Were the Post-Sandy Staten Island Buyouts Successful in Reducing National Vulnerability?

By
Devon McGhee
Dr. Elizabeth A. Albright, Adviser
Dr. Sherri Brokopp Binder, Client
April 28, 2017

Masters project proposal submitted in partial fulfillment of the requirements for the Master of Environmental Management degree in the Nicholas School of the Environment of Duke University
1 EXECUTIVE SUMMARY

Federally-funded buyout programs are often championed as effective post-disaster mitigation efforts in light of anticipated sea level rise and increasing inhabitance of the hazardous coast. As the impacts of climate change are realized, human settlements in areas vulnerable to coastal processes, such as erosion and barrier island migration, will become increasingly at risk to coastal hazards. Though the precise change in coastal storms due to climate change is unknown, it seems likely that, with time, more coastal property owners will be faced with the prospect of relocating on the federal dollar.

However, before federally-funded home buyout programs are assumed to be our country’s solution to coastal vulnerability, their capacity to effectively reduce vulnerability should be evaluated. Through an evaluation of the New York Rising Buyout and Acquisition Program, this analysis seeks to quantify the success of the program in reducing coastal vulnerability nationwide. In order to do so, a methodology was developed to compare the vulnerability of people and property to coastal flood hazards before and after the implementation of the buyout program in Staten Island.

First, the addresses of the buyout locations were determined using the New York State Housing Trust Fund Corporation’s Property Disposal Reports. Publicly available tax documents were then accessed to determine the names of homeowners at the time of Superstorm Sandy. Next, the most recent addresses of homeowners were found through a search of publicly available documents. Finally, origin and relocation address coordinates were assigned using a georeferencing service. With this information, trends in the relocation behavior of buyout participants were identified.

Vulnerability was then measured at both the origin and relocation addresses. Indicators of vulnerability were chosen based on a review of the relevant literature and similar analyses. To capture the multidimensional nature of overall vulnerability, indicators of both exposure and social vulnerability were used. The changes in exposure and social vulnerability were then determined through a comparison of vulnerability at the locations of the buyouts in Staten Island and at the relocation addresses of buyout participants. An overall change in vulnerability score was calculated by first standardizing, and then averaging, the exposure and social vulnerability components. This approach assumes that exposure and social vulnerability are equal contributors to overall vulnerability.

This analysis concludes that significant uncertainty remains with respect to whether or not the $190 million Staten Island buyout program met its objective of reducing the vulnerability of people and property to coastal flood hazards. It finds that over 20% of buyout participants moved to an area at least
as exposed to coastal flood hazards as the buyouts areas in Staten Island. Further, 321 of the 323 buyout participants studied relocated to an area with higher levels of poverty. Two-thirds of the sample moved to an area with a higher proportion of elderly residents. On average, buyout participants saw a 26% increase in their overall vulnerability score following participation in the program.

Based on these findings, this report makes several recommendations with the intent of developing more effective buyout policy in the future:

- Follow-up surveys should be conducted with all buyout program participants. These surveys would provide valuable information about which factors may have influenced a participant’s decision to relocate where they did.
- The results of these surveys may be used to inform incentive strategies that discourage relocation to vulnerable areas. They may also be useful in quantifying the success of future buyout programs. Robust evidence regarding the success of past buyout programs may encourage future participation.
- A preemptive buyout program should be developed and implemented along imminently threatened shorelines. A proactive approach would allow for the more thoughtful and effective relocation of vulnerable populations.
- Finally, we must consider whether or not the current method of post-disaster relocation from the vulnerable coast is the most effective. Large-scale relocation from densely populated coastlines may require a novel approach in order to be successful.
# Table of Contents

1. Executive Summary ........................................... II
2. Abstract .................................................................... 2
3. Introduction .................................................................. 3
4. Research Question .................................................. 3
5. Defining Vulnerability and the Use of Vulnerability Assessments ................. 4
6. Superstorm Sandy and Staten Island ................................ 7
7. Program Objectives and Financing Structure .................................. 9
8. Study Communities .................................................. 13
   8.1 Community Development Block Grant Disaster Recovery Funding ............... 9
   8.2 NY Rising Buyout and Acquisition Program ................................... 10
   8.3 Hierarchy of Objectives ........................................... 12
9. Methods ....................................................................... 18
   10.1 Overview .......................................................... 19
   10.2 Determining Origin Addresses and Trends in Relocation ......................... 19
   10.3 Measuring Vulnerability ................................ ...... 22
       10.3.1 Measuring Exposure .................................... 22
       10.3.2 Measuring Sensitivity and Adaptive Capacity ......................... 24
       10.3.3 Calculating Overall Change in Vulnerability ...................... 27
10. Results and Discussion ........................................... 28
   11.1 Trends in Relocation .......................................... 28
   11.2 Exposure Vulnerability ....................................... 31
       11.2.1 Severe Repetitive Loss Properties on Staten Island .................... 33
   11.3 Social Vulnerability ........................................... 33
   11.4 Overall Vulnerability ......................................... 34
   11.5 Ecological Vulnerability ..................................... 35
11. Other Considerations ............................................... 36
   12.1 Limitations and Future Directions ................................ 36
   12.2 Buyout Best Practices ...................................... 40
   12.3 USACE Proposed Line of Protection ............................ 41
12. Conclusions and Recommendations ................................ 42
   13.1 Recommendations for Buyout Policy and Administration .................... 44
13. Acknowledgements .................................................. 47
14. Bibliography ......................................................... 48
3 ABSTRACT

An increasingly common post-disaster mitigation approach, home buyout programs are generally intended to reduce vulnerability to future disasters. However, to date, there has been no quantitative evaluation of whether or not coastal buyout programs are successful in reducing vulnerability. Through a change in vulnerability analysis, this study quantifies the success of the Staten Island buyout program in reducing the nationwide vulnerability of people and property to coastal flood hazards. Results show an increase in overall vulnerability, which includes exposure and social vulnerability, for 99% of the buyout participants studied. Buyout participants tend to relocate within five miles of their origin addresses, move to areas with higher levels of poverty, higher population density and greater percentages of individuals over 65. Given these results, it remains unclear whether the program met its objective of reducing the vulnerability of people and property to coastal flood hazards.
4 INTRODUCTION

Staten Island, one of New York City’s five boroughs, was shattered by Superstorm Sandy in late October of 2012. The 16-foot peak storm surge devastated the vulnerable, low lying communities of Staten Island’s eastern and southern shores (NY Rising Community Reconstruction Staten Island East & South Shores Planning Committee March 2014). With 23 casualties, over 120,000 residents without electricity and nearly 30% of its building declared to be structurally unsound following the storm, Staten Island was one of New York’s most severely impacted communities (New York City June 2013).

The most expensive storm since Hurricane Katrina, Superstorm Sandy demonstrated the vulnerability of New York, New Jersey, and Connecticut damaging over 650,000 homes and leaving more than 8.5 million people without power (Horton, et al. 2014). Congress appropriated approximately $60 billion to supplement recovery efforts in areas affected by the storm. As part of the Community Development Block Grant Disaster Recovery Program, administered by the Department of Housing and Urban Development, New York State (NYS) received over $4 billion in supplemental funding for recovery and relief efforts (State of New York 2016). Though much of this money was appropriated to housing assistance and economic development initiatives, a portion of the funds were devoted to increasing resilience. As a part of these resilience-building efforts, the voluntary New York Rising Buyout and Acquisition Program was allocated approximately $620 million to fund the purchase of residential properties in the most vulnerable areas impacted by Superstorm Sandy (State of New York 2016).

Federally-funded buyout programs are often championed as a post-disaster mitigation method in light of anticipated sea level rise and increasing inhabitance of the hazardous coast (De Vries and Fraser 2012). As the impacts of climate change are realized, human settlements in areas vulnerable to coastal processes, such as erosion and barrier island migration, will become increasingly at risk to coastal hazards. With sea level rise, absent any change in coastal storms, coastal flooding is expected to triple in the northeast (Horton, et al. 2014). Though the precise change in coastal storms due to climate change is unknown (Horton, et al. 2014), it seems likely that, with time, more coastal property owners will be faced with the prospect of relocating on the federal dollar.

As such, the ability of these buyout and acquisition programs to meet their intended objectives must be evaluated. Through my analysis, I evaluate the success of Staten Island’s buyout program in meeting its objectives. Because these buyouts are federally-funded, program success is considered at the national level.

5 RESEARCH QUESTION

The objective of this study is to determine, quantitatively, whether our nation’s vulnerability to coastal flood hazards has been reduced by the NY Rising Buyout and Acquisition Program. To the extent feasible, I determine how the exposure, sensitivity and adaptive capacity of participating communities have changed. By assessing the change in exposure, sensitivity and adaptive capacity, conclusions are drawn regarding the efficacy of buyout programs in reducing vulnerability to coastal flood hazards. Ultimately, recommendations are made to improve buyout policy and administration.

This analysis seeks to assess whether or not the NY Rising Buyout and Acquisition Program has successfully reduced the vulnerability of people and property to future coastal flood hazards. Three
distinct communities in Staten Island have been evaluated, offering insight as to whether federal buyouts have differential success across communities. As the program has been completely funded by the federal government, and therefore by the federal taxpayers, change in vulnerability will be measured nationwide. Determining the program’s success exclusively based on the vulnerability reduction realized in Staten Island is incomplete and does not consider the possibility that buyout participants relocate to areas comparably vulnerable to coastal flood hazards elsewhere in the United States. Though the vulnerability of the participating Staten Island buyout communities has likely been reduced by the program, it is uncertain whether participating homeowners actually move out of harm’s way. By comparing the vulnerability of buyout participants before the implementation of the buyout program with the vulnerability of participants after the program’s implementation, the change in vulnerability to coastal flood hazards is determined. This analysis holistically determines the program’s success rather than ignoring the possibility that program participants have relocated to similarly vulnerable regions.

This research will address questions brought to light by the research of Binder and others (2015). The authors explore variables that determine whether or not communities of homeowners choose to participate in buyout programs (Binder, Baker and Barile 2015). The research, part of a longitudinal study funded by a National Science Foundation grant, further explores the relationship between the decision to relocate and the resilience of the communities making that decision. The authors assume that buyout programs will become an increasingly common approach to post-disaster mitigation and therefore that the implications of participating in these programs warrant more research. If buyouts continue to be employed in response to our country’s coastal vulnerability, we should be informed about their ability to encourage participation and their potentially disparate effects on diverse communities. However, before federally-funded buyout programs are assumed to be the country’s solution to coastal vulnerability, the capacity of these programs to effectively reduce vulnerability should be evaluated. Ultimately, this assessment determines whether the NY Rising Buyout Program, as implemented in Staten Island, has reduced the nationwide vulnerability of people and property to coastal flood hazards.

6 Defining Vulnerability and the Use of Vulnerability Assessments

In order to measure the change in vulnerability to coastal flood hazards produced by the NY Rising Buyout Program, vulnerability must first be defined. Though the definition of vulnerability varies significantly across fields (Adger 2006, Birkmann, et al. 2013, Fussel 2006), I adopt the International Panel on Climate Change’s (IPCC’s) definition of vulnerability given its applicability to the scope of this analysis. According to the IPCC’s 2007 National Assessment “vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, the sensitivity and adaptive capacity of that system (6).” Adger points out that vulnerability is typically described in terms of exposure and sensitivity to some stressor and ability to adapt to the disturbance (2006). Adaptive capacity, as defined by Cutter et al. is “the ability of a system to adjust to change, moderate the effects, and cope with a disturbance (2008).”

Though there is much theoretical discussion of the components of vulnerability in the work of Adger, Fussel, Birkmann and others, few studies have attempted to quantify overall vulnerability to

---

coastal flood hazards. Cutter and Finch note that, across research communities, overall vulnerability is
commonly recognized as being composed of exposure, sensitivity and adaptive capacity (2008). However,
challenges remain in the creation of an overall, or integrated, vulnerability assessment (VA). Fuchs,
Kuhlicke and Meyer point out that the wide variety of disciplines contributing to vulnerability science
creates many challenges in the creation of an integrated VA (2011). Relevant to this assessment is the
authors’ assessment that contributing disciplines have yet to determine precisely how the components of
vulnerability (typically exposure, sensitivity and adaptive capacity) should be integrated. Further, there
remains uncertainty in the methodology of conducting VAs; whether or not these assessments should be
participatory in nature and if climate change should be a consideration. Finally, the scope of VAs varies
widely across fields. Some consider the vulnerability of the built environment exclusively while others
consider the vulnerability of communities. Ultimately, it remains unclear whether it is either possible or
desirable to create an entirely inclusive and integrated vulnerability assessment (Fuchs, Kuhlicke and
Meyer 2011). As such, like the studies reviewed by Fuchs, Kuhlicke and Meyer, this analysis will consider
vulnerability in the context most relevant to the purpose of the research (2011).

My analysis endeavors to quantify the change in the vulnerability of people and property to
cosmopolitan flood hazards. As previously mentioned, areas affected by Superstorm Sandy are vulnerable to the
impacts of coastal hazards as well as to climate change and the confluence of these two stressors. As such,
my analysis attempts to consider the change in vulnerability to coastal flood hazards in the context of a
changing climate. However, the incorporation of climate change adds an additional layer of complexity to
this analysis. As noted by Romieu et al. 2010, the primary differences between natural hazard and climate
change VAs are in the type of process (climate change is an ongoing stress, a natural hazard is a shock),
the type of assessment (statistical analysis of potential climate change scenarios, quantification of a
disaster’s outcome) and the levels of uncertainty associated with each. Recognizing the complexity of
assessing vulnerability to coastal hazards and climate change, this study will modify a methodology
developed for doing just that.

Vulnerability, as measured in the National Park Service’s (NPS’s) “Coastal Hazards & Climate
Change Asset Vulnerability Assessment Protocol (National Park Service- Sustainable Operations and
Climate Change Branch 2015-2016)” is the sum of exposure, sensitivity and adaptive capacity. Together,
with researchers at the Program for the Study of Developed Shorelines at Western Carolina University,
the NPS protocol was developed to determine the vulnerability of physical assets at coastal national parks
to coastal hazards and climate change. Specifically, the protocol was developed to establish a standardized
methodology and to set best practices within the NPS to guide VAs of the built environment.

As my analysis considers the vulnerability of social assets (lives and livelihoods) as well as physical
assets (property), the NPS protocol has been modified accordingly (Table 1). Concerned with the change
in vulnerability experienced by people and property, these variables are referred to as vulnerability targets
in my analysis. If a vulnerability target is physically located in an area experiencing the direct impacts of a
flood hazard or climate change, it is said to be exposed. If the target is exposed, how well the target fares
is indicated by its sensitivity. If the target somehow adjusts or copes when exposed to the coastal flood hazard, it is said to have adaptive capacity.

Social vulnerability, as defined by Cutter et al., is determined by “those social factors that
influence or shape the susceptibility of various groups to harm and that also govern their ability to respond
(2003).” Within the framework this analysis has adopted for measuring vulnerability (Table 1), the
susceptibility of a vulnerability target (people, property) to coastal flood hazards is comparable to the
adopted definition of sensitivity. Further, the ability of a vulnerability target to respond to a hazard is
comparable to the adopted definition of adaptive capacity. Given the similarity of these definitions, this analysis will use indicators of social vulnerability to determine the change in sensitivity and adaptive capacity of people. Given that information on the sensitivity of individual properties to coastal flood hazards is unavailable, this analysis does not consider the sensitivity of buildings. Further, this analysis assumes that buildings are unable to adapt and therefore do not exhibit adaptive capacity.

*Table 1. Summary of methodology used to measure nationally aggregated change in vulnerability to coastal flood hazards due to the NY Rising Buyout program.*

<table>
<thead>
<tr>
<th>Components of Vulnerability</th>
<th>EXPOSURE</th>
<th>SENSITIVITY</th>
<th>ADAPTIVE CAPACITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitions/Indicators Used</td>
<td>Is the target physically located in an area experiencing the direct impacts of a flood hazard or climate change?</td>
<td>If exposed, how does the target fare?</td>
<td>How does the target adjust or cope with the hazard or climate change impact?</td>
</tr>
<tr>
<td>Property ($)</td>
<td>- Flood Zone - Storm Surge - Shallow Coastal Flooding</td>
<td>Data Largely Unavailable, (Is home elevated? Set back? Etc.)</td>
<td>N/A, Assuming buildings do not adapt.</td>
</tr>
</tbody>
</table>

Having defined the components of vulnerability as relevant to this analysis, it is instructive to consider how these components have been integrated in other VAs. Adger’s review of VAs in the context of socio-ecological systems and climate change points out that suitable metrics for vulnerability have yet to be agreed upon within the research community (2006). Cutter et al. confirm that consensus has yet to be reached in developing a vulnerability framework (2008). Adger notes that a foremost challenge in the quantification of vulnerability is its dynamic nature (2006). Vulnerability is constantly changing as its physical and social elements evolve over time. Further, capturing the interaction between the physical and social elements of vulnerability remains a challenge. Depending on the individual system’s characteristics, common assumptions about the relationship between the physical and social factors may not hold (Adger 2006). For instance, this analysis assumes that a community with a higher population density is more vulnerable to coastal flood hazards than a community with a lower population density. However, if the majority of the high density population is living in high-rise buildings, only a small percentage of this population (those inhabiting the ground floor) would actually be vulnerable to the direct effects of coastal flood hazards.

According to Adger, a measurement attempting to quantify the overall vulnerability of a socio-ecological system requires that the measure account for the dynamic nature of the system and establish a threshold for risk (2006). In other words, determining whether or not a system is vulnerable requires a
value judgement, based on cultural and institutional preferences. In this assessment, I assume that any amount of exposure to the special flood hazard area (SFHA), Category 3 storm surge inundation or shallow coastal flooding is an unacceptable risk and therefore indicates vulnerability. I also assume that any increase in the prevalence of certain social characteristics that may influence sensitivity and adaptive capacity is an unacceptable risk and indicative of vulnerability. A more robust analysis would involve a survey of buyout participants to assess their values and preferences to determine the group’s perceived vulnerability threshold.

Approaches to measuring vulnerability differ based upon the assumptions they made regarding the vulnerability’s causality (Cutter, Barnes, et al. 2008). In some analyses, exposure to the hazard is a given and the analysis identifies baseline social conditions that explain differential loss and capacity (Cutter et al. 2008, Disaster Resilience of Place). In other approaches, vulnerability is simply the probability of being exposed to a hazard (Cutter, Barnes, et al. 2008). This approach is common in earlier work on disaster vulnerability (Romieu, et al. 2010). This traditional approach, in assuming that vulnerability is a product of exposure, results in assessment that tends to consider the economic vulnerability of the built environment. In a third approach, the vulnerability is a function of physical exposure and social response in a particular location (Cutter, Barnes, et al. 2008). According the Fuchs, Birkmann and Glade, a more comprehensive approach allows for a more robust understanding of the variables that influence vulnerability (2012). In attempting to measure exposure, sensitivity and adaptive capacity through a variety of social and physical indicators, the approach taken in this analysis is most closely aligned with Cutter, Barnes, et al.’s approach (2008).

A single function defining the relationship between physical exposure and social response within a particular spatial scale has yet to be identified. The Methods for the Improvement of Vulnerability Assessment in Europe (MOVE) Framework, proposed by Birkmann et al., is a theoretical framework for thinking about systematic vulnerability assessments (2013). However, the authors explicitly note that the framework does not include a specified method for quantification (Birkmann, et al. 2013). They emphasize the fact that the variables influencing vulnerability are dynamic, may interact in non-linear ways and depend on place-based characteristics. For this reason, the authors are unable to suggest precise methods for the quantification of vulnerability. The appropriate methodology is dependent on the system of interest and the characteristics of its vulnerability determinants.

Given the similarity of Szlafsztein and Sterr’s assessment of coastal hazard vulnerability in a region of Brazil to this study’s approach, this analysis will adopt a modified version of their methodology for calculating a comprehensive vulnerability score (2007). In their GIS-based assessment the authors consider both physical and social components of vulnerability. They developed an index for physical vulnerability, based on exposure to hazards, and a separate index for social vulnerability, based on socioeconomic characteristics. The variables incorporated in these indices were weighted based on their relative importance in determining regional vulnerability to coastal hazards. These indices were each standardized based on the number of variables utilized. The standardized indices were then averaged to create a comprehensive vulnerability index.

7 **SUPERSTORM SANDY AND STATEN ISLAND**

Superstorm Sandy arrived in Staten Island, Richmond County, New York on the evening of October 29, 2012 as a post-tropical cyclone (NOAA National Centers for Environmental Information 2012). The winds associated with Sandy were felt across nearly 1,000 miles, making it a true superstorm. The
enormous reach of these winds generated a sizable storm surge which was greatly exacerbated by Sandy’s arrival in New York during a spring high-tide. Further, Sandy approached area in an atypical way and its winds funneled water into the New York-New Jersey bight and straight into New York City (New York City June 2013).

In NYC alone, 51 square miles were flooded. This is considerably more flooding than was anticipated based upon the Federal Emergency Management Agency’s Flood Insurance Risk Maps (FEMA’s FIRMs) which indicated that approximately 33 square miles of NYC would be flooded during a 100-year flood. In Tottenville, Staten Island the floods reached heights of 14 feet causing catastrophic damage to critical infrastructure, homes and businesses. Of the 43 people who died in NYC during Superstorm Sandy, 23 of these deaths occurred in Staten Island (New York City June 2013).

The east and south shores of Staten Island, in particular, are physically and socially vulnerable to coastal flood hazards. Historically, these areas were wetlands that naturally acted to buffer the impacts of coastal storms. However, after the Verrazano-Narrows Bridge opened in the 1960’s, the area rapidly developed and some of the wetlands were filled (New York City June 2013). Nearly 140,000 people live on the east and south shores of Staten Island as of 2014 and between 2000 and 2010 Richmond County was one of the top ten fastest growing counties in the state (NY Rising Community Reconstruction Staten Island East & South Shores Planning Committee March 2014).

In addition to the low-lying topography of the area, the characteristics of the beachfront housing stock also contributed to the coastal flood vulnerability. After completion of the bridge beach bungalows along the coast, which were initially intended for seasonal or temporary housing, were converted into permanent winterized residences as the demand for coastal property increased. These bungalows were particularly hard-hit by Sandy because they were built to lower standards than required for permanent residences and were not adequately flood proofed. The area’s drainage systems were overwhelmed by the influx of water from Sandy and did little to curb inundation. Father Capodanno Boulevard, a main roadway in the area, is a higher elevation than landward communities including Midland Beach and Ocean Breeze. Once the storm surge overtopped the road, the areas behind Father Capodanno filled rapidly with water that, due to the overwhelmed drainage systems, was not redirected immediately back to the ocean (New York City June 2013).

Sandy’s inundation also affected many components of Staten Island’s critical infrastructure and local economy. Bridges connecting Staten Island to NYC and New Jersey were shut down before the storm and remained closed for some time. Substations throughout the island were inundated leaving 121,000 residents without power for several weeks. The two area hospitals were incapacitated by the surge and power outages. The Oakwood Beach Wastewater Treatment Plant, which serves about half of Staten Island, was inundated and several of its pumps were broken. Gas became scarce in the days following the storm as there was no electricity to operate the pumps, difficulty transporting fuel to the area and high demand as 84% of Staten Island’s households have a vehicle. Further, 2,800 businesses of Staten Island’s east and south shores were affected by the storm. Primarily small businesses employing fewer than five people, these business owners face significant economic challenges in recovery given their limited capital and reduction in customer base. Additionally, an estimated 9,500 jobs in the area were adversely impacted by the storm (New York City June 2013).

Recovery and resilience-building efforts in Staten Island following the storm were, and continue to be, widespread and diverse. In addition to the buyout and acquisition program discussed by this analysis, there were many concurrent federally-funded recovery efforts. These include, but were not limited to, the Federal Emergency Management Agency’s Individual and Public Assistance Programs,
temporary housing programs and Small Business Administration assistance. At the state and city level, even more recovery and resilience-building efforts were initiated. Additionally, volunteer organizations active during disaster contributed greatly to relief and recovery efforts.

Understanding the programs and financing structures that support the buyout and acquisition program is essential to clarify its objectives. A brief consideration of the relevant agencies and policies is provided below in addition to a cursory review of how the buyout and acquisition program fits in relative to other federal recovery efforts.

8 PROGRAM OBJECTIVES AND FINANCING STRUCTURE

8.1 COMMUNITY DEVELOPMENT BLOCK GRANT DISASTER RECOVERY FUNDING

Following the destruction of Superstorm Sandy in October of 2012, the United States Department of Housing and Urban Development (HUD) allocated upwards of $4 billion to New York State (NYS) for relief and recovery efforts through the Community Development Block Grant Disaster Recovery (CDBG-DR) program (State of New York 2016). This funding was made available through the Disaster Relief Appropriations Act of 2013, also known as the Sandy Supplemental Bill, which was signed by President Barack Obama in January of 2013. Of the approximately 60 billion federal dollars appropriated to provide disaster assistance to the victims of Superstorm Sandy, $16 billion was allocated to CDBG-DR (Public Law 113-2). The New York State Governor’s Office of Storm Recovery (GOSR) was formed to administer these funds in accordance with the State Action Plan for the expenditure of CDBD-DR program funds (New York State Homes and Community Renewal: Office of Community Renewal April 2013). The State’s Action Plan was initially approved in April of 2013 to guide expenditure of the first $1.8 billion allocation and has been regularly updated through amendments to guide the expenditure of the second and third tranches (Governor’s Office of Storm Recovery 2013).

CDBG-DR funds are exclusively made available to disaster areas designated by the President of the United States. CDBG-DR funds are a supplemental source of federal post-disaster funding that is only made available through congressional approval, in this case through the Sandy Supplemental Bill. These funds are designated to meet needs that are otherwise unmet by permanently authorized disaster recovery funds sanctioned through the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act). Receiving communities within disaster areas must be unable to recover through their own means and have the capacity to administer a recovery program (U.S. Department of Housing and Urban Development 2014). The widespread devastation caused by Sandy throughout NY and the creation of the GOSR ensures that New York (NY) meets both of these requirements.

These funds are generally associated with fewer spending restrictions than permanently authorized disaster relief funds and may be used for a wide variety of recovery efforts that can involve housing and economic development initiatives, infrastructure repair and efforts to prevent future damages in affected areas (U.S. Department of Housing and Urban Development 2014). There can be no duplication of benefits between CDBG-DR and other sources of federal aid such as insurance, Federal Emergency Management Agency (FEMA) individual assistance (IA) and public assistance (PA), Small Business Administration (SBA) loans and US Army Corps of Engineers (USACE) funds (U.S. Department of Housing and Urban Development 2014). Funding from all sources cannot cumulatively exceed the amount needed for a specific recovery activity (U.S. Department of Housing and Urban Development, 2014).
Activities funded through CDBG-DR must meet at least one of three national program objectives (U.S. Department of Housing and Urban Development 2014). These three national objectives are: 1) benefit persons of low and moderate income; 2) aid in prevention or elimination of slums or blight; or 3) meet other urgent community development needs (U.S. Department of Housing and Urban Development 2014). Sandy-related CDBG-DR funds must be granted to at least 50% low and moderate income residents of communities affected by the storm. Low and moderate income populations are determined using HUD’s Low- and Moderate-Income Summary Data which determines eligible areas using Section 8 income limits (U.S. Department of Housing and Urban Development October 2012, 31). 80% of the funds must be spent in the areas most impacted by the storm which includes Nassau, Suffolk, Rockland and Westchester counties (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 9-10).

8.2 NY RISING BUYOUT AND ACQUISITION PROGRAM

In accordance with the first and third national goals of the CDBG-DR, the State Action Plan proposes strategies to address short and long-term disaster recovery needs and contribute to mitigation efforts in areas housing persons of low and moderate income (New York State Homes and Community Renewal: Office of Community Renewal April 2013). The NY Rising Buyout and Acquisition Program has been authorized by the State Action Plan for the expenditure of CDBG-DR funds to mitigate the influence of future storms and improve the resilience of communities in Staten Island and Long Island, NY (Governor’s Office of Storm Recovery 2015). Although Staten Island is a borough of NYC, Staten Island’s Buyouts are administered through the State’s Action Plan for CDBG-DR funds NOT through the City’s Action Plan (NY Rising Buyout and Acquisition Program Policy Manual April 2015, 23).

The buyout and acquisition components of the state’s program are distinct, see Table 2 for a simplified comparison of the programs. While homes eligible for both programs must be volunteered by the property owner, the use of land following the state’s purchase of property is dependent on whether the property is an acquisition or a buyout. Properties acquired through the acquisition portion of the program are eligible for reconstruction and subject to any, potentially more stringent, building codes and policies adopted after the storm. Properties purchased through the buyout component are NOT eligible to future redevelopment and must be maintained as coastal buffer areas in perpetuity (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 15). The GOSR website\(^2\) states that “the Buyout Program improves resiliency of the larger community by transforming parcels of land into wetlands, open space, or stormwater management systems, creating a natural coastal buffer to safeguard against future storms. The coastal buffer areas are intended to address those who live in areas that regularly put homes, residents and emergency responders at high risk due to repeated flooding.”

---

SUMMARY OF ELIGIBILITY CRITERIA, INCENTIVES AND OUTCOMES

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

The buyout component of the program requires that all properties purchased by the state be substantially damaged, losing half their fair market value (FMV) during Superstorm Sandy, Hurricane Irene or Tropical Storm Lee, and located within an enhanced buyout area (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 23). The state has defined an enhanced buyout area as “among the most susceptible to future disasters and therefore present the greatest risk to people and property (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 14).” Through consultation with local governments, FEMA and NYS determined that enhanced buyout areas are those located within the 100 year floodplain and within the FEMA flood map V and A zones (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 39). According to Rachel Wieder, Director of the Buyout and Acquisition Program, 473 buyouts have been completed in Staten Island as of February of 2017.
The acquisition component of this program is available for properties substantially damaged and located outside of the defined enhanced buyout area (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 22-25). Once purchased, these properties may be resiliently redeveloped or converted into undeveloped parks or non-residential uses in perpetuity (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 17). 134 properties have been auctioned by NYS for resilient redevelopment as of October 2015 (Governor’s Office of Storm Recovery 2015).

Both the buyout and acquisition components of the program require that property owners are voluntary participants. Single and two-family primary residences, residential properties and vacant lands within the enhanced buyout area are eligible for buyouts. Buyout participants are offered 100% of their home or property’s pre-storm FMV. Participants are also eligible for a 10% FMV incentive for relocating from the enhanced buyout area. The incentive is intended to encourage buyout participants to relocate in lower risk areas (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 31). A 5% FMV incentive is also available for buyout participants who choose to relocate within one of NYC’s five boroughs. (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 21-25) According to correspondence with the GOSR, the state is keeping track of where buyout participants move within NY to ensure that they are in fact eligible for this 5% incentive (Wieder 2017).

Properties eligible for acquisition may be single or two-family residences, rental properties, second homes or vacant lands adjacent to eligible properties. Acquisition participants are also offered 100% post-storm FMV and may qualify for additional incentives (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 31-32). The Action Plan does not specifically prohibit program participants from relocating to homes within the hazardous floodplain, although doing so is unmistakably incompatible with program objectives as described below (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 30).

8.3 Hierarchy of Objectives

The objectives of the NY Rising Buyout and Acquisition Program are pursuant to the requirements of the program’s authorizing legislation and administering agency. The program was authorized through the congressionally approved Sandy Supplemental Bill and is administered by the Department of Housing and Urban Development. Additionally, the NYS and NYC plans for spending the grant money impose additional requirements on the administration of the program. The suite of potential actions that meet all of these requirements is subsequently narrow even though the CDBG-DR program is generally more flexible than the permanently authorized sources of disaster recovery funding. Further, the administration of the buyout program is limited by the historic lack of such programs in densely populated coastal environments (see FEMA 2011 for overview of buyout best practices). Given that relatively few large-scale buyouts have occurred in places like Staten Island, opportunities for lesson-sharing and program evolution are limited. Greer and Binder point out that the lack of iterative advancement in the realm of post-disaster home buyout policy is also likely due to the lack best practices and empirical buyout program evaluation (2016).

The Stafford Act, through which all permanently authorized federal funding is released following the presidential declaration of a disaster, broadly seeks to “alleviate the suffering and damage which result from such disasters (42 U.S.C. § 5121).” The Act describes six specific actions for doing so. Most applicable of which is to encourage “hazard mitigation measures to reduce losses from disasters (42 U.S.C. § 5121).”
When the permanently authorized funding sources are not sufficient and unmet needs remain in disaster areas, supplemental funding can be authorized by congress. The Sandy Supplemental Bill was approved by congress on January 29, 2013 and provides additional funding aid to communities rebuilding after Sandy. Specifically, the CDBG-DR funds released to HUD were designated to cover “necessary expenses related to disaster relief, long-term recovery, restoration of infrastructure and housing, and economic revitalization in the most impacted and distressed areas resulting from... Hurricane Sandy (Public Law 113-2).”

As outlined above, the CDBG-DR program further requires that eligible projects meet at least one of three national objectives. According to the NYS Action Plan, buyouts and acquisitions will meet either the requirement to benefit low and moderate income peoples or meet urgent housing needs. The NYS Action Plan further serves as a detailed guide for the state’s administration of CDBG-DR funds. In accordance with the requirements of CDBG-DR, the funds will be used to “meet the unmet housing, economic development, community planning and infrastructure needs of impacted communities (New York State Homes and Community Renewal: Office of Community Renewal April 2013, 5).”

The NY Rising Buyout and Acquisition Program proposed in the State’s Action Plan, and described in further detail by the NY Rising Buyout and Acquisition Program Policy Manual, is broadly intended to decrease vulnerability to future floods. By relocating homeowners away from areas Superstorm Sandy proved to be high-risk, the government looks to reduce the suffering and damage potentially caused by future disasters. A secondary goal, in addition to vulnerability reduction, is to encourage investment in the area through rebuilding efforts that encourage reconstruction to a higher, more resilient, standard (NY Rising Buyout and Acquisition Program Policy Manual February 2016).

The success of the program at meeting the hierarchy of goals presented above may only be calculable after the next storm of equal or greater magnitude than Sandy. It may be many years before acquired structures rebuilt to more resilient standards are tested or the success of economic development and community planning initiatives can be evaluated. However, the program’s success in reducing the vulnerability of people and property to flood events, through buyouts, can be quantified now. The effects of the buyout program on vulnerability are more easily measured than the effects of the acquisition component of the program. This is largely because the status of acquisitions varies significantly across Staten Island and data on specific acquired parcels are difficult to acquire. However, information about the progress of the buyout component is more easily obtained. For this reason, my analysis will only consider the buyout component of the NY Rising Buyout and Acquisition Program.

9 STUDY COMMUNITIES

9.1 SELECTION PROCESS

Though buyouts were offered elsewhere in NYS, this analysis will only analyze the change in vulnerability caused by the buyouts in the Oakwood Beach, Graham Beach and Ocean Breeze neighborhoods of Staten Island. The Staten Island buyouts were selected as the focus of this study to remain consistent with the geographic scope of the case studies pursued by Binder, Baker and Barile (2015). However, to better understand the vulnerability of all buyout eligible communities, the state’s selection process is discussed in detail.

Following an assessment of homeowner interest in various projects that could have potentially been funded by the CDBG-DR funds in New York, the state concluded that approximately 2,500
homeowners, of over 7,000 assistance pre-registrants statewide, were interested in a relocation program (New York State Homes and Community Renewal: Office of Community Renewal April 2013). The Governor, Andrew Cuomo, officially announced the buyout program in his February 2013 State of the State Address. Eligible communities were then determined based on an unknown combination of widespread community interest in a buyout program and location within the enhanced buyout areas as defined by the state.

According to the NY Rising Buyout and Acquisition Program Policy Manual, the enhanced buyout areas were those determined to be most susceptible to future disaster and that presented the greatest opportunity for risk reduction (February 2016, 14). The data sources used to make this determination included high resolution topography, 100-year and 500-year flood zones as determined by FEMA’s 2013 Preliminary Flood Insurance Rate Maps (pFIRMs), Sea, Lake and Overland Surges from Hurricanes (SLOSH) model Category 3 inundation estimates, 3 foot sea level rise scenario mapping, shallow coastal flooding prevalence and erosion susceptibility (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 70-72).

Level of community interest was also incorporated into the state’s determination of eligible buyout areas. In order for the buyout program to be successful, contiguous pieces of land needed to be acquired to ensure the establishment of an effective coastal buffer area. Furthermore, the program requires that property owner participation in both the acquisition and buyout program be entirely voluntary.

The first community in Staten Island to vocally express interest in the buyout program was Oakwood Beach. A single resident, Joseph Tirone, appears to have led the charge in Oakwood Beach by skirting the city’s recovery process, and their simultaneously developing Build it Back Program, and applying directly to the state (McEnery 2014). Cuomo announced the Oakwood Beach buyout program in late February of 2013 (Staten Island Advance 2013). The second community to express interest, Ocean Breeze, was also led by a single resident, Frank Moszcynski (McEnery 2014). After pressuring the state, Cuomo announced in November of 2013 that the buyout area would be extended to include Ocean Breeze (New York State 2013). In April of 2014, the state announced the expansion of the buyout program to include the third and final community in Staten Island, Graham Beach (NY Rising 2014). Several other communities, including New Dorp Beach and Midland Beach, pursued the buyout option but were ultimately denied by the state (Rizzi 2014).

My analysis of the buyout program in Staten Island will include all three participating communities: Oakwood Beach, Ocean Breeze and Graham Beach. A comparison of the buyout program’s success in reducing vulnerability across and between these three communities may allow for the identification of specific physical or social community characteristics that affected the program’s outcome. An outcome summary of the Staten Island buyout program in Oakwood Beach, Ocean Breeze and Graham Beach is shown in FIGURES 1 and 2. A map of the approximate boundaries of each buyout community is available in the Appendix (Map 1).
The Oakwood Beach neighborhood was established in the late nineteenth century and is a section of the larger Foxbeach neighborhood (Admin 2012). The oceanfront homes in this community were primarily used as vacation homes until development pressure following the construction of the Verrazano Narrows Bridge encouraged the winterization and permanent inhabitation of these structures (New York
State Homes and Community Renewal: Office of Community Renewal April 2013). Components of the neighborhood were built atop of historic wetlands, making the neighborhood extremely vulnerable to flooding (NY Rising Buyout and Acquisition Program Policy Manual February 2016). The buyout area is bordered to the northeast and southwest by natural areas. The majority of this natural area is a part of Great Kills Park. Great Kills is a component of Gateway National Recreation Area and extends across 580 acres. The park is known for its four beaches, which includes Oakwood Beach, and extensive wetlands (New York Harbor Parks 2017).

The Oakwood Beach Water Pollution Control Plant was built in the neighborhood in 1956 (Admin 2012). In a typical day, this plant treats upwards of 26 million gallons of sewage and serves about half of Staten Island’s population. Despite a loss of power, backup generators kept the plant running during Superstorm Sandy which prevented the release of raw sewage into homes, businesses and ultimately, the NY Harbor (Grunlund 2012).

In Oakwood Beach, 321 buyouts were offered and 300 of these were ultimately accepted and executed. Of the participating properties, 264 were single-family dwellings, 20 were two-family dwellings and 16 were vacant parcels. 28 of the acquired properties were rental properties (Wieder 2017, Figures 1 and 2).

9.3 Graham Beach

The Graham Beach neighborhood is situated between Naughton Avenue and Jefferson Avenue to the east and west and Olympia Boulevard and Father Capodanno Boulevard to the north and south (Lavis 2014). The higher elevation of Father Capodanno Boulevard contributed to the severe inundation experienced by the lower elevation communities in “the bowl” to the North which includes Graham Beach. Like Oakwood Beach, the Graham Beach neighborhood was established in an area that was historically wetlands. A majority of the homes in this neighborhood were also bungalow style vacation homes that were not built to withstand extensive flooding (NY Rising Community Reconstruction Staten Island East & South Shores Planning Committee March 2014).

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, 9 were two-family dwellings and 18 were vacant parcels. Only 1 of the acquired properties was a rental property (Wieder 2017, Figures 1 and 2).

9.4 Ocean Breeze

The Ocean Breeze neighborhood is situated by Seaview Avenue and Naughton Avenue to the east and west and Quincy Avenue and Oceanside Avenue to the north and south (Randall 2013). Like both Oakwood and Graham Beach, the Ocean Breeze neighborhood was established on historic wetlands and was historically a beach community (NY Rising Community Reconstruction Staten Island East & South Shores Planning Committee March 2014). The neighborhood’s location within “the bowl” north of Father Capodanno Boulevard exacerbated the inundation experienced. Just to the northeast of the Ocean Breeze neighborhood is the Staten Island University Hospital, the area’s largest employer and Staten Island’s primary healthcare provider. Also to the northeast of the Ocean Breeze buyout area is Ocean Breeze Park, a 110 acre park of primarily tidal wetlands (NYC Parks 2017).

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, 1 was a two-family dwelling
and 6 were vacant parcels. Only 1 of the acquired properties was a rental property (Wieder 2017, Figures 1 and 2).

9.5 SOCIAL CHARACTERISTICS

An assessment of the social characteristics of the three participating buyout communities was conducted using census-tract level statistics from the 2010 United States Census. I assume that buyout participants are representative of the census tract in which they live though the demographic and socioeconomic composition of buyout participants is unknown.

The three communities fall into three census tracts. The Oakwood Beach community straddles two census tracts (128.05 and 128.06) with the majority of my sample falling within the boundaries of census tract 128.05. Both the Graham Beach and Ocean Breeze communities are entirely within census tract 112.01. 216 of the buyout properties are located within 128.05, 13 are within 128.06 and 94 are within 112.01. The census data compiled about these three communities are summarized in Table 3.

Notably, 8 –16% of the population identifies as a minority, 9-14% identifies as Hispanic, 11-18% are over 65 years old and 27-36% of the population over 25 years old has obtained a Bachelor’s degree or more. Of note is that census tract 128.06 is more densely populated and has many more rental properties than the other two census tracts. Within census tract 112.01, nearly 30% of families with children under the age of 18 are headed by a single parent.

Across the east and south shores of Staten Island as a whole, 8% of the community speaks Russian with approximately 15% of the Oakwood Beach community speaking Russian (NY Rising Community Reconstruction Staten Island East & South Shores Planning Committee March 2014, 66). According to a spokesperson at the Governor’s Office of Storm Recovery, many buyout participants were second or third generation immigrants of Eastern European descent (Wieder 2017). In Ocean Breeze, 9% of the population speaks Spanish and 40% of the population does not speak proficient English (New York State Homes and Community Renewal: Office of Community Renewal April 2013, 66).

According the Social Vulnerability Index 2006-2010, Richmond County ranks medium-low in social vulnerability to environmental hazards when compared to both NYS and the nation (HVRI 2013). Overall, I find that the three buyout communities studied are fairly homogenous. The census tracts in which the Oakwood Beach, Graham Beach and Ocean Breeze communities are located have similar demographic and socioeconomic characteristics.
To my knowledge, there have been no previous analyses regarding the national vulnerability reduction of coastal federal buyout programs. Prior to Sandy, there are relatively few examples of post-disaster large-scale coastal buyouts (including those in New Orleans, Louisiana following Hurricane Katrina, Galveston, Texas following Hurricane Ike and in Kinston, North Carolina following Hurricane Floyd) which may explain the lack of such research (see FEMA 2011 for review of buyout best practices). As such, the methodology I’ve adopted borrows significantly from vulnerability assessments that have been conducted in the context of natural hazards and climate change.

While vulnerability assessment for the reduction of natural hazards risk has been implemented since the 1970s, scholars have only recently started to hybridize climate change and natural hazards VAs (Romieu, et al. 2010). Though to date the occurrence of a particular event cannot be attributed to climate change, it is largely undisputed that the devastation of Superstorm Sandy was enhanced by the influence of sea level rise (Trenberth, Faullo and Shepherd 2015). As such, a cautious approach to measuring the
change in vulnerability to events like Superstorm Sandy should include components of both a natural hazards VA and climate change VA. This ensures that the assessment considers both the current vulnerability of assets to natural hazards and how this vulnerability may be inclined to change with the impacts of climate change.

Specifically, this analysis will assess the change in the vulnerability of people and property to coastal flood hazards before and after the implementation of the buyout program. Origin addresses will refer to parcels that participated in the buyout program and relocation addresses will refer to the parcels to which buyout participants have moved.

10.1 OVERVIEW

My analysis will only consider NY Rising buyout program participants living in the Oakwood Beach, Ocean Breeze and Graham Beach communities of Staten Island at the time of Superstorm Sandy. These communities will be referred to as origin communities (Appendix, Map 1).

Using information, such as property address and homeowner name, the NYS property record database will first be consulted to determine that participating properties were in fact sold to the state. Using these and other available records, the relocation addresses will be determined.

Once origin and relocation addresses for participants have been determined, these locations will be georeferenced and mapped using ArcGIS. Once the locations are mapped a variety of indicators, discussed below, will be used to determine the vulnerability of participating people and property to coastal flood hazards before and after the implementation of the buyout program. The change in vulnerability will then be calculated. This analysis does not quantitatively consider the impact of the buyout program on the vulnerability of the surrounding origin community. It also does not consider how the entry of buyout participants into relocation communities may impact the relocation community’s vulnerability. It is only concerned with the vulnerability of program participants and associated origin and relocation properties.

10.2 DETERMINING ORIGIN ADDRESSES AND TRENDS IN RELOCATION

At the time that this analysis was initiated, the Governor’s Office of Storm Recovery (GOSR) was unreachable and spatial data indicating the location of properties participating in the buyout program were not available. Though the precise locations of buyouts completed in Staten Island were eventually acquired from GOSR, this analysis used an alternative methodology, discussed below, to determine which parcels in the Oakwood Beach, Graham Beach and Ocean Breeze communities participated in the buyout program. A comparison of the origin addresses determined through the methodology utilized and the known buyout locations eventually provided by GOSR is included in the discussion.

The approximate location of each buyout location was first determined using information gathered from a variety of sources including local newspaper articles and press releases from GOSR. Once the approximate location was determined, an extensive review of available information about participating buyout properties led to consultation of the NYS Division of Homes & Community Renewal’s
Annual Property Disposal Guidelines and Reports. Reports available for the fiscal years since Superstorm Sandy were downloaded from the Division’s Website. These publicly available documents include information about all properties acquired by the Housing Trust Fund Corporation (HTFC) for each fiscal year. The HTFC is an agency within the NYS Division of Homes and Community Renewal that is a subsidiary public benefit corporation (Homes and Community Renewal 2017). Though the agency’s primary goal is to create affordable housing for low-income populations, homes acquired by the state through the buyout program were purchased in this agency’s name. I assume this was done out of convenience because it is my understanding that the HTFC already has the institutional capacity and mechanisms in place to arrange for the purchase of existing housing. Additionally, it appears that the HTFC is responsible, at least in part, for the administration of non-disaster related CDBG funds (Homes and Community Renewal 2017). It seems logical that they would also play a role in the administration of the CDBG-DR program.

Using the HTFC Property Disposal Reports for fiscal years 2014, 2015 and 2016, addresses for damaged parcels in Staten Island that were acquired by the buyout program were compiled. Information regarding the closing date of the sale of these properties and the purchase price of the home, including any incentives, were also collected.

A majority of the properties listed in the 2014 document were also listed in the 2015 document. Generally, these properties had the same closing date in both documents but, in some cases, there was a large discrepancy in the purchase price listed in each document. Within the 2014 document, the amount listed is a very precise number, for example $442,381.50, whereas in the 2015 document the amount listed for the same property was rounded and imprecise $440,000.00. For properties that were listed in both the 2014 and 2015 documents or the 2015 and 2016 documents, the numbers from the more recent document were used in the final analysis. After ensuring no duplicate addresses, there remained 443 potential buyout properties.

Using the NYC Department of Finance Website a search was conducted by address. 33 of the 443 potential properties had a home number of 0 and could not be found though this portal. I assume that these properties are either uninhabited or undeveloped parcels that were acquired by the state. This seems feasible given that 40 vacant parcels were ultimately acquired according to GOSR (Wieder 2017). As my analysis only concerns the vulnerability of people and improved property, these 33 properties were removed from the sample.

Through the NYC Department of Finance portal, Notices of Revised Property Value issued at the date closest to the date of Superstorm Sandy were acquired for each potential origin address. This document contains the name of the origin address’ owner at the time of the assessment. Using the homeowner’s name, a search by party name was done through the ARCIS public record website. This search produces a list of documents including, if the property was in fact a buyout, a NYC Property Buyout Transfer Tax Document. This document was filed when the buyout participant signed their property over

---


to the HTFC. The document may also give the participant’s most recent known address, their potential relocation address. Unfortunately, for many participants, the address listed in the document was the origin address. Other participants did not have recent addresses listed in this document or only listed a PO Box which would not be associated with their place of residence or personal property.

Once all origin addresses and associated homeowner names were acquired, it became clear that in some cases many properties were owned by the same individual. Through use of Google Maps, many of these properties were determined to be rental units. These rental units were removed from the sample because it was impossible, with the time and resources available, to determine the name of the individual living in the rental property. Without knowing the renter’s name, the relocation address cannot be determined. Other properties were owned by limited liability corporations (LLCs) and, in this instance, it was also unclear who was inhabiting the property at the time of Sandy. These properties were also removed from the sample.

To gather more complete information about the relocation addresses of buyout participants within the study sample, access to the LexisNexis Advance Public Records Search\(^6\) was acquired. Using this tool, most recent addresses were confirmed for all but 20 buyout participants. Recent addresses may not have been available for these individuals for a variety of reasons including discrepancies in spelling of name between NYS documents and other public records, relocation outside of the country or homelessness. Searches were performed using homeowner names and previously known addresses in Staten Island. As the tool is incredibly precise, a good amount of guess and check was involved regarding whether or not to include middle initials or whether to search by husband or wife (if both were listed as homeowners in the NYS documents).

Though this tool returns all known addresses associated with a particular individual, this analysis only considers the address indicated as most recent by the LexisNexis Advance Public Records Search tool. Some of the addresses indicated as most recent were owned by the homeowner for many years. I assume in these instances that the individual owned two or more homes at the time of Sandy and simply moved from their origin address to the second home after the storm. Other most recent addresses for buyout participants were not listed under their names. This may indicate that a buyout participant moved in with family or friends and is having official documents such as bills and taxes sent to this address. If time allowed, a deeper analysis of relocation patterns after partaking in a buyout program would be insightful.

After removing properties from the sample due to insufficient information, the final sample size was 323 properties. Referencing newspaper articles and GOSR press releases, each origin address was assigned to an origin community. 229 of the origin addresses fall within the Oakwood Beach community. 40 were assigned to the Graham Beach community and 54 were within the Ocean Breeze community. The distribution of addresses throughout the three communities generally reflects the number of total buyouts completed in each community. In Oakwood Beach, 300 buyouts were completed as compared to 86 in Ocean Breeze and 87 in Graham Beach (Wieder 2017). Map 2 in the Appendix displays the location of origin addresses and defines the buyout communities.

---

The latitude and longitude of origin and relocation addresses were then determined using a georeferencing service\(^7\). The service was unable to find a latitude and longitude for approximately 10% of the addresses. The locations of these addresses were determined using Google Maps. For some addresses, location was estimated as Google Maps was unsure of where a particular house number fell along a street. This seemed to be especially prevalent in communities that appear to have been recently built. Though the accuracy of the georeferencing was spot-checked for approximately 10% of the samples, there was some residual error. The impact of using inaccurate coordinates for both origin and relocation addresses will be addressed in the discussion.

In addition to serving as a starting point for the vulnerability assessment, discussed below, the origin and relocation address information also provides a lot of detail about the relocation trends of buyout participants in Staten Island. These trends are identified within the results and will be discussed at length.

### 10.3 Measuring Vulnerability

In their creation of the MOVE (Methods for the Improvement of Vulnerability Assessments in Europe) conceptual framework, Birkmann et al., acknowledge the importance of considering the multifaceted contributors to vulnerability (2013). Specifically, this analysis considers social community characteristics and characteristics of the physical environment that influence the exposure, sensitivity and adaptive capacity of people and property to flood hazards. Measuring vulnerability of properties pre- and post-buyout program is a relatively simple analysis dependent on exposure. I am unable to collect information on the pre- and post-relocation sensitivity of individual properties. Further, I assume the built environment to be incapable of adaptation and therefore this analysis does not consider the adaptive capacity of property. Measuring the sensitivity and adaptive capacity of people involves an assessment of several indicators of social vulnerability.

#### 10.3.1 Measuring Exposure

The exposure of people and property to coastal flood hazards at the origin and relocation addresses is indicated by flood zone, storm surge and shallow coastal flooding datasets. These indicators were chosen based on the indicators used by NPS and the indicators used by NYS to determine the extreme and high risk areas that comprise the enhanced buyout area (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 70-72). Additionally, the Coastal Flood Exposure Mapper tool, an interactive online mapping service run by the National Oceanic and Atmospheric Administration’s Office of Coastal Management, was consulted (2015). The Coastal Flood Exposure Mapper uses shallow coastal flooding, FEMA flood zones, storm surge inundation and projected sea level rise to create a coastal flood hazard composite (NOAA’s Office for Coastal Management 2015).

Origin and relocation addresses falling within Special Flood Hazard Areas (SFHAs), or the V or A flood zones as determined by FEMA’s Flood Insurance Rate Maps (FIRMs), are considered vulnerable to coastal flood hazards. Origin and relocation addresses falling within the Category 3 storm surge inundation projected by the hydrodynamic Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model are considered vulnerable to coastal flood hazards. Finally, origin and relocation addresses exposed to shallow

---

coastal flooding, as determined by National Weather Service designations made using National Oceanic and Atmospheric Administration (NOAA) tide gauge readings, are considered vulnerable to coastal flood hazards. The indicators used for the exposure vulnerability analysis, and their data sources, are summarized in Appendix Table 12.

Like the NPS analysis of physical assets, the exposure analysis includes indicators that show current and future risk (National Park Service- Sustainable Operations and Climate Change Branch 2015-2016). However, unlike the NPS analysis, this assessment does not include the historic exposure of origin and relocation addresses to historic coastal flood hazards. If available, the inclusion of this information would arguably make the analysis more robust. Another notable difference is that this analysis, unlike the NPS protocol, does not account for sea level rise directly. Current shallow coastal flooding, or nuisance flooding, exposure is used as a proxy for future vulnerability to sea level rise. Coastal areas currently experiencing flooding associated with high-tides are likely already feeling the effects of sea level rise and are therefore vulnerable to further sea level rise in the future. A more robust analysis would include exposure to projected change in flood zones, storm surge and erosion projections under a climate change regime. However, to date, this information is not locally available. Further, complications arise in determining the time horizon used for climate change projections. Adopting a 30 year time horizon because the average mortgage is paid over 30 years assumes that participants remain at the relocation addresses for 30 years and are therefore exposed to hazards exacerbated by projected climate changes. The difficulty in setting an appropriate time horizon for projected sea level rise encouraged the use of shallow coastal flooding as a proxy. Shallow coastal flooding is observable for origin and relocation addresses today and therefore identifies current exposure risk at those locations while also providing insight to future vulnerability (NOAA Center for Operational Oceanographic Products and Services 2014).

Using ArcGIS, origin and relocation addresses have been determined to be either within or outside of the area affected by each exposure indicator (SFHA, Category 3 inundation, shallow coastal flooding). The spatial join tool was used to determine whether or not each address fell within or outside the boundaries of the shapefile for each indicator. For each indicator an addresses is exposed to, a vulnerability score of one is assigned. Addresses that are not exposed to an indicator have been assigned a vulnerability score of zero for that indicator. The cumulative exposure vulnerability score for each address was then determined by summing the address’ scores for each indicator. Using this approach, an address that is not exposed to any indicator has an exposure vulnerability of zero. An address that is exposed to all three indicators has an exposure vulnerability of three. In accordance with the NPS protocol, the magnitude of exposure is not considered. Locally specific data indicating the extent of exposure is largely unavailable. Therefore, an origin address exposed to one foot of inundation during a Category 3 hurricane is assumed to be as exposed as an address with 10 feet of inundation.

Exposure of origin and relocation address pairs will be compared, with more vulnerability points indicating a higher exposure vulnerability. In this analysis, the change in exposure vulnerability is used to indicate the change in a buyout participant’s exposure to the physical impacts of coastal flood hazards before and after participation in the program. If the vulnerability exposure score is greater for the relocation address than the origin address, the change in exposure vulnerability for that indicator is one. The change is then summed across the three indicators for each address pair.

As the overarching goal of the NY Rising Buyout and Acquisition Program is to reduce the vulnerability of people and property to coastal flood hazards (NY Rising Buyout and Acquisition Program Policy Manual February 2016), it is essential to evaluate whether or not this objective has been met in determining the program’s success. Measuring the change in exposure to coastal flood hazards is one
approach that may be used to quantify a buyout program’s ability to reduce vulnerability. However, as noted by Birkmann et al., vulnerability is complex and multifaceted (2013). In an attempt to be more comprehensive, this analysis also quantifies how the sensitivity and adaptive capacity components of vulnerability, largely determined by social characteristics, have changed due to the implementation of the buyout program.

10.3.2 Measuring Sensitivity and Adaptive Capacity

The change in sensitivity and adaptive capacity of people will be determined based on seven indicators of social vulnerability. The sensitivity and adaptive capacity of property, the other vulnerability reduction target, will not be assessed. This is due to the fact that information about the sensitivity of individual properties is largely unavailable. Working within the time constraints of this analysis, determining whether individual properties have been flood-proofed, set-back or elevated is not feasible. Further, given the static and inanimate nature of the built environment, this analysis assumes that the structures themselves are not capable of adaptation.

Typical indicators of social vulnerability, such as, income, age and race, are characteristics of individuals. However, as noted by Cutter et al., social vulnerability is also dependent on place-based characteristics like population growth, characteristics of the built environment and characteristics of the community for which vulnerability is being assessed (2008). In order to directly compare the social vulnerability of diverse places to environmental hazards, the Social Vulnerability Index (SoVI) was developed (HVRI 2013). This tool provides information about the relative capacities for counties in the United States to prepare and respond to an environmental hazard (HVRI 2013). However, because the Oakwood Beach, Graham Beach and Ocean Breeze communities are all located within Richmond County, New York and many buyout participants relocated within Richmond County, the SoVI index does not provide information at the spatial scale necessary to compare social vulnerability between origin and relocation addresses.

Though the SoVI index does not provide information at a spatial scale fine enough for this analysis, it was used to inform the choice of social vulnerability indicators. According to the Hazards and Vulnerability Research Institute (HVRI), 72% of the variation in social vulnerability is explained by just seven of the variables used in SoVI. These include race, class, wealth, elderly population and service industry employment (HVRI 2013). The societal exposure feature of the Coastal Flood Exposure Mapper was also consulted in selecting social vulnerability indicators. The Coastal Flood Exposure Mapper tool only considers social vulnerability to coastal flood hazards while the SoVI index is mindful of all environmental hazards (NOAA’s Office for Coastal Management 2015). Considering the indicators used by both of these tools and the supporting literature, this analysis considers the indicators of social vulnerability shown in Table 4. These data were sourced from the United States Decennial 2010 Census, 2006-2010 5-year American Community Survey (ACS), 2008-2012 5-year ACS and 2010-2014 5-year ACS.

---


ACS\textsuperscript{11}. A summary of social vulnerability indicators and data sources used is shown in Appendix Table 12. Though census data are available at many spatial scales, the census tract level was determined to be most appropriate for this analysis. Data available at the census tract level generally has less error than data gathered at the block group level. Additionally, the census tracts in Richmond County line up neatly with the buyout communities as they have been defined. Had block groups been used, each community would be comprised of multiple block groups, complicating the analysis and assumptions.

*Table 4. Indicators of Social Vulnerability.*

<table>
<thead>
<tr>
<th>Indicators of Social Vulnerability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Density</td>
</tr>
<tr>
<td>Percent of Population Over 65</td>
</tr>
<tr>
<td>Percent Minority Population</td>
</tr>
<tr>
<td>Percent Hispanic Population</td>
</tr>
<tr>
<td>Percent of Families With Children Headed by a Single Parent</td>
</tr>
<tr>
<td>Percent of Population Over 25 who has Attained a Bachelor's Degree or More</td>
</tr>
<tr>
<td>Percent of Population for Whom the Ratio of Income to Poverty is Below 1</td>
</tr>
</tbody>
</table>

The Oakwood Beach community straddles two census tracts, 128.05 and 128.06. The Graham Beach and Ocean Breeze communities are both entirely within census tract 112.01. In determining the social vulnerability of each of these communities, I assume that the buyout participants within each community are representative of the census tract within which they are situated. However, because information about the demographic composition of buyout participants is unavailable, there are no data to support this simplifying assumption.

Additionally, because community characteristics such as age structure, demography, density, educational attainment and poverty level are known to change over time, this analysis is mindful of utilizing census data from the most temporally relevant data set. For the origin addresses, homeowners are known to have occupied these homes at the time of Superstorm Sandy in 2012. Because the most comprehensive census dataset, the decennial census, was collected just two years prior, social vulnerability characteristics for the origin addresses were extracted from the 2010 Census data. However, homeowners were determined to be at their relocation addresses over a variety of time periods between 2012 and 2016. As such, data collected by the 5-year ACS 2010-2014 is more likely to represent communities as they were when buyout participants were known to live at their relocation address.

All indicators, except for the percent of population for whom the ratio of poverty is greater than one, are extracted from a single data source (see Appendix Table 12 for details). In initially assessing data available for poverty metrics, it was made obvious that the measures utilized in the Decennial Census and ACS are not identical. To be consistent, the ACS was chosen as the source for poverty data for both the origin and relocation addresses. The Great Recession of 2008 caused economic turbulence across the

country and the available ACS data sets reflect this turbulence. For both the origin and relocation addresses, subsequent surveys produced very different numbers for income to poverty ratio. In an attempt to generate poverty metrics more representative of those experienced by buyout participants within their origin and relocation communities, the ratio of poverty to income was averaged between two ACS periods. Origin address census tracts are assigned a percent of population for whom the ratio of income to poverty is below one based on an average of the 2006-2010 5-year ACS and the 2008-2012 5-year ACS. For the relocation addresses an average of the 2008-2012 5-year ACS and 2010-2014 5-year ACS was taken.

The change in social vulnerability has not been measured in the same way as the change in exposure vulnerability. Unlike when measuring exposure, it is somewhat arbitrary and contentious to establish a social vulnerability indicator threshold above or below which people are considered vulnerable. For instance, SoVI scores estimate a county’s vulnerability as compared to other counties. The index does not attempt to determine a threshold above or below which a county is vulnerable (HVRI 2013). For example, it is widely known that elderly people are more vulnerable during disasters because they tend to have limited mobility and are more likely to live alone. For the purposes of this analysis, I could assume that if more than 15% of a population is elderly that community is vulnerable. However, because a binary approach is used, I would also be assuming that a community with an elderly population less than 15% is not vulnerable to coastal flood hazards and is therefore given a vulnerability score of zero. There is no literature to support this assumption and because vulnerability is place specific, the appropriate threshold may vary from census tract to census tract greatly complicating the analysis. Additionally, creating a change in social vulnerability index allows change in social vulnerability to be compared across origin-relocation address pairs.

To simplify the social vulnerability component of the assessment, the change in social vulnerability will be evaluated in relative terms. For instance, if Homeowner A assumes a 3% single-parent household occurrence at their origin address but assumes a 10% single-parent household occurrence at their relocation address, this homeowner’s social vulnerability is assumed to have increased when compared to the baseline vulnerability experience in Staten Island. If the social vulnerability indicator exhibits higher vulnerability in the relocation address than the origin address, a vulnerability score of one is awarded for that indicator. If the social vulnerability indicator is the same or lower for the relocation address than the origin address, a vulnerability score of zero is awarded. As with the exposure analysis, each indicator has a possible vulnerability score of either zero or one. The scores for all seven vulnerability indicators are summed for each pair of origin and relocation addresses. The higher the social vulnerability score, the more vulnerable the buyout participant is at their relocation address than they were at their origin address. The maximum score for this component is seven and the minimum is zero.

This approach to measuring the change in social vulnerability makes many assumptions. I assume that, on average, buyout participants are representative of the census tract within which they are located and are therefore likely to reflect the social vulnerability characteristics of that census tract. Additionally, this approach assumes that, upon relocating, participants will be representative of their relocation address’ census tract. In other words, individuals are assumed to represent their communities. Given that individuals are assumed to represent the community, the change in vulnerability for individual participants is not of interest. This analysis is only interested in evaluating how the vulnerability of people and property within the Oakwood Beach, Graham Beach and Ocean Breeze communities has changed due to the buyout program.
Due to time constraints and a lack of resources available to contact buyout participants to conduct a post-relocation survey, it is difficult to determine if and how individuals have integrated into their relocation address communities. Because of this uncertainty, it is impossible to say with certainty whether the change in an individual’s vulnerability is reflected by the change in their pre- and post-relocation community’s vulnerability. For instance, consider a situation in which a 30 year-old individual moves from a community with a 10% elderly population to a community with a majority elderly population. Though this individual is not likely to be more vulnerable after they move, the vulnerability score of one indicates that vulnerability has increased. However, because information about individual buyout participant’s demographic characteristics is unknown, an average change in social vulnerability score for each community is reported to correct for this potentially incorrect assumption. By evaluating the change in vulnerability at the community level, discrepancies in the change in vulnerability of the individual are accounted for.

Given the lack of available literature and the limited scope of this analysis, the change in the exposure and social vulnerability of Oakwood Beach, Graham Beach, Ocean Breeze community members who did not participate in the buyout program is not considered. The change in the exposure and social vulnerability of the receiving relocation communities is also not considered.

10.3.3 Calculating Overall Change in Vulnerability

To calculate the change in overall change in vulnerability of people and property to coastal flood hazards, the change in exposure and change in social vulnerability scores for each origin-address pair will be standardized based on the number of indicators used for each component of the analysis. Unlike in Szlafstein and Sterr’s assessment, the indicators will not be weighted based on their relative importance in influencing vulnerability (2007). This is because data on the relative importance of the indicators used in this analysis in determining the vulnerability of people and property to coastal flood hazards are not widely available. The standardization of exposure and social vulnerability scores assumes that exposure and social vulnerability are equally important in determining overall vulnerability. Once the scores have been standardized, the exposure and social vulnerability scores will be averaged to determine overall vulnerability.
11 RESULTS AND DISCUSSION

“Property acquisition (buyout) is one of many forms of hazard mitigation. It is also the most permanent form. It removes people from harm’s way forever.” (FEMA 2011)

11.1 TRENDS IN RELOCATION

Prior to this study, virtually no data about the relocation of buyout participants have been analyzed. Generally, once a state has disbursed payment to the buyout participant, it appears that communication between the state and the buyout participant ends. In NY, GOSR only kept track of buyout participants eligible for the 5% incentive for relocating with NYC’s five boroughs (Wieder 2017). This was done to ensure that participants only received the incentive if they actually relocated within NYC. However, it is unclear whether buyout participants were actually inhabiting these addresses or had simply given the state the address of a family member or friend. The relocation addresses of these buyout participants are not publically available and it does not seem as though NYS will be further analyzing these data.

Without knowing, with certainty, where all buyout participants move, it is impossible to determine whether or not the buyout program has met its goal of moving people from harm’s way. The relocation behaviors of this study’s sample of buyout participants was analyzed to identify trends in movement following participation in the buyout program. Collecting information about the relocation of buyout participants can inform incentive approaches as well as help assess the program’s efficacy.

Of the 323 buyout participants studied, nearly 82% relocated within New York State. 75% of all participants relocated within Richmond County (Staten Island) and 22% of participants relocated within the same zip code as their origin address. Across the three communities, this trend was relatively consistent. These results are summarized in Table 5. As one might expect, the majority of the buyout participants stayed in NYS. This may be due to the incentives offered by the state for participants who relocated within the five boroughs of NYC. However, it seems more likely that individuals may have chosen to stay in NYS to stay close to their family, friends, place of employment or schools, if they have children.

Approximately 18% of buyout participants relocated outside of NYS. Participants moved to Arizona, Connecticut, Delaware, Florida, Maryland, New Jersey, Nevada, Pennsylvania, Texas and Washington. Of the 60 participants who moved out of NYS, half moved to New Jersey. Table 6 summarizes buyout participant relocation by state. Without conducting a follow-up survey with individuals who moved out of state it is impossible to say with any certainty why they decided to move where they did. As seen in the Appendix Maps 6 and 7, those who relocated tended to stay close to the coast which may indicate an attachment to place. Individuals who relocated to Florida may have decided to retire there. Others may have relocated out of state to be close to family, friends or other resources. The two individuals who relocated to Nevada happened to be neighbors in Staten Island. It is unclear whether or not they were related.

Of the 264 buyout participants who stayed within NYS, 242 stayed in Staten Island. The remaining 22 participants moved to ten cities in NY. Notably, 11 buyout participants moved to Brooklyn. Participants also relocated to Astoria, Bloomingburg, Carmel, Chaumont, Goshen, Middletown, New York, Salisbury Mills and Warwick.
Table 5. Summary of Relocation within NYS for all Buyout Communities.

<table>
<thead>
<tr>
<th>Relocation by State</th>
<th>Total (323)</th>
<th>Oakwood Beach (229)</th>
<th>Graham Beach (40)</th>
<th>Ocean Breeze (54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relocated in NY State</td>
<td>264</td>
<td>189</td>
<td>32</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>81.73</td>
<td>82.53</td>
<td>80.00</td>
<td>79.63</td>
</tr>
<tr>
<td>Relocated in Richmond County</td>
<td>242</td>
<td>174</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>74.92</td>
<td>75.98</td>
<td>75.00</td>
<td>70.37</td>
</tr>
<tr>
<td>Relocated in Origin Zip Code</td>
<td>72</td>
<td>57</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>22.29</td>
<td>24.89</td>
<td>17.50</td>
<td>14.81</td>
</tr>
</tbody>
</table>

Table 6. Relocation of Participants to States Other Than NY.

<table>
<thead>
<tr>
<th>Relocation By State</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>1</td>
<td>0.31</td>
</tr>
<tr>
<td>Connecticut</td>
<td>1</td>
<td>0.31</td>
</tr>
<tr>
<td>Delaware</td>
<td>1</td>
<td>0.31</td>
</tr>
<tr>
<td>Florida</td>
<td>14</td>
<td>4.33</td>
</tr>
<tr>
<td>Maryland</td>
<td>1</td>
<td>0.31</td>
</tr>
<tr>
<td>New Jersey</td>
<td>30</td>
<td>9.29</td>
</tr>
<tr>
<td>Nevada</td>
<td>2</td>
<td>0.62</td>
</tr>
<tr>
<td>New York</td>
<td>264</td>
<td>81.73</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>7</td>
<td>2.17</td>
</tr>
<tr>
<td>Texas</td>
<td>1</td>
<td>0.31</td>
</tr>
<tr>
<td>Washington</td>
<td>1</td>
<td>0.31</td>
</tr>
<tr>
<td>Totals</td>
<td>323</td>
<td>100</td>
</tr>
</tbody>
</table>

The 242 buyout participants who relocated within Staten Island moved to a total of 12 zip codes. Table 7 summarizes the relocation of participants within Staten Island by zip code. The majority of participants relocated to zip codes 10306, 10312, 10314 and 10308. Nearly 40% of all buyout participants who relocated within Staten Island relocated to zip codes 10305 and 10306. All three of the buyout communities fall within these two zip codes. 53% of those buyout participants originating in Ocean Breeze relocated to the buyout zip codes. Only 37% of the buyout participants originating in Oakwood Beach relocated to the buyout zip codes. This begs the question of whether or not the NY Rising Buyout Program actually did permanently move program participants out of harm’s way. The results of the vulnerability analysis, the results of which are discussed below, attempt to answer this question in a quantitative and replicable way.

Using the point distance tool in ArcGIS, the approximate linear distance between each pair of origin and relocation addresses was calculated. Though there is error involved in this calculation due to possible inaccuracies in the coordinates returned by the georeferencing service, these distances provide a very rough estimate of how far buyout participants moved from their origin address. For all participants, the median distance moved was 3.96 miles. The least distance moved by a single participant was 0.04 miles. The greatest distance moved was 2400 miles. This great distance was achieved by the single relocation to the state of Washington. Again, with over 120 buyout participants moving within 3 miles of their origin address.
address and 19 moving within a mile of their origin address, I am skeptical of the buyout program’s success in relocating homeowners away from vulnerable areas. Tables 8 and 9 provide additional details about the distances moved by buyout participants in this study’s sample.

Table 7. Relocation of Participants within Staten Island by Zip Code. The buyouts were offered in zip codes 10305 and 10306.

<table>
<thead>
<tr>
<th>Relocation Within Staten Island (Zip Code)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
</tr>
<tr>
<td>10301</td>
</tr>
<tr>
<td>10302</td>
</tr>
<tr>
<td>10303</td>
</tr>
<tr>
<td>10304</td>
</tr>
<tr>
<td>10305</td>
</tr>
<tr>
<td>10306</td>
</tr>
<tr>
<td>10307</td>
</tr>
<tr>
<td>10308</td>
</tr>
<tr>
<td>10309</td>
</tr>
<tr>
<td>10310</td>
</tr>
<tr>
<td>10312</td>
</tr>
<tr>
<td>10314</td>
</tr>
<tr>
<td>Totals</td>
</tr>
</tbody>
</table>

Table 8. Summary Statistics of Distance Moved by Buyout Participants.

<table>
<thead>
<tr>
<th>Summary Statistics of Distance Moved By Buyout Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Distance Moved (mi)</td>
</tr>
<tr>
<td>------------------------------</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Oakwood Beach</td>
</tr>
<tr>
<td>Ocean Breeze</td>
</tr>
<tr>
<td>Graham Beach</td>
</tr>
</tbody>
</table>
In assessing the exposure vulnerability of the origin and relocation addresses, three indicators were used. These were location within the SFHA as designated by FEMA’s V and A flood zones, exposure to any level of inundation associated with a projected Category 3 storm surge using the SLOSH model and exposure to frequent shallow coastal flooding. When considering the results of this portion of the assessment, it is essential to note that because an address’ exposure vulnerability is based on location, there is some error introduced by the possibility of origin and buyout addresses being assigned incorrect coordinates by the georeferencing service. Though the accuracy of approximately 10% of all addresses was spot-checked and every address is located within the correct state, there are no guarantees that the coordinates assigned to a particular address represent its precise location.

As per the terms of the buyout program, all eligible properties must be within FEMA’S mapped 100-year floodplain which includes the V and the A zones. (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 17). All 323 origin addresses analyzed were located within the AE zone, confirming adherence to this eligibility requirement set by the buyout program. On average, the origin addresses were projected to be exposed to 20ft of storm surge with a Category 3 storm. Though Superstorm Sandy was technically designated a post-tropical cyclone when it reached NY, the extent of its flooding at the origin addresses (Appendix Map 3) surpassed the surge predicted for a Category 1 hurricane but was less than the inundation predicted for a Category 3 storm (Appendix Map 4).

Only 135 of the 323 origin addresses in the sample were exposed to frequent shallow coastal flooding. The shallow coastal flooding data used in this analysis was downloaded from the Coastal Flood Exposure Mapper. According to the tool’s metadata, the map shows “low-lying coastal areas prone to flooding during extreme high tides.” This exposure is based on designations made by the National Weather Service (NWS) using tide gauge readings. If the tide gauge shows water depth over a locally-specific threshold set by NWS, shallow coastal flooding occurs. Many of the origin addresses may not have been exposed to this indicator because the buyout areas are set back from the coastline or ‘protected’ from minor flooding by higher elevation roads such as Father Capodanno Drive or the open spaces of Great Kills Park. Map 5 in the Appendix summarizes the results of the exposure analysis for the origin addresses.

Because the majority of the origin properties were not exposed to shallow coastal flooding, many did not receive the highest possible exposure score (3). This is misleading given that it is unequivocally

Table 9. Summary of Buyout Participants Who Moved Within 5 Miles of Their Origin Address.

<table>
<thead>
<tr>
<th>Distance Moved from Origin</th>
<th>Number of Participants</th>
<th>% of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moved &lt;1mi from Origin</td>
<td>19</td>
<td>5.88</td>
</tr>
<tr>
<td>Moved &lt;3mi from Origin</td>
<td>123</td>
<td>38.08</td>
</tr>
<tr>
<td>Moved &lt;5mi from Origin</td>
<td>195</td>
<td>60.37</td>
</tr>
</tbody>
</table>

11.2 EXPOSURE VULNERABILITY

In assessing the exposure vulnerability of the origin and relocation addresses, three indicators were used. These were location within the SFHA as designated by FEMA’s V and A flood zones, exposure to any level of inundation associated with a projected Category 3 storm surge using the SLOSH model and exposure to frequent shallow coastal flooding. When considering the results of this portion of the assessment, it is essential to note that because an address’ exposure vulnerability is based on location, there is some error introduced by the possibility of origin and buyout addresses being assigned incorrect coordinates by the georeferencing service. Though the accuracy of approximately 10% of all addresses was spot-checked and every address is located within the correct state, there are no guarantees that the coordinates assigned to a particular address represent its precise location.

As per the terms of the buyout program, all eligible properties must be within FEMA’S mapped 100-year floodplain which includes the V and the A zones. (NY Rising Buyout and Acquisition Program Policy Manual February 2016, 17). All 323 origin addresses analyzed were located within the AE zone, confirming adherence to this eligibility requirement set by the buyout program. On average, the origin addresses were projected to be exposed to 20ft of storm surge with a Category 3 storm. Though Superstorm Sandy was technically designated a post-tropical cyclone when it reached NY, the extent of its flooding at the origin addresses (Appendix Map 3) surpassed the surge predicted for a Category 1 hurricane but was less than the inundation predicted for a Category 3 storm (Appendix Map 4).

Only 135 of the 323 origin addresses in the sample were exposed to frequent shallow coastal flooding. The shallow coastal flooding data used in this analysis was downloaded from the Coastal Flood Exposure Mapper. According to the tool’s metadata, the map shows “low-lying coastal areas prone to flooding during extreme high tides.” This exposure is based on designations made by the National Weather Service (NWS) using tide gauge readings. If the tide gauge shows water depth over a locally-specific threshold set by NWS, shallow coastal flooding occurs. Many of the origin addresses may not have been exposed to this indicator because the buyout areas are set back from the coastline or ‘protected’ from minor flooding by higher elevation roads such as Father Capodanno Drive or the open spaces of Great Kills Park. Map 5 in the Appendix summarizes the results of the exposure analysis for the origin addresses.

Because the majority of the origin properties were not exposed to shallow coastal flooding, many did not receive the highest possible exposure score (3). This is misleading given that it is unequivocally

known that these properties were devastated during Superstorm Sandy and are therefore vulnerable to coastal flood hazards. However, given the influence that sea level rise and other climate change impacts may have on coastal flood hazards, the shallow coastal flooding indicator was kept in the analysis as an indicator of future flood risk due to sea level rise.

The cumulative exposure score for relocation addresses was much lower than initially expected. Only 24 of the 323 relocation addresses were located within the A zone. One buyout participant who relocated within Staten Island moved into the VE zone, or the zone designated by FEMA to be susceptible to the 100-year flood and wave action (National Flood Insurance Program 2007). 67 of the relocation addresses were exposed to the projected storm surge of a Category 3 storm with an average inundation potential of 12ft. The extent of storm surge observed during Superstorm Sandy is shown for relocation addresses in the NYC area in Appendix Map 6. Only two of the relocation addresses were exposed to shallow coastal flooding. Both of these addresses are within one of the buyout community zip codes on Staten Island.

In total, the relocation addresses scored only 94 out of possible 969 exposure vulnerability points. The exposure vulnerability of relocation addresses may be underestimated for a variety of reasons. One potential explanation for the low exposure score, despite the coastal location of many of the relocation addresses (Appendix Maps 7 and 8), is that the data used for the exposure indicators may be out of date. For instance, pFIRMs issued in 2015 were used to determine the flood zone for the origin addresses. However, for the relocation addresses the National Flood Hazard Layer was used. Though this layer includes the most up-to-date FIRMs nationwide as of August 2016, many maps may not have been recently updated and therefore do not accurately represent current risk (National Flood Insurance Program 2015). The date associated with the FIRM used varies across the country and in some regions that have not experienced a devastating storm in the recent past, this information may be grossly out of date. This is particularly an issue in coastal regions where populations are growing and the influence of expanding infrastructure and impervious surface has not yet been accounted for within the maps. The problem is also prevalent in regions that are already feeling the effects of climate change.

Between origin and relocation address pairs, the vulnerability exposure increased for only two buyout participants. One reason for this is that my methodology does not award an exposure vulnerability score unless the exposure for an indicator increased between the origin and relocation address. Given that all of the origin addresses had exposure vulnerability scores of at least two, a relocation address would have to be exposed to all three indicators to be considered more vulnerable than the origin address. As discussed, the shallow coastal flooding indicator is quite limited in extent and it would therefore require that a relocation address be in an extremely low lying area and imminently threatened by sea level rise in order to present as more vulnerable using this approach.

Looking across all three indicators, the exposure vulnerability for relocation addresses was equal or greater than exposure vulnerability for origin addresses for 69 pairs. These 69 buyout participants relocated to an area at least as exposed as their origin address in Staten Island. Of these, 59 households relocated within NY and 55 of those relocated within Staten Island. Map 9 in the Appendix displays the relocation addresses that are closest to the buyout locations. Additionally, five relocated to Florida, four to New Jersey and one to Delaware. This very basic analysis alone shows that buyout participants have not moved out of harm’s way. Even using data that systematically underestimates risk, over 20% of all of the buyout participants are living in a region that is at least as exposed as their buyout address in Staten Island.
11.2.1 Severe Repetitive Loss Properties on Staten Island

In addition to the known and widespread effects Superstorm Sandy had on the buyout communities, and the analysis described above, the Severe Repetitive Loss Database\(^{13}\) was utilized to provide a supplementary understanding of exposure vulnerability in Staten Island. Severe Repetitive Loss Properties (SLRPs) are the 30,000 most frequently flooded properties in the National Flood Insurance Program (NFIP) (Moore and Eastman 2016). As of November 30, 2015, there were 1,802 of these properties in New York State. 116 of these are within NYC’s five boroughs and 44 of these are on Staten Island. Of the SLRPs on Staten Island, 30, or 68% are located within the two buyout zip codes (10305 and 10306). These 30 properties have been cumulatively flooded 133 times and have received $4,161,901 in payments from the NFIP. On average each property was flooded four times and received a payout of $138,730 per flood.

11.3 Social Vulnerability

In order to assess the change in social vulnerability between the origin and relocation addresses of buyout participants, seven indicators of social vulnerability were assessed. These were population density, percent of population over 65, percent minority population, percent Hispanic population, percent of single-parent families, percent of population that has attained a Bachelor’s degree or more and percent of population for whom the ratio of income to poverty is less than one. If an indicator was found to change in a way that indicated a higher social vulnerability for the relocation addresses, a social vulnerability score of one was awarded. If the vulnerability did not increase for an indicator, a score of zero was awarded. Across all seven social vulnerability indicators, a maximum score of seven was possible. Participants that did not experience an increase in social vulnerability, as indicated by the selected variables, received a social vulnerability score of zero.

Social vulnerability increased for every indicator for only one origin-relocation address pair. This buyout participant relocated to a more densely populated census tract with larger elderly, minority and Hispanic populations, more single-parent households, higher levels of poverty and fewer people with Bachelor’s degrees. Aggregated across the entire sample, the change in social vulnerability was an increase of 1183 out of a possible 2261. The average change in social vulnerability score across the sample was an increase of 3.66 out of a possible seven. Social vulnerability did not increase for only two of the buyout participants.

Nearly all of the buyout participants relocated to an area with higher levels of poverty. Two-thirds of the buyout participants relocated to an area with a greater proportion of the population over 65. Over 60% of the buyout participants relocated to an area with a higher population density. Only 3.4% of buyout participants relocated to an area with a higher occurrence of single-parent families. A summary of the change in social vulnerability measured is available in Table 10. In this table, the average social vulnerability is averaged across the 323 origin-address pairs and is out of a maximum possible social vulnerability score of seven. For each indicator, the average is on a scale from zero to one. Higher averages indicate that more buyout participants in the study sample experienced an increase in social vulnerability for that particular indicator.

\(^{13}\) The SRLP Database was obtained through a June 2014 Freedom of Information Act request, and was provided to the Natural Resources Defense Council on June 7\(^{th}\), 2016 as a pdf document. NRDC converted the original pdf document into an excel spreadsheet, which is titled “SRLP original database unchanged” and dated August 12, 2016.
Overall, buyout participants tended to move to census tracts with higher levels of poverty and older populations. Few conclusions can be made about this trend without following up with buyout participants. It is possible that the FMV and incentives received by buyout participants were not enough to cover any payments they still had to make on their bought out property and also relocate to a home in a comparable area. There is also a possibility that many of the homeowners were older and tended to move to areas with more concentrated senior populations. These findings are generally supported by the work of Binder and Greer (2016).

Table 10. Summary of Change in Social Vulnerability Results. Average change in social vulnerability is out of a maximum social vulnerability score of seven. Average change for each indicator is out of a maximum social vulnerability score of one for that indicator.

<table>
<thead>
<tr>
<th>Summary of Δ Social Vulnerability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>Average Change in Social Vulnerability Score</td>
</tr>
<tr>
<td>Indicator with Greatest Increase</td>
</tr>
<tr>
<td>Indicator with Least Increase</td>
</tr>
<tr>
<td>Avg. Δ Population Density</td>
</tr>
<tr>
<td>Avg. Δ % Poverty</td>
</tr>
<tr>
<td>Avg. Δ % Educational Attainment</td>
</tr>
<tr>
<td>Avg. Δ % Poverty</td>
</tr>
</tbody>
</table>

11.4 OVERALL VULNERABILITY

In considering indicators of both exposure and social vulnerability, this analysis finds that overall vulnerability has increased for 99% of the buyout participants considered. Overall vulnerability, as measured in this analysis, is the average of the standardized exposure and social vulnerability scores. Across the three buyout communities and all participants, overall vulnerability score was found to increase by 85 out of a maximum possible increase of 323. This cumulative change in vulnerability is the result of standardizing the scores of the exposure and social vulnerability components by the number of indicators used and then averaging these standardized scores for each origin-relocation address pair. The cumulative change in vulnerability observed within each community is consistent with the number of addresses considered for that community. The average change in vulnerability for a single buyout participant was a 26% increase from the baseline vulnerability score observed in Staten Island. Across the three communities, participants originating in Graham Beach experienced the greatest change in vulnerability with an average increase of 29% from the origin address vulnerability. Taken as a whole, the vulnerability of Oakwood Beach participants increased the least. These results are summarized in Table 11.
In interpreting these results, it is essential to note that this analysis considers the change in the exposure and social vulnerability of buyout program participants. Any increase in vulnerability is in excess of the baseline vulnerability experienced in Staten Island. Given that the buyout participants were, by definition, vulnerable and negatively impacted by Superstorm Sandy, this finding is significant for a variety of reasons. As discussed in the Exposure Vulnerability results, only two buyout participants experienced an increase in exposure vulnerability score. However, 69 of the 323 buyout participants did not experience a decrease in exposure vulnerability upon participation in the buyout program. This means that over 20% of the buyout participants are no less exposed to coastal flood hazards at their relocation address than they were at their origin address.

Repeating the overall vulnerability analysis for these 69 most exposed buyout participants, a vulnerability score of one is awarded if exposure vulnerability is the same or greater than that of the origin community, I find a cumulative increase in overall vulnerability of 35.67. This is an average overall vulnerability score increase for each buyout participant of 52% from the origin overall vulnerability score. Comparatively, on a whole, the average overall vulnerability score across all buyout participants only increased by 26% over the baseline origin vulnerability score. This indicates that while the overall vulnerability score of all but two of the buyout participants increased, the increase in overall vulnerability was double for those participants who relocated to regions at least as exposed to coastal flood hazards as their origin address in Staten Island.

11.5 Ecological Vulnerability

Though this analysis focuses primarily on the ability of the buyout component of the NY Rising Buyout and Acquisition Program to reduce the vulnerability of people and property to coastal flood hazards, I will also consider the program’s ability to meet its other goal in an effort to be comprehensive in my review.

In addition to relocating people from the vulnerable buyout communities, the buyout program requires that the properties acquired by the state be maintained as coastal buffer areas in perpetuity in an effort to reduce future vulnerability. Following discussions with representatives of the NYC Department of Environmental Conservation (Lang 2017), NYC Department of City Planning (Johnson and Farishta 2017) and Governor’s Office of Storm Recovery (Wieder 2017) it is clear that now, four and a half years after Superstorm Sandy, no one is quite sure who will be responsible for the maintenance of these properties or in what precise form they will be maintained. The consensus seems to be that future ownership and use will likely be determined on a parcel by parcel basis and will consider the ownership and use of nearby natural areas. For reference all open spaces within one mile of the buyout properties are shown in Appendix Map 10.

### Table 11. Summary of Overall Vulnerability Analysis results.

<table>
<thead>
<tr>
<th>Overall Vulnerability Scores</th>
<th>Cumulative Δ Vulnerability Score</th>
<th>Average Δ Vulnerability Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>84.83</td>
<td>0.26</td>
</tr>
<tr>
<td>Oakwood Beach</td>
<td>58.76</td>
<td>0.26</td>
</tr>
<tr>
<td>Graham Beach</td>
<td>11.50</td>
<td>0.29</td>
</tr>
<tr>
<td>Ocean Breeze</td>
<td>14.57</td>
<td>0.27</td>
</tr>
</tbody>
</table>

In interpreting these results, it is essential to note that this analysis considers the change in the exposure and social vulnerability of buyout program participants. Any increase in vulnerability is in excess of the baseline vulnerability experienced in Staten Island. Given that the buyout participants were, by definition, vulnerable and negatively impacted by Superstorm Sandy, this finding is significant for a variety of reasons. As discussed in the Exposure Vulnerability results, only two buyout participants experienced an increase in exposure vulnerability score. However, 69 of the 323 buyout participants did not experience a decrease in exposure vulnerability upon participation in the buyout program. This means that over 20% of the buyout participants are no less exposed to coastal flood hazards at their relocation address than they were at their origin address.

Repeating the overall vulnerability analysis for these 69 most exposed buyout participants, a vulnerability score of one is awarded if exposure vulnerability is the same or greater than that of the origin community, I find a cumulative increase in overall vulnerability of 35.67. This is an average overall vulnerability score increase for each buyout participant of 52% from the origin overall vulnerability score. Comparatively, on a whole, the average overall vulnerability score across all buyout participants only increased by 26% over the baseline origin vulnerability score. This indicates that while the overall vulnerability score of all but two of the buyout participants increased, the increase in overall vulnerability was double for those participants who relocated to regions at least as exposed to coastal flood hazards as their origin address in Staten Island.

11.5 Ecological Vulnerability

Though this analysis focuses primarily on the ability of the buyout component of the NY Rising Buyout and Acquisition Program to reduce the vulnerability of people and property to coastal flood hazards, I will also consider the program’s ability to meet its other goal in an effort to be comprehensive in my review.

In addition to relocating people from the vulnerable buyout communities, the buyout program requires that the properties acquired by the state be maintained as coastal buffer areas in perpetuity in an effort to reduce future vulnerability. Following discussions with representatives of the NYC Department of Environmental Conservation (Lang 2017), NYC Department of City Planning (Johnson and Farishta 2017) and Governor’s Office of Storm Recovery (Wieder 2017) it is clear that now, four and a half years after Superstorm Sandy, no one is quite sure who will be responsible for the maintenance of these properties or in what precise form they will be maintained. The consensus seems to be that future ownership and use will likely be determined on a parcel by parcel basis and will consider the ownership and use of nearby natural areas. For reference all open spaces within one mile of the buyout properties are shown in Appendix Map 10.
According to a representative of the NYC Department of Environmental Conservation, buyout properties within 100 feet of delineated freshwater wetlands are within the jurisdiction of the NYS Freshwater Wetlands Act. As such, these properties have specified requirements for sediment and erosion control procedures during demolition, debris removal and vegetative seeding after demolition. These procedures are intended to ensure that the property is able to integrate seamlessly with the neighboring wetlands and blend into the surrounding ecological community. However, beyond the 150 or so buyout properties that fall within 100’ of a delineated wetland, the DEC representative was unsure of specific procedures being followed in the demolition and subsequent maintenance of the remaining properties.

Having a clear plan in place soon after acquisition is essential to ensure that these properties are able to serve as coastal buffer zones in perpetuity and do not remain vacant and a constant reminder to the remaining community of the devastation they faced during the storm. In Kinston, North Carolina since Hurricanes Fran and Floyd in 1996 and 1999 nearly 1600 homes were acquired by the state (NOAA Office for Coastal Management 2017). A visit to Kinston in the spring of 2016 revealed that nothing had been done with the acquired land. Some parcels sat vacant, some structures remained standing, completely overcome with overgrowth. Other lots had been turned into electronics dumping grounds. These properties, between what remains of the community and the river, are a constant reminder to the residents of Kinston of the devastation of the hurricanes of the late 1990s and of the state’s ultimate failure. These properties have great potential to be community resources but local politics and a lack of funding have, so far, prevented these lands from assuming any meaningful use. Kinston was devastated again by flooding following Hurricane Matthew in October of 2016. It is unclear whether they are willing to participate in another buyout program.

If buyout programs are going to be championed as a disaster mitigation tool as our vulnerability to flooding increases, we must be sure that they meet their goals and do not dissuade remaining community members from future participation. Vulnerability to flooding is an expanding problem and if relocation is to be the answer we need to encourage participation by ensuring that these properties maintain their protective abilities overtime and provide a resource to remaining community members. Further research must also be done to assess whether or not these vacant areas are effective in providing flood protection or ecosystem services.

### 12 Other Considerations

#### 12.1 Limitations and Future Directions

The methodology for measuring the change in overall vulnerability employed by this study is not the best and certainly not the only possible approach. However, the findings of this study illustrate that it is far from certain whether or not buyout programs are successful in moving vulnerable populations from harm’s way. If buyouts continue to be championed as a post-disaster mitigation approach, buyout policy must be crafted to ensure that vulnerability is in fact reduced. In order to craft effective and fiscally responsible buyout policy, further research on the efficacy of recent buyout programs is recommended. Knowing whether or not buyout programs have met their objectives and analyzing trends in the relocation of buyout participants can help craft future buyout policy that is more informed and, ultimately, more likely to be successful. A discussion of the limitations of this study and recommendations for future research are presented to inform more robust assessments of buyout programs moving forward.
Due to an initial inability to acquire information regarding the precise location of buyout parcels, a creative approach was taken to determine origin addresses. As mentioned, a shapefile containing polygons for each buyout parcel in Staten Island was eventually obtained from the Governor's Office of Storm Recovery in early February of 2017. At this point, the analysis had largely been completed using the origin addresses obtained through an extensive review of publically available documents. However, obtaining a file with confirmed buyout locations was instrumental in checking the accuracy of the buyout origin addresses. Maps 11 and 12 in the Appendix show the origin addresses, as determined through my methods, in relation to the parcels confirmed to have been bought out by GOSR. Though the method used to acquire the origin addresses was haphazard and dependent on publically available documents, it was surprisingly accurate. Notably, there are several properties on Tarlton St. in the Oakwood Beach community that do not align with the parcels acquired by the state. Though these origin addresses are definitively located on Tarlton Street, it is unclear where along the street they were in actuality. Because these properties were assigned coordinates closer to the waterfront than they may have been, the exposure vulnerability for these seven addresses may be overstated.

Inaccuracy in the precise location of origin and relocation addresses is also likely. Because only addresses for origin and relocation parcels could be obtained, a georeferencing service was used to determine the approximate coordinates of the properties. However, as demonstrated by the misplaced Tarlton St. properties, the georeferencing was not completely accurate. Upon receiving the coordinates for both the origin and relocation addresses, all points were confirmed to be located within the correct state. However, only 10% of all addresses were spot checked to guarantee accurate locations within the state. There is the potential that some of the remaining addresses were not assigned correct coordinates by the georeferencing service. This could be problematic because the values used to determine exposure and social vulnerability are dependent on the address’ location. If an address was not assigned the correct coordinates, it may have assumed inaccurate values for the exposure and social vulnerability indicators and the estimate of change in overall vulnerability score may not reflect the actual change in vulnerability score for that particular origin-address pair. However, because the findings of this study focus on the change in exposure, social and overall vulnerability scores aggregated for each of the three communities, the influence of relatively few inaccurate coordinates on the conclusions drawn is likely to be minimal. Had this analysis considered the change in vulnerability scores for individual origin-relocation address pairs, this would be an issue of serious concern.

This analysis does not consider the socioeconomic or demographic characteristics of individual buyout participants because this information was not accessible within the constraints of the study. As such, it is impossible to reach conclusions about how the social vulnerability for a single buyout participant changed between their origin and relocation addresses. For instance, an individual of Hispanic decent may actually experience a decrease in social vulnerability upon relocating to a community with a higher percentage Hispanic population which is contrary to the assumptions made by this analysis. It is difficult to determine if and how individuals have integrated into their relocation address communities. Because of this uncertainty, it is impossible to say with certainty whether the change in an individual’s vulnerability score is reflected by the change in their pre- and post-relocation community’s vulnerability. However, by assessing change in vulnerability scores as aggregated for the three communities, instead of for the individual, this study attempts to overcome these potential discrepancies. In doing so, this assessment assumes that, on average, buyout participants from each of the three communities are representative of the census tract within which their community is located.
Largely due to a lack of literature on the topic, this analysis chose not to weight the contribution of any individual indicators to overall vulnerability. Further, standardized exposure and social vulnerability scores contributed equally to overall vulnerability scores. Frazier, Thompson and Dezzani point out that the failure to weight indicators based on how they influence vulnerability may result in inaccurate estimates of vulnerability (2014). However, as it is largely agreed that vulnerability is spatially explicit and that the variables contributing to vulnerability vary across both space and time (Frazier, Thompson and Dezzani 2014 and Adger 2006), this analysis’ occupation of different spatial and temporal scales makes it incredibly difficult to account for the weighting of vulnerability indicators across origin and relocation addresses. Additionally, this analysis does not account for the potential interaction between indicators. For instance, this approach assumes that being exposed to Category 3 inundation and shallow coastal flood has an equivalent impact on overall vulnerability as being exposed to Category 3 inundation and within a special flood hazard area. This approach also assumes that an origin-address pair with a social vulnerability score of 3 due to increases in poverty, percent minority and percent elderly is the same as a score of 3 due to increases in single parent households, percent Hispanic and an increase in poverty. The actual interaction of these indicators and how they influence vulnerability is unknown.

This study found that all but two buyout participants experienced an increase in social vulnerability score while only two buyout participants experienced an increase in exposure vulnerability score. As such, the overall vulnerability score of the majority of the sample is expressed entirely in terms of social vulnerability. The argument could be made that, if people or property are not exposed to a coastal flood hazard in the first place, they cannot exhibit sensitivity or adaptive capacity. This is because many definitions of vulnerability, especially those originating in the field of natural hazards, define vulnerability as the potential for loss and therefore, vulnerability is not possible without exposure (Frazier, Thompson and Dezzani 2014, Adger 2006, and Fussel 2007). However, in this analysis, sensitivity and adaptive capacity (as indicated by change in social vulnerability score) are considered to be contributing to the overall vulnerability score even in the absence of exposure. Though this study is particularly concerned with the reduction in vulnerability to coastal flood hazards, social vulnerability of buyout participants at their relocation address is important in determining how they may fair when exposed to all other hazards. Further, there is ample reason to believe that the indicators chosen to determine exposure vulnerability may be systematically underestimating exposure to coastal flood hazards.

As discussed in the exposure vulnerability results, the exposure vulnerability of the relocation addresses was much lower than anticipated. This is likely due to the suite of chosen exposure indicators. As mentioned earlier, the National Flood Hazard Layer which was used to indicate special flood hazard areas for the relocation addresses may be out of date for some localities and therefore may not consider recent development and increases in impervious surfaces or other variables that may increase flood risk. The extent of the shallow coastal flooding indicator was very limited and even many of the clearly exposed origin addresses did not receive an exposure vulnerability score for this indicator. In Staten Island, this may be because many of the areas currently exposed to shallow coastal flooding are located very close to the shoreline and within Great Kills Park. The indicator was kept in the analysis to illustrate the future flood risk due to sea level rise. Further, the Category 3 inundation prediction was taken from the National Weather Service’s Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model which has several known limitations. For instance, the model does not consider the impact of waves on top of storm surge or account for riverine and inland flooding contributions (National Hurricane Center 2017).

The destruction caused by Superstorm Sandy is just a single example of our systematic underestimation of exposure vulnerability. Modeling approaches at the time of Sandy did not consider
the option that the storm could hit New York at high tide and, therefore, the effect this confluence of factors had on storm surge inundation was not anticipated. In future analyses, it may be beneficial to consider a wider variety of exposure vulnerability indicators to try and account for the fact that no models are entirely inclusive. Some measure incorporating distance from coast and elevation may be incorporated as a simple indicator of vulnerability. Though such a measure would not account for topographical inconsistencies like floodwalls or elevated roadways and factors such as erosion, high tide frequency or inland runoff, it is a simple indicator of relative risk and may be easier to interpret.

Another potential way to overcome the potential underestimation of exposure vulnerability would be to take into consideration historic inundation experienced by a locality. This is an approach that was taken by the National Park Service in their assessment of the vulnerability of coastal national parks. However, the NPS assessment was reliant on the institutional memory and the low turnover rate of employees working within a park to create an accurate hind cast of previous flooding events. Not only would finding appropriate historic flood extent data for all origin and relocation addresses greatly complicate this analysis but, the data are also largely unavailable. Future studies may benefit from determining whether or not any of the origin properties were Severe Repetitive Loss Properties as this could serve as a proxy for historical flooding. If so, an additional benefit of the buyout program may be the reduction of repetitive flood loss and NFIP payments. Unless, of course, buyout participants moved into another area with high incidences of SRLPs. This too is unknown, access to depersonalized information on the Severe Repetitive Loss Program and its properties could allow buyout programs to target these properties for acquisition or provide added incentives for these homeowners to encourage them to participate and relocate to a less vulnerable place. Moving forward, it is essential that data regarding the extent coastal flooding is collected so that it can inform vulnerability and risk analyses.

Future research would benefit from consideration of other aspects of buyout participant’s relocation. For instance, this analysis used the most recent address available as the participant’s relocation address. It is unknown whether the participant is actually residing at this address or if they are having their mail sent to a family member or friend until they are able to find more permanent housing. It would also be interesting to consider whether buyout participants move from a home or rental property to another home or rental property. However, because of difficulty in identifying and locating renters, this analysis would be quite difficult without the implementation of a longitudinal survey. It would also be worth investigating how many buyout participants are able to buy a home at their relocation address and what the average loan or mortgage is for purchase of this new property. Another relocation trend worth considering is how many times a buyout participant moves before they are living in a stable, permanent residence.

Future analyses may also benefit from a more detailed consideration of how the vulnerability of physical property to coastal flood hazards has changed. Though this analysis does consider whether or not a property is exposed to coastal flood hazards, it does not consider the value of the property exposed. Further it does not consider whether the property has been elevated, is located directly behind a levee or has been otherwise flood proofed. An economic assessment of the vulnerable properties relocated out of harm’s way could be included in further analyses to construct an economic argument for the value of these programs.

Further, this analysis does not consider how the vulnerability of how those who were affected by the program, but did not participate, was changed. Homeowners neighboring the buyout areas were undoubtedly affected by the buyouts in some way and both their exposure and social vulnerability may have changed. A loss of tax-base in the community may decrease customers at locally-owned retail
establishments and increase social vulnerability. Widespread awareness about the exposure vulnerability of the area may increase flood preparedness initiatives and decrease the area’s vulnerability. The possibilities are numerous and uncertain. There is also the potential that communities experiencing an influx of relocating buyout participants may experience a change in vulnerability. This analysis also does not consider how the return of the buyout properties to coastal buffer areas in perpetuity may decrease the area’s exposure vulnerability. However, because of the still widespread uncertainty of the fate of buyout parcels this would be difficult to quantify in the near term.

A standardized survey designed to assess the experiences of buyout participants with the program may also be useful for informing future policies. This type of survey could provide insight as to the demographic characteristics of individuals, why these individuals chose to take the buyout, what influenced their decision of where to relocate and whether or not their participation in the program was a positive or negative experience. If buyout programs tend to have many unintended negative consequences, one can assume it may be difficult to convince individuals to participate. A more holistic understanding of how buyouts and other relocation programs influence the lives and livelihoods of participants can be used to inform policies that encourage positive outcomes and limit unintended negative consequences.

The findings of this research indicate that it is unclear whether or not the coastal buyout program implemented in Staten Island following Superstorm Sandy, met its objective of reducing vulnerability to coastal flood hazards. In order to craft robust and informed recommendations for improving federal buyout policy on the coast, a sound understanding of the history and success of buyout programs more broadly is instructive. Studying buyout programs that have been successful on the coast in the past may provide insight as to what kind of policies need to be implemented to ensure successful coastal buyouts in the future.

12.2 BUYOUT BEST PRACTICES

In 2011, FEMA released a collection of mitigation best practice stories. To get a better idea of where buyouts have been successfully implemented in the past and how programs can be improved moving forward, this document was analyzed. Of the 133 buyout case studies explored in this document, only 25 appear to have occurred in counties along the coast. Of the case studies that provided numbers about the number of properties acquired, only 19 included the acquisition of more than 100 properties through a single program.

The best practices compiled by FEMA for this report are almost entirely relocations of few homeowners out of a riverine floodplain. Nearly all of the buyout programs discussed in the report have occurred since 1993. In 1993, widespread riverine flooding throughout 9 states in the Midwest encouraged the implementation of buyout programs throughout the region. In Missouri from 1993-2003 nearly $100 million from a variety of sources was to the state to help acquire, relocated and elevate nearly 5000 properties. The Missouri Buyout Program is largely thought to be a success for in 2002, when the floods returned to the affected area, another disaster was avoided (Missouri State Emergency Management Agency August 2002). However, across all of the buyout programs discussed in the report there is not a single methodology identified for quantifying the success of these programs. Accounts of success in the report are largely based on anecdotal evidence of how a buyout area fairs during a flood event at a later date. None of the case studies consider the relocation of buyout participants or confirm that they have moved outside of the area vulnerable to flooding. In small, rural riverine towns, it is easy to see how program success was so casually observed. When only a handful of homes are moved, and
available housing stock is known, one would expect that the program administrators have a good idea of where participants relocate. However, in a larger buyout program implemented along a densely populated coast, it is unclear if success can, or should, be casually evaluated based on the observed impacts of future flood events. Given that over 190 million federal taxpayer dollars were spent on buyouts in Staten Island alone (Wieder 2017), the issue of fiscal responsibility must be a consideration. A systematic evaluation of the success of buyout programs, especially those spending hundreds of millions of taxpayer dollars, is essential to prevent continued wasteful federal expenditure.

Though this report was released in 2011, and therefore does not include the most recent buyout programs, there is still a clear lack of historic large coastal buyout programs that may be used to inform the development of future programs. Further, there has been no systematic attempt to evaluate the success of buyout programs on a whole. Even if the success of small, rural, riverine buyout programs had been systematically evaluated, it is unclear whether the findings of that assessment would even apply to the large, urban, coastal buyouts. Without a solid understanding of whether or not these programs meet their objectives, it seems unwise for our country to encourage use of this strategy to reduce vulnerability along the coast.

12.3 USACE Proposed Line of Protection

In order to comprehensively evaluate the success of the Staten Island buyout program, it is essential to consider the program and its impacts within the wider context of risk reduction efforts in Staten Island. The NY Rising Buyout and Acquisition Program was not the only tool employed to reduce vulnerability in NY following Superstorm Sandy. Other programs such as opportunities for home elevation, updates of stormwater infrastructure, flood preparedness education campaigns and protective infrastructure solutions were, and continue to be, implemented. Ultimately, reducing vulnerability along the coast will require a multi-faceted approach. However, in order to guarantee success, it is imperative that risk reduction programs are not working against one another. One initiative of particular importance to meeting the objectives of the buyout program is the United States Army Corps of Engineer’s proposed line of protection to be constructed in front of the bought out parcels.

In 1993, the United States House of Representatives Committee on Public Works and Transportation authorized a feasibility study of coastal storm risk reduction projects for the south and east shores of Staten Island. However, funding to complete the study was difficult to procure. From 1993 until Superstorm Sandy in 2012, political pressure to complete the study accumulated. When the funding to complete the study was made available by funds authorized by the Disaster Relief Appropriations Act of 2013, the United States Army Corps of Engineers (USACE) rushed to take advantage of the opportunity. Phase 1 of the project, which stretches from Fort Wadsworth to Oakwood Beach has been approved. Phase 2 from Great Kills to Tottenville is still pending approval (Shapiro 2016).

In September of 2016, an Interim Feasibility Report was released by USACE (USACE and NYS DEC 2016). This report details plans to build an earthen levee, vertical floodwall, buried seawall and other structures intended to “reduce the risk of damage associated with the historic coastal flooding (USACE and NYS DEC 2016, vi).” As shown in Map 13 in the Appendix, these structures are planned to be erected directly in front of the buyout areas.

The possible construction of the structure raises many questions. Chief among them is whether or not the coastal buffer areas will be able to serve their intended protective services if they are located behind a buried seawall. Throughout the 240-paged feasibility report, there are numerous references to the buyout areas and it seems that consideration of their ability to be maintained as coastal buffer areas
in perpetuity has been taken. Specifically, a tide gate will be installed to allow water to reach the wetlands behind the structures. However, given the uncertainty associated with the performance of hardened infrastructure, I remain skeptical of the ability for coastal buffer areas to perform their vulnerability-reducing ecosystem services from behind a seawall.

Further, the construction of this structure raises the question of whether or not buyout participants were put through a likely stressful and questionably effectual program for no reason at all. If the seawall is constructed and performs as expected, many of the buyout participants could have continued to safely occupy their origin addresses for the foreseeable future. Additionally, it is unclear whether individuals would have chosen to participate in the buyouts if they had known the structure was likely to be constructed.

13 CONCLUSIONS AND RECOMMENDATIONS

This analysis concludes that significant uncertainty remains with respect to whether or not the Staten Island buyout program met its objective of reducing the vulnerability of people and property to coastal flood hazards. The relocation patterns of 323 buyout participants from the Oakwood Beach, Graham Beach and Ocean Breeze communities of Staten Island were analyzed. Given that a total of 473 buyouts were completed in these three communities, the change in exposure and social vulnerability for nearly 70% of the program’s total participants was assessed (Wieder 2017). As the study sample captures such a large portion of the entire buyout participant population on Staten Island, I am confident that my results accurately reflect trends in the program’s efficacy as a whole.

As one might expect, 82% of the buyout participants relocated within the state of NY. 75% of all participants relocated within Staten Island. Nearly 40% of buyout participants who relocated within Staten Island relocated to the zip codes in which the buyouts were offered (10305 and 10306). Overall, 22% of buyout participants relocated within the same zip code from which they originated. Of the 18% of buyout participants who moved out of state, half moved to New Jersey. Given the importance of sense of place and the incentives offered by the state, it is unsurprising to find that 256 of the 323 buyout participants relocated within NYC. Participants who moved out of state relocated to Arizona, Connecticut, Delaware, Florida, Maryland, Nevada, Pennsylvania, Texas and Washington.

Buyout participants moved between 0.04 and 2400 linear miles from their origin addresses to their relocation addresses. Nearly 6% of all buyout participants moved with one mile of their origin address. 38% moved within three miles of their origin address and over 60% moved within five miles of their origin address.

To determine the change in vulnerability to coastal flood hazards, vulnerability was first defined as the sum of exposure, sensitivity and adaptive capacity. Sensitivity and adaptive capacity were assumed to be indicated by variables that determine social vulnerability. Exposure vulnerability and social vulnerability scores for all origin and relocation addresses were determined using GIS. To determine the overall change in vulnerability, the change in exposure vulnerability and the change in social vulnerability were calculated.

An exposure vulnerability score was given to each origin and relocation address in the sample. This score had a range of zero to three, with an exposure vulnerability score of zero indicating that the address was not within the extent of the area vulnerable to Category 3 storm inundation, within the special flood hazard area and subject to shallow coastal flooding. Addresses with an exposure vulnerability
score of three were within the extent of the area vulnerable to Category 3 storm inundation, within the special flood hazard area and subject to shallow coastal flooding. A change in exposure vulnerability score of one was awarded if the relocation address had a higher exposure vulnerability score than the origin address. A score of one indicates that the buyout participant relocated to an area with higher exposure vulnerability. If the exposure vulnerability score remained the same or decreased, a change in exposure vulnerability score of zero was awarded. A score of zero indicates that the buyout participant relocated to an area at least as exposed as their home in Staten Island.

I found that the exposure vulnerability score only increased for two of the 323 buyout participants. However, the exposure vulnerability score of 69 buyout participants did not decrease following their participation in the buyout program. This finding is significant because it indicates that over 20% of the NY Rising buyout program participants in Staten Island relocated to an area more or equally exposed than their origin address in Staten Island.

The change in social vulnerability score was calculated for each origin-relocation address pair. To calculate this score, seven indicators of social vulnerability were measured for each address. Using US Census data at the census tract level, values for population density, percent of population over 65, percent minority population, percent Hispanic, percent of families with children headed by a single parent, percent of population over 25 years old who has attained a Bachelor’s degree or more and percent of the population for whom the ratio of income to poverty is below one were obtained for each address. The values for each of these indicators were compared across each origin-relocation address pair. If the value changed in a way known to increase social vulnerability, for example an increase in percent minority population or a decrease in educational attainment, a change in social vulnerability score of one was awarded. If the value did not change or changed in a way known to decrease social vulnerability, a change in social vulnerability score of zero was awarded. As such, the maximum possible change in vulnerability score was seven and the minimum was zero.

For one buyout participant, social vulnerability increased across all seven indicators. Across the entire sample, the average change in social vulnerability score was an increase of 3.66 out of a maximum possible increase of seven. Social vulnerability increased for all but two of the buyout participants. Nearly all of the buyout participants relocated to an area with higher levels of poverty. Two-thirds of the buyout participants relocated to an area with a greater proportion of the population over 65. Over 60% of the buyout participants relocated to an area with a higher population density. Only 3.4% of buyout participants relocated to an area with a higher occurrence of single-parent families. These findings are significant because they indicate that buyout participants may not be able to relocate to areas comparable to their origin communities. This may be because following the economic loss associated with a natural disaster, individuals are unable to use the entire fair market value of the bought out property to put towards their purchase of a new home. Additionally, because federal disaster recovery programs prohibit the duplication of benefits, the actual amount of money received by the buyout participant for the acquisition of their home may vary significantly. Upside-down mortgages are paid off before the check is cut to the homeowner and any flood insurance claims paid out or monies put towards the recovery of the home are subtracted from the FMV. Follow-up surveys with buyout participants would be useful to shed light on why participants relocated to where they did.

To calculate the change in overall vulnerability, the change in exposure and change in social vulnerability scores for each origin-relocation address pair were standardized based on the number of indicators used within each of those analyses. Standardizing the scores ensures that in the overall vulnerability calculation social vulnerability isn’t weighted more heavily simply because more indicators
were used. Standardization ensures that exposure and social vulnerability are assumed to contribute equally to overall vulnerability. Once the scores were standardized, the change in exposure and change in social vulnerability scores were averaged. Averaging the scores guarantees that the final score is on a scale of zero to one, remaining consistent with the binary approach applied in earlier steps. The maximum possible change in overall vulnerability score for a single origin-relocation address pair was one and the minimum was zero. Observed overall change in vulnerability scores ranged from 0 to 0.52. The average change in overall vulnerability score was 0.26. This indicates that, on average, the overall vulnerability score of buyout participants increased by 26% from the baseline overall vulnerability observed at the origin address in Staten Island. As exposure vulnerability scores only increased for two of the buyout participants, this change is primarily driven by an increase in social vulnerability score. 69 buyout participants relocated to an area with an exposure vulnerability score the same as or greater than that observed at the origin address. If change in overall vulnerability is calculated for just this subset of the sample, the overall vulnerability score if shown to increase by 52% from the baseline overall vulnerability observed at the origin address in Staten Island.

These findings indicate that the overall vulnerability of the buyout participants may have increased following their participation in the buyout program and cast doubt on the success of the $190 million federally-funded program. Further, it remains unclear whether the buyout program met its goal of reducing the vulnerability of people and property to coastal flood hazards. Though this analysis is only a first attempt at quantifying the success of a buyout program in meeting its objectives, the findings indicate that the overall vulnerability increased for 99% of the program’s participants.

13.1 Recommendations For Buyout Policy and Administration

As buyout programs are likely to become more common tools of post-disaster mitigation and because they will likely be used with increasing frequency along the coasts, developing a way to measure the success of these programs is simply good practice. The results of such assessments can then be used to inform the policy and administration of future buyout programs at both the federal and state level, ultimately creating a more effective tool for reducing vulnerability along the coast. As a first step towards more successful coastal buyout programs, recommendations are made based on the findings of this analysis.

First, I recommend the consideration of the applicability of current buyout policy and administration. Greer and Binder make it clear that little, if anything, has been done to encourage policy learning in federal home buyout policy (2016). Given the infrequent and questionably effective application of buyout programs along densely populated coastlines, there must be critical consideration of whether or not the administration of buyout programs through a disaster recovery framework is appropriate. Specifically, the role of state and federal government in the administration of large coastal buyouts should be discussed. State administration, as has been done historically, of buyout programs may be appropriate for smaller programs but states may easily be overwhelmed or simply not have the capacity to administer large-scale buyout programs like those following Superstorm Sandy. In the wake of Sandy, NYS had to stand up an entirely new office and streams for information and funding. One can easily imagine how this task may be insurmountable for states with lower capacity than NY. Further, this type of response-based administration is simply unsustainable. Given the short-term nature of the Governor’s Office of Storm Recovery, the associated funding and the inevitability of another storm, it appears that these efforts will just need to be duplicated following the next disaster. In the context of large-scale coastal buyouts, it may
make more sense for these programs to have some type of permanent and ongoing oversight and administration by a federal agency.

In order to create a robust and effective buyout program encourages participation, the experiences of past buyout participants should be analyzed. By creating a mandatory survey program that is administered throughout the buyout process, invaluable information about what informs an individual’s decision to relocate or not could be collected. Further this information could be used to assess why individuals choose to relocate where they do. This would shed light on the efficacy of implemented incentive programs and allow more effective incentives to be created in the future. A suite of different, but equitable, incentives could be offered to insure that individual program participants are able to participate because their personal needs are met.

Further education and awareness about federal buyout programs is necessary to ensure the success of buyouts in the future. Without the single buyout advocates in each of the three Staten Island Communities studied, it seems doubtful that the buyout option would have been pursued in these areas at all. Additionally, the study and quantification of the efficacy of buyout programs to date could be incorporated into educational information on buyouts and be utilized to encourage program participation. Numerical estimates of a program’s success may be more effective in convincing potential participants of its efficacy than anecdotal evidence.

In addition to reforming buyout programs implemented in response to disaster, I recommend the creation of an anticipatory buyout and easement program. Over time, property owners on the coast may become more aware of and responsive to their risks. Any interest in relocation should be supported by the federal government. Ultimately, this type of preemptive program would likely produce cost savings as it would reduce the federal government’s wasteful and continuous expenditure on replacing vulnerable infrastructure, maintaining flood prone roads, covering repetitive flood insurance claims and investing in controversial hardened infrastructure. Instead of practically incentivizing homeowners to stay in vulnerable coastal areas until the next disaster, a multiphase anticipatory buyout and easement program would encourage adaptation.

Ideally, this type of program would first create a scientifically-vetted methodology to determine the nation’s most imminently threatened coastal communities. This evaluation would need to be repeated at a prescribed time interval or in response to changing coastal conditions. New development in these areas would require a locally variable and predetermined setback from the nearest imminently threatened property. Homes currently within the threatened area would be given a period of 10 years to sell their property to the program administrators for fair market value plus some incentive for participation. Homes remaining unsold after the initial phase of the program sunsets after 10 years will be subject to a tax intended to cover state and municipal expenditures associated with coastal flood hazards. This ensures that the rest of the nation is not fiscally responsible for the unsound decision-making of those occupying vulnerable coastlines. Should these remaining homes be damaged substantially by flooding, homeowners will be offered the post-damage value for their property. Any home in the threatened area that is put on the market will be purchased by the state. Residents of any home sold to the state must agree to relocate outside of the 100-year flood zone as defined by Flood Inundation Risk Maps updated within the past 5 years. If an updated map does not exist, an independent determination of the 100-year flood zone will be required. Any homeowner choosing not to comply will not receive any incentives associated with their relocation and will be responsible for any costs incurred by the state and federal governments for coastal flood hazards associated with their properties. Any funds remaining after the acquisition of homes will fund maintenance of the area and economic development
initiatives in less vulnerable locales. All properties acquired by the state will be demolished and returned to their natural state in perpetuity, requiring minimal maintenance. By gradually reducing funding associated with the National Flood Insurance Program, infrastructure maintenance and coastal protection, federal and state monies will be ‘freed up’ to encourage adaptation. However, this type of program would require a large initial investment by the federal government. An in-depth cost benefit analysis would be required to make the case for this type of upfront investment.

A common argument made against the implementation of buyout programs is that the affected locale is faced with a drastic loss of tax base. While this may be the case for buyouts implemented in smaller municipalities, it is hardly an appropriate argument when 75% of the NY Rising Buyout program participants stayed within the county. However, negative economic effects may be felt on a community level. This could be addressed by a state mechanism for redistributing taxes for some limited amount of time after the program’s implementation so that the community dealing with the buyouts can get back on its feet. However, this program must recognize that, with increased risk of coastal flood hazards, coastal areas may lose value. Proactive governments should shift investment away from these areas to lessen the blow of inevitable disaster. Further, a task force should be developed to devise a scheme for generating income from post-buyout natural state properties. A strategy must be developed to reward a municipality’s decision to reduce their coastal flood hazard risk. If the acquired properties have no value other than the intangible coastal protection services they provide, it will be difficult to convince individuals and states to participate.
14 ACKNOWLEDGEMENTS

Thank you to all of the people who have contributed to the development of this project, in big ways and small.

Elizabeth Albright, Advisor, Assistant Professor, Nicholas School of the Environment
Sherri Brokopp Binder, Client, President BrokoppBinder Research & Consulting, LLC
Katherine Bunting-Howarth, Associate Director, New York SeaGrant
Michael Burger, Executive Director, Sabin Center for Climate Change Law at Columbia University
Ellis Calvin, Senior Planner, Regional Plan Association
Helen Cheng, Coastal Resilience Specialist, New York SeaGrant
Andrew Coburn, Associate Director, Program for the Study of Developed Shorelines
Jessica Fain, Director of Policy, Planning and Engagement at Science and Resiliency Institute @ Jamaica Bay
Aleena Farishta, City Planner II, NYC Department of City Planning
Matthew Fuchs, Policy Researcher and Analyst, The Pew Charitable Trusts
Kalani Gates, Research Project Support Associate, The Research Corporation of the University of Hawai’i
Trevor Johnson, City Planner, NYC Department of City Planning
Christopher Lang, Environmental Analyst, New England Interstate Water Pollution Control Commission
Robert Moore, Senior Policy Analyst, Water Program, Natural Resources Defense Council
Stephen Roady, Advisor, Duke University School of Law
David Salvesen, University of North Carolina Institute for the Environment
Lisa Schiavino, Extension Director, California SeaGrant
Gavin Smith, Advisor, Research Professor, University of North Carolina
Dean Tarulli, Environmental Analyst, New England Interstate Water Pollution Control Commission
Jessica Whitehead, Coastal Communities Hazards Adaptation Specialist, North Carolina SeaGrant
Amanda Whittemore Martin, PhD Student, University of North Carolina
Rachel Wieder, Director, Buyout & Acquisition Programs, New York State Governor's Office of Storm Recovery
15 BIBLIOGRAPHY


FEMA. 2011. "Mitigation Best Practices: Public and Private Sector Best Practice Stories for Acquisition/Buyouts Activity/Project Tyes in All States and Territories relating to Flooding Hazards."


Lang, Christopher, interview by Devon McGhee. 2017. *NEIWPCC Environmental Analyst, NYS DEC Division of Environmental Permits* (February 24).


www.nhc.noaa.gov/surge/slosh.php#UPDATES.


Wieder, Rachel, interview by Devon McGhee. 2017. Director, Buyout & Acquisition Programs, Governor's Office of Storm Recovery (February 3).
Origin Address Locations

Map 2. Location of Origin Addresses within each of the buyout communities. Addresses were obtained from the Housing Trust Fund Corporation’s Property Disposal Reports for 2014, 2015 and 2016. Coordinates for each address were obtained using a georeferencing service.
## APPENDICES

### Table 12. Summary of data sources used for exposure and social vulnerability indicators.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Origin Source</th>
<th>Data Download</th>
<th>Relocation Source</th>
<th>Data Download</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOAA- National Weather Service's National Hurricane</td>
<td></td>
<td>NOAA- National Weather Service's National Hurricane</td>
<td></td>
</tr>
<tr>
<td>Exposure Category 3 Inundation</td>
<td>Center</td>
<td><a href="http://www.nhc.noaa.gov/nationalsurge/">http://www.nhc.noaa.gov/nationalsurge/</a></td>
<td>NOAA- Sea level Rise and Coastal Flooding Impacts</td>
<td><a href="http://www.nhc.noaa.gov/nationalsurge/">http://www.nhc.noaa.gov/nationalsurge/</a></td>
</tr>
<tr>
<td>Exposure Shallow Coastal Flooding</td>
<td>NOAA- Sea level Rise and Coastal Flooding Impacts</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Extent of Storm Surge Observed at Buyout Locations During Sandy

Map 3. Extent of Sandy Surge Observed at Origin Addresses During Superstorm Sandy. Layer indicating Sandy extent was acquired from FEMA’s Modeling Task Force- Hurricane Sandy Impact Analysis. Data available for download at: https://data.femadata.com/MOTF/Hurricane_Sandy.
Map 5. Results of Exposure Analysis for Origin Addresses. See Table 12 for details regarding exposure indicator data sources and download availability.
Extent of Storm Surge Observed at Relocation Addresses During Sandy

Map 6. Extent of Surge Observed at Relocation Addresses During Superstorm Sandy. Layer indicating Sandy extent was acquired from FEMA’s Modeling Task Force- Hurricane Sandy Impact Analysis. Data available for download at: https://data.femadata.com/MOTF/Hurricane_Sandy.
Map 7. Locations of All Relocation Addresses. Addresses were obtained using a variety of publically available resources and the LexisNexis Advance Property Records Search Tool. Coordinates for each address were obtained using a georeferencing service.
Map 8. Relocation Addresses in and around Staten Island. Addresses were obtained using a variety of publicly available resources and the LexisNexis Advance Property Records Search Tool. Coordinates for each address were obtained using a georeferencing service.
Map 9. Relocation Addresses Located Nearest to Buyout Areas. One individual moved 0.04 linear miles from their origin address. 19 individuals moved within 1 mile of their origin address.
Open Space Within One Mile of Buyout Properties

Map 10. Open Spaces within One Mile of Buyouts. Open spaces shown include parks, beaches, playgrounds and greenways. Open space layer available for download at: https://data.cityofnewyork.us/Recreation/Open-Space-Parks-/g84h-jbjm/data
Map 11. Comparison of definitively acquired Oakwood Beach buyout properties included in shapefile obtained from GOSR and origin addresses as determined using the methodology described in this report.
Map 12. Comparison of definitively acquired Graham Beach and Ocean Breeze buyout properties included in shapefile obtained from GOSR and origin addresses as determined using the methodology described in this report.
Map 13. USACE proposed coastal protection structure and location of definitively acquired buyout properties using shapefile obtained from GOSR. Base layer obtained from the South Shore of Staten Island, New York Coastal Storm Risk Management: Interim Feasibility Study for Fort Wadsworth to Oakwood Beach Figure ES-1, pg. ii.