The role of Citizen Science in Climate Adaptation

How can citizens use their knowledge to influence the climate adaptation process?

A comparative case study to citizens science initiatives in Amersfoort (Meetjestad Amersfoort) and Apeldoorn (IOT Apeldoorn).

Master Thesis

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Own picture of Climate Street in Apeldoorn

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Abstract

The impact of climate change in our daily lives is more urgent than ever before. With more heat stress and flooding issues due to heavy rainfall, especially cities need to adapt to the climate change. With the growing amount of people that live in cities, it is harder to create space for climate adaptation within the urban area. Although, there is need for more green and other climate adaptive measures to keep the city a pleasant place to stay. In recent years, participation is on the rise and the new environmental law requires more participation. Citizens and property owners are and must co-create the urban area together with the municipality. In this research the role of citizen science is researched in the participation process to make the Climate Street in Apeldoorn and the city of Amersfoort climate adaptive.

In the city of Apeldoorn, there is a cooperation between citizens and the government, in making the 'Climate Street,' as it is called, climate adaptive. With the citizens-initiative 'IOT Apeldoorn,' they monitor the impact of the taken measures, this is citizens doing science. Due to these monitoring activities, the measures are assessed. The monitoring activities will show how effective certain climate adaptation measures are and where climate adaptation should gain more attention.

Next to the case of Apeldoorn, the city of Amersfoort is researched. In Amersfoort, the citizen science initiative Meetjestad provides research to climate change in Amersfoort. Citizens monitoring the impact of climate change in their own neighbourhood. With the collected data of the past years, Meetjestad Amersfoort is making the shift towards climate adaptive measures.

In both cases, citizens are contributing to the process of climate adaptation. Citizens can help searching for the local needs. Due to the citizen science activities, there becomes data available on the local scale. This information is useful for planning climate adaptive measures. The citizen science activities are a part of the broader goal of participation. Citizen science initiatives are an important contribution to the participation process towards climate adaptation, while it takes some time to build trust between the municipality and the community. Citizen science contributes to good participation, but sufficient participation requires more involvement of other citizens, next to the citizen science initiatives.

Key words: Climate adaptation, Citizen Science, Participation, Cities, Climate change

Preface

Dear reader,

After a little more than five years, my study period ends. Started in September 2017 with the bachelor of Geography, Planning & Environment and finishing the master of Spatial planning with a focus on Cities, Water & Climate Change, in the autumn of 2022. My life as a student was an interesting phase that taught me a lot.

With a specific generated interest in climate adaptation the last five years, I authored my thesis about climate adaptation in the urban area. With interest in participation of citizens, I came to the idea of the role of citizens in the participation process of climate adaptation. I hope to do something with sustainability in my future.

With the process of writing a master thesis, it is a lot of thinking and rethinking about every detail. First, I would like to specially thank my supervisor Pascal Beckers for the convenient help and the nice conversations we had. It really helped me to restructure my thesis and improve it.
Secondly, I want to thank all interviewees who made time available for me during the fieldwork phase. All these interviews were nice conversations and gave me interesting new insights.
Third and lastly, I want to thank my family and friends for supporting me during the time of drafting this thesis. This helped me through the entire process.

Thanks all, and I hope you enjoy reading.

Simon van der Velden
October 2022

Content

1. Intro

1.1 Introduction

The impact of climate change is becoming more prevalent the last decades. The IPCC report of 2022 is clear about the effect of climate change and states that action is needed. More heat waves and flooding issues due to heavy rainfall are occurring in the coming years. Currently, we can perceive the impact of climate change in our daily lives already. Climate change already causes more heat, water, and drought issues (NU.nl, 2021). Due to climate change, there are more extremes in the weather. Because of the impact of climate change, we must adapt our lives and livelihoods (IPCC, 2022). The latest IPCC Report, from February 2022, on climate change, is more alarming than ever before. There needs to be a change in our way of live and our way of planning the urban area. Especially cities do suffer from the impact of climate change. Because cities are dense areas with minimal space for greenery, problems like heat and flooding issues becoming more of an issue. Therefore, cities need to adapt and change their strategy in making the city more liveable and sustainable. The city needs to transform towards a climate adaptive city.
There is lately a transition in the creation of new plans within the city. Slowly the society changes from a vertical, top-down to a horizontal bottom-up approach society (Rotmans, 2014). Citizens start wondering about their own neighbourhood and are seeking for new ways to improve their environment. Citizens are local 'experts' in their area and you could say that they know best about the problems they are facing. The transition to more participation and involvement of citizens in the process of making the urban area is an interesting topic to do research on. And next to that, the problems of our current era are complex and therefore in need of more involvement of citizens. The current system of politics needs to change. Citizens should think along and this needs to be fair and equal, they should have a real voice in the process and a form of tokenism must be avoided (E. Rovers, 2022).

A new phenomenon, which is called citizen science, is on the rise. This concept of science that is done by citizens, gives new insights in the environment the inhabitants live in. With this form of science, citizens gather data themselves (Wolf et al, 2021). Citizens can measure the air quality in their neighbourhood for example or measure the temperature in their homes during a heat wave. This 'new' form of information is becoming more prevalent and causes added information in the process of urban planning. How do municipalities respond to this citizen 'made information? And which citizens involve in such science projects?
With the new environmental law, which is announced to be implemented in July 2023, participation will be required. If the municipality wants to change the public area, it needs to have participation within the process of creating these new climate adaptive spaces. The obligation for participation is not strict in the way it should be organised, the environmental law only states that it is mandatory. This makes the new environmental law debatable on the real impact on participation. What is participation and how should it be organised? This is an important question that has no clear answer in the new environmental law. Although it is important for municipalities to do research into participation because the society is changing, and more active citizens are on the rise. How do municipalities deal with the involvement of citizens and other stakeholders? Participation will gain more attention and must be implemented due to the new law and therefore research into participation in climate adaptation is an interesting and urgent topic.

The city of Apeldoorn, located in the province of Gelderland in the Netherlands, is aware of the need to adapt the city to climate change. The municipality assigned two streets in the city centre of Apeldoorn to become the Climate Street (in Dutch Klimaatstraat). In this area different stakeholders, like the municipality, citizens, business owners, are working together in making the street climate adaptive. The citizen science initiative IOT Apeldoorn is monitoring the temperature in the area for example. Gathering data by citizens about their own environment is called citizen science. And therefore, citizens provide information for the municipality to implement more green or any other adaptive measures. These measures are, when implemented, monitored by their impact on the Climate Street. A co-creation between different stakeholders to make the space within the city centre climate adaptive and more attractive. The Climate Street is a pilot for the rest of the broader plans for the city centre of Apeldoorn. Which is making Apeldoorn a 'Parkstad,' a city with the feel of a park. The National government provided a subsidy for the Climate Street to be a guiding example where other cities can learn from and take benefit from. This learning effect was needed to get a subsidy from the national government. The lessons learned should be shared with other cities. The case of the Climate Street will be more elaborated in the methodology section and the results chapter.

Next to the case of Apeldoorn, there is in this thesis attention for the case of Amersfoort. In Amersfoort which is a city located in the province of Utrecht, citizens are already monitoring various aspects in their area for some years. They also monitor the impact of climate change on their urban area. This citizen science initiative is called Meetjestad Amersfoort. Currently they are busy with monitoring the impact of the urban heat islands (UHI) effects on the very local level. It is, according to Meetjestad Amersfoort, interesting and in need to monitor very local and not only build on the higher scale KNMI (Weather institute of the Netherlands) measurements. With local citizen science projects, data about the small scale become visible and helps to gain engagement of citizens in the climate change programme.
The cases of Apeldoorn and Amersfoort are compared in this research and differences between the two cases are sought and will be presented.

1.2 Research problem

Climate change has lately more impact on our daily lives. There are more heat waves occurring in the Netherlands and more flooding issues due to extreme rainfall. This is a direct cause of climate change (IPCC, 2022). The summer of 2022 shows again the impact of climate change in especially the urban areas with more heat and draught issues. During a heat wave, for example, cities are becoming unpleasant and unhealthy places for citizens. The temperature in the urban areas rises and this causes not only discomfort, but it also causes a reduction in the quality of life (Leal Filho et al., 2021). Most of the cities are nowadays dense areas with less room for greenery and other climate adaptive measures. While green is one of the solutions against heat islands and flooding issues (Reynolds et al., 2019). Therefore, cities need to find ways to implement more green space in their areas. To keep the city liveable, it is necessary to adapt the city to climate change.
With the information era we are living in, the amount of information is becoming an overload. However, it also brings in innovative ways of latest information that can be used in different situations. For example, citizen science that is used in measuring the impact of climate change in a specific neighbourhood. Like monitoring temperatures during a heat wave. Citizens become an

expert in their local environment and therefore have interesting information that could be used in making the urban area climate adaptive (Rovers, 2022).
The new environmental law, which will be introduced in July 2023, requires participation. Participation is compulsory with the new environmental law, but it is not stated how it should be organised (VNG, 2019). Therefore, it is interesting to dive into the participation that will be obligatory in the process of climate adaptation, in the form of citizen science. The city of Apeldoorn already started making their city centre climate adaptive and involve citizens and business owners within the process. This new way of creating adaptive places brings in more interaction between different parties. It is required, with the new environmental law, to involve stakeholders in the process of developing the area. With the rising attention and amount of citizen science, a new source of information comes in. How responds the municipality to this new source of information? Does it help to take the right measures in making the space climate adaptive or is this new 'extra' information creating more conflict between the government and the citizens? And can citizens participate in these new projects or are governments still the leading party and therefore the decision-maker?

1.3 Research aim

The goal of this master thesis research is to dive into the role of citizens in adapting the city of Apeldoorn and Amersfoort to climate change. With citizen science, citizens do measurements by themselves in their neighbourhood. For example, they monitor the temperature in the area to get data about the impact of heat waves. Next to citizen science, local inhabitants do have specific knowledge of their environment because they are living there. With a society that is changing from vertical, top-down society, towards a horizontal bottom-up society (Rotmans, 2014), it is interesting to investigate what citizens can do with their knowledge. The research aim is to get an insight in the role of citizens knowledge in the participation process to climate adaptive measures in the city centre of Apeldoorn and in the city of Amersfoort.

1.4 Research question(s)

This research is divided in one main question and four sub-questions. The main question of this research is:

What can be the role of citizen science in the participation process to more climate adaptation in Apeldoorn and Amersfoort, and what are considerations for citizens to contribute?

To structure this main question there are four sub-questions that will contribute to answer the main question. These sub-questions are:

- *What different measures of climate adaptation can be distinguished in the two cases?*
- *What is the role of citizens in the initiatives in Apeldoorn and Amersfoort?*
- *Why are citizens contributing to citizen science projects?*
- *How is citizen science used in the participation process to more climate adaptation in Apeldoorn and Amersfoort?*

1.5 Relevance

1.5.1 Scientific Relevance

The impact of climate change is clear in the last decade. We, as cities, need to adapt to the changing climate to keep the city liveable. 'Climate change poses increasingly complex problems for resource managers and policymakers that require balanced scientific information, local needs and values, and the role of local knowledge in decision-making' (Djenontin & Meadow, 2018, p 885). This complex problem needs to be solved by policymakers that collaborate with multiple stakeholders, including citizens. Participatory decision-making is more frequently occurring but there is a lack of scientific research in the way participation should be designed. 'Despite appeals in the literature and practice for more public participation, there is still conceptual and empirical confusion about what public participation entails and what objectives it should serve' (Uitenbroek et al, 2019, p2542). Although participation is becoming normalised, it is still not clear in the literature how participation should be organised. What is the real objective of the participation process, and does it really work? The real objective of participation projects should be researched. Therefore, it is interesting to dive into the role of citizen science in the participation process. Because citizen science is a new rising method, it is interesting to dive into this new form of participation and to see what the role is within the decision-making process. What can be the goal of citizen science as form of participation for municipalities? 'The widespread understanding that citizen involvement in NBS (Nature-Based Solutions) and CCA (Climate Change Adaptation) per se leads to more positive, sustainable outcomes does not hold true' (Wamsler et al., 2020, p246). It is interesting to dive into the involvement of citizens in the process of making the city climate proof for the future. While more participation is required, it is no guarantee that it will cause a positive outcome. Therefore, it is interesting to dive into the involvement of citizens in the process of climate adaptation. In the Climate Street in Apeldoorn there is a cooperation between citizens, government, and the business owners. In Amersfoort citizens are collaborating with the municipality. It is relevant to dive into the interaction and the collaboration between these different parties.

The role of citizen science is not yet researched much in climate adaptation (Bremer et al., 2019). With only few research to the impact of citizen science in climate adaptation, it is relevant to do research in this field. Because citizen science and climate adaptation are rising fields, this research could gain new insights and add knowledge to this field of citizen science in climate adaptation. Citizens and municipalities should use each others potential with dealing to climate change (Uitenbroek et al, 2019). They need to cooperate in making the city climate proof. In this research the potential of citizens doing science is researched. It is about what citizens can do with the citizen science activities.

1.5.2 Societal Relevance

The impact of climate change is already there in our daily lives. With more extremes in the weather, like pluvial flooding due to heavy rainfall, and more heat waves, the city becomes less liveable. And therefore, there is a need to adapt the city to the changing climate.

With the new incoming environmental law (Omgevingswet in Dutch) in the Netherlands, participation in decision-making is required. Although there is already a long history of participation processes in the Netherlands, this obligation within the environmental law will be new. Therefore, municipalities need to adapt and change, to create and allow increased involvement of citizens in the projects (Memo Omgevingswet, 2021). The participation should be context specific and therefore it is

not stated how it should be organised. This has a two-sided effect on the participation process. On the one hand you could say it is positive because it creates space for each different project. In that way the participatory aspect could be different for each project by adapting the participation form to the project. On the other hand, it brings a lot of uncertainty for municipalities while it can be vague what to do and it is therefore a risk that participation will not reach it goals (Dieperink, 2017).
With the urgence of climate change, and the impact of climate change, cities need to adapt to stay liveable and desirable. Every citizen will somehow feel the impact of climate change within their city. With more heatwaves and more occurring heavy rainfalls, the city needs to adapt to the new situation. Creating more green will have the consequence of less impact of heat waves and flooding issues. Research that is been done by Natuur & Milieu (Nu.nl, 2022), showed that more than half of the researched neighbourhoods does not reach the minimum amount of green space. The national government have set a minimum amount of green in neighbourhoods, which is not reached most of the times. Natuur & Milieu (2022) are concluding that the Netherlands is having more concrete instead of greenery. This makes neighbourhoods vulnerable for urban heat waves and flooding events. More green is an important solution against heat islands and flooding events. Lower temperatures due to more climate adaptive measures do have a positive impact on the quality of life (Leal Filho, 2021). More space for climate adaptive measures is thus important to keep the city liveable.
In this research two different cities are compared, Amersfoort and Apeldoorn. By comparing two cases, interesting insights can be found. The initiative and the municipality of Apeldoorn could learn from Amersfoort and the other way around. Because both cities do have a different strategy and a different form of collaboration with the municipality, the advantages and limitations of both strategies can be found. It is interesting for both cities to learn from others to improve themselves, which could improve the climate adaptation process.
To end this paragraph, the IPCC Report, which is the most important research about climate change for policy makers, is currently demanding for climate action and the urge to adapt to the climate impact (IPCC, 2022). One of the measures that should be taken in cities is more space for green. This will help cooling down the city during more occurring heat waves. But also other measures are to be taken. There is a task for municipalities to change their urban area for and together with the citizens.

1.6 Reading guide

In this paragraph the structure of this research will be outlined. First, after this introduction chapter, the literature review and the conceptual model, which will be applied in the research, are presented. Secondly, in chapter three, the methodology part is outlined. Where is stated which methods are used in this researched and why these methods will be used. Thirdly, in chapter four, the found results are presented of this research. In chapter five, the conclusion of this thesis is stated. In Chapter six there will be a critical reflection and some recommendations for further research. In addition to that there will be three recommendations for praxis. Lastly the references and the appendixes will be presented at the end. I hope you enjoy reading this research.

2. Literature & Theoretical Framework

2.1 Climate Adaptation

While on the one hand cities do suffer more from climate change, on the other hand more people live in urban areas. The United Nations (2013) stated that the percentage of people that live in cities will grow from 50% in 2010 to 70% percent in 2050. Having more citizens will result automatically in expansion from cities or densification of the city (Haaland & van den Bosch, 2015). In other words, having more people living in cities will result in less space for climate adaptation. 'Cities are particularly vulnerable to climate change, due to the large and growing urban population worldwide and the complex patterns of economic assets, infrastructures and services that characterize them' (Geneletti & Zardo, 2016, p39). As can been seen, especially cities are vulnerable to climate change and need to adapt themselves to stay liveable for the citizens.

The two most prominent issues for cities are the urban heat islands (UHI) and flooding issues. The urban heat island effect has recently more impact in cities in the Netherlands due to more occurring heat waves in summer times. Due to climate change, heat waves in summers are not an exception anymore but are happening more frequently, as can be seen in the summer of 2022. The urban heat island effect is a problem within the city. It causes an additional amount of heat during warmer days. 'The urban heat island effect is caused primarily by paving over natural land surfaces, particularly with non-reflective paving materials that absorb and retain heat' (Kirn, 2018, p40). This results in an additional heat within the city and makes the city less comfortable during these hotter days. Next to that, it is also causing health issues, especially for elderly and vulnerable people. The quality of life is reduced by the urban heat island effect (Leal Filho et al., 2021).

Next to the urban heat islands, there are more flooding issues. These flooding issues are most of the time due to heavy rainfall. These floodings through heavy rainfalls are called pluvial floodings. Which are more occurring due to the changing climate. Climate change results into more extreme weather (IPCC, 2022). To reduce the impact of climate change, cities need to create more climate adaptive measures. They need to adapt the existing city to the new climate by making changes in the public space. With the densification of the last decades, more concrete and less green is existing in the urban area. For example, more green helps against problems like urban heat islands and pluvial flooding. The government and citizens need to adapt themselves to create space for adaptive measures. For example, in gardens there must be more greenery, but the public space also needs to change. More blue infrastructure in the city helps reduce the temperature during warmer days and makes it more easy for water to leave the city after a heavy rainfall. Municipalities and citizens need to work together to find spaces and solutions for more climate adaptation within the urban area.

As stated before, one of the examples to help reducing the impact of climate change, is implementing more green within the city. Urban greening is a growing strategy to reduce the impact of climate change and promoting resilience within the city (Reynolds et al., 2019). Urban greening is gaining more attention in cities during the last decade and have multiple positive impacts on the city. Next to the positive impact of greenery for the climate, urban green has also a positive effect on the wellbeing from citizens (Ponizony et all, 2017). Urban green is a multi-beneficial measure for the city. More green in the urban area improves the levels of physical activity and next to that makes citizens feel relaxed faster (Ponizony et all, 2017). 'Nature based solutions such as urban green space offers an environmental friendly method to mitigate urban flood risk' (Pudifoot et al., 2021, p 3). Greenery in the urban area not only helps fighting against urban heat islands but also against flooding issues.

With climate change, more heavy rainfalls are occurring, and this will be more frequently in the coming years. More green seems to be the logic solution in adapting the city to more pluvial flooding events.
Other adaptive measures could also be taken in the urban area. While green is the most common and known measure against climate change, there are for example measures with more space for blue infrastructure. This is another form of bringing the nature back within the city. The blue infrastructure is next to more green, a measure against the impact of climate change. 'A combination of measures is required for all-inclusive climate vulnerability reduction' (Voskamp & van de Ven, 2015, p163). Most common adaptation measurements are blue (water) and green (greenery), it is interesting to do research in climate adaptive measurements next to the blue and green examples (Voskamp & Van de Ven, 2015).
Within the city, there needs to be more adaptive measures against the impact of the climate change. In the 'Climate Street,' they made some water fountains for example to adapt the city centre to the heat. By this additional water in the street, there is a cooling option for the citizens, and the fountain has a cooling effect on the local level. This is an example in keeping the city liveable and pleasant during warmer days. Innovative ways of adapting the city to the changing climate must be found together with citizens.

Different Universities of Applied Sciences in the Netherlands have combined their power to do research on climate adaptation and the role of citizen involvement. In the first part of this report, it becomes clear that there is an urgence of cities to adapt to the changing climate. More often, like the floodings in Limburg in July 2021, we face extremes in the weather (Report, 2021). The normal amounts of precipitation, draught and heat are exceeded more than ever before and are expected to be exceeded even more. In the preface of the report, it becomes clear that more extremes in the weather are no longer an exception. Therefore, there is a need for governmental parties to make the public space climate proof (Report on climate adaptation, 2021). The effects for inhabitants would then be limited. In this literature chapter, this report about the participation of citizens in climate adaptation is mentioned several times because it gives interesting insights in climate adaptation and participation of citizens.

2.2 Citizen Participation

Participation is a widely researched phenomenon and seems to be more needed in these current times. With themes like climate change and the energy transition, issues started to become complex and in need of different stakeholders to be solved. Participation of citizens is therefore needed. 'Citizen participation is a process which provides private individuals an opportunity to influence public decisions' (Parker, 2002, p1). Citizen participation is about citizens influencing public decisions. And therefore, a cocreation of the public space. To adapt the city to climate change, participation of citizens is needed. The public area needs to change but also the private area of citizens needs to transform.

One of the measures that make the city climate adaptive, is implementing more urban green. Participation of citizens can be realised in three separate phases of the greening project, the designing phase, the delivery phase, and the maintenance phase (Willems et al., 2020). In these three distinct phases, different forms of participation are desirable. It is important to find out what the

objective of the local government is when implementing a specific form of participation (Uitenbroek et al., 2019). With the new environmental law (Omgevingswet), participation will be required. However, it is not prescribed how it should be organised. The government could choose themselves about the different form of participation. This makes the environmental law interesting for this research.
As stated before, climate adaptation, and especially greenery, has multiple positive effects. 'The benefits of green infrastructure are widely recognised, yet the actual design, delivery, and maintenance are to be found difficult' (Willems et al., 2020, p22). Within the urban greening process, participation is applicable and can make the project more successful. Local governments, who are responsible for urban green, are increasingly moving towards more involvement of different stakeholders in co-delivering the greenery (Uitenbroek et al., 2019). It is therefore interesting to dive into the role of participation in the process of climate adaptation. Climate adaptation is a new and emerging policy field which makes it interesting to dive into (Uitenbroek et al., 2019). Because this field of climate adaptation is quite new, one of the benefits is that is creates room for experimenting with new forms of participation, 'Since they are less bounded by existing routines and ways of working' (Uitenbroek et al., 2019, p2530).

'Citizen coproduction presumes a shift of responsibilities for public goods and services away from or in addition to governments and businesses, towards citizens' (Mees et al., 2019, p 199). The shift towards more responsibilities for citizens seems clear. Citizens do not only involve in the process to more climate adaptive measures, but they are also gaining more responsibility. This also requires a new demand for citizens.
When elaborating about participation, the ladder from Arnstein could not be missed. Arnstein provided a framework to express the distinct levels of participation (1969). There are eight different forms of citizen participation in the ladder, see figure 1. These steps are divided in three diverse types of participation. The two at the bottom of the ladder are so-called non-participation. These are not meant to enable citizens to participate but are ways for the powerholders to maintain their power (Arnstein, 1969). The three levels above, are ways of tokenism. This is, according to Arnstein, a manner for policy makers to let people think they involve in the project, but the policy makers are still making the decisions. They simply lack power to insure they heeded to the powerful (Arnstein, 1969). And then there is a type of participation that can be seen as just and real. Arnstein calls it citizens' power. In these forms of participation, citizens do have a voice in the decision-making. This ladder of Arnstein helps to understand participation in general. But there must be stated that it is a simplification of the real-life situation. There need to be said that it is not a classification ladder. Higher on the ladder means not per se that there is more participation. It only states the level of influence citizens can have. Some projects need more involvement of citizens than others.

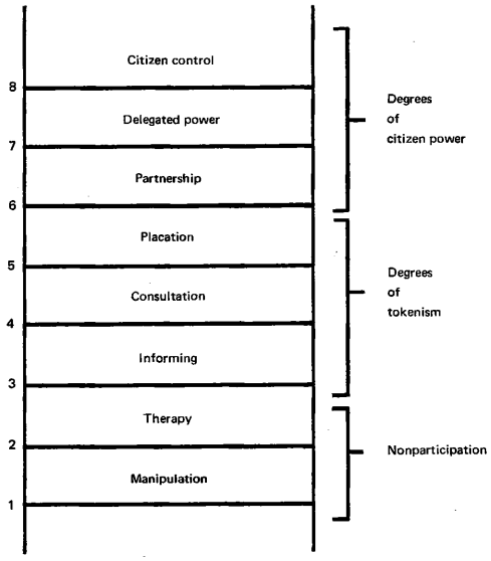

Figure 1: Ladder of participation (Arnstein, 1969)

The ladder of participation can be helpful to understand the level of participation in a certain project. Cogan and Sharpe (1984) did research the benefits of participation in the planning process. Parker (2003) summarized these advantages in four points. Firstly, with the involvement of citizens, innovative ideas and information can brought into the planning process. Secondly, there could be more public support for planning decisions because of citizens that contributed to the process. Thirdly, conflicts and costly delays could be avoided because the involvement of citizens in an early stage. And lastly, there can grow trust between the government and the public (Parker, 2003). Citizen participation can have multiple benefits.

Participation is a process which is currently urgent and therefore interesting to do research on. The benefits which are presented above seem to be a trustworthy reason to implement it more often. There can be said that participation seems nice in theory but is facing issues when it is implemented in real life. How to deal with all different views of stakeholders? How to involve a representative group of stakeholders? It is also a time consuming and costly process (Russel & Vidler, 2000) and it can be hard to involve the lower income group (Peatie, 1968). Participation is fair because it involves citizens in the process which can cause a broader supported outcome. But it can be hard to reach and involve all different stakeholders in the process. Some people do not have the time to involve in the process or are difficult to reach. It is thus important to do research on participation in the planning process.

The participation Ladder of Arnstein is adjusted by Petts (1999). The term of public involvement is widely discussed. 'A key issue which public involvement tries to address is that of trust in public decision-making' (Robinson & Bond, 2003). For the ladder there could be stated that higher on the ladder, means more trust from the government towards the citizens. If the government does have more trust in their citizens, there would be a higher chance of giving them more power. It is interesting to find out that trust and participation are two concepts that interrelate with each other. But there can be questioned what influences what exactly. Trust in citizens can lead to higher empowerment levels. But giving citizens more power could also lead to more trust. Trust is an interesting part of the concept of participation.

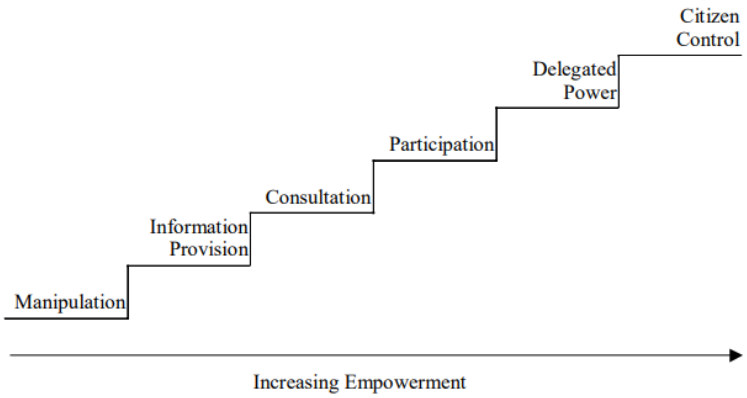

Figure 2: adjusted ladder of Arnstein by Petts, retrieved from Robinson and Bond (2003)

The last author mentioned on the concept of Participation does talk about citizen engagement in science. Which is presented in an escalator framework by Skarlatidou & Haklay (2021). There are 7 levels of engagement of citizens in science. Every step higher on the escalator, the less number of citizens that are involved. The levels 1 and 2 are about citizens that are consuming science passively.

By reading the newspaper for example or watching a documentary on tv. The next levels of the escalator are about actively consuming science. Going to a museum for example is level 3. In level 4, limited involvement in citizen science activities is occurring. A limited contribution by citizens is noticed. Counting birds in your garden once a year to help an organisation for example.
In the fifth level of engagement, citizens could join a citizen science community. This results in small involvement in a citizen science community by supporting activities. From level 6 and 7 the citizens starting do their own research. Level 7 means that citizens design their own sensors for example.

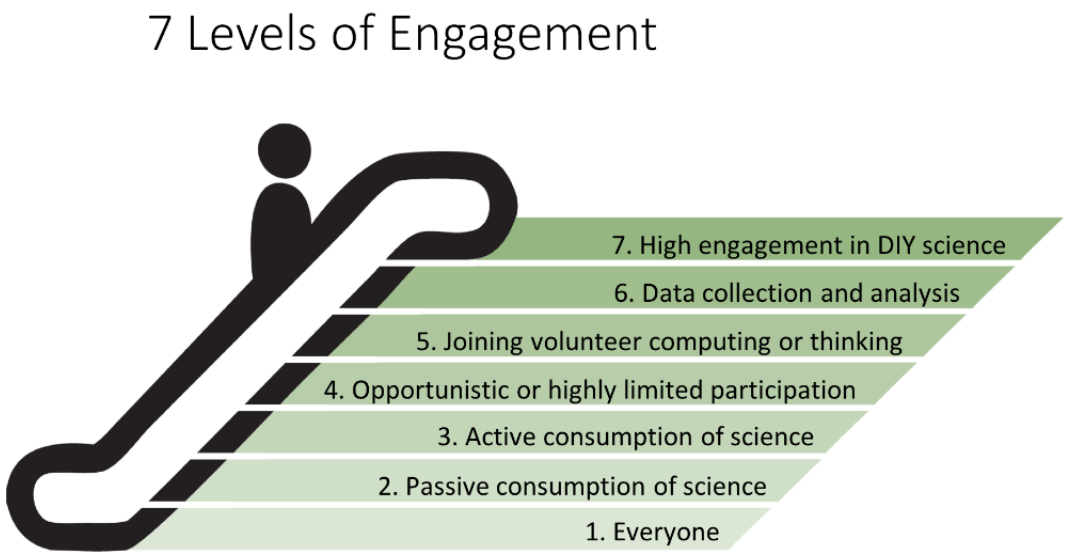

Figure 3: escalator public engagement (Skarlatidou & Haklay, 2021)

What can be seen in the escalator of engagement, is that higher on the escalator, less citizens are involved. 'As the level of engagement increases, the demands required of participants increases and the number of participants drops by an order of an magnitude' (Skarlatidou & Haklay, 2021, p7). More engagement means also more requirements and more demands. Only a small number of citizens are capable to involve in the way as meant in level 7 of the escalator. This has also to do with the amount of time citizens have. Higher on the escalator means more time-consuming activities. This escalator is interesting for this research. If a government would like to involve more citizens, it could question if they should invest in the higher levels of engagement or the lower levels. Because many citizens are in the lower three levels of engagement, a lot of citizens can be reached by investing in these levels. The escalator is useful to see whether citizens are engaged in a citizen science community. But it could create a focus on a specific group of people. A lot of citizens with a background in the technique could be high on the escalator because of their expertise. It is important to keep this in mind when doing this research. Higher on the escalator does not mean better, but different. Different citizens can have distinct roles in citizen science communities.

One of the important parts of citizens involvement is their own local knowledge. Citizen can monitor different variables to strengthen their worries on how they experience heat waves for example. The monitoring of temperature can underpin their own feelings. In the report on climate adaptation there is stated that if you know how citizens experience the weather, you can interfere on that as a municipality (report on climate adaptation, 2021, p3). Monitoring the effects of climate change in the

neighbourhood supports the experiences of citizens. Monitoring is therefore a complementary part to the knowledge of citizens in the adaptation process.

Especially when talking about heat issues, the experience of citizens is a crucial factor (Report on climate adaptation, 2021, p12). Inhabitants can feel the difference in temperature during a heat wave on a square with a lot of concrete and a park with a lot of green. The perception of citizens is a key factor in the urban heat island effect. According to the report, inhabitants do have a lack of trust in the available knowledge on climate adaptation within their own neighbourhood. Inhabitants see this as a limiting factor. But there is also a lack of competency within other important stakeholders like housing corporations and real estate developers. An important task for the municipality seems to be the only solution. Citizens do want to participate (Report on climate adaptation, 2021). With the concept of citizen science, more knowledge and data become available. This can help the process to more climate adaptation. Next to that, inhabitants become more motivated if the experience increases (Report on climate adaptation, 2021). Which can be strengthened by doing citizen science.

As can be found in the previous paragraph, there is a lack of available knowledge by inhabitants about adapting the city to climate change. Here is a chance and a key role for the governmental parties. For the municipality, which is the most relevant governmental party for this research There is a task to protect their citizens against the impact of the changing climate. A lot of inhabitants do want to participate but there is a dependency on the knowledge of the municipality (Report on climate adaptation, 2021). It is important to state that inhabitants are an important partner for municipalities in adapting the city to climate change, while the inhabitants own a lot of land. Make more gardens green for example, cannot be done without citizens but will have a significant impact on the adaptation process. An interesting statement in the report on participation in climate adaptation is that the right participation level is dependent on the goal of the participation. It is not needed to completely involve citizens in every project of the adaptation process, but customization is needed and will improve the process. For the municipality it is therefore important to consider what is the goal of the project and which level of participation will fit the best. This is in line with the statement of Uitenbroek et al. (2019), where the level of participation should be dependent on the goal of the municipality. The goal of the participation should be clear and if it is clear the result of the project will be reached easier.

2.3 Citizen science

The last decades our society became more connected through the internet. Recent technologies such as internet and mobile phones, create new possibilities to use citizen-generated data (Townsend, 2015). ‘The interest and use of citizen science projects have increased the last ten years’ (De Moor et al., 2019, p1). Citizen science is science that is done by citizens (in Dutch: Burgerwetenschap). Citizen science is the concept where citizens involve in gathering data (Wolf et al., 2021). This can be environmental data, which will be researched in this thesis, but also other forms of data are possible. Examples are monitoring the air quality nearby a road with a lot of congestion, counting birds or monitor the temperature in different areas during a heat wave. The difference in temperature, during a heat wave, between green space and a square with only concrete, will become visible in the data. With monitoring in these different areas, the difference between ‘grey’ and ‘green’ spaces can

be showed. The impact of urban green on the urban heat island will become visible through this data.

When talking about citizen science, it is important to mention climate services. 'Climate Services (CS) provide information about climate change, climate impacts, climate adaptation, and mitigation measures for decision-makers and other stakeholders to create understanding, raise awareness, and make decisions' (Personal communication, Raaphorst, December 2021). Climate services are important in monitoring the climate impact and finding climate adaptive measures. Citizens can contribute to the data of climate services by citizen science. When there is more participation of citizens in urban planning, their own data can be used to underpin their opinion. It is interesting to dive into this new form of information that enter the arena of urban planning. Are governmental parties willing to accept this data? Most of the times they do have their own sources of information for cases, therefore it is interesting to see what they will do with this new form of information that is brought in. In Apeldoorn, the municipality collaborated with a citizen initiative to monitor the success of climate adaptive measures. Here, citizens are already involved in monitoring the impact of the solutions. But can they also bring in data which can increase the urge of new climate adaptive measures? And not only assessing the finished measures?
The case in Amersfoort will give more insight in what can be done with the data that is collected by the citizens. They decide themselves what, where and how to monitor. 'A co-design process and climate service that contribute to urban climate resilience require an acknowledgement that the process will demand time, efforts, flexibility, and reflexivity by all involved partners '(Neset et al., 2021, p8). As can been seen, citizen science is also demanding a lot from citizens. Research needs to be done to find out how citizens can involve in the climate adaptation process, but also about doable citizen science activities. It should not ask too much from citizens that they would not do it on the longer term.

'Citizen science projects need to attract citizens and motivate them to dedicate their energy and time to science' (De Moor et al., 2019, p1). The difficulty of citizen science, as stated before, is that is asks active citizen engagement. The involvement of citizens in the project is becoming more of a need with the new environmental law that will be introduced in July 2023. And next to the upcoming requirement, it is also in demand of the governmental parties to gain more support for the taken measures within the city. If there is more involvement of citizen in the process, the carrying capacity will be higher. The interesting question is how to involve a diverse group of citizens in the project. Prior studies show that many people make only a small contribution to a citizen science project and a small number of people contribute the largest part (De Moor et al., 2019). It is interesting to dive into the group of people that contribute to a citizen science project. Is it a diverse group of people and what are their considerations to involve in such a project? In this research the role of citizen science in the process to more climate adaptation is investigated.

In the report, there is great attention for the role of citizens through citizen science. 'Citizen science is a way to make people aware of their environment and to involve them with taking measures' (Report on climate adaptation, 2021, p 14). Because the term of citizen science has multiple interpretations it is important to dive into the definition that the report is using. According to the report, citizen science is about the design, execute or collecting of data through non-scientists (Report on climate adaptation, 2021, p14). It is thus about the involvement of citizens in collecting

data about the environment. This has benefits also for the costs of these monitoring programmes. It is a cheap way for scientist to collect data together with citizens and citizens learn in that way about the topic of research (Report on climate adaptation, 2021, p37).
There can be found two different forms of citizen science in the report of citizen participation in climate adaptation. The first one is crowd sourcing/sensing, which has as main goal to collect data. The second one is more focused on community building and is called participatory monitoring. Which has a specific focus on collecting data and next to that on community building. Where the goal is to connect people with each other and with their environment. There are two different forms of citizen science which has both a different goal. For the cases of Apeldoorn and Amersfoort these different forms will be researched and there will be tried to find out what is the main goal of the citizen science projects.
The report is clear about the benefits of citizen science in the process to more climate adaptation. These benefits are shared between the citizens that involve, the scientists and for the policy practice. The main driver for the use of citizen science is the collection of the data, the benefits for the involved citizens and the policy practice is a bycatch. It becomes clear that it is mostly done to get insight into the environment.

2.4 Conceptual model

In this section the conceptual model will be presented. Based on the theory section, the model is made. The conceptual model is presented below in figure 4. The need for climate adaptation is there because of the changing climate. With a different impact on the local scale, citizens can have diverse needs. Climate adaptation measures are needed within the city to keep it liveable and to meet the local needs.
In the conceptual model there is attention for the role of citizens. With the rise of citizen science in the last years, it is interesting to dive into this new field of information. What could be the impact of science that is brought in by citizens? Next to the citizen science, citizens can contribute to the participation with their own local experience or local knowledge. Because they are local inhabitants, they do have expert information about the area. This citizens knowledge would have an influence on the task of the government.
Governments are increasingly shifting to more participation of citizens in the process of more urban greenery for example (Uitenbroek et al., 2019). Governments involve citizens in the process of climate adaptation. With more urgence in adapting the city, municipalities are seeking the local needs and taking measures. In addition to that, the new environmental law, has a requirement of participation in the programmes to adapt the city to climate change by changing the urban area. Governments do have an obligation to involve citizens within the process.
As a result of this, it is interesting to see what the influence of the participation process will be into the climate adaptation in the city centre of Apeldoorn and Amersfoort. The interaction between the municipality and the citizens, the power of citizens, and the goal of the participation process is the bottom line in the conceptual model. These three variables are key factors in the participation process.

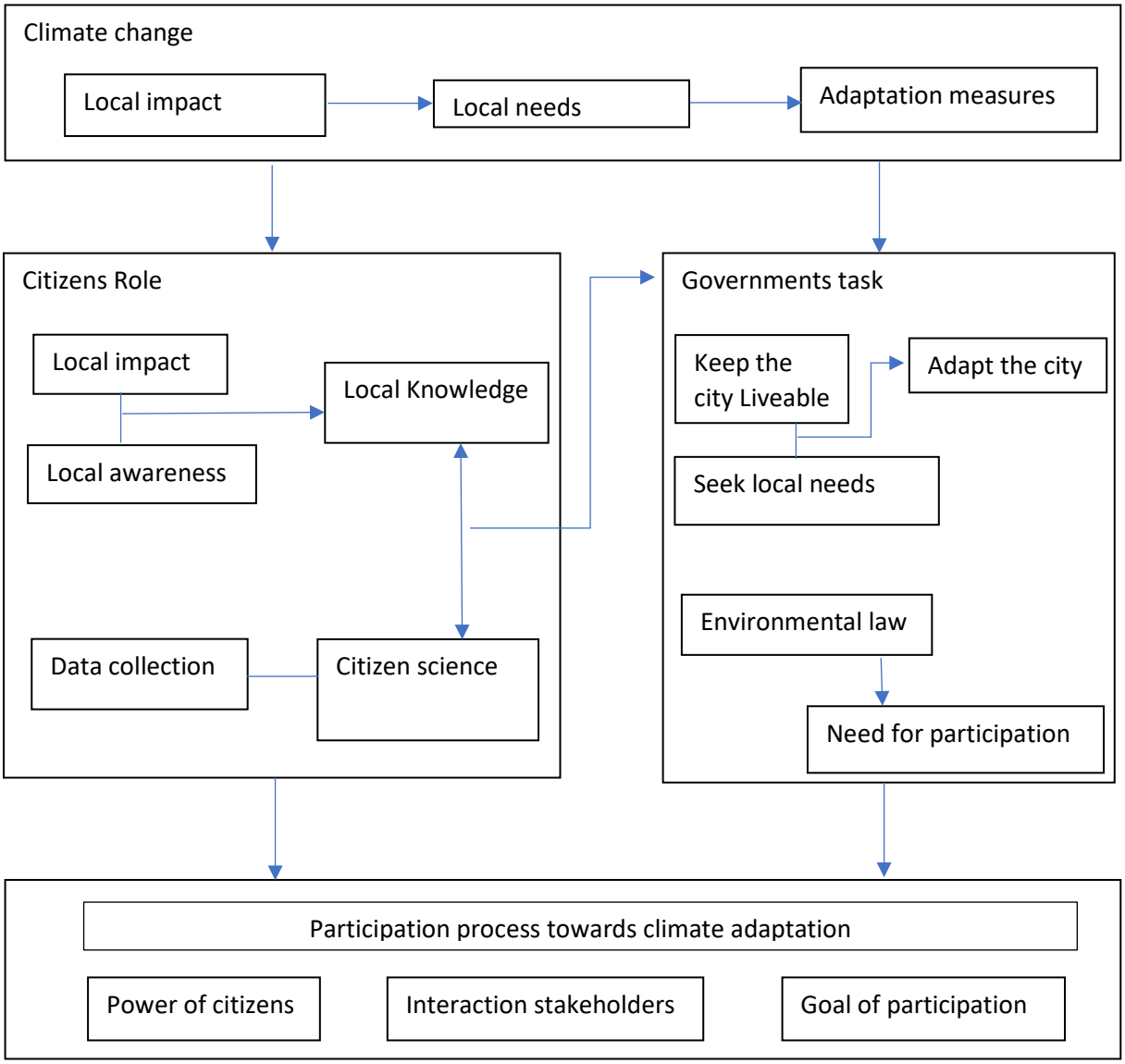

Figure 4: conceptual model, own creation

2.6 Operationalisation

In this section of the research the operationalisation part will be stated. When doing research, one important thing is defining the main concepts. At first for the researcher itself to know and state how every concept will be researched. But on the other hand, also for the reader. What definitions of the concepts were used by the researcher? This is important to understand the taken research and helps to avoid misinterpretations and therefore wrong conclusions. The main idea of the operationalisation chapter is how every different concept is defined. The core variables need to be defined properly. This is needed because concepts can be interpreted in diverse ways (Verschuuren & Doorewaard, 2021). In empirical research it is required to define specifically the researched variables to avoid losing focus (Verschuuren & Doorewaard, 2021). With the literature, definitions are made in a stipulative way. It is not only about what literature talks about the definition but also about a chosen way of the researcher. This will help to steer the research and to gather data during the interviews. In the appendix, the operationalisation table will be presented.

The following different concepts are operationalised: Climate Change, Citizens Role, Governments task and the participation process.

Climate change
Our climate is changing, and we need to adapt ourselves to keep our environment liveable. Especially cities need to adapt themselves because these areas are the most vulnerable. As stated in the literature section, cities are dense areas and are therefore more exposed to problems such as heat islands and flooding issues (Geneletti & Zardo, 2016). With climate change is meant the shift to more extreme whether in the Netherlands. More occurring heat waves in the summer times and more extreme rainfall. The changing climate results in more outliers in the weather. Cities need to adapt to stay liveable under these new circumstances (IPCC, 2022). In this research climate change is the cause for cities to adapt themselves. There are next to climate change other reasons to make the city climate adaptive, for example more green also has a benefit on the wellbeing of citizens, but climate change is one of the main reasons for cities to adapt themselves.

Citizens Role
As can be found in different articles about the case of the Climate Street in Apeldoorn, citizens do play a role in making this street climate adaptive. Two important indicators that are chosen for this research are citizen science and citizens knowledge. These two indicators need to be further elaborated in this researched to make them usable for the interviews. Citizen science has not one clear definition in the literature. Some state that it is only about collecting data and others state that it is also about the interpretation of the data. Which makes it harder to define the concept of citizen science. To structure this research there is chosen to use the following definition of citizen science:

'Citizen science encompasses a collaboration and partnership between professional scientists and volunteers in scientific activities, which may take different forms, from data collection to comprehensive participation in problem identification, methodology design, analysis, and dissemination of findings. Within this context, citizen science has the characteristics of upstream engagement which contributes to the creation of shared responsibility amongst scientists, policy actors, and the lay public.' (Skarlatidou & Haklay, 2021, p4)

As can be seen in de definition of Skarlatidou & Haklay, citizen science is a broad concept. For this thesis research it is important to state that citizen science is about citizens that participate in collecting data that is used for climate adaptive measures. What can be the role of citizen science in the participation process to more climate adaptation? Next to the data they collect, they also interpret this data by themselves, and it can cause awareness about the impact of climate change within their own environment.
Next to citizen science, citizens knowledge is researched. What can citizen do with their own local knowledge in the participation process to more climate adaptation. Citizens are local experts in their own environment. Because they live there for a longer period, they have specific knowledge about their neighbourhood.

Governments task
Within changing the urban area and make it climate adaptive, the local government has a central task to protect their citizens. Climate change is demanding change within the urban area to keep the

city liveable and pleasant to stay (IPCC, 2022). There is a task for the government to keep the city liveable and therefore make it climate adaptive. With more green for example the city will become more climate adaptive. In this research there is investigated if the government takes their task seriously and how the new environmental law does play a role. The new environmental law that will be introduced in July 2023, is demanding for more participation. This means that governments do have the task to involve citizens within different projects in the urban area. On the one hand there is the task for the government to make the city climate adaptive, and on the other hand there is a task for more participation in the process to climate adaptation. Within the interviews there is researched how the government sees their role and what motivations they have in making the city climate adaptive.

Participation process

When talking about the variable of participation, it is interesting and needed to operationalise this properly. As Arnstein (1969) stated a long time ago, there are different forms of participation existing. The ladder of participation helps to understand and distinguish differences between forms of participation. The three different layers that are the most applicable and helps to do research of the participation in the case are the three different degrees of participation. Which are: non-participation, degrees of tokenism and citizen power. What forms of participation are existing in the case that is researched. In addition to that, the engagement of the citizens in citizen science initiatives is researched. To what extent are the interviewed respondents engaged in the citizen science communities. The engagement ladder of Skarlatidou & Haklay (2021) contributes to this part. How much involvement of citizens is desired and feasible?

Lastly, the role of trust in the participation process is researched. Trust is an important variable in the participation of citizens (Robinson & Bond, 2003). The interaction with between the citizens and the government would be better if there is trust among both parties. There will be attention for the role of trust between the municipality and the citizens in the participation process.

3. Methodology

3.1 Research Philosophy

'The term research philosophy refers to a system of beliefs and assumptions about the development of knowledge' (Saunders & Lewis, 2019, p130). It is significant to state the philosophy that lays behind the research. Everyone looks to the world with a specific view. Conscious or unconscious, the researcher will make assumptions during this research. 'Still, conscious choice or not, the philosophy of science applied by researchers greatly influences which subject they will study and how the research is conducted' (Van Thiel, 2014, p31). It is therefore important to mention the philosophy of this research to enhance transparency. When stating the research philosophy, two main components are to be mentioned. The epistemology and the ontology. Ontology is about how we see the reality (Moon & Blackman, 2014). Is there only one reality or are there multiple realities possible? Epistemology is about how we create knowledge (Moon & Blackman, 2014).
For the component of ontology, relativism is the most applicable. There are multiple, intangible mental constructions, local and specific in nature dependent on the group or individuals for their form and content (Guba & Lincoln, 1994). Within this case study towards the role of citizens in adapting the city to climate change, the local environment is important. The goal of this research is to find out what impact citizens can have in the participation process. This is not statistical research with a number as outcome, but more about how citizens can play a role in the participation process. There will be not one main outcome but there are more interpretations possible.
The epistemology is subjectivism. There is, as stated before, not one main answer to be expected. Different citizens can have a different view on the way they could play a role in the participation process to a more climate adaptive area. The role of citizens knowledge is researched and afterwards interpreted. The philosophy of this research is therefore constructivism. Because the knowledge that citizens brings in in the participation process is made by themselves. They interpret this knowledge by themselves and can differ between each other. The goal of this research is to get an insight into what citizens can do with their specific knowledge in the climate adaptation process.

3.2 Research strategy

'A central element of the research design is the choice of which strategy to follow and what methods and techniques to apply' (van Thiel, 2014, p57). It is important to state how the research will be taken and why different methods are used. The strategy for this research is a comparative case study. This research will focus on two cases. The case of Apeldoorn and the case of Amersfoort. Both cases are mid-sized cities in the Netherlands. There is a Climate Street in the city centre of Apeldoorn which has the goal to become climate adaptive and which is a pilot area to evaluate adaptation measures. By a cooperation between the government and citizens, climate adaptation is improved in the area. The initiative of IOT Apeldoorn did conduct the monitoring in the Climate Street project.
In Amersfoort, the citizen science initiative of Meetjestad is doing research at climate change impact within their city. Citizens monitoring the impact of climate change in Amersfoort.
This research has a qualitative approach. Because of the information that is needed in answering the main question. When there is a limited amount of existing knowledge in the research field, statistical research can be hard (Van Thiel, 2014). The goal of this research is to get an insight in how citizens can use their knowledge in the process towards climate adaptation. Therefore, a qualitative research

approach is conducted. The two cases will be compared because of the difference between them. Multiple cities around the world are recently collaborating with citizen science initiatives. It is interesting to do research in this 'new' cooperation between the municipality and the citizen initiatives. The two cases are chosen because they differ. In Amersfoort, the municipality seem to have a different role in comparison to the Apeldoorn case. The municipality of Apeldoorn is more a leader, and the municipality of Amersfoort is more a facilitator. The consequences of differences between the two cities will be compared. The differences between the role of the municipalities, and the different role that citizens can have will be researched.

3.3 Research methods

The first source of information for this research is a literature study. When diving into the already existing literature about citizen science and climate adaptation, the first knowledge is created. This information will be useful in the operationalisation section. This operationalisation will help to identify the variables in the research (Van Thiel, 2014). Secondly, there will be a content analysis of other documents. Recently, multiple universities of applied sciences in the Netherlands have published together a report about citizen participation in climate adaptation (December 2021). This report will help to identify different forms of participation in climate adaptation. By doing this content analysis, different codes within participation in climate adaptation can be found which could be useful in the interviews. This document analysis will be useful to evaluate the findings in the case of Apeldoorn & Amersfoort. Next to the report there will be policy documents and other available documents of the two cases analysed. For the case of Amersfoort, the initiative of Meetjestad provided a document about their values and their activities. This document is analysed to get a first insight into this initiative. For the Apeldoorn case multiple articles were shared by the municipality. These articles helped to get a first impression of the Climate Street in Apeldoorn.
Thirdly, this qualitative research will contain interviews. Semi structured interviews with citizens and the municipalities will take place. 'Semi-structured interviewing is to gain detailed and focused insights into how individuals perceive a topic of interest to researchers' (Silverman, 2015, p149). With the interviews, the goal is to find out what role citizens can have in the transition to more climate adaptation. The semi-structured interviews give the opportunity to identify emergent themes through naturalistic conversation (Silverman, 2015). The purpose of the interview is to see what kind of themes interviewees have in mind when talking about their role in the climate adaptation process. The best way to find out of their opinion is by semi-structured interviews and not steer to much but let the conversation be natural. To get an overall view of the cases it is important to interview different actors. These two different stakeholders could have a different view, and it is therefore needed to interview them both. By doing semi-structured interviews the goal is to understand how key stakeholders perceive and understand an issue (Silverman, 2015). But the focus of the interviews will be on the citizens.

Conducted interviews

In this research nine semi-structured interviews were conducted. These interviews were the main form of data collection for this research. For the case of Apeldoorn five interviewees were found and for the case of Amersfoort four interviewees. Some interviews were held online due to lack of time from the respondents or the travel distance that was too long. Other interviews were held in real life on various locations.

For the two cases the researcher was interested in both sides of the involved stakeholders. That is why the researcher interviewed one person from each municipality and the other interviews were with persons that engage in the citizen science initiatives. One interview was held with the company Connected Green. This business supported the monitoring activities in the project of the Climate Street. The persons from the municipality could give me insight in the role of the governmental parties. Why and how is the government collaborating with these citizen science initiatives? It is interesting to dive into the role of the government to see how the participation is working out. The interaction between the municipality and the citizens is researched.
The biggest number of interviews were with people who are a volunteering in the citizen science initiatives. These persons will give insight in their reason to contribute to these initiatives and what their impact could be in the adaptation to a more climate proof city. They will also talk about the interaction with the municipality and how it could be improved. In the table below the interviewees are presented. The researcher gained permission to use the names of the interviewees in this research.

	Name of interviewees	Case	Date
1	Bernie Ter Steege (Municipality)	Apeldoorn	01.06.2022
2	Remko Welling	Apeldoorn	08.06.2022
3	Sandra Sijbrandij (Municipality)	Amersfoort	13.06.2022
4	Jeroen van Bussel	Apeldoorn	14.06.2022
5	Marcel Meek	Apeldoorn	14.06.2022
6	Jan Roemer	Amersfoort	24.06.2022
7	Kamiel Niezink (Connected Green)	Apeldoorn	29.06.2022
8	Ger Hanssen	Amersfoort	06.07.2022
9	Harmen Zijp	Amersfoort	26.08.2022

Figure 5: List of interviewees (Own creation)

For the results chapter I will reference multiple times to these interviewees. I chose to number each interviewee from 1 to 9 to make it easier to read the results chapter. Due to this choice I reference to each interviewee with a number. Interviewee 1 is Bernie ter Steege. The researcher will reference like this (interviewee 1, personal Communication, 2022).

Interview Guide & Data Analysis

The interview guide is made in line with the conceptual model. The interview guide is semi-structured to ensure all needed information is requested in the interviews. The semi-structured interview guide is a guideline for the interviews (Van Thiel, 2014). When formulating the questions for the interview, it is important to be clear and make not too long sentences (Van Thiel, 2014). The interview guide is presented in the appendix of this research. For each different interview person, the guide is adjusted a bit to better fit the respondent's role.
Last to mention in this section is about the data analysis. When doing qualitative analysis, it is important to structure all the data you have collected (Van Thiel, 2014). The transcripts of the interviews will be the main data source that needs to be analysed. By using Atlas.TI, coding of the data will be done. 'This process is often one of trial and error, which places great demands on the researcher in terms of creativity and logical thinking' (Van Thiel, 2014, p143). 'Codes can be assigned to all kinds of things: opinions, behaviours, motives, activities, meanings, relations, situations, events,

or perceptions' (Miles & Huberman, 1994, p. 61). The first cycle of coding is the first step of structuring the gained data. Doing this first cycle coding helps to filter the relevant themes out of the whole transcript. In the second cycle of coding, the most important themes are named, and the data could be organised. In other words, Code groups are made. With the code groups, the data is structured which make it more applicable to analyse. Coding helps to structure all the data that is collected and makes it therefore usable for analysis (Van Thiel, 2014).
In the final phase, the researcher will try to generate new theories to answer the research question. 'The different codes are compared and contrasted with each other to search for patterns, cause and effect relations, and other forms of interconnection' (Van Thiel, 2014, p148). During this phase, the researcher searched for patterns. Multiple code groups were compared and merged if possible. This supported the structuring of the data analysis.

3.4 Validity, Reliability & Ethics

First the difference between the two concepts of validity and reliability will be elaborated. Validity is about if the measurements that are done are fitting to the research that is done. Do the research methods help to answer the questions? Reliability is about the repeatability of the research. Would you get the same result if you repeat the whole research? And would the result be the same if someone else would do the research? Reliability is harder to achieve because this research contains semi-structured interviews. 'The impact of the interviewer and of the context means that consistency and objectivity are hard to achieve' (Denscombe, 2010, p 193). This has an adverse effect on the reliability of the research. It is important to keep that in mind. Therefore, the researcher will report the decisions that are made during the research process and elaborate as much as possible on the interviews that were conducted. Documenting during the research helps to enhance the reliability of the research. In that way it becomes visible which decisions the researcher made and more important why they are made.
Next to the reliability, the validity is another vital aspect of the research. Validity is about the accuracy and precision of the collected data (Denscombe, 2010). It is crucial for the validity to first operationalize the important variables in the research. If the operationalisation results in confusion, due to a lack of defining and/or exclusion of the variables, the validity of the research conclusion would be affected (Van Thiel, 2014). Stated this, it is from vital consideration to think through the operationalisation of the research variables.
Lastly, some statements about ethics. 'Research should never be misleading' (Van Thiel, 2014, p154). It is important for the participants that they know what the research is about. At the start of each interview, the researcher tells the goal of the interview and introduces the topic. In addition to that, the researcher must gain permission from interviewees to use the data and share the results (Eisenhouwer & Wynaden, 2021). The researcher asked at the start of each interview for permission to record the interview and if the respondents name could be used in the thesis. There was permission from all interviewees.

3.5 Case Climate Street Apeldoorn

In the city of Apeldoorn, which is in the province Gelderland in the Netherlands, a street is proclaimed to be the climate street. In the city centre of Apeldoorn two streets are together part of the Climate Street. In this area, climate proof measures are taken. Different stakeholders work together in adapting the two streets to the changing climate. With a specific focus on heat problems and flooding issues.

The last years these two streets started to be outdated and becoming deteriorated (Municipality Apeldoorn, n.d.). It became clear that there must be done something to regenerate the success of the streets. By working together, with inhabitants, property owners, government and shop owners, co-creation of the place started. One of the interesting parts in this case are the tools they use to monitor the impact of the measures. The citizen initiative of 'IOT Apeldoorn,' provides the measurements of the impact from the adaptive measures that are taken (Municipality Apeldoorn, n.d.). In that way they are monitoring the effect of the measures and can assess innovative ideas to see what the effect is. It helps to improve the liveability and sustainability of the area.

In the municipality of Apeldoorn, they do have a great ambition to green the city centre. With more green and less concrete, they want to make the city climate adaptive. Next to that it will also generate more success for the inner-city area.

By this participation project, the government tries to gain more support for the measures that are needed to adapt the city to climate change. The project of the Climate Street started three years ago, in 2019, and is finished by now. The monitoring of the area continues and is extended in the city centre. More areas in the city centre of Apeldoorn are monitored now (Personal communication, T. Straatsma, 2022).

3.6 Case Meetjestad Amersfoort

Next to the case of the climate Street in Apeldoorn, which is specific, there is another case for this research. In Amersfoort there is for a couple of years an active group of citizens that collect different interesting data within their neighbourhood. In 2015 the initiative of Meetjestad Amersfoort started. Currently, citizens In Amersfoort monitor the environment of their city. It is a combination of the smart city and the climate proof city (Baggerman, 2020). Together with other cities within Europa, they share their experience and knowledge under the name of ScoreWater (Meijer, 2020). With other cities in Europe, they share their findings and help each other to improve the citizens science projects towards more climate adaptation. These forms of citizen science are on the rise and deserve attention. In Amersfoort, the municipality collaborates with the citizens but gives room for their research strategy and focus (Baggerman, 2020). In comparison to the case in Apeldoorn, the Meetjestad initiative has more freedom in what to monitor. The municipality is less involved in this case in comparison to the Apeldoorn case.

4. Results

4.1 Case of Apeldoorn

The first case that will be presented is the Apeldoorn case. In this case there was a focus on the Climate Street project which started in 2019. The Climate Street in Apeldoorn is assigned by the municipality to become climate proof. Within the city centre of Apeldoorn, two streets are part of this Climate Street. Different climate adaptive measures are taken, and the impact of these measures are monitored by citizens. In Apeldoorn, the municipality worked together with the initiative IOT Apeldoorn to monitor the impact of the climate adaptive measures. This initiative is interested in the internet of things (IOT). It is a citizen science community that is based in Apeldoorn. In the next paragraphs there will be referred to as IOT Apeldoorn.

4.1.1 Background information

Apeldoorn is a city in the province of Gelderland with around 140.000 inhabitants. Apeldoorn is located nearby the national park de Hoge Veluwe. The city has a green image and is known for its city parks.

For the case of Apeldoorn different documents were analysed for this section. The municipality provided some documents of the Climate Street and there were some extra documents found on the internet. But most of the findings are gained via the conducted interviews.

The case of Apeldoorn has a focus on the so-called Climate Street. In the city centre of Apeldoorn, two streets are transformed into an area where climate adaptive measures were taken. The street needs to become climate adaptive. With more heat and more heavy rainfalls due to climate change, the street is changed to become climate adaptive. The city centre needs to be attractive and climate proof. The climate adaptive measures will be stated in the next paragraph.

Citizens monitor the impact of the measures. The citizen initiative of IOT Apeldoorn provided the monitoring of the area. Next to the involvement of the IOT Apeldoorn, which will be further elaborated later, the company of Connected Green helped with monitoring the area. Connected green provided the soil humidity sensors (Interviewee 7, personal Communication, 2021). Connected green is a commercial party that focuses on better water use for greenery and therefore tries to reduce the impact of draught.

The Climate Street in Apeldoorn is functioning as a pilot project for other cities within the province of Gelderland (J. Poldermans, 2021). There are multiple municipalities that monitor their city and by doing so, they can learn from the effectiveness of the measures. The climate street was partly financed by the national government under the terms of sharing the knowledge of this pilot project with other cities (J. Poldermans, 2021). Monitoring the effects gives insights in if the changes in the city have a positive impact. In that way it becomes clear if the measures that are taken are worth it.

4.1.2 The project Climate Street

'The government of Apeldoorn has made a promise, a few years before the Climate Street project, to the business association in the city centre that the street would be redesigned' (Interviewee 1, personal communication, 2022). There was an obligation for the municipality to reinvest in these two streets in the city centre. The business association demands the municipality that it was about time to reinvest in the area. Next to the involvement of the business owners, there was also a momentum for climate adaptation because of two hot summers during the start of the transformation

(Interviewee 1, personal communication, 2022). The municipality started to make some plans for these two streets in the city centre of Apeldoorn. The Marktstraat and the Beekstraat, which are both located in the city centre of Apeldoorn, are together called the Climate Street. The goal of the Climate Street was two sided. On the one hand to show the city how to become climate adaptive and on the other hand to make it more attractive. 'It is important to make the city attractive for people to stay and go for shopping' (interviewee 1, personal communication, 2022). The playing element of the small fountains that are placed in the streets is another key factor for the municipality, it needs to be nice but also fun to stay (Interviewee 1, personal communication, 2022). The municipality wanted some elements in the climate street to stimulate playing. It needs to be fun for children. This is a goal that fits in the broader goal of the municipality of Apeldoorn to be a comfortable family city.

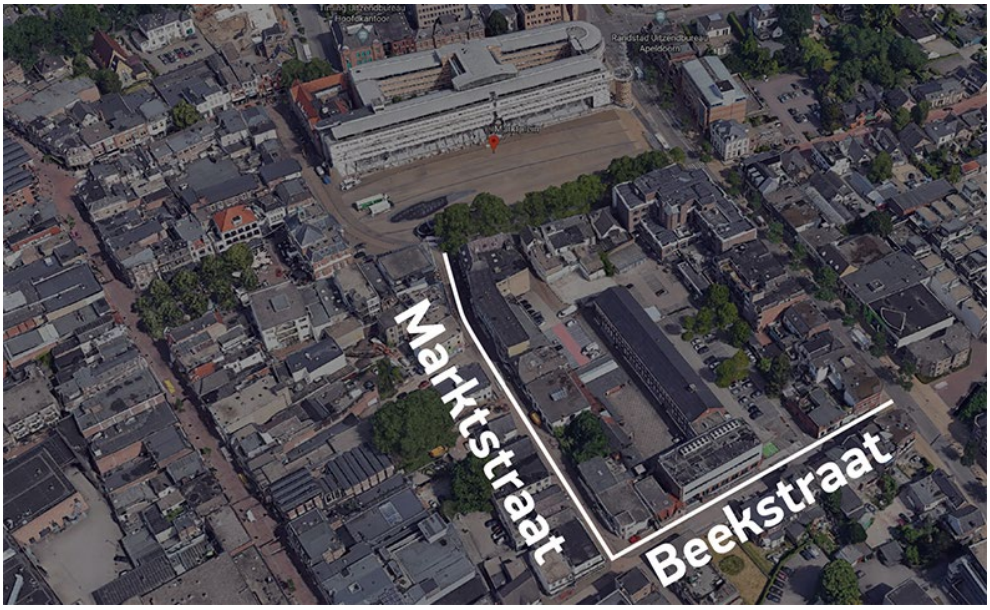

Figure 6: Climate Street Apeldoorn (municipality of Apeldoorn)
https://www.apeldoorn.nl/klimaatstraat

The project of the Climate Street was started because of the heat problems in the inner-city area in Apeldoorn (Interviewee 4, personal Communication, 2022). The role of monitoring the area was to get an insight into heat stress in the centre of Apeldoorn (Interviewee 3, Personal Communication, 2022). The municipality asked the IOT Apeldoorn to help and provide the monitoring in the climate street (interviewee 4, personal communication, 2022). The goal of monitoring in the climate street is to make people aware of the impact of the Climate Street and connect them more with the impact of climate change (interviewee 1, personal communication, 2022). The IOT community consist of between ten to twenty active members and started in 2016. All members are volunteers in this initiative and have a shared interest in technique. They are interested in collecting data about various aspects of the environment and the internet of things network. It started with monitoring the impact of fireworks on New Year's Eve (interviewee 4, personal communication, 2022). The IOT community build devices to monitor the impact of firework on particular matter levels. This gained interest by some council members of the Municipality of Apeldoorn. The first contact between the municipality and the initiative was made. Due to this first contact the municipality started a cooperation with the IOT community during the Climate Street project.
By sharing the collected data, it becomes visible for citizens what the real impact is of the climate street. Make the impact visible in data. It was not focused on changing the area afterwards because

of the outcomes of the monitoring in the Climate Street. But other places in the city that will be transformed in the future can learn from the outcomes of monitoring the Climate Street. For example, there are plans to place multiple trees nearby the area of the Climate Street. There is the desire to create more space for urban green in a robust way (interviewee 1, personal communication, 2022). The Climate Street was a good start and created a wish to make climate adaptation even more present in other parts of the city. More climate adaptive measures are expected in the city of Apeldoorn partly as a cause of the success of the Climate Street project.

4.1.3 Climate adaptation measures

The climate street is a pilot area for the other streets within the city. It is about making the street climate proof and create an important impulse for playability for kids and more attractive for visitors (Interviewee 1, Personal Communication, 2022). The goal of the climate street, according to the municipality, is to show the rest of the city how to create a climate proof area. There was a focus on heat and focus on implementation of green in the area (Interviewee 1, personal communication, 2022).

The main problem that must be fixed in the climate street was the heat issue (Interviewee 1, personal communication). With a nice momentum of two hot summers the need for change was made clearer. In addition to that, it was about showing the city that climate adaptation makes the city also more attractive (interviewee 1, personal communication, 2022). Various parts in the Climate Street were changed. There was a lot of concrete in these two streets which causes heat stress (interviewee 5, personal communication, 2022). One of the measures against heat stress in the Climate Street is more space for blue infrastructure in the area. Small fountains are placed and there is a little river to cool down the area, see figure 7. It fits also to the goal of the municipality to improve the playability for kids in the city centre. In addition to that, there is also a disconnection of rainwater in the Climate Street. The use and storage of water is changed in the area to be more resistant in times of draught and rainy days. During times of rain the water is stored in a cistern under the ground (interviewee 1, personal communication, 2022). This water is stored for the times of draught. With the impact of climate change there are more times of extreme rainfall and periods of extreme draught. The cistern will help to make the Climate Street climate proof. The water that was left over from rainy days is used in times of more draught. A better use of water within the city.

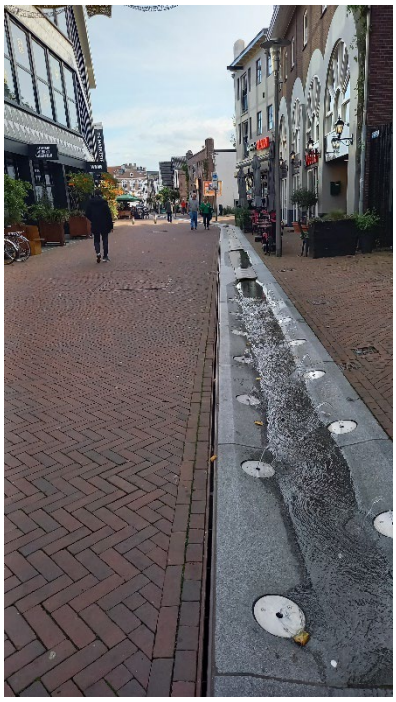

Figure 7: Fountains in climate street, own picture

Next to the implementation of water there is also placed some façade green in cooperation with the business owners. More green is a way to make the city more climate adaptive. It helps cooling down the area. There are also placed a few trees in the project area (Interviewee 1, personal communication, 2022). It can be hard to implement a lot of greenery in the city centre, because city centres are designed for shopping. Currently more green is implemented in more upper scale projects in the city of Apeldoorn (interviewee 1, personal communication, 2022). In Apeldoorn different measures are taken to make the space climate adaptive. ‘A combination of measures is

required for all-inclusive climate vulnerability reduction (Voskamp & van de Ven, 2015, p163). The different climate adaptation measures in Apeldoorn, shows that theory meets practice.

4.1.4 Climate Street as a Pilot

The case of the climate street is a showcase to show the rest of the city how climate adaptation could be done. 'The climate street was some sort of catalysator for the bigger project of park city Apeldoorn' (interviewee 1, personal communication, 2022). Within the municipality of Apeldoorn there is the goal to create the park city Apeldoorn. Due to the Climate Street, urban green within the city is becoming more valuable by citizens. Urban green improves mental health of citizens and makes the city more attractive (Ponizony et all., 2017), the interviewed citizens also see this. 'With the start of the Climate Street a few years ago, we really needed to convince the citizens of the need for climate adaptive measures' (interviewee 1, personal communication, 2022). Currently, citizens accept and understand the need for more urban green in Apeldoorn, it is no discussion anymore. It is a given that we need to adapt to the changing climate. Citizens are changed in that way during the past five years.

'The climate street was a pilot project from the national government' (interviewee 1, personal communication, 2022). There was a subsidy gained by the municipality of Apeldoorn from the national government to start a pilot. The subsidy was gained because the Climate Street had climate adaptation measures. The subsidy from the National Government required monitoring in the pilot. The impact of the measures must be monitored to show the impact of urban green on temperature levels for example in the Climate Street. Next to the monitoring activities, Connected Green provided some measurements about humidity. The company Connected Green contributes with their monitoring activities to the maintaining of the greenery in the Climate Street (interviewee 7, personal communication, 2022).
Apeldoorn needed to share their findings of the pilot with other municipalities. The pilot was about showing how a city centre could be attractive and how climate adaptation would play a role in this goal. It is a showcase for other cities but also for other parts of the city of Apeldoorn. The Climate Street is a pilot area for the other streets within the city. Goal of the climate street according to the municipality is show the rest of the city how to create a climate proof street. Focus on heat and focus on implementation of green in the area (Interviewee 1, personal communication, 2022).

Currently there are plans from the municipality to make the monitored data visible on a dashboard in the city (interviewee 1, personal communication, 2022). The idea is that citizens who walk by, can see what the difference is in temperature under a tree or below a normal façade. The goal of that dashboard is to make people more aware about climate change impact and the effects climate adaptation measures. Make it visible for citizens. This creates more awareness among citizens about climate change impact and about the usability of the taken measures. The project of the climate street is not finished yet. Still improvements can be made and there is sought for more space for green and other climate adaptive measures.

4.2 Case of Amersfoort

The second case that will be presented is the case of Meetjestad Amersfoort. Citizens are sharing and creating knowledge together in the citizen science community Meetjestad Amersfoort. Meetjestad is located at the War building in Amersfoort. With monitoring their environment, data about climate change is collected. Meetjestad is cooperating with Bergen in Norway and Utrecht & Tilburg in the Netherlands. They share knowledge among these cities.

4.2.1 Background information

Amersfoort is the second biggest city of the province of Utrecht. With around 160.000 inhabitants it has a comparable size as Apeldoorn. The municipality of Amersfoort had the desire to involve citizens in the process of climate change. The citizen science initiative of Meetjestad was founded together with the Municipality of Amersfoort and some citizens. In paragraph 4.2.2 there will be an elaboration on the foundation of Meetjestad Amersfoort.
For the case of Amersfoort there was an interesting document available to analyse on the internet. This book about Meetjestad Amersfoort, provided some interesting insights in the goal of the Meetjestad Initiative. It is a bit outdated (2017), but still interesting to read and analyse. Analysing this book resulted in the first information about Meetjestad Amersfoort.

'The Meetjestad initiative is a project where involved citizens in and around Amersfoort monitoring the climate and research their own environment' (J. Kremer, 2017, p1). The reason Meetjestad started, was because the municipality and the water boards wanted to involve citizens of Amersfoort in research into climate change impact. There was a wish to start this initiative to involve citizens in climate change. The KNMI (the national weather institute) provides measurements outside the city boundaries. The municipality of Amersfoort was interested in data about the climate of the inner city, which is collected more on a micro scale and should be available on an open network for everyone (J. Kremer, 2017). The main goal of Meetjestad Amersfoort is monitoring climate factors in Amersfoort.

'Collecting data through monitoring is useful, but the awareness that the climate is changing is the most important' (T. Telkamp, 2017, p9). Telkamp states in the book of Meetjestad Amersfoort, that climate change is not prevented by monitoring, but it helps to think about how to adapt to climate change. It makes you aware of what happens in your environment. Citizens monitor their environment to think about adaptation strategies and to research the impact of climate change on the local scale.
The municipality of Amersfoort stated in the book about Meetjestad that it is needed for municipalities to trust citizens and you must be able to let go (S. Sijbrandij, 2017). For municipalities it can be hard because it can feel like experimenting. It is therefore interesting to see that the municipality stated this in the book about Meetjestad. In the interviews there is special attention to this freedom for citizens and this new role of the municipality.
The people from Meetjestad Amersfoort have a core group of volunteers which is led by three citizens. They are taking responsibility for the interaction with the municipality. The most volunteers that are participating in Meetjestad do not interact with the municipality.

4.2.2 In-depth information

Meetjestad is founded in the War building, which is a breeding place in Amersfoort. The War is a place for social activities and a space to meet with others. This means that it is a place where citizens collectively create social value (interviewee 9, personal communication, 2022). With Harmen & Diana form the War, Sandra from the municipality and Dimitri from the waterboards, Meetjestad was made (Interviewee 9, Personal communication, 2022). The municipality of Amersfoort had a desire to connect more citizens with their living area. With the idea that if people were doing research in their own surroundings, citizens would be more connected with their environment and therefore it would lead to a better environment (interviewee 3, personal communication, 2022). The main idea for the municipality was to connect more people with climate change. With citizens doing research, more people become connected with the concept of climate change problems like heat and heavy rainfalls. One of the goals of the municipality was to let people remove concrete out of their gardens. But the responsible person from the municipality did not like the idea that the government is a leader who demands people to act (Interviewee 3, personal communication, 2022). For that reason, they want to focus on citizens that do research themselves. The idea of starting a citizen science community came from bat research that was held with the municipality in Amersfoort. Once a year, a group of 30 to 40 volunteers cycled around town to find some bats. A lot of people were interested in the concept of doing research and that was noticed by the municipality (Interviewee 3, personal communication, 2022). Because of that, the municipality thought citizens like to do research in their own area. At this point the responsible person from the municipality contacted people from the War. The War is a place for bottom-up ideas and a does consist of a connected community. At the War, the Cooperative University of Amersfoort was founded. Because Amersfoort is a city without a university, we taught we made a university ourselves (Interviewee 9, personal communication, 2022). This university of Amersfoort did do research with volunteer citizens that live in Amersfoort. The contact was made between the municipality and the community at the War. And the same shared idea was there to start a collaboration. Meetjestad Amersfoort was found in 2015.

In the picture of figure 8 below, one monitor device can be seen. This device is new and currently a few months active monitoring the thickness of the tree. In the initiative of Meetjestad they do have a focus on trial and error. Currently they try to research climate change with devices around the city with a device that monitors among others temperature and humidity. Recently, one volunteer designed another model. ‘It is measuring the thickness of the tree, and it could even be a better way to measure the impact of heat and draught than all the other devices’ (interviewee 9, personal communication, 2022). They are still searching for the best way to monitor on the best viable way. The next step is about interpreting the collected data. It is about what can we do with the data we have collected to make the change into action (interviewee 9, personal communication, 2022).

Figure 8; own picture of monitor device Meetjestad Amersfoort

4.2.3 Climate adaptation in Amersfoort

In this part of the research the difference between the two cases becomes visible. In Amersfoort there are currently no climate adaptive measures taken because of the initiative Meetjestad. The municipality of Amersfoort is working with climate change for the past 15 years. Different measures are taken in the city like more green and other climate adaptive measures. But climate adaptive measures are not taken yet due to the monitoring activities of Meetjestad Amersfoort. 'We are now in the phase of analysing the data we collected during the past years (interviewee 3, personal communication, 2022). It is currently about using the collected data to take climate adaptive measures. For the case of Amersfoort, it was interesting to see that the municipality was financing the initiative although Meetjestad did not have a hard result they promised to deliver. The seven past years there are no measures taken against heat due to the initiative of Meetjestad (interviewee 3, personal communication, 2022). The idea of Meetjestad is creating knowledge about climate change and climate impact. The phase of taking real acting will follow the coming years (Interviewee 9, personal communication, 2022). Meetjestad contributes to the knowledge about climate change (interviewee 3, personal communication, 2022).

As can be seen in Amersfoort there are no climate adaptive measures taken with the involvement of the citizen science initiative. The municipality of Amersfoort is active on the process to climate adaptation, but the involvement of Meetjestad did not cause changes in the urban area.
In Apeldoorn, the IOT community is monitoring the effects of the taken measures. The municipality of Amersfoort provides more freedom for the citizen science initiative in comparison to the municipality of Apeldoorn. In Apeldoorn, the outline of the project of the climate street was already made and the IOT community only had a voice in the monitoring aspect of the project. Because of the different role of the municipality in both cities, there is a difference in the climate adaptation process that relates to citizen science.

4.3 Citizens Role

4.3.1 Introduction

In the process to more climate adaptation, the role of citizens is researched. What can be the role of citizens in this participation process to create a more climate adaptive city? Citizens that are actively involved in the initiatives of IOT Apeldoorn or Meetjestad Amersfoort do have a role in the participation process. Important to state is that some citizens are more involved in the communication with the municipality than others. 'I chose to only involve in Meetjestad in a passive way' (interviewee 8, personal communication, 2022). It is a challenge for citizens with a full-time job, to involve more actively in such initiatives. Some people do have a lack of time to involve like they would do when having more time available. Citizen science can be a time-consuming process, but citizen science is for everyone doable (interviewee 8, personal communication, 2022). The level of involvement will differ between citizens. It is important to have a core group of people that engages in the most active way in the initiative and have contact with the municipality. It is not necessary for everyone to involve in the same way. With a citizen that made two monitoring instruments and implement and maintain these two, this can be a way of participating in the initiatives. More monitoring means more data to work with and more data to compare.

Citizens can play a role in their citizen science initiatives and therefore interact in the participation process to more climate adaptation. As stated before, not all citizens do have that amount of time to involve in the full way. It is important to create a core group of citizens that are actively involved in the initiative. 'It doesn't have to be a well-oiled machine, you need a core group and volunteers that help working along' (interviewee 8, personal communication, 2022). It is needed to have a stable group to keep the initiative alive, but it is recommended to keep it low-profile. Keep it accessible for everyone is an important condition for the success of a citizen science initiative.

Local knowledge

In Meetjestad Amersfoort, there is a lot of room for citizens to bring in their own goals and ideas to the initiative (Interviewee 9, personal communication, 2022). During the first three years of Meetjestad Amersfoort, the initiative was seeking for a project to start with. There was an open process without a real goal. Different people that participated in the initiative, could bring in their own ideas. The only obligation was that the project must be on climate change. For the municipality, the goal was to connect people with climate change (interviewee 3, personal communication, 2022). Citizens were invited via the (social) media to visit a meeting at Meetjestad to talk about climate change (interviewee 9, personal communication, 2022). The meeting was open, it was only captured that it was about climate change. Citizens came to the open meeting and did have the opportunity to bring in their own values and ideas. It was hard to sell the idea of the open process in the town hall because municipalities are result-oriented. It was hard to convince the government of the open process idea of Meetjestad, but it worked out.
In contradiction there is the case of Apeldoorn where the municipality stated beforehand what the idea was of the Climate Street and asked if the IOT community could help. Still citizens have a role in the case of Apeldoorn but there can be seen that in Amersfoort there was a bigger role for citizens. In Apeldoorn citizens were limited by the already made plans and they do have less impact on the monitoring. Citizens in Apeldoorn did have a voice in the monitoring aspect of the Climate Street. Although, the municipality did not accept all our ideas (Interviewee 2, personal communication,

2022). The IOT had some ideas about more data to collect with the monitoring for example, but that was not accepted by the municipality. The use of citizens knowledge is different in both cities. While in Amersfoort there is a lot of space to bring in own ideas and knowledge in the projects of Meetjestad, in Apeldoorn there is limited space for own local knowledge in the Climate Street case. The role of the municipality in Apeldoorn's seems to be stronger than in Amersfoort.

Local needs

With the help of citizens in the process to climate adaptation, there could be sought for local needs. What is needed by the citizens in their area to make it more climate adaptive and what are the key issues in a specific area. With the help of citizens there could be measures taken that fit the local need is the hypothesis. Citizens that live somewhere would know at best what is needed in their environment.

The municipality of Amersfoort works with modelling data. As a municipality we looked to the city through the glass of a model, it is all estimated data but not real data (Interviewee 3, personal communication, 2022). Currently, the municipality of Amersfoort is making the change to sharpen their models with real data. They sharpen their models with data and experiences from Meetjestad Amersfoort. The role of citizens is to help the municipality by checking their models with real data. With the monitoring activities of Meetjestad, the models of Amersfoort are checked. It helps to start looking with more detail to what is happening on the neighbourhood level. Monitoring results leads to more customization. For example, due to the monitoring activities, hotter places in the city can be found and therefore local needs become clear (interviewee 8, personal communication, 2022). Next to the monitoring, Meetjestad also provides experiences of citizens that are brought into the data of the municipality of Amersfoort. These data and experience information helps the municipality to act more on a local scale and take the necessary steps in the future to become more climate adaptative. Measures should be taken that fit the local needs.

In Apeldoorn this is less the case. The Climate Street was planned in the inner-city area and therefore different than the case of Amersfoort where the whole city is monitored. The citizens that are active in the IOT community had not a personal belonging in the Climate Street case. They wanted to do something with their knowledge about technique to help the municipality and therefore their city. It is important to state that the goal of the IOT community is different than Meetjestad. The IOT has not the main goal to gain information about climate change but has the broader goal of sharing knowledge with citizens. Although, the Climate Street is more attractive and more pleasant to stay after the implementation of the measures according to citizens. The Climate Street does fit to the local needs.

4.3.2 Citizen science

How citizens define citizen science

During the interviews, a section was about the view of interviewees on the concept of citizen science. It was interesting to hear their definition of citizen science. In the theory chapter the definition of Wolf et all (2021) is used. This definition is about citizens engage in gathering data. With the start of this research, the assumption was that citizen science initiatives are a large part of the broader goal of participation for municipalities. During the conducted research there is found that citizen science is only a small part of participation. It is a real contribution to the participation with making the city climate adaptive, but it is important to state that it is a part of participation. Participation in spatial

development should involve different stakeholders and citizens. Citizen science can be an important contribution, but it is a small part. The different views on what citizen science is, are presented below.

'Citizen science is about collecting, processing and interpreting data by citizens' (interviewee 2, personal communication, 2022). Science that is done by citizens. 'Citizen science is participation with the use of technique' (interviewee 4, personal communication, 2022). This member of the IOT Apeldoorn sees citizen science as a form of participation. 'With the help of technology, we try to connect with topics that are relevant in Apeldoorn (interviewee 4, personal communication, 2022). Hitch on topics that are alive in the city and therefore contribute to the needs of Apeldoorn citizens. Citizen science is about monitoring in the public space and make these data public available (interviewee 8, personal communication, 2022). One of the crucial factors for citizens science, is that it must contain open-source data. All the data that is collected should be open and transparent for everyone. This is also a key factor for the success of citizens science initiatives which will be more elaborated on at the end of this research.

There are also some critics about the term of citizen science. 'Citizen science is a wrong concept in my opinion' (interviewee 9, personal communication, 2022). It is interesting to realize that some people do not agree with a concept. 'It is an artificial separation between scientist and citizens on how science should be made and that there is only one way to conduct science' (interviewee 9, personal communication, 2022). Science is done in the same way for the past 50 years and that is how it should be done, it is better to call it institutional science and just science (interviewee 9, personal communication, 2022). According to this interviewee it is unnecessary to divide science for diverse groups. He would recommend calling it community science because there is a group of people who are interested in doing research together and has the goal to gain some new knowledge. 'I would describe it more as community science because it is done with a community that has the same reason to interact with each other to research in their area' (Interviewee 6, personal communication, 2022). The term citizen before science has some critics which is interesting to hear. Beforehand there was no assumption that the concept of citizen science would face some critics by the interviewees. It was interesting to notice that multiple citizens would rather name it community science.

Collecting data & usability

In paragraph 2.3 there is stated that citizens science is about citizens involving in gathering data (Wolf et al., 2021). Both initiatives do fulfil to these requirements of citizen science. Volunteers at both initiatives are actively involved in collecting data about their environment. In Amersfoort they design and assess their own devices to monitor the area. With the available knowledge within their community, they build monitoring devices.
In Apeldoorn they used the gained knowledge from Meetjestad Amersfoort to build devices to monitor (interviewee 3, personal communication, 2022). Meetjestad Amersfoort and IOT Apeldoorn did had contact in the beginning and Meetjestad Amersfoort wanted to incorporate the Apeldoorn community within their project (Interviewee 2, personal communication, 2022). But Apeldoorn decided they did want to be self-contained. 'There is a strong desire to keep these projects authentic' (interviewee 2, personal communication, 2022). The community in Apeldoorn did use the first knowledge from Amersfoort but decided they did want to be authentic.

In both cities, citizens collect data about the environment. But the usability of the data is for both cities a challenge. How should the data be interpreted and what to do with the data? In Apeldoorn, the municipality promised to design a dashboard in the Climate Street to make the gained data visible for citizens. The municipality is currently creating a dashboard with data about the Climate Street to show citizens the impact of the measurements (interviewee 1, personal communication, 2022). With the goal to make citizens aware of the impact of climate change and the impact of climate adaptive measures. To show the difference in temperature on a sizzling summer day between a place with a lot of concrete and nearby a tree. In addition to that, the next step for the municipality of Apeldoorn is to create the 'park city' (interviewee 1, personal communication, 2022). With the pilot in the climate street, different measures are evaluated, and this gained knowledge can be used for implementing climate adaptation measures in the other parts of the city.
In Amersfoort, the usability and interpretation of the data is the next step. In Amersfoort there are a lot of monitoring devices active in the city. The next step is about how to interpret all these data (interviewee 8, personal communication, 2022). 'Maybe we design an app where citizens can create useful knowledge for their specific demand' (Interviewee 9, personal communication). This next step must be made in the future.

Both cities are facing the challenge of creating usable graphs and information out of the collected data. With a lot of collected data, the next step is to make the data usable. In Apeldoorn, the municipality has the goal of creating a green city. With the help of the pilot project from the Climate Street, useful knowledge is gained to improve the rest of the city. In addition to that, the municipality tries to make citizens more aware of climate change with the dashboard that is under construction. In Amersfoort they have collected a lot of different data around the city for the last years. They are currently making all these data useful for citizens. How can we make the data easily accessible and understandable for citizens? With the idea that citizens can create knowledge that is interesting for their personal desires. How is climate change impacting in their neighbourhood and what actions could they consider?

Why they contribute to citizen science activities

Citizens do have varied reasons to involve in a citizen science project. Below are several reasons presented why citizens involve in such initiatives.

'You can start thinking yourself about climate change, there is a lot of literature available, and you can do research yourself' (Interviewee 6, personal communication, 2022). It is important to function as a citizen and start doing own research. You should not be waiting for the government or political parties before change will happen. You can start yourself. In that case it could be possible that you help your local politics (interviewee 6, personal communication, 2022).

'Although I trust and believe all the data of the RIVM (National institute for public health and environment), I think it is good to do your own measurements and have the control over your data collection' (interviewee 8, personal communication, 2022). You can verify the collected data of the RIVM. In this case it is important for the interviewee that data that is collected by bigger parties should be checked or verified. He still trusts the collected data of the RIVM but thinks it is important to remove the distrust of others about the RIVM. Monitoring yourself helps to make the institutes more trustworthy for others.

‘Citizen science leads to more understanding of choices made by the municipality’ (Interviewee 3, personal communication, 2022). Through citizen science, citizens are actively involved in collecting data and the interpretation of data. Therefore, they would better understand the decisions that are made by the municipality and other governmental parties. Participation through citizen science contributes to transparency of governments (Interviewee 3, personal communication, 2022).

‘I wanted to share my own knowledge and make myself useful in the local area’ (interviewee 4, personal communication, 2022). A person who worked for different companies around the world, had the idea to stop sharing knowledge around the globe but act more on a local scale. How can I use my knowledge in my own environment (Interviewee 4, personal communication, 2022)? It is about to give something in return to Apeldoorn. A personal desire to share gained knowledge from all over the world and return home and use the gained knowledge.

According to the municipality of Apeldoorn, people contribute to citizen science projects because they want to mean something for their city with the help of data (Interviewee 1, personal communication, 2022). This results in citizens that are contributing because they do have interest in data collection or data analysis and use that knowledge to invest in the city. In that way they like to use their knowledge for the benefits of the city.

‘We all need to become more of an expert at climate change’ (interviewee 9, personal communication, 2022). There is a need for having more knowledge from citizens about climate change and climate adaptation. The initiative of Meetjestad contributes to that need for more knowledge. With this knowledge, the discussion about climate adaptation and climate change is no longer exclusive for scientists and policymakers. Citizens can involve in these conversations because they do have the needed knowledge to talk along. Meetjestad is already for a few years active and have a lot of involved citizens in four cities in two countries. That helps with becoming credible for institutes (interviewee 9, personal communication, 2022).

‘There are three groups of citizens that involve in citizen science initiatives; engineers who are interested in knowledge not in results, engaged citizens that contribute to the city and citizens with extremist ideas about climate and environment’ (interviewee 2, personal communication, 2022). According to this person, there are three different sort of people who are involving in citizen science initiatives. In the IOT Apeldoorn initiative most of the involved citizens are engineers who are interested in knowledge and citizens who would like to contribute to their city. ‘I would position myself at the first and second group’ (Interviewee 2, personal communication, 2022).

Above are presented several reasons for citizens to contribute to these citizen science initiatives. as can be seen there are some different ideas for citizens to involve in these projects. Not everyone has the same reason to participate and involve in a citizen science project. Some citizens find it important to share their knowledge with their environment. To improve their own environment and to mean something for their city. Other citizens find it important to involve in citizen science initiatives to get involved in the research and the discussion about climate change. Citizens are important actors in the conversation about climate change, but they need to change their area and behaviour as well. You could better have them involved. It also would lead to a better understanding of choices that are made by the municipality because of the own research that is done by citizens.

4.3.3 Participation with the government, a citizen perspective

In this paragraph the interaction with the municipalities is discussed. Due to the new environmental law that will be introduced in July 2023, citizen participation will be required. The government is free in what form of participation will be used in a project. Citizen science is researched in this thesis as a form of participation.

This paragraph is about the perspective of citizens and how they could involve in the participation process. In paragraph 4.4 the perspective of the governments will be discussed. In the conclusion chapter both perspectives will be combined to state something about the participation process in general. The two cases are first separately explained and then the differences and commonalities are discussed.

IOT Apeldoorn

'Citizen science will be important for future municipalities to make success of policies' (Interviewee 2, personal communication, 2022). Municipalities should invest time in these citizen science initiatives to accept that citizens are cooperating in collecting and interpreting data. The importance of citizen science will increase the coming years. It was a challenge for me to work with governments instead of companies because the municipality was slower (Personal communication 4, personal communication, 2022). For some citizens, working together with the municipality was getting used to the working pace. 'Due to the involvement of citizens through citizen science, the municipality saw that as a possibility to shape citizen participation' (Interviewee 3, personal communication, 2022). In addition to that, interviewee 4 sees citizen science and citizen participation as a hype for municipalities. Interviewee 4 is questioning the real number of citizens that really involve in such projects? When could you talk about a fair participation level? For the case of the Climate Street there was a real interest from the council member who was responsible, and the citizens were heard (interviewee 4, personal communication, 2022). But in a broader field, interviewee 4 is questioning the real number of citizens that participate and what happens with those participation moments.

The participation meetings with all the stakeholders were fine (interviewee 3, personal communication, 2022). All different involved stakeholders were present including members of IOT Apeldoorn. The IOT had a voice during the meetings. The IOT held a few meetups with their community members to discuss what is possible for them and to keep the other members updated (interviewee 5, personal communication, 2022). The meetups were about what devices they would build, about the durability of the battery and about the costs. They made an agreement with the municipality that all data would be open source. The idea was that the municipality would make a climate map from all the gained data of the monitoring activities (interviewee 5, personal communication, 2022). Currently the climate map is under construction and on the plan to install in the Climate Street to make the impact visible for citizens (interviewee 1, personal communication, 2022).

The IOT community offered some more knowledge to the municipality that was not accepted by them (interviewee 2, personal communication, 2022). This discussion was about getting even better results. The IOT had the idea that the measurements could be better if the monitoring went a bit differently and more elaborated. There was a desire to let this discussion be held more intensively but that was not the case (interviewee 2, personal communication, 2022). 'Because of a lack of time I didn't want more influence on the project of the Climate Street, I can imagine some people would like to have more influence on the project' (interviewee 4, personal communication, 2022). The

concept of the Climate Street was already made. The IOT only had influence on the monitoring activities. It can be hard to place this case on the ladder of Arnstein that is discussed in chapter 2.2. The municipality is a strong leader in the Climate Street and did already make the concept for the climate adaptation measures in the street. The role of the IOT community was about the monitoring activities in the Climate Street. There was no agreement about the involvement of citizens in the concept of the Climate Street. Some citizens wanted more influence on the project others did not. On the monitoring part there was some extra knowledge available within the IOT community, but the municipality did not want to use that extra information in the monitoring. The power of citizens is therefore a bit lower on the participation ladder.
The IOT community had a good relationship with the responsible council member (interviewee 4, personal communication, 2022). As can be found from the interviews, a good cooperation with the municipality is important for the citizens perspective. The person who is responsible for the contact with the citizen science initiative has therefore a vital role. After all there could be said that all interviewees from the IOT Apeldoorn were enthusiast about the case. 'The collaboration was fun, and I would involve in such a project again' (interviewee 4, personal communication, 2022).

Meetjestad Amersfoort

The idea of Meetjestad started with the request from the municipality that wanted to involve citizens in where climate change has substantial impact (interviewee 9, personal communication, 2022). The cooperative university of Amersfoort was excited about the idea of involving citizens in researching the impact of climate change in their own neighbourhood. This idea gave the university of Amersfoort a project where people are worried about and it gives relevance (interviewee 9, personal communication, 2022). For the University it was a nice topic to involve citizens and to reach out to more citizens in Amersfoort. The first years of Meetjestad, there was an open process with the goal to do research on climate change (interviewee 9, personal communication, 2022). For the first meeting there was the idea to invite citizens to come to the War building and had a conversation about climate change. What was going to happen was not clear, citizens must take the lead and come with ideas. There was a lot of freedom. After one year there was a core group who were not deterred for the open process (interviewee 9, personal communication, 2022). This group started slowly to narrow down the idea to the project of Meetjestad. That finally resulted in some monitoring devices. This took some years.

For the municipality, an open process is hard. Most governmental parties like to have hard results that are measurable. This open process created freedom on the one hand but more difficulties for the municipality on the other hand. At the start of Meetjestad, climate change was not even on the agenda of the municipality (interviewee 3, personal communication, 2022). This made it even harder to get access to some financial resources. But the municipality of Amersfoort wanted to involve citizens in climate change so Meetjestad stated to the municipality that they wanted this project so they should get access to financial resources. An open process can be interesting for some citizens but also a neglect in direction for some others and for the municipality. An open process gives on the other side the opportunity for citizens to bring in their own ideas and knowledge. It is therefore special that the municipality of Amersfoort agreed on the financial support for the first three years of Amersfoort. This shows trust in citizens to let them do it themselves this is seen as positive by the citizens of Amersfoort.

Not everyone from Meetjestad have contact with the municipality. The core group has once in the three weeks a meeting with the municipality including some other partners. The last years the contact with the municipality was less convenient. Due to the issue of housing the War community, the last six years it was the question if Meetjestad and the War would keep existing (interviewee 9, personal communication, 2022). In 2016 the previous location of the War was for sale. A crowdfunding started to buy the location from the municipality. Although there was enough money raised to buy the location, the municipality sold it for two hundred thousand euros more to a project developer (interviewee 9, personal communication, 2022). This resulted in a struggle for survival and a more negative relationship with the municipality. It is important to mention that the municipality is a multi-headed monster (interviewee 9, personal communication, 2022). The department of real estate had the assignment to sell the land. This department does not know what the War and Meetjestad was doing. The relationship with the contact person of the municipality and the environment department of the municipality is still great (interviewee 9, personal communication, 2022). After they sold the location to the project developer, there was a lot of protest from the citizens. The department of real estate saw that the War building had such an impact and they realized how many citizens were involved. In addition to that, there was the covid issue of last years. There can be said that it was difficult years for Meetjestad Amersfoort. 'I think it will take another year before we are on the level of 2016' (Interviewee 9, personal communication, 2022).

In Amersfoort there is a prominent level of citizen power. Citizens can decide themselves what they wanted to research and what their approach is to do the research. The municipality creates a lot of freedom for the citizens of Meetjestad Amersfoort. This has on the one hand the advantage of an important level of citizen power. On the other hand, it has in this case the consequence that there are no measures taken due to the involvement of Meetjestad Amersfoort. This is not per se a neglect but is important to mention. Because of the prominent level of freedom for citizens, it takes some years before some measures of climate adaptation are implemented. This is the main difference with the city of Apeldoorn where climate adaptation measures are taken but the involvement of citizens in that process is small. The importance for citizens of a good contact with the responsible employee from the municipality is also in Amersfoort clear.

4.4 Governments task

4.4.1 Local needs

Governments have a key role in the change to a climate adaptive city. Governments have the task to keep the city liveable for their citizens. Climate change is demanding change within the urban area to keep the city liveable and pleasant to stay (IPCC, 2022). 'You need to have a heat plan, citizens must have a cool area nearby such as parks and other greenery areas' (interviewee 1, personal communication, 2022). This is especially needed during hotter days which will be more occurring due to the changing climate. 'The knowledge of Meetjestad contributes to our knowledge about climate change' (interviewee 3, personal communication, 2022). With the data that is collected by Meetjestad Amersfoort, the municipality has the chance to interfere in the climate adaptation process in a more accurate way. With this new knowledge there could be customization to better fit the local needs. Climate change is an urgent problem for governments, and they are seeking for the right measures that could be taken.

Due to climate change and Covid-19, the importance of green has grown (interviewee 1, personal communication, 2022). Urban green has a positive impact on the wellbeing from citizens (Ponizony et all., 2017). The literature is mentioning the positive effects of urban green on citizens. Due to climate change and the covid-19 pandemic, with lockdowns and more working from home, urban green has become more valuable for citizens.

4.4.2 Participation with citizens

The case of Apeldoorn

The city of Apeldoorn has cooperated with the IOT Apeldoorn in making the climate street more climate proof. The help of IOT Apeldoorn was focused on getting an insight into the effectiveness of the taken measurements. The municipality was the leader of the project and decided mostly what happened.

The municipality had leader role in the climate street project (interviewee 1, personal communication, 2022). The investments were made by the municipality because the area that would transform was in the city centre and must be public accessible (interviewee 1, personal communication, 2022). The area belongs to the municipality, and they owned for example the bike garage in the area. Therefore, a leadership role for the municipality was the most logic. During some design sessions and participation evenings entrepreneurs, who had a store in the street, were involving and thinking along. Where do we place the façade green and can we gain more place for our terraces (interviewee 1, personal communication, 2022). There was a negotiation between the business owners and the municipality. They needed each other to transform the street into the climate street because of property rights.

The municipality already had some small ideas about monitoring the impact of the measures but due to the financial involvement of the national government the monitoring would be extended. The idea of involving IOT Apeldoorn came along and was therefore an interesting for the municipality to work with. The contact with the IOT community was made via the monitoring activities of IOT Apeldoorn during new years eve. These activities gained interest from the municipality and the contact between those two was made. ‘It is important for local governments that they are open for the involvement of citizen science initiatives’ (interviewee 1, personal communication, 2022). It is of importance to listen to them and let involve them into the participation process. Although the idea of the Climate Street was already made, during the meetings with the different stakeholders the plans for the monitoring activities were discussed.

The case of Amersfoort

The municipality of Amersfoort found out that during a bat research, a couple of years ago, a lot of citizens were interested in research and came by to ask what was happening there (interviewee 3, personal communication, 2022). This helped to start the idea of doing more research together with citizens in their own living area. The idea was that if people do research within their own environment, you will gain more engagement of citizens with their own environment (interviewee 3, personal communication). More engagement of citizens will lead to a better environment. The reason to start the initiative of Meetjestad Amersfoort was clear for the municipality.

For the municipality, the goal was to involve citizens in the research to climate change and therefore, that citizens would change their gardens for example to become more climate adaptive. ‘How to

become sustainable as a city, together with the citizens' (interviewee 3, personal communication, 2022). The municipality found out that it takes a lot of time. The first years, the municipality did not show up at meetings from Meetjestad. The responsible person from the municipality noticed that citizens must get to know working with the municipality on equal ground. The goal was to search and research together with citizens the impact of climate change (interview 3, personal communication, 2022). It took three to four years before the municipality did show up at the meetings. There is a distrust from citizens towards the municipality. 'Someone asked who I was, and I told I was from the municipality, he taught I was there to check what they were doing here' (Interviewee 3, personal communication, 2022). Trust needs to grow between citizens and the municipality. Trust about a new form of cooperation between the municipality and the citizens. For the municipality it was hard to gain trust and cooperation from citizen with this new form of working together.

'I notice a gap between citizens and municipalities in the current times' (interviewee 3, personal communication, 2022).

From both sides there needs to be more trust towards each other and more listening to each other. It is about cooperating on an equal ground. The person who is responsible for the cooperation with Meetjestad acknowledges that it can be hard to involve other municipal employees in her story with the initiative because there is on the short term no hard result. But if she talks a bit longer with her colleagues, she notices that most of the people find it interesting and exciting what is happening with Meetjestad. After all there could be said that the cooperation between the municipality and citizens is good and fun, but it takes some time to build trust. Not only trust from citizens towards the municipality but also trust from colleagues at the municipality who are not involved in the cooperation with Meetjestad. The importance of good contact between the municipality and the initiative is in both cases visible. The contact person from the municipality needs to connect with the initiative and the other way around. Trust from both parties is of significant importance in the participation process.

5. Conclusion

In this conclusion chapter the main research question will be answered. First, there will be a short recap whereby all different sub-questions will be answered. Thereafter the main research question will be answered.

5.1 Sub-questions

5.1.1 What different measures of climate adaptation can be distinguished in the two cases?

In Apeldoorn, the climate adaptation measures are visible in the Climate Street. There is more space for greenery and more space for water. More green is added in the area and there is blue infrastructure to cool down the area during warmer days. Rainwater is contained for times of draught and heat in a cistern under the ground. Different measures are assessed in the Climate Street to see what the impact of these measures can be. This is made possible due to the monitoring activities.

In Amersfoort there are no climate adaptive measures taken due to the monitoring activities of Meetjestad. They are currently in the phase of making the shift from data collection, towards data interpretation. Data interpretation could lead to taking climate adaptation measures.

5.1.2 What is the role of citizens in the initiatives in Apeldoorn and Amersfoort?

Citizens do have a significant role in these citizen science initiatives. Without them, these initiatives would not exist. Citizens can have distinct roles in these initiatives. Not all citizens do have that amount of time to invest in the initiative. There are citizens that have a full-time job that requires most of their time and energy. There was an interviewee who made two monitor devices and placed them in his garden. His task is to maintain these two. Another interviewee is the founder of Meetjestad and is in that way more involved. He has another role in this initiative and has the responsibility to interact with the municipality for example. Different citizens can have distinct roles in these initiatives but there can be said that it is accessible for everyone to involve. Everyone can contribute in their own way.

5.1.3 Why are citizens contributing to citizen science projects?

There are several reasons for citizens to contribute to citizen science projects. Some citizens want to contribute to their environment and share their knowledge with others. There are citizens that possess knowledge about techniques to build devices to monitor climate change. Other citizens find it important to generate more knowledge about the impact of climate change. What is the real impact of climate change in our area? A desire to have more knowledge about the impact of climate change in their own urban area. The last motivation for citizens to contribute is about the idea that if we check the data ourselves, there will be more carry weight for decisions that are made by the government. In that case monitoring means checking data by governments and more trust from citizens towards the municipality. It will result in more trust among citizens and governmental parties.

5.1.4 How is citizen science used in the participation process to more climate adaptation in Apeldoorn and Amersfoort?

Citizen science is used in both initiatives in the process to more climate adaptation. In Apeldoorn, the municipality took climate adaptive measures and the initiative IOT Apeldoorn did monitor the

impact. The monitoring activities were meant to gain more insight into the effectiveness of the measures that were taken. In that way that it could be used for other climate adaptation projects in the city of Apeldoorn. In other words, take lessons of the taken measures. In addition to that, it is the idea to make climate adaptation more visible for citizens. What is the impact of these measures on the temperature in the street for example. More awareness among citizens about the usability of these climate adaptation measures.
In Amersfoort, the situation is a bit different. The municipality wanted to involve citizens in climate change. The idea of monitoring the impact of climate change with citizens started. With the idea that if citizens monitor their environment, they become more connected with climate change impact and with their own environment. A two-sided effect. With the citizen science project in Amersfoort, citizens engage in the process of making the city climate adaptive. The last years they collected data about the impact of climate change in Amersfoort, currently they are shifting towards interpreting and analysing the collected data. Action will follow in the coming years due to the monitoring activities. The difference between the two cases becomes visible in this sub-question.
Citizen science leads to more use of local knowledge and experience in both cities. With this knowledge, there could be taken better climate adaptive measures in the future. Customization is more possible and therefore the local needs are better found. Climate adaptive measures that will be taken could better fit to specific local needs due to citizen science activities.

5.2 Main Research Question

The main research question was:
What can be the role of citizen science in the participation process to more climate adaptation in Apeldoorn and Amersfoort, and what are considerations for citizens to contribute?

By answering the different sub-questions, the research question can be answered. In this research there was attention for two cases. One in Amersfoort and one in Apeldoorn.
In Apeldoorn, the municipality assigned two streets in the inner-city area as the Climate Street. In this place there must be shown that climate adaptation is necessary and that it makes the area more attractive. With more greenery and space for blue infrastructure, this place is made climate adaptive. This area is a pilot for the broader goal of the municipality to create a park city out of Apeldoorn. With the help of the citizen science initiative IOT Apeldoorn, the Climate Street is monitored and the impact of the taken measures becomes clear. Citizens in Apeldoorn participate in the Climate Street. During different participation meetings that were held before the implementation of the project, the IOT Apeldoorn was one of the stakeholders during these meetings. They had a voice in the monitoring activities that would take place in the Climate Street. The concept for the street was already made. Citizens in Apeldoorn contributed to the street with designing and making the monitoring devices. They did not have a role in the climate adaptation measures. The power of citizens in Apeldoorn is therefore limited. The citizens of Apeldoorn did have a role in the process towards climate adaptation. They monitor the impact of the current measures and are supporting therefore new measures that could be taken in the future. They helped gaining insight in the impact of the taken measures.
In Amersfoort, the municipality wanted to involve citizens in the topic of climate change. Together with citizens they founded the initiative of Meetjestad Amersfoort. Within this community, they research the impact of climate change in their city. With an interesting cooperation with other cities,

they can share knowledge with them. The citizens that are active in Meetjestad Amersfoort have a lot of freedom to decide what, where and how to monitor. They have collected a lot of data about the environment for the past years. Currently they are in the phase of interpreting the collected data. It is about making the shift to interpret the data that is collected. Climate adaptation process is about implementing but also about searching the local needs. In Amersfoort there are no measures taken due to the monitoring of Meetjestad. But with all the data they have collected, they have created a lot of knowledge and awareness of climate change impact. They are now focussing on making the collected data easily accessible for citizens to use the data for their specific environment. The climate adaptation implementations will follow the coming years. In Amersfoort, citizens have more freedom but there are no taken measures against climate change yet.

The similarities between the two cities are clear. In both cases, citizens involve in the process of climate adaptation with monitoring activities. These activities are generating insight in the impact of climate change on a local scale. In Apeldoorn they monitor the impact of specific measures that are taken in the Climate Street. This knowledge could help to improve the climate adaptation measures in Apeldoorn. In Amersfoort, the shift to translate the generated knowledge into implementation of climate adaptive measures must be taken. But there are signs they will make the change soon. While in Apeldoorn the measures are implemented, in Amersfoort there is more freedom for citizens. They can decide themselves what they want to monitor and how they wanted to monitor. In Apeldoorn, the measures are taken and the IOT Apeldoorn had less involvement in the monitoring activities in comparison to the Amersfoort case. It is important to state that both participation processes do have a different goal. In Amersfoort it is about connecting citizens with climate change impact. In Apeldoorn it is more about let citizens participate because they are interested in technique and monitoring. And because of these monitoring activities, they could raise awareness of other citizens about climate impact and climate adaptation.

What can be drawn form this research is that there are conditions for the success of these initiatives and their collaboration with the municipality. In both cases it becomes clear that a good contact with the municipality is of crucial importance. In many interviews that were held, the role of the responsible municipality contact person became clear. In Apeldoorn, the interviewees mentioned the great collaboration with the council member. In addition to that, citizens appreciate it when they get trust from the municipality. The freedom on what to monitor in Amersfoort is a good example of trust from the municipality towards the citizens. But there also needs to be trust the other way around. Citizens must trust the municipality. With the growing urgence of participation in spatial decisions, also due to the requirement of participation with the upcoming environmental law, citizens and governments need to collaborate more. They must interact with each other on the same ground. As citizen participation can lead to more trust (Parker, 2003), I would add that more trust would lead to better citizen participation. Participation not only generates more trust, but trust generates more and especially better participation. This research showed that trust is an important aspect of interaction between the municipality and citizens. Citizen participation would benefit from more trust from both parties at the start of the participation process. Trust from citizens towards the municipality that they will collaborate without ulterior motives, and trust from the municipality towards citizens that they can create knowledge and ideas for climate adaptation measures and measurements.

To conclude, Amersfoort seems to have more freedom and Apeldoorn seem to have more clear climate adaptation measures. But in both cities the climate adaptation process is improved due to the involvement of citizens. Citizen science is an important contribution in this process because it helps in seeking the local needs. Citizen science can be an important part of participation but because citizen science initiatives consist mainly of people that are interested in technology, more other citizens should be involved in the process.

6. Reflection, Limitations & Recommendations

6.1 Reflection & Limitations

Conducting this master thesis was a long and complex process. I made the choice myself to make some more months available for this research to create time for other important things. This resulted in a period that was less heavy and made me feel relaxed during drafting this thesis. In this closing chapter of the research, I will reflect on the thesis.

One of the main challenges of this research was finding respondents for this research. The contact with the municipality was easily made but the citizens were harder to reach. In Apeldoorn I attended a meeting from the IOT community to gain an entrance in the community. This helped a lot to gain the contacts that were needed for the case of Apeldoorn.
In Amersfoort it was much harder to reach out to citizens. It seemed like they did not had interest in an interview. Via a chatroom that I entered I found an interview and due to multiple mails, I finally reached the chair and founder of Meetjestad. This took longer than I expected beforehand. The contact with the municipality was easily made but contacting citizens can be a challenge. Beforehand I thought it would be easier to contact citizens.

There was another outcome than I expected beforehand. Citizen science does have a vital role, but it is one of the variables of participation. I thought beforehand that citizen science could be enough to fulfil the participation goals, but that was not the case. All interviewees said that citizen science is a small part of the broader goal of participation. This was interesting to find out during this research. The theory of local needs and awareness was less important than expected. Although some interviewees mentioned the impact of climate change, the interviewees did not feel local impact and therefore local need. Most of them are aware of climate change problems but are not directly facing the issues themselves. In addition to that, the role of trust was more important than I thought beforehand. In the theory chapter trust came along but I did not implement the role of trust in the conceptual model.

Limitations and recommendations for further research

This thesis focused on the role of citizens knowledge in the participation process to more climate adaptation. In this research there was less attention for the role of the municipality. There was only one interviewee of both cases from the municipality. The focus was on the role of citizens; therefore, the role of the municipality was smaller. In future research there could be more attention to the role of the government in this participation process toward climate adaptation and their role in collaborating with citizens science initiatives. The role of the municipalities should not be underestimated.

Because the interviews that were conducted for this research were semi-structured, the repeatability of this research is not too high. The less structured interviews are, the lower the reliability and validity is (Van Thiel, 2014). Doing semi-structured interviews has the advantage of gaining unexpected knowledge but has the downside of a lower repeatability of the research. In addition to that, with only two forms of data collection, triangulation is not reached. Next to desk research and interviews, doing observations or action research, could improve the research. Although the researcher attended a meeting from the IOT Apeldoorn to reach out to respondents, attending meetings of the initiatives could gain interesting insights. These observations could improve the research and are recommended for further research.
The last limitation of this research is about the comparability of the two cases. While in Apeldoorn there was a case which was specific, the Amersfoort case was too broad. For this research it was not a real problem that the cases differ, but it would be more interesting if there was another case which was even more comparable with the Apeldoorn case. Because citizen science is a rising phenomenon, there were only a few cases to choose from. In addition to that, I would recommend when doing research on citizen science initiatives, to choose multiple citizen science initiatives. Because as stated before, it can be hard to reach out to respondents for the research.

6.2 Recommendations for Praxis

In this section, three recommendations for praxis are presented. The recommendations are made for municipalities and citizen science initiatives.

1. The communication between the municipality and the citizen science initiative is crucial. Make someone responsible for the interaction with citizens and give time to create trust among both.

The first recommendation is about the interaction between the citizens and the municipality. During this research, there was found that the interaction between these two parties is of high importance. The citizens of Amersfoort and Apeldoorn did like the contact with the municipality because there was someone who was responsible and showed real interest in them. For a municipality it is therefore of vital importance that there is one responsible contact person who keeps contact with the citizens. In addition to that, it is important to notice that trust can be a main issue. Time is needed to grow trust between both. There is a gap between the government and the citizens. When investing in the contact with the initiative and show real interest, trust starts to grow. Municipalities must trust the capabilities of citizens, and citizens must trust the municipalities goals. It will cost time and courage, but the results will pay-out in the future.

2. Citizen science communities should be low profile and not too well organised. It is important to have a core group of a few people who can be some sort of leaders and take responsibility for the contact with the municipality.

Many citizens are not having the amount of time to invest in the citizen science community. It is needed for the initiatives that there are some persons who can keep the community alive and organise meetings. Many citizens like to contribute to these initiatives but do not have enough time to organise meetings and keep contact with the municipality. In addition to that, Keep it low profile.

A lot of citizens do like the ‘informal’ setting these initiatives can have. It is attractive for citizens that it is not a too well-organized initiative. This creates space for citizens to bring in their own ideas because there is no hierarchy in the community.

3. The data that is collected must be open source.

The last recommendation for praxis is about the collected data. Citizens have the desire that all data that is created must be open source. It must be accessible for everyone. This makes the data more trustworthy and makes it transparent. Data must be accessible for everyone who want to get insight in data about their own environment. Citizens want to have control over their collected data.

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8. Appendix

8.1 operationalisation table

Concept	**Dimension**	**Indicator**
Climate Change	Local impact Local needs	More Heat waves Urban heat Islands More Extreme rainfall Pluvial Flooding Need for adaptation
Governments Task	Requirement of participation with the new law Take care about citizens	Develop to climate adaptive space Seek the local needs
Citizens Role	Citizen Science Citizens Knowledge	Collecting Data Usability of data in participation process Local Needs Local Knowledge Local impact, awareness
Participation Process	Non-participation Degrees of tokenism Degrees of citizen power	Power of different Stakeholders Interaction Outcome of the process

8.2 Interview Guide

I used two different interview guides because of the difference between the two cases. There are only minor changes to make the guides fit to the case. The interviews were held in Dutch language.

8.2.1 Apeldoorn

Interviewguide

Goedendag, ik ben Simon van der Velden, masterstudent Spatial Planning met een specialisatie in steden, water en klimaatverandering. Bedankt voor uw belangstelling om deel te nemen aan dit onderzoek. Als u het wilt kunt u anoniem blijven in dit onderzoek anders zou ik graag uw naam vermelden in de resultaten. Uw persoonlijke informatie wordt niet vermeld. Om uw antwoorden te kunnen transcriberen en interpreteren zou ik uw toestemming willen vragen om het interview op te nemen. De opnames worden enkel door mij beluisterd. Het interview zal naar schatting 50 minuten duren. Heeft u nog vragen voordat we beginnen?

Mijn onderzoek gaat over de klimaatstraat in Apeldoorn. Ik doe onderzoek naar de rol van citizen science op het proces van klimaatadaptatie. In dit onderzoek wordt er gekeken naar de relatie tussen klimaatadaptatie en burgerparticipatie door middel van Citizen science.

1. Kennismaken
- Wie bent u? Achtergrond (Werk etc.)
- Op welke manier bent u betrokken (geweest) bij de klimaatstraat?
- Wat was uw belang hierin? Wat was voor u een reden om hieraan mee te werken?
- Wat was uw taak?

2. Klimaatstraat
- Wat was het doel van het project van de klimaatstraat? Waarom is het gestart?
- Hoe manifesteert zich volgens u klimaatverandering in uw woongebied/Apeldoorn?
- Wat is er allemaal veranderd in de klimaatstraat sinds de start van het project? Welke klimaat adaptieve maatregelen zijn er genomen?
- Welke rol speelde klimaatverandering in dit project?
- Hoe kijkt u terug op het project van de klimaatstraat? Positief of negatief? En waarom?

3. Participatie (algemeen)
- Hoe was de participatie opgezet? Welk doel diende de participatie? Waarom is daarvoor gekozen?
- Hoe kijkt u in het algemeen naar de participatie rondom het project van de klimaatstraat?
- Hoe was de taakverdeling? Wie deed wat?
- Hoe zag een participatiebijeenkomst eruit? Hoe hebt u die ervaren? Wat was de inzet op zo'n avond?

4. Taak burgers (Participatie specifieker)
- Op welke manier werden burgers betrokken? Wat konden burgers doen? Wat hadden burgers in te brengen? (Kennis, data, eigen ervaringen?)
- Hoe heeft u de samenwerking met burgers ervaren?
- Wat was de rol van Citizen science? Hielp dat mee in het proces? Hoe werd er met die informatie omgesprongen? Hoe zou u Citizen science omschrijven?
- Ervaarde u dat ook zo? Had u het idee dat u iets in te brengen had? (of: had dit impact op het participatieproces?)
- Bent u tevreden over het proces?
- Wat kan de rol van citizen science zijn in dit soort projecten?
- Is dit haalbaar voor burgers? Tijd en energie die erbij komt kijken? Korte reflectie daarop vragen.

- (In hoeverre bent u door het CS-project meer verbonden met uw eigen omgeving geraakt?)

5. Taak gemeente (Participatie specifieker)
- Welke rol nam de gemeente aan in het project van de klimaatstraat? Waarom is daarvoor gekozen?
-Wat was voor jullie de aanleiding voor het project van de klimaatstraat?
- Hoe verliep de samenwerking met burgers en andere stakeholders?
- In hoeverre speelt de nieuwe omgevingswet een rol in dit project? Heeft dit een voorbereidend karakter op wat komen gaat? Kijken jullie daartegen op de komende tijd, en hebben jullie van de klimaatstraat er wat van geleerd?
- In hoeverre lukt het om veel verschillende burgers bij het proces te betrekken? Citizen science vraagt wel iets van burgers en spreekt bepaalde burgers waarschijnlijk meer aan dan de andere.

6. Lessen voor de toekomst
- Wat hebben jullie geleerd van dit project op het gebied van participatie van burgers?
- Wat zou je anders doen? Wat zou je zeker weer doen?
- Dit was een pilot initiatief, is dit nu al breder uitgerold en zo ja hoe en waar?
- Hoe kijkt u in het geheel terug op dit project?

Hartelijk dank voor de medewerking. Dit is het einde van het interview. Mocht u het interessant vinden kan ik het eindresultaat naar u opsturen.

8.2.2 Amersfoort

Interviewguide

Goedendag, ik ben Simon van der Velden, masterstudent Spatial Planning met een specialisatie in steden, water en klimaatverandering. Bedankt voor uw belangstelling om deel te nemen aan dit onderzoek. Als u het wilt kunt u anoniem blijven in dit onderzoek anders zou ik graag uw naam vermelden in de resultaten. Uw persoonlijke informatie wordt niet vermeld. Om uw antwoorden te kunnen transcriberen en interpreteren zou ik uw toestemming willen vragen om het interview op te nemen. De opnames worden enkel door mij beluisterd. Het interview zal naar schatting 50 minuten duren. Heeft u nog vragen voordat we beginnen?

Mijn onderzoek gaat over het burgerinitiatief Meetjestad in Amersfoort. Ik doe onderzoek naar de rol van citizen science op het proces van klimaatadaptatie. In dit onderzoek wordt er gekeken naar de relatie tussen klimaatadaptatie en burgerparticipatie door middel van Citizen science.

1. Kennismaken
- Wie bent u? Achtergrond (Werk etc.)
- Op welke manier bent u betrokken bij Meetjestad?
- Wat is voor u een reden om hiermee samen te werken?
- Wat is/was uw taak in dit samenwerkingsverband?

2. Meetjestad
- Wat was het doel van het project van Meetjestad? Waarom is het gestart? Hoe is het gestart en waarom?
- Hoe manifesteert zich volgens u klimaatverandering in uw woongebied/Amersfoort?
- Welke rol speelde klimaatverandering in het project Meetjestad?
- Wat is er allemaal veranderd in de Amersfoort sinds de start van het project? Welke klimaat adaptieve maatregelen zijn er genomen? (Dat ook samenhangt met het project Meetjestad)
- Hoe kijkt u naar het initiatief van de Meetjestad? En waarom?

3. Participatie (algemeen)
- Hoe wordt er samengewerkt met Meetjestad en de gemeente Amersfoort, en eventueel andere partijen? Wie neemt initiatief, wie heeft de regie? Door wie is het gestart?
- Hoe worden de taken verdeeld tussen Meetjestad en de gemeente?
- Hoe ziet zo'n sessie eruit?
- Hoe kijkt u in het algemeen naar de participatie rondom de klimaatadaptatie in Amersfoort?
- Zijn er wel eens participatieavonden geweest? Zo ja, hoe zag dat eruit? Wat was het doel van zo'n bijeenkomst?

4. Taak burgers (Participatie specifieker)
- Op welke manier worden burgers betrokken? Wat kunnen burgers doen? Wat hadden burgers in te brengen? (Kennis, data, eigen ervaringen?) (link met Meetjestad houden, niet naar Burgers te breed gaan).
- Hoe heeft u de samenwerking met burgers ervaren?
- Wat was de rol van Citizen science? Helpt dat mee in het proces van klimaatadaptatie? Hoe wordt er met die informatie omgesprongen? Hoe zou u Citizen science omschrijven?
- Ervaarde u dat ook zo? Had u het idee dat u iets in te brengen had? (of: had dit impact op het participatieproces?)
- Bent u tevreden over het proces?
- Wat kan de rol van citizen science zijn in dit soort projecten?
- Is dit haalbaar voor burgers? Tijd en energie die erbij komt kijken? Korte reflectie daarop vragen.
- (In hoeverre bent u door het CS-project meer verbonden met uw eigen omgeving geraakt?)

5. Taak gemeente (Participatie specifieker)
- Welke rol neemt de gemeente aan in het proces van klimaatadaptatie? Waarom is daarvoor gekozen?
-Wat was voor jullie de aanleiding om samen te werken met Meetjestad?
- Hoe verloopt de samenwerking met burgers en andere stakeholders?
- In hoeverre speelt de nieuwe omgevingswet een rol in de samenwerking met Meetjestad? Heeft dit een voorbereidend karakter op wat komen gaat? Kijken jullie daartegen op de komende tijd, en is dat een reden om samen te werken met burgers?
- In hoeverre lukt het om veel verschillende burgers bij het proces te betrekken? Citizen science vraagt wel iets van burgers en spreekt bepaalde burgers waarschijnlijk meer aan dan de andere. Hoe kijken jullie daar vanuit de gemeente naar? Is CS afdoende of is het een onderdeel van het bredere doel van participatie?

6. Lessen voor de toekomst
- Wat hebben jullie geleerd van de samenwerking met Meetjestad op het gebied van participatie van burgers?
- Wat zou je anders doen? Wat zou je zeker weer doen?
- Hoe kijkt u in het geheel terug op dit project? Heeft u nog een afsluitende conclusie over meetjestad en de samenwerking met de gemeente en misschien andere stakeholders daarbij?

Heeft u nog een vraag voor mij?

Hartelijk dank voor de medewerking. Dit is het einde van het interview. Mocht u het interessant vinden kan ik het eindresultaat naar u opsturen.