10) Extreme Temperatures Hazard Analysis for New York City

a) Hazard Profile

i) Hazard Description

Extreme temperatures, both cold and hot, have a significant effect on human health and/or infrastructure. Weather conditions that represent extreme cold or heat vary across the different areas of the country because people experience a range of average temperatures based on their particular region.

Extreme Heat

Temperatures that hover 10 degrees or more above the average high temperature for a region, and last for several weeks, constitute an extreme heat event. During summer months, high atmospheric pressure traps hazy and damp air near the ground, creating a humid and muggy dome throughout New York City. Prolonged exposure to extreme heat may lead to serious health problems, including heat stroke, heat exhaustion, or sunburn. Seniors, young children, and those who are sick or overweight are more likely to succumb to extreme heat. New York City receives advisories from the NWS when the predicted heat index is greater than 100° F for one or more days, or the predicted heat index is 95° F or greater for two or more days. These advisories are based on historical weather analysis and mortality data analysis conducted by DOHMH. Based on these advisories and consultation with the NWS, the City activates its Heat Emergency Plan.

Extreme Cold

Extreme cold events are days where the mean daily temperature (average of the high and low recorded temperatures over a 24-hour period) falls below 32° F. Prolonged exposure to extreme cold temperatures will lead to serious health problems such as hypothermia, cold stress, frostbite, or freezing of the exposed extremities such as fingers, toes, nose and earlobes. Infants, seniors, people who are homeless, and those living in a home without adequate heat are most susceptible to such conditions. As the temperature drops and wind speed increases heat can leave the body more rapidly. This phenomenon is known as the wind-chill effect, which can exacerbate an extreme cold event.

Compared to other natural hazards, fatalities caused by extreme temperatures ranks the highest in the United States, with 188 deaths every year. Between 1994 and 2007, there were 89 heat-related fatalities in New York City. This total does not account for deaths that were accelerated because of extreme heat conditions. New York City's Office of the Chief Medical Examiner classifies a death as heat-related if two of the following three criteria exist: 1) pathologically elevated core-body temperature of the decedent, usually greater than 105° F at the time of or immediately after death; 2) substantial environmental or circumstantial evidence of heat as a contributor to death; and/or 3) decedent in a decomposed condition without evidence of other cause of death. Based on these criteria, the numbers of heat-related deaths can be substantially lower from what other cities report.

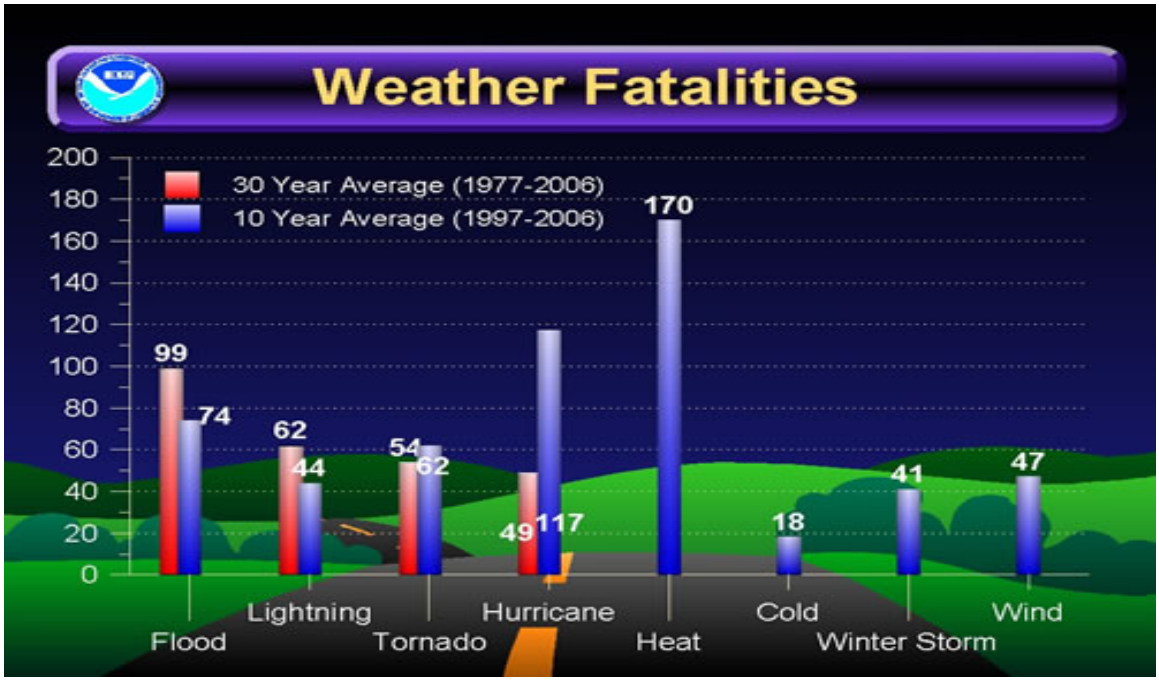

Figure 56: National Weather Fatalities (Source: NOAA, 2006)

ii) Severity

Extreme heat

The NWS heat index is a chart that measures the apparent temperature of the air as it increases with relative humidity. The NWS uses the heat index to determine what effects the temperature and humidity will have on the population. The heat index table describes the adverse effects that prolonged exposure can have on individuals. The NWS devised heat index values for shady, light wind conditions. Exposure to full sunshine can increase heat index values by up to 15 degrees. In addition, strong winds, particularly with very hot, dry air are extremely hazardous to individuals.

To aid in the prediction of and response to an extreme heat event, the NWS provides alerts to New York City when heat indices approach hazardous levels. Table 30 provides the alert procedures for the NWS. Upon issuing an extreme heat advisory, the NWS does the following:

- Includes heat index values and City forecasts
- Issues special weather statements including who is most at risk, safety rules for reducing risk, and the extent of the hazard and heat index values
- Assists state/local health officials in preparing civil emergency messages for the severe heat wave

NWS Heat Index Scale

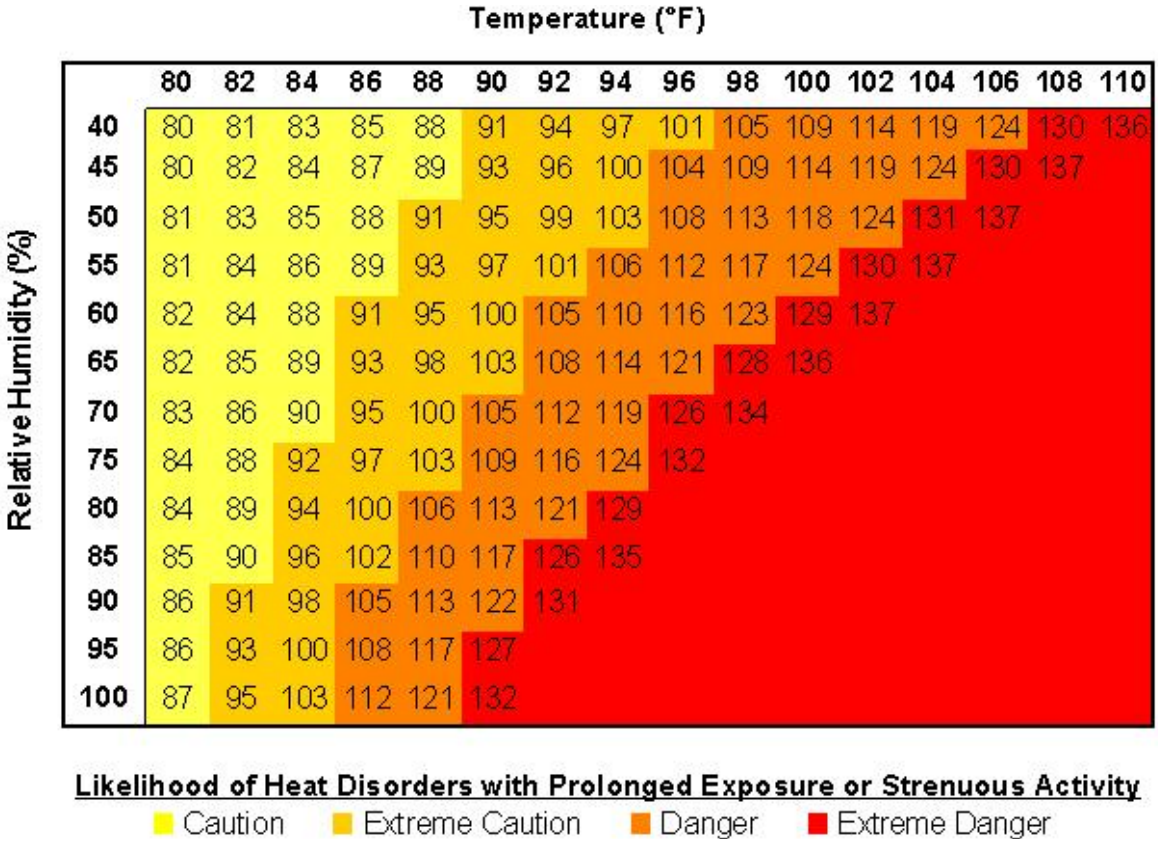

Table 30: NWS Apparent Temperature Product (Source: NWS, 2008)

Health Hazards Associated with Heat Index Values		
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 exhaustion possible with prolonged exposure and/or physical activity**
Caution	**80°F-90°F**	**Fatigue possible with prolonged exposure and/or physical activity**

Table 31: Adverse Conditions Associated with the Heat Index

When conditions warrant, the NWS issues heat-related weather products for New York City. Table 32 describes criteria for these products.

NWS Heat Products	
Product	**Criteria**
Heat Advisory (New York City)	Issued within 24 hours prior to onset of any of the following conditions: • Heat index of at least 100° F but less than 105° F for any period of time • Maximum heat index of 95°F or greater for two consecutive days • Nighttime lows above 80° F for any period of time
Excessive Heat Watch	Issued within 48 hours prior to onset of the following conditions: • Heat index of at least 105° F for more than 3 hours per day for 2 consecutive days • Heat index of at least 115° F for any time of 95° F or higher for two consecutive days
Excessive Heat Warning	Issued within 24 hours of onset of the following conditions: • Heat index of at least 105° F for more than 3 hours per day for 2 consecutive days • Heat index of more than 115° F for any time period

Table 32: NWS Extreme Heat Weather Products

Extreme Cold

The NWS created a wind chill chart that measures apparent temperature felt on exposed skin due to the combination of air temperature and wind speed.

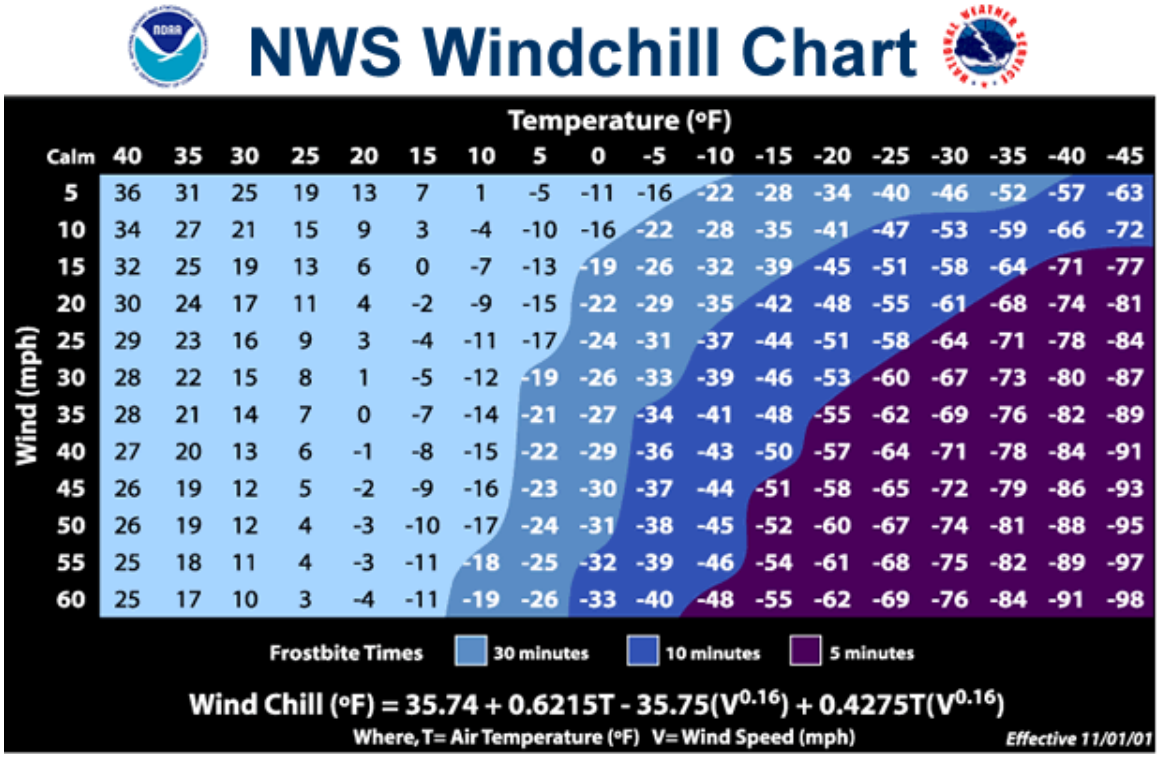

Table 33: NWS Windchill Chart (Source: NWS, 2008)

When conditions warrant, the NWS issues wind chill products for New York City. Table 34 describes criteria for these weather products.

NWS Wind Chill Products	
Product	**Description**
Wind Chill Watch	Issued by the NWS when there is a chance that wind chill temperatures will decrease to at least 24º F below zero during the next 24 to 48 hours
Wind Chill Advisory	Issued when the wind chill could be life threatening if action is not taken. The criteria for this advisory are expected wind chill readings of 15º F to 24º F degrees below zero
Wind Chill Warning	Issued when wind chill readings are life threatening. Wind chill readings of 25º F below zero or lower are expected

Table 34: NWS Wind Chill Products

iii) Probability

Based on data from DOHMH, New York City residents can expect approximately four extreme heat events per year (totaling nine days) where the heat index is 100° F or greater for one or more days, or a heat index of 95° F or greater for two or more days. Scientists predict the effects of global warming will cause this number to increase.

According to NWS data, New York City residents can expect approximately 25 days per year where the mean daily temperature falls below 32° F.

iv) Location

Extreme temperatures affect all of New York City. However, an urban environment can exacerbate an extreme heat event. This is known as the urban heat island effect. Figure 57 a thermal image of New York City, taken on July 22, 2002, one of the hottest days of that year. The second map displays the City's vegetative cover. Based on a comparison of the two images, hotspots generally correlate to areas that lack vegetation. These areas within the City are of greatest vulnerability during extreme heat events. For both extreme heat and cold, there are geographic variations in vulnerability due to demographic features, such as concentrations of seniors, young children, and individuals living below the poverty line (who are less likely to have adequate heat and air conditioning). See the Demographics section on page 16.

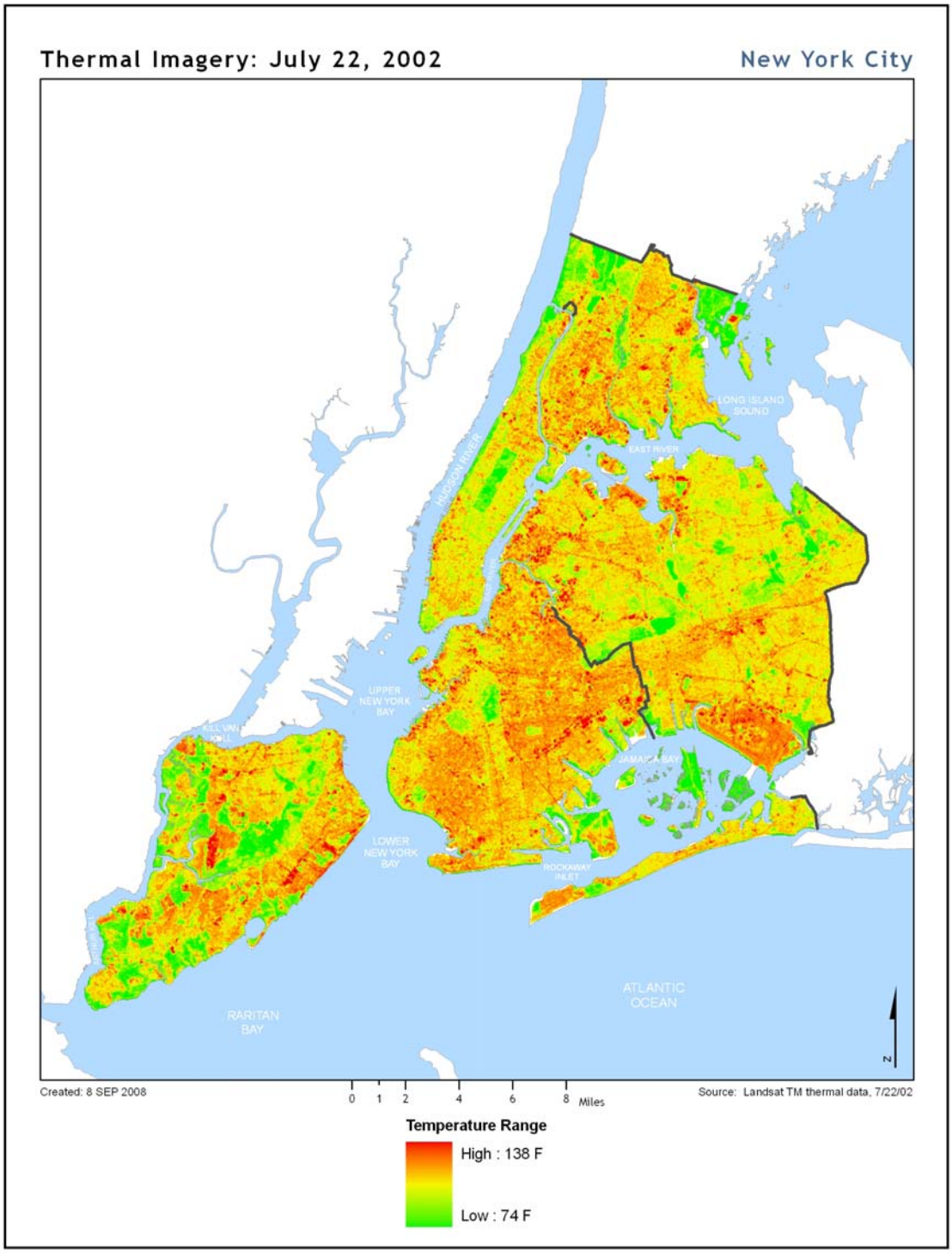

Figure 57: New York City Thermal Imagery Taken on July 22, 2002

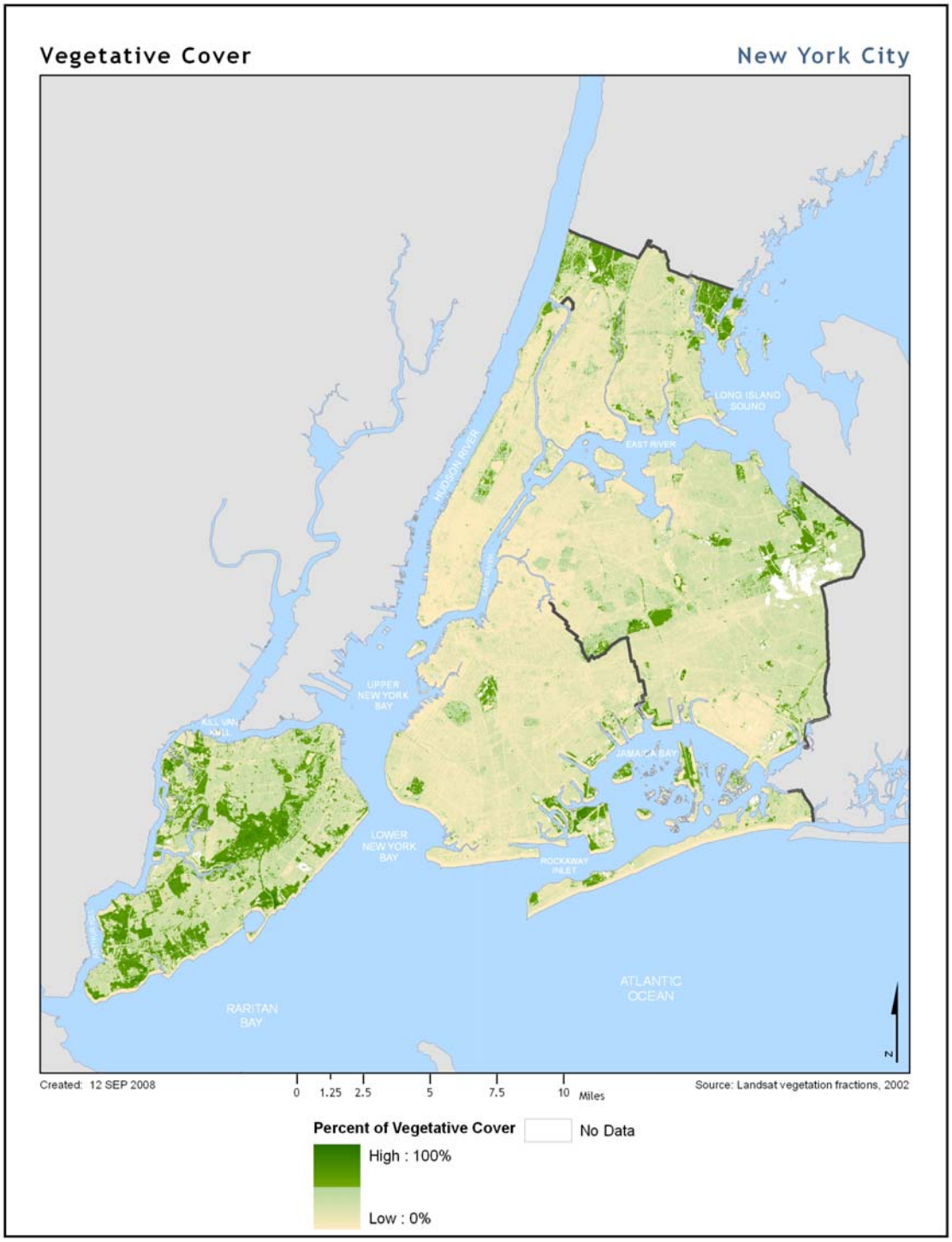

Figure 58: New York City Vegetative Cover

v) Historic Occurrences

Historic Occurrences of Extreme Temperatures in New York City			
Date	**Event**	**Location**	**Description**
Jul. 13, 1995	Extreme Heat	Citywide	• Temperatures rose to a record high of 102° F in Central Park • Responsible for 7 deaths in New York City • Hundreds treated for heat-related illness
Jul. 4–6, 1999	Extreme Heat	Citywide	• Extremely hot and humid air mass covered the region July 4–6 • July 4, temperatures soared into the mid and upper 90s • Heat indices from 100 to 105° F • Widespread blackouts observed throughout the region • Responsible for 31 deaths in New York City.
Jan. 17–18, 2000	Extreme Cold	Citywide	• Arctic cold front swept across the region Jan. 16 • Strong and gusty northwest winds combined with well below normal temperatures • Extremely low windchill values • Responsible for 3 deaths: 2 homeless men, and a hospital patient who wandered outdoors
Jan. 21, 2000	Extreme Cold	Citywide	• Northwest winds averaged 52 mph at LaGuardia Airport from around 2 PM to 8 PM • Temperatures fell to around 10° F; windchill values plummeted to –30° F along the coast and –35° F inland • No deaths reported for this event
Jan. 27–28, 2000	Extreme Cold	Citywide	• Extremely low windchill values • JFK Airport: windchill of –30° F around 8 AM on the 28th when the temperature was 9° F and the wind speed was 24 mph • LaGuardia Airport: windchill of –28° F • No deaths reported for this event.

Historic Occurrences of Extreme Temperatures in New York City			
Date	**Event**	**Location**	**Description**
Aug. 8–10, 2001	Extreme Heat	Citywide	• Bermuda high-pressure system "pumped" hot temperatures and high humidity across the region • 6-day heat wave began on Sunday, August 5, when temperatures first reached 90° F at Central Park • High temperatures at Central Park reached 103° F on the 9th and 99° F on the 7th and 8th • Heat indices ranged between 105 and 110° F • OEM opened cooling centers throughout the City • Responsible for four deaths
July 2–4, 2002	Extreme Heat	Citywide	• Temperatures rose into the mid and upper 90s across the region • Overnight low temperatures remained in the lower 80s • Temperatures averaged 10 to 15° F above normal • July 4, the temperature reached 98° F at LaGuardia Airport, which set a new record • Heat indices from 100 to 105° F • Cooling centers opened across the City • No deaths reported for this event
July 29–Aug. 5, 2004	Extreme Heat	Citywide	• 8-day heat wave began on July 29 and extended through Aug. 5 • High temperatures mid and upper 90s • Heat indices 100 to 105° F on July 29; 95 to 100° F on July 30 and 31 • No deaths reported for this event
Aug. 1–3, 2006	Extreme Heat	Citywide	• 3 consecutive days of excessive heat • Temperatures in the 90s to 100° F • Heat indices ranged from 105 to 115° F • Responsible for 40 deaths in New York City • Scattered power outages • OEM opened 383 cooling centers. Record temperatures set throughout the region
Feb. 4–8, 2007	Extreme Cold	Citywide	• Arctic air mass produced subfreezing temperatures • Daily mean temperature averaged 15° F below normal for 5 consecutive days • 11 fatalities reported due to hypothermia

Historic Occurrences of Extreme Temperatures in New York City			
Date	**Event**	**Location**	**Description**
Mar. 6–9, 2007	Extreme Cold	Citywide	• Arctic air mass produced temperatures 19° F below normal for 3 consecutive days • One fatality reported

Table 35: Historic Occurrences of Extreme Temperatures in New York City

b) Vulnerability Assessment

i) Impact to New York City

New York City's urban environment exacerbates hazardous conditions resulting from extreme heat. Conditions that induce heat-related illnesses include stagnant atmospheric conditions and poor air quality. Consequently, people living in New York City are at greater risk from the effects of a heat wave than those living in less urbanized areas. New York City also has a large number of individuals who may be susceptible to extreme heat conditions, such as seniors and those living below the poverty line.

The built environment of New York City greatly contributes to the phenomenon of the urban heat-island effect. Heat islands develop when built surfaces replace a large portion of natural land. Incoming solar radiation is trapped during the day and is then re-radiated at night. This slows the cooling process, keeping nighttime air temperatures high, relative to temperatures in less urbanized areas. According to meteorologists, a heat island is a well-defined area where temperatures are higher than the surrounding region, sometimes as much as 15º F higher. In infrared satellite photographs of New York City, particularly at night, the City appears as a distinct "heat island," as much as 20º F warmer than the surrounding suburbs.

Concrete, asphalt, and metal absorb the sun's heat during the day before radiating it out into the environment at night. These materials trap solar radiation faster than wooded parks and suburban lawns and fields, and hence cool more slowly, radiating a furnace-like heat. Other by-products of the City's activities, such as exhaust fumes, burning furnaces, heating units, smokestacks, and even New York City's dense population, contribute to this phenomenon. In addition, the City's numerous tall buildings block the path of cooling winds from the Atlantic Ocean. Generally, wind speeds greater than 15 to 20 miles per hour can substantially dissipate heat and reduce the heat island effect.

A link exists between extreme heat and power disruptions. During the summer months, when temperatures rise above 90° F, demand for electricity also rises to operate air conditioners, fans, and other devices. This increase in demand stresses the electrical generation, transmission, and distribution infrastructure, which in turn increases the likelihood that sections or components of the electrical system will fail, causing power outages.

During hot weather, some people illegally open fire hydrants for use as sprinklers. The resulting drop in system water pressure can reduce firefighting capabilities and create potentially life-threatening situations for the public. Hydrant spray caps reduce the

discharge of open hydrants from approximately 1,000 gallons per minute to 25 gallons per minute. FDNY distributes hydrant spray caps to the public to prevent this waste.

During periods of extreme cold and hot temperatures, inadequate protection from harsh elements is especially dangerous. Consequently, during extreme temperature conditions, New York City's homeless population is especially vulnerable. Both the New York City Heat and Winter Weather Emergency Plans include strategies for outreach to these populations.

ii) Structural Vulnerability

A large portion of New York City's utility infrastructure is susceptible to cracks and breaks from extreme temperatures. During the winter periods, frozen pipes are a routine occurrence. This can create service interruptions in water, drainage, and gas supply. To limit these effects, utility providers monitor conditions, perform routine maintenance, and address problems as they arise. Although buildings in New York City are generally not susceptible to extreme temperatures, some provisions in the building code aim to reduce the effects of extreme heat or cold. Movable bridges within New York City are susceptible to damage from extreme heat conditions. Aging utility infrastructure is also of particular concern.

iii) Potential Loss Estimate

Unlike other natural hazards that affect New York City, extreme temperatures have limited physical destructive force. The primary concern associated with extreme temperatures is public health and safety and the effect on vulnerable populations. Situational, social, and physical characteristics help to identify vulnerable populations. The following groups are vulnerable or at greater risk to extreme temperatures:

- People who are homeless
- Infants and small children under age five (see Demographics section on page 16 for map)
- People age 65 or older (see Demographics section on page 16 for map)
- People who are obese
- People with medical conditions
- People who work outdoors
- Women who are pregnant
- People who are poor