



5.4.2 Drought

This section provides a hazard profile and vulnerability assessment of the drought hazard for Putnam County.

5.4.2.1 Hazard Profile

This section presents information regarding the description, extent, location, previous occurrences and losses, climate change projections and probability of future occurrences for the drought hazard.

Description

Drought is a period characterized by long durations of below-normal precipitation levels. Drought is different from aridity, which is a permanent feature of climate restricted to regions with typically low rainfall whereas drought is a temporary irregularity. Drought conditions can occur in virtually all climatic zones and vary significantly from one region to another. Droughts are relative to the normal precipitation in that region. Additionally, drought can enhance wildfire/brush fire risk, affecting plant life, agriculture, water supply, aquatic ecology, and wildlife.

According to the 2019 NYS Hazard Mitigation Plan, there are four types of droughts:

- *Meteorological (climatological) Drought*: a shortfall of precipitation over a period of time that creates dry conditions.
- *Hydrological Drought*: changes in surface and subsurface water supplies. Impacts can extend for years beyond the incidence of drought due to factors such as waterbody levels, reduced stream flow, and decreased snow pack.
- *Agricultural Drought*: Droughts that share characteristics of both meteorological and hydrological droughts in the context of agriculture, including crops, livestock and forestry.
- *Socioeconomic Drought* – Population and socioeconomic impacts to drought, including supply, demand, and economic activity.

Extent

The severity of a drought depends on the degree of moisture deficiency, the duration of the event, and the size and location of the affected area. Drought duration and areal extent contribute to the severity of potential impacts. New York State applies two methodologies to identify the different drought stages: the State Drought Index (SDI) and the Palmer Drought Severity Index (PDSI).

State Drought Index

The New York State Department of Environmental Conservation (NYSDEC) divides New York State into nine drought management regions, with divisions roughly following drainage basin contours and county lines. Putnam County is located in the Catskills Drought Region (Region II). NYSDEC monitors precipitation, stream flow, lake and reservoir levels, and groundwater levels at least monthly in each region and more frequently during periods of drought. NYSDEC uses these data to assess the condition of each region, which can range from *normal* to *drought disaster* as described in Figure 5.4.2-1 **Error! Reference source not found.** (NYSDEC 2018).

The SDI evaluates drought conditions by comparing stream flows, precipitation, lake and reservoir storage levels, and groundwater levels to historical or “normal” values. The State’s Drought Management Task Force uses those factors along with data related to levels of water use, duration of the dry period, and season to assess



drought across the State. The data acquired are compared to critical threshold values to indicate a normal or changeable drought condition. The indicators are weighted regionally to reflect the different circumstances within each drought management region (NYS DEC2020).

Palmer Drought Severity Index

The Palmer Drought Severity Index (PDSI) is primarily based on soil conditions. Soil with decreased moisture content is the first indicator of an overall moisture deficit. Table 5.4.2-1 lists the PDSI classifications. At the one end of the spectrum, 0 is used as normal and drought is indicated by negative numbers. For example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The PDSI can reflect excess precipitation using positive numbers; however, this is not shown in Table 5.4.2-1. The PDSI is commonly converted to the Palmer Drought Category. (National Drought Mitigation Center [NDMC] 2020).

Figure 5.4.2.1-1. NYSDEC Drought Stages

Drought Stage	Description
Drought Watch	The least severe of the stages, a drought watch is declared when a drought is developing. Public water suppliers begin to conserve water and urge customers to reduce water use.
Drought Warning	Voluntary water conservation is intensified. Public water suppliers and industries update and implement local drought contingency plans. Local agencies make plans in case of emergency declaration.
Drought Emergency	The Governor may declare emergency. The Disaster Preparedness Commission coordinates response. Mandatory local/county water restrictions may be imposed. Communities may need to tap alternative water sources to avoid depleting water supplies, protect public health and provide for essential uses.
Drought Disaster	Disaster plans are implemented. Water use is further restricted. The Governor may declare disaster and request federal disaster assistance. Emergency legislation may be enacted. The state provides equipment and technical assistance to communities.

Table 5.4.2-1. Palmer Drought Category and Palmer Drought Index Descriptions

Category	Description	Possible Impacts	Palmer Drought Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting and growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-1.0 to -1.99
D1	Moderate drought	Some damage to crops and pastures; fire risk high; streams, reservoirs, or wells low; some water shortages developing or imminent; voluntary water-use restrictions requested.	-2.0 to -2.99
D2	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.	-3.0 to -3.99
D3	Extreme drought	Major crop or pasture losses; extreme fire danger; widespread water shortages or restrictions.	-4.0 to -4.99
D4	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies.	-5.0 or less

Source: US Drought Monitor, 2020

Location

Droughts are a regional phenomenon that have the potential to directly or indirectly impact every person in Putnam County, as well as the local and regional economy. Additionally, with Putnam County being home to a large portion of New York City’s Croton Watershed, drought impacts can result in impacts to New York City, particularly parts of Lower Manhattan, the Upper East Side, and the south and eastern Bronx. During drought conditions, the Croton Watershed provides up to 30% of daily consumption for NYC Watershed consumers compared to 10% of consumers during normal conditions.

In Putnam County, drought events can occur throughout the year. Variations in typical expected amounts of precipitation can lead to periods of dry weather and drought (NYS DHSES 2019). The location of Putnam



County between the Great Lakes and the Atlantic Ocean provides significant moisture that generates precipitation throughout the region.

Previous Occurrences and Losses

Putnam County less occasionally experiences severe or extreme drought conditions owing to an overall humid climate. However, abnormally dry conditions are relatively frequent, with such conditions recurring at least annually for variation durations during the past five years. Based on available historical records, the communities in the planning area are equally susceptible to drought events and should mitigate to an extent of moderate drought. With much of the County included in the Croton Watershed and the remainder draining directly to the tidal portion of the Hudson River, droughts and dry periods in Putnam County have direct impacts on water users in the County as well as those downstream in the lower portion of the State.

Previous droughts have had significant impacts on the County and region. In 1981, the Croton River (which is impounded at the Croton Falls Dam in Putnam County) dried up in Westchester County (New York Times, 1981). A major drought in 1965 resulted in the pumping of water from the Hudson River into the West Branch Reservoir – an operation that recurred in the 1985 drought (New York City Department of Environmental Protection 2020).

FEMA Disaster Declarations

Between 1954 and 2020, Federal Emergency Management Agency (FEMA) declared that New York State experienced one drought-related disaster (DR) or emergency (EM) that was classified as a water shortage. Generally, drought-related disasters affect a wide region of the state and can impact many counties. Putnam County was included in this declaration, which included a number of counties in southern New York as well as all of New York City.

USDA Agricultural Disaster Declarations

The U.S. Department of Agriculture (USDA) keeps records of agricultural disasters. Between 2014 and April 2020, there were no USDA Agricultural Disasters declared for drought. The USDA-reported crop losses provide another indicator of previous events. The USDA records indicate that Putnam County has not experienced crop losses from drought events from 2014 to April 2020.

Previous Events

Table 5.4.2-2 lists known drought events between 2014 and 2020 that impacted Putnam County and its municipalities based on all sources researched.

Table 5.4.2-2. Drought Events in Putnam County, NY between 2014 and 2020

Table with 3 columns: Dates of Event, Duration (Approx.), and Event Details*. It lists four drought events: March 17-March 30, 2020; September 17-November 5, 2019; December 5, 2017-January 1, 2018; and September 26-October 30, 2017.



Dates of Event	Duration (Approx.)	Event Details*
April 19, 2016- May 8, 2017	1 year and 3 weeks	Drought and abnormally dry conditions persisted for more than a calendar year between spring 2016 and 2017. Between October 2016 and March 2017, severe drought conditions occurred and between mid-November and January extreme drought conditions occurred for portions of the County.
May 5, 2015- February 23, 2016	10 months	The latter half of 2015 saw abnormally dry conditions, with D1 (“Moderate drought”) conditions observed May 19 th to June 15 th and in September through December.
August 26- December 15, 2014	3.5 months	According to the U.S. Drought Monitor, conditions were classified at D0, or <i>abnormally dry</i> status across Putnam County in the last quarter of 2014.

Sources: USDA 2020; NDMC 2020

* Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table.

Climate Change Projections

Temperatures and precipitation amounts are expected to increase within the East Hudson and Mohawk River Valleys region. Precipitation totals will increase by up to five percent by the 2050s and by up to 10 percent by the 2080s (assuming a baseline of 38 inches). Table 5.4.2-3 lists projected seasonal precipitation changes within the East Hudson and Mohawk River Valleys region ClimAID Region (NYSERDA 2014).

Table 5.4.2-3. Projected Seasonal Precipitation Change in Region 5, 2050s (percent change)

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

Source: NYSERDA 2011

Winter precipitation in Putnam County and southern New York is expected to decrease gradually and take the form of rain. (NYSERDA 2014). These fluctuations in snowfall could result in an increase or decrease in the county’s winter snowpack. Reductions in snowpack would increase the possibility of drought (NYSERDA 2011).

Extreme heat events are likely to increase in intensity and duration throughout New York State, and short-duration warm season droughts will become more common. With the increase in temperatures, heat waves (defined as 3 or more consecutive days with maximum temperatures at or above 90 °F) will become more frequent and intense. Summer droughts are projected to increase under these conditions (NYSERDA 2014).

The number of short-duration droughts in late summer is expected to increase in frequency, intensity, and duration. These changes will become more apparent as the century progresses. Droughts in the northeast United States have been associated with unpredictable, potentially climate-change-sensitive local and remote modes of multi-year, ocean-atmosphere variability. Changes in distribution of precipitation throughout the year and in the timing of snowmelt can increase frequency of droughts (NYSERDA 2011).

Probability of Future Occurrences

Putnam County has experienced a range of drought conditions from *abnormally dry* to *extreme*, or D0 to D3 according to the Palmer Drought Category. Based on the historic record and climate projections for the region, it is anticipated that Putnam County will continue to experience drought events in the future that will likely worsen with climate change. Based on the periods of time that Putnam County spent in at least *abnormally dry* conditions and input from the Planning Committee, the probability for drought in the county is considered *occasional*. Refer to Section 5.3 for additional information on the hazard ranking methodology and probability criteria.



5.4.2.2 Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. All of Putnam County is exposed to the drought hazard; therefore, all assets within the County (population, structures, critical facilities, and lifelines), as described in Section 4 (County Profile), are potentially vulnerable to a drought event. The following text evaluates and estimates the potential impact of the drought hazard in the County.

Impact on Life, Health, and Safety

The entire population of Putnam County is exposed to drought events (i.e., 99,070 people, 2018 American Community Survey 5-year population estimates). Drought conditions can cause a shortage of potable water for human consumption, both in quantity and quality. A decrease in available water may also impact power generation and availability to residents.

Public health impacts may include an increase in heat-related illnesses, waterborne illnesses, recreational risks, limited food availability, and reduced living conditions. Vulnerable populations could be particularly susceptible to the drought hazard and cascading impacts due to age, health conditions, and limited ability to mobilize to shelter, cooling and medical resources. Other possible impacts to health due to drought include increased recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and sanitation and hygiene; compromised food and nutrition; and increased incidence of illness and disease. Overall, the health implications of drought are numerous. Some drought-related health effects are short-term while others can be long-term (CDC 2020). Furthermore, the Centers for Disease Control and Prevention’s (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Putnam County’s overall score is 0.1117, indicating that its communities have low vulnerability (CDC 2016). Being aware of the County’s overall ranking can help inform how the communities may react to a drought event based upon available resources. Areas with low vulnerability are likely more prepared to respond to drought events.

There are 129 community water supply systems, 246 non-community transient water supply systems, and 63 non-transient, non-community water supply systems in Putnam County (New York State Department of Health 2019). The Environmental Working Group identified that the largest water system is located in the Town of Carmel, which serves approximately 5,000 people (NY Times and Environmental Working Group 2012).

Changes in the water demand within Putnam County communities could become strained during a drought event. Surface water supplies are affected more quickly during droughts than groundwater sources; however, groundwater supplies generally take longer to recover. Diverse water supplies could help to protect and mitigate against the impacts of drought events. During dry periods, soil water can deplete quickly. If precipitation deficiencies continue, people who depend on other sources of water will begin to feel impacts of the shortage. Those who rely on surface water (e.g., reservoirs and lakes) and subsurface water (e.g., groundwater) are usually the last to be affected. A short-term drought that persists for 3 to 6 months might have little impact on these sectors, depending on characteristics of the hydrologic system and intensity of water use (NYS DHSES 2014).

Impact on General Building Stock

No structures are anticipated to be directly affected by a drought event. However, droughts 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) also known as the wildland-urban interface and wildland-urban intermix hazard areas (WUI). Therefore, all assets in and adjacent to, the WUI zone, including population, structures, critical facilities, lifelines, and businesses are considered vulnerable to wildfire. Refer Section 5.4.10 for the Wildfire risk assessment.



Impact on Critical Facilities

Water supply facilities may be affected by short supplies of water. As mentioned, drought events generally do not impact buildings; however, droughts have the potential to impact agriculture-related facilities and critical facilities that are associated with potable water supplies. Also, those critical facilities in and adjacent to the WUI zone are considered vulnerable to wildfire. Refer to Section 5.4.10 for the Wildfire risk assessment.

Impact on the Economy

Drought can produce a range of impacts that span many economic sectors and can reach beyond an area experiencing physical drought. As previously discussed, water withdrawals are not only used for potable water but for use in the commercial/industrial/mining sectors and power generation. When a state of water emergency is declared by the State (when a potential or actual water shortage endangers the public health, safety and welfare), the New York Department of Environmental Conservation may impose mandatory water restrictions and require specific actions to be taken by water suppliers.

A prolonged drought can have serious direct and indirect economic impacts on a community. As noted in the 2019 New York State Hazard Mitigation Plan, Putnam County does not have reported damages from drought events (NYS DHSES 2019). However, economic impacts that could occur include the following:

- Decreased land prices
- Loss to industries directly dependent on agricultural production (e.g., machinery and
- Fertilizer manufacturers, food processors, dairies, etc.)
- Unemployment from drought-related declines in production
- Strain on financial institutions (foreclosures, more credit risk, capital shortfalls)
- Revenue losses to Federal, State, and Local governments (from reduced tax base)
- Reduction of economic development
- Fewer agricultural producers (due to bankruptcies, new occupations)
- Rural population loss.

When a drought occurs, the agricultural industry is most at risk for economic impact and damage. Cornell University found that more than 70-percent of unirrigated, rain-fed field crops throughout the State of New York had losses between 30- and 90-percent during a major drought that occurred in 2016 (Cornell University 2017). If the average production (dollar value) per crop type could be identified on a per-acre basis, loss estimates could be developed based on assumed percent damage that could result from a drought. If a drought impacted 40 percent of the crops sold from Putnam County farms, losses would be estimated at \$77.4 billion based on 2017 market values (USDA 2017).

Based on information from the 2017 Census of Agriculture, the average farm size in Putnam County was 441 acres, which is a 1.6-percent increase from 2012 statistics. Table 5.4.2-4 lists the acreage of agricultural land exposed to the drought hazard.

Table 5.4.2-4. Agricultural Land in Putnam County, NY in 2017

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Harvested Cropland (acres)
2,040,220	900,217,576	396,433,817	320,041,858

Source: USDA 2017



Impact on the Environment

Drought can impact the environment because it can trigger wildfires, increase insect infestations, and exacerbate the spread of disease (NOAA 2020). Droughts will also impact water resources that are relied upon by aquatic and terrestrial species. Ecologically sensitive areas, such as wetlands, can be particularly vulnerable to drought periods because they are dependent on steady water levels and soil moisture availability to sustain growth. As a result, these types of habitats can be negatively impacted after long periods of dryness.

Cascading Impacts to Other Hazards

Drought may trigger wildfires in the County. As discussed in earlier sections, drought can lead to increasing temperatures and evaporation of moisture, which are ideal dry conditions for wildfire events to occur. Dry, hot, and windy weather combined with dry vegetation is more susceptible to sparking wildfires when met with a spark created by humans or natural events, such as lightning (National Integrated Drought Information System 2020). Refer to Section 5.4.8 (Wildfire) for more information about the wildfire hazard of concern.

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the County can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development.
- Projected changes in population.
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Projected Development

As discussed in Section 4, areas targeted for future growth and development were identified across the County. Any areas of growth could be potentially impacted by the drought hazard because the entire County is exposed and vulnerable to droughts. Future growth and development could impact the amount of potable water available due to a drain on the available water resources. An increased use of water resources would not only impact the County’s population, but it would also exacerbate impacts to other areas of the County as discussed above, including agriculture and recreational facilities. Refer to Section 9 (Jurisdictional Annexes) for a discussion on potential new development.

Projected Changes in Population

According to the U.S. Census Bureau, the population in Putnam County has decreased by approximately 0.7-percent between 2010 and 2018 (US Census Bureau 2020). However, estimated population projections provided by the 2017 Cornell Program on Applied Demographics indicates that the County’s population will increase slowly into 2040, increasing the total population to approximately 100,435 persons (Cornell University Program on Applied Demographics 2017). An increase in the population throughout Putnam County will increase the County’s risk to drought events and may put more stress on the available water supplies. Refer to Section 4 (County Profile), which includes a more thorough discussion about population trends for the County.

Climate Change

As discussed above, most studies project that the State of New York will see an increase in average annual temperatures. Additionally, the State is projected to experience more frequent droughts which may affect the availability of water supplies, primarily placing an increased stress on the population and their available potable



water. A decrease in water supply, or increase in water supply demand, may increase the County’s vulnerability to structural fire and wildfire events. Critical water-related service sectors may need to adjust management practices and actively manage resources to accommodate for future changes.

Droughts 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 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 (NYSERDA 2014). The greatest likelihood of future water shortages is likely to occur on small water systems.

Change of Vulnerability Since the 2015 HMP

The 2015 hazard mitigation plan included drought hazards in the extreme temperature hazard of concern. For this updated plan, drought is assessed as its own hazard of concern for the County. A qualitative assessment was conducted for population, buildings and critical facilities using data from the 2017 USDA Census of Agriculture to assess potential economic impacts. Overall, the number of persons and farms impacted by drought has increased since the last plan was published.

Identified Issues

The following are identified issues associated with the drought hazard:

- Potential drought effects on the ground water and well resources in the county provides a possible issue of potable water supply.
- Droughts contribute to conditions conducive to wildfires, reduce fire-fighting capabilities, and have negative impacts on agriculture throughout the County.