APPENDIX F: HUDSON VALLEY CLIMATE RESILIENCE

New York's changing climate presents new challenges and opportunities for communities. It is vital for local decision-makers to understand their community's vulnerability to changing climatic conditions and consider their natural resources as an important asset in planning for resilience, managing climate risks, and recovering quickly from extreme weather events.

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The New York State Energy Research and Development Authority (NYSERDA) has been studying, documenting, and modeling the impacts of climate change in New York State for several years. This appendix presents climate trends and projections for the East Hudson and Mohawk River Valleys from NYSERDA's *Responding to Climate Change in New York State* (ClimAID) (Rosenzweig et al. 2011, Horton et al. 2014), as well as opportunities from the New York Climate Smart Communities program for putting a natural resources inventory to action for building climate resilience. A summary of projections for the West Hudson Valley, New York City, and Long Island can be obtained at www.dec.ny.gov/docs/remediation_hudson_pdf/cphv.pdf.

Climate Hazards in New York State

Three significant climate hazards are expected to affect New York State residents during the 21st century: increasing temperatures, rising sea level, and changing precipitation patterns.

Increasing Temperatures

Annual average temperatures have been steadily rising in New York State. Since 1970, they have been increasing at a rate of 0.6 degrees Fahrenheit (F) per decade. In winter months, this warming effect is even greater, at 1.1 degrees F per decade.

Since 1970, temperature increases in New York have surpassed national and global averages:

- Global annual average temperature up nearly **1°F**
- U.S. annual average temperature up **1.8°F**
- New York annual average temperature up nearly **2°F**
- New York winter temperatures up almost **5°F.**

Models project that annual average temperature in the Hudson Valley region will rise by an additional 4 to 6°F by 2050; and 6 to 11 °F by 2100.

Air Temperature Projections (°F)	Baseline 1971-2000	2020s	2050s	2080s	2100
Annual average air temperature	50°F	52.3 - 53.2°F	54.5 - 56.2°F	55.6 - 59.7°F	56.1 - 61.4°F
Increase in annual average	—	2.3 - 3.2°F	4.5 - 6.22°F	5.6 - 9.72°F	6.1 - 11.4°F

Rising Sea Level

Global sea level is rising due to various factors, including thermal expansion from warmer water temperatures and melting of land-based ice. Because the Hudson River estuary is connected to and influenced by the sea, it experiences tides, contains saltwater in its lower reaches, and its water level is rising with global sea level. Sea level rise along New York's coastline is greater than the global average due to readjustment of the Earth's crust from the last ice age and other local factors. Since 1900, sea level in the lower Hudson has risen one foot. Sea level in New York harbor has risen 15 inches in the last 150 years. It is projected to increase another 11 to 21 inches or more by 2050. At the upper range of projections, it is possible that Hudson riverfront communities could experience as much as six feet of sea level rise by the end of the 21st century.

Sea Level Rise Projections (inches)	Baseline 1971-2000	2020s	2050s	2080s	2100
Mid-range estimate of rise for Troy Dam	—	3 - 7″	9 - 19″	14 - 36″	18 - 46″
Mid-range estimate of rise for NYC	—^	4 - 8″	11 - 21″	18 - 39″	22 - 50″

Changing Precipitation Patterns

Precipitation has become more variable and extreme, whereas total rainfall has changed only marginally. Annual rainfall occurring in heavy downpour events increased 74% between the periods of 1950-1979 and 1980-2009. Projections indicate that total annual precipitation could increase almost 15% by mid-century.

In the future, Hudson Valley communities can expect more dry periods intermixed with heavy rain events and decreased snow cover in winter.

Precipitation Projections (inches)	Baseline 1971-2000	2020s	2050s	2080s	2100
Total annual precipitation	51″	52″ - 54.5″	53″ - 57″	53.5″ - 58.5″	53.5″ to 61.5″
% Increase in annual precipitation	—	2 - 7%	4 - 12%	5 - 15%	5 - 21%
# Days with precipitation > 1″	10	14 - 15	14 - 16	15 - 17	*
# Days with precipitation > 2″	1	3-4	4	4-5	*

* No data available

Climate Risks

Increasing temperatures, rising sea levels, and changing precipitation patterns will lead to climate risks that Hudson Valley communities can start preparing for now. This section introduces major climate risks associated with these hazards.

Heat Waves

Increasing annual temperatures will lead to more frequent, intense, and long-lasting heat waves during the summer, posing a serious threat to human health. The number of days above 95 degrees F is expected to more than triple by 2050 and rise dramatically by 2080, while the number of days below freezing will steadily decrease.

Heat Wave Projections	Baseline 1971-2000	2020s	2050s	2080s	2100
# Days per year above 90°F	10	26-31	39 - 52	44 - 76	*
# Days per year above 95°F	1	2 - 4	3 - 10	6 - 25	*
# Heat waves per year	2	3 - 4	5 - 7	6 - 9	*
Average # days of each heat wave	4	5	5 - 6	5 - 7	*
# Days per year ≤ 32°F	134	52 - 58	42 - 48	30 - 42	*

* No data available

Short-term Drought

Soil moisture will likely decrease with warmer, less snowy winters, fewer steady rainfall events, and higher evaporation from increased temperatures. This could lead to more frequent and intense periods of short-term drought, threatening local drinking water supplies, base flow in streams, and agricultural production.

Flooding

Increased sea level rise and intense precipitation events could lead to more frequent flooding along the Hudson River and its tributaries, threatening waterfront assets such as homes, businesses, sewage infrastructure, roads, and more. To manage flood risk, communities should consider projected sea level rise and flooding when planning future development.

Flood projections for New York State show a dramatic increase in the probability and flood height of today's *100-year storm* (i.e., the storm with a 1% or greater chance of occurring in any year).

Flooding Projections	Baseline 1971-2000	2020s	2050s	2080s	2100
Increase in probability of 100-year flood	0%	20 - 50%	70 - 190%	140 - 610%	*
Flood height of 100-year flood (feet)	15′	15.3 - 15.7′	15.9 - 16.8′	16.5 - 18.3′	*

Scenic Hudson's online sea level rise mapper can be used to explore projected sea level rise along the Hudson River at www.scenichudson.org/slr/mapper.

Building Resilience through Adaptation

Federal and state policies can be expected to mandate strong coastal and floodplain construction standards and pre-disaster mitigation planning in order for municipalities to secure hazard mitigation funding; however, local decision-makers often have the greatest capacity to influence resilience in their communities. A natural resources inventory can be used to identify risk-prone areas as well as inform an adaptation strategy that takes advantage of the services provided by natural systems, such as floodwater retention in wetlands or reduction of heat impacts by urban forests.

Climate Smart Resiliency Planning: A Planning Evaluation Tool for New York State Communities, *Version 2.0* (2014) and the Climate Smart Communities Certification Program provide frameworks for assessing vulnerability and implementing actions to reduce risk from climate impacts. Suggested actions that can benefit from the data in an NRI include the following:

- conserve wetlands and forests to manage stormwater, recharge groundwater, and mitigate flooding
- conserve, revegetate and reconnect floodplains and buffers in riparian areas
- discourage new construction in flood-prone areas
- protect bluffs or eroding cliffs from disturbance or development
- increase tree canopy to reduce heat impacts
- integrate sea level projections into zoning and building codes for new shoreline development.

Work groups may want to consider undertaking detailed inventory studies that contribute to resiliency planning; for example, maps of sea level rise projection along Hudson shorelines or of flood-prone areas may be especially valuable. Refer to Chapter 4 to see how these could integrate with the recommended NRI components. See Appendix B for publications and web resources for further reading.

Helpful resources:

New York State Climate Smart Communities Climate Smart Resiliency Planning: A Planning Evaluation Tool for New York State Communities Version 2.0. 2014. www.dec.ny.gov/docs/administration_pdf/csrptool.pdf

Horton, R., D. Bader, C. Rosenzweig, A. DeGaetano, and W.Solecki. 2014. Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information. New York State Energy Research and Development Authority (NYSERDA), Albany, NY. www.nyserda.ny.gov/climaid

Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, P. Grabhorn (editors). 2011. Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation. Synthesis Report. New York State Energy Research and Development Authority (NYSERDA), Albany, NY. www.nyserda.ny.gov/climaid

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