Climate Change Adaptation in New York City
Building a Risk Management Response

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NCCARF Seminar Series
June 28, 2010

http://www.nyas.org/Publications/Annals/
http://www3.interscience.wiley.com/
New York City is Vulnerable

New York City is prone to losses from weather-related natural catastrophes.

• Top 10 in US population vulnerable to coastal flooding

• Second only to Miami in assets exposed to coastal flooding

• Simple wind damage index: NYC second to Tokyo, Japan.

• Economic loss ~2x insured loss.

• Major coastal storm could result in ~$1 billion economic loss.
Create Integrative Process

Stakeholders include:
- City Agencies
- Regional Authorities
- Private Stakeholders

Integration across Sector-specific Working Groups

Expert Knowledge:
- Climate change Scientists
- Legal experts
- Insurance experts

High-Level Buy-In
Coordinating Role

Mayor or City Official
City-wide Sustainability Office

Stakeholder Task Force
Expert Panel

New York City Panel on Climate Change
# Build on Existing Knowledge

<table>
<thead>
<tr>
<th>YEAR</th>
<th>REPORT TITLE</th>
<th>ORGANIZATION/PUBLISHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underway - 2010</td>
<td>New York State ClimAID Adaptation Assessment</td>
<td>New York State Energy Research &amp; Development Authority</td>
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<tr>
<td>2009</td>
<td>New York City Panel on Climate Change</td>
<td>Columbia University and CUNY</td>
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<tr>
<td>Late 2009/early 2010</td>
<td>New York City Climate Change Adaptation Task Force</td>
<td>NYC Office of Long Term Planning &amp; Sustainability</td>
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<tr>
<td>Underway - 2009</td>
<td>Long Island Shore Study</td>
<td>The Nature Conservancy</td>
</tr>
<tr>
<td>2008</td>
<td>New York City’s Vulnerability to Coastal Flooding: Storm Surge Modeling of Past Cyclones</td>
<td>Bulletin of the American Meteorological Society</td>
</tr>
<tr>
<td>2008</td>
<td>Climate Change Program Assessment and Action Plan</td>
<td>New York City Department of Environmental Protection</td>
</tr>
<tr>
<td>2007</td>
<td>Confronting Climate Change in the U.S. Northeast: Science, Impacts and Solutions</td>
<td>Union of Concerned Scientists</td>
</tr>
<tr>
<td>2007</td>
<td>August 8, 2007 Storm Report</td>
<td>Metropolitan Transit Authority</td>
</tr>
<tr>
<td>2001</td>
<td>Climate Change and a Global City: Potential Consequences of Climate Variability and Change</td>
<td>U.S. National Assessment &amp; Columbia Earth Institute</td>
</tr>
<tr>
<td>1999</td>
<td>Hot Nights in the City: Global Warming, Sea-Level Rise and the New York Metropolitan Region</td>
<td>Environmental Defense Fund</td>
</tr>
</tbody>
</table>
Establish Guiding Principles

Flexible Adaptation Pathways


New York City Panel on Climate Change
1. Identify current and future climate hazards
2. Conduct inventory of infrastructure and assets and begin to identify vulnerabilities
3. Characterize risk
4. Develop initial list of strategies
5. Prioritize strategies
6. Prepare and implement Adaptation Plans
7. Monitor and reassess
Guide stakeholders through completing:

• Inventory of At-Risk Infrastructure
• Risk Assessment Matrix
• Strategy Prioritization Framework

Leading to Climate Resilient City Report

NYC Climate Change Task Force

Expected Late 2010

NPCC Report, 2010
Observed Climate and Future Projections

Identify current and future climate hazards

Temperature

Precipitation

Source: Columbia University Center for Climate Systems Research

New York City Panel on Climate Change
Identify Climate Hazards

Sea Level Rise

Based on observed rates of icemelt in Greenland and West Antarctica and paleoclimate records.
### Identify Climate Hazards

#### Coastal Flood Events

<table>
<thead>
<tr>
<th>Extreme Event</th>
<th>Baseline (1971-2000)</th>
<th>2020s</th>
<th>2050s</th>
<th>2080s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-in-10 yr flood to reoccur, on average</td>
<td>~once every 10 yrs</td>
<td>~once every 8 (8 to 10) 10 yrs</td>
<td>~once every 3 (3 to 6) 8 yrs</td>
<td>~once every 1 (1 to 3) 3 yrs</td>
</tr>
<tr>
<td>Flood heights (in ft) associated with 1-in-10 yr flood</td>
<td>6.3</td>
<td>6.5 (6.5 to 6.8) 6.8</td>
<td>6.8 (7.0 to 7.3) 7.5</td>
<td>7.1 (7.4 to 8.2) 8.5</td>
</tr>
<tr>
<td>1-in-100 yr flood to reoccur, on average</td>
<td>~once every 100 yrs</td>
<td>~once every 60 (65 to 80) 85 yrs</td>
<td>~once every 30 (35 to 55) 75 yrs</td>
<td>~once every 15 (15 to 35) 45 yrs</td>
</tr>
<tr>
<td>Flood heights (in ft) associated with 1-in-100 yr flood</td>
<td>8.6</td>
<td>8.7 (8.8 to 9.0) 9.1</td>
<td>9.0 (9.2 to 9.8) 9.7</td>
<td>9.4 (9.6 to 10.5) 10.7</td>
</tr>
<tr>
<td>1-in-500 yr flood to reoccur, on average</td>
<td>~once every 500 yrs</td>
<td>~once every 370 (380 to 450) 470 yrs</td>
<td>~once every 240 (250 to 330) 380 yrs</td>
<td>~once every 100 (120 to 250) 300 yrs</td>
</tr>
<tr>
<td>Flood heights (in ft) associated with 1-in-500 yr flood</td>
<td>10.7</td>
<td>10.9 (10.9 to 11.2) 11.2</td>
<td>11.2 (11.4 to 11.7) 11.9</td>
<td>11.5 (11.8 to 12.6) 12.9</td>
</tr>
</tbody>
</table>

**Note:** Does not include the rapid ice-melt scenario. Numbers inside parentheses indicate central range (67% of model-based distribution); numbers outside are full range.
## Qualitative Changes in Extreme Events

**IPCC (2007).**

<table>
<thead>
<tr>
<th>Extreme Event</th>
<th>Probable Direction Throughout 21st Century</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intense hurricanes</td>
<td>![arrow] (Up)</td>
<td>More likely than not</td>
</tr>
<tr>
<td>Nor'easters</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td>Extreme winds</td>
<td>![arrow] (Up)</td>
<td>More likely than not</td>
</tr>
</tbody>
</table>

Note: >50% is used when the likelihood can be estimated with reasonably good precision, and 33 to 66% is used when there is not high confidence in the likelihood estimate.

NPCC Report, 2010
Identify Infrastructure Impacts

Sea Level Rise Risk Factors & Likelihoods

- Higher average sea levels
  - Extremely likely
- More frequent and enhanced coastal flooding
  - Very likely
- Shortened 100-year flood recurrence period
  - Very likely

Potential Implications for NYC Infrastructure

- **W** – Increase of inflow of seawater to sewers and WPCPs
- **T** – Increase in damage to infrastructure not manufactured to withstand saltwater exposure
- **W** – Increase in flood risk to WPCPs due to flooding and wave action
- **T** – Increases in delays on public transportation

W Water; T Transportation

NPCC Report, 2010
Characterize Risk

To determine risk of climate change on infrastructure

1. Probability of a climate change hazard
2. Likelihood of that hazard causing an impact
3. Magnitude of consequence, should that impact occur

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>risks for which adaptation strategies should be developed</td>
</tr>
<tr>
<td>Orange</td>
<td>risks for which adaptation strategies may need to be developed or for which further information is needed</td>
</tr>
<tr>
<td>Yellow</td>
<td>risks for which impacts should be monitored but which may not need actions at this time</td>
</tr>
</tbody>
</table>

Source: Columbia University Center for Climate Systems Research
### Develop and Prioritize Adaptation Strategies

#### Potential Strategy Prioritization Categories

- **Cost**
- **Feasibility**
- **Timing of Implementation**
- **Efficacy**
- **Resiliency Rating**
- **Co-benefits**

<table>
<thead>
<tr>
<th>Adaptation Strategy</th>
<th>Strategy Cost (1 = low to 3 = high)</th>
<th>Strategy Feasibility (1 = high to 3 = low)</th>
<th>Timing of Implementation (1 = high to 3 = low)</th>
<th>Efficacy (1 = high to 3 = low)</th>
<th>Resiliency rating (1 = high to 3 = low)</th>
<th>Co-benefits (1 = high to 3 = low)</th>
<th>Average*</th>
<th>Notes &amp; institutional considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean drains</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Build flood walls</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2.2</td>
<td></td>
</tr>
</tbody>
</table>

*1 = high priority strategy, 2 = medium priority strategy, 3 = low priority strategy*
Prepare and Implement Adaptation Plans

- Agency-specific or city-wide

- Adaptation types
  - Operations/management
  - Hard/soft infrastructure
  - Policy

- Specific steps and timeline for implementation, including identifying responsible parties

- Key strategies, such as those that address high-risks, are win-win with mitigation, or low-cost
Water Sector Strategies

Operations and Management
- Improve repair, fix leaks, survey tidegates.

Infrastructure
- Hard: NYCDEP is raising pumps and generators at Far Rockaway Wastewater Treatment Plant from belowground to 14 ft about sea-level.
- Soft: Expand Staten Island Bluebelt Constructed Wetlands Program

Treatment tanks overflowed at Hunts Point, Bronx WPCP March 2001 storm; unusually high tide elevations prevented discharge of treated sewage into East River, caused back-up
Transportation Sector Strategies

Operations and Management
- Improve pumping, increase backup emergency equipment, improve storm information and forecasting

Infrastructure
- Hard: Raise seawalls/barriers, elevations of runways, low-lying tracks, roadways
- Soft: Porous drainage ‘sheds’ around stations

Worst-track storm surge flood zones SSCat1 red, SS brown, SS3 in yellow, SS4 green. Color lines subways; black lines rail systems.

LDEO, Google Earth, NYSEMO flood zones, NYCT subway lines, NYMTC NPCC Report, 2010
Each barrier would require large open navigation channels for ships and a porous cross section allowing sufficient tidal exchange and river discharge from New York Harbor to maintain ship passage and water quality.

- Conceptual designs of storm surge barriers are contributing to discussion on how to deal with the increasing risks of storm surge in New York City and the surrounding region in the era.

- Significant economic, environmental, and social costs. Barriers would not protect all neighborhoods, nor would they protect against other substantial damages from wind and rain that often accompany hurricanes in the New York City region.

- New York could protect against levels of surge with a combination of local measures (such as flood walls and reclaimed natural barriers), improved storm information and forecasting, and evacuation plans for at least the next several decades.

- More study of risks and large-scale interventions needed at this time.
Citywide Approaches Policies and Standards

- Flood protection standards
- Land-use planning
- Risk-sharing
- Evacuation plans

Challenges
- Multiple jurisdictions
- Process

Needed Immediately!
- Coordinated Indicators and Monitoring Program

Climate Protection Levels Workbook
Chapter 6 Insurance
NPCC Report, 2010
Monitor and Reassess

Proposed structure and process of monitoring climate change, impact, and adaptation parameters, and for translating them into indicators for New York City.
Areas for Further Studies

- Identify, characterize, and understand nonlinear tipping points, triggers, and decision pathways
- Analyze the economics and financing of adaptation
- Conduct feasibility study of non-structural and structural citywide protective measures
- Do sensitivity tests of critical infrastructure facilities and operations
- Study the interdependencies between and within infrastructure sectors and systems
Urban Climate Change Research Network
First Assessment Report on Climate Change in Cities ARC3
www.uccrn.org

UCCRN/ARC3
Side Event to Discuss UCCRN/ARC3 Process
Wednesday, June 30
4:00-5:30pm

ARC3, 2010