



# IMPROVING EQUITY IN CLOUDBURST RESILIENCE IN NEW YORK CITY

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WORKSHOP IN APPLIED EARTH SYSTEMS POLICY ANALYSIS  
MPA IN ENVIRONMENTAL SCIENCE AND POLICY  
FINAL REPORT, SPRING 2023

# ACKNOWLEDGMENTS

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To fulfill the requirements for the Master of Public Administration in Environmental Science and Policy program at Columbia University, students must complete a workshop course in which they undertake analytic projects for real-world clients in government and nonprofit agencies to analyze sustainability issues and make policy recommendations. For the workshop course this spring semester, we had the privilege of working with the Division of Integrated Water Management at the New York City Department of Environmental Protection to determine how to better integrate equity into cloudburst resiliency projects.

We would like to thank our client, the Division of Integrated Water Management at the New York City Department of Environmental Protection. In particular, we would like to thank Alan Cohn, Kaitlin Stath, Amy Motzny, John Brock, and Joseph Woodrick.

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# EXECUTIVE SUMMARY

New York City (the City) is expected to experience an increase in frequent extreme weather events due to climate change. Since Hurricane Ida, which occurred in September 2021, the City is working on resilience strategies for heavy rainfall events such as cloudbursts. However, while most of the plans are focused on technical solutions, like gray and green infrastructure, equity has yet to be fully integrated into these solutions. Equity is an essential consideration because some segments of the City's population and some communities will be more vulnerable and at risk when faced with cloudbursts.

This semester, the Division of Integrated Water Management at the New York City Department of Environmental Protection (NYC DEP or DEP) requested that our Workshop team research key strategies and definitions that the Department can use to incorporate equity into their cloudburst resilience projects. With that purpose in mind, the team conducted research and came up with innovative ways to better integrate equity into the current cloudburst work being done in the city.

To understand the current situation in New York City, our team conducted an extensive review of current initiatives both for cloudbursts and equity. At the same time, six case study cities were analyzed to review best practices in cloudburst management and equity. Eleven expert interviews were also conducted with representatives from city governments, nonprofits, and educational institutions both in the United States and abroad. The information gathered from this combination of secondary and primary research informs our set of final recommendations for DEP.

The team's work has culminated in four key deliverables: i) A project design to create an integrated equity strategy; ii) a stakeholder list of potential community partners for DEP; iii) additional indicators to refine DEP's future cloudburst project neighborhood selection; and iv) a customized assessment tool to measure cloudburst risk levels of neighborhoods in New York City.

# 1. INTRODUCTION

In August 2021, the remnants of Hurricane Ida hit New York City. In little over an hour, 3.15 inches of rain fell, setting a local rainfall record and vastly overwhelming the sewer system. The City experienced street and subway flooding, sewer backups, and severe basement flooding (New York City Deputy Mayor for Administration, n.d). Thirteen people were killed in New York City during Hurricane Ida, eleven of whom resided in basement apartments in Central and Eastern Queens (Zaveri, 2021). As a pivotal event, Ida highlighted the severe impact that cloudburst events can have on the City.

The DEP defines a cloudburst event as “a sudden, heavy downpour where a lot of rain falls in a short amount of time” (NYC DEP & NYC MOCEJ, 2022). Cloudbursts are distinguished by the intensity and short duration of each event. This differentiates the phenomena from general stormwater causes and management, as cloudbursts overwhelm the current infrastructure, designed to handle rain that falls over a longer period of time.

While all New Yorkers are exposed to the dangers of flooding that comes with cloudbursts, some communities are at an increased risk of destruction and loss of life. This means that in New York City, equity has to be achieved by diverting more resources and protection to communities that are at greater risk and are more vulnerable to cloudbursts.





## 1.1 Cloudburst Management in New York City

New York City has authored several stormwater management and resilience plans that outline the City's current efforts to manage cloudbursts and other extreme rainfall events. Many of these reports were published in the past two years, showing that the City is placing increased emphasis on managing cloudbursts, especially in light of the impact Hurricane Ida had on the City.

New York City defines cloudburst management as

*"a combination of grey infrastructure, like drainage pipes and underground tanks, and green infrastructure, like trees and rain gardens. These projects consider larger volume storage, typically building for up to the future 10-yr (2.3 inches/hour), and provide Combined Sewer Overflows (CSO) reduction benefits as well as stormwater resilience" (NYC DEP & NYC MOCEJ, 2022).*

Currently, there are three cloudburst management pilot projects underway. These projects are at the South Jamaica Houses, Clinton Houses, and in St. Albans, Queens. The projects are focused on building new green and gray infrastructure (NYC DEP & NYC MOCEJ, 2022). Current cloudburst projects are primarily prioritized based on physical risk and focus on infrastructure improvements.

Additionally, on January 9th, 2023 Mayor Adams announced a \$390 million investment into cloudburst management projects in four other neighborhoods - Corona (Queens), Kissena Park (Queens), Parkchester (Bronx), and East New York (Brooklyn). These areas were selected using criteria including "historic and future stormwater flooding hotspots, existing city projects, environmental justice areas, and social factors that may increase vulnerability to stormwater flooding" (New York City Office of the Mayor, 2023).



IMAGE: EMILIO GARCIA

## 1.2 Equity in New York City

Equity definitions vary across New York City's governmental agencies. DEP currently uses the US Water Alliance's definition of equity, which states that water equity is achieved when "all communities have access to safe, clean, affordable drinking water and wastewater services; share in the economic, social, and environmental benefits of water systems; and are resilient in the face of floods, drought, and other climate risks" (US Water Alliance, n.d.).

The **NYC Mayor's Office of Equity (MOE)** aims to achieve equity in New York City, but an explicit definition of equity is not offered. Rather, MOE's mission states they "will dismantle explicit and implicit bias in municipal government functions" as well as "provide meaningful, unburdened access to resources, and create avenues of economic support" (MOE, 2023). Their vision is for every resident of New York City to "live a healthy and fulfilling life free of racism, bigotry, sexism, poverty, violence, age discrimination, disability discrimination, transphobia, homophobia, and other tools of oppression" (MOE, 2023).

**CreateNYC**, a cultural plan set forth by the NYC Office of Cultural Affairs, defines equity broadly as where "assets are distributed fairly and justly for the benefit of the public." They further define inclusion as the "degree to which individuals with diverse perspectives and backgrounds are able to participate fully in all elements of an organization, agency, or system" (NYC Cultural Affairs, 2019). **OneNYC**, the development plan for NYC introduced in 2015, defines equity as "fairness and equal access to assets, services, resources, and opportunities so that all New Yorkers can reach their full potential" (OneNYC, 2015).

DEP's current definition of equity from the US Water Alliance is a positive start, but does not provide a practical guide for DEP programming as it lacks an operational component. This is also true for the equity definitions seen in other New York City agencies. A more refined definition is needed in order to practically integrate equity into DEP's work for cloudburst resilience and beyond.



## 2. LITERATURE REVIEW

### 2.1 Research Problem

The primary question guiding the team's research is: [What are key definitions and strategies that DEP should use to effectively integrate equity and resilience in cloudburst management?](#)

The team took a two-pronged approach to answer this question. First, the team conducted a thorough literature review to gain a broad understanding of both equity and resilience. The literature review focused on six cities, domestic and international, and provided in-depth information about the complexities each faces in defining and actualizing equity and resilience for cloudburst management. The team simultaneously conducted interviews with key experts from across the United States and abroad to gain insight into local definitions of and responses to both equity and climate resilience.

### 2.2 Case Studies

To create a suite of recommendations for the NYC DEP, six cities were selected for review of their cloudburst resilience plans and equity initiatives. This section outlines the findings from the research on Copenhagen, Mumbai, Baltimore, Austin, Portland, and Seattle.

These cities were chosen because they shared at least one similarity to New York City, making them a practical comparison. Some of these characteristics include density of population, climatic conditions, gray infrastructure, and the extent and impact of the risks on the vulnerable communities within the city.

**COPENHAGEN****MUMBAI****BALTIMORE****AUSTIN****PORTLAND****SEATTLE**



## 2.2.1 Copenhagen

In 2012, Copenhagen issued a Cloudburst Management Plan which outlined a strategy to utilize gray and green systems to absorb and convey stormwater from heavy rainfall events. The City developed and published the Plan in response to a 2011 cloudburst event that caused nearly \$1 billion in damage, including to homes, transportation systems, and other infrastructure. Public health was also compromised. Primarily, the Plan sought to reduce the impacts of pluvial flooding due to heavy rains, which are expected to increase in frequency as a result of climate change. In 2015, New York City and Copenhagen signed a 3-year Memorandum of Cooperation (MoC) to exchange knowledge on solutions to climate challenges in light of similar vulnerabilities. Through the MoC, New York and Copenhagen continue to learn from one another; likewise, they share findings with other cities worldwide, facing similar climate-related challenges, especially flooding.

### **Cloudburst Strategies**

Copenhagen developed a cloudburst formula (ASLA, n.d.) based on a six-step procedure for integrating the Blue-Green approach. The six steps involve the following:



IMAGE: ROLANDS VALSBERG

1. Data investigation and gathering to rank the areas that bear threat to cloudbursts.
2. Modelling and mapping vulnerable regions based on their stormwater catchments.
3. Producing the “Cost of Doing Nothing”, which is a financial scenario mapping “business as usual” (ASLA, n.d.). The activity demonstrated that doing nothing would cost approximately \$60-90 million annually.
4. Identifying hotspots to transfer strategic planning to human-scale experience.
5. Developing an overall strategy for public participation.
6. Conducting a socio-economic cost-benefit analysis, which revealed Blue-Green solutions could create savings of up to 50% greater than conventional solutions.

### Equity Initiatives

While equity is not explicitly defined in the Copenhagen Cloudburst Management Plan, the Urban Renewal Plan aims to improve the quality of life for residents and the community as a whole. In the Vesterbro area of the city, the urban renewal efforts are focused on addressing the challenges of aging infrastructure, inadequate housing conditions and economic disparities. This effort is unified by a long-term and broad-palette initiative intended to help improve the quality of life of residents through citizen partnership and local involvement to create socially, physically, and culturally sustainable urban areas (Technical and Environmental Administration, 2012).

#### KEY TAKEAWAYS FROM COPENHAGEN

New York City can focus on developing adaptation strategies by:

1. Establishing a detailed Cloudburst plan to mitigate damage and increase real estate values. This will help decrease insurance property and life coverage payments;
2. Adopting the Blue-Green approach, which represents the future as it establishes urban ecological waterscape, and balances sound financial investment and economic opportunities with social benefit improvements;
3. Initiating public-private partnerships and cross-agency collaborations; and
4. Using GIS modeling for “blue spot” identification and integration with the socio-economic map to overlay flood risk with disadvantaged communities.

## 2.2.2 Mumbai

Like New York, Mumbai faces challenges of poor coastal management and drainage planning, which exacerbates the flood risk and vulnerability of economically weaker communities. Mumbai also maintains a dense stormwater management network that is largely restricted to the island city, which means that the surface drainage from suburban areas ultimately drains into the sea. The city therefore becomes highly vulnerable to urban flooding after sudden rainfall, also called Extreme Rainfall Events (ERE). To tackle these unprecedented climate risks, the city established the Mumbai Climate Action Plan (MCAP) in 2022.

### Cloudburst Strategies

Beginning in 2022, and with an ambition of making Mumbai climate resilient by 2050, the planners undertook a six step process for the MCAP. These steps covered the plan's design, development, implementation, and ongoing assessment:

- Vulnerability assessment based on various socio-economic and demographic indicators revealed the most vulnerable communities;
- Assessment of urban flooding risk, based on ERE;
- Probability modeling through a frequency, intensity, and spatial analysis of ERE;
- Multi-stakeholder consultations to create action plans based on the type of issue;
- Review and alignment of Key Action Plans with funding, timelines, and assessment and feedback mechanism for accountability.



IMAGE: GCSHUTTER ON GETTY IMAGES

## Equity Initiatives

To integrate equity and inclusion into the MCAP Key Action Plans, the planners expanded the C40\* definition of equity as “improved health and equitable distribution of benefits to address the needs of vulnerable communities and other impacted groups” (MCAP, 2022). This definition integrates co-benefits for residents on health and well-being by increasing economic prosperity and promoting education and skill development. The beneficiaries include vulnerable groups such as women, children, the elderly, persons with disabilities, low-income communities, and informal communities (such as residents and workers).

For community engagement, MCAP recommends initiatives for minimizing disaster risk and impact by strengthening early warning systems, data monitoring and integration, and community engagement. The monitoring of these initiatives will be done by using several Key Performance Indicators (KPIs) determined before implementing the plan. Some of the KPIs related to disaster risk management are:

- Percentage of population trained in emergency response;
- Demographic information of people implementing response actions;
- Number of residents from the vulnerable communities participating in the public planning process and public awareness events; and
- Types of NGOs involved in city issues related to flood management (MCAP, 2022).

### KEY TAKEAWAYS FROM MUMBAI

New York City can focus on developing mitigation and adaptation strategies by:

1. Engaging both internal and external stakeholders in the planning and policy-making process;
2. Mapping and analyzing the vulnerable communities;
3. Creating shelters in the most vulnerable communities;
4. Embedding plans for achieving equity in all the departments working on cloudburst resilience;
5. Adopting robust water management practices like groundwater percolation and rainwater harvesting in and around vulnerable communities; and
6. Establishing Key Performance Indicators to monitor and track the progress of the resilience program.

*\*C40 definition of equity is “equitable and inclusive planning which ensures that actions respond to social inequities and the needs of those impacted by climate change and/or climate policy” (C40 Knowledge Community, n.d.).*



### 2.2.3 Baltimore

Baltimore is a city vulnerable to cloudbursts and urban flooding, given the city's location, history, and current socioeconomic conditions. Planned segregation and limited Black homeownership has contributed to historical inequalities which persist to this day. This historical discrimination makes it more difficult for these communities to respond and recover from natural disasters like cloudbursts.

#### Cloudburst Strategies

The primary document outlining Baltimore's climate initiatives is the 2012 Climate Action Plan, which specifically suggests strategies pertinent to cloudbursts. This Plan focuses on three issues: higher temperatures, sea level rise and flooding, and precipitation and storms. One strategy to mitigate the effects of cloudbursts is the use of green infrastructure like "urban forests, orchards, and riparian buffers" to help slow water flows during storms and increase the amount of permeable surfaces that can absorb excess rainwater (City of Baltimore, 2013). As of 2023, the Climate Action Plan is being updated through public engagement and with the assistance of a diverse sixteen-member advisory board (Baltimore Office of Sustainability, n.d.).

At the same time, the 2019 Sustainability Plan focuses on climate preparedness. Preparedness would be achieved through initiatives outlined in the City's Emergency Operation Plan, the 2018 Disaster Preparedness and Planning Project, which is once again focused on green and gray infrastructure projects and the creation of community-based resilience hubs (City of Baltimore, 2019).



IMAGE: STYVES EXANTUS.



## Equity Initiatives

Baltimore has taken several steps to achieve equity, including codifying equity into the city code in 2018, through the Baltimore Equity Assessment Ordinance (Department of Planning, n.d.; Office of Equity and Civil Rights, 2018). The Ordinance specifically calls for city agencies to undergo annual equity assessments along with ongoing efforts to increase staff diversity and encourage an equity lens in all their work which can be found in *Appendix A* (Office of Equity and Civil Rights, n.d.).

As with New York City, different departments in Baltimore City define equity differently, but the one by the Office of Equity and Environmental Justice in the Baltimore City Department of Public Works stands out for being more operational. It defines equity as “providing different levels of support and assistance, depending on specific needs, abilities, or circumstances” (Baltimore City Department of Public Works, n.d.).

Baltimore also conducts public outreach as a key part of their community engagement work. This is done through holding meetings with communities in locations where members feel the most comfortable, such as in local churches and sometimes even private homes (Baja et al., 2018). Baltimore worked closely with local leaders to build trust with communities and launched a communications campaign highlighting extraordinary stories from community members. Residents engaged in the process as a way to share their experiences and highlight the City’s effort to actively listen to and respond to their needs (Baja and Granberg, 2018).

Education is also a big part of the community engagement work done in Baltimore. The city conducted community workshops to educate residents on floods and the appropriate emergency response (Baja and Granberg, 2018). They also developed a school program to enhance students’ environmental literacy (City of Baltimore, 2019).

To tailor solutions to the needs of communities, Baltimore also created local resilience hubs in each community to provide resources in times of crisis which serve as “a way for the city to coordinate mitigation and adaptation efforts” (Baja and Granberg, 2018). A resilience hub, run by the city, is built to provide protection and resources during times of extreme weather events (City of Baltimore, 2019).

Finally, Baltimore uses a unique data-driven approach to prioritize cloudburst

infrastructure projects based on equity. Using the Equity Prioritization Tool developed by infrastructure consulting firm, AECOM, the tool draws upon over “100 layers of contextual data” to calculate the equity impacts of different projects (AECOM, 2022). This allows officials to better prioritize their projects to meet equity needs and goals.

### KEY TAKEAWAYS FROM BALTIMORE

New York City can focus their equity efforts by:

1. Establishing diverse advisory committees so that recommendations for the operationalization of equity are reflective of community vulnerability, and ongoing monitoring ensures ongoing equity;
2. Engaging with local leaders who serve as a bridge between the government and local communities;
3. Tailoring resilience strategies to the needs, capacities, and assets of the community;
4. Taking into account feedback from the public to make strategies more efficient;
5. Creating resilience hubs to facilitate coordination during cloudbursts and as to provide education and engagement on a frequent basis; and
6. Prioritizing new cloudburst resilient infrastructure projects through a framework that ensures equity and monitors project management and assessment.

IMAGE: CHLOE SIMPSON.



## 2.2.4 Austin

Austin is the tenth most racially segregated city in the United States (Winkie, 2014). A history of redlining and segregation has led to low Black homeownership in the city. According to the Austin Climate Resilience Action Plan, precipitation patterns will become more variable, with intense rainfall more commonly interspaced with droughts in the region, due to climate change. Floods are one of the four major climate hazards of concern for Austin (City of Austin, 2018).

### Cloudburst Strategies

The Austin Climate Equity Plan was adopted in 2021, with a focus on addressing the causes of climate change and transforming Austin into a more sustainable city. This plan does not mention the term "cloudburst" specifically. The Plan is divided into five main areas: sustainable buildings, transportation and land use, transportation electrification, food and product consumption, and natural systems. The topic of flooding is mainly addressed within the natural systems strategy with green infrastructure highlighted as a key method for flooding prevention.

### Equity Initiatives

In 2016, Austin created an Equity Office to address historical inequities in the city. In 2017, it developed a pilot for an Equity Assessment Tool to be used by all the municipality's departments in the budgeting process to better integrate equity concerns (Equity Office, "About" 2023).



IMAGE: ROSCHETZKLSTOCKPHOTO ON GETTY IMAGES.

The Office refines the tool with the assistance of the Equity Action Team (EAT), an open coalition of the city staff and community members that works with the other city departments to promote racial equity initiatives (Equity Office, “What we do”, 2023). The team also maintains the Equity Action Team Dashboard (Equity Office, “Dashboard”, 2023), which can also be replicated by each department.

Austin’s Climate Equity Plan focuses on racial equity, defined as “the condition when race no longer predicts a person’s quality of life outcomes in our community” (City of Austin, 2021). It further highlights that Black, indigenous and people of color as particularly “vulnerable” to climate change effects. The Plan also recognizes other “marginalized groups” that experience “heightened risk and increased sensitivity to climate change and have fewer resources to help them cope with, adapt to and recover from climate disasters” (City of Austin, 2021). These groups can be low-income communities, youth, LGBTQIA+ communities, immigrants and refugees, people with disabilities, those experiencing homelessness or with criminal records, seniors, and women. Austin is currently preparing their Rain to River Plan, focused on climate change, population growth, and racial inequities, and is initiating community engagement with efforts like the Community Climate Ambassadors Program and the Resilience Hub Network (Watershed Protection Department, 2023).

### **KEY TAKEAWAYS FROM AUSTIN**

New York City can focus their equity efforts by:

1. Setting up diverse advisory committee to monitor and provide recommendations on equity, such as the Equity Action Team;
2. Designing a prioritization framework for cloudburst resilient infrastructure; and
3. Defining key indicators for equity to be assessed during the budgeting process.



## 2.2.5 Portland

Flooding has a long history in the Portland area, with severe floods recorded as early as 1861. Flood-prone areas of Portland are at low elevations along streams and rivers, such as the Columbia River floodplain, the Lower Columbia Slough, and Johnson Creek (City of Portland, “Risk and Vulnerability Assessment”, 2014). In recent years, warmer winters with the potential for more intense rain events are expected, as are hotter, drier summers. Increasing intense rain events put a strain on Portland's existing stormwater management and urban flooding systems (City of Portland, “Climate Change Preparation Strategy”, 2014). Winter floods also have far-reaching local effects on economic, social, and environmental systems. As such, disparities exist in Portland's BIPOC communities and low-income areas, which are exacerbated by the effects of climate change.

### **Cloudburst Strategies**

Portland's flood management strategies come from its 2014 Climate Change Preparation Strategy. Of the strategies, objective 6, focuses on increasing the resilience of the natural and built environment to intense rain events and associated flooding. (City of Portland, “Climate Change Preparation Strategy”, 2014). Additionally, Portland's Floodplain Resilience Plan Proposed Draft focuses on mitigating flood hazards. The Plan's three key focuses are to create a work plan, conduct public engagement, and achieve intergovernmental coordination. None of the documents specifically use the term "cloudburst".

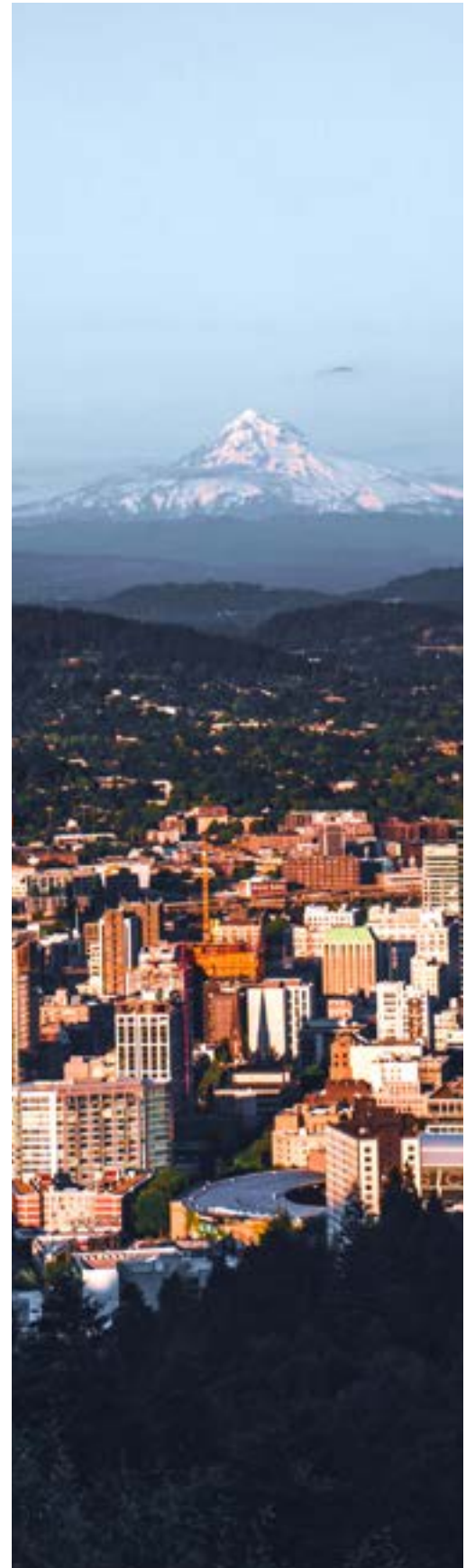


IMAGE: ANTHONY LONDER .

## Equity Initiatives

The Portland Plan is a clear strategy that prioritizes equity through the implementation of resilience efforts. The Portland Plan defines equity as “when everyone has access to the opportunities necessary to satisfy their essential needs, advance their well-being and achieve their full potential. Equity is both the means to healthy communities and an end that benefits us all,” (City of Portland, “Climate Change Preparation Strategy”, 2014).

Portland’s Climate Change Preparation Strategy aims to mitigate climate-related vulnerabilities for households and companies and respond to the consequences of disasters/events as they occur. The Strategy employs an adaptive management approach that stresses resilience across a variety of future scenarios and highlights the importance of monitoring and responding to changes locally (City of Portland, “Climate Change Preparation Strategy”, 2014). This strategy also provides multiple benefits to the community by meeting the needs of vulnerable populations, building the resilience of natural systems and infrastructure, and preparing for impacts on public health (City of Portland, “Climate Change Preparation Strategy”, 2014).

To develop the Strategy, Portland conducted a risk assessment and developed recommended actions to address major climate change vulnerabilities. Portland periodically monitors climate trends, forecasts, and impacts, assesses vulnerabilities and hazards, sets priorities, and finds ways to maximize co-benefits and equitability. This strategy further specifies 12 objectives for 2030 and identifies resilience-building initiatives (City of Portland, “Climate Change Preparation Strategy”, 2014).

### KEY TAKEAWAYS FROM PORTLAND

New York City can focus their adaptive strategy efforts by:

1. Drawing up specific objectives to improve cloudburst related climate resilience and the capacity of vulnerable communities;
2. Monitoring cloudburst and flood data with Social Vulnerability Index (SoVI) in maps to assess the risks of communities and improve the resilience infrastructure;
3. Developing a climate adaptation plan to prioritize investments in low-income neighborhoods and communities of color; and
4. Engaging with communities to comprehend, plan for, and respond to cloudburst impacts through providing public education, information, and other services.

## 2.2.6 Seattle

Known for its rainy weather, Seattle has a long history of heavy rainfall dating back to the early 1900s. One of the most notable heavy rainfall occurred in November 2006, when Seattle received a record-breaking amount of rainfall in a single day, causing widespread flooding and landslides (Yardley, 2006). The City of Seattle has made progress in enhancing city infrastructure and emergency response preparations in order to better deal with future cloudbursts.

### Cloudburst Strategies

While there is no mention of cloudbursts in the city's official documents or plans, Seattle's Stormwater Management Plan is a guiding document for the City's flood response in case of heavy rainfall. The Seattle Climate Action Plan directs the city to assess the effects of climate change on the drainage system and develop ways to enhance resilience. The Sustainability & Environment Agency has adopted a Green Stormwater Infrastructure (GSI) Policy and Implementation Plan selecting GSI as the preferred stormwater management method.

### Equity Initiatives

The Seattle Equity & Environment Initiative seeks to integrate environmental and social justice considerations into all city decision-making processes and to benefit communities of color and low-income communities, which were historically disproportionately affected by environmental hazards.



IMAGE: ANDREA LEOPARDI



To achieve equity, the initiative uses a data-driven approach to identify and address the root causes of disparities, including systemic racism and lack of access to resources and opportunities (City of Seattle, 2023). This involves a focus on equitable investments in communities, creating green jobs and businesses for underserved populations, and engaging communities in decision-making processes. The initiative also aims to ensure that policies and programs are designed with equity and justice in mind to ensure all residents have access to a healthy and sustainable environment (City of Seattle, 2023). The Community-Centric Approach is a critical component of the Seattle Equity & Environment Agenda. This approach prioritizes the engagement of communities and stakeholders in the development and implementation of policies and programs that address environmental and equity issues.

### KEY TAKEAWAYS FROM SEATTLE

New York City can enhance their planning for cloudburst management by:

1. Prioritizing investment in the planning and construction of green stormwater infrastructure;
2. Integrating environmental and social justice considerations into all city decision-making processes; and
3. Publishing flood precautions and instructions for residents as a part of awareness building.

IMAGE: KLIKK ON GETTY IMAGES





## 2.3 Expert Interviews

The team conducted primary research through 11 expert interviews in seven different cities already engaging in equity programming or are intending to engage very soon. The experts we interviewed represented various organizations including: the Diversity, Inclusion and Equity Community Advisory Council of Baltimore County, World Resources Institute India, Advanced Science Research Center CUNY, Duwamish River Community Coalition, Portland Water Bureau, RainReady CNT, Bayou Conservancy, and Love and Healing Work. Other interviewees have requested to remain anonymous.

To initiate the interview design process, the team first identified more than 50 experts in cloudburst or other natural disaster events, resilience, and equity by conducting Google searches, reading media and news articles, and following up with personal connections. These individuals were grouped into government agencies, environmental justice organizations, environmental organizations, community members, private companies and entities, schools, non-governmental organizations (NGOs), and an “others” group, for stakeholders that did not fall into any of the previously listed categories. A distinction was made between “environmental justice” and “environmental organizations” to identify groups that primarily focus on the fair treatment of all members of communities versus groups that prioritize protection of the natural environment. The team made sure to interview people from the case study cities, and interviewed experts from Baltimore, Mumbai, Austin, New York City, Seattle, Portland, ranging in public, private, non-profit, and advocacy.

A formal script was crafted and shared at the onset of an interview with interviewees. The script reiterated the project description, discussed the interview expectations and protocol, and included definitions of cloudbursts and cloudburst management. The interviewee was given the opportunity to ask questions and provide or revoke consent. The questions asked during interviews are included in *Table A*. The interviewees also provided their thoughts on changes that could increase equity in cloudburst resilience planning and community engagement, and, where relevant, offered information on how equity is operationalized (e.g., through budgets, strategic plans, staff, etc.) within their organization.

**TABLE A: INTERVIEW QUESTIONS**

|                                               |                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>General Questions for all Interviewees</b> | What is your professional relationship with climate change?                                                                                                                                                                                                                                               |
|                                               | Are you familiar with the terms “cloudbursts” and/or “cloudburst planning approaches”? If so, what do these terms mean to you?                                                                                                                                                                            |
|                                               | Have you had any personal experiences with cloudburst events? If so, how would you describe your experience?                                                                                                                                                                                              |
|                                               | What does equity mean to you/how does your organization define equity?                                                                                                                                                                                                                                    |
|                                               | What gaps, if any, exist in understandings about equity between environmental groups, government organizations, community members, or other relevant players in conversations on climate events like cloudbursts? Do you have any recommendations for making a cloudburst resiliency plan more equitable? |
| <b>Questions for Environmental Groups</b>     | What practices in your outreach and communication have you found to be particularly successful while engaging with at risk communities affected by cloudbursts or similar climate events?                                                                                                                 |
|                                               | What challenges have you encountered in communicating with at risk communities and how can they be minimized?                                                                                                                                                                                             |
| <b>Questions for Government Agencies</b>      | What current limitations exist in attaining equity in planning for cloudburst resilience or similar climate events?                                                                                                                                                                                       |
|                                               | What structural changes could or should take place to support the expansion of a more equitable cloudburst resiliency program?                                                                                                                                                                            |
| <b>Data Questions (for Organizations)</b>     | Does [organization name] measure or collect any information on equity? If so, how?<br>a. Does [organization name] gather and utilize census information? How?<br>b. Does [organization name] use any data sources or databases to analyze flooding events? Which ones?                                    |
|                                               | How does your program operationalize on equity?<br>a. Do you have a budget? Is there a staff person, stakeholder group, steering committee? Are there initiatives?<br>b. Is there a strategic plan? Can we see the strategic plan?                                                                        |

## KEY TAKEAWAYS FROM INTERVIEWS

1. **Managing disasters should be focused on a proactive approach, not a reactive one.** Resilience should be built to ensure communities can withstand incidences such as cloudbursts, rather than scrambling to provide aid after it happens.
2. **Cloudburst is a good term for policy, but not very relevant to communities,** only the impact of cloudbursts means something to them and is a useful point of engagement for at-risk communities.
3. **Trust and communication are key** in community engagement work and it is vital that community members feel comfortable with and trust that decision-makers have their best interests in mind. Better communication is needed between the government and communities because, presently, there is a mismatch of understanding between what hyperlocal communities prioritize and how the government approaches climate change in those communities.
4. **Better building techniques** will help prevent massive destruction to affordable housing and **allowing communities to choose where and how they will relocate** is necessary. These resilience efforts must be done in vulnerable communities, not just in areas with high economic value.
5. **Communities should be addressed as equals and experts** and should be listened to. People working with these communities should maintain humility and proactively listen and work with communities to get appropriate resources and capacity-build. As such, **solutions should be community-based and community-driven.**
6. The **issues that people face are intersectional.** Cloudbursts may be layered with other events (e.g., drought, heat, etc.).
7. **Resilience work is traumatizing,** so people need healing, trauma-informed care, and the acknowledgment that it is hard work.
8. **Students must be involved in the practice from the beginning,** throughout high school, and continuing into higher education. Theory without practice does not prepare them to do the work.
9. There is a white dominant culture taught by dominant systems that make it seem as though there is only one right way to manage disasters and equity. **Resilience work should insert different cultures and knowledge systems,** and make traditional ecological knowledge systems more visible.
10. For outreach, it is necessary **to go to community gathering spaces such as churches where people feel comfortable, ensure messaging is accessible** by translating it into various languages, and compensate people wherever possible when they volunteer insight or time.

## 3. PROJECT DESIGN RECOMMENDATIONS

Reflecting on the research findings from the team's literature review and expert interviews, the next section describes our recommendations to DEP for an equity definition, integrated equity strategy, stakeholder engagement, and additional indicators to refine DEP's future neighborhood selection.

### 3.1 Redefining Equity

As previously highlighted, current definitions of equity used by the NYC DEP and other New York City agencies are aspirational but not operational. While these definitions are beneficial to have, they do not provide a concise direction of action that DEP can reference to guide their cloudburst programs and initiatives. Two cities from our research that provide useful equity definitions for DEP to consider are Mumbai and Baltimore.

- **Mumbai:** "Improved health and equitable distribution of benefits to address the needs of vulnerable communities and other impacted groups" (MCAP, 2022, p. 23).
- **Baltimore:** "Providing different levels of support and assistance, depending on specific needs, abilities, or circumstances" (Baltimore City Department of Public Works n.d.)

Both cities place an emphasis on differentiated levels of support for at-risk communities to ensure equal access to critical resources, and to achieve an equal level of benefits. At the same time, our expert interviews emphasized the importance of including communities in decision making and highlighted the need for government institutions to share power with the people they seek to serve. With this in mind the team recommends the following re-definition of equity to the NYC DEP:

**Equity ensures fair and equal access to resources and opportunities and inclusivity in planning and engagement, with the goal of improving outcomes and achieving the full potential for all people.**



This recommended definition is a starting point, and the team believes that the most accurate definition for the DEP should be created through extensive consultation with at-risk communities. Therefore, the team strongly recommends that DEP use this definition as a foundation that will be refined through conversations with community leaders to find the most effective ways to identify and articulate equity in a New York City context.

## 3.2 Integrated Equity Strategy

The team recommends that DEP engage with local communities on a frequent basis, and also provide resources to build their capacity to respond to future cloudburst events. At the core of this strategy are two important principles: community-centric programming and trauma-informed care.

**Community-centric programming:** As noted previously, to achieve equity it is critical to prioritize the needs and preferences of at-risk communities. This means involving community members and leaders in decision-making wherever possible, actively listening and responding to their feedback, and being open when adapting strategies and changing approaches. This will allow DEP to create tailored solutions to each community and overcome any existing mistrust.

**Trauma-informed care:** Trauma does not look the same for everyone and it can come from multiple sources, whether it is generational trauma from a community's historical experiences, or from recent events, such as Hurricane Ida, which put many communities in literal life-or-death situations. These memories can create immense stress which might trigger "avoidance behaviors", whereby individuals "avoid reminders of the events or triggers", such as community meetings. It can also fuel "anger and frustration with authority [figures]" (Rosenberg et al., 2022). Therefore, it is important to recognize that individuals and communities may have experienced trauma due to cloudbursts.

Currently, there is no official guideline on integrating trauma-informed care into disaster recovery and/or planning, much less for cloudbursts. DEP can work with federal agencies, such as the Substance Abuse Mental Health Services Administration's Disaster Technical Assistance Center to develop a mental health response to cloudbursts (Substance Abuse Mental Health Services Administration, 2023). Additionally, DEP can also work with the New York City Department of Health and

Mental Hygiene and NYC Well, which is a virtual mental health and substance use service provided by the City, to integrate mental health considerations into all aspects of community engagement.

In 2022, a group of experts from Seattle and Los Angeles proposed a “Trauma-informed recovery planning approach to disasters” (Rosenberg et al., 2022, p. 4) which can serve as a useful starting point for DEP to formulate their own approach to trauma-informed care (*Table B*).

**TABLE B: TRAUMA-INFORMED RECOVERY PLANNING APPROACH TO DISASTERS**

| PRINCIPLE                               | Operationalizing in the context of trauma-informed care in disaster recovery and planning                                                                                                                                  |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cultural, Historical, and Gender Issues | <ul style="list-style-type: none"> <li>• Work with local partners to understand community culture, sources of local pride, and history of trauma</li> <li>• Ensure equitable access of resources for all groups</li> </ul> |
| Safety                                  | <ul style="list-style-type: none"> <li>• Support physical and psychological safety at all times</li> </ul>                                                                                                                 |
| Transparency and Trustworthiness        | <ul style="list-style-type: none"> <li>• Build trust with the community through open, transparent communication, and be reliable and accountable for actions</li> </ul>                                                    |
| Peer Support                            | <ul style="list-style-type: none"> <li>• Provide space for peer-to-peer collaboration</li> <li>• Promote local resources</li> <li>• Leverage existing support systems in a community</li> </ul>                            |
| Empowerment and Choice                  | <ul style="list-style-type: none"> <li>• Recognize and empower community as decision-makers</li> <li>• Value community experience</li> <li>• Give back to and compensate the community wherever possible</li> </ul>        |
| Collaboration and Mutuality             | <ul style="list-style-type: none"> <li>• Promote community voices and initiatives</li> <li>• Provide options for participation and decision-making</li> </ul>                                                              |

*Trauma-informed recovery planning approaches adapted from Rosenberg, Errett, and Eisenmann (2022, 4)*

### 3.2.1 Working with Community Leaders

Community leaders can bridge the gap between at-risk communities and the DEP. Collaborative relationships can serve a multitude of purposes, such as, but not limited to, building trust, engaging in effective decision making, and improving communication and outreach.

In any community, there are certain individuals who emerge as thought leaders and influential figures. These individuals are often religious leaders, local business owners, or nonprofit leaders who work in the area. Inherently embedded in the community, leaders enjoy widespread trust and legitimacy, which is helpful for DEP to collect feedback, understand concerns on the ground, and communicate new information. Members of the community likely feel more comfortable talking to a leader they know well rather than a stranger from the government. Community leaders are especially important conduits for new immigrants, refugees, and undocumented individuals who might be hesitant to interact with government officials.

#### **Borough-Specific Equity Advisory Committees**

The DEP can involve community leaders in decision making and leverage their awareness of unique issues on the ground through equity advisory committees. The equity advisory committee is a gathering of leaders from government entities and community groups. It serves as a direct platform for community leaders to provide feedback on government programs and highlight equity concerns. This allows leaders to directly influence policies and programs. For government officials, the advisory committee is a mechanism to collect valuable feedback and be more attuned to equity issues in their work. These committees usually renew their membership every one to two years to bring in a diverse set of perspectives.

For the equity advisory committees to be effective in New York City, the team recommends that a separate committee be established for each of the five boroughs. By doing so, the committees have an increased capacity to address the unique equity and cloudbursts challenges facing their communities. Moreover, advisory committees that operate on a smaller scale at the borough level are much better situated to truly understand how new policies and programming impact specific neighborhoods and the people within them. These committees, however, should remain in conversation with one another to help the DEP build city-wide initiatives and strategies.

### **Ambassador Program**

Another way which the DEP can work closely with community leaders is through an ambassador program. This initiative would involve the DEP recruiting a network of ambassadors to conduct community outreach and engagement. Stipends should be provided to compensate for the work being done for the DEP and to motivate ambassadors to stay committed to the program. The DEP would work with ambassadors to create a unique engagement strategy tailored to each community's needs and preferences. This strategy would also encompass a reporting mechanism where the ambassadors would provide regular updates on concerns they have heard from other community members. Additionally, the DEP should consider organizing an annual workshop to bring together all ambassadors in the program to share best practices for community outreach, emergency response, and planning in the event of cloudbursts. These workshops would be a great learning opportunity for both the ambassadors and DEP to understand what are the most effective strategies to connect with at-risk communities.

## **3.2.2 Gathering Feedback and Data from the Community**

Communicating directly with communities is a way to understand the most prominent concerns regarding cloudbursts, and collect valuable data to enhance DEP's understanding of specific neighborhoods. The information can help DEP prioritize the needs of a community and create more targeted and relevant programs and initiatives to build up cloudburst resilience across the City. Data and feedback can be gathered through surveys, town halls, and focus groups.

### **Surveys**

Community surveys are a powerful tool for data collection on a variety of metrics and indicators. The key to an effective survey is that the information gathered should be novel and supplement surveys already being conducted, such as census surveys. Examples of information that surveys can use to uncover are knowledge of cloudbursts, awareness of evacuation plans, access to emergency alert systems, etc. This information will help DEP better understand the unique vulnerabilities in each community.



To maximize response rates these surveys should be conducted using a variety of ways, such as online, by mail, and in-person, with language translations and disability accommodations made available to maximize accessibility. Additionally, to understand how cloudburst vulnerability and resilience change in a community over time, these surveys should be conducted on a regular basis, such as once every five years.

### **Town Halls**

Town halls are another common method of community engagement that provide an opportunity for the wider community to come together and discuss cloudbursts issues with city officials, and for residents to highlight environmental justice and equity concerns to the DEP and/or relevant authorities.

A successful town hall is dependent on the level of attendance and quality of the feedback gathered, which in turn is contingent upon the degree and level of access to events. Organizing town halls in central locations in the neighborhood where people feel the most comfortable, such as a community center or school, will help put residents at ease and encourage them to speak more openly about their concerns. At the same time, providing an incentive such as food or a monetary stipend would mitigate the costs incurred by community members when attending these meetings and encourage higher attendance. Notification of the meetings should also be done in multiple languages and other accommodations should be made during the meeting to ensure everyone understands the issues discussed. Finally, these meetings ought to be scheduled on days and at times that are most convenient for the community members, such as on non-work days and after-hours. Town halls should occur on an annual basis to consistently gather feedback.



### **Focus Groups**

Focus groups are similar to town halls but are smaller and target specific demographics. This is an effective method of honing in on certain subgroups that are more vulnerable in a community such as the elderly, people with disabilities, and non-English speakers. Focus groups allow DEP to gauge a community's understanding of cloudbursts and gather important feedback regarding ways to achieve equity through cloudburst resilience programming. Through these sessions, DEP can become more informed on gaps that need to be addressed, as well as the existing community resources to support.

Similar to town halls, these focus groups should be held in accessible locations with relevant accommodations. Community leaders can be especially helpful here to facilitate discussions and ensure all participants feel comfortable voicing their specific opinions and concerns. Seeing as focus groups are more resource intensive than town halls, our team recommends DEP conducts these focus groups once every three to four years to understand how challenges are evolving and stay up to date on what needs were addressed.

### **3.2.3 Education and Empowerment**

Another important step to achieving equity is raising awareness and knowledge of cloudbursts and empowering community members with the tools to respond. At the same time, internal diversity within the DEP is a powerful way to enhance awareness of equity within the Department, which can lead to better cloudburst programming overall. Where hiring is not possible, internships and fellowships are a way of bringing in more diverse perspectives into the DEP workforce.

### **School Programs**

Schools are essential partners in enhancing environmental literacy and awareness of cloudbursts, specifically for youth. To do this, DEP can develop a cloudburst and environmental curriculum in collaboration with schools in at-risk communities and the NYC Department of Education. The curriculum should be focused on a few key themes such as the science behind extreme weather phenomena like cloudbursts, the appropriate emergency response, ways to build community resilience, and environmental justice. The purpose of such a curriculum is to equip young people with the knowledge and skills to build awareness and resilience for themselves, their families and the broader community. School programs and cloudburst curriculum can

cultivate future community advocates, who will be more well-versed in cloudbursts and able to identify gaps in DEP's approach in future surveys, town halls, and focus groups.

In the event of a cloudburst, schools must also be prepared to evacuate students. Therefore, it is essential that all schools in neighborhoods at elevated risks of cloudbursts have an emergency response plan. In cases where such a plan is not in place, DEP should work closely with school staff such as custodians, who have an intimate understanding of the school layout and infrastructure, to plan escape routes and mitigation strategies. Through emergency response drills, these schools, their staff, and students can be more prepared for cloudbursts both in school and at home.

### **Internships and Fellowships**

As noted previously, a means of achieving equity is diversity, and it is important for DEP to have perspectives from people with lived experiences to enhance their cloudburst programming from the planning stage. Community engagement is a way of bringing in that perspective, but internal diversity will also be effective. DEP's internal diversity empowers members of these communities to have a hand in the decision-making process at DEP and impact their neighborhoods.

The team recognizes that hiring is a complex process that might not be immediately feasible. Therefore, a more practical and accessible option that would allow the DEP to diversify their staffing is through internships and fellowships. DEP can consider working with local schools, colleges, and community colleges to target students ranging from high school juniors to college students who come from at-risk communities and recruit them into internships and fellowships. These students gain from the practical work experience provided through the internship and/or fellowship and can provide insight from their lived experiences of cloudbursts, thereby shaping programs from within DEP. The intention behind this is to prioritize equity from the beginning of any cloudburst program rather than as an afterthought.

DEP can leverage existing internship and fellowship programs such as the Urban Fellows Program and Civil Service Pathways Fellowship to recruit their interns and fellows, or use these existing programs as models to design a unique DEP program. Another useful model is the Presidential Management Fellowship (PMF), which is targeted at advanced degree holders to cultivate the next generation of government leaders (US Office of Personnel Management, n.d.). Recognizing that obtaining an

advanced degree is not the most accessible, especially for those from a low-income background, the DEP can instead work with local colleges to target graduating seniors with a potential pathway to full time employment after the Fellowship.

### **Cloudburst Roadshow and Workshops**

Beyond schools, community education is equally as important and this can be done through events such as roadshows and workshops. A cloudburst roadshow is a mobile exhibition (*Figure 1*) that would be set up to display critical information about cloudbursts, response and preparedness strategies, and extraordinary stories from different New Yorkers. These extraordinary stories refer to incidents when residents survived cloudbursts or flooding within their homes. The purpose of highlighting these stories is to inspire the viewer as well as to center the lives and lived experiences of community members which conveys the explicit intention of the DEP to center communities in their cloudburst resilience approaches. Overall, the roadshow would educate community members on cloudbursts and strategies to prepare and respond to them in the future. The exhibition should be located in well-frequented community locations such as community centers, bus stops, religious institutions etc. DEP could also work with the New York Public Library, Brooklyn Public Library, and Queens Public Library to house the exhibition in libraries across the City.



*Figure 1: Example of a cloudburst roadshow at a library*



A more hands-on way to educate the public is through community workshops where trainers from DEP and community leaders engage in more in-depth discussions about cloudbursts and relevant mitigation and response strategies. This strategy is more resource-intensive than a roadshow but is more proactive and will increase the chances of community participants retaining this critical knowledge into the future.

### 3.2.4 Providing Institutional Support

Communities that are more vulnerable to cloudbursts often have limited access to critical resources that help build resilience and effectively respond. As such, providing additional institutional support through financing and emergency supplies is a practical way for DEP to be more equitable.

#### **Resilience Hubs**

Resilience hubs are found in various cities and highlighted by experts as a solution to plan for and respond to natural disasters. The hubs provide emergency resources and shelter in the event of disasters such as flooding. Moreover, they are also avenues through which DEP can provide direct support to at-risk communities while strengthening local resilience to cloudbursts. Bringing resources closer and making them more readily accessible reduces the time needed to distribute life-saving necessities and tools, and allows communities to mitigate damage from cloudbursts more effectively. Hubs are also useful focal points for communication during the event of a cloudburst and enable vital information to be conveyed more efficiently. Before a cloudburst even happens, hubs can also serve as educational facilities to share best practices for cloudburst resilience and response with community members.

Involving the community to establish these resilience hubs is essential. Hubs should be located at existing and recognizable neighborhood gathering locations such as religious institutions or community centers to ensure it meets the specific needs of the community. (Grunwald et al., 2022).

Currently, the New York City Housing Authority (NYCHA) is planning to retrofit community spaces on its properties to serve as resilience hubs for climate events (Watson et al., 2021). DEP can consider working with NYCHA to include resources for cloudbursts in these resilience hubs and support the formation of future hubs.

### Cloudburst Insurance

Property damage occurs during cloudbursts due to the volume of rainfall that occurs in a short period of time. Despite this, because of the novel nature of cloudbursts, they are currently not covered in most insurance schemes. For example, through the National Flood Insurance Reform Act the Federal Emergency Management Agency (FEMA) requires and provides flood insurance to those living in Special Flood Hazard Areas (Sweeney et al., 2022). Typical flood insurance, therefore, is distributed based on a property's location in the floodplain and does not consider inland flooding. As a result, communities outside the floodplain that might be at risk of cloudbursts are left uninsured and without protection when cloudburst flooding occurs.

To address this insurance gap, DEP should consider establishing a low-cost insurance scheme targeted at communities that are most at risk of cloudbursts. The scheme should be designed with efficiency in mind to ensure that communities are able to access their claims as quickly as possible after a cloudburst event. This insurance scheme should be a parametric insurance, which refers to “a type of insurance contract that insures a policyholder against the occurrence of a specific event by paying a set amount based on the magnitude of the event, as opposed to the magnitude of the losses” (National Association of Insurance Commissioners, 2023). The magnitude of the event can refer to the inches of rain that falls during a cloudburst event or the level of flooding which can be easily detected through flood monitors.

IMAGE: NATHALIA SEGATO



In March 2023, the Environmental Defense Fund (EDF) launched a pilot insurance project which provides fast post-disaster financial assistance after floods, including those caused by rainfall in New York City (*Box 1*). DEP should consider using this project as a model for its own cloudburst insurance, or seek to join the coalition of EDF and its partners to include floods as a result of cloudbursts into events covered by this innovative insurance scheme.

#### **TEXT BOX 1: PARAMETRIC INSURANCE PILOT PROJECT BY EDF IN NEW YORK CITY**

The project is supported by a National Science Foundation Civic Innovation Challenge award and is focused on providing financial assistance to low- and moderate- income households after flooding events. These communities are specifically targeted because they are more vulnerable to floods, often cannot afford necessary repairs, and lack the capacity to access post-disaster relief provided by the federal government due to complex and cumbersome processes (Sweeney et al., 2023). Federal disaster assistance also often takes a long time to process and be distributed, which does not address the immediate financial needs of communities after a flood (Kousky, 2023).

Currently the program provides insurance payouts through emergency cash grants which are available through an assistance program following a major flood. The funds for this program come from a reinsurance company that dispenses the funds to a trusted nonprofit organization which then handles the distribution to insurance claimants. These cash grants are not meant to cover the full extent of the damage but rather provide immediate support while communities wait for other forms of assistance (Kousky, 2023).

This pilot project is a result of a multisectoral partnership between government, nonprofits, and insurance companies. These organizations are the New York City Mayor's Office of Climate and Environmental Justice, Environmental Defense Fund, Center for NYC Neighborhoods, SBP, Global Parametrics, and insurance firms GuyCarpenter and SwissRe Corporate Solutions (Environmental Defense Fund, n.d.).

### Cloudburst Recovery Fund

To supplement the financial support provided through the above-mentioned insurance program, DEP should also consider setting up a cloudburst recovery fund. This fund will provide higher levels of financial support for bigger recovery projects for households and businesses.

New York City adopted a similar program in the past in the form of the Build it Back program, launched by the Mayor's Office of Housing Recovery Operations to provide assistance to households impacted by Hurricane Sandy (NYC Recovery, n.d.) However, this program was mired with controversy and inefficiencies due to complications on the City level and the general slow-moving nature of federal natural disaster aid (Buettner et al., 2014). As such, while Hurricane Sandy hit over ten years ago, projects for the program are still ongoing (NYC Recovery, n.d.).

Learning from the mistakes of the Build it Back program, DEP can consider setting aside existing capital to create a rainy-day fund that communities can tap into after cloudburst events. This will allow the funds to be immediately available from the DEP rather than waiting months for federal funding. This will potentially enable faster and more efficient distribution of critical monetary support to communities. To set up this fund, DEP can consider working with the New York City Emergency Management, which currently has a grant program for community emergency preparedness initiatives (NYC Emergency Management, n.d.)

A final consideration for the cloudburst recovery fund is that it should not discriminate on the basis of citizenship status. Undocumented immigrants tend to be uninsured and are not able to access typical federal assistance programs; unfortunately, they are also among the communities most vulnerable to the impacts of cloudbursts. Thus, having a recovery fund available to them can have a profound impact. Given that undocumented immigrants might feel hesitant towards government aid, to bridge that gap, DEP can provide these funds through nonprofits the community trusts.





### 3.3 Stakeholder Engagement List

As noted before, community groups and leaders as essential partners for DEP to build cloudburst resilience. As such, the team has curated a list of stakeholders for each of the neighborhoods currently selected for cloudburst infrastructure improvements (Kissena Park/Flushing, East Harlem, East New York, Corona, South Jamaica, Parkchester, and St. Albans). While some of the stakeholders identified have had key roles in supporting their communities impacted by climate-related events, others work closely with, or are members of, at-risk communities. Stakeholders have trusting relationships with their communities, and are knowledgeable about its cultures, values, and languages. Thus, these partnerships will allow DEP to increase equity in cloudburst resilience planning by leveraging existing support systems and recognizing communities as self-determining decision makers.

The team first created a general list of stakeholders including **schools and colleges, businesses and associations, organizations, and individuals**, as examples, which the DEP can reference for future project neighborhoods. Many schools in NYC closed after Hurricane Sandy and were unable to reopen due to flood damage (Fanelli, 2012). At the same time, multiple colleges and universities around the City have scholarships and funds that are available to students and faculty for aid after storms and other weather-related events. For example, through the Hurricane Sandy Scholarship and an employee loan program, Touro University distributed over \$70,000 to students and employees after the hurricane (Touro University, 2013). Hence, schools not only provide climate education, but can serve to provide resources in the face of cloudburst events as well as to provide resilience strategies based on past experiences.

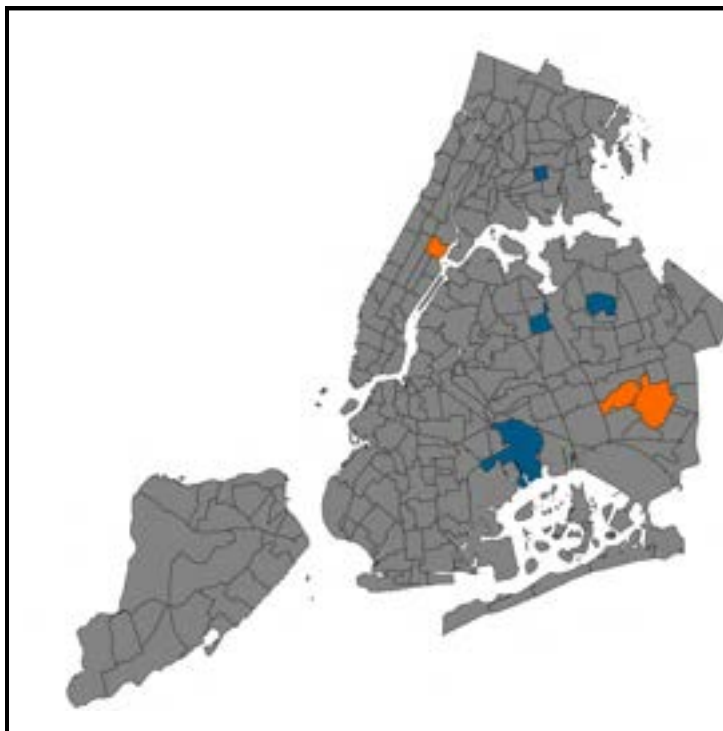
Like schools, hospitals were also closed down due to hurricanes and large rain events, and others were inundated with patients. As such, the damage faced and the number of patients during such periods makes hospitals a pertinent group of stakeholders. Small businesses are also likely to have a difficult time recovering from cloudburst events. For this reason, our team also examined stakeholders and business organizations that helped small businesses recover from Hurricane Ida. These organizations currently provide support after flooding, or the team believes they would be useful in assisting in education, outreach, or aid to individuals, specific communities, and businesses. Many of the listed stakeholders in *Table C* were interviewed by the media after flooding and cloudburst events, are prominent in their communities, and were identified through published news articles.

**TABLE C: STAKEHOLDER LIST**

|                                      |                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Kissena Park/Flushing, Queens</b> | <ul style="list-style-type: none"> <li>• Queens College</li> <li>• Queensborough Community College</li> <li>• New York Presbyterian Queens Hospital</li> <li>• Flushing Hospital Medical Center</li> <li>• Latimer Gardens</li> <li>• Queens MuseumChristie and Co.</li> </ul>                                              |
| <b>East Harlem, Manhattan</b>        | <ul style="list-style-type: none"> <li>• High School for Climate Justice</li> <li>• Mount Sinai Hospital</li> <li>• NYC Health and Hospitals Metropolitan</li> <li>• Washington Housing</li> <li>• Wagner Houses</li> <li>• Tafadar Sourov</li> <li>• Gale Brewer</li> <li>• Islamic Cultural Center of New York</li> </ul> |
| <b>East New York, Brooklyn</b>       | <ul style="list-style-type: none"> <li>• Touro College</li> <li>• Spring Creek Rehabilitation and Nursing Care Center</li> <li>• Breukelen Houses</li> <li>• Linden Houses</li> <li>• Spring Creek Towers</li> <li>• Gateway Center Shopping Mall</li> </ul>                                                                |
| <b>Corona, Queens</b>                | <ul style="list-style-type: none"> <li>• Elmcort</li> <li>• Yoselin Genao-Estrella</li> <li>• Urban Health Plan Plaza Del Sol Family Health Center</li> <li>• Queens Community House</li> </ul>                                                                                                                             |
| <b>South Jamaica, Queens</b>         | <ul style="list-style-type: none"> <li>• Stormwater Infrastructure Matters (SWIM)</li> <li>• Science and Resilience Institute at Jamaica Bay</li> </ul>                                                                                                                                                                     |

*(Continued on next page)*

|                           |                                                                                                                                                                                                                                                                                                                     |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Parkchester, Bronx</b> | <ul style="list-style-type: none"> <li>• Parkchester Community Center</li> <li>• Voices Unbroken</li> <li>• NAACP Parkchester Branch</li> <li>• Bronx Community Board 9</li> </ul>                                                                                                                                  |
| <b>St. Albans, Queens</b> | <ul style="list-style-type: none"> <li>• St. Albans Community Living Center</li> <li>• NYC Health and Hospitals/Gotham Health, Springfield</li> <li>• Addisleigh Park Civic Organization</li> <li>• St. Albans Pumping Station</li> </ul>                                                                           |
| <b>General</b>            | <ul style="list-style-type: none"> <li>• NYC Housing Authority</li> <li>• NYC Hurricane Service Center</li> <li>• Regional Plan AssociationBrooklyn Chamber of Commerce</li> <li>• Queens Chamber of Commerce</li> <li>• NYC Small Business Services</li> <li>• CitizensNYC</li> <li>• Make the Road NYC</li> </ul> |



## LEGEND

- Pilot Projects
- New Investments

*Figure 2: Map of neighborhoods currently selected for cloudburst infrastructure improvements (Kissena Park/Flushing, East Harlem, East New York, Corona, South Jamaica, Parkchester, and St. Albans)*

### 3.4 Refining Neighborhood Selection Criteria

Due to the unexpected and sudden nature of cloudbursts, both physical infrastructure and social indicators should be considered when determining vulnerability for future project neighborhood selection. The team has identified the following additional social and physical indicators for DEP to consider when prioritizing neighborhoods for cloudburst investment.

#### Physical Vulnerability Metrics

Physical elements and factors involving infrastructure will determine the risk of an area to cloudbursts. Specifically,

- **Housing stock** - number of basement units:
  - During Hurricane Ida, the majority of New Yorkers killed were in basement apartments. A citywide inventory of basement apartments would go a long way in determining neighborhood risk; however, our team recognizes the complexity of this task due to many units being illegal.
- **Age of infrastructure:**
  - The date of recent sewer and drainage updates will determine the capacity and age of critical stormwater infrastructure. Newer infrastructure presumably should be better equipped to handle a cloudburst event.
- **Proximity to green infrastructure:**
  - Green infrastructure investments within a quarter of a mile of an individual home or corner provide protection by absorbing additional rainfall that would otherwise overwhelm the drainage system.





### Social Vulnerability Indicators

Social elements and factors are likely to determine the risk of an individual and community to cloudbursts. Specifically,

- **Environmental justice areas:**

- In NYC, environmental justice areas are based on the percent of the population identified as a minority (51.5%) and/or below poverty (23.59%).

- **Immigrant populations:**

- Immigrant communities account for the portion of the population that is non-English speaking, documented, and/or undocumented. These demographic characteristics impact their ability to receive timely emergency alerts, as well as access to funding post-disaster.

- **Access to emergency alerts:**

- Households with internet access, cell phone owners, and the number of individuals signed up with NotifyNYC are indicative of access to emergency communication and services. These impact the ability of a person to be aware of a cloudburst event and the immediate danger.

- **Other vulnerable populations:**

- Other demographics considered can include the percent of the population that is elderly, disabled, or renters. These impact the ability of a person to evacuate after receiving a cloudburst alert.

The team recommends focusing on the number of basement apartments and immigrant populations as critical indicators to be determined in the immediate term. This is because 4,000 single-family homes across the City were damaged during Ida. Much of this damage was concentrated in the basements of apartments, which overwhelmingly tend to be occupied by lower-income families, many of whom are immigrants of varying citizenship status. At the same time, an estimated 51,000 undocumented immigrants were affected by Ida, yet they are ineligible for FEMA's Individual Assistance funding, making it harder for them to recover from property damage or loss (NYC Deputy Mayor for Administration, n.d).

These indicators are a first step towards defining the metrics, which are covered in the next chapter of the report.

### 3.5 Timeline

Taking all these recommendations into consideration, the following is an overview of the potential roll out of different programs arranged from phases one to three (Table D). The ranking is based on what can feasibly be implemented by DEP in the short, medium, and long term.

**TABLE D: TIMELINE OF PROGRAM ROLLOUT**

|                                        | Phase 1: Short Term                                                                                                                                                                                                                                                                                                                | Phase 2: Medium Term                                                                                                                                                                                                | Phase 3: Long Term                                                                                                                                                               |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Overall Engagement Strategy</b>     | <ul style="list-style-type: none"> <li>• Borough specific advisory committees</li> <li>• Town Halls</li> <li>• Focus Groups</li> <li>• Establish cloudburst evacuation plans in schools</li> <li>• Leverage existing internships and fellowships</li> <li>• Resiliency Hubs</li> <li>• Join EDF insurance pilot project</li> </ul> | <ul style="list-style-type: none"> <li>• Community Surveys</li> <li>• Design and implement cloudburst school curriculum</li> <li>• Create new internships and fellowships</li> <li>• Cloudburst roadshow</li> </ul> | <ul style="list-style-type: none"> <li>• Ambassador Program</li> <li>• Cloudburst workshops</li> <li>• Cloudburst Insurance</li> <li>• Cloudburst Recovery Fund</li> </ul>       |
| <b>Stakeholder Engagement</b>          | <ul style="list-style-type: none"> <li>• Outreach to community stakeholders in pilot project neighborhoods</li> </ul>                                                                                                                                                                                                              | <ul style="list-style-type: none"> <li>• Outreach to community stakeholders in future project neighborhoods</li> </ul>                                                                                              | <ul style="list-style-type: none"> <li>• Outreach to community stakeholders in neighborhoods not yet selected for cloudburst projects or newly selected neighborhoods</li> </ul> |
| <b>Refining Neighborhood Selection</b> | <ul style="list-style-type: none"> <li>• Decide on additional criteria for neighborhood selection</li> </ul>                                                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>• Collect data on additional criteria for neighborhood selection</li> </ul>                                                                                                  | <ul style="list-style-type: none"> <li>• Select new neighborhoods based on more robust criteria</li> </ul>                                                                       |

## 4. ASSESSMENT CRITERIA AND TOOL

The development of assessment criteria is an essential part of the process to achieve equity in cloudburst resilience. It is also an important step in the identification of vulnerable communities and populations most at risk, specifically in the event of cloudbursts. Thus, the assessment criteria work in tandem with the neighborhood selection criteria developed as part of the project design.

The team's goal when developing the assessment criteria is to create a user-friendly tool for the DEP to use in identifying communities vulnerable to cloudbursts as well as to track the impacts of resiliency initiatives. The tool is highly adaptable and can be modified according to a community's characteristics and needs.

With those goals in mind, the team followed three steps in the development of the tool:

1. Identified specific criteria that put communities at risk in the event of cloudbursts - environmental, physical infrastructure, social and economic.
2. Listed indicators under the aforementioned groups
3. Ranked the criteria within selected communities and made them part of the decision making process.

### 4.1 Preparing the Framework

In order to determine which indicators should be included in the tool, the team reviewed the city case studies and their equity or vulnerability assessment methodologies.

The indicators used in Austin are listed in the Climate Equity Plan of 2021 (City of Austin, 2021). Within the plan, while race is the defining indicator, it also recognizes other "marginalized groups" such as: low-income communities; youth; LGBTQIA+ communities; immigrant, migrant, and/or refugee communities; people with special needs; people experiencing homelessness; people with criminal records; seniors, and women (City of Austin, 2021).

In the Baltimore City Code, equity is defined as "closing the gap in policy, practice, and allocation of City resources so that race, gender, religion, sexual orientations, and income do not predict one's success, while also improving outcomes for all" (Baltimore

City Department of Legislative Reference, 2022). These indicators were considered in the development of the tool.

The vulnerability indicators from the Mumbai Climate Action Plan (BMC, 2022) are based on various socio-economic and demographic indicators. To conduct this assessment, Mumbai used the World Resources Institute's (WRI) spatial vulnerability assessment framework. The framework identifies vulnerability by analyzing climate risk, socio-economic conditions, and accessibility of infrastructure and essential services, considering demographic as well as geographic differences.

For Portland, the indicators originate from a map created by the city of Portland, the Oregon Bureau of Planning and Sustainability for the Climate Change Preparation Strategy Risk, and the Vulnerabilities Assessment made by the City of Portland and Multnomah County. In this document, at-risk communities are identified by meeting at least three of the following criteria: renters, lower educational attainment, reduced household income, and people of color. If three of these indicators are met, then a community is determined to be medium-high at risk, and if all 4 indicators are met, then a community is determined to be high-risk (City of Portland, 2014).

For Seattle, the indicators are adapted from the Seattle Climate Action Plan, created by the Seattle Office of Sustainability and Environment and GGLO. The report discusses enhancing equity in climate actions by meeting the needs of lower income, disabled, recent immigrants, and older citizens (City of Seattle, 2013).

The team compiled 44 relevant indicators from the case studies and equity screening tools currently used by government agencies to prepare a comprehensive list. Once all the relevant indicators were compiled, the team categorized the vulnerability indicators into four sections/categories, listed below. A full list of the indicators and a simplified version of the tool can be found in *Appendix C*.

- Climate change (specific risk to cloudbursts)
- Physical vulnerability
- Social vulnerability
- Economic vulnerability





There are two types of indicators: direct and proxy. Some indicators are directly related to the risks posed by cloudbursts on communities and hence are used as direct indicators. Others are not directly related to risks associated with cloudbursts but are effective proxies to determine risk – these are proxy indicators.

In the tool, each indicator is accompanied by its description, data sources, and means for collecting data in the future. Based on the data collected, the indicators can be ranked into low, medium and high risks. All the indicators have their own impact levels defined based on the descriptions and are weighted normally.

## 4.2 Methodology of the Assessment Tool

In order to assess the risk level of each indicator two factors are considered: impact and likelihood. Each factor has three grades: for impact, low (1), medium (2), and high (3), and, for likelihood, unlikely (1), likely (2), and certain (3). The grades for likelihood of occurrence are divided in three probability ranges. This is based on the standard probability definition of the United Nations Intergovernmental Panel on Climate Change (IPCC), but the assessment tool uses different category names (Kause et al., 2022). As seen in the risk matrix below (*Figure 3*), the final risk level of each indicator is calculated by multiplying the score for impact with the score for likelihood.

|             |        | LIKELIHOOD                         |                                   |                                         |
|-------------|--------|------------------------------------|-----------------------------------|-----------------------------------------|
|             |        | →                                  |                                   |                                         |
| IMPACT<br>↓ |        | Unlikely<br>0 - 33%<br>Probability | Likely<br>33 - 66%<br>Probability | Certain<br>More than 66%<br>probability |
|             | Low    | 1                                  | 2                                 | 3                                       |
|             | Medium | 2                                  | 4                                 | 6                                       |
|             | High   | 3                                  | 6                                 | 9                                       |

*Figure 3: 3x3 Risk Matrix for each indicator. The risk score per indicator equals its impact score times its likelihood score. Red indicates high risk level, Yellow indicates medium risk level, and Green indicates low risk level.*

Figure 4 illustrates a section of the tool: the climate change factor which is the general category tied to more specific indicators listed. Indicators listed in bold are the direct indicators and the others are proxy indicators. The original source of the indicator is listed for the DEP's reference, along with a detailed indicator description to provide relevant context of the indicator. The mechanism of future data collection is also noted for the DEP's reference. In the rightmost columns, the risk score and level is noted for each indicator which is a result of the process described above where the impact score is multiplied with the likelihood score. Over time, the risk score and level for some of the indicators should change depending on the evolving characteristics of different neighborhoods and the progress of cloudburst resilience efforts.

| Vulnerability Factors                          | SI no. | Indicators                        | Indicator source | Indicator description                                                                                                                                                                                                                                                                                                                               | Mechanism for data collection | Impact                                             | Likelihood                         | Risk   |
|------------------------------------------------|--------|-----------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------------------------------------------------|------------------------------------|--------|
| Climate change (Specific to Cloudburst Events) | 1      | <b>Cloudburst events per year</b> | NYC              | Number of cloudburst events recorded in the neighborhood per year                                                                                                                                                                                                                                                                                   | NYC DEP                       | High - More than 95% of the population is affected | Certain- More than 66% probability | High   |
|                                                | 2      | Coastal flood hazard              | EPA EJ Screen    | National level data depicting areas in coastal counties in the United States along the Atlantic Ocean that are most prone to coastal flood hazards.                                                                                                                                                                                                 | EJ Screen tool                | Medium - 50 -95% of the population is affected     | Certain- More than 66% probability | High   |
|                                                | 3      | Estimated 100-year floodplains    | EPA EJ Screen    | National level data depicting the estimated 100-year floodplains for the US- 2016                                                                                                                                                                                                                                                                   | EJ Screen tool                | Medium - 50 -95% of the population is affected     | Certain- More than 66% probability | High   |
|                                                | 4      | <b>Flood risk</b>                 | EPA EJ Screen    | The First Street Foundation Flood Model provides a consistent and unified methodology across the entire country with continuous outputs. This extends into areas that have no previous flood modelling and even areas that do not have recorded hydrologic data. As a result, there is increased visibility into new regions of the entire country. | EJ Screen tool                | High - More than 95% of the population is affected | Likely- 34-66% probability         | High   |
|                                                | 5      | Sea Level Rise                    | NOAA             | Risk of permanent flooding with sea-level rises. These data can be used to look for areas of potential permanent inundation based on chosen sea level rise estimates (i.e., 1 to 6 feet) in relation to locations of social and economic vulnerability                                                                                              | EJ Screen tool                | Medium - 50 -95% of the population is affected     | Likely- 34-66% probability         | Medium |

Figure 4: Details of the Risk Assessment Tool



With the risk score and level defined for each indicator, an overall risk score and level for a neighborhood is determined by summing up all the risk scores from each indicator. This can be seen in *Figure 5*. Overtime, as risk scores and levels for indicators change, so will the overall risk score and level for each neighborhood.

|                                       |      |
|---------------------------------------|------|
| <b>Name of the Neighborhood</b>       | XXX  |
| <b>Risk Score of the Neighborhood</b> | 265  |
| <b>Risk Level of the Neighborhood</b> | High |

*Figure 5: Table Summarizing Overall Risk Score and Level for Example Neighborhood XXX*

The team also developed a second version of the tool that uses a weighted average method for the indicators. This means that indicators do not impact the final risk score and level equally. This represents one of the ways the tool can be modified to more accurately measure risks in New York City. Weighted average is calculated based on the four groups and the number of direct indicators within. The only difference when compared to the previous method, is that this method increases the overall risk score of the neighborhood. The weight of the direct indicators in each vulnerability group will push the score higher as they are valued more. *Figure 6* below represents the weighted average calculation used. The weighted average method can be used when comparing different neighborhoods and the vulnerability of each neighborhood, but it will not have much impact on the individual risk level.

| Factors        | Factor wise weightage | Total indicators | % div. of leading and proxy ind. | Leading indicator |                      | Proxy indicator |                      |
|----------------|-----------------------|------------------|----------------------------------|-------------------|----------------------|-----------------|----------------------|
|                |                       |                  |                                  | Number            | Weight per indicator | Number          | Weight per indicator |
| Climate change | 11                    | 5                | 5.5                              | 2                 | 2.8                  | 3               | 1.8                  |
| Physical       | 43                    | 19               | 21.5                             | 7                 | 3.1                  | 12              | 1.8                  |
| Social         | 32                    | 14               | 16                               | 5                 | 3.2                  | 9               | 1.8                  |
| Economic       | 14                    | 6                | 7                                | 3                 | 2.3                  | 3               | 2.3                  |
|                | 100                   | 44               |                                  | 17                |                      | 27              |                      |

*Figure 6: Defining the Weightage as per the Direct and Proxy Indicators*

After comparing both models, the team concluded that a version of the tool that does not weigh indicators will be more helpful for the DEP for the purpose of neighborhood risk assessment. A step-wise manual for the assessment tool is provided in *Appendix B*.

However, if the objective is to compare different neighborhoods in the monitoring phase, the weighted version might be useful.

## 4.2 Key Features of the Assessment Tool

1. It is a comprehensive list of 44 indicators across several factors.
2. Each indicator has its own impact of severity defined based on its unique definitions.
3. Likelihood of occurrence is divided in three probability of occurrence ranges.
4. Each indicator provides its own risk level making controlling of the indicator easier.
5. Final risk score and risk level of the neighborhood are calculated automatically after ranking the indicators into low, medium, or high risk, and then summing them up.
6. It is an easy to adapt and user-friendly excel based tool.
7. This tool can be used as a baseline to assess the risks faced by the neighborhoods, as well as a monitoring mechanism to track the progress.
8. The tool can be used with two methods of calculation: the simple average method (all indicators carry the same weight) and the weighted average method (direct indicators carry more weight than the proxy indicators).





## 5. CONCLUSION

Hurricane Ida's impact on New York City in September 2021 demonstrated the clear threat that cloudbursts pose, as well as highlighted the communities in New York City that are most vulnerable. The disproportionate impacts indicate a clear need to account for the varying levels of vulnerability and to integrate equity into DEP's cloudburst resilience investments.

The team sought to help DEP with the following recommendations of (i) an operational equity definition; (ii) outlining an integrated equity strategy; (iii) proposing a stakeholder engagement list with localized neighborhood recommendations; (iv) recommending a set of criteria to refine neighborhood selection; and (v) creating a risk assessment tool that can be used to identify vulnerable neighborhoods.

The most critical consideration for DEP is to ensure that equity's definition is inclusive and crafted through extensive consultation with affected communities. In crafting a stakeholder engagement strategy, DEP should ensure that it is community-centric and trauma-informed at its core. In looking at neighborhood selection, DEP should center indicators such as basement apartments and immigrant populations in order to serve the most vulnerable populations. Lastly, the customized assessment tool can be used to evaluate a neighborhood's vulnerability both now and during future monitoring. This set of recommendations will help DEP prioritize cloudburst resilience resources and investments in specific neighborhoods that need it most.



IMAGE: LUKE STACKPOOLE



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# APPENDIX

## Appendix A

### From Baltimore:

*Details on Equity Lens promoted by the Baltimore Equity in Planning Committee*

These equity lens questions were listed in the Equity Action Plan (Baltimore City Department of Planning, 2017):

#### 1. Structural Equity:

- a. What historic advantages or disadvantages do residents face?
- b. What current policies and practices promote or discourage equity? Are there policy barriers that can be removed to close health and wealth gaps?
- c. How can this agency institutionalize an equity framework and be accountable to it?
- d. How can the City build a shared understanding of equity in government?

#### 2. Procedural Equity:

- a. Are engagement and representation inclusive, accessible and authentic?
- b. How can citizens be better informed about how City government functions?
- c. How can citizens influence decision making?
- d. What does an equitable outcome look like in this situation, and who helps decide that?

#### 3. Distributional Equity:

##### a. Public Investment:

- i. How is public money spent? Who receives money and at whose expense?
- ii. How can this agency ensure that areas with the most need receive resources commensurate with their need and that those resources are used effectively and equitably?

##### b. Development:

- i. What is the impact of development? What policies are available to prevent displacement as neighborhoods change and preserve opportunities for existing and low-income residents?
- ii. What is the developer's track record for fulfilling project benchmarks or aspirations that contribute to equity?
- iii. How can development be used to create opportunities for housing, jobs and education for residents most in need of them?

#### 4. Transgenerational Equity:

- How are the needs of future generations considered in current planning efforts?
- Do the concept and implementation of sustainability include equity?
- Will future generations of city residents bear an unfair burden if a proposed plan is fully implemented?

## Appendix B: Step-wise Manual for Assessment Tool

The assessment tool is Excel based. The purpose is to calculate the risk scores and risk levels of neighborhoods by following the steps mentioned below for each indicator:

**Step 1:** Select the level of impact (low, medium, or high), from the dropdown menu, according to available data/information. The corresponding score appears.

|   |                                |               |                                                                                                                                                     |                |                                                                                                                                                           |                                     |   |   |      |
|---|--------------------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|---|---|------|
| 2 | Coastal Flood hazard           | EPA E1 Screen | National level data depicting areas in coastal counties in the United States along the Atlantic Ocean that are most prone to coastal flood hazards. | E1 Screen tool | Low - Less than 50% of neighborhood is affected                                                                                                           | Certain - More than 66% probability | 3 | 6 | High |
| 3 | Estimated 100-year floodplains | EPA E1 Screen | National level data depicting the estimated 100-year floodplains for the US - 2016.                                                                 | E1 Screen tool | Low - Less than 50% of neighbourhood is affected<br>Medium - 50 - 95% of the population is affected<br>High - More than 95% of the population is affected |                                     |   |   | High |
|   |                                |               | The First Street Foundation Flood Model provides a consistent and unified methodology across the nation                                             |                |                                                                                                                                                           |                                     |   |   |      |

**Step 2:** Similar to Step 1, select the likelihood (unlikely, likely, or certain) from the dropdown menu. The corresponding score appears.

|   |                                |               |                                                                                                                                                     |                |                                                 |                                                                                                    |   |   |      |
|---|--------------------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------|---|---|------|
| 2 | Coastal Flood hazard           | EPA E1 Screen | National level data depicting areas in coastal counties in the United States along the Atlantic Ocean that are most prone to coastal flood hazards. | E1 Screen tool | Medium - 50 - 95% of the population is affected | Certain - More than 66% probability                                                                | 3 | 6 | High |
| 3 | Estimated 100-year floodplains | EPA E1 Screen | National level data depicting the estimated 100-year floodplains for the US - 2016.                                                                 | E1 Screen tool | Medium - 50 - 95% of the population is affected | Unlikely - 0-33% probability<br>Likely - 34-66% probability<br>Certain - More than 66% probability |   |   |      |
|   |                                |               | The First Street Foundation Flood Model provides a consistent and unified methodology across the nation                                             |                |                                                 |                                                                                                    |   |   |      |

**Step 3:** Once both the impact and likelihood scores are determined, the risk score for a particular indicator is calculated in the last column by multiplying the impact and likelihood scores. To keep the tool comprehensive, the individual scores are hidden.

**Step 4:** The risk level for that particular indicator are determined based on the risk matrix. The three risk levels are: (i) Low Risk if  $\leq 3$ ; (ii) Medium if  $\leq 5$ ; and (iii) High Risk if  $\leq 9$ .

|   |                      |               |                                                                                                                                                     |                |                                                 |                                     |   |   |      |
|---|----------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------------------------------------------|-------------------------------------|---|---|------|
| 2 | Coastal Flood hazard | EPA E1 Screen | National level data depicting areas in coastal counties in the United States along the Atlantic Ocean that are most prone to coastal flood hazards. | E1 Screen tool | Medium - 50 - 95% of the population is affected | Certain - More than 66% probability | 3 | 6 | High |
|---|----------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------------------------------------------|-------------------------------------|---|---|------|

**Step 5:** The total risk score of the neighborhood is then calculated by summing up risk scores obtained for each indicator. The overall risk level of the neighborhood is determined as per the total risk score. The caps of the overall risks (Low if  $\leq 44$ , Medium if  $\leq 176$ , and High if  $\leq 396$ ) are obtained by calculating the aggregation of 44 indicators' possible low risk, medium risk and high risk.

|                                |      |
|--------------------------------|------|
| Name of the Neighborhood       | XXX  |
| Risk Score of the Neighborhood | 265  |
| Risk Level of the Neighborhood | High |

## Appendix C: Assessment Tool Layout

| Vulnerability Factors                          | Indicators                     | Indicator source | Indicator description                                                                                                                               | Potential sites for data collection | Impact                                                  | Likelihood                                  | Risk |
|------------------------------------------------|--------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|---------------------------------------------------------|---------------------------------------------|------|
| Climate change (Specific to Cloudburst Events) | Cloudburst events per year     | NYC              | Number of cloudburst events recorded in the neighborhood per year.                                                                                  | NYC DEP                             | <i>Low</i><br>Less than 50% of neighborhood is affected | <i>Certain</i><br>More than 66% probability | Low  |
|                                                | Coastal flood hazard           | EPA EJ Screen    | National level data depicting areas in coastal counties in the United States along the Atlantic Ocean that are most prone to coastal flood hazards. | EJ Screen tool                      | <i>Medium</i><br>50-95% of the neighborhood is affected | <i>Certain</i><br>More than 66% probability | High |
|                                                | Estimated 100-year floodplains | EPA EJ Screen    | National level data depicting the estimated 100-year floodplains for the US- 2016.                                                                  | EJ Screen tool                      | <i>Medium</i><br>50-95% of the neighborhood is affected | <i>Certain</i><br>More than 66% probability | High |

|                                    |                              |               |                                                                                                                                                                                                                                                                                                                                                    |                |                                                                                                      |                                             |        |
|------------------------------------|------------------------------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------------------------------------------------------------------------------------------------------|---------------------------------------------|--------|
|                                    | <b>Flood risk</b>            | EPA EJ Screen | The First Street Foundation Flood Model provides a consistent and unified methodology across the entire country with continuous outputs. This extends into areas that have no previous flood modeling and even areas that do not have recorded hydrologic data. As a result, there is increased visibility into new regions of the entire country. | EJ Screen tool | <i>Medium</i><br>50-95% of the neighborhood is affected                                              | <i>Likely</i><br>4-66% probability          | Medium |
|                                    | Sea level rise               | NOAA          | Risk of permanent flooding with sea-level rises. These data can be used to look for areas of potential permanent inundation based on chosen sea level rise estimates (i.e., 1 to 6 feet) in relation to locations of social and economic vulnerability.                                                                                            | EJ Screen tool | <i>Medium</i><br>50-95% of the neighborhood is affected                                              | <i>Likely</i><br>34-66% probability         | Medium |
| <b>Physical and Infrastructure</b> | <b>Location of the house</b> | NYC           | Houses in basements or 1st floor are most prone to risk of flooding due to a cloudburst event. Poor escape routes exacerbate this risk. This indicator is a measure of that.                                                                                                                                                                       | NYCHA          | <i>Low</i><br>Houses in middle or higher floors with no proper escape routes                         | <i>Certain</i><br>More than 66% probability | Low    |
|                                    | Condition of the house       | MCAP 2022     | Households living in houses with temporary roofing material or dilapidated old houses are looked for through this indicator.                                                                                                                                                                                                                       | NYCHA          | <i>High</i><br>Households living in houses with temporary roofing material or dilapidated old houses | <i>Certain</i><br>More than 66% probability | High   |



|  |                                         |                                                   |                                                                                                                                                                                                                       |             |                                                                                                         |                                          |        |
|--|-----------------------------------------|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------------------------------------------------------------------------------------------------------|------------------------------------------|--------|
|  | <b>House having lead paints</b>         | EPA EJ Screen                                     | Percentage of housing units built before 1960, that have potential exposure to lead paint, an indicator to measure the at risk population.                                                                            | NYCHA       | <i>High</i><br>Houses built before 1960                                                                 | <i>Certain</i> More than 66% probability | High   |
|  | <b>Access to urban recreation areas</b> | MCAP 2022, Portland Vulnerability Assessment 2014 | Urban recreation areas refer to open spaces like parks, grounds, playground within walking proximity, and the access of those urban recreation areas by households in neighborhood is defined through this indicator. | Zoning maps | <i>Medium</i><br>Access to urban recreation areas within 5 km                                           | <i>Likely</i> 34-66% probability         | Medium |
|  | Access to public transit                | MCAP 2022, Portland Vulnerability Assessment 2014 | Population having access to public transit within 1 km on a normal day, and having access to public transit within 1 km during a cloudburst event.                                                                    | MTA maps    | <i>Low-</i><br>Population having easy access to public transit within 1 km                              | <i>Likely</i> 34-66% probability         | Low    |
|  | Access to drinking water                | MCAP 2022                                         | Households with access to tap water from treated source and the distance of that source from their house.                                                                                                             | NYC DEP     | <i>High</i><br>Households with access to untreated tap water                                            | <i>Certain</i> More than 66% probability | High   |
|  | Contamination of the drinking water     | MCAP 2022, EPA EJ Screen                          | Access to contaminated piped water due to less maintenance of the pipes, proximity to any industry thereby causing contamination in water, with negative health impacts.                                              | NYC DEP     | <i>Medium-</i><br>Maintenance of pipes is not frequent leading to contamination of water for households | <i>Likely</i> 34-66% probability         | Medium |

|  |                                                   |                |                                                                                                                                                     |                                                   |                                                                                             |                                          |      |
|--|---------------------------------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------------------------------------------------|------------------------------------------|------|
|  | <b>Condition of the stormwater infrastructure</b> | NYC            | This refers to the condition and/availability of pipelines and other stormwater infrastructure in the neighborhood.                                 | NYC DEP                                           | <i>Medium</i><br>Storm water drains available but not maintained frequently in neighborhood | <i>Certain</i> More than 66% probability | High |
|  | Access to food security                           | EPA EJ Screen  | Low income and low access tract measured at 1 mile for urban areas and 10 miles for rural areas.                                                    | NYC Environment & Health data portal              | <i>High</i><br>Food access not within 2 miles                                               | <i>Certain</i> More than 66% probability | High |
|  | Access to maintained infrastructure for cooking   | MCAP 2022      | Households with proper and maintained infrastructure pipelines.                                                                                     | NYC Environment & Health data portal              | <i>Low</i><br>Households having access to proper infrastructure pipelines                   | <i>Certain</i> More than 66% probability | Low  |
|  | Access to affordable electricity                  | MCAP 2022      | Households with electricity and the affordability of the same.                                                                                      | NYC Environment & Health data portal              | <i>Medium</i><br>Households with electricity                                                | <i>Certain</i> More than 66% probability | High |
|  | Access to fire services                           | MCAP 2022      | Access to fire services within 5 minutes response time at 35 km/hr is measured by this indicator.                                                   | Zoning maps                                       | <i>High</i><br>Limited or no access to fire services                                        | <i>Certain</i> More than 66% probability | High |
|  | <b>Access to healthcare</b>                       | MCAP 2022, NYC | Access to healthcare in 5 km driving distance is measured by this indicator.                                                                        | Zoning maps/ NYC Environment & Health data portal | <i>High</i><br>Limited access to health care                                                | <i>Certain</i> More than 66% probability | High |
|  | <b>Access to flood shelters</b>                   | MCAP 2022      | Population having access to flood shelters within a proximity of 1 km on a regular day and during a cloudburst event is measured by this indicator. | Zoning maps                                       | <i>Low</i><br>Population having access to flood shelters within a proximity of 1 km         | <i>Certain</i> More than 66% probability | Low  |

|  |                                |                                        |                                                                                                                                                                                                                                                                     |                |                                                                                                    |                                             |      |
|--|--------------------------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------------------------------------------------------------------------------------------|---------------------------------------------|------|
|  | Access to education facilities | Portland Vulnerability Assessment 2014 | Access to education institution (especially elementary and middle) within a proximity of 1 km in the neighborhood is identified through this indicator.                                                                                                             | Zoning maps    | <i>High</i><br>Access to education institution (specially elementary and middle) not withing 5 kms | <i>Certain</i><br>More than 66% probability | High |
|  | <b>Composition of sidewalk</b> | Portland Vulnerability Assessment 2014 | This indicator mainly describes the materials used in the sidewalk used by pedestrians. Non porous surfaces have no percolation capacity hence exacerbate urban flooding. Porous surfaces like rain gardens/ lawn can increase the potential of surface absorption. | Zoning maps    | <i>High</i><br>Non porous materials used in side walks                                             | <i>Certain</i><br>More than 66% probability | High |
|  | Proximity from traffic         | EPA EJ Screen                          | For this indicator, the calculation can be made by the count of vehicles per day (average annual daily traffic) at major roads within 500 meters (or nearest one beyond 500 m), divided by distance in meters.                                                      | EJ Screen tool | <i>Low</i><br>Low average traffic within 500 m                                                     | <i>Certain</i><br>More than 66% probability | Low  |
|  | Proximity to superfund sites   | EPA EJ Screen                          | Count of proposed and listed NPL sites within 5 km (or nearest one beyond 5 km), each divided by distance in km.                                                                                                                                                    | EJ Screen tool | <i>High</i><br>Superfund site on site or within 2 kms                                              | <i>Certain</i><br>More than 66% probability | High |
|  | Proximity to RMP facility      | EPA EJ Screen                          | Count of RMP (potential chemical accident management plan) facilities within 5 km (or nearest one beyond 5 km), each divided by distance in km.                                                                                                                     | EJ Screen tool | <i>Medium</i><br>Count of RMP (waste from chemical facilities) within 5 km                         | <i>Unlikely</i><br>0-33% probability        | Low  |

|        |                                                      |               |                                                                                                                                                                                                              |                |                                                                                                                       |                                             |        |
|--------|------------------------------------------------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------|
| Social | Literacy rate                                        | MCAP 2022     | Effective literacy rate. The current literacy rate of NYC is 75%.                                                                                                                                            | Census Bureau  | <i>High</i><br>Literacy rate is less than 50%                                                                         | <i>Certain</i><br>More than 66% probability | High   |
|        | <b>Gender Imbalance</b>                              | MCAP 2022     | It is defined by the sex ratio. NYC has currently a ratio of 53:47 - female to male population.                                                                                                              | Census Bureau  | <i>Medium</i><br>Deviation by 10% from the standard ratio of NYC                                                      | <i>Likely</i><br>34-66% probability         | Medium |
|        | <b>Social Composition</b>                            | MCAP 2022     | Percentage of historically underrepresented population is measured through this indicator.                                                                                                                   | Census Bureau  | <i>High</i><br>Deviation by more than 10% from the standard social composition of NYC                                 | <i>Certain</i><br>More than 66% probability | High   |
|        | % of population in limited English speaking          | EPA EJ Screen | Percentage of households in which no one age 14 and over speaks English "very well" or speaks English only (as a fraction of households). NYC has currently about 65% of households where English is spoken. | EJ Screen tool | <i>Medium</i><br>Households where only 50% of the adults living speak in English                                      | <i>Unlikely</i><br>0-33% probability        | Low    |
|        | % of population with less than high school education | EPA EJ Screen | Percentage of individuals age 25 and over with less than high school degree.                                                                                                                                 | EJ Screen tool | <i>High</i><br>More than 10% deviation of population with people over 25 and no college degree from the state average | <i>Certain</i><br>More than 66% probability | High   |
|        | % of population under age 5                          | EPA EJ Screen | Percentage of individuals under age 5 as a fraction of population.                                                                                                                                           | EJ Screen tool | <i>High</i><br>Deviation by more than 10% from the state average                                                      | <i>Unlikely</i><br>0-33% probability        | Low    |
|        | % of population over age 64                          | EPA EJ Screen | Percentage of individuals over age 64 as a fraction of the population.                                                                                                                                       | EJ Screen tool | <i>Medium</i><br>Deviation by 10% from the state average                                                              | <i>Certain</i><br>More than 66% probability | High   |

|  |                                               |                                    |                                                                                                                                                                                                                                           |                                                            |                                                                                                          |                                             |        |
|--|-----------------------------------------------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|---------------------------------------------|--------|
|  | <b>Life Expectancy</b>                        | EPA EJ Screen                      | As of 2020, NYC has an average life expectancy of 77.7 years, and this indicator compares that average with the neighborhood.                                                                                                             | EJ Screen tool                                             | <i>High</i><br>Deviation by more than 10 percent from the state average                                  | <i>Certain</i><br>More than 66% probability | High   |
|  | Medically Underserved                         | EPA EJ Screen                      | Medically Underserved Areas/Populations are areas or populations designated by US Health Resources & Services Administration as having too few primary care providers, high infant mortality, high poverty, or a high elderly population. | EJ Screen tool                                             | <i>Medium-</i><br>Less than 50% of neighborhood in the medically underserved area specified by EJ Screen | <i>Likely-</i><br>34-66% probability        | Medium |
|  | LGBTQIA Communities                           | Austin Climate Equity Plan 2020-21 | Percentage of LGBTQIA community inclusion in the neighborhood is represented through this indicator.                                                                                                                                      | Behavioural Risk Factor Surveillance System (BRFSS)        | <i>Medium</i><br>Minor resistance for the % LGBTQIA population                                           | <i>Certain</i><br>More than 66% probability | High   |
|  | Immigrant, Migrant and/or Refugee Communities | Austin Climate Equity Plan 2020-21 | This is the presence of immigrants or migrant and/or refugees in the neighborhood.                                                                                                                                                        | Census Bureau                                              | <i>High</i><br>Mostly Immigrant, Migrant and/or Refugee Communities                                      | <i>Certain</i><br>More than 66% probability | High   |
|  | People with Criminal Records                  | Austin Climate Equity Plan 2020-21 | Percentage of people with a criminal history in the neighborhood.                                                                                                                                                                         | Official Criminal History Records                          | <i>Low</i><br>% of people having criminal history matching with an average community criminal rate       | <i>Unlikely</i><br>0-33% probability        | Low    |
|  | People with special needs                     | Seattle Climate Action Plan 2013   | People with physical, mental, or medical impairment which prevents the exercise of a normal bodily function are measured through this indicator.                                                                                          | Public Record (Centers for Disease Control and Prevention) | <i>High</i><br>More than 10% deviation from average community% of special needs                          | <i>Certain</i><br>More than 66% probability | High   |



|          |                                                 |                                    |                                                                                                                                                                |                                                            |                                                                                         |                                             |        |
|----------|-------------------------------------------------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------------|---------------------------------------------|--------|
|          | Access to emergency services like alerts        | MCAP 2022                          | This refers to the households of the neighborhood getting alerts during an emergency like a cloudburst event or a flood                                        | Public Record (Centers for Disease Control and Prevention) | <i>Medium</i><br>In case of emergency only 50% of neighborhood gets alerts              | <i>Likely</i><br>34-66% probability         | Medium |
| Economic | Homeownership                                   | MCAP                               | Percentage of population living in their own house. 2021 data from NYS Comptroller shows that the state average is 55%.                                        | Census Bureau                                              | <i>High</i><br>More than 10% deviation from the state average of homeowners             | <i>Certain</i><br>More than 66% probability | High   |
|          | Wealth of households                            | SoVI                               | The abundance of valuable material possessions or resources in households of the neighborhood.                                                                 | SoVI data                                                  | <i>Medium</i> -<br>10% deviation from average wealth per neighborhood of NYC            | <i>Likely</i><br>34-66% probability         | Medium |
|          | White + blue collar job employment distribution | SoVI                               | As per the current statistics, White-collar workers make up 85.28% of the working population in New York City, while blue-collar employees account for 14.72%. | SoVI data                                                  | <i>High</i><br>More than 10% deviation in either of the job types from the city average | <i>Certain</i><br>More than 66% probability | High   |
|          | Unemployment                                    | EPA EJ Screen                      | Unemployment rate of the neighborhood as compared to New York City average, which, as per the Labor statistics, is 5.1%.                                       | EJ Screening Tool                                          | <i>Low</i><br>Maintaining the city's average of 5.1% unemployment                       | <i>Unlikely</i><br>0-33% probability        | Low    |
|          | Low-income communities                          | Austin Climate Equity Plan 2020-21 | The poverty rate in the community is at least 20%, or the median family income (MFI) does not exceed 80 percent of statewide median family income.             | Census Bureau                                              | <i>Low</i><br>Poverty rate of neighborhood is at 20% and 80% of population is at MFI    | <i>Certain</i><br>More than 66% probability | Low    |

|  |                      |                                            |                                                                                                                                                                                                                  |                  |                                                                            |                                     |     |
|--|----------------------|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------------------------------------------------------------|-------------------------------------|-----|
|  | Individual<br>Income | Baltimore<br>Equity<br>Action<br>Plan 2017 | As per statistics, the individual income is divided into two age categories of 25-44 and 45-64. Residents aged 25 to 44 earn \$152,675, while those between 45 and 64 years old have a median wage of \$134,575. | Census<br>Bureau | <i>Low</i><br>Matching the NYC individual incomes in different categories. | <i>Likely</i><br>34-66% probability | Low |
|--|----------------------|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------------------------------------------------------------|-------------------------------------|-----|

# GLOSSARY

| Term                                   | Definition                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Cloudburst</b>                      | A sudden, heavy downpour where a lot of rain falls in a short amount of time                                                                                                                                                                                                                                                                   |
| <b>Combined Sewer Overflow (CSO)</b>   | A combined sewer system collects rainwater runoff, domestic sewage, and industrial wastewater into one pipe.                                                                                                                                                                                                                                   |
| <b>Green infrastructure</b>            | Green infrastructure mimics nature and captures rainwater where it falls, and includes permeable pavement, rain gardens, bioretention cells (or bioswales), vegetative swales, infiltration trenches, green roofs, planter boxes, rainwater harvesting (rain barrels or cisterns), rooftop (downspout) disconnection, and urban tree canopies. |
| <b>Gray infrastructure</b>             | Gray infrastructure is traditional stormwater infrastructure in the built environment such as gutters, drains, pipes, and retention basins.                                                                                                                                                                                                    |
| <b>Megacity</b>                        | A city with over 10 million inhabitants is referred to as a megacity                                                                                                                                                                                                                                                                           |
| <b>Memorandum of Cooperation (MoC)</b> | A memorandum of cooperation is an agreement document written between parties to cooperatively work together on an agreed upon project or meet an agreed upon objective.                                                                                                                                                                        |
| <b>Stormwater</b>                      | Stormwater is water from rain or melting snow that does not soak into the ground but runs off into waterways. It flows from rooftops, over paved areas and bare soil, and through sloped lawns while picking up a variety of materials on its way.                                                                                             |

# THE COLUMBIA TEAM



**CHRISTINE OW**

WORKSHOP MANAGER  
(SHE/HER/HERS)

Christine is an early career professional with a strong passion for water, particularly in how it intersects with equity and international development. In pursuit of this interest, she penned a research thesis paper proposing a theoretical framework that outlines how water nonprofits can be instrumental to community empowerment to drive institutional change in rural communities in developing countries. She graduated with a B.A. in Political Science from the University of California, Los Angeles, with minors in Environmental Systems and Society, Global Studies, and Asian Languages (Korean). Currently, she is working as a Graduate Research Assistant for the Columbia Water Center where she conducts research on water access challenges for indigenous communities in the United States. She also volunteers with Circle of Blue mainly supporting their communications work. Upon graduation she will be starting her work as an Analyst at Bluefield Research on Digital Water.



**DHRUVI PATEL**

DEPUTY MANAGER  
(SHE/HER/HERS)

Dhruvi previously worked in India as an environmental researcher focusing on wastewater management; as well as an environmental educator for water, sanitation and hygiene (WASH) in government schools and marginalized communities. Her core skills lie in areas of environmental compliance and monitoring, urban environment management, curriculum development and community engagement for sustainability education. She aims at appropriating her competencies to engage vulnerable communities in exploring equitable and sustainable ways of utilizing resources while also gauging her skills in the development of cross-sector partnerships for the efficient implementation of environmental policies. She is eager to take an impassioned approach to learn ways to address equity while planning for climate resiliency.

**CANDICE ASARE** *(SHE/HER/HERS)*

Candice acquired her Bachelor of Science in Biology with an emphasis in Ecology, Evolution, and Behavior degree from the University of Texas at Austin. Since then, she has gained work experience in areas such as ornithology, botany, forestry, and wildlife biology. Recently, she worked as a wildlife biologist primarily monitoring state and federally protected species in California. Through her work she has seen the impact and destruction natural disasters can cause and the toll that they have on the local community. From her past experiences, she recognizes the importance of having systems and policies in place that best serve local communities, especially those most vulnerable or disenfranchised after natural disasters.

**NICOLE CORNELL** *(SHE/HER/HERS)*

Nicole graduated from Union College in Upstate New York in 2021 with a B.A. in Environmental Policy and minors in Political Science and Geology. After graduation, she began working at Merrill Lynch in Private Executive Services and has continued working there part-time since being at Columbia. She also has experience in local government, specifically stormwater management, as well as the non-profit sector, and is also currently a newsletter editor for Brooklyn350, an environmental advocacy group.

**IPSITA DASH** *(SHE/HER/HERS)*

Ipsita has a bachelor's degree in architecture and a masters degree in environmental design with over five years of work experience in corporate sustainability and climate change. Her domain knowledge is on areas of water and waste management, biodiversity, carbon emissions and climate change. She has worked on risk mapping in water-stressed areas of operation within the country, zero liquid discharge for water-intensive industries and circular water management, among other environmental issues during her stint with an Indian conglomerate. The last stint with UNDP, before joining Columbia University, introduced her to nature-based solutions used in building the coastal resilience of the urban poor and vulnerable communities.



**HELENA GRESSLER** *(SHE/HER/HERS)*

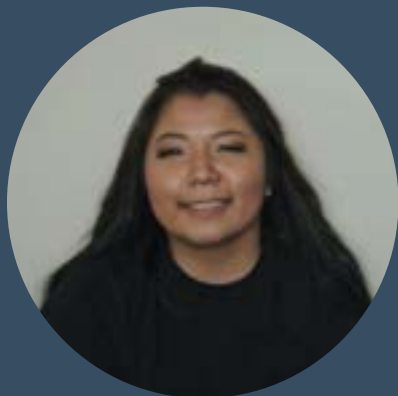
Helena is a Brazilian diplomat, with a firm conviction on the essential role of public policies and international cooperation to improve people's lives, promote environmental sustainability, and overcome historical inequities. She graduated in Law in 2006, at the University of Brasilia, in the capital, where she also worked for a few years as an attorney and serving as a clerk at the Brazilian Supreme Court, right before joining the Foreign Service in 2009. As a diplomat, she worked at the Ministry of Foreign Affairs' Department of Science and Technology Cooperation and in the Department of China. She was also posted in the Consulate of Brazil in Boston and in the Embassy of Brazil in Bogotá, Colombia.

**KELLY O'CONNELL** *(SHE/HER/HERS)*

Kelly is a young professional eager to pursue opportunities to further her knowledge on climate issues and develop solutions with a community centered and equitable approach. She is interested in international environmental policy and climate resiliency, and in particular, developing the legal structures and protections that will ensure the safety of those experiencing frontline impacts and environmental displacement. Prior to Columbia, she was employed with the government affairs team at Plug Power, working to access funding for green hydrogen development and expansion projects. Kelly received her BA in Political Science and Spanish from Villanova University. There, she also minored in Sustainability Studies and Latin American Studies in line with her passions and her concern for environmental issues on a global scale.

**OLIVIA PARKER** *(SHE/HER/HERS)*

Olivia is passionate about improving the strength of communities, especially through climate resilience, urban development, and disaster preparedness projects. She has a strong background in technical writing, research, and stakeholder coordination. Prior to SIPA, she worked for the New York City Office of Management and Budget where she managed the environmental reviews for CDBG-DR funded housing recovery and coastal resiliency projects throughout NYC. Olivia also received a B.A. in Sustainable Development from Columbia University in 2018.

**EMILY SIANGKAM** (SHE/HER/HERS)

Emily Siangkam graduated from the University of Washington with a degree in Environmental Studies and Geography: Data Science. There, she served as a legal assistant where she led the outreach program to better support underserved students facing legal obstacles. She currently interns for EPA Region 10 in the Surface Water Enforcement Section, where she provides technical assistance in innovating correspondence processes, and conducts enforcement actions under the Clean Water Act. Having grown up in an unincorporated community with limited infrastructure and resources, Emily is passionate about protecting at-risk communities from the impacts of climate change and building resilience for underserved communities.

**YUEYUE YU** (SHE/HER/HERS)

Yueyue is a passionate analyst for regional climate issues and environmental justice. She received a B.S. from UC-Irvine with a major in Earth System Science. She is eager to take her current knowledge and experience of water and climate to the public sector. She learned oceanography, water resources policy, and global climate change and participated in a mock trial of the water pollution injustice issues in college. She worked first as a consultant in an environment and energy consultancy and then had an internship in a provincial government energy agency.

**DR. NANCY DEGNAN**

FACULTY ADVISOR  
(SHE/HER/HERS)

Nancy served as Assistant Dean at SIPA and as the Associate Director at the School of Architecture, Planning and Preservation. She is currently the Executive Director of the Center for Environmental Research and Conservation (CERC). At CERC, Dr. Degnan spearheads initiatives and programming in education, training and applied research STEM (science, technology, engineering and math). Her research and writing has focused on community-based initiatives in education, sustainable development and redevelopment, as well as microfinance and enterprise development. She is also a member of Columbia Business School's Deming Board, Chazen Institute.

# WORKSHOP IN APPLIED EARTH SYSTEMS MANAGEMENT

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