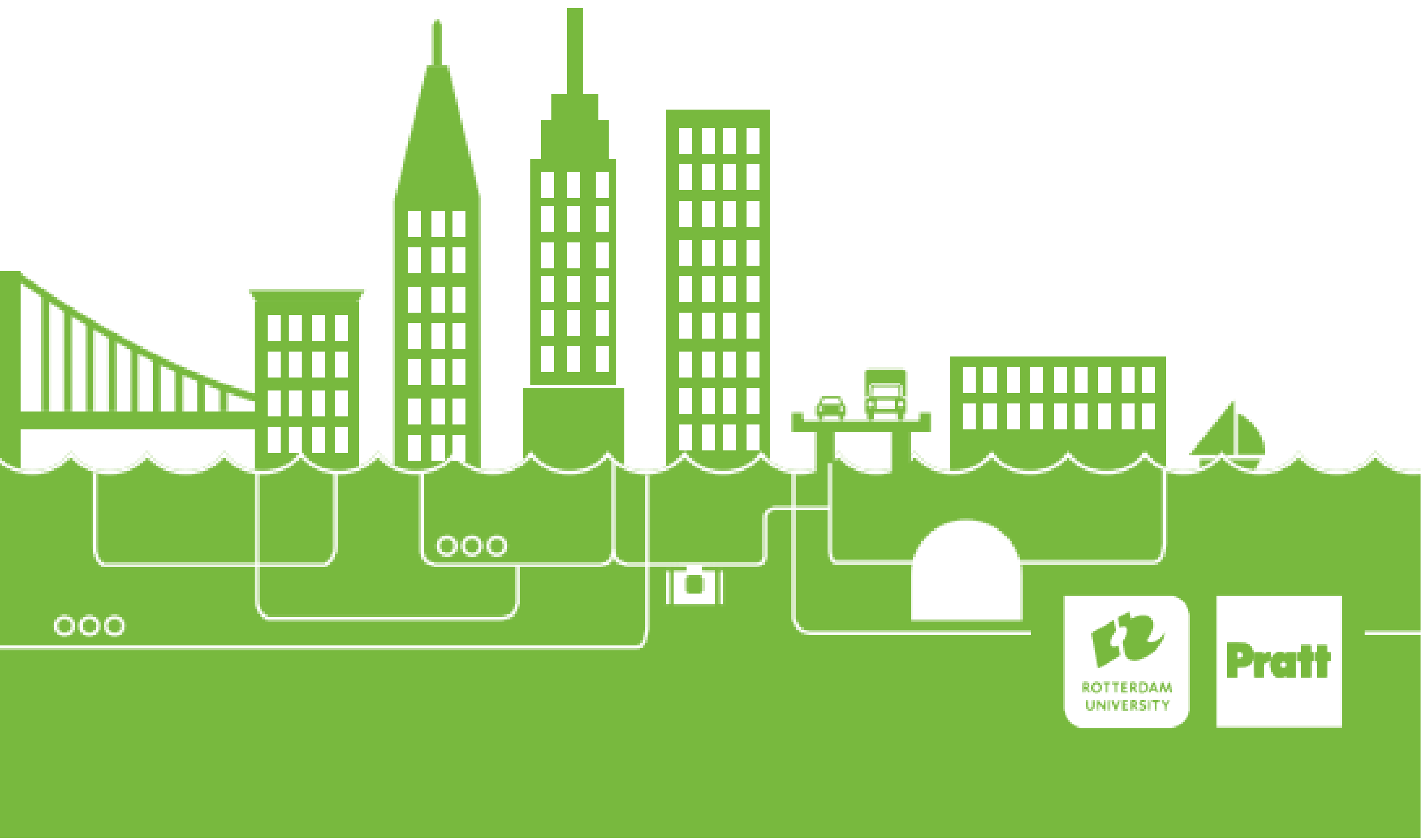
INTERNATIONAL NETWORK FOR
RESILIENT WATERFRONT COMMUNITIES:
INCLUSIVE INNOVATION FOR RESILIENCE IN DELTA CITIES

Approaching climate resilience in waterfront communities

A comparative study between Red Hook, New York and Heijplaat, Rotterdam



Bachelor thesis report - Rotterdam University of Applied Sciences (2014/2015)

"Approaching climate resilience in waterfront communities"

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On behalf of:
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Preface

Throughout my time as student I have always been fascinated about the link between our society and the built environment as a whole. Over the last two years, through the program of International Cooperation and Sustainable Development, I have been able to combine my passion for travel and culture to explore urban areas abroad in interdisciplinary research projects. In a short encounter with students of the Pratt University in New York, March last year, my curiosity was peaked and I chose to link my thesis research with the pioneering research program International Network for Resilient Waterfront Communities, a collaboration between RDM Campus and Pratt.

With this Bachelor thesis report on Approaching Climate Resilience in Waterfront Communities I near the end of my studies in Architecture and Construction Engineering and hope to have created a basis for further research and employment in sustainable urban development.

The making of this document could have never happened without a heap of people whom I am very thankful for. Hereby I acknowledge my thanks to:

My tutors Hannah Beljaars-Frederiks and Gita Nandan, for guiding me.
Gita, Elliot, Mark and Stitch for making me feel more than welcome in the studio of Thread Collective
My parents for endless trust and support.
My brother Bram for the final pushes and the repose he brought me in times of stress.
My housemates for feeding me and inspiring me by graduating themselves.
My friends, colleagues and all other people that saw me through this.

Thanks!

Lukas Taks
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Rotterdam

Summary

The research is conducted to add knowledge on the comparability of waterfront communities to the combined research agenda of Pratt University and Rotterdam University of Applied Sciences named International Network for Resilient Waterfront Communities (RWC). The hypothesis is that knowledge can be exchanged on how to approach climate resilience in waterfront communities. The purpose of this thesis is to give insight in how and to what extent climate resilience approaches in different areas can complement one another. In order to do so the thesis studies the waterfront communities of Red Hook, New York and Heijplaat, Rotterdam.

The first chapter of the thesis elaborates on the incentive of the research, the research questions that framed the research and the scope in which the research is conducted. The global trend of globalization and the projected quantification of people living in waterfront communities form the relevance of the research in relation to climate resilience.

The rest of the thesis is comprised of three chapters that explore the definition of climate resiliency in relation to waterfront communities, the comparability of the context and approaches and the lessons that could be learned from both approaches in order to make the hypothesis of RWC tangible.

To make climate resilience comprehensible, the terms used throughout the research are broken down into sizeable pieces over the course of the second chapter.

Over the last decades the amount of extreme weather events that affected big urban agglomerates has risen and the effects have often proven to be disastrous for the local living environments. The vulnerability of these urban areas varies throughout different regions in the world, but is always subject to a set physical, economic and societal aspects of the waterfront community. Climate resiliency measures either limit the exposure and sensitivity of communities to the effects of climate change or build capacity to absorb, adapt and respond to these changes. A participatory planning process is most viable for resilient development as it incorporates a certain user centered and directed flexibility for future needs and possibilities.

In approaching climate resilience a lot of solutions are being developed locally for the same problems that exist, and will come, worldwide. This is part of the motivation behind the creation of many climate resilience networks throughout the world.

Chapter three brings theory into practice and sketches the place specific vulnerabilities of both areas and how it is expected to overcome these vulnerabilities; the climate resilience approach. The frame of reference that is created through exploring the vulnerability of Red Hook and Heijplaat, sets some boundaries to the extent in which the approaches in both areas can contribute to climate resilience abroad. By a varying focus on these vulnerabilities an indication can been given on missing ingredients of the approaches on either side, which imposes that improvement is possible.

Both areas know a great resemblance in historic development and the currently present socio-economic disparities. Economic and societal factors have proven to be significant influencers when it comes to climate vulnerability. Although physical aspects determine the exposure of both waterfront communities to climate change, they also offer limitations to the access to work, resources and facilities and the emergency response. Overall, communities with low economic capital are often located in geographically vulnerable areas, as is also the case in this comparison.

The cut-off location of both neighborhoods and the interdepence that comes with it has resulted in a large capacity of the community to organize itself and take matters in their own hands. The clear division of land use throughout the old harbor areas implies a varying set of actors and interests where the whole neighborhood is concerned.

The further comparison of physical, economic and societal resources and actors in both areas clearly shows differences in the approach towards climate resilience. By referring to existing similarities and differences in vulnerability the chapter emphasizes the differences and similarities in the approaches for both areas and their application.

Due to a difference in focus and urgency that drives the climate resilience approach in both areas, different measures are taken. Where adaptation measures are key in Red Hook, mitigation measures are stressed in Heijplaat. Although these measures could already prove value to one another, it is not merely the measures on their own that make the study interesting.

The resources that are addressed and the responsibilities that are taken throughout the participatory planning processes stipulate the differences in the approaches. The effect that the various actors in the area, their participation and their economic capital have on the possibilities of the planning process are immense.

In both cases the local inhabitants play an important role in the development of the neighborhood. Inhabitants and community organizations are, as experts of their living environment, vital to effective planning under changing conditions.

The responsibility, and challenge, of the government lays in displaying a flexible attitude towards adapting their own resources; funding, regulations and planning, for facilitating the needed development. The responsibility for private actors lays in using the offered physical, economic and societal resources accordingly. This acts out differently in both neighborhoods.

The approach in Red Hook is an agglomeration of projects that address the primal needs of the inhabitants. In Heijplaat the approach is spread as a blanket over the full planning area and builds on the partnership of private parties, public entities and the local inhabitants.

The comparative research resulted in a set of chances and possibilities to establish more climate resilient development on various aspects in both areas. The last chapter maps out these opportunities for each area on how to improve locally applied climate resilience approach.The research puts focus on the exchange of two successfully applied practices that fill a gap in the approach abroad.

After this elaboration on the vulnerabilities and applied approaches in both areas the thesis will conclude that knowledge that contributes the efforts in approaching climate resilience in waterfront communities can indeed be exchanged between Red Hook, New York and Heijplaat, Rotterdam.

In light of the global threat of climate change to delta cities and the amount of established resilience networks climate, resilient pathways will continue to develop. It is therefore vital that adoption of new resources continues, to remain flexible in planning and adaptable in design. The challenges and opportunities that are illustrated in this research set the stage for future research, innovations and sharing of knowledge.

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1. Introduction

The introduction of this report first describes the incentive and goals of the performed research on climate resilience approaches in the waterfront areas of Red Hook, New York and Heijplaat, Rotterdam. Furthermore this chapter elaborates on the problem definition and the research questions that ensue that definition. Also the significance of this research will be laid out in relation to relevant current problems in the work field. In addition, the research approach and methods on which the research is based will be presented.

1.1. Inducement

The RDM Campus and Pratt University want to broaden the existing Dutch-American collaboration (Connecting Delta Cities, 2014) and sharing of knowledge on resilient waterfront development into education on an international scale. In follow-up of the successful Brooklyn-Rotterdam Waterfront Exchange (BRWE) program both parties started pioneering the International Network for Resilient Waterfront Communities (RWC) last year (RWC, 2014).

Through the minor International Cooperation and Sustainable Development (ICSD) and Pi-XL: Think Global, Act Local the Rotterdam University of Applied Sciences (HRo) has connected its curriculum to the combined research agenda of RWC. In work sessions and exploring conversations with students and tutors from Pratt, the deprived neighborhoods Red Hook, New York and Heijplaat, Rotterdam have been the topic of discussion.

RWC aims to find out through research what can be learned from one another in the resilient development of these waterfront communities and if knowledge from either side is applicable on the other.

1.2. Problem definition

The neighborhoods of Heijplaat and Red Hook both are experimental grounds for sustainable development in their city. In Heijplaat as well as in Red Hook the involved developing parties are looking for the right approach to come to a more climate resilient neighborhood in response of recent and future climate changes.

Although a lot of adaptation and mitigation techniques and measures are available, and may already be implemented, differences in context have expressed urgency on different themes. The unclarity on what actually defines climate resilience in this context adds to the fragmented application of various techniques and measures, resulting in an absence of an integral and inclusive approach on climate resilience in both waterfront communities

The hypothesis from the RWC program is that a certain exchange of knowledge can take place in how to approach climate resilience in these areas (RWC, 2014). As it is not specifically clear on which points either neighborhood can learn from the other the main research question is formulated as follows:

How, and to what extent, can the existing climate resilience approach in Red Hook, New York contribute to the climate resilience approach in Heijplaat, Rotterdam and vice versa?

1.3. Research goals

A basic *requirement* for this report is that it should add knowledge to the combined research agenda of the HRo and Pratt that has been given form in BRWE, ICSD and, most recently, RWC. The research hereby aims to gain new insights in the comparability of waterfront communities in New York and Rotterdam and the approaches towards climate resilience that apply in both areas.

The *main goal* of the research is to illustrate the interplay between the waterfront areas of Red Hook, New York and Heijplaat, Rotterdam and the specific climate resilience approach that is applied locally. The research targets to give recommendations on how to improve climate resilience approaches in both areas by analyzing the key elements in the different climate resilience approaches and see which parts could be adapted or adopted on either side, taking in mind differences in context.

By performing a comparative study in two vulnerable waterfront communities, the research further *intents* to find out to which extent the issue of climate change and the effort towards climate resilience have a general approach that is applicable in similar waterfront areas globally.

1.4. Relevance

As of 2010, half of the world's population lives in urbanized areas, and of those 3.5 billion people, 38% live in large urban agglomerations or mega-cities (United Nations, 2011). It is expected that by the year 2050 66% of the world's population will live in cities (United Nations, 2014) and a big part of those cities (existing and new) will be in coastal areas. By that time, 1.3 billion people are projected to live in flood-prone urban areas (PBL Netherlands Environmental Assessment Agency, 2014).

To prepare for the needed climate resilience there is a currently expanding number of international networks of governments, companies and entrepreneurs, as well as educational institutions, as we see happening with the International Network for Resilient Waterfront Communities (RWC). In this and many similar networks Rotterdam and New York are both represented. Comparative research in networks as RWC can help define the comparability of waterfront areas globally when it comes to approaching climate resilience. This might help design a global framework for climate resilient development in waterfront areas.

In general more research is needed about the relationship between mitigation, adaptation and sustainable development (Denton, et al., 2014) in relation to climate change.

Red Hook and Heijplaat are examples of vulnerable waterfront areas in developed countries and have been the topic of previous research and design projects at both knowledge institutes connected to this research. As both areas are currently considered as playgrounds for sustainable development within their city, they will continue to be interesting for further research and innovations as the developments continue over the coming years.

1.5. Scope of research

In line with RWC this research focusses on resilience in waterfront communities. The research delimits itself to a comparison between the climate resilience approaches in two socio-economically deprived neighborhoods, being; Red Hook, New York and Heijplaat, Rotterdam.

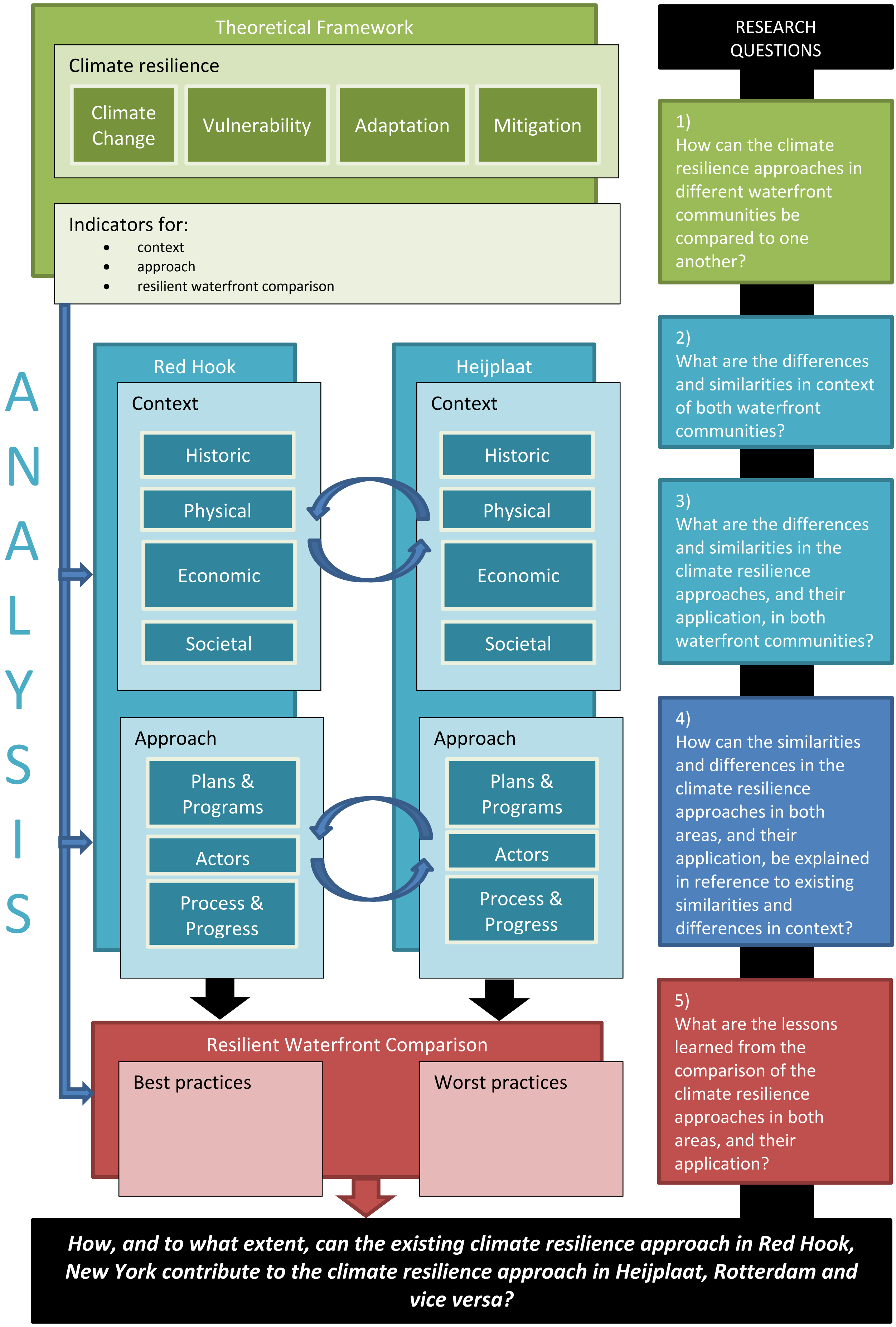
When analyzing the approaches on climate resilience the research limits itself to the indicators that are formed from the theoretical framework. The research reviews the content, organization and planned implementation of the approaches. It might however be hard to produce solid facts about the actual success and effectiveness of the application of approach due to the ongoing process of implementation and planning.

Within climate resilience the research tries to match climate change adaptation and climate change mitigation to the sustainable development of both areas. Climate change adaptation in this research is related to the rising flood risk in waterfront areas due to broadening deltas, more extreme weather conditions and the rise of groundwater and sea levels. Climate change mitigation is demarcated in this research to reducing the emission of greenhouse gasses (GHG), as a result of energy use in residential buildings.

To be able to compare the impacts of climate change in both areas and the effectiveness of the locally applied approaches it is attempted to match as much as possible of the neighborhoods components, or context. Earlier explorations by other researchers (Doepel Strijkers Architects, 2013) (Hogeschool Rotterdam, 2014) (Veelen, 2015) (Vollaard, 2014) (Pratt, 2014) suggest that a certain level of comparability is to be expected through the focus on waterfront areas in two large Delta Cities, which can both be marked as socioeconomically deprived neighborhoods with high rates of government assisted housing. The criteria that will be drafted up for comparison will set the boundaries of the research. Eventual surviving differences in context may help conclude why either one of the districts or approaches would be more resilient than the other.

References might be made throughout the research to other coastal areas or waterfront communities, when relevant, to make a link to the global scale of the issue.

1.6. Research structure



RWC

1.7. Research approach

To get a comprehensive picture of both areas and approaches the research has been conducted in both New York (November – February) and Rotterdam (February – July). The structure and planning of the research is formed around the time spent abroad.

As the research describes different contexts, ranging from physical location specifics to societal systems and economic approaches, it requires a range of various research methods to answer the formulated questions. The table below shows which methods are connected to which part of the research. The diagram on the previous page shows the structure of the research and which questions are answered in which part of the research. The colors in the table below correspond with the colors used in the diagram.

Theoretical framework	Desk research, interviews, meetings and other events
Context analysis	Desk research, location visits, interviews, meetings and other events
Comparative analysis	Interviews, reviews, meetings and other events
Lessons learned	Interviews and reviews

Theoretical framework

The theoretical framework for this research is partly based on literature (and lectures) provided through ICSD courses. A part of the theoretical framework is already formed prior to the research period. Self-conducted desk research further specifies the framework to fit the research subject of climate resilience in waterfront communities.

To help define work field terms in relation to local developments, several meetings and presentations are attended in New York and Rotterdam. Throughout conducted interviews and reviews reflection has taken place on the formulated definition.

The end goal of the theoretical framework is to derive a set of indicators on which we can base the assessment of the researched approaches in light of resilient development in both areas. The indicators for climate resilience will also lead to a list of criteria for the initial context analysis and comparison.

Context analysis

The key aspects of the context analysis are represented by the criteria that are drafted up in the theoretical framework. These criteria help line out the research and information that is needed to make a qualitative comparison between the climate resilience approaches in both areas.

As a basis for the location and planning analysis, data is used from different research and planning documents from local city agencies and, to smaller extent, local knowledge institutions. Desk research is furthermore used to better understand the (historic) development of the research area and the local organization and planning structures. Throughout the research period several location visits take place to discover the physical and social aspects of both areas. The local expertise of my tutors is an additional source for historic, current and future (planning) information.

Interviews with involved parties in the resilient development of both neighborhoods contribute to an understanding of the current developments and planning mechanisms, as well as the functioning of, and the interrelation between, different components of the context.

Comparative analysis

The comparative analysis of the climate resilience approaches in both areas is based on the indicators that result from the theoretical framework. The (key) components of the approaches are judged on their contribution to climate resilience in the neighborhood. The relation of the approaches to their previously defined contexts can explain differences in application and success. Again data is used from different research and planning documents from local city agencies and, to smaller extent, local knowledge institutions.

The comparison in effectiveness of both approaches is delimited by the drafted indicators and criteria. In reviews, interviews, meetings and other events with local experts and actors the context and approaches from abroad are reviewed.

Lessons learned

The lessons learned are based on the best and worst practices that have surfaced by analyzing, comparing and judging the existing approaches. The contributing and limiting factors in both approaches will be linked to see if data and measures might be interchanged between the two areas. By aligning the practices to the same indicators of vulnerability abroad a set of chances and opportunities will be drafted for improving the approaches on either side. This ultimately results in an answer to the main research question:

How, and to what extent, can the existing climate resilience approach in Red Hook, New York contribute to the climate resilience approach in Heijplaat, Rotterdam and vice versa?

2. Breaking down climate resilience

This chapter will be dedicated to forming the theoretical framework by stipulating the exact meaning of the terms used throughout the research. It is important to break down climate resilience, and its parts, to their bare essentials so a list of indicators and criteria for resilient development can be created to structure the comparison between climate resilience approaches in Red Hook, New York and Heijplaat Rotterdam.

The chapter first describes the context of climate change and the vulnerability of waterfront communities to this changing climate. It then continues by defining the desired reality of climate resilience and the aspects of the trail that leads there.

When the terms are scaled down from their generic character to the specifics of the scope of the research an answer can be given to the question:
How can the climate resilience approaches in different waterfront communities be compared to one another?

2.1. Climate change

As climate change has been an important topic on the international agenda for the last decennia it is not surprising that we can use a well-aged definition:
"Climate change means 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." (United Nations, 1994)

When looking at the climate change challenges that lay ahead for the existing and future delta cities, there is a lot that can be listed. The rising sea level is obviously one trend to be concerned with. The broadening of global hurricane belts and a rise in heavy rain fall is another. Global warming can be a third and then there's a whole variety of specific sub elements of those three subjects. In general we need to prepare for changing, and more, extreme weather conditions. According to the United Nations (UN) Secretary General climate change is the major, overriding environmental issue of our time (UNEP, 2015).

The possible response of communities and the built environment to climate change is defined as climate resilience. In wake of big natural disasters in world cities as Melbourne, Tokyo and New York, amongst others, climate resilience has become a more urgent topic. The disruptive force of extreme weather events in coastal areas and waterfront cities and the further predicted climate change will have a big effect on humanity and civilization as we know it today (Hardy, 2003). It is obvious that a lot of similar climate change risks play a role in waterfront cities. However the severity and urgency of the risks may differ.

A few water related risks that New York City is facing as a result of climate change, according to the U.S. Environmental Protection Agency (EPA), are increased hurricane intensity and storm surge, and more flooding due to more frequent heavy rains and sea level rise (SLR). In addition, the growing frequency of heat waves is stressed as an important risk, as this could negatively influence the health of people in the city as a result of the Urban Heat Island Effect (UHIE) and a possible declining air quality, as well as a big drop in food production and water reserves in the larger New York State area. (EPA, 2014)

For the city of Rotterdam flooding and storm resilience are an issue, but not as heavily as in New York. One reason for that is, that water safety has been a topic on the national agenda for the last 62-years. A second reason is that the Netherlands as a whole are less prone to super storms and hurricanes due to a more moderate climate and the United Kingdom and Ireland as a barrier between the country and the Big Atlantic.

SLR, heavier rainfall and the changing ground water levels are more problematic on their own. The UHIE and air quality are also very dominant problems in the city of Rotterdam. Due to the extensive harbor activities, an industry that revolves around fossil fuels for about 50% (Moving@Rotterdam, 2013), and a large overaged housing stock the focus in Rotterdam is currently largely on limiting GHG-emissions in city and harbor and optimizing energy efficiency throughout its confines.

2.2. Vulnerabilities

The damage done, and existing problems caused, by our changing climate throughout different regions all around the world has made it clear that our "wealthiest" and "most developed" cities are also vulnerable to climate change. Maybe even more than other cities, as there is more to lose.

Vulnerability is a key element in the framework of climate resilience (IPCC, 2014). Communities that are less capable of developing climate resiliency infrastructures and response systems are more likely to experience the negative impacts of climate change. IPCC describes three characteristics of vulnerability; "adaptive capacity, sensitivity, and exposure."

The exposure of an area could be described as the change in climate it is likely to experience. Sensitivity describes the likelihood of how the area is affected due to the exposure to that changing climate. Together they impose the potential (negative) impact on the local environment and its functions. Adaptive capacity can be seen as the potential to lighten the effects of exposure and sensitivity. Adaptive capacity can, with that definition, also incorporate some mitigative qualities that lessen the risk of (hazardous) climate change effects. This will later be addressed separately as mitigative capacity (2.4).

Sensitivity and exposure deal with both economic and geographical elements that vary extensively from neighborhood to neighborhood. Adaptive capacity contains a wide range of elements that deal not only with technology and economic development, but with various societal factors as well. These societal factors range from human capital and governance structures to values, perceptions and traditions (IPCC, 2001). This societal part of adaptive capacity can be linked to what is discussed as community capacity within current documents on climate resilience as the Rising Community Reconstruction Plan (RCRP) or in the subject material of Pratt's PSPD program (Stein, 2014). While there are generic dimensions to adaptive capacity, there are at least as many indicators that are specific to a particular impact of climate change or specific to a local environment (Tol & Yohe, 2007). Even though a variety in elements exists, clear parallels can be found between communities with a similar vulnerability (IPCC, 2001).

When describing the vulnerability of an area, IPCC makes a distinction between geographical vulnerability on one side and **economic vulnerability** on the other. In their definition it is possible to find societal elements of adaptive capacity in both, but through the demarcation of this research, and its focus on approaches for climate resilience in socio-economically deprived neighborhoods, it becomes more clear to discuss the social and institutional factors of climate vulnerability as a separate third category; **societal vulnerability**. Geographical vulnerability, as described by IPCC, deals with the full physical aspects of an environment as it incorporates natural components as well as artificial components (e.g. infrastructure). Throughout the remainder of this research geographical vulnerability will be addressed as **physical vulnerability** to align the terminology used in this paragraph with the components of climate resilience approaches. A distinction within physical elements can still be made with the addressors of geographical and technological.

In order to learn from one another in approaching climate resilience the comparability of climate vulnerability in Red Hook, NY and Heijplaat, Rotterdam is key. From the following elaboration on all three categories a set of indicators for climate vulnerability will arise. The various determinants of vulnerability will be listed per category.

Physical

Physical vulnerability is a shared concern for all Delta Cities. There is of course a difference in landscape, climate and soil types between different Delta Cities worldwide (for example; Ho Chi Minh City and Melbourne), but with water levels rising globally at sea (SLR) and in most river deltas, as well as predicted extremer weather conditions globally, low-lying waterfront areas are by default more vulnerable when it comes to water safety. The location of a waterfront area within a city and its distance/relation to sea, ocean and other water bodies heavily influence the flood risk. Nonetheless, their extensive waterfront make them geographically flood prone.

The Dutch Delta Works, dikes and dunes are known all around the globe for their water protection qualities. This large scale development is an impressive showcase of water management. On a smaller scale of water management physical vulnerability can relate to the functioning of sewer systems and the water retention qualities of materials used in the public space.

Another important determinant for physical vulnerability is the state of the built environment in the area. The building year, typology and maintenance of the housing stock, public spaces and other infrastructures influence the livelihood of the area. With these variables in mind it is clear that through appropriate adaptive measures and planning mechanisms physical vulnerability can be influenced positively.

The capacity to develop response systems, as societal part of a climate resiliency strategy, can, on the other hand, also be obstructed by geographical components. Far Rockaways, New York, for example, is a cut-off area sandwiched between the oceanic waterfront and the Jamaica Bay. The peninsula only connects to the city of New York via the Marine Parkway Bridge and the Cross Bay Bridge, or by a Subway line that crosses the bay. During the Sandy storm surge streets flooded, cars were swept away and these vital infrastructures were damaged. This is partially why it took up to three weeks before proper help, or even electricity, reached the local community. For that period of time they were left to their own devices. (Ocean Bay Community Development Corporation, 2014) (Hester Street Collaborative, 2014) Coney Island and Red Hook underwent similar response problems due to the limited accessibility to both neighborhoods.

Indicators for physical vulnerability

- Distance to delta front
- Extent and type of waterfront
- Flood risk
    - Area elevation
    - Predicted SLR and rainfall
    - Water protective structures
- Water retention qualities
- Sewer system
- Accessibility of neighborhood
- Building stock
    - Typology
    - Building year
    - Building materials
    - Maintenance
    - Function
- Positioning of vital infrastructure
    - Soft
    - Utilities

Economic

The neighborhoods in NYC that where most affected by super storm Sandy were those neighborhoods that, on average, distinctively deal with great socioeconomic disparities in relation to other parts of the city. These areas, i.a. Far Rockaways, Coney Island and Red Hook, are known for their big public housing projects and low-income levels which makes them economically vulnerable. As discussed in the previous paragraph these are all neighborhoods with a big physical vulnerability as well.

In areas that are more flood prone, low-income households have shown to be disproportionately overrepresented compared to households with higher income. The conditions that these areas are exposed to are under strong influence of climate change and should expect an increase in intensity and frequency of natural storm events. (Winsemius, et al., 2015)

In the storm event of Katrina (2005) the Lower 9th Ward, a neighborhood in decline and one of the poorest areas in the city of New Orleans, was almost obliterated. The Lower 9th Ward is built on a former swamp and has an isolated location in the city. (City of New Orleans, 2006) (Tijdelijke Samenscholing, 2015)

When it comes down to natural hazards, Penn State University states that, wealth is one of the most elaborate factors in vulnerability. Poor people generally have a lower capacity to deal with the impacts of natural hazards. Most importantly; the poor are less able to afford housing and other infrastructure that can withstand extreme events. An extra factor is that the poor are less likely to have insurance policies that can contribute. (PennState University, 2015)

The Coastal Zone Management Subgroup of the IPCC also takes features as the economic value (gross domestic product, GDP) of the flood-prone area and the number of jobs into account in its evaluation of the vulnerability of coastal regions, and its comparison of the threat to individual nations and cities (IPCC, 2014). The influence that the physical vulnerability of an area and the imposed climate risks have on real estate value in the area should also not be underestimated, as this could later thwart climate resilient investments.

Although high income per capita might not be considered as a necessary or sufficient indicator for the capacity of an community to adapt to climate change (Schneider, 2001), the extensive government assisted housing in both researched areas does bind the indicator to very relevant factors of funding, institutional structures and business models.

Indicators for economic vulnerability

- Property division
- Real estate value
- Income levels
- Costs of living
- Employment rates
- Local employment
- GDP of the area
- Subsidies and funding
- Investors
- Insurance policy

Societal

The societal vulnerability of an area is derived from social components and institutional structures. The social component builds on the presence of inhabitants, and sense of community, within any given urban environment. The institutional component originates from networks of, and the organization within, various parties that establish their influence on the local environment through use, planning and/or regulation.

On a very basic level societal vulnerability has to deal with the composition of the community. Population density and the distribution of different social groups can add to social sensitivity of a neighborhood as it insinuates how many people are affected and which networks they can fall back upon (Winkler, Baumert, Blanchard, S., & J., 2007). In response to disruptive climate events the existence and specification of emergency protocols and routes can play an important role in climate vulnerability. In case of such an event, continued communication with emergency services, relatives and loved ones is dependent on robust and up-to-date communication networks as phone and internet (Wi-Fi).

Following from a diversion in land-use, the division of property, and its rights, over various parties can result in an agglomeration of fragmented intrinsically motivated interests that might oppose to large scale planning. Ownership, as a societal determinant of vulnerability, is not solely limited to the physical side of real estate, but often finds its way into planning processes as well. In these planning processes the amount of transparency and the involvement of inhabitants determine a participatory component in which communication is key.

The understanding throughout the community of the consequences of climate change is vital in relation to improving climate vulnerability. This results, in part, from the notion that conflict with local perceptions, customs, traditions and values can throw up a cultural barrier in approaching climate resilience (Winkler, Baumert, Blanchard, S., & J., 2007). Towards planning it is important that this understanding is present in all actors, so that resiliency guidelines are unambiguously included within all actions and developments.

The ability and the will of a community to organize itself can results in less dependence on external actors and may lessen the overall vulnerability as climate resilience efforts can be steered from a user centered perspective.

Indicators for societal vulnerability

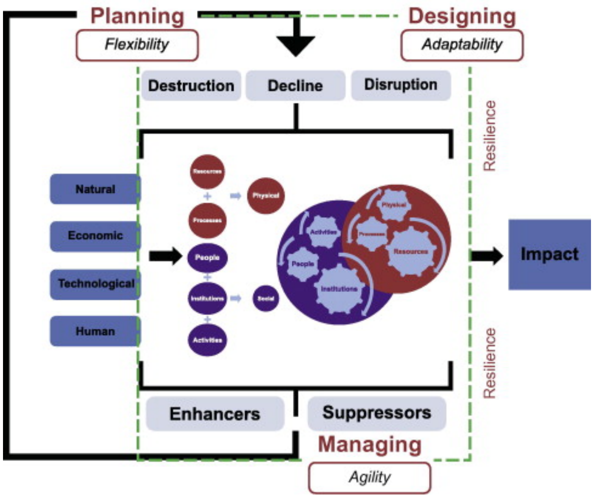
- Population density
- Demographics
- Emergency response
- Communication networks
- Standards of living
- Property owners & rights (land-use)
- Knowledge
- Participatory planning
- Transparency
- Resiliency guidelines & legislation
- Community organization

2.3. Resilience

After years of sustainability debate and heaps of definitions, Brundlandt's definition of sustainable development is still most broadly used within the field of urban development;
"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987).

Sustainable development is not lost on us, but resilience has slowly taken over as the new hot topic throughout many work fields within the domain of the built environment. The Intergovernmental Panel on Climate Change (IPCC) describes resilient pathways as a means towards sustainable development (Denton, et al., 2014). A definite settlement on what defines resilience has not been reached though, partly because it represents a very abstract concept.

Within the program of the minor International Cooperation & Sustainable Development (ICSD) the conceptual framework, as shown below (Desouza & Flanery, 2013), is used as a reference for the definition of resilience in the domain of the built environment.



In their paper 'Designing, planning, and managing resilient cities: A conceptual framework' resilience, in terms of cities, is generally referred to as the ability to absorb, adapt and respond to changes in an urban system.

Desouza and Flanery discuss the various components within a city (center), the stressors that impact a city (left), the outcomes of stress (top), and three sets of interventions (designing, planning, and managing) for building resilient cities through networks.

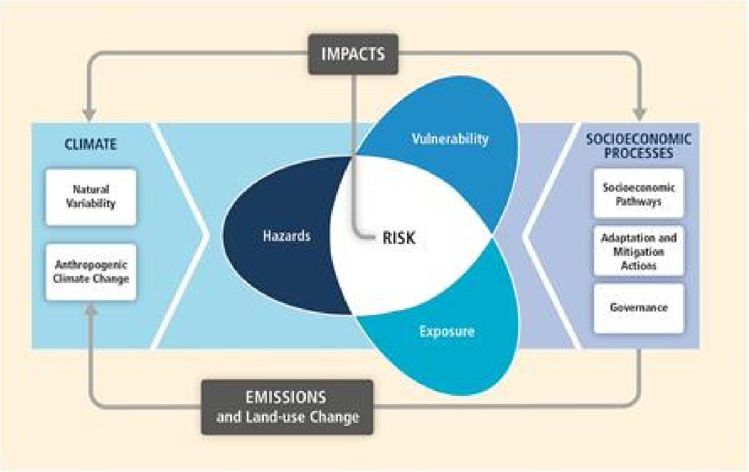
The model shows a great interconnection between, and influence of, many facets of society. The societal component of the conceptual framework is described as critical in approaching resilient cities as people are the corner stone of society as a whole, and thus influence all other components of resilient development. Physical components, as infrastructure, are important for cities, but the most important part of resiliency is cited as "enabling people to bounce back from shocks". The ability to absorb, adapt, but, primarily, respond heavily depends on human interaction, communication and functioning networks of society.

Desouza and Flanery therefor place a distinct emphasis on networks and describe a participatory planning process as most viable for resilient development as it incorporates a certain user centered and directed flexibility for future needs, which the traditional service based planning can just not fulfill.
Furthermore, resilience shares much with other existing urban goals, such as sustainability, governance and economic development. This makes resilience compliable to a wide range of planning and societal mechanisms that could be integrated in an overall strategy for climate resilient cities.

When looking at, and comparing, resilience in the cities of New York and Rotterdam it is alas impossible to include all components of the framework in one comprehensive thesis study.

'Climate resilience', as mentioned in the title of this chapter, could be seen as a delimitation within the framework above. With 'climate resilience' we focus on the natural stressor of climate change that we want our Delta Cities to be resilient against.

To zoom in on climate resilience the following model by the IPCC is added. The model (IPCC, 2012) displays our natural stressor; climate (change), on the left and our socioeconomic processes (city/society) on the right.



In the middle the key aspects of the current focus on climate resilience in waterfront cities can be found. 'Hazards' (like Sandy) are a natural occurring thing, but the frequency and intensity is under strong influence of our changing environment. The component of 'exposure' for waterfront areas is, in relation to these events, to some extend a give-away, but the 'vulnerability' of an area, as discussed in the previous paragraph, is a more complex structure of contextual sensitivity, consisting of physical, economical and societal aspects. All three terms together form the risk of potential impact.

The interrelation between our climate and societal efforts is shown in the arrows in the top and bottom of the model. Efforts towards climate resilience lead back to the center of the diagram, influencing the risk of climate change to the urban environment. The impacts of extreme weather events in waterfront areas ask for adaptation actions that influence the vulnerability, and to some extend exposure, of an area. The flow of emissions and land-use change calls for mitigation actions that lower our impact on the climate, indirectly lessen the climate change and thus limit the hazards that are at hand.

It are those adaptation and mitigation measures that we use in planning towards climate resilience. In the fifth assessment report of the International Panel of Climate Change (IPCC) climate resilient pathways are described as "development trajectories that combine adaptation and mitigation to realize the goal of sustainable development" (Denton, et al., 2014). Thus, ideally a climate resiliency approach would work from both sides.

In the remainder of this chapter both mitigation and adaptation, and their main attributes, will be discussed in relation to climate resilience efforts in waterfront communities.

2.4. Climate resilient pathways

To achieve the desired reality of a climate resilient environment both adaptation and mitigation measures have to be adopted into our development trajectories, or approaches. The ability of an environment to go either way can be best described by the terms adaptive and mitigative capacity. Adaptive capacity has been described earlier as a characteristic of vulnerability, dealing with physical, economical and societal components. It is consequently imminent that in addressing climate resilient approaches, and the linked capacities, the same categorization can be used. Through the two-sided presence of adaptive capacity vulnerability becomes an assessment framework for resilience.

As announced; the previous demarcation where adaptive capacity 'also incorporate(d) some mitigative qualities that lessen the risk of (hazardous) climate change effects' (2.2) will now be set aside as mitigative capacity will be discussed separately.

This paragraph will address the relevance, terminology and basic technological principals of both adaptation and mitigation, but moreover turn towards the components crucial for application of those principals, and the improvement of vulnerability, that are often imbedded in more societal and economical fields. This reflection towards the 'how' of climate resilient development will result in a list of criteria for climate resilience approaches.

Adaptation

Adaptation knows a lot of sides and it is important to take in mind the wide range of measures that are applicable. Within the boundaries of this research climate change adaptation measures are primarily restricted to storm resilience; the ability of a community to absorb, adapt and respond to extreme weather events. Storm resilience as a subcategory of climate resilience, knows two key factors, being social and physical.

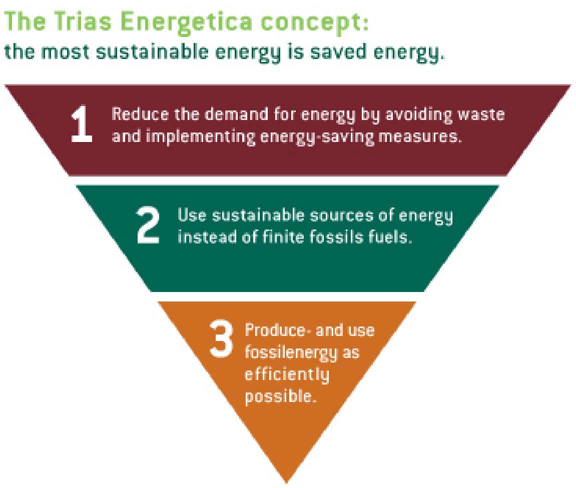
The physical factor in storm resilience is flood protection. Flood protection deals with vulnerabilities relating to the 'sensitivity' and 'exposure' of an area. In flood protection a division can be made in wet proof and dry proof measures. Wet proof measures allow water to come into the building without damaging it or its contents; making it less sensitive to floods. Dry proof measures, or structural flood protection, happens, by definition, outside of the buildings functions, either shielding or sealing parts of the building; leaving them less exposed to floods.

The social factor in storm resiliency is mainly focused around water safety and the response to a storm. It can be divided in the fields of communication and evacuation, and can be linked to the earlier addressed 'adaptive capacity' and the need for networks in resilient planning (2.1).

Adaptation measures often have a direct and local effect, but often affect the water management of the surrounding areas as well. The relation between local vulnerabilities and regional planning mechanisms has to be embraced in approaching climate resilience throughout delta cities. The variation of adaptation measures happen on different levels that influence each other.

Mitigation

As energy still originates largely from fossil fuels as oil, coal and gas, it has a big impact on our environment by GHG-emissions alone. Day in day out, tons of CO2 and methane gas drift up into the atmosphere, trapping sun radiation and slowly warming up the air, contributing through global warming to the inevitable climate change (VPRO, 2015). A lot of these emissions are thought to come from heavy industries. Partly this is right, but the bulk of GHG-emissions originates from energy production and usage. The production and use of energy in the U.S. as a whole accounts for more than 80% of GHG-emissions in the country (EPA, 2010). A stunning 37% of CO2 emissions in NYC comes from residential buildings alone (City of New York, 2014). If we are able to limit our energy use at home we can lower our impact on our climate.



When looking at energy efficiency in residential buildings as a component of climate change mitigation, it is important to break energy efficiency down to three key aspects, as shown in the picture on the left (Lysen, 1996) (Agentschap NL, 2013):

1. Reduce the amount of energy needed to a minimum;
2. Enlarge use of renewable energy sources;
3. Efficient use of fossil energy when needed to support renewable energy.

The challenge of retrofitting the existing housing stock mainly lays in the first step of the model; energy savings. This step deals with technical properties of the building as well as the energy usage itself.

By retrofitting existing facades through second skin techniques, giving heightened insulation properties to the building, the energy demand can be reduced massively (Urban Green Council, 2013) (Platform31, 2013). Predicted extreme heat (UHIE) and cold place higher requirements on retrofits in relation to energy use and comfort in residential buildings (Urban Green Council, 2014) (Enterprise Community Partners, 2015).

Smart techniques that are controllable through phone, apps or other devices can further optimize the energy management at home by minimizing peeks and maximizing energy exchanges by controlling, and educating about, the energy usage of individuals and households (ICY, 2015).

The other two steps of the Trias Energetica connect to a larger scale of (renewable) energy generation and distribution that depends depend largely on the urban network, e.g. campus, a building is located on. The goal of self-sufficient housing, when it comes to energy, is not always possible to achieve within the context of the building itself. The financial case for energy neutral retrofitting multi-story residential buildings in the Netherlands for instance is still not fully closed, while this is achieved for smaller housing units (Dulk F. d., 2012). In producing and sharing energy on a neighborhood far more can be achieved than by everyone on its own. This step towards climate resilience asks for a connection to wider focused sustainable development.

Mitigation has a long-term, global effect on climate resilience, rather than the local, direct effect of adaptation. The goal of international agreements on GHGs is to encourage decision makers at various levels to initiate actions that lead to the mitigation of GHGs.

Application

Although some mitigation and adaptation measures have been addressed during the course of the two previous paragraphs, the full technological range is too wide to describe without any context. The vital aspect of physical climate resilience resources is that a range of viable options is available. These technological options need to be placed in the light of economic, technological and societal potential and constraints towards their adoption that exist within the context of application (Winkler, Baumert, Blanchard, S., & J., 2007). The success of a climate resilient pathway does therefor not directly lay within the physical elements of adaptation and mitigation measures, but is often dominated by the economic and societal factors of its context, resources and actors.

Economic potential and constraints follow from the earlier addressed indicators of vulnerability (2.2). Opportunity costs of devoting resources to mitigation or adaptation play an important role in this balance. These partly lay in insurance policies, GDP, market conditions, funding and property prices.

It is important that a reasonable pay-off time is connected to any investments made towards climate resilience. Mitigation measures will only start to have a noticeable effect on our climate after 10-20 years, but a very big effect in the scope of 30-40 years (Tegenlicht, 2015). The connected drop in energy demand and usage does have a faster return, but will also demand patience of investors.

The societal influence on the success of climate resilient pathways starts with an understanding by local decision makers of the economic and technological potential of adaptation and mitigation measures within the context of their area. This follows their basic understanding of the effects and risks of climate change to the local environment. For application it has to be taken in mind that communities in itself know different scales of vulnerability that require different adaptation and mitigation measures (Planners Network NYC, 2014).

The access that different actors have to decision-making processes, and the extent in which they participate, are societal conditions for approaching climate resilience as they lead to flexibility in planning and adaptability in design (Desouza & Flanery, 2013). The community, the private sector and the government have to work together to make neighborhood planning function properly (Nandan, 2014). Understandable communication about planning towards inhabitants is vital for implementation (Pratt, 2014). Through sense of ownership that can be created in these participatory planning processes a certain commitment and mutual responsibility can grow between the various advocates and partners.

The more associated actors participate, the more inclusive the approach towards climate resilience can become. The resources that are available within the structure of these processes are, next to planning documents, mainly policies and regulations that either constrain or support adoption of adaptation and mitigation measures in the area.

As the interrelation between both vulnerability and resilience has become more apparent during the course of this chapter, it can be concluded that: to become climate resilient is to move beyond climate vulnerabilities. The main criteria for climate resilience approaches in this retrospect is that they improve the earlier addressed indicators for climate resilience.

It has to be noted that as physical, economic and societal influences differ from one location to another it can be that adoption of certain measures and policies might be possible in one country and totally impossible in another. Still there are some general criteria that can be linked to climate resilience approaches.

Physical criteria
Range of viable technological options
Availability and distribution of resources to adopt

Economic criteria
Patience in pay-off-time
Subsidies and funding

Societal criteria
Various levels of application
Knowledge of effects of climate change
Participatory decision-making
Wide/full range of actors
Trustworthy advocates & partners
Policy & regulation

3. Resilient waterfront comparison

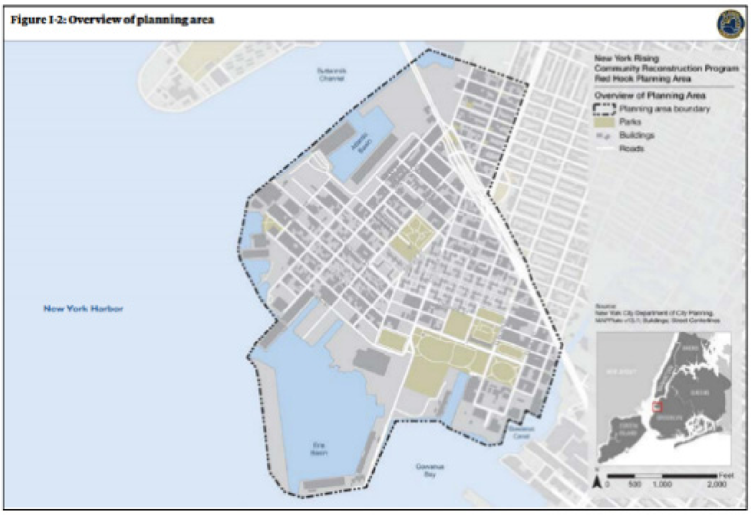
The previous chapter delivered a set of indicators of climate vulnerability and criteria for climate resilience approaches that apply for waterfront communities. As clear parallels can be found between communities with a similar vulnerability (2.2), this chapter will first make a comparison between the areas of Red Hook, NY and Heijplaat, Rotterdam based on these indicators of climate vulnerability. In follow up the current climate resilience plans, programs and approaches in both areas will be laid out against the drafted criteria for climate resilience approaches to further determine and discuss the level of resilience in these waterfront communities.

3.1. Meet the neighborhoods

In the first chapter of this research a brief introduction of both areas has already been given in text. This paragraph will refresh some of the selection criteria and give a short visualization of both neighborhoods.

Red Hook

Red Hook is a neighborhood in the southwest of Brooklyn, NY and borders the New York Harbor. The waterfront of the area has been in use for centuries and is still active today. Due to this history the waterfront is marked by various historic buildings. The outer skirts of the area are in use for business. In the center of the neighborhood the government assisted housing projects Red Hook East and West facilitate housing for about 6.500 inhabitants. During the storm surge of Sandy (2012) the neighborhood was heavily affected.



Heijplaat

Heijplaat, Rotterdam is an isolated neighborhood on the south bank of the river Maas. In the old unembanked neighborhood, which was originally created for harbor laborers, a massive 80% of housing units is government assisted. The original harbor activities have moved, but all the old industrial buildings still dominate the waterfront. Heijplaat has become a playground for sustainability through various projects and programs.

3.2. Vulnerabilities

The easiest way to make the vulnerability to climate change in both areas, and their differences, visible is to align data on the selected determinants. The full set of data, that was gathered throughout various location visits, interviews and desk research, can be found in the appendices and is divided the three categories of vulnerability, as discussed in chapter (2.2); physical, economic and societal.

Physical

The storm surge of Sandy (2012) flooded big parts of New York City and had devastating effects for the waterfront community Red Hook. This is partly due to the absence of flood protective infrastructure in the neighborhood and in the Hudson Delta. The unembanked area of Heijplaat does relish from such infrastructure. Almost the half of the Netherlands is actually dependent on the flood protective qualities of the Dutch Delta Works. As discussed the moderate climate also adds to a smaller exposure of the neighborhood to similar storm events. Nevertheless the proximity of the river delta and the elevation make both neighborhoods geographically flood prone. Both areas are in the 100-year flood plain and subject to the risks and potential impacts of SLR and more extreme weather events.

Both areas are isolated from the rest of the city by water on one side and large transportation infrastructures on the other. This imposes a risk for supply of resources and services in case of emergency and lowers the capacity to develop response systems. The disconnection to the surrounding areas does seem to have a positive societal effect on the community bonding within the area as will be addressed under societal vulnerability.

The remoteness of the neighborhoods follow from the extensive harbor activities that dominated both areas from the start. Behind the historic waterfronts of the unembanked neighborhoods lay residential enclaves that are dominated by government assisted housing. This similarity in division of property, with industrial businesses on the waterfront and residential in the center, are characteristic for the physical profile of both neighborhoods.

The size of the planning areas is almost the same, but the size of the community differs immensely. This has big implications for the building typology throughout both neighborhoods. The building typology of government assisted housing in both areas are almost contradicting; low-rise row houses dominate in Heijplaat, whereas developments of NYCHA are built on the concept of towers-in-the park. Most of these housing units stem from the time that the harbors were vastly expanding (50s). They could either be deemed historical (Heijplaat) or old (Red Hook), but in both cases they do not live up to recent building regulations and are in a state of overdue maintenance.

It has to be taken in mind that a super storm hit NYC just a few years ago and that the scale of operation differs immensely, but it can be deducted that key elements of the physical environment in New York are not maintained as well as in Rotterdam. This derives partly from the state of streets, sidewalks and quays that appear not to be attended for in a while. Also the sewer system and associated pumps in Red Hook give the impression to be outdated. Above ground energy distribution, as well as long-term temporary installations, throughout parts of Red Hook are seemingly more vulnerable to storm impact than the energy networks that are below ground in Heijplaat.

Although both living environments are relatively green, the presence of the extensive harbor areas limits the water retention capacity of the neighborhoods to a minimum.

Economic

The communities can be distinguished as socio-economically deprived when, amongst other things, income levels and employment rates are compared to the rest of the city. This heavily burdens the capacity of the community to absorb, adapt and respond to respond to possible effects of climate change.

The biggest economic vulnerability derives from the abnormal percentage of government assisted housing in both areas in relation to owner occupied housing units (10-15%). As government assisted housing is provided affordably for people with low incomes (and well-fare) the economic capital of inhabitants is low. The entities that run the government assisted housing projects in the areas both deal with financial problems, due to cutbacks in funding and mismanagement, which makes improvement of the housing units more difficult. There is a very clear difference in magnitude again, but the deficits cannot go unmentioned.

Both neighborhoods have thrived on the early harbor activities in the area and have eventually dropped into decline after containerization and movement of harbor activities further down the river delta. While previous to this change the neighborhoods mainly housed employees of the harbor industries, afterwards there was little work left and unemployment levels rose. This has resulted in a decline of inhabitants throughout both areas over time as commuting to work became more difficult, due to the cut-off location, and facilities could no longer be supported.

The storm event of Sandy has further existing burdened small businesses in Red Hook with water damage to building as well as supplies and inventory. The small financial resources of the shop owners has made it hard to restart their enterprises (RCRP, 2014).

Flood insurance policies are based on the possibility of flooding; the higher the exposure and sensitivity of the area are, the higher the insurance rates get. This year, for the first time since the Watersnoodramp in 1953, flood insurance has become possible again in the Netherlands. In Red Hook the insurance rates have skyrocketed after old flood maps were reviewed in wake of Sandy. The disproportionate levels that flood insurance have now reached in the most economically vulnerable areas in New York (Center for NYC Neighborhoods, 2014) underwrite the statement of Penn State (2.2) that wealth is indeed one of the most elaborate factors in vulnerability.

The property values of buildings in both areas are dependent on their own physical state as well as the physical and societal state of the environment. As the exposure and sensitivity of the area are also taken into account property values are lower than in other parts of both cities.

Red Hook heavily depends on governmental and private funding for repairs and (re)development of the neighborhood.

Societal

The history of the neighborhood, as addressed under economical vulnerability, also influences some of the societal vulnerability and climate resilience challenges today. Red Hook has moved from freight port to crack capital of the US (1990s) to a rising community today that aims for climate resilience in the future. Heijplaat has moved from a vibrant workers village to a neighborhood in decline, and is now rising again through educational activity and innovative measures towards climate resilience.

A big share in societal vulnerability comes from population density in the area, which connects to the physical indicator of building typology. The amount of people that are affected in Red Hook is about 8 times as big as in Heijplaat. This insinuates that more facilities would be available in Red Hook as well, but in comparison to the amount of people that live in the neighborhood, this level is still low (RCRP, 2014).

Both areas are identified by their community capacity. This seems to evolve partly from the physical barrier to connect to other parts of the city, which makes the inhabitants more interdependent. Moreover it seems to be driven by a feeling of apparent peril. In both areas the community engagement has flourished in times of distress. In Heijplaat the imposed demolition has united inhabitants against expansion of the harbor activities in the area. In Red Hook the devastating effects of Sandy made the community unite more than ever (Schloss, 2014). Sense of community cannot be demanded of inhabitants in planning processes (Planners Network NYC, 2014), but luckily is present in both neighborhoods.

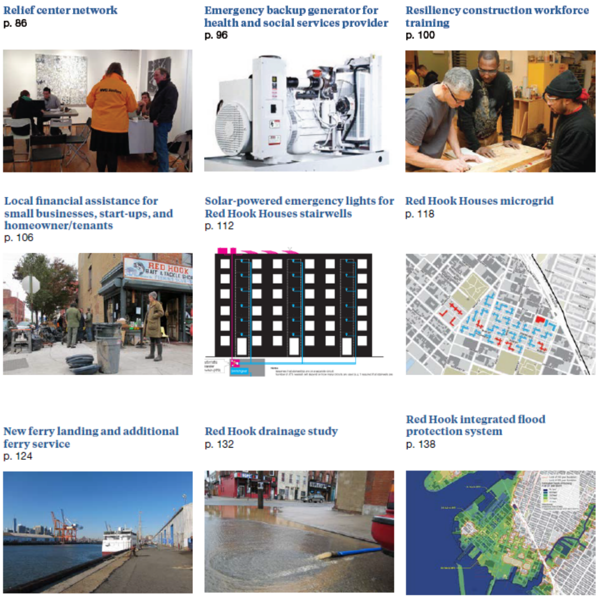
The social influence on adaptive capacity is further developed in Red Hook through the various community organizations in the neighborhood, as well as physical communication networks and emergency planning. In Red Hook it is clearer on which networks people could fall back upon. The community is also more able to advocate their ideas for development in the neighborhood.

The earlier addressed property division results in various actors with different interest. All these actors fulfill different roles and have a varying influence in the planning process. The amount of actors in Heijplaat is limited to a few major parties. In Red Hook this network consists of a wider range of big and small parties. Varying interest per actor might complicate the participatory planning process in Red Hook, as communication and common ground might be harder to establish.

3.3. Approaches

As the vulnerabilities of both areas, and their similarity, are now known, the planned climate resilience approaches can be reviewed accordingly. As discussed in paragraph 2.4 the application of the approaches is not merely limited to technological resources that are available for innovating the built environment, but is mainly given form through societal and economic resources and the actors that influence the process. The key components of the planned approaches will be discussed as various resources at hand. In reflection of the actors and their participation and roles the research will elaborate on the societal and economic constructs behind the approaches.

Resources



The planning approach in Red Hook knows two main dividers; the community based planning through the New York Rising Community Reconstruction Program (RCRP) and the more conservative Request for Proposals (RFP) of the Housing Authority (HA).

In the community based process of RCRP analysis of risks, needs and opportunities has resulted in a set of viable measures for application (RCRP, 2014). A selection is made throughout the document in projects that have a high priority and provide immediate profitable results in relation to climate resilience. These subdivided projects, as shows above, can directly be fully funded through the Community Development Block Grant Disaster Recovery (CDBG- DR) that is available through RCRP. The remaining projects have to be funded additionally.

The proposed study of the sewage system and the integrated flood protection system obviously deal with the physical vulnerability of the neighborhood.

In light of the period that Red Hook Houses (RHh) and other parts of Red Hook were out of power after Sandy, discussion has taken root on developing a self-sustaining energy production in the neighborhood through a micro-grid. The power outage that lasted over two weeks bereft the inhabitants of basic requirements as lighting and heating. Even though this affected all single housing units at NYCHA, emphasis in independence is laid on essential public facilities as stairway lighting, elevator functions and communication network that enhance the ability of the needed emergency response and evacuation.

Various other projects as; relief center networks, back-up generators and resiliency trainings, that are listed also relate to the vulnerability in response systems, evacuation and emergency resources.

The 72-hour community response plan is the eye-catcher in climate resilient development of Red Hook. A similar response plan is also developed/planned in other neighborhoods like the Lower East Side (LES Ready!, 2014) in follow up of RBD and other post-Sandy planning. The interesting part of the Community Response Plan; Ready Red Hook is, that it is already developed and given form through collaboration of community parties. An actual part of planning which has found a practical application throughout the neighborhood.

The latest addition in planning towards climate resilience in Red Hook is that NYCHA has put out an RFP for RHh on November 14th, 2014. In this RFP they do not request their usual conservative reconstruction and repairs for the projects, but a progressive and innovative plan for the campus of RHh. This particular RFP follows RFPs for public housing projects in Coney Island and other heavy struck neighborhoods. The focus on climate resilience, inclusive design and participation are surprising, to say the least (Khabazi, 2015). The resources and organizational structure that market parties have, gives more potential for resilient development than the government structure of the HA. The economic resources that are made available flow from federal recovery funding similar to CDBG-DR.

The approach in Heijplaat encompasses innovation, economic stimulation, green infrastructure, water retention, flood protection, energy efficiency and sustainable housing concepts (CHV) and is a joined effort of various actors for approaching climate resilience. Main ingredients for the approach are civic participation and awareness.

The program on energy neutrality, Heijplaat Klimaatneutraal 2020, is the first project in the Netherlands that runs on the scale of the neighborhood and it could therefore be viewed as an experiment. The goal is to eventually produce more energy than is used and thus become climate neutral as a neighborhood. The approach on energy efficiency is primarily focused on the retrofitting of the existing housing stock and would later be extended in streamlining distribution of the locally produced energy through a micro-grid.

The flood protection strategy is multi-layered. Instead of only focusing on the physical dry proofing with dams, dikes and other infrastructure, attention is also given to the social side of storm resilience. The adaptation approach includes flood prevention, reduction of impacts and management of the potential damage. The latter parts of the approach have not been developed, though.

Actors

The basis of the approach through RCRP has been the bottom-up participatory planning process of the local community, facilitated by the government. Throughout the planning process consulting firms and other professionals have added their technical and economic expertise to that of the governments, to come to the presented set of viable options.

NYCHA as a government agency has, in an open call to Architects and Engineers (A&E), approached the market for climate resilient development in Red Hook houses. The development will be funded by HUD, (possibly) FEMA and NYSERDA. NYCHA keeps control over the eventual design by letting firms compete, but these A&E will have to take lead in the actual development. The role of inhabitants of the projects will be determined by the selection of NYCHA and the work of the chosen A&E.

The municipality of Rotterdam, Rotterdam Port Authority, Eneco, Stedin Netbeheerder, RDM Campus, Hogeschool Rotterdam & VWH have signed a partnership agreement (Samenwerkingsovereenkomst Gebiedsontwikkeling Heijplaat) in 2012 that encloses multiple projects for the development of a Resilient Heijplaat. Inhabitants of Heijplaat have been included in a large part of the planning process so far and are an important contributor to the ongoing developments today.

The municipality of Rotterdam has actively steered towards civic participation on their part, or actually activating the local community to interact with the planning and actual development of the neighborhood. By informing the community in an early stage about climate resilience, the community has become aware of the potential benefits for their living environment and now share the view of that desired reality. Private actors also have been actively stimulated to participate in the planning process and share costs and responsibilities.

3.4. Climate resilience comparative

Much of the vulnerabilities in the area follow from the resembling historic development of both areas. Both remote waterfront communities deal with a deficit in local employment and facilities, an exclusion of residential functions from the waterfront and an overaged building stock. The proximity of the river delta and the elevation of both unembanked neighborhoods make them geographically flood prone as well.

As water safety is a more urgent topic in NYC it is not surprising that the approach in Red Hook is primarily focusing on the storm resiliency of the neighborhood and community as a whole while the approach in Heijplaat incorporates the buildings scale intensively by its focus on energy efficiency. In the aftermath of Sandy communities in New York were less in the mood to talk long-term resiliency as there were more urgent problems at hand (Planners Network NYC, 2014).

It is interesting at least that although this difference in focus exists, both plans stress the importance of a micro-grid within the neighborhood. In Heijplaat the micro-grid accentuates a response to the current inefficient power usage and distribution and stresses the possibility of a climate neutral self-sufficient neighborhood. In Red Hook the main argument for this development is to become less dependent on the functioning of the citywide structures of the New York Power Authority (NYPA) in case of emergency.

In the example addressed above adaptive capacity can be heightened through mitigative action and vice versa. In research on climate adaptation in Toronto a certain overlap between adaptation and mitigation measures could also be found (Penney, 2008). It is important that planners and decision makers have insight in the two-sided contribution of such measures towards climate resilience and can act on that.

As flood risk has not lead to life threatening situation in Heijplaat, due to the protective infrastructure in the Maas delta, there has been no need or urgency, as of yet, to develop the latter two steps of the multi-layered approach in how to absorb and respond to the potential impact of flooding. In Red Hook the social side of storm resiliency has already taken form through various initiatives in the wake of Sandy. These initiatives proved to be necessary as the physical flood protection (step 1) that the neighborhood could rely on was almost nonexistent. Ready Red Hook and Red Hook Wi-Fi illustrate the present capacity of the community to organize itself and the need of inhabitants for communication with, and connection to, their social environment.

Inhabitants of Red Hook have contributed as experts of their community to plural researches and designs for the neighborhood in RBD and RCRP. In the planning process towards a climate resilient Heijplaat, the local inhabitants have also been important to assess the needs of the community.

The participatory planning process in Heijplaat includes representatives of the government, the community and private actors and addresses climate resilience on the neighborhood level. In Red Hook the approach is spread over different plans and processes in which various actors are active. The approach works from an agglomeration of singular projects throughout the neighborhood that address the most urgent risks and needs of the community in approaching climate resilience. In Heijplaat in comparison a picture is drawn, literally, that illustrates the desired reality for the neighborhood as a whole with the projects therein. In the neighborhood approach all stakeholders of the area are informed on and, when needed, included in the subparts of development. This contributes to the understanding of the pathways that leads to the crafted comprehensive desired reality. Framing of the climate resilient strategy into various key projects makes planning, investment and development comprehensible.

In Red Hook there is a large dependence on federal, state, city and international funding for disaster recovery and resiliency planning, whereas the climate resilient development in Heijplaat is building on financial participation of private actors.

Overall the comparison between vulnerabilities, approaches, application of climate resilience measures and the resources and actors behind it shows that the effectiveness differs on different aspects throughout the researched communities. Although the resiliency measures are bound to the specific vulnerabilities of each area, lessons can be learned from system designed solutions in best practices worldwide (Planners Network NYC, 2014).

Through further reviewing examples of effective and ineffective planning and application and expounding on their origin, the challenges and opportunities for climate resilient pathways can now be listed. Similar societal elements that contributed to climate resilience in both areas already ratify the criteria of a participatory planning process (2.3) and the link to various scales of planning as boundary conditions (2.4).

4. Learning curve

With both approaches linked to their context, and the theoretical framework as a whole, this chapter completes the comparison of Red Hook, NY and Heijplaat, Rotterdam and aims to map out the main opportunities that can be deducted from this comparison, towards a better climate resilience aproach in both waterfront communities. The contributing and limiting factors of both approaches will be illustrated by best and worst practices from both areas and their surroundings. The practices discussed in this chapter are a selection from the more extensive analyses of the approaches in both areas. All cases will be linked to priory mentioned vulnerabilities, actors and resources in both areas.

4.1. Best practices

The selected practices deal with the aspects of planning that are perceived as vital in the approach towards climate resilience the waterfront communities of Red Hook and Heijplaat.

Needs & risk assessment

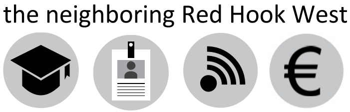
The 'Dutch' planning process of research centered design that was applied in Rebuild by Design (RBD) easily found support in the organized communities of New York. The planning process of research design is formed to effectively deal with big societal problems that apply locally. All projects within the design competition did so accordingly by using inhabitants of the researched area as experts of their environment.
The needs and risk assessment that has been the basis for the Red Hook Rising Community Reconstruction Program (RCRP) acted on the same principal and has translated the most urgent needs and risks into projects or planning trajectories to deal with the most vital climate vulnerabilities of the planning area.

Emergency response

Parts of the communication and evacuation, in relation to storm resilience, have been addressed in various community based initiatives and plans throughout New York, as in WifiNY, Red Hook Wi-Fi, LES Ready! and Ready Red Hook (LES Ready!, 2014) (Cohen, 2014) (Urban Omnibus, 2013) (Red Hook Coalition, 2014). Key components of these plans are up-to-date communication mechanisms, information distribution, 'know-your-neighbor', evacuation/shelter protocols and preparation. Community services as Wi-Fi and locally initiated response systems in New York add to the connection between inhabitants.
Ready Red Hook is a 72-hour community response plan that it is already developed and given form through collaboration between community parties and planning professionals.

Climate resilience education

The shared experience of, and effort towards, interconnectedness leads to the point where ownership is achieved in various social aspects of communication and evacuation. In various ways inhabitants of Red Hook have also become stewards in these developments.
Red Hook Wi-Fi is a project that should provide a storm resilient communication network throughout the neighborhood. The project relies on a learning track for teenagers and young adults to learn the necessary skills for application. Through this training their chances for jobs improve, which adds to the economical and societal side of community capacity.
The NYCHA farm also functions as a training center on urban farming for youngsters in school and seniors from the neighboring Red Hook West Senior Center.



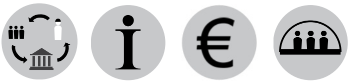
Co-creating climate resilience

The climate resilient development in Heijplaat is based around a partnership agreement signed by the local government, private actors and representatives if the neighborhood. The agreement clearly divides roles and responsibilities for all actors involved in the planning process and implementation. The Municipality of Rotterdam actively motivated the private actors for commitment of time, expertise, resources and finance.

In this construct the government facilitates the planning process, private actors ensure sustainable development through innovative design and the inhabitants ensure that climate resilience measures are taken accordingly to the needs of the community. The participatory planning process is based on mutual gains and shared responsibility in different phases of initiation, planning, realization and maintenance.

For the affirmation of the measures that are planned, knowledge can be gained from the local community. Communities are looked upon as vital sources of information, but are not always taken seriously in taking part in the actual planning process/development. In this participatory planning process the community nests itself as expert of their own environment. Where the tenants association in Heijplaat was invited to participate in the planning process, they also became co-owners of the climate resilience plans for their area. With this sense of ownership comes responsibility, and vice versa. This notion is extended in the participatory planning process to commit actors to the planned developments. The inhabitants have now become (enthusiastic) leaders of the climate resilient development.

The further inclusion of private actors as Eneco, RPA and Van Omme & de Groot, originally Woonbron, within this development make a wide range of physical, economic and societal resources available. The mindset of private actors is slowly shifting from making profit to being sustainable, while making a profit (Peek & Remmen, 2012). As the consumer becomes more focused on sustainable design/development, great business opportunities arise (Tilburg, Francken, Tulder, & Rosa, 2012). Through long-term commitment to flood protection not only future risks and costs are reduced, but a long-term value is created through contribution towards climate resilience.



Incubator for climate resilience

In the development of Heijplaat RDM has become a real incubator for a more climate resilient waterfront community. Through transforming the old harbor buildings and water side to a hub for innovative businesses that are driven by research, design and manufacturing, RDM functions as an impetus in the climate resilient development of the area.

The reshoring of manufacturing activities to the historic waterfront community is modelled around prototyping. Through the collaboration between knowledge institutes and private parties, innovation in manufacturing is stimulated. The resulting spin-off of this development is that new businesses come to the area. Many small business startups that root at RDM are founded by former students of the knowledge institutes based at that same location in follow up of their education. The local employment level in Heijplaat is currently low, but with the completion of het Nieuwe Dorp (the New Village) it is expected that a part of the people working at RDM will move to the area. Also jobs should become available for the current inhabitants of the neighborhood.

RDM supplies and shares functions, facilities, employment, education and innovative concepts in climate resilience measures with its direct environment. The dock and village expand the laboratory of the large manufacturing halls into the urban environment of Heijplaat. The projects displayed in the CHV and on site have become an attraction for international delegations of urban planners, architects and designers.

The cultural activities organized in the old submarine hangar (Onderzeebootloods) also draw more tourists and visitors towards the waterfront community. This combined rise in users of the area might prove of extra value when it could make various facilities in the neighborhood, which were lost over time, profitable again.

4.2. Worst practices

The selected practices deal with the aspects of planning and implementation that are perceived as limiting factors in the approach towards climate resilience the waterfront communities of Red Hook and Heijplaat.

Disconnected development

The fragmentation of entities that exists throughout the different scales of the government structure in the US (Planners Network NYC, 2014) effects the coverage of climate resiliency efforts.

There are a lot of plans underway for flood protection on the large scale of the city and region. On the medium scale of neighborhoods plans and programs are developed on green infrastructure, off-grid utilities, micro-grids and community engagement (NYCHA, 2014). The island of NYCHA is not completely and directly involved in planning mechanisms of the wider area. In documents on adaptation strategies for the city all typologies are addressed apart from the 'towers-in-the-park' that illustrates the public housing projects of NYCHA. For flood protection in public housing there has not been decided on a preferred method or retrofit (DCP, 2014). Apart from assigned project in RCRP no comprehensive plan has been drafted that specifically addresses the government assisted housing units in the area as a whole including its tenants.

The wide range of actors in the neighborhood makes it hard to oversee all developments that are planned for the area. A further absence of an overall plan for the neighborhood sometimes results in developments that disconnect with the needs for climate resilience of the waterfront community.

In the needed redevelopment of Coffey Park, a centrally located park in Red Hook bordering Red Hook Houses, the Department of Parks and Recreation (DPR) coble stone paths are replaced with the more impervious material; asphalt. This materialization is totally not in line with needed water retention measures.

In the development of the retail center of IKEA between 2004 and 2008 a lot more missed chances can be appointed when it is reviewed through the scope of climate resilient development. Although redevelopment of the waterfront and quays has made the direct surroundings more attractive, no immediate measures towards flood protection or water retention were incorporated. Furthermore employment of the retail center is not local, although it is one of the biggest employers in the area and replaced a still active dry dock with about 100 local employees. The shuttle services that the retail center provides have made the neighborhood a bit more accessible, but this mainly profits themselves and their customers.

Upcoming developments on the waterfront could act as an incubator for change when it connect more to the needs of the community.

Allocation of funds

Carroll Gardens Association (CGA) a non-profit organization, which possesses multiple affordable housing blocks in Red Hook, applied for federal funding through Built It Back, but only received the funding for repairing the damage of the housing stock two years after the storm (Heramia, 2015).

The Department of Housing and Urban Development (HUD) and FEMA are also still allocating funds to city and state governments. The funds flow from various levels of government and need to be distributed over various planning entities in the large region that was affected during Sandy (Rebuild by Design, 2015).

With the big dependence on emergency funding that exist in the neighborhood it is frustrating to inhabitants that it takes long before these funds are allocated as it slows the climate resilient development of the neighborhood. Good things are happening on a planning level, but only a little bit of that money has in fact reached the ground. (Planners Network NYC, 2014)

The allocated funds that are currently available to adopt adaptation and mitigation measures, but these funds are an unsustainable economic resource. For continuation of a climate resilient pathway the economic challenges have to be overcome through new models of exploitation.

Lack of commitment

Woonbron exits the development of het Nieuwe Dorp in 2014 due to the financial risks that are connected to the private development for the social housing corporation. This exit of the main residential property owner displays part of the economic vulnerability in government assisted housing. The existing deficits from the corporation are out of proportion with the investment that is needed in relation to the other property the actor owns throughout the region.

Although a new private developer has already been appointed by the Municipality, the inhabitants hold their landlord responsible for the promised development of facilities in the neighborhood, which was also a part of the responsibility Woonbron signed off on in the partnership agreement in 2012 (Heijplaat, 2014).

The reappointment of a private actor have set the developments back and have also caused insecurity about the earlier made commitments to the local community. The participatory planning process and set regulations have proven not to be able to ensure participation and responsibility of all parties involved.

Competing interests

In the latest developments for Heijplaat competing interests have arisen between the local inhabitants that reside in the residential area and the RPA that continues development of the harbor activities in the area. It is logical that the involved parties in the planning process seek to get the most advantage for themselves, but eventually all parties included should agree with the decisions made.

The inhabitants feel that living and recreation are being repressed by industrial developments (Heijplaat, 2014). The Condor hangar that has been constructed over the last years has become much bigger than expected and limits the views and open space in the area. Planning of the new access road that leads to a more stimulating business life on the waterfront, and RDM is particular, is a point of discussion as a quiet living environment on the harbor side will be disrupted by the busy access road.

The discontent of the inhabitants can be traced back to the notion that the intent of these developments should be translated and communicated to understandable words. The spin-off effects these developments have for the climate resilient development of the neighborhood as a whole might not be clear. What might further add to the disapproval of the harbor development, is that actual developments in the residential area are slow.

4.3. Knowledge exchange

The relation of the approaches to their previously defined contexts have helped to explain differences in application and success.

Elements for successfully applying the existing approaches can be adopted in a more integral approach for resilient development in both areas. The paragraph builds on the clear correlation that exist between the best practices in Heijplaat and the worst practices in Red Hook, and vice versa.

It could be discussed that Heijplaat is ahead in approaching climate resilience as the neighborhood has proven to be less exposed to floods and is, to some extent, ensured of dry feet through national water management policy. Nonetheless there are gaps of knowledge in the climate resilience approach that could be filled through an exchange of knowledge with Red Hook.

This exchange could start with completing planning of the multi-layered flood protection approach in Heijplaat with emergency response plans.

On the other side, the educational efforts made in Red Hook towards stewardship in climate resilience are reviewed as a best practice, but when they would be linked to a RDM-like development they could further stimulate climate resilience knowledge, innovation and employment in the area and function as the incubator that IKEA could not be.

Red Hook	Heijplaat
RDM CAMPUS — RDM-like incubator to combine climate resilience education with innovation, employment and facilities	READY RED HOOK — Implementation of Ready Red Hook in Heijplaat to fulfill latter steps in multi-layered flood protection approach

Other viable possibilities for climate resilient development in both areas are listed below.

Red Hook	Heijplaat
Implementation of Groenkleed to enliven vacant lots and add to water retention capacity	Creation of urban farm lands to supply in local produce in food, water retention and education
Unplug NYCHA from grid by using the full campus for clean energy production	NUL OP DE METER — Implementation of energy efficiency retrofit in existing housing stock to reduce GHG-emissions
Repurpose ground floor in building blocks for commercial activities to fund mitigation measures	Stimulation of efficient energy use of inhabitants by rewarding lowest energy bill with benefits.

The initially expected contribution that the approaches in both areas could have to one another is given form through the cases addressed above, but the extent in which this contribution is applicable has not fully been explored. Possibilities for further development and practices have been mapped for further exploration.

MAP OF OPPORTUNITIES - RED HOOK

MAP OF OPPORTUNITIES - HEIJPLAAT

Conclusion

In the previous chapters all data has been discussed to answer the main question of this research;

How, and to what extent, can the existing climate resilience approach in Red Hook, New York contribute to the climate resilience approach in Heijplaat, Rotterdam and vice versa?

Planning towards a climate resilient waterfront community is well underway in both neighborhoods. The approaches towards climate resilience differ in both areas due to a variation in scale, context and urgency, but moreover there are significant similarities in vulnerability as well (3.2). Throughout the comparison of the climate resilience approaches clear parallels have been found, as becoming climate resilient is to move beyond climate vulnerabilities (2.4).

During the course of this comparative study is has become clear that knowledge on approaching climate resilience in waterfront communities can be exchanged on various levels between Red Hook, New York and Heijplaat, Rotterdam (4.3).

The main lessons learned for both neighborhoods revolve around the arrangement of the planning process and the division of roles and responsibilities in approaching climate resilience (4). Knowledge about technological solutions and the available adaptation and mitigation measures is existent in both areas. The challenge lays in defining the climate resilient pathway or, in other words; combining these measures in such a way through planning that physical, economic and societal benefits are created in the sustainable development of the area.

Whereas the planning process in Heijplaat is inclusive for all actors and the development of the whole neighborhood is encompassed, the approach in Red Hook is more fragmented over various planning structures and actors (0). The idea of a climate resilient neighborhood should be integrated into all planning and development activities. It has to be clear for everyone involved what the desired reality of their environment is, in order to prevent loss of resources and capacity (4.2). The more associated actors participate, the more inclusive the approach towards climate resilience can become (2.4) due to the resources and responsibilities that can be shared.

Thus planning towards a desired reality of climate resilience requires a participatory planning process, as demonstrated in Heijplaat, in which:
- The local government takes responsibility in initiating and facilitating the planning process,
- The community is empowered and recognized as an expert of their living environment,
- Private actors are motivated to look beyond profit today, for a more sustainable profit in the future (4.1).

Clear communication on the flood risks and the possibilities for sustainable development are key factors to ensure commitment of the various parties involved in the planning process. Expanding and sharing knowledge on the effects of climate change enables the different actors to contribute to climate resilience in the planning areas accordingly to their capacity.

The sharing of knowledge between the two waterfront communities becomes viable in planning towards implementation of best practices that have been applied in one area and fill a gap of knowledge/planning in the other. The practices that deem most suitable for application abroad, as a result of this research, are stated as follows;

1) Heijplaat can improve its multi-layered flood protection approach by translating the emergency response plan of Ready Red Hook to its own community.

2) The climate resilience development in Red Hook can benefit from a RDM-like incubator for education, innovation and employment.

This shows some of the aspects of how approaches in different waterfront communities can contribute to each other, but is has to be taken into account that resilience is bound to place, or at least to climate vulnerabilities. When the found comparability between the context of Red Hook and Heijplaat would not be existent, the comparability of both approaches would also diminish.

It is hard to conclude to what extent the approaches can contribute, as climate resilience efforts have continued over the duration of this research, and are continuing as you read this. As climate resiliency measures taken locally influence the vulnerability of each area, a shift in comparability might come into existence.

It could be no surprise that there is no general approach that could easily be applied in similar waterfront communities globally, due to the local differences in physical, economic and societal aspects of approaching climate resilience; indicators, actors and resources. But there is always something to be learned.

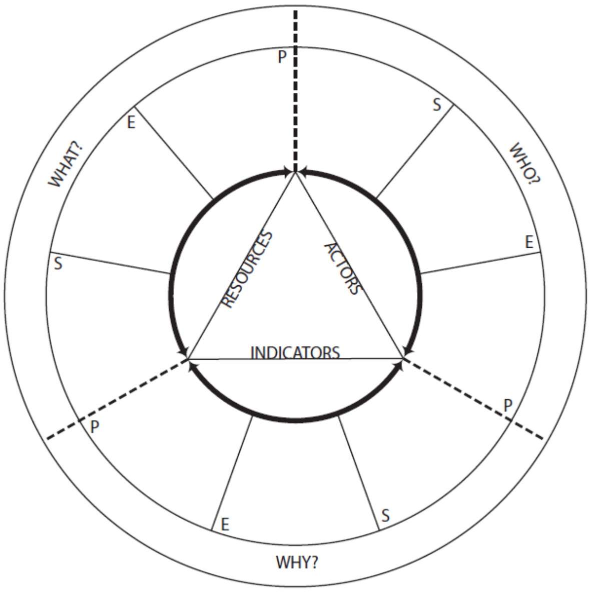
In sharing knowledge on climate resilience approaches through international networks as RWC we define the extent in which approaches can contribute to one another.

Recommendations

In continuing the efforts towards climate resilience in both waterfront communities the lessons learned could be implemented in the approach abroad. Other possibilities for improving climate resilience in both areas (4.3) should be further explored for implementation.

The extent of contribution that approaches throughout other waterfront communities can have on more climate resilient pathways in these areas is left unexplored. By quantifying the conducted study in communities throughout other delta cities connected to the International Network for Resilient Waterfront Communities (RWC) a database of applied climate resilient pathways can be build. The agglomeration of approaches from different areas can lead to new, out-of-the-box, insights on how to tackle specific climate vulnerabilities, as already shown in comparison of Red Hook and Heijplaat. Intensification and spread of this research may in time result in a toolkit for approaching climate resilience in waterfront communities as a whole.

The analysis tool used to structure this research, as shown below, could prove a handhold for the further explorations.



Discussion

Applying a climate resilience approach is, due to context and relevance, totally different in either one of the neighborhoods as other forces and urgencies are at play. Planning and building towards climate resilience in Red Hook is still in state of emergency. In reassuring basic needs and the 'normality' of the living environment the communities in New York have until now been able to bounce back, but not forward (Planners Network NYC, 2014). The rush that is needed to protect the heavy struck area from another storm needs the current planning mechanism and the available resources for immediate action. As stated in paragraph 3.4 "communities are not in the mood to talk long-term resiliency" when faced with the immediate threat and damage of water, so it can be debated of a climate resilient pathway has already been developed.

The fact that Red Hook has suffered a blowback in development by the effects of Sandy might have given an altered impression of the neighborhood and the development paths in relation to the less disturbed development in Heijplaat. There is a certain repose in approaching climate resilience in Heijplaat, which makes experimenting in planning mechanisms and sustainable building technology possible.

Where there is no particular urgency involved and dry feet are more or less ensured, as in Heijplaat, there is a maybe even a disconnect towards approaching climate resilience as the need for storm resilience measures is not present in day-to-day lives.

The difference in scale of approaching climate resilience is a significant one. The scale of government structures, legislation, funding and resiliency efforts in the Netherlands might be most comparable to the level of a single state in the US. A decentralization of government is heavily debated in the wake of Sandy to be empowered to more adequate and qualitative actions in response of a natural disaster.

As the collaboration between Pratt and HRo suffered a blowback during the course of this research it is to be questioned to what extent the combined research agenda is still sustainable.

As the initial focus of the research was purely on climate resilience approaches in government assisted housing, the data collected during the time abroad was not completely directed to answering the current research question. This might have resulted in some short turns throughout the thesis. An important note is that the accessibility to certain literature and knowledge is strongly linked to the location of research.
A lot of data has been collected by the researcher himself in interviews, open conversations and the attendance of meetings and other events. Therefor misinterpretation of data could apply.

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