8. Drought

A. Hazard Profile

i. Hazard Description

The National Weather Service describes four types of drought: meteorological, agricultural, hydrological, and socioeconomic – most of which can significantly affect New York City.

Meteorological, or climatological, drought is defined in terms of the departure from a normal precipitation pattern and the duration of the hazard. This type of drought has a slow onset—it usually takes at least three months to develop—and may last for several seasons or years.

Agricultural drought links meteorological drought to agricultural impacts due to precipitation shortages and soil-water deficits. This type of drought has minimal direct impact on New York City because there is no significant agricultural activity within the city's boundaries.

Hydrological droughts, which often lag behind meteorological and agricultural droughts, involve deficiencies in surface water and sub-surface water supplies. The frequency and severity of hydrological drought is often defined on a watershed basin scale. Although climate is a primary contributor, other factors—such as changes in land use, land degradation, and the construction of dams—all affect the hydrological characteristics of the basin.

Finally, there is socioeconomic drought, which occurs when a water shortage begins to affect the population, individually and collectively.

Drought differs from other hazards in many ways. For one thing, its effects take a considerable time to develop, and the extent of the hazard can linger for prolonged periods after the drought itself has ceased. Moreover, while most definitions of socioeconomic drought associate the hazard with supply, demand, and economic good, the absence of a definitive and universally accepted definition complicates the determination of whether a drought is occurring and the level of its severity. Finally, compared to other natural hazards, the geographical area, impacts, and the duration of drought are difficult to quantify. This is especially true in New York City because its water comes from three upstate sources.

ii. Severity

The New York City Department of Environmental Protection (DEP) has developed the *New York City Drought Management Plan* to guide the City's response to a drought. The current *Drought Management Plan* has three phases: drought watch, drought warning, and drought emergency. Drought emergency is further subdivided into three stages, each with increasingly severe mandated water-use restrictions. The *Drought Management Plan* establishes guidelines for declaring a watch, warning, or emergency and the appropriate response for each phase. Factors such as prevailing hydrological and meteorological conditions, as well as certain operational considerations, inform the guidelines.

DEP declares a drought watch when there is less than a 50% probability that either of the two largest reservoir systems—the Delaware (Cannonsville, Neversink, Pepacton, and Rondout reservoirs) or the Catskill (Ashokan and Schoharie reservoirs)—will fill by the following June 1, the start of the water year.

DEP declares a drought warning when there is less than a 33% probability that either the Delaware or the Catskill system will fill by the start of the water year.

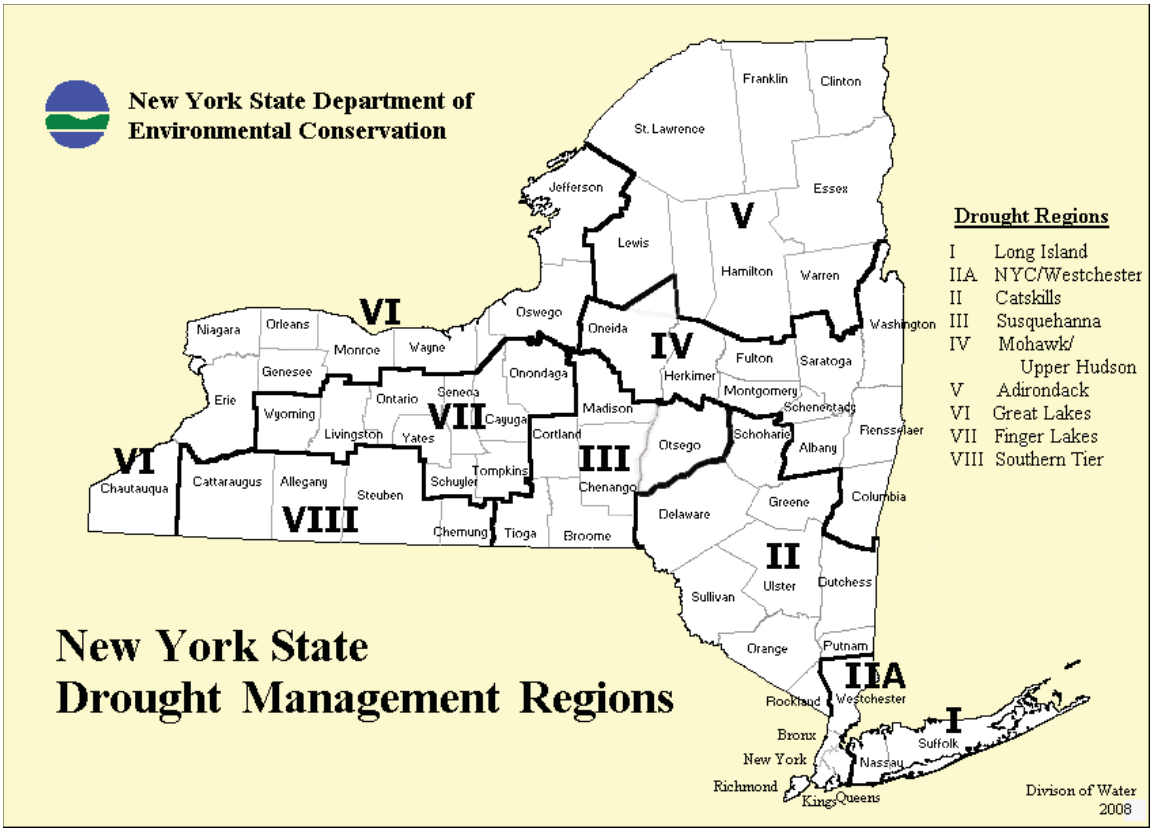
DEP declares a drought emergency when there is a reasonable probability that, without the implementation of stringent measures to reduce consumption, a protracted dry period would drain the city's reservoirs. DEP estimates this probability during dry periods in consultation with the New York State Drought Management Task Force and the New York State Disaster Preparedness Commission. Analyses of the historical record, the pattern of the dry-period months, water quality, sub-system storage balances, delivery system status, system construction, maintenance operations, snow cover, precipitation patterns, use forecasts, and other factors inform the estimation.

As of the writing of this report, DEP is updating the *Drought Management Plan*, which will be renamed

the *Water Shortage and Contingency Plan* and will be ready in early 2014. In addition to covering water supply problems due to drought, the updated plan will also address issues related to infrastructure failure and planned system repairs.

weather that brings 62% of normal precipitation or less occurs one year out of 50 in New York City.

Figure 3.8.59: New York State Drought Management Regions (Source: NYS DEC, 2008)



iii. Probability

Occasional drought is a normal, recurrent feature of virtually every climate in the United States. According to the New York State Department of Environmental Conservation (NYS DEC), New York's average annual precipitation ranges from 28 inches in the Lake Champlain Valley to 60 inches in the Catskills. This precipitation feeds the state's streams, lakes, and coasts.

However, even with a temperate, moist climate, normal fluctuations in regional weather patterns can lead to periods of dry weather. The last severe droughts in New York State occurred in the mid-1960s and again in the early and mid-1980s. According to the *National Drought Atlas*, a guide to the severity, frequency, and duration of droughts for the continental United States,

iv. Location

Droughts tend to affect New York City on a city-wide basis. This is in large part because the city gets its water from outside its borders. As described in New York City's Hazard Environment in Chapter 3, major components of the city's water supply system are located upstate, making the system vulnerable to weather conditions to the north. As part of its *New York State Drought Plan*, NYS DEC subdivided the state into drought management regions. New York City is located in Drought Region IIA; however, most of its watershed lies to the north in Region II (see Figure 3.8.59).

v. Historic Occurrences

Table 3.8.35, below, indicates that there were several significant droughts between 1963 and 2003.

Table 3.8.35: Droughts in New York City 1963 to 2003

Date	Event	Location	Description
1963–1965	Drought emergency	Citywide	• Intense water conservation campaign November 1963 to May 1964 • August 18, 1965, federal government declares water shortage disaster in New York City • New York State's only federal disaster declaration for a drought
1980–1982	Drought emergency	Citywide	• Drought watch issued in October 1980 • Drought warning issued in November • Drought emergency put into effect when water storage levels drop to 33% on January 1, 1981 • Downgraded to warning January 18, 1982, and to watch November 11, 1982
1985–1986	Drought emergency	Citywide	• Drought watch issued February 25, 1985, when water storage levels drop to 50% • In span of two months, drought conditions upgraded from drought watch to drought warning to drought emergency • Downgraded to warning November 1985 • Normal conditions restored February 25, 1986 • No damages recorded for this event • *New York State Drought Plan* revised based on lessons learned from this and earlier 1980s droughts
1989	Drought emergency	Citywide	• Drought watch issued January 17, when water-storage facilities were at 58% • Drought conditions upgraded to drought emergency (Stage II) March 22 • Conditions restored to normal May 15
1991	Drought warning	Citywide	• Drought watch issued September 25, when water-storage facilities were at 53% • DEP subsequently issues drought warning
1995	Drought warning	Citywide	• Drought watch issued July 5, when water-storage capacities fall to 84% • Drought warning issued September 13 • Normal conditions restored November 14
2001–2003	Drought emergency	Citywide	• Drought watch issued December 23, 2001, with water-storage levels at 44% • One month later DEP issues drought warning • Drought emergency issued April 1, 2002 • Over next eight months, increased precipitation and reduced water consumption alleviate drought conditions • Normal conditions restored January 2, 2003

Since 2003, the city has experienced two episodes of abnormally dry weather, formally defined by the National Climatic Data Center as "under moderate drought conditions." The first of these episodes began on June 29, 2010, and lasted four months, and the second began on March 20, 2012, and lasted two and a half months. However, neither episode was severe enough to be classified as a drought watch, warning, or emergency.

B. Vulnerability Assessment

Each drought produces a unique set of impacts on New York City, depending not only on its severity, duration, and spatial extent but also on ever-changing social conditions. As shown in Figure 3.8.60: Drought Impacts on Social, Economic, Built, Natural, and Future Environments, drought can directly or indirectly affect New York City's social, economic, built, natural, and future environments.

i. Social Environment

Drought can negatively affect the population of New York City in many ways. The harmful effects of this hazard may be particularly acute among vulnerable populations including the very young, seniors, low-income populations, and those with pre-existing health conditions.

Severe droughts can adversely affect public health. They can lead to a diminished quantity and quality of potable water, which can, in turn, increase the likelihood of dehydration. Compromised sanitation and hygiene from water shortages can result in increased illness and disease. According to the Centers for Disease Control (CDC), decreased rainfall can cause groundwater and surface water to become polluted with viruses, protozoa, and bacteria, increasing the risk of disease outbreaks.

Prolonged drought can also diminish air quality, according to the CDC, increasing particulates suspended in the air from dust and wildfires. Wildfires can increase airborne particles that can irritate bronchial passages and lungs, increasing chronic respiratory illnesses and the risk of acute respiratory infection.

The health effects of drought may be most pronounced among those with pre-existing health conditions, who may be more susceptible to illness and the spread of disease. Poor air quality due to dust and wildfires may exacerbate conditions for people with chronic respiratory disease such as asthma. Given the prolonged and chronic nature of droughts, there may be indirect health effects that are not readily identified, making it challenging to monitor and plan for these events.

Droughts may also affect the population by compromising the availability of food and nutrition. Limits on growing season and low crop yields, along with increasing food prices, could result in food shortages. This could adversely affect low-income populations, which may lack the resources to contend with these drought impacts.

Water shortages may also increase recreational risks for swimmers and boaters.

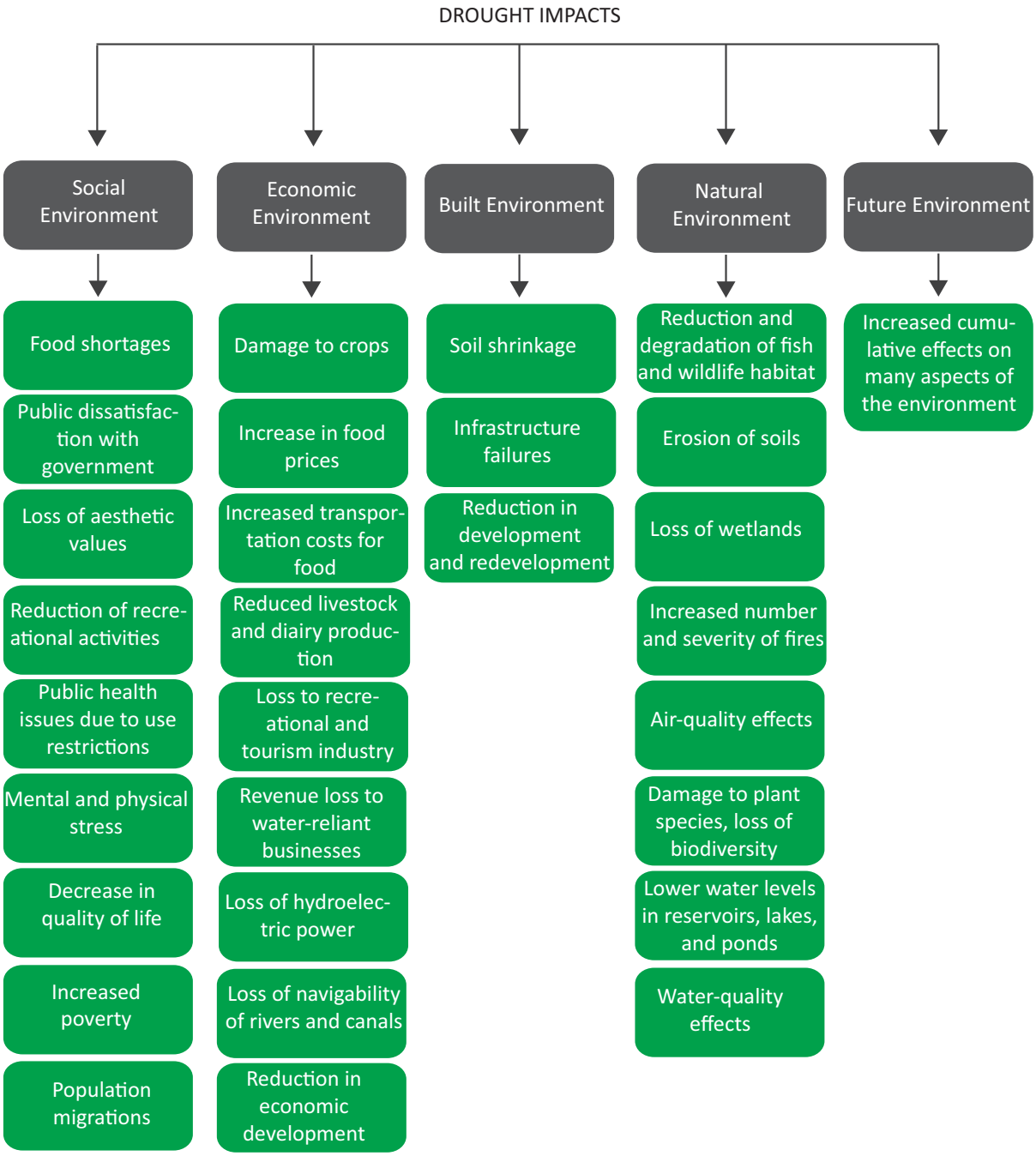
Drought can also have direct and indirect economic impacts. Businesses reliant on water—such as car washes, landscapers, and manufacturers—may be forced to suspend all or a portion of their activities due to reduced water levels and subsequent curtailment of water usage. The indirect impacts associated with drought may be far-reaching.

ii. Built Environment

In general, drought does not cause structural damage and does not affect infrastructure such as highways, bridges, and electric conveyance systems. Drought can, however, impact water-borne transportation systems, including ferries and barges, due to periods of low water. In addition, droughts can affect the functioning of the energy and steam supply systems in New York City. A number of power-generation plants rely on potable water to produce power. In the event of a drought, water use restrictions can cause a disruption or reduction in power supply. The steam system in New York City relies heavily on water at certain times of year. During the winter months, the steam system consumes a peak of 1.6 million gallons of water per hour.

Drought can also cause severe soil shrinkage, which can compromise the foundation upon which infrastructure stands, including retaining walls and bulk-

Figure 3.8.60: Drought Impacts on Social, Economic, Built, Natural, and Future Environments



heads. (For more information on infrastructure impacts, see Section 3.18 Infrastructure Failures.) However, soil shrinkage only causes real damage if soils shrink and swell as the moisture content decreases and increases. According to the U.S. Geological Survey, New York City soils typically are not high-swelling in nature. Therefore, there is a very low risk of structural damage associated with drought.

Droughts can affect green roofs, though. In New York City, green roofs contain vegetation that provides insulation, combats the urban heat island effect, and improves air quality. Droughts impair and imperil plants on green roofs, disrupting their ability to reduce air pollution and provide other benefits.

iii. Natural Environment

Drought has a much more severe impact on the natural environment than it does on the built environment. Effects may include loss of wetlands, damage to plant species, and reduction in biodiversity. For example, New York City's waterfront mainly consists of wetlands that range from approximately 5,600 acres to just over 10,000 acres, located in Jamaica Bay, on Staten Island, and along the Long Island Sound. These wetlands provide wildlife protection and improve water quality. In Jamaica Bay Park alone, 325 species of birds, 50 species of butterflies, and 100 species of finfish inhabit the wetlands.

Droughts can threaten community gardens. There are nearly 500 community gardens in New York City. Like green roofs, these gardens help reduce air pollution and combat the urban heat island effect, and they also increase access to fresh produce.

Drought can also impact the natural environment by contributing to erosion, wildfires, poor air quality, poor water quality, and soil shrinkage.

iv. Future Environment

Climate change projections indicate future disruptions in precipitation patterns and increasing temperatures. According to the New York City Panel on Climate Change (NPCC), by the 2050s it is more likely than not that late-summer short-duration droughts will increase in New York City.

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