5.4.1 Drought

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

5.4.1.1 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 a temporary irregularity that differs from aridity, which is a permanent feature of climate restricted to regions with typically low rainfall. Drought conditions occur in virtually all climatic zones. Drought characteristics vary significantly from one region to another and are relative to the normal precipitation in that region. Drought can increase wildfire/brush fire risk and 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).

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. 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 Table 5.4.1-1 (NYSDEC 2018). Figure 5.4.1-1 shows the drought regions of New York State. Broome County (circled in red) is located within the Susquehanna Drought Region (Region III).

The SDI evaluates drought conditions by determining whether numerous indicators reach dire thresholds. It compares the following four parameters to historical or "normal" values to evaluate drought conditions: stream flows, precipitation, lake and reservoir storage levels, and groundwater levels. 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 within different areas of 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 DHSES 2014). Table 5.4.1-1 lists the SDI range of values within the normal stage and the three drought stages.

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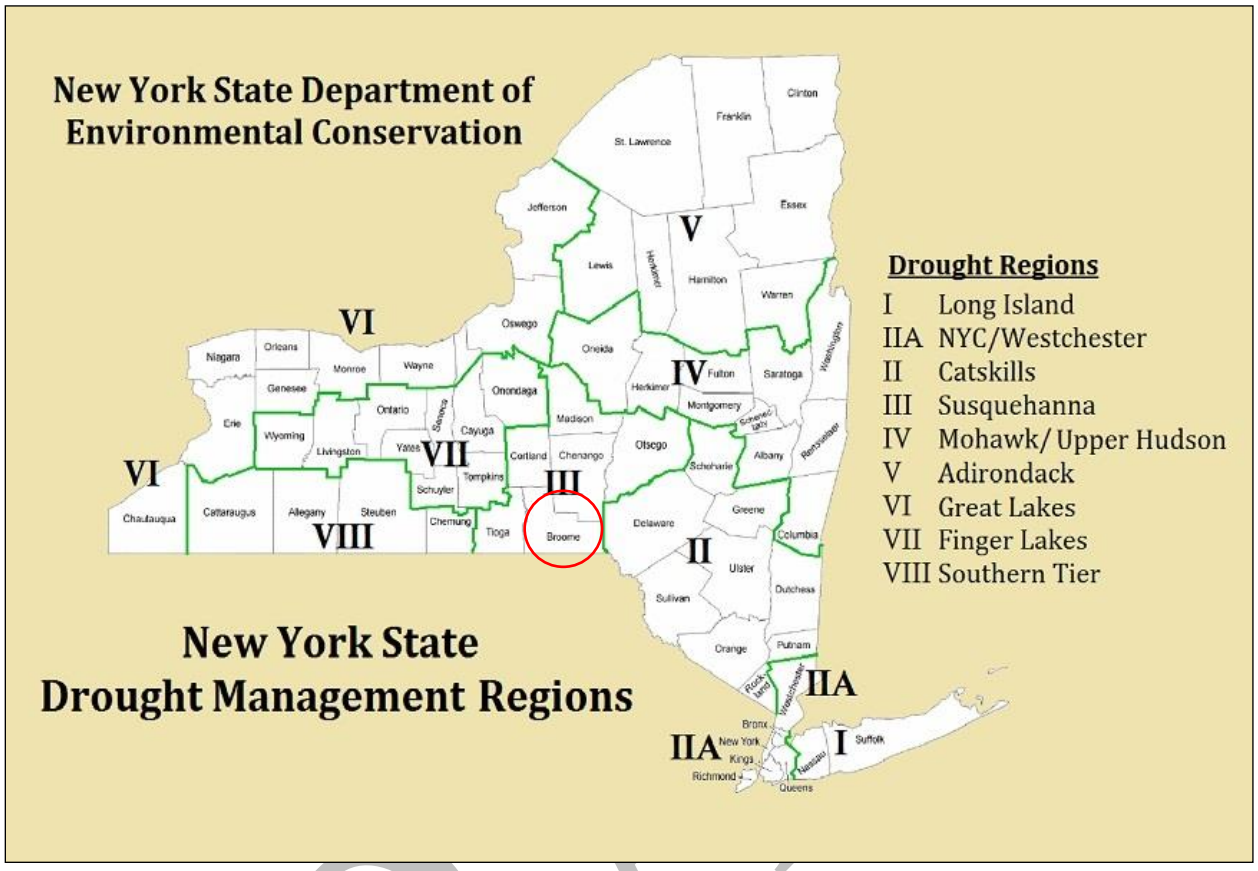
Figure 5.4.1-1. NYSDEC Drought Management Regions of New York State



Source: *NYSDEC 2015*
Note: *The red circle indicates the location of Broome County.*

Table 5.4.1-1. State Drought Index Range of Values

Drought Stage	Drought Index Range	NYSDEC Description
Normal	100 to 150	Normal is considered the standard moisture soil levels found throughout New York State.
Watch	75 to 100	Drought Watch is the first stage of drought. This stage is declared by the NYSDEC and is intended to give notice of a developing drought. At this stage, the public is urged to conserve water. Public water purveyors and industries are urged to update and begin to implement individual drought contingency plans.
Warning	50 to 70	Drought Warning is the second stage of drought. This stage is 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 resource agencies are notified to prepare for emergency response measures.
Emergency	0 to 50	Drought Emergency is the third stage of drought. This stage is declared by the New York State Division of Homeland Security and Emergency Services (NYS DHSES), based upon the recommendation of the Task Force. The emergency declaration is a notice of existing severe and persistent drought conditions, as well as 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, and the declaration is a notice of the most severe and persistent drought conditions. At this stage, a significant number of communities in the impacted area likely are unable to respond adequately.

Source: *NYS DHSES 2014*

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 5.4.1-2 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 5.4.1-2. The PDSI is commonly converted to the Palmer Drought Category. (National Drought Mitigation Center [NDMC] 2013).

Table 5.4.1-2. 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 Broome County, as well as the local and regional economy. Drought events can occur in Broome County any time of the year. Variations in the normal amounts of precipitation can lead to periods of dry weather and periods of drought (NYS DHSES 2014). Broome 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 from neighboring Chenango County, across the southern portion of the county, and into Tioga County, from the east to the southwest. The Susquehanna is also fed by the Chenango River which empties into the Susquehanna at the City of Binghamton. The Whitney Point Reservoir is located on the Otselic River, near its confluence with the Tioughnioga River that feeds into the Chenango River is found in the northern portion of the county. Drought impacting Broome County would have impacts downstream of the Susquehanna, including neighboring Tioga County in New York and Pennsylvania.

Previous Occurrences and Losses

Broome County does not typically 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.

Between 1954 and 2018, 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.

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Generally, drought-related disasters affect a wide region of the state and can impact many counties; however, Broome County was not included in the disaster declaration.

The U.S. Department of Agriculture (USDA) keeps records of agricultural disasters. In 2012, USDA Agricultural Disasters S3427 and S3441 were declared for drought. In 2016, USDA Agricultural Disasters S4023, S4031, and S4062 were declared for drought. The USDA-reported crop losses provide another indicator of previous events. The USDA records indicate that Broome County has not experienced crop losses from drought events from 2014 to 2018. Crop losses prior to 2014 were unavailable.

Table 5.4.1-3 lists known drought events between 2012 and 2018 that have affected Broome County and its municipalities based on all sources researched.

Table 5.4.1-3. Drought Events in Broome County, NY between 2012 and 2018

Dates of Event	Event Details*
April 3–May 15, 2012	According to the U.S. Drought monitor, conditions were classified at D0, or *abnormally dry* status across Broome County from April 3–May 15, 2012.
July 17–September 4, 2012	According to the U.S. Drought monitor, conditions were classified at D0, or *abnormally dry* status across Broome County from July 17–September 4, 2012.
May 21–May 28, 2013	According to the U.S. Drought monitor, conditions were classified at D0, or *abnormally dry* status across Broome County from May 21–May 28, 2013.
June 18–July 6, 2014	According to the U.S. Drought monitor, conditions were classified at D0, or *abnormally dry* status across Broome County from June 18–July 1, 2014
November 5, 2013–January 6, 2014	According to the U.S. Drought monitor, conditions were classified at D0, or *abnormally dry* status across Broome County from November 5, 2013–January 6, 2014
October 14–October 21, 2014.	According to the U.S. Drought monitor, conditions were classified at D0, or *abnormally dry* status across Broome County from October 14–October 21, 2014.
March 31–April 20, 2015.	According to the U.S. Drought monitor, conditions were classified at D0, or *abnormally dry* status across Broome County from March 31–April 20, 2015.
September 22–November 16, 2015.	According to the U.S. Drought monitor, conditions were classified at D0, or *abnormally dry* status across Broome County from September 22–November 16, 2015. Leaves dropped early and lawns browned.
April 26, 2016–February 20, 2017	According to the U.S. Drought monitor, conditions were classified at D0, or *abnormally dry* status across Broome County from April 26–July 4, 2016; D1 or *moderate drought* status from July 5–July 25, D2 or *severe drought* from July 26–August 15, 2016; D1 or *moderate drought* status from August 16–December 19, 2016; and D0 or *abnormally dry* status from December 20, 2016–February 20, 2017. Surveying of New York farmers showed significant crop losses and pastures were dry. Apples were reported as being smaller and sweeter and grapes were slightly small and less acidic throughout the state. New York dairy farmers and Christmas tree farms struggled. Discolored water was reported in Endicott, NY from July 27–August 19, 2016. Shallow wells in the Northeast went dry. A drought watch and warning was issued for New York in July. Drought resulted in shallow marshes, negatively impacting duck and goose hunting in the state.
October 17–October 30, 2017.	According to the U.S. Drought monitor, conditions were classified at D0, or *abnormally dry* status across Broome County from October 17–October 30, 2017. Dried vegetation resulted in leaves forgoing color changes in the county.
December 19, 2017–February 26, 2018.	According to the U.S. Drought monitor, conditions were classified at D0, or *abnormally dry* status across Broome County from December 19, 2017–January 1, 2018; D1 or *moderate drought* from January 2–February 12, 2018; and D0 or *abnormally dry* from February 13–February 26, 2018.

Sources: USDA 2018; NDMC 2018

** 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 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 5.4.1-4 lists projected seasonal precipitation changes within the Southern Tier ClimAID Region (NYSERDA 2014).

Table 5.4.1-4. 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 Broome County might 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

In the past, Broome County has experienced a range of drought conditions from *abnormally dry* to *severe*, or D0 to D2, in accordance with the Palmer Drought Category. Based on the historic record and climate projections for the region, it is anticipated that Broome County will continue to experience drought events in the future. Based on the periods of time that Broome County 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) as presented in Table 5.4.1-3. Refer to Section 5.3 for additional information on the hazard ranking methodology and probability criteria.

5.4.1.2 Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. All of Broome 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.

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Impact on Life, Health, and Safety

The entire population of Broome County is vulnerable to drought events (2016 American Community Survey 5 Year Estimate: 197,381 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. 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 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 Broome County because approximately 80% of water for public use comes from groundwater sources. Rural populations within the county might also rely upon private water supply from local groundwater resources (Broome County Comprehensive Plan 2012). It is noted that the Susquehanna River Basin Commission regulates consumptive water use. Approved surface water and groundwater withdrawal dockets as well as grandfathered water uses are mapped on their site at https://www.srbc.net/waav/Map.

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 5.4.8 of the HMP for additional discussion of the wildfire hazard in Broome County.

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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).

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).

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 2012 Census of Agriculture, 563 farms were present in Broome County, encompassing 79,676 acres of total farmland. The average farm size was 142 acres. Products sold from Broome County farms had a total market value of $30.7 million ($18.9 million: milk from cows, $3.93 million: cattle and calves, $2.45 million: other crops and hay, averaging $54,553 per farm. The 2012 Census indicated that 275 farm operators reported farming as their primary occupation (USDA 2012). Table 5.4.1-5 lists the acreage of agricultural land exposed to the drought hazard.

Table 5.4.1-5. Agricultural Land in Broome County, NY in 2012

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Harvested Cropland (acres)	Total Cropland Used Only For Pasture/Grazing (acres)
563	79,676	38,075	31,901	1,341

Source: USDA 2012

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 agricultural products sold from Broome County farms, losses would be estimated at $12.28 million based on 2012 market values.

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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.

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, Broome County will experience a continual population decrease through 2040 (a decline of over 17,400 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 Comprehensive Plan (2012), the county has seen a decrease in population from the City of Binghamton and most villages, while the populations in the rural towns have increased. This might require reallocation of water resources to meet demands during a drought. 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.

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Change of Vulnerability since the 2013 HMP

The 2013 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 2012 USDA Census of Agriculture to assess potential economic impacts. According to the U.S. Census Bureau 2017 Population Estimates, the population of Broome County has decreased slightly 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 slightly increased from 2007 to 2012; therefore, an increased area of agricultural land is exposed to the drought hazard. Overall, the entire county will continue to be exposed and vulnerable to drought events.

Issues Identified

The potential drought effects on the ground water and well resources in the county provides a possible issue of potable water supply that was identified to be addressed by the county. In addition, as the City of Binghamton relies on surface (river) water for its potable water supply, low river levels could represent a water supply crisis for its residents and businesses. Furthermore, as noted above, droughts contribute to conditions conducive to wildfires, reduce fire-fighting capabilities, and have negative impacts on agriculture throughout the county.

Per the FEMA Mitigation Ideas guidance, in order to mitigate drought impacts communities may develop drought emergency plans, develop criteria for triggers for drought-related actions, develop a drought communication plan and early warning protocol, develop agreements for secondary water sources to be used during drought conditions, or to establish an agricultural water usage schedule to support recharge of ground water. (FEMA, 2013).

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