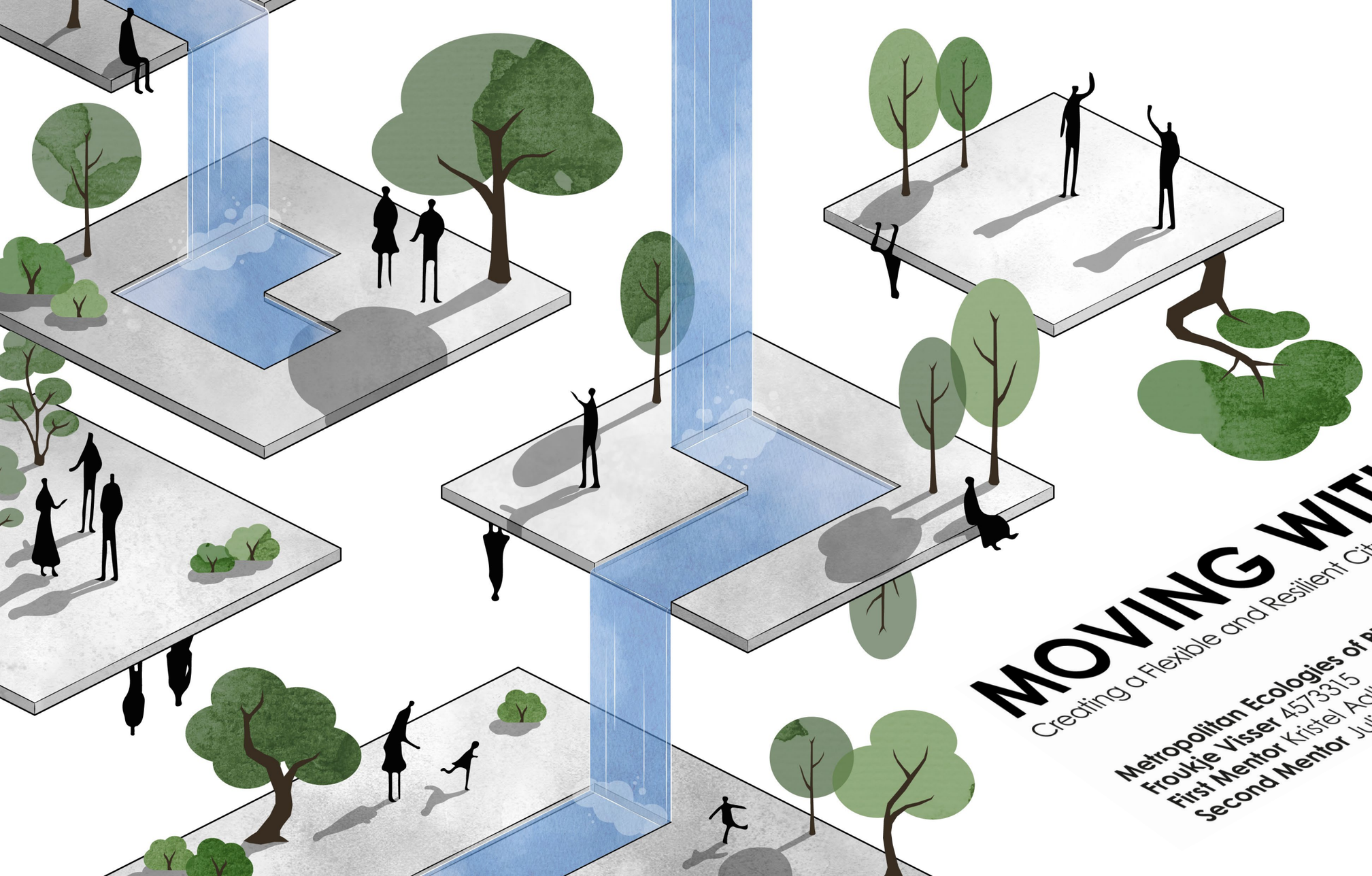

MOVING WITH WATER

Creating a Flexible and Resilient City in the Face of Extreme Weather

Metropolitan Ecologies of Place
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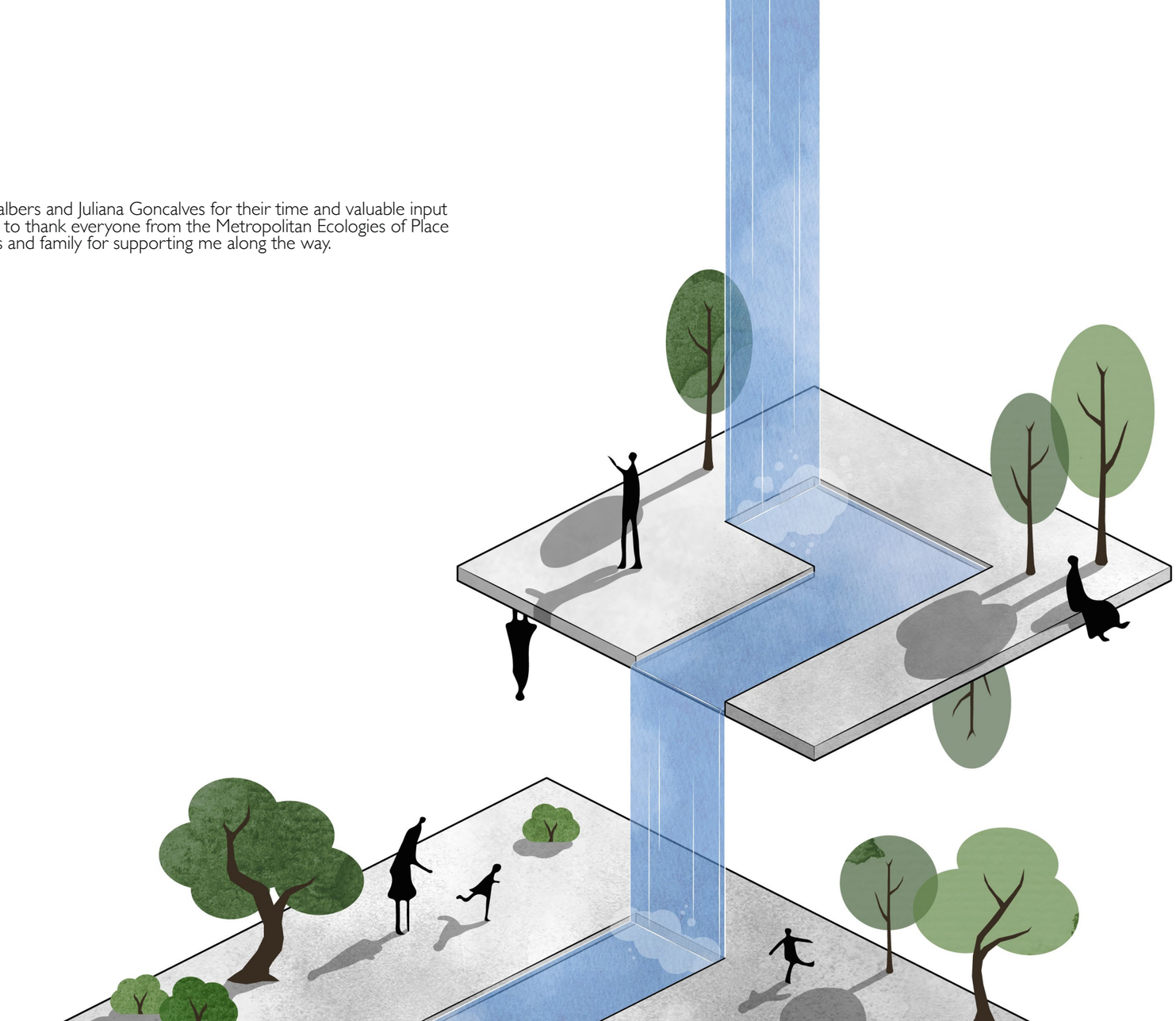
First Mentor Kristel Aalbers
Second Mentor Juliana Goncalves

I would like to thank my mentors Kristel Aalbers and Juliana Goncalves for their time and valuable input during my graduation year. I also would like to thank everyone from the Metropolitan Ecologies of Place studio as well as my friends and family for supporting me along the way.



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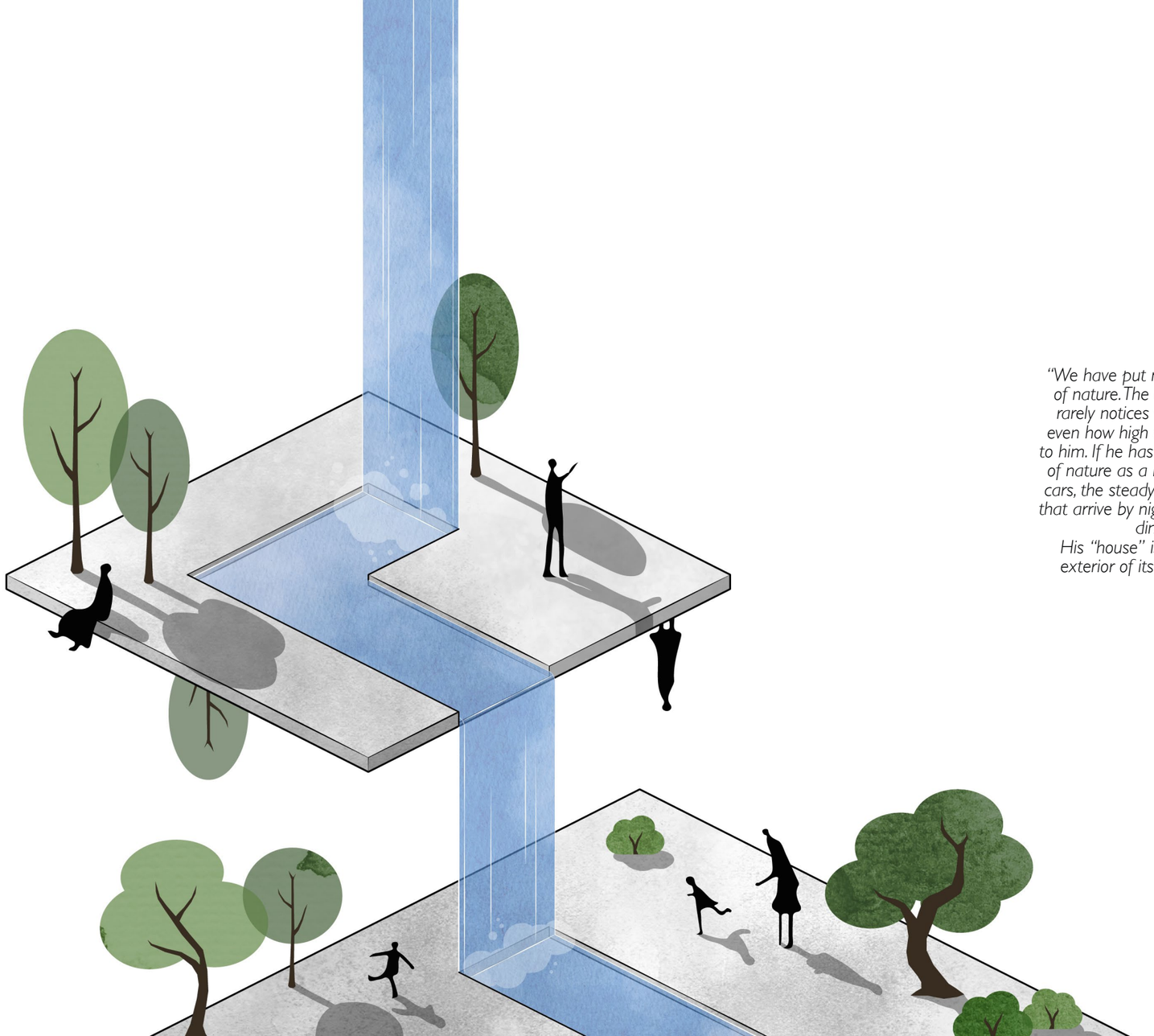


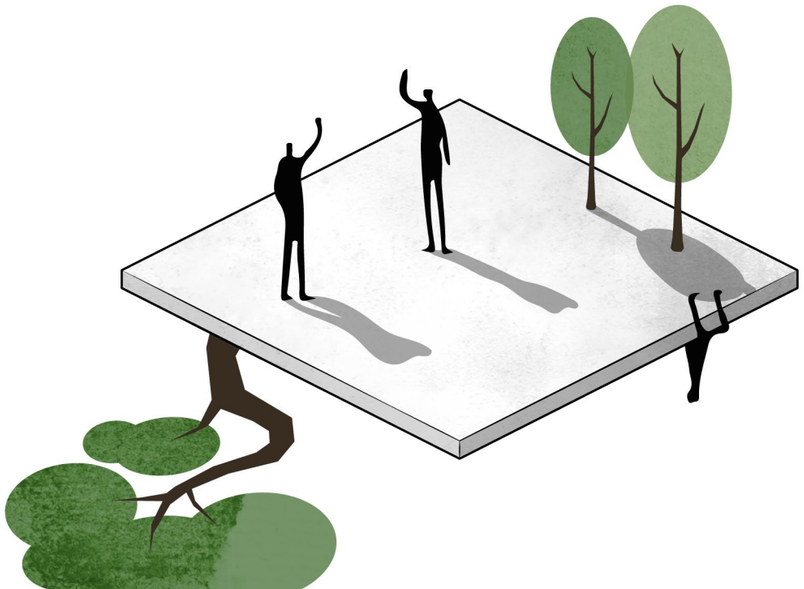
"We have put many stages of artifice and device, of manufacture and alteration, between ourselves and the rest of nature. The ordinary city dweller knows nothing of the earth's productivity; he does not know the sunrise and rarely notices when the sun sets; ask him in what phase the moon is, or when the tide in the harbor is high, or even how high the average tide runs, and likely as not he cannot answer you. Seed-time and harvest are nothing to him. If he has never witnessed an earthquake, a great flood, or a hurricane, he probably does not feel the power of nature as a reality surrounding his life at all. His realities are the motors that run elevators, subway trains, and cars, the steady feed of water and gas through the mains and of electricity over the wires, the crates of food-stuff that arrive by night and are spread for his inspection before his day begins, the concrete and brick, bright steel and dingy woodwork that take the place of earth and waterside and sheltering roof for him.
His "house" is an apartment in the great man-made city; so far as he is concerned, it has only an interior, no exterior of its own. It could not collapse, let in rain, or blow away. If it leaks the fault is with a pipe or with the people upstairs, not with heaven."

- Susanne K. Langer (Langer, 1942)

Motivation

The first and only time I remember my hometown being on the national news is when a major storm caused extremely high water levels and the threat of a possible dyke breach back in 2012. The small and usually quiet town in Groningen flooded with journalists and my mother was even interviewed while running errands after the storm passed (van den Breemer, 2012). At the time it seemed like something that does not happen often and will most likely not happen again. Bad luck, not part of a pattern. But news about and experiences with water nuisance and other extreme weather events seem to become more frequent as time goes on. At the same time, snow days seem to become less frequent as I get older. I remember walking through knee-deep snow to get to elementary school as a child, but nowadays I barely even expect snow when winter rolls around. The last time the famous ice-skating race the 'Elfstedentocht' was held was the year of my birth, 1997. With climate change progressing, the chances of the race ever happening again go down every year (KNMI, 2022b). To me and many other people, changes in weather are a reminder of the effects and progression of climate change.

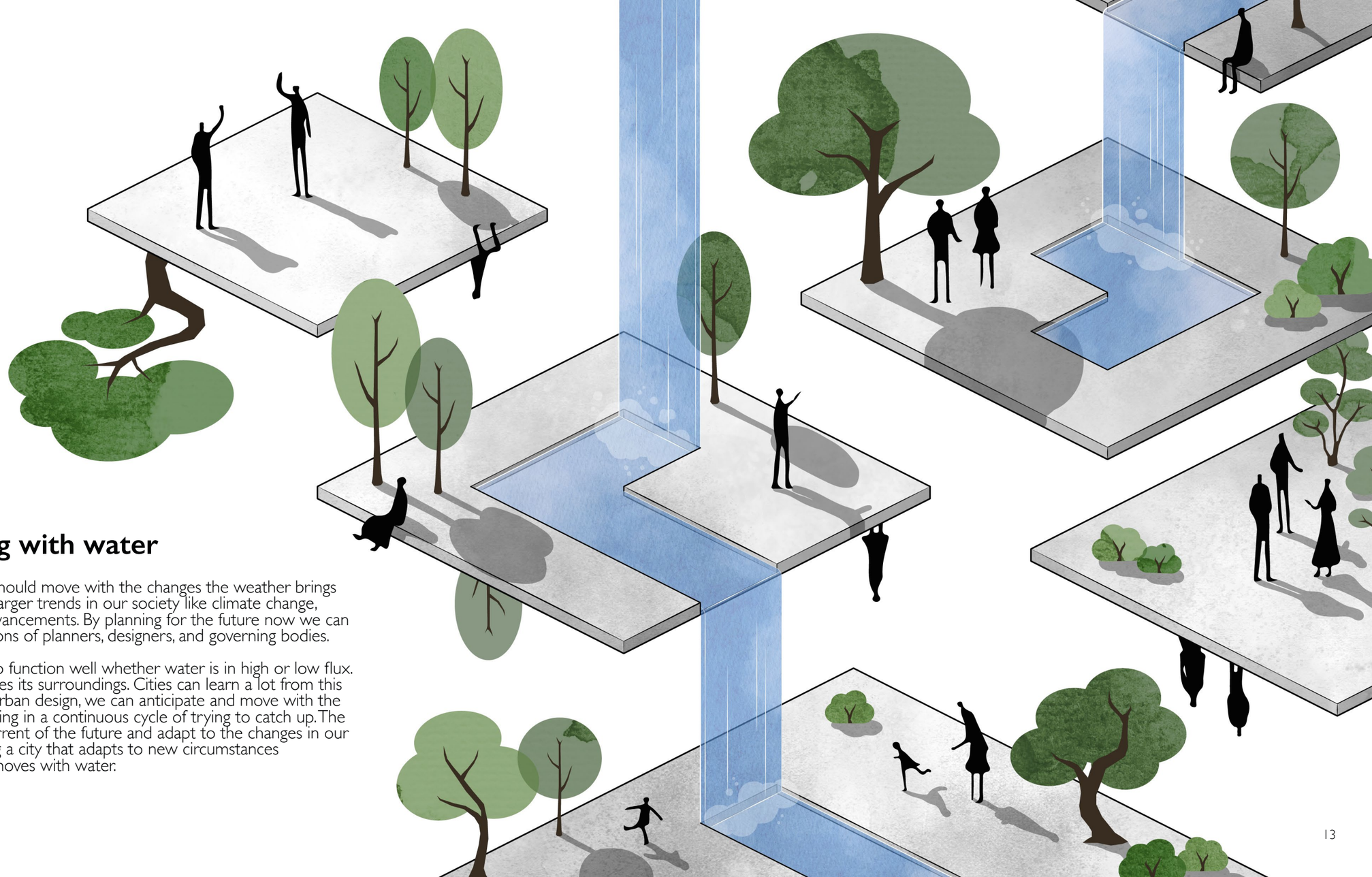
With this project, I hope to increase the ability of our cities to cope with weather extremes. Creating a city that can accommodate the changes in our weather pattern, while keeping the changes in our climate visible. A harmless yet important reminder that action is needed.



Moving with water

The built environment of the future should move with the changes the weather brings as well as evolve with slower and larger trends in our society like climate change, demographic changes, and technical advancements. By planning for the future now we can reduce obstacles for future generations of planners, designers, and governing bodies.

The built environment should be able to function well whether water is in high or low flux. Water is fluid. It is shaped by and shapes its surroundings. Cities can learn a lot from this fluidity. By increasing the flexibility of urban design, we can anticipate and move with the changes the future brings instead of being in a continuous cycle of trying to catch up. The built environment should follow the current of the future and adapt to the changes in our climate and weather. Creating a city that adapts to new circumstances and moves with water.



Problem Statement

In this chapter, the main problems this report will address will be expanded upon. There is also a discussion on other considerations that should be made when talking about these particular problems. The chapter will conclude with a clear challenge that arises from the problem.

Extreme weather

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, mainly in 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).

However, 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 led to estimated damages between 450 and 2080 million euros (Philip et al., 2020).

Traditional Dutch infrastructure is not always equipped to deal with all these changes in weather patterns as it was not built with these new extremes in mind (Dai et al., 2017). As climate change progresses, expectations are that extreme weather events will happen more and our cities are not prepared for it. Our cities will need to adapt. Drastic changes need to be made to the built environments to cope with extreme weather.

Climate change and the effect on weather

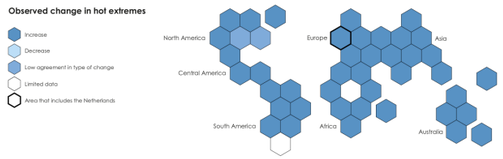


Figure 1 Worldwide observed changes in hot extremes, based on data from IPCC (IPCC, 2021).

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).

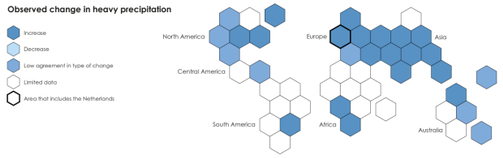


Figure 2 Worldwide observed changes in heavy precipitation, based on data from IPCC (IPCC, 2021).

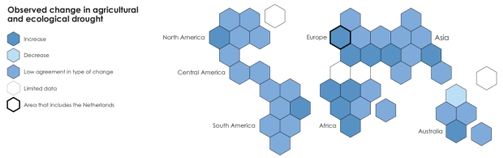


Figure 3 Worldwide observed changes in agricultural and ecological drought, based on data from IPCC (IPCC, 2021).

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 global warming can be limted 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 Celsius (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 Celsius.

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.b). These extreme weather events will increase as global warming progresses (KNMI, 2021b). The expected increase in rainfall is correlated to the

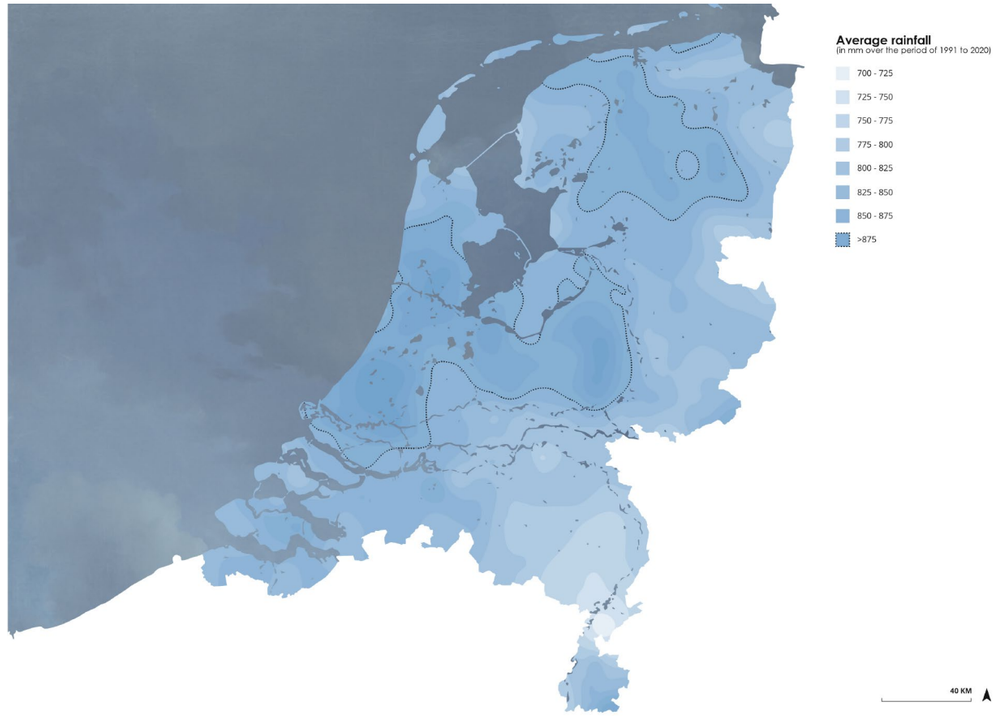


Figure 4 Average rainfall in the Netherlands, based on data from KNMI (KNMI, 2022a)

amount of water vapor in the air. The increase in water vapor is about 7% for every degree Celsius of temperature increase. Looking at past observations, rain could increase more than this 7% that is calculated and could be as high as 14% (KNMI, 2021a). How this correlates to rain intensity is shown in figure 5.

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 predict those odds to increase, meaning rainfall of over 58 mm of rain in an hour will be 5 to 10 times as

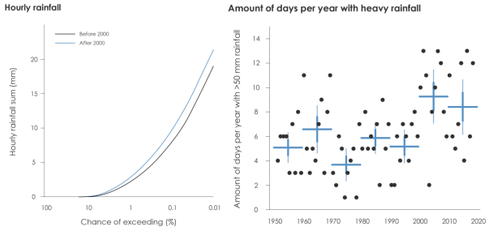


Figure 4.1 Graph comparing hourly rainfall data from before and after 2000, Based on data from KNMI (KNMI, n.d.b).
Figure 4.2 Graph showing days with rainfall >50 mm, based on data from KNMI (KNMI, n.d.b).

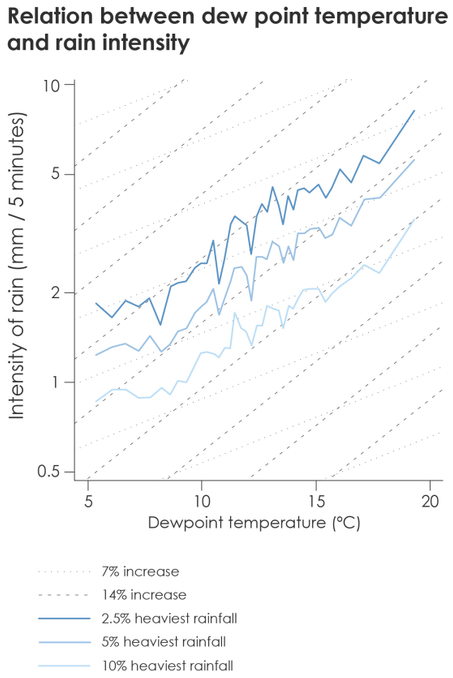


Figure 5 Relation between dew point temperature and increased rain intensity (temperature is expressed in dewpoint temperature to refer to thermal conditions with a relatively constant humidity), based on data from KNMI (KNMI, 2021a).

likely as it is now (KNMI, 2021a). Suddenly an event that happens once in a lifetime, becomes a regular occurrence.

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 leading to low groundwater levels and causing damage to nature, agriculture, and the built environment. Droughts in the Netherlands

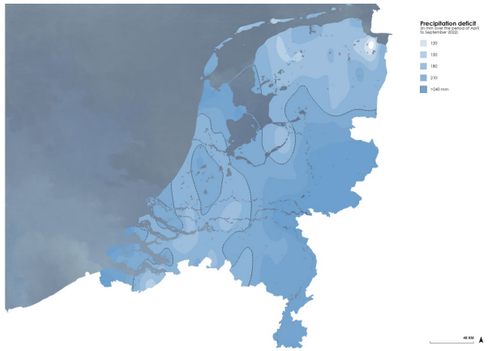


Figure 6 Precipitation deficit in the Netherlands in 2022, based on data from KNMI (KNMI, 2022).

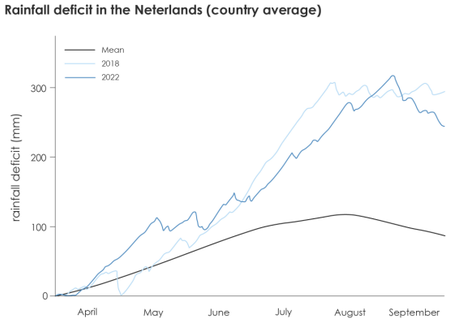


Figure 6.1 Graph showing drought in recent years compared to the mean, based on data from KNMI (KNMI, 2022c).

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.c).

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).

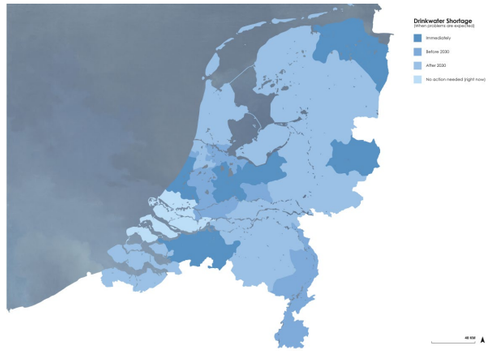


Figure 7 Drinking water shortage in the Netherlands, based on data from Vereniging van Waterbedrijven in Nederland (Geudens & Kramer, 2022).

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).

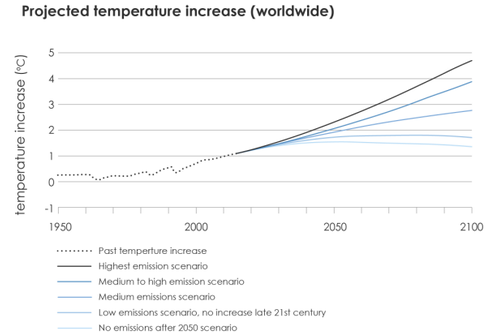


Figure 8 Projected temperature increase this century showing bigger uncertainty as time goes on, based on data from IPCC (IPCC, 2021).

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.

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, flexible urban planning will always be beneficial to anticipate foreseen and unforeseen changes.

Considerations

Although the main focus of this report 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

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). Heat is also a contributing factor when it comes to drought. When implementing climate adaptation for drought and heavy rainfall, thermal comfort is an aspect that should be considered.

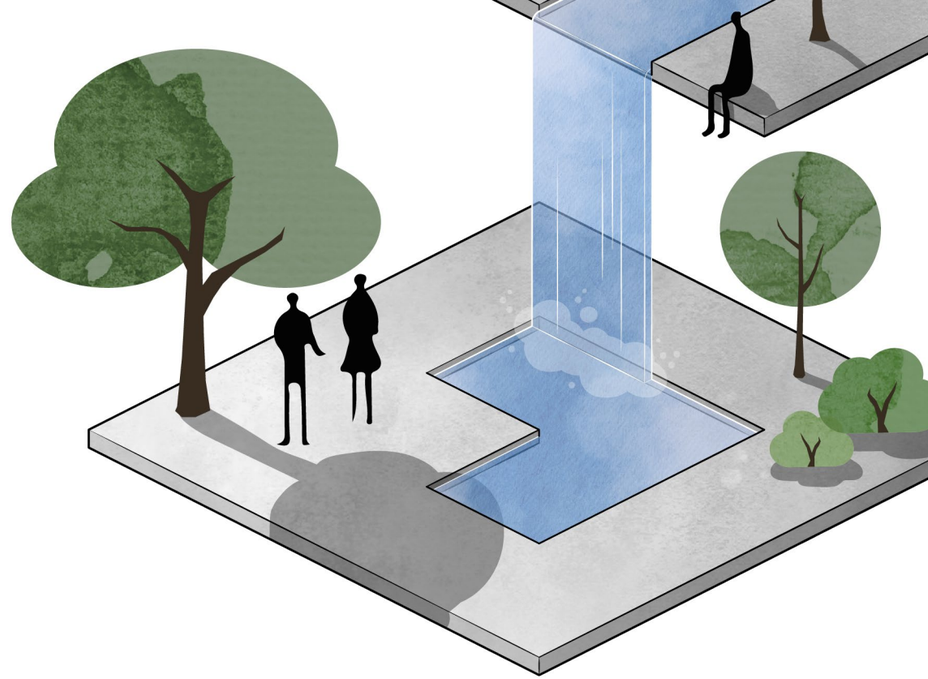
Intervention location
Another aspect that should be considered has more to do with where to intervene. People living in disadvantaged neighborhoods are often more vulnerable and at risk for the effects of climate change. These are often people of lower income groups living in older neighborhoods where the need for renewal/renovation of the built environment is high. 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).

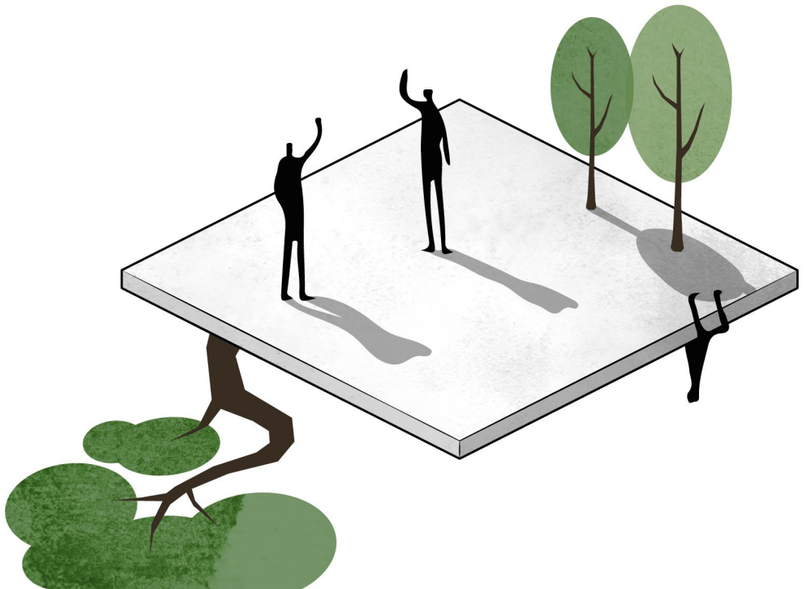
Scale
The interaction between the city and its wider surroundings is also important when looking to create climate-adaptable cities as it greatly impacts weather and climate within the city (KNMI, 2021b). The European Union also stresses the need for robust ecosystems for climate change mitigation and 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.

Use
Many cities in the Netherlands are still growing and are dealing with other transitions related to climate change, like the energy transition and the move towards a circular economy. On top of this, there are also other ambitions related to social, ecological, and a host of other challenges. This means there is pressure on space; there are many needs that need to be fulfilled within the same surface area. Implementing climate adaptation cannot take up endless amounts of space and will need to be implemented in unity with other uses.

Creating resilience

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), the term resilience is further expanded upon in the next chapter) 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.





Research Framework

In this chapter, the main set-up of this report will be explained. This includes the research questions this report will address, the theoretical framework, the conceptual framework, the methods used, the timeline, and the main aim of this report.

Research Questions

The problems formulated in the previous chapter bring up multiple questions to be researched further. This report will address the following questions:

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

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?

3 How can climate adaptation measures be best aligned with other spatial goals?

3.1 What spatial goals conflict and align with climate adaptive measures?

Some main definitions are now given for often-used vocabulary in this report.

Vulnerability
When speaking of vulnerability, the vulnerability of the built environment is meant. In this report, vulnerability is mentioned in terms of area and in terms of population. When talking about vulnerable areas, places, where the built environment is not equipped to handle current or future extreme weather, are meant. When talking about vulnerable populations, groups of people who live in places that are less equipped to deal with extreme weather are meant as well as people who are not equipped to deal with the (financial) repercussions of extreme weather. Vulnerability therefore always relates to the readiness of a place to deal with extreme weather.

Resilience
According to the Oxford Dictionary, resilience is, "the ability of people or things to recover quickly after something unpleasant, such as a shock, injury, etc." (Oxford University Press, n.d.). In this report when resilience is mentioned, it is specified as socio-ecological resilience. This definition of resilience sees nature and society as an intertwined system and its resilience refers to what the system can endure without losing its key functions, as well as its ability to learn and adapt (Meerow & Newell, 2016), (Folke et al., 2016).

Sustainability
The definition that the Oxford Dictionary gives for sustainability is, "the ability to continue or be continued for a long time" (Oxford University Press, n.d.). However, in this report, it is argued that sustainability should also be resilient, as a sustainable solution should be able to cope with unforeseen change (Quigley et al., 2018).

Adaptability
Adaptability is the ability to change and cope with new situations (Oxford University Press, n.d.). Within the context of this report, adaptability is seen as a necessary component of resilience.

Flexibility
Flexibility generally means the ability to change. In the context of urban design, this can mean that a place can change to accommodate different functions or it can mean that one place accommodates changing activities (Sanei et al., 2018).

Theoretical Framework

Resilience, Nature, and the City

When we talk about climate change, we often talk about sustainability. How can a city become more sustainable? Within the context of sustainability, it is not always clear whether a sustainable place is also resilient or adaptable to future change (Quigley et al., 2018). In the past two decades, there has been a growing call for sustainability to account more for change and the uncertainty of the future. A sustainable solution should be able to deal with an unforeseen change. A sustainable solution should be resilient (Quigley et al., 2018). When it comes to something as unpredictable as climate change, resilience is crucial.

Resilience is a term that often comes up when sustainability and climate adaptation are talked about. According to the Oxford Dictionary, resilience is, "the ability of people or things to recover quickly after something unpleasant, such as a shock, injury, etc." (Oxford University Press, n.d.). Within the field of urbanism, this resilience is often specified as socio-ecological resilience. This definition of resilience states that people and societies as a whole are an integral part of nature. It is shaped by and shapes the natural system around it, we are not just interacting with nature, but are part of nature (Folke et al., 2016). Socio-economic resilience does not look at society and nature as separate but as a single complex system. Resilience should be achieved for the system as a whole. It should be cooperating, capable of taking blows and adapting (Meerow & Newell, 2016).

This is in contrast with how a lot of people think. In the Western world, people tend to think of nature as a space with a lack of people and urban space as a lack of nature. They see themselves as separate from nature instead of part of this bigger system. Jelmer Mommers ponders this topic in his book on climate change, wondering why people think we are separate from nature when our lives (the air in our lungs and the bacteria in our gut) prove that we are not (Mommers, 2019). The quote at the beginning of this report from Susanne Langer also describes this disconnect to the larger system around us, stating that many of us are not aware of the productivity and capabilities of nature and the elements, even though they surround us every day (Langer, 1942).

This disconnect can also be seen in the way we have designed our cities, in most ways stagnant when dealing with changing circumstances. It does not blow with the wind or rise with the tides. It often does not even respond to us, even though we are constantly changing; our needs, and our activities. People are fluid with their needs and demands, yet our cities are often not. Many problems we are facing in our cities stem from this lack of flexibility in the urban system. A housing shortage does not happen overnight but is the result of decades-long trouble to adapt a rigid city to changing demands.

Nature is dynamic, weather and seasons change nature and its surroundings. It is fluid and adaptable, able to take blows. The urban environment is static, capable of small changes, but with no true adaptability. Traditional urban planning is unable to deal with the change that is constantly present in every society on the planet (Duarte & Beirão, 2010). Changes take months to years, and weather and seasons are a blanket on top, but not an integral part of the physical environment. If people and societies are truly a part of nature, then why do we not build our cities like nature, with adaptability and resilience?

This lack of flexibility and adaptability is strange as our use of public space changes from year to year, season to season, and even day to day. In a rapidly changing climate, we cannot permit our urban environment to be static in dealing with change, especially since that change is so unpredictable. The physical components of a city and the urban structure have to be able to adapt to its context and its internal and external pressures (De Lotto et al., 2017). Because of climate change, cities are becoming damaged and uncomfortable to live

in. Meanwhile, one rigid solution is replaced with another and another.

What would happen if we did not design the urban environment for one future, but for multiple scenarios? With multiple outcomes possible or even being able to switch between states. Why do we not bring the fluidity of nature into our urban environment?

Resilience and flexibility

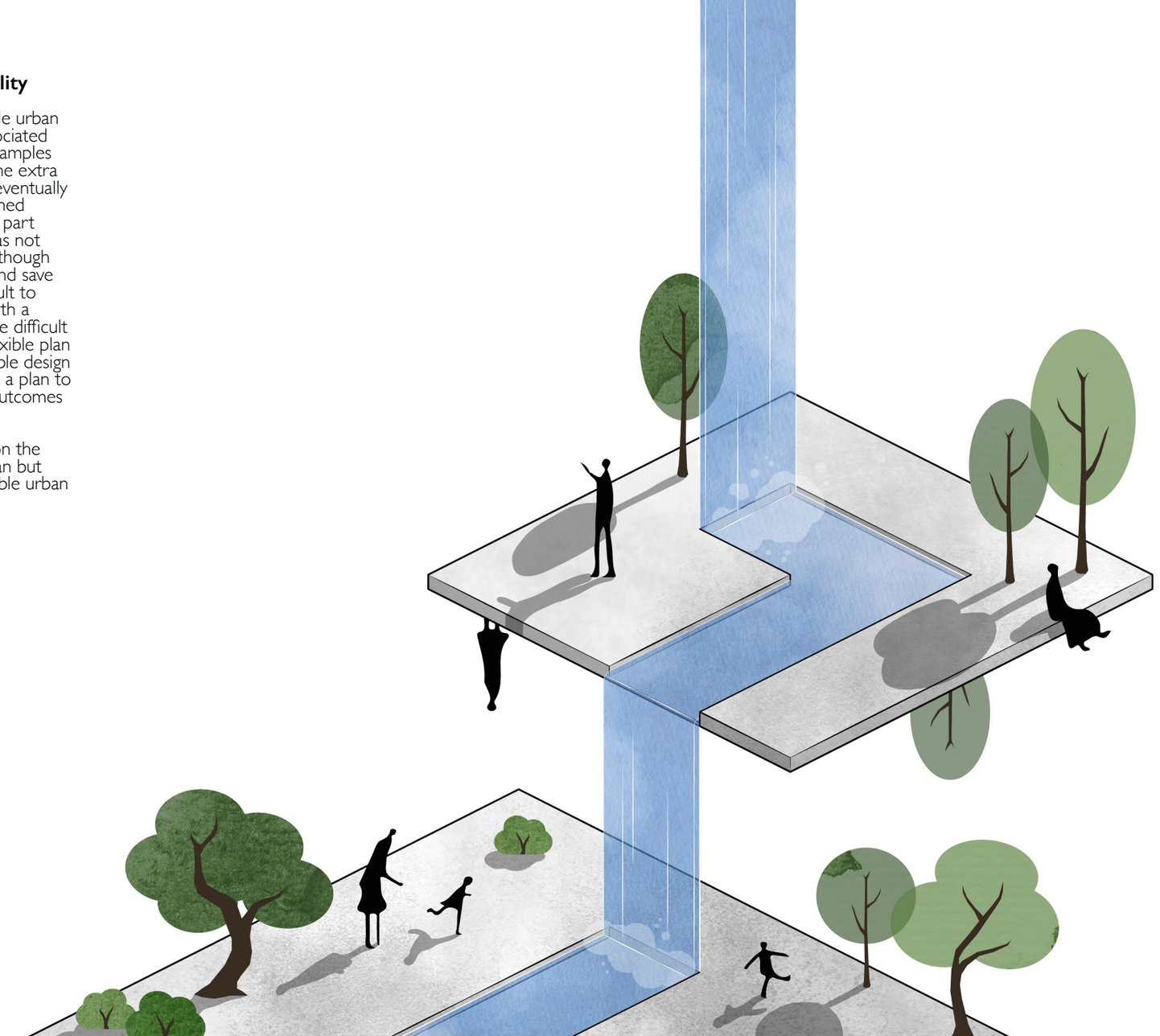
Resilience and flexibility seem almost inseparable. For a city to be resilient, it must be capable of repeated adaptation and change to adjust to the needs of its citizens and the environment (De Lotto et al., 2017). De Lotto's paper calls for resilient cities to bend without breaking, being able to cope with external shock by absorbing it through flexible systems (De Lotto et al., 2017). However, some vocabulary in the paper still seems to see cities as inflexible systems. Words like 'withstand' seem to indicate some kind of resistance still present in a flexible system. A case could be made that in a truly flexible system, one state would not be considered worse than another, and changes in circumstance can be accommodated and do not need to be combatted.

The possibility of the function or structure of a place changing in the future should always be considered when making an urban design. When change is an inevitability, flexibility is a necessity (Sanei et al., 2018).

The obstacles on the road to flexibility

One of the obstacles when making a flexible urban plan or design is the often higher costs associated with flexibility. A 2008 paper gives some examples of flexible architectural projects and how the extra costs of making the projects flexible were eventually won back by its flexibility. When space opened up in a building due to a change in use, this part could be sold or rented out quickly as it was not bound by one use (Habraken, 2008). Even though the hypothesis is that flexibility will in the end save money by being flexible, it can still be difficult to convince stakeholders to invest in a plan with a higher starting cost. Especially since it can be difficult to prove when and how much money a flexible plan can save. Another obstacle is getting a flexible design approved as it might be difficult to approve a plan to be built when there are multiple possible outcomes (Duarte & Beirão, 2010).

These hurdles can vary widely depending on the size, timespan, and other specifics of the plan but should be considered when creating a flexible urban design.



Conceptual Framework

In the face of extreme weather, our cities should become more flexible and resilient. With this project, Utrecht is taken as a case study to implement a flexible and climate-adaptive design to cope with extreme weather. Within the city, there are other things to consider aside from climate adaptation, like a growing population, densification plans as well as other spatial ambitions the municipality has. On top of this, there might be more things that put pressure on the available space in the future. With limited space, the urgency for flexible design grows.

Utrecht is not a blank canvas. There is a rich history to the city and current functionalities are already embedded into the (public) space. A lot of the space in Utrecht already serves a function, but there is still some room to grow and densify. With big challenges like climate change laying ahead, this available space might not be enough to fulfill every goal the municipality has.

Adaptation to extreme weather is one of the large changes that Utrecht is currently faced with. To prepare for the effects of climate change, more measures will need to be taken to make sure Utrecht can cope with the weather extremes of the future. For drought, this will mean among other things making sure there is enough drinking water year-round, making sure the water levels do not drop below a certain threshold where it could damage the built environment, and trying to retain as much rainwater as possible (Gemeente Utrecht, 2022c). In terms of dealing with heavy rainfall, this means making sure the city is safe during heavy rainfall, as well as trying to avoid damage to the built environment. The amount of rain the city needs to deal with will increase over time and space is needed to implement these measures.

Another challenge the municipality is faced with is a growing population. This increase in population is expected to continue until at least 2050 (CBS, 2022). For the city, this also means an increase in population density, around 1.200 extra inhabitants per km2 are expected in 2040 compared to 2021 (Gemeente Utrecht, n.d.a). The demand for housing is high and the current supply does not suffice. Extra people will also mean added facilities and added pressure on space.

In addition to implementing climate adaptation and accommodating a growing population, the municipality also has other spatial ambitions. Examples of this are creating more room for green spaces (Gemeente Utrecht, 2021c) or increasing the number of possibilities for recreation along the water (Gemeente Utrecht, 2022b). These ambitions require space as well.

All these different factors and ambitions are putting pressure on the available space in Utrecht. This means compromises need to be made in terms of what goals have priority over others and efforts need to be made to achieve multiple different things within the same available space. Establishing limits for growth and setting boundaries for what has priority over other things is important to ensure Utrecht will remain a livable and thriving city in the future.

It is also important for Utrecht to become more flexible in dealing with changing circumstances. The needs of the city are not set in stone and it is hard to predict the exact needs of Utrecht 20, 40, or even 80 years from now. Flexibility within the (public) space of Utrecht and the planning process is necessary to quickly adapt to changing priorities and unforeseen events.

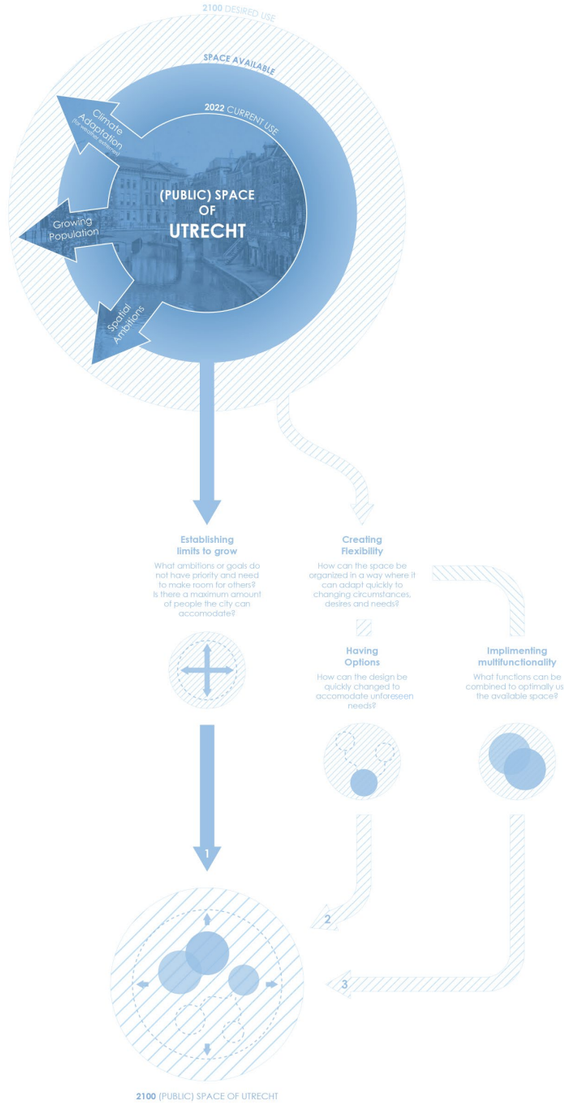


Figure 9 Conceptual framework

Methods

To answer all the research questions and get to an eventual design, certain steps are constructed.

Getting started
research

The research will start by looking into the problem of extreme weather in general. What are the expected scenarios when it comes to extreme weather and what are the problems that arise from them? Are there any related issues? What does the problem entail and what could the consequences be for a city?

The main aim of this stage
Getting an understanding of the problem at hand.

Relevant research questions
What are the current and expected effects of climate change on weather patterns in the Netherlands?
How can the resilience of cities against extreme weather events, mainly drought and heavy rainfall, be increased?

The large scale and medium scale
Analysis and research

When a more general understanding of the problem is established, it is important to relate this information and knowledge to the location of Utrecht. What are factors that make a place more vulnerable to extreme weather and what locations of Utrecht are more vulnerable when it comes to these issues? What are other factors that play a role in deciding where to intervene? Vulnerabilities will be overlayed together with other factors to get an eventual location for a design intervention.
It is also relevant to look at Utrecht's general history and ambitions for the future. How do these ambitions align and clash with adaptation to extreme weather? Are these ambitions feasible?

The main aim of this stage
Grasping how the problem expresses itself within Utrecht and figuring out where the best places are to intervene.

Relevant research questions
How can climate adaptation measures be best aligned with other spatial goals?
What spatial goals conflict and align with climate adaptive measures?

The small scale
Analysis, research, and fieldwork

Zooming in further, it is again important to look at how the problem of extreme weather expresses itself on an even smaller scale. The ambitions for the area can be related to climate adaptation to see where goals can be combined and where compromises need to be made. It is important to know where the strengths and weaknesses of the area lie and how they can be mitigated or used as an advantage.

The main aim of this stage
Understanding how the problems affect the small-scale location, what other issues the area deals with, and what its strengths and weaknesses are.

Relevant research questions
How can climate adaptation measures be best aligned with other spatial goals?
What spatial goals conflict and align with climate adaptive measures?

Vision
Goals and scenarios

With all the knowledge gained from the previous steps, a vision will be set up. What will the future of Utrecht look like if it was fully adapted to extreme weather? What are the main goals and what has priority? How does climate adaptation tie into other goals?

The main aim of this stage
Sketching a scenario for an Utrecht that is fully adapted to extreme weather.

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

Design
Concept and scenarios

Coming from the vision, the design is an expression of what the vision could practically look like. What interventions will be needed to achieve the goals that are set up by the vision?
For the entire location intervention sets will be made. These are interventions that work well together and can uplift the different areas to reach various goals. For certain locations, these intervention sets will be further elaborated into a fully fletched design. This design will then be shown in different scenarios to show how it deals with different weather circumstances and to test its flexibility.

The main aim of this stage
Taking a peak at what Utrecht could look like in the future.

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

Assessment
Goals and criteria

For the assessment the main goals of this project will be broken down into subgoals, these are necessary components to reach the overarching goal. For these subgoals, it is then established what it means to reach them. What does a space need to reach this goal and what will it look like if it does not reach it? For every subgoal it is established what a bad outcome, medium outcome, and good outcome are and the different designs will be tested against them. This will then show how well the different designs score for that subgoal. This way the different designs can be tested against each other and against the vision to show whether it is successful.

The main aim of this stage
Seeing if the design reaches the goals set up in the vision.

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

Conclusion and reflection
Reaching the goal

Lastly, all previous knowledge will be brought back together to show the general insight this project has to offer. Its strengths and weaknesses will also be discussed.

The main aim of this stage
Bringing together all information and conclusions gathered from previous stages within the project.

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

The goal

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.

Dealing with extremes

A lot of things need to happen in the upcoming decades. Climate adaptation and other large transitions on top of renovation and densification. Within cities, this can create certain conflicts over space, especially within already dense areas. The same space must be adapted for heavy rainfall, be adapted for drought, and retain its functionality within the city. In this chapter different needs are discussed and strategies are set up to deal with the extremes in the use of the same space.

Climate adaptation

Utrecht is in a part of the country that deals with water-related problems as well as drought-related problems. What is considered to be extreme weather now may become the new normal in a few decades. The biggest variables in weather are seen around winter and summer as they will both become warmer. The summer will show more rainfall, although this rainfall will most likely be one or several peaks of rain, with dry spells before and/or after. The winter can also become a lot wetter but with fewer peaks like in the summer and more continuous rainfall (Nature Today, n.d.), (Climate Data, n.d.), (Alweer, 2013), (Beste Reistijd, n.d.).. The city and its surroundings will need to adapt to this new normal when it comes to weather patterns and this has a lot of repercussions for the built environment.

Underprepared

Over time it has become increasingly clear that water and extreme weather pose a real threat to the built environment. The way we currently cope with these extremes will not be sufficient in the future (Palazzo, 2018). Many scientists agree that even if we drastically reduce our emissions, our climate and our weather patterns will still change in the upcoming century. These weather changes will put immense pressure on our cities and current efforts to reduce the consequences do not sufficiently address the extent to which these changes in weather will influence our cities and their inhabitants (Henstra, 2012).

Cities are densely populated and complex entities. They are especially vulnerable to extreme weather because of the density and accumulation of interdependent processes and infrastructure (Henstra, 2012). This magnifies the consequences of extreme weather (Voskamp & van de Ven, 2014). Cities are becoming increasingly more vulnerable to extreme weather as time goes on. Action needs to be taken now as the time we have to adapt our cities to a changing climate is declining (Short, 2021).

The traditional way of urban planning may be inherently unable to adapt to threats like climate change as the scope of many projects is not long-term enough to address this problem and the unforeseen changes it will bring. A lot of current measures that attempt to adapt to extreme weather and water threats are designed as local, temporary fixes that are unable to adapt to changing conditions (Palazzo, 2018).

It is the long-term and uncertain nature of climate change that causes problems when making designs and policies for climate adaptation in our cities. Efforts are often focused on adaptation that yields immediate effect even though adaptation for the future must also start now (Henstra, 2012).

Use of space

Next to extreme weather, cities are also faced with extreme use of space. Plans need to be made to increase housing, facilities, and functions within already built-up space. On top of this, some other ambitions and changes need to be made because of changes in demographics, types of services/companies that want to settle in or leave the area, or improvements that need to be made to the built environment. All these aspects require space or changes to be made to the built environment. Not making these changes in time can have big repercussions for a city and its inhabitants.

Many large problems cities have faced in the past couple of decades are the result of the lack of long-term vision we are seeing right now when it comes to problems related to climate change. Plans to combat issues always come when the problems are already affecting a lot of people. The current housing shortage many cities in the Netherlands are faced with is an example of a use of space issue that suffers from a lack of long-term vision and inflexibility. How come an issue like this was not addressed until it was way too late? And what can we learn from it?

Utrecht specifically has some large problems related to supply and demand on the housing market, they even have one of the highest percentages of overbidding on houses in the whole country (CBS, 2021) all the while sectors like retail and the inner city of Utrecht are dealing with more and more vacant buildings (DUIC, 2021a), (DUIC, 2021b). Although there is some discussion on the exact causes of the current housing crisis, some things do pop up more often when the root of the problem is speculated about.

The first possible cause that is talked about is that housing plans were based on prognoses that turned out to be wrong (Obbink, 2020). These prognoses underestimated the demand for housing drastically, leading to a mismatch of planned housing and needed housing. Another possible cause that is often mentioned is the economic crisis in 2008, calling a halt to many construction projects at the time (Obbink, 2020).

Although large and complex issues like these are rarely the result of a few simple reasons, these two reasons in particular are very reminiscent of the problem were are faced with at the moment with climate change. We have a large and complex issue with multiple prognoses, but we do not know which one will turn out to be correct. Choosing to base our plans on the wrong scenario could spell disastrous. On top of that, we do not know what unforeseen events and changes will be on our way to an eventual solution. There could be technological advances or rare climate events that could completely change the way we deal with climate change and its effects.

Problems cannot always be predicted. Especially with the problems related to the housing market, the economic crisis played a big part in worsening it. Together with the wrong prognosis, it was difficult to react to a problem and its twists and turns once it was on its way. Large and complex problems call for general flexibility and adaptability that can bend with arising problems and changing circumstances. This is a type of flexibility and adaptability that we are missing in many areas of the built environment.

Adapting to the unforeseen

Changing the built environment to adapt to climate change and extreme weather is expensive and takes time (Short, 2021). In a continuously changing climate, it is therefore important that a solution does not just adapt to weather circumstances of the upcoming years, but reaches beyond that timeframe. This calls for flexibility in planning and design.

Ways to increase flexibility can range from more multifunctional spaces to temporary public space design. The exact strategy for a particular place is dependent on the current needs and possible future needs of a place.

Increasing flexibility, especially within climate adaptation can have more benefits than just being able to deal with change. It can also help to create functional spaces that can be used on and off depending on the needs at that time. This way the space can be used for climate adaptation, but does not lose its functionality within the city. This is especially important in cities that are dealing with things like inner-city densification and other conflicts over space.

Adaptation to extreme weather

Apart from increased flexibility and adaptability, some other changes will also need to be made when it comes to dealing with extreme weather.

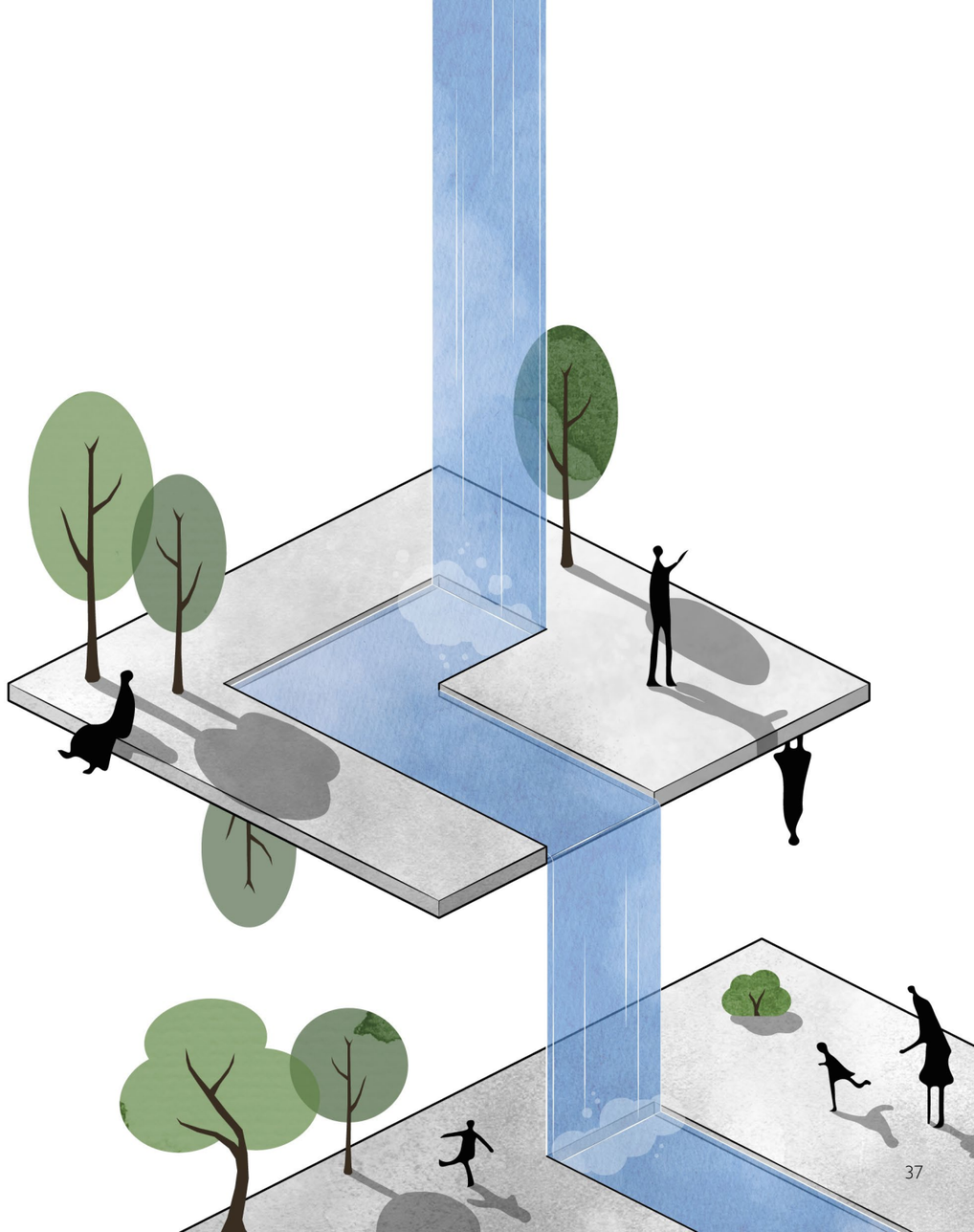
Rainwater is still seen as something to get rid of instead of a resource that can be used (Palazzo, 2018). It is important for water to become a valuable resource instead of something to dispose of. This is an idea prevalent in the sponge city concept, which is a leading strategy for climate adaptation in many Asian countries (Li et al., 2018).

Something that should also be taken into consideration when adapting our cities to extreme weather is planning land use in a risk-appropriate way (Henstra, 2012). This means assessing the risk factors of a certain location and developing or not developing accordingly. This is currently not done enough.

To combat the negative effects of weather extremes the importance of resilient blue-green infrastructure is often stressed as well. This is because of their capacity to store excess water and combat heat stress. It can also increase the quality of ecosystems and their ability to bounce back from extreme weather (Voskamp & van de Ven, 2014). When creating a resilient future city, it is important to use the natural system as a starting point for adaptation and to work in a nature-inclusive way (Baptist et al., 2019).

Other areas of improvement lie in increasing awareness of weather-related risks, the protection of important infrastructure, and well-functioning emergency management (Henstra, 2012).

These elements have great potential for improvement compared to the current way of working and should therefore also be considered when creating a vision and an eventual design in Utrecht.



Utrecht

In 1674 a huge storm hit the city of Utrecht which caused major damage to the city. Most notably, the main church (the Domkerk) partially collapsed leaving a huge pile of rubble in the center of Utrecht. The leftover part of the church was patched up, but the pile of rubble left over from the collapse would remain there for another century and a half (Dom Under, n.d.). The ability to recover from storms has increased since then, but what are the current vulnerabilities of Utrecht to weather extremes?

In this chapter research and analysis are done on the city of Utrecht, which is concluded with a couple of maps of the most vulnerable areas in the city/municipality and possible sites to implement a small-scale public space design.

The Past

An introduction to Utrecht

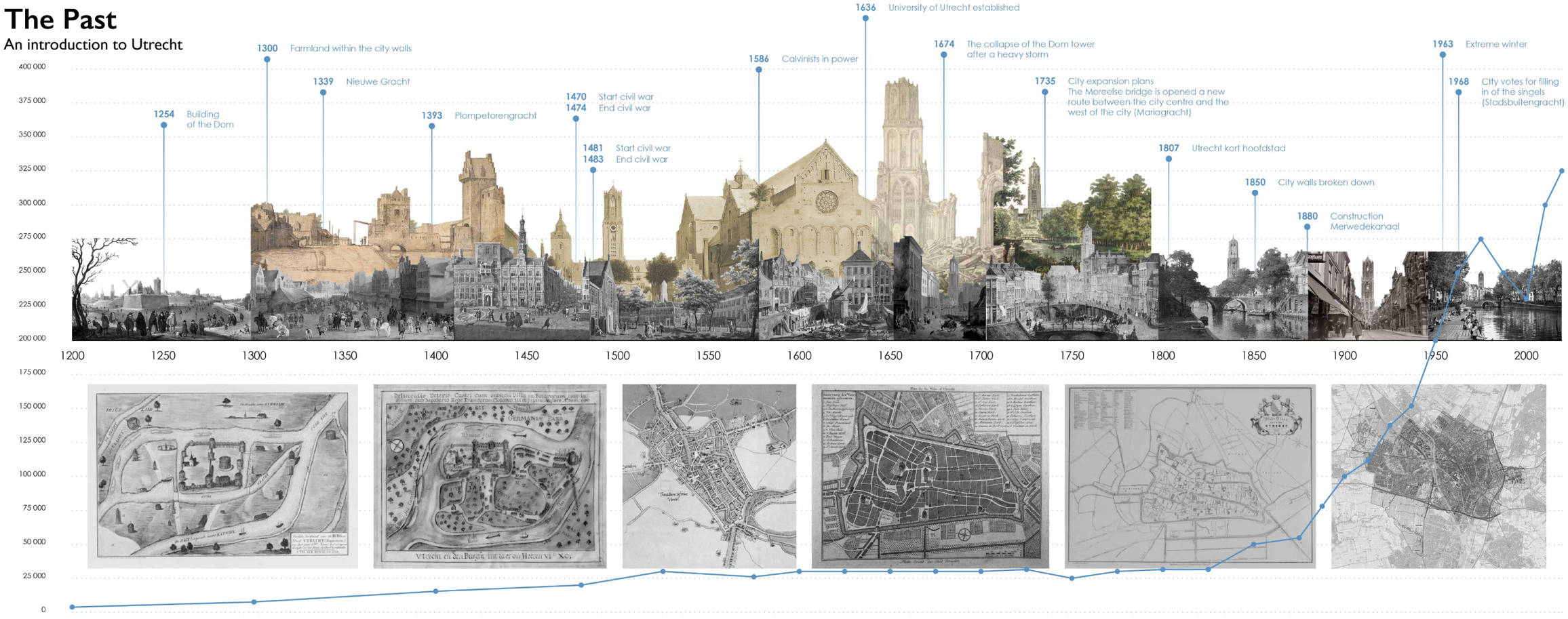


Figure 10 Historic timeline of Utrecht showing population and city growth as well as some highlighted events

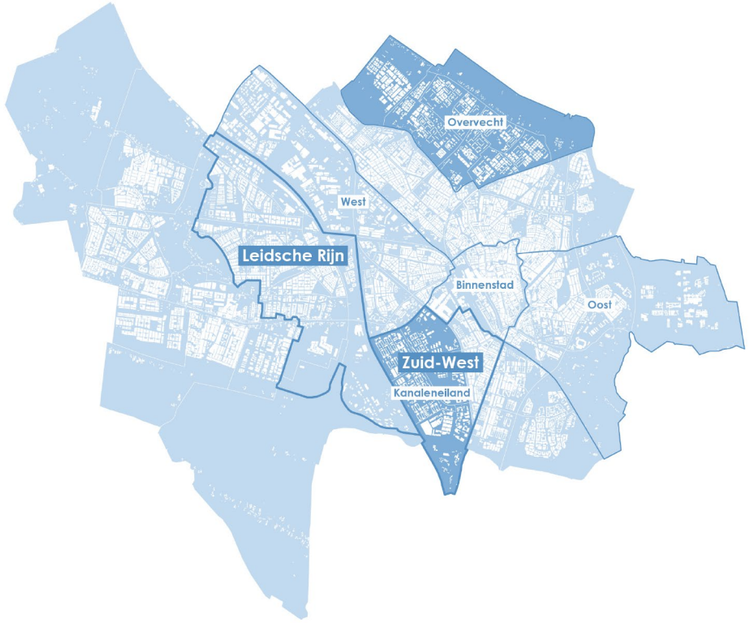
Water has historically always been of importance to Utrecht (Gemeente Utrecht, 2022b), although the use and relationship to water have changed over the years. This importance of water can also be seen in old maps of the city like the one shown in figure 10. The city finds its origin in a Roman fort that settled around a branch of the Rhine and the Vecht as they were part of an important transport route at the time. Because of this strategic location, the city slowly developed itself into a trade city in the middle ages. Multiple canals were dug that connected to the rivers and it is around this time that the signature cellars along the canals were developed, a feature that the city is still famous for. The harbor remained part of the city until it was moved out during the 20th century. This also meant a shift in the function of the water in the city, moving away from trade and opening up opportunities for leisure along the water. Many of the historic cellars switched their function to restaurants and bars (Gemeente Utrecht, 2022b).

The Future

Some researchers speculate that the focal point of growth in the Netherlands will slowly shift from the West to the East in the upcoming century. In these scenarios, the Randstad will remain of importance when it comes to things like governance and logistics (Baptist et al., 2019). This would mean that although growth might be expected in Utrecht in the upcoming decades, this can stagnate or even start to decrease somewhere in the next 100 years.

The population of Utrecht is growing and an increase in population is expected until at least 2050 (CBS, 2022). The municipality themselves are expecting this growth to occur in every neighborhood in the city until at least 2040. Not all areas of the city are growing at the same rate, however. The neighborhoods Zuidwest en Leidsche Rijn are expected to grow the most, followed by Oost, Overvecht, Binnenstad, and West. To accommodate this growth the municipality is expecting to build an extra 57.000 houses by 2040 (Gemeente Utrecht, 2021a). Most of the growth in the city is accommodated by inner-city growth. This means the need for smart use of space will arise (Gemeente Utrecht, 2020).

When it comes to transformation, the neighborhoods of Overvecht and Kanalen Eiland will be changed quite a bit in the upcoming years as a lot of the roads and public spaces require maintenance (Gemeente Utrecht, 2022c). This opens up opportunities to transform these neighborhoods in other ways as well.



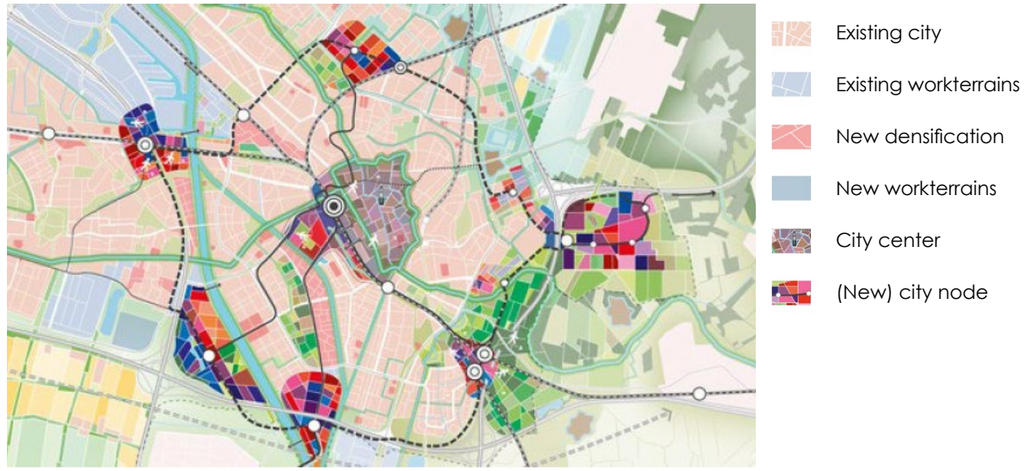


Figure 11 Growth vision of the municipality of Utrecht (Gemeente Utrecht, 2021d)

Ambitions

The municipality of Utrecht has many ambitions and vision documents, most of which look at the city of Utrecht until 2040. Some of the ambitions are about larger themes like; making green-blue connections and breaking down barriers. Others are fairly specific and local. A couple of ambitions of the municipality will now be elaborated upon.

Growth

The population of Utrecht is growing. The municipality is aiming for what they call 'healthy growth'. Their vision of what this will look like is the development of new city centers around the historical core (Gemeente Utrecht, 2021d). Where these cores will be located can be seen in figure 11.

Because of the amount of growth and inner-city growth Utrecht will experience, the municipality is open to new and creative ways of using space. They call for more flexibility and more combined uses in the same place (Gemeente Utrecht, 2020).

Public space

A recurring theme in Utrecht's future policy documents is looking back to the past to envision what the future might look like. This is especially the case when it comes to public spaces. What this could look like is fewer cars and a focus on slow traffic within the city as well as the reintroduction of some canals that have been previously filled in.

The municipality also wants to achieve a minimum of 40% green space in all horizontal spaces in the city. This means an extra 420 hectares of green within the city limits and 60 000 extra trees. On top of that, they also want to provide more shade. A minimum of 40% cover along main routes and 30% cover along other routes (Gemeente Utrecht, 2021c).

Another ambition Utrecht has is increasing opportunities for people to stay and recreate on and around the water. This means more places people can swim or canoe, but also creating high-value green spaces along the water where people can relax. This need is partially driven by an increase

in temperature in the summer as people tend to gravitate towards the cooling effect of the water during these hot and dry days (Gemeente Utrecht, 2022b).

Climate adaptation and water

With new constructions on Utrecht's dyke system expected to be completed around 2030, the risk of a breach and subsequential flooding will be reduced to once every 30.000 years (Gemeente Utrecht, 2021c). This means the main threat Utrecht will be facing is pluvial flooding due to extreme rainfall and not a dyke breach.

Most ambitions for adaptation to extreme weather are related to heavy rainfall. Some of the main aspirations are to retain as much rainwater as possible and to have a public space and sewer system that is equipped to deal with a shower of 80 mm of rain in an hour. (Gemeente Utrecht, 2022c). Although these are excellent ambitions, most of their climate change and extreme weather statistics are slightly more optimistic when compared to nationwide statistics (Gemeente Utrecht, 2021c), (KNMI, 2021). Most of their plans also do not exceed the year 2040. Add on top of this the uncertainty of the problem and Utrecht might still be underprepared to face extreme weather despite having high ambitions compared to some other cities.

In terms of climate adaptation for drought a lot less is known and planned, this shows a lack of preparation for when drought-related problems arise and worsen in the future. The municipality also admits they do not have enough information on topics like drought and biodiversity (Gemeente Utrecht, 2021c).

All in all, Utrecht has some ambitious plans for the future. However, not all areas are as well considered as others and the time horizon is not placed far enough to truly get a good grip on what climate change will do to the city.

Synergies

Looking at the current ambitions of Utrecht and the necessary steps needed to adapt the city to extreme weather there is an opportunity to combine climate adaptation with other goals. Certain goals specifically are very suitable to be combined with climate adaptive measures.

Implementing interventions to relieve the effects of heavy rain and drought can be very well combined with general improvements of the public space. This is also beneficial in terms of results. An improvement of the public space is a direct added benefit to the surrounding area, while climate adaptive measures might not give such a direct visible impact.

The goal to increase the number of green spaces in the city is something that also goes very well with climate adaptation. Green spaces can store water, relieve heat and increase the overall resilience of the natural system. Climate adaptation, therefore, goes hand in hand with an increase in green space.

Another goal that is very well suited to be combined with climate adaptation is the goal of recreation along the water. To combat extreme weather more water storage and surface water will need to be implemented, increasing the amount of opportunities for people to gather and recreate near the water.

Lastly, it is clear Utrecht is trying to be ambitious when it comes to climate change and its effects. If this ambition could be harnessed into long-term action it can make Utrecht a front-runner city when it comes to climate adaptation. It is however crucial that a more long-term vision and planning strategy is established to reach the full payoff of this ambition.

Clashes

Utrecht is planning quite some densification projects in the upcoming decade, which will most likely be followed by even more in the future. This densification comes with some possible side effects that could be problematic in reaching climate adaptation goals.

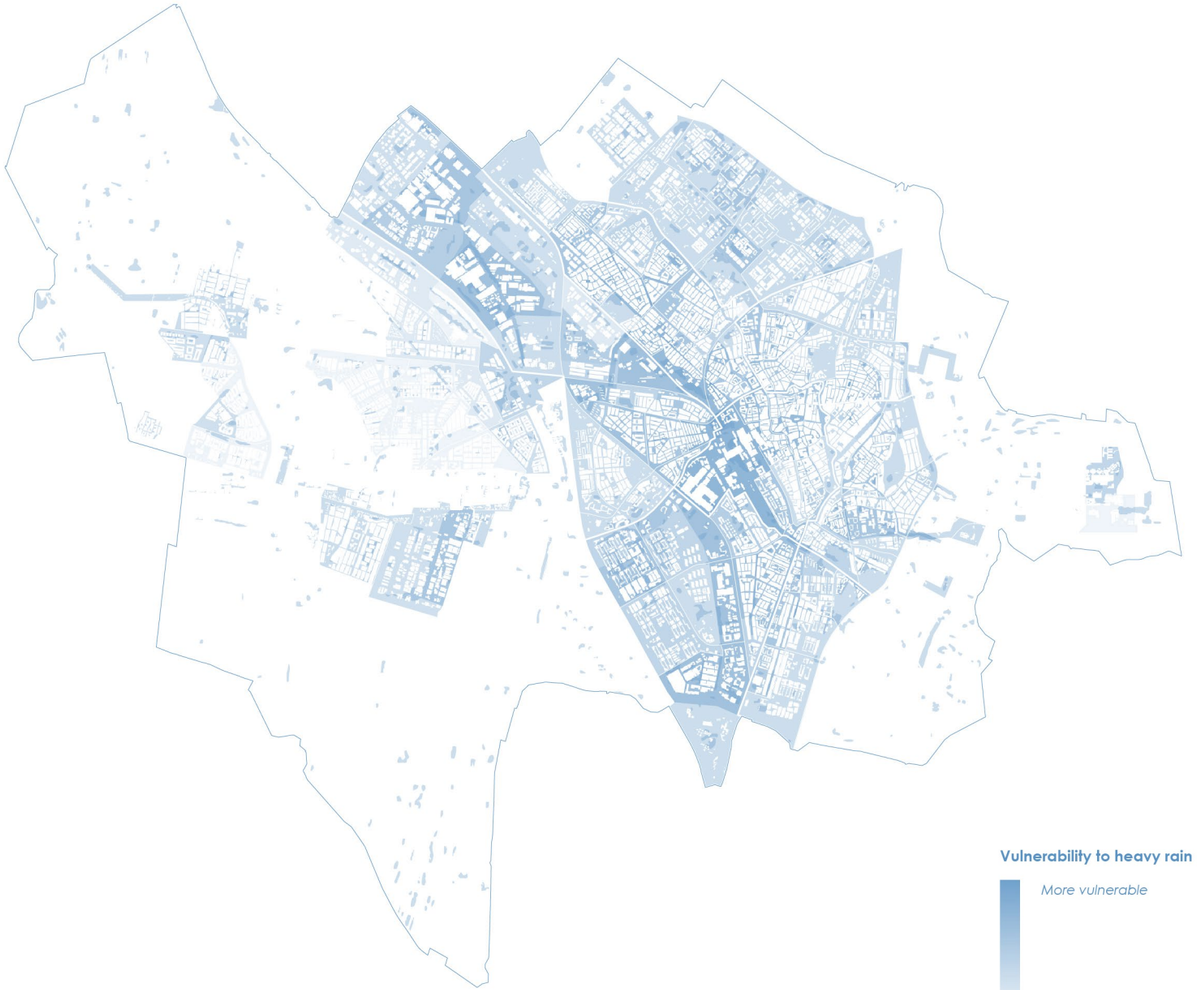
Densification leaves less available space to implement other interventions. And this reaches beyond just the housing projects, as more people also increase the need for other facilities, reducing available space even further. This also has some big repercussions in terms of microclimate and general livability. More built-up space means that heat can become an even bigger issue in the city. It also leaves less room for public space and green space, which is essential, especially in dense areas where many people do not have any private outdoor space.

Densification is something that needs to be weighed carefully against other goals to make sure the pressure does not push out essential functions.

Where to intervene

When deciding where to intervene within the city it is important to understand where the vulnerabilities lie and where the built environment is left most defenseless against extreme weather. What this vulnerability means and where it is most prominent in the city will now be explored.

Vulnerability to heavy rain



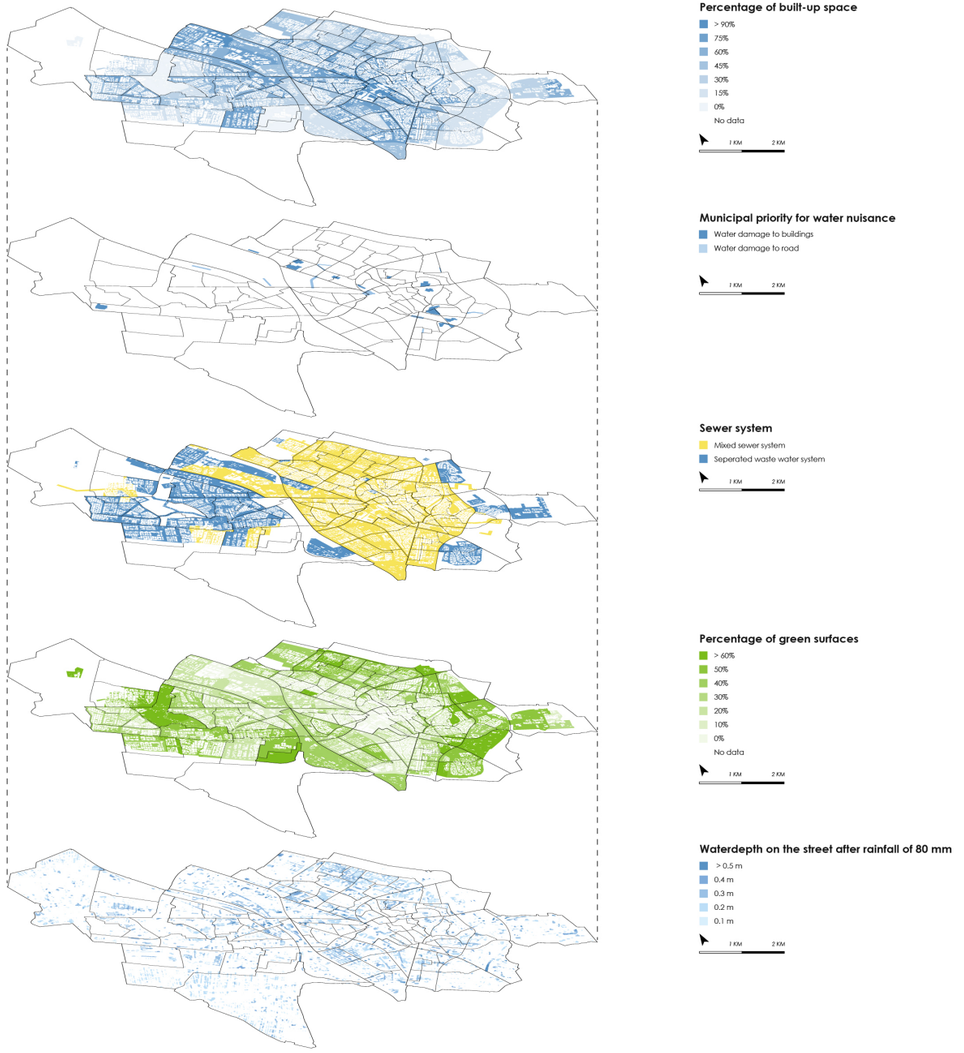


Figure 12 Layers indicating possible vulnerability to heavy rain, (Gemeente Utrecht, 2021c), (Gemeente Utrecht, 2022c).

Many factors play a role in how vulnerable a place is to heavy rain. Some of these factors can be used as a reasonable predictor of how well a certain location can cope with a large influx of rain.

Built up space
The amount of built-up (paved) space in a certain area can increase vulnerability to heavy rain significantly. The chances of infiltration of water into the ground are minimal, which means most of the water ends up in the sewer system or surface water. Especially in combination with little to no surface water in an area, the sewer system can be easily overwhelmed with flooding as a consequence. This can be seen quite well in figure 12 in the city center, there is a very high percentage of paved spaces, but because of the canals water nuisance is a lot less than you would expect based on the built-up area.

Current problems
Based on past problems with damage to buildings and infrastructure, the municipality has allocated a few areas of extra attention when it comes to rain damage. These areas do not give a picture of the full extent of current and future problems but are important to take into account when it comes to vulnerable places.

Sewer systems
There are two main types of sewer systems in Utrecht. A mixed system and a separate system. In a mixed system, rainwater and wastewater are drained through the same system, making it more prone to being overwhelmed during a heavy downpour (Gemeente Utrecht, 2022c).

Green space
More green spaces mean more chances of infiltration and a more delayed influx of water into the sewer system, meaning it will get overwhelmed less easily (Gemeente Utrecht, 2022c). Green spaces, therefore, reduce the vulnerability to heavy rainfall.

Water on the street after rainfall
Simulating a downpour of 80 mm gives an image of where problems can occur during heavy rainfall.

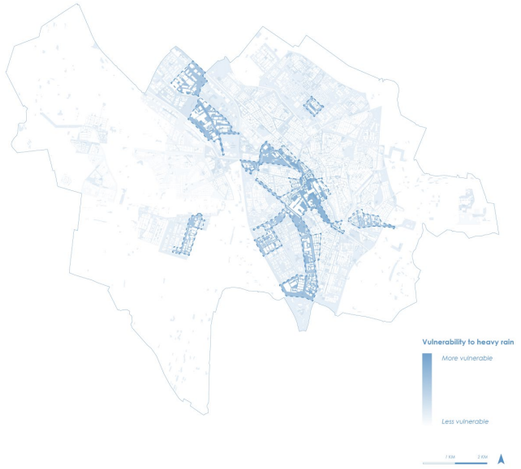
More detailed analysis maps can be found in the analysis appendix.

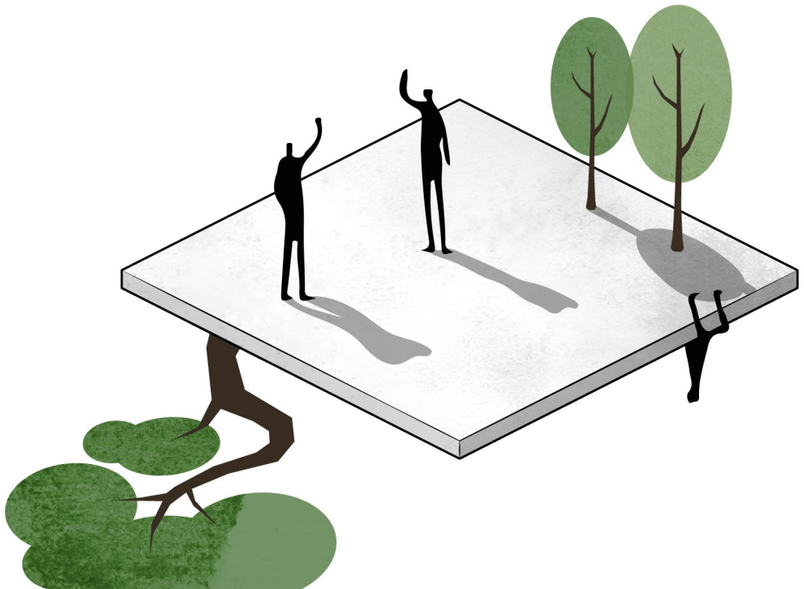
Vulnerable

From overlaying these risk factors for heavy rain some places pop up with a heightened vulnerability. Some of these places are already experiencing problems and with climate change progressing the areas with overlapping vulnerabilities may experience some serious problems in the near future.

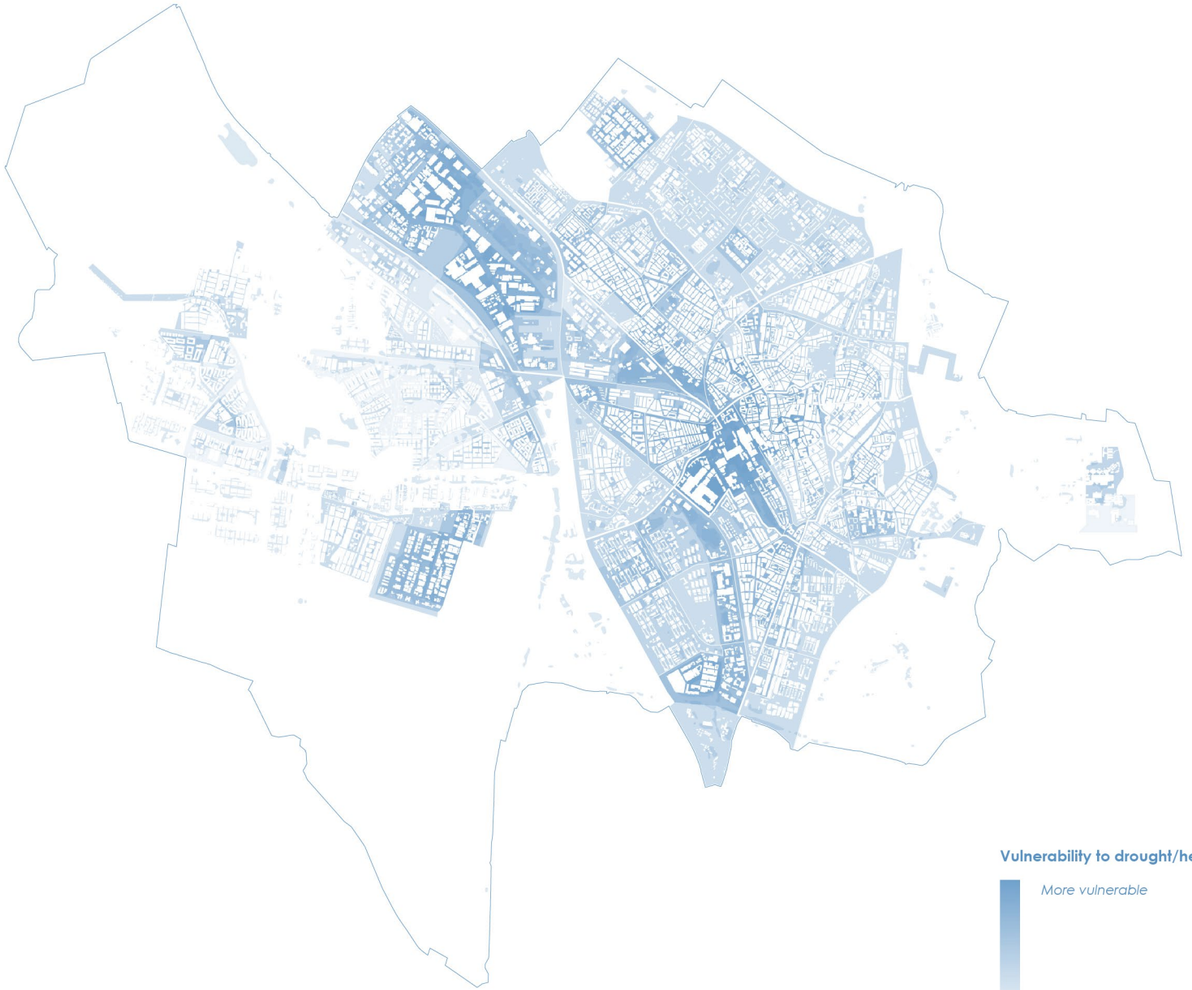
The extra vulnerable areas are highlighted in the map below.

Areas most vulnerable to heavy rain





Vulnerability to drought and heat



Vulnerability to drought/heat

More vulnerable

Less vulnerable

1 KM 2 KM

Percentage of built-up space
- > 90%
- 75%
- 60%
- 45%
- 30%
- 15%
- 0%
- No data

1 KM 2 KM

Municipal priority for heat stress
- Heat stress issues

1 KM 2 KM

Sewer system
- Mixed sewer system
- Seperated waste water system

1 KM 2 KM

Percentage of green surfaces
- > 60%
- 50%
- 40%
- 30%
- 20%
- 10%
- 0%
- No data

1 KM 2 KM

Heat stress
- + 5 °C
- + 3,5 °C
- + 2 °C
- equal to prediction
- - 2 °C
- - 5 °C
- - 10 °C

1 KM 2 KM

Figure 13 Layers indicating possible vulnerability to drought and heat, (Gemeente Utrecht, 2021c), (Gemeente Utrecht, 2022c), (Gemeente Utrecht, n.d.b).

Some risk factors for heavy rain also increase the vulnerability to drought and heat. Drought is a problem that is often overlooked and therefore the data on drought is often incomplete. Information on damages due to low groundwater levels for example is not available. Data on heat is more widely accessible, but vulnerability to drought is on a more speculative level than heat or heavy rain.

Built up space
A higher percentage of built-up space means less water that ends up infiltrating green spaces. The rainwater in these places ends up flowing out of the area through surface water or the sewer system and usually does not do much in terms of replenishing groundwater or helping nature flourish. Built-up spaces are also more vulnerable to heat as many surfaces within the built environment retain heat, increasing temperatures on hot days.

Current problems
Similar to the municipality's priority areas for water damage, there are also priority areas for heat stress. Many of these places align with highly paved areas, often in industrial areas or business parks.

Sewer system
A mixed sewer system can also be a vulnerability to drought. Rainwater that ends up mixing with wastewater has less potential to be reused or redirected. Reusing rainwater can help the city significantly during drought and mixed systems makes this harder to realize.

Green space
green space is one of the best solutions against heat. Low percentages of green in a neighborhood make them especially vulnerable to the urban heat island effect and heat stress. These places also retain less rainwater, making them more vulnerable to droughts.

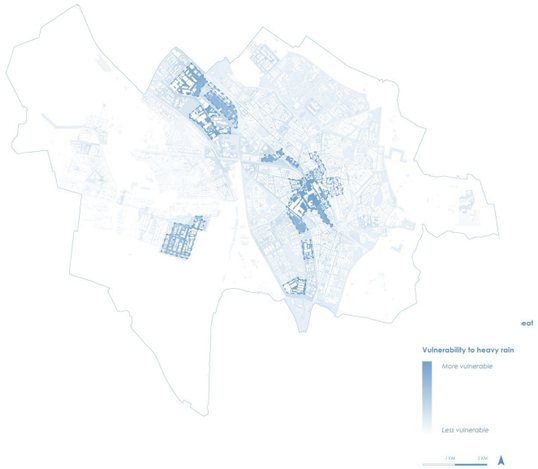
Heat stress
A simulation of the city during a hot summer day shows areas that are more and less vulnerable to heat. These places that get extremely hot during warm weather are a direct threat to the well-being of their inhabitants.

More detailed analysis maps can be found in the analysis appendix

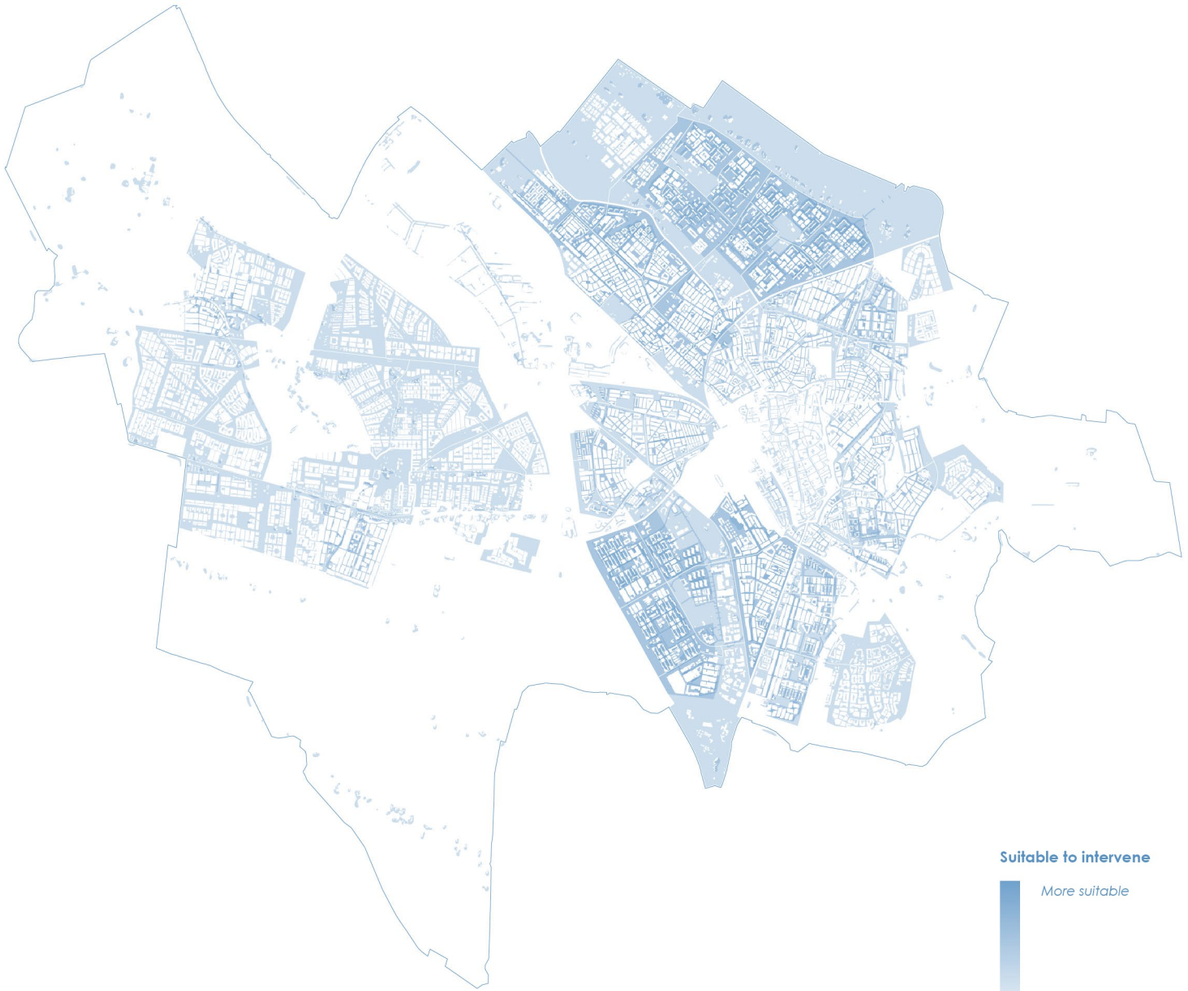
Vulnerable

Similarly to the vulnerability to heavy rain, overlapping the areas that are particularly vulnerable to drought and heat shows the places that are or will be most affected currently and in the near future. They are highlighted in the map below. These areas partially overlap with the vulnerability to heavy rain as both problems share certain risk factors, but there is still a difference in which particular areas are most vulnerable.

Areas most vulnerable to drought and heat



Where to intervene

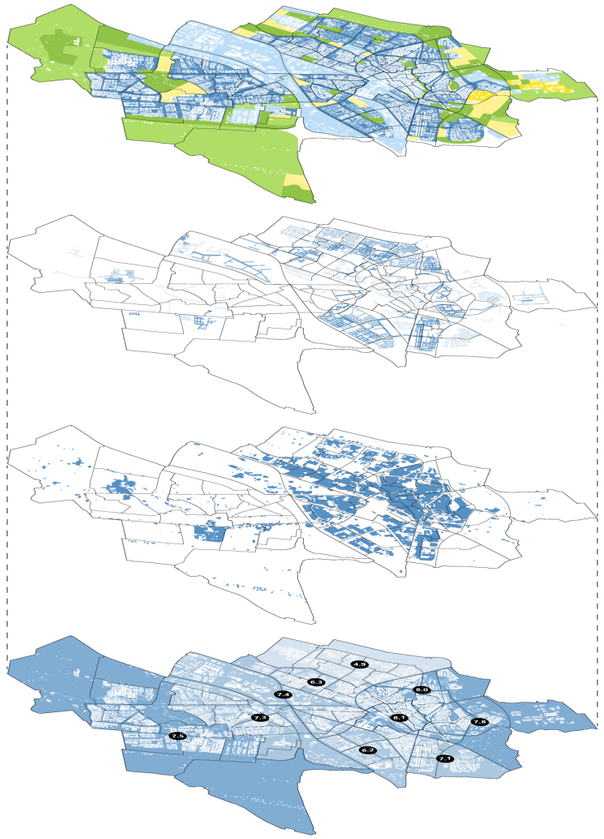


Suitable to intervene

More suitable

Less suitable

1 KM 2 KM



Main function
- Housing
- Retail and service industry
- Businesspark / Industry
- Nature
- Farming
- Education
- Leisure / sports

1 KM 2 KM

Replacement due for main sewage system
- 2022 - 2026
- 2027 - 2030
- 2031 - 2035
- 2036 - 2040
- 2041 - 2050

1 KM 2 KM

Construction year
- Built before 1965

1 KM 2 KM

Public space grade
- > 7.5
- 5.0 - 7.5
- < 5.0

1 KM 2 KM

Figure 14 Layers indicating possible locations to intervene, (Gemeente Utrecht, 2022c), (Parallel, 2020), (Hoekstra, 2017).

Other criteria are also important to consider when deciding where adaptation of the public space is most needed as they influence the overall vulnerability of a place and the overall impact of an intervention.

Function
The function of a place is important to consider when deciding where to intervene. Heat stress is a significant problem in an industrial area, but when it is near people their homes the impact on the livability of inhabitants is far greater.

Replacement sewer
The age and state of the sewer system are also considered when looking at the best place to implement interventions. It not only has an impact on capacity but can also be an opportunity as an intervention can be combined with sewer maintenance.

Construction year
The age of buildings can make them more vulnerable to damage. The age of a building often also says something about the general age and state of the public space surrounding it.

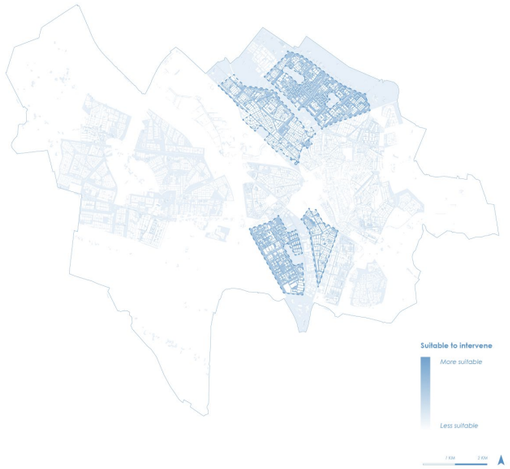
Quality of public space
How high the public space is regarded in the different neighborhoods is also a factor weighing in. Adapting the neighborhoods to extreme weather can also be an opportunity to increase the overall quality of public space.

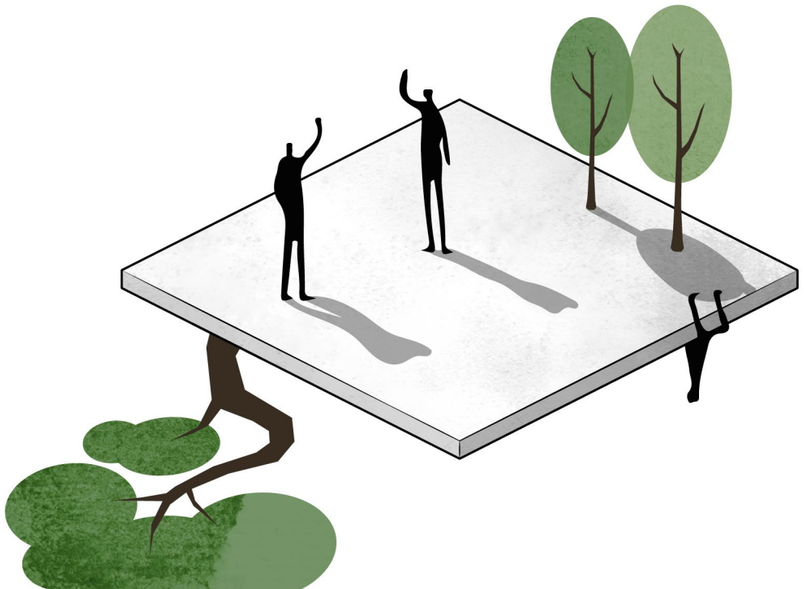
More detailed analysis maps can be found in the analysis appendix.

Where to intervene

Overlapping these aspects shows some areas that would be more suitable for intervention. These areas are highlighted in the map shown below.

Areas most suitable to intervene

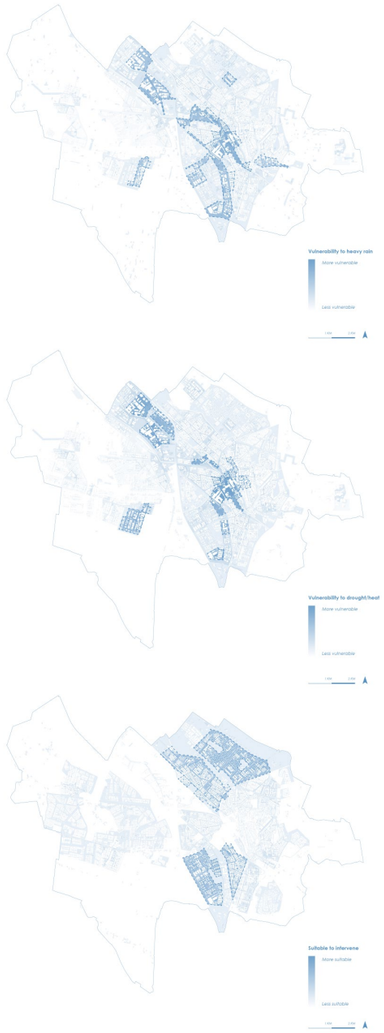


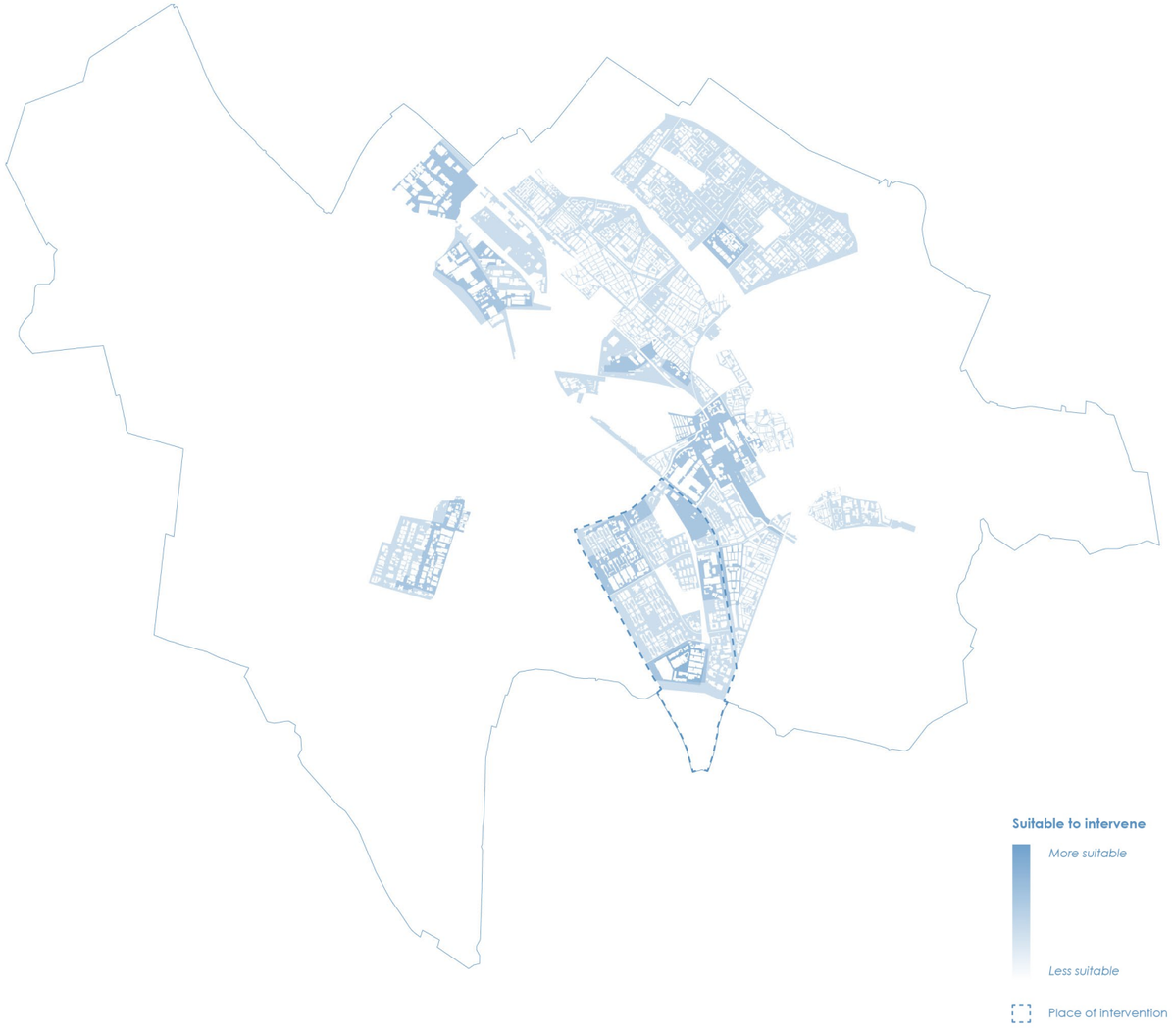


Chosen location

Assessing Utrecht for vulnerability to drought, heat, and heavy rain while also incorporating the other factors that play a role in the decision, gives a few possible locations where intervention would be most impactful and meaningful. From these spots, a final location is chosen. The chosen area of intervention is located in Kanaleneiland and Transwijk. This location deals with vulnerability to all aspects, it is also an older neighborhood in need of maintenance and with a lower-quality public space.

In the next chapter, these two neighborhoods are explored in depth, firstly looking at how the before mentioned problems and vulnerabilities express themselves on a smaller scale. After that, the history, present, and future of these neighborhoods will be laid out. Further research will then show the specific problems and vulnerable areas that are present after which a vision will be set up for both neighborhoods. This vision will then express itself in interventions and a detailed design for multiple locations.





Kanaleneiland and Transwijk

Kanaleneiland and Transwijk are two neighborhoods from the fifties located on a piece of land between the Amsterdam-Rijnkanaal and the Merwedekanaal. Although quite modern at the time, the quality of the built environment has fallen behind the rest of the city in recent decades. On top of that they are dealing with vulnerabilities to extreme weather as well as a generally lower livability for inhabitants. In this chapter, the public space in these two neighborhoods will be discussed further.

Vulnerabilities of Kanaleneiland and Transwijk

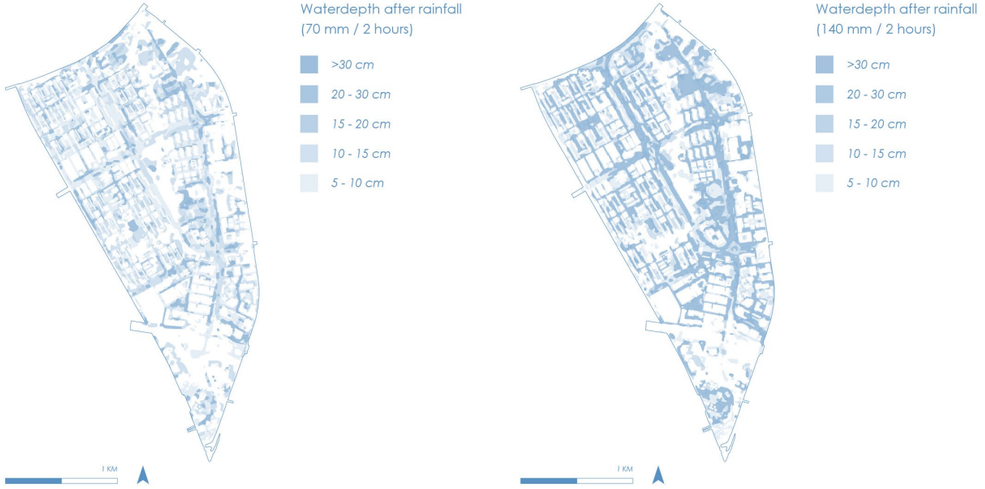


Figure 15 Waterdepth after different intensities of rain, based on data from Provincie Utrecht (Provincie Utrecht, n.d.b)

It is important to look at the different issues within the chosen location in more detail. Not all areas deal with the same problems to the same extent although some overlapping problem areas do exist. The larger roads and some larger paved spaces within the neighborhood are most vulnerable to pluvial flooding as can be seen in the simulations with heavy rainfall and very heavy rainfall. The housing blocks are also quite vulnerable to heavy rain, which can lead to some serious hinder and damage.

Unfortunately, there are no drought-specific data sets to show where the problems and damage occur. However, drought is not a problem that is ever only located in a small area but affects larger areas. It is therefore important to implement interventions against drought throughout both neighborhoods.
Heat is a problem with a lot more data and a lot more consequences directly felt by inhabitants and visitors of the area. The west side of both neighborhoods seems to deal with the most consequences of heat stress. The difference between locations however is not always very large and most areas deal with elevated temperatures to a certain extent.

Not all problems need to be solved within the exact location they occur. When it comes to capturing rainwater, this can also be done outside of the location with the most issues, as long as it relieves the affected area.

Figure 16 Various statistics on temperature in Kanaleneiland and Transwijk, based on data from Provincie Utrecht (Provincie Utrecht, n.d.b)

The past and future of Kanaleneiland and Transwijk

Kanaleneiland and Transwijk are two neighborhoods that were built mainly during the fifties and sixties. This means there are quite some renovations needed when it comes to buildings, public space, and aspects of the water system like the sewer network. Both areas deal with different measures of water nuisance and problems related to heat. There are also quite some improvements that could be made to the public space as a whole, a lot of it is outdated and underused. On top of that the neighborhoods are home to some more vulnerable populations in terms of, among other things, income.

Implementing climate adaptive measures in these neighborhoods, will not only relieve the current and future climate stresses but also open up an opportunity to help reach other goals these neighborhoods have.

General vision and history

The neighborhoods of Kanaleneiland and Transwijk have their origin in the fifties when construction first started. At the time it was quite a modern neighborhood using recurring stamp patterns for the housing blocks with public space in between and a strict division between working, living, and relaxing. Non-housing functions, like schools, stores, healthcare, and sports facilities, were placed in strips along clusters of housing blocks. The recurring stamps seen with these housing blocks are of historical value to the municipality (Gemeente Utrecht, 2022a).

The original plan was created separately from the business park/industrial area to the east and south. The plans and vision for this area will be addressed later on in this chapter.

In terms of goals and vision for these neighborhoods, the municipality has some quite clear plans when it comes to densification. In terms of public space, there are some main goals they want to achieve by 2040.

Figure 17 Original expansion plan for the neighborhoods of Transwijk and Kanaleneiland (Gemeente Utrecht, 2022)

Livability
One of the goals the municipality has for the neighborhoods of Kanaleneiland and Transwijk is to increase livability. Within this theme, certain points will have an impact on the public space.

Expanding social connections between people in the area and healthier living are two of these points. Part of this is increasing safety and increasing connections for slow traffic and public transportation, as well as increasing green spaces. Mentioned multiple times is the need for more social opportunities, and increasing the number of places where people can meet and interact. An important part of this is safety, having eyes on the street, and connecting people (Gemeente Utrecht, 2022a).

Also connected to livability are climate adaptation measures and the transition to sustainable energy. According to the municipality, this transition should be visible within buildings as well as in the public domain and also include interventions to combat heat and water nuisance (Gemeente Utrecht, 2022a).

The neighborhoods will see some significant densification in the upcoming years, adding new housing and new facilities. With these changes, they hope to strengthen the economy of the region and create more lively neighborhoods. The densification plans created for the neighborhoods are also a way to finance the increase in green spaces.

Green and blue spaces
The quality of green spaces in the area has gone down over the years and does not hold up to the standard they once had. The ambition of the municipality is not just to increase the quality of the green that is already present but also to add at least 7 hectares of extra green space. This extra green space should serve multiple functions within the neighborhood. It should strengthen the ecological value and provide a space to live for plants and wildlife. It should also keep the neighborhoods cooler and be equipped to store rainwater. Flat roofs should also be utilized to add green space, water storage, or sustainable energy (Gemeente Utrecht, 2022a). Many people living in the area do not have a garden or any private outdoor space, which places extra importance on public green spaces. This means these spaces should also have functions where people can relax, play, and do sports.

Mobility
When it comes to mobility there is a larger pattern of reducing space for cars and increasing space for people. By encouraging slow traffic and public transport, there will be more open space to implement green and public space, tying into the idea of more social connections in the neighborhood. The neighborhoods should also invite people to take walks. The municipality's plan to encourage walking is to create small routes ranging from 1.5 to 3 kilometers. This could be partially achieved by cutting up streets to implement more green spaces close to homes.

Inhabitants

When reading vision documents for the nieghborhoods it can be seen that the opinion of inhabitants differs sometimes from the view the municipality has on the area. It is interesting to see how their views differ and overlap.

Commonalities
Increasing green and creating more facilities close by are the biggest areas of overlap between the municipality and the inhabitants.

In terms of green, inhabitants would like to see more variety in character, green and blue spaces that range from wide, open, and busy to quieter and more intimate. They also wish that green spaces would be more beautiful in different seasons, with a bigger variety of plant life. Green spaces must also be safe, as now some of these places are felt to be unsafe by the people that live near them. Some possibilities for green space that are mentioned by inhabitants, but not the municipality are opportunities for community gardens where people can grow their own food or vertical gardens (Gemeente Utrecht, 2022a).

Clashes and worries
With the increase in housing in the area some of the current inhabitants worry that there will be a division between new and old inhabitants, which enforces the need for social interaction and meeting spaces within the neighborhoods.

A big clash between the municipality and inhabitants is on the topic of parking. Inhabitants worry that they will not be able to park close to their houses/facilities or will not be able to afford the introduction of paid parking, as many inhabitants do

not have a large budget (Gemeente Utrecht, 2022a).

A question asked to inhabitants was; "what would make you proud of this neighborhood?". The main themes that popped up during this question were safety and maintenance. Some other points that stand out were opportunities for youth to play and gather, art, giving more opportunities to local shops/ businesses, and more restaurants/cafes.

Business park and industry

As mentioned before, the plans for the surrounding business park and the industrial area next to Transwijk and Kanaleneiland are set up separately from the vision for the neighborhood, which means there is little to no connection between the areas. The current industrial area is separated by a big street from the housing blocks and is home to mainly service industry and government services (Gemeente Utrecht, 2012). Some goals for the areas overlap with the goals for the other parts of Kanaleneiland and Transwijk, like the need for more safety and the mixing of more functions. By mixing new functions into the space Utrecht wants to attract new people to the area during different times and increase social safety (Gemeente Utrecht, 2012). The expectation is that the demand for places where businesses can settle will grow until 2030. Some other expectations are that a clean manufacturing industry could return. The municipality sees chances to intensify and mix the current functions with new functions like agriculture, nature, and education (Provincie Utrecht, n.d.a).

After 2040

The vision of the municipality for these neighborhoods goes until 2040, as do most visions set up by Utrecht.

There is a crucial flaw with these visions; that they do not answer the question of what could happen after 2040. This means that climate change and many other changes beyond 2040 are not accounted for. Many larger transitions, like the transition towards a circular economy or climate neutrality, that will take decades to achieve are not often mentioned and when they are it is quite brief and vague.

Taking climate adaptation for extreme rainfall as an example; currently, Utrecht is preparing for a downpour of 80 mm in one hour (Gemeente Utrecht, 2022c). This might be enough for 2040, but depending on the climate scenario, this might be insufficient in 2040 or outdated within 10-20 years after that. With the time it takes to set up and realize a new plan, it is not an option to wait until 2040 to find out whether it will be sufficient.

The main reason for this short timeframe is the tenure of the municipal council, which lasts 4 years. Setting up a vision or plans beyond this tenure is already difficult to achieve, but reaching beyond the tenure of the municipality is essential when it comes to adapting to large changes like climate change. The municipality mentions that they want to make the neighborhoods of Kanaleneiland and Transwijk climate resistant in 2040 (Gemeente Utrecht, 2022a), but how long will this resistance last if there are no plans set up after 2040? What happens when climate change progresses more quickly and there are no plans for how to deal with this scenario? These designs and visions should be more like a comma and less like a full stop, mentioning possible adaptations or changes based on different future scenarios.

Creating flexibility will allow for new plans to be more seamlessly attached to the current urban fabric. Creating plans with benefits for now and possibilities for the future. It can prevent Utrecht from running behind on the times when its climate goals do not align with how fast climate change might progress.

Increasing participation from citizens could be one of the ways to achieve this as well. When reading statements from citizens and their view of the neighborhood it is clear to see they care and are looking towards a future that is good for them as well as their children. Inhabitants often stay in the neighborhood far beyond the 4-year governing period of a municipal council and getting them invested in future-proofing the neighborhood might be a good way to increase long-term vision and planning.

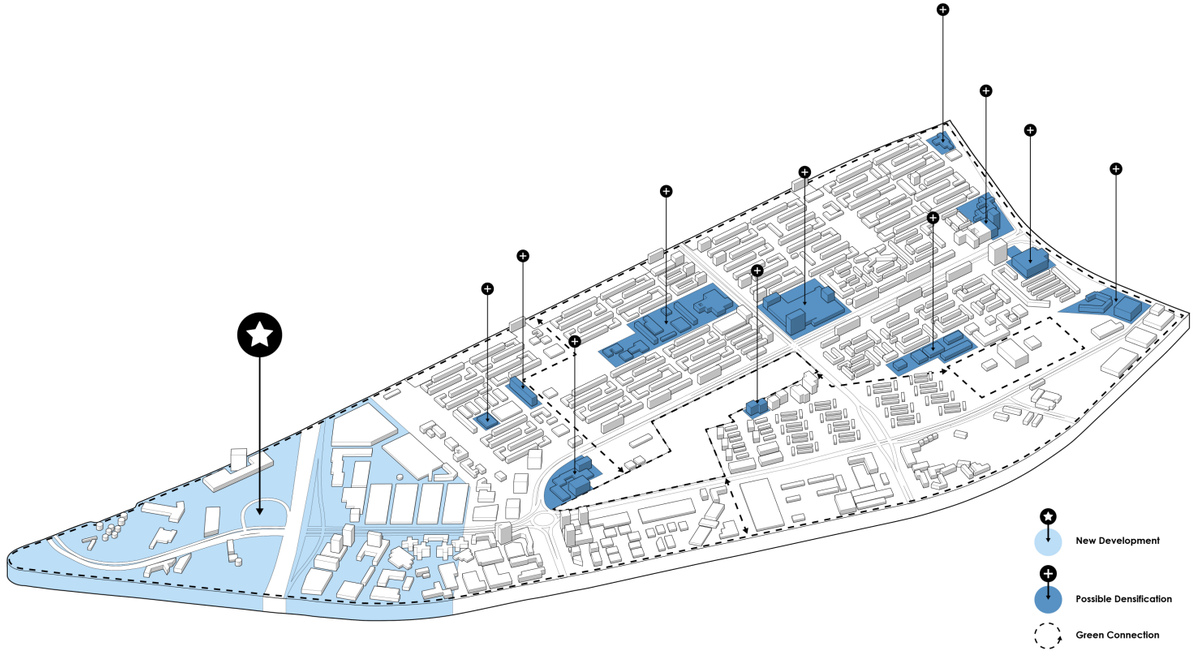


Figure 18 Current plans for the neighborhoods, based on data from Gemeente Utrecht (Gemeente Utrecht, 2022)

Development locations

Shown in the figure above are some important future development locations. The southern part of the neighborhood will be part of a new city node previously seen in figure 11. What the exact plans or functions for this location will be is not clear yet, but the area will certainly be intensified in terms of use.

The smaller areas highlighted in the figure are possible spots for densification. For some of the locations concrete plans are already set up, and some locations are purely in an exploratory phase.

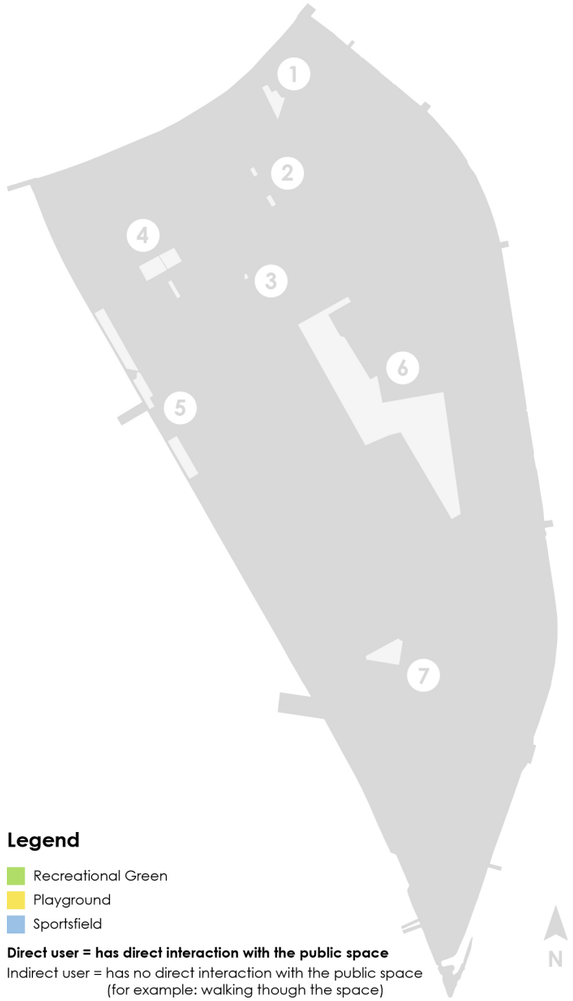
When looking for ways to adapt these neighborhoods it is important to consider the current plans and how the new plan will attach to them.

Types of public space

Figure 19 Fieldwork route, public space, and places visited

Different types of public space can be found in Kanaleneiland and Transwijk. They range in size and function, with a few recurring patterns of public space mainly in the housing blocks. Two of the most prominent and largest public spaces are Transwijk Park and the waterside park to the west of both neighborhoods. The three main functions that the public space falls into are play, sports, and green. The sports and play areas are mostly aimed at kids, while the green spaces attract a wider audience.

On the next page, an overview of seven different public places can be seen together with their main functions and features.



Legend

- Recreational Green
- Playground
- Sportsfield

Direct user = has direct interaction with the public space
Indirect user = has no direct interaction with the public space (for example: walking though the space)

1 Trapveld Olof Palmelaan
21-02-2023
10:30 - 11:00


Location

Important elements

- Playground
- Football field
- Grass field
- Benches

Main users spotted

- People walking
- Inhabitants of adjacent houses

2 Voetbalkooi Van Eysingalaan
21-02-2023
11:00 - 11:30


Location

Important elements

- Playground
- Football cage
- Basketball court
- Parking

Main users spotted

- People walking

3 Eyup Sultan Camii Moskee
21-02-2023
11:30 - 12:00


Location

Important elements

- Grass field
- Hedge
- Benches
- Mosque
- Shops

Main users spotted

- People walking
- People cycling
- People shopping
- People talking

4 Speeltuin Anansi
21-02-2023
12:00 - 12:30


Location

Important elements

- Playground
- Sportsfield
- Benches
- School
- Daycare

Main users spotted

- People walking
- **Schoolchildren and teacher playing sports**
- **Children playing**

5 Speelweide Rooseveltlaan
21-02-2023
12:30 - 13:00


Location

Important elements

- Playground
- Sportsfield
- Grass field
- Benches
- Restaurant

Main users spotted

- People walking
- People running
- People cycling
- **People walking their dog**
- **People exercising**

6 Park Transwijk
21-02-2023
13:00 - 14:00


Location

Important elements

- Playground
- Sportsfield
- Grass field
- Lake
- Benches
- School
- Daycare
- Petting zoo
- Restaurant

Main users spotted

- People walking
- People running
- People cycling
- **People walking their dog**
- **People exercising**
- **Person feeding the ducks**
- **Children playing**

7 't Parkhuys
21-02-2023
14:00 - 14:30


Location

Important elements

- Grass field
- Benches
- Shops
- Restaurant

Main users spotted

- People walking
- People shopping
- **People having lunch or having a drink**

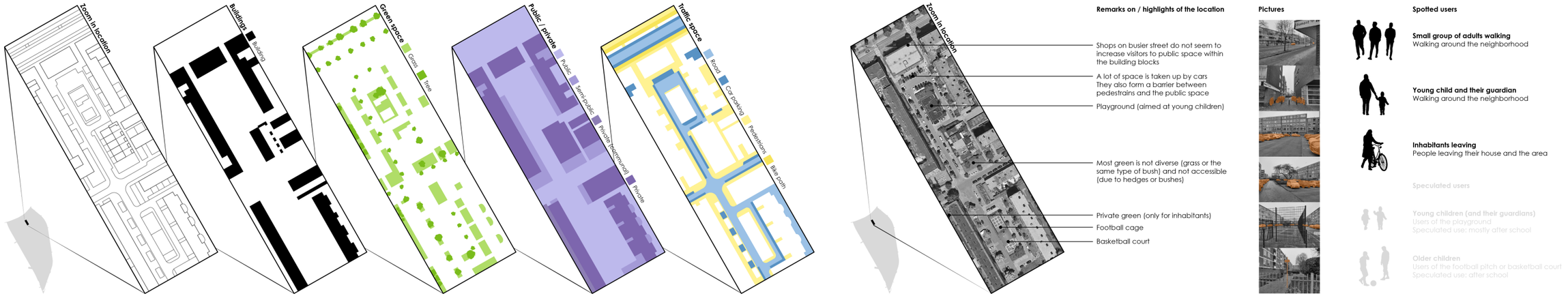


Figure 20 In depth analysis of one of the public spaces that was visited, public space within the recurring housing stamps

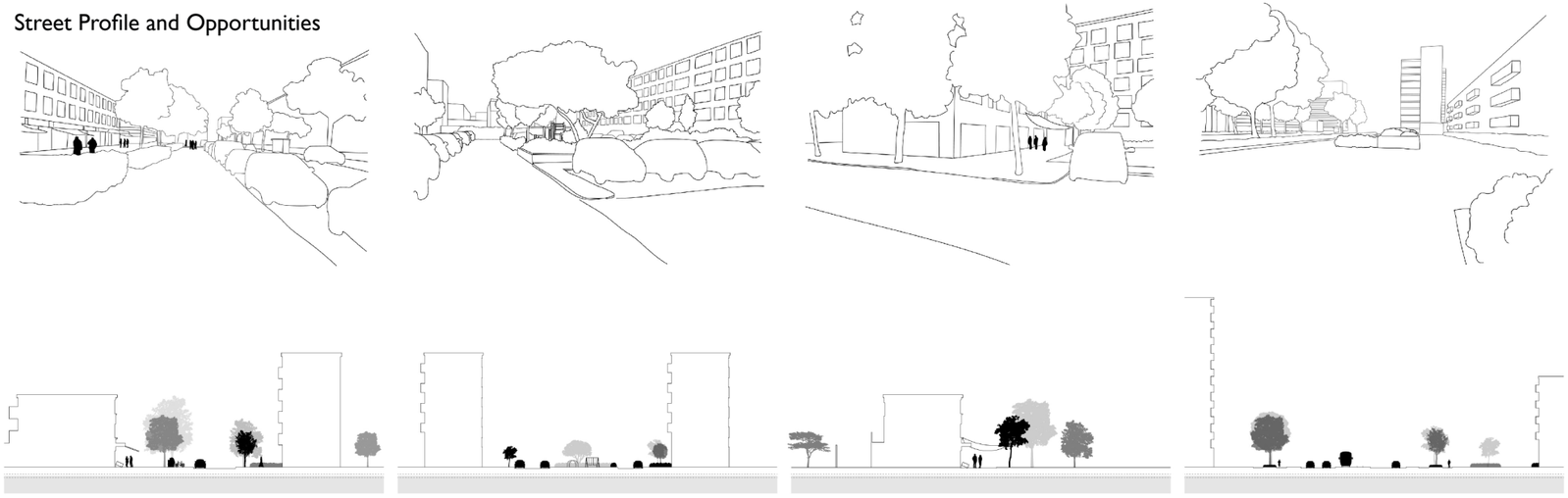
Recurring public space pattern

One of the public spaces in the neighborhoods is a recurring pattern of public space inside the housing stamps which can be seen in figure 20. These public spaces are shaped like small rectangles and occur on their own or in pairs of two, enclosed by the housing. In the example shown above, there are two of these rectangles present, one with a playground for smaller children and one with a soccer court and a basketball court. What stands out right away with these public spaces is that they are fully enclosed by roads and parked cars. When looking at the public space, the cars completely dominate the view with the public space being almost invisible from some angles. The amount of space reserved for cars far outweighs the public space and traffic space as a whole takes up most of the public domain, leaving little room for quality public and/or green space.

The functions on the other side of the housing blocks from the public space vary from private gardens to parking spaces or communal gardens, which are only accessible to inhabitants of the directly adjacent housing blocks. On the side of the larger road, there are a few shops present, but the public space within the housing blocks does not invite people present on the larger road to use it or wander into it. The path to the public space is narrow and mostly blocked by parked bicycles. Parked cars make it hard to see if there is even a public space present.

The green spaces within the blocks are not designed to be used and come mostly in the form of small strips of grass or bushes. The green space in the communal garden seems to be of higher value but is not widely accessible.

Street Profile and Opportunities



LOCATION
Street with local shops and housing

LOCATION
Small playground inclosed by housing (recurring pattern)

LOCATION
Local supermarket next to housing

LOCATION
Big street running through the neighborhoods

Road between housing and a few shops

People are meeting in this area, but there are no opportunities to sit or seek shelter (outside of a small overhang near the shops). There are a few trees and bushes, but most of the area is paved. Cars form a barrier between housing and the public space

Design opportunities
- Reduce barrier by removing the parked cars and narrowing the street
- Introduce surface water
- Introduce more green and increase variety
- Add a form of shelter
- Add more opportunity to sit or meet
- Keep some open space so the shops have an opportunity to stall goods outside or increase the size of their terrace during warm weather

Playground and parking lots

A playground inbetween housing blocks, a recurring pattern in the different blocks. The playground is completely enclosed by parking lots and roads.

Design opportunities
- Cluster parking on one side of the housing buildings, freeing up room for public space on the other side uninterupted by roads and parking
- Introduce surface water, possibly a combination of wadi and playground
- Introduce more green and increase variety

Small shop surrounded by housing

Another place where people are making an attempt to meet. There is even a curtain hung up between a tree and a balcony to create some sort of informal shelter. There is no opportunity to sit or gather.

Design opportunities
- Open up space to be more inviting
- Introduce surface water
- Introduce more green and increase variety
- Add a form of shelter
- Add more opportunity to sit or meet
- Keep some open space so the shops have an opportunity to stall goods outside or increase the size of their terrace during warm weather

Green strip along road and tram tracks

In this area there is a pretty big strip of green between the road and housing. It is mainly grass and not very diverse. There is no opportunity to sit or gather.

Design opportunities
- Create a barrier between housing and the large road (gradient from housing to road)
- Create places to stay for the inhabitants
- Introduce surface water
- Introduce more green and increase variety
- Connect green to larger network

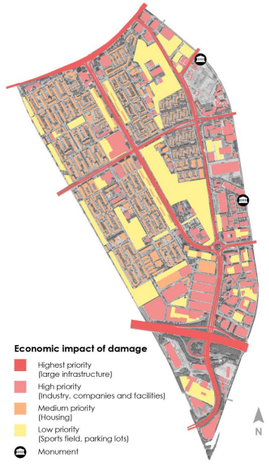
Within the area, there are a few places that are an example of some recurring observations within the neighborhoods.

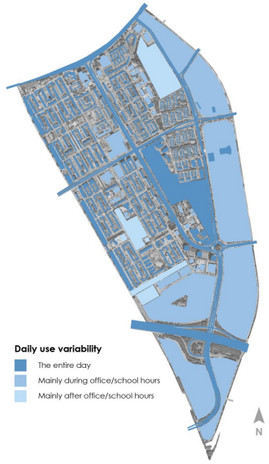
Social opportunities
In quite a few places, most notably near local supermarkets, places of worship, and education buildings, there were some people gathered in small groups. Even though these people were talking for long periods, there was often no space they could sit or seek shelter. Sometimes people took it upon themselves to create this, at one of the local shops a drape was hung up from a balcony and some trees to create a makeshift shelter.

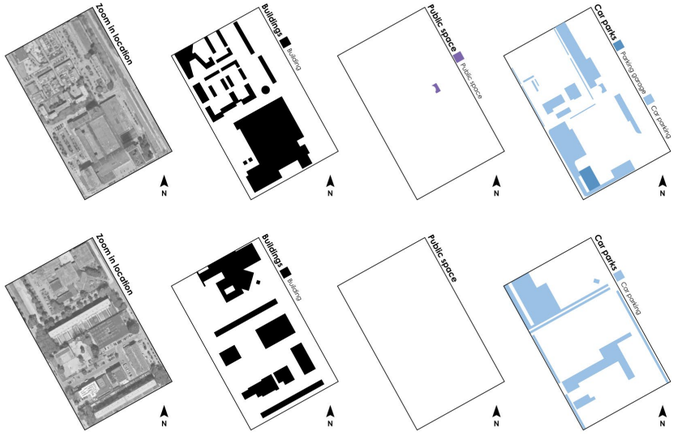
Places where people are trying to gather even though the public space does not encourage this behavior, are optimal locations to implement a design that promotes social interaction and gathering. This is also in line with the municipality's ambitions and opens up opportunities to create these meeting spaces in combination with climate adaptive measures.

Car dominated
Almost every part of these two neighborhoods is car-dominated. Public space is cut up by parking and disconnected from the housing blocks by roads and parking. Most public buildings, commercial buildings, and high-rise housing buildings are surrounded by huge parking lots, and some green spaces are even illegally used as extra parking spots. These spaces for cars not only divide people and discourage walking/cycling, but they also make the areas more prone to heat stress and water nuisance as they are large, heavily paved areas.

Underused open space
Another recurring pattern in the neighborhoods is underutilized open spaces. An example of one of these spaces is the large green strip next to the larger roads in the neighborhood. They provide no use to the inhabitants, as there are no elements to interact with and are almost exclusively grassland, providing no real ecological benefit to the area. Many similar spaces can be found in the neighborhood, spaces that serve little to no function while taking up a sizeable space.







Safety, Social opportunities, and flexibility opportunities

Based on previous findings a few aspects of Kanaleneiland and Transwijk are mapped out above. They fall into three main categories; safety, opportunities for flexibility, and social opportunities.

The two safety maps show where in the neighborhood it is most important to protect people and the built environment from harm/ damage. Depending on the threat, it shows where the priority should lie when implementing an intervention.

Opportunities for flexibility maps varied use throughout the day or season, highlighting possibilities for flexible uses throughout time. Exchange of water could for example take place between areas that are mainly used during office hours or mainly used after office hours.

Social opportunities are spaces where people are more likely to run into each other or gather, like schools, mosques, churches, and shops. Implementing climate adaptive measures in these places also opens up opportunities to facilitate these meetings and social interaction. The need for meeting places is shown in the maps at the top right of this page. Two places where social opportunities are located are zoomed into and public space is compared to the spaces inhabited by buildings and cars. Even though these are spaces where people naturally meet each other, there is little to no public space where people could sit down or have a chat.

Combining safety, flexibility opportunities, and social opportunities can lead to an overall enhanced public space that is not just climate adaptive, but maintains functionality and increases the overall livability for inhabitants from a social perspective.

Connection to the larger scale

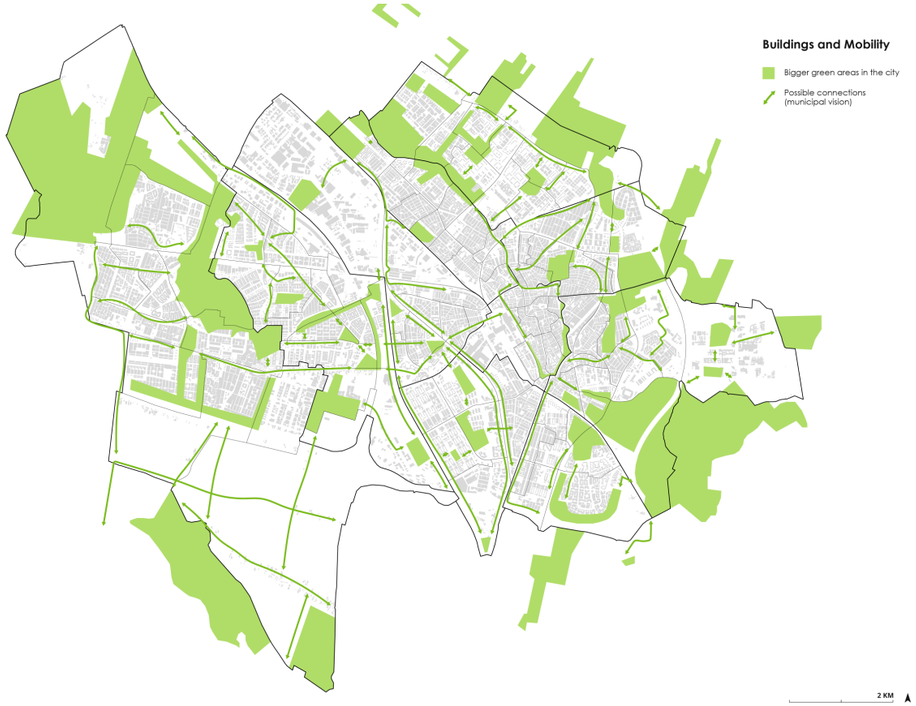


Figure 21a Green network of Utrecht with new connections from municipal vision, based on data from Gemeente Utrecht (Gemeente Utrecht, 2018)

Currently, the green spaces within the area are quite disconnected from each other as well as the larger natural network in/around the city. Within the neighborhoods of Kanaleneiland and Transwijk, there are some opportunities to fill in some missing links within this network. Especially along the water, there is an opportunity to use open or underused spaces to create a more attractive and adaptive waterfront. Chances to add green space on buildings and roofs should also be explored in the vicinity.

Green should however not just stay at the edges of the neighborhood, but also cut into it to relieve problems like heat stress deeper in the neighborhood.

In the design chapter, the connection between the green network and the design will be further elaborated upon.

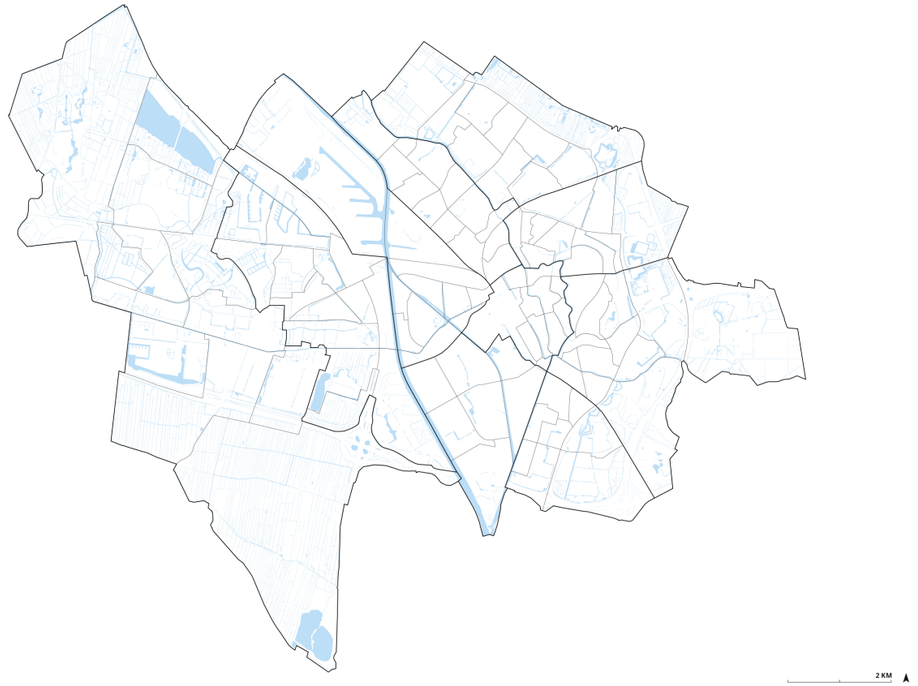


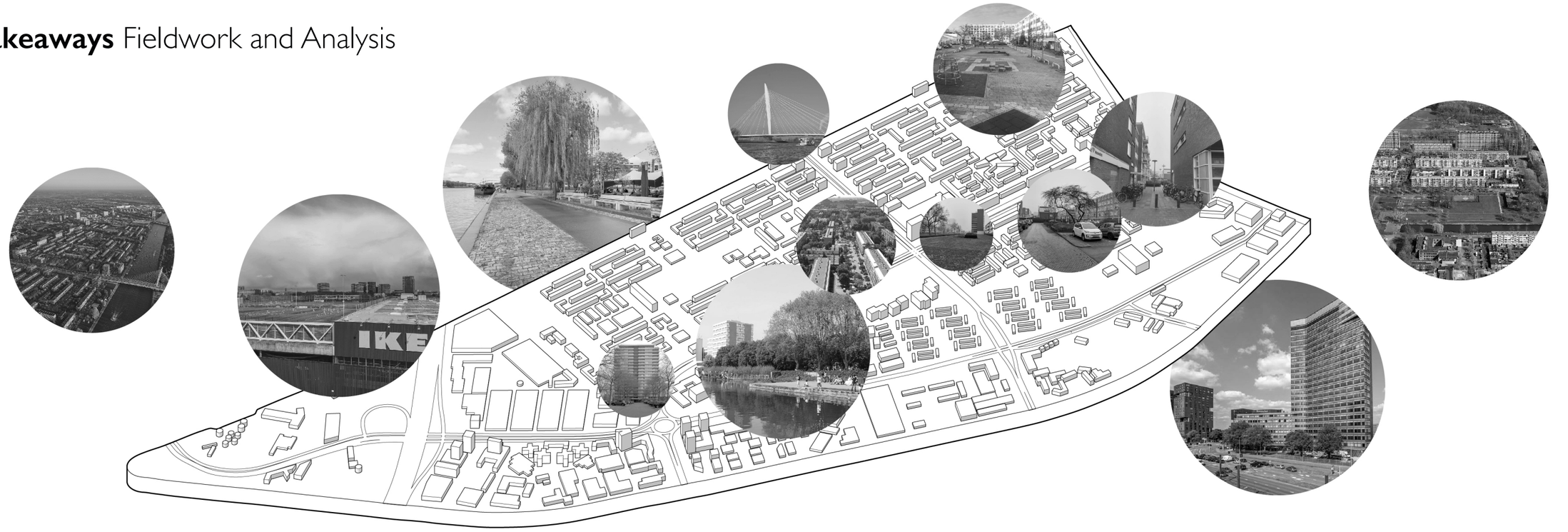
Figure 21b Waterways

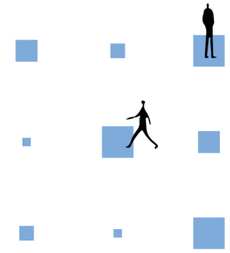
The neighborhoods of Kanaleneiland and Transwijk are surrounded by water but contain little surface water themselves. There are a few water connections made below the surface using so-called divers. Bringing these connections to the surface and making them more visible can be combined with creating more meeting places and leisure spaces around the water, which are both ambitions the municipality has for the area.

The two main channels along the east and west side of the neighborhoods transport a lot of water out of the city, it would therefore be beneficial if the water within the neighborhoods does not directly flow into these two channels, but retain the water for a longer period. Looking at the use of the two channels (appendix 2.13) there are also opportunities for different functions along the water.

Later on, the connection between the water network and the design will be further explained.

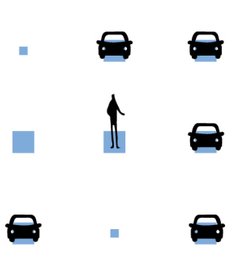
Main Takeaways Fieldwork and Analysis



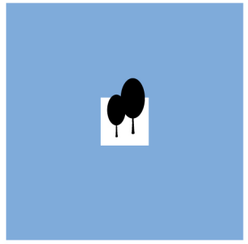


Gaps in public space
Not everyone has a place to stay in the public domain

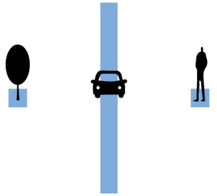
Nowhere to go
Not enough public space near social places



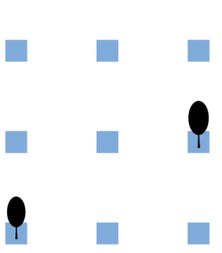
Car dominated
Space for cars outweighs space for people



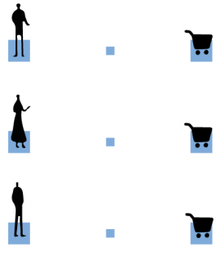
Heavily paved
Paved areas leave little space for green and blue



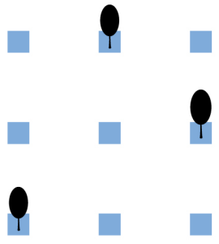
Disconnected
Green and public space is split up by barriers



Underutilized
Many spaces are not used for a large amount of time



Seperated functions
Housing and other functions are often seperated



Low quality green
Not a lot of variety in plantlife

Vision

Utrecht in 2100 will be a place where the elements, weather, and seasons are an integral part of the city rather than just a blanket on top. The city moves with fluctuations in water and changes with the seasons. It is also able to move with changes in use and adapt to the current needs and circumstances at that time. What exactly this will look like in terms of goals and ambitions- is laid out in this chapter. The chapter is concluded with a vision map on the scale of the municipality.

Scenarios Heavy Rainfall

When it comes to rainfall, multiple scenarios are possible based on the amount of rain at that given moment.

General practice
As much rainwater as possible is kept within the city or general area around the city. The rainwater that is captured is stored to be used in dryer periods.

Very light rain (0-20 mm/ hour)
Public space looks largely unchanged from what it would be during dry weather. Some extra opportunities to look for cover from the elements are present.

Figure 22 Wadi for water infiltration (Landscape Australia, 2020)

Light rain (20-50 mm/hour)
Water is captured and stored locally within the different neighborhoods. Water is more prominent in the streetscape in the form of small-scale storage and transport of water.

Figure 23 Water storage on a street level (Tredje Natur, 2016b)

Medium rain (50-80 mm/hour)
Water is being redirected on a smaller scale towards buffers and basins within the city.

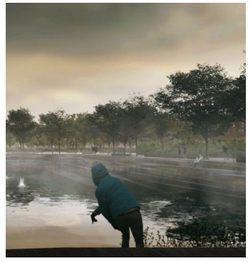


Figure 24 Watersquare (Tredje Natur, 2019)

Heavy rain scenario: normal functionality (80-100 mm/hour)
Water is very visible in the streetscape. Activities that are less prominent during rainy weather are less accessible. Every destination is still accessible, although it might be via a different route than usual. Some roads might be smaller than usual and some paths may look different than in a dry period. After rainfall of this magnitude, more opportunities to play or recreate around water are possible. Large changes in the streetscape can be seen compared to a dry scenario.

Water is being redirected on a larger scale towards buffer basins outside of the city. There are no damages to buildings, infrastructure, or nature.

Figure 25 Large scale waterstorage (Tredje Natur, 2020)

Heavy rain scenario: reduced functionality (100 – 120 mm/hour)
Water is redirected to places where the problems can be contained. Some minor damages can occur and water might pool in unintended places, resulting in minor mobility problems. People can still reach any location within the city.

Figure 26 Slight flooding of a street (Holmes, 2016)

Heavy rain scenario: emergency (120+ mm/hour)
With rainfall reaching these levels, there will be some inevitable damage and nuisance. The core functions of the city are protected. In the case that showers like these become more frequent in the coming century, the plan should be adapted to also increase resilience against this amount of rainfall without damage or nuisance.

Figure 27 Flooded park (Holmes, 2016)

Summary

General practise
- Retention
- Infiltration

Very light rain (0-20 mm/ hour)
- More cover

Light rain (20-50 mm/hour)
- Local water storage

Medium rain (50-80 mm/hour)
- More water in the streetscape
- Medium scale buffers

Heavy rain scenario (80-100 mm/hour)
- City looks drastically different
- Large scale buffers

Heavy rain scenario (100 – 120 mm/hour)
- Minor damage
- No reduced mobility

Heavy rain scenario (120+ mm/hour)
- Emergency

Scenarios Drought and Heat

There are multiple scenarios that can play out within the city depending on the severity of the drought.

General practice
Utrecht will not have to depend on water sources outside of the province. Water is stored in periods with rainfall to be used at times with less rain. Efforts are made to reuse and reduce water consumption within the city.

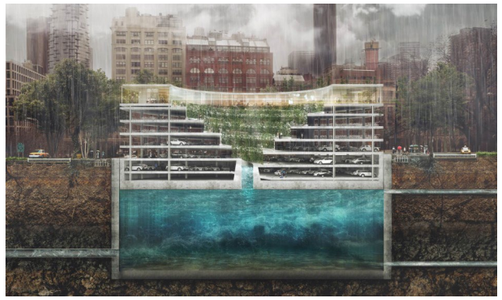


Figure 28 Water storage below a parking garage (Tredje Natur, 2016a)

Mild drought (precipitation deficit of 150 mm)
Normal water usage is possible without running out of (drinking) water. No damage to nature or the built environment occurs.

Figure 29 Square with cooling water element (LOLA Landscape Architects, 2021)

Drought (precipitation deficit of 350 mm)
The water level does not decrease to a point where it can cause building damage. Damage to nature is avoided by redirecting stored water to areas where it is needed. Efforts are made to reduce water consumption, without disrupting any processes in the city.

Figure 30 Public square design (OBJ, 2021)

Severe drought (precipitation deficit of 350+ mm)
Households still have water during extreme scenarios, non-essential companies might need to adjust their water use during extremely dry periods. Some damages can occur, but systems are put in place to bounce back quickly even after a drought this severe.

Figure 31 Waterfront ecology/recreation park (Delva, n.d.)

Other extremes

All other interventions must be made with thermal comfort in mind and interventions cannot work against thermal comfort. If a choice needs to be made between two options, thermal comfort can be a deciding factor.

Figure 32 Heat relieving park (Mask Architects, n.d.)

Summary

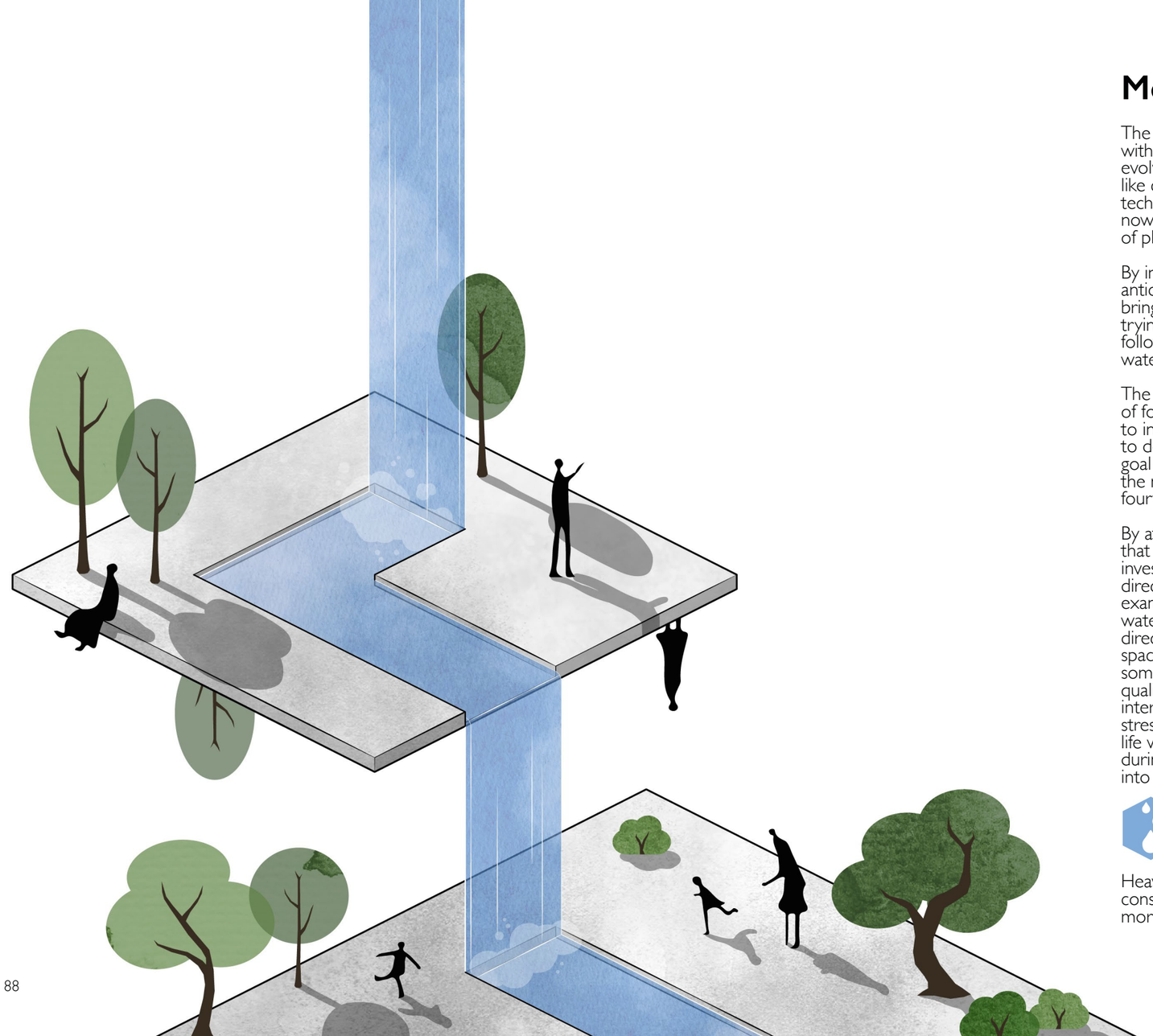
General practise
- Not dependant on outside water sources
- Reducing/Reusing

Mild drought (precipitation deficit of 150 mm)
- No damage
- Normal water use

Drought (precipitation deficit of 350 mm)
- Avoiding damage
- Reduction without disruption

Severe drought (precipitation deficit of 350+ mm)
- Minor damage
- Adjusted water use

Heat
- Consider thermal comfort



Moving with water

The built environment of the future should move with the changes the weather brings as well as evolve with slower and larger trends in our society like climate change, demographic changes, and technical advancements. By planning for the future now we can reduce obstacles for future generations of planners, designers, and governing bodies.

By increasing the flexibility of urban design, we can anticipate and move with the changes the future brings instead of being in a continuous cycle of trying to catch up. The built environment should follow the current of the future and move with water.

The vision for Kanaleneiland and Transwijk consists of four main goals. The first two goals are related to increasing the ability of these neighborhoods to deal with heavy rainfall and drought. The third goal is to increase and enhance social spaces in the neighborhoods. Tied to all of these goals is the fourth goal, increasing flexibility.

By attaching long-term goals to interventions that also yield immediate results, plans and their investments will be more easily accepted as it directly benefits the neighborhoods. A concrete example of this is creating social spaces around water storage, the social spaces can be used directly even if the water storage aspects of the space might not be used to their full capacity until some years later. Another example is improving soil quality and implementing more green spaces. These interventions have direct benefits by combating heat stress and increasing livability for animal- and plant life while the long-term goals of reducing damage during droughts and heavy rainfall might lie further into the future

Dealing with heavy rain

Heavy rain is a very direct threat with many visible consequences. With rainfall getting more intense and more frequent, different measures will need to be taken to accommodate the abrupt influxes of water in the built environment. These adaptations are essential to avoid damage and flooding in the future.

Dealing with drought and heat

Drought is a much slower and creeping threat than heavy rain. Its effects, like a shortage of drinking water, can be hard to spot at first. When it eventually does cause problems, the problems are big. Natural environments can take months to years to recover from drought and damage to the built environment can cause significant problems. Heat is a problem that cannot be underestimated as its effects on people go far beyond reduced comfort.

Creating social spaces

Weather is not a constant, fluctuation in rain and temperature means that adapting to it will not leave the built environment looking the same throughout time and the different seasons. This opens up an opportunity to connect implementations to combat extreme weather with social spaces that can be used on and off in different weather circumstances. By combining social goals with climate-adaptive goals, the beneficial effects of the interventions will be immediate.

Increasing flexibility

Arguably the most important factor of this project is the introduction of more flexibility in the built environment. All previous goals are connected by their aim to increase flexibility, boosting adaptability for the future and all its unforeseen changes.

Requirements and limitations

There are a few ground rules and limitations that need to be set in place for the scenarios and interventions to be as effective as possible.

Always functional
Spaces must be functional in any situation, which means it functions well whether it is dry for an extended period or full of water for an extended period. What it does not mean is that it has to be functional for people in any situation. A space might function as a place for a social gathering and sports in one weather scenario but might function as a water storage in another.

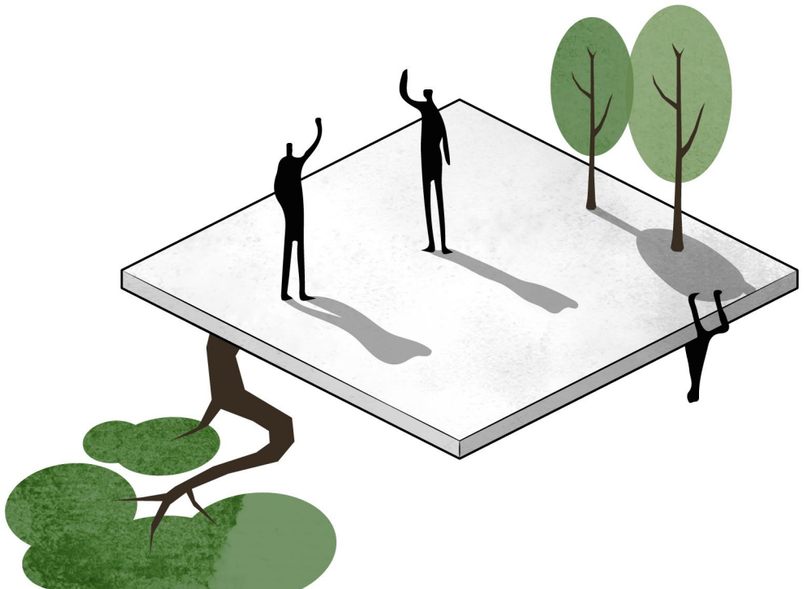
Safety first
Safety should be a priority when implementing new measures in these two neighborhoods. That means that protecting people from harm and buildings from damage is the number one concern and should be addressed first when starting to adapt these neighborhoods.

Water towards nature
The livability of these neighborhoods depends largely on the state of the natural system that is intertwined with it. Within the neighborhoods, natural and urban water storage solutions will exist. In a post-drought scenario, the natural system will need to receive water first to ensure it bounces back as quickly as possible. This means that urban spaces will remain dry for slightly longer.

Livability above expansion
Within the neighborhoods, livability should have priority over expansion. With the current densification plans of the area, there is no threat to livability yet. Any future densification plans should be tested on whether or not they worsen certain problems like heat stress. Only plans that are proven to not worsen the current problems or have measures to actively combat their adverse effects should be approved.

Our neighborhood
With an increase in the quality of the public space and new housing units from densification, it is important to make sure current inhabitants are not pushed out of the neighborhood. This means not only making sure prices/rents do not increase drastically but also making sure that there is affordable housing near when people want to move to a larger or smaller house. The two neighborhoods currently have a high percentage of social housing, and with new densification plans it is important to also build social housing. Current inhabitants and their children should reap the benefits of improvements to the neighborhood.

Flexible plans
New buildings should be flexible and equipped to deal with a change in function. When approving plans at least one plan should be laid out of how the building could deal with a function change. An example of this could be that if a new business wants to settle in the area, it must also prove that with a reasonable price, it can be converted to housing.



Public Space Design

With a vision established, it will now be explored what this vision could look like in Utrecht. A design concept is set up for the entire neighborhood and for three locations an in-depth public space design will be created.

Strengths, Opportunities, Threats and Weaknesses

When looking at design opportunities for the area of Kanaleneiland and transwijk, it is important to know where the neighborhoods function well and where the pressure points are. During the design process, there should be a knowledge of what to reduce and what to increase, what to mitigate, and what to enhance. Some weaknesses, threats, strengths, and opportunities the current public space in these areas have is laid out below.

Weaknesses

Highly paved
Built-up space dominates green and open space, creating problems with heat, water, and overall livability of people and other life.

Non-diverse green
The green present in both neighborhoods is often small-scale and has little variety of plant life. Most places are too small or not diverse enough to sustain different types of plants and wildlife.

Separation and disconnect
Places and people are often divided by roads, cars, or past planning decisions. This discourages desired behaviors like biking, cycling, and social meetings.

Lacking public space
There are too few spaces where people can meet and gather, lowering social connections within the neighborhoods.

Threats

Heat stress
During summer, temperatures within the area can rise to a point where it affects the health and well-being of the inhabitants. A problem that will only worsen as climate change progresses.

Water nuisance
Due to the high amount of paved and built space, heavy rainfall posed a threat to mobility and buildings. This is another problem that will only get worse as time goes on due to increased rainfall.

Gaps in public space
Public space is not designed for all groups, which can lead to isolation. Many public spaces are aimed at younger kids or aimed at people who play sports/ exercise outdoors. This already leaves out large groups of people. An example of how this can be harmful to certain populations is the statistics on the amount of lonely elderly, which is quite high in both neighborhoods (Nationale klimaatadaptatiestrategie team, 2020).

Safety
Perceived safety in certain areas is quite low, which can make people abstain from visiting certain areas and using the space and its facilities.

Strengths

Transwijk park
Park Transwijk is a space that is currently widely used throughout all hours of the day. It has diverse functions and spaces that differ in character from small and intimate to very open and busy. It attracts a wide audience and functions well overall.

West waterfront
Another widely used space that attracts many people at all hours is the West waterfront park. It also has a strong connection to the water, strengthening its identity.

Opportunities

Social buildings
As mentioned a few times before, there are quite some places where people are already meeting within the neighborhood. Facilitating and connecting these places can only strengthen and broaden the social connections made in the neighborhood.

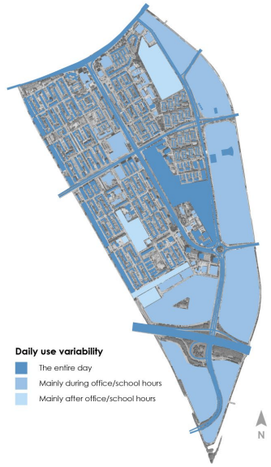
Open and underused space
There are many places within the area that serve little to no function or are only used during parts

of the day/year. These places are excellent to implement flexible interventions and increase functionality.

East waterfront
One of the very well-functioning areas of the neighborhoods is the west waterfront. The east waterfront is currently home to offices and parking lots, which means there is room to improve this area and uplift its quality to the standard of the other waterside park.

Water as a meeting place
Because there are quite a few ambitions and opportunities when it comes to the social character of these neighborhoods, climate adaptative measures can be a great facilitating factor in reaching social goals while also reaching climate adaptation goals.

Design Concept



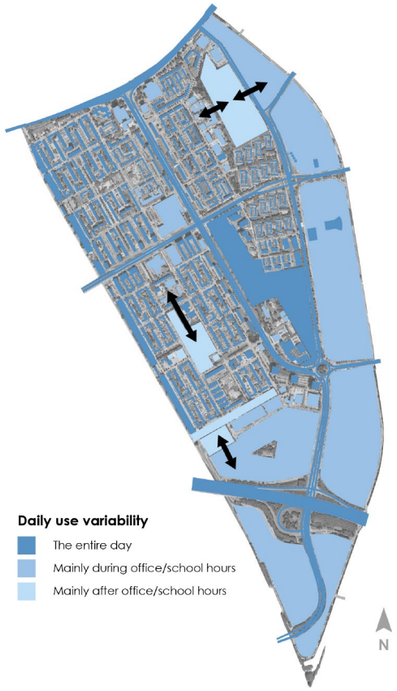
Based on research, analysis, observations, and ambitions the municipality has, a design concept can be created for Kanaleneiland and Transwijk.

Two birds, one stone

The implementation of climate adaptive measures like water storage can be combined with social opportunities and ambitions by using these measures to improve the space surrounding it. Creating a route of water, and enhancing social spaces along the way. The route will pass buildings with social potential and spaces with an opportunity to exchange water during the day/seasons.

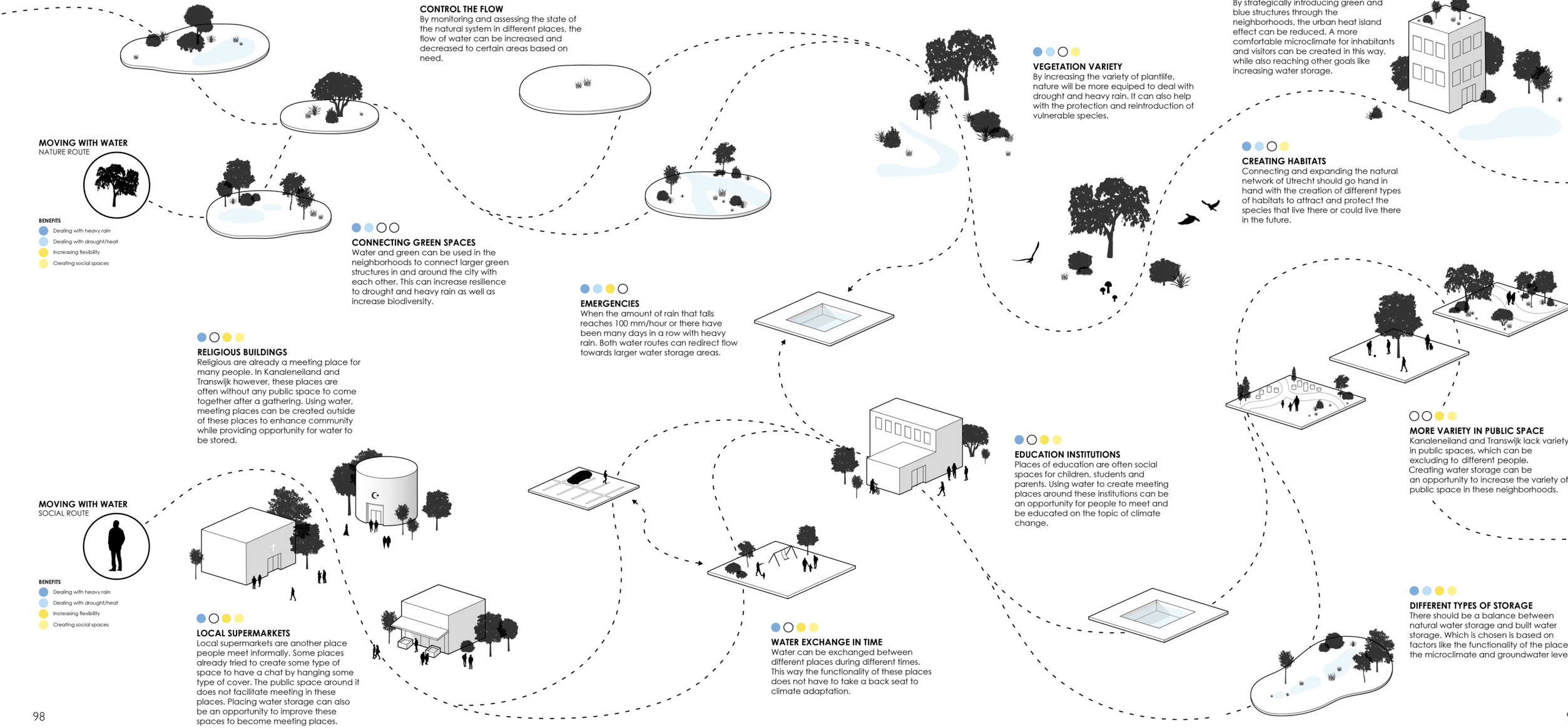
There are a few design possibilities that can be explored for these spaces. Firstly, attracting factors, things that can pull people towards this route or keep people in the area once there. Secondly, how these spaces attach to the current functions in surrounding areas. Something that can also be an inspirational factor is the historic and cultural value of the area and Utrecht as a whole, how can these new spaces relate to the context and history of Utrecht? Something that should be considered when designing these spaces is how they would function in different scenarios, in terms of climate and use.

Another opportunity that implementing climate adaptive measures brings is the strengthening of the natural network of Utrecht, looking for green-blue connections and enhancing ecological value. This can be done in combination with social spaces or separately, creating different characters of public and green spaces within the two neighborhoods.



Emergency storage

Within the neighborhoods, larger water storage needs to be implemented to be able to deal with rainfall peaks. The water from the natural network, as well as the water from the social water route need to be in connection with this emergency storage so the flow of water can be redirected towards this storage during heavy/prolonged rainfall.



MOVING WITH WATER
NATURE ROUTE

BENEFITS
- Dealing with heavy rain
- Dealing with drought/heat
- Increasing flexibility
- Creating social spaces

CONTROL THE FLOW
By monitoring and assessing the state of the natural system in different places, the flow of water can be increased and decreased to certain areas based on need.

CONNECTING GREEN SPACES
Water and green can be used in the neighborhoods to connect larger green structures in and around the city with each other. This can increase resilience to drought and heavy rain as well as increase biodiversity.

EMERGENCIES
When the amount of rain that falls reaches 100 mm/hour or there have been many days in a row with heavy rain. Both water routes can redirect flow towards larger water storage areas.

VEGETATION VARIETY
By increasing the variety of plantlife, nature will be more equiped to deal with drought and heavy rain. It can also help with the protection and reintroduction of vulnerable species.

COMBATING HEAT
By strategically introducing green and blue structures through the neighborhoods, the urban heat island effect can be reduced. A more comfortable microclimate for inhabitants and visitors can be created in this way, while also reaching other goals like increasing water storage.

CREATING HABITATS
Connecting and expanding the natural network of Utrecht should go hand in hand with the creation of different types of habitats to attract and protect the species that live there or could live there in the future.

MORE VARIETY IN PUBLIC SPACE
Kanaleneiland and Transwijk lack variety in public spaces, which can be excluding to different people. Creating water storage can be an opportunity to increase the variety of public space in these neighborhoods.

DIFFERENT TYPES OF STORAGE
There should be a balance between natural water storage and built water storage. Which is chosen is based on factors like the functionality of the place, the microclimate and groundwater level.

EDUCATION INSTITUTIONS
Places of education are often social spaces for children, students and parents. Using water to create meeting places around these institutions can be an opportunity for people to meet and be educated on the topic of climate change.

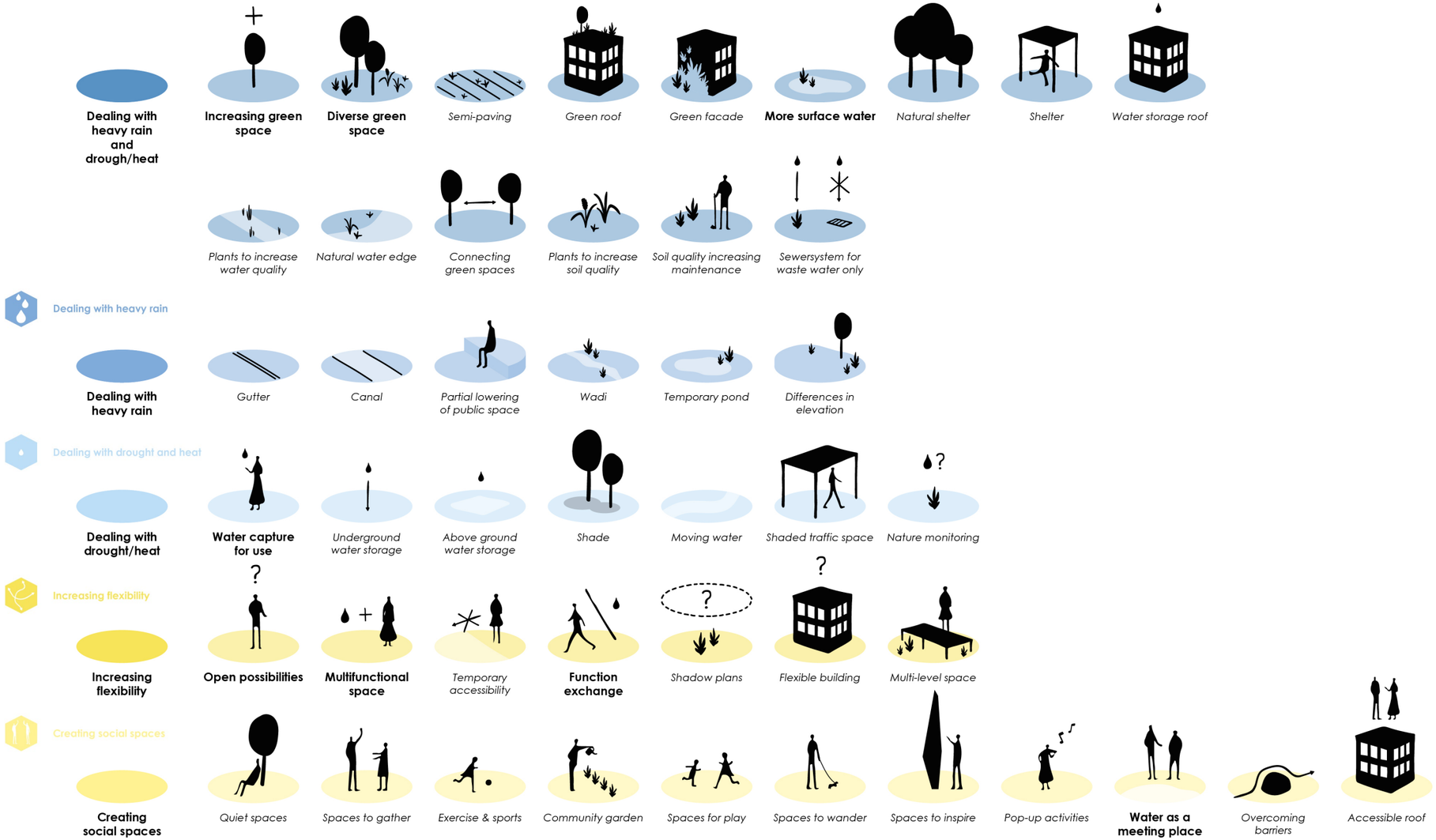
WATER EXCHANGE IN TIME
Water can be exchanged between different places during different times. This way the functionality of these places does not have to take a back seat to climate adaptation.

RELIGIOUS BUILDINGS
Religious are already a meeting place for many people. In Kanaleneiland and Transwijk however, these places are often without any public space to come together after a gathering. Using water, meeting places can be created outside of these places to enhance community while providing opportunity for water to be stored.

MOVING WITH WATER
SOCIAL ROUTE

BENEFITS
- Dealing with heavy rain
- Dealing with drought/heat
- Increasing flexibility
- Creating social spaces

LOCAL SUPERMARKETS
Local supermarkets are another place people meet informally. Some places already tried to create some type of space to have a chat by hanging some type of cover. The public space around it does not facilitate meeting in these places. Placing water storage can also be an opportunity to improve these spaces to become meeting places.



Interventions

With the design concept and four main goals in mind, some main interventions can be established for these two neighborhoods. They are divided into groups based on the goal that the intervention helps to achieve, although some interventions achieve multiple goals at once.

This intervention set is partially inspired by 'Handreiking droogte en groen' (NKWK, 2023) and 'Bouwstenen klimaatpleinen provincie Utrecht' (Atelier GroenBlauw, 2021). Some of the interventions are quite straightforward like introducing more surface water or creating shade. Some might warrant some explanation, they will be discussed now.

The intervention ***shadow plans*** can mainly be useful in places that are very monofunctional or have a function that is expected to decrease or increase drastically. The shadow plan intervention in these cases will make sure that there is a backup plan ready for when these spaces lose their original function. This can also mean that space is designed with a future function in mind, even if it will not fulfill this function for many years. Connected to this intervention is the intervention ***flexible building***. Which is mainly aimed to create more buildings that can quickly be inhabited by different functions without needing many renovations.

Overcoming barriers is mainly about trying to reduce and overcome the physical barriers in the area. This can mean a large road or other infrastructural hurdle or two disconnected places that are separated by another function.

The intervention ***open possibilities*** aims to create spaces that are not too defined, but open for interpretation in terms of use. This also ties into the intervention ***pop-up activities***. With more open spaces, there is room for more temporary functions and activities that change with the weather and the seasons.

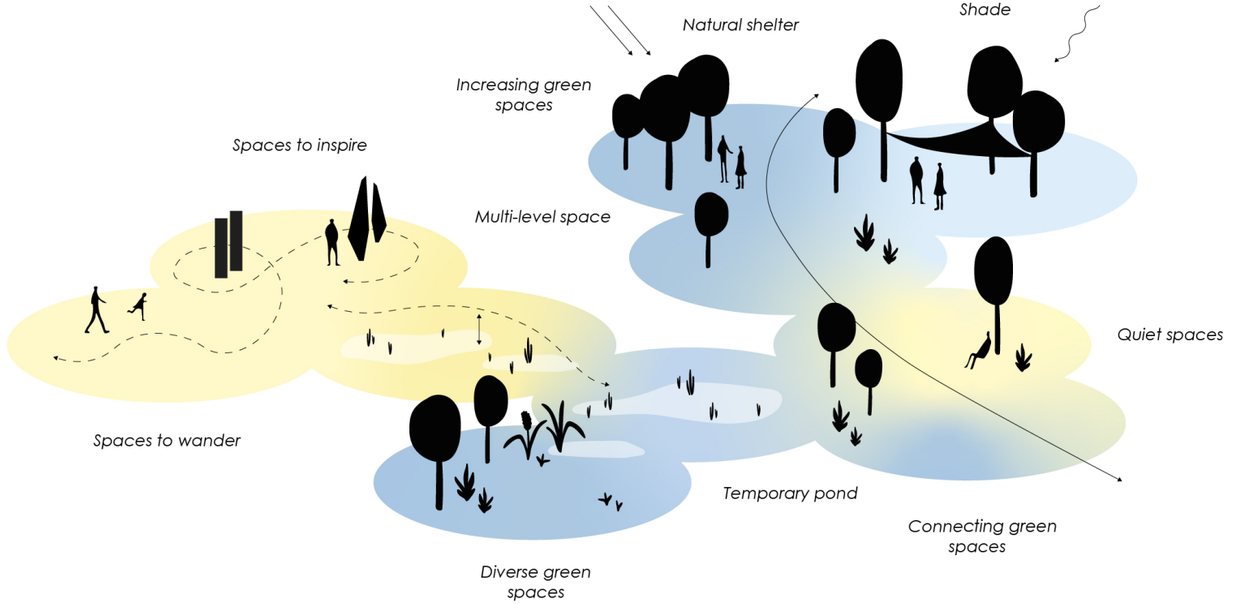
Connecting interventions

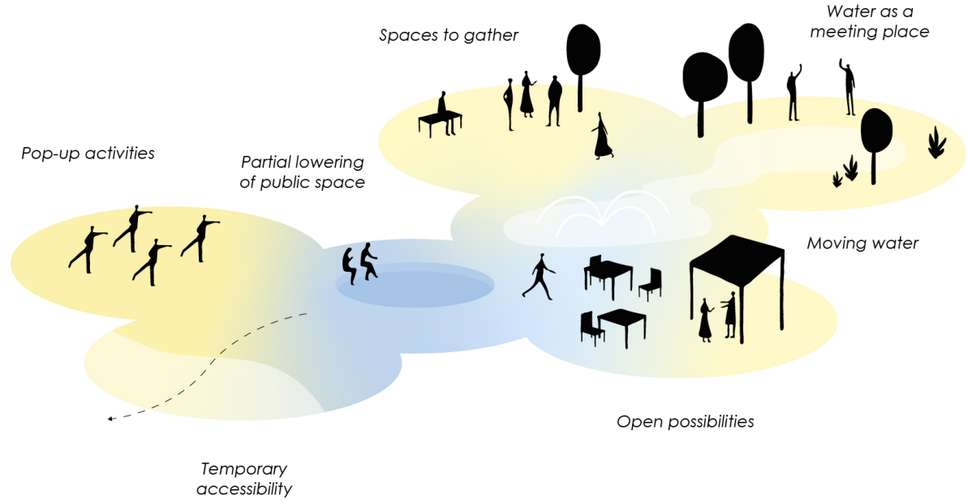
It speaks for itself that some interventions go very well together, while others are not as easily combined. By creating different sets of interventions for different places, more variety in characters will arise.

Two examples of how these interventions can attach to create different spaces are shown to the right. One suits the natural route quite well, including more green space, temporary ponds, and diversifying green space. This creates a more quiet character of public space that is well suited for people to walk around, enjoy nature or art, and find a quiet spot to read.

The other set of interventions shows a more lively space with more public functions and more built-up space, although natural space is still very much present. These more active interventions like pop-up activities and spaces to gather are well suited along the social route.

Later on in this chapter, these sets and combinations of interventions will be explained further and put into the context of the location of Transwijk and Kanaleneiland.





The routes

How these routes are situated inside the neighborhoods follows a few rules:

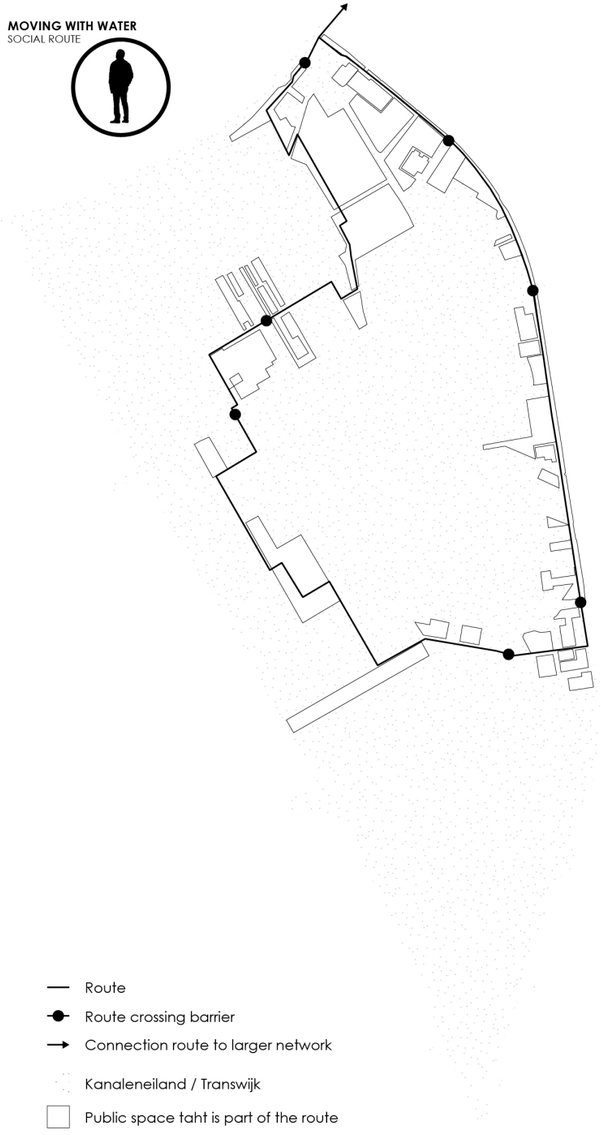
Distance to public space
One of the aspects that influence the placement of the routes is the distance between people's homes and a high-quality public space (preferably a green one). The goal of both routes is to intersect into the neighborhoods in such a way that more people live close to a high-quality public space and/or a high-quality green space.

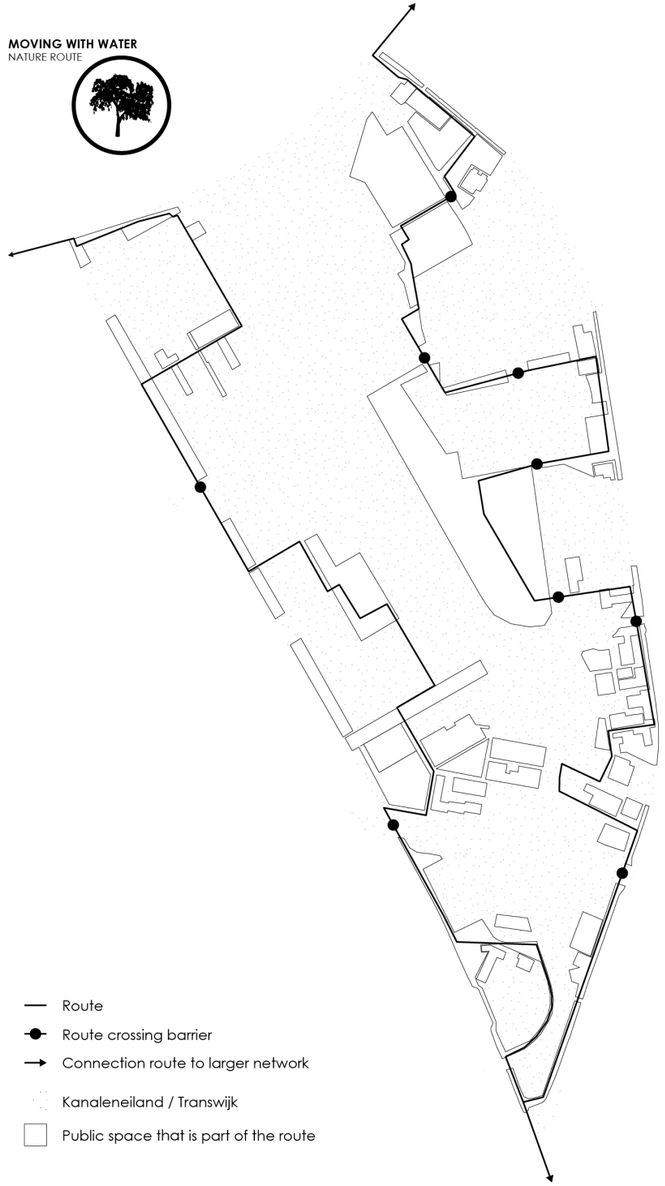
Social hot spots
For the social route specifically, the route must follow current social spots, like the local supermarket, a place of worship, or a sports facility. This way the public spaces are in places where the flow of people is naturally directed towards and these spaces will be in spots where people will easily stumble upon them.

Crossing paths
A third criterion for the placement of the routes is how they intersect and meet each other. One of the goals is to create more variety of public space and these two routes both have their own characteristics. By making them meet and separating them, you get an assortment of different spots ranging from natural and quiet to busy and built-up.

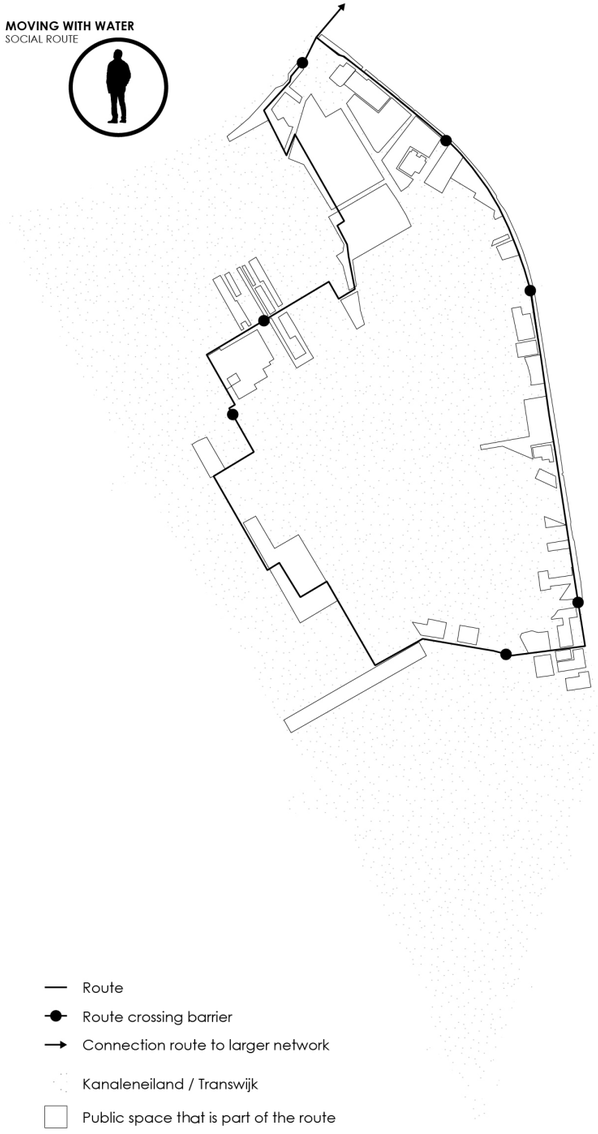
Barriers
The last criterion has to do with barriers along the routes. Although it is impossible to not cross any roads or other barriers with these routes, it is possible to pick places with less impact to cross these barriers. One example of this is keeping the routes away from large and busy intersections and choosing to cross further along the road.

The resulting two routes based on the beforementioned criteria are shown to the right and on the next page.

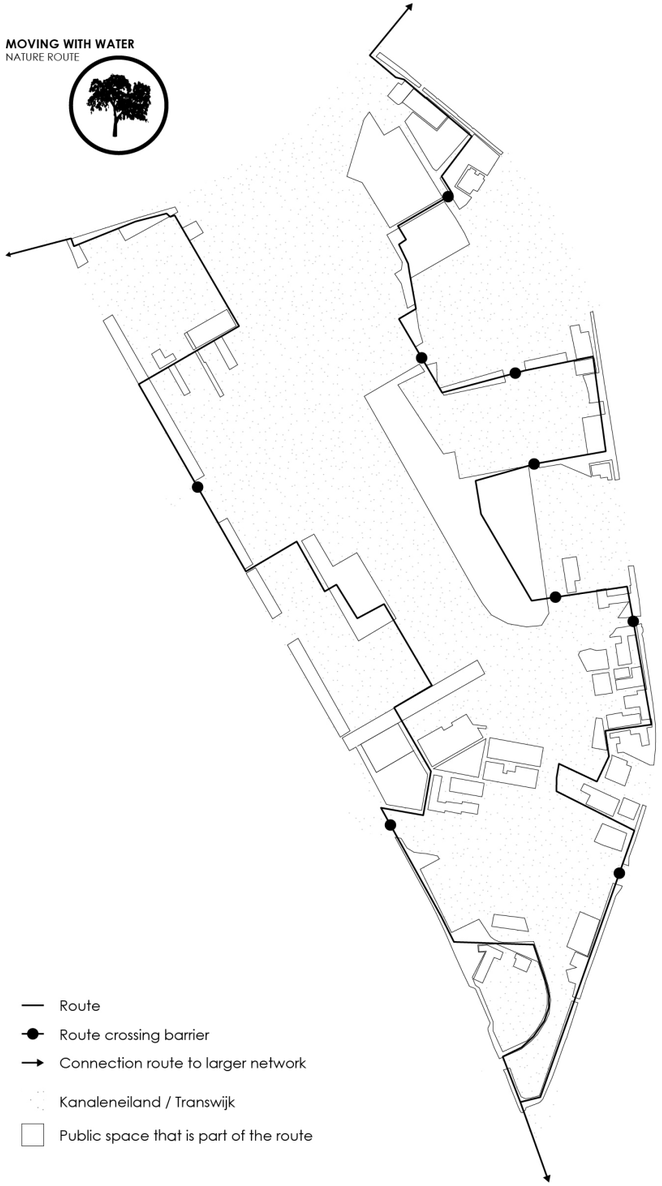




MOVING WITH WATER
SOCIAL ROUTE



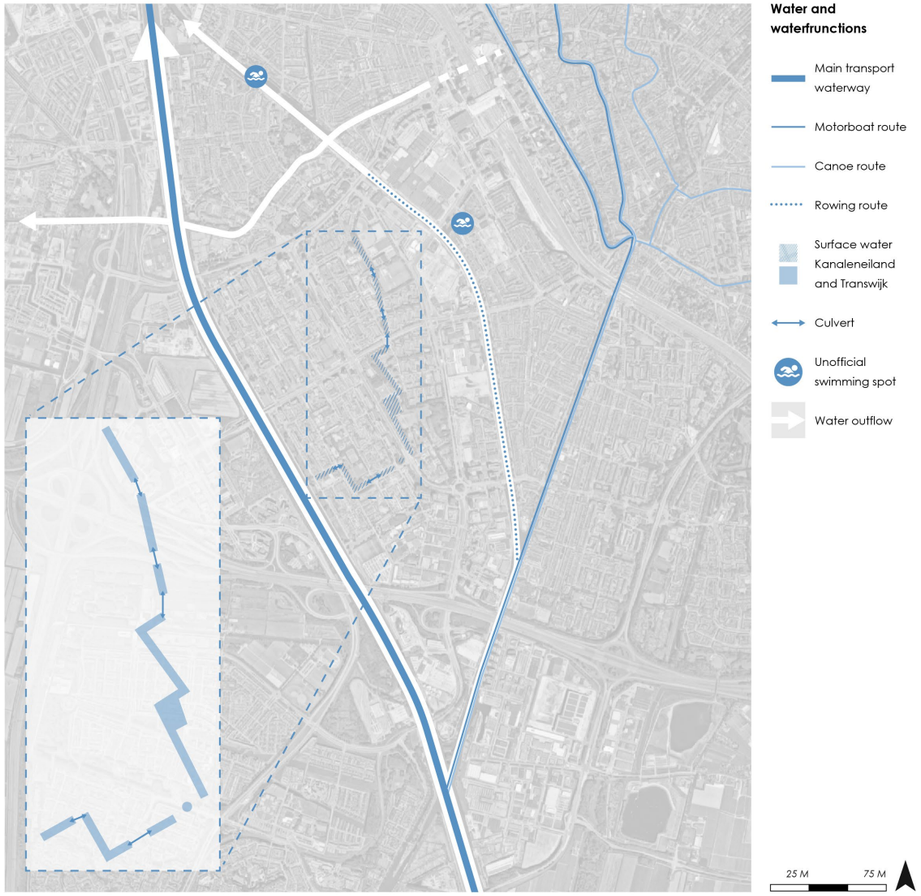
MOVING WITH WATER
NATURE ROUTE



Connection to surrounding green network

The municipality of Utrecht has a general vision set up with current and future connections and green spaces, what this vision looks like for Kanaleneiland, Transwijk, and its surroundings is shown above. Something to consider when looking at the maps above is that the municipality sometimes classifies sports fields as green spaces. Even if the fields are made of real grass, which they often are not, the ecological value of these spaces is not very significant, and therefore in the figures above a distinction is made between green spaces and sports fields.

Most of the desired green connections do not have a concrete plan set up for them yet. The nature route aims to fill in these missing links for the neighborhoods of Kanaleneiland and Transwijk as well as create connections to the larger network that surrounds them.



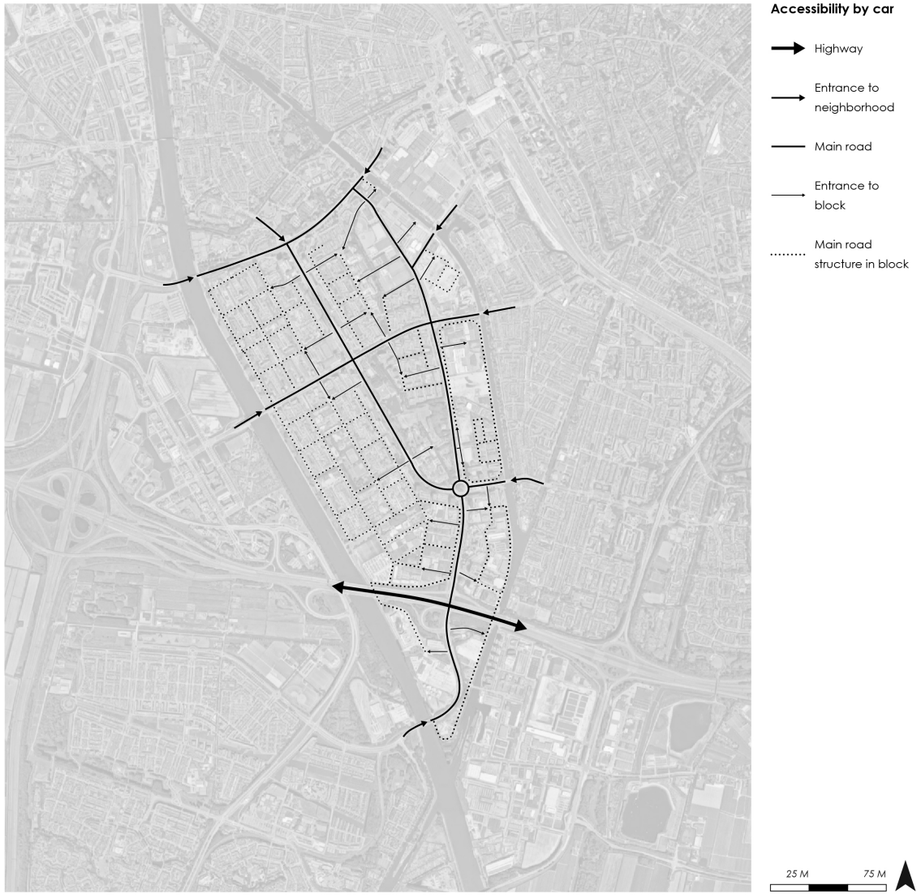
Connection to surrounding water network

The two main functions of the water that surround Kanaleneiland and Transwijk are transportation on the West side (Amsterdam-Rijnkanaal) and sports/ recreation on the East side (Merwedekanaal). These functions are not disrupted in the new design and when it comes to recreation, this character is enhanced.

Within the neighborhood, the main water structure is cut into two parts with a road forming a barrier between the two. The water structure is also linear in shape, which leads to poor water circulation.

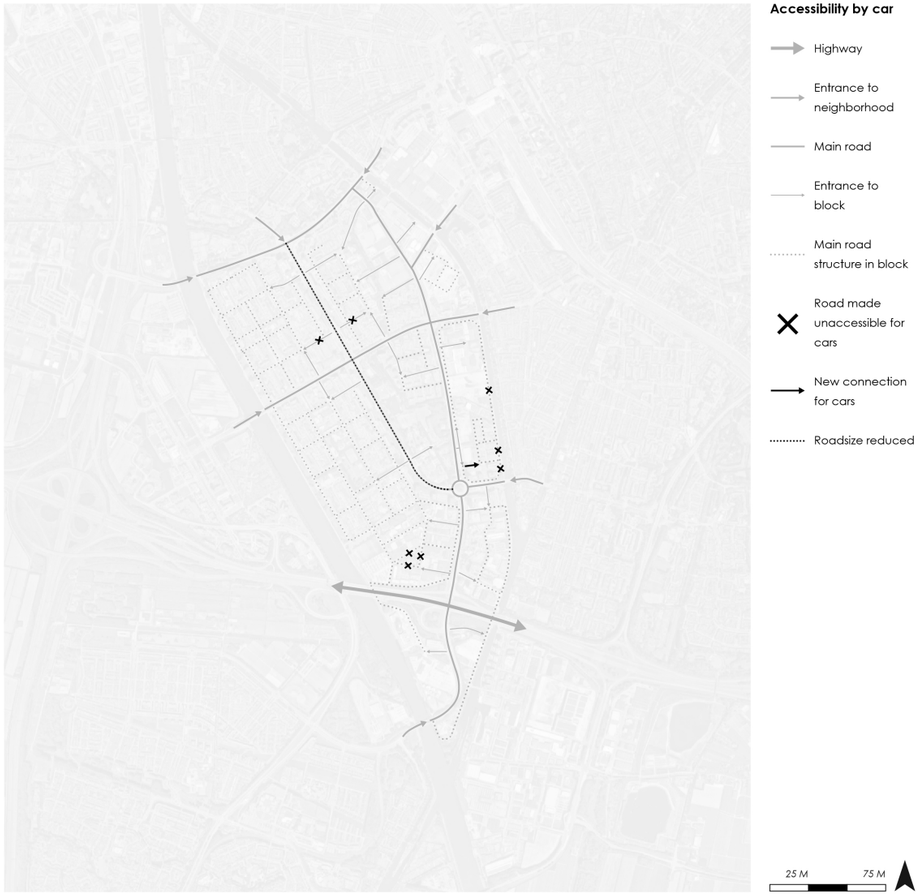
The new design aims to connect the two disconnected parts of the water structure in Kanaleneiland and Transwijk. In addition to this, it also connects in such a way that it creates two loops through which water circulation is possible.

By implementing more surface water in general, the two neighborhoods can retain more rainwater. This is especially important when it comes to these neighborhoods because as soon as the water ends up in one of the surrounding canals, it is immediately transported out of the area.



Connection to surrounding road network

As mentioned before, Kanaleneiland and Transwijk are quite car-dominated neighborhoods and this can be seen clearly when looking at the road network. Almost every part of the area is accessible by car with a larger road close by. Especially the larger roads form a significant barrier for people, nature, and water.



In the new design, a few smaller roads are made inaccessible for cars. The locations nearby are still accessible for car traffic via another route which means car traffic remains largely unaffected. Slow traffic however gains a lot from this change by creating a safer and more pleasant environment for them.

One of the larger roads is reduced in size to create room for other functions and to reduce the barrier that it creates.

Connection to surrounding public transport

When it comes to public transport, Kanaleneiland and Transwijk are very well connected. Multiple lines of Busses and Trams come through the area and have a close-by link to Utrecht central station.

Interventions in the neighborhoods can lead to an increased flow of people toward the area. This means some public transport stops might be busier and more active during different times. This can have some consequences for the surrounding inhabitants. Since most of these stops are already located near a larger road, the nuisance it might create in terms of noise will most likely not be a problem. Having more people going in and out of the area during different times of the day does have the capacity to increase safety by having more eyes on the street, which would be a positive side effect of the interventions.

The nature route

The nature route is the largest of the two routes as it aims to also connect to a larger green network. Within this route, three main types of space can be identified. Spaces that are part of the waterfront, community spaces that are aiming to bring people together, and the industrial oasis.

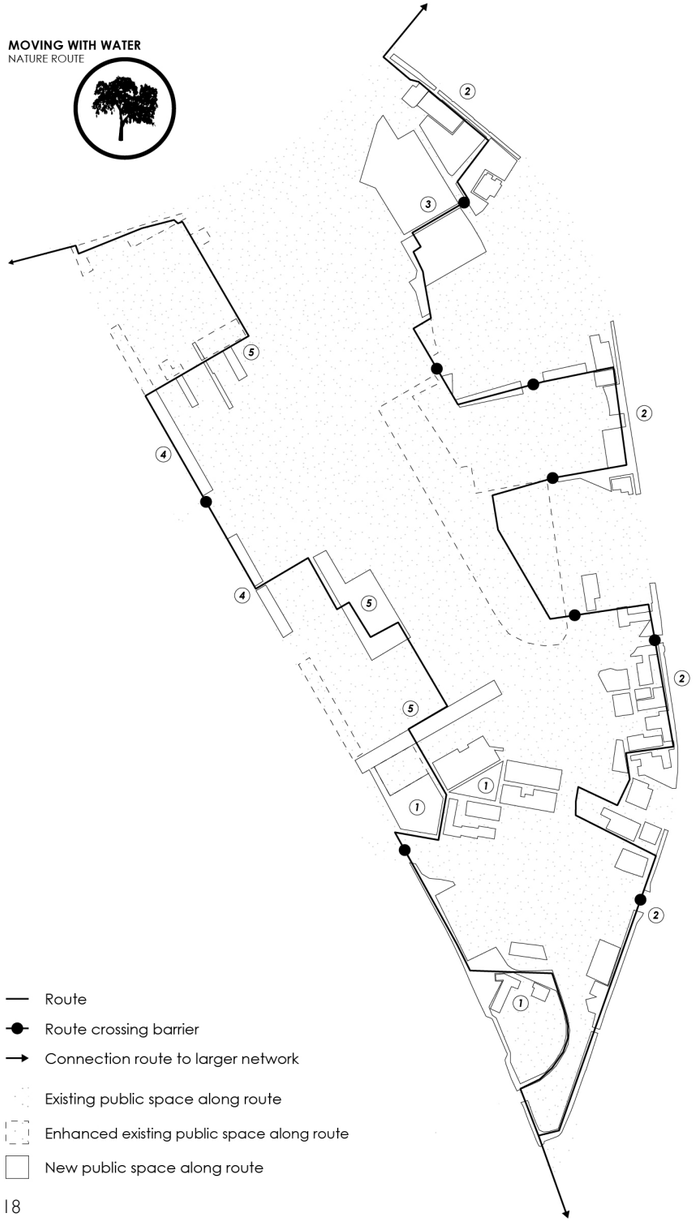
Waterfront character
The waterfront of these two neighborhoods is very important for the identity of the area as well as for Utrecht as a whole. The spaces along the waterfront are therefore spaces that aim to enhance the connection between people and the water, not just making space for nature, but also for recreation and relaxation. How this character expresses itself can differ, since the social route and nature route meet and separate many times along the waterfront.

Industrial Oasis character
This industrial oasis character pops up in spots with large amounts of industry/offices. Many of these spaces deal very heavily with heat stress but have very little leftover space to implement large interventions. In these spaces, the interventions on rooftops and using every part of the public space are essential to adapt to current and future problems.

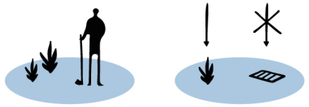
Community space
Lastly, there are community spaces. These spaces are located closer to homes and are more embedded into and alongside housing blocks. Important for these spaces is to appeal to a wide audience. The main aim of these spaces is to connect inhabitants and visitors and to create a safe public space close to people's homes.

Some possible intervention sets along the route can be seen on the next page

MOVING WITH WATER
NATURE ROUTE



General


Soil quality increasing maintenance

Sewersystem for waste water only


Plants to increase water quality


Plants to increase soil quality


Nature monitoring

1


Green roof

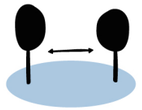

Green facade


Water storage roof


Shaded traffic space


Multi-level space

4


Connecting green spaces

Moving water


Water as a meeting place

3

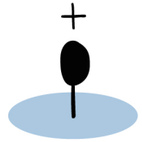

Natural shelter


Shade


Multi-level space


Accessible roof

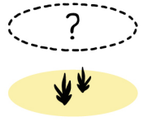
2


Increasing green space


Diverse green space


Plants to increase water quality


Multi-level space


Shadow plans


Quiet spaces


Spaces to wander


Spaces to inspire

5


Diverse green space


Water capture for use

Underground water storage


Multifunctional space


Community garden


Water as a meeting place

The social route

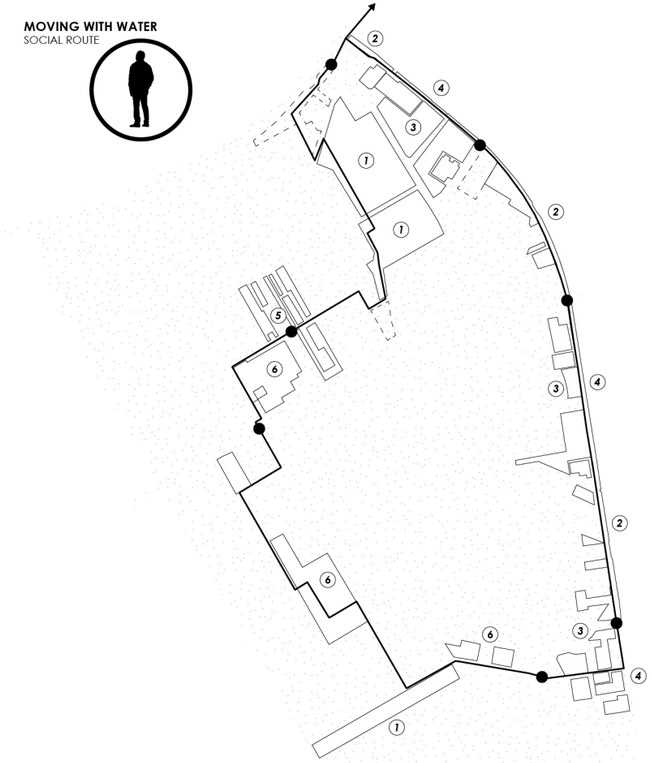
The social route is a smaller route than the previous one and has two main characters.

Waterfront character
Just like the nature route, the social route partially follows the waterfront. The connection between people and water is very important here. This means the current makeup of the space will change drastically from a closed-off industrial/office space to an open and accessible public space.

Community space
The other character within this route is the community space character. These spaces are more prominent in this route than in the previous one as this route follows many social spots within the neighborhoods and housing blocks. The aim is to provide a space to go before or after people visit these social spaces or as a destination within itself if they live close by.

Some possible intervention sets along the route can be seen on the next page

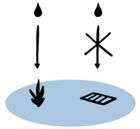
MOVING WITH WATER
SOCIAL ROUTE



- Route
- Route crossing barrier
- Connection route to larger network
- Kanaleneiland / Transwijk
- Existing public space along route
- New / Enhanced public space along route

General

Soil quality increasing maintenance



Sewersystem for waste water only

Nature monitoring

3

Green roof

Green facade

Water storage roof

Accessible roof

6

Underground water storage

Community garden

Spaces for play

Multifunctional space

Water capture for use

1

Function exchange

Temporary accessibility

Above ground water storage

Natural shelter

Exercise & sports

Spaces for play

Shade

Shaded traffic space

Partial lowering of public space

5

Wadi

Differences in elevation

Spaces to wander

Spaces to inspire

2

Multi-level space

Plants to increase water quality

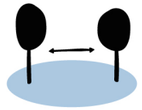
Water as a meeting place

Natural water edge

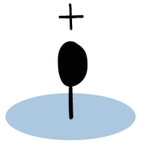
4

Water as a meeting place

Spaces to gather



Connecting green spaces



Increasing green space

Pop-up activities

Open possibilities

Zoom in locations

Within the routes, some spaces are explored further and a more elaborate design will be created for these spaces. The locations are purposely spread out over the two neighborhoods. They deal with different problems and serve different functions within the area.

Location 1

Emergency water storage

The first location can be found near a bigger road that passes through housing blocks. This is a larger space than other available spaces in the neighborhoods and will therefore be used as emergency water storage. Due to the placements near housing as well as stores and a mosque, creating a space where people can come together will also be a focal point for this location.

The main focus of this area
Dealing with heavy rainfall and creating a community space.
Routes involved
The social route

Location 2

Waterfront

The second location is a space along the eastern waterfront. Offices and companies dominate this side of the neighborhood and it is much less visited than the waterfront to the west. Utrecht speculates that in the future this space might see a return of the makers industry. For this location, the focus will be to see how public space could be shaped in such a way as to provide benefits to people now while also allowing the possible future return of industry.

The main focus of this area
Increasing flexibility to function changes and strengthening the connection between people and the water.
Routes involved
The social route and the nature route

Location 3

Industrial Oasis

The third location is a mix of businesses and larger commercial functions like furniture stores and hardware stores. It is a very dense area with little space left over for public functions and it is an area that deals very heavily with heat stress. The main focus for this area is to try and use all available space to its fullest by capturing rainwater and combating heat stress.

The main focus of this area
Dealing with drought and combating heat stress in a densely built space.
Routes involved
The nature route

Detailed design Emergency water storage

With the design concept, general characters, and interventions for the neighborhoods set up it is time to zoom in on one a smaller area to see what the new neighborhoods look like with all the interventions set up. The first spot to zoom into is the emergency storage.

Without intervention

What stands out currently in this location is the large presence of cars. The Beneluxlaan consists of two large roads with a tram track in the middle. Both sides of the avenue are lined with flats with large parking lots on the other side. Even with the municipality's plans to reduce the road size for the Beneluxlaan, the area maintains a strong car-dominated character. The area does not entice inhabitants to walk to a nearby destination as housing is surrounded by car infrastructure.

Some green spaces are present surrounding the road, but they are not very much used as most of it is plain grassland next to a busy road. These green areas house no other functions and are not part of the municipality's green network plan. This means the ecological value of these spaces or the value to inhabitants is not likely to increase without added intervention.

One of the location's strengths is its connectivity for cars and public transport to the rest of the neighborhood and city, this connectivity is however lacking for other means of transport, especially walking. This is mainly due to the high amount of infrastructural barriers present.

100 M 200 M

Tram line Road Buildings Green space Tram stop Bus stop Zoomed in design area Route

100 M 200 M

Emergency water storage

The emergency storage will be located along one of the larger roads in the neighborhood. What makes this a suitable place for water storage is the fact that there are some large green areas located between the flats and the road. On top of this, the municipality already has some plans to narrow this road (Gemeente Utrecht, 2022a), and the current space is not used to its fullest with most of the green space being bare grassland. Altogether this leaves quite some open space for a larger intervention.

The main function of the water storage will be to deal with large peaks in rainfall. Smaller showers can be stored locally, but when these smaller basins begin to fill up, the water will need another place to go. Because of this function, the water storage in this location will need to be larger in size, to be able to cope with water coming in from a larger area within the neighborhood. This also means it needs to be connected to a larger water structure running through both neighborhoods.

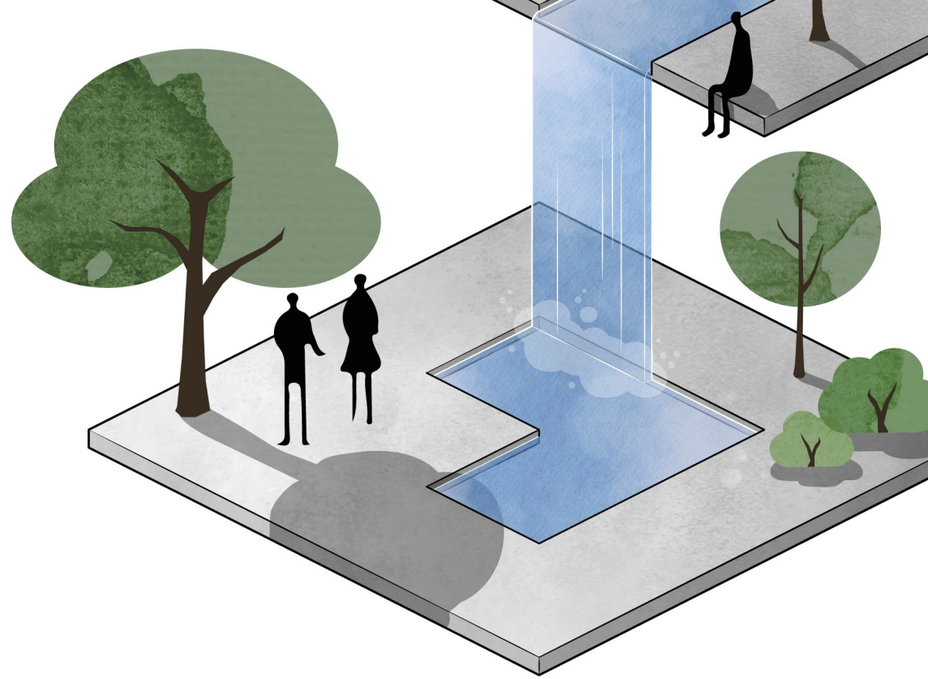
The social route crosses paths with the location for emergency water storage. Where the paths of these two cross will be a more social and lively place where public functions will need to be combined with water storage solutions. Later on in this chapter, a more detailed look at this place will be shown.

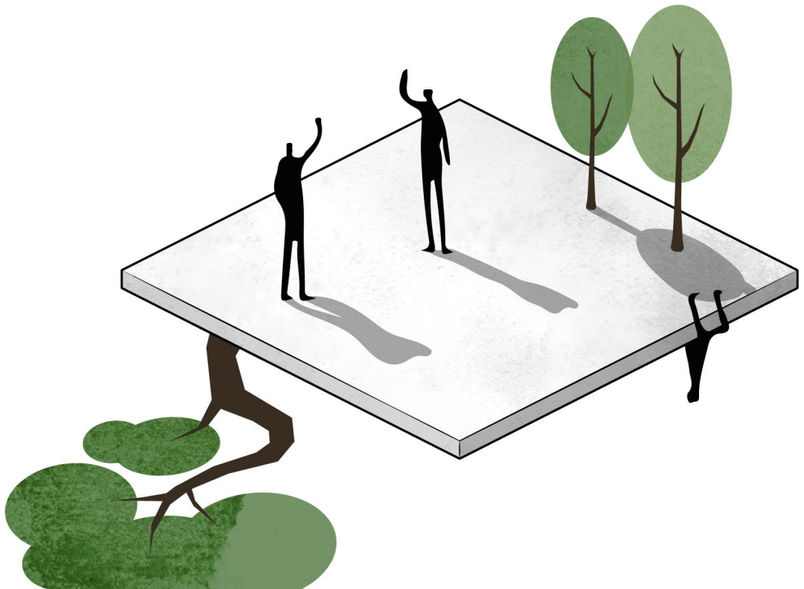
Design concept

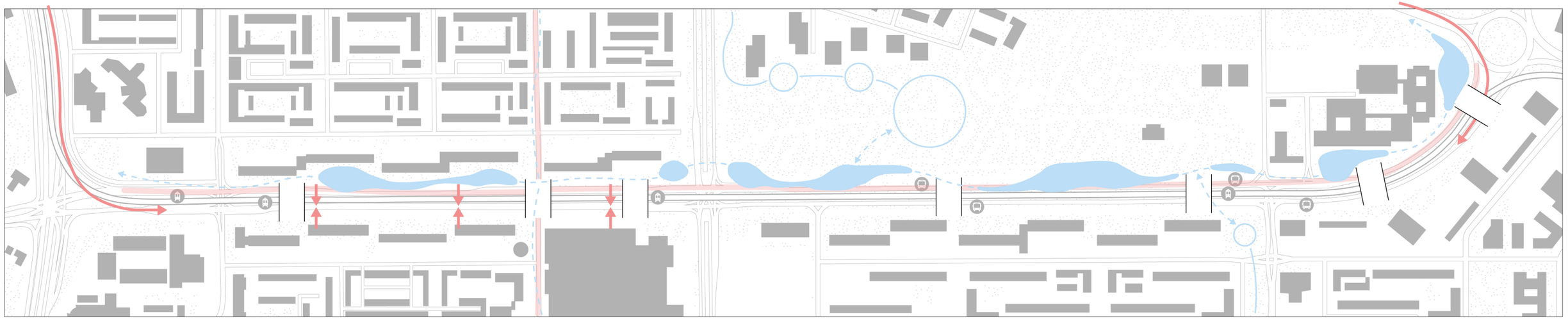
To implement water storage along the road, the street size will need to be significantly reduced. As mentioned before the municipality already has a plan to do this. The municipality wants to narrow both roads with one lane, but in this report, another solution is proposed. By taking away both lanes on one side instead of one lane on both roads, a larger space opens up on one side of the tram tracks. This also allows pedestrians from one side to get to the tram without having to cross any car lanes. Conflicts between pedestrians and cars are reduced even further by making one of the roads entering the housing blocks a pedestrian street. Cars can still enter the housing blocks and have access to all of the houses by taking one exit sooner when entering the neighborhood from the north. This should have minimal impact on car access, but will greatly improve the walkability of the location, making it possible for inhabitants to walk to the shops with minimal disturbance of cars. Car parks will also be stacked creating multi-level parking. This opens up more space for public space.

As mentioned before, the space needs to fulfill a water storage use as well as be a public space use with several other functions. To achieve this within the available space, multilevel space will be used. This means that water storage will in some spots run under the public space, allowing for both functions to be accomplished within the same space.

Lastly, the Water storage along the road will be connected to the larger bodies of water in Transwijkpark and the water structure to the west of the road.

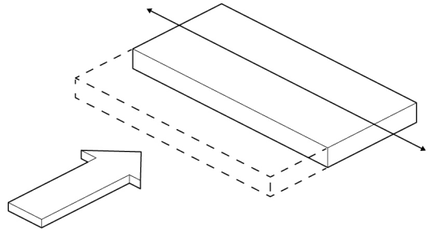


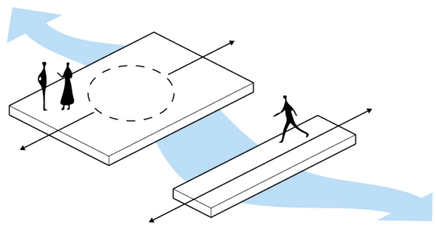


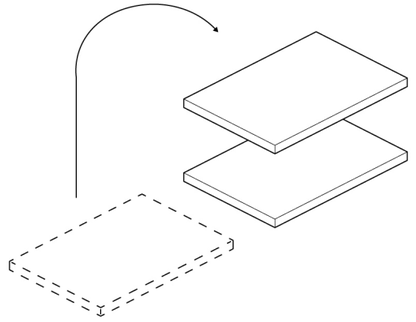


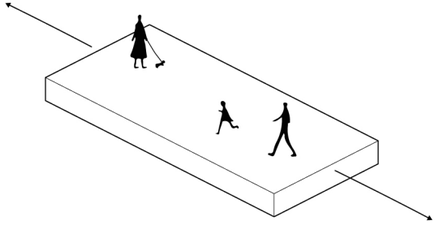
Tram line
Road
Buildings
Green space
Tram stop
Bus stop
Redirected route
Narrowed street
Narrowed street
New water storage
Current water
Current connection
New connection
Busier public space / Crossing

100 M
200 M









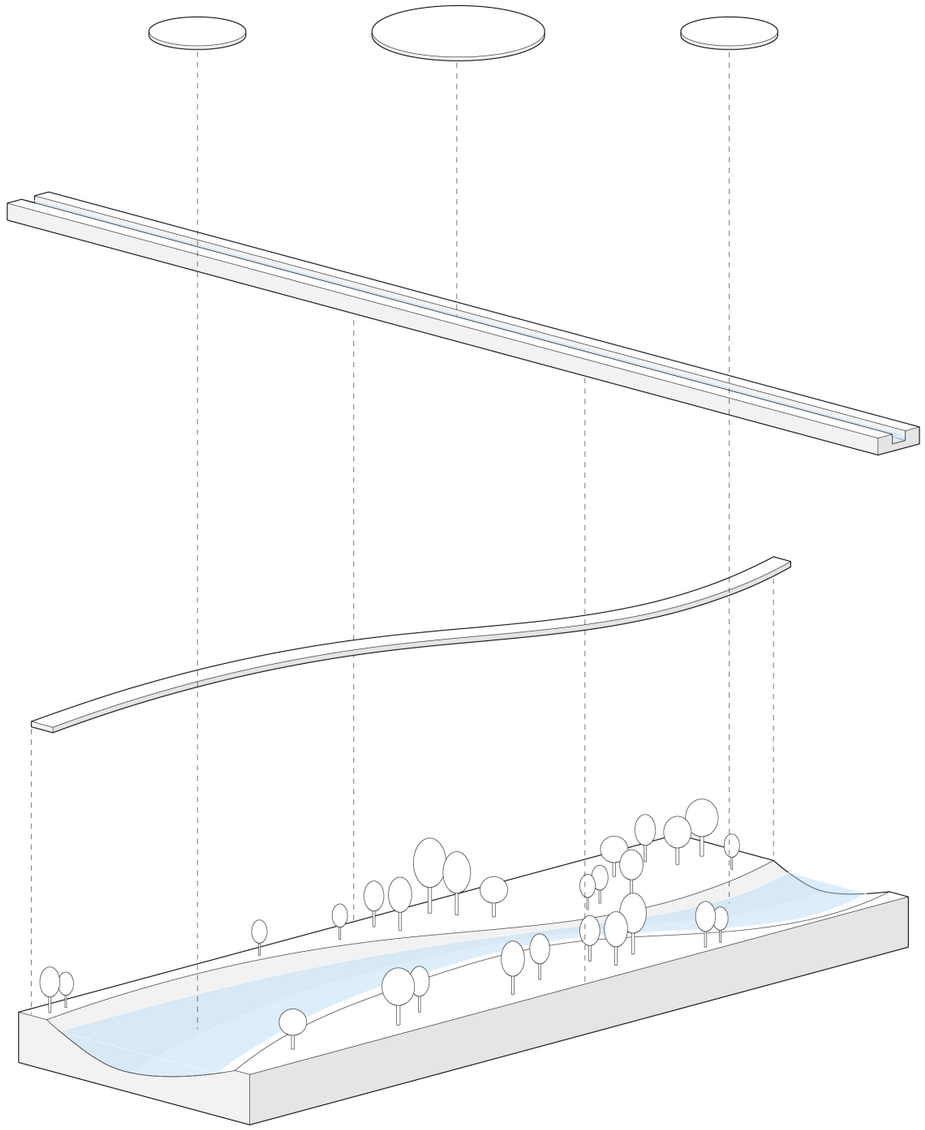
❶ Reduce road size for cars

❷ Water storage connected beneath public space

❸ Reduce and stack parking space

❹ Connect surface water

❺ Slow traffic only roads



The squares
Fourth intervention

The fourth intervention is the creation of squares along the water buffer. This is the final intervention for this design. The main aim is to create more spaces to meet and gather for different types of functions and events. This means the character of the squares is quite open, this way it can easily be adapted to accommodate different functions.

The slow traffic road
Third intervention

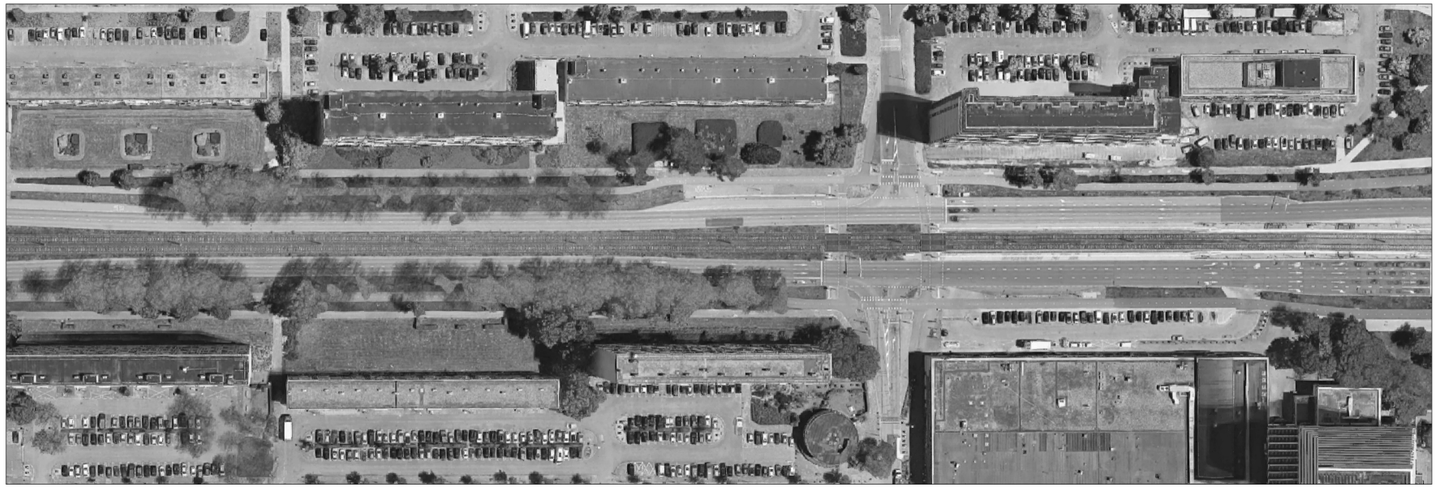
The third intervention is to adapt the road crossing the emergency storage to a slow traffic only road. By making this change, inhabitants have a safer and more comfortable route to take from their homes to the shops on the other side of the road. Since this is quite a big intervention, it shows up later on the timeline.

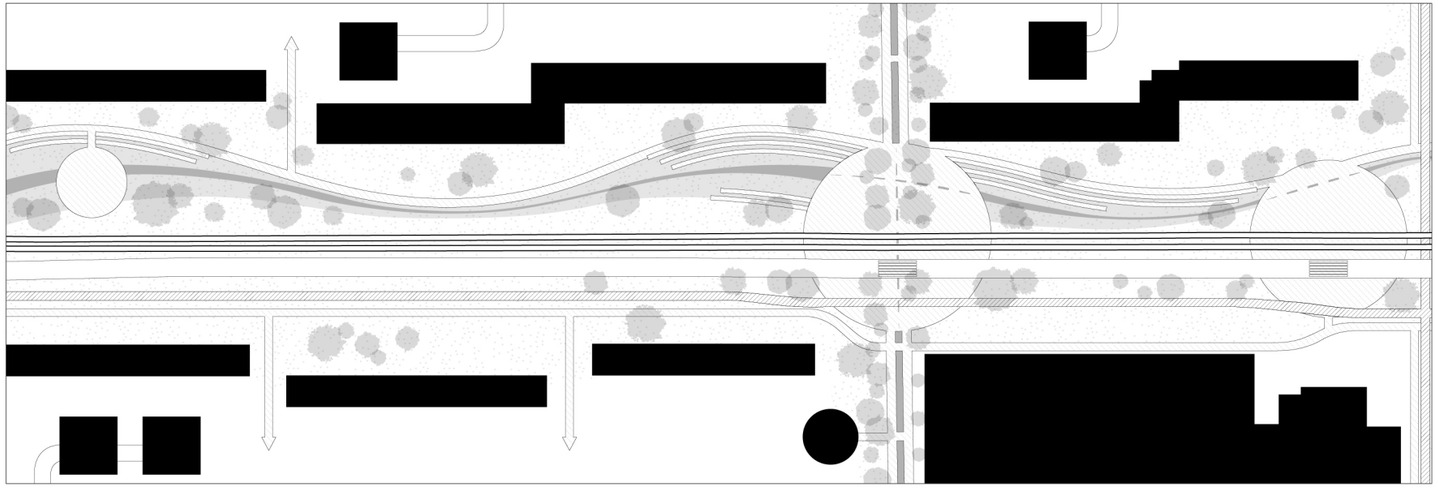
A path along the buffer
Second intervention

The second intervention is to create a path along the water buffer. This includes people in the design and creates a more quiet route to take compared to the old footpaths directly next to the road. It also creates a connection to Transwijk Park.

Emergency water storage
First Intervention

The foundation of this design is the emergency water storage buffer. This buffer is natural in character, making it a more affordable option compared to other types of buffers. By making it the first intervention in the timeline the biggest functionality of the space is eminently fulfilled.





Tram line Road Buildings Green space Permanent water Seasonal water Footpath Bikepath

25 M 50 M

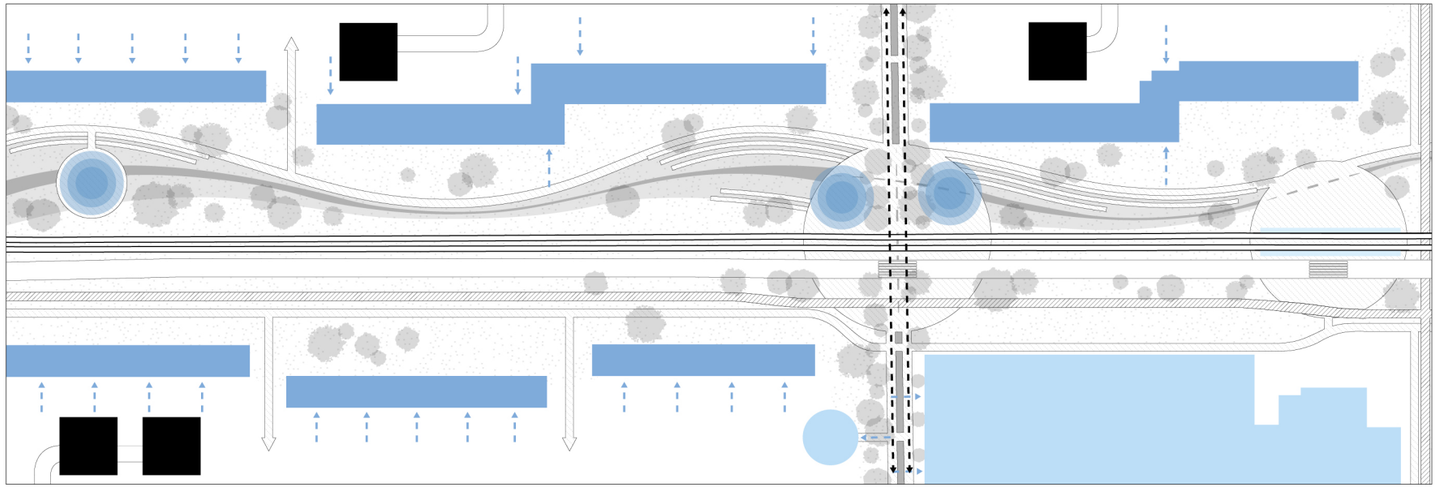
25 M 50 M

The design

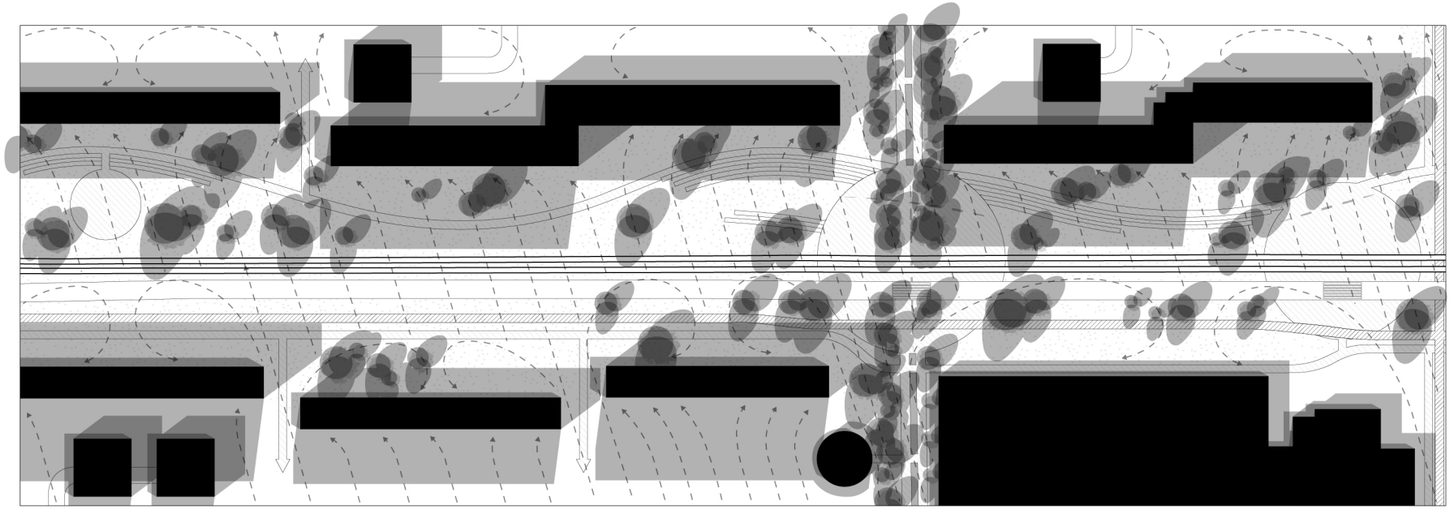
Zooming into a location along the road, the two roads can be seen as well as a smaller road that crosses it. This smaller road is the street along which the social route is situated. Apparent right away is the dominance cars have over this space. In the new design, this dominance is completely flipped, creating a place for inhabitants and visitors to gather along the water with minimal invasion of cars.

The street profile of the social route is changed to slow traffic only, a small canal is added in the middle to store and transport water to and from the area. This street will be well suited for inhabitants to go from their houses to the shops and mosque also situated along the slow traffic street.

The space opened up by removing one of the roads combined with the old grass patches is transformed into a park that winds along the water storage space. Around the crossing and the tram stop, larger public spaces can be found. More flowing and natural shapes are used in the design to convey the idea of moving with the water and nature. Using the water to almost shape the public space surrounding it. Multiple spots along the water provide an opportunity to sit, thus creating a stronger connection between people and the water.



Tram line
Road
Buildings
Green space
Permanent water
Seasonal water
Footpath
Bikepath
Social building (stores, place of worship)
Housing
Entrance
Tramstop
Space for event or pop-up function
Connection housing and shops
25 M
50 M



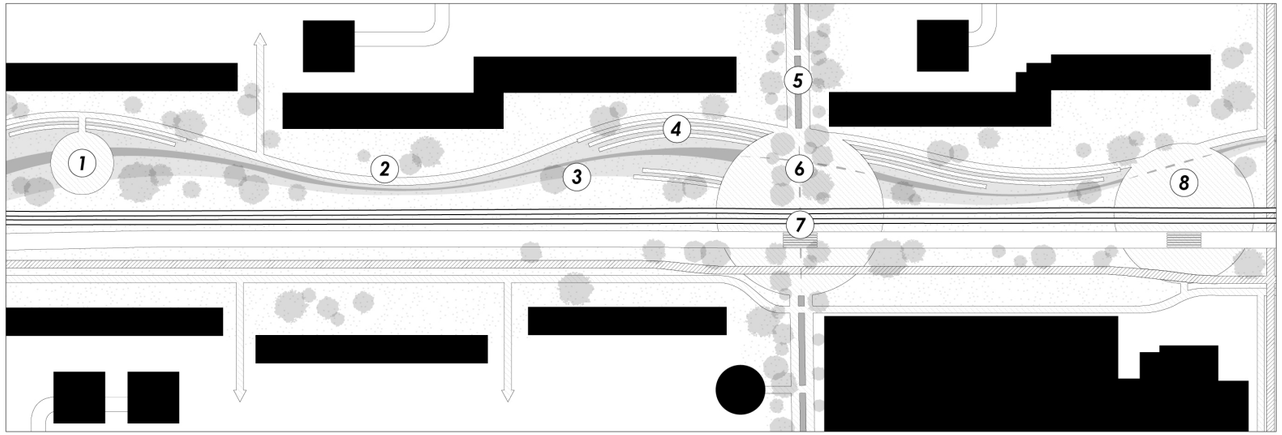
Tram line
Road
Buildings
Green space
Footpath
Bikepath
Schadow (morning, afternoon and evening)
Most likely wind direction
25 M
50 M

Social places and microclimate

Some elements of the microclimate and facilities in the area are important to ensure the space will be well-used and comfortable.

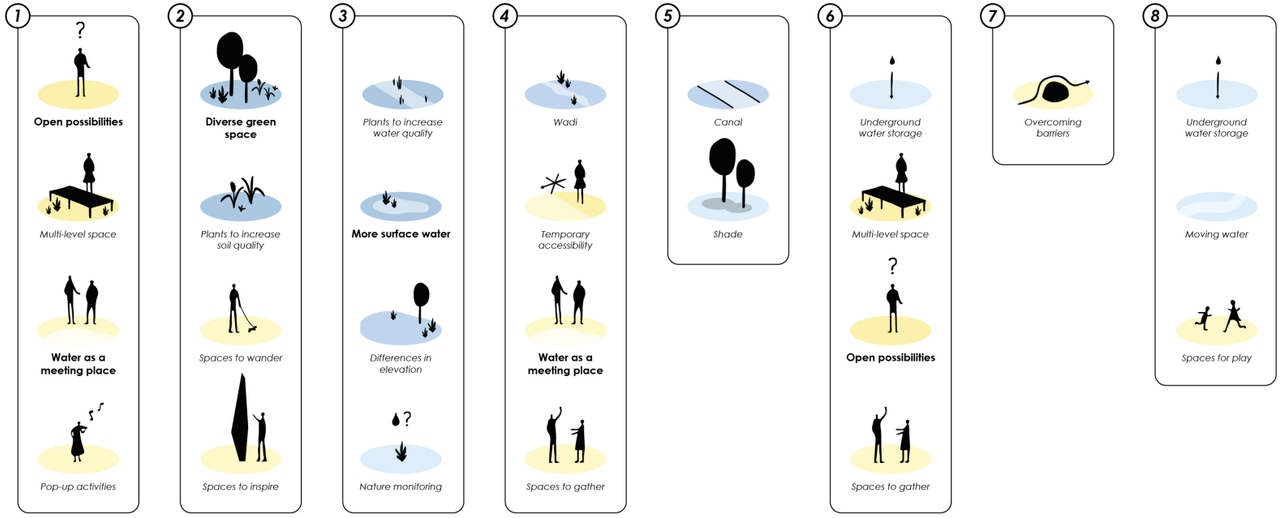
Although some entrances to the buildings are located on the side of the new public space, most housing buildings open up to the other side. This means the public space will also need its own attracting factors to pull surrounding inhabitants towards the space. The renewed slow-traffic street will connect housing blocks directly to the shops and the mosque across the street. This means there will be a natural flow of people coming through this part of the public space. The same can be said for the tram stop, which will also have a natural flow of people coming in and going through the area.

In terms of microclimate, it is important to provide extra cover and shade in places where there is not any shadow present during the morning, afternoon, and evening. Although this cover would be most beneficial during hot weather it can also be useful as a refuge from the rain or to provide some shelter from the wind. In terms of wind, it is important that fumes from cars can be carried away by the wind and that it does not linger in the area due to the covering of trees for example.



Tram line | Road | Buildings | Green space | Permanent water | Seasonal water | Footpath | Bikepath

25 M 50 M



Interventions

Different spots within the location serve different purposes and will be used differently throughout the seasons.

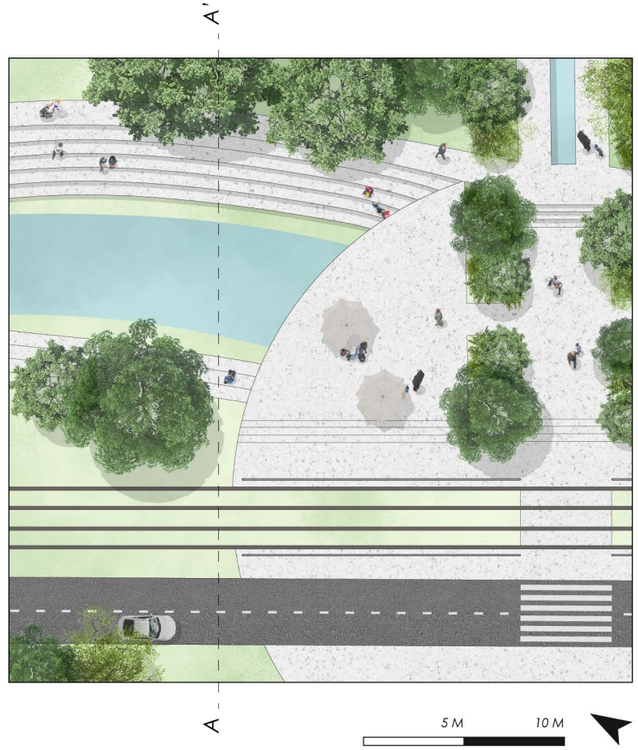
1
The smaller public space along the route is situated above the water storage and is created to be a space with open possibilities. This means it can serve as a space for a small gathering, a sports class, or a small concert. Its design is set up for people to stumble upon and maybe stick around if they see something interesting going on.

2,3,4
Along the route that follows the water storage, multiple interventions are made. Firstly, plant life is diversified with plants that improve water- and/or soil quality. The trees close to the water storage are species that can survive on dry land as well as in the water like willows and alder trees. The route is made to wander along and can also be used as a path with sculptures or temporary art exhibits. Because the route is connected to Transwijk Park, people can extend their walk in the connected green spaces. Along the route are plenty of places to rest in the sun or the shade depending on the weather.

5,7
The slow-traffic street has a canal as well as plenty of trees to cool down pedestrians using it in warm weather. The barrier of the road is reduced by creating a larger pedestrian area around it. Visually this gives pedestrians a clear route to follow and makes car drivers more aware of the upcoming crossing.

6
The square next to the crossing is another versatile space. Due to the higher volume of people walking by it can be a spot for a coffee or ice-cream cart to set up shop during warmer weather. The square has many trees to provide some shade and shelter for people using the space. The trees are also used as an indication of the social route running through it.

8
The final small square near the tram stop has some small fountains for people to cool down around or for children to play in.



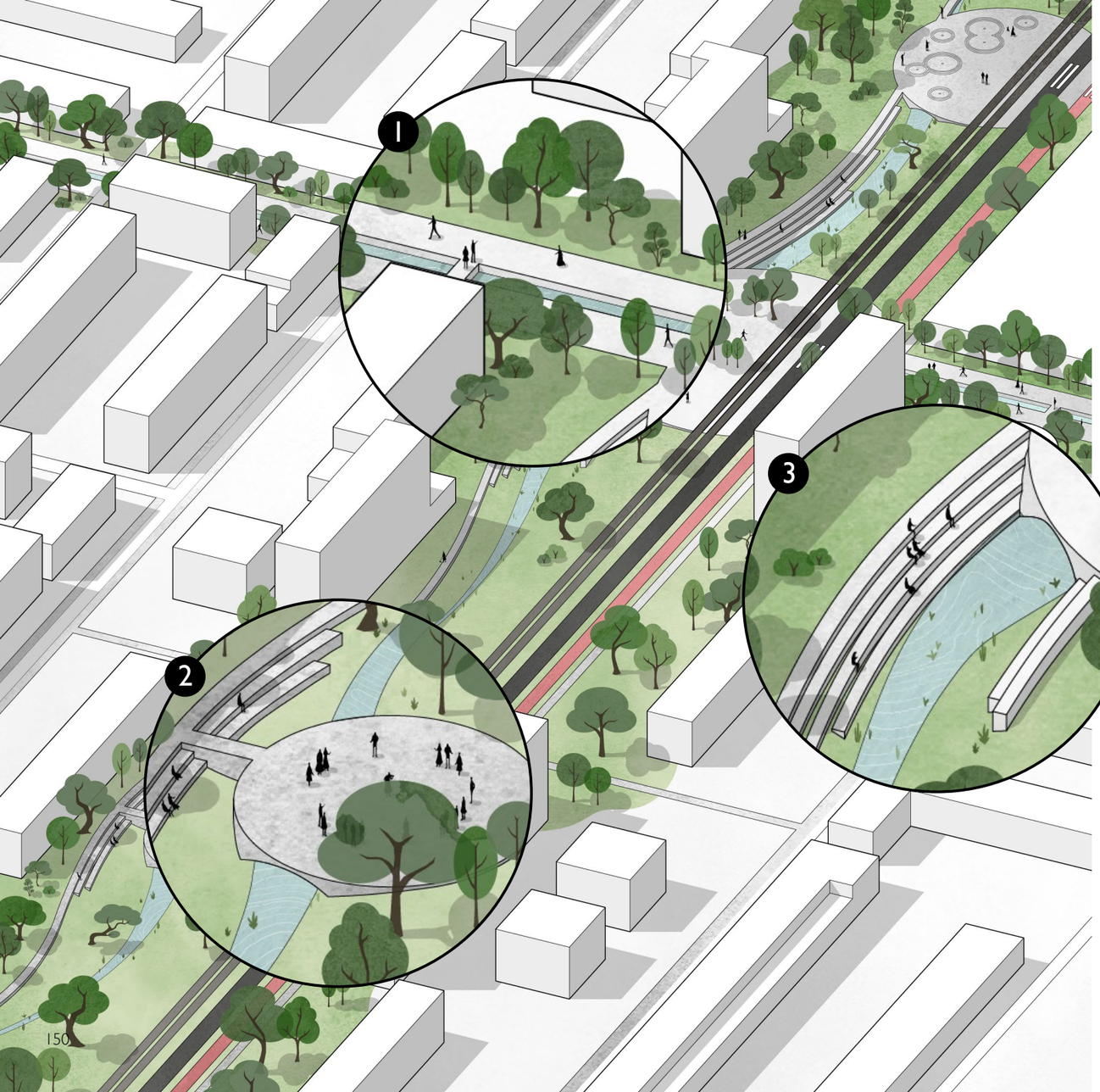
The completed design creates a completely different character for the Beneluxlaan. One with more space for water, nature, and people. The focal point of the avenue shifts from transportation to water.

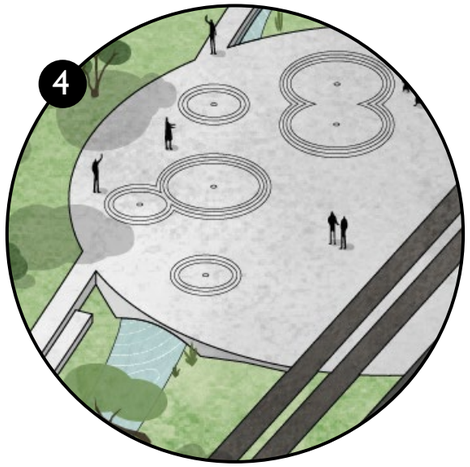
This not only makes sure the surrounding area is better equipped to deal with extreme rainfall, but it also creates a space that can be used and enjoyed by inhabitants and visitors.

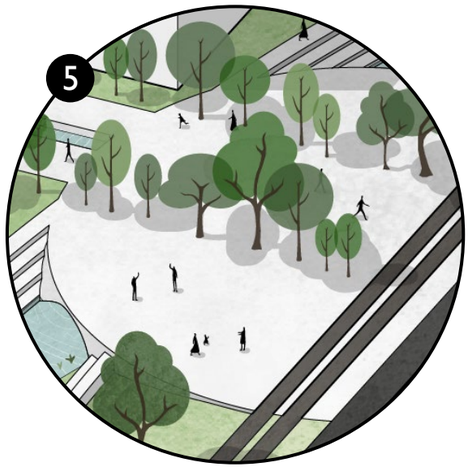
Due to the new connections made for nature, the area increases in ecological value which in turn also brings added benefits to people. Creating a healthier habitat for all.

Everyday

A small stream of water runs along the Beneluxlaan. Some people are having lunch next to the water, in the shade, or the sun. A street performer plays their violin on a small square above the water. People have gathered around to watch them play. Some people in the larger square are meeting after they went to the mosque, they seem to be laughing about something and are planning to go to the shops after. A couple of people can be seen carrying some grocery bags from the supermarket back to their homes along the canal.







Everyday scenario

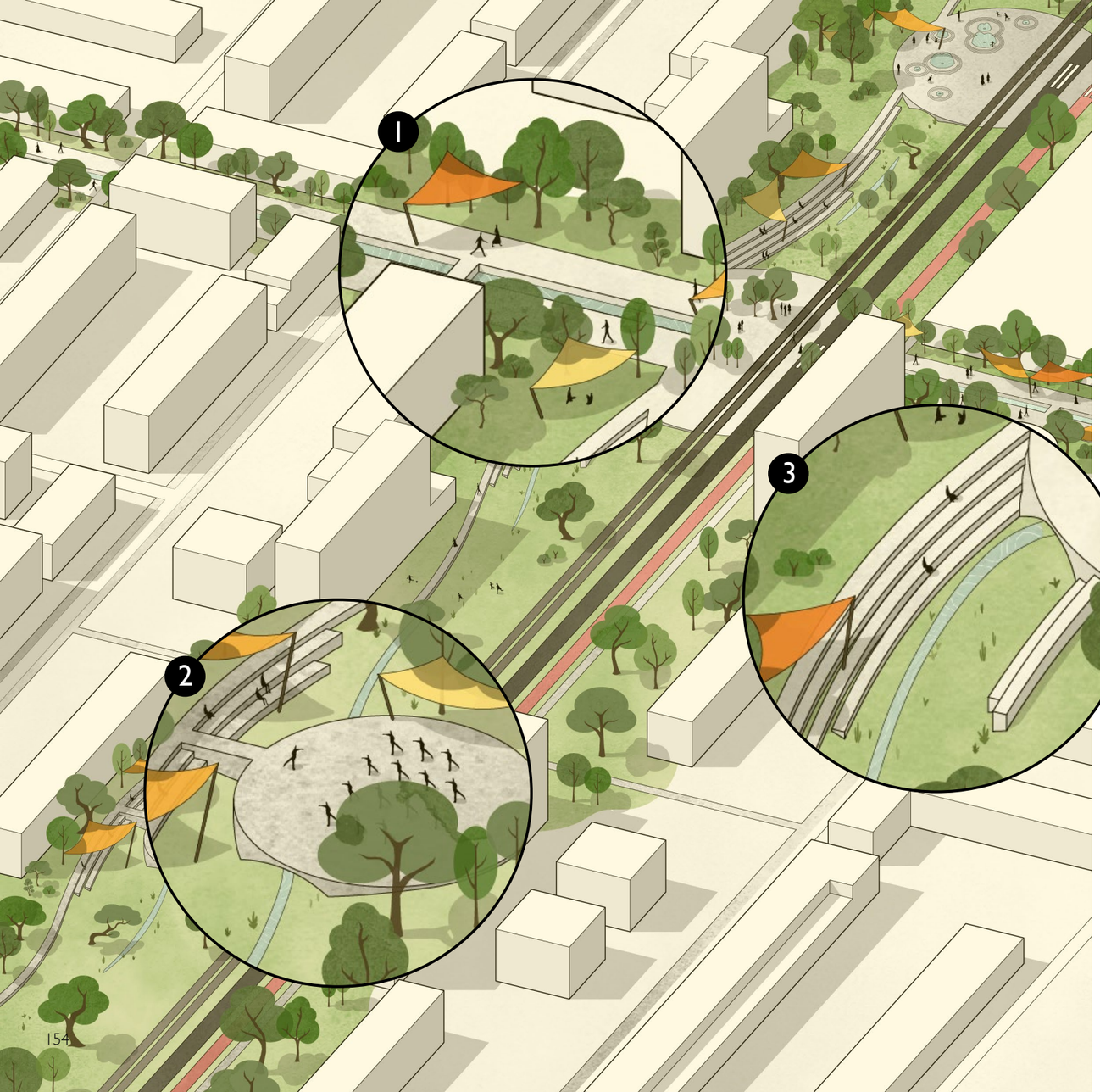
During an everyday scenario, this public space is a place where people can lounge, take a walk, or attend an event. Sitting and relaxing along the water is encouraged with many opportunities to do so in various spots along the large water storage basin.

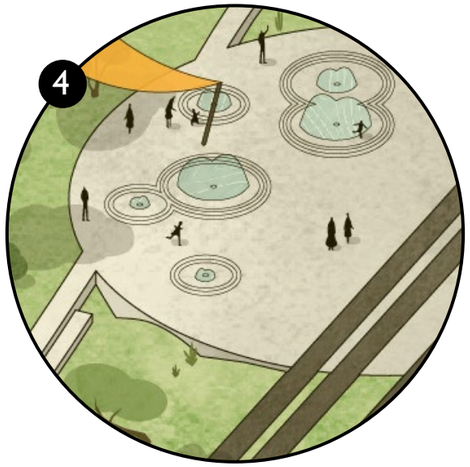
The main features of this space are the larger square through which the social route crosses, a smaller square along the water, and a square next to the tram stop. The social route follows a canal and is guided by rows of trees towards an area with shops and other facilities, making it a useful route for inhabitants to take when doing groceries.

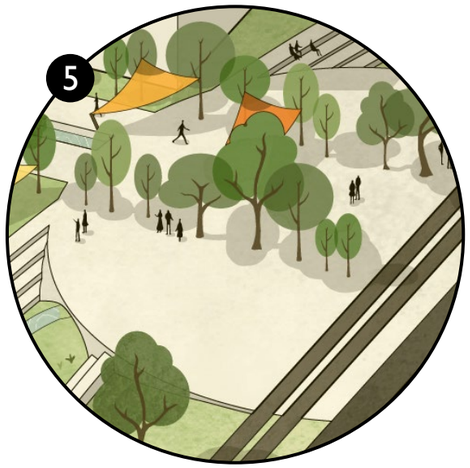
The space is set up to be open, with an appeal to a wide audience of inhabitants and visitors. The path along the water and the different squares can be used in a variety of ways and provides an interesting space to walk through and explore.

Drought

It is a hot day in Utrecht and it hasn't rained in a while. Most of the water storage next to the Beneluxlaan is dried up apart from a few spots. The trees and plants were not doing so well, so a few days ago some water was redirected from the park to revive some of the plants. It seems to have worked as some have perked up already! Most people along the water have found a spot in the shade to cool down and a couple of children are playing in the fountains next to the tram stop. A yoga class is taking place on the small square along the path.





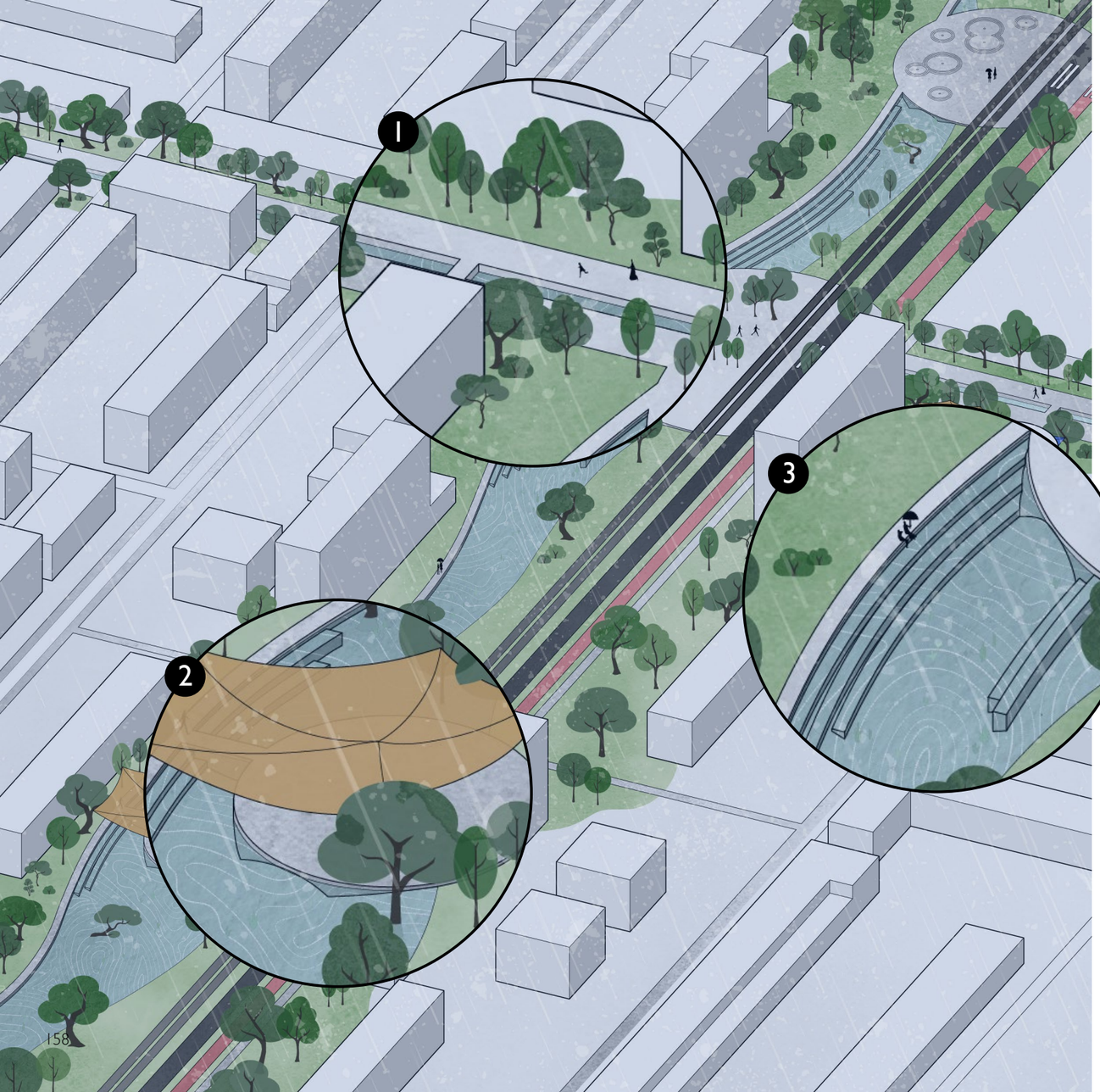


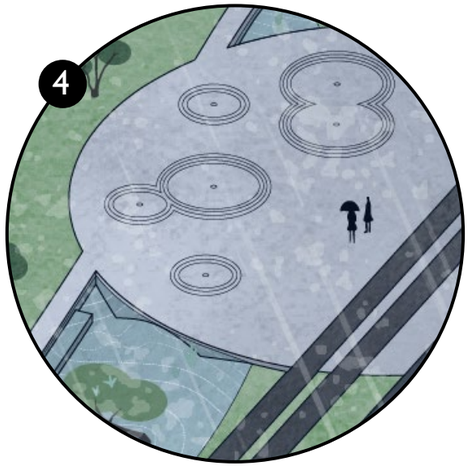
Drought / heat scenario

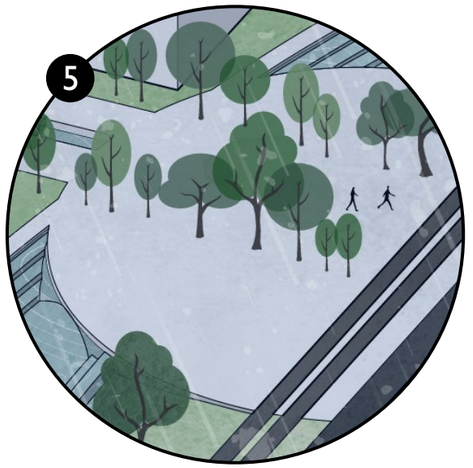
During a warm and dry summer, more people need a space to relax outside, cool down and recreate. In terms of heat, shelter from trees and other coverings help to reduce exposure to direct sunlight for people walking through or staying in the area. The lack of water in the storage space opens up opportunities for people to picnic, play or exercise. Moving water on one of the squares also helps people to deal with the heat. Redirecting water within the neighborhood can make sure that natural spaces are not getting too damaged by the drought. Rainwater that was captured during times with more rain can also be used to irrigate natural areas when they need it. This helps these areas to bounce back quicker after the drought is over.

A Rainy Season

The waterline stops just a few inches below the path. It has been raining heavily for several days now and the water along the Beneluxlaan has been slowly filling up. Not many people are out, but a few have dared to go out with an umbrella to walk their dog or head to the shops. The trees along the street make the rain a bit more bearable. Luckily the ducks seem to be having fun in the water today.







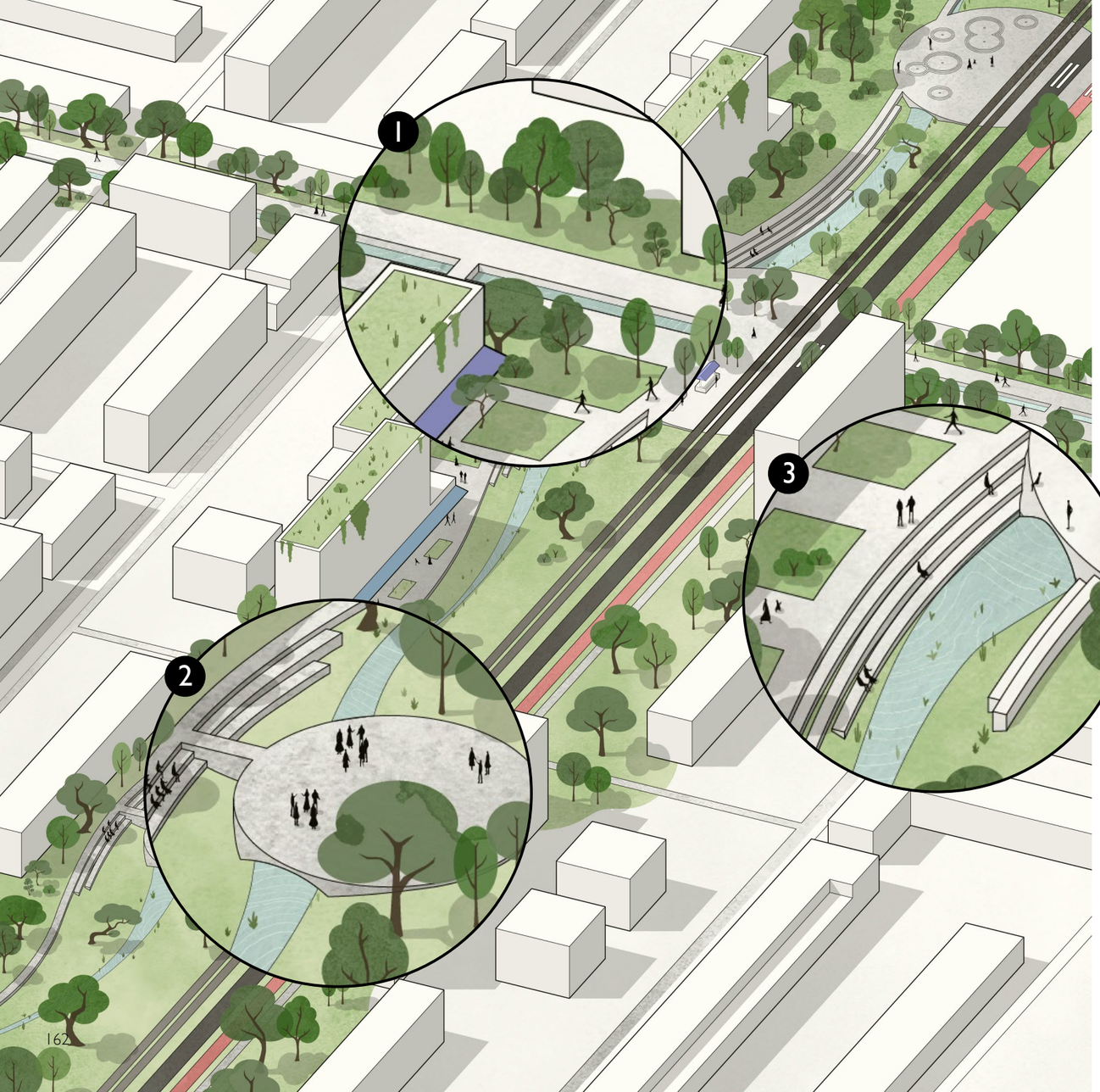
Heavy rain scenario

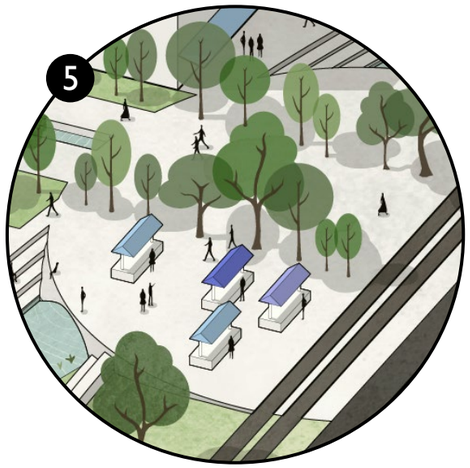
During a time with a lot of rain, the function of this public space shifts from a space primarily for people and their activities to a space primarily for water storage and nature. Less foot traffic will come through the area, although it still retains its function for people walking to a nearby destination or people walking their dogs. Some coverings in strategic places can make sure important events can continue and people still have a sheltered place to stand or sit after, for example, going to the mosque.

As the space is fairly large, the amount of water stored there is substantial. This means that it takes time for the space to switch between the different scenarios. After a rainy couple of days, the space will be filled with water for a while, containing most of the human activity to the main footpath and the squares.

A New Function

The influx of people from the recent densification project meant that the neighborhood needed a few more facilities. Some of those were implemented along the water on the Beneluxlaan. When the apartment buildings were renovated they got a public ground floor that now houses a hairdresser, a gym, a small grocery store, and more. With a few small changes, the new functions were easy to accommodate in the area.





Flexibility scenario

In this scenario, densification projects nearby have increased the demand for facilities in the area. The renovation of buildings along the street opens up an opportunity to adapt the space for a public ground floor in which these extra functions can be housed. This creates an almost boulevard-like structure increasing foot traffic in the area quite drastically. Except for widening some of the paths, these extra functions are easily accommodated in the space. The open space already present can also be used as an extension for some of the shops with market stalls for a local supermarket or a small terrace for a cafe.

This scenario is chosen as it is a reasonably likely one. The densification projects already approved by the municipality are just around the corner from this public place and the flats surrounding it are due for a serious upgrade within the next couple of decades. The function of water storage is a lot more unlikely to drastically change as climate change will not just disappear overnight. Dealing with extra rainwater will need to be done for many decades in the future.

Detailed design Waterfront

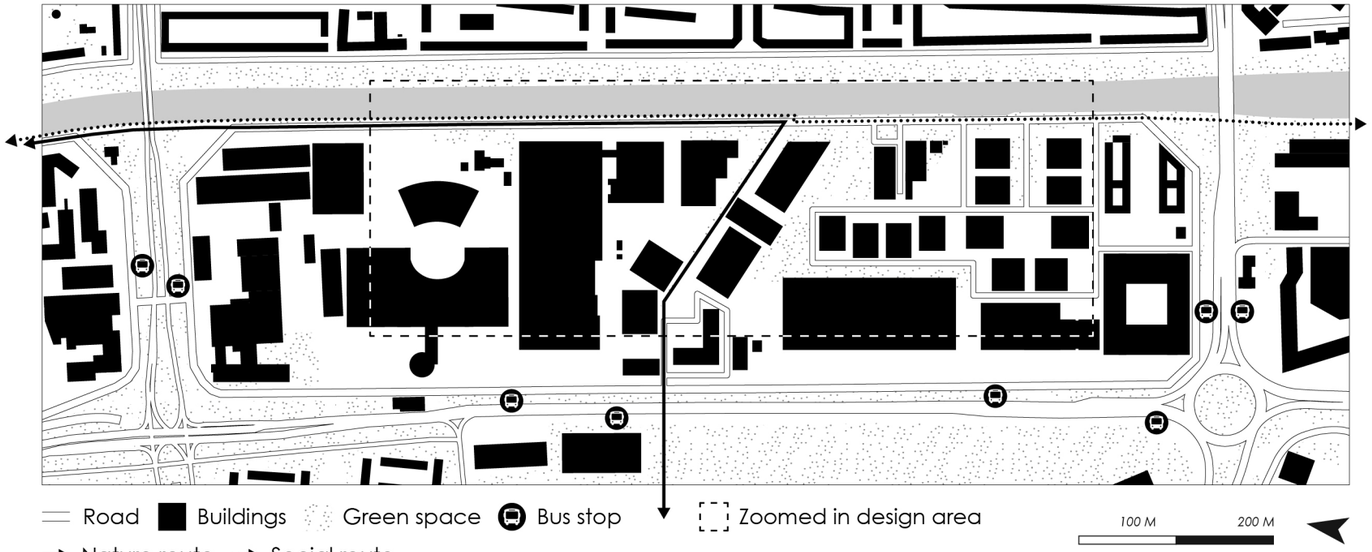
The second zoomed-in design location is the waterfront. This area has other challenges and aims that the previous location with a larger focus on flexibility for the future.

Without intervention

The main use of the canal present at this location is rowing. The canal is also home to some houseboats along the opposite waterfront. The waterside consists of a small strip of grass followed by a bike path and footpath. It does not allow for many plants or animals to settle along the water. Not many opportunities for people to relax along the water exist either.

The main function of the area is to house businesses, warehouses, and offices. Some parts of the area are still in development, which means some offices/ businesses are added to the area in the near future. Further along the canal, some housing is also under construction, adding some more variety in function to an otherwise quite monofunctional area.

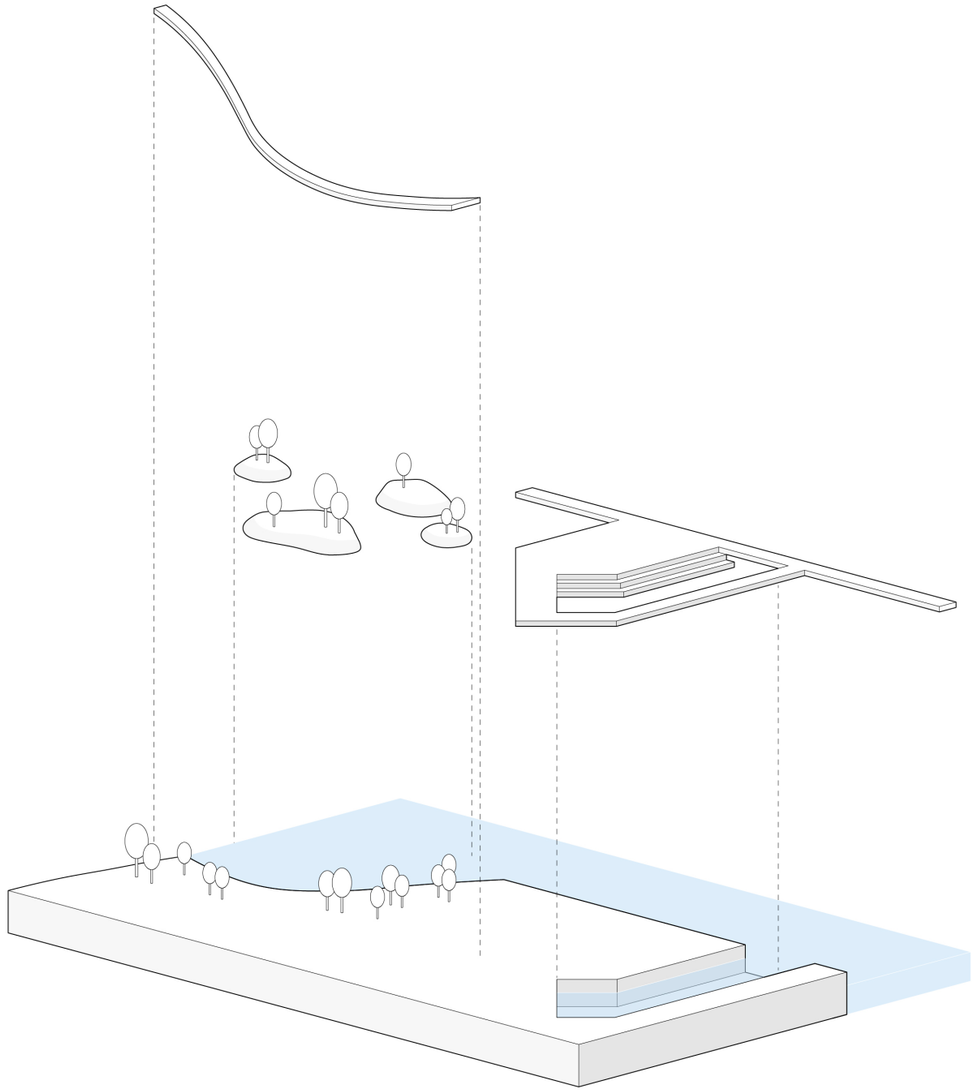
Compared to the western waterfront of Kanaleneiland, this waterfront does not have many features that pull people towards the water.



The location

This location along the coast is home to many larger and smaller businesses and offices. This monofunctional use means the area is not prone to visitors and is not used much outside of office hours. The main feature of the location is the waterfront and the canal. There is however not a strong connection between the buildings and the waterfront as the waterfront itself lacks an attractive place to meet or gather.

The nature route and the social route both pass through this location. They partially overlap creating different types of characters within the location. The northern part of the location is where the social route and natural route overlap. This area is therefore more suited for interventions that are natural in character and promote more quiet types of recreation and activity, like walking. The southern part is part of the social route only and could therefore be busier in character.



Wooden walkway
Third intervention

To give people the opportunity to enjoy the space without intruding too much into the habitat of the animals and plant life a wooden walkway is created along the natural water edge.

Ecological islands
Second intervention

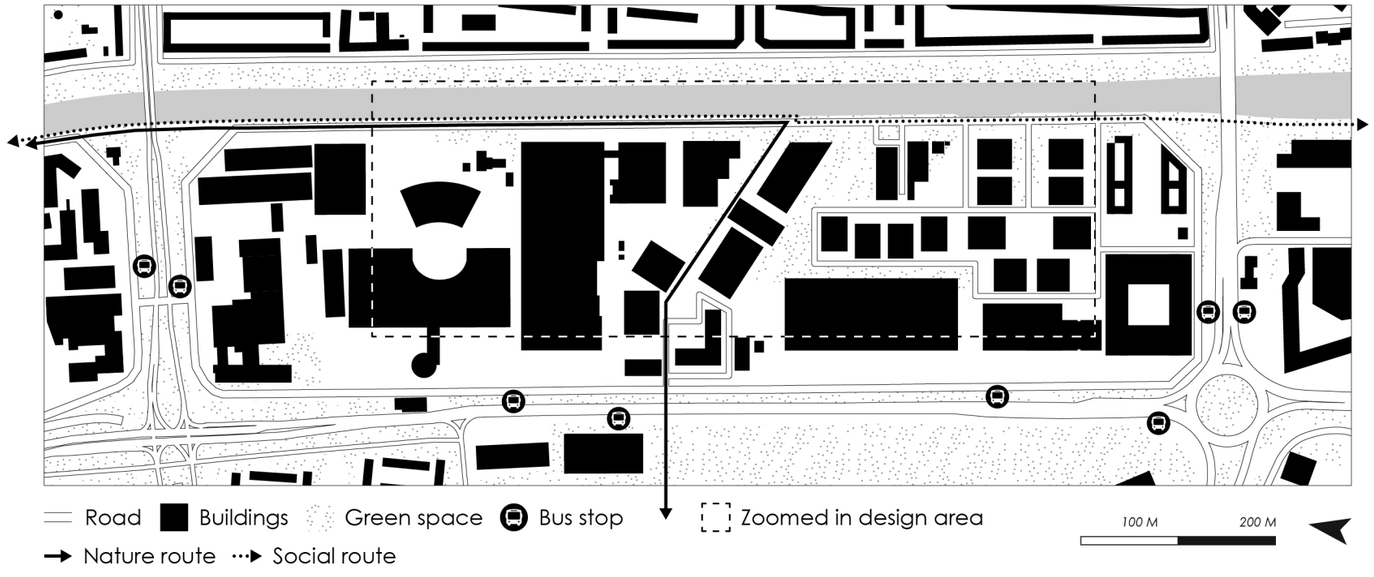
To increase the ecological value of the area further, small islands are created in front of the new water's edge. They serve to mellow out some waves made by rowers and create spaces for waterbirds to nest in a space that is inaccessible by people.

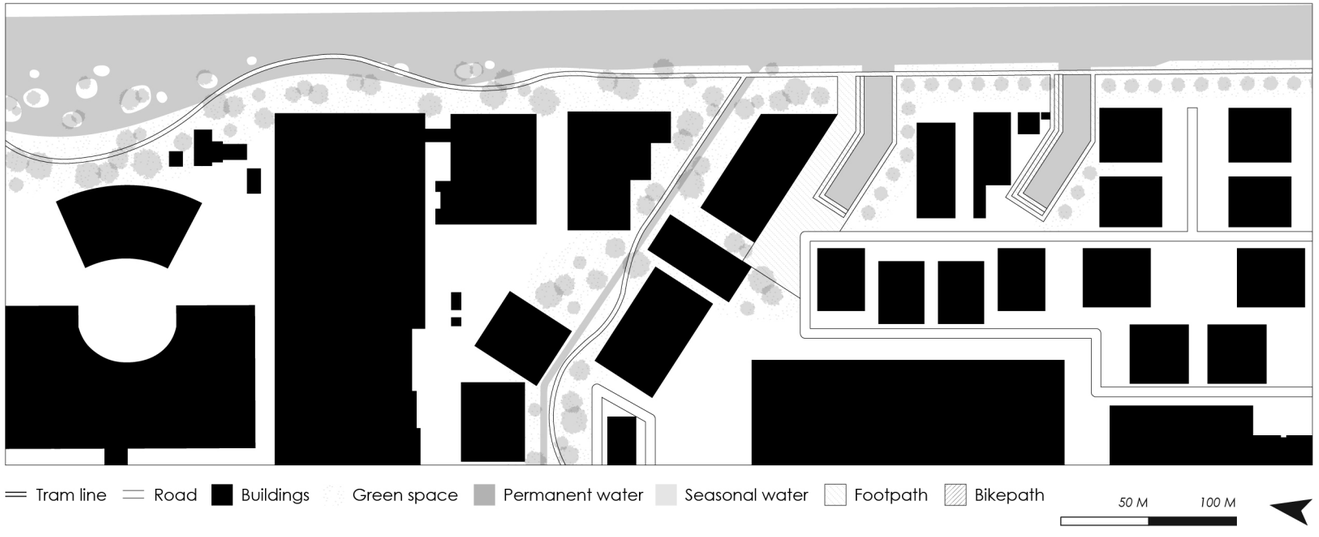
Waterfront public space
Fourth intervention

As a final intervention on the timeline, a new public waterfront is created which includes a cove in the waterfront. The main aim of this space is to create a well-functioning public space with high flexibility for the future. Initially, the function of the space will be a social space along the water. The space is however suited to be converted to either a dock for boats to load and unload goods or a more recreational dock for rowboats and canoes. If in the future the need arises to convert the space to more of an industrial area, this is possible with limited intervention. If the municipality wants to increase the recreational character of the area, this is again possible with very limited intervention.

A new edge
First Intervention

At the base of this design lays the creation of a natural water's edge. This not only creates a more suitable environment for different types of water plants and waterbirds, but it also creates an interesting space for people to wander through.



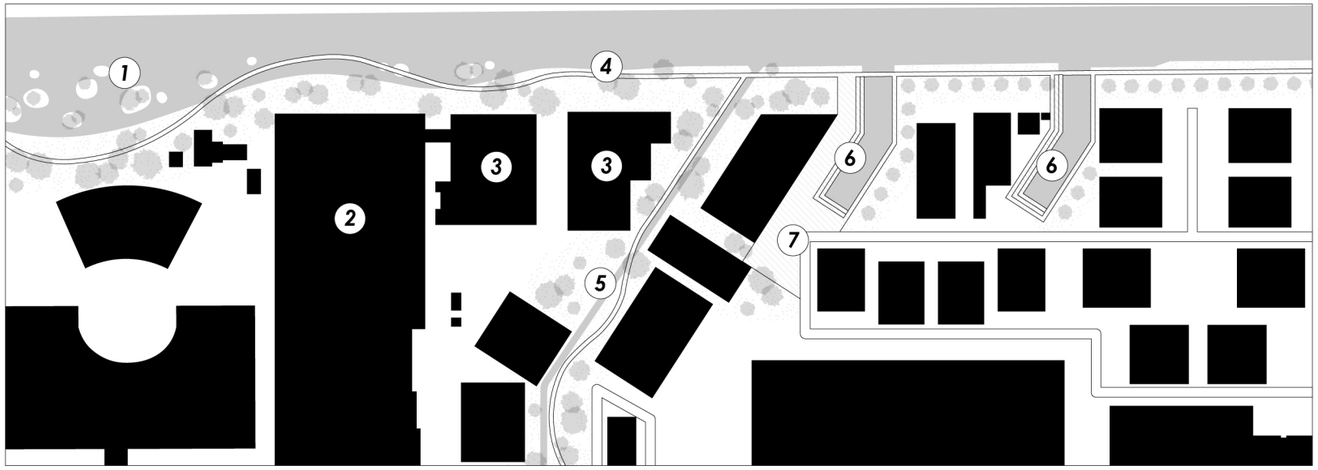


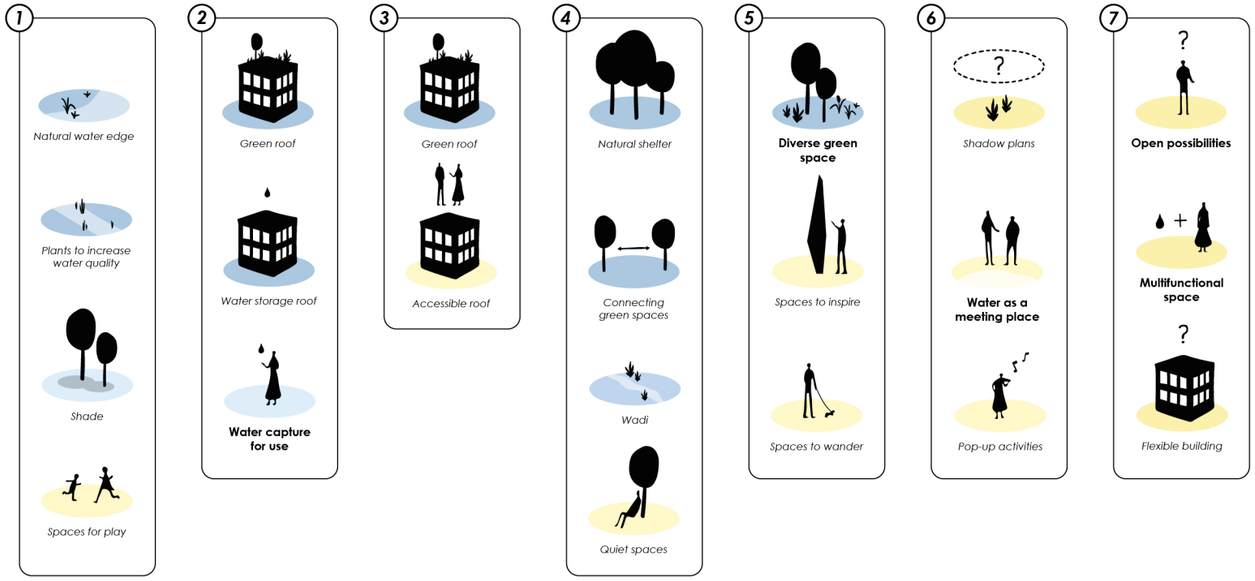
The design

The different elements together form the following design. A more rigid waterfront can be seen to the south, while the northern part of the location is home to the natural edge. This also correlates to the different routes that are part of the waterfront.

The nature route cuts back into the neighborhood, creating a connection to Transwijk Park and alleviating some heat stress for the surrounding area.

The coves are the most drastic intervention that creates a completely new space along the water for people to gather and socialize. The municipality of Utrecht has expressed the possibility of a clean makers industry returning to this area in the future, making these coves very useful for the transport of goods. On the other hand, the municipality has also expressed wanting to increase opportunities to recreate and relax along water. In this scenario, these coves can also serve a very useful purpose.





Interventions

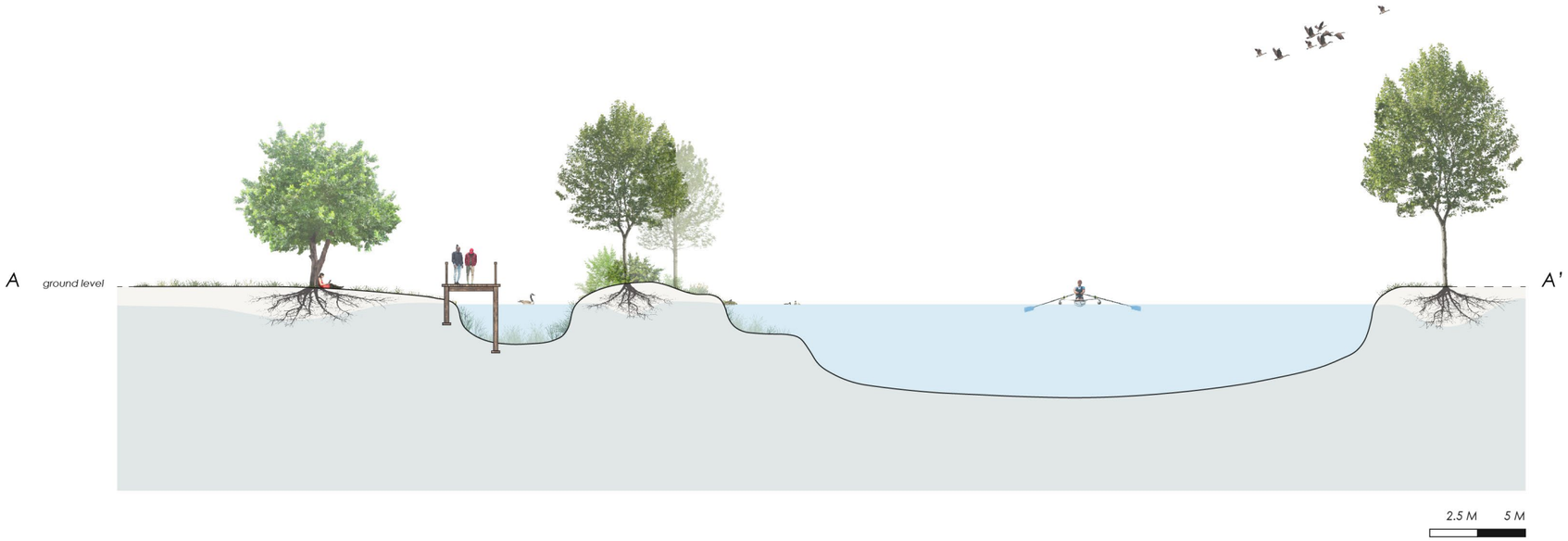
The different waterfront characters are reflected in the interventions that are applied to the locations, with the northern part having more climate-adaptive and natural elements while the southern side has more social interventions applied.

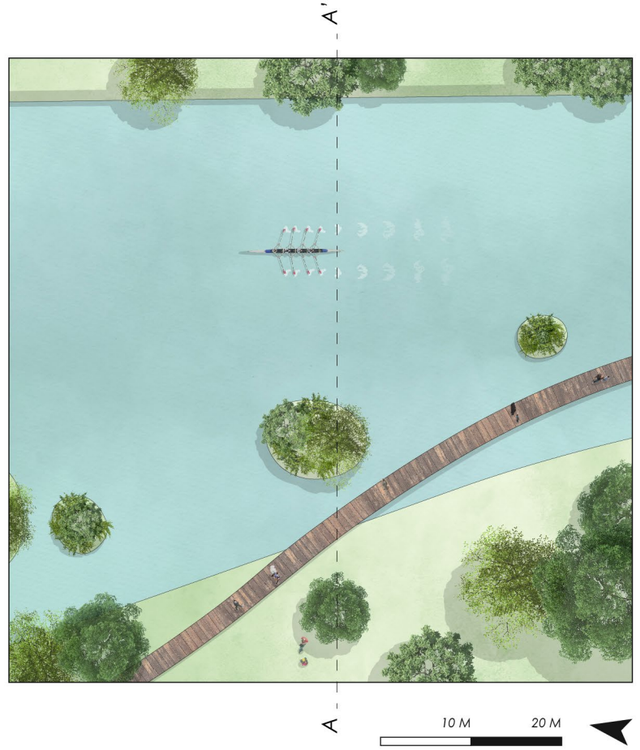
1,4
These locations are part of the natural edge and the main interventions are focused on creating a space for people, animals, and plants with natural elements.

2,3
Since this location is home to a few bigger businesses and warehouses, there are opportunities for the roof spaces to be used as a green/blue roof or for the roof space to be an extension of the public space below.

5
This location serves as a connection between the waterfront and Transwijk Park. It has a more natural and quiet character. It also serves as an extra link between the waterfront and the rest of the neighborhood.

6,7
More social interventions and functions can be found at these locations. They serve as a public space for inhabitants and visitors and aim to connect people with the water.





The design results in a more attractive waterfront that is higher in ecological value and brings people from the surrounding area toward the water. The function of recreation and sports is still present while also bringing a more quiet and nature-centered character to the area.

Bringing nature to the forefront creates an opportunity for people to take a break and have a walk along the water while also allowing of undisturbed pieces of nature to exist.

Detailed design Industrial Oasis

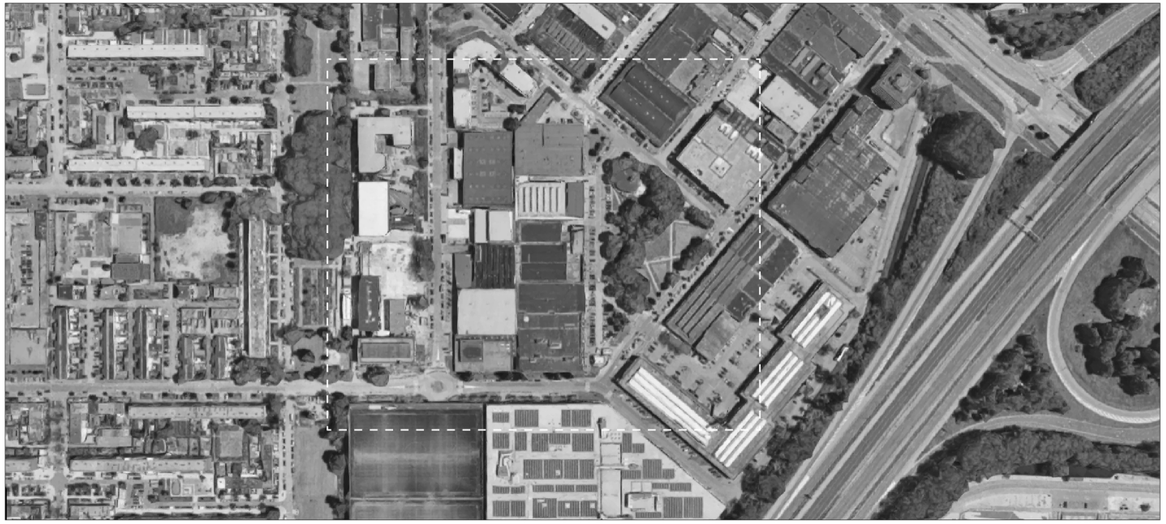
The third and last zoomed-in design location is located in an area of the neighborhood with large commercial functions that currently deals a lot with heat stress. Within the routes, it is part of the Industrial oasis character.

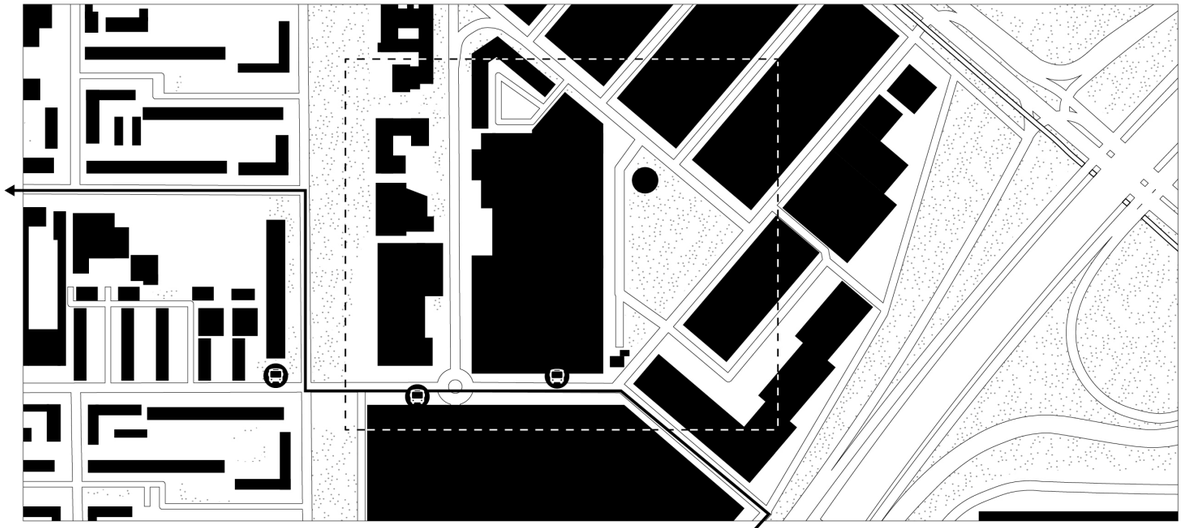
Without intervention

This location is home to many larger commercial functions like hardware stores and furniture stores. Due to the presence of these functions, cars completely dominate this part of the neighborhood, leading to a high amount of paved surfaces and a lot of heat stress. A small park is present in the area, but it is not used very often. This could partially be due to people traveling by car directly to their destination, which leads to low foot traffic in the area.

The location is also home to many buildings with flat roofs. Some are used for energy production through solar panels, but others go unused. The flat, often dark, roofs only add to the heat stress problem.

The high amount of paved surfaces also poses a threat when it comes to heavy rain, as there are few opportunities for rainwater to infiltrate.

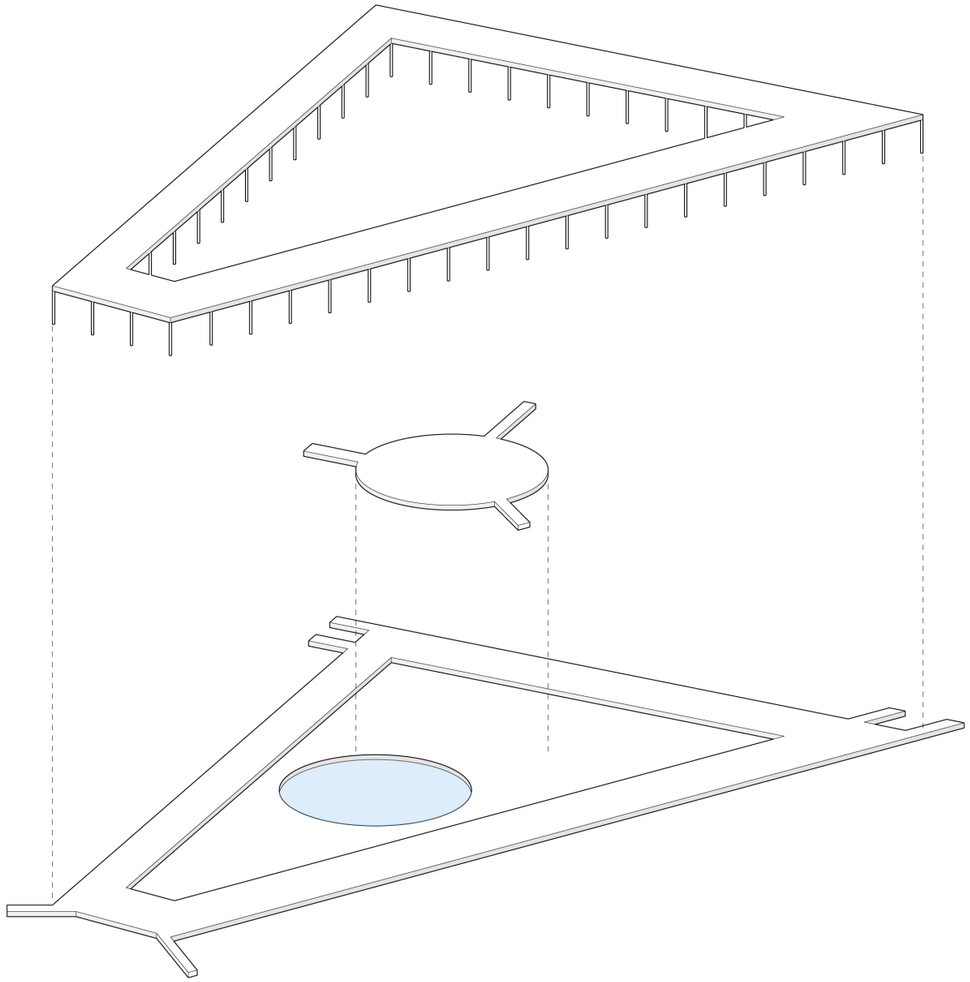




The location

The location is an industrial/commercial area that is wedged in between an area with mostly housing and a highway. The space is heavily built up and the buildings cover a large percentage of the surface. These attributes make the location especially vulnerable to heat stress and heavy rain. It also makes it more difficult to intervene, as there is little open space left.

In the center of a few large buildings, a small park is present which also houses a small café. The park however is not visited a lot. The space is not particularly welcoming to pedestrians or even cyclists, and most people enter the area by car.



Roof space
Second intervention

To relieve the most important issues of this location it is important to use part of the roof space to capture water and increase green. Due to limited space, it is essential to use the roofs as a means to implement interventions.

Shaded walkway
Fourth intervention

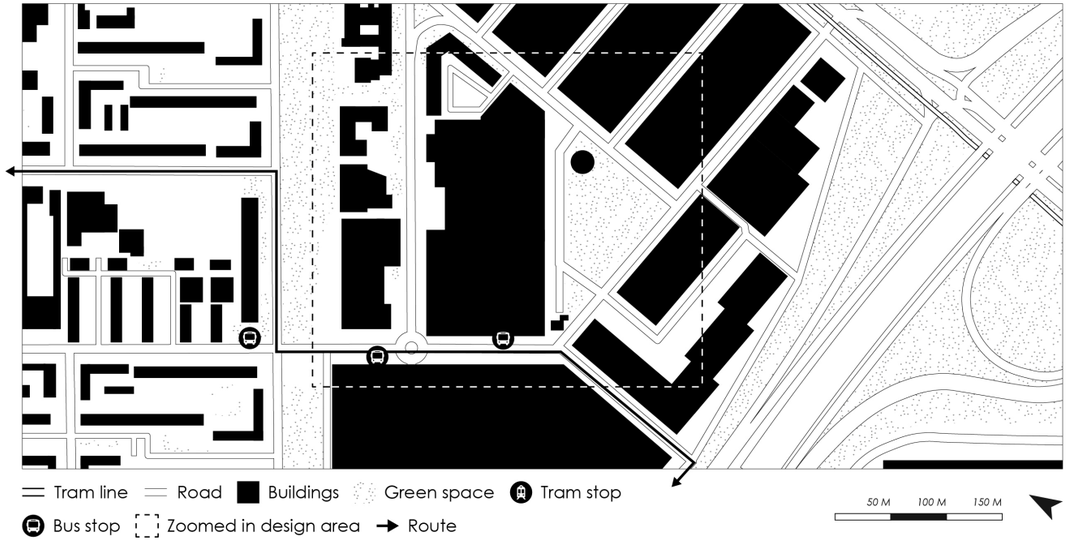
The shaded walkway greatly increases comfort for people visiting the area, especially on hot summer days and during rainfall. The walkway also creates a more gentle transition from the inside of the stores to the public space outside.

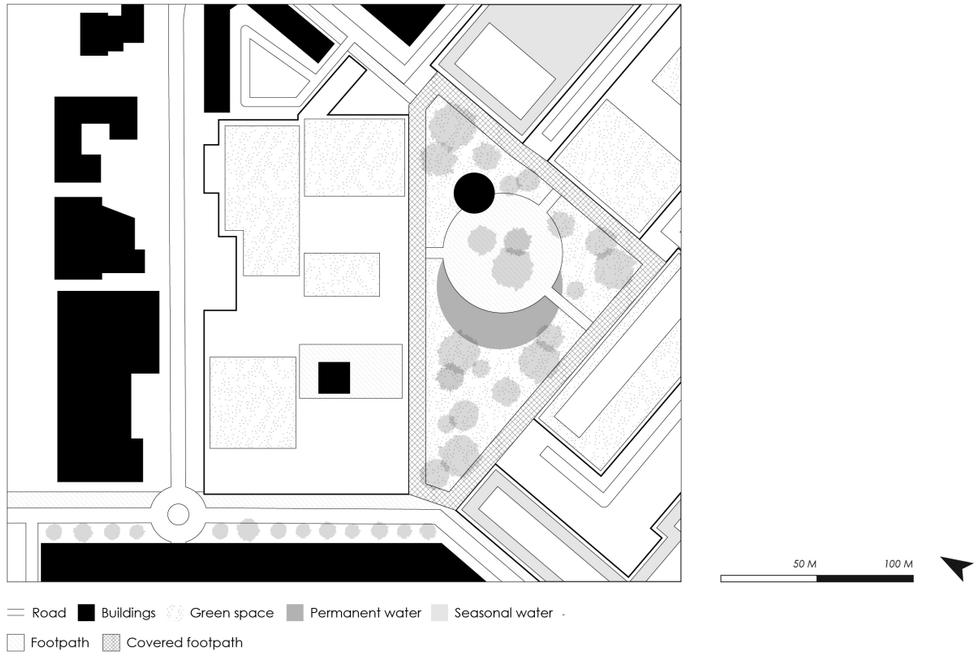
Square
Third intervention

Within the park, a square is added to create a meeting place around the water and the already present café.

Slow traffic and water
First Intervention

The very first intervention is to redevelop the space around the park as a pedestrian-only area. The park itself is also diversified and a natural water buffer becomes a central element of the space.

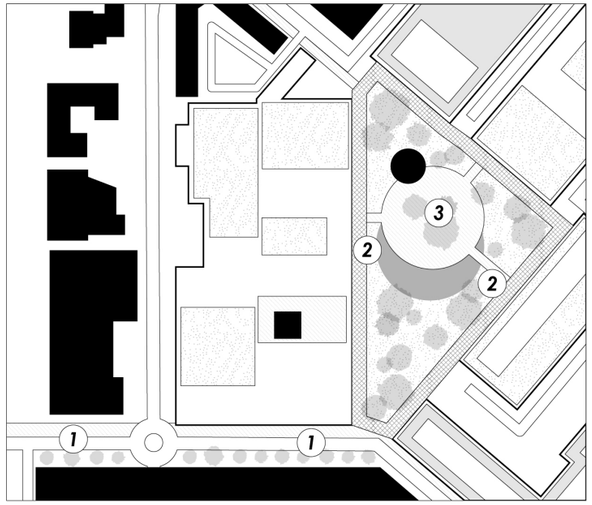




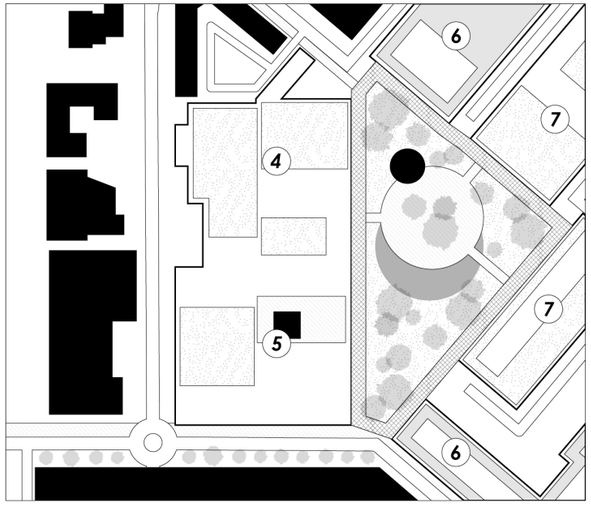
The design

All elements together form the following design. The design is situated on two levels; the ground level and the roofs. The roof spaces are transformed from a flat dark surface to water storage and green spaces, while the ground floor focuses more on people. The park is diversified in plant life and an element of water is added. The park is also connected to the nature route, creating a connection with other green areas.

Comfort is a high priority for this location as it deals with heat stress. This means a shaded walkway is created to shield people, while also adding natural shelter in the form of trees.



Road Buildings Green space Permanent water Seasonal water
Footpath Covered footpath



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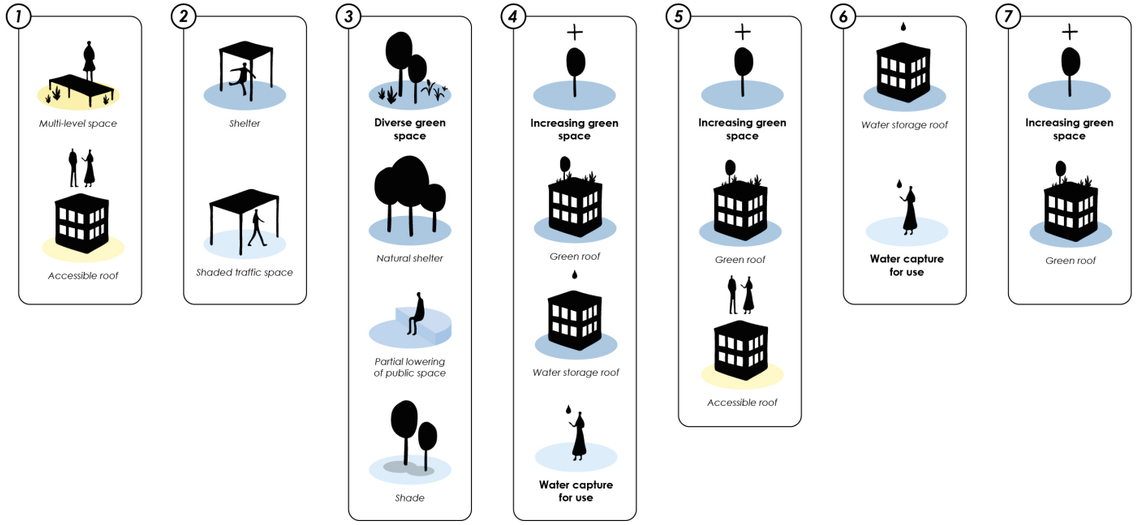


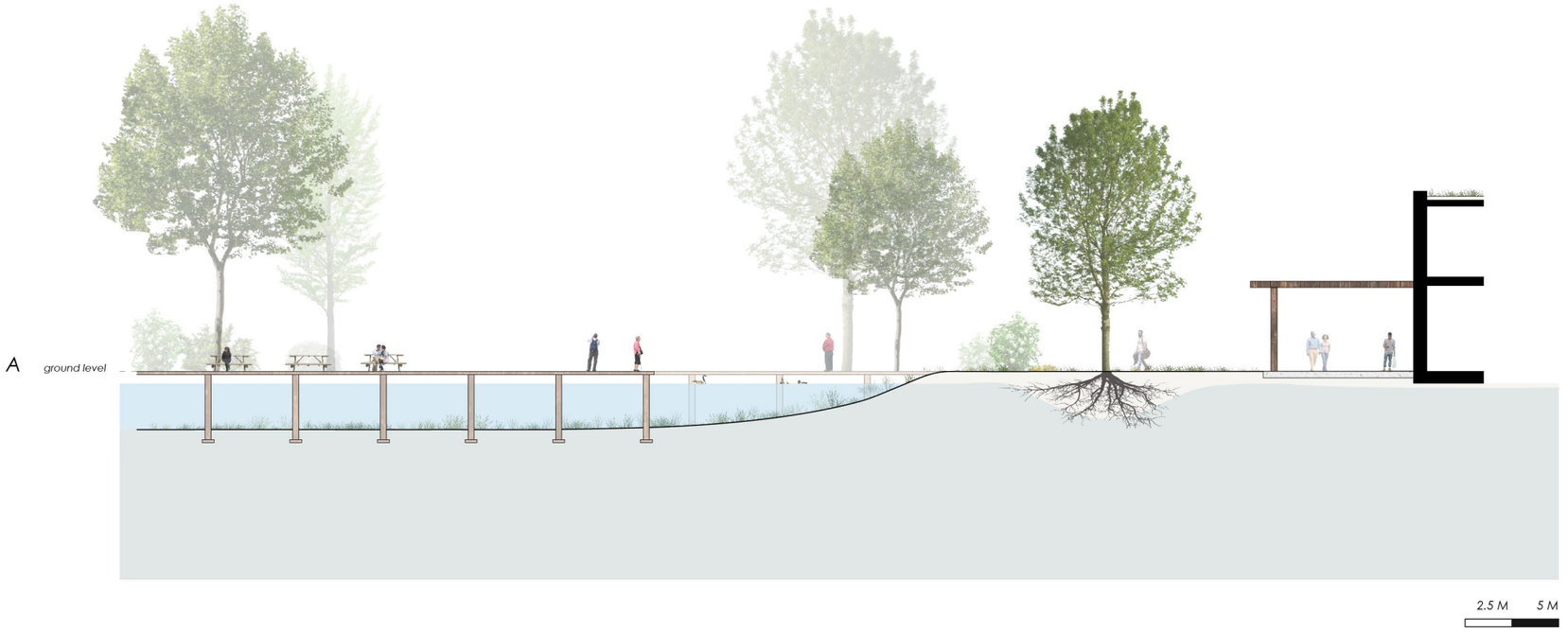
Interventions

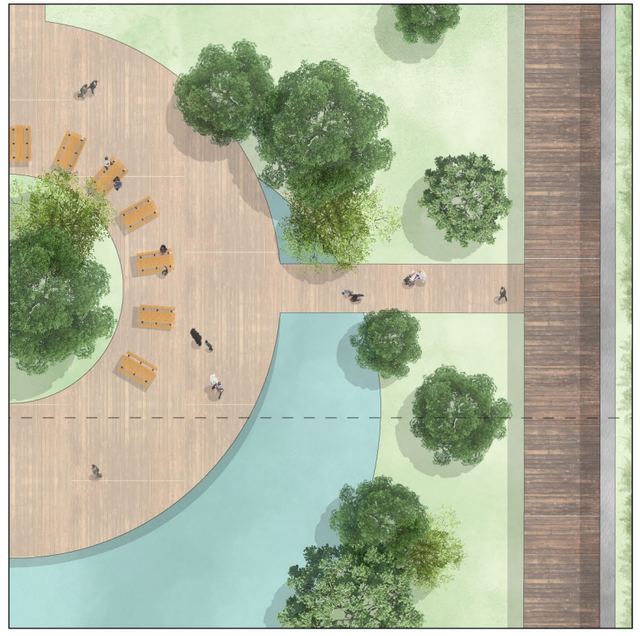
To achieve the desired goals, different interventions are implemented throughout the location.

1
The road that is part of the nature route is transformed to create a more pedestrian-friendly road with green strips alongside it. This route is connected to the small park that is present in this location.

2,3
The park itself is transformed with climate adaptive measures to create more comfort for visitors and to build a more interesting space to visit and stay.

4,5,6,7
The roofs are mainly used for climate adaptive measures like capturing water and increasing green. One of the roofs is also made accessible for people to look out over the transformed roofscape.





In this new design for the area, more space is made for nature, water, and people. Comfort is a high priority with multiple places to seek shelter from the elements.

This new design gives visitors and employees an escape from the heat and a place to meet. It also has the ability to have a positive effect on the surrounding businesses. Instead of parking right in front of the door of the place people came for, people will pass some other stores on foot on the way there. This creates a space that is more akin to a shopping street than an industrial area that also happens to house some commercial functions.


SWISS
BOXSPRINGS

Evaluation

Scenario assessment

To evaluate how the design functions and how the design functions within the different scenarios, it is important to look back on the four main goals that the design wants to accomplish. What is important per goal is laid out below. All subgoals directly flow from the biggest issues currently present in the two neighborhoods. An example of this can be seen within the 'creating social spaces' category. At the moment one of the big issues in the neighborhoods of Kanaleneiland and Transwijk is the dominance cars have over slow traffic and the space they take up compared to how much space social spaces take up. Therefore extra importance is placed on prioritizing slow traffic within newly created spaces and this is directly reflected in the assessment criteria.

Dealing with heavy rain

Capacity to store rainwater
low score (1) The space stores less water than would fall within the area during a 100 mm downpour
medium score (3) The space stores as much water as would fall within the area during a 100 mm downpour
high score (5) The space stores more water than would fall within the area during a 100 mm downpour

Percentage of water that infiltrates
low score (1) No changes compared to the old situation
medium score (3) Increased infiltration compared to the old situation
high score (5) Rainwater is kept out of the sewer system completely

The comfort of people during rain
low score (1) There are no spaces for people to take cover and the space is almost unusable for people during rain
medium score (3) Some cover is provided for people and trees along paths shield some of the rain
high score (5) Slow traffic is shielded completely from rain, public space is at least partly covered to be used during rain

Dealing with drought and heat

Capacity to capture rainwater for later use
low score (1) No extra capture is implemented
medium score (3) Some water is captured for use in the public space like fountains, watering plants, or irrigating green roofs and facades
high score (5) Capturing and re-using water is completely integrated in the space and captured water can be used outside and in buildings for multiple uses.

Green space
low score (1) No significant changes compared to the old situation
medium score (3) Built-up spaces are converted to green areas with more variety and extra surface water as well
high score (5) A large area is converted from built-up space to green space, the green space is diverse in nature and connected to a larger network

The comfort of people during drought/heat
low score (1) Not a lot of shade or shelter is present, there is not a lot of green space in the area
medium score (3) Trees or covers provide some shade for people and more green spaces are introduced to cool down the area
high score (5) The space is full of green and water, there are plenty of places to stay and walk in the shade, and moving water provides an opportunity for people to cool down

Increasing flexibility

Multifunctionality
low score (1) The space is monofunctional
medium score (3) The space fulfills more than one function
high score (5) The space has a lot of open possibilities and can be used by many people or for different things at the same time

Versatility
low score (1) When the space does not fulfill its primary function, it is not very much used
medium score (3) With some work to switch between functions the space can be used to fulfill different purposes at different times
high score (5) The space provides an opportunity for many different types of events and activities to take place without many changes

Capacity to deal with change
low score (1) In case of a drastic change of function for the area, the space needs to be completely redesigned to function properly
medium score (3) To adapt to a new function some work is involved, but large elements of the space can be reused and quickly adapted
high score (5) With some small changes the space can be reorganized to fulfill a completely different purpose

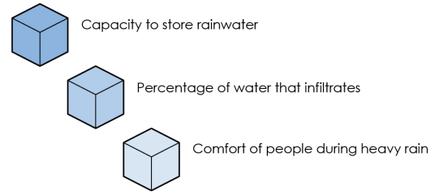
Creating social spaces

Inclusivity
low score (1) The space only caters to the needs of a specific group
medium score (3) The space caters to multiple different groups of people
high score (5) Most people within the neighborhood can relate to and find something they like within the space. It can bring neighbors who do not have a lot in common together

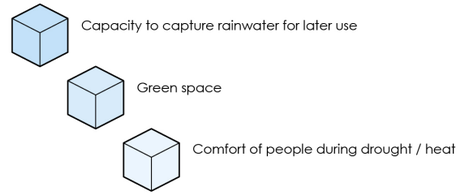
Mobility
low score (1) The space is car dominant and there are many barriers for slow traffic
medium score (3) Cars and slow traffic are mostly separated
high score (5) The space caters completely to slow traffic with no interference from cars

Comfort and aesthetics
low score (1) There is a lack of variety in the space, there are no particular elements that can pull people towards the space, and the space is disconnected from other public space
medium score (3) There are opportunities to sit and gather and the space has a lot of natural elements or water elements
high score (5) There are many places to sit, gather and enjoy the space, there is a large variety of green space, and there are opportunities to gather around the water. The space is large and connects to a larger network people can walk around in and explore.

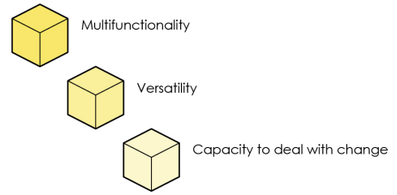
Dealing with heavy rain



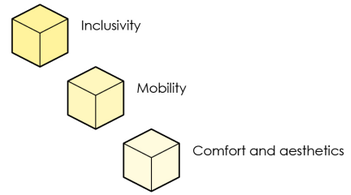
Dealing with drought and heat



Increasing flexibility



Creating social spaces



Design 1

48

Dealing with heavy rain

- Increase capacity to store rainwater — 5
- Increase infiltration — 5
- Increase comfort of people during heavy rain — 3

13

Dealing with drought and heat

- Increase capacity to capture rainwater for later use — 3
- Increase and diversify green space — 3
- Increase comfort of people during drought / heat — 5

11

Increasing flexibility

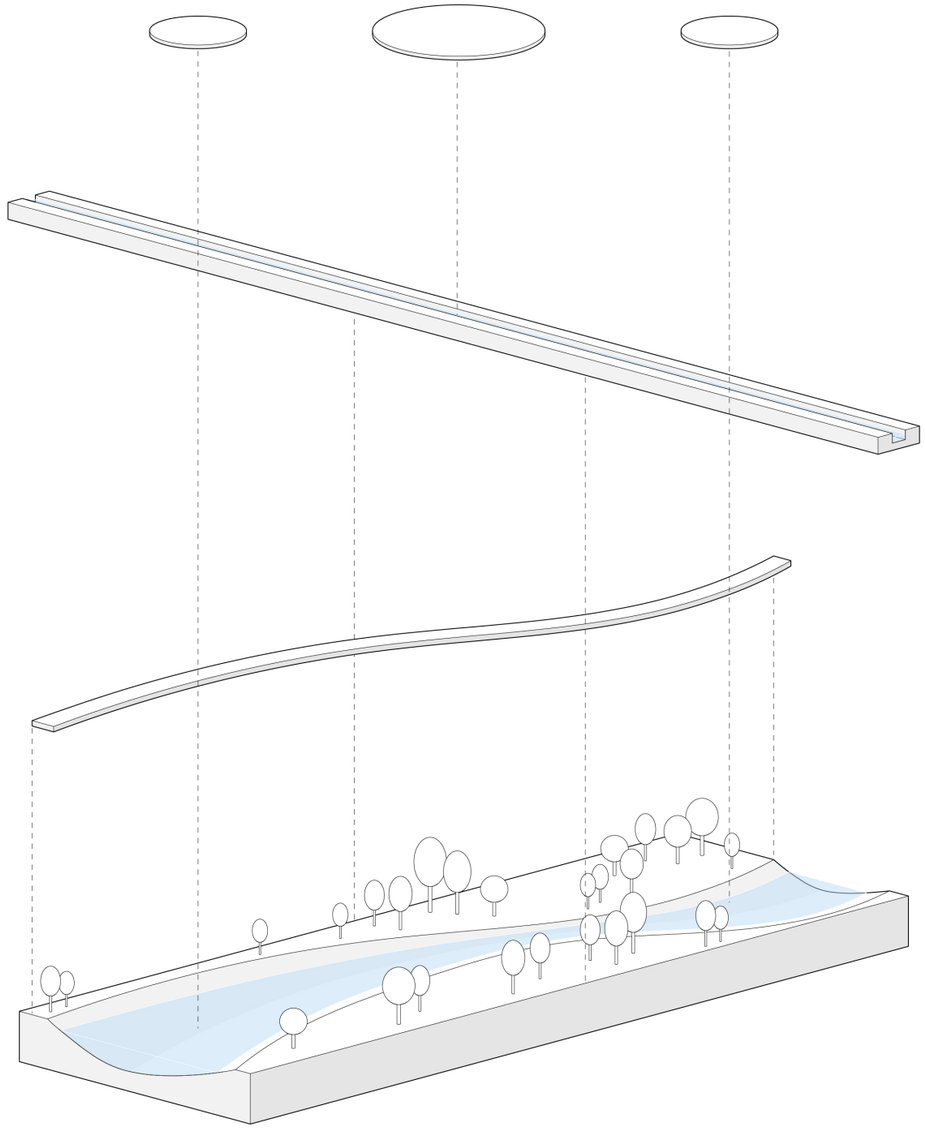
- Increase multifunctionality — 3
- Increase versatility — 5
- Increase capacity to deal with change — 3

11

Creating social spaces

- Create more inclusive spaces — 5
- Increase mobility for slow traffic — 3
- Create comfortable and attractive public space — 5

13



Design 2

48

Dealing with heavy rain

- Increase capacity to store rainwater — 3
- Increase infiltration — 5
- Increase comfort of people during heavy rain — 3

11

Dealing with drought and heat

- Increase capacity to capture rainwater for later use — 3
- Increase and diversify green space — 5
- Increase comfort of people during drought / heat — 3

11

Increasing flexibility

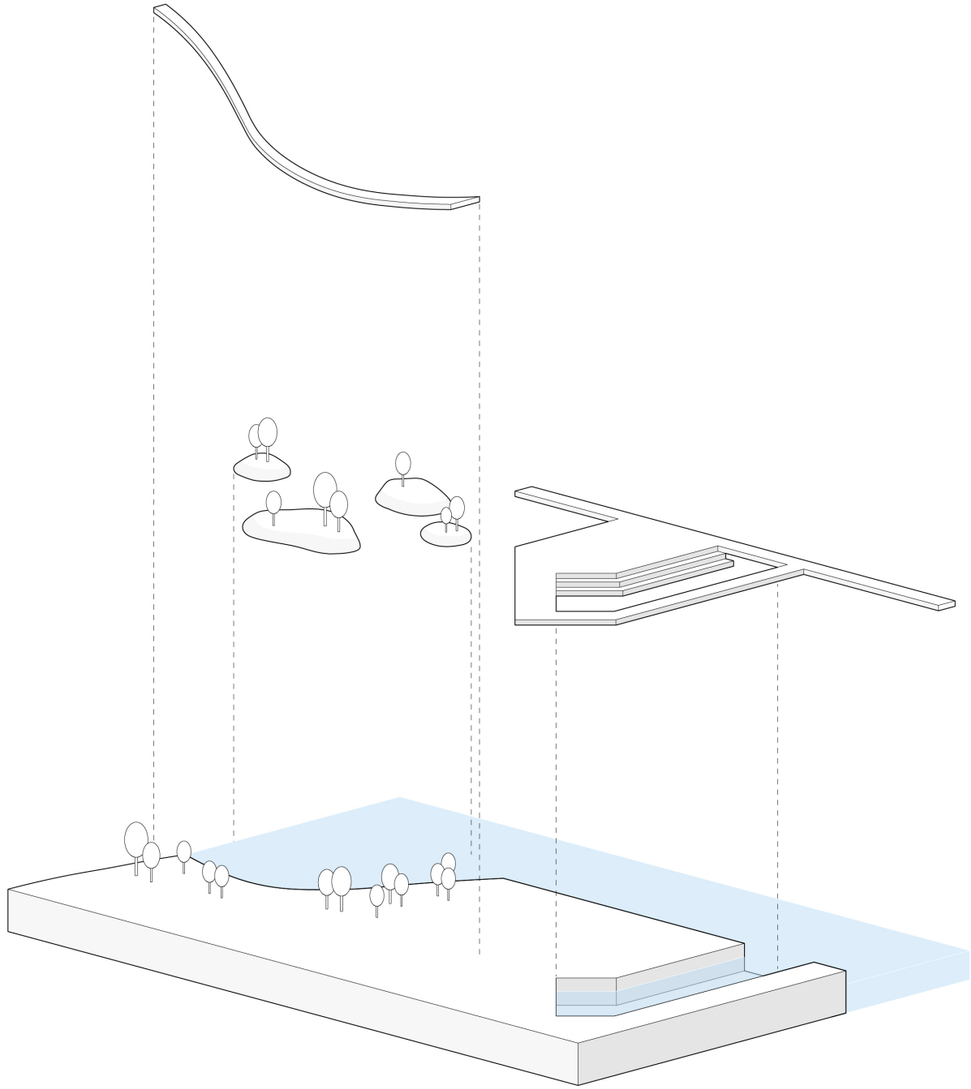
- Increase multifunctionality — 5
- Increase versatility — 3
- Increase capacity to deal with change — 5

13

Creating social spaces

- Create more inclusive spaces — 3
- Increase mobility for slow traffic — 5
- Create comfortable and attractive public space — 5

13



Design 3

38

Dealing with heavy rain

- Increase capacity to store rainwater — 5
- Increase infiltration — 1
- Increase comfort of people during heavy rain — 5

11

Dealing with drought and heat

- Increase capacity to capture rainwater for later use — 5
- Increase and diversify green space — 3
- Increase comfort of people during drought / heat — 5

13

Increasing flexibility

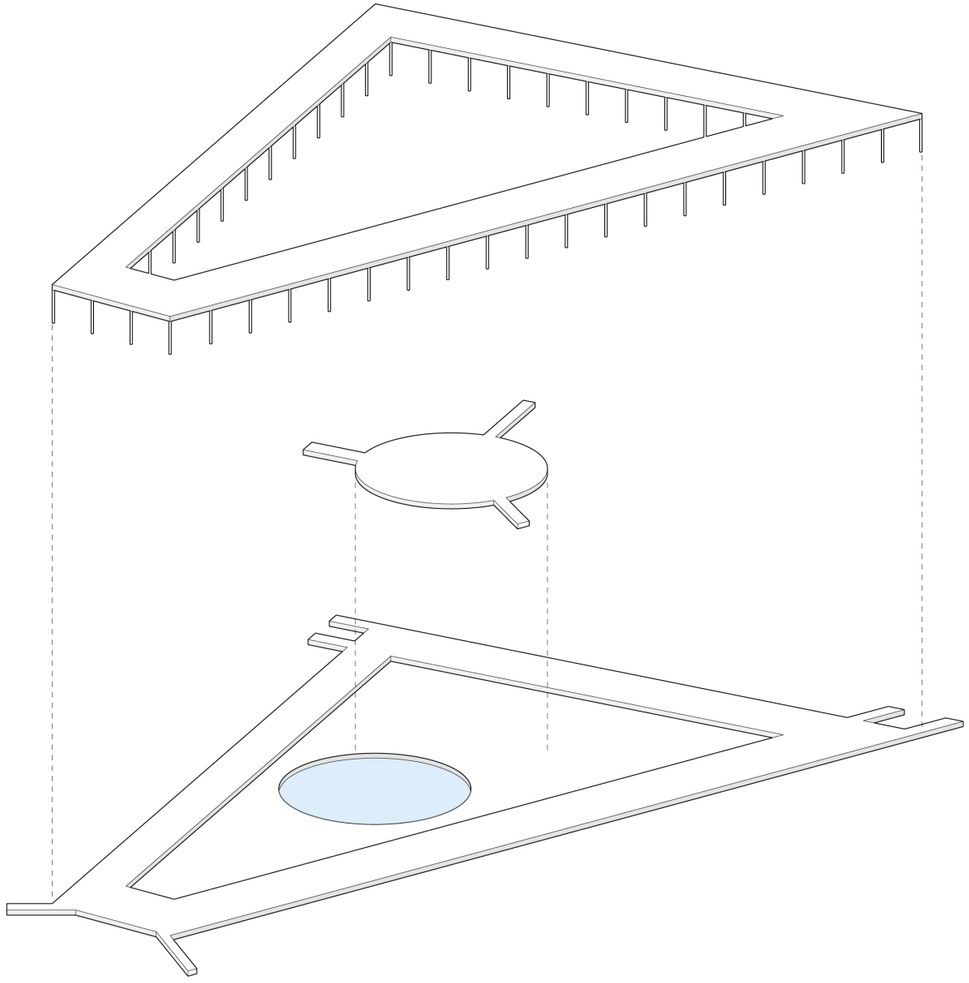
- Increase multifunctionality — 1
- Increase versatility — 3
- Increase capacity to deal with change — 3

7

Creating social spaces

- Create more inclusive spaces — 1
- Increase mobility for slow traffic — 3
- Create comfortable and attractive public space — 3

7



Reaching goals

Next to the assessment based on the four predetermined goals, it is also important to look at the goals the municipality has and how the design works towards these goals

Green goals
The goal of the municipality in terms of green space is to enhance the already present green and add at least 7 hectares of extra green space. How much of this green should be implemented in the design location is hard to determine, but an estimate can be made. For the sake of convenience it can be said that since Kanaleneiland and Transwijk make up about 4% of the surface area of the municipality, it should house about 4% of the extra green. This comes down to an extra 2800 m2 of green space.

When looking at the detailed designs within the neighborhood, the exact amount of green that is added can be looked at within the 3 zoomed-in design locations. For the first location, this is roughly 7200 m2, for location 2 it is about 8380 m2 and for location 3 it is about 8900 m2. In total that is an added green area of 24480 m2. Just within the three detailed design locations the green goal is reached and exceeded to almost 35% of the total green goal of the municipality. This could also be an indication that the goal the municipality has set up is a low bar to pass and should be increased.

In terms of enhancing green space, multiple interventions are set up and implemented to reach this goal such as creating new connections in the green network and diversifying plant life.

Water goals
To give a concrete example of how the design works towards water-related goals, water storage will be looked at.

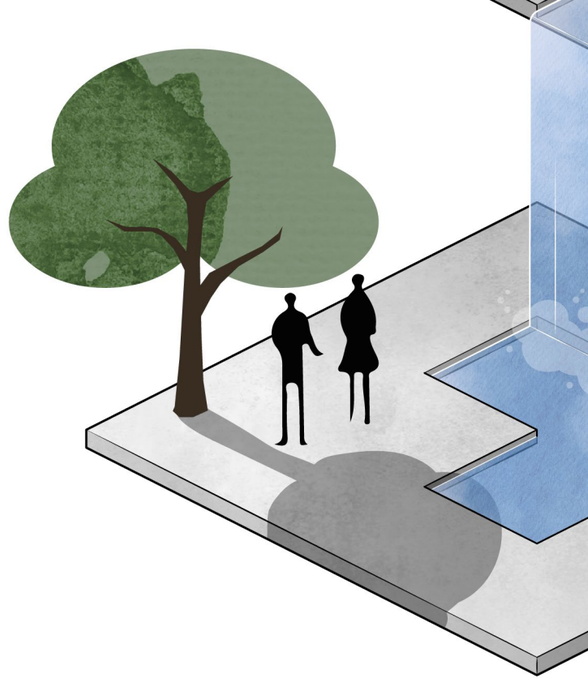
Amounts of rain are expressed in millimeters. 1 millimeter of rain means that 1 liter will fall on a surface area of 1 m2. The goal of the municipality is to deal with a shower of 80 mm of rain in an hour. (Gemeente Utrecht, 2022c). For this project, the goal was to increase this to at least 100 mm of rain. A shower of 100 mm means the neighborhoods of Kanaleneiland and Transwijk need to deal with 390 million liters of water at once.

There is no number for the exact amount of water that can be stored in the neighborhood, but the amount that can be stored in the emergency water storage can be closely approximated. The emergency storage, when looking at its empty state, can capture about 95 million liters. This is almost 25% of the amount that falls in the neighborhoods during a 100 mm shower and 30% of an 80 mm shower. Meanwhile, the emergency storage itself takes up less than 2,5% of the surface area in the two neighborhoods. In combination with smaller-scale water storage throughout the neighborhood and increased infiltration, the design sufficiently addresses the problem of peak rainfall.

Social goals
Social goals are harder to measure quantitatively. The municipality's goal is to create social opportunities and increase the number of places where people can meet and interact (Gemeente Utrecht, 2022a) and these designs have certainly done that by creating more slow-traffic friendly spaces and more community spaces. How successful these spaces would be is hard to prove, but interventions are set in place to try and ensure the design's success.

Safety and eyes on the street are other points mentioned by the municipality (Gemeente Utrecht, 2022a). Although these points received less attention in the design, some interventions like diversifying functions and creating places that are busier during different times of day can have a positive effect on safety.

Routes
Another part of the municipality's plan is to encourage walking by creating small routes ranging from 1.5 to 3 kilometers (Gemeente Utrecht, 2022a). The social route in total is 6.5 kilometers, and the nature route in total is 11.3 kilometers, too long to qualify to reach this goal. However, because of the overlap of the different routes smaller routes start to appear. The smallest of these routes is 1.7 kilometers and there are multiple possible routes below 3 kilometers. Therefore this goal is also reached within the design



Conclusion and Reflection

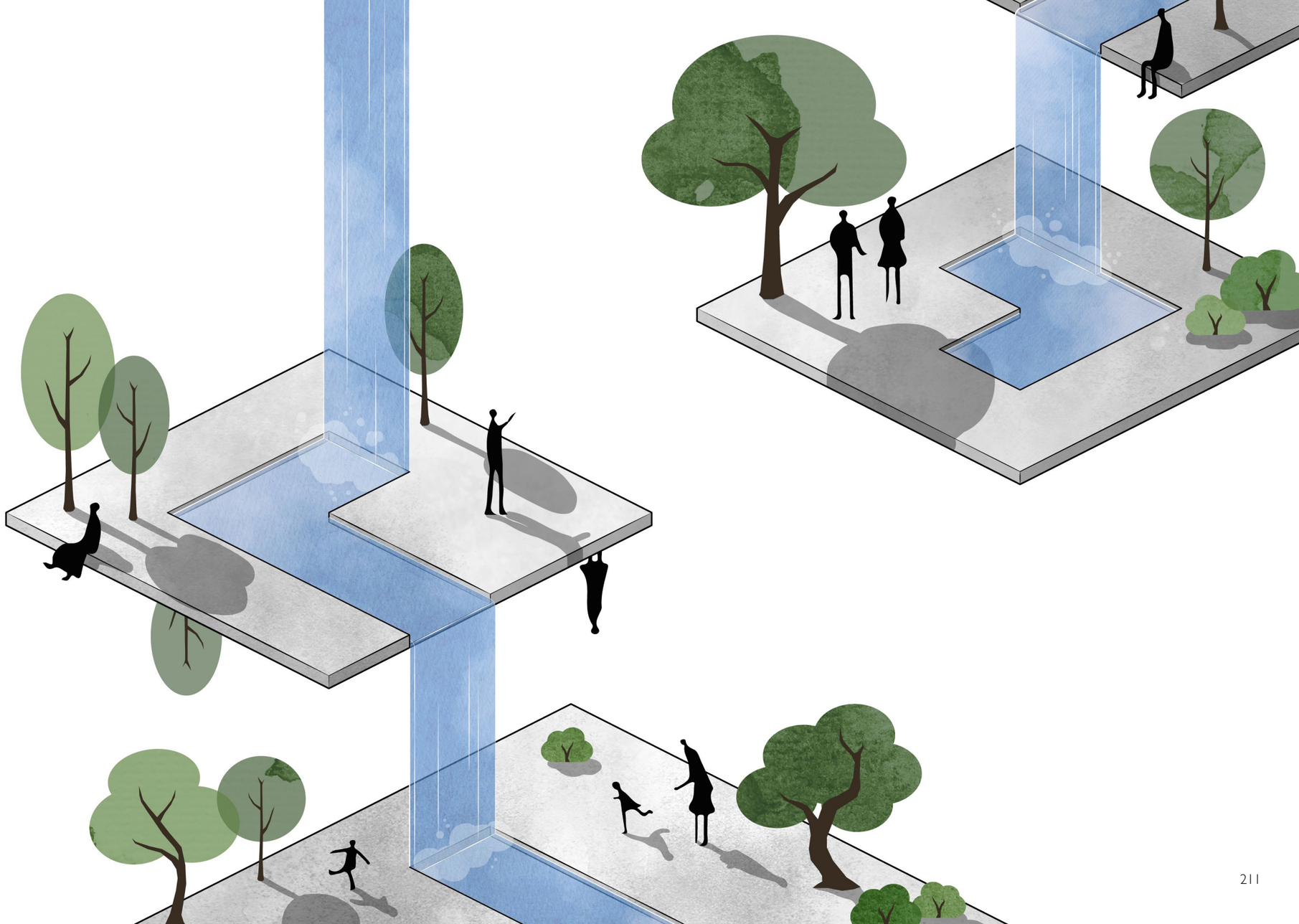
Conclusion

There is a general disconnect between our cities and nature. Our cities are too stagnant and do not adapt quickly enough to changes, it does not respond to our needs or those of the environment. Society and our surroundings are constantly changing and cities are not equipped to deal with it. Many problems we are facing in our cities stem from the lack of flexibility.

Our climate is changing and so are our weather patterns. It is becoming increasingly clear that extreme weather is a threat to many cities across the globe and the Netherlands is no different. Climate adaptation is not happening fast enough, we need to break the cycle of trying to catch up to the problem and get ahead of it instead. 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). The problems our cities are facing are only worsened by the fact that many governing bodies do not plan far enough in advance when it comes to large changes and transitions

This report calls for more flexibility and long-term planning in every aspect of the urban system; cities should be more adaptable in dealing with change. For adaptation to extreme weather, this means that places should be able to handle drought, heavy rain, and any scenario in between. In terms of function, this means being able to shift and adapt to different needs with minimal intervention.

A lot can still be won in terms of flexible cities and cities that are more in tune with nature. Utrecht could be a frontrunner when it comes to climate adaptation. It is an ambitious city, only flexibility and long-term vision are lacking.



Reflection

Social and scientific relevance

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 starting out and conversations and research on how to best achieve this are very much relevant. On top of this, within the conversations about climate adaptation, drought is often a problem that takes a backseat to the more visible threat of heavy rainfall and flooding. Taking drought into consideration specifically is therefore of great added value when talking about climate adaptation.

Secondly, this report looks at climate adaptation for extreme weather from a lens of flexibility. Looking at Utrecht it is clear to see we need this flexibility. The municipality of Utrecht, and many other municipalities in the Netherlands, have trouble making plans beyond the tenure of the municipal council and often do not look further into the future than 20 to 30 years. With an uncertain future like that of climate change, the plans made need to be able to adapt quickly when climate scenarios take an unexpected turn. It is important to look at the plans municipalities have to see if they will suffice in the future and whether they are adaptable enough to cope with unexpected changes. This flexibility will also help to implement climate adaptation in spaces with multiple conflicting ambitions and can help to reach multiple goals within the same space. This is especially important within a growing city like Utrecht.

Lastly, the research in this report also yields 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.

Transferability

The design outcome of this project is specifically aimed at Utrecht but contains strategies and interventions that would be beneficial to adapt other Dutch or similar cities to extreme weather events. Especially the general vision and flexibility concepts can be easily adapted to fit within different cities that expect to deal with comparable climate/weather scenarios. The design outcome is specific to Utrecht but consists of interventions that can also benefit or inspire different cities to take similar action.

Limitations

There are a few limitations in the proposal that will need to be addressed in the future and taken into account when looking at this project.

Where one of the possible issues lies within this proposal, is in proposing a flexible planning outcome. How can a governing body agree to an urban plan that has multiple future scenarios? And will good plans be rejected because one of the possible outcomes is not to a party's liking, even though many of the other possible outcomes would be greatly beneficial?

Another point to address is the financing of a flexible plan. Flexible design often requires a bigger initial investment than a rigid design. The idea is that, with time, this flexibility will pay itself back by needing fewer adjustments in the future. However, this might pose a difficulty when needing to convince a governing body or another party to invest. It can also be difficult to prove exactly how much money it will save in the future or when these benefits will pay themselves back.

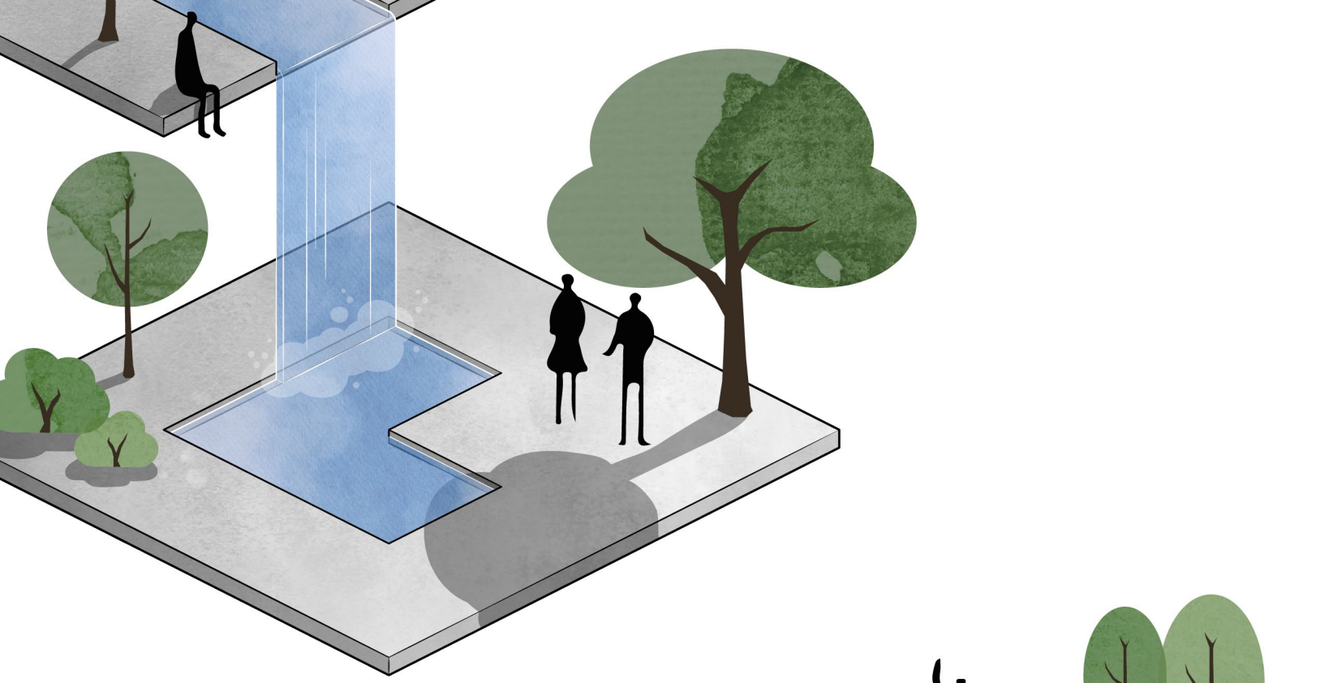
Another limitation of this report relates to the design concept. It is not yet adequately explored how the smaller-scale design concept interacts with and connects to the rest of the city and larger surroundings. Especially when it comes to the supply of drinking water for example this connection to the larger scale is important to find a long-term reliable solution. This connection to the larger scale is extremely important as the design is not located in isolation and the failure or success of a plan depends largely on the interaction between the design and its surroundings.

Continuation

Within this project, some gaps are of importance but have not yet been explored adequately.

One of these gaps is the planning process. In the analysis of Transwijk and Kanaleneiland, it is mentioned that the tenure of the municipal council and the related planning process is a big part of the reason a lot of strategies do not look far enough into the future. However, this report does not mention or address the planning process itself. The report focuses on designing and therefore does not account for possibly important (or even easier) solutions that might lie within the planning process. When talking about flexibility it is important to not just consider the design but to also look at the design process and the policies that guide them. Due to time constraints, this report does not dive into these topics. Considering the short time horizons many municipalities work with, it would be beneficial to look deeper into flexibility within the design process and policy making.

Another point of further study is how this flexibility functions and could function with transitions that are not climate-related. For example, large changes in housing demand due to a rapid demographic change or a technological change that diminishes the need for large parts of industry or create the need for a whole different type of industry. Although flexibility for these different types of function changes is talked about briefly in this report, further study on how cities can become more quickly adaptable to these types of changes would be very useful.



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Appendix 1 Large scale analysis

Water safety

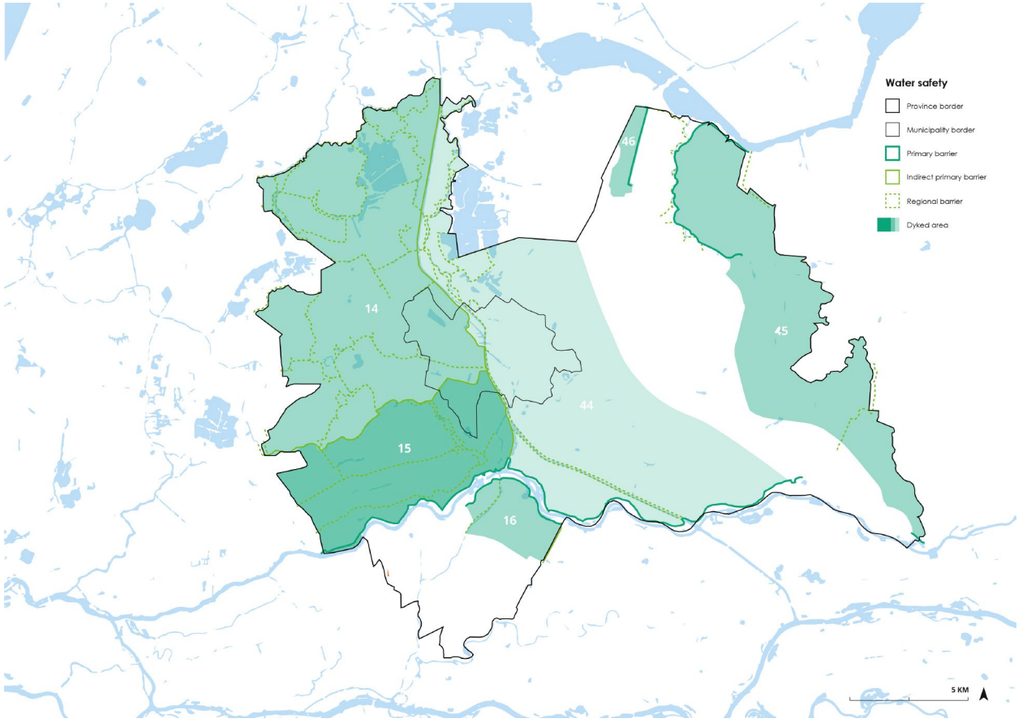

Figure 1.1 Water bariers and dykes, based on data from Provincie Utrecht (Provincie Utrecht, 2009).

Water collection

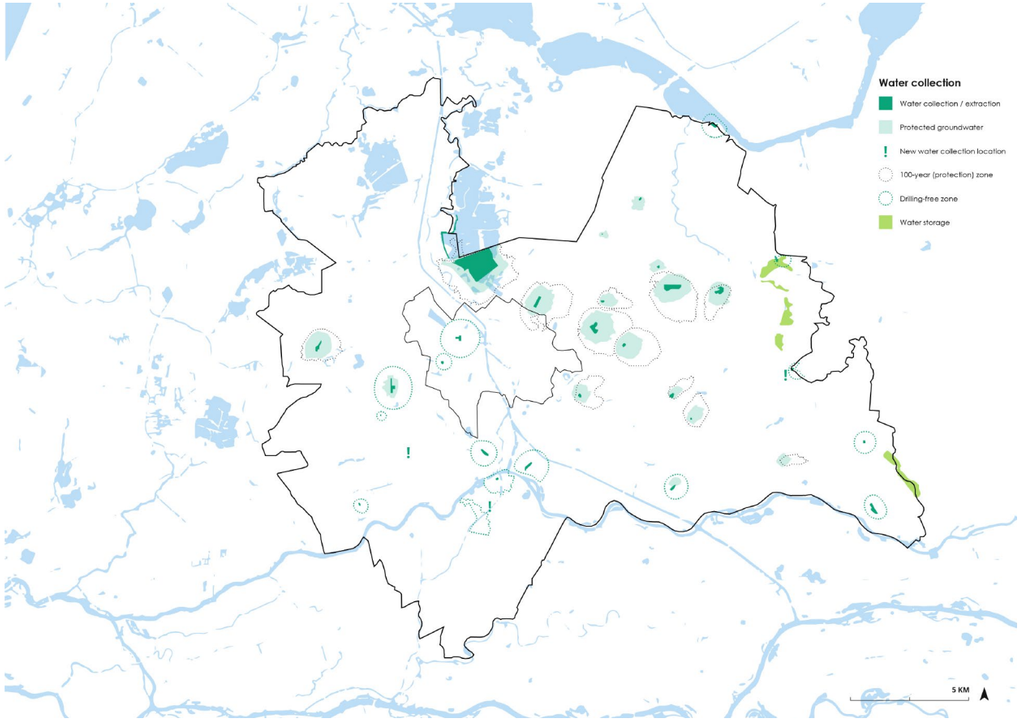

Figure 1.2 Locations and protective measures for water collection points, based on data from Provincie Utrecht (Provincie Utrecht, 2022a).

Elevation

Figure 1.3 Elevation, based on data from AHN (Actueel Hoogtebestand Nederland, n.d.)

Groundwater Level (dry conditions)

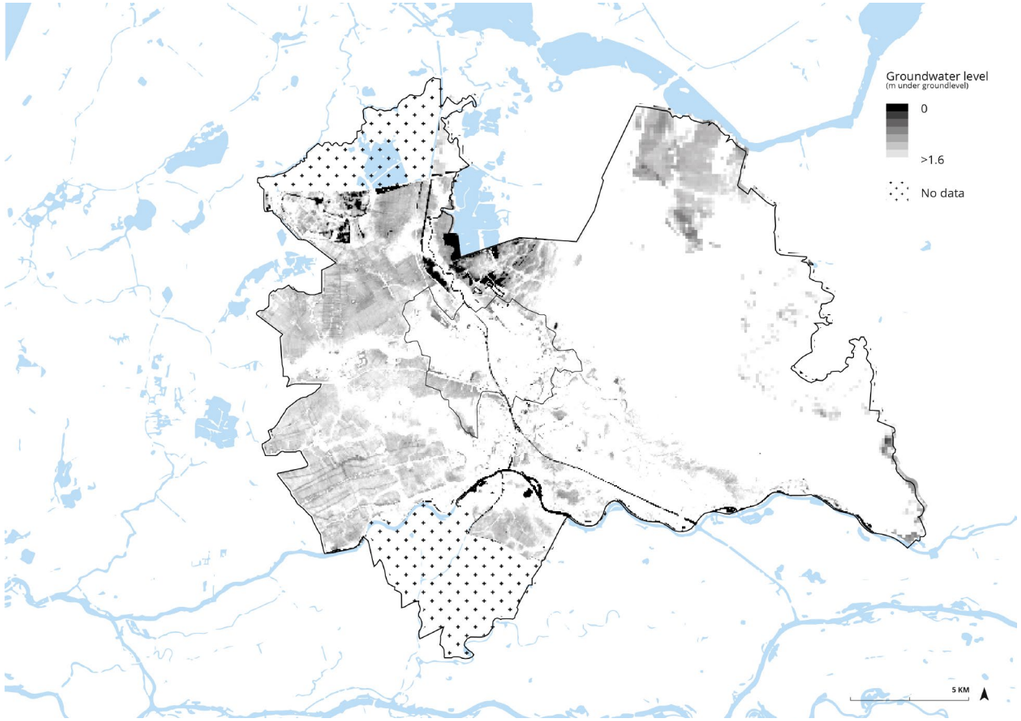

Figure 1.4 Average groundwater level during low water, based on data from Provincie Utrecht (Provincie Utrecht, 2014c), (Provincie Utrecht, 2014d)

Groundwater Level (wet conditions)

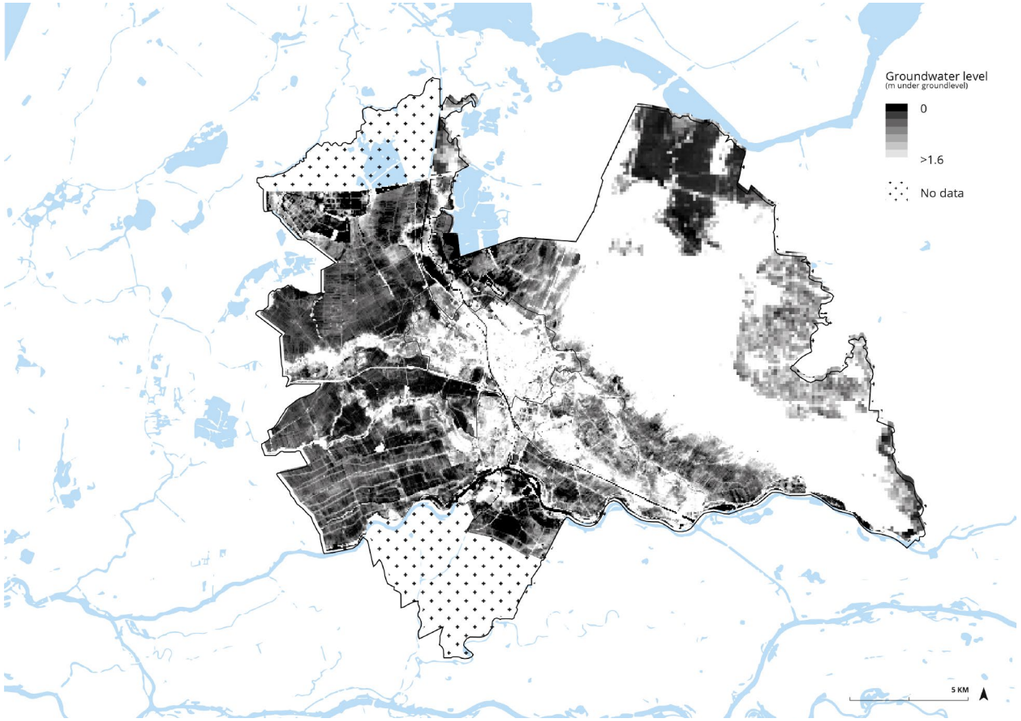

Figure 1.5 Average groundwater level during high water, based on data from Provincie Utrecht (Provincie Utrecht, 2014a), (Provincie Utrecht, 2014b)

Soil

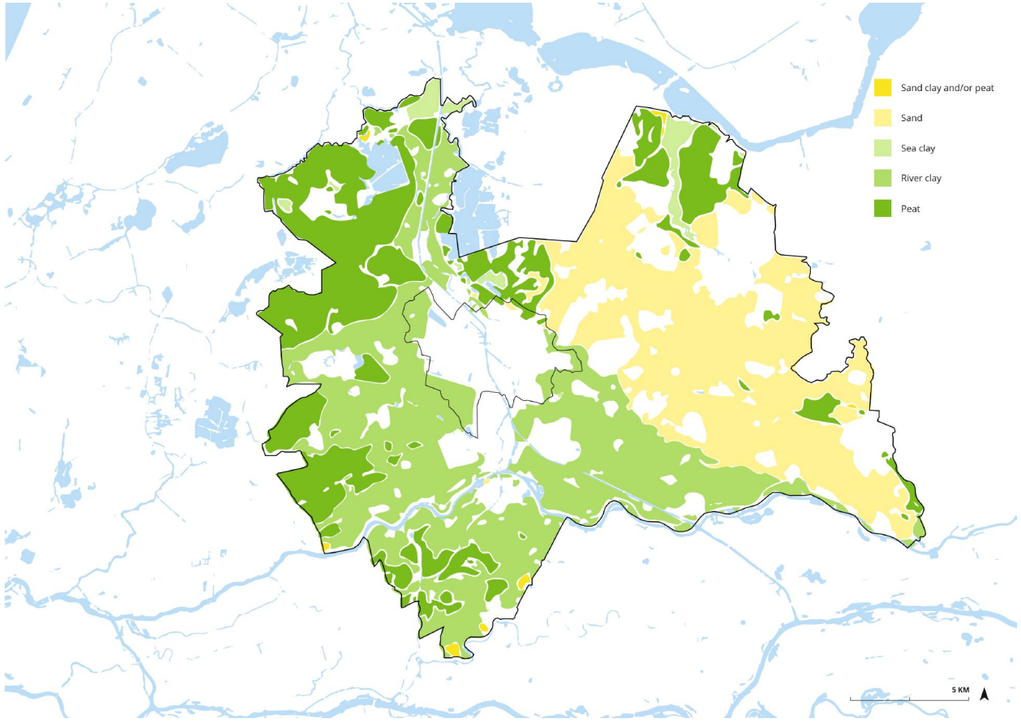

Figure 1.6 Soil types, based on data from Provincie Utrecht (Provincie Utrecht, 2019)

Subsidence

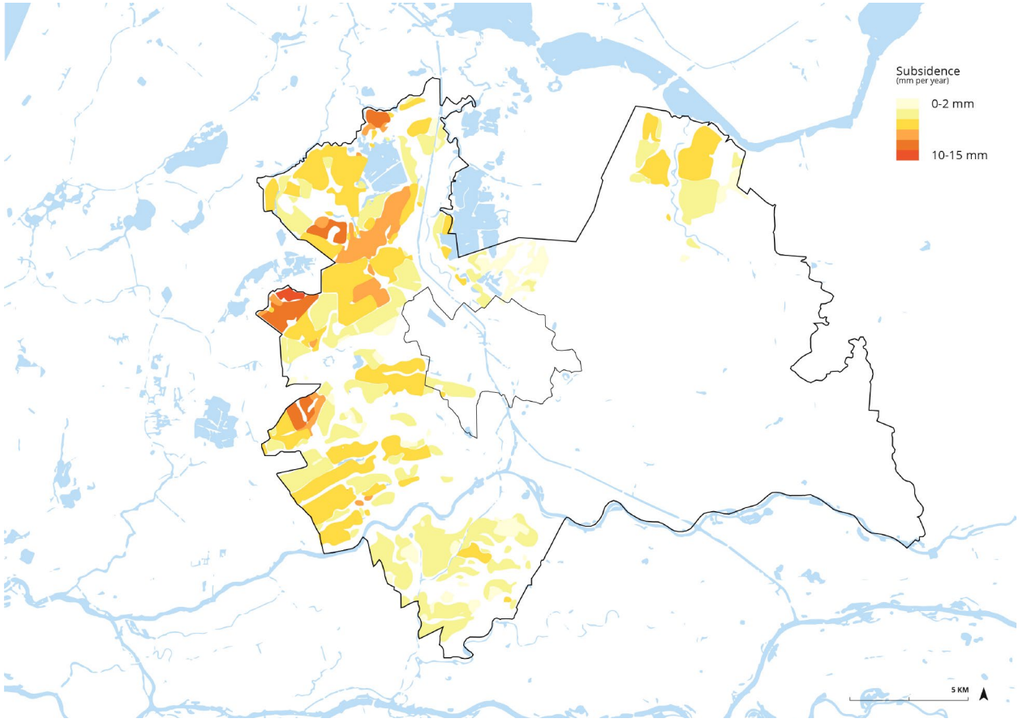

Figure 1.7 Subsidence, based on data from Provincie Utrecht (Provincie Utrecht, 2022b)

Nature and Agriculture

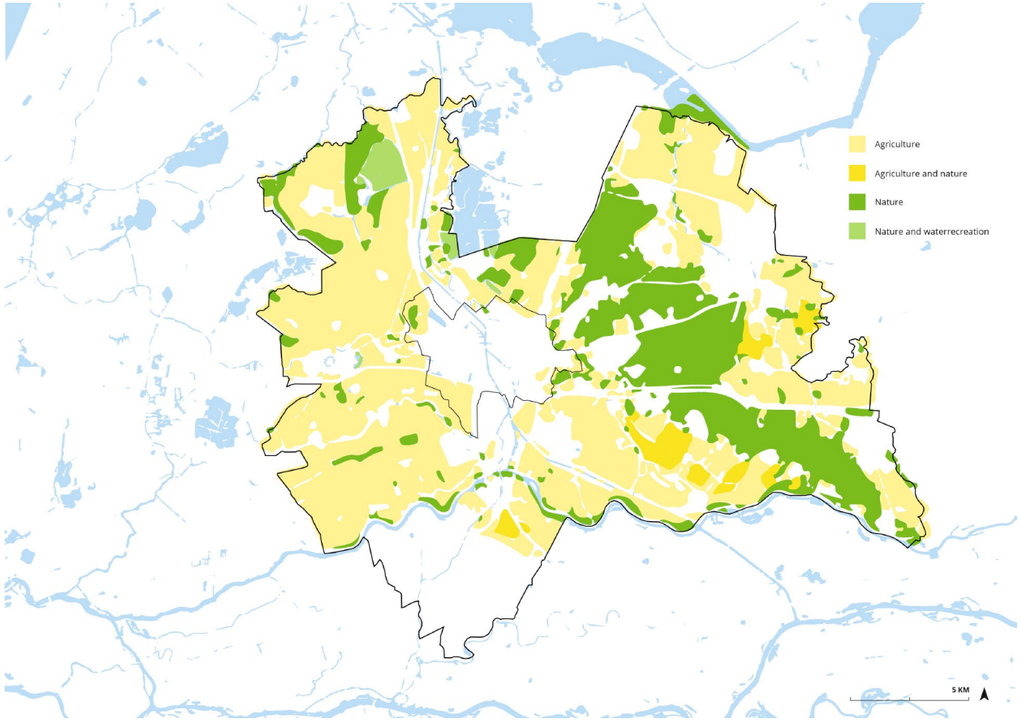

Figure 1.8 Land use, based on data from Provincie Utrecht (Provincie Utrecht, 2009).

Natural networks

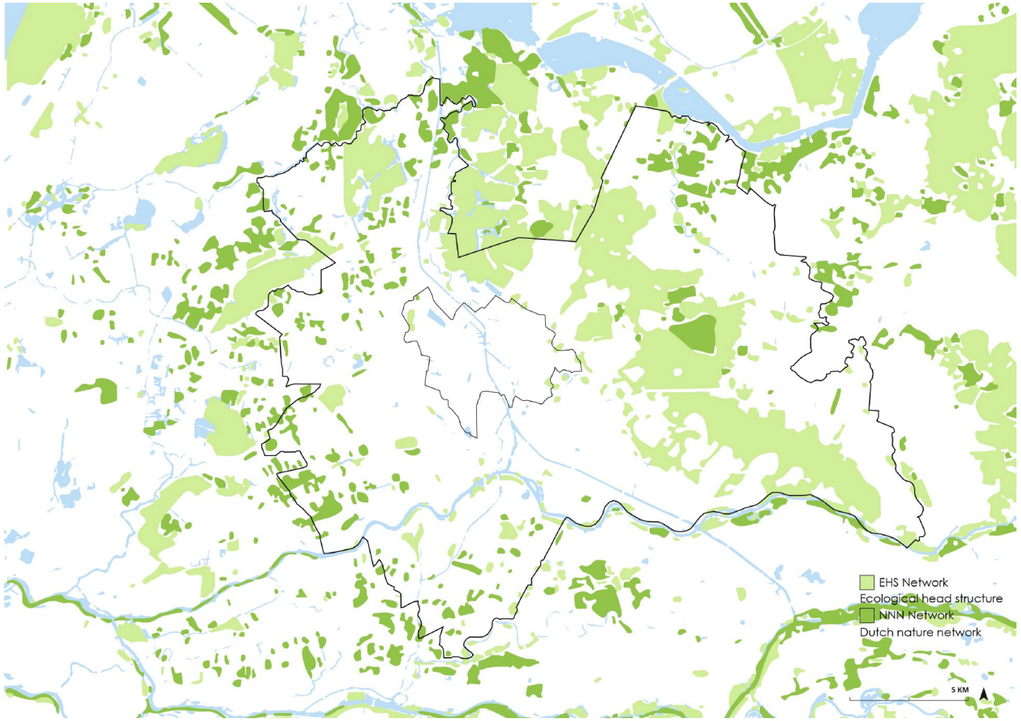

Figure 1.9 Green networks (EHS and NNN), based on data from Planbureau voor de Leefomgeving (Planbureau voor de Leefomgeving, 2017)

Appendix 2 City scale analysis

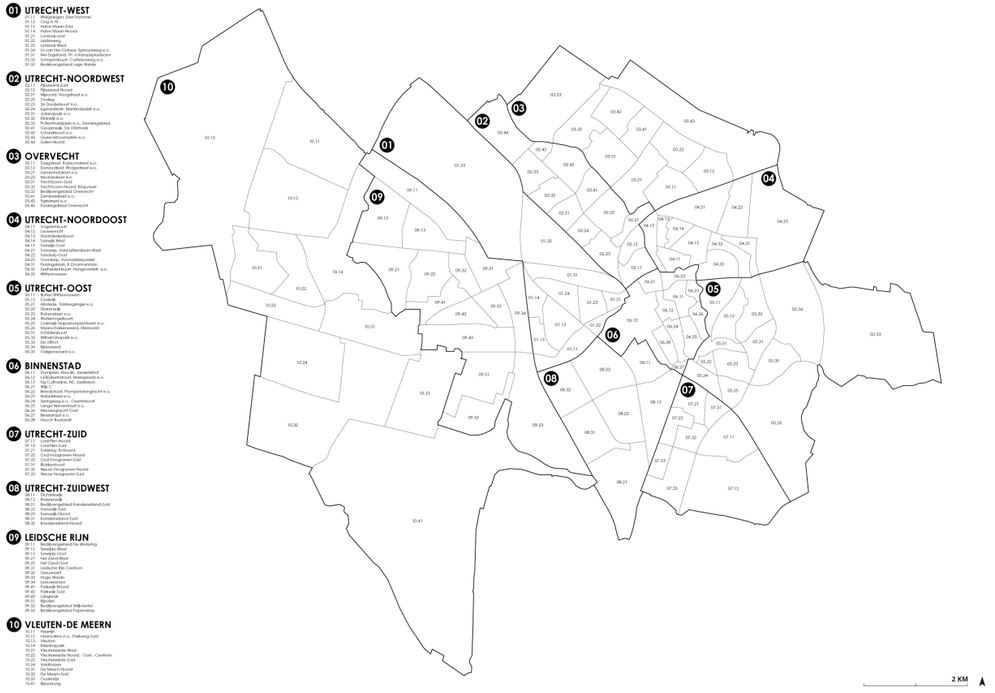

Figure 2.1 The different districts and neighborhoods od Utrecht

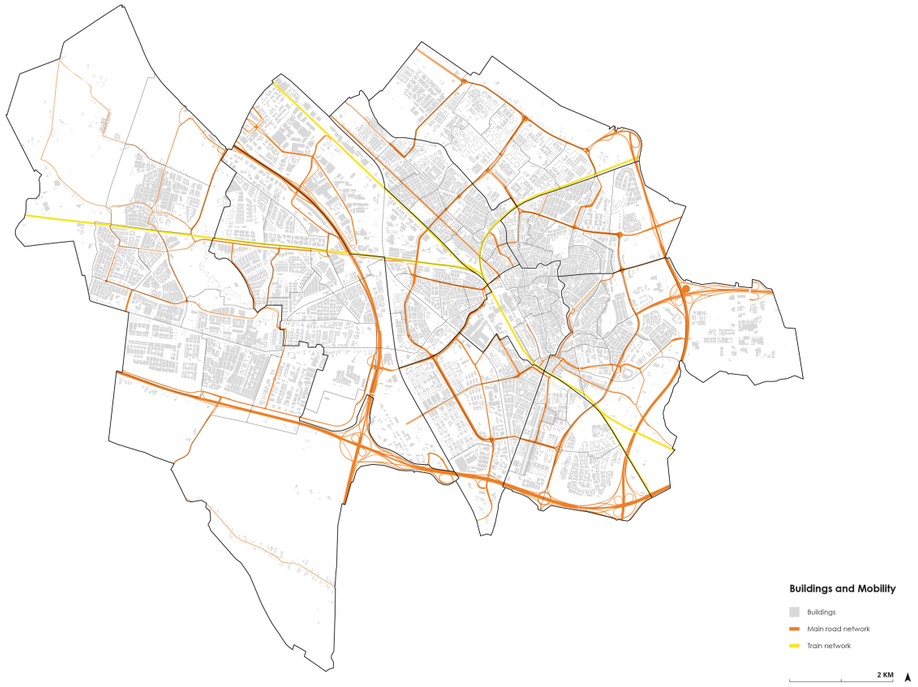

Figure 2.2 Buildings, main roadnetwork and trainnetwork

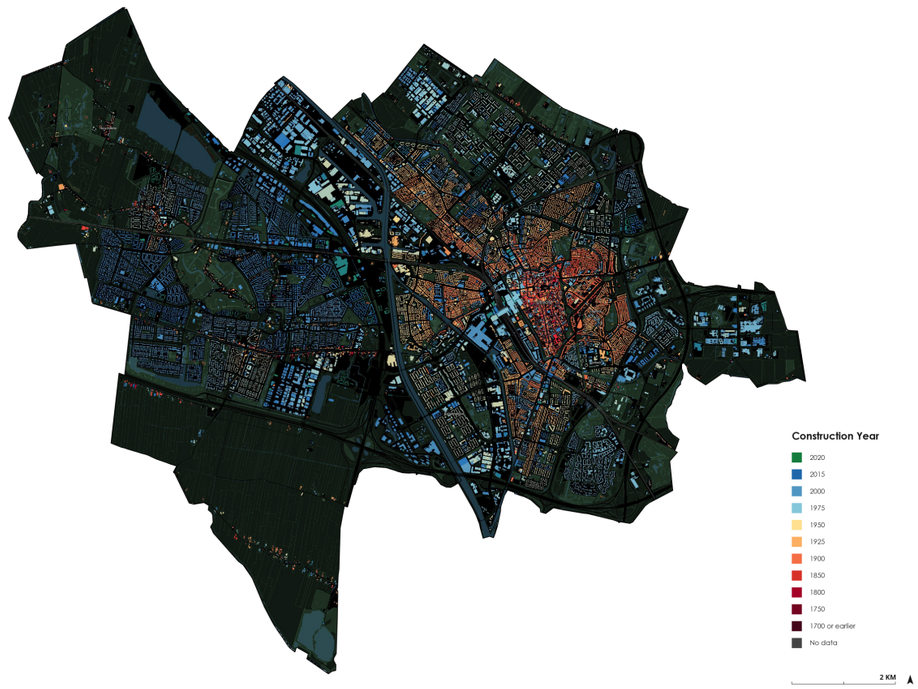

Figure 2.3 Construction year of buildings, based on data from Parallel (Parallel, 2020).

Functions

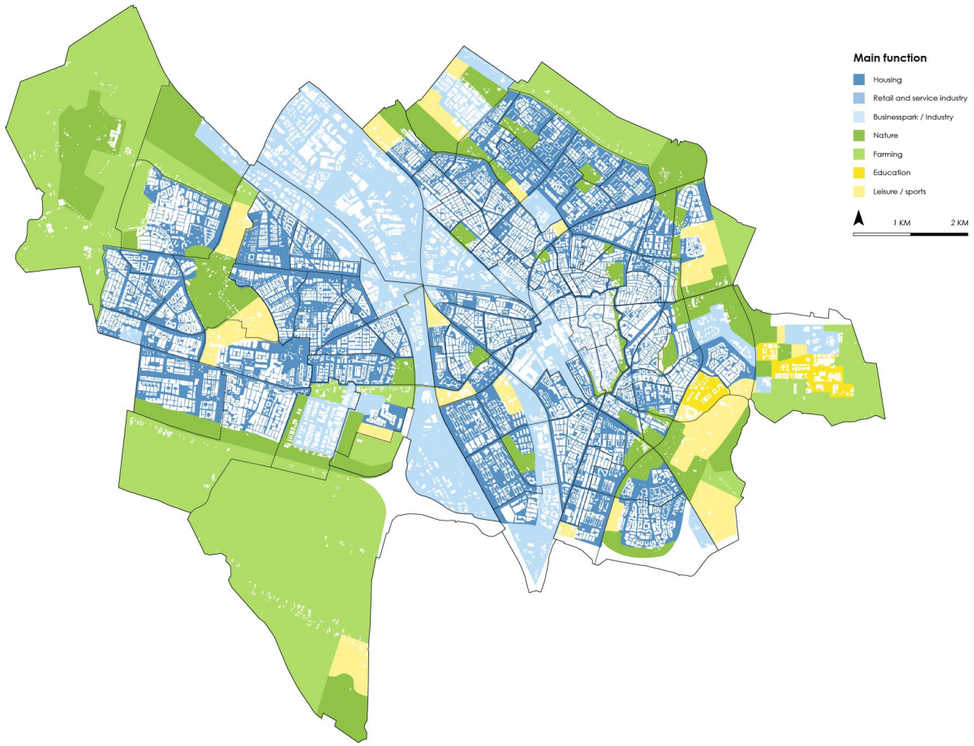

Figure 2.4 Main functions

Districts

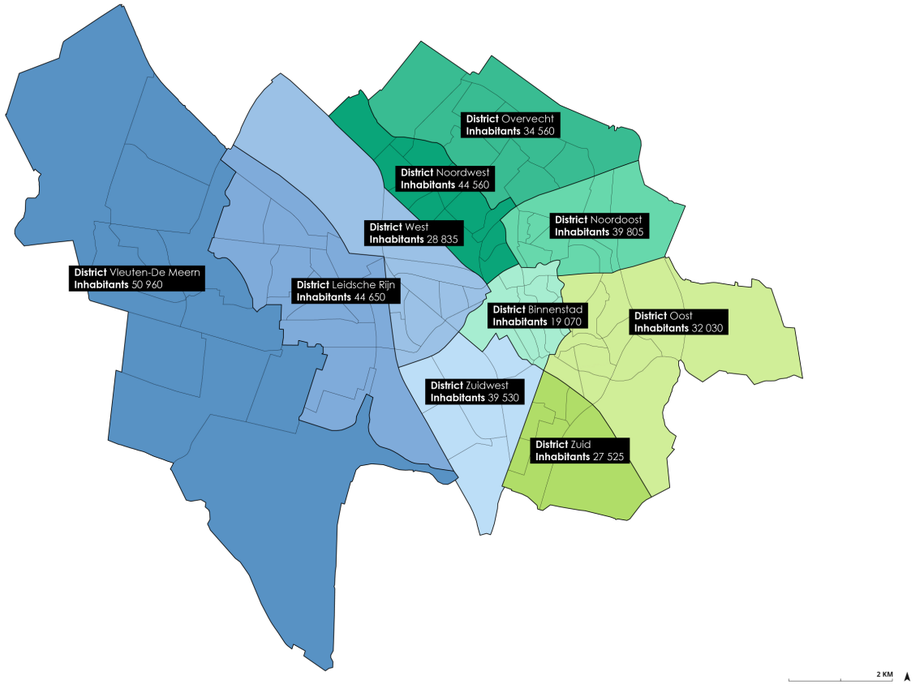

Figure 2.5 Districts of Utrecht

Figure 2.6 In depth statistics on the different districts in Utrecht, based on data from Alle Cijfers (Alle Cijfers, n.d.).

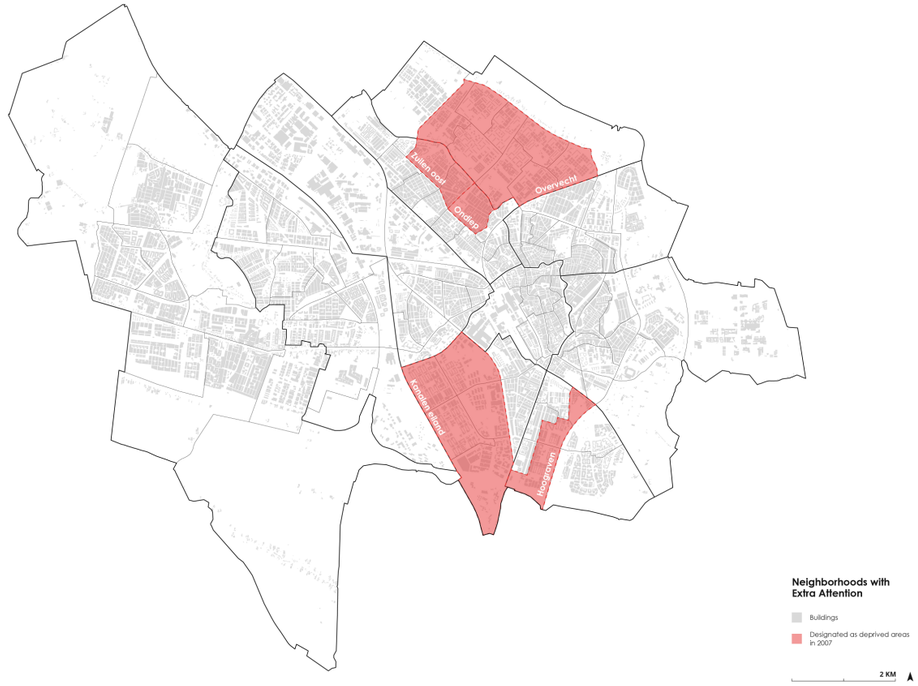

Figure 2.7 Disadvantaged neighborhoods, based on data from Trouw (van Essen, 2007).

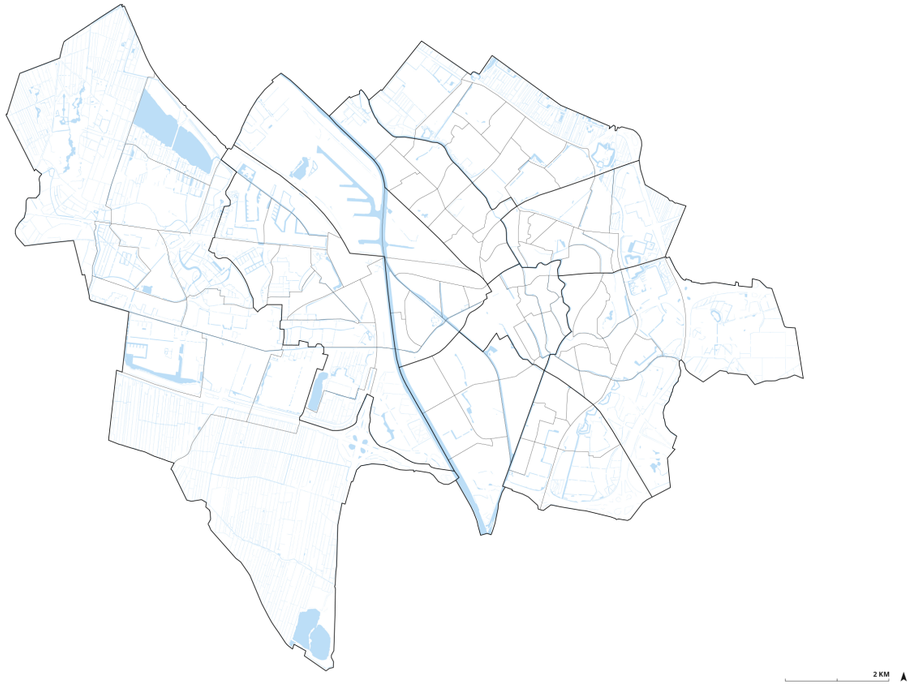

Figure 2.8 Waterways

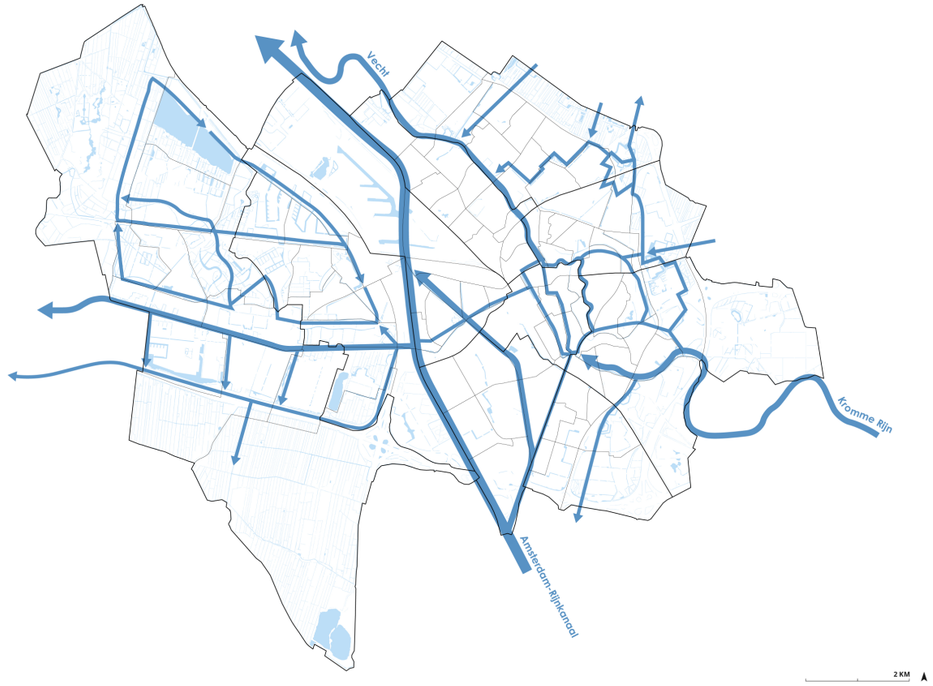

Figure 2.9 Flow of water, based on data from Gemeente Utrecht (Gemeente Utrecht, 2022c).

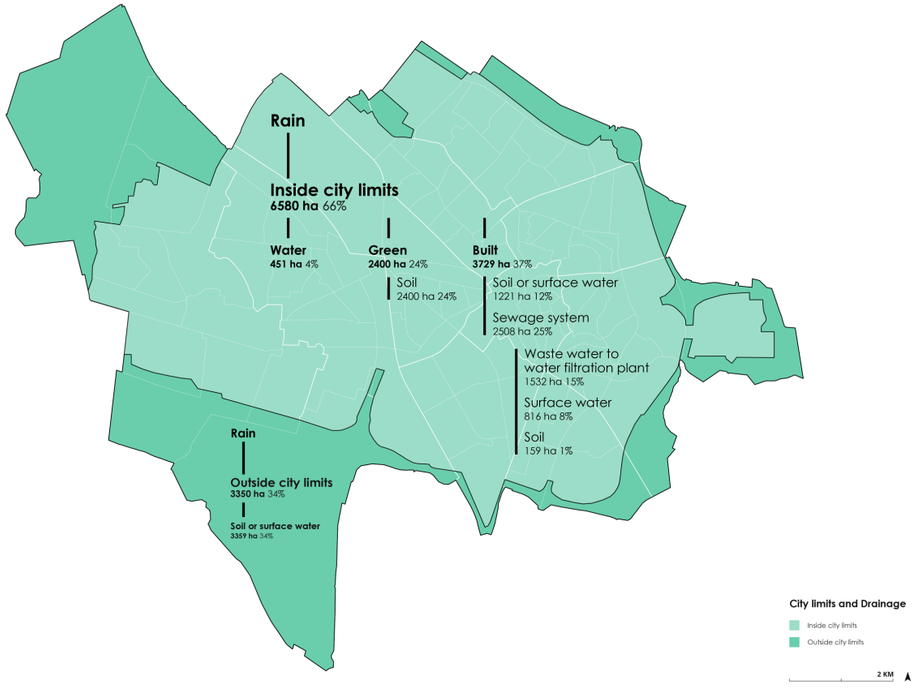

Figure 2.10 Where rainwater ends up, based on data from Gemeente Utrecht (Gemeente Utrecht, 2022c).

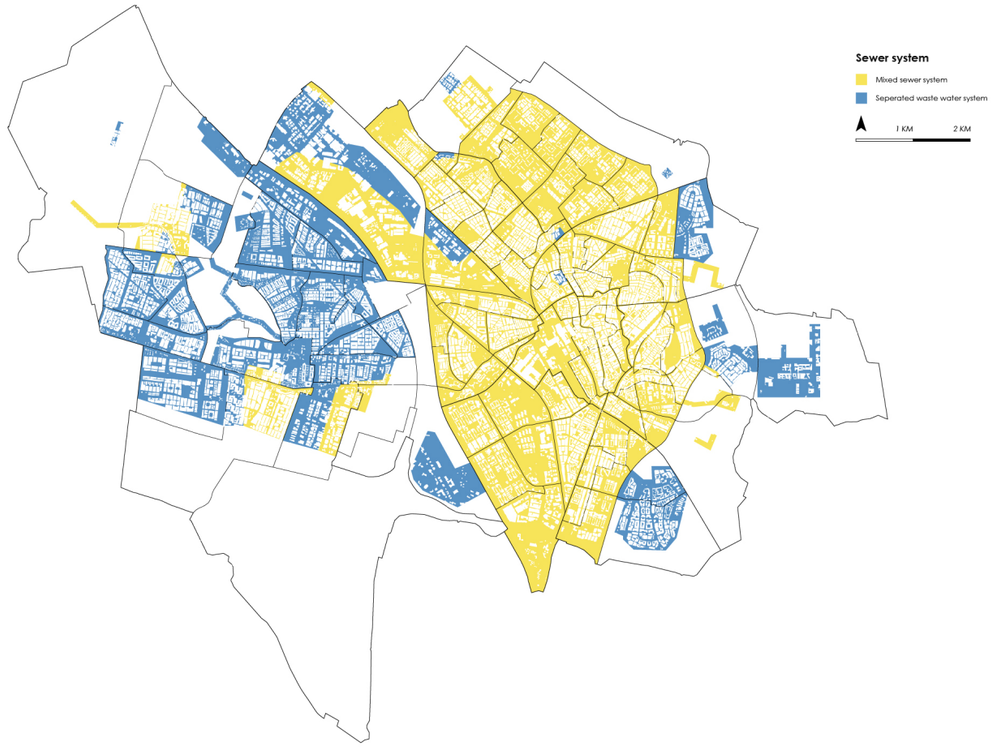

Figure 2.11 Different sewage systems in Utrecht, based on data from Gemeente Utrecht (Gemeente Utrecht, 2022c).

Sewage Replacement

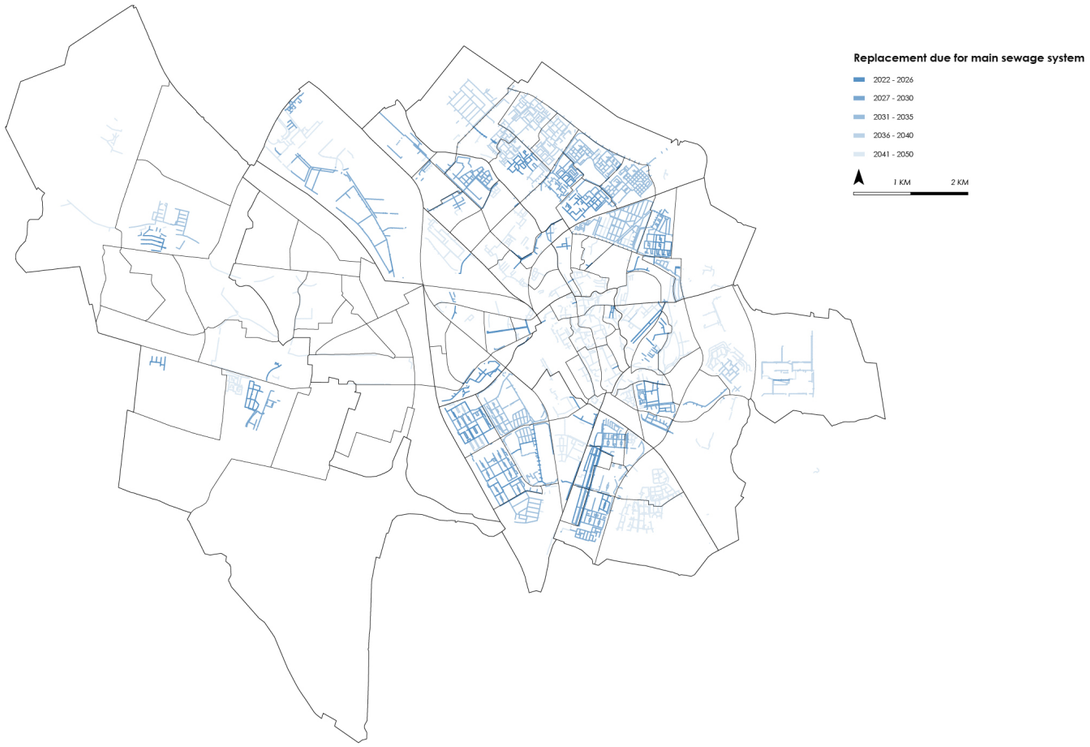

Figure 2.12 When sewagepipes are due for maintenance or replacement, based on data from Gemeente Utrecht (Gemeente Utrecht, 2022c).

Water functions

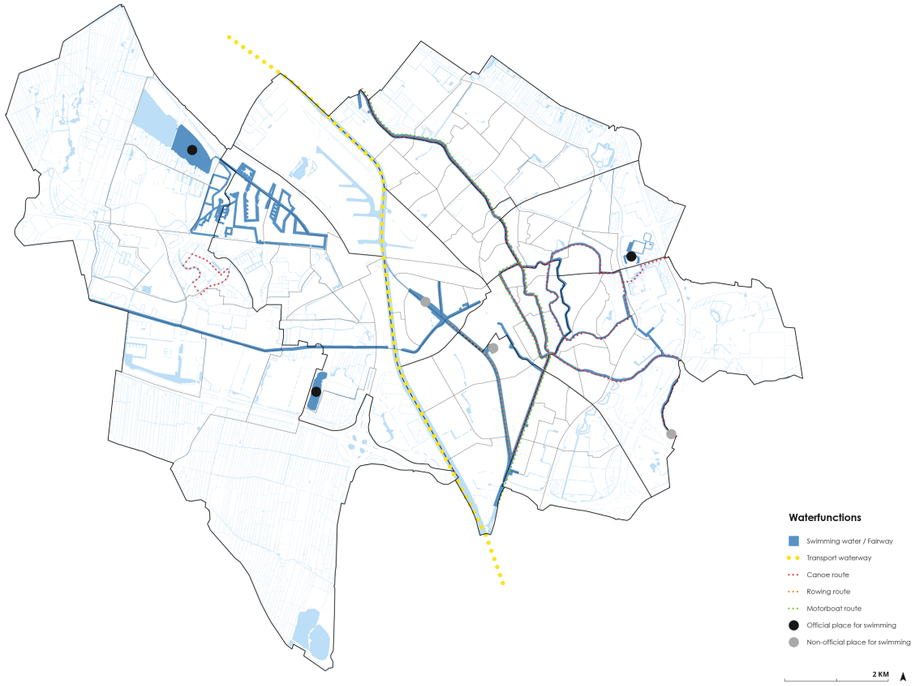

Figure 2.13 Water functions, based on data from Gemeente Utrecht (Gemeente Utrecht, 2022c).

Water Nuissance

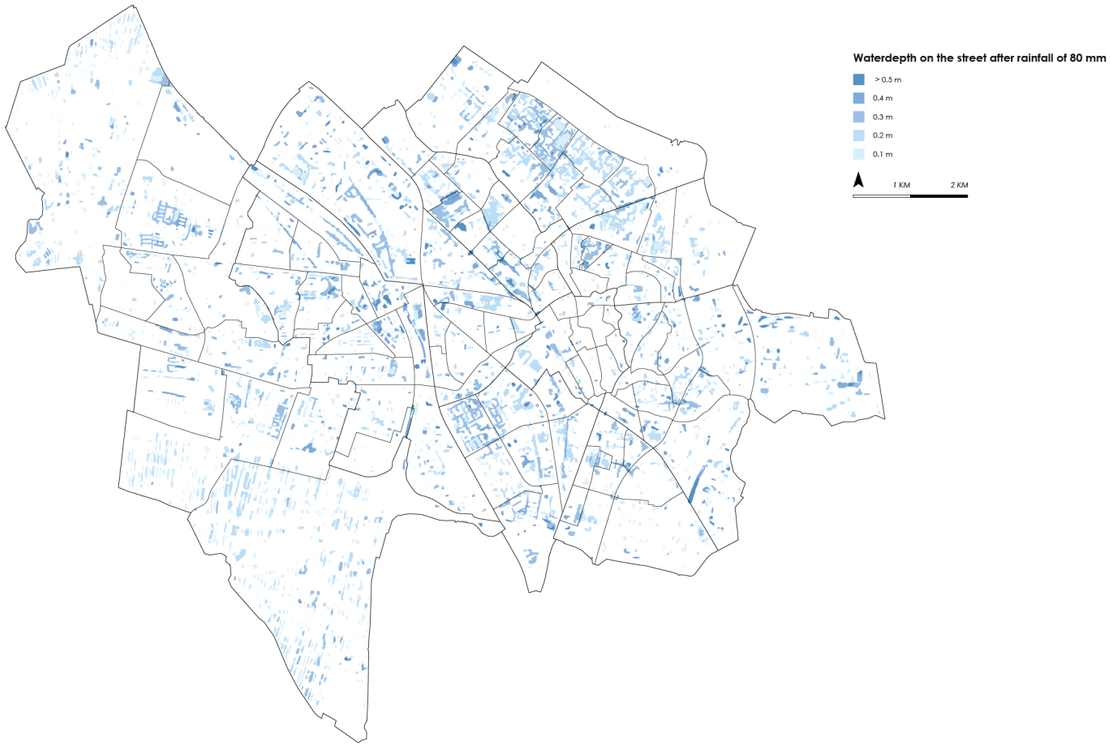

Figure 2.14 Waterdepth after heavy rainfall, based on data from Gemeente Utrecht (Gemeente Utrecht, 2022c).

Green spaces

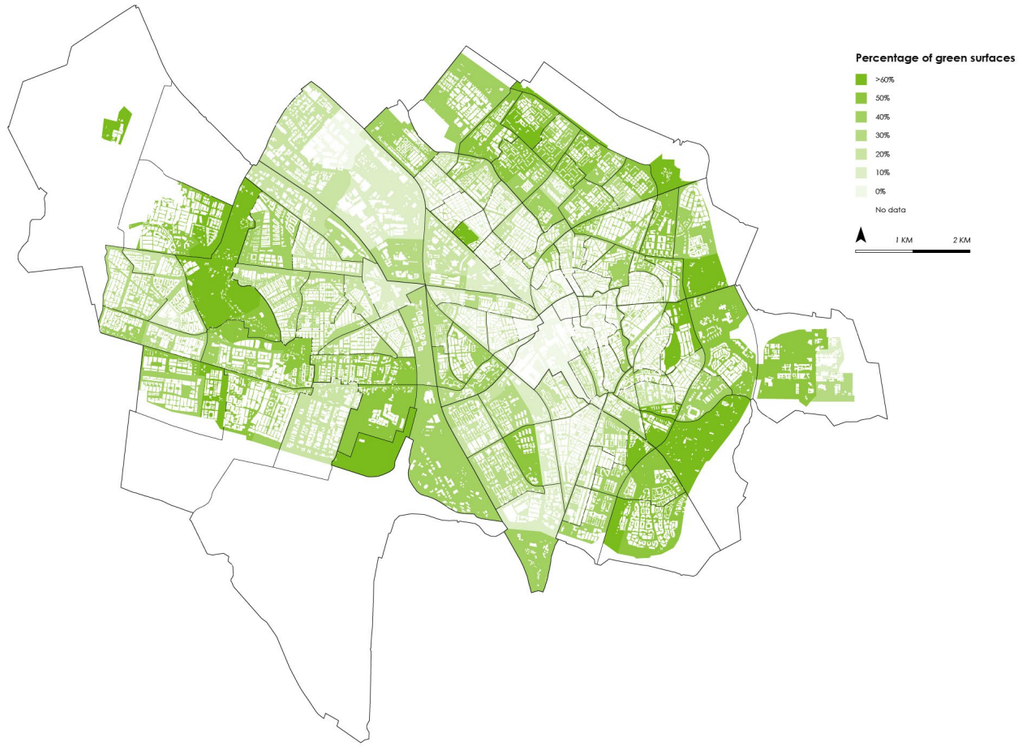

Figure 2.15 Percentage of green in different neighborhoods, based on data from Gemeente Utrecht (Gemeente Utrecht, 2021c).

Built up space

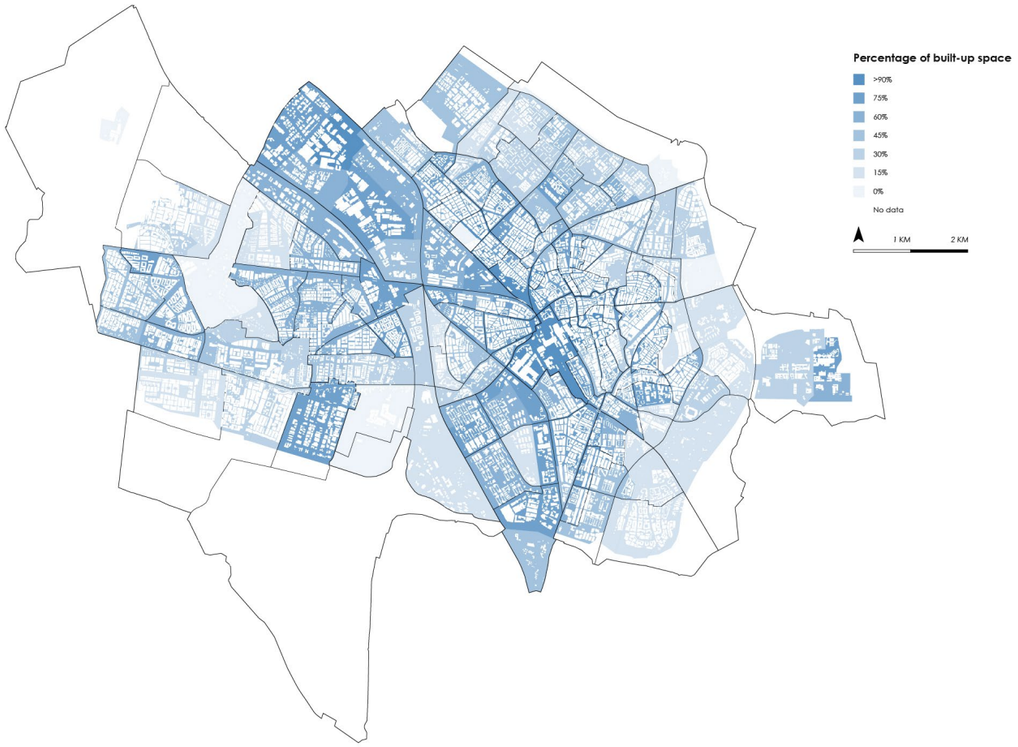

Figure 2.16 Percentage of built-up space in different neighborhoods, based on data from Gemeente Utrecht (Gemeente Utrecht, 2021c).

Heat stress

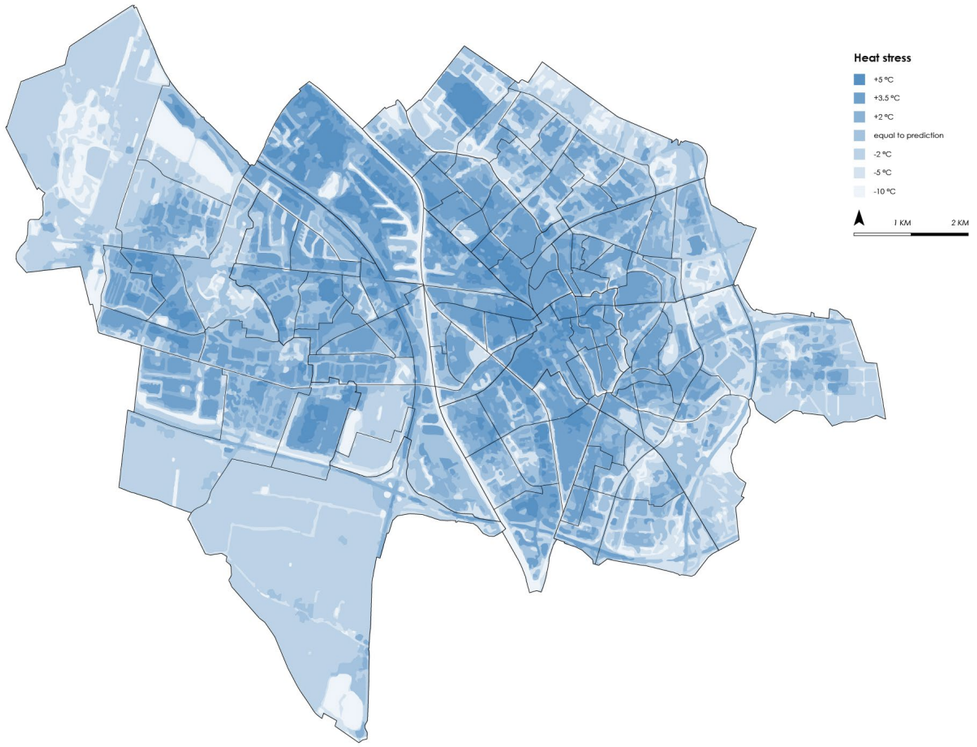

Figure 2.17 Heatstress, based on data from Gemeente Utrecht (Gemeente Utrecht, n.d.b).

Priority areas heat stress and water damage

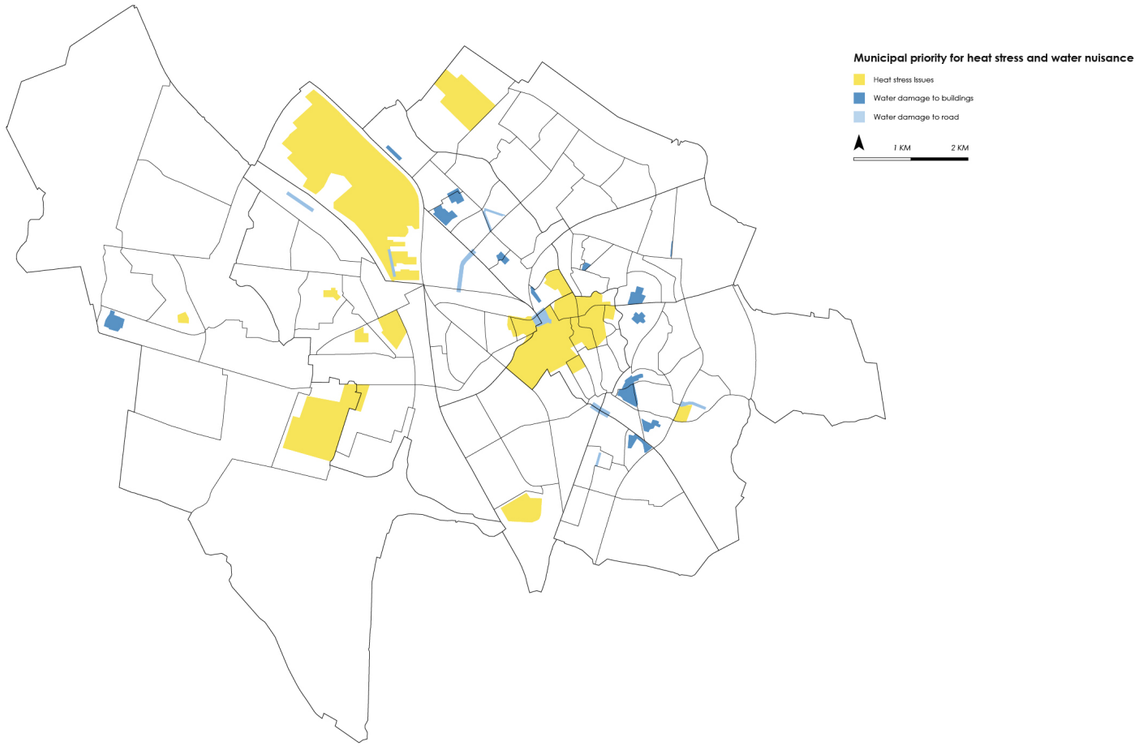

Figure 2.18 By the municipality designated areas with particulary bad problems related to heat and water, based on data from Gemeente Utrecht (Gemeente Utrecht, 2021c).

Public space quality

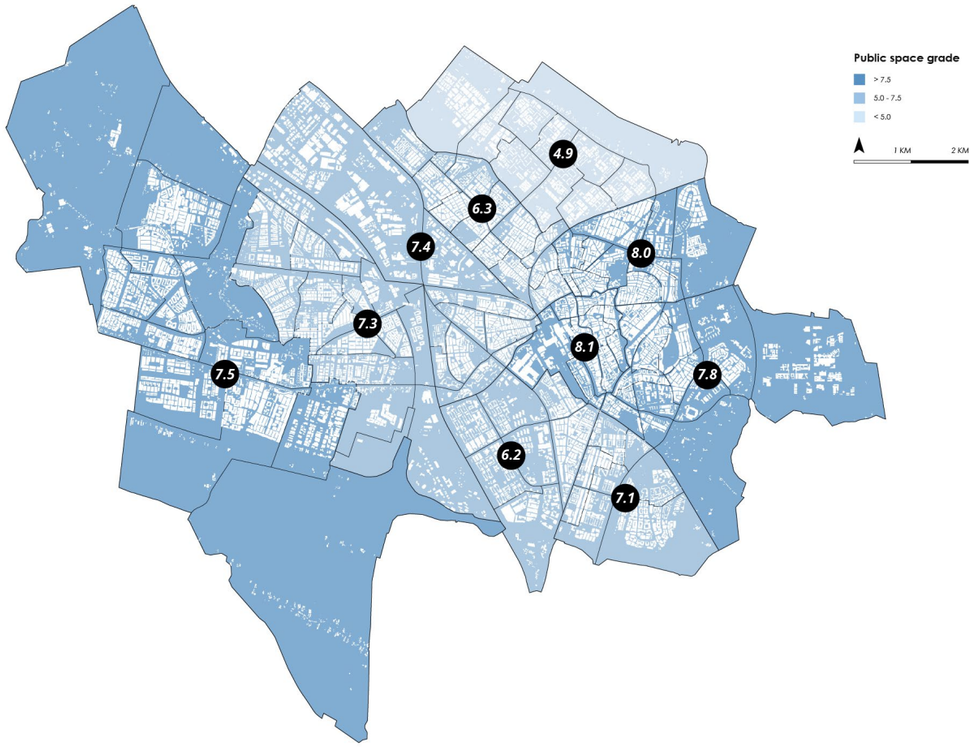

Figure 2.19 Quality of public space according to residents, based on data from Algemeen Dagblad (Hoekstra, 2017)

Appendix 3 Timeline

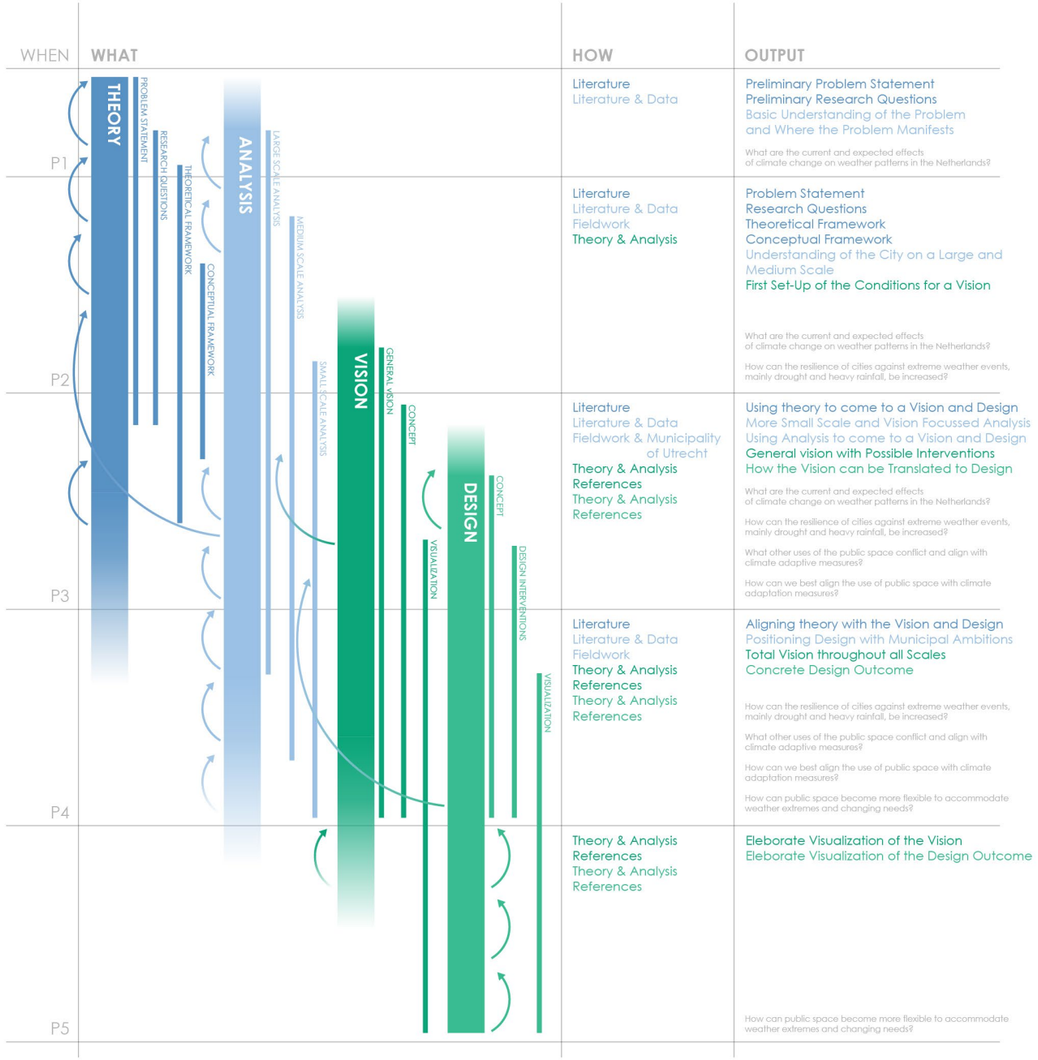

Figure 3.1 Timeline with methods used and output from different phases