Master's Thesis

Flood Risk and Environmental Justice in New York City: An Examination of Policy Plans and Initiatives at Different Indices of Social Vulnerability

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List of Abbreviations

BRTF	Building Resiliency Task Force
CDC	Centers for Disease Control and Prevention
DCP	Department of City Planning (of New York City)
EJ	Environmental Justice
EJM	Environmental Justice Movement
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
IPCC	Intergovernmental Panel on Climate Change
LULU	Locally Undesired Land Use
NOAA	National Oceanic and Atmospheric Administration
NPCC	New York City Panel on Climate Change
NYC	New York City
SLR	Sea Level Rise
SVI	Social Vulnerability Index
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
US	United States

Abstract

The following study examines and assesses the different policy plans and projects in place to protect and assist individuals in flood-prone areas of New York City, who are of different levels of social vulnerability. Historically in the United States, low-income communities and communities of color have faced a twofold environmental problem compared to their wealthy and/or White neighbors: not only were these communities more likely to be located near toxic sites such as incinerators or landfills, but the US government was also slower to respond to toxic events. Consequently, with this understanding of historical impacts, it would be expected that socially vulnerable groups, comprised predominantly of low-income populations and people of color, face differential exposure to climate change-induced flooding, in addition to receiving less governmental aid and protection, when compared with wealthier and less socially vulnerable populations of the same region. Using freely available Geographic Information System data from governmental organizations, this thesis visualizes New York City neighborhoods that are at risk of flooding in the near future, by their level of social vulnerability. The study examines and evaluates local New York City policy plans, reports, and initiatives to determine if there are differential protections in place for different social classes. Findings from the analysis of governmental reports and laws, an assessment using the Environmental Justice Framework to reveal underlying problems in the policies, and contextualization within the existing literature show that while New York City does not offer more or less protection to high-income communities, inherent socioeconomic differences can cause one law to result in differential applications and outcomes between communities. This thesis concludes with recommendations for future policies, including an incentive for landlords to retrofit buildings, while simultaneously maintaining a system which allows low-income residents to have access to safe, flood-resilient homes. Ultimately, although New York City governmental bodies and officials demonstrate an increasing awareness of the relationship between environmental justice, equity issues, and flooding, this thesis argues that because New York City policies do not properly address critical socioeconomic inequities, the current system of governance in New York City is in fact insufficient to protect socially vulnerable populations.

Key Words: Environmental Justice, Flooding, New York City, Social Vulnerability

Acknowledgements

Chapter 1. Introduction

1.1 Background

Throughout the last 50 years, numerous studies and reports have been published in the United States (US) that argue that low-income communities and communities of color experience differential burdens and threats from environmental hazards and natural disasters (US Government Accountability Office 1983, Lavelle and Coyle 1992, Ringquist 2005). These reports often emphasize a twofold problem; not only are hazardous conditions more likely to be found near these communities, the government's response and clean-up efforts in these areas are more likely to take longer and be less effective (Lavelle and Coyle 1992). This is particularly tragic, because low-income communities frequently lack the resources to move away from their homes or fight for their rights in court. Originally, the majority of the landmark reports examined the relationship between these communities, toxic dumping sites and air pollutants, and inadequate governmental responses. However, in the last 20 years as researchers and policymakers have begun to understand the far-reaching impacts of climate change, the research focus has shifted.

As a result, a new component to social vulnerability has come to light, stemming from flood risk. In coastal communities, flooding is usually the result of sea level rise (SLR) and storm surges. Climate change is associated with more frequent, stronger, and more unpredictable storms and hurricanes (Coumou and Rahmstorf 2012). Several studies have begun to assess the economic impact of climate change on coastal regions, however, the research on social impacts has only emerged in more recent years. One of the main areas for these studies in the US has been in Miami, one of the country's most popular beach destinations. The city is also home to large low-income, Latino and African American populations, and the studies have shown that climate change affects these populations more so than their wealthier and often White neighbors (Chakraborty, Collins Timothy et al. 2014, Montgomery and Chakraborty 2015, Maldonado, Collins et al. 2016). Given the US's extensive coastlines and that in 2010, 39% of the population (123.3 million people) lived in counties directly on a coastal shoreline (National Oceanic and Atmospheric Administration 2018), there is an urgent need and large opportunity for research in these areas.

New York City (NYC) on the East Coast of the US is one of these areas. It also happens to be one of the most popular and charismatic mega-cities in the world, which is why it is surprising that more research has not already been performed to examine the impact of climate change on social vulnerability and flood risk, in the ways that it has been in other cities, such as Miami (Montgomery and Chakraborty 2015), New Orleans (Hunt and Watkiss 2011) and the greater London area (Fielding 2012). NYC is simultaneously the most populous and densely populated major city in the US, with

approximately 8.6 million people and an area of around 790 square kilometers (US Census Bureau n.d.). The City also contains 800 kilometers of coastline and two inlets, one from the south and another from the northeast, through which it comes in contact with the Atlantic Ocean (The City of New York 2013). Once a strong economic and strategic advantage, these extensive coastlines and the proximity to the Atlantic Ocean make NYC particularly vulnerable to SLR and storm surges. Superstorm Sandy in 2012 was evidence of this vulnerability. The storm resulted in severe flooding, left 2 million people without electricity, and cost $19 billion in damage (The City of New York 2013); even now in 2019, portions of NYC are still recovering.

NYC is also demographically very diverse; around 32.1% of inhabits report identifying as White alone, 29.1% as Hispanic or Latino, 24.3% as Black or African American, and 14.0% as Asian, with the remaining groups such as those identifying as multi-racial, Pacific Islander, or Native American comprising less than 5%, though there is some overlap in identities (US Census Bureau, n.d.). Although NYC is one of the wealthiest cities in America and the country's economic capital, the US Census Bureau reports that NYC median household income from 2013-2017 was nearly $58,000 and that by their nationally agreed upon metrics, 19.6% of people in NYC live below the poverty line (US Census Bureau, n.d.), making this population especially vulnerable to disasters. Though social vulnerability and income are two separate and distinct metrics, social vulnerability is strongly tied to income. Low-income populations, which in the US are also frequently communities of color, are almost always the most socially vulnerable because these populations do not have the same resources as their higher-income neighbors to evacuate and prepare for disaster or recover to the same extent. As such, these income, racial, and vulnerability demographics, coupled with the threats of flooding, make NYC an ideal case study.

Figure 1. Map of NYC with its five boroughs: Brooklyn, The Bronx, Manhattan, Queens, and Staten Island.

1.2 Problem Statement

As a result of climate change, high tide in NYC is expected to rise anywhere from 15-75 inches by 2100 (Horton, Little et al. 2015). The extent of this flooding increases even more with the inclusion of storm surges brought on by an increase in extreme weather events, as seen with Superstorm Sandy in 2012. There are currently numerous governmental departments and non-governmental organizations investigating and mapping projections of SLR as well as potential future storm surges throughout NYC through the year 2100. As of yet, none of the flood projections incorporate socioeconomics or social vulnerability. Historically, natural disasters have tended to impact low-income communities harder than those of higher income, and the government's response to helping these disadvantaged communities has been largely inadequate compared to wealthier neighborhoods. NYC presents a unique study site because of its racial and socioeconomic diversity and the number of policy plans and projects in place to protect and help communities recover. Still, there is very little existing research in NYC that studies the differential impacts of flooding on individuals based on social class or race, or that examines and assesses whether the policy plans designed to protect and assist communities are equal between neighborhoods of different levels of social vulnerability. As such, this thesis research adds to a relatively young body of scientific literature examining the relationship between flood risk, exposure, social vulnerability, and policy, within the context of the well-established field of environmental justice.

1.3 Research Objectives

The following research is practice-oriented and tests hypotheses that were developed based off of an in-depth literature review. The objectives of this thesis are to:

• Identify the areas of flood risk in NYC along a range of social vulnerabilities;

• Evaluate and compare the availability and effectiveness of current policy plans and projects for areas of greater and lesser social vulnerability;

• And should differences exist, explain why these policy plans and projects might differ in availability or implementation.

Given that this thesis is policy- and social science-based, the research will not, nor cannot assess if highly vulnerable communities in NYC are indeed more prone to flooding, due to a lack of statistical tools and skills on the researcher's part. Rather, this thesis aims to evaluate whether there are different policy plans and initiatives in place for different subpopulations of the city, and what the ramifications of this might be both in terms of availability of the initiatives and their potential to remedy flood risk and resiliency.

1.4 Reading Guide

The following chapter of this thesis, Chapter 2, begins with an overview of environmental justice and the associated movement in the US, followed by an examination of the literature, debates, and realities of flood risk and vulnerability, and ending with a look at how urban environments, in particular NYC, are coping with these challenges. Subsequently, Chapter 3 describes and elaborates on the research framework and methodology used to identify areas of flood risk with regards to social vulnerability, and to assess the relevant policy instruments and plans. Chapter 4 first presents maps that visualize social vulnerability and existing and projected flood risk, and then elaborates on the laws, policy initiatives, and projects that have been implemented since Superstorm Sandy to increase resiliency and protect residents. This chapter also provides initial answers to the research sub-questions. Finally, Chapter 5 discusses the findings within the context of the Environmental Justice Framework and existing literature, to examine whether the existing policies are indeed sufficient to simultaneously protect and provide for residents with lower and higher levels of social vulnerability.

Chapter 2. Literature Review

2.1 The Rise of the Environmental Justice Movement in the US: Impacts of Environmental Hazards on Low-Income Communities and Communities of Color

In the 1970s and 80s, many Americans began to realize that environmental risks and hazards disproportionately affected certain populations. Moreover, these populations were usually of lower income or communities of color. These findings also came at the tail end of the Civil Rights Movement of the 1950s and 60s, which saw unprecedented protests and policy changes in response to systemic racism, in particular against African Americans. Though the term "environmental justice" was originally founded in the US, this phenomenon and issues of environmental equity can be found throughout the world in both developed and developing nations, including Brazil, England, and India (McLeod, Langford et al. 2000, Williams and Mawdsley 2006, Martinez-Alier, Temper et al. 2016). Particularly in the US, this new movement, the Environmental Justice Movement (EJM), would address disparities in environmental equity on the basis of class, race, and sex, though this thesis will focus on the former two subjects. Given the US's position as the birthplace of the EJM and the fact that the majority of EJ research worldwide is largely still based in the US (Reed and George 2011), this country provides an intriguing study site.

At its core, environmental equity refers to the disproportionate effects of environmental hazards, risks, and degradation on people and regions (Cutter 1995). It is also important to note that the roots of environmental equity lie in studies of social equity, or the role of class, race, sex, and other metrics on the use of and proximity to the environment and environmental hazards. In early examples, researchers and communities examined the locations and impacts of toxic waste sites, dumping, and air and water pollution. In general, environmental equity implies that risk should be distributed equally (Ikeme 2003), and that one race or class should not shoulder the burden more so than another. Environmental justice (EJ) on the other hand is more politically charged (Cutter 1995) and utilizes a common and previously employed injustice frame (Taylor 2000); EJ requires that some type of corrective action must be taken to address the wrongdoing that was imposed on a certain group (Bullard 1994). It also incorporates the notion of the "simultaneity of oppression" (Taylor 2000), or that discrimination is intersectional, inseparable and can come from multiple sources (e.g. class, race, sex, geography, etc.). It is worth noting that historically, injustice frames as they pertain to the environment have been used to address the injustice of human degradation of natural ecosystems, such as deforestation (Taylor 2000). This new EJM movement, however, shifts the attention to the relationships between human harm on one another, and how discrimination from corporations or governmental entities, usually on the basis of race and class, have resulted in environmental degradation. This shift in meaning and understanding is also represented in the use

of "equity" versus "justice" through time. One author notes that by the early 1990s, the term "environmental justice" had replaced "environmental equity," and ultimately the EJM was born (Taylor 2000). For the purposes of this thesis, the preferred term will be "environmental justice," which addresses racial, class-based, and geographic equity.

Though the EJM may have only started officially in the latter part of the 20th century, these concepts and this fight were by no means a new phenomenon. In trying to improve everyday working and living conditions in their neighborhoods and factories, EJ has been part of White, poor and working-class America and communities of color for over a hundred years (Taylor 2000). As a result, when the EJM did come to the forefront of the American political consciousness, it was thanks to "a loose alliance of grass-roots and national environmental and civil rights leaders, academics, and activists," and not the polluting industries or even governmental regulatory agencies (Bullard 1994, p. xvi-xvii). At its core, the EJM was a bottom-up movement which began with the publication and dissemination of a series of reports.

The first of these landmark reports was published in 1983 by the US Government Accountability Office. The study found that African American majority neighborhoods in the Southern US were disproportionately located near a high number of waste sites (US Government Accountability Office 1983). That study was later backed up by another group, the United Church of Christ Commission, in 1987 with a report titled *Toxic Waste and Race in the United States* (Brulle and Pellow 2006). These landmark reports were however not limited to studies on racial minorities. One particularly active group in the late 1980s, the Citizens Clearinghouse for Hazardous Wastes, was primarily White and working class and mobilized individuals to gain justice for low- and middle-income Americans.

In 1991, the First National People of Color Environmental Leadership Summit concluded a year-long project and culminated in a document titled the *Principles of Environmental Justice* (First National People of Color Environmental Leadership Summit 1991). However, only in 1990 did the US Environmental Protection Agency (EPA) take claims of environmental injustices seriously, when Administrator William Reilly established a working group to examine the evidence and draft policy proposals to address it (Brulle and Pellow 2006). Finally in 1992, the EPA officially acknowledged the problem with a report titled *Environmental Equity: Reducing Risk for All Communities* (United States, Environmental Protection Agency, Environmental Equity Workgroup 1992); it was the first federal agency with the power to address the problem to do so, and led to the formation of a number of offices and councils (Brulle and Pellow 2006). Then in 1994, President Clinton signed an executive

order titled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requiring all federal agencies to take the concepts and impacts of EJ into account in decision-making processes (Exec. Order No. 12898 1994). Ultimately, the fact that this movement and the push for environmental protection and justice for socially vulnerable populations in the US had to come from citizens and grass-roots organizations, rather than the governmental agencies designed to protect them, such as the EPA, indicates a severe failing in governance.

Even with the necessary federal awareness of EJ concepts, there are underlying issues that need to be addressed in conjunction with EJ for change to be effective, notably concepts surrounding the interconnected layers of equity. As previously mentioned, locally undesired land uses (LULUs) such as incinerators, landfills, and toxic waste sites are more likely to be located near low-income communities. To understand this requires awareness of geographic equity, which refers to this unequal spatial distribution of LULUs (Bullard 2001), in addition to social equity. These factors have a large impact on household and individual decision-making; geographic and social inequities explain why some people have no choice but to stay in polluted areas or work more dangerous jobs. While income tends to be a good determinant of proximity to LULUs in the US, reports and studies have shown that there is an even better determinant: race (Lavelle and Coyle 1992, Ringquist 2005). A groundbreaking report by Lavelle and Coyle (1992, p. S1) in the National Law Journal uncovered that,

> There is a racial divide in the way the U.S. government cleans up toxic waste sites and punishes polluters. White communities see faster action, better results and stiffer penalties than communities where blacks, Hispanics and other minorities live. This unequal protection often occurs whether the community is wealthy or poor. These findings suggest that unequal protection is placing communities of color at special risk.

Furthermore, in 2005, a meta-analysis of 49 instances of environmental studies came to the same conclusion: race had been a greater determinant of environmental inequity than economic class (Ringquist 2005). It is, however, worth noting that there is some debate about these findings and other similar studies. Opponents question whether they are truly representative of racial inequalities or rather class-based market dynamics (Downey 1998). Still, two authors remark that while these perspectives are largely overshadowed by the existing literature, the debates have served to enhance methodological approaches and conceptual models (Brulle and Pellow 2006). There is no doubt that EJ discussions have improved situations and awareness of these issues at both the community and federal government levels, but new and rapidly changing environmental problems have also come to the forefront in the last 20 years.

To address EJ in policy and attempt to remedy it, Robert Bullard, who is commonly referred to as the father of EJ and has been at the forefront of the EJM in the US for decades, drafted and introduced the Environmental Justice Framework (EJF), comprised of five basic elements (Bullard 1994, p. 10). The EJF:

> "(1) Incorporates the principle of the 'right' of all individuals to be protected from environmental degradation,
> (2) Adopts a public health model of prevention (elimination of the threat before harm occurs) as the preferred strategy,
> (3) Shifts the burden of proof to polluters/dischargers who do harm, discriminate, or who do not give equal protection to racial and ethnic minorities, and other 'protected' classes,
> (4) Allows disparate impact and statistical weight, as opposed to 'intent,' to infer discrimination,
> (5) Redresses disproportionate impact through 'targeted' action and resources."

Through an exploration of these elements, the EJF attempts to make EJ more democratic. When applied to a policy or governmental instrument, it uncovers underlying motivations and assumptions to determine if the policy or instruments truly redress unjust or inequitable disparities.

2.2 Climate Change: New Threats to Socially Vulnerable Populations

Currently, the most urgent environmental threat is that of man-made climate change. There is no longer a scientific controversy regarding climate change. Global average temperatures have increased significantly over the last 150 years which have resulted in variations to the planet's climate (Jones, Wigley et al. 1986, Folland, Karl et al. 2002). The number of natural disasters, from floods to wildfires and extreme weather events has increased significantly in the last 100 years (Ritchie and Roser 2019). Moreover, studies and meta-analyses have found that the leading cause of climate change has been human influence and the release of carbon dioxide from the burning of fossil fuels (Anderson, Hawkins et al. 2016). One meta-analysis in particular examined nearly 12,000 climate abstracts from a 20 year period and found that an overwhelming 97% of these articles endorsed the consensus that the current change in climate is attributable to human activity (Cook, Nuccitelli et al. 2013). One of the consequences of climate change and the corresponding increase in average global temperature is SLR (Raper, Wigley et al. 1996). SLR, coupled with the changing hydrological cycle (Held and Soden 2006) already has and will continue to impact the rate of coastal flooding, making it not only more frequent, but also more severe. The aftermath of such events can be quite devastating from economic and social standpoints, among others. Though this thesis primarily considers economic and social impacts of climate-dependent environmental processes and disasters, namely flooding, it is important to mention that climate change will continue to affect

wildlife and numerous realms of society, such as the economic productivity of agriculture and fisheries (Lam, Cheung et al. 2016), and climate-based human migration, just to name a few.

It is also important to keep in mind that the concepts and environmental inequities that were brought to light in the 1980s and 90s are still present today and are rapidly evolving as a result of climate change. Moreover, due to the increasing negative impacts and differential effects of climate change, and the growing awareness of EJ in the literature and policy, the term "climate justice" has arisen. Climate justice incorporates the main elements of equity, as well as the notion of rights and responsibilities, into the effects of climate change (Bulkeley, Edwards et al. 2014). The field examines who is responsible for climate change, who is responsible for mitigating it and adapting in response to it, and the rights of nations and people to be protected from it (Bulkeley, Edwards et al. 2014). Much of climate justice work has been concentrated in lawsuits aimed at fossil fuel companies for contributing to climate change (Starr 2016), or lawsuits targeting governments for not sufficiently stopping its progression and protecting their citizens from its adverse effects (Schiermeier 2015). One study notes that the majority of climate justice literature and cases have focused on national and international scales (Bulkeley, Edwards et al. 2014), though there is work being done at urban levels. Thus, through the examination of the effect of climate change-based flooding on socially vulnerable populations, this thesis is undoubtedly related to climate justice. Nonetheless, the topics that are discussed are more reminiscent of earlier EJ claims concerning individual communities, rather than entire countries. Moreover, reports from the NYC Mayor's Office and the New York Panel on Climate Change (NPCC) more frequently employ the term "environmental justice" as opposed to "climate justice." In the one report from the Mayor's Office that that refers to "climate justice," it is within the context of achieving carbon neutrality through widespread clean energy initiatives, divesting from fossil fuel industries, and minimizing heat vulnerability; there is no mention of flooding or social vulnerability (The City of New York 2019). As such, while "climate justice" is no doubt becoming increasingly important and is a growing subcategory of EJ, for the sake of consistency with NYC reports and initiatives and the use of the EJF in Section 5.1, the preferred term throughout the majority of this thesis will remain "environmental justice."

2.2.1 Economic Impacts and Burdens of Climate Change

Several studies have already attempted to quantify the current and projected economic impacts of climate change; the US National Oceanic and Atmospheric Administration (NOAA) currently maintains a count of billion-dollar weather and climate disasters in the US adjusted for current price inflation, beginning with 1980 and continuing to the present day. In the period from 1980-2018, there were 244 events totaling more than $1.68 trillion (NOAA NCEI 2019). Of those, only 42 were

tropical cyclones (i.e. hurricanes and other similar, weaker cyclones), but these events accounted for the majority of deaths and economic losses, totaling $927.5 billion (NOAA NCEI 2019) and highlighting the particularly devastating impacts of these storms. There is no doubt that the costs and fatalities associated with flooding have increased over the last decades. However one study posits that this increase likely has had more to do with societal shifts and changes in vulnerability (Kunkel, Jr. et al. 1999); populations, cities, and infrastructure development in and around coastal areas has grown tremendously, which in turn has resulted in increased exposure to flood hazards. Still, an article published around the same time, found that there had indeed been an increase in heavy rain events (Karl, Knight et al. 1996), which led authors from the US National Climatic Data Center to argue that the increasing economic flood-related losses result from a two-fold interaction: increasing coastal development, and worsening storms (Ross and Lott 2003). More than a third of the US population already lives near a coastal shoreline, and this number is projected to increase (NOAA 2018), emphasizing the need to study this subject and monitor it into the future.

Another component to the projected increase in flooding events, is the social impact. The hazards associated with flooding are never just inundation and the physical threat, but include the whole cascade of events that follow. This can include power outages, damages to infrastructure, disease and public health outbreaks, environmental pollution, and more. Given that they are often discussed simultaneously, sometimes even interchangeably, in policy and within the scientific literature, it is important, first and foremost to clarify the difference between risks, hazards, and vulnerability within the context of flooding.

2.2.2 Defining Hazard, Risk, and Vulnerability in the Context of Flooding and Social Systems
In the US, the EJM also spurred discourse surrounding specific terms, and how policymakers and governmental officials use them. This discourse has extended into the scientific community. Possibly the most logical place to begin is with the definition of "hazard," or any potential source of harm or damage. A hazard has no delineated scope in definition; it can take the form of a branch on a road affecting a few people, or an unstable dam endangering thousands. Meanwhile, hazard (represented in terms of a probability), coupled with the expected severity of the adverse effects, determines risk. Viewed through the lens of risk assessment, risk comprises a combination of hazard, exposure, vulnerability, resilience, and coping capacity (Vojinović and Abbott 2018). There are, however, numerous definitions of risk that can even vary by academic field (Aven 2010).

Vulnerability is an extremely broad term as well, referring to a general susceptibility to harm. Existing research has also shown that vulnerability is not solely dependent on the exposure to harm,

but also on the resilience and sensitivity of the system (Turner, Kasperson et al. 2003). One study posits, that in social systems in particular, a community's capacity for adaptation in dealing with negative outcomes plays a large role in determining vulnerability as well (Smit and Wandel 2006). Moreover, it has been shown in the scientific literature, that engineers and natural scientists use the term differently from social scientists (Füssel 2007, O'Brien, Eriksen et al. 2007). More notably, Füssel (2007, p. 155) argues that "the resulting disagreement about the appropriate definition of vulnerability is a frequent cause for misunderstanding in interdisciplinary research on climate change." Together, these arguments illustrate the need to clarify and specify the type of vulnerability that will be applied. As emphasized in previous sections, this thesis will focus on social vulnerability and the variables that affect it.

In the US, the Centers for Disease Control and Prevention (CDC) refers to social vulnerability as a community's or individual's ability to cope with and recover from external stressors. These stressors can include floods, earthquakes, and disease outbreaks, among others. This capacity for endurance and recovery in response to a disaster is also known as resilience. The CDC uses a metric called the Social Vulnerability Index (SVI) to help governmental officials determine which areas and "communities may need support in preparing for hazards or recovering from disaster" (Centers for Disease Control and Prevention 2018). The SVI is a relative number that utilizes data from the US census to identify 15 different variables. These metrics integrate the knowledge and awareness that variables such as income, the ability to understand instructions in English, and population density all affect an individual's ability to evacuate in advance of a storm, for example. Though not an exhaustive list, the SVI also includes data on race, employment, age, disability, and availability of transportation, making it a very thorough tool for assessing relative social vulnerability in counties across the US. (See Appendix 1 for more information on the composition of the SVI.)

Ultimately, all of these factors, combined with increasing SLR and risks from climate change, affect an individual's or system's flood risk. On its own, flooding in an uninhabited wetland, does not pose a risk to humans or infrastructure. It could however present a risk to the ecosystem and the organisms that rely on it. As such, risk assessment depends a great deal on perception and the value assigned to certain structures or communities. When examining a system with people, many questions arise. Vojinović and Abbott (2018, p. 55) outline three "hard questions" that engineers must ask themselves, "1. What is an 'acceptable' level of risk?; 2. What is a 'fair and socially just' distribution of risk?; 3. What should be the 'priorities' in our efforts to attain risk reduction?"

Historically, these questions would have been asked of social scientists and even policymakers, not necessarily engineers. However, in recent years there has been a push towards a transdisciplinary, holistic approach (Vojinović and Abbott 2018) that examines the interactions between components such as drainage systems, social structure, and governance systems to create adaptive solutions. An effective policy plan should employ a similar approach. As one group of authors expertly summarize, "to obtain policies that are effective at both international and local levels requires careful analysis of the underlying mechanisms across scientific disciplines and approaches, and must take politics into account" (Sterner, Barbier et al. 2019, p. 14). Take for example the Dutch Ministry of Infrastructure and the Environment; the Ministry no longer focuses on the probability of failure of their unique water defenses, like dams and dykes, rather they focus on the risk, notably the probability of failure multiplied by the real life consequences ("Water Management in the Netherlands" 2011). Moreover, they emphasize that risk can never be zero. This change in perspective is characteristic of a larger paradigm shift.

Within the context of this thesis, the hazard is water or new-found coastal flooding brought on by climate change. The primary vulnerabilities discussed in this thesis are geographic and social; namely, low-lying areas are particularly prone to flooding, while low-income communities are less likely to be able to cope with flooding, for the reasons that were previously mentioned. Together, the potential for inundation and the existing vulnerabilities determine the risk that a flood-based disaster will occur.

2.2.3 Grounding Flood Risk and Social Vulnerability in the Real-World
While the scientific community continues to debate, define, and study these topics, it is important to remember that there are people and families at the other end, who are often struggling to survive and persevere in the face of the increasing severity and frequency of natural disasters brought on by climate change. The issues at the root of the EJM in the 1980s and 90s, notably the differential exposure to risk and the weaker governmental response to disasters in communities of color, are still present, just in another form. Communities that only flooded during once in a lifetime hurricanes are now seeing the impacts of climate change and SLR more frequently.

In applying the concepts of hazard, risk, and social vulnerability to the real world, it is necessary to identify which metrics are the greatest determinants of risk. The authors of a meta-analysis comprising 67 flood disaster case studies, Rufat et al. (2015), found that demographic characteristics, poverty or socioeconomic status, and health were the primary drivers of vulnerability. Poverty in particular, permeates nearly every part of the disaster process, as two

authors show; from risk perception and preparedness to communication, recovery, and reconstruction, poverty prevents adequate resilience (Fothergill and Peek 2004). Rufat et al. (2015) also note that risk perception and coping capacity play an important role. These latter two metrics are often not represented by traditional social vulnerability metrics. A study examining exposure and awareness of flood risk in England and Wales found that the most vulnerable, in particular the working class, were not only more likely to live in floodplains, but also when there was equal risk of exposure between classes, poorer and less educated populations exhibited lower rates of flood risk awareness (Fielding 2012). The study demonstrates that first and foremost, awareness plays a large role in disaster potential, but also that EJ is not an issue that is in any way limited to the US.

A common and well-studied region in America is southern Florida, especially the city of Miami. Like many areas along the southern and eastern coasts of the US, Miami is at risk of damage and destruction from tropical storms and hurricanes. However, the city also faces ever-present, monthly threats from general SLR. One study found that from 1998-2013, the number of rain-induced flood events in Miami increased by 33%, while the number of tide-induced flood events rose by over 400% (Wdowinski, Bray et al. 2016).

When equipped with just a basic understanding of EJ issues in the US, it is not surprising to learn that certain communities in Miami face greater exposure to flooding and the associated risks. Studies have shown that in Miami, even though wealthy and predominantly White populations experience flooding because they live on the more desirable coastal properties, neighborhoods with greater populations of non-Hispanic Blacks and Hispanic populations face greater exposure to inland flooding, without benefiting from the desired coastal amenities (Chakraborty, Collins Timothy et al. 2014, Collins, Grineski et al. 2018). Moreover, earlier research on the aftermath of Hurricane Andrew, which struck Miami in 1992, showed that Black and non-Cuban Hispanic neighborhoods faced greater rates of property damage and were more likely to receive insufficient settlement amounts from their insurances (Peacock and Girard 1997). Donner and Rodriguez (2008) draw on previous literature to emphasize that these same groups were also less likely to seek out support from aid workers and those affiliated with the government, out of fear of deportation or general mistrust in public institutions. A report from two authors with a long history of studying social vulnerability in the Miami, Montgomery and Chakraborty (2015), found that inland flood risk was more correlated with racial and ethnic minority status, than social vulnerability. They contend that this correlation is likely due to the fact that low-income and minority communities have fewer choices in housing locations (Montgomery and Chakraborty 2015); in the case of race and ethnicity,

racist red-lining practices on the part of residential real estate agents has increased segregation in neighborhoods across the US, not just in Miami. These findings unfortunately align with those from nearly 40 years ago; communities of color often have no choice but to live in disaster-prone regions. It is just that due to climate change, these types of "disasters" have shifted from toxic dump sites to areas of increased flooding and others. The findings also show that even when policymakers and governmental officials do provide aid, there is so much deep-rooted mistrust of public organizations, that the aid would likely not be as effective as it could be. This is no doubt an issue that policymakers in the US must acknowledge and contend with as they implement and push for protections and policy implementations for vulnerable groups. Robert Bullard, previously cited for his work on EJ, made a controversial yet compelling argument: that "much of the death and destruction attributed to 'natural' disasters is in fact unnatural and man-made" (Bullard 2008, p. 757). He argues that the catastrophes from hurricanes, tornadoes, and the like, are often because the government and political economy have either uncaringly put certain groups of people in vulnerable environments, or simply failed to protect them in advance of natural disasters, resulting in a greater scale of damage. These findings and arguments point to the need to reevaluate and improve disaster- and aid-related governance systems in the US.

As these injustices continue to come to light, the job of policymakers becomes increasing complex. Balancing issues of systemic poverty and race, mistrust in what many perceive to be a broken system, and the new difficulties brought on by climate change, just to name a few, will challenge governance into the foreseeable future. Based on their research, numerous authors have provided policy strategy recommendations. These include greater inclusion and input from low-income and working class communities, and better education for first responders and national agencies about local vulnerabilities (Fothergill and Peek 2004). Since low-income individuals are more likely to live in risky, older housing units, presenting challenges and dangerous weak points for many communities, Fothergill and Peek (2004) recommended policies to offer subsidies to landlords to make structural improvements and bring their property up to safety standards. Simultaneously, they recommended that governments ensure that rent control allows low-income individuals to remain in and afford their homes after improvement. Others have noted that certain areas, such as those in urban centers, are very diverse in race, income, and other demographics (Koks, Jongman et al. 2015, Maldonado, Collins et al. 2016). One study concluded that traditional flood risk management tends to overlook this heterogeneity (Koks, Jongman et al. 2015). The research suggests that whenever possible, policymakers need to tailor policies, evacuation plans, and resource distribution to the socioeconomic characteristics of smaller areas, such as neighborhoods or even housing complexes.

2.3 Social Vulnerability, Flood Risk, and Resilience in Urban Areas

As policymakers and scientists examine the recent past and look to the future, significant patterns in urbanization and migration also emerge. In the early 1800s, almost 100% of the US population lived in rural areas (US Census Bureau 2012b). Meanwhile, data from the 2010 US Census showed that 81% of the total US population lives in urban areas (defined as having 50,000 people or more); this number increased by 12% in only the ten years from 2000-2010 (US Census Bureau 2012a). The number of people in US cities is largely expected to increase, though the projected rates of increase are no match for rapidly urbanizing areas in parts of Africa and Asia (Montgomery 2008).

Increases in large scale human migration due to climate change is also expected (Myers 2002, Reuveny 2007, Black, Adger et al. 2011). So-called "environmental refugees" move either within their own country or across borders because environmental issues such as drought, flooding and desertification have hindered their ability to support themselves and their families. Moreover, some social scientists predict that this could lead to increasing conflicts in the receiving areas (Reuveny 2007). In certain cities, such as Miami, "climate gentrification" is pushing low-income residents and residents of color out of historically undesirable neighborhoods that their families had lived in for generations, as the wealthy seek to move away from the coast, and further inland onto higher ground (Keenan, Hill et al. 2018). This sows discontent among those who can no longer afford and are priced out of their own neighborhoods.

Urban settings are areas of vulnerability concerns to begin with, notwithstanding the fact the that populations of coastal megacities have grown tremendously over the last couple of decades (Nicholls 1995); cities face unique vulnerabilities through increased population density, finite escape routes and dense infrastructure, and high poverty rates (Donner and Rodríguez 2008), coincidentally making them a particularly interesting study site. After examining the mounting evidence, two authors, Donner and Rodríguez (2008, p. 1089) "argue that if we fail to acknowledge and act on the mounting evidence regarding population composition, migration, inequality, and disaster vulnerability, we will continue to experience disasters with greater regularity and intensity." Moreover, evidence from climate justice literature suggests that climate change is not just something that is superficially affecting cities; it is also a force that can exacerbate inequalities and uneven rates of development (Bulkeley, Edwards et al. 2014). Faced with these challenges, cities have begun to adapt and increase their resilience in a host of ways.

2.3.1 Strengthening Resilience and Adaptive Capacity in Urban Areas
Although urban areas experience unique vulnerabilities, they also tend to have more access to political and economic capital, in addition to benefitting from greater resources, compared to their small town counterparts (Cross 2001). This allows cities to have greater autonomy and impact over their own climate resilience, in a way that assists more citizens per square kilometer. The first step in this however, is to assess their own climate resilience.

Within this context, the Rockefeller Foundation and ARUP, a renowned independent firm specializing in studying and finding solutions in nearly every sector of built environments, created the City Resilience Index as a tool to assist cities in identifying their climate resilience strengths and weaknesses, and to facilitate engagement within cities. The two organizations also agree that "a city's resilience depends on its physical assets, as well as its policies, social capital and institutions" (Arup International Development 2017, p. 5). They describe city resilience as the ability for a city to provide an environment in which the people who live and work there cannot only survive, but also still prosper, regardless of external stresses. The authors also place special emphasis on the poor and otherwise vulnerable. In design and assessment, the authors highlight seven key qualities of resilient systems; they are: reflective, flexible, integrated, robust, resourceful, redundant, and inclusive (Arup International Development 2017). Of particular importance for areas that experience flood hazards, are systems that are reflective and flexible, meaning that the systems are aware of and responsive to uncertainty, and have processes that will allow them to evolve and adapt based on new research and changing circumstances, for instance SLR. In the context of this thesis, inclusiveness of the system is also vital; wide-spread community engagement, which includes the most vulnerable, helps to sow an environment that is conducive to building a resilient city. Moreover, urban strategies must also consider whether their initiatives truly address questions of injustice within their economies and communities (Bulkeley, Carmin et al. 2013). Of the dimensions that the Index touches upon, such as "health and wellbeing" and "leadership and strategy," the first goal they elaborate on is minimizing human vulnerability, further emphasizing the importance of basic well-being in an individual's or community's ability to deal with unexpected circumstances.

Achieving resilience, however, depends a great deal on the governance systems in place. The C40 cities, a network of cities around the world committed to taking climate action and sharing knowledge, in conjunction with Arup, published a comprehensive report in 2015 titled: *Powering Climate Action: Cities as Global Changemakers*. The report surveyed the various governance approaches that cities use to produce climate action, and emphasizes that "governance – rather than just power – impacts a city's capacity to take action" (Arup International Development & C40

Cities Climate Leadership Group 2015, p. 5). This is characteristic of a larger paradigm shift (Rhodes 1996, Peters and Pierre 1998, Jordan, Wurzel et al. 2005), demonstrating the value of governance, a system in which public and private actors work together to deliver services, over a system that relies solely on the rigid administrative structure of the government. Through collaboration and partnerships, governments can still enact comprehensive change even when they have limited power; the report emphasizes that cities, with their large populations, and as hubs of innovation and economic activity, are in a unique position employ these strategies. Arup and the C40's report finds that in general, there are six city governance typologies: commanding, collaborating, legislating, facilitating, implementing, and providing (Arup International Development & C40 Cities Climate Leadership Group, 2015). The report notes that cities regularly employ different governance strategies based on budget and power limitations in the sector they wish to impact.

The findings compiled by Arup and C40 also align with the existing literature on city governance strategies. Historically, cities have used self-governing, regulating, provisioning, and enabling strategies and policy tools to impact change (Bulkeley, Schroeder et al. 2011, Arup International Development & C40 Cities Climate Leadership Group, 2015); increasingly, as cities deal with climate change, they have also started to use partnerships to achieve climate action (Bulkeley, Schroeder et al. 2011). Experimentation is a large part of climate change adaptations in cities, and is opening new doors for governance (Castán Broto and Bulkeley 2013). These experiments, though usually created by municipal governments, frequently involve partnerships with the private sector and other actors, allowing for new policy spaces to flourish. As previously mentioned, urban areas face unique threats that can negatively impact social vulnerability. Still, the opportunities for improved governance, especially in parts of the US that have historically let down low-income communities, communities of color, and other vulnerable populations, provide promise for the future, even as climate change brings new threats.

2.3.2 Social Vulnerability, Flooding, and Governance in New York City

As history has shown, when environmental issues and disasters affect populations of different incomes and races in the US, there are bound to be problems of equity, and NYC is no exception. NYC has a history of environmental equity issues; studies note that there is a correlation between race/ethnicity, in particular Hispanic and Black populations, and living near so-called "undesirable facilities," such as hazardous waste treatment sites, disposal and sewage treatment facilities, and bus garages and highways (Fricker and Hengartner 2001, Jacobson, Hengartner et al. 2005). Another study found that poverty, immigration, and housing status are significantly associated with neighborhood stressors, which can lead to negative health effects for the populations that live there

(Maroko, Weiss Riley et al. 2014). A separate study examining climate change research, found that NYC is among six cities in the world with "the most quantitatively advanced studies of city-scale climate change impacts"(Hunt and Watkiss 2011, p. 27). Yet, woefully few of the studies examining flooding in NYC have taken into account social vulnerability, income, or race, let alone examine the governance implications.

In the wake of Sandy, journalists were some of the first to remark on the differential impacts of the storm on NYC's subpopulations (Rohde 2012, "Where Hurricane Sandy Still Hurts" 2012). One journalist commented that while many wealthy households could afford to redirect all their time and money to preparing their families for the storm, or even relocate to a hotel, many New Yorkers, especially those in service jobs, could not (Rohde 2012). A scientific study by Faber (2015) examined the demographics of those who were inundated and otherwise impacted when Superstorm Sandy hit NYC. The author found that in nearly 1 in 3 of the flooded census tracts, the poverty rate was greater than 20%, indicating that poverty was greater in flooded over dry tracts. Meanwhile, Black residents, in particular those of lower income, were more likely to live in flooded tracts (Faber 2015). While White residents did occupy a large share of the flooded tracts, those that were inundated tended to be over 65 years in age and have higher rates of poverty, than those who stayed dry. Though Asian- and Latino- majority tracts did not face the same degree of flooding as many White- and Black- majority tracts, they were particularly impacted by the transit disruptions that followed the storm (Faber 2015); this in turn affected the ability of these populations to get back to work and jumpstart the recovery process, further highlighting the idea that social vulnerability permeates every part of resiliency and recovery. A recent study based on surveys collected from NYC residents found that instances of previous harm, such as Superstorm Sandy, was a significant predictor of perception regarding worsening future storm impacts (Reckien and Petkova 2019). People of color in NYC were also more likely to consider adaptation to severe storm or heatwaves an individual responsibility. This may be due to a long history of the government underserving these communities, but the study raises an interesting point in that these populations may decide to depend on themselves rather than governmental aid (Reckien and Petkova 2019).

Though NYC leaves much to be desired on the environmental equity front, it is worth commending the city for transforming the NPCC, originally established in 2008, from just a scientific panel to an organizational body that serves and advises the city. Since then, the Panel has published numerous reports on the examined and projected impacts of climate change in NYC, in addition to the implications of flooding, public health, and resilience. The Panel's second publication in 2015 came

largely in response to Superstorm Sandy. When Superstorm Sandy, frequently also called Hurricane Sandy or just Sandy, battered NYC in October 2012, many areas of the city faced record-breaking flooding. Though NYC was in no way the only region on the eastern seaboard where Sandy wrought havoc, NYC's population density, economic value as both a center of US commerce and with some of the highest priced real estate in the country, and northern location, made the storm particularly destructive and largely unexpected. As a result of the storm, nearly 90,000 buildings were in the wake of the inundation zone, and as previously mentioned, nearly 2 million people were left without electricity, with a total of around $19 billion in immediate damage (The City of New York 2013). It was an awakening moment for many New Yorkers and governmental officials regarding the city's relationship with climate change, especially if it was to survive into the future.

Though there are global estimates for SLR, regional characteristics can cause certain areas to experience more rapid SLR than others; this is the case for NYC. In the NPCC's 2015 report, which comprises a set of peer-reviewed publications, the group reports that SLR in NYC rose an average of 3.05 centimeters per decade since 1900, which is almost twice the rate of of the observed global average or of around 1.27-1.78 centimeters per decade (Horton, Little et al. 2015). The authors also expect that SLR in NYC will not only continue to surpass the global rate, but also likely accelerate in the future, with a total high of around 1.8 meters by 2100. Moreover, the authors of the reports executive summary emphasize that, "it is virtually certain that sea level rise alone will lead to an increased frequency and intensity of coastal flooding as the century progresses" (NPCC 2015). While the authors also note that the number of very intense hurricanes and threats from greater precipitation will likely increase, it is clear that regular coastal flooding will become a monthly certainty for the city, not just a seasonal source of disaster (Horton, Little et al. 2015).

The NPCC reports from 2015 discuss vulnerability largely with regards to health impacts, such as air pollution, proximity to potentially hazardous materials, and vector-borne diseases. The authors do recognize that subpopulations such as the elderly, African Americans, and those with less education are more likely to face temperature related difficulties and stresses (Kinney, Matte et al. 2015), however they do not discuss the term "social vulnerability" or extend their metrics to include flood risk. In the conclusions and recommendations chapter of the report however, they list examining "societal vulnerabilities and resiliency strategies at neighborhood scales" (New York City Panel on Climate Change 2015b, p. 107) as an interesting and important direction for future research. In March of 2019, the NPCC released their third report, which for the first time included an extensive study of EJ and equity issues, in addition to social vulnerability mapping (Foster, Leichenko et al.

2019). The authors thoroughly address the differential impacts that demographics and social vulnerability can have on a person's ability to cope with natural disasters. The report identifies spatial patterns and unequal distributions in social vulnerability with regard to climate stressors, finding that high levels of social vulnerability are consistently correlated with low-income communities and higher presences of African American and Hispanic residents (Foster, Leichenko et al. 2019). Their report, however, does not map social vulnerability with regards to the NPCC's flood projections.

While studies have been performed to assess the impact of Superstorm Sandy on various subpopulations of NYC, thus far, none have assessed differences in flood protections or policy initiatives between areas of low and high social vulnerability. Based off the C40 and Arup's research, NYC's mayor and legislative branches have relatively strong powers when it comes to their ability to successfully pass and enforce laws and regulations. Given the history of EJ in the US regarding differential environmental impacts and enforcement, findings and lessons from the literature regarding equity and the pervasiveness of poverty, and the fact that Superstorm Sandy impacted residents of all incomes, this thesis posits two hypotheses:

- First, that there are more policy plans, initiatives, and instruments available to protect wealthy New Yorkers and those with less vulnerability, than lower income and more socially vulnerable New Yorkers;

- And second, that the policy plans relevant to wealthier neighborhoods are more robust and effectively applied than those that are relevant to areas of lower income and higher social vulnerability.

The subsequent chapter, Chapter 3, outlines the research questions and methodology used to test these hypotheses.

Chapter 3. Research Design

The following research design and framework follows the steps as outlined by Verschuren and Doorewaard (2010) to ensure coherent formulation of research questions and subsequent data collection and analysis. Sections 3.1-3.3 address the conceptual design aspect and elaborate on how the questions were originally formulated and drawn; meanwhile, Sections 3.4-3.7 address the technical design aspect and how these questions were addressed and the frameworks that were applied.

3.1 Research Framework

The following research framework is based off of steps 1-6 of Verschuren and Doorewaard's (2010) step-by-step approach as explained on pages 83-84 of their book. Given that step 7 of this method is to evaluate whether the model elaborated in the previous steps needs to be revised, it will not appear below. This comes with the understanding that step 7 was indeed performed, but that what is outlined below is the most recent model.

Part 1. The objective of the research project.

The ultimate objective of this study was to identify the differences in policy plans and projects for communities of low and high social vulnerability, and why these differences exist. The first step in this, however, was to identify these communities in the first place, and then the policy plans and projects that apply to them.

Part 2. The object(s) of the research project.

The research object is NYC, and more specifically the spatial distribution of social vulnerability and flood risk throughout the city.

Part 3. The nature of the research perspective.

Given that this thesis is largely twofold, first requiring an assessment of neighborhoods at risk of flooding and at different levels of social vulnerability, and only thereafter the evaluation and assessment of policy plans and projects, the nature of the research perspective is also twofold.

To address the first component, this thesis employed diagnostic research to identify the flood risk neighborhoods, assess their social vulnerability, and address the differential availability of policy plans and projects between neighborhoods. With regards to the second component, this thesis employed evaluation research to judge and analyze the applicable interventions (i.e. the policy plans

and projects). Evaluation was performed using assessment criteria from Bullard's (1994, 2001) Environmental Justice Framework as well as concepts from the existing scientific literature.

Part 4. The sources of the research perspective.

As illustrated in Chapter 2 of this proposal, the sources of the research perspective rely heavily on existing studies and theory regarding Environmental Equity and Justice. These concepts were used as a background to understand the impacts of climate change on socially vulnerable populations, such as those of low-income or populations of color. The final source of the research perspective, linking these ideas to NYC, was theory and literature on the impacts of and adaptations to climate change in urban areas.

Part 5. Schematic presentation of the research framework.
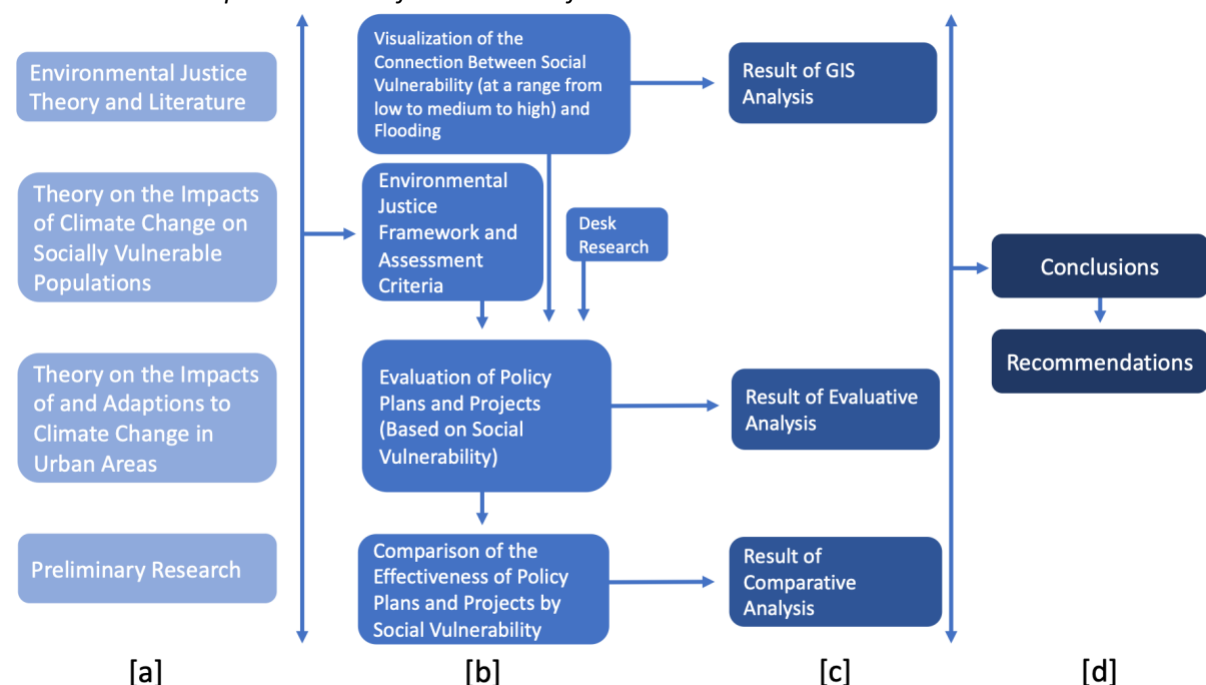
Figure 2. Schematic Presentation of the Research Framework.

Part 6. Research framework formulated as an elaborate argument.
The argument below follows Verschuren and Doorewaard's (2010) guide. The lettered list adheres to the lettered sections in Figure 2.

(a) The framework above illustrates a study examining the differential protection of socially vulnerable populations with regards to environmental hazards, most notably flooding. It was based on the consultation of relevant scientific literature and a Geographic Information System (GIS) mapping tool to yield the assessment criteria,

(b) By means of which policy plans and projects designed to assist NYC neighborhoods with different levels of social vulnerability at risk of flooding were evaluated and compared;

(c) A synthesis of the results of this identification, comparison, and evaluation concludes with

(d) Conclusions and recommendations for how these differences can be remedied.

3.2 Research Question

The primary research question addresses and encompasses the research objective. However, in order to fully address each layer of the primary question, smaller, step-wise sub-questions are elaborated.

3.2.1 Primary Research Question

How do differences in social vulnerability affect the availability and effectiveness of government-based flood risk policy plans and projects in New York City?

3.2.2 Research Sub-Questions

i. With regards to flooding, where in NYC are low, medium, and high socially vulnerable, at-risk communities located?

ii. How do the policy plans and projects that are in place to protect and support at-risk communities compare between different levels of social vulnerability?

iii. Why does the application or effectiveness of these policy plans and projects differ with regards to social vulnerability?

3.3 Defining Concepts

Climate Change: This study employs the United Nations Framework Convention on Climate Change (UNFCCC) definition of climate change, namely that it is a process "attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods" (UNFCCC 2011). This definition is, however, not to be mistaken with that of the Intergovernmental Panel on Climate Change (IPCC), which incorporates the changes in the mean climate and variability over time, whether due to human activity or simply natural global variability.

Climate Change Adaptation: Climate change adaptation refers to the alteration of economic, social, or ecological systems and the adoption of certain strategies to mitigate potential damage or even benefit from the current and expected impacts of climate change. This definition is also based on the UNFCCC definition (UNFCCC n.d.).

Environmental Equity: This term incorporates social equity to refer to the disproportionate effects of environmental hazards, risks, and degradation on certain people and regions usually by class, race, and/or sex (Cutter 1995). It also implies that risk should be distributed equally (Ikeme 2003), and that one race or class should not shoulder the burden more so than another.

Environmental Justice: Environmental Justice is based on theories in Environmental Equity and requires that some type of corrective action must be taken to address the differential environmental damage or wrongdoing that was imposed on a certain group, if not prevent this damage in the first place (Bullard 1994).

Hazard: A hazard is any potential source of harm or damage. This thesis frequently used the phrase "flood hazard" to denote a hazard primarily brought on by sea-level rise or storm surges, particularly in low-lying areas.

Geographic Equity: Within the context of Environment Equity and Justice, Geographic Equity refers to the unequal spatial distribution and locations of communities (typically of low-income and communities of color) to LULUs, such as landfills and toxic sites (Bullard 2001).

Low- versus High-Socially Vulnerable Community or Neighborhood: The social vulnerability requirements for each category are of course relative to one another and differ greatly by region. Low- and high-socially vulnerable communities were identified and delineated during the mapping stage of this study, using the CDC's Social Vulnerability Index. Social vulnerability tends to align with median household income, since those with the economic and material resources to prepare, evacuate, and recover are generally less vulnerable to disasters.

Person and/or Community of Color: This study to refers to people, communities, and neighborhoods "of color" to mean any non-White individual or non-White majority group of people. This typically includes individuals who identify as Black or African American, Hispanic or Latino, Asian, Pacific Islander, American Indian or Indigenous, or multi-racial/ethnic.

Procedural Equity: Within the context of Environment Equity and Justice, Procedural Equity refers to to degree to which individuals have equal protection under laws, regulations, and enforcement. As Bullard (2001, p. 156) emphasizes, "unequal protection might result from nonscientific and undemocratic decisions, exclusionary practices, public hearings held in remote locations and at

inconvenient times […]." Of particular relevance to Spanish-speaking populations (among others) in America, is the prevalence of materials and communications that are available exclusively in English.

Risk: Risk is commonly defined as the hazard or probability, multiplied by the consequences or expected severity of the outcome. The term can have many scientific or mathematical definitions, depending on the academic field.

Social Equity: Within the context of Environment Equity and Justice, Social Equity refers to extent that sociological factors (described by Bullard (2001) as class, race, ethnicity, culture, and political power, to name a few) affect the availability and privilege of environmental decision-making, such as the ability to choose the healthiest neighborhoods or safest jobs.

Social Vulnerability: Social Vulnerability refers to the resilience or capacity for which people, communities, or societies can cope with and recover from the impacts of natural hazards, such as floods, earthquakes, and disease outbreaks (Cutter, Boruff et al. 2003, Cutter and Finch 2008). The US Centers for Disease Control and Prevention utilizes a similar definition to derive the "Social Vulnerability Index" (SVI); this index relies on fifteen US Census variables (such as poverty and population density) to identify communities that may require additional support in preparing for or recovering from disasters (Centers for Disease Control and Prevention 2018). Socially vulnerable populations are typically of low-income and cannot respond as well to such external stressors.

3.4 Research Strategy
3.4.1 Research Unit
The research unit for this thesis was NYC as a whole, followed by the neighborhoods that were selected based on the SVI and flood projections. There is a wide range of vulnerability in NYC, which was useful for the purposes of this study.

3.4.2 Selection of Research Unit
Given its racial diversity and the deep household wealth disparities that are present, coupled with the threat of SLR, NYC was an ideal and interesting unit for this thesis. As previously mentioned, there is also a multitude of open data, made freely available by various departments in the city and state governments of New York and the federal government, most notably for the purposes of this thesis, social vulnerability data and flood projections.

The SVI was a particularly useful tool for this study because it was designed "to help local officials identify communities that may need support in preparing for hazards; or recovering from disaster" (Centers for Disease Control and Prevention 2018). Given that the aim of this thesis was also to identify communities and ultimately assess policy for flood risk, the fact that the SVI caters to and assists local officials in disaster-planning makes the Index more insightful than income or population density alone.

The SVI data employed takes the form of a GIS shapefile, which facilitated the overlay with flood maps. A drawback, however, that other researchers using GIS have noted, is that flood zones do not spatially correspond with census block boundaries (Maantay and Maroko 2009). This of course makes sense, given that flood zones are the result of geomorphological features, while census blocks are determined by the government. Still, it does mean that only part of census block might experience a flood risk. Furthermore, by using NYC as a case study, Reckien (2018) illustrated that social vulnerability can be quite variable based off of different techniques and weighted values. Nonetheless, Negri, Burkardt et al. (2005) argue that using data at the census tract level in conjunction with GIS is an effective tool for mapping vulnerability and flooding, among other disaster types. Additionally, given that the focus of this thesis was policy-based, rather than map-based, the discrepancy is worth noting, but is not a large issue. It is also worth noting that NYC is quite heterogenous, with demographic characteristics that can range greatly within a single city block, let alone census tract. There was not much that could be done about this however, and the SVI was still the best and most accessible tool for this study. More information regarding the exact composition of the SVI can be found in Appendix 1.

3.4.3 Research Boundary

Given that there are a multitude of historical data and flood projections for NYC, it was necessary to set a research boundary. This thesis employed the SVI from the most recent year on file: 2016. The research also only used data on the 100-year floodplain, which represents areas with a 1% annual chance of flooding. Though data on the 500-year floodplain was available, it was not employed in this study. Others have noted that the 100-year floodplain is more commonly used and as such, is a better standard from which to compare with other regions (Maantay and Maroko 2009, Chakraborty, Collins Timothy et al. 2014, Montgomery and Chakraborty 2015). Exact information on the GIS shapefiles that were used can be found in Appendix 2.

There have been many policy plans and projects through the years to protect New York's coasts and coastal communities, at the local, state, and federal level. As a result, this study only took into

account plans and projects following Superstorm Sandy in 2012, because of its role as an awakening moment for many New Yorkers and policymakers. Additionally, the previously mentioned literature suggests that the most effective governance and planning happens when officials understand community needs at the local level (Fothergill and Peek 2004, Koks, Jongman et al. 2015). Especially in a country as large as the US, local flood resilience is often the result of local policy. Though that policy might depend on federal funds and be subject to federal rules, it is still designed, passed, and implemented at the city level. As such, the primary study interest was local NYC policy, and this thesis analyzed and assessed instruments that were developed by city governmental departments and offices.

3.5 Research Material and Accessing Method

NYC is a highly studied region, with research coming from both academic and research institutes, as well as governmental departments. Moreover, the findings and data from these institutions and the reports they publish are often made freely available. This is a general advantage for individuals studying NYC, not only in the field of governance. The data used in this thesis comprised GIS shapefiles of social vulnerability and flood predictions from various sources, as elaborated below. Policy plans and projects in NYC are usually, if not always, published and distributed online, which facilitates accessibility. In discussions with the first supervisor of this study, it became clear that interviews with stakeholders would contribute relatively little to the study and it was agreed upon that they would not be necessary. As such, the sources for this study relied on freely available data found largely on online governmental databases.

3.5.1 Materials and Methods

The three sub-questions each touch on a different type of research question, with the hope that this enabled a more holistic approach and result. The materials and methods are outlined for each question below and are further illustrated in Table 1.

i. *With regards to flooding, where in NYC are low, medium, and high socially vulnerable, at-risk communities located?*

To answer this question, ESRI's ArcGIS software was used to overlay maps of social vulnerability with maps of flood predictions, as a function of storm surges and SLR. Data on social vulnerability was available through the CDC's 2016 SVI. Meanwhile, data on high tide and storm surges was freely available from a combination of the NYC Department of City Planning (DCP), NYC Department of Small Business Services, NPCC, and the Mayor's Office.

ii. How do the policy plans and projects that are in place to protect and support at-risk communities compare between different levels of social vulnerability?

To answer this question, policy instruments and initiatives to help people in flood-prone areas were investigated and analyzed. The focus was placed on the plans and initiatives created by local NYC government bodies, following the events of Superstorm Sandy in 2012. The differences in potential use and application of these instruments between various communities was also investigated.

iii. Why does the application or effectiveness of these policy plans and projects differ with regards to social vulnerability?

To answer this question, this study was contextualized within the existing scientific literature. Previous research and case studies from other regions were examined to identify which situations might be applicable to NYC as well.

Research Sub-Questions	Type of Research Question	Data Required to Answer this Question	Data Source	Method of Data Acquisition
i. With regards to flooding, where in NYC are low, medium, and high socially vulnerable, at-risk communities located?	Descriptive	Spatial data on social vulnerability throughout NYC	Secondary Data: GIS Data/Shapefiles for Social Vulnerability In NYC	Desk Research: Using ArcGIS software to map the overlap between social vulnerability and flooding
		Spatial data on flood and storm surge projections for NYC	Secondary Data: GIS Data/Shapefiles for Flood Predictions	
ii. How do the policy plans and projects that are in place to protect and support at-risk communities compare between different levels of social vulnerability?	Evaluative	-Existence of policy plans and projects -Scope/extent of these plans -Feasibility of these plans	Policy Plans and Projects	Desk Research: Policy Plans and Projects that were always available on local online government databases

Research Sub-Questions	Type of Research Question	Data Required to Answer this Question	Data Source	Method of Data Acquisition
iii. Why does the application or effectiveness of these policy plans and projects differ with regards to social vulnerability?	Explanatory	-Previously determined policy plans and projects -Existing scientific literature on social vulnerability	Policy Plans and Projects	Desk Research: Policy Plans and Projects that were always available on local online government databases

Table 1. Table illustrating the data and data acquisition necessary to answer each sub-question, thereby also answering the primary research question.

3.5.2 Ethics Statement

This thesis employed freely available data from governmental organizations, and neither interviews nor sensitive data about individuals or groups were needed or used. As such, there was no foreseeable need for an official Ethical Review by the University of Twente. That said, the study did utilize social vulnerability data from the CDC, though it was entirely anonymous and vetted by the CDC. With this demographic data in mind, a certain awareness of the deep-rooted issues, sensitivities, and history regarding race and socio-economics in America needed to be considered. Given that the researcher is a woman of color, born and raised in America and familiar with these issues, special attention was paid that the concepts were discussed and analyzed appropriately, and with due care.

3.6 Data Analysis

3.6.1 Method of Data Analysis

The method of data analysis is divided by the three sub-questions as illustrated in Table 2 below.

Research Sub-Questions	Method of Data Acquisition	Method of Analysis
i. With regards to flooding, where in NYC are low, medium, and high socially vulnerable, at-risk communities located?	Desk Research: Using ArcGIS software to map the overlap between social vulnerability and flooding	Quantitative: The formulated maps were analyzed by hand to identify where at-risk communities are.

Research Sub-Questions	Method of Data Acquisition	Method of Analysis
ii. How do the policy plans and projects that are in place to protect and support at-risk communities compare between different levels of social vulnerability?	Desk Research: Policy Plans and Projects that were always available on local online government databases	Qualitative: Findings from the selected policy documents were extracted to identify trends.
iii. Why does the application or effectiveness of these policy plans and projects differ with regards to social vulnerability?	Desk Research: Policy Plans and Projects that were always available on local online government databases; existing database of scientific literature	Qualitative: The selected policy plans and projects were assessed using the Environmental Justice Framework (Bullard 2001) and analyzed and contextualized within the existing scientific literature and previous case studies, to identify causes for differences.

Table 2. Table illustrating the method of analysis by research sub-question and method of data acquisition.

3.6.2 Validation of Data Analysis

The validation of data analysis for the quantitative portion of the study (i.e. the mapping portion) relied on using multiple data points from trusted sources, namely different administrative bodies of the US government. Analysis was performed using a trusted and popular software, ArcGIS. Previous studies have tested the efficacy of using GIS and US Census data in mapping social vulnerability, and though some limitations have been found (Nelson, Abkowitz et al. 2015), it is a generally reliable and useful tool for this type of data analysis (Sheppard, Leitner et al. 1999, Maantay 2002).

The validation of data analysis for the qualitative portion of the study (i.e. the policy assessments and comparisons) relied on the popular and tested method of qualitative triangulation (Carter, Bryant-Lukosius et al. 2014). Triangulation of sources and analysis comprises pulling and analyzing data and information from several sources. This study utilized mapping data, policy plans and projects, and the existing scientific literature to compile findings, analyze data, and draw conclusions.

3.6.3 Analytical Framework

The framework, as illustrated in Figure 3 below, begins by stating the primary research question and then dividing it into delineated sub-questions that address the individual components of the primary question. Steps 1-5 are elaborated below.
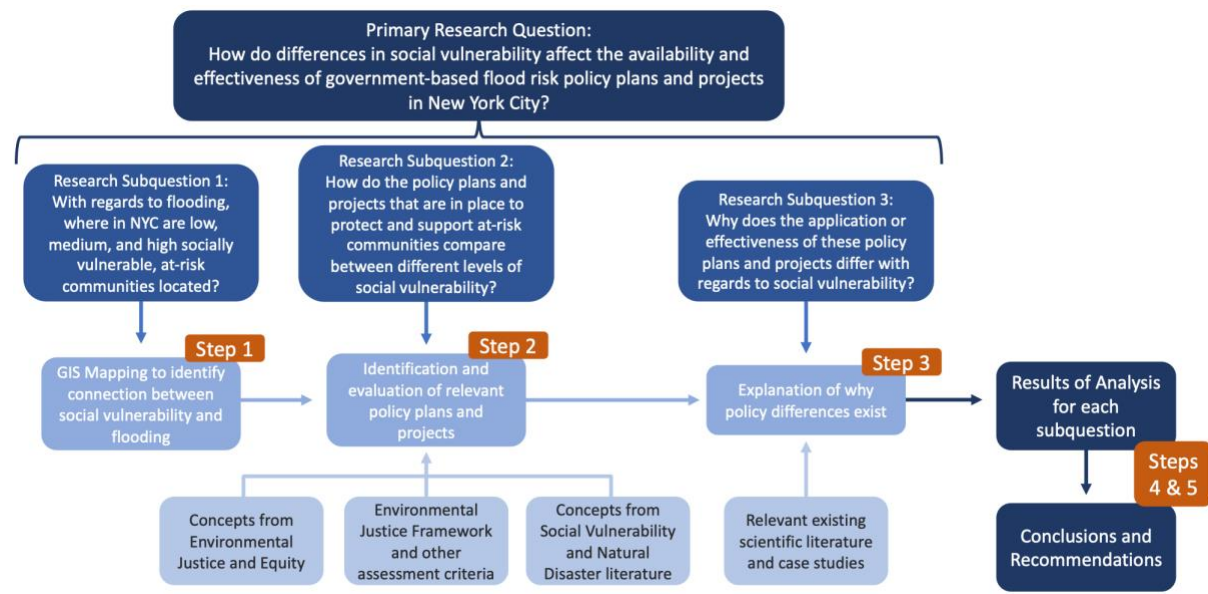
Figure 3. Step-Wise Analytical Framework for the Study.

Step 1 required the identification and proper analysis of communities with flood risk

Step 2 involved the analysis and evaluation of the relevant policy plans and project by income, using existing literature and frameworks.

Step 3 employed previous scientific studies to analyze why certain differences in policy plans and projects exist between different vulnerability levels.

Steps 4 & 5 allowed for the synthesis and analysis of the data from all three sub-questions to formulate conclusions and provide recommendations for how these differences could be resolved in the future.

Chapter 4. Findings

The subsequent result sections detail the maps displaying the extent of social vulnerability and flood risk, and outline the relevant policies, laws, and government initiatives that were launched in NYC following Superstorm Sandy.

4.1 Social Vulnerability and Flood Maps

The following are maps that were derived using the CDC's SVI and inundation zone and flood projection maps from city government offices. Detailed information regarding the GIS layers and individual sources by map can be found in Appendix 2.

These maps address the first research sub-question, namely: *With regards to flooding, where in NYC are low, medium, and high socially vulnerable, at-risk communities located?* The locations of socially vulnerable populations at risk of flooding are spread throughout coasts of the five boroughs of the city, as illustrated by the maps. There are clear areas, such as in Lower Manhattan which is highly flood-prone, where populations of high and low vulnerability live immediately side by side, however there are also many areas with medium vulnerability and different gradients. The northern reaches of NYC, comprising northern Manhattan and the southern Bronx exhibit very conspicuous areas of high social vulnerability, which aligns with the findings from the 2019 NPCC report (Foster, Leichenko et al. 2019). Still, an examination of the Rockaway Peninsula in Queens and the southern and western Brooklyn coasts show that overall, while there are general social vulnerability patterns in the whole of NYC, flood risk in NYC is not localized exclusively to areas of high or low social vulnerability.
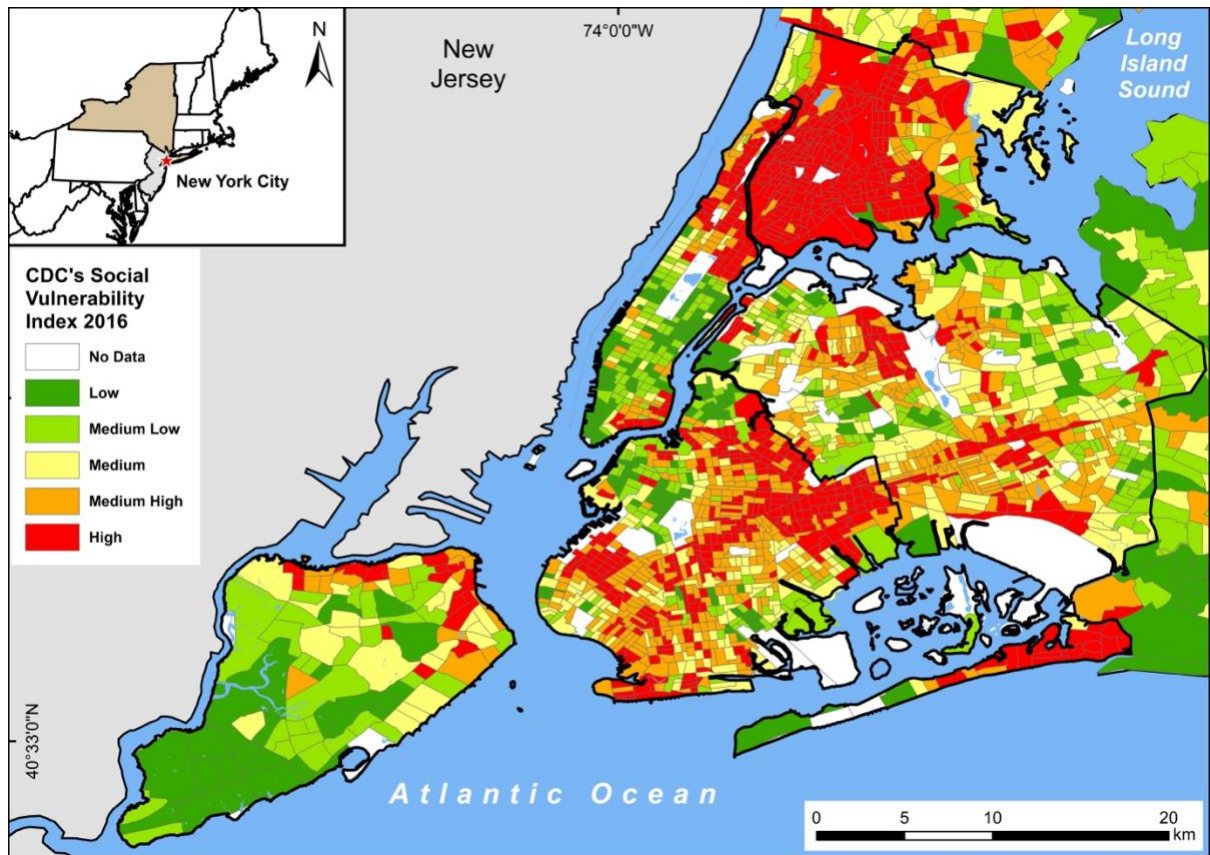
Figure 4. Social Vulnerability in New York City, based on the CDC's SVI.
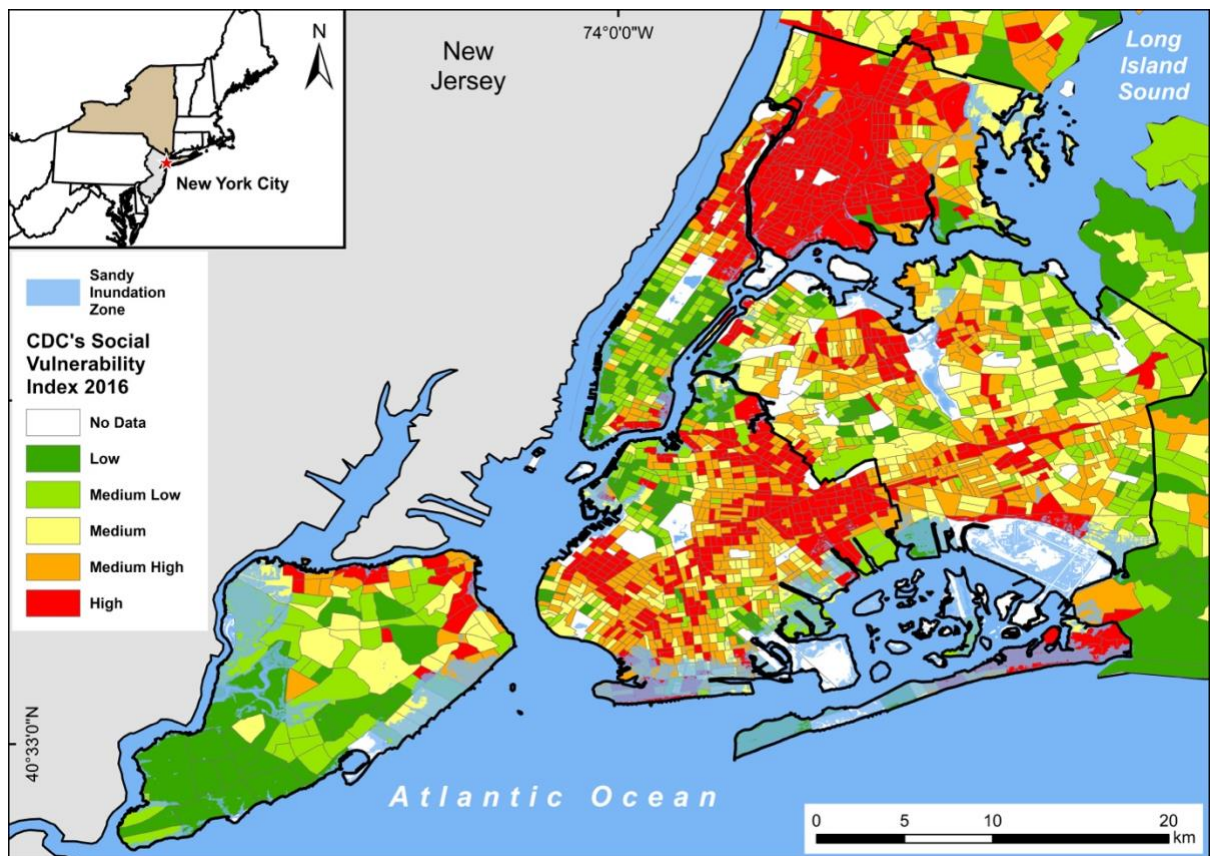
Figure 5. Superstorm Sandy Inundation Zone, mapped over the CDC's SVI.
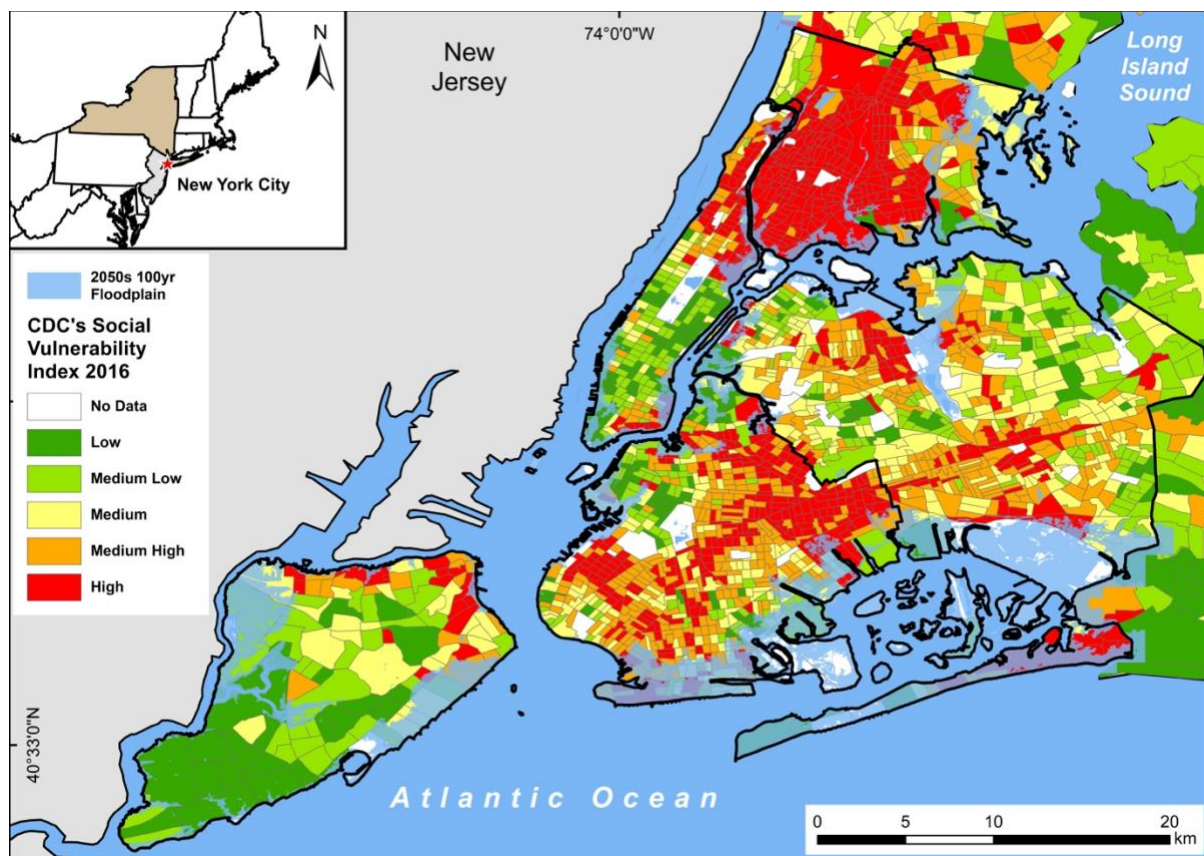
Figure 6. 2050s 100-year Floodplain, mapped over the CDC's SVI.

The original intent of this thesis was to select specific neighborhoods at a range of social vulnerabilities and compare the availability and scope of policy plans and initiatives that were unique and exclusive to these neighborhoods, as a function of their social vulnerability. As research progressed however, it became clear that the vast majority of initiatives were citywide, rather than tailored to individual neighborhoods, nullifying the intended analysis. This difficulty and the initiatives are expanded on in the following section.

4.2 Policies, Laws, and Initiatives

First and foremost, as previously stated, the majority of the earliest policy initiatives that came in the months following Superstorm Sandy were indeed citywide. While studies and plans have since been made for certain coastal areas, nearly all of the City Council laws that were passed, such as zoning laws were not tailored to specific neighborhoods. Thus, with regards to the second research sub-question: *how do the policy plans and projects that are in place to protect and support at-risk communities compare between different levels of social vulnerability?,* it is clear that from a policy standpoint, there was neither a commitment to addressing social vulnerability, nor preferential treatment for wealthier communities, contrary to the original hypothesis formulated based on the

literature review. This finding also negates any effort to compare the differential availability or coverage of policy initiatives between areas of different levels of social vulnerability, given that there simply are none. As such, the following findings sections comprise an overview of how the relevant reports, initiatives, and policies attempted to address and remedy issues surrounding flooding, resilience, and environmental justice throughout the city.

Table 3 contains a general overview and grouping of NYC policies, programs, initiatives, and laws that were drafted following Superstorm Sandy. The initiatives are introduced below as the result of a search into the NYC governmental websites and databases, and the City Council online legislative archives. Though the initiatives and findings are introduced here, they are further discussed, analyzed, and assessed in Chapter 5 of this thesis.

Program or Initiative	Report or Initiative Title	Leading Governmental Department(s)
PlaNYC, later OneNYC	**2013: *PlaNYC: A Stronger, More Resilient New York*** **2014: *PlaNYC Progress Report: Sustainability and Resiliency 2014***	NYC Special Initiative for Rebuilding and Resiliency; the Mayor's Office including: Mayor's Office of Recovery and Resiliency; Mayor's Office of Sustainability; NYC Climate Policy and Programs
	2015: *One New York: The Plan for a Strong and Just City* **2016: *OneNYC 2016 Progress Report*** **2017: *OneNYC 2017 Progress Report*** **2018: *OneNYC 2018 Progress Report*** **2019: *OneNYC 2050: Building a Strong and Fair City***	The Mayor's Office and numerous mayoral departments, not just those relating to sustainability and resiliency.
Zoning for Flood Risk	Introduced in 2013, and includes initiatives such as: • **Resilient Neighborhoods** • Resilient Retail	Department of City Planning
City Council Local Laws	**Selection of proposed and enacted laws**	NYC City Council; Building Resiliency Task Force
Build it Back	Build It Back program to assist homeowners in residential rebuilding	NYC Mayor's Office of Housing Recovery Operations; NYC Department of Buildings; funded by the US Department of Housing and Urban Development

Table 3. Table outlining the policies, reports, and initiatives at the city-governance level, designed to protect NYC communities against flooding. The titles in bold are introduced below and further discussed in Chapter 5.

4.2.1 Citywide Initiatives: PlaNYC and OneNYC

The majority of policies and initiatives that were implemented from late 2012 to the present are citywide, rather than localized in neighborhoods. As such, there are no special protections or treatment for high-income communities, negating the first hypothesis. Perhaps the most comprehensive and ambitious initiative at the time was PlaNYC, which later became OneNYC.

PlaNYC was originally a program launched in 2007, by then Mayor Michael Bloomberg, taking into account the projected effects of climate change on the city, among other issues that would affect NYC and its inhabitants. The original report, titled *A Greener Greater New York*, emphasized the city's commitment to combatting climate change and planning for the future (The City of New York 2007). It established the Mayor's Office of Long-Term Planning, and ambitious goals to cut greenhouse gas emissions by over 30 percent by 2030. It also included resiliency initiatives that performed quite well and did in fact provide protections from Sandy (The City of New York 2013). However, even with these initiatives, the city was vastly underprepared in October 2012 for Sandy's strength and flooding. Following the storm in December 2012, the Mayor's Office established the Special Initiative for Rebuilding and Resiliency (SIRR) which was tasked with drafting a plan to protect NYC's buildings, infrastructure, and communities from the projected impacts of climate change. The SIRR engaged with governmental partners at the city, state, and federal level and briefed public officials and over 320 organizations from community-based, labor, environmental, and business sectors (The City of New York 2013).

The result of the SIRR's work was *PlaNYC: A Stronger, More Resilient New York*, which outlines a ten-year, multi-billion dollar program with 257 separate initiatives for strengthening infrastructure systems and the most devastated neighborhoods (The City of New York 2013). The 400+ page report is extremely thorough; it begins with an examination of Sandy's impacts and in-depth climate risk analyses, outlining what the city would expect in the medium term, through the 2020s, and the long term, through the 2050s. Divided into sections, the report analyzes the impact and provides suggestions on economic recovery, community preparedness, and environmental remediation. The report discusses not only impacts on and suggestions for buildings, utilities, and healthcare, but also individual NYC neighborhoods. The report found that the elderly and those with physical limitations and disabilities were often left stranded when the power went out. Moreover, the report contends that residents of public housing developments near the waterfront felt the impacts of the storm "particularly acutely" (The City of New York 2013, p. 18). It is important to note that the term "environmental justice" also appears in the beginning of the report as a metric that the studies examined, but it is never again mentioned.

Of particular importance was coastal protection; the authors identify different potential types of flood protections such as levees, floodwalls, and other barriers, for nearly the entire expanse of NYC's coastline. The city emphasizes employing a diverse array of tailored, scalable solutions (The City of New York 2013). While these protections are tailored to local neighborhoods, their available space and their needs, the protections are largely just suggestions on what could be done given adequate funding, rather than a plan on what would be done. The concrete, specific plans are saved for five of what they considered the hardest-hit regions: the Brooklyn-Queens Waterfront, the eastern and southern shores of Staten Island, southern Queens, southern Brooklyn, and southern Manhattan. As such, these were the neighborhoods that were chosen to receive the most funding for coastal protection. The selected regions represent the full spectrum of social vulnerabilities, and include protections for some of the wealthiest and poorest neighborhoods in the city, once again indicating that the city is not only interested in protecting the most economically valuable neighborhoods. Table 4, which outlines the number of specifically developed initiatives by region, versus the number of citywide initiatives that would generally impact and be of benefit to the selected region, can be found below. Given that these five areas are already very large, with each one comprising numerous neighborhoods with different ethnic and economic backgrounds, a single "specifically developed initiative" would apply to multiple neighborhoods. This also means that comparative analysis of neighborhoods would again yield very little.

	Number of Specifically Developed Initiatives	Number of Citywide and Other Initiatives that Impact Directly
Brooklyn-Queens Waterfront	11	76
Staten Island	12	78
Southern Queens	13	82
Southern Manhattan	9	72
Southern Brooklyn	17	83

Table 4. Initiatives from the PlaNYC: A Stronger More Resilient New York report by location. Table derived from information from the PlaNYC Progress Report: Sustainability and Resiliency 2014 (The City of New York 2014).

Initial projects following the storm also focused on repairing and strengthening critical infrastructure, such as hospitals, tunnels, power facilities, and transportation. Given that the wealthy are more likely to visit hospitals before serious issues present themselves and spend more money on healthcare (Moore, Newman et al. 1992, Cooper, Cooper et al. 2012), it might make sense that

hospitals are more likely to be located in areas of the city with lower social vulnerability. Through this connection, the argument could then be made that improvements to these structures and their surrounding areas disproportionately benefit wealthier neighborhoods. This is, however, not the case in NYC. As illustrated in Figure 7, municipal hospitals at the time were located throughout the city in areas of diverse social vulnerability, and frequently in poorer and more socially vulnerable areas. Figure 7 also shows the distribution of subway stations in NYC as of 2018. The greatest density of stops is in Manhattan, though there are numerous bus lines throughout the city. As of early 2019, the city reported that 64% of New Yorkers live within about 800 meters (0.5 miles) of a subway station or Select Bus Service stop, and 97% live within about 400 meters (0.25 miles) of a regular bus stop (The City of New York 2019). Thus, improvements to critical subway stations and other transport lines do not disproportionately benefit wealthier areas over poorer ones either.
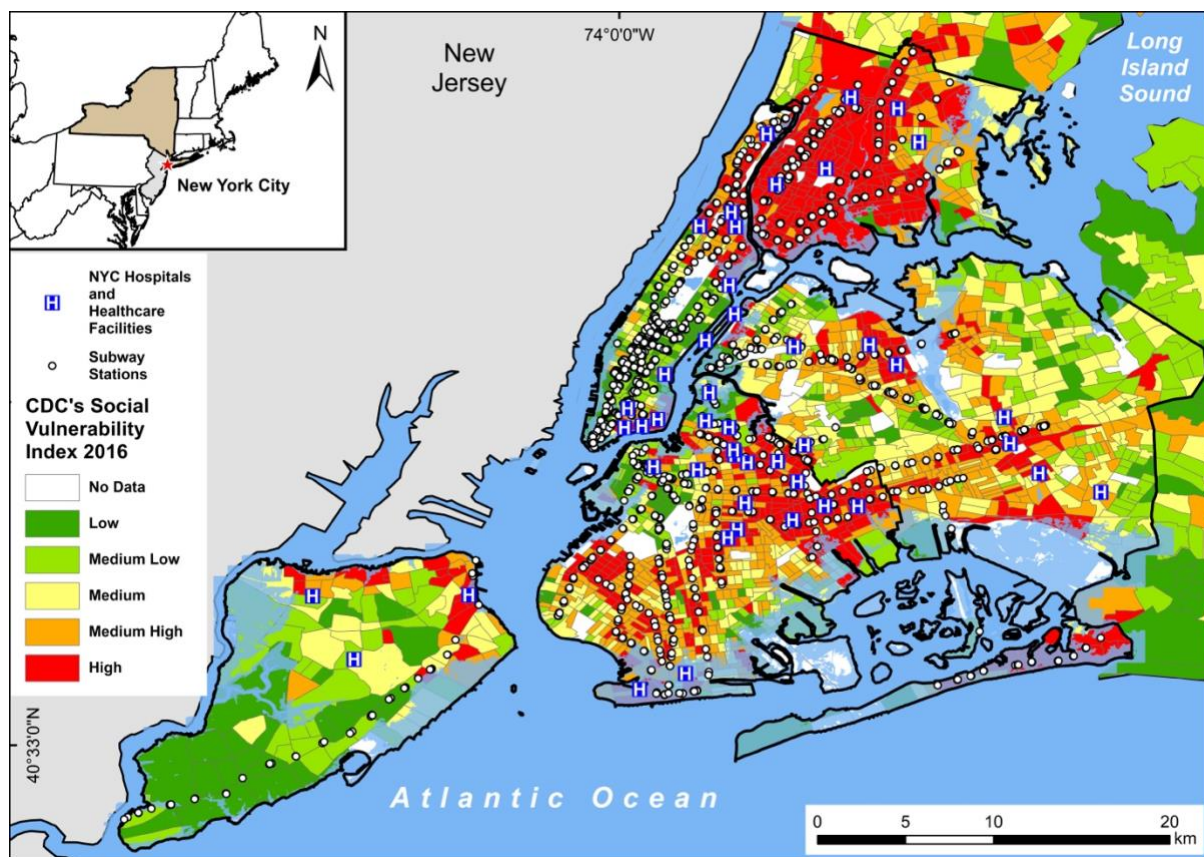
Figure 7. Location of municipal hospitals and subway entrances in NYC, mapped with regards to the 2050s 100-year Floodplain and the CDC's SVI.

The *PlaNYC Progress Report: Sustainability and Resiliency 2014*, meanwhile, provided an updated perspective on where these initiatives stood, designated as either completed, in progress, or not started (The City of New York 2014). The reports do mention that some demographics, in particular the elderly and those of lower income, experienced greater impacts from the storm, but there is no discussion in either of the reports about social vulnerability. The report does mention that the DCP

would "conduct local studies…that will identify ways to reduce risk from natural hazards, foster economic and social resiliency" (The City of New York 2014, p. 85) on three separate occasions with regards to three of the five regions listed above. That said, the authors never define "social resiliency" or discuss how they would address it. As with the previous year's report, EJ issues are mentioned. However, they are only discussed with regards to the location of brownfields, the city's vacant and largely industrially-contaminated land, or brownfield-related environmental protection and remediation.

In 2015, with the new mayor, Mayor Bill de Blasio, PlaNYC was transformed into One New York and later OneNYC. The OneNYC reports widen in their scope while placing a great deal of emphasis on creating a just society and improving equity throughout social and city systems; they examine a wide array of issues and variables from improving healthcare and the criminal justice system, to sustainability and resilience (The City of New York 2015). This report is largely organized by wide-reaching citywide goals and visions, rather than focused analyses of neighborhoods and tailored solutions. The 2015 report does mention that NYC aims to reduce the social vulnerability index for neighborhoods throughout the city, though it never mentions which neighborhoods, or by which strategies it would do so. Progress reports were published annually from 2016 to 2018, and in 2019 a multivolume report was published titled *OneNYC 2050: Building a Strong and Fair City*. Interestingly, the 2016 and 2017 progress reports state that there was no updated data available for the goal of reducing the social vulnerability index of certain neighborhood, and in the 2018 and 2019 reports, the term is completely absent.

With regards to EJ, it is worth noting that in 2015, the OneNYC authors dedicate a few pages to environmental justice, and "recognize that equity and environmental conditions are inexorably linked […] particularly for residents of low-income communities that have historically been burdened with a disproportionate share of environmental risk"(The City of New York 2015, p. 164). However, NYC's EJ subsection falls exclusively under the sustainability chapter of the report. While there is a very brief mention of flooding in southern Queens, the EJ portion focuses almost entirely on air quality, brownfields, waste, and other public health hazards. Within the resilience chapter of the same report, the authors do contend that growing economic inequality threatens the fabric of the city and emphasize the value and importance of community strengthening, "by building the community, social, and economic resiliency of our neighborhoods" (The City of New York 2015, p. 219). The idea of improving community resiliency and preparedness is reiterated throughout the

chapter, alongside infrastructure development and coastal defense, without ever fully being called "environmental justice."

The 2016 and 2017 progress reports once again include subsections dedicated to addressing EJ. This time however, they include information regarding the relevance of community preparedness. Meanwhile, in the resiliency chapter of the 2016 progress report, the term EJ makes an appearance. Subsequently, in the 2017 progress report, the authors include EJ alongside social vulnerability and demographic features as relevant to flood resilience, marking an evolving consideration of these factors.

Figure 8 shows the progress of numerous flood protection projects and studies throughout of the city, as of 2018. There is a clear focus on addressing the flood-prone southern regions that were most affected by Sandy, though there are some northern projects as well, centered mostly around vital infrastructure sites. Given that the northern reaches of the city were not hit as hard during Sandy, it is understandable that they have not been as heavily studied. Still, given the increasing 100-year floodplain, it will become imperative in the coming years that NYC protect the northern areas as well.
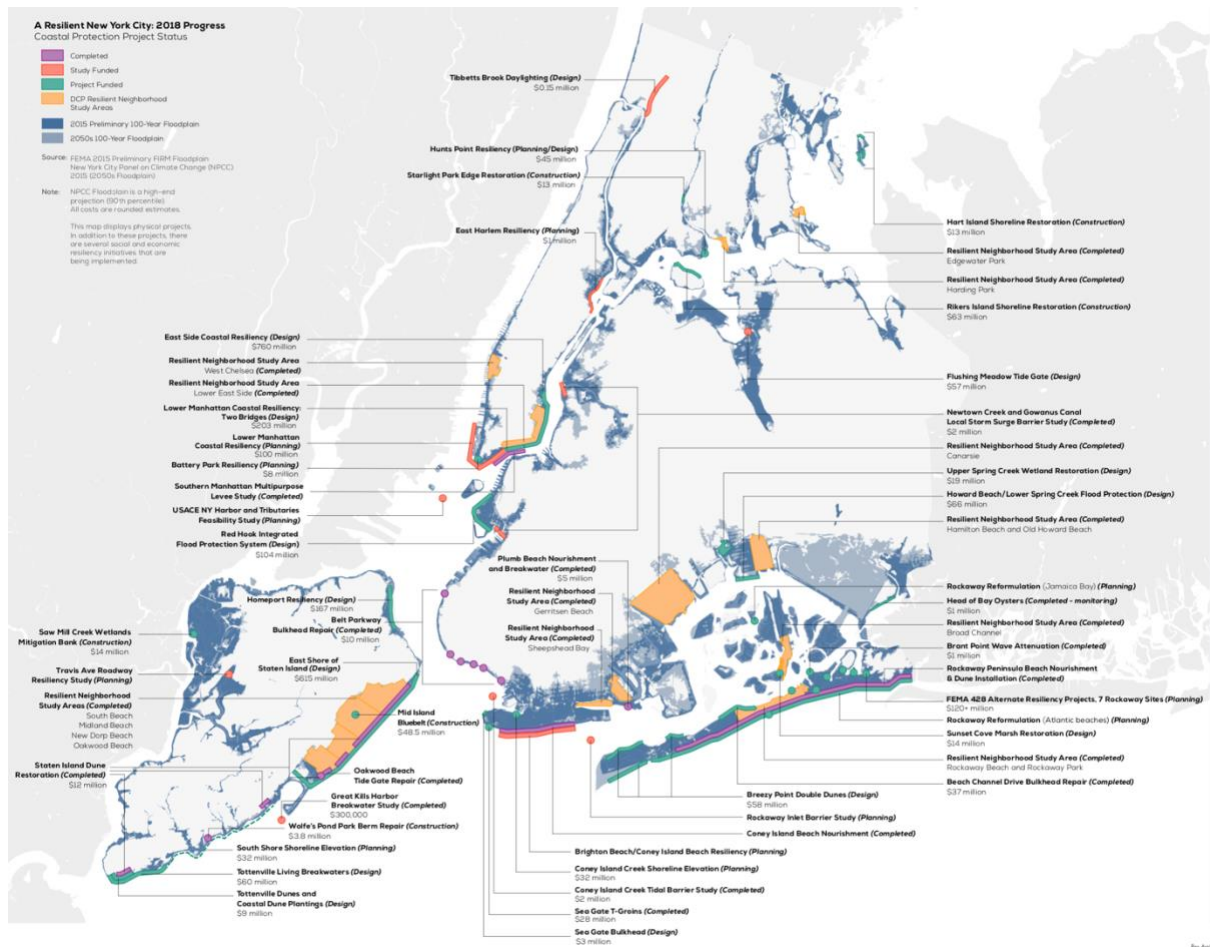
Figure 8. NYC Coastal Protection Project Status as of 2018. (Source: The City of New York 2018, p. 88-89)

4.2.2 Citywide Laws: Zoning for Flood Risk and City Council Laws

Zoning laws are frequently used to, among other things, control land development, as well as dictate building, construction, and safety requirements. Following Superstorm Sandy, several governmental departments, such as the DCP and the NYC Department of Buildings, employed zoning regulations and changes to simplify, expedite, or even incentivize rebuilding and sustainability. The 2013 Flood Resilience Zoning Text Amendments removed regulatory obstacles, making it easier to use flood-proofing techniques such as elevating buildings and moving mechanical systems to higher floors (NYC Department of City Planning 2017). Meanwhile the 2015 Special Regulations for Neighborhood Recovery allowed for a faster, simpler system of flood-resilient construction in areas where homes were being rebuilt. Many of the proposals for the new zoning laws or amendments originally came from the Building Resiliency Task Force (BRTF), which was formed following Sandy.

In 2013 the BRTF produced a report outlining 33 policy proposals that were designed to remove barriers to resilient buildings and construction. The BRTF argued that since no one knew from where or when the next natural disaster would strike, owners should have options with regards to

retrofitting their buildings. Moreover, the new laws and resiliency requirements would only affect new constructions and existing buildings when they begin renovations. The authors argue that this system of grandfathering in older buildings would give existing building owners the freedom to upgrade their property at the most cost-effective time.

Ultimately, these zoning proposals, laws, and amendments had to be approved by the NYC City Council. A collection of local laws that were presented to the City Council pertaining to flood adaptation, as well as some relating to environmental justice, can be found in Appendix 3. The vast majority of the laws, in particular the laws that were passed, contained amendments to building codes, though some also addressed emergency preparedness and awareness. With a total of 51 council members, there is a wide range of law-sponsorship; some laws only had one sponsor, and another had 43, though the median number was 13 members. Interestingly, a law introduced in 2014 requiring density assessments of flood-prone areas and an examination of whether or not these densities would in turn affect the evacuation potential of residents, did not pass. A similar law, introduced in 2018 is currently still in committee, pending approval.

Just a few months ago, in May of 2019, the City of New York, spearheaded by the NYC DCP published an updated report titled Zoning for Coastal Flood Resiliency: Planning for Resilient Neighborhoods. The report outlines how homeowners, landlords, and business owners located in the current and future floodplains could design or retrofit their homes and buildings to be more resilient, reduce damage, and cost less in flood-insurance (NYC Department of City Planning 2019). The suggestions come in part from discussions that the NYC DCP has had with communities since 2012, when Sandy struck. Though there was widespread community engagement, and the reports do identify certain "resilient neighborhoods," these zoning laws once again apply to the whole city, and do not offer tailored solutions to specific neighborhoods and their needs. As a result, they also do not offer greater protections for higher or lower income residents, contrary to this thesis's original hypothesis. Ultimately, while the regulatory framework has changed, making it easier to adopt flood resilient strategies, it is largely up to individual home- and business-owners to decide what to do with their property.

4.2.3 NYC Department of City Planning: Resilient Neighborhoods
Though most policy instruments are citywide, it is worth mentioning the Resilient Neighborhoods project. Launched in 2013 and spearheaded by the NYC DCP, the project "is a place-based planning initiative to identify neighborhood-specific strategies, including zoning and land use changes, to support the vitality and resiliency of communities in the floodplain and prepare them for future

storms" (NYC Department of City Planning n.d.). Through funding from the US Department of Housing and Urban Development Community Development Block Grant for Disaster Recovery, the NYC DCP performed studies in the regions to address resiliency through investments in infrastructure and other initiatives. The Resilient Neighborhoods initiative lists three primary goals: to reduce flood risks, plan for future adaptation needs, and allow neighborhoods to remain vibrant in addition to becoming resilient. The studies identified ten neighborhoods that were heavily affected by Superstorm Sandy or are otherwise at risk of flooding, for which citywide zoning changes would supposedly not be sufficient to address local land-use and resiliency issues (NYC Department of City Planning n.d.). That said the aforementioned "zoning and land-use changes" for the listed neighborhoods are extremely vague and general, and therefore wholly inadequate for comparison. Why these neighborhoods were chosen over other flood-prone neighborhoods is also not explained.

Borough	Map Code	DCP Resilient Neighborhoods
The Bronx	A	Edgewater Park
	B	Harding Park
Manhattan	C	West Chelsea
	D	East Village, Lower East Side, Two Bridges
Brooklyn	E	Carnarsie
	F	Gerritsen Beach
	G	Sheepshead Bay
Queens	H	Old Howard Beach, Hamilton Beach, and Broad Channel
	I	Rockaway Park & Rockaway Beach
Staten Island	J	East Shore

Table 5. Overview of the NYC DCP Resilient Neighborhoods by borough. Map Code letters refer to the neighborhood locations in Figure 9.

There are other areas throughout NYC where feasibility studies were initiated, including a Coney Island Creek Resiliency Study (Map Code K), Gowanus Canal Storm Surge Barrier Study (Map Code L), Newtown Creek study (Map Code M), and Lower Manhattan study. In addition to these areas there are strong groups for Hunts Point Resiliency and East Side Coastal Resiliency. Figure 9 visualizes these areas.
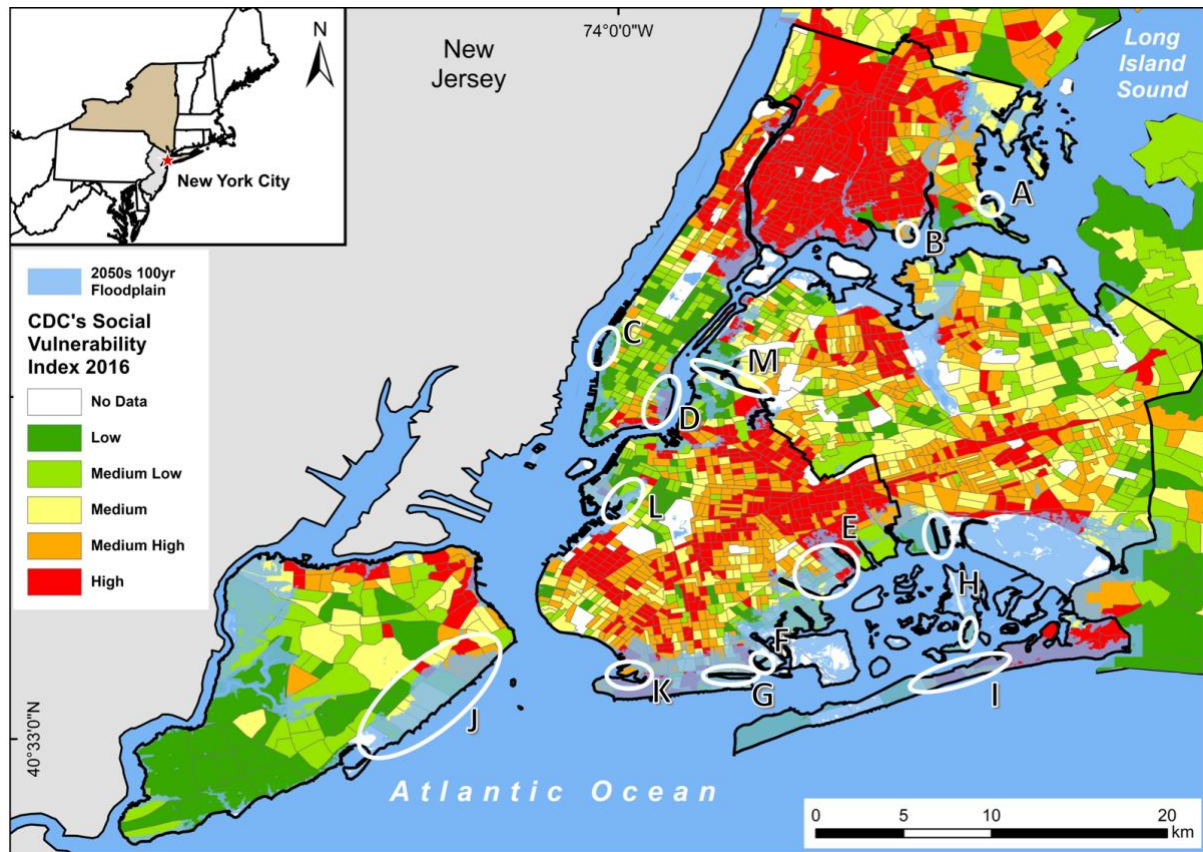
Figure 9. Approximate locations of the DCP-selected Resilient Neighborhoods and the other city-lead feasibility studies, with respect to social vulnerability. Letters refer to the neighborhood names in Table 5.

The map clearly shows that regions with different levels of social vulnerability are protected and studied. Given the strong link between the SVI and income, it is also once again clear that NYC is not offering greater flood protection for high-income residents, as was originally hypothesized.

It is important to point out, however, that there are significantly more initiatives for the Lower Manhattan area than most other areas of NYC. This part of the city includes some of the priciest real estate and wealthiest zip codes in NYC, if not the entire US. It also hosts City Hall and perhaps most importantly, the Financial District, which affects the economy of the entire country. It is also the location of the Two Bridges neighborhood and Chinatown, both of which are home to large populations of color and would be considered largely low-income, but also partially middle-income. Given that Lower Manhattan, is a financial, media, and cultural hub of NYC and the entire US, it makes sense that the city would expend more time and money to protect it. However, because members from the whole range of median household incomes reside there, with some median incomes of less than $20,000 per year and other medians of over $250,000 per year (NYC Planning

Population FactFinder n.d.), it would be difficult to assess whether there are differential protections in place for communities of different incomes or levels of social vulnerability.

Chapter 5. Discussion and Conclusions

Ultimately, the first hypothesis derived from the literature review, that there are conceivably more policy plans and initiatives in place to protect wealthy New Yorkers and those with less vulnerability, than lower income and more socially vulnerable New Yorkers, was proven false. Given that climate economics and economic value has typically dictated climate policy (Hsiang, Kopp et al. 2017), these findings are surprising, especially for one of the wealthiest cities in the world.

As such, although the US does have a history of inadequate environmental protection for low-income communities and communities of color, the same cannot necessarily be said about NYC in the present day. This is not to say that NYC does not have its own EJ issues. Even the city admits that socially vulnerable populations have been and continue to be more likely to live near toxic brownfields, however, the city claims that it is more committed than ever to cleaning these up (The City of New York 2019). Moreover, with regards to newer EJ threats, notably climate change and in this instance flooding, NYC is no more committed to installing flood protections in wealthier areas than it is in poorer neighborhoods, in stark contrast to the US's political history. This may be for any number of reasons; NYC government is considered very liberal and largely progressive, and given the city's size, reputation, and fame, is frequently in the spotlight. NYC has also committed to becoming a "model for resident-centered government" by utilizing new forms of civic and stakeholder engagement (The City of New York 2015). It may be that NYC from a public relations standpoint simply cannot afford the scandal of differential protections, though this has not stopped the city in the past. In February of this year, NYC agreed to pay back $5.3 million dollars to the Federal Emergency Management Agency (FEMA), over fraudulent claims that the city filed following Superstorm Sandy (Ferré-Sadurní 2019).

Therefore, at the surface level, initiatives from NYC and the Mayor's Office may seem genuine, and they may indeed be genuine. However, to ignore NYC's history of catering to special interests such as those of big business and real estate (Haag 2019) would be naive. Therefore, if the policies and initiatives really address underlying barriers to community resiliency is another question. The following section of this thesis, Section 5.1, analyzes the City's OneNYC initiatives and reports through Robert Bullard's Environmental Justice Framework, to determine how thorough they truly are. Subsequently, the discussion in Section 5.2 utilizes the previously identified neighborhoods of interest to investigate if the city-wide initiatives are indeed sufficient to provide for and protect neighborhoods of differing social vulnerabilities. Given that income affects every component of the disaster process, including resilience and recovery, as Fothergill and Peek (2004) argue, it is

necessary to dig deeper into how a policy might affect individuals of different income levels, rather than to take the initiatives and reports at face value.

5.1 Discussing Post-Sandy Initiatives and Policies in Light of the Environmental Justice Framework

As highlighted briefly in Section 4.2.1, the changing language used in the PlaNYC and OneNYC initiatives is indicative of a larger shift. The awareness of terms and evolution in their usage between sections of the report from one year's publication to the next, shows a growing understanding of and commitment to redressing EJ issues and social vulnerability on the part of NYC local government. Moreover, it is clear that from 2015 to 2017, the city was not only beginning to consider flooding an EJ issue, but also emphasize the interconnectedness of community preparedness, social vulnerability, and resiliency. This a key step in the right direction, which is supported by Bulkeley et al.'s (2014) work on climate justice; the authors argue that basic recognition is extremely important and valuable, given that procedural justice is impossible to pursue without it.

A good determinant of whether or not NYC's initiatives hold up, is to consider them in light of the EJF (Bullard 1994). The framework was originally formulated in the late 1990s in response to the public health and toxicity concerns that culminated in the EJM. However, just as EJ issues broadened in scope to include climate change impacts and challenges, so too can the EJF. At its core, the EJF's purpose is "to uncover the underlying assumptions that may contribute to and produce unequal protection," (Bullard 2001, p. 153) thereby assessing the true effectiveness of an initiatives claim to address EJ. The paragraphs below are organized by the five elements of the EJF, first introduced in Section 2.1 of this thesis.

(1) "The environmental justice framework incorporates the principle of the 'right' of all individuals to be protected from environmental degradation." (Bullard 1997)
The PlaNYC nor the OneNYC reports never explicitly state that New Yorkers have the right to be protected from flooding, toxic sites, or any source of environmental degradation. The OneNYC 2050 report, however, does state that the city, both from the side of the government and its residents, "must secure a livable climate for the next generation" (The City of New York 2019, p. 43). The city also claims to operate on a "philosophy [...] based on a set of foundational principles developed by organizations with decades of experience fighting for climate and environmental justice worldwide and here in New York City" (The City of New York 2019, p. 10). The language used definitely connotes discussions of rights and privileges, recognizing that a livable climate is a base necessity for

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life. Still, categorizing something as a "right" has implicit power, marking it as something for everyone, rather than the select few decision-makers (Bullard 2001). The OneNYC 2050 report does, however, repeatedly argue that access to quality healthcare is a right, not a privilege. Though this may seem intuitive and like a basic human right for residents of many European countries, this is not the case for residents of the US. Given that most environmental hazards are linked to public health risks, the city's commitment to universal healthcare is definitely a step in the right direction.

(2) "The environmental justice framework adopts a public health model of prevention (elimination of the threat before harm occurs) as the preferred strategy." (Bullard 1997)

This element of the EJF is clearly based off of the early environmental health hazards upon which the EJM was based. When applied to the current era and flooding, the prevention strategy, in particular for flooding which is due to or exacerbated by SLR, would be to curb climate change. While climate change is here to stay, NYC recognizes that it can be slowed down, vowing to become completely carbon neutral by 2050. The city's leadership claims that they "are committed to a just transition to carbon neutrality, climate resiliency, and a clean economy [...] while holding those responsible for climate change to account" (The City of New York 2019, p. 10). Though NYC could never slow climate change on its own, this bold stance indicates their commitment to prevention, as well as protection.

Still, it needs to be said that there is a certain level of moral hazard in rebuilding damaged houses in the floodplain, as other authors and journalists have suggested (Boone and Klosky 2013, Christin & Kline 2017, Bovard 2017). Though highly controversial, one way to prevent residential flooding in the Rockaway Peninsula of southern Queens, for example, would be to not rebuild the residences that were destroyed. Historically, those areas were once marshes and barrier islands (The City of New York 2013). As a result, they firstly, bore the full force of Superstorm Sandy, but secondly, would act as an excellent storm surge barrier for parts of Brooklyn and Queens, if rehabilitated. Others have also suggested this as an alternative solution, even more than ten years before Superstorm Sandy (Gornitz, Couch et al. 2001). It would mean displacing countless residents, but many already were displaced in the wake of Sandy, and likely will be given future SLR and storm projections. In fact, by 2080, the Rockaway Peninsula will likely face simple monthly tidal flooding. Following Sandy, New York State did perform property buyouts for willing residents of certain areas who lost their homes, but the city and state may have to consider doing more of this in the future. By the 2020s, in NYC there will be more than 88,000 buildings in the 100-year floodplain; the city will have to consider if it really is responsible, especially in light of the prevention mindset, to keep rebuilding homes in

particularly at-risk and hazardous areas. Thus, while NYC is definitely cognizant of flood prevention mechanisms, it may have to adopt less popular strategies in the long run.

(3) *"The environmental justice framework shifts the burden of proof to polluters/dischargers who do harm, discriminate, or who do not give equal protection to racial and ethnic minorities, and other 'protected' classes."* (Bullard 1997)

Historically, afflicted populations in the US have had to prove, typically in court, that they have indeed been harmed by polluting organizations. This can be a severe financial and time burden for socially vulnerable individuals and raises issues of procedural inequity. As a result, this element of the EJF requires that polluters themselves must prove that they are neither producing environmental harm nor discriminating against a particular demographic group. When applied to the context of policy and climate change-induced flooding, city officials and governmental bodies loosely take the role of "polluters." Though not "polluters" in the historical or traditional sense, government bodies have the power to determine who will and will not be offered protection from inundation and the potential myriad of aftereffects that follow flood events, such as power outages and public health risks. As Bullard (2008) emphasizes, much of the disaster in "natural disasters" comes from unequal governmental protection and the social and political forces that shape who lives where and is therefore exposed to potentially avoidable hazards. Thus, though the government is not the source of the hazard, governmental negligence can undoubtedly result in environmental harm (Bullard 2008). Following this logic, it would become the responsibility of NYC departments to prove that they are adequately building flood protection measures, as well as employing and enforcing laws and initiatives for all residents. Though the city voluntarily produces a yearly progress report, NYC has not yet mandated such a measure and the current system requires that individual residents sue the city, which as previously argued, is a process that frequently excludes the most vulnerable. As the following section, Section 5.2 explains, a single law or initiative applied in two different neighborhoods, let alone a whole city, has the potential for very different outcomes because of underlying demographic conditions. As such, in order to remedy EJ difficulties within the city, this element of the EJF recommends that NYC governmental bodies adopt a strategy in which they have to prove that the chosen law or initiative does not disproportionately harm socially vulnerable populations, nor benefit less vulnerable ones. Ultimately, it could be an effective and valuable tool to hold NYC government accountable for neglect.

(4) *"The environmental justice framework allows disparate impact and statistical weight, as opposed to 'intent,' to infer discrimination."* (Bullard 1997)

Proving "intent" is usually required for prosecution in EJ cases (Gerrard 1994). However, it is nearly impossible to prove that a discriminating practice is intentional (Gerrard 1994, Bullard 2001), especially given the sensitivities that surround race in the US. As a result, this element has notable implications for court cases and other legal actions. It would be much easier to prosecute and penalize polluting and discriminatory organizations if proving statistical significance or correlation were the primary requirement. NYC is well positioned to implement such a change in the law, considering its commitment to data-based decision-making. This commitment is evidenced by the city's plans to mitigate and adapt to climate change impacts in a country whose current presidential administration denies the existence of climate change. Moreover, the establishment of the NPCC as an advisory body to the city government, reinforces the city's resolve to heeding and acting on scientific conclusions and information. Given that taking a polluter to court is a process that excludes many socially vulnerable people, this element of the EJF would also benefit from element three; a system in which polluters must statistically prove that they are not disproportionately targeting certain communities, would likely be much more accessible, arbitrary, and fair than the current one.

(5) *"The environmental justice framework redresses disproportionate impact through 'targeted' action and resources."* (Bullard 1997)

Through neighborhood by neighborhood analysis, the PlaNYC report definitely provides targeted proposals for coastal resilience, while the later goal and vision-based OneNYC proposals offer targeted proposals for tackling income inequality, healthcare, and other equity related issues. Together they provide a knowledge base from which the city is well poised to tackle flood-based EJ concerns. Whether these proposals actually provide targeted action, however, is another question. In 2017, several journalists have asked whether NYC really was better prepared and protected then, than five years ago when Sandy struck (Klinenberg 2015, McGeehan & Hu 2017, Rothstein 2017). The answer was a weak "yes." By 2017, hospitals, power plants, and other vital infrastructure were in better condition, but as one journalist wrote: "most of the big plans to stormproof New York City remain just that: plans" (McGeehan & Hu 2017), indicating that NYC has failed to follow through on the "targeted action" front of the EJF.

After examining the OneNYC report's evolving use of EJ terms and contexts in Section 4.2.1, as well as assessing city initiatives and policies in light of the EJF, two things become clear: firstly, NYC is aware of these issues and their root causes, and secondly, they have proposals and initiatives to redress them. Still, the city's residents and communities would benefit greatly from a change in how environmental discrimination is viewed and prosecuted. While awareness is undoubtedly the first

step in this process, NYC's slow pace in actually moving forward, raises questions about the city's long-term commitments and indicates that there is much room for improvement.

5.2 Discussing and Analyzing Findings in Light of the Existing Research

With an understanding of common EJ issues, such as those pertaining to procedural and economic inequity, it becomes easier to conceive of how a singular city-wide policy, that does not even confer preferential treatment for certain populations, might be applied differently and with different levels of effectiveness in some areas over others. Though it seems as if NYC is protecting the areas and neighborhoods with the greatest flood risk, regardless of wealth, economic importance, or social vulnerability, it is important to remember that as Fothergill and Peek (2004) proposed, poverty impacts every part of the preparation and recovery process. As other authors have argued, cities may simply be too heterogeneous for wide-sweeping legislation (Koks, Jongman et al. 2015), such as zoning laws. Findings from the existing literature base suggest that inefficient governance that does not expressly protect socially vulnerable populations, may lead to compositional changes in city neighborhoods that benefit wealthier, predominantly White groups.

The following discussion digs deeper to continue to address the third research sub-question: *Why does the application or effectiveness of these policy plans and projects differ with regards to social vulnerability?*, by breaking down certain components of NYC living, namely housing, transportation, and language, to highlight how the same laws and initiatives can have differential impacts and outcomes on communities with different levels of social vulnerability.

5.2.1 Housing
Housing is a very large concern for many New Yorkers; in fact, in a survey by the city, 61% of New Yorkers report that housing is one of the most important issues in NYC (The City of New York 2019). Following Superstorm Sandy, large sums of money became available to homeowners from the federal government, largely through the Build It Back program which provided financial and construction assistance to households that either completely lost their homes, or whose homes suffered significant damage. Though the program was in no way perfect, suffering from slow reimbursements, restrictions, and other problems (Buettner & Chen 2014, Rosenberg 2016) it did ultimately help thousands of homeowners repair, rebuild, or elevate their homes such that they would hopefully be resilient to future storms (NYC Housing Recovery 2019). In this way, homeowners of all incomes could be supported.

The situation is quite different for those who rent. NYC is one on the most expensive places to rent an apartment in the world (Hoffower 2019), and though there are government subsidized affordable housing options and other programs to help lower income residents, there are great differences in homes and their resiliency. The BRTF, which drafted many of the zoning proposals did so with the knowledge that independent building sectors would increase their resiliency in different ways. Notably, the BRTF believed that market forces would encourage landlords to increase resiliency on their own, and that these parties would choose to go beyond the minimum code standards to make their properties more appealing. In some areas, landlords have chosen to do so. For instance the American Copper Buildings on Manhattan's East Side implemented some of the the most forward thinking resiliency measures in the city, acknowledging that this would be a large selling point, and that they could then charge higher rents (Rose 2017), effectively out-pricing low- and middle-income New Yorkers. Moreover, the more stringent resiliency requirements only apply to new constructions and old buildings when owners choose to renovate. Though the city's affordable housing is run by the New York City Housing Authority, which is in the process of updating their buildings, albeit very slowly (McGeehan & Hu 2017), many people rent units in older buildings from independent landlords with limited incentives to improve their housing. The concept of "Zoning for Flood Risk" relies on market forces and housing choice, but as previous EJ studies have emphasized, not everyone has the privilege of choosing where they live, particularly low-income communities and communities of color (Taylor 2000, Brulle and Pellow 2006, Donner and Rodríguez 2008).

Current zoning laws could produce a scenario in which low-income, vulnerable housing communities are situated next to flood resilient, luxury high-rises available only to the higher wealth classes, thereby creating a system in which low-income populations may be priced out of resilient or higher elevation housing. Empirical evidence of "climate gentrification" in Miami (Keenan, Hill et al. 2018), points to a possible scenario in NYC in which, wealthy, predominantly White populations seek to develop higher ground such as in Harlem, that historically has belonged to Black and low-income populations. This may seem far-fetched and highly speculative given that storms like Sandy happen on a decadal basis if not more, even considering that the number and severity of hurricanes, tropical storms, and nor'easters that hit NYC is expected to increase (New York City Panel on Climate Change 2015a). However, by 2100, daily tidal flooding due to sea level rise could exceed the catastrophic flood reaches of Sandy (Orton, Lin et al. 2019). Evidence from Miami suggests that this will undoubtedly alter NYC's day-to-day systems, in addition to buying behavior, as it has in other regions like New Orleans (Fussell, Sastry et al. 2010), which has a long history of catastrophic flooding. Evidence from New Orleans also suggests that those who are able to recover and return to

their homes sooner, which have been historically wealthier and White populations, are disproportionately represented in early efforts for recovery and planning (Elliott, Bellone Hite et al. 2009), creating a feedback loop that benefits these populations. These occurrences echo a consideration from within the field of climate justice; Bulkeley et al. (2014) remark that it is vital to question "whether interventions in the name of climate change serve to maintain the interests of an elite at the expense of a minority, and as such perpetuate patterns of inequality in the city," further validating the concern of widespread compositional changes in NYC.

These ideas surrounding changing housing composition with respect to flood risk are not necessarily new. However, the findings from this thesis regarding policy initiatives support what existing scientific literature has suggested: that if left to play out, market forces could benefit wealthy individuals, while excluding socially vulnerable ones. As such, low-income renters are likely worse off than low-income homeowners, when it comes to their own resiliency. More pressingly however, citywide zoning laws that are not explicitly tailored to one neighborhood or demographic over another, indirectly benefit the wealthier social classes and homeowners. This in a way confirms the second research hypothesis that was developed based on the literature review, namely that policy plans that apply to wealthier neighborhoods are more robust and effective than those that apply to areas of lower income. Citywide zoning and initiatives could have far reaching implications for housing patterns, well into the future. Ultimately, when contextualized within the existing literature, it is clear that although New York housing laws and zoning amendments following Sandy were intended to strengthen the city as a whole, they may simply serve to deepen existing inequities in housing and relative exposure to risk. Gaps in NYC zoning laws present an ideal situation to implement one of Fothergill and Peek's (2004) recommendations: to offer subsidies to landlords to retrofit their buildings, make structural improvements, and thereby improve flood resiliency, while also providing legislation to ensure that low-income individuals can continue to afford their homes after improvement.

5.2.2 Transportation

Transportation, or lack thereof, is another much discussed component of social vulnerability in the existing literature. This component is usually two-fold; first, evacuations in advance of storms are highly dependent on car-ownership, and second, following storms many low-income individuals rely on public transportation in order to return to work and earn money to begin and accelerate the process of recovery.

In advance of Hurricane Katrina, the residents of affected areas who did not own vehicles were more likely to be left behind in emergency evacuations (Raphael, Berube et al. 2006). History has shown that non-vehicle owning households are at a severe disadvantage in their ability to escape the path of hurricanes, and are often forced to shelter in place, risking their lives in the process. This presents a challenge for NYC because car ownership rates are so low. They are lowest in most of Manhattan and the southern Bronx, with less than one in four households owning a car (NYCEDC 2018). Ownership typically increases with increasing distance from Manhattan, or the inner city. Many argue that these numbers have a lot to do with the lack of available parking, particularly in high density areas (Weinberger, Seaman et al. 2009, Guo 2013). In fact, in March of 2014 a local law was introduced to the City Council "requiring an assessment of the density of development in flood-prone areas in order to determine whether such density interferes with the ability of the inhabitants of such areas to reach safety in response to storms and other natural disasters" (See Appendix 3, File Number Int 0162-2014). It was not passed and ultimately filed. A local law with the same title was introduced in June 2018 (See Appendix 3, File Number Int 0963-2018) and is currently in committee, indicating that the relationship between density and evacuation is still very much on the minds of city lawmakers.

This is not an easy discussion though. While vehicles provide benefits in evacuation settings, car emissions do contribute greatly to climate change. Part of the city's OneNYC 2050 plan is to lower the overall number of cars in the city by providing people with more environmentally friendly options such as public transportation and bicycles (The City of New York 2050). Additionally, with building and resiliency improvements, more residents will be able to shelter in place. However, it is imperative that the city find solutions in the meanwhile, as well as for particularly vulnerable populations for whom this strategy is inadequate.

Public transportation was a large concern following Superstorm Sandy. The storm inundated and crippled the city's subway and tunnel infrastructure impacting residents' ability to go to work and perform other basic tasks (The City of New York 2013). In NYC, 55% of workers depend on public transportation for their daily commute (NYCEDC 2012), and through this also their livelihoods. As Faber (2015) argued, although White and Black New Yorkers were more likely to live in flooded census tracts, Asian- and Latino-majority tracts felt the greatest burden from diminished public transport. This is something that the city must also take into consideration. Though the lack of functioning subway lines following Sandy affected the entire city and working people from all social classes, it is particularly important for low-income individuals who live paycheck to paycheck. Nearly

40% of Americans could not afford a $400 emergency expense (Federal Reserve Board Division of Consumer and Community Affairs 2018), so for low-income households, a missed week of work could not only put them under financial strain, but also be a severe barrier to the recovery process that medium- and high-income households would likely not have to face. The city will have to consider the best ways, such as bussing, to not only evacuate those without access to independent vehicles, but also get people back to work sooner.

5.2.3 Language and Awareness

A third feature that that the literature emphasizes is the importance of language and awareness, both in advance of a storm and following it. In this regard, the city has made significant strides. Though the PlaNYC and OneNYC reports are only available in English, this does make sense given their extensive and highly technical nature. However, in 2016, Mayor Bill de Blasio passed a bill requiring all NYC agency websites "whenever practicable," to offer translations into the six most commonly spoken languages in the city, besides English (Marking 2016). These languages include Spanish, Chinese, Russian, Bengali, French Creole, and Korean, in addition to the Google Translate tool that many of the NYC.gov websites already offered. It was definitely a step in the right direction and has extensive ramifications for the emergency preparedness, recovery, and resiliency related websites. The move facilitates dissemination of information for the city's many immigrant communities and other areas where English comprehension may be low.

This, in conjunction with the city's increasing commitment to working with social organizations such as community networks and religious institutions (The City of New York 2019), is also a sign of good faith for communities, given that many attributed the low levels of evacuation in certain areas to general distrust in the government and governmental authorities (Faber 2015). In fact, a survey investigating around two thousand NYC residents found that trust in local government and assistance was one of the greatest predictors of household emergency preparedness in advance of Sandy (Martins, Louis-Charles Hans et al. 2018). This increasing level of trust is particularly important when engaging communities of color in NYC, which have been shown to prefer self-reliance rather than reliance on government aid (Reckien and Petkova 2019). Moreover, leveraging existing networks of community-based organization is a vital tool in mobilizing resilience following a storm, as one study examining two NYC neighborhoods has shown (Graham, Debucquoy et al. 2016). Thus, just the simple act of offering widespread translation services, accessible to various groups, on the NYC.gov website in addition to community involvement might not only enable more people to have access to information, but also make them more likely to heed warnings.

The PlaNYC and OneNYC reports also emphasize the vital role that telecommunications play in emergency preparedness. The city has done well in launching many initiatives to utilize existing widespread cellphone ownership among all social classes, though reliance on cellular devices does tend exclude older citizens. In Local Law 2013/098, the City Council amended the administrative code to provide recommendations to residential and commercial building owners with regards to improving emergency preparedness and posting of information. This law is very important, especially for individuals who rent their homes and as a result may not be as aware as homeowners, of what evacuation zone they live in. It is also particularly relevant for high density areas in which many residents live in a single building, where it is difficult for city employees to go door-to-door with information. When it comes to language accessibility, increasing awareness, and disseminating information, the city definitely has improved, especially with regards to socially vulnerable populations which can include non-native English speakers and those living in densely populated areas.

5.3 NYC's Governance Style: Is it sufficient to protect socially vulnerable populations?

NYC is governed by a complex, highly interconnected system of governmental bodies that operate at the city, state, and federal level. From FEMA, the US Department of Housing and Urban Development, and the State Department of Environmental Conservation, to even the US Coast Guard, various governmental departments dictate what can and cannot be done with regards to housing and the NYC waterfront. Still, it is NYC's numerous departments and mayoral offices that typically have the most concrete and specific initiatives and plans for the city itself. This makes sense since, as previously reiterated, local, neighborhood-based flood mitigation strategies and resiliency solutions tend to be more effective than larger policies. Furthermore, the findings from this thesis emphasize that NYC governmental officials and bodies are clearly aware that certain populations face differential and unique difficulties and injustices. Their attempts to address resiliency through improving equity and social justice align with the findings from Eakin and Luers' (2006) study regarding addressing equity and poverty to improve resiliency as a whole. The question however remains, is the city's current governance strategy sufficient to protect socially vulnerable populations?

Based off of the C40 mayoral governance styles, NYC's mayor and legislative government have strong regulatory powers to set and enforce policies, in ways that other mayors may not. As such NYC is well positioned to pass effective laws and ensure that individuals and organizations follow them. Still, with regards to improving building resiliency, the city has largely allowed existing

building-owners to improve at their own pace. This has a produced a situation in which over 70,000 buildings in the floodplain still be have not been retrofitted (Trangle 2017). As illustrated earlier, this policy also shows great potential to disproportionately benefit the wealthy and those who have greater economic and social freedom in where they live, in stark contrast to lower-income New Yorkers and those living in older buildings. If the premises of the OneNYC reports and initiatives regarding a "strong and just city" are to be believed, then the NYC Department of Buildings and the DCP, which jointly govern buildings in NYC, must ensure that all New Yorkers have access to resilient housing. Moreover, expansion of the Resilient Neighborhoods initiative and further localized resiliency studies should prove effective.

One region that has received minimal protections comprises the northern Manhattan and southern Bronx areas, which are home to large populations of highly socially vulnerable residents; these would be prime locations for the next Resilient Neighborhoods studies. Based off of Figure 8 and Figure 9, it is clear that NYC has begun, if not already completed many coastal protection projects along the severely battered southern Queens, Brooklyn, Manhattan, and Staten Island coasts. This is understandable, given that these areas were hardest hit by Superstorm Sandy. Yet, the *PlaNYC: A Stronger More Resilient New York* report even contends that if Sandy had hit the city just a few hours earlier when high tide was in the northern reaches of the city, it would have had a significant impact on "parts of the Bronx, Northern Queens, and East Harlem" (The City of New York 2013, p. 21). It was pure timing that high vulnerability areas such as the South Bronx and East Harlem were not hit as badly as other regions of the city. Figure 6, which displays the 2050 100-year floodplain, corroborates this claim: that East Harlem and parts of the Bronx will more likely than not experience a great deal of flooding in the future. As previously emphasized and visualized in the maps, these are areas with high levels of social vulnerability; in the South Bronx and Harlem, 1 in 3 people and nearly 1 in 4 people live in poverty, respectively (NYC Department of Health 2018a, 2018b). This is higher than both their borough averages and the NYC average. Given that the neighborhoods are home to low-income, largely Black and Hispanic populations, with low rates of native English-speakers, these areas could have faced crippling socioeconomics effects as previous discussions and literature have shown. Indeed, East Harlem is one of four NYC neighborhoods where more than 75% of the food retail floor area will be in 100-year floodplain by the 2050s (The City of New York 2013). This, coupled with the fact that most governmental food aid now operates electronically (through the Electronic Benefits Transfer system) and is therefore vulnerable to power outages, could create devastating food shortages and situations where low-income people could not even afford to buy food, if it were available. The demographic characteristics of these northern areas coupled with the

flood risk and lack of current flood protections make the southern Bronx and East Harlem ideal study locations for the Resilient Neighborhoods initiative and other governance ideas.

Ultimately, the city is definitely on the right track with regards to improving transportation access while being environmentally friendly, and the increased use of multiple languages and community organizations in resiliency efforts is highly commendable. Moreover, the fact that the city is trying to address general social justice and economic inequality as a way to increase neighborhood resiliency is quite forward-thinking from a governance standpoint. However, NYC governmental bodies must also continue to consider the context of city social structure as Reckien and Petkova (2019) emphasize, and that different ethnic and economic subpopulations have various perceptions of and responses to climate change adaptation. Housing and flood protection require direct approaches and consistent reevaluation and monitoring. In these regards and others, NYC's current method of governance is insufficient to protect socially vulnerable populations, and corroborates the second hypothesis of this thesis, that policies are more effectively applied in and protect wealthier areas compared to poorer areas. Thus, the city must improve and cannot afford to lose the momentum towards climate adaptation that was spurred on by Superstorm Sandy.

5.4 Final Remarks and Recommendations for Future Research and Policy

Cities, with their demographic heterogeneity, complex governance systems comprised of many overlapping bodies, and increasing threats from climate change, are undoubtedly difficult areas for which to create emergency protocols, employ recovery efforts, and develop effective policy initiatives, as the existing literature has shown. Nonetheless, the findings from this thesis illustrate that NYC governmental departments and offices are no more committed to protecting wealthy subsections of the city, as they are poorer ones. Moreover, the city's reports and commitment to addressing inequality as a way to decrease climate change vulnerability show an increasing awareness and evolving understanding of the socioeconomic and EJ issues at the heart of social vulnerability.

Still, within the context of existing scientific literature, such as reports on the long-term compositional effects of hurricanes like Katrina in New Orleans and the pervasive nature of poverty, it is evident that NYC's reliance on and preference for citywide zoning and regulatory laws leaves socially vulnerable populations largely unprotected. By not explicitly creating laws to protect and aid these populations, NYC government is in effect unfairly neglecting and underserving them. Thus, with regards to this thesis's overarching research question: *How do differences in social vulnerability affect the availability and effectiveness of government-based flood risk policy plans and projects in*

New York City?, it becomes clear that while differences in social vulnerability do not affect the availability of policy plans and initiatives, the underlying components of social vulnerability, such as income, race, and language, do indeed impact the application and effectiveness of NYC's policy plans.

Interesting research directions could include a statistically significant analysis of whether low-income, or otherwise socially vulnerable populations in NYC are indeed exposed to greater levels of flood risk, in the same way that they are disproportionately exposed to toxic brownfields. From a policy standpoint, it would also be interesting to study the Build It Back program's applicant profiles, to see if there are demographic trends and differences in who is aware of the program, who is applying for aid, and who is ultimately receiving it.

As NYC plans for future storms, governmental officials and organizations could benefit greatly from examining cases from other cities such as Miami, Houston, and New Orleans. These cities have long histories of inundations, and are prime examples of the intersection between flooding, social vulnerability, and environmental justice. Additionally, policies to incentivize and subsidize retrofitting of residential buildings in low-income areas, coupled with regulations to prevent disproportionate rent increases would like help many socially vulnerable areas. It would also allow more residents to safely shelter in place, thereby reducing the strain and dilemma of evacuation for individuals and households without vehicles. Seven years after Superstorm Sandy, it is also time for the city to study, plan flood protections, and draft policies for the highly socially vulnerable northern NYC communities of Manhattan and the Bronx, as they have in other regions. The city has a responsibility to protect all New Yorkers, and given that the number of flood events in NYC is projected to increase, this task will only become more difficult. Still, given NYC's growing awareness of social vulnerability and the city's willingness to listen to recommendations from the NPCC, there is hope that future policy will better protect disadvantaged populations. This is the case for many cities across the US that have implemented EJ programs, such as San Francisco and Chicago (Baptista, Sachs et al. 2019). Environmental inequity is phenomenon that has been perpetuated and reinforced through generations; as previously argued, numerous mechanisms such as colonialism, racism, and systemic poverty have contributed to this inequity around the world and in the US. As a result, it may take further generations to remedy hazardous sites and change housing patterns for the better. With increasing recognition of the problem however, change may accelerate in NYC and beyond. Residents, communities, and decision-makers in NYC must continue to hold each other accountable

to ensure that these policies are indeed passed and effectively so, as well as maintain the momentum for increasing flood resiliency that followed Sandy.

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Appendices

Appendix 1. Social Vulnerability Index

The CDC's Social Vulnerability Index (SVI) components and methodology is based off of work by Flanagan et al. (2011). It utilizes 15 individual variables for which data is drawn from the US Census. These variables are grouped into 4 overall themes, as displayed in Figure A1 below.

In total, the SVI is derived from a percentile ranking system, and generates a ranking for each of the 15 indicator variables, based on calculating the proportion of scores by all census tracts. Themes are then ranked based off the indicator rankings that they correspond with, and each tract ultimately receives a ranking based off of the sum of the individual theme rankings. Given that the SVI is a relative value, all census tracts in the US have an SVI, which is relative to any other tract in the state.
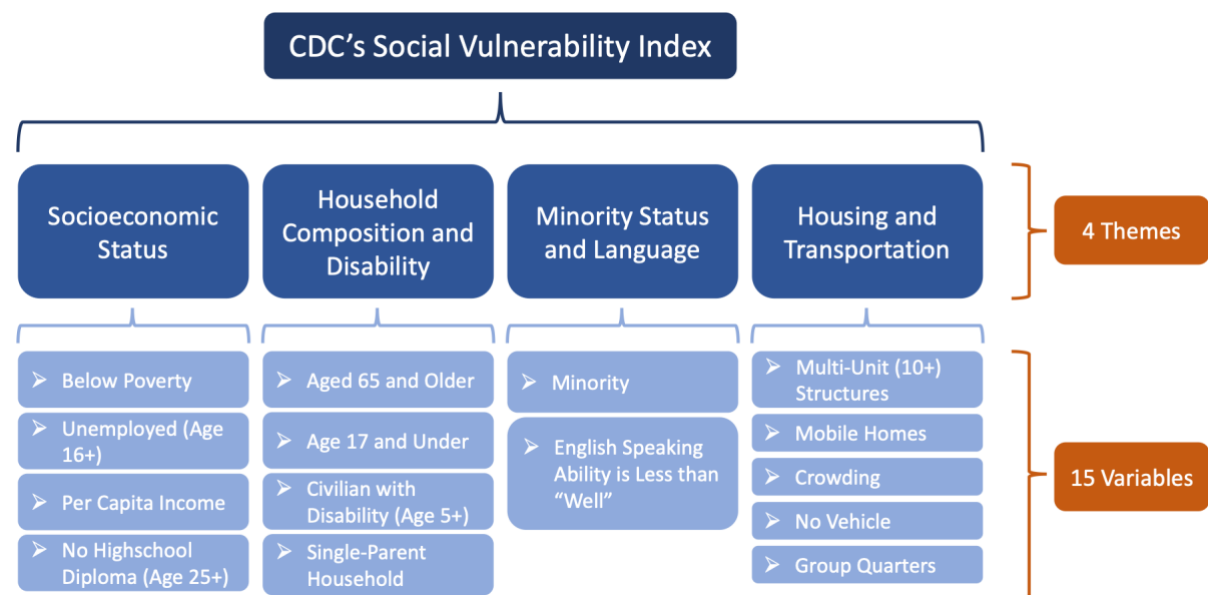
Figure A1. Composition of the CDC's Social Vulnerability Index, illustrating how the 15 variables and 4 themes that comprise it are grouped. Figure based off of information from Flanagan et al. (2011).

Reference:

Flanagan Barry, E., Gregory Edward, W., Hallisey Elaine, J., Heitgerd Janet, L., & Lewis, B. (2011). A Social Vulnerability Index for Disaster Management. In *Journal of Homeland Security and Emergency Management* (Vol. 8).

Appendix 2. Map Data and GIS Shapefile Sources

Figures 1, 4, 5, 6, 7, and 9 were created and compiled specifically for this thesis. As explained in Chapter 3, the maps comprise existing GIS shapefiles that were downloaded from various governmental databases. The sources are grouped by figure, and where applicable, each source includes the given GIS shapefile name, the short blurb that accompanied it, and the corresponding link, among other information.

Figure 1. Map of NYC with its five boroughs: Brooklyn, The Bronx, Manhattan, Queens, and Staten Island.

Borough Boundaries
> "GIS data: Boundaries of Boroughs (water areas excluded)"
> Created on Jan 29, 2013. Updated on May 24, 2019.
> Data provided by the Department of City Planning (DCP).
> Retrieved on Jun 1, 2019 from https://data.cityofnewyork.us/City-Government/Borough-Boundaries/tqmj-j8zm

USA State Boundaries
> "This group layer presents the boundary lines of the states of the United States."
> Created on Mar 19, 2012. Updated on Jun 18, 2019.
> Data provided by Esri (creators of the ArcGIS Software).
> Retrieved on Jun 20, 2019 from
> https://www.arcgis.com/home/item.html?id=540003aa59b047d7a1f465f7b1df1950

Figure 4. Social Vulnerability in New York City, based on the CDC's SVI.

Borough Boundaries
> "GIS data: Boundaries of Boroughs (water areas excluded)"
> Created on Jan 29, 2013. Updated on May 24, 2019.
> Data provided by the Department of City Planning (DCP).
> Retrieved on Jun 1, 2019 from https://data.cityofnewyork.us/City-Government/Borough-Boundaries/tqmj-j8zm

USA State Boundaries
> "This group layer presents the boundary lines of the states of the United States."
> Created on Mar 19, 2012. Updated on Jun 18, 2019.
> Data provided by Esri (creators of the ArcGIS Software).
> Retrieved on Jun 20, 2019 from
> https://www.arcgis.com/home/item.html?id=540003aa59b047d7a1f465f7b1df1950

TIGER/Line Shapefile, 2018, county, Bronx County, NY, Area Hydrography County-based Shapefile
> Metadata created on November 29, 2018.
> Retrieved on Jun 1, 2019 from https://catalog.data.gov/dataset/tiger-line-shapefile-2018-county-bronx-county-ny-area-hydrography-county-based-shapefile

TIGER/Line Shapefile, 2018, county, Kings County, NY, Area Hydrography County-based Shapefile
> Metadata created on November 29, 2018.
> Retrieved on Jun 1, 2019 from https://catalog.data.gov/dataset/tiger-line-shapefile-2018-county-kings-county-ny-area-hydrography-county-based-shapefile

TIGER/Line Shapefile, 2018, county, New York County, NY, Area Hydrography County-based Shapefile

Metadata created on November 29, 2018.
Retrieved on Jun 1, 2019 from https://catalog.data.gov/dataset/tiger-line-shapefile-2018-county-new-york-county-ny-area-hydrography-county-based-shapefile

TIGER/Line Shapefile, 2018, county, Queens County, NY, Area Hydrography County-based Shapefile
Metadata created on November 29, 2018.
Retrieved on Jun 1, 2019 from https://catalog.data.gov/dataset/tiger-line-shapefile-2018-county-queens-county-ny-area-hydrography-county-based-shapefile

TIGER/Line Shapefile, 2018, county, Richmond County, NY, Area Hydrography County-based Shapefile
Metadata created on November 29, 2018.
Retrieved on Jun 1, 2019 from https://catalog.data.gov/dataset/tiger-line-shapefile-2018-county-richmond-county-ny-area-hydrography-county-based-shapefile

Preferred Citation for the Social Vulnerability Index from the CDC:
Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. Social Vulnerability Index 2016 Database New York. data-and-tools-download.html. Accessed on 21 May 2019 https://svi.cdc.gov/data-and-tools-download.html

Figure 5. Superstorm Sandy Inundation Zone, mapped over the CDC's SVI.
Figure 5 utilizes the same layers and aesthetic techniques as Figure 4 in addition to the following layer:

Sandy Inundation Zone
"Areas of New York City that were flooded as a result of Hurricane Sandy."
Created on Nov 9, 2015. Updated on Sep 10, 2018.
Data provided by the NYC Department of Small Business Services (SBS).
Retrieved on Jun 1, 2019 from https://data.cityofnewyork.us/Environment/Sandy-Inundation-Zone/uyj8-7rv5

Figure 6. 2050s 100-year Floodplain, mapped over the CDC's SVI
Figure 6 utilizes the same layers and aesthetic techniques as Figure 4 in addition to the following layer:

Sea Level Rise Maps (2050s 100-year Floodplain)
"This is the 100-Year Floodplain for the 2050s based on FEMA's Preliminary Work Map data and the New York Panel on Climate Change's 90th Percentile Projects for Sea-Level Rise (31 inches)."
Created on Jul 13, 2013. Updated on Sep 10, 2018.
Data provided by the Mayor's Office of Long-Term Planning and Sustainability on behalf of CUNY Institute for Sustainable Cities and the New York Panel on Climate Change.
Retrieved on Jun 1, 2019 from https://data.cityofnewyork.us/Environment/Sea-Level-Rise-Maps-2050s-100-year-Floodplain-/hbw8-2bah

Figure 7. Location of municipal hospitals and subway entrances in NYC, mapped with regards to the 2050s 100-year Floodplain and the CDC's SVI.

Figure 7 utilizes the same layers and aesthetic techniques as Figure 6 in addition to the following layers:

NYC Health + Hospitals Facilities - 2011

    "NYC Health + Hospitals is the largest municipal health care system in the country serving more than one million New Yorkers every year. The City's public health care delivery system provides trauma, emergency, medical, mental health and substance abuse services across the five boroughs. This is a list of the public hospitals, skilled nursing facilities, and some of the community-based health centers that are part of the NYC Health + Hospitals system as of 2011."

    Created on Oct 11, 2011. Updated on Jul 3, 2019.

    Data provided by NYC Health + Hospitals.

    Retrieved on Aug 17, 2019 https://data.cityofnewyork.us/Health/NYC-Health-Hospitals-Facilities-2011/ymhw-9cz9

Subway Entrances

"Map of NYC Subway Entrances"

    Created on Apr 10, 2013. Updated on Sept 10, 2018.

    Data provided by the Metropolitan Transportation Authority

    Retrieved on Aug 17, 2019 https://data.cityofnewyork.us/Transportation/Subway-Entrances/drex-xx56

Figure 9. Approximate locations of the DCP-selected Resilient Neighborhoods and the other city-lead feasibility studies, with respect to social vulnerability.

Figure 9 utilizes exactly the same map, and therefore also the same layers and aesthetic techniques as Figure 6. Shapes and letters were manually added to indicate corresponding DCP research and study sites.

Appendix 3. Overview of City Council Laws

The following table comprises a selection of laws that were passed by the NYC City Council beginning in September of 2012 through the August 1, 2019. They were selected via a database search of the City Council legislative archives (https://legistar.council.nyc.gov/Legislation.aspx). The following search terms were used: "flood" (which included terms such as floodplain, flood-prone, flood-resistant, etc); "flooding"; "sea level rise"; "climate change"; and "environmental justice." The titles, names, and summaries of the yielded search results were skimmed, and only relevant introduced laws were collected and compiled in Table A3 below.

File #	On Agenda	Status	Law #	Date Enacted	Title	# of Sponsors
Int 0834-2012	18 Apr 2012	E	2012 /042	22 Sep 2012	A Local Law to amend the New York city charter, in relation to convening the New York city panel on climate change regularly, for the purpose of producing a report on climate change adaptation in New York city.	21
Int 0988-2012	18 Dec 2012	F	NA	NA	A Local Law to amend the New York city building code, in relation to flood-resistant construction.	17
Int 1153-2013	12 Sep 2013	F	NA	NA	A Local Law to amend the administrative code of the city of New York, in relation to requiring buildings, that are located in the 100-year floodplain and are both larger than 300,000 square feet and taller than 6 stories, or that are located in the 500-year floodplain and contain space for critical facilities, to elevate or otherwise flood-protect building mechanical equipment.	10
Int 1017-2013	13 Mar 2013	E	2013 /031	2 Apr 2013	A Local Law in relation to waiver of fees for businesses recovering from damage caused by Hurricane Sandy.	29
Int 1095-2013	24 Jun 2013	E	2013 /082	2 Oct 2013	A Local Law to amend the administrative code of the city of New York, in relation to creating a manual on flood construction and protection standards.	17
Int 1105-2013	26 Jun 2013	E	2013 /084	2 Oct 2013	A Local Law to amend the New York city charter, in relation to planning for resiliency to climate change as a	15

					responsibility of the office of long-term planning and sustainability.	
Int 0983-2012	18 Dec 2012	E	2013 /095	19 Nov 2013	A Local Law to amend the New York city building code, in relation to flood-resistant construction requirements for health facilities.	27
Int 0990-2012	18 Dec 2012	E	2013 /096	19 Nov 2013	A Local Law to amend the administrative code of the city of New York and the New York city building code, in relation to the adoption of best available flood maps.	21
Int 1085-2013	24 Jun 2013	E	2013 /098	19 Nov 2013	A Local Law to amend the administrative code of the city of New York, in relation to emergency preparedness recommendations for owners of residential and commercial buildings and the posting of emergency information in certain residential buildings	16
Int 1089-2013	24 Jun 2013	E	2013 /099	19 Nov 2013	A Local Law to amend the administrative code of the city of New York, the New York city building code and the New York city mechanical code, in relation to cabling for certain building systems and fuel-oil storage in flood-prone areas.	16
Int 1096-2013	24 Jun 2013	E	2013 /100	19 Nov 2013	A Local Law to amend the New York city building code, the New York city mechanical code and the New York city fire code, in relation to relocating and protecting building systems in flood-prone areas.	19
Int 1092-2013	24 Jun 2013	E	2013 /108	2 Dec 2013	A Local Law to amend the administrative code of the city of New York and the New York city building code, in relation to secondary electrical power, heating and cooling systems for I-1 and I-2 occupancies and for adult homes, enriched housing, community residences and intermediate care	15

					facilities, where such occupancies are located in flood-prone areas.	
Int 1093-2013	24 Jun 2013	E	2013 /109	2 Dec 2013	A Local Law to amend the administrative code of the city of New York and the New York city building code, in relation to removing barriers to the usage of temporary flood control and response devices.	13
Int 0162-2014	12 Mar 2014	F	NA	NA	A Local Law requiring an assessment of the density of development in flood-prone areas in order to determine whether such density interferes with the ability of the inhabitants of such areas to reach safety in response to storms and other natural disasters.	3
Int 0279-2014	10 Apr 2014	F	NA	NA	A Local Law to amend the administrative code of the city of New York, in relation to a one year delay for businesses affected by Hurricane Sandy to comply with the Earned Sick Time Act.	6
Int 0246-2014	10 Apr 2014	F	NA	NA	A Local Law in relation to penalties pursuant to the earned sick time act, for businesses recovering from damage caused by Hurricane Sandy.	6
Int 0342-2014	14 May 2014	F	NA	NA	A Local Law to amend the administrative code of the city of New York, in relation to the creation of a remediation of unsafe flooded homes program.	17
Int 0864-2015	23 Jul 2015	F	NA	NA	A Local Law to amend the administrative code of the city of New York, in relation to a special flood hazard area notification	5

Int 0727-2015	31 Mar 2015	E	2015 /034	28 Apr 2015	A Local Law to amend the administrative code of the city of New York, in relation to the assessment of real property damaged by the severe storm that occurred on the twenty-ninth and thirtieth of October, two thousand twelve.	10
Int 0425-2014	24 Jul 2014	E	2015 /072	10 Aug 2015	A Local Law to amend the administrative code of the city of New York, in relation to communications resiliency	37
Int 1198-2016	25 May 2016	E	2017 /056	21 Mar 2017	A Local Law to amend the administrative code of the city of New York, in relation to flood mitigation in southeast Queens	11
Int 0359-2014	29 May 2014	E	2017 /060	25 Apr 2017	A Local Law to amend the administrative code of the city of New York, in relation to requiring a study of environmental justice areas and the establishment of an environmental justice portal	35
Int 0886-2015	17 Sep 2015	E	2017 /064	25 Apr 2017	A Local Law to amend the administrative code of the city of New York, in relation to identifying and addressing environmental justice issues	43
Int 0963-2018	7 Jun 2018	C			A Local Law requiring an assessment of the density of development in flood-prone areas in order to determine whether such density interferes with the ability of the inhabitants of such areas to reach safety in response to storms and other natural disasters	1
Int 0566-2018	14 Feb 2018	C			A Local Law to amend the administrative code of the city of New York, in relation to the creation of a free elevation certificate program	1
Int 0382-2018	31 Jan 2018	C			A Local Law to amend the administrative code of the city of New York, in relation to a	1

					special flood hazard area notification	
Int 0193-2018	31 Jan 2018	C			A Local Law to amend the administrative code of the city of New York, in relation to the creation of a remediation of unsafe flooded homes program	1
Int 0628-2018	7 Mar 2018	E	2018 /172	27 Oct 2018	A Local Law to amend the administrative code of the city of New York, in relation to requiring a map of areas in the city most vulnerable to increased flooding in the future and a plan to address such flooding	12
Int 0750-2018	11 Apr 2018	E	2018 /179	27 Oct 2018	A Local Law to amend the administrative code of the city of New York, in relation to creation of a New York City Jamaica Bay task force, which would provide advice and recommendations to the city with respect to the Jamaica Bay clean-up and resiliency project.	10
Int 1620-2019	26 Jun 2019	C			A Local Law to amend the administrative code of the city of New York, in relation to the creation of a comprehensive five borough plan to protect the entire shoreline from climate change, sea level rise and sunny day flooding	3
Int 1399-2019	13 Feb 2019	C			A Local Law to amend the New York city charter and the administrative code, in relation to creation of a department of sustainability and climate change and repealing section 20 of chapter 1 of the New York city charter.	10

Table A3. Compiled list of NYC City Council laws that relate to flood-based resiliency and adaptation. Under the category of Status, "E" refers to enacted laws, "F" refers to filed or not enacted laws, and "C" refers to laws that are currently still in committee, as of August 1, 2019.