CLIMATE SUMMARY FOR COMMUNITIES

Working toward climate resilience

This summary was completed to provide information for community-level land use planning and decision-making. It identifies historic climate trends and introduces future projections and strategies to address the climate hazards most likely to affect Hudson Valley communities. The summary is based on information currently available to the New York State Department of Environmental Conservation (NYSDEC) and its partners.

New York's changing climate presents new challenges and opportunities for communities in the state. It is vital for local decision-makers to understand their community's vulnerability to a changing climate and take steps to increase their climate resilience.

Central to the information in this document is the concept of **Climate Resilience**—the ability to manage climate risks, respond productively as climate changes, and recover quickly from extreme events. Our climate resiliency can be greatly enhanced by protecting and augmenting natural systems, like green and natural infrastructure.

Research students studying a map of the Hudson River estuary (E. Murphy)

This document was created by the New York State Department of Environmental Conservation's Hudson River Estuary Program and Cornell University's Water Resources Institute in collaboration with DEC's Office of Climate Change. The Estuary Program helps people enjoy, protect, and revitalize the Hudson River and its valley. The program was created in 1987 and extends from the Troy dam to upper New York harbor.

BENEFITS

The Estuary Program is built around six key benefits:

1. Clean water
2. Resilient communities
3. Vital estuary ecosystem
4. Estuary Fish, Wildlife, & Habitats
5. Natural Scenery
6. Education, River Access, Recreation & Inspiration

The Estuary Program is funded by the New York State Environmental Protection Fund. The New York State Water Resources Institute at Cornell University seeks to foster an understanding of the critical connections between people and the state's waters. It also seeks to empower communities to make informed decisions about land use that minimize impacts to water resources, including drinking water supplies, floodplains, and aquatic habitats.

The New York State Office of Climate Change was created to lead development, in concert with other DEC programs and New York State agencies, of programs and policies that mitigate greenhouse gas (GHG) emissions and help New York communities and individuals adapt when changes in climate cannot be avoided.

The information provided in this document was taken from the following:

- **The NYS 2100 Commission Report (**http://www.governor.ny.gov/assets/documents/NYS2100.pdf**)**
- **Responding to Climate Change in New York (**http://goo.gl/Ug5LCb)
- **The DEC Climate Smart Communities Program (**http://www.dec.ny.gov/energy/50845.html**)**

Additional information about climate change in the Hudson Valley can be found on NYSDEC's webpages, starting with http://www.dec.ny.gov/lands/39786.html

For the latest funding, events and opportunities, sign up for our *Climate Resiliency in the Hudson Estuary* newsletter:
https://public.govdelivery.com/accounts/NYSDEC/subscriber/new?topic_id=NYSDEC_147

CONTACT INFORMATION

Libby Zemaitis

Climate Outreach Specialist, Hudson River Estuary Program

New York State Department of Environmental Conservation
21 S Putt Corners Road, New Paltz, NY 12561
(845) 256-3153 | libby.zemaitis@dec.ny.gov
www.dec.ny.gov

Cornell University

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Introduction

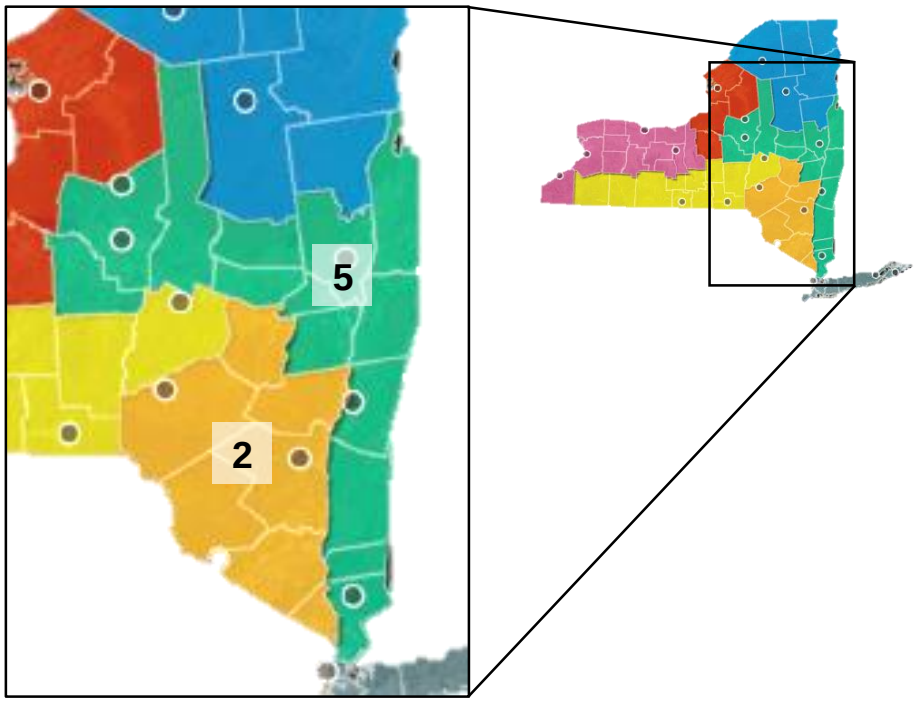
Although our climate is always shifting, New York has experienced particularly rapid changes to our regional climate in the last century and the trend is expected to continue through the 21st century. Hudson Valley communities could benefit from improved planning, response and recovery relevant to climate events, as highlighted by the impacts suffered by Hurricanes Sandy (2012) and Irene (2011) and Tropical Storm Lee (2011). Using the latest studies from New York State, this document presents the Hudson Valley's primary climate hazards and the risks and opportunities they present.

What does climate resilience mean to your community?

Climate Hazards in New York State

Three significant climate hazards (trends) are expected to affect New York State residents during the 21st century: *increasing temperatures, rising sea level*, and *changing precipitation patterns*. These trends are leading to three primary climate risks (human impacts): *flooding, heat waves* and *drought*. Communities can plan and implement resilience strategies to reduce their vulnerability and thrive under changing conditions. Risks and resilience opportunities are discussed later in this document.

Climate projections are displayed according to two Hudson Valley regions: Region 2, west of the Hudson River (Delaware, Greene, Orange, Schoharie, Sullivan, Rockland, and Ulster counties), and Region 5, east of the Hudson River (Albany, Columbia, Dutchess, Fulton, Herkimer, Madison, Montgomery, Oneida, Putnam, Rensselaer, Saratoga, Schenectady, Washington, and Westchester counties).

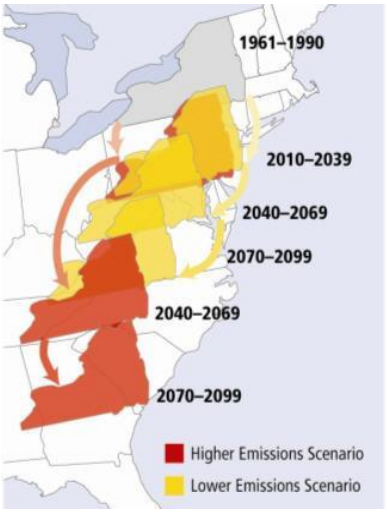


ClimAID climate regions 2 and 5, circles represent meteorological stations (NYSERDA).

Increasing temperatures

Annual average temperatures have been steadily increasing in New York State, posing new challenges to human health, electricity demand, and many of our industries, including tourism, recreation and agriculture. Since 1970, temperature increases in New York have surpassed national and global averages with our winters being particularly hard hit:

- 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**



Our average annual temperature is expected to increase approximately four to six degrees by mid-century and as much as 11 degrees by 2100. By the end of the century, we can expect the same number of days above 90 degrees as South Carolina experiences today.

AIR TEMPERATURE PROJECTIONS FOR WEST OF THE HUDSON

	Baseline 1971-2000	2020s	2050s	2080s	2100
Annual average air temperature	48˚F	52.2 - 53.1˚F	54.2 - 56.1˚F	55.4 - 59.6˚F	56.2 - 61.2˚F
Increase in annual average	-	2.2 - 3.1˚F	4.2 - 6.1˚F	5.4 - 9.6˚F	6.2 - 11.2˚F

AIR TEMPERATURE PROJECTIONS FOR EAST OF THE HUDSON

	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 - 6.2˚F	5.6 - 9.7˚F	6.1 - 11.4˚F

Rising sea level

Since 1900, sea level in the lower Hudson has risen 13 inches. **Sea level in New York harbor has risen 15 inches in the last 150 years**. It is projected to increase a minimum of nine additional inches by 2050. The mid-range projections for sea level rise along the Hudson River is approximately 10 to 20 inches by mid-century and as much as 50 inches by 2100. However, 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 if rapid ice melt occurs.

SEA LEVEL RISE PROJECTIONS FOR THE HUDSON

	Baseline 1971-2000	2020s	2050s	2080s	2100
Low estimate of rise in sea level	-	1 - 2"	5 - 8"	10 - 13"	11 - 15"
High estimate of rise in sea level	-	9 - 10"	27 - 30"	54 - 58"	71 - 75"

Global sea level is rising due to various factors, including thermal expansion from warmer water temperatures and melting of land-based ice. The Hudson River is connected to and influenced by the sea; therefore, it experiences tides and contains saltwater in its lower reaches. This is why the river south of the federal dam at Troy is considered an estuary. It is also the reason why the Hudson River's 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.

Changing precipitation patterns

Precipitation has become more variable and extreme, whereas total rainfall has changed only marginally. **Rain falling in heavy downpour events have increased 74% between the periods of 1950-1979 and 1980-2009 in the Northeast**. Projections indicate total annual precipitation should increase as much as 11% by mid-century and 18% by 2100. Overall in New York State, we can expect more dry periods intermixed with heavy rain and decreased snow cover in winter.

PRECIPITATION PROJECTIONS FOR WEST OF THE HUDSON

	Baseline 1971-2000	2020s	2050s	2080s	2100
Total annual precipitation	48"	48.5" - 52"	49.5" - 53.5"	51" - 54.5"	48.5" - 56.5"
% Increase in annual precipitation	-	1 - 8%	3 - 11%	6 - 14%	1 - 18%
Days with precipitation > 1"	12	12 - 13	13 - 14	13 - 15	*
Days with precipitation > 2"	2	2	2 - 3	2 - 3	*

PRECIPITATION PROJECTIONS FOR EAST OF THE HUDSON

	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 and Opportunities for Your Community

Heat waves, short-term drought and flooding are the primary climate risks Hudson Valley communities face as result of the hazards introduced in the previous section. Your community can start preparing for now for climate risks by increasing your resilience. Are these three primary risks highlighted in your municipality's current Comprehensive Plan? Building climate resiliency presents opportunities for adapting infrastructure, institutions, and communities as climate changes to respond productively and recover quickly from extreme events. Resiliency also depends on maintaining or enhancing natural systems and the vital benefits they provide communities, such as clean air and water, wildlife habitat, and natural flood protection. Effective conservation of natural areas for climate resiliency occurs across property and political boundaries and requires a broader view of natural landscapes. Conducting a natural resource inventory is a step toward identifying important natural areas in your community and considering them in local planning processes.

The section below introduces major climate risks and opportunities for action that may be important in your community. These suggestions are taken from DEC's Climate Smart Communities guidelines. For more information, refer to the list of resources at the end of this document.

RISK: 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 and increased electricity demand from air conditioning. Heat waves are a particular concern in more urban developed areas where the urban heat island effect can further exacerbate hot temperatures. By mid-century, the number of days above 95 degrees is expected to more than triple and heat waves will occur two to three times as often and last 25 to 50% longer.

HEAT WAVE PROJECTIONS FOR WEST OF THE HUDSON

	Baseline 1971-2000	2020s	2050s	2080s	2100
Days per year above 90˚F	12	19 - 25	31 - 47	38 - 77	*
Days per year above 95˚F	2	2 - 5	5 - 12	7 - 28	*
Heat waves per year	2	3	4 - 6	5 - 9	*
Average length (days) of each heat wave	4	5	5 - 6	5 - 7	*
Days per year ≤ 32˚F	138	108 - 116	86 - 100	65 - 89	*

HEAT WAVE PROJECTIONS FOR EAST OF THE HUDSON

	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	1	3 - 4	5 - 7	6 - 9	*
Average length (days) of each heat wave	4	5	5 - 6	5 - 7	*
Days per year ≤ 32˚F	155	127 - 136	104 - 119	84 - 109	*

OPPORTUNITIES

Develop and implement a community heat-emergency plan for the municipality or in collaboration with neighboring municipalities. This plan should identify vulnerable populations and existing resources and networks, and outline a course of action during a high-heat event.

Increase shading in public spaces with trees and other structures. During times of extreme heat, public spaces should provide relief for residents and animals, especially those who do not have access to air conditioning. Green infrastructure (natural and nature-based system for stormwater management) also provides greater cooling.

Expand cooling centers. To reduce hospitalization rates and deaths associated with heat waves, make sure the community has sufficient cooling centers with multiple modes of transit to and from these locations.

RISK: Short-term drought

Periods of short-term drought will be more frequent and severe given warmer, less snowy winters, fewer steady rainfalls, and higher evaporation from increased temperatures. These droughts can threaten local drinking water supplies, agricultural production, and aquatic ecosystems.

OPPORTUNITIES

Implement a water conservation and reuse program. Outline and implement best-practices and technologies to decrease water use and increase rainwater harvesting. Encourage xeriscaping—landscaping that requires little or no irrigation.

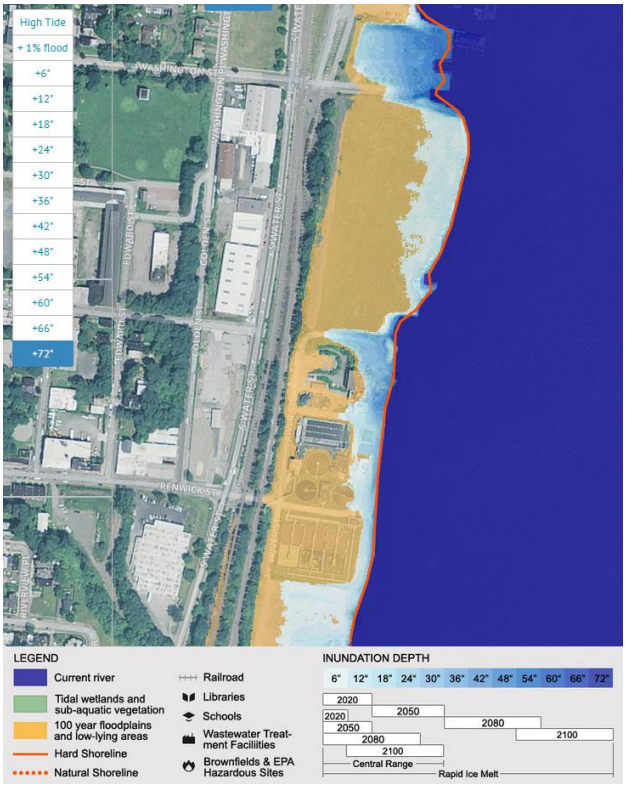
Maintain existing natural infrastructure. Protecting existing forested areas and wetlands will contribute to groundwater infiltration, which can decrease the extent of drought.

Implement a source-water protection program. Identify, map and protect local water supply sources and their watersheds or recharge areas.

RISK: Flooding

Increased intense precipitation and sea level rise could lead to more frequent flooding along the Hudson River and its tributaries, potentially threatening waterfront assets such as homes, businesses, sewage infrastructure, roads and more. New York projects that today's 1% ("100-year") storm will become 20 to 50% more likely by 2020 and as much as 610% more likely by 2100. Furthermore, the 1% storm will be 3 to 7 inches higher by 2020 and 1.5 to 3.3 inches higher by 2100. Hudson Valley communities encompass over $4.5 billion in vulnerable property represented by more than 18,500 policies in the National Flood Insurance Program. To date, there have been nearly $290 million in total flooding claims under this program and policy holders pay over $18 million a year. Does your community have a Flood Damage Prevention Ordinance or something similar?

If you are a Hudson Riverfront community, you can explore your flood risk using Scenic Hudson's online Sea Level Rise Mapper. You can also download a summary that details the magnitude of homes, people and property at risk over time.



Screenshot of Newburgh's waterfront under worse case flooding scenario on Scenic Hudson's Sea Level Rise Mapper

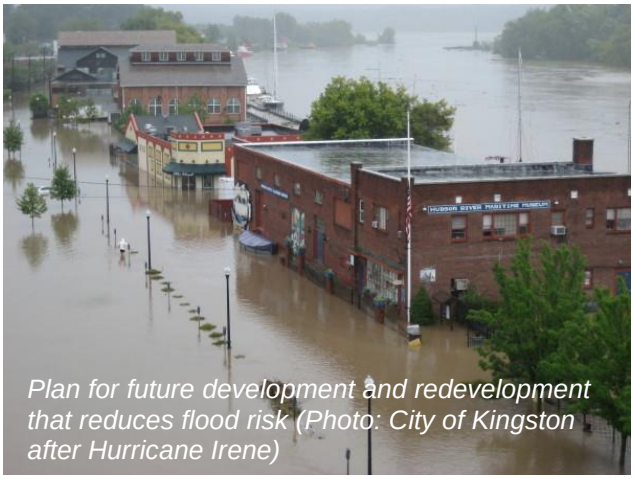
FLOOD PROJECTIONS FOR THE HUDSON

	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	15'	15.3 - 15.7'	15.9 - 16.8'	16.5 - 18.3'	*

*No data available

Flooding is exacerbated in communities by the stormwater runoff produced from impervious cover from urban development. Stormwater runoff is of particular importance in municipalities designated as MS4 or those that have combined sewer systems. Your community could consider projected flooding in future development and redevelopment proposals, and recommend conserving natural areas and implementing green infrastructure, such as permeable pavement or rain gardens, to reduce this risk.

There is a very strong relationship between land-use and flooding that is essential to addressing increased flood risk from climate change along streams. Healthy watersheds, including both land and water resources, can reduce erosion and flooding impacts, minimize public infrastructure costs, and be more resilient to climate change—all ecosystem services that directly benefit our communities and cost less than the alternatives.



Plan for future development and redevelopment that reduces flood risk (Photo: City of Kingston after Hurricane Irene)

OPPORTUNITIES

Seek financial assistance for flood adaptation. Please reference our fact sheet on Financing Flood Resilience, listed in the resources at the end of this document.

Incorporate future flooding into municipal planning. Include flood resilience into a municipal Capital Improvement Plan, updated Local Waterfront Revitalization Program, or another relevant plan. Require waterfront and streamside developers to consider flooding and sea level rise over the lifespan of projects.

Use natural vegetated buffers to protect assets from flood risk. Enhance or create natural vegetated shoreline and stream buffers to protect natural areas for flood mitigation and wildlife habitat. Consider facilitating a managed retreat from flood-prone areas over the long term and allowing for the migration of habitats as the floodplain evolves. Please see the sections on riparian areas in the Water Resource and Habitat Summaries.

Right size culverts. Many communities rely on culverts that are undersized and prone to cause flooding, especially given the trend of more intense precipitation. Culverts should be inspected and re-sized to adequately handle water flows and reduce flooding.

Promote best practices and technologies to address flooding. Promote flood prevention strategies, such as minimizing impervious surface areas and promoting the use of green infrastructure practices or natural features that help manage stormwater. See the resources at the end of this document for more on stormwater management and green infrastructure.

Identify and conserve natural areas contributing to stormwater management. In addition to natural vegetated stream buffers, forests, wetlands, and other natural areas are critical to managing stormwater on the landscape by intercepting rain and snowfall, reducing and slowing runoff, and contributing to groundwater recharge.

What Can I do Next?

Learn about how other Hudson River communities are adapting to climate risks.

Read our case studies on Flood Resilience Task Forces in Kingston, Catskill, Piermont and Stony Point: http://www.dec.ny.gov/energy/93950.html

See how green infrastructure is reducing stormwater runoff and local flooding issues in the Hudson Valley: http://www.dec.ny.gov/lands/58930.html

Flood Adaptation Strategies for Hudson Riverfront Communities:
http://www.slideshare.net/hrepclimate/flood-adaptation-strategies

Read how New York City is adapting its urban waterfront to address flood risk:
http://www.nyc.gov/html/dcp/html/sustainable_communities/sustain_com4.shtml

Stay up to date on funding, events, and new information about climate resilience.

Subscribe to our *Climate Resiliency in the Hudson Estuary* newsletter
https://public.govdelivery.com/accounts/NYSDEC/subscriber/new?topic_id=NYSDEC_147

Visit our Climate Resilience webpage:
http://www.dec.ny.gov/lands/39786.html

Read our fact sheet on Financing Flood Resilience:
http://wri.cals.cornell.edu/sites/wri.cals.cornell.edu/files/shared/documents/2015_Financing%20_Flood_Res.pdf

Understand how well prepared you are in planning for climate resilience. Fill out the DEC's Climate Smart Resiliency Planning tool to identify strengths and gaps in your municipal planning, outreach and emergency management related to climate risks.

Climate Smart Resiliency Planning (PDF): http://www.dec.ny.gov/docs/administration_pdf/csrptool.pdf

For more information on the topics discussed in this summary, please see the following sources:

- Financing Flood Resilience Fact Sheet:
  http://www.dec.ny.gov/docs/remediation_hudson_pdf/financefr.pdf
- Scenic Hudson's Sea Level Rise Mapper: http://scenichudson.org/slr/mapper
- Creating a Natural Resource Inventory: http://www.dec.ny.gov/lands/100925.html
- NYSDEC Office of Climate Change: http://www.dec.ny.gov/energy/44992.html
- The NYS 2100 Commission Report: http://www.governor.ny.gov/assets/documents/NYS2100.pdf
- Responding to Climate Change in New York: http://goo.gl/Ug5LCb

Tap into the Climate Smart Community network. Has your municipality taken the proactive step of becoming a Climate Smart Community? Participation will provide more opportunity to receive state assistance and resources to reduce greenhouse gas emissions, save energy and improve climate resiliency. Your community will be eligible for technical assistance as the program transitions to an actual certification.

NYSDEC Climate Smart Communities:
http://www.dec.ny.gov/energy/50845.html
VHB Engineering, Inc.
e-mail: climatesmart@vhb.com
Phone: 617-924-1770 x1287