Analysis of Post-Sandy Single-Family Housing Market in Staten Island, New York

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ACADEMIC ABSTRACT

Over the past few decades, several destructive hurricanes have damaged housing in a large number of coastal areas; these include hurricanes Andrew, Katrina, Sandy, and most recently, Harvey. This thesis is an examination of the single-family housing market in Staten Island, New York, following one such destructive storm, Hurricane Sandy, which affected at least 24 states in 2012, from Florida to Maine. This study focuses on two questions:

- What are the housing market differences in terms of sales and prices, between neighborhoods affected by the storm and neighborhoods that were outside the direct damage areas?
- What are the major parameters impacting the housing market post-Sandy in Staten Island?

In this thesis will use FEMA damage determination estimates as a foundation for measuring damage caused to properties within the housing market and consists of four categories: destroyed, major, minor and affected. The findings suggest that sales increased for properties damaged by the storm, and New York State's Home Buyout Policy was one of the major reasons for the increase in sales. Buyout numbers reflect that the policy had some success in permanently restricting future development in severely damaged communities, and the resulting relocation impacted the sales inland. Further data and program evaluation research is needed to fully decipher the impacts of buyouts on Staten Island's residential real estate. With regard to housing prices, the study found out that Hurricane Sandy caused extensive damage and brought down the property

values of major damage properties by 24.32 percent. Bounce back to the pre-disaster value was much slower for the damaged properties as compared to the rest of the housing market. Housing market activities after a major storm are often influenced by a number of factors like damage levels, population characteristics, risk perceptions, short-term and long-term recovery measures, availability of finances, government policies, etc. In the post-Sandy housing market scenario, socioeconomic factors were not a major influencing force. Additionally, damage levels had a significant impact on property sales as well as property values in the impacted area.

The data-driven approach of this study could be applied to other communities and events in the future to holistically analyze the parameters that affect the housing market after major disasters. It has also opened up various areas of concern like the role of government policies, risk perceptions of people, effect of insurance policies, and building restrictions, etc. for future research.

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GENERAL AUDIENCE ABSTRACT

Recent hurricanes have made it clear that housing is the single greatest component of all losses in terms of economic value and buildings damaged. Housing damage resulting from floods has increased in the United States, despite local, state and federal encouragement to mitigate flood hazards and regulate development in flood-prone areas (Atreya, 2013). The two primary causes of these increased costs are: (1) a rise in the occurrence and strength of the extreme weather events, and (2) increased development and value of property in physically vulnerable areas. The overlap of the above two factors resulted in tremendous losses of property in Staten Island and other coastal communities along the Atlantic Coast. Hurricane Sandy was a reminder of how vulnerable such areas could be.

After hurricane Sandy, damaged properties experienced higher than usual housing sales and changed property values. This research, seeks to improve the current state of knowledge about housing market following a major disaster through examining single-family housing sales and prices in Staten Island, New York. The housing price recovery rate was much slower for the properties that sustained damage, and the impacts lasted for at least four years after the storm. Researchers studying housing recovery have utilized a variety of indicators like financial characteristics, government policies, social parameters, damage, housing characteristics, etc. to capture the dimensions of recovery. In Sandy's case damage was the major influencing parameter, and it completely changed the housing dynamics of the affected coastal regions.

Housing market, in terms of damage, restoration, and recovery, is a fundamental indicator of disaster resilience. Every community is different and so are the effects of disasters on residential markets. This study clearly highlights this point and underscores the importance of using contextual methods and datasets in conducting the research.

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CHAPTER 1

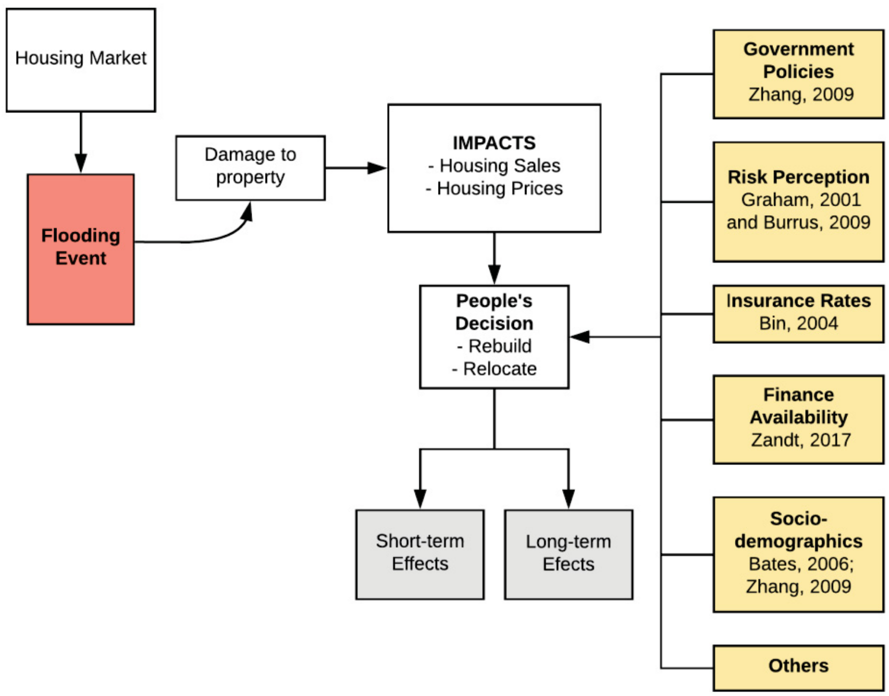
Introduction

Over the past three decades, a number of destructive hurricanes and coastal storms have impacted the U.S. coastal region - from hurricane Andrew in 1992, hurricane Katrina in 2005, hurricane Sandy in 2012, and most recently hurricane Harvey in 2017. A large part of the damages caused by these hurricanes was the destruction of residential property. For instance, Hurricane Katrina in 2005 wreaked havoc in the United States and displaced more than a million Gulf Coast residents (Beracha, 2008). There were also three Category 4 hurricanes that made landfall in the year 2017, marking it as one of the deadliest years in American disaster history, inflicting billions of dollars in damage (Drye, 2017). These hurricanes devastated the Gulf and Atlantic Coast regions of the United States. As per the preliminary estimates, hurricane Harvey alone damaged 203,000 housing units, of which 12,700 were destroyed completely (Amadeo, 2018).

Hurricanes in the past have acted as large exogenous shocks and have had considerable implications on the residential market (Beracha, 2008). The impacts on the housing markets could be short-term as well as long-term depending on the damage inflicted. Immediately following a storm, the majority of the affected areas deal with disrupted infrastructure, damaged or destroyed housing, interrupted accessibility, etc. Some people move out temporarily until the condition returns to pre-disaster levels. As a result, in the short-term, impacts include shrinking inventory and sudden higher demand for rental properties (Paris, 2018). After the storm has passed, people navigate the complex process of filing insurance claims, looking for government assistance, and deciding whether to rebuild or relocate. The decision of homeowners and renters to return to their communities following any major storm is influenced by a number of factors like damage levels

(Bin, 2004), population characteristics (Bates, 2006), risk perceptions (Graham, 2001 and Burrus, 2009), short-term and long-term recovery measures, availability of finances (Zandt, 2017), and government policies (Zhang, 2009). Figure 1 depicts these factors within the coastal housing market after a storm.

Figure 1: Coastal Housing Market after Disturbances



This research is motivated by the increased frequency and strength of storms impacting the coastal regions of the United States. Sandy and other recent disasters underscore the vulnerability of coastal communities to extreme events under current climatic conditions. This research examines the single-family housing market in Staten Island following Superstorm Sandy in October 2012. Hurricane Sandy made landfall as a Category 2 hurricane near Atlantic City, New Jersey on October 29, 2012 and the resulting storm surge brought widespread damage to much of the New York-New Jersey-Connecticut coastal area. Staten Island, one of New York City's five boroughs, was shattered by hurricane Sandy. A 16ft high storm surge was recorded in the low-lying communities of Staten Island's eastern and southern shores (City of New York, 2013). The resulting surge and wave action caused severe structural damage in areas directly facing the shoreline.

According to Quarantelli's (1982) typology of sheltering and housing, there are four phases of post-disaster housing recovery: emergency sheltering, temporary sheltering, temporary housing, and permanent housing. In this research, I focus on the fourth typology: permanent housing market after disasters. This research seeks to improve the current knowledge of factors influencing the single-family housing market following hurricane Sandy in Staten Island.

First, I will examine the differences in sales transactions and property prices between neighborhoods affected by the storm and neighborhoods that were outside the direct damage areas. Second, I will analyze the major parameters impacting the housing market post Sandy. Results of the analysis suggest that damage from storm surge and New York State's home buyout policy implemented after the storm were the major factors influencing the sales transactions of the damaged properties. In terms of property value, this research opens further research questions like: why the property value recovery rates were lower for the damaged properties when the rest of the market recovered at a much faster pace.

This thesis is organized as follows: Chapter 2 presents a review of the literature that summarizes previous research on the housing market post major storms and factors influencing the market; Chapter 3 discusses the study area, data and methodology used. Additionally, it reports the data acquisition and merging processes; Chapter 4 describes the descriptive, spatial, and statistical analyses and their outcomes; Chapter 5 summarizes the research findings, discusses research limitations and mentions points for further research.

CHAPTER 2

Literature Review

Housing constitutes the largest segment of the post-disaster recovery cost as it forms a major portion of built structures in any community (Comerio, 1998). Disasters have varying degrees of impacts on local housing markets, and thus demand a different set of actions. In the last few decades, disasters, specifically hurricanes in the United States, have caused housing losses on a scale similar to those experienced during disasters in underdeveloped countries (Comerio, 1997).

Some storms in the past have had huge impacts on the local housing markets. Hurricane Hugo, in 1989 affected around 91,435 (87% of which were single-family) units in the United States. Hurricane Andrew, made a landfall in 1992 and destroyed 23,000 homes, and seriously damaged 285,000 homes (The National Association of Realtors, 2006). In 2005, Hurricane Katrina damaged 302,000 housing units along the Gulf Coast, which surpassed the effects of all earlier natural disasters (NLIHC, 2005). The storm displaced 750,000 households, and four years after the disaster, home sales in New Orleans dropped by 23 percent. Katrina stimulated the local real estate; people left from destroyed structures and relocated inland, shortage of building supplies in the short-term increased housing costs, and out-of-state investors bought properties in large numbers (Rich, 2005). In the last five-year period, housing losses after hurricanes and coastal storms were huge, with Hurricane Sandy damaging 650,000 units in 2012 (Blake, 2013). The year 2017 was one of the worst hurricane seasons and brought a record number of hurricanes and storm damages to the Atlantic and the Gulf Coast states, with Hurricane Irma alone destroying 25% of homes in Florida Keys (Bauerlein, 2017).

Peacock (2018) states that "In the United States, permanent housing recovery is primarily a market-driven process". In 1995, Qurantelli wrote that the topic of permanent housing is ignored almost totally at local level disaster planning in the US. Post-disaster planning for housing recovery has come a long way from that point, but still, permanent housing is an issue for many, and difficult to comprehend in terms of how it will react and what factors will play a major role in it. The literature on housing markets after disasters is full of contradictory findings. Some communities take months to clean up and rehabilitate after a disaster, while others are wiped out and must be rebuilt, whereas some are completely devastated and impossible to restore. All the above scenarios have a domino effect on local housing inventories, rental rates, home prices and transactions, and land use conversions (Zhang, 2006; Bin and Polasky, 2004; Beracha and Prati, 2008). Hurricanes are a large spatial phenomenon and their destructive effects can also be felt beyond the local boundaries (Murphy, 2009). Some less affected communities in the region might experience an influx of displaced citizens and may elevate housing demand significantly.

Various scenarios arise in a post-disaster situation. In some cases, the sales and housing demand increase after the disasters, while in some other situations, there is a huge drop in the demand. Property abandonment and change in residential land use have also been the outcomes of a housing recovery process, jeopardizing the area's housing market (Zhang, 2006). Similarly, markets have seen a drop as well as a huge increase in the housing prices after disasters.

2.1 Demand and Supply of Housing

Generally, previous literatures differ about the correlation between disaster and housing sales: 1) the affected areas experience a recession; or 2) the affected areas experience a boom. Real estate studies and articles infer that response in residential real estate post major storms takes the form of a bubble. Beracha and Prati (2008), mention that local housing markets face a housing shortage shortly after a storm and then appropriate in the medium term as supply slowly returns to earlier levels. Sometimes, local economic activity which is negatively affected by a hurricane reduces the housing demand in the short term (Murphy, 2009). A study by the National Association of Realtors (2006), also points to a significant decline in housing activity in the months immediately following the hurricanes, and then return to the pre-storm conditions in the upcoming months or years. In the aftermath of Hurricane Andrew, housing sales in Florida fell by 4.1 percent in the third quarter of 1992 when hurricane Andrew hit from the second quarter (The National Association of Realtors, 2006). However, in the fourth quarter, sales in Florida experienced an increase of 31 percent from the third quarter. Attractiveness of hurricane-prone areas might also be affected in response to the hurricane strike, reducing the demand in the long run.

On the contrary, some evidence suggests an increase in the transaction volume after hurricanes. Home sales might occur because of homeowner's choice to relocate or due to lack of financial capacity (Zhang, 2006). Housing sales followed a positive correction and became very active in the impact areas following Hurricane Andrew and Katrina (Zhang, 2006) after experiencing a temporary dip. Beracha and Prati (2008), examined consequent changes in quarterly housing sales volume for zip codes impacted by six major hurricanes, from 2004 through 2005. They found that the number of transactions made in the affected zip codes increased over the course of the year, more rapidly than for the rest of the state (Beracha, 2008).

2.2 Housing Prices

Researchers have inspected the influence of storms and flood hazards, both inland and coastal, on residential property values in many different areas across the United States and around the world. There are a handful of studies of the impacts of hurricanes on the sales and value. However, the empirical evidence of the impact of hurricane strikes on housing prices is inconclusive. On one hand, shortage in housing supply immediately after the event has caused the prices to rise in the short run (Murphy, 2009). In case of Katrina, Vigdor (2008) found that both housing and rent prices in the affected areas increased after the storm. This happened because there was an imbalance between the supply and demand. According to a study conducted by the Federal Reserve Bank of Dallas, “a typical hurricane strike raises house prices for a number of years, with a maximum effect of between 3 to 4 percent three years after the occurrences” (Murphy, 2009).

On the other hand, housing prices have plunged because of various reasons like scale of damage, excess housing availability in the market, increase in insurance premiums, etc. After Hurricane Floyd in 1999, market value of houses located inside the floodplain reduced in Pitt County, North Carolina (Bin, 2004). According to Bin and Polasky, the pre-Floyd estimated discount for a location in a floodplain was $4,888 which doubled to $10,825 after the storm. Graham and Hall (2001), and Beracha and Prati (2008), took a regional approach, and focused on the impacts of hurricanes on housing prices in the nearby but unaffected counties. They found no noticeable effect of hurricane strikes on house prices.

2.3 Factors influencing the Housing Market

Multiple parameters are responsible for the changes in housing sales and price. Housing recovery after disasters is often constrained by social, economic, political, and other unique local contexts (Mukherji, 2017). According to Bolin (1991), these limiting conditions may include the availability of suitable areas for new housing, post-disaster land use regulations, hazard mitigation programs, governmental housing and related aid programs, culturally prescribed housing patterns, pre-disaster social trends, and political conflict in the recovery and reconstruction process. Residential real estate following any major storm is influenced by a number of factors like damage levels, population characteristics, change in supply-demand, people's sentiments, short-term and long-term recovery measures, availability of finances, government policies, etc. Mukherji (2017), mentions that household parameters like condition and location of the house prior to the disaster, type of housing tenure, quality of building materials used, and access to resources, information, and services affect a household's ability to rebuild after a disaster.

Socio-demographic: Peacock, et al. (2018), state that the social construction of vulnerability plays an important role in shaping the outcomes of a housing recovery process. Researchers often hypothesize that pre-disaster social patterns affect the post-disaster sales and recovery (Bolin, 1991; Zhang, 2006; Quarantelli, 1995), and some suggest that market-based recovery scenarios could heighten the pre-disaster inequities (Peacock, 2018). Low income and minority population often face many challenges while recovering from disasters (Zhang, 2006), and respond differently. A study of the impacts of Hurricane Ike found that after controlling for storm effects (wind and flood levels), the housing in lower income and minority neighborhoods suffered higher damage levels (Peacock, 2014). A consistent finding was that minority households were likely to live in poorer-quality homes in less desirable and potentially more risky neighborhoods. Hurricane Katrina, reinforced and expanded the social vulnerability patterns with respect to race and income, explaining disparities in housing damage and recovery (Green, 2007). Following hurricane Andrew, researchers documented differential disaster impacts and the housing recovery problems. The neighborhood recovery process was affected by race/ethnicity composition, and owner-occupied housing recovered more rapidly than rental units (Peacock, 2012; Zhang, 2006). Research from other sources also concluded that rental properties have taken significantly longer to rebuild. Lessons from the past suggest that rental properties, homes in minority, and lower income neighborhoods have experienced a slower housing recovery (Peacock, 2014; Zhang, 2006; Peacock, 2018).

Financial characteristics: Mukherji (2017), points out that in the United States, governments at local, state, and federal levels play a limited role in housing reconstruction, leaving the task of rebuilding mainly to market forces with some assistance from FEMA. With the exception of the 1964 Alaskan Earthquake, Americans have primarily relied on a combination of private assistance or funds and constrained intervention from government for housing recovery after the destruction from disasters (Peacock, 2018). In the past, recovery rates have been faster for families with adequately insured housing or ones with own financial resources (Zandt, 2017). Lack of adequate monetary resources has also resulted in sales, property abandonment, and land use change, as owners have given up on the property and relocated (Zhang, 2006). Research following Andrew has also documented a differential disaster impact and access to housing recovery resources (Zhang, 2006; Peacock, 2018). Zandt (2017), states that the private market for communities affected by Hurricane Harvey will take care of these households.

Government Grants and Policies: Grants and Policies also play a major role in financing after disasters and affect the residential housing market to a large extent. Often local planning decisions are influenced by policies at the state and federal level (McCarthy, 2008). For example, requirement of flood insurance in flood prone areas might drive up the property prices (Bin, 2004) or incentives to direct economic development and to fulfil housing needs might increase the sales

(McCarthy, 2008). Residential relocation policies initiated by placing restrictions on redevelopment following a disaster are seen as a dramatic method to permanently reduce the risk (Freudenberg, 2016). Research and recent knowledge suggest additional effort is required to match recovery policies and government grants with local market housing conditions. Planning for housing recovery means targeting insurance and government recovery programs to meet a range of local situations.

Risk Perception: Perceived hazard risk, is believed to be an additional indirect factor influencing the market that is not immediately observable and quantifiable (Graham, 2001). Researchers examining post-disaster housing markets have utilized perceptional measures to capture various dimensions of housing sales and prices. Lindell (2009), found out a relation between proximity to flood hazard and the price people were willing to pay for a residential property. However, recency, frequency, and severity of the hazards affect this, and the link between hazard proximity and perceived risk is often imperfect. In some cases, property values in the coastal communities have experienced an immediate decline with each successive hurricane (Graham and Hall, 2001), while in others the price discount for housing located within a floodplain was significantly larger than before (Bin and Polasky, 2004). Following hurricane Bonnie in 1998 and hurricane Floyd in 1999, people's perceptions of likelihood of hurricane strikes in the region changed and the home prices and the housing market suffered losses (Burrus, 2009). Hallstrom and Smith (2005), found a proximity effect where housing prices dip as much as 19 percent based on homeowners' response to the information conveyed by storms passing nearby.

In addition to the above factors, damage caused by an event also decides the course and period of residential market's recovery. The damage sustained by a home sets the initial baseline for housing and ultimate household recovery, and is critical for understanding resilience (Zhang, 2018). Damage was a critical determining factor for household displacement and dislocation in the case of Katrina (Levine, 2007), which had major consequences for the housing recovery. Higher levels of damage demand more input and financial resources to repair or rebuild housing.

All the above stated factors don't act in isolation, rather they are interdependent and change in one often influences another. For example, availability of finance, resources, and information is often influenced by socio-economic parameters like race/ ethnicity and impacts the risk perception, recovery, etc. The differences in property values mentioned above may also partly reflect recovery policies that focus on a particular section of the region. In case of Hurricane Andrew, researchers speculate that a home price difference existed because more policies were focused on owner occupants, while very few addressed rental housing (Zhang, 2009).

2.4 Research Approach

In sum, the impact of disasters on housing market varies case by case and is a result of various underlying parameters. In contrast to much of the peer-reviewed research that looks at one or lesser variables (Bin, 2004; Graham, 2001; Burrus, 2009), this research looks at multiple variables possibly affecting the housing market pre-and-post-hurricane Sandy. The approach of this research is to study the effect of Hurricane Sandy on Staten Island's single-family housing market using some of the factors mentioned above. Understanding the overall impact of various factors (household, neighborhood, and damage) after Sandy will allow decision makers to plan accordingly for the future housing markets impacted by natural disasters. In this research, I use specific damage data at the parcel level, unlike many preceding similar studies. This research contributes to the growing body of literature on behavior of housing markets post-disasters by analyzing micro-level data and by comparing the findings with past trends. The present study also confirms some of the previous findings and adds to the existing literature about variations in housing markets of coastal and inland neighborhoods.

CHAPTER 3

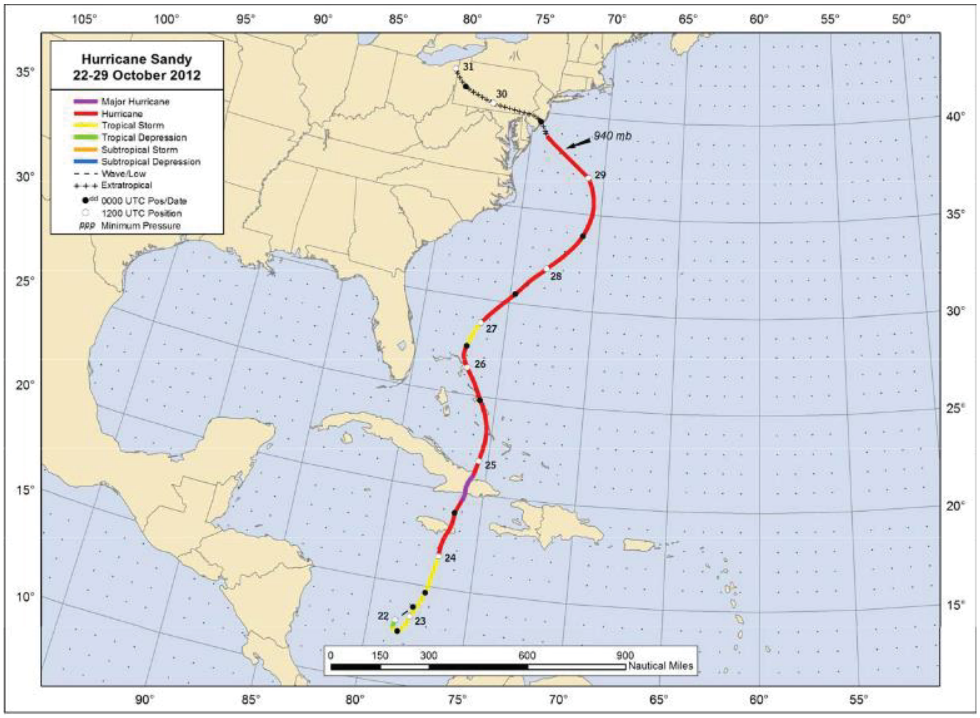
Study Area, Data, and Methods

4.1 Superstorm Sandy

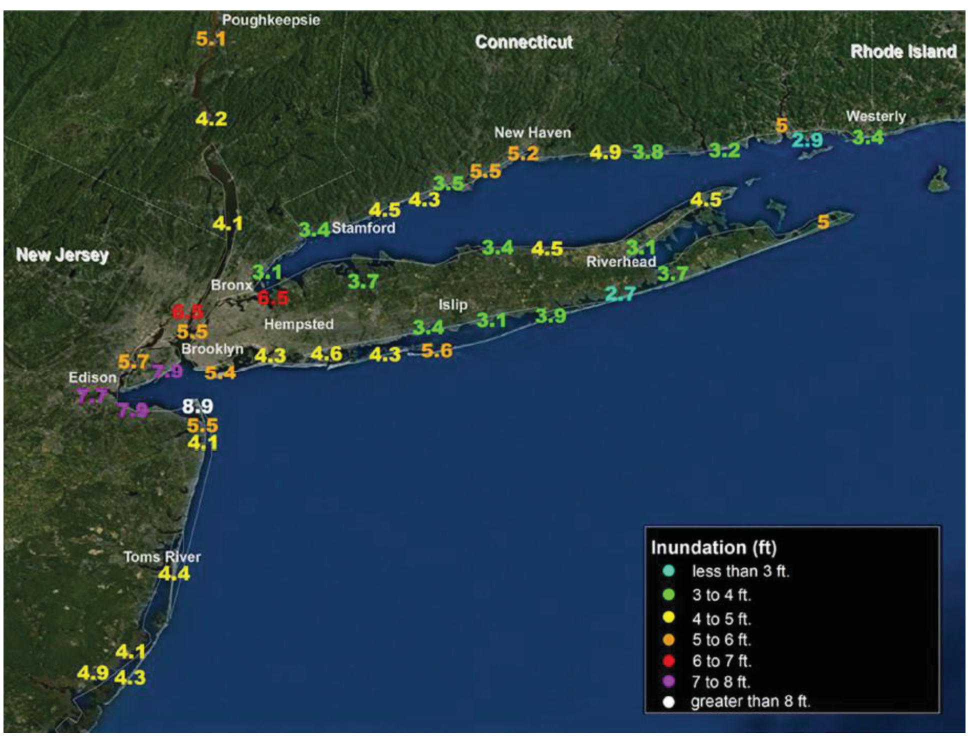
On October 29, 2012, a post-tropical cyclone Sandy made landfall near Atlantic City, New Jersey, inflicting billions of dollars of damage to life and property (NYC, 2014). Hurricane Sandy was the second costliest hurricane in the United States until hurricanes Harvey and Maria made landfall in 2017. A series of improbable set of factors such as the unusual path of the storm, spring high tide that was higher than normal because of a full moon, and high wind speed combined to generate a massive storm surge (FEMA, 2013). Flooding and wind damage from the hurricane, affected 24 states across the northeastern and mid-Atlantic United States (Hurricane Sandy Rebuilding Task Force, 2013). Millions were affected by the storm - 147 people died, 650,000 homes were damaged, and 8 million U.S. residents were without power (Blake, 2013). The storm caused widespread damage to buildings and infrastructure of the entire affected area. The estimated economic damage across the United States was approximately 50 billion dollars (FEMA, 2013). New York and New Jersey were the most severely damaged states.

Hurricane Sandy caused water levels to rise along the entire east coast of the United States and was primarily a storm surge event (Blake, 2013). Coastal and riverine areas along the New York and New Jersey coastline received large-scale flooding. Storm surge accompanied by powerful damaging waves caused shoreline damage in the northern New Jersey, Staten Island, and western Long Island (Blake, 2013).

Map 1: Hurricane Sandy Track Positions: 22 - 29 October 2012



Map 2: Estimated inundation (feet above ground level) for Sandy calculated from USGS high-water marks and NOS tide gauges along the U.S. East Coast

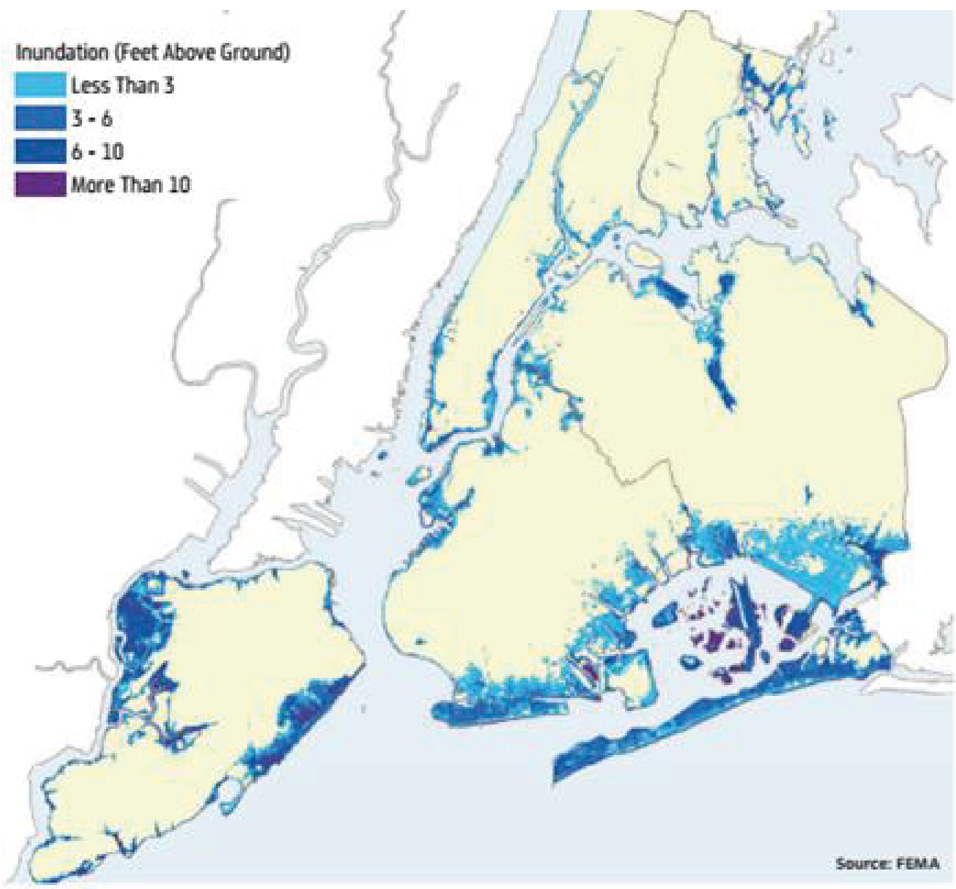


Source: National Hurricane Center Sandy Report (https://www.weather.gov/okx/HurricaneSandy)

4.2 New York City

New York City and its suburbs suffered immense damage from the storm. Hurricane Sandy flooded 51 square miles of the New York City i.e. 16.6 percent of the city's land and reached 76,000 buildings which contained nearly nine percent of the total housing units in the city (Furman Center, 2013). Due to New York City's urban characteristics, the storm's impact was greatly magnified. Five coastal areas of New York - the Brooklyn-Queens Waterfront, the East and South shores of Staten Island, South Queens, Southern Brooklyn, and Southern Manhattan were particularly hard hit by the storm (City of New York, 2013). Map 3 shows the extent of the storm surge throughout New York City.

Map 3: Hurricane Sandy Inundation - New York City



Data Source: FEMA

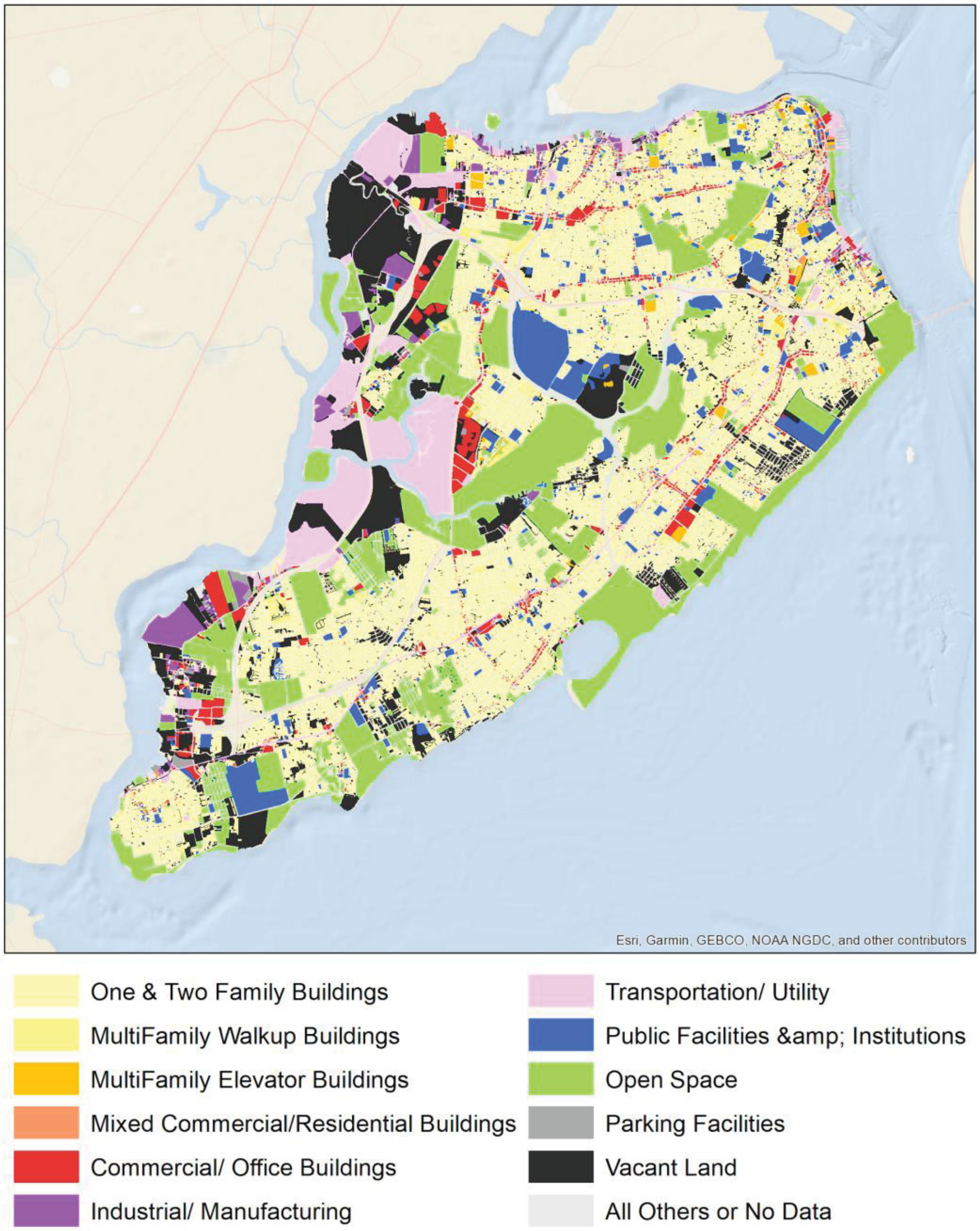
The storm caused approximately $20 billion in damage to the city's buildings and infrastructure (NYC, 2014). According to an initial analysis conducted by the New York State Association of Realtors, the housing activity was on hold in the affected areas as recovery took precedence. Sandy's immediate impact on real estate was also evident from the coastal neighborhoods of Queens and Staten Island being tragically leveled to the ground. Damage from the hurricane was devastating, in some parts, storm surge and floodwaters pushed houses right off their foundations or caused walls to collapse (City of New York, 2013). Around 150,000 residents were displaced from their homes and were forced to look for temporary housing or immediate repairs (NYC, 2014). In all, 305,000 housing units (10,000 of which were damaged by more than half their value) in New York were damaged or destroyed by the storm. Buildings in the coastal neighborhoods sustained more damage as compared to the inland areas with still water flooding (NYC, 2014). Overall, the buildings that suffered the most severe structural damage were 1-story, light-frame buildings, which represent 18% of the impacted building stock (City of New York, 2013).

4.3 Staten Island

The coastlines of Long Island and New Jersey meet at a 120-degree angle, concentrating and sending the surge directly toward Staten Island (Main, 2012). According to USGS, the highest surge levels in New York City were recorded on Staten Island and the borough was shattered by Hurricane Sandy. Some of the Staten Island neighborhoods like Ocean Breeze and Oakwood Beach were completely devastated, with homes destroyed, local residents drowned, and the survivors clearly traumatized by the storm's intensity and destruction. Twenty-four Staten Islanders lost their lives, and the majority of these deaths were attributed to drowning in areas where storm surge rose rapidly (NYC, 2014). The East and South Shores of Staten Island experienced a widespread inundation since they were directly exposed to storm surge and destructive waves along the shore (City of New York, 2013). A 14 ft. high storm surge was recorded in the low-lying communities of Staten Island's eastern and southern shores (City of New York, 2013).

The expansion of residential development in island's natural wetlands was part of the problem. As a result of urbanization, Staten Island's shores hardscaped the natural sponge (wetlands, marshes, etc.) with roads, parking lots, housing development, stores, hospitals, and all other elements of urbanization (City of New York, 2013). The earlier half of the 20th century marked construction of vacation homes (Beach cottages and bungalows) in Staten Island. After WWII, veterans retorted the affordable land as permanent housing near the beach, adding to the earlier seasonal housing. By the late 1960s, Staten Island's population started to grow rapidly and the housing construction grew simultaneously (City of New York, 2013). With the opening of the Verrazano-Narrows Bridge in 1964, Staten Island began to transform into a more suburban, auto-oriented community (City of New York, 2013). The rate of population growth in Staten Island from 1990 to 2010 was higher than other New York City boroughs (Center for an Urban Future, 2011). This continued residential development significantly reduced the area under wetlands and marshes, making the development highly vulnerable to the effects of SLR and Climate Change. Staten Island is the least populated borough of NYC, with 470,467 residents according to the ACS, yet it has been the fastest growing borough over the past three decades (NYC, 2014).

Map 4: Existing Land Use of Staten Island



Data Source: NYC PLUTO dataset

4.4 Data and Methodology

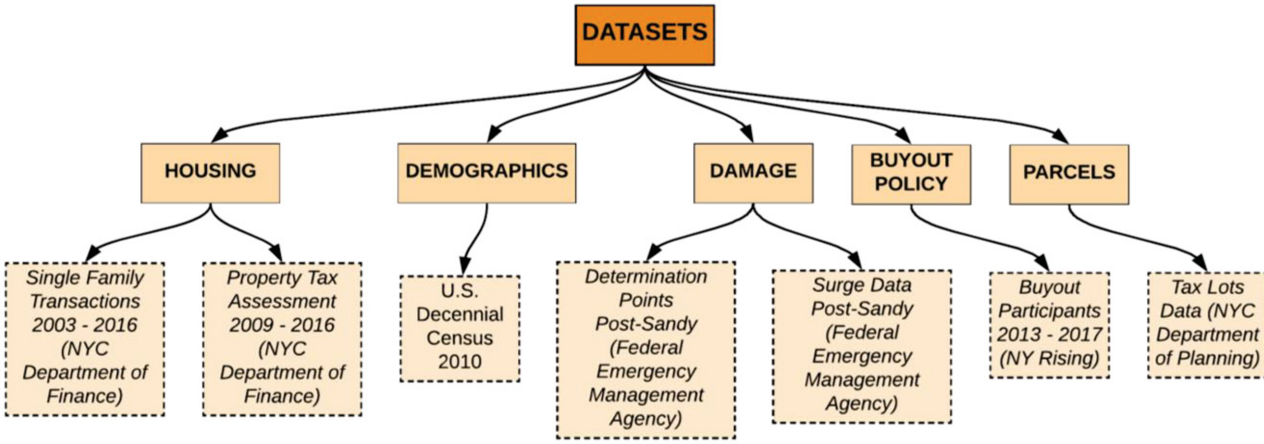
A disaster interrupts the normal housing market and its ongoing processes. After any disaster the housing market usually goes through different phases until it is recovered and is back to its normal functioning. According to Quarantelli's (1982) typology of sheltering and housing, there are four phases of post-disaster housing recovery: emergency sheltering, temporary sheltering, temporary housing, and permanent housing. In this research, I focus on the fourth category i.e. permanent housing market after disasters.

The majority of Staten Island neighborhoods are low density consisting of one- and two-family homes. Single-family attached and detached homes account for 78 percent of owner-occupied units in Staten Island (2010) and the highest of all submarkets in NYC (HUD, 2015). Thus, I focused on parcel level data for single-family housing. Another reason to study the single-family transactions was 42% of the residential buildings in the surge area were single-family homes (Furman Center, 2013). A parcel was considered as single-family based on its classification by the New York City Local government.

a. Datasets

Different scholars in the past have used different types of measures to evaluate the housing market trends and recovery after coastal storms. For example, tax appraisal, land-use change and census data (Zhang, 2009), data on building permits (Stevenson, Emrich, Mitchell and Cutter, 2010), housing sales and price data (Bin and Polasky, 2004; Zhang, 2006), occupancy certificates data, etc. have been used to analyze the effects on housing markets. Proper dataset and analytical techniques are crucial to carry out an in-depth study of the housing market and to identify the major factors at play after hazards. The data used for the study could be divided as follows (Figure 2):

Figure 2: Datasets used in the Research



In order to accurately assess the sudden changes in residential real estate caused by a disaster the data needs to be longitudinal and appropriately timed. To gauge the effects of Hurricane Sandy on Staten Island's housing market, the study employs five major datasets. These data sets include sale transactions, property tax assessment, census information at block group level, and damage assessment. PLUTO[1] lots database was used for merging all the information with the housing data.

i. Housing

The following two housing data sets out of the various available in the market are used in this research.

Sales Transactions: The data set consists of individual housing transactions information for single-family homes in Staten Island and is acquired from the New York City Department of Finance's annualized sales data available online. The housing sales data is based on single-family transactions that took place in Staten Island between the years 2003 and 2016. The data set permitted greater precision, and the frequent observations allowed a better time-lapse reflection of

[1] PLUTO: Extensive land use and geographic data at the tax lot level for new York City

what happened with prices over time. The property transactions contained information on housing characteristics (age, square footage, number of bedrooms, etc.) as well as sale date and sale price. Additionally, it contained zoning related information like building class, frontages, and number of stories. The transactions data I focused on for this study include frequency and types of sales (sale date and sale price).

Property Tax Assessment: The property tax assessments provide information on appraised building values and housing characteristics for every single land parcel in Staten Island. Each tax parcel in the county is assigned a land use code reflecting the nature of the property. Tax class-1 includes one- to three-unit residential properties. The market value of class-1- properties is determined by using statistical analysis that incorporates the recent selling prices of similar properties in the neighborhood (NYC, Finance Department). Similar properties mean properties that are close in size, style, and age. Land and structure value for each parcel are appraised separately and then combined. If the year of assessment is 2001 that means the property values are for the fiscal year 2001/2002 assessments. In this research, appraised value of the properties from 2012 to 2016 are used to study the change in property values based on different parameters after hurricane Sandy. Unlike the housing sales data, the tax assessment data set provided us with an equal time interval between data points which was essential to track the abrupt changes caused by any disturbance.

ii. Damage Assessment

The level of damage inflicted by the storm varied, and not all the inundated buildings were damaged. Damage assessment data is a combination of aerial imagery assessment and on-ground interviews conducted by the FEMA Modeling Task Force. The damage data set provided by

FEMA represents a point on each building in the Sandy inundation zone (319,575 total buildings), as well as points outside the inundation zone where aerial imagery was available. The building point-damage estimates collected by FEMA quantify the damage suffered by each property affected by Sandy, and thus, it was used as a measure of damage. The data consists of locational information, surge depths, and damage information. A summary of classification criteria used by FEMA is available in the Appendix. Based on the amount of full verified loss the damage is categorized as affected, minor, major, and destroyed.

iii. Demographics Database

Demographic factors like median income, race, class, poverty level, etc. contribute to the unevenness of disaster experiences of victims in the face of seemingly indiscriminate forces of natural disasters. Evidence from the past shows that Hurricanes Katrina and Andrew exacerbated the underlying socio-economic inequities, forcing people out of their neighborhoods (Green, 2007; Beracha, 2008; Zhang, 2009; Bates, 2009). Thus, going beyond the physical damage caused by the storm, I focused on the demographic factors of the communities caught in storm's path to understand the variation in impacts across the households. 2010 block group level demographic data for Staten Island was collected and cleaned up for the analysis purpose.

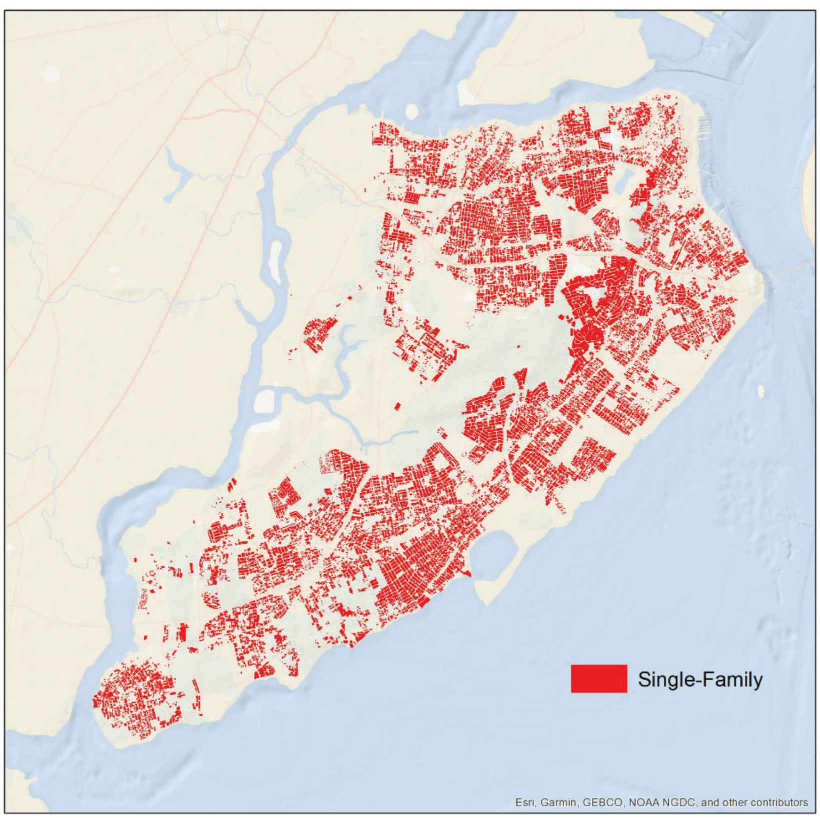
iv. Buyout Policy

Buyout program is employed in the states of New York, New Jersey, and Connecticut following Irene and Sandy (Freudenberg, 2016). The government's plan is to demolish the homes and preserve the land as open space in perpetuity. Three communities in Staten Island - Oakwood Beach, Graham Beach, and Ocean Breeze opted for the voluntary buyouts (Nonko, 2017). Homeowners were offered the pre-storm value of their home, then the government took ownership of their land. Secondary information about number of buyouts offered, signed, and closed within each of the three Staten Island communities is used to analyze the impacts of this policy on housing market.

b. Methodology

Data obtained from various sources was cleaned before conducting further analysis. Tax parcels file was available in the shapefile format from PLUTO. Finally, the tax lots shapefile was used to merge all the above datasets. The parcel land use data contained detailed land use information for each parcel. Tax parcels were imported to GIS and all the single-family parcels were retained for Staten Island after deleting all the other tax classes. Map 5 shows the single-family tax parcels in Staten Island.

Map 5: Single-Family parcels in Staten Island



Data Source: NYC PLUTO dataset

The next step was adding the damage assessment information to the sales transactions database. FEMA damage assessment dataset was available and had locational information attached. Using the locational information and after changing the projection, I overlaid the damaged assessment data over single-family lots database from PLUTO. Using the spatial join tool in ArcMap I was able to attach all the damage and surge depth information to each individual single-family parcel in Staten Island. Demographic information at block group level for the year 2010 was joined to the above database.

Sales transactions data was available by borough and year for the whole New York City. Single-family transactions data from different years were merged. Housing transactions data was available in a csv format and required preliminary cleaning. All the sales transactions below $5000 and the outliers were deleted. The sales data was in a relational database format. The property identifier for each transaction consisted of Borough ID, Block ID, and Lot ID which was used as a link to attach the sales data to the tax parcels shapefile. The single-family transactions data for all years (2003 - 2015) was merged after dropping other residential, commercial, and industrial properties from the sample. Tax appraisal data was available by borough and year for the whole NYC. Tax appraisal data from 2009 through 2016 was combined and joined in a similar way to the damage and demographics information.

CHAPTER 4

Descriptive Statistics and Analysis

First section of this chapter outlines descriptive statistics of the study area and provides a brief overview of Staten Island's neighborhood characteristics, household characteristics, housing market background, and building damage caused by Hurricane Sandy. As such, it provides some benchmarks against which to measure the damage which Sandy inflicted and to assess the changes that occurred in the housing market.

4.1 Demographics

To set a context for this analysis, it is important to understand socio-demographic characteristics of the population, like the median income, racial composition, and housing occupancy and ownership. Residents of Staten Island are relatively homogeneous with respect to income and it has the lowest proportion of residents (11.8 percent) living below the poverty line (NYU Furman Center, 2011). Block groups in the study area vary to some extent in terms of median income. The median income in Staten Island was 73179.30 dollars in 2010, with a standard deviation of 28803.55 dollars and was more compared to the city (U.S. Census Bureau, 2010). Staten Island is New York City's least populous and most homogenous borough in terms of racial diversity. On an average the racial characteristics of the bock groups in Staten Island also differ from the rest of the city. Their population has higher percentages of white and are less diverse. Block groups in Staten Island had an average of 72.51 percent of Whites, 10.81 percent of African Americans, and 7.34 percent of Asians. The housing stock in Staten Island also differs from those of the city population as a whole. The average rate of occupancy in Staten Island was 93.53 percent in 2010, and 63.71 percent of the occupied housing stock was owner occupied (U.S.

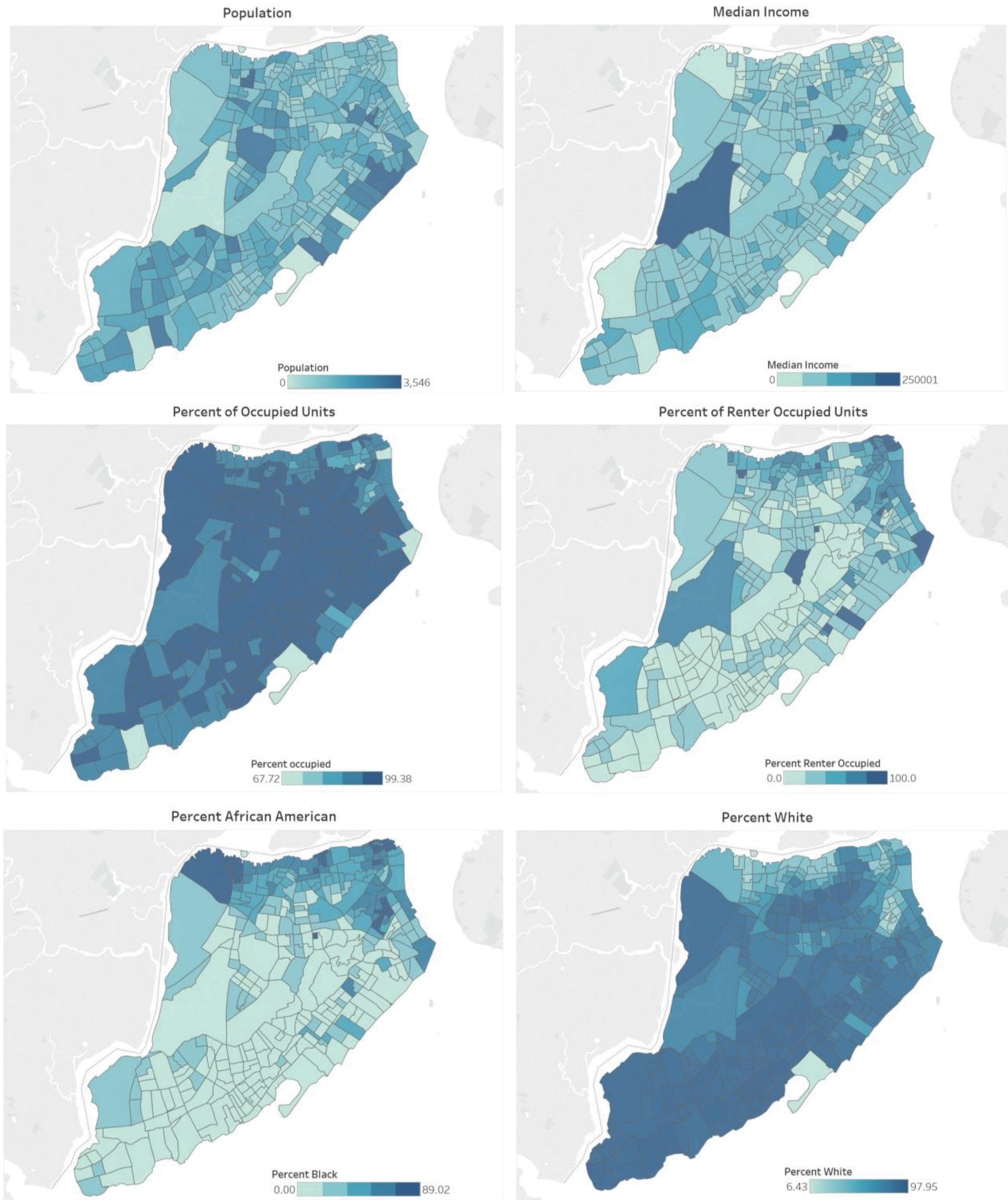
Census Bureau, 2010). Contrarily, only 31 percent of the homes were owner occupied in the New York City.

Table 1: Descriptive statistics of the neighborhood characteristics

Variable	Count	Mean	Std. Dev	Min	Max	New York City
Population	307	1526.81	631.27	31.00	3546	8,175,133
Housing Units	307	575.43	240.02	15.00	1340	3,371,062
Median Income	307	73179.30	28803.55	0.00	250001	50,285
Population Density	307	14748.67	9349.33	28.17	83263.52	27,012.4
Percent White	307	72.51	23.44	7.57	97.98	44.0
Percent African American	307	10.81	16.29	0.00	81.42	25.6
Percent America Indian	307	0.40	0.49	0.00	3.23	0.7
Percent Asian	307	7.34	6.25	0.00	45.78	12.7
Percent Native Hawaiian	307	0.05	0.11	0.00	0.82	0.1
Percent Other Race	307	6.23	6.75	0.00	34.18	13.0
Percent Two or More races	307	2.67	1.81	0.00	12.90	4.0
Percent Owner	307	63.71	20.97	0.00	100	31.0
Percent Renter	307	36.29	20.97	0.00	100	69.0
Percent Occupied	307	93.53	4.10	67.72	99.38	92.3
Percent Vacant	307	6.47	4.10	0.62	32.28	7.8

Data Source: 2010 BG Census Data, Staten Island, New York

Map 6 (a,b,c,d,e,f): Block Group Sociodemographic Characteristics



Data Source: 2010 BG Census Data, Staten Island, New York

The spatial distribution of demographics is important to understand the vulnerabilities and the extent of damage that Sandy caused in Staten Island. The block groups located on the east and the south shores of Staten Island are densely populated and were significantly impacted by the storm (Map 6a). Nearly 140,000 people live on the east and south shores of Staten Island, and from 2000 through 2010 Staten Island was one of the top ten fastest growing counties in the state (GOSR, 2014).

Approximately nine percent i.e. 6906 single-family parcels were located in the surge area. The average age of housing in Staten Island was 46.72 years at the time of Hurricane Sandy in 2012, indicating that majority of the housing in this area was constructed in the 1970s. Single-family attached and detached homes accounted for 78 percent of owner-occupied units in the county in 2010 (HUD, 2015).

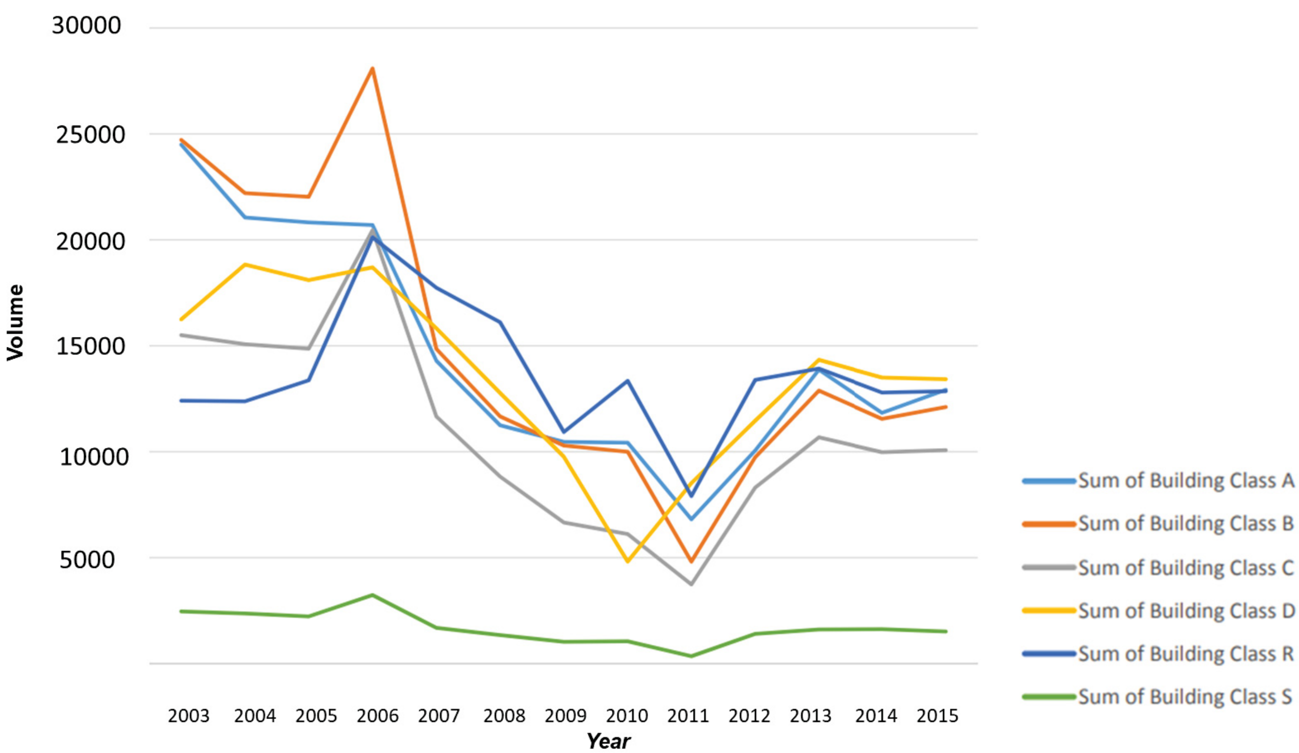
4.2 New York City: Housing Market

This section profiles the pre-Sandy housing market in the five boroughs of New York City with a focus on Staten Island. It provides a background to understand the market trends before the storm and to assess the damage it caused. New York City's housing has experienced a vibrant and unrestrained decade. The construction boom in early 2000s was followed by a bust which saw the growth slow to the lowest rate in 12 years. Over the past decade NYC's home prices and sales volume followed a boom and bust pattern as well.

The city's housing market was at its peak around 2005, and sales volume for all the building categories increased between 2005 and 2006 (Figure 3). During the peak, residential real estate and financial services sectors grew rapidly in New York. The building activity increased in all corners of NYC, and Staten Island experienced the largest percent increase in its housing stock

(NYU Furman Center, 2009). However, in 2006, the housing bubble busted and sent the nation spiraling into the most severe recession since the Great Depression (NYU Furman Center, 2011). Sales prices and volume started declining, and new residential development in New York City came to a halt by 2009. The number of sales in all the boroughs declined dramatically during the housing bust, though somewhat in different times (Figure 4). The subprime mortgage crisis resulted in long-term devaluation of New York City's housing market (NYU Furman Center, 2012).

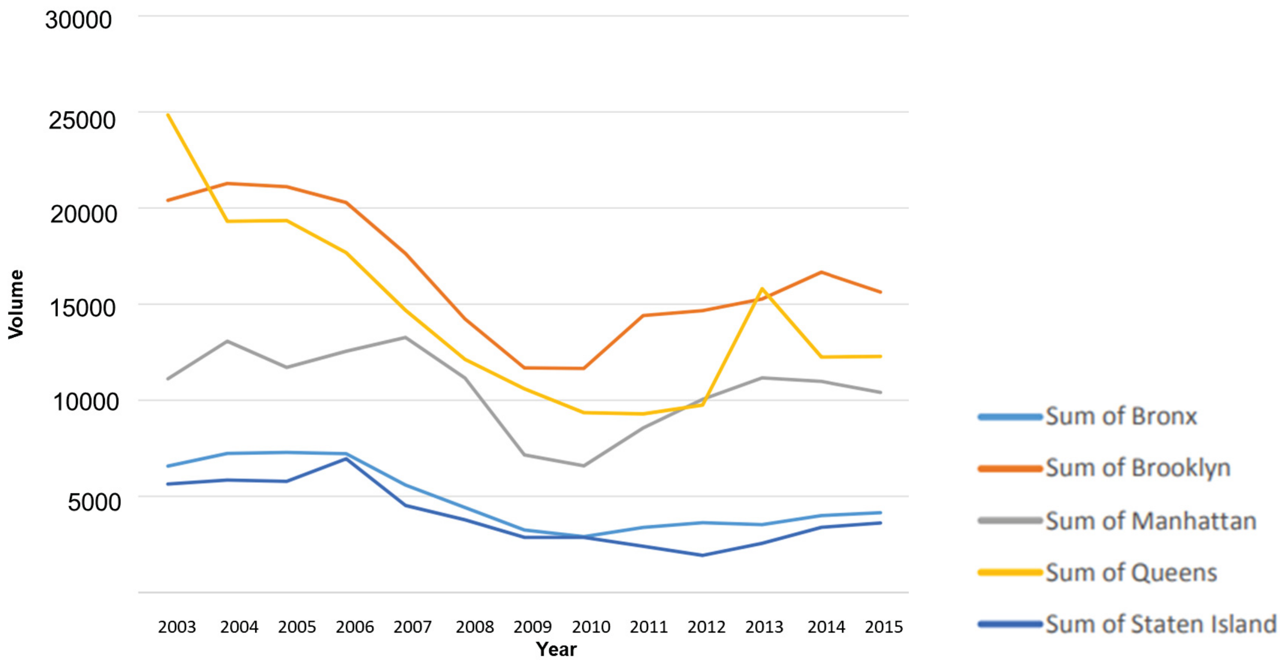
Figure 3: Property sales categorized by Building Class



Data Source: NYC, Department of Finance

While the city continued its nascent recovery from the housing market crisis in 2012, homeowners particularly in the hardest hit neighborhoods continued to struggle (NYU Furman Center, 2013). In 2012, when Superstorm Sandy hit New York, the residential market was still recovering from the housing crisis (Furman Center, 2012). Home prices were up from 2011, but new foreclosure stats were also up in 2012. Each borough saw at least a modest increase in the number of property sales from 2012 to 2013 (Figure 4). Volume of sales also increased for second year in a row in 2013.

Figure 4: Property Sales categorized by Boroughs



Data Source: NYC, Department of Finance

The number of new residential building permits in Staten Island stayed fundamentally even from 2009 to 2012, while the permits increased citywide. Similarly, the prices for single-family homes in Staten Island remained relatively flat during the recovery period i.e. from 2011 to 2012. On the contrary, prices for the same property types in New York City improved during that period. The homes sales in Staten Island experienced an increase after 2012, but remained low as compared to the mid-2000s. From 2004 through 2011, the rate of home sales declined on an average of 13 percent annually, before increasing an average of 16 percent a year in 2012 and 2013 (HUD, 2015). In 2012, the biggest year-over-year change in sales volume was in Staten Island where the number of sale transactions increased by 27 percent to 3,405 sales (Furman Center, 2013).

4.3 Damage to the Housing Stock

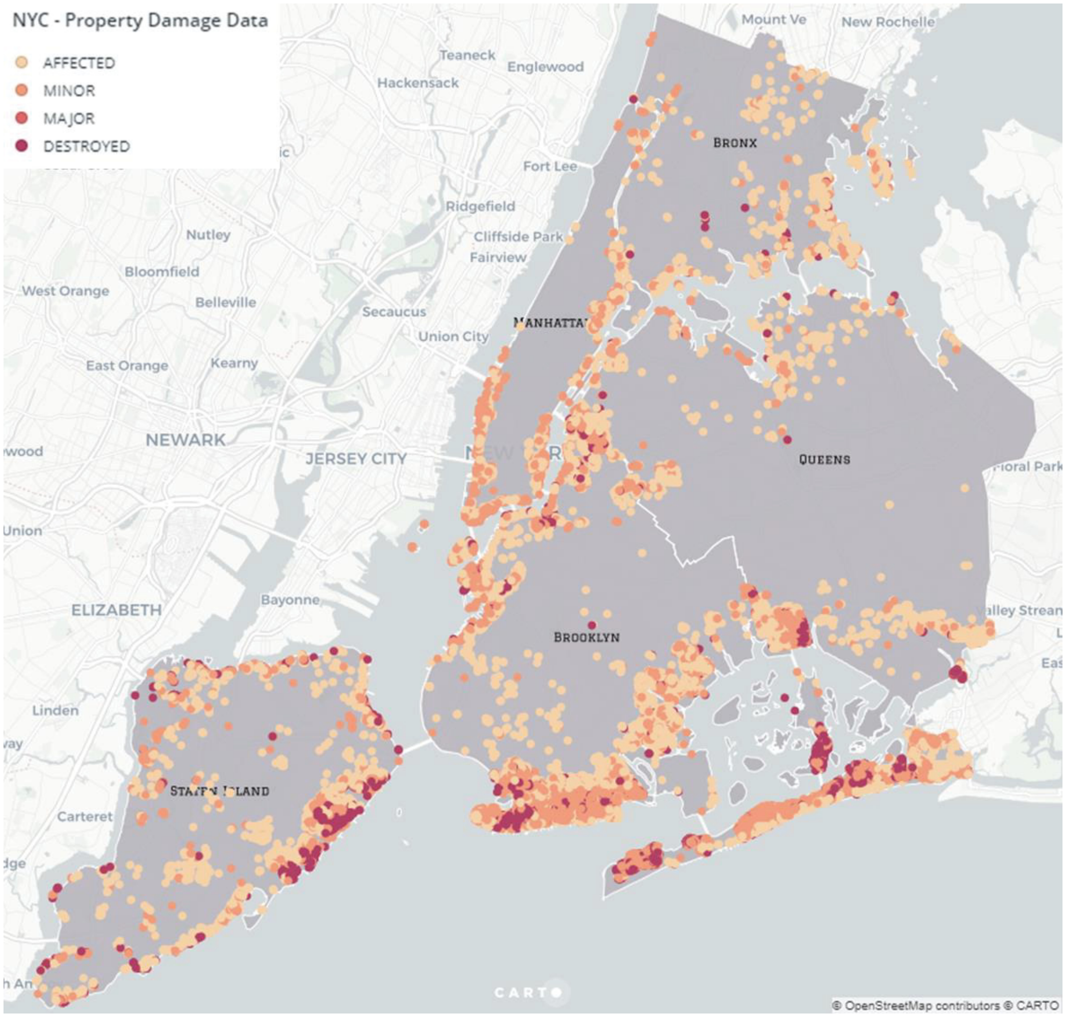
Hurricane Sandy's surge reached 75,919 buildings in New York City comprising 302,303 housing units. Thirty percent of the city's total housing stock was situated in the evacuation zones (demarcated prior to 2013) that were considered susceptible to coastal flooding (Furman Center, 2012). Table 2 reports classification of damage levels for buildings in the Sandy inundation zone. In New York City, around 13.5 percent of the buildings affected by Hurricane Sandy suffered major damage. Highest number of buildings were damaged in Brooklyn (29,916), followed by Bronx (21,777) and Staten Island (11,576). Staten Island was hit the hardest, with 26 percent of the buildings having suffered major damage. In Manhattan, least number of buildings (0.31 percent) suffered major damage, and around 68 percent of the destroyed structures were located in Queens.

Table 2: Building Damage Statistics for New York City

	NYC	Queens	Bronx	Brooklyn	Manhattan	Staten Island
Affected	26313	6897	1368	13012	899	4137
Minor	31780	10972	543	14581	1348	4336
Major	9126	3728	47	2317	7	3027
Destroyed	262	180	0	6	0	76

Data Source: FEMA determination points database

Map 7: Distribution of damage points in the New York City



Data Source: FEMA determination points database

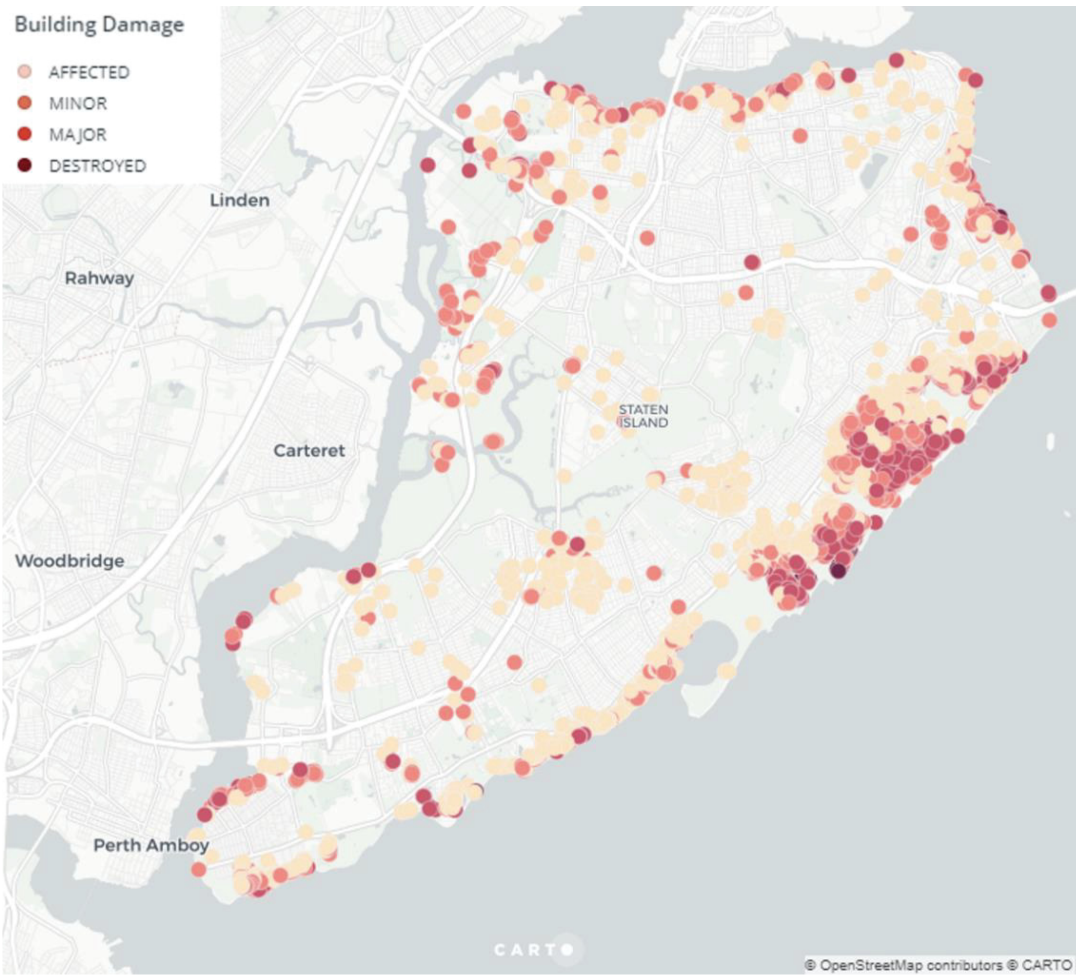
Table 3: Building Damage Statistics for Staten Island

	Damaged buildings	Single-Family Units	
	Number	Number	Percent of total units
Total	11576	7141	61.69
Affected	4137	2570	62.12
Minor	4336	2652	61.16

Major	3027	1919	63.4
Destroyed	76	0	0

Data Source: FEMA determination points database

Map 8: Distribution of Damage Points in Staten Island



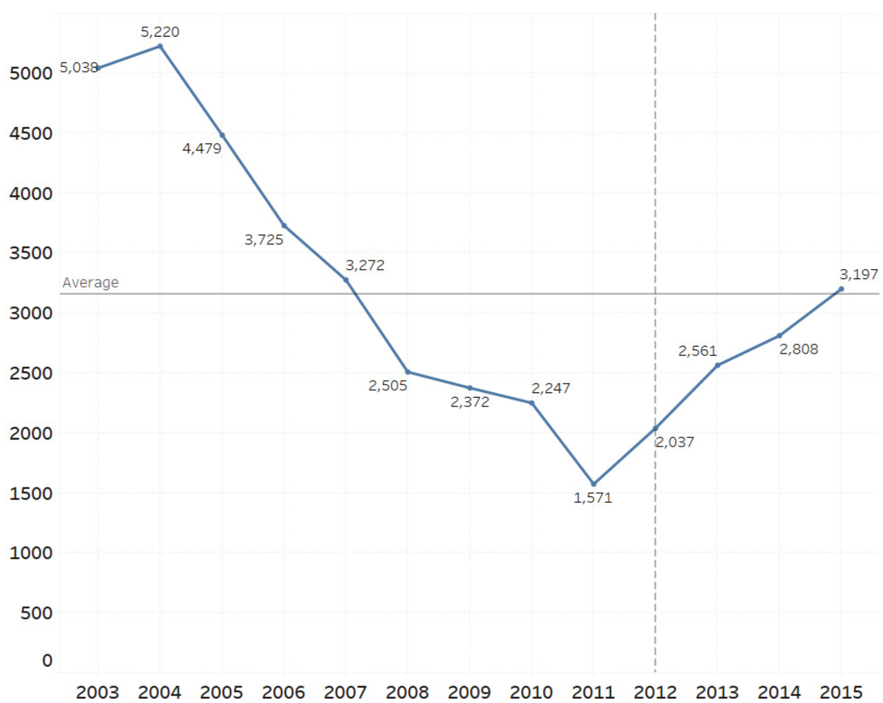
Data Source: FEMA determination points database

4.4 Staten Island: Housing Sales after Sandy

The housing sales in Staten Island were at a peak around 2004, which went on decreasing until it hit the rock-bottom in 2011. The single-family housing market rebounded in the year 2011, parallel to the rest of the city. Development activity continued an upward trajectory in 2013 like the other boroughs of NYC. Despite the increase, housing construction remained below levels seen before the housing boom.

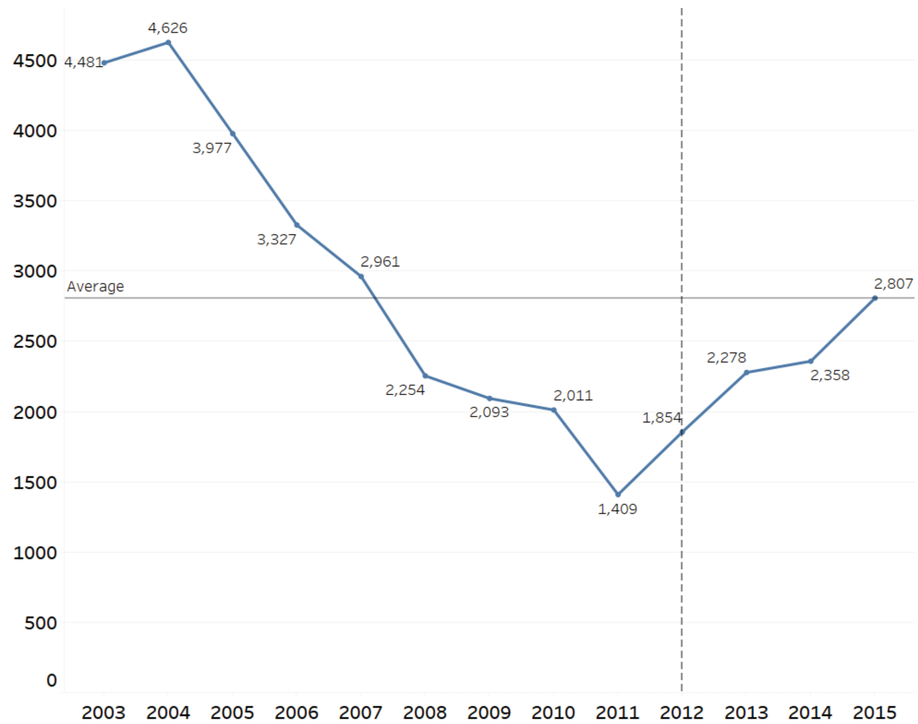
One of the findings of this descriptive analysis is that the housing market for the inland areas not affected by the storm did not show a considerate difference post-sandy (Figure 6). It simply depicts a trend similar to the rest of the New York City. Answering the first research objective of identifying the market differences between neighborhoods affected and unaffected by the storm, Figure 6 and Figure 7, depict the change in sales volume. A clear increasing trend is visible in the properties affected by Hurricane Sandy. Increase in sales of damaged properties, could be a combination of recovering housing market and hurricane Sandy. For the hardest hit houses i.e., homes that suffered major damage the results are quite apparent (Figure 9).

Figure 5: Single-Family Housing Sales in Staten Island



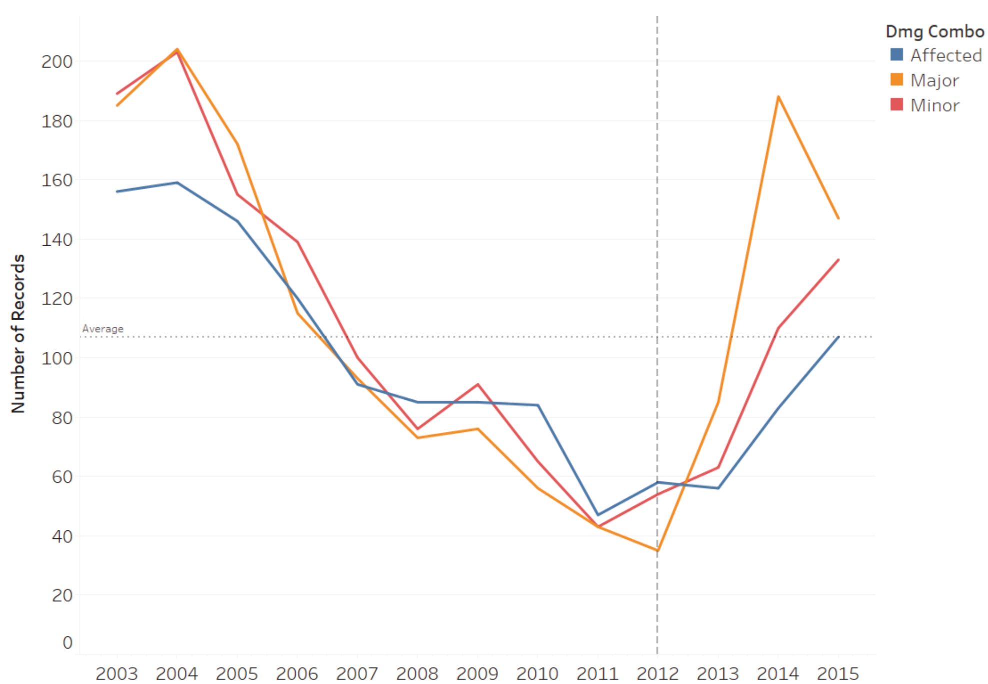
Data Source: NYC, Department of Finance

Figure 6: Sales of Undamaged Single-Family Homes in Staten Island



Data Source: NYC, Department of Finance

Figure 7: Sales of Damaged Single-Family Homes in Staten Island



Data Source: NYC, Department of Finance, FEMA damage determination points

The volume of sales for undamaged properties increased in correspondence with the rest of the market. The percent difference in volume of sales was huge for the properties damaged by the storm (Figure 9) as compared to the unaffected properties (Figure 8).

Figure 8: Percent difference in number of undamaged property sales

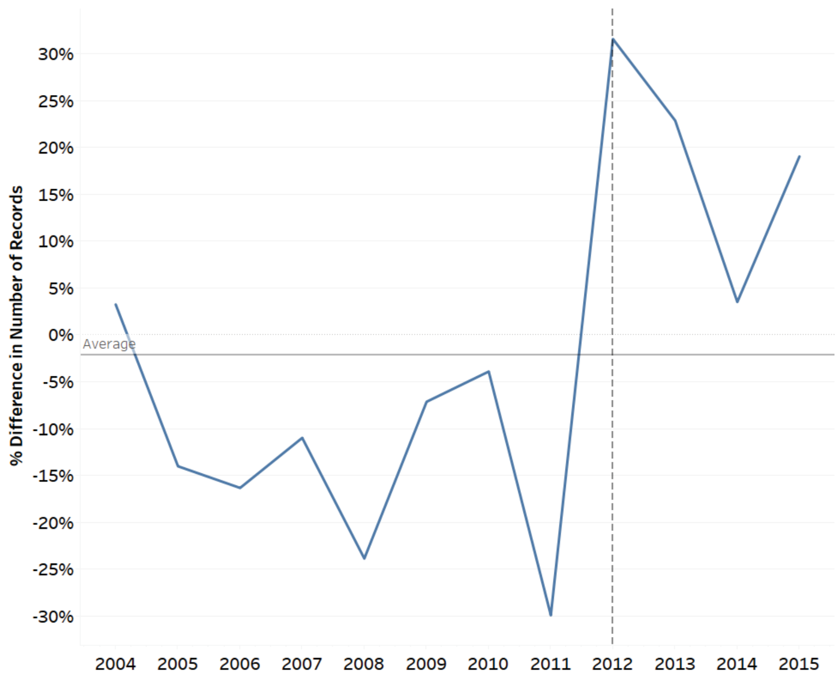
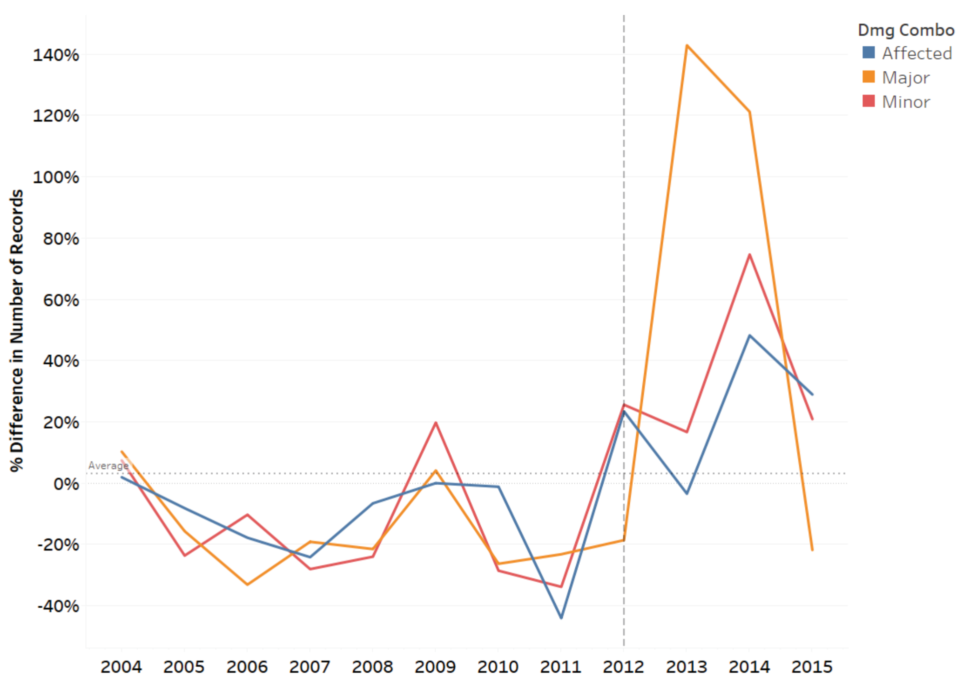
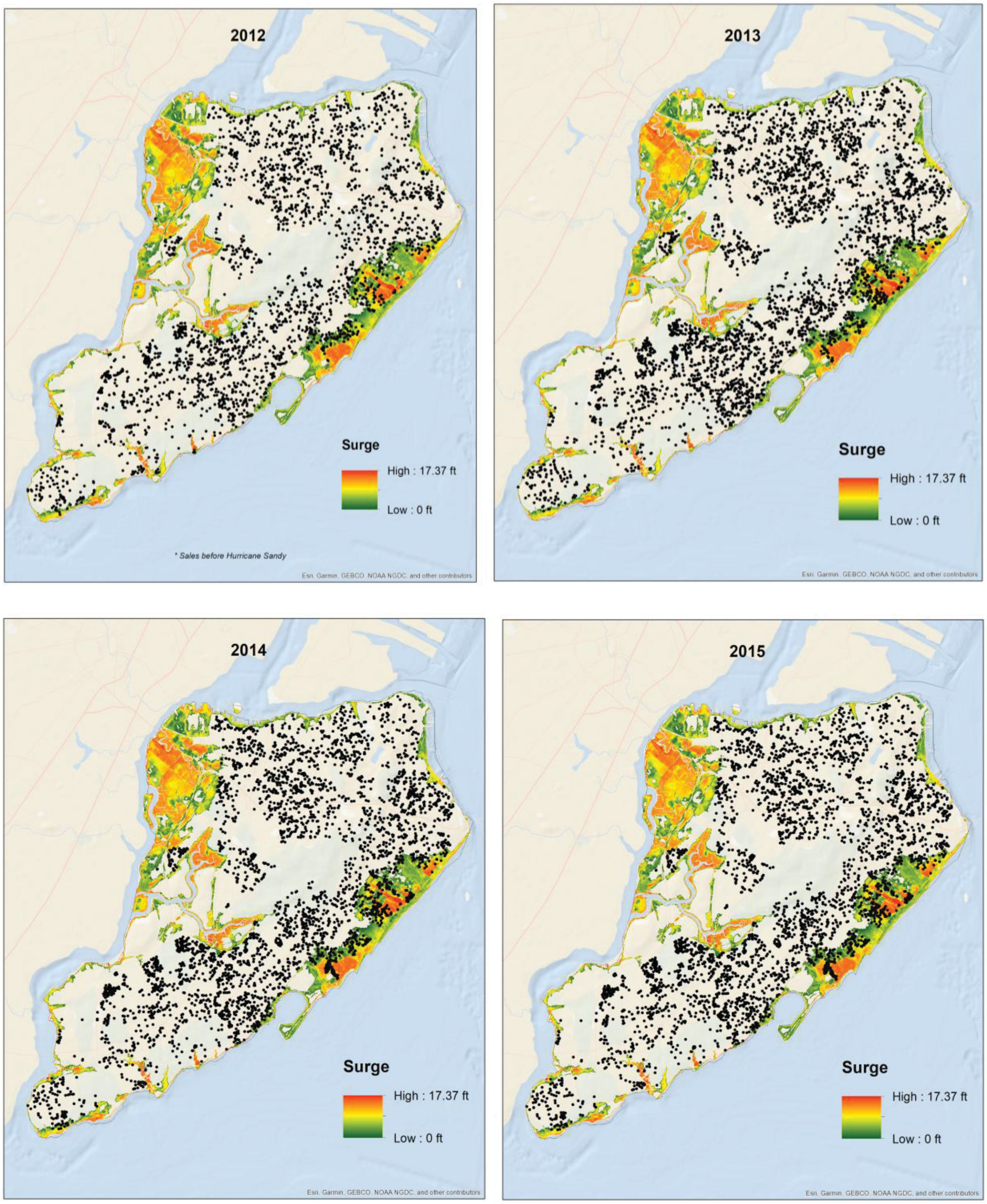


Figure 9: Percent Difference in Damaged Property Sales



Map 9 (a, b, c, d): Distribution of Single-Family Home Sales from 2012 to 2015

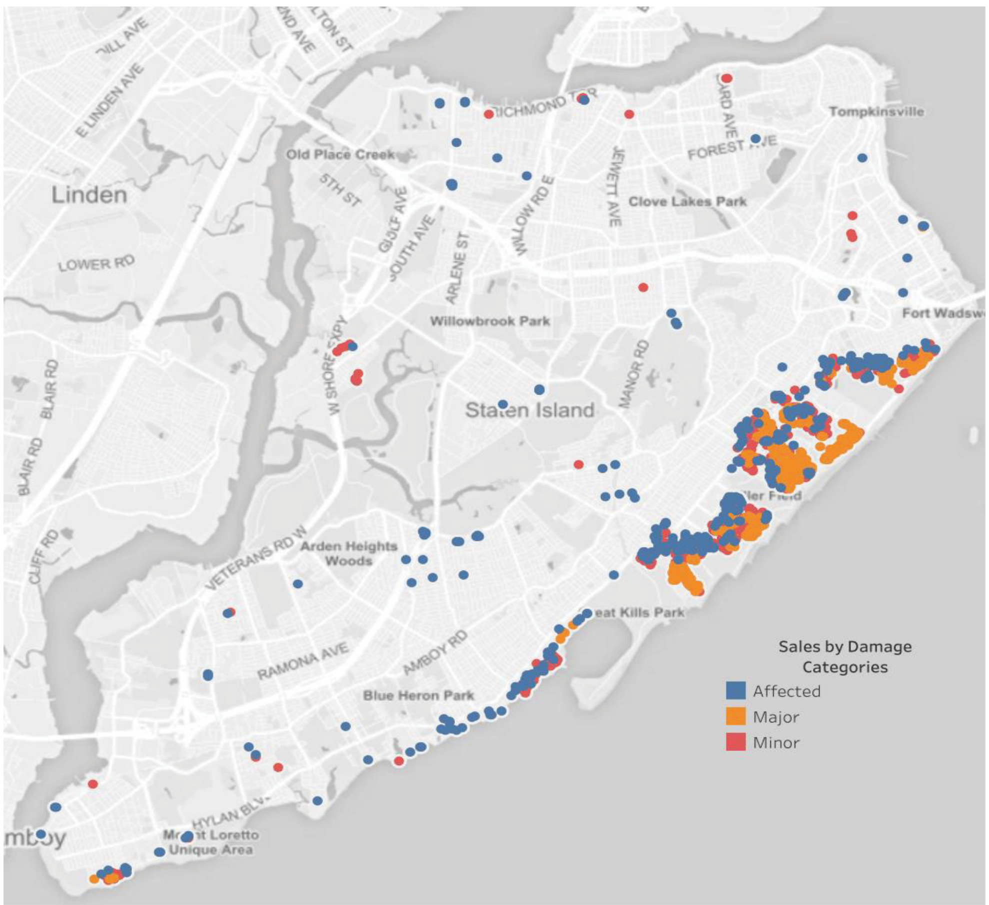


Data Source: NYC, Department of Finance and, FEMA Inundation Data

a. Housing Sales Data: Statistical Analysis

After further analysis it occurred that out of the 11,548 properties assessed by FEMA 3,167 properties were not sold even once and the remaining 55% properties were sold at least once in the span of 12 years. The number of sale transactions for the FEMA assessed properties from 2003 to 2015 were 4,172. Map 10, shows the spatial location of sales of the damaged properties.

Map 10: Location of Single-Family Home Sales categorized by Damage



Data Source: NYC, Department of Finance, FEMA damage determination points

The universe of the data set used for the following analysis is properties damaged by Hurricane Sandy. The number of single-family houses in Staten Island damaged by Sandy is 7,141 of which 1,389 were sold after the event. Property sales after the storm, until December 2015, are considered in the following analysis. A dummy variable (sold) to identify sale after hurricane sandy is added, where 1 means the property is sold and 0 means the property is not sold. The results do not indicate a strong relationship between the property sale and socio-demographic characteristics. However, there is a weak positive correlation between the sale and property damage (Major and Damage_c_1).

Table 4: Correlation Analysis: Property Sale

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sold	1.00															
Affected	-0.06	1.00														
Minor	0.03	-0.58	1.00													
Major	0.11	-0.46	-0.45	1.00												
Damage	0.10	-0.86	0.10	0.82	1.00											
Median Income	0.01	-0.02	-0.01	0.03	0.03	1.00										
Percent Occupied	0.04	-0.01	-0.01	0.02	0.02	0.06	1.00									
Percent Vacant	0.04	0.03	0.01	-0.04	-0.04	0.29	-0.30	1.00								
Percent White	0.06	-0.01	-0.04	-0.10	0.04	0.38	0.42	-0.15	1.00							
Percent Black	0.05	0.06	0.03	-0.03	-0.09	-0.30	-0.09	0.26	-0.88	1.00						
Percent American Indian	0.02	0.00	0.03	-0.03	-0.01	-0.26	-0.02	0.11	-0.43	0.45	1.00					
Percent Asian	0.00	-0.06	0.09	0.04	0.01	-0.14	0.20	0.15	-0.10	-0.04	-0.04	1.00				
Percent Hawian	0.01	-0.01	-0.02	0.03	0.03	-0.32	0.05	-0.07	-0.06	0.04	0.03	0.11	1.00			
Percent Other	0.05	-0.06	0.02	0.01	0.05	-0.19	-0.06	0.26	-0.80	0.79	0.35	0.09	0.09	1.00		
Percent More	-0.05	-0.05	0.04	-0.07	0.03	-0.32	0.07	0.00	-0.62	0.62	0.63	0.07	0.04	0.60	1.00	
Percent Owner	0.07	0.07	-0.03	0.07	-0.09	-0.36	0.37	-0.14	0.75	-0.59	-0.35	-0.03	-0.12	-0.71	-0.56	1.00

The second research objective is to analyze the major parameters impacting housing market post-Sandy. Table 5 provides the details of the parameters considered to answer that research objective. The goal is to study the impact of demographic characteristics and damage levels on the single-family housing sales after the storm. Logit regression model is used to explore the effects of various factors on sales. Dependent variable in this analysis is binomial - whether the property damaged by Hurricane Sandy is sold or not. The dependent variable data is derived directly from the housing transactions data obtained from the NYC, Department of Finance. This data set uses single-family housing sales of affected properties in Staten Island after the event i.e., sales data from November 2012 through December 2015.

Table 5: Variables used in the Model

Variable		Description	Data Source
		Demographic data	
Percent Renter	PerRenter	Percent of Renters in the neighborhood	2010 block group census data
Percent Black	PerBlack	Percentage of black households in the neighborhood	2010 block group census data
Median Income	Median_inc	Median income of the population in the neighborhood	2010 block group census data
		Damage Data	
Damage combination	Damage_c_1	Level of damage caused by hurricane Sandy	FEMA damage assessment data

Through this model, I try to assess the correlation between the property sale and the other parameters like damage, housing characteristics, and demographics. The explanatory variables fall into two classes. The first involves data about damage and destruction caused by the hurricane. The second contains variables related to neighborhood characteristics, which are acquired from 2010 census block group data. Various census parameters were tried while running the initial model, however, only the following were found to be significant enough. These block group/neighborhood level variables include poverty level, race, median income etc.

Table 6: Logistic Regression Model: Damaged Property Sales

Parameter	Odds Ratio	Percent Difference	P>|z|	[95% Conf. Interval]	
Renter	.9746611	-2.53389	0.000	.9672388	.9821404

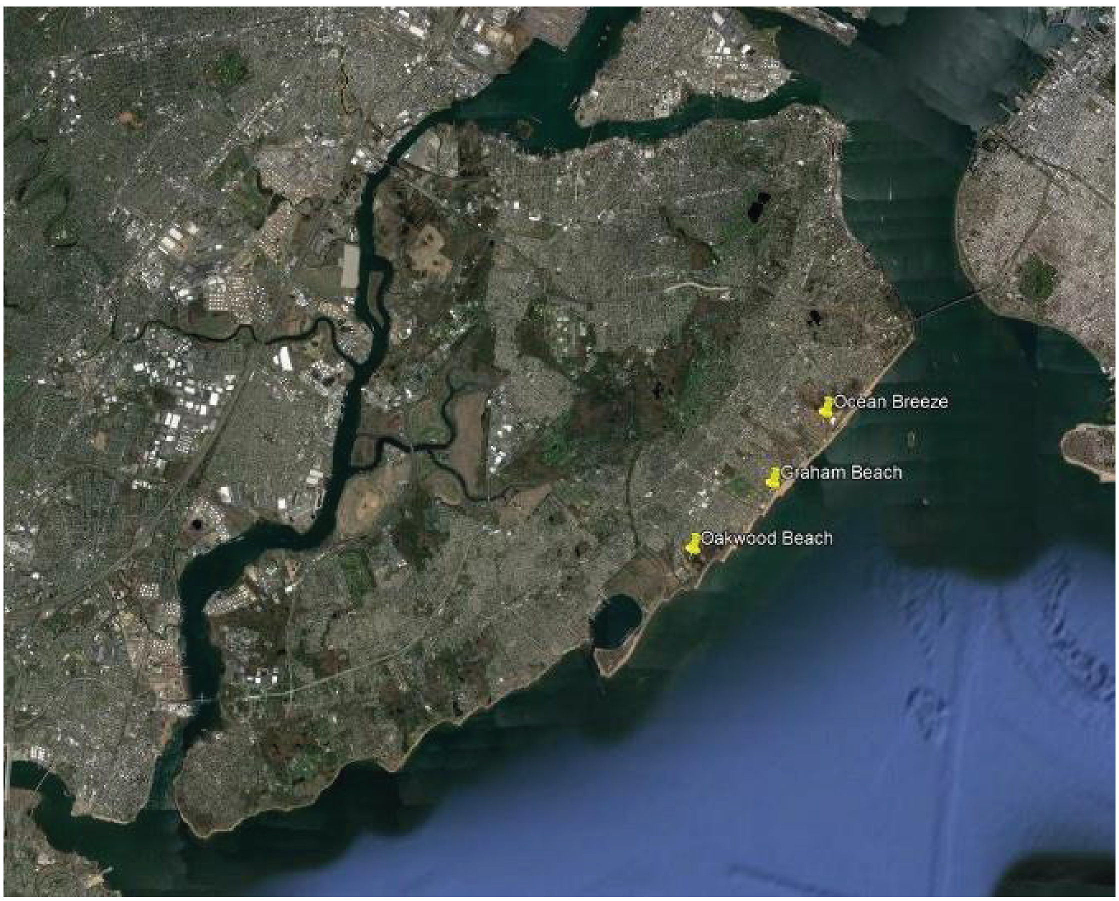
Percent Black	.9947488	-0.52512	0.381	.9830933	1.006543
Median Income	.9999926	-0.00074	0.000	.9999893	.9999958
Damage	1.491473	49.1473	0.000	1.385117	1.605997

All three socio-economic variables considered in the model have a negative impact on the property sale. The demographic variables i.e. percent of renters, percent of African Americans, and median income have a negative coefficient, indicating an inverse relationship between the sale probability and their number. Results of the above analysis depict that there was no significant correlation between the home sales and the socio-demographics of the neighborhoods. Some degree of correlation is depicted between damage level and sales. The coefficient on the damage variable (Damage_c_1) has a positive sign and is statistically significant. It indicates that the likelihood of the property being sold was proportional to the damage caused.

Since the initial results of the housing sales were not conclusive enough as to why the sales of damaged houses increased, or what were the major factors affecting the sales, I decided to study the Buyout Policy sales. Research suggests that in the past government policies after disasters have had a significant impact on the overall housing markets of the region. The number of impacted properties sold after the storm is 1,389, and almost 473 (34 percent) of them were bought out under the New York State Government's Buyout Program (McGhee, 2017). These 473 properties are in the buyout communities shown in Map 11.

In response to the storm, New York State developed a Home Buyout Program to transform the repetitively flooded areas into preservation land (Binder, 2016). The homes in the designated zones (summary of the eligibility criteria could be found in the Appendix) were offered 100% of their pre-storm fair-market value. Additionally, the homeowners were provided a 5 percent incentive if the occupant's property was in an enhanced buyout area and if they permanently relocated within the same county (Appendix B). A 10 percent incentive was provided if the property was located in a high-risk enhanced buyout area (Appendix B). Three communities in the Staten Island opted to enroll in the buyout program. Neighborhoods participating in the program are Oakwood Beach, Graham Beach, and Ocean Breeze (McGhee, 2017).

Map 11: Buyout Communities



Following information is obtained from a research conducted by McGhee (2017)[2].

In Oakwood Beach, 321 buyouts were offered and 300 of these were ultimately accepted

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[2] Information related to property acquisitions was acquired from interviews with the Director, Buyout & Acquisition Programs, Governor's Office of Storm Recovery (GSOR).

and executed. Of the participating properties, 264 were single-family dwelling. In Graham Beach, 120 buyouts were offered and 87 of these were ultimately accepted and executed. Of the participating properties, 60 were single-family dwellings. In Ocean Breeze, 108 buyouts were offered and 86 of those were ultimately accepted and executed. Of the participating properties, 79 were single-family dwellings.

Table 7: Buyout Statistics

Community	**Offered**	**Signed**	**Closed**
Oakwood Beach	321 (264)	317	300
Ocean Breeze	108 (79)	97	86
Graham Beach	120 (60)	106	87
Total	549	520	473

Source: McGhee (2017)

In order to study the change in volume of sales in the buyout communities, Zillow neighborhood boundaries were used to depict the approximate location and boundary. Sales occurring within those boundaries were isolated from 2003 through 2015 and plotted. Following graphs depict the sales information for the communities where buyouts were offered and closed. To some extent they explain the spike in sales after hurricane sandy in the coastal neighborhoods of Staten Island, since sales increased significantly in the year 2013 for all three communities.

Figure 10: Single-Family Property Sales in Oakwood Beach

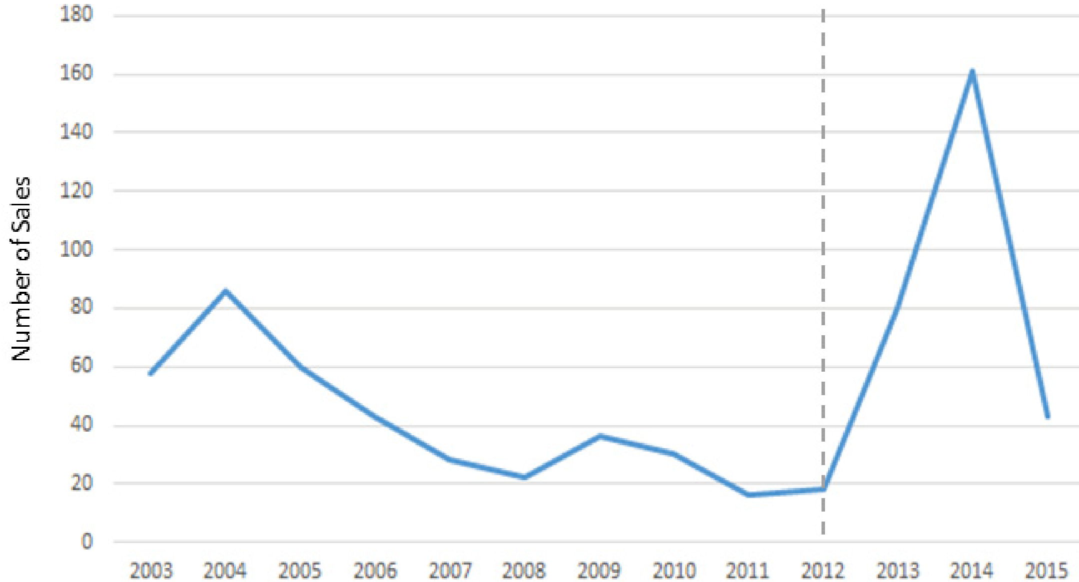


Figure 11: Single-Family Property Sales in South Beach (Ocean Breeze)

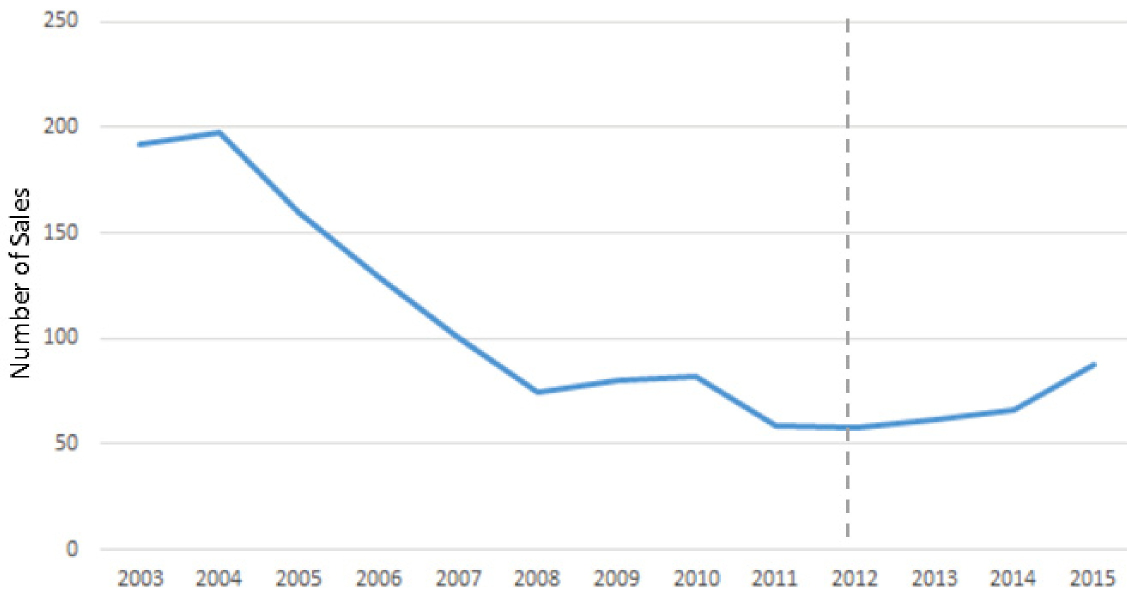
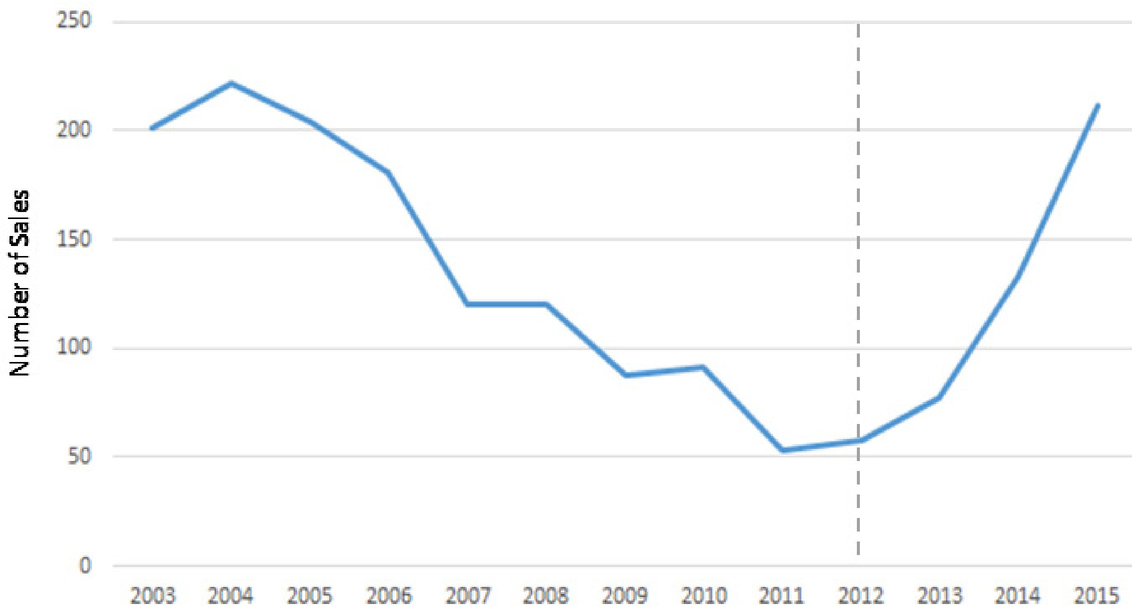


Figure 12: Single-Family Property Sales in Midland Beach (Graham Breeze)



While the program was voluntary some incentives (5 percent of pre-storm value) were offered to the homeowners who decided to relocate within the county (McGhee, 2017). According, to a study conducted by McGhee (2017), 74.92 percent (242) of the participants moved within Staten Island. This in turn increased the property sales for inland as well as coastal properties and affected the housing market to some extent. However, no details are available about the relocation of these homeowners.

b. Housing Price: Statistical Analysis

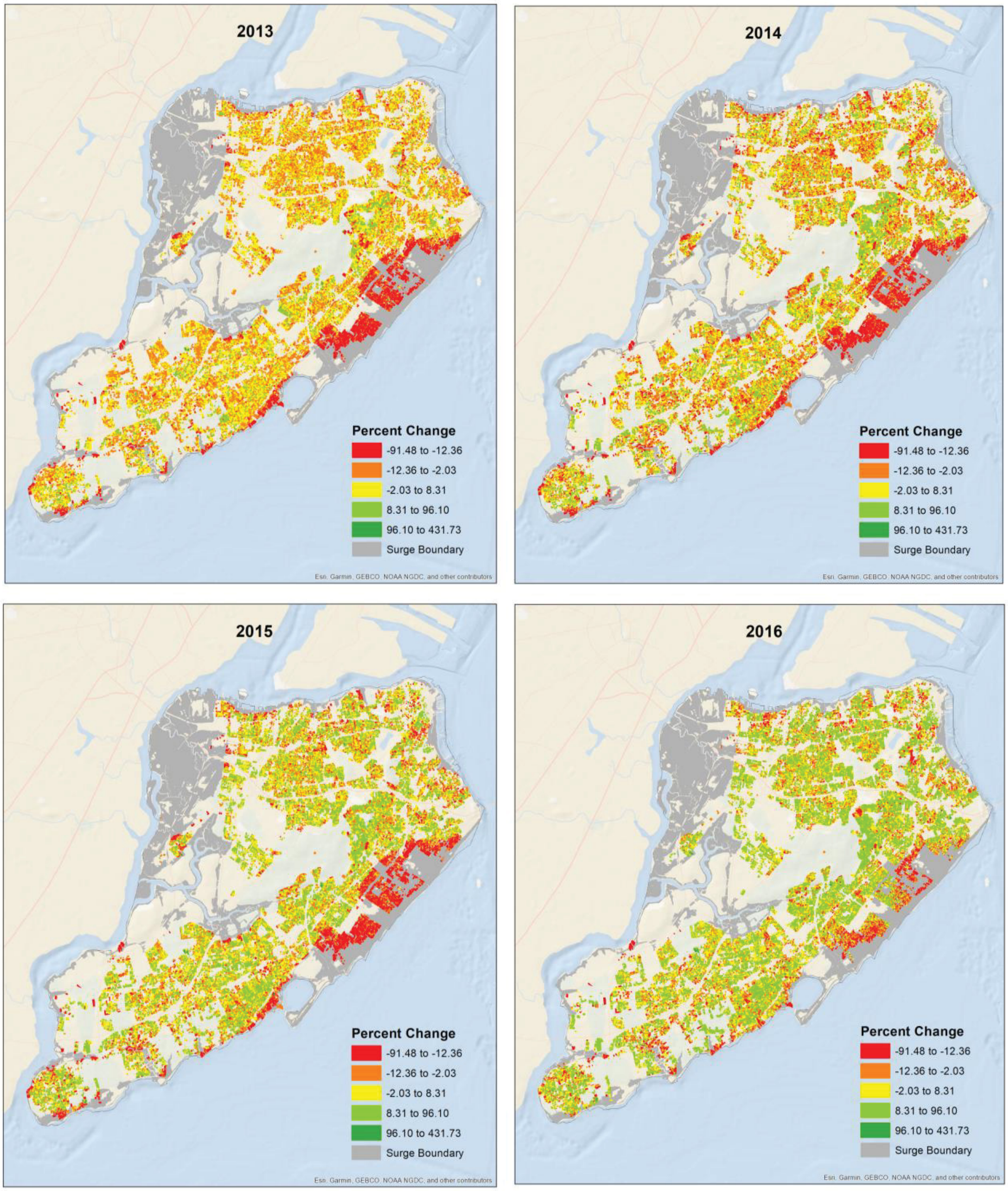
To address the first research objective of assessing the market differences between neighborhoods affected by the storm and neighborhoods that were outside the direct damage areas, I analyze the change in property values categorized by level of damage. Table 8 provides a detailed summary statistics of changes in home values. I have used appraised values of each single-family home in Staten Island - one pre-disaster (2012), and four post-disaster values for four subsequent years.

Consideration of the pre-Sandy housing prices served as a benchmark for assessing the state of the recovery. Compared to pre-disaster (2012) assessment, the median home value declined by almost 80,000 dollars i.e. -24.32 percent for homes that suffered major damage. Median property value reduced by 20.29 percent and 13.90 percent for minor damage and affected properties respectively. In 2016, four years after the storm, the median property value of damaged properties represented some gain compared to the previous year. Yet, they still remained below the 2012 level. Property value remained below 2012 average for 2014, 2015, and 2016 with a slight improvement every year.

Table 8: Change in the Median Property Values by Damage Categories

	No Damage	Percent Change	Affected	Percent Change	Minor	Percent Change	Major	Percent Change
2012	400,000	-----	386,000	-----	371,000	-----	329,000	-----
2013	390,000	-2.50	324,000	-16.06	297,000	-19.95	249,000	-24.32
2014	396,000	-1.00	327,000	-15.28	307,000	-17.25	270,000	-17.93
2015	415,000	3.75	329,000	-14.77	309,000	-16.71	275,000	-16.41
2016	432,000	8.00	377,000	-02.33	351,000	-05.39	306,000	-06.99

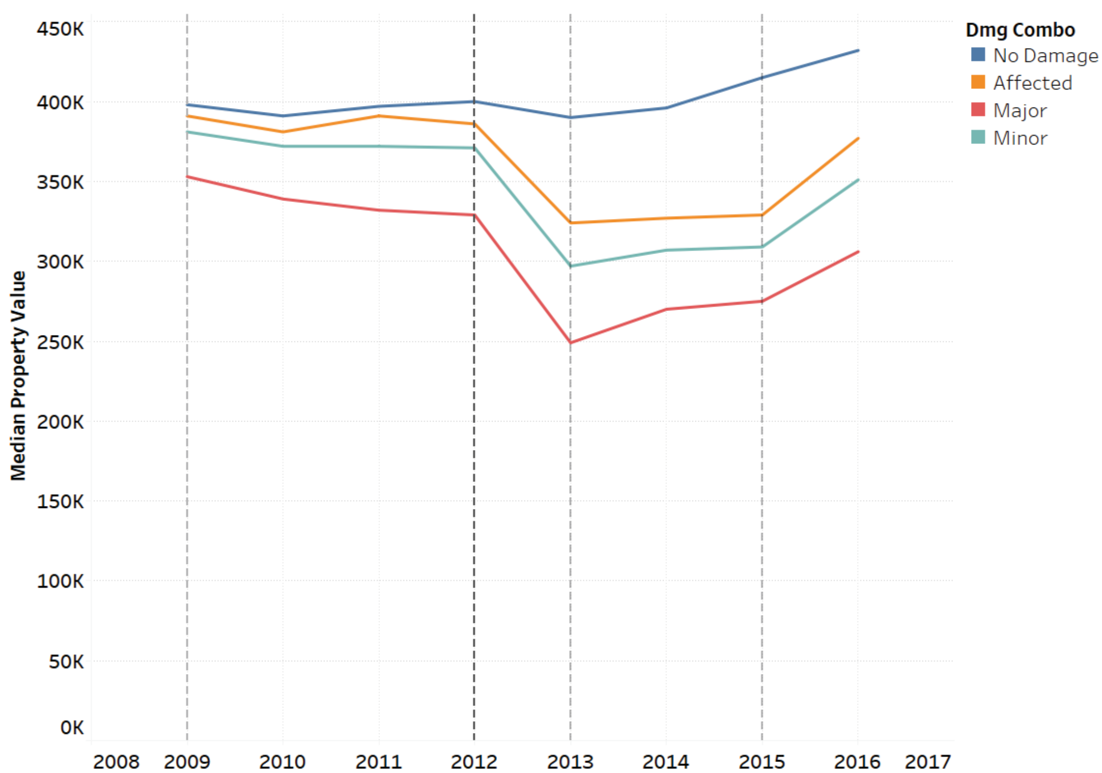
Map 12: (a, b, c, d): Change in Single-Family Property Values



Homes that did not suffer any damage, experienced an average reduction of 2.5 percent in their property value. In 2014, the median home value of properties not impacted by Sandy, represented a gain of $19,000 over its 2012 value; however, the properties affected by the storm had not reached their pre-disaster levels. In 2015, and 2016, the trend continued and the property values increased for the no damage properties.

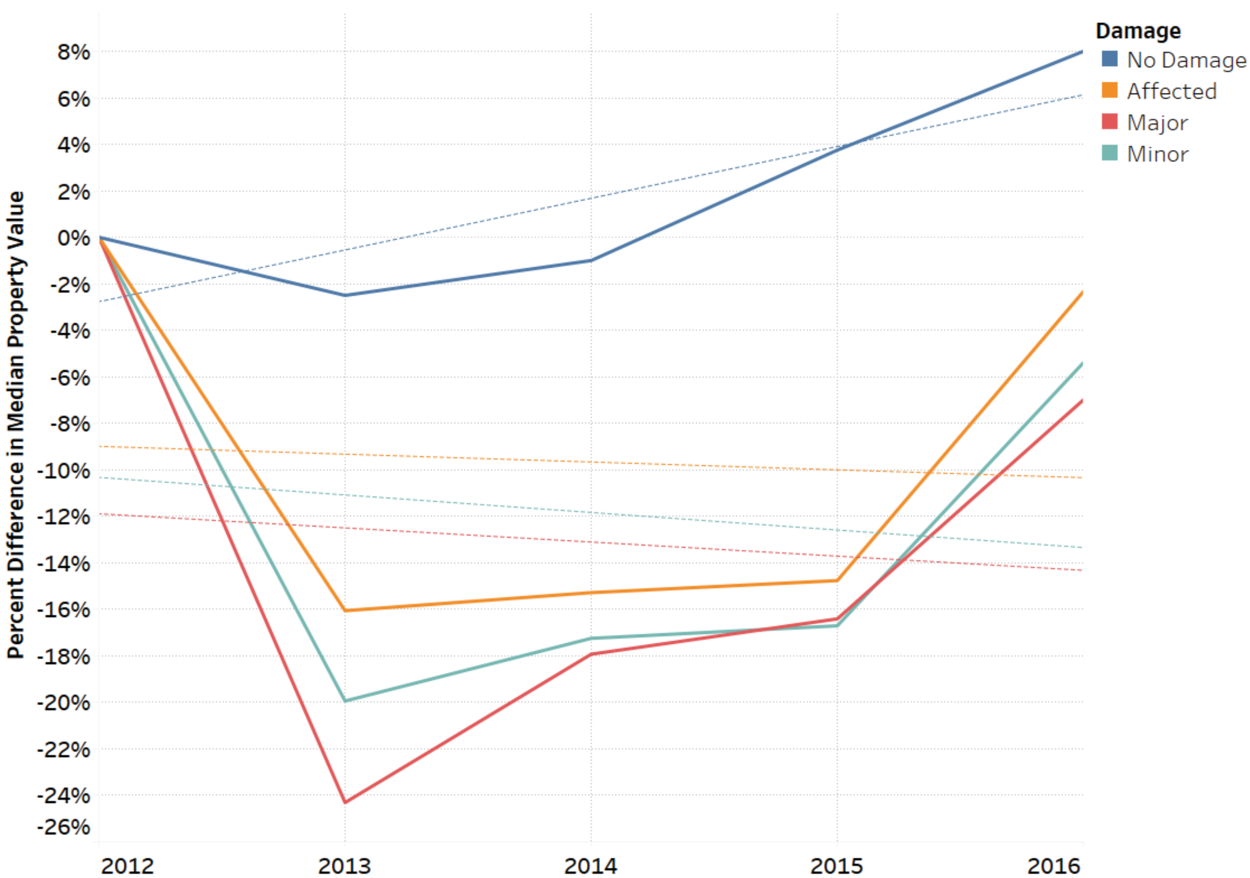
The damage caused by Sandy is clearly evident in the above maps. Since most of the coastal properties experienced flooding they suffered a huge hit and their property values were still below the 2012 levels even four years after the storm. The difference between inland and coastal neighborhoods could be spotted easily in Map 12. It also illustrates that majority of properties that experienced reduction in the values are clustered on the eastern shore of Staten Island where the most extensive inundation occurred in the low-lying residential areas (GOSR, 2014). All three buyout communities – Oakwood Beach, Midland Beach and South Beach lie on the East shore and experienced a drop in their property values.

Figure 13: Change in Median Property Value categorized by Damage



Percent change in median property value for each year is calculated with respect to the year 2012. Figure 13 and Figure 14, illustrate the change in the median value and percent change in the median value for each damage category as well as for the properties not damaged by Hurricane Sandy. From 2009 to 2012 there was not a significant difference in the property values in any of the damage categories. However, the property values of the affected single-family homes depict a huge drop in their values and remain below the 2012 level for the following four years. Results of the graph suggest that there was a huge drop in the property values for major damage properties followed by minor and affected properties. The large price penalty among the damaged properties particularly the ones which suffered major damage persisted for four years.

Figure 14: Percent Difference in Median Property Values categorized by Damage



Changes in the property values after Superstorm Sandy indicate a significant positive deviation for properties unaffected by the storm and negative deviations for those in the damage categories.

i. Correlation Analysis: Property Value

In order to answer the second research objective of identifying major factors that affected the housing market, Table 9 lists the intercorrelations among all variables. The final sample consisted of 75,884 single-family homes in which the data from 2012 to 2016 were merged. The correlation variables fall into three major categories i.e. housing characteristics, neighborhood characteristics, and damage caused by the storm.

All the damage categories have a negative correlation with the property values for the study period i.e. from 2012 through 2016. This indicates that the properties impacted by the storm were lower value properties. The degree of negative correlation in the years following the storm i.e. 2013 through 2016 increased slightly for minor and major damage properties. In 2016, the correlation variable decreased again for minor damaged properties indicating recovery and return to the normal pre-storm value. Even the combined damage variable depicts a similar trend of reduction in property prices after the storm. The 'damage_c_1' variable combines all types of damages in one column. The correlation becomes more negative after the storm suggesting the level of damage is inversely proportional to the price i.e. higher the damage lower the property price. Percentage of White population, median income, and percent of owner occupied properties are some of the variables that have moderate positive correlation with the home value for all the years. Whereas, other racial groups have weak to moderate negative correlation with the property values. The results depict that the intercorrelations between the socio-demographic characteristics and property values remained unaffected by the storm. Similarly, the correlation between household characteristics (area and age of the structure) stayed unchanged. Both the variables portray a positive relationship with the home value.

Table 9: Correlation Analysis: Property Value

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2012	1.00																			
2013	0.96	1.00																		
2014	0.93	0.97	1.00																	
2015	0.92	0.96	0.97	1.00																
2016	0.91	0.93	0.94	0.96	1.00															
Affected	-0.01	-0.05	-0.05	-0.07	-0.04	1.00														
Minor	-0.04	-0.11	-0.10	-0.12	-0.09	-0.04	1.00													
Major	-0.08	-0.14	-0.12	-0.13	-0.12	-0.03	-0.03	1.00												
Damage	-0.09	-0.19	-0.17	-0.19	-0.16	0.26	0.58	0.74	1.00											
Area (sqft)	0.78	0.77	0.75	0.78	0.76	-0.02	-0.04	-0.07	-0.08	1.00										
Year Built	0.03	0.03	0.03	0.05	0.04	0.02	0.04	0.00	0.02	0.01	1.00									
Median Income	0.30	0.32	0.32	0.32	0.31	-0.03	-0.03	-0.02	-0.05	0.15	0.06	1.00								
Percent White	0.32	0.31	0.31	0.31	0.31	0.06	0.06	0.04	0.09	0.10	0.07	0.45	1.00							
Percent Black	-0.29	-0.28	-0.27	-0.28	-0.28	-0.05	-0.06	-0.06	-0.10	-0.10	-0.11	-0.45	-0.91	1.00						
Percent American Indian	-0.21	-0.20	-0.20	-0.19	-0.20	-0.05	-0.06	-0.04	-0.08	-0.09	-0.17	-0.27	-0.60	0.58	1.00					
Percent Asian	-0.08	-0.07	-0.07	-0.07	-0.07	-0.04	-0.02	-0.03	-0.05	0.00	0.15	-0.05	-0.46	0.11	0.07	1.00				
Percent Hawaiian	-0.06	-0.06	-0.06	-0.07	-0.06	-0.02	-0.01	-0.02	-0.03	-0.03	-0.04	-0.05	-0.11	0.08	0.05	0.04	1.00			
Percent Other	-0.34	-0.34	-0.33	-0.33	-0.33	-0.04	-0.02	0.01	-0.02	-0.13	-0.15	-0.47	-0.84	0.75	0.62	0.16	0.11	1.00		
Percent Two or More	-0.32	-0.32	-0.32	-0.32	-0.31	-0.04	-0.03	-0.01	-0.04	-0.13	-0.15	-0.40	-0.81	0.71	0.59	0.24	0.15	0.77	1.00	
Percent Owner	0.24	0.25	0.24	0.24	0.24	0.02	-0.02	-0.04	-0.04	0.09	0.16	0.53	0.56	-0.59	-0.40	0.02	-0.09	-0.59	-0.58	1.00

Tax assessment data for all the single-family parcels in Staten Island is used to construct the following model. The difference in housing value between 2012 and 2013 is coded into two categories - no change or increase in the price, and decrease in the price. A binary regression model (Logistic) is used, since the response variable, increase or decrease in the housing price, is a dichotomous variable. The independent parameters used in the model are area of the property, year the structure was built, value of the property in 2012 (before Sandy), percent of African American population, and Median Income in 2010.

Table 10: Logistic Regression: Change in Property Value

Parameter	Description	Odds Ratio	Percent Difference	P>|z|	[95% Conf. Interval]	
Damage_c_1	FEMA damage determination data	0.184591	-81.54087	0.000	0.1711746	0.1990596
GR_SQFT	Area of the property in square feet	1.000037	0.0037	0.021	1.000006	1.000069
YRB	Year the structure was built	0.999298	-0.07016	0.000	0.9990368	0.9995601
F2012	Market value in 2012	0.999998	-0.00014	0.000	0.9999984	0.9999987
PerBlack	Percent of African American population in the Block Group	0.995858	-0.41411	0.000	0.9946921	0.9970271
MedIncome	Median Income in 2010	1.00000	0.0006	0.000	1.000006	1.000007

R^2 – 0.0693

Storm damaged properties are more likely to have suffered a large reduction in the property values in 2013. According to the results, the price reduction increased significantly with the increase in damage levels. Damage caused by the storm came out to be the only variable having considerable impact on the prices. Although this research could not determine the factors affecting the change, it quantified the losses in property values regardless.

Discussion

This portion summarizes the major conclusions from analysis presented in the above paragraphs. In this research, I examined Hurricane Sandy's impact on the single-family housing market in Staten Island. Descriptive statistics, intercorrelations, and regression models were applied to answer two research questions: (1) Are there any market differences between neighborhoods affected by the storm and the neighborhoods that were outside the direct damage area? and, (2) What were the factors affecting the single-family housing market in Staten Island?

Objective 1: After comparing the volume of sales before and after Sandy, 2003 to 2016, it appears that the sales of major damage properties increased by approximately 140 percent from the previous year, while the sales dropped by 7 percent for undamaged properties. Around 34 percent of the damaged property sales (550 homes), in Staten Island, were an outcome of the State's Buyout Policy. The results of our empirical analysis suggest that home prices of the affected properties experienced a dip from 2013 through 2016 while the transaction volume increased for that period. In 2013, median housing prices dropped by 24.32 percent for major damage, 19.95 percent for minor damage, 16.06 percent for affected properties and only 2.5 percent for undamaged properties. Three years following the storm (2015), the median home value for undamaged properties returned to its pre-disaster levels. However, this was not the case for properties affected by the storm. Spatial distribution of the percent change in property values clearly depicts a difference in recovery of inland vs coastal properties. It indicates that the prices of coastal properties experienced a drop after the storm and remained below 2012 levels for rest of the time period.

Objective 2: Based on the results it is clear that socio-demographic and household variables considered in the research did not influence the housing sales and prices post-disaster. Damage caused by the storm had a weak to moderate correlation in impacting both the sale volume and prices. Consideration of the Buyout Policy suggests that approximately 34 percent of the sales of the affected properties were contributed by the policy. According to McGhee (2017), almost 75 percent of the buyout policy participants relocated within Staten Island. This in turn increased the demand for inland as well as coastal properties in the county. However, additional research needs to be conducted to understand the in-depth impacts of the policy on the housing market. Conclusions, limitations and further research questions are mentioned in the next chapter.

CHAPTER 5

Discussion, Limitations, and Future Research

This chapter provides conclusions, contributions, and limitations of this work with questions for future research. This thesis presents an information driven outline for the assessment of the post-disaster housing market and illustrates an example of how the housing market can be analyzed inside a specific boundary. Numerous secondary datasets, ranging from demographics to damage data, are used to achieve the objective of evaluating the residential market after a disaster.

Through analysis of pre-and-post-Sandy single-family property sales, I found out that there was a relative increase in the sales of damaged properties as compared to the undamaged properties. New York State's Home Buyout Policy was one of the major reasons for increased sales. The buyout policy permanently altered the neighborhood dynamics and impacted the sales both on the coast and inland. To explore the further impacts of the policy, it would be worth investigating the following: (1) What demand was created for which type of properties? (2) Which communities in Staten Island saw the maximum demand from the buyout program participants? A careful consideration and analysis of the effects of government policies like this one will provide guidance for mitigating the effects of future major hurricanes.

Significant and negative impacts on housing prices could be directly attributed to differing damage levels and surge depths. The drop in the market values of single-family housing corresponded to the damage inflicted by the flooding water. In Staten Island, property values recovered at a slower pace for some neighborhoods. Thus, it is critical to address these issues with programs and policies to monitor the changes and differences. The results of this study can help concerned groups to emphasize more on particular sites i.e. areas whose property values are still below 2012 levels and plan to help the residents. A valuable supplement to the analysis in this study would be an exploration of why property value recovery rates differed so substantially across the neighborhoods. It would provide further guidance to policymakers about how to steer toward more equitable and sustainable recovery. Thus, various questions arise from this analysis: (1) whether the effects of the storm on property values reveal a new truth for coastal and waterfront areas, (2) is there a relation between lower property values and new floodplain maps, (3) whether the new building restrictions are delaying the process of rebuilding the damage structures.

In conclusion, Sandy affected Staten Island's housing and neighborhoods in many ways -it altered the coastal neighborhoods permanently and had a severe impact on the property prices. A combination of damage levels and buyout policy resulted in the above outcomes. Going beyond Staten Island and Sandy, it is important to recognize these special circumstances that arise after a major disaster and the pressures that they can exert on the permanent housing market. The increase in intensity and frequency of extreme weather events underscores the risk of building and rebuilding homes in areas threatened by storm damage, and has created an urgent need for better understanding of housing market recovery. Finally, in a broader context, the approach and methods used in this study can be applied to many communities and other disasters, and in the future to examine housing markets. This research has identified several areas of extra examination that would help to improve or reinforce the conclusions from this study.

REFERENCES

1. Atreya, A., Ferreira, S., & Kriesel, W. (2013). Forgetting the flood? An analysis of the flood risk discount over time. Land Economics, 89(4), 577-596.
2. Amadeo, K. (2018, March 1). Hurricane Harvey Facts, Damage and Costs. The Balance. Retrieved from https://www.thebalance.com/hurricane-harvey-facts-damage-costs-4150087
3. Bates, L. K. (2006). Post-Katrina Housing: Problems, Policies, and Prospects for African-Americans in New Orleans. The Black Scholar, 36(4), 13-31.
4. Bauerlein, V., Calvert, S., Kamp, J. (2017, September 12). Hurricane Irma Destroyed 25% of Homes in Florida Keys, FEMA Estimates. The Wall Street Journal. retrieved from https://www.wsj.com/articles/hurricane-irma-destroyed-25-of-homes-in-florida-keys-fema-estimates-1505233551
5. Beracha, E., & Prati, R. S. (2008). How major hurricanes impact housing prices and transaction volume. REAL ESTATE ISSUES-AMERICAN SOCIETY OF REAL ESTATE COUNSELORS, 33(1), 45.
6. Bin, O., & Polasky, S. (2004). Effects of flood hazards on property values: evidence before and after Hurricane Floyd. Land Economics, 80(4), 490-500.
7. Binder, S. B., & Greer, A. (2016). The devil is in the details: Linking home buyout policy, practice, and experience after hurricane Sandy. Politics and Governance, 4(4), 97-106.
8. Blake, E. S., Kimberlain, T. B., Berg, R. J., Cangialosi, J. P., & Beven Ii, J. L. (2013). Tropical cyclone report: Hurricane sandy. National Hurricane Center, 12, 1-10. retrieved from https://www.nhc.noaa.gov/data/tcr/AL182012_Sandy.pdf
9. Bolin, R., & Stanford, L. (1991). Shelter, housing and recovery: A comparison of US disasters. Disasters, 15(1), 24-34.
10. Burrus Jr, R. T., Graham Jr, J. E., Hall, W. W., & Schuhmann, P. W. (2009). Home-Buyer Sentiment and Hurricane Landfalls. Appraisal Journal, 77(4).
11. Center for an Urban Future. (2011). Staten Island: Then and Now. retrieved from https://nycfuture.org/pdf/Staten_Island_-_Then_and_Now.pdf
12. City of New York. (2013). PlaNYC: A Stronger and More Resilient New York. New York City Mayor's Office, retrieved from http://s-media.nyc.gov/agencies/sirr/SIRR_singles_Lo_res.pdf

13. Comerio, M. C. (1997). Housing issues after disasters. Journal of Contingencies and Crisis Management, 5(3), 166-178.
14. Comerio, M. C. (1998). Disaster Hits Home: New Policy for Urban Housing Recovery, Berkeley: University of California Press.
15. Drye, W. (2017, November 30). 2017 Hurricane Season Was the Most Expensive in U.S. History. National Geographic. Retrieved from https://news.nationalgeographic.com/2017/11/2017-hurricane-season-most-expensive-us-history-spd/
16. FEMA. (2013). Hurricane Sandy in New Jersey and New York. Mitigation Assessment Team Report, retrieved from https://www.fema.gov/media-library-data/1386850803857-025eb299df32c6782fdcbb6f69b35b13/Combined_Sandy_MAT_Report_508post.pdf
17. Freudenberg, R., Calvin, E., Tolkoff, L., & Brawley, D. (2016). Buy-In for Buyouts: The Case for Managed Retreat from Flood Zones. Lincoln Institute of Land Policy.
18. Furman Center. (2013). Sandy's Effects on Housing in New York City. retrieved from http://furmancenter.org/files/publications/SandysEffectsOnHousingInNYC.pdf
19. GOSR, 2014. NY Rising Community Reconstruction Program East & South Shores Staten Island. New York State Governor's Office of Storm Recovery retrieved from https://stormrecovery.ny.gov/sites/default/files/crp/community/documents/statenisland_nyrcr_plan_20mb.pdf
20. Graham Jr, J. E., & Hall Jr, W. W. (2001). Hurricanes, housing market activity, and coastal real estate values. Appraisal Journal, 69(4), 379-379
21. Green, R., Bates, L. K., & Smyth, A. (2007). Impediments to recovery in New Orleans' upper and lower ninth ward: One year after hurricane Katrina. Disasters, 31(4), 311-335.
22. Gudell, S. (2017, Sep 7). Hurricanes Harvey & Irma: What They Could Mean for Housing. Forbes. Retrived form https://www.forbes.com/sites/zillow/2017/09/07/hurricanes-harvey-irma-what-we-know-and-what-to-expect/#5d53a4233e71
23. Hallstrom, D. G., & Smith, V. K. (2005). Market responses to hurricanes. Journal of Environmental Economics and Management, 50(3), 541-561.
24. Hurricane Sandy Rebuilding Task Force. (2013). Hurricane Sandy Rebuilding Strategy Stronger Communities, A Resilient Region. retrieved from https://www.hud.gov/sites/documents/HSREBUILDINGSTRATEGY.PDF

25. Kelly, C., Costa, K., Edelman, S. (2017, October 3). Safe, Strong, and Just Rebuilding After Hurricanes Harvey, Irma, and Maria. Center for American Progress. Retrieved from https://www.americanprogress.org/issues/green/reports/2017/10/03/440134/safe-strong-just-rebuilding-hurricanes-harvey-irma-maria/
26. Levine, J. N., Esnard, A. M., & Sapat, A. (2007). Population displacement and housing dilemmas due to catastrophic disasters. Journal of planning literature, 22(1), 3-15.
27. Lindell, M. K., Zhang, Y., & Hwang, S. N. (2009). Hazard proximity or risk perception? Evaluating effects of natural and technological hazards on housing values. Environment and Behavior, 42(5), 597-624.
28. Main, M.D. (2012, November 08). Hurricane Sandy's Storm Surge Mapped… Before it Hit. Huffpost. retrieved from https://www.huffingtonpost.com/2012/11/08/hurricane-sandys-storm-surge-map_n_2094939.html
29. McCarthy, K. F., & Hanson, M. (2008). Post-Katrina recovery of the housing market along the Mississippi Gulf Coast (No. 511). Rand Corporation.
30. McGhee, D. (2017). Were the Post-Sandy Staten Island Buyouts Successful in Reducing National Vulnerability?
31. Mukherji, A. (2017, April 26). Post-Disaster Housing Recovery. Oxford Research Encyclopedia of Natural Hazard Science. Ed. Retrieved 28 Aug. 2018, from http://naturalhazardscience.oxfordre.com/view/10.1093/acrefore/9780199389407.001.0001/acrefore-9780199389407-e-82.
32. Murphy, A., & Strobl, E. (2009). The impact of hurricanes on housing prices: evidence from US coastal cities.
33. National Low Income Housing Coalition (NLIHC) (2005). Preliminary Estimates of Hurricane Katrina's Impact on Low Income Housing Units, NLIHC Research Notes 05-02. Retrieved from https://www.scribd.com/document/265294/Hurricane-Katrina-s-Impact-on-Low-Income-Housing-Units
34. Nonko, E. (2017). Staten Island neighborhoods damaged by Hurricane Sandy may be rezoned. Curbed New York. retrieved from https://ny.curbed.com/2017/5/3/15528676/staten-island-rezoning-hurricane-sandy-recovery

35. NYC. (2014). The City of New York Hazard Mitigation Plan 2014. retrieved from http://www.nyc.gov/html/oem/downloads/pdf/hazard_mitigation/plan_update_2014/final_draft_nyc_hmp.pdf
36. NYC, Department of City Planning. Land Use Map Guidelines. retrieved from https://www1.nyc.gov/assets/planning/download/pdf/applicants/applicant-portal/land_use_map_guidelines.pdf
37. NYC Finance Department. NYC Residential Property Taxes. retrieved from http://www1.nyc.gov/assets/finance/downloads/pdf/brochures/class_1_guide.pdf
38. NYU Furman Center. (2011). State of New York City's Housing and Neighborhoods in 2011. retrieved from http://furmancenter.org/research/sonychan/2011-report
39. NYU Furman Center. (2012). State of New York City's Housing and Neighborhoods in 2012. retrieved from http://furmancenter.org/research/sonychan/2012-report http://furmancenter.org/research/sonychan/2011-report
40. NYU Furman Center. (2013). State of New York City's Housing and Neighborhoods in 2013. retrieved from http://furmancenter.org/research/sonychan/2013-report http://furmancenter.org/research/sonychan/2011-report
41. Paris, E. (2018, January 22). The Natural Disasters Of 2017's Impact On The Housing Market Will Surprise You. retrieved from https://www.forbes.com/sites/ellenparis/2018/01/22/the-natural-disasters-of-2017s-impact-on-the-housing-market-will-surprise-you/#7e6e7ba814c3
42. Peacock, W. G., Gladwin, H., & Morrow, B. H. (2012). Hurricane Andrew: Ethnicity, gender and the sociology of disasters. Routledge.
43. Peacock, W. G., Van Zandt, S., Zhang, Y., & Highfield, W. E. (2014). Inequities in long-term housing recovery after disasters. Journal of the American Planning Association, 80(4), 356-371.
44. Peacock, W. G., Dash, N., Zhang, Y., & Van Zandt, S. (2018). Post-Disaster Sheltering, Temporary Housing and Permanent Housing Recovery. In Handbook of Disaster Research (pp. 569-594). Springer, Cham.
45. Rich, M. (2005, September 5). Housing Boom May Continue After Storm, Experts Say. The New York Times. Retrieved from

https://www.nytimes.com/2005/09/05/business/housing-boom-may-continue-after-storm-experts-say.html

46. Sean, C., De la Roca, J., Findlan, K., Ellen, I. G., Madar, J., Moriarty, S., ... & Willis, M. (2014). State of New York City's Housing and Neighborhoods in 2013. New York: New York University Furman Center for Real Estate and Urban Policy. retrieved from http://furmancenter.org/files/sotc/SOC2013_HighRes.pdf
47. Stevenson, J. R., Emrich, C. T., Mitchell, J. T., & Cutter, S. L. (2010). Using building permits to monitor disaster recovery: A spatio-temporal case study of coastal Mississippi following Hurricane Katrina. Cartography and Geographic Information Science, 37(1), 57-68.
48. The National Association of Realtors. (2006). The Impact of Hurricanes on Housing and Economic Activity: A Case Study for Florida. retrieved from http://narfocus.com/billdatabase/clientfiles/172/4/2310.pdf
49. City of New York. (2013). A stronger and more resilient New York. retrieved from http://s-media.nyc.gov/agencies/sirr/SIRR_singles_Lo_res.pdf
50. U.S. Census Bureau. 2010. Summary File 1 Dataset.
51. U.S. Department of Housing and Urban Development (HUD). 2015. Comprehensive Housing Market Analysis - New York City, New York. retrieved from https://www.huduser.gov/portal/publications/pdf/NYC-comp-16.pdf
52. Vigdor, J. (2008). The economic aftermath of Hurricane Katrina. Journal of Economic Perspectives, 22(4), 135-54.
53. Zandt, S.V. (2017, November 20). A Place to call Home: Planning for Equitable Post-Disaster Housing Recovery. retrieved form https://hazards.colorado.edu/news/research-counts/a-place-to-call-home-planning-for-equitable-post-disaster-housing-recovery
54. Zhang, Y. (2006). Modeling single-family housing recovery after Hurricane Andrew in Miami-Dade County, FL (Unpublished Doctoral Dissertation) Texas A&M University, College Station, TX
55. Zhang, Y., & Peacock, W. G. (2009). Planning for housing recovery? Lessons learned from Hurricane Andrew. Journal of the American Planning Association, 76(1), 5-24.

Appendix A

Building Damage Classification by FEMA

FEMA DAMAGE CLASSIFICATION		VISIBLE IMAGERY BASED CLASSIFICATION				INUNDATION ASSESSMENTS
DAMAGE LEVEL	**OBSERVED DAMAGE**	**Roof Covering**	**Roof Diaphragm**	**Collapsed Walls**	**Other Considerations**	
Affected	Generally superficial damage to solid structures (loss of tiles or roof shingles); some mobile homes and light structures damaged or displaced.	Up to 20%	None	None	Gutters and/or awning; loss of vinyl or metal siding	Field Verified Flood Depth (or Storm Surge): >0 to 2 feet relative to the ground surface at structure. Depth damage relationships may vary based on building or foundation type, as well as duration or velocity of flood event.
Minor	Solid structures sustain exterior damage (e.g., missing roofs or roof segments); some mobile homes and light structures are destroyed, many are damaged or displaced.	>20%	Up to 20%	None	Collapse of chimney; garage doors collapse inward; failure of porch or carport Mobile homes could be partially off foundation	Field Verified Flood Depth (or Storm Surge): 2 to 5 feet relative to the ground surface at structure. Depth damage relationships may vary based on building or foundation type, as well as duration or velocity of flood event.
Major	Wind: Some solid structures are destroyed; most sustain exterior and interior damage (roofs missing, interior walls exposed); most mobile homes and light structures are destroyed.	-	>20%	Some exterior walls are collapsed.	Mobile home could be completely off foundation – if appears to be repairable.	Field Verified Flood Depth: Greater than 5 feet, modeling observed, relative to the ground surface at structure, and not high rise construction. Depth damage relationships may vary based on building or foundation type, as well as duration or velocity of flood event.
	Storm Surge: Extensive structural damage and/or partial collapse due to surge effects. Partial collapse of exterior bearing walls.			Some exterior walls are collapsed		Major is the general category where the onset of Substantial Damage (>50% of building value) as defined by the National Flood Insurance Program (NFIP) may occur.
Destroyed	Wind: Most solid and all light or mobile home structures destroyed.	-	-	Majority of the exterior walls are collapsed.	-	-
	Storm Surge: The structure has been completely destroyed or washed away by surge effects.	-	-	Majority of the exterior walls are collapsed		

Key attributes for these building determination points include:

DAMAGE: Damage level estimated based on visible aerial imagery

INUNDATED: Presence or absence of inundation based on visible aerial imagery

DAMAGETYPE: Indicates if damage was determined based on visible imagery or observed inundation or both.

DMG_COMBO: Damage level based on the combination of visible imagery and water depth estimated at each structure point based on the FEMA-MOTF observed inundation products.

DEPTH: The depth in feet of inundation at each structure point relative to the ground surface.

Appendix B

Property Buyouts Selection Criteria

SUMMARY OF ELIGIBILITY CRITERIA, INCENTIVES AND OUTCOMES	
ACQUISITION	BUYOUT
Property Eligibility Requirements	
• Property in eligible county • Located in 100 year and/or 500 year floodplains • Substantially damaged during qualifying storm • Property is either one-family residence, two-family residence, rental property, second home or adjacent vacant land	• Property in eligible county • Located in 100 year floodplain • Substantially damaged during qualifying storm • Property is either one-family residence, two-family residence, rental property, or vacant land within enhanced buyout area
Owner Eligibility Requirements	
• Participant owns property • Participant is citizen or eligible immigrant • Participant meets one of CDBG National Objectives	• Participant owns property • Participant is citizen or eligible immigrant • Participant meets one of CDBG National Objectives
Incentives	
• Gradient Resettlement Incentive available depending on property value lost • Additional 50% post-storm FMV available if property value loss > 50% pre-storm value • Not available for Second homes or FEMA non-compliant applicants	• 5% Replacement Dwelling Incentive if replacement dwelling purchased within NYC's five boroughs • 10% Enhanced Buyout Incentive for properties within enhanced buyout area (all) • FEMA non-compliant applicants are not eligible for incentives
Outcome	
• Property acquired by state, eligible for redevelopment	• Property acquired by state, maintained as coastal buffer area in perpetuity

Every property in the Program is classified as either being within the Enhanced Buyout Area (EBA) or outside of the EBA in areas eligible for Acquisition (also known as the 100-year and 500-year floodplains).