SOMERSET COUNTY

HAZARD MITIGATION PLAN

SOMERSET COUNTY MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN

FINAL PLAN UPDATE
JULY 2019

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Section 5.4.6: RISK ASSESSMENT-DROUGHT

Prepared by the Somerset County Mitigation Planning Committee

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 NWS Drought Fact Sheet (October 2012), drought is defined as a deficiency in precipitation over an extended period. 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. In some cases, community water issues and other negative social, environmental, and economic impacts are associated with these periods of below-normal precipitation.

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 based on the impact of drought conditions (meteorological, agricultural or hydrological drought) on supply and demand of some economic goods. These occur when the demand for an economic good exceeds supply as a result of a weather-related deficit in water supply. (NWS Drought Fact Sheet (October 2012)).

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 stream flows, 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, 2017).

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 5.4.6-1 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 (NOAA CPC, 2017).

Table 5.4.6-1. PDSI Classifications

Palmer Classifications	
+ 4.0 or more	extremely moist
+ 3.0 to 3.9	very moist spell
+ 2.0 to 2.9	unusual moist spell
-1.9 to +1.9	near normal
-2.0 to -2.9	moderate drought
-3.0 to -3.9	severe drought
-4.0 or less	extreme drought

Source: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/cdus/palmer_drought/wpdanote.shtml(2017)

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 (NOAA CPC, 2017). 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 CPC, 2017).

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 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 5.4.6-2).

Table 5.4.6-2. 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
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, 2017

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 Somerset County for this plan update (NDMC, 2017).

The North America Drought Monitor (NADM) 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, 2017).

During a severe drought that occurred between 1998 and 1999, the New Jersey Department of Environmental Protection (NJDEP) had difficulty comparing the severity of drought throughout the State. In order to improve drought severity monitoring and measurement from region to region, the NJDEP developed a unique set of indices specifically designed for the characteristics and needs of New Jersey (Table 5.4.6-3). These indices were implemented in January 2001. This new set of state-wide indicators, supplements the PDSI with the measurement of regional precipitation, stream-flow, reservoir levels, and ground-water levels. The status of each indicator can be classified as: near or above normal, moderately dry, severely dry, or extremely dry; a color is associated with each classification. The status is based on a statistical analysis of historical values with generally the driest 10% being classified as extremely dry, from 10%-30% as severely dry, and 30%-50% as moderately dry (NJ HMP, 2014).

Table 5.4.6-3. Drought Indicators for New Jersey

Color	Drought Status Indicator
Green	Near or above normal
Yellow	Moderately dry
Orange	Severely dry
Red	Extremely dry

Source: NJ DEP, 2016

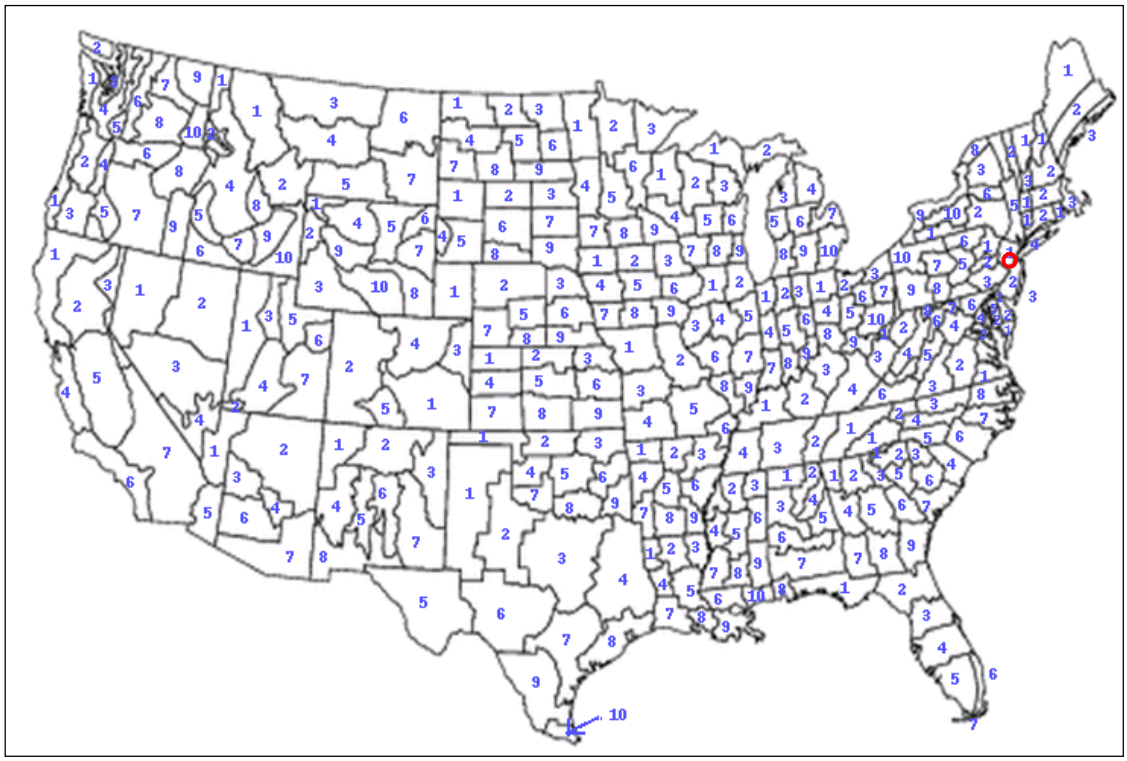
Location

The location of drought events throughout the State of New Jersey and Somerset County are further identified below.

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. Of these, 344 are in the conterminous U.S., with additional divisions in Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, and Pacific trust territories. 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).

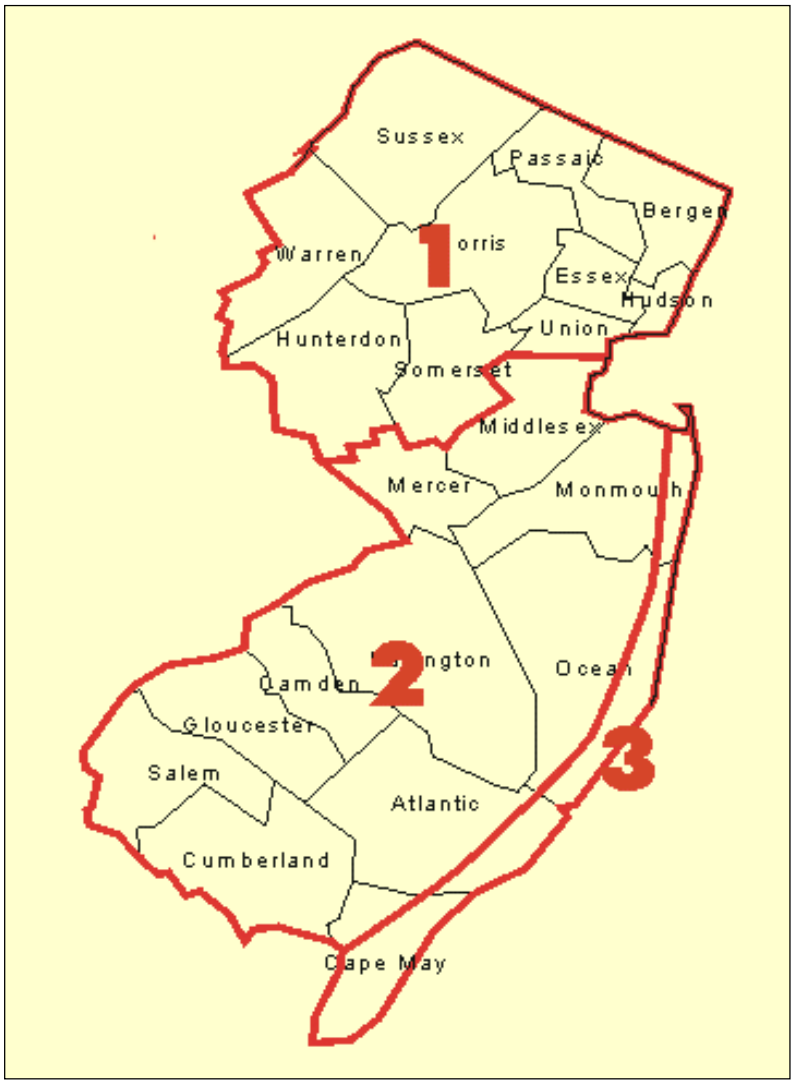
According to NOAA, the State of New Jersey is made up of three climate divisions: Northern Climate Division, the Southern Climate Division and the Coastal Climate Division. Somerset County is located within the Northern Climate Division (NOAA, 2017). Figure 5.4.6-1 shows the climate divisions throughout the U.S. and Figure 5.4.6-2 shows the climate divisions of the State of New Jersey.

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



Source: NOAA, 2017 (https://www.esrl.noaa.gov/psd/data/usclimdivs/data/map.html)
Note (1): The red circle indicates the approximate location of Somerset County, Climate Division 1.
Note (2): 1 = Northern Climate Division; 2 = Southern Climate Division; 3 = Coastal Climate Division

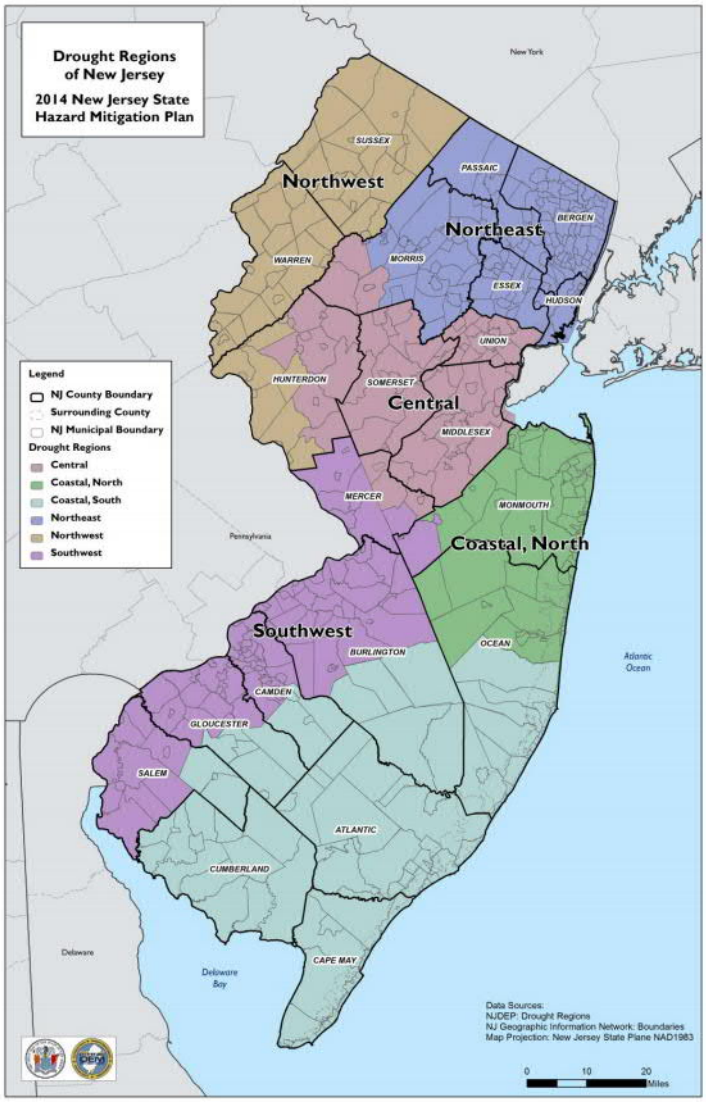
Figure 5.4.6-2. Climate Divisions of New Jersey



Source: Climate Prediction Center (CPC), 2017
Note: 1 = Northern Climate Division; 2 = Southern Climate Division; 3 = Coastal Climate Division

According to the NJ HMP 2014, the New Jersey Department of Environmental Protection (NJDEP) divides New Jersey into six drought regions that are based on regional similarities in water-supply sources and rainfall patterns. These boundaries usually correspond to natural watershed boundaries. Regional boundaries match municipal boundaries in order to facilitate enforcement of potential water-use restrictions. The drought regions allow New Jersey to respond to changing conditions without imposing restrictions on areas that are not experiencing water shortages (Hoffman and Domber, 2003). The NJDEP indicates that Somerset County is wholly within the Central Drought Region (Figure 5.4.6-3).

Figure 5.4.6-3. NJDEP Drought Regions in New Jersey



Source: NJ HMP, 2014

Previous Occurrences and Losses

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

According to NOAA's NCDC storm events database, Somerset County experienced 42 drought events between June 1997 and August 2017. The NCDC database records no property damages, crop damages, deaths, or injuries as a result of these events. 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 1960 and 2011, one drought event occurred within the County. The database indicated that drought events and losses specifically associated with Somerset County and its municipalities totaled over $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 2017, FEMA declared that the State of New Jersey experienced two drought-related disaster declarations: one major disaster (DR) and one emergency (EM). Both were classified as water shortages impacting all 21 of the state's counties with DR-205 in 1965, and EM-3080 in 1980 (FEMA, 2017) (NJ HMP, 2014).

The NJ HMP (2014) also includes drought events recorded by the USDA, whereby 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. Data is available for the years 2012 through 2017. USDA records indicate two declarations for Somerset County. The first occurred as a result of excessive heat and drought from April 2015 to September 2015. The second occurred as a result of the combined effects of freeze, excessive heat, and drought from April 2016 to September 2016.

Based on all sources researched, known drought and extreme events, between 1923 and 2017, that have affected Somerset 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. Events that have occurred since the last plan update document was prepared are included in the last rows of the table, following the June-October 2010 event record summary.

Table 5.4.6-4. Drought Events affecting Somerset County Between 1923 and 2017

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
July – September 1923	Drought	N/A	N/A	Lowest PDSI was -3.48 in August 1923.	Somerset County HMP
July 1929 – September 1932	Drought	N/A	N/A	During the 1930s, there was widespread drought in the U.S. The Northeast was dry in the beginning of the decade with a 39-month drought period. Eight months were in severe drought and 15 months were in moderate drought. The lowest PDSI was -3.91. Agricultural effects were most severe in the fall of 1930.	Somerset County HMP
January – February 1931	Drought	N/A	N/A	Lowest PDSI was -3.11 in January 1931.	Somerset County HMP
November 1931 – February 1932	Drought	N/A	N/A	Lowest PDSI was -3.68 in December 1931.	Somerset County HMP
July – September 1932	Drought	N/A	N/A	Lowest PDSI was -3.81 in September 1932.	Somerset County HMP
December 1939 – January 1940	Drought	N/A	N/A	Lowest PDSI was -3.21 in January 1940.	Somerset County HMP
May – July 1949	Dry Conditions	N/A	N/A	Most of New Jersey had less than 0.5 inches of rain during this period, crops suffered heavy damage, and June was the driest month on record, 0.08 inches of rain fell in Somerset County; warmest summer in Northeast.	Somerset County HMP
November 1949 – January 1950	Drought	N/A	N/A	Lowest PDSI was -3.24 in January 1949.	Somerset County HMP
October 1952	Drought	N/A	N/A	Driest month ever observed, less than 50% normal rainfall, many fires reported east of the Rockies; drought caused fires throughout various states across the country, an estimated 15 million acres have burned beyond the point of recovery, New Jersey among these states.	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
June 1953 – July 1955	Drought	N/A	N/A	A drought continued for 26 months in northern New Jersey, with the lowest PDSI of -3.62. Two months were in severe drought. Southern New Jersey had drought conditions for 24 months with the lowest PDSI of -4.70 and four months in extreme drought, one in severe and one in moderate. Along the coastal areas of the State, drought conditions continued for 29 months with a lowest PDSI of -3.19. Average precipitation in New Jersey was 1.13 inches in July 1995.	Somerset County HMP
August 1961 – September 1966	Drought and Water Shortage	DR-205	Yes	Longest and most severe drought in US history, affected 14 states on the east coast; Longest and most severe drought in New Jersey's history, drought conditions started in the coastal areas and continued towards the northern and southern areas of New Jersey; lowest PDSI was -5.25 in August 1966; a Major Disaster Declaration was issued on August 18, 1965, Somerset County received public assistance.	Somerset County HMP
May 1980 – May 1981	Drought and Water Shortage	EM-3083	Yes	Drought affected central and eastern US, estimated $20 B in damage/cost to agriculture, estimated 10,000 deaths including heat stress-related; Serious rainfall deficits seen in much of New Jersey, by October the PDSI was -4 (extreme drought), Gov. Byrne issued an emergency order to mandate water rationing in northern New Jersey, Somerset County was included in the water rationing; several Somerset County municipalities declared a state of emergency by NJ Governor Byrne; an Emergency Declaration was declared on October 19, 1980, Somerset County receive public assistance.	Somerset County HMP
March – October 1995	Dry Conditions	N/A	N/A	Unseasonably hot and dry weather in northwestern and central New Jersey; drought intensified through the summer, brush fire potential increased; rainfall totals were below normal, some months were driest on record, March was considered one of the driest in New Jersey's history, second half of August very dry, areas saw no rain in two weeks; Gov. Whitman declared a drought for New Jersey communities, state of emergency declared in Somerset County.	Somerset County HMP
June – July 1997	Dry Conditions	N/A	N/A	Reservoir levels down in many areas, precipitation totals in New Jersey were below normal, SC had a -6.0 precipitation deficit, losses in agriculture; some New Jersey residents under a water ban for car washing and watering lawns.	Somerset County HMP
July 1998 – September 1999	Drought	N/A	N/A	This was the worst-ever drought for farmers in New Jersey. Many parts of the east were eight to 18 inches below normal rainfall over the last year. Precipitation deficits ranged from six to 14 inches across the region, with the lowest PDSI of -3.86 in	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				July 1999. Extreme drought was noted in New Jersey. The New Jersey Department of Agriculture reported that the agricultural industry in the State lost $80M due to drought. There was a water use restriction in New Jersey and a drought emergency was declared in August. The Clinton Administration declared New Jersey a disaster area and the USDA declared New Jersey an agricultural disaster. Gov. Whitman declared mandatory water restrictions and a drought emergency was declared in Somerset County. President Clinton declared this event the worst drought on record. The Senate approved $7.4B in emergency farm aid and it was the most costly weather event of 1999. Somerset County experienced $5M in crop damages.	
October 2001 – May 2002	Drought	N/A	N/A	New Jersey had the driest July-February on record with a lowest PDSI of 4.42 in February. Gov. McGreevey declared a state-wide drought emergency. The drought resulted in $10B worth of damages throughout the affected areas New Jersey's agricultural industry had $300M in damages due to the drought conditions.	Somerset County HMP
June – October 2005	Drought	NA	NA	June through October were the warmest and driest months on record in New Jersey. Heat and sun damaged many different crops, milk production was down due to the affect the heat had on the cows. Many trees changed color early and lost their leaves, forest fires burned 43.5 acres in the State. September 2005 was the 5th driest September since 1895. New Jersey Gov. Codey declared a drought watch in September. SBA instituted a drought disaster assistance program for small agricultural-dependent businesses in counties throughout New Jersey, including Somerset County.	Somerset County HMP
May 2007	Dry Conditions	N/A	N/A	Average of 1.55 inches of rain fell, 11th driest May on record, 17,000 acres of Pinelands burned, ground water levels and discharge of river below normal, above average warm temperatures.	Somerset County HMP
June – October 2010	Drought	N/A	N/A	The 2010 summer drought took its toll on New Jersey farmers. September 2010 was the 4th warmest September on record since 1895. In Somerset County, Franklin Township declared a water emergency on Sept. 16th and placed a 90 day ban on filling pools, washing cars, and limited the amount of lawn	NOAA-NCDC; NJ.com

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				watering. In November, the Secretary of Agriculture declared all counties in southern, central and northwest New Jersey natural disaster areas. As a declared Agricultural Disaster Area, Somerset County farmers were eligible to receive federal assistance.	
April 2015 – September 2015	Drought and Excessive Heat	N/A	N/A	Rainfall deficits decreased reservoir, ground water and streamflow levels. NJ DEP issued a drought watch on November 23, 2015 for the northeast part of the state including all or parts of Somerset County and encouraged residents to voluntarily conserve water. The drought watch continued through October, November, and December.	NOAA NCDC, USDA
April 2016 – September 2016	Combined effects of freeze, excessive heat, and drought	N/A	N/A	In October 2016, the USDA designated 11 counties as primary natural disaster designations due to losses caused by the combined effects of freeze, excessive heat and drought that occurred between April and September 2016. Farmers and ranchers in declared and contiguous counties qualified for natural disaster assistance. Somerset County was a declared county during this event.	USDA

Source(s): NOAA-NCDC, USDA, Drought Impact Reporter, NRCC

AMS	American Meteorological Society	NOAA	National Oceanic and Atmospheric Administration
CPC	Climate Prediction Center	NJ	New Jersey
DIR	Drought Impact Reporter	NJDEP	New Jersey Department of Environmental Protection
FEMA	Federal Emergency Management Agency	NRCC	Northeast Regional Climate Center
HMP	Hazard Mitigation Plan	ONJSC	Office of New Jersey State Climatologist
K	Thousand ($)	PDSI	Palmer Drought Severity Index
M	Million ($)	SBA	Small Business Administration
N/A	Not Applicable	SHELDUS	Spatial Hazard Events and Losses Database for the United States
NCD	Northern Climate Division	U.S.	United States
NCDC	National Climatic Data Center	USDA	U.S. Agricultural Department

Probability of Future Events

It is estimated that Somerset 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 Somerset 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).

VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed and vulnerable in the identified hazard area. For the drought hazard, all of Somerset County has been identified as the hazard area. Therefore, all assets (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), are vulnerable to a drought. The following text evaluates and estimates the potential impact of the drought hazard on Somerset 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 2008 Somerset County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Essentially, all of Somerset 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.

Data and Methodology

Data was collected from HAZUS-MH, NJDEP, USDA Somerset County Planning Division, and Planning Committee sources. 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 conditions can cause a shortage of water for human consumption and reduce local fire-fighting capabilities. According to the New Jersey HMP, counties most often affected by a drought are densely populated areas that rely on above-ground reservoirs for their water supply; this includes a portion of Somerset County. Areas more resistant to drought conditions are less densely populated and rely on groundwater or surface water sources (NJ HMP, 2014).

Somerset County's water is predominately from above-ground/surface water sources. New Jersey American Water (NJAW) supplies water to all communities in Somerset County, including only a small portion of Franklin Township and excluding Rocky Hill Borough, via the Raritan Basin and Short Hills Systems. Therefore, greater than 245,000 people in Somerset County are serviced by municipal water sources (Sleeper, 2008).

As discussed in Section 4 of this Plan, the Raritan and Short Hills systems primary water sources include the Raritan River, Millstone River, the Delaware and Raritan Canal and the Passaic River (Short Hills only). The surface water flow of these water bodies is augmented by Spruce Run and Round Valley Reservoirs located in Hunterdon County. Additionally, a small portion of the water supply is well water from wellfields distributed throughout the system (Sleeper, 2008).

The New Jersey Water Supply Authority developed a model of the Raritan Basin System to re-evaluate the safe yield and assess the impact of future changes to the system (e.g., conditions not yet observed or operations not yet tried). The safe yield is the amount of water that a system can supply without failure during a repeat of the drought of record. For this model, the drought of record was the 1963 to 1966 drought in which precipitation was less than two-thirds of the annual average of 46 inches of rain between 1895 and 2002. Currently, contracted water sales are approximately 82 percent of the Raritan Basin's safe yield. Therefore, the system has an adequate water supply for its current demands during a drought of record (NJWSA, 2005).

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. Approximately 25% of the land in Somerset County is forested (Somerset County GIS Land Use Land Cover 2007 data). Risk to life and property is greatest in those areas where forested areas adjoin urbanized areas (high density residential, commercial and industrial) or wildland/urban interface (WUI). Refer to the Wildfire Risk Assessment for more detailed information on the vulnerability of the built environment to the wildfire hazard.

Impact on Critical Facilities

It is expected that critical facilities will continue to be operational during a drought event.

Impact on the Economy

New Jersey agriculture ranks third in economic importance to the State. According to the NJ State HMP, the market value of agricultural products sold in the State in 2008 was $1.1Billion. As noted, agricultural resources need ample water supplies for successful production, relying on natural precipitation and the supply and demand of surface and groundwater resources, both of which become limited or compromised during times of drought. A prolonged drought can have a serious economic impact on a community (i.e., a lessened crop yield, financial loss to the farmer). The entire agricultural industry in Somerset County is vulnerable to the drought hazard.

The 2017 Census of Agriculture was not yet released at the time this plan was drafted. According to the USDA 2012 Census of Agriculture (best readily available as of the time this report), there are 400 farms, occupying 34,735 acres. This represents a six percent increase in total land in farms, but a ten percent decrease in the overall number of farms, as compared to the previous agriculture census of 2007. This land is categorized as cropland (58.3%), pastureland (15.2%), woodland (17.4%), and other uses (9.1%). Orchards are included in the woodland land use category.).

The leading agricultural crops produced in Somerset County include corn for grain, hay (alfalfa and other), soybeans and wheat winter. Additionally, land in Somerset County is used to for orchards and to raise cattle and calves (USDA, 2012). Table 5.4.6-5 shows acreage, yield and production of crops for Somerset County as a whole that would be exposed to the drought hazard.

Table 5.4.6-5. Acreage, Yield and Production of Crops in Somerset County for 2012

Crop Type	Planted (acres)	Harvested (acres)	Yield per acre	Total Production
Corn for Grain	2,300	2,657	90 bushels	237,916 bushels
Hay – land used for all hay and all haylage, grass silage, and greenchop	____*	9,758	2.0 tons	19,514 tons
Soybeans	3,000**	2,354	37 bushels	87,369 bushels
Wheat Winter	1,500	1,169	48 bushels	56,386 bushels

Source: USDA, 2012;

Notes: * USDA did not provide the number of acres of hay planted for 2012. This figure is acres of hay planted in 2002, obtained from the Somerset County Comprehensive Farmland Preservation Plan Update. All other data in the table was obtained from USDA.

** Data not available for all years; Somerset County's dataset jumps from 2007 to 2014. Planted acres above of 3,000 are reflective of year 2014.

According to the 2012 Census of Agriculture, crop sales are at $20.7 Million for Somerset County which is 89-percent of the market value of agricultural products sold. Livestock sales total nearly $2.5 Million. The average market value of products sold per farm has increased from 2007 ($42,496) to 2012 ($58,016) (USDA, 2012). Drought can impact both crop and livestock sales.

Historic agricultural loss information was found for Somerset County for the 1999 drought (July 1998 to September 1999) and statewide 2002 drought. According to SHELDUS, in 1999 Somerset County experienced an estimated crop loss of $5 Million. In 2002, statewide drought conditions impacted Somerset County's total agricultural sales ($15.1 million), mainly in the crop/nursery/greenhouse sector. From 1987 to 1997, crop sales had increased from $7.56 million to $10.49 million in the County, but were down 27% to $8.3 million in 2002 due to drought conditions (Morris Land Conservancy, 2007).

Current modeling tools are not available to estimate specific losses for this hazard. Based on 2002 data, hay was planted on 8,500 acres with sales totaling $748,000. Similarly, grains (including corn for grain, wheat for grain and soybeans for grain) were planted on more than 7,000 acres and sold for $757,000 in 2002 (Morris Land Conservancy, 2007). Loss estimates could be calculated based on total sales and assumed percent damages that could result from a drought. For the purposes of this plan update, 2002 dollars were escalated to 2018 dollars to reflect the degree of potential impacts should an event of similar magnitude and severity occur again today. Table 5.4.6-6 shows 25%, 50% and 75% loss estimates for hay and grain based on 2002 sales figures.

Table 5.4.6-6. Estimated Dollar Losses for Crops in Somerset County

Crop Type	Total Sales (2002)*	Total Sales (2002, escalated to 2018 dollars)	25% Loss Estimate	50% Loss Estimate	75% Loss Estimate
Hay	$748,000	$1,043,249	$260,812	$521,625	$782,437
Grain**	$757,000	$1,055,802	$263,951	$527,901	$791,852
Total	$1,505,000	$2,099,051	$524,763	$1,049,526	$1,574,288

Source: * Morris Land Conservancy, 2007

Notes: ** Grains include corn for grain, wheat for grain and soybeans for grain.

Alternatively, loss estimates that could result from drought conditions can also be calculated based on total production and assumed percent damages. Please note that the severity of a drought, in terms of area extent as well as intensity and duration will affect crop loss. Table 5.4.6-7 shows 25%, 50% and 75% loss estimates for corn, forage, soybeans and wheat based on 2012 production.

Table 5.4.6-7. Estimated Production Losses for Crops in Somerset County

Crop Type	Total Production (2012)	25% Loss Estimate	50% Loss Estimate	75% Loss Estimate
Corn for Grain (bushels)	237,916	59,479	118,958	178,437
Hay* (tons)	19,514	4,879	9,757	14,636
Soybeans (bushels)	87,369	21,842	43,685	65,527
Wheat Winter (bushels)	56,386	14,097	28,193	42,290

* Includes land used for all hay and all haylage, grass silage and greenchop as reported by USDA.
Source: USDA, 2012

Increased demand for water and electricity during drought conditions may result in shortages and a higher cost for these resources (FEMA, 1997). Industries that rely on water for business may be impacted the hardest (e.g., nurseries, golf courses, places of recreation). Even though most businesses will still be operational, they may be impacted aesthetically. In addition, because droughts vary in geographic extent and severity, Somerset County may also be impacted by supply/price of food for crops grown outside of the immediate area.

Change of Vulnerability

When examining the change in the County's vulnerability to drought events from the 2012 HMP to this update, it is important to look at each entity that is exposed and vulnerable. The total population across the County has increased as shown by the 2000 to 2010 U.S. Census (297,490 persons in 2000 versus an 8.7% increase to 323,444 persons by 2010, and an additional 1.6 % estimated between 2010 and 2014. The County's population is continuing to increase both overall, and in the vast majority of its municipalities, based on the 2014 population estimates (https://www.co.somerset.nj.us/about/census-quick-facts/population-info). As mentioned earlier, Somerset County's water is predominately from above-ground/surface water sources. Therefore, the County's population continues to be exposed to this hazard.

In terms of the agricultural industry for Somerset County, from 2007 to 2012, there was a 10% decrease in the number of farms (445 farms to 400 farms, respectively); however there was an increase in the number of acres of land in farms (6% change from 32,721 acres to 34,735 acres) and the average size of a farm (from 74 acres to 87 acres). The total market value of products sold in Somerset County, both crop and livestock sales increased from nearly $19 million in 2007 to more than $23 million in 2012 (USDA, 2012). Therefore, their potential crop and livestock loss due to drought has increased overall since the last plan update.

Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the 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.

Effect of Climate Change on Vulnerability

The changes in global climate that are projected to occur in the coming decades will have significant impacts on New Jersey. Impacts related to increasing temperatures are already being felt throughout the State.

Several agencies, organizations, and academic institutions have addressed the potential effects of climate change on New Jersey. The New Jersey Climate Adaption Alliance facilitated by Rutgers University provided a description of climate change in New Jersey, the report included past changes that have been documented from historical observations as well as expected changes based on projections of temperature, precipitation and sea level through the end of the century. Among other findings the report states that projections are that short-duration warm season droughts are likely to become more common [Horton et al 2011]. However, the increase in frequency of droughts ranges from only slightly more likely under the low emissions scenario [IPCC 2000] to as frequent as once per year under the high (A1F1) emissions scenario [Frumhoff et al 2007] (New Jersey Climate Adaption Alliance, 2012).

The Union of Concerned Scientists also prepared an overview of how climate change may affect New Jersey. According to the Union, rising summer temperatures coupled with little change in summer rainfall are projected to increase the frequency of short-term (one- to three month) droughts (The Union of Concerned Scientists, Date Unknown).

Both projections would increase stress on both natural and managed ecosystems across New Jersey.

Additional Data and Next Steps

Historic data available indicate that droughts can impact Somerset County and impact the local economy. For future plan updates, localized concerns and impacts will be collected and analyzed. Mitigation efforts could include development of a drought contingency plan, development of "triggers" for drought related actions, or provision of incentives to influence active water conservation techniques.