5.4.2 Drought

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the drought hazard in Dutchess County.

5.4.2.1 Profile

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.

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 relative 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, and other parameters. 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 shortfalls (including snowfall) on surface or subsurface water supply. It 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 an 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 (for example 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 (National Drought Mitigation Center 2014).

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 (U.S. Energy Information Administration, Date Unknown). 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 (NOAA 2014). Dutchess County is located in the Hudson Valley Climate Division.
New York State is divided into nine drought management regions based roughly on drainage basin and county lines. NYSDEC monitors precipitation, lake and reservoir levels, stream flow, and groundwater level at least monthly in each region and more frequently during periods of drought. NYSDEC uses this data to assess the condition of each region, which can range from "normal" to "drought disaster" (NYSDEC 2015). Figure 5.4.2-1 shows the drought regions of New York State with Dutchess County circled. Dutchess County is located within the Catskills Drought Region.

**Figure 5.4.2-1. Drought Regions of New York State**

The severity of a drought depends on the degree of moisture deficiency, the duration, 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 (NOAA Date Unknown). The New York State Department of Environmental Conservation (NYSDEC) and the New York State Drought Management Task Force identifies droughts in the following four stages:

- **Normal** is considered the standard moisture soil levels found throughout New York State
- **Drought Watch** is the first stage of drought. This stage is declared by the NYSDEC and is intended to give advance notice of a developing drought. As this stage, the general public is urged to conserve water.
Public water purveyors and industries are urged to update and begin to implement individual drought contingency plans.

- **Drought Warning** is the second stage of drought. This stage is also declared by the NYSDEC and is a notice of impending and imminent severe drought conditions. A warning declaration includes stepping up public awareness and increasing voluntary conservation. Public water supply purveyors and industries are urged to continue to implement local drought contingency plans. Federal, state and local water resources agencies are notified to prepare for emergency response measures.

- **Drought Emergency** is the third stage of drought. This stage is declared by the NYSDHSES, based upon recommendation of the Task Force. It is a notice of existing severe and persistent drought conditions. An emergency declaration is a notice for local water resources agencies to mandate conservation and implement other emergency response measures. A continuing and worsening drought emergency may result in the New York State governor declaring a drought disaster. It is a notice of the most severe and persistent drought conditions. At this stage, a significant proportion of communities in the impacted area likely are unable to respond adequately.

New York State uses two methodologies to determine the various drought stages. The Palmer Drought Index (PDI) is a commonly used drought indicator and is primarily based on soil conditions. These are typically the first indicators that a moisture deficit is present. These values range from -1 to +5 with positive values indicating wetter conditions and negative values representing drier conditions (NYS DHSES 2014).

The second methodology used by New York State was developed by the NYSDEC and is referred to as the State Drought Index (SDI). The SDI evaluates drought conditions on a more comprehensive basis by measuring whether numerous indicators reach dire thresholds. The data collected is compared against critical threshold values to show a normal or changeable drought condition. The indicators are weighted on a regional basis to reflect the unique circumstances of each drought management region (NYS DHSES 2014).

**Previous Occurrences and Losses**

Between 1954 and 2015, New York State experienced one FEMA declared drought-related major declaration (DR) classified as a water shortage. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Dutchess County was included in this declaration (FEMA 2015).

Agriculture-related drought disasters are quite common. One-half to two-thirds of the counties in the U.S. have been designated as disaster areas in each of the past several years. The USDA Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and mid-2015, New York State has been included in 27 USDA declarations. Of those 27 declarations, Dutchess County has been included in eight of the declarations; however, only two of them were a result of drought conditions (S3427 in 2012 and S3759 in 2014).

For this 2015 Plan Update, known drought events, including FEMA and USDA disasters, that have impacted Dutchess County between 1990 and 2015 are identified in Table 5.4.2-1. Please note that not all events that have occurred in the County are included due to the extent of documentation and the fact that not all sources may have been identified or researched. Loss and impact information 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 Update.
### Table 5.4.2-1. Drought Events Impacting Dutchess County, 1990 to 2015

<table>
<thead>
<tr>
<th>Dates of Event</th>
<th>Event Type</th>
<th>FEMA Declaration Number</th>
<th>County Designated?</th>
<th>Losses / Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>August – December 1993</td>
<td>Drought</td>
<td>N/A</td>
<td>N/A</td>
<td>A four month drought impacted several counties in New York State including: Albany, Columbia, Delaware, Dutchess, Greene, Otsego, Rensselaer, Schoharie, Sullivan, and Ulster. The damage from the drought primarily affected the agriculture sector's feed grain. The estimate losses were over 40% and in some areas nearly 100% in feed losses. There were significant losses in hay, corn, and a few other fruit and vegetable crops. On August 5th, the NYS Drought Management Task Force issued a drought alert advisory for Delaware, Dutchess, Sullivan, and Ulster Counties. The State had approximately $50 million in damages from this drought.</td>
</tr>
<tr>
<td>February – April 1994</td>
<td>Drought</td>
<td>N/A</td>
<td>N/A</td>
<td>Three month drought in New York State impacted several counties: Delaware, Dutchess, Greene, Otsego, Schoharie, Sullivan and Ulster. New York City experienced a reduction in the usable storage of the City's water supply.</td>
</tr>
<tr>
<td>October 1994</td>
<td>Drought</td>
<td>N/A</td>
<td>N/A</td>
<td>A drought impacted the entire State, including Dutchess County.</td>
</tr>
<tr>
<td>October 1995</td>
<td>Drought</td>
<td>N/A</td>
<td>N/A</td>
<td>A drought watch and warning were issued for eastern New York State and the Governor requested USDA disaster aid to farmers in several counties.</td>
</tr>
<tr>
<td>April 1999</td>
<td>Drought</td>
<td>N/A</td>
<td>N/A</td>
<td>This was the second driest April on record in the City of Albany and the driest of the century. In surrounding areas, rainfall amounts were below normal. The lack of rain and gusty winds led to numerous brush fires during the month.</td>
</tr>
<tr>
<td>August 1999</td>
<td>Drought</td>
<td>N/A</td>
<td>N/A</td>
<td>August was the peak of the long-term drought across eastern New York State that began in July 1998. Rainfall and snowmelt only totaled up to 80% of the normal precipitation. A drought warning was issued, along with an agricultural disaster declaration. Numerous wildfires were reported and wells went dry. Most communities impacted by the drought implemented voluntary or mandatory water restrictions.</td>
</tr>
<tr>
<td>July – December 2012</td>
<td>Drought</td>
<td>N/A</td>
<td>N/A</td>
<td>The Governor of New York State issued a statewide ban on outdoor residential brush burning due to dry weather and elevated fire danger. Emergency personnel were at a higher state of readiness for wildfire outbreaks. The lack of snowfall during the winter lead to an increase in the dryness. Some areas of New York State received only 25% of average rainfall during the spring and early summer. The heat and drought during July jeopardized second and third cuttings of hay in the State. Additionally, the dryer weather brought a higher incidence of mosquitoes with West Nile Virus to parts of New York State. There were 107 reported cases of West Nile Virus and nine deaths across the State. The USDA included Dutchess in a disaster declaration for this event (S3427).</td>
</tr>
<tr>
<td>2014</td>
<td>Drought</td>
<td>N/A</td>
<td>N/A</td>
<td>The USDA included Dutchess County in a disaster declaration for the 2014 drought (S3759).</td>
</tr>
</tbody>
</table>

Source(s): FEMA 2015; NYS HMP 2014; NOAA-NCDC 2015

FEMA Federal Emergency Management Agency
HMP Hazard Mitigation Plan
NCDC National Climatic Data Center
NOAA National Oceanic and Atmospheric Administration
USDA U.S. Department of Agriculture

DMA 2000 Hazard Mitigation Plan – Dutchess County, New York
February 2016
Probability of Future Occurrences

Based upon risk factors for and past occurrences, it is likely that droughts will occur across New York State and Dutchess County in the future. In addition, as temperatures increase (see climate change impacts), the probability for future droughts will likely increase as well. Therefore, it is likely that droughts will occur in the State and County of varied severity in the future.

It is estimated that Dutchess 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 Dutchess 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 5.3-3).

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. Dutchess County is part of Region 5, East Hudson and Mohawk River Valleys. Some of the issues in this region, affected by climate change, include: more frequent heat waves and above 90°F days, more heat-related deaths, increased frequency of heavy precipitation and flooding, decline in air quality, etc. (NYSERDA, 2011).

Temperatures in New York State are warming, with an average rate of warming over the past century of 0.25° F per decade. Average annual temperatures are projected to increase across New York State by 2° F to 3.4° F by the 2020s, 4.1° F to 6.8° F by the 2050s, and 5.3° F to 10.1° F by the 2080s. By the end of the century, the greatest warming is projected to be in the northern section of the State (NYSERDA, 2014).

Regional precipitation across New York State is projected to increase by approximately one to eight-percent by the 2020s, three to 12-percent by the 2050s, and four to 15-percent by the 2080s. By the end of the century, the greatest increases in precipitation are projected to be in the northern areas of the State (NYSERDA, 2014).

In Region 5, it is estimated that temperatures will increase by 3.5°F to 7.1°F by the 2050s and 4.1°F to 11.4°F by the 2080s (baseline of 47.6°F). Precipitation totals will increase between 2 and 15% by the 2050s and 3 to 17% by the 2080s (baseline of 38.6 inches). The changes in temperature and precipitation are likely to produce an increase in extreme heat, intense precipitation, and more occurrences of short-duration warm season droughts. Both heavy precipitation events and warm season droughts are projected to become more frequent and intense during this century. Table 5.4.2-2 displays the projected seasonal precipitation change for the East Hudson and Mohawk River Valleys ClimAID Region (NYSERDA, 2014).

Table 5.4.2-2. Projected Seasonal Precipitation Change in Region 5, 2050s (% change)

<table>
<thead>
<tr>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 to +15</td>
<td>-5 to +10</td>
<td>-5 to +5</td>
<td>-5 to +10</td>
</tr>
</tbody>
</table>

Source: NYSERDA 2011
In Region 5, the frequency of heat waves, cold events, intense precipitation, drought, and coastal flooding are projected to increase. Table 5.4.2-3 displays the projected changes in extreme events and includes the minimum, central range and maximum days per year.

Table 5.4.2-3. Changes in Extreme Events in Region 5 – Heat Waves and Intense Precipitation

<table>
<thead>
<tr>
<th>Event Type</th>
<th># Days Per Year</th>
<th>Baseline</th>
<th>2020s</th>
<th>2050s</th>
<th>2080s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Waves</td>
<td>Number of Days per year with maximum temperature exceeding: minimum, (central range), and maximum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90°F</td>
<td>10</td>
<td>11 (14 to 20) 28</td>
<td>17 (20 to 35) 49</td>
<td>18 (26 to 60) 75</td>
<td></td>
</tr>
<tr>
<td>95°F</td>
<td>1</td>
<td>1 (2 to 4) 7</td>
<td>3 (3 to 10) 18</td>
<td>3 (6 to 25) 42</td>
<td></td>
</tr>
<tr>
<td>Number of heat waves per year</td>
<td>2</td>
<td>2 (2 to 3) 4</td>
<td>3 (3 to 5) 7</td>
<td>3 (4 to 8) 9</td>
<td></td>
</tr>
<tr>
<td>Average duration</td>
<td>4</td>
<td>4 (4 to 5) 5</td>
<td>4 (4 to 5) 6</td>
<td>4 (4 to 6) 9</td>
<td></td>
</tr>
<tr>
<td>Intense Precipitation</td>
<td>Number of days per year with rainfall exceeding:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 inch</td>
<td>1</td>
<td>8 (10 to 11) 12</td>
<td>9 (10 to 11) 12</td>
<td>10 (10 to 12) 14</td>
<td></td>
</tr>
<tr>
<td>2 inches</td>
<td>1</td>
<td>1 (1 to 2) 2</td>
<td>1 (1 to 2) 2</td>
<td>1 (1 to 2) 2</td>
<td></td>
</tr>
</tbody>
</table>

Source: NYSERDA 2014
5.4.2.2 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 Dutchess County has been identified as exposed. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), are exposed and potentially vulnerable to a drought. The following text evaluates and estimates the potential impact of the drought hazard on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2006 Dutchess County Hazard Mitigation Plan and 2010 Eastern Dutchess All-Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

The entire 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, densely-populated areas where communities rely on surface water supplies (above ground reservoirs) for industrial, commercial, and domestic purposes, and certain areas where elderly, impoverished or otherwise vulnerable populations are located. 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.

Data and Methodology

Data was collected from USDA, NOAA-NCDC, Dutchess County, and the Steering and Planning Committees. Insufficient data was 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 may have devastating effects on communities and the surrounding environment. The amount of devastation depends on the strength and duration of a drought event. One impact of drought is its impact on water supply. When drought conditions persist with little to no relief, water restrictions may be put into place by local or state governments. These restrictions can include watering of lawns, washing cars, etc. In exceptional drought conditions, watering of lawns and crops may not be an option. If crops are not able to receive water, farmland will dry out and crops will die. This can lead to crop shortages, which, in turn, increases the price of food (North Carolina State University 2013).

Droughts also have the potential to lead to water pollution due to the lack of rain water to dilute any chemicals in water sources. Contaminated water supplies may be harmful to plans and animals. If water is not getting into the soils, the ground will dry up and become unstable. Unstable soils increase the risk of erosion and loss of top soil (North Carolina State University 2013).

The impacts on public health from drought can be severe which includes increase in heat-related illnesses, waterborne illnesses, recreational risks, limited food availability, and reduced living conditions. Those individuals who rely on water, such as farmers, may experience financial-related stress. Decreased amounts and quality of
water during drought events have the potential to reduce the availability of electricity (hydropower, coal-burning and nuclear) (North Carolina State University 2013).

Drought conditions can affect people’s health and safety including health problems related to low water flows and poor water quality; and health problems related to dust. Droughts also have the potential to lead to loss of human life (NDMC 2014). 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. Health implications of drought are numerous. Some drought-related health effects are short-term while others can be long-term (CDC 2012).

As previously stated, drought conditions can cause shortages in water for human consumption. Droughts can also lead to reduced local firefighting capabilities. The drought hazard is a concern for Dutchess County because the County’s water is supplied by both surface water and groundwater. In the short-term, surface water supplies are affected more quickly during droughts than groundwater sources.

**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 wildfire urban interface (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 5.4.8 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.

**Impact on the Economy**

When a drought occurs, the agricultural industry is most at risk in terms of economic impact and damage. During droughts, crops do not mature leading to a lessened crop yield, wildlife and livestock are undernourished, land values decrease, and ultimately there is financial loss to the farmer (FEMA, 1997).

Based on the 2012 Census of Agriculture, there were 678 farms in Dutchess County, with 112,482 acres of total land in farms. The average farm size was 166 acres. Dutchess County farms had a total market value of products sold of $26 million in crop sales and $23 million in livestock sales), averaging $72,303 per farm. The Census indicated that 368 of farm operators reported farming as their primary occupation (USDA 2012). Table 5.4.2-4 shows the acreage of agricultural land exposed to the drought hazard.

**Table 5.4.2-4. Agricultural Land in Dutchess County in 2012**

<table>
<thead>
<tr>
<th>Number of Farms</th>
<th>Land in Farms (acres)</th>
<th>Total Cropland (acres)</th>
<th>Harvested Cropland (acres)</th>
<th>Irrigated Land (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>678</td>
<td>112,482</td>
<td>45,576</td>
<td>(D)</td>
<td>843</td>
</tr>
</tbody>
</table>

Source: USDA 2012

(D) Withheld to avoid disclosing data for individual farms

The 2012 Census of Agriculture for Dutchess County indicated that the top crop items, by acres, in the County are forage land used for all hay and haylage, grass silage, and greenchop (25,038 acres), corn for grain (6,492 acres), and soybeans for beans (2,442 acres).
A prolonged drought can have a serious economic impact on a community. Increased demand for water and electricity may result in shortages and a higher cost for these resources (FEMA, 2005). Industries that rely on water for business may be impacted the hardest (e.g., landscaping businesses). Even though most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant to the recreation and tourism industry. In addition, droughts in another area could impact the food supply/price of food for residents in the County.

**Future Growth and Development**

As discussed in Section 4, areas targeted for future growth and development have been identified across Dutchess County. Future growth could impact the amount of potable water available due to a drain on the available water resources. Other areas that could be impacted include agriculture and recreational facilities such as golf courses, farms, and nurseries. Areas targeted for potential future growth and development in the next five (5) years have been identified across the County at the municipal level. Refer to the jurisdictional annexes in Volume II of this HMP.

**Effect of Climate Change on Vulnerability**

Nearly every region in the country is facing some increased risk of seasonal drought. Climate change can significantly affect the sustainability of water supplies in the future. As parts of the United States get drier, the amount and quality of water available will likely decrease, impacting people’s health and food supplies. With climate change, the entire country will likely face some level of drought. A report by the Natural Resources Defense Council (NRDC) found that 1,100 counties (one-third of all counties in the contiguous 48 states) face higher risks of water shortages by mid-century as a result of climate change. More than 400 of these counties will face extremely high risks of water shortages.

**Change of Vulnerability**

When examining the change in the County’s vulnerability to drought events from the original HMP to this update, it is important to look at each entity that is exposed and vulnerable. The total population across the County has continued to increase over the past few years, which will place a greater stress on the water supply during a drought event. In terms of the agricultural industry for Dutchess County, there has been a 3.4% increase in the total number of farms and a 9.9% increase in total farmland area since 2007 (USDA 2012).

**Additional Data and Next Steps**

For the Plan Update, 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, Dutchess County, and local efforts.