New York State Climate Hazards Profile

Final Report | Report Number 18-11a | June 2018

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

University at Buffalo School of Architecture and Planning

NYSERDA's Promise to New Yorkers:

NYSERDA provides resources, expertise, and objective information so New Yorkers can make confident, informed energy decisions.

Mission Statement:

Advance innovative energy solutions in ways that improve New York's economy and environment.

Vision Statement:

Serve as a catalyst – advancing energy innovation, technology, and investment; transforming New York's economy; and empowering people to choose clean and efficient energy as part of their everyday lives.

Cover Image: FEMA/Liz Roll

NOTICE

This report was prepared by The State University of New York at Buffalo (hereafter "University at Buffalo") in the course of performing work contracted for and sponsored by the New York State Energy Research and Development Authority (hereafter "NYSERDA"). The opinions expressed in this report do not necessarily reflect those of NYSERDA or the State of New York, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it. Further, NYSERDA, the State of New York, and the contractor make no warranties or representations, expressed or implied, as to the fitness for particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, or other information contained, described, disclosed, or referred to in this report. NYSERDA, the State of New York, and the contractor make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately owned rights and will assume no liability for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this report.

NYSERDA makes every effort to provide accurate information about copyright owners and related matters in the reports we publish. Contractors are responsible for determining and satisfying copyright or other use restrictions regarding the content of reports that they write, in compliance with NYSERDA's policies and federal law. If you are the copyright owner and believe a NYSERDA report has not properly attributed your work to you or has used it without permission, please email print@nyserda.ny.gov.

Information contained in this document, such as web page addresses, are current at the time of publication.

CONTACTS

Amanda Stevens, Project Manager
NYSERDA
17 Columbia Circle
Albany, New York 12203-6399
amanda.stevens@nyserda.ny.gov

Nicholas B. Rajkovich, Principal Investigator
University at Buffalo School of Architecture and Planning
Hayes Hall, University at Buffalo
Buffalo, New York 14214
rajkovic@buffalo.edu

PROJECT PREPARED BY

Tuzzo, Michael E., Elizabeth Gilman, Nicholas B. Rajkovich, Bartholomew Roberts (University at Buffalo); Ellen Cousins, Sean Daigneault, and Stefan Cecelski (Weather Analytics).

PROJECT ADVISORY COMMITTEE

Claire Barnett, Healthy Schools Network
Joseph Borowiec, NYSERDA
Robert Carver, NYSERDA
Tom Eisele, New York City Mayor's Office of Recovery and Resiliency
Jeff Jones, Healthy Schools Network
Kim Knowlton, Natural Resources Defense Council and Columbia University's Mailman School of Public Health
Dana Kochnower, New York City Mayor's Office of Recovery and Resiliency
Ann Kosmal, U.S. General Services Administration
Alison Kwok, University of Oregon
Chris Pyke, U.S. Green Building Council
Jodi Smits Anderson, Dormitory Authority of the State of New York (DASNY)
Robert G. Shibley, University at Buffalo School of Architecture and Planning
Kevin Stack, Northeast Green Building Consulting, LLC
Ernest Sternberg, University at Buffalo Department of Urban and Regional Planning
Alex Wilson, Resilient Design Institute

PREFERRED CITATION

Tuzzo, Michael E., Elizabeth Gilman, Nicholas B. Rajkovich, Bartholomew Roberts, Ellen Cousins, Sean Daigneault, and Stefan Cecelski. 2018. New York State Climate Hazards Profile. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

Table of Contents

INTRODUCTION

This report provides information on the historical, current, and potential future impacts of climate change on the built environment. Data in this report are broken down by region and county, allowing property owners and operators, policymakers, architects, planners, and engineers to visualize climate risks at a local level. Please note that data are not available for all climate-related hazards. For example, there is very little research on the spread of pests like termites.

HISTORICAL CLIMATE-RELATED HAZARDS

Climate hazard events including hurricanes, severe storms, and winter storms have caused significant damage to buildings in New York State. Changing climate conditions, including increases in temperature and precipitation, could potentially increase the frequency and intensity of these climate hazard events. Data from the University of South Carolina's Spatial Hazard Events and Losses Database for the United States (SHELDUS) are used in this document to visualize where these events have occurred in the past and how much damage they have caused. Visit the SHELDUS database at hvri.geog.sc.edu/SHELDUS/ for more information.

One limitation of the SHELDUS database is the underreporting of losses due to hurricanes/tropical storms. To correct this, SHELDUS data for hurricanes/tropical storms were supplemented with loss data from the FEMA Public Assistance Data for Presidential Disaster Declarations. To maintain consistency with the SHELDUS data, Presidential Disaster Declaration costs from FEMA were restricted to items that accounted for property damage. Visit the FEMA database at www.fema.gov/data-feeds# for more information.

CURRENT CLIMATE-RELATED HAZARDS

The results of the Climate Risk Reports are calculated using 37 years (1979 through 2015) of 30km resolution data. Data used by Weather Analytics were derived from the Climate Forecast System Reanalysis dataset produced by the National Centers for Environmental Prediction. These data were enhanced by including rapid gap-filling, rationalization of disparate data, error correction, and interpolation. Weather Analytics also fused topography to enhance quality of output data. Through a proprietary extraction, transformation, and loading process, Weather Analytics provided data from legacy binary files for additional analysis.

The 'exceedance probability' is the likelihood that a threshold will be exceeded within a single year. For example, an exceedance probability of .66 for high temperature means there is a 66% chance that a region's temperature will exceed 90°F in a given year. Probabilities were calculated using straightforward statistical analysis of the data. Thresholds were based on relative atmospheric extremes for New York State over 37 years by meteorologists at Weather Analytics.

FUTURE CLIMATE-RELATED HAZARDS

The climate projections in this report were adapted from Horton et al.'s 2014 report for NYSERDA entitled *Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information*. Horton et al. divided these data into low (10th percentile), middle (25th to 75th percentile), and high (90th percentile) estimates for periods beginning in 2020, 2050, and 2080. The projections from Horton et al. are not probabilities, so the specific numbers should not be emphasized; the potential for uncertainty and error should be acknowledged when used by a buildings professional.

Hurricanes/Tropical Storms

HAZARD DESCRIPTION

Hurricanes and tropical storms produce severe winds, intense precipitation, and storm surge. While the more densely populated coastal areas of New York State, such as New York City, are the most vulnerable to damages from these coastal storms, their effects can be seen on varying levels across the entire State.[1]

HAZARD HISTORY IN NEW YORK STATE

Although there have been only 10 major hurricanes/tropical storm events in New York State over the past half century, the cost to communities has been nearly $11 billion.[2] Most of the direct impact was felt in New York City and Long Island (ClimAID Region 4), where 98% of all hurricane and tropical storm costs have occurred. However, hurricanes and tropical storms have caused severe damage across the State. Effects from Hurricane Irene in 2011 sprawled through Long Island, New York City, Hudson Valley, Capital District, Mohawk Valley, and the North Country (ClimAID Regions 2, 3, 4, 5, and 7), with most of their counties requiring both public and individual assistance from FEMA. Similarly, disaster declarations were made in Hudson Valley, Mohawk Valley, and the Southern Tier (ClimAID Regions 2, 3, and 5) in response to Tropical Storm Lee in 2011. In 1972, flooding from Tropical Storm Agnes caused damage all the way from Hudson Valley to Western New York, ultimately affecting ClimAID Regions 1, 2, 3, 5, and 6.[2]

IMPACT ON BUILDINGS

Due to their geographic scale, extended periods of exposure, high winds, intense precipitation, and storm surges, hurricanes and tropical storms are one of the most destructive types of climate-related hazards.[3] Extreme winds can remove roof and wall coverings, destroy homes, and tear up trees. Coastal storms and their remnants produce intense rainfall, which can lead to serious flooding or flash flooding. Storm surges can rise 25 feet above the normal water level when they combine with high tides, creating hurricane storm tides.[1] Flooding from either precipitation or storm surges can lift smaller structures from their foundations or cause significant damage to building systems located below the base flood elevation (BFE).

ANTICIPATED CHANGES

The strength of hurricanes and tropical storms may increase due to a rise in oceanic and atmospheric temperatures. In addition, as sea levels rise, the associated coastal flooding and storm surge may increase.[2]

REFERENCES

1. New York State Division of Homeland Security and Emergency Services. 2014. *NYS Standard Multi-Hazard Mitigation Plan (State Mitigation Plan) 2014*. NYSDHSES. Accessed May 8, 2018. http://www.dhses.ny.gov/recovery/mitigation/plan.cfm.

2. Federal Emergency Management Agency. 2016. "Data Visualization: Disaster Declarations for States and Counties." FEMA. Accessed May 8, 2018. https://www.fema.gov/data-visualization-disaster-declarations-states-and-counties.

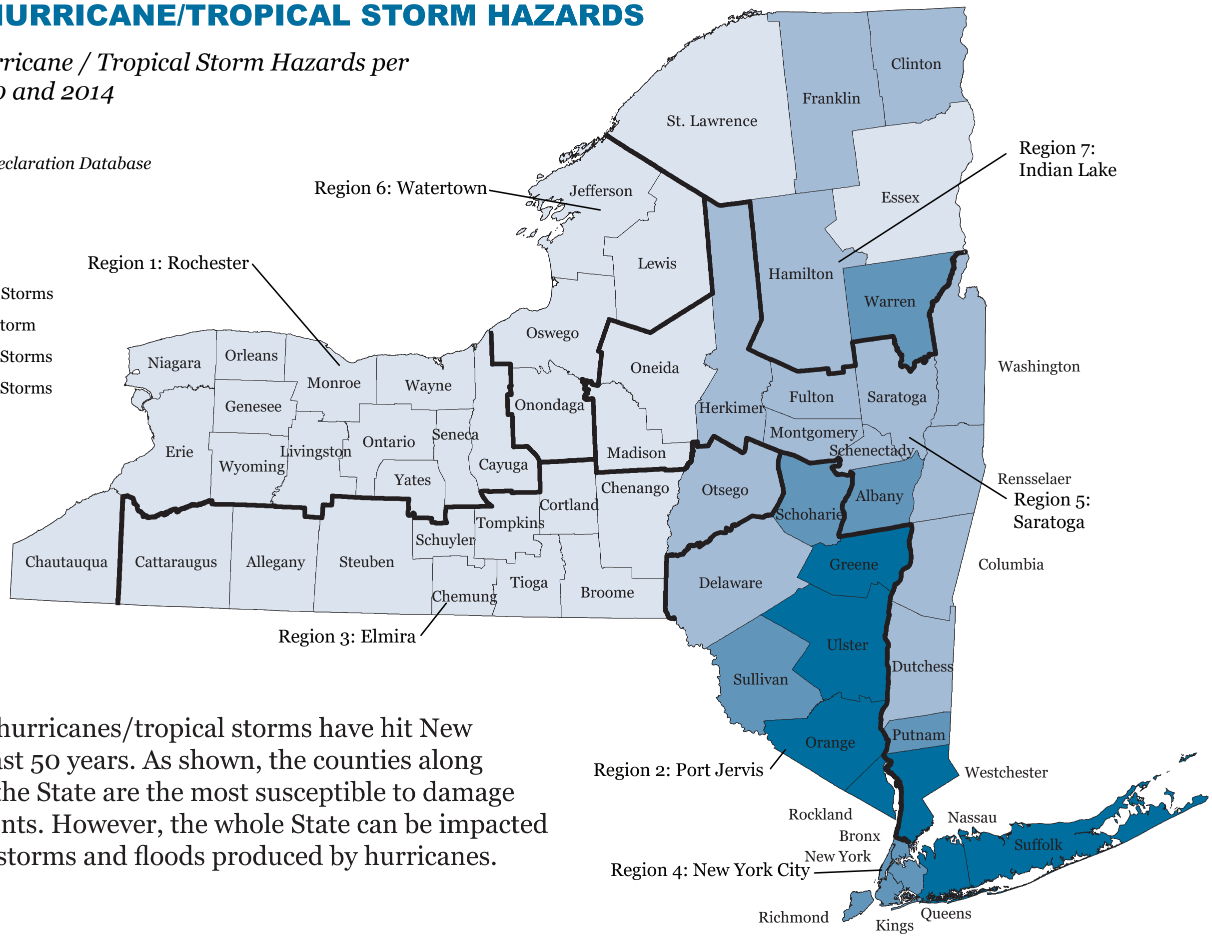
3. Changnon, S.A., D. Changnon, E.R. Fosse, D.C. Hoganson, R.J. Roth Sr., and J.M. Totsch, 1997. "Effects of Recent Weather Extremes on the Insurance Industry: Major Implications for the Atmospheric Sciences." *Bulletin of the American Meteorological Society* 78, no. 3. 425-435. Accessed May 8, 2018. https://journals.ametsoc.org/doi/pdf/10.1175/1520-0477%281997%29078%3C0425%3AEORWEO%3E2.0.CO%3B2.

HISTORICAL HURRICANE/TROPICAL STORM HAZARDS

Total Number of Hurricane / Tropical Storm Hazards per County between 1960 and 2014

Data Source:
FEMA Presidential Disaster Declaration Database

Legend:
- 0 Hurricanes / Tropical Storms
- 1 Hurricane / Tropical Storm
- 2 Hurricanes / Tropical Storms
- 3 Hurricanes / Tropical Storms



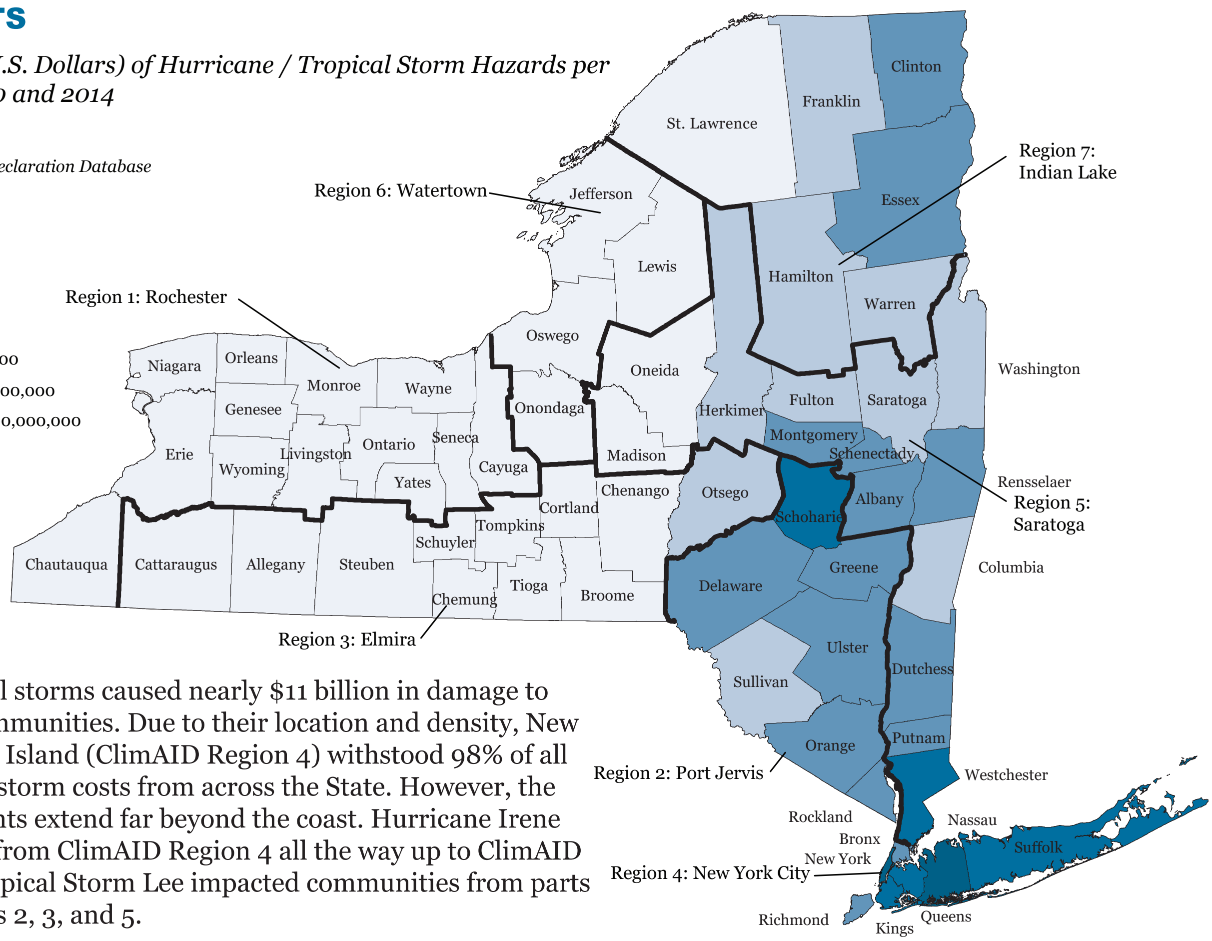
A small number of hurricanes/tropical storms have hit New York State in the past 50 years. As shown, the counties along the eastern side of the State are the most susceptible to damage caused by these events. However, the whole State can be impacted by widespread rainstorms and floods produced by hurricanes.

HISTORICAL HURRICANE / TROPICAL STORM HAZARD COSTS

Total Cost (in 2015 U.S. Dollars) of Hurricane / Tropical Storm Hazards per County between 1960 and 2014

Data Source:
FEMA Presidential Disaster Declaration Database

Legend:
- No Damage
- $7,000 - $1,500,000
- $1,500,001 - $25,000,000
- $25,000,001 - $1,000,000,000
- $1,000,000,001 - $8,300,000,000



Hurricanes/tropical storms caused nearly $11 billion in damage to New York State communities. Due to their location and density, New York City and Long Island (ClimAID Region 4) withstood 98% of all hurricane/tropical storm costs from across the State. However, the effects of these events extend far beyond the coast. Hurricane Irene impacted counties from ClimAID Region 4 all the way up to ClimAID Region 7, while Tropical Storm Lee impacted communities from parts of ClimAID Regions 2, 3, and 5.

Flooding

HAZARD DESCRIPTION

Flooding is a regular event in New York State, occurring at least once every seven years in all 62 counties.[1] The *2014 New York State Hazard Mitigation Plan* identifies nine types of flooding that cause damage to buildings: riverine overbank flooding, flash floods, alluvial fan floods, mudflows or debris floods, dam- and levee-break floods, local draining or high groundwater levels, fluctuating lake levels, ice jams, and coastal flooding.[2] Factors that increase flood risk include land elevation, proximity to a water body, and precipitation amount.[2]

HAZARD HISTORY IN NEW YORK STATE

Flooding in New York State is most commonly caused by rainfall or melting snow that accumulates faster than the soil can absorb it or streams and rivers can carry it away.[3] Various types of precipitation can lead to floods, including small-scale thunderstorms, coastal storms, seasonal nor'easters, and snow storms.[2] Over the past half century, communities near large bodies of water, such as the Great Lakes, Lake Champlain, the Hudson River, and the Susquehanna River, have all experienced higher-than-average rates of flooding.[4]

IMPACT ON BUILDINGS

Buildings can be damaged by floods through foundation scour, uplift from hydrostatic pressure, and debris carried by floodwaters. In some cases, structures can be completely destroyed. Flooding can impact structures by leaving behind contaminated sediment as well as causing significant mold growth. Building-specific strategies aim to break the "damage-rebuild-damage" cycle through flood resistant building materials and flood barriers. Strategies can also include neighborhood-based flood protection activities designed to help communities prepare for flooding events.

ANTICIPATED CHANGES

According to the Intensity Duration Frequency (IDF) curve generator (developed by NRCC and NYSERDA), with a 100-year return period, New York City will see projected maximums of 4.14 inches of rainfall per hour during a 1-hour storm and 0.46 inches per hour during a 24-hour storm (2040 to 2069). The observed maximums for the same types of storms (1970 to 1999) were 3.63 inches per hour and 0.40 inches per hour, respectively.[5] This tool can help size green and gray infrastructure to accommodate a greater intake of stormwater and reduce the chances of flooding. Additionally, land use and soil compaction often decrease a watershed's ability to cope with extreme precipitation, increasing local flooding risk.

REFERENCES

1. Federal Emergency Management Agency. 2016. "Data Visualization: Disaster Declarations for States and Counties." FEMA. Accessed May 8, 2018. https://www.fema.gov/data-visualization-disaster-declarations-states-and-counties

2. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki, 2014. "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information." Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 8, 2018. https://www.nyserda.ny.gov/climaid

3. New York State Division of Homeland Security and Emergency Services. 2014. *NYS Standard Multi-Hazard Mitigation Plan (State Mitigation Plan) 2014*. NYSDHSES. Accessed May 8, 2018. http://www.dhses.ny.gov/recovery/mitigation/plan.cfm

4. University of South Carolina. 2016. "Spatial Hazard Events and Losses Database for the United States (SHELDUS)." Hazards and Vulnerability Research Institute. Accessed May 8, 2018. http://hvri.geog.sc.edu/SHELDUS/

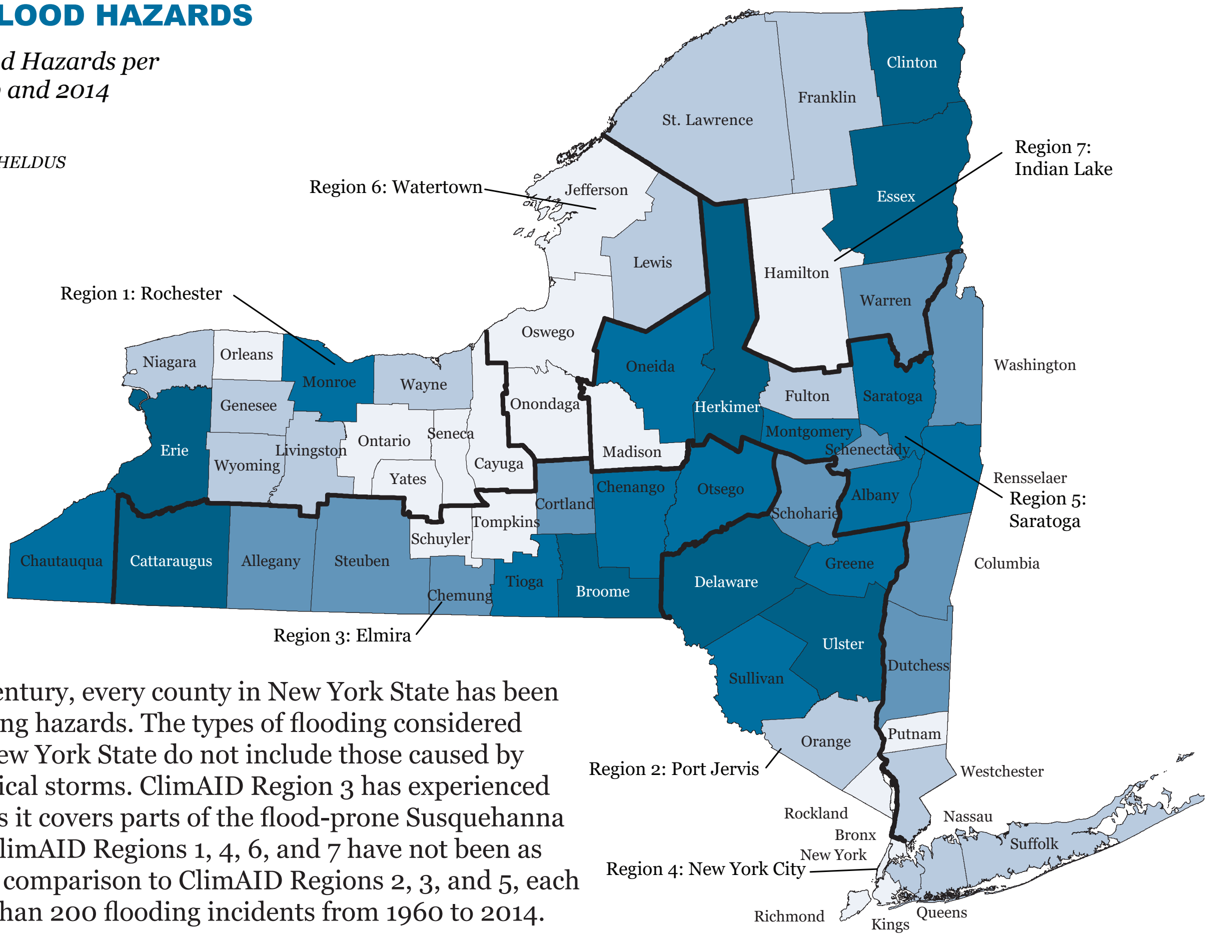
5. Northeast Regional Climate Center (NRCC) and New York State Energy Research and Development Authority (NYSERDA). 2015. "Intensity Duration Frequency Curves for New York State: Future Projections for a Changing Climate." Cornell University. Accessed June 5, 2018. http://ny-idf-projections.nrcc.cornell.edu/#dialog_box

HISTORICAL FLOOD HAZARDS

Total Number of Flood Hazards per County between 1960 and 2014

Data Source:
University of South Carolina SHELDUS

Legend:
- 24 - 33 Floods
- 34 - 42 Floods
- 43 - 50 Floods
- 51 - 63 Floods
- 64 - 83 Floods



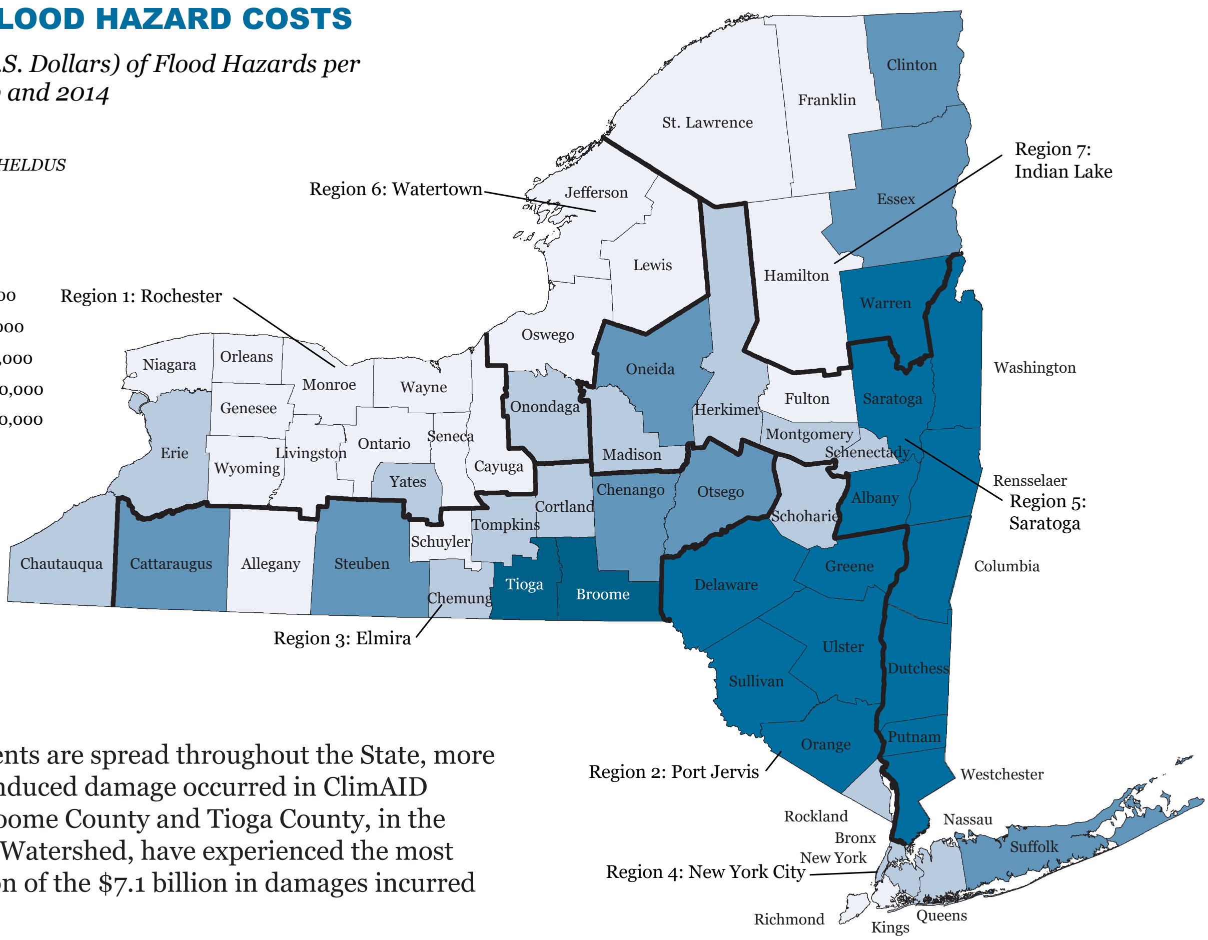
Over the past half century, every county in New York State has been challenged by flooding hazards. The types of flooding considered a regular event in New York State do not include those caused by hurricanes and tropical storms. ClimAID Region 3 has experienced the most flooding, as it covers parts of the flood-prone Susquehanna River Watershed. ClimAID Regions 1, 4, 6, and 7 have not been as prone to flooding in comparison to ClimAID Regions 2, 3, and 5, each of which had more than 200 flooding incidents from 1960 to 2014.

HISTORICAL FLOOD HAZARD COSTS

Total Cost (in 2015 U.S. Dollars) of Flood Hazards per County between 1960 and 2014

Data Source:
University of South Carolina SHELDUS

Legend:
- $3,100,000 - $25,300,000
- $25,300,001 - $57,000,000
- $57,000,001 - $163,000,000
- $163,000,001 - $430,600,000
- $430,600,001 - $915,000,000



Though flooding events are spread throughout the State, more than 60% of flood-induced damage occurred in ClimAID Regions 3 and 5. Broome County and Tioga County, in the Susquehanna River Watershed, have experienced the most damage: $1.56 billion of the $7.1 billion in damages incurred statewide.

CURRENT DAYS OVER 1" OF RAINFALL

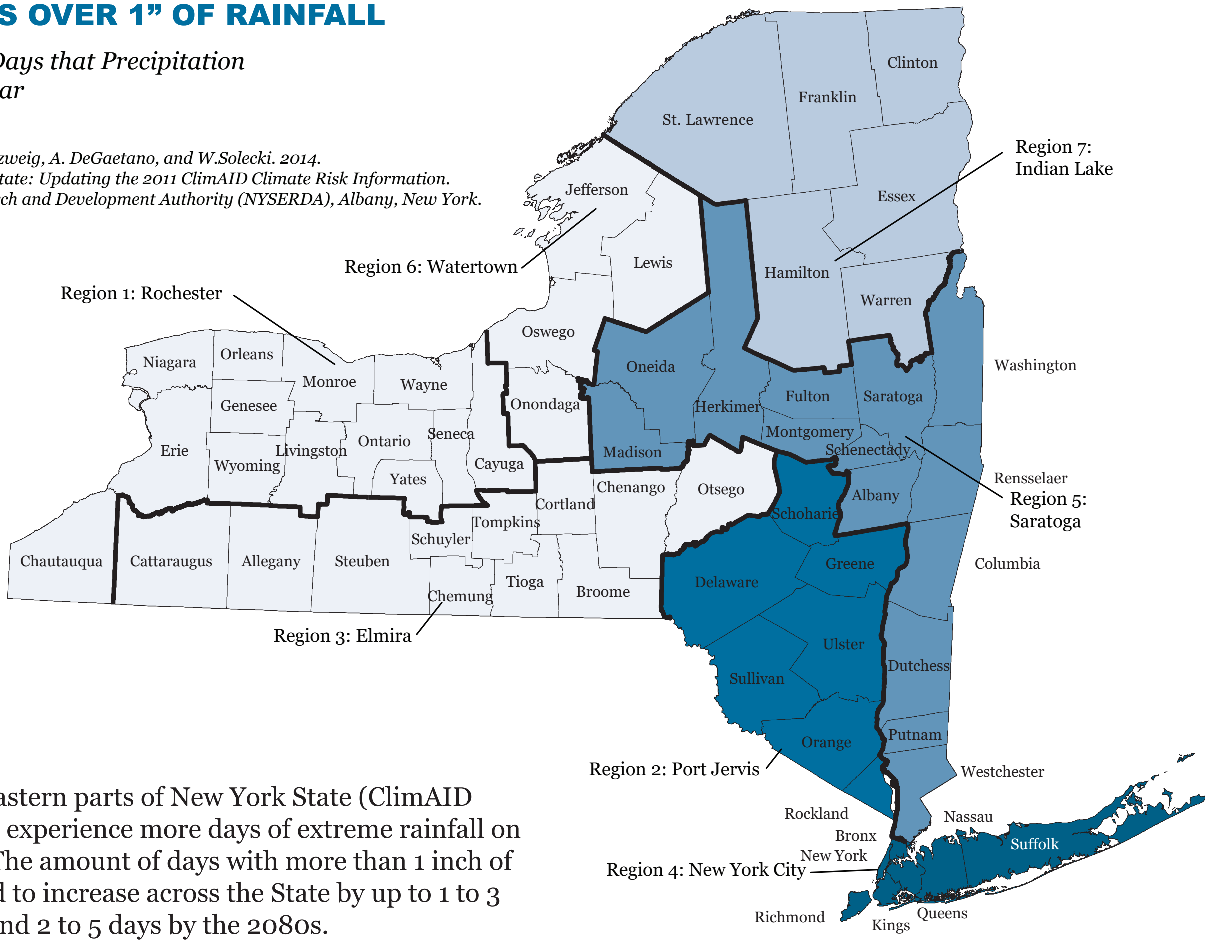
Average Number of Days that Precipitation Will Exceed 1" in a Year

Data Derived From:

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, New York.

Legend:

- 5 - 6 days
- 7 - 8 days
- 9 - 10 days
- 11 - 12 days
- 13 - 14 days



The southern and eastern parts of New York State (ClimAID Regions 2, 4, and 5) experience more days of extreme rainfall on average each year. The amount of days with more than 1 inch of rainfall are expected to increase across the State by up to 1 to 3 days by the 2020s and 2 to 5 days by the 2080s.

FUTURE DAYS OVER 1" OF RAINFALL

ClimAID Region: City (Current Baseline)	2020s			2050s			2080s		
	Low	Middle	High	Low	Middle	High	Low	Middle	High
Region 1: Rochester (Average of 5 days/year)	4	5 to 5	6	4	5 to 5	6	4	5 to 6	7
Region 2: Port Jervis (Average of 12 days/year)	11	12 to 13	14	12	13 to 14	15	12	13 to 15	16
Region 3: Elmira (Average of 6 days/year)	6	6 to 7	7	6	6 to 7	8	6	7 to 8	8
Region 4: New York City (Average of 13 days/year)	13	14 to 15	16	13	14 to 16	17	14	15 to 17	18
Region 5: Saratoga (Average of 10 days/year)	10	10 to 11	12	10	11 to 12	13	10	11 to 13	14
Region 6: Watertown (Average of 6 days/year)	6	7 to 8	8	7	7 to 8	9	7	7 to 9	10
Region 7: Indian Lake (Average of 7 days/year)	7	7 to 8	9	7	8 to 9	10	8	8 to 10	11

DATA SOURCE

1. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki, 2014. "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information." Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 8, 2018. nyserda.ny.gov/climaid3

CURRENT DAYS MORE THAN 2” OF RAINFALL

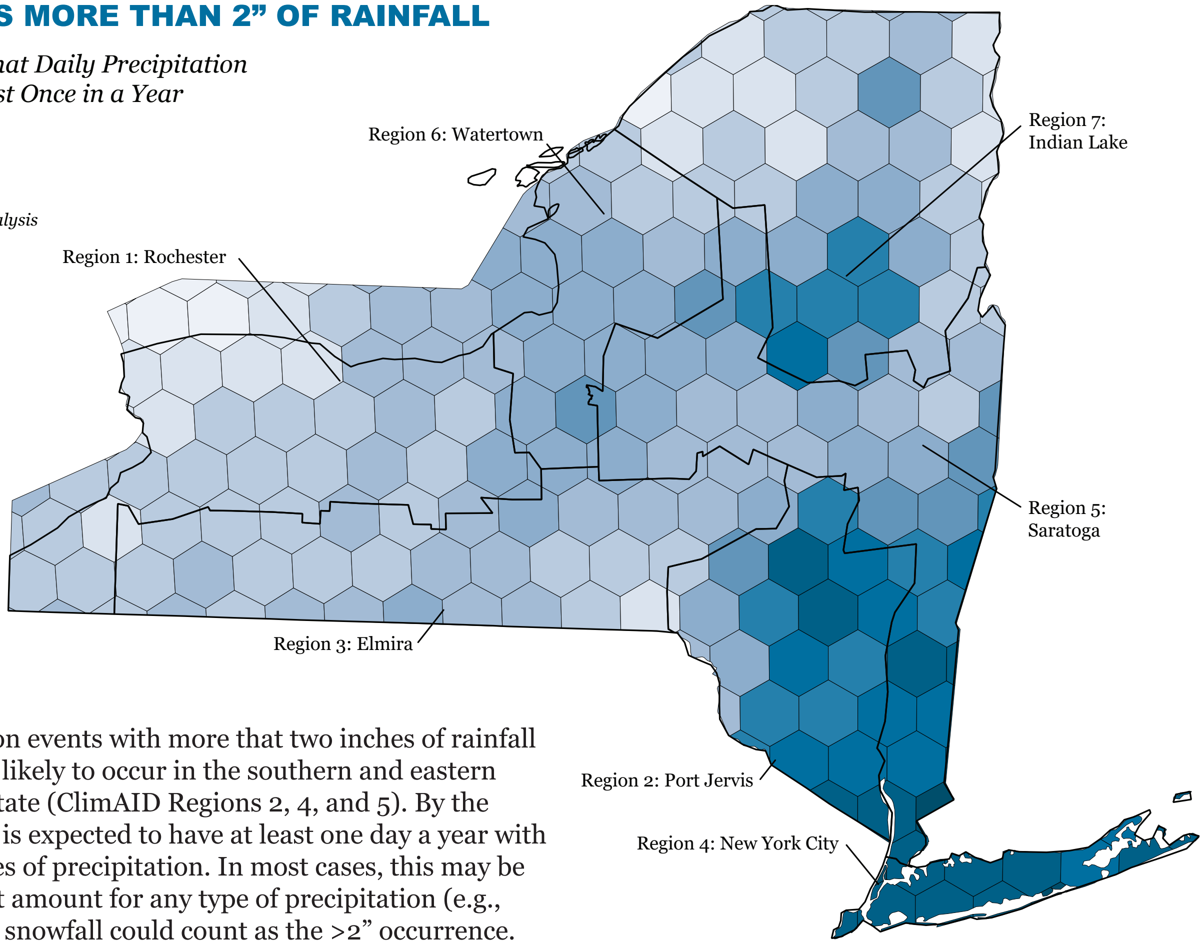
Percent Probability that Daily Precipitation Will Exceed 2” at Least Once in a Year

Map Produced By:
Weather Analytics

Data Derived From:
Climate Forecast System Reanalysis

Legend:

- 10.80 - 18.40%
- 18.41 - 25.90%
- 25.91 - 33.50%
- 33.51 - 41.10%
- 41.11 - 48.60%
- 48.61 - 56.20%
- 56.21 - 63.80%
- 63.81 - 71.40%
- 71.41 - 78.90%
- 78.91 - 86.50%



Extreme precipitation events with more that two inches of rainfall in one day are more likely to occur in the southern and eastern parts of New York State (ClimAID Regions 2, 4, and 5). By the 2080s, every region is expected to have at least one day a year with more than two inches of precipitation. In most cases, this may be the liquid equivalent amount for any type of precipitation (e.g., rain, snow); a heavy snowfall could count as the >2” occurrence.

FUTURE DAYS MORE THAN 2” OF RAINFALL

ClimAID Region: City (Current Baseline)	2020s			2050s			2080s		
	Low	Middle	High	Low	Middle	High	Low	Middle	High
Region 1: Rochester (Average of 0.6 days/year)	0.6	0.6 to 0.7	0.8	0.5	0.6 to 0.8	0.9	0.5	0.6 to 0.9	1
Region 2: Port Jervis (Average of 2 days/year)	2	2 to 2	3	2	2 to 3	3	2	2 to 3	3
Region 3: Elmira (Average of 0.6 days/year)	0.6	0.7 to 0.9	1	0.7	0.8 to 1	1	0.7	0.8 to 1	1
Region 4: New York City (Average of 3 days/year)	3	3 to 4	5	3	4 to 4	5	3	4 to 5	5
Region 5: Saratoga (Average of 1 day/year)	1	1 to 2	2	1	1 to 2	2	1	1 to 2	2
Region 6: Watertown (Average of 0.8 days/year)	0.6	0.7 to 1	1	0.7	0.7 to 1	1	0.7	0.8 to 1	1
Region 7: Indian Lake (Average of 0.8 days/year)	0.7	0.8 to 1	1	0.8	0.9 to 1	1	0.8	0.9 to 1	1

DATA SOURCE

1. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki, 2014. “Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information.” Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 8, 2018. nyserda.ny.gov/climaid

Severe Storms

HAZARD DESCRIPTION

Severe storms include intense precipitation events that occur over a short period of hours or even minutes. Often occurring in warmer months, these intense events are commonly associated with convective storms.[1] The severe storms discussed in this section do not include hurricanes or tropical storms.

HAZARD HISTORY IN NEW YORK STATE

Over the past half century, severe storms have impacted most regions of New York State, with two-thirds of these hazard events occurring between the months of May and August.[2] Though the geography responsible for producing heavy rainfall is more common in coastal areas, parts of Western and Central New York, particularly Chautauqua, Erie (ClimAID Region 1), Otsego (ClimAID Region 3), and Oneida Counties (ClimAID Region 5) experienced the largest amount of severe storm events between 1960 and 2014.[3] Severe storms also occurred, though less significantly, in the Finger Lakes Region (part of ClimAID Region 1), the Adirondacks (ClimAID Region 7), New York City, and Long Island (ClimAID Region 4).[2]

IMPACT ON BUILDINGS

Severe storms can cause wind damage, water damage, and power loss from downed electrical lines. Strategies that provide wind and water protection are critical to ensure that buildings avoid or minimize damage from severe storms.

ANTICIPATED CHANGES

With temperatures projected to warm across New York State, the frequency and intensity of severe storms may increase.[1] Some research also suggests that lightning, which can cause wildfires, building fires, or other types of damage, may also increase in frequency with warmer temperatures and higher humidity.[1]

REFERENCES

1. Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, and P. Grabhorn (Eds.). 2011. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation*. Albany, NY: New York State Energy Research and Development Authority (NYSERDA). Accessed May 8, 2018. nyserda.ny.gov/climaid

2. University of South Carolina. 2016. "Spatial Hazard Events and Losses Database for the United States (SHELDUS). " Hazards and Vulnerability Research Institute. Accessed May 8, 2018. http://hvri.geog.sc.edu/SHELDUS/

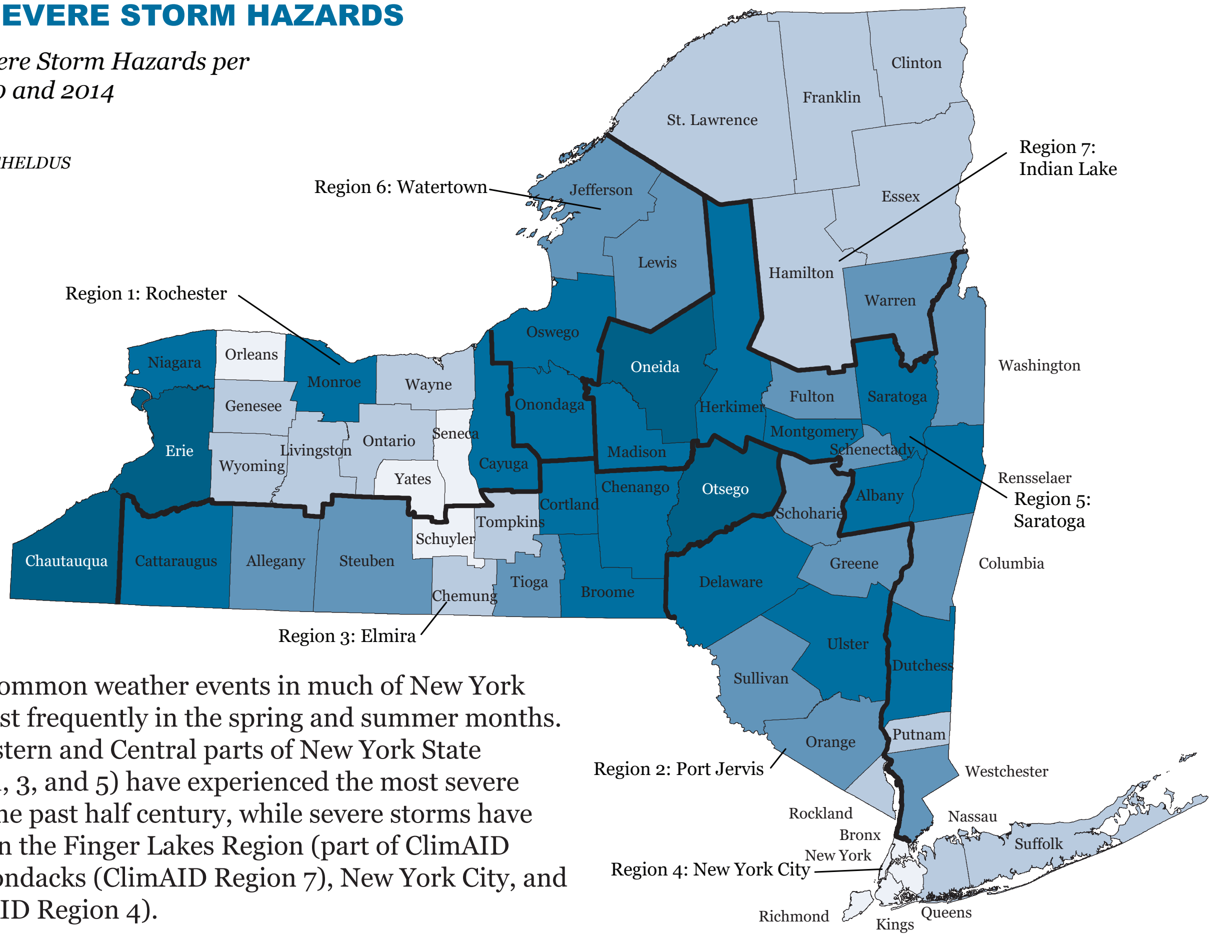
3. Federal Emergency Management Agency. 2016. "Data Visualization: Disaster Declarations for States and Counties." FEMA. Accessed May 8, 2018. https://www.fema.gov/data-visualization-disaster-declarations-states-and-counties

HISTORICAL SEVERE STORM HAZARDS

Total Number of Severe Storm Hazards per County between 1960 and 2014

Data Source:
University of South Carolina SHELDUS

Legend:
- 90 - 102 Severe Storms
- 103 - 120 Severe Storms
- 121 - 139 Severe Storms
- 140 - 164 Severe Storms
- 165 - 194 Severe Storms



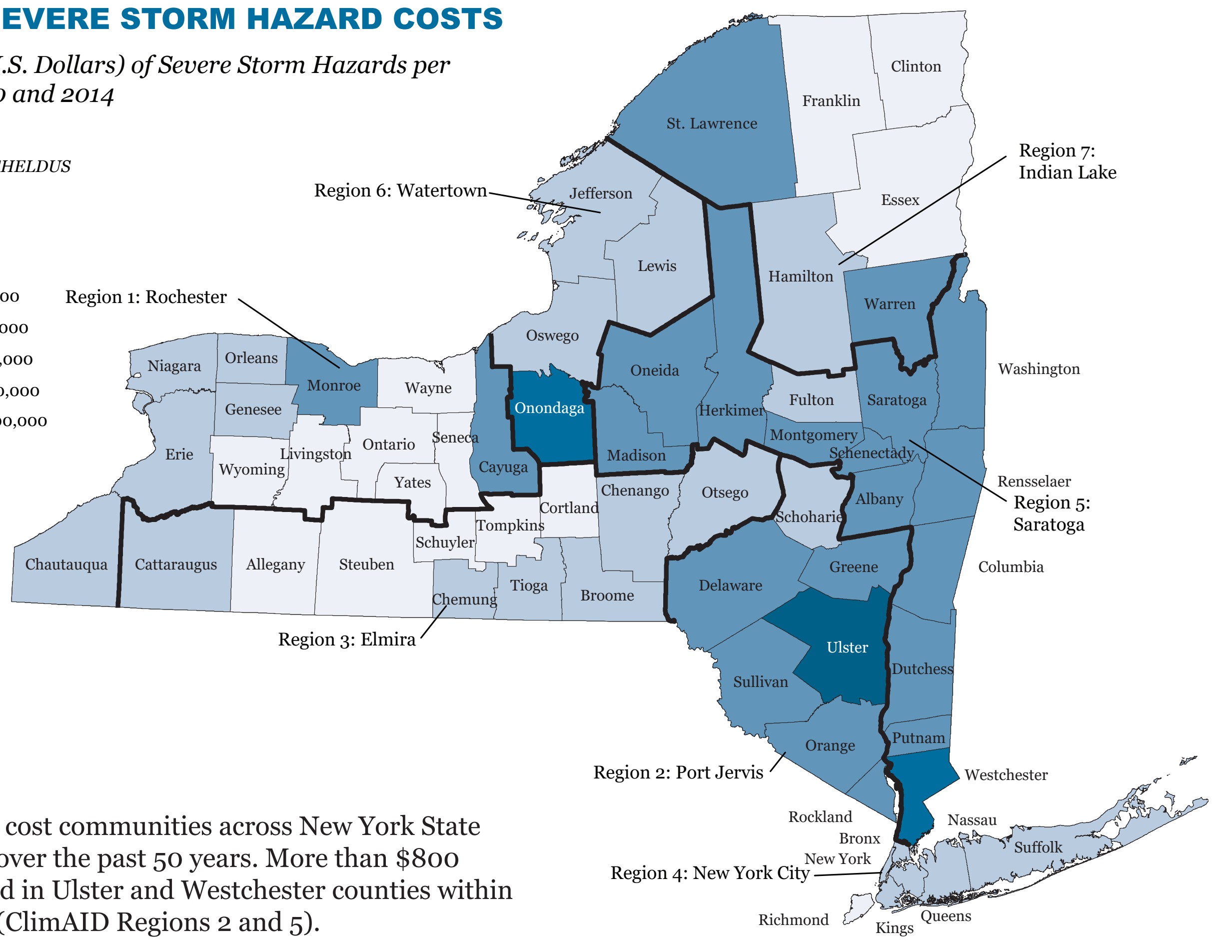
Severe storms are common weather events in much of New York State, occurring most frequently in the spring and summer months. Counties in the Western and Central parts of New York State (ClimAID Regions 1, 3, and 5) have experienced the most severe storm events over the past half century, while severe storms have been less frequent in the Finger Lakes Region (part of ClimAID Region 1), the Adirondacks (ClimAID Region 7), New York City, and Long Island (ClimAID Region 4).

HISTORICAL SEVERE STORM HAZARD COSTS

Total Cost (in 2015 U.S. Dollars) of Severe Storm Hazards per County between 1960 and 2014

Data Source:
University of South Carolina SHELDUS

Legend:
- $4,350,000 - $16,700,000
- $16,700,001 - $38,000,000
- $38,000,001 - $82,000,000
- $82,000,001 - $136,000,000
- $136,000,001 - $667,800,000



Severe storms have cost communities across New York State nearly $2.8 billion over the past 50 years. More than $800 million was incurred in Ulster and Westchester counties within the Hudson Valley (ClimAID Regions 2 and 5).

Winter Storms

HAZARD DESCRIPTION

Winter storms can include cold temperatures, snow, ice, high winds, blizzard conditions, and other localized phenomena, such as lake effect snowstorms.[1] These storms can cause significant physical damage or property loss.

HAZARD HISTORY IN NEW YORK STATE

Although all areas of New York State are susceptible to winter storms, they are most prevalent in the areas along the eastern shores of Lake Ontario and Lake Erie (ClimAID Region 1), counties in the Adirondacks (ClimAID Region 7), and the Tug Hill Plateau (ClimAID Region 6). These areas have greater exposure to the moisture from the Great Lakes.[1]

Lake effect snowstorms, which can generate as much as 80 inches of snow in a single event, are most frequent in places downwind from the Great Lakes.[2] Erie, Chautauqua, and Cattaraugus counties (ClimAID Region 1) are most impacted by Lake Erie, while Oswego, Jefferson, and Cayuga counties (ClimAID Regions 1 and 6) are most impacted by Lake Ontario.[2] Communities in the northernmost part of the state, particularly those in the Adirondacks Region (ClimAID Region 7) and parts of the Tug Hill Plateau (ClimAID Region 6) also have high rates of winter storms, though winter events in these locations are driven by a higher-than-average snowfall rate and lower overall temperatures rather than lake effect.[2]

IMPACT ON BUILDINGS

Damage to the building stock from winter weather hazards includes collapsed roofs from excessive snow loads, power outages, and damage to overburdened heating systems. Building system interventions to resist damage from winter storms include using above code levels of insulation and designing for increased wind loads. In addition, programs or policies that encourage neighborhoods to be more resilient and engage residents to be part of a "whole community" approach can assist with emergency management.

ANTICIPATED CHANGES

The severity of a winter storm depends on several physical and climatological factors, including precipitation amounts and temperature.[3] Although seasonal projections are less certain than annual results, significant increases in regional precipitation amounts are expected to occur during winter months in New York State. In addition, models suggest the decrease in ice cover on the Great Lakes may lead to increased lake effect snow in the coming decades. However, by mid-century these lake effect snow hazards may decrease as temperatures below freezing become less common.[2]

REFERENCES

1. Changnon, S.A., D. Changnon, E.R. Fosse, D.C. Hoganson, R.J. Roth Sr., and J.M. Totsch, 1997. "Effects of Recent Weather Extremes on the Insurance Industry: Major Implications for the Atmospheric Sciences." *Bulletin of the American Meteorological Society* 78, no. 3. 425-435. Accessed May 8, 2018. https://journals.ametsoc.org/doi/pdf/10.1175/1520-0477%281997%29078%3C0425%3AEORWEO%3E2.0.CO%3B2

2. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki, 2014. "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information." Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 8, 2018. nyserda.ny.gov/climaid

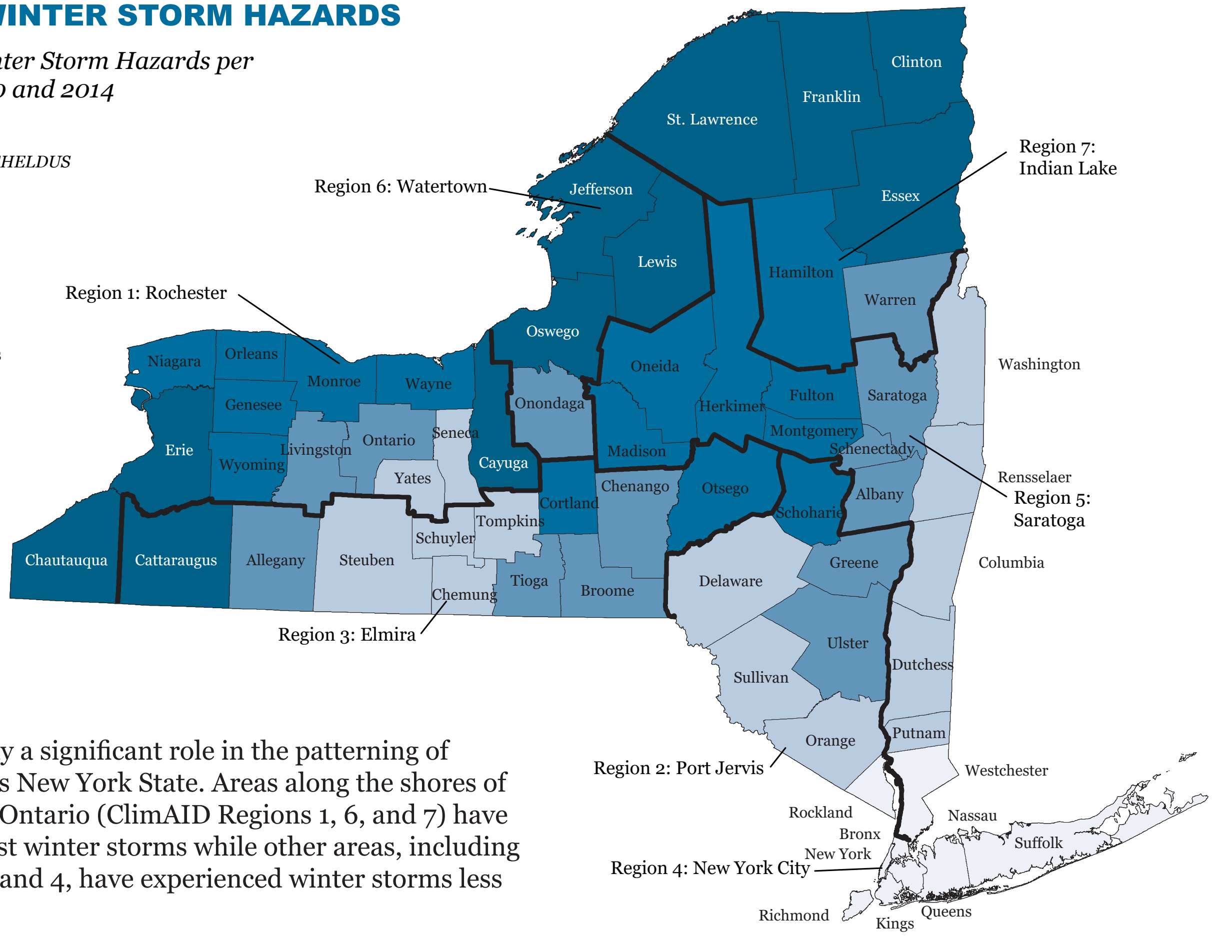
3. Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, and P. Grabhorn (Eds.). 2011. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation*. Albany, NY: New York State Energy Research and Development Authority (NYSERDA). Accessed May 8, 2018. nyserda.ny.gov/climaid

HISTORICAL WINTER STORM HAZARDS

Total Number of Winter Storm Hazards per County between 1960 and 2014

Data Source:
University of South Carolina SHELDUS

Legend:
- 52 - 66 Winter Storms
- 67 - 106 Winter Storms
- 107 - 128 Winter Storms
- 129 - 155 Winter Storms
- 156 - 195 Winter Storms



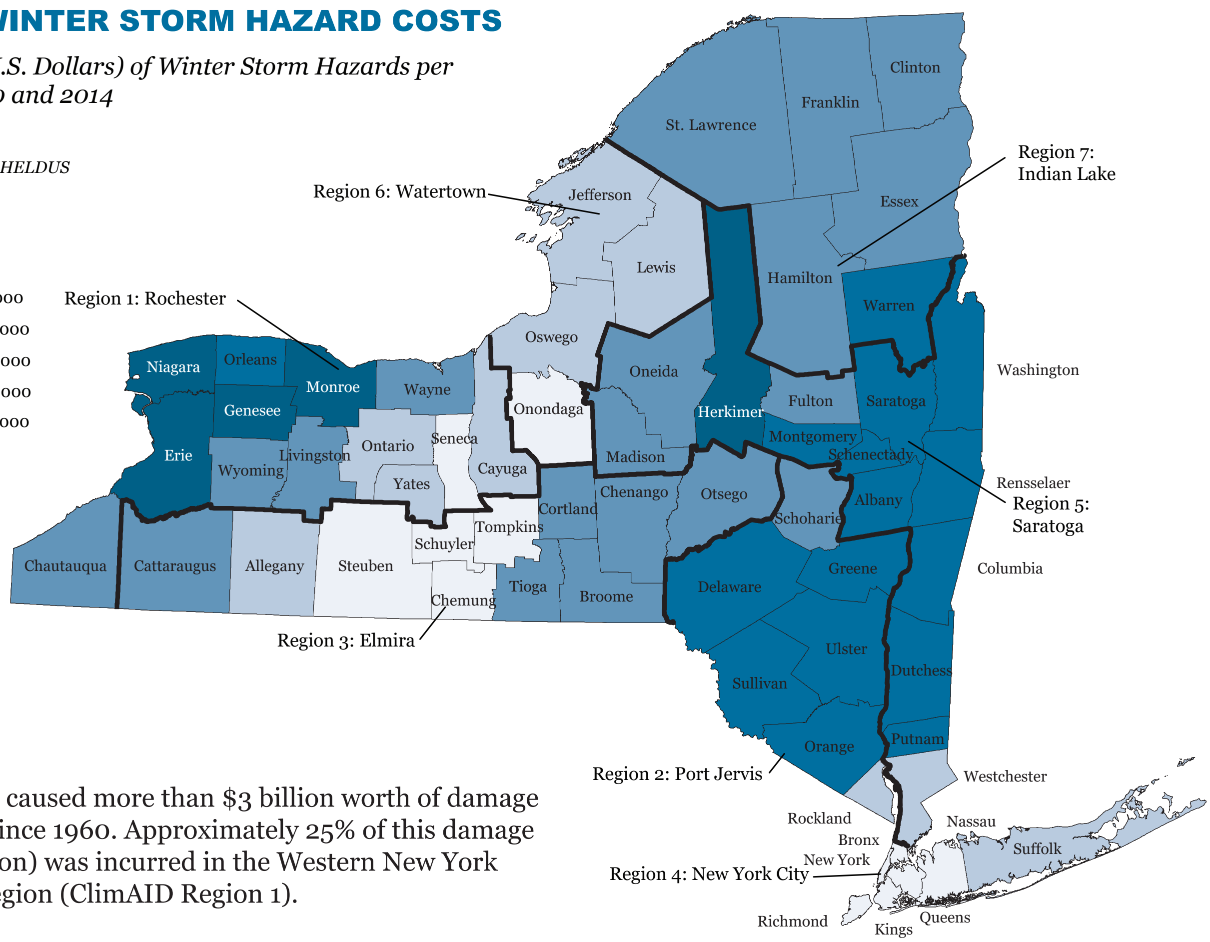
The Great Lakes play a significant role in the patterning of winter storms across New York State. Areas along the shores of Lake Erie and Lake Ontario (ClimAID Regions 1, 6, and 7) have experienced the most winter storms while other areas, including ClimAID Regions 2 and 4, have experienced winter storms less frequently.

HISTORICAL WINTER STORM HAZARD COSTS

Total Cost (in 2015 U.S. Dollars) of Winter Storm Hazards per County between 1960 and 2014

Data Source:
University of South Carolina SHELDUS

Legend:
- $5,600,000 - $23,000,000
- $23,000,001 - $42,500,000
- $42,500,001 - $60,000,000
- $60,000,001 - $82,500,000
- $82,500,001 - $98,500,000



Winter storms have caused more than $3 billion worth of damage in New York State since 1960. Approximately 25% of this damage (roughly $780 million) was incurred in the Western New York and Great Plains Region (ClimAID Region 1).

CURRENT DAYS UNDER 32°F

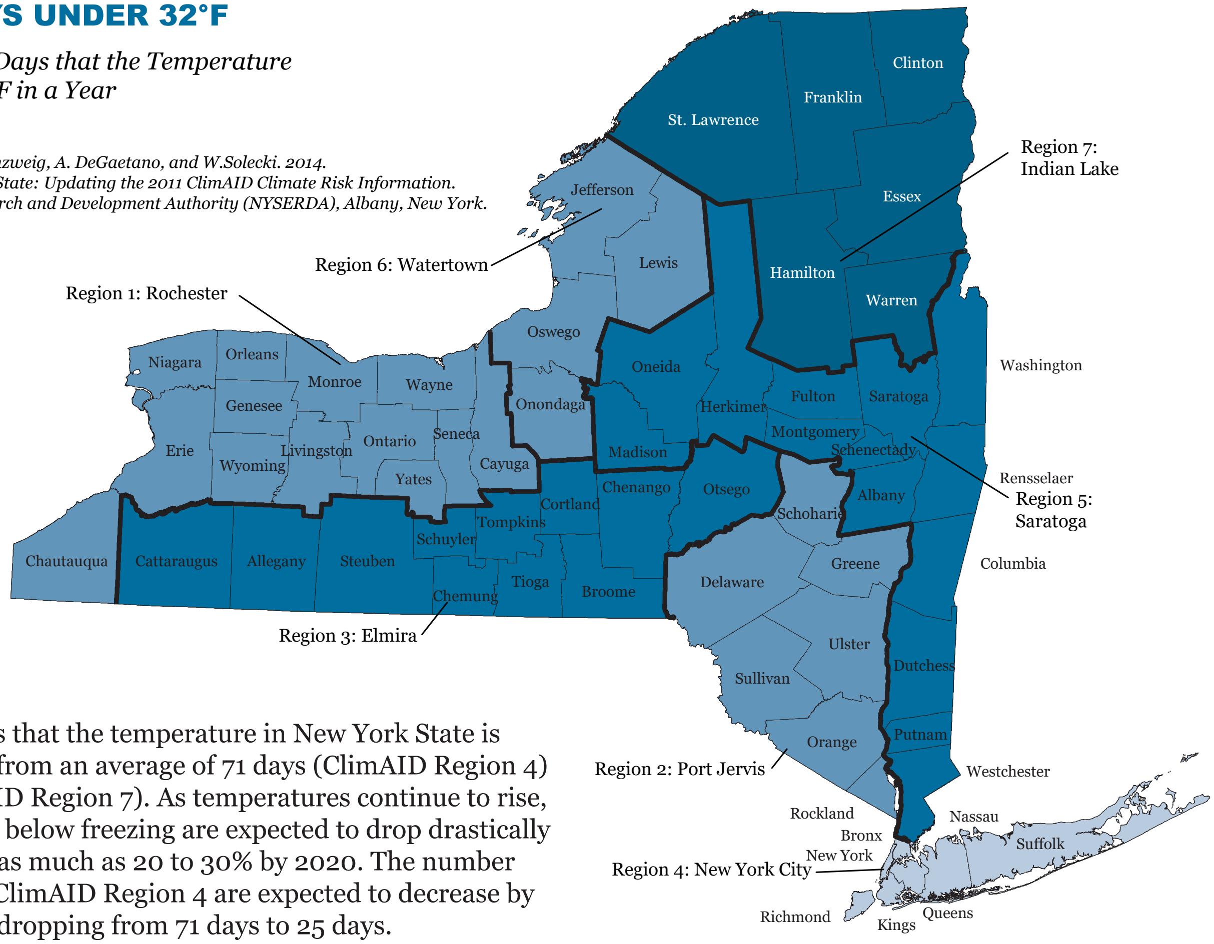
Average Number of Days that the Temperature Will Drop Below 32°F in a Year

Data Derived From:

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, New York.

Legend:

- < 69 days
- 70 - 109 days
- 110 - 149 days
- 150 - 189 days
- > 190 days



The number of days that the temperature in New York State is below 32°F ranges from an average of 71 days (ClimAID Region 4) to 193 days (ClimAID Region 7). As temperatures continue to rise, the number of days below freezing are expected to drop drastically across the State by as much as 20 to 30% by 2020. The number of freezing days in ClimAID Region 4 are expected to decrease by 65% by the 2080s, dropping from 71 days to 25 days.

FUTURE DAYS UNDER 32°F

ClimAID Region: City (Current Baseline)	2020s			2050s			2080s		
	Low	Middle	High	Low	Middle	High	Low	Middle	High
Region 1: Rochester (Average of 133 days/year)	99	103 to 111	116	78	84 to 96	102	59	68 to 88	97
Region 2: Port Jervis (Average of 138 days/year)	106	108 to 116	120	79	86 to 100	108	59	65 to 89	101
Region 3: Elmira (Average of 152 days/year)	119	122 to 130	134	94	100 to 114	120	72	79 to 103	116
Region 4: New York City (Average of 71 days/year)	50	52 to 58	60	37	42 to 48	52	25	30 to 42	49
Region 5: Saratoga (Average of 155 days/year)	123	127 to 136	139	98	104 to 119	125	77	84 to 109	120
Region 6: Watertown (Average of 147 days/year)	116	119 to 126	130	96	102 to 113	119	78	85 to 104	114
Region 7: Indian Lake (Average of 193 days/year)	159	162 to 172	177	131	138 to 154	161	107	118 to 143	156

DATA SOURCE

1. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki, 2014. "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information." Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 8, 2018. nyserda.ny.gov/climaid

Wildfire

HAZARD DESCRIPTION

Wildfires are the unplanned and unwanted burning of vegetation. They occur not only in forested or undeveloped areas, but also along the wildland-urban interface. Though they often begin unnoticed, they spread quickly and cause damage to thousands of acres in New York State every year. As extreme heat and droughts become more frequent and intense, drier conditions in the warmer months can lead to a growing threat of wildfires.[1]

HAZARD HISTORY IN NEW YORK STATE

According to the New York State Forest Ranger Force, over the past 25 years, rangers have suppressed 6,971 wildfires, which burned a total of 67,273 acres.[1] Areas with high concentrations of forested lands are the most susceptible to wildfires. With nearly two-thirds of the State's land acreage consumed by non-federal forested lands, most of New York falls within this range. Regions that are the most vulnerable include the Adirondacks, Catskills, Hudson Highlands, Shawangunk Ridge, and Long Island Pine Barrens (ClimAID Regions 4, 7, and 2). The wetlands of Western New York and the Southern Tier (ClimAID Regions 1 and 3) are open, non-forested lands that can burn in very dry conditions. These fires can quickly turn into wildland-urban interface fires, threatening the built environment.[1]

IMPACT ON BUILDINGS

Though wildfires can pose a serious threat to buildings and human safety, they tend to occur in areas with fewer structures. As a result, they have not caused the same level of damage to the built environment as other climate-related hazards. The most recent wildfire in New York State occurred in Suffolk County in the spring of 2013. That event burned approximately 1,240 acres in the Hamlet of Manorville, engulfing three homes in flames and damaging or destroying six other buildings.[1] As developments continue to encroach on the edge of forests and other natural lands, the potential for wildfire damage will likely increase in New York State.

ANTICIPATED CHANGES

As extended droughts and heat waves are projected to increase in New York State, wildfire hazards are likely to increase as well. An accumulation of fallen leaves and brush on forest floors, due to a lack of natural or controlled fires, now acts as potential fuel. Allowing periodic forest fires reduces the risk of devastating wildfires by eliminating excess underbrush and can make forest ecosystems healthier.[1]

REFERENCES

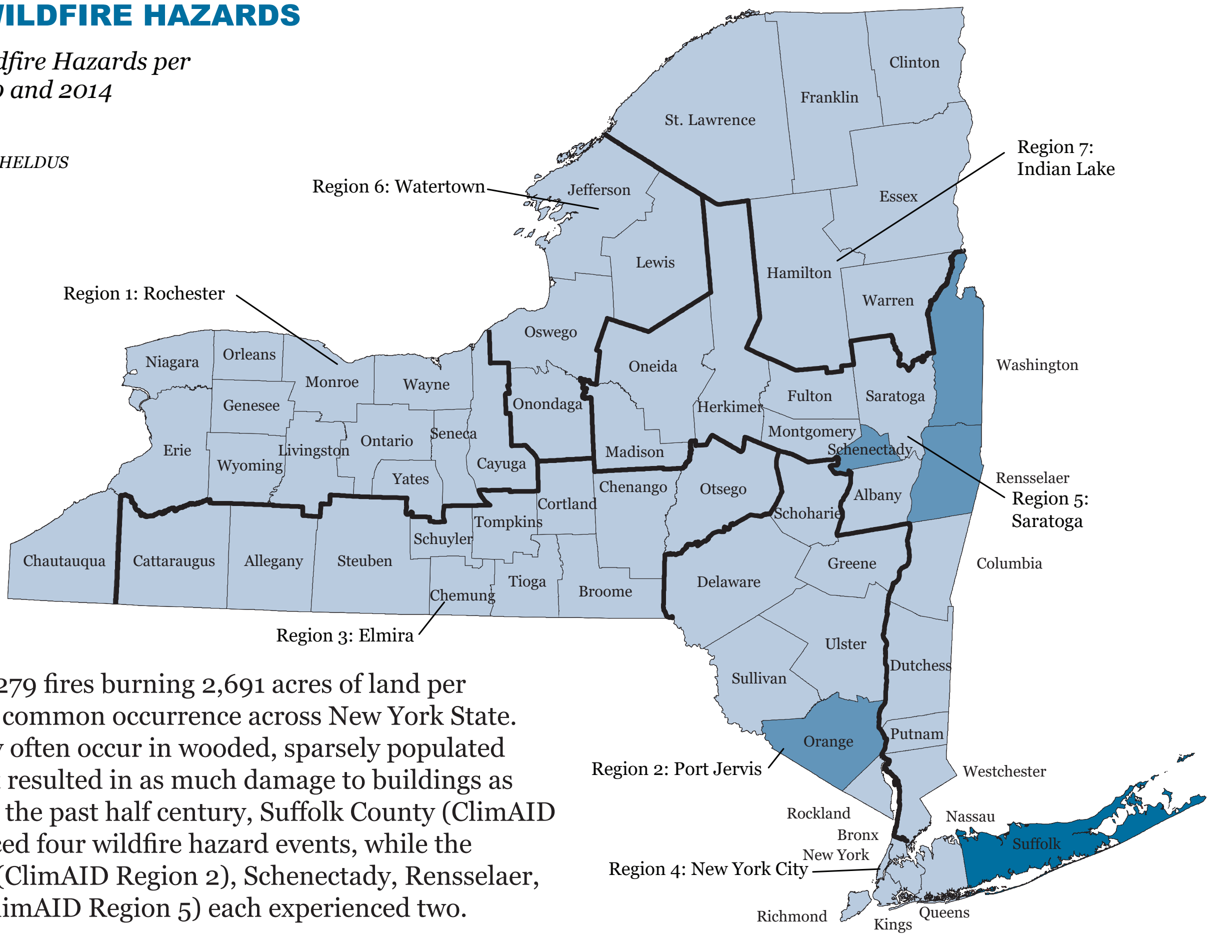
1. New York State Division of Homeland Security and Emergency Services. 2014. *NYS Standard Multi-Hazard Mitigation Plan (State Mitigation Plan) 2014*. NYSDHSES. Accessed May 9, 2018. http://www.dhses.ny.gov/recovery/mitigation/plan.cfm.

HISTORICAL WILDFIRE HAZARDS

Total Number of Wildfire Hazards per County between 1960 and 2014

Data Source:
University of South Carolina SHELDUS

Legend:
- 1 Wildfire
- 2 Wildfires
- 4 Wildfires



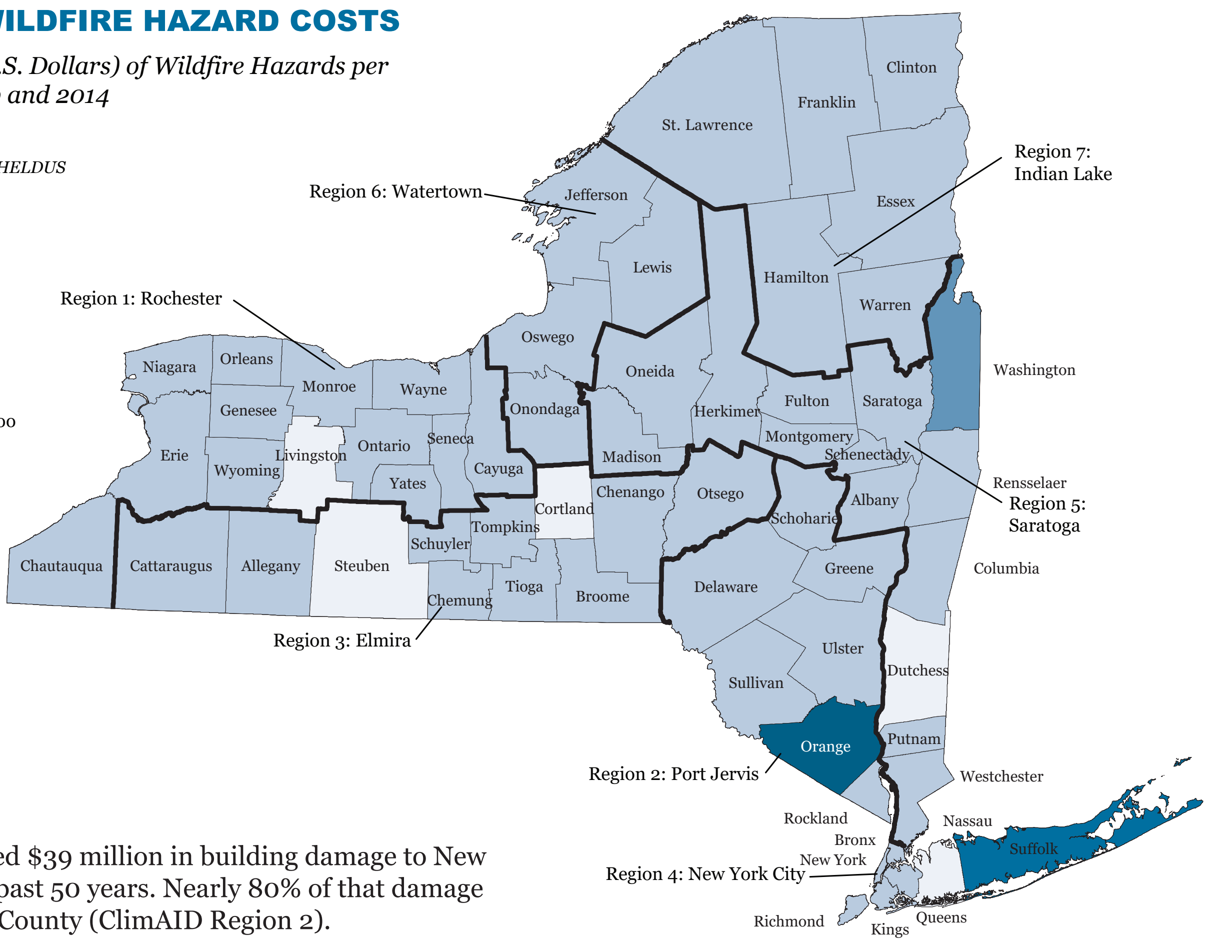
With an average of 279 fires burning 2,691 acres of land per year, wildfires are a common occurrence across New York State. However, since they often occur in wooded, sparsely populated areas, they have not resulted in as much damage to buildings as other hazards. Over the past half century, Suffolk County (ClimAID Region 4) experienced four wildfire hazard events, while the counties of Orange (ClimAID Region 2), Schenectady, Rensselaer, and Washington (ClimAID Region 5) each experienced two.

HISTORICAL WILDFIRE HAZARD COSTS

Total Cost (in 2015 U.S. Dollars) of Wildfire Hazards per County between 1960 and 2014

Data Source:
University of South Carolina SHELDUS

Legend:
- $0 - $32,000
- $32,001 - $70,000
- $70,001 - $190,000
- $190,001 - $4,600,00
- $4,600,001 - $30,700,000



Wildfires have caused $39 million in building damage to New York State over the past 50 years. Nearly 80% of that damage occurred in Orange County (ClimAID Region 2).

Sea Level Rise

HAZARD DESCRIPTION

As warming ocean waters expand, and glaciers and ice sheets melt, the threat of rising sea levels increases for coastal communities. Sea level rise can exacerbate risks from hurricanes and tropical storms. As such, the adaptation of homes, businesses, and infrastructure to the risk of inundation becomes crucial.[1]

HAZARD HISTORY IN NEW YORK STATE

Sea level rise associated with climate change will have a significant effect, not only on the coastal areas of New York State, but also on the areas along the tide-controlled Hudson River.[2] Communities along both sides of the river from Long Island and New York City to the Troy Dam, roughly 160 miles apart, are at risk from sea level rise. Currently, the rates of sea level rise on coastlines in the state range from 0.86 to 1.5 inches per decade, with an average of 1.2 inches per decade since 1900.[1] The observed change in sea level over the past century can be attributed to the expansion of warming oceans. However, melting of glaciers and ice sheets may become the dominant contributor to sea level rise during this century.[1] Due to its coastal location, ClimAID Region 4 is the most vulnerable to sea level rise. Damage from sea level rise has the potential to be significant, mainly because New York City and Long Island contain 51.1% of the State's building stock and 57.5% of the State's total building value.[3]

IMPACT ON BUILDINGS

Sea level rise may continue to threaten vulnerable homes, businesses, and infrastructure in all coastal areas.[2] Most of the infrastructure that protects coastal areas, including levees and seawalls, has been designed for current sea levels and may be overtopped by rising water levels or undermined by increased erosion in the future.[2] Similarly, gray infrastructure may become overwhelmed as water levels exceed their design capacity. Sea level rise increases the threat of flooding and water damage to buildings and operation systems. One strategy for adaptation to this climate hazard could be to retreat away from the coastline and develop new communities farther inland. Another adaptation strategy is to retrofit existing buildings so that their lowest level and building systems are above the base flood elevation (BFE).

ANTICIPATED CHANGES

Sea level along the coast and the Hudson River (ClimAID Regions 2, 4, and 5) is projected to rise 3 to 8 inches by the 2020s, 9 to 21 inches by the 2050s, and 14 to 39 inches by the 2080s. The high-end projection, which correlates with the rapid ice-melt scenario, is an estimated sea level rise of 58 inches by the 2080s.[4] As such, sea level rise not only affects communities along the coast, but can potentially affect areas such as Troy and Albany. In the long term, rising sea levels may cause permanent inundation in areas currently occupied by buildings.[2] They can also exacerbate the effects of storm surges, increasing the risk associated with of coastal flooding events.[1]

REFERENCES

1. Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, and P. Grabhorn (Eds.). 2011. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation.* Albany, NY: New York State Energy Research and Development Authority (NYSERDA). Accessed May 9, 2018. nyserda.ny.gov/climaid

2. New York State Division of Homeland Security and Emergency Services. 2014. *NYS Standard Multi-Hazard Mitigation Plan (State Mitigation Plan) 2014.* NYSDHSES. Accessed May 8, 2018. http://www.dhses.ny.gov/recovery/mitigation/plan.cfm

3. Federal Emergency Management Agency. "HAZUS-MH Software." FEMA. Available at https://www.fema.gov/hazus

4. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki. 2014. "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information." Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 9, 2018. nyserda.ny.gov/climaid

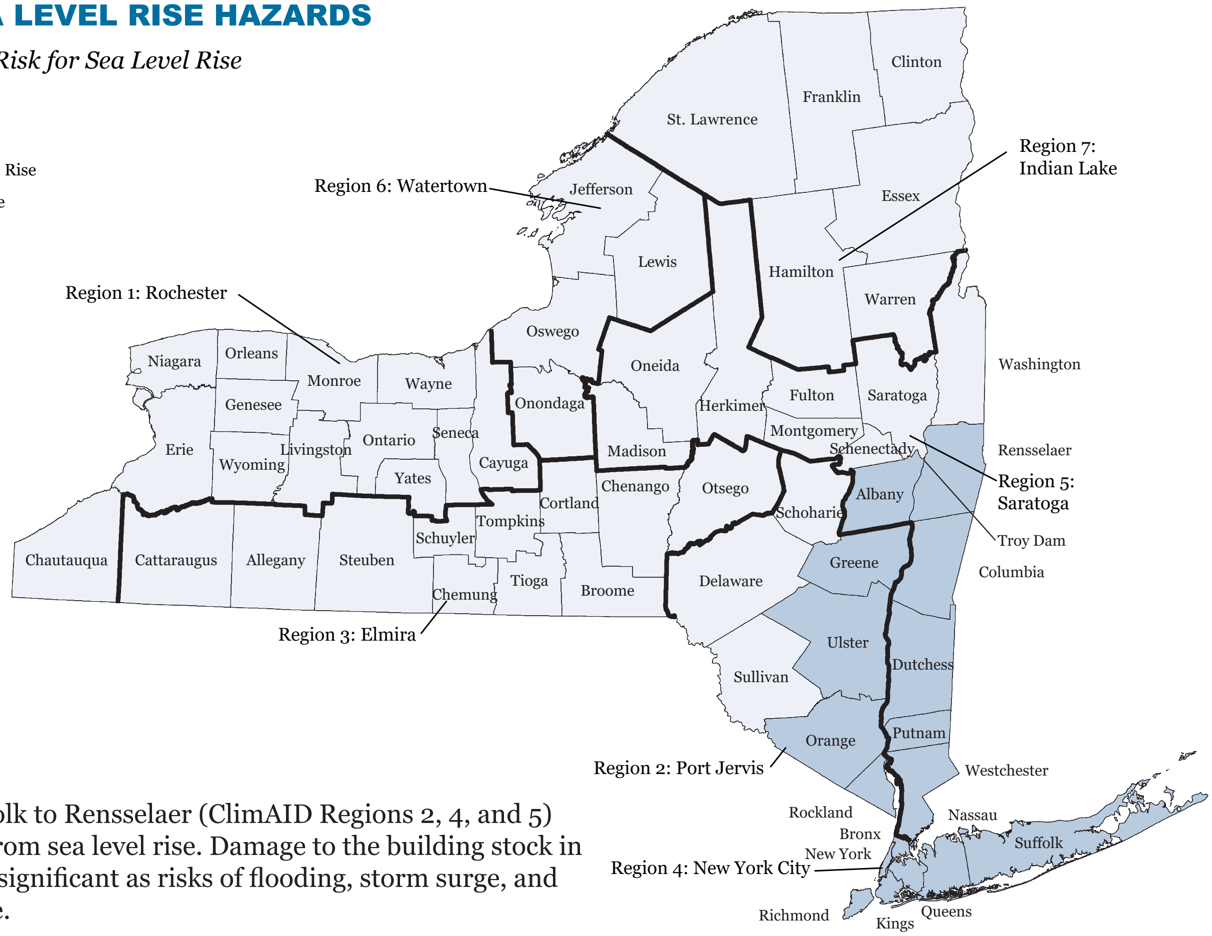
CURRENT SEA LEVEL RISE HAZARDS

Current Counties at Risk for Sea Level Rise

Legend:

Not Subject to Sea Level Rise

Subject to Sea Level Rise



Counties from Suffolk to Rensselaer (ClimAID Regions 2, 4, and 5) are at serious risk from sea level rise. Damage to the building stock in these areas may be significant as risks of flooding, storm surge, and inundation increase.

DATA SOURCE

1. New York State Energy Research and Development Authority. 2016. "Coastal New York Future Floodplain Mapper." Albany, New York: NYSERDA. Accessed May 9, 2018. https://www.nyclimatescience.org/catalog/doc?DocId=vitroIndividual:http://www.nyclimatescience.org/individual/n30129.

FUTURE SEA LEVEL RISE HAZARDS (INCHES)

ClimAID Region (Analyzed City)	2020s			2050s			2080s		
	Low	Middle	High	Low	Middle	High	Low	Middle	High
Region 4 (at New York City)	2	4 to 8	10	8	11 to 21	30	13	18 to 39	58
Regions 2 and 5 (at Troy Dam)	1	3 to 7	9	5	9 to 19	27	10	14 to 36	54

DATA SOURCE

1. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki, 2014. "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information." Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 8, 2018. nyserda.ny.gov/climaid

Heat Waves

HAZARD DESCRIPTION

Prolonged periods of hot weather are projected to become more frequent and intense in New York State. Excessive heat can create stresses on human populations, including heat-related illness and death. Heat waves also pose new challenges to energy systems, air quality, infrastructure, and buildings.[1]

HAZARD HISTORY IN NEW YORK STATE

Temperatures are warming across New York State at an average rate of 0.25°F per decade, which increases the potential for extreme heat events.[2] Areas in ClimAID Region 7 of New York State experienced the most extreme temperature events between 1960 and 2014; however, ClimAID Region 4 experienced a significant spike in the number of events since 2010.[3] The increase in extreme temperature events can be partially attributed to the urban heat island effect, which has a localized impact on ground surface and air temperatures. Geography including land elevation, character of the landscape, and proximity to bodies of water, plays a significant role in the urban heat island effect and the temperatures experienced by the State as a whole. New York State's geography and atmospheric circulation conditions make all regions of the State susceptible to heat waves.[4]

IMPACT ON BUILDINGS

Though heat waves do not generally cause physical damage to buildings, they can stress energy systems and reduce air quality. Buildings without air-conditioning or other cooling strategies can increase exposure to high temperatures, putting occupants at risk of heat-related illnesses and death. Strategies related to building ventilation, insulation, and window shading can help keep indoor environments cool during periods of extreme heat.[4]

ANTICIPATED CHANGES

The average annual temperatures across New York State are projected to increase by as much as 10°F by the 2080s, with the most warming occurring in the northern parts of the State (including ClimAID Regions 6 and 7). New York City is projected to have between 24 and 33 days over 90°F and three to four heat waves by the 2020s, 32 to 57 days over 90°F and four to seven heat waves by the 2050s, and 38 to 87 days over 90°F and five to nine heat waves by the 2080s. Data collected between 1971 and 2000 show baselines of 18 days over 90°F and two heat waves for New York City.[2] High temperatures can also contribute to other types of extreme events such as drought or wildfire.[5]

REFERENCES

1. Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, and P. Grabhorn (Eds.). 2011. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation*. Albany, NY: New York State Energy Research and Development Authority (NYSERDA). Accessed May 9, 2018. nyserda.ny.gov/climaid.

2. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki, 2014. "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information." Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 9, 2018. nyserda.ny.gov/climaid.

3. University of South Carolina. 2016. "Spatial Hazard Events and Losses Database for the United States (SHELDUS)." Hazards and Vulnerability Research Institute. Accessed May 9, 2018. http://hvri.geog.sc.edu/SHELDUS/.

4. New York State Division of Homeland Security and Emergency Services. 2014. *NYS Standard Multi-Hazard Mitigation Plan (State Mitigation Plan) 2014*. NYSDHSES. Accessed May 9, 2018. http://www.dhses.ny.gov/recovery/mitigation/plan.cfm.

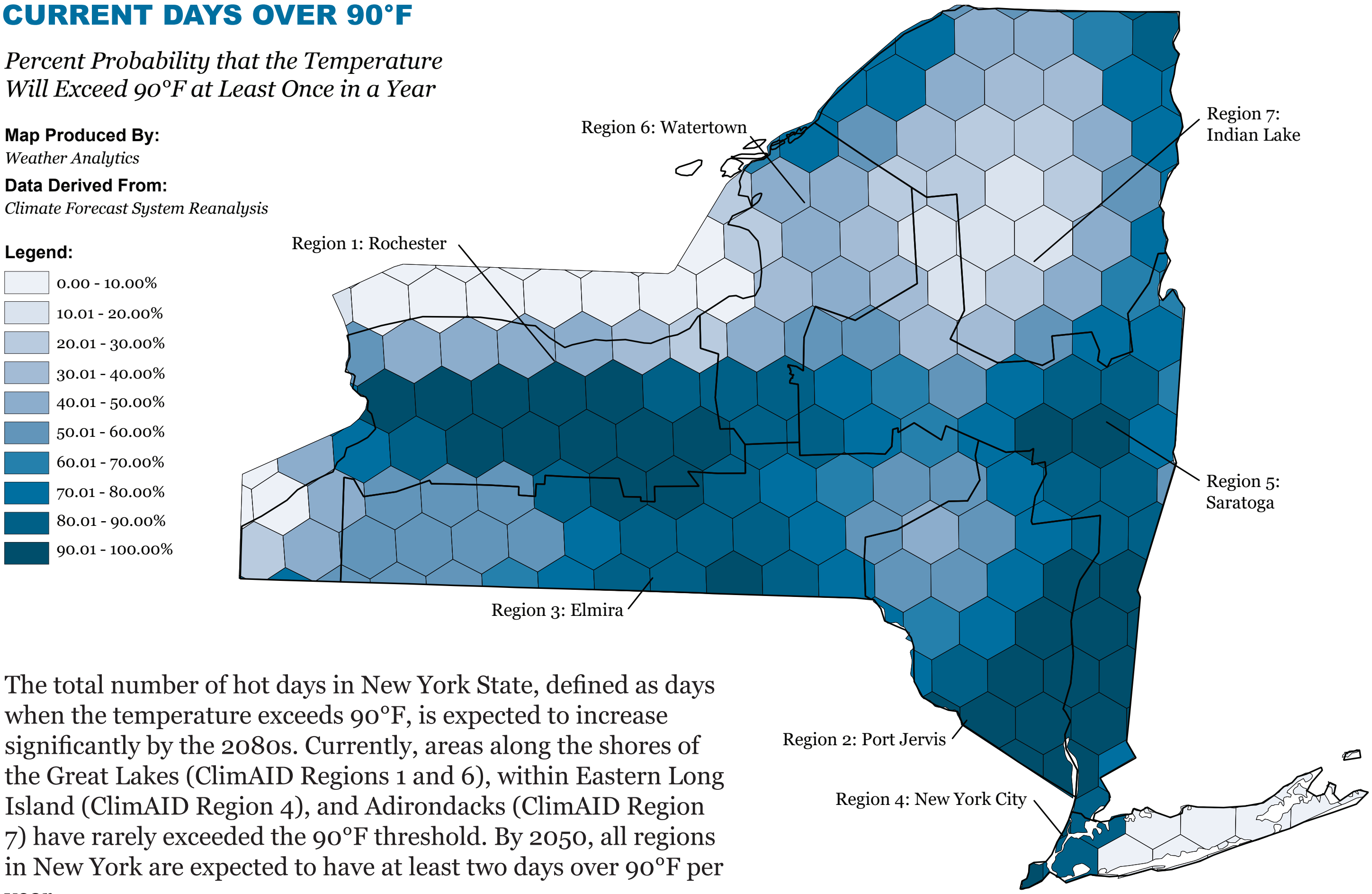
5. National Academies of Sciences, Engineering, and Medicine. 2016. *Attribution of Extreme Weather Events in the Context of Climate Change*. National Academies Press. Accessed May 9, 2018. https://www.ncdc.noaa.gov/billions/mapping.

CURRENT DAYS OVER 90°F

Percent Probability that the Temperature Will Exceed 90°F at Least Once in a Year

Map Produced By:
Weather Analytics

Data Derived From:
Climate Forecast System Reanalysis



The total number of hot days in New York State, defined as days when the temperature exceeds 90°F, is expected to increase significantly by the 2080s. Currently, areas along the shores of the Great Lakes (ClimAID Regions 1 and 6), within Eastern Long Island (ClimAID Region 4), and Adirondacks (ClimAID Region 7) have rarely exceeded the 90°F threshold. By 2050, all regions in New York are expected to have at least two days over 90°F per year.

FUTURE DAYS OVER 90°F

ClimAID Region: City (Current Baseline)	2020s			2050s			2080s		
	Low	Middle	High	Low	Middle	High	Low	Middle	High
Region 1: Rochester (Average of 8 days/year)	12	14 to 17	19	18	22 to 34	42	22	27 to 57	73
Region 2: Port Jervis (Average of 12 days/year)	16	19 to 25	27	24	31 to 47	56	31	38 to 77	85
Region 3: Elmira (Average of 10 days/year)	15	17 to 21	23	22	26 to 41	47	28	33 to 67	79
Region 4: New York City (Average of 18 days/year)	24	26 to 31	33	32	39 to 52	57	38	44 to 76	87
Region 5: Saratoga (Average of 10 days/year)	14	17 to 22	23	22	27 to 41	50	27	35 to 70	82
Region 6: Watertown (Average of 3 days/year)	5	6 to 8	10	9	12 to 21	26	12	17 to 44	57
Region 7: Indian Lake (Average of 0.3 days/year)	0.5	0.8 to 2	2	2	3 to 6	10	3	5 to 19	27

DATA SOURCE

1. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki, 2014. "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information." Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 8, 2018. nyserda.ny.gov/climaid.

CURRENT HEAT WAVE PROBABILITY

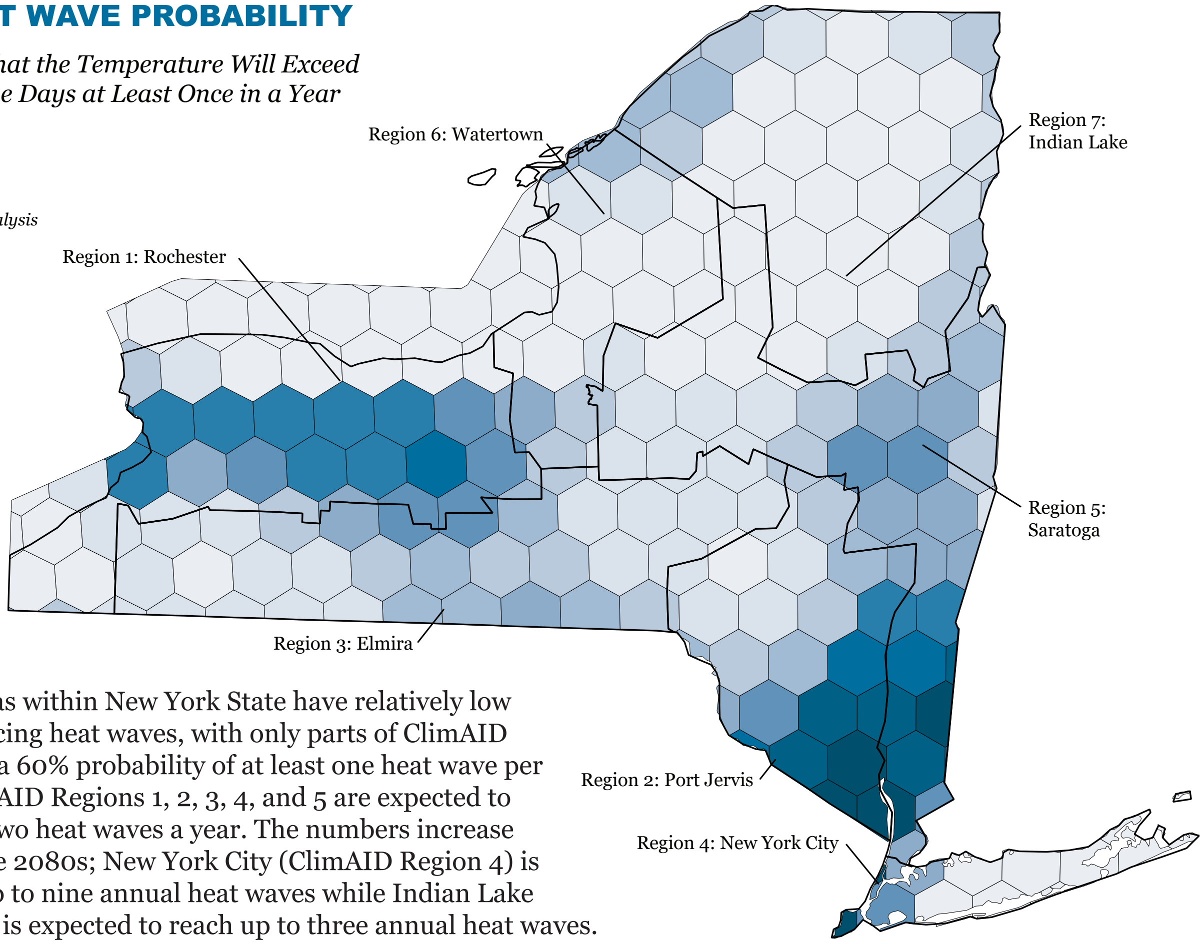
Percent Probability that the Temperature Will Exceed 90°F for 3 Consecutive Days at Least Once in a Year

Map Produced By:
Weather Analytics

Data Derived From:
Climate Forecast System Reanalysis

Legend:

- 0.00 - 7.60%
- 7.61 - 15.10%
- 15.11 - 22.70%
- 22.71 - 30.30%
- 30.31 - 37.80%
- 37.81 - 45.40%
- 45.41 - 53.00%
- 53.01 - 60.50%
- 60.51 - 68.10%
- 68.11 - 75.70%



Currently, most areas within New York State have relatively low chances of experiencing heat waves, with only parts of ClimAID Region 2 exceeding a 60% probability of at least one heat wave per year. By 2020, ClimAID Regions 1, 2, 3, 4, and 5 are expected to experience at least two heat waves a year. The numbers increase in each region by the 2080s; New York City (ClimAID Region 4) is expected to reach up to nine annual heat waves while Indian Lake (ClimAID Region 7) is expected to reach up to three annual heat waves.

FUTURE NUMBER OF HEAT WAVES

ClimAID Region: City (Current Baseline)	2020s			2050s			2080s		
	Low	Middle	High	Low	Middle	High	Low	Middle	High
Region 1: Rochester (Currently 0.7 per year)	2	2 to 2	2	2	3 to 4	5	3	3 to 8	8
Region 2: Port Jervis (Currently 1 per year)	2	3 to 3	4	3	4 to 6	8	4	5 to 9	9
Region 3: Elmira (Currently 1 per year)	2	2 to 3	3	3	3 to 6	6	3	4 to 9	9
Region 4: New York City (Currently 2 per year)	3	3 to 4	4	4	5 to 7	7	5	6 to 9	9
Region 5: Saratoga (Currently 1 per year)	2	2 to 3	4	3	4 to 6	7	4	5 to 8	9
Region 6: Watertown (Currently 0.2 per year)	0.6	0.8 to 0.9	1	1	1 to 3	3	1	2 to 6	7
Region 7: Indian Lake (Currently 0 per year)	0	0.1 to 0.2	0.2	0.2	0.3 to 0.7	1	0.2	0.5 to 2	3

DATA SOURCE

1. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki, 2014. "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information." Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 8, 2018. nyserda.ny.gov/climaid

CURRENT DURATION OF HEAT WAVES

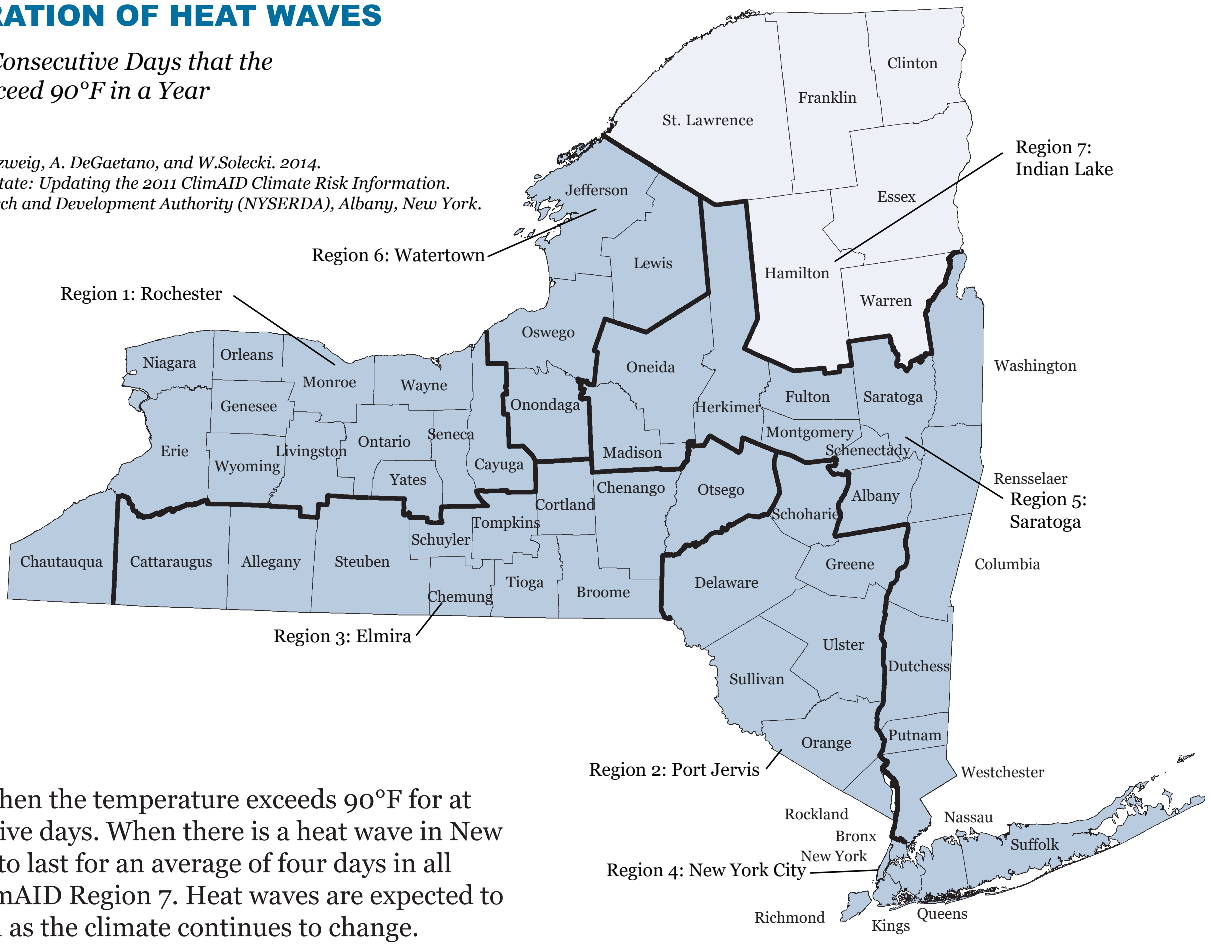
Average Number of Consecutive Days that the Temperature Will Exceed 90°F in a Year

Data Derived From:

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, New York.

Legend:

- 3 days
- 4 days



Heat waves occur when the temperature exceeds 90°F for at least three consecutive days. When there is a heat wave in New York State, it tends to last for an average of four days in all areas except for ClimAID Region 7. Heat waves are expected to increase in duration as the climate continues to change.

FUTURE DURATION OF HEAT WAVES

ClimAID Region: City (Current Baseline)	2020s			2050s			2080s		
	Low	Middle	High	Low	Middle	High	Low	Middle	High
Region 1: Rochester (Average of 4 days)	4	4 to 4	4	4	4 to 5	5	4	5 to 6	6
Region 2: Port Jervis (Average of 4 days)	4	5 to 5	5	5	5 to 6	6	5	5 to 7	8
Region 3: Elmira (Average of 4 days)	4	4 to 5	5	5	5 to 5	5	5	5 to 6	7
Region 4: New York City (Average of 4 days)	5	5 to 5	5	5	5 to 6	6	5	5 to 7	8
Region 5: Saratoga (Average of 4 days)	4	5 to 5	5	5	5 to 6	6	5	5 to 7	9
Region 6: Watertown (Average of 4 days)	3	4 to 4	4	4	4 to 4	5	4	4 to 6	6
Region 7: Indian Lake (Average of 3 days)	3	3 to 4	4	3	3 to 4	4	4	4 to 5	5

DATA SOURCE

1. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki, 2014. "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information." Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 8, 2018. nyserda.ny.gov/climaid

Pest Infestation

HAZARD DESCRIPTION

Rising temperatures may contribute to an increase in pests and invasive species. Pests and invasive species can cause disruptions to ecosystems and the agricultural sector, as well as increased exposure to infectious diseases.[1] Without the right adaptation measures, such as integrated pest management strategies, pest control can turn into a dangerous cycle in which the response exacerbates the issues. For instance, if harsh pesticides are used on pests, these control measures might unintentionally kill beneficial insects, such as pollinators.

HAZARD HISTORY IN NEW YORK STATE

Climate change caused a fluctuation in seasonal timings of migration and budding, and in the range of species in the Northern Hemisphere. This shift in range can be seen in ClimAID Region 1, where the emerald ash borer caused significant damage to the urban tree canopy.[1]

IMPACT ON BUILDINGS

Warmer temperatures and the introduction of non-native species may lead to changes in the use of pesticides and other pest management systems.[1] Higher temperatures can lead to building damage as insects and other pests increasingly use wood and other common building materials as food and shelter. In addition, trees weakened by pests, like the emerald ash borer, are more susceptible to wind damage, increasing the likelihood that trees might fall on buildings or disrupt electrical lines.[3]

ANTICIPATED CHANGES

By 2100, New York State's climate may resemble the one currently found in the Southeastern United States.[2] Environmental and ecological constraints prevented certain species from surviving or thriving in New York State in the past,[1] but changes in temperature and precipitation may allow some invasive species to migrate northward.[4]

REFERENCES

1. Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, and P. Grabhorn (Eds.). 2011. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation*. Albany, NY: New York State Energy Research and Development Authority (NYSERDA). Accessed May 9, 2018. nyserda.ny.gov/climaid

2. New York State Division of Homeland Security and Emergency Services. 2014. *NYS Standard Multi-Hazard Mitigation Plan (State Mitigation Plan) 2014*. NYSDHSES. Accessed May 9, 2018. http://www.dhses.ny.gov/recovery/mitigation/plan.cfm.

3. Horton, R., D. Bader, C. Rozenzweig, A.T. DeGaetano, W. and Solecki, 2014. "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information." Albany, New York: New York State Energy Research and Development Authority (NYSERDA). Accessed May 9, 2018. nyserda.ny.gov/climaid

4. Leichenko, R., D. Major, K. Johnson, L. Patrick, and M. O'Grady. 2011. "An Economic Analysis of Climate Change Impacts and Adaptations in New York State." In *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation.* Edited by Albany, NY: New York State Energy Research and Development Authority (NYSERDA). 501-649. Accessed May 9, 2018. nyserda.ny.gov/climaid

NYSERDA, a public benefit corporation, offers objective information and analysis, innovative programs, technical expertise, and support to help New Yorkers increase energy efficiency, save money, use renewable energy, and reduce reliance on fossil fuels. NYSERDA professionals work to protect the environment and create clean-energy jobs. NYSERDA has been developing partnerships to advance innovative energy solutions in New York State since 1975.

To learn more about NYSERDA's programs and funding opportunities, visit nyserda.ny.gov or follow us on Twitter, Facebook, YouTube, or Instagram.

The University at Buffalo School of Architecture and Planning is guided by a culture of experimentation, a core belief in learning by doing, and a spirit of public service and inclusion. The school has shown that design and planning are agents of change for community, place, culture, social justice and the natural world since 1969.

University of Buffalo
School of Architecture and Planning

121 Hayes Hall
Buffalo, NY 14214-8030

local: 716-829-5900
fax: 716-829-2297

ap-info@buffalo.edu
ap.buffalo.edu

New York State
Energy Research and
Development Authority

17 Columbia Circle
Albany, NY 12203-6399

toll free: 866-NYSERDA
local: 518-862-1090
fax: 518-862-1091

info@nyserda.ny.gov
nyserda.ny.gov