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# New York City Panel on Climate Change 2019 Report Chapter 6: Community-Based Assessments of Adaptation and Equity

Sheila Foster,[1] Robin Leichenko,[2] Khai Hoan Nguyen,[2] Reginald Blake,[3] Howard Kunreuther,[4] Malgosia Madajewicz,[5] Elisaveta P. Petkova,[5] Rae Zimmerman,[6] Cecil Corbin-Mark,[7] Elizabeth Yeampierre,[8] Angela Tovar,[9] Cynthia Herrera,[5,7] and Daron Ravenborg[10]

[1]Georgetown University, Washington, DC. [2]Rutgers University, New Brunswick, New Jersey. [3]New York City College of Technology, New York, New York. [4]University of Pennsylvania, Philadelphia, Pennsylvania. [5]Columbia University, New York, New York. [6]New York University, New York, New York. [7]WE ACT, New York, New York. [8]UPROSE, New York, New York. [9]THE POINT, New York, New York. [10]Fordham School of Law, New York, New York

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## 6.1. Introduction

There is a widespread awareness that the uneven distribution of climate change impacts combined with preexisting social and economic challenges makes some communities more vulnerable than others (Reckien *et al.*, 2018; IPCC, 2014; Leichenko *et al.*, 2011). There is also growing recognition of the need for inclusion of community perspectives, viewpoints, and exigencies into adaptation decision making and planning (Chu *et al.*, 2016).

The concept of equity relates to climate change adaptation through inequalities in climate change impacts and vulnerabilities, as well as through uneven involvement in adaptation planning. It recognizes that disparities in health outcomes, inequities in living conditions, and lack of political power place low-income communities and many communities of color at greater risk and limit their capacity to adapt. The NPCC3 Workgroup on Community-Based Assessment of Adaptation and Equity (CBA Workgroup) explored how equity concerns can be incorporated into climate change vulnerability assessments and community adaptation planning in New York City.

The CBA Workgroup's explicit focus on equity in vulnerability and adaptation is a new contribution to the NPCC. While prior New York State research by Leichenko *et al.* (2011) identified a need for consideration of equity and environmental justice in the analysis of state-wide climate impacts, vulnerabilities, and adaptation, the formation of the CBA Workgroup within the NPCC3 reflects the city's recognition of and strong commitment to these issues.

The CBA Workgroup tasks included assessing social vulnerability patterns and identifying indicators to track social vulnerability at the neighborhood level (see Chapter 8, Indicators and Monitoring), conducting case studies of community adaptation in socially vulnerable neighborhoods, and identifying effective practices for incorporating equity into adaptation planning at the city level. These tasks were accomplished through:

1. **Investigation of spatial patterns of social vulnerability to climate change stressors in New York City.** This entailed compilation, review, and assessment of recent vulnerability mapping studies conducted in New York City and elsewhere in the United States. The aim of this review was to identify spatial patterns of vulnerability to climate change stresses across neighborhoods and communities and to provide guidance on methods and indicators that

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can be used to monitor and track neighborhood vulnerability over time.[a]

2. **Case studies in socially and economically disadvantaged communities**. Case studies of climate change vulnerability and adaptation were undertaken in collaboration with three community-based organizations (CBOs)—WE ACT for Environmental Justice in Harlem, THE POINT CDC in Hunts Point, and UPROSE in Sunset Park. These CBOs are situated predominantly in neighborhoods whose residents are often low-income or people of color who have been excluded from opportunity and resources. All of these CBOs have mobilized to develop climate adaptation plans for their communities.
3. **Examination of community-based adaptation planning efforts.** For each case study community, we collaborated with CBOs and New York City planners to explore how community group perspectives and input are incorporated into the development and implementation of community-based adaptation plans.
4. **Analysis of current practices for incorporating equity**. This task was achieved via comparative investigation of how New York City and other cities in the northeastern United States incorporate principles of equity into community adaptation planning.

Relying on long-established conventions and practices within the field of environmental justice and emerging practices for community-based vulnerability analysis, the CBA Workgroup adopted a collaborative co-production model for assessing vulnerability and equitable adaptation (Deas *et al.*, 2017; Sarzynski 2015; Lemos and Morehouse, 2005; Cole and Foster 2001). This approach involved meeting at the outset with CBOs from the targeted study neighborhoods and including them as full participating members and contributors to the CBA Workgroup. Given that the broad mandate of the CBA Workgroup was to examine ways in which equity is incorporated into climate adaptation planning, partnering with local communities helped ensure that the work process and product adhere to the principles of environmental justice.

## 6.2. Framing equity in the climate change context

Research on climate change has drawn attention to numerous inequalities associated with mitigation, vulnerability, and adaptation. These include the uneven distribution of greenhouse gas emissions and mitigation responsibility; differential vulnerability to climate stressors across regions, communities, and social groups; and intergenerational equity in terms of who should bear the cost of impacts and mitigation efforts (Parks and Roberts, 2010; Paalova and Adger, 2006; Kasperson and Dow, 1991). The equity dimensions of adaptation also highlight differences in capacity to respond to climate stresses and recover from climate shocks, and the possibility of uneven benefits and burdens linked to adaptation efforts (Klein *et al.*, 2014; Smit and Wandel, 2006).

At the urban scale, the research points to the disproportionate risks from climate change impacts in low-income communities, the existence of economic and social factors that may undermine or limit community adaptive capacity, the importance of including a diversity of community voices and perspectives in adaptation planning efforts, and the need for equitable allocation of adaptation resources (Reckien *et al.*, 2018; Deas *et al.*, 2017; Anguelovski *et al.*, 2016; Chu *et al.*, 2016; NAACP, 2015; Schlosberg and Collins, 2014; Bulkeley *et al.*, 2014; Ross and Berkes, 2014).

While there is increasing recognition of equity issues in urban adaptation planning, there remains a need for a more systematic framework for urban adaptation and equity analysis. Ideally, such a framework would serve as a template for cities that wish to incorporate fully equity considerations into adaptation planning. In proposing such a framework, this chapter draws on the climate change adaptation, mitigation, and environmental justice literatures (Reckien *et al.*, 2018; Foster, 2017; Schlosberg and Collins, 2014; McDermott *et al.*, 2013; Leichenko *et al.*, 2011; Cole and Foster, 2001). In particular, the

[a]Except where noted, our examination of social vulnerability to climate change stressors is intended to reflect vulnerability to all six types of stressors identified in NPCC 2019 Chapters 2, 3, and 4, including those associated with (1) extreme heat and humidity; (2) heavy downpours; (3) drought; (4) sea level rise and coastal flooding; (5) extreme winds; and (6) cold snaps.

chapter builds upon the equity framework developed by McDermott *et al.* (2013) for application to payments for ecosystem services. As suggested by McDermott *et al.* (2013), our approach incorporates three elements: distributional, contextual, and procedural equity (see Box 6.1).

**Box 6.1: Three dimensions of equity in adaptation (based on McDermott *et al.*, 2013)**

| | |
|---|---|
| ***Distributive equity*** | Emphasizes disparities across social groups, neighborhoods, and communities in vulnerability, adaptive capacity, and the outcomes of adaptation actions |
| ***Contextual equity*** | Emphasizes social, economic, and political factors and processes that contribute to uneven vulnerability and shape adaptive capacity |
| ***Procedural equity*** | Emphasizes the extent and robustness of public and community participation in adaptation planning and decision making |

*Distributional equity* emphasizes the uneven environmental burdens and benefits across groups and neighborhoods (Foster, 2017). The literature on environmental justice, for example, has brought attention to racial and ethnic disparities in the distribution of polluting facilities and other environmental hazards and the lack of environmental amenities such as green spaces in low-income and minority communities (Coburn *et al.*, 2006; Cole and Foster, 2001; Fothergill *et al.*, 1999; U.S. EPA, 1992).

Within the climate change literature, elements of distributional equity include recognition of inequalities in social vulnerability to climate change; inequalities in the capacity to adapt or influence mitigation of climate change; inequalities in benefits associated with adaptation policies; and inequalities and unintended consequences of adaptation and mitigation efforts (McDermott *et al.*, 2013; Leichenko *et al.*, 2011).

Distributional equity in both the environmental justice and climate adaptation literatures brings attention to the distribution of costs and benefits of policy initiatives on various populations. Rooted in principles of equality and social welfare, efforts to incorporate distributive equity are often needs based (McDermott *et al.*, 2013). As such, these approaches directly target the least advantaged communities and most at-risk community members in standard-setting and adaptation planning.

While the notion of *contextual equity*, as proposed by McDermott *et al.* (2013), is a relatively recent addition to climate change adaptation discussions, its essential elements are well recognized in the climate vulnerability and environmental justice literatures, both of which emphasize social "root causes" of vulnerability, including the influence of structural racism (Ribot, 2014; Cole and Foster, 2001). Social context (and history) is important to understanding existing disparities and to adequate assessment of social impacts at different stages of the planning process (i.e., preplanning, planning, action development, implementation, and evaluation/feedbacks on outcomes) (Sarzynski, 2015; O'Brien *et al.*, 2007).

Contextual equity draws attention to factors that contribute to social vulnerabilities and recognizes that differences in power and access can prevent some communities from receiving resources or from participating in the decision-making process (Fraser, 2009). Consideration of contextual equity entails recognition of the "uneven playing field" that is created for some communities as a result of pre-existing economic, social, and political inequalities (McDermott *et al.*, 2013). A contextual equity approach suggests that recognition of socioeconomic conditions and existing injustices is critical for designing community-based adaptation strategies (Schlosberg *et al.*, 2017).

Within the environmental justice and climate change literatures, *procedural equity* is typically defined as the representation and inclusion of affected individuals, communities, and groups in environmental and adaptation priority-setting and decision making. With respect to climate change impacts, this includes decisions about adaptation strategies and actions, as well as emergency preparedness and emergency response in relation to climate-related risks. Efforts to achieve procedural equity most often require explicit mechanisms to ensure participation of affected actors in policy and planning decisions (Chu *et al.*, 2016; Schlosberg, 2013; Leichenko *et al.*, 2011).

Traditional efforts to include groups historically deprived of resources in environmental and adaptation decision-making processes include

public hearings and meetings, citizen advisory councils, and citizen panels (Sarzynski, 2015). However, the climate change community is also paying increased attention to the need for greater inclusion of affected groups in the climate assessment process. Co-production of adaptation entails collaboration between researchers, policy makers, and affected groups in the identification of critical risks and vulnerabilities, formulation of adaptation options, and selection and implementation of response strategies (Cornell *et al.*, 2013; Kirchhoff *et al.*, 2013; Rosenzweig *et al.*, 2011).

This type of collaborative engagement of affected communities in all phases of adaptation planning and implementation has been identified by the environmental justice community as a critical need in the New York region (NYCEJA, 2018; NYCEJA, 2016; Sandy Regional Assembly, 2013). More generally, co-production approaches are considered vital for identification of sustainable adaptation pathways (Eisenhauer, 2016) and for fostering of equitable and sustainable cities (Rosenzweig *et al.*, 2018; Iaione, 2016; Foster and Iaione, 2016).

The remainder of the chapter is structured along these three dimensions of equity. Distributional equity is captured in Section 6.3's examination of spatial vulnerability patterns and indicators, where the primary emphasis is on measurement and tracking of spatial inequalities in vulnerability and capacity to adapt to climate change stressors. Contextual equity is highlighted in Section 6.4 through three case studies of socially vulnerable communities, in which we examine how climate stressors overlap with social and economic barriers and disadvantages, as well as legacy environmental justice issues. In Section 6.5, the concept of procedural equity is employed to examine community involvement in local adaptation planning efforts in New York City. In Section 6.6, we employ all three equity dimensions in a comparative examination of adaptation efforts in five cities in the Northeast of the United States.

## 6.3. Spatial analysis

Vulnerability to climate change is defined as the susceptibility of a given population, system, or place to harm from exposure to climate-related shocks and stresses (IPCC, 2012). Social vulnerability analysis, which has been extensively developed in the hazard and climate change literatures, describes the relationship between social characteristics and biophysical vulnerability to climate change stressors and other environmental hazards, as well as the distribution of tangible and intangible impacts on particular subpopulations or communities (Cutter and Finch, 2008; Adger, 2006; Cutter *et al.*, 2000).

In addition to measuring vulnerability to climate stressors, social vulnerability analysis increasingly is used to measure vulnerability to toxic and hazardous facility siting and to determine environmental justice areas based on indicators that track proximity and exposure to a variety of pollution sources (Foster, 2017; Sadd *et al.*, 2011).

A similar literature identifies social and biophysical factors that contribute to community climate change and disaster resilience (Leichenko *et al.*, 2015; Cutter *et al.*, 2014). Social factors that have been found to contribute to resilience include, for example, economic vitality and diversity; quality of housing and infrastructure; institutional, governance, and civic capacities; presence of strong social networks; and availability of health insurance. Biophysical factors include the presence of natural flood buffers and pervious surfaces, availability of locally sourced food supplies, adequacy of local water supplies, and location outside of low-elevation coastal zones (Cutter *et al.*, 2014; Leichenko, 2011).

Social vulnerability analysis focuses on demographic and socioeconomic factors that increase or attenuate the effects of climate change or other hazard events on a local population. Factors that are often found in the literature include socioeconomic status (wealth or poverty); education; age; access and functional needs; gender; race and ethnicity (Cutter *et al.*, 2009) (see Appendix 6.A).

Through the creation of empirical metrics and indicators of social vulnerability, researchers capture a wide array of factors that shape the susceptibility of certain populations and communities to harm from environmental hazard events and the ability to recover following these events (Tate, 2012; Cutter *et al.*, 2003).

Consideration of distributional equity is foundational to all types of social vulnerability analysis, where the goal is to document the uneven distribution of vulnerabilities to climate shocks and stress across neighborhoods, communities, and regions. Vulnerability analysis is often explicitly designed to help identify "hot spots" for needs-based targeting of resources and policies to communities that

are most at risk (de Sherbinin, 2014; Dunning and Durden, 2011).

In the following discussion, we describe methodological approaches used for social vulnerability analysis and mapping in New York City and elsewhere. We examine vulnerability mapping applications conducted by nonprofit organizations, academic institutions, and governmental agencies. We also provide recommendations for spatial vulnerability tracking at the neighborhood level.

### 6.3.1 Vulnerability mapping

Vulnerability mapping is a widely used approach for assessment of the spatial patterns related to climate change risks and for allocation of resources to at risk communities (de Sherbinin, 2014). Mapping of social vulnerability patterns provides a comparative, cross-sectional overview of vulnerability levels across various parts of a study area (e.g., comparing counties, census tracts, or block groups) (see Box 6.2).

The two most prevalent frameworks for social vulnerability mapping applications in the United States are the Social Vulnerability Index (SoVI), a product of the Hazards and Vulnerability Research Institute at the University of South Carolina (Cutter *et al.*, 2003), and the Social Vulnerability Index (SVI), a product of the U.S. Centers for Disease Control (CDC) (Flanagan *et al.*, 2011). SoVI and SVI are widely used by state and local government agencies to document spatial patterns of vulnerability to climate stressors for the purpose of targeting resources to those areas with the greatest needs (HVRI, 2018a; CDC SVI, 2018).

These and related approaches are intended to capture social conditions that influence vulnerability to a range of climate stressors. Importantly, these efforts emphasize general vulnerability to climate stresses, and can also be designed to capture population exposure to specific climate stresses such as heat or coastal flooding.

All the approaches to vulnerability mapping rely on selected indicators of social vulnerability. Table 6.1, based on Cutter *et al.* (2009), classifies common social vulnerability indicators into general categories used in different studies. These categories include socioeconomic status, gender, race and/or ethnicity, age, housing tenure, employment, occupation, family structure, education, population growth, access to medical services, access and functional needs populations, and social dependence.

**Box 6.2: Definition of census spatial units (U.S. Census Bureau, 2018; NYC DCP, 2018b)**

| | |
|---|---|
| ***County or statistically equivalent entity*** | Primary legal divisions of most states |
| ***Census tracts*** | Subdivisions of a county or equivalent entity. Tracts generally have a population size between 1200 and 8000 people. The spatial extents of tracts vary widely depending on the density of settlement |
| ***Census blocks*** | Subdivisions which form the building block of all other geographic units tabulated by the U.S. Census such as tracts, places, and American Indian Reservations |
| ***Community district (CD)*** | New York City is organized into 59 CDs. Each CD is represented by a Community Board, composed of volunteer community members appointed by the Borough President, who assist neighborhood residents and advise on neighborhood and citywide planning and service issues |
| ***Public use microdata areas (PUMAs)*** | Statistical geographic areas defined for the dissemination of public use microdata sample (PUMS) data. PUMAs are aggregated from census tracts and have a minimum population of 100,000. They are used to approximate populations of CDs or combinations of CDs. There are 59 CDs in New York City but only 55 NYC PUMAs |
| ***Neighborhood tabulation areas (NTAs)*** | Aggregations of census tracts that are subsets of New York City's 55 PUMAs with a minimum population of 15,000. NTA boundaries and their associated names may not represent neighborhoods |

While generalized social vulnerability maps such as SoVI and SVI are not intended to document physical exposure to specific climate change stressors,

**Table 6.1. Indicators of vulnerability (based on Cutter *et al.*, 2009)**

| Concept or characteristic | Proxy variable | Effect on social vulnerability |
|---|---|---|
| Socioeconomic status | % poverty | Increases |
| | Per capita income | High-decreases; low-increases |
| Gender | % female-headed households | Increases |
| Race and/or ethnicity | % African Americans | Increases |
| | % Hispanics | Increases |
| Age | % elderly | Increases |
| | % under 18 | Increases |
| Housing tenure (ownership) | % renters | Increases |
| | % homeowners | Decreases |
| Employment | % unemployed | Increases |
| Occupation | % agricultural workers | Increases |
| | % low-skilled service jobs | Increases |
| Family structure | % single-parent households | Increases |
| | Large family | Increases |
| Education | % less than high school | Increases |
| Population growth | Rapid growth | Increases |
| Access to medical services | Higher density of medical establishments and services | Decreases |
| Access and functional needs populations | Homeless, tourists, transients, nursing home residents | Increases |
| Social dependence | % social security recipients | Increases |

many studies combine social vulnerability maps with other maps displaying exposure to specific climate stressors such as coastal flooding (e.g., U.S. Climate Resilience Toolkit, 2018; Martinich *et al.*, 2013). The resulting "overlay" maps help to pinpoint intersections between social and biophysical vulnerabilities (O'Brien *et al.*, 2004).

**6.3.1.1 SoVI applications.** The current edition of the SoVI (2010–2014) is constructed using a set of 29 socio-demographic variables related to age, education, employment, income, health, household structure, housing, language barriers, poverty, race/ethnicity, and transportation access (see Table 6.2 and Appendix 6.A). Data sources for SoVI variables generally come from the most recently available U.S. Census (last completed in 2010), and the annual and 5-year updates from the American Community Survey (ACS).

The SoVI index employs principal component analysis (PCA), which is a statistical technique that reduces a large set of variables into a smaller set of aggregated factors (Tate, 2012). Cardinality (+) or (–) is assigned to component loadings. Positive loadings are associated with increased vulnerability and negative loadings with decreased vulnerability. The equally weighted components are added together to create a numerical social vulnerability value for each spatial unit (county, census tract, etc.).

The SoVI approach is widely used for social vulnerability mapping throughout the United States. Examples include applications in the Southeastern U.S. (OXFAM, 2009), California (Cooley *et al.*, 2012), New Jersey (Pflicke *et al.*, 2015), and a number of studies in New York City (Nature Conservancy, 2013; de Sherbinin and Bardy, 2015). These efforts involve employing some or all of the variables in the SoVI and utilizing PCA to tabulate the social vulnerability scores. Key differences among SoVI-like vulnerability indices lie in the number and type of variables included, the spatial unit of analysis, inclusion of data sources other than the U.S. Census, and areas of study.

In some cases, the selection of variables for inclusion may be influenced by the type of climate stressor that the researcher wishes to examine. For example, Cooley *et al.* (2012) use the SoVI method, but

**Table 6.2. The SoVI index**

| Index name and author(s) | Data and geography | Number of indicators and methodology | References |
|---|---|---|---|
| Social Vulnerability Index (SoVI) to environmental hazards<br>Cutter *et al.* from the Hazard Vulnerability Research Institute (HVRI) at the University of South Carolina | Data for the latest edition from U.S. Census (2010) and American Community Survey (2010–2014). Data can be used to compare and visualize social vulnerability patterns at different scalar levels (i.e., county, tract, and block group) in the United States. Other data sources: Geographic Names and Information System (GNIS); model-based Small Area Health Insurance Estimates from U.S. Census Bureau<br>Editions of SoVI<br>SoVI 2010–2014 latest edition uses same 29 indicators as SoVI 2006–10<br>SoVI 2006–2010 edition used 29 indicators<br>SoVI 2000 modified edition used 32 indicators<br>SoVI 2000 original edition used 42 indicators | 29 indicators<br>Principal component analysis (PCA) is a data reduction technique used to synthesize socioeconomic variables and assign cardinality to component loadings (+) or (−); positive loadings are associated with increased vulnerability and negative with decreased vulnerability; after cardinalities are determined, components are added together to create numerical social vulnerability score. Equal weighting is applied for all variables | Cutter *et al.* (2003)<br>http://artsandsciences.sc.edu/geog/hvri/sovi%C2%AE-0 (website) |

select indicators that are intended to capture social vulnerability to extreme heat, coastal flooding, wild fires, and air quality (see Appendix 6.A). Another source of differences is whether the variables reflect portions of the population within given characteristics in a block or tract or the density of households or individuals with those characteristics.

Methods used to combine individual factors into an index (e.g., with or without weights, etc.) are another source of variations. Social vulnerability patterns identified in the applications reflect the specific combinations of variables and scale used to create each index.

The New York City studies were used to illustrate how the SoVI approach has been applied to examine distributional vulnerabilities to climate change–related coastal flood risk at the neighborhood level (see Table 6.3). These include the Nature Conservancy Mapping Portal (2013) and a study by de Sherbinin and Bardy (2015). Each of these studies follows the prescribed SoVI framework by Cutter *et al.* (2003) with modifications of variable selection in some instances.

The Nature Conservancy analysis of social vulnerability to flooding and sea level rise in New York City utilized 27 variables from the SoVI 2006 to 2010 edition, excluding two variables due to lack of data availability (Nature Conservancy, 2013). The results demonstrate that medium and high levels of social vulnerability are concentrated in census tracts located in northern Manhattan, the South Bronx, the Lower East side, western and southern Brooklyn, north-central Queens (e.g., Flushing), and the Rockaways. Census tracts in our three case study areas (northern Manhattan; Sunset Park, Brooklyn; and Hunts Point, Bronx) display medium or high levels of vulnerability according to this analysis (see Figs. 6.1 and 6.2). Results of the de Sherbinin and Bardy (2015) analysis reveal similar distributions of social vulnerability to climate stressors (flooding) across city neighborhoods. They examined spatial vulnerabilities across block groups using the general

**Table 6.3. Selected examples of SoVI-based indexing and mapping in New York metropolitan region**

| Index name | Data and geography | Number of indicators and methodology | Climate stressors and other environmental hazards | References |
|---|---|---|---|---|
| The Nature Conservancy Coastal Resilience Mapping Portal (2013) | Data from U.S. Census (2010) and American Community Survey (2006–10).<br>Tract level for New York City, Hudson Valley, and Long Island | 27 indicators (from the SoVI 2006 to 2010 edition)<br>Principal component analysis (PCA) | Coastal flooding and sea level rise | Nature Conservancy (2013) |
| Social vulnerability to floods in two coastal megacities: New York City and Mumbai (2015) | Data from U.S. Census (2010) and American Community Survey (2006–2010)<br>Block group level for New York City | 21 indicators (reduced from SoVI 2006 to 2010 edition's 32 indicators to 21 due to data availability)<br>Principal component analysis (PCA) | Coastal flooding | de Sherbinin and Bardy (2015) |

SoVI approach but reduced the number of variables to 21 (variables that were not available at the block group level were excluded from the analysis).

While patterns of social vulnerability largely overlap across the two SoVI-based New York City studies, a key difference among them stems from the unit of analysis. In the visualizations in Figures 6.1 and 6.2, the finer spatial detail provided by the block group analysis in de Sherbinin and Bardy (2015) appears to reveal greater concentrations of highly vulnerable block groups in some areas than are apparent from the census tract results in the Nature Conservancy (2013) analysis.

In the cases of northern Manhattan and the South Bronx, for example, the tract visualization indicates that this area has medium vulnerability with small pockets of high vulnerability. In contrast, the two block group visualizations both reveal large concentrations of high vulnerability block groups within these "medium" vulnerability tracts. These areas of high vulnerability are not well captured in the tract-level analysis. While these results are contingent on how the data are classified in the visualization, they nonetheless reveal important differences between block group and census tract-level results.

**6.3.1.2 SVI applications.** The Center for Disease Control Agency of Toxic Substances and Disease Registry (CDC ATSDR) has its own social vulnerability framework and indexing methodology based on the work of Flanagan *et al.* (2011). The SVI utilizes 15 indicators, which are categorized into four themes: socioeconomic status, household composition and disability, minority status and language, and housing and transportation (see Table 6.4 and Appendix 6.A).

The CDC ATSDR employs a percentile ranking methodology, which entails calculation of the proportion of scores in a distribution that a specific score is greater than or equal to, for all census tracts. It then generates percentile rankings for the 15 individual indicator variables. Theme rankings are calculated by summing the percentiles for the variables comprising each theme and ordering the summed percentiles for each theme to determine the theme-specific percentile ranking. Tract ranking is determined by combining the sums for each theme, ordering the tracts, and calculating the overall percentile ranking for each tract. The SVI index has been estimated for all census tracts in the United States (CDC SVI, 2016).

The SVI index is widely used by governmental agencies, particularly public health departments (CDC SVI, 2018). A notable example is the application of the SVI index for the City of Seattle and King County by their Department of Public Health Division of Emergency Preparedness (SVI Seattle-King County, 2013) (see Appendix 6.A). The SVI for Seattle was created by ranking each tract according to its level of vulnerability in comparison

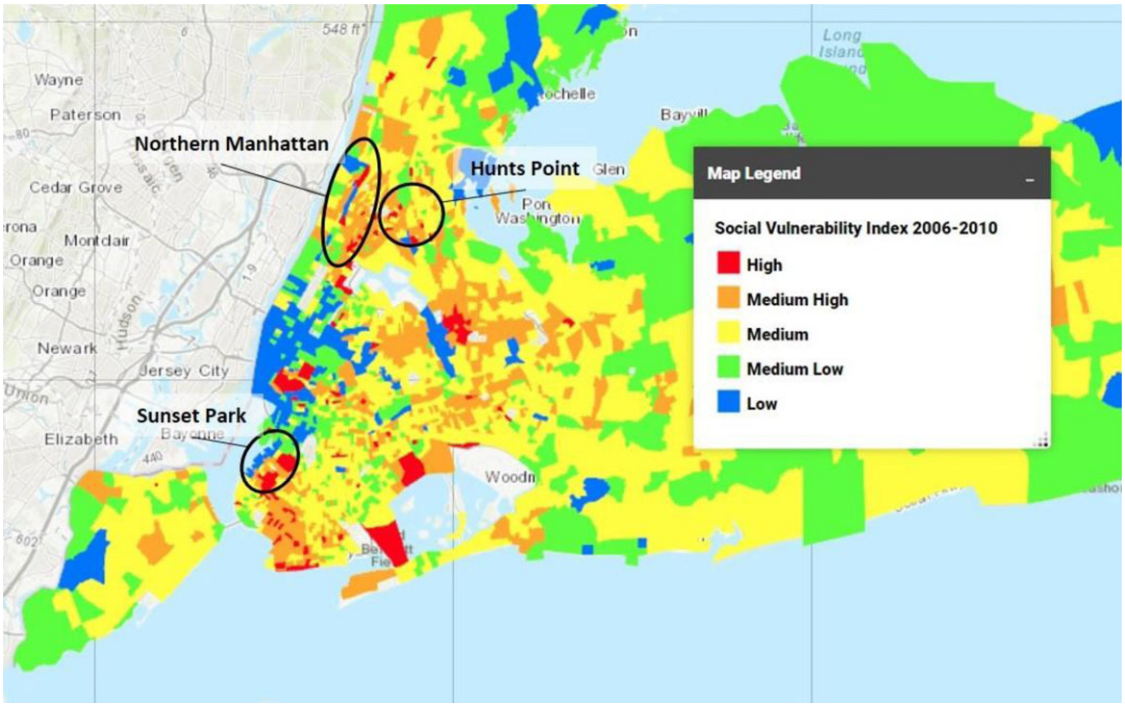


**Figure 6.1.** Social vulnerability index (SoVI) by the Nature Conservancy at census tract level (Nature Conservancy, 2013). NOTE: NPCC3 community case study neighborhoods are circled.

to the average across (1) the state of Washington, (2) the Urban Area Security Initiatives (UASI), (3) King County, and (4) Emergency Management Regions.

Other examples include the Dartmouth Flood Observatory overlay of flooding data onto the social vulnerability map for the City of Houston, which was constructed from the CDC SVI online mapping application. This usage of CDC SVI was picked up by several media outlets covering the postflooding period in Houston following Hurricane Harvey (Deaton, 2017; Misra, 2017) (see Appendix 6.A).

In contrast to SoVI applications that display some flexibility in choice of variables to include in the analysis, SVI applications generally include the same 15 variables and generally utilize percentile rankings. As such, the SVI results are more directly comparable across different applications. Because tract-level data for the SVI can be directly downloaded from the CDC website, the SVI can be rapidly deployed following a disaster event, as was done after Hurricane Harvey (see Appendix 6.A).

While a general SVI analysis has not been conducted for New York City, the CDC SVI (2016) model provides statewide vulnerability estimates for New York State. These results, which entail comparison of all census tracts in New York State, reveal high and medium vulnerability in many of the same areas of New York City that were identified by SoVI analyses (see Fig. 6.3). As with the SoVI studies, the New York State SVI indicates medium or high levels of general social vulnerability in all three of our case study areas.

The consistency of the findings between SoVI and SVI reflects the underlying commonalities in the variables used to document social vulnerability in both indices. These results also support our selection of vulnerable communities for the chapter's case studies.

**6.3.1.3 Other social vulnerability mapping applications.** In addition to SoVI- and SVI-based studies, there are many other types of vulnerability mapping applications that use different methods of variable selection and index compilation (see Table 6.5). Three examples include a climate vulnerability assessment for the City of Boston by the Resiliency Office (Martin, 2015), a social

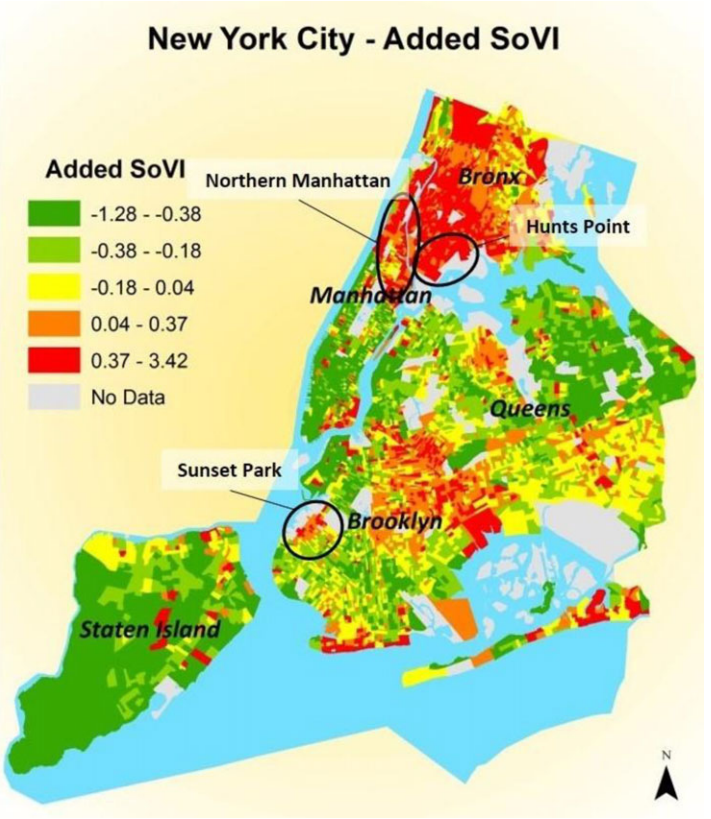


**Figure 6.2.** **Social vulnerability to floods in New York City at census block group level using a modified SOVI in which component scores are equally weighted, added together, and averaged (de Sherbinin and Bardy, 2015).**
**Note: NPCC3 community case study neighborhoods are circled.**

vulnerability assessment for the City of New York (Reckien, 2018), and the Heat Vulnerability Index by the New York City Department of Health and Mental Hygiene (City of New York, 2017b).

The social vulnerability mapping application by Martin (2015) utilizes 12 indicators, which were derived via correlation analysis based on an original set of 63 attributes assessed to be linked to social vulnerability. These 12 indicators include children, people with disabilities, older adults, people with chronic and acute medical illness, social isolation, people with low-to-no income, people of color, people with limited English proficiency, people with less than high school education, renters, women, and those lacking a vehicle. Using these variables, Martin (2015) created 12 separate vulnerability indicator maps, each of which is intended to reveal hotspots of social vulnerability for particular indicators at the tract and neighborhood levels (see Fig. 6.4).

Reckien (2018) conducted a comprehensive comparison of different statistical approaches for social vulnerability assessment in New York City. The study used a base set of 10 variables including: total population, female population, African American population, Asian population, Hispanic population, population under 10 years old, population over 65, population living in poverty, population with access to a car, and single-person households. The study compares a range of different approaches to index construction. These approaches include additive normalization without weighting, additive normalization with weighting, and PCA. The study finds that results tend to vary depending on how the indices are constructed. In general, weighted additive approaches may suggest higher levels of social vulnerability throughout the city than PCA approaches. Using a combination of these approaches, Reckien (2018) was able to isolate hotspots that showed consistently high levels of

**Table 6.4. The SVI index**

| Index name and source | Data and geography | Number of indicators and methodology | References |
|---|---|---|---|
| Social Vulnerability Index (SVI) to climate stressors and other environmental hazards (2016)<br>Center for Disease Control Agency for Toxic Substances and Disease Registry (CDC ATSDR) | Data for the latest edition (2016) came from U.S. Census 2010 and American Community Survey (2012–2016).<br>Tract level in the United States | 15 indicators<br>Percentile ranking values range from 0 to 1, with higher values indicating greater vulnerability. For each tract, CDC ATSDR generated percentile rank (1) for 15 individual variables, (2) for four theme domains, and (3) for overall position. Theme domain ranking involves summing percentiles for variables constituting each theme and ordering summed percentiles. Overall, tract ranking involves summing the sums for each theme and ordering the tracts | Flanagan *et al.* (2011)<br>https://svi.cdc.gov/Documents/Data/2014_SVI_Data/SVI2014Documentation.pdf (methodology)<br>https://svi.cdc.gov/map.aspx (interactive map) |

vulnerability across the methods. Each of our three case study neighborhoods is revealed as a hotspot on this composite map (see Fig. 6.5).

In contrast to most of the SoVI and SVI applications discussed above, the Heat Vulnerability Index, launched in 2015 by the New York City Department of Health and Mental Hygiene and Columbia University, focuses on a single climate stressor. The index, based on a case study of heat vulnerability in New York City by Madrigano *et al.* (2015), is intended to help identify neighborhoods that are most at risk to adverse health effects during extreme heat events.

The index includes two environmental factors (daytime summer surface temperature and distribution of greenspace) and two social factors (poverty as measured by the percent of people receiving public assistance and race as measured by the percent of non-Hispanic blacks residing in the community). Each of these factors has been shown to be associated with increased risk for heat-related death in New York City (Madrigano *et al.*, 2015). The values for each neighborhood are used to assign a score from 1 (lowest risk) to 5 (highest risk). The index serves as a tool to identify communities that are vulnerable to heat extremes and to assist in guiding the allocation of adaptation and mitigation resources (e.g., outreach efforts, planting street trees) to different areas (see Fig. 6.6).

### *6.3.2 Assessment of vulnerability mapping approaches and recommendations*

Despite the widespread usage of social vulnerability analysis and the SoVI and SVI, there are limitations of vulnerability indices for application to policy and planning decisions (Preston *et al.*, 2011; Schmidtlein *et al.*, 2008). For example, social vulnerability scores, which are employed to map and visualize patterns of social vulnerability, only provide a relative indicator of vulnerability in comparison to other areas.

In other words, a low vulnerability score simply means that one area has relatively lower social vulnerability than areas with higher scores; a low vulnerability score does not ensure that an area is resilient to climate shocks, nor does it imply that all of the residents of that area have low vulnerability. Other limitations, such as the lack of attention to underlying social vulnerability drivers, are inherent to this approach (Rufat *et al.*, 2015). Researchers are continuing to seek ways to improve social vulnerability methodologies, for example through uncertainty and sensitivity analysis (Tate, 2013).

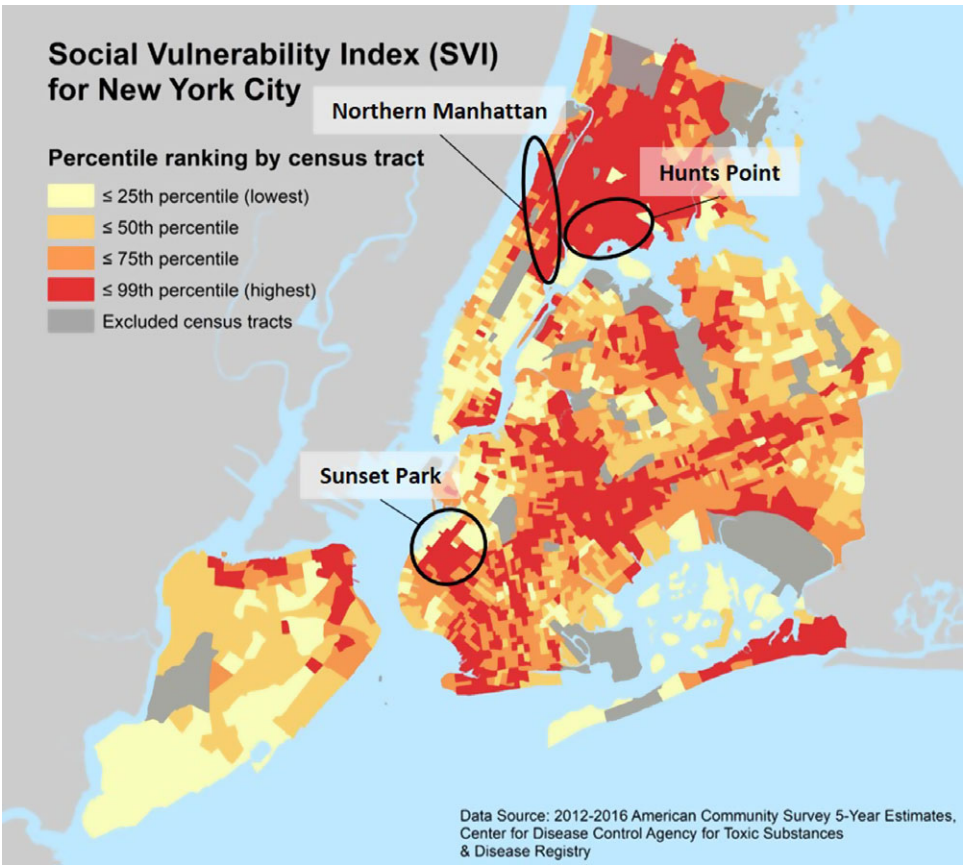


**Figure 6.3.** SVI New York State application displaying results for New York City (map constructed by the CBA Workgroup). The SVI utilizes 15 indicators, which are categorized into four themes: socioeconomic status, household composition and disability, minority status and language, and housing and transportation.
NOTE: NPCC3 community case study neighborhoods are circled.

Social vulnerability analysis provides useful information on spatial patterns via comparison of different communities or neighborhoods. However, this type of aggregated, composite vulnerability index has more limited utility for tracking how vulnerability changes over time in a particular community or geographic area. The numerical score values for individual tracts are not directly comparable over time because the scores for each time period are calculated relative to other tracts during that time period. In addition, the scores do not provide clear guidance on which components of social vulnerability have contributed to changes in score values. For these reasons, tracking of changes in social vulnerability over time can be better accomplished through the use of single variable indicators.

As the above review suggests, there are many options for documenting and tracking spatial vulnerability in New York City. Both SoVI and SVI have been empirically validated and replicated and are widely used throughout the United States (Bakkensen *et al.*, 2017; Myers *et al.*, 2008; Cutter and Emrich, 2006). Creation of social vulnerability maps based on either method would aid in the identification of census tracts with high levels of social vulnerability to all types of climate stressors including heat and floods.

Either method would require updates on a regular basis as new ACS and Census data are released. These updates could potentially be incorporated into future NPCC assessments. In conjunction with updates based on new data releases, they would also need to be regularly evaluated based on "ground truthing" in local communities to ensure that mapping results reflect conditions perceived by local residents (Schmidtlein *et al.*, 2008; O'Brien *et al.*, 2004).

**Table 6.5. Other social vulnerability indexes and applications**

| Index name | Data and geography | Number of indicators and methodology | Climate stressors and other environmental hazards | References |
|---|---|---|---|---|
| Social Determinants of Vulnerability Framework: Climate Vulnerability Assessment for the City of Boston (2016) | Data from U.S. Census 2010, American Community Survey (2008–2012), and SimplyMap Easy Analytic Software. Census tract level for City of Boston | 12 indicators<br>Correlation analysis and mapping of hotspots | Environmental hazards (non-specific) | Martin (2015) |
| Heat Vulnerability Index (2017) | Data from U.S. Census (2010), American Community Survey, New York City Department of Parks and Recreation, U.S. Geological Survey. Community district for New York | Four indicators (two environmental and two social)<br>Additive normalization approach | Heat | City of New York (2017b); Madrigano *et al.* (2015) |
| Social vulnerability index for New York City (2018) | Data from U.S. Census 2010 and American Community Survey (2006–2010). Census tract level | 10 indicators<br>Compared indices using: (1) additive normalization with weighting; (2) additive normalization with no weighting; (3) principal component analysis (PCA) | Flooding and heat | Reckien (2018) |

As an alternative or supplement to construction of vulnerability indices, the city may also consider tracking of specific indicators of neighborhood vulnerability over time. Use of specific indicators would permit documentation of changes over time (see Chapter 8, Indicators and Monitoring) and ensure continual needs-based targeting of adaptation efforts as part of the proposed pilot New York City Climate Change Resilience Indicators and Monitoring System (NYCLIM). While many factors contribute to social vulnerability of specific households or groups, the above approaches permit identification of variables that are widely found to be indicative of social vulnerability.

The proposed variables (see Table 6.6), all of which were found to contribute to social vulnerability in the studies reviewed above, are intended to provide a starting point for vulnerability tracking for climate stressors in New York City and may be supplemented with additional indicators that are viewed as relevant by the city or by particular communities:

- Access and functional needs populations
- Educational attainment
- English fluency
- Female-headed household
- Foreign-born population
- Income
- Older adults over 65
- Poverty
- Race/ethnicity
- Rent burden

These proposed indicators, which are updated annually by the ACS at the census tract level, would allow for the tracking of factors that are widely thought to contribute to social vulnerability

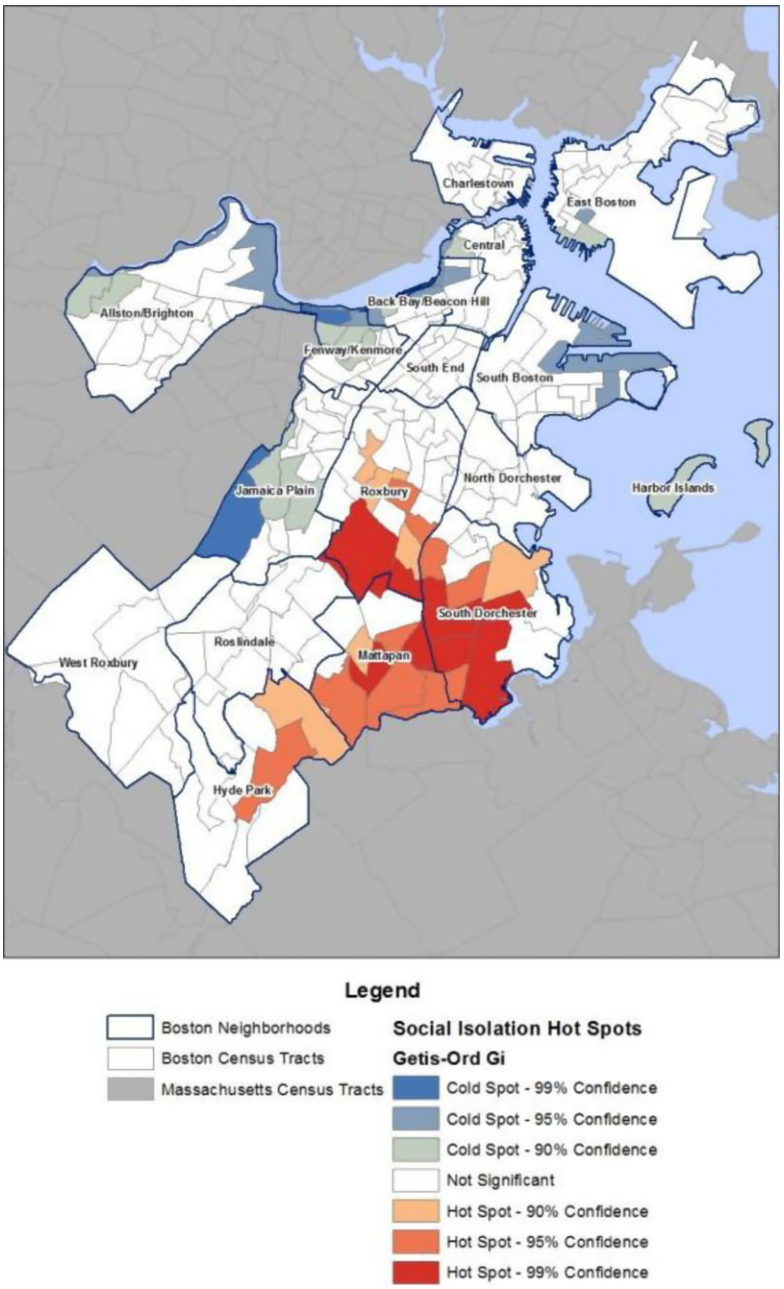


**Figure 6.4.** Illustration of single variable indicator (social isolation) map showing hotspots in the City of Boston (Martin, 2015).

and spatial differences or inequalities in vulnerability. The indicators are intended to capture demographic, economic, housing, and educational disparities across neighborhoods. They also capture access and functional needs populations and older populations who are especially at risk to climate extremes (Kinney *et al.*, 2015).

One important consideration with respect to tracking is the unit of analysis. While block groups provide fine-scale details on the locations of socially

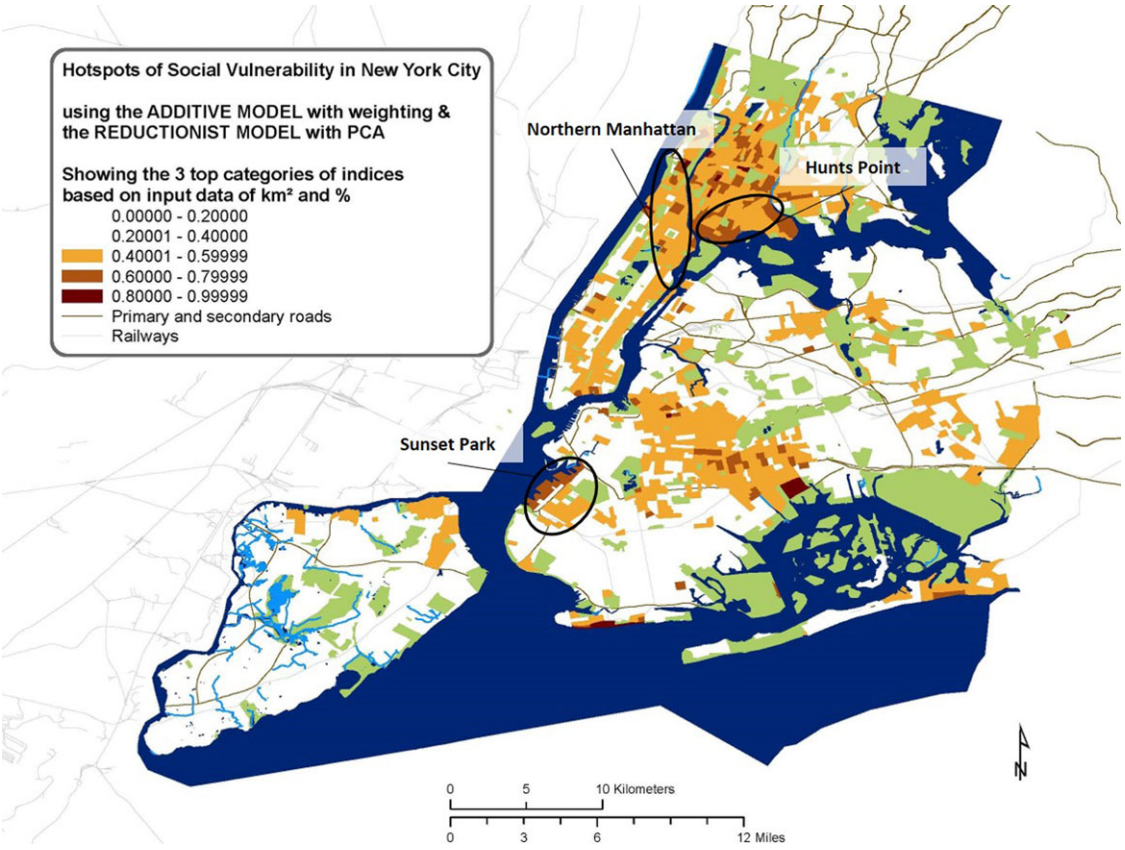


**Figure 6.5.** Map of vulnerability hotspots in New York City (Reckien, 2018).
NOTE: NPCC3 community case study neighborhoods are circled.

vulnerable populations, these data are not consistently available for all block groups in the city.

Because tract-level data are available on a consistent basis, and because the City uses aggregated tract-level data to determine administrative boundaries (e.g., community districts (CDs), neighborhood tabulation areas), we propose tracking at this more aggregated level. We suggest that the tracking process should be supplemented, as needed, using city health data sources (e.g., NYC Environment and Health Data Portal) to ensure accurate documentation of access and functional needs populations.

Additional city-specific health-related variables related to climate change might include, for example, population lacking air conditioning, population lacking health insurance, population living with chronic health conditions, population with asthma, and population dependent on electric medical equipment (Kinney *et al.*, 2015; McArdle, 2013).

Social vulnerability mapping provides important information about distributional inequalities in susceptibility to harm as a result of climate change, and how these inequalities vary across New York City communities. This information can serve as a useful tool for needs-based targeting of adaptation resources. However, social vulnerability mapping does not illuminate why certain neighborhoods are more vulnerable than others.

To effectively address, or to reduce, social vulnerability to climate change, it is necessary to understand the factors that shape the vulnerability of a particular neighborhood or community. As will be discussed in the next section, equitable climate change adaptation planning requires a contextual assessment and analysis of inequity in vulnerability to climate change impacts.

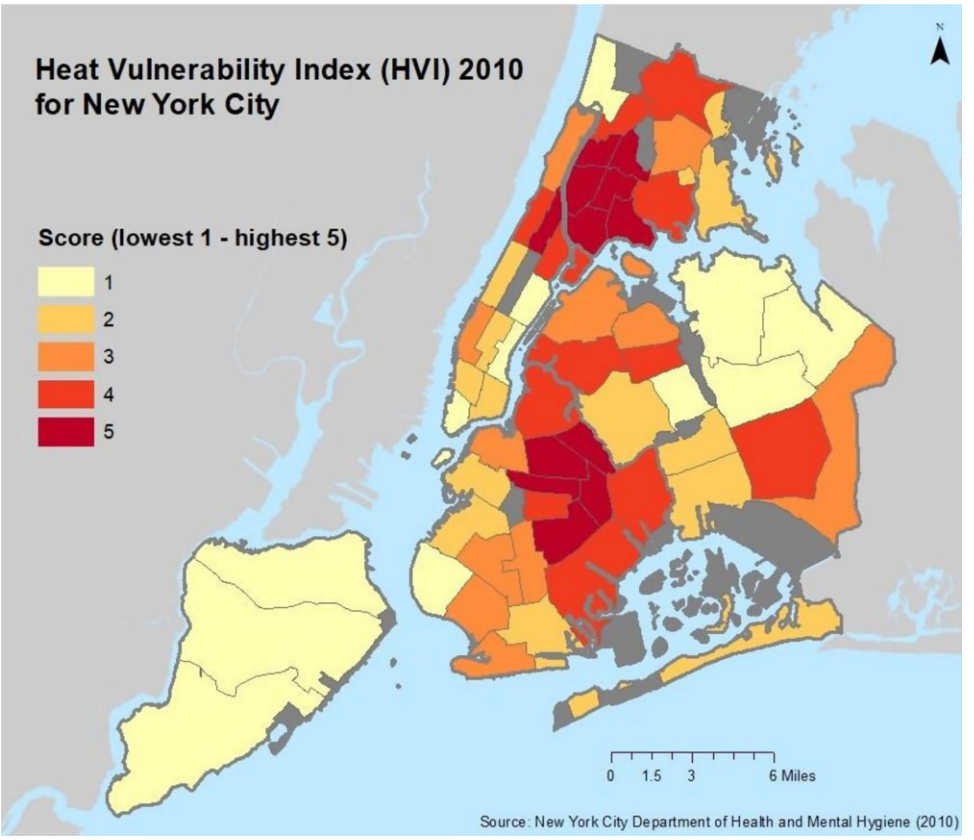


**Figure 6.6.** Heat Vulnerability Index for New York City based on data from NYC DOHMH (2015).

## 6.4. Community case studies

In this section, we conduct a contextual equity analysis via case studies of socially vulnerable communities. This type of qualitative case study research and the community inputs we sought and received is a critical supplement to analysis of distributive equity. It is necessary to validate spatial patterns of vulnerability and to explain why certain communities are more vulnerable to environmental and climate extremes than others. The results of the SoVI, SVI, and other social vulnerability analyses played an important role in the selection of our case study communities.

A core tenet of the environmental justice movement is that environmentally overburdened communities should "speak for themselves" with regard to the ways that they suffer the injustice of disproportionate hazard exposure (Bullard and Alston, 1990). As such, the very concept of environmental injustice (or inequality) is rooted in the idea of contextual equity. Scholars have articulated and analyzed the theory of environmental injustice "from the ground up," investigating and listening to (as well as capturing the voices of) communities as a window into economic and social factors and dynamics rendering those communities vulnerable to disproportionate hazard exposure (Cole and Foster, 2001; Foster, 2017).

Following this approach to the issue of climate justice and equity, the CBA Workgroup conducted case studies of three environmental justice communities in New York City: northern Manhattan; Sunset Park, Brooklyn; and Hunts Point, the Bronx in order to better understand the interaction between environmental and climate stressors and social and economic disadvantages. We collaborated with major CBOs in these neighborhoods to capture the different contexts in which the communities face climate and other risks.

**Table 6.6. Initial proposed list of vulnerability indicators for NYCLIM**

| Vulnerability factor | Potential social indicators | Census data source |
|---|---|---|
| Access and functional needs populations | Percent of civilian non-institutionalized population with a disability | ACS 2012–2016 DP02 |
| Educational attainment | Percent population with bachelor's degree or higher | U.S. Census 2010 S1501<br>ACS 2012–2016 SF1501 |
| | Percent population over 25 years old with no high school degree | U.S. Census 2010 S1501<br>ACS 2012–2016 SF1501 |
| English fluency | Percent population 5 years or over who speak English less than "very well" | ACS 2012–2016 DP02 |
| Female-headed household | Percent of female-headed households | U.S. Census 2010 QT-P11<br>ACS 2012–2016 S1101 |
| Foreign-born population | Percent of foreign-born population | ACS 2012–2016 B05002 |
| Income | Median household income | ACS 2012–2016 DP03 |
| | Percent of households receiving public assistance income | ACS 2012–2016 B19057 |
| Older adults over 65 | Percent population over 65 years old | U.S. Census 2010 DP-1<br>ACS 2012–2016 DP05 |
| Poverty | Percent of population living below poverty level | ACS 2012–2016 S1701 |
| Race/ethnicity | Percent of nonwhite population | U.S. Census 2010 DP-1<br>ACS 2012–2016 DP05 |
| Rent burden | Percent of occupied units paying 35% or more of household income on rent | ACS 2012–2016 DP04 |

These CBOs, all of which are engaged with their communities in the development of climate action plans, include WE ACT (West Harlem, northern Manhattan), UPROSE (Sunset Park, Brooklyn), and THE POINT CDC (Hunts Point, South Bronx).

In addition to interviewing representatives from each of these CBOs, the CBA Workgroup also interviewed city officials, reviewed policy and planning documents from both the city and the CBOs, and collected relevant demographic and health data from city agencies and public sources. CBO representatives also provided feedback and comments on earlier drafts of this chapter, which were incorporated into subsequent drafts.

The CBA Workgroup selected these case study communities for three primary reasons. The first reason is that these communities in many ways exemplify and are representative of the social vulnerability that characterizes many of New York City's neighborhoods. As researchers at NYU's Furman Center found in their 2017 "State of New York City's Housing and Neighborhoods" report, low-income New Yorkers of different races and ethnicities tend to live in certain areas of the city and under significantly different conditions than do most others (Austensen *et al.*, 2017).

Low-income New Yorkers, especially those who are non-Hispanic black and Hispanic, live in neighborhoods with more violence, poorer quality schools and housing conditions, fewer college graduates, and lower rates of employment. Low-income non-Hispanic blacks and Hispanics tend to be concentrated in the Bronx, northern Manhattan, and northern Brooklyn. Low-income Asian residents are more concentrated in southern Brooklyn, parts of Queens, and the Lower East Side of Manhattan. Low-income whites are concentrated in southern and northwest parts of Brooklyn (Austensen *et al.*, 2017).

The second reason we chose these communities and CBOs is their engagement in climate change. In addition to having a history of environmental justice activism, they are each deeply engaged in climate adaptation, mitigation, and resilience projects. Importantly, the CBOs have been given support by foundations, such as the Kresge Foundation, that help fund community-based climate efforts in socially marginalized or vulnerable neighborhoods. Northern Manhattan, Sunset Park, and Hunts Point thus represent a

selected sample of communities that reflect the ways social vulnerability manifests in New York City and that have a long history of advocacy for environmental and climate justice. These communities have also been highlighted in the City of New York's OneNYC Plan (City of New York, 2015).

The third reason we chose these case study communities is their social vulnerability. These three neighborhoods were identified from the indices reviewed in Section 6.3. Those results, which are indicative of distributional inequalities across city neighborhoods, show that these are appropriate case study areas for further investigation of contextual and procedural equity related to climate change.

The case studies provide contextual information about these predominantly racial and ethnic minority, low-income communities and the critical climate and non-climate stressors that concern them. The CBA Workgroup collaborated with CBO representatives to document climate stressors and equity issues to gain a better and more complete picture of vulnerability concerns in these communities. We also investigated their interactions with the city's climate mitigation and adaptation efforts as a lens into assessing the issue of procedural equity, which is the subject of Section 6.5.

In addition to interviewing each CBO to learn about the historical and current vulnerability of these communities to environmental pollution and climate change, we also captured their demographic and social profiles using publicly available data (see Appendix 6.A). Current socio-demographic data about the study areas were collected and described at the CD level from the New York City Department of City Planning (NYC DCP, 2018a). Census data for CDs come from the 2000 U.S. Census, 2010 U.S. Census, and the latest 2012–2016 ACS. Public use microdata areas can be used to approximate data for the CDs.

### 6.4.1 *Northern Manhattan (Harlem, Washington Heights, Inwood)*

The geographic area for the northern Manhattan case study consists of the northern portion of New York City's Borough of Manhattan. It includes the following neighborhoods: Hamilton Heights, Manhattanville, and West Harlem (Manhattan CD 9); Central Harlem (Manhattan CD 10); East Harlem (Manhattan CD 11); and Washington Heights, Inwood, and Marble Hill (Manhattan CD 12) (see Fig. 6.7). The Hudson River, located west of the study area, and the Harlem River, east of the study area, separate the island of Manhattan from New Jersey and the Bronx, respectively. Northern Manhattan has an estimated area of 8.1 sq miles. It had a population of over 600,000 people in 2016 and a population density of approximately 74,950 people per sq mile.

Northern Manhattan is home to many educational and health-related institutions including Columbia University, City University of New York, St. Luke's–Roosevelt Hospital, Harlem Center for Health Promotion and Disease Prevention, Harlem Hospital Center, and Columbia Medical Center. It also contains major transportation infrastructure including the Henry Hudson Parkway, Broadway/Amsterdam, heavily traveled north–south truck routes, Harlem River Bridge, six north–south subway lines, and numerous MTA bus routes.

This area is characterized by very heavy traffic density, experiencing twice the rate of miles traveled than the rest of New York City. While the average annual amount of vehicle miles for cars and trucks traveled per square kilometer in New York City is 23 million miles, it is almost 47 million miles in Washington Heights, 40 million miles in Central Harlem, and 60 million miles in East Harlem (NYC DOHMH, 2018). These are indicators of emissions from automobile exhaust, brake wear, and tire wear.

Northern Manhattan is also host to multiple polluting or hazardous sources including MTA bus depots, the North River Wastewater Treatment Plant, and the closed 135th Street Marine Waste Transfer Station. Harlem is home to a number of public housing (NYCHA) buildings and also the disproportionate siting of environmentally hazardous land uses, which have been a source of many community complaints about air pollution (Sze, 2006).

Given the area's history as a manufacturing and industrial center, some communities in northern Manhattan, particularly Harlem, have long been characterized as experiencing disproportionate exposure to waste, pesticides, toxic products, and other environmental hazards (Sze, 2006; Brown *et al.*, 2003).

This heavy exposure has contributed to poor air quality in the neighborhood, among other health stressors (Brown *et al.*, 2003). Asthma rates in 2005

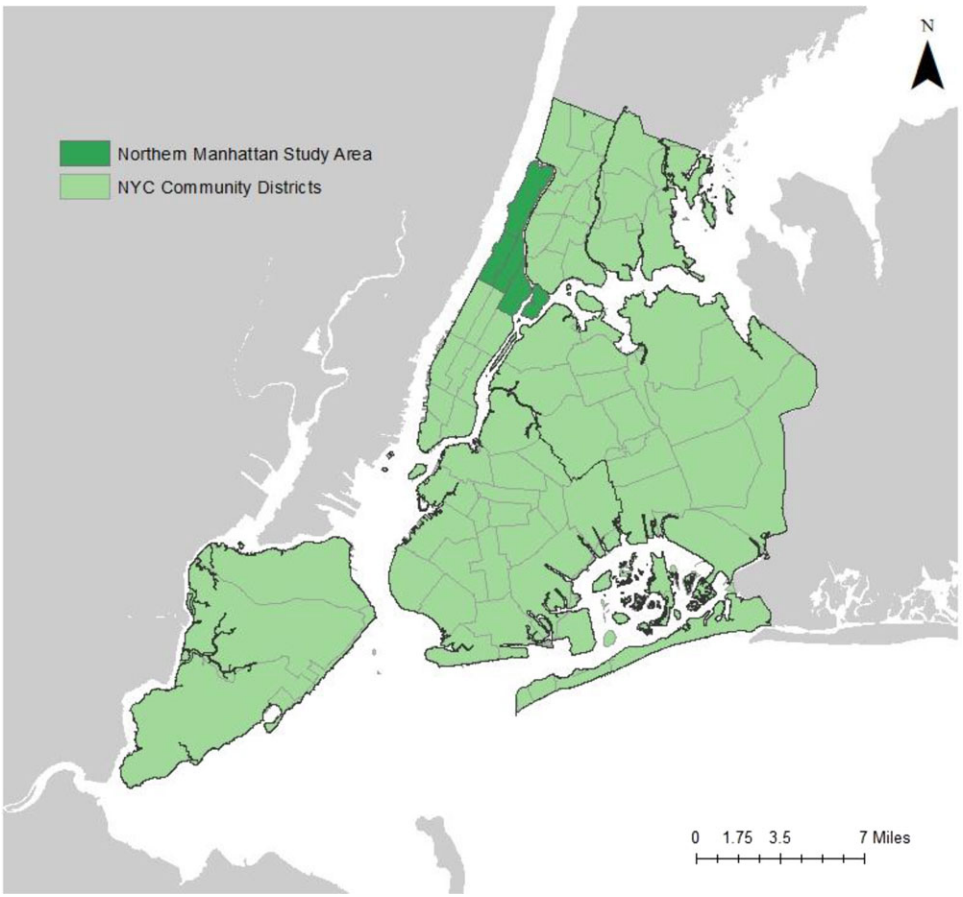


**Figure 6.7.** Northern Manhattan case study region.

were four times the national average and some studies have found that at least one in four children in Central Harlem has asthma (Corburn *et al.*, 2006; Nicholas *et al.*, 2005; Diaz *et al.*, 2000). When compared to the city as a whole, Central and East Harlem, in particular, have worse air pollution, higher asthma hospitalizations and emergency visits among children and adults, and worse health outcomes overall (Corburn *et al.*, 2006). In Central and East Harlem, asthma emergency visits in 2014 for children 5–14 years old average 638 and 631 per 10,000 residents, respectively. These rates are significantly higher than those for Manhattan (304) and New York City overall (260) (NYC DOHMH, 2018).

Similarly, asthma hospitalization rates in people over 15 years old are disproportionately higher for this area with rates of 44 and 48 per 10,000 residents, respectively in Central and East Harlem, which are more than twice the rates of Manhattan (17) and NYC (22) (NYC DOHMH, 2018). Many emergency room visits are attributable to exposure to fine particulates (PM2.5). In Central and East Harlem, PM2.5 emergency visits were 137 and 147 per 100,000 residents for adults and 291 and 299 for children—again, much higher than PM2.5 ER visits for Manhattan (46 for adults and 144 for children) or New York City as a whole (45 for adults and 107 for children) (NYC DOHMH, 2018).

Many northern Manhattan communities are socially and economically fragile. More than 20% of northern Manhattan residents live at or below the poverty line. They live in poor housing stock often with exposure to lead paint and elevated indoor pollution rates (Corburn *et al.*, 2006). In Central Harlem and Washington Heights in 2011, fewer homes and structures were rated in good or excellent shape (60% and 50%, respectively), as

compared to those in Manhattan (80%) and New York City overall (75%) (NYC DOHMH, 2018).

Likewise, only about 37% of renter occupied homes in Central Harlem and 34% in Washington Heights reported no maintenance deficiencies, compared to 48% in Manhattan and 44% in New York City as a whole (NYC DOHMH, 2018). Homes in Washington Heights (26%), Central and East Harlem (28% and 31%, respectively) report maintenance deficiencies at twice the rate for Manhattan (14%) and New York City overall (15%) (NYC DOHMH, 2018).

Notwithstanding the long history of struggle against environmental injustice, zoning, and other land-use changes in recent years, scholars and community activists are increasingly concerned about the threat of displacement and gentrification in Harlem and other parts of northern Manhattan (Savitch-Lew, 2018; Morse, 2017; Checker, 2011). As higher-earning individuals are being drawn into core cities, the price of housing is rising and putting pressure on the affordability of its neighborhoods for many longtime residents (Goldstein, 2017). Many low-income minority communities in northern Manhattan are now undergoing changing demographics, with many residents moving away and more affluent residents moving in (Zanoni, 2011).

Even though other regions of New York were influenced by three decades of gentrification, upper Manhattan did not experience much of it until the end of the 20th century (Outka, 2016). Between 2000 and 2016, northern Manhattan gained over 60,000 people, an increase of 11.4% as compared to an increase of 6.4% for the Borough of Manhattan and 6.6% citywide. White and Asian populations increased by more than 90%, while black population decreased by 10%. The Hispanic population had a modest increase of less than 3%.

Despite this overall growth in the region, some neighborhoods including Washington Heights and Inwood both experienced population declines of 15,554 and 2341, respectively, with increasing numbers of less affluent residents leaving these areas since 2000. Community Board 12 Chair, Pamela Palanque-North, attributes the decline of low-income populations to the lack of affordable housing options in Washington Heights (DNAinfo, 2012). Table 6.7 shows a list of indicators that are relevant to community vulnerability to climate change and compares data for those indicators in northern Manhattan with that of the Borough of Manhattan and the city as a whole.

As these broad trends suggest, many neighborhoods in northern Manhattan are experiencing a high degree of what some researchers term "ethnic churning"—large percentage shifts in the demographics of the area that can render some of these communities vulnerable to weakening social ties or social capital (Betancur, 2011; Sadd *et al.*, 1999). Researchers have found that ethnic churning, more generally, can leave communities vulnerable to hazardous facility siting and other environmental inequities due to frayed social ties.

On the other hand, areas richer in social capital are better able to resist such siting, regardless of their level of other political and economic assets (Balzarini and Shlay, 2018; Cutter *et al.*, 2014; Pastor and Manuel, 2001). While ethnic churning may not have left northern Manhattan communities vulnerable to hazardous waste facility siting, frayed social ties can threaten their ability to adapt and survive extreme weather events such as heat waves (Klinenberg, 2015).

Other non-climate stressors that contribute to community vulnerability in northern Manhattan communities include rising energy costs, lack of access to healthy and affordable food choices, quality health care, affordable and equitable transit, and safe and quality housing.

In addition to traditional environmental pollution and poor air quality conditions, there are significant climate stressors in the neighborhood. Chief among these is exposure to heat waves due to the urban heat island effect and the lack of adequate air conditioning in many homes (Vant-Hull *et al.* 2018).

In Washington Heights in 2013, for instance, only 73% of adults over the age of 65 reported having air conditioning in their home, a lower rate than Manhattan (88%) and New York City overall (87%) (NYC DOMH, 2018). Heat stress emergency visits per 100,000 residents were higher in Washington Heights (12), Central Harlem, (18) and East Harlem (13), than in Manhattan (8) and New York City overall (9) (NYC DOHMH, 2018).

Some neighborhoods near the Hudson and East Rivers are located within the 100-year floodplain and are also at risk to sea level rise and storm surge (see Chapter 3, Sea Level Rise; and

**Table 6.7. Socioeconomic characteristics of northern Manhattan, with climate change vulnerability implications, compared with the Borough of Manhattan and New York City (NYC DCP, 2018a)**

| Indicators | Northern Manhattan | Manhattan | New York City |
|---|---|---|---|
| Foreign-born population | 34.4% | 28.9% | 37.2% |
| Limited English proficiency | 24.2% | 15.6% | 23.0% |
| Educational attainment or residents aged 25+ with bachelor's degree or higher | 35.6% | 60.4% | 36.2% |
| Median household income ($2016) | $40,917 | $75,513 | $55,191 |
| Unemployment rate | 11.0% | 6.9% | 8.6% |
| Poverty measure (authors' calculation based on residents who have income below the NYCgov* poverty threshold) | 21.6% | 13.9% | 20.3% |
| Renter-occupied housing units | 89.3% | 76.9% | 68.0% |
| Rent burden (households spending more than 35% of income on rent | 42.7% | 37.1% | 44.6% |
| Access and functional needs populations | 12.1% | 9.9% | 10.5% |
| Population over 65 | 11.5% | 14.4% | 13.0% |

*The NYCgov poverty measure is a metric that was developed by the Poverty Research Unit of the Mayor's Office for Economic Opportunity in order to capture poverty in the city more accurately than the federal measure (City of New York, 2018a).

Chapter 4, Coastal Flooding). Almost 95% of the East Harlem area and 64% of the Central Harlem area are located within the hurricane evacuation zone; this is substantially larger than the area for the rest of Manhattan (49%) and New York City overall (47%) (NYC DOHMH, 2018).

### *6.4.2 Sunset Park, Brooklyn*

Sunset Park is a waterfront neighborhood located in the western part of Brooklyn (Fig. 6.8). It has an area of approximately 3.7 square miles. Sunset Park is a community with more than 150,000 residents with a population density of approximately 40,880 people per sq mile. It is bordered by the neighborhoods of Park Slope and Greenwood Heights to the north and Bay Bridge to the south. It is roughly bound by 15th Street to the north; Fort Hamilton Parkway, 37th Street, and 8th Ave to the east; 65th Street to the south; and Upper New York Bay. The Gowanus Expressway/Interstate I-278 divides the neighborhood into two distinct areas: the industrial waterfront and the upland residential community.

Sunset Park is home to one of the last industrial working waterfronts in New York City. Dominant economic activities are anchored in manufacturing, wholesale trade, and construction. Sunset Park is also home to a critical assemblage of city-owned waterfront properties such as the South Brooklyn Marine Terminal, Bush Terminal Industrial Campus, Brooklyn Meat Market, and the Brooklyn Army Terminal (NYC SIRR, 2013). The waterfront hosts automobile shops, active industrial and polluting facilities, brownfield sites, and defunct factories (NYC DCP, 2011).

Sunset Park is also home to multiple rail and highway networks including the Bay Ridge Channel, Cross Harbor barge service, Bay Ridge Rail Line, and the Gowanus Expressway. The area is characterized by high traffic density, with about 26 million annual vehicle miles traveled per square kilometer (NYC DOHMH, 2018). Heavy congestion and a high volume of truck traffic on the Gowanus Expressway and on the waterfront contribute to the poor air quality in neighborhood.

A predominantly Hispanic and Asian immigrant community, the area is also undergoing some demographic change as the number of Hispanics and non-Hispanic Blacks is decreasing slightly, while Asian and White populations are increasing sharply. This demographic change is happening alongside the transition from an industrial to a service economy, which creates job insecurity in a community with relatively low levels of formal education and high levels of limited English proficiency (see Table 6.8).

Although Sunset Park retains some of its manufacturing sectors, it has experienced a gradual decline in industrial activities and related jobs over

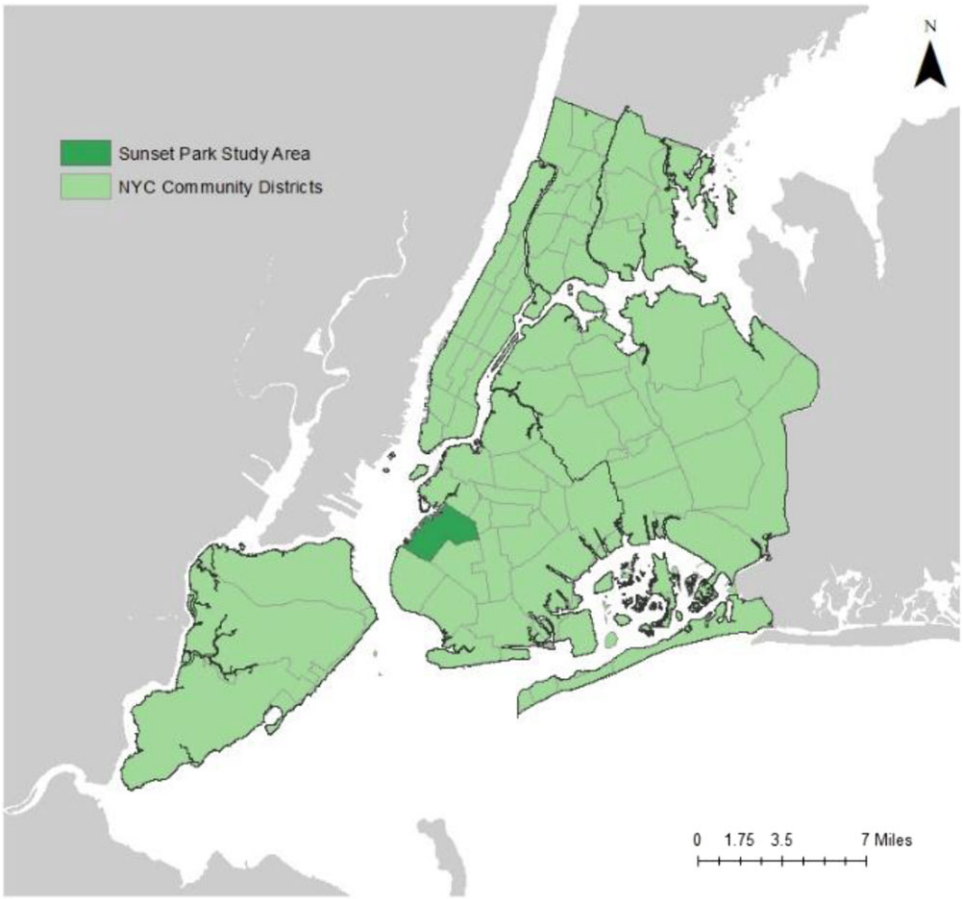


**Figure 6.8.** Sunset Park, Brooklyn case study region.

the past several decades (Hum, 2014). The increased presence of commercial development in the area often means a higher share of unskilled, low-wage jobs in the service sector, as compared to skilled industrial jobs that historically offered a higher wage (Hum, 2014).

The commercialization of Sunset Park is widely perceived by residents as catering to middle- and upper-middle-class clientele and is becoming increasingly inaccessible to the area's low-income residents. Similar to the socio-demographic shifts in northern Manhattan, these changes are indicative of a larger gentrification of the area, as "young white professionals" and "creative-class members" who cannot afford other areas in the city are settling in once-dilapidated sections of the community (Hum, 2014).

Some also point to the additional development pressure resulting from rezoning of the area as a driver for gentrification (Sze and Yeampierre, 2018; Amar, 2017; Warerkar, 2017; Hum, 2014). As Sunset Park benefits from the environmental cleanup of its industrial legacy and the City's efforts to redevelop the waterfront, it is likely that the area will continue to attract additional newcomers, putting pressure on existing residents who face rising housing costs (Sze and Yeampierre, 2018).

At the same time that cost of living and rents are rising, low-income residents in the neighborhood often live with poor housing conditions. Housing quality for low-income tenants is a big, and very public, concern in Sunset Park, as indicated through media coverage. In a 2015 survey, 58% of renter-occupied homes in the area reported at least one maintenance defect (e.g., water leaks, cracks and holes, inadequate heating, presence of mice or rats, toilet breakdowns, and peeling paint) (NYC DOHMH, 2018).

**Table 6.8. Socioeconomic characteristics of Sunset Park, Brooklyn, with climate change vulnerability implications, compared with the Borough of Brooklyn and New York City (NYC DCP, 2018a)**

| Indicators | Sunset Park | Brooklyn | New York City |
|---|---|---|---|
| Foreign-born population | 47.8% | 37.2% | 37.2% |
| Limited English proficiency | 48.6% | 23.1% | 23.0% |
| Educational attainment or residents age 25+ with bachelor's degree or higher | 26.2% | 34.1% | 36.2% |
| Median household income ($2016) | $48,232 | $50,640 | $55,191 |
| Unemployment rate | 7.7% | 9.0% | 8.6% |
| Poverty measure (residents who have income below the NYCgov poverty threshold)* | 29.4% | 20.5% | 20.3% |
| Renter-occupied housing units | 73.9% | 70.6% | 68.0% |
| Rent burden (households spending more than 35% of income on rent) | 51.7% | 45.7% | 44.6% |
| Access and functional needs populations | 8.6% | 10.1% | 10.5% |
| Population over 65 | 8.9% | 12.2% | 13.0% |

*The NYCgov poverty measure is a metric that was developed by the Poverty Research Unit of the Mayor's Office for Economic Opportunity in order to capture poverty in the city more accurately than the federal measure (City of New York, 2018a).

Sunset Park's waterfront location and the presence of numerous power plants, waste stations, and other industrial sites render the neighborhood vulnerable to both the direct impacts of sea level rise and higher storm surge as well as indirect industrial-contaminated flooding. The area, located next to New York Harbor, is home to electrical generators operated by New York Power Authority, diesel-powered electric generators owned by Con Edison, turbine units belonging to Eastern Generation, the Hamilton Avenue Marine Transfer Station, a commercial waste station, a recycling facility, a garage for garbage trucks, the Owls Head Wastewater Treatment Plant, and other numerous brownfields and nonoperational industrial buildings.

Sunset Park is also located within a combined sewer district in New York City, which implies that during flooding events, sanitary and storm waters will be intermingled (NYC SIRR, 2013).

The low-lying neighborhood is particularly vulnerable to flooding (see Chapter 3, Sea Level Rise; and Chapter 4, Coastal Flooding). Over 33% of the Sunset Park area is located within hurricane evacuation zones (NYC DOHMH, 2018). This risk carries with it the potential that surging storm water could spread toxins from the many nearby industrial sites. During Hurricane Sandy, Sunset Park's waterfront was heavily flooded and chemical-contaminated water was pushed into residential areas (Madrigano *et al.*, 2018; Bautista *et al.* 2015).

Another climate-related stressor is heat, as hot summers can worsen the effects of air pollution and impact low-income residents without adequate air conditioning. In a citywide 2015 survey, 69% of adults aged 65 and over reported air conditioning in the home in 2013, which was lower than Brooklyn's overall 86.7% and New York City's overall 87.7% (NYC DOHMH, 2018). About 4.5 per 100,000 Sunset Park residents were admitted for heat stress hospitalization in 2013; higher than Brooklyn's rate of 3 and New York City's overall rate of 2 per 100,000 residents (NYC DOHMH, 2018).

Moreover, the area is perceived by residents as lacking sufficient greenspace to help mitigate the effects of heat exposure. Only 26% of Sunset Park's area is estimated to have vegetative cover (i.e., trees and grass), which is comparable to the amount of greenspace in Brooklyn but about 10% lower than that average amount of green space in New York City (NYC DOHMH, 2018).

### *6.4.3 Hunts Point, South Bronx*

Hunts Point (Fig. 6.9) is located in the South Bronx. It occupies approximately 4.4. sq miles. As of 2016, Hunts Point had a population of more than 160,000 people with a population density of approximately 36,663 people per sq mile. It is home to the NYC Food Distribution Center (FDC) and its related infrastructure.

The 329-acre FDC facility occupies nearly half of the Hunts Point Peninsula in the South Bronx.

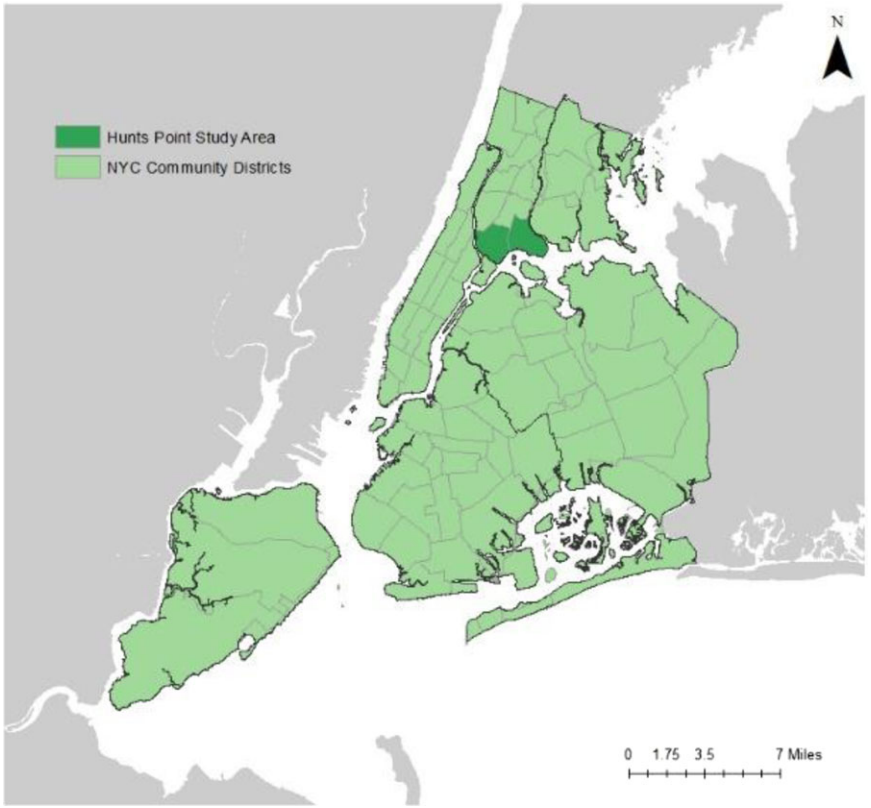


**Figure 6.9.** Hunts Point, South Bronx case study region.

It is owned and operated by the New York City Economic Development Corporation (NYCEDC) with an annual revenue of more than $3 billion (NYC SIRR, 2013). It employs about 7000 people (NYC Food Policy, 2014). The FDC, consisting of the Hunts Point Terminal Produce Market, the Cooperative Meat Market, and the New Fulton Fish Market, provides food and produce for 23 million people regionally, and supplies 60% of New York residents' fruit and vegetable consumption (NYC Food Policy, 2014).

Activities at the FDC involve more than 10,000 truck trips per day. In addition to the FDC, Hunts Point also contains nine waste transfer stations (WTS) that contribute to the truck traffic in the neighborhood (New York Environment Report, 2015). Although there are numerous expressways in the South Bronx and Hunts Point, there are no direct access routes from the highways to the industrial areas.

Air pollution is one of the most pressing environmental issues in Hunts Point given vehicle and truck traffic serving the FDC and industrial facilities and spilling over into residential streets (Corburn *et al.*, 2006). Exposure to fine particulate matter (PM 2.5) is elevated in the area compared to the Bronx and NYC overall; average rates in 2016 are 8.3 mcg per cubic meter in the area versus 7.8 overall in the Bronx and 7.5 overall in NYC (NYC DOHMH, 2018).

For adults in Hunts Point, the attributable asthma emergency department visit rate was 138 per 100,000, more than twice the rate for the Bronx (67) and citywide (45) (NYC DOHMH, 2018). For children, however, exposure to PM 2.5 is highly elevated compared with the rest of the Bronx and NYC (251 per 100,000 in Hunts Point-Mott Haven, compared with the Bronx 128 and NYC 107) (NYC DOHMH, 2018).

Hunts Point is predominantly made up of Hispanics and non-Hispanic Blacks. Residents have suffered from a high rate of poverty and the prevalence of asthma among all age groups (see Table 6.9). The Department of Health Bureau of Biometrics and Health Statistics reported that the Bronx has the

**Table 6.9. Socioeconomic characteristics of Hunts Point-Mott Haven, with climate change vulnerability implications, compared with the Borough of the Bronx and New York City (NYC DCP, 2018a)**

| Indicators | Hunts Point-Mott Haven | the Bronx | New York City |
|---|---|---|---|
| Foreign-born population | 29.6% | 34.9% | 37.2% |
| Limited English proficiency | 32.6% | 26.0% | 23.0% |
| Educational attainment, or residents age 25+ with bachelor's degree or higher | 9.8% | 19.1% | 36.2% |
| Median household income ($2016) | $23,131 | $35,302 | $55,191 |
| Unemployment rate | 12.2% | 12.7% | 8.6% |
| Poverty measure (residents who have income below the NYCgov poverty threshold)* | 29.3% | 25.0% | 20.3% |
| Renter-occupied housing units | 92.4% | 80.9% | 68.0% |
| Rent burden (households spending more than 35% of income on rent) | 48.6% | 50.6% | 44.6% |
| Access and functional needs populations | 14.0% | 13.8% | 10.5% |
| Population over 65 | 8.2% | 11.3% | 13.0% |

*The NYCgov poverty measure is a metric that was developed by the Poverty Research Unit of the Mayor's Office for Economic Opportunity in order to capture poverty in the city more accurately than the federal measure (City of New York, 2018a).

highest age-adjusted asthma death rate (43 deaths per million) among all counties in the state. In 2013, Hunts Point-Longwood had the third-highest asthma hospitalization rate among children 5–14, more than twice the city rate (88 per 100,000 for Hunts Point; 72 for the Bronx; and 36 for NYC) (NYC DOHMH, 2018).

Similarly, the rate of asthma emergency room visits in 2014 for people aged 15 and over is elevated (340 per 10,000 residents) compared to the Bronx overall (224) and New York City (115) (NYC DOHMH, 2018). The rate of adult hospitalizations for asthma in Hunts Point is also twice the citywide rate (592 per 100,000 adults for Hunts Point-Longwood; 482 for the Bronx; 260 for NYC) (NYC DOHMH, 2018). A study by New York University also found that children in the South Bronx are twice as likely to attend a school near a highway as compared to other children in New York City (New York University Wagner ICIS, 2006).

As in other low-income communities, the housing stock in Hunts Point is old and fragile. Less than 50% of homes and structures in 2011 were rated as good or excellent, lower than those that rated similarly in the Bronx (58%) and New York City (75%) (NYC DOHMH, 2018). For example, the rate of homes with cracks, holes, and leaks has been higher there than in the Bronx and citywide. Nearly, one-third of homes (30%) reported three or more maintenance deficiencies (NYC DOHMH, 2018). Homes in this area had more sources of indoor allergens and pollutants that can exacerbate asthma than the rest of the Bronx and NYC (Corburn *et al.*, 2006). In 2014, as many as 40% of residents, for instance, reported the presence of cockroaches and rats in their building, higher than the reporting rates of the Bronx and New York City overall (NYC DOHMH, 2018)

Surrounded by the East River on two sides and the Bronx River on the third, Hunts Point is highly vulnerable to flooding. Approximately 93 acres of the site, or 28%, lies within the 100-year floodplain (NYC SIRR, 2013) (see Chapter 3, Sea Level Rise; and Chapter 4, Coastal Flooding). Over 70% of the Hunts Point-Mott Haven Area is located within a hurricane evacuation zone (NYC DOHMH, 2018).

Much like the other communities studied, climate change can exacerbate existing environmental risks in Hunts Point. The coastline has a history of heavy industrialization that contaminated the land around factories and rendered it unusable. In addition, the Hunts Point neighborhood also has numerous auto-mechanic shops and other auto-related infrastructure. Extreme precipitation events, sea level rise, and flooding can spread industrial chemical pollutants into residential areas. While the Hunts Point FDC was spared the worst inundation when Hurricane Sandy hit in 2012, residents and city officials are concerned about the impacts of future extreme weather

**Table 6.10. Summary of social, economic, climate, and other environmental stressors and needs identified by CBOs in the three case study communities**

| Communities | Northern Manhattan | Sunset Park, Brooklyn | Hunts Point, Bronx |
|---|---|---|---|
| **Social and economic stressors** | | | |
| Aging housing stock | X | X | X |
| Decrease in manufacturing jobs | – | X | – |
| Energy cost burdens | X | – | – |
| Increase in commercial presence | X | X | – |
| Health disparities | X | – | X |
| High number of foreign-born residents | – | X | – |
| High rate of poverty | X | X | X |
| Lack of affordable housing options | X | X | X |
| Rising cost of living | X | X | – |
| Unemployment | X | – | – |
| **Climate stressors** | | | |
| Rising average temperatures | X | X | X |
| Growing number of heat waves and hot days | X | X | X |
| Changing patterns of precipitation and inland flooding | X | X | X |
| Sea level rise | X | X | X |
| Coastal flooding from storm surge and sea level rise | X | X | X |
| Extreme hurricane winds | X | X | X |
| Drought | – | – | – |
| Cold snaps | – | – | – |
| **Other environmental stressors** | | | |
| Air pollution | X | X | X |
| High truck traffic | X | X | X |
| Storm water runoff | X | X | X |
| **Community needs** | | | |
| Access to healthcare services | X | – | – |
| Access to healthy food and lifestyle programs | – | – | X |
| Access to the waterfront | X | X | – |
| Access to affordable housing | X | X | X |
| Access to public health facilities | – | – | X |
| Access to greenspace | X | X | X |
| Improved disaster preparedness and evacuation planning | X | X | X |
| Protection of local employment | – | X | X |

events on the food supply system (NYC SIRR, 2013).

Hunts Point is also vulnerable to the impacts of the urban heat island effect. The neighborhood has limited green space and cooling facilities. Only 16% of the area has vegetative cover including trees and grass, which is much lower than the overall Bronx coverage (36%) and New York City coverage (35%) (NYC DOHMH, 2018). The effects of extreme heat are worsened by excessive truck exhaust. In 2013, heat stress hospitalizations were 3.5 per 100,000 residents, compared with the citywide rate of 2.4 per 100,000 residents.

### *6.4.4 Summary of contextual equity concerns in case study communities*

In the last two decades, New York City has become a more expensive, less affordable place to live (Yager, 2015). Communities in northern Manhattan, Sunset Park, and Hunts Point are all confronting the challenge of gentrification and/or displacement (Austensen *et al.*, 2015). In particular, CBOs identified numerous concerns related to changing social and economic conditions, including, concern about the rising cost of living, increased rents, and lack of affordable housing options (see Table 6.10) (Austensen *et al.*, 2015).

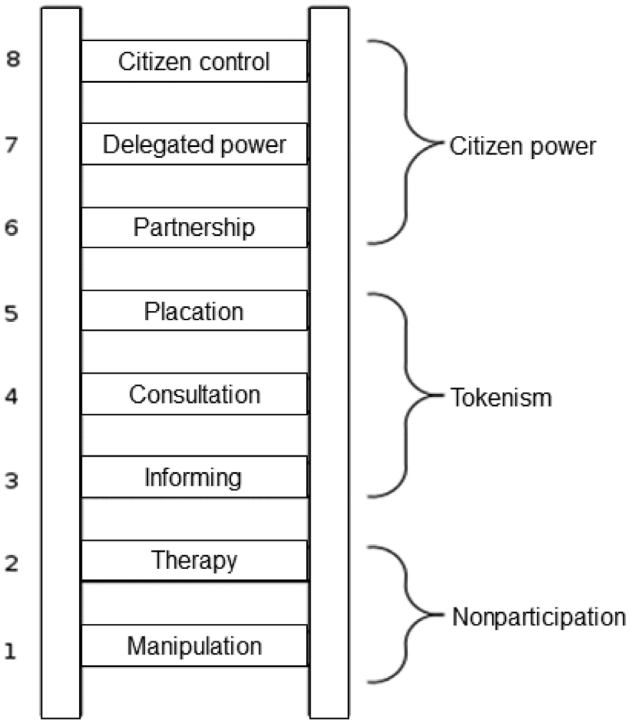


**Figure 6.10.** **Eight rungs on the ladder of citizen participation (Arnstein, 1969).**

In addition, the processes of deindustrialization and commercialization create great uncertainty regarding job opportunities. At the same time, there is an increased presence of commercial development in these areas, offering unskilled jobs in the service sector (as compared to skilled manufacturing and industrial jobs). These jobs do not allow existing residents to meet increases in the cost of living, particularly of housing.

New commercial activities typically cater to middle- and upper-middle-class clientele and are generally not accessible to low-income residents (Adams, 2016; Gonzalez, 2016). The growth of the commercial sector also contributes to conflicts over land use and planning. Vacant warehouses and buildings are being bought by private developers, which threatens to transform working-class neighborhoods into unaffordable upscale enclaves. Residents and community activists are actively fighting to preserve their manufacturing zoning and job opportunities (Fainstein, 2011; Sze and Yeampierre, 2018; Checker, 2011).

The neighborhoods of northern Manhattan, Sunset Park, and Hunts Point are hotspots of environmental pollution (see Table 6.10). They are disproportionately burdened with numerous hazardous and polluting industrial facilities and related activities (e.g., garbage processing centers, power plants, WTS, bus depots, and heavy traffic).

In all three neighborhoods, many industrial facilities or former industrial sites are located on the waterfront, which make them vulnerable to extreme flooding and heavy storm surges (Fainstein, 2011; Bautista *et al.*, 2015). These neighborhoods and their residents are concerned about having adequate emergency preparedness capacity and evacuation centers during natural disasters (NYCEJA, 2018).

Low-income residents bear the health consequences of living in proximity to these toxic sites. There is significant concern regarding toxic chemicals on the waterfront being displaced into residential areas. On the other hand, many young children and adults suffer from asthma and other respiratory illnesses, which can be exacerbated by worsened air quality during extreme heat events. Due to a lack of quality recreational green space, the more vulnerable residents, such as the elderly and children, are at risk of heat-related illnesses.

In order to address the unique ways and contexts in which communities are both ecologically and socially vulnerable, the CBOs on the CBA Workgroup emphasized that their communities lack some of the basic goods and services that are important to fostering resilient communities. A shortage of affordable and quality housing stock, lack of adequate health care and public health facilities, lack of access to healthy food and green spaces undermine these communities' ability to face and adapt to the environmental and climate stressors present in their communities. Expanding their access to these basic social and environmental goods should be a critical part of adaptation planning in socially vulnerable communities.

The CBOs also emphasized the importance of early and meaningful engagement with public officials in all phases of development planning in their communities, including adaptation planning and implementation. Each of the CBOs has engaged, often extensively, in adaptation planning in their communities and with their residents. The challenge is how to align these planning efforts with the city's adaptation planning processes. As we will discuss in Section 6.5, robust community engagement is a critical element of procedural equity in climate change adaptation.

## 6.5. Procedural equity

This section describes how each of the three case study communities engage in, and are included in, local adaptation planning efforts. Based on relevant literature, interviews with representatives from each of the CBOs, and conversations with City officials, we examine these efforts through the lens of procedural equity that draws upon Arnstein's (1969) widely used "ladder" of public participation (see Fig. 6.10). This study offered a typology or hierarchy of participation that illustrates the range of potential public engagement in official decision-making processes. The ladder depicts various levels of engagement ranging from nonparticipation (manipulation and power) to tokenism (informing, consultation, placation) to citizen empowerment (partnership, delegated power, and citizen control).

Arnstein (1969) argues that if restricted to the first two levels, participation will not change the *status quo* or result in meaningful engagement. The metaphor of the ladder also suggests a ranking of the levels. The higher levels are preferable to the lower, and the ultimate goal of participation is the achievement of decision-making power for citizens.

We also build upon recent work by Sarzynski (2015) who has developed a typology specific to public participation in climate adaptation planning. Based on the work of Dietz and Stern (2008), Sarzynski (2015) suggests a typology to categorize the different levels of public participation in climate change adaptation in cities (see Box 6.3).

### *6.5.1 Community-based adaptation initiatives and projects*

Most of the community-based adaptation efforts of our three partner CBOs fit into the categories of inclusive planning, nongovernmental planning, and nongovernmental provision. Each CBO is simultaneously participating in city-initiated and city-led planning and adaptation efforts, in parallel with its own internal grassroots efforts in the communities. These parallel efforts suggest opportunities in the future for more partnerships or co-production of adaptation planning that would involve these communities earlier and more substantively in the process of designing resilience plans.

These opportunities could result in more efficient planning processes that incorporate community knowledge and expertise at the design stage, addressing early on the unique ways that different communities are vulnerable. This could increase the capacity of city planning processes to be more adaptive to local conditions and vulnerabilities.

**6.5.1.1 WE ACT for environmental justice (WE ACT) and northern Manhattan.** WE ACT began its advocacy work in 1988 by opposing the North River Wastewater Treatment Plant and protesting the exclusion of vulnerable populations and communities from local and state decision-making processes. Starting in 1990, WE ACT became increasingly active in addressing air pollution and environmental health concerns, including children and youth exposure to lead in northern Manhattan communities. WE ACT is now one of the leading environmental justice organizations in New York City and nationwide. Its mission is to educate, empower, and mobilize residents of northern Manhattan regarding environmental issues that affect their health and quality of life.

### Box 6.3: Types of public participation in climate adaptation planning (based on Sarzynski (2015))

***Traditional government-led climate planning***: The most common form of climate adaptation planning and action; participation tends to be limited in duration, intensity and influence; and to pursue instrumental goals; common formats include public consultation workshops, citizen engagement, public comments on draft plans or proposed rules (one-way information exchange).

***Inclusive planning***: A government-led process that emphasizes intensive public consultation and recognizes that public participation can help improve the quality and legitimacy of government plans; common formats include selecting experienced nongovernmental actors to be part of steering committees, consulting with community emergency responders; creating citizen advisory committees or task forces.

***Nongovernmental planning***: A nongovernmental organization-led climate adaptation planning effort with minimal government involvement; aims to pursue a broader scope of participants and intrinsic goals; common formats include scenario-based stakeholder engagement (often led by university researchers) and consultation with community participants.

***Nongovernmental provision***: These include community self-help and community-based initiatives to adapt to locally important climate risks; can also be private business led; nongovernmental led actions reveal private and nonprofit sector capacity for urban climate governance.

***Partnerships***: These involve the formation of public-private partnerships (PPPs), often government led but have also been led by NGOs; a downside of PPPs is that they may result in loss of public accountability and transparency or lead to private-sector favoritism; degree of private citizen involvement tends to be minimal.

***Co-production***: A process that involves both government and community participants intensely and substantively in adaptation planning and implementation; differs from partnership approach due to explicit involvement of civil society and individual citizens in provision of urban climate governance; can include community-based adaptation targeting low-income communities, community action planning, and scenario-based stakeholder engagement.

WE ACT engages in a number of community adaptation projects that include elements of both nongovernmental and inclusive planning (Table 6.11). Chief among its efforts is the Northern Manhattan Climate Action Plan (NMCA), a community-produced climate adaptation plan. WE ACT served as the community broker in the planning process of the NMCA, which closely followed the template of nongovernmental planning. Its role entailed convening public residents, scientists, and other stakeholders to engage in a broad but locally adapted planning process.

WE ACT also directly participates in the city's Solarize NYC program, again as a community broker, to convene and engage residents and other stakeholders. In this city-initiated project, which relies on principles of inclusive planning, WE ACT facilitated community engagement in the city's efforts to promote group purchasing of solar power. In addition, WE ACT participates in the Healthy and Sustainable Public Housing Initiative. Working in partnership with NYCHA, this project entailed outreach to residents of public housing and organization of a series of workshops to solicit feedback on environmental issues affecting community residents.

**6.5.1.2 UPROSE and Sunset Park.** The United Puerto Rican Organization of Sunset Park (UPROSE) is one of Brooklyn's oldest Latino social service agencies and CBOs. It was incorporated in 1966 and originally intended to serve the then-predominantly Puerto Rican neighborhood. As Sunset Park experienced significant demographic change in recent decades, UPROSE has extended its outreach to other Spanish-speaking populations and to the Chinese population in the community. UPROSE serves as an advocacy organization for a variety of environmental justice and public health issues including waterfront redevelopment, cleanup and remediation of local brownfields, transportation access, public and open spaces, air quality, and educational and youth empowerment campaigns. Its primary mission is to promote sustainability and climate change resiliency in Sunset Park.

UPROSE's climate adaptation efforts generally fit into the category of nongovernmental planning and nongovernmental provision (see Table 6.12). These efforts include establishment of the Sunset Park Climate Justice Center, the Be a Block Captain program, and the Climate Justice Youth Summit. Each of these efforts involves engagement of residents and/or local businesses and young people in community

**Table 6.11. Selected northern Manhattan community mitigation and adaptation projects**

| Current WE ACT projects | Description | Community engagement | References |
|---|---|---|---|
| Northern Manhattan Climate Action Plan (NMCA) | Result of a community-based planning process held from January through July of 2015: included residents from Central Harlem, East Harlem, Washington Heights, and West Harlem<br>Four themes: energy democracy, emergency preparedness, social hubs, and public participation | Seven public workshops, hundreds of community members, meetings with partners and city agencies. NPCC3 members provided climate projections and interacted with community members at workshops | https://www.weact.org/campaigns/nmca/ |
| Solar Uptown Now! (part of Solarize NYC) | Campaign to enable northern Manhattan community members to purchase solar as a group. Project helps customers choose solar installers that offer competitive, transparent pricing<br>Partnership with Solar One, the Urban Homesteading Assistance Board, and Sustainable CUNY | Provided option to purchase solar power as a group, with objective of reducing cost of solar installation for all participants | https://solaruptownnow.org/landing/ |
| Healthy and Sustainable Public Housing | Work with residents of NYCHA's Dyckman Houses to improve their homes and community well-being | Series of workshops with residents living in NYCHA buildings to solicit feedback on how to address environmental issues faced by the community | https://www.weact.org/dyckman/3 |

adaptation planning, emergency preparedness, and training in community organizing.

**6.5.1.3 THE POINT CDC and Hunts Point.** THE POINT Community Development Corporation (CDC), founded in 1994, is a nonprofit organization of the South Bronx. The organization is dedicated to youth development and the cultural and economic revitalization of Hunts Point. It is also an advocacy group for environmental and

**Table 6.12. Selected Sunset Park community adaptation projects**

| Current UPROSE projects | Description | Community engagement | References |
|---|---|---|---|
| Sunset Park Climate Justice Center | Designed to create, implement, and manage community climate adaptation and resiliency planning | Gathers community members, residents, and local business leaders to participate in the planning process | https://www.uprose.org/climate-justice/ |
| Block Captains | Recruits and trains local residents to volunteer as block captains to implement climate resiliency strategies | Takes inventories of neighborhood vulnerability and coordinates climate adaptability workshops | https://www.uprose.org/climate-justice/ |
| Climate Justice Youth Summit | Organizes and trains young people of color to hone their engagement, social justice, and leadership skills | Hosts a 2-day annual event where young people from NYC gather to learn about environmental justice issues in their communities | https://www.uprose.org/youth-summit-2017/ |

**Table 6.13. Selected Hunts Point community adaptation projects**

| Current THE POINT CDC projects | Description | Community engagement | References |
|---|---|---|---|
| Hunts Point Lifelines | Part of the Energy Resiliency Project to provide 11.6 MW of "resilient" energy generation capacity for the Hunts Point peninsula led by NYCEDC in partnership with the Mayor's Office of Recovery and Resiliency (ORR), local stakeholders, and the THE POINT CDC | Formed an advisory working group, neighborhood outreach team; held four public meetings and a community workshop | https://www.nycedc.com/project/hunts-point-resiliency-implementation |
| Be a Buddy NYC | The city is launching a 2-year, multistakeholder pilot to promote community cohesion. Through partnerships with community-based organizations, Be A Buddy NYC will develop and test strategies for protecting at-risk New Yorkers from the health impacts of extreme heat in the South Bronx, Central Brooklyn, and northern Manhattan | A community-led preparedness model that promotes social cohesion | https://www1.nyc.gov/assets/orr/pdf/Cool_Neighborhoods_NYC_Report_FINAL.pdf |
| South Bronx Community Resiliency Agency | Engage local communities in creating a comprehensive climate resilience agenda that will strengthen the physical and social resilience of the South Bronx Significant and Industrial Area (SMIA); enable THE POINT CDC to influence the next phases of Hunts Point Resiliency | Coordination with local residents and neighborhoods (e.g., Port Morris, Soundview, Mott Haven, and Longwood) | https://thepoint.org/community-development/reenvisioning/ |

climate justice issues in the South Bronx. THE POINT CDC engages in both nongovernmental and inclusive forms of community adaptation planning (see Table 6.13).

Specifically, its South Bronx Community Resiliency Agenda (SBCRA), which can be categorized as a nongovernmental planning effort, is engaging local communities in the creation of a comprehensive resilience plan. The SBCRA's goals are to strengthen the local capacity for community-led resilience planning and ultimately to strengthen the physical and social resilience of the South Bronx Significant Maritime and Industrial Area (SMIA) and surrounding neighborhoods (Port Morris, Soundview, Mott Haven, and Longwood).

In terms of inclusive planning, THE POINT CDC is working with the city, as a local stakeholder, with the New York City Economic Development Corporation (NYCEDC) and the Mayor's Office of Recovery and Resilience to implement a $45 million Hunts Point Lifelines project to improve coastal resilience of the region.

The Hunts Point Lifeline was developed from the Rebuild by Design competition which was funded through the Housing and Urban Development (HUD) Community Development Block Grant Disaster Recovery (CDBG-DR). It includes two feasibility studies for energy resilience and flood risk reduction, as well as a conceptual design for a resilient energy pilot project (see Table 6.13).

THE POINT CDC is also one of the three implementing partners for the city's Be a Buddy program, a climate adaptation initiative to promote community cohesion and develop and test strategies for protecting at-risk residents from health impacts of extreme heat in the South Bronx.

### 6.5.2 *Community perspectives on procedural equity in adaptation planning*

Even for those communities sought out for their input and engagement in city-led adaptation and resilience-building processes, there is a perception that existing city outreach efforts are conducted in good faith but may miss some of the ways these communities are uniquely vulnerable. In particular, these CBOs perceive that they are asked for their input and engagement often after critical decisions have been made, leaving little room for these groups and their communities to meaningfully shape development to meet their needs. In other words, these communities reported that they are often approached after policies and designs have been selected.

Some examples that the CBOs offered to support this viewpoint are recent resilience-building initiatives and development decisions that prioritize market-oriented development and ignore the equity implications of these efforts. The Hunts Point Lifelines Resiliency Project, for example, involved a yearlong community engagement process that identified flood risk and resilient energy as priority areas. This process was described by the CBO as very structured and rigid, with little room left for community inputs and creative ideas. While the project is making headway toward a more economically viable coastline, community members expressed concern that the city's concept of resilience was overly focused on coastal protection and renewable energy to the exclusion of social concerns such as gentrification and displacement.

Similarly, in Sunset Park, the CBO expressed heightened concern that development and resilience projects initiated or approved by the city could potentially lead to or accelerate displacement of local residents. Specifically, the CBO pointed to the mayor's plan for a Made In NYC campus to bring back manufacturing to the waterfront. Not only did community members express that there was a lack of communication about this initiative, but they also indicated that there was a lack of engagement in the visioning process about development of the waterfront in ways that do not lead to or accelerate displacement of residents (Santore, 2017). The CBO expressed interest in linking the Made in NYC campus to a community-led regenerative energy hub project. However, the CBO also expressed concern that the city's rezoning proposals to accommodate commercial development would limit possibilities for such a project.

Thus, one consistent area of concern for each of these communities, but particularly in northern Manhattan and Sunset Park, is that city climate adaptation and resilience projects will contribute to the out-migration of long-term residents and the weakening of social networks and social capital, both necessary for creating resilient communities. Each CBO expressed a strong desire for city officials and initiatives to actively support residents through cooperative practices that build up social capital and therefore preserve vulnerable neighborhoods through equitable development practices. As Schlosberg *et al.* (2017, pp. 422–423) observe, in planning for climate adaptation, "local community groups . . . do not operate in a risk management or simple resilience framework," but rather "focus more on . . . basic needs and capabilities of every day."

Adaptation and resilience planning might entail a stronger focus on community development (e.g., building schools, safer streets, and greening space) in order to reduce the potential of displacing longtime residents and be more responsive to the social sustainability of these communities.

For instance, WE ACT has engaged in extensive climate action planning with deep community engagement and a collaborative process of identifying vulnerabilities and adaptation needs. Out of that process has emerged a focus on critical infrastructure required for emergency preparedness and resilience—including a community microgrid, neighborhood and senior facilities, cooling centers, grocery stores/food, and refrigeration for medication in an emergency.

WE ACT is also focused on energy democracy—the shift from centralized, corporate fossil fuel–generated energy to energy generated and governed by communities and that supports local economies, energy security, and the health and well-being of the people within those communities. Given this extensive planning and engagement process in place in northern Manhattan, the city could leverage these efforts to implement adaptation and resilience projects that account for both contextual and procedural equity.

The current inclusion of these CBOs and their communities in city planning processes is noted as

a positive aspect of the city's approach to procedural equity. However, when asked about areas in which the city can facilitate vulnerability reduction and resilience, each partner CBO expressed some frustration with the level of participation and engagement with city agencies and staff on environmental and climate planning. As referenced earlier, there is a palpable feeling among the CBOs that the city could be a model for more meaningful and empowering inclusion of vulnerable communities (NYCEJA, 2016; NYCEJA, 2018).

In particular, each CBO expressed interest in a more fully collaborative, co-production model of equitable adaptation and resilience planning in which city officials work side by side with CBOs (and other actors) at the outset to design and implement climate adaptation and resilience planning. This model could, for example, improve the quality of planning processes focused at the neighborhood level by better incorporating the unique ways in which specific communities are both ecologically and socially vulnerable, as discussed above.

As Sarzynski (2015) has noted, the co-production or co-creation model of urban climate adaptation is underway in many countries around the world as a way to more deeply involve civil society and citizens in the provision of adaptation and resilience strategies.

Consider one prominent example from Europe to illustrate what this co-production model might resemble. In 2016, the City of Vejle, Denmark launched Europe's first Resilience Strategy, with support from the 100 Resilient Cities Program of the Rockefeller Foundation (100RC). The strategy envisions more than 100 city-wide projects or initiatives over the course of 4 years and three neighborhoods that will be used as "laboratories" for experimenting with different resilience projects. The city's strategy was produced through a process of "co-creation" that required collaboration between citizens and the municipality, including workshops where residents were invited to shape and build 3D models of what a resilient Vejle would look like, as well as to inject their priorities and concerns into the city's strategy.

Involving the community early on and inviting their broad input at the conception of a city's resilience strategy increase the chances that neighborhood participation will drive climate adaptation planning. Thus, these plans will reflect community needs and address their unique vulnerabilities (Rockefeller Foundation, 2016).

## 6.6. Cross-city analysis

In this section, we shift from a community-level analysis to consideration of how equity is being incorporated in urban adaptation planning at the city level in the Northeast. This cross-city analysis provides a window into how New York City and other nearby cities are incorporating principles of distributive, procedural, and contextual equity into community adaptation planning.

Many cities throughout the United States and elsewhere have recognized the importance of incorporating equity into adaptation planning. In this section, we explore how New York and other cities in the Northeast of the United States incorporate the three dimensions of equity—distributional, contextual, and procedural—in the design and implementation of climate adaptation strategies.

Information for this section is based on a review of each city's plans and targeted interviews conducted by the CBA Workgroup (see Appendix 6.B). These interviews were conducted with city officials in charge of adaptation planning and with representatives of CBOs in each city. The interview questions were focused on the issue of equitable adaptation, particularly seeking to capture the extent of community involvement during the planning and implementation process.

In addition to New York, we analyzed adaptation plans and planning processes in Boston, Baltimore, Philadelphia, and Newark (see Table 6.14). The goals of this review were to provide an overview of how equity is understood and incorporated into adaptation planning efforts in each city. The review also provided information on adaptation decision making and governance in each city as well as the stakeholders involved.

### *6.6.1 Adaptation planning in northeast cities*

All five cities are engaged in a number of different types of climate adaptation planning. In some cases, these efforts are designed as standalone city plans that target climate change preparedness (e.g., Climate Ready Boston, Baltimore Climate Action Plan). In other cases, planning for the impacts of climate change is incorporated into larger sustainability planning efforts (e.g., OneNYC, Resilient Boston, Newark Sustainability Action Plan). Two of the

**Table 6.14. Selected city adaptation and policy plans**

| City | Population | Plan |
|---|---|---|
| New York City | 8.623 million | OneNYC: The Plan for a Strong and Just City (2015); OneNYC Progress Reports (2016, 2017, and 2018)<br>New York City Panel on Climate Change (NPCC) Report: Building the Knowledge Base for Climate Resiliency (2015)<br>New York City Panel on Climate Change Report (NPCC): Building a Risk Management Response (2010)<br>New York City Special Initiative on Recovery and Resiliency (NYC SIRR) (2013) |
| Boston | 685,094 | Greenovate Boston: Climate Action Plan Update (2014)<br>Climate Ready Boston (2016)<br>Resilient Boston: An Equitable and Connected City (2017) |
| Baltimore | 611,458 | Baltimore Climate Action Plan (CAP) (2013)<br>City of Baltimore: Disaster Preparedness and Planning Project, A Combined All-Hazards Mitigation and Climate Adaptation Plan (2013)<br>The Baltimore Sustainability Plan (2018) (Final Draft) |
| Newark | 285,154 | The City of Newark: Sustainability Action Plan (2013) (currently being updated) |
| Philadelphia | 1.581 million | Growing Stronger: Toward a Climate-Ready Philadelphia (2015)<br>Greenworks: A Vision for a Sustainable Philadelphia (2016) |

cities—Boston and New York—are participants in the Rockefeller 100 Resilient Cities project; Boston's adaptation plans were developed in collaboration with the Rockefeller program. Several of the cities are also members of the C40 and ICLEI networks.

Each of these cities is also engaged in a number of specific projects that entail community-based climate change adaptation planning. These projects are initiated and managed through a variety of different agencies in each city, including the offices of planning, sustainability, emergency management, housing, and health. The projects generally emphasize specific types of adaptation actions such as post-disaster recovery, heat warnings and/or reduction of the effects of extreme heat, and flood protection. All of the cities participated in adaptation projects funded by the Kresge Foundation that entailed collaboration between cities and communities in the design of community-based adaptation projects. Table 6.15 outlines these initiatives across the five cities.

Each of the cities incorporates, to some degree, recognition of equity in both their citywide and community-based adaptation planning efforts. The goal of the CBA Workgroup's analysis was to determine whether there are lessons, insights, and/or effective practices that could be gleaned from each of these city's efforts to incorporate equity into adaptation planning. More specifically, the focus was on extracting from these cities' plans and planning processes whether and how each dimension of equity manifests and is operationalized.

**6.6.1.1 Distributional equity in city adaptation planning.** Each of the cities studied intentionally and explicitly adheres to the principle of distributional equity in its adaptation planning documents and program descriptions (see Tables 6.15 and 6.16). They do so, first, by targeting their programs and initiatives toward disadvantaged and socially vulnerable neighborhoods and populations. A number of these plans and programs entail documenting vulnerability to climate change stressors at the neighborhood level.

The 2016 Climate Ready Boston and the 2015 Climate-Ready Philadelphia plans, for example, both use spatial indicators of neighborhood vulnerability in order to document the locations of socially vulnerable populations as a part of their climate assessment processes (Boston Department of the Environment, 2016; Philadelphia Office of Sustainability and ICF International, 2015).

New York's Cool Neighborhood program and the City of Baltimore's plan target socially vulnerable populations in an effort to identify neighborhoods that are likely to be disproportionately exposed to extreme heat (City of New York, 2017b; Baltimore Office of Sustainability, 2013b).

In addition to utilizing social vulnerability mapping tools to identify vulnerable populations,

**Table 6.15. Selected city adaptation projects and initiatives**

| Project/initiative name | Description | Municipal agencies in charge and/or nongovernmental organizations involved |
|---|---|---|
| **New York City** | | |
| Hurricane Sandy Houses of Worship & Charitable Organization Recovery Task Force (2017) | Established by Mayor de Blasio to better understand the role of faith-based organizations, nonprofit organizations, and other community-based organizations in Hurricane Sandy recovery efforts. http://www1.nyc.gov/assets/orr/images/content/header/Hurricane-Sandy-Recovery-Task-Force-Report-April-2017.pdf | New York City Council; Mayor's Office of Recovery and Resiliency; NYC Office of Emergency Management |
| NYC Flood Hazard Mapper (2017) | Online interactive mapping product that provides a comprehensive overview of the extent of existing and future coastal flooding. https://www.floodhelpny.org/ | NYC Department of City Planning |
| NYC CoolRoofs (2009) | Citywide initiative that provides local job-seekers with training and work experience installing energy-saving reflective rooftops. Also supports the City's goal to reduce carbon emissions 80% by 2050 (80 × 50). Has short-term focus on communities with highest heat-related health risks. https://www1.nyc.gov/nycbusiness/article/nyc-coolroofs | NYC Department of Small Business Services; Mayor's Office of Sustainability; Mayor's Office of Recovery and Resiliency; Sustainability South Bronx |
| NYC Solar Partnership (made up of two programs, Solarize NYC and Shared Solar NYC (2016)) | Solarize NYC program: short-term, local, community-led initiative that connects communities with solar installers. Designed to reduce barriers for communities that have historically had limited access to solar by providing informal resources and offerings at discounted pricing<br>Shared Solar NYC program: designed to connect interested customers (e.g., renters and homeowners) with community-shared solar systems. https://www.nycedc.com/program/nyc-solar-partnership | Sustainable CUNY of the City University of New York; New York City Economic Development Corporation; Mayor's Office of Sustainability |
| NYC Resilient Neighborhoods (2013) | Place-based planning initiative to identify neighborhood-specific strategies, including zoning and land-use changes. Focus on preparedness and resilience in communities located in floodplains. http://www1.nyc.gov/site/planning/plans/resilient-neighborhoods.page | NYC Department of City Planning; Mayor's Office of Recovery and Resiliency; Housing Recovery Operations; NYC Department of Environmental Protection |
| Cool Neighborhoods Program (2017) | Designed to curb effect of extreme heat in neighborhoods identified as vulnerable to heat-related health risks. Heat Vulnerability Index (2017) used to identify high-risk neighborhoods. http://www1.nyc.gov/assets/orr/pdf/Cool_Neighborhoods_NYC_Report_FINAL.pdf | Mayor's Office of Recovery and Resiliency; NYC Department of Parks & Recreation; NYC Department of Health; NYC Department of Small Business Services; NYC Office of Emergency Management: Columbia University; members of nonprofit and private sectors |

*Continued*

**Table 6.15.** *Continued*

| Project/initiative name | Description | Municipal agencies in charge and/or nongovernmental organizations involved |
|---|---|---|
| **Boston** | | |
| Climate Ready Boston (2016) | Ongoing initiative to help neighborhoods and communities plan for future climate change impacts and develop resilient solutions<br>Targets communities that have highest flood risks and high concentrations of vulnerable residents and critical infrastructure (e.g., East Boston, Charlestown, South Boston). https://www.boston.gov/departments/environment/climate-ready-boston | Boston Environment Department; Boston Planning and Development Agency; Massachusetts Office of Coastal Zone Management; the Barr Foundation |
| Climate Ready Boston Map Explorer (2017) | Mapping tool to explore risks of flooding and extreme heat and how these risks intersect with social factors. https://www.boston.gov/departments/environment/climate-ready-boston-map-explorer | Boston Environment Department |
| Moakley Park Vision Plan (2018) | Vision plan for Moakley Park in South Boston (60 acres) to serve as coastal protection site and prevent future flooding of nearby homes. https://www.boston.gov/departments/parks-and-recreation/moakley-park-vision-plan | Boston Parks and Recreation Department |
| **Baltimore** | | |
| "Every Story Counts" Campaign (2017) | Initiative that seeks to promote equity and inclusion in building a more sustainable and resilient Baltimore. http://www.baltimoresustainability.org/every-story-counts/ | Baltimore Office of Sustainability 2016 |
| Code Red Heat Alert Plan (2011) | Multiagency-coordinated approach to provide cooling relief to vulnerable populations in the city during a heat crisis. https://health.baltimorecity.gov/coderedinfo | Baltimore City Department of Health |
| Baltimore Green Network Vision (2018) | Vision plan that promotes urban resilience through land-use equity to increase urban green infrastructure and amenities in underinvested neighborhoods (draft plan under review). http://greennetwork.Civicomment.org/ | Baltimore Department of Planning |
| **Newark** | | |
| Cumulative Impact Ordinance and Zoning Amendments (2016) | Legislation passed by the City Council of Newark that considers environmental justice implications in land use and zoning regulations, aiming to reduce health disparities in low-income residents and people of color. https://newark.legistar.com/LegislationDetail.aspx?ID=2770971&GUID=D0C566D0-463A-482D-A4AC-78884351DA79&FullText=1 | Newark Department of Planning and Zoning |

*Continued*

**Table 6.15.** *Continued*

| Project/initiative name | Description | Municipal agencies in charge and/or nongovernmental organizations involved |
|---|---|---|
| Prepared Together (2018) | Initiative that contains series of impact volunteering projects to build community resilience via green infrastructure and disaster preparedness education and outreach. Projects include Sustainable Stormwater Stewards, Newark Tree Count, and Extreme Weather Event Preparedness. https://www.newarknj.gov/card/prepared-together | Newark Office of Sustainability; Environmental Commission; municipal departments; Newark community members |
| **Philadelphia** | | |
| Greenworks Equity Index (2018) | Program to identify underserved communities affected by disproportionate impacts of environmental stressors as well as build community adaptive capacity and climate resiliency. https://beta.phila.gov/departments/office-of-sustainability/greenworks/greenworks-equity-index/ | Philadelphia Office of Sustainability |
| Ready Philadelphia (2017) | Program that guides residents to create emergency plans for extreme weather events on the block level. https://beta.phila.gov/departments/oem/programs/readyphiladelphia/ | Philadelphia Office of Emergency Management |
| Greenworks Dashboard (2017) | Visualization tool that allows users to view data about Greenworks sustainability visions (e.g., food and drinking water, health, outdoor and indoor air quality, clean and efficient energy). https://cityofphiladelphia.github.io/greenworks-dashboard/ | Philadelphia Office of Sustainability; Office of Open Data and Digital Transformation |

and specifically disproportionate exposure to climate stressors and other environmental hazards, many of these cities also seek to address distributional inequities in the provision of environmental amenities. These cities specifically target the provision of green infrastructure to socially vulnerable neighborhoods. Efforts to develop green flood protection, stormwater management, and waterfront parks are particularly evident in Boston, New York, and Philadelphia. Additionally, Newark is making efforts to pilot these types of projects in some of its historically vulnerable communities.

Along with programs intended to reduce disproportionate exposure and vulnerability to climate stressors, all of the cities have programs in place to enhance local environmental quality in disadvantaged neighborhoods. These programs also emphasize improvement of baseline environmental conditions through programs designed, for example, to improve air quality, remediate brownfields, or enhance access to public transportation and solar energy.

**6.6.1.2 Contextual equity in city adaptation planning.** Contextual equity is acknowledged in several ways in all of the cities' adaptation planning efforts. All of the cities studied acknowledge in their planning documents and efforts the legacy of structural racism and the ways that it shapes current social, economic, political, and environmental disparities in low-income and minority communities and populations. In some cases, it is a core principle guiding a city's effort.

Most of the cities incorporate attention to equity in their hiring practices via commitment to maintaining a diverse workforce in city agencies. Less common practices include direct linkage of adaptation plans to broader inequalities, designing co-benefits for low-income and minority residents,

**Table 6.16. Programs and activities in northeastern U.S. cities, intended to address distributive equity (identified based on review of planning documents)**

| Program areas | Baltimore | Boston | Newark | New York City | Philadelphia |
|---|---|---|---|---|---|
| Air quality | X | – | X | X | X |
| Affordability of flood insurance | – | – | – | X | – |
| Brownfield remediation | X | X | – | X | – |
| Building community capacity | X | X | – | X | X |
| Community land trust | X | – | X | – | – |
| Community vulnerability assessment | X | X | – | X | X |
| Energy retrofitting | X | – | – | X | X |
| Equitable access to recycling | – | – | – | X | X |
| Equitable access to solar energy | X | X | – | X | X |
| Equitable access to transportation | X | – | – | – | – |
| Green infrastructure | X | X | X | X | X |
| Toxic hotspots | – | – | – | X | – |
| Indoor health hazards | X | – | X | X | – |
| Youth and school programs | X | X | – | – | – |

Note: Distributive equity emphasizes disparities across social groups, neighborhoods, and communities in vulnerability, adaptive capacity, and the outcomes of adaptation actions.

and the hiring of equity consultants for training of city staff.

One example of how contextual equity is manifested in adaptation planning is through the use of vulnerability assessments that go beyond indices and indicators to capture the unique ways that historical legacies and contemporary social and economic processes shape the vulnerability of particular neighborhoods.

Thus, for example, New York City engages in neighborhood vulnerability assessments, employing the case study method to identify the social issues that affect people at the neighborhood level, and consults with community resilience focus groups to structure the case studies. As is evident in this report, case studies can be useful in understanding the dynamics underlying neighborhood vulnerability and in gaining better insights into how adaptation planning can produce co-benefits for vulnerable populations.

**6.6.1.3 Procedural equity in city adaptation planning.** All of the city plans recognize the need for procedural equity in adaptation planning (see Table 6.17). These efforts reflect elements of both traditional and inclusive planning. The most common ways that cities engage with communities in adaptation planning are through community meetings and inclusion of community representatives and organizations as part of advisory boards. Four of the five cities engage in both of these practices. Three of the cities conduct public forums and workshops. Less-common approaches to procedural equity include youth convening and avoidance of overly technical language, both of which are practiced only by Baltimore.

There is evidence of many strong collaborative relationships between city officials engaged in adaptation planning and CBOs in cities like New York, Boston, and Newark. In some cities, based on our interviews with city officials and CBO representatives, we were able to identify public engagement processes that resemble higher levels on Arnstein's ladder of citizen participation (see Fig. 6.10 in Section 6.5) and even those that resemble Sarzynki's co-production model (see Box 6.3 in Section 6.5). In each of these cases, capacity—both the city's and that of the CBO—turns out to be a significant variable.

In particular, established or relatively well-resourced (e.g., foundation supported) CBOs are able to not only engage in their own adaptation planning processes, but also, when given the chance, they substantively and substantially shape their city's plan and implementation. They can help the city design adaptation plans and projects that do not duplicate existing community-based efforts, but rather leverage them.

**Table 6.17. Activities and programs in northeastern U.S. cities intended to address procedural equity (identified based on the review of planning documents)**

| Program areas | Baltimore | Boston | Newark | New York City | Philadelphia |
|---|---|---|---|---|---|
| Avoidance of overly technical language | X | – | – | – | – |
| Community representatives and organizations on advisory boards | X | X | X | X | – |
| Community meetings | X | X | – | X | X |
| Public, telephone, and online surveys | X | – | – | X | X |
| Public forums and workshops | X | X | – | X | – |
| Youth convening | X | – | – | – | – |

Note: Procedural equity emphasizes the extent and robustness of public and community participation in adaptation planning and decision making.

In some instances, as is the case in one city we studied, CBOs can have significant influence in crafting plans where the city itself is consistently strapped for resources and funding. CBOs and communities play a watchdog roll, functioning in some areas not covered in city programs.

### *6.6.2 Summary and insights on effective practices for equitable adaptation planning*

Our examination of adaptation plans and practices in northeastern cities provided a number of insights on how equity can be incorporated into adaptation planning. Every city recognizes that all three types of equity are an important component of adaptation planning. In practice, however, the cities largely emphasized distributional equity in these efforts, through documentation of the locations of socially vulnerable neighborhoods and targeting of adaptation projects and initiatives toward disadvantaged and socially vulnerable communities.

While the cities recognize the importance of contextual equity, specific strategies to address underlying drivers of such inequalities are relatively limited. Most city efforts to address contextual inequalities focus on ensuring diversity in hiring practices.

Regarding procedural equity, there is evidence of collaboration and co-production in some city-based adaptation efforts. However, efforts to incorporate procedural equity more typically followed traditional planning or blend elements of traditional and inclusive planning.

All of the cities display elements of effective practices for incorporating distributional equity in their adaptation planning. While elements of contextual and procedural equity are also evident in some of these efforts, incorporation of all three elements of equity into community adaptation planning is still an aspiration for all of the cities. Incorporation of all three equity elements represents an important goal for ensuring equity in future community-based adaptation planning efforts.

## 6.7. Conclusions and recommendations

This chapter explored equity in community-based adaptation planning in New York City. The chapter adopted an equity framework that incorporated three key dimensions of equity, including distributional, contextual, and procedural equity. Distributional equity emphasizes disparities across social groups, neighborhoods, and communities in vulnerability, adaptive capacity, and outcomes of adaptation actions. Contextual equity considers how social, economic, and political factors and processes contribute to vulnerability and shape adaptive capacity. Procedural equity emphasizes the extent and robustness of public and community participation in adaptation planning and decision making.

**Key Findings**

- A framework for equitable adaptation to climate change requires incorporation of distributional, contextual, and procedural equity in adaptation planning.
- Social vulnerability to climate change stressors is unequally distributed across New York City; high levels of social vulnerability are consistently found in areas with lower incomes and higher shares of African-American and Hispanic residents.
- Collaboratively produced case studies (northern Manhattan; Hunts Point, South Bronx;

Sunset Park, Brooklyn) demonstrate that high levels of social vulnerability to climate change overlap with disproportionate exposure to environmental pollution, health stressors, and gentrification pressures.
- New York City communities are involved in many forms of adaptation planning (e.g., traditional government led, inclusive, nongovernmental) but express a desire for deeper engagement with the city via use of fully collaborative, co-production planning approaches.
- Cross-city analysis reveals that New York and other cities in the Northeast are incorporating all three forms of equity in their adaptation planning, but largely emphasize distributional equity in these efforts.

### Recommendations for New York City

- There should be future tracking of social vulnerability through the proposed New York City Climate Change Resilience Indicators and Monitoring System (NYCLIM); this tracking may be accomplished using index-based methods such as SoVI or SVI, through individual variables, or via a combination of approaches.
- All forms of equity should be reflected in climate adaptation efforts, particularly if resilience planning is focused at the neighborhood level.
- Local communities should be involved earlier and more often in order to understand local context and ensure procedural equity in climate adaptation planning.
- City officials should work side by side with communities at the outset to codesign and coimplement neighborhood-based climate adaptation projects.
- Climate change adaptation projects should contain a stronger focus on community development to reduce the potential of displacing longtime residents and to promote the social sustainability of local communities.

### Recommendations for Research

This examination of equity in climate change adaptation planning revealed several areas where further investigation is warranted. While this chapter focused primarily on adaptation planning efforts and specific projects, there is a need for further attention to, and analysis of, equity issues surrounding the implementation of adaptation plans. This includes recognition of equity issues associated with decisions about how projects are selected and implemented as well as equity issues that may arise from the unintended consequences of these efforts.

There is also a need to consider the equity consequences of city- and region-wide adaptation planning efforts. Large-scale barriers, flood control measures, and other projects will have differential effects across neighborhoods and communities, and will require community input in all phases of planning. All three forms of equity identified in this chapter should be taken into account when planning the types of large-scale adaptations that may ultimately be needed to prepare New York City for climate change.

- There is a need for further investigation of optimal methods to track both social vulnerability to climate change and resilience at the community scale.
- There is a need for further investigation of the use of co-production planning models in the climate context and their adaptability to NYC.
- There is a need for further investigation of the equity impacts of climate change adaptation projects, including both community-specific projects and city- and region-wide efforts, such as proposed regional storm surge barriers.
- There is a need for further investigation of potential linkages and synergies between adaptation and mitigation planning and community equity.

## References

Adams, M.H. 2016. The end of Black Harlem. New York Times. Accessed May 27, 2016. https://www.nytimes.com/2016/05/29/opinion/sunday/the-end-of-black-harlem.html.

Adger, W.N. 2006. Vulnerability. *Glob. Environ. Change* **16:** 268–281.

Amar, S. 2017. Some Sunset Park locals fear a 'privileged minority' would benefit from industry city rezoning. Gothamist.

Anguelovski, I., L. Shi, E. Chu, *et al.* 2016. Equity impacts of urban land use planning for climate adaptation: critical perspectives from the global north and south. *J. Plann. Educ. Res.* **36:** 333–348.

Arnstein, S.R. 1969. A ladder of citizen participation. *J. Am. Inst. Plann.* **35:** 216–224.

Austensen, M., A. Desronvil, R. Enkh-Amgalan, *et al.* 2017. State of New York City's housing and neighborhoods. Furman Center for Real Estate & Urban Policy.

Austensen, M., I. Gould Ellen, L. Herrine, *et al.* 2015. State of New York City's housing and neighborhoods. Furman Center for Real Estate & Urban Policy.

Bakkensen, L.A., C. Fox-Lent, L.K. Read, *et al.* 2017. Validating resilience and vulnerability indices in the context of natural disasters. *Risk Anal.* **37:** 982–1004.

Baltimore Office of Sustainability. 2013a. Baltimore climate action plan. City of Baltimore: Baltimore Office of Sustainability.

Baltimore Office of Sustainability. 2013b. Disaster preparedness and planning project, a combined all-hazards mitigation and climate adaptation plan. City of Baltimore: Baltimore Office of Sustainability.

Baltimore Office of Sustainability. 2018. The Baltimore sustainability plan-final draft. City of Baltimore: Baltimore Office of Sustainability.

Balzarini, J.E. & A.B. Shlay. 2018. The strength of strong ties reconsidered: social ties and collective power in a gentrifying community. *Soc. Curr.* **5:** 67–85.

Bautista, E., J.C. Osorio & N. Dwyer. 2015. Building climate justice and reducing industrial waterfront vulnerability. *Soc. Res.* **82:** 821–838.

Berke, P., G. Newman, J. Lee, *et al.* 2015. Evaluation of networks of plans and vulnerability to hazards and climate change: a resilience scorecard. *J. Am. Plann. Assoc.* **81:** 287–302.

Betancur, J. 2011. Gentrification and community fabric in Chicago. *Urban Stud.* **48:** 383–406.

Boston Department of the Environment. 2016. Climate ready Boston. Accessed October 15, 2018. https://www.boston.gov/departments/environment/climate-ready-boston.

Brown, P., B. Mayer, S. Zavestoski, *et al.* 2003. The health politics of asthma: environmental justice and collective illness experience in the United States. *Soc. Sci. Med.* **57:** 453–464.

Bulkeley, H., G.A. Edwards & S. Fuller. 2014. Contesting climate justice in the city: examining politics and practice in urban climate change experiments. *Glob. Environ. Change* **25:** 31–40.

Bullard, R.D. & D.A. Alston. 1990. *We Speak for Ourselves: Social Justice, Race, and Environment.* Panos Institute.

CDC SVI (Center for Disease Control Social Vulnerability Index). 2016. Agency for Toxic Substances & Disease Registry. Accessed October 15, 2018. https://svi.cdc.gov/.

CDC SVI (Center for Disease Control Social Vulnerability Index). 2018. SVI publications, posters, presentations, and other materials. Agency for Toxic Substances & Disease Registry. Accessed October 15, 2018. https://svi.cdc.gov/SVIPublicationsPostersPresentations.html.

Checker, M. 2011. Wiped out by the "greenwave": environmental gentrification and the paradoxical politics of urban sustainability. *City Soc.* **23:** 210–229.

Chu, E., I. Anguelovski & J. Carmin. 2016. Inclusive approaches to urban climate adaptation planning and implementation in the Global South. *Clim. Policy* **16:** 372–392.

City of Boston. 2017. Resilient Boston: an equitable and connected city. Mayor's Office of Resilience and Racial Equality.

City of New York. 2015. One New York: the plan for a strong and just city. Accessed October 15, 2018. https://onenyc.cityofnewyork.us/.

City of New York. 2016. OneNYC: 2016 progress report. Accessed October 15, 2018. https://onenyc.cityofnewyork.us/wp-content/uploads/2018/04/OneNYC-2016-Progress-Report-1.pdf.

City of New York. 2017a. OneNYC: 2017 progress report. Accessed October 15, 2018. https://onenyc.cityofnewyork.us/wp-content/uploads/2018/04/OneNYC_Progress_Report_2017-1.pdf.

City of New York. 2017b. Cool neighborhoods report. Accessed October 15, 2018. http://www1.nyc.gov/assets/orr/pdf/Cool_Neighborhoods_NYC_Report_FINAL.pdf.

City of New York. 2018. New York City government poverty measure 2005–2016. Accessed October 15, 2018. https://www1.nyc.gov/assets/opportunity/pdf/18_poverty_measure_report.pdf.

Cole, L.W. & S.R. Foster. 2001. *From the Ground Up: Environmental Racism and the Rise of the Environmental Justice Movement.* NYU Press.

Cooley, H., E. Moore, M. Heberger, *et al.* 2012. Social vulnerability to climate change in California. California Energy Commission. Accessed October 15, 2018. http://www.energy.ca.gov/2012publications/CEC-500-2012-013/CEC-500-2012-013.pdf.

Corburn, J., J. Osleeb & M. Porter. 2006. Urban asthma and the neighborhood environment in New York City. *Health Place* **12:** 167–179.

Cornell, S., F. Berkhout, W. Tuinstra, *et al.* 2013. Opening up knowledge systems for better responses to global environmental change. *Environ. Sci. Policy* **28:** 60–70.

Cutter, S.L., B.J. Boruff & W. Shirley. 2003. Social vulnerability to environmental hazards*. *Social Science Quarterly.* **84**: 242–261.

Cutter, S.L. & C. Finch. 2008. Temporal and spatial changes in social vulnerability to natural hazards. *Proc. Natl. Acad. Sci. USA* **105:** 2301–2306.

Cutter, S.L. & C.T. Emrich. 2006. Moral hazard, social catastrophe: the changing face of vulnerability along the hurricane coasts. *Ann. Am. Acad. Pol. Soc. Sci.* **604:** 102–112.

Cutter, S. L., C. T. Emrich, J. J. Webb *et al.* 2009. Social vulnerability to climate variability hazards: A review of the literature. Final Report to Oxfam America. pp. 1–44.

Cutter, S.L., J.T. Mitchell & M.S. Scott. 2000. Revealing the vulnerability of people and places: a case study of Georgetown County, South Carolina. *Ann. Assoc. Am. Geogr.* **90:** 713–737.

Cutter, S.L., K.D. Ash & C.T. Emrich. 2014. The geographies of community disaster resilience. *Glob. Environ. Change* **29:** 65–77.

de Sherbinin, A. 2014. Climate change hotspots mapping: what have we learned? *Clim. Change* **123:** 23–37.

de Sherbinin, A. & G. Bardy. 2015. *Social Vulnerability to Floods in Two Coastal Megacities: New York City and Mumbai.* Vienna Yearbook of Population Research, pp. 131–165.

Deas, M., J. Grannis, S. Hoverter, *et al.* 2017. Opportunities for equitable adaptation in cities: a workshop summary report. Georgetown Climate Center.

Deaton, J. 2017. Hurricane Harvey hit low-income communities hardest. Nexus Media. Accessed September 1, 2017. https://nexusmedianews.com/hurricane-harvey-hit-low-income-communities-hardest-6966d859e61f.

Diaz, T., T. Sturm, T. Matte, *et al.* 2000. Medication use among children with asthma in East Harlem. *Pediatrics* **105:** 1188–1193.

Dietz, S. & N. Stern. 2008. Why economic analysis supports strong action on climate change: a response to the Stern Review's critics. *Review of Environmental Economics and Policy*. **2**: 94–113.

DNAinfo. 2012. Locals and pols concerned about uptown affordable housing crisis. DNAinfo. Accessed October 12, 2012. httinfo.com/new-york/20121012/washington-heights/locals-pols-concerned-about-uptown-affordable-housing-crisis/ ps://www.dna.

Dunning, C.M. & S.E. Durden. 2011. Social vulnerability analysis methods for Corps planning. US Army Engineer Institute for Water Resources.

Eisenhauer, D.C. 2016. Pathways to climate change adaptation: making climate change action political. *Geogr. Compass* **10:** 207–221.

Emrich, C.T. & S.L. Cutter. 2011. Social vulnerability to climate-sensitive hazards in the southern United States. *Weather Clim. Soc.* **3:** 193–208.

Flanagan B.E., E.W. Gregory, E.J. Hallisey, *et al.* 2011. A social vulnerability index for disaster management. *Journal of Homeland Security & Emergency Management*. **8:** 1–22.

Foster, S. 2017. Vulnerability, equality, and environmental justice: the potential and limits of law. In *The Routledge Handbook of Environmental Justice*. R. Holifield, J. Chakraborty & G. Walker, Eds.: 136–148. New York, NY: Routledge.

Foster, S.R. & C. Iaione. 2016. The city as a commons. *Yale L. Pol'y Rev.* **34:** 281.

Fothergill, A., E.G. Maestas & J.D. Darlington. 1999. Race, ethnicity and disasters in the United States: a review of the literature. *Disasters* **23:** 156–173.

Fraser, N. 2009. *Scales of Justice: Reimagining Political Space in a Globalizing World*. Columbia University Press.

Goldstein, B.D. 2017. *The Roots of Urban Renaissance*. Harvard University Press.

Gonzalez, D. 2016. In Sunset Park, a call for 'innovation' leads to fears of gentrification. New York Times. Accessed March 6, 2016. https://www.nytimes.com/2016/03/07/nyregion/in-sunset-park-a-call-for-innovation-leads-to-fears-of-gentrification.html.

Greenovate Boston. 2014. Climate action plan update. City of Boston: Greenovate Boston.

Hum, T. 2014. *Making a Global Immigrant Neighborhood: Brooklyn's Sunset Park*. Temple University Press.

HVRI (Hazard Vulnerability Research Institute). 2018a. Applications: selected applications of the usage of SoVI. University of South Carolina. Accessed October 15, 2018. http://artsandsciences.sc.edu/geog/hvri/applications.

HVRI (Hazard Vulnerability Research Institute). 2018b. SoVI: Social Vulnerability Index for the United States 2010–2014. University of South Carolina. Accessed October 15, 2018. http://artsandsciences.sc.edu/geog/hvri/sovi®-evolution.

Iaione, C. 2016. The CO-City: sharing, collaborating, cooperating, and commoning in the city. *Am. J. Econ. Sociol.* **75:** 415–455.

IPCC (Intergovernmental Panel on Climate Change). 2012. Managing the risks of extreme events and disasters to advance climate change adaptation: special report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, NY:Cambridge University Press.

IPCC (Intergovernmental Panel on Climate Change). 2014. Climate Change 2014: impacts, adaptation, and vulnerability. In *Part A: Global and Sectoral Aspects*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, NY:Cambridge University Press.

Kasperson, R.E. & K.M. Dow. 1991. Developmental and geographical equity in global environmental change: a framework for analysis. *Eval. Rev.* **15:** 149–170.

Kinney, P.L., T. Matte, K. Knowlton, *et al.* 2015. New York City panel on climate change 2015 report chapter 5: public health impacts and resiliency. *Ann. N.Y. Acad. Sci.* **1336:** 67–88.

Kirchhoff, C.J., M.C. Lemos & S. Dessai. 2013. Actionable knowledge for environmental decision making: broadening the usability of climate science. *Annu. Rev. Environ. Resourc.* **38:** 393–414.

Klein R., G. Midgley, B. Preston, *et al.* 2014. Adaptation opportunities, constraints and limits. Impacts, adaptation and vulnerability. In . *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. C.B. Field, V.R. Barros, D.J. Dokken, et al., Eds.: 899–943. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Klinenberg, E. 2015. *Heat Wave: A Social Autopsy of Disaster in Chicago*. University of Chicago Press.

Leichenko, R. 2011. Climate change and urban resilience. *Curr. Opin. Environ. Sustain.* **3:** 164–168.

Leichenko, R., M. McDermott & E. Bezborodko. 2015. Barriers, limits and limitations to resilience. *J. Extreme Events* **2:** 1550002.

Leichenko, R., Y. Klein, M. Panero, *et al.* 2011. Equity and economics. *Ann. N.Y. Acad. Sci.* **1244:** 62–78.

Lemos, M.C. & B.J. Morehouse. 2005. The co-production of science and policy in integrated climate assessments. *Glob. Environ. Change* **15:** 57–68.

Madrigano, J., J.C. Osorio, E. Bautista, *et al.* 2018. Fugitive chemicals and environmental justice: a model for environmental monitoring following climate-related disasters. *Environ. Just.* **11:** 95–100.

Madrigano, J., K. Ito, S. Johnson, *et al.* 2015. A case-only study of vulnerability to heat wave–related mortality in New York City (2000–2011). *Environ. Health Perspect.* **123:** 672.

Martin, S.A. 2015. A framework to understand the relationship between social factors that reduce resilience in cities: application to the City of Boston. *Int. J. Disaster Risk Reduct.* **12:** 53–80.

Martinich, J., J. Neumann, L. Ludwig, *et al.* 2013. Risks of sea level rise to disadvantaged communities in the United States. *Mitig. Adapt. Strat. Glob. Change* **18:** 169–185.

McArdle, A. 2013. Storm surges, disaster planning, and vulnerable populations at the urban periphery: imagining a resilient New York after superstorm Sandy. *Idaho L. Rev.* **50:** 19–46.

McDermott, M., S. Mahanty & K. Schreckenberg. 2013. Examining equity: a multidimensional framework for assessing equity in payments for ecosystem services. *Environ. Sci. Policy* **33:** 416–427.

Misra, T. 2017. A catastrophe for Houston's most vulnerable people. The Atlantic. Accessed August 27, 2017. https://www.theatlantic.com/news/archive/2017/08/a-catastrophe-for-houstons-most-vulnerable-people/538155/a.

Morse, S. 2017. Harlem: displacement not integration. In *Zoned Out! Race, Displacement, and City Planning in New York City.* T. Angotti & S. Morse, Eds.: 96–120. New York City: Terreform.

Myers, C.A., T. Slack & J. Singelmann. 2008. Social vulnerability and migration in the wake of disaster: the case of Hurricanes Katrina and Rita. *Popul. Environ.* **29:** 271–291.

NAACP. 2015. Equity in building resilience in adaptation planning. NAACP.

Nature Conservancy. 2013. Coastal resilience New York mapping portal. Accessed October 15, 2018. http://maps.coastalresilience.org/newyork/.

New York City Panel on Climate Change. 2015. Building the knowledge base for climate resiliency. *Ann. N.Y. Acad. Sci.* **1336:** 1–150.

New York Environment Report. 2015. The Bronx is breathing. Accessed October 15, 2018. https://www.nyenvironmentreport.com/the-bronx-is-breathing/.

New York University Wagner Graduate School of Public Service Institute for Civil Infrastructure Systems (ICIS). 2006. South Bronx Environmental Health and Policy Study. Land Use, Transportation and Industrial Facilities: GIS to Support Improved Land Use Initiatives and Policies, the South Bronx, NYC. In *South Bronx Environmental Health and Policy Study: Public Health and Environmental Policy Analysis Final Report for Phase V*. C. Restrepo & R. Zimmerman, Eds.: 47–53. New York University. Accessed October 15, 2018. https://wagner.nyu.edu/files/publications/5%20NYUWagner-PhaseVReportApril2008.pdf

Nicholas, S.W., B. Jean-Louis, B. Ortiz, *et al.* 2005. Addressing the childhood asthma crisis in Harlem: the Harlem Children's Zone Asthma Initiative. *Am. J. Public Health* **95:** 245–249.

NPCC (New York City Panel on Climate Change). 2010. Climate change adaptation in New York City: building a risk management response: New York City Panel on Climate Change 2010 Report. Blackwell Publications.

NYC DCP (New York City Department of City Planning). 2011. Sunset Park 197a plan. New York City Department of City Planning.

NYC DCP (New York City Department of City Planning). 2018a. New York City Department of City Planning population data. Accessed October 15, 2018. http://www1.nyc.gov/site/planning/data-maps/nyc-population.page.

NYC DCP (New York City Department of City Planning). 2018b. Glossary of planning terms. Accessed October 15, 2018. https://www1.nyc.gov/site/planning/zoning/glossary.page.

NYC DOHMH (New York City Department of Health and Mental Hygiene). 2015. Heat Vulnerability Index. Accessed October 15, 2018. http://a816-dohbesp.nyc.gov/IndicatorPublic/EPHTPDF/HVI_FAQ.pdf.

NYC DOHMH (New York City Department of Health and Mental Hygiene). 2018. Environment & health and data portal. Accessed October 15, 2018. http://a816-dohbesp.nyc.gov/IndicatorPublic/QuickView.aspx.

NYC Food Policy. 2014. NYC food by the numbers: the Hunts Point Food Distribution Center. Accessed October 15, 2018. http://www.nycfoodpolicy.org/nyc-food-numbers-hunts-point-food-distribution-center/.

NYC SIRR (Special Initiative for Rebuilding and Resiliency). 2013. A stronger, more resilience New York. NYC.

NYCEJA (New York City Environmental Justice Alliance). 2016. NYC climate justice agenda: strengthening the Mayor's OneNYC plan. NYC.

NYCEJA (New York City Environmental Justice Alliance). 2018. NYC climate justice agenda. Midway to 2030: building resiliency and equity for a just transition. NYC.

O'Brien, K., R. Leichenko, U. Kelkar, *et al.* 2004. Mapping vulnerability to multiple stressors: climate change and globalization in India. *Glob. Environ. Change* **14:** 303–313.

O'Brien, K., S. Eriksen, L.P. Nygaard, *et al.* 2007. Why different interpretations of vulnerability matter in climate change discourses. *Clim. Policy* **7:** 73–88.

Outka, P. 2016. *Race and Nature from Transcendentalism to the Harlem Renaissance.* Springer.

OXFAM. 2009. Exposed: Social vulnerability and climate change in the U.S. Southeast.: 1–24. Accessed October 5th, 2018. https://policy-practice.oxfamamerica.org/static/oa3/files/Exposed-Social-Vulnerability-and-Climate-Change-in-the-US-Southeast.pdf

Paavola, J. & W.N. Adger. 2006. Fair adaptation to climate change. *Ecol. Econ.* **56:** 594–609.

Parks, B.C. & J.T. Roberts. 2010. Climate change, social theory and justice. *Theory Cult. Soc.* **27:** 134–166.

Pastor, M., Jr. 2001. Common ground at ground zero? The new economy and the new organizing in Los Angeles. *Antipode* **33:** 260–289.

Pflicke, K.M., M. Greenberg, J. Whytlaw, *et al.* 2015. Populations vulnerable to climate change in New Jersey: update of a statistical analysis.

Philadelphia Office of Sustainability. 2016. Greenworks: a vision for a sustainable Philadelphi. City of Philadelphia: Philadelphia Office of Sustainability.

Philadelphia Office of Sustainability & ICF International. 2015. Growing stronger: toward a climate-ready Philadelphia. City of Philadelphia: Philadelphia Office of Sustainability & ICF International.

Preston, B.L., E.J. Yuen & R.M. Westaway. 2011. Putting vulnerability to climate change on the map: a review of approaches, benefits, and risks. *Sustain. Sci.* **6:** 177–202.

Reckien, D. 2018. What is in an index? Construction method, data metric, and weighting scheme determine the outcome of composite social vulnerability indices in New York City. *Region. Environ. Change* **18:** 1439–1451.

Reckien D., S. Lwasa, D. Satterthwaite, *et al.* 2018. Equity, environmental justice, and urban climate change. In *Climate Change and Cities: Second Assessment Report of the Urban Climate Change Research Network*. C. Rosenzweig, W. Solecki, P. Romero-Lankao *et al.*, Eds.: 173–244. Cambridge, UK: Cambridge University Press.

Ribot, J. 2014. Cause and response: vulnerability and climate in the Anthropocene. *J. Peasant Stud.* **41:** 667–705.

Rockefeller Foundation. 2016. Resilient Rotterdam: ready for the 21st century. Accessed October 15, 2018. http://www.100resilientcities.org/resilient-rotterdam-ready-for-the-21st-century/#/-_/.

Rosenzweig, C., W.D. Solecki, P. Romero-Lankao, *et al.* 2018. Climate change and cities: second assessment report of the urban climate change research network. Cambridge University Press.

Rosenzweig, C., W.D. Solecki, R. Blake, *et al.* 2011. Developing coastal adaptation to climate change in the New York City infrastructure-shed: process, approach, tools, and strategies. *Clim. Change* **106:** 93–127.

Ross, H. & F. Berkes. 2014. Research approaches for understanding, enhancing, and monitoring community resilience. *Society & Natural Resources.* **27**: 787–804.

Rufat, S., E. Tate, C.G. Burton, *et al.* 2015. Social vulnerability to floods: review of case studies and implications for measurement. *Int. J. Disaster Risk Reduct.* **14:** 470–486.

Sadd, J.L., M. Pastor, Jr., J.T. Boer, *et al.* 1999. "Every breath you take . . . ": the demographics of toxic air releases in Southern California. *Econ. Dev. Quart.* **13:** 107–123.

Sadd, J.L., M. Pastor, R. Morello-Frosch, *et al.* 2011. Playing it safe: assessing cumulative impact and social vulnerability through an environmental justice screening method in the south coast air basin, California. *Int. J. Environ. Res. Public Health* **8:** 1441–1459.

Sandy Regional Assembly. 2013. Recovery from the ground up: strategies for community-based resiliency in New York and New Jersey. Accessed October 15, 2018. http://newyork.resiliencesystem.org/sandy-regional-assembly-recovery-agenda.

Santore, J. 2017. Sunset Park officials, activists call for more engagement on development projects (updated). Sunset Park Patch. Accessed February 16, 2017. https://patch.com/new-york/sunset-park/sunset-park-officials-activists-call-more-engagement-development-projects.

Sarzynski, A. 2015. Public participation, civic capacity, and climate change adaptation in cities. *Urban Clim.* **14:** 52–67.

Savitch-Lew, A. 2018. 4 Months after rezoning, East Harlem stakeholders remain. CityLimits.Org. Accessed March 19, 2018. https://citylimits.org/2018/03/19/4-months-after-rezoning-east-harlem-stakeholders-remain-vigilant/.

Schlosberg, D. 2013. Theorising environmental justice: the expanding sphere of a discourse. *Environ. Polit.* **22:** 37–55.

Schlosberg, D. & L.B. Collins. 2014. From environmental to climate justice: climate change and the discourse of environmental justice. *Wiley Interdiscip. Rev. Clim. Change* **5:** 359–374.

Schlosberg, D., L.B. Collins & S. Niemeyer. 2017. Adaptation policy and community discourse: risk, vulnerability, and just transformation. *Environ. Polit.* **26:** 413–437.

Schmidtlein, M.C., R.C. Deutsch, W.W. Piegorsch, *et al.* 2008. A sensitivity analysis of the social vulnerability index. *Risk Anal.* **28:** 1099–1114.

Smit, B. & J. Wandel. 2006. Adaptation, adaptive capacity and vulnerability. *Glob. Environ. Change* **16:** 282–292.

SVI Seattle-King County (Social vulnerability Index for Seattle-King County). 2013. Supplemental Documentation. Department of Public Health Division of Emergency Preparedness. Accessed October 5, 2018. https://www.kingcounty.gov/depts/health/emergency-preparedness/partnerships/Community-Resilience-Equity-Program/~/media/depts/health/emergency-preparedness/documents/social-vulnerability-index-supplement.ashx.

Sze, J. 2006. *Noxious New York: The Racial Politics of Urban Health and Environmental Justice.* MIT Press.

Sze, J. & E. Yeampierre. 2018. Just transition and just green enough: climate justice, economic development and community resilience. In *Just Green Enough: Urban Development and Environmental Gentrification.* W. Curran & T. Hamilton, Eds.: 61–73. Routledge.

Tate, E. 2012. Social vulnerability indices: a comparative assessment using uncertainty and sensitivity analysis. *Nat. Hazards.* **63:** 325–347.

Tate, E. 2013. Uncertainty analysis for a social vulnerability index. *Ann. Assoc. Am. Geogr.* **103**: 526–543.

U.S. Census Bureau. 2018. 2010 Geographic terms and concepts. Accessed October 5, 2018. https://www.census.gov/geo/reference/terms.html.

U.S. Climate Resilence Toolkit. 2018. Accessed October 5, 2018. https://toolkit.climate.gov/tools.

U.S. EPA (Environmental Protection Agency). 1992. Environmental equity. Reducing risks for all communities. Washington, DC: U.S. EPA.

Vant-Hull, B., P. Ramamurthy, B. Havlik, *et al.* 2018. The Harlem Heat Project: A Unique Media–Community Collaboration to Study Indoor Heat Waves. *Bull. Am. Meteorol. Soc.* **99:** 2491–2506.

Warerkar, T. 2017. Rezoning of Sunset Park's Industry City complex is on the horizon. Curbed NY. Accessed October 23, 2017. https://ny.curbed.com/2017/10/23/16524818/industry-city-sunset-park-rezoning.

Yager, J. 2015. The challenge of rising rents: exploring whether a new tax benefit could help keep unsubsidized rental units affordable. Furman Center for Real Estate & Urban Policy.

Zanoni, C. 2011. Census shows puzzling decrease in Upper Manhattan — Washington Heights & Inwood. DNAinfo. Accessed March 25, 2011. https://www.dnainfo.com/new-york/20110325/washington-heights-inwood/census-shows-puzzling-decrease-upper-manhattan.

## Appendix 6.A

### *Social indicators used in SoVI and SVI*

**Table 6.A.1. Twenty-nine social indicators used in SoVI 2010–2014 (HVRI, 2018b)**

| Indicators in Social Vulnerability Index (SoVI) 2010–2014 |
|---|
| 1. Percent Asian |
| 2. Percent African-American |
| 3. Percent Hispanic |
| 4. Percent Native American |
| 5. Percent population under 5 years or 65 and over |
| 6. Percent children living in married couple families |
| 7. Median age |
| 8. Percent households receiving Social Security benefits |
| 9. Percent poverty |
| 10. Percent households earning over $200,000 annually |
| 11. Per capita income |
| 12. Percent speaking English as a second language with limited English proficiency |
| 13. Percent female |
| 14. Percent female headed households |
| 15. Nursing home residents per capita |
| 16. Hospitals per capita (county-level only) |
| 17. Percent of population without health insurance (county-level only) |
| 18. Percent with less than 12th grade education |
| 19. Percent civilian unemployment |
| 20. People per unit |
| 21. Percent renters |
| 22. Median housing value |
| 23. Median gross rent |
| 24. Percent mobile homes |
| 25. Percent employment in extractive industries |
| 26. Percent employment in service industry |
| 27. Percent female participation in labor force |
| 28. Percent of housing units with no car |
| 29. Percent of unoccupied housing units |

**Table 6.A.2. Selected examples of SoVI-based indexing and mapping**

| Index name | Data and geography | Number of indicators and methodology | Risks and hazards | References |
|---|---|---|---|---|
| Social Vulnerability Mapping of the Southeastern States in the United States (2009) for OXFAM | Data from U.S. Census (2000) and American Community Survey (2005–2009). County level for 13 U.S. southeastern states | 32 indicators (from an outdated SoVI 2000 modified edition); Principal component analysis (PCA) | Environmental hazards focusing on climate-related hazards (i.e., drought, flooding, hurricane-force winds, and sea level rise) | OFXAM (2009) and Emrich and Cutter (2011) |
| Social Vulnerability to Climate Change in California (2012) | Data from U.S. Census (2000) and American Community Survey (2005–2009). Tract level for the state of California | 19 indicators (reduced from SoVI 2000 modified edition's 32 to 19 indicators based on the Project Advisory Committee); Principal component analysis (PCA) | Environmental hazards focusing on climate-related hazards (i.e., extreme heat, wildfire risk, coastal flooding from sea level rise, and air quality) | Cooley et al. (2012) |
| Social Vulnerability Index for the State of New Jersey (2015) | Data from U.S. Census (2010) and American Community Survey (2006–2010). Tract level for New Jersey | 30 indicators (29 indicators came from the SoVI 2006–2010 edition and 1 non-SoVI indicator); Principal component analysis (PCA) | Environmental hazards focusing on climate-related hazards (i.e., flooding) | Pflicke et al. (2015) |

**Table 6.A.3. The 15 social indicators used in the SVI (Flanagan et al., 2011)**

| Indicators in Social Vulnerability Index (SVI) |
|---|
| *Socioeconomic status* |
| 1. Persons below poverty |
| 2. Civilians (age 16+) unemployed |
| 3. Per capita income |
| 4. Persons (age 25+) with no high school diploma |
| *Household Composition and Disability* |
| 1. Persons aged 65 or older |
| 2. Persons aged 17 or younger |
| 3. Civilian with a disability |
| 4. Single-parent household |
| *Minority Status and Language* |
| 1. Minority (all persons except white, non-Hispanic) |
| 2. Persons (age 5+) speaking English "less than well" |
| *Housing and Transportation* |
| 1. Multiunit housing (10+ units) |
| 2. Mobile homes |
| 3. Crowding (household level, more people than rooms estimate) |
| 4. Households with no vehicle |
| 5. Persons in institutionalized group quarters |

**Table 6.A.4. Selected examples of SVI-based indexing and mapping**

| Index name | Data and geography | Number of indicators and methodology | Risks and hazards | References |
|---|---|---|---|---|
| Social Vulnerability Index (SVI) for Seattle and King County (2013) | Data from U.S. Census 2010 and American Community Survey (2006–2010). Census tract level for Seattle and King County | 15 indicators Percentile ranking | Environmental hazards | SVI Seattle-King County (2013) |
| Social Vulnerability Index (SVI) for the City of Washington, North Carolina (2015) | Data from U.S. Census 2010. Block group level for Washington, North Carolina | 12 indicators (three indicators excluded due to lack of available data at block group level) Percentile ranking | Environmental hazards focusing on climate-related hazards (e.g., flooding and sea level rise) | Berke et al. (2015) |
| Media outlets referencing the Center for Disease Control Social Vulnerability Index (CDC SVI) in post-Houston flood (2017) | Data from U.S. Census (2010) and American Community Survey (2010–2014). Tract level in New York State and New York City | 15 indicators Percentile ranking | Environmental hazards | Misra (2017) and Deaton (2017) |

Note: Demographic and social profiles of case study communities. Northern Manhattan consists of Hamilton Heights, Manhattanville, and West Harlem (Manhattan CD 9 / PUMA 3802); Central Harlem (Manhattan CD 10 / PUMA 3803); East Harlem (Manhattan CD 11 / PUMA 3804); and Washington Heights, Inwood, and Marble Hill (Manhattan CD 12 / PUMA 3801). Sunset Park consists of Sunset Park and Windsor Terrace (Brooklyn CD 7 / PUMA 4012). Hunts Point consists of Melrose, Mott-Haven, Port Morris (Bronx CD 1), and Hunts Point and Longwood (Bronx CD 2); PUMA 3710 approximately represents Bronx CD 1 and 2. Demographic data were collected from the New York City Department of City Planning. Data came from the 2012 to 2016 American Community Survey 5-Year Estimates.

**Table 6.A.5. Demographic makeup of northern Manhattan (NYC DCP, 2018)**

| Northern Manhattan | Northern Manhattan estimate 2016 | Northern Manhattan growth/decline between 2000 and 2016 | Northern Manhattan estimate percent (%) 2016 | Manhattan estimate percent (%) 2016 | New York City estimate percent (%) 2016 |
|---|---|---|---|---|---|
| Total population | 607,096 | 11.4% | 100.0% | 100.0% | 100.0% |
| White non-Hispanic | 112,330 | 90.9% | 18.5% | 47.1% | 32.3% |
| Black non-Hispanic | 159,073 | −10.2% | 26.2% | 12.6% | 22.2% |
| Asian and Pacific Islander non-Hispanic | 30,336 | 113.9% | 5.0% | 11.7% | 13.6% |
| Other non-Hispanic | 3537 | 14.4% | 0.6% | 0.5% | 1.1% |
| Two or more race non-Hispanic | 11,666 | 20.8% | 1.9% | 2.2% | 1.8% |
| Hispanic origin | 290,154 | 2.9% | 47.8% | 25.9% | 29.0% |

**Table 6.A.6. Demographic makeup of Sunset Park, Brooklyn (NYC DCP, 2018)**

| Sunset Park | Sunset Park estimate 2016 | Sunset Park growth/decline between 2000 and 2016 | Sunset Park estimate percent (%) 2016 | Brooklyn estimate percent (%) 2016 | New York city estimate percent (%) 2016 |
|---|---|---|---|---|---|
| Total population | 151,258 | 26.0% | 100.0% | 100.0% | 100.0% |
| White non-Hispanic | 33,714 | 23.2% | 22.3% | 35.8% | 32.3% |
| Black non-Hispanic | 3917 | −6.8% | 2.6% | 30.9% | 22.2% |
| Asian and Pacific Islander non-Hispanic | 48,965 | 134.2% | 32.4% | 11.6% | 13.6% |
| Other non-Hispanic | 632 | −31.7% | 0.4% | 0.6% | 1.1% |
| Two or more race non-Hispanic | 1754 | −47.2% | 1.2% | 1.7% | 1.8% |
| Hispanic origin | 62,276 | −1.7% | 41.2% | 19.4% | 29.0% |

**Table 6.A.7. Demographic makeup of Hunts Point-Mott Haven, South Bronx (NYC DCP, 2018)**

| Hunts Point-Mott Haven | Hunts Point-Mott Haven estimate 2016 | Hunts Point-Mott Haven growth/decline between 2000 and 2016 | Hunts Point-Mott Haven estimate percent (%) 2016 | Bronx estimate percent (%) 2016 | New York City estimate percent (%) 2016 |
|---|---|---|---|---|---|
| Total population | 161,319 | 25.1% | 100.0% | 100.0% | 100.0% |
| White non-Hispanic | 2567 | 52.9% | 1.6% | 9.6% | 32.3% |
| Black non-Hispanic | 45,438 | 45.2% | 28.2% | 29.5% | 22.2% |
| Asian and Pacific Islander non-Hispanic | 1298 | 107.0% | 0.8% | 3.6% | 13.6% |
| Other non-Hispanic | 1182 | 102.7% | 0.7% | 0.9% | 1.1% |
| Two or more race non-Hispanic | 842 | −22.8% | 0.5% | 1.0% | 1.8% |
| Hispanic origin | 109,992 | 17.4% | 68.2% | 55.4% | 29.0% |

## Appendix 6.B

### *Interview Guide for Cross-City Analysis*

1. On the Community Engagement Process

This set of questions is designed to explore the experience of initiating and carrying out the engagement process between city officials, researchers, and community representatives.

- Who initiated the community engagement process? How? Why?
- Did you reach out to, or engage, the community in connection with a project or proposal?
    - If so, did the project envision a collaborative relationship with the community in shaping the project, or was the project already in place before the community engagement process was initiated?
- What were the guiding principles or goals/objectives for community engagement?
    - Equity? Inclusion? Participation? Collaboration?
- What did the community engagement process entail?
    - What were the outreach strategies? How did the participants become involved?
    - What were the meeting formats? Workshops? Meetings? What were their goals/objectives? What were the outcomes?
- What were the community representatives' concerns regarding climate change impacts/stressors? Did they mention other non-climate stressors, specifically those related to social or economic vulnerabilities?
- How did community feedback and local knowledge get integrated or taken into consideration on this particular project or other projects?
- Were there other institutions or entities (from civil society, nonprofit sector, universities or other researchers, private sector, or government) that you involved in the community engagement process?
    - If so, how and why did you choose particular institutions or entities to get involved with the community in the project/process?
    - What were their respective roles in the community engagement process or in the project overall?
- What is your assessment of the success of the community engagement process? Are there things you could or would have done differently? Why?

2. On the Collaborative Community-based Adaptation Framework

This set of questions is designed to solicit feedback and opinion on a set of protocols for community engagement in adaptation and resiliency planning that takes collaboration and equity into consideration

- What are, or should be, the criteria for measuring community-led adaptation efforts?
    - Inclusion? Equity? Participation? Collaboration? Efficiency? Effectiveness?
    - Is there a framework that you already use for guidance?
- Based on your experience, what is the best entry point for local governments and other public officials to engage with communities on climate resiliency efforts?
- Do you have any thoughts on how best to create a good process for collaboration that engages communities at the beginning of the planning process for resiliency?
- Do you think it would be useful to have a set of protocols for this kind of collaborative community engagement process with equity as a strong component?