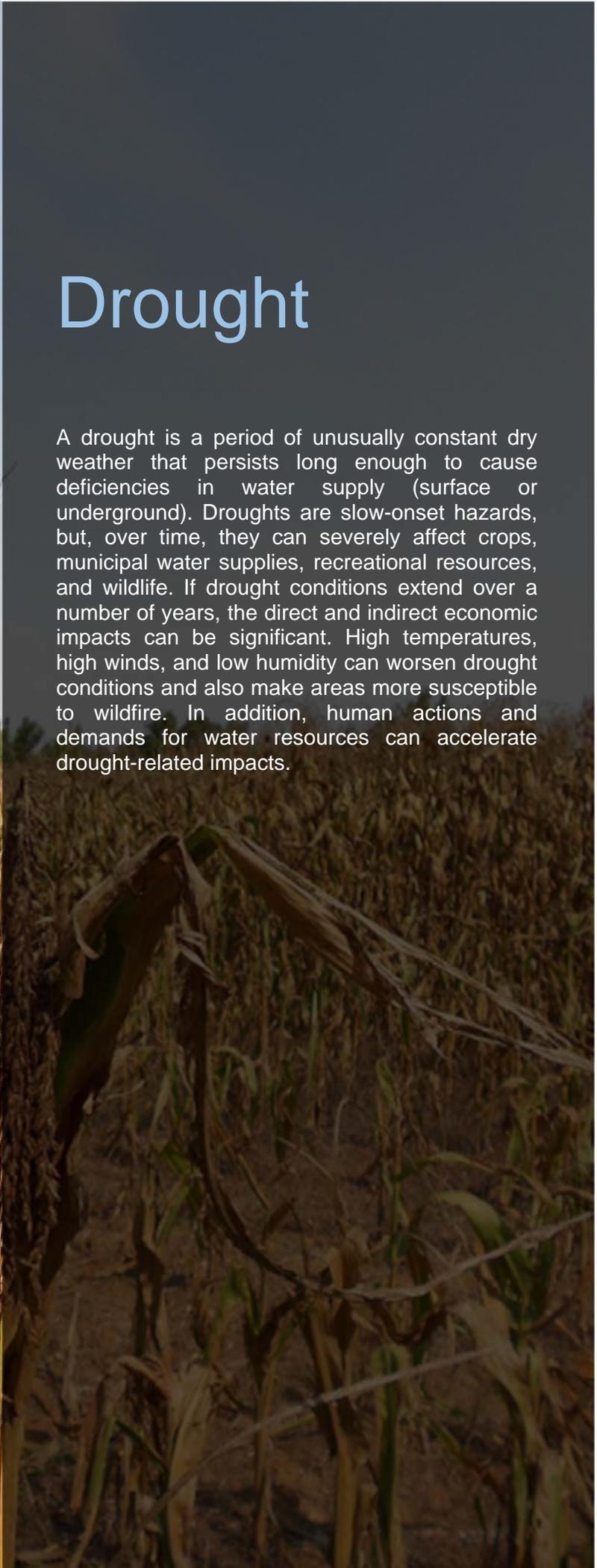




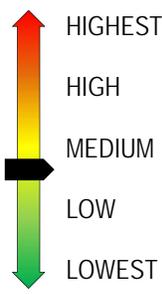
Drought

A drought is a period of unusually constant dry weather that persists long enough to cause deficiencies in water supply (surface or underground). Droughts are slow-onset hazards, but, over time, they can severely affect crops, municipal water supplies, recreational resources, and wildlife. If drought conditions extend over a number of years, the direct and indirect economic impacts can be significant. High temperatures, high winds, and low humidity can worsen drought conditions and also make areas more susceptible to wildfire. In addition, human actions and demands for water resources can accelerate drought-related impacts.



2.0 RISK ASSESSMENT

2.2.2 Drought

A drought is a period of abnormally dry weather that persists long enough to produce a serious hydrological imbalance.				
 <p>Vulnerability</p> <p>HIGHEST</p> <p>HIGH</p> <p>MEDIUM</p> <p>LOW</p> <p>LOWEST</p>	Period of Occurrence	At any time, typically after a period of prolonged absence of precipitation	Hazard Index Ranking:	Low
	Warning Time:	Over 24 hours	State Risk Ranking:	5
	Probability:	Remote (unlikely to occur on an annual basis)	Severity:	Critical (25-50% of land area affected)
	Type of Hazard:	Natural	Disaster Declarations:	USDA FSA S3384 USDA FSA S4131

Hazard Introduction and Overview

“Drought” is a period of abnormally dry weather, which persists long enough to produce a serious hydrological imbalance. Drought is a term used in relation to who or what is affected by the lack of moisture. Drought can be a result of multiple causes, including global weather patterns that produce persistent, upper-level high-pressure systems with warm, dry air, resulting in less precipitation. Droughts develop slowly; typically, they are already underway when officially identified. There are several types of droughts (Sears, 2017, p. 138).

- **Meteorological Drought:** Differences from the normal precipitation amounts. Because not every area receives the same amount of rainfall, a drought in one place might not be considered a drought in another.
- **Agricultural Drought:** Moisture deficiency seriously injurious to crops, livestock, or other agricultural commodities. Parched crops may wither and die. Pastures may become insufficient to support livestock. The effects of agricultural droughts are difficult to measure because there are many other variables that may impact production during the same growing season.
- **Hydrological Drought:** Reduction in stream flow, lake and reservoir levels, depletion of soil moisture, and a lowering of the groundwater table. Consequently, there is a decrease in groundwater discharge to streams and lakes. Prolonged hydrological drought will affect the water supply.
- **Socioeconomic Drought:** A lack of water that begins to affect people’s daily lives.



Precipitation falls in uneven patterns across the country; the amount of precipitation at a particular location varies from year to year, but over the years, the average amount is reasonably constant. The amount of rain and snow also varies with the seasons. Even if the total amount of rainfall for a year is about average, rainfall shortages can occur during a period when moisture is critically necessary for plant growth, such as in early summer. When little to no rain falls, soils can dry out, and plants can die. When rainfall is less than normal for several weeks, months, or years the water in wells increases. If dry weather persists and water-supply problems develop, the dry period can become a drought (USGS, n.d.).

Location and Extent

Droughts occur throughout North America, and in any given year at least one region will experience drought conditions. Droughts are region-wide phenomena that can affect all areas and jurisdictions within the region. Within Washington County, the effects of drought would be nearly equal. The severity of drought can vary throughout the year; what begins as a mild drought can become severe or extreme, then subside to a mild incident. This process can take weeks or months, and the effects can be felt after drought conditions end.

The Palmer Drought Severity Index (PDSI) is a measure of drought that widely used to track moisture conditions. The PDSI is “an interval of time, generally in months or years in duration, during which the actual moisture supply at a given place rather consistently falls short of the climatically appropriate moisture supply.” The range of PDSI is from -4.0 (extremely dry) to +4.0 (excessively wet), with the central half (-0.5 to +0.5) representing the normal or near-normal conditions. In the United States, the USDA, National Drought Mitigation Center at the University of Nebraska-Lincoln, U.S.

USDM AND PDSI COMPARISON			
U.S. Drought Monitor		Palmer Drought Severity Index	
N/A		> 4.0	Extreme moist spell
		3.0 to 3.99	Very moist spell
		2.0 to 2.99	Unusual moist spell
		1.0 to 1.99	Moist spell
		0.50 to 0.99	Incipient moist spell
		-0.49 to 0.49	Near normal
		-0.5 to -0.99	Incipient dry spell
D0	Abnormally dry	-1.0 to -1.99	Mild drought
D1	Moderate drought	-2.0 to -2.99	Moderate drought
D2	Severe drought	-3.0 to -3.99	Severe drought
D3	Extreme drought	< -4.0	Extreme drought
D4	Exceptional drought	N/A	

Department of Commerce, and National Oceanic and Atmospheric Administration (NOAA) developed another measurement of droughts named the U.S. Drought Monitor (USDM). The table at right shows the two scales and how they compare.



In addition to the PDSI, the Crop Moisture Index (CMI) calculates the change in moisture available from week to week, which gives a short-term status of agricultural moisture (National Weather Service, 2005). The following table describes the Crop Moisture Index.

Though it is difficult to anticipate precisely where drought conditions will occur in the future, Washington County can estimate the chances of experiencing drought conditions generally. NOAA's Earth System Research Laboratory (ESRL) has divided the U.S. into "climate divisions." ESRL further maintains data for each of these areas, including the historical Palmer Drought Severity Index (PDSI) values for all months between 1895 and 2018. Washington County's climate division, Southeastern Ohio, experienced drought conditions (i.e., incipient, mild, moderate, severe, or extreme drought per the PDSI) in 40.73% of the months between 1895 and 2020.

CROP MOISTURE INDEX	
<i>Crop Moisture Index Value</i>	<i>Drought Condition</i>
3.0 and up	Excessively Wet
2.0 to 2.9	Wet
1.0 to 1.9	Moist
-0.9 to 0.9	Slightly Dry/ Favorable Moist
-1.0 to -1.9	Abnormally Dry
-2.0 to -2.9	Excessively Dry
-3.0 or less	Severely Dry

Source: National Weather Service



Washington County Hazard Mitigation Plan

ESRL Climate Divisions & Months Spent in Drought

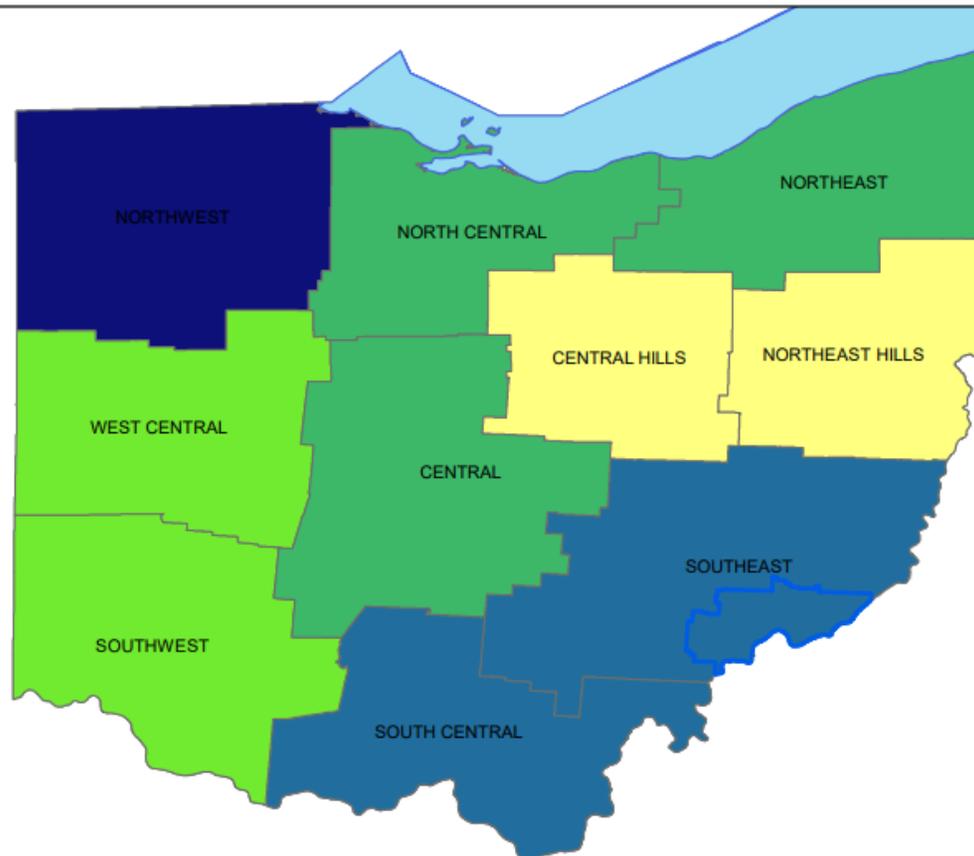
Data Source(s):
NOAA Earth System Research Laboratories

DISCLAIMER: Data is meant for use as reference only. Some sources may be intended to be used at national or regional scales and are thus used beyond their original intent for demonstrative purposes.



Months in Severe/Extreme Drought

- 4.89% - 5.62%
- 5.62% - 6.61%
- 6.61% - 7.08%
- 7.08% - 7.54%
- 7.54% - 7.94%



Hazard Impacts

Droughts can impact drinking water both in terms of availability and demand. According to the U.S. Environmental Protection Agency (EPA), as temperatures rise, people and animals need more water to maintain health. Additionally, a large number of economic activities require abundant water sources such as energy production and growing food crops. As droughts reduce available water sources, local officials will need to monitor water usage closely to maintain enough for critical uses. An extreme drought would have a negative effect on the large agricultural sector of Washington County which makes up approximately 35% of the land cover. In 2020 Washington County had 1,106 farms, consisting of 144,406 acres and producing over \$42 million of crops and livestock (OEDA, 2020).

Prolonged droughts can affect municipality's ability to provide adequate water supplies, as water storage supplies would begin to become critically low throughout the region. Mandatory water conservation measures, and water use priorities may be enacted and enforced. The Ohio Department of Health (ODH) may have to conduct water quality sampling of numerous private water wells throughout the region as a buildup of contaminants in these wells is common during extreme drought conditions. Local clinics and hospitals may begin to see a significant increase of respiratory infections (i.e., asthma, bronchitis and pneumonia) resulting from the extremely dry and windy conditions affecting air quality.

The significant lowering of the ground-water table and a decrease in ground-water discharge to streams and lakes may have an effect on tourism and recreational attractions at parks and lakes. The Ohio Environmental Protection Agency (OEPA) in coordination with the Ohio Department of Natural Resources (ODNR) may be required to post no boating and no swimming signs at various lakes and streams where water quality standards are not being met due to stagnant and contaminated water. Stagnant water from reduced levels can provide a breeding ground for disease-carrying mosquitoes.

The effects of drought would negatively impact the following business types throughout Washington County; farmers, local water utilities, restaurants, tourism industry (recreation at parks and lakes, golfing, boating, fishing, etc.), laundry mats, community swimming pools, and car washes.



The National Drought Mitigation Center has developed the U.S. Drought Monitor. The Drought Monitor is a map that is updated weekly using data from the previous week to show areas of the U.S. that are in a drought. The following table lists the U.S. Drought Monitor classifications of drought, along with potential impacts.

U.S. DROUGHT MONITOR CLASSIFICATION			
Category	Description	Possible Impacts	Palmer Drought Severity Index
D0	Abnormally Dry	Going into drought: <ul style="list-style-type: none"> • Short-term dryness slowing planting, growth of crops or pastures Coming out of drought <ul style="list-style-type: none"> • Some lingering water deficits • Pastures or crops not fully recovered 	-1.0 to -1.9
D1	Moderate Drought	<ul style="list-style-type: none"> • Some damage to crops, pastures • Streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested 	-2.0 to -2.9
D2	Severe Drought	<ul style="list-style-type: none"> • Crop or pasture losses likely • Water shortages common • Water restrictions imposed 	-3.0 to -3.9
D3	Extreme Drought	<ul style="list-style-type: none"> • Major crop/pasture losses • Widespread shortages or restrictions 	-4.0 to -4.9
D4	Exceptional Drought	<ul style="list-style-type: none"> • Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies 	-5.0 or less

Source: National Drought Mitigation Center



No two states experience drought the same way. In an effort to communicate the effects of drought on a smaller scale, the U.S. Drought Monitor developed a table presenting drought impacts that have reported in each state. The following table presents impacts listed for the state of Ohio.

DROUGHT IMPACTS BY STATE, OHIO	
Category	Impact
D0	Crop growth is stunted; stock pond levels decline
	Prayer session is held for rain
D1	Hay yield is low; hay is expensive; corn is curling; farmers feed hay early; fruit (cherries and plums) yield is low
	Small brush fires occur; burn bans begin
	Voluntary water restrictions are requested
	Fewer mosquitoes are observed than normal
	Drought is hard on landscaping businesses
D2	Crops are suffering
	The number of wildfires is high
	Trees lose leaves early
	Soil is dry, cracked, and pulling away from foundations
	Creeks are dried up
D3	Soybeans are severely dry, crop yields are minimal, supplemental hay for livestock increases, livestock are stressed
	Lawns go dormant
D4	Ohio has had little or no experience in D4 so no impacts have been recorded at that level in the Drought Impact Reporter

Source: National Drought Mitigation Center

Severe drought conditions can negatively affect human health (CDC, 2019). Some effects are experienced short-term and can be directly observed and measured, while others are indirect and are not easy to anticipate or monitor. The possible health implications of drought include:

- Compromised quantity and quality of drinking water;
- 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.



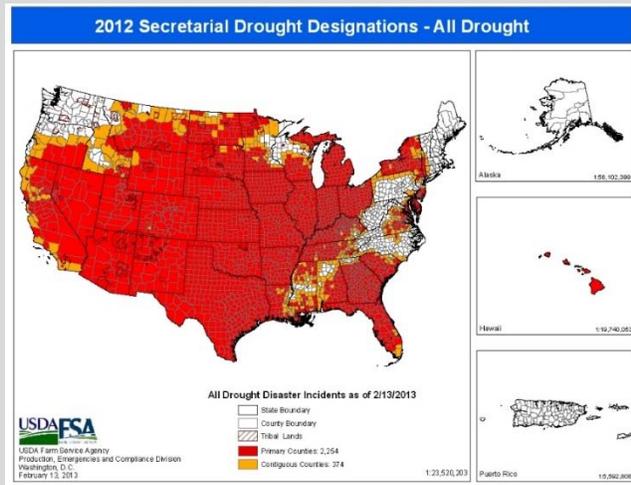
Historical Occurrences

Data sources suggest that four significant droughts have impacted Washington County, occurring in 1999, 2002, 2012 and 2016. Washington County received drought-related disaster declarations from the Secretary of the U.S. Department of Agriculture in 2012 and 2016 (USDA Farm Services Agency, 2020).

2012 DROUGHT (Excessive Heat)

USDA FSA Designation: S3384 (Primary)

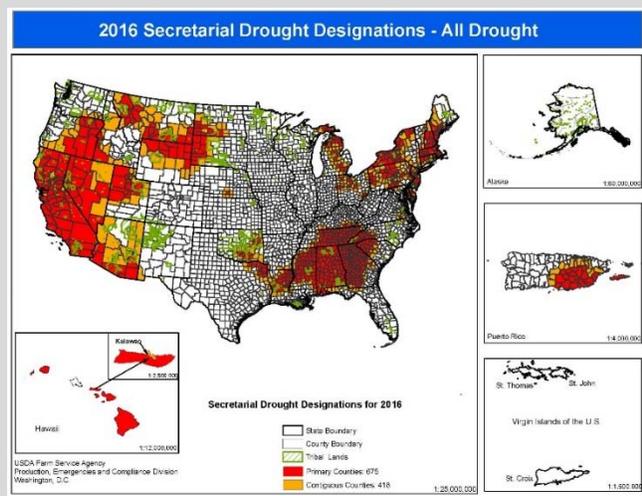
Most locations ended the winter season of 2011-2012 with near-normal precipitation and below-normal snowfall, which led to below-normal snowmelt. March experienced much-above-normal, record-breaking temperatures, which led to above-normal evapotranspiration and an early start to the growing season. This condition, combined with a lack of snowmelt in the winter, led to abnormally dry conditions across the region by the middle of April. Given much-below-normal rainfall in April and May, topsoil preconditioned for drought, and already low streamflow across area streams, rivers, and lakes, drought conditions developed across the Midwest region by May. With high pressure remaining in control outside of some fast-moving low-pressure systems, dry weather ruled the summer months. Record-breaking heat combined and a lack of substantial precipitation brought on devastating drought conditions. By the middle of July, all of the local areas were in at least D2 or severe drought conditions with a large portion of the area in D3 or extreme drought conditions (on a scale from D0 to D4 drought severity). These conditions lasted until the middle of August.



2016 DROUGHT

USDA FSA Designation: S4131 (Contiguous)

Based on the Palmer Drought Index, severe to extreme drought affected approximately 7% of the contiguous United States at the end of July 2016. About 22% of the contiguous U.S. fell in the moderate to extreme drought category. Washington County experienced extreme drought conditions. Washington County received a secretarial designation on April 5, 2017, for the period of May 1, 2016, through December 10, 2016.



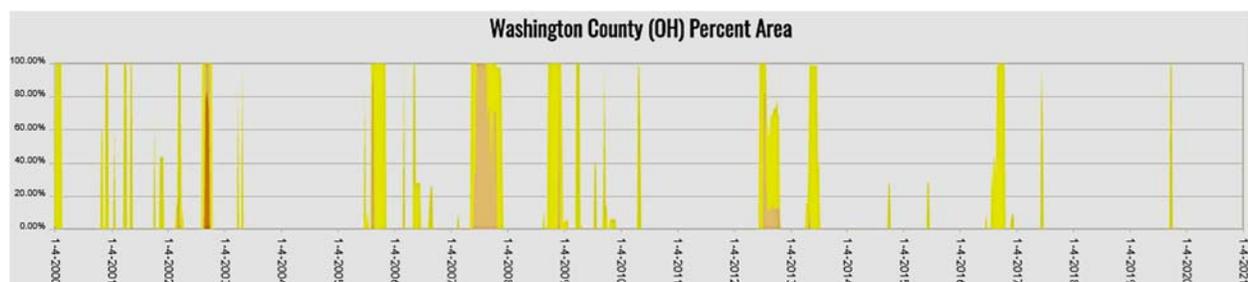
The National Centers for Environmental Information (NCEI) Storm Events Database records instances of drought from 1999 to present. The following table presents the NCEI droughts that affected Washington County.

HISTORICAL DROUGHT OCCURRENCES – WASHINGTON COUNTY					
Location	Date	Injuries	Deaths	Property Damage	Crop Damage
Washington (Zone)	6/1/1999	0	0	\$0	\$0
Washington (Zone)	7/1/1999	0	0	\$0	\$0
Washington (Zone)	8/1/1999	0	0	\$0	\$0
Washington (Zone)	9/1/1999	0	0	\$0	\$0
Washington (Zone)	10/1/1999	0	0	\$0	\$0
Washington (Zone)	9/1/2002	0	0	\$0	\$0

Source: NCEI Storm Events Database

According to the NCEI, there were droughts in Washington County in 1999 and 2002. The 1999 drought affected all of Washington County, as well as the surrounding region. No property or crop damage was recorded for either incident; however, groundwater shortages were a concern throughout the county.

The US Drought Monitor at the University of Nebraska, Lincoln, lists periods of drought in a time series since 2000, which is shown below. According to the USDM, Washington County was in a period of drought in 2002 as noted in the NCEI database, as well as in 2007 and 2012, which were not noted in the NCEI database.



Countywide Drought – 2012

During the summer of 2012, much of the United States experienced drought. In 2012, the state of Ohio experienced several weather and climate-related events, each of which exacerbated the effects of the drought. The drought, which lasted from May to September, was the seventh statewide drought in Ohio since 1988. In addition to the drought, there were freezes



in April, following an extraordinarily warm March. On June 29, a derecho inflicted nearly \$1 billion in damage in Ohio, and on July 1 a hailstorm affected the northeastern portion of the state.

According to the Central U.S. 2012 Drought Assessment sponsored by the National Integrated Drought Information System, National Drought Mitigation Center, and the University of Nebraska-Lincoln, the Drought Monitor maps underestimated the severity of the drought in Ohio compared to the PDSI maps.

Countywide Drought – July, 2020

As of July 2020, hot and dry conditions across Ohio caused slight drought conditions in the state. Temperatures averaged two to eight degrees above normal, and outside of heavy thunderstorms, widespread rainfall was sparse. Nearly 80% of Ohio reported abnormally dry conditions, and more than 12% of the state, including portions of Washington County, experienced drought conditions.

Loss and Damages

The USDA maintains data regarding agricultural activities through five-year censuses. The following table provides an overview of the 2007, 2012, and 2017 censuses.

CENSUS OF AGRICULTURAL DATA – WASHINGTON COUNTY					
Year	Farms	Land in Farms (acres)	Harvested Cropland (acres)	Average Harvested Cropland per Farm (acres)	Market Value of Agricultural Products Sold
2007	856	124,069	40,678	56.5	\$24,473,000
2012	1,222	138,940	44,473	52.5	\$30,479,000
2017	1,106	144,406	49,824	56.6	\$42,049,000

Source: USDA, Census of Agricultural

Although there is no direct correlation between the presence of farms and drought risk, the market value of agricultural products sold provides evidence of total economic activity exposed to losses from drought. On average, \$32,333,666 in agricultural products in Washington County are vulnerable to drought conditions in any given year.



Vulnerability Assessment

This section summarizes the vulnerability to Washington County from drought. Washington County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. The following table presents the results of that survey regarding drought.

PUBLIC SENTIMENT, DROUGHT – WASHINGTON COUNTY					
Hazard	Level of Concern				Total Responses
	Not at All	Somewhat	Concerned	Very	
Drought	17 (47.22%)	14 (38.89%)	5 (13.89%)	0 (0.00%)	36
In the past ten years, do you remember this hazard occurring in your community?				10 (27.78%)	36
Have you noticed an increase in the occurrences or intensity of this hazard?				8 (22.22%)	36
Have you noticed a decrease in the occurrences or intensity of this hazard?				0 (0.00%)	36

Source: Online Public Survey Results

Crop Loss Study

Structures are rarely affected by droughts, they usually affect people, animals, and crops. To determine the historical impact of a drought on the agricultural industry in Washington County a crop loss study was performed. A drought year (2012) was compared to a non-drought year (2011) to identify differences in output that may have resulted from the drought conditions.

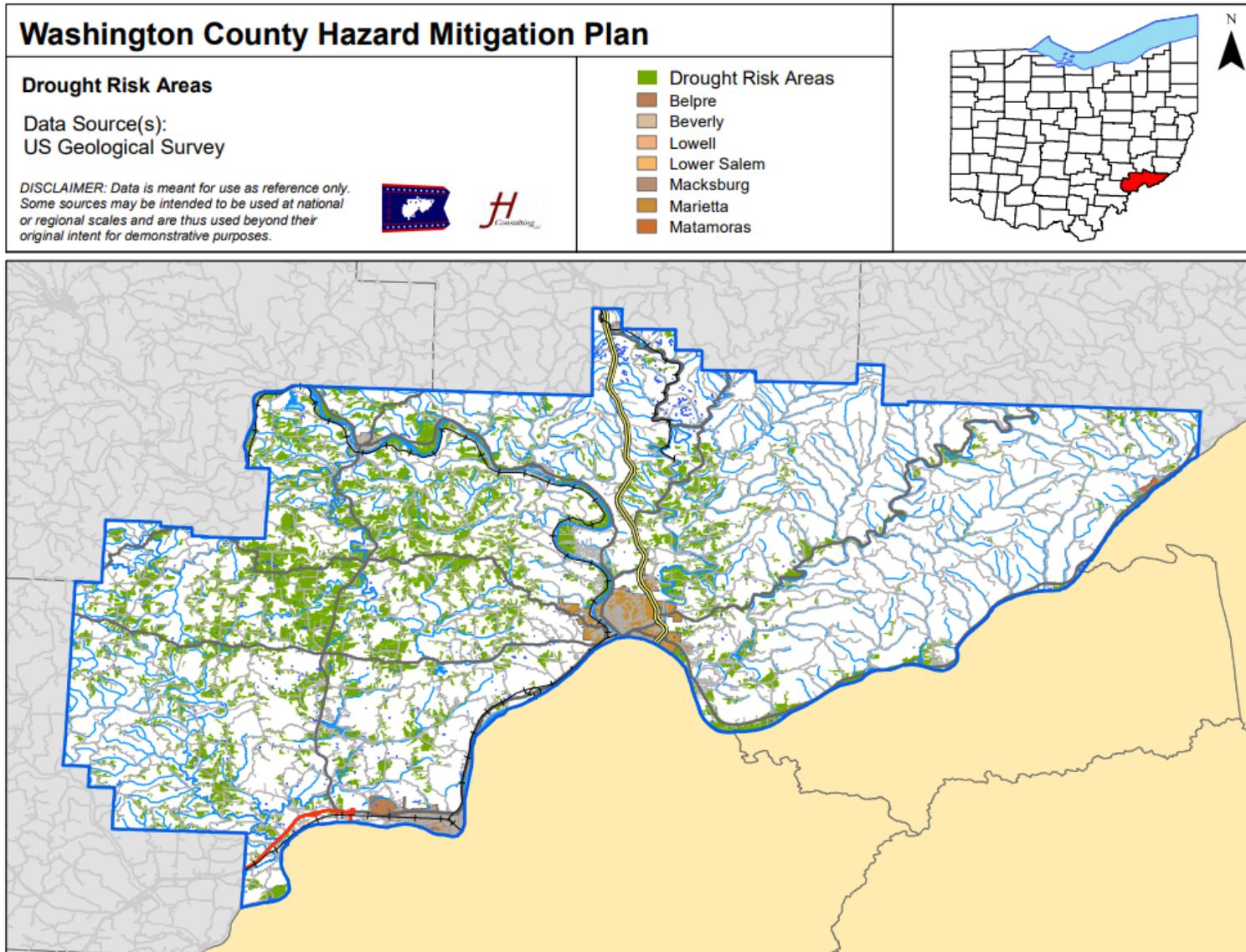
Using the USDA’s National Agricultural Statistics Service (NASS), the crop production numbers for four major crops in Washington County were found for 2011 and 2012. Production of corn, hay (excluding alfalfa), soybeans and winter wheat were compared between the two years. The results are shown in the table below. Three of the four crops saw decreases in yield of varying amounts, while soybeans saw an increase in yield. Overall in Washington County agricultural yield decreased by 360,800 units, a reduction of 21.08%, between 2011 and 2012. Using the same data set from the USDA to obtain production amounts for 2013 show that this drop in production was most likely caused by the drought conditions. Production of corn, hay and winter wheat all recovered significantly in 2013 with corn production surpassing the number of bushels produced in 2011.

CROP PRODUCTION – WASHINGTON COUNTY (Bushels or Tons)				
Product	2011	2012	Difference	%Δ
Corn	1,320,000	932,000	(388,000)	-29.39%
Hay	34,900	28,500	(6,400)	-18.34%
Soybeans	296,000	370,000	74,000	25.00%
Wheat	60,900	20,500	(40,400)	-66.34%
Total	1,711,800	1,351,000	(360,800)	-21.08%

Source: USDA, National Agricultural Statistics Service



The following map graphically depicts potential risk areas in Washington County. Risk areas correspond to those with land uses of “crop” and “pasture.”



The following table assigns point totals based on the research presented in this profile for each category that appears in Ohio EMA's Mitigation Information Portal (MIP) tool.

DROUGHT VULNERABILITY SUMMARY			
<i>Category</i>	<i>Points</i>	<i>Description</i>	<i>Notes</i>
Frequency	2	Low	Four events in 21 years (i.e., 1999-2020) yields an estimate of 0.19 incidents per annum.
Response	4	One month	Though the agricultural response may be extensive and much longer, it is a response that is not as acute as many other emergency responses.
Onset	1	Over 24 hours	Drought conditions occur following an extended period of specific hydrological conditions.
Magnitude	3	Critical (25-50% of land area affected)	Washington County has a land area of 635 mi ² (Census 2019) (or 406,400 acres). Given 144,406 acres in farmland (2017 Census of Agriculture), approximately 35.53% of the county's land area is agriculture.
Business	2	One week	Drought is not likely to necessitate wide-spread business closures for extended periods.
Human	2	Low (some illnesses)	Drought is not likely to result in injuries; however can result in a slight increase in respiratory infections such as bronchitis and pneumonia.
Property	1	Less than 10% of property affected	Though a significant amount of the land area could be impacted, drought conditions do not affect personal property as severely.
Total	15	Low	

