Abstract
In light of growing concerns about flood risk in the Hudson River Estuary, working together with the Hudson River Estuary Program, we conducted in-depth individual and focus group interviews, as well as a household survey to evaluate flood risk responses in Troy and Kingston. This report summarizes initial findings regarding flood risk exposure, perception, preparedness actions, and views of policy interventions. Regarding exposure, residents of color may be more likely to face risks of flooding. Nearly half of residents are unsure whether they live within the Special Flood Hazard Era defined by the Federal Emergency Management Administration. Flood risk perception is responsive to past experience of flood impacts. Past flood experience predicts flood preparedness actions, with the exception of flood insurance, which is driven by the mandatory purchase requirement of the National Flood Insurance Program. Respondents generally show support for hard infrastructure, living shoreline, and insurance premium offsets for flood preparedness investments, but views on buyouts of flood-prone homes are more mixed. These preliminary findings set the stage for multivariate analyses aimed at understanding the predictors of flood risk awareness and preparedness.

Summary Points
- In Troy and Kingston, awareness of flood risk is uneven, and outreach on this account is warranted, particularly renters and among homeowners who have not experienced flood impacts in the past.
- Support for flood management policy interventions appears strong, particularly with regard to living shorelines.

Introduction
The eastern US coast, including inland estuarine areas, has experienced an increase in severe weather impacts in recent years. In addition, the 150 miles of the Hudson River that stretch from New York City to Troy, New York are rising with the sea. Based on current scientific research, the New York State Department of Environmental Conservation (New York State Department Environmental Conservation 2017) estimates that river levels in the Mid-Hudson Region could rise by up to 27 inches by the 2050s and up to 71 inches by 2100. Thus far, research has largely highlighted the impacts of flooding due to climate change on coastal areas, yet it is also a growing threat to inland communities, where recognition of that risk remains mixed.

In this context, several difficult questions arise. First, to what extent are people in increasingly flood-prone locales aware and concerned about flood risk? Second, to what extent are people in varying situations responding to risk by taking actions to prepare for
future flooding? Third, what levels of support are there for different policy interventions that might reduce risks from flooding? In partnership with the Hudson River Estuary Program and the New York State Water Resources Institute, we undertook interview, focus group, and questionnaire survey research to gain insight into these issues in two localities in the Hudson River Valley, Troy and Kingston.

Analysts have offered numerous perspectives for understanding how risk perception and preparedness actions relate to attributes of hazards, individual actors, and available mitigating actions (Rogers 1975; Lindell and Perry 2004; Slovic et al. 2004; Tierney 2014; R. Meyer and Kunreuther 2017). Approaches that emphasize ameliorating information deficits to promote rational risk management have increasingly given way to theories that focus on how people in risky situations draw on varying cognitive heuristics, values, material resources, and social norms to evaluate uncertain risks. Here, we draw primarily on the protective action decision model (PADM) (Lindell and Perry 2004), which holds that people evaluate hazards in terms of environmental cues and risk warnings, processing information about hazards and protective actions in light of characteristics of messages and their sources. This perspective highlights the importance of not just the perceived probability and magnitude of a risk in motivating action, but also its immediacy. PADM also draws on social influence theories that highlight how people consider perceived social norms in assessing whether a protective action is desirable: are my friends and neighbors taking protective actions, and would they disapprove if I did not? We draw on related literature that suggests that past experience of flooding leads to stronger perception of risk, which may in turn underpin insurance purchase and other protective actions (M. A. Meyer et al. 2018; Thistlethwaite et al. 2018; Haney 2019).

This report focuses on four dimensions of risk response: exposure, perception, preparedness actions, and views on policy interventions.

*Exposure* refers to the extent to which one is likely to experience flooding. Our interest here is in whether different populations experience markedly different exposure to flood risks.

*Perception* refers both to people’s judgments about the likelihood and magnitude of flooding and to their levels of worry about it. In conjunction with personal attributes, access to resources, and social norms, risk perception can influence the extents to which people take action to prepare for flooding and show support for policy interventions aimed at reducing flood risk.

*Preparedness actions* are things household members might do to lessen or prevent losses in the event of a flood. These actions range from relatively easy things like storing documents in safe locations to costly actions like elevating a house above base flood elevation. One action of particular interest is the purchase of flood insurance within the National Flood Insurance Program (NFIP). Through the NFIP, the Federal Emergency Management Administration (FEMA) requires owners of properties holding federally backed mortgages and located within areas estimated to have a 1% annual probability of flooding (Special Flood Hazard Areas, or SFHAs) to purchase flood insurance. Historically, insurance
premiums under the NFIP have been heavily subsidized. Recent legislation has in market-rate premiums and mandated updated flood zone maps to reflect changing risk. The result has been a rise in flood insurance premiums and the threat of insurance requirements in locations newly mapped into SFHAs. Although mandated, take-up of flood insurance in SFHAs is estimated at about 50%, with marked regional variation (Kousky 2018). We are interested in understanding how and why different groups are more or less likely to purchase flood insurance and take other preparedness actions.

Finally, *policy interventions* are actions that government agencies or other actors undertake to diminish risk of losses due to flooding at a broader scale. These can be physical changes in infrastructure and land features that alter hydrology or place barriers in the way of flood waters. They can also be regulations or incentives aimed at promoting behaviors that diminish risk.

We examined each of these elements in Troy and Kingston, New York. We chose to focus research in these locales over the course of conversations with partners in the Hudson River Estuary Program (HREP) from 2017 to 2019. Troy and Kingston are cities of modest size with populations of about 50,000 and 23,000 respectively. Both have substantial histories of flooding and experienced significant flood impacts from Hurricane Irene in August 2011. In the past decade, Kingston has been the locus of a wide range of activities aimed at flooding, several facilitated by HREP, providing a point of comparison. We conducted a household survey and key informant interviews in each city as well as four focus group discussions in flood-affected neighborhoods of Troy. Details are provided in the Methods section below.

**Results & Discussion**

*Focus group discussions*

Our qualitative analysis of focus group discussion yielded three central findings. First, while some participants had vivid memories of past floods, for the most part flooding was not a major day-to-day concern. Second, participants raised several concerns around flood insurance. Many had little knowledge of it. For those who did, worry about costs often predominated in their responses. Trust in the NFIP was low, with concerns about low claim payouts and unfair procedures. Third, participants believed the municipal government should be responsible for protecting residents from flood risk but expressed little faith that it was adequately meeting this responsibility.

*Exposure: Who lives in the SFHA?*

One major concern in policy and academic discussions around flood risk is the potential that as flood risk intensifies it will, like other environmental and public health hazards, be borne disproportionately by low-income people of color. Using the GIS-based indicator of whether each respondent’s address was in the SFHA, we examined several potential axes of unequal exposure. In both Troy and Kingston, respondents within the SFHA reported somewhat higher income levels than those outside the SFHA, but differences did not reach statistical significance at a 95% confidence level. Education levels also showed no significant differences.
Across racial categories, only one significant difference emerged: in Troy, respondents located inside the SFHA were more likely to identify as Latinx or Hispanic than outside the SFHA. The proportion Black within the SFHA was higher in both Troy and Kingston, but the differences were not significant at the 95% level. In separate analyses using data from the U.S. Census Bureau's American Community Survey and the Mapping Inequality project (Nelson et al. 2021), we found that in Troy, (1) census block groups with more than 30% of area in the SFHA have higher proportions of Black residents than other block groups, and (2) among survey recipients, those within areas redlined (rated “C” or “D”) by the Home Owners' Loan Corporation in the 1930s had significantly higher Flood Factor scores than those in areas rated “A” or “B.”

**Knowledge of SFHA status**

Our focus group discussions suggested that awareness of flood risk is not widespread and that for many people it is due to the mandate to purchase flood insurance that they learn their homes are located in the SFHA. This mandate applies only to homeowners with federally backed mortgages. Our survey results appear to bear this out. Using a question asking whether the respondent’s home was in the SFHA, we classified respondents by georeferenced SFHA location. The graph below shows the results for the full sample, without survey weighting. First, more than half of respondents did not know whether they were located in the SFHA. This proportion was higher among renters, three-quarters of whom indicated that they do not know their home’s SFHA status. Among homeowners, the proportion answering “Don’t know” was lower. Still, among homeowners with mortgages whose addresses were in the SFHA, more than 25% did not know whether they were in the SFHA.
Perception: Concern about flooding
We measured concern about flooding by asking respondents to rate their level of agreement with the statement, “I am very worried about the possibility of my home being flooded in the future.” Consistent with a good deal of research on flood risk perception, people who indicated their homes had been impacted by flooding in the past were more likely to agree with this statement. Being located in or out of the SFHA did not make a significant difference. Given the results presented above, showing that many residents are unsure of their SFHA status, it is understandable that subjective experience of flood impacts should have a stronger effect.

Flood preparedness actions
To assess the extent to which respondents’ households had taken actions to prepare for flooding, we asked them to indicate whether each of the following actions had been taken in their household. The list is adapted from Koerth and colleagues (2013):

- I pay attention to storm flood warnings.
- I have attended information sessions about flooding.
- I have learned where the circuit breaker panel is in order to turn off all electricity in my home.
- I have informed myself about flood insurance.
- I have planned what to do in case of flooding.
- I have an emergency kit (e.g., radio with batteries, food, water).
- I store important documents where I can find them quickly (e.g., identity card).
- I moved valued items to upper rooms/out of the basement.
- I store sandbags.
- I bought protective barriers for the windows, doors, or basement openings of this home.
- I have made other adaptations or modifications in the structure of my home or property to reduce flood risk.
- My furnace is in a flood safe location.
- I have a sump pump.
- I moved to a less risky house or apartment because of the probability of being affected by floods.
- I have a plan for making sure any pet I own is safe in the event of a flood.

Each of these actions may be of interest on its own. However, to construct an overall measure of flood preparedness actions, we began by using principal components analysis (PCA) to condense the variation among these items. This helps to account, for example, for differences between actions that are relatively easy to take and those that are more costly.
or difficult. We used the first PCA component as an index of the extent to which a respondent’s household was preparing for flooding. In contrast with concern about flooding, this variable shows notable differences across values of both past flood impact and SFHA location. In Troy, those who had experienced past flood impacts showed high, statistically indistinguishable levels of flood preparation regardless of SFHA location. Respondents who had experienced no past impacts had lower values, and of these, respondents living outside the SFHA had lower levels of preparation than those within the SFHA. In Kingston, a small number of respondents living within the SFHA had experienced past flood impacts, yielding a very large confidence interval. Respondents living outside the SFHA who had experienced flood impacts had flood preparation index levels comparable to impacted respondents in Troy. Kingston residents who had experienced no flood impacts had lower flood preparation levels, with no discernible difference by SFHA status.

Flood insurance
In line with evidence regarding other flood preparedness actions, we might expect flood insurance purchase to respond to past experience of flood impacts. However, we do not find marked differences due to flood experience. Rather, flood insurance purchase aligns with homeownership and SFHA status, in line with the mandatory purchase requirement under the NFIP, which stipulates that homeowners with federally backed mortgages whose homes are within the SFHA purchase flood insurance. Despite this mandate, several studies have found low levels of take-up within this population (Kousky 2018). Focusing on only the subsample of homeowners who currently have mortgages, we find that in both Troy and Kingston, between 65% and 75% report having flood insurance, as indicated in the graph below. This is a higher take-up rate than many studies have reported, but still leaves one-fifth to one-third of households in the area covered by the mandatory purchase requirement reporting that they have no flood insurance policy.

Responses to the question, “Do you currently have a flood insurance policy for your home?” for respondents reporting homeownership with a mortgage
Policy interventions

We presented four brief flood management policy intervention scenarios, indicating interventions currently being implemented or considered in some locales. Respondents were asked to rate their level of approval of each intervention. We were interested in overall levels of support for each approach. In addition, we aimed to ascertain whether there are differences in levels of approval between people within the SFHA, who would presumably benefit directly from these interventions, and other respondents who would not experience direct benefits.

The first prompt read as follows: The city invests in strengthening and extending flood protection infrastructure along the Hudson River and local waterways using concrete and stone rubble barriers. Support for this “hard infrastructure” approach was greater than opposition and somewhat higher in Troy than in Kingston. For interpreting this difference, it should be noted that the seawall spanning the central riverbank in Troy recently underwent repairs.

The second scenario describes a “soft infrastructure” approach: The municipal government invests in “living shorelines,” which restore natural features that protect against floods and “floodable” waterfront parks that can hold flood water. In both Troy and Kingston, this intervention garnered the highest levels of approval, with over 80% choosing “strongly approve” or “somewhat approve.” Levels of support do not differ by SFHA status.
The third scenario addressed a variation on an option currently available within the National Flood Insurance Program aimed at incentivizing risk-mitigating actions: Homeowners receive low-interest loans for home-improvements that reduce risk and damage from floods, like moving utilities out of basements to places where flooding is less likely to harm them. Flood insurance premiums are reduced by an amount greater than the cost of repaying the loan. This option also received relatively high levels of approval, with little variation by SFHA status.
The last scenario concerns buyouts: With assistance from a federal funding program, your local government offers homeowners in flood-prone areas the full market-value of their house if they agree to relocate. These homes would be demolished, and no new building would be permitted in those areas, so that the land can serve to buffer flooding. Responses to this prompt were more complicated. Levels of approval were lower in each city, particularly among SFHA residents in Troy, who showed significantly higher levels of disapproval than non-SFHA respondents. Among respondents living outside the SFHA, in both cities about one-quarter chose “neutral,” while very few SFHA residents had a neutral opinion on buyouts.

The preferences expressed surrounding policy interventions suggest several points for consideration. It appears that of the four interventions, living shorelines elicit the strongest support, which may be encouraging as the Hudson River Estuary Program promotes similar flood management efforts. Opinion on buyouts, on the other hand, is more polarized. In line with other recent work on buyouts and managed retreat, where this option is considered it is clear that sustained, responsive outreach is necessary (Siders, Hino, and Mach 2019; Koslov 2016). Overall, it does not appear that people outside the SFHA reject interventions that benefit people in flood-affected areas.

We need to note that while the use of simplified scenarios may give a general sense of views, it may not be a reliable guide for practical implementation efforts. In particular, scenario prompts did not mention trade-offs, such as increased taxes or other costs that interventions might bring. One element that was incorporated was the level of government spearheading interventions, with the first two focusing on the municipal government and the last two the federal government (the third implicitly, the fourth explicitly). This last point relates to another pair of survey items that asked respondents to indicate “the level of government that you trust the most” to manage certain issues. As the graph below shows,
with regard to local flooding issues, in both Troy and Kingston, local governments garnered the highest levels of trust. This contrasts with other issues (besides flooding and COVID-19), for which state government was most trusted. We note that in both cases around half indicated “none” or did not respond. While focus group participants in flood-affected neighborhoods expressed strong concern about the Troy municipal government’s capacity and initiative around flooding, survey results suggest a modest degree of confidence in municipal governments as a locus of flood management efforts.

**Policy Implications**

These analyses are preliminary, and further analysis and discussion with stakeholders will be necessary to generate robust policy recommendations. Nonetheless, we highlight two key areas of interest.

- Regarding flood resilience interventions, there appears to be appreciable public support for living shorelines, while buyouts may be contentious. This may indicate a promising environment for HREP and state and local agencies to further pursue this option. With regard to buyouts, patterns of support differed across cities, with lower support in Troy. If buyouts are considered in Troy, careful engagement will be
necessary. More broadly, on buyouts and other interventions, attending to the particular concerns present in any given locale is crucial to implementing broader efforts in place.

- Many respondents, particularly those not affected by the flood insurance mandatory purchase requirement, express low awareness of flooding-related risks. In particular, it may help to undertake outreach to renters to help them understand their levels of risk and their options for protective measures. There is ample room for expanding outreach surrounding flood insurance and other flood preparedness measures.

**Methods**

To learn about core concerns around flooding among residents and local officials, we conducted several key informant interviews in both Troy and Kingston. In 2019, we conducted two sets of focus group conversations in neighborhoods of Troy that have been heavily affected by flooding. Focus group discussion participants comprised people from a range of racial and socioeconomic backgrounds, including both homeowners and renters. These conversations gave us a strong sense of the range of residents’ concerns surrounding flooding in the context of broader neighborhood dynamics and community histories.

In 2020, we fielded a mail survey of households in both cities. To facilitate comparison between people facing different levels of flood exposure, we used a random sample of households in each city, with a higher sampling proportion in census block groups with substantial area inside the SFHA. The Cornell Survey Research Institute facilitated design, implementation, and data entry. Due to the pandemic shutdown, the survey was conducted over the summer, rather than in the spring, as originally planned, and with rapid response funding we reworked the questionnaire to include parallel questions about flooding and COVID-19 risks. We received 499 valid questionnaires (279 from Kingston and 220 from Troy), a response rate of 13.3%.

In our analyses, we weight observations to counteract two forms of potential bias. First, the design of the sample gives households different probabilities of being sampled depending on which city they are in and whether or not they are in the SFHA vicinity. Second, the demographics of respondents are not consistent with United States Census Bureau estimates for each city, suggesting a systematic pattern of nonresponse. We calculated weights based on (1) the probability of being sampled for each subsample (Troy flood, Troy nonflood, Kingston flood, Kingston nonflood) and (2) reported homeowner or renter status alongside Census Bureau estimates of the proportion of homeowners in each city. For the latter, we used household estimates from the 2019 American Community Survey.

For each response, we georeferenced the address to which the questionnaire was sampled. Using SFHA maps from FEMA and Rensselaer County, New York, we used a geographic information system (GIS) to ascertain for each point location whether it was located within the SFHA. We also obtained the Flood Factor score generated by analyses led by the First Street Foundation [https://floodfactor.com](https://floodfactor.com). We analyze Troy and Kingston samples separately in order to highlight differing patterns across the two cities.
While the survey was underway, team members analyzed transcripts of focus group discussions and interviews. We used qualitative coding methods to identify themes concerning past flood experience, perception of current flood risks, concerns about flood insurance, and the role of the city government in responding to flood risk. We submitted to the *International Journal of Disaster Risk Reduction*, and following a positive review we are revising it for resubmission.

**Outreach Comments**

In January 2021, we met with HREP partners to share some outputs and chart next steps. On April 26, 2021, we shared preliminary findings with members of the Waterfront Resilience Council. We have discussed with HREP staff the possibility of presenting at least one more webinar or workshop later in 2021. On the basis of more complete analyses still underway, we will also create materials for education and outreach for HREP.

**Student Training**

Two students received training within this project in 2020.

**Sarah Alexander**, a graduate student in the field of Development Sociology at Cornell University, did extensive work on survey design as well as qualitative data analysis and write-up of our report on the focus group discussion analysis. Sarah finished her Ph.D. in December, 2020. She continues to collaborate on related work.

**James Zhang**, an undergraduate student majoring in Environment & Sustainability, assisted with quantitative analyses and GIS work starting in spring 2020. Through this process, he has learned how to use a new statistical software package (Stata) and has acquired new skills in statistical and geographical analysis, while also gaining substantive knowledge regarding flood risk.

**Publications, Presentations**

We completed and submitted for review a publication based on the qualitative work conducted in Troy. This paper, titled “Flood Risk Perception and Responses among Urban Residents in the Northeastern United States,” is under review at the International Journal of Disaster Risk Reduction. We have shared the draft with partners at HREP. We will also give a presentation of this work at the American Sociological Association Annual Meeting in August 2021.

**References**


Proposed Activities

Our main goals for 2021 are to convert our survey data into outputs and impacts. These efforts contribute to priorities of Building Community Resilience, Water Resource Literacy, and Assessing Government Infrastructure Programs.

Research

Survey: We have currently planned three directions of analysis of the survey data collected last year:

risk respectively, and what are the reasons for differing responses to these two risks?

2. Modeling flood risk perception and response: How do flood experience, trust in government, and demographic factors affect flood risk perception and protective actions?

3. Understanding flood risk mitigation policy preferences: What are overall levels of support for different resilience interventions? We will examine predictors of approval or disapproval of four policy intervention scenarios including hard infrastructure, living shorelines, buyouts, and loans for flood-resilient home improvements.

We will support an undergraduate research assistant to help with data analysis and to prepare data presentations for stakeholders as well as research publications, with Jack Zinda’s supervision. We aim to prepare at least two papers for submission this year. We will work with HREP partners to agree on arrangements for review and/or co-authorship of all journal publications from this work.

**Outreach**

We will work closely with HREP to translate research findings into outreach for policy-makers and community members. As soon as we have solid, stakeholder-relevant survey analysis outputs, we will work with HREP to organize webinars with the Flood Resilience Learning Network and the Waterfront Resilience Coordination Group. We will use those webinars as occasions for dialogue about what additional issues our data might address and brainstorm about outreach materials and programming that would be useful to them. These conversations will provide a foundation for preparing specific policy and engagement recommendations, developed with HREP staff and parsed out by two key audiences in the Hudson Valley:

- partners supporting flood resilience, and
- local governments (municipalities/counties)

One output will be a slide deck of infographics visually displaying key survey results and insights, provided to HREP for website use and other modes of dissemination. We will also publish at least one policy brief through the Global Development apparatus that has succeeded CaRDI.