Urban heat adaptation

Understanding the emergence of institutional barriers for heat adaptation

Master's Thesis

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MSc Spatial planning

Nijmegen School of Management

Radboud University

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Abstract

This thesis investigates the institutional barriers that impede the mainstreaming of heat stress adaptation and urban heat island mitigation. It focusses on understanding the underlying factors that cause institutional barriers to emerge. In this way it contributes to the theorization of the embeddedness of institutional barriers within their institutional context. As literature indicates that mainstreaming climate change adaptation is especially difficult for small- and mid-sized cities in the Netherlands, due to limited human and financial resources, the focus is on the mid-sized Dutch city of Alkmaar (Hoppe et al., 2014). Through adopting an in-depth approach this research takes a closer look at the difficult work of making the urban environment heat proof. This research found that planning practitioners believe that risk perceptions of citizens are low due to the following physical characteristics of extreme heat: its creeping nature that makes the problem less visible, the fact that it only occurs for a short period of time, and the perception that periods of extreme heat are pleasant, rather than a problem. Urgency to take heat adaptation action is therefore low, as citizens do not exert pressure on decision-makers to do something about it. However, with the adoption of the Deltaplan 2018 by the national government, municipalities are obliged to give heat adaptation some attention. According to this plan, they have to develop local stress tests, conduct risk dialogues and present implementation agendas for not only heat but also for drought, flooding and waterlogging. Yet, this research reveals that climate change adaptation revolves still mainly around water issues, as institutions inert. On the one hand climate change adaptation revolves around a water minded adaptation path as no 'focus event' has taken place yet, and on the other hand because there is a lack of leadership and institutional entrepreneurs that can exert agency to change this. Additionally, the emergence of institutional barriers that impede the mainstreaming of heat adaptation can be explained by governance arrangements, such as the changing Dutch planning law, budget cuts in the municipal budgets by the national government, and the anticipation of municipalities on subsidies from higher levels of government. To conclude, as change of institutions is often slow, heat adaptation can be best linked to implementing water adaptation measures or an enhancement of the attractiveness of the municipality in the spatial domain, i.e. the greening of the city.

Keywords: heat stress, urban heat island, adaptation, mainstreaming, urban planning

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I hope you enjoy reading this thesis as much as I enjoyed writing it.

Lotte Bruinsel
March 2020

"A city exists for the sake of a good life, not for the sake of life only"
- Aristotle

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Introduction

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1.1 Background

In June 2018, the first national heat congress was organized in the Netherlands (Ministry of Infrastructure and Water Management, 2018). Minister of Infrastructure and Water Management Cora van Nieuwenhuizen explained at the congress that in her opinion:

"Heat stress is an underestimated problem. A silent killer, invisible but effective."

While over the last decade planning for climate change adaption has gained more attention, climate change adaptation remains predominantly a water issue (Hoppe, van den Berg & Coenen, 2014). Apart from some frontrunner cities, most municipalities are not taking action to address heat stress. This is surprising, as the heat wave of 2006 accounted for approximately 1000 heat-related deaths in the Netherlands, which placed the Netherlands in 4th place in a list of the worldwide deadliest natural disasters for 2006 (Klok & Kluck, 2018). As such, it demonstrates the catastrophic impact heat extremes can have in the Netherlands. This thesis therefore inquires urban responses to heat stress and the urban heat island (UHI) effect. The urban heat island effect describes the fact that urban areas experience significantly higher temperatures compared to their rural and suburban surroundings, providing urban areas with temperatures that can be up to more than 7 °C hotter compared to rural and suburban areas (Heaviside, Cai & Vardoulakis, 2015). Urban heat islands are the result of the way cities are built and the way humans utilize cities (Kirn, 2018). The heating effect is mainly caused through modifications in land surfaces, by paving natural land surfaces with impervious non-reflective surfaces resulting in less reflection and more storage of heat from solar radiation. In addition, also the release of anthropogenic (human-made) heat sources such as air conditioning and car exhausts enhance the heat effect. As such, neglecting to create and implement measures to adapt to heat stress and mitigate urban heat islands will make cities places where heat extremes are felt most dramatically. The fact that events of extreme heat are likely to occur more often in the future and the continuing growth of the urban population make this even more problematic

(PBL, 2016). As Ulrich Beck asserts, today's society can be perceived as a 'risk society' (Beck, 1992). Increasingly, modern society faces risks that are characterized by their global and invisible character. These risks are foremost characterized as constructs of society, whose impacts cannot always be controlled or calculated (Beck, 2009). In pursuit to prevent, debate and manage these risks, modern society has become a 'risk' society' (Beck, 2006). Risk of catastrophic impacts of heat extremes is therefore a product of the interrelation between occurrences of extreme heat events and policy decisions about whether or not to adapt to the impacts.

1.2 Urban climate change adaptation governance

Over the past two decades, several theorists argued that cities are critical places to prepare for climate change impacts (Bulkeley, 2012; Rosenzweig, Solecki and Slosberg, 2006). The reason for this is twofold. In the first place, because the local variation in climate change impacts require 'place-based' climate adaptation policies. Secondly, local governments are responsible for spatial planning in their municipality or city and thus able to shape and create adaptation measures and set up networks of actors (Uittenbroek, 2016; Bulkeley, 2012). Yet, many Dutch cities have failed to mainstream heat adaptation measures in spatial planning policies (Hoppe et al., 2014, Tennekes, Driessen, van Rijswick & van Bree, 2014). This is particularly discernible when it comes to small- and mid-sized cities, that face the same climate change challenges as large cities, albeit with less available financial and human resources (Hoppe et al., 2014). This makes them rely heavily on their networks for the creation and implementation of climate change adaptation policy. Despite this, heat adaptation is getting increased attention at the national level (Ministry of Infrastructure and Environment, 2017). Thus, a mismatch between local and national climate change adaptation policy is visible. While heat is outlined as one of the key climate change adaptation topics at national level, locally climate change adaptation policy seems to focus predominantly on implementing water related climate change adaptation policies. Therefore, it is interesting to look at the institutional barriers that impede the creation and implementation of heat adaptation policy at the local level. While over the past years an increasing amount of literature on institutional barriers that impede the mainstreaming of climate change adaptation policy has been developed, so far little attention is given to understand why these institutional barriers emerge (Eisenack et al., 2014; Biesbroek, Termeer,

Klostermann & Kabat, 2014; Runhaar, Mees, Wardekker, van der Sluijs & Driessen, 2012). Understanding why barriers emerge will help actors to deal with and possibly overcome them. Therefore, this thesis looks more closely at why these barriers occur, through focusing on the wider and institutional context within which these barriers emerge. The focus is on governance instead of government. This shift is widely cited in the literature, and refers to the replacement of government as the steering actor of socio-economic activities by a model where multiple public and private actors share power and agency (Rhodes, 2012). Next to the traditional regulatory governing methods of the state, new methods such as incentives, voluntary measures and collaboration between actors are introduced. However, the shift to governance provides more complexity, as the inter-relationship between multiple public and private actors is a process with conflicting interests, tensions and contradictions. Through investigating heat adaptation policy in Alkmaar, this thesis aims to draw focus to the emergence of institutional barriers that impede the mainstreaming of local heat adaptation and urban heat island mitigation policy in a Dutch mid-sized city.

1.3 Research perspective

1.3.1 Research scope

The scope of this research is restricted to the subject of heat stress adaptation and urban heat island mitigation, which will for the enhancement of the readability of this thesis further be described as heat adaptation. Other climate change impacts (cloud bursting, flooding and drought) will therefore be excluded from the scope of this research. Policy for heat adaptation covers several policy domains, the focus of this research is however solely on the policy field of spatial planning. According to Füssel (2007) two types of adaptation can be distinguished from one another: autonomous and planned adaptation. Autonomous adaptation refers to taking unconscious adaptation actions, which can for instance be triggered by ecological changes in natural systems (e.g. installing air-conditioning) (Malik, Qin & Smith, 2010). Planned adaptation, on the other hand, is purposefully planned, and policy decisions are made under the awareness that climatic conditions are changing or are about to change. The latter type of adaptation will be given attention to in this research. Empirical data is gathered from a Dutch case, consisting of a mid-sized city. The scope of the respondents includes actors that influence, contribute, make or implement spatial planning policy.

1.3.2 Research aim

The thesis aims to enrich our empirical knowledge about the emergence of institutional barriers that impede the mainstreaming of heat adaptation in Dutch mid-sized cities. As an exemplary case for a mid-sized city, Alkmaar is used. The main goal is to build theory that explains factors that influence the emergence of institutional barriers for heat adaptation. In addition, this research aims to produce findings that are of practical use for local and national officials. By establishing the main institutional barriers to heat adaptation, and theorizing why they emerge, officials could be better equipped to deal with those barriers.

1.3.3 Research questions

The following central question is formulated:

How do institutional barriers emerge that impede the mainstreaming of heat stress adaptation and urban heat island mitigation in a mid-sized city in the Netherlands?

In order to answer the central question the following sub-questions need to be answered first:

- **Theoretical questions: 1)** Which institutional barriers that impede the mainstreaming of climate change adaptation can be derived from the academic literature? **2)** What explanations for the emergence of institutional barriers that impede the mainstreaming of heat stress adaptation and urban heat island mitigation can be derived from the academic literature?

- **Empirical questions: 3)** Which institutional barriers that impede the mainstreaming of heat stress adaptation and urban heat islands mitigation can be identified in Alkmaar? **4)** How are the identified institutional barriers that impede the mainstreaming of heat stress adaptation and urban heat islands mitigation in Alkmaar interdependent from each other? **5)** Which factors explain the emergence of these institutional barriers?

1.4 Societal and scientific relevance

1.4.1 Societal relevance

The societal relevance of this thesis is based on the assumption that planning should anticipate on future problems that undermine the quality of life, and that the decisions planners make today can affect the lives and health of the current generation, but also of the next generations. The impacts of heat extremes, that increase through the urban heat island effect, can lead to health risks, such as heat induced illness and mortality (KNMI, 2015; Klok & Kluck, 2018). Simultaneously, heat extremes worsen thermal discomfort indoors and outdoors, affecting the liveability of a city. Forecasts of the Royal Dutch Meteorological institute (2015) show that, in the future, climate change will result in more frequent and longer periods of extreme heat. In addition, it is expected that in the following years the urban population in Dutch cities will grow (PBL, 2016). Against this backdrop, if Dutch cities continue to neglect the development of policy for heat adaptation, a hot future is waiting. In this future, heat extremes can result in inequalities and have deep societal impacts. After all, not everyone has the same adaptive capacity to adapt to heat extremes. Elderly people (65+) for instance, have more difficulty with adjusting their bodies to higher temperatures and are more sensitive for heat induced mortality than the rest of the population. Similarly, people with less financial resources may not have the resources to buy cooling technologies, which makes them more vulnerable to heat extremes. Therefore, policy for heat adaptation should not be developed in isolation but has to incorporate socio-economic trends and the spatial distribution of vulnerable people. As I stressed the importance of developing and implementing heat adaptation policy above, the findings of this research can help local public officials to better understand which barriers need to be overcome to implement policy to reduce heat stress and urban heat islands. Additionally, the findings will provide a deeper understanding of the influence of the institutional context within which these barriers emerge in. This will give policy officials at the national level, that are engaged with steering municipalities to accelerate the implementation of heat adaptation measures, better insight in why certain heat adaptation strategies are chosen and what impedes this acceleration process. Because of these reasons it contributes knowledge to the research field that aims to limit the impacts of heats stress and urban heat islands on society.

1.4.2 Scientific relevance

Recently, scientific literature has included questions related to the role of social factors and conditions in limiting our capability to adapt proactively to future environmental changes (Biesbroek et al., 2014). These factors and conditions are often labelled as 'barriers to adaptation' (Biesbroek, 2014). So far, most studies have focused on identifying institutional barriers that impede the policy creation and implementation of climate change adaptation measures, rather than explaining how these barriers emerge and how they can be overcome (Biesbroek et al., 2014; Eisenack et al., 2014; Bisaro, Roggero & Villamayor-Tomas, 2018). Runhaar, Mees, Wardekker, Van der Sluijs & Driessen (2012) for instance, identified which implementation and problem recognition barriers and stimuli for flooding and heat stress adaptation were presented in Dutch cities. Moser and Ekstrom (2010) linked possible institutional barriers for climate change adaptation to the different phases of the policy process. In a recent article, Runhaar, Wilk, Persson, Uittenbroek & Wamsler (2018) provided a generic framework of institutional barriers that impede climate change mainstreaming, through identifying six main categories: timing, characterization of problem at hand, resources, cognitive factors, organizational factors and political factors. While there are various studies identifying generic institutional barriers, the factors that cause these barriers to emerge and sustain are poorly understood (Eisenack et al., 2014). Simultaneously, the case study literature focusing on climate change adaptation barriers underexposes heat stress barriers compared to barriers for adapting to water issues. This research attempts to fill these gaps, through conducting a more in-depth analysis, that attempts to understand how institutional barriers that impede the mainstreaming of heat adaptation emerge. In addition, previous research identified problem recognition barriers, such as a lack of risk perception, awareness and urgency, as main reasons why the implementation of heat adaptation is lacking (Runhaar et al., 2012; Tennekes et al., 2014). By exploring the development of risk perceptions, this research contributes to the existing body of literature that draws on Urlich Beck's assertion that risk is a societal construct.

1.5 Thesis outline

In this first chapter the broad context of this research was outlined. I explained why it is necessary that Dutch cities have to adapt to heat extremes and mitigate urban heat islands. Subsequently, I argued that this remains a challenge for many cities, as institutional barriers impede the mainstreaming of heat adaptation policies. The following chapter lays out the phenomenon of the urban heat island, it presents some background information about the bio-physical process of urban heat islands, their possible impacts, the measures that can be taken to adapt and mitigate, and some policy examples of cities that are frontrunners in implementing policy for heat adaptation. Chapter 3 provides the theoretical framework that will outline the core concepts of this research drawing on the scientific literature of climate change adaptation, governance, risk and hazard, multi-level governance and new institutionalism. This chapter will answer my first two sub-questions. In chapter 4, the methodological choices that are made in this thesis are discussed. The case study of this research is discussed in greater detail in chapter 5. Subsequently, in chapter 6 the empirical findings will be presented and discussed. The final chapter will answer the research questions, discuss the theoretical contributions of the findings, and will reflect on the research process, after which recommendations for further scientific research and recommendations for planning practices will be addressed.

The urban heat island

The phenomenon, its impacts and how to cope with it

2.1 Introduction: the urban heat island

The urban heat island phenomenon has been the subject of a large body of research, and describes the significantly higher air temperatures within urban areas compared to their rural and suburban surroundings (Heaviside et al., 2015; Zhao, Lee, Smith, & Oleson, 2014). It is experienced worldwide and is present in cities of all climatic regions (Stewart & Oke, 2012). The intensity of urban heat islands is most strongly experienced after sunset, when heat is re-radiated from urban structures, and in weather conditions with low wind, reduced cloud cover and under high pressure (anticyclonic) periods (Soltani & Sharifi, 2017; Gunawardena, Wells, & Kershaw, 2017). Increased temperatures during hot weather can result in a set of problematic impacts, such as heat induced illness and mortality, air pollution, increased use of air-conditioner, and ground-level ozone (Kirn, 2018). Whereas public policy is mainly concerned with these negative impacts emanating of urban heat islands during summer time, in colder weather urban heat islands can also bring positive effects such as a decrease in the use of heating systems and an increase in the number of people exercising outside (Akbari & Kolokotsa, 2016; Boer et al., 2006; Kleerekoper, 2016). In this chapter I will explain the urban heat island effect in greater detail. The first section explains the underlying processes that contribute to the creation of the urban heat island. The subsequent section provides a concise overview of measures that can be used to reduce the urban heat island effect and adapt to heat stress. I will end this chapter through discussing the policies of some cities at the forefront of developing and implementing policies to adapt to heat.

2.2 Why is it hotter in the city?

2.2.1 Urban scale levels

The creation of urban heat islands is embedded in the interaction of different surface elements with adjacent atmospheric layers (Arnfield, 2003). In order to understand this process, the level of scale is an important topic of discussion. According to Soltani and Sharifi (2017) three different scales can be delineated in which urban heat islands can be present: the urban surface layer, the urban canopy layer and the urban boundary layer. The urban surface layer (USL) consists of a patchwork of different surface materials, e.g. green space, paved areas, and asphalt (figure 2.1) (Arnfield, 2003; Soltani & Sharifi, 2017). Each element has a different ability to absorb or reflect solar radiation. The air temperature is impacted by the heat that is released from land surfaces and is mixed through convection (Soltani & Sharifi, 2017). The urban canopy layer (UCL) illustrates the part of atmosphere between the surface cover and roof level (figure 2. 1) (Arnfield, 2003; Gunawardena et al., 2017). The climate in this layer is influenced by the geometry of buildings, orientation of open spaces, sky view factor, aspect ratio (height to width), land cover materials, and wind flow (Soltani & Sharifi, 2017). Heat in this layer has a fundamental impact on the human comfort and health in cities (Gunawardena et al., 2017). The urban boundary level (UBL) is the air layer above roof-level and treetop level that reaches to the point where the atmosphere is no longer affected by urban landscapes (van Hove et al., 2011). This layer is rather homogenous and the temperature is influenced through released heat at the urban surface layer that blends with the urban canopy layer and above via air turbulence (Soltani & Sharifi, 2017; Arnfield, 2003). Changing parameters within the UCL will simultaneously have their implications for the UBL as a whole (Kleerekoper, 2016).

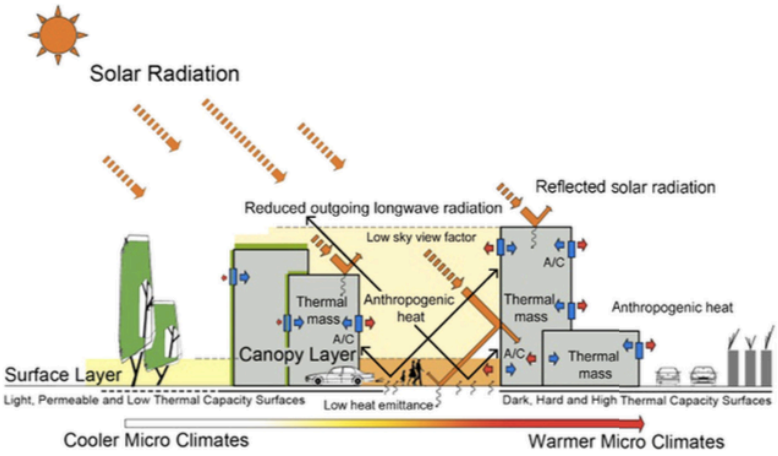

Figure 2.1. The creation of the urban heat island at microscale (Soltani & Sharifi, 2017, p. 531)

2.2.2. Factors contributing to urban heat islands

There are various factors embedded in the complex interaction between the urban climate and the urban built environment that cause the creation of the urban heat island (Taha, 1997). Literature posits that the UHI is an outcome of how cities are built and utilized (Kirn, 2018). Modifications in land surfaces through ongoing urbanization have resulted in changes in vertical fluxes of heat, mass and momentum, which have an effect on the regional hydro-climatology in cities (Wolters, Bessembinder & Brandsma, 2014; Ningrum, 2018; Imran, Kala, Ng & Muthukumaran, 2018). The urban energy balance equation outlines the role played by surface properties and anthropogenic heat in near-surface climates, which will help to better understand the physical process substitute to the development of the UHI (Taha, 1997). The urban surface energy balance can be written as follows (Wicki, Parlow & Feigenwinter, 2018; Mirzaei & Haghighat, 2010):

$$Q^* + Q_f = Q_H + Q_E + \Delta Q_S + \Delta Q_A$$

With:

Q^* = Net radiation; (sum of all short- and longwave radiation fluxes)
Q_f = Anthropogenic heat; (heat release by combustion, traffic and human metabolism)
Q_H = Turbulent sensible heat flux density; (temperature)
Q_E = Turbulent latent heat flux density; (evaporation)
ΔQ_S = Net heat storage; (all energy storage mechanisms within elements of the control volume e.g. air, trees, building fabrics, soil)
ΔQ_A = Net heat advection. (The transport of sensible or latent heat by a moving fluid, e.g. air)

(Mirzaei & Haghighat, 2010).

Due to the fact that the parameters in the above cited equation are characteristics and functions of city locations, the energy balance changes inside a city when these parameters change (Mirzaei & Haghighat, 2010). Urban heat islands are a result of two predominant factors: anthropogenic (human-made) heat sources (Q_f) and heat from solar radiation (Memon, Leung & Chunho, 2008). Anthropogenic heat sources, such as automobiles, air-conditioners and other power plants, is the kind of heat that enters the environment instantly and directly.

Heat from solar radiation is often articulated as net radiation (Q*), this is the difference between all incoming and all outgoing short- and long-wave radiation. In other words, all the incoming energy which is not reflected influences the climate (van der Harst, 2011). Nevertheless, a large part of solar radiation is absorbed and stored in urban built structures and re-radiated in the form of heat (Memon et al., 2008). Thus, the part of solar radiation that heats up the environment directly is little. During the day one of the factors that contributes to the creation of UHIs is the low level of albedo, which is the ratio of reflected solar radiation (van der Harst, 2011). An albedo of 0 means no reflection and 1 indicates that all incoming radiation is reflected. In general, surfaces with dark colours tend to have a low albedo and surfaces with light colours a high albedo (Kirn, 2018; Memon et al., 2008). The dark surfaces that cities mostly consist of, thus, contribute to the creation of the UHI. However, it has to be noted that there also exist dark surfaces with a high albedo, as certain dark materials contain pigments that better reflect infrared radiation (van der Harst, 2011). In addition, most of the surface materials that are utilized in cities are impervious (e.g. paved surfaces) and are made in such a way that storm water quickly drains. As vaporization extracts heat from the surface, the outcome of having less vaporization, due to dry surfaces, is that the same solar radiation is retained as additional heat (Kirn, 2018; Zhao, et al., 2014; Wolters et al., 2014). Furthermore, due to the geometry, spacing and orientation of buildings, reflected short-wave radiation is often caught by another surface (e.g. wall of a building), where it is absorbed rather than escaping into the atmosphere (van Hove et al., 2011). This especially appears within an urban canyon. On a similar note, during the night the geometry of buildings can create an accumulation heat (van Hove et al., 2011). The cooling of air at night is predominantly caused through the release of longwave radiation by the surface (Wolters et al., 2014). However, this process is less efficient in cities in comparison to rural areas, as a part of the emitted radiation of the surface is absorbed or reflected through buildings and other vertical surfaces and therefore does not disappear in the sky. This effect increases when buildings are higher and are built closer together, as the sky view factor (the part of the sky which is visible from the ground up) decreases resulting in a higher absorption and storage of heat in the built structures (Memon et al., 2008). Another factor that contributes to the creation of UHIs at night is the urban surface. The surface in cities mostly consists of materials such as stone, concrete, tarmac and other materials with a high thermal capacity. These kinds of materials can absorb and store more solar radiation that is received during the day in comparison to materials used in rural areas, such as vegetation and soil (Zhao et al., 2014). After sunset, the energy that is stored during daytime will be released to the environment through longwave radiations (Memon et al., 2008; Aflaki et al., 2017).

A further contribution to the development of UHIs, especially at night, is air pollution in the urban atmosphere (KNMI, 2010). This contributes to the accumulation of heat, through absorbing and reflecting outgoing infrared radiation and decreasing incoming radiation. Simultaneously, the UHI effect itself accelerates the formation of air pollution, as due to higher temperatures the creation of smog through photochemical reactions of pollutants in the air intensifies (Phelan et al., 2015). Finally, heat advection influences the development of an urban heat island (Basset, Cai, Chapman, Heaviside & Thornes, 2017). Urban heat advection can be described as "the horizontal transport of heat originating from urban areas" (Basset et al, 2017, p.183). Heat is advected differently in each of the different layers that are outlined in the previous section. Inside of the urban canopy-layer UHI, the airflow advects heat through networks of street canyons. The urban boundary layer UHI, on the other hand, receives its heat from the air underneath. Warm air forms a thermal dome, which can be advected horizontally by airflow. Figure 2.2. illustrates how the urban heat island effect works on meso- and microscale.

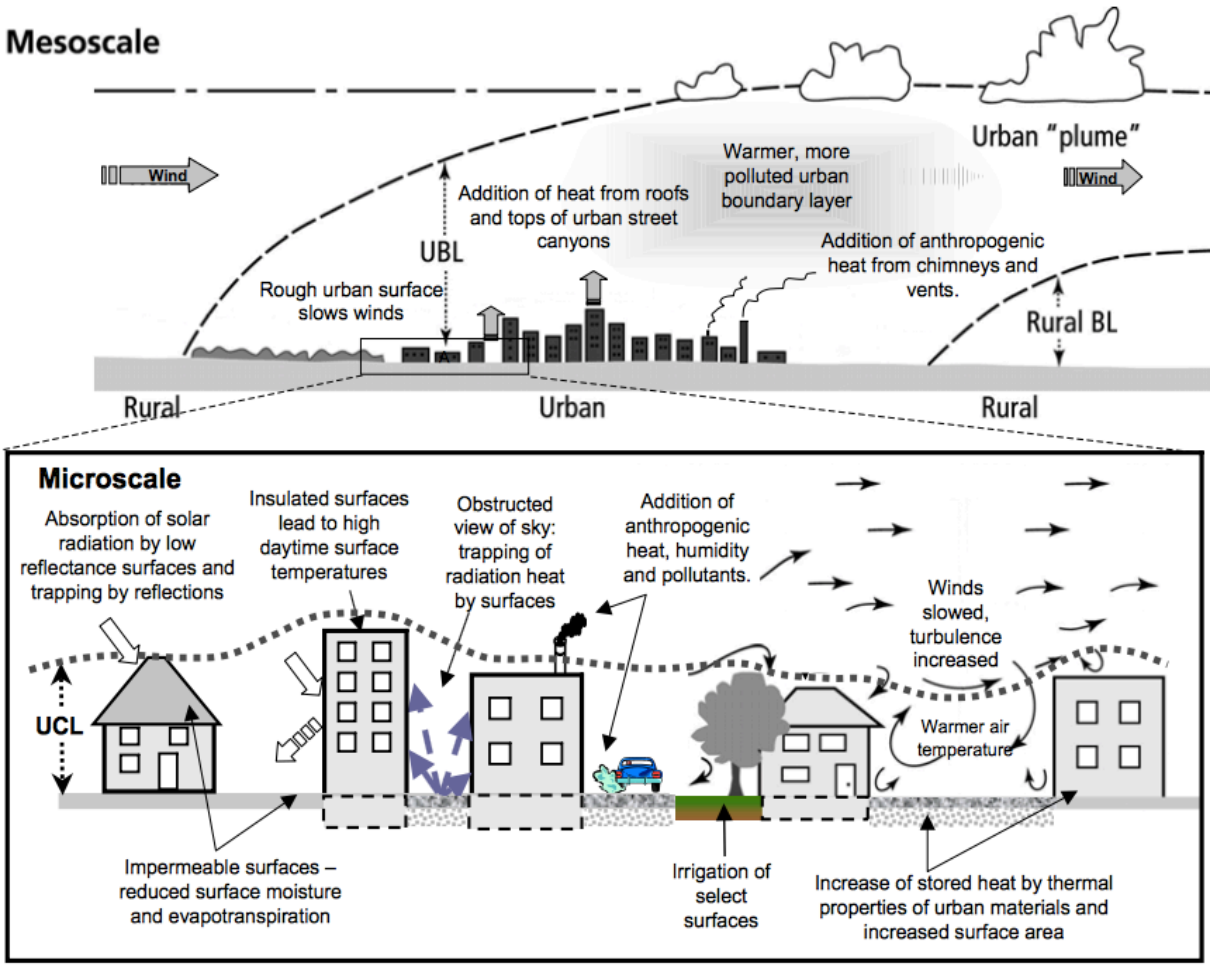

Figure 2.2. Creation of the urban heat island at micro- and mesoscale (Voogt, n.d.)

2.3 Why adapt to extreme heat and reduce the urban heat island effect?

This section discusses the impacts of increasing temperatures in cities. With climate scenarios showing an increase in the mean temperature and number of tropical days in the Netherlands, combined with ongoing urbanization by increasing inner-city developments, which is likely to increase the amount of urban heat islands, the negative impacts outlined below will no longer be a distant threat but will become present reality (KNMI, 2015; Claassens & Koomen, 2017). Due to rising temperatures and the urban heat island effect heat stress is likely to appear more often in the future (Klok & Kluck, 2018). This section illustrates which foremost consequences will occur when people neglect to implement measures to adapt their environment to higher temperatures.

2.3.1 Human health and comfort

Exposure to heat stress can result in health and comfort impacts. The heat wave of 2003 has showed the deathly impacts of urban heat stress. In the Netherlands, between 1400 and 2000 people suffered from heat related deaths. Huynen, Martens, Schram, Weijenberg and Kunst (2001) point to the correlation between temperature and mortality in the Netherlands. In their article they showed an increase of mortality by 12% on heat wave days, which means 40 more deaths per day (Klok & Kluck, 2018). Besides mortality, heat stress can result in heat induced illnesses such as: heat exhaustion, heat stroke, heat cramps and heat rash (Howe & Boden, 2007). It further contributes to a decrease in sleep quality and labour productivity (Klok & Kluck, 2018). During hot nights people sleep shorter and wake up more often, causing negative effects such as tiredness and a higher susceptibility to infections (Daanen, Arts & Janssen, 2010). Heat extremes also influence labour productivity negatively, through reducing peoples work pace and increasing the number of mistakes they make at work (Hancock, Ross & Szalma, 2007). The vulnerability of people to the impacts of heat stress varies per individual and is influenced by demography and socioeconomic status, as well as the location where the individual lives (Phelan et al., 2015).

The following groups can be identified as being more vulnerable to heat stress than others:

- Infants, elderly above 65 years, people who are ill, take medicines, alcohol or drugs, are overweight, and pregnant women;
- Patients suffering from cardiovascular diseases and subject to the additional risk of heart failure;
- People who are unaware of the problems associated with extreme heat and do not adapt their clothing or do not take extra measures;
- People who are unable to move from overheated places (Kleerekoper, 2016, p. 55).

2.3.2 Air pollution

Heat and air pollution have a reciprocal relationship, as they intensify each other (Li et al., 2018). High temperatures increase the creation of summer smog (ozone at street level), as they intensify the photochemical reaction of pollutants in the air (Phelan et al., 2015; Kleerekoper, 2016). Besides, during periods of hot weather, there usually is little wind, resulting in air pollution that cannot be dispersed or reduced in these periods (Kleerekoper, 2016). Research has observed that for Los Angeles every 1°C of increase, with a temperature above 22°C, shows a smog increase by 5% (Phelan et al., 2015). It is highlighted that this is problematic, as there are negative impacts emanating from air pollution, such as heightened incidence of allergic respiratory disease such as asthma resulting from increased air pollutants (Phelan et al., 2015).

2.3.3 Energy consumption

The building stock in the Netherlands is not built for periods of extreme heat (Kleerekoper, 2016). Several commonly used building characteristics in the Netherlands increase the chance of indoor overheating during periods of warm weather, such as poor protection against solar radiation, large surfaces of windows and no passive cooling systems. Therefore, it is presumable that higher temperatures are likely to increase the use of mechanical cooling systems such as air-conditioning, raising the release of CO_2 emissions (Kleerekoper, Van Esch, Salcedo, 2012; Kirn, 2018; Akbari & Kolokotsa, 2016). Research has shown that modern office buildings with large glass surfaces or windows need to switch on their air conditioning system already when the temperature outdoor reaches 12-15°C (Keerekoper, 2016). An added effect of this is that the heat exhausted by the air conditioners warms up the city even more, starting

a vicious cycle of sorts. The increase in the use of mechanical cooling systems during hot weather, simultaneously, increases the peak electricity demand (Akbari & Kolokotsa, 2016).

2.3.4 Organic life

Higher temperatures can produce changes in flora and fauna that increase the spreading of viruses and bacteria (Kleerekoper, 2016). This is due to the fact that pathogenic micro-organisms have an optimum temperature to be active, which is generally during higher ambient temperatures (Daanen et al., 2010). Rahola, Oppen & Mulder (2009) argue that more bacterial life as result of higher temperatures might result in increases of food infections such as salmonella. Whereas they argue that this is not a significant problem yet, they do expect that in the future this will become a more severe problem. Besides, the so called vectors (e.g. mosquitos, ticks, sand flies and midges) that transfer these micro-organisms, prefer a climate that is warm and humid (Daanen et al., 2010). Van Lier, Rahamat-Langendoen & van Vliet (2006) present in their overview of the effects of global warming on vector related diseases, that in the Netherlands climate change may lead to an increase in Lyme disease. Rising temperatures also result in a greater number of insects occurring earlier in the year (Rahola et al., 2009). This and multiplying species, and abundant vegetation can create nuisance as it can cause an increase in allergies (Kleerekoper, 2016; Rahola et al., 2009). However, rising temperature can also provide positive impacts, such as the increase of yields from agricultural land and extension of the growing season (Kleerekoper, 2016). The rising temperatures can introduce new agricultural possibilities, as more areas will be suitable for heat-tolerant crops such as wine.

2.4 Adapting to extreme heat

So far, this chapter has attempted to explain the underlying factors causing the emergence of urban heat islands. Particularly, the implementation of measures in the built environment can enhance the reduction of the urban heat island. However, behavioural changes are also required to fully adapt to heat stress. The following section of this chapter outlines the measures that can be taken in the built environment to adapt to periods of extreme heat.

2.4.1 Heat adaptation measures in the built environment

The preceding section showed that various elements of the built structure contribute to the increase in surface temperature in the urban environment. Thus, in order to combat urban heat islands, modifications in the urban structure through spatial planning are needed (Ningrum, 2018). The scientific literature has inquired a broad array of possible measures, which can be used to reduce the UHI. Some of those strategies can be implemented only during the design and planning stage, whereas others are also possible to implement after the design and planning stages. Five categories of measures can be distinguished: reducing direct heating, greening, blue infrastructure, ventilation, and radiation.

Reducing direct heating can reduce the exposure of urban areas to extreme heat (Klok & Kluck, 2018). Strategies to reduce direct heating are decreasing the number of cars and air conditioners.

Green and Blue strategies can be used to mitigate the effect of urban heat islands (Gunawardena et al., 2017). Greening strategies such as green spaces and vegetation enable the cooling process through providing shade and evaporative cooling. Green spaces come in various forms such as parks, streets, trees and verges, urban forests, private gardens, fringes of transport corridors, and vegetated roofs and facades (Gunawardena et al., 2017). Steeneveld, Koopmas, Heusinkveld, van Hove and Holtslag (2011) inquired the relationship between the UHI and green cover fraction in Dutch cities and villages, and they assert that the UHI will decrease with an increase of vegetation cover, especially during hot days. Greening policies are considered to be a key instrument in the reduction of UHIs, not only because of their effectiveness but also due to the relatively low cost and high acceptance among citizens, furthermore their implementation is easy and can be done fast (Gunawardena et al, 2017; Kleerekoper, 2016). As street trees are considered the most effective greening instrument to reduce the UHI effect, forerunner cities, such as New York City, have implemented polices that concentrate on the increase of the number of trees and their heterogeneity to assure resistance to vegetal diseases (Kleerekloper, 2016; NYC, 2017; Rosenzweig et al., 2006). Blue strategies can also be used to mitigate heat. However, the use of water is rather contested as it on the one hand can cool through evaporation, but on the other hand also can warm the city as water bodies, when stagnant, can store heat (Albers et al., 2015). Generally, water applications have the largest cooling effect if they contain a large surface, or if the water is flowing or dispersed (Kleerekoper, 2016).

Ventilation and radiance strategies are often achieved through the implementation of hard built up, engineered, and physical structures. For instance, the urban geometry can influence the UHI effect, as it can control the wind flow, the radiation incident on materials that can store heat, the amount of shading and the containment of radiation by multiple reflections between buildings and street surface (Kleerekoper, 2016; Chung & Park, 2016). The Aspect Ratio (AR) which is the ratio between the height of buildings (H) and the distance between buildings (W), influences the incoming radiation, wind speeds, Sky-View-Factor (SVF) and albedo (Al-sallal & Al-rais, 2012; Van der Harst, 2011). High aspect ratios can therefore reduce overheating by solar radiation (Kleerekoper, 2016). This strategy is ambivalent with the built environment of Mediterranean cities that often contain narrow streets, which create shade. Nevertheless, this also has negative effects, such as reduced air flow, higher solar reflections, the trapping of anthropogenic heat, as well as lower sky view factors. The outdoor thermal comfort is also influenced by the morphology of building blocks. In the Netherlands, literature shows that using closed building blocks (courtyard) will provide the highest thermal comfort conditions (Taleghani, Kleerekoper, Tenpierk & Dobbelsteen, 2015). Moreover, the orientation of streets also influences the radiation load and wind speed. Orienting buildings in such a way that wind can be used as cooling factor, is an interesting design principle for warm countries. In the Netherlands, however, using wind as a cooling measure is contentious, because stimulating wind for ventilation in summer can cause highly uncomfortable or even dangerous situations in winter time. Because of this, the orientation of streets will bring some design challenges, especially when taking both solar and wind orientation into account. Due to the exchange of air between the canopy and boundary layer, ventilation can also be provided through mixing high and low buildings. Another radiance measure is 'cool roofs' which are roofs that are attributed with retroreflective materials with high thermal emittance, such as cool-coloured or white roofing materials available for coating, tiles, painted metal (Chung & Park, 2016; Akbari & Kolokotsa, 2016). Although cool roofs and green roofs both decrease the sensible heat flux, they differ from each other in the mechanism they use (Imran et al., 2018). Whereas green roofs utilize measures that create evapotranspiration and shade to decrease the sensible heat flux, cool roofs use measures to change the thermal property of surface materials (Imran et al., 2018; Kleerekoper, 2016). The higher albedo of cool roofs results in more reflection of incoming solar radiation, providing a lower net radiation and subsequently reducing the sensible heat flux (Imran et al., 2018). However, the literature highlights that some materials used in cool roofs can have ambiguous effects, such as a reduction of heat gain during the winter (Chung & Park,

2016). For this reason, the suitability of cool roofs as a strategy for reducing UHIs dependents on the city's climate. It can be argued that the use of certain cool roof materials is not desirable in cold or humid climates. 'Cool pavement' is another mitigation strategy for reducing UHIs. Just like cool roofs, cool pavement can decrease the absorption of solar radiation, trough using materials that are solar-reflective (Kirn, 2018; Akbari & Kolokosta, 2016). Various technologies can be used to create cool pavements. Akabri & Kolokotsa (2016) identify the following technologies: "cool coatings, chip seals, whitetopping (use of a thin layer of light-coloured concrete on asphalt), coloured concrete, light-coloured concrete, grasscrete (cellular grassed paving in concrete or plastic) and permeable pavements" (Akbari & Kolokotsa, 2016, p. 837). The major advance of the implementation of cool roofs and cool pavement is that it is the cheapest way to reduce the urban heat island effect (Kleerekoper, 2016). Although other measures might have a higher effect on reducing UHIs, cool roofs and cool pavements are cheaper and technically more feasible, allowing the coverage of bigger surface, which leads to better results.

Examples of green and blue strategies

Figure 2.3

Urban forest (park)

A park or urban forest is a green area within an urban environment (Kleerekoper, 2016). They can be built to lower air and surface temperatures and create a Park Cool Island (PCI). The way the park is designed plays a role on the effect of a PCI. For instance, a good design to create a PCI involves many trees that provide shade.

Figure 2.4

Street trees

Street trees offer shade, which can enhance outdoor comfort, and when put along the side of the front of houses indoor comfort as well (Kluck et al., 2017). The surface itself radiates less heat to the environment when the sun is prevented from warming up the surface. Besides shading, trees can also cool the environment as they reflect part of the solar radiation and cool the air through evaporation.

Figure 2.5

Public and private gardens

Areas used for public or private gardens have a positive contribution to heat adaptation comparted to hardened surfaces. As trees can provide shade for humans, greenery lower to the surface shades the surface preventing it to heat up. Moreover, planted soil has a higher capacity of water infiltration and can cool more by evaporation (Kluck et al., 2017).

Figure 2.6

Green roofs

Green roofs are covered with greenery, either completely or partially, on top of a waterproof membrane (Kirn, 2018). In addition, some roofs have layers of root barrier, as well as drainage and irrigation systems. Many studies have suggested green roofs as a strategy for the mitigation of UHIs and adaptation of storm-water, as they absorb storm-water and provide lower air temperatures, reducing the demand of energy for cooling buildings (Susca, Gaffin, & Dell'Osso, 2011; Mees & Driessen, 2011). In addition to providing mitigation and adaptation strategies, green roofs also create other advantages, such as an increase in air quality, biodiversity and urban amenities.

Figure 2.7

Fountains and water features

Evaporation from fountains or water features has a cooling effect on the surrounding environment. Implementing fountains in high use places are recognized as a good cost-effective option to adapt to heat (Kleerekoper, 2016).

Examples of ventilation and radiance strategies

Figure 2.8

Grassland

During the night the high sky view factor of open fields enables heat to escape quickly through long-wave radiation (Kleerekoper, 2016).

Figure 2.9

'Cool roofs'

'Cool roofs' are roofs that are attributed with retroreflective materials with high thermal emittance, such as cool-coloured or white roofing materials available for coating, tiles, painted metal (Chung & Park, 2016; Akbari & Kolokotsa, 2016).

Figure 2.10

'Cool pavement'

'Cool pavement' is another mitigation strategy for reducing UHIs. Just like cool roofs, cool pavement can decrease the absorption of solar radiation, trough using materials that are solar reflective (Kirn, 2018; Akbari & Kolokosta, 2016). Various technologies can be used to create 'cool pavements'. Akabri & Kolokotsa (2016) identify the following technologies: "cool coatings, chip seals, whitetopping (use of a thin layer of light-coloured concrete on asphalt), coloured concrete, light-coloured concrete, grasscrete (cellular grassed paving in concrete or plastic) and permeable pavements" (Akbari & Kolokotsa, 2016, p. 837).

2.5 Examples from practice

By focusing on the instruments other cities have employed to reduce the urban heat island effect and adapt to extreme heat this section shows that although cities have the same objective, the instruments they use to achieve this objective vary. The policy instruments that New York, London, Toronto and Arnhem have adopted are reviewed here. These cities contain either a temperate maritime climate or a temperate continental climate, which makes their technical instruments suitable examples for the Dutch context (Döpp et al., 2011).

2.5.1 New York City

During the last decade, New York City has taken multiple measures to reduce the urban heat island effect (NYC, 2018). In 2007, the strategic plan of New York City called *PlaNYC 2030* proposed zoning regulations that require commercial and community facility parking lots over 12,000 square feet to provide within each lot a fixed number

Figure 2.11 Greenwich village, NYC. Sand-colored pavements reflect more of the sun's radiation and adding trees to sidewalks provides shade during hot days (Made by author, 2018)

of canopy trees in planting islands. Besides that, the plan also presented the development of the *Million Trees NYC* program, which aimed to plant one million trees on private residential, institutional, and vacant land properties, by 2017. Subsequently, in 2008 the City of New York and New York State passed legislation to stimulate the implementation of green roofs as substitute for dark roofs in the city (The City of New York, 2017). A one-year tax relief of $4.50 per square foot on green roofs was installed. Furthermore, in 2009 the NYC *CoolRoofs* program was released, to incentivize the owners of buildings to cool down their roofs by painting them with white reflective coating (NYC, 2017). Moreover, the installation of these cool roofs is free for affordable housing and supportive housing organizations, non-profits, select cooperatively-owned housing, and select organizations providing public, cultural, and/or community services (City of New York, 2017). Coinciding with this was the new requirement of the New York Building code that most new buildings had to have 75 percent of the roof surface covered with reflective white coating or to be ENERGY Star rated as highly reflective (NYC CoolRoofs, n.d.). In 2017, New York City adopted *The Cool neighbourhoods NYC* programme. This programme has a specific focus on the climate adaptation of heat stress and presents a comprehensive strategy to reduce the urban heat island effect and to cope with circumstances of extreme heat in New York City. Besides the instruments mentioned above, the programme discusses the implementation of light-coloured pavement and green infrastructure.

2.5.2 London

In 2016 *The London plan* was instituted, which addresses the spatial development strategy for London. Included is a guiding framework for adapting to heat stress and for the reduction of the urban heat island effect. The plan requires developers of major real estate projects to follow the cooling hierarchy (outlined below) to reduce potential overheating and reliance on air condition systems in buildings (London plan, 2016, p. 195):

1. Minimize internal heat generation through energy-efficient design;
2. Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls;
3. Manage the heat within the building through exposed internal thermal mass and high ceilings;
4. Passive ventilation;
5. Mechanical ventilation;
6. Active cooling systems (ensuring they are the lowest carbon options).

The plan articulates that developers should consider the integration of green infrastructure, such as green roofs, green walls, tree planting and soft landscaping in their development proposals. Besides this, they should maximize opportunities to orientate buildings and streets in a way which minimizes summer solar gain, while maximizing winter solar gain as well. In accordance with the *London plan* the *London environment strategy* was developed in 2018. Heat risk was considered as one of the key environmental challenges that London faces. The strategy presented multiple policies and proposals, for example the creation of a communication protocol for the citizens of London for periods of extreme heat and cold, and also the development of *Energy for Londoners energy efficiency* programmes in order to minimize overheating in existing buildings. *The Energy for Londoners* programme effectuates the promotion of measures to mitigate heat, for example solar shading, cool and green roofs, as well as tree shading both in and around houses. Subsequently, the strategy considers multiple measures regarding the implementation of greenery. For instance, subsidies for creating green spaces, *greenness index*, investment in various small and medium scale greening projects in London and a *Greener City Fund*. The latter is used to invest in strategically important green infrastructure projects. In July 2019, the city has launched itself as the world first *National Park City*, with the objective to make London over 50% green and blue (London National Park City, n.d.).

2.5.3 Toronto

The climate adaptation program *Ahead of the Storm: Preparing Toronto for Climate Change* was released in 2008. Two programmes to reduce the vulnerability of people to extreme heat were included, *Heat Alert System* and *Hot Weather Response plan.* In 2009, the City Council of Toronto adopted the *Toronto Green Standard*, which sets building performance standards for new constructions. Those standards are meant as guidelines to promote sustainable site and building design strategies (Wang, Berardi & Akbari, 2016; City of Toronto, n.d.). The standard is divided into four different tiers, where only the standards set in the first tier are mandatory and the standards in tier 2-4 are voluntarily (City of Toronto, n.d.). Mandatory measures for reducing the urban heat island effect around buildings are based on two key pillars: the provision of green or cool roofs, and the use of high-albedo paving materials, open grid pavement, shading from tree canopy, shading from architectural structures that are vegetated or have an initial solar reflectance of at least 0.33 at installation or a Solar Reflectance Index (SRI) of 29, and shade from structures with energy generation in non-roof hardscape. The percentage of non-roof hardscape or roof that is required to implement these strategies differs between

residential and non-residential buildings and between low rise residential and mid to high rise residential buildings. Besides, the *Design Guidelines for Greening Surface Parking Lots* enforces the policy goals for tree canopy cover and water efficiency (Wang et al., 2016). Simultaneously, due to targets for tree canopy, the municipality commits itself to increase the amount of urban forest.

2.5.4 Arnhem

Arnhem is one of the first Dutch cities that has developed a policy for heat stress adaptation (Atlas Natuurlijk Kapitaal, n.d.). In 2012, the city council enacted the *Structure Vision 2020-2040*, which presented the following ambition: *"The city sets the bar high by striving for a climate-proof city in all weather conditions"* (p. 53). The vision identified specific guidelines for heat adaptation, with the general principle that with the development of public spaces and construction projects attention has to be given to the implications for heat stress. Moreover, construction projects that take place in heat-prone areas may not aggravate the urban climate. The vision articulates that heat stress should be reduced or prevented through the implementation of more greenery, less hardened surfaces, different use of materials, shading, and more water. Additionally, wind streams should also be taken in consideration to cool down the environment. Furthermore, policy states that the open spaces and parks at the edge of the Veluwe have to stay open due to their cooling effect. To stimulate heat adaptation, the municipality uses several policy instruments, such as a website that distributes information about how inhabitants can contribute to make the city heat-proof (Arnhem Klimaatbestendig, 2019). Next to this, the municipality also grants subsidies for greening paved areas that are identified as heat prone in order to stimulate heat adaptation (City of Arnhem, n.d.).

Theoretical framework

Understanding the emergence of institutional barriers from theory

As I explained in the introduction of this thesis, climate change adaptation has become an increasingly important topic over the last century (Tennekes et al., 2014). However, the development and implementation of heat adaption policy in urban areas remains a struggle. Action can be held back as institutional barriers such as a lack of financial resources or staff arise. In the first section of this chapter I will address these institutional barriers, after I have discussed why mainstreaming is favoured as a strategy for implementing climate change adaptation policies. This will help identify the institutional barriers that impede heat adaptation in the empirical data. In the second part of this chapter I propose three frameworks that contribute to understanding how these institutional barriers emerge. Those are risk and hazard theory, multi-level governance, and new institutionalism. Although the frameworks differ in explanations, they each argue the importance of contextual factors. Whereas risk and hazard theory elaborate on the wider context, multi-level governance and new institutionalism theories shed light on how institutional barriers are embedded in institutions. For the analytical purpose of this thesis these frameworks offer complementary, rather than competitive insights. To conclude this chapter a conceptual framework is presented in the final section.

3.1 Mainstreaming climate change adaptation

Literature on cimate change adaptation disinghuishes two forms of public policy action (Dewulf, Meijerink, & Runhaar, 2015). On the one hand, climate change adaptation policy can be implemented through a ‘dedicated’ or ‘standalone’ approach, which is characterized by the creation of new policy sectors, with particular resources, objectives, policy instruments and a formal organization of responsibilities (Dewulf et al., 2015; Uittenbroek, 2014). On the other hand, a more integrated approach can be pursued, which is referred to as ‘mainstreaming’. The concept of mainstreaming draws from the environmental policy integration (EPI) theory, which raised increasing policy interest and scientific interest in the late 1990s and early 2000s

(Persson, Eckerberg, & Nilsson, 2016; Jordan & Lenschow, 2010). It was first introduced in the Brundtland Report in 1987, providing a solution to connect environmental objectives with other societal issues (Jordan & Lenschow, 2010). EPI advocates for "integration of environmental objectives into non-environmental policy sectors" (Lafferty & Hovden, 2003, p. 1) e.g. in urban planning, transport, agriculture and other policy domains (Runhaar, Driessen, & Uittenbroek, 2014). Mainstreaming is considered to be a specific form of EPI, as it focuses primarily on the integration of climate change adaptation in other policy sectors, leaving the integration of other environmental concerns out (Uittenbroek, Janssen-Jansen & Runhaar, 2013; Rauken, Mydske, & Winsvold, 2015). The institutional shaping of climate change adaptation through a mainstreaming approach is a recurrent focus of the climate change adaptation governance literature (Runhaar et al., 2018; Dewulf et al., 2015; Uittenbroek et al., 2013). Scholars argue that this more holistic approach has several advantages compared to the development of stand-alone policies. By integrating climate adaptation issues in existing sectoral domains, synergies (win-win solutions) can be created. For example, the implementation of greening can reduce the risk of flooding or heat stress and at the same time increase the spatial quality of an urban area (Runhaar et al., 2014; Runhaar et al., 2018; Mees & Driessen, 2011). Simultaneously, mainstreaming is also advantageous due to its ability to increase the efficient use of financial, human and physical resources and the stimulation of innovation in sector-specific policies and plans (Uittenbroek et al., 2013; Runhaar et al., 2018; Runhaar et al., 2014; Dewulf et al., 2015; Adelle & Russel, 2013). 'Windows of opportunity' such as the redevelopment of a neighboorhoud can be used to mainstream climate adaptation (Runhaar et al., 2018; Moser & Ekstrom, 2010). For these reasons, mainstreaming has not only gained attention in the scientific literature but also in policy practice. In the Netherlands, the climate adapatation programmes enacted at the national level argue that climate change adpatation should be mainstreamed (VROM, 2007; IM & EZ, 2017). This aim was set with the release of the first National Adaptation Strategy (*Make room for climate*), which set the goal to mainstream climate adaptation actions by 2015 (VROM, 2007). There is, however, also critique on mainstreaming as a policy strategy. These critiques highlight the risk of diminishing issue visibility, and the 'dilution' of policy, compared to a dedicated approach, where institutional responsibilities are differentiated with their own resources and jurisdiction (Persson et al., 2016).

3.1.1 Defining the concept

Both EPI and mainstreaming are not theorized by one single definition and are part of 'conceptual stretching' in the academic literature as well as in policy pratice (Persson et al., 2016; Runhaar et al., 2018). The debate of defining mainstreaming in the literature focuses mostly on how much priority is given to environmental objectives within other sectors (Jordan & Lenschow, 2010). Lafferty and Hovden (2003) argue that the 'mother concept' of EPI has a *strong* understanding, as 'principled priority' is attributed to environmental objectives (Jordan & Lenschow, 2010). The concept of 'principled priority' asserts that environmental objectives must be seen as a principal in the process of 'balancing' out other societal issues, e.g. social and economic issues. Over time, weaker notions of the concept occurred in the literature. For instance, Peters (1998) moved away from the idea of 'principled priority' for only environmental objectives to a wider set of principled priorities (Jordan & Lenschow, 2010). Mainstreaming encompasses this weaker notion, as the aim is gaining attention for climate change adaptation issues, instead of gaining priority for them (Uittenbroek, 2014; Rauken et al., 2015). Furthermore, a distinction can be made between scholars who focus on strategies subjected to public policy, with governments as the main actors (Persson et al. 2016), and researches such as Runhaar, Driessen and Uittenbroek (2014) who emphasize the importance of sector-wide incorporation instead of focusing on an individual organization level. Runhaar, Driessen and Uittenbroek (2014) advocate for the incorporation of private actors who are involved, such as companies and non-governmental organizations (NGOs). In this thesis, both public and private actors are addressed, as effective responses to climate change depend on the cooperation of government actors, private parties and civil-society groups and citizens along networks (Stiller & Meijerink, 2016). In practice, mainstreaming of climate change adaptation also occurs in various forms. For instance, New York City (NYC) recently adopted the *OneNYC 2018* programme. This programme was adopted to set out a strategy for creating a resilient New York City. Here, climate adaptation is one of the central topics that is incorporated and is integrated in the future visions of sectors, such as infrastructure and housing. The city of Rotterdam has released a specific climate adaptation strategy that lays out the impacts of climate change and outlines for different areas the adaptation measures that should be implemented (City of Rotterdam, 2013). In the case of adaptation to heat stress, the city of Rotterdam identifies different policy instruments and asserts that heat-proof measures should be implemented in the design phase of new building developments.

3.1.2 Conceptualizing institutional barriers of climate change adapatation

Drawing from the broad climate change adaptation literature of developed nations (Runhaar et al., 2018; Ekstrom & Moser, 2014), scholars started recently to address questions about the social factors that impede our ability to proactively adapt to future environmental changes (Biesbroek, 2014). To approach an answer to these questions it is often argued that there are 'barriers to adaptation' which can surface in the development and implementation of climate change adaptation plans. On the other hand, there are also various factors that can stimulate the mainstreaming process of climate adaptation. Different theoretical perspectives have been used to define barriers to adaptation. Terms often used synonymously are *limits, challenges*, *obstacles*, and *constraints* (Azhoni, Jude & Holman, 2018). However, among researchers a consensus is emerging to use barriers in relation to human action or decision-making and limits when unsurpassable and obsolete obstacles emerge (Eisenack et al., 2014; Biesbroek et al., 2014; Oberlack, 2017; Azhoni et al., 2018; Moser & Ekstrom, 2010). Barriers are defined as obstacles emerging from socio-economic and institutional factors, that are mutable and can be overcome (Moser & Ekstrom, 2010; Eisenack et al., 2014). Barriers "can be overcome with concerted effort, creative management, change of thinking, prioritization, and related shifts in resources, land uses, institution, etc." (Moser and Ekstrom, 2010, p. 2.). However, overcoming all barriers does not automatically lead to positive outcomes (Moser & Ekstrom, 2010). Despite this, barriers are a recurrent topic of research and multiple scholars have attempted to create systematic frameworks to identify barriers emerging from emprical research (Moser & Eksrom, 2010; Eisenack & Stecker, 2012; Runhaar et al., 2018). Moser and Ekstrom (2010) developed a framework that identifies different climate change adaptation barriers for each phase of the decision-making process – the understanding phase, planning phase, and managing phase (figure, 3.1). Each phase of the policy cylce consists of various stages, where barriers can constrain the policy progress. Barriers identified in the understandig phase are "the unavailablity or inaccesiblity of information and knowledge, legitimacy, creditability, trust and receptivity to the information and willingness and ability to use it" (Azhoni et al., 2018, p.739). In the planning phase, roles of leadership related to authority and to the ability to identify threats and opportunities are essential. Also, having leaders that are able to come up with alternative adaptation stratgies and build consensus, credibility, and trust, are important. Barriers that appear during the managing phase are a lack of resources, legal and procedural unfeasibility, routines, and a lack of learning capacity (Moser & Ekstrom, 2010; Runhaar et al., 2018).

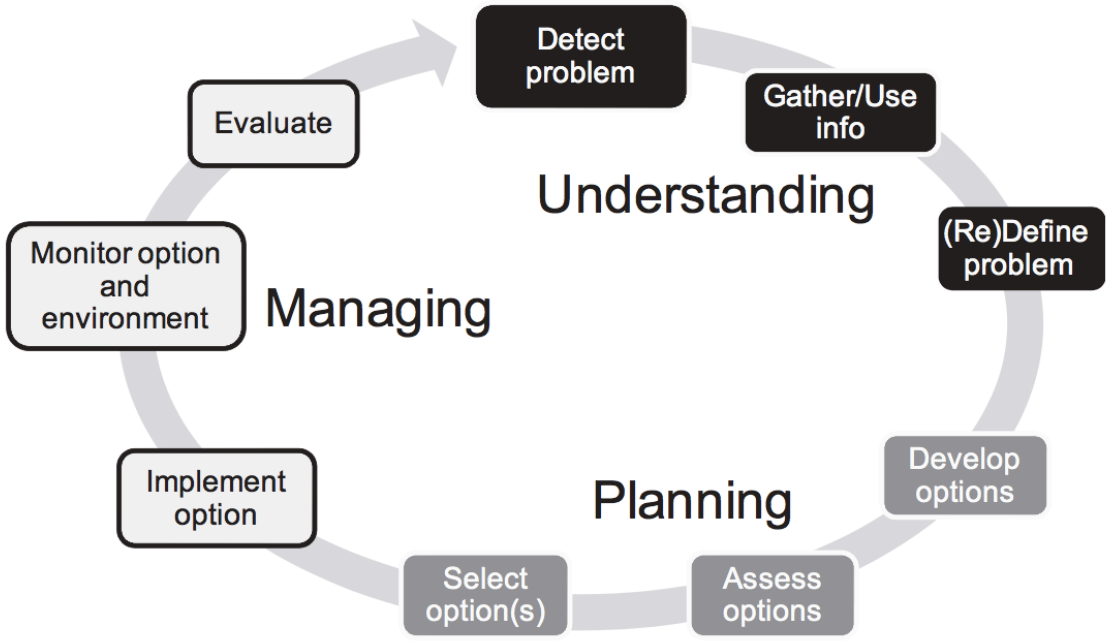

Figure 3.1. Decision-making phases and stages climate adaptation process (Moser & Ekstrom, 2010)

The framework of Moser and Ekstrom (2010) links the barriers to the different decision-making phases and stages. However, the presented barriers are not specific for the mainstreaming process of climate change adaptation. Therefore, the framework of Runhaar, Wilk, Persson, Uittenbroek and Wamsler (2018) provides a useful addition, as they developed a systematic framework which identified barriers that are specific to climate change adapatation mainstreaming. They have categorized the different barriers not according to the different decision-making phases but instead identified six categories emanating from the climate change adapation mainstraming and environmental policy integration (EPI) literature, which are: political factors, organisational factors, resources, congitive factors, characteristices of the adaptaton problem at hand, and timing.

The first category *political factors* involves for instance, the extent of political commitment. Political commitment can be explained in terms of agenda-setting (Uittenbroek, 2014). Three streams can be distinguished in order for an issue to rise on the political agenda: *problems* – policy makers need to acknowledge and want to deal with a problem, regardless of the policies or ideas they may have in dealing with them; *policies* – policy makers working in a specific

policy domains have their own ideas about which actions and policies are needed; *politics* – refers to the importance that politicians give to respective issues – without concerning polices and problems (Uittenbroek, 2014). A 'policy window', "an opening for placing an issue on the political agenda" (Uittenbroek, 2014, p. 68) is created when these three streams are combined. Besides, Uittenbroek, Janssen-Jansen and Runhaar (2013) argue that political commitment can also be gained indirectly, through integrating climate change adaptation issues into existing domains, synergies allow policy makers to allocated resources by combining resources from different policy domains. Other political factors are (in) flexibility of legislative and policy context, support and pressure, how consistently policy is carried out across different levels of policy, the level of political stability, and the level of public awareness (Runhaar et al., 2012).

The second category comprises *organisational factors*, which relate to both intra- and inter-organisational factors, for instance the level of administrative fragmentation (Runhaar et al., 2018). Fragmentation can be a barrier, when it results in inconsistent regulations and mandates (Stead & Meijers, 2009). Another organisational factor is the extent of organizational routines (Uittenbroek, 2016). Routines are established through rules and culture and are part of a self-reinforcing mechanism that intends to increase the effectiveness and efficiency of routines. However, when routines become more standardized through self-reinforcing mechanisms, routines can become a restraining factor. An example of this is when dominant synergies are developed, through the combination of resources and practices in the pursuit for synergies, leading to one particular type of synergy becoming the dominant one. As time passes, this synergy becomes more strongly rooted within an organization. Solely when an alternative synergy is in a way superior to the current dominant synergy, another synergy will be adopted. This limits the amount of alternative options that are considered by the organization. Therefore, adding new objectives and practice will be challenging. Organisational factors, furthermore, include "formal requirements or incentives to develop sectoral adaptation plans, presence of absence of a supportive regulative framework, mandates and statues, coordination and cooperation between government departments, coordination among policy levels, cooperation with private actors, clarity about responsibilities for adaptation and administrative leadership" (Runhaar et al., 2018, p. 1203).

Another factor is *resources*, not only financial resources are included, but also human resources (Ekstrom & Moser, 2014). Examples of human resources are for instance the degree of expertise and knowledge among the actors involved, and the availability of staff (Runhaar et

al., 2018). Moser and Ekstrom (2010) found in their research that when praticoners were asked what impedes climate adapation planning, inadequite resources are often given as first response.

Moreover, scholars point to the importance of *cognitive* factors, such as the degree of scientific uncertainty about the impacts of climate change (Ekstrom & Moser, 2014; Biesbroek et al., 2014; Runhaar, 2018). But also the the level of urgency, for example when the rise of sea-level is seen as a long-term problem, of which the impacts will be felt at least a generation away, there will be less urgency to do something about it than when the impacts are expected in the near future (Ekstrom & Moser, 2014). Futhermore, the degree of awareness of climate change and its risks and the level of social learning are also considerd as cognitieve factors.

The fifth factor is the *Characteristics of the adaptation problem at issue*, which comprises how the adaptation objective is framed and connected with sectoral objectives, as well as the level of detail in which adaptation objectives are conceptualized and how compatible the time frames are (Runhaar et al., 2018).

The final factor is *timing*. According to Uittenbroek (2016) urban renewal provides a 'window of opportunity' to implement climate adapation measures. Also 'focusing events' appear to be a stimuli and a 'window of opportunity' for the implementation of climate adapation, as they are accompanied with preceived urgency and enhanced stakeholder and public support (Runhaar et al., 2018).

3.2 Theorizing risk: understanding a low sense of urgency

Planning for climate change adaptation measures starts with recognizing climate change related risks (Runhaar et al., 2012). This section will therefore outline how extreme urban heat can be perceived as a societal risk. It starts out by outlining the definition of risk used in this thesis, and the variables that make up risk. Then, the difference between actual and perceived risk is explained. Following this, an explanation is given of how risk perception can influence problem framing and policy shaping. Subsequently, it will be discussed why scientific uncertainty can be an obstacle for climate adaptation and why extreme heat receives a low sense of urgency by

Dutch policy officials. This section ends with explaining how a 'focus event' or how framing strategies can increase the degree of urgency to address climate adaptation issues.

3.2.1 Defining Risk

Departing from a socio-ecological system perspective, climate risk is explained as the result of human-nature interactions (Dewan, 2013). In other words, risk of heat stress cannot solely be attributed to the potential physical hazard (e.g. heat), as it relies also on the vulnerability of the population. Scholars acknowledge that there are various socioeconomic factors that are significant for people's ability to prepare for, respond to, and recover from climate risks such as heat waves (Rohat et al., 2019). That is why risk is in this research calculated as the product of hazard and vulnerability (Filho, Icaza, Neht, Klavins & Morgan, 2018).

Hazard

Hazard is defined here as the source of threat that has the possibility to harm people and damage material goods or natural assets (Filho et al., 2018). The risk of a hazard is often estimated through identifying the hazard and its frequency, probability and duration (Yuan, Wei, Wang & Mi, 2017). Hazard is a pre-existing condition which can become a catastrophe when influenced by certain exogenous and endogenous factors. Different types of hazard can be distinguished: natural hazards (tsunami), technological (genetic modification of crops) hazards or man-made hazards (civil war) (Dewan, 2013). However, both natural causes and anthropogenic factors can trigger natural hazards (Neuval, 2009).

Vulnerability

The term vulnerability is not new and is used across various disciplines (Turner et al., 2003; O'Lenick et al., 2019). Although scholars in hazard research and other disciplines have given extensive attention to the concept of vulnerability, there is no clear and common conceptualization of the concept (Dewan, 2013). Therefore, the framing, analytical approach and characterization of indicators differs based on the adopted school of thought and central research questions (O'Lenick et al., 2019). This research follows a socio-ecological system approach and adopts for this reason the interpretation of vulnerability defined by Filho, Icaza, Neht, Klavins and Morgan (2018). They describe vulnerability as the "physical, social, economic, environmental and institutional structures and processes that determine a system's or object's susceptibility and coping and adaptation capacities regarding the way that it reacts

to dangers" (Filho et al., 2018, p. 1141). Therefore, drawing from the IPCC's three component approach, vulnerability is characterized as exposure, sensitivity and adaptive capacity (Filho et al., 2018; O'Lenick et al., 2019). From a climate change and UHI point of view, exposure identifies the level of which people and their valued objects are located in places that have the potential to be harmed by the impacts of climate change (Filho et al., 2018). The local climatology and urban meteorology in combination with urban land use patterns are the predominant determents for the intra-urban distribution of heat (Wilhelmi & Hayden, 2010). Moreover, it is more likely for people to be exposed to extreme heat in areas that contain little greening, shadow spaces and consist of impervious and dark surfaces, as these features contribute to the creation of heat islands (Arnfield, 2003; Soltani & Sharifi, 2017). Furthermore, sensitivity is understood as the level to which material goods and people have the ability to absorb the effects of climate change without suffering for a long period of time (Wilhelmi & Hayden, 2010). Generally, the goal of adaptive action is to reduce sensitivity rather than to eliminate it, as the latter would often demand a change of location (Dewan, 2013). Rohat et al. (2019) point to the fact that, in the context of the UHI, the elderly (people above 65 years old) have a lower ability to adjust and thermoregulate their bodies when lower temperatures change into high temperature, which makes them more sensitive to heat than adults. One other factor that influences a person's sensitivity is their perception of risk, as this is regarded to influence the way people behave (Wilhelmi & Hayden, 2010). People with a higher risk perception may take more action to reduce their sensitivity, leading to them being less vulnerable. Finally, adaptive capacity is the ability to cope with the existing and anticipated negative effects of climate change, through taking anticipatory measures that reduce those former effects (Wilhelmi & Hayden, 2010; Dewan, 2013). There are different factors that determine the adaptive capacity such as the political will, and human and financial resources. Examples of adaptive capacity strategies, in the context of heat stress, are using air-conditioning or staying inside during a heatwave. The level of vulnerability can be separated between individual vulnerability (individuals or households) and collective vulnerability (nations, region or communities) (Adger & Kelly, 1999). Whereas the level of individual vulnerability is dependent on factors such as the ability of an individual or household to have access to resources and their social status, the collective degree of vulnerability depends on the institutional and market structures, infrastructure, and income. So, the term vulnerability distinguishes two different sides. On the one hand, it refers to the 'external' drivers, such as climate change, urbanization, socio-economic and environmental changes (Wilhelmi and Hayden, 2010). For instance, the materials used in urban development can influence the urban

heat island effect. On the other hand, it refers to the 'internal' side of climate impact, as risk is not only the result of environmental change and natural events (e.g. heat waves) but is also influenced by the sensitivity and the adaptive capacity of a society or system (Filho et al., 2018). Therefore, to fully understand vulnerability, attention needs to be given to the complex dynamics between the human and nature systems (de Graaf, van de Giesen & van de Ven, 2009). Hence, in the context of the UHI, a system or municipality can be identified as vulnerable when it is likely to be influenced negatively by the urban heat island effect and people are unable to cope with the impacts (Dewan, 2013).

3.2.2 Perceiving risk

Whereas the previous section outlined the technical definition of risk that is used throughout this thesis, this section will focus on the way humans perceive and react to risk. Drawing on the research fields of psychology and behavioural economics, this section outlines the relationship between cognitive factors and the implementation of heat adaptation measures, adopting the analytical lens of risk perception (Berkhout, 2011; Grothmann & Pratt, 2005). Due to the uncertainty of the impacts of climate change, scholars that follow a behavioural approach argue that organizations choose adaptive responses that are 'good enough' in conformation with normative ideas (Berkhout, 2011). Therefore, the perception and interpretation of risk by social actors is important (Azhoni et al., 2018). High perceptions of risk can put pressure on the decision-makers and therefore influence decisions (Schmidt-Thomé, 2006). In the vulnerability science, adaptation can be best understood in terms of ways to secure 'valued attributes'. Therefore, values play a significant role in the determination of adaption goals in regard to adaptation to climate change (Dow, Berkhout & Preston, 2013; Grothmann & Pratt, 2005). According to Hartzell-Nichols (2011) "Adaptation is fundamentally an ethical issue because the aim of adaption is to protect that which we value" (Hartzell-Nichols, 2011, p. 690). For instance, examples of valued objectives are security, health or safety (Dow et al., 2013). Grothmann & Pratt (2005) assert that the relative risk perception is the predominant determent of the motivation to adapt. The relative risk perception is a result of someone's perceived probability of being exposed to the impacts of climate change, together with someone's estimations of the damage these impacts make to things he or she values (perceived severity), in relation to the urgency and the amount of damage of other problems in life (Grothmann & Pratt, 2005). Therefore, the higher the perceived risk of an actor is, the higher the need for adaptation measures to deal with the risk (Dow et al., 2013). The way in which actors are

exposed, perceive risk, and are able to manage risk varies between them. So, the valuation of the effects and consequences of climate change by different actors is constituted by their social attitudes and their perceived estimation of the probability of occurrence. Hence, the way risk is perceived is on the one hand based on a material dimension, and on the other hand culturally defined and socially constructed. That is why the same kind of risk can for one group or person be seen as intolerable while another group or person can view this risk as tolerable. For instance, people who experienced previous harm are more likely to implement adaptive strategies, regardless of their resources, than people who did not experience harm (Smith, 2018). Runhaar et al. (2012) found in their research that inquired how urban planners in Dutch urban areas deal with and perceive heat stress and flooding, that citizens do not consider increasing temperatures a risk. It is often stressed that extreme heat is a creeping problem. That is, it's is coming on slowly and suddenly it's there. So, while the problem of cloud bursting is felt all year around and shows its negative impacts clearly, such as basements that are flooded, periods of extreme heat are only occasionally attention-grabbing (Kennisportaal Ruimtelijke Adaptatie, n.d.; Volkskrant, 2015). Simultaneously, it is argued that only a small area (e.g. city centre) is vulnerable for heat stress. Therefore, it can be asserted that the relative risk perception of citizens is low as they perceive a low probability of being exposed to the impacts of heat stress.

3.2.3 How to cope with uncertainty?

While climate scientists agree that the number of heatwaves will increase over the next century, the exact increase in frequency and duration remains uncertain (Döpp et al., 2011). The way policy deals with forms of uncertainty will determine if adaptation policy is created or institutional inertia occurs. Adger et al. (2009) assert that an important factor for overcoming institutional inertia is that policy-makers have to frame uncertainty as an opportunity rather than an obstacle, because despite these uncertainties climate change adaptation decisions need to be taken in the present (Termeer et al., 2011). Viewing uncertainty as an obstacle will result mostly in reactive adaptation (Azhoni et al., 2018). This happens for instance when risk is managed and decision-making is guided through a cost-benefit analysis that deals with uncertainties through making them quantifiable by producing climate change and socio-economic scenarios that provide future projections of the climate, demography, economy, technology and policy (Kuklicke & Dermeritt, 2016; Yuan et al., 2017). Due to the impossibility to give exact predictions at local levels, evaluations and scenarios are not precise (Carmin & Dodman, 2013). This is especially the case for determining levels of extreme heat, as the urban heat island effect

complicates the precise modelling of heat stress further. As knowing the costs and benefits of alternatives are key in this approach, uncertainty about the impacts of climate change results mostly in reactive adaptation (Azhoni et al., 2018). On a similar note, Juhola, Keskitalo and Westerhoff (2011) point out that uncertainties that are concerned with climate modelling may instigate local policy-makers to react to identified vulnerabilities, instead of taking anticipatory climate change adaptation measures. According to Adger et al. (2009), decision-making strategies, therefore, need to be 'robust'. Policy-makers need to "systematically examine the performance of their adaptation strategies over a wide range of plausible futures driven by uncertainty about the future state of climate and many other economic, political and cultural factors" (Adger et al., 2009, p. 344).

3.2.4 Heat adapatation: a low sense of urgency to take action

Scholars stipulate that heat stress is not approached as an urgent problem by politicians and citizens in the Netherlands (Runhaar et al., 2012; Tennekes et al., 2014). Tennekes et al. (2014) observe in their research that in the Netherlands health problems emanating from periods of extreme heat are seen as an individual problem rather than a public one. Dutch policy regarding the effects of heat waves therefore is focused on informing the public about the dangers related to heat waves. Framing the impacts of heat as a personal problem rather than a public one results in a low sense of urgency for policy officials to create heat adaptation policy in the spatial planning department. Presumably, treating heat stress as a personal responsibility will worsen heat stress as it is likely to increase the private purchase of air conditioning. On a similar note, Runhaar et al. (2012) show that the status quo that heat stress is not considered to have a clear 'problem owner' contributes to a low sense of urgency to adopted public heat adaptation policy. A high perception of risk can put pressure on decision-makers to adopt a heat-specific climate adaptation policy. However, citizens tend to perceive the risks related to heat as low or are aware of the risk, and are therefore not likely to put pressure on decision-makers, which often leads to lower urgency given to an issue.

3.2.5 A 'window of opportunity': increasing risk perception and urgency

Scholars argue that a crisis or focusing event has to take place to create or trigger a 'window of opportunity' for moving a climate issue up the policy agenda or to gain institutional or public attention for it (Verduin, Meijerink & Leroy, 2012). Crises are "events or developments widely perceived by members of relevant communities to constitute urgent threats to core community values and structures" (Boin, 't Hart and McConnell, 2009, cited in Verduin et al., 2012, p. 472). A focusing event can be defined as "an event that is sudden, relatively rare, can be reasonably defined as harmful or revealing the possibility of potentially greater future harm, inflicts harm or suggests potential harm that is or could be concentrated on a definable geographical area or community of interest, and that is known to policy makers and the public virtually simultaneously" (cited in Birkland, 2004; Birkland 1998; see also Lowry, 2006, p. 315). In this regard the occurrence of a deathly heat wave can be perceived as a crisis or focusing event. When a 'window of opportunity' opens up, an opportunity occurs for 'policy entrepreneurs' to connect problems with solutions and to put the development of new policy plans in motion (Verduin et al., 2012). However, the occurrence of windows of opportunity opened by focusing events or a crisis does not automatically result in a change in policy (Verduin et al., 2012). After experiencing a deathly heat wave in the Netherlands in 2006, municipalities did not take adaptation actions for heat stress (Klok & Kluck, 2018). This event, however, accounted for approximately 1000 heat-related deaths in the Netherlands, ranking it in 4th place among the worldwide deadliest natural disasters for 2006 (Klok & Kluck, 2018). This in essence already shows the urgency of the situation. Yet, Verduin, Meijerink and Leroy (2012) assert that framing strategies can be used to increase the publics sense of urgency about a problem. A situation where change does not occur is not only attributable to the lack of urgency of the nature of the problem, but also to how policy makers and the media frame and communicate an issue to the public (Runhaar et al., 2012). For instance, describing climate change as an issue of great scientific uncertainties can impede the recognition of the urgent nature of the problem at hand.

3.3 Multi-level governance

Due to trends like globalization, regionalization and the increasing influence of information technology, a shift from ‘government’ to ‘governance’ has taken place (Hajer, van Tatenhove & Laurent, 2004). This shift refers to a new process of governing, in which government is replaced as steering actor of socio-economic activities by a model where multiple public and private actors share power and agency (Rhodes, 2012). According to Hajer, van Tatenhove and Laurent (2004) this rise of new political-administrative arrangements does not mean a complete drawing back of the state from the public arena. Rather, the role of the state is redefined. Instead of giving direct direction to society, they argue that the role of the state has become more and more that of a coordinator and facilitator of political processes. Increasingly, governance has drawn attention as an analytical approach in social sciences. However, the concept is ambiguous as it has various definitions and applications. In this research the framework of multi-level governance is used. This refers to both the vertical and horizontal coordination of policy (Bulkeley & Betsill, 2013). A multilevel governance framework will help understand how the relationships between different levels of government, as well as across a growing number of government and non-governmental actors, influences the implementation of climate change adaptation policy. Vertical coordination refers to interdependencies and interactions between different levels of government. Because of the local nature of climate change impacts, implementing national adaptation strategies requires coordination between national, regional, and local levels of government. Those levels of government are best positioned to mobilize local actors operating across different social and policy sectors. These local actors can use their local knowledge to develop place-tailored adaptation solutions (Dabrowski, 2018). However, local adaptation measures have to be viewed as ‘nested’ in the legal and institutional frameworks of higher scales of government (regional, national, European) (Corfee-Morlot et al., 2009). The Dutch National ‘Delta Programme', for example, was started and led by the national government, but is implemented by regional sub-programmes, in which cities, local impacts of climate change, and place-specific solutions play a central role (Dabrowski, 2018). However, obstacles to effective climate change adaptation may drive from a mismatch between the priorities and preferences at for instance local and national level (Corfee-Morlot et al., 2009). Additionally, Dabrowski (2018) found that decentralisation reforms in the Netherlands caused limited financial resources for municipalities, as decentralised policies were not followed by a proportionate increase of fiscal transfers to the local level, while municipal

budgets were stretched following the financial crisis and austerity measures. The horizontal dimension refers to the collaboration across administrative boundaries (Dabrowski, 2018). An example of this is the cooperation of cities in international networks, such as the C40 Cities climate leadership group. In groups like these, knowledge and pool resources are shared, and cross-boundary issues are addressed. Another example is the Regional Adaptation Strategy for Haaglanden which was a developed through a regional cooperation between the Haaglanden authority, water boards, municipality and the Province of South Holland (Dabrowski, 2018). These arrangements are conducive to learning, but they can suffer from a lack of leadership or divergent interests and approaches of the different parties within the arrangement.

3.4 New institutionalism

According to Adger et al. (2009), barriers are the result of endogenous factors and arise 'inside' society (Azhoni, Holman & Jude, 2017). Understanding how these barriers arise therefore requires analytical attention to the specific institutional context within which action takes place (Alexander, 2005; Oberlack, 2017). I draw here from the theoretical notion of 'new institutionalism', which is an approach that studies the relationship between structure and agency, and change and performance in social and economic (political) systems (March & Olsen, 2005). An institutional approach can be seen as complementing the theory of multi-level governance described above. As new institutionalism aims to explain how institutions structure the behaviour of actors, it corresponds with the understanding of multi-level governance of climate change adaptation as a process controlled by local governments but structured through national policy. This following section attempts to explain how institutional barriers arise through understanding how institutions structure the behaviour of actors. Moreover, this section also endeavours to explain the factors that will change institutions, which can be helpful for understanding how to overcome institutional barriers.

3.4.1 Understanding 'New institutionalism'

From the late 1960s, several paradigms of 'new institutionalism' emerged parallel to each other in different fields of science, e.g. economics (North, 1990, Coase, 1960; Williamson, 1998), sociology (Giddens, 1984), political science (Ostrom, 2005), planning (Alexander, 2005, Healey, 2007) and governance and organization theory (DiMaggio & Powell, 1991), providing analytical frameworks that position institutions at the core of their analyses (Peters, 2005).

Scholars moved away from theories of behaviourism and rational choice, which had been dominating since the early 1950s. The analytical stance of these theories focused on the assumption that individuals are making their own choices and are not constrained by institutions (Peters, 2005). According to those theories, individuals are acting autonomously either based on rational-calculation for maximizing individual benefits or sociopsychology characteristics (Peters, 2005; Healey, 2007). As a reaction on the behavioural revolution, the 'New institutionalism' theory gave attention to the influence of institutions in constraining or enabling behaviour of those individuals (Peters, 2005). The concepts of 'institutions' and 'institutionalisation' are ambiguous, as across disciplines and even within disciplines itself the way these concepts are construed differ (Powell & DiMaggio, 1991; Healey, 2018). In this thesis, institutions are understood as the rules, norms and organized practices embedded in social contexts, which structure human behaviour (Healey, 2007; March & Olsen, 2005; Giddens, 1984; DiMaggio & Powell, 1991). This includes formal rules (e.g. statutory regulation, laws, constitutions), informal rules (e.g. normative rules, convention, self-imposed codes of conduct, norms) and routines (Healey, 2007; Salet, 2018). Institutions can constrain or incentivize behaviour through creating a set of rules within which actors make decisions and operate (Miller, Rhodes & Macdonnell, 1997; Peters, 2005). Healey (2007) argues that "they are kind of 'soft infrastructure' of the governance of social life" (Healey, 2007, p. 65). 'New institutionalism' knows different schools of thought. Hall and Taylor (1996) wrote a commonly cited article which distinguished three analytical approaches of 'new institutionalism' from each other: historical institutionalism (HI), rational choice institutionalism (RI) and sociological institutionalism (SI). Similar to these approaches is the fact that, although they developed independently, they all endeavour to explain how institutions and behaviour are related, as well as the process of institutional change and institutional inertia (Root, 2016). These schools of thought are rather complementary to each other than that they are competitive (Peter, 2005). The first school of thought is historical institutionalism. Historical institutionalists emphasize the 'path dependency' of institutions and the unintended consequences of institutional design. Decision-makers are limited in their choices and strategic responses, as institutions are shaped by historical factors. In order to understand the policy decisions that are made now, decisions that are made earlier need to be taken into account as path dependency may occur in which the path developed by earlier decisions persists until they are forced by some significant power to divert from the established direction. Moreover, historical institutionalism focuses on power asymmetries that are an outcome of power struggles in the creation of institutions (Hall & Taylor, 1996; Lockwood, Kuzemko, Mitchel &

Hogette, 2017). Historical institutionalists stress that the unequal distribution of power through institutions across social groups, will consequently result in the fact that some groups will lose while others win (Halle & Taylor, 1996). The rational choice theory draws from scholars in the field of economics like Williamson (1998) and Coase (1960) and highlights that the interests and preferences of individuals or organisations are fixed and based on strategic and rational thinking in order to maximize their material well-being (Healey, 2007; Hall & Taylor, 1996). Institutions shape behaviour, as they affect the range as well as the order of alternative options on the choice-agenda, or because they provide information and enforcement mechanisms in which individuals aim to maximize their preferences (Peters, 2005). They pursue this in a highly strategic manner, for which extensive calculation is required (Hall & Taylor, 1996). Institutions can reduce uncertainty for actors, for instance through the implementation of tools like transaction costs or property rights, it is likely that this will provide better social outcomes as actors are directed towards particular calculations. While sociological institutionalists also view individuals as rational and goal-oriented, they also point to the fact that what individuals view as a rational choice is in itself socially constructed (Hall & Taylor, 1996). They use a broader definition of institutions, where not only formal rules, procedures and norms are included but also "the symbol systems, cognitive scripts and moral templates that provide the 'frames of meaning' guiding human action" (Hall & Taylor, 1996, p. 947). This theory posits that institutions do not emerge in order to maximize individual's preferences but are constructed through practices that are culturally specific (Hall & Taylor, 1996). This happens as a result of processes associated with the transmission of cultural practices more generally. According to March & Olsen (2013) institutions provide actors with 'a logic of appropriateness'. Actors are socialized into certain institutional roles. Therefore, actors behave according to rules and norms that are seen as appropriate for their role or identity (Hall &Taylor,1996). Furthermore, sociological institutionalism stresses that the meaning that is given to social life is created through the mutual interaction between actors and institutions (Alexander, 2005). In addition, an important aspect of sociological institutionalism is the idea that action and interpretation are tightly bound up and can not to be seen as completely separate concepts (Hall & Taylor, 1996). Besides these traditional schools of thought, there are also more recently developed schools of thought such as normative institutionalism and discursive institutionalism, which are both embedded in the sociological institutionalist tradition (Root, 2016; Schmidt, 2012). Discursive institutionalism argues that institutions are at the same time given and contingent (Kromidha & Córdoba-pachón, 2017). Institutions are on the one hand given, as agents act within the given institutional context, and on the other hand they are contingent, related to the actions of agents.

Therefore, institutions are internal to the actors, since they serve both as structures limiting actors and as constructs created and changed by the same actors. In this approach, discourses are theorized as being of key importance in the understanding of social and political realities (Kaufmann & Wiering, 2017, Schmidt, 2011). Following Schmidt's (2012) understanding, discourse is not just referring "to what is said (ideas) but also to who said what to whom, where, when, how, and why (discursive interactions)" (Schmidt, 2012, p. 2). In other words, discourses are not only understood as solely ideas that give meaning to social realities, but also as the process of creating and communicating new ideas (Schmidt, 2011). Ideas and discourses shape or constrain behaviour, materializing in institutions (Kaufmann & Wiering, 2017).

Exploring and defining ideas

Schimdt (2012) points out that ideas tend to occur across three levels. First, at the *policy* level. This level encompasses the specific policy solutions to particular problems (Schimdt, 2012, Gillard, 2016). Second, at *program* level, which includes the more general underlying assumptions and principles underpinning the policy ideas. Furthermore, this level determines which problems need to be solved by such polices, "the issues to be considered, the goals to be achieved, the norms, methods and instruments to be applied, and the objectives and ideas which all in all frame the more immediate policy ideas proposed as solutions for any given problem" (Schmidt, 2012, p. 4). Finally, the last level is *philosophy*, which refers to the implicit norms and values of knowledge and society (Schmidt, 2012). The ideas at this level serve as background knowledge and frame the policies and programmes (Wahlström & Sundberg, 2018, Schmidt, 2012). It is however difficult to identify this level of ideas because they are often left unarticulated.

3.4.2 Institutional inertia and change

Increasingly, attention is given in institutional theory to understanding how institutions change (March & Olsen, 2008). Institutions are ambiguous in the sense that they bring stability and certainty, however in situations where change is desired the inertial qualities of institutions serve as a challenge (Root, 2016; Munck af Rosenschöld & Rozema, 2019). Change is not easy and does not occur quickly, as institutions are "relatively enduring features of political and social life (rules, norms, procedures) that structure behaviour and that cannot be changed easily or instantaneously" (Mahoney & Thelen, 2010, p. 4). Historical institutionalists understand institutional inertia as a result of path dependency (Root, 2016). It is created through the aim of

institutions to maintain and replicate the status quo. Early historical institutionalism stresses that in order for institutions to change, exogenous shocks or crises need to take place which will lead to 'critical junctures' (March & Olsen, 2008). Those junctures lead to radical institutional changes, which then become stable in changing circumstances (Lockwood et al., 2017). Eventually, this will develop a pattern of 'punctuated equilibrium'. However, more recent research posits that change can also evolve more gradually, created by endogenous sources of instability, due to the unanticipated and unintended results of institutions that point to the limitations of an optimal institutional design. Whereas rational choice institutionalists argue that change is 'deliberately mobilised' in governance processes through 'strategic projects', such as new partnerships or land use regulation (Healey, 2007). In the case of competitive selection, institutions will predominately survive when the current institutions create more value to the relevant actors than the alternatives do (Hall & Taylor, 1996). Sociological institutionalists assert that institutional practices change through a process of learning and responding to novel situations (Root, 2016). New institutions are adopted because they improve the social legitimacy of an organization or its members. March & Olsen (2005) refer to a 'logic of social appropriateness' rather than a 'logic of consequences'. "Rules of appropriateness are seen as carriers of lessons from experience as those lessons are encoded either by individuals and collectives drawing inferences from their own and other experiences, or by differential survival and reproduction of institutions, roles and identities based on particular rules" (March & Olsen, 2004, p.12). Hence, institutions are history-dependent and when novel situations appear they are modified through a process of interpretation, where actors try to keep their legitimacy and their position within the institutional context intact as much as possible. Therefore, change is not easy, and tends to occur slowly (Root, 2016). Discursive institutionalists (Schmidt, 2012) emphasize that structure and agency have a reciprocal relationship, as institutions themselves are shaped through actions of agents. Similarly, the literature on institutional entrepreneurship also discusses that structure and agency are mutually constitutive (Garud, Hardy & Maguire, 2007). So, discursive institutionalists argue that institutional change is achieved through agency. But as actors are influenced by institutions that structure their behaviour and define their interests, how can they think beyond these institutions to imagine and adopt new practices? The answer lies in conceptualizing institutional structures not solely as a constrain for agency, but also as platforms that can be used for the unfolding of entrepreneurial activities. From this point of view, actors (institutional entrepreneurs) have the capacity to think outside their institutions (Schmidt, 2012).

Agency is here defined as "the temporally constructed engagement by actors of different structural environments – the temporal-relational context of action – which, through the interplay of habit, imagination, and judgment, both reproduces and transforms those structures in interactive response to the problems posed by changing historical situations" (Emirbayer & Mische, 1998, p. 970). Following Searle (1995), institutional change can drive from actors acting unconscious as well as conscious, as actors can 'decide' to use institutions differently. Schmidt (2012) identifies two important features of actors in order to understand how institutions emerge or change: the 'background ideational abilities' of actors and 'foreground discursive abilities' of actors. Whereas the former explains the creation of institutions and how they maintain, the later explains how institutions change or inert. These 'background ideational abilities' originate from a Bourdieusian perspective, following Bourdieu's concept of 'habitus', which is the "system of dispositions social agents acquire over time, through an implicit or explicit learning process, that functions as a system of generative schemes" (Bourdieu 1989 [1976], p. 177). These dispositions are schemes of action, perception and evaluation that guide actor's behaviour. It is the social process instead of the individual process that creates 'habitus'. Hence, people's sense of agency or modes of conduct are not shaped through following a specific rule, but through "following the institutions of a 'logic of practice'" (Sapiro, 2015, Bourdieu 1990, p. 11). So, in order for institutions to change, discursive elements have to change as well. Therefore, Schmidt (2012) points to the 'foreground discursive abilities' of actors, representing the 'logic of communication' which is at the foundation of an agent's capacities to think, speak, and act outside of their institutions, even though they are inside them. These abilities enable them to deliberate about the institutional rules even while they are using them, and to persuade others to change institutions or to keep them as they are (Schmidt, 2012).

3.5 Conceptual framework

In a simplified form, this conceptual framework illustrates the causal relationships between the mainstreaming of heat adaptation and the institutional barriers that can impede this, and the factors driven from the literature review that explain why these institutional barriers emerge (figure 3.2). According to the literature review, the many institutional barriers can be categorized into six categories: political barriers, organisational barriers, resource barriers, cognitive barriers, characteristics of the adaptation problem at issue, and timing. If institutional barriers emerge it is presumed that they influence the degree of mainstreaming of heat

adaptation. Which barriers impede the mainstreaming of heat adaptation depends on the specific context within which climate change adaptation has to take place. The conceptual framework does not attempt to illustrate the exact relationship between these different categories and specific explanations, it rather shows the main factors, as found in the literature review, that are expected to be underneath the general emergence of institutional barriers. However, based on the literature a couple of expectations can be made about the arrows that point to the institutional barriers. It can be expected that low perceptions of risk influence the emergence of cognitive barriers, such as a low level of urgency and a low degree of awareness. Vertical governance is expected to influence the emergence of resource barriers, such as a lack of financial resources. Finally, the expectation is that new institutionalist theory provides an explanation for the emergence of organisational factors, such as routines, and a lack of a supportive regulative framework, mandates and statues.

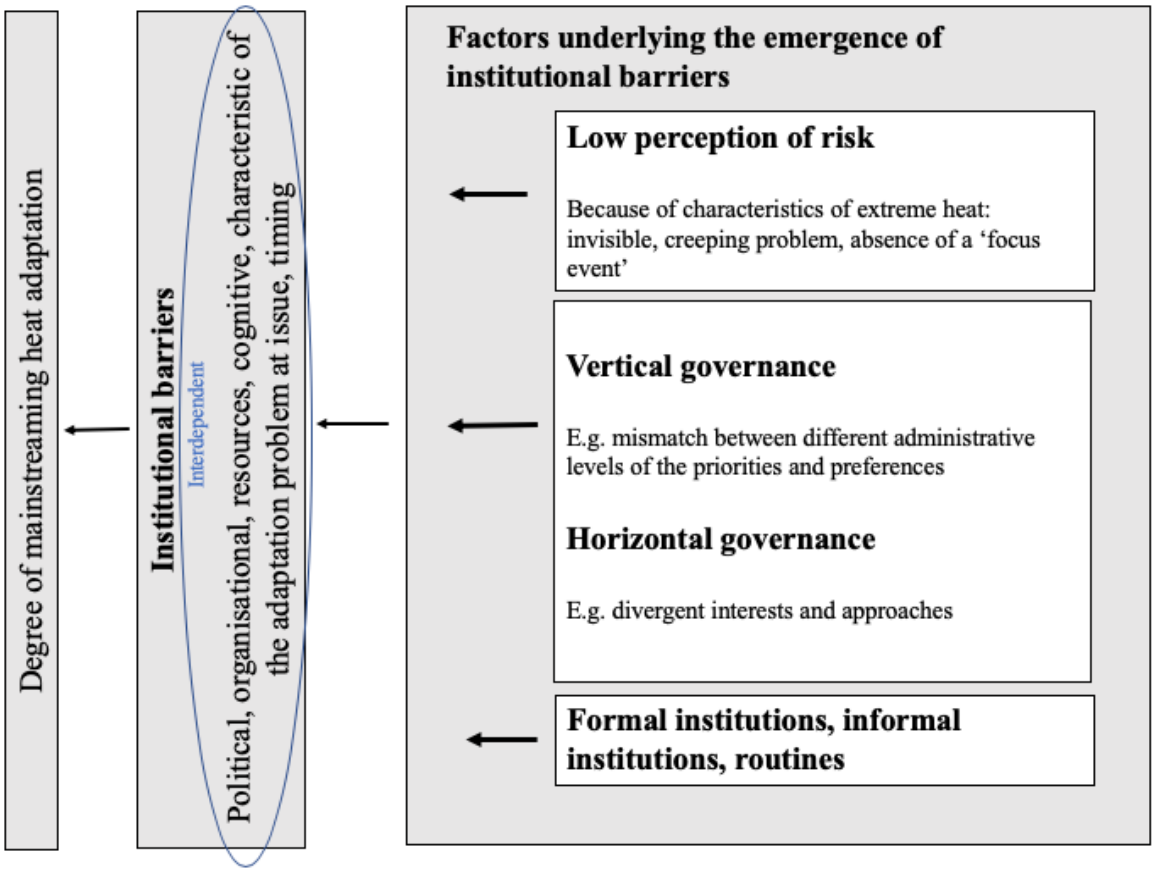

Figure 3.2. Conceptual framework (created by author)

Methodology

The following chapter elaborates on the methodological choices made in this thesis. The first section (4.1) will outline the underlying philosophy, epistemology and ontology of this research. Subsequently, the research strategy (4.2) is elaborated on. Followed by the research design (4.3) and research methods (4.4). Finally, I lay out the validity and reliability of this research.

4.1 Philosophy, epistemology and ontology

According to Morgan and Smircich (1980) "all approaches to social science are based on interrelated sets of assumptions regarding ontology, human nature, and epistemology" (Morgan & Smirich 1980, p. 491). This section therefore provides an explanation of these underlying assumptions for choosing the methodological choices in this research. What I try to do in this research is to expand the perspective and look beyond the descriptive observation of mapping the existing barriers. That is why in this research an interpretivist epistemology is adopted, which has the purpose of understanding human behaviour (Parker, 2016; Bryman, 2012). The shared view within this doctrine is that studying the human world asks for different research methods than researching the natural world does, as these are sufficiently different from each other (Liashenko, 2018). Whereas the goal of natural sciences is to explain the natural world, the goal of social and human sciences is to understand the human world (Parker, 2016; Bryman, 2012). The interpretive approach in this research is based on the philosophy of phenomenalism. This approach attempts to examine the perceptions and meanings participants have of the research object that is being studied (Smith & Osborn, 2015). This philosophy raises the following question: how do individuals make sense of the world around them? (Bryman, 2012). This interpretative phenomenology drives from the works of scholars such as Edmund Husserl and Alfred Schutz (Parker, 2016; Bryman, 2012). Husserl argued that things do not need to be viewed as abstract conceptualizations or as the definitions set by preceding scientific hypotheses, but things have to be seen in the way they present themselves in their own terms (Smith & Osborn, 2015). Schutz states "The world of nature as explored by the natural scientist does not 'mean' anything to molecules, atoms and electrons. But the observational field of the social scientist - social reality- has a specific meaning and relevance structure for the beings

living, acting and thinking within it. By a series of common-sense constructs they have pre-selected and pre-interpreted this world which they experience as the reality of their daily lives. It is these thought objects of theirs which determine their behaviour by motivating it." (Schutz, 1962, p. 59). In this line of thought, participants attribute meanings to human action. According to these meanings, they act, and also attribute value to the actions of others (Bryman, 2012). The aim of the researcher is to view things from the point of view of the participant, in order to interpret their actions and understand the meaning of these actions (Bryman, 2012). The underlying ontological stance in this research is constructivist, which means that I am aware that reality is socially constructed. Social phenomena and their meanings and ideas are constructed "by humans through their action and interaction" (Orlikowski & Baroudi, 1991, p. 14) and are in a constant state of revision (Bryman, 2012). From this conceptual lens, I recognize the world as subjective. Therefore, the research subjects of this thesis are viewed as endogenous and socially constructed. Additionally, in this interpretative approach I also recognize that the interaction between the researcher and its participants contributes to the construction of the social world (Andrade, 2009).

4.2 Research strategy

In this research a qualitative research strategy is adopted (Bryman, 2012). This is in line with the chosen philosophy, epistemology and ontology, and research question in this research. The subject of this research is the emergence of institutional barriers for heat adaptation. To understand their interdependencies, how they emerge, and to grasp the complexity of the research problem, an analysis is conducted which attempts to look deeper into the problem. Therefore, a qualitative research approach is most suitable. In its purest form a qualitative analysis is conducted through induction, which means that the researcher infers patterns, themes and categories of analysis from the data and subsequently generates a new theory (Srivastava & Hopwood, 2009). This research, however, is conducted in a more reflexive way of "weaving back and forth between data and theory" (Bryman, 2012, p.12). First, academic literature is reviewed which provides the general propositions about which institutional barriers are likely to be identified in the empirical data. In addition, multiple explanations about how these barriers might emerge and how they are possibly interconnected with each other are driven from the literature. As there is limited availability of scientific literature about institutional barriers for mainstreaming heat adaptation, more general literature about mainstreaming climate change

adaptation is foremost being used. Subsequently, data is collected and analysed. Based on the empirical insights, theory is revised for the specific subject of the emergence of institutional barriers that impede heat adaptation. Thus, this research is characterized as an inductive-iterative study (Bryman, 2012).

4.3 Research design: case study

The research design in this thesis is a case study. Yin (2003) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2003, p. 13). According to Bryman (2012) the focus of a case study is an intensive examination of the setting, which is often concerned with explaining the unique features of the case. This gives researchers the opportunity to gain a deeper holistic view of the research problem (Baškarada, 2014). Yin (2009) asserts that a case study has "many more variables of interest than data points", that rely "on multiple sources of evidence, with data needing to be converged in a triangulating fashion," and that "benefits from the prior development of theoretical propositions to guide data collection and analysis" (Yin, 2009, p. 18). A case study research design is the most appropriate research design for this research as the aim is not to make general claims but to understand how institutional barriers emerge for this specific context. A case study will allow for an in-depth analysis of the relation between the different barriers that arise and the emergence of institutional barriers. Besides this, a case study design complements the research strategy of this study.

4.3.1 Single embedded case study design

Yin (2003) distinguishes four types of case study: holistic, embedded, single and multiple. In this research a single embedded case study is used. Although a multiple case study would give better generalizable data, I have chosen a single case study design because the goal is to provide an analysis that digs deeper than solely identifying barriers that are present. The research entity that is utilized for this case is a city. Besides, a distinction between case study types can be made regarding the purpose of the research. This research uses an exploratory case study, as the purpose is to gain new insights in understanding how institutional barriers that impede the adaptation heat stress emerge.

4.3.2 Case study selection

The case in this research has been selected based on several criteria. The first criterion is based on geography. The research is focused on climate adaptation for heat stress and mitigation of urban heat islands in the Dutch context, therefore the case has to be situated in the Netherlands. Next, the research focuses on the urban scale, as in the first place literature argues that action for climate change adaptation should be developed and implemented at the local level. In addition, the urban heat island is in general recognized as an urban phenomenon, for this reason the case also has to be a city. Furthermore, an important aspect for the selection of the case is the size of the city. It has to be a small or mid-sized city, with a strong or very strong urban character. Literature argues that compared to the large cities in the Netherlands, mid- and small-sized cities have less human and financial resources to implement climate change adaptation measures and are therefore more dependent on their network to implement these measures (Hoppe et al., 2014). Considering this difference and the fact that there are more mid- and small-sized cities in the Netherlands than large ones, choosing a small- or mid-sized city makes the case more representative for other cities in the Netherlands which results in findings that can be better generalized. A large city is here defined as a city that contains more than 200.000 inhabitants, cities between 200.000 inhabitants and 100.000 are classified as medium sized cities, and cities with less than 100.000 inhabitants are classified as small cities (Hoppe et al., 2014; CBS, n.d.). A strong urban character is based on the identification of cities with between 1500 and 2500 addresses per square kilometre (CBS, n.d.). Cities have a very strong urban character when they have more than 2500 addresses per square kilometre. Another requirement for selecting a case was the occurrence of the urban heat island effect, as this would recognize the necessary to create and implement spatial planning policy for urban heat islands and heat stress. Besides, the city had to already have enacted their spatial vision (*Omgevingsvisie*). Against the background that the transition to the new environmental act (*Omgevingswet*) requires every municipality in the Netherlands to present their so called ‘Environmental vision’ (*Omgevingsvisie*) in the upcoming years, selecting a city that already has uploaded their vision will make sure no outdated policy is reviewed.

4.4 Resereach methods: data collection and data analysis

Data in this research is collected by using a triangular method. Before conducting fieldwork, desk research was excucted on relevant scietific literature, policy documents and reports. Subsequently, in total 9 experts were interviewed face-to-face. In-depth interviews (between 40min and 1h30 min) were conducted across a period slightly longer than tree months between 30 May 2019 and 5 September 2019. Apart from two interviews with two experts, all interviews were one-to-one. I stopped interviewing when I felt I rearched saturation of knowledge, through recognising a pattern, and snowball sampling stopped as respondents started pointing to people I already interviewed. Appendix 3 provides an overview of the respondents that were interviewed. Different types of interviews can be distinguihed from each other, in this research semi-structured interviews were held (Bryman, 2012). This allowed for asking follow-up questions during the course of the interview. All interviews were recoreded, transcribed, and coded using the software Atlas-ti.

4.4.1 Interview methodology: profile of respondents

The data in this research will in part emerge from interviews with experts. In this research a purposeful sampling strategy is used, as the purpose is to interview people that are 'information rich' and can best help to understand the object of this research. Two purposeful sampling strategies were used in this research. On the one hand snowball sampling was utilized, as due to the complexity of the organization and the development of policy along networks, it was not clear in the beginning which experts were responsible for certain tasks related to the study object (Bryman, 2012). Therefore, an employee of the municipality of Alkmaar who I did not interview helped me to get the snowball rolling. On the other hand, maximum variation sampling was used (Bryman, 2012). This means that respondents were selected based on their different backgrounds, as these cannot only have different perspectives on the phenomenon being studied, but also have different degrees of power to influence it. Therefore, experts with different connections to the policy making and implementation of adaptation measures for heat adaptation were selected.

Three categories of respondents can be characterized:

- Politicians
- Employees of the city Alkmaar in the field of spatial planning
- Partners: experts from partner organizations of the city of Alkmaar

4.4.2 Methodological framework

Figure 4.1 provides an overview of the methods used to collected data in each step of the research process and shows from which source it is acquired.

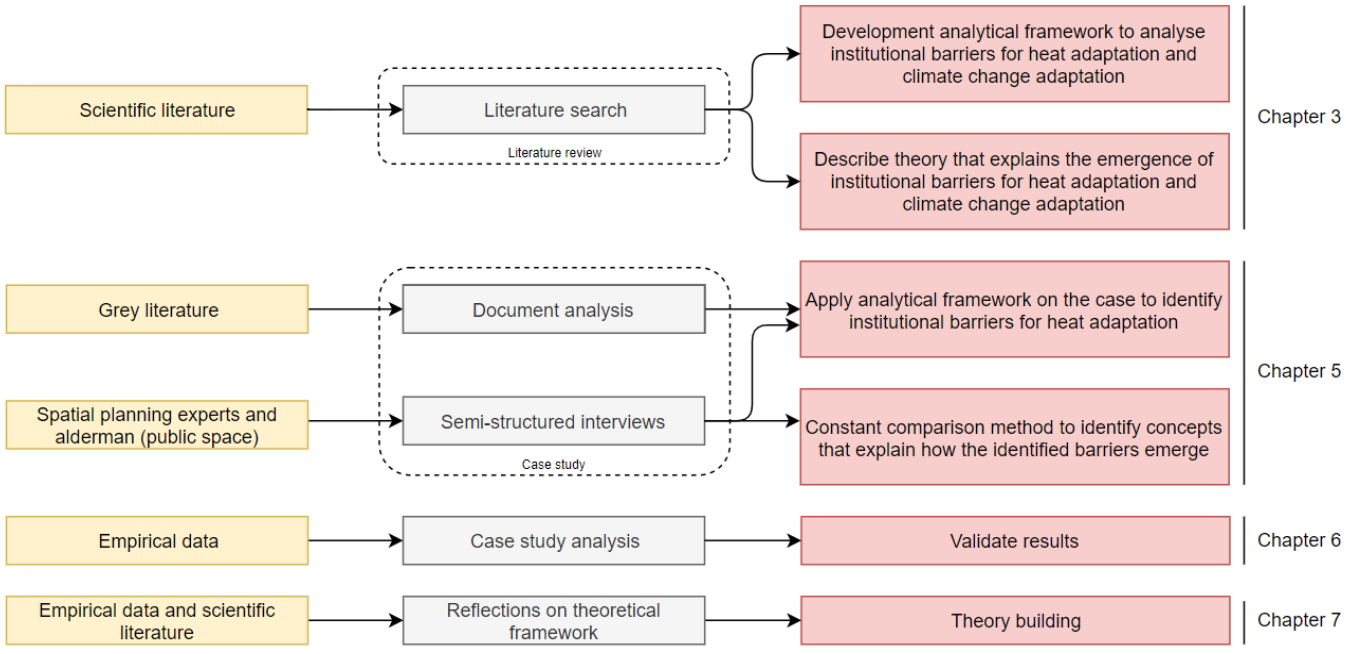

Figure 4.1. Overview data collection method of this research (created by author)

4.5 Validity and reliability

4.5.1 Internal validity

To increase the internal validity in this research the strategic choice is made to apply a triangulation of research methods and sources (Bryman, 2012). As in this research the findings of the document-analysis and semi-structured interviews converge, it can be argued that the findings and the conclusion in this research are more valid. Additionally, a constant comparison method was used that codes the semi-structured interviews, which resulted in the development of concepts from data that explain how barriers emerge. This method also enhances the internal validity of this research.

4.5.2 External validity

The external validity of this research is here viewed as the level of transferability of the findings (Bryman, 2012). The external validity of this research is relatively low, this is due to the focus of this research on one case. However, in qualitative research it is always difficult to generalize, as it is often concerned with a small N compared to quantitative research. Lincoln and Guba (1985) therefore argue that for a qualitative research to be externally valid it is important to have a thick description of the field research. This is provided in this research through, transcribing all recorded interviews and comprehensive case descriptions. The case in this research is based on strategic sampling, therefore the findings can be best transferred to cases with similar characteristics, i.e. Dutch mid-sized cities that have urban heat islands and do implement climate adaptation measures for cloud bursting, but do not have specific heat policy and do not implement specific measures for the adaptation of heat.

4.5.3 Reliability

A research is reliable if the research can be replicated (Bryman, 2012). In qualitative research this is often a difficult criterion to meet, as social settings and circumstances change. Therefore, reliability in qualitative research is foremost concerned with consistency. This is pursued in this research through using the same interview topics in each interview. Also, the transcription of each interview, and the codification of the interviews and documents contribute to the reproducibility of this research.

The Dutch context

Responding to extreme heat in the Netherlands and Alkmaar

5.1 Heat extremes in the Netherlands

During the early 21st century, climate change has emerged as one of the key issues (Carter et al., 2015). Primarily due to the anthropogenic emissions of greenhouse gasses, the worlds temperature has already increased with 1°C above pre-industrial levels (IPCC, 2019). Pursuing the current rate of warming of 0,2% per decade, global warming will reach 1,5°C between 2030 and 2052 (Perkins-Kirkpatrick & Gibson, 2017). Whether this actually happens depends on various factors such as the pace of greenhouse gas emissions, the rate of deforestation, and the ecosystems response to the changing climate (Carter et al., 2015). However, there is high probability that appearance of extreme weather events, such as heat waves and heavy precipitation events, will increase. In 2014, the *KNMI'14: Climate change scenarios for the 21st century - A Netherlands perspective* was published by the Royal Dutch Meteorological Institute. The report projects four different climate scenarios for the Netherlands, that can be distinguished from each other based on their global air temperatures and air flow pattern. All scenarios show a temperature increase by 2050, that varies between 1°C and 2,3°C. During the winter months this will result in a decrease of days with temperatures below 0°C, while during the summer an increase of warm days and more frequent events of heat waves are observed (KNMI, 2015). Similarly, an increase in tropical nights with a minimum temperature of 20°C and higher, and days with maximum temperature of 25°C or higher will appear in the summer. Moreover, due to the urban heat island effect, temperatures in urban areas will on average be 1°C higher than in rural environments (Ministry of Infrastructure and Water Management, 2018). This difference in temperature between rural and urban environments can, however, increase during the night to more than 7°C.

5.1.1 National heat adaptation policy

In the Netherlands, planning for climate change adaptation has in the last decade mainly followed the path of adapting to water challenges, with exception of some frontrunner cities (Hoppe et al., 2014). This is not to say that at national scale the risk of the impacts of extreme heat is not recognized. In 2006, the *National Programme Adaptation Space and Climate* (ARK, acronym) was put in place, which includes the initial step for climate change adaptation planning in the Netherlands (Biesbroek et al., 2014). This joint programme consisting of four ministries, and the umbrella organizations for 12 provinces, more than 400 municipalities, and 26 water boards published the first *National Adaptation Strategy* (NAS) in 2007, which was called *Make room for climate* (VROM, 2007). The goal of the NAS was to climate proof the Netherlands and mainstream climate adaptation policies by 2015. It presented a broad vision for climate change adaptation in the Netherlands, considering multiple climate change challenges across different sectors (Biesbroek et al., 2014). The strategy recognized the increasing probability of occurrences of heat waves and argued that once these occur, dramatic consequences might have to be faced. The strategy stated: "In the absence of adaptation measures, the number of people dying as a result of heat waves is likely to increase during the summer" (VROM, 2007, p. 11). It stipulates that, particularly, in urban areas heat islands and heat stress should be prevented to guarantee a good quality of life, which in part had to be done through providing a different layout of urban areas. Three years later, the ARK programme was ceased and its goals were adopted by the *Delta Programme* (Hoppe et al., 2014). The Delta programme narrowed down the broad climate adaptation approach that was applied in the NAS. The main focus of the programme involved water safety, freshwater supply and climate-resilient urban development. In 2014, the sub-programme *Delta Resolution Spatial Adaption* was enacted. This has set the objective that climate change adaptation policies have to be mainstreamed by 2020, and the sequential aim to make the Netherlands climate proof by 2050 (Ministry of Infrastructure and Environment & Ministry of Economy, 2014). However, the *Deltaplan 2018* argued that the current approach stimulates actors too little to achieve the set ambitions (Ministry of Infrastructure and Water Management, 2018). Simultaneously, big differences among municipalities in the degree of climate change adaptation appeared, due to the non-committal nature of this national policy. The aim of implementing the Deltaplan 2018 was therefore to speed up and intensify the process of climate adaptation. One of the guiding principles the plan laid out, was the development of a local stress test by municipalities to illustrate the vulnerabilities for their municipality, regarding heat, drought, flooding and

waterlogging, which should be presented no later than 2019. One year later, municipalities, provinces and waterboards have to present the challenges and measures through the stress tests, risk dialogues and implementation agendas. The Minister of Infrastructure and Water Management has made funds available for all local authorities in 2019 and 2020 (Ministry of Infrastructure and Water Management, 2018). This is intended for the support of this process, knowledge development and sharing, and the development of pilots. Additional national funding will be available for the implementation of measures in 2021. To complement the Delta programme, a revised national adaptation strategy was introduced in 2016 and subsequently, in 2018 the NAS implementation programme was published (Ministry of Infrastructure and Environment, 2016; Ministry of Infrastructure and Water Management, 2018 a; Ministry of Infrastructure and Water Management, 2019). Similar to the Delta programme, extreme heat was considered as one of the main impacts of climate change, illustrating its impacts in different sectors such as agriculture, health, and infrastructure (Ministry of Infrastructure and Environment, 2016). Additionally, the programme team of the NAS organized the first heat stress congress in June 2018 (Ministry of Infrastructure and Water Management, 2019). Attention was paid here to the question "How can the Netherlands cope with a climate which is getting warmer?". The most recent Deltaprogramma, *Doing work on the delta: adapting the Netherlands to climate change in time* (2019), presents actions for climate adaptation that complement the delta programme spatial adaptation, such as investigating which building regulations can serve as instruments for the stimulation of climate change adaptation measures.

5.2 Introducing the case study

This section will describe the study site Alkmaar in more detail. Alkmaar is situated in the North of the Netherlands in the province of Noord-Holland (Figure 5.1), and is part of the region Alkmaar, which besides Alkmaar consists of the municipalities: Bergen, Uitgeest, Castricum, Heiloo, Heerhugowaard and Langedijk.

Since 2015, the municipality of Alkmaar is merged with the de

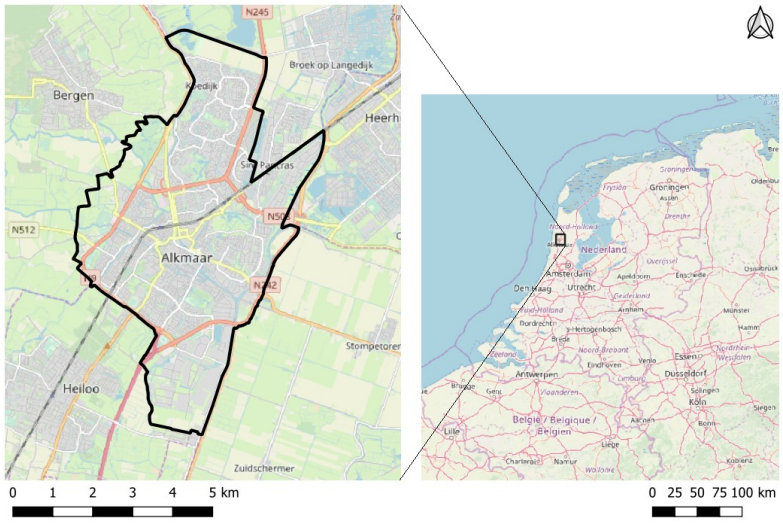

Figure 5.1. Location case study area (Openstreetmap, cbs [edited by author])

municipalities Graft-De Rijp and Schermer, which encompasses the rural area of the municipality. With 108.558 inhabitants, Alkmaar can be considered a medium-sized city (CBS, 2019). The city's famous cheese market, historical city centre, the (Schermer) mills and its location near the beach have made it a popular touristic destination (City of Alkmaar, 2017 a). Therefore, part of the city's economic development plan is based around attracting more tourists and day-trippers (City of Alkmaar, 2015). Forecasts of the province show an increasing housing demand in Alkmaar, especially for housing situated in a more urban context (Province of Noord-Holland, 2018.; City of Alkmaar, 2017). To facilitate this demand the industrial area around the Noordhollandsch Kanaal will be developed into an attractive urban area in the coming next years. Just like other places in the Netherlands, Alkmaar will experience impacts of climate change. The vulnerability scan (*kwetsbaarheidsscan*) shows that most heat islands are visible in business areas such as Boekelermeer-Zuid and Boekelermeer-Noord, the eastern part of Oosterhout. Besides, it is also visible that urban heat islands are formed in the historic city centre of Alkmaar, which is enclosed by water. The sequential section addresses Alkmaar's climate change adaptation policy, after first having discussed the climate change adaptation policy of the region of Alkmaar and province of Noord-Holland.

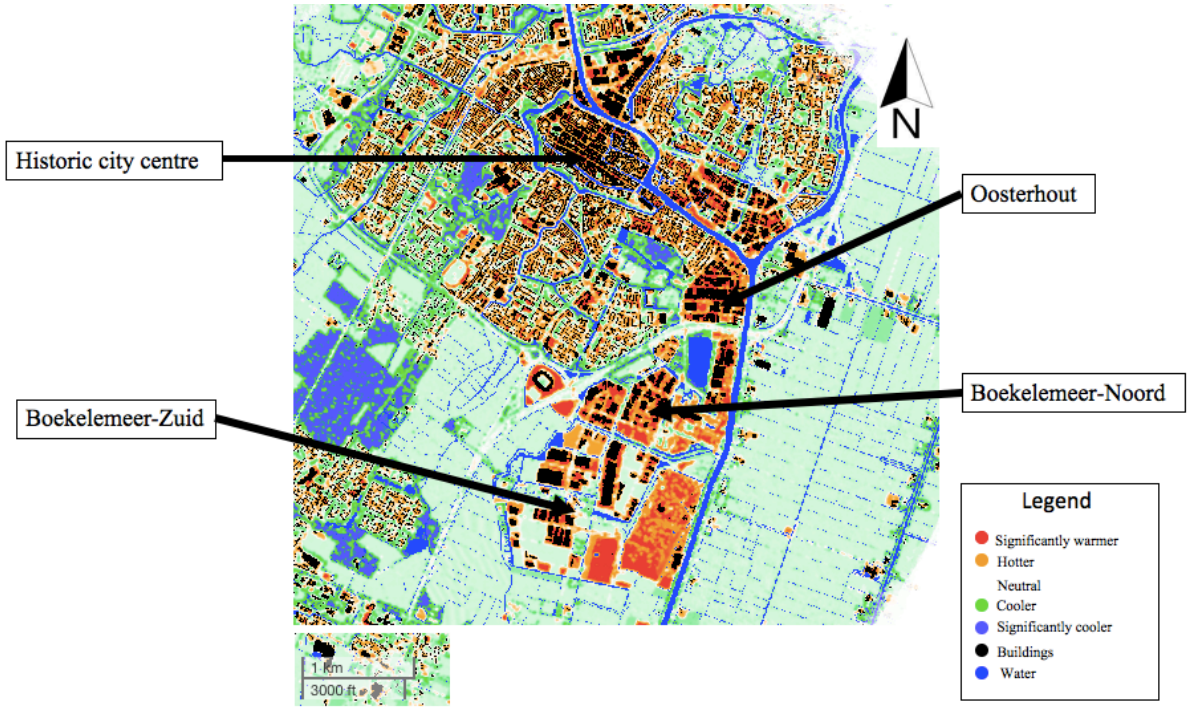

Figure 5.2 Heat map Alkmaar (Hoogheemraadschap Hollands Noorderkwartier [edited by author])

5.2.1 Climate change adaptation planning in Noord-Holland and Region of Alkmaar

The province of Noord-Holland is responsible for issuing a comprehensive planning vision that covers the provincial level. In 2018, the province of Noord-Holland published the *Omgevingsvisie NH2050*, after the province had convened multiple partners including municipalities, the regions and the water boards to identify the autonomous developments that take place in Noord-Holland and the challenges that result from these developments (Province of Noord-Holland, 2018). Subsequently, perceptions on how to deal with these challenges of various stakeholders were gathered, out of which the main ambition and related objectives arose. One of the objectives the vision states is that climate change threatens our environment and therefore climate change adaptation measures should be implemented. In relation to planning for climate change adaptation the vision mentions "We make sure that we are sufficiently prepared for waterlogging, heat stress, subsidence, salinization and the consequences of flooding" (p.11). In addition, another challenge the *Omgevinsvisie NH2050* identifies is urbanization, as it states: "The need for housing in Noord-Holland South and Noord-Holland North will continue to increase in the future" (p. 9). To cope with this housing shortage, new spatial developments in urban areas will be planned. With the construction of these new spatial developments, the province has a strong orientation towards including nature (*natuurinclusief bouwen*). Including nature such as greenery and water in spatial developments is not only advantageous for enhancing the biodiversity it asserts but can also contribute to preventing heat stress. However, the vision does not reflect on how new urban developments can create heat islands or acknowledge the influence of heat on air pollution. On 18 April 2018 the draft version of the *Omgevingsverordening Noord-Holland* was enacted. The *Omgevingsverordening Noord-Holland* describes the rules that are laid down by the province on the design of the surrounding area in this specific province, and to which citizens, municipalities and water boards have to comply with when carrying out plans and projects. The aim of the *Omgevingsverordening* is to anchor the most important subjects from the *Omgevingsvisie NH2050*. Once the official *Omgevinsverordening* has been published, it replaces all existing regulations relating to the living environment, such as the *Provinciale ruimtelijke Verordening* and the *Provinciale Milieuverordening.* With regard to heat, the draft version laid out that zoning plans that enable new spatial developments will be required to include a description of the way climate change risks have been taken into account in the plan. One of the risks identified is heat. Additionally, it has to describe the measures and provisions

taken to prevent or limit the risk and the consideration that has been given to this. At regional level, the region of Alkmaar has made a plan that presents the developments and trends in the region and identifies concrete choices and policy recommendations for these trends and developments. This plan is called *Omgevingsbeeld. Diversiteit als troef* (2017) and illustrates a perspective for the region for the next 13 years. This plan builds upon the momentum from the *Regiobeeld2025*, which was published in 2014 and was the starting point of the articulation of regional ambitions and the implementation of strategic regional cooperation. The *Omgevingsbeeld* is binding at regional level, guiding for the municipalities of the region, and agenda-setting for the province. It articulates that the region has to prepare for periods of heat, among other climate change impacts. In order to make the region climate proof, the plan argues that water and greenery should be implemented in existing neighbourhoods. Simultaneously, with the transformation of residential or industrial areas the principle of multiple use of space must be applied, through for instance roof gardens, water squares and green car parks. Implementing greenery is mentioned as an instrument to prevent heat stress.

5.2.2 Climate change adaptation policy in Alkmaar

Alkmaar has in 2017 published their so-called Environmental vision (*Omgevingsvisie) Omgevingsvisie Alkmaar 2040* to anticipate on the new Environmental law (*Omgevingswet)* that comes into force in 2021 (Aan de slag met de omgevingswet, n.d.). The Environmental Vision substitutes the Structure Vision (*Structuurvisie*), which municipalities were obliged to develop before. The Environmental vision contains a long-term strategic vision for the entire physical environment. It has to include the main features of the quality of the physical environment, the proposed development, use, management, protection and conservation of the territory, and the main elements of the policy in all relevant areas of the physical environment. Alkmaar's Environmental vision presents three main ambitions. The first ambition is the new area development along the banks of the Noordhollansch Kanaal. The plan is to transform this industrial area, into a high-density multi-functional (housing, businesses, recreation) urban area. Additionally, it has to serve as a pilot project for sustainable area development and for the implementation of new smart city technologies that are expected to enhance the air quality, energy transition, noise exposure and exposure to heat stress. The second ambition is "Compact City Alkmaar", this ambition elaborates on the fact that urban development should take place within the city itself. In other words, densifying the city rather than expanding the city. The vision states that densification will put pressure on the liveability of the city and the amount of

public space. To keep the city liveable, it is therefore important that the quality of public space, parks, water and green routes are ensured. At the same time, measures should be implemented to climate-proof the city. As densification will also increase the growth of heat stress during hot days and decrease the space for collecting water from heavy rain showers, greening the 'grey' surfaces will help to tackle both problems the vision states. The third and last ambition presented in the vision is "climate-proof and innovate rural area". The vision discusses that the impacts of climate change will also be visible in the rural area of Alkmaar. For example, the rural landscape and agricultural production will be influenced when events of waterlogging or periods of drought occur. Moreover, the salinization of the ground and surface water by subsidence, sea lever rise, and prolonged dry periods is another challenge that is already becoming a problem in Alkmaar. A year before the publication of the Environmental vision, the city of Alkmaar released the policy document *Greenery policy plan 2017-2027* (City of Alkmaar, 2016). This policy document lays out the vision and ambition of public green in the municipality of Alkmaar for the period 2017-2027. It argues that green can be used to adapt to climate change impacts, including heat stress. Thereby it follows the *coalition agreement 2015-2018* that stated, "In order to prevent damage or limit future intensive precipitation or heat periods, more space is needed for green space and water in urban areas" (City of Alkmaar, n.d., p. 20). Incorporating greenery in squares and encouraging façade gardens and vertical green will help to prevent heat stress and waterlogging in the relatively petrified historic city centre, the report argued. Simultaneously, greenery will be implemented in other neighbourhoods that lack greenery or where extra greenery is desirable for rainwater infiltration or the prevention of heat stress. As part of the green policy of Alkmaar a separate plan that elaborates on the tree structure was released in 2017 (City of Alkmaar, 2017 b). This report is called *Tree structure plan Alkmaar 2017-2027*. While the Environmental vision and the greening policy document do elaborate on heat stress, they do not mention urban heat islands, this plan however does acknowledge their existence and discusses that tree structures play an important role for reducing the urban heat island effect. Another policy document that elaborates on taking climate change adaption in Alkmaar is *Policy plan urban water 2017-2026* (Stadswerk072, 2017), which shows Alkmaar's strategy for the sewerage system and water. The most important item in this policy plan is climate change and its consequences. Even though this policy plan predominantly focuses on the way the municipality aims to fulfil the duty of taking care for waste water, rainwater and groundwater, the plan also elaborates on heat stress as part of the climate change adaptation challenge. The policy plan articulates four specific climate change impacts: flooding, waterlogging, heat stress and drought.

Results

Insights on institutional barriers and their emergence

This chapter lays out the results of this research. The structure of the results is based on the sequence of the sub-questions outlined in chapter 1. The first section will elaborate on the current policy for heat adaptation. Subsequently, the institutional barriers and their interdependencies that impede the mainstreaming of heat adaptation are presented, followed by explanations of why these institutional barriers emerge. Then the 'seeds of change' are discussed and the chapter is closed through discussing the findings in the light of the existing scientific literature.

6.1 A 'greening' policy: the ideas underlying Alkmaar's heat adaptation policy

As set out in the theoretical framework of this thesis, Schmidt (2012) stresses that ideas occur across three levels. This section will discuss for each level the ideas with regard to Alkmaar's heat adaptation policy. Doing this will help better understand Alkmaar's current policy and policy solutions for heat adaptation.

6.1.1 Policy

Alkmaar's policy for heat adaptation can be identified as a 'greening' policy, as policy solutions for heat stress are foremost based around implementing different kinds of greenery, such as trees, grass, vegetated roofs and facades. All respondents assert that implementing green is the main method used to adapt to heat stress and mitigate urban heat islands.

"The prevention of heat stress is in my opinion to make as little paved surface as possible, and to soften the existing paved surface. For example, by making green roofs or by making green facades. […] Laying out water and to ensure that the plants with trees are closed as little as possible so that air can flow through them." (Respondent 1)

In 2016, the municipality of Alkmaar published *Green policy plan Alkmaar 2017-2027* (City of Alkmaar, 2016). This policy document lays out the vision and ambition of public green areas in the municipality of Alkmaar for the period 2017-2027. It argues that green can be used to adapt to climate change impacts, including heat stress. In this it follows the *coalition agreement 2015-2018* that stated, *"In order to prevent damage or limit future intensive precipitation or heat periods, more space is needed for green space and water in urban areas"* (City of Alkmaar, 2016, p. 17). Incorporating greenery in squares and encouraging façade gardens and vertical green will help to prevent heat stress and waterlogging in the relatively petrified historic city centre, the report argued. Simultaneously, greenery will be implemented in other neighbourhoods that lack greenery or where extra greenery is desirable for rainwater infiltration or for the prevention of heat stress. Although the city's climate adaptation approach is not yet published, a respondent read the following from the draft version, *"greening can make a major contribution to the cooling of urban areas*" (Respondent 2). The execution of this policy is also visible in the new area development called the Kanaalzone, as the environmental image of the Kanaalzone development states, *"a green city is a climate adaptive city"* (2019, p. 4). On a similar note, the alderman argues that, together with cloud bursting challenges, heat stress will be dealt with in the Kanaalzone through greening the area. He states the following:

"In the Kanaalzone we are going to make it extremely green, so much greener in the public space. But also implementing green on and against the buildings." (Alderman public space of the municipality Alkmaar)

Other greening policy measures are the implementation of three tiny forests in the next two years. Moreover, the municipality has a subsidy for schools to green their schoolyards. Although the initial approach behind this policy is to get children engaged with nature, this at the same time reduces heat stress. Above all, a respondent argues that this subsidy is now being used for the purpose of heat adaptation as well.

"I notice that schools become more aware of heat, a while ago there was a school that said: 'we want more trees on the square, because we want more shade for the children'." (Respondent 7)

Besides implementing green in public spaces, policy focusses also on raising awareness of the importance of green space in private gardens. This is for instance done through the initiative

stone break (*Steenbreek*), which provides tips for how to green your private garden. In addition, the municipality stimulates implementing greenery through hosting the competition *Green neighbourhood champion* (*Groene buurt kampioen*). Residents can send in a greening idea for their own neighbourhood and the best idea will be implemented. As the respondents and the documents explain, policy for heat stress adaptation is concerned with implementing greenery measures and to a lesser extent water measures. However, other measures that have the possibility to reduce heat stress such as light-coloured material, the wind flow or the morphology of building blocks are not mentioned in policy documents. In conclusion, policy for heat stress is dominated by a 'greening' discourse.

6.1.2 Program

In Alkmaar, adaptation for heat stress is not addressed as a separate topic, but as a part of the climate change adaptation challenge. This means that measures to deal with heat stress are in most cases only implemented when they provide synergies.

"I don't think it is seen as specifically separate subjects. If you offer space for water adaptation, through working with trees, you also adapt to heat stress." (Respondent 3)

"*For us heat is really part of the bigger picture and is not seen as a separate story. So it really is part of the story climate adaptation and does not get specific attention."* (Respondent 2)

The goals to be achieved and the instruments applied are therefore considered for the overall issue of climate change adaptation. The alderman pointed out that although a standardized measurement method is missing for heat stress, this is not necessarily recognized as a problem. He states the following:

"What we are measuring now is just how much are we climate proof, what percentage of Alkmaar." (Alderman public space of the municipality of Alkmaar)

In conclusion, the main objective is not to solve the specific problem of heat stress but to climate-proof the city. The preference for greening therefore drives from the fact that it provides synergies for multiple climate change adaptation subjects.

6.1.3 Philosophy

In Alkmaar the philosophy behind implementing measures for climate change adaptation is that a city should have a good liveability. Liveability is argued to be one of the key things for the city to enhance its attractiveness as a living and recreational environment.

"You want to remain a liveable city, you don't want people to move away." (Respondent 4)

The concept of liveability encompasses a lot of things and legitimates why climate change adaptation measures should be taken.

"It's not liveable if your basement is flooded a few times a year, it's not liveable if you pass out from the heat" (Respondent 3)

Likewise, the interviewees argue that implementing green also enhances the liveability of the city as it creates a better quality environment where people tend to be happier. In conclusion, the policy preference for implementing greening measures to adapt to heat stress also arises from the philosophy of providing a liveable city. The fact that greening can at the same time adapt to extreme heat and enhance the liveability of the city on other topics, makes it a favoured strategy. To conclude, on all three levels of ideas, heat adaptation emerges out of a synergy of the implementation of measures for other issues related to climate adaptation and liveability, and is not explicitly treated as a separate problem. On the policy level, Alkmaar takes on a greening policy approach. On the program level, the focus is on climate-proofing the city through the creation of synergies between different climate issues. On the philosophy level, Alkmaar has the realisation of a liveable city as its main point of departure.

6.2 Urban heat adaptation barriers

This paragraph discusses the institutional barriers that impede the mainstreaming of heat stress adaptation. As barriers often co-occur or reinforce each other, the following sections do not only describe the institutional barriers that emerged, but also outline their interdependencies. The institutional barriers that are found emerge in different stages of the decision-making process. Whereas some barriers impede the development of specific heat adaptation policy, others impede the implementation of heat adaptation measures. Based on this, two groups of

barriers can be divided: policy development barriers and implementation barriers. However, a lack of knowledge, lack of financial resources, lack of staff and a lack of information and guidance arise both during policy development and policy implementation. Beside these, a low sense of urgency impedes the development of policy. Other barriers that arise during the policy implementation phase are: lack of a supportive regulative framework, other land use priorities, conflicting interest with stakeholders. and routines.

6.2.1 Human resources: lack of knowledge

A lack of knowledge regarding heat adaptation within the organisation turns out to be one of the predominant barriers. A respondent argues:

"People get bogged down in the subject, and are dropping out" (Respondent 5)

This respondent asserts that, currently it is not clear what the definition of heat stress is and what the levels of heat stress are that should be accepted. This lack of knowledge is related to a lack of guidance of higher levels of government, because national policy does not outline the levels of heat stress that can be accepted. Another respondent argues that missing knowledge about temperatures at lower scale levels impedes the creation of policy measures for vulnerable groups for heat stress, such as schools and retirement homes (Respondent 7). In addition, while respondents stress that the city of Alkmaar is made climate-proof by implementing greenery, knowledge about other measures that could be implemented for adapting to periods of extreme heat is lacking. This does not mean that respondents at the core of implementing adaptation measures or designing spaces are ignorant of the existence of other measures for heat adaptation. They indicate, however, that knowledge is missing with regard to the impact these 'other' measures would have on reducing extreme heat, and the emanating negative side effects of these measures that can possibly emerge. For instance, it is not clear if light coloured pavement or roofs helps to reduce urban heat islands.

"*Look, I know that in Boston they have forbidden to paint roofs white because this causes the top layer of air get too hot. What strikes me more and more is that people talk to each other without really thinking about: 'is this true or not?'. For God's sake, let's do some good research!*" (Respondent 4).

6.2.2 Lack of financial resources

Respondents point out that one of the main barriers is a lack of financial resources. The alderman mentions that money is always lacking, especially due to the budget cuts of the national governments. This also puts pressure on other policy areas such as the social domain.

"The question is: in the total budget, what is the priority of heat stress? Are we going to do less about healthcare, so that we can do something about heat stress? That of course is always the field of tension, as money is a scarce resource" (Alderman public space at the municipality of Alkmaar)

Therefore, priorities have to made about which places should be made climate-proof first, as climate-proofing the municipality as a whole is very expensive.

"If you look at what we are investing in, we have a map that shows the entire municipality of Alkmaar as regards to heat stress and waterlogging, and that's where the top 10 prioritizations are chosen that will be improved. Which in turn makes you get a new top 10, because that top 10 doesn't end there anymore." (Alderman public space at the municipality of Alkmaar)

However, other respondents argue that climate proofing current areas in Alkmaar is foremost concerned with waterlogging issues. The reason for this is twofold: in the first place because waterlogging is perceived to have more urgency, and on the other hand because most financial resources are present at the sewage department (Respondent 6, 5). Furthermore, at the implementation level it is argued that it would be nice if project developers would increase their maximum investment for implementing measures for climate change adaptation (Respondent 4). However, this is found to be difficult as project developers are foremost concerned with making as much money as possible and there are no regulative tools to force them to implement heat adaptation measures.

6.2.3 Human resources: Lack of staff

Stadswerk072 lacks staff with a certain professional background to tackle the challenge of climate change adaptation (Respondent 5). For example, people with a background in urban planning are lacking. This lack of staff is related to the insufficient cooperation between departments and a lack of financial resources. Better cooperation between departments can help

fill this capacity gap. However, a respondent argues that people are thinking too much pigeonholed. However, all the other respondents argue that departments are working together well. A lack of staff is also recognized by policy officials who argue that even though outlining general policy for climate change adaptation is feasible with the staff available, they mention that staff for the actual implementation of this policy is lacking.

6.2.4 Lack of information or guidance

Because higher levels of government do not provide norms, it is not clear how heat stress is defined and what the levels of heat stress are that should be accepted (Respondent 5).

"*The national level of government says: 'municipalities, it's up to you to decide what you do or do not accept.' But I think that municipalities can do very little with that. Municipalities are going to look to each other and if there is no urgency, they just don't do it*." (Respondent 5)

In addition, this respondent also argues that because of the lack of capacity, priorities have to be set. That's why the national government or higher up in the organisations should provide guidelines to specify not only the problem but also the task.

"That one manager is just not going to make it on his own and you need something else from the width of the organization. From higher up of the organization we need direction: this is the direction we are going to take, and this means that I expect this from spatial planning, this from Stadswerk and this from traffic etcetera." (Respondent 5)

A policy official also argues that because there is not a specific heat department and lots of departments have something to do with it, there is not someone or some department who takes the lead (Respondent 7).

6.2.5 Low sense of urgency

From the interviews it became clear that the obligation to provide implementation agendas comprises an urgent imperative for implementing heat stress adaptation measures. Since climate change adaptation is viewed as an overarching challenge, the alderman argues that all climate change adaptation topics (drought, waterlogging, flooding and heat) have the same

urgency. However, the other respondents feel that in reality the political focus is slightly more on drought and waterlogging challenges.

"The questions of the alderman are more regarding building nature-inclusive and regarding water. But heat stress is not specifically mentioned. Nobody has ever asked me, what about the heat stress at this location?" (Respondent 3)

The interviews revealed that because Alkmaar contains a lot of greenery, heat stress is perceived as a less urgent issue compared to drought and waterlogging. However, as the heat stress tests show the accumulation of heat in the historic inner city of Alkmaar, respondents concerned with green policy and the implementation of climate change adaptation recognized a high level of urgency in this part of the city. On the other hand, respondents who have more influence on policy development perceive heat in the inner city as a less urgent topic. Respondents argue that it is difficult to show other people the urgency of heat stress as the perceived risk is low due the fact that the occurrence of heat is not yet perceived as a problem and there are is no information available that shows the exact temperature increase for specific locations in the following years. One respondent argues that heat stress is less politically visible, because of the creeping nature of the problem (Respondent 2). Whereas waterlogging events appear often and are perceived to damage things people value, heat extremes appear incidental and are therefore not yet perceived as a problem by citizens, as they enjoy the nice weather. It is believed that heat waves have to appear sequentially for a couple of years, before citizens see the link between weather and climate and no longer perceive heat as nice. This quote further exemplifies what needs to happen for heat stress to gain more attention:

"We have of course the cheese market which is extremely important. But last summer it was so hot here that the cheeses could no longer be exhibited on the market because they melted. This is of course not a good thing when 3000 Japanese and Germans are standing there, and you have to cover your cheeses because they are melting. So, these are annoying issues for your economy in the long term, and I think it could well be that it is not the social health component that can be decisive, but the economic tourism factor. Because it doesn't bring you money if you can't show your cheeses and people think it's too hot to look at cheeses with 40 degrees on a square." (Respondent 2)

Even though there is a sense of urgency and a sense awareness of respondents of the increase of heat extremes in the following years, the fact that it not yet threatens things people value makes it less of an urgent topic. Consequently, there is not a specific extreme heat policy.

6.2.6 Lack of a supportive regulative framework

All respondents that are involved in the process of implementing measures for climate change adaptation argue that a supportive regulative framework for implementing heat adaptation measures is missing. If developers do not want to implement measures to reduce extreme heat, there is no regulative tool to force these unwilling developers to implement these measures. The following quote exemplifies this:

"I have the idea that facades can contribute a lot more to heat stress reduction. But facades aren't ours and we don't have the sticks to turn them around, so to speak. […] because the developer is in charge of the façade, but he says: 'I want windows'." (Respondent 1)

Policy officials explain that a regulative framework is missing, because there are difficulties with the legal anchoring of climate change adaptation strategies and policies. However, it is argued that the new environmental law provides more opportunities for this in the future (Respondent 2, 5). Yet, even when this new law is put into use there is still difficulty with regard to determining what should be anchored legally.

"It is just very difficult to secure climate adaptation in zoning plans in one way or another, because: where do you set the bar, and what standards do you use?" (Respondent 5)

This difficulty is due, inter alia, to the lack of knowledge of the norms of heat stress that can be accepted. In addition, it is also felt that you do not want to give developers too many regulations they have to commit to.

"*If you come up with a large list of regulations such as: it must be socially inclusive, it must have a certain percentage of social housing, parking, the bicycle, it has to include nature etcetera. Then the developer says: 'Alkmaar, good luck, I am first going to fill the rest of The Netherlands with buildings instead'.*" (Respondent 3)

This brings the question: do you use incentives, or impose the implementation of measures? One respondent explains that finding an answer to this question is a big challenge (Respondent 2).

6.2.7 Other land use priorities

Another principal observation is that measures that enhance mobility are receiving priority for space over implementing greenery. It is argued that Alkmaar is a 'car minded' city (Respondent 1,4). The fact that mobility and accessibility are seen as an economic precondition makes it a higher priority than implementing greenery for climate adaptive reasons. This provides a struggle with the implementation of greenery:

"*I see that the intensification of the use of a city also means that we simply put on a lot of pavement and unfortunately not much greenery. For example, recently some extra parking spaces have been made in the city centre. Then I think I would have preferred not to build parking spaces but to make them extra green*." (Respondent 1)

Besides, it is argued that because the development of parking basements and the building of parking facilities is expensive and the fact that Alkmaar is not very good at enforcing built parking solutions, car parking will be facilitated in public spaces. However, the same respondent also states that the municipality tries to facilitate parking as much as possible on grass surfaces, but this comes with some technical challenges such as the amount of sunlight required to let the grass grow. Simultaneously, other road users are also getting much space.

"*A big threat is the car, and so are other road users. Because nowadays we want bike paths of 4 or 5 meters wide, as cycling is important. But if you want to cycle and you want space to walk and lots of space for the car, and public transport, such as a separate bus lane, that is all paved surface."* (Respondent 1)

It is also noticed that squares in the inner city contain a small number of trees, because these squares function as places where activities such as a market or festival are organised, leaving little room for trees. Besides these other functions receiving priority for physical space, there are also policy issues that receive more attention at policy level. A respondent indicates that the

energy transition gets more attention within the organisation (Respondent 2). Although it is a political decision, the respondent likes to see some attention shifting from the energy transition to climate change adaptation. This prioritisation of other land use functions is related to a low sense of urgency for heat adaptation.

6.2.8 Conflicting interests with stakeholders

The interviewees indicate that greening measures can be difficult to implement because stakeholders have other interests. Several examples are given. For instance, implementing solar cells receives priority over implementing greenery, such as roof gardens, by developers. As energy costs money, developers prefer to build energy-efficient buildings. The respondent argues that developers lack knowledge as garden roofs provide better yields of solar panels.

"Developers say: 'no we do solar panels on the roofs so we don't do a roof garden', so then I explain that a roof garden cools the local climate on the roof, providing solar panels with better yields. Then you see those people look a bit blurry and wonder: 'how is that possible?' In fact, they are only focusing on those energy consumption levels." (Respondent 1)

As there is no regulative framework to force unwilling developers to implement heat adaptation measures, conflicting interest can become an institutional barrier. Both barriers are therefore related. Another example is presented by an urban designer, who explained that with the development of a square, it is preferable to implement a green surface. However, this causes tension with the owners of the businesses there, who like to put their terraces on paved surfaces (Respondent 4). Although the urban designer attempts to explain that having a green surface is also beneficial for them, as it is not good for their businesses either when it gets too hot, it is likely that the development of the square will be a compromise.

"Actually, you would like it to be all +green. But that's going to be a problem with those business owners. So, we are also working on how we can make it as green as possible, a kind of compromise model." (Respondent 4)

This conflicting interest is related to a lack of public awareness, because these business owners are not aware of the negative consequences of implementing impervious surfaces. The same urban designer argues that a trend is visible where residents like to have an outdoor area with

no trees. The expectation is that in regard of climate change adaptation this will be a topic of discussion in the coming next years.

6.2.9 Routines

In Alkmaar multiple routines that impede heat adaptation are observed. The first observation is that the norm is to implement impervious surfaces, rather than pervious surfaces such as grass. Simultaneously, the implementation of heat adaptation measures is embedded in a 'greening routine'. Although this may seem paradoxical with the former routine, it means that the policy strategy for heat adaptation is exploiting synergies of implementing greenery for other purposes. This routine can be seen as a barrier, as because of this routine learning with regard to heat adaptive measures is also predominantly concerned with greenery. As a consequence of this, learning about other measures that can be used to adapt to heat stress or mitigate urban heat islands is missing.

"*We have the kind of perception that if we place enough trees, it would be fine. But I think there are also a lot of developments and innovations in the light of heat adaptation. However, there is simply too little attention for that*." (Respondent 5)

The result of this is that other alternative strategies are not taken into account. However, it has to be noted that although this 'greening routine' impedes on the one hand the implementation of other heat stress adaptation measures, on the other hand it is also the number one driver for implementing measures for extreme heat at all. Finally, because in the past decades the climate of the Netherlands was characterised by cold winters, urban designers used to design streets that would enhance the amount of sunlight shining into windows, warming up houses.

6.3 Explaining the emergence of institutional barriers

In this paragraph the causes subsequent to the emergence of institutional barriers that impede heat adaptation will be discussed. The results will be interpreted based on the literature outlined in the theoretical framework (chapter 3). As the theories used in the theoretical framework are not sufficient to explain the emergence of institutional barriers in this specific context, theory will be complemented with literature regarding urban identity and city branding.

6.3.1 A low sense of urgency: heat adaptation as formal requirement

Previous research argued that heat adaptation in the Netherlands was hindered because it was viewed as an individual task instead of a public one (Runhaar et al., 2012; Tennekes, 2014). Recently, this changed as the installation of formal regulations set by the national government to provide implementation agendas for heat adaptation made it a public task. What also changed is that this formal regulation resulted in an increase of urgency to implement heat adaptation. However, while this moved the issue up the policy agenda, compared to other climate adaptation issues heat still receives a low sense of urgency. The absence of a specific heat adaptation policy can therefore partly be explained by this low sense of urgency. There are several factors subsequent to this low sense of urgency. Firstly, policy officials argue that because citizens are either unaware of the causal relationship between climate change and extreme heat events or because they have low risk perceptions with regard to extreme heat events, citizens do not exert pressure on decision-makers to do something about the matter. Since heat only occurs for a short period of time, periods of extreme heat are not perceived as a problem, but as something positive by citizens. In addition, the creeping nature of increasing temperatures makes the problem less visible. Secondly, policy officials argue that the topic is less urgent because the likelihood that heat extremes will increase in temperature and appear more often is something that will appear in the future and does not damage things that are valued at this moment. Waterlogging, in contrast, is damaging in the present time. Therefore, policy officials perceive that the moment heat extremes will damage things that are valued, such as the cheese market, action will be undertaken. In third place, urgency to take action is low because heat stress only occurs in certain areas, such as the city centre. Moreover, policy officials perceive a high adaptive capacity of the overall city to heat, because the city contains a large amount of green. Despite the large amount of green in the city, there are still heat islands visible on the heat stress map of Alkmaar. Therefore, these spots need to gain specific heat adaptation policy attention. Risk and hazard theory draws attention to the importance of a crisis or focusing event to create a trigger or a ‘window of opportunity’ for moving a climate issue up the policy agenda or to gain institutional or public attention for it (Verduin et al., 2012). It can be concluded that because a ‘window of opportunity’ has not yet appeared, no specific heat adaptation policy is created.

6.3.2 Heat adaptation policy implications of multi-level governance

This following section addresses the implications of multi-level governance on the emergence of institutional barriers. In Alkmaar, hierarchical policy power was used through vertical governance to put heat adaptation on the municipal agenda. However, literature argues that action at the local scale cannot only be enabled, but also constrained by the national government. Scholars assert that the vertical relationship between local and higher levels of government relates mainly to the ability of municipalities to access higher-level funding and resources in order to respond effectively to climate change impacts. In Alkmaar, heat adaptation polices inert, as resources for the implementation of heat adaptation measures are not yet made available by the national government. In addition, financial resources for the implementation of heat adaptation policy are lacking due to budget cuts of the national government on the financial resources of municipalities. This and the recent decentralisation of policy fields, such as healthcare and youth care, without a proportional increase of funding from the central government, stretched municipal budgets (Dabrowski, 2018). In this context of budget cuts, a 'wait and see' stance is adopted. This is also the result of a mismatch between the long-term perspective at the national level, which requires municipalities to accelerate their adaptation policies and the four-year electoral cycle perspective of local leaders, who were argued to have a shorter time perspective. Therefore, respondents argued that they felt priority was given to other more publicly visible policy issues. This also explains for instance why their climate change adaptation policy revolves around dealing with cloud bursting impacts. So, devolving climate change adaptation tasks should be accompanied with available financial resources. Secondly, Corfee Molot et al. (2009) note that the way local governments can respond to climate change challenges is often 'nested' in legal and institutional frameworks at higher scales of government. Beside the fact that local policies are dependent on national budgets, as is set out above, they are also dependent on the legal framework set by national government. It is argued that at the moment there is a mismatch between provincial policy and jurisdiction. This is because the provincial Environmental vision (*Omgevingsvisie*) is already adapted to the new Environmental law and therefore not yet legally enforceable for municipalities. In addition, the current legal framework is argued to be insufficient for the legal anchoring of climate change adaptation policies. Therefore, the creation of a regulative framework to support the implementation of climate change policies will wait until the new Environmental law will be adopted that provides more options for legal anchoring. Thirdly, although heat adaptation is

guided through a national mandate, national leadership is lacking in the formulation of heat adaptation norms. As there is a low perception of urgency to implement heat adaptation measures, without specifying the heat adaptation task it can be expected that no specific heat adaptation policy will be implemented. Besides the vertical dimension of multi-level governance, the horizontal dimension also has its implications on the rise of institutional barriers. For the implementation of climate change adaptation policy, Alkmaar cooperates with municipalities within the region and with the water board Hoogheemraadschap Hollands Noorderkwartier, in the regional partnership *Waterketen* and the recently started project *Spatial adaptation*. Dabrowksi (2018) argued that these networks are favourable to learning and give local governments access to flows of knowledge and resources. Therefore, a lack of knowledge about issues related to extreme heat and urban heat islands can be attributed to the observation of a respondent who argued that knowledge is exchanged within the network on all other climate change adaptation issues except from heat.

6.3.3 Institutionalized water board tasks and deeply rooted routines

Overall, there is a strong emphasis on adaptation to cloud bursting impacts in Alkmaar. To better understand this dominance in the climate change adaptation policy, and to understand why heat adaptation revolves around a strategy focused on exploiting the synergies of implementing greenery or measures for other climate issues (as opposed to focusing on heat adaptation on its own), it is important to address how institutions inert. Historical Institutionalism (HI) makes explicit that institutions are shaped by historical factors, and views inertia as a result of path dependency. Therefore, these strong policy monopolies can be explained by deeply rooted institutions. First, a strong water dominance is established through structural path dependency. The Netherlands knows a long tradition of water management and flood defence (Sanczuk-Galwaiczek, Sobolewska-Mikulska, Ritzema, Jantsje & van Loon-Steensma, 2018). After the middle ages, a collective system for dike building and management emerged. Water boards were established to supervise flood protection and drainage efforts, as the drainage of many swamps produced soil subsidence. Until today, the tasks of water boards lie still exclusively in the field of water management. This deeply institutionalized task of water boards can partly explain the dominance of water adaptation in Alkmaar's overall climate change adaptation policy. As is argued by the interviewed water manager, although the water board contributes to heat adaptation by providing heat stress maps for the municipality and

organising knowledge meetings regarding heat stress, heat adaptation is in comparison to drought, flooding and waterlogging not a task of the water board. Thus, the emphasis in the regional cooperation is on these subjects. Water adaptation is further stimulated by the development of a legally required procedure, the *water test* (*watertoets*). The shift from 'government' to 'governance' influenced the water domain, as traditional water issues are becoming more intertwined with the spatial domain. The occurrence of waterlogging crises in 1993, 1995 and 1998 provided a 'window of opportunity' for moving climate change adaptation to water impacts up the policy agenda. Following these events, the *Commission water management 21st century* was established, which among other tasks conducts research to look at water management in relation to spatial planning. They concluded that the cooperation at the political-administrative level was insufficient and water was given little attention in spatial planning (Commissie Waterbeheer 21e eeuw, 2000). To make water a more guiding principle in spatial planning, the development of a legally required procedure, the *water test,* was established. The *water test* sets the obligation for spatial planners to involve the water manager at an early stage in the planning process that has the aim to inform, advice, weight and ultimately assess the hydrological aspects in spatial plans and decisions. Respondents argue that the fact that for water management there is a tool that legally enforces the incorporation of water adaptation in spatial planning, makes it easier to implement measures. Such a tool is missing for the incorporation of heat adaptation measures in spatial plans. Beside this structural path dependency, a cultural path dependency is the policy strategy for heat adaptation by exploiting the synergies of implementing greenery. Clearly, there is a greening routine for implementing heat adaptation measures. A respondent argues that green is viewed as important by policies and that where other municipalities have cut back money for implementing greenery this was never the case in Alkmaar. The fact that traditionally Alkmaar has always been a green city can explain this. A discursive institutionalist perspective can also help understand why heat adaptation is only implemented as a synergy of the implementation of measures for other issues such as waterlogging and why the overall norm is to implement impervious surfaces. From the interviews it became clear that there is a person in the organisation (municipality) that has already in the past argued to implement measures to make a neighbourhood heat proof. Thus, this person is able to think outside the existing institutions. Yet, as Schmidt (2012) states, a person's 'foreground discursive abilities' explains why institutions inert or change. The explanation of why this routine persists drives from the observation that this person did not have the persuasive capacity to persuade others to do this. Sources of power and resources were missing to make things happen and to exert effective leadership. Since historic institutionalism

argues that in order to change a path, a crisis or focus event has to take place, the fact that no focus event appeared can explain why heat adaptation revolves around a strategy focused on exploiting the synergies of implementing greenery or measures for other climate issues. Given the creeping nature of the UHI problem, and the literal invisibility of urban heat islands, it is hard to imagine what such a focusing event could encompass. The heat wave of 2006 caused many deaths in The Netherlands, but this did not put urban heat firmly on the public agenda. On the other hand, discursive institutionalists rely more on the belief that endogenous forces change institutions. Therefore, changes in the status quo of heat adaptation depends on the persuasiveness of the person arguing for those changes. An increase in this persuasiveness is already visible, as it is argued that the outcomes of the stress test help to make colleagues more aware of why heat adaptation measures should be implemented.

6.3.4 A green image: urban identity and city branding

Both the concepts city place branding and urban identity stipulate the importance of a city's image (Riza, Doratli & Fasli, 2012). Lynch (1981) defines place identity as "the extent to which a person can recognize or recall a place as being distinct from other places" (1981, in Oktay, 2002, p. 261). Key to the concept of urban identity is the way people's image and memories of a city are shaped through a city's identifiable urban elements such as public spaces and monumental buildings (Riza et al., 2012; Oktay, 2002). By assigning certain values to a place, individuals can derive meaning from it. This makes them more connected to their environment and confirms that the environment belongs to them. This encourages people to take care of and be involved with their environment (Oktay, 2002). In addition, place identity can also be used to promote a city. Faced with a shift from a local to a global environment, increasingly cities have to compete with each other in order to be an attractive tourist destination, workplace, culturally rich place and much more (Riza et al., 2012). In doing so, they develop strategies to promote themselves, such as city branding (Gulsrund, Gooding & Konijnendijk, 2013). City branding is concerned with creating an image that is unique and differentiable from others (Riza et al., 2012). According to Kotler, "places are products whose identities and values must be designed and marketed" (1999, in Riza et al., 2012, p. 294). Cities can reinforce their identity through building on existing factors such as quality of life or landscape (Gulsrund et al., 2013). One type of city branding is focused on branding a 'green' or environmentally-sustainable city. When used in a marketing context, the word green refers both to environmental policy and to the biophysical dimension. The former is about issues of sustainable development, pollution

control, and reducing emissions. The latter refers to the green space component in cities, such as parks and other urban vegetation, and underlines the value of green urban space in improving the quality of urban life. As Richard Florida (2008), author of a popularizing book on place branding, argues, 'place' is as a key determinant for people's happiness and success. He assumes that in order for cities to attract economic factors such as talent, innovation and creativity, cities should have high quality living environments that include good parks and public areas. Therefore, branding cities as 'green' has become a global tool for municipal officials to promise prospective tourists and inhabitants a better quality of life, increasing a cities competitive advantage. These concepts can explain for a part why Alkmaar has a 'greening routine'. As is set out above, Alkmaar already has a lot of greenery. The city's philosophy behind the implementation of greenery is to enhance its liveability. That is why liveability is one of the three overarching themes (liveability, safety and infrastructure) spatial planning revolves around. A liveable, safe city with good infrastructure is seen as a precondition for attracting visitors, business, and residents. Additionally, it is also believed that residents resonate more with the liveability of a city, rather than with how climate-proof a city is. This also makes implementing greenery a favoured strategy. And as climate change adaptation and liveability should not be seen as mutually exclusive, implementing green can serve both causes. Implementing greenery therefore drives from the broader context of providing a 'good quality of life' in the city, in order to keep and attract residents, businesses and visitors. Besides the fact that Alkmaar receives it identity from a green environment, it is mainly known for its cheese market. The promotion of Alkmaar as a tourist destination revolves therefore mainly around the cheese market. It is therefore presumable that when increasing temperatures will let these cheeses melt, a 'window of opportunity' will appear. When the cheeses cannot be displayed because of the heat, visitors will be less likely to come. So, the impacts of high temperatures on the cheese market will probably decrease the cities attractiveness as tourist destination, having a negative effect on the city's economy.

6.4 'Seeds for change'

The interviews showed that there are some 'seeds for change' that can help overcome the identified institutional barriers presented above that impede heat adaptation. Influences of national policy have played a key role in moving up heat adaptation on the policy agenda. However, national funds for the implementation of climate change adaptation measures will

not be made available until 2021. But with access to financial resources in the offing, a lack of financial resources to implement heat adaptation measures can be solved. Also, these funds can be used to hire new staff. Furthermore, the adoption of the new planning law in 2021 will provide more opportunity for local norm setting. Besides this, at the regional level, policy officials already look into the possibility of stretching out the water test into a climate test. Both are hopeful developments for the creation of a supportive regulative framework in the future. Another 'seed for change' is the Kanaalzone development which shows outward signs in line with green (new) urbanism design principles. This can indicate a shift from the preference for a 'car-minded' city to a more sustainable city, which supports less car use and gives a higher priority for implementing greenery. This can mean that not in every case priority for space will be given to car infrastructure over implementing green measures. Furthermore, two factors can be identified that may increase the sense of urgency for heat adaptation in the future. First, the results from the stress test will help create awareness among municipal officials and help them to look beyond the structure they act in. Presumably, this can help change the routine of designing streets and places, that warm up the area. Secondly, in a scenario where the cheese market experiences harm from rising temperatures, for instance because the cheeses are melting, a 'window of opportunity' is likely to appear. If this happens, valued attributes (the cheese market) are harmed, which will increase the risk perceptions among the market salesmen, leading to a higher sense of urgency to take action. The expectation is that this would lead to the salesmen putting pressure on the municipality to adapt to extreme heat.

6.5 Discussion

Before conducting this research, little was known about how institutional barriers for heat adaptation arose. So far, research has predominantly focused on providing a descriptive analysis of institutional barriers, by identifying the institutional factors that impede or stimulate the policy creation as well as implementation of climate change adaptation policy. In addition, previous research concerned with investigating institutional barriers for heat adaptation in the Dutch context focused on identifying barriers that impede the recognition of heat stress as a problem (Runhaar et al., 2012; Tennekes, 2014). Those studies showed that heat stress was not perceived as an urgent problem because there is no clear 'problem owner'. This research, on the other hand, reveals that due to the formal regulations set by the national government to provide implementation agendas for heat adaptation, heat is recognized to be a public task,

which increases the sense of urgency. However, the creeping and invisible nature of the problem explain why, compared to other climate change adaptation challenges, the sense of urgency remains low. This corresponds with the findings of Runhaar et al. (2012) who also showed that features of the problem at hand such as the fact that heat stress only occurs over a short period of time and the fact that only a small area is vulnerable for heat stress (e.g. city centre), contributed to a low sense of awareness and urgency. However, the results of this research show that the emergence of institutional barriers in the case cannot be solely attributed to the physical features of heat stress. In fact, the results show a tremendous influence of the national legal and institutional frameworks in not only stimulating the implementation of heat adaptation policy, but also in limiting local implementation possibilities. On the one hand, vertical governance has stimulated the moving of the issue of heat adaptation up the policy agenda. On the other hand, the findings of this research correlate with the results of Dabrowski (2018) who explored the influence of multi-level governance on the urban adaption policies for flooding in the South Wing of the Randstad. Both investigations found that in times of budget cuts climate change adaptation issues that are viewed as less urgent are relegated to the waiting room. In addition, the recent decentralization of policy fields stretched municipal budgets influencing a lack of financial resources for implementing climate change adaptation issues. Besides that, the implementation of heat adaptation measures through a 'greening routine' can be explained as an outcome of path dependency. As traditionally Alkmaar is a green city and has supported the implementation of green over a long time for other purposes, green is still one of the main measures for climate adaptation in Alkmaar. Another explanation which was not elaborated on in the theoretical framework of this thesis, but which has emerged out of the findings, is that greenery is part of the Alkmaar's city branding strategy. Therefore, implementing green is part of enhancing the city's liveability which is good for attracting visitors, businesses and residents. Central to the discursive institutionalist literature is the explanation of institutional change as a consequence of agency (Schmidt, 2012). Institutional inertia can therefore be expected to emerge when agency is lacking. The routine to implement impervious surface can thus be understood by the lack of 'foreground discursive' abilities of actors that can think outside their structure to exert agency.

Conclusion

7.1 Answering the research questions

This thesis began with the observation that urban adaptation responses to climate change pay little attention to heat stress and urban heat islands, which causes climate change adaptation to remain predominately a water issue. After the deadly heatwave in 2006, one can wonder why heat adaptation is not much of an issue in most climate change adaptation policies of Dutch cities. Therefore, this research has looked into the institutional barriers that impede the mainstreaming of heat adaptation. Current research on institutional barriers has so far mostly focused on identifying institutional barriers that impede climate change adaptation, rather than explaining how these barriers emerge. The aim of this thesis was therefore to overcome this knowledge gap. Because of this, I did not only attempt to identify institutional barriers that impede the mainstreaming of heat adaptation policy, but also to explore how these institutional barriers emerge. In order to achieve this goal, sub-questions were developed to help answer the central question of this research: *How do institutional barriers emerge that impede the mainstreaming of heat stress adaptation and urban heat island mitigation in a mid-sized city in the Netherlands?* Before answering the main question, I discuss the key findings that answer the sub-questions:

1. Which institutional barriers that impede the mainstreaming of climate change adaptation can be derived from the academic literature?
2. What explanations for the emergence of institutional barriers that impede the mainstreaming of heat stress adaptation and urban heat island mitigation can be derived from the academic literature?
3. Which institutional barriers that impede the mainstreaming of heat stress adaptation and urban heat islands mitigation can be identified in Alkmaar?
4. How are the identified institutional barriers that impede the mainstreaming of heat stress adaptation and mitigation for urban heat islands in Alkmaar interdependent of each other?
5. Which factors explain the emergence of these institutional barriers?

1. Which institutional barriers that impede the mainstreaming of climate change adaptation can be derived from the academic literature?

The answer to this question has been provided in the theoretical framework (chapter 3). The academic literature identifies several institutional barriers that can impede the mainstreaming of climate change adaptation. According to Moser and Esktrom (2010) different institutional barriers appear in different stages – understanding, planning, managing - of the decision-making process. Runhaar, Wilk Persson, Uittenbroek and Wamsler (2018) developed a generic analytical framework of institutional barriers that impede the mainstreaming of climate change adaptation. They identified six categories of institutional barriers that impede the mainstreaming of climate change adaptation: political factors, organisational factors, resources, cognitive factors, characteristics of the adaptation problem at issue, and timing. This framework was used in this research to structure the institutional barriers found in the literature (table 7.1). *Political barriers* involve, for instance, a lack of political commitment, inflexibility of legislative and policy context, and a low level of public awareness. If the public is not aware of the risks climate change impacts bring along, they are not inclined to put pressure on decision-makers to take climate adaptation action. *Organisational barriers* relate to both intra- and inter-organisational factors, such as a lack of formal requirements or incentives to develop sectoral adaptation plans, absence of a supportive regulative framework, and poor coordination and cooperation between government departments. In addition to these barriers, the literature review also has found that organisational routines can become an institutional barrier when routines become more standardized. For example, when climate change adaptation is approached by an organizational routine of implementing greenery, alternative options are not likely to be implemented. Literature argues that small- and midsized Dutch cities have more difficulty with implementing climate change adaptation as they have little human and financial *resources*. Here, human resources comprise not only the amount of available staff, but also the degree of expertise and knowledge the actors that are involved have. *Cognitive barriers* that can impede mainstreaming climate change adaptation are: a high degree of scientific uncertainty about the impacts of climate change, low degree of awareness of climate change and its risks, and a low level of social learning. Also, the perception of a low level of urgency can be a barrier. Low levels of urgency are for instance perceived in circumstances where the impacts of climate change are felt in the future, leading to a lower sense of urgency to do something about it now than when the impacts are expected or felt currently. Another barrier identified by Runhaar et al. (2018) are the *characteristics of the adaptation problem at issue.*

Whether this will be a barrier depends for instance on how the adaptation objective is framed and connected with sectoral objectives, as well as the level of detail in which adaptation objectives are conceptualized, and how compatible the time frames are. The final category, *timing,* relates to whether there is a momentum for the implementation of climate change adaptation measures, such as a new area development or redevelopment of a neighbourhood. If this is not the case, it is less plausible that climate change adaptation measures will be implemented. To conclude, the academic literature identifies a large array of institutional barriers that can possibly impede the mainstreaming of climate change adaptation, and those barriers appear in different stages of the decision-making process and are related to multiple factors. Which barriers are relevant, and their degree of importance, depends on the specific context within which climate change adaptation has to take place. All the barriers found in the literature are summarized in table 7.1 below.

CATEGORY	INSTITUTIONAL BARRIER
POLITICAL FACTORS	Lack of political commitment Inflexibility of legislative and policy context Low level of public awareness, support and pressure Low level of political stability
ORGANISATIONAL FACTORS	High level of administrative fragmentation Organizational routines Absence of formal requirements of incentives to develop sectoral adaptation plans Absence of a supportive regulative framework, mandates and statues Lack of coordination and cooperation between government departments Lack of coordination with private actors Ambiguity about responsibilities for adaptation Lack of administrative leadership
RESOURCES	Lack of financial resources Lack of human resources
COGNITIVE FACTORS	High degree of scientific uncertainty about the impacts of climate change Low level of urgency Low degree of awareness of climate change and its risks Low level of social learning
CHARACTERISTICS OF THE ADAPTATION PROBLEM AT ISSUE	Low level of detail in which adaptation objectives are conceptualized Incompatible time frame
TIMING	Absence of a 'window of opportunity'. A crisis or a focus event has not yet appeared

Table 7.1 Overview of institutional barriers that can impede climate change adaptation (created by author)

2. What explanations for the emergence of institutional barriers that impede the mainstreaming of heat stress adaptation and urban heat island mitigation can be derived from the academic literature?

In the literature review (chapter 3) several factors were found that explained the emergence of institutional barriers that impede the mainstreaming of heat adaptation. Characteristics of extreme heat can cause the emergence of problem recognition barriers. The creeping nature of extreme heat and the fact that only a small area is vulnerable for heat stress can result in low perceptions of risk. This influences the emergence of a low sense of urgency, as low perceptions of risk do not activate the public to put pressure on decision-makers. In addition, the literature (Runhaar et al., 2012) argues that the uncertain nature of heat extremes caused that Dutch urban planners are not being aware of the increasing heat extremes. Multi-level governance is argued to also influence the emergence of barriers. Vertical governance influences the emergence of institutional barriers such as a lack of financial resources, inflexibility of legislative and policy context, lack of formal requirements or incentives to develop sectoral adaptation plans, and absence of a supportive regulative framework, mandates and statues. The vertical coordination refers to the interdependencies between the european, national, provincal, regonal and national levels of government. The fact that local policy is 'nested' in the legal and institutional frameworks of higher levels of government hampers their leeway to mainstream heat adaptation. Similarly, horizontal governance also influences the emergence of barriers such as a lack of resources, or poor cooperation with private actors. These barriers can arise due to divergent interests and approaches of the different constituent parties. Finally, the theory of 'New institutionalism' is used to explain how behaviour of actors is enabled or constrained by institutions. Institutions can be sub-divided into formal rules (e.g. statutory regulation, laws, constitutions), informal rules (e.g. normative rules, convention, norms) and routines. 'New institutionalism' knows different schools of thought, which are complementary rather than competitive to each other in their explanations of how institutions and behaviour are related. Examples of institutionalist approaches are historical institutionalism, rational choice institutionalism, sociological institutionalism, and discursive institutionalism. A historical institutionalist approach can explain the emergence of heat adaptation routines, by arguing that decision-makers are limited in their choices and strategic responses to adapt to heat due to decisions that are made earlier.

3. Which institutional barriers that impede the mainstreaming of heat stress adaptation and urban heat islands mitigation can be identified in Alkmaar?

This research has found nine institutional barriers that impede the mainstreaming of heat adaptation. These barriers can be subdivided into two groups. The first group are barriers that impede the development of specific heat adaptation policy. A specific heat adaptation policy means that attention is given to heat adaptation in policy through approaching the implementation of measures from an extreme heat point of view. This is contrasted to a policy where heat adaptation measures are only implemented as a synergy of the implementation of other measures. Institutional barriers that impede the development of a specific heat adaptation policy are: a low sense of urgency, lack of knowledge, lack of financial resources, lack of staff, and lack of information or guidance. The results show that different kinds of knowledge are missing that impede the development of specific heat adaptation policy. In the first place, it is not clear what the definition of heat stress is and what the levels of heat stress are that should be accepted. Secondly, knowledge about temperatures at lower scale level is missing. Another important institutional barrier is the lack of financial resources in the municipal budget. This requires the municipality to prioritize according to the urgency of the impacts emanating from climate change, for the implementation of climate change adaptation measures. However, policy officials perceive a low sense of urgency to adapt to extreme heat within the municipality, because Alkmaar already contains lots of greenery. Simultaneously, Stadswerk072 lacks staff with an urban planning expertise, which is argued to be needed for implementing heat adaptation. Furthermore, guidance and information from the national government about a norm for heat stress are lacking. Whereas the first group of institutional barriers is concerned with the development of policy, the second is related to the implementation of policy. The second group are institutional barriers that impede the implementation of heat stress measures, which is foremost concerned with implementing greenery. The barriers that impede this are: conflicting interest with stakeholders, other land use priorities, lack of a supportive regulative framework, lack of staff, financial resources, a lack of knowledge, lack of information and guidance, and a greening routine. However, it has to be noted that the latter barrier ‘greening routine’ impedes on the one hand the implementation of other heat stress adaptation measures, on the other hand it is also the number one driver for implementing measures for extreme heat at all. Besides this, other land use priorities, such as parking space, are often found more important than implementing greenery, which also has to do with the fact that Alkmaar strives to be a car-friendly city. Conflicting interests with

stakeholders also impede the implementation of greenery, for instance as implementing solar cells on roofs receives often priority by developers over implementing garden roofs.

4. How are the identified institutional barriers that impede the mainstreaming of heat stress adaptation and mitigation for urban heat islands in Alkmaar interdependent of each other?

Several interdependencies between the identified institutional barriers are found in this study. These interdependencies are outlined in chapter 6. The missing knowledge about the definition of heat stress and what levels of heat stress should be accepted partly emerges due to the lack of guidance of higher levels of government, as national policy does not outline in their policy the levels of heat stress that are deemed acceptable. Both barriers are therefore interdependent of each other. Knowledge that is missing with regard to heat adaptation measures other than implementing greenery is in part attributable to the greening routing heat adaptation revolves around. This is because learning with regard to heat adaptation is mainly concerned with greenery and does not include 'other' measures that can be used to adapt to extreme heat. The recognized lack of staff is related to a lack of financial resources and poor cooperation between departments within the organisation, as both contribute to the emergence of this lack of staff. Another identified institutional barrier is formed by conflicting interests between actors such as developers and business owners. This barrier arises from the status quo, in which there is no regulative tool to force actors to implement heat adaptation measures. But also from the lack of awareness actors have of synergies that can both contribute to the energy transition and adaptation to extreme heat, and the lacking awareness of actors of the negative consequences of certain surface properties on their outdoor comfort during the summer. Finally, a low sense of urgency is one of the underlying causes that explain why other land use topics receive priority in physical space over heat adaptation measures.

5. Which factors explain the emergence of these institutional barriers?

Drawing on the findings of the empirical research, several factors explain the emergence of institutional barriers. In the first place, the nature of heat extremes gives rise to low perceptions of risk, which again causes a low sense of urgency for implementing heat adaptation. This study found that low perceptions of risk drive from the following factors: extreme heat only occurs for a short period of time, the creeping nature of increasing temperatures makes the problem

less visible, heat extremes do not damage things that are valued at this moment, and heat stress only occurs in certain areas. Policy officials believe that because of these low perceptions of risk or because citizens are unaware of the causal relationship between climate change and extreme heat events, citizens do not exert pressure on decision-makers to implement heat adaptation. This combined with the fact that policy officials perceive a high adaptive capacity of the overall city to extreme heat, due to the large amount of green the city contains, contributes to a low sense of urgency for implementing heat adaptation. Secondly, a lack of financial resources, a lack of a supportive regulative framework, and a lack of information and guidance can be understood as an outcome of vertical governance. Financial resources are lacking as funds for the implementation of heat adaptation measures are not yet made available by the national government. In addition, budgets cuts from the national government and the decentralisation of policy fields has stretched municipal budgets, leading to insufficient financial resources. A lack of a supportive regulative framework can in part be explained by the current legal framework, which is insufficient for the legal anchoring of climate change adaptation policies. Moreover, although heat adaptation is guided through a national mandate, national leadership is lacking in the formulation of heat adaptation norms. Thirdly, horizontal governance is found to have an influence on a lack of knowledge. For the implementation of climate change adaptation, Alkmaar cooperates with municipalities within the region and the water board Hoogheemraadshap Hollands Noorderkwartier, in the regional partnership *Waterketen* and the recently started project *Spatial adaptation*. It is argued that within the network knowledge is exchanged on all other climate change adaptation issues, except for heat. Therefore, the existing horizontal governance arrangement can be seen as a cause for the lack of knowledge about heat adaptation. Furthermore, a historical institutionalist (HI) and city branding approach explain why heat adaptation revolves around a greening routine. From a HI point of view the emergence of this routine can be understood through path dependency. This study found that implementing greenery for other purposes has always been an important policy in Alkmaar. So, where other municipalities did cut back money for implementing greenery, this has never happened in Alkmaar. Therefore, parts of the city are already heat proof through the amount of greenery they contain. From a city branding approach, a greening routine has been an important part of Alkmaar's strategy for creating a liveable city, which is deemed important for keeping and attracting residents, businesses and visitors. Greenery can be implemented to enhance the liveability. However, at the same time it can also create heat proof areas. Yet, this greening routine impedes the implementation of other heat adaptation measures. But overall, also keeping in mind the lack of financial resources, this greening routine can in my point of

view be seen as a legitimate choice. Finally, a discursive institutionalist perspective explains why routines of implementing impervious surfaces and designing principles to enhance the amount of sunlight shining into windows to warm up houses persist, as actors are "following the institutions of a 'logic of practice'" (Sapiro, 2015, Bourdieu 1990, p.11). Changes of these institutions are rather difficult to achieve, as the literature asserts actors do not only need to have the ability to think beyond these structures but also have to persuade others to change these institutions, from the interviews it became clear that the latter is difficult to achieve.

How do institutional barriers emerge that impede the mainstreaming of heat stress adaptation and urban heat island mitigation in a mid-sized city in the Netherlands?

The sub-questions outlined above have served to help answer the main question, which is:

How do institutional barriers emerge that impede the mainstreaming of heat stress adaptation and urban heat island mitigation in a mid-sized city in the Netherlands?

I will now briefly repeat the main findings that answer this question. The results show that low risk perceptions of extreme heat influence the emergence of a low sense of urgency to mainstream heat adaptation policy. Citizens do not exert pressure on decision-makers, which is believed to be the result of unawareness or low perceptions of risk of heat extremes. The creeping nature of increasing temperatures, the fact that heat extremes appear for a short period of time, and the belief that heat extremes are not perceived as a problem by citizens are subsequent to the low perceptions of risk by citizens. In addition, policy officials argue that the absence of a 'focus event' and their perception that the city has a high adaptive capacity, as it contains already lots of greenery, contribute to a low sense of urgency for developing and implementing specific heat adaptation policy. Vertical governance is found to be a major influential factor for on the one hand the stimulation of heat adaptation policy, and on the other hand the emergence of institutional barriers. The formal regulation set by the national government to develop stress tests, have risk dialogues, and create implementation agendas, moved heat adaptation up the local political agenda. However, due to budget cuts of the national government, financial resources are scarce. Therefore, the municipality depends on subsidies of higher levels of government to implement heat adaptation measures, which are not yet made available by the national government. Thus, a 'wait and see' stance is adopted. Also, a lack of

a supportive regulative framework emerges due to institutional inertia. The expected Environmental law (*Omgevingswet*), that provides more opportunities for legal anchoring of climate change adaptation policy, has not yet been adopted. It can be assumed that adaptation of this law will lead to more strong anchoring of climate change adaptation policy. The findings also show that the horizontal governance arrangement influences a lack of knowledge, as it is argued that knowledge about heat adaptation is not exchanged with the partners of the Region Alkmaar who cooperate together on spatial adaptation. Alkmaar's heat adaptation policy revolves around a 'greening' routine. This has several explanations. In the first place, the implementation of greenery can be explained by the role of path dependency, as it has always been recognized as important, therefore the municipality did never cut back money for implementing greenery. Secondly, from a city branding perspective, implementing greenery serves at the same time for an improvement of the liveability of the city, which is important for keeping and attracting residents, businesses and visitors. Finally, as mentioned before, institutional barriers are interlinked and can reinforce each other. This 'greening' routine is further magnified through the lack of financial resources and a lack of knowledge, as heat adaption is only implemented as a synergy of the implementation of greenery for other purposes. Finally, climate change adaptation policy is predominantly treated as a water issue, as cloud bursting impacts are perceived to have a higher sense of urgency compared to periods of extreme heat. Due to the higher visibility of the problem and the appearance of 'focus events', perceptions of risk are high, resulting in pressure on local politics. Heat, however, is a creeping problem and risk perceptions are relatively low. Moreover, more financial resources are available to implement water adaptation measures, as resources from the sewage levy can be used. Also, the fact that water adaptation requires foremost investments in the public domain makes it easier to implement measures compared to heat adaptation, as adapting or mitigation heat requires the implementation of technical measures that are placed in, on and on top of buildings as well. This is perceived to be difficult as project developers and building owners have other priorities, which is argued to not always result in the desired amount of investment of project developers in implementing heat adaptation measures or the implementation of heat adaptation measures at all. With no supportive regulative framework to force project developers and building owners this remains difficult. This differs also from implementing waterlogging adaptation measures as the water test sets the obligation for spatial planners to involve the water manager at an early stage in the planning process that has the aim to inform, advice, weight and ultimately assess the hydrological aspects in spatial plans and decisions. Thus, the incorporation of water adaptation measures in spatial planning is easier as water management has a tool that

legally enforces this. It is therefore not surprising that in the context of lacking financial resources, no supportive legal framework, a lack of knowledge and lack of staff in combination with a low sense of urgency, heat adaptation measures are only implemented as they can be linked to water adaptation measures or an enhancement of the attractiveness of the municipality in the spatial domain, i.e. the greening of the city.

7.2 Theory building

With the enactment of the regulative obligation to develop stress tests, risk dialogues, and implementation agendas regarding heat, drought, flooding, and waterlogging for each municipality by the Dutch national government, a momentum is created for the development and implementation of heat adaptation policy. However, the mainstreaming of heat adaptation policy is currently confronted with various institutional barriers that impede the acceleration process of heat adaptation. This study identifies four mechanisms that generate these institutional barriers that cause institutional inertia: low perceptions of risk, governance arrangements, path-dependency, lack of leadership.

Low perceptions of risk

The role of low perceptions of risk is central in explaining why heat adaptation receives a low sense of urgency, as citizens with low perceptions of risk are not likely to exert pressure on decision-makers to applicate heat adaptation policy. The relative perception of risk is constructed out of someone's perceived probability of being exposed to the impacts of extreme heat events and someone's estimation of the damage these impacts make to things he or she values (perceive severity), in relation to the urgency and the amount of damage of other problems in life (Grothmann & Pratt, 2005). Low perceptions of risk for heat extremes can therefore drive from the fact that citizens do not estimate that heat extremes damage 'valued attributes'. Periods of extreme heat are perceived as something pleasant, instead of something damaging. Besides that, citizens have of a low estimation of being exposed to heat extremes. This is because the creeping nature of rising temperatures makes the problem relatively invisible, combined with the fact that heat stress only occurs over a short period of time in only a small area. Simultaneously, decision-makers and policy officials are less likely to see heat as an urgent topic when they perceive that heat extremes do not materialize into damaging things valued. In addition, the absence of a 'focus event', such as a couple of deadly heat waves in a

row also contributes to lower sense of urgency to develop and implement heat adaptation policy present time. This is in agreement with Urlich Beck´s (2009) understanding of risk as a social construct.

Governance arrangements

Consistent with the subsidiarity principle, municipalities are responsible for preparing for climate change impacts. However, responses to the impacts of heat extremes are often 'nested' in legal and institutional frameworks at higher scales of government (Corfee-Molot et al., 2009). Various governance arrangements, such as the changing Dutch planning law, budget cuts in the municipal budgets by the national government, and the anticipation of municipalities on subsidies from higher levels of government contribute to the emergence of institutional barriers, such as a lack of financial resources. This is in line with vertical governance theory, which states that institutional arrangements structure the behaviour of local governments.

Path-dependency

Understanding why institutions inert as a result of the path-dependency of institutions and the unintended consequences of institutional design, drives from an historical institutionalist approach (Peter, 2005). Funding for heat adaptation is allocated at the regional level. These existing regional networks of knowledge and resources demonstrate the enduring dominance of viewing climate change adaptation as predominantly a water issue. Regional cooperation of climate change adaptation consists of networks with several municipalities and the water board(s). However, the deeply institutionalized task of the water boards lies still exclusively in the field of water management, which thus only concerns drought, flooding and waterlogging issues. This can result for instance in a lack of knowledge in the field of heat extremes.

Lack of leadership

This study observed that the ability for local government to respond to extreme heat is impeded by a lack of leadership of the national government. Although the Dutch national government stimulates heat adaptation through obliging to develop stress tests, risk dialogues, and create implementation agendas for heat, they do not provide norms for heat stress. This can for instance result in a lack of a supportive regulative framework, as it can provide difficulty with

setting standards. Simultaneously, a lack of institutional entrepreneurship can cause organizational routines such as implementing impervious surfaces rather than pervious surfaces (e.g. grass surfaces) to persist.

To conclude, it is important to note that it is evident that institutional barriers do not arise in isolation but are interlinked. Thus, the emerge of an institutional barrier can also be explained by another institutional barrier.

7.3 Reflection

7.3.1 Timing

A shortcoming of this research is the moment it was conducted. During the period of this research, municipalities have started to conform to the regulative obligations of the national government to develop stress tests, have risk dialogues and develop implementation agendas. Planning practitioners in Alkmaar had just finished the developments of stress tests but did not have had the risk dialogues yet. The findings would have been more interesting if they were conducted after the enactment of the implementation agendas. As for instance the outcomes of risk dialogues can possibly influence the perceptions of risk of planning practitioners. In addition, a lack of financial resources is found to be an important institutional barrier, however the national government makes funds available in 2021 to finance the implementation agendas. It is interesting to look if this is still a barrier then, which would imply that other climate change issues receive priority or the amount of funding is not sufficient enough. Besides, Uittenbroek (2016) argues that it is more interesting to look at the institutional barriers that arise during the implementation phase of climate change adaptation, because although policy is created, this does not mean that policy is also implemented. Despite the sub-optimal timing of this research, I expect the findings to remain relevant even with the enactment of the implementation agendas and the implementation of the new funds. For example, the specific nature of extreme heat, which causes a lack of urgency among citizens and officials, is not expected to disappear when new funds are made available.

7.3.2 Methodological considerations

Eisenack et al. (2014) argue that barriers that impede climate change adaptation are "relative to the specified adaptive actions that are considered, to the actors that may exercise them and to the specific situation in which they may be taken" (p. 868), therefore the research design had to acknowledge the importance of context in explaining why institutional barriers emerge. A single embedded case study design was adopted, as this actor-centred strategy was expected to come up with a thick description of the decision-making process in which institutional barriers arise. This research strategy has proven to come up with detailed results and revealed some pieces of the complex puzzle of why institutional barriers emerge. The research design of this study has integrated two methods, which are a document-analysis and semi-structured interviews. The advantages of this is that it helps to gain an in-depth understanding of the case and that it makes it easier to cross-check data. By using a triangulation of research methods, the internal validity of the findings of this research increased. For instance, the observation outlined in chapter 6 that heat adaptation follows a 'greening' routine arose both from the data emanating of the document-analysis and the semi-structured interviews. However, the external validity of this research is low, as this research only includes one case. This makes the transferability of the findings low as these are embedded in the specific context of this case. This can therefore be approached as a limitation of this study. Related to this, the scope of this research was limited. It is not said that the findings, which stem from interviews with policy officials responsible for climate change adaptation in urban planning, are shared among other departments of the municipality. Furthermore, it would require a larger population to really prove the findings of this thesis. As such, this thesis can be seen as an exploration into the subject of institutional heat adaptation barriers, but further research can investigate whether the findings hold true for a more quantitative research format. Another methodological limitation is the selection of respondents. As this research investigates institutional barriers to mainstreaming heat adaptation policy, it would be beneficial to interview people who should do something with the topic but are for example not aware of it. As the researcher was dependent on the willingness of people to corporate, respondents that had a certain awareness of the topic where interviewed. Despite this limitation, I believe that the most relevant people on the subject of heat adaptation are local officials who are responsible for climate change adaptation in Alkmaar. Through snowball sampling, I interviewed a large portion of this group of people. Another limitation can be found in the way the sub-questions have been formulated. After the research was conducted, it was found that the findings related to several questions

have some overlap. This led to some parts of chapters 6 and 7 overlapping, which impedes readability.

7.3.3 Considerations regarding theory

Because this research used existing theories to research a relatively new domain in climate adaptation (heat stress), it makes sense to reflect on those theories. Most of the theory discussed in chapter 3 turned out to be relevant for the topic. Also, I did not find any major discrepancies between my findings and the expectations stemming from the theory. However, some of the theories used, such as risk theory, have quite a general orientation. This makes it difficult to apply them to measurable concepts. Therefore, it is not surprising that the theory was validated. The inclusion of a theory building paragraph was a way of dealing with this issue. In this paragraph, the theory is tailored towards heat-specific concepts.

While the research angle used in this thesis is novel for heat, it is not for other adaptation challenges, such as flooding. Therefore, the theoretical contributions of this research to the academic literature are only in part novel, namely in their application for heat adaptation. Looking back at the propositions driven from the theoretical framework the results seem quite self-evident, and confirm these theories.

Besides this, another issue that occurred with the theory was that it turned out to be incomplete in order to explain why institutional barriers emerge. Therefore, additional theories - urban identity and city branding - were added to explain the results further.

7.4 Recommendations

7.4.1 Recommendations for future research

This research was a first attempt to investigate how institutional barriers for heat adaptation emerge. Building forward on the presented limitations above, future research should include further qualitative research that inquires how institutional barriers emerge in other cases. An interesting research direction would be a comparative case study. The advantage of a comparative research design is that it can investigate the factors that are common between cases that explain the emergence of similar institutional barriers and factors that are case-specific, providing an understanding of why different institutional barriers emerge in different contexts.

Adopting a comparative case study design will therefore make the findings more transferable. In addition, future research could also use different scopes. For instance, research can, beside investigating which institutional barriers impede the implementation of heat adaptation measures, also include technical barriers (e.g. it is difficult to implement trees because of the large quantity of cables and pipes in the subsurface) From the interviews it became clear that this is also a major factor of why it is difficult to implement heat adaptation measures. This could present the a more full picture of the difficulties that go along with the implementation of heat adaptation policy. Finally, conducting research after the implementation agendas are presented and funds are made available by national government to implement the implementation agendas would be interesting, because it would test the effectiveness of national policy in their attempt to accelerate the climate change adaptation process in municipalities. Currently, inertia occurs for instance due to a lack of financial resources, research that is conducted after the funds of the national government are made available for policy implementation can therefore outline if these funds are sufficient enough to let this barrier disappear. However, as these funds are received at the regional level, the recommendation is to expand the research through not only investigating the actors that are engaged at the municipal level but also in the regional level with heat adaptation policy.

7.4.2 Practical recommendations

The implementation agendas have been proven to be an effective measure for heat adaptation. Therefore, further developing them will help mitigate the problem at hand.

Secondly, a lot of resources in the municipality of Alkmaar are being reserved for the energy transition. However, the energy transition and heat adaptation often share similar methods, therefore it is recommended to look for attempts to create synergies. For example, the implementation of collective thermal energy storage systems can serve both goals, as it will reduce the amount of air condition used by households during periods of heat extremes, thus mitigating urban heat. Another example is incorporating green on roofs with solar panels, which serve to both enhance the amount of electricity won by solar panels and reduce urban heat. The latter is already argued by one of the interviewees.

On a more general note, similar to the two examples illustrated above, a way forward for urban heat adaptation lies in the degree in which heat adaptation is mainstreamed into the various related policy fields. This could help to put extreme heat as an issue on the map, as other policy

departments will be required to think about ways their department can help reduce heat. In addition, sessions with policy officials from different policy departments that can take measures for heat adaptation can be held, to discuss how they can incorporate heat adaptation measures in there policy fields. Something similar is already being done in the *Koppelkansen* project in Amsterdam, in which different policy fields come together in order to co-create (https://www.kennisactiewater.nl/co-creatie-trajecten/koppelkansen/). The heat adaptation strategy of Alkmaar is currently dominated by a greenery discourse. Having officials from different departments discuss what they can do to reduce heat, could lead to more specific measures as opposed to solely focusing on greenery.

Finally, the national government could help municipalities by giving more clear guidance on heat adaptation. This could be done by instructing municipalities on the expectation the national government has of them. For example, through setting clear norms for the amount of heat stress that is acceptable.

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Appendices

Appendix 1 - Interview guide

Each interview was tailor-made for the respondent as they were all involved in different parts of the process of developing or implementing measures for heat adaptation. Therefore this interview provides an overview of general questions. Questions where either supplemented or left out based on the expertise of the respondent.

(A) Introduction

- Ask permission for the recording the interview
- Introducing the research

- Introduction respondent:

A: Can you introduce yourself?
B: Can you explain your role in developing or implementing adaptation measures for heat stress and mitigation measures for heat islands?

(B) Problem recognition

1. What is the policy of Alkmaar on implementing measures to adapt to heat and mitigate urban heat islands?

2. To what extent is this policy being implemented?

3. What does your organization understand by adaptation of heat stress?
   A: How would you subscribe heat stress adaptation?

4. In your opinion, what are the main barriers that impede the development and/or implementation of measures to combat heat stress and heat islands?
   A: How did these arise?

(C) Diagnosis: formal institutional barriers

5. Do you consider the obligation to perform a heat stress test as an incentive to develop and/or implement adaptation measures for heat stress and mitigation measures for heat islands?
   A: Are there any other formal incentives or requirements from higher authorities (European, national, provincial) to develop plans for the climate adaptation of heat stress?

6. Do you believe that more supporting legislation is needed for the implementation of measures to combat heat stress and urban heat islands?
   A: Why (not)?

7. Is current legislation flexible enough to experiment adaptive measures for heat stress and mitigation measures for heat islands?

8. Do you think it is clear which departments in the municipality of Alkmaar are responsible for the development and implementation of policy for adaptation measures for heat stress and measures to reduce the urban heat island?

9. To what extent are there clear rules within your department about which spatial issues have priority over government spending?
   A: How does heat stress adaptation relate to other climate adaptation issues in the municipality with regard to the priority given to it in funding?
   B: Are there other spatial issues or climate adaptation measures that have priority over municipal funding measures for adaptation to heat stress?

(D) Mechanisms of institutional inertia

10. How are heat adaptation measures financed?

11. Are there any difficulties in funding heat adaptation measures?

12. Is there sufficient knowledge within your organisation regarding climate adaptation for heat stress and mitigation of heat islands?

13. What knowledge is still lacking?

14. How much help do you get from consultants and external experts?

15. Does your organisation see the uncertainty about the extent to which heat stress will occur as an opportunity or obstacle?
    A: Why?

16. Which tools or strategies are used to deal with these uncertainties?

17. Alkmaar's environmental vision states that it is necessary to make Alkmaar climate-proof. Why do you consider this to be a legitimate ambition?

(E) Agency and social learning

18. To what extent does the municipality have a person or group of persons who take a leadership position within the organisation to initiate policy for heat stress and heat islands?

    A: Is this person or are these persons influential enough for these initiatives to be carried out?

19. To what extent is there an exchange of information about heat between different departments of the municipality?

20. To what extent is there an exchange of information about heat with actors outside the municipality (e.g. knowledge networks, social organisations and other cities)?
    A: From which groups do you learn most?

21. To what extent is learning within your organisation promoted with regard to heat stress adaptation and heat island mitigation? (Existence of feedback mechanisms, information networks, networks of experts).

22. To what extent is experimented with implementing measures for heat stress and heat islands?

(F) Informal institutional barriers and routines

23. In your opinion, what are the main motivations of the organisation to develop and implement climate adaptation measures for heat stress? And can you rank these priorities?
    A: Does this differ from your personal motivation to develop and implement climate adaptation measures for heat stress?

24. To what extent is the norm within your organization to make plans to align policies with existing plans made at higher levels of government?

25. The Environmental Vision discusses the implementation of greening and water as two important adaptation tools, are these the main tools used to adapt to heat stress or are there other tools used?
    A: Why these instruments?

26. I would like to know more about the organizational culture, what do you think characterizes your organizational culture?

(G) Conclusion

- Do you have any other topics you want to say about, in relation to heat stress and heat islands, that have not yet been discussed?
- Do you have any tips for my follow-up interviews?
- Can I come back later by phone or e-mail if I still have a question?

Appendix 2 – Likert scale

Respondent:……

1. Do you think Alkmaar municipality considers climate change induced heat stress as an urgent problem?

Low urgency				High urgency
1	2	3	4	5

A: Do you personally consider heat stress an urgent problem in Alkmaar?

Low urgency				High urgency
1	2	3	4	5

2. In your opinion, how urgent does the Alkmaar municipality consider heat stress, in comparison to drought, waterlogging, and flooding?

	Low urgency				High urgency
Drought	1	2	3	4	5
Waterlogging	1	2	3	4	5
Flooding	1	2	3	4	5

A: How urgent do you consider heat stress, in comparison to drought, waterlogging, and flooding?

	Low urgency				High urgency
Drought	1	2	3	4	5
Waterlogging	1	2	3	4	5
Flooding	1	2	3	4	5

3. To what extent does Alkmaar municipality consider the heat-island effect an urgent problem in the inner city of Alkmaar?

Low urgency				High urgency
1	2	3	4	5

A: To what extent do you consider the heat-island effect an urgent problem in the inner city of Alkmaar?

Low urgency				High urgency
1	2	3	4	5

Appendix 3 – List of respondents

Municipality of Alkmaar

Marcel van Zon - public space alderman

Simone Stam - Policy official green

Esther Brun - Urban designer

Ben Kaptein -Urban designer

Sander Koolen - Policy official

Wendy Sanders - Environmental designer

Region of Alkmaar

Lutine de Boer – region coordinator for the municpality of Alkmaar

Stadswerk072

Hoi-man Hau – public space team leader

Water board: Hoogheemraadschap Hollands Noorderkwartier

Karel Bruin-Baerts – programme manager spatial adaptation

Appendix 4 - Code list

Code families	Codes
Phases decision-making process	Understanding
	Planning
	Managing
Levels of ideas	Policy
	Program
	Philosophy
Institutional barriers	
Political factors	(Lack of) political commitment
	(In)flexibility of legislative and policy context
	Low level of public awareness, support and pressure
	Other priorities
Organisational factors	High level of administrative fragmentation
	Organizational routines
	(In)clarity of responsibility for implementing and creating heat adaptation policy
	(Absence) of a supportive regulative framework, mandates and statues
	(Lack of) coordination and cooperation between departments
	(Lack of) cooperation with actors outside the municipality
	(Lack of) leadership and institutional entrepreneurship
	(Lack of) guidance and information
Resources	(Lack of) human resources - (Lack of) knowledge - (Lack of) staff - (Lack of) staff with a certain expertise
	(Lack of) financial resources
Cognitive factors	High level of uncertainty:

	-about the impacts of extreme heat - about the relationship of extreme heat events and climate change
	(Low level of) urgency
	(Low level of) learning
Characteristics of the adaptation problem at issue	Low level of detail in which adaptation objectives are conceptualized
Timing	(Absence of) a 'window of opportunity'
Stimulating factors	Synergies
	Formal requirements to develop adaptation plans or implement adaptation measures
	Subsidies from higher levels of government
Factors that explain why institutional barriers emerge	Path dependency
	Vertical governance
	Horizontal governance
	Low perceptions of risk
	City branding
	Urban identity