests dependencies between two variables but may only be used when the independent variable is on a binominal scale. The significance level alpha was set to 5% for all t-tests. If the Levene test was significant ($p < .05$) and a violation of the assumption of equal variances may be given, a Welch test was executed instead of a Student's t-test. The Kruskal-Wallis (KW) test also tests dependencies but is more flexible considering the type of variable. It can detect more dependencies at the price of preciseness. In contrast to KW, the Pearson test is more precise, which leads to less assumptions of correlations. The trade-off between sensitivity and generality was made in favour for the Pearson test for the Likert scale items considering that the research project is a first approach to test general influences. The KW test was still conducted for the variables with three different groups (education, house year and last renovation), because they were not measured on an ordinal scale. Also, the χ^2 test was used to test dependencies between these grouped items and the yes/no items for possible obstacles and needs for BGI. For all tests, a normal distribution of variances needed to be given and was checked before conducting the tests by graphical analyses of the distribution.

Table 7: Statistical tests used to analyse dependencies and correlations

	Incentives (linear)	**Obstacles (binominal)**	**Needs (binominal)**	**Green roofs (linear)**
Descriptive factors				
Age (linear)	Pearson	Kruskal-Wallis	Kruskal-Wallis	Pearson
Gender (binominal)	t-test	Kruskal-Wallis	Kruskal-Wallis	t-test
Education (3 options)	Kruskal-Wallis	X^2	X^2	Kruskal-Wallis
House year (3 options)	Kruskal-Wallis	X^2	X^2	Kruskal-Wallis
Last renovation (3 options)	Kruskal-Wallis	X^2	X^2	Kruskal-Wallis
Opinion				
Climate change (linear)	Kruskal-Wallis	Kruskal-Wallis	Kruskal-Wallis	Pearson
Flooding (linear)	Kruskal-Wallis	Kruskal-Wallis	Kruskal-Wallis	Pearson
Heat stress (linear)	Kruskal-Wallis	Kruskal-Wallis	Kruskal-Wallis	Pearson

The descriptive statistics, correlations and dependencies were used to answer the first research sub-question on why houseowners' have differing opinions on BGI. For the second research sub-question, the differences in opinion on green roofs of the three groups were evaluated with a Dwass-Steel-Critchlow-Fligner pairwise comparison, which has a particular approach of controlling the familywise error rate to reduce the probability of false results (Critchlow & Fligner, 1991). This test tests possible dependencies between two groups. The effects of the three frames, reflected in the opinion on green roofs after, were compared and analysed to assess which line of arguments corresponds best with houseowners.

3.4 Ethical considerations

All participants of the survey were informed about the nature, method and purpose of the research and asked for consensus. Protecting the dignity of each respondent was the highest priority. It was communicated to the participants that they had the right to terminate their participation in the study without giving a reason at any time and that the data was collected anonymously, only used for the purposes of this study, and not passed on to third parties to remain confidentiality. No names or functions were revealed.

3.5 Limitations

When using a survey, a compromise between good explanations and a short survey must be found. This leads to interpretations by participants for some elements, which might not be clear to all participants. It is difficult for the researcher to know about these uncertainties and how they may adulterate the quality of the results. The aim of conducting a short survey also leads to sacrifices when measuring and testing theories. In this case only a limited number of theories (e.g. influences) could be tested and only the opinion on it. The open text fields are a good compromise to detect factors that were not considered but seemed to be important to the participants.

It cannot be measured either, whether people actually behave in the way that they express their opinion. Only the opinion and the self-perceived or self-expected behaviour could be measured and a conclusion from this self-estimation to actual behaviour cannot be made. Direct questions about perception would also only reflect the opinion or perceived perception. In order to measure true perception as well as the final implementation, different and long-term research methods should be chosen.

Obviously only people willing to respond to a survey and being able to scan a QR code could participate in the study. This led to some individuals not being able to participate, because they did not have a smartphone or did not know how to use it to scan the code. It further can also be assumed that people are more likely to take part in the survey if they are interested in the topic, which is likely to be the case when they consider the topic to be relevant.

Further, the design of the research may be biased by the positive opinion on BGI by the researcher herself, the so-called experimenter bias. On one hand the whole survey is written in a way that assumes positive opinions on the topics and on the other hand the answers are non-consciously biased by participants because of the assumption of an expected outcome (answering in accordance with the option that is assumed to be most favoured by the researcher).

The sample does not represent the Dutch population of houseowners, but is expected to have a higher income, a higher level of education and to be older than the Dutch average houseowner. Considering the already very specific target group, this is a sacrifice that had to be made in order to complete the survey within the set timeframe. By compromising external validity, internal validity was improved. Thus, good results within the sample are expected, but a conclusion for the whole population cannot easily be drawn.

Lastly, the restrictions due to the Covid-19 pandemic, exacerbated many of the limitations. The survey distribution had to take place with an adequate distance. It should also not be underestimated that residents may have other concerns on their mind right now, which may lead to distorted results or not filling in the survey at all. Nevertheless, a positive effect of it were the many people working from home, who were thus easier to approach.

4 Results

This chapter presents the relevant results of this research project. After presenting descriptive statistics of the variables, the found significant dependencies and correlations within the survey elements are analysed, and the influences of the different frames on the opinion of green roofs are investigated. The full statistical data of the dependencies can be found in *Appendix III.*

4.1 Descriptive statistics about opinions and perceptions

For the descriptive results, the number of participants that answered the question (N), the mean value (M), the median value, and the standard deviation (SD) are displayed. For the obstacles and needs, only the number of answers was recorded.

Climate change is perceived as an important topic by the respondents, as can be seen in *Table 8*. The sample group perceives the personal risk of climate change (M(69)=3.58, SD=1.02) as less important compared to the overall risk of it (M(69)=4.25, SD=0.793). Climate change was viewed as an urgent topic (*M(69)*=4.38, *SD*=0.688).

Table 8: Opinion on climate change

	cc.risk	cc.urgency	cc.personal_risk	cc.personal_impact	cc.cost	cc.personal_safety
N	69	69	69	69	69	69
Mean	4.25	4.38	3.58	4.01	4.12	3.72
Median	4	4	4	4	4	4
SD	0.793	0.688	1.02	0.883	0.850	0.856

There are more houseowners who have experienced heat stress (M(69)=2.84, SD=1.11; *Table 9*) rather than flooding (M(69)=2.14, SD=1.10; *Table 10*). Worries about heat stress in the future were ranked highest by participants (*M(69)*=4.09, *SD*=0.680).

Table 9: Descriptive statistics of heat stress

	h.experience	h.future	h.health	h.house_vulnerability	h.house_insulation
N	69	69	69	69	69
Mean	2.84	4.09	3.81	3.16	3.22
Median	3	4	4	3	3
SD	1.11	0.680	0.809	1.02	0.983

Not many participants, as seen in *Table 10*, state that they have experienced flooding within the last five years (M(69)=2.14, SD=1.10). Nevertheless, the perceived risk (M(69)=3.41, SD=1.05) and vulnerability (M(69)=3.07, SD=0.929) were rated higher than neutral.

Table 10: *Descriptive statistics of flooding*

	f.experience	f.risk_close	f.vulnerability
N	69	69	69
Mean	2.14	3.41	3.07
Median	2	4	3
SD	1.10	1.05	0.929

A subsidy as an incentive got the highest endorsement by the sample (M(69)=2.77, SD=0.489). Implementing BGI due to policy compliance was rated the lowest (M(69)=2.25, SD=0.775). Improving the attractiveness of the own house (M(69)=2.47, SD=0.762) and the neighbourhood (M(69)=2.56, SD=0.655) were also valued less. All other environmental incentives are rated similarly (*Table 11*).

Table 11: Descriptive statistics of incentives to implementing BGI

	i.subsidy	i.policy	i.biodiversity	i.waterquality	i.airquality	i.attractiveness	i.heatstress
N	69	69	69	69	69	68	69
Mean	2.77	2.25	2.62	2.62	2.67	2.47	2.59
Median	3	2	3	3	3	3	3
SD	0.489	0.775	0.571	0.545	0.560	0.762	0.577

	i.waterstress	i.attractiveness_neighbourhood	i.environmental_neighbourhood
N	69	68	69
Mean	2.52	2.56	2.65
Median	3	3	3
SD	0.655	0.655	0.590

In the open text field four participants indicated that saving money, a good personal feeling, better insulation and thus less costs for heating, and advantages for the environment in general would incentivise them.

Also within the evaluation of possible obstacles (*Table 12*), monetary obstacles (N=22, 31.88%) were rated highest, as well as the fear of getting false recommendations (N=22, 31.88%). Only three participants were of the opinion that climate change might not be as bad as predicted and there may not be a necessity for BGI (N=3, 4.35%). A high percentage mentioned that nothing was keeping them from installing BGI (N=20, 28.99%).

Table 12: Descriptive statistics of obstacles to implementing BGI

	o.finance	o.no_necessity	o.complicated	o.bad_advise	o.more_work	o.damage	o.less_assets	o.nothing
N	22	3	20	22	17	19	21	20

Further, nine more obstacles were identified in the free text fields. A too high initial investment, a hard to access roof, being busy with private issues, limited possibilities, conflict with photovoltaic, a higher cost-effect rate in other countries, the need for an independent consultant, too expensive consultancy services, and that a lot was done already, were mentioned.

When asked for their needs, more than half of the houseowners named the need for more information in general (N=38, 55.07%) and the information of the possibilities at their home (N=36; 52.17%). Only three participants did not feel like they need anything for a possible implementation (N=3, 4.35%). See *Table 13*.

Table 13: Descriptive statistics of needs for implementing BGI

	n.info	n.technical_info	n.possible	n.money	n.nothing
N	38	22	36	22	3

Two people stated that there is a conflict with photovoltaic and one person said that an independent advisory service was needed. These answers were given by three different people to the ones that gave similar answers in the free text field for the obstacles.

4.2 Statistical tests of dependencies and correlations

Table 14 shows how many of the evaluated Likert elements showed statistically significant associations. The significant elements are further described and discussed in Chapter 5. The detailed results of all elements can be found in *Appendix III.*

Table 14: Number of Likert elements with statistically significant association out of total elements.

	Incentives (linear)	**Obstacles (binominal)**	**Needs (binominal)**	**Green roofs (linear)**
Descriptive factors				
Age (linear)	**1/10**	**1/8**	**2/5**	**2/8**
Gender (binominal)	0/10	**1/8**	0/5	0/8
Education (3 options)	**1/10**	0/8	0/5	0/8
House year (3 options)	0/10	0/8	0/5	0/8
Last renovation (3 options)	0/10	0/8	**1/5**	0/8
Opinion				
Climate change (linear)	**1/10**	**2/8**	**2/5**	**6/8**
Flooding (linear)	**1/10**	0/8	0/5	0/8
Heat stress (linear)	**3/10**	0/8	**1/5**	**4/8**

Age

i.waterstress	Pearson's r=0.387; p=<.001
o.finance	KW χ^2=5.53, p=0.019, ε^2=0.0813
n.possible	KW χ^2=4.71, p=0.030, ε^2=0.0692
n.funds	KW χ^2=5.03, p=0.025, ε^2=0.0739
g.policy	Pearson's r=0.237, p=0.025
g.heatstress_personal	Pearson's r=0.360, p=0.001

A positive correlation between age and flooding as an incentive to implement BGI is found. Significantly more younger people view financing as an obstacle and list funds as a need for implementation. Whereas older people state that they would need to know if BGI is feasible for their home. The younger the respondents, the higher they rated the importance of policies and regulations to stimulate the implementation of green roofs. The item about reducing personal heat stress through green roofs scored higher with older participants.

Gender

o.complicated	KW χ^2=5.86, p=0.015, ε^2=0.0862

Regarding BGI obstacles, 47.83% of women view the implementation of BGI as complicated in comparison to 19.57% of men.

Education

i.subsidy	KW χ^2=12.115, p=0.002, ε^2=0.178

The pairwise comparison of MBO and HBO education levels shows that for MBO graduates a subsidy is more important than for HBO graduates (W(47)=4.95, p=0.001).

Last renovation

n.funds	KW χ^2=6.62, p=0.037

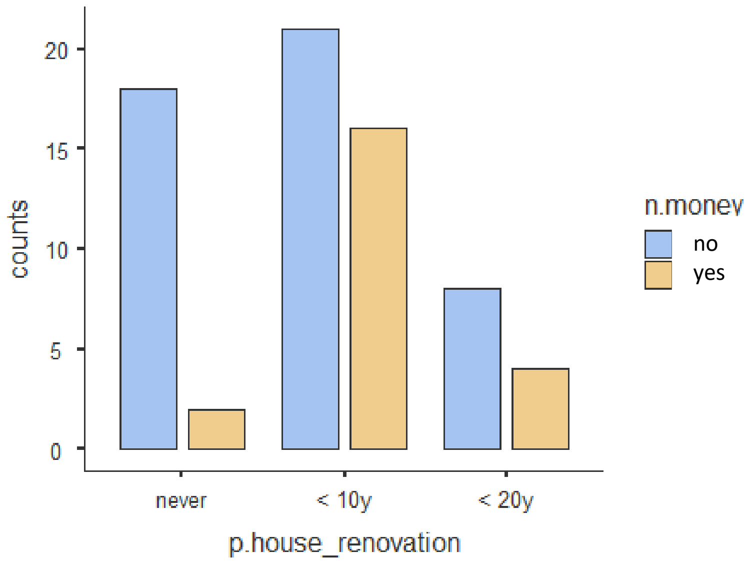

Figure 9: Dependency between last house renovation and the need for financial support for implementing BGI

Participants that have not renovated their house at all show a significant difference in terms of their need for financial support. Most of them state that they do not need financial support (*Figure 9*).

Climate change

i.airquality	KW χ^2=10.7, p=0.005, ε^2=0.158
o.finance	KW χ^2=14.9, p=<.001, ε^2=0.219
o.nothing	KW χ^2=10.3, p=0.001, ε^2=0.152
n.info	KW χ^2=4.09, p=0.043, ε^2=0.0601
n.possible	KW χ^2=5.59, p=0.018, ε^2=0.0821
g.need	Pearson's r=0.380, p=<.001
g.policy	Pearson's r=0.269, p=0.013
g.useful	Pearson's r=0.285, p=0.009
g.waterstress_country	Pearson's r=0.288, p=0.009
g.profit_neighbourhood	Pearson's r=0.212, p=0.040
g.waterstress_neighbourhood	Pearson's r=0.212, p=0.040

Participants who view climate change as an important and urgent topic answered that the improvement of air quality would be an asset for them. Additionally, financing of BGI was viewed as an obstacle by this group. While, general information as well as the information if an implemenation is possible on the own property is perceived as needed. They also agreed more with the Likert items about the implementation of green roofs. Not only the general need and usefulness was rated more positive, but also the benefit for their neighbourhood and the whole country.

Heat stress

i.subsidy	KW χ^2=7.90, p=0.019, ε^2=0.116
i.waterquality	KW χ^2=6.23, p=0.044, ε^2=0.0916
i.heatstress	KW χ^2=17.8, p=<.001, ε^2=0.262
n.nothing	KW χ^2=4.72, p=0.030, ε^2=0.0694
g.policy	Pearson's r=0.439, p=< .001
g.waterstress_country	Pearson's r=0.309, p=0.005
g.house_value	Pearson's r=0.320, p=0.004
g.heatstress_personal	Pearson's r=0.361, p=0.001

Participants who view heat stress as an important issue result in having significantly different opinions on a few items. Obviously, the reduction of heat stress would be an incentive for them as well as a subsidy and an improved water quality. When asked about the implementation of a green roof, they had a significantly more positive opinion on having more policies and regulations, the reduction of flooding in the Netherlands, the increased house value, and reduced heat stress.

4.3 Opinion on green roofs after reading differently framed texts

In order to assess the influence of the framed texts, the mean and standard deviation for each Likert-item are compared and tested for significant differences.

Table 15: Opinion on green roofs after reading differently framed texts about the topic (N=23 for each frame)

Frame	1 - Subsidy		2 - Loss		3 - Gain	
	Mean	SD	Mean	SD	Mean	SD
g.plans	1.77	0.429	1.65	0.489	1.70	0.470
g.need	3.91	0.793	4.13	0.694	3.91	0.793
g.policy	3.91	0.793	4.00	0.853	3.87	0.694
g.useful	3.96	0.825	4.35	0.647	3.96	0.928
g.flooding_country	3.77	0.685	4.04	0.825	4.00	0.953
g.house_value	3.09	0.949	3.26	0.619	2.91	0.949
g.heatstress_personal	3.70	0.876	3.61	0.839	3.74	0.810
g.profit_neighbourhood	3.74	0.915	3.83	0.778	3.61	0.656
g.waterstress_neighbourhood	3.17	0.834	3.39	0.891	3.09	1.08

A difference in the answers between the three frames can be seen from *Table 15*. Participants, who read the loss frame found green roofs to be more important compared to the two other groups (M(23)=4.35, SD=0.647). This group is more positive about all measures, except for the plans to install a green roof themselves (M(23)=1.65, SD=0.489) and the influence on the personal level of heat stress (M(23)=3.61, 0.839). Nevertheless, the Kruskal-Wallis test does not show statistically significant dependencies between frames and the opinion on green roofs. Thus, also the pair-wise comparison using the Dwass-Steel-Critchlow-Fligner test, does not suggest results with significant relevance.

4.4 Qualitative results

The distribution of the survey and feedback emails led to qualitative results in addition to the results of the survey itself.

The benefits of combining a green roof with photovoltaic is not known by all residents and even perceived as a hindrance. Some residents reported that there was no space on their roof due to previously installed photovoltaic power and one stressed in a feedback mail that the seemingly disadvantage of having to choose one of the two, was not available in the survey.

A disadvantage regarding private houses that the survey did not cover was the weak roofs. It was reported by one resident that even solar panels are considered too much weight for some of the old houses.

For several potential respondents, their old age was a reason not to change anything at their house, and they also did not want to contribute to the study due to this reason.

5 Discussion

This chapter answers the research questions with the knowledge gained from the scientific literature and the results of empirical analysis. The results are further discussed and interpreted as well.

5.1 Sub-question 1: Why do private houseowners' opinions on BGI differ?

In order to answer the research question, the influences of the assessed independent variables, on the opinion of BGI, were analysed. The independent variables are age, gender, education, the year the house was built, the last renovation, and the opinion on climate change, flooding, and heat stress

The personal characteristics, age, gender, and education do not influence the opinion on BGI significantly. Further, the year the house was built in and the last renovation do not have impact on the opinion on BGI.

As proposed by Kollmuss and Agyeman (2002) and Ajzen (1991) a positive environmental attitude, measured by the **attitude about climate change**, influences the opinion on BGI positively.

In contradiction to the literature, houseowners' opinion on BGI is more positive, if they are concerned about heat stress rather than flooding. Hegger et al. (2017) and Runhaar et al. (2012) found that the perceived behavioural control of heat stress is small in the Netherlands and that is why it would not be likely to be the crucial factor for implementation (and thus a positive opinion on BGI). That finding cannot be confirmed within this sample. Importantly, **heat stress** is reported to be more of a concern than flooding. Furthermore, participants who stated to be concerned about heat stress, showed a more positive opinion on BGI. Looking back on hot summers in the past years, the perception and perceived behavioural control might have changed. Nevertheless, the more likely explanation is the close proximity of many houses of the sample to waterways which reduce flooding on a small scale.

The opinion of houseowners on BGI changes differ due to two significant effects. Firstly, whether they have a positive opinion on climate change, and secondly, if they are concerned about heat stress. Personal characteristics and the opinion on flooding do not play a connotative role.

5.2 Sub-question 2: How does different framing of green roofs influence the opinion of private houseowners on BGI?

Before giving their opinion on green roofs, the participants read one of three randomly allocated texts about green roofs, without knowing about the three possible options. The first one with a focus on a **subsidy** for green roofs, the second one framing climate change without adaptation (e.g. green roofs) as a **loss** concerning heat stress and flooding, and the third one highlighting the benefits of green roofs as a **gain** to mitigate heat stress and flooding.

It was found that framing climate change as a loss leads to a slightly more positive opinion on the implementation of BGI, in comparison to the frames focussing on a subsidy or the gain due to less heat stress and flooding. Nevertheless, there is no statistical significance in these results and a certain conclusion and answer to the research question cannot be made.

This outcome goes in hand with the expectations drawn from the theoretical literature about effects of framing. It was expected that the loss frame leads to stronger and more positive opinions on green roofs (Tversky & Kahnman, 1981) and that the gain frame is not perceived as more positive than the rather neutral subsidy but may be perceived as keeping the current standards (Kahnman & Tversky, 1984). On the contrary, in a similar study, Spence and Pidgeon (2010) ended up with more positive results for a gain frame about climate change mitigation (as opposed to a loss frame). They assumed that climate change mitigation may be treated as a preventive measure and thereby will lead to more positive results than otherwise expected. It is a contradiction to the results within this study, nevertheless, it should be noted that the assumption of homogeneity of variance in their study was not met and results should be treated with caution. Further, it differs if aimed for mitigation or adaptation of climate change. In contrary to the study of Spence and Pidgeon (2010) the focus of this study was on climate change adaptation (instead of mitigation) and BGI was not considered a preventive measure, which changes the assumptions of the expected outcome.

5.3 Main question: How can private houseowners be mobilised to implement BGI?

Almost a third of all participants answered that there was “nothing” keeping them from installing BGI. Thus, the question arises how they can be taken from this neutral state, where nothing is hindering them but also there is no action yet, to a state that they do implement BGI. Four pillars of action were identified based on the statistical analysis and are described below.

Both qualitative and quantitative results show that there is an uncertainty when it comes to BGI, due to a lack of reliable and comprehensible **information**. Providing information that citizens can easily access is the initial step of changing citizens’ perception, attitude and thus the implementation of BGI in a positive way. There is particular request for advisory services to judge which kind of BGI would be a good fit for the personal situation. For some municipalities, it is common practice to provide energy advisors free of charge. The same practice could positively affect the implementation of BGI Furthermore, even environmentally concerned citizens lack awareness in options available, and were unaware of the energy yield benefits which a combination of photovoltaics and green roofs can achieve. Identifying and closing knowledge gaps like this one are an asset for further private actions.

Further, citizens need to understand the **urgency** of climate change, as described by Bubeck et al. (2013) and found in this study through the correlation between the opinions on climate change and green roofs. Understanding the urgency of the topic will not only influence the opinion on BGI positively but also trigger implementation. In close connection to this issue, **flooding** is not perceived as a big problem, because the population relies on governmental actions and there were no recent, major floods. The experience of flooding in the past years do not result in a more positive opinion on green roofs. Even after reading the text which framed flooding due to climate change as a loss for the participants, no dependency with a significant effect could be found. Framing flooding as a still occurring issue and concern of everyone, may mobilise more people.

Financial incentives play a more important role than non-monetary incentives. Only if a person has enough financial resources available, then they can focus on other values, such as pro-environmental behaviour. Even though the income was not asked directly, groups that tend to have less funds, such as younger people or people that did go through a renovation lately, identified financing as a relevant factor. It cannot be proven that income directly matters, but the availability of funds, as expected, seems to play a significant role.

Policies and regulations were not perceived by the respondents as a beneficial tool for steering the adaptation process. Nevertheless, it should be noted that only the perception of policies was measured and not their effect itself. The possible gap between perception and behaviour may be explained by the shift in Dutch policy making from public participation to governmental participation (Mees et al., 2019). Hereby, the interest of both governments and citizens is to transfer more responsibilities to citizen initiatives.

Understanding the urgency of climate change adaptation and the risks of water and heat stress, as well as providing independent organisations to inform and advise houseowners personally could change their opinion on BGI and thereby mobilise more citizens to implement BGI. Financial support for houseowners, who see the financial benefits as an incentive, can lead to more implementations in places where BGI is needed the most, such as heat islands in city centres.

6 Conclusions

The objectives of this thesis were to improve the understanding on factors that can mobilise private houseowners to implement blue-green infrastructure and to assess the potential of framing as a tool for changing private houseowners' perception. In this chapter the answers to the research question are given in a condensed way, the research limitations are reflected upon and directions for future research are drawn.

6.1 Answers to the research questions

The first sub-question analysed why houseowner's opinions on BGI differ. It was found that the opinions on climate change and heat stress influences the opinion on BGI. Participants, who viewed climate change and heat stress as urgent and important topics, did the same for green roofs.

The influence of the opinion of houseowners on BGI through different framing was assessed within the second sub-question. The opinion on green roofs were compared after reading a text which either highlighted a subsidy for green roofs, the loss due to climate change without adaptation, or the gain of adaptation with a green roof. A tendency to be more positive about green roofs after reading a text, which framed climate change without adaptations as a loss, was found, but cannot be proven to have differences with statistical significance in comparison to the other two frames.

Finally, the main question was answered, how houseowners can be mobilised to implement BGI. In order to mobilise houseowners, four pillars of action with a positive influence on the opinion on BGI were found. Reliable information about BGI and financial incentives are measures that may be taken by governments, whereas, the urgency of climate change adaptation and framing flooding as a current issue are two important pieces of the puzzle for the right attitude.

6.2 Reflections on the research limitations

A limitation that cannot be eliminated but only be minimised within surveys is the research bias, i.e. the tendency of a person to answer a question untruthfully, for example, because a socially expected answer is preferred. For this thesis, this bias should be kept in mind when analysing the total numbers of a factor.

Another major limitation to this research was the specific sample, which is older, richer, more educated, and consist of more male participants compared to the average Dutch population. Considering the scope and topic of the research, it was the only feasible option within the time and logistical constraints. Nevertheless, during the data collection the question arose who might be reached and might benefit from the research and possible implications.

The respondents stated that policies would not motivate them to install more BGI. It is obvious that citizens wish for more freedom of choice and especially in the Netherlands a shift to governmental participation, instead of public participation, can be seen. This effect comes with some challenges. More 'skilled neighbourhoods' and areas with residents that do not need to worry about their basic needs have the capacity to implement initiatives such as BGI and bring their neighbourhood forward in a progress of change. On the other side, neighbourhoods with residents, who have to deal with other issues, such as providing the basic income, or areas with more rental houses, would benefit from clear policies. Thus, asking only to the more affluent population, who do not live in rental houses, does not reflect what the general population needs. It may even enlarge the gap further and foster inequality.

The way of data collection by asking people in their homes led to more participants filling in the survey, who have a positive opinion on environmental measures. Others stated right away that they were not interested in the topic. It would be especially interesting to examine the views of the latter group.

6.3 Directions for future research

Based on the results and insights gained through this thesis, four major directions are identified for future research. Firstly, a larger sample should be chosen to verify whether or not the differences found are of significance. Especially, the representation of the group of people that already implemented BGI should be larger in the sample, so that statistical analysis can be conducted.

Secondly, more details regarding incentives, obstacles, and needs should be examined. Due to the scope of this study, not every possible detail, which is proposed within the scientific literature could be analysed. For instance, it should be determined which and how the information can be brought to the population to ensure a trustful communication process. Another question, which should be elaborated further, is how climate change urgencies can be made visible and reach a broad public. The effect of mainstreaming, the influence of improved communication, pleasure of giving and the effects of self-efficacy and response efficacy should be further probed.

Thirdly, the external validity of this study was compromised to ensure a high internal validity. In future research projects a focus on BGI that a group of people, rather than individuals, can install could lead to a higher external validity. Another possibility would be a hypothetical study, such as a game-like simulation of real-world decision situations. By doing so, the sample is expected to give a better picture of the Dutch population and can assure conclusions and recommendations aiming for an equal society. Assuming that the population with less means is often times neglected, a focus on disadvantaged groups could also be beneficial for the overall picture.

Fourthly and lastly, the influences on behaviour are not entirely understood by the scientific community. A broader study, analysing actual behaviour over a longer span of time and not only the perceptions of individuals at a certain point in time, would bring insights with more certainty regarding the intention behaviour gap.

Understanding the opinions of houseowners on BGI and the influencing factors to implement BGI themselves can contribute to mobilising more residents to act on their own property. This understanding in combination with governmental actions can bring the Netherlands closer to its goal of making cities climate resilient and water-robust by 2050 and contribute to biodiversity. In order to see a shift within the close future, actions from all stakeholders are required.

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Appendix I – Original Survey in Dutch

Welkom! Mijn naam is Miriam en ik ben masterstudent watermanagement aan de Universiteit Twente en zou u graag wat informatie voor mijn afstudeerproject willen vragen. Het doel van mijn onderzoek is om de perceptie over blauwgroene aanpassingen beter te begrijpen. Een voorbeeld hiervan is een groen dak. Dit is een dak waar vegetatie op een speciale onderlaag groeit. En groen dak kan aangepast worden met een helling tot 45 graden. De enquête zal niet langer dan 10min moeten duren. Al uw gegevens worden anoniem behandeld, niet aan derden verstrekt en na het onderzoeksproject verwijderd. Bedankt voor uw bijdrage!

Miriam Lenk (m.lenk@student.utwente.nl)

Eerst een paar vragen over u en uw woonsituatie.

Deze informatie wordt gebruikt voor het analyseren van de resultaten.

Geboortejaar:

Geslacht

- ◯ mannelijk
- ◯ vrouwelijk
- ◯ divers

Hoogste opleiding

- ◯ geen opleiding
- ◯ basisschool
- ◯ middelbare school
- ◯ MBO
- ◯ HBO
- ◯ WO

Ik ben huiseigenaar.

- ◯ ja
- ◯ nee

Bouwjaar van uw huis?

- ○ vóór 1970
- ○ 1970 - 2000
- ○ na 2000

Wanneer heeft u voor het laatst verbouwd of gerenoveerd?

- ○ nooit
- ○ binnen de laatse 10 jaar
- ○ binnen de laatste 20 jaar
- ○ langer dan 20 jaar geleden

Wat is de hellingshoek van uw dak?

- ○ 0 t/m 5°
- ○ 5 t/m 15°
- ○ 15 t/m 45°
- ○ meer dan 45°

Geef alstublieft uw persoonlijke mening over klimaatverandering.

	zeer mee oneens	mee oneens	neutraal	mee eens	zeer mee eens
Klimaatverandering is een ernstig risico voor de mensheid.	○	○	○	○	○
Er is noodzaak om aanpassingen te doen voor klimaatverandering.	○	○	○	○	○
Mijn leven wordt beïnvloed door klimaatverandering.	○	○	○	○	○
Handelingen van individuen hebben impact op klimaatverandering.	○	○	○	○	○
Tijdig aanpassen aan klimaatverandering kost minder dan het betalen van de schade achteraf.	○	○	○	○	○
Aanpassing aan klimaatverandering verhoogt mijn persoonlijke veiligheid.	○	○	○	○	○

Geef alstublieft uw persoonlijke mening over wateroverlast en hittestress.

	zeer mee oneens	mee oneens	neutraal	mee eens	zeer mee eens
Ik beschouw wateroverlast als een groot risico voor mijn leefomgeving.	○	○	○	○	○
Ik voel me kwetsbaar voor wateroverlast.	○	○	○	○	○
Hittestress zal de komende jaren ernstiger worden.	○	○	○	○	○
Hete zomers zijn een probleem voor de volksgezondheid.	○	○	○	○	○
Ik maak mij zorgen over het koel houden van mijn woning in de zomer.	○	○	○	○	○
Mijn huis is goed geïsoleerd om hete zomers te weerstaan.	○	○	○	○	○
Mijn huis is goed beschermd tegen wateroverlast.	○	○	○	○	○
Ik heb in de afgelopen vijf jaren wateroverlast ervaren.	○	○	○	○	○
Ik heb in de afgelopen vijf jaren hittestress ervaren.	○	○	○	○	○

Welke van de volgende factoren zou u motiveren om (verdere) blauwgroene aanpassingen, zoals regenwateropvang of groene daken, te implementeren?

	niet motiverend	neutraal	motiverend
een subsidie	○	○	○
beleid / regelgeving voor ieder huis	○	○	○
voordelen voor de biodiversiteit	○	○	○
verbetering van de waterkwaliteit	○	○	○
verbetering van de luchtkwaliteit	○	○	○
Het ziet er mooi uit	○	○	○
verminderen van hittestress	○	○	○
verminderen van wateroverlast	○	○	○
bijdragen aan een mooie buurt	○	○	○
bijdragen aan een milieuvriendelijke buurt	○	○	○
andere:	○	○	○

Ik maak me zorgen ten opzichte van blauwgroene aanpassingen dat ...

- ☐ de financiële voordelen tegenvallen.
- ☐ klimaatverandering minder erg blijkt te zijn en dus adaptatie niet nodig was.
- ☐ het veel moeite kost een subsidie aan te vragen.
- ☐ ik slecht word geadviseerd.
- ☐ ik nog meer werk met mijn huis zou hebben.
- ☐ er bij de implementatie iets aan mijn huis stuk gaat.
- ☐ de voordelen tegen zullen vallen.
- ☐ Ik maak me geen zorgen.
- ☐ anders: ____

Voor toekomstige implementatie van blauwgroene aanpassingen zou ik ... nodig hebben. (Kies max. 2 opties)

- ☐ meer informatie over voor- en nadelen
- ☐ meer technische details
- ☐ een beoordeling of mijn dak geschikt is
- ☐ financiële hulp
- ☐ niks
- ☐ andere: ____

Please note that only one of the frames was shown each time and the participants did not know about this random distribution!

Frame 1 - Subsidie

Lees alstublieft de tekst en geef vervolgens uw mening over groene daken.

De gemeente wil het aantal groene daken vergroten om warmte- en waterstress te verminderen. Omdat groene daken niet goedkoop zijn, bieden ze elk huishouden een subsidie aan. Hoewel groene daken duurder zijn dan gewone daken, kan het toch een goede deal zijn wanneer een renovatie hoe dan ook nodig is.

(Fotobron: www.groenedakenleiden.nl/uncategorized/groendak-in-cronesteijn/)

Frame 2 - Verlies

Lees alstublieft de tekst en geef vervolgens uw mening over groene daken.

Toekomstige generaties zullen de meeste gevolgen van klimaatverandering gaan ondervinden. De huidige leefomgeving wordt echter al beïnvloed door klimaatverandering. Studies tonen aan dat klimaatverandering leidt tot hitte- en waterstress, daarnaast heeft het een verminderde lucht- en waterkwaliteit tot gevolg. Groene daken kunnen dit risico op hitte- en waterstress in en om uw huis verminderen. De begroeiing op het dak vermindert lucht- en waterverontreiniging, verder voorkomt het plaatsen van een groen dak waardevermindering van uw huis.

(Fotobron: www.groenedakenleiden.nl/uncategorized/groendak-in-cronesteijn/)

Frame 3 - Winst

Lees alstublieft de tekst en geef vervolgens uw mening over groene daken.

Studies tonen aan dat het voor Nederlanders belangrijk is om op een milieuvriendelijke manier te leven. Dit kunnen we doen door ons gedrag beetje bij beetje aan te passen richting een duurzamere levensstijl.
Dit is belangrijk omdat we zo kunnen bijdragen aan adaptatie voor klimaatverandering, wat leidt tot een beter klimaat in onze wijken. Groene daken zijn een manier om als individu iets te veranderen. Door de lucht in de directe omgeving af te koelen op warme dagen, regenwater vast te houden op regenachtige dagen en de lucht- en waterkwaliteit te verbeteren door een goede plantenkeuze.

(Fotobron: www.groenedakenleiden.nl/uncategorized/groendak-in-cronesteijn/)

Ik heb een groen dak.

- ◯ Ja
- ◯ Nee

Ik overweeg een groendak aan te leggen.

- ◯ Ja
- ◯ Nee

Geef alstublieft uw mening over groene daken!

	zeer mee oneens	mee oneens	neutraal	mee eens	zeer mee eens
We hebben meer groene daken nodig in ons land!	○	○	○	○	○
Er moet meer beleid komen ter bevordering van groene daken.	○	○	○	○	○
Groene daken zijn nuttig om de warmte in steden te verminderen.	○	○	○	○	○
Groene daken dragen bij aan het verminderen van de wateroverlast in ons land.	○	○	○	○	○
Een groendak verhoogt de waarde van mijn huis.	○	○	○	○	○
Ik zal in de zomer persoonlijk profiteren van een koeler huis.	○	○	○	○	○
Onze buurt zou baat hebben bij meer groene daken.	○	○	○	○	○
Als er meer huizen in mijn straat groene daken hadden, zouden we na hevige regenval minder water op straat hebben.	○	○	○	○	○

Appendix II – Survey Translation in English

Welcome! My name is Miriam and I am a master student in water management at the University of Twente and would like to ask you some information for my graduation project. The aim of my research is to better understand the perception about blue-green adaptations. An example of this is a green roof. This is a roof where vegetation grows on a special substrate. And green roof can be adjusted with a slope of up to 45 degrees. The survey should not take longer than 10min. All your data will be treated anonymously, will not be provided to third parties and will be deleted after the research project. Thanks for your contribution!

Miriam Lenk (m.lenk@student.utwente.nl)

First, a few questions about you and your living situation.

This information is used to analyse the results.

Year of birth:

Gender

- ○ male
- ○ female
- ○ divers

Highest level of education

- ○ no education
- ○ primary education
- ○ vocational education
- ○ secondary education
- ○ technical college
- ○ university

I am a houseowner.

- ○ yes
- ○ no

When was your house built?

- ◯ earlier then 1970
- ◯ 1970 - 2000
- ◯ after 2000

When did the last renovation take place?

- ◯ never
- ◯ within the past 10 years
- ◯ within the past 20 years
- ◯ more than 20 years ago

What is the slope of your roof?

- ◯ 0 - 5°
- ◯ 5 - 15°
- ◯ 15 - 45°
- ◯ more than 45°

Please provide your personal opinion on climate change.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Climate change is a serious risk to humanity.	○	○	○	○	○
There is a need to make adjustments for climate change.	○	○	○	○	○
My life is affected by climate change.	○	○	○	○	○
Actions by individuals have an impact on climate change.	○	○	○	○	○
Timely adaptation to climate change costs less than paying the damage afterwards.	○	○	○	○	○
Adapting to climate change increases my personal safety.	○	○	○	○	○

Please provide your personal opinion on flooding and heat stress.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I consider flooding to be a major risk to my living environment.	○	○	○	○	○
I feel vulnerable to waterlogging.	○	○	○	○	○
Heat stress will become more serious in the coming years.	○	○	○	○	○
Hot summers are a public health problem.	○	○	○	○	○
I am concerned about keeping my home cool in the summer.	○	○	○	○	○
My house is well insulated to withstand hot summers.	○	○	○	○	○
My house is well protected against flooding.	○	○	○	○	○
I have experienced flooding in the past five years.	○	○	○	○	○
I have experienced heat stress in the past five years.	○	○	○	○	○

Which of the following factors would incentivise you to implement (further) blue-green adaptations, such as rainwater harvesting or green roofs?

	Not motivating	Neutral	Motivating
a subsidy	○	○	○
policies / regulations for every home	○	○	○
benefits for biodiversity	○	○	○
improving water quality	○	○	○
improvement of air quality	○	○	○
It looks nice	○	○	○
reduce heat stress	○	○	○
reduce flooding	○	○	○
contribute to a beautiful neighborhood	○	○	○
contribute to an environmentally friendly neighborhood	○	○	○
Others:	○	○	○

I am concerned about blue-green infrastructure that ...

- ☐ the financial benefits turn out to be less beneficial than expected.
- ☐ climate change proves to be less severe and therefore adaptation was not necessary.
- ☐ it takes a lot of effort to apply for a subsidy.
- ☐ I am badly advised.
- ☐ I would have more work with my house.
- ☐ something breaks in my house during implementation.
- ☐ the benefits will be disappointing.
- ☐ I am not concerned.
- ☐ different:____

For future implementation of blue-green adjustments, I would need ... (Choose max. 2 options)

- ☐ more information about advantages and disadvantages.
- ☐ more technical details.
- ☐ an assessment of whether my roof is suitable.
- ☐ financial help.
- ☐ nothing.
- ☐ Others:____

Please note that only one of the frames was shown each time and the participants did not know about this random distribution!

Frame 1 - Subsidy

Please read the text and then give your opinion on green roofs.

The municipality wants to increase the number of green roofs to reduce heat and water stress. Since green roofs are not cheap, they offer a subsidy to every household. While green roofs are more expensive than regular roofs, it can still be a good deal when a renovation is needed anyway.

(Picture source: www.groenedakenleiden.nl/uncategorized/groendak-in-cronesteijn/)

Frame 2 - Loss

Please read the text and then give your opinion on green roofs.

Future generations will be most affected by climate change. However, the current living environment is already affected by climate change. Studies show that climate change leads to heat and water stress, in addition to reduced air and water quality. Green roofs can reduce this risk of heat and water stress in and around your home. The vegetation on the roof reduces air and water pollution, furthermore, placing a green roof prevents the depreciation of your house.

(Picture source: www.groenedakenleiden.nl/uncategorized/groendak-in-cronesteijn/)

Frame 3 - Gain

Please read the text and then give your opinion on green roofs.

Studies show that it is important for the Dutch to live in an environmentally friendly way. We can do this by adapting our behaviour little by little towards a more sustainable lifestyle.
This is important because it allows us to contribute to climate change adaptation, leading to a better climate in our neighbourhoods. Green roofs are a way to change something as an individual. By cooling the air in the immediate area on hot days, retaining rainwater on rainy days and improving air and water quality through a good choice of plants.

(Picture source: www.groenedakenleiden.nl/uncategorized/groendak-in-cronesteijn/)

I have a green roof.

- ◯ Yes
- ◯ No

I am considering installing a green roof.

- ◯ Yes
- ◯ No

Please give your opinion on green roofs!

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
We need more green roofs in our country!	○	○	○	○	○
More policies are needed to promote green roofs.	○	○	○	○	○
Green roofs are useful for reducing heat in cities.	○	○	○	○	○
Green roofs contribute to reducing flooding in our country.	○	○	○	○	○
A green roof increases the value of my house.	○	○	○	○	○
I will personally take advantage of a cooler home in the summer.	○	○	○	○	○
Our neighborhood would benefit from more green roofs.	○	○	○	○	○
If there were more houses on my street with green roofs, we would have less water on the street after heavy rainfall.	○	○	○	○	○

Appendix III – Full Statistical Results

Influence of age on incentives to implement BGI

Pearson correlation, assuming a positive correlation

		p.age_year
i.subsidy	Pearson's r	0.068
	p-value	0.288
i.policy	Pearson's r	0.143
	p-value	0.121
i.biodiversity	Pearson's r	-0.015
	p-value	0.549
i.waterquality	Pearson's r	0.116
	p-value	0.172
i.airquality	Pearson's r	0.132
	p-value	0.141
i.attractiveness	Pearson's r	0.138
	p-value	0.131
i.heatstress	Pearson's r	0.099
	p-value	0.210
i.waterstress	**Pearson's r**	**0.387**
	p-value	**< .001**
i.attractiveness_neighbourhood	Pearson's r	0.039
	p-value	0.376
i.environmental_neighbourhood	Pearson's r	0.173
	p-value	0.077

Influence of age on obstacles regarding BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
o.finance	**5.53**	**1**	**0.019**	**0.0813**
o.no_necessity	0.542	1	0.462	0.00797
o.complicated	2.71	1	0.099	0.0399
o.bad_advise	0.0425	1	0.837	6.25E-4
o.more_work	0.112	1	0.738	0.00164
o.damage	1.88	1	0.170	0.0276
o.less_assets	1.52	1	0.218	0.0224
o.nothing	2.06	1	0.151	0.0303

Influence of age on needs regarding BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
n.info	0.0286	1	0.866	4.20E-4
n.technical_info	0.203	1	0.652	0.00299
n.possible	**4.71**	**1**	**0.030**	**0.0692**
n.funds	**5.03**	**1**	**0.025**	**0.0739**
n.nothing	0.0139	1	0.906	2.04E-4

Influence of age on the opinion on green roofs

Pearson correlation assuming a positive correlation

		p.age_year
g.need	Pearson's r	0.112
	p-value	0.180
g.policy	**Pearson's r**	**0.237**
	p-value	**0.025**
g.useful	Pearson's r	0.047
	p-value	0.350
g.waterstress_country	Pearson's r	0.114
	p-value	0.177
g.house_value	Pearson's r	0.176
	p-value	0.074
g.heatstress_personal	**Pearson's r**	**0.360**
	p-value	**0.001**
g.profit_neighbourhood	Pearson's r	0.199
	p-value	0.051
g.waterstress_neighbourhood	Pearson's r	0.122
	p-value	0.159

Influence of gender on incentives to implement BGI

Independent Samples T-Test

		Statistic	df	p	Cohen's d
i.subsidy	Student's t	-0.173	67.0	0.863	-0.0441
i.policy	Student's t	0.218	67.0	0.828	0.0557
i.biodiversity	Student's t	-0.742	67.0	0.460	-0.1896
i.waterquality	Student's t	-0.310	67.0	0.757	-0.0792
i.airquality	Welch's t	-1.792	51.2	0.079	-0.4328
i.attractiveness	Student's t	-0.557	66.0	0.579	-0.1444
i.heatstress	Student's t	-0.587	67.0	0.559	-0.1500
i.waterstress	Student's t	0.000	67.0	1.000	0.0000
i.attractiveness_neighbourhood	Student's t	0.331	66.0	0.741	0.0850
i.environmental_neighbourhood	Welch's t	-2.464	57.4	0.017	-0.5688

Influence of gender on obstacles regarding BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
o.finance	1.61	1	0.204	0.0237
o.no_necessity	1.55	1	0.214	0.0227
o.complicated	**5.86**	**1**	**0.015**	**0.0862**
o.bad_advise	0.822	1	0.365	0.0121
o.more_work	1.88	1	0.170	0.0277
o.damage	1.75	1	0.185	0.0258
o.less_assets	0.304	1	0.582	0.00446
o.nothing	0.867	1	0.352	0.0128

Influence of gender on needs regarding BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
n.info	0.0289	1	0.865	4.24E-4
n.technical_info	0.822	1	0.365	0.0121
n.possible	0.00	1	1.000	0.00
n.funds	0.132	1	0.717	0.00193
n.nothing	1.55	1	0.214	0.0227

Influence of gender on incentives to implement BGI

Independent Samples T-Test

		Statistic	df	p	Cohen's d
g.need	Student's t	-1.830	67.0	0.072	-0.4672
g.policy	Student's t	-1.908	67.0	0.061	-0.4873
g.useful	Student's t	-0.310	67.0	0.757	-0.0792
g.waterstress_country	Student's t	0.199	66.0	0.843	0.0511
g.house_value	Student's t	-0.596	67.0	0.553	-0.1522
g.heatstress_personal	Student's t	0.203	67.0	0.839	0.0519
g.profit_neighbourhood	Student's t	-0.432	67.0	0.667	-0.1103
g.waterstress_neighbourhood	Student's t	-1.656	67.0	0.102	-0.4228

Influence of education on incentives to implement BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
i.subsidy	**12.115**	**2**	**0.002**	**0.1782**
i.policy	3.764	2	0.152	0.0554
i.biodiversity	1.369	2	0.504	0.0201
i.waterquality	1.046	2	0.593	0.0154
i.airquality	0.944	2	0.624	0.0139
i.attractiveness	1.548	2	0.461	0.0231
i.heatstress	1.344	2	0.511	0.0198
i.waterstress	0.763	2	0.683	0.0112
i.attractiveness_neighbourhood	2.379	2	0.304	0.0355
i.environmental_neighbourhood	0.955	2	0.620	0.0140

Pairwise comparisons - f.subsidy

		W	p
MBO	**HBO**	**4.95**	**0.001**
MBO	WO	2.49	0.184
HBO	WO	-2.84	0.110

Influence of education on obstacles regarding BGI

X Squared (N= 69)

	χ^2	df	p
o.finance	2.92	2	0.232
o.no_necessity	0.488	2	0.784
o.complicated	0.300	2	0.861
o.bad_advise	2.79	2	0.247
o.more_work	2.41	2	0.299
o.damage	1.27	2	0.530
o.less_assets	2.77	2	0.251
o.nothing	2.42	2	0.299

Influence of education on needs regarding BGI

X Squared (N= 69)

	χ^2	df	p
n.info	0.352	2	0.839
n.technical_info	0.805	2	0.669
n.possible	0.402	2	0.818
n.funds	0.0104	2	0.995
n.nothing	1.87	2	0.393

Influence of education on the opinion on green roofs

Kruskal-Wallis

	χ^2	df	p	ε^2
g.need	3.26978	2	0.195	0.04808
g.policy	0.62403	2	0.732	0.00918
g.useful	0.23300	2	0.890	0.00343
g.waterstress_country	0.30475	2	0.859	0.00455
g.house_value	4.10090	2	0.129	0.06031
g.heatstress_personal	2.16958	2	0.338	0.03191
g.profit_neighbourhood	0.00892	2	0.996	1.31e-4
g.waterstress_neighbourhood	1.04643	2	0.593	0.01539

Influence of the year the house was built on incentives to implement BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
i.subsidy	2.970	2	0.226	0.04368
i.policy	1.131	2	0.568	0.01663
i.biodiversity	2.896	2	0.235	0.04259
i.waterquality	0.808	2	0.668	0.01188
i.airquality	0.852	2	0.653	0.01254
i.attractiveness	1.091	2	0.579	0.01629
i.heatstress	1.973	2	0.373	0.02902
i.waterstress	2.263	2	0.323	0.03327
i.attractiveness_neighbourhood	1.035	2	0.596	0.01545
i.environmental_neighbourhood	0.159	2	0.923	0.00234

Influence of the year the house was built on obstacles regarding BGI

X Squared (N= 69)

	χ^2	df	p
o.finance	0.589	2	0.745
o.no_necessity	1.70	2	0.428
o.complicated	0.644	2	0.725
o.bad_advise	1.02	2	0.600
o.more_work	2.34	2	0.310
o.damage	0.229	2	0.892
o.less_assets	0.444	2	0.801
o.nothing	0.175	2	0.916

Influence of the year the house was built on needs regarding BGI

X Squared (N= 69)

	χ^2	df	p
n.info	1.57	2	0.455
n.technical_info	2.41	2	0.300
n.possible	0.942	2	0.624
n.funds	2.75	2	0.252
n.nothing	1.23	2	0.540

Influence of the year the house was built on the opinion on green roofs

Kruskal-Wallis

	χ^2	df	p	ε^2
g.need	4.0696	2	0.131	0.05985
g.policy	1.6540	2	0.437	0.02432
g.useful	0.0713	2	0.965	0.00105
g.waterstress_country	0.0251	2	0.988	3.74e-4
g.house_value	0.7750	2	0.679	0.01140
g.heatstress_personal	1.4044	2	0.496	0.02065
g.profit_neighbourhood	2.5526	2	0.279	0.03754
g.waterstress_neighbourhood	2.5934	2	0.273	0.03814

Influence of the last renovation on incentives to implement BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
i.subsidy	1.816	2	0.403	0.02671
i.policy	3.168	2	0.205	0.04659
i.biodiversity	2.449	2	0.294	0.03601
i.waterquality	7.530	2	0.023	0.11074
i.airquality	2.319	2	0.314	0.03410
i.attractiveness	5.076	2	0.079	0.07575
i.heatstress	0.621	2	0.733	0.00913
i.waterstress	8.511	2	0.014	0.12516
i.attractiveness_neighbourhood	1.515	2	0.469	0.02262
i.environmental_neighbourhood	2.330	2	0.312	0.03427

Influence of the last renovation on obstacles regarding BGI

X Squared (N= 69)

	χ^2	df	p
o.finance	0.641	2	0.726
o.no_necessity	2.32	2	0.313
o.complicated	0.852	2	0.653
o.bad_advise	0.475	2	0.789
o.more_work	0.526	2	0.769
o.damage	0.104	2	0.949
o.less_assets	3.28	2	0.194
o.nothing	1.72	2	0.423

Influence of the last renovation on needs regarding BGI

X Squared (N= 69)

	χ^2	df	p
n.info	5.82	2	0.054
n.technical_info	0.180	2	0.914
n.possible	3.75	2	0.153
n.funds	**6.62**	**2**	**0.037**
n.nothing	3.68	2	0.159

Contingency Tables

	n.funds		
p.house_renovation	**no**	**yes**	**Total**
never	18	2	20
< 10y	21	16	37
< 20y	8	4	12
Total	47	22	69

Influence of the last renovation on the opinion on green roofs

Kruskal-Wallis

	χ^2	df	p	ε^2
g.need	0.5107	2	0.775	0.00751
g.policy	0.2891	2	0.865	0.00425
g.useful	1.1274	2	0.569	0.01658
g.waterstress_country	0.0357	2	0.982	5.33e-4
g.house_value	0.8528	2	0.653	0.01254
g.heatstress_personal	0.5625	2	0.755	0.00827
g.profit_neighbourhood	1.8912	2	0.388	0.02781
g.waterstress_neighbourhood	0.2162	2	0.898	0.00318

Influence of the opinion on climate change on incentives to implement BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
i.subsidy	4.25	2	0.119	0.0626
i.policy	6.48	2	0.039	0.0952
i.biodiversity	1.69	2	0.431	0.0248
i.waterquality	1.69	2	0.429	0.0249
i.airquality	**10.7**	**2**	**0.005**	**0.158**
i.attractiveness	4.09	2	0.129	0.0611
i.heatstress	4.32	2	0.115	0.0635
i.waterstress	2.97	2	0.226	0.0437
i.attractiveness_neighbourhood	2.46	2	0.293	0.0367
i.environmental_neighbourhood	4.72	2	0.094	0.0694

Influence of the opinion on climate change on obstacles regarding BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
o.finance	**14.9**	**1**	**<.001**	**0.219**
o.no_necessity	1.23	1	0.267	0.0181
o.complicated	0.383	1	0.536	0.00563
o.bad_advise	0.230	1	0.632	0.00338
o.more_work	0.661	1	0.416	0.00972
o.damage	3.71	1	0.054	0.0546
o.less_assets	0.150	1	0.699	0.00220
o.nothing	**10.3**	**1**	**0.001**	**0.152**

Influence of the opinion on climate change on needs regarding BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
n.info	**4.09**	**1**	**0.043**	**0.0601**
n.technical_info	2.16	1	0.141	0.0318
n.possible	**5.59**	**1**	**0.018**	**0.0821**
n.funds	0.269	1	0.604	0.00395
n.nothing	1.40	1	0.236	0.0206

Influence of the opinion on climate change on the opinion on green roofs

Pearson, positive correlation

		cc.average
g.need	**Pearson's r**	**0.380**
	p-value	**< .001**
g.policy	**Pearson's r**	**0.269**
	p-value	**0.013**
g.useful	**Pearson's r**	**0.285**
	p-value	**0.009**
g.waterstress_country	**Pearson's r**	**0.288**
	p-value	**0.009**
g.house_value	Pearson's r	0.183
	p-value	0.066
g.heatstress_personal	Pearson's r	0.118
	p-value	0.167
g.profit_neighbourhood	**Pearson's r**	**0.212**
	p-value	**0.040**
g.waterstress_neighbourhood	**Pearson's r**	**0.212**
	p-value	**0.040**

Kruskal-Wallis (c.urgency)

	χ^2	df	p
g.plans	3.27	3	0.351
g.need	**16.47**	**3**	**< .001**
g.policy	5.11	3	0.164
g.useful	**8.27**	**3**	**0.041**
g.waterstress_country	5.92	3	0.116
g.house_value	2.91	3	0.405
g.heatstress_personal	2.21	3	0.530
g.profit_neighbourhood	4.17	3	0.244
g.waterstress_neighbourhood	**8.19**	**3**	**0.042**

Influence of the opinion on flooding on incentives to implement BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
i.subsidy	4.07	2	0.131	0.0598
i.policy	3.74	2	0.154	0.0550
i.biodiversity	5.75	2	0.056	0.0846
i.waterquality	3.73	2	0.155	0.0549
i.airquality	1.92	2	0.383	0.0282
i.attractiveness	1.72	2	0.423	0.0257
i.heatstress	3.44	2	0.179	0.0506
i.waterstress	**14.6**	**2**	**<.001**	**0.215**
i.attractiveness_neighbourhood	1.57	2	0.456	0.0235
i.environmental_neighbourhood	4.44	2	0.108	0.0653

Influence of the opinion on flooding on obstacles regarding BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
o.finance	0.980	1	0.322	0.0144
o.no_necessity	2.22E-4	1	0.988	3.26E-6
o.complicated	0.644	1	0.422	0.00948
o.bad_advise	0.513	1	0.474	0.00755
o.more_work	7.94E-4	1	0.978	1.17E-5
o.damage	0.382	1	0.536	0.00562
o.less_assets	0.586	1	0.444	0.00861
o.nothing	0.207	1	0.649	0.00304

Influence of the opinion on flooding on needs regarding BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
n.info	0.00838	1	0.927	1.23E-4
n.technical_info	0.684	1	0.408	0.0101
n.possible	0.0179	1	0.894	2.63E-4
n.funds	1.27	1	0.260	0.0187

Kruskal-Wallis

	χ^2	df	p	ε^2
n.nothing	0.0498	1	0.823	7.33E-4

Influence of the opinion on flooding on the opinion on green roofs

		f.average
g.need	Pearson's r	0.053
	p-value	0.334
g.policy	Pearson's r	0.098
	p-value	0.213
g.useful	Pearson's r	0.170
	p-value	0.082
g.waterstress_country	Pearson's r	0.172
	p-value	0.080
g.house_value	Pearson's r	0.102
	p-value	0.203
g.heatstress_personal	Pearson's r	0.137
	p-value	0.130
g.profit_neighbourhood	Pearson's r	-0.048
	p-value	0.653
g.waterstress_neighbourhood	Pearson's r	0.148
	p-value	0.113

Influence of the opinion on heat stress on incentives to implement BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
i.subsidy	**7.90**	**2**	**0.019**	**0.116**
i.policy	3.11	2	0.212	0.0457
i.biodiversity	0.312	2	0.856	0.00459
i.waterquality	**6.23**	**2**	**0.044**	**0.0916**
i.airquality	2.18	2	0.335	0.0321
i.attractiveness	2.63	2	0.269	0.0392
i.heatstress	**17.8**	**2**	**<.001**	**0.262**
i.waterstress	3.44	2	0.179	0.0505
i.attractiveness_neighbourhood	0.541	2	0.763	0.00807
i.environmental_neighbourhood	0.574	2	0.750	0.00844

Influence of the opinion on heat stress on obstacles regarding BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
o.finance	0.0170	1	0.896	2.49E-4
o.no_necessity	3.30	1	0.069	0.0485
o.complicated	0.915	1	0.339	0.0135
o.bad_advise	0.00208	1	0.964	3.05E-5
o.more_work	0.185	1	0.668	0.00271
o.damage	0.984	1	0.321	0.0145
o.less_assets	0.00978	1	0.921	1.44E-4
o.nothing	2.82	1	0.093	0.0414

Influence of the opinion on heat stress on needs regarding BGI

Kruskal-Wallis

	χ^2	df	p	ε^2
n.info	0.0313	1	0.860	4.60E-4
n.technical_info	0.0748	1	0.784	0.00110
n.possible	1.67	1	0.196	0.0246
n.funds	1.94	1	0.164	0.0286
n.nothing	**4.72**	**1**	**0.030**	**0.0694**

Influence of the opinion on heat stress on the opinion on green roofs

Pearson, assuming a positive correlation

		h.average
g.need	Pearson's r	0.195
	p-value	0.054
g.policy	**Pearson's r**	**0.439**
	p-value	**< .001**
g.useful	Pearson's r	0.196
	p-value	0.054
g.waterstress_country	**Pearson's r**	**0.309**
	p-value	**0.005**
g.house_value	**Pearson's r**	**0.320**
	p-value	**0.004**
g.heatstress_personal	**Pearson's r**	**0.361**
	p-value	**0.001**
g.profit_neighbourhood	Pearson's r	0.197
	p-value	0.053
g.waterstress_neighbourhood	Pearson's r	0.199
	p-value	0.051

Frames

Kruskal-Wallis

	χ^2	df	p
g.need	1.179	2	0.555
g.policy	0.526	2	0.769
g.useful	3.349	2	0.187
g.waterstress_country	1.804	2	0.406
g.house_value	2.072	2	0.355
g.heatstress_personal	0.341	2	0.843
g.profit_neighbourhood	1.489	2	0.475
g.waterstress_neighbourhood	1.193	2	0.551