



5.4.2 Drought

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

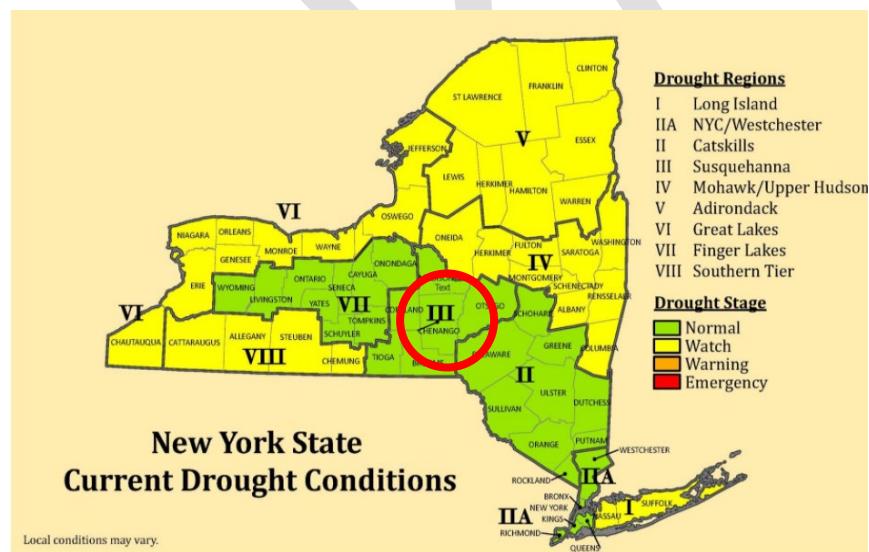
Description

Drought is a period characterized by long durations of below normal precipitation. Drought is a temporary irregularity and differs from aridity since the latter is restricted to low rainfall regions and is a permanent feature of climate. Drought conditions occur in virtually all climatic zones yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life.

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. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. New York State applies two methodologies to identify the different drought stages - the Palmer Drought Severity Index (PDSI) and the State Drought Index (SDI). The two different indices inform the agricultural and water supplier sectors, in that the PDSI puts an emphasis on soil moisture and helps the State understand agricultural impacts, whereas the SDI provides guidance to public and private water suppliers and withdrawals (NYSDEC 2020).

Figure 5.4.2-1. NYSDEC Region Map



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. Chenango County is located within the Susquehanna Drought Region (Region III). 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*.

The State Drought Index compares four parameters to historic or "normal" values to evaluate drought conditions: stream flows, precipitation, lake and reservoir storage levels, and groundwater levels. New York's Drought Management Task Force uses those factors as well as water use, duration of the dry period, and season to assess drought in different parts of the state. (NYSDEC 2020).

New York also uses the Palmer Drought Index, a measure of soil moisture calculated by the National Weather Service. The two indices show us different things about drought. The Palmer Index, with its emphasis on soil moisture, helps us understand agricultural impacts. The State Index helps assess the impact on human welfare and the regional economy (NYDEC 2020).

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 the table. The PDSI is commonly converted to the Palmer Drought Category (National Drought Mitigation Center [NDMC] 2013).

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: NDMC 2013





Location

Droughts are a regional phenomenon that have the potential to directly or indirectly impact every person in Chenango County. In general, droughts can occur at any given time of the year in the County, though most often occurs late summer to early fall. When compared to other parts of the country, this hazard is relatively less likely to occur in this region and most of New York State (NYSDHSES 2019).

Chenango County is situated between the Great Lakes and the Atlantic Ocean. These water bodies provide significant moisture that generates precipitation throughout the region. The Susquehanna River flows through the southern portion of the County, with the County's tributaries feeding downstream waterways. Drought impacting the County would have impacts downstream of the Susquehanna, including neighboring Broome County in New York and in Pennsylvania.

Previous Occurrences and Losses

Chenango County does not usually experience severe or extreme drought due to its proximity to the Great Lakes and Atlantic Ocean. 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.

FEMA Disaster Declarations

Between 1954 and April 2020, 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; however, Chenango County was not included in the disaster declaration.

USDA Agricultural Disaster Declarations

The U.S. Department of Agriculture (USDA) keeps records of agricultural disasters. In 2016, the USDA designed the County's drought as a disaster (S4031) beginning July 2016. The County experienced losses to its corn crop due to the drought.

Previous Events

Table 5.4.2-2 lists known drought events between 2015 and 2020 that impacted Chenango County and its municipalities based on all sources researched.

Table 5.4.2-2. Drought Events in Chenango County, NY between 2015 and April 2020

Dates of Event	Event Details*
May-June 2015	Small portions of Chenango County featured abnormally dry conditions in late May and through June 2015.
Spring-Winter 2016	Beginning in April 2016 and through mid-January of 2017, large portions of Chenango County experienced abnormally dry conditions. Between October 2016 to December 2016, most of the County's land area experienced a moderate drought. The drought was reported to be one of the worst to hit the region in decades, resulting in one of the first designated drought watches in more than a decade. The USDA Farm Service Agency declared most counties in the region to be in a natural disaster area. A Cornell University survey found that nearly three-quarters of unirrigated, rain-fed crops and pasture acreage experienced losses between 30 and 90 percent.
October 2017	October 2017 saw abnormally dry conditions throughout the County.





Dates of Event	Event Details*
Winter 2018	Between December 2017 and early February 2018, significant portions of the County experienced abnormally dry conditions.
June-July 2018	The County experienced abnormally dry conditions in the summer of 2018. This was part of a moderate drought that impacted adjacent northeastern states.

Sources: USDA 2020; NDMC 2020; Cornell University 2017

* 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

Climate change can contribute to increased chances of drought and its secondary impacts such as decreased water supply and higher threat of wildfires. Temperatures and precipitation amounts are expected to increase within the Southern Tier region. Precipitation totals will change between 4 and 10 percent by the 2050s and between 6 and 14 percent by the 2080s (baseline of 35 inches). Table 5.4.2-3 lists projected seasonal precipitation changes within the Southern Tier ClimAID Region (NYSERDA 2014).

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

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

Source: NYSERDA 2011

Snowfall rates in Chenango County may increase due to reduced freezing of the Great Lakes as temperatures are predicted to warm. However, as the climate warms, temperatures could rise enough to the point where winter precipitation might fall as rain instead of snow (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.

Extreme heat events are likely to increase 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).

By the end of the 21st century, the number of droughts is likely to increase, as the effect of higher temperatures on evaporation is likely to outweigh the increase in precipitation. Droughts in the northeast United States have been associated with local and remote modes of multi-year, ocean-atmosphere variability that are unpredictable and could change with climate change. Changes in distribution of precipitation throughout the year and in timing of snowmelt could increase frequency of droughts (NYSERDA 2011).

Probability of Future Occurrences

Chenango County has historically experienced a range of drought conditions from *abnormally dry* to *moderate*, or D0 to D1, in accordance with the Palmer Drought Category. Based on the historic record and climate projections for the region, it is anticipated that Chenango County will continue to experience drought events in the future. Based on the periods of time that Chenango spent in at least *abnormally dry* conditions and input from the Planning Committee, the probability for drought in the county is considered ‘occasional’ (between 10% and 100% annual probability of a hazard event occurring).





5.4.2.2 Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. All of Chenango 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 Chenango County is vulnerable to drought events (2018 American Community Survey 5-Year Estimate: 48,348 people). Drought conditions can affect public health and safety, including reduced local firefighting capabilities, health problems related to low water flows and poor water quality, and health problems related to dust. If droughts are severe enough, these health problems can lead to loss of human life.

Other possible impacts include 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. Due to their age, health conditions, and limited ability to mobilize to shelters, cooling, and medical resources, the infirm, young, and elderly are particularly susceptible to drought and extreme temperatures, sometimes associated with drought conditions. The percent of elderly persons living in Chenango County increased from 16.6% in 2010, to 19.7% (9,539 persons) in 2018 (U.S. Census 2018). Some drought-related health effects are short term, while others can be long term (CDC 2012). Social impacts primarily involve public safety, health, conflicts among water users, reduced quality of life, and inequities in distribution of impacts and disaster relief. Many economic and environmental effects induce social impacts, as well (NYS DHSES 2014).

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 (for example, reservoirs and lakes) and subsurface water (for example, 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).

According to the USGS Water Science School, groundwater levels are dependent on recharge from infiltration of precipitation, so when a drought hits the land surface, it can impact the water levels below ground. When rainfall is less than normal for several weeks, months, or years, the flow of streams and rivers declines, water levels in lakes and reservoirs fall, and the depth to water in wells increases. If dry weather persists and water-supply problems develop, the dry period can become a drought.

The water level in the aquifer that supplies a well does not always stay the same. Droughts, seasonal variations in rainfall, and pumping affect the height of the groundwater levels. If a well is pumped at a faster rate than the aquifer feeding it is recharged by precipitation or other underground flow, then water levels in the well can be lowered. This can happen during drought, due to the extreme deficit of rain. The water level in a well can also be lowered if other wells near it are withdrawing too much water (USGS 2019).

The drought hazard is a concern for Chenango County because the majority of water for public use comes from groundwater sources, including aquifers. The major aquifers within Chenango County can provide between 300,000 to 500,000 gallons per day, per well, with minor aquifers yielding 1,000 to 10,000 gallons per day, per well (Chenango County 2016). The major and some minor population centers within the County are located near primary aquifers and have access to an abundant ground water supply during non-drought conditions. Rural residential water supply systems in Chenango County are typically supplied by natural springs and drilled water wells, however, unfortunately these residential properties often have small lots and poor soil and improperly





developed water wells that are easily contaminated by wastewater systems or improper drainage systems (Chenango County 2016).

Impact on General Building Stock

A drought event is not expected to directly affect any structures; however, a secondary hazard most commonly associated with drought is wildfire. Prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. Though some structures can become vulnerable to wildfire that are within or near the wildfire urban interface, this is more likely following long periods of drought. Refer to Section 5.4.10 (Wildfire) of the HMP for additional discussion of the wildfire hazard in Chenango County.

Impact on Critical Facilities

Water supply facilities may be affected by drought events. The county's public water supply system is a mix of public and privately-owned water systems, but much of the rural populations are served by private wells and are significantly affected by periods of diminished groundwater resources. A short-term drought that persists for 3 to 6 months could have little impact on surface water and subsurface water, depending on characteristics of the hydrologic system and intensity of water use (NYS DHSES 2014). However, since droughts are often slow-onset hazards, over time, they can severely affect crops, water supply, recreational resources, and wildlife. If drought conditions persist over a number of years, both direct and indirect economic impacts can be significant. Human actions and demands for water resources can accelerate drought-related impacts in the county (NYS DHSES 2019).

Impact on the Economy

Drought events impact the economy, including loss of business function and damage and loss of inventory. Industries that rely on water for business can be impacted the hardest (e.g., agriculture, forestry, fisheries, waterborne activities). In addition to losses in crop yields and livestock production, drought is associated with increased insect infestations, plant diseases, and wind erosion. Drought can lead to reduced income for farmers and reduced business for retailers and others who provide goods and services to farmers, leading to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue. Prices for food, energy, and other products might also increase as supplies decrease (NYS DHSES 2014). In a Socioeconomic Drought, water shortages being to affect the population of an area, both individually and collectively (NYS DHSES 2019). This can include the supply or demand of goods, as well as the economic output of an area.

Direct and indirect losses to agricultural producers, livestock producers, timber producers, fishery producers, and tourism include the following:

- Damage to crop quality and crop losses.
- Insect infestation leading to crop and tree losses.
- Plant diseases leading to loss of agricultural crops and trees.
- Reduced productivity of livestock due to unavailability of feed and mortality rates (i.e., milk production, meat).
- Reduction in tourism and outdoor activities such as hunting, fishing, and boating.
- Increased risk of brush fires and wildfires due to dried crops, grasses, and dying trees.

When a drought occurs, the agricultural industry is most at risk for economic impact and damage. A large majority of the state's agriculture is rain-fed without irrigation; however, summer precipitation currently is not





sufficient to fully meet crop water needs during most years (NYSERDA 2011). Based on information from the 2017 Census of Agriculture, 770 farms were present in Chenango County, encompassing 148,982 acres of total farmland. The average farm size was 193 acres. Products sold from Chenango County farms had a total market value of \$67.9 million (\$41.6 million: milk from cows, \$9.3 million: other crops and hay, \$6.8 million: cattle and calves, \$5.5 million: grains, oilseeds, dry beans, dry peas). The 2017 Agricultural Census indicated that 643 farm operators reported farming as their primary occupation (USDA 2017). Table 5.4.2-4 lists the acreage of agricultural land exposed to the drought hazard.

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

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Harvested Cropland (acres)
770	148,982	77,079	65,359

Source: USDA 2017

A prolonged drought can have a serious economic impact on a community. Increased demand for water and electricity can result in shortages and higher costs for these resources. Industries that rely on water for business could be impacted the most (e.g., landscaping businesses). Although most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant within the recreation and tourism industry. Moreover, droughts within another area could impact the food supply and price of food for residents within the county.

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). Drought can 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. As a cascading effect of these droughts, wildfires can also have detrimental effects on the environment, including pollution from the smoke of the fire, ecological damage and loss of habitat, and water contamination due to damaged/ burnt vegetative cover (US Forestry Service, 2020).

Cascading Impacts on Other Hazards

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 5.4.10 (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 drain on 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 population projections from the Cornell Program on Applied Demographics, Chenango County will experience a continual population decrease through 2040 (a decline of over 7,500 people in total by 2040). This decrease will reduce the overall vulnerability of the county's population over time. While less people will reside in the county, populations could move into more rural areas of the county, increasing the stress on the water supplies in those locations.

According to the Chenango County Comprehensive Plan (2016), the county has seen an increase in population and development patterns along the Chenango River/NYS Route 12 corridor, as well as the Susquehanna River/NYS Routes 7 and 8 corridor. However, the overall population density of the majority of municipalities, as well as for the County as a whole, has been decreasing. Refer to Section 4.6.2 (Population Trends) in the County Profile for a discussion on trends for the county.

Climate Change

As discussed earlier, summer droughts are projected to increase, which could affect water supply, agriculture and ecosystems (NYSERDA 2014). An increased incidence of drought might impact availability of water supplies, primarily placing an increased stress on the population. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire, could increase and threaten structures. If a wildfire were to occur during a drought, emergency services might face complications from a water shortage depending on their water source, and critical water-related service sectors might need to adjust management practices and actively manage resources. Increased incidence of drought increases the potential for impacts on the local economy, including the production of agricultural products.

Change of Vulnerability Since the 2016 HMP

The 2016 HMP provided a summary of historic loss information and qualitative assessment for the drought hazard. For this HMP Update, 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. According to the U.S. Census Bureau American Community Survey 2018 Population Estimates, the population of Chenango County has decreased by roughly 4.2% since the 2010 Census; therefore, the number of people exposed to the drought hazard has decreased. The number of farms and total acreage of farmland has also decreased from 2012 to 2017; therefore, an decreased area of agricultural land is exposed to the drought hazard. Overall, the entire county will continue to be exposed and vulnerable to drought events.

