Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Personal information	
Name	Froukje Visser
Student number	4573315

Studio		
Name / Theme	Metropolitan Ecologies of Place Metropolitan Ecologies of Place is an interdisciplinary studio that deals with transformation and the larger flows present in the urban environment.	
Main mentor	Kristel Aalbers	Environmental Technology and Design
Second mentor	Juliana Goncalves	Spatial Planning and Strategy
Argumentation of choice of the studio	This research project fits well within the context of the Metropolitan Ecologies of Place studio as it deals with the effects of climate change, the adaptation that is necessary to combat them, and the larger system of water within the urban environment.	

Graduation project	
Title of the graduation project	Moving with water Creating a flexible and resilient city in the face of extreme weather
Goal	
Location	
Utrecht (city)	
Problem statement	

An incident that is still fresh in the mind of people in the Netherlands, Belgium, and Germany is the major flooding caused by extreme rainfall in July of 2021. Heavy rainfall in mainly Germany and Limburg caused local flooding as well as flooding further downstream with an estimated 1.8 billion euros in damages (Ekker, 2021).

Later that year it was confirmed by scientists that this event was linked to climate change. The chance of extreme rainfall is elevated in the whole of western Europe with a factor between 1,2 and 9. Meanwhile, the amount of rain during these events also increased between 3% and 19% (Ekker, 2021).

But problems with water are not just more prevalent on one extreme of the spectrum. Periods with a lack of water are also on the rise. The summer of 2018 is one example of an extremely dry period that lead to estimated damages between 450 and 2080 million euros (Philip et al., 2020).

As climate change progresses, expectations are that events like this will happen more and our cities are not prepared for it. Drastic changes need to be made to the built environments to cope with extreme weather.

Climate change and the effect on weather

Temperatures are increasing all around the globe and for some areas around the world, this has also meant an increase in heavy rainfall and an increase in droughts (IPCC, 2021).

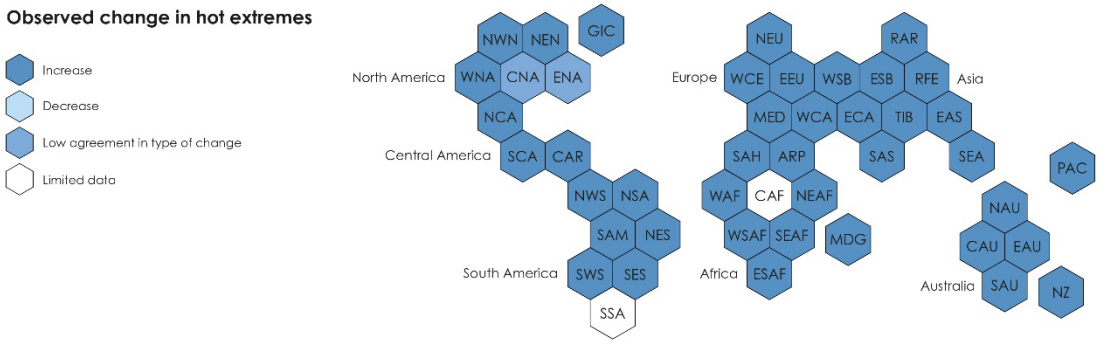

Figure 1 Worldwide observed changes in hot extremes, based on data from IPCC (IPCC, 2021).

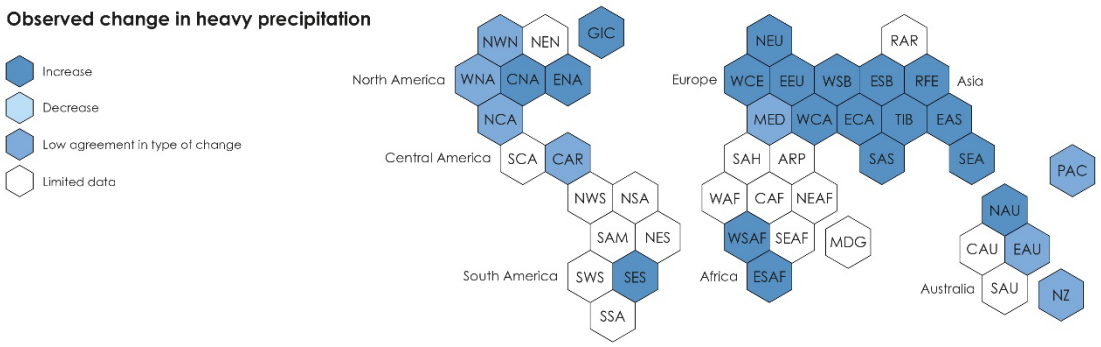

Figure 2 Worldwide observed changes in heavy precipitation, based on data from IPCC (IPCC, 2021).

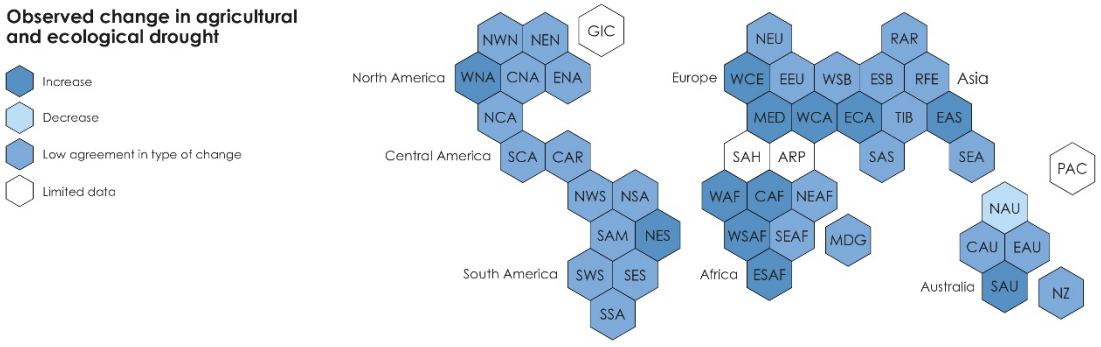

Figure 3 Worldwide observed changes in agricultural and ecological drought, based on data from IPCC (IPCC, 2021).

The Netherlands will also experience more extreme weather patterns in the future. This includes long-lasting drought spells, heat waves, and heavy rainfall (van Hattum, 2022). A recent survey among Dutch climate scientists revealed that none of the sixteen scientists interviewed believed we can contain global warming to 2.0 degrees Celsius. One of the lead authors of the IPCC climate report Gert-Jan Nabuurs voiced his concern, saying we are on the road to surpassing 3.0 degrees (Duintjer, Tebbens & Nijland, 2022). This means more severe weather, perhaps sooner or worse than studies have predicted based on a global temperature increase of 1.5 to 2.0 degrees.

Rainfall

A downpour is defined as a shower of more than 25 mm of rain in an hour. Heavy rainfall is defined as a shower of more than 50 mm of rain in an hour or more than 100 mm of rain in a day (KNMI, n.d.). These extreme weather events will increase as global warming progresses (KNMI, 2021). The expected increase is about 7% more rain during a shower for every degree (Celsius) of temperature increase. There is some uncertainty around the number of 7%, especially during the summer where the expected increase in rainfall can lie between 2% and 14% for every degree of increase in temperature. Currently, a shower of more than 58 mm of rain in an hour will happen about once every 100 years. That means that in a specific location, in a year, the chances of a shower with rainfall to that extent happening is about 1%. Current calculations expect those chances to go up, meaning rainfall of over 58 mm of rain in an hour will be 5 to 10 times as likely as it is now (KNMI, 2021). Suddenly an event that happens once in a lifetime, becomes a regular occurrence.

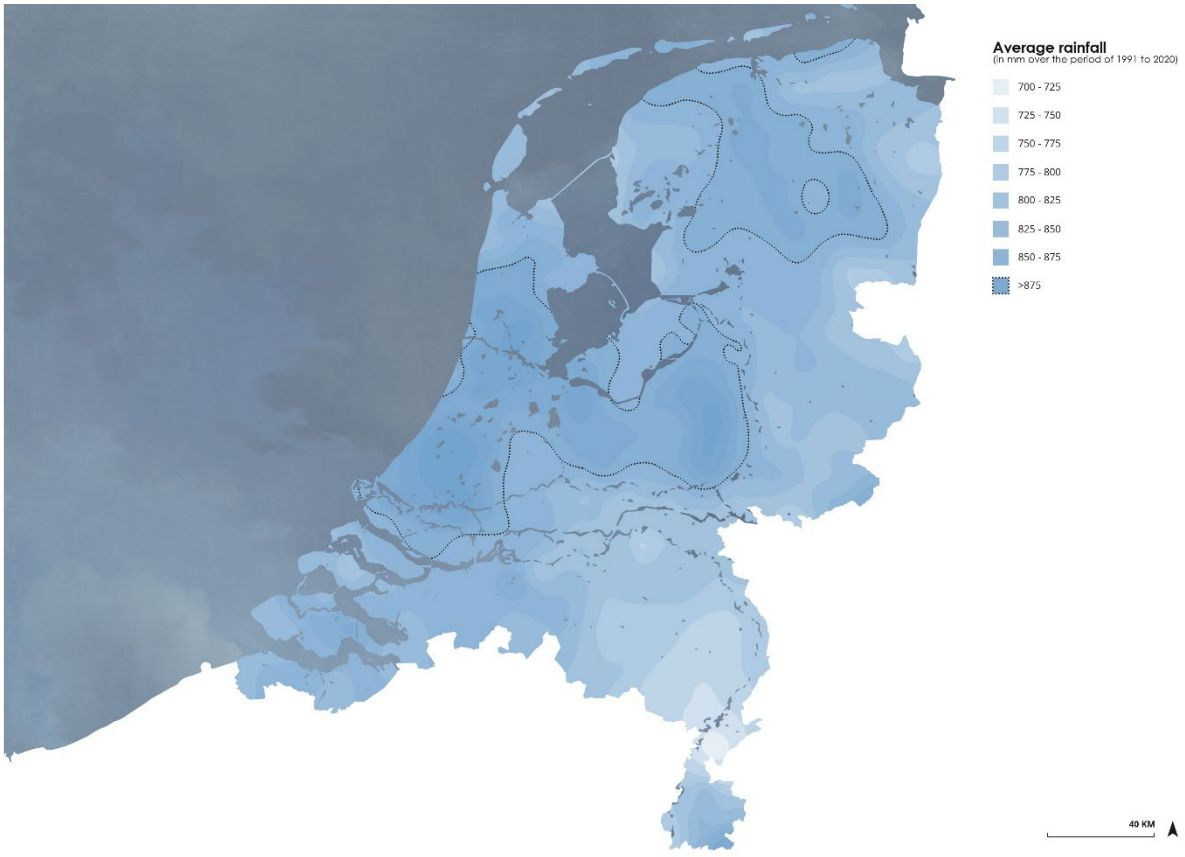

Figure 4 Average rainfall in the Netherlands, based on data from KNMI (KNMI, 2022)

Drought and water shortages

Drought is often harder to define. Generally speaking, a dry spell is called a drought when the evaporation exceeds the amount of rainfall in a certain period. Droughts in the Netherlands significantly increase in two of the four climate scenario's from the IPCC report, recently other calculations seem to support the dryer scenarios (KNMI, n.d.).

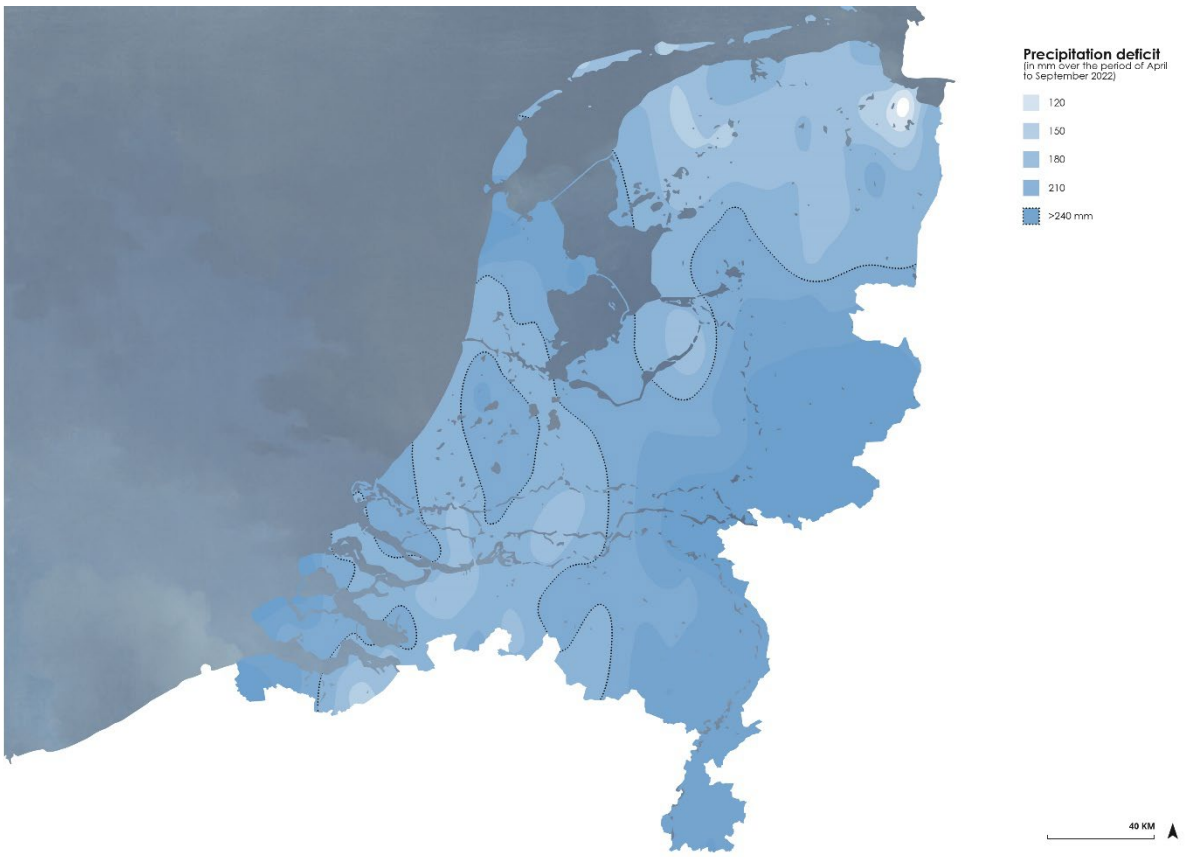

Figure 5 Precipitation deficit in the Netherlands in 2022, based on data from KNMI (KNMI, 2022).

Another consequence of more extreme weather is that we are at higher risk of water shortages, due to rain being at the wrong place or during the wrong time (Baptist et al., 2019). This causes some areas of the Netherlands to deal with water shortage issues, already in the very near future (Geudens & Kramer, 2022).

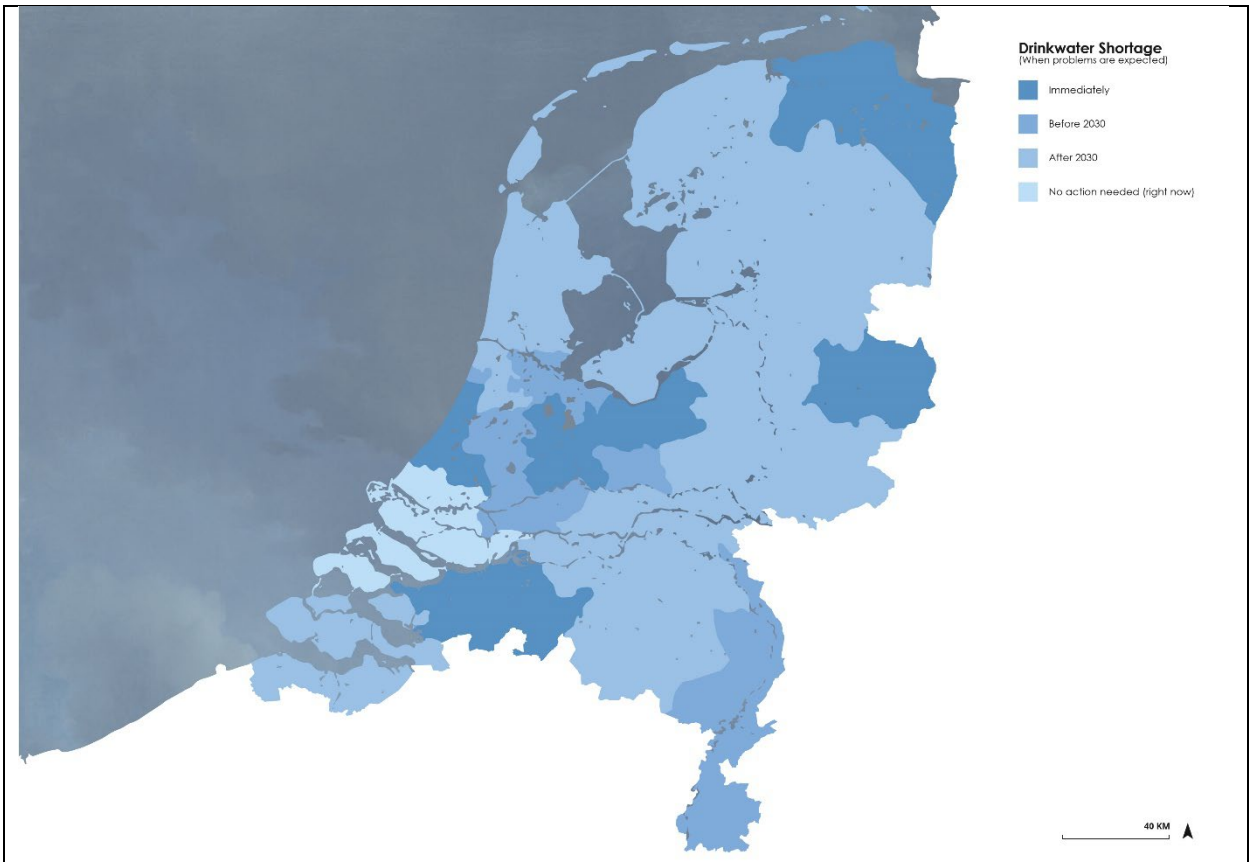

Figure 6 Drinkwater shortage in the Netherlands, based on data from Vereniging van Waterbedrijven in Nederland (Geudens & Kramer, 2022).

Traditional Dutch infrastructure is not always equipped to deal with all these changes in weather patterns (Dai et al., 2017). Our cities will need to adapt.

Uncertainty

The problem is that the effects that arise as a consequence of climate change are not always so predictable. The consequences of global warming on our weather patterns in the short term are fairly well predicted, but the further we look into the future, the more uncertainty is attached to our predictions on climate and weather (Tyler & Moench, 2012). This means we cannot only count on an approach based on preventing and mitigating what is predicted because it lacks the ability to deal with this uncertainty (Wardekker et al., 2009).

Because of the large amount of uncertainty that comes with climate change and its effects, there is no one-size-fits-all solution to the problem. An urban design that tries to prevent and mitigate the effects of climate change cannot be a stagnant one. If it is, it is inevitable that within a few decades, it will have become obsolete and a new design and investment needs to be made to adapt or completely reconstruct the original design.

And climate change is not the only change that will happen in the upcoming century, many changes we cannot predict or even imagine yet. It is therefore understandable that people in the past have already called for urban design to become more flexible. Friedman already called for this change in 1997. Although his paper considers changes in demographics and different needs and demands on the housing market as the driver of a need for flexible

planning, the idea remains largely the same; We are dealing with uncertain future scenarios and thus we need to implement a flexible planning solution (Friedman, 1997). The difference in problems in Friedman's paper shows that no matter the time we live in, the idea of flexible urban planning will always be beneficial to anticipate foreseen and unforeseen changes.

Considerations

Although the main focus of this thesis is climate adaptation for weather extremes related to water; drought and heavy rainfall, some considerations must be made for other weather extremes, related issues as well as other considerations that will determine the approach of how to tackle these issues.

Heat is one of the elements that will need to be considered when looking at climate adaptation for weather extremes. Heat is one of the most noticeable and well-predicted parts of climate change, with huge implications for the comfort of life in cities. During hot periods elderly are especially vulnerable. About 1.8% of deaths during the summer are attributed to heat, without climate change this number is estimated to be 1.24%. This means every year, about 250 people die directly from the effects of climate change (RIVM, 2021). When implementing climate adaptation for drought and heavy rainfall, thermal comfort is an aspect that should be considered.

Another aspect that should be considered has more to do with where to intervene. People living in disadvantaged neighborhoods are often more vulnerable and at risk for the effects of climate change, they live in places with more heavily built-up areas, have less access to green spaces, and live in higher buildings. All risk factors when it comes to the urban heat island effect and pluvial flooding (Verhaeghe & Segers, 2022), (Stuiver et al., n.d.), (Brunt, 2022).

The interaction between the city and its wider surroundings is also important when looking to create climate-adaptable cities as it greatly impacts weather and climate within the city (KNMI, 2021). The European Union also stresses the need for robust ecosystems for climate change mitigation and adaptation (European Commission, 2021). To adapt our cities to the effects of climate change we need to look at the city from different scales, local interventions only are not enough.

The Assignment

The challenge lies in creating a resilient system (an ecological system that is equipped to deal with changes without losing its capacity to function (Tyler & Moench, 2012)). that cannot only adapt to the predicted changes in weather patterns but is also able to accommodate and recover from pressures that may not yet have revealed themselves.

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Research questions

How can public space become more flexible to accommodate weather extremes and changing needs?

How can this be implemented in Utrecht?

1. What are the current and expected effects of climate change on weather patterns in the Netherlands?

2. How can the resilience of cities against extreme weather events, mainly drought and heavy rainfall, be increased?

2.1 How can resilience against drought be increased?

2.2 How can resilience against heavy rainfall be increased?

2.3 How can climate adaptation for drought and heavy rainfall be best combined?

3. How does the use of public space change throughout different seasons/weather circumstances?

4. How can we align the use of public space with climate adaptation measures?

Design assignment

The goal of this project is to use flexible design to accommodate changes in weather and use throughout the seasons in Utrecht and for this flexibility to extend to a level where it can adapt quickly to changing circumstances and demands. No matter if these changes are small and every other week or a few decades from now. The aim is for the public space of Utrecht

to get into a rhythm with its use and its seasons and to be more adaptive to its current and future weather and use.

Process

Method description

To answer the research questions posed, a timeline is established which is shown in figure 7. Laid out are the different phases of research as well as what methods are used and what the outcome is at each stage. Every stage will now be briefly described as well as any additional goals and aims.

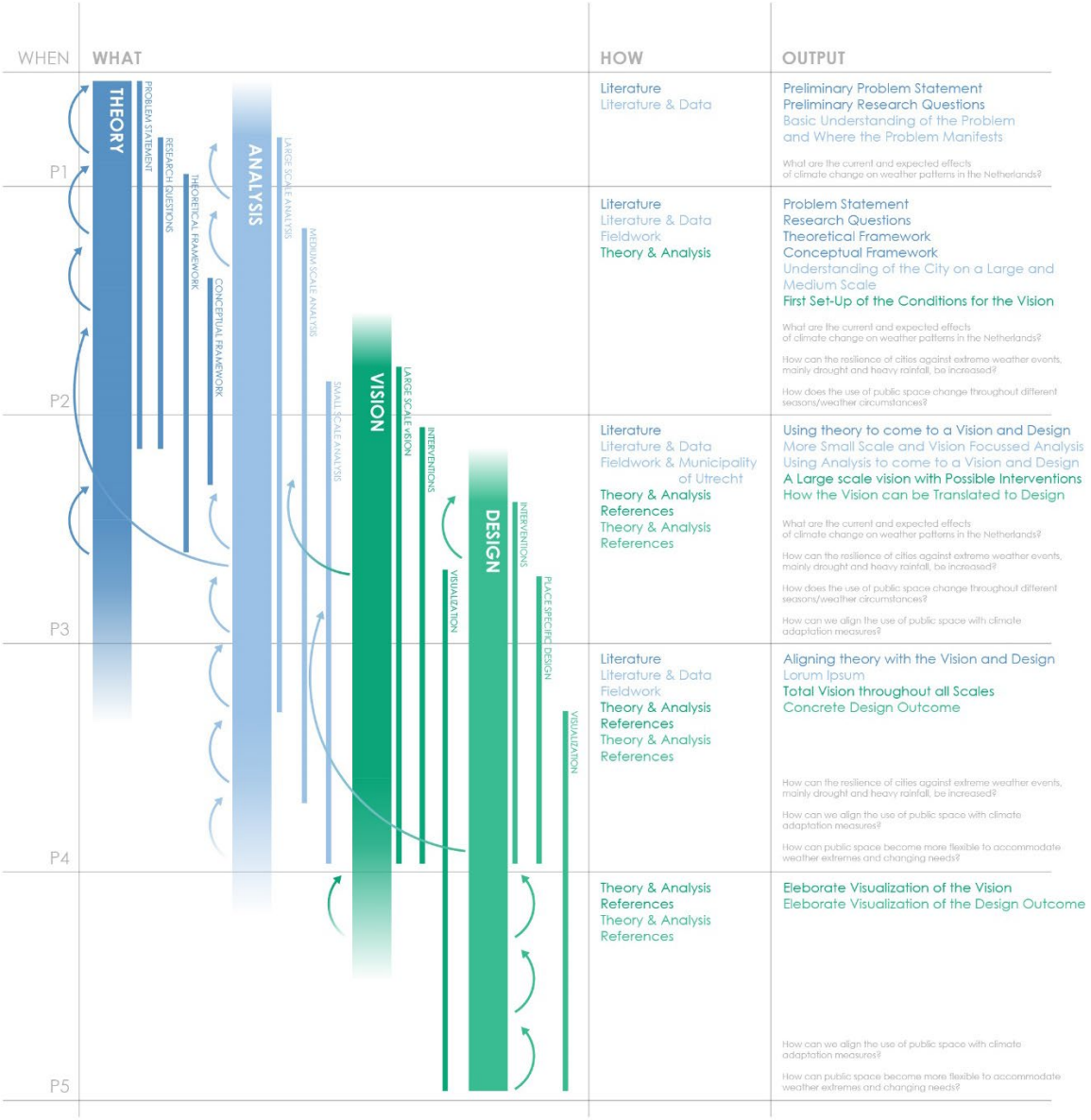

Figure 7 Timeline with methods used and output from different phases

P1
In this stage, the main issues that will be addressed are formulated. Preliminary research questions will be formulated, as well as a preliminary problem statement. The first steps are made to set up a theoretical framework.

P1 – P2
In this phase, research questions, theoretical framework, conceptual framework, and methods have a clear outline. An analysis is started on a medium scale and a large scale. This leads to the identification of especially vulnerable areas within the chosen location, these are possible locations for a smaller-scale analysis and eventual design intervention. Goals and guidelines for the vision are set up as well.

P2 – P3
The research set-up and theoretical backing are by and large completed. Next, a location for a small-scale design intervention is chosen followed by an in-depth analysis of the location as well as fieldwork. The vision is mostly laid out by combining analysis through all scales and a start is made toward an eventual design.

P3 – P4
In this phase, a lot of attention will go to the alignment of the narrative throughout the whole report. The Vision and public space design will be mostly completed.

P4 – P5
With the main research complete, this stage will entail going through the entire research and addressing any inconsistencies and deficiencies. Furthermore, this stage will be used to further elaborate and visualize the vision and the design.

From Main themes to Goals
The research for this report starts from two major points. Flexibility, concerning climate change as well as human behavior, and Climate adaptation. These main topics will both be explored separately and in a general context. After this more general phase, these topics will be discussed in the context of the location of Utrecht to uncover the specific challenges and particular ways this location functions in relation to the topics of flexibility and climate adaptation. In addition, the vulnerable areas (for extreme weather) of Utrecht will be identified and from these areas, a final design location will be chosen. In the next phase, place-specific and general knowledge will be combined to come to a vision for the municipality of Utrecht as well as a design for one of its neighborhoods.

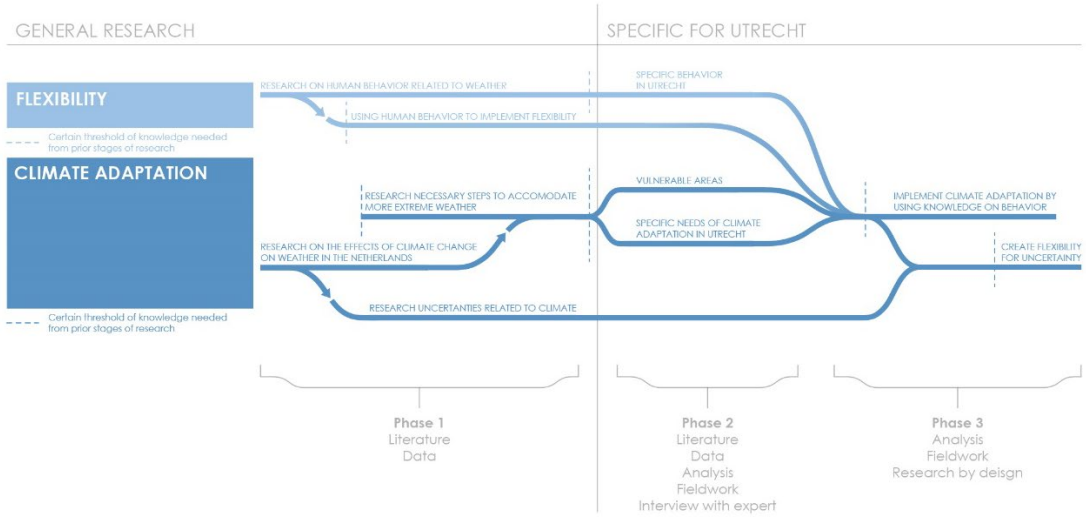

Figure 8 Elaboration upon methods used and stages of research

Literature and general practical preference

Key literature

Duarte, J. P., & Beirão, J. (2010). Towards a methodology for flexible urban design: Designing with urban patterns and shape grammars. Environment and Planning, 38, 879–902.

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Reflection

There are a few reasons why this project is relevant on a social and scientific level.

Firstly, there is a clear need to adapt our cities to a changing climate. A city needs to be able to accommodate future weather extremes to avoid major damage and to keep its inhabitants safe. The transition to climate-adaptive cities is still very much starting out and conversations and research on how to best achieve this are still very much relevant.

Secondly, this report looks at climate adaptation for extreme weather from a lens of flexibility. Looking to create flexible climate adaptation is not necessarily a new idea, but using changes in human behavior to implement this flexibility has not been seen often before.

Lastly, the research in this report will also yield a clear design example of what the implementation of flexible climate adaptation can look like, adding to the possible solutions for coping with extreme weather.

This project relates heavily to urban design in terms of research and scale and therefore fits well within the urbanism master track.