SOFTENING THE HARDER GROUND

Researching the potential of new street profiles that include a 50% green surface.

Ilse van den Brink

COLOFON

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Master Thesis Report
Department of Architecture, Urbanism and the Building Sciences
Urbanism Track

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Urban Fabrics graduation studio
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Second mentor: Eric Luiten

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PREFACE

This thesis is a result of a graduation year at the Urban Fabrics studio for the master Urbanism at the Delft Technical University.

The urban environment has always fascinated me, even before starting my studies to become an urban designer. In my life I have lived in many different places with many different urban environments; from the ever busy metropolis Singapore, to a small Dutch town called Dirksland, and many things in between such as Fredericia, Denmark and now the old city of Delft. Each with their own form of activeness, cultures and spaces to accommodate for peoples needs. It is this activeness, the need to do things and move, that is especially interesting to me. How do we get to where we want to go? What is the system behind it and what are the peoples preferences? Is there a way to influence this movement?

On the other hand, the first year of the masters has confronted me with the limited amount of green that we think we can add to the urban. Even though, in my mind, it would add attractiveness to a place and have benefits when it comes to urban and climate change challenges that we need to urgently tackle, it seems like a sometimes far fetched idea to really integrate it in the design. One of my tutors of a design studio in the first year said to me: why don't we just make all the outside space green and have no pavement at all? This concept stayed in the back of my mind; why don't we do this in more places? Are we really that used to living on the hard surfaces that this would not be an option?

It is these two interests that lead me to writing this theses, where I combine the themes of mobility and nature. Even though writing this thesis turned into quite a challenge, especially during the covid pandemic, and resulted in me learning more about myself than I thought I would, I can now proudly present this thesis to you all!

I want to thank my mentor team, Rients Dijkstra and Eric Luiten, for their guidance, critique and support through the year. Their belief in the project inspired me and kept me motivated to evolve further, also in the times that this felt tough to do. I also want to thank my family and friends for their interest, motivation and help throughout the year. Thank you all.

I hope you all enjoy reading this thesis and that it will encourage you to soften some harder ground!

Ilse van den Brink

ABSTRACT

The Netherlands is facing urbanisation and densification, and the domination of car use in our mobility system. Both challenges result in built structures and hard surfaces claiming the public space and leaving less space for green and other functions, resulting in the imbalance in public space demand. Within public spaces the green has a low ecological value and climate change challenges, such as Urban Heat Island Effect and water infiltrattion problems, are not addressed. Yet, we see a call for a mobility transition that is oriented to dominantly soft and shared modes of transport.

This thesis investigates how the mobility transition can be used to create green structures within movement spaces that cater to the urban ecological demand, using the region of Haaglanden as a case study. The urban ecological demand concerns three themes: ecology, social activities, and climate. Each of these themes are represented in the ecosystem services (such as water infiltration or food provision) that natural green and blue structures provide and from which we, as humans, derive direct and indirect benefits.

A strong regional green structure can be created through urban environments by making use of the existing mobility network. By moving the focus away from transportation by car to slow and shared transport and by creating linear green structures, the street is used to connect larger green patches within and around the urban fabric. To realise a regional green structure the street profiles need to change; more soft surfaces are to be applied by minimising the space reserved for car use. A Green Street Toolbox is developed as an instrument to obtain an integrated design where all urban ecological demands are considered by applying a systematic approach to the various considerations. Linking the tools of the instrument to the services they provide to the public space allows for this systematic approach.

By applying the toolbox in combination with new street profiles to the chosen design locations in The Hague, this thesis shows that an average result of softening almost 50% of the street surface is a reachable goal. All these softened surfaces provide ecosystem services to our urban environment, leaving us with healthier and higher quality public spaces.

NEDERLANDSE SAMENVATTING
DE HARDE GROND VERZACHTEN

Een onderzoek naar de mogelijkheden van nieuwe straatprofielen om aan een 50% groene oppervlakte te komen.

Nederland heeft te maken met verstedelijking en verdichting, door het tekort aan woningen en de wens van mensen om in of bij de stad te wonen. Daarnaast heeft de auto de overhand in ons mobiliteitssysteem en neemt deze veel ruimte in beslag. Dit zorgt ervoor dat de openbare ruimte voornamelijk uit harde grond bestaat en er vaak een laag percentage groen aanwezig is. In dit soort gebieden zijn de effecten van klimaatverandering, zoals het hitte-eiland effect, wateroverlast en vermindering van ecologische waarden, overduidelijk aanwezig.

Groenstructuren helpen met het verminderen van de bovenstaande effecten. Constanza et al. (1997) definieert ecosysteem-diensten als de goederen (zoals eten) en diensten (zoals water opname) die geleverd worden door het toevoegen van groenstructuren, en waar wij, als mens, de directe en indirecte voordelen van ontvangen. Sterke groenstructuren worden gerealiseerd door goede verbindingen in het groennetwerk, ook wel het patch-corridor matrix concept genoemd (Dramstad, Olsen en Forman, 1996). Een groenstructuur bestaat uit vlakken, die verbonden worden door lijnen of stapstenen. Dieren gebruiken de verbindingen om zich te verplaatsen tussen de verschillende vlakken. Hoe meer verbindingen aanwezig zijn, des te sterker de groenstructuur. Echter zijn onze steden voor een groot deel verhard en worden de groenstructuren die om de stad liggen vaak onderbroken.

In de stedelijke gebieden is een verandering in het mobiliteitssysteem gaande, waar langzaam verkeer (zoals lopen of fietsen) en gedeeld verkeer (zoals openbaar vervoer of deelauto) meer gebruikt worden. Een persoon die loopt of fietst neemt twintig keer zo weinig ruimte in beslag als een persoon die met de auto gaat, en een deelauto vervangt negen tot dertien privéauto's. Door deze verandering kan het aan de auto geweide oppervlak verminderd worden.

Door de mobiliteitstransitie naar langzaam en gedeeld verkeer te omarmen is er meer ruimte voor zacht oppervlak in de straat en is de inrichting van de bewegingsruimte beter in balans. Een uitgebreider groennetwerk voor de stad en haar omgeving kan, in balans, gerealiseerd worden en de leefomgeving in de stad verbeteren. Deze scriptie onderzoekt daarom de volgende vraag: *hoe kan de mobiliteitstransitie naar langzaam en gedeeld verkeer gebruikt worden om groenstructuren te realiseren in bewegingsruimtes terwijl het voldoet aan de stedelijk ecologische vraag?*

De sub-onderzoeksvragen gaan in op de verschillende typologieën van bewegingsruimtes, de toepassing van groen in deze ruimtes, en de verschillende wensen die daar van toepassing zijn. De resultaten vormen de basis voor een ontwerp instrument dat bijdraagt aan het systematisch vergroenen van bewegingsruimtes. Deze onderdelen zijn onderzocht op drie verschillende schalen: regio, stad en straatschaalniveau,. Voor de regionale schaal is gekeken naar de regio Haaglanden, en als stedelijke schaal is gekeken naar de stad Den Haag, waaruit twee aders zijn gekozen voor de schaal van de straat. Regio Haaglanden is voor een groot deel verstedelijkt, en de steden zijn verplicht binnen de stadsgrenzen te groeien ter bescherming van het beperkte groen dat om de steden ligt.

Voor het bepalen van de test locatie is onderzocht waar de grootste vraag naar verbetering in de stedelijke omgeving ligt, waar de vraag naar groen is en waar de mogelijkheden in het mobiliteits systeem zijn. Uit de regioanalyse is gebleken dat de stad Den Haag en de dorpen in het Westland de grootste vraag hebben naar groen, en verbeteringen met betrekking tot klimaatadaptatie en leefbaarheid. Echter zien we dat Den Haag de grootste mogelijkheden biedt voor verandering van het mobiliteits systeem. Verbetering van de toegankelijkheid voor fietsers en voetgangers is al onderdeel van het stadsbeleid, en openbaar vervoer is op veel delen in de stad goed bereikbaar.

Op regionale schaal wordt door vergroening van het mobiliteitsnetwerk gezorgd voor verbinding(en) tussen bestaande groengebieden in de regio. Uit het huidige mobiliteits netwerk komen twee opties voort voor het verbinden van groenstructuren: Lange (regionale) aders die het groen om de stad verbinden (1), en korte (lokale) aders die de kwaliteit van de lange aders en de leefbaarheid van de stad verbeteren (2). In de regionale visie die is ontworpen voor dit project zorgen regionale aders voor verbindingen in het Nationaal Natuur Netwerk (NNN) en parken in de stad. De lokale aders verbinden kleinere groengebieden en leggen een focus op de leefbaarheid. Als test- en ontwerp locatie is gekozen voor twee regionale aders. De eerste is gelegen in Scheveningen, en die verbindt de oost- en west-duinen met een hoofdverkeersweg. De tweede ader loopt van het centrum van Scheveningen naar het centrum van Den Haag en kan verder doorgetrokken worden naar Delft en zelfs Rotterdam. Deze ader loopt langs verschillende wijken, straatprofielen en groengebieden.

Om een goede groenstructuur te realiseren op de twee aders moet er verandering komen in het straatprofiel. Om ruimte te maken voor andere functies naast autogebruik op de straat, moet de ruimte voor auto's geminimaliseerd worden, wat samengevat kan worden in drie mobiliteits profielen. Het eerste profiel heeft een breedte van 16 meter en bevat een trambaan waar auto's over rijdent, en fietspad en stoep. Het tweede profiel bedekt 14 meter en bevat een autoweg in twee richtingen, een fietspad en stoep. Het derde profiel is 10,5 meter breed en maakt gebruik van een fietsstraat waar de auto te gast is, met daarnaast een stoep. Naast deze profielen is ruimte voor groenstroken, die op verschillende manieren ingedeeld kunnen worden. Er kan gekozen worden voor meer wegdelen en smallere groenstroken, of voor het zo veel mogelijk samenvoegen van groen zodat een brede groenstrook ontstaat. De bredere groenstroken zorgen voor een hoger biodiversiteitsgehalte. Voor een fatsoenlijke groenverbinding tussen groengebieden is minimaal 10 of 20 meter groenstrook nodig. Wanneer deze smaller wordt, moet gebruikt gemaakt worden van voldoende groenvlakken in de structuur (Gemeente Delft, 2004).

Nu kan de groenstructuur ingevuld worden, waarbij gebruik gemaakt wordt van de voor deze scriptie ontworpen toolbox. In de toolbox wordt gebruik gemaakt van simpele groene onderdelen, zoals bomen, struiken en water elementen. Deze gereedschappen worden verbonden aan de ecosysteemdiensten, die zorgen voor ecologische, sociale en klimaat adaptieve benodigdheden voor de straat. Denk aan een natuurspeeltuin, waar water kan infiltreren in de onverharde grond en waar kinderen kunnen spelen, of aan een boom die voor verkoeling zorgt door schaduw- en water evaporatie. De toolbox geeft een overzicht van verschillende gereedschappen die toegepast kunnen worden in de straat om de stedelijk ecologische vraag in te vullen door middel van ecosysteem diensten.

Wanneer de toolbox in samenspraak met de nieuwe mobiliteit straatprofielen wordt toegepast op de gekozen locaties, laat de scriptie zien dat het mogelijk is om 50% van het straatoppervlak te vergroenen. Voor de ader in Scheveningen is het percentage onverhard oppervlak verhoogd van 2% naar 49%. Twee bijzondere locaties op deze ader zijn gekozen om te laten zien hoe de toolbox gebruikt wordt om vlakken in de groenstructuur aan te brengen. Het ontharde oppervlak gaat in deze locaties van 13% naar 45% en van 9% naar 51%. In de tweede ader zijn meer smallere straten te vinden, maar de verandering in onverhard oppervlak is significant,: een verhoging van 5% naar 45%. Bij de bijzondere locatie hier, is het percentage onverhard oppervlak van 0,3% naar 31% gegaan.

Deze scriptie laat zien dat het gebruik van een ontwerp instrument, in dit geval de toolbox voor groene straten, samen met het veranderen van straatprofielen kan zorgen voor een ontharding van 50% van het straat oppervlak. Als de gereedschappen juist worden toegepast, zorgt de verzachting voor ecosysteem diensten in de stedelijke omgeving, waardoor de leefomgeving gezonder wordt én van hogere kwaliteit. Echter is voor het realiseren van een 50% groen straatoppervlak in de stad wel een gedrag- en gedachteverandering nodig bij ontwerpers én gebruikers. Meer groen in de straat en gebruik van langzaam en gedeeld verkeer moet de standaard worden. Laten we met zijn allen veranderen en onze harde grond verzachten!

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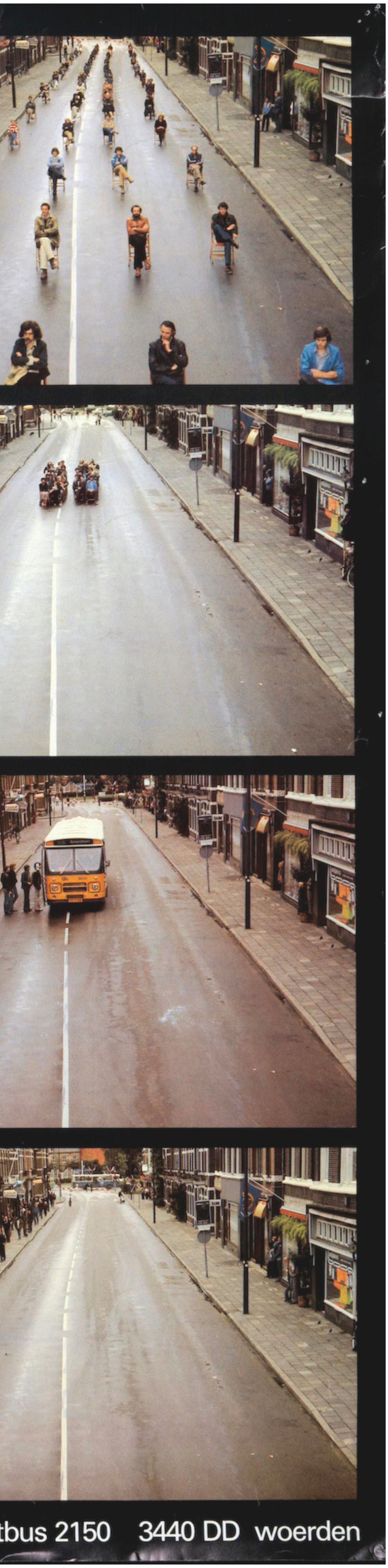
RUIMTEGEBRUIK
echte nederlandse fietsersbond
post



01 THE INTRODUCTION

The introduction provides the reader with an overview of the problem field in which this thesis positions itself, what the context of the thesis will be in terms of geographical location and what the thesis aims to work towards.

Figure 1-1: For who do we design the space? Source: from fietsersbond by A. Haytsma , 1978 (https://www.fietsersbond.nl/nieuws/van-wie-is-de-ruimte/

1.1 MOTIVATION: URBAN CHALLENGES

Changes in the urban environment
Urban challenges are seen all around us. Several phenomena built up these challenges worldwide. A growth in population and urbanisation are causing urban areas to densify. It is predicted that sixty percent of the worlds population will live in cities by 2030. Shortages of housing increase densification through the need for new houses, where the Netherland aims at building 845.000 new homes before 2030 (Rijksoverheid, 2020). With every bit of densification, the urban green is threatened to disappear. Yet these green structures are becoming more important to help combat the increasing challenges posed by climate change, such as risks of flooding, the Urban Heat Island (Effect), extreme weather circumstances, and growing amounts of air pollution (van Stiphout, 2019). The climate challenges are not only creating problems for cities, but it is also threatening the worldwide state of biodiversity. The Global Biodiversity Outlook created by the UN introduces targets to combat the negative changes, yet non of the 2020 targets have been met and so, drastic changes need to be made. One of the main pathways introduced is the transition to sustainable cities and infrastructure, which encourages to "deploy 'green infrastructure' and make space for nature within build landscapes." (Secretariat of the convention on biological diversity, 2020).

In a short period of time, having a car has become the norm (Verkade & Brommelstoet, 2020). At first it was thought that the car would be taking away pressure from busy cities, where people can travel longer distances, for example, from home to work (Millieudifensie, 2017). Yet it seems that, for some, the car is becoming more of a burden than a relief. Some of the newspaper cuttings to the right (Figure 1-2) indicate this, citizens find that urban areas are starting to cramp for space. But a transition is starting in most larger cities, where cyclist and pedestrians are claiming more space and are given more space, especially in city centres.

These urban challenges are pressing themes in the urbanism field and the two areas of green structures and mobility transitions are a major element. Yet, in general, these two themes are seen as separate, even though they occupy the same (public) space. The research done in this thesis will therefore focus on finding possibilities combine the areas of mobility and green structures together to help tackle the urban challenges.

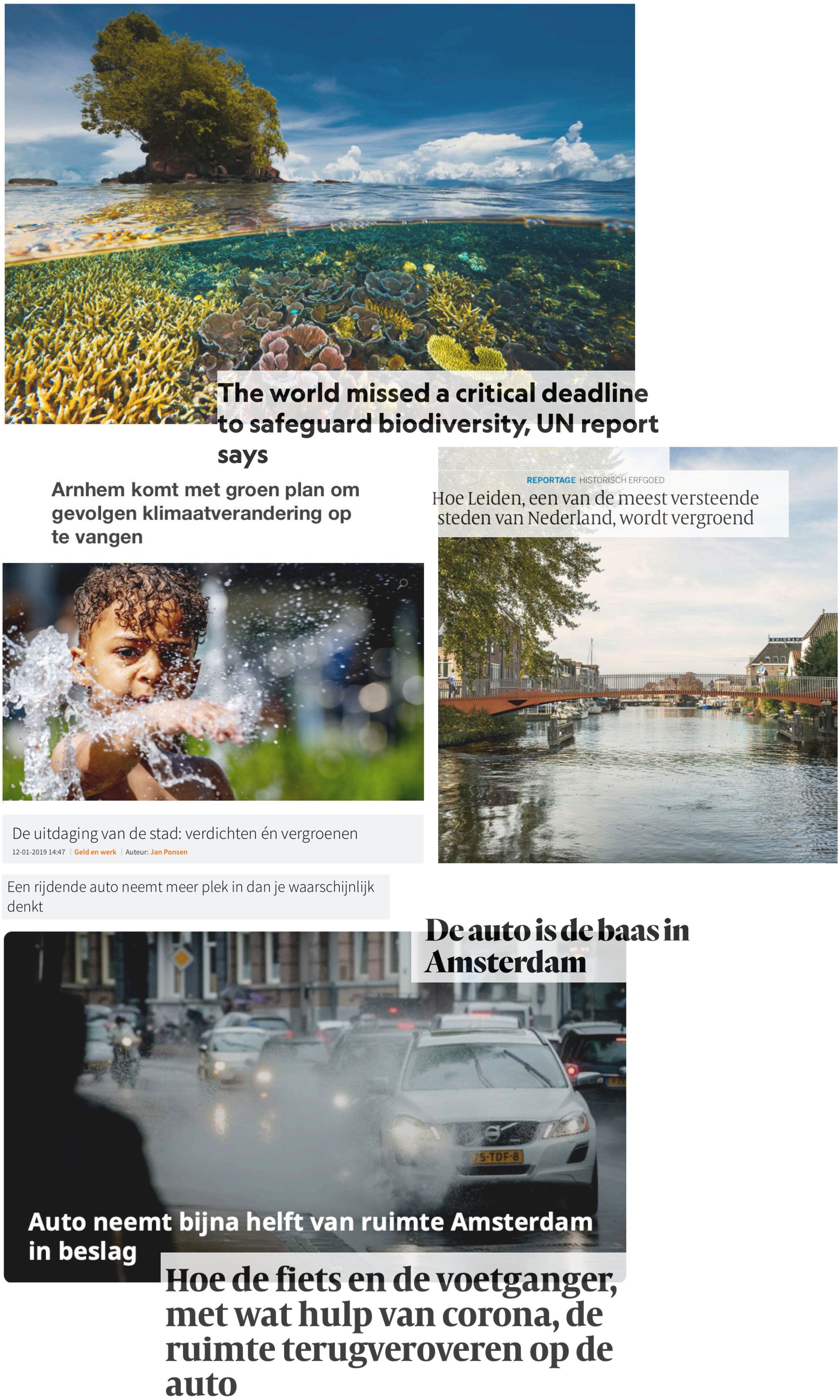


Figure 1-2: Compilation of news articles indicating the motivation and importance of the theme for this thesis. Compilation by Author. Sources: (Zimmer, 2020) (Ponsen, 2019) (NOS, 2020) (Dirks, 2020) (nu.nl, 2020) (Cornelissen, 2017) (Ederveen & Jansen, 2019) (Kraak, 2020)

1.2 REGION OF HAAGLANDEN AS THE RESEARCH LOCATION

In recent years, the Netherlands has witnessed an increase in population in many of the larger cities, and especially in the Randstad. This increase has accelerated since 2008, both due to more people moving to the cities as well as having a relatively young population with a high birth rate. (Centraal Planbureau, n.d.) The region of Haaglanden is part of the Randstad, located towards the South (Figure 1-3) and is a collection of eight municipalities (Figure 1-4), each with different characteristics. There are the cities such as The Hague, Delft and Scheveningen, the smaller towns such as Pijnacker, Nootdorp and Zoetermeer, the industry and horticulture of the Westland and the green area of Midden Delfland. The green spaces between the urban areas within the municipalities reduce as new housing and industry is introduced to reach the aims of the economic policies of the municipalities. Lack of collabration between the municipalities makes that the impact on the regional green structure is even larger. To be able to reach a high standard regional green structure in combination with meeting the aims of the economic policies, solutions need to be found within the current build environment.

Figure 1-3: The region of Haaglanden in the context of the Randstad (figure by Author).

Figure 1-4: Municipalities in the region of Haaglanden (figure by Author, data from OSM).


Wassenaar
Den Haag
Leidschendam
-Voorburg
Zoetermeer
Rijswijk
Pijnakker
-Nootdorp
Westland
Delft
Midden-Delfland
N

1.3 THE PROBLEM FIELD

1.3.1 URBAN DEVELOPMENTS

Urbanisation

The term urbanisation refers to a country or region that is becoming more urban (McGranahan & Sattarthwaite, 2014). Demographically speaking, this can be interpreted as a growing share of the population living in urban settlements (Poston and Bouvier, 2010). This very definition involves the shift of population from rural locations to urban locations, resulting in transformations in both rural as well as urban landscapes (McGranahan & Sattartwaite, 2014). The ongoing trend worldwide is that the urbanisation is accelerating, predicting that sixty percent of the world's population will live in cities by 2030. In 1800 only two percent of the population lived in cities. In 1950 this increased to thirty percent and in 2007 more than half of the world population lived in cities (PWC, 2015).

In the Netherlands, urbanisation started in the second half of the 19th century. People started to move to the city due to the increase in economic and cultural attractiveness of urban areas and due to the agricultural crisis (Ekamper, 2010). Within the region of Haaglanden, cities started growing rapidly (Figure 1-5), where urban areas and the horticulture greenhouses start to fill up the region (topotijdreis.nl, 2020)

Population growth

The increase in population density did not only take place in urban regions but also in the more rural region. The Dutch population increased from 5 million people in 1900 to 17 million in 2020 and is expected to increase to around 18,3 million by 2035 (CBS, 2020a). Almost three-quarters of this growth takes place in large to medium-size cities (municipalities with at least 100 thousand citizens), but also in municipalities around these cities. Most of the cities have a relatively young population and are mainly growing due to a high birth rate and a lower death rate. The cities also attract immigrants, ex-pats and international students (CBS, 2020b)

Housing deficit

Next to population growth, there has been a trend of decreasing household sizes and a preference for larger houses (Farjon, Hazendonk & Hoeffnagel, 1997). These trends are resulting in the Netherlands having to deal with a housing shortage, which currently resides at 331.000 houses. To resolve this shortage and supply for future demand, the country aims at building 845.000 new homes before 2030 (Rijksoverheid, 2020).

The 'Structuurschets Stedelijke Gebieden' (structural sketch urban areas) from 1985 already showed the importance of locating new urban developments within city borders,

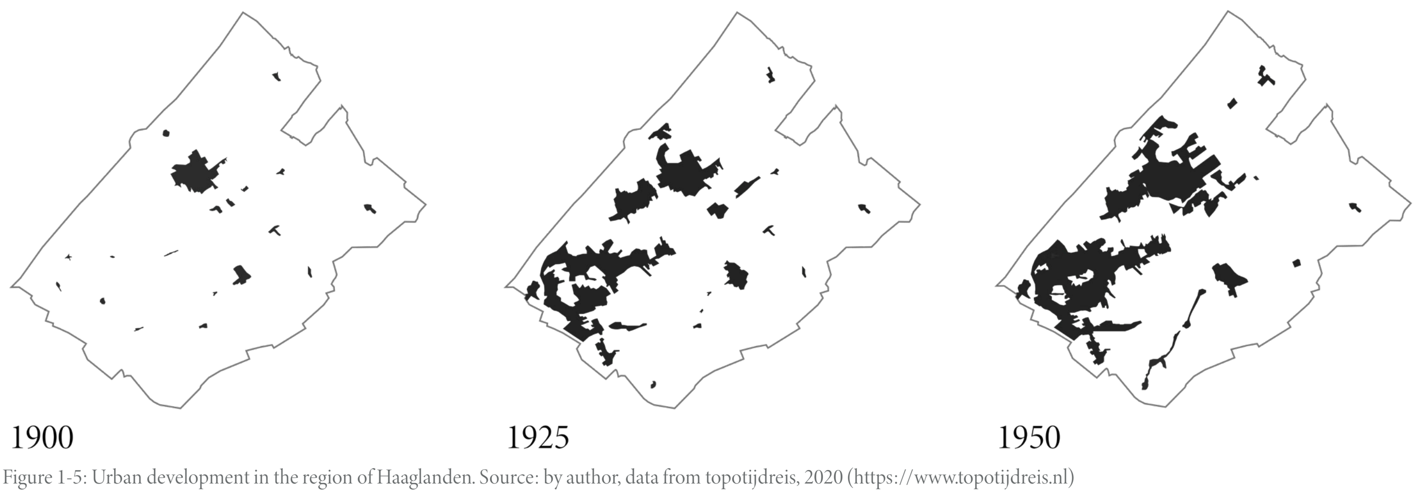


Figure 1-5: Urban development in the region of Haaglanden. Source: by author, data from topotijdreis, 2020 (https://www.topotijdreis.nl)

as growing cities lead to a decay of the environment and surrounding green landscape (Farjon, Hazendonk & Hoeffnagel, 1997). With that, the concept of the compact city is introduced to the Dutch urban developments, where densifying has become the norm (Nabielek, et al., 2012). Figure 1-6 shows where the province of South Holland is planning to realize the housing task, placing a large amount of the housing within current urban environments.

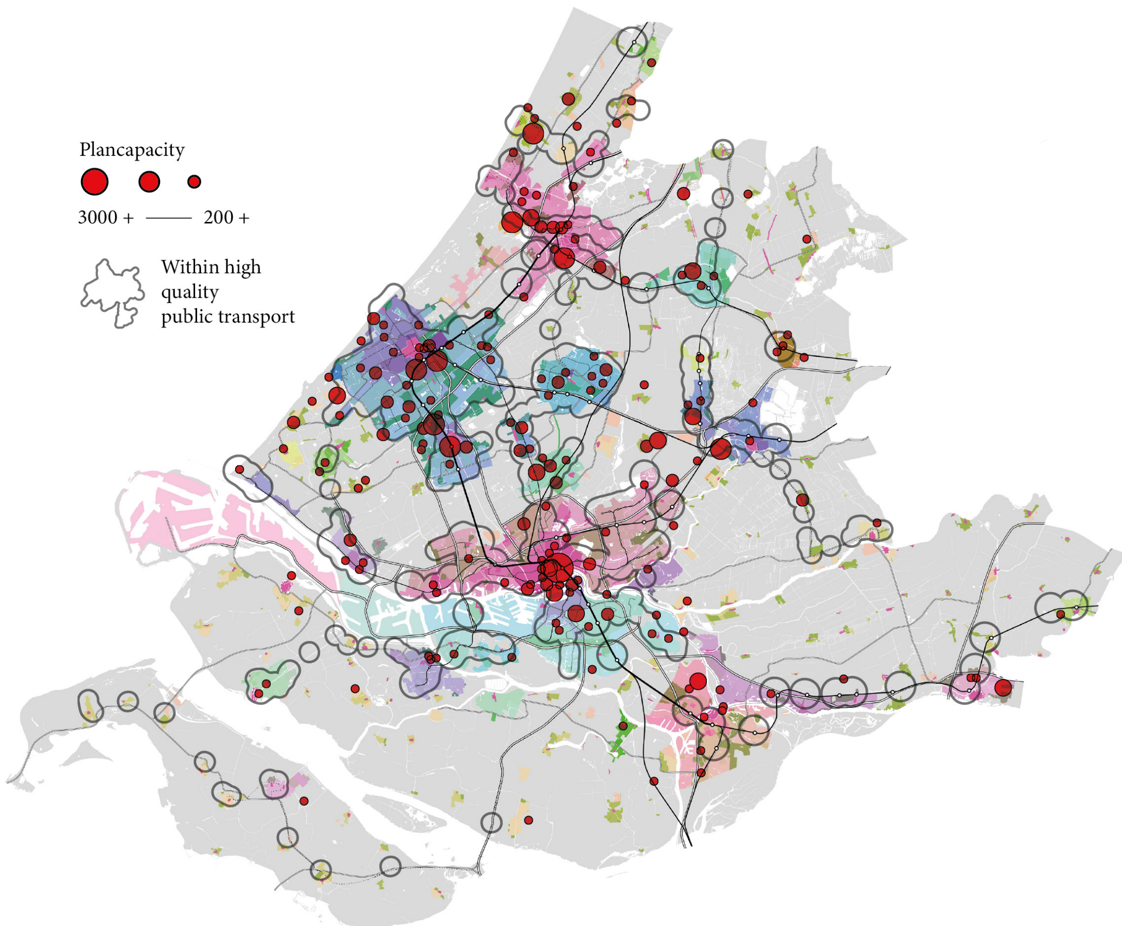
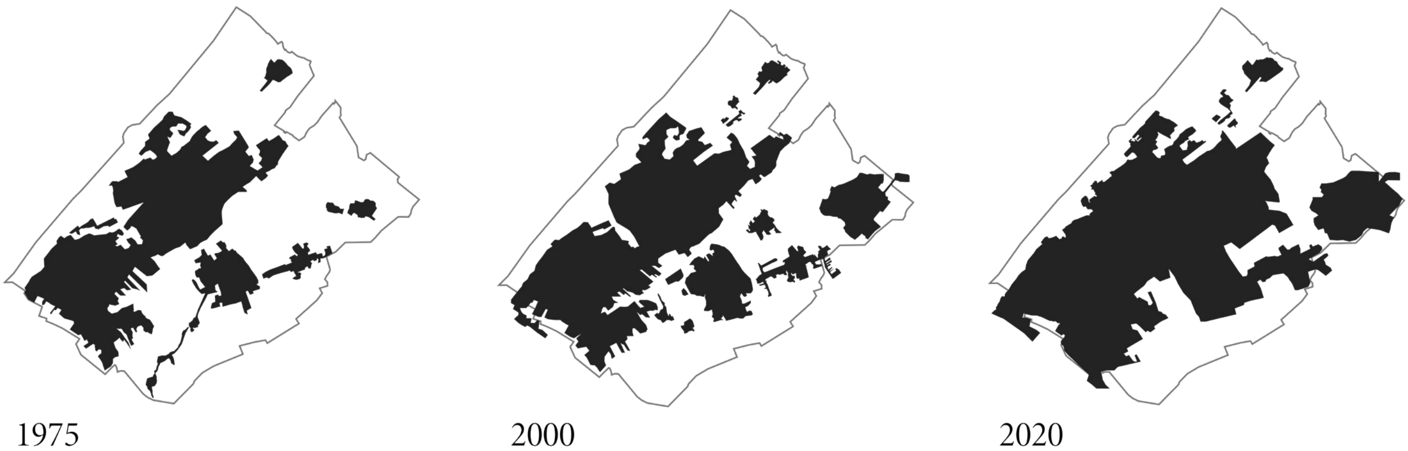


Figure 1-6: Building agenda of the housing task of South Holland for 2017 to 2024. Source: Provincie Zuid-Holland (n.d.)



1.3.2 THE MOBILITY SYSTEM

The growing population leads to growing cities and to a growth in mobility. The growth of the city was partially made possible due to the arrival of the car, allowing people to travel longer distances resulting in urban sprawl. Owning a car has become the norm in a short period of time (Verkade & Brommelstoet, 2020). At first, it was thought that having a car would take away the pressure from busy cities as people would be able to live further away. But as it turns out, most urbanized areas have started to cramp for space as the car takes up a lot of space both as a moving as well as a static object. By comparison, as shown in Figure 1-7, the parked and mobile car takes up more space than cyclists and pedestrians.

Trends and challenges

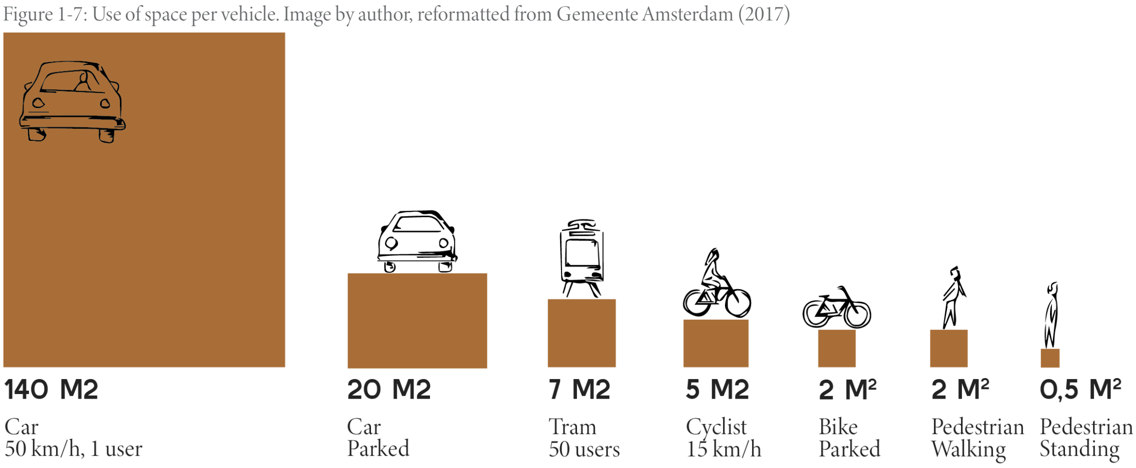
As mentioned in the introduction chapter, news articles often address the need for fewer cars and creating space for slow traffic, but the numbers show that, until now (2020), the amount of cars owned by people in The Hague is still rising with 1,7% per year at the start of 2020. This does not mean that everyone will at some point own a car. For the city of The Hague around 46% of the households do not currently own a car and even though this number is falling, it will stay significant (Gemeente Den Haag, 2011).

Another trend that needs to be considered is the individualisation, where people can set up their preferred package for living, activities and mobility. This makes it harder to predict mobility behaviour. Combined with the fast improvement of technologies in regard to mobility, such as electric bicycles and cars, as well as on-demand knowledge of public transport options, means that mobility will become more diverse (Gemeente Den Haag, 2011).

Mobility transitions, a definition

The European Environment Agency (2019) defines mobility transition using three elements: avoid-shift-improve. To avoid refers to the reduction of the number and/ or length of trips. To improve refers to the increase in uptake of environmentally friendly fuels and vehicles. To shift refers to the shifting of transport modes from less to more environmentally friendly modes. This thesis will focus on the last of the three elements, in particular: the shift towards slow and shared modes of transport such as walking, cycling and public transport.

Figure 1-7: Use of space per vehicle. Image by author, reformatted from Gemeente Amsterdam (2017)



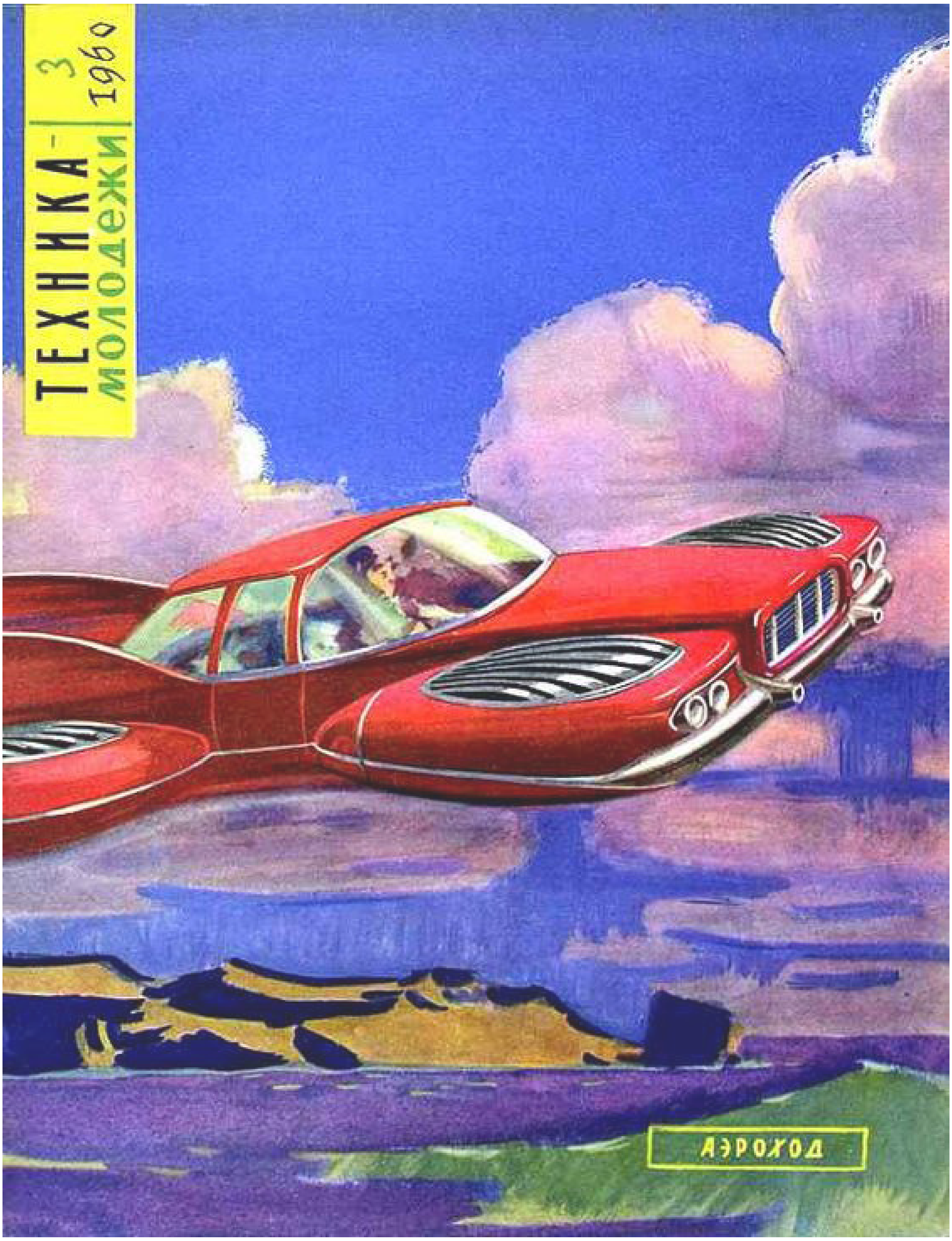


Figure 1-8: Mobility transitions - dreams of the future. soviet-era exploring illustrations exoploring future transportation Source: Tekhnika Molodezhi, (Technology for the Youth) megazine, volume 3, 1960.

1.3.3 PROBLEMS WITH A PAVED ENVIRONMENT

The increase in building density and the need for more infrastructure and parking due to urbanisation increase the paved surface area of cities (de Vries, et al. 2017). Within the province of South Holland, this built surface is grew from 20,4 per cent in 1996 to 23,4 per cent in 2015 (CBS, 2019). This increase in hard surfaces brings with it multiple threats caused by climate change, such as the urban heat island (UHI) and flooding (van Stiphout, 2019).

Urban Heat Island effect

The Urban Heat Island (UHI) effect represents the elevated temperatures of urban environments in comparison to its surrounding rural environment. The UHI can be split into two categories: surface and atmospheric UHI (European Protection Agency (EPA), 2008) The sun will heat exposed surface areas like roofs, walls and pavements, as they tend to absorb a significant amount of the incident radiation. The surfaces will, in turn, heat the surrounding air, which happens through a slow-release mainly seen and felt around sundown (EPA, 2008) (Arrau & Pena, 2019). This timing, however, will change depending on surface type, season, and weather conditions (EPA, 2008).

Urban flooding

Extreme weather conditions are also a result of climate change. Summers will be warmer and have less but heavier rain, whereas the winter will have more and heavier rain (WUR, n.d.). The built surface areas are causing the surface to be impermeable to water flow. This, in turn, increases the amount and run-off of water that arrives at sewers and permeable surfaces (Scalenghe & Marsan, 2009) increasing the number of floods in urban environments (WUR, n.d.).

Figure 1-9: Upper Image. Urban infrastructure leading to fully paved movement spaces. Source: by author

Figure 1-10: Middle Image. People 'enjoying' the heat in Amsterdam, having a drink at a cafe with their feet in the water of a inflatable swimming pool. Source:

Figure 1-11: Lower Image. A boy canoing on the water in the city where he lives due to a flooding. Source: NOS Nieuws (2020) Waterpleinen rotonde met "zwembad". Zo gaan gemeenten wateroverlast tegen.


BRANDWEER
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1.3.4 GREEN IN HAAGLANDEN

Climate change not only poses threats for cities, it is also threatening the worldwide state of biodiversity. One of the main pathways the UN introduces to minimize our impact on biodiversity is to transition to sustainable cities and infrastructure and make space for nature within built landscapes (Secretariat of the Convention on Biological Diversity, 2020). This will also help combat the climate change challenges aforementioned. Trees and other vegetation will help minimize the UHI through shading and evapotranspiration (EPA, 2008). Vegetation will help protect cities against flooding in extreme weather conditions as it will create more permeable surfaces to absorb the water (Scalenghe & Ajmone Marsan, 2009).

Green in the region of Haaglanden

Within Haaglanden, green structures create borders around and between the cities of the region (Figure 1-13). The sea-side consists of dunes that are marked as Natura-2000 zones. Towards the North-East the peat meadows indicate the edge of the 'Groene Hart'. The Zwetzone, connecting to the Midden Delfland is situated towards the South-East. The cities are spotted with shreds of green. The Westland only shows a few small patches of green and can be considered the least 'nature-rich' area in the region (Haags millieucentrum, 2008).

Most of the 'border green' is part of the Dutch National Nature Network (Nationaal Natuurnetwerk (NNN)), which is shown for this region in Figure 1-12. Within this NNN the cities act as a barrier between the ecological areas (Haags millieucentrum, 2008). Yet, when taking into account the urban green structure the NNN could be connected through the urban environment as well. This could give a boost to the NNN when used to the right potential. This concept of using urban green structure to connect remove the barriers is currently not used due to organisational reasons. (The municipalities are responsible for the urban development and the provinces for the NNN).

Figure 1-12: Upper Image. The Dutch National Naturenetwork (Nationaal Natuur Netwerk, NNN) in the region of Haaglanden.

Figure 1-13: Lower Image. The green network of The Hague within the NNN

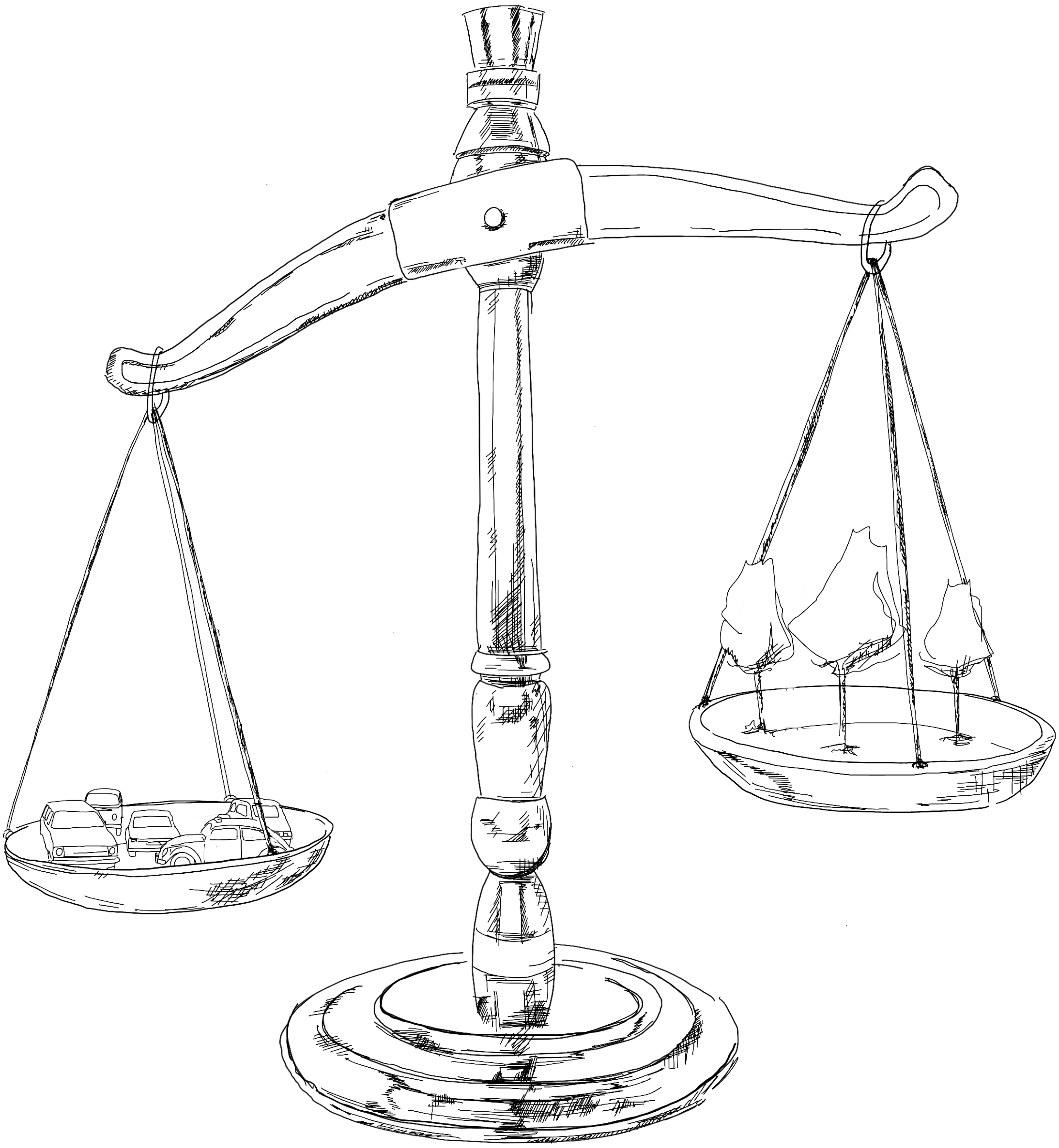

Figure 1-14: The demand for public space is not in balance, where the car dominates the streets and green is less dominant Source: image by author.

1.4 PROBLEM STATEMENT

The Netherlands is facing the challenge of urbanisation and densification to suffice to the housing need. Another challenge is the current mobility system, dominated by personal transportation in the form of car use. The car, as either a moving or static object, dominates the design of public space. Both challenges result in built structures and hard surfaces claiming most of the public space and leaving less space for green. It results in an imbalance in public space demand. Within this environment, climate change challenges such as the Urban Heat Island Effect and water infiltration problems have become urgent and the ecological value of the green structure is low.

Yet, there is a call for a mobility transition, oriented towards a dominantly soft and shared mobility system. This change in the system can lead to a change in public space design where there is less need for the car, restoring the balance of the space demand to create more green structures.

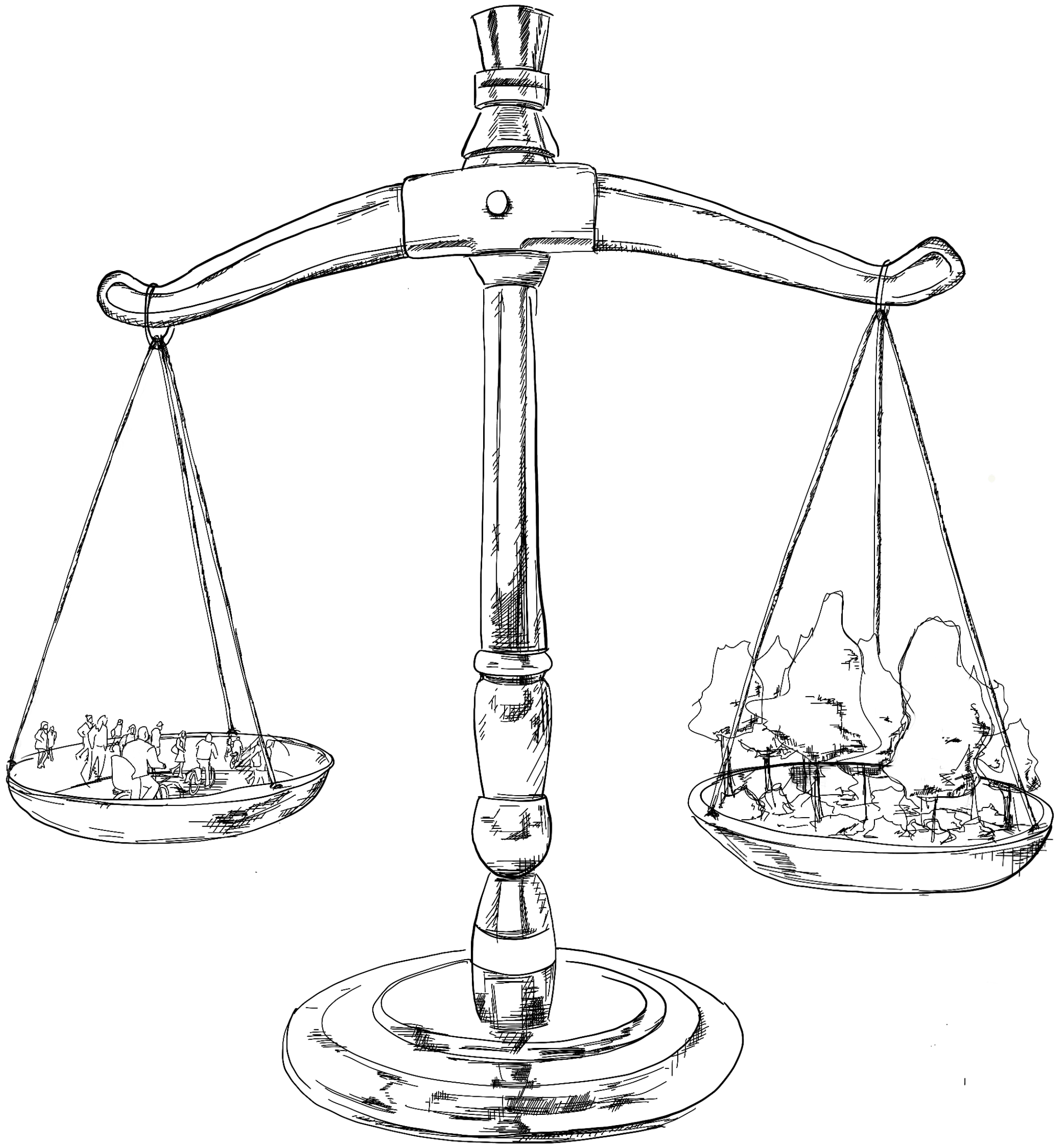

Figure 1-15: The aim for this thesis is to create a balance between the demand for public space from mobility and green structures. Source: image by author.

1.5 RESEARCH AIM

This research aims to use the mobility transition to soft and shared modes of transport as a means to soften the hardened urban fabric. A green structure is created within the movement spaces. This structure caters to the urban ecological demand, on the one hand by designing for higher ecological value and connecting green structures and on the other hand, aiding in the combat of climate change challenges. As such, the urban environment will provide better living conditions for all inhabitants: animals, vegetation and people.


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veer begonnen
Stomerij Wasserij Dry Cleaning Service

02 THE THEORETICAL UNDERPINNING

This chapter provides the research with a theoretical base that underpins and connects the different concepts researched in the problem field. It does so by answering two questions: 1. Why is it important to increase ecological environments in the urban? 2. Why should we combine ecology with the mobility network?

Figure 2-1: Natural playground ath the primary school on the Westduinweg, Scheveningen. Source: photograph by author

2.1 UNDERPINNING THE WHY

This first part refers to the question 'Why is it important to increase ecological environments in the urban environment?' To answer this question, first the term 'urban environment' is explained. Next the two concepts of ecosystem services and social-ecological urbanism are explained, as they bring together the need for green structures to cater for social and environmental needs within the urban environments.

2.1.1 THE URBAN ENVIRONMENT; A DEFINITION

The term 'urban environment' is often used in research regarding urban design and planning while it is not always defined. Understanding the concept of the term urban environment is crucial to analysing movement spaces, mobility trends and green networks in the region of Haaglanden. Looking into the definition of both 'urban' and 'environment' the concept of urban environment seems to apply to both the spatial as well as the natural studies. In the Oxford dictionary, 'Urban' is defined as 'relating to, or characteristic of a town or city' (Oxford, 2020a) indicating spatial implications. Lussault (2003, as cited in Senecal, 2007) refers to it as a complex and relatively central organisation of lived space. It can include different types of areas ranging from metropolises, city centres and neighbourhoods to mid-size towns; spaces characterised by patterns of development and social interactions (Senecal, 2007). 'Environment' is defined as either the 'surroundings or conditions in which a person, animal or plant lives and operates', as well as the 'natural world as a whole or in a particular geographical area, especially as affected by human activity' (Oxford, 2020b). This refers to a point of view from the natural sciences. Besides, the definitions of both 'urban' and 'environment' suggest a connection to the study of the social sciences. Within research, the term seems to be used either with a focus on this social aspect, for example when trying to understand actions and social practices taking place in a city, or with a focus on natural sciences discussing problems such as climate, water, air, animals etc. (Senecal, 2007). However, one could say that the built environment will always be dependent on the social environment and the social environment will be dependent on the built environment. As William Cronon (1996) says, our attention is directed towards societies' perception of the surroundings, resulting in the urban environment being a compilation of social facts and states of nature. As such, one can define the urban environment as the built environment shaped as such that it can facilitate the entanglement of social needs and states of nature applicable to a specific geographical location.

2.1.2 ECOSYSTEM SERVICES

Ecosystem services, as defined by Constanza et al. (1997), refer to goods (such as food) and services (such as waste assimilation) that are presented by the ecosystem functions and from which we, as the human population, can derive the benefits, both directly and indirectly. These ecosystem functions can vary to be, for example, the habitat, biological or system properties, or processes of ecosystems. A study by Folke et al. (1997) estimates that cities claim support from ecosystems that consist of an area at least 500 to 1000 times larger than the area of the city itself. On the other hand, natural ecosystems are also present within the cities, contributing to public health and an increase of quality of life for the citizens. These consist mainly of natural green and blue areas; the urban ecosystems (Bolund & Hunhammer, 1999). Bolund and Hunhammer (1999) identify seven different urban ecosystems; street trees, lawns/parks, urban forests, cultivated land, wetlands, lakes/sea, and streams. The street trees need to be regarded as a part of a larger ecosystem since they are too small to be regarded as their own ecosystem.

These ecosystems each have different services they can offer. Constanz et al. define seventeen services, of these six services can be selected to have larger importance in urban areas; air filtering, micro-climate regulation, noise reduction, rainwater drainage, sewage treatment, and recreational/ cultural values (Bolund and Hundhammer, 1999). De Urbanisten, et. al. (2016) make this list longer, and devide the ecosystem services into four categorties: Regulating services, cultural services, production services and supporting services. This list of services also include ecological services, such as soil fertility, pollination, life cycle protection and biodiversity (De Urbanisten, et. al. 2016)

While some of these ecosystem services are limited to landscape size and continuity, such as food production or pollination, many are not. It is these interdependent services that value addressing in urban environments, where they could be designed to provide specific ecosystem services. Although it can be expected that multiple ecosystem services are not mutually exclusive; they will always affect one another, the fact that optimizing one ecosystem service may not optimize the overall ecosystem services production is often neglected (Windhanger, et al., 2010).

A broader array of information on a project on different scales and political objectives is needed to be aware of the different ecosystem services that are available and necessary (Windhanger, et al., 2010). The framework for ecological design by Lovell and Johnston (2009) demonstrates this importance of a multi-scalar and multi-temporal approach to create, what they call, multifunctional landscapes. The ecological design process is made up of five steps; 1. Describe the project site and landscape context. 2. Characterize and analyse existing features and functions. 3. Develop masterplan using an ecosystem approach. 4. Develop site designs to
reveal the ecological function and 5. Monitor the ecological function. The monitoring of the ecological function is of importance to derive whether proper implications have been chosen, for there is no applied research that suggests specific design guidelines for a multi-scalar landscape design.

Within this thesis project, the ecosystem services of the green structure will be used to create more attractive and liveable environments. The focus of the ecosystem design will be placed on combatting environmental challenges such as heat and rainwater drainage, and to create attractive environments for flora and fauna.

2.1.3 SOCIAL-ECOLOGICAL URBANISM

Barthel, et al., (2013) built the theory on social-ecological urbanism with resilience theory as its foundation, focusing on system-level design that buffers capacity and potential for renewal concerning internal and external disturbances. The concept of social-ecological integration is defined by Forgaci (2018) as 'the capacity of social-ecological systems to sustain synergies and to alleviate conflicts between the patterns and processes of coexisting ecological and social components.' These social and ecological design components include both spatial and institutional components (Barthel, et al. 2013). The social-ecological design applies resources combined with adaptability from ecological and social components to the urban environment to enhance the composition and configuration to fulfil social and ecological goals (Forgaci, 2018).

The primary approach in social-ecological urbanism is to deal with in-depth sustainability and to use urban design to link the ecological and social systems. To understand these linkages and the interplay needed, all systems need to be made a natural and integrated part of future urban design. To achieve this, one tenet in social-ecological design is starting from the local conditions of the site to achieve a suitable integrated design (Barthel, et al. 2013). Barthel, et al. (2013) identifies six important social-ecological design components (three spatial and three institutional) that help create a comprehensive structure; green

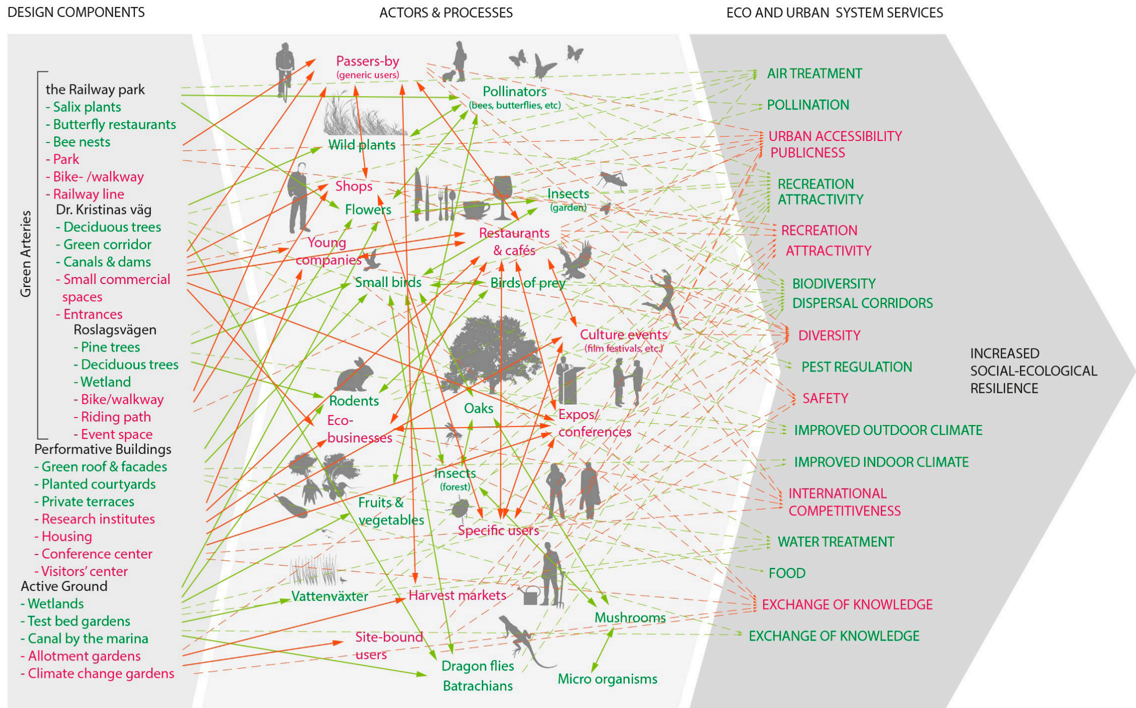


Figure 2-2: Social and ecological systems are dynamically interconnected, designing spatial morphology to create high quality urban areas and services while supporting local ecosystem services. The design components create conditions for actors and processes which generate these eco and urban services. Source: Barthel, et al., 2013

arteries, active grounds, performative buildings, property rights/rules, social networks, and local traditions. The spatial components include main elements of urban form whereas the institutional components include owner rights and forms of management (Barthel, et al., 2013).

When designing a structure that caters to the urban ecological demand, it is important to integrate the social and ecological systems of the location. Part of this is finding the local problems and local solutions that focus on social networks and functions as well as the ecosystem services that can improve the location, as explained before.

2.2 UNDERPINNING THE WHERE

This second part of the theoretical underpinning answers the following question: why should we combine ecology with the mobility network? The question is answered by looking into theories for green networks; the patch-corridor matrix, and trends within mobility.

2.2.1 PATCH-CORRIDOR MATRIX

The Patch-corridor-matrix concept is formed by Dramstad, Olson and Forman (1996) and describes how the earth is a compilation of a variety of land mosaics. Each mosaic consists of a simple spatial language combining patches, corridors, and the matrix. Adding, removing, or rearranging elements within the mosaic will change its function and flows. This can be done either by natural processes as well as human activities. Each of the mosaic elements is shortly explained below.

The patches form the plant and animal habitat that are increasingly scattered. Even though patches show some relation to their surroundings, they often have some degree of isolation, the effect and severity being dependent on the species that are present. Patches often originate from remnants of, for example, woods either introduced by humans, formed through disturbance (such as a windstorm) or are created as an environmental resource. Each patch has edges and boundaries, sometimes hard sometimes soft. These edges hold a significant ecological function, where they work as an ecological transition zone between different types of habitats (this transition zone can also be from a human-made to a natural habitat).

Corridors provide landscape connectivity, in particular in the form of wildlife movement corridors and steppingstones. Wildlife can move through a corridor or across steppingstones to move between patches. On the other hand, corridors can also act as a barrier or filter to certain species movement, such as roadways, railroads, power lines etc. Streams and rivers also have an exceptional significance in a landscape.

The overall structure and the functional integrity of these elements put together create a pattern or mosaic. Within these mosaics, one can assess the ecological health using the overall connectivity of the natural systems in the region. Corridors will often cross and combine to create networks. These networks enclose other landscape elements. But this encasement can also result in fragmentation, often considered to cause loss and isolation of habitat. It is important to look at multiple scales when looking at fragmentation and health of habitat in general, as the impacts can be perceived differently on different scales. "Only by recognizing and addressing landscape changes across different scales can planners and designers maximize protection of biodiversity and natural processes." (Dramstad, et al., 1996).

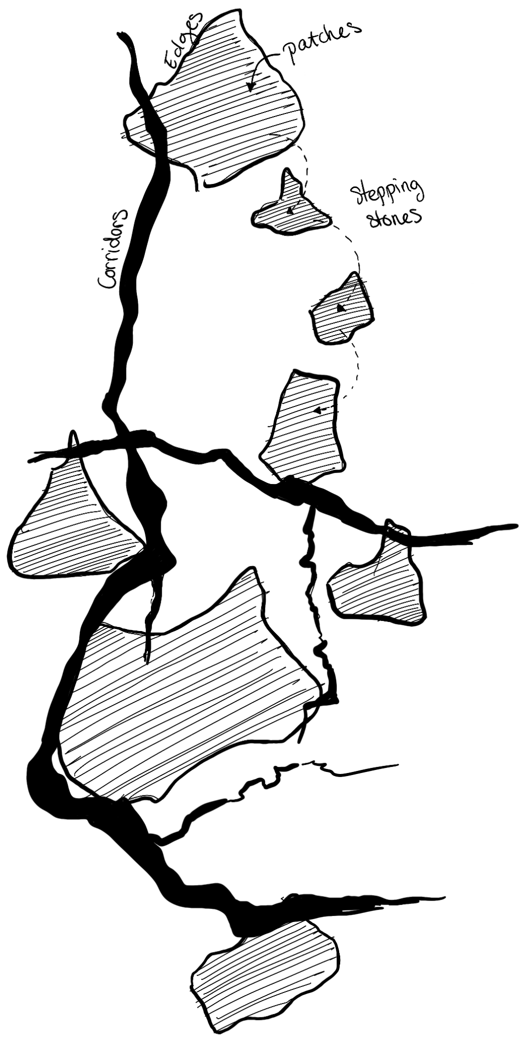


Figure 2-3: Visual representation of the patch corridor matrix.
Source: by author.

2.2.2 A GREEN NETWORK THROUGH CITIES

The PCM and NNN as explained above refer mainly to green structures in rural areas and urban green structures are not specifically considered. Yet, urban structures act differently than rural structures. Due to urbanisation, green spaces in cities are more fragmented causing the green spaces to become small and isolated, impacting the populations abundance, genetic variation, and species richness (Fahring, 2003; Mckinney, 2002; Mabelis, 1998) as the reduction of habitat of an animal species entails that the number of reproduction spaces, shelters and amount of food that is available reduces as well (Mabelis, 1998). The fragmented habitats can be connected such that they form a tight network to minimize extinction of local populations by compensating through the (re)colonisation of unused habitats. Mabelis (1998) mentions three possibilities for creating this network that relate to the elements of the PCM: 1. Adding corridors for the exchange of local populations and possibly for procreation, 2. Adding (small) habitats as steppingstones, and/ or 3. Adding ecological bridges or tunnels to reduce the spreading resistance.

The impact of this network on biodiversity is dependent on two different factors: the size of the habitat and the vegetation added to the habitat. The criteria of both factors are in turn dependent on the species that inhabit the area naturally (Mabelis, 1998; Lepczyk, et. al. 2017; Beninde, et. al. 2015). The patch size often indicates the number of biotopes that are present in that patch, the larger the patch, the more biotopes. This increases the biodiversity by attracting different animal species that need different biotopes as well as attracting species that need multiple biotopes throughout their life cycle (Mabelis, 1998). When it comes to corridor connections between patches, primary and secondary corridors need a minimum width of 20m and 10m respectively to allow proper animal and plant dispersal. Yet, in cities, this amount of space is often not available. In such cases a smaller width (3m at the smallest) can be applied as long as there is a larger width or steppingstone available in some places along the corridor (Gemeente Delft, 2004).

Within these patches and corridors, it is important to focus on preserving and improving the habitats of native species to reach a high urban biodiversity (Mabelis, 1998). To do so, it is important to first make inventory of the current situation and understand the current flora and fauna species in both the design area as well as the full urban green structure (Mabelis, 1998; Vink, et. al., 2017). This means, urban biodiversity should reach a large variety of urban biotopes to house as many of the native species (Mabelis, 1998).

2.2.3 MOBILITY TRANSITIONS

The European Environment Agency (2019) defines mobility transition using three elements: avoid-shift-improve. To avoid refers to the reduction of the number and/ or length of trips. To improve refers to the increase in uptake of environmentally friendly fuels and vehicles. To shift refers to the shifting of transport modes from less to more environmentally friendly modes.

Mobility transition plans as proposed by cities mainly focus on improving and shifting. Improving in the form of transitioning from fossil-fuelled transport to renewable energy fuelled transport. The shift places its focus on creating more attractive atmospheres for the use of the bike, walking or public transport (slow and shared transportation). Large and fast transport is limited to the outer roads, leaving more space for slow transport in the inner cities (Gemeente Den Haag, 2011) (Gemeente Rotterdam 2020). Projects such as the Merwe-vierhaven in Rotterdam and Merwedekanaalzone in Utrecht follow this principle, where cars are not allowed into the neighbourhood, but people are encouraged to use slow transport and shared transportation (Gemeente Utrecht, et al.

2020; Rotterdam Makersdistrict, 2019). In recent years, the car has started to become part of the shared transport system. Organisations such as Greenwheels or hubs such as introduced in Delft, Delft Mobility (Nieuw Delft, 2021) are becoming more numerous. CROW (n.d.) concluded that car sharing leads to a decrease in car ownership, where 30% of shared car users own less cars than before they started using shared cars. As such, one shared car replaces nine to thirteen privately owned cars. This results in a lower need for parking with a reduction in the parking needs by 3 to 5 cars. In other countries than the Netherlands, shared cars are integrated in the transport company marketing and/or in the user subscription (Crow, n.d.). The concept of Mobility as a Service (MaaS), where different transportation modes are combined in one subscription and can be accessed through one interface, can be applied to help direct the shift from ownership based transportation to shared transportation (Jittrapirom, et. al., 2017).

In any case, mobility systems are created to connect different places, and to ensure permeability, streets should always connect to other streets (Carmona, et. al., 2003). Even with transitions in the mobility system, the physical network it creates will most likely stay for a large part, but will change in the profile design and the use, for example by reducing parking spaces through the use of shared car systems.

2.3 CONCLUSION

The theoretical underpinning forms a basis for two important questions: 1. Why is it important to increase ecological environments in the urban? And 2. Why should we combine ecology with the mobility network?

As explained in the problem field, the increased built and paved environments pose many challenges that need to be solved, such as the heat island effect, flooding due to the lack of water resistance and low ecological value. Making use of the ecosystem services that are presented when increasing green in urban environments, one can try to tackle these problems. In the meantime, the social-ecological urbanism shows how these ecosystem services and green structures in general also have benefits for the social system when implemented considering the needs of a specific location.

Yet, the problem field also showed that the green structure of the region of Haaglanden does not work as a complete network. According to the patch-corridor matrix theory, a network of green is important for the ecological status of a region. The main reason that this green structure is not a complete network is because of the urban environments that act as barriers because of the abundance of hard surfaces. But this urban environment shows potential in the mobility network that is already present. If space is created within this network to place more green elements in the street, the green network in the rural areas can also be connected through the urban areas.

03 THE METHODOLOGY

This chapter of the report explains the research questions of the thesis, and the approach and methods used to answer the questions.

Figure 3-1: Roundabout with flora and fountain on the Bankastraat, The Hague. Source: photograph by author

3.1 RESEARCH QUESTIONS

Following the research aim from chapter 1, the following research question has been developed:
How can the mobility transition to soft and shared modes of transport be used to create green structures within movement spaces, that cater to the urban ecological demand?
To answer this question, five sub-questions have been formulated. The first three questions analyse the current situation and the problem field within the chosen research location in more detail: movement space, the green structures, and the urban ecological demand as defined through conflicts of interest. Questions four and five focus on the design product of the thesis that will help answer the question through research through design.

SQ1: What are the different **typologies of movement space** in urban environments?

SQ2: What are the applications of **green in movemen**t spaces?

SQ3: What are the **conflicts of interest** to consider when designing a balanced movement space?

SQ4: What **design instrument** can contribute to creating a more systematic approach in the design of movement spaces that cater to urban ecological demand?

SQ5: How is the design instrument used in the **design location**?

3.2 THROUGH THE SCALES

The project places its focus for research and design on three different scales: the regional scale, the city scale, and the street scale. For the regional scale, the focus will be placed on creating a green network with a high ecological value through the urban environment. The mobility network will be used as the base for this green network. On a city scale, it is important that the green network is linked to the urban green structures of the city. This will ensure that a proper patch-corridor system is created and that the social aspect of green structures is integrated in the vision and design. Finally, the street scale will show how the implementation of a regional green structure will configure itself in public space.

The research through the scales also shapes the setup of this thesis. First the regional and city analysis leads to the regional vision of the green structure. Next, city and street analysis form the base of the design instrument. Lastly, the street design is used to show the implementation of the instrument and how it relates back to the regional vision of creating a stronger green network.

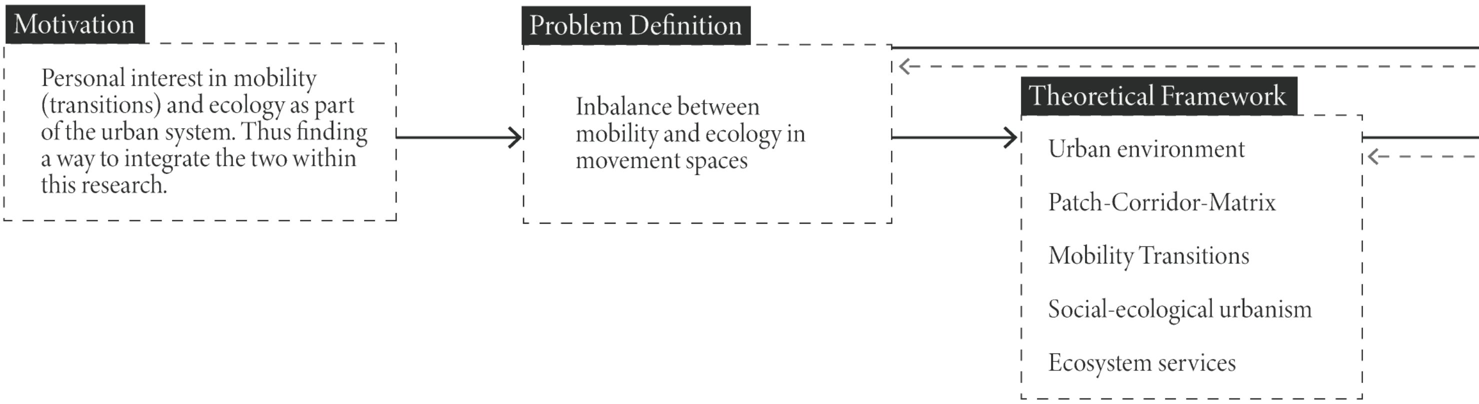
Figure 3-2: Map showing the green network of the region in green, and the mobility network of the region in orange.

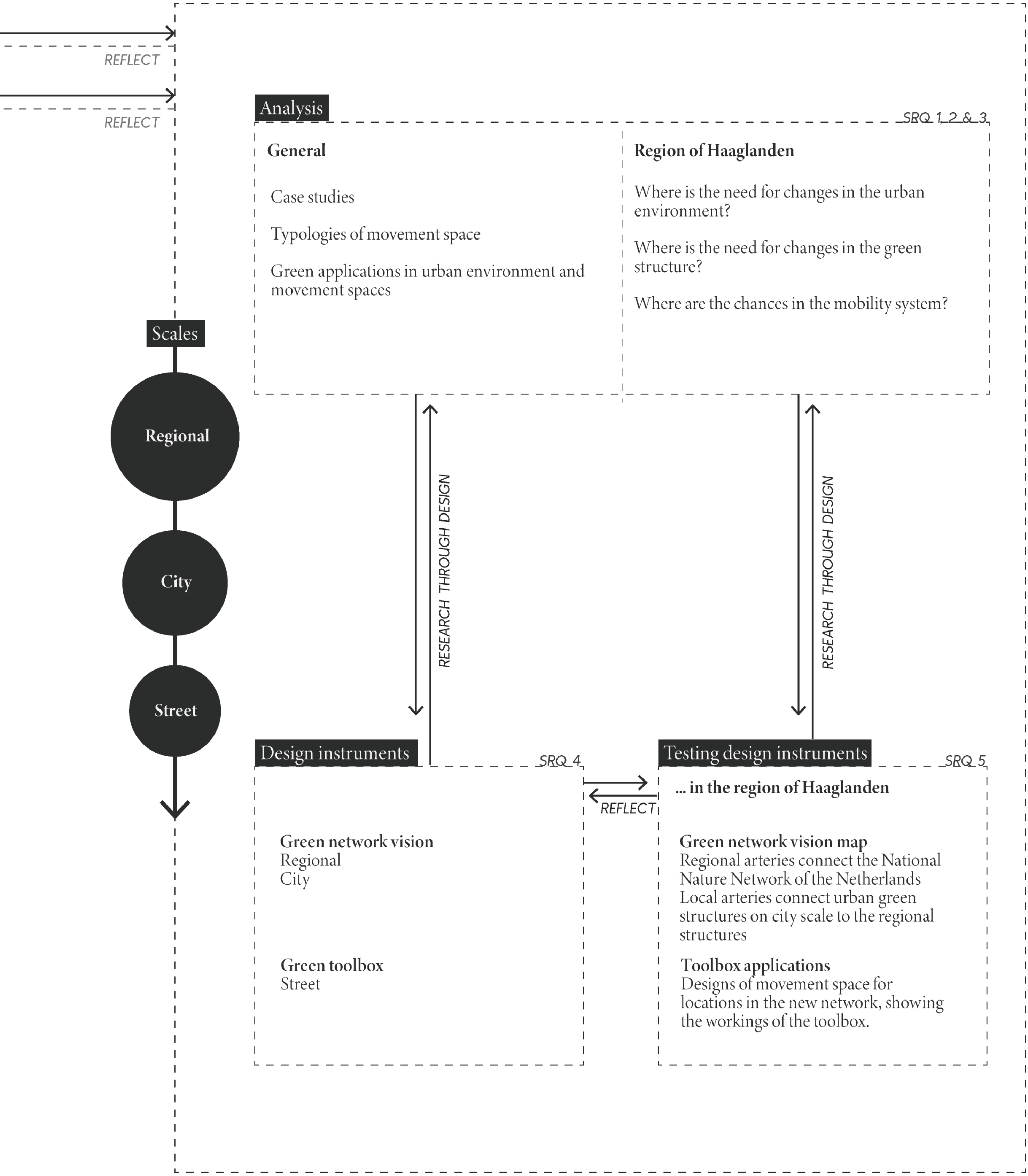
3.3 THE RESEARCH APPROACH

The diagram on the following page (Figure 3-4) shows the relationship between the different research areas that will also be explained here. There are three elements that feed into each other and form the basis for the main body of research: the motivation, problem definition and theoretical framework. The main body itself has three elements: analysis, design instruments and testing design instruments, which are all related to the three scales of the research. There should always be movement back and forth between the analysis and the design. The research through design should create new questions from which more detailed analysis will give input to the design outcome.

The design instruments focus on creating a toolbox that can be applied on the different scales to create a green urban ecological network that also creates a more attractive urban environment. This toolbox is given shape in the form of a booklet with a matrix where green tools and the ecosystem services they can provide are linked, and followed by more detailed explanations of the tools. The tools will be applied and tested in the chosen design locations within the region of Haaglanden. The sites will be chosen such that the situation for which the designs will be made show different challenges that can occur when implementing the toolbox. The sites will be chosen using the regional and city analysis, where the focus is placed on three themes: green functions, social functions, and environmental challenges.

Figure 3-3: Research approach framework. Source: by author.




REFLECT
REFLECT
Analysis
SRQ 1, 2 & 3
General
Case studies
Typologies of movement space
Green applications in urban environment and movement spaces
Region of Haaglanden
Where is the need for changes in the urban environment?
Where is the need for changes in the green structure?
Where are the chances in the mobility system?
Scales
Regional
City
Street
RESEARCH THROUGH DESIGN
RESEARCH THROUGH DESIGN
Design instruments
SRQ 4
Green network vision
Regional
City
Green toolbox
Street
REFLECT
Testing design instruments
SRQ 5
... in the region of Haaglanden
Green network vision map
Regional arteries connect the National Nature Network of the Netherlands
Local arteries connect urban green structures on city scale to the regional structures
Toolbox applications
Designs of movement space for locations in the new network, showing the workings of the toolbox.

3.4 RESEARCH METHODS AND OUTCOMES

How can the mobility transition to soft and shared modes of transport be used to create green structures, within movement spaces, that cater to the urban ecological demand?

Sub Research Questions	Research Methods
SRQ 1: What are the different typologies of movement space in urban environments?	**Literature review** researching the concept of movement space and corresponding typologies. **Case studies** on movement spaces to understand the spatial context **Field work** on the application in the region of Haaglanden **Data anlysis** of current mobility use and predicted future use in the region of Haaglanden. **Policy analysis** on the mobility transition. **Spatial mapping** of the mobility system and results for the above.
SRQ 2: What are the applications of green in movement spaces?	**Literature review** on applications of green in movement spaces and urban ecology **Case studies** and **field work** on the application of green in movement space and ecological benefits. **Data analysis** and **spatial mapping** of the urban ecology in the region of Haaglanden **Policy analysis** on the planned and necessary changes for urban ecology.
SRQ 3: What are the conflicts of interest to consider when designing a balanced movement space?	**Case studies** to find the key stakeholders involved with mobility and ecology. **Literature review** on the friction and synergies between mobility and ecology. **Spatial mapping** of the frictions and synergies in space and of the stakeholders.
SRQ 4:What design instrument can contribute to creating a more systematic approach in the design of movement spaces that cater to urban ecological demand?	Create a **toolbox** using the results from the city and street analysis
SQ5: How is the design instrument used in the design location?	**Research through design** to test the application of the patternbox in different locations in the region of Haaglanden

Outcomes	Design
Overview of the design elements used in movement spaces. Understand and visualize the elements and workings of movement spaces. Know the physical applications of design elements and potential locations for scenario building Know the needs of movement spaces in the region of Haaglanden. List of the policy targets for future implementation. Maps on the current state of the mobility system and necessary changes in the region of Haaglanden.	**Regional vision** The regional vision showcases how a green structure can be implemented in the urban environment using the mobility system, while connecting to national green structures.
Overview of green design elements in current movement spaces and the uses in the ecological system. Understand and visualize green in movements paces and larger scale implications and influences. Understanding and mapping of current state and future goals of ecology in the region of Haaglanden. Overview of the policy targets that have to be implemented.	**Design instruments** A toolbox allows for a systematic approach to green street design by providing simple tools that can be implemented in the street.
Insight in design solutions for a balanced public space design. Understand the possibilities and limitations where mobility transition caters to ecological demand. Potential locations for scenario building.	**Testing design instruments** The region of Haaglanden is used to show the application of the toolbox in different types of movement space. The design will showcase the linear elements needed to design a green corridor and the implementation of the tools in these elements as well as exceptions to the linear elements and how these can be designed using the toolbox.
Design tools to be implemented in the street to create a green network and soft surfaces	
Implementing the design tools in multiple locations with a different context, which will showcase challenges and possibilities of the tools.	

04 THE VISION

Within this fourth chapter, an analysis of the region of Haaglanden is made to find the places with a need for change in the human construct, the places with a need for green, and the possibilities to realize these changes within the mobility system. The conclusions are then used to create a vision map for new green structures for the region of Haaglanden.

Figure 4-4: The water tower in the Oostduinen. Source: photograph by author.

4.1 THE NEEDS IN THE URBAN ENVIRONMENT

As mentioned in the problem field, urban environments act as a barrier within the green structures since most of the environment is often paved. It was also mentioned that this paved environment causes multiple problems, such as low liveability, urban heat islands, flooding, etc. In this part of the chapter, the problems that we find in the urban environment are analysed in more detail to find the places with the highest need for change.

4.1.1 PROBLEMS IN THE URBAN ENVIRONMENT

Liveability

Liveability of a place can be defined as the extent to which the living environment meets the needs and wishes of the people (Ministerie van Binnenlandse zaken en Koninkrijksrelaties, 2018). Ministerie van Binnenlandse zaken (2018) has developed a tool for the Netherlands called the Liveability Index, showing the liveability and its developments of all neighbourhoods and districts in the Netherlands. As such, it provides information for evaluation, needed adjustments, and policy generation by municipalities. The degree of liveability is based on a set of 100 indicators, that can be categorised in a couple of groups: housing, inhabitants, facilities, safety, and the physical environment.

For the region of Haaglanden, the areas with the lowest liveability score are in the southern neighbourhoods of The Hague and in the southern neighbourhoods of Delft, see Figure 4-2. The area with the lowest score of largely insufficient is the Schilderswijk in The Hague. The areas with a lower liveability that are in Delft are categorized with a 'poor' liveability status status; where poor is defined as almost satisfactory. This is also applicable for some of the neighbourhoods in The Hague. The environment is not optimal and there is still a need for change.

Climate and water challenges

The problem field explains two main problems that are created in environments that are largely paved: the urban heat island (UHI) effect and urban flooding due to the challenges in water regulation with heavy rainfalls. Figure 4-3 shows the UHI effect in the region of Haaglanden, where the highest UHI can be seen in the city centres and in most of the Westland, due to the number greenhouses for the horticulture. The UHI is lower closer to the edge of the city and closer to the rural (and greener) areas.

Figure 4-4 indicates locations with a high chance of flooding when an extreme weather situation (100ml of rain in 2 hours) occurs. Many of the streets in The Hague will have water run-off problems in these situations. The Westland also shows high chances of flooding.

Green in the region

Green in urban environments is said to have both social as well as environmental benefits, especially when green is close to the houses of the city's inhabitants. Figure 4-6 shows the impact of the current green on the temperature of the environment, and the decrease in degrees temperature. The map indicates that the city centres are the places where more green is needed, as the current amount of green is low (as shown in the problem field).

For people to be able to reach green structures easily, it should be within walking distance (500m) of their house and work locations. The green areas in the map of Figure 4-5 are the locations that have green within walking distance. The Westland has a considerably low amount of green that can be reached easily, but there are also a lot of empty spots in The Hague, Delft and the surrounding towns.

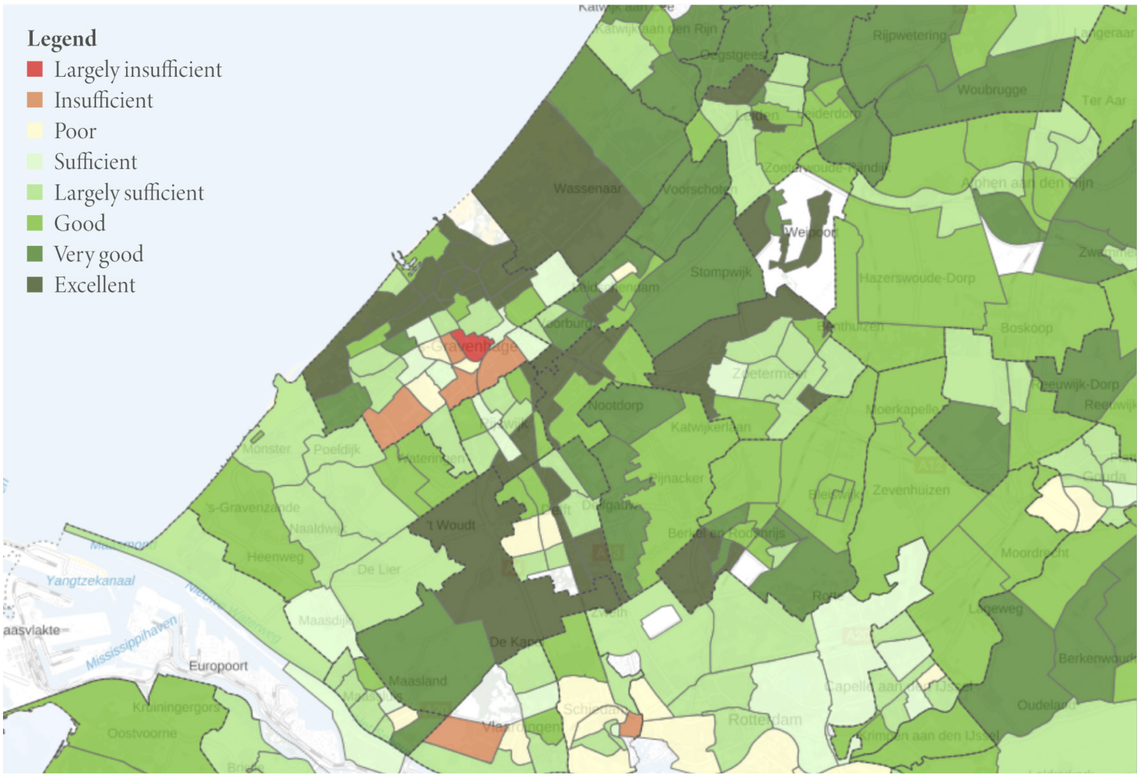


Figure 4-5: Map showing the livability index for the neighbourhoods of the region of Haaglanden. Source: ***Leefbarometer,*** Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2018.

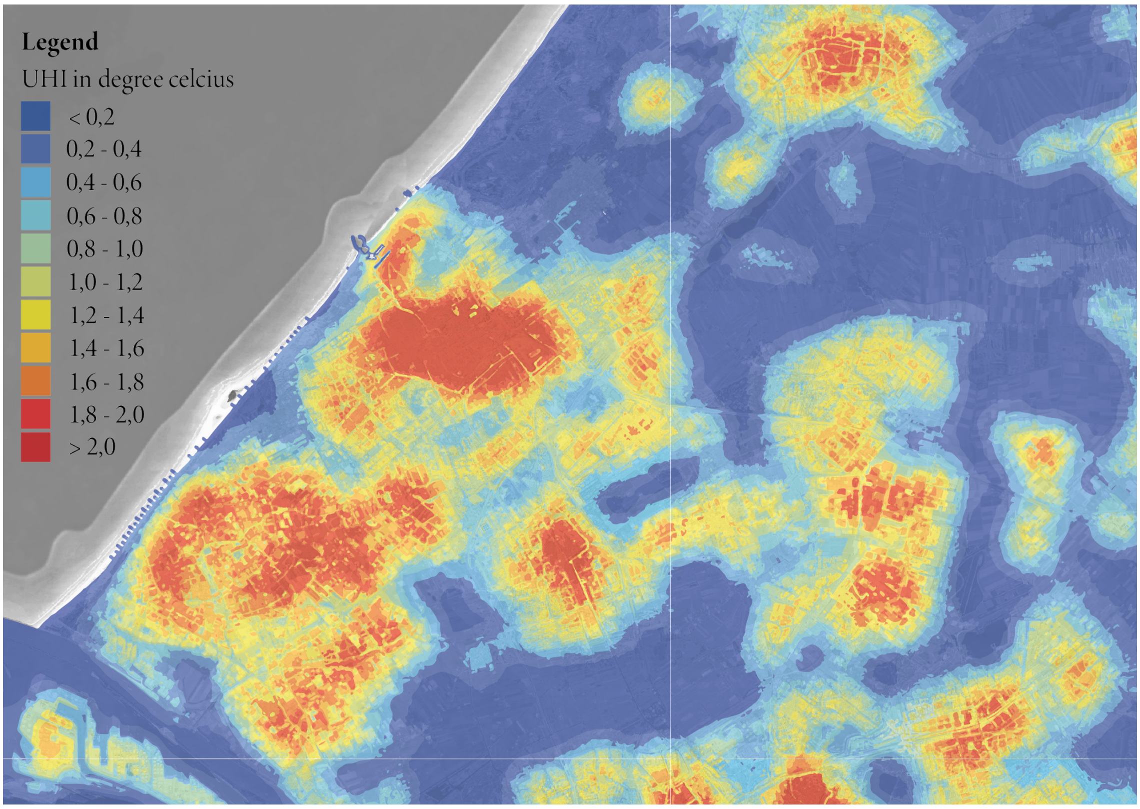
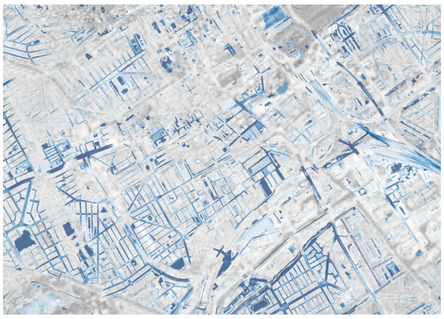


Figure 4-6: Urban Heat Island effect in the region of Haaglanden. Source: Atlas Leefomgeving, Geodan and Rijkswaterstaat (n.d.), edited by author.

4.1.2 CONCLUSION

The map on the next page (Figure 4-7) shows the main conclusions of the analysis described above. It shows that the highest need for change in the urban environment is in the city of The Hague and in the Westland. The Hague shows high problems with UHI, low liveability values and a few locations with no green within walking distance. The Westland has challenges with UHI effect, and most places do not have green within walking distance. Therefore, these are the places with the highest need for changes when it comes to the urban environment.



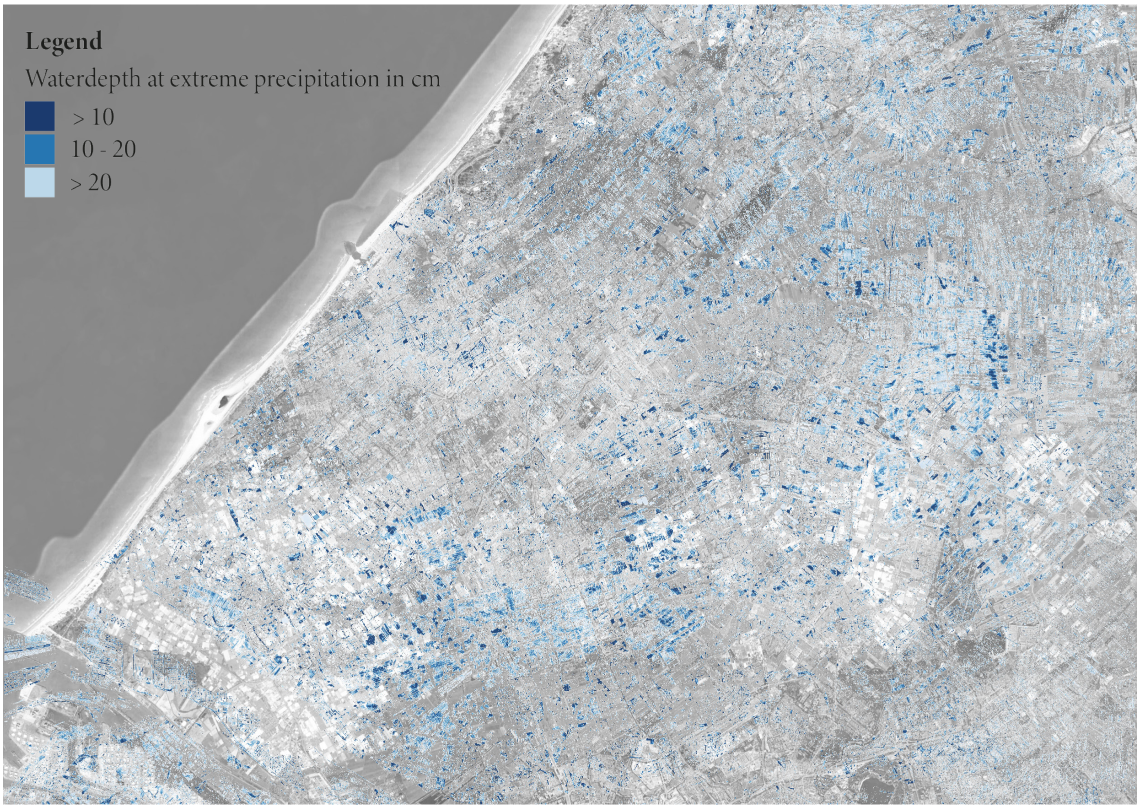


Figure 4-7: Map showing flooding problems in the region of Haaglanden with heavy rainfall. Top right: zoom in of The Hague, around the centre and Holland Spoor. Source: Atlas Leefomgeving, Geodan and Rijkswaterstaat (n.d.), edited by author.

Figure 4-8: Map showing the locations where there is green located within 500m, a walking distance. Source: by author, editing data through QGIS.

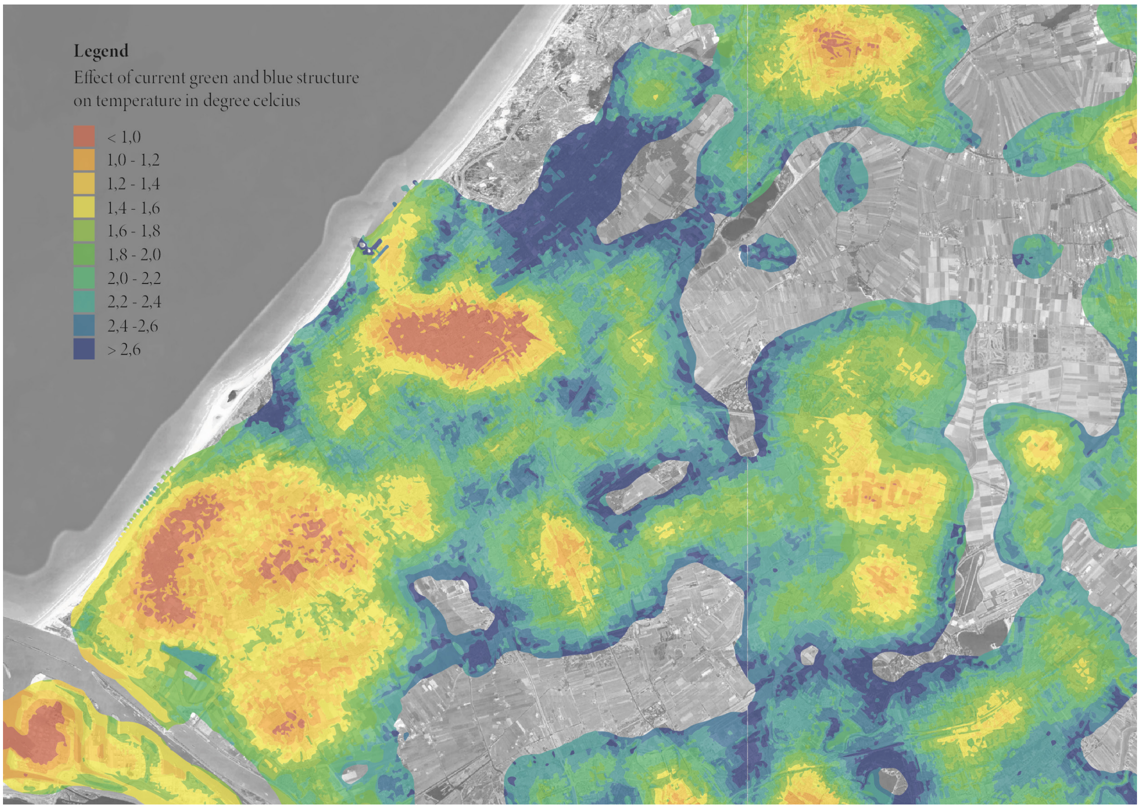
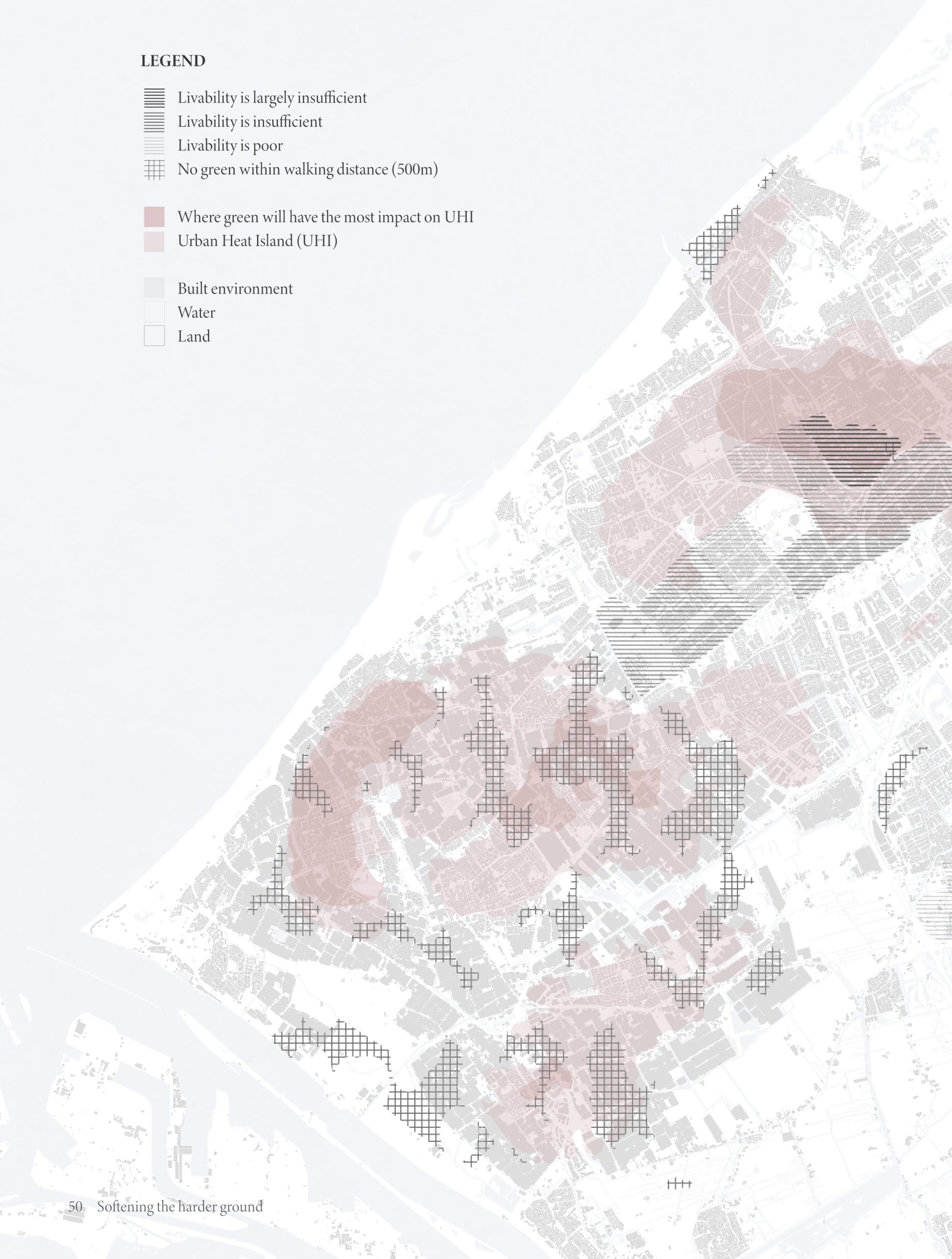
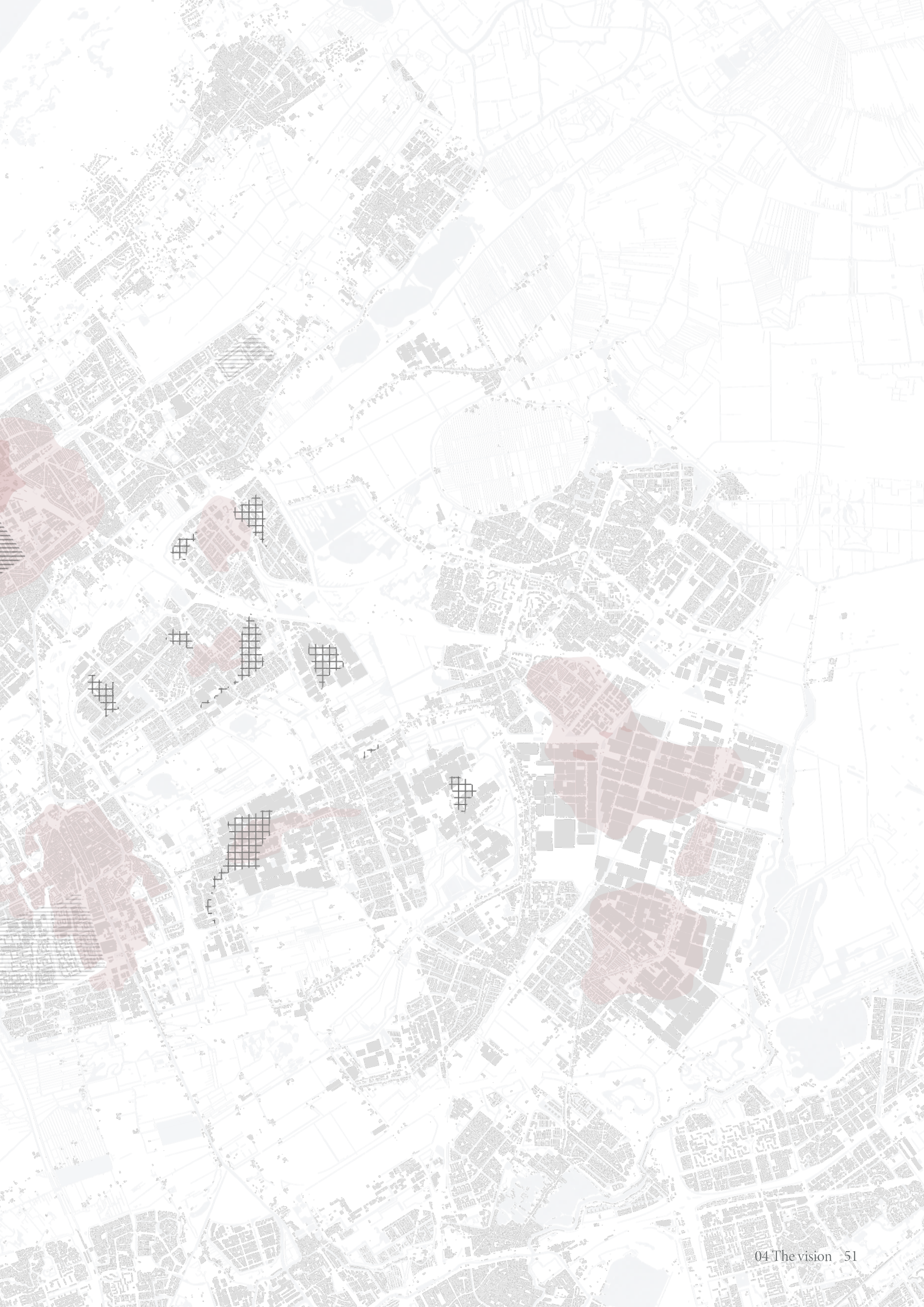


Figure 4-9: Effect of the current green and blue structure on temperatures in the urban environment. Source: RIVM, 2020.

Figure 4-10: Conclusion map showing the main challenges of the build environment in the region of Haaglanden. Source: by author.





4.2 THE NEED FOR GREEN

The conclusion for the 'needs in the urban environment' already show that there is a need for green to help social and environmental challenges. This part of the chapter will therefor look further into the current green in the region of Haaglanden and form a conclusion on the need for green to create a better green structure.

4.2.1 GREEN IN HAAGLANDEN

The green structure

Within the region of Haaglanden, the green structure can be divided into two layers; the green structure surrounding the urban environment and the urban green structure. The green structure surrounding the urban creates a border around and between the cities in the region. These structures mainly consist of large patches with different types of green, creating interesting environments for large biodiversity. The green structure in the urban environment consists of smaller patches and includes some corridors that are mainly made up of trees along the larger streets.

Green structures are a part of provincial and city government analysis and vision planning. The province of South Holland analyses the green structure for both biodiversity as well as liveability on different scales, looking at the boundary green as well as the urban structure. Three of the scales mentioned by the province are interesting for this thesis: the inner landscapes, the urban-land relations and the urban green and water as shown in Figure 4-8. The inner landscapes are challenged by the urban need for space, which challenges the quality of the space. Urban-land relations mainly miss high quality connections for slow transport and need more green spots to act as steppingstones. The urban green and blue structures are getting more attention and can be used to achieve the goals for the previous two scales. This can be done by creating stronger connections within the structure and make use of the already ongoing local initiatives (Provincie Zuid-Holland, et.al., 2017).

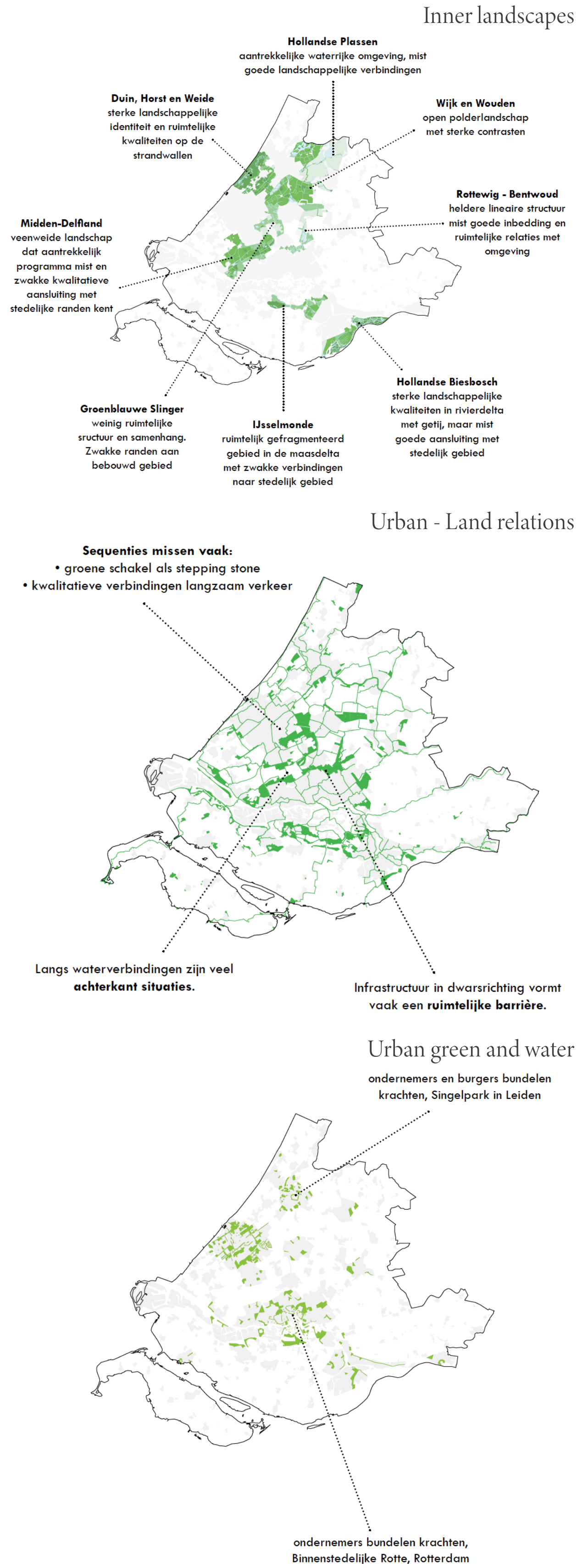


Figure 4-11: Levels of urban landscape as defined by the province of South Holland (three out of five). Source: Provincie Zuid Holland, et al. 2017.

Figure 4-12: Green structure outside the urban environment. Source: by author, data from OSM.

Figure 4-13: Green structure within the urban environment. Source: by author, data from OSM

Biodiversity in the region

Not all green structures pose ecological benefits, especially small structures, such as tree lines, that are in cities. The map in Figure 4-11 shows this through the biodiversity rating given to neighbourhoods in The Hague. The neighbourhoods with the highest biodiversity rating are located towards the outer edges of the city. The inner neighbourhoods often have a lower biodiversity rating. The neighbourhoods towards the South have the lowest biodiversity rating of the city. This rating determined by counting the different flora and fauna types, a list and explanation of which can be found in chapter "07 The design" in"7.1.2 Scheveningen flora and fauna" on page 98 and "7.1.2 Centres flora and fauna" on page 136.

Geomorphology of The Hague

The green and urban structure originates from the geomorphological history of the region. The sea front has moved towards the west over time, leaving peat, clay, and sand as the layers in the subsoil. The dunes and forests, but also the location of the country estates on the coast embankment have a direct relation with these subsoils (Gemeente Den Haag, 2016) As such, the subsoil gives an insight into the biodiversity in the region. The soil will also determine the needs for water infiltration and foundation of street elements. These details are discussed in chapter seven, where the specific design locations are studied individually.

4.2.2 CONCLUSION

The map in Figure 4-14 shows the main conclusions from the analysis of the green structure in the region of Haaglanden. Most of the surface area of the cities, towns and Westland have less than 40% of green. The exceptions to this are often located around the city parks. The biodiversity rating was only found for the city of The Hague. Notebly, there are locations with a low biodiversity rating but a high percentage of green surface. A reason for this could be that the current green is not sufficient enough to impact biodiversity and, as a result, is not a building block in the regional green network.

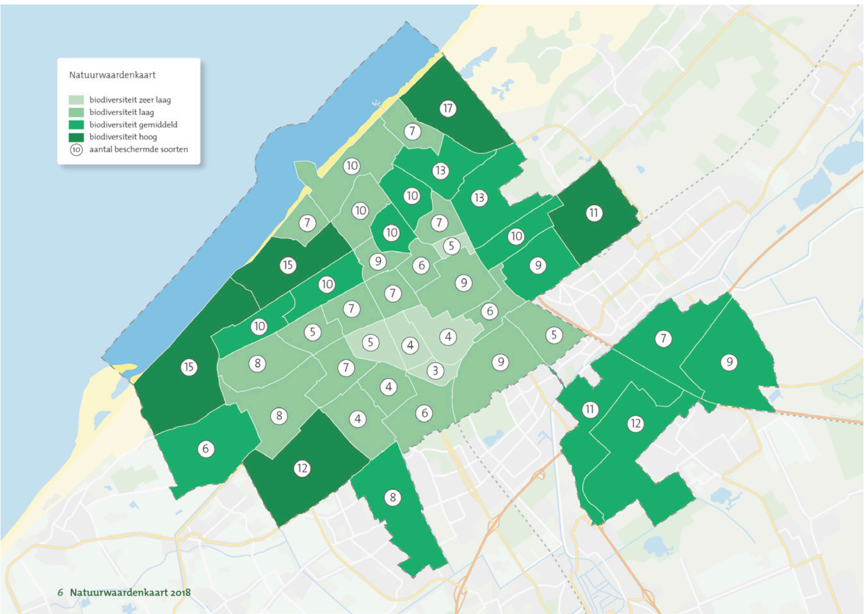


Figure 4-14: Mapping the value of nature in The Hague. Source: ***Natuurwaardekaart 2018,*** van den Hoorn and Vogelaar, 2018.

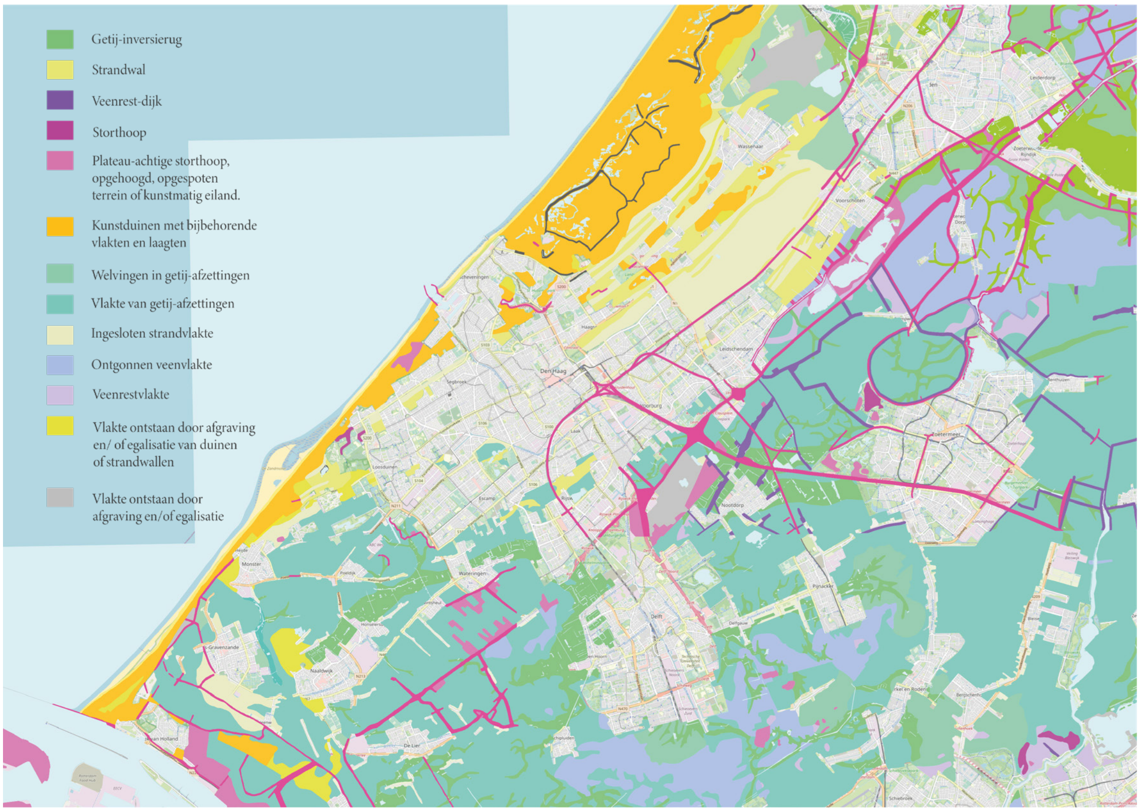


Figure 4-15: Layers of the subsoil of the region of Haaglanden. Source: ***Archeologie en Geologie van Den Haag,*** Gemeente Den Haag, n.d.

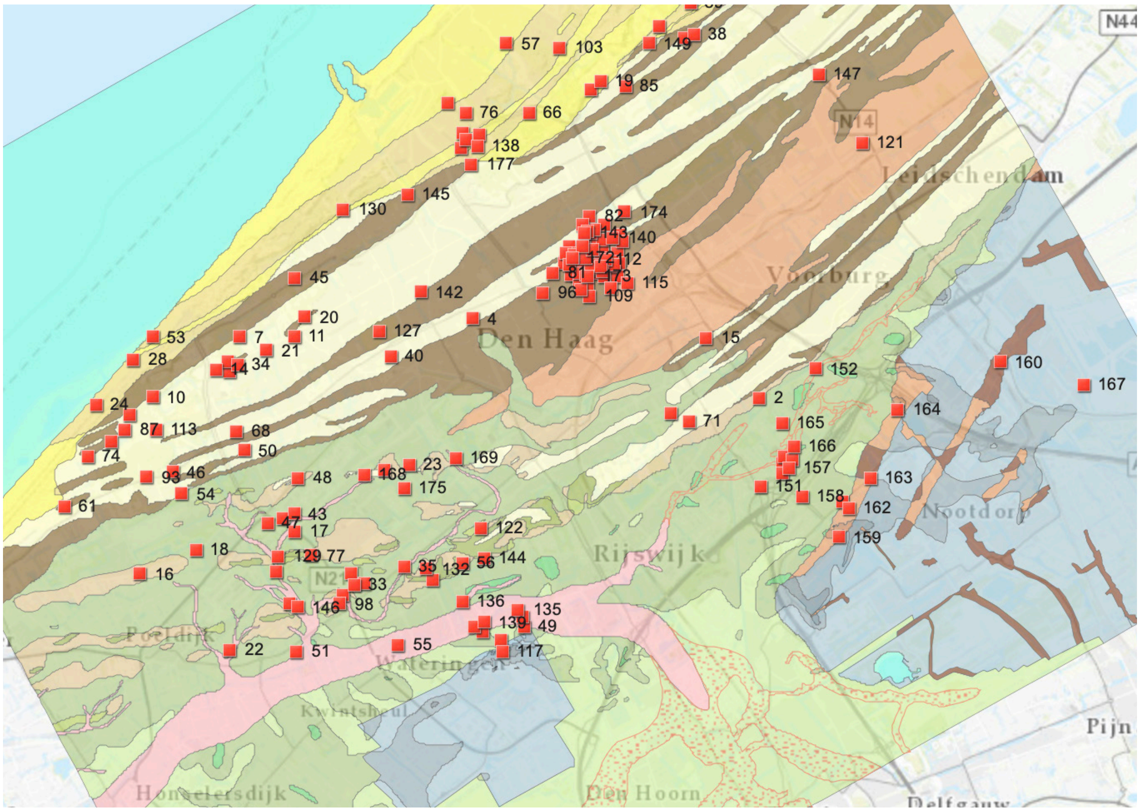
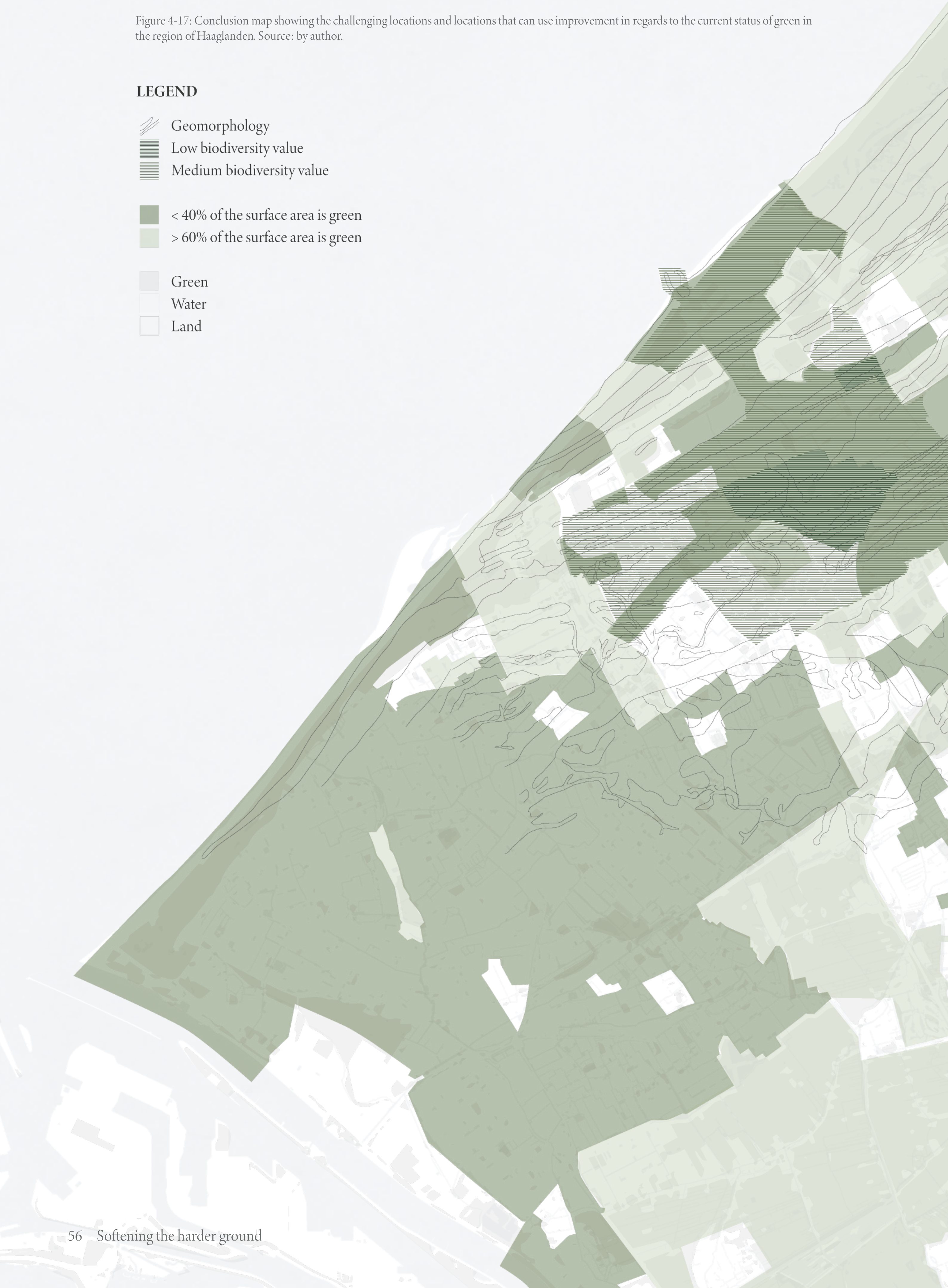
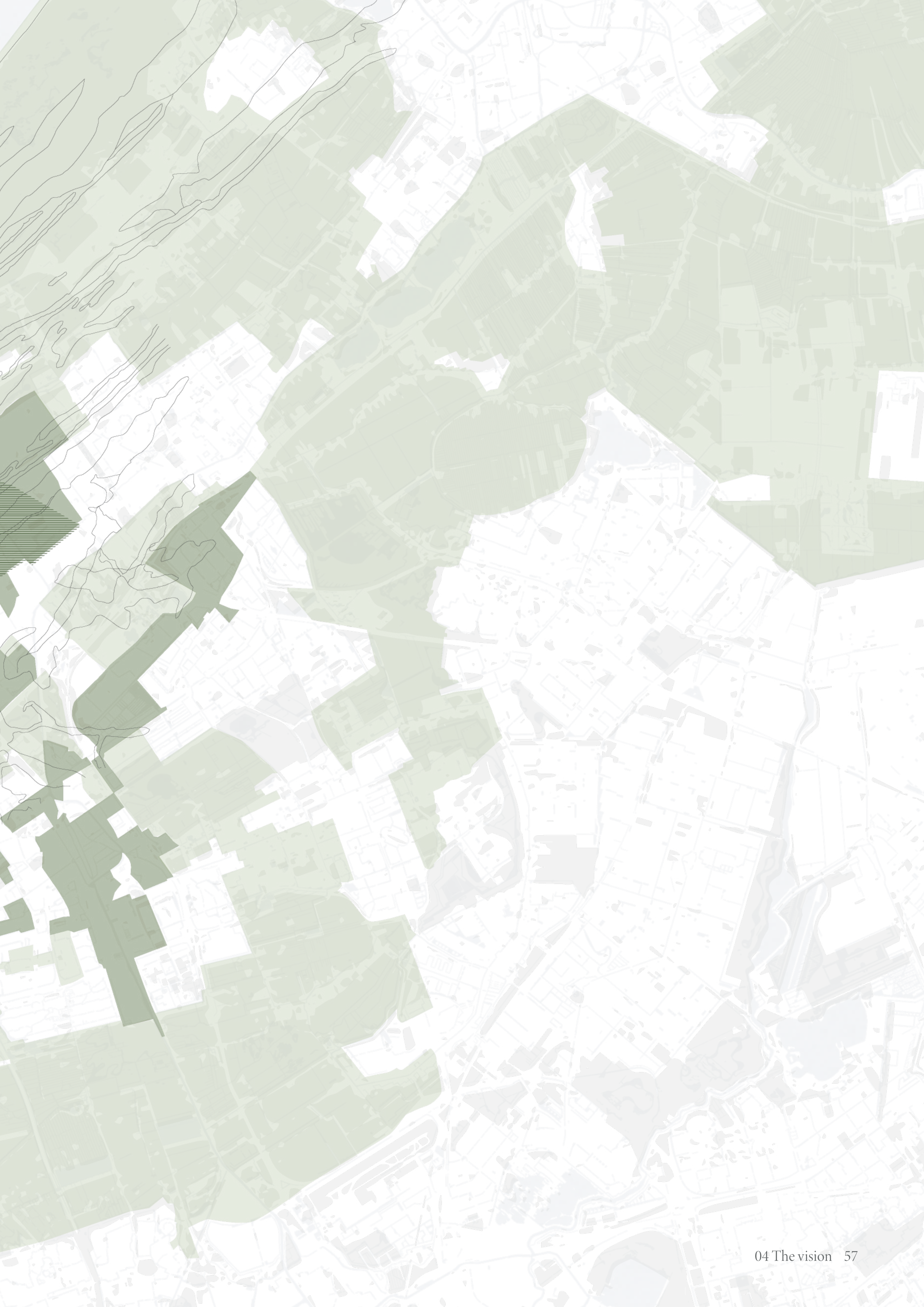


Figure 4-16: Geomorphological subsoil of The Hague and surroundings. Source: ***Archeologie en Geologie van Den Haag,*** Gemeente Den Haag, n.d.

Figure 4-17: Conclusion map showing the challenging locations and locations that can use improvement in regards to the current status of green in the region of Haaglanden. Source: by author.





4.3 THE CHANCES IN THE MOBILITY NETWORK

The problem field and theoretical underpinning indicate that the mobility network could play an important role in creating a stronger green network for the region of Haaglanden. Especially since there is a shift in the larger cities from the use of fast transport such as cars, to more use of slow transport and public transport. This part of the analysis investigates the current mobility network to find where the possibilities lie for changing the mobility network to create a stronger green network.

4.3.1 THE CURRENT MOBILITY NETWORK

Slow mobility network

When considering the slow mobility network, a distinction is made between cyclists and pedestrians, the networks for which are shown in Figure 4-17 and Figure 4-18, respectively. The map for the cycling network shows the locations in which the bicycle lanes have been made distinctive, though these are not the only places for cyclists. The marked lanes are often located on the larger streets, where cars tend to drive 50km/h or more. Residential streets often do not have a specific bicycle lane, but cyclists are still welcome. There is also a national cycling network and a 'star route' network created by The Hague as indicated in the map of Figure 4-15. These routes create long lines in the cycling network as they are designed to direct the cyclists through the city safely and connect the parks inside and outside the city so these are easily reached and enjoyed in free time.

The pedestrian network often consists of very short distances, as the preferred distance for walking is around 500m. This can also be seen in the map in Figure 4-16, where most indicated routes are very short. What this map doesn't show properly is that most streets have a sidewalk along the whole street, also creating longer connections for pedestrians. When it comes to the pedestrian network, it is important that a focus is placed on creating good connections to stations for public transport. If this connection is easily made, more people will most likely decide to walk and use public transport. This is also one of the aims of the municipality of The Hague. The municipality has also defined larger areas to become pedestrian domains, such as the centre of Scheveningen and the centre of The Hague where the public space is mainly designed for pedestrians.

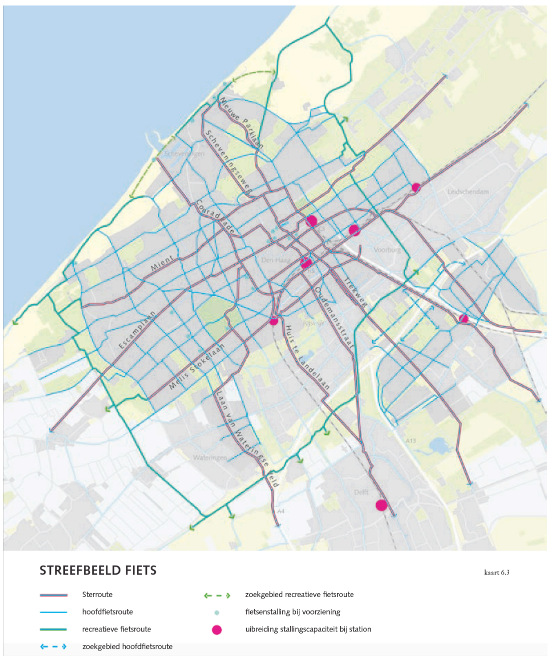


Figure 4-18: Aim for creating better infrastructure for cyclists in The Hague. Source: ***Haagse Nota Mobiliteit, bewust kiezen, slim organiseren,*** Gemeente Den Haag, 2011.

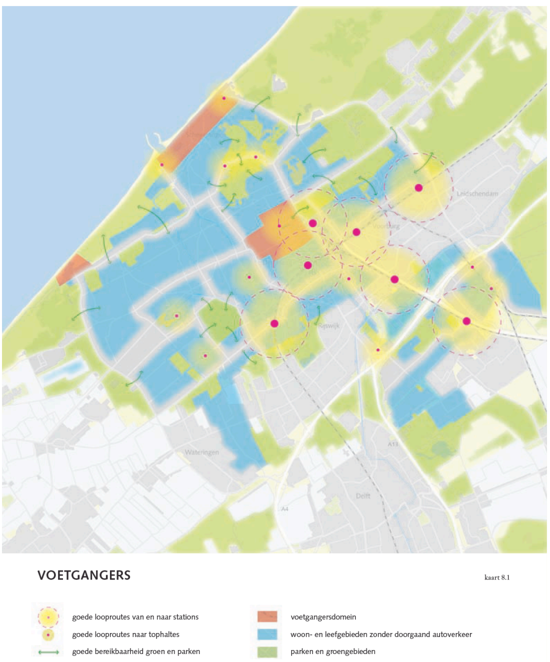


Figure 4-19: Aim for a better pedestrian network in The Hague. Source: ***Haagse Nota Mobiliteit, bewust kiezen, slim organiseren,*** Gemeente Den Haag, 2011.

Figure 4-20: The cycling network for The Hague and surrounding areas. Source: by author, data from OSM and

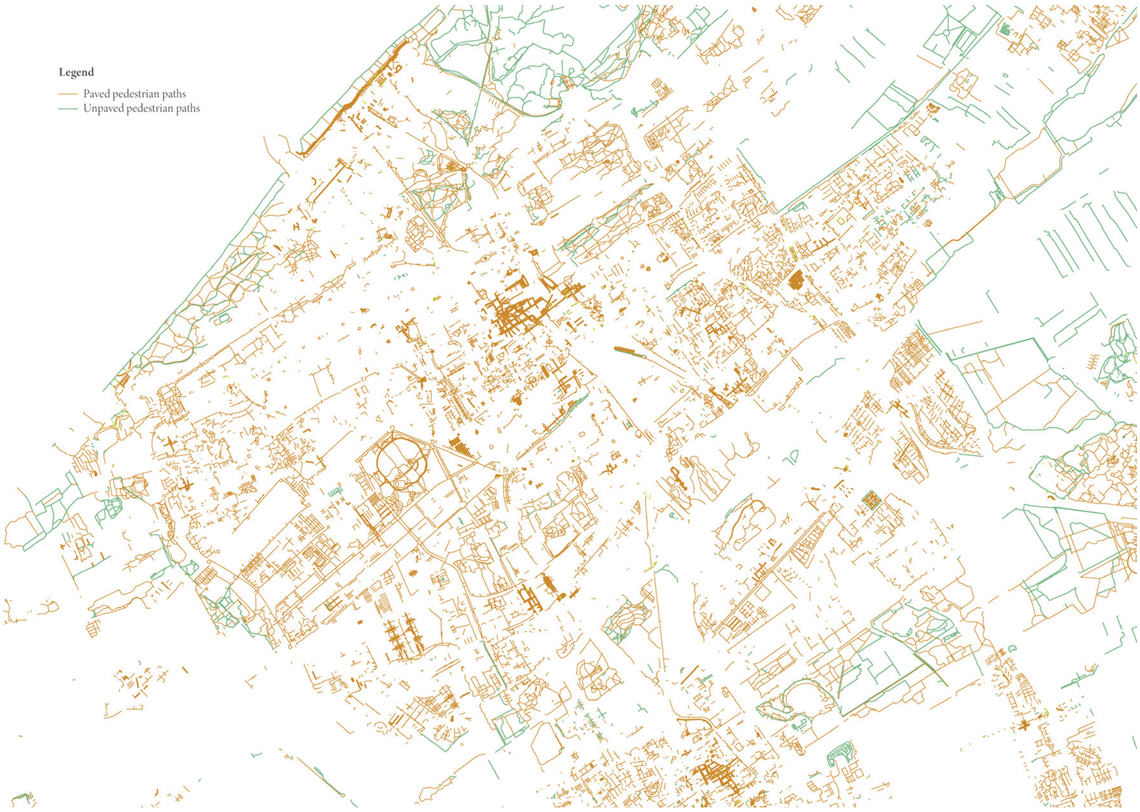


Figure 4-21: Pedestrian network in The Hague and surrounding areas, with soft and paved locations. Source: by author, data from OSM.

Fast mobility network
The fast mobility network consists of the facilities for transport by motorized vehicles, including all road typologies as well as parking. This network is designed through a hierarchical system, where the larger streets often create a connection for longer distances (Figure 4-19). Streets such as residential streets are placed lower in the hierarchy, but often have the highest surface area dedicated to parking as people are used to parking close to their home. It is the residential streets that also occur most in The Hague and might therefore have the largest impact in changing the green percentage for the city. Yet, streets such as an urban main road create long connections through the city, which makes them suitable for green arteries that connect the current urban and surrounding green structure.

4.3.2 CONCLUSION

Looking at the mobility network, there seem to be two ways in which the network can be used when adding green structures to it. The first aims at using the longer arteries that are mainly focused on fast mobility to create connections in the existing green network of the region. Here the focus is placed on the ecology of the green network and how to make this stronger. The second aim is using the smaller (residential) streets to create a greener living environment. Here the focus is on adding green that helps shape a pleasant environment that considers the climate challenges as well as creating recreational areas. In order to achieve these aims, space needs to be made in the street for green.

Legend
- Motorway
- Primary roads
- Secondary roads
- Tertiary roads
- Residential roads
- Service roads

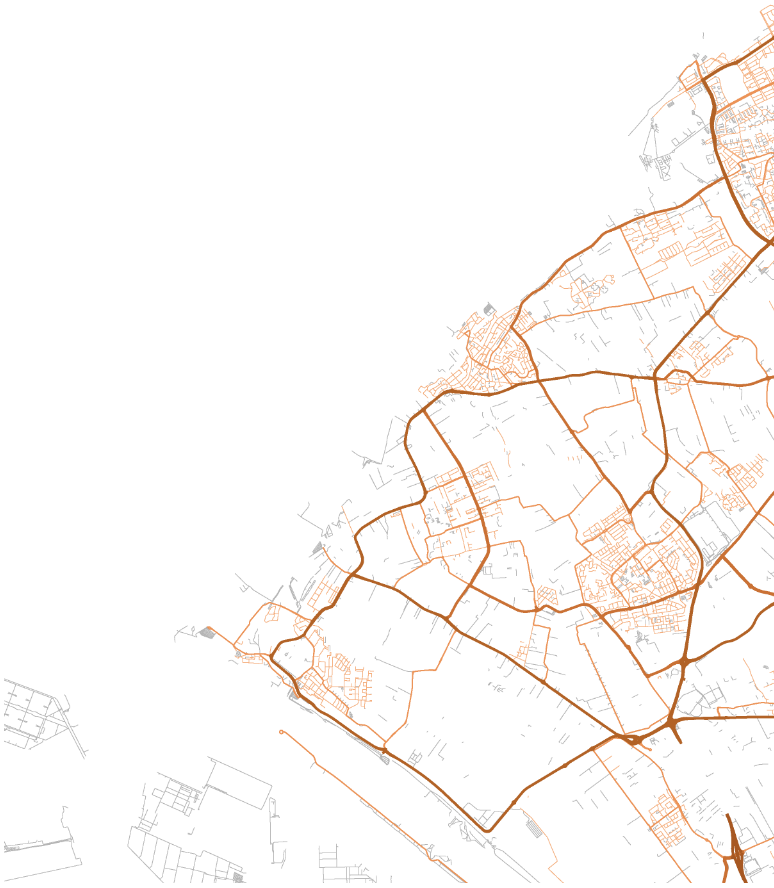


Figure 4-22: Fast mobility network, with the colours indicating the hirarchy of streets. Source: by author, data from OSM.

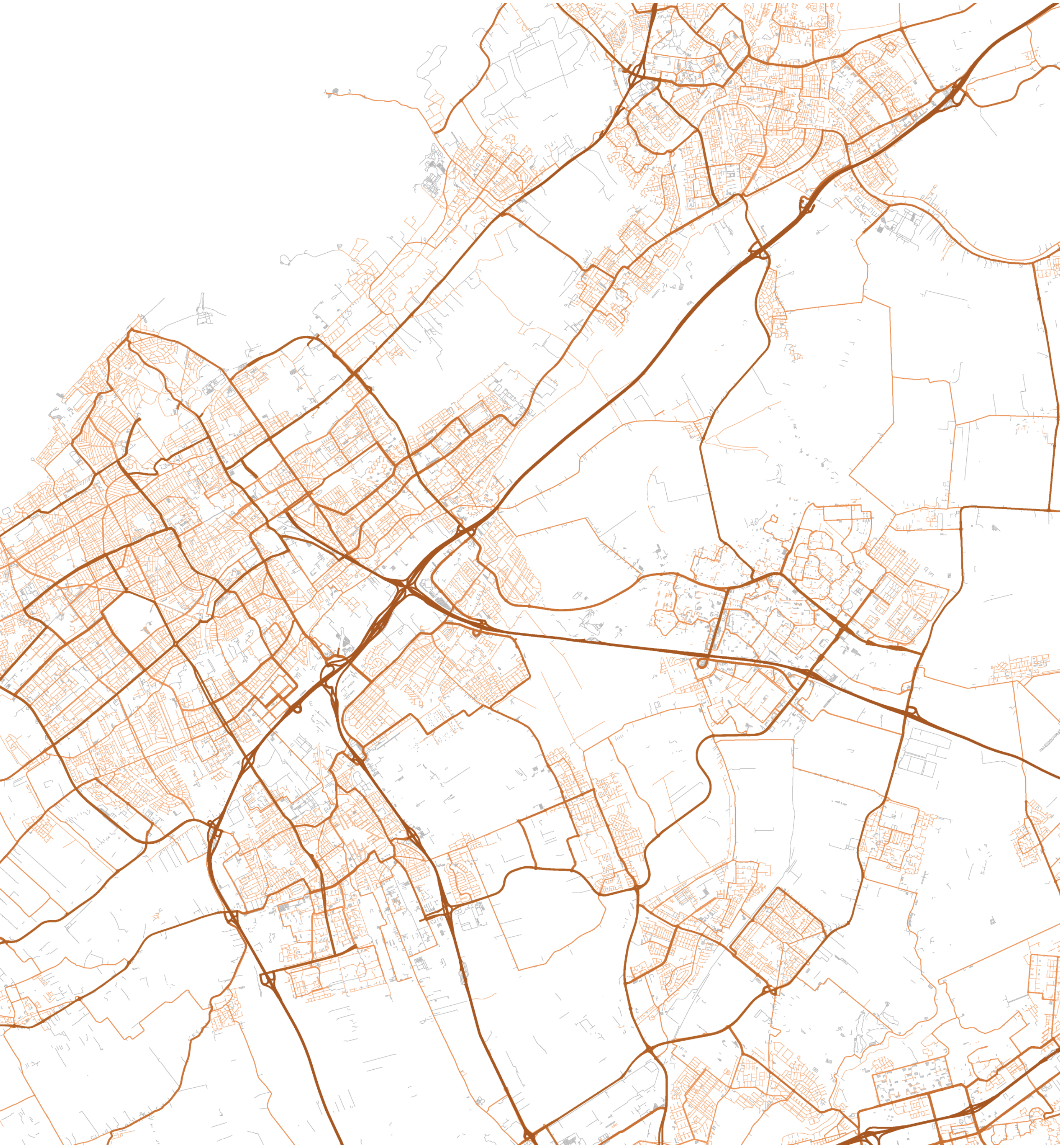
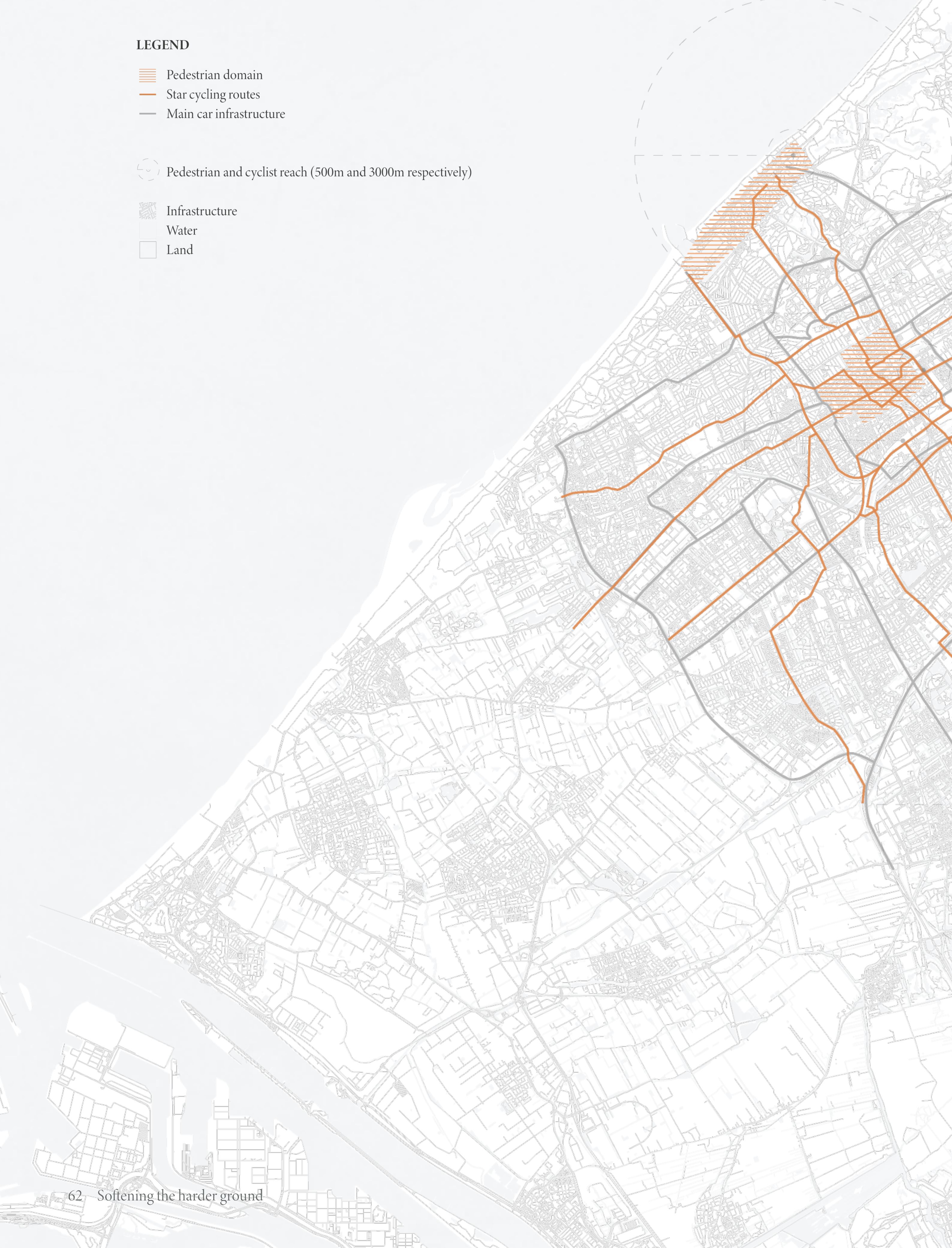


Figure 4-23: Conclusion map showing the oppertunities that are presented within the mobility network that can help create a stronger green network in the region of Haaglanden. Source: by Author.



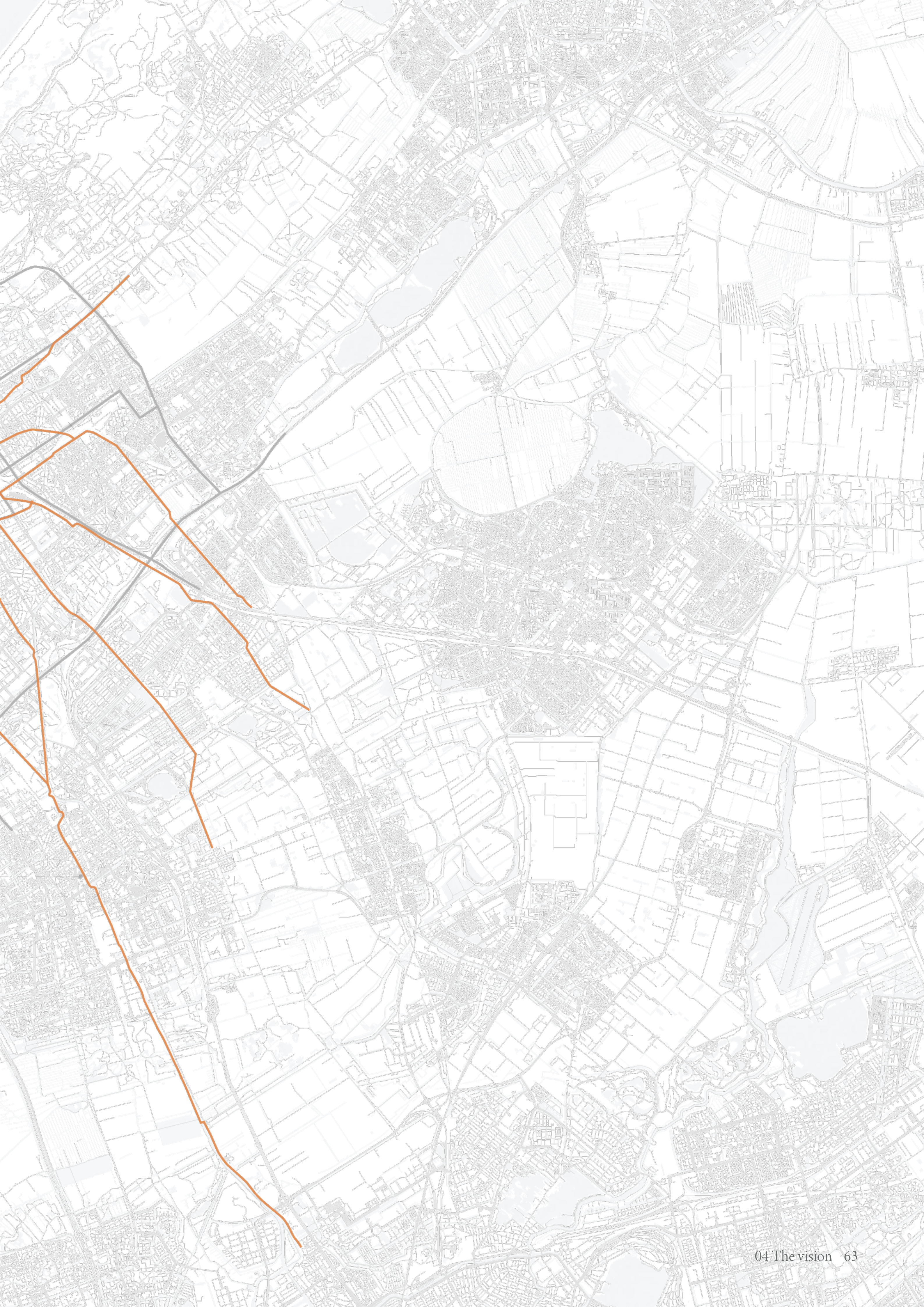
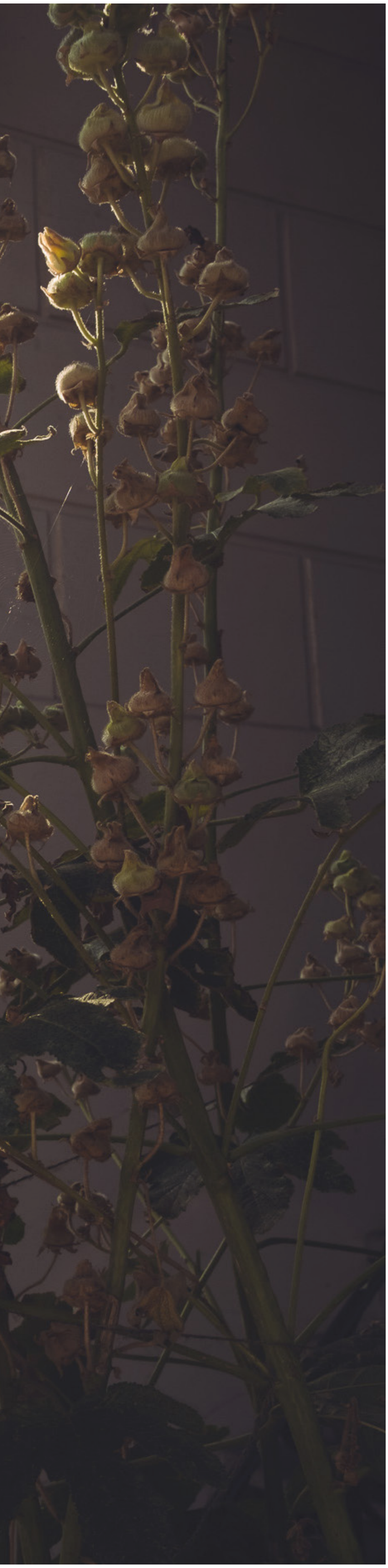


Figure 4-24: Regional vision map, creating green arteries in the mobility network. Source: by author

4.4 A STRONGER REGIONAL NETWORK

In this greenifying vision for the region of Haaglanden, the National Nature Network (NNN) is strengthened by making use of the mobility network to create connections through cities between green structures surrounding the city. There are larger arteries (the regional arteries) to connect green areas from the NNN such as the dunes, the Scheveningse Bosjes and the Midden Delfland. The smaller arteries (the local arteries) create connections between the urban green structures such as parks, cemeteries, and allotment gardens, while in the meantime also connecting these to the large arteries. The urban green structures also work well as steppingstones within the urban environment for fauna to safely cross within the NNN.



05 THE AMBITION

This fifth chapter defines the locations that are chosen for the design locations. These are used to show the workings of the vision on a smaller scale. Secondly, new mobility profiles are introduced to make space for green structures on the street. Using these two concepts, the ambitions for the designs in the thesis are defined.

Figure 5-1: Holyhocks in the facade gardens of Scheveningen, planted by the residents. Source: photograph by author.

5.1 FOCUSSING ON TWO ARTERIES

Two arteries have been chosen from the regional arteries in the vision map, to show how the regional vision is implemented on a smaller scale. These arteries are shown in the map below (Figure 5-21). The first artery is in Scheveningen and follows the direction of the coastline. On the regional scale, this artery creates a connection between the two dune parks that are located on either side of Scheveningen, but in the meantime, the artery itself is a large throughfare for car transport. The other artery is placed perpendicular to the first artery and connects the centre of Scheveningen to the centre of The Hague and can be continued to Delft and even Rotterdam. This artery is also considered to be one of the star cycling routes for The Hague but is not yet experienced as such. It is therefore a good oppertunity to adjust the street profiles on this artery and make them interesting for slow transportation movement between city centres.

Figure 5-2: The two design arteries, chosen from the vision. Source: by author

5.2 ADJUSTING THE MOBILITY WIDTHS

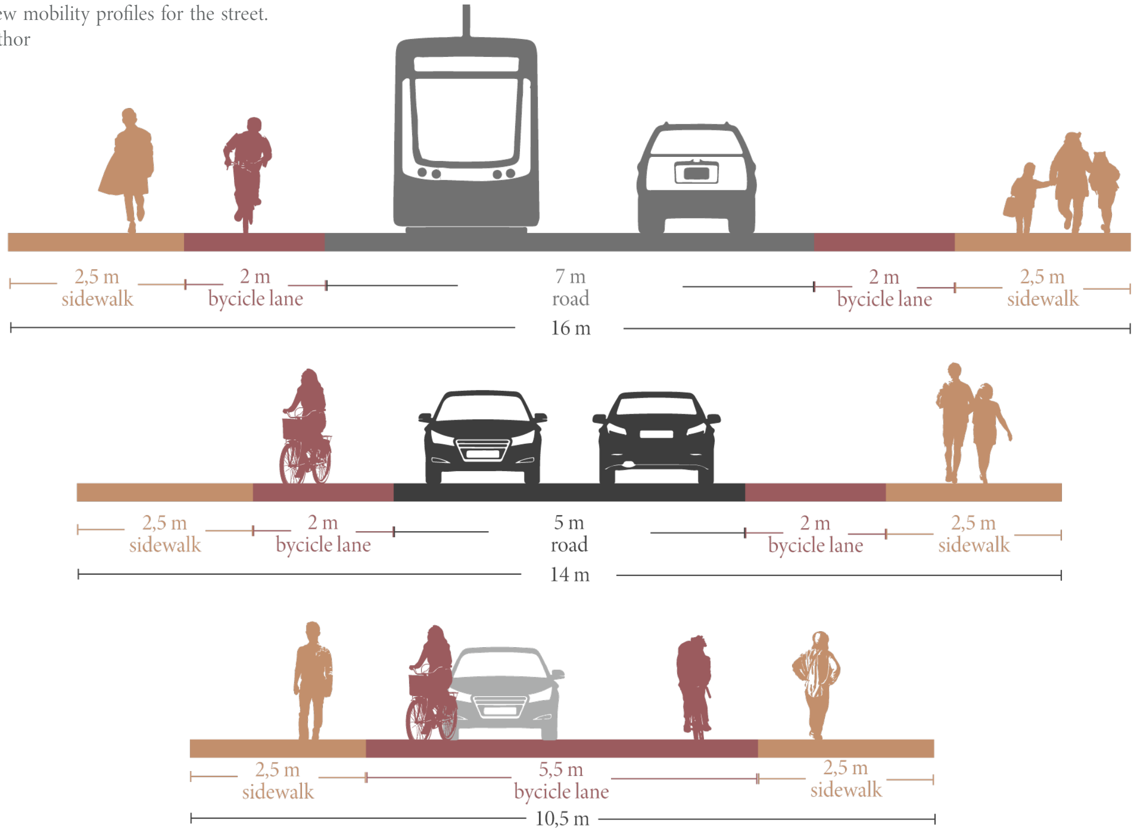
Our current street profiles are designed to provide a lot of space to car mobility and parking, and to allow people to move as fast as possible from one place to the next. Most of the time, this results in streets that are packed with cars and not much space is left for other functions. Often, this space dedicated to cars is larger than the space that is needed. Therefore, this thesis proposes three new profiles for mobility on the street based on the minimum needed width for each transportation mode.

The largest mobility width is needed when the street needs to accommodate tram use. To minimize the width here, cars and trams will occupy the same space. Based on the width used in current profiles in the Hague, the width for this profile will be seven metres, and cyclist can still safely cycle next to the tram. When there is no tram in the street profile, the cars will need a width of five meters to be able to drive in both directions.

When it comes to bicycle lanes, attention needs to be paid to the upcoming trends, where more people are using electric bikes and (electric) carrier bicycles, which require more space due to speed and size. Keeping this in mind, the preferred width for bicycle lanes next to the road is two meters to allow two cyclists to safely bike next to each other. When designing bicycle lanes that are separated from the road, the width will be three meters when cyclist go in two directions (Fietsersbond, n.d.). In this width, cyclists can comfortably move with three people next to each other. In the third profile option, the cyclists and cars are placed on the same part, creating a bicycle road. In this case, the car is a guest on the bicycle lane and as such, the width can be decreased to 5,5 meters total.

Lastly, the pedestrians need a large enough space to move comfortably in two directions. To allow for proper movement, where people can also stay a while and talk to people they meet on the street, the sidewalks will have to be 2,5 meters in width. This number can be applied in most cases, as three people can still walk past each other comfortably. There might be some exceptions where more pedestrians make use of the space than average, which might give need to a larger sidewalk.

Figure 5-3: New mobility profiles for the street.
Source: By author



5.3 MAKE 50% OF THE STREET GREEN

When using the three profiles for mobility in the street design, a lot of space in the street profile will be left for green infill. The diagram on the following page shows a simplification of the general widths of the artery. Figure 5-23 shows a part of the diagram in relation to the map to show how the diagram relates to the street. As can be seen, the diagram is not an exact plan of the street but projects the width only. In addition, the green structures are added to the diagram.

The main point of the diagram is to show the difference that can be made when making use of the mobility profiles explained before. When adding a width of 14 or 16 meters, almost 50% of the street can be made green. Compared to the current 2 and 3 percent, this would completely change the environment and appearance of our streets (see "Appendix 1: Corridor surfaces calculations".

In the following chapters, this profile with 50% green is taken on as the goal for the designs. On the one hand, the designs will show whether a 50% green profile is realistic. On the other hand, the project can be used as an example of how our streets could look if we remove spaces dedicated to cars. These visualisations might challenge the reader to think about whether the way in which we design and use our streets currently is the best option.

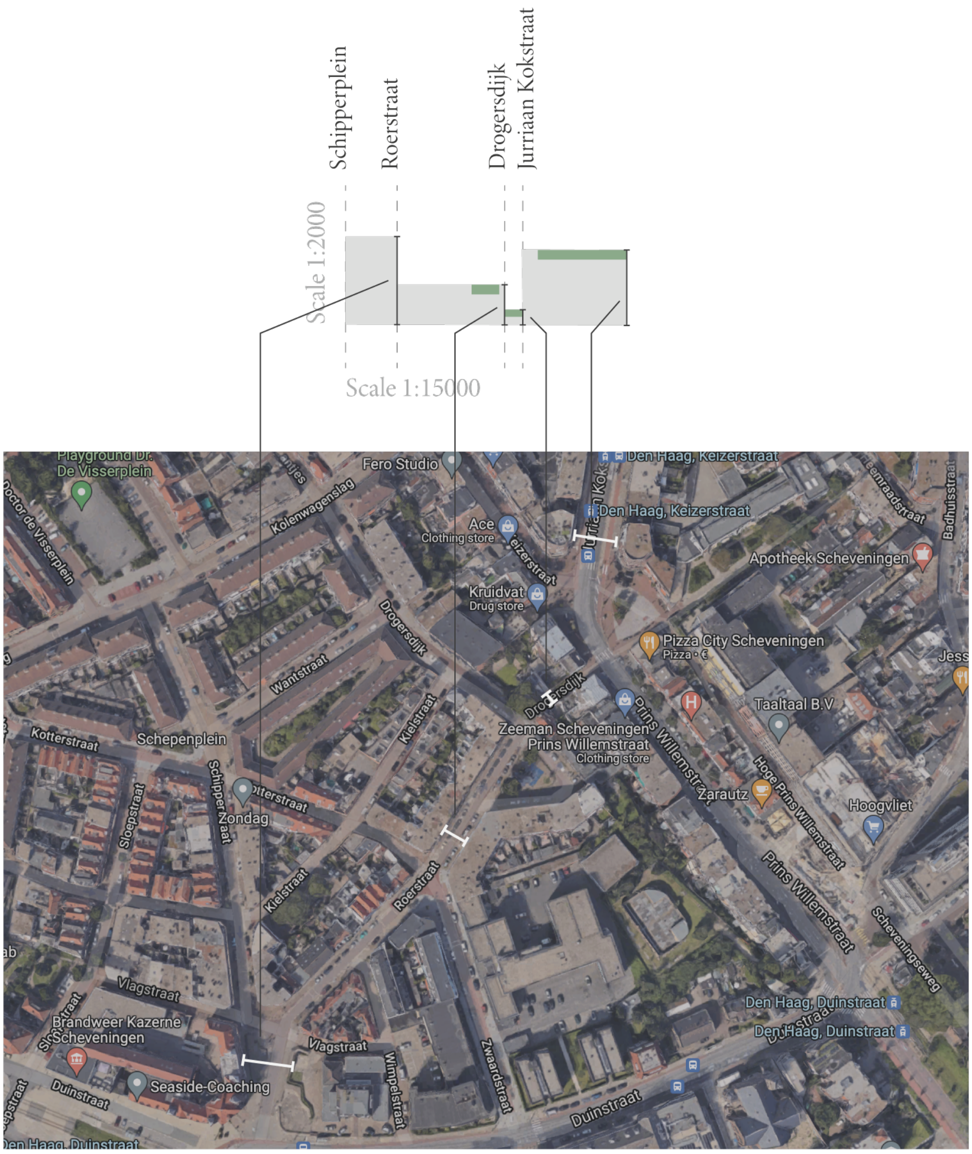


Figure 5-4: Figure showing how the diagram on the following page is derived from google maps. Source: Image by author


Duindorpdam
Westduinweg
Schipperplein
Roerstraat
Drogersdijk
Jurriaan Kokstraat
Gevers Deynootweg
Scale 1:2000
Scale 1:15000
Duindorpdam
Westduinweg
Schipperplein
Roerstraat
Drogersdijk
Jurriaan Kokstraat
Gevers Deynootweg
Scale 1:2000
Scale 1:15000
Kurhausweg
Badhuisweg
Dr. Aletta Jacobsweg
Bankastraat
Nassauplein
Nassaulaan
Mauritskade
Parkstraat
Scale 1:2000
Scale 1:15000
Kurhausweg
Badhuisweg
Dr. Aletta Jacobsweg
Bankastraat
Nassauplein
Nassaulaan
Mauritskade
Parkstraat
Scale 1:2000
Scale 1:15000

Figure 5-5: Diagrams showing the widths of the arteries, the current green and the possible percentage of green when the mobility space is minimized. Source: image by author

06 THE TOOLBOX

To reach the aim of designing streets that consist for 50% of green, a toolbox is created as part of the products of this thesis. The proces to the formation and the analysis used to create this toolbox are explained in this chapter.

Figure 6-6: Different plants in facade gardens in Scheveningen.
Source: photograph by author.

6.1 UNDERSTANDING THE STREET

Carmona, et al. (2003) says infrastructure to be part of the public space networks that are located in between the urban block and calls it movement channels. This network of movement channels facilitates movement between different urban environments, but at the same time these channels can be considered urban environments of their own. The typology and characteristics of these spaces will differ depending on the function(s) of the environment in they are located. Some spaces can be as large as a squares and parks, which also facilitate movement, but this thesis places its focus on (networks of) streets.

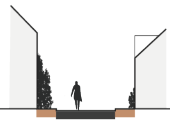
6.1.1 HOW WE USE THE STREET

The street is a linear three-dimensional space embedded within buildings (Carmona et al. 2003). Meyer, et al. (2021) says streets are designed to function as a thoroughfare from buildings to other buildings or other parts of the town or city. The street gives space to both social activities as well as movement, but the ratio between these two has changed dramatically over time. When the streets were mainly filled with pedestrians and horse-drawn carriages, movement space and social space would overlap. As such, social space was ensured as pedestrian movement encourages social, economic, and cultural exchange. Nowadays, as the horse-drawn carriages are replaced by closed off cars, the distinguishment between movement and social space on the street has become more apparent. The introduction of sidewalks during the 18th and 19th century already separated pedestrian movement from vehicular movement. Following that, the increased levels of car ownership and increased speed and size caused the transportation system of roads to shift even more in design. A hierarchical system was introduced, which can still be seen in the street typologies that are applied nowadays (Carmona, et al. 2003).

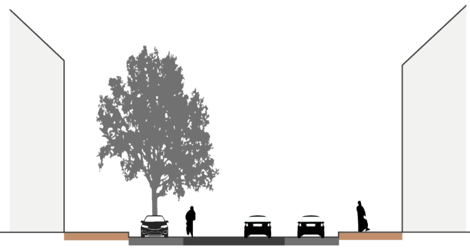
Most often, the hierarchical system can be identified through the width of the street; larger streets will often have more space for throughfare vehicle movement whereas smaller streets focus more on destination. Take, for example, the old design of the Coolsingel in Rotterdam, as one of the main throughfare streets in the city it gives a lot of space for car movement and public transport. The Trompetstraat in Delft, as an alley, can be almost the opposite. Filled with green facades and hardly ever used by cars the street creates an optimum environment for slow movement. The design of the Dutch 'lanen' can be placed in between these two more extreme typologies: it facilitates fast throughfare movement in the middle whereas the side streets allow for slower movement and parking. The fast and slow movement is separated by rows of trees. Yet, changes in street design are changing the use of hierarchy, such is the case for the new design of the Coolsingel, where cyclists and pedestrians are getting more space and space for the car is reduced (Gemeente Rotterdam, n.d.). These and other typologies are explained further in "Appendix 2: Theory essay".

Overall, a distinguishment can be made between three types of spaces that built up the street. The first and second would be the social space and movement space, which were already defined above. A third space that is used as a main space in this thesis would be defined as green space. Green space is often used as a barrier between the vehicular movement and pedestrian movement, or to split different hierarchical parts within one street (which is what happens in a 'laan'). These structures can be used to great ecological benefit when designed in the right way. Yet some green structures can also give a great possibility to overlap with the social space.

Figure 6-7: Catagorising streets on their width, grouped per 10m. One example for each width category has been chosen as to give an idea of the possible parts and elements. Other streets that fall within a category can have different characteristics than shown here (by Author).

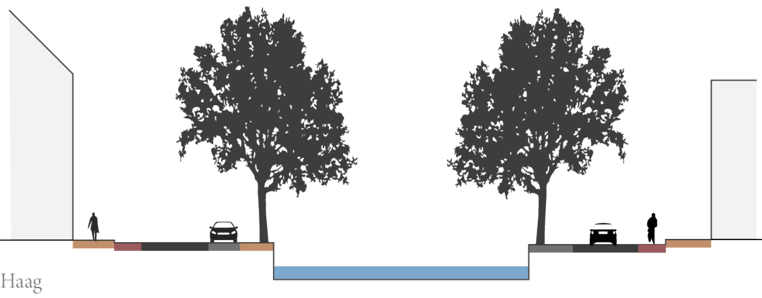


Smaller than 10m
Trompetstraat, Delft

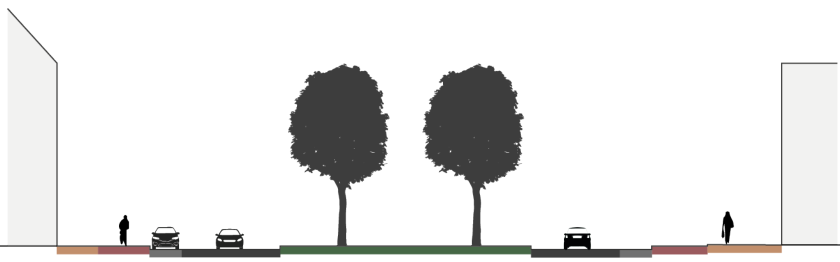


Width is 10m - 20m
Fluwelen Burgwal, Den Haag

Width is 20m - 30m
Regentesselaan, Den Haag



Width is 30m - 40m
Zwarteweg/ Boomsluiterskade, Den Haag



Width is 40m - 50m
De la Reyweg, Den Haag

Width is 50m - 60m
Burgemeester Elsenlaan, Rijswijk

6.1.3 DIVIDING THE STREET INTO SECTIONS AND ELEMENTS

As explained on the previous page, the different types of mobility and space uses in the street are often separated from each other. To do so, the street is formed through an accumulation of different parts. When placed together, these parts create the profile of the street. Using the left three images of Figure 6-2, the main parts can already be identified: the road, the bicycle lanes, the sidewalk, space allocated to public transport, a soft shoulder, water, and parking. It is the way in which these parts are accumulated that informs us of the use of the street and the street typology present.

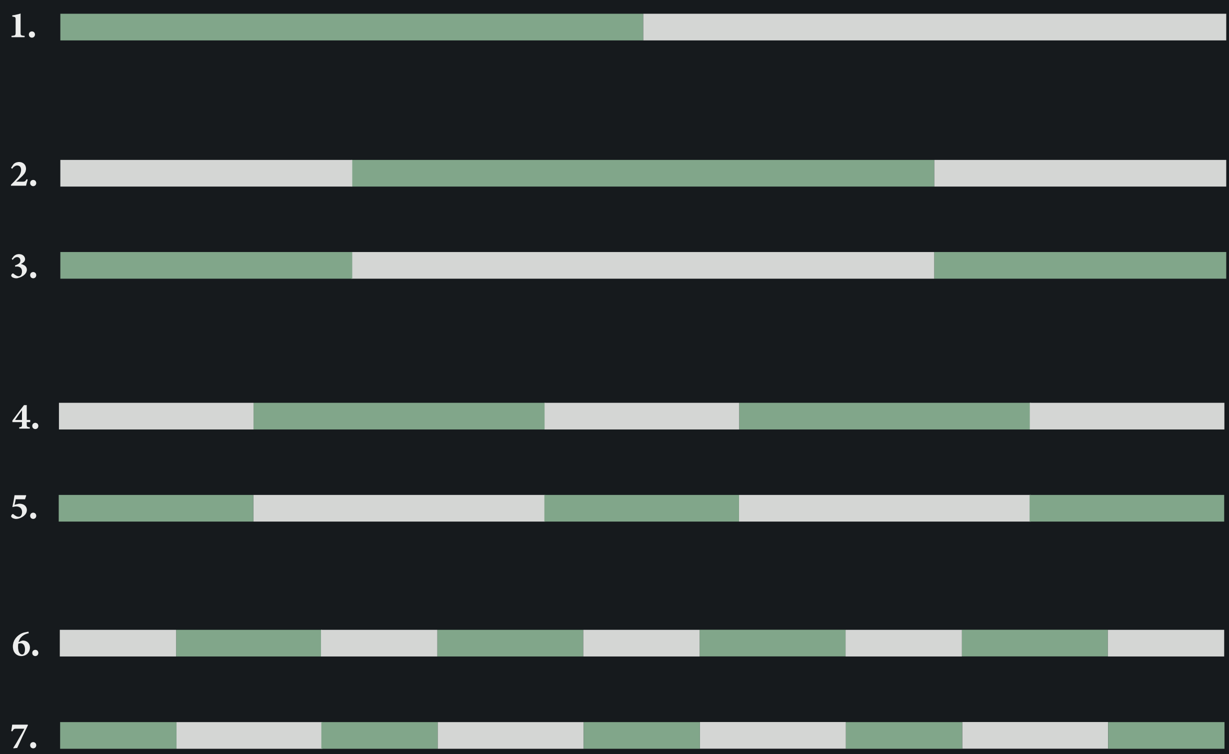
Different components can be placed within the parts to make them more functional and/or attractive. These include the materialisation of the parts; such as pavers, asphalt or grass. Other components focus more on, for example, street furniture or vegetation.

It is always the composition created out of both parts and elements that build a street. It is dependent on the main function of the street and the type of street what parts and elements are chosen for the design. It is also the parts or elements that can be changed to create a more sustainable and/or attractive street.

Figure 6-8: Deconstructing the street (by Author).

6.2 PROFILING THE STREET

The profiling scheme shown below (Figure 6-3) is designed as a first step in the ambition of making 50% of our streets green. In this scheme, a distinguishment is made between two surfaces: a soft surface and a hard surface. The parts of a street profile dedicated to mobility usually have a hard surface, whereas the green spaces in the street built up the soft surface. When (re)designing a street that needs to have a focus on soft surfaces, it is important to ensure these surfaces are added to the street profile and for that, designers can use the basic idea presented in this scheme.



Within the scheme, for each profile surface there is 50% soft surface and 50% hard surface. These surfaces can be distributed onto the profile in different ways, starting with one side soft and the other hard (profile 1). With each next step, the soft and/ or hard surface is split into more pieces.

Every time an extra step is taken, the choice needs to be made whether the outer edge of the street should have a hard or a soft surface. A hard surface would indicate a sidewalk next to the buildings (and possibly other mobility, depending on the profile chosen), which is a convenient way of moving from your house onto the street. Soft edges are often applied as front gardens or façade gardens, but as these are private property, there is no assurance that a soft surface will be applied. In the case of creating a public green surface, considerations need to be made whether the barriers created by the crossings to the building entrances do not disturb the purpose of the soft structure too much. A pro of having such a soft surface next to the building would be that the experience of the street can be very different as it has a soft surface as soon as you step onto it.

The width of the soft surface and hard surface sections in the different profiles also needs to be considered. As the scheme shows, the width of a singular section becomes smaller as the profile is split up more. Within the hard surface sections, this will result in a difference in the number of mobility types in one section. In profile number 3, all movement will take place in the middle section, whereas each form of movement (walking, cycling and cars) can be split up in profile 6. Off course, the exact size of each section will differ depending on the needs of the movement. When looking at the soft structures, the main consideration would be the ecological benefit. Most often, a larger width will give more possibilities for ecology than a smaller width.

To fully incorporate the ecological benefit of soft surfaces, more parts of the section need to be considered than just the profile, as is shown in the lower part of the scheme. Ecology moves through and changes within and between different layers: the canopy layer, the understory, the herb layer, the ground layer, and the soil layer. As the scheme shows, the canopy and soil layer can be connected throughout the whole width of the street even though the profile is divided into many sections. As such, a continuation in the green structure for certain species of flora and fauna can still be created. To achieve this, the right choice needs to be made in vegetation that is applied, and in the detailing of the street to create a continuous ecologically beneficial soil.

Figure 6-9: Diagram of profiles that can be applied to the street to add soft and harder grounds.

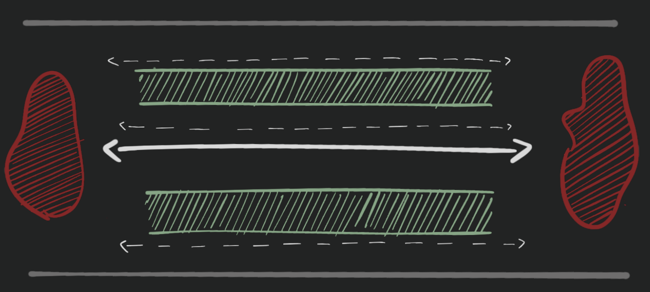
6.3 USING THE STREET

The next step in designing a green street is to consider the uses of that street and the interventions for which we are designing, as this will determine the infill of the street. These uses and interventions are dependend on the three themes explained in the beginning of this chapter: social use, green use, and mobility use. The diagrams in Figure 6-4 each consider all three uses, while the focus of the situation can be on one or two uses only. For example, in the case of linear movement, the focus is placed on mobility use and the other uses are a supplementary to this mobility use. Whereas, in the case of social green, the green use and social use merge together to create a more attractive environment, and the mobility use is supplementary.

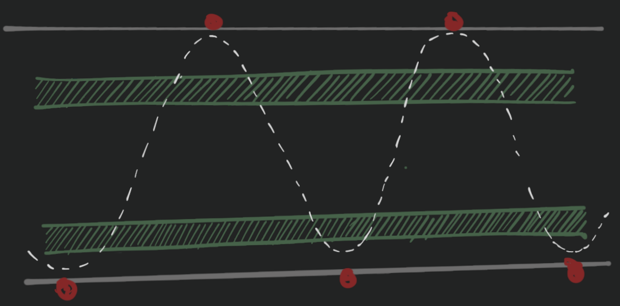
When designing for a specific location, one or more design situations can apply. Each situation has a design goal, but there are often challenges to reaching this goal. The defined challenges should be considered, and preferably overcome, through the design that is created for that location. The given design situation should cover most possibilities, but there could be some extra situations. At least, these situations cover the needs for this thesis.

Figure 6-10: Design situations that are applicable to different locations.

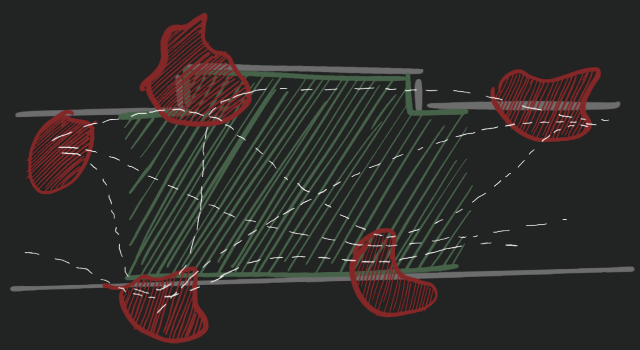
Figure 6-11: Photograph showing a location with where the ZigZag situation is applicable. Source: photograph by author



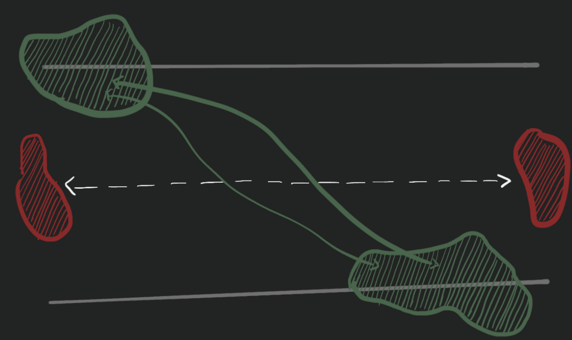
Linear movement
The street provides for throughfare movement from one place to the next. This creates the possibility for adding linear green structures along the movement spaces in the street.



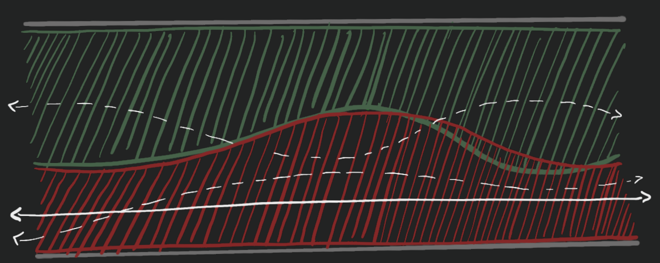
ZigZag
Often seen in streets with public functions in the buildings, people like to zigzag from one building to the next, and to opposite sides of the street. When wanting to apply linear elements of green, the need for people to cross will create barriers that have to be bridged.



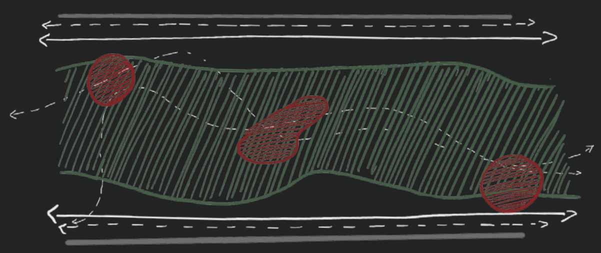
Maximum space
Large public spaces can be used to largely increase the amount of green in the street, but designers must consider the random movement of people between different activity clusters.



Connecting green
Using public space to connect green patches. The movement of people between social activity spots can work as a barrier in this connection.



Social activities
Creating safe space for social activity on the street by connecting the social space to green space and encouraging slow movement.



Social green
The green structure provides space for social activities that are connected by slow movement infrastructures.

6.4 INFILL OF THE STREET

Once a decision has been made on the profile and design situation of the street, it is time to fill in the parts with elements. Currently, the application of softening the ground and adding green to streets is a very sporadic process. Therefore, a product of this thesis is a toolbox that can be used to make grounded choices in the elements that are added to the street design. The tools within this toolbox are evaluated and chosen through the services that they can provide to the design location. These services are based on the theory of ecosystem services.

6.4.1 (ECOSYSTEM) SERVICES AS AN EVALUATION AND IMPLEMENTATION TOOL

As explained in the theoretical underpinning, ecosystem services refer to the goods and services that are presented by the ecosystem functions, from which we can derive direct and indirect benefits (Constanza, et. al., 1997). Some of the ecosystem services are limited to landscape size and continuity but most can be applied on the street, although maybe not to the same degree as in rural areas. Therefore, they will be referred to as services that are related to green structures and elements in the street. The services used in the green street toolbox are divided into three categories: ecology, climate and social. Each services is explained below.

Ecology
Pollination
The fertilization of vegetation by insects. Pollination is important for farming but also for wild vegetation. Around 84% of the vegetation in Europe is dependent on pollination to reproduce.

Soil Fertility
Soil fertility refers to the ability of the soil to provide the vegetation with the needed nutrients. The larger the variation of soil life (such as worms, mildew, and bacteria) the better the soil and the better the vegetation growth.

Life Cycle Protection
Plants and animals go through a specific life cycle during their existence. Many plants and animals need different habitats throughout their life. The chance that plants and animals can survive will be larger when these habitats are protected. Within these habitats, pollination and seed transfer must be protected, or genetic sources can be kept.

Biodiversity
Biodiversity within an area is a key factor in creating and maintaining healthy ecosystems and influences the possibility of many of the afore mentioned ecosystem services (such as soil fertility and pollination).

Climate
Purification of Air, Water, and Soil
The air, water and soil in industrialized countries is often polluted. The main polluters are 1. particulate matter in the air, due to traffic, industry, and stock farming, 2. fertilizers and herbicides from farming and 3. waste products such as heavy metals from the sewers and industry. Specific plant and animal species help to replace, dilute, or retain these pollutants and some micro-organisms help break down the pollutants.

Heat Regulation
In summer months, the temperature in urban environments can rise by seven degrees compared to the surrounding rural areas due to the Urban Heat Island effect. Heat

waves cause health complaints, and in the Netherlands, 30 people die per degree celsius temperature rise per week. Green- and water structures and air currents have a cooling effect op the urban climate and can strongly decrease the heat in summer months

Water Regulation
Water regulation refers to temporarily catching the (rain)water. In the case of a soft surface, the water can infiltrate the soil or water can be in containers and used in the dryer periods. Proper water regulation can also help with creating new green recreation and more biodiversity when new natural areas are designed.

Social
Disturbance Regulation
Disturbance is a continual occurrence in our current society. These include noise disturbances from for example traffic, wind disturbance, and visual disturbances. Many of which will be reduced by adding green elements. This results in more tranquillity and less stress, increasing the appreciation of an area.

Cultural Heritage
Cultural heritage refers to objects and natural elements or landscapes with a remarkable natural interest to the common heritage. These often refer to larger ecosystems but can also refer to the indigenous species.

Educational
Science and education about nature is important for understanding the human body, flora and fauna and full ecosystems. Knowledge on nature can be used to restore and preserve current nature areas and ecosystems. The education on nature will help create awareness for the urge to safe our natural systems.

Recreation
Green recreation refers to all forms of recreation in green environments, such as sports, going for walks, playing in the playground. It encourages relaxation as well as movement in all age categories. As such, green areas benefit the general health of the residents and creates a more attractive living environment.

Ornamental Resources
Animal and plant products, such as skins, shells, and flowers, are used as ornaments, and whole plants are used for landscaping and ornaments.

◉ Primary Service

● Secondary Service

SERVICES

TOOLS

TOOLS		ECOLOGY SE1 Pollination	SE2 Soil fertility	SE3 Life cycle protection	SE4 Biodiversity
VEGETATION					
Grass	TV1	●	●	●	●
Bushes and shrubs	TV2	●	◉	◉	◉
Flowerbeds	TV3	◉	◉	◉	◉
Trees	TV4	●	◉	◉	◉
Green tree surrounding	TV5	●	◉	◉	◉
Facade gardens	TV6	●	◉	◉	◉
Floating green	TV7	●		◉	◉
Hanging green	TV8	●		●	◉
WATER STRUCTURES					
Ditches	TW1		◉	◉	◉
Bioswales (Wadi)	TW2	●	◉	◉	◉
Urban water channels	TW3			●	●
Natural banks	TW4	●	◉	◉	◉
Green in hard banks	TW5				
MATERIALS					
Porous pavement	TM1				●
Lifted planters	TM2	●		●	●
Dry stone walls	TM3	●		●	●
Facilities for fauna	TM4			◉	◉
Water infiltration boxes	TM5				
Rainwater storage	TM6				
Sprinkling	TM7				

Figure 6-12: The toolbox matrix, tools versus services.

CLIMATE			SOCIAL
SC1 Purification of air, water and soil	SC2 Climate regulation	SC3 Water regulation	SS1 Disturbance regulation
●	●	◉	
◉	◉	●	◉
◉	●	●	
◉	◉	●	◉
●	●	◉	◉
●	◉	◉	◉
◉	●		
●	◉		
●	●	◉	
●	●	◉	
●	●	◉	
●	●	◉	
		◉	
	●	◉	
●	●	●	
●	●		
		◉	
		◉	
	◉		

6.4.2 THE GREEN STREET TOOLBOX MATRIX

The matrix shown to the left links the services explained before to the tools that can be implemented to soften the ground. The tools are divided into three categories: vegetation, water structures and materials. The water structures refer to water elements that are above ground. The material tools refer to extra facilities that can be applied when it is not possible to use the vegetation and/ or water structure tools, or when extra facilities are needed in addition to those tools.

Each tool has one or multiple services that it can provide. These provisions can either be a primary service, in which case the service will always be a product of the tool, or a secondary surface, where the tool needs to be implemented in a specific way for the service to be provided. A further explanation on this will be given in the next chapter and in the 'a green street toolbox' book.

When using the toolbox to create a new design, not all services need to be of importance when implementing a tool. Therefore, a numbering system has been added to the toolbox that shows the tools and the reason they were added to the design. For example, if a tree is used to regulate heat, the designer would give the tool the following number: TV4-SC2.

6.5 THE TOOLBOX AS A BOOK

To fully explain all the tools that are placed in the toolbox, a small booklet is created, which can be downloaded as a separate document called "The green street toolbox". Each tool has a separate spread (see Figure 6-7) in which a more detailed description is given, starting with an explanation on when the tool can be applied. Secondly, the primary and secondary services that are provided by the tool are mentioned. And thirdly, an explanation is given on the considerations that need to be made when implementing this tool. For example, when looking at porous paving materials, some will have enough space for vegetation to grown between them, while others are only designed to allow water to infiltrate the soil. The choice of pavers should depend on the services that are needed.

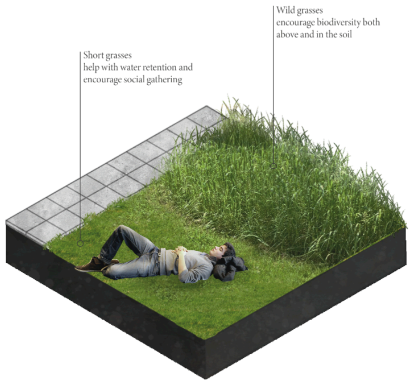
In addition to the explanatory text, the left page also gives another overview of the primary and secondary services that can be provided by the tool. A collage is placed on the right page to give an example of what the tool can look like. Since they are just an example, when creating a new design the social, ecological and mobility needs of that specific location should always be considered while implementing the tools.

Figure 6-13: Toolbox booklet example pages for two different tools. Source: by author

TV1 **SC3** Water regulation
SE1 Pollination
SE2 Soil quality
SE3 Life cycle protection
SE4 Biodiversity
SC1 Purification of air, water and soil
SC2 Climate regulation

GRASSES

Grass fields or patches of grass can be applied in any situation where there is no excessive amount of movement. Grass surfaces let rainwater infiltrate the soil, and when designed with a slight slope it will also be able to hold water temporarily. As such grass field help with managing ground water and prevent drying out of the soil. When applying short grass to a surface, the field might also be used for social activities, such as picknicks or playing sports, but these short grass fields don't have any benefit for the biodiversity of the area. To achieve that, a field with wild and taller grass is needed, which also stimulate root growth, resulting in better soil quality and water retention. Lastly, taller grass also emits more water evaporation, resulting in a slight cooling effect to the surrounding (Pötz, 2016).



14 The green street toolbox

Vegetation 15

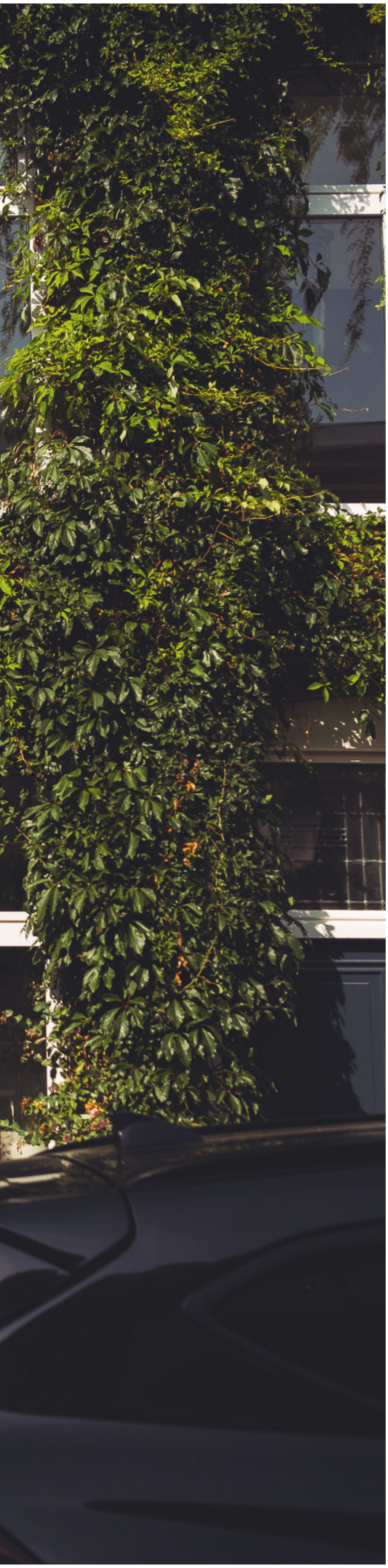
TM2 **SC3** Water regulation
SE2 Soil quality
SE4 Biodiversity
SC2 Climate regulation

POROUS PAVEMENT

Porous paving materials are a good option when the movement space is not used as intensively but still needs a stable surface. Take for example the parking lots, pedestrian paths from the parking lots to the sidewalk or playgrounds. In such cases porous paving will still allow water to infiltrate the soil directly, provide space for grasses to grow through and increase the soil quality. The extent to which the secondary surfaces (soil quality, biodiversity, and climate regulation) are provided depends on the type of porous pavement that is chosen. There are many different options of porous materials, such as grass concrete pavers, porous pavers, open-joint pavers, woodchips, gravel, or shells. Depending on the percentage of the opening, the ecological surfaces will or will not be applicable (Pötz, 2016).

44 The green street toolbox

Materials 45



07 THE DESIGN

The design chapter applies the new street profiles and the toolbox to the chosen arteries and the design locations within the arteries. This showcases how the design instruments are used to reacht the goal of a 50% soft surface for the street.

Figure 7-1: Large climbing plants in facade gardens in Scheveningen. Source: photograph by author.

ARTERY ALONG THE COAST

Figure 7-2: Map visualising the different aspects of the artery along the coast in order to give the reader a visual on the location we are working with.
Source: Figure by author, photos by author

7.1 ALONG THE COASTLINE

1.7.1 FOCUS OF THE ARTERY

The artery in Scheveningen functions as a throughfare along the coastline that is mainly focussed on motorized vehicles. As such, most of the artery is built as an urban main street with a large area designated to cars. Public transport, specifically trams and busses, are added to the profile halfway down the artery. This results in an artery that is largely paved, with only 1,8% of the surface being a soft surface. The green that can be found in the area mostly consists of lines of trees, with minimal tree surroundings.

The absence of soft surface causes the Urban Heat Island (UHI) effect to be very high in most of the artery, yet it is most present on the Westduinweg. It also causes the water to not infiltrate as well, leaving sporadic spots of flooding on days with high rainfall.

Following the coastline, the Northern side of the artery includes living and mixed functions, while the Southern side of the artery passes along a residential area (Figure 7-10). On the east side of the artery, the use is dominated by large attractions such as the boulevard, pier, Kurhaus, cinema, casino's and so on, resulting in an area where all types of mobility make use of the same space. Both sides of the artery give entrance to the Westduinen and Oostduinen, also attracting people to park their car or bike.

As a conclusion of this analysis, a few ecosystem services that are in focus of the whole artery have been chosen. The ecology ecosystem services should all be applied in the green structure, giving special attention to the ecology that is in the dunes in order to connect the West- and Oostduinen. The full artery also needs attention to climate and water regulations.

(See the analysis diagram in Figure 7-10 for a detailed visualisation of the analysis results)

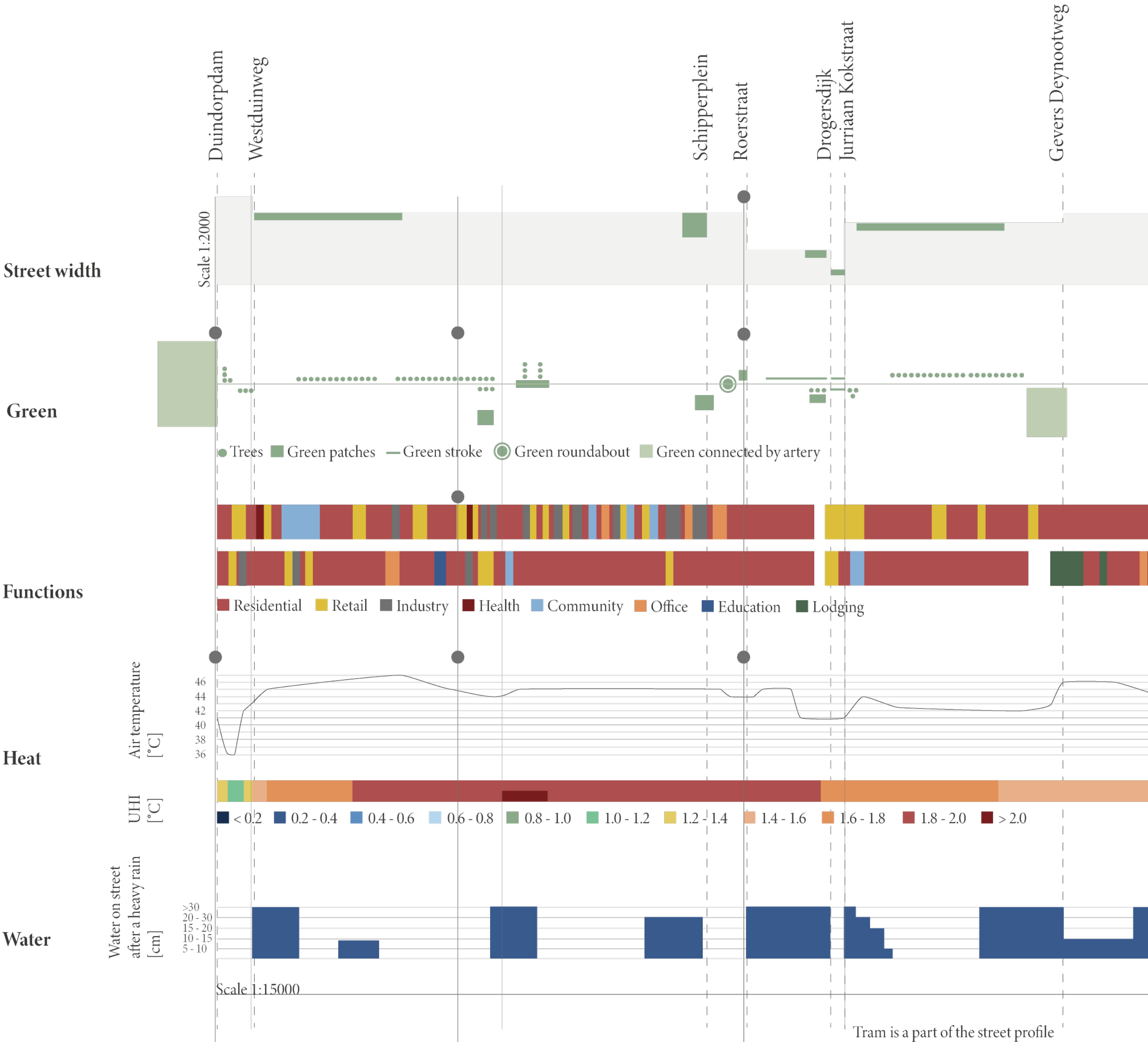
Figure 7-3: Sections of the current street profiles in photos. Source: all photos by author


RUTTEN


uitgezonderd




RY-636-N



Large amounts of space not used for green
Water below the bridge results in a lower UHI

High amounts of green, including a natural playground next to the school.
A primary school is located next to the main street.
High UHI and air temperatures

Small widths create challenges for claiming space for green elements.
Yet there is a relatively high amount of green already.
But also a high UHI

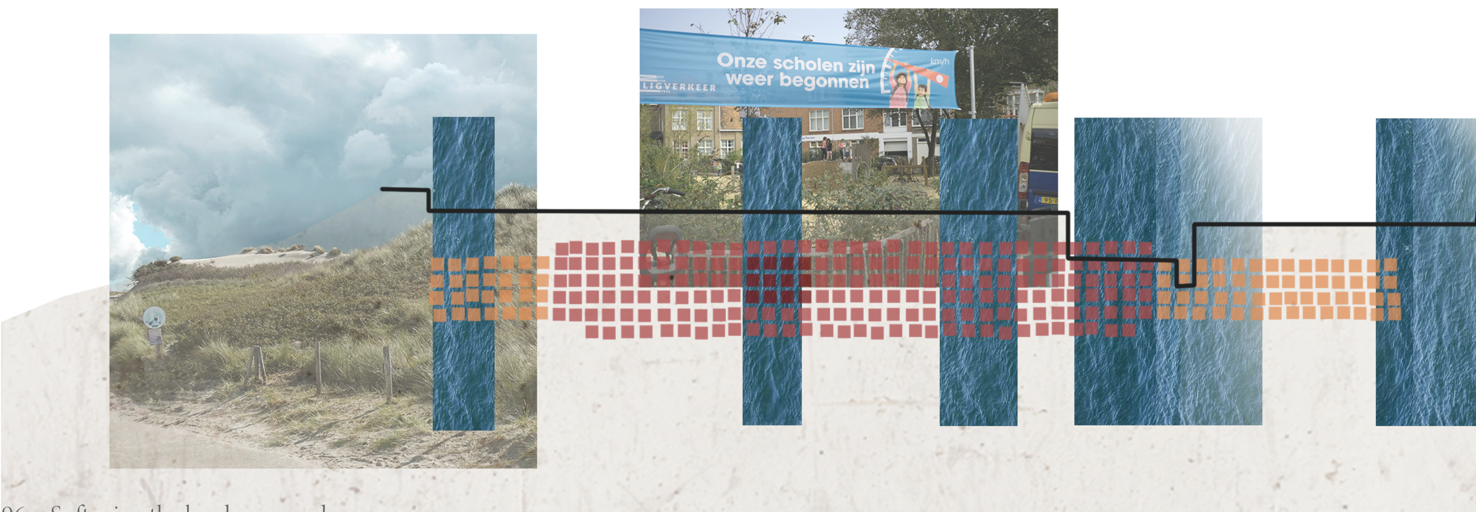
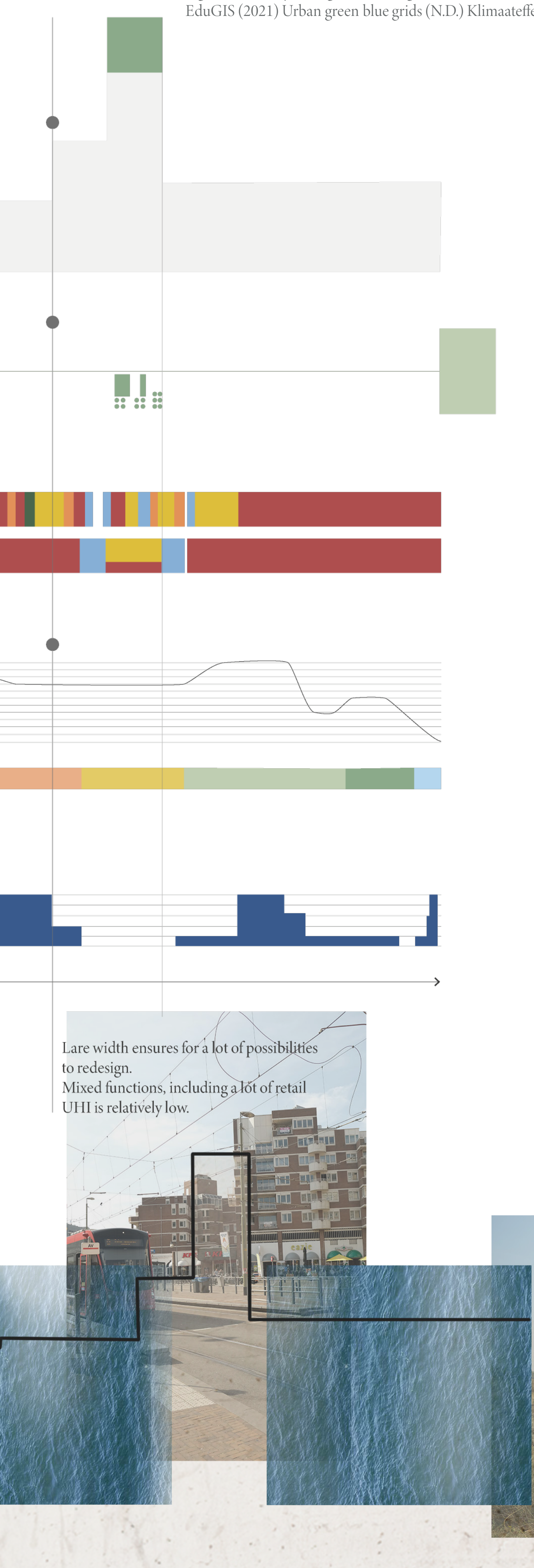


Figure 7-4: Analysis diagram showing data on street width, green, functions, heat and water. Figure by author based on data retrieved from: Google Maps (2021), EduGIS (2021) Urban green blue grids (N.D.) Klimaateffectatlas (N.D.) and Atlas Leefomgeving (2021)



Street Width
The street width diagram shows the distance measured between the buildings on both side of a street, which can in turn be used to calculate the total surface of the street. The diagram also shows the amount of green that is currently located in the street. The numbers for these widths have been measured using Google Maps.

Green
The green diagram shows the current types of green located on the artery, consistent of trees, green patches, green strokes, and green roundabouts. The diagram also shows the green areas that are connected by the artery. This diagram was constructed using Google Maps and analysis during site visits.

Functions
Both sides of the streets have different functions as their main use, and the main function also changes along the artery. The current functions will influence the uses and needs of the street profiles depending on the use and number of people that come through. The data is obtained from maps by EduGIS (2021).

Heat
The heat data shows two different factors: Urban Heat Island (UHI) and perceived temperature. The urban heat islands shows the average temperature difference between the urban area and rural area, where urban area's can often be a few degrees hotter than rural areas (Urban green blue grids, N.D.) The perceived temperature is based on data from a hot summer day, on July 1st, 2015, and calculated using multiple weather components: the air temperature, solar radiation, wind speed and humidity (Klimaateffectatlas, N.D.). We see in the that the perceived temperature can be high even though the urban heat island is relatively low. This can be related to the fact that perceived temperature is not only based on air temperature but also on the other components mentioned before, whereas the UHI is based on air temperature only.

Water
The diagram shows the possible depth of the water that accumulates on the street after a heavy rainfall. The data is based on a map on Atlas Leefomgeving (2021) by Climate Adaptation Services. The data is based on a reainfall that happens once every 100 years. Due to climate change, heavy rainfall will happen more often and with that, water will accumulate on the streets more often.

7.1.2 SCHEVENINGEN FLORA AND FAUNA

Figure 7-11 shows the different species of flora and fauna that are used as the icon species for the Scheveningen artery. The species chosen occur in the sea dunes and Waddeneilanden of the Netherlands. These areas are known for their large surfaces of bushes and shrubs and has become a rich ground for the native species such as the sea-buckthorn and common juniper. Large trees such as the english oak and field elm are found in the old dunes and inland edges of the dunes (Maes, 2006; Johnson and More, 2007).

The dune areas know a large variety of fauna species, a few of the most common have been chosen for this artery. The green structure in the artery cannot always be wide enough (10 meters and above) to function as a full corridor and needs patches to sustain it for biodiversity purposes. Therefore, the icon species are relatively small and often already occur in urban environments and will be able to make use of the more narrow corridors (Gemeente Den Haag, 2018; Vogelbescherming Nederland, n.d., Haags Millieucentrum, 2008).

Figure 7-5: The flora and fauna found in the areas where the centres artery is located. Source: by author

Queen of Spain fritillary
Issoria Lathonia

Buff-tailed bumblebee
Bombus terrestris

Hedgehog
Erinaceus europaeus

Grayling
Hipparchia semele

Lesser spotted woodpecker
Dryobates minor

Bearded miner bee
Andrena barbilabris

European rabbit
Oryctolagus cuniculus

Small heath
Coenonympha pamphilus

House sparrow
Passer domesticus

Common carder bee
Bombus pascuorum

Common pepistrelle bat
Pipistrellus pipistrellus

Common juniper
Juniperus communis

Sea-buckthorn
Hippophae rhamnoides

European spindle
Euonymus europaeus

English oak
Quercus robur

Grey poplar
Populus xcanescens

European buckthorn
Rhamnus cathartica

Scotch rose
Rosa spinosissima

Field elm
Ulmus minor

European ash
Fraxinus excelsior

7.1.3 DESIGNING THE ARTERY

The largest part of the artery can be redesigned by applying three new street profiles (Figure 7-12). These profiles focus on minimizing the parking spaces on the street and reducing the width of the car lanes. As such, the urban main streets have a shift in focus, where the throughfare of slow mobility has the upper hand.

Street profile A can be considered a medium sized profile, with widths of around 25m. These streets do not have to accommodate the tram, making it possible to use the mobility profile of 14m. The bicycle is placed next to the car lane, separating the pedestrians from the faster movement by the green structure. A few parking spots are placed within the green structure. They are double parking spots, to also accommodate for trucks, placed 50m apart but switching between sides of the profile. By placing only half of the parking width in the green structure and keeping half of the parking width on the road ensures a larger green area that can provide to ecological benefits. By creating semi-paved parking spots, they still help with water regulation.

The second profile, B, is of smaller width and must accommodate the tram. It is chosen to place the green structure on one side only, to create a larger width and have a higher ecological benefit. To have a benefit at all, the structure needs to be at least three meters wide. In arteries with a small width for the green structure, the patches along the artery are of great importance (Mabelis, 1998). The parking lots are placed fully in the green structure to make sure the cyclists do not have to make way for parked cars and move onto the tram tracks and will only be available on one side of the profile. This does result in larger barriers within the green structure, which will be minimized by placing the parking around 100m apart from each other.

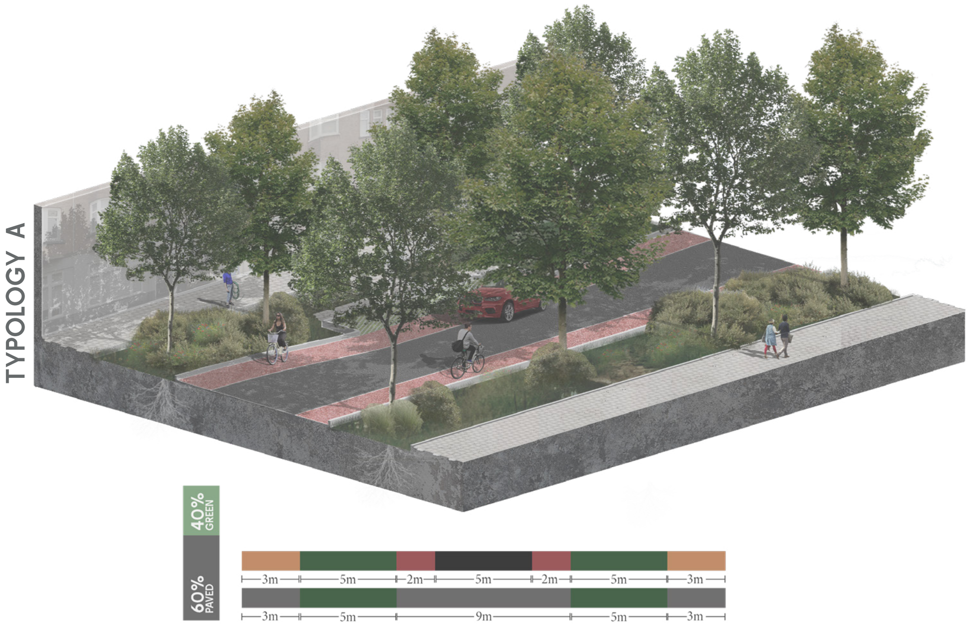
The third profile, profile C, is applied to a street with a large width of more than 40m. In such a profile, the width of the green structure can be large enough to allocate space to both ecological green as well as social green where people can hang out.

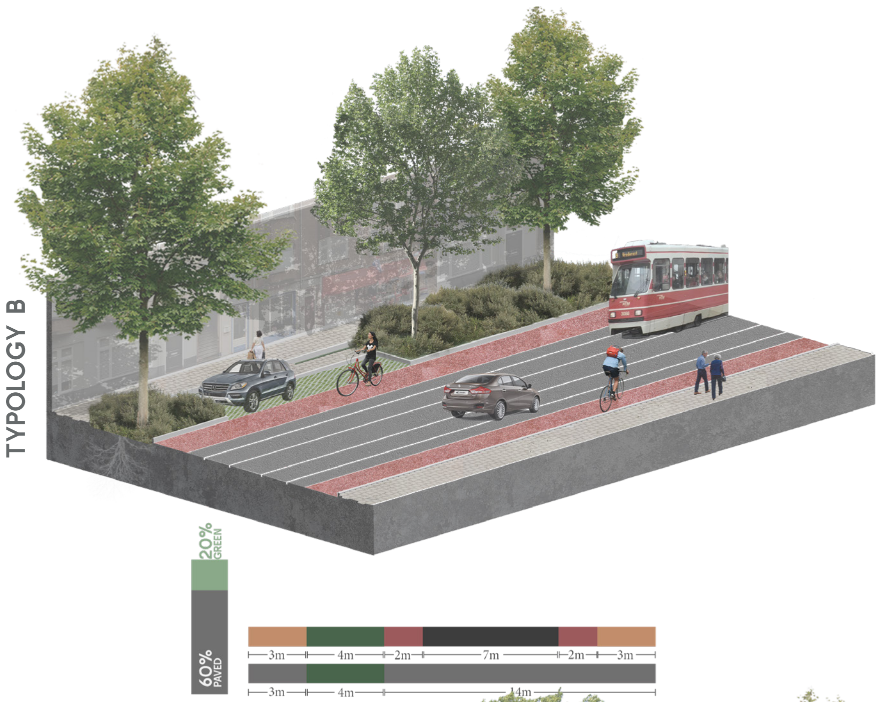
By minimizing the parking spaces on the street and reducing the width of the car lanes, the main street has a shift in focus, where slow mobility has the upper hand. The main street is a throughfare for all types of transport (see 'network' in Figure 7-13). This has also allowed for a linear green structure that can be continued throughout the whole artery (see 'green structure' in Figure 7-13). Apart from these linear elements, the artery has exception locations where spaces such as squares, and roundabouts create a larger width and more possibilities for softening. By making use of those larger spaces and the linear green structure, 49% of the artery along the coastline can be softened (see 'green surface percentage' in Figure 7-13, and the calculations can be found in "Appendix 1: Corridor surfaces calculations").

7.1.4 DESIGNING THE EXCEPTIONS

As mentioned before, the three main typologies can be applied on most of the artery, but there are also some exceptions. These mainly consist of larger public spaces with more complex uses. For this artery, two exceptions will be used to show the implementation of the toolbox on a smaller scale. The first location focusses on the primary school at the Westduinweg. The second location focusses on the Kurhaus tramstop at the Gevers Deynootweg.

Figure 7-6: New street profiles adding green structures to the mobility network. Source: by author


TYPOLOGY A
40% GREEN
60% PAVED
3m 5m 2m 5m 2m 5m 3m
3m 5m 9m 5m 3m


TYPOLOGY B
20% GREEN
60% PAVED
3m 4m 2m 7m 2m 3m
3m 4m 14m

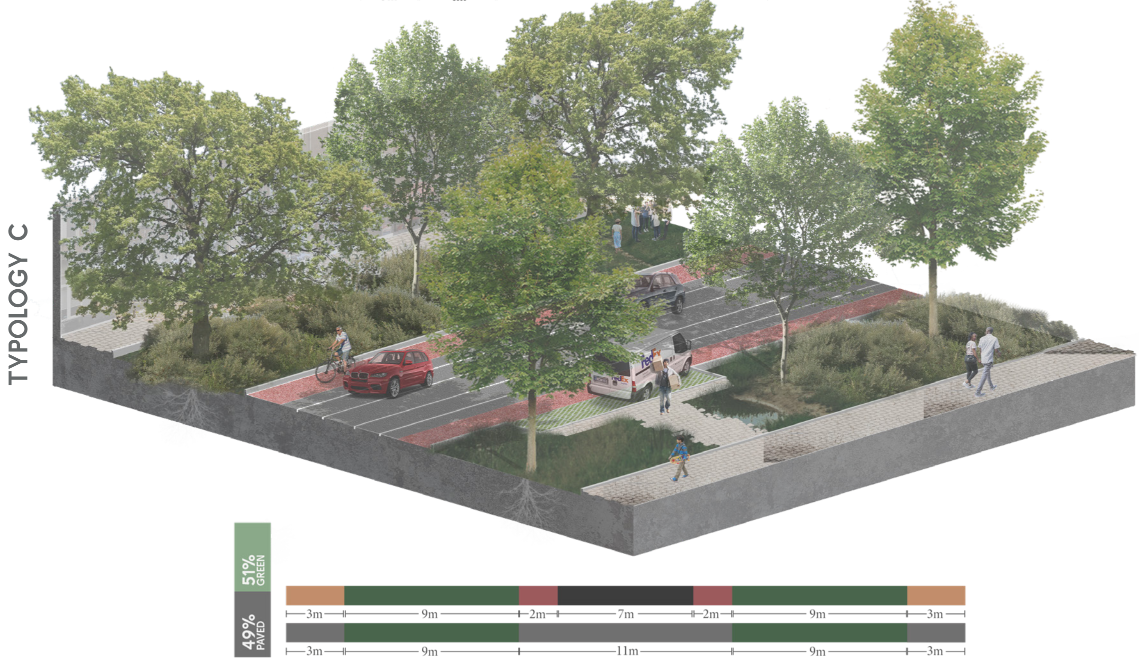
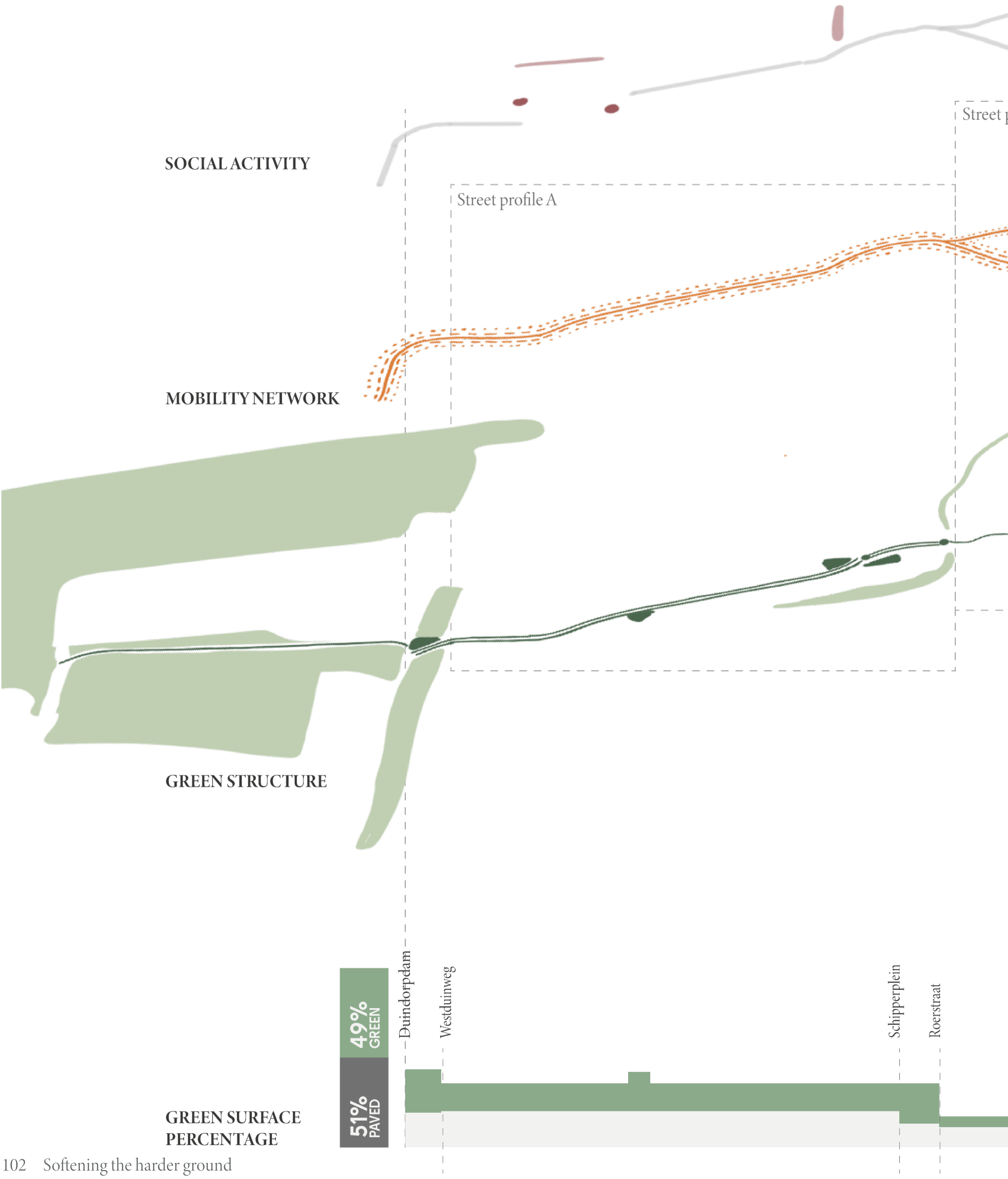
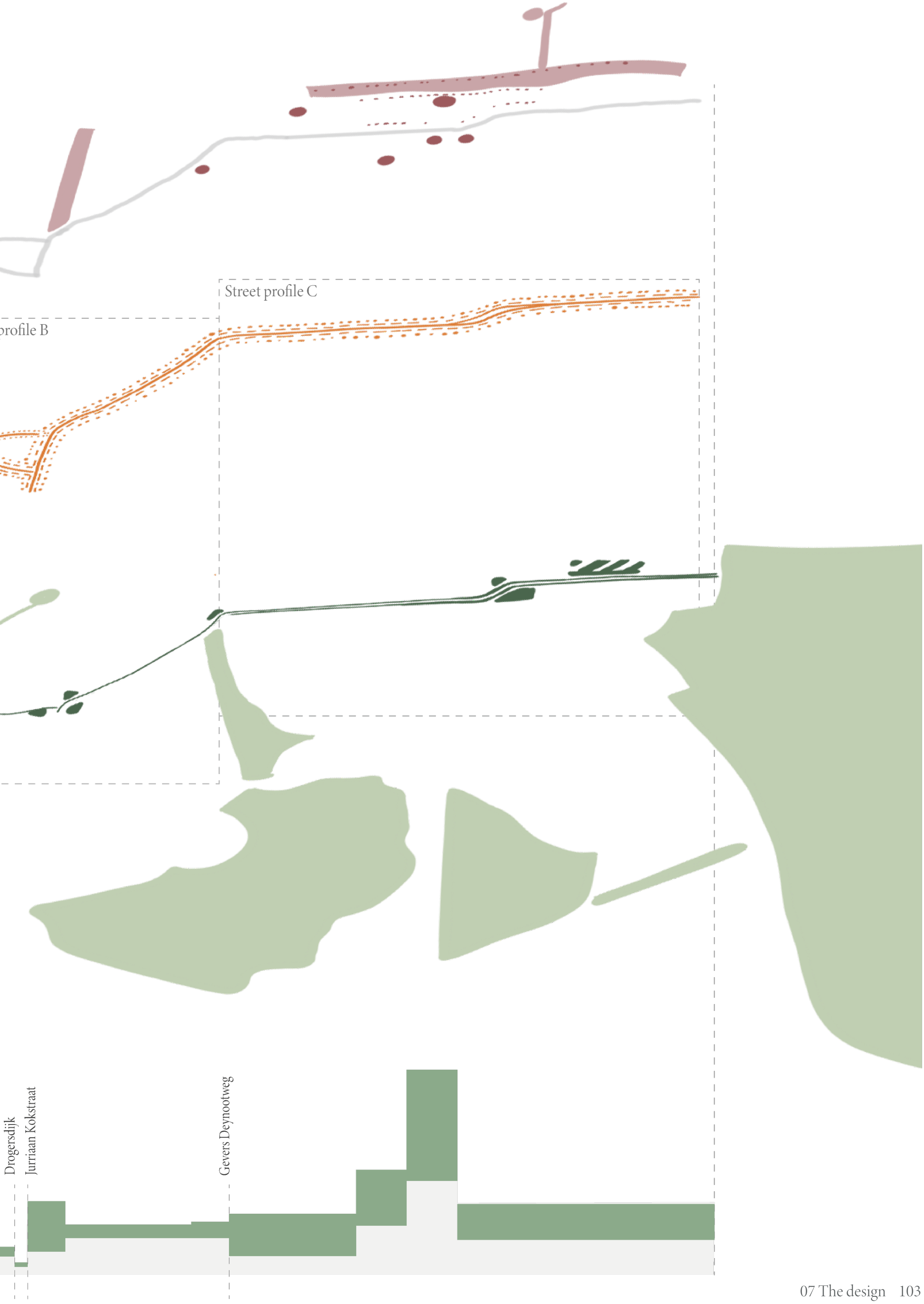

TYPOLOGY C
51% GREEN
49% PAVED
3m 9m 2m 7m 2m 9m 3m
3m 9m 11m 9m 3m

Figure 7-7: The new system of the corridor. Source: by author





Street profile C
profile B
Drogersdijk
Jurriaan Kokstraat
Gevers Deynootweg

PRIMARY SCHOOL PUBLIC SPACES

The current school space

The first design locvation that will be described is the school district. Because of the primary school in this location, the design has a specific target group, the children and their parents. They make use of the public space in specific time frames, namely when the school opens and closes, and the children must be picked up, creating a hot spot for bicycle parking. The analysis diagram (Figure 7-10) also shows that this location has the highest UHI effect of the artery, creating uncomfortable outdoor environments, especially on hot days without shading. The school does already have a natural playground in front of the main entrance, providing shaded space for children to play and water to infiltrate. Because of this playground, the percentage of soft ground is already high relative to other parts of the artery.

The design of this location should focus on the following Ecosystem Services: climate regulation, education, and recreation. The design should also include concepts improving the ESS for the whole artery, mainly through biodiversity and life cycle protection.

TV4-SC2
TM1-SC3

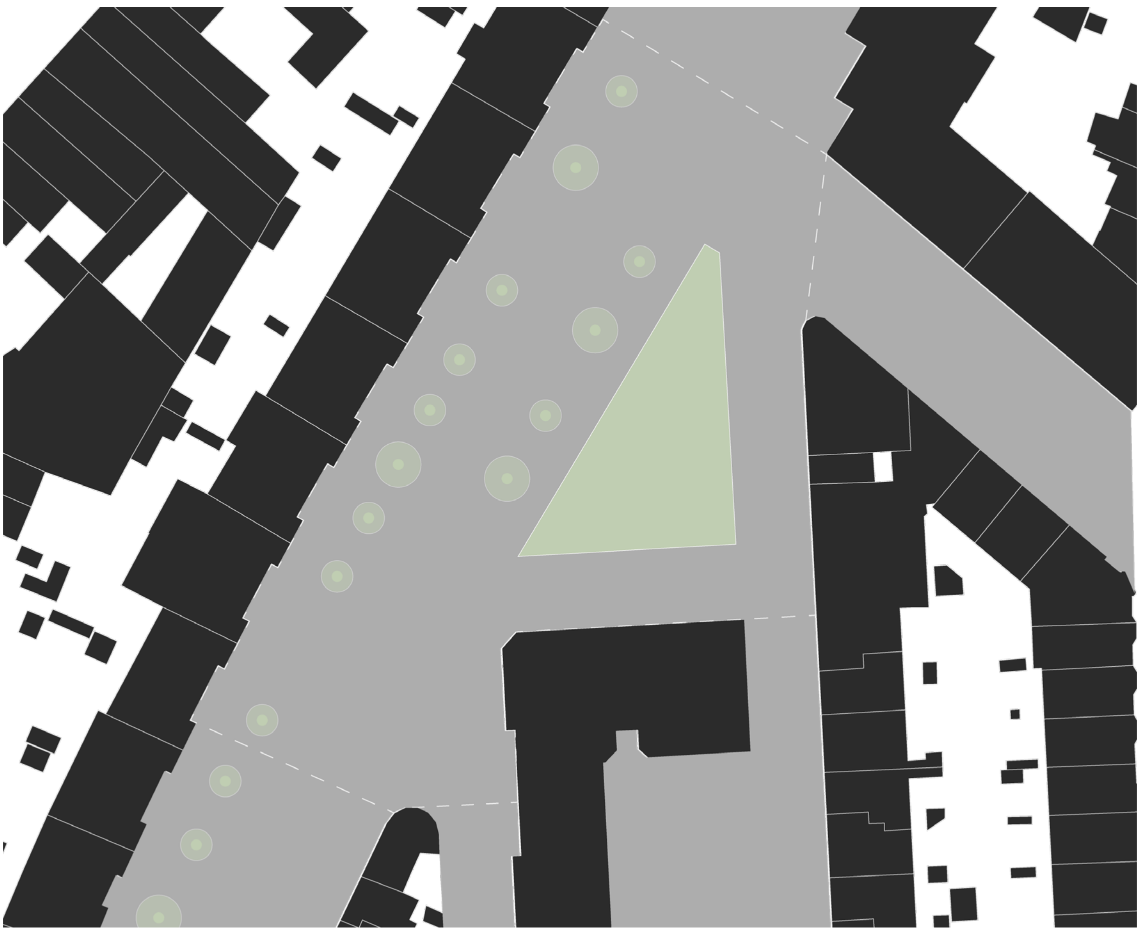


Figure 7-8: Diagrams of the current soft versus hard ground situation for the school area. Source: by author

Figure 7-9: Image showing the current school area, with the natural playground in front of the school

Figure 7-10: Map of the current school area. Source: Google earth pro

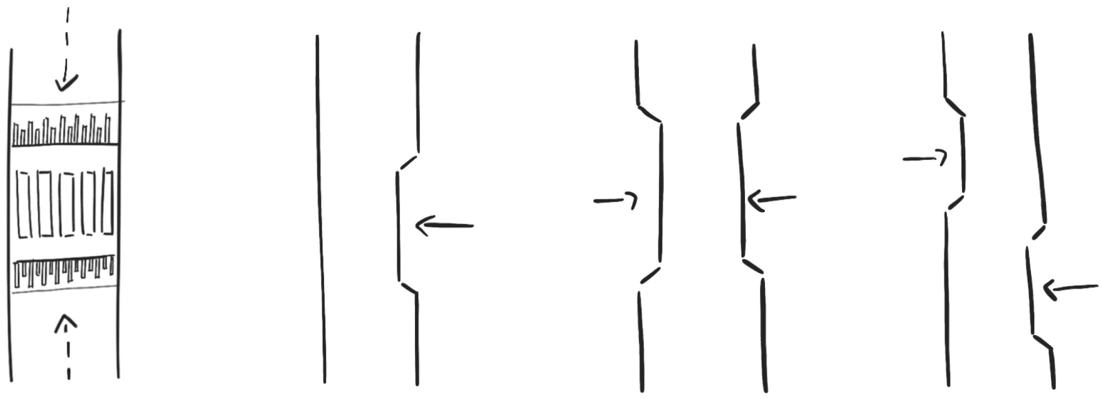
Designing a new safe space for school children

The redesign of this location can be explained in three parts. The first part considers the new main street typology that is added, which, in this case, is street profile A. Some safety measures can be implemented to create a safer environment for children that need to cross such a main road, options for which are shown in Figure 7-17. In this case, it was chosen to make use of the parking spaces to taper the street on both sides but placing them in different locations, to slow down the cars. These are also the parking spots that can be used by the parents to pick up their children from school.

The green structure in this location will focus on vegetation that is related to the dune areas, such as oak and elm trees and a lot of bushes (see Figure 7-11 for a more detailed list). The green structure on the East side of the street includes a natural ditch, that can transport and hold water in heavy rainfalls and can slow down the need for water infiltration and regulation. The above ground water can also be used as an educational factor, as it shows the children of the primary school when water needs to be regulated and potentially where it goes. The green elements next to the cross walks are kept smaller and especially lower. This ensures that car users have a better overview of pedestrians wanting to cross the road.

The second consideration concerns the street network surrounding the school. The car direction will stay one way. The sidewalks have been made larger at the side entrances to the school, taking away the parking possibilities but making space for cyclists, pedestrians and people waiting. The smaller road size ensures a lower car speed. The street at the front of the school is taken out, making more space for the children and parents, and leading us to the third design consideration.

The two design parts explained above both concern designing for safety of the children and parents going to the school and creating less space for cars and more space for de parents. This third part focusses on the infill of those new pedestrian spaces. By removing the road in front of the school, the playground can be connected to the school by continuing the soft surface. Bicycle parking can be added on this soft surface instead of the parking spaces for cars. Extra trees are added to the playground to create more shade. The sidewalks at the side entrances to the school have trees with green surroundings to create shade and spaces for rainwater to infiltrate the soil.



Adding a threshold in the street before pedestrian crossings.

Tapering the street from one side

Tapering the street from two sides opposite each other.

Tapering the street using two sides in different locations.

Figure 7-11: Diagrams of the design possibilities to create a safer road for slow traffic and children.

Figure 7-12: 3D visualisation showing the street profile and natural playground in front of the school.


2263
P

Figure 7-13: Plan of the new school area design. Source: by author. Base map from Google Earth Pro.


BB
CC

Considering the details

At this moment, the soil in this area mainly consists of sand.. To create an ecologically attractive green structure, this sand needs to be mixed with compost to give it more nutrients for the vegetation. This mixture has been added up to a depth of 1,5m to give the plants and especially the trees more space (around 40 m3 per tree). Usually, the sand and compost mixture is placed to the ground water level, but that is located at 6m for this location and would therefore be too deep.

A pathway from the parking spaces to the sidewalk needs to be designed such that it does not abrupt the green structure too much. To do so, the West side of the road has open-joint pavers to create a permeable path and keep the mixed soil continuous (section AA, Figure 7-20). The East side of the road has a wooden bridge structure to be able to cross the ditch (section BB, Figure 7-21).

Section CC (Figure 7-22) shows how the ditch is continued below the intersections with the main street. A pipeline is set in a lava foundation that is used below the pavement. This lava foundation is also used below the semi-permeable parking spaces (section AA, Figure 7-20) as it can absorb and hold more water. The asphalt, on the other hand, has a foundation of mixed granulite on top of sand, which should be able to hold the heavy vehicles such as trucks, busses, and trams.

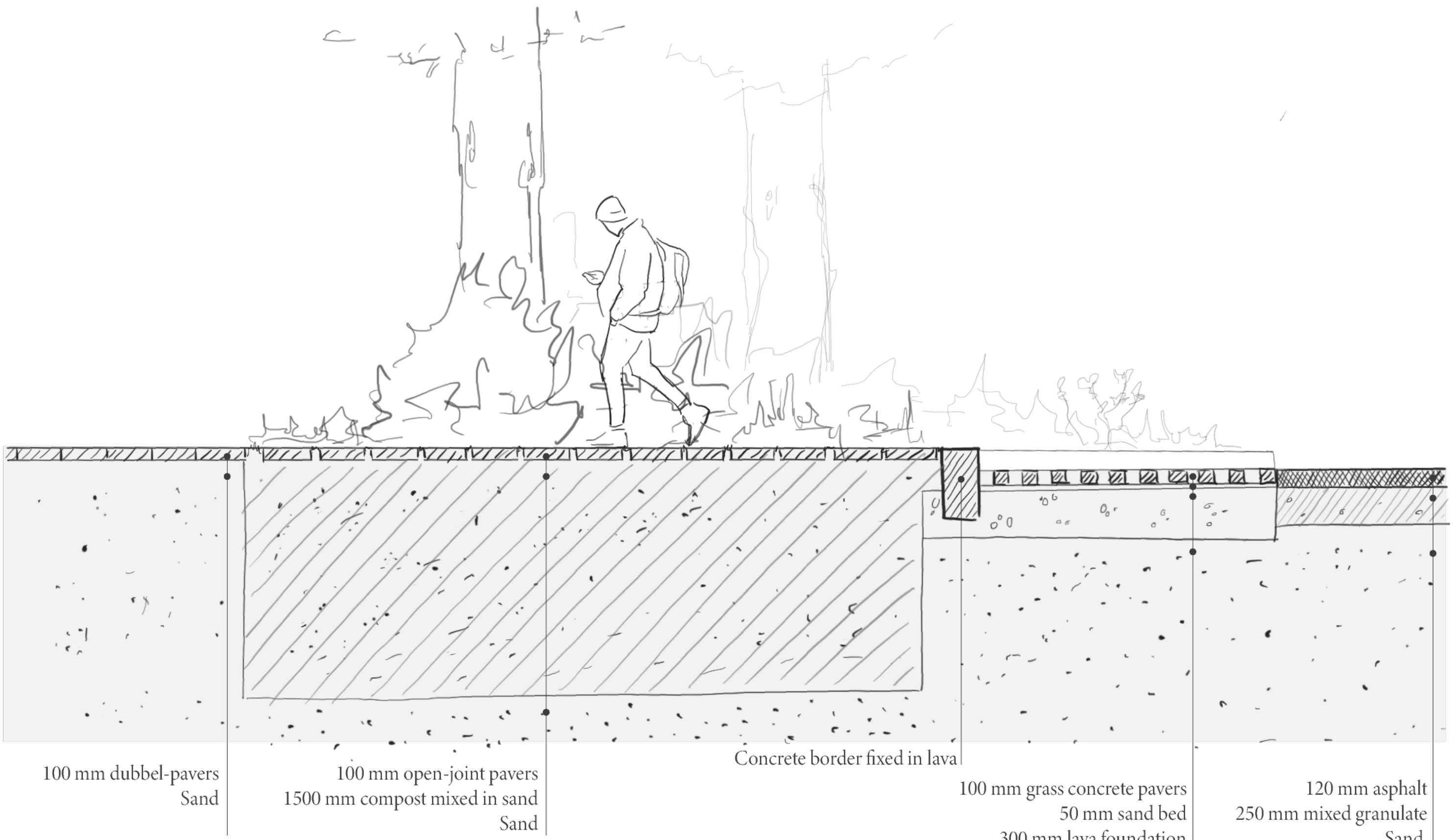


Figure 7-14: Section AA. open-joint pavers to reach from the parking spots to the sidewalk.

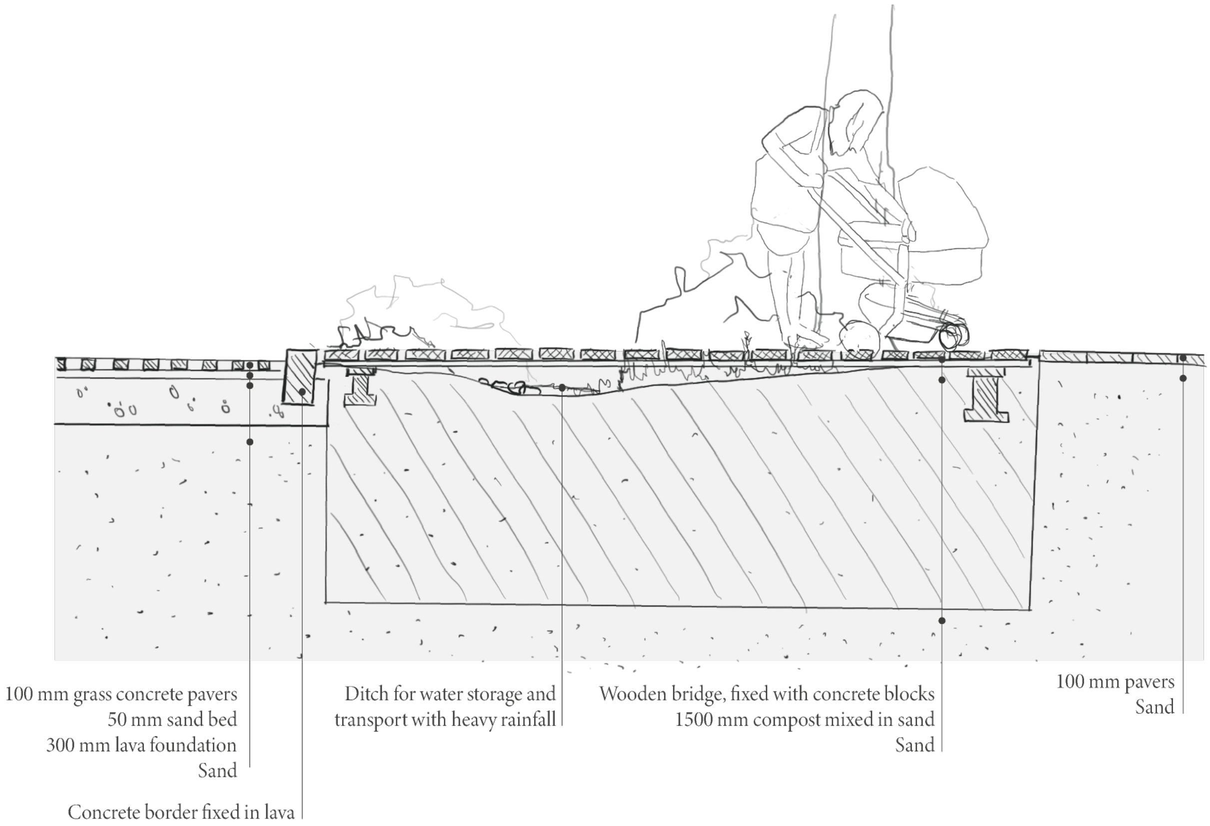


Figure 7-15: Section BB. Ditches in the green structure are used for water storage and transport with heavy rainfalls. Wooden bridges reach from the parking spots to the sidewalk.

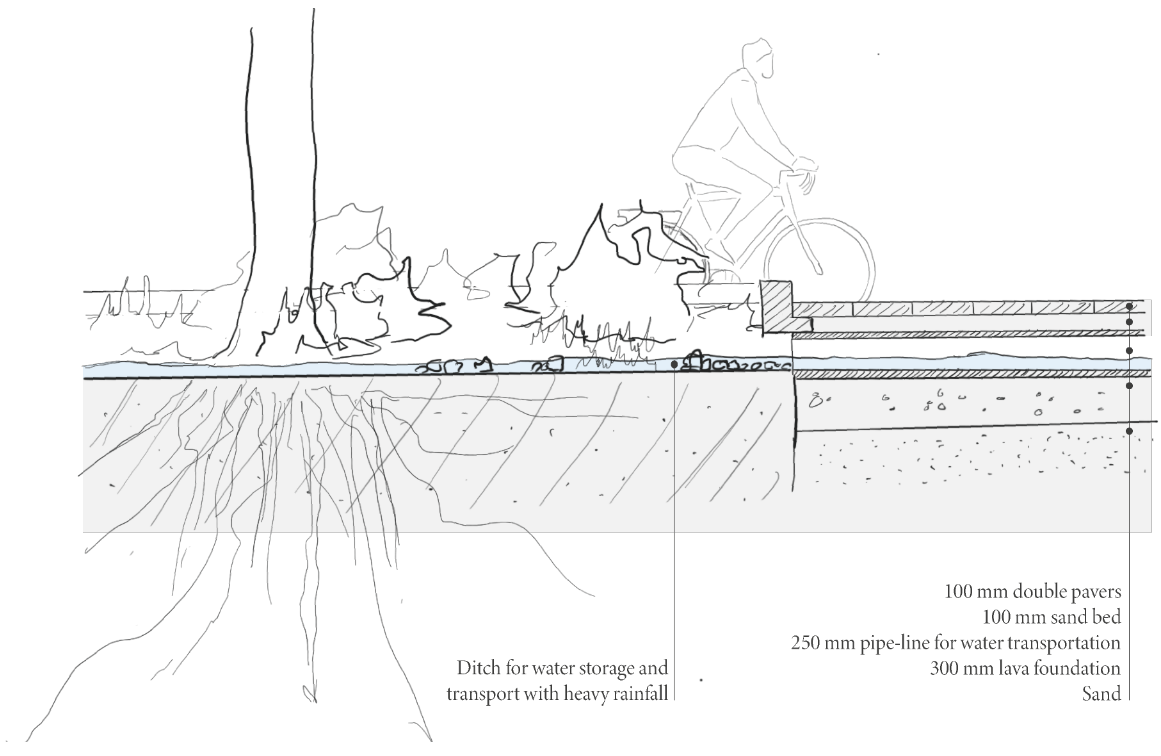


Figure 7-16: Section CC. A pipeline is placed under the pavement where cars and pedestrians need to cross the ditches, to ensure that the water is connected along the whole street.

Evaluating the design

By making use of the new street profile and creating more soft surfaces around the school, this design location has 45% of the surface softened, as a opposed to the 13% it was before. Five different tools have been applied in this softened surface: Grass, bushes and shrubs, trees, ditches, and porous pavements. By adding only these 5 tools, sixteen ecosystem services were provided to the location. By choosing local vegetation, that relates to the vegetation in the dunes, all ecology services were provided by the vegetation. The local vegetation and the open water system of the ditches can also provide an educational benefit to the children of the school. Lastly, the natural playground creates a social gathering space that also has water regulation and ecological benefits for the space.

Figure 7-17: Diagrams of the new soft versus hard ground situation for the school area. Source: by author

KURHAUS TRAM STOP

The current Kurhaus tram stop
The second design location is the square located near the Kurhaus. This location is interesting due to the tram stop which is used by large amounts of people, going to the beach or one of the many other functions located in the area. The tram stop also creates an exception to the street profile, where more space is given to motorized vehicles compared to other locations. Yet, the terrasses of the cafes located to the West side of the road also make use of paved surfaces. The east side of the road already includes large planters with vegetation that can be linked to the Oostduinen, which are located only a few hundred meters down the road. With these planters being the only vegetation, the area consists only for 9% of soft surfaces.

When looking into the analysis diagram from Figure 7-10, the following problems need to be considered for the Kurhaus location: there are many different functions, the location has a relatively high UHI and some water retention problems with heavy rainfall. The location would also be a perfect spot to provide the green structure with a relatively large patch as a steppingstone due to the large surface area. The design should therefore focus on the following ecosystem services: climate and water regulation, recreational use of the green structure, biodiversity, soil fertility, pollination, and life cycle protection.

TV2-SE4
TV2-SC3
TV4-SC2

Figure 7-18: Map showing the current soft versus hard ground situation for the Kurhaus area.

Figure 7-19: The Kurhaus area in the current situation.

Figure 7-20: Map of the current Kurhaus area. Source: Google Earth Pro.

Designing the Kurhaus park

The design of the Kurhaus tram stop location can also be explained using three sections. Starting with the area in which the road is located, this area is already an exception to the standard profile (profile C) due to the frequently used tram stop. Therefore, there will be no cars on the tram rails, but they will be directed past the tram stop and redirected back unto tram rails further down the road. Without the cars on the tram rails, the tram stop can be designed as green tram rails. There will also be trees placed on the platforms to create shading for waiting passengers.

The area to the east side of the road will be turned into a small park. By removing the large space that is currently allocated to taxi cars, the pedestrian area can be extended all the way to the road. The taxis can make use of the parking spots that will be added. The large, lifted planters that are currently located on the East side will stay, and some additions will be made to this. Some lifted planters have the possibility to sit on the edges, while other parts will have no edges to allow people to walk onto the grass. This grass still provides a soft ground while creating a space for people to sit and allowing people to cross to the other side. This grass and the new planters will be located around the trees that are already in the location. To add more shading to the area, trees will also be added to the already existing planters. The paths in between the park will be designed as a soft surface while the sidewalk going around it will be paved.

The square located on the east side of the road must deal with a lot of movement going in all directions due to the cafes on the square, shops in the passage connected to the square and the Scheveningen boulevard located behind the buildings. The green structures that are created therefore direct the user to the different directions they can take. The most eastern planter is used to separate the main road from the square.

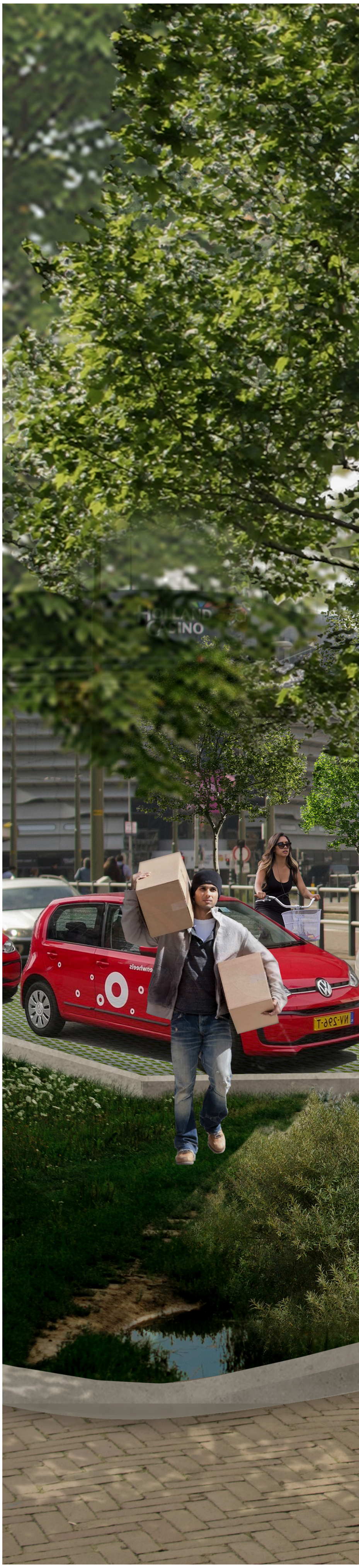


Figure 7-21: 3D visualisation showing the green tramstop of the new Kurhaus park. Source: by author


Gaslicht.com
Vergelijk energie

Figure 7-22: Plan of the new Kurhaus park area. Source: by author

Considering the details

As mentioned before, the pathways in the park on the east side will have soft surfaces. These surfaces will have the same material as the paths in the dunes, which have a top layer of shells on sand. This also means that the soil for the planters will again have to be sand mixed with compost, with a depth of about 1,5 to 2 meters. The existing planters already have an edge that is often used by people to sit on. This will also be implemented on the edges for the new planters, but they will have a varying height to give the planters a playful sight. The sitting height will be around 45cm (see section AA).

To have trees on the tram platforms, the base will have to rest on a compost and sand mixture. The tree roots can be directed further down into the ground when more foundation is needed to hold the pavers. The tram rails are resting on concrete plates. A slid needs to be made in this concrete and filled with gravel to allow water infiltration. The top layer will be sand and soil with grass. There could be the possibility that the grass will not grow properly because the location is close to the sea and experiences salty winds. If this is the case, a gravel layer could be added onto the soil around the tracks to still allow for a permeable surface.

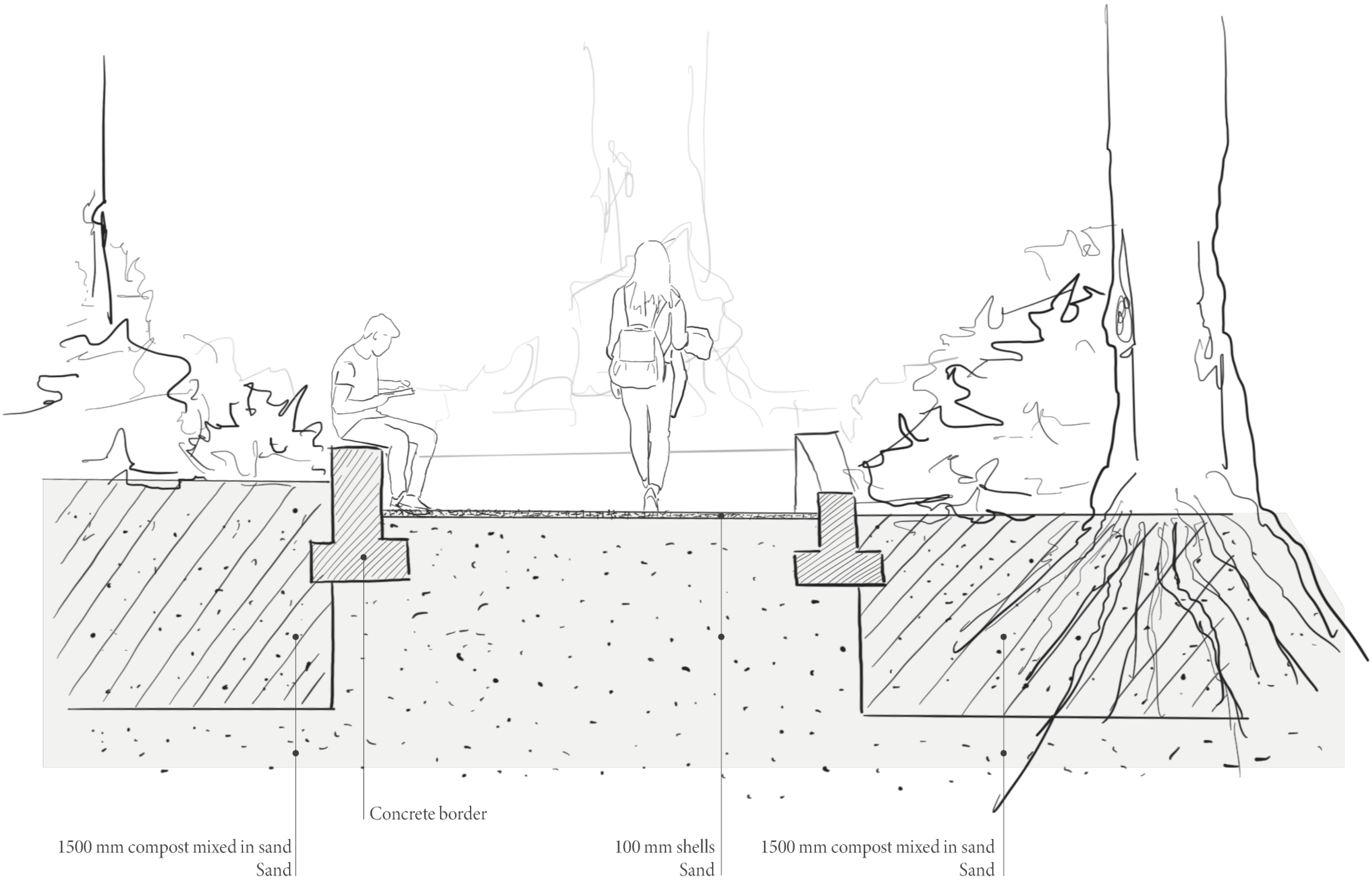


Figure 7-23: Section AA: soft surface pedestrian area with edges around the green structures to profide sitting places in the Kurhaus park. Source: by author

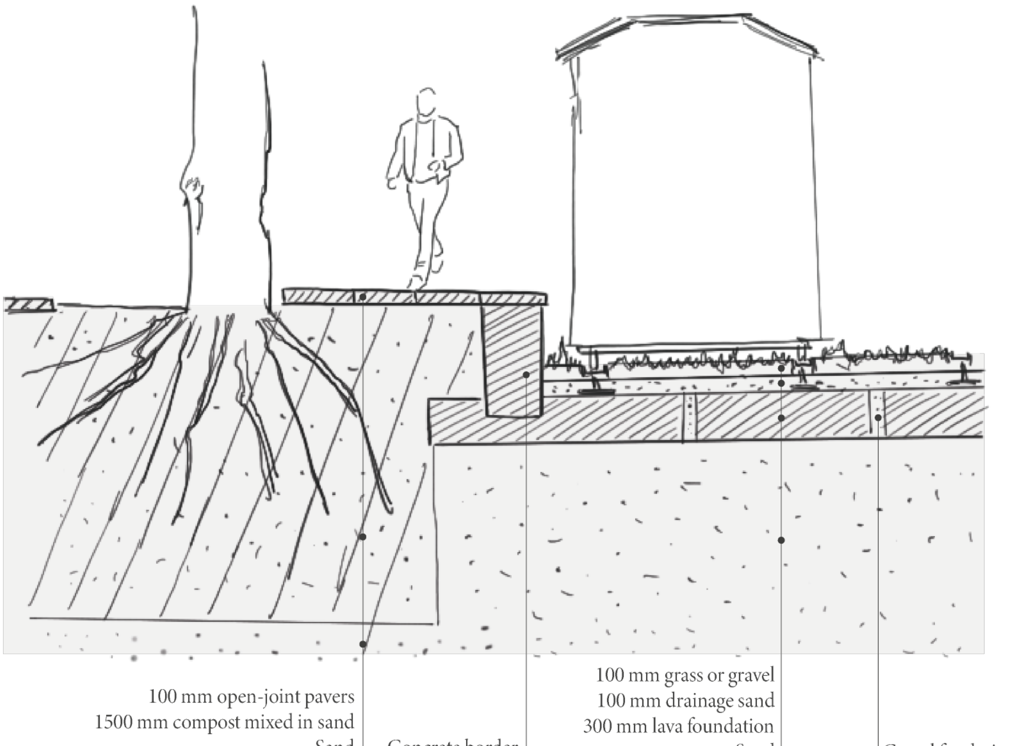


Figure 7-24: Section BB: Adding trees to the tram stop platforms and permeable surfaces between the tram tracks. Source: by author

Evaluating the design

By changing the Kurhaus area into the Kurhaus park, the surface is now 51% softened, which can be considered a drastic change compared to the 9% it was before. Five different tools were added to the area: Grass, bushes and shrubs, flowerbeds, trees, and porous pavement. The vegetation offers a lot of different ecosystem services to the area. The vegetation in this area is again linked to the vegetation of the dunes close by. Because of the size of the area, and the large patches of vegetation that are added to it, the new design creates a perfect patch for fauna within the ecology network.

TV1-SE2
TV1-SE4
TV1-SC2
TV2-SE2
TV2-SE3
TV2-SE4
TV2-SC1
TV2-SC2
TV3-SE1
TV3-SE2
TV3-SE3
TV3-SE4
TV3-SC1
TV4-SE2
TV4-SE3
TV4-SE4
TV4-SC1
TV4-SC2
TM1-SC3

Figure 7-25: Map showing the future soft versus hard ground situation for the Kurhaus area.

Figure 7-26: Diagrams of the design possibilities to create a safer road for slow traffic and children.

7.2 CONNECTING CENTRES

7.2.1 FOCUS OF THE ARTERY

The centres artery is situated perpendicular to the coastline and covers about 6,5 kilometres. It reaches from the Kurhaus in Scheveningen, through the centre of The Hague and onto The Hague Holland Spoor. The artery can also be extended further, reaching Delft and even Rotterdam. Covering many different street typologies, the artery shows varying widths (Figure 7-33) and current green structures (Figure 7-34). From the parkstraat (about halfway in the artery) till past the Rijswijkseweg, the artery includes a tram as part of its mobility system.

The green found on the streets itself is very minimal, with some trees and every now and then some grass patches of very small width, although most roundabouts already have a large green area. Still, the beginning of the artery has a very green feel, and not much UHI problems as the artery moves through the Scheveningse Bosjes. The main UHI problems are found in the centre of The Hague. Yet, possible water regulation problems with heavy rainfall is still present throughout most of the artery, which could be related to bad transfer of water from the road to the soft surfaces.

The different street typologies are related to the many different functions that are located around this artery. From the Kurhaus, the artery moves through a residential area, followed by the green of the Scheveningse Bosjes. The residential function stays until the Nassauplein, where the functions gradually turn into a mix of offices, retail, and other functions.

Two main services are derived from this conclusion of the analysis on which the design for the full artery should focus: water and heat regulation, especially around the centre of The Hague. Another part in the design of this artery is not related to ecosystem services but mobility, where the artery creates an environment that is focused on safe bicycle routs and pedestrian spaces. As such, the artery becomes an attractive connection between the centres of multiple cities to be used by cyclists.

Figure 7-27: Images showing the different street profiles that are found along the artery.



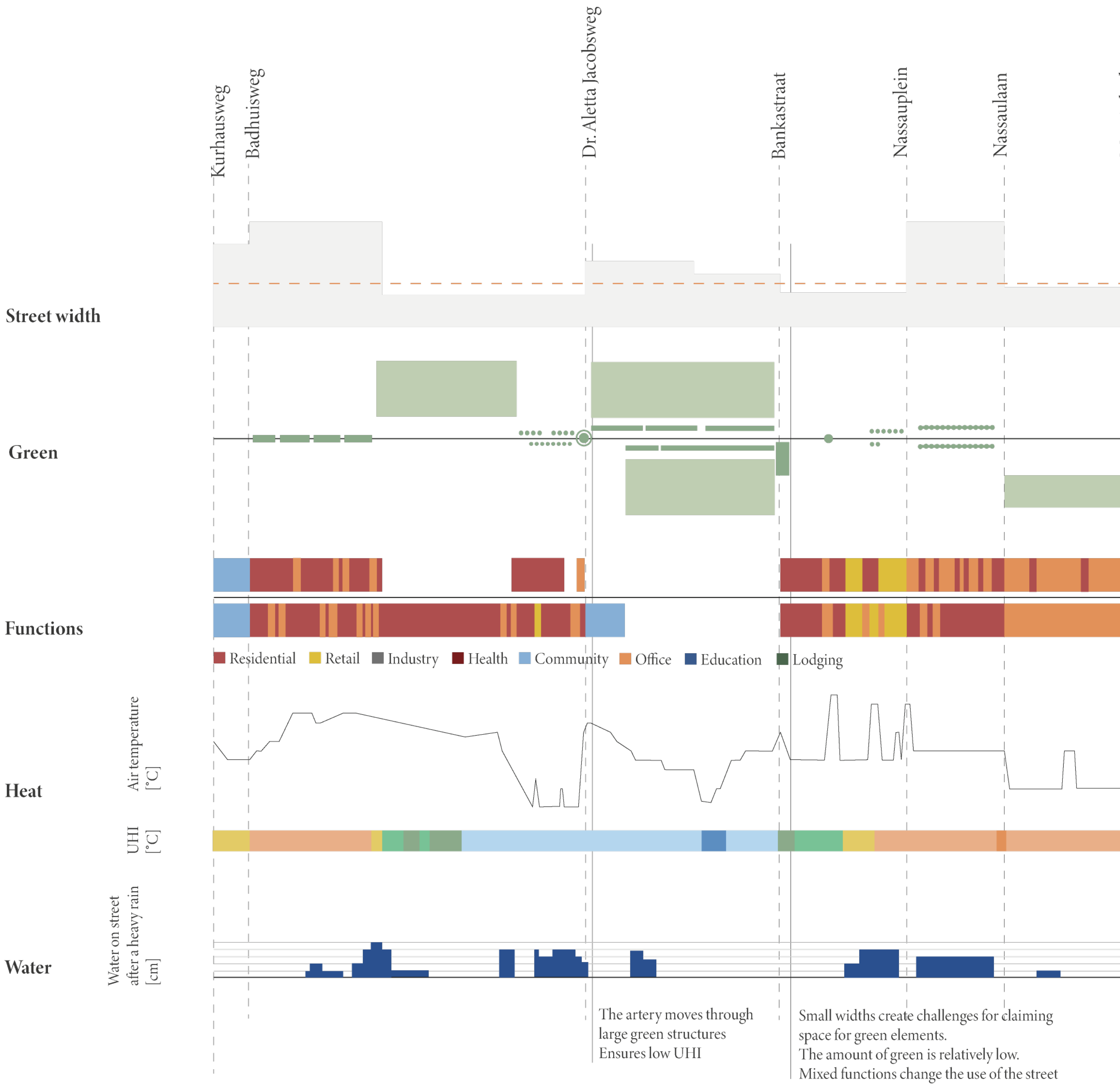
INKT
3+1 GRATIS


LKS



JBM


Rondvaarten



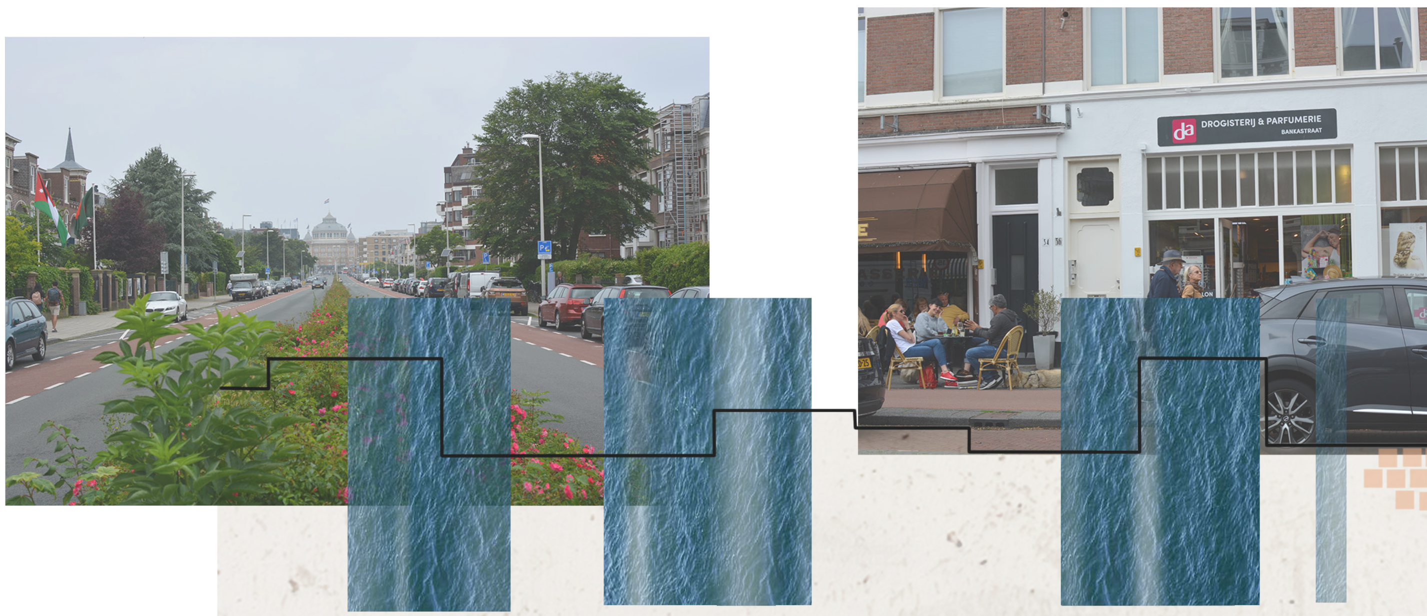
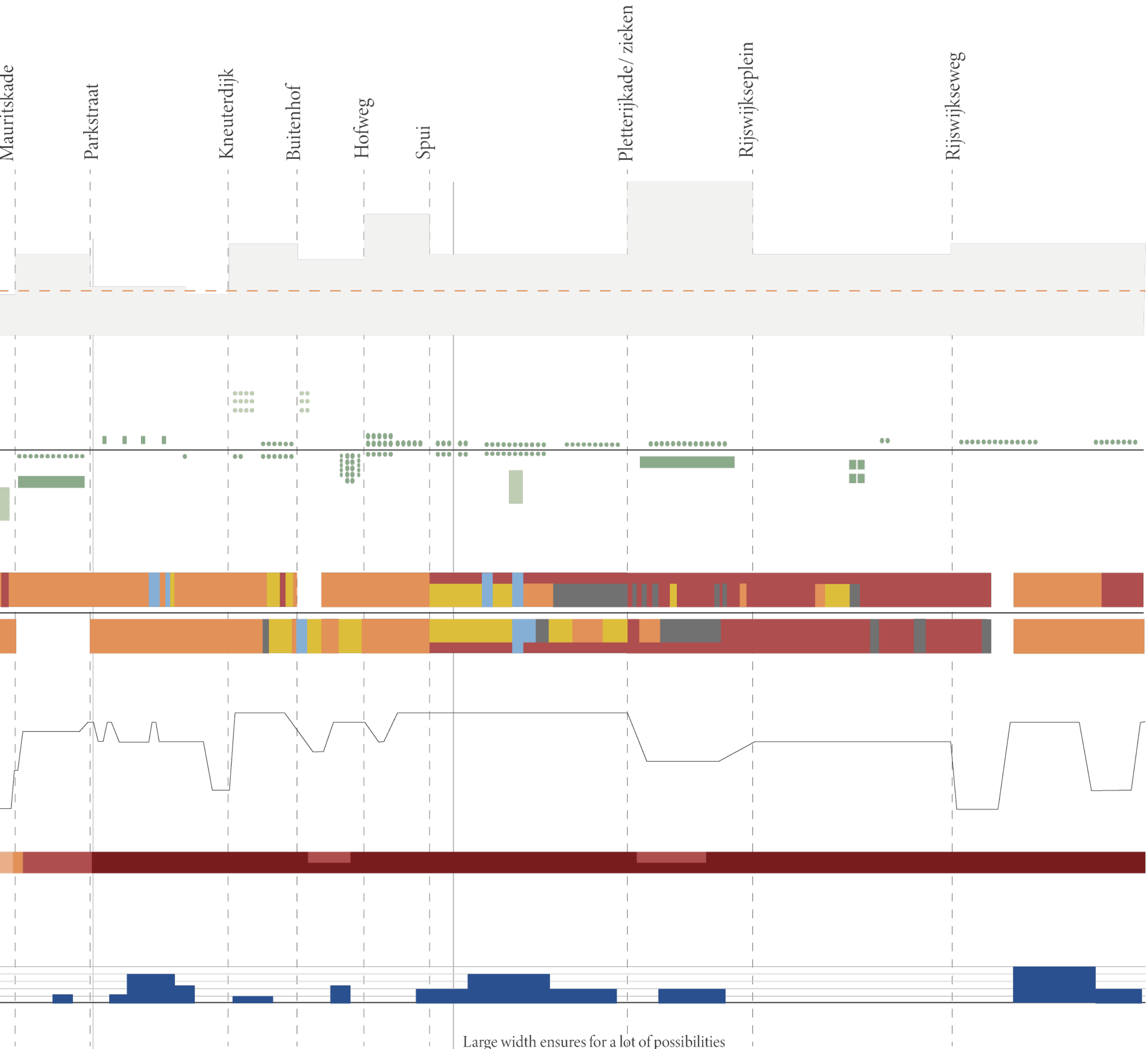
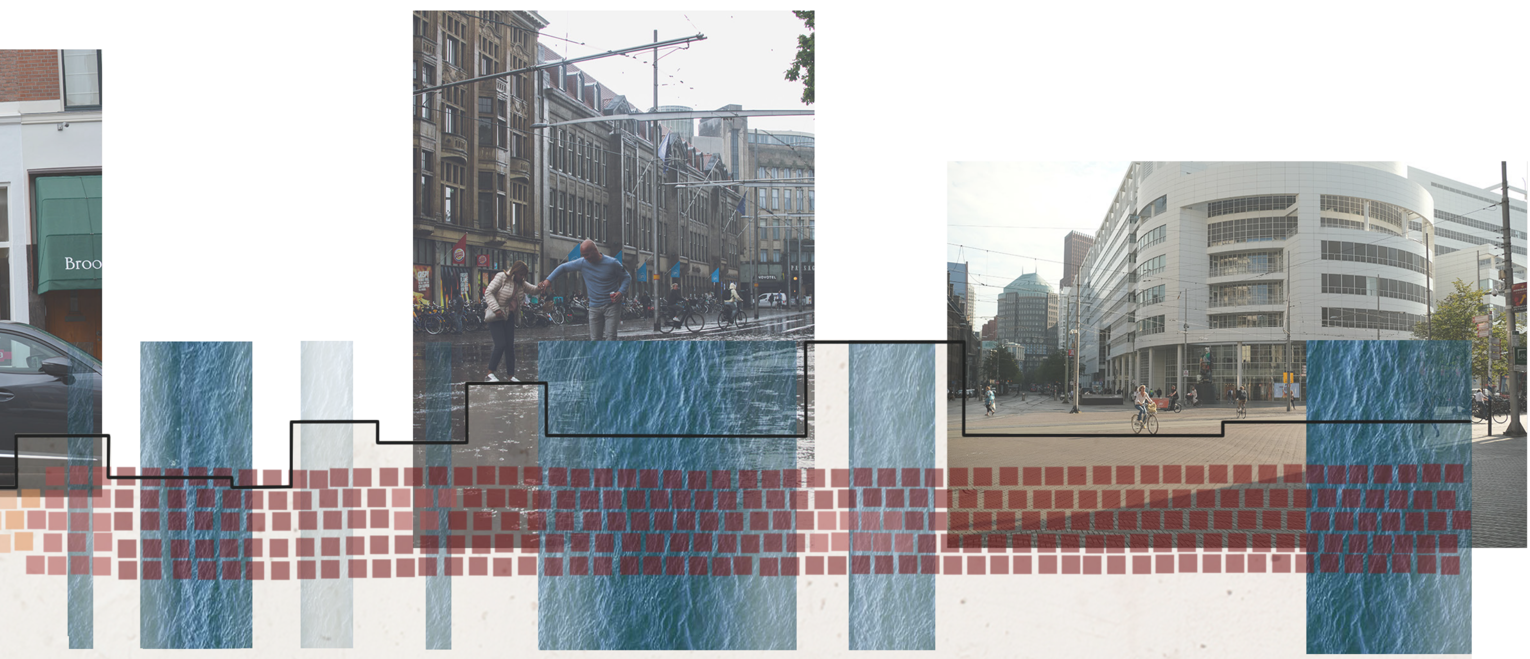


Figure 7-28: Analysis diagram showing data on street width, green, functions, heat and water. Figure by author based on data retrieved from: G
EduGIS (2021) Urban green blue grids (N.D.) Klimaateffectatlas (N.D.) and Atlas Leefomgeving (2021)



Tram is a part of the street profile

Large width ensures for a lot of possibilities to redesign.
Mixed functions, including a lot of retail
UHI is relatively low.



oogle Maps (2021),

7.2.2 DESIGNING THE ARTERY

Four street profiles have been designed for the artery connecting the centres, two of which overlap with the profiles for the first artery (Typology A and C as shown in Figure 7-12). Where the two profiles used before focus on minimizing parking spaces, the two new profiles also focus on creating more safe space for cyclists.

Profile A; the bicycle street, is designed for the smallest street of the artery but can be applied in many situations. In these streets, the road is designed such that the bicycle lane is relatively wide, allowing for the cars to drive on the bicycle lane. As with the previous typologies, parking spots are placed every 50m, with half of the parking lot in the green structure and half on the street. The barrier helps slow down the cars on a road dominated by cyclists.

In street profile B, the bicycle lane is separated from the car and tram lanes. These bicycle lanes have a width of 3m to allow cycling in two directions on both sides of the profile. This typology is therefore most applicable in locations that are used by a lot of cyclists at the same time but can also be applied on streets with many cars, where separating bike lanes from the roads is safer. By giving so much space to the cyclist, there might be a chance that space for green has to be minimized, or the profile must be applied in streets with a large width. Using the conclusions of the analysis and determining the ecosystem services needed in the location can help decide on the better profile.

Within the artery, profile a, the bicycle street is applied the most to create attractive spaces for cyclists and motivate people to take the bike instead of the car. Most other places allow for profile B, where the seperated bike lanes also motivate cycling. By applying these profiles, a strong large green structure can be designed throughout most of the artery. Even though the artery has a lot more small streets compared to the artery in Scheveningen, the design still manages to reach a 46% softened surface.

7.2.3 DESIGNING THE EXCEPTIONS

In this artery one exception is used to show the implementation of the toolbox on a smaller scale. The site is located at the Spui, which is an interesting location when it comes to adding vegetation as the whole area can be said to be a building, even under the ground, due to the underground tram and parking

Figure 7-29: Street profiles from Figure 7-12 on page 100. Source: by author

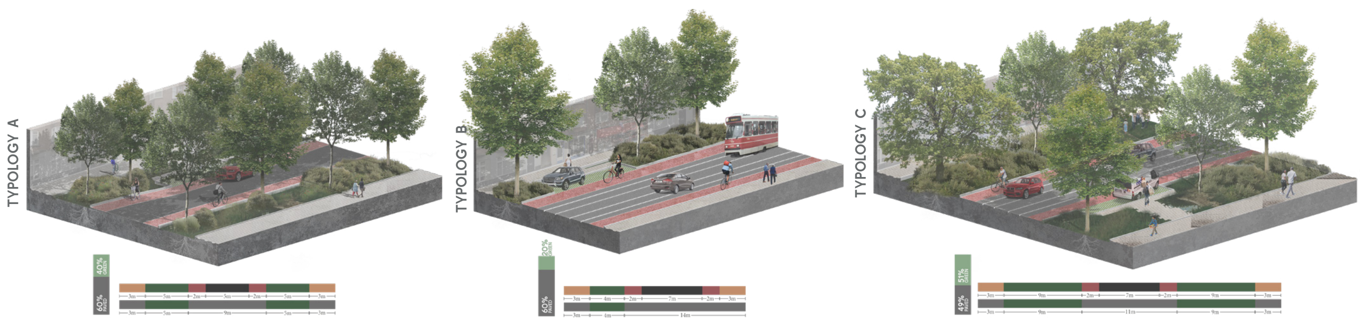
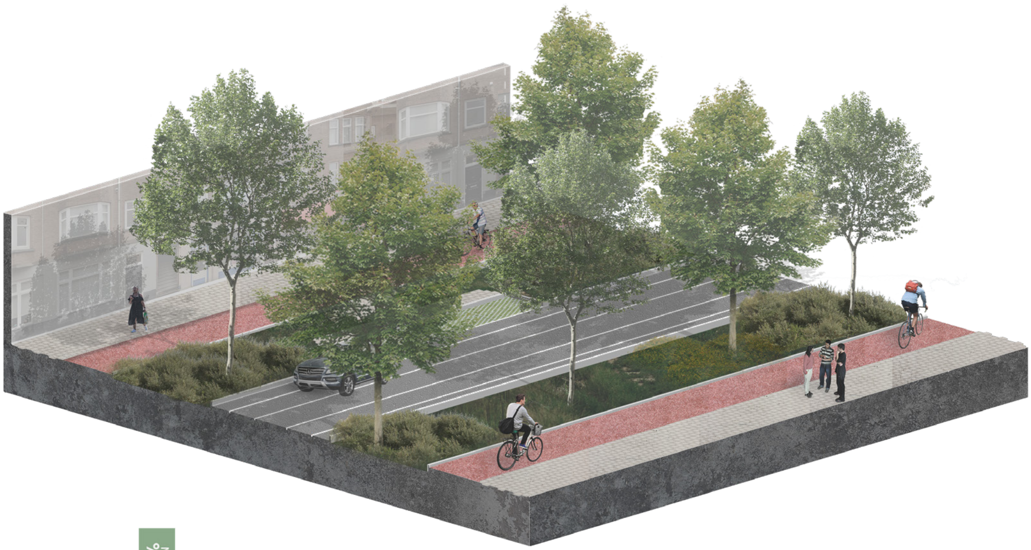
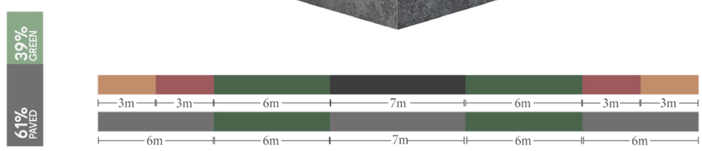


Figure 7-30: New street profiles adding green structures to the mobility network. Source: by author

TYPOLOGY D





TYPOLOGY E

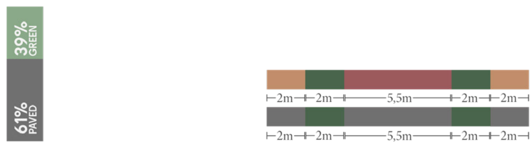
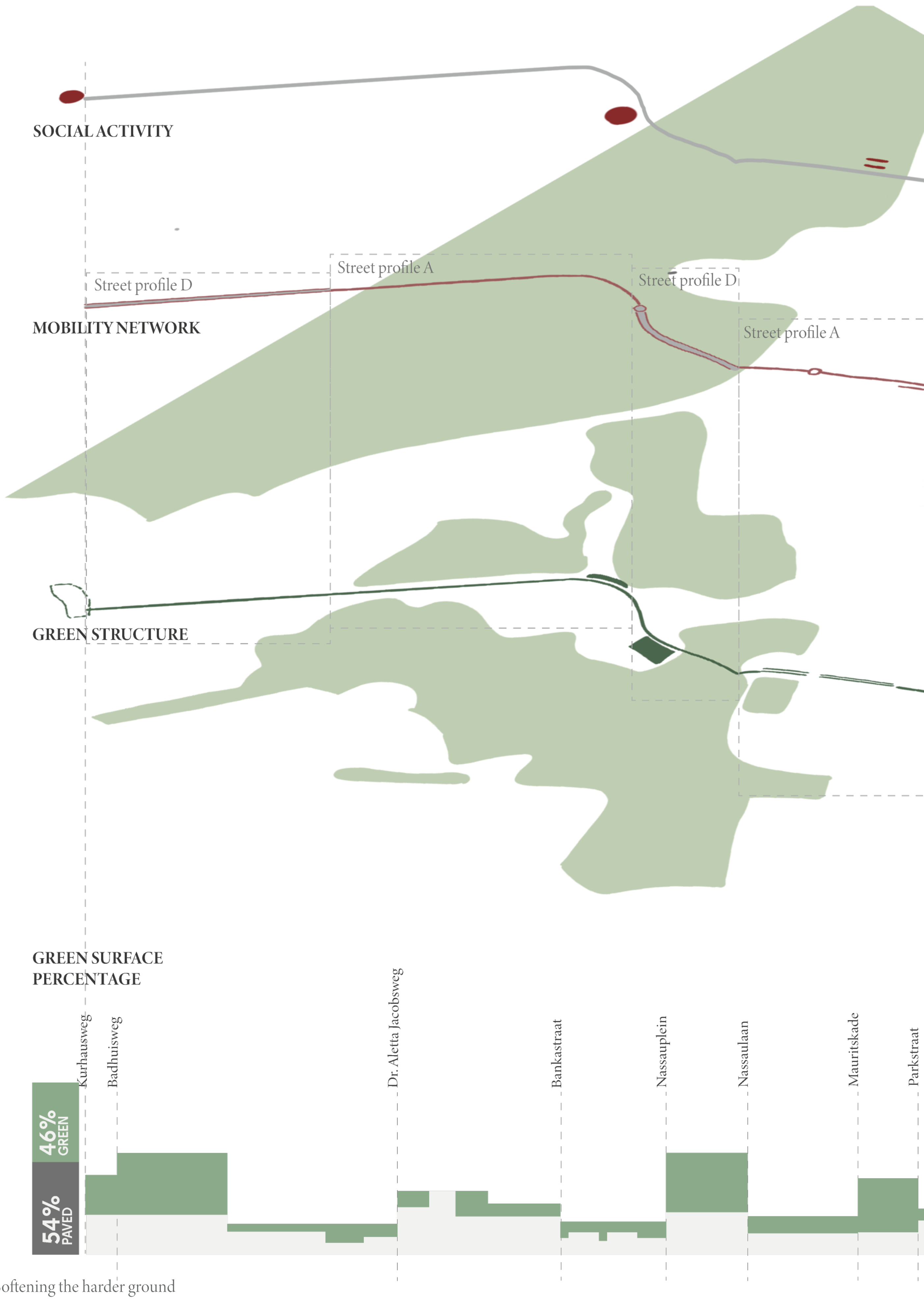


Figure 7-31: Map showing the new social, mobility and green systems of the centres artery, with below the new softened surface percentage when using the design profiles. Source: by author




Street profile C
Street profile B
Kneuterdijk
Buitenhof
Hofweg
Spui
Pletterijkade/ zieken
Rijswijkseplein
Rijswijkseweg

SPUI SHOPPING STREET

The current Spui
The third location for which a design is created is the Spui street in the centre of The Hague. Spui is part of the main shopping area of the Hague and therefore has a lot of different mobility types making use of the same public space. There is a tram going in three directions, cars mainly move in two directions, except for delivery trucks, that are allowed everywhere. There is a slight separation between pedestrians and cyclists, but in general they move through the whole space. Another interesting mobility factor is the underground tram and parking. Because of these, we can say that the Spui is located on top of an underground building. It is therefore also a challenge to include some of the tools from the toolbox and to properly achieve the services that are needed.

Looking at the analysis diagram on Figure 7-34, the Spui location must deal with many challenges. The UHI effect and water regulation problems in this area is very high. This is most likely to the over excessive amount of pavement in the area, with 99,7% of the surface being paved. The only soft surface is a very small tree surrounding. Due to the function of this area, the public space is used by a lot of people who are constantly walking from one shop to another. It is therefore of extra importance that the environment is of high and healthy quality. Another challenge will be found in creating a linear green structure, as we are working with a 'zigzag' type of location (Figure 6-4 on page 82), where people cross the full profile of the street constantly and everywhere.

TV4-SC2

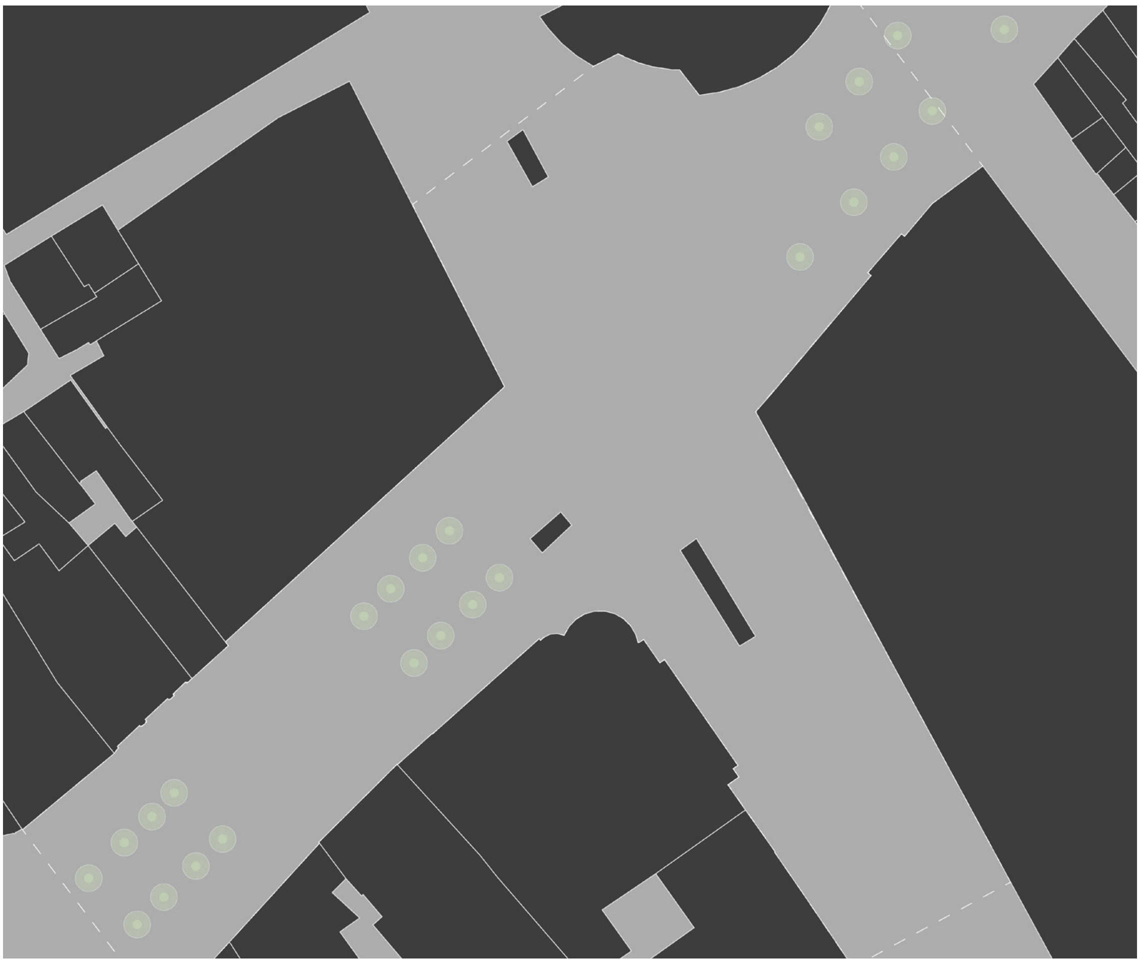


Figure 7-32: Map showing the current soft versus hard ground situation for the Spui area.

Figure 7-33: The Spui crossing in the current situation.

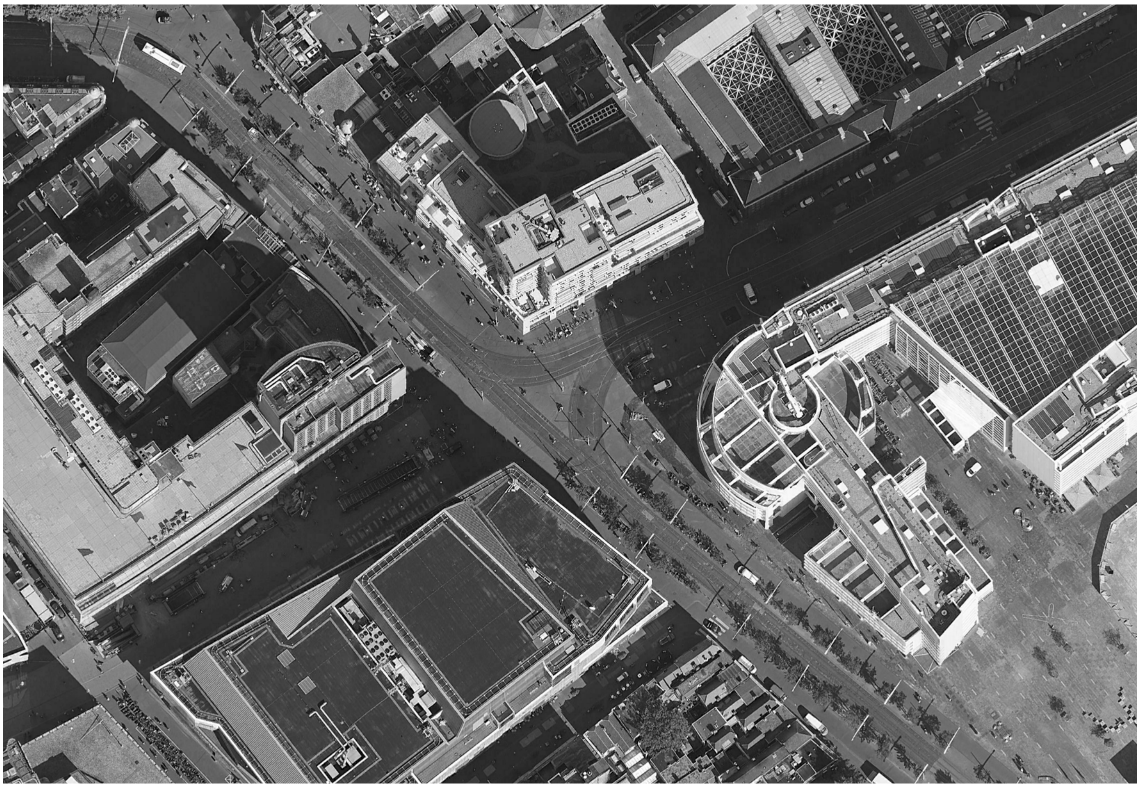


Figure 7-34: Map of the current Spui area. Source: Google earth pro.

Figure 7-35: The flora and fauna found in the areas where the centres artery is located. Source: by author

7.1.2 CENTRES FLORA AND FAUNA

Figure 7-41 shows the flora and fauna species that are used as the icon species for the centres artery. The fauna is linked to fauna from the western polder region, where peat and clay shape the soil. Flora in this area is often linked to the early swamp forrest that used to cover this region, such as willows and the black alder, or current and cherry bushes (Maes, 2006; Johnson and More, 2007).

Most icon fauna species are highly urban species that are found in the city centre of The Hague and surrounding neighbourhoods (Gemeente Den Haag, 2018; Vogelbescherming Nederland, n.d., Haags Millieucentrum, 2008) or species that are present in the Scheveningse bosjes (Gemeente Den Haag, 2018; Haags Millieucentrum, 2008).

Hedgehog
Erinaceus europaeus

Western jackdaw
Coloeus monedula

Hairy footed flower bee
Anthophora plumipes

European rabbit
Oryctolagus cuniculus

Common blackbird
Turdus merula

Garden bumblebee
Bombus hortorum

Daubenton bat
Myotis daubentonii

European peacock
Aglais io

Great tit
Parus major

Common carder bee
Bombus pascuorum

Noctule bat
Nyctalus noctula

Small tortoiseshell
Aglais urticae

House sparrow
Passer domesticus

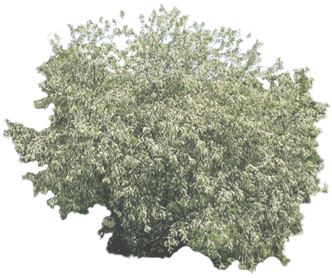
Tree bumblebee
Bombus hypnorum

Common pepistrelle bat
Pipistrellus pipistrellus

Black alder
Alnus glutinosa

Crack willow
Salix fragilis

White willow
Salix alba



Birdcherry
Prunus padus

Blackcurrent
Ribus nigrum

Field elm
Ulmus minor

European ash
Fraxinus excelsior

Designing the new Spui

The redesign of Spui also includes the 'Grote Marktstraat' which it crosses, as it is this crossing where al the mobilities and street profiles of the area come together. The design for this area can be split in four categories, that are spread throughout the location. The profile of the South side of the Spui will be changed into profile B as explained before. In this case, the cars will be moved onto the tram lane, separating the fast transport from the slow transport. It also gives the chance to place a larger green structure on the west side of the street, which will have a width of 4 meters. In this structure, space will be made for bicycle parking on soft surfaces to still allow for water infiltration. A few parking spots will be added for temporary parking, mainly as a drop of and pick up spot. The early Spui used to have a water structure in part of the street. To bring back this element and continue the water structure form the Pletterijkade further down the street, a water channel will be added to the west side of the street. This water channel will allow temporary water storage and transportation during rainfalls and creates an interesting feature in the street. On some parts of the water channel there will be plantings such as shrubs and trees.

This water feature will also be added to the west side of the 'Grote Marktstraat'. Here, lifted planters are added to allow enough space for tree roots to develop, also on top of the parking and tram structures that are found underground. Though these trees will never be able to grow as big as other trees, they will provide the street with some shade and give resting spaces to animals. In this location, it is important that people can cross to the other side of the street in enough places. Therefore, stone paths are created in the water structure, at a height such that the water can also reach higher levels when needed.

The North side of the Spui includes a tram stop, which is currently shaded by trees to which tree surroundings will be added. A green structure will be created around the back of the tram stops, since these places will not be used to enter the platform due to the glass at the back of the tram stop. Climbing plants can be used to cover part of the tram stop and create a higher cooling effect. The tram tracks at the tram stop are changed into a permeable surface to allow water to be absorbed into the soil.

The centre of crossing of the area will have two different elements. In the middle, between the tram tracks, will be another water structure to tie together the two linear structures. The corners of the square will become green patches where people can sit or can walk through. Some lifted planters are added where needed to allow trees to provide the users with shade.

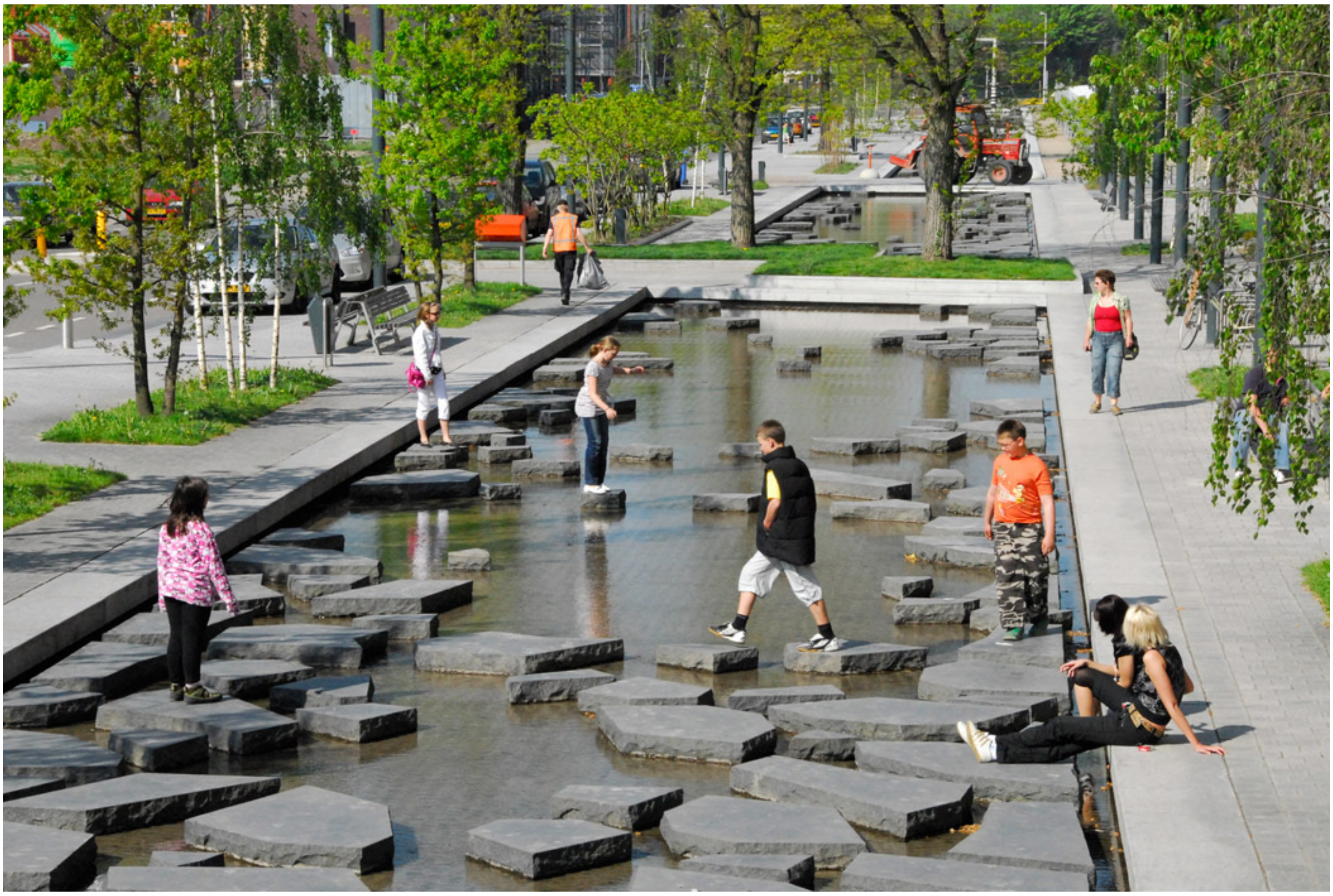
Figure 7-36: 3D visualisation showing the new square of the new Spui area


PRIMARK
PRIMARK

Considering the details
The details that have been chosen for this area are located on top of the underground tram and parking structure. They pose one of the largest challenges for this area when it comes to adding the tools from the toolbox. Detail AA shows a section of the water channel, with further down the bricks that work as a pathway to cross the channel. The foundation of the pathway tiles does not cross the full with of the channel but have space to let the water go through. The depth of the sand layer on top of the underground structure is not very high. For this design, a distance of 1,5 meters to the underground structure has been chosen. The water basin is therefore placed right on top of the structure to ensure the channel is deep enough to provide space for heavy rainfalls.

The second detail shows the lifted planters that are located along the water channel. The planter has a depth of 2 to 2,5 meters, a width of 2 meters and length of 4 meters to allow the roots of the small trees to grow sufficiently. A crate has been added beneath the right planter structure and the roof of the underground tram and parking structure to give the tree roots some extra space.

Figure 7-37: Water channel of Roombeek in Enschede, the Netherlands as a reference for water channel designs. Source: Landezine, 2011, retreived from: https://landezine.com/roombeek-the-brook-by-buro-sant-en-co-landscape-architecture/



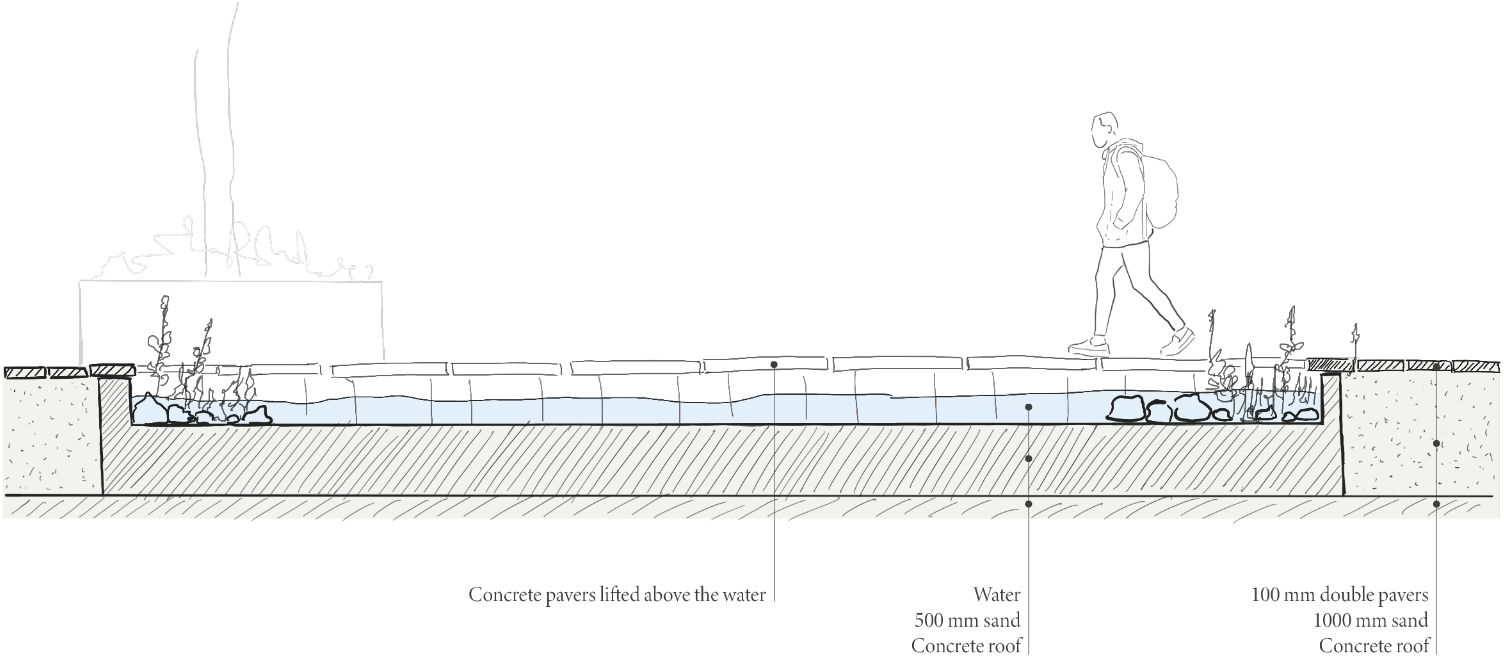


Figure 7-38: Section AA: Section of the water channel at Spui, with pedestrian crossings. Source: by author

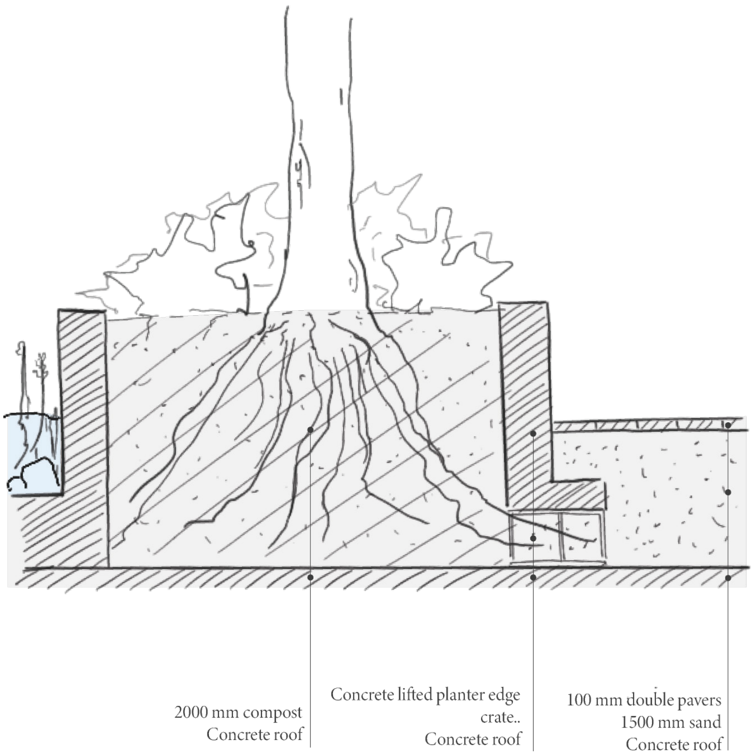


Figure 7-39: Section BB: Vegetation in lifted planters on top of underground parking. Source: by author

Figure 7-40: Plan of the new Spui area. Source: by author

Evaluating the design

In the case of Spui, 31% of the surface has been softened. This percentage is lower than the other cases, which is due to the logistics of the mobility, and specifically the tram, going through the central area of the design location. Another reason for this lower percentage is the tram and parking that is located underground, resulting in limited amount of space that can be dedicated to green. Still, the 31% is a huge improvement compared to the 0.3% soft surface that was there before. In total seven tools were implemented in the softened surface, resulting in ninetheen services for the area. Though it should be said that some of the services might not be of the same quality as in other locations. For example, the trees will not be as large in the lifted planters, resulting in less shadow and cooling. The surfaces will also not create a strong green structure, since it was not possible to create a linear structure that is almost fully connected. Instead, the green in this area will work as stepping stones in the network.

TV1-SE2
TV1-SE4
TV1-SC2
TV3-SE1
TV3-SE2
TV3-SE3
TV3-SE4

TV3-SC1
TV4-SE3
TV4-SE4
TV4-SC1
TV4-SC2
TV5-SE2
TV5-SE3

TW1-SC3
TW1-SE2
TW3-SC3
TW3-SE4

TM1-SC3

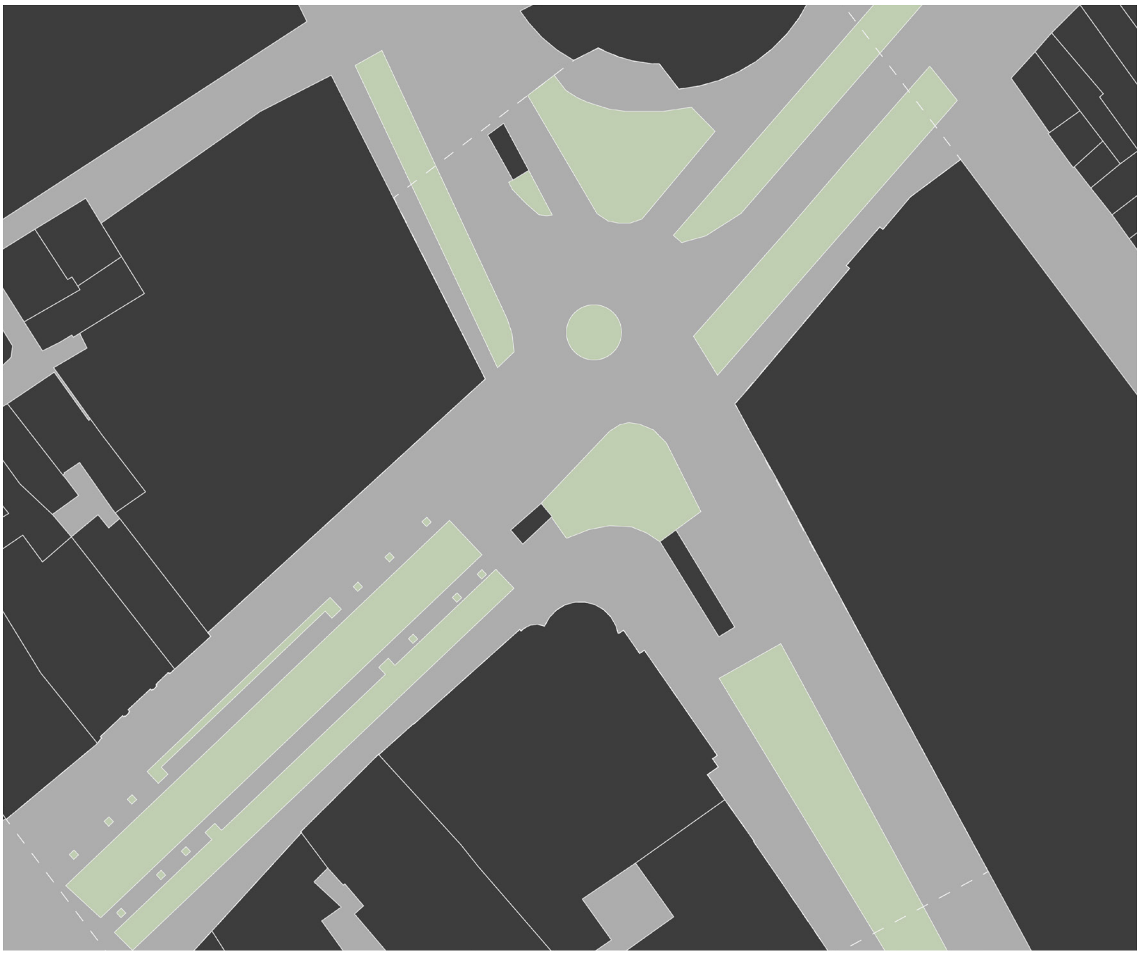


Figure 7-41: Map showing the new soft versus hard ground situation for the Spui area.

08 THE CONCLUSIONS

This final chapter presents the conclusions to this thesis, starting with answering the main research question. The discussion covers two themes: the needed mindset change as a challenge, and the research limitations and recommendations. The last part of this chapter reflects on the thesis work and progress.

Figure 1-16: Water and green structures on the Mauritskade, The Hague. Source: photograph by author.

8.1 CONCLUSION

This thesis explores an approach to cope with the challenges that our current street design poses on our living environment. Where urbanisation and densification, and the domination of car use in our mobility system create a public space that is dominated by hard surfaces, we find that climate change introduces many challenges such as overheating, water infiltration problems and decrease in ecological value. However, there is a call for a mobility transition that is oriented to a dominantly soft and shared mobility system. What if this new system can aid in softening the hard urban fabric? From this thought, the main research question was derived: 'How can the mobility transition to soft and shared modes of transport be used to create green structures within movement spaces, that cater to the urban ecological demand?'

The sub-research questions focus on movement space typologies, green use in movement spaces, and the conflicts of interest that are related to movement spaces. For this thesis, each theme has been studied within the region of Haaglanden. Using the output of these three themes, the design product of this thesis was developed in answer to the main question. These outcomes will be explained below.

First, looking into the current mobility network of the urban environment, it is found that it poses great possibilities to create a stronger green structure. Street networks already create connections between different places. By adding strong linear green structures to these streets, the mobility network will also enhance the regional green network through the urban fabric. Linear structures of 10 to 20 meters in width will provide strong ecological corridors in this network. Structures with smaller widths have to be reinforced using patches along the corridor to increase the biodiversity habitat.

To realise this strong linear green structure a change needs to be made in the profiles that are applied in the street. Currently, the focus of the street is car throughfare and access, and the car is the number one user of space in all movement typologies. To create space for other functions and movement within the street, the allocation of space to cars needs to be minimized. This can be realized by always using the minimum width needed for cars in street profiling while removing almost all parking spaces and redistributing these in a different way. A change to shared mobility that includes the use of shared car systems will aid in the reduction of parking spaces. The leftover space can be used to create quality spaces for slow mobility but should also give attention to the other three interests for street design: the ecological, social, and environmental functions. To create an integrated public space where all interests are considered, the ecosystem services can be used as a design and evaluation tool as they focus on the ecology, climate, and social factors that are realized through implementing certain design tools. As such, when the space for mobility functions is minimized, the ecological, climate and social functions become part of the urban fabric design.

Currently, designing a street is done through common practice for mobility needs. To fully realize the potential of the street when it comes to integrating all interests in the design, a systematic approach to designing the street is needed, as it provides the designer with tools to go by. This thesis proposes 'the green street toolbox', an instrument that can be applied to any location to soften the surface of the street and implement ecosystem services. Within the toolbox, simple tools such as a tree, bushes, or water structures, are linked to the services that they provide for the urban environment. As such, the toolbox provides an overview of all the tools that can be implemented to reach the ecosystem services needed in the design location.

By applying the toolbox in combination with new street profiles to the chosen design locations in The Hague, this thesis shows that an average result of softening almost 50% of the street surface is a reachable goal. All these softened surfaces provide ecosystem services to our urban environment, leaving us with healthier and higher quality public spaces.

8.2 DISCUSSION

8.2.1 A CHANGE IN MINDSET

For the designer
To apply the toolbox to its full potential, a change in mindset of the designer of the street is needed. Where currently street design is focused on mobility systems, which must be ever efficient, the street design should focus on comfort for the people using slow transport or staying in the space and ecology. This means that the starting point in the design should not be mobility, it should be the other needs such as climate changes, ecology and places for social activities that take the upper hand. While this thesis allowed for an open exploration to see what could happen in the street, designing with this new mindset may be hampered by constraining circumstances that come with designing locations in real life. But we must start somewhere, so if only some designers start taking the soft ground as the starting point of designing the street, in the future it can become a common practice.

For the people
When talking to people about this thesis project, one theme often came up: how can you live without having your own car? Even though we see a small upcoming of shared cars and other transport systems, this reoccurring question made me realize that a change in mindset for the people is also needed and may take some time. This is also one of the reasons that this thesis challenges to reach 50% of softened surface: to show the drastic change that can be made in our streets when we remove most of the cars. But, when applying this concept in real life, a slower process is needed, where small steps are taken in the public space to give real life examples of the possible outcomes and give people time to adapt.

8.2.2 RESEARCH LIMITATIONS AND RECOMMENDATIONS

An interesting addition to the research would be the investigation of the process in which the toolbox designs would be implemented in real life. A good example would be the 'Vrijstraat' (see "Appendix 3: Reference case studies") where the designer works together with the residents of the street to replace parking spots with other functions. But this is not possible in all cases, and sometimes a more gradual implementation could be needed.

In addition to this, another avenue for future research is the investigation on where the cars would go when there is no possibility to park in the street. The reality is and most likely will be that cars will always be a part of our mobility system and will have to be placed somewhere. The redistribution of car parking will become an important factor when implementing this concept to a city scale.

8.3 REFLECTION

8.3.1 SOCIETAL RELEVANCE

A big motivator for the mobility transition and improvement of urban ecology is the need for healthy and attractive urban environments for people to live in. The quality of our environment is changing as climate change poses more challenges. Being outside in summer is getting too hot and heavy rainstorms cause water problems on the street. Streets that are filled with cars are not attractive spaces to stay. These problems result in less use of the street by the people and changing the design of our streets can help work against this. The possibilities and speed of a transition in street design depends on acceptance and the need of society to change. The research field already stated that current trends show that (urban) citizens are choosing car over slow traffic and this number is rising still. The designs in this thesis are best used to challenge the ideas people have on the appearance of the street. Some organisations are already working on challenging these ideas, such as the park[ing] day organized by Millieudefensie. The question of whether we shouldn't exchange car facilities for soft and social facilities is already going strong. This thesis adds another thought on our future streets for both designers as well as all public space users through the design result.

8.3.2 SCIENTIFIC RELEVANCE

The topic of designing movement space has always been a very practical operation, focused on mobility use. The ecological sector has only just started to focus on ecology within urban environments. However, there is a gap when it comes to combining the two. This thesis focusses on systematically making use of the movement space design to improve the urban ecology and urban environment by adding green structures in all movement space design.

By designing 'the green street toolbox' this thesis aims at making it easier for designers to apply simple tools on the street while having an impact on ecological, social and climate problems. The designs created with the toolbox challenge the automatic thought that the street does not have space for green structures. At the start, the implementation of green in 50% of the street might seem drastic, but it might not be in the future. There is a responsibility for designers and planners to show what the environment could also look like when some drastic softening changes are made.

8.3.3 ETHICAL CONSIDERATIONS

The way in which mobility is used, to always keep on the move and get to a new location as fast as possible, should be coming to an end. Instead of focusing our streets, which form a large part of our public space, mainly on individualized car transportation, it should be designed for human interaction, attractive environments to stay in and an overall better space. This thesis is created to give a small contribution by showing the drastic improvements that could be made in our streets by minimizing space for cars. Yet, as mentioned before, the car is a big part of our daily system. Doing without is hard to imagine for a lot of people, or even out of the question. Hence the questions are: (a) To what extent can these changes be implemented, and (b) how can the developments around the mobility transition be instrumental to the implementation of green.

8.3.4 THE RELATION BETWEEN THE GRADUATION PROJECT, STUDIO TOPIC, AND MASTER TRACK

This master thesis research is executed as part of the urbanism master track, within the studio of Urban Fabrics. The master programme places its focus on creating innovative and sustainable designs within the built environment. To achieve such a design, this research aims at combining the research on ecology and mobility within the urban environment, and as such, considering physical and social aspects. The research and design are done using different scales that are part of the Urbanism track. This thesis focusses on three scales: the regional, the city, and the street scale. Within the thesis, the street design should also influence the networks at a regional level.

The studio of Urban Fabrics in particular places a large focus on the densifying urban fabric, which poses many challenges to the urban design field. The main point of focus for this thesis is connecting solutions to climate change challenges through green networks with the mobility transition that is developing. In this thesis, densification is only part of the problem field and is not considered much throughout the design process. The studio is also a large advocate of research through design, which is to be the main part of research for this project. As the connection between ecology and mobility is not one that is frequently researched, the research for this thesis cannot just be answered through literature but must mainly be answered through analysing existing spaces. In addition, the design of a toolbox is used to understand this connection between ecology and the urban environment better, and to be able to apply the research to different locations.

8.3.5 RESEARCH AND DESIGN

As mentioned before, research through design is highly encouraged by the Urban Fabrics studio and has become a large part of this thesis, especially as an evaluation tool. From the literature research and looking through case studies it became clear that there is currently no systematic approach to design streets focussed on other functions than mobility. The 'green street toolbox' has been designed to bridge this gap. By applying the toolbox to the chosen design locations within the region of Haaglanden, the chances of softening the harder ground to an impactful number could be evaluated. The result of a 50% softening of the chosen arteries shows that applying the toolbox to street design can have a large impact on our urban environment.

8.3.6 THE RESEARCH APPROACH

During the project, it felt like I was losing sight of the project and the approach and methods I had set for this thesis, even though looking back, I find that the outcome of the thesis remains close to what I envisioned at the start of the process. The reason has most likely been the fact that my first thought was to use the research questions as my guide through the research, as this was the approach most people were taking. While, as can be seen in the structure of the thesis, my approach was focused on using the different scales and the design process as the main guide through writing the thesis. In this process, it was my mentors and peers who reminded me to always get back to the main point of the thesis: softening the harder ground, and how to create a systematic approach to achieve this. Through always linking the research conclusions and design decisions to this main point, the story of the thesis has become clearer and complete with every step taken.

8.3.7 WRITING A THESIS IN A PANDEMIC

One of the reasons I think the research approach did not go as imagined is the influence the covid pandemic had on my work. I have realized that the main way to get my story as complete as possible is talking to people, which usually happened a few times a day when working at the faculty. The short interactions at the coffee machine, insights into other projects and chats about the process with your peers makes a world of difference. This interaction is not realizable online as the computer screen creates a distance. Although it has been an advantage to have a site that was reachable even during the pandemic, because I could reach the site by bike whenever I wanted. As such, the pandemic did not pose challenges to gathering the data needed for this research.

8.3.8 COULD THE PANDEMIC CHANGE THE THOUGHTS ON SOFTENING THE HARDER GROUND?

As mentioned in the discussion, one of the main challenges when wanting to implement the suggested changes to the street would be that people are too accustomed to have a car, and having this car parked in front of their door. Due to the pandemic, an ongoing discussion is whether more people should be working from home more often. If a change like this takes place, chances are that more people are willing to get rid of their car, or at least one of their cars as they are using it less. This can free up the parking spaces in the street for softening the ground.

Another change seems to be the wish of people to have a garden or live close to green structures such as parks, to have a healthy and comfortable living environment when in isolation. The changes proposed for the streets in the design would allow the street to be such a comfortable environment, where the street also allows for interaction with neighbours.

As such the pandemic could have changed the mindset of people in at least two ways, and the changes during the pandemic itself have shown that a community can take on drastic changes when needed, for their safety and health. Now, the importance of creating a healthy urban environment just has to become as apparent.

8.3.9 TRANSFERABILITY OF THE PROJECT

The aim in designing the toolbox is to create a systematic view on the implementation of urban design tools in streets. As such, the toolbox is created such that it can be applicable to any location if the right analysis is done. The tools applied in the toolbox are simple tools such as trees and bushes, that can be applied in any location, but only when the right considerations are made. In the booklet, each tool contains an explanation of these considerations. The difference will be found mainly in the type of, for example, trees that are added to the design. To achieve the highest ecological benefit, the trees should be related to the vegetation that is found locally. Although the design evaluations do show that in some places (such as at Spui), reaching a 50% softening of the surface can be hard, and the services provided might not be as pronounced as in other places.

To realise the proper application in the design the right analysis of the design location is needed. The setup of the thesis gives a good approach for this, starting with defining the needs for the ecology and social functioning of the area followed by defining the possibilities within the mobility network to create strong green connections. These locations are good places to start smaller scale design. The next step would be to define the needed ecosystem services for that location, which will in turn result in a list of tools that can be applied. To apply these tools, the street profile might need adjusting, in which case it is important to focus on creating space for soft ground. The percentage of softened ground can be used as an evaluation tool for improvement, though the evaluation of the derived ecosystem services after implementation of the tools in the street would be the best evaluation.

REFERENCES

Arrau, C.P., Pena, M.A. (2019). Urban heat islands. Urban heat islands (UHIs). https://www.urbanheatislands.com/home

Atlas Leefomgeving. (2021) Kaarten, water op straat na een hevige regenbui. https://www.atlasleefomgeving.nl/kaarten

Barthel, S., Colding, J., Ernstson, H., Erixon, H., Grahn, S., Karsten, C., Marcus, L., Torsvall. J., (2013) Principles of social-ecological urbanism. Royal institute of technology, Stockholm.

Bendine J., Veith, M., Hochkirch, A. (2015). Biodiversity in cities needs space: a meta-analysis of factors determining intra-urban biodiversity variation. Ecology letters. 18. 581-592

de Boer, N. (1996). De randstad bestaat niet. De onmacht tot grootstedelijk beleid. NAi uitgevers, Rotterdam.

Bolund, P., Hunhammar, S. (1999) Ecosystem services in urban areas. Ecological Economics, 29, 293-301.

Bosch, J. Veenenbos, H. (2011) Straten maken, hoe ontwerp je een goed straatprofiel. Martien de Vletter, SUN, Zeist.

Carmona, M. Tiesdell, S. Heath, T. Oc, T. (2003) Public places, urban spaces. 2nd ed. Architectural Press. New York

Centraal Bureau van Statistieken. (2019) Bijna een kwart Zuid-Holland nu bebouwd. CBS. https://www.cbs.nl/nl-nl/nieuws/2019/11/bijna-een-kwart-zuid-holland-nu-bebouwd

(2020a). Waar groeit of krimpt de bevolking. CBS. https://www.researchgate.net/profile/Peter_Ekamper/publication/236683879_De_verstedelijking_van_Nederland_groei_en_spreiding_van_de_Nederlandse_bevolking_sinds_1900/links/0c96051dc2254146e8000000.pdf

(2020b). Sterke groei in steden en randgemeenten verwacht. https://www.cbs.nl/nl-nl/nieuws/2019/37/sterke-groei-in-steden-en-randgemeenten-verwacht

(2020c). Wat is verstedelijking? https://www.cbs.nl/nl-nl/dossier/dossier-verstedelijking/hoofdcategorieen/wat-is-verstedelijking-

Centraal Planbureau. (n.d.) Regionale ontwikkeling en verstedelijking. https://www.wlo2015.nl/rapporten-wlo/regionale-ontwikkelingen-en-verstedelijking

Constanza, R. d'Arge, R. de Groot, R. Farber, S. Grasso, M. Hannon, B. Limburg, K. Naeem, S. O'Neill, R.V. Paruelo, J. Raskin, R.G. Sutton, P. & van den Belt, M. (1997) The value of the world's ecosystem services and natural capital. Nature, 387, 253-260.

Cornelissen, J. (2017, August 8). De auto is de baas in Amsterdam. Het Parool. https://www.parool.nl/nieuws/de-auto-is-de-baas-in-amsterdam~b50bb4c5/

Cronon, W. E. (1996). Uncommon Ground: Rethinking the Human Place in Nature, New York, W. W. Norton & company.

De Urbanisten, College van Rijksadviseurs, Ministerie van Infrastructuur en Milieu, Planbureau voor de Leefomgeving. (2016) Goed groen is goud waard. De Urbanisten

Dirks, B. (2020, February 13). Hoe leiden, een van de meest versteende steden van Nederland, wordt vergroend. Volkskrant. https://www.volkskrant.nl/nieuws-achtergrond/hoe-leiden-een-van-de-meest-versteende-steden-van-nederland-wordt-vergroend~b17e181e/

Dramstad, W.E., Olson, J.D., Forman, R.T.T. (1996) Landscape ecology principles in landscape architecture and land-use planning. Island Press.Ekamper, P. (2010). De verstedelijking van Nederland; groei en spreiding van de Nederlandse bevolking sinds 1900. Demos, 26 (9). 15 - 17. https://www.researchgate.net/profile/Peter_Ekamper/publication/236683879_De_verstedelijking_van_Nederland_groei_en_spreiding_van_de_Nederlandse_bevolking_sinds_1900/links/0c96051dc2254146e8000000.pdf

Ederveen, L. Jansen, C. (2019, September 7). Een rijdende auto neemt meer plek in dan je waarschijnlijk denkt. Een vandaag. https://eenvandaag.avrotros.nl/item/een-rijdende-auto-neemt-meer-plek-in-dan-je-waarschijnlijk-denkt/

EduGIS. (2021). EduGIS Kaarten, verblijfsobjecten gebruiksdoel. https://kaart.edugis.nl/v2/#configurl=maps/layers.json&helpstart=true

Ekamper, P. (2010). De verstedelijking van Nederland. Demos: bulletin over bevolking en samenleving, 26(9), 15-17.

Environmental Protection Agency. (2008). Reducing urban heat islands: compendium of strategies. https://www.epa.gov/heatislands/heat-island-compendium

European Environment Agency (EEA) (2019). The first and last mile; the key to sustainable urban transport. Transport and enviornment report, no 18/2019). Publication office of the European Union.

Fahrig, L. (2003) Effects of habitat fragmentation on biodiversity. Annual review of ecology, evolution, and systematics. 34. 487-515. https://doi.org/10.1146/annurev.ecolsys.34.011802.132419

Farjon, J.M.J., Hazendonk, N.F.C., Hoeffnagel, W.J.C. (1997). Verkenning natuur en verstedelijking 1995 - 2000. Judels en Brinkman, Delft

Fietsersbond. (n.d.) Fietspaden. Retrieved March 07, 2021 from https://www.fietsersbond.nl/ons-werk/infrastructuur/fietspaden/

Folke, C., Jansson, A., Larsson, J., Constanza, R., (1997). Ecosystem appropriation of cities, Ambio, 26 (3), 167-172.

Forgaci, C. (2018) Integrated Urban River Corridors; spatial design for social-ecological resilience in Bucharest and beyond. Delft Technical University.

Forman, R.T.T. (2016) Urban Ecology; science of cities (4th ed.). Cambridge University Press.

Gemeente Amsterdam (2017) Mobiliteitsverkenning; voor een groeiend Amsterdam.

Gemeente Delft (2004) Ecologieplan Delft, een groen netwerk, de groene aders van Delft.

Gemeente Den Haag (2011) Haagse nota mobiliteit; bewust kiezen, slim organiseren.

(2016) Agenda groen voor de stad, 2016. https://denhaag.raadsinformatie.nl/document/3716164/1/RIS294705_bijlage_Agenda_groen_voor_de_stad

(2018) Natuurwaardenkaart. Beleidsafdeling dienst stadsbeheer – duurzaamheid en groen

(n.d.) Archeologie en Geologie van Den Haag. Arcgis. https://ddh.maps.arcgis.com/apps/MapSeries/index.html?appid=303c6ea652c749eda919e8b8ba0427c1

Gemeente Rotterdam (n.d.) Het project. Coolsingel. https://www.coolsingel.nl/het-project/

Gemeente Utrecht, Greystar, AM, Synchroon, Lingotto, Janssen de Jong, BPD Ontwikkeling, G&S Vastgoed, Round Hill Capital, 3T Vastgoed en Boelens de Gruyter (2020) Voorlopig ontwerp stedenbouwkundig plan Merwede.

GinoPress BV. (2020) In Groenlo is zondag veel regen gevallen, in deze straat kan men daarom kanoen. [Photograph]. https://www.bndestem.nl/binnenland/kanoen-over-straat-flinke-wateroverlast-door-wolkbreuk-in-de-achterhoek~a505f10a/?referrer=https%3A%2F%2Fwww.google.com%2F

Haags Milieucentrum. (2008). Effectieve stadsecologie voor een groene wereldstad aan zee. Den Haag. Retreived from: https://www.stichtingoase.nl/litdoc/effectieve-stadsecologie.pdf

(2013) Wilde bijen in Den Haag, een verslag van de bijenmonitor 2012. Den Haag. Retrieved from: https://adoc.pub/wilde-bijen-in-den-haag.html

Harts, J.J., Maat, C., Zeijlmans van Emmichoven, M. (1999) Meervoudig stedelijk ruimtegebruik, methode en analyse. Delft University Press.

Hoekveld, G.A., Jobse R.B., van Weesep J., en Dieleman F.M. (1981) Geografie van stad en platteland in de westerse landen. Haarlem (Romen).

van den Hoorn, M., Vogelaar, E. (2018) Natuurwaardekaart 2018. Gemeente Den Haag, Beleidsafdeling Dienst Stadsbeheer Duurzaamheid en Groen

Jittrapirom, P., Caiati, V., Feneri, A. M., Ebrahimigharehbaghi, S., Alonso González, M. J., & Narayan, J. (2017). Mobility as a service: A critical review of definitions, assessments of schemes, and key challenges. Smart Cities- infrastructure and information. Urban planning, 2, 13 – 15. DOI: 10.17645/up.v2i2.931

Johnson, O., More, D. (2007) ANWB Bomengids van Europa. ANWB uitgeverij boeken, Soest.

van Stiphout, M. (2019). First guide to nature inclusive design. Nextcity.nl

Kraak, H. (2020, September 18). Hoe de fiets en de voetganger, met wat hulp van corona, de ruimte terugverroveren op de auto. De Volkskrant. https://www.volkskrant.nl/nieuws-achtergrond/hoe-de-fiets-en-de-voetganger-met-wat-hulp-van-corona-de-ruimte-terugveroveren-op-de-auto~b548e9ce/

Klimaateffectatlas (N.D.) Heat map, perceived temperature. Klimaateffectatlas https://www.klimaateffectatlas.nl/en/perceived-temperature-heat-map

Lepczyk C.A., La Sorte, F., Aronson, M., Goddard, M., MacGregor-Fors, I., Nilon, C., Warren, P. (2017). Global patterns and drivers of urban birds. In E. Murgui & M. Hedblom (Eds). Ecology and conservation of birds in urban environments. (pp. 13-33). Springer.

Lovell, S.T., Johnston, D.M. (2008). Creating multifunctional landscapes: how can the field of ecology inform the design of the landscape? Front Ecol Environ, 7 (4), 212-220. https://www-jstor-org.tudelft.idm.oclc.org/stable/pdf/25595118.pdf?refreqid=excelsior%3Aeb6ee1656c113e9e2978abc507e570dd

Loyer, F. (1988). Paris nineteenth century. Architecture and urbanism. Abbeville press, New York.

Lussault, M. (2003). « Urbain », dans LUSSAULT, M. et J. LÉVY (dir.). Dictionnaire de la géographie et de l'espace des sociétés, Paris, Belin, p. 949-951.

Mabelis, A.A. (1998) Ruimtelijke samenhang van stedelijk groen voor biodiversiteit. (IBN-RAPPORT 373, ISSN: 0928-6888). Instituut voor bos- en natuuronderzoek.

Maes, B. (2006) Ineemse bomen en struiken in Nederland en Vlaanderen. Herkenning, verspreiding, geschiedenis en gebruik. Uitgeverij Boom, Utrecht.

McGranahan, G., Sattartwaite, D. (2014). Urbanisation concepts and trends. ISBN 978-1-78431-063-9. International Institute for Environment and Development. https://www.jstor.org/stable/pdf/resrep01297.pdf?acceptTC=true&coverpage=false&addFooter=false

McKinney, M.L. (2002) Urbanization, biodiversity and conservation. Bioscience, 52(10), 883-890,

Meyer, H., de Josselin de Jong, F. ,Hoekstra, M. (2012) Public space typologies, using definition of movement spaces to select from 'het ontwerp van de openbare ruimte'.

Milieudefensie (2017) Fietser en voetganger in de knel in Nederlandse steden. https://milieudefensie.nl/actueel/fietser-en-voetganger-in-de-knel-in-nederlandse-steden

Ministerie van Binnenlandse zaken en Koninkrijksrelaties (2018) Leefbarometer, online informatie over de leefbaarheid in alle buurten en wijken. https://www.leefbaarometer.nl/home.php

Nabielek, K., Boschman, S., Harbers, A., Piek M., & Vlonk, A. (2012), Stedelijke verdichting: een ruimtelijke verkenning van binnenstedelijk wonen en werken, Den Haag: Planbureau voor de Leefomgeving.

Natuurmonumenten. (2010). Nationaal Natuurnetwerk, ecologische hoofdstructuur. Natuurmonumenten. https://assets.vlinderstichting.nl/docs/b0bdbe7a-52cd-4d37-aee3-109981875144.pdf

Nieuwenhuis, A. (2015). In Amsterdam genieten mensen op een originele manier van het warme weer [photograph]. https://www.nu.nl/zomerweer/4080004/ns-past-aantal-treindiensten-tropische-hitte.html

NOS Nieuws. (2020, Juli 29). Arnhem komt met groen plan om gevolgen klimaatverandering op te vangen. NOS. https://nos.nl/artikel/2342174-arnhem-komt-met-groen-plan-om-gevolgen-klimaatverandering-op-te-vangen.html

Oxford (2020a) Urban. In Oxford Dictionary. Retrieved, November 20, 2020, from https://www.oxfordlearnersdictionaries.com/definition/american_english/urban

(2020b) Environement. In Oxford Dictionary. Retrieved, November 20, 2020, from https://www.oxfordlearnersdictionaries.com/definition/english/environment?q=environments

Park, R. E., Burgess, E. W., & McKenzie, R. (1925). The city. Chicago: University of Chicago Press.

Planbureau voor de Leefomgeving (PBL). (2010). De staat van de ruimte 2010: de herschikking van stedelijk Nederland. https://www.pbl.nl/publicaties/De-staat-van-de-ruimte-2010.

Ponsen, J. (2019, January 12). De uitdaging van de stad: verdichten en vergroenen. Een vandaag. https://

eenvandaag.avrotros.nl/item/nieuwbouw-gaat-ten-koste-van-groen-in-de-stad/

Provincie Zuid-Holland. (n.d.) Routekaart verstedelijking.

PWC Netherlands. (2015). Rapid urbanisation. https://www.pwc.nl/en/topics/megatrends/urbanisation.html

Rijksoverheid (2020) Staat van de woningmarkt 2020. https://www.rijksoverheid.nl/actueel/nieuws/2020/06/15/

Rijkswaterstaat. (2018). Natuurnetwerk Nederland, EHS. Atlas leefomgeving. https://www.atlasleefomgeving.nl/natuurnetwerk-nederland-ehs

Rotterdam Makersdistrict (2019) Toekomst in de maak, ruimtelijk raamwerk voor M4H. https://m4hrotterdam.nl/wp-content/uploads/2020/02/190627_Boekwerk-klein-voorwoord.pdf

Scalenghe & Ajmone Marsan, 2009

Scalenghe, R., Marsan, F.A. (2009). The anthropogenic sealing of soils in urban areas. Landscape and urban planning, 90, 1-10.

Secretariat of the Convention on Biological Diversity (2020) Global biodiversity outlook 5. Montreal. Retreived from: https://www.cbd.int/gbo5

Senecal, G. (2007) Urban environment: mapping a concept. Environment urbain/ urban environment, 1. https://journals.openedition.org/eue/826

Topotijdreis.nl (2020) Topotijdreis, 200 jaar topografische kaarten. https://www.topotijdreis.nl

Urban Green Blue Grids. (N.D.). Groen blauwe netwerken voor veerkrachtige steden; Hitte. Https://nl.urbangreenbluegrids.com/heat/#heading-0

Verkade, T. te Brommelstoet, M. (2020). Het recht van de snelste, hoe ons verkeer steeds asocialer werd. De Correspondent Uitgevers.

Vink, J. Vollaard, P. de Zwarte, N. (2017). Stads natuur maken; making urban nature. Nai010 uitgevers.

Vogelbescherming Nederland (n.d.) De resultaten, de nationale tuinvogeltelling. Retrieved October 19, 2021, from https://www.vogelbescherming.nl/tuinvogeltelling/resultaten

Wageningen university and research (WUR). (n.d.). Dossier klimaat en waterbeheer. Retrieved on January 24, 2021 from https://www.wur.nl/nl/artikel/Gevolgen-van-klimaatverandering.htm

Windhager, S., Steiner, F., Simmons, M.T., Heymann, D. (2010) Toward ecosystem services as a basis for design. Landscape journal, 29 (2), 107 - 203. https://www.researchgate.net/publication/275861073_Toward_Ecosystem_Services_as_a_Basis_for_Design

Provincie Zuid-Holland, Provincial adviseur ruimtelijke kwaliteit Zuid-Holland, Broekman, M. Vereniging Deltametropool, Nohnik (2017) Verkenning stedelijk landschap en groenblauwe structuur Zuid-Holland: naar een schaalsprong voor een metropolitaan landschapspark.

Zimmer, K. (2020, September 15). The world missed a critical deadline to safeguard biodiversity, UN report says. National Geographic https://www.nationalgeographic.com/science/2020/09/world-missed-critical-deadline-to-safeguard-biodiversity-un-report/

APPENDIX

APPENDIX 1: CORRIDOR SURFACES CALCULATIONS

PERCENTAGE OF GREEN FOR THE SCHEVENINGEN ARTERY

- Hard surface
- Soft surface
- Permiable surface

CURRENT

DUINDORPDAM

Surface	Materialisation	On/off	Width (m)	Percentage
Road		X	7,4	24,03
Public transport road				0,00
Parking				0,00
Shoulder		x	16,88	54,81
Bikelane		x	4,92	15,97
Sidewalk		x	1,6	5,19
Water				0,00
Gardens				0,00
Total			30,8	

Length (m)	91,00
Surface (m2)	2802,8
Green surface (m2)	0,00
Green surface with 14m mobility width	1528,8
Percentage	55
Green surface with 16m mobility width	1301,3
Percentage	46

WESTDUINWEG

Movement	Materialisation	On/off	Width	Percentage
Road		X	9,5	38,78
Public transport road				0,00
Parking		X	4	16,33
Shoulder		x	1,4	5,71
Bikelane		x	4,3	17,55
Sidewalk		x	5,3	21,63
Water				0,00
Gardens				0,00
Total			24,5	

Length (m)	126,00
Surface (m2)	3087
Green surface (m2)	0,00
Green surface with 14m mobility width	1323
Percentage	43
Green surface with 16m mobility width	1008
Percentage	33

ROERSTRAAT

Movement	Materialisation	On/off	Width	Percentage
Road		X	3,2	28,07
Public transport road				0,00
Parking		X	4	35,09
Shoulder				0,00
Bikelane				0,00
Sidewalk		x	4,2	36,84
Water				0,00
Gardens				0,00
Total			11,4	

Length (m)	21,70
Surface (m2)	247,38
Green surface (m2)	0,00
Green surface with 14m mobility width	-56,42
Percentage	-23
Green surface with 16m mobility width	-110,67
Percentage	-45

DROGERSDIJK

Movement	Materialisation	On/off	Width	Percentage
Road				0,00
Public transport road				0,00
Parking				0,00
Shoulder				0,00
Bikelane				0,00
Sidewalk		x	4,33	81,24
Water				0,00
Gardens		x	1	18,76
Total			5,33	

Length (m)	3,40
Surface (m2)	18,122
Green surface (m2)	3,40
Green surface with 14m mobility width	-29,478
Percentage	-163
Green surface with 16m mobility width	-37,978
Percentage	-210

JURIAAN KOKSTRAAT

Movement	Materialisation	On/off	Width	Percentage
Road		x	8	37,74
Public transport road		x		0,00
Parking		x	3,8	17,92
Shoulder				0,00
Bikelane		x	3,9	18,40
Sidewalk		x	5,5	25,94
Water				0,00
Gardens				0,00
Total			21,2	

Length (m)	56,10
Surface (m2)	1189,32
Green surface (m2)	0,00
Green surface with 14m mobility width	403,92
Percentage	34
Green surface with 16m mobility width	263,67
Percentage	22

GEVERS DEYNOOTWEG

Movement	Materialisation	On/off	Width	Percentage
Road		x	9,9	30,63
Public transport road		x	6,15	19,03
Parking		x	2,3	7,12
Shoulder		x	4,3	13,30
Bikelane		x	3,77	11,66
Sidewalk		x	5,9	18,25
Water				0,00
Gardens				0,00
Total			32,32	

Length (m)	19,00
Surface (m2)	614,08
Green surface (m2)	0,00
Green surface with 14m mobility width	348,08
Percentage	57
Green surface with 16m mobility width	300,58
Percentage	49

23	D2	Length (m)	35,00
		Surface (m2)	805
		Green surface (m2)	0,00
		Green surface with 14m mobility width	315
		Percentage	39
		Green surface with 16m mobility width	227,5
		Percentage	28
44,6	D3	Length (m)	14,00
		Surface (m2)	624,4
		Green surface (m2)	0,00
		Green surface with 14m mobility width	428,4
		Percentage	69
		Green surface with 16m mobility width	393,4
		Percentage	63
87,2	D4 kurhaus	Length (m)	14,00
		Surface (m2)	1220,8
		Green surface (m2)	0,00
		Green surface with 14m mobility width	1024,8
		Percentage	84
		Green surface with 16m mobility width	989,8
		Percentage	81
30	D5	Length (m)	47,00
		Surface (m2)	1410
		Green surface (m2)	0,00
		Green surface with 14m mobility width	752
		Percentage	53
		Green surface with 16m mobility width	634,5
		Percentage	45
	Total	M2 space	12018,902
		Current green (m2)	168,00
		M2 possible green (14m)	6124
		M2 possible green (16,5m)	5118,75

NEW DESIGN

Surface	Materialisation	On/off	Width	Percentage
Road		X	5	16,13
Public transport road				0,00
Parking				0,00
Shoulder		x	16	51,61
Bikelane		x	4	12,90
Sidewalk		x	6	19,35
Water				0,00
Gardens				0,00
Total			31	

Length (m)	91,00
Surface (m2)	2821
Green surface (m2)	1456
Percentage	52

Surface	Materialisation	On/off	Width	Percentage
Road		X	5	20,00
Public transport road				0,00
Parking				0,00
Shoulder		x	10	40,00
Bikelane		x	4	16,00
Sidewalk		x	6	24,00
Water				0,00
Gardens				0,00
Total			25	

Length (m)	400,00		140	74	550
Width (m)	25		25	90	25
Surface (m2)	10000	4350	3500	6660	13750
Surface total (m2)	38260				
Green surface (m2)	18386				
Percentage	48				

Surface	Materialisation	On/off	Width	Percentage
Road		X	3,2	28,57
Public transport road				0,00
Parking				0,00
Shoulder		x	4	35,71
Bikelane		x		0,00
Sidewalk		x	4	35,71
Water				0,00
Gardens				0,00
Total			11,2	

Length (m)	50,00	165			
Width (m)	20	11,2			
Surface (m2)	1000	1848	0	0	0
Surface total (m2)	2848				
Green surface (m2)	1300				
Percentage	46				

Surface	Materialisation	On/off	Width	Percentage
Road				0,00
Public transport road				0,00
Parking				0,00
Shoulder				0,00
Bikelane				0,00
Sidewalk		x	4	72,73
Water				0,00
Gardens		x	1,5	27,27
Total			5,5	

Length (m)	34,00
Surface (m2)	187
Green surface (m2)	51
Percentage	27

Surface	Materialisation	On/off	Width	Percentage
Road				0,00
Public transport road			7	33,33
Parking				0,00
Shoulder			4	19,05
Bikelane			4	19,05
Sidewalk			6	28,57
Water				0,00
Gardens				0,00
Total			21	

Length (m)	43,00	560	110		
Width (m)	43	21	23		
Surface (m2)	1849	11760	2530	0	0
Surface total (m2)	16139				
Green surface (m2)	3951				
Percentage	24				

Surface	Materialisation	On/off	Width	Percentage
Road				0,00
Public transport road			7	21,88
Parking				0,00
Shoulder			15	46,88
Bikelane			4	12,50
Sidewalk			6	18,75
Water				0,00
Gardens				0,00
Total			32	

Length (m)	360,00	162	115		357
Width (m)	37	35	43		30
Surface (m2)	13320	5670	4945	11443	10710
Surface total (m2)	46088				
Green surface (m2)	27240				
Percentage	59				

Total	surface	106343
	green surface	52384
	percentage	49%

PERCENTAGE OF GREEN FOR THE CENTRES ARTERY

KURHAUSWEG

Movement	Materialisation	On/off	Width	Percentage
Road		X	12,6	38,77
Public transport road				0,00
Parking		x	3,3	10,15
Shoulder		x	2,6	8,00
Bikelane		x	4,3	13,23
Sidewalk		x	9,7	29,85
Water				0,00
Gardens				0,00
Total			32,5	

Length (m)	100,00
Surface (m2)	3250
Green surface (m2)	0,00
Green surface with 14m mobility width	1850
Percentage	57
Green surface with 16m mobility width	1600
Percentage	49

BADHUISWEG

Movement	Materialisation	On/off	Width	Percentage
Road		X	7,4	18,55
Public transport road				0,00
Parking		X	3,6	9,02
Shoulder		x	2	5,01
Bikelane		x	3,4	8,52
Sidewalk		x	5,3	13,28
Water				0,00
Gardens		x	18,2	45,61
Total			39,9	
			21,7	

Length (m)	715,00
Surface (m2)	28528,5
Green surface (m2)	0,00
Green surface with 14m mobility width	18518,5
Percentage	65
Green surface with 16m mobility width	16731
Percentage	59

BADHUISWEG

Movement	Materialisation	On/off	Width	Percentage
Road		X	6,15	52,12
Public transport road				0,00
Parking		X	1,95	16,53
Shoulder				0,00
Bikelane				0,00
Sidewalk		x	3,7	31,36
Water				0,00
Gardens				0,00
Total			11,8	

Length (m)	217,00
Surface (m2)	2560,6
Green surface (m2)	0,00
Green surface with 14m mobility width	-477,4
Percentage	-19
Green surface with 16m mobility width	-1019,9
Percentage	-40

DOCTER ALETTA JACOBSWEG 1

Movement	Materialisation	On/off	Width	Percentage
Road		X	12,7	51,00
Public transport road				0,00
Parking				0,00
Shoulder		X	6,5	26,10
Bikelane		X	4,3	17,27
Sidewalk		x	1,4	5,62
Water				0,00
Gardens				0,00
Total			24,9	

Length (m)	300,00
Surface (m2)	7470
Green surface (m2)	0,00
Green surface with 14m mobility width	3270
Percentage	44
Green surface with 16m mobility width	2520
Percentage	34

DOCTER ALETTA JACOBSWEG 2

Movement	Materialisation	On/off	Width	Percentage
Road		X	11,2	56,85
Public transport road				0,00
Parking				0,00
Shoulder		X	2,4	12,18
Bikelane		X	6,1	30,96
Sidewalk				0,00
Water				0,00
Gardens				0,00
Total			19,7	

Length (m)	240,00
Surface (m2)	4728
Green surface (m2)	576
Green surface with 14m mobility width	1368
Percentage	29
Green surface with 16m mobility width	768
Percentage	16

BANKASTRAAT

Movement	Materialisation	On/off	Width	Percentage
Road		X	7	52,83
Public transport road				0,00
Parking		X	1,85	13,96
Shoulder				0,00
Bikelane				0,00
Sidewalk		x	4,4	33,21
Water				0,00
Gardens				0,00
Total			13,25	

Length (m)	350,00
Surface (m2)	4637,5
Green surface (m2)	0,00
Green surface with 14m mobility width	-262,5
Percentage	-6
Green surface with 16m mobility width	-1137,5
Percentage	-25

NASSAUPLEIN

Movement	Materialisation	On/off	Width	Percentage
Road		X	8,5	21,04
Public transport road				0,00
Parking		X	7,5	18,56
Shoulder		X	8,4	20,79
Bikelane		X	3,4	8,42
Sidewalk		x	12,6	31,19
Water				0,00
Gardens				0,00
Total			40,4	

Length (m)	265
Surface (m2)	10706
Green surface (m2)	2226
Green surface with 14m mobility width	6996
Percentage	65
Green surface with 16m mobility width	6333,5
Percentage	59

NASSAULAAN

Movement	Materialisation	On/off	Width	Percentage
Road		X	5,2	34,21
Public transport road				0,00
Parking		X	3,3	21,71
Shoulder		X	3	19,74
Bikelane				0,00
Sidewalk		x	3,7	24,34
Water				0,00
Gardens				0,00
Total			15,2	

Length (m)	370
Surface (m2)	5624
Green surface (m2)	1110
Green surface with 14m mobility width	444
Percentage	8
Green surface with 16m mobility width	-481
Percentage	-9

MAURITSKADE

Movement	Materialisation	On/off	Width	Percentage
Road		X	6,6	21,57
Public transport road				0,00
Parking		X	1,5	4,90
Shoulder		X	2,2	7,19
Bikelane		X	3,3	10,78
Sidewalk		x	2	6,54
Water		X	15	49,02
Gardens				0,00
Total			30,6	

Length (m)	200
Surface (m2)	6120
Green surface (m2)	440,00
Green surface with 14m mobility width	3320
Percentage	54
Green surface with 16m mobility width	2820
Percentage	46

PARKSTRAAT

Movement	Materialisation	On/off	Width	Percentage
Road		X	6,5	35,52
Public transport road				0,00
Parking		X	3,3	18,03
Shoulder				0,00
Bikelane		X	3,2	17,49
Sidewalk		x	5,3	28,96
Water				0,00
Gardens				0,00
Total			18,3	

Length (m)	375
Surface (m2)	6862,5
Green surface (m2)	0
Green surface with 14m mobility width	1612,5
Percentage	23
Green surface with 16m mobility width	675
Percentage	10

KNEUTERDIJK

Movement	Materialisation	On/off	Width	Percentage
Road		X	9,35	27,22
Public transport road			10,3	29,99
Parking				0,00
Shoulder				0,00
Bikelane		X	2	5,82
Sidewalk		x	10,7	31,15
Water				0,00
Gardens		X	2	5,82
Total			34,35	

Length (m)	184
Surface (m2)	6320,4
Green surface (m2)	0
Green surface with 14m mobility width	3744,4
Percentage	59
Green surface with 16m mobility width	3284,4
Percentage	52

BUITENHOF

Movement	Materialisation	On/off	Width	Percentage
Road		X	7,5	27,08
Public transport road			8,2	29,60
Parking				0,00
Shoulder				0,00
Bikelane		X	1,4	5,05
Sidewalk		x	10,6	38,27
Water				0,00
Gardens				0,00
Total			27,7	
			13,85	
			11,2	

Length (m)	179
Surface (m2)	4958,3
Green surface (m2)	0
Green surface with 14m mobility width	2452,3
Percentage	49
Green surface with 16m mobility width	2004,8
Percentage	40

HOFWEG

Movement	Materialisation	On/off	Width	Percentage
Road		X	9,25	20,72
Public transport road			7,2	16,13
Parking			4,8	10,75
Shoulder			5,5	12,32
Bikelane		X	2,8	6,27
Sidewalk		x	15,1	33,82
Water				0,00
Gardens				0,00
Total			44,65	

Length (m)	176
Surface (m2)	7858,4
Green surface (m2)	0
Green surface with 14m mobility width	5394,4
Percentage	69
Green surface with 16m mobility width	4954,4
Percentage	63

SPUI

Movement	Materialisation	On/off	Width	Percentage
Road		X	5	16,45
Public transport road			6,5	21,38
Parking				0,00
Shoulder				0,00
Bikelane		X	3,6	11,84
Sidewalk		x	15,3	50,33
Water				0,00
Gardens				0,00
Total			30,4	

Length (m)	536,00
Surface (m2)	16294,4
Green surface (m2)	0,00
Green surface with 14m mobility width	8790,4
Percentage	54
Green surface with 16m mobility width	7450,4
Percentage	46

PLETTERIJKADE/ ZIEKEN

Movement	Materialisation	On/off	Width	Percentage
Road		X	11,3	19,57
Public transport road		X	12,2	21,13
Parking		X	1,4	2,42
Shoulder				0,00
Bikelane		X	3	5,19
Sidewalk		x	10,75	18,61
Water		X	19,1	33,07
Gardens				0,00
Total			57,75	

Length (m)	338,00
Surface (m2)	19519,5
Green surface (m2)	6455,80
Green surface with 14m mobility width	14787,5
Percentage	76
Green surface with 16m mobility width	13942,5
Percentage	71

RIJSWIJKSEPLEIN

Movement	Materialisation	On/off	Width	Percentage
Road		X	5	16,45
Public transport road			6,5	21,38
Parking				0,00
Shoulder				0,00
Bikelane		X	3,6	11,84
Sidewalk		x	15,3	50,33
Water				0,00
Gardens				0,00
Total			30,4	

Length (m)	536,00
Surface (m2)	16294,4
Green surface (m2)	0,00
Green surface with 14m mobility width	8790,4
Percentage	54
Green surface with 16m mobility width	7450,4
Percentage	46

RIJSWIJKSEWEG

Movement	Materialisation	On/off	Width	Percentage
Road		X	15,7	45,24
Public transport road			5,4	15,56
Parking				0,00
Shoulder			5,8	16,71
Bikelane		X	3,7	10,66
Sidewalk		x	4,1	11,82
Water				0,00
Gardens				0,00
Total			34,7	

Length (m)	513,00
Surface (m2)	17801,1
Green surface (m2)	0,00
Green surface with 14m mobility width	10619,1
Percentage	60
Green surface with 16m mobility width	9336,6
Percentage	52

Total			
	M2 space	169533,6	
	Current green (m2)	10807,80	6%
	M2 possible green (14m)	91957,5	54%
	M2 possible green (16,5m)	79871	47%

NEW DESIGN

Surface	Materialisation	On/off	Width	Percentage
Road		X	7	21,21
Public transport road				0,00
Parking				0,00
Shoulder		x	16	48,48
Bikelane		x	4	12,12
Sidewalk		x	6	18,18
Water				0,00
Gardens				0,00
Total			33	

Length (m)	100,00
Surface (m2)	3300
Green surface (m2)	1600
Percentage	48

Surface	Materialisation	On/off	Width	Percentage
Road		X	7	17,86
Public transport road				0,00
Parking				0,00
Shoulder		x	6	15,31
Bikelane		x	4	10,20
Sidewalk		x	4	10,20
Water				0,00
Gardens			18,2	46,43
Total			39,2	

Length (m)	715,00
Surface (m2)	28028
Green surface (m2)	17303
Percentage	62

Surface	Materialisation	On/off	Width	Percentage
Road		X	5,5	44,00
Public transport road				0,00
Parking				0,00
Shoulder		x	3	24,00
Bikelane		x		0,00
Sidewalk		x	4	32,00
Water				0,00
Gardens				0,00
Total			12,5	

Length (m)	808,00	139	158
Width (m)	12,5	35	16
Surface (m2)	10100	4865	2528
Surface total (m2)	17493		
Green surface (m2)	6658		
Percentage	38		

Surface	Materialisation	On/off	Width	Percentage
Road		X	9	36,00
Public transport road				0,00
Parking				0,00
Shoulder		x	6	24,00
Bikelane		x	4	16,00
Sidewalk		x	6	24,00
Water				0,00
Gardens				0,00
Total			25	

Length (m)	53,00	45	435
Width (m)	55	22	25
Surface (m2)	2915	990	10875
Surface total (m2)	14780		
Green surface (m2)	3405		
Percentage	23		

Surface	Materialisation	On/off	Width	Percentage
Road		X	5,5	21,57
Public transport road				0,00
Parking				0,00
Shoulder		x	13	50,98
Bikelane		x		0,00
Sidewalk		x	7	27,45
Water				0,00
Gardens				0,00
Total			25,5	

Length (m)	64,00	177	48
Width (m)	26	13,5	45
Surface (m2)	1664	2389,5	2160
Surface total (m2)	10708,5		
Green surface (m2)	4691		
Percentage	44		

Surface	Materialisation	On/off	Width	Percentage
Road		X	10	23,26
Public transport road				0,00
Parking				0,00
Shoulder		x	27	62,79
Bikelane		x		0,00
Sidewalk		x	6	13,95
Water				0,00
Gardens				0,00
Total			43	

Length (m)	269,00
Surface (m2)	11567
Green surface (m2)	7263
Percentage	63

Surface	Materialisation	On/off	Width	Percentage
Road		X	5,5	36,67
Public transport road				0,00
Parking				0,00
Shoulder		x	6,5	43,33
Bikelane		x		0,00
Sidewalk		x	3	20,00
Water				0,00
Gardens				0,00
Total			15	

Length (m)	350,00
Surface (m2)	5250
Green surface (m2)	2275
Percentage	43

Surface	Materialisation	On/off	Width	Percentage
Road		X	5,5	18,03
Public transport road				0,00
Parking				0,00
Shoulder		x	7	22,95
Bikelane		x		0,00
Sidewalk		x	3	9,84
Water			15	49,18
Gardens				0,00
Total			30,5	

Length (m)	200,00
Surface (m2)	6100
Green surface (m2)	4400
Percentage	72

Surface	Materialisation	On/off	Width	Percentage
Road		X	7	35,00
Public transport road				0,00
Parking				0,00
Shoulder		x	5	25,00
Bikelane		x	4	20,00
Sidewalk		x	4	20,00
Water				0,00
Gardens				0,00
Total			20	

Length (m)	283,00	84
Width (m)	20	10,5
Surface (m2)	5660	882
Surface total (m2)	6542	
Green surface (m2)	1415	
Percentage	22	

Surface	Materialisation	On/off	Width	Percentage
Road		X	7	21,21
Public transport road				0,00
Parking				0,00
Shoulder		x	16	48,48
Bikelane		x	4	12,12
Sidewalk		x	6	18,18
Water				0,00
Gardens				0,00
Total			33	

Length (m)	85,00	124
Width (m)	33	31
Surface (m2)	2805	3844
Surface total (m2)	6649	
Green surface (m2)	3096	
Percentage	47	

Surface	Materialisation	On/off	Width	Percentage
Road		X	7	23,33
Public transport road				0,00
Parking				0,00
Shoulder		x	11	36,67
Bikelane		x	4	13,33
Sidewalk		x	8	26,67
Water				0,00
Gardens				0,00
Total			30	

Length (m)	67,00	57	69
Width (m)	68	30	156
Surface (m2)	4556	1710	10764
Surface total (m2)	17030		
Green surface (m2)	8502		
Percentage	50		

Surface	Materialisation	On/off	Width	Percentage
Road		X	7	15,56
Public transport road				0,00
Parking				0,00
Shoulder		x	26	57,78
Bikelane		x	4	8,89
Sidewalk		x	8	17,78
Water				0,00
Gardens				0,00
Total			45	

Length (m)	177,00
Surface (m2)	7965
Green surface (m2)	4602
Percentage	58

Surface	Materialisation	On/off	Width	Percentage
Road		X	7	23,33
Public transport road				0,00
Parking				0,00
Shoulder		x	9	30,00
Bikelane		x	6	20,00
Sidewalk		x	8	26,67
Water				0,00
Gardens				0,00
Total			30	

Length (m)		163	135
Width (m)		36	30
Surface (m2)	8853	5868	4050
Surface total (m2)	18771		
Green surface (m2)	5561		
Percentage	30		

Surface	Materialisation	On/off	Width	Percentage
Road		X	11	19,13
Public transport road			9,5	16,52
Parking				0,00
Shoulder		x	10	17,39
Bikelane		x		0,00
Sidewalk		x	8	13,91
Water			19	33,04
Gardens				0,00
Total			57,5	

Length (m)	338,00
Surface (m2)	19435
Green surface (m2)	9802
Percentage	50

Surface	Materialisation	On/off	Width	Percentage
Road		X	12	18,46
Public transport road			12	18,46
Parking				0,00
Shoulder		x	35	53,85
Bikelane		x		0,00
Sidewalk		x	6	9,23
Water				0,00
Gardens				0,00
Total			65	

Length (m)	115,00
Surface (m2)	7475
Green surface (m2)	4025
Percentage	54

Surface	Materialisation	On/off	Width	Percentage
Road		X	7	20,00
Public transport road				0,00
Parking				0,00
Shoulder		x	16	45,71
Bikelane		x	6	17,14
Sidewalk		x	6	17,14
Water				0,00
Gardens				0,00
Total			35	

Length (m)	227,00	151
Width (m)	35	35
Surface (m2)	7945	5285
Surface total (m2)	13230	
Green surface (m2)	4232	
Percentage	32	

Total		
	Surface (m2)	194323,5
	Green surface (m2)	88829,5
	percentage	46%

PERCENTAGE OF GREEN FOR DESIGN LOCATIONS

SCHOOL DISTRICT

Total surface 4350

Current			Designed		
Green surface			**Green surface**		
1 Road trees west	9		1 Road shoulders west	564	
2 Road trees east	4		2 Road shoulders east	478	
3 School playground	559		3 School playground	838	
			4 Planters	56	
Total	572	13	Total	1936	45
Paved surface	3778	87	**Paved surface**	2414	55

KURHAUS

Total surface 11443

Current			Designed		
Green surface			**Green surface**		
Green park east	1065		Green park east	3372	
Trees east	10		Green shoulder east	693	
			Green tram	1155	
			Trees at tram	12	
			Green park west	204	
			Green shoulder west	363	
Total	1075	9	Total	5799	51
Paved surface	10368	91	**Paved surface**	5644	49

SPUI

Total surface 8853

Current			Designed		
Green surface			**Green surface**		
Trees North (tram stop)	16		Green tram track	565	
Trees South	8		Green tram stop	370	
			Water structure West	424	
			Green West	261	
			Water structure South	215	
			Green South	354	
			Green East	473	
			Water structure Centre	54	
Total	24	0,3	Total	2716	31
Paved surface	8829	99,7	**Paved surface**	6137	69

APPENDIX 2: THEORY ESSAY

Written for the theory course that was part of the graduation year, AR3U023.

Movement spaces

Researching the typologies of the public spaces through which we move within the region Haaglanden.

AR3U023 Theories of Urbanism

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Abstract

Movement is one of the main aspects for which a city structure is designed. Movement of for example goods, water, waste, and off course, people. A city structure is designed to create accessibility and connections between different destinations. This accessibility and connectivity, and their materialisation in public space is in constant need of change due to the innovations in mobility typologies. The current movement spaces are dependent on an unsustainable urban transportation system based on car dependency. The new challenge is to achieve sustainable urban development with no increase in car use. The current public space network will need to change, and especially the movement spaces. The movement space facilitates for all movement through the urban environment in which we live. To be able to (re)design the movement spaces for the new transportation system it is important to understand what types of movement spaces exist in the current transportation system as well as the urban environments in which the movement spaces exist, for these determine current and future use. This paper looks into the following question: What are the different typologies of movement space in urban environments?
The urban environment is defined as the built environment shaped as such that it can facilitate the entanglement of social needs and states of nature applicable to a specific geographical location. This does not only include city environments, but also more rural and low-density locations as well as high density, metropolitan locations. These urban environments are structured and connected through the public space network, and with that, through movement spaces. A movement space typology can be found in multiple urban environments, where the environment and its function will depict the needed profile of the movement space. The design of the movement space will be thus that it suffices to this other function as well as easy movement for people.

Keywords: Movement spaces, urban environments, movement space typologies, public space network

1. Introduction

Movement is one of the main aspects for which a city structure is designed. Movement of for example goods, water, waste, and off course, people. A city structure is designed to create accessibility and connections between different destinations. This accessibility and connectivity, and their materialisation in public space is in constant need of change due to the innovations in mobility typologies. We, for example, see this happen during the 20th century, when the morphological structure of the public space network changed from interconnected, small-scale, finely meshed street grids to larger-scale road networks surrounding super-blocks due to the arrival of the car (Carmona, et al. 2003).

Carmona, Tiesdell, Heath and Oc (2003) describe the public space network as being composed from two types of space: social space and movement space. Social space encourages people engagement and exchange, either in economic, social or cultural form. The movement space accommodates exactly what it says, movement through the public space network. This movement space will sometimes be the soul function of the space, while in some parts, the movement and social space will overlap, and the type of movement present will be dependent on the function of the space as well as on the preferred types of transportation of that time.

The current movement spaces are dependent on an, according to Newman and Kenworty (1991), unsustainable urban transportation system based on car dependency. The new challenge is to achieve sustainable urban development with no increase in car use (Bertolini, 2002). This challenge brings along with it the fact that most cities are trying to densify instead of expand. This means that development takes place in existing public space networks and existing movement spaces. To be able to design the movement spaces for the new transportation system it is important to understand what types of movement spaces exist in the current transportation system as well as the urban environments in which the movement space is located. The urban environment will determine the current and future preferred transportation system, which will in turn outline the needed change in movement space. This paper will set the basis for the research in movement space changes by looking into the following question: *What are the different typologies of movement space in urban environments?*

To answer this question, this research paper will first look into the term urban environments, starting with defining the term for this paper. Then information on the history of the urban environment will help create a context after which the different types of urban environment are listed and explained. The second part of the paper discusses the main typologies of movement space. A short explanation is given for each movement space with its main characteristics, sections showing these characteristics and the urban environments in which the movement space can be found.

2. The urban environment

The term 'urban environment' is often used in research regarding urban design and planning, while not always being defined. To properly understand the context in which movement space exists this paragraph will look into the meaning of the term urban environment, followed by describing the history and defining the different typologies that apply.

2.1 A definition

Looking into the definition of both 'urban' and 'environment' the concept of urban environment seems to apply to both the spatial as well as the natural studies. In the Oxford dictionary 'Urban' is defined as 'relating to, or characteristic of a town or city' (Oxford, 2020a) indicating spatial implications. Lussault (2003, as cited in Senecal, 2007) refers to it as a complex and relatively central organisation of lived space. It can include different types of areas ranging from metropolises, city centres and neighbourhoods to mid-size towns; spaces characterised by patterns of development and social interactions (Senecal, 2007). 'Environment' is defined as either the 'surroundings or conditions in which a person, animal or plant lives and operates', as well as the 'natural world as a whole or in a particular geographical area, especially as affected by human activity' (Oxford, 2020b). This refers to a point of view from the natural sciences. In addition, the definitions of both 'urban' and 'environment' suggests a connection to the study of the social sciences. Within research, the term seems to be used either with a focus on this social aspect, for example when trying to understand actions and social practices taking place in a city or with a focus on natural sciences discussing problems such as climate, water, air, animals etc. (Senecal, 2007). However, one could say that the built environment will always be dependent on the social environment and the social environment will be dependent on the built environment. As William Cronon (1996) says, our attention is directed towards societies' perception of the surroundings, resulting in the urban environment being a compilation of social facts and states of nature. As such, one can define the urban environment as *the built environment shaped as such that it can facilitate the entanglement of social needs and states of nature applicable to a specific geographical location.*

2.2 Development through time

The urban environment shows an everchanging process as the use of space changes with the developments in production systems and the labour market. Looking back at the pre-industrial city, the urban was defined by its compactness and high density; living and working were close together and often even under the same roof. This compactness had two reasons; there were little transportation options, and the city walls marked the border of the city (Harts, et al. 1999). Yet, due to the high number of people living in the countryside, the city still included many gardens and courtyards, and this only started changing after the Middle Ages (Hoekveld, et al. 1981). The biggest change was seen during the Industrial Revolution. The mechanisation of production asked for large industries and factories with many employees. A migration from the countryside to the city started and working-class neighbourhoods and villa neighbourhoods were built as a result. Another large factor in the development of urban environments was the arrival of the steam train, allowing people to travel larger distances. This resulted in the first signs of suburbanisation, especially with regards to the residential function. The first half of the twentieth century the zoned city takes shape; there are centres with the main services surrounded by the working-class neighbourhoods and industry, followed by the middle class and finally, at some distance, we find the neighbourhoods for the rich (Harts, et al., 1999). It resulted in the concept of the 'functional city', where work and recreation are separated (Hoekveld, et al. 1981). The suburbanisation expanded due to the prosperity after the Second World War, allowing more people to own a car and travel at larger distances (de Broek, 1996). In the Netherlands, policies were formed for the development of bundled de-concentration with central cities surrounded by growth cores. Growth still happened outside the city. This changed when the old city started to run-down and the centre of attention returned to the existing city. The focus was now on urban concentration, where the policy addressed mixed functions with bundling of living, working and recreation. (Harts, et al., 1999). Currently, we even see an addition to these mixed functions, where the knowledge- and culture-economy introduce new types of industry that is finding its place in city centres (Planbureau voor de Leefomgeving (PBL), 2010).

2.3 Types of urban environment

Due to the mixed functions concept, instead of heaving only a city centre as a focus, cities are changing into a collection of many diverse areas, or urban environments. Historic cities focus on entertainment, station areas are filled with offices and shops and residential areas change due to transformation, city renewal and restructuring to facilitate the different preferences of the residents (PBL, 2010). Harts, Maat and Zeijlmans van Emmichoven (1999) define fourteen different urban environments derived from research in the Netherlands; metropolitan centre, urban (sub) centre, amenities concentration, low-urban centre, metropolitan residential area, urban residential area, residential area, residential area near green, low-urban residential area, residential area near industry, industrial area, infrastructure, urban green space, and outskirts. With the exception of 'infrastructure' each of these urban environments will be described. The infrastructure as an urban environment will be discussed further in the paper. In addition, the station area as described by PBL (2010) will be added to the list of urban environments of Harts, et al. (1999)

2.3.1 Metropolitan centre

The metropolitan centre is characterised by a high concentration and mix of functions; mainly non-daily functions (think of shops, culture and culinary functions), employment options and residences. The residences are mainly found stacked on top of each other. The non-daily functions take place mainly on the lower floors. This, combined with the high mix of functions, makes for a high intensity environment, where the amount of activity is highest of all urban environments. Some examples are the city centres of Rotterdam and The Hague. (Harts, et al. 1999)

2.3.2 Urban (sub)centre

The urban (sub)centre also characterises itself with high concentrations and mix of functions, although in considerably smaller numbers than the metropolitan centre. Next to the non-daily functions there is a relatively large amount of daily functions such as grocery stores. The housing will often, but not always, be in stacked formation. In contrast to the metropolitan centre, there will hardly ever be very tall buildings. These types of environment are found mainly in medium to smaller sized cities such as Delft, Schiedam or Spijkenisse, or in the sub-centres of large cities. (Harts, et al. 1999)

2.3.3 Amenities concentrated area

In this area, different amenities such as social, cultural and public functions are located. Think of museums, schools or governmental buildings. These functions provide a relatively high number of employment, but there is a low number of residences. This results in a very specific urban environment that differs a lot from other parts of the city. Examples are campus grounds such as the Delft Technical University of Technology or the Museumpark in Rotterdam. (Harts, et al. 1999)

2.3.4 Low-urban centre

The low-urban centre is a small area with shops for the daily groceries and a few non-daily functions such as other shops or recreational buildings. They occur mainly in residential areas with a low density, causing the intensity of activities to be low. An example can be the street 'Hof van Delftlaan' in the neighbourhood 'Hof van Delft' in Delft. (Harts, et al. 1999)

2.3.5 Metropolitan residential area
The metropolitan residential area has a considerably high concentration of residences that are most often stacked, creating a high-density environment. There will be some daily use shops along the main streets that connect the area to the city centre. They are often located near the shopping and/or business centres of the larger cities such as Rotterdam or The Hague but can also be found in smaller cities such as Schiedam or Delft. (Harts, et al. 1999)

2.3.6 Urban residential area
The urban residential area, with its medium-high density, is often found on the border of the high density to low density areas. The intensity of residences is slightly lower than in the metropolitan residential area but still considerably high. It is characterised by a large percentage of stacked housing with a relatively high amount of green in the area. (Harts, et al. 1999)

2.3.7 Residential area
This area is a lot less compact than other urban environments and distinguished by the high amount of housing and a low number of stores and work locations. Shops and other amenities are often found in subcentres close by. This type of environment is typical for the city borders. (Harts, et al. 1999)

2.3.8 Residential area near green
This type of residential area is very much the same as the previously described general residential area. The main difference is that almost a third of the ground is used by green- and sports functions. These neighbourhoods are found at the borders of the city close to large infrastructures. The main parts of green areas are created to act as a divider between the residences and the large infrastructure. (Harts, et al. 1999)

2.3.9 Low-urban residential area
This type of residential environment has the lowest density of all distinguished residential areas and is characterised by the freestanding housing. It is mainly found in and around the small cores in the countryside and only sometimes at the edge of cities. (Harts, et al. 1999)

2.3.10 Residential area near industry
These residential areas stipulate the gradient from residential areas to industrial areas. Harts, et al. has marked this location as a separate urban environment, since the characteristics are so specific. There is no talk of a mix of residences and offices or industry. Instead, there seems to be a hard border between the two, resulting in two very different environments in one area. (Harts, et al. 1999)

2.3.11 Industrial area
These areas consist of harbour, industry and offices. Especially the industry and harbour are most likely not found in the inner cities. What is striking, is the fact that these areas make up a large part of our urban environments and yet show a low intensity of use and low employment possibilities. More compact parts of cities show a substantially higher employer density, indicating that the companies in these industrial areas use a relatively spread out. (Harts, et al. 1999)

2.3.12 Urban green space
The urban green space consists of parks, cemeteries, sports terrains, allotment gardens, recreational facilities etc.. These areas are considered only as a separate environment when they are connected such that they create a large entity. If they are small patches, they are considered part of the other urban environments. The intensity in use of these areas seems to be relatively low but is dependent on the exact location. (Harts, et al. 1999)

2.3.13 The outskirt
The outskirts as an urban environment are cannot be considered a city environment. There is low employment possibility, residential density and amenities density. The use of the area in general is often very low and will mainly consist of agriculture and nature zones. An example of such an urban environment would be the Midden Delfland. (Harts, et al. 1999)

2.3.14 Station area
In recent years, areas around stations have changed from only transport-based areas to high intensity areas with a mix of functions. This has shifted the attention of planners from only infrastructure based to infrastructure, quality of the surroundings and real estate possibility based (PBL, 2010). The train station, especially a central station, has become a destination point with restaurants, shops and office buildings.

The above-mentioned typologies show that there are many different kinds of urban environments that will in some way seem very similar to each other. The differences mainly lie in the density, use and form. The main conclusion to take from this is that the urban environment does not only include city environments. It also includes the more rural locations.

3. Movement space typologies

As defined in the introduction, movement space is designed to facilitate for movement through the network. In the previous chapter it was mentioned that Harts, et al (1999) considers infrastructure to be an urban environment. Yet, Carmona, et al. (2003) says infrastructure to be part of the public space networks, located in between the urban blocks, but instead call it movement channels. One can say that the network of movement spaces facilitates for movement between different urban environments, but at the same time, large movement spaces can be considered urban environments of their own. The typology and characteristics of a movement space will differ depending on the function(s) of the urban environment in which it is located. This part of the paper will define the different movement space typologies and the characteristics it holds depending on the urban environment it is located in.

3.1 The street

The street is designed to function as a thoroughfare from the buildings in which it is embedded to the other buildings or other parts of the town or city (Meyer, H. et al. 2012). This part of thoroughfare is mainly accommodated by the 'road' within the street. The street as an accumulation of parts accommodates for both movement as well as social activities (Carmona et al. 2003). For example, a sidewalk in front of housing can be used as a small outdoor seating area or the sidewalk marks the entrance to a shop. The structure and materials used to design a street is dependent on the use of the street. For that reason, some different types of street are explained further.

3.1.1 The urban main road

The urban main road acts as the vein of the city, allowing people to move in and out of the city and connecting different urban environments together. It is therefore focussed on easy movement of traffic. The street profile as shown in figure 1 is often very wide, the slow transport is separated from the fast transport and cars are often not parked on the main road. There will sometimes be a side road that allows for car parking (Bosch & Veenenbos, 2011).

3.1.1 The urban street

The urban street finds itself within residential and other functions such as shops, catering or offices. As a result, they become very lively and intensively used, especially during work hours. These streets are located in or close to the metropolitan or urban (sub)centre. The profile will therefore depend on the type of city you are in. For example, figure 3 shows an urban street in Rotterdam with a wide profile while an urban street in old city centres can also be very small (see figure 2). Within the profile, different transport modes tend to mix (Bosch & Veenenbos, 2011).

3.1.2 The residential street

The residential street is designed for quiet and stay, with the main movement going to the residences (see figure 4)People with all transportation types make use of the road, although many streets will also have a sidewalk in the profile. There will most often be parking spots available for residents and visitors. If these are not placed on the streets, they will be available in the plot of the house. These kinds of streets can be found in any residential environment but are mainly located in the lower density ones: urban residential areas, general residential areas and residential areas near green or industry (Bosch & Veenenbos, 2011).

3.1.3 The alley

The alley is a street with a very small profile and is usually paved from façade to façade (see figure FIXME). It is often not accessible to cars, but only to cyclists and pedestrians. An interesting characteristic of the alley is that it often creates a connection through a building block. It is therefore mainly used as a shortcut in the network and entrances to residences in metropolitan and urban (sub)centres. (Meyer, H. et al. 2012).

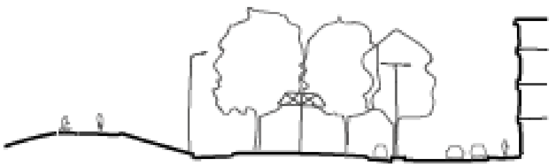


Figure 1: Westzeedijk, Rotterdam (recreation by author, original from Bosch & Veenenbos, 2011)

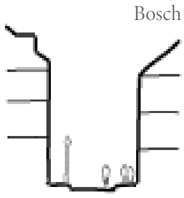


Figure 2: Rechtstraat, Maastricht (recreation by author, original from Bosch & Veenenbos, 2011)

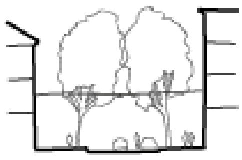


Figure 3: Witte de Withstraat, Rotterdam (recreation by author, original from Bosch & Veenenbos, 2011)

Figure 4: Zwanebloemlaan, Amsterdam (recreation by author, original from Bosch & Veenenbos, 2011)

3.2 The “laan”

The appearance of the “laan” started in the seventeenth and eighteenth century and provided access to the houses or companies that were located on it. The road itself was privatized and often had a board, specific rules and a “laan-master”. Since the “laan” often offered good parallel connections to the main roads, the city board negotiated to make them public. (Meyer, et al. 2012) The main characteristic of a “laan” is the row of trees on each side of the road (Figure 5) or the verge with a double row of trees in the middle (Figure 6). The laan has a very wide profile due to the space needed for the trees while at the same time allowing for a large amount of traffic. The laan is therefore used by many different kinds of transport, and often allows for parking on the side of the street (Bosch & Veenenbos, 2003).

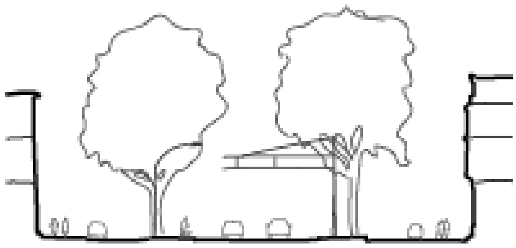


Figure 5: Mathenesserlaan, Rotterdam (recreation by author, original from Bosch & Veenenbos, 2011)

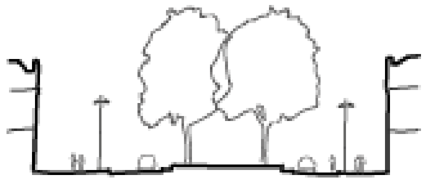


Figure 6: Stationsweg, Den Bosch (recreation by author, original from Bosch & Veenenbos, 2011)

3.3 The boulevard/ avenue

The avenue was designed as a straight-lined connecting- or arrival-road mostly used for important locations such as palaces, castles, farms or towns (Loyer, 1988). The boulevard started as both a defensive structure as well as with a recreational function. In their profile the boulevard has a very large width, with broad roads and promenades and large trees providing shade. Nowadays, both typologies are often used in the same way, as main arteries in metropolitan or urban (sub)centres, such as the Coolsingel in Rotterdam shown in figure 7. (Meyer, H. et al. 2012).

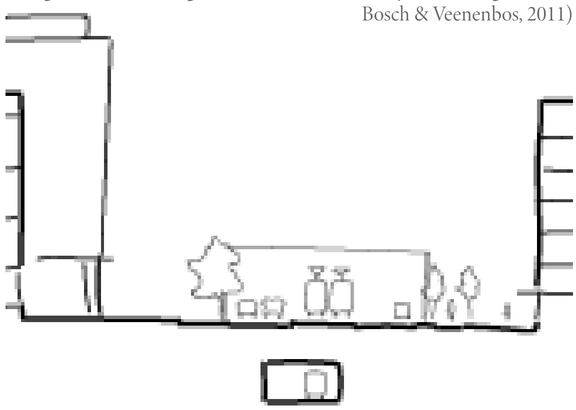


Figure 7: De Coolsingel, Rotterdam (recreation by author, original from Bosch & Veenenbos, 2011)

3.4 The canal

The canal is an excavated water feature that is often found in or around old urban centres. Most canals often have a symmetrical profile (see figure 8), with on both sides buildings and accompanying sidewalk, a road, and an embankment, with the water in the middle. The embankment often houses parking spots and trees. Asymmetrical canals were often used to get the goods from the canal into the buildings right away (Meyer, H. et al. 2012).

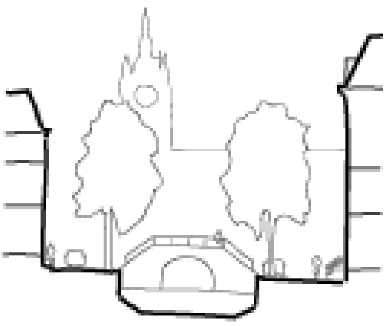


Figure 8: Oude Delft, Delft (recreation by author, original from Bosch & Veenenbos, 2011)

3.5 The moat

The Dutch word for moat, singel, signifies the water or road around a city, town or fortress. In the old cities, most of these places were later transformed to urban pedestrian promenades. They are also used as parts of the water network. Most moats are located in or close to metropolitan or urban centres, but still have a very large profile (figure 9). They give space to public transport, cars, car parking, and slow transportation. Most of the time, the borders of the water are characterized by large patches of green (Meyer, H. et al. 2012).

Figure 9: Noordsingel, Rotterdam (recreation by author, original from Bosch & Veenenbos, 2011)

3.6 The (urban) freeway

The freeway is often considered to be a separate part of infrastructure located outside of the city and connecting multiple cities to each other. The freeway as such is what Harts, et al. (1999) defines as an urban environment of its own. But this network of freeways has also made its way through the Dutch cities, following the example of the German and American freeways, but never as extravagant and they are never integrated with the surroundings. The Netherlands knows three different types of urban freeway: the ring-road, the parkway and the urban motorway. As shown in the profiles in figure 10 and 11, these freeways are separated from the other parts of the city either by lifting or lowering them or, in the case of the parkway, adding green borders next to the main roads (Meyer, H. et al. 2012).

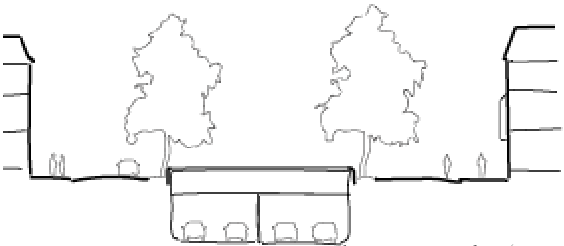


Figure 10: Maastunneltraverse, Rotterdam (recreation by author, original from Meyer, et al. 2012)

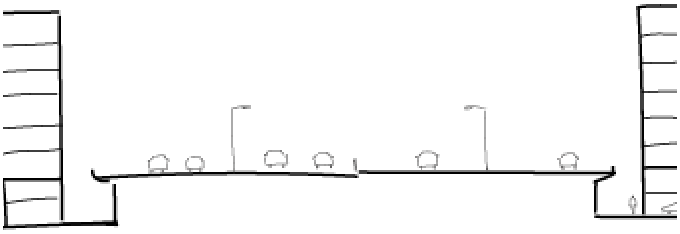


Figure 11: A10 West, Amsterdam (recreation by author, original from Meyer, et al. 2012)

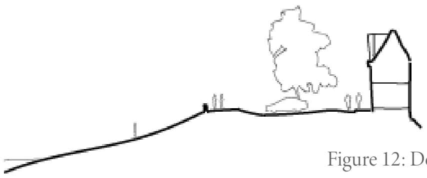


Figure 12: De Waaldijik, Zaltbommel (recreation by author, original from Meyer, et al. 2012)

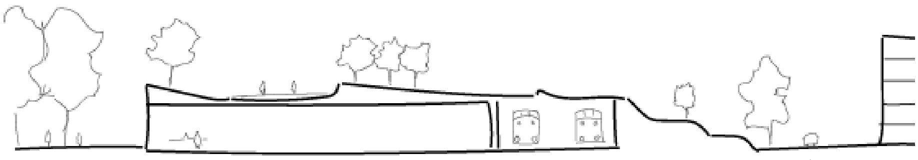


Figure 13: Het dakpark, Vierhavenstraat, Rotterdam (recreation by author, original from Meyer, et al. 2012)

3.7 The dyke

The dyke has always been built with the function of protecting land and urban environments from the water. But ever since dykes were built, they have been used as a movement space as the ground was a lot sturdier than the ground next to the dyke, and they are still used as a movement space since they create important axes in the urban network. In current times, dykes are not always easily recognisable, since the buildings and other structures are often integrated with the dyke (and sometimes even functioning as a dam), as can be seen in figures 12 and 13. (Meyer, H. et al. 2012).

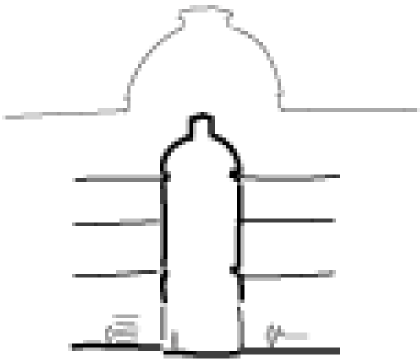


Figure 14: De passage, Den Haag (recreation by author, original from Meyer, et al. 2012)

3.8 The passage

The passage is an interesting kind of movement space that might not be recognised in a standard satellite map on, for example, Google Maps. Like the alley, they offer a short-cut through the larger building blocks, but in this case, they are covered as they pass through buildings. Throughout the years, the passage started to play a more important role in the urban structure of metropolitan and urban (sub)centres and the profile has become larger, as shown in figure 14. Still the profile focusses on pedestrian movement, with connections to the entrances of shops, restaurants and housing inside the building. (Meyer, H. et al. 2012).

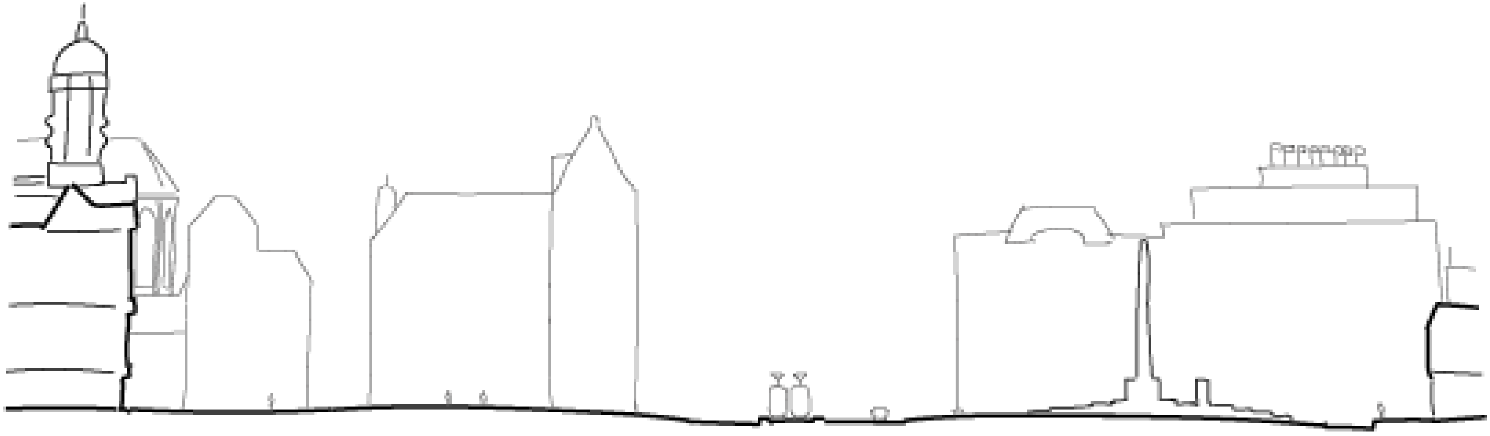


Figure 15: De Dam, Amsterdam (recreation by author, original from Meyer, et al. 2012)

3.9 The square
Carmona, et al. (2003, pg. 178) describes the square as being a static space, where there is less sense-of-movement. But one could also say that the movement becomes more dynamic, as people move in different directions to the different streets connected to the square, while at the same time movement is slowed down due to the larger dimensions of the square compared to the street (see profile in figure 15). The movement that happens on a square can differ from day to day, as the square is designed to accommodate day to day changing activities and will also depend on the location of the square. The square is often used as a collection space for people and social activities while at the same time accommodating different kinds of amenities, and will therefore be located in metropolitan, urban, low-urban or amenity centres. (Meyer, H. et al. 2012).

3.10 The park
The design of a park is often focussed on the addition of nature to the city as well as accommodating social interaction and is therefore an important type of public space for the city. Just like the square, a park is often seen as a static space, but in the meantime one can argue that a park is a more attractive space for movement, especially when using soft transportation modes. In saying that, a park can be designed as an urban environment of its own as urban green space or can be integrated in other kinds of urban environment, being either residential or central space. A strip park is often used next to other types of movement space in residential areas (both in high density as well as lower density environments) to split the area in smaller neighbourhoods. (Meyer, H. et al. 2012).

This list of movement spaces gives an interesting first insight in the broadness of the concept. As the definition in the introduction states, the spaces are clearly based on the provision of movement within space. Yet they also clearly show that most often movement space coincides with social space or other functions, and movement is hardly ever its soul function.

4. Conclusion

Movements spaces, as defined at the start of this paper, are spaces that provide for movement through the public space network of urban environments. These urban environments are shaped as such that they facilitate the entanglement of social needs and states of nature applicable to a specific geographical location. Harts, et al. (1999) derives from this the different intensities of use and main functions of an urban location to define possible typologies. This resulted in a list of fourteen different urban environments, ranging from metropolitan to outskirts and from high density mixed use to low density residential. These urban environments are connected and partially structured through movement spaces in the public space network. Most of these movement spaces create a sense-of-movement (such as the street, boulevard or freeway) while others seem more static but are actually very dynamic (such as the square or park). The amount of movement as well as the type and intensity of movement is dependent on the urban environment in which the movement space is situated. Most typologies of movement space can be applied to several urban environments but will have different points of interest and designs.

As said in the introduction, Carmona, et al. (2003) claims that movement space will often have movement as its soul function. Yet with this essay it was found that a movement space will hardly ever be based on movement alone. Most movement spaces seem to also include some other function. For example, creating attractive living spaces by adding green and water, adding interactive spots for social engagement or the space can be focused on a specific destination. The design of the movement space will be thus that it suffices to this other function as well as easy movement for people.

4.1 Limitations and future research
These definitions and typologies of both urban environments as well as movement spaces in this paper are derived from Dutch literature since this is

where I am personally located. This does mean that there are most likely additional environments and movement spaces, or that the elements in movement space typologies differ in other locations. It is therefore important that research. Another possible future research could be to go more into detail on the movement spaces themselves: what are the different design elements used in the space to supply for the demands of the environment. A last good addition to the research would be to research what elements are easily changeable or can be changed to influence the transportation system transition.

Bibliography

Bertolini, L., le Clerq, F. (2002). Urban development without more mobility by car? Lessons learned from Amster dam, a multimodal urban region. Environment and planning, 35, 575-589.

de Boer, N. (1996). De randstad bestaat niet. De onmacht tot grootstedelijk beleid. NAi uitgevers, Rotterdam.

Bosch, J. Veenenbos, H. (2011) Straten maken, hoe ontwerp je een goed straatprofiel. Martien de Vletter, SUN, Zeist.

Carmona, M. Tiesdell, S. Heath, T. Oc, T. (2003) Public places, urban spaces. 2nd ed. Architectural Press. New York

Cronon, W. E. (1996). Uncommon Ground: Rethinking the Human Place in Nature, New York, W. W. Norton & company.

Senecal, G. (2007) Urban environment: mapping a concept. Environment urbain/ urban environment, 1. https://journals.openedition.org/eue/826

Harts, J.J., Maat, C., Zeijlmans van Emmichoven, M. (1999) Meervoudig stedelijk ruimtegebruik, methode en analyse. Delft University Press.

Hoekveld, G.A., Jobse R.B., van Weesep J., en Dieleman F.M. (1981) Geografie van stad en platteland in de westerse landen. Haarlem (Romen).

Loyer, F. (1988). Paris nineteenth century. Architecture and urbanism. Abbeville press, New York.

Lussault, M. (2003). « Urbain », dans LUSSAULT, M. et J. LÉVY (dir.). Dictionnaire de la géographie et de l'espace des sociétés, Paris, Belin, p. 949-951.

Meyer, H. de Josselin de Jong, F. Hoekstra, M. (2012) Public space typologies, using definition of movement spaces to select from 'het ontwerp van de openbare ruimte'

Newman, P.W.G. & Kenworthy, J.R. (1991) Transport and urban form in thirty-two of the world's principal cities. Transport Reviews, 11:3, 249-272, DOI: 10.1080/01441649108716787.

Oxford (2020a) Urban. In Oxford Dictionary. Retrieved, November 20, 2020, from https://www.oxfordlearnersdictionaries.com/definition/american_english/urban

(2020b) Environement. In Oxford Dictionary. Retrieved, November 20, 2020, from https://www.oxfordlearnersdictionaries.com/definition/english/environment?q=environments

Planbureau voor de Leefomgeving (PBL). (2010). De staat van de ruimte 2010: de herschikking van stedelijk Nederland. https://www.pbl.nl/publicaties/De-staat-van-de-ruimte-2010

APPENDIX 3: REFERENCE CASE STUDIES

REGIONAL SCALE

LONDON NATIONAL PARK CITY

The national park city concept resorts from the idea of the city acting as a park. It provides space for initiatives from different actors such as individuals, cooperations, companies, government, etc. Bottem-Up and Top-Down enitiatives complement eacht other.

Starting from the potentials and qualities of a space, the small scale green structures together create a megastructure consistent of different types of green spaces.

SCALE

Regional / City: The scale of the project is on the whole city of londen, yet the size of the city of London is comparable to the region of Haaglanden.

INTERESTING CONCEPTS

- Using top-down as well as bottum-up initiatives to soften the city.

LIMITATIONS

- Not many documents have been found on this concept of the national park city and how London is planning on achieving this green goal.

Figure 6-1: WATG modular 'Green Block' design for London National Park City (WATG, 13 oct 2017) https://www.watg.com/green-block-will-help-make-london-the-worlds-first-national-park-city/

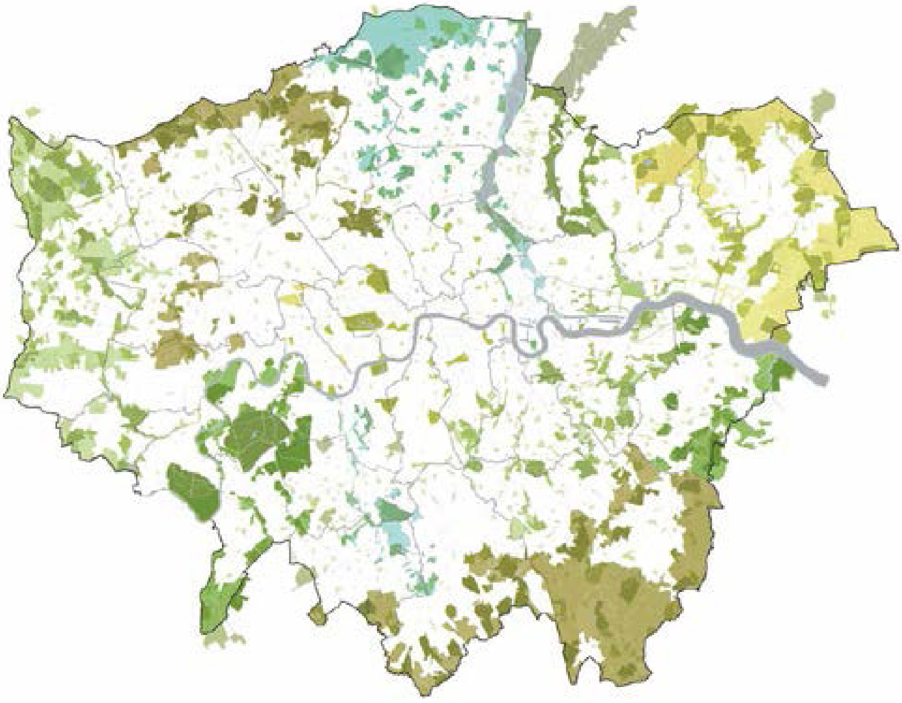


Figure 6-2: London Green Grid (Zuid-Holland

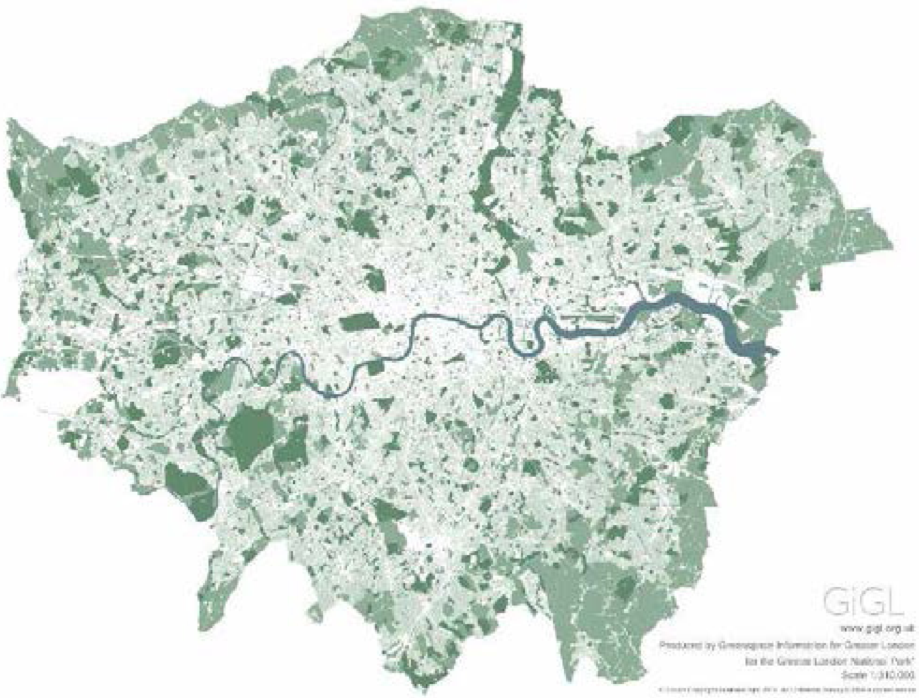


Figure 6-3: London National Park City (Zuid-Holland

CITY SCALE

ROME REFORESTED

By B+B

The project uses the concept of taking the mobility transition towards new sustainable models as a means to gradually develop nature in the city by gradually planting 3 million trees. they will be planted along the streets in the next decades.

It considers a long term strategy developed in different phases. The first phase starts with planting the trees along consular roads which are fundamental connections between the inner city and the surrounding area. They are the most used streets by cars and introducing threes here will have direct benefits on the surroundings. It improves the quality of the air, reducing urban heat islands and mitigating flooding events.

SCALE

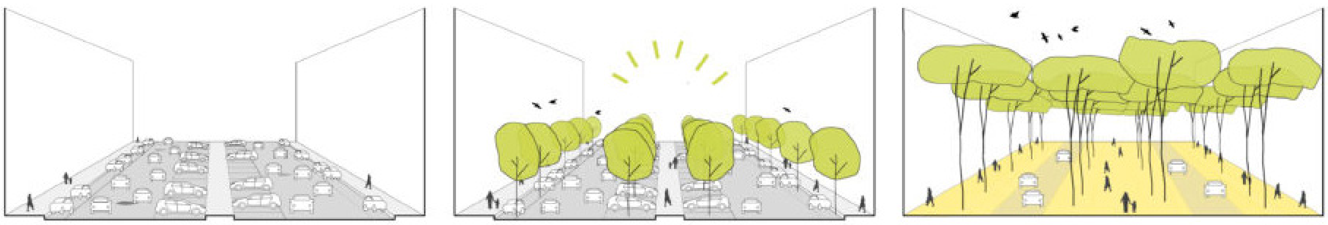
City: design concept for the city of Rome.

INTERESTING CONCEPTS

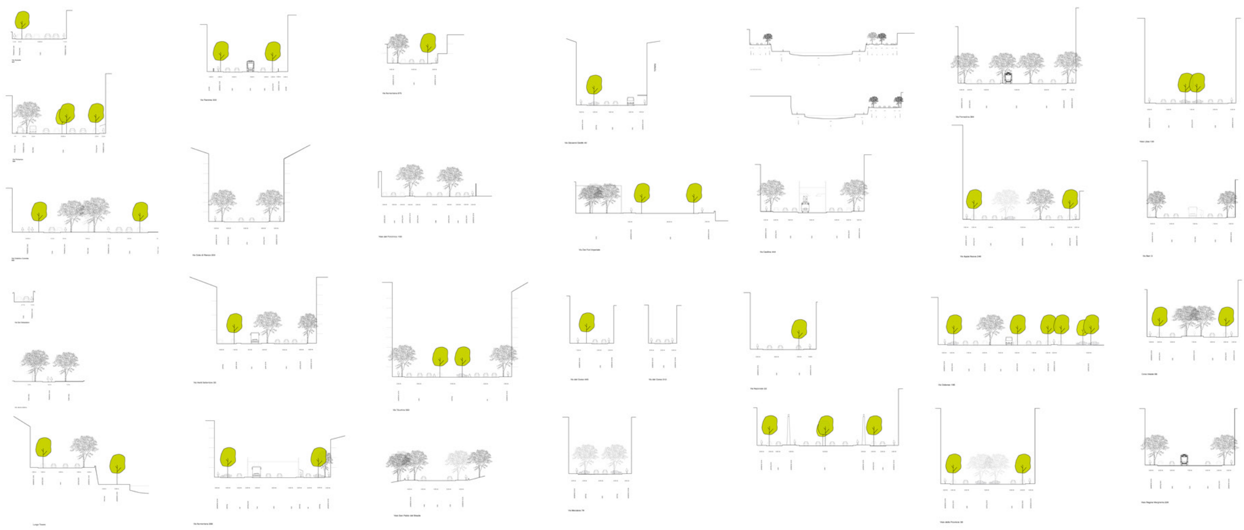
- Phasing of the change in streets following mobility transition.
- Example sections of adding green to different types of streets.

LIMITATIONS

- Main focus is adding trees to the street for ecosystem services. There doesn't seem to be a biodiversty (or ecological) basis yet.



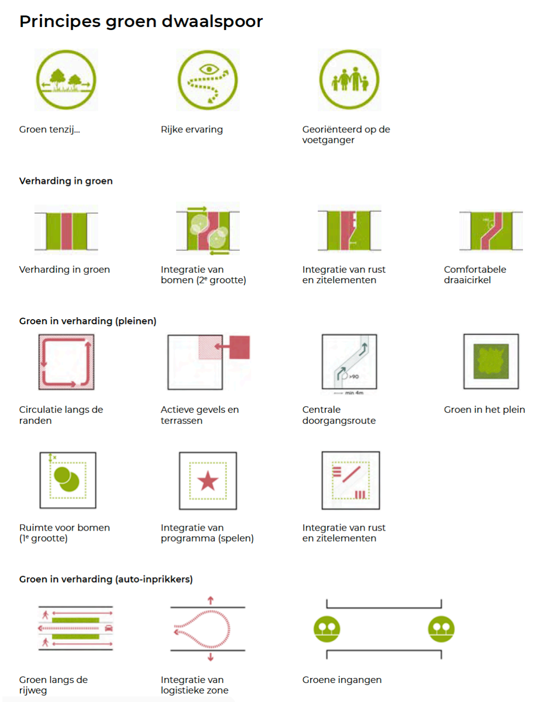
Today   Tomorrow   in 20 years



MERWEDEKANAALZONE CLIMATE PROOF

The public space of the Merwedekanaalzone is designed for pedestrians, with a green appearance. As such the green provides an integral solutions for climate adaptivity and circularity, minimizing heat stress and watersensitivity. This is realized by removing the car from the public spaces in the neighbourhood. Cars are parked in the garages located at four entrances into the neighbourhood fromt the main road (Europalaan). Bikeparking in the public space is also minimized, and the infrastructures below ground is organised such that there is as much space for trees and other vegetation as possible.

Part of making the area more green is the mindset of 'green unless..' which includes two main principles; pavement within green and green within pavement. The first focusses on realizing green at the facade when there is mention of mainly residential function at the ground floor. The second concept is used when there is a high number of (semi-) public functions at the ground floor, where pavement runs along the facade and green zones and lines of trees are placed within.



SCALE

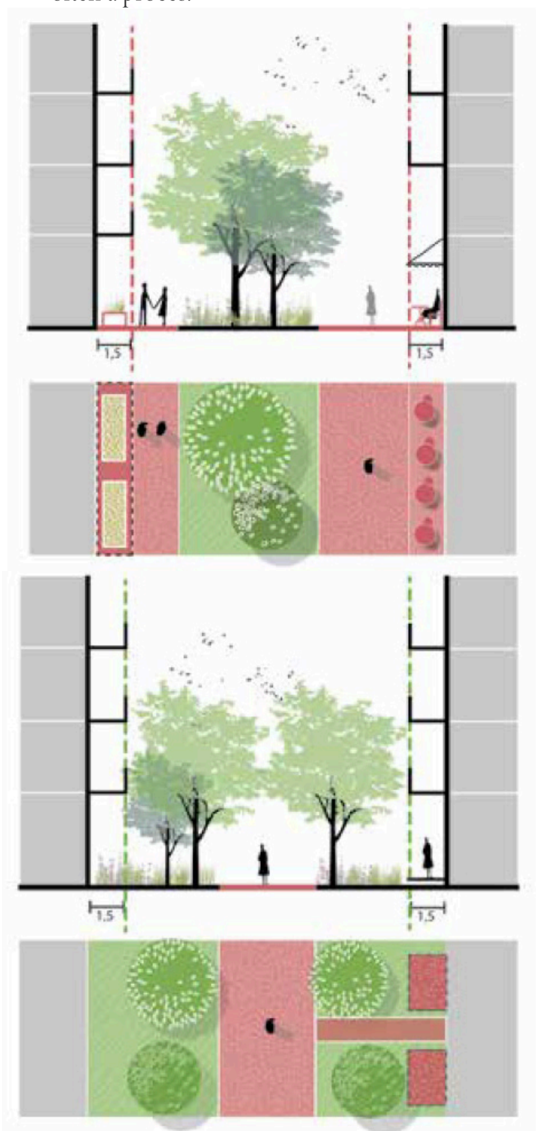
Neighbourhood: The Merwedekanaalzone is located in the city of Utrecht.

INTERESTING CONCEPTS

- Showing concepts of what is possible with streets when there are no cars.
- Creating a neighbourhood green structure with different characters.

LIMITATIONS

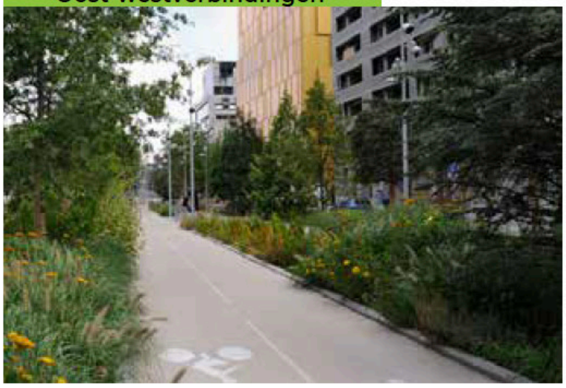
- Fully new design enables the removal of cars from the inner public spaces from the start, which is often a proces.



Stadslanen

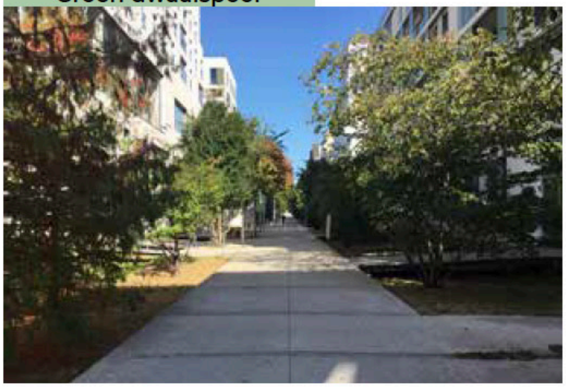
Merwedepark

Oost-westverbindingen

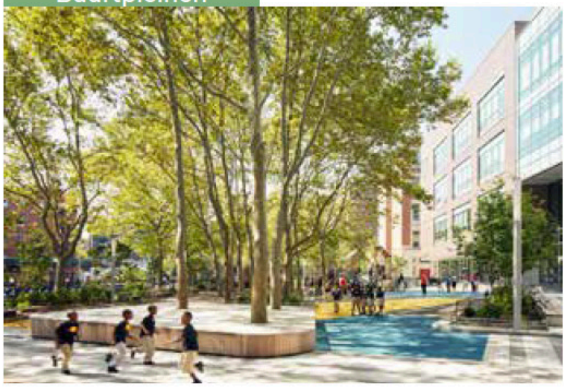


Stadspleinen

Groen dwaalspoor

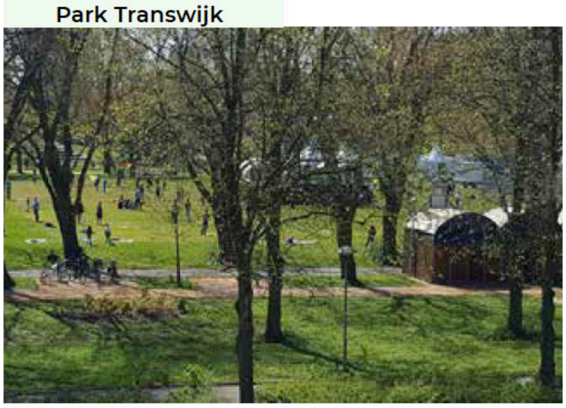


Buurtpleinen



Auto-inprikkers

Park Transwijk



BARCELONA SUPERBLOCK

The Barcelona superblock makes use of the block structure of the city to make neighbourhoods of nine blocks in which the car access is limited. As such more space is created for pedestrians and cyclists and open space for the residents to meet. It also helps achieve the aim of redusing air and noice pollution produced by vehicles going through.

A study carried out on the city showed that creating these superblocks will help reduce the private vehicle use by 230000 per week as people switch to shared and slow transport.

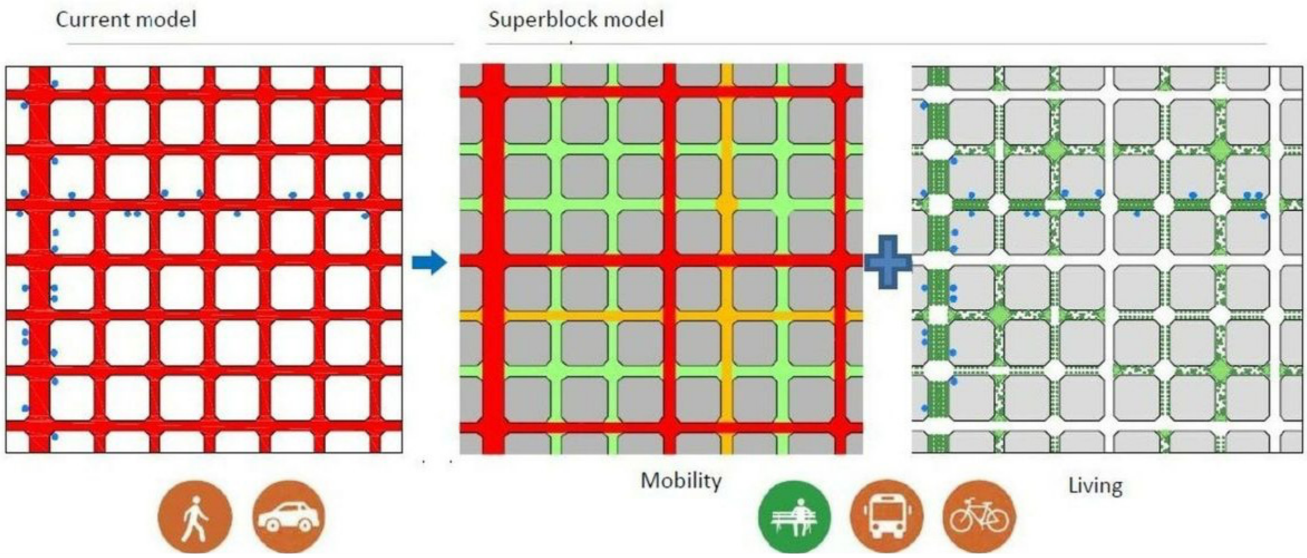
SCALE

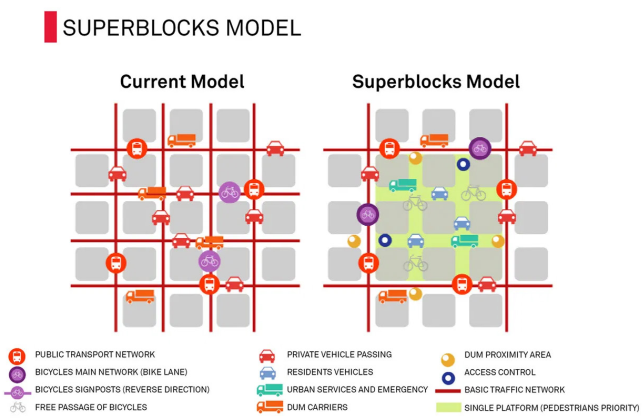
City/neighbourhood: Working with the part of Barcelona that has a very clear square structure.

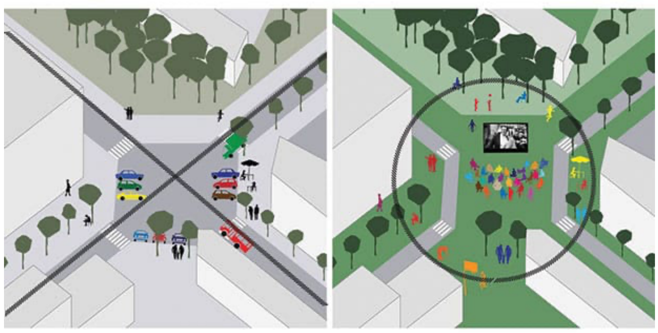
INTERESTING CONCEPTS

- Reorganizing the mobility system in order to make more space for people and green by eliminating cars from some roads and creating hirarchy in roads.

LIMITATIONS







Rethinking urban public space: moving from linear and uni-purpose to dynamic spaces with diverse uses


SEAT
ALHAMBRA
Service
IBIZA
Taller

STREET SCALE

VRIJSTRAAT

The 'Vrijstraat' is a concept where the street is redesigned together with the residents that live there. They create more fun, livable and green streets by starting a car sharing system with all residents in the street. As such, most of the cars that are now parked in the street are removed, leaving more space for green and space for the residents. They are currently working with pilots in nine streets in The Hague.

SCALE

Street: working with specific streets in The Hague

INTERESTING CONCEPTS

- Working together with the residents
- Creating a car sharing system for the street as a starting point to create more space in the street.

LIMITATIONS

- Since they are currently working on pilots, no conclusions can be taken on the outcome.

FULTONSTRAAT

COPERNICUSSTRAAT

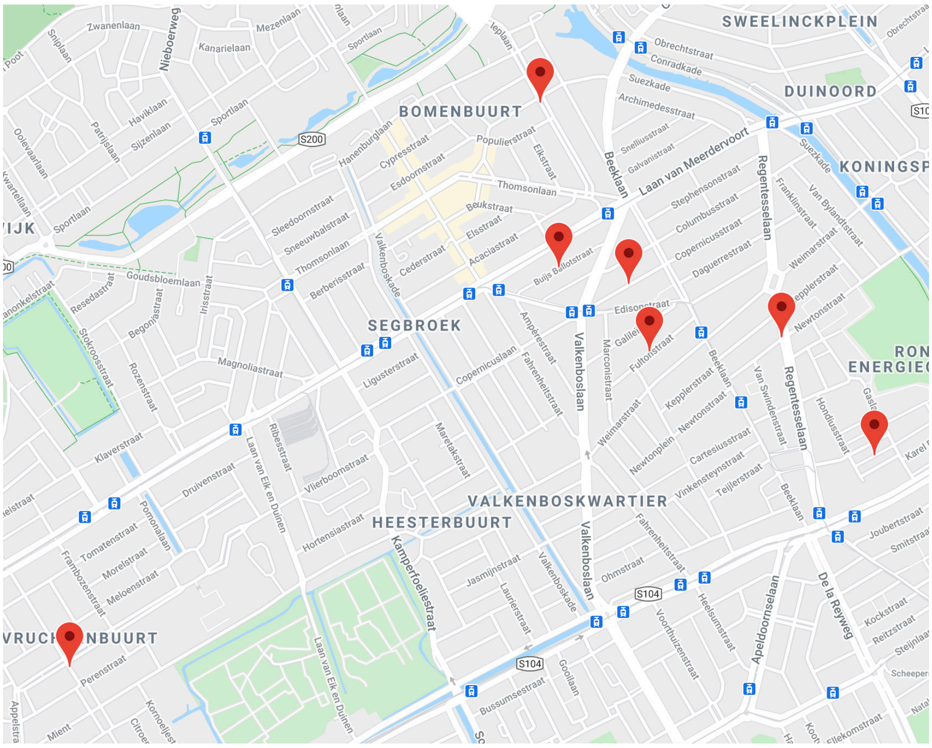
BUIJS BALLOTSTRAAT

ABRIKOZENSTRAAT

IEPLAAN

NOORWITZSTRAAT

NEWTONSTRAAT



GREY TO GREEN, SHEFFIELD

The city of Sheffield is redesigning streets as to create more space for pedestrians and green. Redesigning the layout of the streets reduce vehicle speeds and create this more attractive environment for slow transport together with adding vegetation. They are using a Sustainable Urban Drainage System (SUDS) in the designs. the SUDS is incorporated with meadows, rain gardens, and other vegetation. The soil and plants in the drainage system filter out pollutants before the water ends up in the river. The plants are chosen as to create seasonal meadows with large biodiversity.

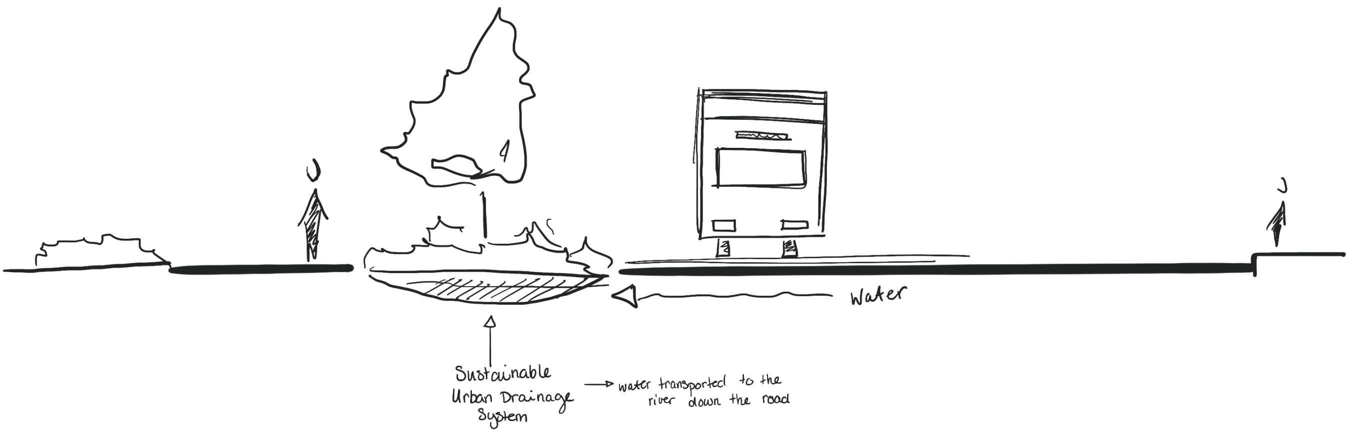
SCALE

Street: pedestrianizing streets in Sheffield.

INTERESTING CONCEPTS

- Making space for vegetation in the street and integrating into this a water retention and run off system.
- Using local species of vegetation.

LIMITATIONS



Artistic impression
Image courtesy of Sheffield University

AMSTERDAM, DE PIJP

600 parking spots have been removed from the streets of the Frans Halsbuurt in the Pijp, Amsterdam. The new design of the streets is created with input from the residents. It resulted in a compilation of streets where, in all but one, the car is a guest (max. 15 km/h). The streets will keep a few parking spots, dedicated to loading and unloading, and for disabled people. As a result, it was possible to make the streets a lot greener than before.

SCALE

Street & neighbourhood: Main changes occur in the street with input from residents, while car parking is solved on neighbourhoosd scale.

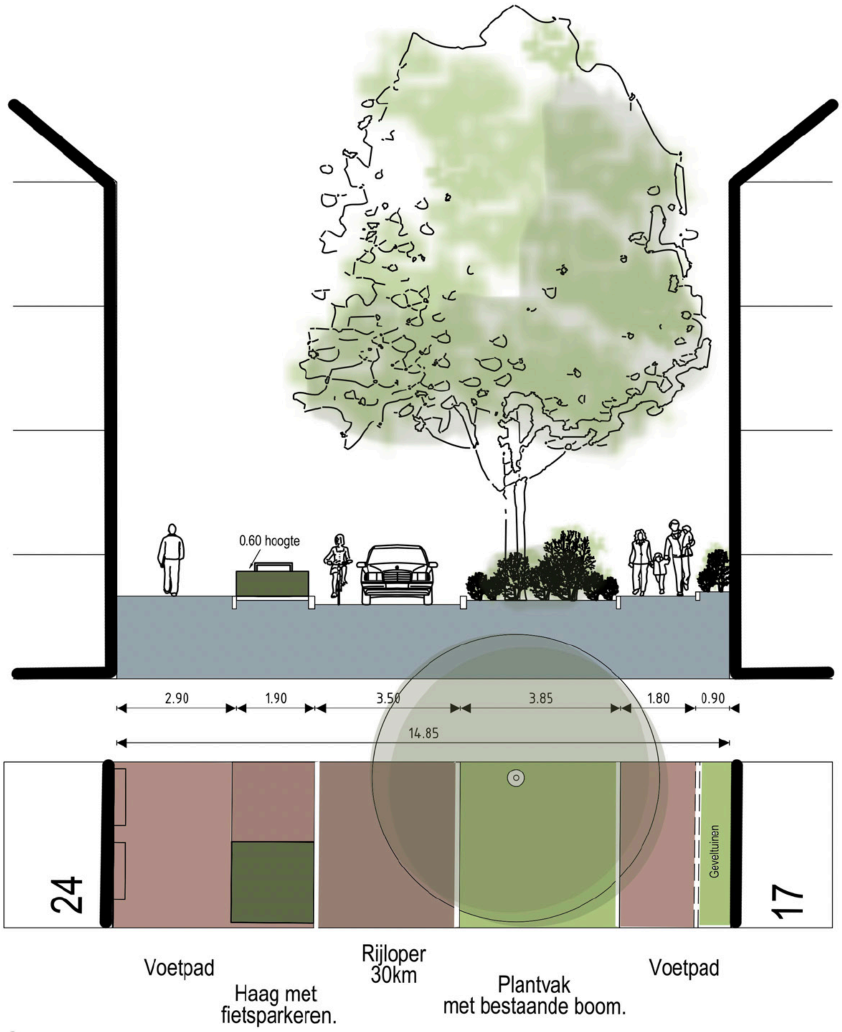
INTERESTING CONCEPTS

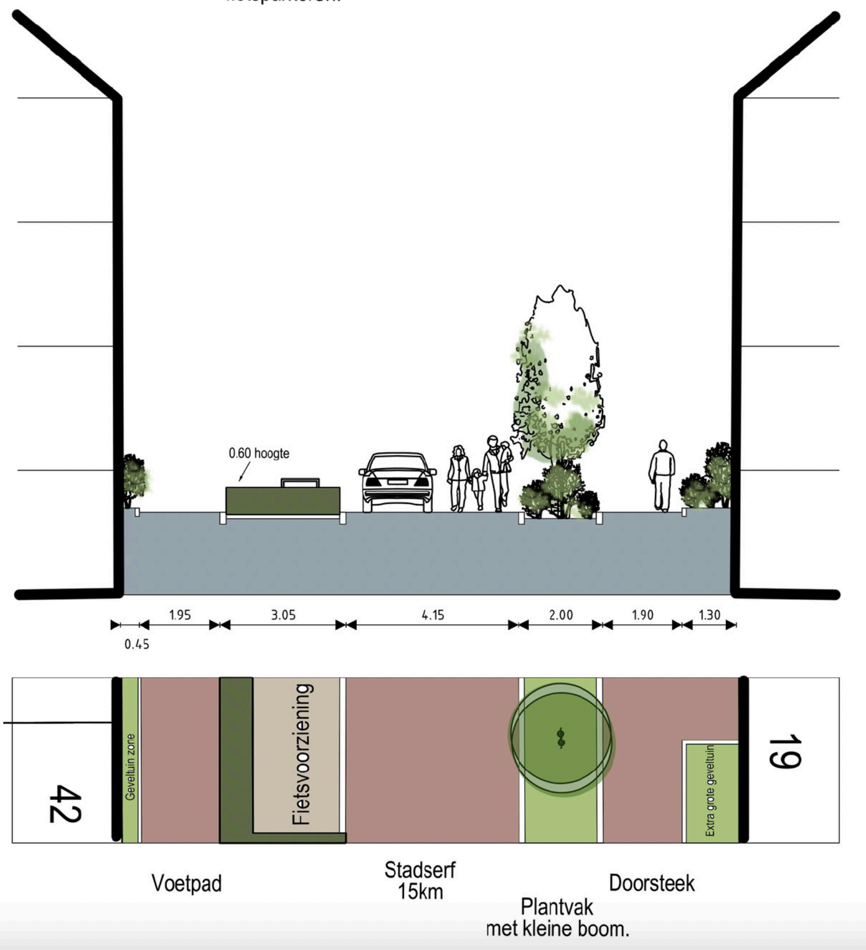
- Placing cars in existing parking garages in the neighbourhood
- Residents assist in the street design

LIMITATIONS

- Providing parking spots in the parking garage results in higher car use since there is always a parking spot available, which was an uncertainty before.

Overweel, J. (2019) Frans Halsstraat: pionieren met autoluw buurtontwerp. De Pijp Krant online https://pijpkrant.amsterdam/de-pijp-krant/news/frans-halsstraat-pionieren-met-autoluw-buurtontwerp/?no_cache=1&tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Baction%5D=detail&cHash=aa5b29647b60847cf9ecedc3aeb02782


0.60 hoogte
2.90
1.90
3.50
3.85
1.80
0.90
14.85
24
Geveltuinen
17
Voetpad
Haag met
fietsparkeren.
Rijloper
30km
Plantvak
met bestaande boom.
Voetpad


0.60 hoogte
1.95
3.05
4.15
2.00
1.90
1.30
0.45
42
Geveltuin zone
Fietsvoorziening
Extra grote geveltuin
19
Voetpad
Stadserf
15km
Doorsteek
Plantvak
met kleine boom.

Graduation thesis of an urban designer