RAIN,
catch it if you can
Anne Witteveen
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Colophon

Rain, catch it if you can

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Acknowledgment

This graduation thesis forms the final product for the master Urbanism at the Delft University of Technology, Faculty of Architecture and the Build Environment. This research is made in order to receive the title of MSc (Master of Science).

This result would not have been possible without the help of other people. First I would like to thank my first mentor, Fransje Hoimeijer. Her knowledge about rain water, subsoil and research was valuable. Also I would like to thank my second mentor, Teake Bouma for helping me with my analysis. Thanks for his constant repetition of certain subjects, I finally had my eureka moment about what he meant and how this could contribute to the research.

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Preface

Water is a fascinating element of nature. The presence of water brings both pros and cons to a city, and plays the role of best friend and enemy in one. Another reason why water is such a fascinating element is the ever continuing need of water in our lives. Personally, it is interesting to combine my background as landscape designer, my master in urbanism and an interest in water engineering in this graduation project. Thereby, I think it is an added value when three disciplines come together. During my studies I frequently used water in my projects and design and I tried to integrate design and technique. One of the challenges I faced in combining design and technique is that the water system often belongs to the civil engineers. In order to create an added value for the project location, while working with the water system, I want to open up both the field of urban design and the field of civil engineering.

I am well aware that a graduation project can give direction to a future career. That it shows a kind of focus/specialism that is more specific than urban design. I want to use this graduation project to expand my social and professional network and to gain knowledge about urban water systems in relation to climate change.

I hope you will enjoy reading this thesis as much as I did making it.

Anne Witteveen, Delft, December 2014.
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Summary

Due to climate changes, we can expect more heavy rainfall, as in the summer of 2014. Especially in the urban environment, these heavy showers, with plenty of rain fall in a short time period, causes a lot of inconvenience. Due to the many paved surfaces, the water can not infiltrate into the soil, and needs to be drained through the water system of sewer pipes and pumps. This system can not handle this peak load. With pluvial flooding and flooded basements as a result. But flooding is not the only climate phenomenon that affects the city. Through the many paved areas and the buildings, the average temperature in the city is higher than in rural areas. This higher temperature has an influence on the health of people and increases the evaporation with the effect of desiccation. Based on this the question that remains is: How can the city adapt to the changing weather conditions?

For this thesis, the neighbourhood ‘het Oude Westen’ in Rotterdam is used as a case study. This neighbourhood has a high urban density, with a surface of which 51% is paved. The district has been designated as an area with both a rainwater assignment as a heat problem.

In order to address the rain water problem and to disembarage the water system, the terms; catch, store, discharge and infiltrate are used. When the rain water can be collected and retained, this creates a reduced pressure on the water system. Infiltration of the soil ensures that the soil remains hydrated and more resistant to drought. City heat can be combated with greenery and water. An increase of 10% green surface area lowers the average temperature of 1°C. However, to solve both the water issue as the heat problems all areas in the city are of interest. But every surface has its specific owner, with its own interests and concerns.

In this thesis the hypothesis has been posed that there is one scale level missing: the intermediate scale. This scale includes all stakeholders and surfaces that are private or public, and encourages collaboration between stakeholders that are related to the different surfaces. Climate interventions should therefore always be location specifically to connect with these stakeholders.

To indicate which actors, related to which surfaces should work together, there are three types of collaboration identified:

- building related collaboration where both owner and user of the property collaborate.
- transition collaboration where both owner and user of the property and public space collaborate.
- consulting collaboration where the owner of the public space consults the user for input and wishes.

From analysis, all surfaces and property relations that are related to the intermediate scale are identified and taken care of. An important conclusion is that the morphology and orientation of the district forms the base of the water and heat problems. One of the assumptions is that the urban structure of roads and buildings stays intact. The solution should therefore be found in the change of the surface, increasing the infiltration possibilities and softening the surface.

To give an idea of the possibilities, a toolbox is created with tools that respond to the water and heat problems and matches with the three forms of cooperation and the indicated areas. A distinction is made between generic properties such as zoning and building generation, and location-specific properties, such as road profile and usage.

These tools are projected at two locations in the district: Henegouwerlaan and Bajonetsstraat. Both locations have a different lay out and function, but also other generic and specific features. For both sites, the impact on the water assignment is calculated for different ways of situations: when interventions are done in the private and collective surface and when they are performed only in the public space. The contribution to the water assignment is also investigated for a situation in which all surfaces and stakeholders work together to soften the neighbourhood and make it greener. 30 % can be solved.

The question remains how to involve residents. Therefore a participatory planning is made.
Samenvatting

Door klimaat veranderingen kunnen we vaker hevige regenbuien verwachten, zoals in de zomer van 2014. Vooral in de stedelijke omgeving zorgen deze hevige buien, waarbij in korte tijd veel regen valt, voor veel overlast. Door de vele verharde oppervlakten kan het water niet in de bodem zakken, al het water moet via het watersysteem van riool buizen en pompen worden afgevoerd. Dit systeem kan deze piekbelasting niet aan, met overstromingen en ondergelopen kelders tot gevolg. Maar wateroverlast is niet het enige klimaat verschijnsel dat de stad treft. Door het vele verharde oppervlak en de bebouwing is de gemiddelde temperatuur in de stad hoger dan op het platteland. Deze hogere temperatuur heeft invloed op de gezondheid van mensen en vergroot het percentage verdamping met verdroging tot gevolg. Hoe kan de stad zich aanpassen aan de veranderende weersomstandigheden?

Voor deze thesis is de wijk het Oude Westen in Rotterdam als casus gebruikt. Deze wijk heeft een hoge stedelijke bebouwingsdichtheid waarvan het oppervlak voor 51% verhard is. De wijk is aangewezen als een gebied met zowel een regenwater opgave als een hitte probleem.

Om het regenwater probleem aan te pakken en het watersysteem te onlasten, wordt er gebruik gemaakt van de termen; opvangen, vasthouden, afvoeren en infiltreren. Wanneer het regenwater kan worden opgevangen en kan worden vastgehouden, zorgt dit voor een verminderde druk op het watersysteem. Infiltratie in de bodem zorgt ervoor dat de bodem gehydrateerd blijft en beter bestand is tegen droogte. Stadshitte kan met groen en water bestreden worden. Een toename van 10% groen oppervlakte verlaagt de gemiddelde temperatuur met 1°C. Echter, om zowel de wateropgave als het hitte probleem aan te pakken zijn alle oppervlakten in de stad van belang. Maar ieder oppervlak is van een andere eigenaar met eigen interesses en belangen.

In deze thesis is de hypothese gesteld dat er een schaalniveau mist: de tussenschaal. Deze schaal omvat alle stakeholders en oppervlakken die privé of openbaar zijn en stimuleert de samenwerking tussen oppervlakten en stakeholders. Klimaatinterventies moeten dan ook altijd locatiespecifiek zijn om aan te sluiten bij deze stakeholders.

Om aan te geven welke partijen er bij welk oppervlak samen moeten werken, zijn er drie typen samenwerking geïdentificeerd:

- gebouw gerelateerde samenwerking: tussen eigenaar en bewoner van de panden.
- overgangssamenwerking: tussen de eigenaar van de openbare ruimte en de eigenaar en bewoner van de panden.
- participatiesamenwerking: de eigenaar van de openbare ruimte betrekt de gebruiker bij plannen en ideeën.

Vanuit analyse zijn alle oppervlakten en eigendomsverhoudingen, die gerelateerd zijn aan de tussenschaal, geïdentificeerd en behandeld. Een belangrijke conclusie is dat de morfologie en de orientatie van de wijk de basis vormen van de water- en hitte opgaven. Een van de uitgangspunten is dat de stedelijke structuur van wegen en gebouwen intact blijft. De oplossing moet dus worden gezocht in het veranderen van het oppervlak, vergroten van het infiltreerbaar vermogen en het verzachten van het oppervlak.

Om een beeld te schetsen van de mogelijkheden is er een toolbox samengesteld met tools die inspelen op het water- en hitte probleem en tevens aansluiten bij de drie samenwerkingsvormen en de desbetreffende oppervlakten. Er is onderscheid gemaakt tussen generieke eigenschappen, zoals bezonning en bouwgeneratie, en locatiespecifieke eigenschappen, zoals weegprofiel en gebruik.

Deze tools zijn geprojecteerd op twee locaties in de wijk: de Henegouwerlaan en de Bajonetstraat. Beide locaties hebben een ander uiterlijk en functie, maar ook andere generieke en specifieke eigenschappen. Voor beide locaties is gekeken wat de invloed op de wateropgave is wanneer alleen interventies worden gedaan op het private en collectieve oppervlak en wanneer ze alleen in de openbare ruimte uitgevoerd worden. Daarnaast is gekeken wat de bijdrage kan zijn wanneer alle oppervlakten en stakeholders samenwerken om de wijk te verzachten en te vergroenen, 30% van de huidige wateropgave kan worden opgelost.

De vraag blijft hoe bewoners te betrekken. Hiervoor is een participatie planning opgesteld.
Reading guide

This thesis is divided in 9 chapters:

1. Problem field
2. Approach
3. Theoretical framework
4. Rotterdam
5. Oude Westen
6. Soften Oude Westen
7. Two locations
8. Participation planning
9. Reflection

The first chapter describes the problem field where this thesis is about. It also states the problem statement and the formulated hypothesis.

In the second chapter the methodology and research questions can be found. Together with the project aim, this results in the approach for the graduation research.

Chapter three contains the theoretical framework. A literature review on the topics of adaptation and collaboration is shown.

Rotterdam is the city that is focused on. The city policy regarding rain water is mentioned in chapter four. The performed case study compares the city policy to the attitude in conducted rain water projects.

Chapter five presents the neighbourhood analysis of the neighbourhood Oude Westen.

Chapter six describes both vision and masterplan for the neighbourhood, using the concept of softening the surface.

Chapter seven is a showcase in which two location are elaborated regarding stakeholders, water system and contribution in lowering the current water assignment of the neighbourhood.

The eighth chapter relates to the participation planning, how to engage the individual.

In the last chapter, chapter nine, the conclusions for the research, recommendations and a reflection on the research.
Problem field
Normally the Dutch summers are warm, about 25°C. Occasionally there is some rain fall or thunder, but the summer month August in summer 2014 was nothing of this. It was really wet and the temperatures were more like the autumn standards. Heavy rainfall, together with thunder and hail [fig.1], places this summer in the top ten wettest summers ever recorded in the Netherlands. But why was this summer so different from the average summer?

Figure 1: Photo collage wet summer of 2014
Climate change

The wet summer weather of 2014 is related to climate change. The changing weather conditions are the noticeable effects of climate change. But what is climate change and what are the effects the world needs to deal with?

Climate change

Climate change is defined by the United Nations Framework Convention on Climate Change (UNFCCC) as ‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods’ (Ministry for the Environment, 2010).

The climate is changing, it always has been, it is a natural variation (Hooimeijer and Van der Toorn Vrijthof, 2008), but there is scientific evidence that the human activities have increased this natural variation by CO$_2$ gas emissions and exhaust fumes. Human influence on the climate system is clear, the event of climate change is irreversible (IPCC, 2013).

The CO$_2$ emissions and exhaust fumes create an extra layer underneath the ozone layer. Solar radiation is reflected at the surface of the earth. Normally this warmth is released into space, but this extra layer of fumes makes the warmth to reflect back to earth. This is causing the earth to warm up (Ministry for the Environment, 2010). This warming of the globe is causing, for example, earlier introduction of spring events and pole ward shifts in plant and animal species (IPCC, 2013).

Changes in several aspects of the human health system have been related to recent warming such as heat related mortality due to the heat island effect and infectious disease vectors (IPCC, 2007). Global warming is also causing more extreme weather- and climate events [fig.3]. The number of cold days and nights will decrease and the number of warm days and nights will increase all over the globe [fig.2].

Changing weather conditions for the Netherlands

A possible scenario for the Netherlands in 2050 is made by the national weather institute KNMI and it defines the upcoming weather changes (KNMI):

• The winter will become wetter and the amount of extreme precipitation will increase (water surplus)
• The amount of heavy precipitation in the summer will increase (water surplus).
• Heat waves will occur more often and periods of drought will increase (water shortage).
• Warming up will continue, this will cause softer winters and warmer summers (urban heat).
• The sea level will continue to rise.

Moreafter, the phenomena of water surplus, water shortage and urban heat island effect are discussed.
(rain)Water surplus

Rain. We have cycled through it, we have got wet, we jumped and splashed in puddles on the street and car wipers can sometimes not even catch up. Although some people say: 'rain, it is good for the garden', for most of us it is just an inconvenient weather event, but beside personal discomfort it is also threatening our lives on a larger scale.

The water system cannot cope with the huge amounts of (rain) water. The system cannot discharge it, the soil cannot absorb it, it remains on the surface of the city [fig.5, 6] (De Urbanisten and Regiegroep Rotterdam Climate Proof, 2013).

What causes it?
Over time Dutch developed an advanced urban water system, which suits a climate that has been fairly stable throughout time. However, the changing climate is increasing the pressure on the Dutch urban water system due to the expectations of increased rainfall (Hooimeijer and Van der Toorn Vrijthof, 2008). The flood risk increases and the society is less willing to accept that risk. Constant urbanization and an increasing amount of paved surface, called soil sealing, puts an even bigger pressure on the urban water system. This system needs to be adjusted, to be able to cope with the effects of climate change. Changing the water system in the urban fabric brings up other problems among which the lack of space within the existing urban tissue.

What are future predictions?
It is expected that the rainfall in autumn will increase with more rain within a short period of time. In spring the predictions are similar, although the expected amount of rainfall is less, in comparison with the autumn expectations. In the summer the predictions show less moments of rainfall, but the peakload will be higher (De Urbanisten and Regiegroep Rotterdam Climate Proof, 2013; IPCC, 2013).

'The urban collection and processing capacity must therefore be enhanced to cope with greater precipitation and the peak precipitation load' (Hooimeijer and Van der Toorn Vrijthof, 2008, p.5). To lower the peak load we can use the system of catch, store and discharge [fig.4].

Figure 4: Catch, store and discharge.

Figure 5: The current water systems cannot cope with the changing precipitation load.

Figure 6: Flooded streets due to heavy precipitation in summer 2014.
Water shortage

In periods of limited rainfall is limited, in which the average temperature increases, drought will occur. Drought is when the amount of evaporation is bigger than the amount of infiltration; the surface is losing moist and water (Goedbloed, 2013). This will happen more and more often during the summer months June, July and August (Gemeentewerken Rotterdam et al., 2011).

Consequences
The main consequence of drought is that it causes damage to several aspects.

- Foundation problem
Some buildings are built on wooden foundation piles. These pillars are under ground and are often in contact with the groundwater. The soil around the pillars is free of oxygen. When the water level lowers, oxygen comes in contact with the pillars that start to rotten. The stability and strength of the pillars and therefore the foundation is influenced with property damage as a result (De Urbanisten and Regiegroep Rotterdam Climate Proof, 2013; Goedbloed, 2013).

- Subsidence
Dehydration of soil causes subsidence of the soil, especially when the soil structure is peat. Peat is a water rich soil type, that rottens and evaporates when it comes in contact with oxygen, causing the land to subside. Once the soil is dehydrated, the capacity to absorb water is limited, this is comparable with a dehydrated sponge. Subsiding land can cause buildings (property damage) and infrastructure to settle with possible economic damage. (De Urbanisten and Regiegroep Rotterdam Climate Proof, 2013; Goedbloed, 2013).

- Heat stress
Increased temperature can cause dehydration and damage of vegetation. When vegetation dies, due to the increasing temperature, the capacity to absorb $CO_2$ and to provide shade and evapotranspiration, will decrease. This will increase the effect of heat island effect and heat stress (Goedbloed, 2013). This aspect will be elaborated further on.

- Surface water
During moments of drought the water temperature increases, with a decreased water quality as a consequence. When the water temperature rises, nutrition’s expand and biological activity increases, causing some (mostly unwanted) water flora to flourish. This can threaten the health of both human, and other species in and around the water (De Urbanisten and Regiegroep Rotterdam Climate Proof, 2013, Goedbloed, 2013).

When the water level in rivers lowers, this has an impact on the river- and shipping activities. The (negative) impact on shipping activities can cause economic damage. Thereby, when the river is connected to the sea, there is an increased possibility that salt water will flow upstream, due to a lack of fresh water to reduce this upstream flow. When salt water reaches further inland, there are infiltration points for fresh water (meant for drinking water) at risk (Goedbloed, 2013).
Another risk of drought is the stability of the (Dutch) dykes. Some older dykes are made of peat and clay. When the clay dries out, the surface water can push away parts of the dyke causing land slides, like in Wilnis in 2003 [fig.8].

What are future predictions?
The expectations are that during the summer months (June, July and August) the temperature will rise, that the amount of rainfall will decrease so that periods of drought will occur more often (KNMI). A solution can be to enlarge the absorbing capacity of the soil, ‘sponge’, or to store the water of peak loads to use it during drought [fig.7 and fig.9].
Heat Island Effect

Global warming is increasing the surface and air temperature. The higher temperature causes two important things: ‘heat island effect’ in cities and longer periods of drought in the summer. The heat island effect will be explained further on.

The heat island effect is the difference in air and surface temperature between the inner city, the suburbs and the countryside [fig.10]. Developed high density urban areas (cities) show a higher Urban Heat Island (UHI) intensity than the surrounding countryside (Bourbia and Boucheriba, 2010; Hove van et al., 2011; Rahola et al., 2009). There are two different versions of heat island; atmospheric heat island (AHI) and surface heat island (SHI). AHI has got higher values during night, when urban materials release the heat they absorbed during the day while SHI values are higher during the day due to direct solar radiation [fig.11](Rahola et al., 2009; Gemeentewerken Rotterdam et al., 2011; TNO, 2010). The Urban Heat Island reaches the maximum in the summer months June, July and August (Gemeentewerken Rotterdam et al., 2011).

What causes it?
Modern urban areas are densely urbanized and contain a lot of buildings and paved (solid) surfaces. Facades, roofs and paved surfaces absorb solar radiation during the day and become warmer. When these dense urban areas are also low – albedo (the capacity to reflect radiation) and with limited shading, the temperature in the city rises even more, while the warm surface warms up the air and makes the temperature rise even further (Klok et al., 2012; Rosenfeld et al., 1995; TNO, 2010).

Consequences
Research has proven that there are direct and indirect relations between temperature and human health. Diverse sources address the consequences of UHI. These consequences can be divided in health issues and consequences caused by air pollution.

Health issues
There are two terms that address the impact of temperature on the human body and wellbeing; thermal comfort and heat stress. Thermal comfort addresses the feeling of being comfortable, heat stress is implying serious health implications at higher temperatures. Thermal comfort is appointed/ influenced by several physical variables: air temperature, water vapour pressure, wind speed and radiation temperature. Heat stress is determining these physical variables but adds humidity and solar radiation (Rahola et al., 2009).

Research proves that night temperature has a major impact on the quality of sleep. When the temperature at night is high, people sleep with open windows, which increase the noticable amount of noise and that influences the depth of sleep. Reducing the quality of sleep can cause exhaustion, decrease the ability to concentrate, lower productivity and learning capacity. Beside that, it influences the lung capacity causing asthma (TNO, 2010).

Besides influencing the quality of sleep, a higher temperature can also increase the impossibility for the
body to sweat and to release and regulate body heat which can cause heat rash, heat cramps, heat exhaustion and heat strokes and dizziness (Gemeentewerken Rotterdam et al., 2011). During heat waves there are more people in the hospitals with dehydration symptoms, kidney failure, cardiovascular problems and the mortality rate increases [fig.12] (Gemeentewerken Rotterdam et al., 2011; Hove van et al., 2011; Rahola et al., 2009).

Air pollution
UHI has several effects on the urban air quality. Higher temperatures accelerate the formation of smog. Mechanical cooling is also contributing to air pollution (Rosenfeld et al., 1995). Studies prove that air pollution during heat waves is increasing death rates with 30-40% and can cause breathing problems (Hove van et al., 2011; Rahola et al., 2009).

What are future predictions?
According to earlier mentioned climate change, regarding temperature, the predictions indicate that the average temperature will rise and that heat waves and moments of drought will occur more often. Considering future developments in climate and urbanization, thermal comfort and heat stress will become more critical in urban areas and it will affect the liveability in cities (Hove van et al., 2011; Steeneveld et al., 2011).
Reducing Urban Heat Island

There are possibilities to reduce the effect of urban heat within the city. They are formed by the green structure, the blue (water) network and the natural cooling mechanisms, like wind, in the city (Rahola et al., 2009).

Green
A classic example of counteracting heat island is to increase the amount of green by planting trees in urban areas (cities). The green structure provides shade in the summer, although the vegetation must be big enough before it can produce enough shade to influence heat stress, it absorbs CO$_2$ (Klein et al., 2005) and they have a cooling effect due to ‘evapotranspiration’ (the evaporation of water) (Bourbia and Boucheriba, 2010; Hove van et al., 2011 & Rosenfeld et al., 1998).

Adding vegetation to the living environment does not only provide shade on the street, but also on buildings and it improves the air quality (TNO, 2010). Creating green roofs and facades isolates the building and thereby lowers the amount of energy needed (contributing to mitigation aims of reducing emissions) (Bourbia and Boucheriba, 2010; Hove van et al., 2011 & Rosenfeld et al., 1998).

Streaming/splashing water can also help to decrease the air temperature at street level. The cooling effect is larger than from still water. Although it evapotranspires, it also creates a higher humidity level that can increase discomfort (Rahola et al., 2009). Splashing water, like water elements, have the largest cooling effect (Hove van et al., 2011), but on the contrary they also increase the possibility for children to get sick when the water is contaminated with bird poo and waste [fig.13].

Colors (albedo)
Green and blue have proven to be effective in lowering the city temperature. Other measurements that have a cooling effect are, for example, light colours on buildings and pavement. After all white reflects heat while black absorbs it (Hove van et al., 2011). This is called ‘albedo’, the lighter the colour (towards white) the more sunlight is reflected by the surface in stead of absorbed. Lighter colors have a higher reflection of solar radiation and the heat absorption is lower (Rosenfeld et al., 1998). The lighter the color, the higher the albedo. White has got the highest albedo and black the lowest [fig. 15] (Rahola et al., 2009).

Increasing the albedo of roofs, facades and pavements can decrease the heat and when a higher albedo is applied on a single building experiments show a 20-40% direct energy savings. Beside that, computer simulations indicate that
the indirect effect of wide scale albedo changes will almost double the direct savings (Rosenfeld et al., 1995; Hove van et al., 2011).

Interventions
Taking measurements to reduce the effects of heat island can be done at three different levels: at individual level, within buildings, to make sure that heat is not leading towards the discomfort of heat stress. At street- and/or building level, to reduce heat island and heat stress and at the city level to counteract the heat island effect itself (Gemeentewerken Rotterdam et al., 2011).

Scientific research mentions three topics that reduce the urban heat island effect. Using green, using water and changing the albedo of materials. Below a few examples of interventions are given per topic.

Greening the city:
- Green quays
- Parks
- Green roofs & facades
- Squares (De Urbanisten and Regiegroep Rotterdam Climate Proof, 2013:97; Tillie et al., 2012:44).

Blueing the city:
- Reducing paved surface
- Water squares
- Blue roofs
- Extra surface water
- Splashing water (De Urbanisten and Regiegroep Rotterdam Climate Proof, 2013:82; Hove van et al., 2011).

Lightening the city:
- Adjust color of pavement
- Adjust color of roofs and facades (Rosenfeld et al., 1995; Hove van et al., 2011)

These topics can be reduced to the the conclusion that urban heat can be reduced, focussing on changing surfaces (water, green, color) or adding elements (trees, fountains) [fig.14].

Figure 14: Cooling can be done by changing changing surfaces (water, green, color) or adding elements (trees, fountains).

Figure 15: ‘The difference between surface and air temperatures on the one side and solar reflectivity of paints and roofing materials facing the sun on the other side. Note that white is 40 °C cooler than black’.
Conclusion climate change

The consequences and future predictions, as described in the subject introduction, form the base and starting point of this graduation project. An enumeration is given for the three subjects:

Water surplus [fig:16]
- more peak moments of precipitation
- current water system cannot handle the amount of water (it is inflexible)
- solution: use catch, store, discharge.

Water shortage [fig:16]
- moments of drought, summer months
- water in the soil evaporates, increased subsidence and dehydration of the land
- solution: use store and infiltration (sponge).

Urban heat island [fig:17]
- high air and surface temperature
- caused by materials and surfaces absorbing solar radiation and releasing this heat at night.
- solution: use surfaces and elements to cool.

Climate change creates a shift in seasons and in the weather conditions, the average temperature will rise. Some areas will become drier and other will suffer from more rain fall. (Inner) Cities contain a lot of non- or semi permeable surface that do not allow the rainwater to infiltrate in the soil. Those materials absorb heat during sunny days and are one of the main elements of creating a heat island effect in cities. The water system cannot handle the surplus of water with flooded streets and basements as a result. With the changing weather conditions, people can expect that the cities will flood more frequently and cities should be prepared to limit these risk.

Beside a surplus assignment, there is also the problem of shortage and the heat island effect. Water is needed to reduce the effects of drought and vegetation needs water to reduce the effect of heat island. So, water appears to be a crucial element that plays the role of enemy and friend at the same time. The ‘sponge’ function should be maintained and the capacity should be enlarges in order to reduce effects of climate change.

For water related climate effects, we can work with catch, store, sponge and discharge to reduce the effects. For temperature related effects we can use surfaces and elements to reduce the effects.
**Tention field private/ public sector**

Within the field of urban design and research, more and more participation is used to realise projects and/or to gain input from locals. This shift from top-down to a more bottom-up approach will be further explained in chapter 3, theoretical framework.

A more bottom-up approach allows the individual and the private sector to join as a whole, projects and decision making. After all, all projects and plans in the public space influence the daily life of locals and their routines. Thereby I think their opinion can give valuable insights in the way a location works and is used. Input from insiders often gives a different view than an outsider would describe.

Although there is a shift towards more bottom-up initiated planning that involves the local residents, the spatial projects are realised in public space. This is also often happens with rainwater projects, for example the water square Benthemplein in Rotterdam. This project included the locals for input, but the project is realised in the public space and financed by the government and institutions. In the last fase of this project, the local residents are not a part of the process any more.

This is contradicting to what the province of Zuid Holland and the municipality of Rotterdam state. They say that rainwater needs to be caught and stored on the location where it falls. This means both on public as on private property. By following this, the private sector needs to be a part of the plans and projects until the end. And the project also needs to cover both public- and private property.

This causes tention between different actors, in terms of interests, values, money flows, investments, time et cetera.

![Climate Change Diagram](image)

Figure 18: An integrated climate approach needs to be implemented on a scale level between private and public.
Problem statement

An integrated approach that deals with the spatial effects of climate change on a scale between public- and private sector is lacking. Within the city there are two scales on which water projects are realized: on individual and municipal scale. On municipal scale there are various projects with various appearances, examples are the watersquares and the underground waterstorage in Rotterdam, ‘drain voeg’ in Amsterdam and climate roads in Copenhagen. Most individuals are not aware of their negative contribution to the water assignment, by keeping their gardens paved. While when they have a positive contribution, the actions are often limited to a rain barrel or some green elements (vegetation) in the garden. This scale could use an increase in number of projects and in the variety of interventions that open up the eyes of how to contribute in an easy way. So when we are talking about scales, there seems to be a scale missing, that overlaps the individual and municipal projects [fig.19].

Hypothesis: missing scale

For this missing scale the following hypothesis is formulated: ‘Between the large scale projects from the municipality and the small scale interventions that home owners can do, an intermediate scale is missing. This scale can be the connector between scales to enhance resilience of the house, street, neighbourhood and city. Based on collaboration.’

This intermediate scale requires collaboration between parties, but what is the ideal coalition and how could this be determined? The third chapter, theoretical framework, addresses not only the requirements for collaboration but also provides guidelines for tackling climate assignments.
Approach
Research setup
The research can be divided in three separate sections. The first section includes all climate related subjects, like the meaning of climate change, the effects of climate change for the Dutch city Rotterdam and how to reduce these effects. A part from this section also includes a case study in which five rain water projects are compared to each other in their attitude and process.

The second section describes how to collaborate and how to determine who to collaborate with. It is about collaboration between scales, sectors and stakeholders. This includes the hypothesis stated in this thesis about a missing collaborative scale.

The last section of the research represents the location Oude Westen, a neighbourhood in Rotterdam where the climate assignment is relevant and where the topic of collaboration is applied. The location is analysed and used as a showcase how the combination of climate intervention and collaboration could look like.

This showcase includes a design which aims to adapt the existing urban morphology in such a way that it can handle/deal with predicted rain fall. These interventions need to give a quality impulse to the people and the city. To make the intervention an integrated climate solution, the spatial and technical adaptation should positively influence multiple climate effects. This underlines the sustainability of the project and the necessity of an investment, to make these interventions; each intervention will address and solve several problems.

Aim
The aim of the research is to find out what the intermediate scale is and how it can be designed with focusing on the water- and climate assignment, while involving multiple stakeholders.

Social relevance
A newspaper article from Ice News describes the effects from the Copenhagen cloudburst in July 2011 [fig.20]. During this cloudburst, enormous amounts of rain came down. It flooded, streets, squares, houses and the city was taken over by the water. There was water damage; people are unable to transport themselves. During the flood, the city life was forced to slow down. It took more than three weeks before the city could function normally again. The material- and economic damage was enormous.

The Netherlands is threatened by flooding and there is a chance that a similar cloudburst that flooded Copenhagen can happen in the Netherlands as well. Although the water can come from multiple directions [fig.21], there is a focus from the government and national institutions on river- and sea water. Rain- and groundwater are underexposed, the problems are addressed, but not all of them are being solved or they are solved on a much smaller scale level, mainly conducted by municipalities and local water boards. When we look at the combination of urbanized areas and the impact on the city life, dealing with rainwater seems to be the most crucial aspect to deal with.

Figure 20. A newsmassage about the cloudburst in July 2011 in Copenhagen. More than 150mm rain fell in just three hours.

Figure 21. In the case of Rotterdam, water come from four different directions: from sea, from rain water, from the rivers or from groundwater.
Recently the Netherlands has suffered from heavy rainfall (autumn 2013, summer 2014), causing pluvial flooding and damage. Insurance companies expect the cost to be millions. Possibly the insurance costs will rise, as a result of the increased possibility that a similar heavy rain event will fall again in the future.

**Scientific relevance**
Climate change and pluvial flooding are not only a scientific subject, they are reality. They are not only research data, but also real life events. They are not only technical assignments, but the impact is physical as well. Multiple borders need to be crossed in order to find solutions for the changing climate. That is the challenge. There is not just one way to tackle these types of assignments. Everyone and everything needs to be incorporated and this requires a whole new approach.

Projects need to be based on scientific results, but need implementation on location in a specific way in order to be successful. Communication and collaboration are important subjects in order to bring science, profession and society together. An urban designer plays a significant role in those processes. They are mediators between scale, institutions, governments and the people. Who can translate data into a design and make generic information location specific. But alone we can not overcome the borders, we need specialists on all sides. And we need the local people to join in as well. How to combine all this and how to cross borders and find an adaptive solution for climate change.

In this graduation thesis I develop a generic method, based on the intermediate scale, to cross these borders and give a location specific translation of this generic method in a design. I provide arguments why people should join in and how this collaboration can be achieved. This graduation thesis is an exploration how scientific knowledge, spatial design and society can work together to make the city more adaptive and future/ climate proof.

**Ethical dimension**
Looking how other projects have been done and distillating the ‘good’ (noted by others as effective) and useful things out of it, is one of the ethical dimensions in this graduation project. Another dimension is that there is not one right or best solution. Through contextual design approach, the future possibilities for the project location will be specified. By making interventions, there must be an idea how these will affect the local users and owners and what are changes and risk that might play a role.

**Research questions**

**Main research question**
What can be considered the ‘urban intermediate scale’ and in what way could it enable cities to adapt to the effects of climate change, regarding water surplus, drought and heat island, while improving quality of public space and engaging the individual in the Oude Westen district in Rotterdam?

**Sub questions**
1. What is the urban intermediate scale?
2. What are integrated options of adaptation, regarding water surplus, drought and heat island? How do this relate to spatial quality?
3. How to engage the individual in spatial projects?

**Intended outcome**
1. A design on the intermediate scale, focussed on a solution for water surplus, drought and urban heat.
2. An integrated approach for climate change, that positively influences multiple climate challenges.

**Scientific relevance**
Climate change and pluvial flooding are not only a scientific subject, they are reality. They are not only research data, but also real life events. They are not only technical assignments, but the impact is physical as well. Multiple borders need to be crossed in order to find solutions for the changing climate. That is the challenge. There is not just one way to tackle these types of assignments. Everyone and everything needs to be incorporated and this requires a whole new approach.

Projects need to be based on scientific results, but need implementation on location in a specific way in order to be successful. Communication and collaboration are important subjects in order to bring science, profession and society together. An urban designer plays a significant role in those processes. They are mediators between scale, institutions, governments and the people. Who can translate data into a design and make generic information location specific. But alone we can not overcome the borders, we need specialists on all sides. And we need the local people to join in as well. How to combine all this and how to cross borders and find an adaptive solution for climate change.
Methodology scheme

Scheme of relations
This scheme of relations visualizes the relation between four topics [fig.22]. Private and public parties have a direct relation due to the fact that both parties are needed in order to work on the intermediate scale and they need to collaborate together. When addressing climate assignments, sectors (like environment, infrastructure, housing etc.) and parties need to work together to achieve an integrated approach which can be effective for multiple subjects and scales. Collaboration is the key to success!

Figure 22: Relation scheme.
Scheme of methods

Different methods are used in order to answer the research questions as mentioned previously [fig.24]. The different methods will be explained further on.

- Data analysis location
This method is used for gathering data about urban heat and the water assignment for the neighbourhood Oude Westen. This data came from the institute CBS, autocad measurements, excel sheets and climate related studies/reports/literature. This data is then translated in maps to make it more clear. Further on, data analysis is used to give a neighbourhood perspective about facts and numbers in the categories demographics, housing, age and other topics.

- Case study
A case study is used to compare the process and attitude of three rain water projects in Rotterdam to other rain water projects in other cities. For the comparison are aspects used from the theoretical framework.

- Interviews/surveys
Based on the theoretical framework, subject collaboration, core stakeholders are selected. These core stakeholders were interviewed and/or filled in a questionnaire, that gave input for conclusions or focus.

- Literature review
Literature is used to form the context of climate change and the issue of pluvial flooding, where this thesis evolves around. More literature is used in the chapter “Theoretical
framework’, this gives insights and guidelines how to manage the process behind the project. Conclusions of these literature reviews are used forther on in the graduation research.

- Mapping
  The method ‘mapping’ is used to make the data analysis more understandable. Mapping is also used to visualise location analysis of diverse topics and to make them comparable.

- Visualising 3D
  In order to make the interventions visible for a larger audience, the 3D technique or perspective drawings are used. These visuals give a 3 dimentional impression of the proposed interventions on location.

These methods were used on different moments in the graduation project. Figure 23 is showing the relations between the methods and the moment they were used in the project.

<table>
<thead>
<tr>
<th>Subquestion 1: What is the urban intermediate scale?</th>
<th>visualising 3D</th>
<th>mapping</th>
<th>literature review</th>
<th>interviews/questionnaires</th>
<th>case study</th>
<th>data analysis/ location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subquestion 2: What are integrated options of adaptation, regarding water surplus, drought and heat island? How does this relate to spatial quality?</td>
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<tr>
<td>Subquestion 3: How to engage the individual/ private sector in spatial projects?</td>
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Figure 24: Overview methods in combination with sub research questions.
Theoretical framework
Adaptation

In order to gain useful knowledge, two subjects need to be researched: How to address climate change? What strategies/methods tackle these issues? And the other subject addresses the need for communication: How to collaborate?

In this theoretical framework both subjects are elaborated by literature, quotes and examples. A summary of the most important aspects is given at the end of the chapter.

Sub-question 2 mentions the adaptive capacity of space. When looking at policy documents of municipalities and provinces, the aim to adapt is broadly accepted. That would indicate that there is knowledge about the conduct ion of adaptation. This together with the words of Han Meyer in an interview in March 13, 2014: ‘We do want to adapt, but we do not know how’, triggered the wish to research this theme.

Climate change is irreversible

The fact that climate change is now recognized as unavoidable and irreversible, makes this issue the key challenge of this 21st century (Hamin and Gurran, 2009). It is the challenge for spatial planners to include climate change in planning and policy making and to increase the debate on how to do this (Biesbroek et al., 2009).

For decades the research, debate and discussion about climate change has been done by climatic scientists who searched for scientific and statistical evidence to underline the changing climate. Climate change was perceived as an environmental problem and not as a human issue. The research was mono disciplinary by nature. In the last decades there is a growing political and media attention for climate change and the societal impact of it. More and more, climate change becomes a widely known issue and multiple institutes, organizations, governments and local actors are involved in policy and decision making. The research of climate change has shifted towards a co-production between multiple stakeholders within different fields of interest; climate change is now a trans disciplinary strategy (Biesbroek et al., 2009).

‘Successful coordination to optimize the planning process requires a trans disciplinary approach from scientists, politicians and society.’ – Biesbroek et al, 2009, p.234.

Two strategies to tackle climate change

The United Nations Framework Convention on Climate (UNFCCC) identifies two strategies to address climate change: mitigation and adaptation (Klein et al., 2005; IPCC, 2007, p.748).

Adaptation is the adjustment of the natural and human systems, that makes the system able to reduce the impact and to absorb shocks of sudden changes in weather conditions and increase the capacity to recover in such a way that the impact of the shock is reduced. The system needs to be able to respond to current- and expected conditions which are uncertain. The system needs to be able to manage the unavoidable by direct damage prevention, therefore the ‘what if’ scenario is needed in policy and planning processes (IPCC, 2001; IPCC, 2007; Klein et al., 2005; Larsen and Gunnarsson-Östling, 2009; Laukkonen et al., 2009; Tol, 2005).

Mitigation is reducing the current and future production of greenhouse gases by limiting human activities that produce the gases. It is aiming to reduce the indirect damage that global warming causes on a local scale. Politicians and planners try to avoid that (Biesbroek et al., 2009; Hamin and Gurran, 2009; IPCC, 2007; Klein et al. 2005; Laukkonen et al., 2009). Mitigation is more about behaviour and attitude towards climate change than an physical translation of the problems.

Looking at the aimed scale and intention of this graduation project, adaptation is the strategy to use.

Performing adaptation

There are three main subjects that describe adaptation. According to Klein et al. (2005) there are at least three important subjects that play a significant role in the way adaptation works. The first subject is ‘space and scale’, the second is ‘costs and benefits’ and the third ‘the actors and type of policy involved’. Tol (2005), Biesbroek et al. (2009), Bosello et al. (2007) and the IPCC report of 2007 agree with Klein et al. that there are three main subjects to describe adaptation, although they mention time as an subject instead of costs and benefits.

During interviews with people from different municipalities the subject of costs & benefits was mentioned to be
important. The questions: who is responsible, who is paying and who is maintaining are important as well. This makes that there are four subjects that define adaptation [fig.25].

Describing subjects

Time

Biesbroek et al. (2009) underline the difference in time perception, by naming a short term investment with a short term solution and a short term investment with a long term result. The time horizon of adaptation is short and the effect is rapid (Bosello et al., 2007).

Space/scale

Adaptation is local and regional oriented with a social economic perspective (Biesbroek et al., 2009; Bosello et al., 2007). Adaptation needs to be flexible in order to handle the uncertain effects of climate change (Bosello et al., 2007; Hamin and Gurran, 2009), the impact of climate change is local (Laukkonen et al., 2009).

Involved stakeholders

While talking about the involved stakeholders in executing projects, there are two directions. The limited but large sectors in combination with a governmental instrument (top-down) and the direction of involving the local stakeholders who all have different opinions and interests (bottom-up) (Bosello et al., 2007; IPCC, 2007; Klein et al., 2005). One question remains: who is responsible for what? The project is formed locally with different people involved in every project and location (Klein et al., 2005; Tol, 2005)

Conclusion

There are four topics that describe adaptation. These topics need to be considered before starting a new project. They determine the scope of the assignment and the formation of the project team.
Collaboration

Sub-question 3 is: How to engage the individual in spatial projects. This involves the subject ‘involved stakeholders’ from the previous chapter Adaptation [fig.26] in combination with the question how do we collaborate and how do we choose whom to collaborate with?

In order to grasp this topic, a literature review is produced with this topic and these questions. No organisation, can solve the complex environmental issues of this time, on its own. In order to find a solution, collaboration with partners is needed but how should we collaborate with others and with who? In this essay both these questions are addressed and a guideline for collaboration within the field of environmental assignments is provided. This guideline describes three subjects that need to be thought about and which need to be addressed prior to the collaboration. The first subject is the determination of the type of assignment: which collaboration strategy suits this assignment the best. This paper addresses four strategies: mono-, multi-, inter- and transdisciplinary work. The second subject is to determine what knowledge and influenced are needed in order to make the collaboration a success, based on the circle of vital coalitions and the ladder of participation. Finally it is important to reach ‘mutual gain’ with those who are selected for collaboration in order to strengthen the assignment and collaboration.

Why do we need to collaborate?
No organization alone can solve the complex environmental issues of this time. There is a need for collaboration. Alliances and networks have proven to be valuable in the search for the optimal solution for these issues (Bremekamp et al., 2009, 2010).

In the 1960s, spatial planning and policy making was confronted with new types of spatial issues such as pre-war city renewal. In order to tackle the planning and policy making of these new spatial issues, the development towards integration of theory and practice took place. This resulted in the search of effective ways of working and the growing role of collaborative teamwork gave other parties and stakeholders the opportunity to interact in spatial planning and policy making. (Innes and Booher, 2010). At the end, the diversity of interests and opinions expanded within the planning and policy making processes that requests a different approach, -planning process and a different for every project and a different planning process and it needs a different team of actors. Because every assignment is a unique process (van Doorn, 2004). In spite of this it is possible to point out different typologies in collaboration based on involved sectors and stakeholders. There is no general solution that can be given, although there can be a general guideline that has to be adjusted and specified for each individual assignment.

The profession of urban planning and design contains environmental issues in a spatial context. As mentioned before, by dealing with environmental issues of this time, there is a need for collaboration. And from the spatial dimension of the profession there is also a need for collaboration. But how do we collaborate and who are the right partners to collaborate with?

Figure 26: The subject ‘Collaboration’ addresses the subject ‘involved stakeholders’ from adaptation more in depth.
Four collaboration strategies

Four basic strategies for collaboration can be found. All based on collaboration between different sectors and disciplines, but all with a different point of view. The four identified strategies are mono-, multi-, inter- and transdisciplinary collaboration. The last three use social processes for knowledge production (Klein, 2008). All four strategies will be explained by their characteristics and how they differ from the other strategies. In the last paragraph the shifting perspective between science and collaboration is mentioned.

- **Monodisciplinary**
  This strategy is a simple version of collaboration. Knowledge and collaboration stay within the boundaries of a single sector or discipline [fig.27]. Within this discipline, scientists work together from a similar point of view in order to investigate or discover something in a similar field. Often there is no real problem that needs to be solved and with the input of only one discipline and point of view, there is a limited space for solving complex issues (Hidding, 2006). The monodisciplinary approach is the only one of the four strategies that does not involve other disciplines.

- **Multidisciplinary**
  Within the multidisciplinary approach, multiple science disciplines work together in order to produce and gain knowledge on the same issue, question or project [fig.28]. Although there is a collaboration between different disciplines, they do work separate from each other within their own boundaries and deliver their thoughts and point of views on the issue (Hidding, 2006; Hulster et al., 2009). There is a high level of respect towards the knowledge from other disciplines and there is a need of a certain level of understanding towards the other collaborating disciplines. By working together from each individual discipline without interacting creates a lack of intercommunication and this makes that the disciplines remain working within their own boundaries, this is a vicious circle (Alvargonzález, 2011; Wickson et al., 2006). Although there is no intercommunication, the variety of science disciplines that collaborate is endless (Greenberg, 2010). And there with the approach, multiple perspectives come together (Alvargonzález, 2011).

- **Interdisciplinary**
  Interdisciplinary is the collaboration between a variety of multiple scientific disciplines in an integral, interactive and intercommunicative way [fig.29] (Brandt et al., 2013). Within this collaboration skills and knowledge are combined. Disciplines are linked together into a coordinated and coherent whole (Alvargonzález, 2011; Hulster et al., 2009) and work together by exchange of knowledge and data in order to solve a shared problem. Thereby they cross the borders of their own discipline and is intercommunication, and interaction possible (Hidding, 2006; Wickson et al., 2006).

- **Transdisciplinary**
  ‘Successful coordination to optimize the planning process requires a transdisciplinary approach from scientists,
Transdisciplinary collaboration is the collaboration between scientists of various disciplines and practitioners from outside academia by integrating knowledge, experience and practice [fig.30]. The aim is to get natural and social scientist to collaborate with stakeholders in society (Klein, 2008). While the other strategies of collaboration remained within their boundaries, transdisciplinary strives to go over and beyond the individual disciplines (Alvargonzález, 2011).

The focus is on environmental and large social challenges by grasping the complexity of environmental issues from nowadays. Due to the increased global warming, these challenges are plenty. Transdisciplinary work addresses real world problems and is searching for real world solutions which can easily be implemented in the human environment (Pohl, 2005). In order to implement a solution on a smaller scale, the input of individuals and local stakeholders is required; transdisciplinary disciplines promote the common good.

According to Brandt et al. (2013) transdisciplinary is the same as interdisciplinary but is adding and integration with participation from society that creates a mutual learning process between science and society. Another difference is that transdisciplinary does include the ‘who is involved’ question, unlike inter (Wickson et al., 2006). Intercommunication is one of the important key elements in successful transdisciplinary collaboration.

- Shifting perspective, democratization of collaboration
The perspective of science and collaboration is shifting. From a traditional linear method, relying on formal research, the focus goes towards a nonlinear socially constructed method engaging both science and stakeholders (Innes and Booher, 2010). Research and collaboration are democratizing. There is a sense of necessity that complex issues should be addressed integral and from an innovative point of view (Groot et al., 2010).

From an environmental perspective, the need for sustainability is underpinning a growing demand for research that takes account of complex contexts and interactions between natural and social systems. The social context calls for interaction with an increasingly engaged population and drives research in more participatory and consultative directions. All together this indicates a changing research landscape, promoting knowledge production that attempts to solve world problems through a dialogue with multiple stakeholders who together produce valuable knowledge (Wickson et al., 2006).

How to collaborate
The previous sections of the paper gave insight in the four strategies for collaboration and what is needed to tackle climate change. The ‘how’ question has been addressed. This third part will address the ‘who’ question. From environmental issues there is a need to solve the problems with transdisciplinary collaboration which includes individual stakeholders from society. But then the question arises ‘who needs to join in solving the problem and how
can you make the collaboration successful?

- Aligning ambition
Collaboration is dealing with different interests on individual and organizational level. The challenge is to gain insight in all those opinions and interests in order to choose correct partners and to conduct maximum benefits from the collaboration. ‘Dialogues among stakeholders are essential to discover the mutual gain opportunities and agreements’ (Innes and Booher, 2010, p. 5). In Bremekamp et al. (2009) three words are mentioned that can help to provide this insight: ambition, interest and context [fig.31]. Ambition (inner circle) is creating a shared image of the issue, problem, solution and opportunities. In every project there are different interests (middle circle) that play a role in the process. It is important to have insight in all the motives whether they are individual, from an organization or collective, they are the base for the conversation. The last, context (outer circle), is divided in three parts; players, process and surroundings. Players are the stakeholders and their background, process is the facing and management of the process and the surrounding refers to the context location of the issue.

Within collaboration each partner will formulate question, solution, opportunities and form of the outcome differently. By aligning this puzzle in advance of stating the project will clarify the ambition on the team and the process. If one of the topics cannot reach consensus among the partners, the combination within the team can be changed until the optimum alignment is formulated where ambition and interests strengthen the power of collaboration (optimal is process and project dependent).

- Vital coalitions
Among involved stakeholders there can be a division about who is more involved and who are joining the discussion for input. The involvement of stakeholders can be separated in three circles (Rooij et al., 2012); the inner core represents the direct project partners. They are the stimulating force behind the assignment and their collaboration is strategic. The first ring exists of covenant alliances. This ring provides material and specific knowledge needed for realization of the goals set up by the core stakeholders. The last group of stakeholders is the group of cooperating organizations and groups who are involved in the discussion about the assignment and provide input [fig.32]. The goal: determine the primary and other stakeholders is to find out who needs to be involved in the process of aligning ambition and who is involved in vital coalitions.

- Participation
As mentioned before, there is value in the dialogue between stakeholders and involving multiple stakeholders with multiple interests in order to create mutual gain. There is a bottom —up approach for involving stakeholders (mostly from the local scale) that is called participation. This group is often referred to as the tertiary group of stakeholders.

In 1967, the politic system in the Netherlands was showing signs of change. There was an atmosphere of discontent and agitation. The Netherlands stood on the doorstep of
change (Lijphart, 1998).

In 1991 the prime minister of that time, Wim Kok, argued that there was a need to search for a new balance between the ongoing individualization and solidarity among the people. The newspaper cited: ‘Een principiële herziening van het stelsel is noodzakelijk. Daarvoor is nodig dat er een derde weg wordt bewandeld tussen de gevolgen van de emancipatie met de individualisering enerzijds, en de solidariteit en saamhorigheid anderzijds.’ (de Jong, 1991). (English translation of the quote: a principal review of the system is requited. Therefore we need to take another road, the third road that follows the effects of emancipation with the individualization on one side and the solidarity on the other side). And this third road was the road that strived for society participation (de Jong, 1991). This new form of society should involve citizens to participate in their direct living environment, from activities, to maintenance and design. By letting people participate and have influence on what happens in their neighbourhood, a level of awareness and responsibility can be achieved (ProDemos, 2012). And that is what could change society as a whole.

- Participation ladder
There are various degrees of participation, the ladder of participation from Edelenbos and Munnikhof (2001) show these degrees [fig.33]. The higher the step on the ladder the more stakeholders are involved in the process and the higher the level of influence can be of the assignment. A higher level of influence can also mean that a specific group should be embraced as a primary or secondary group of stakeholders.

Conclusions
In this literature review the subject of collaboration has been addressed. Although it is given that one single organization alone cannot solve the complex environmental issues of this time and that there is a need for collaboration, the question arises how do we collaborate and who are the right partners to join with in collaboration?

Via literature four basic collaboration strategies can be found; mono-, multi-, inter- and transdisciplinary collaboration. By explaining these strategies together with adaptation, a short conclusion can be made while speaking in the perspective of collaboration. Adaptation has got a more transdisciplinary perspective and finds the sources of input in the bottom-up approach.

- Who to join in collaboration
So a specific assignment asks for a certain collaboration strategy. For the question ‘who are right partners to join in collaboration?’ a method is found in the diagram of Bremekamp et al. (2009) in which three circles are described. Each circle represents a topic that needs to be discussed with the joining stakeholders in order to align ambition for the given assignment. When joining stakeholders can reach agreement on these three subjects: ambition, interest and context, than the project can gain strength and this ‘mutual gain’ (Innes and Booher, 2010, p. 5) can influence the effectiveness and the success of the collaboration.
Assignment

1. Determine the type of assignment, for example an environmental assignment, and the collaboration strategy that accompanies this type the best (Rooij, 2012), figure 27-30.

2. Determine what knowledge and influences are needed in order to bring success to the collaboration. Based on the circle of vital coalitions [fig.32] as mentioned in Rooij et al. (2012) and the ladder of participation from Edelenbos and Munnikhof (2001), figure 33.

3. Reaching ‘mutual gain’ within the group of stakeholders in order to strengthen the assignment and collaboration, by aligning ambition (Bremekamp, 2009), figure 31.

But there is a previous step to take before a certain group can start the dialogue. This step is determined who is important for the assignment as a core stakeholder and who is needed to provide input. A diagram can show the different layers of involvement (figure 5) together with the ladder of participation by Edelenbos and Munnikhof (2001) methods can be given to determine who the ideal core stakeholder is and who is standing on the edge of the collaboration.

Of course in the field of spatial planning not one project is similar to another. A method can be provided and ways to think and aspects to discuss can be general, but they must always be adjusted to the needs of a new assignment and collaboration. An overall concluding scheme [24] of this paper can be made. It describes moments of choice making and subjects of discussion in order to optimize the collaboration to reach the optimum collaboration and result.

- Using findings
This literature review forms a base for the graduation research/project: ‘Rain failure. The third water threat for the Netherlands (working title)’. One of the sub research questions is mentioning how to engage individuals in spatial projects and in order to answer this research question, three questions needed to be answered: what is the base for the project regarding aim, climate strategy and collaboration strategy, who are primary stakeholders (based on vital coalitions) and how to reach ‘mutual gain’.

These questions will help to structure the project aim and stakeholders and they will help to determine with whom to talk about what. Beside that these findings are useful to formulate a base for the project; they also help to give structure to the executed case study.
Conclusion theoretical framework

In the introduction of this chapter is stated that an integrated approach of climate assignments between the public- and private sector is lacking and that a new overlapping scale needs to be introduced. When an initiator wants to setup a climate related project within this intermediate scale, there are a few aspects that require attention. Concluding from the two subjects described in this theoretical framework (adaptation and collaboration) there are seven aspects that guide the process of composing a project team and determining the scope of the project.

Before composing a project team there are three aspects that need to be discussed or thought of:

• Determine the type of assignment and the collaboration strategy that accompanies this type the best.
• Determine what knowledge and influences are needed in order to make the collaboration a success.
• Reaching ‘mutual gain’ within the group of stakeholders in order to strengthen the assignment and collaboration, by aligning ambition.

When talking about adaptation, there are three aspects that need determination:

• what is the focus in time, short or long time horizon?
• what is the focus in space/scale?
• who is paying for what and who is responsible for maintenance?

The subject ‘collaboration’ is a more in depth research to the subject of ‘involved stakeholders’. These two subjects are considered to be one.

The relation of adaptation with climate change in urban developments and the intermediate scale, six aspects can be specified:

• The attitude of the assignment is adaptation. Being flexible and acting local. The project itself can be typed as adjusting existing urban context to the waterassignment, without changing the urban structure. The collaboration strategy must be transdisciplinary in order to involve government, scientists and civil society.
• The intermediate scale in combination with the water assignment requires knowledge of the location, local water systems, policy, property, climate and the current climate assignment on the specific location.
• All the stakeholders who are related to this intermediate scale have own interests and ambitions. This needs to be analysed. Methods of mutual gain intent to activate stakeholders to join the collaboration. This needs further specification, but in general solutions that lower the bills are catching interest.
• When it comes to the water assignment it is important to retain the water until the moment you need it in times of drought. So timewise you need to cover weeks or even months while you have to catch the water and reduce the risk of flooding immediately.
• The intermediate scale is a local scale, while the water assignment covers whole cities. Both scales need to work together.
• This model partly relies on the interest and ambitions of the involved stakeholders. Who is willing to contribute to what?
Policy of Rotterdam

The city of Rotterdam wants to create extra opportunities for the city to become more attractive for living, working, relaxing and investments. But besides creating extra opportunities, there is also a climate issue that needs to be dealt with. The aim is to reach the level of a climate resilient city that also benefits from other city opportunities for climate change: strengthen the economy, improving the living environment and enlarge the participation of inhabitants.

The adaptation strategy of the city mentions six main goals for adaptation: being safe of water from outside the city, a minimum impact from heavy precipitation, the harbor remains safe and accessible, awareness among inhabitants about climate change and their role in adaptation, liveability and attractiveness of the city and the adaptive strategy improves the economy and the image of the city.

To reach this climate resilient situation, the city has developed a strategy that distinguishes four subjects [fig.34]. The base of the adaptive strategy is the current robust water system of storm surges, dykes, surface waters, sewers and pumps. Adding to that, reduce the vulnerability to flooding and to make the city more resilient. By using other urban projects to realize adaptive innovations, smart adjustments can be done. In the end it is the intention of the city to profit from climate adaptation and can create added value as mentioned above.

The policy of Rotterdam is also related to the water issue of the city. They name a few important aspects to focus on while conducting policy or project plans as well. The principal of retain, store and discharge is not only applicable in the public space, but also on private property. Possible solutions for preventing water damage by heavy rainfall should not only be found within surface water and sewer systems but also in public space, in buildings and on individual property, think of gardens and roofs.

- Catch the rain where it falls and retain it there. Or create opportunities to discharge slowly, but only if retain or storage is not possible on the location.
- Work area specific, the context is determining the assignment. Use the small vessels (sponge) of the water system and extend those.
- Increase storage capacity, enlarge the amount of surface water if possible and use a design to integrate technical solutions in public and private space.
- For water and climate adaptive interventions, go along with other projects like sewer and infrastructural projects.
- Improve the city climate, extend the capacity to retain rainwater and to cool down.

(De Urbanisten and Regiegroep Rotterdam Climate Proof, 2013; Rotterdam Climate Proof, 2013).

Figure 34: The adaptive strategy of Rotterdam distinguishes four subjects: using the current robust water system, adjust the city with adaptive measures to create resilience, using other urban projects to realize the strategy and creating added values for the city.
Case study

This case study is conducted with the aim to determine the attitude of rain water projects. The municipality of Rotterdam mentions that the city intents to make adaptive interventions that can serve the city and in which participation can take place. Rain water interventions should use both private and public surfaces. The question is if the rain water projects of the city recall this policy statement.

Five projects are analysed and compared using the aspects; adaptation and collaboration, as described in chapter 3; Theoretical Framework.

From an adaptative point of view, these five cases have been analysed using: time, space/scale and costs & benefits. From a collaborative point of view is look at the core stakeholders and wether they perform an integrated climate approach.

**City: Amsterdam**

Name project: Derde Oosterparkstraat [fig.36].
Project description: Construction of a permeable road by using a type of brick called ‘drainvoeg’.

- **Time**
  - short term investment, long term solution
  - rapid result

- **Space/ scale**
  - local oriented
  - permanent

- **Costs and benefits**
  - responsibility: municipality and waterboard
  - financing: municipality and waterboard
  - maintenance: municipality and waterboard

- **Core stakeholders**
  - bottom-up
  - local stakeholders
    - municipality
    - waterboard
    - inhabitants
    - Rainproof
  - participation

- **Integrated climate approach: yes**
City: Culemborg
Name project: EVA-Lanxmeer [fig.37].
Project discription: Constructing a climate neutral neighbourhood.

Time
• short term investment, long term solution
• rapid result

Space/ scale
• local oriented, (inter) national example project
• flexible

Costs and benefits
• responsibility: municipality and foundation EVA
• financing: municipality and foundation EVA
• maintenance: Terra Bella, residents association EVA-Lanxmeer

Core stakeholders
• bottom-up
• local stakeholders
  - municipality
  - foundation EVA
  - future inhabitants
• participation

Integrated climate approach: yes

City: Rotterdam
Name project: Museumpark garage [fig.38].
Project discription: Underground storage capacity.

Time
• short term investment, short term solution
• rapid result

Space/ scale
• local oriented
• permanent

Costs and benefits
• responsibility: municipality and waterboard
• financing: municipality
• maintenance: municipality

Core stakeholders
• top-down
• limited amount of actors
  - municipality
  - waterboard
• institutions

Integrated climate approach: no
City: Rotterdam
Name project: Kruisplein garage [fig.39].
Project description: Underground storage capacity.

Time
• short term investment, short term solution
• rapid result

Space/scale
• local oriented
• permanent

Costs and benefits
• responsibility: municipality and waterboard
• financing: waterboard
• maintenance: municipality

Core stakeholders
• top-down
• limited amount of actors
  - municipality
  - waterboard
• institutions

Integrated climate approach: no

City: Rotterdam
Name project: Discharge Central District CS [fig.40].
Project description: Enlarge discharge capacity via overflow in surface water.

Time
• short term investment, short term solution
• rapid result

Space/scale
• local oriented
• permanent

Costs and benefits
• responsibility: municipality and waterboard
• financing: municipality and waterboard
• maintenance: municipality

Core stakeholders
• top-down
• local stakeholders
  - municipality
  - waterboard
  - local businesses
• limited amount of actors
• institutions

Integrated climate approach: no
Conclusion

The attitude of Rotterdam differs a lot from the attitude of Amsterdam and Culemborg. Rotterdam performed these rain water projects with the same partners and realised the projects completely within the public space. This does not correspond to the policy statements the city did previously. Both other cases include local stakeholders like inhabitants and they perform more bottom-up.

Looking at the rain water projects of the municipality of Rotterdam in comparison to their policies, the hypothesis of a missing scale gets confirmed. In order to match the policy statements of the municipality and to involve locals by creating awareness for climate change and solutions, the city needs to change her attitude in rain water projects. The projects need to be location specific and therefore the involved stakeholders differ per location. Besides that the mindset need to be changed, a surplus of water can serve at other moments. The analysed projects store and lower the peak load for the water system, they do not serve an integrated climate approach that can serve the city at multiple levels.

Link to graduation project
- using local input from inhabitants
- search for solutions on both public and private surfaces
- apply an integrated climate approach
- adjust the process to the needs of the location.

The road materialisation used in Amsterdam, ‘drainvoeg’ [fig.41], is very useful for the graduation project as well.

From the policy of the city, there are four statements extremely valuable for the project.

- Catch the rain where it falls and retain it there. Or create opportunities to discharge slowly, but only if retain or storage is not possible on the location.
- Work area specific, the context is determining the assignment. Use the small vessels (sponge) of the water system and extend those.
- Increase storage capacity, enlarge the amount of surface water if possible and use a design to integrate technical solutions in public and private space.
- Improve the city climate, extend the capacity to retain rainwater and to cool down.

Figure 41: ‘Drainvoeg’ principle: placing a strip of felt in between the bricks.
Oude Westen
Location

Why the ‘Oude Westen’
Looking at several maps of the city of Rotterdam regarding the water assignments [fig.42], temperature [fig.43] and foundation problems [fig.44], two locations appear to have the highest rate when the three maps are combined [34]. These locations are: Oude Westen and Oude Noorden.

To determine which location is having the most problems, two other subjects have been consulted; the population density and the relation paved-unpaved surface. The density prescribes the population per km². The more people, the less space is left for interventions, which makes it a challenge. For the paved-unpaved counts, the more paved surface, the warmer the area. In combination with a high density, a real challenge. The area with the highest score on both subjects is Oude Westen. Therefore the Oude Westen contains the most problems and challenges and that is where this graduation project is looking for.

Figure 42: This image shows all the areas within the city of Rotterdam that have a water assignment (blue areas).

Figure 43: This image shows where in the city the temperature remains above the 20°C for a number of days. The more red, the longer the period of more than 20°C.

Figure 44: Foundation risk map: high risk (red), medium risk (orange), low risk (yellow).

Figure 45: Combination of the three maps. Looking at the highest values of each map, results in two areas where these values are all present.
Neighbourhood Oude Westen
This neighbourhood is a typical residential neighbourhood within the city center of Rotterdam. The neighbourhood is bordered by four main roads: Weena in the north, ’s-Gravendijkwal in the west, Rochussenstraat in the south and the Westersingel [fig.47], one of the waterways of W. Rose (van Es, 2010) which is still visible and in function as a part of the city water system, in the east. Within the area there are three large, access, roads and many small residential streets with parking on both sides. Two old polder roads, West kruiskade and Nieuwe Binnenweg, separate the neighbourhoods in three parts [fig.48]

The area is easy accessible due to its location near the central station. The structure within the area is open, friendly and dynamic (Gemeente Rotterdam, 2008). The area is multicultural and is international oriented when it comes to inhabitants, food, smells and languages.

The goals of the current policy for the neighbourhood (Binden en verleiden) are to bind the current inhabitants and businesses more to the current urban tissue and to seduce future inhabitants to move in. The neighbourhoods scores low in level of education, income, participation and safety, it is an empowerment neighbourhood. Overall the people are satisfied about the neighbourhood and about 1/4 of the inhabitants is actively involved, through participation, in the developments of the neighbourhood and improving the quality and livability of the area (Greeven et al., 2009).
Figure 47: Four large roads form the borders of the neighbourhood.

Figure 48: Two old polder roads separate the neighbourhood in three parts.
1884: Rotterdam annexed the land to the city.

1890: The land was quickly developed and built.

1930-1940: WW II. Oude Westen has been saved from bombing and fires. Emergency stores arise.

First plans to erase the urban tissue of the Oude Westen.

Multiple plans to wipe off the neighbourhood from the map of Rotterdam.

March: The action group Het Oude Westen is founded.

Oude Westen got a project group city renewal.

New projects reconnect the neighbourhood to the city.

The Action group Het Oude Westen is rewarded with the Maaskantprijs.

1894: Development continues. The houses are small and lack good foundation.

1870: Individual developers start to built. Waterways are filled and development starts, often along the West-Kruiskade.

1887: Coolpolder plan: De Jongh makes a plan for the polder, based on the north-south oriented streets with some major boulevards and lanes.

1903: The area is practically full.

1964: Plans for demolition.

1970: City renewal

1975:

1980:

1980-1993:

1839: The land belongs to Delfshaven. The long polderlines are visible on the map.

1870: Individual developers start to build. Waterways are filled and development starts, often along the West-Kruiskade.

1882: Development continues. The houses are small and lack good foundation.

1887: Coolpolder plan: De Jongh makes a plan for the polder, based on the north-south oriented streets with some major boulevards and lanes.

1903: The area is practically full.

1964: Plans for demolition.

2011: Policy map connecting neighbourhood to the surrounding city.

Figure 49: Maps of built development
**History**

**Neighbourhood Oude Westen**
This neighbourhood is a typical residential neighbourhood within the city center of Rotterdam. The neighbourhood is bordered by four main roads: Weena in the north, ‘s-Gravendijkwal in the west, Rochussenstraat in the south and the Westersingel [fig.47], one of the waterways of W. Rose (van Es, 2010) which is still visible and in function as a part of the city water system, in the east. Within the area there are three large, access, roads and many small residential streets with parking on both sides. Two old polder roads, West kruiskade and Nieuwe Binnenweg, seperate the neighbourhoos in three parts [fig.48].

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**Before it belonged to Rotterdam**
The land, what is now the neighbourhood Oude Westen, belonged to the municipality Delfshaven for centuries. It was part of the Coolpolder, an old wet agricultural polder on the west side of the old city of Rotterdam. There were two long east-west connecting roads between the old city triangle and the surrounding polders, one was a country road that connected Rotterdam to Delfshaven and the other was a main polder ditch accompanied by a path [fig.48]. In between these two long lines were small north south oriented ditches and strips of land. Around mid-1800 Delfshaven started to sell pieces of land to developers and they started to develop the land, ditches were filled up and transformed into small roads. Small buildings arose on the narrow plots (van der Gaag, 1993; van Es, 2010).

In 1872 the Nieuwe Waterweg was opened and the trade grew. With this growing trade, more and more people came to Rotterdam to live and the city and the harbor needed to expand. Developing the Coolpolder was logical, the area was close located to the city of Rotterdam and could expand the harbor over the entire river bank, although the land did not belong to Rotterdam. Its city architect W.N. Rose, did made plans to develop the Coolpolder by geometrical lines and squares, since 1852. In 1866 he designed his third extension plan which followed the landscape patterns instead of introducing a new grid. This plan has not been executed. A plan that was executed was his Waterplan in 1854. This system of waterways was meant to separate the urban water from the polder water in order to improve water quality. Due to this plan the city water could be flushed, which improved the water quality. The groundwater level became lower so the city could expand. The new waterlines became city walks and along these green and blue lines the land was developed as a residential area for wealthy citizens. One of these waterlines, the Westersingel, seperated the city of Rotterdam from the sub-municipality Delfshaven.

The growth of the city between 1880 and 1900 was enormous and the pressure on the city increased even more. Expanding to the west became necessary. In 1883 the municipality asked G.J. de Jongh to come up with a solution. He advised annexation of the land and presented his expansion-and sewer plan for the Coolpolder. The plan was inspired by the third plan of Rose from 1866.

![Figure 50: The Westersingel, one of the waterlines from the Waterplan of W. Rose on the east side of the neighbourhood.](image-url)
Becoming a Rotterdam neighbourhood
In 1884 the municipality of Rotterdam officially annexed the Coolpolder and the small scale development became a part of the city. The area was quickly developed by individual plans without any structure or overall plan. The base was formed by the old polder parcelation. The developments started around the West-Kruiskade with the development of the Gouvernestraat as one of the first or even as the first street. Due to the individual developments in the area, every street looks different. Even when they are built around the same time. Since the annexation the municipality of Rotterdam had the task to guide the development as good as possible. New street plans came to reality due to a kind of negotiation policies and measurements. De Jongh managed to lead the individual developments according to his polder plan. And with this negotiation approach and his expansion and sewer plan, De Jongh led Rotterdam into a new era of planning, where the municipality could set regulations for development.

Changing or improving
Only in his second revision of his polder plan, De Jongh started to design singels, streets, lanes and squares. Behind his static streets with impressive houses, the small working houses were built. This representative new street view of lanes and housing was hiding the small poverty behind (Van der Gaag, 1993, p. 11). The neighbourhood Oude Westen became an unwanted dissonance.

Around 1903 the Oude Westen was almost completely developed. Left over space was filled and incidentally buildings were replaces by new constructions. The two ‘long polder lines’ remained in the city and they became the route for public life with a range of small shops and businesses (Van der Gaag, 1993). While in the official city policy the neighbourhood was unwanted and needed to be hidden, in daily life the neighbourhood was a vital, bustling part of the city.

Through the years several plans to radically restructure the neighbourhood have been made and have been swept away. In 1938 J. Wils designed a new plan for the old Diergaarde area. The high and modern buildings were standing in the open space and this plan was meant to be an example for the rest of the neighbourhood (CIAM style). During the WWII the Oude Westen was spared of bombs and the fire, to be regret by some people. The reconstruction plans of Van Traa in 1946 were modest compared to the plans which rose in the ‘50. Plans to connect the Weena with the Nieuwe Binnenweg would mean the demolishing of more than 2000 houses in order to create a broad street (profile) and to ‘finish’ the formal road structure plan of De Jongh. The lack of money stopped this plan and other plans came along. For example the plans to place a university in the middle of the neighbourhood, but building in the polder appeared to be cheaper. In 1964 plans were made to gradually demolish the entire neighbourhood, only the edges would remain [fig.51] (Van der Gaag, 1993).

These plans were accepted in 1969 by the municipal policy and were meant to create the possibility for the city to extent the concept ‘green fingers’. While waiting for these plans to
be executed, the neighbourhood got a improvement plan
to improve temporary and on a small scale by addressing
parking problems and the lack of playgrounds.

The continuing threat of demolition caused the
neighbourhood to decrease in quality. People were not
willing to invest and maintenance was behind schedule.
Families, who could afford, left the neighbourhood and due
to the low rent, other people came in. The first sounds of
protest came from a group of mothers who said their children
grew up in a neglected neighbourhood. They demanded
acceptation and connection to the rest of the city. Their
call got response from others and in 1970 an action group
‘Aktiegroep Het Oude Westen’ was established, to maintain
and improve the neighbourhood which was well known for
its vibrant nightlife that reminded to the old city center.
The city renewal was facing the utopian plans of 1969 and
arose validation and appreciation for the neighbourhood.
One of the most important starting points of this policy
was: a good residence in a good living environment with
attention for the poor. The municipality bought individual
owned houses in order to stop housing speculations in the
area. The bought properties were transferred to housing
corporations who would take care of the maintenance, good
quality of the property and surroundings and affordable
rent.

In 1975 the Oude Westen got a city renewal project
group, in which the action group had a majority of votes.
Together with the municipality they made a vision for the
area. In 1976 this resulted in a new policy document for the
neighbourhood that gave inhabitants the certainty about
the future of their neighbourhood. For the Oude Westen
these plans for city renewal meant that 40% of the houses
were replaced by new buildings, 40% was renovated and
20% was only slightly modernized. No property remained
untouched by this renewal. Collective ownership was one
of the trial and error approaches and due to the coalition
between active inhabitants and a group of architects,
more acceptance of the multicultural appearance and the
cultivation of this quality appeared. In 1980 the action
group was rewarded with the ‘Maaskantprijs’, for their
participation and contribution to the city renewal (Van der
Gaag, 1993; Van Es, 2010).

More visions and structure plans arise for the
neighbourhood to connect the area better to the rest of the
city and to improve the quality of living within. Also safety
and drugs control are major topics. Recent visions and plans
involve the inhabitants of the neighbourhood. One of the
initiatives is Aliantie West-Kruiskade, that want to put the
neighbourhood and especially the West-Kruiskade in the
picture (Woonstad Rotterdam, 2010).
Figure 53: The urban structure of 1910, 1970 and 2012.
Morphology

In this section, the structure and orientation of the neighbourhood will be discussed.

The structure of the neighbourhood has remain similar to the original structure of 1910. The base for the road structure is the underlying landscape/polder structure.

Over the years some streets are changes and building blocks are replaced by newer blocks, but the percentage of built vs unbuilt surface is relatively the same.

The map of 1910 shows that 39% of the area consist of buildings. The innergardens are not a part of the built surface. In 1970 the percentage was higher with 41% built surface and due to the new made east-west connections and public spaces, the percentage built surface in 2012 is reduced to 34% [fig. 53].

Nevertheless, this neighbourhood shows in 2012 a housing density of 71 houses per ha, this is indicated as a high density urban area. The streets are narrow, many surfaces are paved and building blocks dominate the horizon. The open spaces, the squares, make the neighbourhood more liveable and useful for playing and meeting other people.

‘Deze wijk moet het hebben van zijn pleintjes.’
- by Norbert Broers (Woonstad Rotterdam, 2010, p. 64)
[‘this neighbourhood needs its squares’]
Figure 54: Shadow measured at 13.00 hour every month on the 21st. Top left: January, top right: June, bottom left: July and bottom right: December.
The second morphological subject is the orientation of the neighbourhood. The orientation is almost North-South and most streets lead from North to South as well [fig.56].

For the orientation towards the sun, a small sun study has been done. The sun and shadow situation of the neighbourhood are analysed by looking at the shading of the buildings of the 21st day of every month at 13.00 hour. The overview is represented in figure 54. The conclusion map [fig.57] shows both the shadow as the sun side of streets and squares. Due to the North-South orientation of the neighbourhood structure, almost every street and square has got both a shadow and a sun side. Although in the winter months most small streets do not receive any direct sunlight.

Figure 55: Shade by summer and winter position of the sun on a small street profile (10m wide).

Figure 56: North-South orientation.

Figure 57: Shadow-and sun sides.
To get back to my hypothesis: ‘Between the large scale projects from the municipality and the small scale interventions that home owners can do, an intermediate scale is missing. This scale can be the connector between scales to enhance resilience of the house, street, neighbourhood and city, based on collaboration.’ - Hypothesis on page 26.

As the hypothesis states, the intermediate scale addresses both private owned property and public property from the municipality. Therefore it is important to gain knowledge about what subjects are related to this intermediate scale and how this relates to the Oude Westen.

The base of the intermediate scale is the tension between public and private, whether it is about value, interests, surface or maintenance. Therefore it is obvious that these subjects need to be looked into. Who owns what and what kind of spaces are we talking about?

Figure 58: The intermediate scale deals with both private and public property and the tension between ownership, usage, intentions and interests of these sectors.
**Private/collective**

Almost all building blocks have an innerspace that is either publicly accessible, collectively owned by the housing corporation or private. Map 59 shows which innerspace has got what type of accessibility.

Some of these spaces are meant for sports activities (picture 1), these locations are publicly accessible. Some are almost completely paved (picture 2) and some are both paved and green (picture 3). The amount of private gardens seems to have a positive influence on the amount of green space. Most collective spaces are paved, this is easier for maintenance.

Based on satellite images and personal observations, the ratio paved/green is about 50%/50%.

Figure 59: Three types of inner gardens, private, collectively owned or publically accessible. The photos are made by the author.
The ownership of property in the neighbourhood is quite clear. A large amount of buildings is owned by housing corporation Woonstad, they own more than 70% of the properties [fig. 60,61]. Other owners are private owners (they bought their house and live in it), private renters (they bought the house, but rent it to others) and the municipality. They own only a small percentage of the buildings.

When comparing the ownership ratio from the neighbourhood to the ratio of Rotterdam, the percentage of rent is much higher in the neighbourhood. This can be explained by the large percentage of ownership of Woonstad, the active housing corporation in the neighbourhood [fig.61].
Four generations of buildings
The neighbourhood is a mix of building styles. From 19th century to 1970s’ city renewal and recently new build properties. The size of the buildings and the blocks expanded over time, from the single designed houses in the 19th century to the large building blocks of the city renewal.

The property can be divided in four generation of buildings: before WW I (1860-1914), before WW II (1918-1940), the city renewal (1978-1990) and the modern new built (1990- now). All four generations are still present in the neighbourhood, although the first and third generation are best represented. The undermentioned percentages represent the amount of built surface in this generation.

1. 1st generation: 39.5%
2. 2nd generation: 17%
3. 3rd generation: 41%
4. 4th generation: 2.5%

Figure 62: Four building generations are present in the neighbourhood.
The first generation buildings show a close relation to the North-South oriented small streets. Each building has got decoration, detailing in brickwork and/or white plaster. The houses were built in series of multiple houses. The brick buildings count two to five floors, finished with a gable roof. Most of these 19th-century buildings have been replaced but in some streets they are still present and represent the 19th century style of architecture [fig.63].

This style shows a facade articulation with a clear separation of the different floors. Although most buildings have a gable facade, the roof typology differs. There are pointed facades with a tilted roof, gable roofs, flat roofs and other varieties. The detailing and decoration is characteristic for this generation of buildings.

The second generation was built between 1918-1940 and expresses itself by building blocks that were united behind a shared facade. Without exception, all these buildings count four floors. The architecture is characterized by simple brickwork and the absence of detailing [fig.64]. The facade articulation puts a focus on the ground floor. The roofs are either flat or tilted. The articulated entrance/ground floor is characteristic for this building generation.

Figure 63: The first generation.
Figure 64: The second generation.
The time of city renewal, 1978-1990, marks the third generation of buildings. The base is a building block with a shared courtyard and the height varies between three and five layers. The housing complexes have flat roofs. The style is recognizable due to the use of various forms, colors and materials (van Es, 2010) [fig.65]. Most roofs are flat and there is no facade articulation.

The fourth generation is now under construction or recently completed [fig.66]. This generation is modern but still suits the old road structure and some of the features of the first generation seem to make a comeback. For example the horizontal lining in the facade, the grey plinth and the facade articulation which shows every floor.
The roads appear in two categories [fig. 67]:

- The neighbourhood access road. Roads with a maximum speed of 50 km per hour and traffic in two directions. Type of surface: asphalt.

- The residential streets, 30 km per hour and one direction traffic. Type of surface: brick.

In base the access roads are the boundaries of the neighbourhood and they provide connect the neighbourhood to the city. Within the neighbourhood an old grid of small residential streets provide access the interior of the neighbourhood.
These two types of roads can be divided into four variants.

Access roads [fig. 68]:
- Two direction traffic and often accompanied by a tram and/or bus. On both sides buildings border the street profile.
- Roads that are bordered on one side by buildings and that open up towards surface water on the other side.

Small residential streets [fig. 69]:
- With buildings on both sides.
- Street on the edge of a square or an other open space.

Figure 68: Two variants of access roads.

Figure 69: Two variants of small residential streets.
Surfaces

In the public space there is a difference between roads and public spaces, like squares and parks. The roads are already described, which leaves the public space. The public spaces have a certain surface type and use. The questions what is where for whom and how do these spaces look like are relevant. In order to answer these question, the neighbourhood is analysed within a larger context.

In total 40 public spaces are analysed. Figure 70 shows all the locations that are analysed. The subjects of analysis are: surface type, possible activities, elements and atmosphere. All locations are categorized as can be seen in the location index. 17 of the 40 location that are analysed are located within the neighbourhood.

Location index:

Zoo
1. Diergaarde Blijdorp
2. Bentincklaan
3. Henegouwerplein
Park
4. Essenburgsingel
5. Heemraadsingel
6. Wijkpark
7. Museumpark
8. Het Park
9. Westersingel
10. Branco van Dantzigpark
11. Akeleistraat
12. Kogelvangerstraat
13. Adrianaplein
14. Babylon schoolplein
15. Gerrit Stekmanplein
16. Josephsplein
17. Diergaardesingel
18. Hobokenstraat
19. Schiedamse Vest
20. Frank van Borselenstraat
21. Jan van Avennesstraat
22. Oostervantstraat
23. Aleidisstraat
24. Skatepark Westblaak
25. Coolhaven
26. Zijdewindeplein
27. Rijnhoutplein
28. Toni Koopmanplein
29. St Mariastraat
30. Stationsplein
31. Kruisplein
32. Diergaardesingel x Kruisplein
33. ’s Gravendijkwal
34. Schouwburgplein
35. Tiendplein
36. Speelcentrum Weena
37. Roehussenstraat
38. Jan Evertsplaats
39. Joost Banckertsplaats
40. Lijnbaan

Figure 70: Placing the numbers on their location.
Of the 40 locations:
- 7 are marked as a park
- 16 contain play objects
- 12 contain game objects (ball sports etc.)
- 40 have a solid (paved) surface
- 18 also have a soft surface
- 8 locations have surface water
- 36 locations have trees as lose elements
- 11 contain a terrace function.

The activities are quite scattered. The neighbourhoods with more children, also have more public spaces with play- and game possibilities. Remarkable is that of 40 location, 23 locations only have a solid surface! This is 57,5% of all analysed locations! And 13 of these locations are located within the neighbourhood the Oude Westen. So of the 17 locations within the neighbourhood, 13 locations only have a solid surface.

Looking at rain water surplus and how to deal with it, more softer surface would increase the amount of permeable surface and thereby the ‘sponge’ capacity of the soil.
These conclusions are translated back to the neighbourhood. These two pages are showing the surface typology [fig.72] in the public spaces in the neighbourhood and the use of them [fig.73], according to the previous analysis. Both pages show a map and three photographs that visualise a number on the map.

Figure 72: Different surface types.
Figure 73: Use of public space

Legend
- playing (play+game)
- relaxing (park)
- drinking and meeting (terrace)
Collaboration

The intermediate scale requires collaboration between all stakeholders in this scale. It is an collaborative scale! When saying that stakeholder need to collaborate, the question arises who needs to work when with who?

The residents live in the buildings, owned by the corporation, municipality or themselves. In the case of them renting the property, they are not responsible for maintenance, renovations et cetera but they are only users. The municipality owns the public space, but the inhabitants use this space. The waterboard has an almost invisible role, but their decisions influence both the owner of the property and the owner of public space. For example when they would decide that the groundwater level needs to lower.

Every stakeholder is related to an other stakeholder. Every surface they use overlaps with the responsibility of an other stakeholder.

Where the responsibility of one stakeholder stops, the responsibility of another is seamlessly connected to it. The fact that every surface has an owner and user, makes that performing projects on this scale is complicated.

This underlines that collaboration is important. And when stakeholders are willing to participate or to start the dialogue with each other about interests and ambitions, then successful interventions, which are embedded in the local scale- and structure, can come out.

But not every stakeholder needs to be a part of every intervention. It is based on which surface will be used for the intervention and what is the intention of the intervention.

When we talk about building related collaboration, all surfaces that belong to the building (like roof, facades and courtyard) are part of the conversation between the stakeholders who own or use these surfaces. It is a collaboration between owner and user of the building related surfaces.

The surfaces that form the transition between building and public space need another form of collaboration. Not only are the stakeholders who are related to the building (owner and user) involved, but also the owner of the public space.

But even when the owner of the public space would do an intervention in the public space, close to the buildings and in the range of daily activities for the inhabitants, it seems logical that the users are consulted before acting. After all they are the ones that use these spaces.
Willing to participate!
Throughout the centuries this neighbourhood was developed by organic growth and the large scale plans of De Jongh and Witteveen could not change the vibrant small scale neighbourhood. Oude Westen has got the strength to survive al the demolition plans. Active involvement of inhabitants in the development of the neighbourhood shows goodwill towards the quality and vitality of the neighbourhood. Multiple initiatives, organisations and groups can be found in the neighbourhood like The Actiegroep with their own location, de Leeszaal, a public library with donated books where lectures and small scale classes are given, a food spreading organisation to help those who have little money to spend. These are only a few examples of the active involvement of locals with their neighbourhood and with each other. All initiatives are runned by local residents. The questionnaire held among residents also pointed this out. Although the neighbourhood is not rich, many people are willing to contribute to activities and programs like maintenance.

This high level of involvement [fig.75] characterizes the neighbourhood and its vibrant life. Throughout the centuries it has always been the inhabitants who made their neighbourhood and that is valuable and that can certainly help with future innovations and developments in the neighbourhood. Especially when these innovations require the interaction between inhabitants and the municipality.

Figure 75: Oude Westen social index 2012 : social intercation and involvement.
Problems

The neighbourhood is plagued by several issues that form a problem for the future quality of the area.

One of these issues is the heat island effect that influences daily activity and human health. The red contour covers the area where the temperature is higher than 20°C for more than 18 days in a row [fig.76]. The narrow street structure prevents wind to blow through the streets so the warm air remains in the neighbourhood. The large amount of paved and built area is absorbing the sun warmth and they release this heat in the evening, making it impossible for the area to cool down at night. So, yes, the neighbourhood morphology is part of the reason why this neighbourhood is suffering from the heat island effect.

Another issue that plagues this neighbourhood is the event of soil subsidence [fig.77]. Soil subsidence is an effect of human interfering with the natural soil system. The natural soil type is peat, a water containing soil type that subsides when the water is drained. Pumps drain the land to make it usable, causing the soil to subside and the groundlevel will lower. The red dots represent the areas where the soil is getting lower and lower, with consequences for the stability of property and infrastructure. The soil subsidence is also increasing the pressure on ground water level and the threat of pluvial flooding. This downwards spiral is comparable with a bath tub.
Although the city of Rotterdam is a water city, the neighbourhood Oude Westen hardly notices anything of these large waters. When looking at the map, the surplus of water from the neighbourhood is not discharged on surface water. There is only one overflow nearby at the Westersingel, but it is not reasonable to think that this overflow can handle all the surplus in case of heavy rain.

The conclusion must be that all the surplus of rainwater disappears into the sewer system and that all this clean rain water is discharged towards water cleaning facilities while it is often of good quality and does not need the cleaning treatment. The challenge is to disconnect the rain water from the sewer system and adjust the urban space in order to deal with this clean water, this will also lower the pressure on the sewer system, overflows and pumps.

Figure 78: Water system of the neighbourhood Oude Westen and the surrounding context.
The entire neighbourhood is part of the water assignment from the municipality between 2015 and 2050 [fig.79]. Not only is this water assignment based on potential flooding from the river but also on potential flooding from rainwater.

The neighbourhood is a dense center location which contains large amounts of paved surfaces. In figure 80 the current situation of the neighbourhood is visualised. When it is raining, water falls on four types of surfaces; surface water (like the Westersingel), soft surface (grass, bushes, vegetation), solid surfaces (paved areas, asphalt) and on buildings.

51% of all the rain that falls down in the neighbourhood, falls on solid surfaces, this water can not infiltrate in the soil and is discharged via the sewer system. This same counts for the built surface. Only the rain that falls on soft surfaces can infiltrate in the soil.

Besides discharge and infiltration, there is also evaporation of water. This can only occur when sunlight can warm up the water, therefore evaporation only takes place by surface water and soft surfaces.

The lack of large amounts of surface water and soft surfaces makes that almost all fallen rain needs to be discharged via the existing watersystem. And this pressure is a part of the problem. When the pressure gets to high, the water cannot be discharged, with flooding as a result. The water assignment of the current situation is calculated to be 12,491m³.
Conclusions

The morphology of the neighbourhood is the result of organic development, based on the underlying polder structure. This organic development, together with the city renewal programmes, resulted in four recognisable building generations. Each generation has got its own features and characteristic elements.

When it comes to ownership of property in the neighbourhood, the housing corporation Woonstad is an important stakeholder. They own more than 70%.

The intermediate scale is a collaborative scale in which diverse stakeholders play a role and different surfaces are present. Stakeholders need to collaborate in order to realise projects that suit owners and users. There are three types of collaboration defined:

- building related collaboration where both owner and user of the property collaborate.
- transition collaboration where both owner and user of the property and public space collaborate.
- consulting collaboration where the owner of the public space consults the user for input and wishes.

Just like the water problems, the heat problem can be related to both the neighbourhood morphology and surface typology. One of the starting points for this project is that the structure of the neighbourhood (streets and building blocks) will remain mostly the same. So solutions of these two assignments need to be found elsewhere.
Soften Oude Westen
Figure 81: Benefits from a soft soil in comparison with a solid soil; infiltration and absorption.
**Soften the city**

The structure of streets and building blocks remains mostly the same, but the surface typology can change. The neighbourhood contains 85% solid surfaces of which 51% solid surfaces like streets and pavement. In order to solve both water- and heat issues, changing the surface materials makes a difference. Therefore soften the Oude Westen solves at least a part of the assignments.

But why should we soften? And what are the positive effects of softening?

**Changing surface, solid to soft.**

Changing the surface form solid to a soft surface brings multiple benefits; noise, sun light and warmth can be absorbed. Beside that, an open soil can absorb rain water more easily. This results in a hydrated soil and gives possibilities for vegetation to grow and to provide a cooler environment. Without a hydrated soil, no vegetation will live long and one of the solutions to bring down urban heat is using green. Apparently, dealing with rain water in a smart way as by giving it back to the natural system seems to be a basic demand for the city to cool down. Without water, there are no possibilities for green and water elements to cool down. By extending the amount of soft surface with 10%, the average temperature will lower by 1°C (Buijs and Streng, 2013).

By addressing the importance of using water, comes the use of rain water. A fact: rain water is for free and it will fall no matter what, why not using this free gift from nature to lower bills, provide joy and hydrate the soil.

![Diagram](image-url)  
Figure 82: A hydrated soil provides minerals for vegetation and allows them to grow, the benefit is more cooling when vegetation grows bigger.
Vision

The North-south oriented streets form the leading structure in the neighbourhood. These long lines are crossed by a newer East-West structure of streets. Connected to these East-West structures public spaces like squares and playgrounds are attached. They are the places for gathering and playing in the neighbourhood. The original structure of the neighbourhood [fig.53, 1910] is more and more enriched by squares and wide pedestrian streets.

The squares and wide streets catch more sunlight than the narrow residential streets. The basic ingredient for evapotranspiration and cooling are present (sun warmth), only green and water is still missing. By focussing on green and water on these squares, the surrounding area can cool down. Adding more green to the neighbourhood has also health benefits.

By extending the East-West connections and making new squares, the amount of ‘cool places’ can be enlarged. The squares are very important for the social interaction in the neighbourhood, often children play there and parents meet. When these spaces become healthier and cooler, they effect more people due to the social gathering of people.

The goal to cool down the neighbourhood with a minimum of 1°C requires at least 10% more soft surface. The squares are big enough to contribute to this temperature goal. Thereby soften the surface helps the water assignment in a positive way and by placing a water element, it can also become a part of the playgrounds for children.

The green and blue structure is placed in a network that used
existing and new squares and wide pedestrian streets in the East-West direction. To implement the network, the green strips provide direction to search for space and possibilities to realise this network. Besides proposing a network, the building stock in the neighbourhood needs renovation and re-development. This goes for the building between the Bajonetstraat and Adrianaplein as well. This red coloured building in figure 85 is scheduled to be demolished. A redevelopment of this spot can include climate assignments and integration in the East-West network.

Within this vision the task to deal with climate and rain water in specific. The ambition is to get an integrated climate approach. How can the nuisance from rain water be reduced, while also reducing the effects of other climate issues?

Neighbourhood goal
- Soften the surfaces without influencing the functionality of these surfaces.
- Reduce air temperature with 1°C by enlarging the amount of soft surface with at least 10%.

Demands
This vision results in a few demands for further development of the neighbourhood;
- The network needs to incorporate existing public spaces and East-West connections and this will be enlarged.
- Rain water needs to be caught wherever possible.
- The amount of permeable surface needs to be enlarged in order to soften the neighbourhood.
- Climate assignments and the contribution to that needs to be kept in mind while re-developing buildings.
- Squares will get a green and blue focus in order to cool down the surrounding area.
- The spatial structure of streets and building blocks will remain mostly the same.

Figure 85: Vision map with search area for network and building renewal.
As mentioned in the vision, the neighbourhood needs to become softer. More permeable surfaces, more water and green. This was also one of the outcomes of the questionnaire spread among inhabitants (more results see attachment 2).

In the theoretical framework four aspects were described to define adaptation and three steps that need to be taken by forming a collaboration between stakeholders. These seven aspects will be used to describe the design ‘soften Oude Westen’. As mentioned in the description of adaptation, the aspect of time defines itself as a short term investment with a short or long term solution. In the case of this graduation project there is both a short and a long term solution offered.

The short term investment is investing in action needed right now. All small actions as proposed are such interventions, for example small facade gardens or softer gardens. They can improve the situation within a short time frame and the effect is rapidly noticeable. In order to place all short term investments in a structure, a long term solution needs to be mentioned. For this neighbourhood a long term goal is to reduce the air temperature and to reduce the water assignment as addressed in figure 80.

For example, trees need time to grow, so their contribution to cooling, shading and improving air quality takes time before the maximum contribution is reached. Nevertheless without planting them in the first place, they can not grow at all. So planting trees to greener the street and to open up the soil is a short term investment with a short term result (directly after planting the street will look greener) but over time they contribute to a long term solution of improving the urban climate. So far, the value of using short term investment contribute to long term solutions.

When we look at the yearly perception of time, there are moments when heavy rainfall is predicted and moments of drought are indicated. It seems logical to keep the surplus and use this in time of shortage. This means that the water needs to be stored for a longer period of time.

When we look at time, related to interventions and the intermediate scale, small individual interventions can trigger collaboration of others which can lead to more bigger interventions that can make a difference.

In order to let the local residents join in or to trigger them to participate, a planning needs to be made how this can be done and what the bigger goal is. This is enlarging the awareness, that interventions can make a difference and that the people themselves can benefit from it.
Stakeholders

In the chapter 4, Rotterdam, the conclusion mentioned a certain attitude towards planning and involving stakeholders: the bottom-up approach. This includes local inhabitants to participate in the process.

In chapter 3 the subject of collaboration is described. Three tasks came out which need to be answered before starting the project/process.

1. Determine the type of assignment.
   The mindset needed for this assignment is adaptation, reducing the impact of heavy rainfall and urban heat. The assignment is to adjust the existing neighbourhood Oude Westen to these two issues without changing the neighbourhood structure. In order to achieve a maximum reduction, all surfaces need to contribute. This means both public and private surfaces. A transdisciplinary approach brings both parties together, knowledge, experience and practice needs to be combined.

2. Determine what knowledge and influences are needed.
   Who are core stakeholders?
   Knowledge about the daily life and intentions of the neighbourhood as well as the intentions of the municipality and housing corporation are needed. Not to forget, knowledge about the current watersystem, so the waterboard is needed to participate. This results in four core stakeholders: inhabitants of the neighbourhood Oude Westen, housing corporation Woonstad, the municipality of Rotterdam and the waterboard Hoogheemraadschap Schiedam en Krimpenerwaard. Via a participation planning (chapter 8), the process of bringing these stakeholders together will be explained.

3. Reaching mutual gain by aligning ambitions and interests.
   For all the core stakeholders information about ambitions and interests is collected. The inhabitants want to have a safe and pleasant neighbourhood which may be greener. The municipality wants a vital, future and climate proof neighbourhood. The Housing corporation also strives for a vital neighbourhood with a certain level of property value, a good relationship with the inhabitants and climate proof. The waterboard aims at a safe and clean water system in an attractive environment which is future proof.

Aligning ambition
- Inhabitants: a safe and pleasant neighbourhood
- Municipality: a vital and climate/future proof neighbourhood
- Housing corporation: a vital and livable neighbourhood
- Waterboard: a safe and dry neighbourhood

Joined ambition:
‘A vital, safe and climate/future proof neighbourhood that suits the urban context and the inhabitants.’

The neighbourhoods’ ambition is to become a more vital, safe and climate/future proof neighbourhood where inhabitants partly influence their own environment. All core stakeholders are willing to start the dialogue with each other in order to see if they can bring the intentions they have to a next level.
Space/ scale

One of the subject of adaptation was space/scale. Adaptation is both local and regional and needs to be flexible in order to handle the uncertain effects of climate change. The large scale in this project is the scale of the neighbourhood Oude Westen and the local scale are the two locations which will be elaborated in chapter 7.

In this case, the large scale plan provide guidelines for the local and small scale interventions and the other way around, the small scale interventions contribute to a larger goal. The design needs to be flexible, which means that it can not only handle uncertain amounts of water, but that it is also an added value for the surroundings when there is no rain water in the system.

Roads
The first layer of this neighbourhood design is the road differentiation. As mentioned before, the neighbourhood is surrounded and crossed by access roads. Beside the access roads, the neighbourhood itself also contains roads and streets, most of them are North-South oriented. Just a few streets still cross the entire neighbourhood in this North-South direction. These ‘continuing roads’ form the second type of roads. The third and last type is the small residential street.

For both the access roads and the small residential streets are new road profiles proposed conform the guidelines of the policy Rotterdamse stijl. Not only the material will change to more permeable materials, but also the lay-out of the profile will change.

Figure 87: Road differentiation.
Water system
The second layer is the water system which exists of three steps. The first step is catching the water where possible. This happens on every surface, but because the roof only can play the role of catch, this is where nr 1 is placed. The second step is to infiltrate, re-use and discharge the water in streets and inner gardens. Infiltration goes directly into the soil, re-use is bringing the water back to the households to use it as grey water to, for example, flush the toilets. The third step is infiltrate and use the water in public spaces like squares. One of the outcomes of the questionnaire among inhabitants brought up that most people would like to see a water element in the public space where children can play in in summer. Enlarging the amount of (surface) water on the squares contributes to the cooling of the surrounding areas and provides a moist soil for vegetation to grow.

This water system is applied through the entire neighbourhood. After all every surface needs to contribute to the waterassignment. We need to chatch it where it falls.

Figure 88: Water system exists of three steps from catch to infiltrate, discharge and use.
Network
The third and last layer is the proposed network. The network uses existing- and new public spaces to run from East to West through the neighbourhood. It is designed to maximize the cooling capacity of the neighbourhood. Therefore the focus is on using green and blue elements to create evapotranspiration and shade.

In order to make the network visible and recognisable when walking down a street, tall elements (trees) are used as network related elements. Chosen is to use multi stemmed birch trees for their white stem and apple trees for their blossom color, fruit and autumn colour. The fruit is public, so everyone can pick them. In the winter the white birch trees are still recognisable.

The network crosses streets in its East-West structure. Some of these roads are dominant over the network which means that these streets continue in the same way. The profile and material remain the same. Other streets are subordinate to the network. These streets will change in material when crossing a part of the network and limited parking places will remain. The changing of material and color creates a visual barrier that slows down the traffic.

In the layer, road differentiation, the two neighbourhood streets are mentioned. One street profile remains and the other will change. The small residential streets are subordinate to the network, while the continuing streets are dominant over the network. Figure 89 shows the concept of the network and neighbourhood streets and the profiles that belong to these streets.

Surface materials for the network are more permeable (for bricks and pavement) or are soft, like grass. For the vegetation, different heights and species are required to maximize the evapotranspiration. The soft surface makes it possible for water to infiltrate into the soil, this provides nutrients for the vegetation to grow. The water system indicates that the squares have some kind of large water element, whether it is an infiltration field or a water play object.

![Network Diagram](image-url)
Figure 90: Multi-stemmed birch trees: recognisable white stem, climbable.

Figure 91: Apple trees: blossom, fruit, autumn colors, fauna

Figure 92: The network of public spaces, recognisable and some squares are green/blue to cool down the surrounding area.
The East-West connections are a part of the network and the water system. For these locations there are three variants to deal and discharge rain water. By visualising these streets, the recognisable trees of the network can be seen as well. The network only uses public spaces, therefore the focus of these three variants is on the public space.

Figure 93: Variant 1, the middle of the street is an infiltration field with grass and trees. Water from the rain pipes is transported by the infiltration tile towards the gutter and infiltration zone.

Figure 94: Variant 2, the middle of the street contains a solid gutter with a playfull look and way of streaming. Water will runn down via a rainpipe, through the tile gutter into the street gutter.

Figure 95: Variant 3, one side of the street is an infiltration zone. Water will runn down a rainpipe via a gutter towards this zone or will flow directly into this infiltration field. trees added.
Costs & benefits

Who is responsible for what? In a traditional process the municipality would be responsible for the interventions and maintenance in the public space and the housing corporation for all building related projects. This thesis addresses that there are more stakeholders involved and all of them should contribute to the process, planning, execution and maintenance if they can.

One of the outcomes of the questionnaire among inhabitants is that they are financially not able to contribute, but they are willing to join the process and to do the maintenance of the interventions they will be involved in.

The housing corporation is still responsible for their property, but the costs for interventions can come from elsewere. For example the municipality has a subsidy for green roofs. An other example could be to ask a little bit more rent from the people who would financially benefit from a green roof; due to its isolating capacity that lowers the energy bill. At the end of the year, these people will not pay more than normally, they only pay to an other party.

For the process and initiatives for interventions, the neighbourhoods’ residents can play a major role. When they want to do projects in their gardens, the initiative comes from them. Possibly the Aktiegroep Oude Westen can contribute to that by facsilitating a meeting location in the neighbourhood.

Beside all this, there are new structures needed that activate people to join and that provide mutual benefits for all involved parties. The question ‘what is in it for me’ is important. Underlining the financial, health related, climate proof, social and other benefits, makes it easier for parties to join in. And then structures for payment and maintenance can be discussed.
Masterplan Oude Westen
The tree layers of the neighbourhood design; roads, water system and network, are explained and combined in this map.

The three road types are visualised. The materialisation of these roads will change when possible, into more permeable materials. This will enlarge the infiltration capacity of the surface. Rain water can infiltrate more easily.

The network uses the East-West direction of squares and pedestrian streets. Some of the squares have a green/blue focus due to the orientation of the sun and the amount of sunlight on the squares. The green and blue interventions, in combination with sunlight, cool down the surrounding area and create a more pleasant urban climate.

The new building block is visible in red. This block will be elaborated on in the next chapter.

> Figure 96: Masterplan Oude Westen.
Figure 97: Toolbox based on collaboration, green and blue, heat and water.
Tools

Previous in this document is mentioned that the intention is to soften the solid surfaces, this contributes to the water assignment and to reducing urban heat. But this ‘soften’ can be done in many ways.

The intention is to open up peoples eyes, on how easy they can contribute with small interventions to the goal of softening the city. Therefore climate tools are mentioned. These are examples of small interventions that can make (small) changes to the neighbourhood. One can think of changing surfaces, adding elements and changing current systems without changing the current building context.

These ‘tools’ are related to the previous mentioned surfaces and the three themes: water, heat and collaboration. Heat can be solved in adjusting the surface and to place elements that can cool the area. Rain water nuisance can be addressed using the term catch, infiltrate, discharge and (re)use. Together with the three types of collaboration, this resulted in the toolbox on the previous page. All tools have their own contribution to the climate assignment. Although each tool contributes, the combination of tools strengthens the effect.

Thinking about what can be done with each surface that is relatively easy to achieve and what contributes to the climate assignment of rain water and urban heat. In that way it is easy to discover what can be done with a certain surface. What type of collaboration goes with it and how it contributes to the water and heat assignment. This learns us that even the small and simple steps can make a difference.

The amount of tools can be enlarged by the input of others. The given tools will be used in the further project.

Most important is to notice that these tools are examples of what can be done. They can trigger discussion and possible collaboration between stakeholders. The mind switch towards ‘it is easy for me to contribute and I always wanted a green facade’ is valuable if any initiative wants to succeed.

Some tools have application limits. For example the application of a water roof depends on the building construction and if this is strong enough to carry this roof type.
This toolbox is generic and one of the topics that is important in this thesis is location specific interventions and processes. How do we make a generic toolbox location specific and what are the tools that suit certain generic or specific topics.

The generic- and specific topics are presented in chapter 5, Oude Westen. The generic topics are generally applicable and are scattered around the neighbourhood. The specific topics are fixed to a location.

Generic: collaboration types
- private or collective garden
- building generations
- sun orientation and sun side

Specific: road type
- use

< Figure 98: Toolbox scheme, related to generic topics as collaboration, building generation and sun side.>
Explaination behind generic - and specifi topics, what tools can be applied where?

Addressing all interventions that take place in and around the building and the gardens.

First building generation: rich in details. These details need to be visible to remain the architectural value. If possible apply a green roof.

Access road: if possible change the material, unless this does not create travel discomfort. Cool down with green and blue elements and if possible apply permeable and soft material.

Addressing all interventions that are connected to both buildings and the public space.

Second building generation: strengthen the focus on the plinth Apply green facade and if possible a green roof.

Access road: if possible change the material, unless this does not create travel discomfort. Cool down with green and blue elements and if possible apply permeable and soft material.

Addressing all interventions that just take place in the public space.

Third building generation: apply focus on ground floor, similar to the second building generation.

Residential street: change material into more permeable material. Enlarge the pavement on the sun side, this is the side to work with sun related tools. Avoid tools that narrow down the profile.

Private garden

Is private property. Interventions that can be done without collaboration or with collaboration with a similar party like the neighbours.

Fourth building generation: develop new buildings, so they can have internal water storage and enough carrying capacity to hold a blue roof. Green roof-and facade possible.

Residential street: change material into more permeable material. Enlarge the pavement on the sun side, this is the side to work with sun related tools. Avoid tools that narrow down the profile.

Collective garden

Is a collective used surface. Interventions that require a larger surface.

Only use tools that can cool down the surrounding area by evaporation, evapotranspiration or shade (green and blue)

Play activities

Apply play materials- and objects and make sure that green- and blue tools are safe for children.

Sun side

First building generation: rich in details. These details need to be visible to remain the architectural value. If possible apply a green roof.

Access road: if possible change the material, unless this does not create travel discomfort. Cool down with green and blue elements and if possible apply permeable and soft material.

Second building generation: strengthen the focus on the plinth Apply green facade and if possible a green roof.

Access road: if possible change the material, unless this does not create travel discomfort. Cool down with green and blue elements and if possible apply permeable and soft material.

Third building generation: apply focus on ground floor, similar to the second building generation.

Residential street: change material into more permeable material. Enlarge the pavement on the sun side, this is the side to work with sun related tools. Avoid tools that narrow down the profile.

Fourth building generation: develop new buildings, so they can have internal water storage and enough carrying capacity to hold a blue roof. Green roof-and facade possible.

Residential street: change material into more permeable material. Enlarge the pavement on the sun side, this is the side to work with sun related tools. Avoid tools that narrow down the profile.

Play activities

Apply play materials- and objects and make sure that green- and blue tools are safe for children.
Two locations
Two Locations, based on the tension field between public and private ownership, water and heat problems. These location function as a showcase for the implementation of the toolbox, network and watersystem, on a specific location. They show how the area could transform and what elements would contribute to the climate assignments.

The locations are: Henegouwerlaan with Akeleistraat, Bajonetstraat with Adrianaplein.

These locations are chosen to be able to separate the interventions in two groups: building related interventions (based on the building related collaboration) and public space related interventions (based on the other two types of collaboration). For every situation the contribution to the water assignment is calculated when this design would be realised.

A few analytical maps provide input for this chapter:
- Figure 56 and 57: orientation
- Figure 59: ownership gardens
- Figure 60: ownership of property
- Figure 62: building generations
- Figure 67: road types
- Figure 73: use of space

Figure 99: Roof typology: slope or flat in percentage. These surfaces are most often not used and possible valuable in catching and retaining water.

Figure 100: Map with the two locations
An overview of used materials is given. These materials are used on all locations.
Henegouwerlaan

This street is one of the access roads that run North-South. This street has a broad profile, two parallel roads with building on the side and asphalt lanes in the middle. These lanes are a part of the tunnell trace built in 1937-1842, commissioned by W.G. Witteveen.

This tracee with the tree lanes is a national monument. The parallel roads are frequently used by cars and bicycles that go towards the center. Although there are tram lines placed, there is no longer a tramline running through this street. Only when trams need to take a detour, these lines will be used occasionally. Therefore the street needs to remain functional for the tram, car, bicycle and pedestrian as well as for parking.
Figure 101: Entire page, location analysis Henegouwerlaan. From left to the right: sun orientation, building generation, ownership gardens, ownership property and road type.
Analysis
During the analysis of the street, I found out that the asphalt road in the middle is a national monument, together with the trees along the side. Between this monument and the buildings is a parallel road. This road is well used by cars and bicycles who use this road as a ‘bicycle highway’ towards the center. The facade is long, tall and dense, just a few public, open, spaces are directly located next to the road profile. These spaces will be a part of the public space network as introduced in chapter 6.

The total road profile from building to building feels like three profiles. The tree lane separates the parallel roads physical and visual from the fast profile. This can be strengthened to connect the parallel road more to the buildings and to visually slow down the traffic to enhance safety even more.

The national monument needs to be remained and respected. So only the space between the trees and the buildings can be rearranged. The bicycle needs to have their own space, due to the crowded bicycle and car traffic during the day. Safety first!

Due to the function of the parallel road as a passing route, the activities on the street are related to that. People passing by bike, car and by foot. The bus drives by. At the crossings people come and go to the other side of the street and occasionally people talk to each other on the corners of the street.

As mentioned before, the present spaces will be connected in a public space network, the sidewalk on the road profile will be a part of this network.

The water system will use the long road perspective before bending towards the public spaces. Important is to maintain the comfort of travelling on this road, so the water system may not interrupt the long transport movement with sudden lines in the width of the profile.

Figure 102: The separation between the parallel street and the asphalt lanes.

Figure 103: The space between the buildings and the Platanus lane is one space, it could feel more like one space.
Water assignment
The current water assignment of this location is 419m³, which is 3.4% of the neighbourhood water assignment. The surface on which the rain falls, is visualised in figure 104.

Concept
The Henegouwerlaan is a busy parallel road for both cars and bicycles. They travel from South to North of the city and towards the station and center area. Especially during rush hours this street is well used by these two groups of travellers. Therefore safe and comfortable passing by is required. The water system follows the long street perspective and uses the network structure to discharge water towards squares and other public spaces.

The Henegouwerlaan is a static large street, with static buildings on the side. To increase the static appearance of the road, a second lane of trees is proposed.

Generic vs specific
The toolbox, as presented on page 106, shows generic tools, to be used by these generic topics. Location specific input comes from the road typology. The Henegouwerlaan is an access road with buildings on both side. On the next page is shown what tools are chosen to be implemented along this street and wether they are based on generic or specific topics.
Figure 106: Tools for the Henegouwerlaan.
Building related interventions.
When both housing corporation and residents would work together to achieve more permeable surface and use all surfaces, the map [fig. 107] could represent the new situation.

All flat roofs contain a green layer. The type of vegetation and layer thickness depends on the carrying capacity of the building construction and the wishes of the residents. All courtyards are transformed. The private gardens are softer and the collective gardens are greener and contain infiltration fields [fig.108].
The water system concentrates on catch, discharge from the roof towards the innergarden and infiltrate into the soil. Here the water can infiltrate in an underground storage space where the water will be collected. From this reservoir, the water can be re-used in the houses for flushing of toilets.

The water assignment is reduced by 12% to 369m³, while the current water assignment is 419m³.
Public space related interventions.
When the municipality, in collaboration with the residents and the housing corporation, would execute the neighbourhood masterplan [fig.96] with the concept of softening the surfaces, figure 111 could visualise the results. Street profiles will change, the network will be implemented, squares will transform and the water system is a part of these new structures. The monumental road structure will remain, the parallel road on the right, will change in profile. Materials are more permeable and open water gutters are introduced. The parking places are made from grass tiles and are placed next to the car lane. Cyclists have their own lane so the large amount of cyclists who use this road daily can travel safe. The pedestrians have a broader pavement to walk on, which is a link to the static road the henegouwerlaan used to be. A second tree lane is applied to underline the static appearance of the road.

< Figure 111: Possible outcome of maximum collaboration between municipality, housing corporation and residents to soften the public space.

Figure 112: Section public space related interventions.
The water system concentrates on discharge, infiltrate and use. The water on the streets will infiltrate into the soil and gets discharged towards the sewer system or towards the squares where it will be collected into a water element that can serve the purpose of a play element for children. Between street and square are locations where the water can infiltrate into the soil via an infiltration field.

The water assignment is reduced by 21% to 332m$^3$, while the current water assignment is 419m$^3$.

Figure 113: Water system public space related interventions.

> Figure 114: Water system public space related interventions shown in map.
Building and public space related interventions.
When all stakeholders would collaborate to adjust the site to the maximum, figure 115 could represent the result. Both public, private and collective surfaces are more permeable and softer.
The water assignment is reduced by 33% to 283m$^3$, while the current water assignment is 419m$^3$. A total collaboration shows the biggest result in solving the water assignment and reducing the pressure on the current water system by introducing infiltration possibilities and permable materials.

Figure 117: Water system building and public space related interventions.

> Figure 118: Water system building and public space related interventions shown on map.
Akeleistraat

This street is part of the East-West street structure that is part of the network.

Concept
According the water system, rain water will run trough this street towards the square on the East side. Here the water will be collected and used for a water element. All attached houses have their entrances in this street, these need to remain accessible.

Generic vs specific
The toolbox, as presented on page 106, shows generic topics and tools to use by these generic topics. Location specific input comes from the road typology. The Akeleistraat is a small street with buildings on both sides and is an East-West connection in the network. On the next page is shown what tools are chosen to be implemented along this street and wether they are based on generic or specific topics.
Figure 120: Tools for the Akeleistraat.
Building related interventions.
When possible the roofs are adjusted into green roofs. The private gardens are softer and the collective gardens are more green and contain infiltration fields.
The water system concentrates at catch, discharge and infiltration. From the roofs, the water is discharged into the gardens and towards the street. In the gardens, the water is collected at the infiltration fields where it can slowly infiltrate into the soil. These infiltration fields can be connected to an underground reservoir where the rain water can be stored. From here, the water can be re-used in a grey water circuit for the houses.
Public space related interventions.
Streets and pavements have become more permeable due to the application of permeable material that allow rain water to infiltrate into the soil. The houses on both sides of the small street are accessible from this street, therefore is chosen to create an infiltration field in the middle of the street. Without rain water, this is a green playfield for children. With rain, it is a pool of water that slowly infiltrate into the soil. The trees benefit from both the soft surface and the hydrated soil. A water gutter from the Henegouwerlaan provides the infiltration field with rain water.
The water system exists of discharge and infiltration measurements. The gutters discharge the water from the streets towards a sewer system or to infiltration fields as located in de Akeleistraat. Here the water can infiltrate into the soil.
Figure 129: Possible outcome of maximum collaboration between all stakeholders on all surfaces.

Building and public space related interventions.
All surfaces are softer, greener and more permeable.

Figure 130: Section building and public space related interventions.
The water system is more dynamic. Rain water that is caught and discharged from the roofs can flow in two directions, towards the gardens and towards the street. Disconnected rain pipes, on the street side of the houses, discharge the rain water above ground towards the infiltration field on the street. The rain water that runs towards the gardens is collected in an infiltration field as well. This field is connected with an underground reservoir and this provides a grey water system towards the houses for flushing toilets.

The contribution to the water assignment is already mentioned in the paragraph Henegouwerlaan.
Bajonetstraat

The Bajonetstraat is one of the small residential streets which are secondary to the network. The street is small and guided by buildings on both sides. The perspective is long, the North-South orientation of the street is clear.

According the neighbourhood design, this streetprofile will change. The two sided parking will be reduced to a one sided parking.
Figure 135: Entire page, location analysis Bajonetstraat. From left to the right: sun orientation, building generation, ownership gardens, ownership property and road type.
Analysis
This residential street is a small profile street with 3-4 floor high buildings on the side. The long profile is one of the remains of the original neighbourhood structure (1910) and all lines and elements seem to strengthen this long perspective. There are a few open spaces next to the street, but they form a different and separated place from the street.

One side of the street catches more direct sunlight; this side is also the side where small trees are planted. In the middle of the street a building block will be demolished and newly developed. Important for new developments in the street is that new structures respect and contribute to the characterising long street perspective.

The water assignment for this location is now 861m³, this is 7% of the neighbourhood assignment.

Figure 136: Current water assignment for this location.

Figure 137: The long street perspective is characterizing for this street and needs to be maintained.
Figure 138: Concept: using the sun side for green and blue.

Figure 139: Concept drawings for the Bajonetstraat.

Concept
According to the neighbourhood design layer ‘network’, the present open spaces will be connected in this network, using open spaces, East-West connections and parts of the street itself.

The layer ‘water system’ implicates the use of the long perspective as a discharge line, while the public spaces are areas to apply nr 3: use and infiltration. Another input is the sun side of the street. When a side catches more sun, there is a basic ingredient present for evapotranspiration of vegetation; sunlight/ warmth. This street side is then also the side to concentrate green at.

Generic vs specific
The toolbox, as presented on page 106, shows generic topics and tools to use for these generic topics. Location specific input comes from the road typology. The Bajonetstraat is a small street with buildings on both sides. On the next is shown what tools are chosen to be implemented along this street and wether they are based on generic or specific topics.
Figure 140: Tools for the Bajonetstraat.
Building related interventions.

When both housing corporation and residents would work together to achieve more permeable surface and use all surfaces, map [fig. 141] could represent the new situation.

All flat roofs contain a green layer. The type of vegetation and layer thickness depends on the carrying capacity of the building construction and the wishes of the residents. All courtyards are transformed. The private gardens are softer and the collective gardens are greener and contain infiltration fields [fig. 142]. The roof of the new building is a blue roof and functions as a water storage surface. The groundfloor of this building contains both a living- and a parking function. The section and the parking will be elaborated later on.
The water system catches rain water on the roofs and the green roofs can retain the water longer. From the roofs, the water is discharged in two directions: towards the street and towards the gardens. The gardens are often a combination of private and collective surfaces. On the collective surfaces, there are possibilities to create large infiltration fields where the water can infiltrate into the soil.

The water assignment is reduced by 20.5% to 685m$^3$, where the current water assignment is 861m$^3$.

Figure 143: Water system building related interventions.  
> Figure 144: Water system building related interventions shown in map.
Public space related interventions.
The street profile has changed as mentioned before. The left side of the street remains with parking possibilities, the right side provides a wider pavement, an open water gutter and space for vegetation. All surfaces have changed into more permeable surfaces. The road uses a red brick in combination with the *drainvoeg* technique. The parking places have the same red brick as the road, only small pieces of grass interrupt the stone surface; they make the parking lots permeable. A side benefit is formed by the fact that the streets look greener when there are less cars parked in the street. The network crosses the street at two locations. Both the Bajonetstraat and the Adrianastraat are subordinate to the network. The material of the car lane changes from red brick to a grey stone.
Via disconnected gutters the water goes from the roof via a disconnected drain pipe towards the permeable surfaces like the parking lots and then towards the open gutter. The grass tile used in the parking lots and the *drainvoeg* technique used in the street, provide infiltration in the soil. When the water reaches the gutter, it will be transported towards the public spaces where infiltration and use are possible.

The water assignment is reduced by 15.5% to 729m³, where the current water assignment is 861m³.
Building and public space related interventions.

All surfaces are softer, greener and more permeable.
The water system can work optimal when the water can be discharged from the roofs in two directions where it will be transported towards the squares where it can infiltrate, via infiltration fields, into the soil.

The amount of soft surface- and permeable surface is increased and the amount of solid surfaces is decreased. The total water assignment of 861m³ is reduced by 36% to an assignment of 553m³.

Figure 151: Water system building and public space related interventions.

> Figure 152: Water system building and public space related interventions shown on map.
Parking
During the profile adjustment of the Bajonetstraat and the Adrianastraat, parking spaces were sacrificed. These parking spots need to be compensated. A possibility is to do this under the new building, the surface of the building is large enough to re-locate 48 of the 94 sacrificed parking lots [fig.154]. Placing the whole parking underground is not an option due to the weak carrying capacity of the soil. Two other options remain, half into the ground or completely on top of the soil.

The parking spaces are placed 1 meter below ground level and 3 meter above [fig.155]. One of the requirements for the parking place is that it is capable of infiltrating rain water into the soil. Possible trees can grow here so that the people in the building see green instead of parked cars.
Figure 155: Parking 1m below ground level and 3m above.

Figure 156: Reference trees trough roof.

Figure 157: Use hollow columns to transport rain water from the roof of the car parking to the grass field below.
Adrianaplein

In the original neighbourhood structure of 1910, there were no squares or open spaces. During the city renewal an old building block was replaced with a smaller new block. Together with this new block an open space, a square, was created.

Analysis
This neighbourhood square got a play function for children. This space is strongly related to the school playground of the primary school ‘Babylon’ on the other side of the Adrianastraat. When the children get out of school they play on the square while the parents watch. It is also a square where local children play. One of the border buildings of the square will be demolished. On this location a new building will be developed. This location happens to be also the side of the square that catches the most direct sunlight.

1. determine sunside of the square
2. use this side/ facade for evapotranspiration
3. concentrate green on this side
4. using natural runoff to ‘feed’ the green en transporation side of the square

Figure 158: Concept: using the sun side for green and blue.

Figure 159: Concept: connect public spaces, concentrate water on the square and adjust the building to a South-West sun orientation.

Figure 160: Analysis, the square is divided, only a small part is functional play space.
Figure 161: Tools for the Adrianaplein.
Building related interventions.
Where possible, green roofs are applied to retain the rain water longer and to isolate the property below. The gardens are a combination of private gardens and collective spaces. The gardens of the new building are collective and elevated. This principle is explained in the previous paragraph, Bajonetstraat. The new building has a strong South-West orientation in the South facade. This optimises the absorption of sunlight by vertical green.
The new building is constructed in such a way that it can hold a water roof, that has a storage capacity. From this roof water will be discharged into three directions: towards the garden where possibilities for infiltration into the soil need to be researched. This is related to the earlier mentioned parking under/ in the building. Water is also guided into the building where it will be re-used as grey water.
Public space related interventions.
The network that crosses the Adrianaplein has a strong connection with the playground on the other side of the Adrianastraat. Both squares have play facilities while the Adrianaplein also incorporates water infiltration and a piece of nature. The square is enriched with grass fields with birch trees, apple trees, benches and a water element, that can be used as playground element as well. The playground is still present, as well as the play elements that used to be present on the square.
The square can catch the falling water. It will discharge the water from the playground into the soil on the edge of the playground. The water falling on the grass will immediately infiltrate in the soil. The third discharge route is towards the square. The water will run down and via the infiltration tile it will run into the infiltration zone where it can slowly infiltrate into the soil. The gutters from the street flow into the square. They end up in a water reservoir which is connected to a large and shallow tray. This tray is a water element, that can be used to play with. This can be designed as a water play element with sliders and dams. Children can determine themselves whether or not they let the water run down the tray. On the end of the tray, the water runs into the infiltration zone.

Figure 168: Water system public space related interventions.

Figure 169: Water system public space related interventions shown in map.
Building and public space related interventions.

The square is a green space where you can hear birds sing while having a picnic in the grass under the trees, the children are playing. The square is a combination of a playground for children and a piece of nature. All placed elements should address at least one of the two. The natural character of the green part of the square is important. Most elements need to be placed on the North side of the square due to sun, run of and route. A nice thing to add is that due to the grass surfaces the soil is softer and cooler. When it would snow in the winter, the snow will remain longer on the grass than on the pavement and snowman can be made or a local snowball fight can be held.
The water system can now function as a whole. The shape of the South facade of the new building, and the shape of the square are based on an optimal South-West orientation to catch optimal sun light and warmth. In combination with the infiltration field, vegetation, green surfaces and water element, this results in a cooler environment. The collaboration between sun, green, water and temperature is shown on this square.
Figure 174: Oude Westen current water assignment

Figure 175: Water assignment Oude Westen when all mentioned building and public space related interventions are applied.
Soften Oude Westen

The biggest results in lowering the water assignment can be seen when all stakeholders join in contributing to soften the neighbourhood. When all mentioned building and public space related interventions are applied on the entire neighbourhood, the result is a reduction of 30% on the current water assignment of 12,491m³.

The amount of soft and permeable surface increased by 23%. This will result in lowering the average neighbourhood temperature with at least 1°C, but this can only be achieved when all stakeholders participate and when all surfaces are used to soften.
Participation planning
In this thesis the value of involving local residents by addressing the problem of rainwater is appointed. However, the question remains: How to involve this group in initiatives and how to encourage this group to come up with initiatives and ideas. This participatory planning focuses on this question, and describes a possible participation process, that can start as soon as this thesis is finished. However, the schedule is an indication of possible steps and is not directly implementable. There is no timeframe attached to it.

- Presenting findings to residents, the municipality and Woonstad.
  The findings of the research will be presented during the current affairs consultation which is organized every month by the Aktiegroup Het Oude Westen. This presentation will mention the contribution to the softening of the surface of the neighbourhood and the contribution to the reduction of the water assignment. Also, the relationship between the increase of soft surface and the decrease of the average temperature is described. This evening is one of the moments to assess initiatives and requirements. Woonstads’ voucher action, de WOWtjes, will be appointed as additional funding opportunity for citizen initiatives. The app Huissjeboompjebeter is also mentioned as an example of what can be done in and around the home to contribute to the concept of softening and greening.

- Visits Bajonettuin with a small presentation.
  This courtyard is softened and the potential of infiltration of rainwater into the soil increases. This project is a showcase project for other gardens.

- Bringing together residents and municipality.
  Bringing together initiatives to take place in the public space. Using the collaboration types for the public space. This meeting(s) include brainstorm sessions on needs and initiatives, design sessions and discussions on the possible ways of financing and maintenance.

- Bringing together residents and Woonstad.
  Bringing together initiatives that take place in, on or inside (courtyard) the block. Hereby the building related collaboration type is used. This meeting(s) include brainstorm sessions of needs and initiatives, design sessions and discussions on possible ways of financing and maintenance. The vouchers of Woonstad, the WOWtjes, will be highlighted.

- Linking back possible designs.
  Possible designs will be communicated with the residents that initiated the ideas.

- Looking at alternative methods of financing.
  The residents of the neighbourhood have indicated that they do not have financial resources to contribute, but that are willing to help by offering time and manpower. Perhaps organize a flea market, a theme day, an event where everyone helps collecting tiles or other events with the possibility to gain money or to lower the costs of realisation. Another possibility is to ask local businesses (think of the Alliantie West-Kruiskade) for sponsorship.

- Setting up maintenance groups (with residents).

- Focus on mutual interests.
  One of the reasons for people to participate in initiatives is the question: What’s in it for me? An example of a small mutual gain for both municipality and residents: the municipality provides a piece of sidewalk for the realization of facade gardens. The street tiles are extracted by residents themselves and handed over to the municipality (linked to an event), for each submitted tile one receives a small amount of money that must be used to purchase plants for a facade garden or one receives seeds to plant. The municipality can then reuse the tiles or crush and apply as curvet under pavement. However, it is important that stakeholders dare to think differently and want to think of ways to improve mutual interest.

- Ask for sponsorship of trees.
  Ask a tree nursery for a donation. They might want to sponsor a number of young trees to plant in the neighbourhood. This moment of planting can also be an event.

- Opening (water) square.
  The opening of a square with a water element is also a neighbourhood day. Make it the day of the rain and provide some bottles of water (which are sponsored by Evides ...).

- Suggestion box.
  Put a suggestion box down somewhere in the neighbourhood (preferably somewhere inside) to collect initiatives, wishes and ideas. Once a month an idea is chosen. The submitter wins a rain barrel and relevant stakeholders for the specific initiative are brought together to advance the submission.
Conclusions

The Rotterdam neighbourhood the Oude Westen is indicated as a neighbourhood with both a rain water assignment and an urban heat problem. The morphology of the neighbourhood (spatial structure and orientation) is partly responsible for these two problematic effects of climate change. The neighbourhood is a highly urbanised area with more than 70 houses per hectare and 51% of the surface is paved. The rain water can not infiltrate into the soil and all rain water needs to be discharged via sewer systems and pumps. Every heavy shower increases the pressure on this water system. Streets and basements get flooded, when the discharge capacity is insufficient. The paved surface absorbs sun warmth and releases this at night, the neighbourhood can not cool. The small streeet block the wind to cool as well.

In order to tackle these two effects of climate change, the solution needs to be found in changing surfaces. This means both private and public surfaces, but reality shows that most projects are realised in just the public space. A scale level is missing: the intermediate scale. This scale level addresses both private and public surafces, the transition between these surfaces and who owns and uses what surfaces.

The climate assignment, together with the posed hypothesis that an intermediate scale needs to be applied, resulted in the following main research question:

What can be considered the ‘urban intermediate scale’ and in what way could it enable cities to adapt to the effects of climate change, regarding water surplus, drought and heat island, while improving quality of public space and engaging the individual in the Oude Westen district in Rotterdam?

The hypothesis and the question: How to engage the individual, both reveal a need for collaboration. Via a theoretical literature review the questions: How to collaborate and who to join in collaboration are researched into. This resulted in two valuable theories:

• Determine the circle of vital coalitions. Who are the most important (core) stakeholders?
• Aligning ambition. Analyse among the (core) stakeholders what their ambitions and interests are regarding the assignment or project. Align these personal ambitions to a shared ambition.

The effects of climate change can be reduced by applying adaptive strategies. But what is adaptation and what defines adaptation? Via a literature review, these questions have been studied. Adaptation is the adjustment of natural and human systems to reduce the effects of climate change. Four topics define adaptation:

• Time. What is the time horizon? Is it short term or long term?
• Space/ scale. What is the scale to address? What spaces are influenced?
• Involved stakeholders. Who needs to be involved in order to achieve a local adjustment of systems?
• Cost& benefits. Who pays for what, who is responsible for what and who maintains what?

These topics from literature have been investigated with the
neighbourhood Oude Westen as a case.

**Circle of vital coalitions.**
Based on the intermediate scale is found that the core stakeholders are the municipality of Rotterdam, the waterboard Hoogheemraadschap Schieland en Krimpenerwaard, the housing corporation Woonstad and the residents of the neighbourhood. Three collaborative types are identified:

- building related collaboration where both owner and user of the property collaborate.
- transition collaboration where both owner and user of the property and public space collaborate.
- consulting collaboration where the owner of the public space consults the user for input and wishes.

**Aligning ambition.**
- Inhabitants: a safe and pleasant neighbourhood
- Municipality: a vital and climate/future proof neighbourhood
- Housing corporation: a vital and liveable neighbourhood
- Waterboard: a safe and dry neighbourhood

Shared ambition:
'A vital, safe and climate/future proof neighbourhood that suits the urban context and the inhabitants.'

The shared neighbourhood ambition is to become a more vital, safe and climate/future proof neighbourhood where inhabitants partly influence their own environment. All core stakeholders are willing to start the dialogue with each other in order to see if they can bring the intentions they have to a next level.

**Time.**
Use water surplus to compromise moments of drought. Catch and store the water. Whether this is in the soil or in reservoirs. Make it re-usable.

**Space/scale.**
The scale is the intermediate scale that addresses both private and public spaces. The scale level is local, a neighbourhood level is the highest level where this intermediate scale is applied on in this thesis. The influenced spaces are all spaces that are related to the intermediate scale: courtyards (both private and collective gardens), the buildings, the public space (pavements, streets, squares etcetera).

**Cost & benefits.**
The inhabitants are willing to contribute by offering time and manpower. Also they are willing to help with the maintenance of realised initiatives. Alternative finance methods need to be thought of, a few examples are given in chapter 8. Think of organising a neighbourhood event or fund raising.
The problem field gives notice of the climate effects that cities suffer from and these are also applicable on Rotterdam and the neighbourhood Oude Westen. Can we reduce the effects? Yes, we can reduce the water assignment and lower the average temperature in the city by enlarging the amount of soft and permeable surfaces. But the biggest result can only be achieved when all surfaces contribute and change into soft surfaces, permeable surfaces or surface water.

And this can only be done when all stakeholders collaborate to achieve a shared goal. Both private and public sector need to collaborate and join forces. This requires communication and needs the willingness to work together. The intermediate scale is a communicative scale; without communication, collaboration can not be done. And without collaboration between all parties, the contribution to lower the water assignment will be minimum.

The local residents are one of the stakeholders in this collaboration, but in the case of the neighbourhood Oude Westen, they are not able to contribute financially. Other financial structures need to be discussed. The locals are willing to contribute by organise festivities that can generate financial input for local projects, or to maintain the spatial projects (watering plants, remove weeds, mown grass et cetera).

More awareness needs to be created of how people can contribute and who needs to join in, to realise a specific project. Besides that, it needs to be clear what’s in it for each stakeholder. What is the gain?

A critical remark.
A critical remark must be made, regarding the interventions of chapter 7 that reduce the neighbourhood water assignment. When the interventions, that cover both private and public surfaces, are realised all over the neighbourhood, the contribution to reduce the current water assignment is 30%. That leaves 70% of the current water assignment yet to be solved.
Applicability

This thesis uses the Rotterdam neighbourhood the Oude Westen as a case. The conclusions and interventions are thereby context related. Nevertheless, the method of using the intermediate scale to analyse the location and to determine stakeholders is generic and applicable on other neighbourhoods. The stakeholders, their interests and ambitions, will change every time, so the translation from collaboration type to participation planning will be different for every neighbourhood. The toolbox is also generic applicable. The specific characteristics may differ per location and provide an other combination of tools every time this toolbox is used.

Yes, the toolbox/strategy that is developed in this thesis, is applicable on other locations, but this only applies for the method of the intermediate scale and the generic toolbox. Although the toolbox addresses both rain water and heat related tools, other locations must face the same challenges as the Oude Westen.
Recommendations

The method used in this graduation research is based on this collaborative intermediate scale. All surfaces and stakeholders related to this scale need to be analysed. The theoretical input and the themes to discuss before starting a project, are together with the intermediate scale a generic method that can be applied on all neighbourhoods. The analysed themes and the tools are generic, but the information itself is location specific. The implementation of the tools is based on location specific characteristics.

The main recommendation for the municipality of Rotterdam, the housing corporation and the residents of the Oude Westen is to work with the shared ambition to improve the neighbourhood. The topic how to involve the locals, is a complex topic. Together with alternative models for financing small initiatives, this needs further elaboration. People devote whole theses and investigations to these subjects. My knowledge is not sufficient enough to present the perfect participation model on how to engage the individual. I am an urban designer and I can only underline the importance of their engagement.

Further research:
- Alternative models for financing.
- Participation model of how to engage the individual.
Personal reflection

I started this graduation year with the intention to do ‘something’ with water. In the first few weeks the topic changed from rivers to quays to embankments. I wanted my graduation project to have a urban context, therefore I desided to look for a water issue in the city. Rain water appeared to be the ideal topic for me. Together with climate change, this forms this a threat for the city of Rotterdam.

Looking back on the start of this research, it took quite a while before I found my focus and defined what topic I was going to address. This lack of focus in the beginning can be assigned to the lack of an usable existing method of what I wanted to do. I had to develop my own method, which took me quite some time. I succeed in the end, but only recently I totally got to understand what I did and how topics are related to each other. I really needed this periode to define my own assignment and to make it clear. Not only for myself but also to others. Why addressing these analytical topics? How do they relate? How can you use them and what makes an intervention location specific. I struggled and I conquered :)

I am not totally satisfied with the final result, due to the partly open end of how to engage the individual. The ideal situation would be if I can play a role in the participation planning I set up up. Besides that, it would be great if this thesis can result in real spatial interventions that contribute to the water and heat assignment for the neighbourhood. Who knows...
Image credits

Fig. 01 Photo collage.
- Retrieved 29 November, 2014, from http://www.volkskrant.nl/binnenland/was-gisteren-de-natstedag-ooit~a3704938/
- Retrieved 06 November, 2014, from https://twitter.com/RuSt/status/493678182609215488/photo/1

Fig. 02 IPCC, 2007, page 53

Fig. 03 Retrieved 04 April, 2014, from http://extremeweatherheroes.org/science-of-extreme-weather/global-evidence.aspx

Fig. 05 Retrieved 02 April, 2014, from http://www.rioolinfo/klimaatverandering

Fig. 06 Photo by Anja Speetjens, 2014

Fig. 08 Retrieved 23 November, 2014, from http://www.kennislink.nl/publicaties/wisptelturig-water

Fig. 10 Retrieved 04 April, 2014, from http://www.weatherquestions.com/What_is_the_urban_heat_island.htm

Fig. 11 Retrieved 04 April, 2014, from http://www.epa.gov/heatisland/about/index.htm

Fig. 12 Rahola et al., 2009, page 12


Fig. 15 Rosenfeld et al., 1995, page 256

Fig. 20 Retrieved 04 April, 2014, from http://www.icenews.is/2011/07/07/copenhagen-still-struggling-after-weekend-floods/

Fig. 21 De Urbanisten and Regiegroep Rotterdam Climate Proof, 2013, page 14

Fig. 27 Rooij, 2010, slide 34

Fig. 28 Rooij, 2010, slide 34

Fig. 29 Rooij, 2010, slide 34

Fig. 30 Rooij, 2010, slide 34

Fig. 31 Bremekamp et al., 2009, page 9

Fig. 33 Edelenbos en Monnikhof, 2001, page 242

Fig. 34 De Urbanisten and Regiegroep Rotterdam Climate Proof, 2013, page 27

Fig. 36 Retrieved 22 September, 2014, from http://drainvast.nl/projecten/egmond-aan-zee

Fig. 37 Retrieved 22 September, 2014, from http://www.eva-lanxmeer.nl/in/hoven

Fig. 38 Retrieved 22 September, 2014, from http://www.schielanddekrimpenerwaard.nl/projecten/projecten/waterplan_rotterdam_0

Fig. 39 Retrieved 22 September, 2014, from http://www.rotterdam.nl/waterbergkingruipepleinagarage

Fig. 40 Retrieved 22 September, 2014, from http://uair01.blogspot.nl/2011_07_01_archive.html

Fig. 41 See fig.36

Fig. 42 Goedbloed, 2013, page 26
Fig. 43  Interactieve klimaatatlas Rotterdam 2012
Fig. 44  Gemeentewerken, Gemeente Rotterdam, Ingenieursbureau, 2006.
Fig. 49  Time line
- Van der Gaag et al., 1993, page 16
- Gemeente Rotterdam, 2011, page 20
Fig. 51  Van der Gaag et al., 1993, page 16-17
Fig. 52  Van der Gaag, 1993, page 18
Fig. 75  Gemeente Rotterdam, 2012.
Fig. 90  Photo by Anouk Ruijters, 2011
Fig. 91  Photo by DominionSpy,, 2004
Fig. 156 Photo by Matthijs Borghgraef, 2008
Literature


recent meteorological observations and datasets provided by hobby meteorologists. Wageningen: Alterra.


Sewer history. Tracking down the roots of Our


TNO. (2010). Dossier Klimaatverandering. Utrecht: TNO.


- 1. Excell sheet calculations waterassignment
- 2. Questionnaire inhabitants Oude Westen (Dutch)
- 3. Results Questionnaire (Dutch)
- 4. Questionnaire municipality, Woonstad and waterboard (Dutch)
- 5. Demographic data
- 6. Study public spaces
- 7. Rotterdam history
- 8. History sewer and dealing with rainwater
1. Excell sheet calculations waterassignment

<table>
<thead>
<tr>
<th>Land coverage</th>
<th>Cloud area</th>
<th>Depression storage</th>
<th>Infiltration loss</th>
<th>Specific discharge</th>
<th>DEQI</th>
<th>your area</th>
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<td>m²</td>
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<td>(mm)</td>
<td>(m³/s)</td>
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</table>

- Depression storage: 
  \[0.03 \times \text{depression storage} - 0.001 \times \text{infiltration loss} - 0.001 \times \text{surface} \]

- If the formula goes negative, you change it to 0.

When there is open water, you can store 0.5 m³ per m². When there is no water, you do not have to find another solution.
2. Questionnaire inhabitants Oude Westen (Dutch)

Enquete Oude Westen onder bewoners.

Ten behoeve van informatie vergaart voor onderzoek aan de TU Delft met betrekking tot regenwateroverlast en het betrekken van burgers bij waterheugangs initiatieven. Uitgevoerd door Anne Witteveen.

Indien u korting op water, waterschapsbelasting en/of gemeentebelasting wil zou ontvangen, zou u dan willen investeren in waterbergingsoplossingen in en rondom uw huis?

0 ja 0 nee

Heeft u zelf maatregelen getroffen om dit overlast tegen te gaan?

0 ja 0 nee

Heeft u wel eens regenwateroverlast?

0 ja 0 nee

Heeft u zelf maatregelen getroffen om dit overlast tegen te gaan?

0 ja 0 nee

Ruimte voor opmerkingen:

Mogelijkheid krijgen om te reageren op een voorstel en het geven van input.

0 Ja, ik wil betrokken blijven bij het onderzoek, wat inhoudt dat ik op een later moment de mogelijkheid krijg om te reageren op een voorstel en het gevoel van input.

0 Ja, ik wil deelname bij waterheugangs initiatieven. Uitgevoerd door Anne Witteveen.

Indien u het oordeel van eigenaar of huurder alcohol?

0 eigenaar 0 huurder

Bent u bereid om een financiële bijdrage te leveren voor de aanleg van regenwater projecten bij u in de buurt/wijk?

0 ja 0 nee

Bent u bereid om deel te nemen aan een onderhoudsprogramma voor de openbare ruimte bij u in de buurt/wijk?

0 ja 0 nee

Bent u bereid om een financiële bijdrage te leveren voor de aanleg van regenwater projecten bij u in de buurt/wijk?

0 ja 0 nee

Bent u bereid om deel te nemen aan een onderhoudsprogramma voor de openbare ruimte bij u in de buurt/wijk?

0 ja 0 nee

Mogelijkheid krijgen om te reageren op een voorstel en het geven van input.

0 Ja, ik wil betrokken blijven bij het onderzoek, wat inhoudt dat ik op een later moment de mogelijkheid krijg om te reageren op een voorstel en het gevoel van input.

0 Ja, ik wil deelname bij waterheugangs initiatieven. Uitgevoerd door Anne Witteveen.
3. Results questionnaire inhabitants Oude Westen (Dutch)

Resultaten enquête Oude Westen onder 20 bewoners.

Ten behoeve van informatie vergaring voor onderzoek aan de TU Delft met betrekking tot regenwateroverlast en het betrekken van burgers bij waterbergings initiatieven. Uitgevoerd door Anne Witteveen.

Ja, ik wil betrokken blijven bij het onderzoek, wat inhoud dat ik op een later moment de resultaten enquete Oude Westen onder 20 bewoners.

Mag de wijk groen genoeg zijn?
- ja
- nee
- geen mening

Heeft u een voor/ achtertuin?
- ja
- nee
- anders

Heeft u een kelder?
- ja
- nee
- anders

Heeft u zelf drainage aangelegd onder terras?
- ja
- nee
- anders

Heeft u een huurder bent?
- ja
- nee
- anders

Heeft u een kelder?
- ja
- nee
- anders

Vindt u de straat breed genoeg?
- ja
- nee
- geen mening

Vindt u de wijk groen genoeg?
- ja
- nee
- geen mening

Denk u dat de plassen en de parken belangrijk zijn voor de sociale interactie binnen de wijk?
- ja
- nee
- geen mening

Denk u dat de plassen en de parken belangrijk zijn voor de sociale interactie binnen de wijk?
- ja
- nee
- geen mening

Indien ja, wat is/s zijn de maatregelen?
- ja
- nee
- anders

Bent u tevreden over de wijk?
- huurder
- eigenaar
- geen mening

Bent u bereid om deel te nemen aan een onderhoudsprogramma voor de openbare ruimte bij u in de straat/wijk?
- ja
- nee
- anders

Zou u willen dat er meer voetogenen mogelijkheid krijg om te reageren op een voorstel en het geven van input.
- ja
- nee
- geen mening

Verder vragen:

Zou u meer zichtbaar water willen in de wijk?
- ja
- nee
- geen mening

Indien ja, wat is/s zijn de maatregelen?
- ja
- nee
- anders

Als u het tot nu toe regenwateroverlast als een probleem heeft waarmee te kampen bent, laten we u volgende vragen nog een keer hooren.

Bent u bereid om een financiële bijdrage te leveren voor de aanleg van regenwaterprojecten bij u in de straat/wijk?
- ja
- nee
- andere

Heeft u zelf maatregelen getroffen om dit overlast tegen te gaan?
- ja
- nee
- anders

Heeft u zien dat er voldoende openbare ruimte is in de wijk?
- ja
- nee
- geen mening

Heeft u korting op water, waterschapsbelasting en/of gemeentebelasting onderhoudsprogramma voor de openbare ruimte bij u in de straat/wijk?
- ja
- nee
- andere

Heeft u korting op water, waterschapsbelasting en/of gemeentebelasting onderhoudsprogramma voor de openbare ruimte bij u in de straat/wijk?
- ja
- nee
- andere

Heeft u een huurder bent?
- ja
- nee
- anders

Heeft u een huurder bent?
- ja
- nee
- anders

Heeft u een voor/ achtertuin?
- ja
- nee
- anders

Zou u meer zichtbaar water willen in de wijk?
- ja
- nee
- geen mening

Indien ja, wat is/s zijn de maatregelen?
- ja
- nee
- anders

Indien ja en/of gemeentebelasting in en rondom uw huis?
- ja
- nee
- andere

Indien ja, wat is/s zijn de maatregelen?
- ja
- nee
- anders

Heeft u zelf drainage aangelegd onder terras?
- ja
- nee
- anders

Heeft u zelf drainage aangelegd onder terras?
- ja
- nee
- anders

Ja, ik wil op de hoogte gehouden worden over het onderzoek.
- ja
- nee
- geen mening
4. Questionnaire municipality, Woonstad and waterboard (Dutch)

Municipality

Enquete Oude Westen

Ten behoeve van informeringsopgave over onderwerp
van de TSD heef met bewooning ten regenwaterperspectief en
het beleid van kerken bij waterbeheerorganisaties
Uitgezet door: Anouk Wiemer.

Namen instuur: Gemeente Rotterdam
Naam van zender van de enquête: Bas de Wild

De relatie tussen de gemeente en de bewoners van het
Oude Westen is:
  ✔ goed
  ✗ moeilijk
  ✗ slecht

Heeft de gemeente bewoners bij projecten?
Deze interventies van het water project en de interactie die daarvoor nodig is, voelt g aan het net
  ✔ interessen kunnen, informatie over de gemeente
  ✗ interessen kunnen, geen informatie over de gemeente

Net voor een soort projecten is de gemeente altijd aanwezig in de woordl:
Vooroordeel grafisch beeld (schetsbureau) in een bepaald deel van het Oude Westen, waarbij wordt
onderhandeld over het ontwerp van verkeersregelingen en de kansen van zowel de bewoners als van water
mogelijk is. In dit stadium wordt nog nie beschouwd grafisch beeld...
Een andere projectheeft vredestijd op de situatie van de tien in particulier leven, waarbij
interesse regenwaterverhouding staat geplaatst.
In het verleden heeft de gemeente regenwaterprojecten om veiligheid en veiligheid in de
sanering haven is...
Zie bovenstaande.

Voor regenwaterprojecten stelt de gemeente samen met (meer) ouderen (aanwezig mogelijk):
  ✔ bezoeken
  ✗ telefoongesprekken
  ✗ bijeenkomsten
  ✗ bewoners
  ✗ shelter
  ✗ andere (niet opgenomen)

Wilt de gemeente bewoners in de regenwaterprojecten aan de slag klare worden te maken?
  ✔ ja
  ✗ nee
  ✗ niet van toepassing

Is de gemeneheer ook bewoners kennis te geven over
OM vragen en regenwaterprojecten
  ✔ ja
  ✗ nee
  ✗ niet van toepassing

Er is behoefte aan een aanpak van regenwater. Voor het overige zijn geen specifieke projecten:
  ✔ ja
  ✗ nee
  ✗ niet van toepassing

Is de gemeente bereid om subsidie te verstrekken voor
voorziening regenwaterprojecten in de vorm van donatie
  ✔ ja
  ✗ nee
  ✗ niet van toepassing

In het verleden bestond er een subsidie voor
  ✔ ja
  ✗ nee
  ✗ niet van toepassing

Stellingen:

De gemeente heeft inbegrepen en de bouw van de
  ✔ ja
  ✗ nee
  ✗ niet van toepassing

De gemeente is bereid om financiële steun voor
  ✔ ja
  ✗ nee
  ✗ niet van toepassing

De gemeente dient er aan te komen, klimaat, toekomst en
  ✔ ja
  ✗ nee
  ✗ niet van toepassing

Ja, ik wil op de hoogte gehouden worden over het onderwerp.
  ✔ ja
  ✗ nee

Bemerkenswaardige opmerkingen:

Hartelijk dank voor uw medewerking.


**Woonstad**

**Enquete Oude Westen**

Ten behoeve van informatie vergroting voor onderzoek van de TSD-Deel, voorbereiding van opnameverslagen voor het betrekken van burgers bij waterbergsinitiatieven. Uitgevoerd door Anne Wittevrouwen.

Naam bedrijf: **Woonstad Rotterdam**
Naam van installer van de enquête: **Erik Hoef Aak**
Percentage van panden in eigendom van Woonstad met de wijk H de Oude Westen in Rotterdam: **75%**

De relatie tussen Woonstad en de bewoners van de Oude Westen in:
- **Niet goed**
- **Meezig**
- **Slecht**

Hoe betrekt Woonstad bewoners bij projecten?

- **Ja**
- **Nee**

Behalve vastgoed projecten, doet Woonstad ook nog ander projecten met het publiek? voor de wijk?

- **Ja**
- **Nee**

In welke mate past Woonstad hun panden aan op klimaatveranderingen zoals meer regenwater en perioden van zware druppels?

**Ja**

Wat is belangrijk voor Woonstad? Meerdere antwoorden mogelijk.
- 0 winst maken
- 0 zo veel mogelijk vastgoed bouwen
- 0 waardezichheidsverschijnsel vastgoed portefeuille
- 0 goede relatie tot bewoners en gemeente
- 0 voorbereiding van de toekomst: vooral het vastgoed oms
- 0 anders:

Wat is voor Woonstad een reden om geld te investeren in bestaand vastgoed? Meerdere antwoorden mogelijk.
- **Waardevoordeel/ verhoging van vastgoed**
- **winst op kortetermijn**
- **winst op lange termijn**

Hoeveel is de waardezichheidsverschijnsel vastgoed per ongeveer?
- **Ja**
- **Nee**

Heeft Woonstad veel aansprakelijkheden met regenwater te maken en opschade aan haar vastgoed?

- **Ja**
- **Nee**

Voor(minutes) vrijt Woonstad om overlast en/of schade aan haar vastgoed te maken?

- **Ja**
- **Nee**

**Stellingen**

Woonstad houdt rekening met de verwachte bewoners in de buurt bij renovatie en/of nieuwbouw?
- **Ja**
- **Nee**

Woonstad is bereid om te investeren in haar panden in de wijk om de leefbaarheid te verbeteren?
- **Ja**
- **Nee**

Woonstad denkt verder dan alleen vastgoed en denkt ook aan gron, klimaat, toekomst en leefbaarheid?
- **Ja**
- **Nee**

Indien er meer huizen enz. worden, ziet dat dan winst of wat meer in de andere bijkomende oplossing om de woonwoonleefbaarheid te maken?
- **Ja**
- **Nee**

Woonstad is bereid om te investeren in regenwater opzicht van bouwkracht en in mond van haar vastgoed?
- **Ja**
- **Nee**

Ja, ik wil op de hoogte gehouden worden over het onderzoek.
- **Ja**
- **Nee**

Ja, ik wil betrokken blijven bij het onderzoek, wat doet dat ik op een later moment de wel bij het onderzoek en op het gesprek is.

Ruimte voor opmerkingen:

Hartelijk dank voor uw medewerking!
Waterboard

Enquete Oude Westen

Ten behoeve van informatieverzorging voor onderzoek van het VWRicht een bericht over het informeren van wat er bij wetgeving van waterprijzen initieert.

Uitgevoerd door Ann Marijnissen

Naam behaald: HHSSck
Naam van celmer van de enquête: Lieven Bult

Wat voor soort projecten is het Waterboardbaak bestemd voor?

a) Bestrijding en beheer van natuur en natuurlijke omgeving (leeuwen, diers...) en
b) Bestrijding en beheer van water (waterprijzen, riolering, etc.)

Welke van de genoemde projecten zijn voor het Waterboardbaak gebruikt?

a) Bestrijding en beheer van natuur en natuurlijke omgeving (leeuwen, diers...)

Zo goed mogelijk projecten gebruikt.

a) Bestrijding en beheer van natuur en natuurlijke omgeving (leeuwen, diers...)

Wat voor het grootste hulpverlenende projecten, on welke projecten wel het Waterboardbaak dan samen? (geven deze antwoord mogelijk)

a) Bestrijding en beheer van natuur en natuurlijke omgeving (leeuwen, diers...)

Voorbeelden van hulpverlenende projecten:

a) Bestrijding en beheer van natuur en natuurlijke omgeving (leeuwen, diers...)

Waarom het Waterboardbaak wel voor soorten met behulp van de enquête van de informeren van wat er bij wetgeving van waterprijzen initieert?

a) Bestrijding en beheer van natuur en natuurlijke omgeving (leeuwen, diers...)

Indien ja, hoe worden bevorderen bij betrokkenen?

a) Bestrijding en beheer van natuur en natuurlijke omgeving (leeuwen, diers...)

Betrekken leden en over verschillende richtingen van de wetten en besluiten te informeren.
5. Data Oude Westen

1/3 of the household contains children. This 1/3rd covers 54% of all inhabitants of the neighbourhood. 15% of all inhabitants is in the age range between 0-14 years old. Average in Rotterdam 16.5% between 0-14 years old...
6. Study public spaces

Location index:

1. Diergaarde Blijdorp
2. Sportfield
3. Bentincklaan
4. Henegouwerplein
5. Park
6. Essenburgsingel
7. Heemraadsingel
8. Wijkpark
9. Museumpark
10. Branco van Dantzigpark
11. Akeleistraat
12. Kogelvangerstraat
13. Adrianeplein
14. Babylon schoolplein
15. Gerrit Sterkmanplein
16. Josephplein
17. Diergaardesingel
18. Hobokenstraat
19. Schiedamse Vest
20. Frank van Borselenstraat
21. Jan van Avennesstraat
22. Oostervantstraat
23. Aleidisstraat
24. Skatepark Westblaak
25. Square
26. Zijdewindeplein
27. Rijnhoutplein
28. Toni Koopmanplein
29. St Mariastraat
30. Stationsplein
31. Kruisplein
32. Diergaardesingel x Kruisplein
33. ‘s Gravendijkwal
34. Schouwburgplein
35. Tiendplein
36. Speelcentrum Weena
37. Rochussenstraat
38. Jan Evertsplaats
39. Joost Banckertsplaats
40. Lijnbaan

Figure 70: Placing the numbers on their location.
1. Diergaarde Blijdorp

Legend

functions

(ball) games
catering/ coffe
park

animal farm

play area

parking

sit possibilities

meeting

elements

fence
green border
tree

low green

build element
closing time

surface

asphalt

stone

semi permeable

rubber play surface

grass

water
5. Heemraadsingel

6. Wijkpark

7. Museumpark
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<td><img src="image2" alt="Gerrit Sterkmanplein" /></td>
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<td><img src="image4" alt="Babylon schoolplein" /></td>
<td><img src="image5" alt="Gerrit Sterkmanplein" /></td>
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<td><img src="image8" alt="Gerrit Sterkmanplein" /></td>
<td><img src="image9" alt="Josephplein" /></td>
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</tbody>
</table>
23. Aleidisstraat

24. Skatepark Westblaak

25. Coolhaven
26. Zijdewindeplein

27. Rijnhoutplein

28. Toni Koopmanplein
32. Diergaardesingel x Kruisplein

33. ’s Gravendijkwal

34. Schouwburgplein
35. Tiendplein

36. Speelcentrum Weena

37. Rochussenstraat
38. Jan Evertsplaats

39. Joost Banckertsplaats

40. Lijnbaan
A small settlement along the river called Rotta/Rotte.

The city of Rotterdam got her city rights.

The city grows and becomes the second city of the Republic.

Diagrams the Nieuwe Waterweg.

Lodewijk Pincofft takes the lead in developing Rotterdam Zuid.

First large scale expansion plan for the city: Waterproject by city architect W.N. Rose.

Second large extension: urbanisation on Rotterdam Zuid.

14 May: bombing the city. 8 May: liberation of Rotterdam.

Opening Lijnbaan: first carless shopping street in Europe.

1945

1953

1970-1975

2001

Rotterdam: world harbour

History of Rotterdam

1837

1890

1937

1955

2000

Historical development of Rotterdam.
7. Rotterdam history

The city of Rotterdam is the spatial context where this graduation project takes place. Therefore it is useful to fresh up the history of this context. Four events are highlighted in the timeline. Later on it will become clear that three of the four events are closely related to the history of the neighbourhood where the project will go more in depth.

Around 800 books mention a small fisherman settlement along a river called Rotte or Rotta. This small settlement grew and in 1270 a dam was placed in the river. The reasons why differ. This dam gave the city later on its name: Rotterdam (Hooimeijer et al., 2005). In 1340 the city got city rights and is a trading center for water transport. The city of Rotterdam grows and grows and becomes the second city of the Republic, after Amsterdam (Rotterdam, 2014).

In 1854 the city undertakes its first large scale expansion plan, made by city architect Willem Rose. Until this moment the city remained within its triangular boundaries [27]. Roses ‘Waterplan’ was meant to remediate the water system and to improve the city hygiene (Rotterdam info, 2014). Nowadays the city still owns her waterways and canals to this plan of Rose.

Between 1866 and 1872 the Nieuwe Waterweg was created. This new waterway gave Rotterdam an open sea connection to the North Sea with the hope to revitalize the Rotterdam harbours. Hydraulic engineer Pieter Caland got the order to make the connection.

So far as the expansion took place on the north side of the river. In 1879 a trader called Lodewijk Pincoffs took the lead by developing his business on the south bank and thereby marked the start of developing Rotterdam Zuid (Top10). This expansion is the second large expansion of the city (Communicatie team kop van zuid Rotterdam).

On May 14 1940 German bombs ruin the inner city of Rotterdam and the fire created by the bombing ruins even more [28]. The city is burning and smoking. After this bombardment the current city architect, Witteveen, starts with the challenging task of restructuring the bombed city. On May 8, 1945, allies officially liberate the city. The reconstruction of the city can begin. The plans made by Witteveen are swept away and the plans of his colleague Van Traa are executed (Walsum et al., 1955).

In 1953 Rotterdam opens the first carless shopping street of Europe: de Lijnbaan. From out the 1970s’ the city starts with her city renewal program and the neighbourhoods Oude Westen and Afrikaanderwijk are one of the first. For decades the only bridge between north and south Rotterdam was the Willemsbridge, but in 1996 a second bridge celebrates was opened. The famous Erasmusbrug, aka The Swan, is now in use [29]. In 2001 the city became Capital of Culture 2001.

In 2001 the city became Capital of Culture 2001.
Roman Empire: Combination of gutters and sewer systems.

Middle Ages: Open sewers and gutters. Waste on the streets.

Fresh rainwater in wells and surface waters was polluted by leaking sewers. Rain only used for farming.

John Snow discovers the relation between diseases and contaminated water.

More attention for hygiene and closed sewer systems.

Realization of the Paris sewer "Les Eaux" by Eugene Belgrand and the London sewer by Joseph Bazalgette.

Realization of the mixed sewer in Amsterdam.

Realization of a separated sewer in Amsterdam. It is a waste to reuse treated water.

Using of mixed and separated sewers.

History sewer systems in the city:

- 700-1500: Organic infiltration and destruction of waste
- Roman Empire: Combination of gutters and sewer systems.
- Middle Ages: Open sewers and gutters. Waste on the streets.
- Poor health conditions, many diseases and deaths.
- Realization of the Paris sewer "Les Eaux" by Eugene Belgrand and the London sewer by Joseph Bazalgette.
- Realization of the mixed sewer in Amsterdam.
- Realization of a separated sewer in Amsterdam.
- Separated rainwater sewer is appearing more and more.
- Water reusing as grey water within the house.

History dealing with rain water in the city:

- 700-1500: Rainwater naturally infiltrated in the open soil.
- Rainwater could no longer infiltrate so the water was directed towards the sewer.
- Middle Ages: Sewers in wells and sewage pipes were used for farming.
- John Snow discovers the relation between diseases and contaminated water.
- More attention for hygiene and closed sewer systems.
- Realization of a separated sewer in Amsterdam.
- Separated rainwater sewer is appearing more and more.
- Water reusing as grey water within the house.

Dates:

- 700-1500
- 1840-1890
- 1859-1870
- 1910
- 1930
- 1859-1870
- 1910
- 1930
- 1859-1870
- 1910
- 1930
- 1859-1870
- 1910
- 1930
- 1859-1870
8. History sewer and dealing with rainwater

For a long time, rainwater was equal to nuisance and waste. One needed to get rid of it as soon as possible. Rainwater was from that point of view treated the same as other waste water. And in order to understand the changing point of views trough time, this timeline of sewer and rain water is made.

Throughout history and even today there are locations in the world where waste and wastewater can naturally infiltrate in the soil. This is only possible in areas where the pressure of population is low. The Romans are famous for their water and sewer system. They had systems and gutters above and under the ground to transport clean- and waste water [25]. After the Roman empire collapsed the knowledge of water systems seems to disappear. During the Middle Ages waste water was dumped on the streets without any larger system of gutters (RIONED, 2014). Due to this method clean drinking water was infected and bacteria and fungi could expand in numbers, many diseases ravaged the cities. In 1855 John Snow discovers the relation between diseases and contaminated water which resulted in closed gutters and sewers (Sewer history, 2014; Sterner, 2014).

Between 1840 and 1890 Paris got as one of the first cities a main underground sewer system made by Eugene Belguard, called ‘Les egouts’ [26]. Between 1859 and 1870 London also got a main sewer system which still operates as the main sewer these days (History, 2014). In the beginning of the 20th century the principal of a sewer was implemented in Amsterdam, only 20 years later the capital also implemented a separated system for clean rain water. This clean water was used for irrigation of land.

This state of mind, separating clean rainwater from waste water, reaches more and more support. More cities divide their water systems and aim to reuse the rainwater for other purposes (M987, 2010).

Heel lang stond het hemelwater gelijk aan overlast, aan afval. Je moest er zo snel mogelijk van af zien te komen. Als er een nieuwe wijk werd gebouwd, werd een riool aangelegd en daar ging vanzelfsprekend ook het regenwater in. We hadden het water onzichtbaar gemaakt. Nu weten we beter: dat water is Schoon en waardevol. We moeten het niet in het riool laten wegstromen, we moeten het vasthouden daar waar het valt en het gebruiken om de stad aangenamer en koeler te maken.

- by Frans van de Ven, hoofddocent stedelijk waterbeheer aan de TU Delft en verbonden aan Deltares (Metz and van den Heuvel, 2012:185)