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# Introduction to *Climate Change Adaptation in New York City: Building a Risk Management Response*

Climate change has the potential to impact everyday life in New York City. Environmental conditions as we experience them today will shift, exposing the city and its residents to new hazards and heightened risks. We will be challenged by increasing temperatures, changes in precipitation patterns, rising sea levels, and more intense and frequent extreme events. While mitigation actions that reduce greenhouse gas emissions will help to decrease the magnitude and impact of future changes, they will not prevent climate change from occurring altogether. Given the impacts of climate change and the high costs and long-term planning needed to adapt effectively, investment can be considered today to begin the adaptation process. Taking action now will limit damages and costs through the coming decades and, in many cases, can provide near-term benefits and operational cost savings. By recognizing the risks posed by climate change early, in some cases decades before impacts are likely to be felt, the city will be able to develop incremental actions to increase its climate resilience. This report, which is part of the New York City Panel on Climate Change's (NPCC) overall effort to advise the City on climate change, outlines the need for early and ongoing adaptation actions in New York and suggests approaches to create a practical adaptation program.

A report issued by the NPCC in February 2009 projected that New York City may face a 4–7.5°F increase in its mean annual temperature, a 5–10% increase in its baseline rainfall, and at least 12–23 inches of sea level rise by the end of the century. Sea level rise may be much greater if accelerated ice melt continues in polar regions. These climate changes will affect many aspects of the city's infrastructure, such as increased strain on materials; heightened energy demand; more frequent and more extensive street, basement, and sewer flooding; and permanent inundation of low-lying areas and wetlands.

At the same time, New York has opportunities to develop responsive climate change adaptation measures, both in the near- and long-term, that protect its citizens and the infrastructure on which they depend. The central question is, how can the city marshal its capacity to devise and implement a robust climate change adaptation strategy?

To support these efforts, which are a part of New York City's long-term sustainability plan (PlaNYC), Mayor Michael Bloomberg convened a panel of climate change and impact scientists, university scholars, and private-sector experts to advise on issues related to climate change and adaptation. Funded through a grant from the Rockefeller Foundation and modeled on the Intergovernmental Panel on Climate Change (IPCC), the NPCC was launched in August 2008. As part of its activities, the NPCC has developed tools to assist the New York City Climate Change Adaptation Task Force, which was convened to develop a coordinated adaptation plan for the city's critical infrastructure and consists of over 40 public- and private-sector stakeholders. Development and implementation of the Task Force process was done in collaboration with the Boston Consulting Group. The City's overall adaptation plan is being developed by the Mayor's Office of Long-Term Planning and Sustainability.

## Climate change adaptation as a challenge and opportunity for cities

Climate change is now under way, and every day more people recognize it as a major concern. An international panel of leading climate scientists, the Intergovernmental Panel on Climate Change,

was formed in 1988 by the World Meteorological Organization (WMO) and by the United Nations Environment Programme (UNEP) to provide objective and up-to-date information regarding the changing climate. In its 2007 Fourth Assessment Report (AR4), the IPCC states that there is a greater than 90% chance that rising global temperatures, observed since 1750, are primarily due to human actions (IPCC, 2007). As had been predicted in the 19th century, the principal driver of climate change over the past century has been increasing levels of atmospheric greenhouse gases from fossil-fuel combustion, changing land-use practices, and other activities. Atmospheric concentrations of the major greenhouse gas, carbon dioxide ($CO_2$), are now more than one-third higher than in pre-industrial times. Concentrations of other important greenhouse gases, including methane ($CH_4$), tropospheric ozone ($O_3$), and nitrous oxide ($N_2O$), have increased as well. Largely as a result of work done by the IPCC and the United Nations Framework Convention on Climate Change (UNFCCC), efforts to mitigate the severity of climate change by limiting levels of atmospheric concentrations of greenhouse gases are under way globally.

While it is critical to lessen the anthropogenic contribution to greenhouse gas concentrations in order to reduce the long-term magnitude and rate of climate change, many observers have noted that such *mitigation* efforts alone are not enough. Since some impacts from climate change are inevitable due to greenhouse gas effects already in the pipeline and the long timeframe of some climate-system processes, responses to climate change have grown beyond a sole focus on mitigation to include *adaptation* measures in an effort to minimize its consequences. However, there is a clear link between mitigation and adaptation, since both are aimed at managing the risks posed by a changing climate on human well-being and societal functions.

Climate change presents significant challenges and opportunities for people and places throughout the world. Cities face a specific set of challenges that require a set of adaptation strategies due to their concentration of people, inability to shift locales easily, overlapping regulatory jurisdictions, and especially the variety and complexity of infrastructure and the population's dependence on it. In part because of these special challenges, urban decision makers already feel the pressure of a limited pool of resources to address a wide range of needs. Climate change and associated adaptations are likely to place further strain on these tight resources.

Climate change complicates urban planning by adding another dimension to uncertainty about future conditions. Although urban decision makers are used to managing uncertainty in economic growth and population dynamics, climate change brings further uncertainties due to the evolving nature of the climate system, its potential impacts on many aspects of urban life, and the untested effectiveness of adaptation strategies.

Although climate change will exacerbate existing urban challenges and environmental stressors, it also provides an opportunity for cities by encouraging infrastructure investments, creating jobs, and improving urban planning and regulation. If cities respond wisely, they will create better climate management for their citizens and for the infrastructure that enables their quality of life and movement. Effective adaptation measures can also bring near-term benefits, such as reduced maintenance or energy costs, achieved through conservation efforts and increased efficiency.

To address these questions and challenges, the NPCC suggests adopting a multidimensional risk management framework based on up-to-date information about climate science, impacts, and adaptive strategies. Risk management creates a framework for climate change planning that can be incorporated with other ongoing planning processes to improve resiliency on an intra- and intergenerational basis.

Climate change adaptation planning should not be done in isolation. Developing a coordinated approach among government agencies and private entities can reduce redundancy and promote cost-effectiveness by sharing best practices and prioritizing adaptations with co-benefits to a range of stakeholders. Coordination of mitigation and adaptation planning also can help to develop synergies between the two climate change response options.

## New York City Panel on Climate Change

The mission of the NPCC is to advise the Mayor and the New York City Climate Change Adaptation Task Force on climate change and adaptation. In the first phase of this work, the NPCC has focused on climate change's potential to positively and negatively affect the critical infrastructure of New York City, which is in line with the scope of the Task Force. Specific tasks of the NPCC are to:

(1) Create climate change projections for the New York City region;
(2) Develop planning tools to help guide stakeholders in their adaptation planning and strategy-creation process;
(3) Examine how the regulatory environment influences infrastructure-related decision making; and
(4) Produce a summary report on climate change adaptation for New York City that outlines major themes and best practices to be included in a comprehensive adaptation program.

To carry out these tasks, the NPCC prepared this report to help lay the foundation for climate change adaptation in the city and created three workbooks to guide Task Force members in their climate change adaptation planning process. The workbooks can be found in the Appendices to this volume:

- The **Climate Risk Information (CRI)** workbook presents climate trends and projections for New York City and identifies potential risks to the city's critical infrastructure posed by climate change (Appendix A);
- The **Adaptation Assessment Guidebook (AAG)** outlines a process through which stakeholders can develop and implement adaptation plans (Appendix B); and
- The **Climate Protection Levels (CPL)** workbook evaluates some of the policies, rules, and regulations that govern infrastructure in New York City to determine how they could be affected by climate change (Appendix C).

While the focus of the NPCC is climate change adaptation, there are clear links between adaptation and mitigation. Where applicable, climate change mitigation is discussed in the report, and opportunities are identified that can serve as combined mitigation and adaptation strategies.

Although the work of the NPCC has focused on New York City, its efforts, findings, and tools are applicable to other cities and metropolitan regions. Likewise, the climate risk management approach developed here can be used for planning climate change adaptation in other sectors besides infrastructure.

## Report structure and topics

This report covers some of the key issues New York City and other urban areas could usefully consider when developing a climate change adaptation response. The first section (Chapters 1 and 2) sets the context for adaptation in New York City, detailing past and present climate change adaptation efforts in the region, and presents a multidimensional risk management approach to climate change adaptation through the development of "Flexible Adaptation Pathways."[1] The second section (Chapters 3 and 4) provides climate change projections developed for the city and describes the challenges that cities face in adapting their critical infrastructure. The last section (Chapters 5, 6, and 7) discusses the roles that laws, regulations, and private insurers can play in adaptation and identifies the crucial need for a monitoring and

indicators program, which is essential for informing effective adaptation decisions in a changing climate.

## NYC adaptation in context

Climate change adaptation in New York City builds on more than a decade of assessments and studies and is grounded in the City's broader sustainability program known as PlaNYC (Chapter 1). These efforts provide a science-based foundation and a broad, long-term context for responding to climate change in the city. On the basis of this foundation, the NPCC advised the City on creating a multistep adaptation planning process that included identifying climate hazards and impacts, developing and evaluating adaptation strategies, implementing actions, and monitoring results. The ultimate goal is for stakeholders to incorporate climate change adaptation planning into their existing planning and operational processes.

## Adopting a risk-based approach

The NPCC helped the city develop a risk management approach to address current and future climate hazards based on the growing recognition that climate change threatens the operation of critical infrastructure, such as subways, tunnels and bridges, and water supply systems (Chapter 2). The goal of this approach is to guide the evolution of Flexible Adaptation Pathways to address dynamic climate conditions over the coming decades.

## Climate observations and projections

The NPCC used peer-reviewed methods to develop climate change projections for New York City and the area served by its critical infrastructure (Chapter 3). These temperature, precipitation, and sea level rise projections are based on results from global climate model simulations with several greenhouse gas emissions scenarios downscaled to New York City and the surrounding region. An additional set of sea level rise projections were included, based on observed polar ice melt rates and paleoclimate studies. These results are presented as model-based probabilities with central ranges and high and low projections for use by decision makers who are responsible for managing and protecting critical infrastructure in the region. Projections for both mean changes and changes in extreme events were developed and include indications of the likelihoods associated with each projection. Qualitative information about how other climate variables important to critical infrastructure, such as hurricanes, nor'easters, ice storms, lightning, and winds, may change is also provided.

## Infrastructure impacts and adaptation challenges

The projected changes in climate are likely to have a variety of impacts on New York City's critical infrastructure. Some of these impacts are well documented and understood, while others are not. The NPCC identified the key challenges of adapting to climate change in a dense, urban environment (Chapter 4) and made several recommendations as to how to overcome these challenges.

## Law and regulation

The legal system is an important area of knowledge and experience and can be a critical tool in climate change adaptation planning. The NPCC explored how some of the existing rules and regulations could be used to foster adaptation (Chapter 5). Many current regulations influence decisions related to maintenance and operations of existing infrastructure, as well as the siting

and building of new infrastructure. One of the significant findings of the NPCC is that the existing legal framework is well suited to accommodate a wide variety of climate change adaptation issues.

### Insurance industry

The insurance industry also plays a key role in dealing with climate risks and offers several opportunities to foster effective adaptation (Chapter 6). Private insurers have much experience at translating risk information into commercial practices, and that history can offer valuable lessons for shaping climate change adaptation measures for New York City.

### Indicators and monitoring

In order to create an ongoing citywide climate change adaptation planning process, a formal monitoring system is needed to track climate science, impacts, and adaptation actions (Chapter 7). Although many indicators are currently tracked in isolation, additional processing is needed to understand them in the context of a changing climate and its impacts. Bringing together the climate science indicators with the impact indicators can provide critical information for tracking if, when, and how climate is the driving factor behind any given impact. Such information is critical for making effective decisions.

## Putting adaptation in place

The goal of the NPCC is to contribute to an effective, ongoing, and beneficial process for responding to the risks that climate change poses to New York City in the coming decades. As this summary report documents, New York City is already well on its way to the development of Flexible Adaptation Pathways and a comprehensive planning process to mitigate the risks posed by climate change.

## Endnotes

[1]This concept has been adapted from the City of London's work on climate change adaptation, in particular the TE2100 project published in "The Thames Estuary 2100 Plan," April 2009: http://www.environment-agency.gov.uk/research/library/consultations/106100.aspx

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