Hell and High Water: Climate Change Effects in the Empire State

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New York State Department of Environmental Conservation

- State Sea Level Rise Task Force
  - http://www.dec.ny.gov/docs/administration_pdf/slrtffinalrep.pdf
- State Climate Action Plan Interim Report
  - http://www.dec.ny.gov/energy/80930.html
- ClimAID
  - http://www.nyserda.ny.gov/climaid
- State Interagency Task Force on Adaptation
- Governor's Conference on Emergency Preparedness – Oct. 29-30
  - http://prepare-conference.ny.gov/prepare/agenda.cfm

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Responding to Climate Change in New York State

The ClimAID Integrated Assessment for Effective Climate Change Adaptation Strategies

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and the ClimAID Team

NYSERDA

CENTER FOR CLIMATE SYSTEMS RESEARCH
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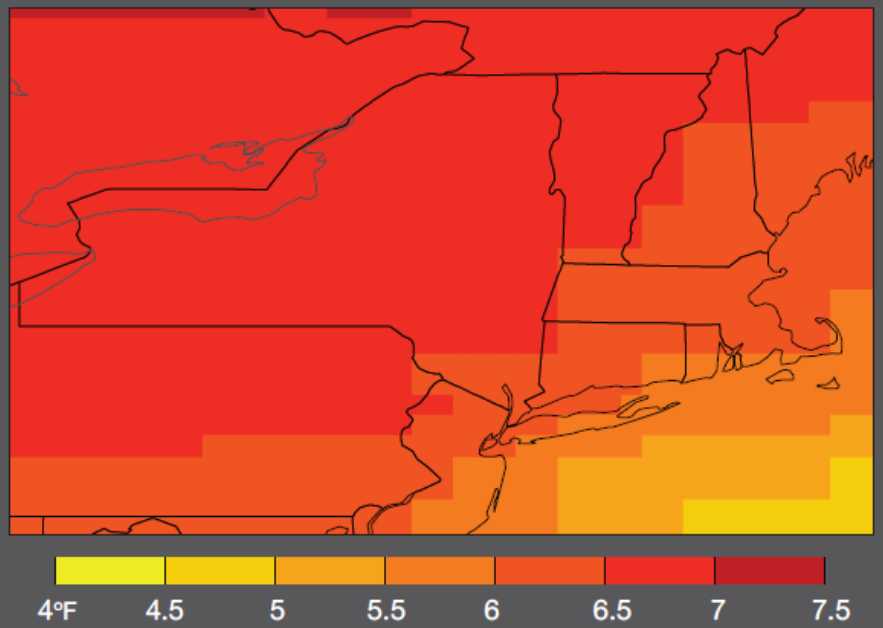
Cornell University

The INSTITUTE for SUSTAINABLE CITIES
CITY UNIVERSITY OF NEW YORK

New York State Climate Regions

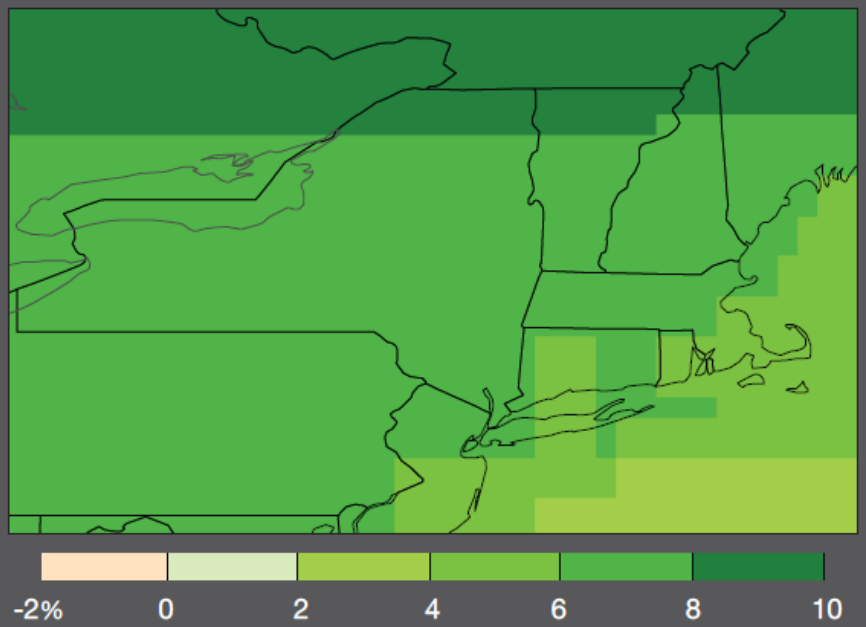
Integrating Mechanisms Climate

Projected Annual Temperature Change, 2080s (ºF)



Average annual temperatures are projected to increase by 4.0 to 9.0ºF by the 2080s, with the lower end of this range projected under lower greenhouse gas emissions scenarios and the higher end under higher emissions scenarios. A mid-range emissions scenario, A1B, was used for the maps above, yielding temperature increases of about 7ºF for most of the state. The A1B trajectory is associated with relatively rapid increases in emissions for the first half of this century, followed by a gradual decrease in emissions after 2050.

Projected Annual Precipitation Change, 2080s (%)



Precipitation across New York State may increase by approximately 5 to 15 percent by the 2080s, with the greatest increases in the northern parts of the state. Much of this additional precipitation may occur during the winter months as rain, while late summer and early fall precipitation could decline slightly. Both maps show the average across 16 global climate models.

Integrating Mechanisms Climate

		Baseline[1] 1971–2000	2020s	2050s	2080s
Region 1					
Stations used for Region 1 are Buffalo, Rochester, Geneva and Fredonia.	Air temperature[2]	48°F	+1.5 to 3.0°F	+3.0 to 5.5°F	+4.5 to 8.5°F
	Precipitation	37 in	0 to +5%	0 to +10%	0 to 15%
Region 2					
Stations used for Region 2 are Mohonk Lake, Port Jervis, and Walton.	Air temperature[2]	48°F	+1.5 to 3.0°F	+3.0 to 5.0°F	+4.0 to 8.0°F
	Precipitation	48 in	0 to +5%	0 to +10%	+5 to 10%
Region 3					
Stations used for Region 3 are Elmira, Cooperstown, and Binghamton.	Air temperature[2]	46°F	2.0 to 3.0°F	+3.5 to 5.5°F	+4.5 to 8.5°F
	Precipitation	38 in	0 to +5%	0 to +10%	+5 to 10%
Region 4					
Stations used for Region 4 are New York City (Central Park and LaGuardia Airport), Riverhead, and Bridgehampton.	Air temperature[2]	53°F	+1.5 to 3.0°F	+3.0 to 5.0°F	+4.0 to 7.5°F
	Precipitation	47 in	0 to +5%	0 to +10%	+5 to 10%
Region 5					
Stations used for Region 5 are Utica, Yorktown Heights, Saratoga Springs, and the Hudson Correctional Facility.	Air temperature[2]	50°F	+1.5 to 3.0°F	+3.0 to 5.5°F	+4.0 to 8.0°F
	Precipitation	51 in	0 to +5%	0 to +5%	+5 to 10%
Region 6					
Stations used for Region 6 are Boonville and Watertown.	Air temperature[2]	44°F	+1.5 to 3.0°F	+ 3.5 to 5.5°F	+4.5 to 9.0°F
	Precipitation	51 in	0 to +5%	0 to +10%	+5 to 15%
Region 7					
Stations used for Region 7 are Wanakena, Indian Lake, and Peru.	Air temperature[2]	42°F	+1.5 to 3.0°F	+3.0 to 5.5°F	+4.0 to 9.0°F
	Precipitation	39 in	0 to +5%	0 to +5%	+5 to 15%

Integrating Mechanisms Climate

Rochester (Region 1): Full range of changes in extreme events: minimum, (central range*), and maximum					
	Extreme event	Baseline	2020s	2050s	2080s
Heat Waves & Cold Events	Number of days per year with maximum temperature exceeding				
	90°F	8	8 (10 to 17) 23	12 (17 to 30) 44	16 (22 to 52) 68
	95°F	0.8	0.9 (2 to 4) 6	2 (3 to 9) 17	3 (6 to 22) 38
	Number of heat waves per year[2]	0.8	0.9 (1 to 2) 3	2 (2 to 4) 6	2 (3 to 7) 8
	average duration	4	4 (4 to 4) 5	4 (4 to 5) 5	4 (4 to 5) 7
	Number of days per year with min. temp. at or below 32°F	133	99 (104 to 116) 126	76 (90 to 103) 108	53 (75 to 97) 106
Intense Precipitation	Number of days per year with rainfall exceeding:				
	1 inch	5	3 (4 to 5) 6	3 (4 to 6) 7	3 (4 to 6) 7
	2 inches	0.6	0.4 (0.5 to 0.7) 0.9	0.3 (0.5 to 0.8) 1	0.2 (0.5 to 1) 1

Port Jervis (Region 2): Full range of changes in extreme events: minimum, (central range*), and maximum					
	Extreme event	Baseline	2020s	2050s	2080s
Heat Waves & Cold Events	Number of days per year with maximum temperature exceeding				
	90°F	12	13 (14 to 24) 34	16 (22 to 40) 53	21 (28 to 65) 75
	95°F	2	2 (2 to 5) 10	3 (5 to 12) 20	4 (7 to 28) 39
	Number of heat waves per year[2]	2	2 (2 to 3) 5	2 (3 to 5) 7	3 (4 to 9) 10
	average duration	4	4 (4 to 5) 5	5 (5 to5) 6	5 (5 to 6) 8
	Number of days per year with min. temp. at or below 32°F	138	101 (111 to 121) 128	70 (91 to 111) 115	57 (70 to 101) 112
Intense Precipitation	Number of days per year with rainfall exceeding:				
	1 inch	12	10 (11 to 13) 14	10 (12 to 14) 14	10 (12 to 14) 15
	2 inches	2	1 (2 to 2) 3	1 (2 to 3) 3	1 (2 to 3) 3

Integrating Mechanisms Climate

Projected Sea Level Rise for New York State (inches)

Modeled Sea Level Rise	2020s	2050s	2080s
GCM-based	+1 to +5	+5 to +12	+8 to +23
Rapid Ice Melt Scenario	+4 to +10	+17 to +29	+37 to +55

Changes in extreme events

- Projected increase in heat wave occurrence and magnitude
- Observed and projected increases in heavy rainfall
- Projected increases in short-term summer drought

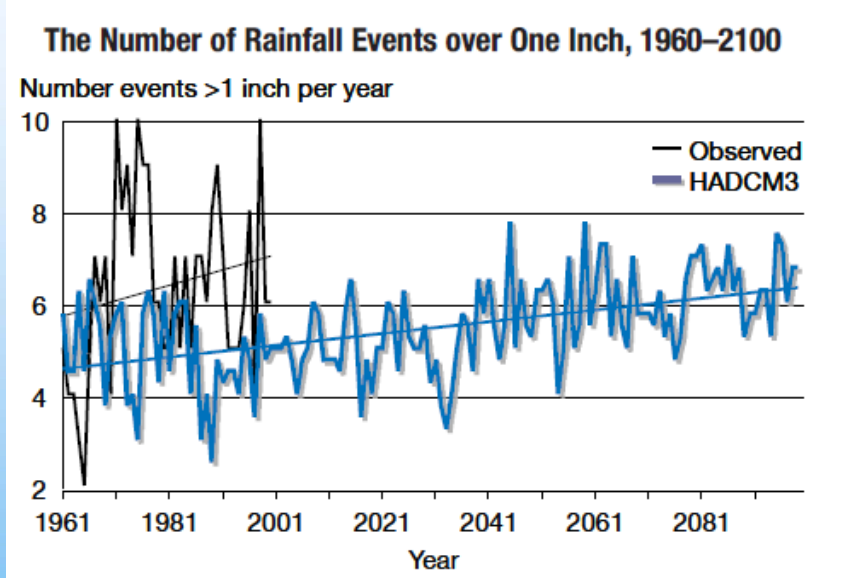
Recommendations Stakeholders

- ✓ Integrate adaptation with everyday operations
  - Assess potential for complementary effects
  - Be aware of unintended consequences
- ✓ Evaluate design and performance standards and regulations
  - Consider up-to-date climate projections
- ✓ Identify partnership opportunities
  - Within New York State and more broadly
- ✓ Specific effects, case studies and recommendations:

Agriculture	Coastal Zones	Ecosystems
Energy	Public Health	Telecommunications
Transportation	Water Resources	

Water Resources Key Climate Impacts

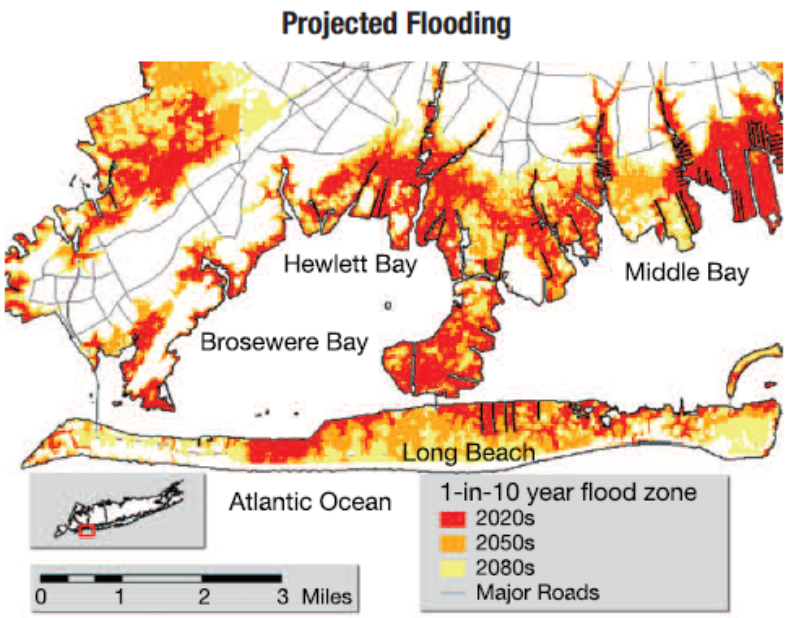
- ✓ Heavy rainfall has increased over the last 50 years
  - Trend projected to continue
  - Localized flash flooding
- ✓ Flooding has the potential to increase water pollution
  - Water treatment plants mainly on floodplains
- ✓ Less frequent summer rainfall may affect water supply
  - Primarily on smaller water systems and wells
- ✓ Reduced flows on larger rivers
  - Possible water conflicts (e.g., agriculture vs. domestic)
- ✓ Increased water temperatures
  - Affect aquatic health and ability to assimilate wastewater effluent



The observed number of rainfall events exceeding one inch from 1960 to 2000 is shown by the black line, and the projected number of such events, using the HadCM3 model, is show by blue line. These results are broadly consistent with those of the other 15 GCMs used by ClimAID.

Coastal Zones Key Climate Impacts

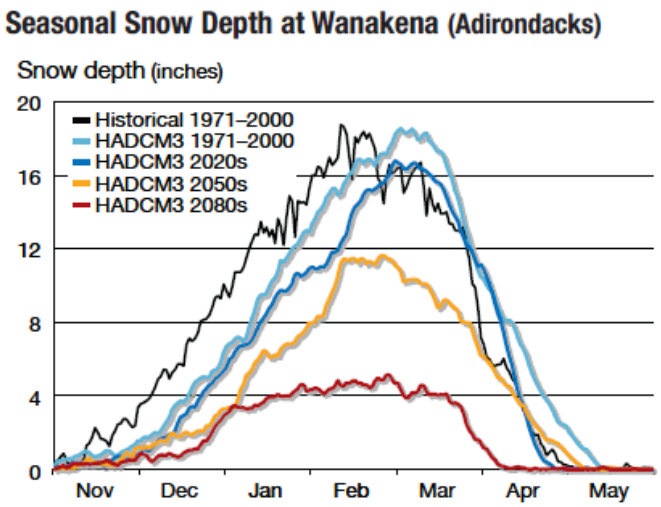
- ✓ Alteration of barrier islands
  - Strong coastal storm surge
  - Beach erosion, dune overwash, new inlet creation
- ✓ Inundation of coastal populations due to sea level rise
  - More frequent flooding in areas now near sea level
- ✓ Loss of coastal wetlands and salt marsh stress
  - Reduced species diversity
- ✓ Migration of cold water species
  - Blue claw crabs replace lobster
- ✓ Salt water intrusion on the Hudson
  - Tides, storm surge and salt water propagate upriver



Projected flood map for 1-in-10 year storm event for Long Beach and surrounding bay communities for ClimAID rapid ice melt scenario.

Ecosystems Key Climate Impacts

- ✓ Changes will favor the expansion of invasive species
  - Generalists such as white-tail deer benefit
- ✓ Longer growing season and possible CO_2 fertilization
  - Increased hardwood productivity
  - Drought and nutrient availability may limit
- ✓ Fast growing plant species see greater benefits
  - Weeds do better!
- ✓ Altered hydrology on streams rivers and lakes
  - Timing and amount of snowmelt change
  - Less ice cover
- ✓ Increased temperature detrimental to brook trout
  - Also species adapted to snow

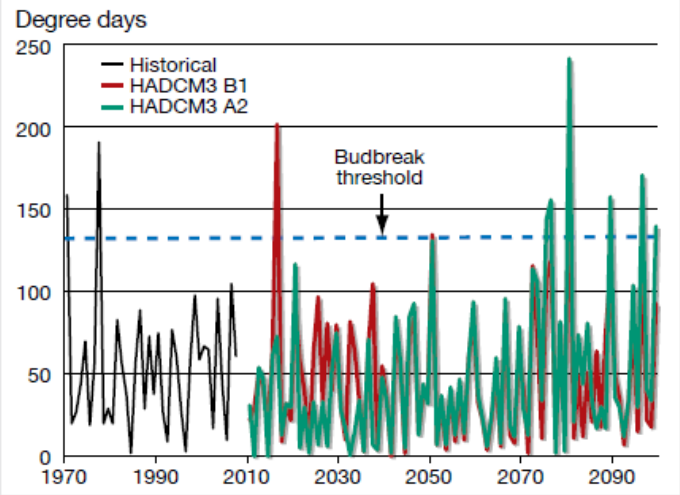


Snowpack is projected to decline sharply due to future warming. The black line shows historical snowpack, and the colored lines show projected snowpack over the months with snow for three future time periods under one relatively high emissions scenario (A2) using one global climate model, UK Met Office Hadley Centre Model version 3 (HadCM3). These projections are broadly consistent with those of other models used in ClimAID.

Agriculture Key Climate Impacts

- ✓ Increased heat stress
  - Crop yield/quality and livestock productivity suffer
- ✓ Increased weed and pest pressure
  - Earlier emergence
  - Greater overwintering potential
- ✓ Opportunities to explore new crops
  - Higher temperatures and longer growing seasons
- ✓ Short-term summer drought risk
  - Also pressures due to rainfall increases (e.g., spring planting)

Projected Degree Days above 60°F Prior to Last Frost



As temperatures rise, plants flower earlier in the spring. This can make them more vulnerable to damage from late spring frost. Climate change has the potential to exacerbate this vulnerability in Concord grapes grown in New York State. The dotted blue line represents a cumulative degree-day threshold that would lead to bud break prior to the last spring frost for Concord grapes in the Fredonia region. Years exceeding the threshold would have a high risk of frost damage. As the chart shows, under a higher emissions scenarios (A2, green line), this is projected happen much more frequently in the later part of this century. These results are broadly consistent with the other global climate models used in ClimAID.

Energy Key Climate Impacts

- ✓ More heat waves
  - Increased A/C …. increased peak energy loads
- ✓ Increased water and air temperature and sea level rise
  - Decreased efficiency and cooling capacity
  - Vulnerable infrastructure
- ✓ Higher winter temperatures
  - Decreased heating demand
  - Perhaps affecting natural gas markets
- ✓ Increased challenges for renewables
  - Hydropower…. Summer drought
  - Solar and wind …. Uncertainty in clouds/wind
  - Biomass depends on growing season conditions

Projected Changes in Peak Electricity Demand for Heating and Cooling, 2020s (compared to current peak demand)

Weather Station	Heating Season **Decrease** in MWp Electricity Demand in 2020s	Cooling Season **Increase** in MWp Electricity Demand in 2020s
Buffalo	14–27	55–111
Rochester	9–18	53–105
Syracuse	19–37	61–122
Massena	5–10	7–15
Watertown	11–21	29–57
Albany	15–29	63–126
Poughkeepsie	12–25	72–145
NY City (LGA)	40–80	249–497
Islip	27–58	194–387

ClimAID global climate models project that average annual temperature will rise by 1.5 to 3.0°F in the 2020s compared to the 1970–1999 baseline period. An analysis of the sensitivity of energy demand to these changes shows that while heating energy use will decrease slightly, cooling energy use will increase much more.

Transportation Key Climate Impacts

- ✓ Heavy precipitation
  - Street flooding and mass transit delays
- ✓ Sea level rise
  - Subways and tunnels at risk of flooding
  - Railways along Hudson vulnerable to flooding
  - Coastal roadways and interstates
- ✓ High temperatures
  - Increased AC needs on mass transit
  - Longer runways
  - Asphalt and train rail stresses
- ✓ Great Lakes ice cover
  - Longer shipping season
  - More lake effect snow

Telecommunications Climate Impacts

- ✓ Heat waves

  Telecommunications systems vulnerable to power outages

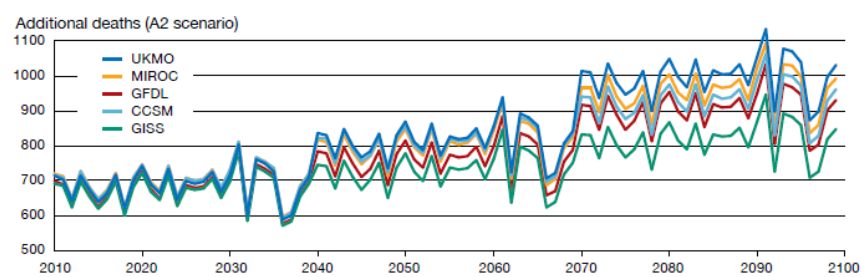
- ✓ Heavy rain, flooding and sea level rise

  Increased vulnerability of infrastructure

Public Health Key Climate Impacts

- ✓ Increased temperature
  - Heat-related illness and death will increase
  - Cold-related deaths decrease, but do not compensate
- ✓ Worsening air quality (smog, wildfires, pollen)
  - Increased cardiovascular and respiratory illness and death
- ✓ Vector-borne disease spread
  - For example, West Nile Virus and Lyme disease
- ✓ Flooding from heavy rain
  - Water and food-borne disease risk
  - Increased stress and mental health problems
  - Recreational water quality compromised

Projected temperature-related deaths in NY county



As climate continues to warm, heat-related deaths are expected to increase, while cold-related deaths are expected to decrease. A preliminary study of all of these temperature-related deaths from 2010 to 2100 in New York County was undertaken using 5 climate models from the set of ClimAID models under lower (B1) and higher (A2) emissions scenarios. The results suggest that increases in heat-related deaths will outweigh reductions in cold-related deaths, resulting in a net increase in deaths due to climate change. The lower-emission scenario (B1) is projected to result in substantially fewer deaths by the 2080s. The chart shows the results from 5 models for the higher (A2) emissions scenario. These results are broadly consistent with the other global climate models used in ClimAID.

Conclusions

- ✓ Success of NY's response will depend on effective adaptation strategies
- ✓ Climate change brings opportunities and challenges
  - Climate interacts with (exacerbates) existing stressors
- ✓ Sea level rise and coastal flooding greatest challenge
  - Affect multiple sectors and large populations
- ✓ Many adaptation needs can occur near term and at modest cost
  - Presents opportunities for co-benefits
  - Infrastructure investment already needed
- ✓ Scientist-policy maker dialogue imperative