Countering the current paradoxical trend of redeveloping New York City's vulnerable waterfronts

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1. Introduction

The growing impact of changing environmental and economic conditions on a global level, generates an urgent requirement for cities to respond in a resilient way. Therefore, this research aims to gain insights on the physical transformation of vulnerable industrial waterfronts that deal with productive decline and climate change. This paper will illustrate current redevelopment methods that are implemented in (post-)industrial coastal areas in the metropole city of New York (Fig.1) and conduct a critical analysis regarding this paradoxical redevelopment by mega-projects that are favoring exclusive access for rich communities or mere leisure activities. The paper will use the redevelopment of Williamsburg, Brooklyn as an exemplary case of an already redeveloped waterfront where industry is relentlessly replaced by mere residential and recreational facilities. To counter this method of urban planning, the paper will test a novel research strategy at the intermediate scale on the vulnerable waterfront of the Coney Island Creek, more south in Brooklyn, which can be considered as a best example of urgently needed transformation of remaining industrial coastal areas in the city.

This paper questions the profit-based motifs of current real estate developers. How can coastal areas that are in direct threat of storms, rising sea-level and pollution function resiliently in the future, when they are rapidly developed in order to generate the highest possible profit-range?

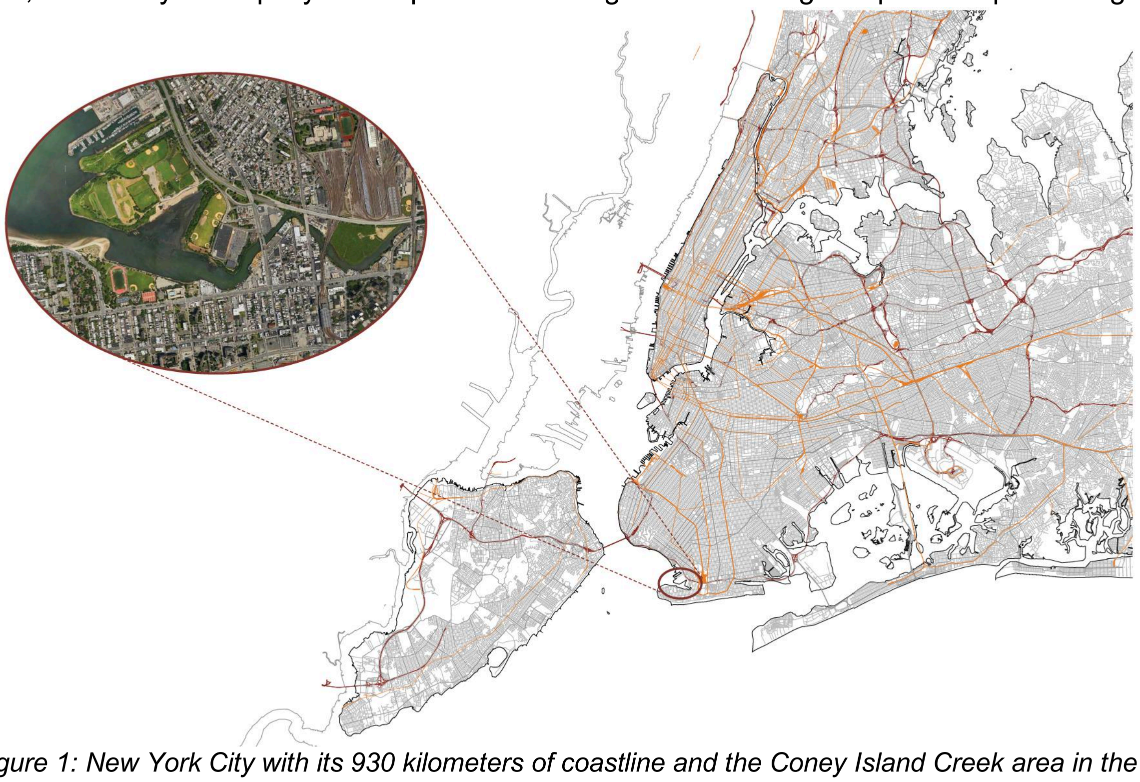

Figure 1: New York City with its 930 kilometers of coastline and the Coney Island Creek area in the southernmost point of Brooklyn, NY. Source: map by Drs. Gitte Schreurs, aerial photo by Apple Maps.

2. Global awareness of a changing environmental and economic climate.

2.1 Environmental changes

New York City is one of many cities worldwide that is suffering under the consequences of growing environmental issues. Climate change is causing the seas to rise and storms to intensify around New York; inundations of more than two meters are expected to occur every five years by 2030. Changes in climate are generally measured by three parameters: the sea-level, the mean yearly temperature and the mean yearly precipitation.

When we look at these parameters, the numbers don't lie: trends in temperature, precipitation and sea levels have increased overall throughout the century. In New York City, mean annual temperature has increased 2.5°C and mean annual precipitation has increased 19.5cm (a change of 1.4% per decade) from 1900 to 2011. Year-to-year precipitation variability was greater from 1956 to 2011 than from 1900-1955. Sea-level in New York has risen 33.5cm since 1900. (NYPCC, 2013) Temperature, precipitation and sea level are expected to rise even further by 2020 and 2050. The New York City Panel for Climate Change has calculated the estimated increase for each parameter with low-, middle- and high-estimates (for best- and worst-case scenarios) (Fig.2).

Baseline Climate and Mean Annual Changes

Air temperature Baseline (1971 - 2000) 54°F	Low-estimate (10th percentile)	Middle range (25th to 75th percentile)	High-estimate (90th percentile)
2020s	+ 1.5°F	+ 2.0°F to + 3.0°F	+ 3.0°F
2050s	+ 3.0°F	+ 4.0°F to + 5.5°F	+ 6.5°F
Precipitation Baseline (1971 - 2000) 50.1 inches	**Low-estimate (10th percentile)**	**Middle range (25th to 75th percentile)**	**High-estimate (90th percentile)**
2020s	-1 percent	0 to + 10 percent	+ 10 percent
2050s	1 percent	+ 5 to + 10 percent	+ 15 percent
Sea level rise Baseline (2000-2004) 0 inches	**Low-estimate (10th percentile)**	**Middle range (25th to 75th percentile)**	**High-estimate (90th percentile)**
2020s	2 inches	4 to 8 inches	11 inches
2050s	7 inches	11 to 24 inches	31 inches

Based on 35 GCMs (24 for sea level rise) and two Representative Concentration Pathways. Baseline data are from the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) United States Historical Climatology Network (USHCN), Version 2 (Menne et al., 2009). Shown are the 10th percentile, 25th percentile, 75th percentile, and 90th percentile 30-year mean values from model-based outcomes.Temperature values are rounded to the nearest 0.5°F, percipitation values are rounded to the nearest 5 percent, and sea level rise values rounded to the nearest inch.

Figure 2: Baseline Climate and Mean Annual Changes by the NYC Panel of Climate Change Source: NPCC Climate Risk Information Report, 2013

Besides sea-level, temperature and precipitation, there is a fourth important parameter to illustrate the impact of climate change on the urban conditions: the occurrence of extreme weather events. In 2012, super storm Sandy had a devastating impact on New York City and was an eye-opener that the city needs proper risk management and resilient urban planning to answer to future extreme weather events. Even though a storm like Sandy is no direct outcome of climate change, the impact of a storm on the city increases significantly due to the changing environmental parameters. The extent and magnitude of coastal flooding during super storm Sandy increased due to the risen sea level in the New York City area. Also, unusually warm upper ocean temperatures made the hurricane gain additional strength (NYPCC, 2013). Numbers show that there has been a general increase in the overall strength of hurricanes in the North Atlantic since the 1980's (USGCRP, 2013). It is during extreme events like these that the risks and flaws in the current urban planning system are exposed. It is crucial for the future of the city that new coastal developments take into account the devastating consequences of these more regularly occurring events.

Though not only hurricanes are a direct threat to the waterfront of New York City, but also the regular coastal flooding. Rising sea-level increases the impact of coastal flooding and flash floods during heavy rainfall or storms. Several flood maps show the projected impact of floods on the urban fabric.

The New York City Department of City Planning has developed the Flood Hazard Mapper, providing a comprehensive overview of coastal flood hazards that threaten the city today (NYCgov). The mapper also shows how the flood hazards are likely to increase in the future as a consequence of climate change and aims to function as a tool for the making of resilient design decisions by property owners, companies, architects and planners.

FEMA (Federal Emergency Management Agency) has also developed Flood maps, showing projected flood zones for the future of New York City, taking into account sea-level rise from both ocean warming and ice sheet melt. They also factor in local conditions such as vertical land movement and regional climate variations. The maps represent the potential flood extent of the 100-year (1% annual chance) and 500-year (0.2% annual chance) flood areas in the 2020's and 2050's, based on the high-estimate of sea-level rise. This means an estimated sea-level rise of 28 centimeters by 2020 and 78,7 centimeters by 2050, in comparison to the sea-level of 2013 (Fig.3).

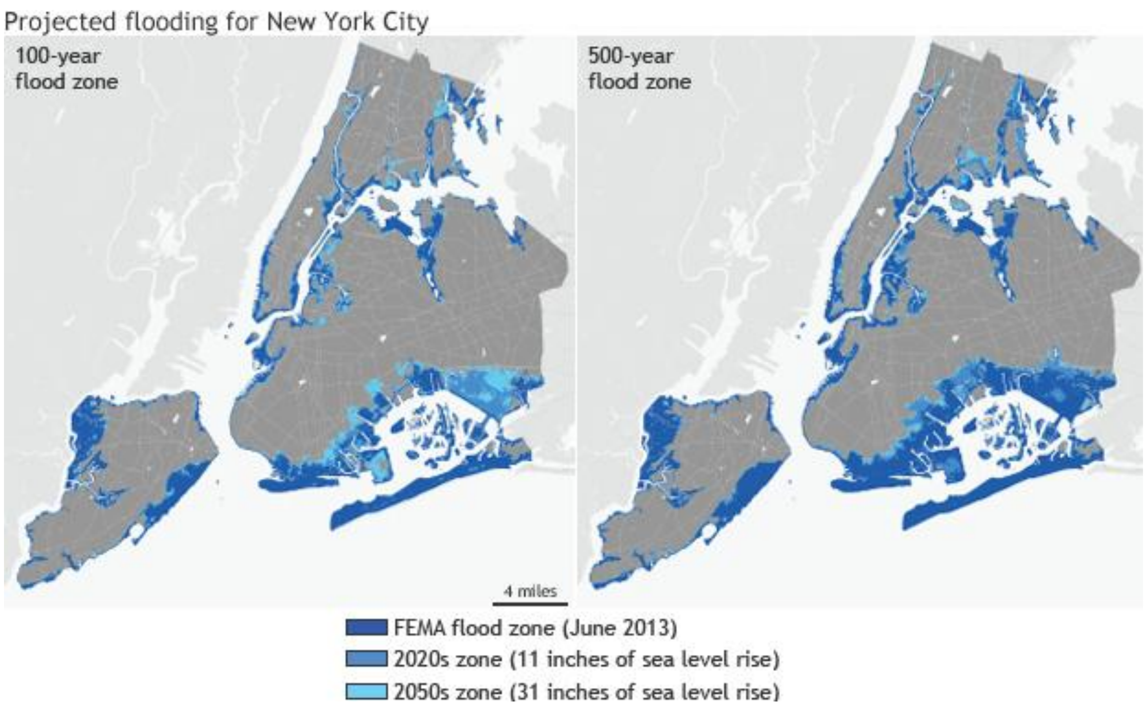

Figure 3: 100-year and 500-year inundation map of FEMA
Source: NPCC Climate Risk Information Report, 2013

After hurricane Katrina (2005) and super storm Sandy (2012), a general awareness for the dangers of climate change and its potential impact on the coastal urban fabric of New York has grown. Yet, we can see a clear paradox in today's city -and especially coastal-development. Despite the awareness for water threat: waterfront property values are rapidly rising, pushing all industrial activity out of the city. There has never been a higher demand for coastal residential development in New York City, while research on how to deal with climate change is still in full progress. The current mindset of city planners and local governments appears to be mainly set on problem-solving after a peak moment, instead of prevention.

2.2 Economic changes

New York City's 930 kilometers of coastline were once indispensable for the growth and prosperity of economy in the city. The city's waterfront has been subject to a vibrant history of industrial development. The first colonial settlements of the 17th century were mostly located at the waterfront. Because of the thriving agriculture that was rapidly developing at the water and the lack of paved roads, ships became the main transportation method between the islands that formed New York City. During the first industrial revolution at the end of the 18th century, industries replaced the agriculture at the waterfronts of New York because of this beneficial transportation by freight ships. At the start of the 19th century, the enormous amount of freight boats was accompanied by ferries to serve commuters between the different boroughs. Waterfronts seemed more important than ever for the economic wealth of the city.

However, when the New York Central Railroad was introduced in the 1850's, a large part of freight transportation shifted to trains for they were faster than ships and had more possibilities of reaching other cities and states. After the completion of the Brooklyn and Verrazano Bridges, physically connecting the different islands of New York, trains and trucks became the most important sources of freight transportation. Industries adjusted to this shift and started facing the streets instead of the waterfront, entailing the decline of the waterfront's importance. This inevitably resulted in graduate relocation of many industries to more inland sites. As a consequence of this relocation, New York City of today knows a large stretch of post-industrial waterfront landscapes with underused or even abandoned warehouses and docks.

Today, developers deal with the issue of how to reprogram or revive these locations. Different approaches are tested on the post-industrial coastal landscape. One of the new developments we can witness at coastal areas is the emergence of 'modern industry's' that are partially reclaiming the old industrial sites, trying to sustain the economy in the city. Warehouses are converted into coworking spaces for young entrepreneurs or recreational facilities (parks, playgrounds, etc.) are implemented to provide waterfront access for the community. However well-intended, this change of initial industry to more modern facilities does not only have a positive social impact. Simultaneously with the exodus of larger industries from their prime waterfront locations, employment opportunities for low-educated workers disappear out of the city center. Affordable housing for low-income families and walk-to-work opportunities become non-existent because of the rapidly rising property and land value by gentrification at the coastline. The conversion to 'modern industries' inevitably contributes to an elite waterfront accessibility and rise in value of the neighboring properties.

What generates even a larger social and economic impact, is most of the post-industrial waterfronts today being rezoned or reprogrammed to fully non-industrial uses, eliminating all initial productive activities, favoring exclusive waterfront access for tourists and high-income residents.

3. The paradox of property value and resilient waterfront redevelopment

For the first time in the history of New York, the city shows a significant interest in the repurpose of urban coastal areas. Often, adaptation in New York City is implied by transformation of the productive or residential waterfront to natural flood zones with mere natural or recreational purposes (D'Hooghe, MIT CAU, 2014). These parks and piers are implemented by the city on many waterfronts in or within close proximity to Manhattan, to serve inhabitants and tourists by offering leisure activities and magnificent views over the city skyline. Ferries are recently initiated to connect the different boroughs and offer easy access from Manhattan to Brooklyn and Queens. These ferries, as rather minor interventions, generate a huge impact at the area of destination. Comparable to most cities globally, accessibility is key in New York. A direct ferry connection to the touristic and economically thriving Manhattan generates inevitable and rapid gentrification for the receiving end of the ferry line. Waterfront land is bought by large real estate project developers for hallucinatory prices. Existing constructions, dating from the industrial revolution in the 19th century, are ruthlessly demolished and replaced by high-rise, low-cost residential towers, overlooking the Manhattan skyline. To then be sold for millions of dollars to the wealthy few. One of the reference cases to illustrate this phenomenon is Williamsburg, in the north-west of Brooklyn.

3.1 Reference case: Williamsburg, Brooklyn, NY

Williamsburg is a neighborhood in Brooklyn, located east of Manhattan, with the East River as a separation between the two. Since the late 1990's, inland Williamsburg has already been undergoing a form of gentrification by the hipster and artist culture. However, its waterfront fully remained a thriving industrial area, with shipyards and heavy industries characterizing the Williamsburg coastline. The inland area was an easy target for gentrification as it has always been rather easily accessible by metro (L-line) and car (Williamsburg Bridge). Rents in Williamsburg significantly increase when the property is within close proximity of a metro entrance. However, the waterfront recently became more accessible as well for locals and tourists, by the newly initiated East River Ferry line, providing a direct connection to Manhattan and other point in Brooklyn.

During the industrial vitality of the 19th century, employment opportunities were created for many blue-collar workers. This resulted in the development of low-rent residential properties for immigrants and lower-income families, in close proximity to their workplace. However, during the industrial decline of the 20th century, Williamsburg dealt with large unemployment rates, increasing crime and residents relocating to different parts of the city. During the recent revitalization of the 21st century this changed drastically and rents are skyrocketing, pushing out all remaining low- and medium-income residents and families, welcoming an elite, white community. By demolishing the remaining industry that was still operative in the area, walk-to-work opportunities for lower-educated workmen become inexistent in the area.

Until 2005, the waterfront had a land-use of mere manufacturing and industry. Today however, a huge rezoning is initiated as interest for the Williamsburg waterfront has grown rapidly for its stunning views over the Manhattan skyline, improved accessibility and gentrification of the inland areas. Before the rezoning, the waterfront was characterized by active manufacturing, light industrial activity and smaller residential developments. After the rezoning of 2005, the land-use exists primarily out of residential new developments and the designation of old warehouses into expensive lofts. To guarantee a certain social mix in the area, the City Council of New York obliged real estate developers to provide one out of three new developments as affordable housing. However, by loopholes in the regulations, the developers forgo these incentives by creating lower rent apartments at less desired, more inland locations instead of implementing them in the new developments at the waterfront. This generates large-scale residential areas, merely affordable by the elite (Fig. 4).

Figure 4: The redevelopment of the Domino Sugar factory into high-priced apartments and parks
Source: Article in Archdaily: "Domino Sugar Factory Master Plan Development"

The redevelopment of the Williamsburg coastline happened over a very short time span, barely taking into account the environmental issues and economic opportunities that the area has. Inland Williamsburg is safeguarded from the flood zones according to FEMA. However, all of the properties at the Williamsburg waterfront are located within a flood evacuation zone and within the 100-year FEMA Flood inundation zone. During super storm Sandy, Williamsburg was spared from devastation because of low tide. Though power cut-offs, lowered accessibility for emergency services and obstructed escape routes after flooding can generate severe problems for residents living in high-rise towers within flood-zones.

Another major risk in these post-industrial areas during flooding is the pollution. Previous industrial activities have contaminated the soil of the post-industrial sites. The Williamsburg waterfront knows several polluted areas where asthma rates are significantly higher than in non-polluted areas (Fig.5). These areas are particularly risky during flooding, because the contamination in the soil will surface and be transported inland by the floodwater. The contaminated water can enter buildings and mix with sewage water.

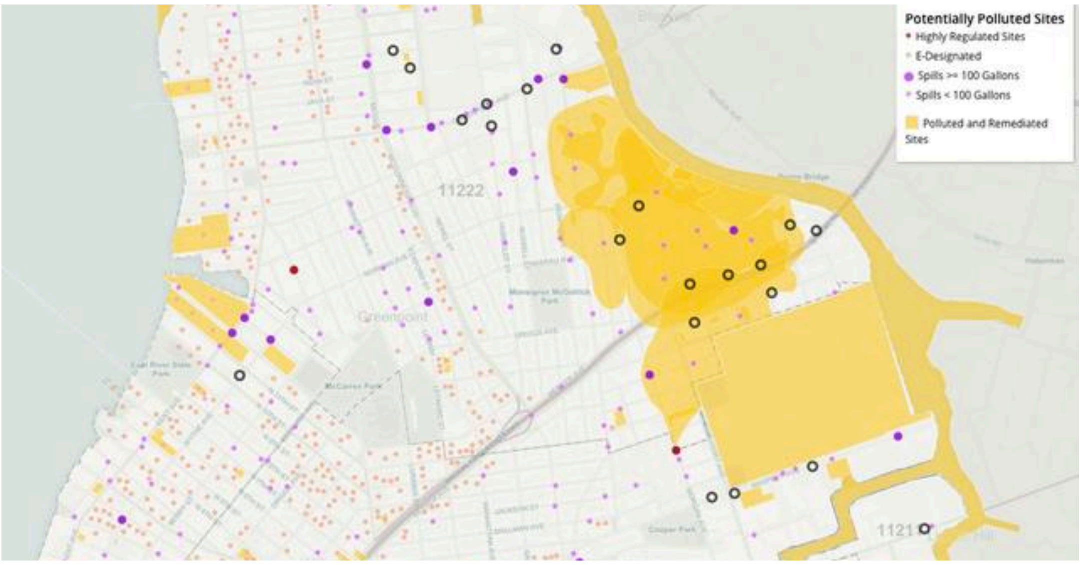

Figure 5: Polluted sites in the Williamsburg/Newtown Creek area.
Source: Website greenpointers.com

The rapid redevelopment of the Williamsburg waterfront (and several other waterfronts) is in direct contradiction with the city's current studies on climate change and the aim for resilient development of New York. The speed of the real estate market and profit-based developments seems to outdo the importance of sustainable city-planning that is more than ever necessary for this metropole, surrounded by water.
This makes us question the city's intention for future development: do we want short-term, profit-based projects with rapid gentrification of very vulnerable coastal areas, or do we choose long-term resilient planning of the city's 930 kilometers of coastline?

4. Understanding actual needs and natural adaptation processes of the urban fabric

This research aims to counter this current tabula rasa approach of redeveloping a waterfront from scratch. It is impossible to tackle all post-industrial waterfront areas -with all their complexity- by only one general solution. Instead, this doctoral thesis seeks to provide answers, based on gaining critical insights regarding the daily operation of a specific waterfront and its unique characteristics such as territorial configuration, property structure, appropriation of collective areas, resilience to climate change and a changing economic situation. The hypothesis is that, by fully understanding the conditions of transformation and the everyday operation of a specific coastal area at the intermediate scale; a full understanding of its levels of resilience can be generated. This profound knowledge can then be reflected on similar coastal areas and function as design strategies for architects and urban planners, taking into account an area's full complexity, fragilities and opportunities. In this way, a resilient answer can be offered that enhances the current social and economic structure of the area, while dealing with the threats of climate change.

This research does not limit itself by analyzing the mere urban situation, neither only the architectural scale of the building itself. Instead, the focus lies at the intermediate scale; the scale of the streetscape, how the building relates to the streetscape and how the user can give meaning to them (Scheerlinck, 2010). The method of this research at the intermediate scale, is to analyze the area by the notion of six parameters, which are believed to cover the crucial aspects that are to be understood to enhance the changing urban conditions on economic and environmental levels.

The first parameter covers the *Activities* of the area, this means the analysis of daily, routine operations, as well as more occasional or time-related activities. Comparative analysis of the activities is conducted at several moments in time: during week and week-end days, before and after working hours, during mid-season and in holidays. The second parameter analyzes the *Morphology* of the area. This takes into account the type, style and land-use of the building, its amount of storeys, appearance of the façade and relation of the building to the streetscape. Parameter three shows how the water is related to the adjacent land: the analysis of the *Waterline*. Is the waterfront visibly of physically accessible from the land? How does this waterfront react during a flood or storm? What is the waterfront activity (if any) and does the shoreline exist out of a hard or soft edge? Next, the analysis of the *Infrastructure* and *Accessibility* is conducted. What kinds of infrastructure connects the area to the broader region and how does this impact the ongoing activities? What is the configuration of the streetscape and how are the individual buildings accessible and related to the sidewalk on pedestrian and vehicle level? Finally, an important aspect in order to fully understand an area, is the social structure. Therefore, the last parameter is the *Social participation.* What is the daily use of space by the direct users? How do they find it convenient and what are their annoyances?

4.1 Reference case: Coney Island Creek, Brooklyn, NY

Coney Island is an urban peninsula, located at the southernmost end of Brooklyn. Coney Island is famous for its amusement park and beach and generates a true exodus to escape the city on hot summer days (Koolhaas, 1978). However, as part of this intriguing urban peninsula where amusement, leisure and entertainment attract many tourists and investors; the Coney Island Creek is a subordinate area, lying in the shadow of this urban glamour. The area around the Creek struggles with a complex coexistence between industrial, recreational and residential waterfront conditions and constant threat of storms and urban floods (Fig.6).

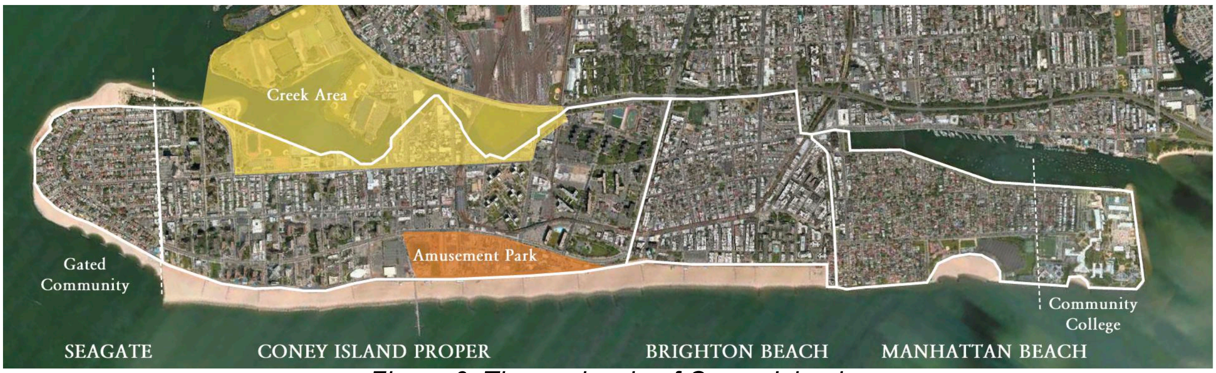

Figure 6: The peninsula of Coney Island
Source: Aerial photo from Apple Maps, edited by Drs. Gitte Schreurs

All these vulnerabilities bring along political disinterest and make the local economy entirely dependent on private investments of small shop owners. The political abandonment and lack of individual capital of the small entrepreneurs leaves little space for alternative commercial and urban development processes to assure the resilience of this industrial waterfront.

The area of the Coney Island Creek is considered the best example of a vulnerable industrial waterfront, in urgent need of redevelopment to guarantee proper living standards and prevent severe decline. The aim is to implement and test the previously explained approach of parameter analysis on this area and therefore unveil the island's complex coexistence between industrial, recreational and residential waterfront conditions. The research wants to understand the vulnerabilities, but also the opportunities of the area, to later implement this knowledge during the development of resilient design strategies for this complex area.

In order to fully understand the area at the intermediate scale, the six parameters are analyzed at the scale of the building block. This method of research will be illustrated below by the example of one building block in the Coney Island Creek area, located between W15th and W16th street, north of Neptune Avenue. This method will later in the research be performed on all six types of building blocks that are to be found in the Coney Island Creek area in order to generate a consistent, comparative analysis of all parameters at the intermediate scale, representative for the entire area of the Creek.

- *Activities*: The building block is generally zoned as M1-2, light manufacturing. With the special overlay zoning CO, which allows for residential and industrial activities to take place in adjacent buildings. For each property, the official land-use, defined by ZoLa New York is mapped and compared to the actual land-use at the time of observation, in June 2018 (Fig. 7). However, in order to display the vibrant activities as correct as possible, all occurring activities are drawn on plan at different moments in time: on a weekday, a weekend day, during working hours and after working hours (Fig. 9). By fully understanding the daily operation and formal or informal activities within this building block, we can understand the actual need for novel spatial facilities and adaptations.

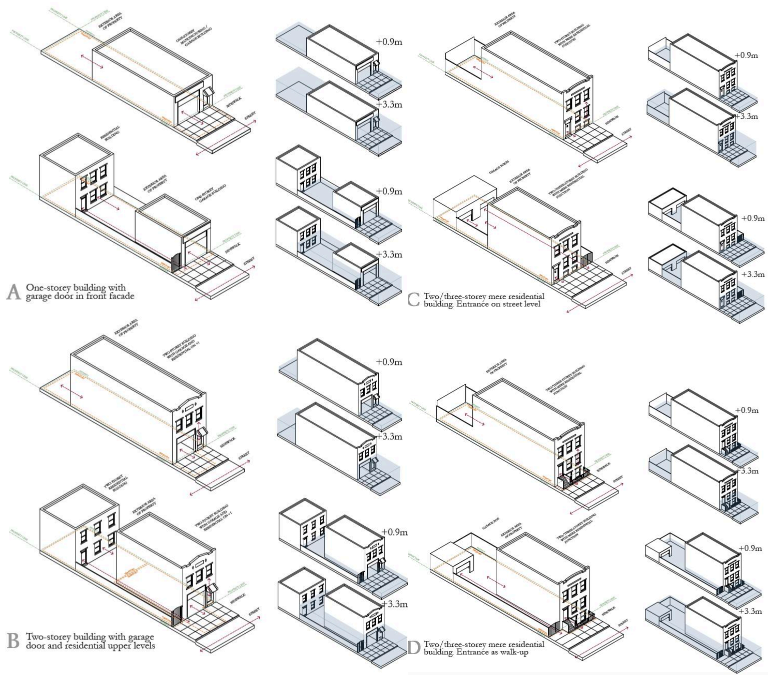

Figure 7 (left): Building block: Official land-use ZoLa NYC vs. actual land-use in June 2018
Source: Maps by Drs. Gitte Schreurs, based on information from ZoLa NYC and observations

Figure 8 (right): Typologies of buildings, located within this building block, by Drs. Gitte Schreurs

- *Morphology*: Analyzing the morphology, means analyzing the typology of the existing buildings, the relation between neighboring constructions and between the building and the streetscape. By analyzing this parameter, we can understand patterns of activities related to types of housing and how the typology of the building is used to benefit the activity. An example within this analyzed building block on Coney Island is typology type B: a two- or three-storey rowhouse, with a garage door on ground-level, providing the opportunity to open up the building and let the territory of the industrial working space extent onto the public sidewalk. Residential facilities can be found on the second (and third) floor of the building, preventing water damage to the house when floods occur (Fig.8). The façade in-between the garage door and the residence windows is used for commercial signages in benefit of the industrial activity on the ground floor. Knowledge on the informal use of indoor-outdoor space and ground floor - upper floor relationships of all building typologies can be used to design more sufficient buildings in similar spatial contexts in the future.

- *Waterline*: The waterline is crucial to investigate when we want to understand how to deal with land-water relationships in urban and architectural planning. In this building block analysis, we analyze two aspects of the waterline. For starters, when applicable, the physical relation between the water of the Creek and the land is drawn in map and section (sea-level vs. ground-floor level, hard or soft edge, natural or landscaped waterfront, etc.). Secondly, the impact of the 100-year and 500-year flood is illustrated per typology, specific for the area. In this example, for every typology is illustrated how a 0.9 meter flood level (1% annual chance) and a 3.3m flood level (0.2% annual chance) would impact the specific building type (Fig.8). This too is important to take into account when new constructions are designed.

- *Infrastructure*: The parameter of infrastructure is most important on the larger scale; the relation of the building block with the surrounding urban fabric. How well accessible is the area by motorized vehicles, public transportation, boats or by foot? How do these connections impact the activities in the area? The analyzed building block is very well-connected to the most important highway of New York City, the Belt Parkway, providing a beneficial accessibility for motorized vehicles. This characteristic triggers car-related entrepreneurs to settle in the area. The main types of land-use in this block -besides residential- are car repair services and parking facilities. Because of the less convenient public transportation, this area is less sought-after for residential purposes, allowing small-scale car-related businesses to remain located in a standard building block. However, if by renewed planning the public transportation would become more beneficial for this area, the land-value would most likely rise rapidly, pushing out all small-scale car-related activities, to replace the industrial activity with residential facilities, generating higher profits from rent.

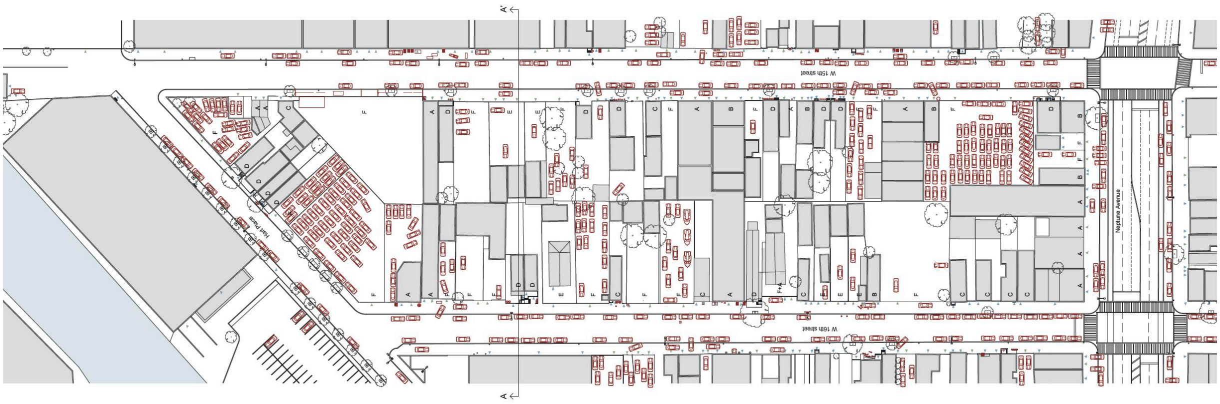

Figure 9: Building block: Activities in June 2018 on a weekday during working hours
Source: Map by Gitte Schreurs

- *Accessibility*: The analysis of the accessibility focuses on the scale of the building. A consistent mapping of all entrances (garage doors and regular doors) within the building block is conducted. The aim is to show the relation between the front door/garage door and the street. Does interior and exterior become one productive territory once the garage door is opened? What are the public/private relationships during informal appropriation of the sidewalk by industrial activities? Is there a direct relation between the sidewalk, the front entrance, the interior and the backyard? Understanding the accessibility of a building in combination with the activities taking place inside and outside can help us to grasp the need of public and private space of these companies or residences.

- *Social participation*: A final and very important parameter is the social participation. Many crucial aspects that contribute to fully understanding the operation of an area are not noticeable by mere spatial analysis. Therefore, for the building block analysis, a survey is taken from several workmen and inhabitants to generate crucial additional information about the daily operation of the area. The aim of the participation process is to understand the social structure of the companies, opinions about the working space or houses, the impact super storm sandy had on personal or property level and gather opinions about spatial and organizational elements they would personally like to change or add to the area.

These six parameters are the research method that resulted out of previously conducted research on this subject. However, they are still subject to change and can be altered as the PhD continues. For now, these six parameters are believed to cover the necessary knowledge to fully understand the aspects of an area at the intermediate scale to conduct the knowledge that is necessary to take into account when designing for this particular, or for similar, areas.

5. Conclusion

New York has 930 kilometers of coastline, of which each area has a very unique character, spatial layout, daily use and social structure. Today, a renewed interest for investing in these coastal areas, seems to generate redevelopments that happen at a fast speed because of profit-based real estate interest for waterfront residences. However, threats from the changing climate have never been more acute than they are today. Therefore, it seems rather paradoxical to develop these billion-dollar projects by a tabula rasa method while research on climate change is still in full progress and the economy is changing rapidly by new technologies. Planners seem to approach the city from a top-down method where demolition is the starting point and profit-based housing is the goal.

Instead, in order to generate a resilient metropole, that can withstand the challenges of the future and answer to today’s needs, we must develop proper design and planning strategies. Not from the mere urban or architectural scale, not from the starting point of demolition, but starting from the actual need of the specific area. By analyzing the urban fabric at the intermediate scale, elements will surface that normally stay invisible for the general urban planner or the architect.

This research believes that resilient redevelopment is only possible by fully understanding the existing situation and the natural processes of spatial use and small-scale adaptation. Only then we can provide resilient future-proof planning and designing solutions for coastal areas that are as complex as these in New York City, and reflect this practice towards similar areas globally.

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