The state of urban climate adaptation in the Netherlands and Flanders

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Wageningen, February 6, 2017

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Course information
Master Urban Environmental Management
MSc Thesis Land Use Planning
LUP-80436
36 ECTS

WAGENINGEN
UNIVERSITY & RESEARCH

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Acknowledgements

With this thesis I finished my master Urban Environmental Management at the Wageningen University. The choice for the topic of the thesis was already made back in 2013. After an internship and some extra time, it ended in this final product. This whole process would not be possible with the help of the following people:

My supervisors Gerrit-Jan Carsjens & ing. Sanda Lenzholzer who remained patient and helpful during the whole duration of the project. Even on moments I was afraid to contact them again after a long period of radio silence from my side they were still helpful. They motivated me to finish the research project.

The interviewees of the eleven cities in the Netherlands and Flanders for their willingness and time to share their knowledge about urban climate adaptation in their city.

My LUP classmate, Liyang Qiu, for her help during the preparation phase of the interview questions.

My family, friends and colleagues who kept supporting me and motivated me to finish the study.

Thank you to all!

Joram van der Schans, 2017

Abstract

The combination of the ever increasing urbanization and expected climate change in the future, urban climate adaptation becomes more important every day. Focal points of the urban climate in this report are heat stress and wind discomfort by the urban geometry. The current situation of urban climate adaptation in the Netherlands and Flanders is examined. First the sense of urgency and awareness with regards to urban climate phenomena and adaptation measures are studied, the second topic was the planning and design processes for implementation of adaptation. The communication strategy and policy instruments used by the local governments were examined, in addition to the adaptation measures that are already being implemented by the local governments. Information was obtained via interviews with representatives of the cities; these results are placed in the perspective of existing scientific literature. The results of the interviews showed a rather low sense of urgency and awareness in both the Netherlands and Flanders. In general, the results revealed higher urgency and awareness in the Netherlands. However, with regards to actual implementation of instruments and adaptation measures the cities in Flanders are, on average, more active.

Keywords: urban climate adaptation, heat stress, wind discomfort, Netherlands, Flanders

Summary

Already more than 50% of the earth's population lives in cities nowadays. This urbanization trend is expected to grow even further to 60% in 2030 (Arnfield, 2003, Chen and Ng, 2011, Hunt et al., 2012, Mills et al., 2010, Smith and Levermore, 2008). The expectation for Europe is that, in some countries, 90% of the population will live in cities eventually (European Environment Agency, 2006). Urbanization is not without consequences for the environment in and around cities, an urban climate emerges. This urban climate is characterized by, among other phenomena, higher temperatures than in rural areas and changing wind dynamics (Eliasson, 2000, Erell et al., 2011, Grimmond et al., 2010, Lenzholzer, 2013). The fact that the temperatures in the city are higher is known under the name urban heat island and can lead to an increase of up to 10°C (Oke, 1973). Wind dynamics change due to the urban geometry, in some places wind speeds will be very high, while on other places the wind speed is very low (Blocken and Carmeliet, 2004, Park, 1986, Stathopoulos, 2009).

Adaptation with regards to these urban climate phenomena can decrease the negative effects of the urban climate phenomena. In some countries urban climate adaptation is a hot topic, while in other countries urban climate adaptation is not applied. This study is part of a bigger project to study urban climate adaptation worldwide. For this study the focus is on the Netherlands and Flanders, by using the following main research question: **What is the current situation of urban climate adaptation in urban planning and design processes in the Netherlands and Flanders?** The thesis starts with background information about the main planning approaches (top-down and bottom-up planning) and the urban climate phenomena. The theoretical framework further consists of which aspects are needed for urban climate adaptation: what kind of communication is needed, which policy instruments can be used and which concrete adaptation measures are possible?

The research is performed by using in-depth interviews with representatives of eleven cities in the Netherlands and Flanders. In these interviews questions were asked about the sense of urgency and level of awareness of different actors (politicians, citizens and urban planners and designers) with regards to the urban climate phenomena and possible adaptation measures. Also open questions about the adaptation process in their municipality were asked: what kind of communication is used, which (legally binding) policy instruments are used and which concrete adaptation measures are already put in place? All these answers combined offered the possibility to compare the situation in the Netherlands and Flanders with regards to urban climate adaptation.

The interviews offered the insight that the sense of urgency and awareness are, in general, slightly higher in the Netherlands than in Flanders. However, in both countries the results rarely showed a higher than neutral sense of urgency or awareness. Remarkable is that, while having a lower sense of urgency and awareness, the municipalities in Flanders are more active with regards to urban climate adaptation than their Dutch counterparts. The willingness for adaptation seems to be higher in Flanders and also policy instruments are more often used to force adaptation. In the Netherlands the bottom-up approach is favored. Municipalities are often reluctant to act on climate adaptation and are waiting for other actors to take the initiative. In Flanders however urban climate adaptation is tackled by a top-down approach. Cities are actively involved in creating knowledge about the urban climate and sharing this information with other stakeholders. Additionally, they take the initiatives themselves to force adaptation or steer the adaptation process.

Samenvatting

Op dit moment woont al meer dan 50% van de wereldbevolking in steden, in 2030 is de verstedelijking, zo is de verwachting, toegenomen tot 60% (Arnfield, 2003, Chen and Ng, 2011, Hunt et al., 2012, Mills et al., 2010, Smith and Levermore, 2008). Tevens is de verwachting dat, in sommige Europese landen, in 2020 meer dan 90% van de bevolking in steden woont (European Environment Agency, 2006). Urbanisatie gaat niet zonder gevolgen voor de leefomgeving in en om steden: er vormt zich een stadsklimaat. Dit stadsklimaat wordt, onder andere, gekenmerkt door hogere temperaturen dan op het platteland. Ook is er sprake van een andere winddynamiek (Eliasson, 2000, Erell et al., 2011, Grimmond et al., 2010, Lenzholzer, 2013). Dat de temperaturen in de stad hoger zijn, wordt het stedelijk hitte-eilandeffect genoemd en kan tot een maximale verhoging van 10°C leiden (Oke, 1973). De winddynamiek verandert door hoge gebouwen, open pleinen en de oriëntatie van straten. Op sommige plekken is de windsnelheid daardoor hoog, terwijl deze op andere plaatsen juist laag is (Blocken and Carmeliet, 2004, Park, 1986, Stathopoulos, 2009).

Adaptatie ten opzichte van deze stadsklimaatfenomenen kan er voor zorgen dat de bevolking minder last heeft van de schadelijke effecten. In sommige landen wordt er al veel met adaptatie gedaan, terwijl in andere landen adaptatie nog weinig wordt toepast. Deze studie is onderdeel van een groter project waarin stadsklimaatadaptatie wereldwijd in kaart wordt gebracht. Voor deze studie is specifiek gekeken naar Nederland en Vlaanderen aan de hand van de volgende onderzoeksvraag: **Wat is de huidige situatie van stadsklimaatadaptatie in de stedelijke plannings- en ontwerpprocessen in Nederland en Vlaanderen?** De studie begint met het in kaart brengen van de algemene planningsbenaderingen (top-down en bottom-up planning). Daarna wordt kort in gegaan op de stadsklimaatfenomenen. Afsluitend wordt in het theoretisch raamwerk aandacht besteed aan hoe stadsklimaatadaptatie eruit kan zien: wat voor communicatie is er nodig, welke beleidsinstrumenten zijn er mogelijk en welke adaptatiemaatregelen zijn er concreet mogelijk?

De studie is gedaan aan de hand van interviews met vertegenwoordigers van de elf steden die zijn onderzocht. In deze interviews is gevraagd naar het urgentiegevoel en bewustzijn van drie verschillende actoren (politici, burgers en stadsplanners) met betrekking tot de stadsklimaatfenomenen en de mogelijke adaptatiemaatregelen. Daarna zijn open vragen gesteld over hoe het adaptatieproces er bij hen in de gemeente uitziet: wat voor communicatie wordt er gebruikt, zijn er (wettelijk bindende) beleidsinstrumenten in gebruik en zijn er al concrete adaptatiemaatregelen genomen? Al deze antwoorden geven de mogelijkheid om de huidige situatie in Nederland en Vlaanderen met betrekking tot stadsklimaatadaptatie te vergelijken.

De interviews geven het inzicht, dat in Nederland het urgentiegevoel en bewustzijn in bijna alle gevallen iets hoger zijn dan in Vlaanderen. Echter, in beide landen komt het urgentiegevoel en bewustzijn zelden boven de classificatie ‘gemiddeld’ uit. Opvallend is, dat ondanks het lagere urgentiegevoel en bewustzijn de gemeentes in Vlaanderen actiever zijn op het gebied van stadsklimaatadaptatie dan in Nederland. Bijvoorbeeld, beleidsinstrumenten worden vaker ingezet om adaptatie te verplichten en ook de bereidwilligheid om aan adaptatie te doen lijkt hoger te zijn. In Nederland is er vaak sprake van een bottom-up benadering voor stadsklimaatadaptatie. De steden hebben een afwachtende houding en wachten op initiatieven of klachten van andere actoren. In Vlaanderen wordt het stadsklimaat meer gezien vanuit een top-down benadering. Steden zijn zelf actief bezig om de kennis over het stadsklimaat te verhogen, zowel binnen de eigen organisatie als ook voor andere actoren. Daarnaast nemen ze zelf initiatieven om adaptatie te verplichten of te sturen.

Chapter 1: Introduction

Already more than 50% of the earth's population lives in cities nowadays. This urbanization trend is expected to grow even further to 60% in 2030 (Arnfield, 2003, Chen and Ng, 2011, Hunt et al., 2012, Mills et al., 2010, Smith and Levermore, 2008). The percentages of urbanization are even higher in Europe where in 2006 more than 75% of the people lived in urbanized areas, this number is expected to increase to 80% and in some countries even to 90% in 2020 (European Environment Agency, 2006). In addition to the migration of people towards cities the world's population is still expected to increase for the coming decades (Alcoforado and Andrade, 2008). Also the amount of people living in mega cities (more than 10 million inhabitants) will increase from 359 million to 630 million in 2025 (Hunt et al., 2012, United Nations, 2012). Especially the rate of urbanization in Asia is unprecedented, in the coming four decades the urban population will more than double from 1.6 billion to 3.5 billion people.

The urbanization of the world is not without consequences for the environment in and around cities. Cities need to expand in order to accommodate the new people that move to the urban areas. These anthropogenic influences lead to the loss of natural terrain and to an increase of artificial construction and development. Rural land is transformed to urban land, which accommodates for example high-rise buildings. The population growth goes hand in hand with a growing income in developing countries, with a higher income also urban sprawl increases (Alcoforado and Andrade, 2008). The urban geometry also affects the local climate and generates an urban climate. This urban climate differs in more than one way from the climate outside the urban boundary layer. Two commonly known urban climate phenomena are the urban heat island (UHI) and the different wind dynamics caused by the changed aerodynamics of the city (Eliasson, 2000, Erell et al., 2011, Grimmond et al., 2010, Lenzholzer, 2013). With the urban heat island, we mean the temperature difference between an urban area and surrounding rural areas. The temperature in the urban areas will be higher than in the surrounding rural areas (Lopes et al., 2013). This effect is mostly present during the night (Alcoforado and Andrade, 2008, Eliasson, 2000, Erell et al., 2011, Gago et al., 2013, Grimmond et al., 2010, Lenzholzer, 2013, Mills et al., 2010, Stone et al., 2013, Stone and Rodgers, 2001). The wind dynamics in cities can lead to an uncomfortable environment for pedestrians and cyclists, while higher temperatures could disrupt the sleeping patterns of especially elderly and very young people (Reiter, 2010).

Urban climate is related to climate change, because they both have an impact on temperatures and wind patterns. Climate change is expected to lead to a higher sea level and higher temperatures. The increase of temperatures is particularly important for the urban climate because of the already higher temperatures. In addition to this relationship the expansion of cities also increases the influence of the city on the urban climate. More built-up area will lead to a higher intensity of the urban heat island and therefore related problems to the urban heat island will increase. Expansion often happens in frequently flooded areas and because of the higher population water shortages and provision of services will provide difficulties as well (Friend et al., 2014). It is therefore clear that human developments are influencing local climatic conditions and because of climate change the climatic conditions will become worse (Eliasson, 2000, Hoffmann et al., 2012, Mills et al., 2010).

There are ways to counteract the urban heat island and wind discomfort. In most of these possibilities (urban) planning plays a major role (e.g. more vegetation, green roofs & better street orientation) (Eliasson, 2000, Grimmond et al., 2010). Although, technical solutions (e.g. more air condition systems) will work as well, they are not favored because they can lead to mal-adaptation because of the increased carbon emissions (Grimmond et al., 2010, Smith and Levermore, 2008). Apart from adaptation, mitigation is also possible by for example implementing building constraints on high

buildings, decrease the amount of CO_2 emissions or by forbidding the use of black roofs in new designs. However, only mitigation measures are not desirable because urban climate effects are already present (Smith and Levermore, 2008). Mitigation will decrease the level of climate change but cannot prevent climate change from happening anymore (European Environment Agency, 2012).

1.1 Problem description

Although urban climate phenomena are present in the whole world there is not a uniform way of acting on adaptation towards it. There are countries and cities where urban climate adaptation is implemented (e.g. Germany), while it could be that in other countries the urban climate is not considered as an issue. Implementation alone does not lead to success per se: in Gothenburg the willingness to implement urban climate adaptation, by the municipality, did not lead to the desired outcome because the designers were not willing to change their design with regards to available urban climate information (Eliasson, 2000). However, Stuttgart's way of adaptation is considered a success story (European Environment Agency, 2012, Hebbert and Jankovic, 2013, Oke, 1984). It is worth asking the question why there is such a difference between countries.

Before implementation is possible there has to be awareness of the problem. To create awareness of a problem it is necessary to have knowledge about the problem. Without information about the problem on a specific location it is difficult, but not impossible, to convince people that there is a sense of urgency for acting upon it. Information about the urban climate is available for, for example, New York and London, but not for every city in the world (Oke, 1984, Hunt and Watkiss, 2011). Although awareness and availability of knowledge is important, it is not decisive for the process of urban climate adaptation (Smith and Levermore, 2008). Whenever there is knowledge produced, likely by scientists or experts, it could be transferred to policymakers. The transfer of knowledge is not self-evident as the available literature available about it suggests. In many scientific domains and also in the urban climate adaptation there is a gap between theory and practice (Eliasson, 2000, Gago et al., 2013, Mills et al., 2010, Ren et al., 2012). Attempts to bridge this gap are already undertaken with, for example Urban Climate Mapping Systems. This will display the data of studies in understandable maps. Also the impacts of possible measures could be displayed for policy makers (Eliasson, 2000, Ren et al., 2011, Ren et al., 2012). While transfer of knowledge is important, it is equally important to look to the implementation of this knowledge by practitioners in policies and final designs (Erell et al., 2011).

Despite the fact that it is known how urban climate adaptation can be done, it is also clear that there are still differences around the world in the degree of how much action has been taken on implementation. Literature about the characteristics of these differences does not exist today. Scientific articles are written about urban climate adaptation in the United States, Europe and Asia, while there is less literature available about adaptation in Africa. However, an overview of experiences of cities with climate adaptation is lacking. It is valuable to review cities on different continents because urbanization rates differ as well. The problem addressed in this thesis is: the state of urban climate adaptation around the world.

1.2 Research objective and research questions

The research objective is to produce a state of affairs overview of the actual implementation of urban climate adaptation with a focus on the awareness of urban climate phenomena, the transfer of climate data and recommendations to policy makers and the implementation of spatial planning and design measures in planning processes. While inventories of literature written about urban climate adaptation (e.g. Hunt and Watkiss, 2011) and records of the use of tools to implement knowledge (e.g. Ren et al., 2011) are present, an overview of urban climate adaptation worldwide is not present. While the research objective is to give a complete overview of urban climate adaptation worldwide this study

will merely focus on the Netherlands and Flanders. This study is therefore part of a bigger research plan, in which other students also participate. The main research question that will be answered in this study is: **What is the current situation of urban climate adaptation in urban planning and design processes in the Netherlands and Flanders?**

In order to answer the main research question six sub research questions are formulated. The questions are divided in two main categories: Sense of urgency and awareness and planning and design processes for implementation.

Sense of urgency and awareness

1. What is the sense of urgency to adapt the urban environment in the future, amongst citizens, politicians and urban planners and designers?
2. How aware are citizens, politicians and urban planners and designers of urban heat stress and wind discomfort?
3. How aware are citizens, politicians and urban planners and designers of urban climate adaptation measures?

Planning and design processes for implementation

4. What is the role of communication in the process of urban climate adaptation?
5. Which instruments are used to implement urban climate adaptation at the moment?
6. Which concrete urban climate adaptation measures are used in urban climate adaptation strategies?

1.3 Reading guide

In chapter 2 a theoretical framework around the topic of this study is presented. Three different topics are described: urban planning & design in general, urban climate phenomena and methods of urban climate adaptation. In chapter 3 the process of data collection and data analysis is described. The structure of the interviews is the main topic of this chapter. In chapter 4 the results of the data analysis are presented. This chapter is split up in 4 paragraphs, which will focus on different parts of the results. The results for each country are presented and also a comparison between the Netherlands and Flanders is made. Chapter 5 offers a discussion about the results for the Netherlands and Flanders and provides the reader with possible reasons for the observed differences. Chapter 6 concludes the thesis with an answer to the main research question. In addition, a discussion about the used research methods is presented and recommendations for further scientific research are provided. In the annex the complete structure of the interview can be found.

Chapter 2: Theoretical framework

The starting points for the theoretical framework are the sub research questions introduced in paragraph 1.2. There are three topics that will be discussed in this chapter: urban planning & design, urban climate phenomena and urban climate adaptation. As shown in Figure 1 and discussed in chapter 1 there is a relationship between the three topics. In the first paragraph the focus is on which two planning approaches there are for urban planning & design. In paragraph 2.2 the two urban climate phenomena of interest for this study are discussed. In paragraph 2.3 the process of urban climate adaptation is further explained. First the role of communication will be discussed, after that an overview of policy instruments is provided. These instruments can be used to implement climate adaptation. In the final section of paragraph 2.3 four different urban climate adaptation measures are discussed.

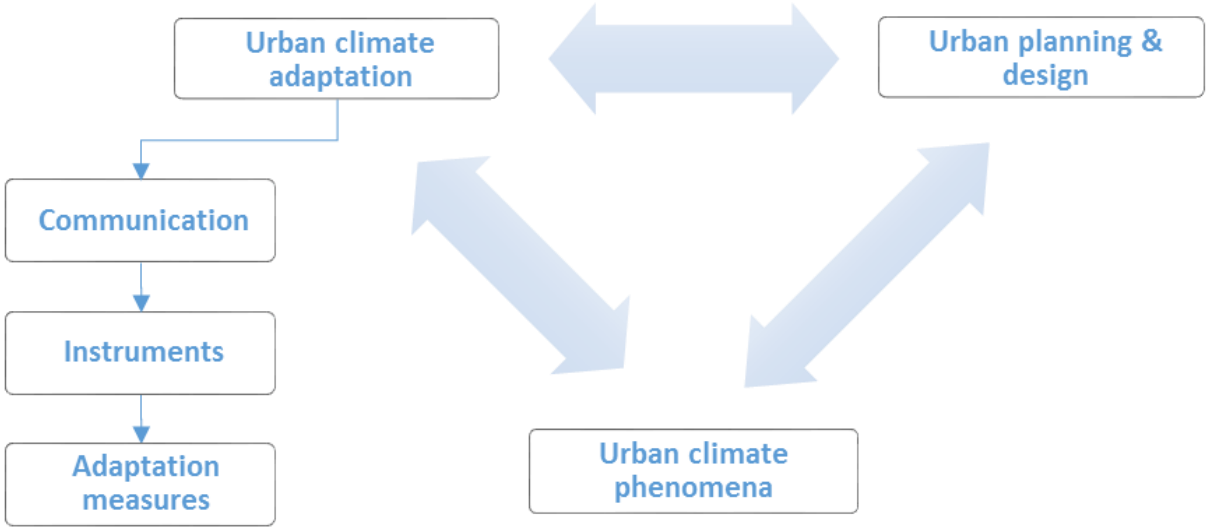

Figure 1: Mind map for the theoretical framework

2.1 Urban planning & design

Spatial planning can be seen as an analytical field but also as an applied field. The applied part of planning is closely interwoven with politics and policy implementation (Pissourios, 2014). Planning frameworks can therefore be identified in the same way as policy implementation can.

The review of literature about policy implementation shows a field split in two paradigms: top-down and bottom-up (Matland, 1995, Pissourios, 2014). The top-down approach was introduced earlier in time, while the bottom-up approach was a response to the weaknesses of the former (Sabatier, 1986). In this paragraph a short description of both paradigms will be given to offer a starting point for the discussion of the thesis results.

According to Pissourios (2014) the top-down approach of policy implementation is represented by the rational planning paradigm in the spatial planning domain. While the bottom-up approach is represented by the collaborative planning paradigm (Healey, 1992, Koontz and Newig, 2014, Pissourios, 2014). This paragraph will show that both planning approaches are vastly different. In this thesis the terms bottom-up and top-down are used, instead of rational planning and collaborative planning. This is done to be in line with the terms used by the interviewees.

The kind of planning approach has an impact on the whole process of urban planning & design and therefore also on urban climate adaptation. For example, in paragraph 2.3, different types of communication frameworks are presented. A bidirectional communication framework corresponds

more with a bottom-up approach, while a unidirectional framework corresponds more with a top-down approach. However, it does not mean that a bottom-up approach strictly uses a bidirectional model. The local planning approach also has a direct relationship with the type of instruments used.

2.1.1 Top-down approach

The main aspect of the top-down approach is that policy decisions are made at the central level (Koontz and Newig, 2014, Pissourios, 2014, Sabatier, 1986). According to Pissourios (2014) a top-down approach also has the tendency to increase the role and power of technical experts. This approach sees policy designers as the central actors and therefore concentrate on factors that can be manipulated at the central level (Matland, 1995). deLeon & deLeon (2002) characterize the top-down approach as the 'common' approach. According to Matland (1995) there are three general factors that influence the success of a top-down approach: tractability of the problem, ability of the statute to structure implementation and non-statutory variables affecting implementation. To fulfill these general factors it is important that policy goals are clear and consistent, the number of actors is minimized, the extent of necessary change is limited and the responsibility for implementation is placed within an agency that is sympathetic with the policy goals (Matland, 1995). In general top-down models see street-level bureaucrats as impediments for successful policy implementation. A proper top-down approach keeps the behavior of local actors within acceptable bounds over time (Sabatier, 1986).

Critics of the top-down approach have identified five aspects in which the approach shows shortcomings:

1. A fundamental flaw is that a top-downer tends to neglect other actors than the central actors. This occurs because they start from the perspective of a central decision-maker (Pissourios, 2014, Sabatier, 1986). It is unrealistic to expect policy designers to completely control the actions of local actors (Matland, 1995).
2. Top-down models are difficult to use when there is no dominant policy or agency present. When multiple actors or government directives are present the implementation of a top-down approach is complicated (Pissourios, 2014, Sabatier, 1986).
3. Top-down models are likely to at least underestimate the strategies that are used by local actors to get around the, centralized, implementation of policies (Pissourios, 2014, Sabatier, 1986).
4. As top-down models focusses on the statutory language it fails to consider the significance of actions taken earlier in the process. Many barriers for policy implementation emerge in the initial stages and therefore those stages must be studied carefully (Matland, 1995).
5. Top-down models are accused of considering implementation as a strictly administrative process. By doing that they ignore or eliminate political aspects of the process. The call for clear and consistent goals contradicts to the knowledge of how legislation is made in practice (Matland, 1995).

2.1.2 Bottom-up approach

As a reaction to the perceived shortcomings of the top-down approach a bottom-up approach was considered by researchers such as Hjern et al. (1978) and Healey (1992). Instead of focusing on centralized decision making, 'bottom-uppers' start with an analysis of the local actors who interact on a particular problem or issue (Sabatier, 1986). deLeon & deLeon (2002) characterize the bottom-up approach as a 'democratic' approach. Bottom-uppers argue that a better understanding of implementation can be gained by looking from the perspective of these local actors (Matland, 1995). Local actors are the key for successful implementation as, according to 'bottom-uppers', policy is really

made at the local level (deLeon and deLeon, 2002, Matland, 1995). Consequences of this are that central actors have no direct influence on the local situation and therefore a wider variation of policies can emerge. 'Bottom-uppers' argue that when there is no freedom given to local policy implementers the implementation is likely to fail (Matland, 1995).

After the identification of the local actors the focus will switch to other, regional and national, actors. Those actors are analyzed to move from the local scene to the top-level policy makers (Sabatier, 1986). According to Sabatier (1986) a strength of the bottom-up approach is that it does not begin with a governmental program but emerges from problems that are perceived by local actors.

There are four criticisms identified for the bottom-up approach:

1. A bottom-up approach neglects earlier steps in the policy-making process. Sabatier (1996) presents an example of the analysis of environmental regulation in the United States. On the government level it was decided, some time ago, that local actors have power. An analysis of the current situation will not show this top-down decision. Decisions made by central actors could be a key why local actors have power or certain goals and opinions (Matland, 1995, Sabatier, 1986).
2. It is also argued that the use of solely a bottom-up approach is not possible because some centralized legislation is always needed to provide a framework with formalized rules and procedures (Koontz and Newig, 2014, Pissourios, 2014).
3. When considering a large planning objective, a community bottom-up process will be inefficient due to the slow progress. A bottom-up approach takes considerably more time than a top-down approach (Pissourios, 2014).
4. In a democratic system the power should be exercised by the stakeholders whose power derives from their accountability towards voters in elections. This is not always the case with local actors (Matland, 1995).

2.1.3 Planning process in practice

As shown by the weaknesses of both approaches it is seldom the case that the extremes of an approach are applicable (deLeon and deLeon, 2002, Matland, 1995). Multiple studies therefore looked into possible synergies between both planning approaches. An in-depth analysis of possible synthesis is beyond the scope and purpose of this study. However, a starting point is provided below.

The distinction between top-down and bottom-up approaches is rarely clear in practice. There are several distributions of top-down/bottom-up possible which are influenced by local contexts and willingness of policy makers. The role of policy makers can differ among projects and countries with one project being more constructed around a top-down approach while other projects are constructed around a bottom-up framework (Koontz and Newig, 2014). It is argued that the scope of bottom-up approaches is limited to local planning or small settlements in which the general outlines for long-term objectives are already set by an approach more characterized by a top-down process. These long-term objectives fall in regional and strategic planning which is better accommodated by a top-down approach (Pissourios, 2014). Sabatier (1986) recognizes that a top-down approach seems to have advantages when there are limited resources or in a situation in which there is already a dominant legislation structuring the situation. Bottom-up approaches are more suitable in situations where there are multiple actors with a level power field or when there is particular interest in the dynamics of a local situation (Sabatier, 1986).

According to Pissourios (2014) the top-down approach is the most dominant paradigm in planning practice at this moment. A reason could be that it allows a better incorporation of planning standards,

such as the number of houses that needs to be built or the acreage of open land. The use of quantitative measures like planning standards is common, while, according to Healey (1992) in the bottom-up approach it is more difficult to use such standards as those comprise of pre-formulated knowledge (Pissourios, 2014).

The planning approaches offer a starting point for an in-depth analysis of urban climate adaptation in the Netherlands and Flanders. A planning approach provides the framework in which governments act on urban climate adaptation. Therefore, it is important to see how the urban planning process is, in practice, in the Netherlands and Flanders.

2.2 Urban climate phenomena

Two urban climate phenomena are of special interest for this study: urban heat island effect and uncomfortable wind dynamics. In addition to this there are other urban phenomena known such as air pollution, which are not the subject of the study. There is no emphasis on air pollution because it is expected that due to changing energy use patterns and the use of other modes of transport the problem will be solved eventually (Hunt et al., 2012). First the urban heat island effect will be described in more detail and after that wind dynamics will be explained.

2.2.1 Urban heat island

The urban heat island was recognized for the first time in 1833 by Luke Howard in his study on the climate of London (Howard, 1833). 50 years later Sir Arthur Schuster did meteorological measurements in Manchester, United Kingdom. He found out that urban temperatures were higher than rural temperatures. In the beginning of the 20th century regional geographers in Germany started doing similar analysis. By the end of the century urban heat island effects were documented over the whole world (Hebbert and Jankovic, 2013). In 1973 an urban heat island of 10°C was measured in Europe and as high as 12°C in the United States (Oke, 1973).

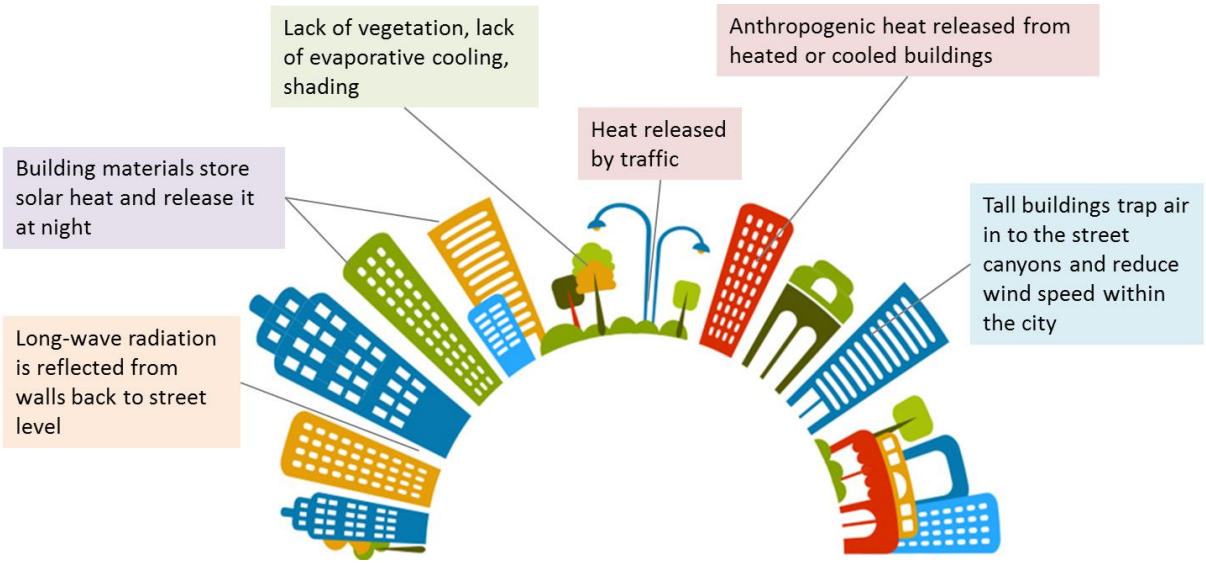

Figure 2: Overview causes Urban Heat Island (ILKKA, 2014)

Temperature differences between urban and rural areas occur due to human urban development. As can be seen in Figure 2 there are multiple reasons that temperature differences exist. The reflectivity and emissivity of the urban environment is different from the rural environment. This is due to the use of construction materials for roads and buildings. Urban areas therefore have an influence on the energy balance of the city. In comparison with green areas in rural areas, construction materials used for cities absorb the shortwave radiation of the sun (Eliasson, 2000, Lenzholzer, 2013, Mavrogianni et

al., 2011, Wilby, 2008). The absorbed heat during day time is released as long wave radiation and therefore heats the environment. The presence of skyscrapers and other buildings traps the long wave radiation and causes additional heating. Because the wind dynamics are changed by the buildings in cities the cooling effect could be lower and thus higher temperatures occur (Eliasson, 2000, Hunt et al., 2012). Last but not least the heat released by traffic has an influence on the temperature within the city.

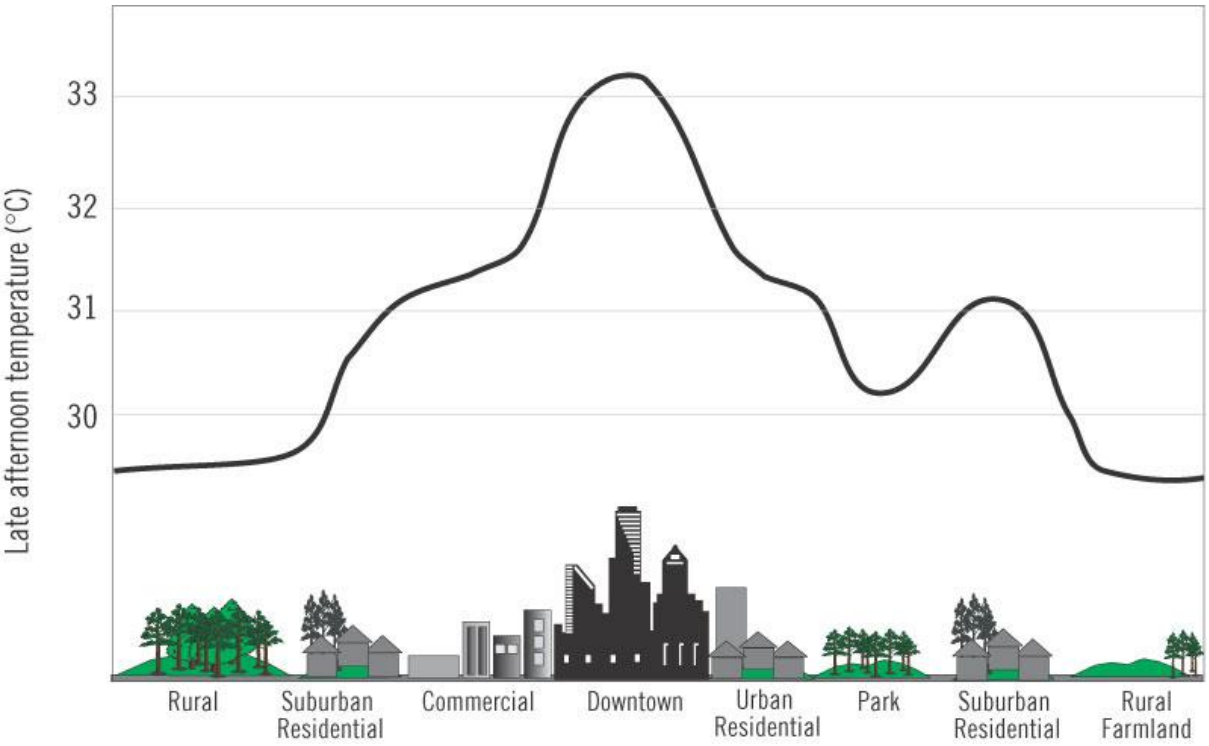

Figure 3: Typical temperature profile urban heat island (Netherlands Space Office, 2011)

In Figure 3 a typical profile for the urban heat island is presented. The maximum intensity for the urban heat island in this example is almost 4°C, which is located in the downtown area of the city. In the residential and commercial areas of the city the intensity is lower. Also the cooling effect of a park is clearly visible as the intensity of the urban island is 1°C lower than in the surrounding residential areas.

Oke (1973) has demonstrated that in cities with just 1.000 inhabitants, temperature differences occur with a maximum intensity of 1.8°C. For cities with 12.000 people a maximum urban heat island of 5.1°C was observed. Therefore, Oke (1973) concluded that there is a relationship between the population size of a city and her urban heat island. There are different relationships for different continents because the characteristics of the cities are different: European cities mostly have lower buildings, while East Asian cities consist of skyscrapers which generally leads to higher temperature differences (Oke, 1973, Hunt et al., 2012).

Different studies have been conducted to find out how urban heat islands will develop in the future due to climate change. A study for London showed a maximum increase of 0.5°C for 2050 (Wilby, 2008), while a study for Tokyo found an average increase of 0.55°C (Adachi et al., 2012). However, other studies do not show a significant increase of urban heat island intensity (Rosenzweig et al., 2005, Hoffmann et al., 2012). It can be expected that the development of the urban heat island depends on the trends of urbanization in the cities. The urbanization trend for developed countries is different than those of developing countries (Smith and Levermore, 2008, Carter, 2011). Even when the urban heat island intensity is not increasing in the future, the air temperature in urban areas will increase anyway due to global climate change, as will the temperature in rural areas. The temperature increase

due to climate change is expected to be around 2 and 2.5°C (Rosenzweig et al., 2006, Adachi et al., 2012, European Environment Agency, 2012). The amount of hot days will grow and heat waves will occur more frequently. It was during the heat wave of 2003 that more than 15.000 people died in France and that heat-related death rates increased with 17% in the United Kingdom (Grimmond et al., 2010, Mavrogianni et al., 2011).

2.2.2 Wind dynamics

Apart from the urban heat island also a change in wind patterns is caused by human development, which is affecting the livability in cities. There is a close relation between the two phenomena as ventilation can decrease the experienced temperature significantly. However, it is also true the other way around as temperature differences trigger wind flows (Park, 1986, Britter and Hanna, 2003, Hunt et al., 2012).

In general, it can be stated that the mean wind speed in cities is lower than in surrounding rural areas (Wilby, 2008, Britter and Hanna, 2003, Wamsler et al., 2012, Eliasson, 2000). According to Lopes et al. (2013) the mean wind speed in the Portuguese city Lisbon is reduced by 30%. The deceleration of the wind is caused by obstacles, which could be a mountain ridge, a city or just one tree. In literature this is referred to as an increase in roughness by which the wind is blocked (Britter and Hanna, 2003, Coceal and Belcher, 2005). Although the average wind speed is lower it does not mean that peak wind speeds are absent. You might have experienced this phenomenon yourself when walking in a city, because on certain locations the wind is always blowing hard. In particular the comfort for pedestrians is influenced by the wind patterns present in cities (Reiter, 2010, Stathopoulos, 2009).

From the wide variety of research done on wind dynamics in cities it can be concluded that especially around tall buildings the wind has an influence on the comfort of pedestrians and cyclists. The wind can be at least twice as high in the neighborhood of these types of buildings (Blocken and Carmeliet, 2004, Reiter, 2010). The wind speeds increase around tall buildings because there are pressure differences. The boundary wind flow collides with the tall building and is deflected downwards, this creates a pressure difference and intensification of the winds on their way to the street, this is called down-wash. In addition to areas around tall buildings with down-wash flows, the orientation of streets and openings between buildings can also generate high horizontally accelerated flows. This is especially true when there are pressure differences between the windward side (high pressure) and leeward side of buildings or streets (low pressure) (Stathopoulos, 2009). However also on places where the density of the urban geometry is changing wind patterns might become uncomfortable (Coceal and Belcher, 2005). The characteristics of the wind patterns in urban areas are also important for another reason: they are responsible for the ventilation of the city. When the wind is blocked by buildings, trees or other obstacles parts of the city are not ventilated and both heat and pollution are trapped in the urban area (Park, 1986). Wind patterns can be changed by appropriate design of buildings and grouping of buildings. Trees, windbreaks but also small additions to buildings like balconies will change the wind pattern (Stathopoulos, 2009, Kramer et al., 1979).

Wind discomfort depends on the type of activities people want to unfold and the wind speeds at that specific moment. For stationary activities, such as sitting, a lower wind speed is desired than for walking. For sitting the wind speeds should not be higher than 2 – 3 m/s for 80% of the time, for walking this increases to 5 – 7 m/s, while the wind gets dangerous when speeds are higher than 20 m/s (Soligo et al., 1998, Lenzholzer, 2013). Taking these different criteria into consideration can help the planning and design of an urban area.

2.3 Urban climate adaptation

In order to elaborate on the topic of urban climate adaptation it is important to have a definition of the term adaptation. The IPCC defined adaptation as the following: *"adjustment in natural or human systems in response to actual or expected climate stimuli or their effects which moderates harm or exploits mutual opportunities."* (IPCC, 2007) Adaptation requires a multi-disciplinary approach, which covers multiple policy domains. Tàbara et al. (2010) states that climate adaptation can be understood as a multiple-step social process which should focus on four main dimensions:

1. Perceptions, frames and awareness

The first step for making a climate adaptation strategy is to find out what the current level of awareness of the actors is: 'do actors feel a need to adapt?' is one of the key questions of this step. This indicates that a sense of urgency, the feeling that adaptation is needed, is vital for successful adaptation. After the answer on that question it is important to see which opportunities and barriers there are for an increase in awareness. Different actors require different approaches to increase the level of their awareness as they have different frameworks in which they see urban climate adaptation. The challenge is to integrate the different views in one comprehensive climate adaptation strategy (Tàbara et al., 2010).

2. Incentives, sanctions and motives

The second dimension for climate adaptation is to look at the motivation of actors to act on climate problems, awareness alone will not lead to action. After the understanding of the driving forces for action it is important to see which incentives and sanctions can be used to increase the motivation. Each instrument has a different effect on the actors and therefore it is important to take a close look at the motivations for each actor (Tàbara et al., 2010).

3. Individual adaptation options and resources

As the third step policy makers need to look at which adaptation measures are feasible options for urban climate adaptation. Which individual adaptation options are possible, are new technologies possible? Those are examples of questions that can be asked in this step of the process. According to Tàbara et al. (2010) it Is important that adaptation measures are mainstreamed in broader sustainability strategies. The mainstreaming will lead to more efficient and meaningful urban climate adaptation (Tàbara et al., 2010).

4. Institutions and feedback processes

The final step in the climate learning ladder is to look how institutions and feedback processes can be used to sustain adaptation processes. This could mean that new institutions are needed or that existing ones need modification. The product of this final step is a process that ensures learning feedbacks and adaptation in the long term (Tàbara et al., 2010).

1. Perceptions, frames and awareness
2. Incentives, sanctions and motives
3. Individual adaptation options and resources
4. Institutions and feedback processes (Tàbara et al., 2010)

These four dimensions form a 'climate learning ladder' for successful climate adaptation building and ultimately adaptation itself. In Figure 4 this ladder is displayed, while also providing simple questions for decision-makers to use during the process.

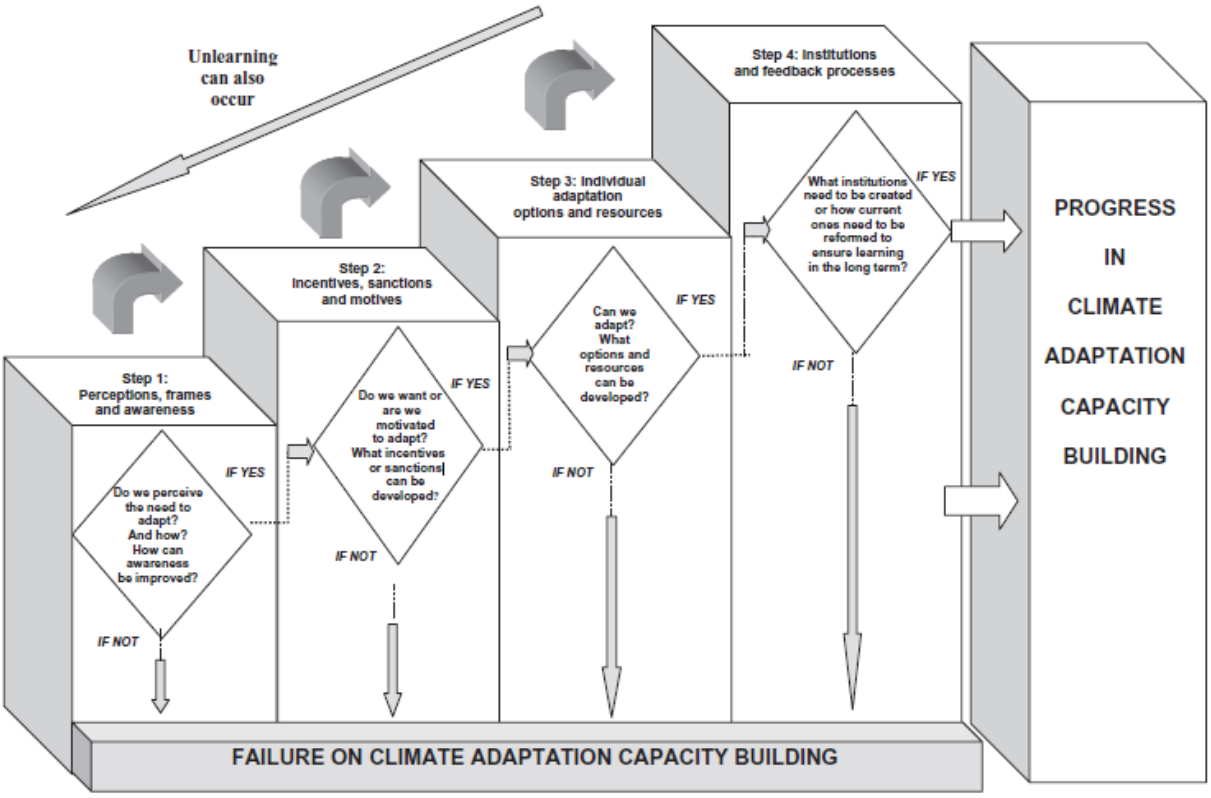

Figure 4: The 'climate learning ladder' adapted from Tàbara et al. (2010)

The climate learning ladder offers a starting point for a more in depth discussion of important aspects of the urban climate adaptation situation in the Netherlands and Flanders. While the ladder provides us with four different dimensions the focus of this study is on the first three. The expectation is that the current situation in the case studies is sufficiently covered by the first three dimensions of the ladder. In the next sections of this chapter a broader exploration of the first three dimensions is offered.

2.3.1 Communication

In the climate learning ladder perceptions, frames and awareness are identified as the first dimension of the adaptation process (Tàbara et al., 2010). The importance of awareness is also acknowledged in other scientific literature, which identifies awareness as the first focus point (Fernandez et al., 2016, McNamara, 2013, Moser and Ekstrom, 2010). Fernandez et al. (2016) argues that without awareness adaptation is impossible to implement. An important factor in creating awareness is communication.

Communication is not only a key aspect of the adaptation process but is a key process for policy adaptation in general (Schofield, 2001). Communication is important to increase awareness and understanding among actors; it is also capable of creating engagement around the actors involved in the process. Examples of these actors are, among others, national and local governments, communities, NGO's, international organizations and businesses (Nerlich et al., 2010). When communication is not properly organized it can interrupt or derail the social interaction among actors involved in the adaptation process (Moser and Ekstrom, 2010). In this paragraph we will take a closer look on the role of communication in the urban climate adaptation process.

It has never been easy to communicate about climate change adaptation. There are multiple reasons why there are several challenges for the communication about this topic (Moser, 2010, Moser, 2014, van Woerkum, 2007). Moser (2010) identifies 8 different reasons for the existence of these challenges; several reasons are also identified in other literature: distant impacts in time and space of climate

change, the complexity of the topic and the lack of consensus among experts about the exact impacts. These factors of climate change make it difficult to create awareness, or in other words public engagement, among the actors involved in the process (Moser, 2010, Tiller and Schott, 2013, Wirth et al., 2014).

In order to have successful communication it is important to identify clear goals for the process. This guides the other choices that have to be made for building an effective communication process (Moser, 2010). Not long ago the only goal of communication was to inform and educate the lay audience (Moser, 2016). The view was that appropriate action would follow from an increase in awareness and knowledge. However, as identified in other scientific domains, there is an 'attitude-behavior' gap which defies the assumption of the aforementioned relationship (Ballantyne, 2016, Moser, 2010, Tiller and Schott, 2013). There is a limit to what education and information can achieve for climate adaptation (Moser, 2016, Tàbara et al., 2010, Whitmarsh et al., 2013). In order to address the challenge of this disconnect and limit, climate change communication needs a transition to two additional goals, which follows from the first goal of raising awareness (Ballantyne, 2016):

1. Changing attitudes, communication can change the way actors think and feel about climate adaptation. It can increase the level of social engagement and action for policies and legislation proposed by the government.
2. Changing behavior, communication can motivate actors to actively take adaptation actions. Behavioral change often needs a long-term approach but can also lead to changes in social and cultural norms and values that act more broadly (ICLEI, 2009, Moser, 2010, Tiller and Schott, 2013, Wirth et al., 2014).

After the identification of the objectives for the communication process it is important to define a communication framework. Important factors for the frameworks are the audience involved, how the issue will be framed, which messages and messengers are used, which communication channels are used and lastly how is the process going to be evaluated (Moser, 2010)? As said before climate change is difficult to understand for lay audiences, therefore it is important for the communication to use simple metaphors, imagery and a frame that is appealing to the audience. An experiment conducted by Hart and Nisbet (2012) showed that the same information has different effects on different groups. It is important that the frame in which the information is presented resonates with the target group (Jacquet et al., 2014). While it might be appealing to use fear messages to increase the sense of urgency among the actors they seem to be counterproductive. If municipalities or other actors still desire to use the discourse of fear, it is important that it is accompanied by understandable information about the issue and possible measures that can be used by the target audience. Messengers that are trusted by the audience increase the credibility of the provided information (Nerlich et al., 2010).

In short, good preparation beforehand will improve the results of the communication process. It is important to have knowledge about the target audience to understand which type of communication should be used. Afterwards, evaluation is needed to keep the communication efforts up to date and effective (Moser, 2010). While the focus is on transitioning the communication from merely providing knowledge to increase awareness to change actors attitudes and behavior, this does not mean that the importance of raising awareness is negligible (McNamara, 2013, Moser, 2016). While many studies are done about how communication should look, it remains a question, according to Moser (2016), how to move audiences from mere awareness to active engagement in the adaptation process. Especially in the highly politicized topic that climate change is (Moser, 2016).

Communication about urban climate adaptation is partly structured by the planning approach used by a government. However, a top-down planning approach does not necessarily mean a unidirectional communication model is used; the same is true for a bottom-up planning approach. Most current communication models are characterized by an approach in which the communication is unidirectional from sender to recipient (Ballantyne, 2016). Those models are called transmission models; the starting point is that the recipient needs to be properly informed before they will act upon climate adaptation (Pearce et al., 2015). Often experts are used in these top-down approaches to inform the lay audience about climate change and possible adaptation measures. The transmission model for communication is therefore mostly used for fulfilling the first objective of communication: raising awareness. In a response to the top-down approach there is also a bottom-up approach which is characterized by a bidirectional or dialogical format. This model is called the deliberation model by Pearce et al. (2015). This model for communication emerged in the 70's and 80's and is better suited to fulfill the second and third objective of communication: changing attitudes and behavior (Ballantyne, 2016). Pearce et al. (2015) recognize a recent shift in literature from the transmission model to a dialogic model.

In most literature it is argued that the bidirectional approach would lead to better results, although in practice it is not used often (Moser, 2014, Nerlich et al., 2010, Pearce et al., 2015). It is argued that the level of engagement by other actors will be higher, as they become coauthors of the outcomes, and therefore also the level of adaptation will increase (Ballantyne, 2016). This model is said to cope with the shortcomings of the transmission model, which oversimplifies the complexity of achieving attitude and behavior change. The bidirectional communication model can be implemented by the national government but can also emerge from local community-based movements. Often these local initiatives use different languages and media outlets to present their opinions. Therefore, lessons can be learned by the national government from these bottom-up movements (Nerlich et al., 2010, Pearce et al., 2015). Top-down and bottom-up approaches are compatible with each other and can exist next to each other, often they are even complementary to each other (Jacquet et al., 2014).

2.3.2 Instruments

Following from the second dimension of the climate ladder it is important to look at which instruments can be used for urban climate adaptation. The governmental actors can use several instruments to create incentives and motivations among other actors for climate adaptation. As indicated in the first section of this chapter the use of instruments depends on the views of the local actors (Tàbara et al., 2010). Other local factors, such as the common planning approach in a city or country, have an influence on which instruments are suitable. With the implementation of public policy, the government can mandate or facilitate urban climate adaptation. The goal of the instruments is to promote or force the use of urban climate adaptation measures.

According to Hood (1986) instruments can be classified by the type of instrument. For example, one instrument can focus on increasing knowledge, while another could focus on providing financial incentives for urban climate adaptation. Hood (1986) developed a 'NATO' classification scheme for policy instruments. This scheme recognizes four different governing resources: Nodality, Authority, Treasure and Organization. Each group consists of several instruments that share the same characteristics. According to Henstra (2016) this classification scheme is applied in policy studies literature. For this study the same classification will be used when comparing the cities in the Netherlands and Flanders with each other. These instruments chosen also affect the communication process, as the policies have to be communicated towards the other actors in the process. A key part of the first type on instruments, nodality, is the generation of knowledge. This is similar to one of the three objectives of communication, as mentioned by Moser (2010).

Nodality

The key assumption of the instruments in this group is that the target groups are motivated to take adaptation measures, but lack sufficient knowledge about how to adapt. The instruments therefore focus on the generation of knowledge and the transfer of the knowledge between the different actors. Illustrative instruments are knowledge generation by scientific inquiry, visualization of knowledge to focus on the local situation, education and training and the implementation of knowledge-sharing networks (Henstra, 2016). All these instruments should be part of a comprehensive communication framework. Knowledge about the actors involved is critical to make nodality instruments an effective policy approach (Moser, 2010, van Woerkum, 2007).

Instruments within this classification are not distinctive for a top-down or bottom-up approach. The generation of knowledge can be a collaborative process in which both the government and local citizens can play an important role. But it could also be that the government dictates which knowledge is shared and how it is shared. Governmental actors are often facilitators in the use of these instruments. In the knowledge-sharing networks the government can set these up and provide a framework in which other actors can share their knowledge (Henstra, 2016).

Authority

Governmental actors can use their authority to make urban climate adaptation happen. There is one assumption made when using an instrument from this group: target groups are motivated by a commitment to follow state-issued directives. This can be due to the fact that the target groups respect the legitimacy of the government or they are afraid of penalties for not following the directives. Three characteristic instruments in this group are: legislation, regulations and standards. Legislation for example could include the obligation of implementing adaptation strategies in the planning and design process (Henstra, 2016).

As authority instruments rely on the legitimate power of the state they are characteristic for a top-down approach. The central actor, the government, issues legislation which has to be followed by the other actors. Building standards, for example, are used to set out design and performance criteria for new, or renovated, constructions. However, the legislative power of the central actor can also be used to implement a bottom-up approach. The central actor, could for example, provide legislation that implement a bottom-up process for urban climate adaptation in the future.

Treasure

The third group of instruments for governments to stimulate climate adaptation is via the public treasury. It is assumed that target groups will not take action, unless they are motivated by financial incentives. There are three different instruments identified within this group: direct program spending, financial incentives and taxation. Direct program spending focusses on investments in flood protection infrastructure and relocation of services. Financial incentives can be offered by grants and subsidies. Taxation can be done by offering a tax deduction to incentivize adaptation. However, it can also be done by increasing the taxes for targets that live in vulnerable areas to cover the additional costs of reducing the risks in those areas (Henstra, 2016).

Treasure instruments are often implemented by the central actor, the government. This means that the use of these measures is characteristic for a top-down approach. Also the administration for subsidies, taxation and direct program spending are done by the central actor in the process.

Organization

The last group of instruments, which can be used for climate adaptation implementation, are organization-based. They assume that problematic conditions and behaviors can be addressed directly

by incorporating policy principles into government operations. They focus on the processes within the government and show how these can be deployed to increase the level of adaptation. Henstra (2016) identifies two examples of these instruments: demonstration and procurement. Demonstration focusses on climate-proofing of the assets owned by the government. Procurement focusses on the purchase policies for goods, works and services of the government.

This group of instruments is not specifically part of a top-down or bottom-up approach. The instruments are focused on the central actor themselves and therefore there is no effect for other actors. The use of these instruments can be caused by public pressure and therefore emerge from a bottom-up approach, but it could also be emerging from a desire of the central actor to provide an example to the other actors, of how climate adaptation can be done.

Synergy

The different instrument categories have their own strengths, weaknesses and requirements. In addition to the categorization on typology of the instruments they can be evaluated by four attributes identified by Landry and Varone (2005). These attributes are:

1. Resource intensiveness
2. Targeting precision
3. Political risk
4. Ideological and financial constraints

The attributes differ for every type of instruments. It is beyond the scope of this study to present an in depth analysis of these attributes for all instruments. In the paper of Henstra (2016) there is a table which shows more detailed information. The optimal conditions for urban climate adaptation are reached when they are used in complementary ways. For example, the nodality instruments can be used to inform the target groups of the existence of treasure instruments (Henstra, 2016).

2.3.3 Urban climate adaptation measures

The third dimension of the climate learning ladder outlines a focus on individual adaptation options and resources. As an important aspect of adaptation measures Tàbara et al. (2010) mentioned mainstreaming individual options in broader sustainable strategies. According to Uittenbroek et al. (2013) there are two ways for a government to implement urban climate adaptation: the dedicated approach and the mainstreaming approach. In the dedicated approach there is a specific policy domain for urban climate adaptation. This requires a high level of political support and often leads to a top-down process. The mainstreaming approach means that climate related problems are integrated in existing policy domains. This approach looks for couplings between existing policy objectives and climate adaptation. The mainstreaming approach is considered to lead to more effective and efficient policy-making (Tàbara et al., 2010, Uittenbroek et al., 2013).

In this chapter four groups of adaptation measures are discussed: urban design, vegetation, the use of materials and reducing anthropogenic heat. In accordance to these categories different possibilities are presented. When possible also the consequences of the adaptation measures are provided. While we discuss specific climate adaptation measures there is always the possibility to make couplings with existing policies. The use of urban vegetation, for example, also increases the biodiversity and livability of a neighborhood. While at the same time it also adapts urban heat stress and wind discomfort.

Urban design

The structure of the city has an important influence on the extent of the urban heat island and prevailing wind patterns.

Urban heat island adaptation measures

The size of the city determines to a significant extent the intensity of the urban heat island; however, it is difficult to change the size of the city so other measures should be found. The wind and solar orientation of new buildings and new streets could be used for adaptation. Especially ventilation has a high adaptation capacity, it can lower the Physiological Equivalent Temperature (PET) by a maximum of 15°C (Müller et al., 2013). A study done in Melbourne shows a decrease in real temperature of 0.8°C when the wind speed increases from 0 m/s to 0.5 m/s (Morris et al., 2001). In theory ventilation could make the urban heat island disappear completely when the velocity is sufficient (Park, 1986). The wind speed needed to reduce the urban heat island intensity differs per urban area. A study for Seoul shows that that a wind speed of about 6 m/s is sufficient, while a study for Lisbon showed a wind speed of about 8 m/s (Lopes et al., 2013).

Ventilation is optimal when there is a 45° angle with the prevailing wind direction. An analysis of the wind conditions is necessary to successfully implement this measure (Smith and Levermore, 2008). Prevailing wind directions might be different during the year, which can have an impact on the possible effects. For the Netherlands it makes adaptation through ventilation difficult because the cooling wind in the summer can lead to an undesired situation in the winter (Kleerekoper, 2011).

The structure of the city can help cooling by increasing the mix of air from the canopy layer with the boundary layer. The mixing depends on the height / width ratio of streets, and the best mixing is acquired when the ratio is 0.5. If the ratio is higher than 2.0, the mixing is not taking place anymore. Slanted roofs also promote mixing of the layers because air is forced up (Kleerekoper, 2011).

The city structure also impacts the amount of solar radiation received by buildings. Although it seems logical to lower the sun exposure in order to lower the urban heat island it has negative effects as well. When building heights increase it leads to less sun exposure for other buildings and ventilation of the air becomes more difficult. Also more shadow during the winter might create uncomfortable conditions and higher energy consumption (Gago et al., 2013). Because of the potential negative effects it is important to design buildings on an individual scale in such a way that they collect enough sun but don't create too much shadow for other buildings (Keefe and Martin, 2007).

An analysis for the city of Atlanta done by Stone et al. (2013) shows that land use changes can have a big influence on heat islands. What is special about this result is the fact that the researchers simulated land use change outside the city to see the influence within the city. Changing an area outside of the city to 100% forest reduced temperatures by 0.1°C, while 100% asphalt would increase temperatures by 0.4 – 0.7°C (Stone et al., 2013).

The different urban design adaptation possibilities have different scales. Promoting ventilation is done on a neighborhood or city scale, while sun exposure is most efficient when done on an individual building scale. Land use changes can be done on different scales but is most effective on a city scale. Ventilation and land use changes are planning measures while sun exposure is a design measure. The implementation of policies that promote studies to sun exposure and wind ventilation can stimulate the application of adaptation measures.

Wind dynamics adaptation measures

Local wind dynamics that are caused by the city design can have positive and negative effects. A wind that is too low will lead to additional air pollution while too high winds can create uncomfortable conditions for pedestrians. The assessment of pedestrian wind conditions is mandatory in many European and North American cities according to Wu and Kriksic (2012). However, in the Netherlands and Flanders this is not the case (Wu and Kriksic, 2012).

Tall buildings can be strategically placed in context with prevailing wind directions. If a taller building is located downwind of a smaller building the wind will be blocked and forced into the pedestrian levels. When a tall building is located upwind of a smaller building the wind will pass over the street (Wu and Kriksic, 2012). The design of cities and in particular buildings depends on the local climate conditions. Depending on temperature and prevailing wind speeds it can be beneficial to construct a stepped podium around a tall building to reduce the winds that are deflected downwards by the building. This is a beneficial design in a cold climate. While in a hot climate without high wind speeds a straight facade with openings is better suited as it promotes air ventilation at the ground level and makes it possible to ventilate areas that are otherwise sheltered by the solid facade (Wu and Kriksic, 2012). Another way to adapt to high winds on the street level is to construct a large canopy above street level that deflects the wind. A recessed entrance will create more favorable winds around the entrance. The latter will not include a base or canopy and therefore is not deflecting the wind before it reaches the street level. However such a recessed entrance will not work when it is at a corner because the corner streams will neglect the effect (Wu and Kriksic, 2012, Stathopoulos, 2009).

Horizontally accelerated wind flows caused by the orientation of streets and design of buildings can be lowered by using different orientations for streets. When long streets, parallel to the prevailing wind direction exist, there is a chance that the wind will be canalized along the street. This is especially the case when the street is getting narrower. Longer streets will increase the chance for wind canalization; therefore, reducing the length of streets can decrease the chance of canalization. The general formula for the length of the street is that the street should not be longer than 10 – 20 times the average building height. Longer streets are possible but they should not be in a straight line (Lenzholzer, 2013). High wind speeds through small gaps between high buildings are lower when the orientation of the gap is not parallel to the prevailing wind direction (Cochran, 2004).

The adaptation measures proposed for the wind dynamics focus on a building scale or a small cluster of buildings. Only the wind canalization will work on the scale of streets.

Vegetation

The use of vegetation can help the city to adapt to the urban heat island but also strategically placed trees have an impact on the wind dynamics in a city.

Urban heat island adaptation measures

Increasing vegetation can influence the urban heat island in multiple ways. The addition of a couple of trees can already lead to a significantly lower temperature for individual buildings because of the shadow created. Moreover, a study for typical one-story buildings in the United States showed that the addition of three trees per house can lead to energy savings up to 57%, half of which would be due to shadow. The remaining savings are caused by evapotranspiration of the trees (Vasilakopoulou et al., 2014). It could be implemented on a scale of one building but also for a whole neighborhood.

A measure that has an impact on the temperature of an individual building is the construction of intensive green roofs (Vasilakopoulou et al., 2014, Gago et al., 2013, Müller et al., 2013, Lenzholzer, 2013). The potential of the implantation of green roofs is big, because 20 – 25% of the city is covered by roofs (Santamouris, 2012). Roofs are called green roofs when the ordinary black roof is replaced by a roof with vegetation. There are two different types of green roofs: extensive and intensive green roofs. Intensive green roofs are called intensive because it needs more maintenance than the extensive variant. Often it is possible to convert a traditional roof to an extensive green roof; this is more difficult for an intensive green roof. An intensive green roof has a thicker growing media (>12

cm) than extensive green roofs (5 – 12 cm). Therefore the adaptation results of intensive green roofs are larger than that of extensive green roofs (Susca et al., 2011).

Just like the addition of trees, green roofs change the temperature in two ways. First it cools down the building in summer time which can lead to a lower demand of air-conditioning, which reduces the energy usage of the building (Takebayashi and Moriyama, 2007). The lower temperatures in the buildings are caused by the higher albedo values of a green roof in comparison with the black roof. Albedo is a reflection coefficient that shows how well a surface reflects sunlight. Exact values depend on the type of vegetation used for the roof. Susca et al. (2011) found values of 0.2 instead of 0.05 for black roofs, while Getter et al. (2007) found maximum values of 0.7 – 0.85. Temperatures inside buildings are lowered with 2 - 4 °C when the outside temperature is between 25 °C and 30 °C. As every 0.5 °C means a maximum energy saving of 8% a maximum of 32% could be saved by implementing green roofs (Getter et al., 2007, Santamouris, 2012). The surface temperature itself can be lowered by as much as 25 °C which will lead to a significantly lower sensible heat flux and less heat emitted during the night (Gago et al., 2013). The second way of cooling the environment is done by evapotranspiration. Green roofs are also able to retain water better and are thus capable of reducing storm runoff (Köhler et al., 2002). Cool roofs are also impacting their surroundings. According to Gago et al. (2013) a bigger roof has a bigger effect for the surroundings than a smaller roof (Gago et al., 2013).

The effects of green roofs on the intensity of urban heat islands is not exactly known, however a few simulations are done in different cities. For the city of Chicago, which is a leading city in green roofing, temperatures at 19:00 – 23:00 were 2 - 3 °C cooler comparing to the situation with normal roofs. A simulation for New York shows that the peak temperature is lowered by 0.37 – 0.86 °C. The height of the building with a green roof is important, when a building is taller than 10m the effect on the street level temperature is negligible (Santamouris, 2012). Instead of roofs one could also use green pergola's or car ports which are covered by vegetation.

Next to the application of green roofs also increasing green spaces on the street level can have a significant effect on the urban heat island. The ways of adaptation are the same as with green roofs: shading, evapotranspiration and albedo differences.

The character of the green infrastructure is a key factor for the actual results of the measure. While trees are providing shade to lower the surface temperature, grass is lowering the surface temperature by a lower albedo and evapotranspiration. During the day shadows provided by trees can lower the PET by more than 20°C while grasslands can lower the PET by a maximum of 12°C**.** At night this relationship is exactly the other way because trees are blocking wind ventilation and long wave radiation (Müller et al., 2013).

In addition to a lower PET also the air temperature is lowered. Different studies have found different effects of parks on temperatures. One study shows that the effect could be as big as 4°C and that cool islands are created (Gago et al., 2013). While another study finds temperatures to be lower on average 1 - 2°C and maxima of 7°C, based on field-base measurements (Santamouris, 2012). The size of the park is significant in their capacity to cool the surroundings. The relation between size and cooling capacity is not linear. Multiple smaller parks cool the city more than one big park (Vasilakopoulou et al., 2014, Gago et al., 2013, Hunt et al., 2012). Temperatures in surrounding areas of parks are influenced as well. A study for New York shows that 1,5km downwind of a park the measured temperatures were 1,5°C lower (Ca et al., 1998). Whereas for Gothenburg effects were found at a distance of 1100 meters (Kleerekoper, 2011).

The scale of implementation of urban parks is at the neighborhood or city level. It will need planners and designers to think about the location and size of green areas. This could be forced by policies but also could be done in a more informal way.

Wind dynamics adaptation measures

In the same way as city design can influence the wind dynamics vegetation can do that as well. High wind speeds at squares in cities can be lowered by strategically placed vegetation. The wind speed depends on the ratio between the height of the buildings and the width of the space between them. By adding rows of trees the width can be reduced and the wind might overshoot the open space instead of creating high speeds (Lenzholzer, 2013). In addition, trees are able to block winds in the same way as porous screens block the wind and are therefore useful in streets where the canalization effect is present.

Strategic placement of trees and shrubs can change the wind dynamics in cities. It can have an effect on the thermal conditions, both positive and negative, but also on the uncomfortable wind flows around buildings and open spaces. As the wind is blocked by vegetation it will search for other routes to keep flowing. This means that wind patterns are changed and the amount of ventilation changes. In general it can be said that blocking of the wind lowers the wind speed, trees are responsible for 22% lower wind speeds (Coceal and Belcher, 2005). Depending on the prevailing wind direction in different seasons it might be beneficial to block winds. However, it depends on the goals of the adaptation. In the winter you might want to block cold winds to prevent the area to cool even more, while in the summer ventilation might be very important. The implementation of trees and shrubs to change the wind dynamics are more effective when done on a street or neighborhood scale.

Use of materials

Instead of the use of conventional materials for e.g. roofs, asphalt and facades it is possible to adapt to the urban heat island by using other materials (e.g. instead of dark asphalt a lighter color could be used). The use of other materials offers possibilities for heat mitigation, while it does not offer adaptation possibilities for wind dynamics.

Urban heat island adaptation measures

There are several materials used in the urban area that enhance the urban heat island. Among others this includes the asphalt and concrete of pavements but also the mostly dark roofs. First we will focus on the design of pavements. As said the standard design of the pavements is mostly concrete or asphalt. This means that the material has a low albedo and thus does not reflect short wave radiation well. Peak surface temperatures can be as high as 67 °C, which is emitted during the night and thus increasing the urban heat island. Pavements cover around 30% - 45% of the urban area and thus could contribute a lot to urban climate adaptation (Wong and Hogen, 2008). Pavements are among the major contributors to the urban heat island (Vasilakopoulou et al., 2014). There are two ways to adapt to the effects of pavements: change the material of the pavements or cover the pavements by, for example, tree canopies. The latter one is already discussed in the section about vegetation. One of the important characteristics of pavements for urban heat is the solar reflectance, also called albedo. Common pavements have an albedo ranging from 0.05 to 0.4. This depends on the material and the age of the material as weathering and usage changes the albedo. By changing this reflectance, the surface temperature can decrease. Research showed that changing the color of a brick wall could reduce the temperature by 3-5°C (Vasilakopoulou et al., 2014, Wong and Hogen, 2008). In Athens an experiment was done on real scale where pavements were colored with an infrared paint with a higher albedo. Monitoring before and after completion of the project showed a decrease of 12°C surface temperature and a decrease of almost 2°C in air temperature (Santamouris et al., 2012).

Apart from changing the albedo characteristics of the pavement it is also possible to change the permeability. If the pavement is more porous water can enter into the voids, instead of running off. This allows the pavement to evaporate the water when the sun is shining and thus cool down itself. However, when there are longer dry periods the pavement will be warmer instead of cooler, evaporation is not possible anymore and because of the increased surface area it will absorb more radiation (Wong and Hogen, 2008).

In addition to changing the albedo of pavements one can also change the albedo of roofs. As discussed in the previous section about vegetation green roofs can be used. However, also the use of cool roofs instead of black roofs can make a difference. For different types of roofs (steep or low-sloped) different adaptation techniques are needed. Low-sloped roofs consist mostly of built-up roofing or a membrane. There are two different methods to implement a cool roof technique: coatings or single-ply membranes. Most of the time coatings are sprayed on top of the existing roof surface and therefore change the characteristics of the roof in a more urban heat island friendly way. Single-ply membranes are placed over the existing roof structure as a pre-fabricated sheet (Wong and Hogen, 2008).

The market for 'cool' steep roofs is growing although it is significantly smaller than the market for 'cool' low-sloped roofs. In total there are three different types of cool roof techniques available: asphalt shingles, 'cool colored' tiles and cool roof metal products. All these techniques increase the solar reflectance in comparison with an ordinary roofing product. Asphalt shingles replace the common roofing tiles and are most commonly used as a cool roof technique. The solar reflectance increases to 25 – 65% instead of 10 – 30%. 'Cool colored' tiles also replace the common tiles but look very similar. However, there are pigments added that reflect solar reflectance in the infrared spectrum and therefore the reflectance increases to 25 – 70%. Cool roof metal products replace the ordinary tiles by metal products which uses the same technique as the 'cool colored' tiles. The reflectance increases to 20 – 90% (Wong and Hogen, 2008).

A simulation for the city of New York showed a temperature decrease of 0.2°C city-wide with peaks to approximately 1°C. In this simulation 50% of the available roof space was used as a cool roof. Cool roofs not only have a big effect on outside temperatures but also on the temperatures indoors. By lowering the temperatures indoors the demand for air conditioning will decrease and therefore reduce the urban heat island, more on this topic in the next paragraph (Wong and Hogen, 2008). Cool pavements and roofs can be implemented on a building or street scale. However, the results are better when implemented on a wider scale.

Anthropogenic heat

The production of anthropogenic heat by, for example, air-conditioning, industrial activities and traffic has an impact on the urban heat island. In the Northern hemisphere anthropogenic heat is an important factor during the wintertime, while in the summer it is significantly less important (Rizwan et al., 2008, Shahmohamadi et al., 2011). Anthropogenic heat emerges from three major sources: metabolic emission, vehicular emission and building emission. Multiple studies show that the heat emission from buildings, including industry, is the most important source of anthropogenic heat (Allen et al., 2011, Klok et al., 2010). The distribution among the three sources is effected by local conditions.

Urban heat island adaptation measures

A reduction of the anthropogenic heat flux is interwoven with other measures. For example, the use of urban vegetation reduces the demand for cooling and heating of buildings and therefore also the

anthropogenic heat flux. The use of materials with a high albedo can reduce the energy demand of a building due to the lower temperature of the ambient air (Shahmohamadi et al., 2011).

Technical innovations can reduce the production of anthropogenic heat as well. For instance, more efficient air-conditioners will reduce the urban heat island. Also the way air-conditioners work in the future might change. At the moment most air-conditioners are from the air-to-air type while designers are also looking in to other technologies, including using ground water as a heat sink. Technical innovation in the field of thermal insulation could reduce the intensity of the urban heat island as well. Currently the insulation of buildings is very efficient at preserving heat inside a building; however, it is less effective at preserving coldness. If the insulation becomes more effective at the latter this could reduce the energy demand for the cooling of buildings and therefore also the anthropogenic heat flux (Shimoda, 2003).

The use of waste heat and heat storage can lead to an improvement of the energy system by a factor of 6. Heat storage from anthropogenic sources underground can be used in the winter to heat buildings. This reduces the energy consumption by 40 – 80% which leads to a lower anthropogenic heat flux (Kleerekoper, 2011). A Japanese study showed that when all air-conditioning is cut-off the air-temperature drops by 1,0 °C (Kikegawa et al., 2003).

A study for Rotterdam showed that when looked at the whole municipality 80% of the anthropogenic heat flux is coming from buildings. Vehicular heat emission is responsible for the other 20%. The study also showed that the metabolic heat emission is so small that it can be neglected (Klok et al., 2010). The model made by Allen et al. (2011) showed that the distribution is different in Kinshasa (Congo, Africa), where the metabolic heat emission is responsible for at least 30% of the anthropogenic heat flux. These differences emerge due to local climate conditions, as those conditions decide whether heating or cooling is needed. Between 60 – 70% of the energy consumption by buildings is used for heating and cooling (Allen et al., 2011).

Within cities the local conditions differ from each other. Vehicular emissions focus around large roads and highways, while around industrial areas the emission from buildings is the largest factor. In the municipality of Rotterdam an average anthropogenic heat flux of 38GW is measured, however in the city center the heat flux is five times as high (Klok et al., 2010). When this data is used as input for a mesoscale model it shows that 38GW equals a temperature increase of 0,5.°C, while in the heat flux in the city center equals to a temperature increase of 2,0 °C (Ronda et al., 2010).

Another study is conducted for the Ruhr area in Germany where a permanent temperature increase of 0,15 – 0,5 °C was found (Block et al., 2004). There is also a study that looked at the urban heat island in Barrow, Alaska. The urban heat island that emerges during the winter period in Barrow is solely due to anthropogenic heat coming from homes and other buildings. Other factors that influence the urban heat island are negligible for this city due to special local conditions. The average intensity of the heat island is 2,0 °C, with a maximum of 8.37 °C (Hinkel and Nelson, 2007). The results found for Barrow are not directly applicable for mid-latitude cities in the Netherlands and Flanders. However, it does show that heat escaping from heated homes and other buildings can have a significant effect on local urban heat islands.

Chapter 3: Methods

3.1 Type of research

This thesis is part of a larger study where countries worldwide will be analyzed. The purpose of this larger study is to describe the state of urban climate adaptation. As it is too much for one researcher to look at all countries it was decided that the study would be a case study. As case study areas the Netherlands and Flanders were selected. This was done because I am familiar with the Dutch language which makes it more convenient to examine these countries. To examine the state of urban climate adaptation in the Netherlands and Flanders the situation in several cities was examined.

Starting point for the selection of the cities was that there should be a close to equal number of cities in both countries. In addition to this I wanted to select cities with a different geographical location and population size. This was done because I thought these factors might influence the state of urban climate adaptation. In each city an expert on the field of climate adaptation was identified and an in-depth interview was conducted. However, a flexible attitude for the selection of the cities was necessary because not in every city representatives of the municipality were willing to collaborate with the research.

According to the Köppen climate classification the Netherlands and Flanders are located in a temperate oceanic climate. However, there are still differences in local climate conditions due to the geographical location of the cities. In order to incorporate the local differences in climate conditions both urban climate adaptation in coastal and inland cities were observed. Wind discomfort could occur more frequent in coastal cities, while average temperatures in the summer are higher in the inland cities which could increase the effect of the urban heat island. As mentioned before these factors might influence the state of urban climate adaptation. With the use of the selection criteria a total of six Dutch and five Flemish cities were examined with regards to urban climate adaptation. The selected cities were the following:

The Netherlands	Flanders
1. Amsterdam	1. Koksijde
2. Utrecht	2. Antwerpen
3. Rotterdam	3. Gent
4. Maastricht	4. Hasselt
5. Winterswijk	5. Brugge
6. Vlissingen	

Table 1: List of examined cities

3.2 Data collection

Several methods for data collection were used. The theoretical framework of chapter 2 was used to work out a structure for the in-depth interviews. In the next paragraph this structure will be presented. To obtain information about the two cases, the Netherlands and Flanders, expert interviews were conducted. In each city one expert was interviewed, which fitted the purpose of this study as I wanted to compare the Netherlands and Flanders with each other. The choice of the experts was made by asking the cities which civil servant was part of climate adaptation policies. In some cities multiple people were involved in climate adaptation policies and therefore multiple people were present during the interview. Because the interviewees were experts within their city it was assumed that they are well informed about the state of urban climate adaptation in their municipality. The assumption is made that these experts are capable of identifying the opinions and feelings of other actors involved

in the urban climate adaptation process. The type of data collection provides limitations for the study, which will be discussed in chapter 6.

On this page a table is presented with the 11 interviews that were conducted in the autumn of 2014. Also the function of the interviewees is provided; often the interviewees were civil servants for environmental topics. However, in Winterswijk the interview was with the alderman for, among other topics, sustainable energy and environment. From one city, Koksijde, the representative of the municipality did not have the time for an interview; therefore, the answers to the questions came per e-mail. The date on which this email was received is listed in Table 2. In Vlissingen two representatives were present during the interview to provide more accurate information.

When possible the interviews were conducted face-to-face. This meant I traveled to the city of the interviewee. The interviewee therefore had a comfortable feeling as the interview was held in a familiar environment. However, this was not always possible, due to travel costs or travel delays. For these interviews the phone, Skype or email was used. The interviewees were aware that the interviews were taped to work out in a transcript afterwards.

Number	Function	City	Interview date	Type
1.	Head designer project team South	Amsterdam	10-30-14	Face-to-face
2.	Advisor sustainability	Utrecht	10-31-14	Face-to-face
3.	Policy advisor environment and sustainability	Rotterdam	11-03-14	Face-to-face
4.	Landscape advisor	Maastricht	11-04-14	Face-to-face
5.	Civil servant urban development	Koksijde	11-10-14	Email
6.	Alderman sustainable energy and environment	Winterswijk	11-20-14	Face-to-face
7.	Civil servant at the city development office	Antwerpen	11-26-14	Face-to-face
8.	Policy advisors environment and water management	Vlissingen	11-27-14	Phone
10.	Civil servant and part of the climate team	Gent	12-10-14	Skype
11.	Sustainability civil servant	Hasselt	12-17-14	Phone
12.	Director department living environment	Brugge	12-19-14	Skype

Table 2: List of interviews

3.2.1 Structure in-depth interviews and email

The starting point for the structure of the interviews was the set of research questions introduced in paragraph 1.2. In addition to the six questions a set of additional, more in-depth, questions were formulated in line with the theoretical framework in chapter 2. Topics addressed in the theoretical framework were used to identify what is important in urban planning & design and give an indication what type of answers could be expected from the interviewees. The first three main questions focus on the sense of urgency and awareness among citizens, politicians and urban planners & designers. Sub questions were made to focus on specific topics to see what the awareness was.

The focus on heat stress and wind discomfort was made because of the information presented in paragraph 2.2. Similarly, the focus on specific urban climate adaptation measures was based on the knowledge acquired from scientific literature. There are four main groups of adaptation measures, as shown in paragraph 2.3.3: urban design, urban vegetation, the use of other materials and reducing anthropogenic heat.

Information about urban planning & design is presented in paragraph 2.3. The different dimensions of urban planning were presented which resulted into the focus on the communication and policy instruments used by the municipality at this moment. Also, the representatives were asked to identify strengths and weaknesses of the current situation.

The sixth and final research question focused on the current implemented urban climate adaptation measures by the municipality. Although, this did not follow from the theoretical framework it was relevant for this study to know which actions the municipality took at this moment. Questions about possible conflicts and opportunities experienced by the representatives were included here as well.

The structure used was a combination of closed and open questions. For the sense of urgency and awareness a set of closed questions was used, concluded with an open question about the necessity of an increase in awareness and / or sense of urgency. If this was the case, I also asked how they thought this could be achieved. The classification for closed questions can be found in Annex 1, where a complete overview of the structure can be found. The questions about communication, instruments and current adaptation measures solely consist of open questions. Below is a condensed version of the interview structure presented.

Sense of urgency and awareness

1. What is the sense of urgency to adapt the urban environment in the future, amongst citizens, politicians and urban planners and designers?
    - Is it necessary to increase the sense of urgency for urban climate adaptation? If yes, how could this be done?
2. How aware are citizens, politicians and urban planners and designers of urban heat stress and wind discomfort?
    - Is it necessary to increase the awareness for these urban climate phenomena? If yes, how could this be done?
3. How aware are citizens, politicians and urban planners and designers of urban climate adaptation measures?
    - How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with urban design?
    - How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with urban vegetation?
    - How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with the use of other materials?
    - How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with reducing anthropogenic heat?
    - Is it necessary to increase the awareness of these urban climate adaptation possibilities? If yes, what could be done to increase the awareness?

Planning and design processes for implementation

Communication

4. What is the role of communication in the process of urban climate adaptation?
    - Which roles do citizens, politicians and urban planners and designers have in the process of planning, designing and implementing urban climate adaptation measures?

- What is the role of communication to support the planning, design and implementation of adaptation measures?
- What are the strengths and weaknesses of the current communication process?

Instruments

5. Which instruments are used to implement urban climate adaptation at the moment?
    - Are there legally binding instruments used to implement urban climate adaptation measures?
    - Are there other policy instruments used to implement urban climate adaptation measures?
    - What are the strengths and weaknesses of the instruments used to implement urban climate adaptation measures?

Adaptation measures

6. Which concrete urban climate adaptation measures are used in urban climate adaptation strategies?
    - Which concrete urban climate adaptation measures have been implemented in your city?
    - What are the strengths and weaknesses of the implemented urban climate measures?
    - Are there conflicts between aesthetics and urban climate adaptation measures?
    - Are there conflicts between urban functions and urban climate adaptation measures?
    - Are there chances / potentials missed when implementing urban climate adaptation measures?

3.3 Data analysis

Scientific literature was used to identify important topics with regards to urban climate adaptation, as discussed in chapter 2. The results of the literature review contributed to the structure of the interviews. Scientific literature was mainly found with Google Scholar and Scopus.

The interviews were recorded and afterwards typed out in transcripts. The interview transcripts were aggregated per research question to make the analysis of the results easier. All the transcripts were analyzed by the researcher and relevant information was marked and processed to be presented in chapter 4. The results for the closed questions were analyzed with Microsoft Excel and relevant graphs and tables were produced to interpret the results. The sample size for this study was small, which decreased the possibility to make concrete statements about the outcomes.

The answers of the representatives were first analyzed per country to identify specific characteristics of urban climate adaptation. A second analysis was done to compare the results of the two case studies to identify similarities and differences. Also possible explanations for the observed similarities and differences were analyzed and presented in chapter 4.

Chapter 4: Results

In this chapter the outcomes of the interviews with representatives of the municipalities are discussed. Each interview question will have its own paragraph in which the results for the Dutch cities will be described first. After that the Flemish results will be described and each paragraph is finished with a comparison between the two countries.

4.1 Interview results – sense of urgency and awareness

4.1.1 What is the sense of urgency to adapt the urban environment in the future, amongst citizens, politicians and urban planners and designers?

The Netherlands

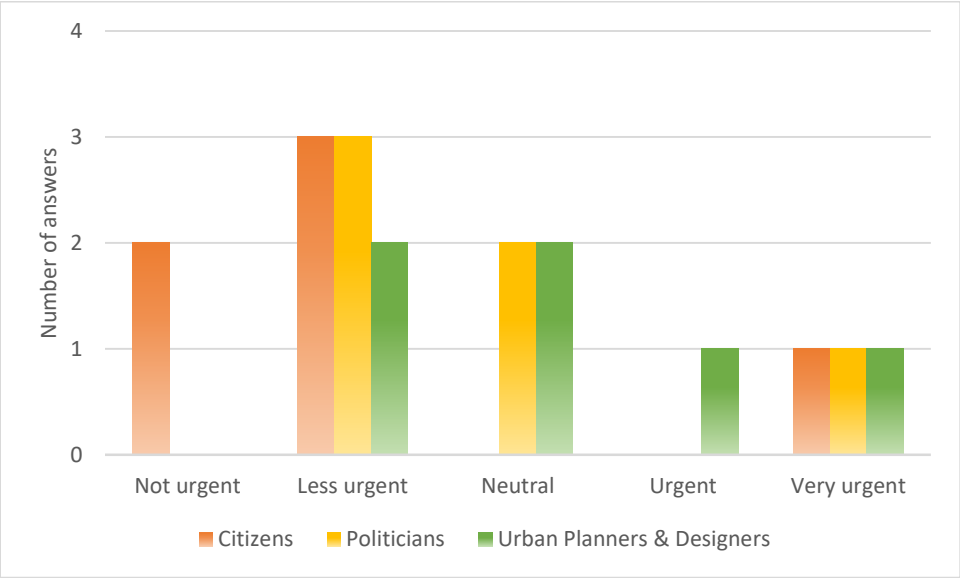

Figure 5: Level of urgency for urban climate adaptation in the Netherlands

As shown in Figure 5 the level of urgency, estimated by the interviewees, is in general higher for urban planners & designers in comparison to the citizens. Also the sense of urgency felt by politicians is higher than the urgency felt by the citizens. With regards to the sense of urgency the interviewee in Amsterdam said the following: "*it is difficult to give the sense of urgency for the politicians, because the latest elections were not that long ago.'* She added that: *'although, they are not in place for a long time it already becomes clear that the alderman focusses on CO_2 emission rather than urban climate adaptation."*

	Amsterdam	Vlissingen	Utrecht	Winterswijk	Maastricht	Rotterdam
Citizens	Not urgent	Less Urgent	Less urgent	Not urgent	Very urgent	Less urgent
Politicians	Neutral	Less Urgent	Less urgent	Neutral	Very urgent	Less urgent
Urban planners & designers	Urgent	Less Urgent	Less urgent	Neutral	Very urgent	Neutral

Table 3: Level of urgency for urban climate adaptation in the Netherlands

As can be seen in Table 3 there is no sense of urgency for urban climate adaptation in Vlissingen and Utrecht. However, the interviewees in Vlissingen added: *"For me these [urban heat island and wind discomfort] are completely different things. There is a big discrepancy between the sense of urgency for wind discomfort and heat stress. For wind discomfort there is a sense of urgency, while for heat*

stress there is not." The interviewee in Winterswijk stated: *"Climate related problems are a difficult subject because there is a lot of uncertainty. The focus of the municipality is, for now, more on the economic interests of the municipality, rather than on climate adaptation."* For Maastricht the sense of urgency is very high since the moment the structure vision was introduced in 2012. For citizens this was confirmed in 2014 when a meeting was organized with 200 randomly selected inhabitants to talk about health in the city. Heat stress was one of the important points that came out of this meeting.

Flanders

As can be seen in Figure 6 the felt level of urgency is low in most of the cities, for citizens the urgency is lower than neutral in all the case cities. Urban planners & designers have a higher sense of urgency than the other two actors; however, the difference with the politicians is small. The interviewee in Gent said that it was difficult to make the difference between the three groups. But at the same time she recognized that a sense of urgency is important to get measures implemented.

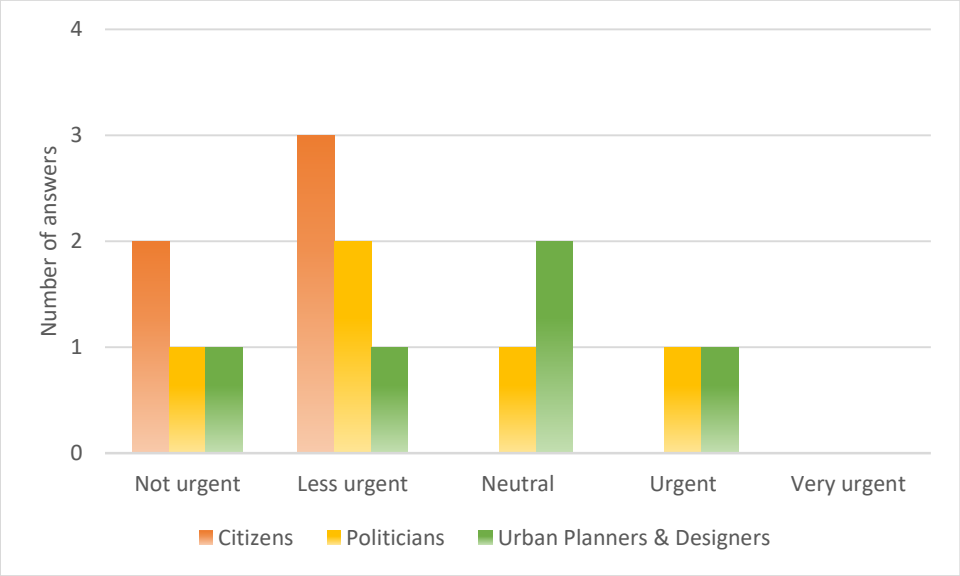

Figure 6: Level of urgency for urban climate adaptation in Flanders

In Table 4 it is evident that in Brugge and Hasselt the sense of urgency among all the three groups is low. In the other cities there is a larger difference among the actors. In Gent, for example, the sense of urgency among urban planners & designers is two levels higher than among citizens. In Antwerpen the politicians have the highest sense of urgency, this in contrast to Koksijde where the urban planners & designers have the most urgent feeling. In Brugge and Hasselt the sense of urgency is low because it is unknown whether or not there are urban climate related problems. Currently the urgency is low in Hasselt; however, the topic starts to gain momentum in the organization according to the interviewee.

	Brugge	Hasselt	Gent	Antwerpen	Koksijde
Citizens	Not urgent	Not urgent	Less urgent	Less urgent	Less urgent
Politicians	Not urgent	Less urgent	Neutral	Urgent	Less urgent
Urban planners & designers	Not urgent	Less urgent	Urgent	Neutral	Neutral

Table 4: Level of urgency for urban climate adaptation in Flanders

About awareness among politicians the interviewee in Antwerpen stated: *"For politicians, urban climate adaptation is an important topic. In October we signed the Mayors adapt and Covenant of*

Mayors. The signing of these two initiatives shows that there is a sense of urgency among the politicians." In the end of 2015 the Mayor's adapt and Covenant of Mayors merged and formed a new initiative: Covenant of Mayors for Climate and Energy: *"The new Covenant of Mayors for Climate and Energy brings together local and regional authorities voluntarily committing to implementing the EU's climate and energy objectives on their territory."* (European Union, 2015)

Comparison

In Figure 7 a comparison between the different actors in the Netherlands and Flanders is made. It shows that the citizens in the Netherlands have a slightly higher sense of urgency; the same can be said for the politicians and urban planners & designers. In both countries urban planners & designers have the highest sense of urgency with at least a neutral sense of urgency in more than 50% of the cities.

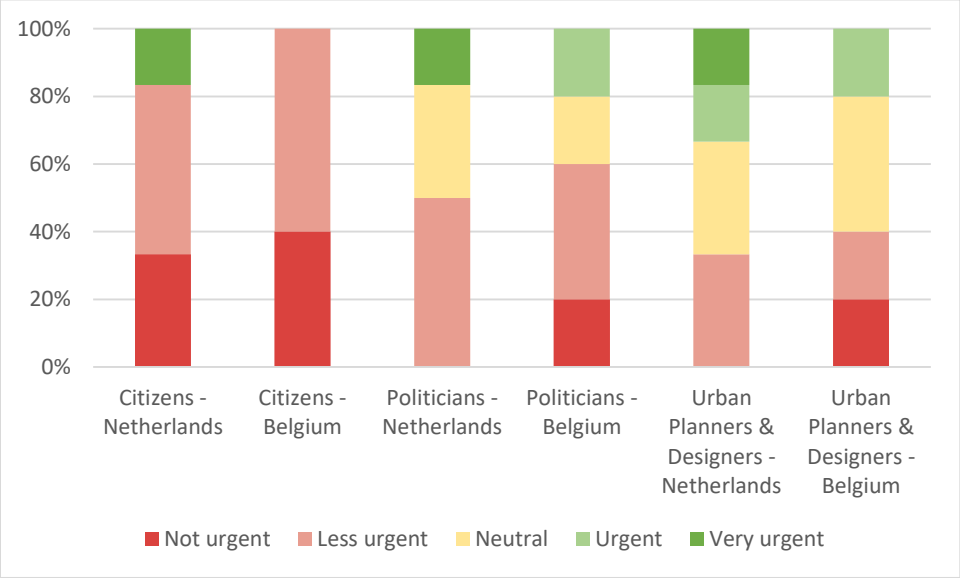

Figure 7: Comparison level of urgency for urban climate adaptation

In the case cities the sense of urgency in the Netherlands seems to be higher than in Flanders. This is partly caused by the high sense of urgency in Maastricht, where the municipality implemented climate adaptation in the structure vision in 2012. In Flanders the sense of urgency is lower and there is little sense of urgency in two cities.

To make an additional comparison between the countries I transformed the answers to the questions to points. This means that very aware is 5 points, aware is 4 points, neutral is 3 points, less aware is 2 points and not aware is 1 point. This means that for every question a maximum of 15 points can be scored among all the three actors.

The level of urgency felt with regards to the urban climate is higher in the Netherlands than in Flanders, as can be seen in Figure 8. The average sense of urgency in the Netherlands is 8,2 for the three actors combined, in Flanders this is 6,6. Both countries have an average sense of urgency lower than neutral among all three actors. The urban planners & designers have the highest urgency of the three actors, while the citizens have the lowest. The average difference between these actors is one point: 1,6 for citizens in Flanders and 2,6 for urban planners and designers. In the Netherlands the awareness is approximately 0,5 higher. So even for urban planners and designers the average sense of urgency is just above neutral in the Netherlands, while in Flanders it is lower.

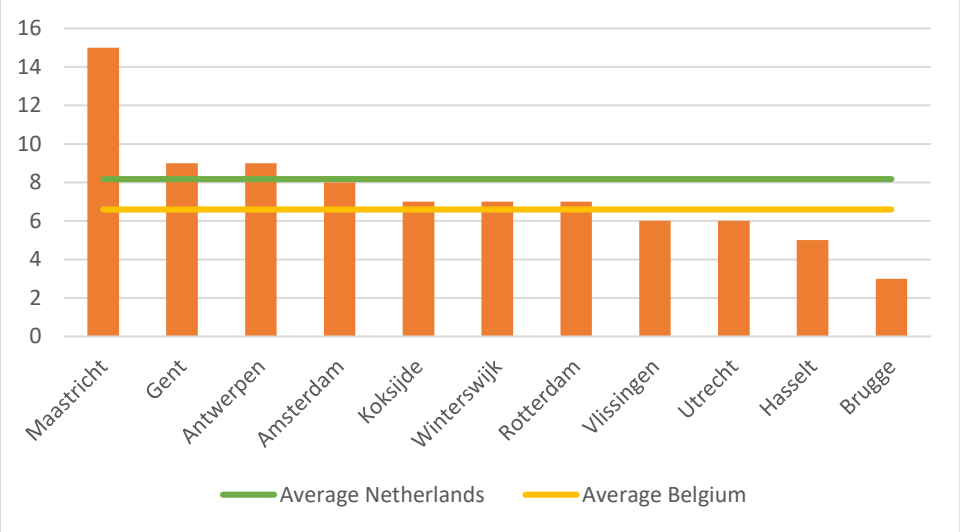

Figure 8: Sense of urgency in the case cities

When looked at the individual cities Maastricht has the maximum score of 15 points. The second and third highest urgency is felt in Gent and Antwerpen with 9 points. The two lowest cities are Hasselt and Brugge, both in Flanders. Except for Maastricht all Dutch cities have a lower urgency than the average score in the Netherlands. Maastricht is the outlier in comparison with the other Dutch cities and has a big influence on the average sense of urgency. In Flanders three cities score higher than the average in Flanders. Without Maastricht both countries would be very similar.

4.1.2 Is it necessary to increase the sense of urgency for urban climate adaptation? If yes, how could this be done?

The Netherlands

According to the interviewee in Amsterdam there are several ways to increase the sense of urgency among the different actors: *"Educate citizens and politicians about the urban climate and provide citizens with financial incentives."* While for urban planners and designers it is important to *"use an interdisciplinary approach to increase the sense of urgency."* In Utrecht the interviewee thinks it is not necessary to increase the sense of urgency because the urban climate is not a big problem at the moment. However, she does admit that it is important that the municipality takes a closer look at the vulnerable groups and this might lead to a higher sense of urgency.

In Vlissingen the interviewees did not find it necessary to raise the sense of urgency. The same is the case in Winterswijk and Rotterdam where the interviewees mention that the municipality does not want to scare citizens with a topic that is not considered to be a big problem at the moment. The interviewee in Rotterdam added that *"it [urban climate adaptation] is an important topic but not an urgent topic. It is important that we pay attention to it, but we do have the feeling that we have some time."* In Maastricht the sense of urgency is already very high and thus an increase is not possible and necessary according to the interviewee.

Flanders

In all the case cities the interviewees said it is needed to increase the sense of urgency, however there is a difference in how this higher urgency should be achieved. In Koksijde, Antwerpen and Gent interviewees mention the presentation of urban climate adaptation examples as a possibility to increase the sense of urgency. In addition to providing the actors with examples the interviewee in Koksijde acknowledges that it is important to raise awareness first. In Antwerpen the interviewee added: *"We are working on maps to show the potential of a green roof for a building. We want to*

attach a marketing campaign to this map to raise awareness among citizens. At the same time, we are creating a tool for urban planners & designers. This tool should make it easier to implement vegetation in development plans for the city."

The interviewee in Gent came up with different possibilities as well. In the communication to all the groups it is important to not use worst case scenarios, this can be done by gathering more knowledge about the exact effects of (urban) climate change in the city. For politicians in specific it could be useful to explain the link between urban climate adaptation and the vision of the city: *"a pleasant, child friendly, healthy and safe city."* To achieve this vision, urban climate adaptation is necessary. For planners, designers and politicians it is important to show that it is financially more interesting to act sooner rather than later.

In Brugge and Hasselt the focus is on gathering more knowledge about the urban climate and spread this knowledge inside the organization. The interviewee in Hasselt added: *"For planners and designers it is important to follow workshops, while for citizens and politicians we can wait for the results of the urban climate study for our city."*

Comparison

In the Netherlands only the interviewee in Amsterdam thinks that it is needed to increase the sense of urgency, while in Flanders all the city representatives say it is important. As possible methods to increase the sense of urgency the interviewee in Amsterdam said the following: *"Educate citizens and politicians about the urban climate and provide citizens with financial incentives. For urban planners and designers an interdisciplinary approach can increase the sense of urgency.*" Interviewees in three Flemish cities acknowledge that it is important to obtain and provide knowledge as well. However, financial incentives and the interdisciplinary approach are unique for Amsterdam.

In contrast to the interviewees in Dutch cities, Flemish interviewees mentioned that it is important to provide other stakeholders with concrete examples of urban climate adaptation methods and their positive outcomes. It is evident that different methods to increase the sense of urgency are mentioned in Flanders and the Netherlands.

4.1.3 How aware are citizens, politicians and urban planners and designers of urban heat stress?

The Netherlands

In Figure 9 it is clearly visible that urban planners and designers are aware of the urban heat island. Only in one of the six cities the planners and designers are less aware. This city is Vlissingen where the level of awareness of all the three groups is low. In Amsterdam the awareness of urban planners & designers is very high, while the awareness of citizens is at a neutral level. The awareness of politicians is in the middle of the three actors; however, it does not necessarily mean that all politicians in Amsterdam are aware of the urban heat island effect.

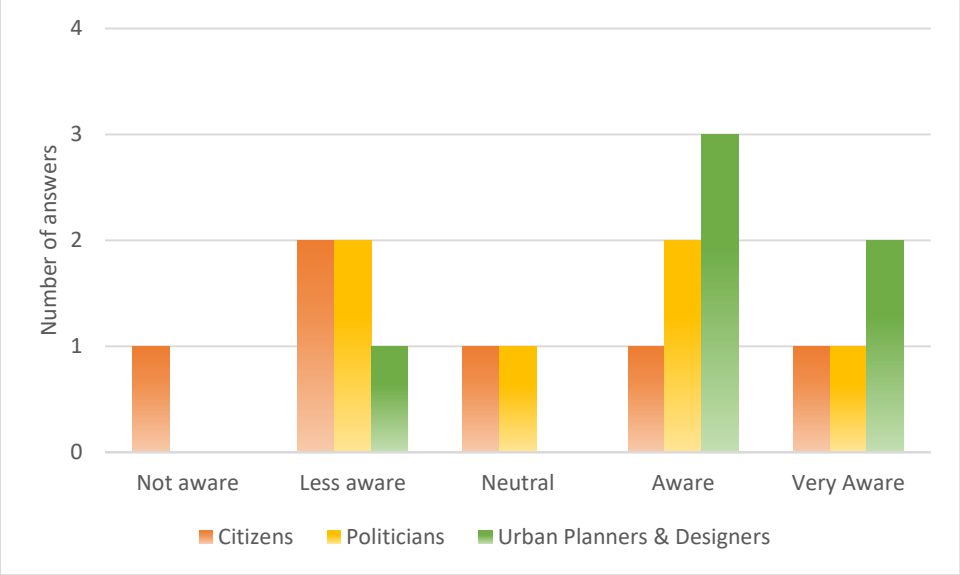

Figure 9: Level of awareness for urban heat stress in the Netherlands

As shown in Table 5 in Utrecht all the groups are aware of the topic, though it again does not mean that everyone in each group is aware of the urban heat island. A study about heat stress pointed out that approximately 20% of the citizens are aware of the urban heat island; the interviewee thinks this is a good score. In Vlissingen and Winterswijk the interviewer first had to explain the urban heat island before the interviewees were able to answer the question. In Winterswijk the urban planners are aware of the urban heat island, while the other groups are less aware. Among all actors, in Maastricht, a very high awareness can be found with regards to urban heat stress. According to the interviewee this was not always the case: *"Since the structure vision in 2012 the awareness is very high, before this there was no awareness at all. Last week we had a meeting with 200 citizens in which heat stress was mentioned as a reason for more vegetation."*

	Amsterdam	Vlissingen	Utrecht	Winterswijk	Maastricht	Rotterdam
Citizens	Neutral	Not aware	Aware	Less aware	Very aware	Less aware
Politicians	Aware	Less aware	Aware	Less aware	Very aware	Neutral
Urban planners & designers	Very aware	Less aware	Aware	Aware	Very aware	Aware

Table 5: Level of awareness for urban heat stress in the Netherlands

Flanders

As shown in Figure 10 the awareness among citizens is the lowest of the three actors, they are the only group that has no awareness in one city. The awareness among the politicians is divided in either a high awareness or a low awareness, while for the urban planners & designers the awareness is more spread out and a bit higher in general.

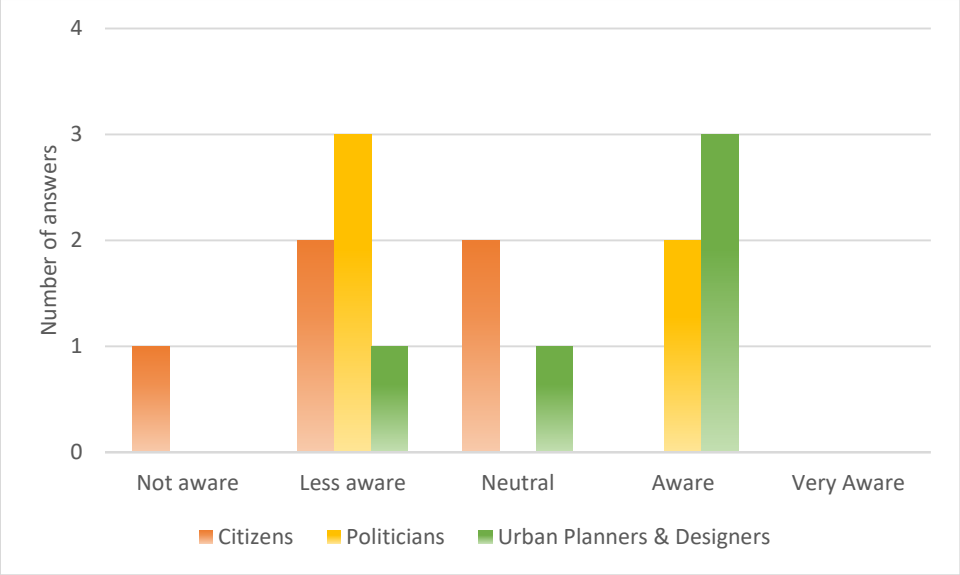

Figure 10: Level of awareness for urban heat stress in Flanders

Of all the examined cities the awareness in Gent is the highest, as can be seen in Table 6, in contrast Hasselt is the city with the lowest awareness: *"I think that the groups are little aware of this. The topic has just become known within the organization. I heard of urban heat stress recently, so I don't expect that others, who are not involved, are aware of this topic."* In Gent the awareness is high because they just conducted a heat study and held info sessions about the topic. In Koksijde the awareness of planners and designers is neutral, but the other two actors have a lower than neutral awareness.

Brugge is the only city in which the citizens have a higher awareness than the politicians: *"It is a general phenomenon here, that the call to act on climate related issues emerge from local stakeholders. In informal chats with these stakeholders I suspect a higher awareness among citizens than within our organization."*

	Brugge	**Hasselt**	**Gent**	**Antwerpen**	**Koksijde**
Citizens	Neutral	Not aware	Neutral	Less aware	Less aware
Politicians	Less aware	Less aware	Aware	Aware	Less aware
Urban planners & designers	Aware	Less aware	Aware	Aware	Neutral

Table 6: Level of awareness for urban heat stress in Flanders

Comparison

In Figure 11 the awareness with regards to the urban heat island is shown for all the actors in the two different countries. For the citizens it is visible that in the Netherlands there is a wide variety of answers given by the representatives. In Flanders there is less difference, however the overall awareness is lower than in the Netherlands. In none of the Flemish cities there is more than a neutral awareness. The awareness among politicians is in both countries higher than among citizens, still there is more awareness in the Netherlands than in Flanders. Urban planners & designers have the highest awareness of the three actors in both countries. In the Netherlands there are two cities where they are very aware and three cities where the planners and designers are aware of urban heat. In three Flemish cities the urban planners and designers are aware of the urban heat island.

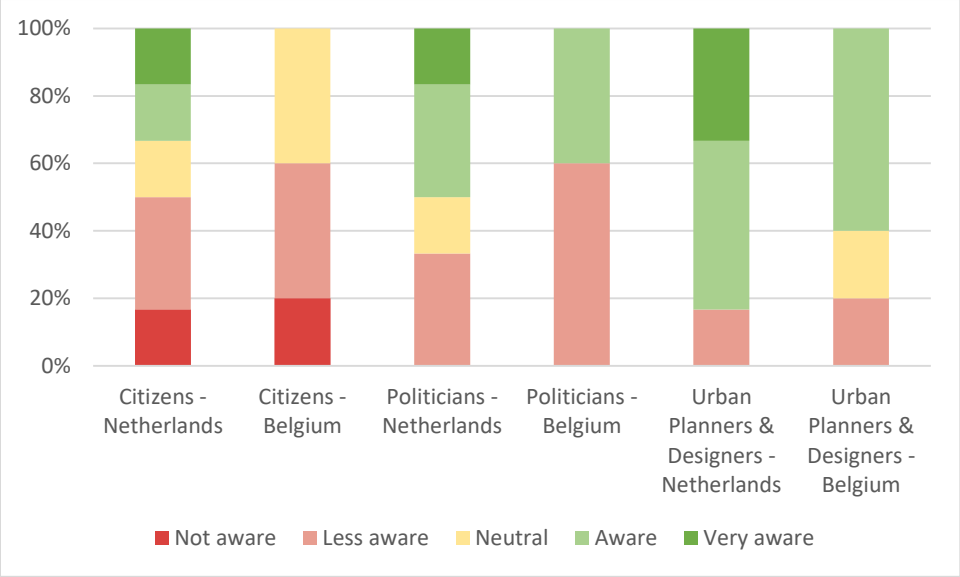

Figure 11: Comparison level of awareness for urban heat stress

When comparing the Netherlands and Flanders the awareness is higher in the Netherlands for all the actors, the average difference was 0,6 for all three actors. In Flanders only the urban planners & designers have an above neutral awareness with a score of 3,4. In the Netherlands the politicians are also above a neutral awareness. The awareness of citizens in Flanders is, on average, 2,2 while in the Netherlands this is 2,8.

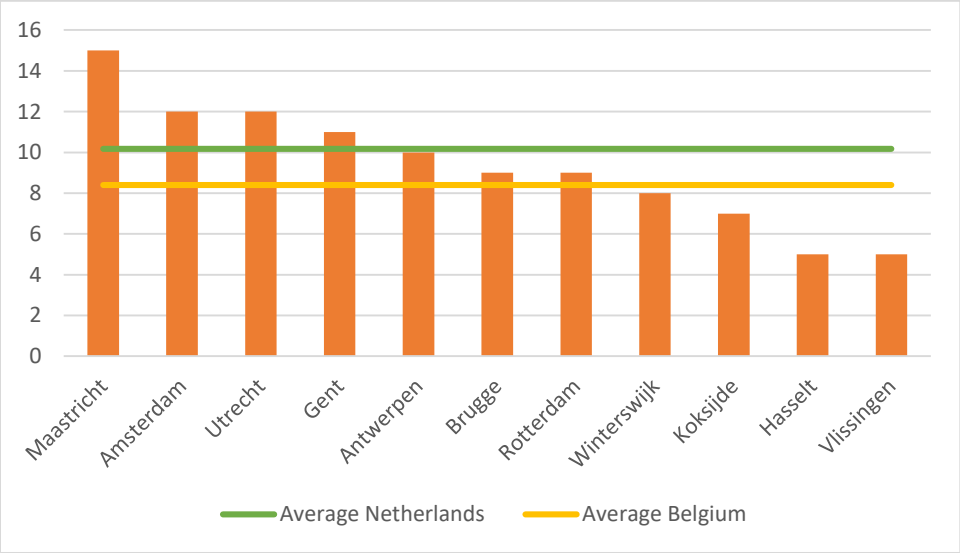

Figure 12: Level of awareness in the case cities for urban heat stress

For the cities it is Maastricht with the highest awareness. Other cities with a high awareness are Amsterdam and Utrecht which both have a score of 12. As can be seen in Figure 12 the first Flemish cities are Gent and Antwerpen which both score around the average of the Dutch cities. 4 of the 6 Dutch cities have a higher awareness than the average Flanders city, while only one Flemish city has a higher awareness than the Dutch average. Vlissingen and Hasselt both have an awareness of 5 points, which means that the average awareness is lower than less aware. The average difference between Flanders and the Netherlands is 1,5.

4.1.4 How aware are citizens, politicians and urban planners and designers of wind discomfort?

The Netherlands

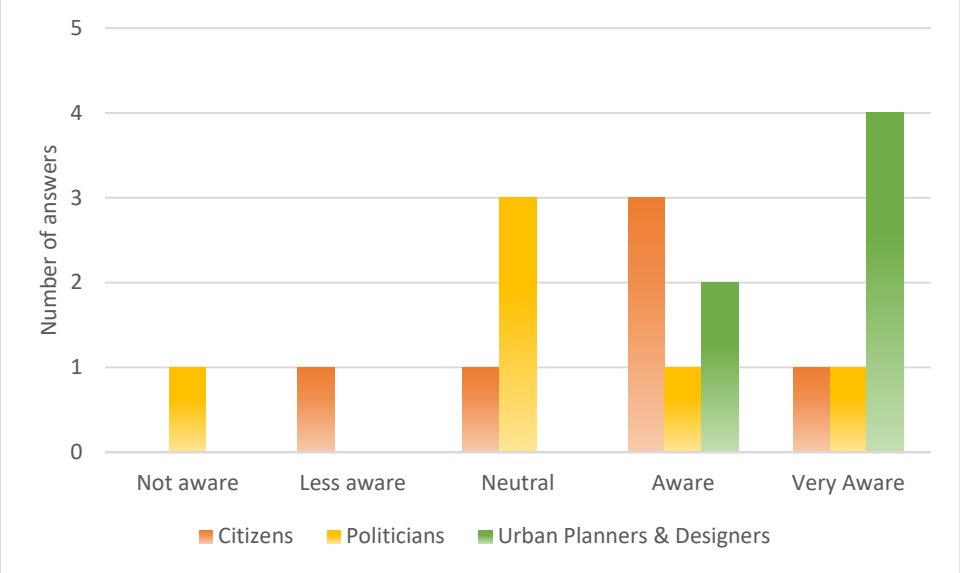

Figure 13: Level of awareness for wind discomfort in the Netherlands

As shown in Figure 13 the awareness of wind discomfort is different from the awareness about the urban heat island. Politicians are less aware of this phenomenon than citizens, but still urban planners and designers are the most aware of the topic. This is best shown in the case of Maastricht where both the citizens and urban planners are aware of the problem in contrast to the politicians. The interviewee added: *"While the urban planners and designers are aware of wind discomfort there is a disagreement about the necessity of wind studies during the planning phase [of a project]."*

	Amsterdam	Vlissingen	Utrecht	Winterswijk	Maastricht	Rotterdam
Citizens	Less aware	Neutral	Very aware	Aware	Aware	Aware
Politicians	Neutral	Neutral	Very aware	Neutral	Not aware	Aware
Urban planners & designers	Very aware	Aware	Very aware	Aware	Very aware	Very aware

Table 7: Level of awareness for wind discomfort in the Netherlands

In Table 7 it is shown that in Utrecht all the actors are very aware of wind discomfort: *"Citizens file complaints about wind discomfort. The complaints also increase the awareness of the politicians and the urban planners and designers."* In Amsterdam and Rotterdam, the interviewees mentioned the existence of regulation about wind speeds around high-rise buildings. The regulation ensures a high level of awareness of the urban planners in these cities. In Vlissingen the awareness is higher with regards to wind discomfort because it is close to the sea and therefore they have experience with wind related problems.

Flanders

The awareness among the actors about wind discomfort is slightly lower than the awareness of the urban heat island, as can be seen in Figure 14. Urban planners and designers have the highest awareness of the three stakeholder groups. Awareness among politicians is slightly higher than awareness among citizens.

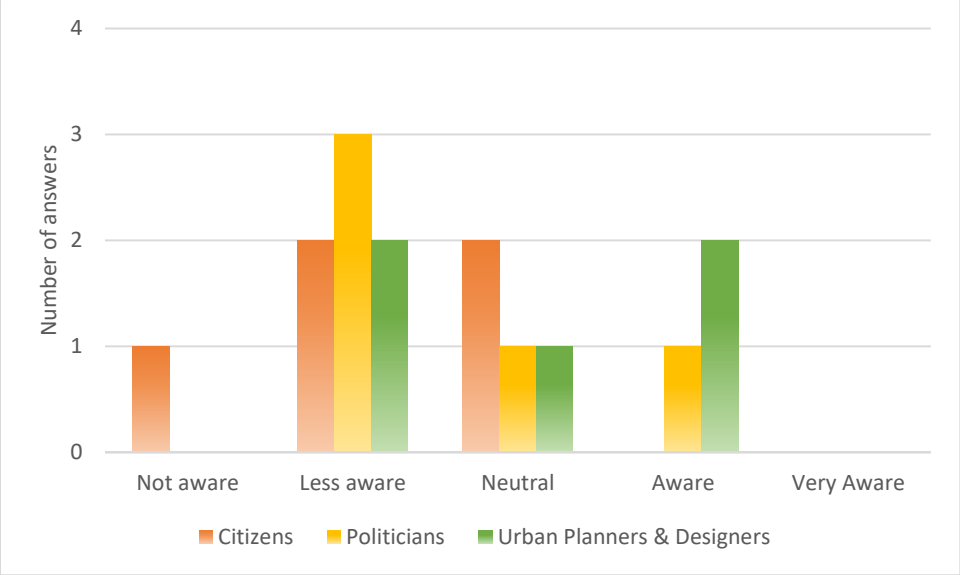

Figure 14: Level of awareness for wind discomfort in Flanders

As shown in Table 8 in Brugge every stakeholder is less aware, the interviewee did not hear complaints about wind discomfort. The wind is important for providing wind energy and from this angle the stakeholders are aware of wind patterns; however as told discomfort seems not to be present in Brugge. In Hasselt knowledge is starting to emerge, but at the moment there is little awareness. In Gent the awareness level is the highest of the five Flemish cities. The interviewee mentions that they are conducting ventilation and wind studies for new city developments.

	Brugge	Hasselt	Gent	Antwerpen	Koksijde
Citizens	Less aware	Not aware	Neutral	Less aware	Neutral
Politicians	Less aware	Less aware	Aware	Neutral	Less aware
Urban planners & designers	Less aware	Less aware	Aware	Neutral	Aware

Table 8: Level of awareness for wind discomfort in Flanders

In Antwerpen the interviewee mentioned: *"Wind discomfort is only incorporated in a framework for high-rise buildings. Therefore, the awareness is rather low. Citizens might experience more discomfort [from wind dynamics than from urban heat], however they probably don't know that the configuration of the city is the cause of the discomfort."* Politicians in Antwerpen do know about wind discomfort, but there is no internal discussion about the topic yet. In Koksijde the awareness amongst urban planners and designers is high, while politicians are less aware about the topic.

Comparison

Among all the actor groups the awareness in the Netherlands is higher, as can be seen in Figure 15. Planners and designers are the actors that have the highest awareness; this is the same for both countries. For citizens the difference is large between Flanders and the Netherlands. In the Netherlands there are two cities with awareness lower or equal to neutral. In Flanders this is the case in all of the case cities, in Hasselt there is no awareness among citizens according to the interviewee.

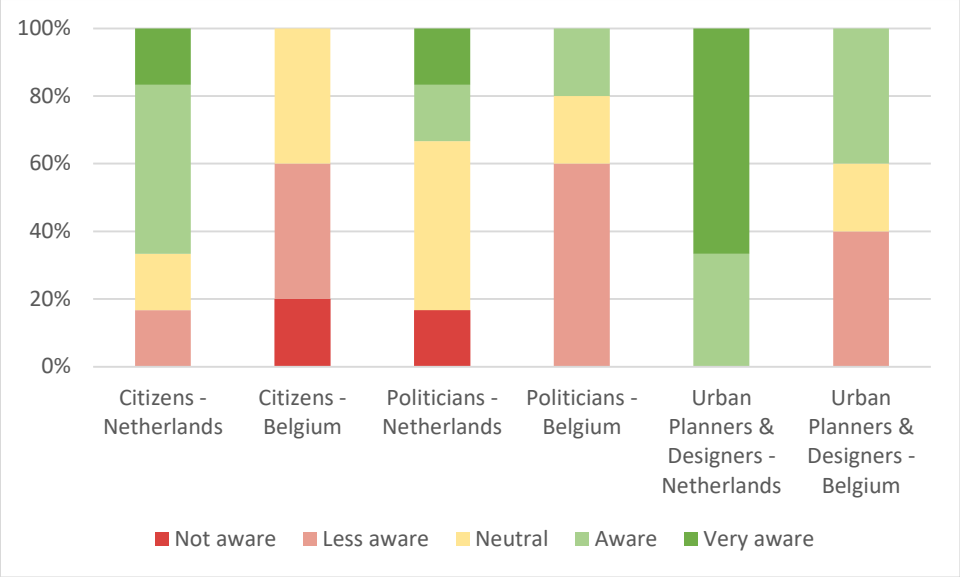

Figure 15: Comparison level of awareness for wind discomfort

The difference in awareness of the politicians is smaller between the Netherlands and Flanders. The answers in the Netherlands are more wide spread, than in Flanders. Political awareness is lower in the Netherlands in comparison to citizens, while in Flanders this is the other way around. The difference for urban planners & designers is larger between Dutch and Flemish cities. In the Dutch cities there is a higher than neutral awareness, while in Flanders only two cities have a higher than neutral awareness.

The sequence of actors is different in the Netherlands and Flanders for wind discomfort. In both countries the urban planners and designers are the most aware of the topic. In Flanders politicians are the second highest, while in the Netherlands the citizens are. An important reason for this difference is the fact that in Maastricht there is no awareness among politicians for wind discomfort. Nevertheless, the awareness in the Netherlands is still higher than the awareness in Flanders for all the actors. The biggest difference is found among urban planners and designers where the average awareness in Flanders is 3,0, while in the Netherlands it is 4,7.

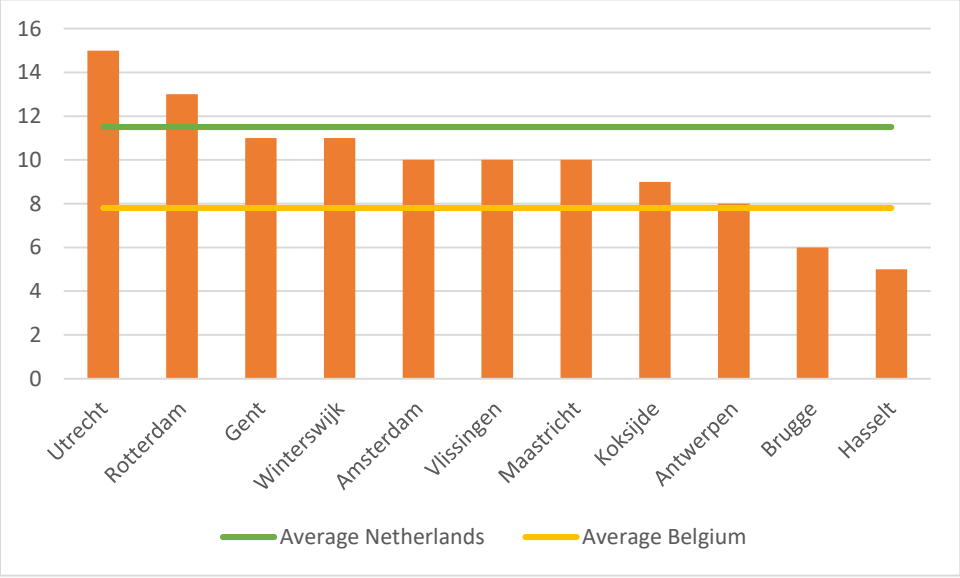

Figure 16: Level of awareness in the case cities for wind discomfort

As can be seen in Figure 16 the awareness is the highest in Utrecht with the maximum score of 15. The only Flemish city in the first seven cities is Gent with a total awareness level of 11, which is still lower than the average awareness of all the Dutch cities. The level of awareness in all the Dutch cities is higher than the average of the Flemish cities. The average difference of awareness is 3,7, which is more than twice the difference than for urban heat stress.

Comparison between the level of awareness for urban heat stress and wind discomfort

In Table 9 a comparison is made between the perceived levels of awareness for both urban climate phenomena in the two countries. The average awareness in Flanders is higher for heat stress than for wind discomfort, which is different than in the Netherlands. The biggest difference, 1,7, between Flanders and the Netherlands is found for urban planners & designers for wind discomfort. On the city level the biggest difference is found in Vlissingen and Maastricht: the level of awareness for wind discomfort in Vlissingen is 5 points higher than for heat stress, however in Maastricht the awareness for heat stress is higher. In the Netherlands interviewees feel that wind discomfort is more present and experienced more often by the actors and therefore the awareness is higher. In Flanders wind discomfort is less experienced and, according to the interviewee in Antwerpen, the link with the configuration of the city is not made. The average of all the results is 3,2, which means the awareness of all the actors for urban climate phenomena is slightly above neutral.

	Actor	Heat stress	Wind discomfort
Flanders	Citizens	2,2	2,2
	Politicians	2,8	2,6
	Urban Planners & Designers	3,4	3,0
	Total	2,8	2,6
Netherlands	Citizens	2,8	3,7
	Politicians	3,3	3,2
	Urban Planners & Designers	4,0	4,7
	Total	3,4	3,8

Table 9: Comparison perceived level of awareness for urban climate phenomena

4.1.5 Is it necessary to increase the awareness for these urban climate phenomena? If yes, how could this be done?

The Netherlands

Several representatives mentioned that there is no need to increase the awareness. In Vlissingen and Winterswijk the representatives mentioned that the first step is to find out whether or not the urban climate is a problem in the municipality. This means that the municipal organization need complaints or information from other organizations and stakeholders about heat stress and wind discomfort before it will act on urban climate. In Maastricht the awareness with regards to heat stress is already high, however with regards to wind problems a higher awareness can be created by, for example, conducting a wind study. The provision of more information will increase the level of awareness about wind discomfort.

In Amsterdam the representative thinks it could be useful to add heat stress in a questionnaire that is send to citizens. This also makes it possible to get in contact with vulnerable groups such as elderly people. For politicians, education can increase the awareness, for planners and designers it is already sufficient. In Utrecht the interviewee mentioned the following: *"Possibilities offered to increase awareness are education about the phenomena, while at the same time possible adaptation measures*

are presented. For politicians it is important to show that no-regret measures offer a great starting point." In Rotterdam the answer was twofold. The municipal organization does not want to create a problem in the city, because there are already enough problems. On the other hand, the municipality has campaigns to stimulate citizens and the representative also mentioned the willingness to obtain more information from the vulnerable groups. For wind discomfort the awareness level is sufficient and no increase is needed according to the interviewee.

Flanders

The interviewee in Brugge thinks it is important to increase the awareness, however: *"First, we have to know if there is a climate related issue and how big this issue is. Also, if there are no problems at this moment we should find out whether or not in the future issues could emerge. I expect that if we know this, awareness will come accordingly."* In Hasselt awareness should be raised anyway, according to the interviewee, although there is little knowledge at the moment. Communication and explanation about the possibilities of urban climate adaptation are key strategies to increase the awareness within the organization and the city. Also the proposition of regulation changes could increase the awareness because politicians and planners and designers are forced to think about these changes.

In Antwerpen the awareness with regards to the urban heat island is quite high already according to the interviewee. Regarding to wind discomfort the awareness is lower and a higher level is desired, however this is difficult because it is not something that is perceived as a problem by the citizens. The discomfort is only temporary, while the effects of heat stress last longer. With regards to possibilities for a higher awareness in the organization the interviewee mentioned: *"The topic has to be taken in consideration in studies, also it is important to constantly mention the topic when it is relevant."* The interviewee added: *"It is important that education is offered and examples of the problems are showed."*

The representative of the municipality of Gent mentioned that it is desired to increase the awareness. One of the goals for a higher level of awareness is to create more support for urban climate adaptation. The possibilities to increase the awareness are similar to the possibilities to increase the sense of urgency. Instead of using worst-case scenarios it focusses on presenting examples and best practices from other cities. In Koksijde heat stress and wind discomfort are not perceived as problems. For politicians more information can be provided about these topics to find out whether or not there are problems.

Comparison

Not all the Dutch cities find it necessary to increase the level of awareness; in 3 of the 6 cities the interviewee mentions that it is not needed to increase awareness at the moment. In Flanders there is more willingness to increase the awareness; however sufficient knowledge of the urban climate is needed first.

The answers of the interviewees in both countries are more or less similar. In the first place the focus is on obtaining more knowledge about the urban climate phenomena in their own cities. In Vlissingen and Winterswijk the attitude is to wait for knowledge from other organizations, while in Flanders the attitude is to actively gather information themselves. In both countries communication towards other actors is mentioned as important to increase awareness. This could be done by, for example, providing information about best practices and no-regret measures. Only in Flanders representatives mention the possibilities of increasing awareness by implementing urban climate adaptation in the decision making processes.

4.1.6 How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with urban design?

The Netherlands

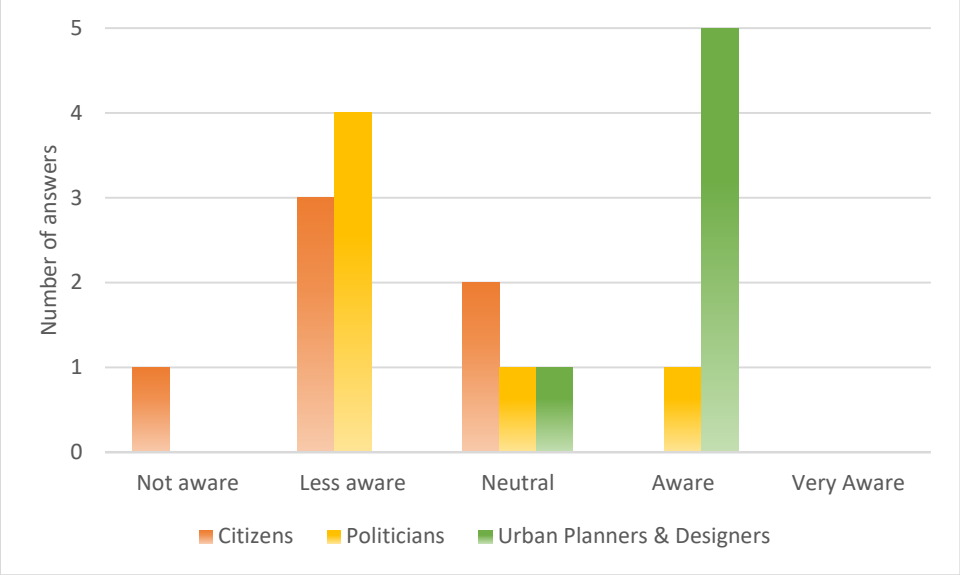

Figure 17: Level of awareness for urban design in the Netherlands

As shown in Figure 17 the awareness of urban planners & designers is much higher than awareness of the other two actors. None of the respondents estimated that the awareness of urban planners & designers is lower than neutral in their municipality. The level of awareness of politicians is more different; however, in most of the cities they are less aware. Citizens are even a bit less aware than politicians, with the representative in Rotterdam answering that citizens are not aware at all.

	Amsterdam	Vlissingen	Utrecht	Winterswijk	Maastricht	Rotterdam
Citizens	Neutral	Neutral	Less aware	Less aware	Less aware	Not aware
Politicians	Neutral	Aware	Less aware	Less aware	Less aware	Less aware
Urban planners & designers	Aware	Aware	Aware	Neutral	Aware	Aware

Table 10: Level of awareness for urban design in the Netherlands

As can be seen in Table 10 the awareness is the highest in Vlissingen, while in Winterswijk the awareness is the lowest of the six case cities. The representative in Amsterdam mentioned that not every planner or designer is aware of the possibilities, however most are. In Utrecht the alderman is very aware of the possibilities, however other politicians are not. In Vlissingen the three actor groups mostly are aware of the possibilities to adapt to wind discomfort, but not so much to heat stress. In Winterswijk and Vlissingen it was mentioned that houses are mostly oriented to have as much sun as possible, so the actors are aware of the effects of city design but do not use them for adaptation. The representatives in Rotterdam and Amsterdam told during the interviews that it is difficult to implement city design measures and that therefore awareness of this topic is not present.

Flanders

The awareness among citizens for the possibilities for adaptation through urban design is low. In 3 of the 5 cities there is no awareness, while only in one city the awareness is neutral. Additionally, in Figure 18 it can be seen that the awareness of urban planners & designers is the highest of the three

actors. The awareness among politicians is in between of the two other actors. In 3 of the 5 cities awareness is lower than neutral.

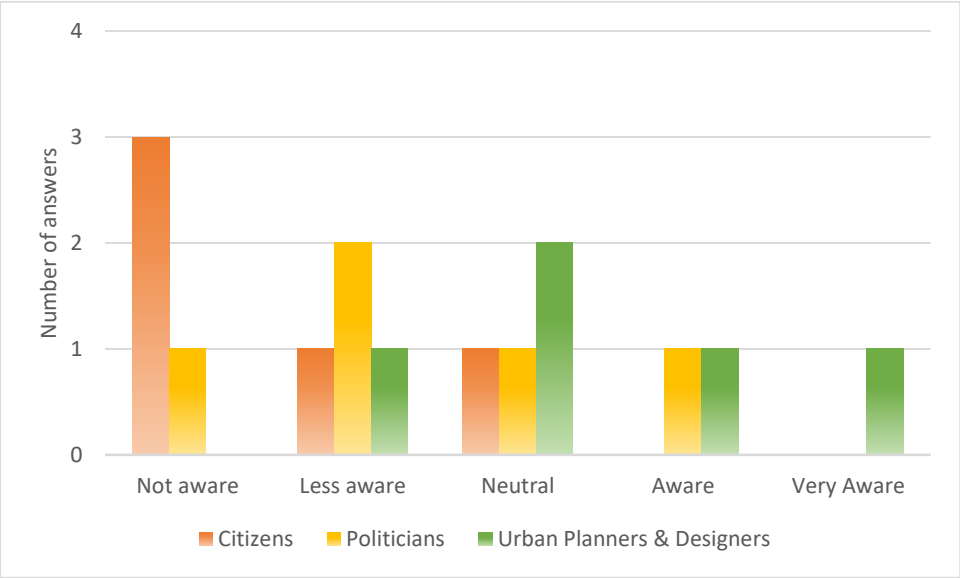

Figure 18: Level of awareness for urban design in Flanders

In Gent the awareness level is the highest of the five Flemish cities. As can be seen in Table 11 there is almost no awareness in Brugge, while Antwerpen sits in the middle of these two. In Gent, according to the interviewee, all the actors have at least a neutral awareness. In addition to the awareness levels the interviewee in Gent also mentioned the following: *"The awareness among citizens is lower than for the other actors because the influence citizens have on city development is low."*

	Brugge	Hasselt	Gent	Antwerpen	Koksijde
Citizens	Not aware	Not aware	Neutral	Less aware	Not aware
Politicians	Less aware	Not aware	Aware	Neutral	Less aware
Urban planners & designers	Less aware	Neutral	Very aware	Neutral	Aware

Table 11: Level of awareness for urban design in Flanders

Awareness in Antwerpen for politicians recently increased: *"We conducted a micro climate study for the Groenplaats (a square in the city center), so they know what the possibilities are for such a study. At the presentation you could feel that the topic becomes more interesting for the actors because it became less abstract."* In Brugge urban design is not yet part of plans, studies or advices.

Comparison

Among all the actors the awareness is higher in the Netherlands than in Flanders; however, the difference for politicians is relatively small as can be seen in Figure 19. In three Flemish cities citizens are not aware of urban design adaptation possibilities, in the Netherlands this is the case in one city. In both countries the awareness is the lowest among citizens and the highest among urban planners and designers.

The only difference for politicians is that in Flanders there is one city with no awareness, while this is not the case in one of the Dutch cities. For urban planners and designers, the awareness is much higher when compared to the other actors. In the Netherlands there is a neutral awareness in Winterswijk, while in the other cities the awareness is a level higher. In Flanders the answers were less concentrated on one of the options.

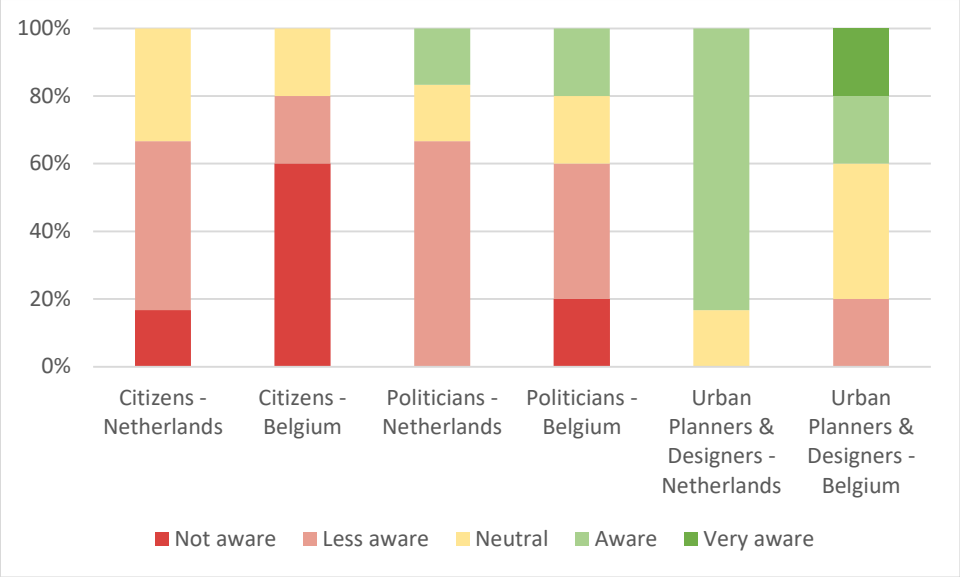

Figure 19: Comparison level of awareness for urban design

4.1.7 How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with urban vegetation?

The Netherlands

In Figure 20 it is shown that urban planners and designers are more aware of the possibilities for adaptation with urban vegetation than politicians and citizens. Only citizens are less aware in two cities, those cities are Amsterdam and Utrecht, in these cities politicians and planners are aware of the potential of urban vegetation. In Utrecht politicians are most aware about green roofs, while planners and designers are also aware of the cooling effect of parks.

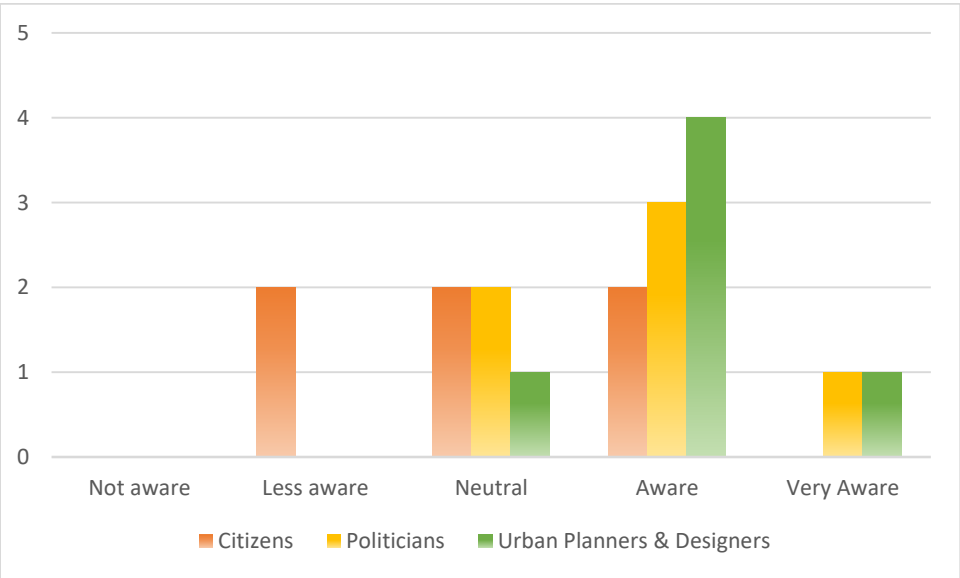

Figure 20: Level of awareness for urban vegetation in the Netherlands

As shown in Table 12 in Vlissingen all the actors are equally aware, however the focus in this city is on the potential that urban vegetation offers for wind adaptation. In Maastricht the awareness is very high for both wind discomfort and heat stress: *"You can see that for the design of new areas in the city the arguments for more vegetation have changed. Where previously vegetation was used because it was nice, nowadays the arguments focus on the cooling effect and enhancement of biodiversity."*

	Amsterdam	Vlissingen	Utrecht	Winterswijk	Maastricht	Rotterdam
Citizens	Less aware	Neutral	Less aware	Neutral	Aware	Aware
Politicians	Aware	Neutral	Aware	Neutral	Very aware	Aware
Urban planners & designers	Aware	Neutral	Aware	Aware	Very aware	Aware

Table 12: Level of awareness for urban vegetation in the Netherlands

Flanders

All the actors in the cities are more aware about the possibilities that urban vegetation offers for adaptation than they were for urban design. As shown in Figure 21 all actors are at least less aware of the possibilities. The awareness of citizens is divided in two groups; in three cities they are aware, while in two cities they are less aware. In general, the differences between the actors are smaller than was the case for urban design.

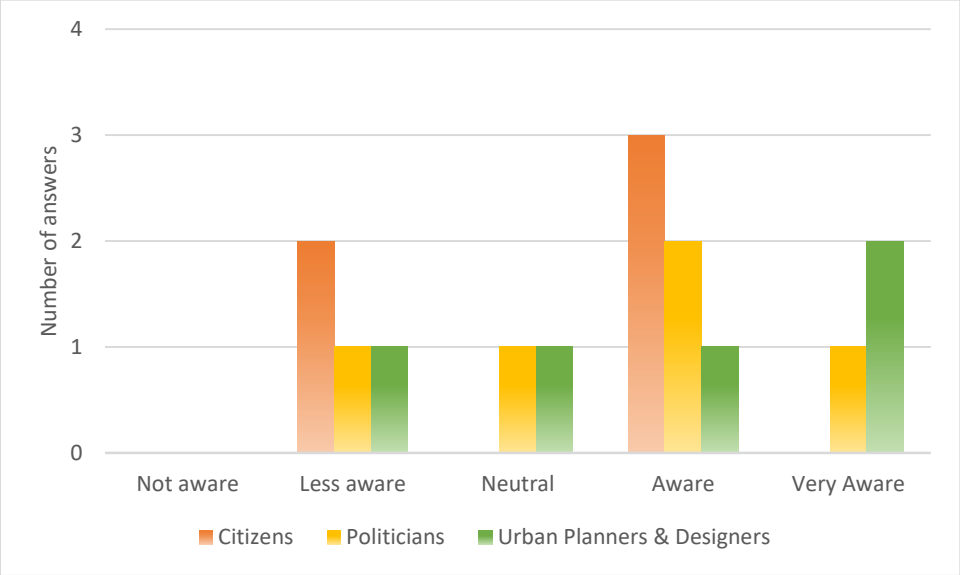

Figure 21: Level of awareness for urban vegetation in Flanders

In Brugge the awareness is the lowest of the Flemish cities, while in Gent the awareness level is the highest. The interviewee in Brugge does mention urban vegetation: *"Urban vegetation is of course an aspect we take in consideration and is important for us. However, this is not due to urban heat stress. The main reason for urban vegetation is the increase in livability and esthetics of the neighborhood."* As can be seen in Table 13 the awareness in Antwerpen and Koksijde is high, while in Hasselt the awareness is less.

The interviewee in Hasselt acknowledges that policies for urban vegetation are more popular than for urban design. They did start with some policies on green roofs and facades; however, they are just getting started on this subject. In Antwerpen the awareness of green roofs is high according to the interviewee, because it is compulsory to include a green roof when a building is newly build or undergoes a major renovation. The goal of this policy is to decrease heat stress and increase water retention. Regarding urban vegetation, the interviewee in Gent mentioned the following: *"Urban vegetation is one of the most concrete measures, it is also the main topic for us at the moment. In communication to other actors the positive effect of vegetation on the urban climate is mentioned. This is the reason why awareness among the actors is relatively high."*

	Brugge	Hasselt	Gent	Antwerpen	Koksijde
Citizens	Less aware	Less aware	Aware	Aware	Aware
Politicians	Less aware	Neutral	Very aware	Aware	Aware
Urban planners & designers	Less aware	Neutral	Very aware	Aware	Very aware

Table 13: Level of awareness for urban vegetation in Flanders

Comparison

When looked at urban vegetation citizens have the lowest awareness among the actor groups in both countries. In both countries urban planners and designers have the highest awareness of the actor groups. The differences between Flemish and Dutch cities are small for urban vegetation. The results suggest that the awareness is slightly higher in the Netherlands, as can be seen in Figure 22.

For the politicians the awareness is slightly higher in the Netherlands, where there is no city with a lower than neutral awareness, while in Flanders the awareness in Brugge is lower than neutral. The same is the case for urban planners and designers. However, there are two cities in Flanders that have the highest level of awareness, while in the Netherlands this is only the case in Maastricht.

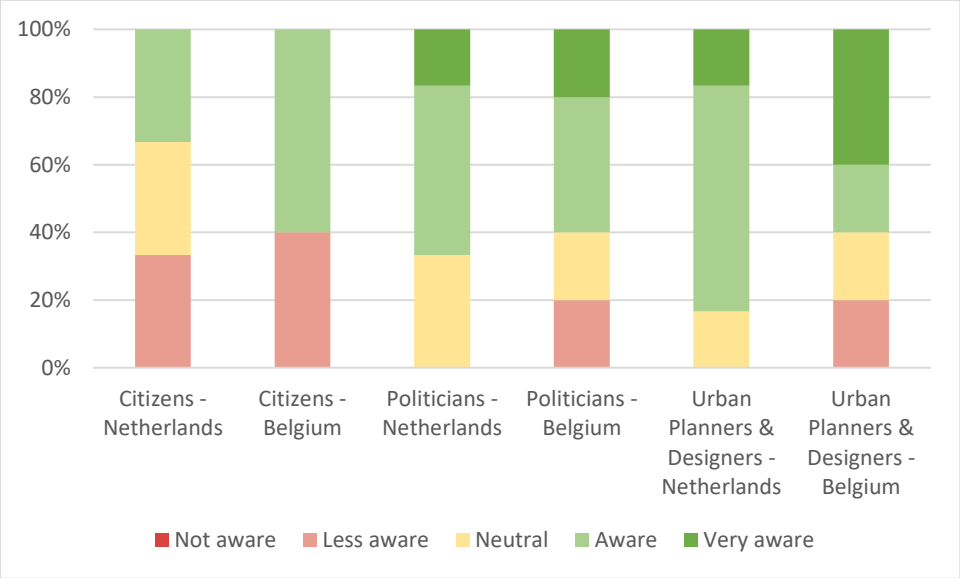

Figure 22: Comparison level of awareness for urban vegetation

4.1.8 How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with the use of other materials?

The Netherlands

Figure 23 shows that planners and designers are the most aware of the possibilities that the use of other materials offer. In none of the cities citizens are aware of this measure. The only city where planners and designers are very aware is in Rotterdam. As shown in Table 14 in Winterswijk, Vlissingen and Amsterdam the awareness is low or even non-existent. The interviewee in Amsterdam added: *"It is unfortunate that little is done on this topic because the effect of light colors and other albedo characteristics can have a big impact on the urban heat island."*

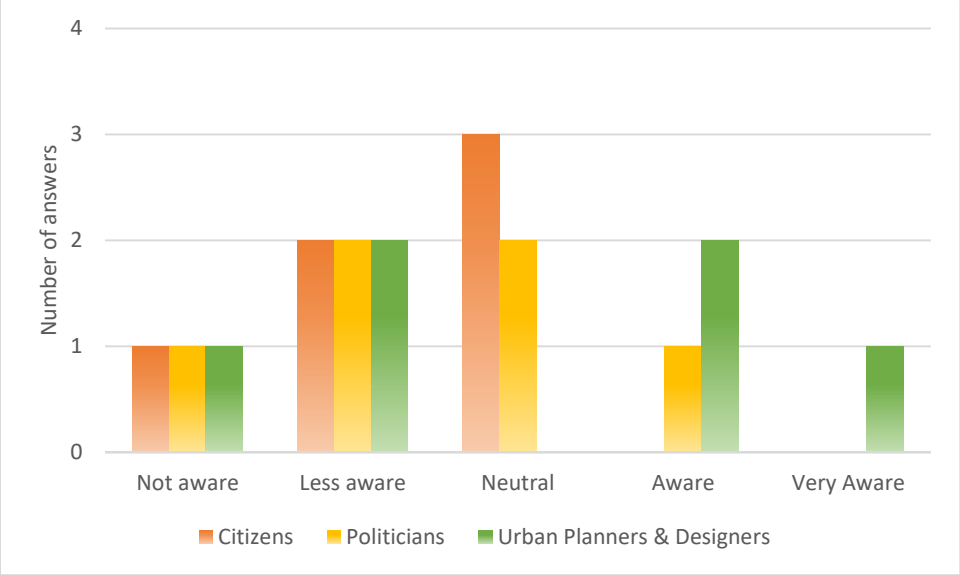

Figure 23: Level of awareness for the use of other materials in the Netherlands

In Maastricht the municipality uses a lighter colored asphalt already, but it does not mean that the awareness is very high in Maastricht. The use of a lighter colored asphalt is not implemented to combat urban heat adaptation. In Utrecht awareness is present among politicians and urban planners and designers: *"The provincial government conducts experiments on a local congress building to see the effect of other materials. Therefore, a level of awareness is present. This measure is still in an experimental phase and is not used on a wide scale."*

	Amsterdam	Vlissingen	Utrecht	Winterswijk	Maastricht	Rotterdam
Citizens	Less aware	Not aware	Neutral	Less aware	Neutral	Neutral
Politicians	Less aware	Not aware	Aware	Less aware	Neutral	Neutral
Urban planners & designers	Less aware	Not aware	Aware	Less aware	Aware	Very aware

Table 14: Level of awareness for the use of other materials in the Netherlands

Flanders

The differences between the three actors are small with regards to the use of other materials, as can be seen in Figure 24. Awareness among urban planners and designers is slightly higher because they are the only actor for which an interviewee identified them as very aware. The awareness level of citizens is more or less equal, the only discrepancy is that in one city a neutral awareness is found for citizens, which is not the case for politicians, because they have a normal awareness in two cities. Urban planners and designers have the highest awareness of all the studied actors.

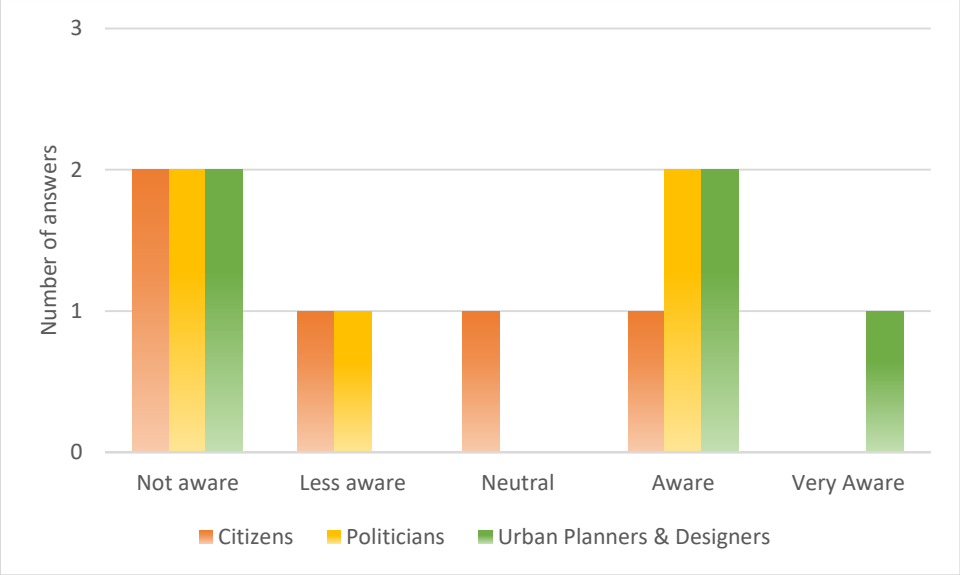

Figure 24: Level of awareness for the use of other materials in Flanders

The differences between the Flemish cities are big, as can be seen in Table 15. The awareness in Antwerpen and Gent is the highest of the five cities. In Brugge and Hasselt there is no awareness, while in Koksijde the citizens and politicians are a little bit aware, while the urban planners & designers show a normal awareness of the possibilities.

In Antwerpen the municipality has building regulations in which is stated that the materials used for roofs should have a certain albedo. Instead of black colored materials citizens and companies are obligated to use a grey colored material. In Gent the civil servants are looking into the possibilities of using a lighter colored asphalt than the black variant. The interviewee in Gent added: "*Awareness among citizens is smaller than for urban vegetation because the actions are less specific and less appealing for the public.*"

	Brugge	**Hasselt**	**Gent**	**Antwerpen**	**Koksijde**
Citizens	Not aware	Not aware	Neutral	Aware	Less aware
Politicians	Not aware	Not aware	Aware	Aware	Less aware
Urban planners & designers	Not aware	Not aware	Very aware	Aware	Aware

Table 15: Level of awareness for the use of other materials in Flanders

Comparison

As can be seen in Figure 25 it is difficult to say in which county the awareness is the highest; as for all the actors there are more cities in Flanders that have a high awareness, while at the same time there are also more cities with a low awareness. Citizens are the least aware of the possibilities for adaptation with the use of materials, while the urban planners and designers are the most aware. For citizens there is no city in the Netherlands with a higher than neutral awareness, while in Flanders there is one city in which the citizens are aware. This would suggest that awareness in Flanders is higher among citizens; however, there are also more Flemish cities that are not aware of using other materials.

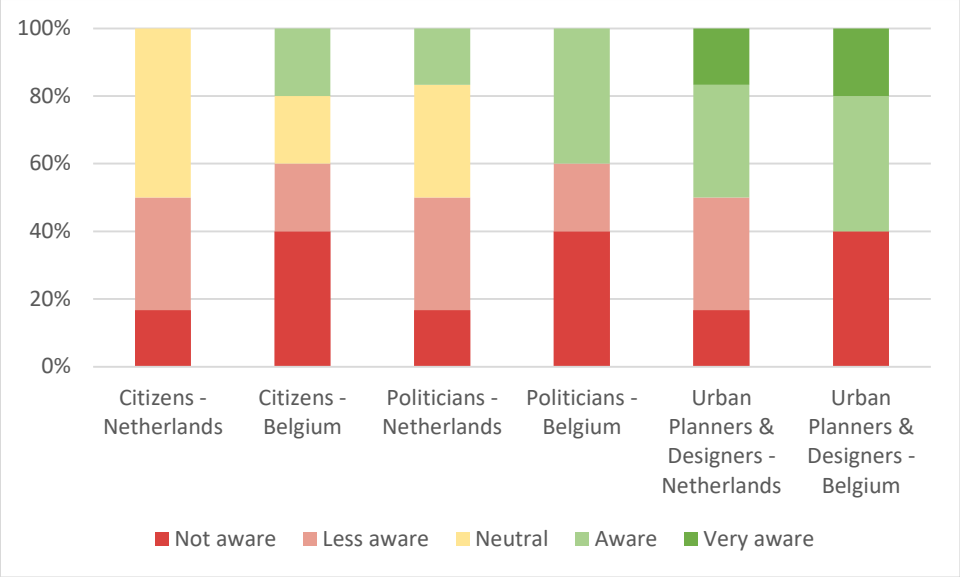

Figure 25: Comparison level of awareness for the use of other materials

The same is the case for politicians; however, the general awareness is a bit higher than for the citizens in both countries. For urban planners and designers, the answers are wide spread in both countries. In both the Netherlands and Flanders there are three cities in which the urban planners and designers are at least aware of the adaptation possibilities with the use of other materials. There is one Dutch city with no awareness among urban planners and designers, while there are two Flemish cities for which this is the case.

4.1.9 How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with reducing anthropogenic heat?

The Netherlands

The distribution for the awareness about anthropogenic heat is more equal than any of the former, as shown in Figure 26. Citizens are a little bit less aware than the other two actors. In general, the awareness is lower than for urban design and urban vegetation, however in comparison with the use of materials the mean is more or less equal.

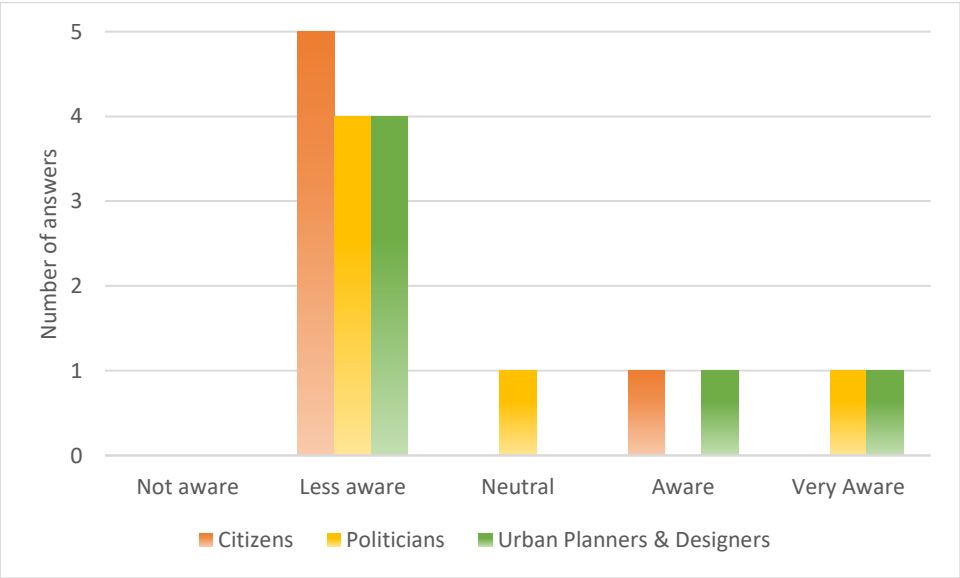

Figure 26: Level of awareness for anthropogenic heat in the Netherlands

As can be seen in Table 16 only in Amsterdam and Rotterdam there is awareness of this possibility. The interviewee in Amsterdam mentioned that everyone is aware of the possibilities less car use and air-conditioning brings. Whether or not this is because of the temperature during the night remains a question which the interviewee couldn't answer. In Vlissingen they do want to reduce car-use, however this is done to decrease CO_2 emissions and not for the urban climate itself. In Maastricht the interviewee is also aware of the possibilities: *"Citizens are reducing car use and the use of air-conditioners. However, this is not done from an ideological standpoint. Instead it originates from a financial point of view."*

	Amsterdam	Vlissingen	Utrecht	Winterswijk	Maastricht	Rotterdam
Citizens	Aware	Less aware	Less aware	Less aware	Less aware	Less aware
Politicians	Very aware	Less aware	Less aware	Less aware	Less aware	Neutral
Urban planners & designers	Very aware	Less aware	Less aware	Less aware	Less aware	Aware

Table 16: Level of awareness for anthropogenic heat in the Netherlands

Flanders

The possibilities to reduce the urban heat island by reducing the amount of anthropogenic heat are the least known of the four. In only one city the awareness is higher than or equal to neutral, while in three cities all the actors are less aware. As shown in Figure 27 the differences among the different actor groups is almost negligible.

As shown in Table 17 the awareness in Brugge among all actors is non-existent. In Hasselt, Gent and Antwerpen the actors are less aware of the possibilities, while in Koksijde the politicians and urban planners & designers are aware of anthropogenic heat. Unfortunately, the representative of Koksijde was not able to answer additional questions on what causes this higher level of awareness.

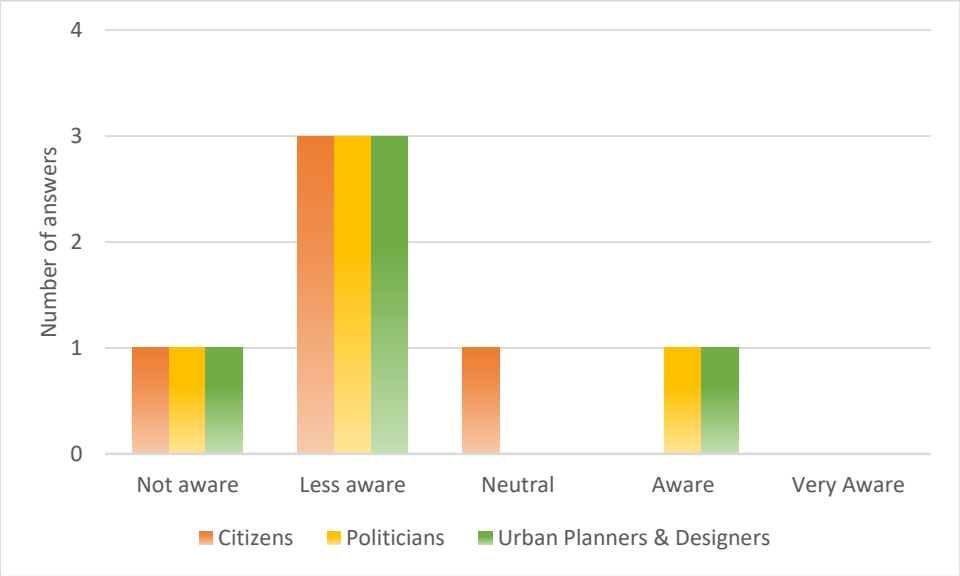

Figure 27: Level of awareness for anthropogenic heat in Flanders

In Hasselt the interviewee thinks that citizens know that air conditioners emit heat to the surroundings: *"However, it is a question whether or not they know the influence on the temperature in the city, especially because of the low awareness of the urban heat island at the moment."* The representative of Gent acknowledges that this measure is the least known of the four. The heat study they conducted showed that anthropogenic heat is not one of the major contributors to the urban

heat island. The interviewee added: *"For urban planners and designers this is a topic they have less influence on. The design, vegetation and materials can be used in the design of a neighborhood, while anthropogenic heat is more about the behavior of citizens and companies."*

	Brugge	Hasselt	Gent	Antwerpen	Koksijde
Citizens	Not aware	Less aware	Less aware	Less aware	Neutral
Politicians	Not aware	Less aware	Less aware	Less aware	Aware
Urban planners & designers	Not aware	Less aware	Less aware	Less aware	Aware

Table 17: Level of awareness for anthropogenic heat in Flanders

Comparison

The awareness of the climate adaptation measure of reducing anthropogenic heat is the lowest of the four studied possibilities in both countries. The awareness is the highest for urban planners and designers in the Netherlands, while in Flanders the politicians and the urban planners and designers have an equal awareness level. The awareness level in the Netherlands is slightly higher than in Flanders.

As shown in Figure 28 there is just one city in the Netherlands for which citizens have a higher than neutral awareness. In Flanders there is just one city with a neutral awareness, while in one city the citizens are not aware according to the interviewees. For the politicians there are two cities in the Netherlands with at least a neutral awareness. While in Flanders it is still just one city with at least a neutral awareness. The same is true for urban planners and designers where still the majority of the cities in both countries have a lower than neutral awareness. In one Flemish city, Brugge, there is no awareness among the actors, according to the interviewee of the municipality.

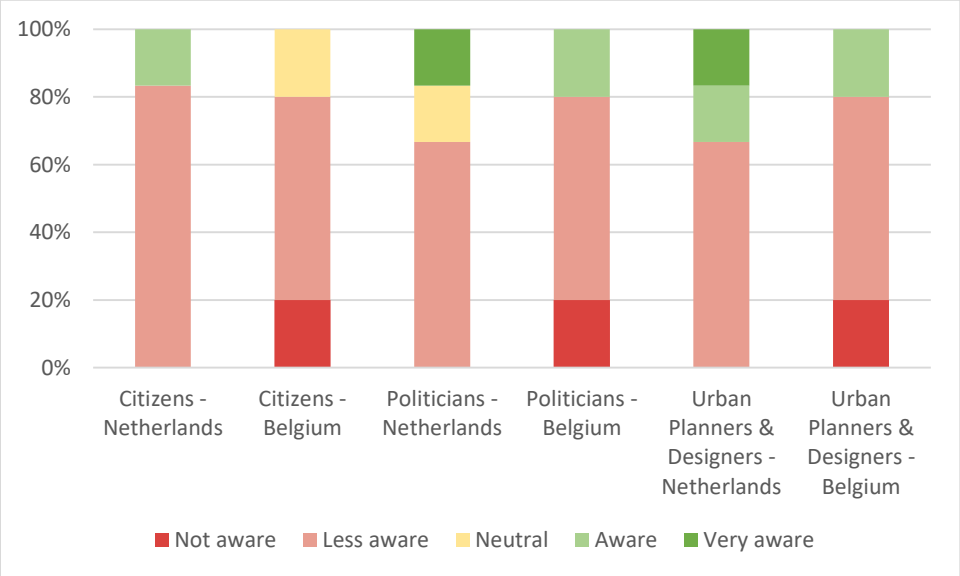

Figure 28: Comparison level of awareness for anthropogenic heat

Comparison between the level of awareness for the four urban climate adaptation measures

In Table 18 an overview of the awareness levels in the Netherlands and Flanders are shown for the adaptation measures. Per actor the average level of awareness is shown while also an average for all the actors is available. For every actor, but two, the awareness in the Netherlands is higher than for the same actor in Flanders. Urban planners & designers have in both countries a neutral awareness with regards to the use of other materials. For urban vegetation the awareness among citizens is 0,2

higher in Flanders. The biggest difference is seen among citizens with regards to urban design and among urban planners & designers for anthropogenic heat.

Subject	Actor	Netherlands	Flanders
Awareness with regards to urban design possibilities	Citizens	2,2	1,6
	Politicians	2,5	2,4
	Urban Planners & Designers	3,8	3,4
	Average actors	2,8	2,5
Awareness with regards to urban vegetation	Citizens	3,0	3,2
	Politicians	3,8	3,6
	Urban Planners & Designers	4,0	3,8
	Average actors	3,6	3,5
Awareness with regards to the use of other materials	Citizens	2,3	2,2
	Politicians	2,5	2,4
	Urban Planners & Designers	3,0	3,0
	Average actors	2,6	2,5
Awareness with regards to reducing anthropogenic heat	Citizens	2,3	2,0
	Politicians	2,7	2,2
	Urban Planners & Designers	2,8	2,2
	Average actors	2,6	2,1

Table 18: Comparison level of awareness for urban climate adaptation measures

The average awareness for all the results is 2,8, which is below neutral and lower than the level of awareness for the urban climate phenomena. The difference between Flanders and the Netherlands is small: 0,25. This means that it is below neutral in both countries. The adaptation measure with the highest awareness is, in both countries, urban vegetation. For all the actors the awareness is at least neutral. Urban vegetation is the only measure for which this is the case. The biggest difference among actors is found with regards to urban design measures. The awareness for urban planners and designers is in both countries more than 1,5 higher than the awareness level for citizens.

4.1.10 Is it necessary to increase the awareness of these urban climate adaptation possibilities? If yes, what could be done to increase the awareness?

The Netherlands

In 3 of the 6 Dutch cities the interviewees mention that it is important to increase awareness. In Rotterdam, Amsterdam and Utrecht education is mentioned as one of the possibilities to increase the awareness. In Utrecht, for example: *"Urban planners & designers with awareness could be used to increase awareness and knowledge among colleagues. Also integral cooperation among departments of the municipality could lead to an increase in awareness."* In Rotterdam they already have an information kiosk about sustainability, when this kiosk also offers concrete information about urban climate adaptation awareness for citizens will increase. In Vlissingen and Winterswijk the interviewees were not sure about the necessity of a higher awareness, because they first want to know for sure that there is a problem. In Amsterdam a similarly sentiment is felt: *"It is a question whether or not awareness should increase. There are enough other problems in the city and there is no need to introduce new problems at the moment."*

In Maastricht it is more a case of keeping the awareness high, rather than increasing the awareness according to the representative. The municipality is doing this by renewing the structure vision every two years instead of every ten years. This offers the possibility to keep it up to date and relevant. The interviewee in Rotterdam recognizes different possibilities for different actors: *"For citizens, education on a concrete level is important. We have an information point about sustainable construction. This could be used to offer more information on urban climate adaptation."* With regards to politicians: *"we focus on measures that have effect on multiple goals. Heat stress is one of the arguments in cooperation with water retention and biodiversity."* For the urban planners and designers: *"It is important to preserve the current knowledge about the measures. New insights and knowledge should be available to them."*

Flanders

The interviewees in Brugge, Antwerpen and Gent all mentioned that at this moment it is not important to increase the awareness. For now, it is more important that the amount of knowledge is increased to get a better view of the possible problems. The representative in Brugge added: *"If we have an overview of the important issues of urban climate the awareness will increase as well."* The representative in Antwerpen mentions that the disclosure of the information is important to increase the awareness among citizens, for example a map which shows the potential for green roofs linked with an information campaign. In Gent they also want to gain more knowledge about the different adaptation measures. Whenever possible they want to quantify those measures.

The interviewee in Hasselt mentioned that: *"For planners and designers I would propose workshops and seminars as important. For the other actors it is about education and providing examples. Our town hall has a green roof which hopefully has a stimulating effect on other actors as well."*

Comparison

In both countries there are multiple cities that do not feel the need to increase the awareness about the adaptation possibilities. In the Netherlands this is the case for Vlissingen, Amsterdam and Winterswijk, while in Flanders this is the case in Brugge, Antwerpen and Gent. In Flanders this is because the municipality first wants to obtain more knowledge about the urban climate phenomena before focusing on the awareness of possible solutions. In the Netherlands this is caused by the reluctance to make the urban climate in to a problem.

There is not a big difference between the two countries with regards to possible ways of increasing the awareness. The argumentation for not feeling the necessity of a higher awareness level is different in the Netherlands than in Flanders. In the Netherlands there are two cities that do not act on urban climate adaptation in general, while in Flanders cities are acting on urban climate adaptation but they first want to focus on the extent of urban climate problems in their city.

4.2 Interview results – communication

4.2.1 Which roles do citizens, politicians and urban planners and designers have in the process of planning, designing and implementing urban climate adaptation measures?

Netherlands

Most of the initiatives in Rotterdam emerge from project developers and housing associations themselves. The municipality has a facilitating role. In addition to this the municipality has meetings with other actors to stimulate the actors to adapt towards the urban climate.

In Utrecht there is no specific implementation of urban climate adaptation measures and therefore the identification of roles for the actors is not possible. In Vlissingen and Winterswijk the questions about communication are not applicable because they do not perceive the urban climate as a problem at the moment. The interviewee in Amsterdam mentioned that the politicians in the city decide on which subject civil servants will work. At the moment the focus is not on urban climate adaptation or sustainability in general and thus there is no exclusive process for urban climate adaptation.

In Maastricht the municipality has two different roles in the process. At some moments they have a facilitating role, which is the case in for example the MaastrichtLAB. This organization promotes citizens to come up with ideas themselves. The ideas are not specifically for urban climate adaptation, but they could be. While most of these ideas are short-term solutions, the municipality comes up with ideas themselves for the long term. The municipality strives to make the long term solutions good for the urban climate. The municipality also wants to inform the citizens sufficiently that they can make their own decisions whenever possible. As is the case in Amsterdam it is the politician who decide about the topics the civil servants can work on.

Flanders

In the city of Gent the municipality is the initiator for urban climate adaptation: "C*limate adaptation mostly comes from the municipality, communication and information disclosure is tailored towards the citizens. This in contrast to climate mitigation, initiatives for mitigation often come from citizens themselves."* In Koksijde the attention for urban climate adaptation is limited: *"at the moment the focus is on sustaining sufficient unpaved area for water retention purposes."* The municipality is the initiator for new developments in Koksijde, other actors are informed about the plans during information sessions organized by the municipality. The interviewees in Brugge and Hasselt see the municipality as the driving force behind urban climate adaptation.

Antwerpen is the only city in which there is a specific platform for citizen initiatives: Stadslab 2050. The purpose of this platform is to unite citizens, companies and the government to work on sustainability. Everyone with ideas to increase the sustainability in Antwerpen is invited to join this initiative. The government has a facilitating role, which is comparable with the role the municipality of Maastricht has with their MaastrichtLAB. Both labs are not specifically for urban climate adaptation but offer a framework in which urban climate adaptation could be possible. In addition to this framework the municipality is the initiator in a top-down framework. According to the interviewee citizens will react when the top-down approach does not work properly.

Comparison

In Dutch cities it is difficult to identify specific roles for urban climate adaptation processes because there is little urban climate adaptation at the moment. As can be seen in Table 19 in 3 of the 6 Dutch cities this question was not applicable. In three Flemish cities a top-down approach can be identified in which the municipality has a leading role in the process of urban climate adaptation. They are the initiator on adaptation projects and are responsible for the disclosure of information. The interviewee in Gent mentions that initiatives coming from other actors are scarce, especially in comparison with climate mitigation. In the Flemish city of Antwerpen the municipality also incorporates a bottom-up approach next to the top-down approach. The municipality is a facilitator of a process in which citizens, companies and the municipality collaborate on urban climate topics.

	Netherlands	Flanders
Facilitating role	Rotterdam	None
Initiator	Amsterdam	Brugge Gent Hasselt
Both	Maastricht	Antwerpen
Not applicable	Utrecht Vlissingen Winterswijk	Koksijde

Table 19: Overview of the role of the municipality in the process of urban climate adaptation

A similar, bottom-up, initiative takes place in Maastricht, where the municipality facilitates the MaastrichtLAB in which citizens can come up with short term solution for climate related problems. For solutions on the longer term there are no bottom-up initiatives in the Netherlands. In Rotterdam the municipality has a facilitating role, while in Amsterdam the politicians have a decisive role in the process. Dutch cities are more passive when compared to Flemish cities where the municipality seems to be more actively looking in to urban climate related problems.

4.2.2 What is the role of communication to support the planning, design and implementation of adaptation measures?

Netherlands

In Rotterdam the current focus is on international stakeholders. The city is part of an international coalition called delta-cities in which 12 cities work together on climate related issues. The international coalition mainly focusses on water issues and not on other urban climate related issues. As it is an international partnership much of the communication about climate adaptation is done in English. According to the interviewee in Rotterdam they plan to change their communication strategy in the near future: *"The new city council wants to focus on the local situation and their own citizens. The communication will no longer focus on international stakeholders but on the local stakeholders. There will be one communication strategy about all green measures in the city. The expectation is that this new strategy will be easier to use and more efficient than the previous one."* In Maastricht the role of communication is to promote the bottom-up approach that is provided by the MaastrichtLAB. Also it is important that actors are informed about the urban climate. The communication within the organization could focus more on making sure that everyone is aware of urban climate adaptation possibilities and that they are implemented from the start of a project.

In Utrecht, Amsterdam, Vlissingen and Winterswijk this question was not applicable as they do not have communication frameworks for the implementation of adaptation measures.

Flanders

In all the cities in which communication for urban climate adaptation is present the role of communication is to inform the actors of the problems and adaptation possibilities. In Brugge: *"communication for the citizens should focus on the advantages of adaptation measures and on the ways in which the municipality is capable to support the implementation of those measures."*

In Antwerpen the EcoHuis (ecological house) is a location and website on which citizens and companies can obtain information about sustainability. Also schools can obtain information about how to educate on this topic. In addition to this it is important that communication strategies are implemented from the beginning of projects. This offers the possibility to already think about possible campaigns and also the funding of these campaigns will be easier. In line with the other interviewees the interviewee in Gent added: *"it is important to not only provide information about the current*

problems and their consequences. But also communicate about possible solutions and the quantitative results of these measures and linking those to existing problems could increase the climate adaptation."

In Hasselt communication for urban climate adaptation is not yet relevant because they first want to find out which challenges there are. In Koksijde the urban climate is not perceived as a problem and therefore specific communication on this topic is not incorporated.

Comparison

In Flanders the focus is on presenting the urban climate topics and issues that emerge in the cities. In addition to this they also provide information about urban climate measures that actors can implement themselves and how the municipality can support this implementation. As shown in Table 20 this is the case in 3 of the 5 case cities. In the Netherlands most of the cities do not feel the urge to work on the role of communication. The city of Rotterdam is working on a campaign that will, in the future, inform citizens about urban climate adaptation possibilities and what the municipality can offer. Also in both countries one interviewee mentions that communication within the municipal organization is important to increase awareness among civil servants.

	Netherlands	**Flanders**
International focus	Rotterdam	None
Focus on citizen initiatives	Maastricht	None
Focus on informing other actors	None	Antwerpen Brugge Gent
Not applicable	Amsterdam Utrecht Vlissingen Winterswijk	Hasselt Koksijde

Table 20: Overview of the role of communication in the process of urban climate adaptation

In general, the differences regarding the role of communication are small. Most of the time, if a communication strategy is present in a city, it focusses on presenting the climate related issues and provides citizens and companies with information on how they can implement adaptation themselves. The communication on urban climate related issues is more present in Flemish cities than in Dutch cities.

4.2.3 What are the strengths and weaknesses of the current communication process?

Netherlands

A weakness in Rotterdam is that the communication at the moment is not focused on the local situation. An example of this is that most of the communication is done in English. For the future the expectation is that the new communication strategy will solve this problem.

The interviewee in Maastricht did not mention strengths or weaknesses when asked about it. However, as an answer to the previous question it was mentioned that communication within the organization should be more focused on making everyone aware on the importance of urban climate adaptation. The interviewee is not aware of real problems with the current communication process, which, according to the interviewee, could indicate that the current communication strategy is good.

For the other Dutch cities this question was not applicable as there is no communication strategy with regards to urban climate adaptation.

Flanders

According to the interviewee in Brugge "A *weakness for communication is that there is no comprehensive communication strategy for climate policies"*. The interviewee added: *"This in contrast to Gent and Antwerpen where they do have a strategy."* The communication about climate mitigation is in both Gent and Antwerpen good, however the interviewees mention that there is a need for better communication towards the citizens on climate adaptation. The representative of Antwerpen mentions that it is more difficult to convince people to act on climate adaptation because the financial incentive for the citizens is smaller than with climate mitigation.

In Gent the interviewee recognized a different weakness: *"The municipality is currently unable to reach all their citizens. Possibly large groups of citizens have never heard of climate adaptation, which is something we should look to improve in the future."* According to the interviewee this could be done by, for example: *"Using existing communication lines towards these citizen groups to also communicate on the topic of urban climate adaptation."*

A strength in Antwerpen is that the municipal organization offers two different approaches: bottom-up and top-down. This means that the input from citizens or other stakeholders can be structured and used via Stadslab 2050. In addition to this the top-down approach is accepted by other stakeholders and therefore provides satisfying results. In Koksijde the input from other stakeholders is usually limited. When there is a lot of room for their input the citizens found it difficult to start, while when the municipality presents concrete ideas citizens think that their input does not matter. A goal for the future in Koksijde is to evoke input from citizens and let them think out of the box.

Comparison

It appears that in Flanders, cities are more critical towards their communication strategies than in the Netherlands. This is shown by the fact that the interviewees in Flanders mention several points of improvement while in the Netherlands the only weakness is found in the focus on international stakeholders, which is a topic they are already changing in the future. Strengths mentioned in Flanders focus on the existence of a comprehensive communication strategy. At the same time weaknesses that are mentioned include that the current communication strategy is unable to reach all citizens.

4.3 Interview results – instruments

4.3.1 Are there legally binding instruments used to implement urban climate adaptation measures?

Netherlands

While there are legally binding instruments, such as zoning plans and building regulations, in which urban climate adaptation could be implemented they were not mentioned in Amsterdam and Utrecht. This is similar for Vlissingen and Winterswijk, however they don't think it is necessary to act on the topic of urban climate adaptation.

Zoning plans in both Rotterdam and Maastricht become more and more flexible to create more dynamic in the city. This flexibility is done because the municipalities want to make more things possible with the zoning plans, instead of making things impossible. In Maastricht this is done by offering a green and water buffering function for almost every location. This means that when there is a possibility for creating more green areas the zoning plans allows this and it can be realized quicker. Therefore, urban climate adaptation measures are not explicitly mentioned in the zoning plans, but they are possible. The interviewees in Rotterdam and Amsterdam mentioned the existence of NEN-

standards about wind patterns. When new buildings are constructed these standards may not be exceeded, according to the interviewees.

Flanders

In all the cities spatial plans exist in which a general outline for areas is described, however in Hasselt it was not mentioned. In these regional implementation plans areas are reserved for residential areas, green areas, etc. In addition to these spatial plans there are building regulations in Antwerpen, Brugge and Gent. In Antwerpen the building regulation focuses on green roofs and the use of materials. When doing a major renovation or constructing a new building people are obligated to construct a green roof or use materials with a low albedo. The updated regulations are implemented in October 2014 and are a result of the heat study conducted earlier.

In Brugge and Gent the regulation focusses on water retention, prescriptions about urban climate adaptation measures are not included yet. The building regulation in Gent was implemented in January 2013 and focusses only on newly constructed buildings. In addition to this Gent has a sustainability meter. This meter is used when planning new city development projects. A predetermined sustainability score is prescribed by the municipality. The project should at least reach this score before it could be implemented. Heat stress and flooding are examples of indicators that determine the score. For facade greening the regulations were simplified to create more possibilities, there is no permit needed for facade greening anymore.

In Hasselt there are no additional instruments: *"At the moment we do not know what the extent of possible issues for the urban climate is. We are preparing building regulations to increase the implementation of green roofs; however, we need more information on the topic first."* In Koksijde there is a provincial zoning plan which reserves the beach as an important area for coastal protection. This makes it very difficult to develop other plans within the beach area. In addition to this there are municipal spatial plans in which, for certain places, green roofs are compulsory.

Comparison

In both countries legally binding instruments exist to possibly implement urban climate adaptation measures, as can be seen in Table 21 there were three different instruments mentioned by the interviewees. Interviewees in the Dutch cities often do not mention these instruments as they are not used for urban climate adaptation at the moment. In more than half of the Flemish cities binding instruments are present for urban climate adaptation. The national government of the Netherlands provides cities with NEN-standards which prescribe norms for wind speeds. Although, the interviewees mentioned these norms as legally binding, this is not the case. The NEN-standards provide guidelines for wind discomfort, but are not obligatory to follow.

	Netherlands	Flanders
Zoning plans / spatial implementation plans	Maastricht Rotterdam	Antwerpen Brugge Gent Koksijde
NEN-standards	Amsterdam Rotterdam	None
Building regulations	None	Antwerpen Brugge Gent
No mentions	Utrecht Vlissingen Winterswijk	Hasselt

Table 21: Overview of legally binding instruments for urban climate adaptation

There is also a difference in how legal instruments are used in the two countries. In the Netherlands spatial plans are used to make adaptation possible without the need to change spatial plans, a procedure that is both costly and time consuming. In Flanders the focus is on making climate adaptation mandatory for new or renovated buildings.

4.3.2 Are there other policy instruments used to implement urban climate adaptation measures?

Netherlands

In the city of Utrecht, the municipal organization is working on a quality vision for the city. According to the interviewee it is expected that urban climate adaptation will be part of this vision. This could be a start for implementation of urban climate adaptation in the future. In Amsterdam there is a building regulation in which is stated that houses should be isolated well, however urban climate adaptation is not mentioned as a driving force for this regulation. Also when the municipality has a tender for new plans sustainability is becoming more important; however, the focus is not on urban climate adaptation. They do have a sustainability fund which offers loans for companies and individuals to execute a sustainable initiative. In Rotterdam there is a subsidy for the implementation of green roofs. According to the interviewee this subsidy has stopped, however when looking at the website of the municipality the subsidy is still in place.

In Maastricht the municipality provides designers and architects with a list of demands about, for example, the type of material that could be used and the height of the buildings. After that plans will be designed and will be checked against the demands set by the municipality. With offering education about adaptation possibilities, the municipality tries to stimulate citizens and companies to implement these possibilities: *"We try to get local actors ambitious about urban climate adaptation. We use education about possible measures to increase the awareness. It is important that we keep doing this in the future. We don't force local actors to construct a green roof after a renovation, but we do hope they will do this without this obligation."* Also they are looking at prescribing a stricter value for the EPC (Energy Performance Coefficient) than the national government prescribes.

Flanders

In Brugge the municipality is waiting for the results of different studies about the urban climate. When these studies are done the municipal organization will start thinking about policy instruments that could cope with possible issues. Brugge did sign the Covenant of Mayors and thinking about signing the Mayors Adapt. Both were initiatives of the European Commission to raise awareness about urban climate mitigation and adaptation among cities. Hasselt, Gent and Antwerpen did sign both treaties

which show that there is political support to tackle urban climate problems. This is not applicable anymore as both initiatives were merged and formed a new initiative: Covenant of Mayors for Climate and Energy.

In Gent there are subsidies for a wide variety of projects. One of these subsidies is about green roofs; the goal is to increase the implementation of green roofs in the municipality. Antwerpen has a specific building regulation for high-rise buildings. This building regulation consists of the following, according to the interviewee: *"Buildings taller than 50 meters are considered high-rise buildings. One of the implications is that a wind study is obligatory. The regulation is in place for one year and until now there are now such studies conducted."* Also subsidies are available when citizens want to implement a green roof, while this is not required by a policy. Only in Gent and Rotterdam subsidies are mentioned as an instrument, while in all the other cities subsidies are considered an adaptation measures. In chapter two different instruments were identified, one of these were subsidies.

Comparison

In both countries there are other policy instruments used to work on the topic of urban climate adaption. In the Netherlands the initiatives are different in all the cities, while in Flanders the initiative focusses on two European treaties. One of these treaties, the Mayor's Adapt obligates the city to make an adaptation strategy to integrate adaptation in the relevant planning topics. In Flanders three cities have signed this treaty while only one Dutch city signed the treaty. It appears that the political engagement in Flanders is higher than in the Netherlands with regards to the European initiatives. In one Flemish city they have specific instruments on high-rise buildings to decrease the wind discomfort around new buildings, this in contrast to the Netherlands where a standard on wind patterns is provided by the national government. In the Dutch cities one municipality focusses on a sustainability fund, while another provides planners and designers with a list of demands for new development plans in the city.

4.3.3 What are the strengths and weaknesses of the instruments used to implement urban climate adaptation measures?

Netherlands

The quality vision in Utrecht is an important document in which the policy for the coming years will be introduced. If urban climate adaptation becomes part of this vision it is considered a strength, because the vision will frame the policies for the following years. However, it is not sure yet whether or not this will be the case.

A strong point of the sustainability fund in Amsterdam is that for the municipality the money will come back later, because the money is a loan to help the initiatives to start. On the long term it will not cost money for the municipality. The interviewee in Maastricht recognized a weakness: *"The current instruments are not obligatory for local actors; however, this is what we want as a municipality. Therefore, this is not going to change in the future."*

Flanders

The interviewee in Brugge mentioned that a strength of the situation in Brugge is that there are multiple methods in which the city can control the planning of the city: *"building regulations offer possibilities to include obligations with regards to urban climate adaptation. For water retention this is already the case, but this also offers opportunities for adaptation."* Support from the politicians is emerging as well: *"The support from aldermen, mayor and members of the city council is increasing. This is represented by the signing of the Covenant of Mayors and in the future there is a possibility they sign the Mayors Adapt as well."*

In Antwerpen and Gent the political support for urban climate mitigation and adaptation is high, as shown by the authorization of the two treaties. A strong point of the instruments in Antwerpen is that most of the regulations are compulsory. Only the regulation for high-rise buildings is not obligatory and therefore it is weaker than the ordinary building regulation. In Gent the building code only focusses on newly constructed buildings, in contrast to Antwerpen. This is a weakness for Gent as there are many buildings which could be renovated. For new buildings the guidelines for green roofs and water retention are considered a strength because they are mandatory. The coastal regulation in Koksijde offers good opportunities for protection; unfortunately, the possibilities for other development are very limited.

Comparison

It appears that in Flanders municipalities focus on implementing mandatory instruments, while Dutch municipalities focus on creating policies that are less restrictive. In accordance to this observation also the identified strengths and weaknesses differ between the countries. In Flanders strengths are identified because the policies are often mandatory for citizens and companies. In Antwerpen the regulations for high-rise buildings is not obligatory, which is considered a weakness. In the Netherlands the interviewee in Utrecht also mentioned that a weakness of their instruments is that it is not obligatory. According to the interviewee in Brugge it is a strength that the municipality has multiple possibilities to control the planning. In the Netherlands strengths are observed when urban climate adaptation could be part of the vision for the city and a policy that will loan money to other organizations to implement climate adaptation measures. Several interviewees in Flanders mention the presence of strong political support as a strength of the current instruments. In the Netherlands none of the interviewees mentioned this.

4.4 Interview results – implementation

4.4.1 Which concrete urban climate adaptation measures have been implemented in your city?

Netherlands

In Amsterdam and Utrecht there are subsidies for green roofs. In Utrecht the interviewee mentioned that the subsidies will be stopped in the near future because the policy is to not have subsidies anymore, however the municipality still offers a subsidy for green roofs and facades. Often the intention of the subsidies is not heat stress or wind discomfort. Although, it is not the focus of the subsidies it does have an impact on the urban climate. In contrast to Rotterdam where the interviewee mentioned subsidies as a policy instrument, the interviewees in Amsterdam, Utrecht and Vlissingen mentioned it as a climate adaptation measure. In addition to the subsidy in Amsterdam the municipality offers the aforementioned sustainability fund. In Utrecht they are working on connecting green areas with each other to create a better living environment.

In Rotterdam the municipality also implements other initiatives like a big park on the roof of a shopping mall and the campaign ‘Tile out, Green in’ (Tegel eruit, Groen erin) in which actors are stimulated to create more green in their gardens or facades. In Winterswijk and Vlissingen the urban climate phenomena are not considered to be an issue and therefore there are no measures implemented. However, in Winterswijk the municipality is acting on the topic of water retention.

In Maastricht the municipality mostly has a facilitating role: *“Zoning plans offer possibilities to implement urban climate adaptation measures. When chances emerge to increase the amount of green areas we want to use those chances immediately.”* Also the municipality is looking into possibilities for a new subsidy program: *“We had a project that citizens could get a subsidy for a green*

roof. However, the conditions were so complex that almost no one tried to get the subsidy. For the future we are looking in to possibilities for a new project to implement green roofs."

Flanders

Until 2013 there was a subsidy offered by the Flemish government for the implementation of green roofs. In Antwerpen and Gent this subsidy is now offered by the local government. In Brugge the municipal organization is looking into the possibility of offering one as well. The municipality also offers other financial assets: *"Groups from neighborhoods can get financial support from the municipality for measures that increase the livability of the area. Facade greening is one of the several measures that are possible, however communication about this should be improved."*

In Hasselt the municipality does not offer a subsidy, however Hasselt is working with a sustainability wallet. With this system, citizens can save points which they can trade for sustainability products. Points can be earned by implementing sustainable measures such as green roofs or facade greening. In Antwerpen green roofs are already obligated and therefore implemented on a wider scale, in addition to this they also have facade greening and green tram rails. The current measures focus on urban vegetation, however they recently also conducted a ventilation study for a small area which might result in other measures as well. In Gent the municipality is conducting a similar study at the moment.

As mentioned before there are strict building regulations in both Antwerpen and Gent. In addition to this Gent also focusses on urban vegetation on all scales. This means that they are working on big city parks but also on facade greening and the placement of just one extra tree. In Koksijde there is no systematic implementation of climate adaptation measures.

Comparison

In both countries cities provide subsidies for green roofs, however often the intention of the subsidies is to create more water retention. Nonetheless, it also adapts towards the urban heat island. In Flanders cities without subsidies at the moment are looking in to offering them in the future as well, while in the Netherlands interviewees mentioned that subsidies will be stopped in the near future. In two Flemish cities studies are conducted to look at wind patterns, in contrast to the Netherlands where such studies are not conducted at the moment. Of course this is not direct implementation but could be a first step towards implementation.

	Netherlands	**Flanders**
Subsidies	Amsterdam Rotterdam Utrecht	Antwerpen Gent
Other financial incentives	Amsterdam	Brugge Hasselt
Urban vegetation	Amsterdam Maastricht Rotterdam Utrecht	Antwerpen Brugge Gent
Ventilation studies	None	Antwerpen Gent
Not applicable	Vlissingen Winterswijk	Koksijde

Table 22: Overview of current urban climate adaptation measures

As can be seen in Table 22 the focus in both countries is on the implementation of urban vegetation measures. In more than 50% of the case cities urban vegetation measures are implemented. Cities are implementing facade greening and green roofs on their own buildings in both countries. Interviewees in both countries mentioned that an increase in urban vegetation also adapts to flooding and increases the livability of the city.

4.4.2 What are the strengths and weaknesses of the implemented urban climate measures?

Netherlands

In Amsterdam the interviewee recognized one strength and one weakness: *"The use of subsidies is seen as a weakness because it takes a lot of time to check whether or not the applicants meet the requirements of the subsidy. The sustainability fund is a strength of our policies, because all the money will come back to the municipality."* In Utrecht a strong point of the measures is that the amount of green will increase in the coming years, however a weakness is that it is only by little steps at a time. In Rotterdam the interviewee looked at the general characteristics of green measures. A disadvantage of these measures is that they take up space which could be used for other purposes as well, an advantage is that multiple goals can be reached by implementing green measures: social cohesion, higher livability and an increase of housing values.

Flanders

In Hasselt the interviewee mentioned: *"A weakness for our measures is that there are no direct financial incentives anymore after the discontinuation of the subsidy for green roofs."* About the measures they did implement the following was said: *"The existence of the sustainability wallet is not yet known by everyone, which obviously is a pivotal point to make it work sufficiently."* A strength of the implementation in Antwerpen is that citizens are obligated to follow the rules set by the local government.

The interviewee in Gent mentioned an important weakness of urban climate adaptation measures in general: *"It is difficult to implement adaptation measures because they take up space. This space could also be used for other initiatives which might be more economically appealing."* However, the interviewee also sees a strong point of the current situation: *"Our adaptation measures can be linked with our city vision, which is: create a pleasant, healthy, livable and child friendly city."* In general, the difficulty with climate adaptation measures is that the exact consequences of the measures are yet unknown.

Comparison

In Flanders the lack of subsidies is mentioned as a weakness by representatives, while in the Netherlands the interviewees see the presence of subsidies as a weakness. Subsidies are labor-intensive for the civil servants and therefore considered inefficient in the Netherlands. In one Flemish city the link is made between the policies and the vision of the municipality. Representatives in both countries mention that a weakness of urban vegetation measures is that it takes up space that cannot be used for other urban functions.

4.4.3 Are there conflicts between aesthetics and urban climate adaptation measures?

Netherlands

According to the interviewee in Amsterdam these types of conflicts are present: *"We want to give each city district a uniform exterior. For the city center this means that a dark, solid brick should be*

used. A lighter, yellow, variant was also proposed but was not chosen because the aesthetics are worse. Also the use of protruding elements is not a common practice. The looks are preferred above the local climate."

In Utrecht conflicts exist because the existence of the urban climate phenomena is not perceived as problems by everyone and therefore the municipal organization prefers a good looking environment instead of an optimal cooling environment. Another conflict that is present in Utrecht is social security due to the lack of street lighting in green areas. The interviewee in Winterswijk mentioned that such problems should not exist, but did not address whether or not they are present in Winterswijk. For Maastricht these conflicts arise because the skyline of the city is protected by law. It is therefore difficult to implement solar panels or green roofs, for example. The use of lighter colors to increase the reflectance is not a problem because of the tradition that most houses are white in Maastricht. The interviewee in Rotterdam also identified a conflict: *"The different opinions about aesthetics make it difficult to implement green measures. One person could like a big tree while another person only thinks of big trees as an irritation."*

Flanders

At the moment there are no big conflicts in Brugge, however the fact that the inner city is a UNESCO world heritage site makes it difficult to implement adaptation measures there. The rules from UNESCO are strict and the interviewee expects that citizens are frustrated. For example, those who want to implement a green roof.

In Antwerpen and Gent conflicts mostly occur at the implementation of facade greening. In Antwerpen the municipality is afraid that citizens will not maintain their facades which would lead to a less appealing streetscape. In Gent the conflict exists between designers which do not like green facades and the local government who wants to implement them.

Comparison

According to the interviewees conflicts between aesthetics and urban climate emerge in both countries. In all the Dutch cities that are implementing adaptation measures conflicts are present, in Flanders in one city the representative mentioned that there are no such conflicts at the moment. The types of conflicts that are present are similar in both countries. The implementation of low albedo materials is difficult in a Dutch city; while in Flanders two representatives mention that facade greening is difficult because other actors are afraid that it will not look pretty in the future. Representatives in both countries mention that protection of inner cities by law makes adaptation with, for example, green roofs difficult.

4.4.4 Are there conflicts between urban functions and urban climate adaptation measures?

Netherlands

In Amsterdam there are conflicts for example because the space below the surface is filled with cables for all sorts of infrastructure. This makes it impossible to plant a big tree in the ground on such places. Also in Rotterdam there are conflicts: *"The placement of trees can create resistance as well. Sometimes there is little space and the citizens want enough parking space. Trees take up this space. Facade greening is also perceived as a problem by some citizens due to the fact that it increases the amount of bugs."* The conflicts in Maastricht arise because the cost of ground space is high and green measures are not providing a lot of money, in contrast to for example the construction of new houses.

Flanders

In Brugge the guidelines of UNESCO make it difficult to use the potential for urban climate adaptation. As said before a study was conducted for the Groenplaats in Antwerpen, a square in the city center, in which different designs were examined. However, there were boundary conditions: *"It was not possible to transform the whole area in to a city park. The local market will still be organized here in the future."* The economic function therefore influences the urban climate adaptation potential.

In Gent there are conflicts about urban functions all the time: *"During every city development project we have meetings with all departments of the municipality. We always have to look for solutions as the space is limited and there is a demand for a couple of urban functions. It is always a balancing act to decide which function is the important on that specific place."* Climate adaptation is difficult to support in this discussions because it is done for the future rather than the present. In Hasselt and Koksijde this is not really an issue because the municipalities are not implementing adaptation measures at the moment.

Comparison

In both countries conflicts between urban functions and urban climate adaptation are present. On multiple topics the conflicts are similar in the Netherlands and Flanders; however, representatives of two Dutch cities mention that the placement of big trees is difficult because of the cables that are below the surface. In Flemish cities this conflict is not mentioned by the interviewees. Similar conflicts that emerge are the financial rewards urban climate adaptation offers in comparison with other urban functions. Adaptation measures are often done for the longer term while other urban functions offer more immediate rewards.

4.4.5 Are there chances / potentials missed when implementing urban climate adaptation measures?

Netherlands

The interviewee in Winterswijk mentioned the following: *"Yes chances are missed, we should make more couplings between water retention and the urban climate."* In Maastricht this specific coupling is already made, but the civil servants have to make sure that these couplings are made all the time. This is not yet the case and therefore some potential is missed there. As mentioned before, this is something the internal communication could improve. According to the interviewee in Rotterdam *"A lot of couplings are already made, but it is unfortunately inevitable that chances are missed."*

Flanders

The interviewees in Brugge, Hasselt and Koksijde did not answer this question because urban climate adaptation is not yet considered to be an issue in these cities. In both Antwerpen and Gent chances are missed however it is not easy to use these chances. In Gent the focus is on creating win-win situations, urban climate adaptation scores good on this principle because for example less imperviousness leads to lower water stress, heat stress and less drought. Also the coupling between climate adaptation and mitigation is often used. The interviewee added: *"It is always difficult to mention missing links. As soon as you identify a missing link you try to fix it as soon as possible. However, I'm sure we are missing opportunities at the moment but I do not have an example."*

In Antwerpen it is difficult to include urban climate adaptation in every project and sometimes they are sidelined and are therefore not able to offer input. They are working on a precipitation model which should make it easier to link water stress and urban green with each other.

Comparison

Representatives in both countries mention the link between heat stress and water retention. In both countries there are cities that are already using this coupling, while in others the representatives mention that this could be a chance for future policies. Other couplings or chances are not mentioned by the representatives, often because the interviewees found it difficult to identify them.

Chapter 5: Discussion

In this chapter the results for the different sub questions will be placed in the perspective of the theoretical framework, presented in chapter 2, and other relevant scientific literature. Differences and similarities between the Netherlands and Flanders will be discussed.

5.1 Sense of urgency and awareness

5.1.1 What is the sense of urgency to adapt the urban environment in the future, amongst citizens, politicians and urban planners and designers?

In this study the sense of urgency is used as a measure to see whether or not actors see the urban climate problems as an important topic for policy making. The results indicate that the sense of urgency in both countries is still low. The perceived sense of urgency in the Netherlands is higher than in Flanders. The 'climate learning ladder' from Tàbara et al. (2010) identifies the sense of urgency as a crucial aspect of the first step for successful climate adaptation, the interviewee in Gent also acknowledged that a sense of urgency is important. In light of the findings from Tàbara et al. (2010) it can be said that, due to the currently low perceived sense of urgency, it is crucial to strive for a higher sense of urgency among the studied actors. The results of the interviews, however, show that the necessity for increasing the low sense of urgency is not felt in 4 of the 6 cities in the Netherlands. The interviewee in Rotterdam, for example, mentioned: *"it [urban climate adaptation] is an important topic but not an urgent topic. It is important that we pay attention to it, but we do have the feeling that we have some time."* In Flanders in all cities the need for an increase of urgency is felt, in 3 of the 5 cities the interviewees mentioned that it is important to provide other actors with examples of urban climate adaptation. In the other cities the focus is on gathering more knowledge about climate related problems before steps can be made to increase the sense of urgency of other actors. A reason for the differences in sense of urgency between politicians and urban planners and designers is provided by the interviewee in Gent: *"[for politicians] There are more important issues [than urban climate adaptation] to work on during this legislative period. Urban planners and designers are used to look at the long term."* The possible solutions mentioned by the interviewees do not mention the importance of a good communication process. However, scientific literature identifies communication as important for creating awareness (Nerlich et al., 2010).

5.1.2 How aware are citizens, politicians and urban planners and designers of urban heat stress and wind discomfort?

In addition to a sense of urgency there is also awareness among actors needed for successful climate adaptation (Fernandez et al., 2016, Tàbara et al., 2010). The results from the interviews show that the awareness in the Netherlands and Flanders are different. In the Netherlands the awareness for urban heat stress and wind discomfort is higher than neutral, while in Flanders a lower than neutral awareness for both urban climate phenomena is found. The results, therefore, indicate that the current level of awareness in both countries can be improved for more successful climate adaptation. The relatively low awareness in both countries is caused by, for example, a lack of knowledge among actors that the urban geometry influences wind patterns, as identified by the interviewee in Antwerpen: *"Citizens might experience more discomfort [from wind dynamics than from urban heat], however they probably don't know that the configuration of the city is the cause of the discomfort."* This is in accordance with what Moser (2010) identified as one of the reasons why climate change is a difficult topic, namely the high level of complexity of the topic. The low awareness also follows from the low sense of urgency for urban climate adaptation: local governments do not perceive it as

important to act on the topic now and therefore the willingness to obtain knowledge about these topics is also limited.

A comparison between the results of urban heat stress and wind discomfort show that in the Netherlands the awareness for wind discomfort is higher, while in Flanders the awareness for urban heat stress is higher. A possible reason for this difference is provided by the interviewee in Antwerpen: *"Tall buildings are less prominent here, than in, for example, Rotterdam. Therefore, the level of wind discomfort is lower here as well."* In the Netherlands extensive research is done with regards to urban heat stress: heat stress was an important topic of the study program knowledge for climate (Rovers et al., 2014). Satellite observations for Dutch cities showed that an urban heat island is present in most cities (Klok et al., 2012). It is remarkable that while these studies are done the level of awareness for urban heat stress is still lower than for wind discomfort. This suggests a gap between theory and practice, which is also identified in other policy domains (Eliasson, 2000, Gago et al., 2013, Mills et al., 2010, Ren et al., 2012). This gap can be bridged by, for example, the transfer of knowledge between scientist and other actors. Several interviewees, for example in Brugge, Hasselt and Maastricht, said that more knowledge is needed to increase the awareness. A similar knowledge gap can be identified between urban planners and designers and the politicians and citizens: awareness of the urban planners and designers is in all cases higher than the other two actors.

5.1.3 How aware are citizens, politicians and urban planners and designers of urban climate adaptation measures?

While it is important to have a sense of urgency to adapt to the urban climate and have awareness about the urban climate problems, it is also necessary to have awareness about urban climate adaptation measures. In line with the earlier results the awareness in the Netherlands is, in general, higher than in Flanders. There are also differences between the awareness for each urban climate adaptation measure: urban design, urban vegetation, the use of other materials and reducing anthropogenic heat. The differences with regards to adaptation measures between the countries are smaller than with regards to the urban climate phenomena. The reason for this is that the level of awareness in the Netherlands is lower for adaptation measures than for urban climate phenomena, while in Belgium the results are more comparable.

The results for each individual measure show that actors are the most aware of urban vegetation measures and the least of measures with regards to anthropogenic heat. The interviewees mention several reasons for these differences, for example the interviewee in Gent: *"Awareness among citizens [for the use of other materials] is smaller than for urban vegetation because the actions are less specific and less appealing for the public."* The interviewee also mentioned with regards to anthropogenic heat: "*For urban planners and designers this [reducing anthropogenic heat] they have less influence on. The design, vegetation and materials can be used in the design of a neighborhood, while anthropogenic heat is more about the behavior of citizens and companies."*

As mentioned before successful adaptation without awareness is difficult, this is also the case with urban climate adaptation measures (Fernandez et al., 2016, Tàbara et al., 2010). This is in accordance with the results of this study: The awareness for urban vegetation is the highest of the four adaptation measures and it is also the measure that is the most used for adaptation. This clearly shows that awareness for the other measures should increase for successful implementation of these adaptation measures. Education is often mentioned as a measure to increase the awareness among the actors. This is in line with the assumption that lay audiences should be informed about a topic to be aware and act on this topic (Moser, 2016). However, there is a limit to what education can achieve for successful urban climate adaptation, the interviewees did not yet mention the attitude-behavior gap

that is identified in literature (Ballantyne, 2016, Mills et al., 2010, Tiller and Schott, 2013). This gap makes it necessary for the driving actors in the process to focus on more than just awareness-raising activities.

5.2 Planning and design processes for implementation

For these group of sub research questions it is important to acknowledge that in some cities there is no planning and design process for the implementation of urban climate adaptation. The urban climate is not perceived as an issue at this moment and therefore no policies are made. This is particularly the case in the Netherlands where in 2 of the 6 cities there is, according to the interviewees, no climate adaptation. In only one of the Flemish cities, Koksijde, the interviewee mentioned there is no urban climate adaptation at the moment. The fact that there is no adaptation in these cities is because the municipalities do not perceive the urban climate as a problem. In the Dutch cities, Winterswijk and Vlissingen, there are no complaints from other stakeholders about the urban climate. In the next sections I will focus on the cities with urban climate adaptation.

5.2.1 What is the role of communication in the process of urban climate adaptation?

The presence of urban climate adaptation does not necessarily mean that there is a specified role for communication. In the Netherlands the results show that in two cities, Rotterdam and Maastricht, there is a role for communication, in Flanders this is the case in three cities. The role of communication in Flanders is to inform other actors about the urban climate. It is assumed that educating other actors will increase the awareness and subsequently adaptation will increase. In literature there are three different objectives for communication identified: raising awareness, changing attitude and changing behavior (Moser, 2010). The focus in Flanders is merely on the first purpose of communication, however this neglect the existence of the attitude-behavior gap (Ballantyne, 2016, Mills et al., 2010, Tiller and Schott, 2013). The recognition of this gap will lead to a transition of communication towards the other two objectives (Ballantyne, 2016).

In Maastricht the focus of the communication is twofold. On the one hand the municipality wants to inform other actors about the urban climate. On the other hand, they want to facilitate the MaastrichtLAB in which citizens participate to initiate adaptation. The latter is characterized by a bidirectional communication approach with direct interaction between the government and the citizens. The other type of communication is a unidirectional model in which information goes from a sender to a recipient (Pearce et al., 2015). This model is typical for the first objective of communication and is still used more often than the bidirectional model (Ballantyne, 2016, Moser, 2010). This is in line with the findings of this study that showed that in Flanders the focus of the local government (sender) is to provide other actors (recipient) with knowledge about urban climate adaptation. In the Netherlands interviewees mentioned that this type of communication could be used to educate other actors about the urban climate. While this model is the most used in these countries it is often argued that the use of a bidirectional communication model eventually should lead to better results (Moser, 2010, Nerlich et al., 2010, Pearce et al., 2015). The interviewees in Gent and Antwerpen mentioned that there is a need for better communication towards citizens. The combination of implementing a bidirectional communication model and shifting the focus to the other objectives of communication could improve the results of the communication in these cases. This is an opportunity for both the Netherlands and Flanders.

5.2.2 Which instruments are used to implement urban climate adaptation at the moment?

As demonstrated in chapter 4 there is a wide range of policy instruments used in both countries. Ranging from legally binding instruments which are used in Flanders, to knowledge0sharing and subsidies used in both countries. Each instrument is based on different assumptions. Hood (1986) developed a 'NATO' classification scheme with four different types of instruments: nodality, authority, treasure and organizational. These instruments are used in both countries, however not in the same amount.

Nodality instruments, such as knowledge-sharing networks, education and the generation of new knowledge, are effective when assumed that target groups are motivated for adaptation but lack the knowledge for it (Henstra, 2016). These instruments were not mentioned as instruments for implementation of urban climate adaptation by the interviewees. However, in earlier answers the interviewees did indicate that knowledge is an important factor in increasing the sense of urgency and awareness among actors. In Flanders the willingness is high to increase the level of knowledge by ordering scientific inquiries, for example in Brugge and Hasselt this is done. Depending on the results of these studies they will decide which steps to take next. In the Netherlands the municipalities are reluctant to generate knowledge themselves. There are several reasons for this attitude, on the one hand the municipalities do not think it is necessary to create more problems in the city. The focus is on other policy topics at the moment. On the other hand, they first want to have indications from other actors that they perceive the urban climate situation as a problem. Knowledge-sharing and education were both mentioned by the interviewees as well. In Maastricht they use the sharing of knowledge in a bottom-up approach in which citizens can share their opinion and knowledge.

In Flanders they use authority instruments in addition to nodality instruments. Authority instruments assume that target groups are motivated by a commitment to follow state-issued directives. Legislation, regulation and standards are typical instruments for this group (Henstra, 2016). In Flanders, for example, building regulations are in place to make adaptation compulsory. In the Netherlands they also use authority instruments, such as zoning plans, however they are used differently than in Flanders. Instead of forcing adaptation they are used as flexible instruments that make adaptation measures possible.

Another type of instruments often used by the municipalities are financial incentives for other actors to implement adaptation measures. Interviewees in both countries mention that subsidies can incentivize actors for adaptation. However, the trend for using financial incentives is different in both countries. In the Netherlands the trend is to use less subsidies, several interviewees identify subsidies as a weakness in the current process. In Amsterdam, for example, the interviewee mentioned: *"The requirements for the subsidy (green roofs in combination with solar panels for schools) were complex, one of the tasks is to check each application. Therefore, many of the applications were rejected. However, the money was supposed to be spend, which meant that the civil servants were actively seeking for good candidates. This was at the expense of other work."* This trend is in stark contrast with Flanders where several interviewees said that they want to offer more subsidies. Subsidies are seen as concrete adaptation measures by most interviewees. However, according to chapter two, subsidies are used as an instrument to implement measures. Subsidies are part of the group with treasure instruments, which also consists of direct program spending and tax regulation (Henstra, 2016). These instruments assume that the target groups are motivated by financial incentives to take action. While there are different ways of offering financial incentives the focus is on using subsidies.

As methods to increase the awareness of other actors about possible adaptation measures several interviewees, for example in Hasselt and Amsterdam, mentioned that it is important to lead by example. In Hasselt the municipality has a green roof on the local town hall. Leading by example is part of the last group of instruments: organization instruments. These instruments assume that behavior can be influenced by implementing policy principles into government operations. Demonstration and procurement are two examples of these instruments (Henstra, 2016). None of the interviewees mentioned that procurement is used at the moment.

One of the most striking differences for me was the use of legally binding instruments that force adaptation. In three cities in Flanders binding instruments are used and in the other cities the willingness was showed to implement these type of instruments. In two Dutch cities binding instruments are used to make climate adaptation possible, in none of the cities the willingness was shown to use instruments that force adaptation. I asked the representative in Gent if she knew a reason why this could be the case: *"In Flanders, cities are allowed to have local building regulations which are stricter than their national counterpart. I do not know if this is the case for the Netherlands, but I do know there are countries where cities are not allowed to have stricter regulations. I presume this is also the case for the Netherlands."* In the Netherlands this was the case in the past, however this has changed according to the interviewee in Maastricht: *"As a municipality you were not allowed to be stricter than the national norm, however this has recently changed."* However, in Maastricht they are not sure if they are going to do this: *"It is unclear if we are going to do this, because we are afraid that stricter norms will frustrate the dynamics of the city."*

All these instruments can be employed by the local government to increase urban climate adaptation. However, in line with the communication process the effectiveness of instruments are influenced by the local situation. Nodality instruments are easy to implement and the financial risks are small, but they are passive instruments and unlikely to achieve widespread behavior change. This in contrast to authority instruments which are binding instruments. However the political risks and financial constraints are higher (Henstra, 2016). A combination of different instruments is probably the most effective way to increase adaptation among all target groups. Knowledge and information sharing tools can, for example, be employed to stimulate the use of subsidies (Henstra, 2016). This could be a solution for the situation in Amsterdam in which civil servants had to look for subsidy candidates themselves.

5.2.3 Which concrete urban climate adaptation measures are used in urban climate adaptation strategies?

In this study I looked at four different adaptation measures, as described in chapter 2 these were: urban design, urban vegetation, the use of other materials and reducing anthropogenic heat. Some of these measures will adapt to both urban heat stress and wind discomfort. Others however, only adapt to one of the two urban climate phenomena. The interviews showed us that only urban vegetation measures are used on a wide scale in both countries. This is in line with what the results showed for awareness of urban climate adaptation measures. The interviews showed that heat stress or wind discomfort is not always the driving force for the implementation of urban vegetation. Instead water retention and the livability of neighborhoods are important factors. This was, for example, mentioned by the interviewee in Utrecht: *"The intention for the stimulation of green roofs is not heat stress but water retention. It is nice that it also lowers the temperature, but it is not marketed as such."* In Maastricht citizens specifically identified urban heat stress as an important factor therefore it is easier to use urban vegetation as an adaptation measure for heat stress.

In 3 of the 4 Dutch cities with urban vegetation measures water retention is the main driving force. In Flemish cities this is only the case in Hasselt. While in the other cities urban heat stress is at least one of the driving forces for urban vegetation measures. A comprehensive strategy seems not to be present in the Netherlands while due to the legally binding structure of the instruments in Flanders urban vegetation is used on a broader scale. Lately, ventilation studies are used more often as well which could lead to the use of more urban design measures with wind discomfort in mind.

Other adaptation measures mentioned often were subsidies in both countries, however as previously stated these are identified as instruments by Henstra (2016) and are therefore discussed earlier. The other types of measures were not implemented in any of the case cities which indicate that there are more opportunities for municipalities to act on urban climate adaptation.

The implementation of urban climate adaptation measures is not always easy. In all cities which act on urban climate adaptation conflict with other urban functions emerge. The interviewee in Amsterdam mentioned for example cables and pipes in the ground which makes it difficult to place additional trees. Heat stress and wind dynamics are at the moment no critical arguments to use urban vegetation. Only in Maastricht there is a study that shows that citizens see heat stress as an important topic, which makes it possible to use urban cooling as an argument to increase urban vegetation. In addition to conflicts with urban functions there are also conflicts with regards to esthetics in both countries. In Brugge the city center is a world heritage site which makes it very difficult to implement adaptation measures because they affect the characteristics of the city. Conflicts most likely exist because at the moment actors do not feel physical problems in relation with the urban climate. In both countries the same type of conflicts and difficulties emerge with regards to the implementation of adaptation measures.

Chapter 6: Conclusion

In this chapter an answer to the main research question is provided. The limitations of the study are discussed in the second part of this chapter. Following from the limitations, recommendations for further scientific research are proposed.

6.1 What is the current situation of urban climate adaptation in urban planning and design processes in the Netherlands and Flanders?

The analysis of the current situation of urban climate adaptation in the Netherlands and Flanders show that in Flanders the situation is better than in the Netherlands. While awareness and sense of urgency in the Netherlands is higher the willingness, shown by the municipalities, for adaptation in Flanders is much higher. In the Netherlands there is reluctance to act on the urban climate and a wait-and-see attitude is adopted. The willingness shown in Flanders offers possibilities for adaptation, while this momentum is not present in the Netherlands.

The first three sub research questions provided an overview of the sense of urgency and awareness in the Netherlands and Flanders. It showed that both values are on average higher in the Netherlands. The presence of sufficient levels of sense of urgency and awareness are part of the first step for the implementation of urban climate adaptation and essential for success (Fernandez et al., 2016, Tàbara et al., 2010). While the values are higher in the Netherlands, it is seldom the case that the levels are higher than neutral (on a scale from not aware to very aware). Following from the interviews it showed that in Flanders there is a preference for using a top-down approach for urban climate adaptation, while in the Netherlands a bottom-up approach is preferred. This means that in the Netherlands the sense of urgency and awareness of citizens is important, while in Flanders the focus is on the urban planners & designers. When comparing these two levels with each other it shows that in Flanders the values are higher which corresponds with the fact that actions on urban climate adaptation are more wide spread in Flanders than in the Netherlands. Improvements with regards to the sense of urgency and awareness are possible and considered a necessity by most of the interviewees.

The interviewees mentioned that it is important to get in contact with groups that are more vulnerable with regards to urban climate phenomena. Communication can play an important role in getting in touch with other groups. Having a clear purpose and scope are vital for an effective communication strategy (Moser, 2010). Several factors such as framing, the messengers and the channels which are used depend on the purpose and scope of the communication (Moser, 2010). New ways of communication and education can increase the sense of urgency and awareness for the urban climate in the Netherlands and Flanders. These methods include the visualization of adaptation options instead of focusing on the risks of the urban climate (Moser, 2014). This was also mentioned by the interviewee in Gent. Other ways to increase awareness are providing target groups with interactive information on platforms they are familiar with, such as smartphone apps for younger people. The gamification and co-design of adaptation options will increase the public engagement and understanding of the urban climate problems.

When looked at the second set of three sub research questions the interviews reveal that in 2 of the 6 Dutch cities actions on urban climate adaptation are negligible, in Flanders this is the case in 1 of the 5 cities. Communication is an important aspect of urban climate adaptation (Moser and Ekstrom, 2010, Schofield, 2001). However, the interviews show that the presence of adaptation does not guarantee a comprehensive communication strategy. In three cities in Flanders communication is used to inform other actors about the urban climate and possible adaptation measures. While in the Netherlands communication only has a role in two cities. The communication in Flanders is

characterized by a unidirectional model with the government as sender and the other actors as recipients. In the Netherlands there is a bidirectional model present in Maastricht where citizens are able to express their own opinions and knowledge as well. With regards to the policy instruments used there is a clear difference between the two countries. In Belgium top-down instruments, such as building regulations, which force adaptation are used in three cities. Additionally, interviewees in four cities mentioned the possibilities that spatial plans offer for urban climate adaptation. In the Netherlands the municipalities are reluctant to use instruments that force adaptation. They use their local spatial plans as a flexible instrument that makes adaptation possible, instead of forcing adaptation. In line with the results about the awareness of urban climate adaptation measures urban vegetation is the most wide spread adaptation measure. Other measures lack the awareness and sense of urgency to be implemented at the moment. Urban climate adaptation is difficult in both countries as conflicts emerge between other urban functions and esthetics. The benefits of acting on urban climate adaptation now instead of later remain unclear for most actors.

The results indicate that one of the most important differences between the Netherlands and Flanders is that in Flanders a top-down approach is used. This might indicate that a top-down approach is better suited for handling with urban climate adaptation. However, there is no such consensus to be found. In most cases a hybrid solution is more useful than one of the extremes (deLeon and deLeon, 2002, Matland, 1995). The preferred planning approach determines which communication and policy instruments are the most applicable (Pissourios, 2014). Research done in New Zealand showed that 45% of the respondents wanted that the government has the responsibility for climate issues (Tiller and Schott, 2013). However, the results of this study show that a wait-and-see attitude is in place in most of the Dutch cities. Often it is assumed that a bottom-up approach is more democratic because stakeholders have the ability to directly influence the decision making process (deLeon and deLeon, 2002, Purcell, 2016). However, this is only true when there is true inclusiveness, meaning that all actors are equal and actively participating in the process. Often in bottom-up approaches this not the case. Sometimes companies have all the power, while smaller stakeholders are neglected (Devlin, 2011, Westerink et al., 2017). This privileged position of larger stakeholders has a negative impact on the democratic legitimacy of the planning process (Mäntysalo et al., 2015). This in contrast to a top-down approach in which democratically elected representatives are directly involved (Hytönen, 2016).

All things considered I think that a more top-down approach to the topic of urban climate adaptation is better. A topic, with a high level of complexity and wide scale, is suited better for a top-down approach in which the government has a leading role. Additionally, the democratic legitimacy is better accommodated by a top-down approach than a bottom-up approach that is not fully inclusive and participatory. The implementation of communication strategies and instruments has to be carefully conducted based on the local situation. Every actor needs a different type of communication and different instruments might be used for different target groups (Henstra, 2016).

6.2 Limitations of the study

Expert interviews formed the main source of gaining information about the current situation with regards to urban climate adaptation in both countries. In just one city an interview was not possible and therefore the interview questions were send via email. The methods allowed for an analysis of the state of urban climate adaptation in the Netherlands and Flanders, however there are several remarks to be made.

For every city only one interviewee was questioned and therefore the results are subject to the opinion of one actor in the process of urban climate adaptation. This interviewee is regarded as an expert on urban climate adaptation, but their insights will still be limited to one perspective. A result

of this single perspective is that the results of the countries are more representative than the result of one city.

Time constraints had two major impacts on the limitations of the study. First, only interviews were conducted with a civil servant, who is working on topics related with urban climate adaptation. I did not directly ask citizens or politicians what their opinions are about urban climate adaptation. This means that the civil servants offer their perspective with regards to the awareness and sense of urgency of other actors. It remains a question how accurate their judgement is. Secondly, I addressed only six cities in the Netherlands and five in Flanders, which means that the sample size is rather small and the results of one city can have a big influence on the results for the whole country, as showed with the results of the city Maastricht in the Netherlands.

Each interviewee has different perceptions of the classification of neutral awareness or neutral sense of urgency. Both concepts are not an objective measure, therefore it could be that one interviewee identifies a neutral sense of urgency while another interviewee in the same city would identify that as a very high sense of urgency. This makes it difficult to make an accurate comparison between cities and countries.

During the interviews I asked about the sense of urgency and awareness of three different actors: citizens, politicians and urban planners and designers. There was no room for additional actors that are important for the implementation of urban climate adaptation. In Rotterdam, for example, the interviewee indicated that housing corporations are important for the process. The frame of the interviews limited the possibilities to get a complete overview of the urban planning and design processes in some cities.

Another difficulty showed itself when comparing the results of the interviewees. Most interviewees mentioned that urban vegetation measures were implemented in their city, however the driving force differs per city. In some cities urban climate adaptation is the driving force for the implementation of urban vegetation measures, while in other cities it seemed that water retention was the main driving force. Therefore, the results could provide a more optimistic view of urban climate adaptation, than would be the case when only looking at adaptation for heat stress and wind discomfort. A similar difficulty emerged with the comparison of policy instruments used for urban climate adaptation. Sometimes interviewees identified subsidies as an adaptation measure, while Henstra (2016) identified subsidies as an instrument.

All in all, the results could have been more accurate by asking more follow-up questions to clarify the answers of the interviewees, asking more concrete questions, interviewing more actors and offer possibilities to include other actors when applicable for the local situation.

6.3 Recommendations for future research

While this study gives us a first insight in urban climate adaptation in the Netherlands and Flanders there is still more to be examined. In addition to the interviews with a single civil servant per city it is interesting to take a closer look to the perspective of other actors, such as other civil servants, citizens and politicians. Do the other actors share the opinion of the civil servant or will they provide a different insight on the process of urban climate adaptation. Difficulties with the classification of the sense of urgency and awareness will become smaller as the sample size becomes larger.

Difficulties with the classification of the sense of urgency and awareness could also be tackled by using a more objective framework. Instead of asking for a subjective opinion a point system could be implemented in which each city (or country) scores points for actions on climate adaptation. For

example, a study about urban heat stress will give one point. Further research how such an objective framework should be used could make the comparison between countries easier and more accurate.

Additional actors and interviews also offer the possibility to get a more comprehensive overview of the planning and design processes with regards to urban climate adaptation. The inclusion of other actors, such as housing corporations, other urban problems, such as flooding will have a positive effect on the comprehensiveness of the study. Additional follow-up questions focused on clarifying answers from interviewees will also help to have consistent results.

The study of additional cities in the Netherlands and Flanders will increase the sample size of the results and therefore the credibility of the study. This also offers the possibility to compare cities with similar population size or climate conditions with each other. Which could provide interesting information about why in some cities urban climate adaptation is done and in other, similar, cities not.

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Annex 1: Interview framework

I'm a student from the Wageningen University in the Netherlands. For our thesis I'm looking at the state of urban climate adaptation in the Netherlands and Flanders. First I will ask questions about the awareness of urban climate. The second part of the interview is about the planning and design processes for implantation of adaptation measures. To get a good overview of the state of urban climate adaptation in your region I would like to ask you to answer the interview questions. Thank you in advance for taking your time to answer the questions.

General Information

1. Name:
2. City:
3. Position: □ Politician □ Urban planner / designer □ Other, ____
4. Organization:
5. Email:

Sense of urgency and awareness

6. What is the sense of urgency to adapt the urban environment in the future, amongst citizens, politicians and urban planners and designers?

	Very urgent	Urgent	Neural	Less Urgent	Not urgent	Don't know
Citizens						
Politicians						
Urban planners & designers						

   a. Is it necessary to increase the sense of urgency for urban climate adaptation? If yes, how could this be done?

7. How aware are citizens, politicians and urban planners and designers of urban heat stress and wind discomfort?

Urban heat stress

	Very aware	Aware	Neural	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners & designers						

Wind discomfort

	Very aware	Aware	Neural	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners & designers						

a. Is it necessary to increase the awareness for these urban climate phenomena? If yes, how could this be done?

8. How aware are citizens, politicians and urban planners and designers of urban climate adaptation measures?
    a. How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with urban design?

	Very aware	Aware	Neural	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners & designers						

b. How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with urban vegetation?

	Very aware	Aware	Neural	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners & designers						

c. How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with the use of other materials?

	Very aware	Aware	Neural	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners & designers						

d. How aware are citizens, politicians and urban planners and designers of the possibility to adapt the urban climate with reducing anthropogenic heat?

	Very aware	Aware	Neural	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners & designers						

e. Is it necessary to increase the awareness of these urban climate adaptation possibilities? If yes, what could be done to increase the awareness?

Planning and design processes for implementation

Communication

9. What is the role of communication in the process of urban climate adaptation?
    a. Which roles do citizens, politicians and urban planners and designers have in the process of planning, designing and implementing urban climate adaptation measures?
    b. What is the role of communication to support the planning, design and implementation of adaptation measures?
    c. What are the strengths and weaknesses of the current communication process?

Instruments

10. Which instruments are used to implement urban climate adaptation at the moment?
    a. Are there legally binding instruments used to implement urban climate adaptation measures?
    b. Are there other policy instruments used to implement urban climate adaptation measures?
    c. What are the strengths and weaknesses of the instruments used to implement urban climate adaptation measures?

Adaptation measures

11. Which concrete urban climate adaptation measures are used in urban climate adaptation strategies?
    a. Which concrete urban climate adaptation measures have been implemented in your city?
    b. What are the strengths and weaknesses of the implemented urban climate measures?
    c. Are there conflicts between aesthetics and urban climate adaptation measures?
    d. Are there conflicts between urban functions and urban climate adaptation measures?
    e. Are there chances / potentials missed when implementing urban climate adaptation measures?

Thank you for answering the interview questions. Do you have any other remarks regarding the urban climate adaptation process or the content of the questions?