

## 5.4.6 DROUGHT

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

### HAZARD PROFILE

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

#### Description

The Climate Prediction Center (CPC) of the National Weather Service (NWS) defines drought as a deficiency of moisture that results in adverse impacts on people, animals, or vegetation over a sizeable area (CPC, 2004). According to the New York State Hazard Mitigation Plan (NYS HMP), drought is a normal, recurrent feature of climate. Although its features vary from region to region, this hazard occurs almost everywhere. Defining drought is therefore difficult; it depends on differences of regions, water supply needs, and disciplinary perspectives. In general, drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector (NYS HMP, 2011). Other climatic factors, such as high temperatures, prolonged high winds and low relative humidity, can aggravate the severity of a drought. These conditions are caused by anomalous weather patterns when shifts in the jet stream block storm systems from reaching an area. As a result, large high-pressure cells may dominate a region for a prolonged period, thus reducing precipitation.

According to the Federal Emergency Management Agency (FEMA) and the NWS, there are four different ways that drought can be defined or grouped:

- **Meteorological** drought is a measure of departure of precipitation from normal. It is defined solely on the degree of dryness. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.
- **Agricultural** drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced ground water or reservoir levels, etc. It occurs when there is not enough water available for a particular crop to grow at a particular time. Agricultural drought is defined in terms of soil moisture deficiencies relative to water demands of plant life, primarily crops.
- **Hydrological** drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply and occurs when these water supplies are below normal. It is related to the effects of precipitation shortfalls on stream flows and reservoir, lake and groundwater levels.
- **Socioeconomic** drought is associated with the supply and demand of some economic good with elements of meteorological, hydrological, and agricultural drought. This differs from the aforementioned types of drought because its occurrence depends on the time and space processes of supply and demand to identify or classify droughts. The supply of many economic goods depends on weather (e.g., water, forage, food grains, fish, and hydroelectric power). Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply.

Drought can produce a range of impacts that span many sectors of an economy and can reach beyond an area experiencing physical drought. This exists because water is integral to our ability to produce goods and provide services. Direct impacts of drought include reduced crop yield, increased fire hazard, reduced water levels, and damage to wildlife and fish habitat. The consequences of these impacts illustrate indirect impacts that include: reduction in crop, rangeland, and forest productivity may result in reduced income for farmers and agribusiness, increased prices for food and timber, unemployment, reduced tax revenues due to reduced expenditures, increased crime, foreclosures, migration, and disaster relief programs. The many impacts of drought can be listed as economic, environmental, or social (NYS HMP, 2011).

Economic impacts occur in agriculture and related sectors because of the reliance of these sectors on surface and subsurface water supplies. Environmental impacts are the result of damage to plant and animal species, wildlife habitat, and air and water quality, forest and grass fires, degradation of landscape quality, loss of biodiversity and soil erosion. Social impacts involve public safety, health, conflicts between water users, reduced quality of life and inequities in the distribution of impacts and disaster relief (NYS HMP, 2011). A summary of potential impacts associated with drought are identified in Table 5.4.6-1. This table includes only some of the potential impacts of drought.

Table 5.4.6-1. Economical, Environmental and Social Impacts of Drought

Economical	Environmental	Social
<ul style="list-style-type: none"> <li>• Loss of national economic growth, slowing down of economic development</li> <li>• Damage to crop quality, less food production</li> <li>• Increase in food prices</li> <li>• Increased importation of food (higher costs)</li> <li>• Insect infestation</li> <li>• Plant disease</li> <li>• Loss from dairy and livestock production</li> <li>• Unavailability of water and feed for livestock which leads to high livestock mortality rates</li> <li>• Disruption of reproduction cycles (breeding delays or unfilled pregnancies)</li> <li>• Increased predation</li> <li>• Increased fire hazard - Range fires and Wildland fires</li> <li>• Damage to fish habitat, loss from fishery production</li> <li>• Income loss for farmers and others affected</li> <li>• Unemployment from production declines</li> <li>• Loss to recreational and tourism industry</li> <li>• Loss of hydroelectric power</li> <li>• Loss of navigability of rivers and canals</li> </ul>	<ul style="list-style-type: none"> <li>• Increased desertification - Damage to animal species</li> <li>• Reduction and degradation of fish and wildlife habitat</li> <li>• Lack of feed and drinking water</li> <li>• Disease</li> <li>• Increased vulnerability to predation.</li> <li>• Loss of wildlife in some areas and too many in others</li> <li>• Increased stress to endangered species</li> <li>• Damage to plant species, loss of biodiversity</li> <li>• Increased number and severity of fires</li> <li>• Wind and water erosion of soils</li> <li>• Loss of wetlands</li> <li>• Increased groundwater depletion</li> <li>• Water quality effects</li> <li>• Increased number and severity of fires</li> <li>• Air quality effects</li> </ul>	<ul style="list-style-type: none"> <li>• Food shortages</li> <li>• Loss of human life from food shortages, heat, suicides, violence</li> <li>• Mental and physical stress</li> <li>• Water user conflicts</li> <li>• Political conflicts</li> <li>• Social unrest</li> <li>• Public dissatisfaction with government regarding drought response</li> <li>• Inequity in the distribution of drought relief</li> <li>• Loss of cultural sites</li> <li>• Reduced quality of life which leads to changes in lifestyle</li> <li>• Increased poverty</li> <li>• Population migrations</li> </ul>

Source: NYS HMP, 2011

## Extent

The extent (e.g., magnitude or severity) of drought can depend on the duration, intensity, geographic extent, and the regional water supply demands made by human activities and vegetation. The intensity of the impact from drought could be minor to total damage in a localized area or regional damage affecting human health and the economy. Generally, impacts of drought evolve gradually and regions of maximum intensity change with time. The severity of a drought is determined by areal extent as well as intensity and duration. The frequency of a drought is determined by analyzing the intensity for a given duration, which allows determination of the probability or percent chance of a more severe event occurring in a given mean return period.

Several indices developed by Wayne Palmer (Palmer Drought Severity Index [PDSI] and Crop Moisture Index [CMI]), as well as the Standardized Precipitation Index (SPI), are the most useful for describing the many scales of drought. Other indices include accumulated departure from normal streamflows, low-flow frequency estimates and changes in water storage, groundwater levels and rates of decline, and lake levels. Most commonly used indices that are used to measure or identify the severity and classification of past and present droughts primarily include, but not limited to, the following:

The Palmer Drought Severity Index (PDSI) was developed in 1965, and indicates the prolonged and abnormal moisture deficiency or excess. The PDSI is an important climatological tool for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather. It can be used to help delineate disaster areas and indicate the availability of irrigation water supplies, reservoir levels, range conditions, amount of stock water, and potential intensity of forest fires (NWS CPC, 2005).

The PDSI has become the semi-official drought index. It is the most effective in determining long-term droughts; however, it is not good with short-term forecasts. Table 5.4.6-2 lists the Palmer Classifications. Zero is used as normal and drought is shown in terms of negative numbers. For example, -2 is moderate drought, -3 is severe drought and -4 is extreme drought. The PDSI also reflects excess precipitation using positive numbers. For example, 2 is moderate rainfall (NOAA, Date Unknown).

Table 5.4.6-2. PSDI Classifications

Palmer Classifications	
4.0 or more	extremely wet
3.0 to 3.99	very wet
2.0 to 2.99	moderately wet
1.0 to 1.99	slightly wet
0.5 to 0.99	incipient wet spell
0.49 to -0.49	near normal
-0.5 to -0.99	incipient dry spell
-1.0 to -1.99	mild drought
-2.0 to -2.99	moderate drought
-3.0 to -3.99	severe drought
-4.0 or less	extreme drought

Source: Hayes, 2006

The CMI, developed by Wayne Palmer in 1968, can be used to measure the status of dryness or wetness affecting warm season crops and field activities. It gives the short-term or current status of purely agricultural drought or moisture surplus and can change rapidly from week to week (NWS CPC, 2005).

The CMI responds more rapidly than the PDSI so it is more effective in calculating short-term abnormal dryness or wetness affecting agriculture. CMI is designed to indicate normal conditions at the beginning and end of the growing season; it uses the same levels as the Palmer Drought (NOAA, Date Unknown).

The Standardized Precipitation Index (SPI) is a probability index that considers only precipitation. It is based on the probability of recording a given amount of precipitation, and the probabilities are standardized so that an index of zero indicates the median precipitation amount (half of the historical precipitation amounts are below the median, and half are above the median). The index is negative for drought, and positive for wet conditions. The SPI is computed by NCDC for several time scales, ranging from one month to 24 months, to capture the various scales of both short-term and long-term drought (Heim, 2008).

The National Drought Mitigation Center (NDMC) helps develop and implement measures to reduce societal vulnerability to drought, stressing preparedness and risk management rather than crisis management. Most of the NDMC's services are directed to state, federal, regional, and tribal governments that are involved in drought and water supply planning. The NDMC produces a daily drought monitor map that identifies drought areas and ranks droughts by intensity. U.S. Drought Monitor summary maps are available from May 1999 through the present and identify general drought areas and classification droughts by intensity ranging from D1 (moderate drought) to D4 (exceptional drought). Category D0, drought watch areas, are either drying out and possibly heading for drought, or are recovering from drought but not yet back to normal, suffering long-term impacts such as low reservoir levels (Table 5.4.6-3).

Table 5.4.6-3. NDMC Drought Severity Classification Table

Category	Description	Possible Impacts	Palmer Drought Severity Index (PDSI)	CPC Soil Moisture Model (%)	USGS Weekly Streamflow (%)	Standardized Precipitation Index (SPI)	Satellite Vegetation Health Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, 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 -1.9	21-30	21-30	-0.5 to -0.7	36-45
D1	Moderate Drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested	-2.0 to -2.9	11-20	11-20	-0.8 to -1.2	26-35
D2	Severe Drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed	-3.0 to -3.9	6-10	6-10	-1.3 to -1.5	16-25

Category	Description	Possible Impacts	Palmer Drought Severity Index (PDSI)	CPC Soil Moisture Model (%)	USGS Weekly Streamflow (%)	Standardized Precipitation Index (SPI)	Satellite Vegetation Health Index
D3	Extreme Drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions	-4.0 to -4.9	3-5	3-5	-1.6 to -1.9	6-15
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	0-2	0-2	-2.0 or less	1-5

Source: NDMC, 2002

Note: Additional indices used, mainly during the growing season, include the USDA/NASS Topsoil Moisture, Crop Moisture Index (CMI), and Keetch Byram Drought Index (KBDI). Indices used primarily during the snow season and in the West include the River Basin Snow Water Content, River Basin Average Precipitation, and the Surface Water Supply Index (SWSI).

The Drought Impact Reporter (DIR) is an interactive tool developed by the NDMC to collect, quantify, and map reported drought impacts for the U.S., which is one of the resources used to identify known drought events throughout Delaware County for this Plan (NDMC, 2007).

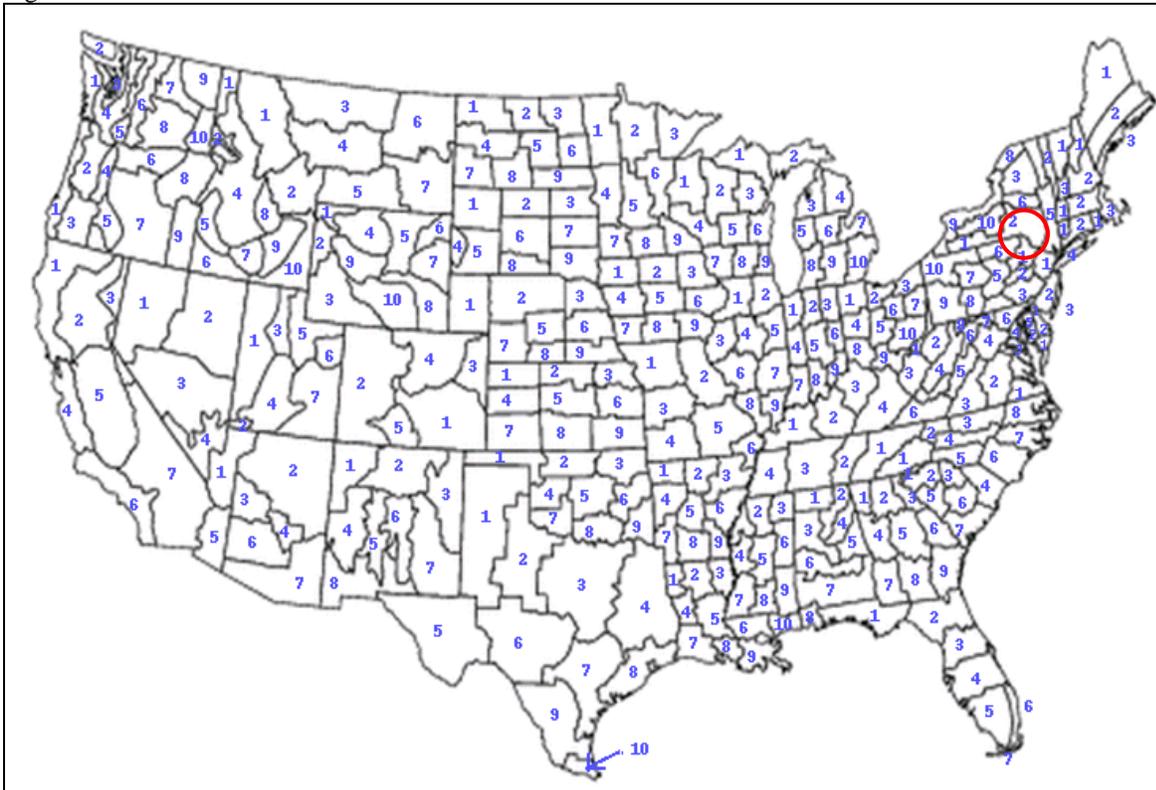
The North America Drought Monitor (NA-DM) is a cooperative effort between drought experts in Canada, Mexico and the U.S. to monitor drought across the continent on an ongoing basis. The Drought Monitor concept was developed as a process that synthesizes multiple indices, outlooks and local impacts, into an assessment that best represents current drought conditions. The final outcome of each Drought Monitor is a consensus of federal, state and academic scientists. Maps of U.S. droughts are available from this source from 2003 to the present (NCDC, 2006).

### Location

Climate divisions are regions within a state that are climatically homogenous. The National Oceanic and Atmospheric Administration (NOAA) has divided the U.S. into 359 climate divisions. The boundaries of these divisions typically coincide with the county boundaries, except in the western U.S., where they are based largely on drainage basins (Energy Information Administration, 2005).

According to NOAA, New York State is made up of 10 climate divisions: Western Plateau, Eastern Plateau, Northern Plateau, Coastal, Hudson Valley, Mohawk Valley, Champlain Valley, St. Lawrence Valley, Great Lakes, and Central Lakes. Delaware County is located within the Eastern Plateau Climate Division (NOAA, Date Unknown). Figure 5.4.6-1 shows the climate divisions throughout the U.S. and Figure 5.4.6-2 shows the climate divisions of New York.

Figure 5.4.6-1. Climate Divisions of the U.S.

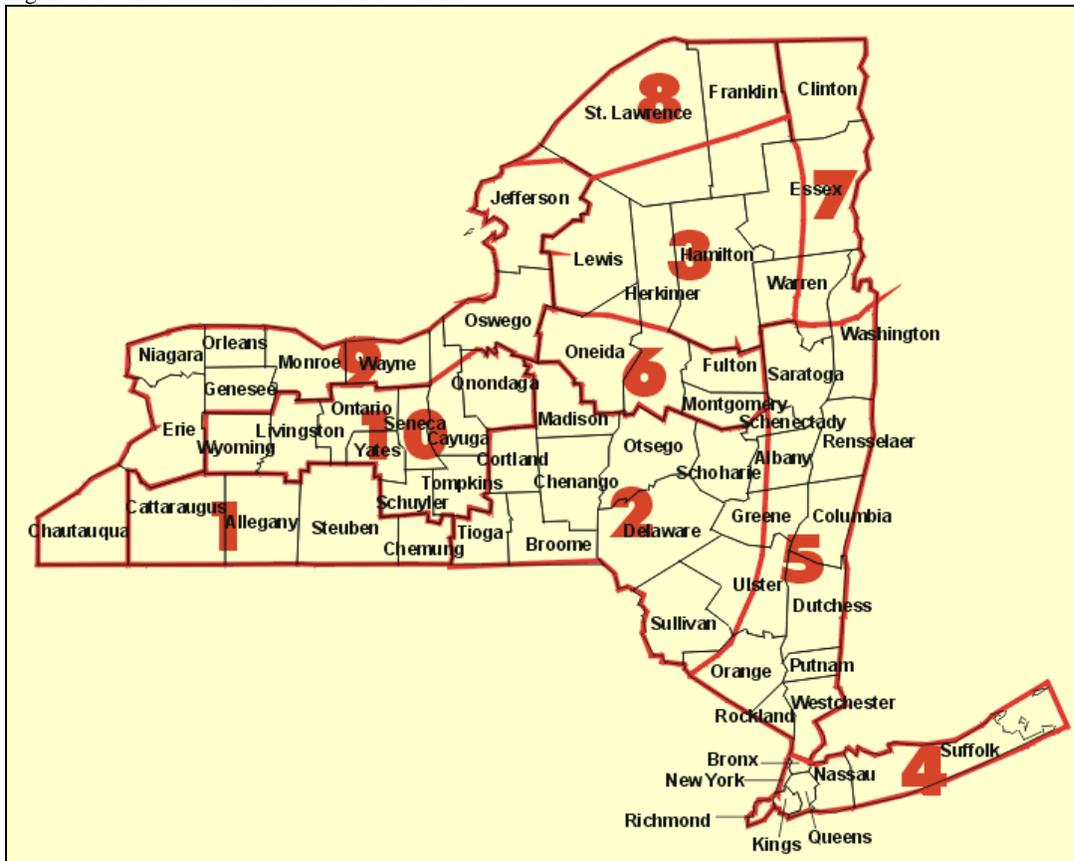


Source: NOAA, Date Unknown

Note (1): The red circle indicates the approximate location of Delaware County (Eastern Plateau).

Note (2): 1 = Western Plateau; 2 = Eastern Plateau; 3 = Northern Plateau; 4 = Coastal; 5 = Hudson Valley;  
6 = Mohawk Valley; 7 = Champlain Valley; 8 = St. Lawrence Valley; 9 = Great Lakes; 10 = Central Lakes

Figure 5.4.6-2. Climate Divisions of New York



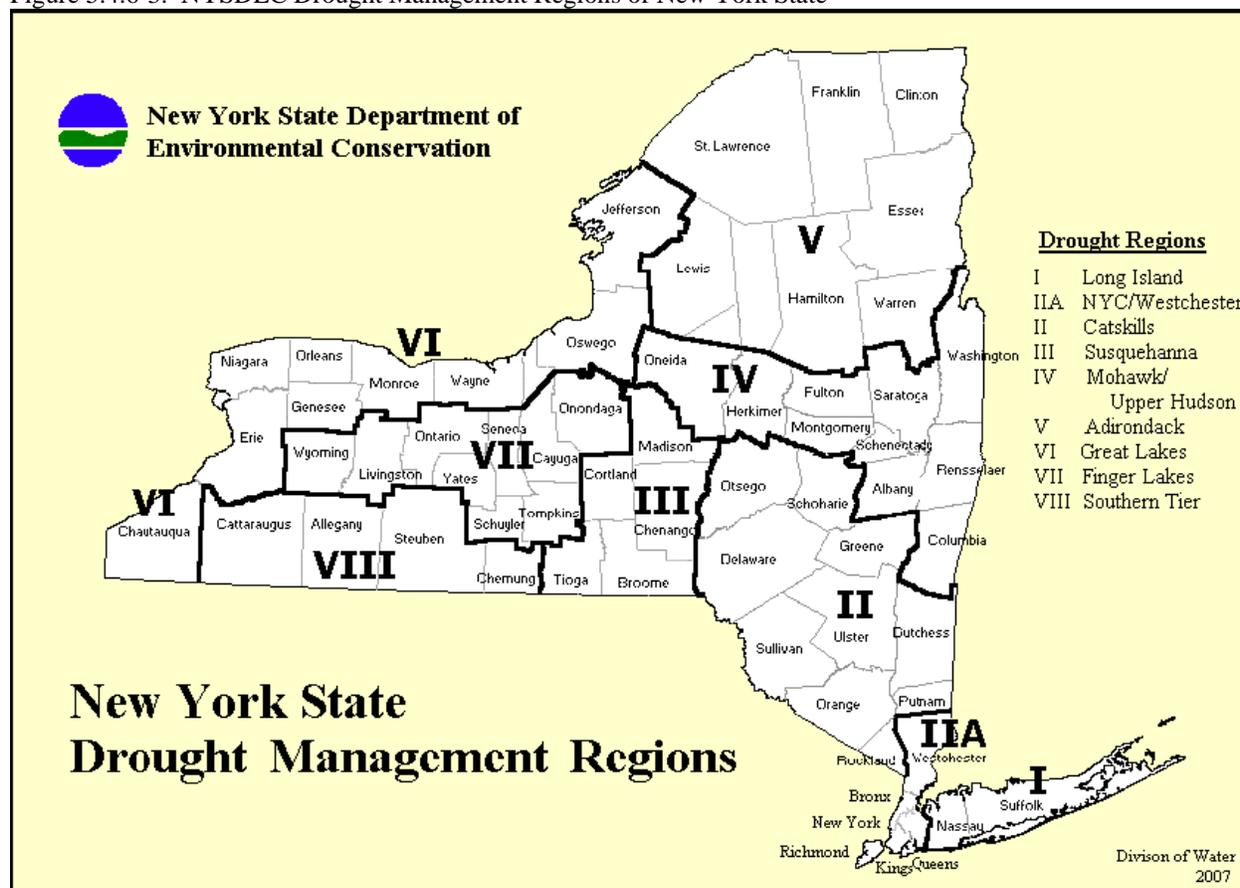
Source: CPC, 2005

Note: 1 = Western Plateau; 2 = Eastern Plateau; 3 = Northern Plateau; 4 = Coastal; 5 = Hudson Valley;

6 = Mohawk Valley; 7 = Champlain Valley; 8 = St. Lawrence Valley; 9 = Great Lakes; 10 = Central Lakes

New York State is divided into nine drought management regions based roughly on drainage basin and county lines. The New York State Department of Environmental Conservation (NYSDEC) monitors precipitation, lake and reservoir levels, stream flow, and groundwater level on a monthly basis in each region and more frequently during periods of drought. The NYSDEC uses this data to assess the condition of each region, which can range from “normal” to “drought disaster” (NYSDEC, Date Unknown). Delaware County is identified as NYSDEC Drought Management Region 2, the Catskills Drought Region (Figure 5.4.6-3).

Figure 5.4.6-3. NYSDEC Drought Management Regions of New York State



Source: NYS HMP, 2011

### Previous Occurrences and Losses

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

According to NOAA's NCDC storm events database, Delaware County experienced seven drought events between April 30, 1950 and November 30, 2011. Total crop damages, as a result of these drought events, were estimated at \$100 million. This total also includes damages to other counties. According to the Hazard Research Lab at the University of South Carolina's Spatial Hazard Events and Losses Database for the U.S. (SHELDUS), between 1988 and 1999, four drought events occurred within the County. The database indicated that drought events and losses specifically associated with Delaware County and its municipalities totaled over \$33,000 in property damage and nearly \$5 million in crop damages. However, these numbers may vary due to the database identifying the location of the hazard event in various forms or throughout multiple counties or regions.

Between 1954 and 2011, FEMA declared that New York State experienced one drought-related disaster (DR) or emergency (EM) classified as one or a combination of the following disaster types: water shortage. Generally, these disasters cover a wide region of the State; therefore, they may have impacted

many counties. However, not all counties were included in the disaster declarations. Of those events, the NYS HMP and other sources indicate that Delaware County has been declared as a disaster area as a result of one drought-related event (FEMA, 2011).

Based on all sources researched, known drought events, between 1965 and 2011, that have affected Delaware County and its municipalities are identified in Table 5.4.6-4. Not all sources have been identified or researched; therefore, Table 5.4.6-4 may not include all events that have occurred throughout the County and region.

Table 5.4.6-4. Drought Events Between 1965 and 2011.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
August 1965	Water Shortage	DR-204	Yes	N/A	FEMA
June - September 1993	Drought	N/A	N/A	Catskills and Capital District, - a prolonged period of drought decimated much of the agriculture in southeast New York State. A drought alert advisory was issued on August 5, 1993 by the New York State Drought Management Task Force for Delaware, Dutchess, Sullivan and Ulster Counties. Estimates of feed grain losses in these counties were well over 40 percent and in some cases nearly 100 percent. Especially hard hit were hay and corn crops as well as other fruits and vegetables.	NOAA-NCDC
August – September 1995	Drought	N/A	N/A	Two month duration with the lowest PDSI at -3.63 in August 1995.	NRCC
May 2005 – March 2006	Drought and Extreme Temperatures	N/A	N/A	Damages and loss to crops caused by drought and high temperatures. Delaware County was in moderate to severe drought conditions during this time.	Drought Impact Reporter, NCDC
September 2005	Drought	N/A	N/A	A report of a well driller having sevens springs go dry and having to drill five wells. Several local water departments issued voluntary and mandatory water restrictions. The affected counties include: Delaware, Greene, Ulster, Sullivan and parts of Otsego.	Drought Impact Reporter
October – November 2007	Drought	N/A	N/A	Due to low water levels in Hinkley Reservoir, the entire state canal system was closed early to traffic, recreational users and commercial users.	Drought Impact Reporter

FEMA Federal Emergency Management Agency  
N/A Not Applicable  
NCDC National Climatic Data Center  
NOAA National Oceanic and Atmospheric Administration  
NRCC Northeast Regional Climate Center

### Probability of Future Events

It is estimated that Delaware County will continue to experience direct and indirect impacts of drought and its impacts on occasion, with the secondary effects causing potential disruption or damage to agricultural activities and creating shortages in water supply within communities.

In Section 5.3, the identified hazards of concern for Delaware County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for drought in the County is considered ‘Frequent’ (likely to occur within 25 years, as presented in Table 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. Delaware County is part of Region 2, Catskill Mountains and West Hudson River Valley. Some of the issues in this region, affected by climate change, include: the watershed for New York City’s water supply, spruce/fir forests disappear from mountains, decline in popular apple varieties, winter recreation declines/summer opportunities increase, Hemlock wooly adelgid destroys trees, and native brook trout decline and replaced by bass (NYSERDA, 2011).

Temperatures are expected to increase throughout the state, by 1.5 to 3°F by the 2020s, 3 to 5.5°F by the 2050s and 4 to 9°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 5.4.6-5 displays the projected seasonal precipitation change for the Catskill Mountains and West Hudson River Valley ClimAID Region (NYSERDA, 2011).

Table 5.4.6-5. Projected Seasonal Precipitation Change in Region 2, 2050s (% change)

Winter	Spring	Summer	Fall
0 to +15	0 to +10	-5 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 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 (Cornell University, Date Unknown). The New York City drinking water system, which includes the Pepacton and Cannonsville Reservoirs located in Delaware County, falls under this category. 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 drought hazard, all of Delaware County has been identified as the hazard area. Therefore, all assets in Delaware County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), are vulnerable to a drought. Assets at particular risk would include any open land or structures at located along the wildland/urban interface (WUI) that could become vulnerable to the wildfire hazard due to extended periods of low rain and high heat, usually associated with a drought. In addition, water supply resources could be impacted by extended periods of low rain. Finally, 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. The following text evaluates and estimates the potential impact of the drought hazard on Delaware County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact, including: (1) impact on life, safety and health of county residents, (2) general building stock, (3) critical facilities, (4) economy and (5) future growth and development
- Further data collections that will assist understanding of this hazard over time
- Overall vulnerability conclusion

### Overview of Vulnerability

All of Delaware County is vulnerable to drought. However, areas at particular risk are: areas used for agricultural purposes (farms and cropland), open/forested land vulnerable to the wildfire hazard, areas where communities rely on private water supply, and certain areas where elderly, impoverished or otherwise vulnerable populations are located.

### Data and Methodology

Data was collected from NYS, the County, and Planning Committee sources. At the time of this draft HMP, insufficient data are available to model the long-term potential impacts of a drought on the County. Over time, additional data 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

Droughts conditions can cause a shortage of water for human consumption and reduce local fire-fighting capabilities. The drought hazard is a concern because private water supply sources in Delaware County are from local groundwater sources.

Social impacts of a drought include mental and physical stress, public safety (increased threat from forest/grass fires), health, conflicts between water users, reduced quality of life, and inequities in the distribution of impacts and disaster relief. The infirm, young, and elderly are particularly susceptible to drought and extreme temperatures, sometimes associated with drought conditions, due to their age, health conditions and limited ability to mobilize to shelters, cooling and medical resources. Impacts on the economy and environment may have social implications as well (Draft NYS HMP, 2011). For the purposes of this HMP, the entire population in the County is vulnerable to drought events.

### **Impact on General Building Stock and Critical Facilities**

No structures are anticipated to be directly affected by a drought and are expected to be operational during a drought event. However, droughts contribute to conditions conducive to wildfires. Risk to life and property is greatest in those areas where forested areas adjoin urbanized areas (high density residential, commercial and industrial) or WUI. Therefore, all assets in and adjacent to, the WUI zone, including population, structures, critical facilities, lifelines, and businesses are considered vulnerable to wildfire. Please refer to Section 5.4.5 regarding the wildfire hazard in Delaware County.

### **Impact on Economy**

A prolonged drought can have serious direct and indirect economic impacts on a community. As noted in the NYS HMP, it is difficult to estimate financial damages as a result of a drought because ‘the more removed the impact from the cause, the more complex the link to the cause’ (NYS HMP, 2011). General economic effects from a drought 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 (Draft NYS HMP, 2011).

A summary of the direct and indirect losses to agricultural producers, livestock producers, timber production, fishery production, and tourism is presented in Table 5.4.6-6 (Draft NYS HMP, 2011).

As noted, agricultural resources need ample water supplies for successful production, relying on natural precipitation and the supply and demand of groundwater resources, both of which become limited or compromised during times of drought. According to the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS), there are 747 farms in Delaware County, occupying 165,572 acres of land in the County. Land is used to raise livestock and grow crops including dairy cows, cattle and calves, nursery and greenhouses, and other livestock (USDA NASS, 2007).

The entire agricultural industry in Delaware County is vulnerable to the drought hazard. As a result of the 2003 drought event, estimated losses included 40 to 100-percent loss of feed grain, as well as crop loss (mainly hay and corn). According to NASS, Delaware County The historic record may assist Delaware County in estimating potential future losses as a result of this hazard of concern.

Table 5.4.6-6. Impacts on the Economy

<b>Losses to Agricultural Producers</b>	<b>Losses to Livestock Producers</b>	<b>Loss from Timber Production</b>
Annual and perennial crop losses	Reduced productivity of rangeland	Wildland fires
Damage to crop quality	Reduced milk production	Tree disease
Income loss for farmers due to reduced crop yields	Forced reduction of foundation stock	Insect infestation
Reduced productivity of cropland (wind erosion, long-term loss of organic matter, etc.)	High cost/unavailability of water for livestock	Impaired productivity of forest land
Insect infestation	Cost of new or supplemental water resource development (wells, dams, pipelines)	Direct loss of trees, especially young ones
Plant disease	High cost/unavailability of feed for livestock	<b>Transportation Industry</b>
Wildlife damage to crops	Increased feed transportation costs	Loss from impaired navigability of streams, rivers, and canals
Increased irrigation costs	High livestock mortality rates	<b>Decline in food production/disrupted food supply</b>
Cost of new or supplemental water resource development (wells, dams, pipelines)	Disruption of reproduction cycles (delayed breeding, more miscarriages)	Increase in food prices
<b>Loss from Fishery Production</b>	Decreased stock weights	Increased importation of food (higher costs)
Damage to fish habitat	Increased predation	<b>Water Suppliers</b>
Loss of fish and other aquatic organisms due to decreased flows	Grass fires	Revenue shortfalls and/or windfall profits
<b>Loss to Recreation and Tourism Industry</b>	<b>Energy-related effects</b>	Cost of water transport or transfer
Loss to manufacturers and sellers of recreational equipment	Increased energy demand and reduced supply because of drought-related power curtailments	Cost of new or supplemental water resource development
Losses related to curtailed activities: hunting and fishing, bird watching, boating, etc.	Costs to energy industry and consumers associated with substituting more expensive fuels (oil) for hydroelectric power	

Source: Draft NYS HMP, 2011

### **Effect of Climate Change on Vulnerability**

The potential effects of climate change on Delaware County’s vulnerability to drought events shall need to be considered as a greater understanding of regional climate change impacts develop.

### **Future Growth and Development**

As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the drought hazard because the entire County is exposed and vulnerable.

### **Additional Data and Next Steps**

For the revised plan, any additional information regarding localized concerns and past impacts will be collected and analyzed. This data will be developed to support future revisions to the plan. Mitigation efforts could include building on existing New York State, Delaware County, and local efforts. The lead State Agency for drought preparedness is the NYSDEC.

### **Overall Vulnerability Assessment**

Historic data available indicate that droughts can impact Delaware County. Drought events can cause significant impacts and losses to the County’s water supply and economy. The overall hazard ranking for Delaware County determined by the Planning Committee for the drought hazard is “Medium” (Tables 5.3-5 and 5.3-6). The cascade effects of drought include increased susceptibility to the wildfire hazard, increased and thus shortages on local resources (i.e., water supply, electricity). Losses associated with the wildfire hazard are discussed earlier in this section.