UConn Climate Corps report on New York City stormwater flood warning and minority language populations

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1. Introduction

1.1. Initial expectations by Rebuild NYC

In response to Hurricane Ida flooding New York City and killing 13 people in the summer of 2022 Rebuild By Design and One Architecture worked together to create “Toward a Rainproof New York City: Turning the Concrete Jungle into a Sponge”. This project was initiated in order to analyze possible policies, programs, and practices that could reduce the risk of stormwater to marginalized populations in the city. While the program is currently focusing on mitigation strategies such as green infrastructure, the disproportionate effect climate change is having on vulnerable non-English speaking populations has yet to be addressed. The disaster of a response to flooding during Hurricane Ida caused the deaths of citizens of mostly Asian descent, who spoke limited English and may not have been aware of storm warnings in their area. As a result of modern urban planning practices in the United States, low-income communities and communities of color have been relegated to living in unsafe areas vulnerable to climate change.

To further their understanding of at-risk communities and their issues with storm warning communication, Rebuild reached out to UConn to seek the assistance of a trio of interns: Alessandro Fattorini, Benjamin Harnisch-Weidauer, & Jessalyn Krenicki. Our tasks have been centered around researching stormwater flooding, community demographics, upcoming policy, as well as networking with NotifyNYC to more accurately understand their methods. Doing so has allowed us to feel confident in the conclusions presented throughout this report.

1.2. Initial Expectation by Climate Corps

When we were initially presented with options for UConn Climate Corps projects available during the Spring ‘23 semester, this project appealed to each of us immediately. The initial expectations from Rebuild and their outline of a potential study plan truly stood out as a project with real-world impact. We were prepared to take on the multitude of languages characterizing New York City and try to narrow down the populations most vulnerable to heavy rain events. The task ended up being far more complex than we initially expected once we made our first deep-dive into the resources provided by RebuildNYC. This wasn’t a project where we could just create a symbol to put in high-risk areas and everyone would understand it. It took some time for us to realize that this was a project about trying to accumulate as much data as possible, pinpoint the most crucial flaws in the system, and offer efficient solutions to imminent dangers. Similar to many of the issues we deal with as environmental science majors, stormwater

flooding in New York City is an interdisciplinary subject that affects social, economic, and environmental factors, and has to be addressed with an adaptive capacity.

2. Notify NYC findings

2.1. Meeting with Rebecca Baudendistel & Nicholas Narine

During our first meeting with NotifyNYC we met Nicholas Narine, program manager for public warning at NYC Emergency Management, and Rebecca Baudendistel, director of public warning at NYC Emergency Management. Through speaking with them we learned about the current notification system, outreach programs, and current roadblocks that they are facing in progress. For one, the notification system currently covers about 97-98% of the population of New York City with plans to increase language coverage. Users who sign up for NotifyNYC can opt to have notifications translated from a limited selection of languages offered by their website. However, only flash flood calls and direct notifications from NotifyNYC utilize this feature while wireless emergency alerts are contributed by FEMA (Federal Emergency Management Agency) and lack any sort of language coverage. Alerts currently only offer Arabic, Bengali, Chinese, English, French, Haitian Creole, Italian, Korean, Polish, Russian, Spanish, Urdu, and Yiddish. This is extremely limited compared to the broad variety of languages that are spoken across the city. NotifyNYC is working on this and has filed with the agency to increase the amount of languages covered by the program.

Communicating storm warnings through modern technology is a very effective way of reaching a large portion of the population, as most have adapted to smartphone culture and trends. However, older and underprivileged populations may not have access to these new technologies to the same extent. Elderly people are less likely to own a smartphone, let alone have the ability to navigate it and use it in an effective way. Poorer communities are simply not able to afford such devices, or at least not for every household member. For these reasons, NYC Emergency Management has launched a public education campaign called Ready New York to bring awareness to the dangers of storm hazards. Through canvassing and tabling events at community halls, places of worship, and other mass meeting areas, the department is hoping to reach unaware portions of the population. Nicholas and Rebecca made it clear that the primary barrier to progress in their organization is funding. Although people volunteer for events, they do need permanent hires to conduct day-to-day operations and expand the warning system. The

primary source of funds are UASI (Urban Areas Security Initiative) grants provided by FEMA, which have not proven to be substantial.

2.2. Meeting with Joshua Rapp

Rebecca and Nicholas were extraordinarily helpful, however they couldn't answer the more scientific questions so we were referred to Joshua Rapp. He is the NYC Emergency Management's staff meteorologist who oversees what notifications go out and to whom. He began our meeting by explaining the inaccuracy of localized forecasting. Rain clouds are not uniformly distributed and have an extreme spatial variability and precise forecasts can not be made until 1-2 hours out from the rainfall. The National Weather Service is currently the most accurate weather forecasting institution, utilizing technology that allows them to forecast at the borough level. As weather predicting technology gets better, the National Weather Service will be the first ones equipped and NotifyNYC will be able to notify residents more precisely.

Rapp continued to stress that there is no more accurate forecast than that of the National Weather Service and explain the flaws of the New York City stormwater flood maps. For example, the maps assume that the entire area of the city will get the same amount of stormwater in the same amount of time. This is highly inaccurate, as storms are not uniform and have spatial variability. Pockets of heavy rain can hit some areas while others may see no precipitation whatsoever. These maps also do not account for the most intense storms such as Hurricane Ida which was a 1/1000 year event. While Joshua made it evident that the New York City stormwater flood maps could not be utilized for weather predicting models, he noted that it could be useful in our research and the goals of RainproofNYC. Two-thirds of the city is made up of impervious surfaces, and these maps incorporate current stormwater infrastructure as well as elevation to display areas that flood as a result. Rapp explained that since these maps focus on more frequent storms (moderate flooding map displays 1/10 year storm), they could be useful in establishing frequent flood areas. He also made us aware that the creation of these maps required many resources, and should therefore be thoroughly utilized.

We concluded our conversation with Joshua Rapp by allowing him to explain the overall situation at the meteorology department of NotifyNYC. They are constantly working on new projects to reach the New York City population such as hazardous travel advisories and establishing a press team, but are underfunded and understaffed. In order to have fully functional meteorological operations, they need enough employees so that at least one or two are working at

all times. His estimates place this number at around twenty employees. Rapp had other ideas to make the process more efficient such as automating the process in a way that a program detects potential storms on the radar, analyzes the storm, and sends out appropriate warnings. While all of this is possible through funding, the biggest roadblock towards more accurate predictions is the resolution of current radar technology.

3. Map and research findings

3.1. Benjamin Harnisch-Weidauer

My area of focus covered the totality of the Bronx (communities one through twelve), communities one through six in Manhattan, and community one in Staten Island. To evaluate the priority level of each community in terms of stormwater risk and languages spoken, I looked at three main resources: the New York City stormwater flood maps, the Endangered Language Alliance's languages of New York City map, and the New York City Department of City Planning community profiles website. Other resources that aided my research were community board websites, NotifyNYC, as well as stormwater projects in other cities around the world. Using the attached table, I systematically went through each community district and highlighted key data points that reflect its standing in regards to languages spoken and stormwater risk.

In regards to languages, I first listed each language spoken in a community based on the languages of New York City map, and then compared this to the languages that can be translated through the translation widget on the community board websites. An interesting finding was that community boards seemed to decide individually whether they used the translating widget or their own translating service, the latter containing a much more narrow range of languages. Through this, I hoped to clarify which language groups are currently lacking storm warning communications. I also included population density and the percentage of the population that is proficient in English as a way of representing the actual magnitude of non-English speakers in a community.

Evaluating stormwater risk was a more subjective task, as my rankings were based on comparative analyses rather than statistical evidence. I judged this based on the percentage of streets in a community that would flood with either deep and contiguous flooding or nuisance flooding, and compared moderate flooding scenarios with extreme scenarios. The latter proved to be a valuable addition, since some communities faced far more extensive flooding circumstances in extreme stormwater events. These events are happening more frequently as a result of climate

change and since these storms pose a greater risk to human well-being, communities should be prepared for the worst. Although this project focuses on stormwater, and not sea level rise, I included statistics on dwellings susceptible to storm surge because stormwater can compound on that. The deaths caused by flooding during Hurricane Ida were the result of people living in basements similar to these dwellings, so since the data was available it made sense to take note of it. Furthermore, I listed the quantity of evacuation centers in each community to reflect the availability of safe shelter for those living in risky living situations.

Following all this analysis and data gathering, I was able to gain a better understanding of which communities were at the highest risk of stormwater flooding and deemed each one a rating of low, medium or high. The primary statistics I used to make these decisions were population density, percent of population not proficient in English, number of languages spoken but not included through the translation widget, and the moderate and extreme stormwater risks that I determined from the stormwater map. Low priority communities are Bronx 3, 6, 8, 11, 12, and Manhattan 1, 2, 4, 5, 6. Medium priority communities are Bronx 1, 2, 5, 7, 9, 10, and Manhattan 3. The highest priority communities are Bronx 4 and Staten Island 1.

It is important to note that these designations are all subjective and based on my own evaluation of the data I collected. Others may come to different conclusions than I have, but I am confident that my process has been quite accurate in determining the communities at greatest risk. These results reflect RainproofNYC's initial presumptions of redlining practices in New York City and how that has worked in tandem with increased stormwater to disproportionately affect vulnerable communities. The Bronx and Staten Island have far more widespread flooding, as well as larger proportions of non-English speaking populations (with the exception of Manhattan 3). Another observation I had is that higher population densities tend to correlate with higher percentages of the population that is non-English speaking

3.2. Jessalyn Krenicki

My area consisted of all of Brooklyn (communities 1-18), as well as most of Staten Island (communities 2 and 3). I utilized many sources that Rebuild pointed us towards, such as each community profile website, community board websites, and NYC stormwater maps. I utilized two different resources for the languages in my area; both the Endangered Language Alliance's languages of New York City map as well as the Jill Hubley Languages of NYC map based on a 2014 community survey.

After doing research with the data I could find on the buildings, stormwater flooding, and languages spoken in each area, I felt confident enough in my general understanding of the communities to begin to evaluate which needed the most assistance. Using these factors, as well as population density and the availability of language translations on community websites, I was able to score each community on a scale of low to high risk. It was difficult to objectively scale these communities, but I did as best I could. The rankings are as follows: Brooklyn 11, 13, and 15 are extremely high, due to high stormwater risk, large non-english fluent populations, no evacuation centers, and many basements below grade. Brooklyn 4, 5, 14, and 18 are all ranked High as well, mostly due to language limitations, high flood risk, and many below-grade basements. Medium-priority are as follows: Brooklyn 1, 7, 10, and 12, and Staten Island 2. These places often were rated high risk in one parameter, but low in another. Brooklyn 2, 3, 8, and Staten Island 3 all straddled the line between medium and low, typically due to low overall priority with many languages not offered or many below grade basements. Finally, all of the remaining communities were deemed Low Priority for not being particularly high risk in any categories: Brooklyn 9, 16, and 17. Brooklyn 6 is also placed into Low priority, as it's already being covered by the Engineering program that Rebuild informed us about early in the process.

Similarly to the rest of my team, my judgements on priority were subjective based on my understanding of the data I was able to gather. These are comparative judgements, and it's important to bolster all communities in New York not only to prevent great damage from storms, but also to begin moving toward a world where language can be less of a barrier to help and warnings.

On that topic, I happened upon a fascinating law in New York- the New York State Language Access Law. This law dictates that, in the interest of resolving the language barriers in New York, "all State agencies that interact with the public must provide interpretation services in any language with respect to the provision of agency services or benefits, and must translate vital agency documents into the top 12 most commonly spoken non-English languages among LEP New Yorkers based on Census data" ("New York State Access Law"). These languages were determined to be: Spanish, Chinese, Russian, Yiddish, Bengali, Korean, Haitian Creole, Italian, Arabic, Polish, French, and Urdu.

No information I found dictates that NYC community boards are state agencies; however, given their key role in the communities they watch over, I believe holding boards to this standard

as well is very important. This policy would make great strides, particularly on official community board websites such as Brooklyn 5 and 14, which do not offer any translation services whatsoever. Some other community boards do offer some translations into various languages, but lack some of the top 12 languages; I think this is something that should be more pervasively implemented in the interest of dismantling the language barrier.

3.3. Alessandro Fattorini

The area of focus that I was tasked with included districts six through twelve of Manhattan and all fourteen districts of Queens. To do so I utilized the same variety of sources as my peers to conduct the background research, that being the NYC stormwater flood maps, the ELA's languages of NYC map, and the New York City Department of City Planning community profiles website. In addition to those resources, I directed my attention toward the city's forecasting methodology and the inherent challenges it confronts as a vast, human-engineered urban environment constructed upon a historically significant wetland ecosystem.

These became my focus while I compiled the data for my communities and found that about half of them had all six NYC evacuation zones within their own communities. This is influenced by Manhattan & Queen’s extended coastal areas, low elevation, and highly impermeable infrastructure. When comparing them to the other boroughs Manhattan is the most impervious, with 63% of its land area impeding infiltration, and also the only part with over 20% open-water. Queens on the other hand is 57% impervious and 27% pervious and the issues this area faces stem more from the low elevation and stormwater infrastructure that needs updating. While these are similar issues to the rest of the city I felt that some of the extremes were more amplified under these specific conditions.

After analyzing data, I gained a better understanding of communities that were highly vulnerable to stormwater flooding. Based on the same factors my peers used; population density, language proficiency, and stormwater risk, I rated each community as low, medium, or high risk, with Queens 14 being extreme as it will likely be almost completely underwater every high tide in the next few decades. The main statistics used to make these decisions were the percentage of non-English proficient population, the number of languages spoken but not translated, and the number of substandard housing units per storm risk level. Using that criteria I categorized them as follows; low: Manhattan 7/9 as well as Queens 5, 6, 8, 9, 11, & 12. Medium priority:

Manhattan 10/12 including Queens 3, 4, & 13. Lastly Manhattan's 8 & 11 fall under the High Priority category and so do Queens 1, 2, 7, 10, and 14.

Once this was completed I turned my focus towards forecasting so that I could more fully understand the conditions that cause a stormwater flooding event. In forecasting weather for a specific location like a borough in New York City, the National Weather Service (NWS) relies on numerical weather prediction models. These models simulate the atmosphere using complex mathematical equations, generating real-time predictions for various weather parameters, including the probability of precipitation (PoP).

Meteorologists analyze multiple models and employ ensemble forecasting techniques to improve overall accuracy. To estimate PoP, they assess the agreement between different models and weigh the various factors that influence precipitation. The percentage is a reflection of their confidence level in rain occurring at a specific location, conveying both the likelihood of precipitation and the level of certainty in the forecast. By incorporating local factors, such as topography and urban heat island effects, the NWS produces accurate, real-time, and localized forecasts for individual boroughs in New York City. Joshua Rapp explained to us that the only thing stopping the NWS from making more accurate predictions is the technical limitations of our technology. With improvements to NWS satellite resolution technology alerts can become more specific, hyperlocal, and accurate in terms of rain volume and rate of precipitation. While this doesn't solve the issue of the communication barrier between NotifyNYC and many New Yorkers it would improve the trust in the system and hopefully promote more usage of some form of weather alert technology.

4. Suggestions/recommendations

4.1. NotifyNYC

Our recommendations for RainproofNYC's suggestions to NotifyNYC are not very extensive since they seem to know exactly what needs to be done to improve warning systems, and simply do not have the funding to make that possible currently. One improvement that they could implement would be the usage of the widget provided on many of the community board websites. The organization can utilize the research we have conducted to assess which minority languages are most common across the city, and include them in app, call and email notifications. If possible, FEMA should be notified and encouraged to increase their language coverage for Wireless Emergency Alerts (WEA), especially with the broad audience their

notifications reach. NotifyNYC should make an effort to reach out to community boards across the city to ensure that each is using the same all-encompassing language translation widget, as we noticed that a notable number have not yet utilized it. The language data we collected can also be used in Ready New York initiatives as well as tabling events to more accurately target language groups on a neighborhood by neighborhood basis. Canvassing should also be increased and should attempt to target mass events that are representative of local populations. Another suggestion we came up with is to use cable television to reach more elderly portions of the population. This can be through the form of advertisements (PSAs) to raise awareness, and more immediate forms of weather alerts during impending storms.

4.2. Already existent solutions

Through research of other cities' approaches to stormwater flooding and warning, we developed some ideas on how RainproofNYC can work with the city to address these issues. Two cities of note have proven to be pioneers in facing this new impact of climate change: Amsterdam and Copenhagen. Flood sensors in Amsterdam are part of the city's comprehensive flood warning system designed to alert citizens of potential flooding in low-lying areas. These sensors are strategically placed throughout the city, monitoring water levels in canals, rivers, and other waterways. The sensors are equipped with advanced technology that can detect rising water levels and send real-time alerts to city officials and emergency services, which relay alerts to citizens via various channels, such as emergency broadcasts on television and radio, text messages, and social media.

Copenhagen uses a similar warning system, along with the use of rain gauges and flow sensors. These sensors monitor the flow of water in streams, rivers, and other waterways and send real-time data to a central server. The server uses this data to analyze water levels, flow rates, and other factors, and then sends alerts to city officials and emergency services if a flood event is likely to occur. Incorporating sensors throughout New York City can prevent complications caused by flash floods, which are different from gradual flooding as they do not immediately succumb to elevation and stormwater infrastructure. Similarly to Copenhagen and Amsterdam, New York City can automate the process so that sensors communicate flooding levels to the warning system which notifies the population. The system implemented by Weather Underground, an organization that sold miniature weather stations (WunderStation) for people to keep at their home for local data gathering, could be a potential project to model after.

Certain areas of New York City itself provided us with inspiration for how the city can address stormwater flooding. The Battery Park City neighborhood has implemented demarcations on lamp posts to signify areas prone to storm surge. While this does not apply to stormwater, similar actions can be taken to mark areas that flood during high precipitation events. Using the New York City stormwater map, areas of frequent flooding can be marked by putting up signs or painting lamp posts and curbs. This can bring awareness to citizens living in the area as well as people who are passing through and are unfamiliar with the neighborhood.

Another initiative in New York City which could prove useful to NotifyNYC is FloodNet, a collaboration between communities, researchers, and the city of New York looking to better understand flood frequency, severity, and impacts. They currently have three projects underway that address different aspects of urban flooding: Flood Watch, FloodSense, and Flood Help NY. The Flood Watch project is a network of residents and organizations, led by New York Sea Grant, that report on local flooding information to help researchers visualize and improve forecasting ability of future storms. FloodSense focuses on actual physical flooding data collected by ultrasonic sensors placed around the city. This project is led by New York University, and utilizes relatively cheap, effective technology that is also easy to install, durable, and interconnected. This real-time data collection method could prove to be extremely useful in determining areas that require more stormwater infrastructure, and in producing accurate flood warnings. Flood Help NY is a resource that provides valuable and informative information for homeowners, primarily low and middle income working class families, about a multitude of flood-related issues. Residents can learn more about flood insurance, retrofits to protect from flood damages, and the risk of climate change in general.

4.3. Other suggestions

There were a few suggestions we brainstormed that aren't directly related to the data we gathered and our focus in our research; however, we thought them relevant to include, in case these are paths not yet walked. If possible, obtaining ad space on local non-English media outlets could bring more people around to existing help such as NotifyNYC; however, NotifyNYC itself needs some improvements to better provide information to New York citizens. Speaking to local "influencers" could have a similar effect in addressing non-English speakers more directly.

In general, specific data is fairly sparse when it comes to language and ethnic coverage in New York. There are a few good sources that provide general information, such as the

Endangered Language Alliance's map that we used, however surveying & polling to collect more data on language and ethnic coverage in New York would allow for more well informed decisions. While we did not uncover any current initiatives working towards addressing this, investments in the sector would greatly improve the ability of Rebuild and projects like NotifyNYC to reach target audiences. Polling for this could be included in the census conducted every ten years, but with immigration such a prevalent and unique aspect of New York City culture, surveys should be conducted more regularly. This could come in the form of door-to-door questionnaires which could be extrapolated to represent the population of a community.

5. Conclusion

5.1. Uncertainties

Throughout this process, we've realized just how nuanced such an issue can be. There is no one good solution to this: there is of course the serious language barrier for many New York City citizens, but there are also social pressures against evacuating; limited research or resources going into the National Weather Service, which halts progress toward faster or more accurate weather forecasting; and as all of this limits us, climate change increases the intensity of the very storms we're facing. Protecting some communities is a great start, but there's so much to do and many angles to take. As Rebuild is focusing on helping governments create research-based, collaborative processes that prepare communities and regions for future challenges, we believe that support needs to be made for some of the pillars on which Rebuild can thrive.

One of the greatest uncertainties in our research comes from the resources that we have used. The stormwater map that we based our risk assessment on was developed using many assumptions that are not exactly representative of an actual mass precipitation event. For one, it assumes that the same amount of stormwater hits every square inch of the city equally, and as time progresses the map will become less and less relevant. This uncertainty could be largely addressed through adaptive scenarios and models based on data, including stormwater figures collected by projects like FloodSense. The language map we used is also limited in its scope of application. Data points merely stated language groups with significant populations in a general area, without pinpointing specific population numbers and locations where residents live. This uncertainty could largely be eliminated through the collection of more accurate demographic language statistics. Another significant uncertainty and assumption has been cooperation by the

public, the government, and other stakeholders. Residents may not respond positively to perceived disturbances to their neighborhoods like demarcation methods or rain gauges and sensors. Perhaps more importantly, with so many of the projects discussed in this report primarily funded by government entities, a major barrier will be applying for more resources.

5.2. What have we learned/accomplished

We've learned a fascinating amount about the dynamics of the different boroughs in New York City, and how those play into stormwater flood risk. Hurricane Ida provided a much needed acknowledgement of the faults in the current flood warning system, and the disproportionate effects that flooding has on non-English speaking populations. However, somehow it still feels like the city is at a greater risk from stormwater than ever, and through our research we have sought to address this with achievable solutions. A surprising revelation has been the large number of organizations and projects that are already working separately to tackle the same issue. We believe that while improved technology such as forecasting resolution could help the city greatly, the most important and effective strategy is improving communication and collaboration. Not only can the projects mentioned throughout this report benefit from sharing data and findings, they can also work towards pushing for legislative change and more funding.

In all, we've made a number of recommendations that hope to improve this issue on many fronts. We've pinpointed a number of specific communities that would benefit most from attention from Rebuild: in Brooklyn, the communities are 11, 13, 4, 5, 14, and 18; in the Bronx the highest priority area is community 4; in Manhattan the high priority communities are 8 and 11; in Queens they are 1, 2, 7, 10, and 14; and Staten Island 1. Many communities beyond that are in need of assistance, but those listed are the ones we believe to be in the most need based on non-English speaking populations and overall flood risk. Overall the majority of the population, regardless of the priority levels we have determined, will benefit from the suggestions we have made. Improving language coverage in warning systems will improve outreach as a whole, and expanding the usage of sensors and flood zone demarcations would not be discriminatory on a community to community basis. Other strategies could be more effective if they are used in more specific, targeted communities, like canvassing events and stormwater infrastructure.

The team at UConn Climate Corps would like to conclude this report by thanking everyone at RebuildNYC for taking the time out of their busy schedules to provide an invaluable learning experience. If there was ever any doubt in our minds whether or not environmental

science was the right direction to head for our studies, this project eliminated any that remained. It allowed us the freedom and opportunity to use what we have learned throughout our time at UConn, and apply that knowledge in a meaningful way that could actually have a positive impact.

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