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Measuring Flood Risk:
What Are NYC Residents Willing to Pay for a Flood Protection System?

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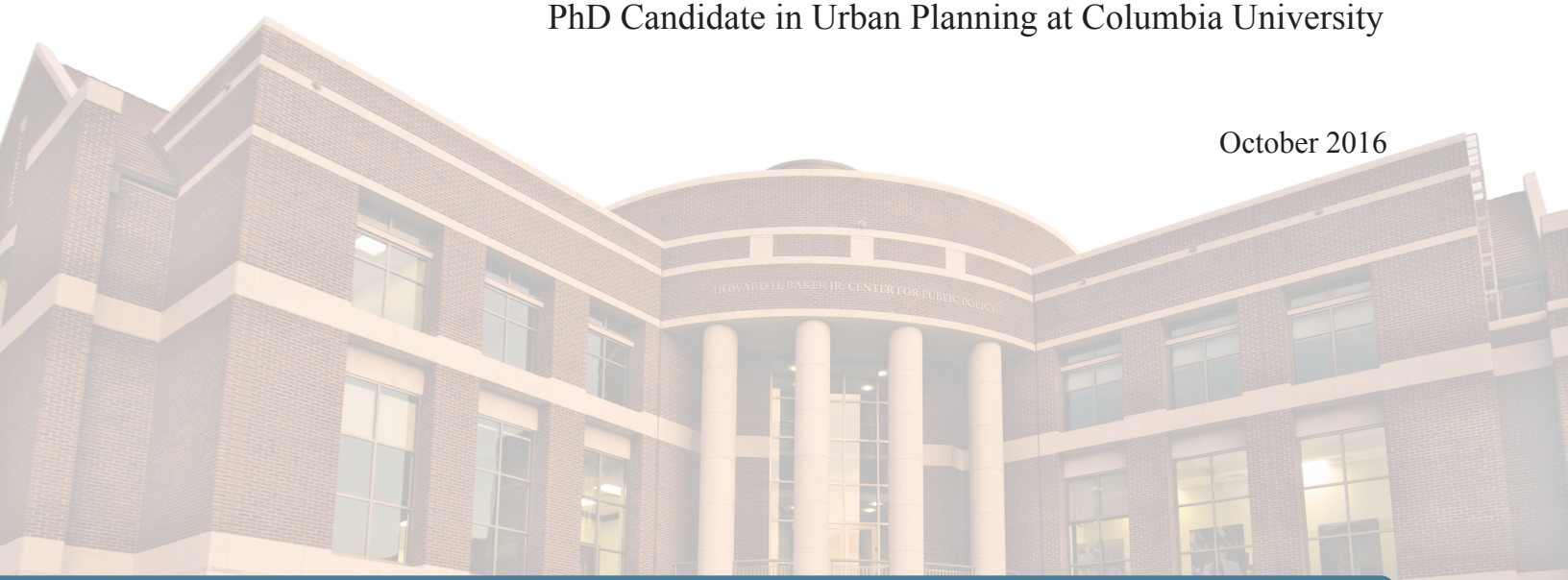

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Measuring Flood Risk

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Introduction

Hurricane Sandy was a "superstorm" that hit the New York City area on October 29, 2012. The hurricane produced more than $19 billion in damages, resulting from storm surges that rose to 14 feet above sea level in lower Manhattan.[1] In the wake of Sandy, vulnerable municipalities and regions are now considering alternative forms of protection against storm and flood risks, beyond insuring individual home and business owners. Though New York City has started feasibility studies for flood protection systems to safeguard coastal neighborhoods, it is unclear how the city might pay for such infrastructure.[2]

This policy brief evaluates how willingness to pay (WTP) for a flood protection system varies with exposure to flood risk, using detailed flood maps and parcel-level data to identify households within and just beyond the 100-year flood plain in New York City. The Federal Emergency Management Agency (FEMA) designates the 100-year flood plain as an area that has at least a 1-in-100 (1%) chance of flooding in any given year. Thus, a home in the 100-year flood plain has a greater than 26% chance of flooding at least one time during the course of a 30-year mortgage. Homes located in the 100-year flood plain with a federally-backed mortgage are required to purchase flood insurance.[3] The federally-run National Flood Insurance Program (NFIP) sets its rates nationally, and currently administers more than 5.3 million policies across the United States.

Past research has estimated that a homeowner's WTP for flood insurance is largely contingent upon their risk level.[4] However, no studies to date have analyzed the WTP for other forms of flood protection. We conducted a survey of single-family homeowners living in the 100- and 500-year flood plains in New York City, and found that WTP for flood control systems varies with the degree of risk that homeowners face. While the majority of residents living in the 100-year flood plain were willing to pay up to $10 a month to contribute to the cost of a seawall, the majority of residents living in the 500-year flood plain, an area that has a 0.2% risk of flooding in any given year, were only willing to pay up to $7 a month. These results are consistent with other studies demonstrating that risk—actual or perceived—plays a large role in individuals' WTP for protection from floods.

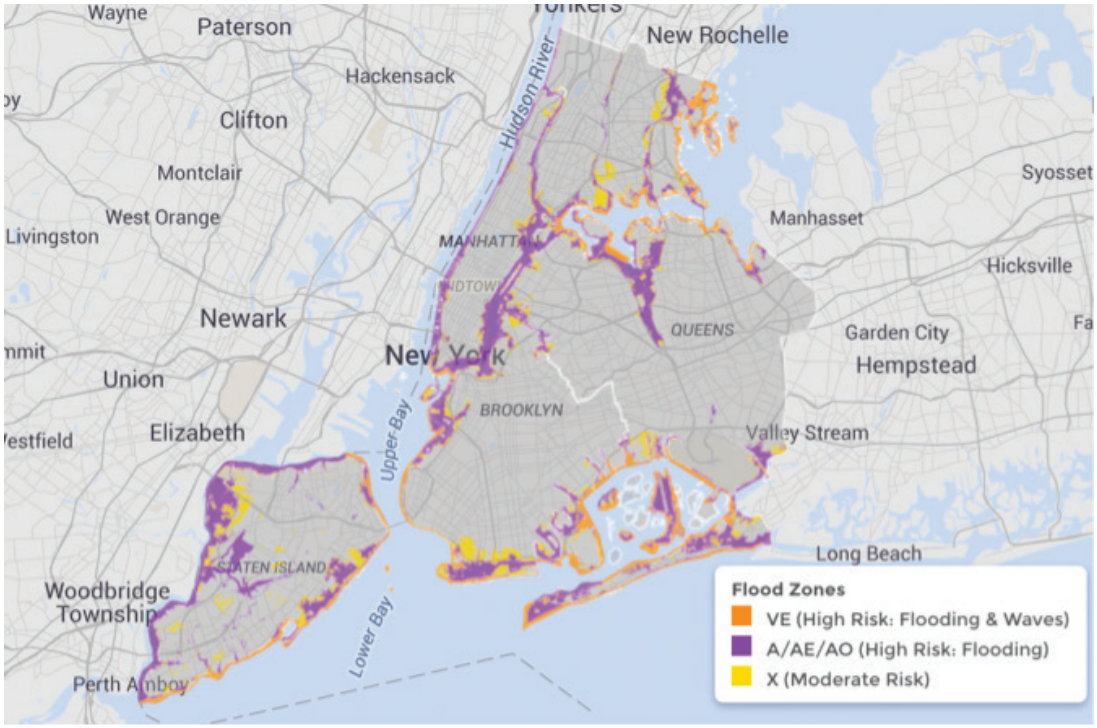
Survey Design

The study was restricted to single-family residences for three reasons. First, survey respondents were asked if they would be willing to pay for a flood protection system by increasing the monthly costs of their household water bill; households in single-family residences (occupied by owners or renters) typically pay their own water bill, while many residents in multifamily buildings have their utility bills folded into their rent or paid for through some type of collective assessment. Second, assessor's data includes parcel addresses but contains very limited information on the number of units in multifamily dwellings, and no apartment numbers, making it difficult to reach such households by mail. Third, residents in the higher floors of multi-story buildings are not subject to a flood risk.[5]

Table 1 summarizes the number of single-family households in the data by flood zone and New York City borough. Just over one-third of the parcels in the city are single-family dwellings and only 4% of parcels are in the 100-year flood plain (high-risk zone). The flood plain sample has the most parcels in Staten Island, followed by Queens and Brooklyn with almost no single family homes in Manhattan in the study.

In the summer and fall of 2015, the Institute for Policy Integrity[6] and research partners mailed an invitation to complete a survey to 13,342 single-family households in New York City's 100-year flood plain and 12,000 randomly selected households located within 500 meters of the 100-year flood plain that is designated as the 500-year flood plain. Choosing homes in the 500-year flood plain that are located in close proximity to the 100-year flood plain allows us to assess opinions of residents where the actual risk of flooding is similar, but the perceived risks are very different. Figure 1 maps the high and moderate risk flood plains across the city.

Figure 1. New York City's 100-year/high risk flood plain (in orange and purple) and 500-year/moderate risk flood plain (in yellow)



Source: Center for New York City Neighborhoods (CNYCN) FloodHelpNY.org, available online at: http://floodhelpny.org/

Table 1. Number of households in New York City boroughs and their flood risk

	Households (in single- and multi-family dwellings)	Single family homes	Households (single and multi-family) in the 100-year flood plain	Single family homes in the 100-year flood plain	Single family homes in the 500-year flood plain buffer zone	Percentage of eligible households that responded to the survey
Brooklyn	283,913	62,313	7,644	2,478	2,702	3.9%
Bronx	94,784	23,316	3,505	1,241	3,822	12.2%
Manhattan	44,948	2,016	1,968	21	86	0.5%
Queens	335,450	158,713	12,881	4,417	7,804	7.0%
Staten Island	131,488	80,224	10,085	5,275	9,087	9.2%
Total	890,583	326,582	36,083	13,432	23,501	7.1%

Notes: All 13,432 single family homes in the 100-year flood plain were recruited to participate in the survey. 12,000 of the 23,501 single family homes in what we have designated as the "buffer zone" in the 500-year flood plain (located within 500 meters of the 100-year flood plain) were randomly selected to be recruited into the survey.

We sent the randomly selected households a letter inviting them to complete an online survey.[7] Ten days after sending the initial letter, we sent a follow-up post card to all households who had not yet responded and a final reminder one week later, informing households that we would not contact them further. The letter and each of the follow-up post cards stated that ten respondents would be randomly selected to receive a $100 gift card.

Of the 25,342 letters sent, we received 1,719 complete responses, for a response rate of 7%. In total, 900 of the respondents lived in the 100-year flood plain, with 819 living just outside of it in the 500-year flood plain in the designated buffer zone.[8] Manhattan had by far the lowest response rate at 0.5% and the Bronx the highest with over 12%. The summary statistics from survey respondents in each sample group (100-year and 500-year flood plain) are shown in Table 2.

Table 2. Summary Statistics of Respondents by Flood Plain[9]

Indicators	100-year flood plain	500-year flood plain buffer zone (within 500 meters of the 100-year flood plain)
Home Owner	95%	94%
Tenure in Home (years)	18	21
Has Flood Insurance Policy	82%	44%
Age (years)	54	59
Female	51%	47%
Number in Household	2.9	2.9
Education (years)	13.2	13.5
Income	$108,562	$143,245
Home Damaged in Sandy	84%	45%
Average Year Home Built	1953	1958
Residential Area (sq. feet)	1,581	1,599
Assessed Lot Value	$18,982	$19,808

Notes: The table above describes survey respondents who were asked about their willingness to pay higher utility fees to fund the flood control system. The survey had 265 respondents in the 100-year flood plain and 382 respondents in the buffer zone (500-year flood plain).[10]

The survey asked respondents a number of questions relevant to flood risk, including questions regarding their flood insurance coverage; damages incurred during Hurricane Sandy; and their attitudes towards risk. These variables were used as statistical controls when estimating respondents' WTP. The answers allow us to estimate WTP for those with and without insurance or those whose homes were damaged by Sandy. We also asked respondents to indicate their flood zone to assess their knowledge of their area's level of risk. We then asked them to indicate the amount they were willing to pay for flood protection added to their own utility bills. So that risk levels would not influence their responses, we did not reveal the residents' FEMA-designated flood zone until after they completed the portion of the survey where they indicated the amount they were willing to pay for flood protection from their own utility bills.

In order to give respondents a sense of what to expect from flood infrastructure, the survey featured the images depicted in Figure 2, before asking what additional fees they were willing to allocate from their utility bills to fund a potential flood control system.

Figure 2. Seawall images, as depicted in the survey to single-family homeowners living in and near the high-risk flood plain in NYC in advance of WTP questions.

Notes: In December 2012, Mayor Bloomberg launched the Special Initiative for Rebuilding and Resiliency and charged it with recommending steps the city should take to protect against the impacts of climate change. This culminated into the June 11, 2013 report "A Stronger, More Resilient New York," which provides recommendations for protecting neighborhoods and infrastructure from future climate events. The survey modeled the flood protection systems after a proposal set forth in the 2013 report. Both images were taken from a proposed flood control system for New York City submitted to "Rebuild by Design" a competition to design a flood control system for New York City hosted in the wake of Superstorm Sandy.[11] The image at left is a deployable seawall, which can be suspended from bridges and roadways and flipped down in the event of flooding. The image at right is bridging berm, a raised narrow strip of land beside the water. In the survey, respondents were told similar defenses would be built around the city.[12]

Findings

Despite similar home ownership rates, 82% of respondents in the 100-year flood plain self-reported having flood insurance, while only 44% of residents in the 500-year flood plain (living 500 meters from the 100-year flood plain) reported having a flood insurance policy.[13] This is likely due to the fact that the government requires that homes and buildings holding federally insured or regulated mortgages in high-risk areas purchase a flood insurance policy. In total, 84% of respondents living in the high-risk zone reported experiencing damage during Hurricane Sandy, compared to 45% of residents living in the 500-year flood plain.

Respondents whose homes were damaged by Sandy were willing to pay around $7 more per month to fund the flood control system compared to respondents whose homes were undamaged.[14] Table 3 shows what percentage of residents in each flood plain would vote "yes" in a referendum instituting a monthly fee (tacked on to the respondent's utility bill) at that level to pay for the cost of a flood protection system.[15]

Table 3. Percent of Respondents Voting "Yes" for Seawall by Monthly Cost and Flood Plain

Monthly Cost	Homeowners in the 100-Year Flood Plain	Homeowners in the 500-Year Flood Plain (within 500 meter buffer)
$0.50	68%	75%
$1	72%	63%
$2	88%	63%
$3	55%	63%
$5	46%	57%
$7	64%	53%
$10	50%	46%
$15	28%	18%
$20	48%	29%
$35	40%	35%
$50	24%	21%

Notes: The above figures depict results from the respondents who were randomly selected to view the Single Binary Choice (SBC) format of the survey. In the SBC format, respondents were asked the following question: "Should City authorities introduce a mandatory fixed fee of $_____ to every New York City households' monthly water bill, for the foreseeable future, to fund the proposed flood control system for New York City?", where one of the 11 cost amounts above was randomly presented in lieu of the blank. Respondents had an equal probability of seeing any one of the 11 cost amounts in the above table and were required to respond yes or no as to whether they were willing to pay that amount. In the 100-year flood plain 265 respondents viewed the SBC format, while the remaining 635 respondents viewed a different version of the survey. In the buffer zone in the 500-year flood plain 382 respondents viewed the SBC format, while the remaining 437 respondents viewed a different version of the survey.[16]

The majority of respondents inside and just beyond the 100-year flood plain support the referendum at the cost of up to $7 a month. Based on this sample, a fee of around $7 to $10 a month to support the costs of a seawall would likely pass through a referendum. When costs exceed $10 a month, support remains relatively strong among respondents living in the 100-year flood plain, though it appears that a referendum including votes across the two flood plains would not pass with a majority.

The cost estimates to build the proposed flood protection system in New York City range from $10 billion to $17 billion for barrier systems, and an additional $10 to $12 billion to shore up enough of the adjacent areas to put the systems in place.[17] Unfortunately, small contributions from residents in high to moderate risk areas would cover only a small portion of the costs. To fully cover such costs, city officials would have to require all 8.9 million New York City residents to pay an extra $10 per month in their utility bills for a minimum of 20 years.

Conclusion

As disasters like Hurricane Sandy are prompting New York and other coastal cities to consider new approaches to resiliency, alternative forms of flood protection beyond individual property insurance must be evaluated. Flood protection systems are extremely costly, and the local, state, and federal government must consider creative and integrated strategies for funding new flood infrastructure. Evaluating what residents are willing to pay for flood infrastructure could aid policymakers' efforts to develop creative funding methods for such systems.

There are a number of additional avenues for further study. First, our results suggest respondents in the 500-year flood plain are willing to pay less than those in the 100 year flood plain for flood control protection; additional research would be useful to help researchers understand how New York City residents even farther away from the flood plain feel about flood protection and how support for flood protection fades with distance from the highest-risk areas. Also, as noted above,we chose to focus on single family homes for this analysis; assessing the willingness-to-pay for flood control measures for residents in apartment, condos and other types of dwellings would provide a more complete picture. The city is currently developing a program to do this.

Most importantly, the research here is not a full cost-benefit analysis for installing flood control systems. Benefits in terms of reduced damages from future storms could far exceed residents' willingness to pay for these programs. This suggests that residents of New York City might not fully understand the benefits of these systems. Better information on flood control systems and how they could reduce both the financial and personal cost of future storms could affect what New York City residents are willing to pay for flood protection.

Endnotes

[1] Rosenzweig, C. and W. Solecki. 2014. "Hurricane Sandy and Adaptation Pathways in New York: Lessons from a First-Responder City." *Global Environmental Change* 28: 395–408.

[2] More information on NYC's coastal resiliency plan is available in the report "One New York: The Plan for a Strong and Just City," available online at: http://www.nyc.gov/html/onenyc/downloads/pdf/publications/OneNYC.pdf

[3] Kousky, C. and H. Kunreuther. 2010. "Improving Flood Insurance and Flood-Risk Management: Insights from St. Louis, Missouri." *Nat. Hazards Rev.* 11, 4: 162-172.

[4] See: Botzen, W.J.W., J.C.J. H. Aerts, and Jeroen CJM van den Bergh. 2009. "Willingness of homeowners to mitigate climate risk through insurance." *Ecological Economics* 68, 2265-2277; and Botzen, W. J. W., and Jeroen CJM van den Bergh. 2012. "Risk attitudes to low-probability climate change risks: WTP for flood insurance." *Journal of Economic Behavior & Organization* 82, 151-166.

[5] Single-family households were identified by restricting the sample to parcels with ownership type of "P" or null in NYC's Property Land Use Tax lot Output (PLUTO) data. The majority of records in PLUTO are blank and the documentation states that null indicates "Unknown (Usually Private Ownership)." To ensure that the sample was restricted to single family homes, only parcels with Building Class Codes beginning with A, which signifies "One Family Dwellings," were included.

[6] The Institute for Policy Integrity (IPI) is a non-partisan organization affiliated with New York University's School of Law. IPI is dedicated to improving the quality of government decision making using analytic tools. See http://policyintegrity.org/ for more information.

[7] Each letter included a unique four-character code that allows us to map survey response to assessor's data and flood zones. The PLUTO extract includes the name of the parcel owner according to tax documents, but it is unclear which households are owner occupied and which are rentals. There are also some concerns that the owner name field might not be updated in our extract of the assessor's data. For this reason, each mailing is addressed to "Flood Zone Resident." Upon accessing the survey website, respondents are provided information on the study and prompted to enter their unique access code. The survey itself was created and hosted in Qualtrics, an online survey software suite. The survey was presented in eight sequential pages and took an average of just over ten minutes to complete. After completing a page, respondents clicked on a button and were unable to return.

[8] For the households in the high-risk zone, we mailed 13,432 letters, of which 88 were returned as undeliverable. The mailings led to 1,128 surveys being started and 900 completed, for a dropout rate of just over 20%. In the second experiment, we randomly selected 12,000 households living within 500 meters of the high-risk zone to recruit by mail. Fifteen of those letters were returned as undeliverable. 1,019 respondents began the survey and 819 completed it, for a dropout rate of 25%.

[9] For more information on the statistics collected in both tables, including robust standard errors, please contact the authors of the report at valerie.stahl@columbia.edu.

[10] We used several different surveys to ask New York City residents about their willingness to pay for flood control systems. The full results, as well as the methodological implications to using the various survey formats, will soon be available in the following paper: Holladay, J. S. and C. Vossler 2016. *Alternative Value Elicitation Formats in Contingent Valuation: A New Hope*.

[11] More information on the Rebuild by Design competition is available from their website: http://www.rebuildbydesign.org/. Both images were taken from the winning proposal "BIG U" submitted by the Big Team, a group of architects and designers from around the world.

[12] NYC Special Initiative for Rebuilding and Resiliency. 2013. *A stronger, more resilient New York*. Available online at: http://www.nyc.gov/html/sirr/html/report/report.shtml.

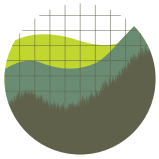
[13] The flood insurance offer intentionally came after the question on respondents' self-reported flood insurance policy as to avoid survey contamination. We also conducted a post-test and found no relationship between those who eventually signed up for flood insurance and their indicated WTP in the survey.

[14] The full results will soon be available in the following paper: Holladay, J. S. and C. Vossler 2016. *Alternative Value Elicitation Formats in Contingent Valuation: A New Hope*.

[15] The survey asked this question using a single binary choice format. Each respondent was asked about a single cost level and the choice was framed as a vote on a referendum. Follow-up questions assessed whether the respondents felt their answers would affect the probability that the flood control system was built and whether they would have to pay if it was in fact built. See full results (which will soon be available) at: Holladay, J. S. and C. Vossler 2016. *Alternative Value Elicitation Formats in Contingent Valuation: A New Hope*.

[16] The other formats of the survey elicited risk through open-ended questions and payment cards. Results are broadly similar for respondents in other treatments. The full results, as well as the methodological implications to using the various survey formats, will soon be available in the following paper: Holladay, J. S. and C. Vossler 2016. *Alternative Value Elicitation Formats in Contingent Valuation: A New Hope*. Please contact valerie.stahl@columbia.edu if you would like to view a pre-print of the paper.

[17] Miyera Navarro references these figures in a *New York Times* article from 11/6/12, available online at: http://www.nytimes.com/2012/11/08/nyregion/after-hurricane-sandy-debating-costly-sea-barriers-in-new-york-area.html?_r=0 s. It is of note that survey respondents were not given the projected costs of the seawall, but were informed that the fee they selected would be imposed on every New Yorker once a month for a period of 10 years. They were also reminded that NYC has over 500 miles of shoreline that would be subject to costly flood protection measures.



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