APPENDIX 3E.2 – NYSHMP SECTION 3.4 CLIMATE CHANGE

Section 3.4: CLIMATE CHANGE

2014 SHMP Update

Climate Change was included in the 2011 plan (**Section 3.3.1**) as a discussion; however, it is expanded in this 2014 update as a separate section to highlight current initiatives by New York State, and to report on adaptation strategies being developed by the state. This section includes the climate change information from the 2011 plan.

This section is not intended to provide a comprehensive review of current scientific evidence and data on climate change, on either a global or jurisdictional scale. In addition, it is not intended to propose or advocate for specific policy-making or regulatory initiatives related to climate change. It is intended to serve as a guide for identifying potential mitigation activities for New York State agencies and local jurisdictions, and to link these activities to strategies, goals and objectives that address mitigation to the impacts and consequences of climate change.

For the purpose of profiling climate change for the 2014 plan update, hazards affected by climate change or its consequences are addressed in this section. Additional data and information related to specific hazards can be found within the respective hazard sections of this plan.

While this plan carefully outlines all natural hazards that threaten our communities, it is recommended that elected officials, planners, and the emergency response/mitigation community recognize the potential for the changing nature of climate and its impacts.

New information and data related to climate change included in the 2014 SHMP update:

- Characteristics
- Location
- Previous events, vulnerabilities and estimated losses
- Climate change adaptation initiatives
- Local plan information related to potential impacts, vulnerabilities and losses
- Changes in development in hazard-prone areas

Specific data sources and key documents are listed at the end of this section.

Characteristics

Climate change is a worldwide concern because of its potential to significantly impact people, natural resources, and economic conditions around the globe. While the magnitude of these changes is difficult to predict, there is broad agreement that they will continue to occur and will dramatically affect many aspects of peoples' daily lives.

Climate change, in and of itself, is not an individual hazard, and is not required to be addressed by Federal mitigation planning criteria, but analysis of the conditions brought on by climate change can provide a better understanding of how risk and vulnerabilities of population, property, environment and the economy may be affected in the future. In addition, changing climatic conditions may exacerbate the impacts of the other hazards that currently affect New York State. Since the 2011 plan, there has been increased confidence that certain changes in multiple atmospheric conditions can be attributed to climate change.

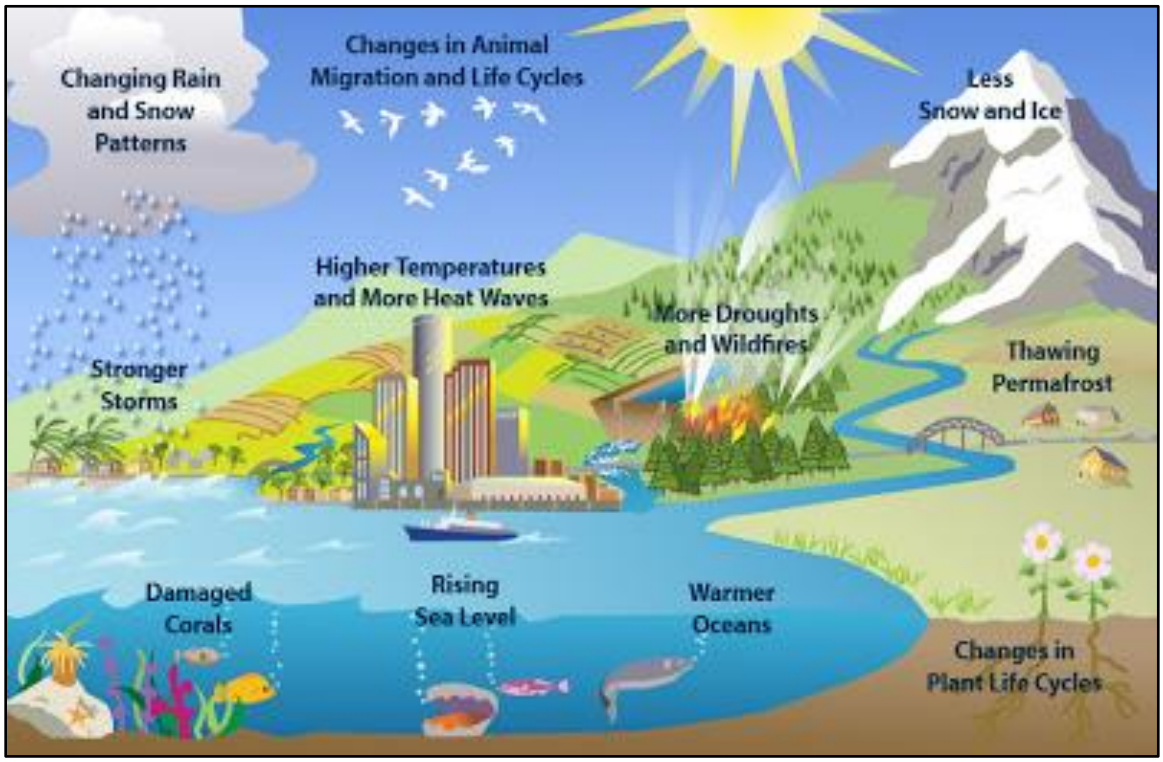
The effects of climate change are already impacting New York State and are projected to increase in the coming years. At the same time, this presents the opportunity to research, identify, and initiate appropriate adaptive strategies and activities that can lessen the effects of climate change on the environment and future populations.

Hazard	Definition and Key Terms
Climate Change	New York State Department of Environmental Conservation Policy CP-49 identifies types of environmental variables vulnerable to climate change as: • Temperature (air, water and ground) • Precipitation • Water quantity/quality • Snow/ice • Sea level rise • Storm frequency and intensity • Humidity • Evaporation • Wind speed and direction These environmental factors also link to other natural hazards and their impacts that area outlined in this plan, which include coastal erosion, flooding, drought, and wildfire.

Climate change is a shift in long-term weather patterns: temperature, precipitation, wind, and more. While the body of scientific evidence that the climate is changing has been universally accepted, the complexities within this field of study make it difficult to precisely define the full scope and magnitude of its consequences. However, climate change experts

are in agreement that one of the greatest threats posed by global warming is sea level rise, which is expected to increase coastal flood frequency and severity from tropical cyclones, extra tropical cyclones and other severe coastal storms.

Figure 3.4a illustrates the widespread impacts of climate change on the natural environment.



Source: http://3.bp.blogspot.com

While climate change may be due in part to natural processes and forces, it is extremely likely (i.e., with 99-100% certainty) that a significant portion of climate change is due to the influence of human beings on nature. In addition to reducing greenhouse gas emissions to lessen the degree of climate change, the state's approach to addressing climate change and its potential impacts is also through adaptation strategies, which are adjustments in natural or human systems to better prepare for the impacts of a changing environment.

3.4.1 Climate Change Profile

Conditions related to climate change are expected to alter both average climate and the frequency and intensity of extreme weather events in New York State[1], which will, in turn, exacerbate what in the past were considered to be "expected" impacts and consequences of

[1] *Responding to Climate Change in New York State* (ClimAID), November 2011, p. 259. The ClimAID report was funded by the New York State Energy Research and Development Authority (NYSERDA), provides the best available scientific information specific to the effects of climate change on energy systems in New York State. p. 259

weather events. These conditions will significantly increase the risk to people, property, environment, and the economy. In addition, indirect impacts on infrastructure may be greater than the direct impacts. One of the most comprehensive studies on climate change in New York State, *Assessment for Effective Climate Change Adaptation Strategies in New York State* (ClimAID), (November 2011), was funded by the New York State Energy Research and Development Authority (NYSERDA) and focused on eight critical sectors within the state - agriculture, coastal zones, ecosystems, energy, public health, telecommunications, transportation, water resources. Each sector was analyzed for risks, vulnerability, and potential challenges caused by conditions related to climate change, as well as potential adaptation strategies. For example, specific risks to the supply, distribution, demand and consumption of energy were identified, linked to principal climate variables, defined, and assigned to locations and "crosscutting links" such as public health, water resources, agriculture or communications. As an additional example, conditions linked to prolonged high temperatures and extreme weather events may temporarily or permanently change energy demand patterns.[2] The ClimAID Report also proposes potential adaptive strategies to mitigate significant effects of climate change on the state's power generation systems.

"Climate change is a reality, extreme weather is a reality, and it is a reality that we are vulnerable."

-Governor Andrew Cuomo
October 2012

These following issues highlighted in the ClimAID reports[3] are also identified in the soon-to-be-released National Climate Assessment Report (draft, September 2013).

- Heat waves, coastal flooding due to sea level rise, and river flooding due to more extreme precipitation events will pose a growing challenge to the region's environmental, social, and economic systems. This will increase the vulnerability of the region's residents, especially populations that are already most disadvantaged.
- Infrastructure will be increasingly compromised by climate-related hazards including sea level rise and coastal flooding, and intense precipitation events.
- Agriculture and ecosystems will be increasingly stressed by climate-related hazards, including higher temperatures, sea level rise and coastal flooding, and more extreme precipitation events. A longer growing season may allow farmers to explore new crop options, but this and other adaptations will not be cost or risk-free, and inequities exist in the capacity for adaptation.
- While a majority of states and several municipalities have begun to incorporate the risk of climate change into their planning activities, implementation of adaptation measures is still at early stages.

[2] ClimAID, p. 260
[3] ClimAID, p. 3 (These issues are also identified in the soon-to-be-released National Climate Assessment Report (draft, September 2013)).

Coastal and Inland Erosion

New York's coastline is subject to a variety of hazards, including coastal storms, long-term sea level rise, erosion, and saltwater intrusion. Development and human settlement puts lives and properties at risk to these coastal hazards.

An area's potential for erosion is determined by four factors: soil characteristics, vegetative cover, climate/rainfall, and topography. The two major erosion mechanisms are wind and water. Wind that blows across sparsely vegetated or disturbed lands can cause erosion by picking up soil, carrying it through the air, and displacing it in another site. Water erosion occurs over land, and in streams and channels. Major storms can cause coastal erosion from the combination of high winds and heavy surf and storm surge. Climate change could exacerbate conditions that lead to both coastal and inland erosion.

Based on various assessments of shoreline changes since the mid-1800s, New York's beaches appear to be experiencing net erosion in general, but beach renourishment has been used in a number of areas as a method to stabilize this underlying trend. Long-term shoreline change rates vary from marginally accretional along some standard beaches, to highly erosional (as much as 20 feet per year) in some highly dynamic inlet areas. Beginning with Hurricane Irene in 2011 and again with Hurricane Sandy in 2012, Fire Island in Suffolk County has experienced above average erosion rates and is considered one of the most vulnerable beaches in New York State. (Additional information related to the USGS Fire Island Survey is provided in **Section 3.5: Coastal Erosion**.)

Coastal erosion and other climate change hazards are also discussed in the following hazard sections:

Section 3.5 Coastal Erosion
Section 3.8 Extreme Temperatures
Section 3.9 Flood
Section 3.12 Hurricane
Section 3.17 Wildfire

Drought

Rising summer temperatures, along with little change in summer rainfall are projected to increase the frequency of short-term (one to three month) droughts. This scenario will lead to impacts on the natural and managed ecosystems across the state. Water management and hydrology are also affected. In addition, drought has been directly linked to an increasing number of land subsidence incidents in other parts of the world. In France, for example, subsidence-related insurance claims have risen by over 50 percent in the last 20 years, costing the affected regions an average $425 million a year[4].

[4]Lloyd's Insurance conference on agricultural issues

Additional information related to the characteristics, vulnerabilities and losses for Drought is provided in **Section 3.6.**

Extreme Temperatures

Temperatures in the Northeast are projected to increase an additional 4.0 to 9.0 degrees Fahrenheit in New York State by the year 2080[5]. Consequences of this change will lead to increased energy usage with direct impact on energy demand and supply. Within 40 years and beyond, the choices made for emissions could make a dramatic difference in the projected impacts of extreme temperatures on energy use.

Since 1970, the annual average temperature in the Northeast has increased by 1.5°F, with winter temperatures rising twice as much. Warming has resulted in many other climate-related changes, including:

- More frequent days with temperatures above 90°F
- A longer growing season
- Increased heavy precipitation

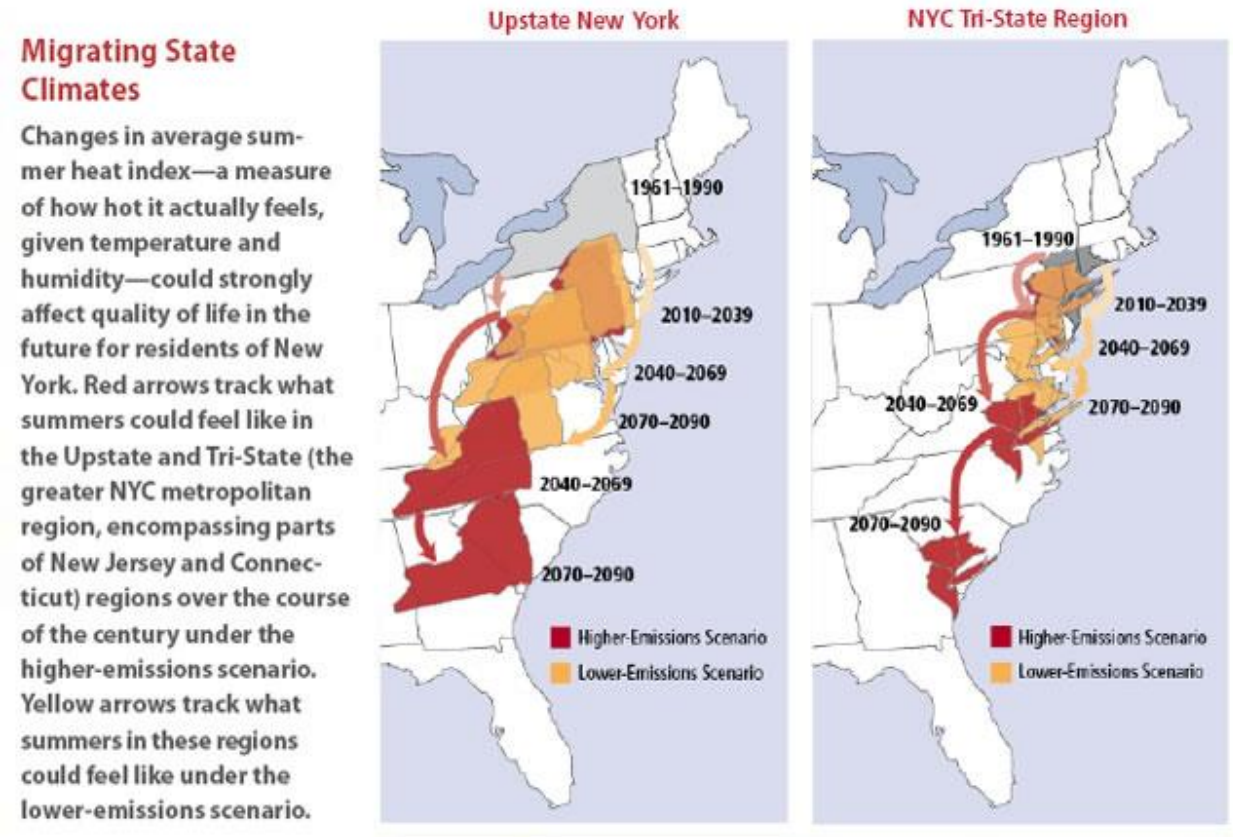
It is unclear whether the frequency or severity of ice storms will change across the state over the next few decades. Some sources predict less winter precipitation falling as snow and more as rain with reduced snowpack. Shorter snow seasons and earlier spring snowmelts are also predicted. However, it is possible that by later this century, changes in the winter snow patterns will impact the southern and northern parts of the state differently, with fewer ice storms in the south. The impact on frequency or severity of ice storms in northern New York later in the century is less uncertain[6].

The Northeast is projected to face continued warming and more extensive climate-related changes, some of which could dramatically alter the region's economy, landscape, character, and quality of life. Also as more northerly areas warm up, insects and pathogens thrive, which may lead to an increasing use of pesticides as the number of affected areas grows. Earlier springs and warmer winters will also lead to growing insect populations.

In addition, changing temperatures will encourage weed-growth to move farther northward, competing with and sometimes overcoming agricultural crops and significantly increasing the costs to produce food.

[5] ClimAID, p. 29
[6] *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions*, Northeast Climate Impacts Assessment (2007), Union of Concerned Scientists

Figure 3.4b illustrates the potential impact of changes in the average summer heat index by the end of the 21st Century.



Source: *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions*, Northeast Climate Impacts Assessment (2007), Union of Concerned Scientists.

Adaptive strategies to lower emissions could reduce the impact of extreme temperatures to the energy sector. Higher emissions are projected to worsen impacts, which would include the following.

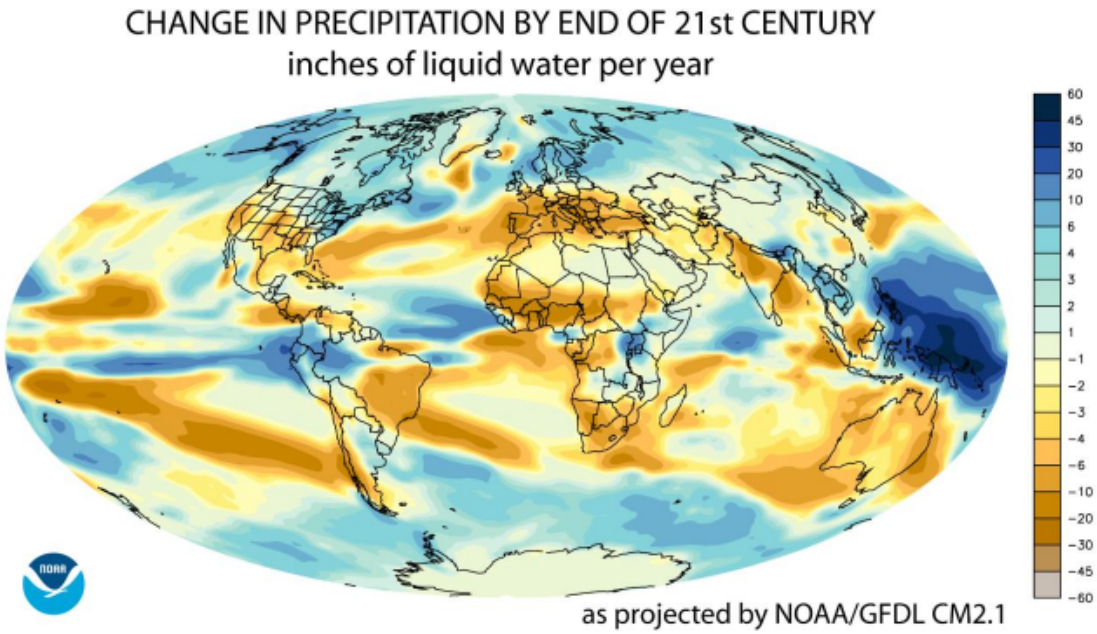
- Winters in the Northeast would be much shorter with fewer cold days and more precipitation.
- The length of the winter snow season would be cut in half across northern New York, and reduced to a week or two in southern parts of the region.
- Cities that today experience few days above 100°F each summer would average 20 such days per summer.
- Short-term (one- to three-month) droughts are projected to occur as frequently as once each summer in the Catskill and Adirondack Mountains, and across the New England states.
- Hot summer conditions would arrive three weeks earlier and last three weeks longer into the fall.
- Sea level in this region is projected to rise more than the global average

Additional information related to the characteristics, vulnerabilities and potential losses due to extreme temperatures is provided in **Section 3.8**.

Precipitation, Flooding and Landslides

Precipitation patterns related to climate change are expected to shift in the coming decades. **Figure 3.4c** illustrates the potential increase in precipitation that could impact New York State by the end of the century. Based on this projection, areas of New York State could see an increase of 3 to 6 inches of rainfall per year. Additionally, this precipitation is projected to occur more often as heavy downpours. Increased precipitation and downpours will lead to more flooding, impacting people, property, and the environment. It can also potentially increase landslides due to higher moisture levels in soils. In addition, changes in precipitation will impact crop production and other segments of the agricultural economy.

Figure 3.4c: Change in Precipitation by the End of 21st Century



Source: NOAA

The Northeast region is also projected to see an increase of approximately 20 to 30% in winter precipitation[7]. Projections are based on lower- or higher-emissions scenarios, which also identify the potential number of "snow-days" across the state. In a high-emission scenario, the Adirondack region could see the snow season cut in half; a low-emission scenario would retain about three-quarters of its snow season, or two to three

[7] Confronting Climate Change

weeks of snow cover per winter month) which would carry over to an impact on the winter tourist economy.

Additional information related to the characteristics, vulnerabilities and potential losses due to precipitation is provided in **Section 3.9: Flooding**.

Severe Storms

Although climatologists are unsure whether the increasing cycle of tropical storm events since 1995 is part of a multi-decadal cycle that will eventually decline, or whether it will be influenced by increasing conditions due to climate change, projections indicate that the severity of all storms and their impacts are increasing and will continue to do so.

Studies link increased tropical storm energy and duration to warmer ocean temperatures[8]. Return intervals of severe storms may also be shortened, resulting in high tide peaks, for example, that occur once every ten years rather than once every hundred years.

Additional information related to the characteristics, vulnerabilities and potential losses due to severe storms is provided in **Section 3.10: Hailstorm, Section 3.11: High Winds, 3.12: Hurricane** and **Section 3.15: Severe Winter Storm**.

Sea Level Rise

Sea level rise associated with climate change will have significant effects on coastal areas. Rising seas will increase coastal erosion, flood wetlands and low-lying lands and worsen coastal flooding. Increased salinity will also impact estuaries and aquifers. Heavy precipitation associated with coastal storms causes increased runoff and river surges that intensify the effects of storm surges from the sea. Levees and seawalls currently protect many coastal areas, but these structures have been designed for current sea level and may be overtopped in the future or undermined by increased erosion.

Various projections of the extent and costs of sea level rise in the next century have been made:

- Residential structures in the 100-year floodplain of New York City and Nassau, Suffolk and Westchester counties have a total estimated value of over $125 billion. While this figure includes riverine as well as coastal flood plains, it reflects the scale of flood exposure in the region. The wide range of options available to address protection of these structures, in addition to the extent and timing will influence the ultimate costs.
- Adaptation measures for coastal areas such as the construction of bulkheads, dikes, and pumping systems can protect property, but these measures are likely to result

[8] Atlantic Hurricanes and Natural Variability in 2005, Trenberth and Shea, Geophysical Research Letters, 2006. 2. Increasing Destructiveness of Tropical Cyclones over the past 30 years, Kerry Emanuel, Nature, V.436, Aug 2005

in further loss of wetlands and beaches with detrimental effects on fish and wildlife, recreation, and tourism. Elevation of structures and land surfaces, and land-use policies that allow shorelines to retreat naturally are less disruptive response strategies but are challenging to implement in areas already highly developed. Land elevation and beach nourishment are attractive options in many ways; yet they are not feasible in all locations, and they require extraordinary financial and political commitments into the indefinite future.

- The ClimAID report[9] projects a sea-level rise of 8 to 23 inches by the 2080s, or a range of 37 to 55 inches with a rapid ice melt scenario. The International Panel on Climate Change (IPCC) predicts, "a sea-level rise of at least one to two feet can be expected by the end of the century, though a wide range of sea-level rise scenarios exist. The growing urban footprint and increasing population density in coastal areas has also amplified the financial and societal impacts of such events[10]." Either scenario will cause a significant impact to coastal assets.

In addition to these sources, the State Sea Level Rise Task Force, charged by the New York State Legislature in 2007 with developing recommendations for adapting to sea level rise, adopted the sea level rise projections in the table below for two regions of the state. Although these projections have not been officially adopted by the Legislature or any New York State agency for regulatory purposes, the New York State Department of Environmental Conservation (DEC) considers them the best available projections for planning purposes[11].

Table 3.4a: Projected Sea Level Rise in Two Regions of New York (ClimAID Integrated Assessment, 2011)

Lower Hudson Valley & Long Island	2020s	2050s	2080s
Sea level rise	2 to 5 in	7 to 12 in	12 to 23 in
Sea level rise with rapid ice-melt scenario	5 to 10 in	19 - 29 in	41 to 55 in

[9] ClimAID, p. 33
[10] "Rising Sea Levels Ranked as Greatest Climate Change Threat", Insurance Journal, 9/4/13
[11] NYSDEC Sea Level Rise Website

Mid-Hudson Valley & Capital Region	2020s	2050s	2080s
Sea level rise	1 to 4 in	5 to 9 in	8 to 18 in
Sea level rise with rapid ice-melt scenario	4 to 9 in	17 to 26 in	37 to 50 in

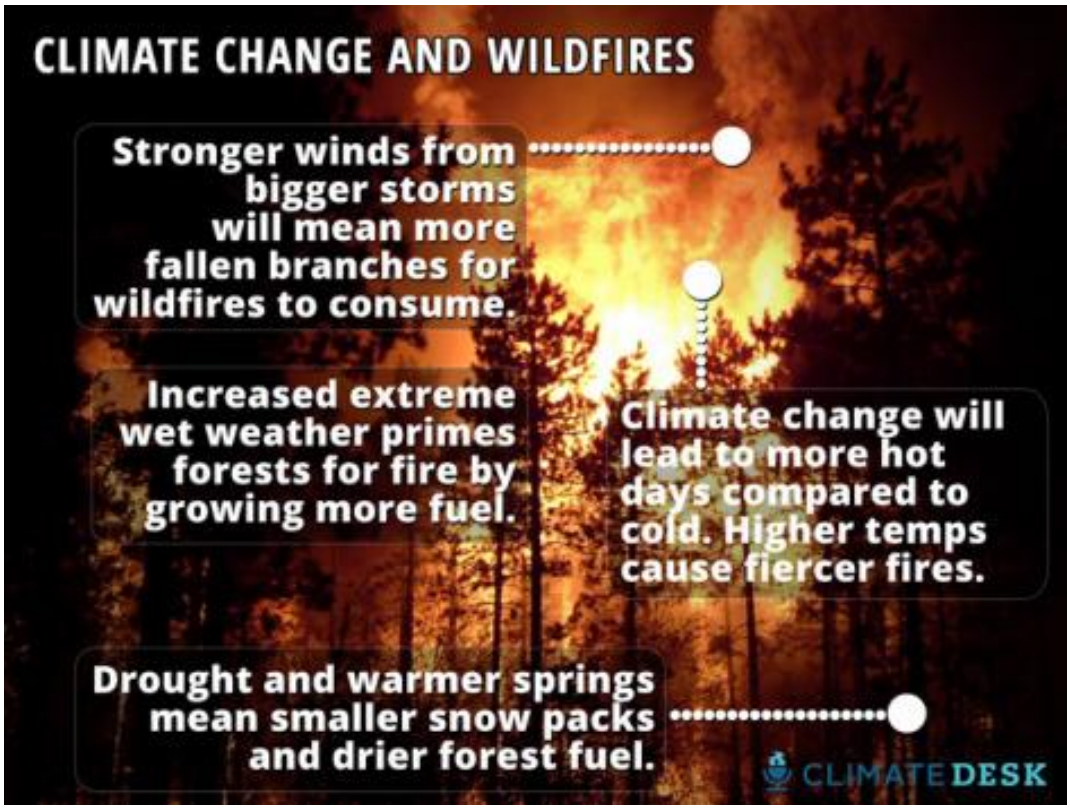
Sea level rise is expected to permanently inundate already low-lying areas and dramatically accelerate erosion – already a severe problem along New York's heavily developed coast. Sea level rise will continue to threaten already-vulnerable homes, businesses and infrastructure as well as environmentally-sensitive salt marshes and estuaries. These areas are critical habitats for large numbers of coastal bird and fish species, and provide ecosystem services such as pollution filtration, sediment trapping, erosion mitigation, and flood control. Wetlands in most areas have been able to keep pace with historic sea-level rise by accreting sediment and growing vertically and by moving inland with the encroaching sea. But the accelerated rates projected for the next 100 years may be too fast for natural accretion and migration to keep up; additionally, coastal development may impede the inland movement of these wetlands. Sea level rise will also likely have an impact on salt water intrusion into coastal freshwater aquifers – impacting drinking water supplies and crop irrigation. Long Island and parts of New York City rely heavily on ground water aquifers for drinking water and agriculture.

Wildfire

Climate changes directly and indirectly affect the growth and productivity of forests: directly due to changes in atmospheric carbon dioxide and climate, and indirectly through complex interactions in forest ecosystems. Climate also affects the frequency and severity of many forest disturbances, such as insect outbreaks, invasive species, wildfires, and storms.

Forests cover approximately 60% of the state's total land area. As temperatures increase, the suitability of a habitat for specific types of trees changes. In addition, there is growing evidence that prolonged heat waves are likely to lead to a greater incidence of wildfires.

Figure 3.4d illustrates the relationship between conditions related to climate change, including extreme temperatures and drought, to wildfires, which can subsequently lead to impacts to the population, environment, and agriculture.



Source: www.grist.org

Additional information related to the characteristics, vulnerabilities and potential losses due to wildfires is provided in **Section 3.17: Wildfire**.

Location (geographic area affected by hazard)

The entire state is potentially vulnerable to the overall effects of climate change related to extreme temperatures and precipitation. In addition, coastal areas and inland waterways are especially susceptible to sea level rise, increasing flooding and coastal erosion. The state's ecosystem is at risk for significant changes that could impact food and water supplies, energy, and the economy.

Sea level rise has the potential to impact 17 counties in New York State that adjoin to tidal bodies of water:

- Albany
- Bronx
- Columbia
- Dutchess
- Greene
- Kings (Brooklyn)
- Nassau
- New York (Manhattan)
- Orange
- Putnam
- Queens
- Rensselaer
- Richmond (Staten Island)
- Rockland
- Suffolk
- Ulster
- Westchester

Two of the 62 counties in New York and the five counties that make up New York City are located along the Atlantic coast, and Long Island Sound, making them especially vulnerable to hurricanes, sea level rise, erosion, salt water intrusion, and other coastal events.

Coastal events can also have inland-reaching impacts; in particular, the inland counties of Westchester, Rockland, Albany, Columbia, Dutchess, Greene, Orange, Putnam, Rensselaer, Rockland, Ulster and Westchester Counties are susceptible to tidal flooding, saltwater intrusion, and erosion caused by hurricanes and coastal storms. In addition, Erie and Chautauqua Counties have experienced erosion from storms, and other counties along the Great Lakes shorelines could become more susceptible to erosion and seiche. **Figure3.4e** depicts coastal areas along the Atlantic Ocean, bays, tidal rivers and the Great Lakes with potential impact from sea level rise.

Figure 3.4e: Sea level Rise Projections for Coastal Areas of New York State

Source: www.geology.com (Google, NASA)

Previous Occurrences

Because of the difficulty in attributing the scope and severity of any particular event to climate change, it has not been identified as a specific hazard in relation to Federal Disaster Declarations, nor is it likely to be in the next several years. Climate change involves interrelated complexities of multiple hazards and conditions, as well as impacts and consequences. Although some industries (such as insurance companies) have started developing methodologies for taking climate change into account, tracking occurrences of climate change over time from a disaster impact probability and severity analysis will be difficult. Future studies and research may result in an accepted methodology for measurement.

Previous occurrences linked to specific hazards are addressed in other hazard profiles and risk assessments:

Section 3.5: Coastal Erosion
Section 3.8: Extreme Temperatures
Section 3.9: Flood
Section 3.12: Hurricane
Section 3.17: Wildfire

Probability of Future Events

There is little disagreement within government, academic, and scientific circles that changes occurring in the atmosphere over multiple decades are impacting the earth's climate. Based on research studies, reports, records of historical events over long periods of time, and predictive models, it is highly likely that climatic changes that New Yorker's have been experiencing will occur much faster in the coming years. Although the extent and magnitude of its impact is not fully determined, ongoing research may further refine predictions for probability and severity.

Despite the recent impacts from Tropical Storm Lee and Hurricane Irene in 2011, and Hurricane Sandy and Winter Storm Nemo in October 2012, there is not unanimous agreement in the scientific community about whether increased Atlantic hurricane activity since 1995 is due to the effects of climate change or a multi-decadal hurricane cycle. There is little or no information available on the frequency and distribution of extra-tropical storms (nor'easters) or on the distribution of their impacts over the landscape. Other than the historical record, there is also little information available on the frequency of Great Lakes storms or the distribution of their impacts over the landscape.

Future sea level rise depends on a number of factors. The amount of carbon dioxide (CO2) emitted will determine how much global warming takes place. The amount of ice that melts will vary according to the amount of global warming, and the same is true of thermal expansion.

Potential Impacts and Consequences of Climate Change

The ClimAID Report identifies both near-term and longer-term climate vulnerabilities for New York State[12]. Vulnerability plays an essential role in determining the severity of climate change impacts. It is important to conduct a comprehensive assessment of vulnerability in order to improve the capacity of a society to adjust its functioning in response to actual and projected climate changes. For the purpose of this hazard, statements were developed to address vulnerabilities for the following sectors:

- Population
- Property
- Critical Infrastructure
- Environment
- Economy
- Continuity of services/Program operations
- Public confidence in the state's governance

[12] ClimAID, p 6

The ClimAID Report suggests the following key criteria related to climate impacts in New York be considered for vulnerability:

- Magnitude
- Timing (e.g., seasonality)
- Persistence and reversibility
- Likelihood (based on estimates of uncertainty)
- Distributional aspects within a region or among socioeconomic groups
- Importance of the at-risk systems
- Thresholds or trigger points that could exacerbate the change

Figure 3.4f is an example of vulnerability analyzed in the ClimAID Report for impacts to Coastal Zones. *[Table will be recreated]* (Additional vulnerability tables for other critical sectors can be found in ClimAID.)

Coastal Zones							
Main Climate Variable	Specific Climate Variable	Probability of Specific Climate Variable	Climate Variable Note	Impact on Resource	Likelihood of Impact	Consequence without Adaptation	Magnitude of Consequence
Infrastructure and Coastal Property							
Sea level rise	Permanent inundation of coastal areas	N/A	By 2050, only a small increase in the area permanently inundated is expected	Entrances to bridges, tunnels, segments of highways, wastewater treatment plans, and sewer outfall systems permanently under sea water	High	Failure of systems	High
				Coastal properties permanently under sea water	High	Abandonment	Medium
				Increase salinity of influent into wastewater pollution control plants	Medium	Corrosion of materials and equipment, failure of systems	High
	Increased frequency, intensity, and duration of storm surge and coastal flooding	Likely/ very likely	Will depend both on sea level rise and on uncertain changes in tropical cyclones and nor'easters	Coastal property damage	High	Potential loss of life Economic impact Failure of systems	High
						Complications to evacuation routes	High
				Increased wear and tear on equipment not designed for salt-water exposure	Medium	More frequent delays and service interruptions on public transportation and low-lying highways	Medium
Ecosystems							
m pe ra tu				Heightened disease, harmful algae	High	Ecosystem vulnerability	Medium

				blooms, and increased competition over resources			
	Warmer coastal sea surface tempera-tures	Likely	N/A	Northward shift in range of habitat for many commercial important fish and shellfish species	High	Decline in fishing industry	High
Precipitation				Affect rates of groundwater recharge lake levels	Medium	Potential shortages of drinking water availability	High
	Increased mean precipitation	More likely than not	N/A	Increased or reduced stream flow	Medium	Affect the delivery of nutrients and pollutants to coastal waters potentially leading to poorer water quality	Medium
Sea level rise	Permanent inundation of coastal areas	N/A	By 2050, only a small increase in the area permanently inundate by expected	Permanent inundation of wetlands	High	Loss of critical wetland habitat	High
		Likely/ Very Likely	Will depend both on sea level rise and on uncertain changes in tropical cyclones and nor'easters	Increased beach erosion	High	Barrier migrations and loss of barrier islands resulting in exposure of the bay and mainland shoreline to more oceanic conditions	High
	Increased wave action	Likely	Will depend both on sea level rise and on uncertain changes in tropical cyclones and nor'easters	Erosion and reshaping of shorelines	Medium	Affect the location and extent of storm surge inundation	High

Population

Hazards linked to climate change have the potential to instigate both direct and indirect consequences that affect the health and well-being of the population, including:

- Contaminated water
- Decreased water quantity
- Failure of sanitation systems
- Infectious disease outbreak
- Loss of health and medical services, including behavioral health
- Separation from social, and/or community cultural systems
- Job loss
- Economic decline

Additional indirect impacts could result in long-term consequences that prohibit or delay the onset of conditions leading to public health issues. Extreme weather events encourage outbreaks of disease and infestation; flooding leads to an increase in fungal growth and

nematodes while drought leads to increases in locust and white fly populations. Changes in ecosystems, agriculture, and water supplies will have extreme impacts on human health.

Globally, heat was a leading weather-related cause of death. Between 2003 and 2012, extreme heat was already the top cause of weather-related deaths in the United States, killing an average of 117 people per year. A recent study[13] found that heat-related mortality around the world due to the effects of climate change may rise 20 percent by the 2020s, and in some worst-case scenarios, it could increase by 90 percent or more by the 2080s, and the net temperature-related mortality, which includes the drop in deaths related to cold weather, could jump by a third compared to current levels.

In addition to more intense heat, related deterioration of air quality could increase the risk of many health problems, especially cardiovascular and respiratory problems. Other populations which may be considered vulnerable in relation to health and medical systems and services include:

- Physically and mentally disabled
- Visually impaired
- Electric-dependent (oxygen, ventilators and other medical equipment required for life-support)
- Elderly
- Lower socio-economic
- Homeless

Projections for warmer winters and hotter summers also increase the opportunity for vector-borne disease outbreaks such as West Nile Virus and Lyme-disease from mosquitos and ticks (respectively). Seasonal pollen production will also accelerate, extending allergy season and increasing risks for asthma.

Emergency responders may also be affected by impacts from climate change, such as increased service demands, and stress and other personal vulnerabilities.

Multiple projects and initiatives address health and safety of the population in relation to climate change conditions. Examples include:

- **2013-2017 State Health Improvement Plan** (New York State Department of Health)
    - The "Promote a Healthy and Safe Environment" plan for New York State focuses on four core areas that impact health, which include: water quality, air quality, built environments, and injuries and occupational health. 'Environment,' as used in the plan, incorporates all dimensions of the

[13] Study produced by the Chinese Center for Disease Control and Prevention, and Radley Horton and Patrick Kinney of Columbia University, reported in the Huffington Post, May 2013.

physical environment that impact health and safety. The impact of and adaptation to climate change was included as a cross-cutting issue within this plan.

Property

The various climate change hazards will impact properties differently. Severe weather events (hurricanes, storm-induced wave action coastal erosion, high winds, etc.) will be more likely to damage or destroy residences, businesses and critical infrastructure. Coastal areas and properties will be especially vulnerable to sea level rise. Although numerous studies and plans have been or are being developed, there is no conclusive decision on the optimal approach to reduce the coastal threats to property. There are three general approaches that could be considered. Some approaches and potential benefits to shoreline protection are described in **Table 3.4b**. Depending on the approach and conditions of the site being addressed, there could be potential for unintended consequences of armoring which ignores the surge-reducing benefits of things like wetlands. For example, protecting one area could increase flood impacts in another. Also, there are many options that have been proposed that are a mix of the three approaches described below that could have a multitude of benefits.

Table 3.4b: Approaches and Benefits of Shoreline Protection to Address Sea Level Rise

Approach	Potential Benefits
Armor the shore with seawalls, dikes, revetments, bulkheads, and other structures	Preserves existing land uses, but wetlands and beaches are squeezed between development and the rising sea
Elevate the land, and possibly wetlands and beaches, as well	Preserves the natural shores and existing land uses, but often costs more than shoreline armoring
Retreat by allowing the wetlands and beaches to take over land that is dry today	Preserves natural shores, but existing land uses are lost

Source: J. Tanski. 2010. "New York". In The Likelihood of Shore Protection along the Atlantic Coast of the United States, ed. Titus and Hudgens: Report to the U.S. Environmental Protection Agency

Critical Infrastructure

Much of the critical infrastructure in coastal areas, such as electric, water, sanitary, communications, and transportation systems could be negatively impacted by multiple hazards related to climate change, such as rising sea levels, extreme temperatures, drought, and flood.

As an example, power failures have occurred on numerous occasions in various locations throughout the State, due to various causes. Since a power failure has the potential of

being a result of conditions caused by climate change, the probability of failure of the energy system increases as the intensity of extreme events increases. This type of incident, depending on severity, could pose significant health and safety risks and would normally require the involvement of local emergency management organizations to coordinate provisions for food, shelter, water, heating, etc[14].

The New York City Panel on Climate Change has studied the potential impacts to the City for several years and has identified the following specific consequences for critical infrastructure[15]:

Temperature-related impacts may include:

- Increased summertime strain on materials
- Increased peak electricity loads in summer & reduced heating requirements in winter

Precipitation-related impacts may include:

- Increased street, basement & sewer flooding
- Reduction of water quality

Sea level rise-related impacts may include:

- Inundation of low-lying areas & wetlands
- Increased structural damage & impaired operations of critical infrastructure such as power, water, sewer, drainage, transportation, communication, health and medical

The ClimAID report provides a comprehensive analysis of the state's infrastructure, its vulnerabilities, and adaptive strategies that could reduce the potential for loss of services as the result of impacts from climate change[16].

Environment

The environment within New York State is one of the sectors most susceptible to impacts from climate change conditions. Extreme temperatures, drought, and sea level rise will impact ecosystems, crops, livestock and, ultimately, food supplies.

Water supplies and quality will also be impacted by extreme heat and drought. Rising sea levels and intensive flooding will affect sensitive natural protective barriers in coastal areas as well as inland waterways. Ultimately, changes in the environment will lead to a higher incidence of public health issues.

Economy

[14] 2011 NYS HMP: Power Failure section
[15] Climate Risk Information (2009), NYC Panel on Climate Change
[16] *Responding to Climate Change in New York State* (Final Technical Report) (November 2011), New York State Energy Research and Development Authority.

Economic costs of climate change impacts have the potential for being extraordinary. Impacts from all the impacts linked to climate change will affect the state's economy in relation to jobs, the prices of goods and services, and costs of development and construction.

Especially vulnerable to economic impacts are the coastal areas, including the Atlantic and the Great Lakes shorelines. As New York Offshore Atlantic Ocean Study (DOS, July 2013) notes, "New Yorkers rely on the ocean for a wide range of economic activities. Over two-thirds of all New Yorkers live in counties that are located within the State's ocean and estuarine regions, accounting for over 275,000 ocean and coastal-related jobs and nearly $7.5 billion in wages in 2009[17]." Dependence on the coastal economy encompasses infrastructure such as transportation (marine, air, land, rail), as well as industry and tourism. Impacts to the coastal environment and property will carry over to impact the state's economy. Loss of homes and businesses in vulnerable coastal areas will cause relocation and possible economic failure.

In addition to the coastal areas, the agricultural economy is especially vulnerable to impacts from climate change. Almost 36,350 farms cover about 25% of the state's land area and generated more than $4.4 billion in 2007. Fruit and vegetable crops alone produce about $500 million annually. Rising air and ocean temperatures will present new opportunities and challenges to agriculture and fishing. For example, increased irrigation and pest control, and declining crop yields will increase costs. Heat also reduces milk production in cows, leading to rising costs. In addition, large temperature-driven die-offs of specific commercial fish, such as lobster, may occur by mid-century.

One of the few positive effects caused by climate change could be the potential for longer growing seasons, which could offset other economic effects related to agriculture.

Continuity of services/Program operations

Emergency operations have the potential to be disrupted by the impacts and consequences of hazards related to climate change. Extreme temperatures may increase the demand for emergency medical calls and cooling centers for a larger population. Flooding and severe storms may impact government facilities and resources. In addition, consequences of events that impact a greater population will strain the capabilities and capacities of multiple sectors of government operations and services.

Public Confidence in the State's Governance

Research studies have supported the close causal link between the efficiency with which governments deliver services, and the degree of trust citizens have in those governments.[18]

[17] National Oceanic and Atmospheric Administration (NOAA), Coastal Services Center [Internet]. 2012. Coastal county snapshots [cited 2012 July 24]. Available from http://www.csc.noaa.gov/snapshots/.

[18] *Public Confidence in Government, and Government Service Delivery,* Harvey Sims; Canadian Centre for Management Development; March 2001; and *Crisis of Confidence in Government Widens: Majority of Public*

This link is exhibited through citizens' acceptance of and timely response to messages related to preparedness and protective actions in the face of an impending disaster, as well as educational initiatives for topics such as adaptation strategies for climate change. Individuals interpret messages and act upon them differently depending upon the confidence they have in the source of the message.

In recent years, New York State has taken a leading role in identifying threats, hazards and vulnerabilities related to climate change and adaptive strategies and actions that can lessen its impacts. Hurricane Sandy, well as Hurricane Irene and Tropical Storm Lee, served as an alert to the public about the potential for increased storms and their severity in the future, and the timely and appropriate response by state and local government to these concerns will assist in promoting confidence in key officials' actions and messages related to climate change and adaptive strategies.

3.4.2 Assessing Climate Change Vulnerability by Jurisdiction

All counties in New York State have vulnerabilities to extreme temperature, increased precipitation, and/or drought. In addition, many counties are prone to flooding which could worsen with influences of climate change. Coastal counties of New York State, already susceptible to impacts from storms, flooding and erosion, will likely experience increased events in the future, both by frequency and by severity.

Local Plan Integration/Risk Assessments

The methodology used to analyze and integrate information related to risk and vulnerability from LHMPs is described in **Section 3.1 and Section 5.**

Fifty-six county hazard mitigation plans were reviewed for the 2014 update, and risk assessment data related to climate change was integrated into this plan. No county plans identified climate change as a single hazard, but addressed it through discussion in relation to other hazards. Table3.4d describes the level of risk, vulnerability and/or loss identified in four county plans that addressed climate change as a risk or vulnerability.

Doubts Government's Abilities in Face of Hurricanes, Pandemic Flu, and Threats of Terrorism, National Center for Disaster Preparedness (NCDP) at Columbia University's Mailman School of Public Health, November 2005.

Table3.4c: Climate Change Risks/Vulnerability Addressed in Local Hazard Mitigation Plans

County	Description of Risk/Vulnerability to Climate Change
Clinton	Climate change is exceedingly likely to bring warmer temperatures to NYS, with extreme heat events increasing in number, intensity and length. An escalation in total annual precipitation is likely with brief, intense rainstorms increasing. Rural areas, agriculture and natural resource dependent riverine communities face challenges in developing adaptation strategies focusing on responding to a changing climate.
Franklin	Climate change is exceedingly likely to bring warmer temperatures to NYS, with extreme heat events increasing in number, intensity and length. An escalation in total annual precipitation is likely with brief, intense rainstorms increasing. Rural areas, and agriculture and natural resource dependent riverine communities face challenges in developing adaptation strategies focusing on responding to a changing climate.
Rockland	Rockland County will continue to experience periodic drought conditions in the foreseeable future, possibly with greater frequency if some of the current predictions regarding climate change prove to be accurate.
Tompkins	According to the climate projections noted in NYSERDA's ClimAID technical report, annual average precipitation is projected to increase by up to 5 percent by the 2020s, up to 10 percent by the 2050s, and up to 15 percent by the 2080s. (2) Because Tompkins County is located at the southern end of Cayuga Lake and has numerous freshwater streams within its boundaries, the County will become increasingly vulnerable to potential impacts from flash flooding events as precipitation increases in amount and frequency. Adverse flood impacts in the City of Ithaca in the area mentioned in the Army Corps of Engineers' report will continue if dredging of the Inlet does not occur.

Source: Excerpts are taken from local plans available at the time of the SHMP update. Some plans may be in the revision process for 2013 and 2014.

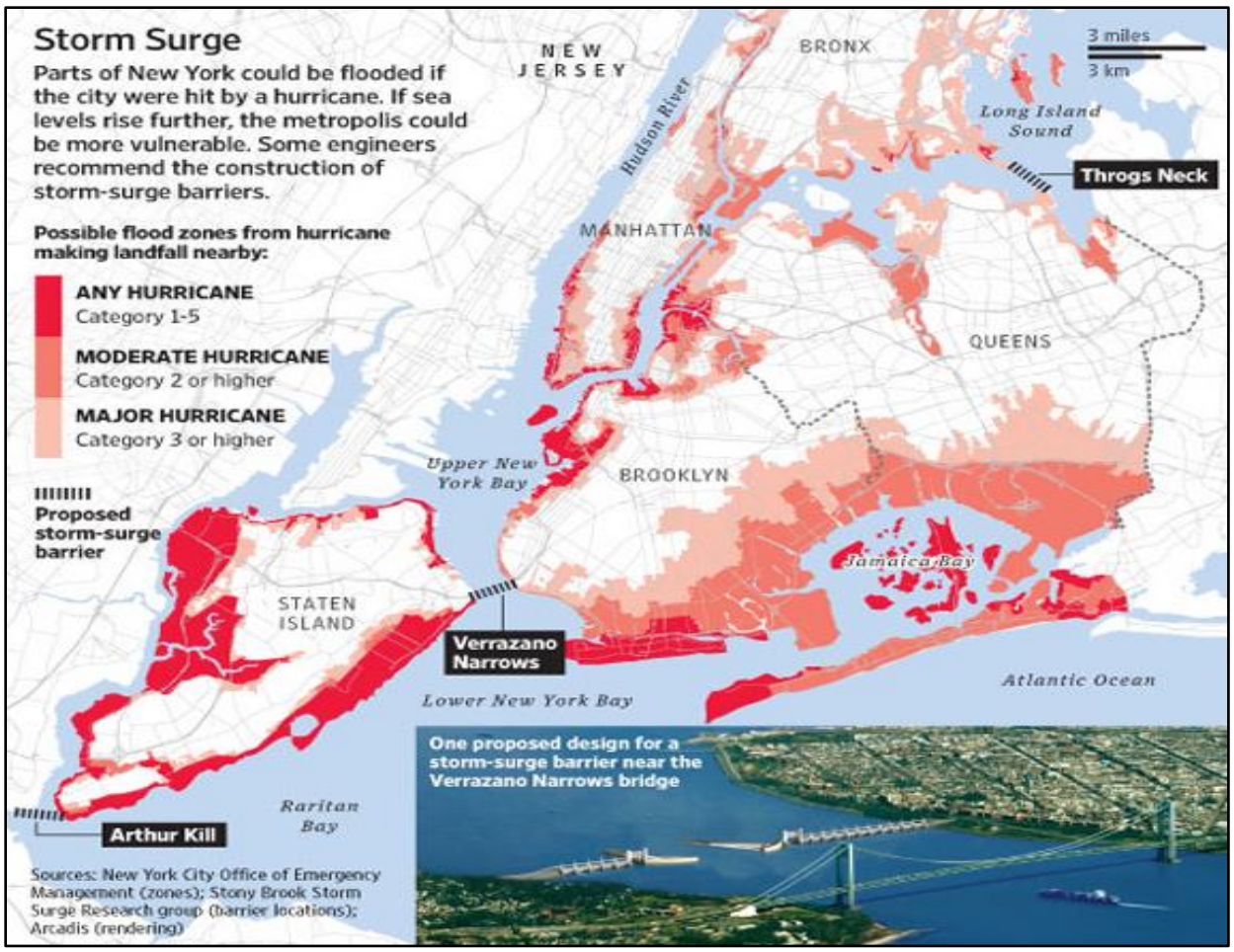
The DHSES Local Hazard Mitigation Planning Standards recommend including climate change as a hazard and take into account the effects that climatic change may have on vulnerabilities to specific hazards. A number of statewide and regional panels and task forces have been established to begin to address the issue of adaptation and community resiliency to climate change, and some have produced guidance documents and climate adaptation assistance tools that hazard mitigation planners and elected officials may find useful in developing or updating local plans.

The ClimAID report provides significant information related to multiple sectors across the state, including critical infrastructure, and vulnerabilities to the hazards and conditions related to climate change. This document also includes as an appendix a *Climate Adaptation Guidebook for New York State* that can be used as a comprehensive guide for county mitigation planning to assess the vulnerability of multiple sectors and identify potential adaptive strategies. (See www.nyserda.ny.gov/climaid; Annex II: NYS Adaptation Guidebook.)

Development in hazard prone areas

It is expected that coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution during the 21st century. Population growth and the rising value of infrastructure in coastal areas increases vulnerability to climate variability, with losses projected to rise even more if the intensity of tropical storms and related conditions increase. Currently, there is no consistent methodology in local hazard mitigation plans to assess the impact of development in relation to climate change, primarily due to the multiple complex hazard conditions linked to climate change. Readiness for increased exposure will be low without implementation of measures for adaptation. Storm surge and flood zone mapping can provide one tool to assess potential vulnerabilities in development-prone coastal and waterfront areas. Some modeling has been done to indicate potential impacts from flood inundation for New York City which can help guide future development. (See **Figure 3.9: Flood section**) In addition, some areas of the city potentially vulnerable to sea level rise would require limitation of future development (building and infrastructure).

Figure 3.4g illustrates storm surge areas of New York and proposed locations for construction of barriers as a potential mitigation measure to protect the coastline from future surge and sea level rise.



Source: www.coastalcare.org

Construction of shoreline protection structures in vulnerable coastal areas may serve to encourage development in high-risk areas. The New York State Sea Level Rise Task Force: Report to the State Legislature (2010) states, "Policy changes needed to reduce vulnerability include limitations on the siting of new development or infrastructure (including transportation corridors) in high-risk areas. Also needed are changes to permit requirements for setbacks and design elevations and modifications to building codes for structural elements and corrosion-resistant equipment.

Figure 3.4h depicts a protective structure susceptible to overwash in future coastal storms and high tides.

Source: New York Sea Level Rise Task Force: Report to the Legislature (2010)

New York State has a number of programs, projects, and initiatives that are underway or pending at the time of this update to address the impacts of climate change on development and critical infrastructure by promoting adaptive measures:

- **Climate Smart Communities Program (NYS DEC)**

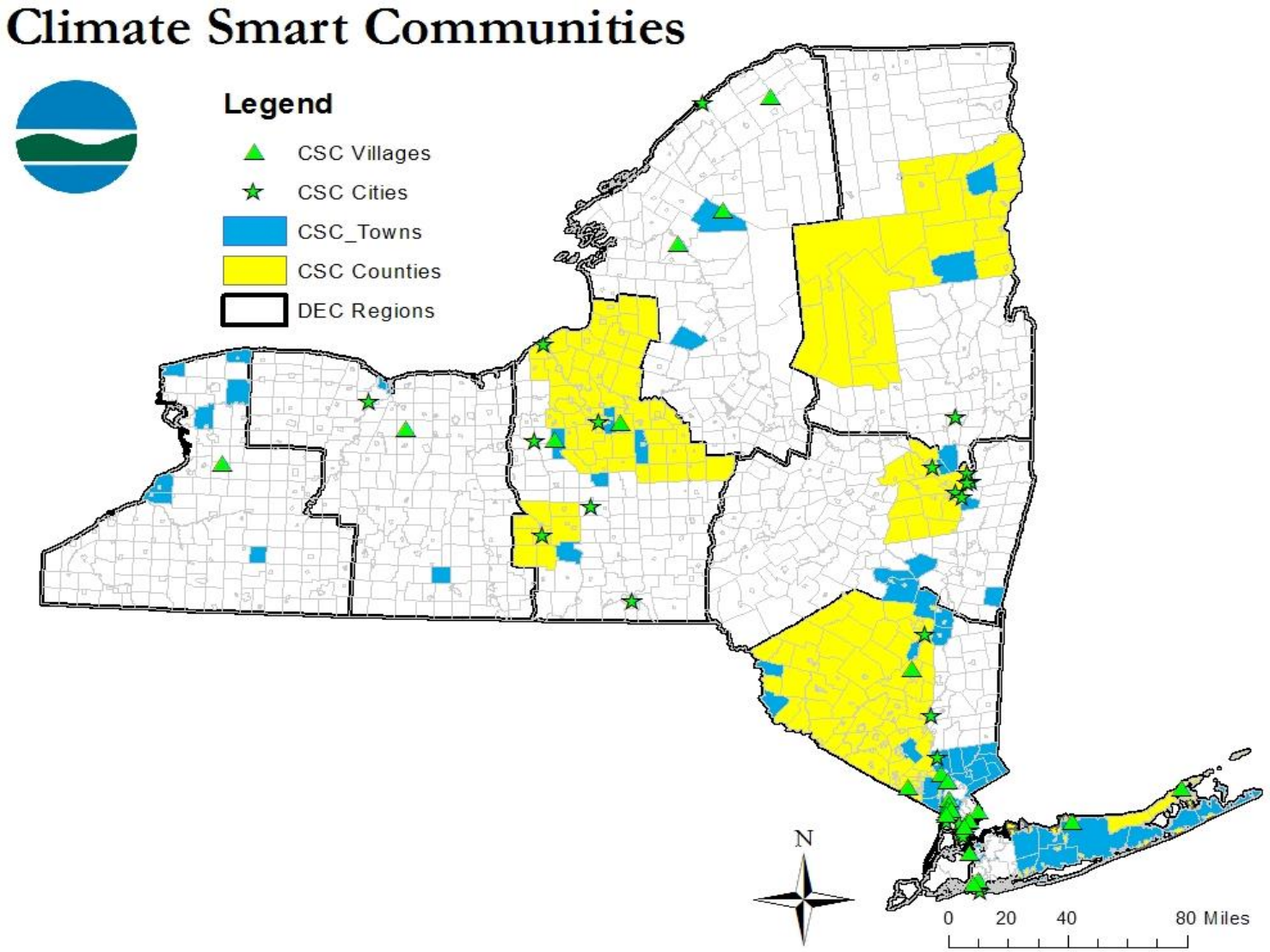
  Climate Smart Communities is a state-local partnership to reduce greenhouse gas emissions, save taxpayer dollars and advance community goals for health and safety, economic vitality, energy independence and quality of life. Communities that enroll in the program are asked to do several key activities such as: identifying sources of greenhouse gases in the community; setting goals for emission reduction; and developing a climate action plan. They are also expected to implement their plans and encourage "go green" activities with businesses, institutions and individuals. The Climate Smart Community Program released "Climate Smart Resiliency Planning: A Planning Evaluation Tool for New York State Communities" in September 2013. This document , based on a similar program initiated in New Jersey, is a comprehensive self-assessment tool to address climate change effects and risks in future community-level plans, and to help local decision-makers identify planning and adaptation opportunities to reduce their community's vulnerability to climate hazards.

Table 3.4d: List of Climate Smart Communities (DEC Climate Smart website)

County	Member Counties, Cities, Towns, and Villages
Albany	City of Albany; County of Albany, City of Cohoes; City of Watervliet; Town of Bethlehem
Broome	City of Binghamton
Cattaraugus	Town of Lyndon
Cayuga	City of Auburn
Columbia	Town of Copake
Cortland	City of Cortland, Town of Preble
Dutchess	City of Beacon; Town of Red Hook; Town of Rhinebeck
Erie	Town of Amherst, Town of Brant; Town of Evans, Village of East Aurora
Essex	County of Essex, Town of Lewis, Town of Schroon
Greene	Town of Cairo; Town of Hunter; Town of Jewett
Hamilton	County of Hamilton
Jefferson	Village of West Carthage
Lewis	Town of Diana, Village of Harrisville
Madison	County of Madison, Town of Cazenovia
Monroe	City of Rochester, Town of Irondequoit
Nassau	City of Long Beach, Town of North Hempstead; Village of East Rockaway; Village of Great Neck Plaza, Village of Woodsburgh
Niagara	Town of Lewiston; Town of Porter; Town of Royalton; Town of Somerset
Onondaga	City of Syracuse; County of Onondaga; Town of DeWitt; Town of Skaneateles; Village of Skaneateles; Village of Fayetteville
Ontario	Village of Victor
Orange	County of Orange, Town of Woodbury
Oswego	City of Oswego; County of Oswego
Rensselaer	City of Rensselaer, City of Troy, Town of East Greenbush
Rockland	County of Rockland, Town of Clarkstown, Town of Orangetown, Village of Montebello
Saint Lawrence	City of Ogdensburg; Village of Norwood

County	Member Counties, Cities, Towns, and Villages
Saratoga	City of Saratoga Springs, Town of Clifton Park
Schenectady	City of Schenectady; County of Schenectady, Town of Niskayuna
Steuben	Town of Campbell
Suffolk	County of Suffolk; Town of Babylon; Town of Brookhaven; Town of East Hampton, Town of Huntington, Town of Islip; Village of Port Jefferson; Town of Smithtown; Town of Southampton
Sullivan	County of Sullivan; Town of Delaware, Town of Tusten, Village of Greenport
Tompkins	City of Ithaca; County of Tompkins; Town of Caroline; Town of Ithaca
Ulster	County of Ulster; City of Kingston; Town of New Paltz; Town of Rosendale; Town of Saugerties; Village of New Paltz
Westchester	City of New Rochelle; City of Peekskill; City of Yonkers; Town of Bedford; Town of Cortland; Town of Greenburgh; Town of Lewisboro; Town of Mamaroneck; Town of New Castle; Town of North Castle; Town of North Salem; Town of Ossining; Town of Pound Ridge; Town of Somers; Town of Yorktown; Village of Ardsley; Village of Dobbs Ferry; Village of Croton-on-Hudson; Village of Hastings-on-Hudson, Village of Irvington, Village of Larchmont; Village of Mamaroneck, Village of Mount Kisco; Village of Ossining; Village of Port Chester; Village of Tarrytown

Figure 3.4i: Map of Climate Smart Communities



Source: NYS DEC (NYSDEC Climate Smart website)

- **Guidance for New York Rising Community Reconstruction Plans (NY Rising Community Reconstruction Program)**

  New York State is assisting communities to rebuild better and safer based on community-driven plans that consider current damage, future threats to community assets, and the community's economic future. In keeping with the National Disaster Recovery Framework, Community Reconstruction Zone (CRZ) Plans consider the needs, risks, and opportunities related to assets in the following categories of recovery support functions: Community Planning and Capacity Building, Economic Development, Health and Social Services, Housing, Infrastructure, and Natural and Cultural Resources.

- **Integrated Assessment for Effective Climate Change Adaptation in New York State** (ClimAID), (NYSERDA) (November 2011)

  This project was undertaken beginning in 2008, by the New York State Environmental Research and Development Authority (NYSERDA) and funded as part of its Environmental Monitoring, Evaluation, and Protection Program (EMEP). As noted in the final report, "The goals of the Integrated Assessment for Effective Climate Change Adaptation Strategies in New York State (ClimAID) are to provide New York State decision-makers with cutting-edge information on its vulnerability to, as well as its ability to derive benefits from, climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge." Additionally, the ClimAID report highlighted areas related to climate change and New York State that warranted additional research, and identified data gaps and monitoring needs in order to help guide future efforts. The ClimAID report covered climate risks, vulnerability, adaptation, equity, and economics in the following areas:

  - Water Resources
  - Coastal zones
  - Ecosystems
  - Agriculture
  - Energy
  - Transportation
  - Telecommunications
  - Public Health

Additional development-related initiatives are described in **Section 3.5: Coastal Erosion**.

3.4.3 Assessing Climate Change Vulnerability of State Facilities

State owned and operated facilities could be vulnerable to multiple impacts and consequences of hazards related to climate change. **Table 3.4e** describes some of these vulnerabilities, which can potentially affect state facilities. Information in this table can serve as a guide to continuity planning for state agencies.

Table 3.4e: Potential Impacts and Consequences to State Facilities from Hazards Associated with Climate Change

Hazard	Potential Impacts and Consequences to State Facilities
Coastal Erosion	• Damage/destruction of facility from loss of dunes and protective measures • Loss of critical infrastructure (communications, mechanical systems, power, water supply, technology)
Drought	• Possible contamination or loss of water supply
Extreme Temperatures	• Power Failure - due to line sag and overheating) • Long-term conditions - rotating closures or full shut-down
Heavy rainfall/Flooding (inland and coastal)	• Inundation from flood waters • Loss of critical infrastructure (communications, mechanical systems, power, water supply, technology) • Loss of use of facility (temporary or permanent)
Disease Outbreak	• Little or no impact expected to facilities • Impact to personnel resources which could affect ability to continue essential services
Sea Level Rise (facilities in vulnerable coastal or tidal areas)	• Inundation from sea water, flooding • Loss of critical infrastructure (communications, mechanical systems, power, water supply, technology) • Loss of use of facility (temporary or permanent)
Severe Storms	• Damage/destruction from wind • Loss of critical infrastructure (communications, mechanical systems, power, water supply, technology) • Loss of use of facility (temporary or permanent)

A project to produce a statewide inventory of facilities was initiated in August 2013, with a projected completion date for the pilot phase of mid-2014. The pilot will identify and assess one category of state critical infrastructure, developing the methodology for what is anticipated to be a multi-year project. The methodology will include analysis of vulnerability and estimated potential losses to state facilities from future hazard events. **Section 3.1.8** provides a comprehensive description of the status of the statewide facilities inventory project.

In the past few years, New York State has implemented a number of initiatives, some of which are applicable to state-owned and operated facilities, intended to address climate change through policy, research, and adaptive measures. The following table describes some of the initiatives and projects that are completed, currently underway, or planned.

Table 3.4f: Climate Change Initiatives in New York State

Type of Initiative	Measure	Date Implemented (*or planned*)
Policy		
Executive Order No. 2	Established a State Energy Planning Board and authorized the creation and implementation of a State Energy Plan.	2008
Executive Order No. 4	Established a State Green Procurement and Agency Sustainability Program.	2009
Executive Order No. 24	Established a goal to reduce greenhouse gas emissions 80% by the year 2050 and prepare a Climate Action Plan.	2009
DEC Policy CP-49/Climate Change and DEC Action	Established goal of the State to reduce greenhouse gas emissions; created the Climate Action Council; required a draft Climate Action Plan by September 2010.	10/22/2010
Research, Studies and Reports		
Technical Report	"Responding to Climate Change in New York State", (ClimAID), Final Report 11-18, NYSERDA: provided a framework to develop and implement a program to reduce greenhouse gasses and dependence on energy.	November 2011
Projects and Initiatives		
Flood Protection (New York City, Mayor's Office)	$20 billion project to build removable floodwalls, levees, gates and other flood defenses for New York City.	[Proposed June 2013]
Climate Smart Communities Certification Program (DEC)	Project to build community support for and commitment to "green" activities. A roadmap for community climate action will be designed. Four pilot communities in 2013.	2013 – on-going
Governor's NY Rising Community	Established to provide additional rebuilding and revitalization assistance to	2013 – on-going

Type of Initiative	Measure	Date Implemented (*or planned*)
Reconstruction Program	communities severely damaged by Hurricanes Sandy, Irene and Lee. To facilitate community redevelopment planning and the resilience of communities, $25 million is allocated for planning in the most affected communities. Future allocations of funds will support implementation of projects and activities identified in the plans that the communities produce.	
Plans and Procedures		
Extreme Weather Planning and Response Guide (DOH)	Consistent with climate change and health priorities of the Centers for Disease Control and Prevention (CDC), the New York State Department of Health (DOH) is updating its preparedness plan for extreme weather emergencies. The Guide serves as a basis for the coordination, preparation, response, and recovery activities.	2013 – on-going
Hudson River Sustainable Shorelines Project (DEC)	Developing guidance for communities on management options for controlling shoreline erosion, including relative costs, impacts on habitat functions and resilience to storms and sea level rise.	Current - 2013
SLAMM Modeling in the Hudson Estuary (DEC)	SLAMM (Sea Level Rise Affecting Marshes Model) is being used to model potential marsh migration in the estuary to develop shoreline conservation priorities and assess the need for barrier removal to facilitate the landward migration of tidal wetlands as sea levels rise. Loss of wetlands can impact water quality, especially in drought or heat extremes.	Current - 2013

Type of Initiative	Measure	Date Implemented (*or planned*)
Post Sandy Enhancement Plan – Consolidated Edison Co. of New York	Identifies issues and makes recommendations related to hardening Consolidated Edison systems, improving information provided to customers, and strengthening partnerships. The plan considers changing weather patterns that could damage systems vulnerable to flooding and high winds/tree damage in more intense future storms. Specific mitigation projects that will mitigate power loss to more than 200,000 customers are detailed (p. 43-44)	June 2013

3.4.4 Estimating Climate Change Potential Losses by Jurisdiction

The methodology used to analyze and integrate information related to estimating potential losses from LHMPs is described in **Section 3.1 and Section 5.**

According to scientific projections, sea level rise associated with climate change will have significant effects on coastal areas in coming years. A study supported by Lloyd's insurance estimated the effects of climate change on storm impacts for undefended Atlantic coastal areas. The summary of finding stated, "If no action is taken by the 2030s, sea level rise could increase future average losses by more than 80% from present levels, meaning that more extensive damage will be experienced more often. An increase of 5% in the number of powerful hurricanes would raise future average flood damage losses to more than 90% above present levels. Even with a decrease in the number of storms, future average losses would be around 70% above present levels." While this study is not specific to New York, the general trend of increasing impacts associated with sea level rise, coupled with increasing coastal development indicates the increasing risk exposure for coastal areas[19].

No FEMA-approved county hazard mitigation plans identify climate change as a hazard; however any loss data available in local plans is referenced in the specific hazard sections of this plan (coastal erosion, extreme temperatures, flood, hurricane and wildfire).

Effects of Changes in development on loss estimates

Although the hazards linked to climate change have the potential to increase losses from future events, the state is taking significant steps to address these issues through adaptive

[19] Lloyd's Insurance

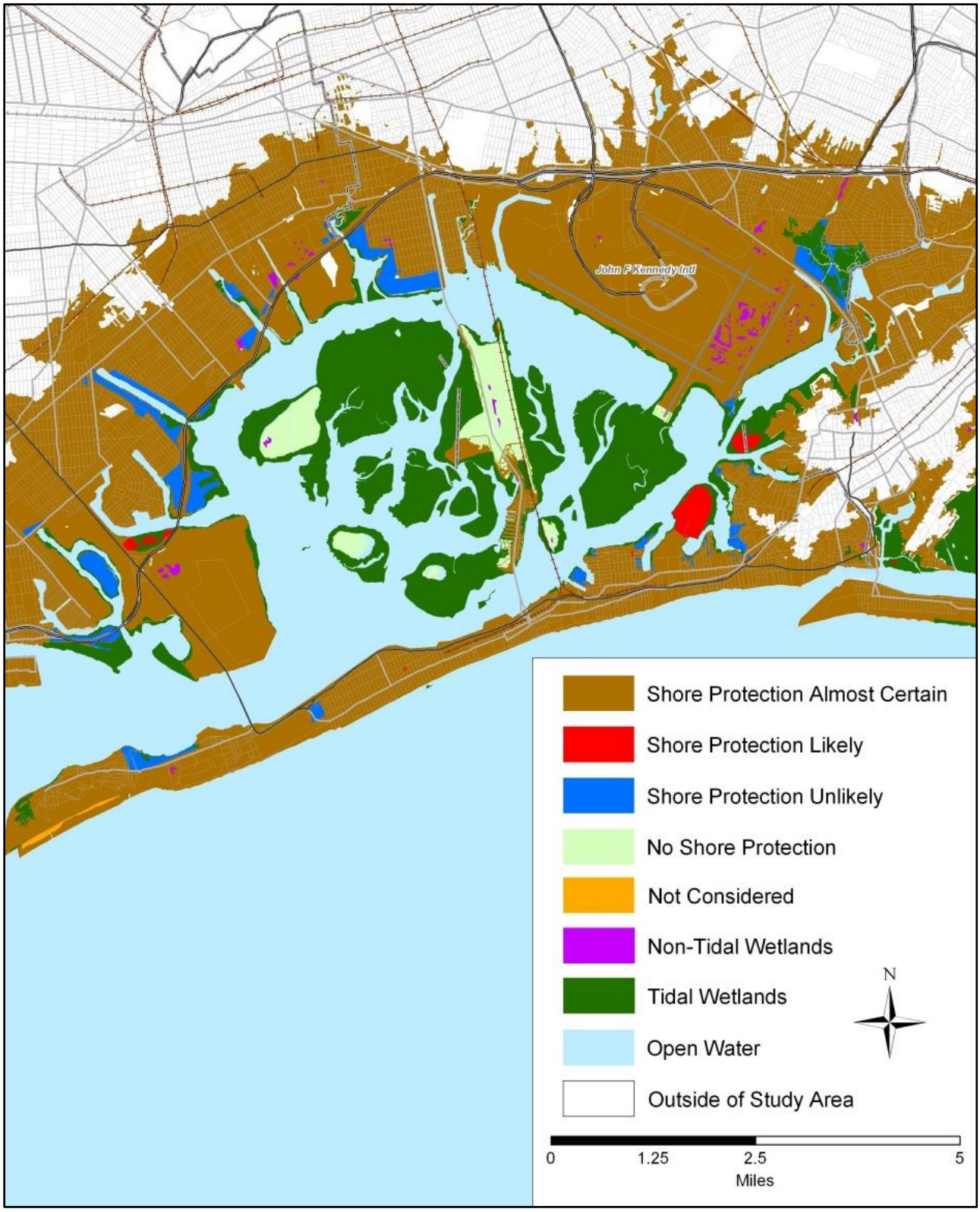
planning. This approach is identifying measures that could lessen the impact of climate change hazards and their resulting losses.

Coastal areas are highly susceptible to loss from the impacts of sea level rise and severe storms, as well as flooding; however, various programs for coastal planning, development, and construction are regulating and providing guidance for appropriate mitigation measures. Other impacts such as drought and extreme temperatures will have little impact on loss estimates related to changes in development.

A $2 million study and mapping project conducted by New York Sea Grants studied the likelihood of shore protection as sea level rises**. Figure 3.4j** depicts the likelihood of various types of protection for Southern Queens. Maps such as these can assist local land use planners in identifying appropriate and acceptable methods for protecting existing development and planning for future development along the New York shoreline which will reduce losses from future events[20].

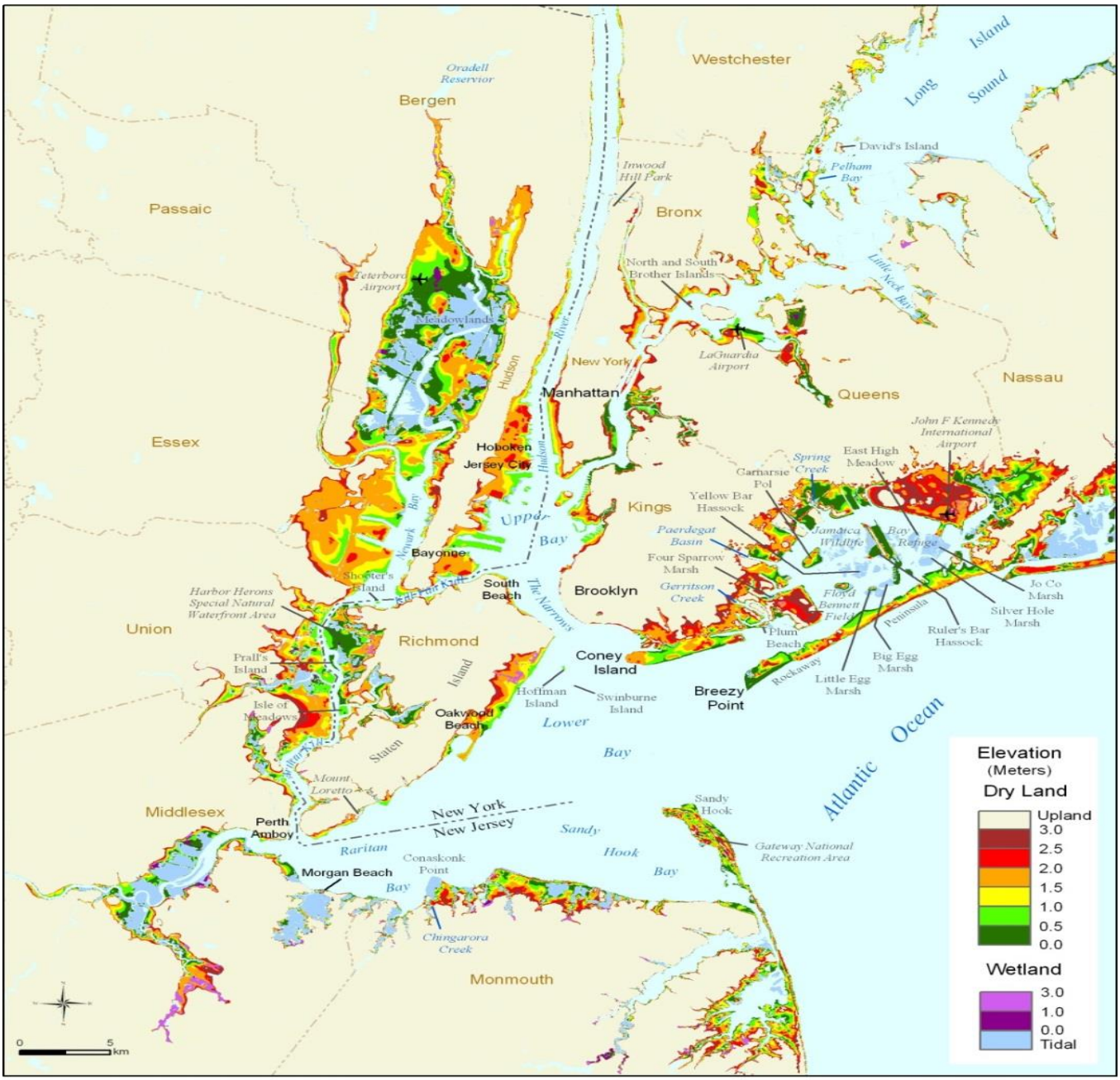
[20] Tanski, The Likelihood of Shore Protection along the Atlantic Coast of the United States. (2010)

Figure 3.4j: New York Sea level Rise Planning Map – Southern Queens



Source: http://plan.risingsea.net/view/S8_Greater_NYC.html

Figure 3.4k is a graphical representation of the lands near the Atlantic Ocean that are close to sea level. Areas depicted in this map could be more susceptible to losses from high tides, sea level rise, and the increased impacts from wind-driven waves due to climate change.



Elevations of Land Close to Sea Level
Elevations are above spring high water, which is the average high tide during new and full moons, and approximately the inland boundary of tidal wetlands. This map is a general graphical representation of elevations in the area depicted, not designed to estimate the precise elevations at specific locations. Actual elevations at specific locations may be 150 cm above or below the elevation shown.
Source: J.G. Titus and J Wang. 2008. "Maps of Lands Close to Sea Level along the Mid-Atlantic Coast". US Environmental Protection Agency.

Source: Titus and Wang, 2008, Maps of Lands Close to Sea Level along the Mid-Atlantic Coast, U.S. Environmental Protection Agency

3.4.5 Estimating Potential Losses of State Facilities

One method of determining potential losses of state facilities related to climate change is to analyze those buildings located within 100-year flood zones—keeping in mind that the FEMA current 100-year flood zones do not take climate change into account. While not all buildings within these zones are likely to flood, some level of vulnerability to future flooding and sea level rise may be linked to these zones. **Figure 3.4l** shows state-owned buildings that lie within the 100-year flood zone. A few data gaps exist that render this a working analysis. First, the New York State Office of General Services (OGS) manages over roughly 56,000 buildings. Secondly, a GIS file exists that has a record of just over 19,000 buildings; this GIS layer is currently in the process of being updated. Finally, not all buildings on record have an associated replacement value. After accounting for these gaps, the flood hazard analysis derived 1,101 buildings in the 100-year flood zone, with 925 buildings having an associated replacement value, to arrive at the total of $364,974,721. Emphasis is placed on the fact that these datasets are part of an on-going state inventory and risk assessment project.

Because of the scope of hazards that are associated with climate change, there is no single reliable dataset that can be used to estimate losses for state facilities. For the estimated losses for state buildings in 100-year flood zones best illustrate vulnerabilities related to increases in precipitation and flooding. This data includes buildings only and does not consider other state-owned and –operated infrastructure at risk, such as roads, bridges, culverts and others.

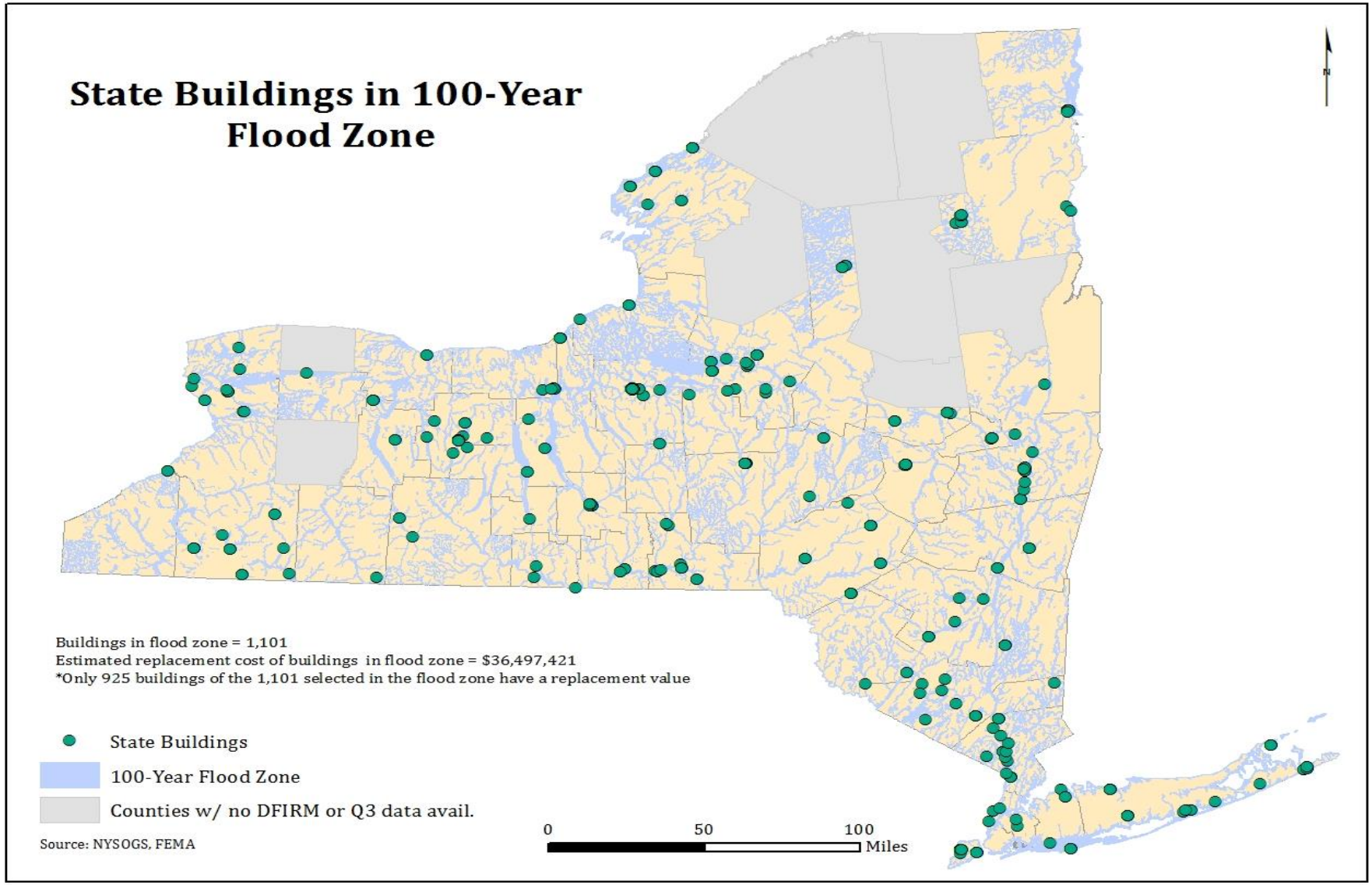
Table 3.4g: State-Owned Buildings in 100-Year Flood Zone

Agency	Number of Buildings	Replacement Cost
Office of General Services (OGS)	5	$52,955,119
Department of Cyber Security (DOCS)	1	$10,167,770
Office of Parks, Recreation and Historic Preservation (OPRHP)	542	$95,357,356
Department Environmental Conservation (DEC)	140	$12,041,616
Office of Mental Health (OMH)	18	$36,440,505
Office of People with Developmental Disabilities (OPWDD)	89	$90,525,608
Department of Military and Naval Affairs (DMNA)	1	$11,627,475
Department of Transportation (DOT)	49	$23,936,201
Office of Children and family Services (OCFS)	11	$2,431,631
Department of Agriculture and Markets (AG&MKTS)	69	$29,491,440
Total	**925**	**$364,974,721**

Source: FEMA, OGS

For estimated losses of state facilities related to specific Hazards, see also **Sections 3.4, 3.9, 3.12** and **3.17**.

Figure 3.4l: State Buildings in 100-Year Flood Zone



3.4.6 Data Sources and Limitations

It is recommended that Jurisdictions that are developing or updating their local Hazard Mitigation Plans take into account the effects that climatic change may have on their vulnerability to specific hazards. A number of statewide and regional panels and task forces have been established to begin to address the issue of adaptation and community resiliency to climate change. Representatives from the NYC Mayor's Office, NYS DHSES, NYS DEC, NYS DOS and other agencies have participated on these panels and task forces. Some of these panels and task forces have produced guidance documents and climate adaptation assistance tools that Hazard Mitigation Planners and elected officials may find of use in developing or updating local Hazard Mitigation Plans, including the following:

- New York Governor's Office, Executive Order 2 (2008) - established a State Energy Planning Board and authorized the creation and implementation of a State Energy Plan
- New York Governor's Office, Executive Order 4 (2009) - established a State Green Procurement and Agency Sustainability Program
- New York Governor's Office, Executive Order 24 (2009) – established a goal to reduce greenhouse gas emissions 80% by the year 2050 and prepare a Climate Action Plan
- New York State Department of Environmental Conservation, CP-49/Climate Change and DEC Action;
    - http://www.dec.ny.gov/energy/50399.html
- NYS Legislative Sea Level Rise Task Force
    - http://www.dec.ny.gov/energy/45202.html
- *Climate Risk Information,* New York City Panel on Climate Change 2010 Report (February 2009)
- *Climate Change Adaptation in New York City: Building a Risk Management Response*: New York City Panel on Climate Change 2010 Report (Nov 2011); Volume 1196
- New York State Sea Level Rise Task Force Report to the Legislature, December 31, 2010
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