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Chapter 1: New York City adaptation in context

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Introduction

New York City has a long history of undertaking ambitious planning projects to meet critical needs. Historical examples include the creation of Central Park and the development of the New York City upstate watershed system in the 1800s, and more recently, the sustainability plan known as PlaNYC, which is charting the city's future for the coming decades. The newest challenge for the city that requires long-term strategic planning is climate change, which is projected to have wide impacts on its critical infrastructure through higher temperatures, more intense flooding events, and sea level rise. Because of its early recognition of the risks posed by climate change and its current commitment to mitigation of greenhouse gas (GHG) emissions as well as to adaptation, New York City has become a national and international leader in responding to climate change.

1.1 A decade of response

Current climate change adaptation efforts in New York City build on previous assessments and studies. Also germane are lessons learned from responding to extreme events in the current climate that challenge the infrastructure. Leading scientists in the region, agencies such as the New York City Department of Environmental Protection (NYC DEP), the Port Authority of New York and New Jersey, and nongovernmental organizations, such as the Environmental Defense Fund, have been studying issues related to climate extremes and climate change for more than a decade (Table 1.1 and Fig. 1.1).

In 2004, a 4-year climate change adaptation initiative was launched by the NYC DEP. The NYC DEP has responsibility for the New York City water and wastewater systems, which supply and drain water for nine million people. The work of the NYC DEP Climate Change Task Force focused primarily on the water supply, sewer, and wastewater treatment systems, but the approach developed has wide application for other infrastructure types and other urban areas. Part of the initiative was the creation of the NYC DEP Climate Change Task Force with the mission to ensure that all aspects of departmental planning:

(1) take into account the potential risks of climate change on the city's water supply, drainage, and wastewater management systems; and
(2) integrate GHG emissions management to the greatest extent possible.

The major product of the NYC DEP Task Force was the Climate Change Assessment and Action Plan for the agency (NYC DEP, 2008). Since many climate change adaptations identified through this process help to increase the robustness of current systems managed by the agency, the NYC DEP Task Force had immediate benefits by improving responses to present-day climate variability, such as managing episodes of intense precipitation in the upstate reservoirs.

Table 1.1. Climate change impacts and adaptation studies in the New York City region

Year	Report title	Organization/Publisher
Under way 2010	New York State ClimAID Adaptation Assessment	New York State Energy Research & Development Authority
Under way 2010	New York State Sea Level Rise Task Force	New York State Department of Environmental Conservation
Under way 2010	New York City Climate Change Adaptation Task Force	NYC Office of Long-Term Planning & Sustainability
2010	New York City Panel on Climate Change	NYC Office of Long-Term Planning & Sustainability
Ongoing	Long Island Shore Study	The Nature Conservancy
2008	NYC DEP Climate Change Program Assessment and Action Plan	New York City Department of Environmental Protection
2007	Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions	Union of Concerned Scientists
2007	August 8, 2007 Storm Report	Metropolitan Transit Authority
2001	Climate Change and a Global City: The Potential Consequences of Climate Variability and Change[a]	U.S. National Assessment & Columbia Earth Institute
1999	Hot Nights in the City: Global Warming, Sea-Level Rise and the New York Metropolitan Region	Environmental Defense Fund
1996	The Baked Apple? Metropolitan New York in the Greenhouse	New York Academy of Sciences

[a]As one of the regional components of the U.S. National Assessment of the Potential Consequences of Climate Variability and Change, the *Metropolitan East Coast Regional Assessment of Climate Variability and Change* (MEC) (Rosenzweig and Solecki, 2001) investigated potential risks of climate variability and change, identified key vulnerabilities to the stresses that climate change is likely to introduce, and examined feasible adaptation strategies. It also drew attention to the need to mitigate atmospheric GHG concentrations in order to reduce climate risks.

1.2 Benchmark climate events

Although no single weather-related event can be attributed to climate change, New York City has experienced climate extremes in its recent history that have brought attention to the potential risks posed by climate change to the city's critical infrastructure. Recent extreme climate-related events include the December 1992 nor'easter that flooded lower Manhattan and portions of the East River Drive and, together with near hurricane-force wind gusts, led to the almost complete shutdown of the New York transportation system. Tropical Storm Floyd in September 1999 caused virtually no coastal surge, but excessive precipitation inland led to severe riverine flooding in the region. An intense rainfall in the early morning hours of August 8, 2007 caused flash floods on nearly every subway line just before the morning commute (Fig. 1.2).

Although there were many contributing factors besides climate, the August 14, 2003 blackout provides an example of how multiple stresses can combine to cause infrastructure breakdowns. The blackout in New York City lasted about 28 hours, halting not only electricity services, but also mass transportation, surface vehicular movement due to signaling outages, and water supply for a much longer period.

These events, which resulted in large social and economic costs, provide valuable insights into the impacts that climate change could have in the future. They also highlight the need, even without climate change, to improve the city's resilience to

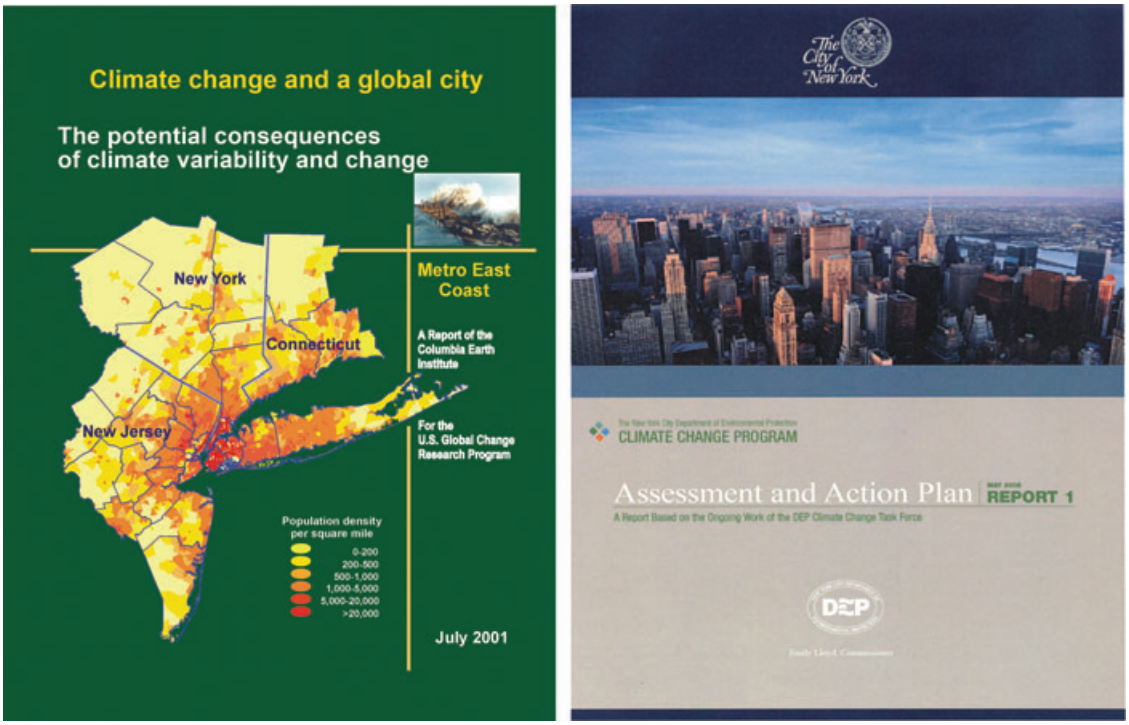


Figure 1.1. "Climate Change and A Global City," the 2001 Metro East Coast study, and the "Department of Environmental Protection Climate Change Program 2008 Assessment and Action Plan."

environmental stressors, of which climate extremes are one of the most important. In many cases, linking adaptation efforts to the climate risks faced by the city today is an effective adaptation strategy.

1.3 Current actions in New York City

Climate change planning in New York City and the surrounding region was strengthened in September 2006, when Mayor Michael Bloomberg created the Office of Long-Term Planning and Sustainability, with the goal of developing a comprehensive plan to create a greener, more sustainable city. Mitigating and adapting to climate change are central goals of the City's comprehensive sustainability plan, PlaNYC, which was released in April 2007.

Climate change in PlaNYC

PlaNYC set an ambitious goal of a 30% reduction of GHG emissions by 2030 from 2005 levels, and the City is implementing actions to accomplish that goal. On July 7, 2008, Mayor Bloomberg announced a long-term action plan to reduce energy consumption and GHG emissions from the city's municipal buildings and operations by 30% by 2017, even earlier than the citywide 2030 goal in PlaNYC. This will cut the city's annual output of GHGs by nearly 1.7 million metric tons and reduce peak demand for electricity by 220-megawatts (NYC, 2007).

In addition to its goals to reduce GHG emissions, PlaNYC also includes adaptation as it recognizes the importance of doing both climate change mitigation and adaptation simultaneously to protect the citizens of New York City. One climate change adaptation goal of PlaNYC is the creation of an interagency Task Force to protect the city's vital infrastructure in the face of a changing climate. To meet that goal, Mayor Bloomberg convened the New York City Climate Change Adaptation Task Force in August 2008. The charge of the Task Force is to identify climate change risks and opportunities for the city's critical infrastructure[1] and to develop coordinated adaptation strategies to address these risks. The Task Force consists of approximately 40 city, state, and federal agencies, regional public authorities, and private companies that operate, maintain,

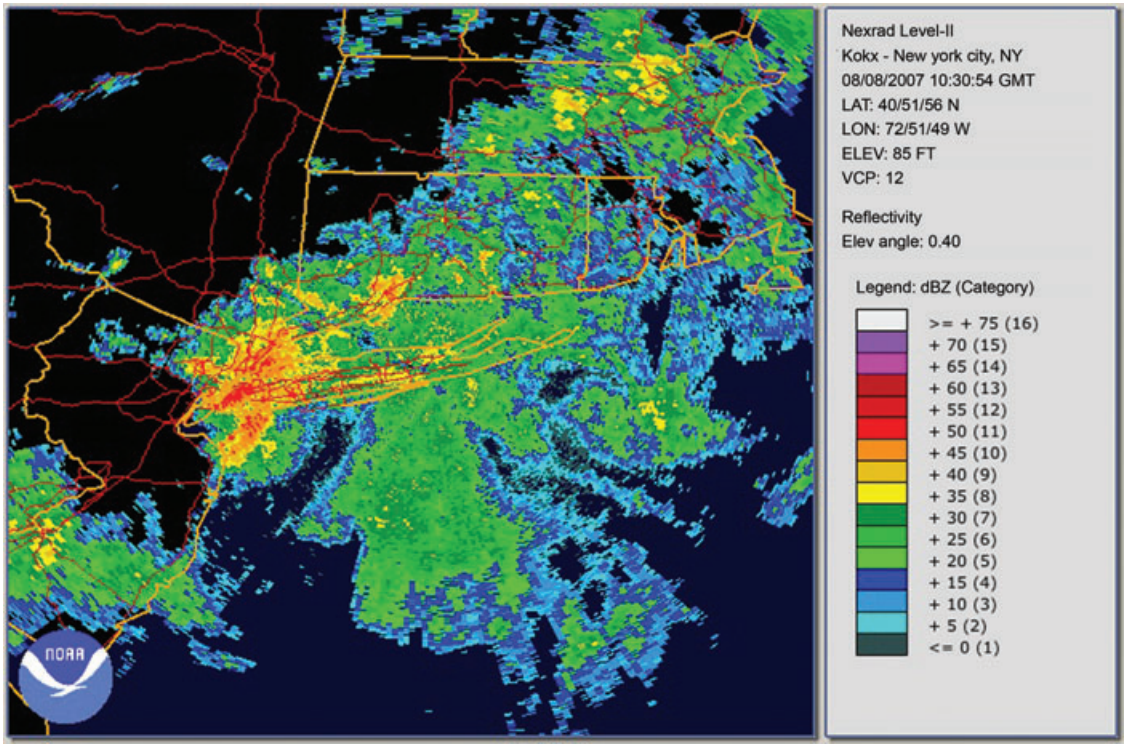


Figure 1.2. NOAA radar image of the August 8, 2007 storm over New York City showing the location and intensity of rainfall. Areas of heavier rainfall are shown in *red*, while lighter rainfall is in *blue*.
Source: NOAA.

or regulate critical infrastructure in the region. The Task Force is developing climate change adaptation strategies to mitigate the risks posed by climate change to the city's critical infrastructure related to energy, transportation, water and waste, natural resources, and communications. A key outcome will be a comprehensive citywide plan to increase the city's climate resilience, which is due to be released in early 2010. The Task Force was created with assistance from the Boston Consulting Group (BCG), which provided *pro bono* assistance to the City and, among other activities, conducted a benchmarking study that identified best practices developed by other cities related to adaptation efforts.

To support the Task Force, Mayor Bloomberg, in partnership with the Rockefeller Foundation, convened a group of climate change and impact scientists, and legal, insurance, and risk management experts as the New York City Panel on Climate Change (NPCC), which was also launched in August 2008, to advise the City on climate change and adaptation (Fig. 1.3).

New York City Panel on Climate Change

The NPCC consists of climate change and impacts scientists, and legal, insurance, and risk management experts and serves as the technical advisory body for the Mayor and the Task Force on issues related to climate change, impacts, and adaptation (Fig. 1.3).

The work of the NPCC is to ensure that the city's adaptation efforts are based on sound science and a thorough understanding of climate change, its potential impacts, and adaptation. To assist the City, the NPCC has analyzed climate change hazards, studied impacts on the critical infrastructure of New York City, and developed a risk management framework for adaptation planning, which, in turn, contributed to the development of the City's climate change adaptation planning framework. The NPCC has created climate change projections for New York City and the surrounding region, developed planning tools to help guide stakeholders in their adaptation planning and

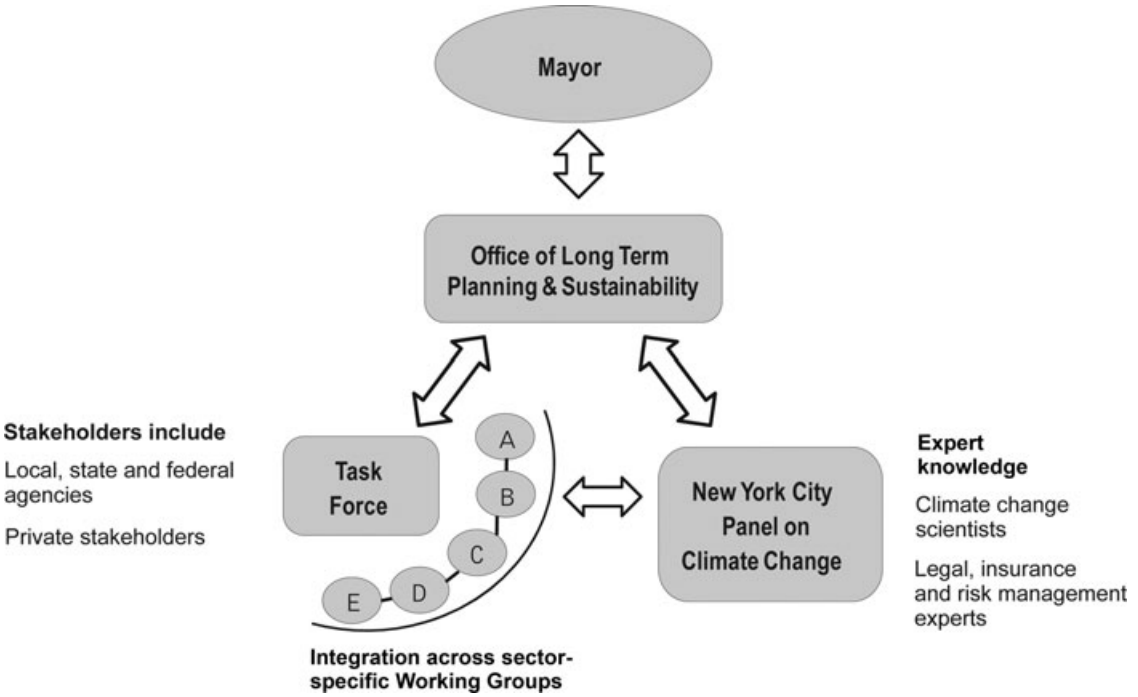


Figure 1.3. **The structure of climate change adaptation in New York City.**

strategy-creation process, and examined how the regulatory environment influences infrastructure-related decision making.

The work of the NPCC is presented in this report, which includes three workbooks to guide Task Force members through the process of identifying climate risks to their critical infrastructure, creating adaptation plans, and considering the regulatory environment as it pertains to climate change adaptation (Box 1.1 and Fig. 1.3).

Box 1.1 New York City Panel on Climate Change tools

To support adaptation planning, the NPCC, with input from the City, the Boston Consulting Group, and the members of the NYC Climate Change Adaptation Task Force, developed tools to help stakeholders identify their risks and place adaptation into context with other planning efforts. In particular, the utilization of a common set of climate change projections developed by the NPCC in the **Climate Risk Information (CRI)** workbook (Fig. 1.4, Appendix A) allowed stakeholders to gain an understanding of the climate science, potential impacts, and uncertainties, and ensured that the impacts identified and strategies developed by the stakeholders were based on the same state-of-the-art climate change projections.

The **Adaptation Assessment Guidebook (AAG)** (Appendix B) was created to help stakeholders understand the adaptation process and begin to create inventories of at-risk infrastructure and to identify appropriate adaptation strategies. The AAG outlines a multi-tiered process.

The **Climate Protection Levels (CPL)** workbook (Appendix C) addresses the potential for climate change to affect current regulations and design standards related to sea level rise and storm surge, heat waves, and inland flooding.

Building on the Climate Risk Information (CRI) workbook, which presents a coordinated set of climate projections for the New York City region, the Adaptation Assessment Guidebook (AAG) describes an eight-step process designed to help stakeholders create an inventory of their at-risk infrastructure and to develop adaptation strategies to address those risks (Fig. 1.5). The steps outlined

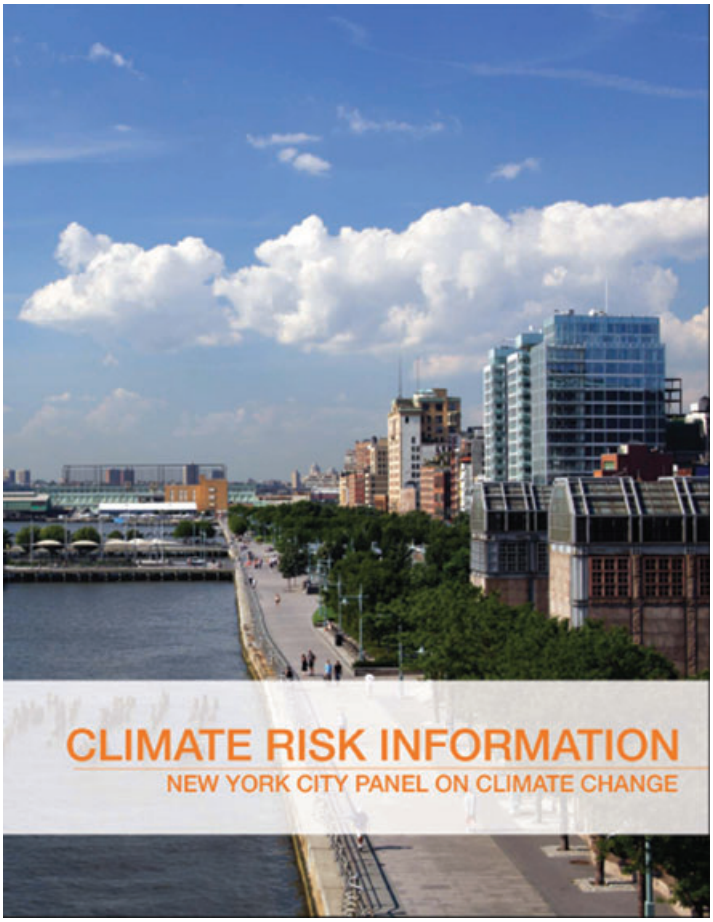


Figure 1.4. New York City Panel on Climate Change Climate Risk Information workbook.

in the AAG are intended to become integral parts of ongoing risk management, maintenance and operation, and capital planning processes of the agencies and organizations that manage and operate critical infrastructure.

As part of its eight-step process, the AAG includes three tools developed to aid the stakeholders in the Climate Change Adaptation Task Force in their adaptation planning process:

(1) **Infrastructure Questionnaires (IQs)**. Sector-specific questionnaires to guide stakeholders in initiating their assessment process and in beginning to create an inventory of their infrastructure at risk to climate change impacts;
(2) **Risk Matrix (RM)**. A tool designed in conjunction with the City and Boston Consulting Group to help stakeholders categorize their lists of at-risk infrastructure based on probability of a climate hazard occurring, likelihood of impact, and magnitude of consequence; and
(3) **Prioritization Framework (PF).** A tool designed in conjunction with the City and Boston Consulting Group to assist stakeholders in developing and prioritizing adaptation strategies.

Together, these process-based tools contributed to the development of climate change adaptation plans for the critical infrastructure of the New York City region. Details of their construction can be found in Appendix B.

The adaptation process should be a dynamic cycle of analysis and action followed by evaluation, further analysis, and refinement (i.e., learn, then act, then learn some more). The eight-step adaptation approach developed by the NPCC fosters Flexible Adaptation Pathways that evolve over time as

Figure 1.5. Adaptation Assessment Steps developed by the NPCC.

understanding of climate change improves and that concurrently reflect local, national, and global economic and social conditions.

Flexible Adaptation Pathways is a concept that encourages building climate change adaptation strategies that can be adjusted and modified over time to reflect the dynamic and ongoing climate change understanding. The concept was developed for use in the London TE2100 project and has been modified for New York City by the NPCC. Flexible strategies allow for adjustments as new information emerges on climate science, impacts, and other unforeseen factors to ensure they remain within an acceptable level of risk as that risk changes over time. This concept is explored further in Chapter 2 and the Adaptation Assessment Guidebook (Appendix B).

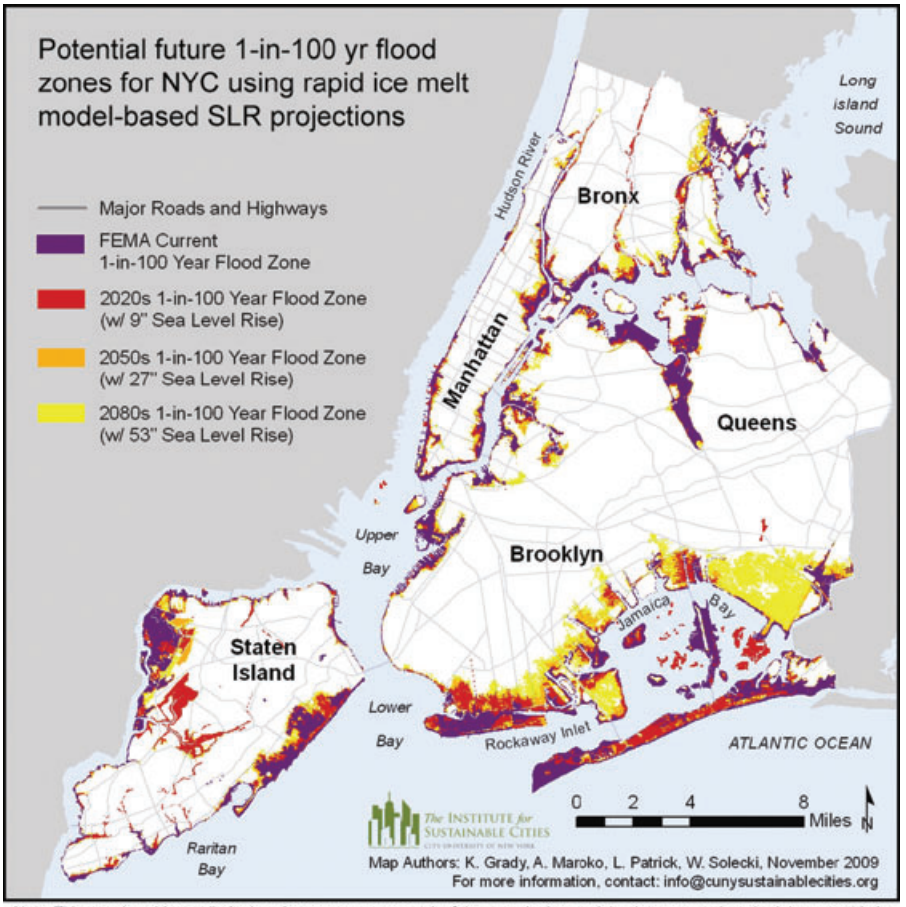
The NPCC also has developed a series of maps that illustrate the potential landward inundation of the 1-in-100-year flood during the 2020s, 2050s, and 2080s by incorporating the 90th percentile sea level rise projections from seven global climate models for those decades both with and without rapid ice-melt scenarios (Fig. 1.6).

These maps should not be interpreted as delineating precise flood boundaries, but rather illustrating three distinct areas: those areas that are currently within the Federal Emergency Management Agency (FEMA) designated 1-in-100-year flood zone; those that are not in the existing flood zone, but could be in the future as a result of sea level rise; and those areas that are not in the existing flood zone and are unlikely to be so through the end of the century. Site-specific analysis is needed to determine actual flood risks for individual neighborhoods or properties. The maps should not be used to assess actual coastal hazards, insurance requirements, or property values, or be used in lieu of Flood Insurance Rate Maps (FIRMs) issued by FEMA.

The multidimensional climate risk management approach developed by the NPCC can be helpful in planning climate change adaptation in other sectors besides infrastructure. Much of the work of the NPCC is also applicable to adaptation efforts in other cities and metropolitan regions.

1.4 National and global climate change adaptation initiatives

New York City is not alone in the undertaking of developing climate change adaptation plans. Climate change policy discussions were once



Note. This map is subject to limitations in accuracy as a result of the quantitative models, datasets, and methodology used in its development. The map and data should not be used to assess actual coastal hazards, insurance requirements or property values or be used in lieu of Flood Insurance Rate Maps issued by FEMA.

Interpretation. The floodplains delineated above in no way represent precise flood boundaries but rather illustrate three distinct areas of interest: 1) areas currently subject to the 1-in-100 year flood that will continue to be subject to flooding in the future, 2) areas that do not currently flood but are expected to potentially experience the 1-in-100 year flood in the future, and 3) areas that do not currently flood and are unlikely to do so in the timeline of the climate projection scenarios used in this research (end of the current century).

Figure 1.6 shows the current FEMA 1-in-100 year flood zone and potential areas that could be impacted by a 1-in-100 year flood in the 2020s, 2050s, and 2080s based on projections of the 90th percentile model-based "rapid ice melt" sea level rise scenario. This estimate is based on the average meltwater rate of 43 inches per century in paleoclimatic times (see CRI Table 3 for more information).

Figure 1.6. Areas potentially at-risk to the 1-in-100 year floods in NYC due to rapid ice melt sea level rise projections derived from global climate models.

mitigation-focused, but increasingly are including the importance of addressing adaptation alongside mitigation, and highlighting the role that cities can play in climate change adaptation. There are new efforts on both national and international levels to encourage the development of climate change adaptation in cities.

At the national level, the American Clean Energy and Security Act of 2009 (ACES), passed by the U.S. House of Representatives, contains detailed provisions for adaptation, including plans to distribute funds to federal and state agencies for adaptation. Mandates for adaptation actions may be part of such future federal initiatives.

The Climate Summit for Mayors hosted by the City of Copenhagen was held in December 2009 in conjunction with the 15th Conference of the Parties (COP15) of the United Nations Framework

Convention on Climate Change (UNFCCC). The goal of the Summit was to highlight the important role that cities play in responding to climate change in regard to both mitigation and adaptation.

Several organizations are sharing best practices in regard to urban climate change initiatives. At a global level, the C40 initiative, a partnership between the Clinton Climate Initiative and the Large Cities Climate Leadership Group, of which New York City is a charter member, was started in 2005 to promote the role cities can play in responding to climate change.

ICLEI, Local Governments for Sustainability, is an organization of more than 1100 local governments and associations. It has brought together city and local government associations in the Local Government Climate Roadmap to work on enhancing the role of cities in international responses to climate change. Though much of its work has focused on mitigation efforts, ICLEI has also begun to recognize the need for cities to adapt to climate change and has launched initiatives in the United States, as well as in Australia, Europe, and Canada.

There are several climate change adaptation studies, including *America's Climate Choices*, an initiative of the National Academies stemming from the Department of Commerce Appropriations Act of 2008, and a U.S. Government Accountability Office study released in October 2009 that highlights New York City's adaptation efforts. Descriptions of climate change adaptation plans from other cities can be found in Chapter 5 on Infrastructure and in the AAG (Appendix B). The Urban Climate Change Research Network (UCCRN), a group of researchers and experts from cities around the world, is conducting the First Assessment Report on Climate Change in Cities (ARC3), to be published in 2010.

1.5 Keys to success

Other municipalities and urban areas can draw from New York City in devising their own decision support processes for climate change, since it has been addressing the issue in a variety of ways for about a decade. Elements that are contributing to New York City's success include strong leadership, broad involvement among government, private sector, and scientific communities, establishment of clear goals, creation of targeted tools to support adaptation planning efforts, development of mechanisms for re-evaluation, and creation of a "knowledge network." The following best practices emerge from the New York City process:

- **High-level proactive leadership** to initiate and coordinate the adaptation process for the critical infrastructure of the city, as well as of the broader metropolitan region;
- **Links to larger sustainability activities** (i.e., PlaNYC), so that climate change is considered as part of a broad range of future trends, rather than in isolation;
- **Involvement of multiple layers of government and a wide range of public and private sector stakeholders and experts**, so that the full set of key actors are included in the coordinated adaptation planning process;
- **Incorporation of climate change risks into stakeholder operations, management, and planning**, ensuring that adaptation strategies may be tailored to both current and future activities;
- **Creation of tools** to help guide a diverse body of stakeholders in "how to" address climate change; and
- **Development of an evolving, dynamic risk management approach** to climate change, leading to Flexible Adaptation Pathways.

A crucial element to successful "mainstreaming" of climate change in New York City is high-level "buy-in." Mayor Bloomberg is the champion of the climate change issue for the city, guiding the overall process with great foresight and courage. In regard to the Task Force and the NPCC, the engaged leadership of the Mayor was essential to the setting and the attainment of climate change goals. At the commissioner level, the groundbreaking work on climate change in relation to the New York City water system was actively initiated and then supported by two NYC DEP commissioners. Just as those responsible for creating the upstate water system for the city in the 1840s had a planning horizon of 100 years, these present-day commissioners are taking on the challenges that climate change poses to the city's water system in the coming century.

Participants learned that in the New York City adaptation planning process it was more effective

when there was active and open engagement among public and private decision makers in the region and climate change experts from a range of disciplines (including physical, biological, and social science) and fields (including the law, insurance, and risk management). Creating an environment of mutual learning, respect, courtesy, and trust was also important to effective outcomes, with balanced contributions from both the decision makers and the experts. For the most part, these interactions were then able to imbue the products of the climate change adaptation activities with the key attributes of salience, relevance, credibility, and legitimacy (Cash *et al.*, 2002).

One critical means of monitoring and reassessing climate change in New York City and the surrounding region (and beyond) has been the creation of a loose "knowledge network" of experts who have worked on a broad spectrum of climate change research, and stakeholders who operate critical infrastructure and who are developing and implementing adaptation actions over time. Periodically, this knowledge network is convened for wide-ranging discussions on evolving understanding of key issues, innovative approaches, and decision-support tools. The knowledge network functions as a clearinghouse of information on climate change adaptation.

Endnote

[1]For the Task Force, critical infrastructure is defined as systems and assets (excluding residential and commercial buildings, handled by other efforts) that support activities so vital to the city that the diminished functioning or destruction of such systems and assets would have a debilitating impact on public safety and/or economic security.

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