

5.4.6 EXTREME TEMPERATURE

This section provides a profile and vulnerability assessment for the extreme temperature hazard.

HAZARD PROFILE

This section provides profile information including description, extent, location, previous occurrences and losses and the probability of future occurrences.

Description

Extreme temperature includes both heat and cold events, which can have a significant impact to human health, commercial/agricultural businesses and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). What constitutes “extreme cold” or “extreme heat” can vary across different areas of the country, based on what the population is accustomed to.

Extreme Cold: Extreme cold events are when temperatures drop well below normal in an area. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered “extreme cold.” Extreme cold temperatures are characterized by the ambient air temperature dropping to approximately 0 degrees Fahrenheit (°F) or below.

Exposure to cold temperatures, whether indoors or outside, can lead to serious or life-threatening health problems such as hypothermia, cold stress, frostbite or freezing of the exposed extremities such as fingers, toes, nose and ear lobes. Hypothermia occurs when the core body temperature is <95°F. If persons exposed to excessive cold are unable to generate enough heat (e.g., through shivering) to maintain a normal core body temperature of 98.6°F, their organs (e.g., brain, heart, or kidneys) can malfunction. When brain function deteriorates, persons with hypothermia are less likely to perceive the need to seek shelter. Signs and symptoms of hypothermia (e.g., lethargy, weakness, loss of coordination, confusion, or uncontrollable shivering) can increase in severity as the body’s core temperature drops. Extreme cold also can cause emergencies in susceptible populations, such as those without shelter, those who are stranded, or those who live in a home that is poorly insulated or without heat (such as mobile homes). Infants and the elderly are particularly at risk, but anyone can be affected (Centers of Disease Control and Prevention [CDC], 2005).

Extremely cold temperatures often accompany a winter storm, so individuals may have to cope with power failures and icy roads. Although staying indoors as much as possible can help reduce the risk of car crashes and falls on the ice, individuals may also face indoor hazards. Many homes will be too cold—either due to a power failure or because the heating system is not adequate for the weather. The use of space heaters and fireplaces to keep warm increases the risk of household fires and carbon monoxide poisoning.

During cold months, carbon monoxide may be high in some areas because the colder weather makes it difficult for car emission control systems to operate effectively. Carbon monoxide levels are typically higher during cold weather because the cold temperatures make combustion less complete and cause inversions that trap pollutants close to the ground (USEPA, 2009).

Extreme Heat: Temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks are defined as extreme heat (FEMA, 2006; CDC, 2009). An extended period of extreme heat of three or more consecutive days is typically called a heat wave and is often accompanied by high humidity (NWS, 2005). There is no universal definition of a heat wave because the

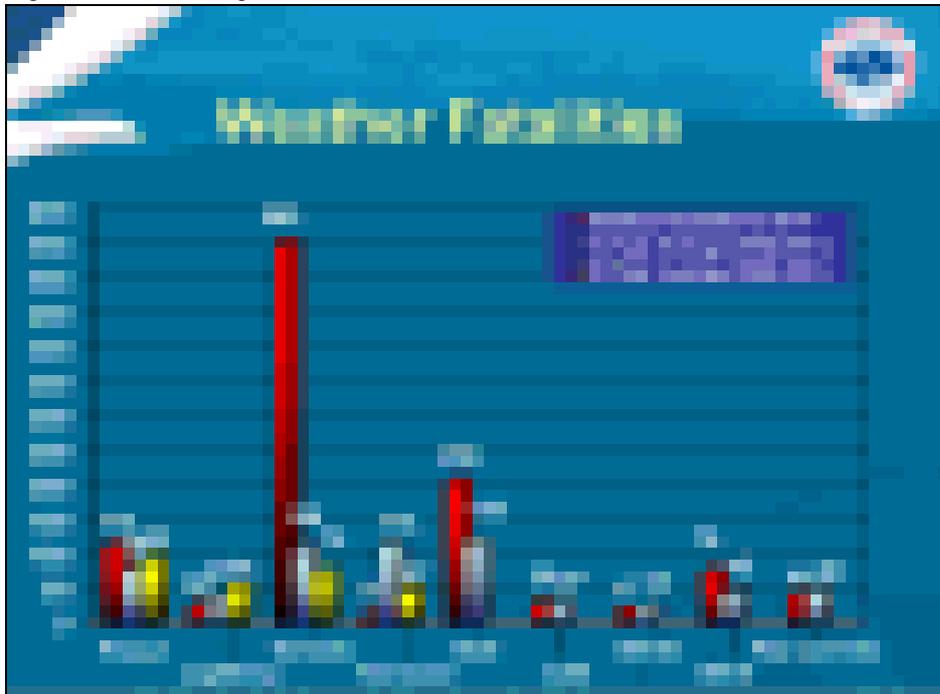
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term is relative to the usual weather in a particular area. The term heat wave is applied both to routine weather variations and to extraordinary spells of heat which may occur only once a century (Meehl and Tebaldi, 2004). A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population (Robinson, 2000). The Weather Channel uses the following criteria for a heat wave in the U.S.: a minimum of 10 states with greater than or equal to 90°F temperatures and the temperatures must be at least five degrees above normal in parts of that area for at least two days or more (The Weather Channel, 2012).

Depending on severity, duration and location; extreme heat events can create or provoke secondary hazards including, but not limited to, dust storms, droughts, wildfires, water shortages and power outages (FEMA, 2006; CDC, 2006). This could result in a broad and far-reaching set of impacts throughout a local area or entire region. Impacts could include significant loss of life and illness; economic costs in transportation, agriculture, production, energy and infrastructure; and losses of ecosystems, wildlife habitats and water resources (Adams, Date Unknown; Meehl and Tebaldi, 2004; CDC, 2006; Draft NYS HMP, 2011).

Extreme heat is the number one weather-related cause of death in the U.S. On average; more than 1,500 people die each year from excessive heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, flooding, hurricanes and lightning combined (NOAA, Date Unknown). In 2011, New York State reported 20 heat-related fatalities (NOAA, 2011). Figure 5.4.6-1 shows the number of weather fatalities based on a 10 year average and 30 year average. Heat has the highest average of weather related fatalities between 2002 and 2011.

Figure 5.4.6-1. Average Number of Weather Related Fatalities in the U.S.



Source: NOAA, 2012

Certain populations are considered vulnerable or at greater risk during extreme heat events. These populations include, but are not limited to the following: the elderly age 65 and older, infants and young

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children under five years of age, pregnant woman, the homeless or poor, the overweight, and people with mental illnesses, disabilities and chronic diseases (NYS HMP, 2008).

Urbanized areas and urbanization creates an exacerbated type of risk during an extreme heat event, compared to rural and suburban areas. As defined by the U.S. Census Bureau, urban areas are classified as all territory, population, and housing units located within urbanized areas and urban clusters. The term urbanized area denotes an urban area of 50,000 or more people. Urban areas under 50,000 people are called urban clusters. The U.S. Census delineates urbanized area and urban cluster boundaries to encompass densely settled territory, which generally consists of:

- A cluster of one or more block groups or census blocks each of which has a population density of at least 1,000 people per square mile at the time.
- Surrounding block groups and census blocks each of which has a population density of at least 500 people per square mile at the time.
- Less densely settled blocks that form enclaves or indentations, or are used to connect discontinuous areas with qualifying densities (U.S. Census Bureau, 2003).

Approximately 47-percent of the world's population lives in urban areas. This number is expected to increase by two-percent each year between 2000 and 2015. Urbanization is caused by natural growth of the urban population and migration of the rural population towards cities (United Nations Environment Program, 2002). As these urban areas develop and change, so does the landscape. Buildings, roads and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist are now impermeable and dry. These changes cause urban areas to become warmer than the surrounding areas. This forms an 'island' of higher temperatures (USEPA, 2009).

The term 'heat island' describes built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with more than one million people can be between 1.8 and 5.4°F warmer than its surrounding areas. In the evening, the difference in air temperatures can be as high as 22°F. Heat islands occur on the surface and in the atmosphere. On a hot, sunny day, the sun can heat dry, exposed urban surfaces to temperatures 50 to 90°F hotter than the air. Heat islands can affect communities by increasing peak energy demand during the summer, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and death, and water quality degradation (USEPA, 2010 and 2011). Detailed information regarding the affects of heat islands is described below.

- Elevated summer temperatures increase the energy demand for cooling. Research has shown that for every 1°F, electricity demand increases between 1.5 and 2-percent, starting when temperatures reach between 68 and 77°F. Urban heat islands increase overall electricity demand, as well as peak demand. This generally occurs during hot, summer afternoons when homes and offices are running cooling systems, electricity and appliances. During extreme heat events, the demand for cooling can overload systems and require utility companies to institute controlled brownouts or blackouts to prevent power outages (USEPA, 2011).
- Urban heat islands raise the demand for electricity during the summer. Companies that provide the electricity generally rely on fossil fuel power plants to meet the demand. This can lead to an increase in air pollution and greenhouse gas emissions. The primary pollutants include sulfur dioxide (SO₂), nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide (CO), and mercury (CO₂). These can all contribute to global climate change. Elevated temperatures can also directly increase the rate of ground-level ozone formation. Ground-level ozone is formed when NO_x and volatile organic compounds (VOCs) react to the presence of sunlight and hot weather (USEPA, 2011).

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- Increased temperatures and higher air pollution levels can affect human health by causing discomfort, respiratory difficulties, heat cramps and exhaustion, heat stroke, and mortality. Heat islands can also intensify the impact of heat waves. High risk populations are at particular risk from extreme heat events (USEPA, 2011).
- Urban areas often have many buildings and paved areas. During the hot, summer months, high pavement and rooftop surface temperatures can heat stormwater runoff. Pavements that are 100°F can elevate initial rainwater temperature from approximately 70°F to over 95°F. The heated stormwater usually becomes runoff and drains into storm sewers and raises water temperatures of streams, river, ponds and lakes. Water temperature affects aquatic life. Rapid temperature changes in aquatic ecosystems from stormwater runoff can be stressful and sometimes fatal to aquatic habitats (USEPA, 2011).

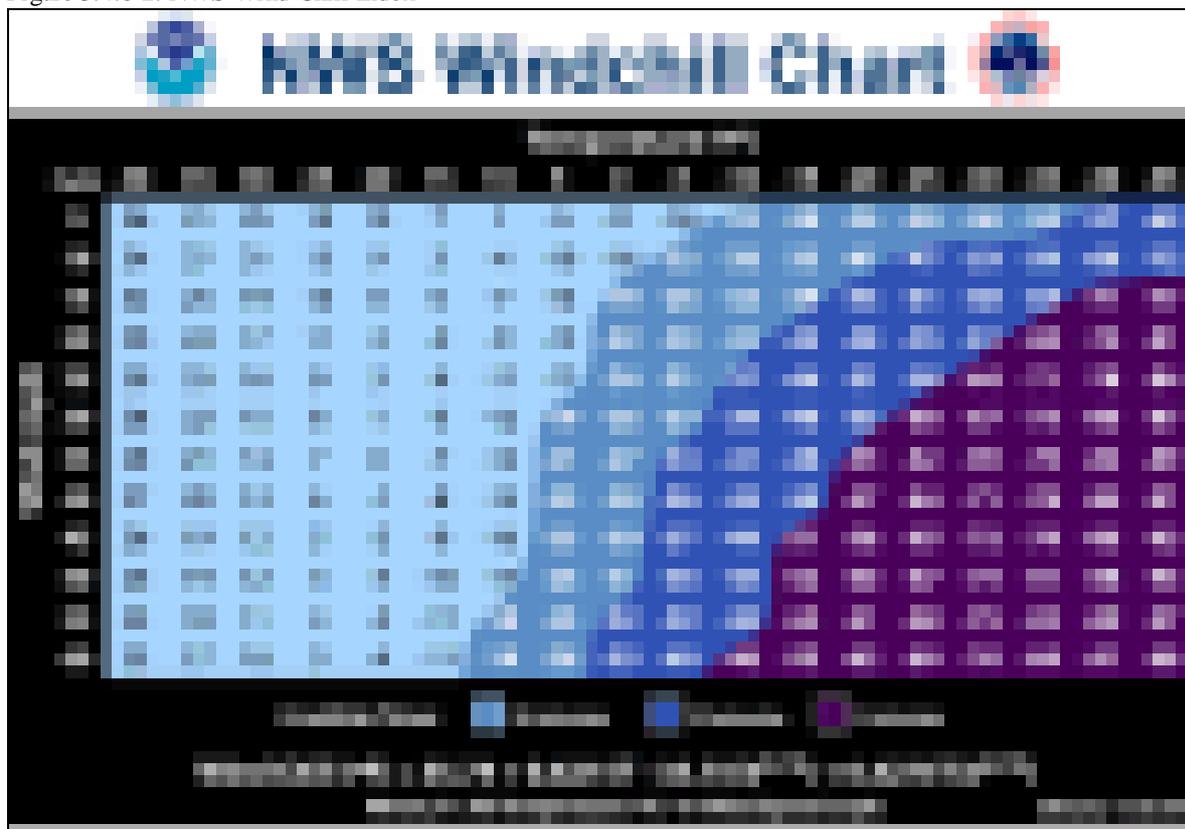
Extent

Extreme Cold Temperatures

The extent (severity or magnitude) of extreme cold temperatures are generally measured through the Wind Chill Temperature (WCT) Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body is cooled at a faster rate causing the skin's temperature to drop (NWS, 2009).

On November 1, 2001, the NWS implemented a new WCT Index. It was designed to more accurately calculate how cold air feels on human skin. Figure 5.4.6-2 shows the new WCT Index. The Index includes a frostbite indicator, showing points where temperature, wind speed and exposure time will produce frostbite to humans. The chart shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS, 2009).

Figure 5.4.6-2. NWS Wind Chill Index



Source: NWS, 2008

According to the New York State Climate (NYSC) Office of Cornell University, cold winter temperatures prevail over New York State whenever Arctic air masses, under high barometric pressure, flow southward from central Canada or from Hudson Bay. High-pressure systems often move just off the Atlantic coast, become more or less stagnant for several days, and then a persistent airflow from the southwest or south affects the State. This circulation brings the very warm, often humid weather of the summer season and the mild, more pleasant temperatures during the fall, winter, and spring seasons. The highest temperature of record in New York State is 108° at Troy on July 22, 1926. Temperatures of 107° have been observed at Lewiston, Elmira, Poughkeepsie, and New York City. The record coldest temperature is -52° at Stillwater Reservoir (northern Herkimer County) on February 9, 1934 and also at Old Forge (also northern Herkimer County) on February 18, 1979. Some 30 communities have recorded temperatures of -40° or colder, most of them occurring in the northern one-half of the state and the remainder in the Western Plateau Climate Division and in localities just south of the Mohawk Valley (NYSC, Date Unknown).

Extreme Heat Temperatures

The extent of extreme heat temperatures are generally measured through the Heat Index, identified in Table 5.4.6-1. Created by the NWS, the Heat Index is a chart which accurately measures apparent temperature of the air as it increases with the relative humidity. The Heat Index can be used to determine what effects the temperature and humidity can have on the population (NYSDPC, 2008; NCDC, 2000)

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Table 5.4.6-1. Heat Index Chart

		Temperature (°F)															
		80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
Relative Humidity (%)	40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
	45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
	50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
	55	81	84	86	89	93	97	101	106	112	117	124	130	137			
	60	82	84	88	91	95	100	105	110	116	123	129	137				
	65	82	85	89	93	98	103	108	114	121	128	136					
	70	83	86	90	95	100	105	112	119	126	134						
	75	84	88	92	97	103	109	116	124	132							
	80	84	89	94	100	106	113	121	129								
	85	85	90	96	102	110	117	126	135								
	90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127											
100	87	95	103	112	121	132											

Source: NCDC, 2000; NYSDPC, 2008

Table 5.4.6-2 describes the adverse effects that prolonged exposure to heat and humidity can have on an individual.

Table 5.4.6-2. Adverse Effects of Prolonged Exposures to Heat on Individuals

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke / Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Source: NYSDEC, 2008

To determine the Heat Index, one needs to know the temperature and relative humidity. Once both values are known, the Heat Index will be the corresponding number with both values. That number provides a temperature that the body feels. It is important to know that the Heat Index values are devised for shady, light wind conditions. Exposure to full sunshine can increase the Heat Index by up to 15 degrees (NYSDEC, 2008).

Location

New York State is divided into 10 climate divisions: Western Plateau, Eastern Plateau, Northern Plateau, Coastal, Hudson Valley, Mohawk Valley, Champlain Valley, St. Lawrence Valley, Great Lakes, and central Lakes. According to NCDC, “Climatic divisions are regions within each state that have been determined to be reasonably climatically homogeneous” (NWS, 2005; NCDC, 2010). Broome County is located within the Eastern Plateau Climate Division. Figure 5.4.6-3 depicts the climate divisions in New York State.

Figure 5.4.6-3. New York State Climate Divisions



Source: NWS, 2005

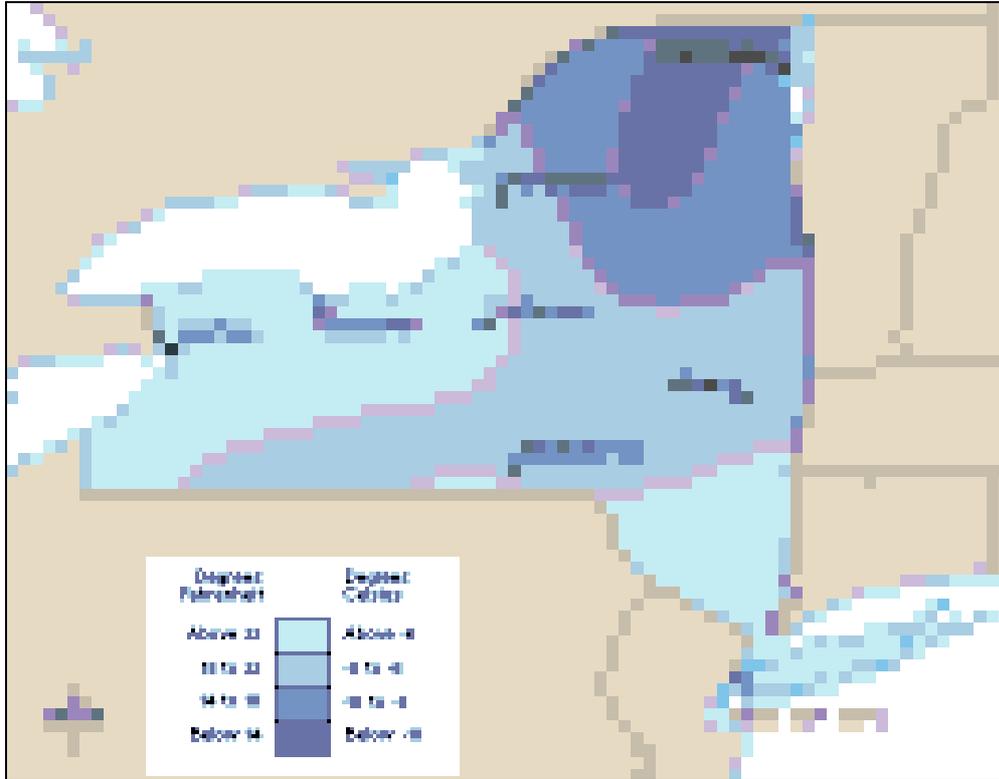
Note: (1) Western Plateau; (2) Eastern Plateau (Catskill Mountains); (3) Northern Plateau (Adirondack Mountains); (4) Coastal; (5) Hudson Valley; (6) Champlain Valley; (7) St. Lawrence Valley; (8) Great Lakes; and (10) Central Lakes.

Extreme Cold Temperatures

Extreme cold temperatures occur throughout most of the winter season and generally accompany most winter storm events throughout the State. The NYSC Office of Cornell University indicates that cold temperatures prevail over the State whenever arctic air masses, under high barometric pressure, flow southward from central Canada or from Hudson Bay (NYSC, Date Unknown). Figure 5.4.6-4 identifies the average January temperatures of the State, with the northeast sections experiencing the coldest conditions and the west and southeast experiencing the mildest winters.

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Figure 5.4.6-4. Average Statewide January Temperatures



Source: World Book Inc., 2007

Many atmospheric and physiographic controls on the climate result in a considerable variation of temperature conditions over New York State. The average annual mean temperature ranges from about 40°F in the Adirondacks to near 55°F in the New York City area. In January, the average mean temperature is approximately 16°F in the Adirondacks and St. Lawrence Valley, but increases to about 26°F along Lake Erie and in the lower Hudson Valley and to 31°F on Long Island. The record coldest temperature in New York State is -52°F at Stillwater Reservoir (northern Herkimer County) on February 9, 1934. Approximately 30 communities have recorded temperatures of -40°F or colder, most of them occurring in the northern half of New York State and the remainder in the Western Plateau Climate Division and in localities just south of the Mohawk Valley (Earth System Research Laboratory [ESRL], Date Unknown; NYSC, Date Unknown).

The winters are long and cold in the Plateau Divisions of New York State (including the Eastern Plateau). In the majority of winter seasons, a temperature of -25°F or lower can be expected in the northern highlands and -15°F or colder in the southwestern and east-central highlands (NYSC, Date Unknown).

As provided by The Weather Channel, average high and low temperatures during the winter months around Broome County are identified in Table 5.4.6-3.

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Table 5.4.6-3. Average High and Low Temperature Range for Winter Months in Broome County

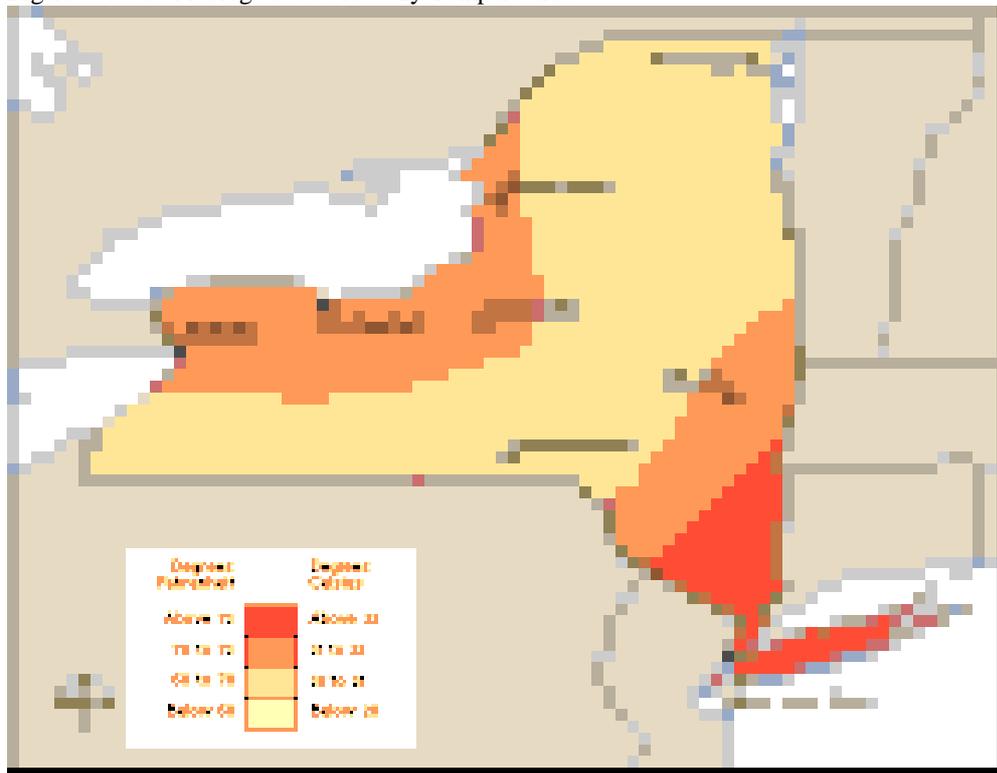
Month	Average High	Average Low	Record Low Event(s)
January	29°F	16°F	-20°F in 1957
February	32°F	18°F	-15°F in 1979
March	41°F	25°F	-7°F in 1993
November	45°F	31°F	3°F in 1976
December	33°F	21°F	-18°F in 1980

Source: The Weather Channel, 2012

Extreme Heat Temperatures

Extreme heat temperatures of varying degrees are existent throughout the State for most of the summer season, except for areas with high altitudes. Figure 5.4.6-5 identifies the average July temperatures of the State, with the southeast and northwest sections experiencing the hottest conditions.

Figure 5.4.6-5. Average Statewide July Temperatures



Source: World Book Inc., 2008

As provided by The Weather Channel, average high and low temperatures during the summer months around Broome County are identified in Table 5.4.6-4.

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Table 5.4.6-4. Average High and Low Temperature Range for Summer Months in Broome County

Month	Average High	Average Low	Record High Event(s)
May	66°F	46°F	89°F in 1996
June	74°F	55°F	94°F in 1952
July	78°F	60°F	98°F in 1988
August	77°F	58°F	95°F in 2002
September	68°F	51°F	96°F in 1953

Source: The Weather Channel, 2012

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with extreme temperatures throughout New York State and Broome County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events could vary. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

The Midwest Regional Climate Center (MRCC) operates an online annual temperature extremes database of the Continental U.S., otherwise known as “MRCC Cooperative Observer Station Annual Temperature Record Data Set”. The data set contains the annual maximum and minimum temperature records for stations in the U.S. Each station has a cooperative observer system i.d. number (coop number), and those examined for this HMP had a running length of more than five years. In New York State, there are 269 stations that were observed; however, only six stations in Broome County. Not every city, town and/or village in New York State contains a station (MRCC, 2012).

There may be some potential problems with the data collected at the stations. The records were created by MRCC at the request of a user. The values of the all-time records for stations with brief histories are limited in accuracy and could vary from nearby stations with longer records. Although the data sets have been through quality control, there is still a need for more resources to quality control extremes. The record sets are for single stations in the cooperative observer network and are limited to the time of operation of each station under one coop number. The records for a place may need to be constructed from several individual station histories. Some of the data may vary from NWS records due to NWS using multiple stations and additional sources like record books (MRCC, Date Unknown).

Based on the data provided by MRCC, Table 5.4.6-5 presents the extreme cold (minimum) and hot (maximum) temperature records for Broome County from 1893 to 2003.

Table 5.4.6-5. MRCC Temperature Extremes – Broome County

Station ID	Name	Begin	End	Max (°F)	Max Date	Min (°F)	Min Date	Avg Max	Avg Min
300691	Binghamton	1893	1968	103	7/9/1936	-28	1/17/1893	50	30.5
300687	Binghamton	1951	2003	98	7/16/1988	-20	1/15/1957	46.1	29.4
302030	Deposit	1962	2003	98	7/15/1995	-31	1/21/1994	49.3	27.5
302627	Endicott	1985	2003	101	7/17/1988	-26	1/21/1994	50.1	27.9
308831	Vestal	1968	1977	92	6/28/1969	-14	1/23/1976	47	27.7
308833	Vestal	1977	1985	95	7/21/1980	-17	2/11/1979	46.8	27.7

Source: MRCC, 2012

Notes: Begin Year is when the data collection began; End Year is when the data collection stopped.



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Between 1954 and 2012, New York State was not included in any major disaster declarations or emergency declarations due to extreme temperatures. Information regarding specific details of temperature extremes in Broome County is scarce; therefore, previous occurrences and losses associated with extreme temperature events are limited. Table 5.4.6-6 summarizes the extreme temperature events in the County.

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Table 5.4.6-6. Extreme Temperature Events between 1950 and 2012

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
June 13-18, 1988	Heat	N/A	N/A		SHELDUS
July 4-11, 1988	Heat	N/A	N/A	Approximately \$2K in property damage.	SHELDUS
August 1, 1988	Heat Wave	N/A	N/A		SHELDUS
October 11, 1993	Record Cold	N/A	N/A	A high pressure stretched from central New England to northeast Pennsylvania, resulting in record lows across parts of the Susquehanna Region. The City of Binghamton dropped to 25°F, setting a new record low.	NOAA-NCDC
October 13-14, 1993	Record Cold	N/A	N/A	A ridge of high pressure moved into central NYS that resulted in record lows across parts of the Susquehanna Region. The City of Binghamton set a new record low of 28°F on the 13 th and 24°F on the 14 th .	NOAA-NCDC
January 15, 2004	Extreme Cold	N/A	N/A	A deep, low pressure system in southeast Canada combined with a large area of high pressure in Ontario created northwest winds of 15 to 25 mph across the area. The northwest winds brought more Arctic air to the region with temperatures dropping to below zero. The wind and cold dropped wind chill values to 20 to 40 below zero. Many schools were closed due to the cold weather. Pipes froze at homes and businesses. Broome County had approximately \$220K in property damage.	NOAA-NCDC
December 14, 2005	Record Cold	N/A	N/A	Many counties in NYS reported record cold temperatures, including Broome County. Temperatures in the County ranged from -6°F at the Binghamton Airport to -13°F at Whitney Point.	NOAA-NCDC, NWS
January 2-3, 2008	Cold	N/A	N/A	In Broome County, temperatures ranged from 0°F to -3°F.	NWS
February 29, 2008	Cold	N/A	N/A	Clear skies and calm winds allowed temperatures to fall below zero across central NYS and northeast Pennsylvania. In Broome County, temperatures ranged from 0°F to -11°F.	NWS
January 14-15, 2009	Low Temperatures	N/A	N/A	In Broome County, temperatures ranged from 4°F to -3°F.	NWS
January 15-16, 2009	Low Temperatures	N/A	N/A	In Broome County, temperatures ranged from -2°F to -18°F.	NWS
July 21, 2011	Extreme Heat	N/A	N/A	The heat index ranged from 96°F in the Town of Vestal to 111°F in the Village of Port Dickinson. The maximum air temperatures	NWS



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Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				ranged from 95°F in Johnson City to 101°F in the Village of Port Dickinson.	

Note (1): Monetary figures within this table were U.S. Dollar (USD) figures calculated during or within the approximate time of the event. If such an event would occur in the present day, monetary losses would be considerably higher in USDs as a result of increased U.S. Inflation Rates.

- NOAA-NCDC National Oceanic Atmospheric Administration – National Climate Data Center
- NWS National Weather Service
- NYS New York State
- SHELDUS Spatial Hazard Events and Losses Database for the United States



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Agriculture-related disasters are quite common. The Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans (EM) to producers suffering losses in those counties and in counties that are contiguous to a designated county. Table 5.4.6-7 presents USDA declared drought, excessive heat, frosts and freeze events impacting Broome County.

Table 5.4.6-7. USDA Declared Disasters

Incidence Period	Event Type	USDA Designation Number	County Designated?*	Losses / Impacts	Source(s)
June 5 to June 8, 2008	Excessive Heat	S2731	Yes	Production losses	USDA
April 28 to May 28, 2008	Frost and Freeze	S2738	Yes	Production losses	USDA
May 31 to June 2, 2009	Frost and freeze	S2895	Yes	Production losses	USDA
February 15 to May 5, 2010	Frost, freeze, high winds, hail, excessive snow, excessive rain and cold temperatures	S3070	Yes	Production losses	USDA
March 1, 2012 and continuing	Frosts & Freeze	S3249	Yes	Physical and production losses attributed to frost and freezing temperatures	USDA
June 5 to 9, 2012	Excessive Heat	S2731	Yes	Production losses were attributed to excessive heat	USDA
June 1 to October 24, 2012	Drought and Excessive Heat	S3427	Yes	Production losses were attributed to drought and excessive heat	USDA
June 26, 2012 and continuing	Drought	S3441	No (Broome a contiguous county)	Physical and production losses were attributed to drought	USDA

Source: USDA, 2012

*Disaster event occurred within the county.

M Presidential Major Disaster Declaration
 N Administrative Physical Loss Notification
 S Secretarial National Disaster Determination
 USDA United States Department of Agriculture



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Probability of Future Events

Several extreme temperature events occur each year throughout Broome County. It is estimated that the County will continue to experience extreme temperatures annually that may induce secondary hazards such as potential snow, hail, ice or wind storms, thunderstorms, drought, human health impacts, utility failure and transportation accidents as well as many other anticipated impacts.

Based on historical records and input from the Planning Committee, the probability of occurrence for extreme temperatures in Broome County is considered “frequent” (hazard event that is likely to occur within 25 years) (see Section 5.3, Tables 5.3-4 and 5.3-6).

Climate Change Impacts

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue growing. Impacts related to increasing temperatures and sea level rise are already being felt in the State. ClimAID: the Integrated Assessment for Effective Climate Change in New York State (ClimAID) was undertaken to provide decision-makers with information on the State’s vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (New York State Energy Research and Development Authority [NYSERDA], 2011).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Broome County is part of Region 3, Southern Tier. Some of the issues in this region, affected by climate change, include: dairy dominates the agricultural economy and milk production losses are projected, Susquehanna River flooding increases, and this region is one of the first parts of the State hit by invasive insects, weeds and other pests moving north (NYSERDA, 2011).

Temperatures are expected to increase throughout the state, by 1.5 to 3°F by the 2020s, 3.5 to 5.5°F by the 2050s and 4.5 to 8.5°F by the 2080s. The lower ends of these ranges are for lower greenhouse gas emissions scenarios and the higher ends for higher emissions scenarios. Annual average precipitation is projected to increase by up to five-percent by the 2020s, up to 10-percent by the 2050s and up to 15-percent by the 2080s. During the winter months is when this additional precipitation will most likely occur, in the form of rain, and with the possibility of slightly reduced precipitation projected for the late summer and early fall. Table 5.4.6-8 displays the projected seasonal precipitation change for the Southern Tier ClimAID Region (NYSERDA, 2011).

Table 5.4.6-8. Projected Seasonal Precipitation Change in Region 3, 2050s (% change)

Winter	Spring	Summer	Fall
+5 to +15	0 to +15	-10 to +10	-5 to +10

Source: NYSEDA, 2011

Even though an increase in annual precipitation is projected, other climate change factors, such as an extended growing season, higher temperatures, and the possibility of more intense, less frequent summer rainfall, may lead to additional droughts and increased short-term drought periods (Cornell University, Date Unknown).

Droughts, typically caused by extreme heat temperatures, can cause deficits in surface and groundwater used for drinking water. The New York State Water Resources Institute at Cornell University conducted a vulnerability assessment of drinking water supplies and climate change. To assess water supplies in New York State, it was assumed that long-term average supply will remain the same but the duration and/or frequency of dry periods may increase. Both types of water supplies, surface water and

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groundwater, were divided into three categories: sensitive to short droughts (two to three months), sensitive to moderate and longer droughts (greater than six months), and relatively sensitive to any droughts. Major reservoir systems are presumed to have moderate sensitivity to drought because there is a likelihood of decreases in summer and fall water availability (Cornell University, Date Unknown). The greatest likelihood of future water shortages is likely to occur on small water systems (Cornell University, Date Unknown).

VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the extreme temperature events, the entire County has been identified as the hazard area. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), are vulnerable. The following text evaluates and estimates the potential impact of extreme temperatures on Broome County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities (4) economy and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2007 Broome County Hazard Mitigation Plan
- Further data collections that will assist understanding of this hazard over time

Overview of Vulnerability

Extreme temperatures generally occur for a short period of time but can cause a range of impacts, particularly to vulnerable populations that may not have access to adequate cooling or heating. This natural hazard can also cause impacts to agriculture (crops and animals), infrastructure (e.g., through pipe bursts associated with freezing, power failure) and the economy.

Data and Methodology

At the time of this Plan, insufficient data is available to model the long-term potential impacts of extreme temperature on Broome County. Over time, additional data such as historical damages, health impacts, and economic losses will be collected to allow better analysis for this hazard. Available information and a preliminary assessment are provided below.

Impact on Life, Health and Safety

For the purposes of this Plan, the entire population in Broome County is vulnerable to extreme temperature events. Extreme temperature events have potential health impacts including injury and death. According to the Centers for Disease Control and Prevention, populations most at risk to extreme cold and heat events include the following: 1) the elderly, who are less able to withstand temperatures extremes due to their age, health conditions and limited mobility to access shelters; 2) infants and children up to four years of age; 3) individuals who are physically ill (e.g., heart disease or high blood pressure), 4) low-income persons that cannot afford proper heating and cooling; and 5) the general public who may overexert during work or exercise during extreme heat events or experience hypothermia during extreme cold events.

Meteorologists can accurately forecast extreme heat event development and the severity of the associated conditions with several days lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations, implement short-term emergency response actions and focus on surveillance and relief efforts on those at greatest risk. Adhering to extreme temperature warnings can significantly reduce the risk of temperature-related deaths.

Refer to Section 4 which summarizes population in Broome County over the age of 65, and population with an annual income below the poverty threshold.

Impact on General Building Stock

All of the building stock in Broome County is exposed to the extreme temperature hazard. Refer to Section 4 which summarizes the building inventory in Broome County. Extreme heat generally does not impact buildings. Extreme heat events can contribute to conditions conducive to wildfires and reduce fire-fighting capabilities. Risk to life and property is greatest in those areas where forested areas adjoin urbanized areas (high density residential, commercial and industrial) or wildland/urban interface (WUI).

Losses may be associated with the overheating of HVAC systems. Extreme cold temperature events can damage buildings through freezing/bursting pipes and freeze/thaw cycles. Additionally, manufactured homes (mobile homes) and antiquated or poorly constructed facilities may have inadequate capabilities to withstand extreme temperatures.

Due to a lack of data regarding past losses specific to Broome County, it is not possible at this time to estimate potential future losses to extreme temperature events.

Impact on Critical Facilities

All critical facilities in Broome County are exposed to the extreme temperature hazard. Impacts to critical facilities are the same as described for general building stock (above). Additionally, it is essential that critical facilities remain operational during natural hazard events. Extreme heat events can sometimes cause short periods of utility failure, commonly referred to as “brown-outs”, due to increased usage from air conditioners, appliances, etc. Similarly, heavy snowfall and ice storms, associated with extreme cold temperature events, can cause power interruption as well. Backup power is recommended for critical facilities and infrastructure.

Impact on Economy

Extreme temperature events also have impacts on the economy, including loss of business function and damage/loss of inventory. Business-owners may be faced with increased financial burdens due to unexpected repairs caused to the building (e.g., pipes bursting), higher than normal utility bills or business interruption due to power failure (i.e., loss of electricity, telecommunications).

The agricultural industry is most at risk in terms of economic impact and damage due to extreme temperature events. Extreme heat events can result in drought and dry conditions and directly impact livestock and crop production.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as extreme temperature events. While predicting changes of extreme temperature events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

The 2011 ‘Responding to Climate Change in New York State’ report was prepared for New York State Energy Research and Development Authority to study the potential impacts of global climate change on New York State. The report indicates it is very likely that New York State will continue to experience increased temperatures through the 21st century. Heat waves are projected to become more frequent and

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intense. Higher summer temperatures will result in an increased stress on people, plants, animals and the environment. Increased temperatures may cause higher ozone concentrations in urban areas which can negatively impact vulnerable population's respiratory health. In addition, higher temperatures will likely increase the demand for electricity for cooling and cause more heat-related deaths. Meanwhile, increased winter temperatures will mean fewer cold-related deaths. It is clear that temperature changes will impact the population and economy of New York State (NYSERDA, 2011).

Change of Vulnerability

When examining the extreme temperature hazard event history, at the time of the 2007 original HMP there was an extreme temperature event about every eight years (1950 to 2007); refer to Table 5.4.6-6 earlier in this profile. However, our records indicate an additional five extreme temperature events have taken place since the original HMP changing the frequency of events to approximately one every five years (1950 to 2012). Therefore, although the population has minimally changed in the county, there is an increased risk due to the increased frequency of events. As discussed, extreme temperature events may impact the agricultural industry. According to the Census of Agriculture, from 2002 to 2007, there was a one-percent decrease in number of farms (588 farms to 580 farms, respectively) and a 12-percent decrease in farmlands in Broome County. Overall, the County will continue to be exposed and vulnerable to extreme temperature events.

Future Growth and Development

Areas targeted for potential future growth and development in the next five (5) years have been identified across the County (refer to Section 4). It is anticipated that any new development and new residents will be exposed to the extreme temperature hazard.

Additional Data and Next Steps

For future plan updates, the County can track data on extreme temperature events, obtain additional information on past and future events, particularly in terms of any injuries, deaths, shelter needs, pipe freeze, agricultural losses and other impacts. This will help to identify any concerns or trends for which mitigation measures should be developed or refined. In time, quantitative modeling of estimated extreme heat/cold events may be feasible as data is gathered and improved. Mitigation actions addressing early warning, dissemination of hazard information, provisions for back-up power, public warming and cooling centers and emergency response are included in Section 9.