Heat stress in senior citizens in the Dutch municipality of Houten: a climate adaptation gap?

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HEAT STRESS IN SENIOR CITIZENS IN THE DUTCH MUNICIPALITY OF HOUTEN: A CLIMATE ADAPTATION GAP?

HITTESTRESS BIJ OUDEREN IN DE GEMEENTE HOUTEN: EEN KLIMAATADAPTATIE KLOOF?

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Abstract

With climate change leading to increasing temperatures, adequate policy measures are necessary for preventing heat stress in vulnerable groups, such as the elderly. This research uses the case study of the Dutch municipality of Houten for 1) identifying personal and environmental factors that contribute to an increased vulnerability to heat stress of senior citizens, 2) adding knowledge on the suitability of the climate change adaptation (CCA) gap framework for evaluating CCA strategies at the municipal level and 3) identifying lock-in mechanisms that contribute to the CCA gap in Houten.

Document analyses combined with semi-structured interviews with municipal stakeholders led to an overview on vulnerability factors for heat stress in senior citizens, to the identification of a CCA gap in the municipality of Houten and to the identification of barriers and possible lock-in mechanisms in this municipality.

The results show that ageing in itself leads to physiological changes that increase vulnerability of senior citizens to heat stress, apart from any other factors that might enhance this vulnerability (e.g. chronical illness, medication use or limited physical or cognitive ability). As people tend to stay indoors on hot days, effective cooling measures for keeping buildings cool are important. Most important factors for influencing indoor air temperature are the use of shading outside the building or reflective windows and the use of night ventilation. For heat stress prevention in public space, adding greenery that provides shade remains the most effective measure. However, in a municipality with a high percentage of greenery already, taking measures on applying adequate urban geometry or albedo of surfaces is effective in (re)development projects.

The four main factors that contribute to the presence of a CCA gap in Houten appear to be informing citizens on the health impacts of heat stress in the elderly and on actions that can help prevent heat stress. Furthermore, taking urban geometry and albedo of surfaces into account in (re)development projects and coordinating and facilitating cooperation between actors are important. Finally, taking a more integral approach on climate adaptation by appointing someone within the municipal organisation with an overall responsibility is a suitable policy measure.

Lock-in mechanisms can hinder closing the CCA gap by reinforcing policy stability. Lock-in mechanisms that are possibly present in the municipality of Houten are the institutional void mechanism, the adaptive expectations mechanism, the social contracting mechanism, the framing (re)production mechanism, the habituation mechanism and the learning effects mechanism.

The results from this research were used to formulate recommendations for the municipality to close the CCA gap and to respond to possible lock-in mechanisms hampering policy implementation. By identifying vulnerability factors of senior citizens to heat stress that are related to personal factors and to environmental factors, an integral overview was created. This can be translated to policy measures for different municipal departments and other actors. This research additionally shows the applicability of the concepts of climate change adaptation gaps and policy lock-in mechanisms at the municipal level.

Samenvatting

Met stijgende temperaturen door klimaatverandering zijn adequate beleidsmaatregelen nodig om hittestress bij kwetsbare groepen zoals ouderen te voorkomen. Dit onderzoek maakt gebruik van een casestudy in de gemeente Houten. Documentanalyses in combinatie met semigestructureerde interviews hebben geleid tot een overzicht van kwetsbaarheidsfactoren voor hittestress bij ouderen, tot de identificatie van een klimaatadaptatiekloof in de gemeente Houten en tot de identificatie van mogelijk aanwezige barrières en lock-in-mechanismen voor beleidsmaatregelen in deze gemeente.

De resultaten laten zien dat veroudering op zichzelf al leidt tot fysiologische veranderingen die de kwetsbaarheid van ouderen voor hittestress vergroten. Dit staat los van andere factoren zoals chronische ziekte, medicijngebruik of fysieke of cognitieve beperkingen die deze kwetsbaarheid nog verder kunnen vergroten. Omdat mensen tijdens warme periodes de neiging hebben om thuis te blijven, zijn effectieve maatregelen om woningen koel te houden belangrijk. De belangrijkste beïnvloedbare factoren hiervoor zijn het gebruik van zonwering aan de buitenzijde van het gebouw of reflecterende ramen en het toepassen van nachtventilatie. De meest effectieve maatregel die genomen kan worden om de openbare ruimte zo koel mogelijk te houden is het uitbreiden van de hoeveelheid schaduwrijk groen. In de gemeente Houten, waar al veel groen aanwezig is, is het toepassen van adequate stedenbouwkundige geometrie of reflectieve bouwmaterialen aanvullend effectief voor de preventie van hittestress in de openbare ruimte.

De klimaatadaptatiekloof in Houten wordt voornamelijk gevormd door vier factoren. Eén daarvan is het informeren van burgers over gezondheidsrisico´s van hittestress bij ouderen en over maatregelen die burgers zelf kunnen nemen om hittestress te voorkomen. Verder zijn het inzetten van stedenbouwkundige geometrie en bouwmaterialen in (her)ontwikkelingsprojecten, het coördineren en faciliteren van samenwerking tussen actoren en het integraal benaderen van klimaatadaptatie binnen de gemeentelijke organisatie belangrijk om de klimaatadaptatiekloof te dichten.

Lock-in-mechanismen kunnen het dichten van de klimaatadaptatiekloof belemmeren door de stabiliteit van het huidige beleid te versterken en veranderingen tegen te houden. Lock-in mechanismen die aanwezig lijken te zijn in de gemeente Houten zijn het institutionele-leegte-mechanisme (een gebrek aan beleidsmatige afspraken), het adaptieve-verwachtingen-mechanisme (een afwachtende houding van actoren ten opzichte van elkaar), het sociale-verwachtingen-mechanisme (opvattingen over rollen en relatie tussen maatschappij en overheid), het framing-(re)productiemechanisme (de rol van (sociale) kaders waarmee gecommuniceerd wordt), het gewenningsmechanisme (terughoudend zijn naar innovatie) en het leer-effect-mechanisme (kennis en ervaring met nieuwe technieken blijft uit door terughoudendheid van actoren).

Op basis van dit onderzoek zijn aanbevelingen geformuleerd voor de gemeente om de klimaatadaptatiekloof te dichten. Het 3-G-concept bleek een bruikbaar middel om factoren in kaart te brengen die de kwetsbaarheid van ouderen voor hitte beïnvloeden en sluit aan bij de verdeling van taken tussen gemeentelijke afdelingen. Dit onderzoek laat zien dat de concepten van een klimaatadaptatiekloof en lock-in-mechanismen gebruikt kunnen worden voor analyses en het opstellen van beleidsmaatregelen op gemeentelijk niveau.

Acknowledgements

This endeavor would not have been possible without dr. Lisanne Groen for her invaluable comments and suggestions. I could also not have undertaken this journey without the municipality of Houten for their cooperation in this research project, and Kinran Consultancy B.V. for connecting me with the municipality. Many thanks to Dominique and all other colleagues from the municipality of Houten for their help and advice. I am also grateful for my proofreaders Sorayma, Zita and Larissa, who helped make this thesis come together. Thanks should also go to the study participants for their time and energy, sharing their knowledge with me. And last but not least, I would like to thank those around me for their moral support: with special thanks to Hugo and the girls for their infinite patience and emotional support, and to Tamara, for always being so understanding and motivating.

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1. List of Abbreviations

CAP: Climate Adaptation Plan

CCA gap: climate change adaptation gap

cETO: Committee for Ethical Assessment of the Open University

DPRA: Deltaplan Ruimtelijke Adaptatie (Delta Plan on Spatial Adaptation)

GGD: Gemeentelijke Gezondheidsdienst (Public Health Service)

GMST: global mean surface temperature

H/W-ratio: height-to-width-ratio

HOVI: Houtense Omgevingsvisie

IPCC: Intergovernmental Panel on Climate Change

NAS: Nationale Klimaatadaptatiestrategie (National Climate Adaptation Strategy)

NKWK: Nationaal Kennis- en Innovatieprogramma Water en Klimaat (National Knowledge and Innovation Programme)

RAS: Regional Adaptation Strategies

RIVM: Rijksinstituut voor Volksgezondheid en Milieu (National Institute for Public Health and the Environment)

SQ: sub question

UHI-effect: urban heat island effect

UNEP: United Nations Environment Programme

WHO: World Health Organisation

3-G-concept: Gebouw-Gebied-Gebruiker framework (framework on Building-Area-User)

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3. Introduction

3.1 Problem definition

Climate change and health

Climate change poses a threat to human health through an altering natural environment. One of these alterations that has a big impact on human health is the increase in temperature. The global mean surface temperature (GMST) has been increasing for the last four decades, each with a record high GMST (IPCC, 2021). The temperature is expected to rise further in the next decades due to continued high greenhouse gas emissions and indirect and long-term effects of the current temperature rise (IPCC, 2021). On a regional and local level, climate change also causes an increase in extreme weather events, including heat waves. Longer periods of high temperatures and higher temperature peaks are causing an even stronger temperature rise in urban areas. Urban areas are generally warmer than rural areas because of the relatively high percentage of paved surfaces and high buildings (blocking wind and reflecting thermal radiation back to the ground surface) and a relatively low percentage of vegetation (with a cooling effect through evapotranspiration and providing shade). The phenomenon of the relatively high temperature in urban areas compared to their rural surroundings is called the "urban heat island effect" (UHI-effect) (Döpp, et al., 2011, pp. 6-8). At the same time, there is a global urbanisation trend, leading to more people living in urban areas. This trend is also visible in the Netherlands. The number of residents in big cities and their surrounding municipalities is expected to continue to grow until at least 2035 (CBS, 2019). The urbanisation trend leads to a growing number of people exposed to the UHI-effect.

Another trend that is observed in the Netherlands is an ageing population. Not only the number of people older than 65 years is expected to increase in the next decades, but within the group of senior citizens, the life-expectancy continues to grow as well (CBS, 2022). Senior citizens are physiologically more vulnerable to heat stress due to age-related changes in thermoregulatory functions (Itani et al., 2020, pp. 2-3). Heat stress is the occurrence of negative health effects in humans (or animals) when a very high surrounding temperature leads to a rise in the core body temperature, causing physiological stress (Itani et al., 2020, pp. 1-2). Senior citizens are also more likely to have a small vital reserve capacity, multiple comorbidities and a limited mobility (Grundy, 2006, pp. 107-108). These factors can contribute to an even further enhanced vulnerability to heat stress. Heat stress can lead to an exacerbation of cardiovascular and renal diseases, diabetes mellitus and can even cause death in case of a heat stroke (RIVM, 2022; WHO, 2018). During the heat wave of 2020, an access mortality (an increased mortality rate during a special event such as a heat wave (Centraal Bureau voor Statistiek, 2022)) of 11% was recorded among 65- to 80-year-olds and up to 23% among people over 80 years old (Centraal Bureau voor Statistiek, 2020). For senior citizens, specific factors are applicable that contribute to heat stress vulnerability. The specific interplay of these factors for this demographic group should be well understood before recommendations can be made to protect their health by means of policy measures. Both risk management strategies (related to acute extreme heat events) and the design of the built environment as a strategy should be included, as it is important to combine both kinds of strategies for optimal heat stress prevention policies when dealing with the UHI-effect (Keith et al., 2020).

Policy measures on heat stress in the Netherlands

The Delta Plan on Spatial Adaptation (Deltaplan Ruimtelijke Adaptatie – DPRA) has been developed at the national level to respond to climate change impacts. It focusses on flooding, heat stress and drought (Kennisportaal Klimaatadaptatie, 2022) and aims to increase the resilience of the Netherlands to climate change. Arising from the DPRA, regional strategies are recorded in the Regional Adaptation Strategies (RAS) and in turn, these RAS form the basis for climate change adaptation policies at the municipal level.

Local climate change adaptation policies, established by municipalities, provide documentation on adaptation plans, including heat stress prevention. With climate adaptation plans still under development, a climate change adaptation gap can be identified between the current and the most optimal municipal policy measures regarding the prevention of heat stress in senior citizens. To close this gap, not only suitable policy measures should be proposed, but factors that might hinder their implementation should be determined as well. Barriers and lock-in mechanisms can hamper the implementation of climate change adaptation policies. Policy lock-in mechanisms are mechanisms that lead to a strengthening of policy stability, making policy change difficult to realise (Groen et al., 2022). These mechanisms can form a positive feedback loop, reinforcing business-as-usual policies despite the necessity of policy change. By identifying barriers and lock-in mechanisms for implementation of climate change adaptation policies beforehand, adequate measures can be taken to eliminate them.

The combination of temperatures rising as a result of climate change, the continued trend of urbanisation and the increasingly ageing population in the Netherlands asks for policy measures that contribute to heat stress prevention in this growing vulnerable group: the elderly (Huynen, et al., 2019, pp. 5-9). A framework for the analysis of suitable policy measures to achieve this is desirable to provide scientific support for the decision-making process at the municipal level with regard to climate change adaptation strategies (Chen et al., 2016). The climate change adaptation gap analysis can provide a useful framework and this research contributes to the body of knowledge on the applicability of this framework at the municipal level. The same applies to the lock-in mechanism framework: this research adds to the robustness of knowledge on the use of this framework with regard to climate change adaptation (instead of mitigation strategies).

3.2 Research aims and questions

The municipality of Houten is a municipality directly southeast of the city of Utrecht, with approximately 50.000 residents (CBS, 2022). The municipality is confronted with an ageing population: currently 15% of the population is older than 65 years, with an expected increase to 25% in 2035 (GGD regio Utrecht, 2022).

This research used the municipality of Houten as a case study, focusses on the biggest vulnerable group in this municipality: the elderly. The case study of Houten was used to identify factors that contribute to the vulnerability of senior citizens to heat stress, to map the current CCA gap in the municipality and to identify barriers and policy lock-in mechanisms that might hamper closing the adaptation gap. Because the vulnerabilities of senior citizens are (at least in part) specific for this demographic group, the research will only focus on the elderly. Other groups that are vulnerable to heat stress are outside the scope of this research, as the specific aspects of vulnerability differ between groups (e.g. the difference between the elderly and young children). Advice on suitable policy measures to prevent heat stress in senior citizens may however be (partially) translated to other groups with similar attributes (e.g. other people with a limited mobility or people who rely on home care workers).

The aims of this research are:

- To study the factors that play a role in the vulnerability of senior citizens to heat stress, making use of the 3-G-concept;
- To identify the existing climate change adaptation gap in the municipality of Houten with regard to policy measures for preventing heat stress in the elderly;
- To identify barriers and policy lock-in mechanisms that might hinder the implementation of suitable policy measures on heat stress prevention in senior citizens in the municipality of Houten;
- To develop recommendations for the municipality of Houten on policy measures for closing the adaptation gap on the prevention of heat stress in senior citizens.

To target the aims of this research, the following research questions will be answered:

Main research question:

To what extent is there a climate change adaptation gap in the municipality of Houten regarding heat stress in senior citizens and how can it be explained?

Sub questions:

1. What factors (based on the 3-G-concept) contribute to the increased vulnerability of senior citizens to heat stress?
2. What would be the most suitable policy measures for the municipality of Houten to prevent heat stress in senior citizens?
3. What are the current policy easures that are implemented by the municipality of Houten to prevent heat stress in senior citizens?
4. What does the adaptation gap between the current and most suitable policy measures to be implemented by the municipality of Houten to prevent heat stress in senior citizens look like?
5. What lock-in mechanisms and barriers can explain the climate change adaptation gap on the prevention of heat stress in senior citizens in the municipality of Houten?

3.3 Definitions

The following definitions were used to demarcate the scope of this research:

Senior citizens: in this research, the definition refers to people over the age of 65 years and is used interchangeably with the term “the elderly”. Both elderly living at home and living in nursing homes or in assisted living situations are included in this research.

Heat stress is defined in this research as all negative health effects on humans as a result of a high surrounding temperatures (Klimaateffectatlas, 2022). Health effects include mental health as well as physical health effects, as health should not only be defined as the absence of disease or disability but as a state of complete physical, mental and social well-being (WHO, 2022). For example, being unable to participate in society as a result of heat, increasing the loneliness of senior citizens, can be considered a mental health effect of heat.

The term “*vulnerability*”, related to climate change impacts, is defined in literature in multiple ways. In this research, the definition of Brooks et al. (2003) was adopted, with vulnerability defined as “a state that exists within a system before it encounters a hazard event” (Brooks, 2003, p. 3). This definition emphasises the characteristics of the affected subjects (e.g. a demographic group like the elderly). See chapter 4.1 for an elaboration on the interpretation of vulnerability in this research.

3.4 Reading guide

Following this introduction, chapter 4 describes the theoretical frameworks that underlie the starting points for this research. In chapter 5, the methods used in this research are elaborated on. The general research method, the document analysis methods, the interview methods, the data analysis methods and the reliability, validity and ethical considerations of this research are discussed. Chapter 6 examines the results of each of the sub questions in this research. Chapter 7 discusses the position of this research in relation to other research and show the limitations of this research, followed by an overall conclusion answering the main research question in chapter 8.

4. Theoretical framework

The theoretical concepts of the 3-G-concept, climate change adaptation gaps and lock-in mechanisms are briefly explained in this chapter. All three of these concepts play a central role in answering the five sub questions of this research. These theoretical frameworks form the basis of knowledge on which the angles of this research are based. Research question 1 (on the factors that contribute to an increased vulnerability of the elderly to heat stress) makes use of the theoretical framework of the 3-G-concept. Research question 4 (identifying the CCA gap in the municipality of Houten) is based on the theoretical concept of CCA gaps. Research question 5 (on barriers and lock-in mechanisms possibly contributing to the CCA gap in Houten) is based on the theoretical framework of policy lock-in mechanisms. These concepts were explored by means of an initial literature search during the development of the research proposal of this research. The concepts outlined below were used to clarify the context of the main research question:

To what extent is there a climate change adaptation gap in the municipality of Houten regarding heat stress in senior citizens and how can it be explained?

4.1 Vulnerability and the 3-G-concept

Vulnerability can be defined variedly, depending on the field of research. The Intergovernmental Panel on Climate Change (IPCC) defines "vulnerability" in its sixth assessment report on climate change as "the propensity or predisposition to be adversely affected and encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt" (IPCC, 2022, p. 43). The World Health Organisation (WHO) is in agreement with the IPCC definition of vulnerability (World Health Organization, 2013, p. 58). Within this broad definition of vulnerability, a distinction can be made between social vulnerability and biophysical vulnerability (Brooks, 2003). Biophysical vulnerability can be described as vulnerability as a result of the magnitude of the hazard, the level of exposure and the sensitivity of an individual or a group (see figure 1). Social vulnerability refers to internal and external factors that determine the state of the individual itself and is often used to describe social inequality, such as poverty or marginalisation (Brooks, 2003, p. 4). Wilhelmi and Hayden (2010) developed an extreme heat vulnerability framework and make a similar distinction between social and biophysical vulnerability. They make a further subdivision of heat vulnerability in terms of exposure, sensitivity and adaptive capacity. Adaptive capacity however, can also be seen as part of biophysical vulnerability (a lack of adaptive capacity in the elderly contributes to an increased sensitivity) or as part of social vulnerability as a result of (behavioural) adaptation (Brooks, 2003, p. 9). Figure 1 shows the abovementioned components of vulnerability that were assessed in this research. The hazard itself in terms of vulnerability is outside the scope of this research. The hazard is this case heat or a hot environment as a result of climate change. Changing the magnitude or occurrence of the hazard (heat) is the domain of climate change *mitigation* and was left aside in this research, focusing on climate change *adaptation* strategies instead.

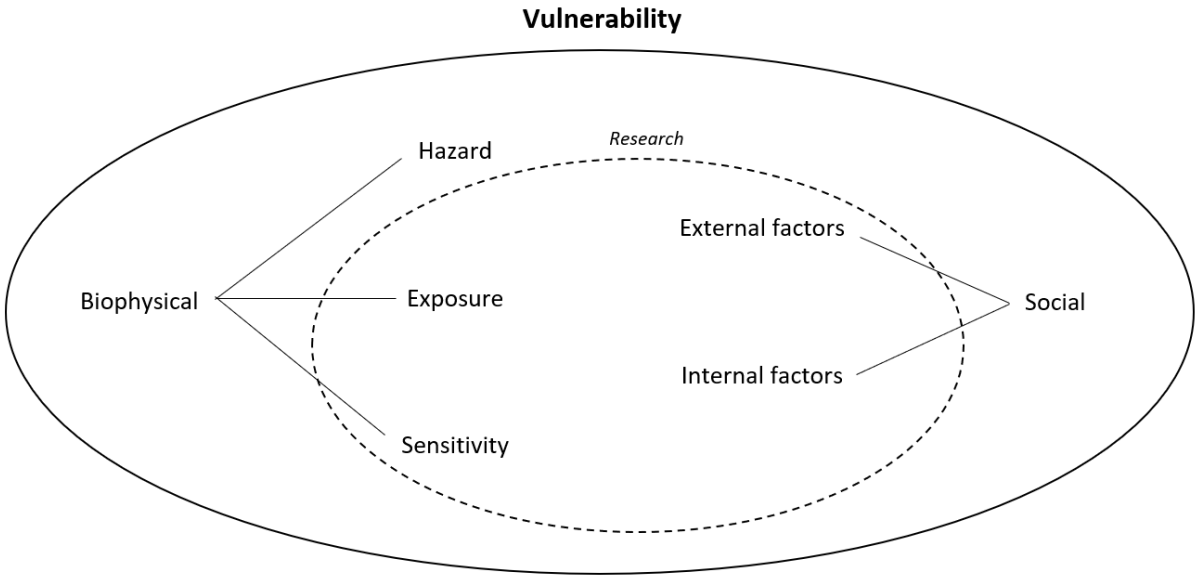

Figure 1: Components of vulnerability and position of this research

To combine the simultaneously different as well as (partially) overlapping definitions of vulnerability and all of the aspects mentioned above, this research uses the 3-G-concept to create an overview of relevant vulnerability factors (see figure 2). The 3-G-concept stands for "Gebouw, Gebied en Gebruiker" (Kennisportaal Klimaatadaptatie, 2022) , which can be translated as "Building, Area and User". It will be referred to in this research as the 3-G-concept.

The 3-G-concept is part of the research line of the National Knowledge and Innovation Program (Nationaal Kennis- en Innovatieprogramma Water en Klimaat, NKWK) in the Netherlands on making cities water-resilient and climate-proof (NKWK, 2022). It is executed by the National Institute for Public Health and the Environment (Rijksinstituut voor Volksgezondheid en Milieu, RIVM), using the 3-G-concept for research on heat stress prevention. By building upon the research by the RIVM and using the 3-G-concept, public health and the spatial domain are linked together in addressing climate change adaptation regarding heat.

This framework is in line with the importance of combining risk management strategies and the design of the built environment as a strategy for optimal heat stress prevention as stated by Keith et al. (2020). The framework facilitates a distinction between recommendations on policy measures from a health perspective (preventing heat stress during heat events) and from the perspective of spatial adaptation (increasing resilience and sustainability of the urban environment). By using the 3-G-concept, these problem domains can be used to translate the vulnerability factors into actionable policy measures, both for the municipality (e.g. the department of spatial planning) and other stakeholders (e.g. housing corporations and health care workers).

In the research project of the RIVM, the "building", "area" and "user" components are defined as follows:

- Building: residential buildings. They zoom in on building characteristics related to orientation, heat radiation permeation, and insulation (De Vries & Mesdaghi, 2021).
- Area: residential areas. They determine the influence of characteristics such as paving, street design, and the presence of green areas and open water (De Vries & Mesdaghi, 2021).

- User: residents of apartments and terraced houses. They mapped behaviour on ventilation and sun shading (Hagens & De Nijs, 2021). Biophysical properties of these users are described in a separate desk study by De Vries et al. (2020).

In this research, the component “area” will be defined broader, as the total living environment of the elderly (e.g. including areas connecting them to shops, health care professionals and transportation). In this research, the component “user” will be defined as senior citizens in the municipality of Houten (see chapter 3.3), regardless of their housing situation. The component “building” will remain defined as defined by the RIVM (containing all types of residential buildings).

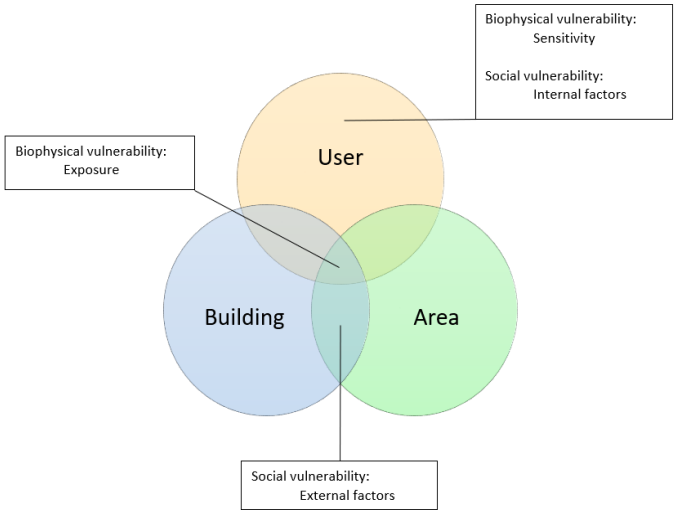

Figure 2: Theoretical framework of vulnerability and the 3-G-concept combined

4.2 Climate change adaptation gap

The term climate change adaptation gap (CCA gap) is used to identify “the difference between existing adaptation efforts and adaptation need” (Chen et al., 2016, p. 404). The United Nations Environment Programme (UNEP) also uses the concept of an adaptation gap to assess existing global adaptation gaps and to evaluate climate change adaptation strategies in a scientific and policy-relevant way (United Nations Environment Programme, 2021, pp. I-2). Since 2014, they established six Adaptation Gap Reports. They defined a CCA gap as “the difference between actually implemented adaptation and a societally set goal, determined largely by preferences related to tolerated climate change impacts, and reflecting resource limitations and competing priorities” (United Nations Environment Programme, 2021, pp. I-3). It is important to note that the goal of the adaptation strategies is a societally set goal, as it emphasizes that this may differ regionally and might change over time. This also applies to resource limitations and competing priorities. As Chen et al. (2016, pp. 404-405) explain, there are multiple reasons why a CCA gap analysis can be helpful: a CCA gap analysis can be performed at the local scale, taking into account specific context and knowledge, leading to actionable outputs. Additionally, a CCA gap analysis enables the evaluation of the effectiveness of adaptation measures by tracking the existing gap over time. These advantages can also be translated to the municipality of Houten, where context-specific policy measures on the prevention of heat stress in senior citizens are desired.

The main disadvantage of using the CCA gap concept is that is can be difficult to compare or translate the outcomes of CCA gap analyses for different locations, as a result of its specificity to a region or city (Chen et al., 2016, p. 404). In this case study for the municipality of Houten, this is not a direct disadvantage, as the research does not aim to make comparisons. This research might set an example on how the use of the CCA gap framework can be used to substantiate policy measures on preventing heat stress in the elderly (or other climate adaptation challenges at the municipal level). In the CCA gap analysis approach, there is no level of perfect adaptation to measure against (Chen et al., 2016 p.404) but if the approach is used in an iterative process of evaluations and modifications, policy measures can increasingly approach the "perfect adaptation" goal.

Chen et al. (2016) also provide a framework for identifying a CCA gap:

1. *Step I: identify and categorize adaptation options*
2. *Step II: survey current adaptation efforts*
3. *Step III: calculate the adaptation gap*

This research follows these steps by: 1) identifying factors that contribute to the vulnerability of the elderly to heat, categorising them according to the 3-G-concept. These factors will lead to an overview of suitable policy measures to reduce this vulnerability and will then 2) be compared to current policy measures on the prevention of heat stress in the elderly in Houten, leading to 3) the identification of the CCA gap in Houten.

The framework of the 3-G-concept and the CCA gap framework come together in step one of the CCA gap framework. The 3-G-concept is used for identifying the most suitable policy measures for heat stress prevention in senior citizens, to make sure that the proposed policy measures are in line with factors that actually contribute to their vulnerability.

4.3 Lock-in mechanisms

International and national governance levels require local governance levels such as municipalities to increasingly prioritise climate change adaptation policies. But even though the necessity for climate change adaptation is widely accepted and acknowledged, little policy measures have been put into action as yet in many municipalities. Lock-in mechanisms can contribute to this lack of policy change towards climate change adaptation by enhancing stabilising dynamics (Groen et al., 2022). Stability in policy systems is not merely an absence of dynamics, but is influenced by dynamic processes as well (contributing to policy stability), leading to the more fitting term "dynamic stability" (Pierson, 2000). This also reflects why a necessity for change does not automatically lead to an actual change in policy: a multitude of factors play a role in dynamic stability, keeping the current policy system in place.

The concept of lock-in mechanisms can be used to explain what underlying mechanisms help maintain policy stability at a time when there is general consensus that change is necessary. Lock-in mechanisms are mechanisms that reinforce existing policy systems, hindering change (Groen et al., 2022, pp. 2-3). The difference with barriers for policy implementation is that barriers can be all kinds of obstacles, whereas lock-in mechanisms specifically focus on the reinforcing mechanisms influencing policy systems. The concept of lock-in mechanisms has already been used in research on climate change mitigation, e.g. on carbon lock-in mechanisms. However, it is still relatively scarcely used in climate change adaptation studies, even though it can provide a useful framework for understanding the presence of a CCA gap (Groen et al., 2022, p. 20). Furthermore, the lock-in mechanism framework provides a holistic approach to examine the different types of mechanisms that drive self-reinforcing dynamics in policy systems: institutional, infrastructural,

technological and behavioural mechanisms can be identified as contributors to dynamic policy stability through the lock-in mechanism concept (Groen et al., 2022, p. 5).

5. Methods

5.1 Research approach

For this research, a case study in the municipality of Houten was conducted on the current adaptation gap on heat stress prevention in senior citizens and on possible barriers and lock-in mechanisms that hinder closing this gap. A case study is a research method that can provide an in-depth analysis of a specific problem at hand (Verschuren & Doorewaard, 2016, p. 186). The complexity of a case study reflects the context- and time-specific characteristics of the research subject (Miles, 2015) and provides a comprehensive view on the subject (Verschuren & Doorewaard, 2016, p. 189). It contributes to the collective process of knowledge accumulation (Flyvbjerg, 2006, p. 227), in this case on vulnerability factors, CCA gaps and lock-in mechanisms for policy implementation at the municipal level. Due to the context-specific characteristics, it is argued that outcomes of case studies are not generalisable to other cases. However, insight into mechanisms in a specific case can contribute to the body of knowledge on a theoretical concept (Miles, 2015).

This research contributes to the body of knowledge on the applicability of the concept of CCA gaps and policy lock-in mechanisms on climate adaptation policies. It contributes to enhancing the understanding about underlying mechanisms that can help sustain a CCA gap (Groen et al., p.16). The research is also practice-oriented and has a high societal relevance: while contributing to the scientific body of knowledge on the subject, it also contributes to solving a policy issue (Verschuren & Doorewaard, 2016, p. 35) by providing the municipality with recommendations on closing the climate change adaptation gap with regard to heat stress in senior citizens. The results from this research were translated by the researcher into a local heat plan (as part of the climate adaptation plan), aiming to support the municipality in closing the existing CCA gap. Substantiating the local heat plan with this academic research is part of the diagnostic part of the policy making cycle (Verschuren & Doorewaard, 2016, pp. 53-56).

The research was conducted following the steps explained below. It should be noted however, that the research process itself has not developed as a strictly linear process. Especially by using the mixed methods approach as adopted in this research, information was exchanged between the document analyses and the semi-structured interviews. Findings from the initial document analyses were used in the interviews as a starting point and information provided by the stakeholders during the interviews was in turn added to the findings of the document analyses. Figure 3 shows how both methods contributed to answering the sub questions in this research. By combining document analyses with interviews, a triangulation method was used to ensure sufficient depth and a comprehensive view of results (Verschuren & Doorewaard, 2016, p. 180). Cross-referencing information from different sources additionally leads to a higher reliability of the research (see chapter 5.5).

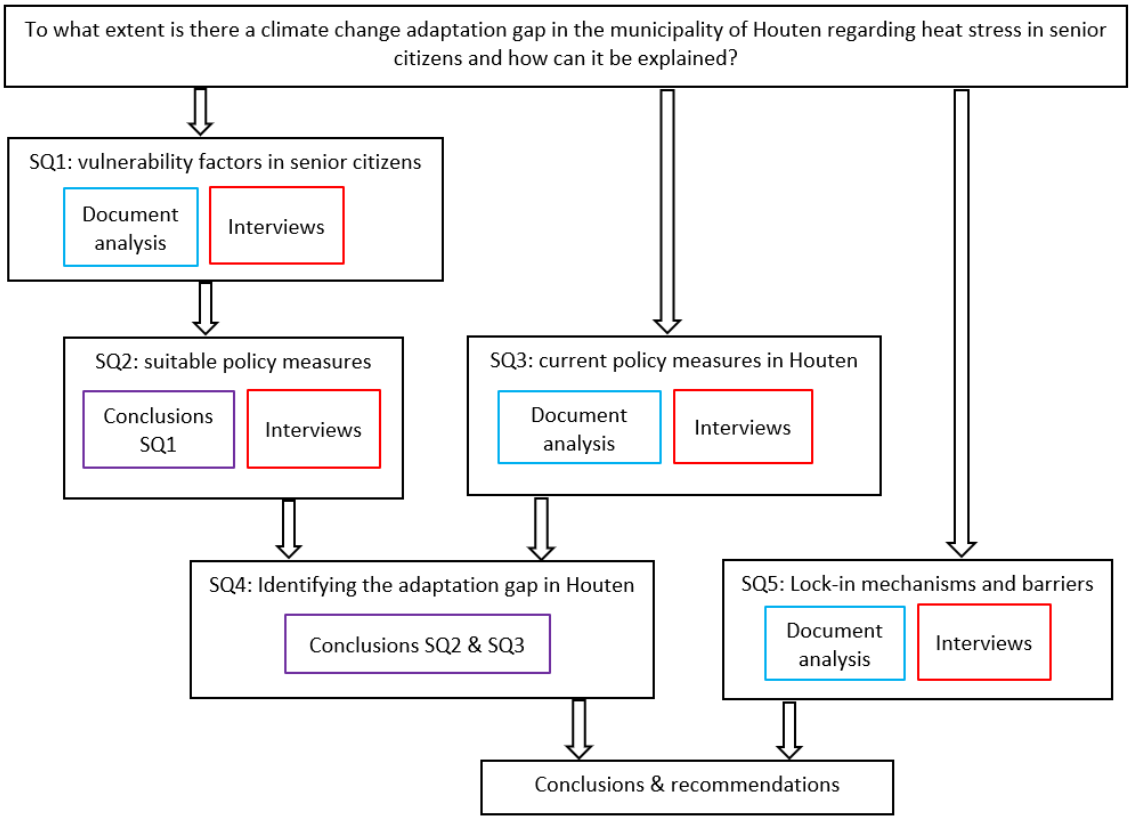

Figure 3: Flowchart of the methods of information gathering per sub question of this research

5.2 Document analyses

5.2.1 Research on vulnerability factors

The starting points for the document analysis on vulnerability factors to heat stress in senior citizens are the two desk studies conducted by the RIVM in cooperation with the NKWK using the 3-G-concept. Information from these studies was further supplemented by searching for relevant scientific literature using the database Web of Science. Only review articles were included to get a comprehensive overview of the current general knowledge on this topic (for general inclusion criteria see addendum 1). Results from this search were assessed based on their title and the contents of the abstracts to select relevant articles. Many of the articles reviewed the health effects of heat stress or morbidity and mortality rates and were discarded (see addendum 1 for the selection flowchart). Subsequent specific additional information was added by selecting relevant articles using either the snowball method on the selected literature and by an additional search on loneliness and heat stress (see addendum 1). The literature search mainly lead to information on “user”-specific vulnerability factors. Therefore, for building characteristics, the desk study by De Vries & Mesdaghi (2021) (including a qualitative and quantitative literature study) remained the main information source. For the component “area” of the 3-G-concept, the main source for the document analysis was the extensive research on climate adaptation in Dutch urban areas by Kleerekoper (2016). This source was the result of the snowball method (checking references of relevant sources).

5.2.2 Research on current policy measures in Houten

The Climate Adaptation Plan (CAP) of Houten (Zwartenkot & Hegger, 2022) was the leading document to gain insight in the current state of affairs on the prevention of heat stress in senior citizens in Houten. An internal

document on the division of tasks on climate adaptation in the municipality of Houten was used for additional information (showing agreements and projects on the topic of heat stress that were outside the scope of the CAP). The researcher had access to these internal documents from the position of intern at the municipality. As part of the CAP, a local heat plan for Houten was also under development at the time of this research, in which the researcher was involved (in cooperation with consultancy agency TAUW and the Province of Utrecht). This involvement resulted in the researchers' access to the local heat plan while it was under development. The researcher further contacted co-workers from the municipality listed in the internal task-division document for more information on heat stress prevention in the municipality but this did not lead to any additional documents.

5.2.3 Research on lock-in mechanisms and barriers

The literature on policy lock-in mechanisms that was used during the development of the research proposal preceding this research was the starting point for the theoretical framework on policy lock-in mechanisms and barriers. The work of Groen et al. (2022) and Biesbroek et al. (2011) formed the foundation for the research on barriers and policy lock-in mechanisms. This information was supplemented by scientific articles from a systematic literature search in the database Web Of Science and the snowball method. For information on selection criteria and results see addendum 1. For this search, the type of article was not specified (contrary to the literature search on vulnerability factors) as the information from case studies and on more specific research questions was considered useful by the researcher (whereas an overview of vulnerability factors in the elderly to heat stress required more general knowledge on the subject). During the article selection, the researcher chose to use the area of the conducted researches for selection, only including articles on climate adaptation in developed countries. This choice was made as challenges of climate adaptation and lock-in mechanisms are context-specific and can differ greatly between developing countries and developed countries (being subject to other governmental and societal institutions and economic challenges, Nath & Behera, 2011).

5.3 Semi-structured interviews

The semi-structured interviews were conducted on municipal employees and among stakeholders involved in the development of the local heat plan for the municipality of Houten. Semi-structured interviews were chosen as the interview method because of the advantage that all relevant topics can be discussed while maintaining an individual approach and the possibility to ask for elaborations on topics. The interview guide (see addendum 2) provides insight into the interview questions. Depending on the profession of the respondent, certain aspects were elaborated on in more detail than others. This way, the semi-structured interviews were suitable for an in-depth analysis of different views on the subject by a heterogeneous respondent group. A strategic selection of respondents was used and is considered suitable for case studies, working with a small number of participants (Verschuren & Doorewaard, 2016, p. 180). Stakeholders that were selected for this research consisted of professionals that work with senior citizens or professionals that work for the municipality of Houten.

Stakeholders were initially selected and contacted via email by a municipal employee, working in the social domain with an extensive network on public health in the municipality. The municipal employee selected these stakeholders from her own professional network in Houten. During a priorly scheduled stakeholder meeting by the municipality and consultancy agency TAUW (involved in developing the local heat plan commissioned by the Province of Utrecht), the researcher introduced herself and announced the invitations for the interview. The researcher contacted the stakeholders via email to invite them to participate. Additionally, municipality employees were approached to gain a more in-depth insight into the policy measures of the municipality. Other stakeholders that did not participate in the stakeholder meeting that

might have been relevant to this subject were approached (e.g. store owners and physiotherapists) but this did not lead to any additional respondents. A total number of five stakeholders agreed to participate in the interviews, see table 1.

Code	Municipal department or company	Interview date
M1	Policy advisor public space	17-11-2022
M2	Policy advisor community	30-11-2022
M3	Policy advisor safety and crisis management	08-12-2022
S1	Organisation for sustainable transportation in Houten	23-11-2022
S2	Public Health Service	30-11-2022

Table 1: Respondents of the interviews

In consultation with the respondents, the interviews were mainly conducted in the town hall and one at the home of a respondent (S2). A comfortable environment for the respondents is important for a small scale research like this case study (Verschuren & Doorewaard, 2016, p. 180), facilitating a pleasant and open conversation. Contact information of the researcher was left with the respondents to encourage them to complement their initial answers with important information that in their opinion should not be left out of the research. Two of the five respondents (S1,2) made use of this invitation. A consent form and an informative letter on the recording of the interview and on the use of data were discussed with and signed by the respondents before the start of the interviews (see addendum 3).

The content of the interviews (see addendum 2 for the interview guide) was based on the knowledge of the researcher from the theoretical frameworks and document analyses in this research. The initial interview questions were also presented to the coordinating municipality official to prevent researcher bias. Researcher bias was further prevented as much as possible by concluding each topic as well as the complete interview with an open question about other relevant knowledge the respondents might have on the subject and would like to share with the researcher.

As a result of the low number of interview participants, the researcher chose to add the results of a public poll on climate change adaptation to the data analysis. The poll was conducted by the municipality of Houten in September 2021 as part of the Climate Adaptation Plan Houten 2022-2027 (Zwartenkot & Hegger, 2022). This poll had 263 respondents, of which 33% was older than 60 years old. The results from the public poll were described in chapters 6.2 (on suitable policy measures for the municipality), 6.3 (the poll itself as part of the CAP) and 6.5 (identifying lock-in mechanisms). It should be noted that the results of the public poll might be biased as a result of an above-average climate awareness among the respondents.

5.4 Data analysis

Data analysis was conducted based on the Grounded Theory, a systematic approach for analysing qualitative data (Baarda, 2014, pp. 156-163). First, open coding was applied to the transcripts from the interviews: fragments were labelled according to its subject and synonyms were joint together. Next, axial coding led to a categorisation by identifying overarching subjects. Categories were then linked to the sub questions of this

research by selective coding. In practice, axial and selective coding were not applied strictly sequentially but overlapped during the process of categorising the codes. Due to the choices that the researcher makes on categorisation, this process can be viewed as partially subjective. To make the researchers choices on categorisation transparent, these choices are recorded in addendum 4, adding to the reliability of this research (see chapter 5.5). The complete data analysis process based on the Grounded Theory was conducted using the software programme Atlas.ti.

5.5 Reliability, validity and ethics

Reliability

Predesigned interview guides for the semi-structured interviews, a systematic coding approach for data analysis and the use of an audit trail increased the quality of this research by increasing its reliability (reflecting reproducibility (Baarda, 2014, pp. 90-91)). An audit trail is a logbook which provides insight into the researchers choices and possible researcher biases (Baarda, 2014, pp. 167-168). In this research, the audit trail consists of documentation of codes and categories that were used in the coding process (see addendum 4). This documentation contributes to the transparency on the researchers' choices during the qualitative data analysis process. Regrettably, due to the nature of some sources (internal documents of the municipality that have not been published for the public), not all sources are included as a reference, reducing transparency.

Validity

A high research validity represents the compatibility of the results with the research question: whether the acquired knowledge adequately represents the knowledge available on the subject (Baarda, 2014, pp. 88-89). The validity of this research was ensured by two forms of triangulation: by combining the results from the literature research with the results from the interviews and by interviewing stakeholders with diverse backgrounds. A triangulation method increases the validity of qualitative research (Baarda, 2014, p. 167). The peer debriefing process by the thesis supervisor further added to the validity (Baarda, 2014, p. 168). In case studies, external validity (the possibility to generalise the research results to other populations (Verschuren & Doorewaard, 2016, p. 136) is less applicable, as the research focusses on context-specific factors (see also chapter 5.1).

Ethics

Ethical considerations regarding privacy, data storage and anonymity of the interviews were taken into account in the research design. The participants were informed about the recording of the interviews, the data storage and their option to end their participation in this research at any given time. They were informed about the right to decline any questions they did not wish to answer and were given the opportunity to ask questions about the interview process. All participants received an informative letter with the information stated above and a consent form was signed before the interviews. See addendum 3 for the contents of the information letter and the consent form. Contact information of the participants (in the form of an email address) was stored on the secured server of the municipality of Houten. The interviews were recorded using a voice recorder. No personal information was recorded, the recordings were transferred from the voice recorder to a password-protected folder on the Open University´s secured SURFdrive, as well as the signed consent forms. The anonymity of the respondents was protected by linking the transcripts only to their general field of work, no personal information was linked to the contents of the interviews. The Committee for Ethical Assessment of the Open University (cETO) has reviewed the research methods of this research and has given its consent for the procedure prior to the interviews.

6. Results

6.1 Vulnerability factors in senior citizens

Sub question 1: What factors (based on the 3-G-concept) contribute to the increased vulnerability of senior citizens to heat stress?

6.1.1 User

Physiological changes

Maintaining a stable core temperature is important for a variety of biological processes and the functioning of internal organs and body systems. The human body will attempt to keep its core temperature around 37°C (Hagens & De Nijs, 2021): in varying surrounding temperatures, the body will use strategies to adapt to its surrounding temperature (to both high and low temperatures). This is called thermoregulation. In reaction to high temperatures, the human body can cool itself down mainly via the skin: by vasodilatation (dilation of the blood vessels, increasing heat emission) and by transpiration (by sweat evaporation) (Hagens & De Nijs, 2021). Physiological processes related to ageing (occurring in all senior citizens) and processes related to certain illnesses can impair the thermoregulatory functions in the elderly (Hagens & De Nijs, 2021; Millyard et al., 2020, pp. 2-3):

- a reduced capacity to produce sweat and a higher internal threshold for the onset of sweating
- a reduced capacity of the blood vessels to dilate and constrict
- a decreased skin blood flow
- a lower level of neurotransmitters resulting in a diminished sense of having to slow down
- chronical illnesses like diabetes mellitus and chronic obstructive pulmonary diseases (COPD)
- a decreased renal functioning
- cardiovascular diseases
- medication
- a limited mobility

A limited mobility can reduce the possibilities of senior citizens to take adequate measures against heat in their homes and can prevent them to seek out places in the area that are cool. This leads to an increased exposure to heat. In spatial adaptation, the limited mobility of senior citizens should be taken into consideration in the assessment of accessibility of cool public spaces. One of the interview respondents (S2) pointed out that it is not only the presence of cool spaces in the area that is important, but that accessibility for people with walking aids or wheelchairs should be taken into account as well. Help can also be needed for people with limited mobility, emphasizing the importance of a good network around the elderly (see also the paragraph below on loneliness).

Dehydration is also a risk factor that can lead to an increased sensitivity to heat stress in the elderly (Hagens & De Nijs, 2021). General changes in water metabolism, a decreased thirst sensation, chronical illnesses and the use of medication make senior citizens more vulnerable to dehydration (Ferry, 2005; Schols et al., 2009). A limited mobility and cognitive decline can also lead to a lower fluid intake and an increased risk of dehydration (Begum & Johnson, 2010, p. 49). However, a decreased sweat production and physiological changes in renal functioning and water regulation should be taken into consideration as well (Benton, 2011, p. 569; Ferry, 2005, pp. 24-25): a lower fluid intake is necessary to prevent dehydration in the elderly than in younger people. Alerting people on the effects that medication can have on the sensation of thirst, water balance and sweat production is, according to one of the interview respondents (S2), a very important focus

point when it comes to individual care in the prevention of heat stress. Incorrect storage of medication was also named (by respondent S2) as an added health risk on hot days: when the storage temperature of medication is too high or the medication is placed in direct sunlight, its effectiveness can change, possibly leading to an exacerbation of health problems.

Behaviour

Some physiological processes that change with ageing also affect behavioural thermoregulation: the adaptive behaviour of people to their surrounding temperature (Millyard et al. (2020)). Behaviour like seeking shade, increasing fluid intake or choosing appropriate clothing for high temperatures can help prevent heat stress (Millyard et al., 2020, p. 4). However, behavioural thermoregulation is driven by thermal discomfort and with age the perception of thermal discomfort decreases. If the elderly do not perceive the temperature as too high, they are less inclined to respond adequately to heat exposure. Respondents from the public poll in the age group 18-30 year old expressed more health- and sleep problems due to heat than people in the age group over 60 years old (Zwartenkot & Hegger, 2022). This might be linked to the changes in perception of thermal discomfort in the elderly. This effect is further enhanced by an inhibited pacing response as a result of lower levels of certain neurotransmitters. This pacing response leads to an (unintentional) lowering of physical workload to adapt to high surrounding temperatures (Millyard et al., 2020, p. 4). With a lower physical condition, small (daily) activities can cost senior citizens a lot of effort and energy, resulting in a high perceived workload for the body. Due to the inhibited pacing response, senior citizens do not automatically adapt their behaviour adequately to high temperatures and have to actively choose to slow down or be reminded of this by their social network. One of the respondents (S1) from the interviews expressed much confidence in the ability of the elderly to pace themselves, “slowing down automatically when it is hot” (based on the respondents’ experience that the elderly are going out less on hot days, not based on information on behaviour or activities indoors). However, if the thermal discomfort is not felt and the subconscious inhibiting pacing response is diminished, senior citizens cannot be expected to automatically slow down on hot days. Another important finding from both the interviews and the public poll that was part of the Climate Adaptation Plan for the municipality of Houten (Zwartenkot & Hegger, 2022), was that people are likely to remain indoors on hot days: 68% of the respondents indicated that they try to remain cool at home, 13% makes use of cool green public spaces and 12% makes use of swimming water in the public space. Among the elderly, it is expected that the percentage of people trying to stay cool at home is even higher, as a result of physical impairments and accessibility issues.

Loneliness

Senior citizens often live alone and experience loneliness (Kennisportaal Klimaatadaptatie, 2022, RIVM, 2022). Social conditions such as loneliness can be risk factors for heat stress (Hagens & De Nijs, 2021). Malmquist et al. (2022, pp. 7-11) found that the reduction of loneliness can help improve someone’s ability to cope with heat. Loneliness can affect someone’s ability to cope with heat (called an “adaptability risk” by Eady (2020, p. 223)) on two levels: on a physical level and on a mental level. On a physical level, social interactions can help the elderly to reduce their pace on hot days. As explained above, changes in neurotransmitter levels affect the elderly’s ability to adjust their pace to a hot environment, so other incentives to do so are necessary. This is also applicable when it comes to being reminded to drink a sufficient amount of fluids on hot days: with a diminished sense of thirst, the elderly need a reminder to drink. This can be facilitated by their social environment (e.g. family or home care workers), and is inhibited if a senior citizen has limited interactions with others. Limitations in physical abilities can also cause the elderly to have less possibilities to enjoy cooling activities, such as swimming or taking a cooling shower or bath (Malmquist et al., 2022). With help they can improve their thermoregulatory behaviour. In terms of mental health effects, social interactions can increase

a person's motivation to self-care and adequate responses to heat (Malmquist et al., 2022). The interview respondents (M1,2,3, S1,2) also unanimously identified loneliness as one of the main risk factors for heat stress in senior citizens. This effect is especially important in elderly living at home, as they are more dependent on a network for care and company.

As part of the National Climate Adaptation Strategy (Nationale Klimaatadaptatiestrategie, NAS), a Loneliness and Heat Map was developed to monitor the demographic group that is extremely vulnerable to heat: lonely elderly (Kennisportaal Klimaatadaptatie, 2022). These maps, available for all municipalities with urban areas, show areas that are both vulnerable to high temperatures and additionally have a high percentage of lonely elderly residents. Figure 4 shows the Loneliness and Heat Map for the municipality of Houten. Colours represent the average perceived temperature on a hot summer day per neighbourhood. The white, grey and black dots represent the density of severely lonely elderly (75 years or older) per square kilometre. The density categories are divided into "low" – less than 10 per km^2 (white dots), "fairly high" – 10 to 50 per km^2 (grey dots) and "high" – more than 50 per km^2 (black dots) (Kennisportaal Klimaatadaptatie, 2022). The map shows that areas with a high perceived temperature on hot days coincide with areas where a high number of severely lonely people older than 75 years old live in the municipality of Houten. The combination of increased sensitivity (due to loneliness) and an increased exposure (due to the high temperatures in their neighbourhood) leads to a further enhanced vulnerability to heat of this group. It should be noted that three of the areas indicated with a black dot are also areas where nursing homes are located. The physical component of loneliness contributing to increased vulnerability to heat stress is expected to be lower in this group compared to elderly living at home because of the availability of care. Caregivers are in close proximity for signalling functions, help with mobility issues and regulating climate control or shades and ventilation etc., in contrast with the situation of lonely elderly living at home.

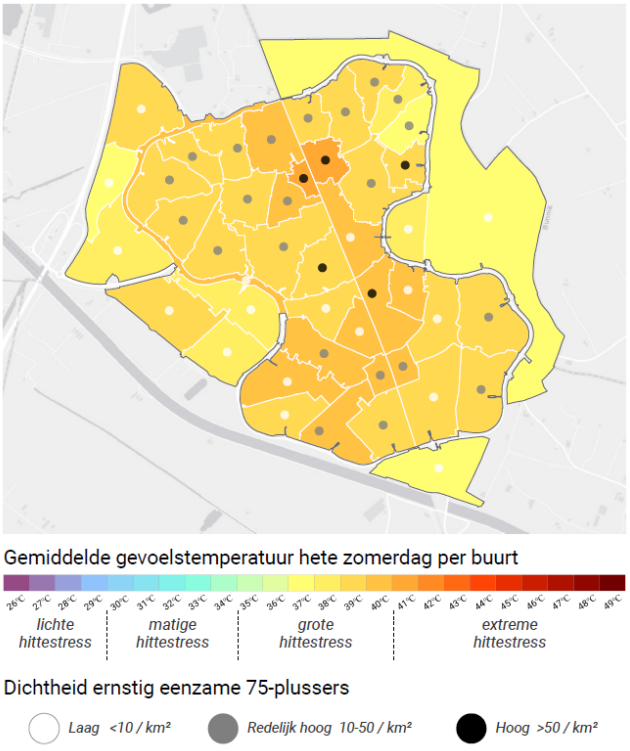

Figure 4: Loneliness and Heat Map of the municipality of Houten (Kennisportaal Klimaatadaptatie, 2022)

6.1.2 Building

Building characteristics influence heat stress in senior citizens by means of exposure: building characteristics can lead to a higher indoor air temperature (De Vries & Mesdaghi, 2021). As mentioned above, people tend to stay at home on hot days, enhancing the importance to create a comfortable environment within the building. De Vries & Mesdaghi (2021) conducted an extensive qualitative and quantitative literature study on the influence of building characteristics on indoor air temperature. They did not specifically focus on the elderly as a demographic group but on residential buildings in general. However, the general findings on building characteristics are applicable to any demographic group, including senior citizens. The main principles influencing indoor air temperature are summarised below. In general, the effect size of these building characteristics is bigger in apartments, compared to terraced houses or detached houses (De Vries & Mesdaghi, 2021, p. 9).

Principles that influence the indoor air temperature:

1) Thermal conduction: the indoor air temperature is mainly influenced by direct and indirect solar radiation and only to a small extent by thermal conduction between the building materials and the outside air (De Vries & Mesdaghi, 2021). This is the result of (at least some) insulation being present in almost all Dutch houses: because of the insulation, the indoor air temperature is not strongly linked to the outside temperature by thermal conduction.
2) Solar radiation: solar radiation on windows has the biggest impact on indoor air temperature. Heat transmission through closed parts of buildings (walls) is low, especially on isolated living layers (De Vries et al., 2020, p. 20). In line with this principle, De Vries & Mesdaghi (2021) concluded that the size of windows and the type of glass used in the windows (clear glass or reflective glass) have the biggest impact on indoor air temperature on hot days. The orientation of the room or house is also an important building characteristic that influences indoor air temperature, as this determines the amount of solar radiation reaching the windows. To prevent the indoor air temperature rising as a result of solar radiation on windows, shading the windows on the outside of the building is the most effective measure (De Vries & Mesdaghi, 2021, pp. 8-9). Outdoor shading can consist of the use of (dynamic) shades or shade from the environment (e.g. other buildings or trees). Reflecting external walls or roofs, solar panels or Blue-Green roofs generally have a negligible effect on the indoor air temperature as these measures are based on minimising solar radiation on closed parts of a building (reflecting walls or roofs, solar panels) or on adding insulation (Blue-Green roofs). For buildings with single-stone walls or roofs without insulation these measures might have a significant effect on indoor air temperature however (De Vries & Mesdaghi, 2021, p. 9).
3) Natural ventilation: natural ventilation is also an important building characteristic that influences indoor air temperature (De Vries & Mesdaghi, 2021, pp. 8-9). Natural ventilation includes cross ventilation (opening opposite windows and/or doors to create an airflow) or night ventilation (opening windows and/or doors during the night). Especially night ventilation is an impactful measure for lowering the indoor air temperature on hot days: it can result in a lower maximum indoor temperature up to 5,5°C (De Vries et al., 2020). However, the use of natural ventilation strongly depends on the user, and whether elderly residents make use of natural ventilation is dependent on behaviour and cognitive and physical capability. Behaviour and physical and cognitive capability also play a role in the use of shades (see point 2). Mechanical ventilation systems appear to have only a small effect on indoor air temperature.

In the interviews, air conditioning is mentioned most often as a measure for keeping the indoor air temperature comfortable on hot days, both as an adequate measure as well as an unsuitable measure. It is

considered an adequate measure if it can help prevent heat stress in vulnerable senior citizens according to one respondent (S1), and is mentioned as a general measure that is often implemented in nursing homes by another (M1). The other respondents (M2,3, S2) disagree with the use of air conditioning as a cooling measure however, due to the energy use and the warming of the surrounding environment. This dichotomy was also found in the public poll: 19% of the respondents indicates that they are concerned about the increased use of air conditioning systems but 12% of the respondents indicates that they have already installed an air conditioning system and 17% is planning to do so. Among respondents in houses without gardens these percentages are slightly higher, 13% and 20% respectively. Other solutions that were mentioned in the interviews for actively cooling homes are the use of a heat pump (that can also be used for cooling) or a fan.

It is notable that the use of sun shading systems was mentioned by only one respondent (S1) and none of the respondents mentioned natural ventilation. Ventilation is not mentioned in the public poll either but this might be the result of the design of the poll (open questions were targeted at broad er topics). A good insulation of the house was mentioned by one respondent as important for keeping a home cool (M2), as well as using green roofs (M1,3) or other innovations (M2) and the presence of a garden (many houses in Houten have a garden) (M1).

6.1.3 Area

As mentioned above, shading outside buildings, for example by trees or other buildings, can contribute to a lower indoor air temperature in houses (De Vries et al., 2020, p. 18). Apart from the influence on indoor air temperature, spatial adaptation influences the exposure to heat in public spaces (Kluck, et al., 2017, p. 21). Cool public spaces can be used to cool down intentionally, but it is also important that people can reach facilities such as shops, the general practitioner and the pharmacy with limited heat exposure. Measures in spatial climate adaptation for minimising the UHI-effect (and heat exposure) can be subdivided into four categories: 1) vegetation, 2) water, 3) urban geometry and 4) material and colour (Kleerekoper, 2016, p. 330).

Vegetation: increasing the amount of vegetation has the biggest impact on reducing heat by spatial adaptation (De Vries & Mesdaghi 2021; Kleerekoper 2016; Kluck, et al. 2017; Wong, Ho, & Tse 2020). Not only can greenery in the form of trees provide shade, vegetation also provides active cooling by evaporation (evaporation of water from leaves, using the energy to heat up water instead of the air) (Kleerekoper, 2016, p. 17). However, during the night, vegetation can block outgoing radiation from paved surfaces back into the atmosphere (Kleerekoper, 2016, p. 172). Because paved surfaces warm up less due to less incoming radiation during the day (as a result of the shade from vegetation), the net effect remains a cooling effect (HvA Urban Technology, 2022). The presence of a green area (e.g. a park) can influence both the perceived outdoor temperature and the indoor air temperature of nearby houses (De Vries et al., 2020, p. 13). Furthermore, parks provide a cool space, and transport cool air to the surrounding area up to a 100m distance (Kluck, et al., 2017). Accessibility of parks to use as a cool public space should be taken into consideration in spatial adaptation: for vulnerable groups such as the elderly, a maximum walking distance of 300 m to public green spaces is recommended (Nuijten, et al., 2018 in Kluck, et al., 2017, p.39). This is especially important for people that do not have access to a private green space (in the form of a garden).

The interview respondents (M1,2,3, S1,2) all stated that overall, the municipality of Houten is already a municipality with lots of greenery. However, a distinction was clearly made between the northern part of Houten and the southern part: in the northern part of Houten, greenery provides shade because there are a lot of big trees. They shade bicycle lanes and sidewalks and provide cool spots to reside (with benches). The southern part of Houten is also green but provides much less shade, as the trees are not fully grown yet. A distinction between “greenery” and “greenery providing shade” seems suitable.

A specific town square that was indicated by all respondents (M1,2,3, S1,2) as an area that is not well adjusted to high temperatures is Het Rond ("The Circle"). This is a paved square with very little greenery and shade, which is an access area for supermarkets and shops. Many senior citizens live nearby and make use of the square. The lack of vegetation clearly stands out for residents and employees of the municipality. The municipality performed an assessment on redevelopment possibilities for the square but no definitive plans have been made due to barriers for implementation (see chapter 6.3.1 and chapter 6.5.1).

Water: The overall cooling effect of water on air temperature is relatively small (De Vries & Mesdaghi, 2021, p. 5; Kluck et al. (2017, p. 33)). It strongly depends on the temperature difference between the water and the air and the volume of the water (De Vries & Mesdaghi, 2021, p. 23). Large bodies of water can contribute to cooling air but can also contribute to the UHI-effect during the night, as water cools down more slowly than air, giving off warmth during the night by ongoing evaporation (Kleerekoper, 2016, p. 83; Kluck, et al., 2017, p. 33). Furthermore, the cooling effect of evaporation of water can be inhibited by weather conditions (e.g. a high humidity or low airflow) (Kleerekoper, 2016, p. 81).

The presence of water is mentioned by respondents (M1,2, S2) as an effective cooling measure, influencing the surrounding air temperature. However, this does not correspond with the scientific literature. The fountain opposite one of the nursing homes is perceived as an adaptive measure against heat and a swimming water is indicated as a cool space where people can cool down. The latter might not be effective as a cool space for elderly however, as a result of limited accessibility for people with a reduced mobility. The presence of a fountain has a negligible cooling effect on the surrounding air temperature, as outlined above.

Urban geometry: urban geometry can also affect the temperature in urban areas, as it influences air flow and incoming solar radiation on paved surfaces (Kleerekoper, 2016, p. 330). Both aspects are influenced by the layout of the street and the height-to-width-ratio (H/W-ratio) of the street and its buildings. In general, a higher H/W-ratio is linked to more shadow, as higher buildings block more sun. However, higher buildings also reduce ventilation and above a certain height, additional shadow does not reach the paved streets and surrounding buildings. The tipping point at which the cooling effect of the increased amount of shadow is outweighed by the reduction in ventilation is not yet specified (Kleerekoper, 2016, p. 332).

In the layout of the street, gaps between buildings or building blocks are important for airflow (De Vries & Mesdaghi, 2021, p. 4). Besides building height and street design, the percentage of green and water are the most important variables that play a role in (Dutch) neighbourhoods with regard to temperature (Kleerekoper, 2016, p.219). Only greenery (M1,2,3, S1,2) and water (M1,2, S2) were indicated by respondents as spatial adaptation measures to heat, urban geometry and albedo of surfaces (see below) were not mentioned. Geometry and albedo might be useful in development projects in the future or for optimising existing areas.

Material and colour: material and colour of surfaces affect the albedo of a surface. The albedo represents the reflectivity of a surface: surfaces with a high albedo reflect more solar radiation and will remain cool (as opposed to surfaces that reflect only a small amount of solar radiation, absorbing more radiation and leading to a warming of the surface). The albedo can be used to influence the surface temperature: an increase of 0,1 in albedo of a surface can lead to a decrease in surface temperature of about 4°C (De Vries & Mesdaghi, 2021, p. 4). The albedo is expressed in a number between 0 (no light is reflected by the surface) and 1 (all of the light is reflected by the surface). An 0,1 increase in albedo can be translated as an increase of 10% in light being reflected. The albedo of surfaces of buildings depends on the building material and its finish (e.g. colour). See figure 5 for an example of different building materials and colours and their albedo (Kleerekoper, 2016). The cooling effect of reflective surfaces is only present when it is applied to large surfaces however (De Vries & Mesdaghi, 2021, p. 5). Moreover, highly reflective surfaces can also increase the temperature in the

surrounding area by reflecting solar radiation to other surfaces. This can be counterproductive in preventing heat stress in senior citizens if reflective surfaces lead to a warming of pavements, for example (Kleerekoper, 2016, pp. 172-173). Where the cooling effect of reflective facades strongly depends on the surrounding area (e.g. a difference between pavement or grass), increasing the albedo of roofs is found to be an effective measure that leads to cooling of an area on street level (Kleerekoper, 2016, p. 172). This way, radiation is reflected back into the atmosphere instead of on other surfaces. The interplay between the albedo of a surface and the geometry and material of its surroundings is complex and should be mapped carefully to make optimal use of the albedo effect for heat stress prevention in (re)development plans.

MATERIAL	TYPE/COLOUR	ALBEDO
Concrete pavement		0.40
Asphalt		0.20
Sandy soil		0.30
Bitumen	Black	0.05
Roofing	White Ecoseal	0.85
Ceramic tiles	Red	0.30
Aluminium/Stainless steel	Blank	0.60
Brick	White/light colour	0.40
Brick	Red	0.20
Brick	Dark	0.10

Figure 5: Albedo of building materials and colours (Kleerekoper, 2016, p. 156)

What further stands out from the interviews are the different interpretations of the term “cool public space”. It can be interpreted as mentioned above: a (green) outdoor space with shade that provides a cool place to reside (e.g. on a bench). However, two of the respondents of the interviews (M3, S2) used the term “cool public space” interchangeably for a cool, publicly accessible *indoor* space as well, for example in churches or libraries. These cool spaces might be used in a crisis situation as well, when people cannot stay in their homes during times of persistent excessive heat.

6.1.4 Summary

An important finding of the research on vulnerability factors of senior citizens to heat is that physiological changes make senior citizens vulnerable to heat, regardless of the presence of illnesses or physical disabilities. Illnesses, disabilities and the use of medication may further enhance vulnerability to heat. These physiological changes also lead to diminished behavioural thermoregulation. Loneliness increases vulnerability to heat stress further on a physical and mental level, the physical level being less prominent in elderly living in nursing homes because a better care network is in place than for senior citizens living at home.

Building characteristics that can be influenced to keep the indoor air temperature from rising too much on hot days are insulation of the building, the amount of solar radiation reaching the windows (by shading systems or shade from the environment) and the use of natural ventilation. Discrepancies were found between the ideas from the interview respondents and the literature (respondents mainly focused on active cooling measurements) and between respondents on the use of air conditioning systems.

For the area, adding greenery is the most important measure to prevent heat stress in the elderly. Houten is already a generally green municipality, but a distinction can be made between green areas with shade and

green areas without shade. The use of cool outdoor public spaces by senior citizens is questionable because of accessibility and mobility challenges and a general tendency of people to stay indoors on hot days. Cool indoor public spaces may provide an accessible alternative and may function as a crisis shelter in emergency situations. Water is perceived as an adequate cooling measure but scientific literature indicates that this adds little to lowering the air temperature. Applying findings in the field of urban geometry and the albedo of surfaces can contribute to reducing the UHI-effect in the town centres of Houten in the future.

6.2 Suitable policy measures

Sub question 2: What would be the most suitable policy measures for the municipality of Houten to prevent heat stress in senior citizens?

6.2.1 Results

Following from the previous chapter, physiological changes lead to limited physical and behavioural thermoregulation in senior citizens, even in healthy elderly. In senior citizens with (chronical) illnesses or disabilities, thermoregulation can be even more compromised. Suitable policy measures should therefore be directed at assisting and alerting senior citizens in taking adequate measures, especially the extra vulnerable group of lonely elderly. These adequate measures consist of seeking shade or a cool place, adjust clothing and activities, drinking enough fluids and making use of shading of windows and natural ventilation. Extra attention should be paid to the use and storage of medication on hot days.

Looking at building characteristics, the municipality should take the abovementioned measures into account in (re)development projects: insulation of the building and the size, orientation and reflectiveness of windows. For existing buildings, the municipality can cooperate with nursing homes, housing corporations and home owners by informing them on the adequate measures that can be taken to reduce heat in buildings: the use of shades on the outside of the building and the use of natural (night) ventilation. The effectiveness of these measures should be communicated to senior citizens and their (care) networks as well.

Spatial adaptation is an important tool for the municipality to reduce the UHI-effect and to reduce heat stress in senior citizens when they make use of the public space. Despite the tendency of people to stay more at home on hot days, they still need to be able to reach shops and facilities with a minimal exposure to heat. Adding greenery can be an effective measure for minimalizing exposure to heat in public space but in a generally green municipality like the municipality of Houten, it is important to make a distinction between vegetation providing shade and vegetation that does not provide shade. Vegetation that does not provide shade contributes to lowering the temperature by evaporation but does not provide protection for senior citizens against direct solar radiation and does not prevent the warming of surfaces. This should be taken into account by the municipality when they plan to add vegetation. Accessibility of cool and shaded public spaces is another concern and should be assessed in the evaluation on cool public spaces: not just the presence of these spots is important but the accessibility of them is as well. An element of accessibility is also the distance to cool public spaces: a maximum distance of 300 m to the nearest parks or cool public spaces is recommended for people with limited mobility (e.g. in areas around nursing homes or neighbourhoods with a high number of senior citizens). In (re)development projects, urban geometry should be taken into account for heat stress prevention, making use of broad street layouts and gaps between building blocks. Making use of a high albedo on roofs can further contribute to minimising the air temperature of an area.

The respondents from the interviews and the public poll indicated four main ideas on suitable policy measures for the prevention of heat stress in senior citizens in their municipality. The following four focus points were suggested:

1) Spatial adaptation: respondents from both the interviews (M1,2,3, S1,2) as well as from the public poll (86%) placed a strong emphasis on adding greenery as spatial adaptation measure for increasing shade and creating more cool spaces. In the interviews it was mentioned as a general adaptation measure, but also specifically with regard to Het Rond and (to a lesser extent) the other town centre, Castellum. Accessibility of cool public spaces was a concern for one of the respondents (S2). Another respondent (M1) pointed out that the municipality should assess whether these cool public spaces are actually used on hot days to determine the effectiveness of creating more of these spaces, as there are already many of these spaces in Houten. Additionally, as discussed in chapter 6.1.1, people tend to cool down at home on hot days. Another desired spatial adaptation measure that was mentioned (by respondent M2 and by 59% of the respondents of the public poll) was increasing the number of publicly accessible water tapping points.
2) Communication to residents of Houten: policy measures regarding informing residents on various subjects was mentioned by all municipal respondents (M1,2,3). Social cohesion plays an important role in this message: according to the respondents, the main message for the municipality to promote is “look after each other”. Respondents (M1,2, S1,2) explained that the municipality of Houten has a strong social cohesion and they encourage the municipal organisation to make use of this characteristic for heat stress prevention in the elderly. Another information flow should consist of actions that people can take themselves to prevent heat stress, the importance of reducing paved surfaces and adding vegetation in private gardens. The encouragement of private actors to reduce paved surfaces was also pressed upon by the respondents of the public poll (Zwartenkot & Hegger, 2022) by informing and stimulating citizens, but possibly even with obligations. Attention for informing citizens on the role of the municipality in heat stress prevention could be important as well, as most respondents (M2,3, S1,2) indicated they did not know what actions the municipality takes in this regard.
3) Coordinating role: all respondents (M1,2,3, S1,2) agreed that an important focus point of the municipality should be to coordinate (existing) social networks to prevent heat stress in vulnerable elderly, especially lonely elderly. The municipality should map the existing networks around elderly, to activate these networks and bring them into contact with each other. The local heat plan that was under development during this research was discussed as a suitable means of doing this, providing a structure to contact stakeholders, to alert them on heat stress prevention measures and to connect existing networks (see chapter 6.3.1). The municipality should take the role of coordinating organisation: initiating action, connecting stakeholders and monitoring and evaluating the process. Respondents from the public poll also indicated that the municipality should work together with other actors, e.g. private companies and housing corporations. Another coordinating role for the municipality could be in a crisis situation. Preparing for a crisis situation should start with working on all aspects of the safety chain: from pro-action in new development projects, prevention and actions during a crisis situation to aftercare (respondent M3).
4) Changes in the internal organisational structure: respondents both from within the municipal organisation as well as outside the organisation (M1,3, S2) indicated that it would be desirable if the responsibilities regarding heat stress prevention were coordinated by one person. They suggested that this could be one person for all climate change adaptation goals, of which heat stress prevention is only one goal.

6.2.2 Summary

In conclusion, suitable policy measures on the prevention of heat stress in senior citizens in the municipality of Houten should consist of spatial adaptation measures, communication, coordination of networks and a change in the municipal organisation. For spatial adaptation, (re)development projects can create opportunities by looking at urban geometry and the albedo of surfaces. Adding greenery in public spaces can be an effective measure as well. However, the net effect size should be taken into account in a municipality with lots of greenery already present and the fact that the majority of the public poll respondents reported that they prefer to cool down at home. Communication is important for facilitating the elderly in taking preventive measures: alerting people on health risks in the elderly as a result of heat stress, advising on adequate heat stress prevention measures and involving other people or networks to assist and alert senior citizens (especially lonely elderly). Providing information on effective measures for residents of the municipality to implement themselves for keeping their homes cool can further contribute to the prevention of heat stress. The importance of shading windows on the outside, natural ventilation and adding vegetation in gardens for shade and cooling through evapotranspiration should be emphasized. Communication tools can also be used to make use of the strong social cohesion already present in the municipality. In addition to spatial adaptation and communication, the municipal organisation can have a coordinating role to connect existing networks and stakeholders. The implementation of the local heat plan can be used to shape this coordinating role. According to the respondents of the interviews, the organisational structure of the municipality could further benefit from appointing a single person to take overall responsibility on climate change adaptation (and on heat stress prevention as an aspect of adaptation).

6.3 Current policy measures in Houten

Sub question 3: What are the current policy measures that are implemented by the municipality of Houten to prevent heat stress in senior citizens?

6.3.1 Results

The main document for the analysis of current policy measures to prevent heat stress in senior citizens in the municipality of Houten is the Climate Adaptation Plan (CAP, (Zwartenkot & Hegger, 2022)). Other documents identified on this topic included an internal informal document on action points around climate adaptation for several departments. A local heat plan and the municipal environmental vision were still under development during this research.

Climate Adaptation Plan (CAP)

In the CAP for the municipality of Houten, the prevention of heat stress is one of its five focal points. It contains an assessment of the vulnerabilities of the municipality to heat, sub goals for reaching their main goal (being climate proof in 2040) and information on the planning of actions and on financial aspects (Zwartenkot & Hegger, 2022).

Assessment

An assessment was carried out by the municipality of Houten in cooperation with consultancy agency Arcadis on the vulnerabilities of Houten to heat, a so-called climate stress test.

Analyses have been carried out on:

- risk locations with a high perceived temperature on hot summer days;
- the percentages of shadow for different areas in the municipality;
- the distance between residences and cooling vegetation;

- locations where many elderly residents live and where the perceived temperature is highest. The two town centres Het Rond and Castellum were marked as high risk locations for heat stress, as has also been pointed out by the respondents of the interviews (Loneliness and Heat Map, see chapter 6.1.1);
- the percentages of paved surfaces for different areas in the municipality.

Public poll
Apart from the climate stress test, a public poll was carried out in September 2021 in the municipality of Houten. The public poll assessed the opinions of the respondents regarding climate change impacts and how they anticipate and respond to these impacts. 263 respondents participated, of which the majority (83%) owns a property with private garden. Topics that were included in the poll were experiences of the respondents with climate change, opinions on adaptive measures in their own home or garden and in public space and a general assessment of ideas regarding climate adaptive strategies.

Set goals
Following from the results of the climate stress test, goals were established in the CAP to increase the resilience of the municipality of Houten to climate change. With regard to heat stress, the following goals were defined (Zwartenkot & Hegger, 2022):

In 2040:

1. the living environment remains liveable during (long) periods of extreme heat. To accomplish this:
    a. at least 40% shade at highest sun position (on the 21st of June) has to be present on recreational locations and locations of slow traffic (e.g. pedestrians and cyclists);
    b. at least 30% shade on neighbourhood level has to be present;
    c. there have to be enough publicly accessible cool recreational locations within walking distance (300m) of residential buildings;
2. vulnerable groups are protected against heat stress during long periods of heat;
3. residents and businesses have structured their private grounds as heat-proof as possible;
4. the built environment is structured in such a way that heat stress is prevented.

The second and third goal are not specified further (e.g. protective measures or what “heat-proof” private grounds look like). Goal number four is specified further within focal point “climate adaptive construction” (for new buildings and project developments). The municipality strives for adhering to the guidelines of the Province of Utrecht regarding climate adaptive construction (Convenant Duurzaam Bouwen, (Provincie Utrecht, 2021)).

Regarding the prevention of heat stress, the following three additional goals were defined (taken from the provinces guidelines, see also chapter 6.4, table 4):

- 40% of all horizontal and vertical surfaces are heat-resilient or are cooling;
- The cooling of buildings does not lead to a warming of the surrounding area;
- Vital and vulnerable functions and greenery in the public space have to be heat-resilient.

These points have not been developed further than the intention of the municipality to follow these guidelines.

Planned actions
To reach these goals for preventing heat stress in Houten in 2040, the following actions are mentioned in the CAP (Zwartenkot & Hegger, 2022):

- Carrying out an assessment of whether there is enough shade present in public places around schools, shops and other services.
- Monitoring the percentage of shade in slow traffic routes in the area of Houten-Zuid (an area with trees that are not yet fully grown and with small types of trees).
- Monitoring the percentage of shade in a few neighbourhoods in the municipality where the 30% shade goal is not being met yet, but is expected to be met in 2040 without further adjustments.
- Expanding and improving cool spaces by planting trees.
- Evaluating the progress that is made on the heat stress prevention goals and the effectiveness of the actions that have been taken.
- Expanding the number of places where dogs are allowed to swim.
- Developing a local heat plan for protecting vulnerable groups to heat stress.
- Enhancing climate awareness in businesses and citizens by incentives for climate adaptive structuring of private grounds.

For the goals regarding the prevention of heat stress, several actions are documented in the planning section of the CAP. Table 2 provides an overview of these actions and the planned year of implementation, from 2022-2027 (Zwartenkot & Hegger, 2022). During this research, it has become clear that the planned actions for 2022 were not feasible, and these are rescheduled for 2023. For each of these actions the expected costs, financing sources and working hours for municipality departments are outlined in rough estimates. The CAP was presented to and approved by the municipal council. In the council proposal, the necessity of the actions mentioned in the CAP were explained and motivated. For actions on the prevention of heat stress, the development of a local heat plan and the establishment of a budget for planting greenery against heat stress are being mentioned explicitly in the council proposal. By approving the proposal and the corresponding CAP, proposed resources were allocated by the council. However, only the budget for planting greenery was further specified.

Action	**Year**
The development of a local heat plan with a focus on vulnerable groups	2022
The assessment of the need for improving and enhancing shaded and cool recreational places	2022
The evaluation of effectiveness of measures to increase heat-resilience in the public space	2024
A (limited) expansion of swimming places for dogs	2022
Expanding and improving shaded and cool spaces and creating new cool spaces where there are currently no cool spaces close by	2023-2027
Making tree mirrors suitable for holding water	2022-2027

Table 2: Actions on the prevention of heat stress in Houten in the CAP (Zwartenkot & Hegger, 2022)

In conclusion, the current status of the CAP mainly shows that an assessment has taken place on vulnerabilities of the municipality and that goals have been set to reduce heat stress, but implementation of these goals have not taken place yet, apart from development of the local heat plan.

Internal document

An informal internal document was sent to the researcher by a colleague, providing insight into additional, smaller goals and tasks on climate adaptation in Houten. This document shows a division of tasks between four departments of the municipality. Some of these tasks are part of the CAP (e.g. the development of the local heat plan and the assessment of cool spaces), other tasks are outside of the scope of the CAP. The document reflects the current status of the implementation of some actions. Only a few concrete actions are mentioned in the document that are (directly or indirectly) related to heat:

- the development of a local heat plan in cooperation with TAUW agency;
- the assessment of the number and effectiveness of cool recreational places;
- citizen initiatives: greening actions (that can contribute to diminishing the UHI-effect but which is not specifically mentioned as goal);
- the subscription to the website "Klimaatklaar.nl", where municipalities publish information on their climate adaptation initiatives. The prevention of heat stress is not mentioned, only as one of the advantages of sustainable roofing;
- arrangements with the municipality's main housing corporation Viveste about greening actions on their properties (not specifically mentioning heat);
- within the subject of water management it is mentioned that actions on this topic (mainly greening actions) can contribute to the prevention of heat stress.

The document raises a couple of questions, as it is unclear whether the document reflects the progress of all current actions (as multiple departments are involved in the tasks of this document, not just one department) or whether other actions are being developed in other departments as well. Contact with municipal employees that were involved in the development of the CAP could not identify other documents on the implementation of the CAP.

Local heat plan

One element of the CAP is the development of a local heat plan for the municipality. A local heat plan follows the general advice from the National Heat Plan developed by the RIVM. In addition, a local heat plans aim to supplement the general advice with actionable policy measures at the municipal level with guidelines specifically tailored for the municipality. It facilitates agreements and responsibilities between actors and enables a cyclical annual evaluation of the extent to which the climate change adaptation goals with regard to heat stress are achieved (Van der Linde & Snepvangers, 2022). Commissioned by the Province of Utrecht, consultancy agency TAUW developed a local heat plan for all municipalities within the province, including the municipality of Houten. However, the municipality of Houten desired an in-depth research on specific actions to be included in the local heat plan. The current research forms the academic basis for additional content of this comprehensive version of the local heat plan. The local heat plan is established as a road map for the municipality, describing concrete actions and consisting of three chapters and an addendum. The first chapter presents the health problems related to heat stress and the importance, the establishment and the goals of the local heat plan. Chapter 2 describes the different phases of the local heat plan with a step-by-step plan for the actions that the municipality can take per phase (and per department). The communication strategy and reaching out to other actors and networks is described in these phases. Chapter 3 provides practical information that can be used to implement the steps described in chapter 2. The addendum provided background information from this research to support the actions described in the local heat plan. The local heat plan was approved by the municipal board of directors in February 2023, ready for implementation in

the same year. By ensuring the agreements in the local heat plan as a policy document, the municipality is obligated to make budgets and capacity available for its implementation.

Environmental vision

A national environmental vision was published in 2020 by the national government (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2022). A provincial environmental vision should be finished for all of the Dutch provinces in 2023 and for all the municipalities in 2024 (Rijksdienst voor het Cultureel Erfgoed, 2022). The municipality of Houten is also in the process of developing their environmental vision (Houtense Omgevingsvisie, HOVI). Environmental visions aim to lead to coherent policy measures across different sectors, safeguarding the physical and human environment (Rijksdienst voor het Cultureel Erfgoed, 2022). In the municipal's environmental vision, the prevention of heat stress is recorded in several so-called themes (representing departments). It is notable that heat or heat stress prevention is not included in the theme "Public Space". This is also emphasized in the theme "Sustainability" where it is stated that their policy is up-to-date, but not yet aligned with the Public Space policies.

Municipality's website

On the website of the municipality of Houten (Gemeente Houten, 2022), where citizens can find information about their municipality, a digital tile is available that redirects to the website "Sustainable Houten" (Gemeente Houten, 2022a). On this website, a page is arranged around adding vegetation in public space and private gardens, with a short mention that greenery can have a cooling effect on hot days. No other information on coping with heat or the prevention of heat stress is provided.

InSite

On the internal website for employees of the municipality, a few additional actions on the prevention of heat stress were found during the summer of 2022. Social media was used for sharing advice from the RIVM and the Public Health Service (GGD: Gemeentelijke Gezondheidsdienst). Publicly accessible water points can be found around the municipality of Houten and the municipality actively shared a map of these water points via social media during summer. The communications department published advice on heat accompanied by local information, for example a reference to the location of water points in Houten was added to the advice to drink enough fluids on hot days.

Interviews

All respondents from the interviews (M1,2,3, S1,2) agreed that the municipality has already taken much action with regard to greenery in public space (creating shade and cool spaces). However, it is notable that for the respondents that are not employed by the municipality (S1,2), it was generally unclear what other policy measures the municipality has currently implemented regarding heat stress prevention.

The municipal employees mentioned the actions listed below that the municipality executes other than providing greenery in public space. Both actions on risk management strategies (performed during heat waves) and on the design of the built environment (spatial adaptation measures) are included in these actions. Spatial adaptation measures are mostly in the policy formulation phase of the policy making cycle as they mainly comprise of assessments of the current situation.

Policy measures known to municipal employees:

- communication (on social media) on heat stress prevention during heat waves;
- agreements for building construction on ensuring cool indoor climates in new buildings;

- the execution of a heat stress test and an assessment of possibilities for redevelopment of Het Rond have been carried out;
- mapping cool public spaces and monitoring of percentages of greenery providing shade on slow traffic routes (providing at least 40% shade);
- encouraging citizens to participate in the “tegelwippen” campaign (where citizens remove private pavement in return for free greenery);
- the department that is responsible for public safety is involved during heat waves (for communication and monitoring, especially being in contact with nursing homes).

Two different general opinions about whether the municipality is taking enough action on the prevention of heat stress could be distinguished: two of the respondents (M1, S1) described current policy measures as satisfactory, the other three (M2,3, S2) emphasized that current measures for the prevention of heat stress in the elderly are lacking. This could be the result of the vast amount of greenery already present in the municipality on the one hand but a lack of knowledge on other measures on the other hand.

All of the respondents were well-informed about the development of a local heat plan, as most of them were involved in either the development project with consultancy agency TAUW (M2,3, S1,2) or in the development of the CAP of Houten (M1). Two of the respondents (M3, S1) explicitly mentioned that the stakeholder meeting during the local heat plan development was important for the exchange of knowledge and ideas on heat stress prevention in senior citizens. They stated that it created possibilities for mapping current networks and that it had increased awareness on the (health) problems of heat stress in vulnerable elderly. For the municipal interview respondents (M1,2,3), it was also felt that national and regional governance levels require certain developments and policy implementation as well, regarding this as a driver to get started with policy development and implementation. The respondents did not specify the steering from other governance levels, but the development of the local heat plan appears to be an example of this: the Province of Utrecht has stated that it is their goal that all of its municipalities (including the municipality of Houten) have developed a local heat plan by the end of 2023 (Provincie Utrecht, 2022). This could be a reason for the local heat plan being documented as a concrete action in the CAP and development being prioritised. Within the municipal organisation (M2,3), the need for someone carrying responsibility for all climate adaptation policy measures was expressed. This view was shared by one respondent (S2) outside of the municipal organisation as well. Currently, different departments work on different challenges for climate adaptation, possibly overlooking important aspects that play an important role in other departments.

6.3.2 Summary

The current policy measures of the municipality of Houten regarding heat are documented in the Climate Adaptation Plan Houten 2022-2027 (Zwartenkot & Hegger, 2022). The current status is that assessments on heat (and other climate change impacts) have been carried out for the municipality, that goals have been set to be climate proof in 2040 and further assessments, monitoring and evaluations have been planned. Concrete actions include the development of a local heat plan, increasing swim water for dogs and expanding cool spaces by planting trees. During this research, the local heat plan was developed (and ready for implementation in March 2023), other actions had not been implemented yet. Besides the CAP, the municipality provides some information on their website on climate adaptation for citizens but heat and heat stress prevention are not explicitly mentioned.

The respondents from the interviews (M,1,2,3, S1,2) agreed that the amount of greenery and shade in the municipality was already extensive. Municipal employees (M,1,2,3) mentioned a few other policy measures for the prevention of heat stress, mainly directed at the assessment of the current situation and tasks for the

municipality during heat waves. The respondents that were not municipal employees (S1,2) could not mention any actions on heat stress prevention other than planting greenery in public space and the local heat plan under development.

In conclusion, the municipality of Houten already possesses a good basis when it comes to providing enough greenery, with the exception of the town centres. A local heat plan was developed during this research, assessments of current vulnerabilities have been carried out and a few actions have been planned for the next few years. However, the established goals for a climate proof Houten by 2040 (including the climate change impact of heat) have been translated into only a few concrete actions but have not been implemented yet.

6.4 Climate change adaptation gap in Houten

Sub question 4: What does the adaptation gap between the current and most suitable policy measures to be implemented by the municipality of Houten to prevent heat stress in senior citizens look like?

To identify the CCA gap in the municipality of Houten, the current and suitable policy measures on the prevention of heat stress in senior citizens were compared (see table 3). The current and suitable policy measures were categorised according to the 3-G-concept.

Current policy measures on heat stress prevention in senior citizens	**Suitable policy measures on heat stress prevention in senior citizens**
User • Communication on general heat stress prevention on social media • A local heat plan was developed during this research (including communication strategies and municipal role as network coordinator) *Building* • Intention to adhere to agreements on climate adaptive construction in new developments (non-specified) • Contact with housing corporation on heat stress prevention (non-specified) *Area* • The presence of lots of greenery in public space (except in the town centres) • Stimulating measures on decreasing pavement by other actors	*User* • Providing information on the increased health risks of heat stress for the elderly (magnitude of the problem) (see chapter 6.1.1) • Involving networks around senior citizens (coordinating role for the municipality) (see chapter 6.1.1 & chapter 6.2.1) • Making use of the existing social cohesion in the municipality for facilitating networks (see chapter 6.2.1) *Building* • Providing information on effective measures for keeping homes cool: shading windows, natural ventilation and adding vegetation in gardens (see chapter 6.1.2) *Area* • In development projects: making use of urban geometry and albedo of surfaces (see chapter 6.1.3) • Adding greenery in public space (see chapter 6.1.3 & chapter 6.2.1)

• Assessment of current vulnerabilities has been carried out • Plans in CAP (not yet executed): expanding cool spaces and swimming water for dogs • Monitoring the amount of shade on slow traffic routes	• Encouraging private citizens and other actors (e.g. housing corporations) to contribute to heat stress prevention, for example by replacing pavement on private property with greenery (see chapter 6.2.1) *Organisation* • Organisational structure for keeping an overview by one person (see chapter 6.2.1)

Table 3: Current policy measures and suitable policy measures for the municipality of Houten

User

Communication on heat stress prevention in the elderly should be expanded. Currently, the municipality mainly communicates on social media with general information on heat stress prevention (e.g. by posting information of the RIVM and GGD). Even though this is an important basis, a few important element are missing. Communication emphasizing the magnitude of the health risks of heat for senior citizens is desirable, as well as using communication strategies for appealing to the existing social cohesion in the municipality to look after each other. Taking a coordinating role to facilitate actors and networks to cooperate and exchange knowledge and experiences to prevent heat stress in the elderly is another desirable policy measure. Actions on the abovementioned adaptation gap with regard to user-specific vulnerabilities are recorded in the local heat plan that was developed during this research. These actions have not been implemented yet.

Building

Information should be provided to (senior) citizens on the most effective measures to keep their homes cool on hot days. These measures consist of making use of outdoor shading of windows and the use of natural (night) ventilation. Adding greenery around homes can also contribute to keeping indoor air temperatures comfortable on hot days. Providing information to citizens on keeping indoor air temperatures comfortable is important, as it can be expected that most people will stay at home for cooling on hot days, especially the elderly. Current documented policy measures with regard to building characteristics consist only of the recorded intention to adhere to the "Agreements for climate adaptive construction of the Province of Utrecht" for new development projects. Table 4 shows the goals that are documented in this agreement with regard to heat stress (Provincie Utrecht, 2021). The description of "heat-resistant or cooling surfaces" (table 4, point 3) might refer to the use of building materials with a high albedo. However, it is not further specified what this entails. Furthermore, the use of vertical surfaces (or horizontal surfaces on street level) with a high albedo can lead to a warming of the surrounding area, which is in conflict with objective number 4 (see table 4). Urban geometry does not appear to be included in the agreements on project (re)developments. Apart from the agreement for development projects, the municipality is in contact with housing corporations on climate adaptation but agreements are currently still unspecified and undocumented.

Area

The municipality of Houten already has lots of greenery in public space. Considerations for the municipality with regard to greenery consist of adding greenery in the town centres Het Rond and Castellum. The stimulating measures to encourage other actors to replace pavement with greenery could be expanded further (some action has taken place but with a small effect). The application of adequate urban geometry

and a high albedo on roofs should be taken into consideration in (re)development projects for keeping urban areas cool.

Organisation

A change in the organizational structure is proposed, additional to the identified policy measures for influencing user-, building- and area characteristics. Appointing someone within the municipal organization with an overall responsibility on climate adaptation was pointed out. This could lead to a more integral approach on climate adaptation (including heat stress prevention in senior citizens) between departments, preventing important aspects from being overlooked.

In conclusion, the current CCA gap regarding heat stress prevention in senior citizens in Houten consists of four main areas:

1) Communication to the public: on heat stress prevention in general and on actions they can take to keep their homes cool. Also stimulating social responsibility towards fellow citizens and encouraging citizens to replace paved surfaces with greenery.
2) Taking urban geometry and albedo of surface into account in (re)development projects, especially in interaction with the surrounding area.
3) A coordinating role towards (existing) networks that work with the elderly, facilitating exchange of knowledge and practice. The use of the existing social cohesion can complement these networks.
4) The organisational structure within the municipality: appointing someone with an overall responsibility for climate change adaptation might contribute to an integral adaptation approach, keeping an overview and preventing oversights from individual departments.

1. At least 40% shade in the project area at highest sun position (21st of June) for residential areas and slow traffic routes and at least 30% on neighbourhood level 2. Cool, shaded places to stay are within walking distance (300 m) and publicly accessible 3. 40% of all horizontal and vertical surfaces are heat-resistant or cooling 4. Cooling of buildings cannot lead to a warming of the area in the direct vicinity 5. Vital and vulnerable facilities and green spaces should be resistant to heat

Table 4: Commitments on heat stress prevention in adaptive construction (Provincie Utrecht, 2021)

6.5 Lock-in mechanisms and barriers

Sub question 5: What lock-in mechanisms and barriers can explain the climate change adaptation gap on the prevention of heat stress in senior citizens in the municipality of Houten?

Barriers can be all kinds of obstacles for policy implementation, whereas lock-in mechanisms are underlying mechanisms that reinforce policy stability and hamper systemic policy change (see chapter 4.4). Barriers might stand alone as the result of contextual factors, but can also be the result of underlying processes or policy dynamics (Biesbroek et al., 2014; Groen et al., 2022).

6.5.1 Barriers

A large number of barriers for climate change adaptation can be identified (Biesbroek et al., 2011). Biesbroek et al. clustered the vast amount of possible barriers for climate change adaptation into seven categories (Biesbroek et al., 2011, p. 185-188):

1. Conflicting timescales: adapting to climate change is a long-term process, whereas political decision-making is often based on short-term results. Other political issues also require attention and can require short-term solutions. This can also be translated as an issue of prioritising (short-term over long-term, see Measham et al., 2011; Mees et al., 2018; Runhaar et al., 2012.
2. Substantive, strategic, and institutional uncertainty:
    a. Substantive uncertainty: uncertainty about data and information (e.g. uncertainty about climate change and natural variability)
    b. Strategic uncertainty: uncertainty about the strategic behaviour of actors (e.g. hidden agendas)
    c. Institutional uncertainty: differences in institutional backgrounds of actors (e.g. differences in viewing problems and solutions)
3. Institutional crowdedness and institutional voids:
    a. Institutional crowdedness: many institutions influencing decision-making processes, e.g. local, regional and national government levels (also called the “snowball effect” by Tryhorn (2010, pp. 121-122): regulations from each governance level add to the difficulty of complying to all of them).
    b. Institutional voids: a lack of institutions enabling, facilitating or stimulating adaptation to climate change (also called “non-supportive legislation” by Wihlborg et al. (2019)). Van den Ende et al. (2022) categorise this as a lock-in mechanism rather than a barrier because of its (institutional) systemic nature (Van den Ende et al., 2022, p. 6).
4. Fragmentation: a lack of coordination between actors and policies at different levels and scales. Institutional fragmentation is also named by Runhaar et al. (2012) and by Measham et al. (2011) as a barrier for climate change adaptation.
5. A lack of awareness and communication: a lack of awareness and communication to the public about the roles and actions on climate change can lead to scepticism, overconfidence and denial about the necessity of climate change adaptation.
6. Motives and willingness to act: psychological attributes (e.g. beliefs, norms and values) can influence adaptive behaviour.
7. Resources: a lack of resources can be a profound barrier to climate change adaptation (Biesbroek et al., 2011; Measham et al., 2011; Mees et al., 2018; Runhaar et al., 2012; Tryhorn, 2010; Wihlborg et al., 2019). Resources include human resources, information resources, financial resources and natural resources.

One of the most prominent barriers that is identified by most of the interview respondents (M1,2,3, S2) is the lack of perceived urgency for measures on heat stress prevention by others (both from the municipal organisation and other governmental levels and from the public). Even between the respondents a difference in urgency is noticeable, ranging from the statement that heat is only a problem for about a week (or two) per year (S1) to the acknowledgement that it is understandable that choices have to be made in local governments (prioritising other actions) (M1,3) to statements that heat is a severe health risk and should be prioritised more (M2, S2). Other than a general lack of awareness, motives and willingness to act can be underlying barriers leading to a lack of perceived urgency (based on norms and beliefs about the impact of heat on public health). Substantive uncertainty about the impact of climate change in general can also be a barrier leading to a lack of perceived urgency if actors or citizens do not estimate climate change to lead to increasing periods of heat in the future.

A lack of resources is also mentioned often in the interviews, confirming that this can be a profound barrier for climate change adaptation policies. A lack of financial resources is mentioned by all respondents (M1,2,3, S1,2) and appears to be a barrier in the municipality of Houten. However, the respondents did not specify how the lack of financial resources manifests itself with regard to heat stress prevention, other than mentioning (respondents S1, M2) that redevelopment of Het Rond would be very costly. The perceived lack of financial resources might also be the result of prioritisation within the municipality: if heat stress prevention (or climate adaptation in general) has a low priority, funds will not be allocated to redevelopment projects such as Het Rond (see also chapter 6.5.2).

Other than financial resources lacking, most respondents report some form of a lack of information as a barrier as well (phrased as “uncertainty about”): roles and responsibilities (M2,3, S2), efficacy of measures that people can take themselves (M2) and the extent to which heat stress prevention is included in the new coalition agreement (M1,3, S2, reflecting uncertainty about political engagement). Most respondents (M1,2,3, S2) further acknowledged that a lack of capacity (in terms of working hours) of municipal departments and employees is an important barrier for policy implementation. Natural resources in terms of land availability (e.g. for adding greenery) was also explicitly mentioned (M1,3) as a barrier for adaptation to heat stress. Land availability as a barrier mainly applied to town centre Het Rond, where the utilitarian function as a market- and event square is a barrier for spatial adaptation and redevelopment of the square with limited space. Conflicting timescales was also mentioned as a barrier for redevelopment projects of Het Rond. As two of the respondents (M1,2) pointed out, these projects take a lot of time, during which other priorities arise and political changes may occur (e.g. a change of board of directors in the municipality).

Fragmentation is also present as a barrier in the municipality of Houten for climate adaptation regarding heat stress prevention. Four out of five respondents (M1,2,3, S2) indicated that the division of responsibilities over different municipal departments complicates adequate policy development and implementation. This fragmentation has also been pointed out in the Environmental vision of the municipality, where heat stress prevention is not linked to the theme “Public Space” and the alignment between Sustainability and Public Space is lacking. However, it is not the division itself that the respondents report as the main problem, but a lack of coordination between the departments. They expressed the need for someone to keep an overview of all projects, goals and tasks for all departments regarding climate adaptation, making sure that all relevant aspects are taken into account.

6.5.2 Lock-in mechanisms

Taking a closer look at mechanisms hindering policy change on climate adaptation that are possibly present in the municipality of Houten, this research builds upon the research by Groen et al. (2022). They have identified the following lock-in mechanisms, both from literature as well as new mechanisms from their case study (Groen et al., 2022, p.7-8):

Economies of scale: production is more efficient on a bigger scale. If actors await the production scale (e.g. of innovations on climate adaptation) to increase, the production scale will remain small, which helps sustain a wait-and-see attitude from actors.

Adaptive expectations: if actors depend their expectations on other actors and measures from other actors remain absent, actors may influence each other (leading to overall passiveness).

Learning effects: learning effects increase the benefits of a technology or a process. For this to occur, the process or technology should be developed or implemented first. If actors await increased benefits from implementation by other actors, implementation and the learning effect might be stalled.

Collective action: actors awaiting collective action to produce solutions for (environmental) problems. If all actors await collective action, no action is taken at all.

Habituation: actors prefer and use methods or processes that they are familiar with above new (possibly better) methods or processes. This way, new methods or processes remain unfamiliar and unused. Van den Ende et al. (2022) describe this as the "aversion to innovation mechanism", Wihlborg et al. (2019) classify this as a barrier.

Power differentiation: actors having their own agenda for acting on problems (gaining power), intentionally strengthening the business-as-usual process.

Economies of scope: the advantage of a broader range of products instead of more specialist products (or services) can lead to an inhibition of the development of specialist products or services (despite a possible necessity for these products or services).

Institutional learning effects: the development of new or additional institutions may lead to benefits and interdependencies that can hamper changes of these institutions at a later stage (institutions sustaining themselves regardless of the need for change).

Social contracting: normative values and expectations about the relationship and responsibilities between the state and society can influence acceptance of policy measures. The researcher views the "avoidance of private responsibility mechanism", described by Van den Ende et al. (2022, p.9-11) as an example of this mechanism: policy measures being directed at private citizens' responsibilities are unsuccessful while private citizens keep looking at the government to take action. The risk-innovation mechanism reported by Biesbroek et al. (2014, p.114) can be seen as an example as well: society perceiving new innovations by governments as risks that are being pinned on citizens, therefore opposing and obstructing the implementation of innovative policy measures (in turn leading to these innovations remain being new instead of becoming mainstream measures).

Co-dependency: a dependency between actors that strengthens their position and is intentionally maintained to prevent change in this (power) arrangement.

Business network effects: maintaining a policy to strengthen an economic position, specifically related to network effects that gain from maintaining current policy decisions.

Framing (re)production: framing can (intentionally or unintentionally) be co-constructed or reproduced and influences the way actors look at a topic. When a certain type of framing is communicated by different actors,

this reinforces the legitimacy of this way of framing, hampering a change of view. Framing (re)production can also lead to an increased polarization on the subject (Biesbroek et al., 2014, p.114).

Biesbroek et al. (2014) further identify the **conflict infection mechanism** as a possible hampering mechanism for climate adaptation policies: previous conflicts between actors can influence decision-making by increasing distrust, disbelief, scepticism or weariness between actors (Biesbroek et al., 2014, p. 114). This leads to further conflicts and sustaining the conflicts.

Van den Ende et al. (2022, p.6-11) further identify the **institutional void mechanism**: "an absence of policy frameworks with clear norms and agreements on adaptation" (Van den Ende et al., 2022, p. 1), which can lead to unclarity on how to reach climate adaptation goals and to ambiguity on priorities. This unclarity can lead to inaction and in turn, feeding further unclarity. The institutional void mechanism is also described in other studies (Kristianssen & Granberg, 2021; Runhaar et al., 2012). It can lead to other mechanisms as well, such as the **avoidance of administrative responsibility mechanism**: climate adaptation policies are fragmented in several sectoral departments, making it possible for departments to slide off responsibilities to other departments. This sliding off of responsibilities leads to further unclarity and inaction. The avoidance of administrative responsibility mechanism is also described by Wihlborg et al. (2019) as "fragmented responsibilities". The "aversion to innovation mechanism" and the "avoidance of private responsibility mechanism" can also be viewed as mechanisms resulting from the institutional void mechanism. In this research, they are categorised as the habituation mechanism and the social contracting mechanism, respectively.

In the interviews, the respondents showed difficulty in specifying underlying mechanisms that might hamper climate change adaptation policies in Houten. However, from their answers a few lock-in mechanisms can be identified in this municipality. Figure 6 provides an overview of the lock-in mechanisms that are possibly present in Houten.

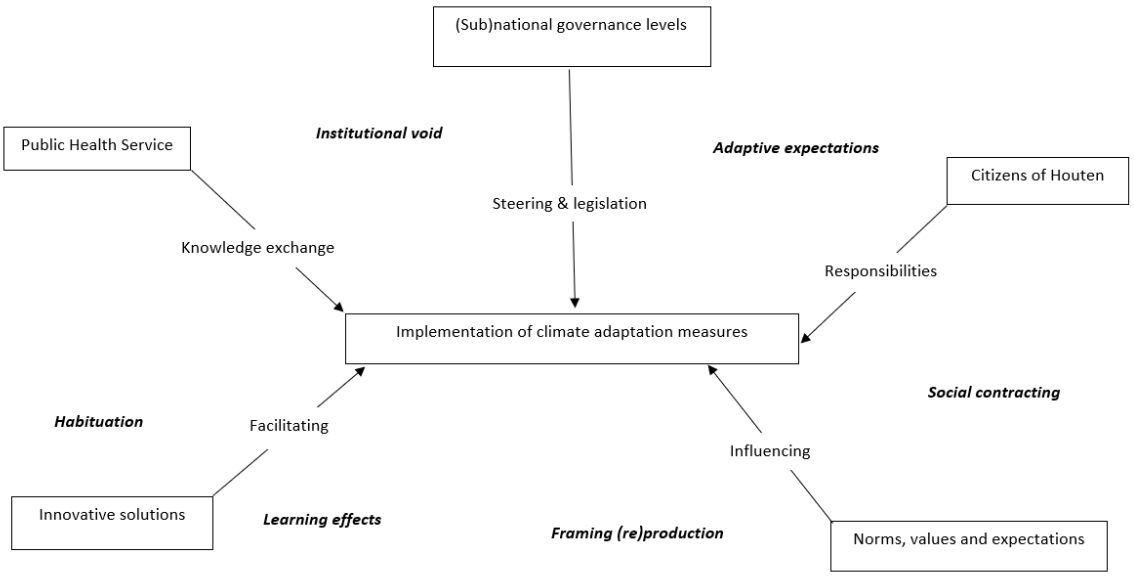

Figure 6: Overview of lock-in mechanisms possibly present in Houten

Some respondents (M1,3) indicated that the current board of directors (appointed in April 2022) of the municipality has decreased the urgency for climate adaptation in their municipal programme. A lack of (national) legislation to steer municipalities towards more climate adaptive policy also came up (M1). These remarks can be translated to the *institutional void mechanism*: without (national) steering towards climate adaptive policy making or legislation, the urgency for the municipality to take action diminishes. The institutional void mechanism appears to present in the municipality on several levels: unclarity about responsibilities between governance levels, between municipal departments and between the municipality and other actors. The unclarity about responsibilities between governance levels in combination with a high workload and tight budgets at the municipal level can result in the prioritisation of other issues. Several respondents (M2,3, S2) indicate that the responsibility for climate adaptation is now fragmented between municipal departments and between the municipality and other actors (such as the GGD). Within the municipality however, the tasks on climate adaptation are recorded in the CAP (Zwartenkot & Hegger, 2022). All proposed actions are allocated to departments, so the avoidance of *administrative responsibility mechanism* does not seem to apply. With regard to responsibility on (public) health-related climate adaptation like heat stress prevention, the *institutional void mechanism* might be present: there is a division between the knowledge on public health and the actors responsible for policy measures. The GGD is the main actor on public health and prevention and the municipality possess less knowledge on health effects of climate change but are held responsible for climate adaptive policies. Without clear arrangements on knowledge exchange, this might lead to a lack of change in policy measures.

Depending on higher governmental levels to provide steering or legislation can also be considered an expression of the *adaptive expectations mechanism*, when local governments await action from higher government levels before taking action themselves. In the municipality of Houten, this mechanism might be present: a climate adaptation plan and a local heat plan are mandatory by other governance levels. The municipality complied with this but has not implemented any other measures (or carried out any other actions described in the CAP). The respondents mentioned the requirements of other governance levels as drivers for policy implementation, even when prioritisation by the municipal board of directors is lacking (see also chapter 6.3.1). The prioritisation of a high amount of vegetation in the municipality seems to be excluded from the adaptive expectation mechanism present in Houten, as they have implemented more than the bare minimum (already near the set goal for 2040: at least 40% shade on slow traffic routes, at least 30% shade on neighbourhood level and cool public spaces within a 300m radius, see chapter 6.3.1).

Innovation was mentioned by two interview respondents (M2, S2) as a possible solution path for heat stress prevention. Both respondents (M2, S2) indicated the use of innovations for heat stress prevention in the context of actions for other actors, which might indicate the presence of the *learning effects mechanism* (with actors expecting other actors to implement new technologies). If the municipality is awaiting other actors (e.g. companies in elder care) to make use of new technologies before providing support (e.g. in the form of funding or other incentives) for the implementation of these technologies, companies might delay innovative technologies as a result of the lack of support. Benefits from these technologies will also remain lacking. The *habituation mechanism* might also be linked to innovation not playing a role in heat stress prevention, as municipal employees might not have the resources (information on effectiveness, budget, time) to use innovation for climate adaptation measures. The extra effort it would cost (in terms of money or time) to explore and implement innovations might lead to employees preferring business-as-usual policies even if new technologies or processes are more efficient. By sticking to business-as-usual methods, more resources might be necessary in the long term (sustaining the lack of resources as a barrier for implementation of innovations).

Private responsibility is relatively well-acknowledged by the municipal employees in Houten: the respondents all expressed the necessity of citizens to actively contribute to climate adaptation, e.g. by adding greenery in

private gardens and removing paved surfaces (M1,2,3, S1,2). In the public poll, 68% of the respondents indicated that they have replaced some pavement with greenery. Nevertheless, 91% also indicated that they think that planting greenery is primarily the municipality's responsibility (Zwartenkot & Hegger, 2022). This indicates the presence of the *social contracting mechanism*: it shows expectations from citizens about the division of responsibilities between government and society. In Houten, citizens do take adaptive measures on climate adaptation (e.g. adding vegetation) but the belief remains that this is primarily the responsibility of the municipality. Simultaneously, interview respondents (S1, M1) indicate that stimulating measures for private citizens to increase the amount of greenery in their gardens has not been very successful and that action from citizens to this regard is lacking. The 68% of the respondents from the public poll stating that they have replaced pavement with greenery might not be representable for the entire population of Houten, as it is expected that people who are most engaged in climate change adaptation are likely to have responded to the poll (see chapter 5.3). In their research, Van den Ende et al. (2022) also mentioned the avoidance of private responsibility mechanism present in the municipality of Houten (Van den Ende et al., 2022, p. 11).

In chapter 6.5.1, a lack of perceived urgency for climate adaptation on the prevention of heat stress was linked to the barriers of motives and willingness to act or to substantive uncertainty about the impact of climate change. However, the lock-in mechanism *framing (re)production* can also play a considerable role in maintaining this barrier. As one of the respondents (M2) put it: many people still regard the Netherlands as a cold and wet country and perceive heat waves as "good summer weather". Citizens might be unaware of the risks that high temperatures involve, and by framing heat waves as a positive occurrence, they (unintentionally) contribute to a downgrading of the necessity to take climate adaptive measures against heat. Among the respondents, one person (S1) indicated that the municipality should not make a big deal of heat since it only causes problems on a few days per year in a relatively small and already vulnerable group in Houten. This way of framing of heat and heat stress contributes to maintaining a view that no actions are necessary to prevent heat stress in senior citizens and that heat is not perceived to cause health problems in a large group of citizens. Possible changes in the future due to climate change are not taken into consideration either.

6.5.3 Summary

As described in the previous chapters, a number of barriers and lock-in mechanisms appear to be present in the municipality of Houten regarding climate adaptation in general and adaptation policies regarding heat stress prevention in particular. See figure 6 for an overview of lock-in mechanisms that might be present in the municipality of Houten. An important barrier that is present in the municipality of Houten is a lack of resources: financial resources, information resources, human resources (time) and natural resources (land availability). This barrier may however be sustained by underlying lock-in mechanisms such as the institutional void mechanism or the adaptive expectations mechanism, which can both be responsible for a lack of prioritisation of climate change adaptation strategies at the municipal level. A lack of perceived urgency (mainly by the public) as a barrier to take measures preventing heat stress appears to be present in Houten. This barrier can be caused by a general lack of awareness, general motives or beliefs or by substantive uncertainty about climate change and its impacts. It can also be caused and/or strengthened by a certain way of framing (heat waves being perceived as "good summer weather"). Where climate adaptation measures regarding heat are perceived as necessary (e.g. adding vegetation), citizens largely consider the municipality responsible for taking action, indicating the presence of the social contracting mechanism. The institutional void mechanism appears to present in the municipality on several levels leading to unclarity about responsibilities between governance levels, between municipal departments and between the municipality and other actors. The adaptive expectations mechanism might partially exist parallel to the institutional void mechanism between governance levels. The habituation mechanism and the learning effects mechanism

possibly contribute to a business-as-usual policy (both in the municipal organisation as well as for other actors), hampering the implementation of innovative technologies or processes.

7. Discussion

This research showed how the frameworks of the 3-G-concept, CCA gaps and lock-in mechanisms are useful in research on climate adaptation at the municipal level. The identification of barriers and lock-in mechanisms present in the municipality of Houten can help understand the presence of the current climate change adaptation gap with regard to heat stress prevention in senior citizens and can provide solution approaches.

Comparing current policy measures in the municipality with suitable policy measures on the prevention of heat stress in senior citizens led to the identification of a CCA gap. The CCA gap analysis proved useful for substantiating recommendations to the municipality, pointing out adaptation priorities (Chen et al., 2016, p. 410). Especially at local governance levels, where choices have to be made regarding allocating budgets and human resources, insight into these adaptation priorities is important. The gap-analysis framework used in this study can be used in further research on adaptation strategies at the municipal level (due to its usefulness for context-specific cases), further adding to the body of knowledge on CCA gap analysis at local governance levels.

Following the line of research by the RIVM (Hagens & De Nijs, 2021; De Vries & Mesdaghi, 2021), the 3-G-concept proved useful for translating all aspects of personal and environmental factors of vulnerability into three components, reflecting different domains: user-specific factors, building characteristics that influence vulnerability and characteristics of the surrounding area that can contribute to vulnerability to heat. Specifying these three components can be relevant for municipal departments, as the vulnerability factors identified within the separate components are easily translatable into fitting actions for departments. Actions regarding vulnerability factors of the component “user”, are for example related to the “Society” department. Actions on building characteristics can be allocated to municipal employees that are involved in development projects and are connected to housing corporations. Policy changes in spatial development and general sustainability goals for the public space can be implemented by the department responsible for spatial adaptation in cooperation with sustainability. This way, current municipal structures (departments) can be used for a multifaceted goal such as heat stress prevention in senior citizens. It is questionable whether the 3-G-concept is also suitable for other climate adaptation goals, such as flooding or drought, as these subjects are less related to personal factors and cover other domains. The 3-G-concept was developed by the RIVM for making recommendations on heat stress prevention with regard to personal-, building- and area characteristics (Hagens & De Nijs, 2021; De Vries & Mesdaghi, 2021). Further research could identify other climate change adaptation topics that might benefit from the 3-G-framework.

As Wilhelmi and Hayden (2010) stated on the development of their framework on vulnerability, it is important to approach local-level vulnerability both top-down as well as bottom-up. By combining scientific literature on vulnerability with information from interviews, and by inviting both local stakeholders and municipal employees, this research aimed for an integration of top-down and bottom-up insights on vulnerability factors of senior citizens to heat stress in the municipality of Houten.

As also pointed out by Groen et al. (2022), the concept of lock-in mechanisms is generally used for climate mitigation strategies. This research shows how the concept of policy lock-in mechanisms can also be used for climate change adaptation strategies. It is the view of the researcher (in accordance with other scholars, e.g. Biesbroek et al. 2014; Groen et al. 2022) that barriers for climate adaptation generally do not stand on their own but are influenced by their political and societal environment. For example, a lack of financial resources can be identified as a barrier within a municipality (as was the case in the municipality of Houten). However, this may be caused by underlying lock-in mechanisms such as the framing (re)production mechanism: framing high temperatures as “good weather” contributes to an oversight of the health problems heat can cause in a

growing group of people. This can contribute to a lower prioritisation and budget allocation on heat stress prevention. The institutional void mechanism can indirectly lead to a lack of financial resources as well, if unclarity about responsibilities leads to an avoidance of responsibilities by municipal departments for example. The identification of lock-in mechanisms can be difficult however. The respondents of the interviews could not identify mechanisms that might hamper climate change adaptation policies. As a result, the researcher identified lock-in mechanisms by translating the described barriers to possible underlying mechanisms. This partially subjective translation is a limitation of this research and further research is necessary to confirm the presence of the identified lock-in mechanisms. The identified lock-in mechanisms might also be the result of lock-in mechanisms at other governance levels than the municipal level. The current research provides unsubstantial data to state with certainty that other lock-in mechanisms (not identified during this research) are not present in the municipality of Houten. Further research is necessary to fill these gaps.

Observations

A few of the findings of the research on vulnerability factors stand out. An interesting observation on the component "user" was the clear link between physiological mechanisms and mental and behavioural aspects of vulnerability to heat stress. Physiological mechanisms and loneliness affect physical ability as well as adequate adaptive behaviour. As Mees et al. (2014) state, home care workers are important for elderly living at home in adapting to climate change. The relation between vulnerability to heat stress and the importance of social or care networks around the elderly found in this study attest to that. For the component "building", a clear discrepancy was found between the literature on the effectiveness of the use of sun shading systems and night ventilation, and the knowledge on these measures by the respondents. For the component "area", a discrepancy was found between the effectiveness and knowledge on the use of urban geometry and albedo of surfaces for cooling the area. The private sector can contribute to this knowledge gap by using innovations for climate change adaptation challenges. Ten Brinke et al. (2022) also emphasise the substantial role that private actors (e.g. housing corporations, construction developers) can play in climate change adaptation at the municipal level.

The CCA gap that was identified for the municipality of Houten included the appointment of someone within the municipal organisation to carry an overall responsibility on climate change adaptation. Interestingly, due to the focus of the document analysis on vulnerability factors as a basis for defining suitable policy measures, this recommendation solely resulted from the input of the interview respondents. This confirms the abovementioned importance of a bottom-up view on policy measures (described by Wilhelmi and Hayden (2010)): this policy measure was identified by stakeholders, regardless of the context shaped by the researcher. This points towards a limitation of this research: with the focus on vulnerability factors to translate into suitable policy measures, overall knowledge on suitable policy measures for climate change adaptation (or heat stress in particular) was not explicitly sought out in the literature. Further research could contribute to the current findings from the research on vulnerability factors.

Another limitation of this research is the sample size of the interviews, which is limited due to a lack of willingness to participate by stakeholders. This can be attributed to the fact that most of the invited stakeholders had already invested time and energy in a stakeholder meeting that was held earlier. Related to the topic of this research, citizens had already participated in the public poll on climate change adaptation held in September 2021. To this regard, respondent M1 pointed out that municipal employees are expected to include citizen participation in policy development but that experience shows that it can be difficult to engage citizens (and other actors) in this process.

Recommendations

Recommendations for the municipality of Houten based on this research are communication on the abovementioned effective but lesser known measures that people can take for keeping their homes cool (the use of shades and night ventilation) and adding vegetation in the two town centres Het Rond and Castellum. A coordinating role for the municipality between networks and other actors is desirable and for (re)development projects, making use of urban geometry and albedo of surfaces is desirable to prevent heat stress in public spaces. The recommendations on cooperating with other actors within the municipality and improving communication strategies are consistent with the findings of Ten Brinke et al. (2022) and possibly represent appropriate measures on climate adaptation at the municipal level in the Netherlands in general.

8. Conclusions

The aims of this research were to identify factors that contribute to the vulnerability of senior citizens to heat stress, to map the current CCA gap in the municipality of Houten and to identify barriers and policy lock-in mechanisms that might hamper closing this gap. The main research question to be answered to target these aims was:

To what extent is there a climate change adaptation gap in the municipality of Houten regarding heat stress in senior citizens and how can it be explained?

To answer this question, document analyses were combined with semi-structured stakeholder interviews. Document analyses covered research on vulnerability factors, current policy measures in the municipality of Houten and research on barriers and lock-in mechanisms hampering policy implementation. The interviews covered the topics of vulnerability factors, suitable policy measures and current policy measures in the municipality and lock-in mechanisms and barriers. Five sub questions were formulated to examine the climate change adaptation gap regarding heat stress in senior citizens in Houten and the factors that might hamper policy change on this subject. Conclusions on these sub questions are described below, leading to the conclusions on answering the main research question.

What factors (based on the 3-G-concept) lead to the increased vulnerability of senior citizens to heat stress?

The 3-G-Concept by the RIVM (Hagens & De Nijs, 2021; De Vries & Mesdaghi, 2021) was used in this research as a framework to map the factors that contribute to the vulnerability of heat stress in senior citizens. Factors linked to the components “user”, “building” and “area” that lead to an enhanced vulnerability to heat stress in the elderly were identified. For the component “user”, this research concludes that general physiological changes as a result of ageing influence the elderly’s ability to adequately respond to heat both directly (e.g. by a diminished sweat production) and indirectly via inhibited thermoregulatory behaviour. These changes occur in all elderly, on top of factors like chronical illnesses, the use of medication and limited physical or cognitive ability that enhance vulnerability to heat even further. A social or care network around vulnerable senior citizens is not only important for physical assistance, but also for mental support (emphasising and motivating adequate behaviour). This explains why loneliness plays an important role in the vulnerability to heat stress in senior citizens. Behaviour or physical ability also influences the component “building”, by influencing the capability to use shades and night ventilation for keeping their homes cool. The use of shading on the outside of the building (preventing solar radiation from reaching windows) and night ventilation are the most effective measures regarding building characteristics, besides general insulation of the building. For the component “area”, adding greenery that provides shade is the most important measure that can be implemented to prevent heat stress in the public space (additionally contributing to a lower indoor air temperature in buildings and homes). Despite people tending to stay at home more when it is hot outside (especially the elderly), they still need to be able to reach shops and other essential facilities (e.g. the pharmacist or general practitioner) without the risk of heat stress. Apart from greenery that provides shade, making use of urban geometry and the albedo of surfaces can contribute effectively to heat stress prevention in public space.

What would be the most suitable policy measures for the municipality of Houten to prevent heat stress in senior citizens?

Following from the research on vulnerability factors of senior citizens to heat stress and additional information from the stakeholder interviews, suitable policy measures for the municipality of Houten are directed at facilitating the elderly to take preventive measures on heat stress themselves or with the help from their network. Communication on health risks and effective preventive measures is important, as well as coordinating networks to assist the elderly in taking preventive measures (especially for lonely elderly). In a municipality with a high percentage of greenery in most neighbourhoods, making use of urban geometry, a high albedo of roofs in (re)development projects and adding greenery in the two town centres Het Rond and Castellum are the most suitable policy measures for heat stress prevention in this municipality with regard to spatial adaptation. For the internal organisation of the municipality it is recommended to appoint someone with overall responsibility on climate change adaptation (including heat stress prevention in senior citizens) for an integral approach between departments.

What are the current policy measures that are implemented by the municipality of Houten to prevent heat stress in senior citizens?

Current policy measures on the prevention of heat stress in senior citizens in the municipality of Houten consist of the execution of assessments and monitoring and evaluating in the next couple of years. Actions that are planned are planting extra trees and expanding swim water for dogs. A local heat plan was developed during this research and is ready for implementation in March 2023. In the local heat plan the coordinating role of the municipality towards other actors and networks is included and the communication strategy is extended with more detailed information on heat stress prevention and health risks for the elderly. These actions have not been implemented yet.

What does the adaptation gap between the current and most suitable policy measures to be implemented by the municipality of Houten to prevent heat stress in senior citizens look like?

By comparing the current policy measures with the most suitable policy measures for heat stress prevention in senior citizens, a CCA gap was identified for the municipality of Houten. Four main focus points can be identified:

1. Informing citizens (senior citizens and their networks) on the increased risks of heat stress in the elderly and actions they can take themselves to prevent heat stress;
2. Coordination and facilitation of knowledge exchange between networks and actors (preferably making use of the strong social cohesion already present in Houten as well);
3. Taking urban geometry and albedo of surfaces into account in (re)development projects, especially in interaction with the surrounding area;
4. Organising an integral approach on climate change adaptation by appointing someone with an overall responsibility on this topic.

What lock-in mechanisms and barriers can explain the adaptation gap between the current and most suitable measures to prevent heat stress in senior citizens in the municipality of Houten?

Important barriers in the municipality of Houten that are identified in this research are a lack of resources, fragmentation (between departments and actors) and motives or beliefs or substantive uncertainty on health impacts of heat stress (leading to a lack of perceived urgency to take action). The following six lock-in mechanisms were identified for the municipality of Houten that possibly underly these barriers: 1) the institutional void mechanism: an absence of policy frameworks and unclarity on responsibilities leading to the shifting of responsibilities; 2) the adaptive expectations mechanism: actors awaiting others to take action (which can be related to the institutional void mechanism and unclarity about responsibilities); 3) the social contracting mechanism: beliefs about the division of responsibilities between the government and private actors leading to inaction in private actors; 4) the framing (re)production mechanism: a specific way of framing a problem might lead to a perceived lack of urgency to take action, 5) the learning effects mechanism: actors awaiting each other in implementing new technologies or processes and 6) the habituation mechanism: a preference for business-as-usual methods above innovations.

To what extent is there a climate change adaptation gap in the municipality of Houten regarding heat stress in senior citizens and how can it be explained?

The conclusions on the sub questions discussed above led to an overall conclusion to answer the main research question. A climate change adaptation gap can be identified for the municipality of Houten on the prevention of heat stress in senior citizens. Firstly, communication on health risks of heat for the elderly and on effective preventive measures should be expanded. Secondly, the use of urban geometry and albedo of surfaces for the prevention of heat stress in public space is recommended. Thirdly, taking a coordinating role in knowledge exchange between actors and networks can contribute to heat stress prevention in senior citizens in the municipality. Lastly, appointing one person within the municipal organisation that is responsible for climate change adaptation can lead to improving the integral approach of policy measures that are divided across departments. The existence of the current CCA gap in this municipality can be explained by the presence of barriers and lock-in mechanisms that help sustain this gap. A lack of perceived urgency for heat stress prevention measures was identified, which can be the result of several barriers: a lack of awareness, motives and willingness to act or substantive uncertainty can all play a role in this lack of perceived urgency for action. A lack of resources (financial resources, information resources, human resources and natural resources), conflicting timescales and fragmentation also contribute to the CCA gap in the municipality of Houten. Lock-in mechanisms that appear to be present in the municipality of Houten are the institutional void mechanism, the adaptive expectations mechanism, the social contracting mechanism, the framing (re)production mechanism, the learning effects mechanism and the habituation mechanism (see figure 6 for an overview of the mechanisms present in the municipality of Houten).

This research contributes to the knowledge on climate change adaptation gaps at the municipal level, adhering to its usefulness for the decision-making process at local governance levels. The lock-in mechanism framework provided insight into possible lock-in mechanisms being present in the municipality of Houten. Further research is necessary however, to confirm the presence of these mechanisms and the absence of other mechanisms in Houten. The role of lock-in mechanisms at other governance levels (contributing to the adaptation gap at the municipal level) should be investigated further as well.

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Addendum 1: search strategies document analyses

Systematic literature searches were conducted as part of the document analysis to gain insight into the current knowledge on the following sub questions:

Sub question 1: *What factors (based on the 3-G-concept) lead to the increased vulnerability (in terms of condition, sensitivity, exposure and adaptive capacity) of senior citizens to heat stress?*

Sub question 5: *What lock-in mechanisms and barriers can explain the adaptation gap between the current and most suitable measures in the municipality of Houten?*

The search terms that were used as a literature search in the database Web of Science are listed below (see table 1 and 2). Within columns, the Boolean operator "OR" was used and between columns the Boolean operator "AND". In addition to this search, the snowball method was used to identify additional relevant articles (using references in useful sources).

Literature search vulnerability factors

Source: Database Web of Science

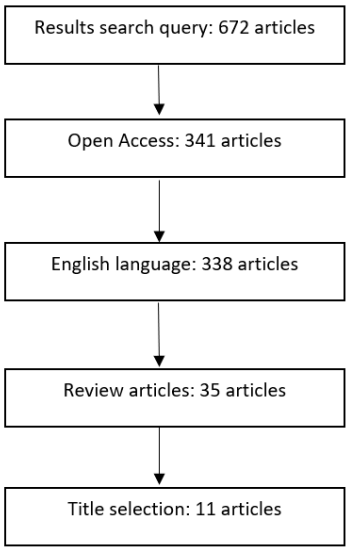
Search query: ((TS=(elderly)) OR (TS=(senior*))) AND ((TS=(heat)) OR (TS=(heat stress))) AND ((TS=(vulnerab*)) OR (TS=(exposure)) OR (TS=(sensitivity)))

Limitations: Open Access, language = English or Dutch, article type = Review Article

Term group 1	**Term group 2**	**Term group 3**
Elderly	Heat	Vulnerab*
Senior*	Heat stress	Exposure
		Sensitivity

Addendum 1, table 1: search terms for the systematic literature search conducted on sub question 1.

Results:



Addendum 1, figure 1: flowchart literature search vulnerability factors. There were no articles available in the Dutch language.

The systematic literature search did not provide articles on loneliness in elderly related to heat stress. Deriving from previous knowledge, the researcher deemed it important to include this aspect in this research and therefore conducted an additional search for scientific literature on this subject. The open database Google Scholar was used, using the search query “loneliness heat stress elderly”. This provided the researcher with one very relevant article, of which the references were used for additional information (snowball method).

Literature search barriers and lock-in mechanisms

Source: Database Web of Science

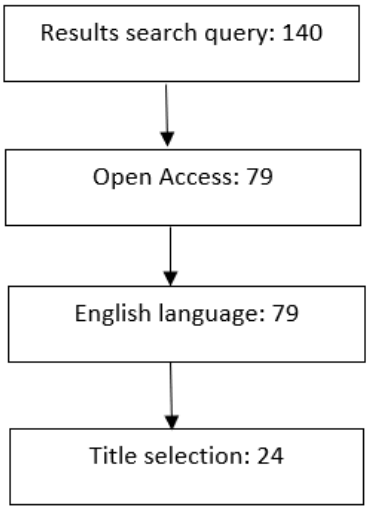
Search query: ((TS=(climate change adaptation)) OR (TS=(adaptation gap))) AND ((TS=(barrier*)) OR (TS=(lock-in mechanism*)) OR (TS=(policy lock-in))) AND (TS=(municipal*))

Limitations: Open Access, language = English or Dutch.

Term group 1	**Term group 2**	**Term group 3**
Climate change adaptation	Barrier*	Municipal*
Adaptation gap	Lock-in mechanism	
	Policy lock-in	

Addendum 1, table 2: search terms for the systematic literature search conducted on sub question 5.

Results:



Addendum 1, figure 2: flowchart literature search barriers and lock-in mechanisms. There were no articles available in the Dutch language.

Addendum 2: Interview guide

Introductie

Ik ben Dilianne Piron, ik ben student aan de masteropleiding Environmental Sciences aan de Open Universiteit en voer dit onderzoek uit als onderdeel van mijn masterscriptie. Ik zit via Kinran Consultancy B.V. gedetacheerd bij de Gemeente Houten, waar mijn onderzoek een bijdrage levert aan het project om een lokaal hitteplan op te stellen voor de gemeente, als onderdeel van het klimaatadaptatieplan van de gemeente.

In samenwerking met adviesbureau TAUW en provincie Utrecht wordt er een lokaal hitteplan opgesteld voor de gemeente Houten, toegespitst op de bescherming van ouderen als kwetsbare groep. Onderdeel hiervan is mijn onderzoek naar factoren die deze kwetsbaarheid beïnvloeden en naar de beleidsmaatregelen die er al zijn of die genomen kunnen worden. Het interview vormt hier een informatiebron voor en zal samen met een literatuuronderzoek de onderbouwing voor het rapport naar de Gemeente Houten vormen.

Heeft u op dit moment nog vragen voor we beginnen?

Interview

Deel 1: factoren die ouderen kwetsbaar maken voor hittestress

1. Op welke manier komt u in aanraking met de problemen rond hitte voor ouderen? Wat zijn uw ervaringen op dit gebied?
2. Zijn er terugkerende problemen of juist goede oplossingsrichtingen die u bent tegengekomen?
3. Als u terugdenkt aan afgelopen zomer, heeft u op hete dagen bepaalde aanpassingen gedaan in uw beroepsuitoefening die te maken hadden met de hitte en ouderen?
4. Zijn er dingen die u had willen aanpassen of doen maar die niet haalbaar waren?
5. Als we kijken naar de directe omgeving van ouderen: beschermt het gebouw waarin u werkt ouderen voldoende tegen hitte?
6. Op welke manieren is verbetering mogelijk in het gebouw?
7. Als we kijken naar de omgeving in bredere zin: welke plekken in de gemeente Houten kent u die goed zijn aangepast voor ouderen tegen hitte?
8. En welke plekken in Houten zijn niet goed aangepast voor ouderen tegen hitte?
9. Heeft u verder nog ideeën over de kwetsbaarheid of problemen van ouderen ten aanzien van hitte?

Deel 2: beleidsmaatregelen in de gemeente Houten

10. In hoeverre vindt u dat de gemeente Houten kan bijdragen aan de preventie van hittestress bij ouderen in hun gemeente?
11. Welke maatregelen kent u die de gemeente Houten neemt ter bescherming van ouderen tijdens periodes van hitte?
12. Wat zijn volgens u geschikte beleidsmaatregelen die de gemeente Houten kan uitvoeren om ouderen te beschermen tegen hitte?
13. Om wat voor redenen zijn volgens u deze beleidsmaatregelen tot nu toe nog niet uitgevoerd door de gemeente?
14. Wat kunnen volgens u redenen zijn die in het algemeen aanpassingen aan een heter klimaat in de toekomst kunnen belemmeren?
15. Heeft u verder zelf nog ideeën over klimaatadaptatiemaatregelen of gemeentelijk beleid ten aanzien van hitte die u wilt delen?

Afsluiting

16. Heeft u nog aanvullende informatie die relevant zou kunnen zijn voor dit onderwerp?

Als u op een later moment nog iets te binnen schiet waarvan u denkt dat het relevant zou kunnen zijn, mag u altijd nog contact met mij opnemen. U heeft mijn contactgegevens ontvangen in de uitnodigingsmail voor dit interview.

Addendum 3: Informed consent and informative letter

Toestemmingsverklaring

voor deelname aan het wetenschappelijk onderzoek:

Heat stress in senior citizens in the Dutch municipality of Houten: a case of insufficient climate change adaptation?

Nederlandse vertaling: Hittestress bij ouderen in de gemeente Houten in Nederland: is er sprake van onvoldoende klimaatadaptatie?

- Ik ben over het onderzoek geïnformeerd. Ik heb de schriftelijke informatie gelezen.
- Ik ben in de gelegenheid gesteld om vragen over het onderzoek te stellen.
- Ik heb over mijn deelname aan het onderzoek kunnen nadenken.
- Ik begrijp dat ik op elk moment uit het onderzoek kan stappen en ik hoef daar geen reden voor op te geven.
- Ik geef toestemming voor het gebruik van de gegevens die tijdens dit onderzoek worden verzameld voor dit wetenschappelijk onderzoek.
- Ik geef hierbij toestemming voor het maken van audio-opnames.
- Ik begrijp dat alle informatie die ik met betrekking tot deze studie verstrek, anoniem zal worden verzameld/verwerkt en niet naar mij terug zal leiden.
- Ik begrijp dat de verzamelde gegevens gedurende 10 jaar, op een veilige wijze door de Open Universiteit worden bewaard.

Als u de bovenstaande punten heeft gelezen en ermee instemt deel te nemen aan het onderzoek, tekent u dit toestemmingsformulier hieronder.

Naam:

Handtekening: Datum:

Ondergetekende, verantwoordelijke onderzoeker, verklaart dat de hierboven genoemde persoon zowel schriftelijk als mondeling over het bovenvermelde onderzoek is geïnformeerd.

Naam: Dilianne Piron

Functie: student master Environmental Sciences aan Open Universiteit Nederland

Handtekening: Datum

Informatiebrief

Interview bij onderzoeksproject “Lokaal hitteplan gemeente Houten”

Informatie over onderzoek en onderzoeker

Het interview wordt geleid door Dilianne Piron, masterstudent van de opleiding Environmental Sciences aan de Open Universiteit, in opdracht van Gemeente Houten, gedetacheerd via Kinran Consultancy B.V. Hoofdonderzoeker is dr. Lisanne Groen.

Contactgegevens:
Dilianne Piron: hittestress.houten@ou.nl
Lisanne Groen: lisanne.groen@ou.nl

Doel van het interview

Het doel van dit onderzoek is het verkrijgen van inzicht in factoren die leiden tot kwetsbaarheid van ouderen t.a.v. hitte en het formuleren van beleidsmaatregelen voor de gemeente Houten ter preventie van hittestress bij ouderen.

Inhoud van het interview

Tijdens het interview zullen er vragen worden gesteld over uw ervaringen en meningen over factoren die een rol kunnen spelen bij de kwetsbaarheid van ouderen voor hitte en over bestaande en gewenste beleidsmaatregelen van de Gemeente Houten.

Privacy

U hoeft geen vragen te beantwoorden die u niet wilt beantwoorden. Uw deelname is vrijwillig en u kunt op elk gewenst moment stoppen zonder opgaaf van reden. De gegevens zullen alleen gekoppeld worden aan uw functie of werkveld en niet aan persoonsgegevens of demografische gegevens. De gegevens over uw functie worden geanonimiseerd door middel van een versleuteling.

Data opslag

Het interview wordt opgenomen met een voice recorder. De audiobestanden worden opgeslagen op een met wachtwoord beveiligde map in de SURFdrive van de Open Universiteit. Deze audiobestanden worden 10 jaar bewaard door de Open Universiteit, waartoe alleen de onderzoeker toegang toe heeft. De audiobestanden worden op geen enkele andere manier gedeeld met andere partijen. Voor de privacy disclaimer van de Open Universiteit kunt u terecht op: https://www.ou.nl/en/web/open-universiteit/personal-data-disclaimer.

Toestemmingsformulier

Middels het toestemmingsformulier geeft u toestemming voor het opnemen van het interview onder de voorwaarden zoals hierboven genoemd. U ontvangt het toestemmingsformulier samen met deze brief per mail. Zou u het formulier willen printen en goed willen doorlezen? Voorafgaand aan het interview bespreken we het formulier en zal de onderzoeker u vragen dit te tekenen. U kunt te allen tijde aanvullende vragen hierover stellen (ook tijdens of na het interview).

Addendum 4: audit trail data analysis

The software programme Atlas.ti was used for the systematic qualitative data analysis of the interviews. The axial and selective coding led to the following categorisation of the data, with figure 1 showing the sub categories that were used and figure 2 showing the results of the open coding step. The results of the coding process is included in this addendum to provide transparency on the choices the researcher has made during the coding process.

Heat stress in senior citizens in Houten	SQ1: vulnerability factors	Area
		Building
		User
	SQ2: suitable policy measures	Actions other actors
		Actions municipality
		Other actors
		Heat plan
		Focus areas
	SQ3: current policy measures	Attention for heat stress
		Current actions other actors
		Current actions municipality
		Municipal organisation
		Greenery and shade
	SQ5: barriers and lock-ins	Barriers
		Lock-in mechanisms

Addendum 4, figure 1: categories from selective and axial coding in the qualitative data analysis process.

Addendum 4, figure 2: results open coding in Atlas.ti.

- efficientie locaties
- grote beweging op gebied van koelteplekken aanbieden
- kerken die altijd open staan
- koele plekken dicht bij woningen
- koele verblijfsplekken
- koelteplek
- Koelteplekken en toegankelijkheid is één deel van het verhaal
- koelteplekken waar gebruik van wordt gemakt
- mensen koele plek bieden bijv in bibliotheek of kerk
- ouderen naar koele plekken
- Waar koelteplekken aanleggen
- waar maken mensen gebruik van tijdens hitte
- langzaam verkeerroutes naar winkelcentra
- ontstenen
- onvoldoende beeld bij goed aangepaste plekken bij hitte
- oudere deel wel bomen maar huizen dichterbij
- parkeerplekken aanwezig Plein het oude dorp
- Platte daken
- plein Castellum weinig groen door gebruiksfunctie verkoop
- Plein in het oude dorp wel veel bomen
- Station Zuid waarschijnlijk minder heet
- steenmassa door parkeerplekken

- SQ1: vulnerability factors
  - Area
  - Building
    - aandacht voor voorkomen hittestress IN woning
    - Bij lange periode van hitte
      - warmte niet uit huis te krijgen
    - geen tuin
    - groene daken
    - hele goede isolatie zorgt voor constante temperatuur, ook in de zomer
    - juridische verankering rond bouwafspraken
    - maatregel in huis
      - deuren dicht doen
    - Onduidelijk hoe de kwaliteit van woningen van ouderen is
    - onduidelijk wat de gemeente voor thuiswonenden kan betekenen
    - Oriëntatie gebouw speelt rol bij hitte
    - probleem langdurige hitte
      - koelt 's nachts niet meer af
    - ramen in gebouw invloed op hitte
    - rolluiken
    - situatie gebruik airco
      - airco
      - oudere slecht ter been
    - tips voor mensen hoe ze hun huis koel kunnen houden
    - warmtepomp werkt goed voor verkoeling

- woningbouwverenigingen
  - aanpassingen gebouw en reaching out
  - benieuwd wat woningbouwverenigingen doen
  - woningbouwvereningen hebben te maken met mensen met lagere sociaaleconomische status
- zonnepanelen inzetten voor verkoeling
- zonwering

- SQ1: vulnerability factors
  - Area
  - Building
  - User
    - acceptatie van zonwering
    - de meeste mensen blijven thuis bij hitte
    - Dementerend
      - niet meer aan zonwering denken
    - eenzaamheid geeft potentieel extra risico
    - indirecte impact hitte
      - thuis blijven -> gemoed/welzijn
    - klachten van bewoners
    - kwetsbaarheid onafhankelijk van hitte
    - Medicijngebruik kan invloed hebben op aanvoelen van uitdroging, waterhuishouding en zweetproductie
    - Onduidelijk of bewoners verzorgingshuizen betrokken worden bij problematiek hitte
    - reactie op toenemende hittegolven
      - airco's worden geplaatst
    - risico van hitte niet volledig weg te nemen
    - risico vooral bij ouderen die thuis wonen
    - slapen lastig bij hitte

- SQ2: suitable policy measures
  - Acties andere actoren
    - actie woningcorporatie
      - "let op elkaar" op een galerij door woningbouwvereniging
      - hittebestendig/ koeler maken
    - acties HA en apotheek
      - bederf / bewaren van medicijnen
      - extra wijzen op bijsluiter en vochtinname
    - GGD uitvoerende partij
    - huisartsen mensen bewust maken van hittestress
    - iedereen kan wel íets doen
    - in de kern is preventie van hittestress de verantwoordelijkheid van mensen zelf
    - innovatie
      - extra aandacht geven bij mensen waar temperatuur binnenshuis te hoog oploopt
      - koelelementen?
      - thermometer op afstand uitlezen
    - Innovatie als oplossingsrichting
    - Inrichting eigen tuin effectief
    - organisaties openingstijden aanpassen
    - reminder extra water mee (toekomst)
    - reminder let op ventilatie (toekomst_
    - Siësta tijd invoeren (maatschappij)
    - siësta voor supermarkten, ook voor personeel
    - signalerende functie voor mensen die bij ouderen thuis komen

- sociale initiatieven
  - bij hitte attenderen
- tijdens extreme hitte
  - bijv een meldpunt
  - soort crisisopvang
- tuinen zelf koel inrichte
- ventilator voor verkoeling
- vergroenen van eigen tuinen
- verwachting hitteprotocollen in verzorgingshuis

- Acties gemeente
  - Communicatie inwoners direct
    - actief campagne voeren over taken gemeente en eigen bijdrage van inwoners
    - communicatie
    - folder in de bus
    - hooguit voorlichting
    - informeren inwoners via krant en social media
    - inwoners beter alarmeren voor hitteperiode
    - let op, hitte. Let op elkaar
    - mensen adviseren over koelen
    - Mensen bewust maken dat je bijvoorbeeld ook let op een ander.
    - mensen via social media bewust maken van letten op elkaar
    - misschien campagne voeren
    - ontstenen vanwege waterafvoer
    - steenbreek
    - taak van overheid
      - informeren over risicos en voorbereiding
    - tegelwippen goede stimulant om te vergroenen en daarmee ook hitte te vermidneren
    - tips voor mensen wat ze zelf kunnen doen
  - Interne organisatiestructuur
    - als programma / thema aanvliegen
    - hitteregisseur bij gemeente
    - hitteregisseur/ klimaatregisseur
      - collega's ontzorgen
      - iemand met affiniteit sociale netwerken gemeente
      - iemand vanuit klimaatadaptatie die de stap richting sociaal domein zet
      - in kaart brengen sociale partners
      - letterlijk faciliteren van bijeenkomst, informerene
      - link tussen sociale partners en fysieke domein
      - stimuleren en faciliteren
    - in organisatie scherper hebben wie doet wat
    - programma manager fysieke leefomgeving
      - lijn uitzetten, overzicht houden over overkoepelend thema
      - meerdere belangen bij elkaar brengen
      - programma manager fysieke leefomgeving kan brug slaan tussen energietransitie, duurzaamheid, klimaat...
      - Programma manager fysieke leefomgeving wel gepland maar is er niet gekomen
  - Koelteplekken/ groen/ aanpassingen openbare ruimte
    - aanpassingen in buitenruimte
    - actie op uitbreiden/verbeteren koelteplekken

- belang van schaduw langzaam verkeersroutes
- fan van watertappunten
- geld besteden aan koelteplekken
- hoeveelheid koele plekken versterken
- hofjes creëren waar veel ouderen wonen
- Kans om te vergroenen
  - Omgevingsvisie
- liefst op loopafstand van heel veel huizen een watertappunt
- locaties creëren waar altijd koelte is
- maatregelen
  - letten op hoeveelheid schaduw verblijfsgebieden
  - schaduw verkeersroutes
- meekoppelkans hitte bij waterafvoer
- meer bomen
- meer groen
- meer groen aanleggen
- meer groen in wijken
- meer openbaar groen
- Misschien huidige koelteplekken verbeteren
- monitoring hoeveelheid schaduw langzaam verkeerroutes
- sommige gemeenten verankerd in beleid
  - koele plekken binnen straal van 300m
  - percentage koelte
  - zicht is op bomen
  - streven 30% schaduw verblijfsgebieden
  - watertjes en watertappunten normaal in straatbeeld
  - wens: meer groen
- afwegen risico's door gemeente bij activiteiten
- avondopenstellingen gemeente
- belangrijk om voor te bereiden op de toekoms
- gemeente openingstijden aanpassen
- groene daken (2)
- inhaken door gemeente
- inventarisatie mogelijkheden
- Kijken naar alle terreinen van de veiligheidsketen
- maatregelen niet overdrijven
- meer gemeenten aansporen
- nadenken over activiteiten
- niet naar de mensen gaan met flesje water
- nog meer hitte
- plan maken voor meerdere jaren (naar toekomst kijken)
- prioriteit bij instellingen ouderenzorg bij crisis
- rekening houden met onregelmatige grillen
- tav beleidsmaatregelen
  - goed is goed genoeg
- verandering bedrijventerrein
- visie maken
  - ideale wereld en wat is dan haalbaar

- voorkeur landelijk maar anders ook lokaal
- wel al aandacht bij gemeenten voor vergroening en energiestransitie, nog niet voor gezondheidsaspecten

- Andere actoren
  - apotheek
  - gadgets
  - gemeente (2)
  - huisartsen
  - huisartsen (2)
  - kerken
  - mantelzorg
  - mensen die thuis komen bij ouderen
  - mensen die zelf contact hebben met ouderen
  - netwerk om ouderen
  - ouderenbonden
  - Rode Kruis
  - thuiszorg
  - tuinen zijn belangrijk
  - verpleeghuizen
  - verzorgingshuis
  - verzorgingshuizen
  - viveste
  - voedselbank actor hittestress
  - voor elkaar zorgen
    - boodschappen doen voor buurvrouw
    - langs iemand gaan die de deur niet meer uit komt door hitte
    - waarschuwen van personeel bij hitte
    - welzijnsconsulenten
    - welzijnswerk actor bij hittestress
    - zelfredzaamheid bevorderen door buurtsamenhang, mensen die op elkaar letten, zorgen voor elkaar
    - zorgorganisaties
    - zorgorganisaties kunnen hitteprotocollen met elkaar delen
  - Hitteplan
    - Crisis/ veiligheid
      - belangrijk om ook in crisistructuur te denken
      - crisisteam stuurt op- en afschaling aan?
      - hele veiligheidsketen kunnen uitvoeren (m.n. uitbreiden van onderdeel proactie)
      - ingrijpen als crisissituatie, bijv koeltecentra?
      - kijk naar de hele veilgheidsketen
      - Meer inzetten op preventief handelen
      - meer preventief gaan zitten op mantelzorg, zelfredzaamheid en eigen verantwoordelijkheid van mensen
      - opschalen van acties bij hitte?
      - proactie op bouwen
      - rampenplan gemeente moet afgesteld worden op wat instellingen ouderen al doen
      - veiligheidsketen proactie bestaande bouw
      - veiligheidsketen proactie nieuwbouw
        - zeespiegel stijging, water opvangen, klimaatadaptatie, hitte
      - Wel al aan preventie kant maar nog veel stappen in veiligheidsketen te zetten
    - Netwerken/ coördinatie
      - communicatie in verzorgingshuis

- eenzaamheid (2)
  - eenzame mensen die verbonden zijn via buurtcentrum, kerk of huisdier
  - wie komen daar over de vloer en kunnen die mensen bereiekn
- gemeente heeft zicht op kwetsbare groepen
- gemeente houdt het overzicht?
- Gemeente kan waarschuwing geven voor hitteperiode
- gemeente knopen doorhakken (niet uitvoerende partij)
- gemeente niet daadwerkelijk acties uitvoeren maar wel alert maken van inwoners
- gemeente partijen samenvoegen
- hitteplan 2.0
  - op zoek gaan naar alle verbindingen
- hitteplan gericht op netwerken, naast gebouw en gebied maatregelen
- in kaart brengen welke zorgorganisaties er zijn (bijv mantelzorg)
- Informatie over netwerken paraat vóór hittegolf
- instellingen samenbrengen
- inzetten netwerken, faciliteren en informeren
- kijken naar welke sociale netwerken je kunt inzetten
- lokale netwerken in kaart brengen
- Meerwaarde hitteplan
  - mensen samenbrengen
- monitoren van hoe het gaat tijdens hitteperiode
  - rol GGD?
- nog net even doorpakken voor de mensen die tussen sociale netwerk door vallen
- op- en afschalen inzet GGD en andere stakehodlers
- oplossingen voor gemeenten om bezig te gaan met gezondheid en gedrag
  - kijken naar verbindingen in de mazen van het zorgnetwerk
- Organisaties moeten elkaar ook kunnen vinden
- overkoelend
- rol gemeente tov eenzame ouderen
- rol gemeente tov sociale minima
- rol gemeente zorginstellingen
  - hoe kunnen ze elkaar aanvullen
- samenwerken met andere werkvelden
- sociale initiatieven zijn er al
  - als gemeente weten dat ze er zijn en een contactpersoon te hebben
- stimuleren op- en afschalen andere stakeholders
- verbinding leggen tussen fysieke en sociale en gezondheidsdomein
- vergemakkelijken voor organisaties die ouderen verzorgen tijdens hitte
- vooral een strakke coördinatie
- vooral informeren van stakeholders
- waarschuwing naar stakeholders om voorbereidingen te treffen voor hitteperiode

- Toekomstbestendig
  - Omgevingsvisie en omgevingsplan geven afdeling veiligheid wel mogelijkheid om ingang te vinden
- hitteplan (2)

- aandachtspunt
  - eenzaamheid, hoe bereik je die mensen die niet tot een netwerk behoren
- belangrijke aandachtspunten
  - medicijngebruik, aanpassingen in huis, zonwering, isolatie en ventilatiemogelijkheden
- nog niet voldoende gebruik gemaakt van koeladviezen

- SQ3: current policy measures
  - Aandacht voor hitte
    - Onduidelijk voor anderen dat er aandacht voor is
      - Als GGD of als inwoner niet duidelijk of actoren elkaar nu kunnen vinden
      - als inwoner onbekend of er wordt nagedacht over crisissituaties hitte
      - Niet zo bekend wat gemeente Houten tegen hittestress doet (als inwoner/GGD)
    - als ambtenaar wel vaststaande taken waar je mee aan de slag moet (ongeacht prioritering vanuit college)
    - bijeenkomst heeft tot denken aangezet
    - er gebeurt al ongelofelijk veel binnen deze gemeente
    - er is aandacht voor problematiek hitte
    - hittestress benoemd in klimaatadaptatieplan
    - maatregelen om hittestress bij ouderen te voorkomen wel bekend
    - nog geen actiepunten vanuit organisatie tbv hitte en ouderen
    - vanuit nationale en regionale overheid ook taken opgelegd waardoor je er toch mee aan de slag moet
  - Huidige acties andere actoren
    - Als inwoner zie ik wel initiatieven
      - buurtapps, facebookgroepen
    - GGD ondersteunt bij realiseren van lokale hitteplannen
    - GGD RU
      - andere GGD-en stimuleren en kennis aanleveren om aan de slag te gaan met lokale hitteplannen
    - grote verzorgingshuizen hebben wel hitteprotocollen
    - media pas aandacht voor hitteplan NA hitte
    - mobiliteitsnetwerk is er al, verbindende maatregel
    - nog weinig innovatie op dit gebied
    - organisaties ouderenzorg hebben eigen plannen
    - veel aandacht besteed aan hitte in media
    - verwachting is dat verzorgingshuizen goed voorbereid zijn op hitte dmv airco's en koeling
    - verzorgingshuizen zijn wel goed op verschillende scenarios's voorbereid
  - Huidige acties door gemeente
    - acties afdeling veiligheid
      - communiceren over hitte bij in werking treden nationaal hitteplan
    - Acties op hitte gemeente
      - social media berichten
    - alleen actie bij hittegolf
    - beleidsmedewerker Gezondheid betrokken bij hitteplan
    - bouwafspraken om woningen en gebouwen koeler te maken
    - collega's veiligheid nemen contact op met verzorgingshuizen over hoe het daar gaat
    - communicatieboodschap vanuit veiligheid
      - let op elkaar
    - functie veiligheid
      - bij hittegolf
    - hittescan is gemaakt
    - huidig
      - ad hoc werken
      - bij lokale zorgorganisaties overbelasting bij zorgmedewerkers door hitte
      - lokale zorgorganisaties hier en daar wel hitteprotocollen
      - lokale zorgorganisaties nemen hitte wel serieus

- huidig hitteplan
  - automatisch meer bewustwording
  - netwerken in kaart brengen
- Huidige maatregelen
  - informeren via social media, verder weet ik niet
  - overdekt autootje
  - vnl communicatie op moment van hitte
- inventarisatie Het Rond
- stakeholderbijeenkomst
  - brengt mensen bij elkaar
- stakeholderbijeenkomst nodigt uit tot uitwisselen hitteprotocollen

- organisatie
  - organisatie gemeente Houten heeft programma managers op thema's aangesteld
  - programma manager fysieke leefomgeving zou er komen maar is er nit
- Vergroening en schaduw
  - actcie bomen planten voor meer schaduw langzaam verkeerroutes
  - al jaren wordt hier ingezet op groen en koelte
  - bedrijventerrein geen koele plekken
  - bomen in Houten-Noord 40 jaar oud - volgroeid
  - Bomen in Houten-Noord zijn groot en geven veel schaduw
  - bomen nog niet groot in Houten-Zuid
  - fietspaden in Houten hebben bomenstroken
  - goede koelteplekken
  - grote bomen belangrijk voor koelteplekken
  - Houten heeft veel groenstroken
  - Houten-Noord heeft veel groen
  - kaart analyse koele plekken
  - tegelwippen goede actie vorig jaar/dit jaar
  - veel koele plekken
  - vergroening

- SQ5: barriers and lock-ins
  - Barriers
    - Lack of knowledge
      - Niet altijd duidelijk voor gemeenten hoe in te grijpen op gezondheid en gedrag
      - niet bekend bij medewerker gezondheid welke instantie gemeente informeert
      - nut van maatregelen
      - onduidelijk hoeveel mensen alleen kwetsbaar zijn voor hitte
      - Onduidelijk of hitteplannen en hittestress in het coalitieakkoord zijn opgenomen
      - Onduidelijk of ouderen toegang hebben tot koelteplekken in Houten-Noord
      - onduidelijk wat goede adviezen zijn om te koelen
      - onduidelijk welke acties helpen om af te koelen voor mensen zelf
    - afd GGD gezondheidsbevordering wel de netwerken, niet de capaciteit om ook hitte mee te nemen
    - afd milieukunde bij GGD niet de juiste connecties bij sociale partners
    - belang van rollen van gemeente
    - beleidsmaatregelen
      - alleen belangrijkste aanpakken
    - beleidsvelden hitte en gezondheidsbevordering haken in elkaar
    - belemmering
      - afweging van risico's
      - geld
      - kostenaspect
      - misschien lastig in kaart te brengen in hoeverre hitte een probleem is in Houten
      - onveilig voelen en daardoor niet ventileren
      - prioritering
      - tijd (vrij kunnen maken voor subsidiëring)
    - belemmering Het Rond aanpassen
      - onvoldoende budget
      - onvoldoende uren
    - bruikbaar blijven activiteiten
    - budget
    - budget koelteplekken 10K per jaar
    - campagne voeren
      - budget nodig
    - campgane voeren kost veel tijd
    - duurzaamheid soms te smal op beleidsniveau, is ook fysieke leefomgeving
    - geld belemmering beleidsmaatregelen
    - gezondheid mensen monitoren is kostbaar en tijdsintensief
    - Het Rond geen ruimte voor bomen vanwege gebruiksfunctie
    - kabels en leidingen
    - kabels en leidingen die daar lopen
    - kostenefficiëntie
    - politiek is keuzes maken
    - prioriteit
    - prioriteiten stellen - hitte?
    - ruimtegebrek belemmering beleidsmaatregele
    - te weinig uren voor klimaatadaptatie
    - tijd
    - tijd belemmering beleidsmaatregelen
    - voelt nu onnatuurlijk dat iemand die over groen gaat, zich moet bemoeien met ouderenzorg

- waarschuwen en evalueren
  - rol gemeente of rol GGD?
- Weinig tijd bij gemeente voor hitte aanpak
- wordt nu nog te veel naast elkaar opgepakt, kan integraler

Lock-in mechanisms

- "even doorzetten" ontoereikend voor toenemende hitte periodes in de toekomst
- (onvoldoende) bestuurlijke aandacht/ opdracht
- afweging hittestress niet onderschatten
- als inwoner zie ik geen problemen
- Besef bij mensen wat voor impact hitte kan hebben op kwetsbare inwoners
- bewoners zien onvoldoende nut van vergroening
- college heeft urgentie minder opgenomen in collegeprogramma
- deel van hittestress treedt ook op buiten hittegolf (gewoon in de zomer)
- fysieke omschakeling vergelijkbaar met jetlag
- gedachte bij hitte dat het "mooi weer" is
- gedrag en gezondheid (nog niet juridisch vastgelegd voor gemeenten om daar iets mee te doen)
- geen sprake van maand boven 40 graden
- gevaarlijkste probleem klimaatverandering=
- gevolg hitte is vroegtijdig overlijden
- gezondheidsaspecten van hittestress nog niet zo bekend bij gemeenten
- het is geen Marokko
- hete periodes zullen in toekomst vaker voor gaan komen
- hitte groot probleem voor kwetsbare mensen
- hitte is impact op je gezondheid
- hitte is maar 2 weken per jaar
- Hitte is minder onder de aandacht dan wateroverlast
- hitte leidt tot oversterfte bepaalde leeftijdsgroepen en mensen met een kwetsbare gezondheid
- hitte valt wel mee
- hitte wordt ervaren als korte periode waar we even doorheen moeten
- hittegolf van een week niet zo'n probleem
- hittegolven komen vaak voor
- impact van hittegolf minder bekend dan doorbreken van dijk of een orkaan
- Impact van hittestress wordt niet goed ingeschat
- klein deel van de mensen alleen kwetsbaar voor hitte
- kwaliteitsverbeteringen
  - klachten houd je toch wel
- lange loopduur van processen
- Mensen zijn zich wel bewust van warmte
- niet doorslaan alles vanuit hitte te zien
- niet duidelijk wat rol van de gemeente is
- omschakelen naar hitte duurt 3 dagen
- onderschatting van noodzaak
- Periode van hitte is best lang
- pieken in temperatuur 2-3 tot 7 dagen uitzitten
- te weinig besef dat hitte een doodsoorzaak is
- te weinig besef van heftigheid hitte voor ouderen
- terugkerend probleem
  - geen goede oplossingen voor langere hitteperiode
- vraag of hitte ook een probleem is in Houten
- we blijven nog hangen in de opvatting dat Nederland een koud land is