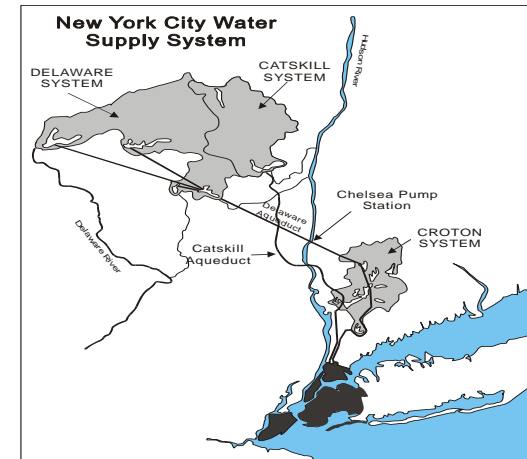
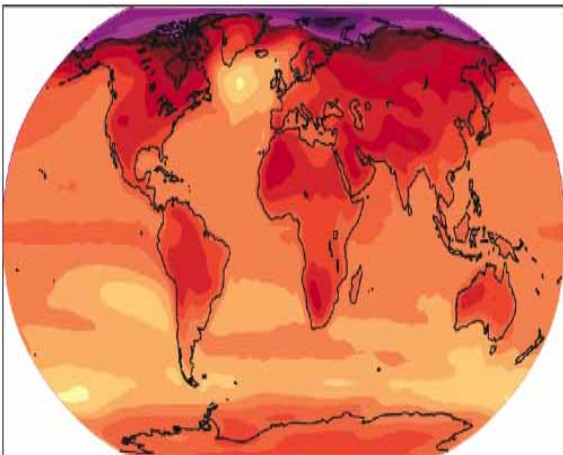


Climate Change and Water in the New York Metropolitan Region

Cynthia Rosenzweig
NASA Goddard Institute for Space Studies

American Meteorological Society
Environmental Seminar Series

Washington, D.C.
June 27, 2008



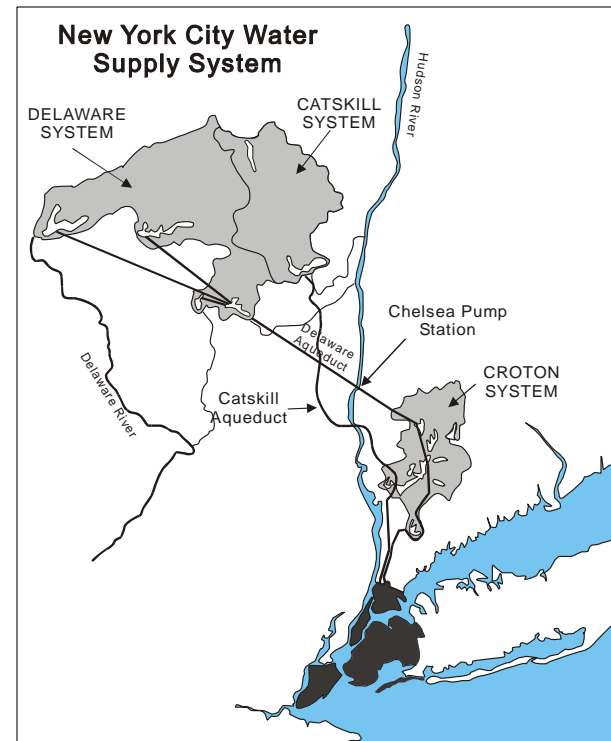
Outline

- **Background**
- **Key Impacts**
- **Climate Risk Information**
- **Flexible Adaptation Strategies**

Background

NYC's Water System

- **Water Supply System:** DEP provides 9 million New Yorkers with 1.35 billion gallons/day of un-filtered drinking water.
- **Sewer System:** DEP operates ~6,500 miles of sanitary, storm, and combined sewer systems, with 450 combined sewer outfalls along the coast.
- **Wastewater Treatment System:** DEP operates NYC's 14 water pollution control plants (WPCPs) – all are located on waterfront property.
- **NYC Harbor and Estuaries:** DEP maintains integrity of local water bodies, which are impaired by sewage discharge during rain events.

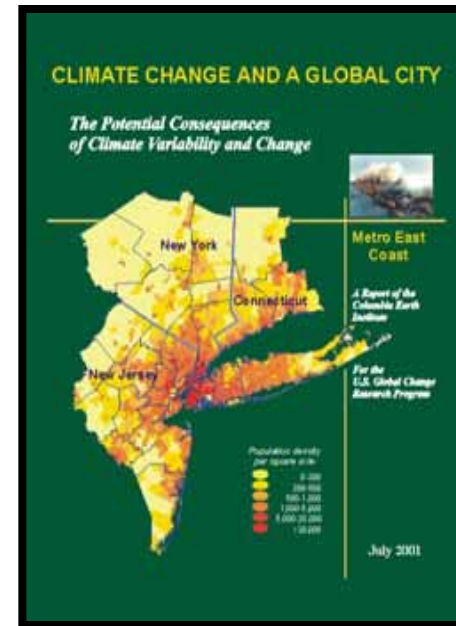


\$10 billion capital plan (2006-2010); responsible capital planning requires consideration of potential impacts of climate change on NYC's water systems.

150 years . . .

Institutionalizing Climate Change at NYC Department of Environmental Protection (DEP)

- 2001: Metro East Coast Assessment was released by scientists at the Columbia University Earth Institute
- 2003: Partnership formed between Columbia University Center for Climate Systems Research / NASA's Goddard Institute for Space Studies (GISS) and DEP
- 2004: Agency-wide DEP Climate Change Task Force in collaboration with Columbia/GISS
- 2008: First report of the Climate Change Program released



NYCDEP Climate Change Task Force On Climate Change

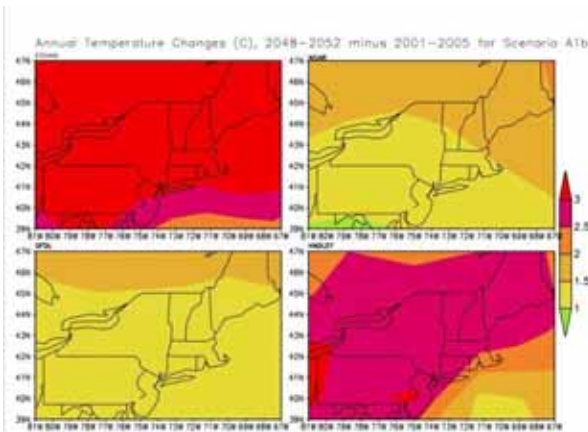
Mission Statement

To ensure that NYCDEP's strategic and capital planning efficiently takes into account the potential effects of climate change—sea level rise, temperature rise, an increase in extreme events, and changing precipitation patterns—on the City's water supply and wastewater treatment systems.

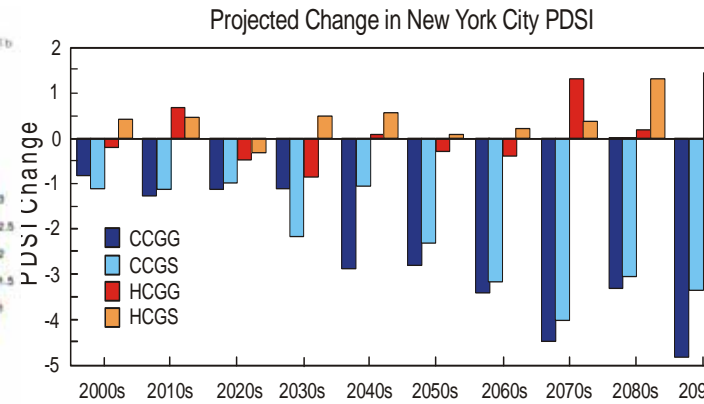
Water Quantity and Water Quality

Climate Change Impacts

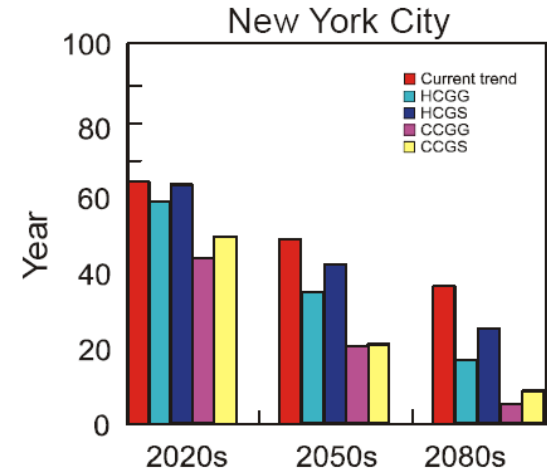
Key Climate Risks and Integrated Impacts



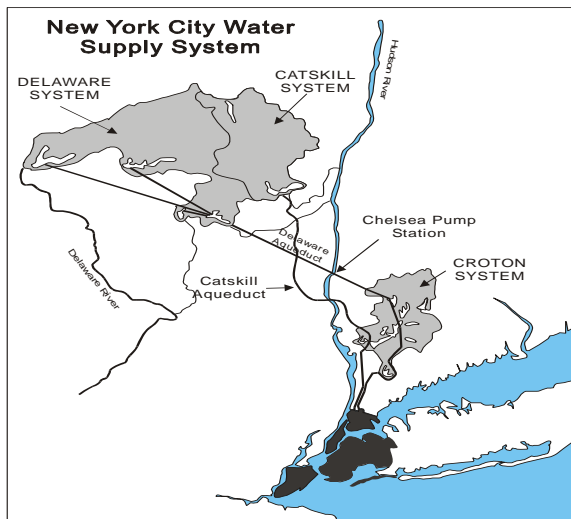
Temperature



Droughts and inland floods



Change in 100-yr coastal floods



Water system



Wastewater treatment plants

Impacts on Watersheds and Sewersheds

- Mean temperatures are expected to increase by 3 to 5 °F by the 2050s, and 4 to 7 °F by the 2080s, possibly leading to
 - Increased water demand
 - Seasonal reduction in water availability
 - Poorer water quality in reservoirs and down-stream estuaries
- Most GCMs suggest an increase in annual precipitation of up to 15 percent by the 2050s, while pointing towards increases in both flood and drought extremes:
 - Greater and more intense precipitation → More water but perhaps of lower quality (turbidity), more flooding, and more CSO events
- Sea level rise of 1-2 feet would mean
 - New stresses on wastewater treatment plants and drainage
 - Increased groundwater pollution

Climate Risk Information

Climate Risk Information for NYMR

Current Climate

- Current climate **trends, indicators, and variability**.

Global Climate Models and Emissions Scenarios (Update ~5 years)

- GCMs characterize **climate uncertainty** (IPCC AR4, 2007).
- **GHG emissions** scenarios span a range of development futures
 - population, GDP, technology (IPCC, 2000).
 - **temperature, precipitation, sea-level rise**

Regional Climate Scenarios for Key Variables

- **Downscaled model-based probabilities** for New York City characterize risks.
- **Regional climate model (RCM) simulations**.

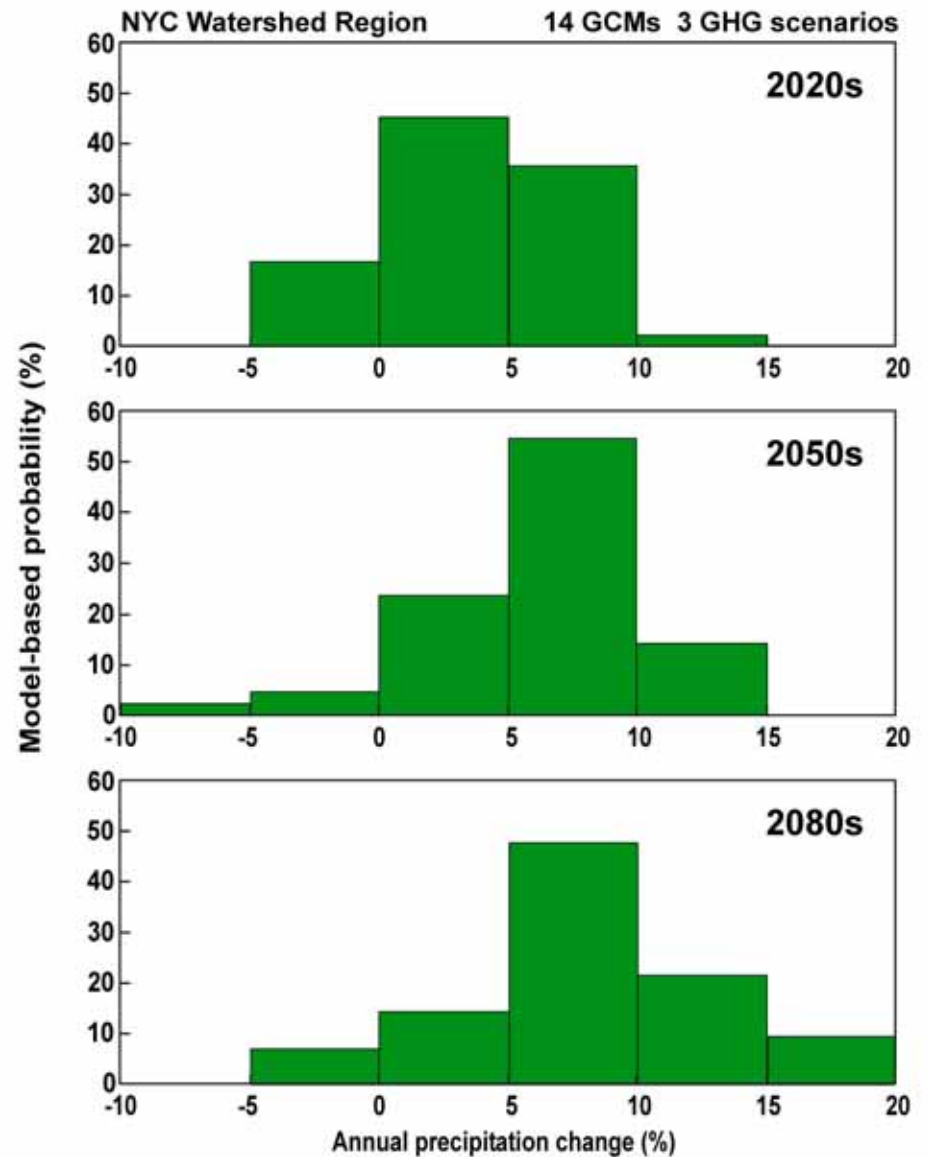
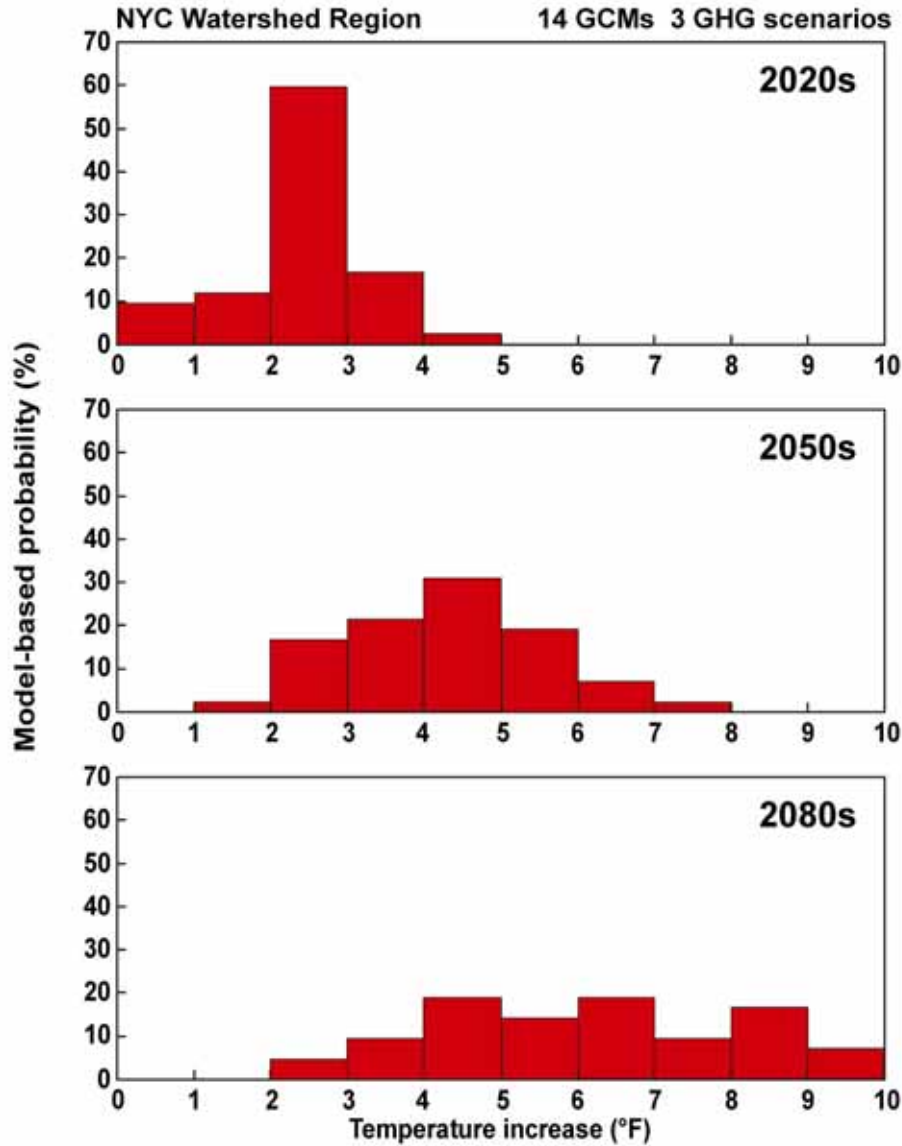
Extreme Events

- **Frequency and intensity** of heatwaves, flooding, droughts, and hurricanes and other storms.

High Impact Scenarios

- **Ice sheet melting** and **Greenland/Arctic sea Ice extent** are monitored and evaluated.

Model-Based Climate Probabilities



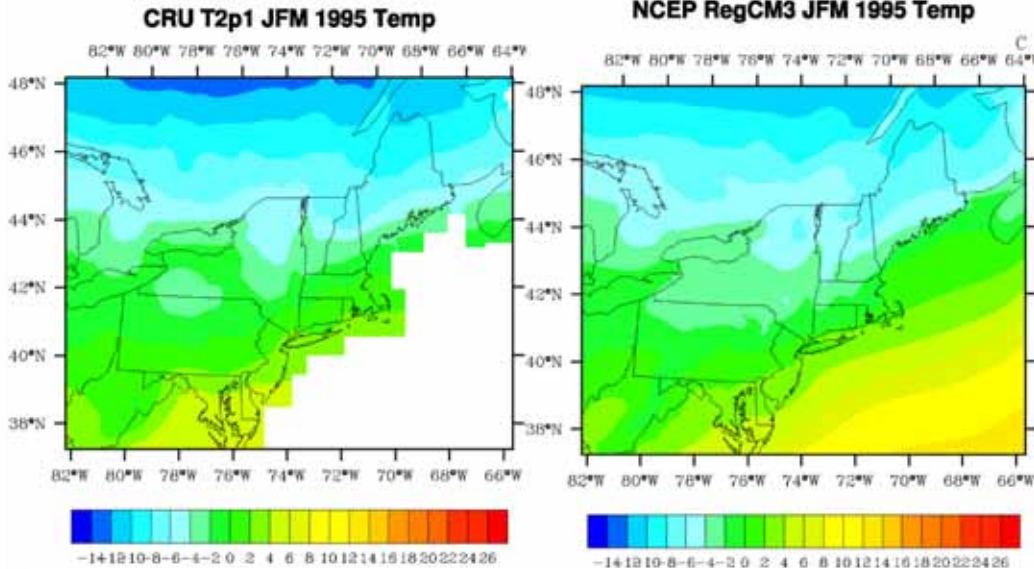
Frequency distribution of temperature (°F), and precipitation (%) changes, relative to 1970-1999, 14 GCMs/3 GHG scenarios

Regional Climate Models

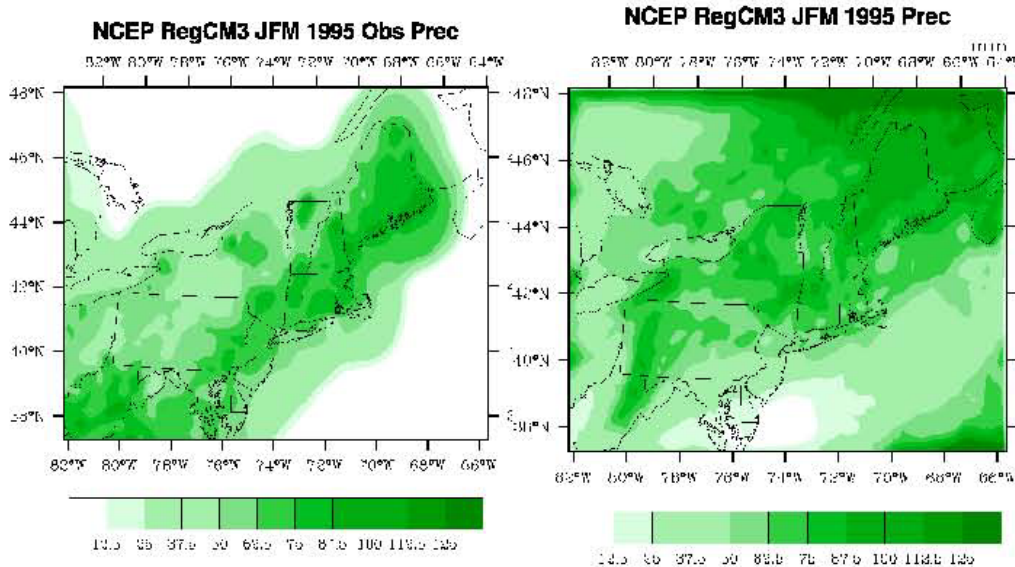
Observed

RegCM3 RCM
driven by observations

1995 Winter Temperature (°C)



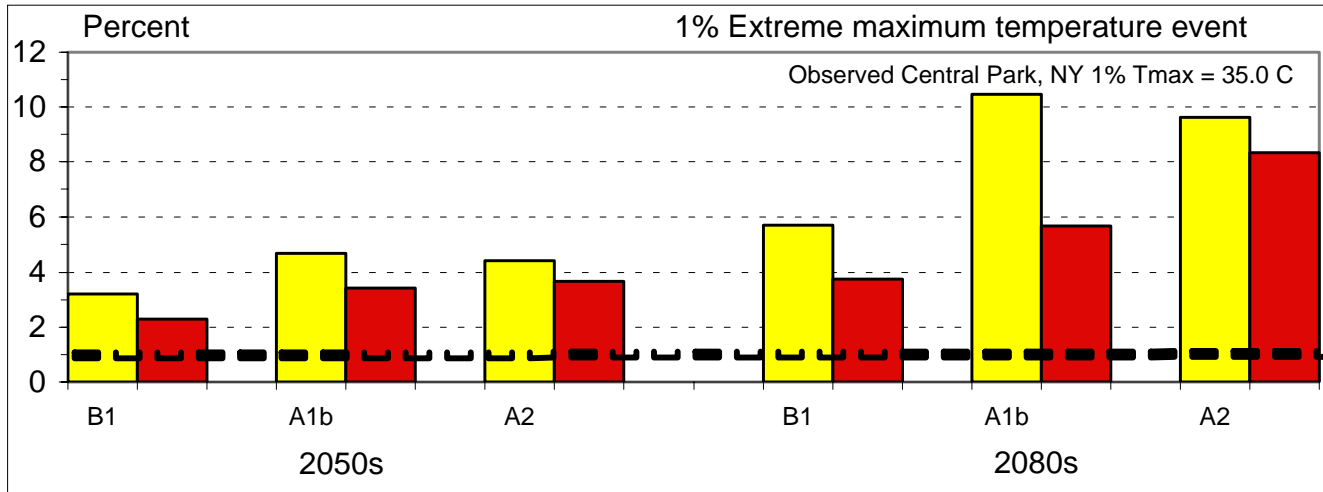
1995 Winter Precipitation
(mm/month)



The RCM is able to generally capture the observed climate patterns, indicating it is suitable for use in climate change studies

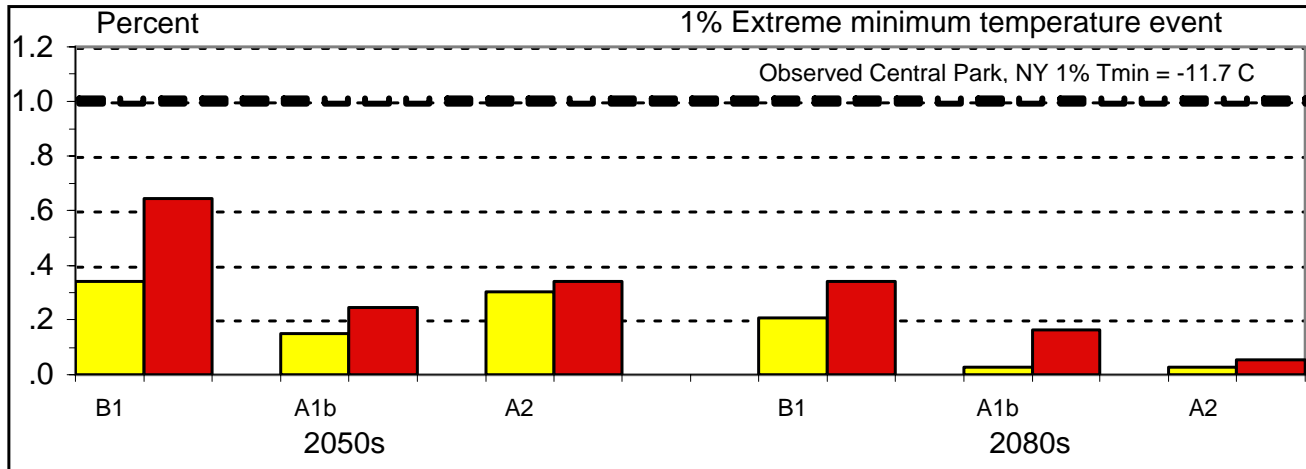
Future Extreme Temperatures

Very hot days occur ~4 times as often in the 2050s...



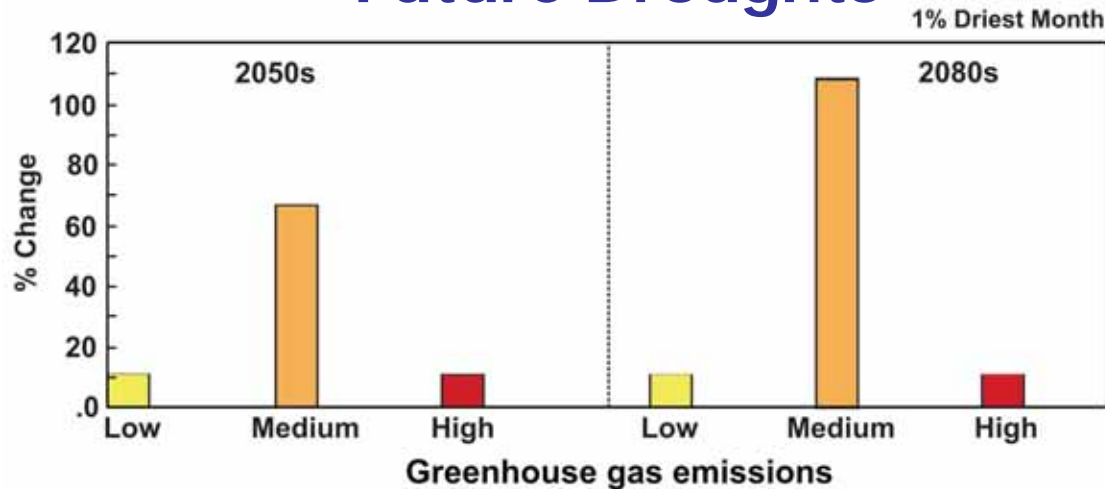
...and ~7 times as often in the 2080s

Very cold nights are ~65% less common in the 2050s...



...and ~85% less common in the 2080s

Future Droughts

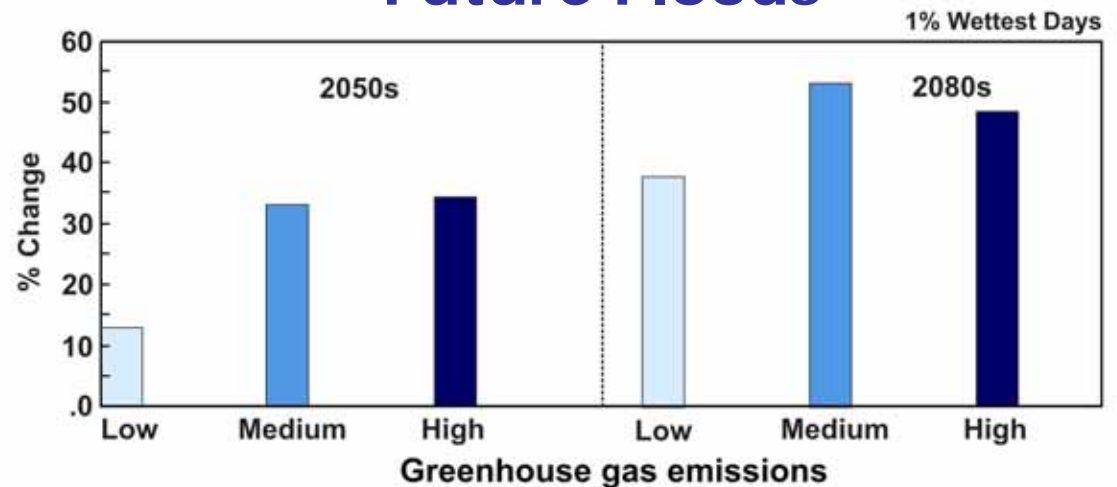


Very dry months* are predicted to occur ~30% more often in the 2050s, and 45% more often in the 2080s.

*Very dry observed months = 1 inch (2.6 cm) or less; normal is 3.65 inches (9.3 cm). Results are relative to the 1% most extreme months from the 1980-1999 GCM baseline

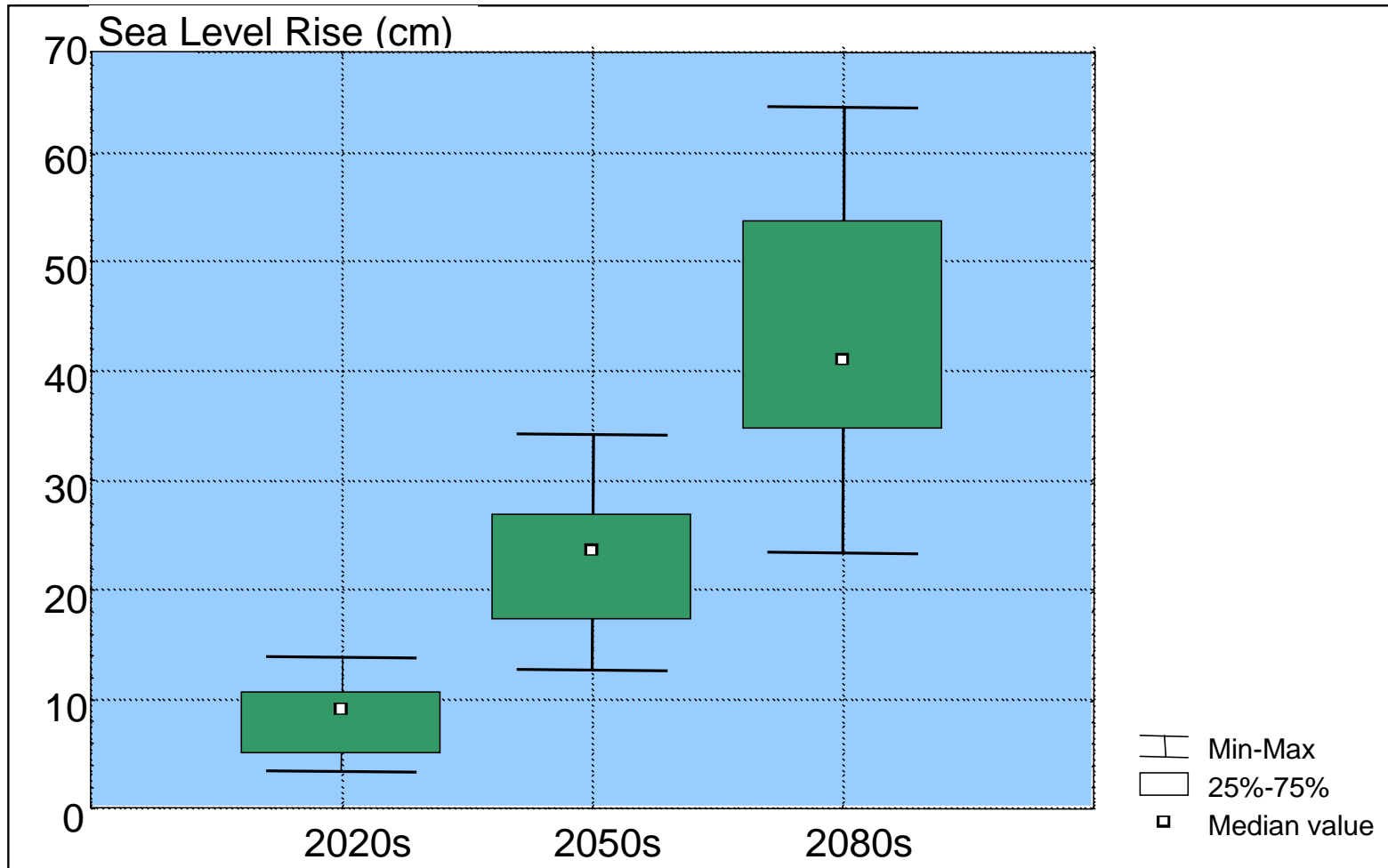
Future Floods

Very wet days* occur ~25% more often in the 2050s, and 50% more often in the 2080s



*Very wet observed days = 1.8 inches (4.5 cm) or more. Results are relative to the 1% most extreme days from the 1980-1999 GCM baseline

GCM Projected Change in Sea Level Rise



Draft April 10, 2008

Columbia Center for Climate Systems Research

Note: There are 7 GCM's and 3 emission scenarios used.

Base = 2000 to 2004, 2020s = 2020-2029, etc...

Challenge of Icesheet Melting

Global sea level
~1.7mm/year
for 20th century

~3 mm/year
since the 1990s

Sea level rise
NY Metro Region
~2.6 mm/year
for 20th century
(.1 in/year)

Combined effect of **local**
subsidence and sea level rise



Icesheet Melting

Timing highly uncertain

Risk management challenge:

- Track obs & climate science
- Test use of qualitative high and very high scenarios
- Update scenarios 3-5 yrs

Coastal Flood Risk



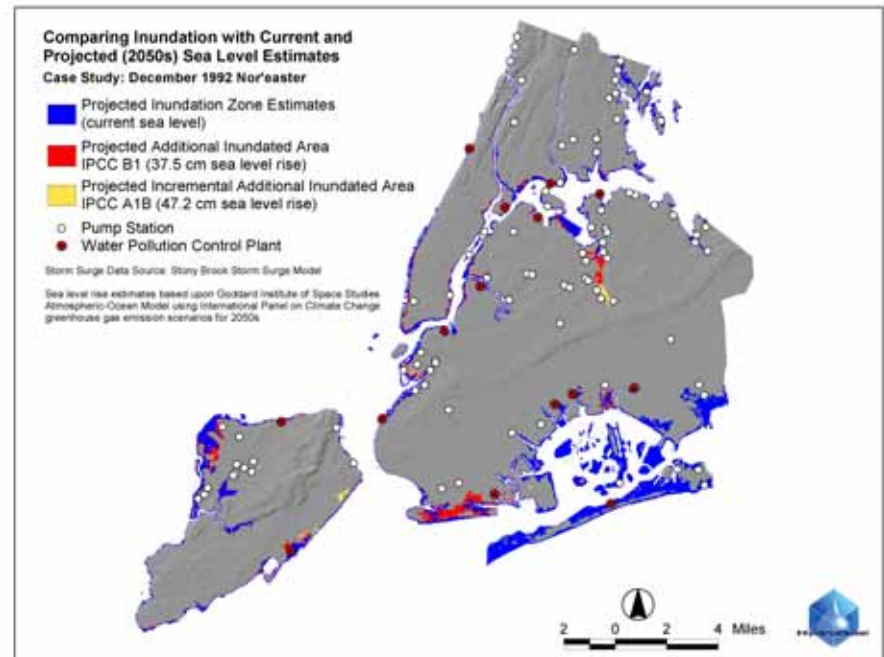
Worst-track storm surge flood zones for Saffir-Simpson Cat.1 in red, SS2 in brown, SS3 in yellow, and SS4 in green. Shaded lines are subways, black lines are rail systems. Lamont-Doherty Earth Observatory, Google Earth, and NYSEMO

http://www.mta.info/mta/pdf/storm_report_2007.pdf

Coastal Flooding

Coastal flooding that currently occurs once every 5 years may average once a year in the 2050s

Coastal flooding that currently occurs once every 10 years may occur 1-2 times per year by the 2080s



DEP Infrastructure

Climate Change Adaptation

Framework for Adapting Water Systems to Climate Change

- Gain understanding of current climate risks
- Anticipate future climate changes
- Develop climate protection levels
- Evaluate flexible adaptation pathways
- Monitor and reassess

Timescale

Short-term: ~1-5 years

Medium-term: ~1-2 decades*

Long-term: ~2-5+ decades*

Types of Adaptation

Operations / Management

Infrastructure

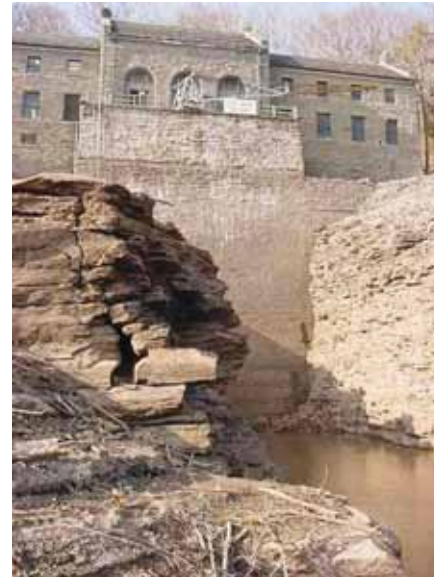
Insurance and Policy

**Link to Capital Cycle*

Water Availability and Quality – Adaptation

Water Availability

- Diversify water sources (desalinization, expand groundwater system)
- Expand water conservation and usage restrictions
- Expand water transfer capabilities

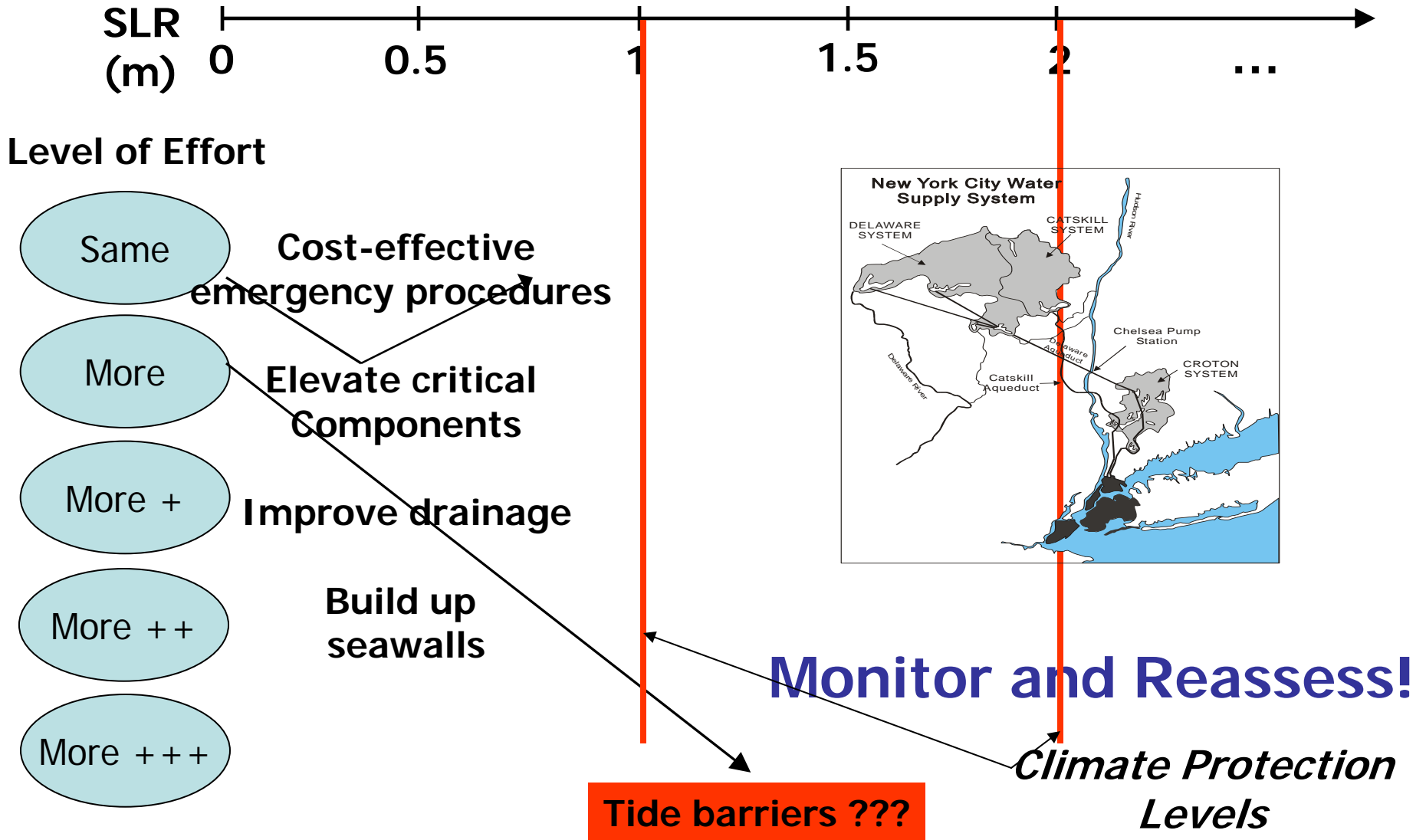


Water Quality

- Acquire additional land and expand conservation programs
- Increase operational flexibility
- Treat with chemicals as necessary



Working with Agencies to Construct Flexible Adaptation Pathways



Observations on NYC DEP Climate Adaptation Assessment

- Excellent local leadership
- Assessments; peer-reviewed science, IPCC
- Collaboration with university centers and Federal agencies with strength in climate change
- Regular technical and policy meetings
- Climate change workshops for all staff
- Role of research, consultants

Consistency, Coordination, Persistence

NEW YORK CITY TIMELINE



COMMISSIONERS
ANNOUNCE MANHATTAN
STREET GRID PLAN

1800
1825
1850



PLANS UNVEILED
FOR CENTRAL PARK

1875



THE FIRST SUBWAY
LINE BEGINS SERVICE
IN NEW YORK CITY

1900



IDLEWILD AIRPORT
OPENS—LATER
RENAMED JFK
INTERNATIONAL
AIRPORT

1925
1950

Credit: Top Images (Central Park and subway);
New York City Department of Records/
Municipal Archives

1975
2000

Now is **our** moment to make a difference in the future of our city

Throughout our history, there have been key moments when New Yorkers looked forward and took bold steps to prepare our city for its future.

The street grid plan of 1811 plotted out room for a million people—more than 10 times Manhattan's population at the time. In 1858, we unveiled plans for a Central Park devoted to the people—even though most New Yorkers still lived a mile away. Starting in 1901, we began building one of the world's largest subway systems when our city was mostly still farmland and fields. And 50 years ago, we transformed a golf course into the international aviation hub of the United States through the construction of JFK International Airport.

Now is our moment—and we need your help.

There are many ways to get involved.

Visit our website www.nyc.gov/planyc. Here you can learn more about each goal and share your ideas on how to reach them.

If you can't log on, [send us a letter](#).

Look for a [town hall meeting](#) in your borough.

And most importantly, [tell your family and friends](#) so we can hear from them, too.

All of New York has a stake in this discussion—because every New Yorker will experience its impact.

And over the next three months, these ideas—your ideas—will shape a plan to secure our city's sustainable future.

planNYC

Visit www.nyc.gov/planyc

Ten goals for creating a sustainable city over the next 25 years

openNYC

- 1 Create homes for almost a million more New Yorkers, while making housing more affordable and sustainable
- 2 Improve travel times by adding transit capacity for millions more residents, visitors, and workers
- 3 Ensure that all New Yorkers live within a 10-minute walk of a park

maintainNYC

- 4 Develop critical back-up systems for our aging water network to ensure long-term reliability
- 5 Reach a full "state of good repair" on New York City's roads, subways, and rails for the first time in history
- 6 Provide cleaner, more reliable power for every New Yorker by upgrading our energy infrastructure

greenNYC

- 7 Reduce global warming emissions by more than 30%
- 8 Achieve the cleanest air of any big city in America
- 9 Clean up all contaminated land in New York City
- 10 Open 90% of our waterways for recreation by reducing water pollution and preserving our natural areas

Together we can make the New York of 2030 cleaner, healthier, more reliable, and more sustainable than the city we love today.

