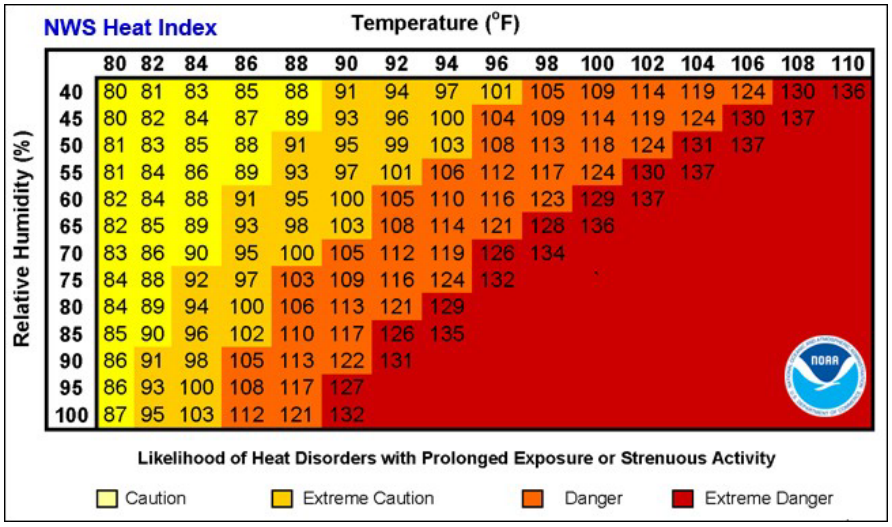
4.2 Drought and Extreme Heat

Description

According to the Federal Emergency Management Agency (FEMA), extreme heat is a period of high heat and humidity with temperatures above 90 degrees for at least two to three days. In extreme heat the human body works extra hard to maintain a normal temperature, which can lead to death. Extreme heat is responsible for the highest number of annual deaths among all weather-related hazards. Humid conditions, which add to the discomfort of high temperatures, occur when a high-pressure weather system traps hazy, moist air near the ground. Extreme heat may also contribute to the formation of a drought if moisture and precipitation are lacking. The National Weather Service's Heat Index Chart is provided in **Figure 4.2.1**.

Figure 4.2.1: Heat Index Chart



Source: National Weather Service

Extreme heat events are often accompanied by drought conditions when the events are prolonged. A drought is a shortage in precipitation over an extended period of time. Droughts are common throughout all climatic zones and can range in length from a couple of weeks to multiple years or decades in some areas.

According to the National Oceanic and Atmospheric Administration (NOAA), there are three common types of droughts: Meteorological, Agricultural, and Hydrological. Meteorological drought severity is calculated by the amount of the rainfall deficit (compared to annual averages) and the length of the dry period. Agricultural drought is based on the effects to agriculture by factors such as rainfall and soil water deficits or diminished groundwater/reservoir levels needed for irrigation. Hydrological drought is based on the effects of rainfall shortages on the water supply, such as stream flow, reservoir and lake levels, and groundwater table decline.

Location

Drought is a countywide hazard that can affect all locations and jurisdictions in Clinton County. More specifically, these hazards typically occur at a regional scale. Droughts most commonly occur in Ohio from spring through autumn; however, they may occur at any time throughout the year.

Extent

Due to the regional nature of droughts and extreme heat events, effects may be noticed throughout the County in both the urbanized and rural areas. All jurisdictions within the County may be affected in

a single drought event. In Clinton County, droughts are often linked to prolonged periods of above average temperatures and little to no precipitation.

Initial effects of drought can be noticed within a short period, as soil may dry out and plants may wither and die. When drought conditions persist over several weeks, months, or years, effects may be more pronounced with reductions in water levels of wells, lakes, reservoirs, streams, and rivers. Water supply issues for agriculture, commercial/industrial activities, and private consumption may arise if drought conditions persist over a long term.

The extent of the drought is determined by the Palmer Drought Severity Index (PDSI), shown below in **Table 4.2.2**. In this way, the Index can be utilized as a tool to help define disaster areas and indicate the availability of irrigation water supplies, reservoir levels, range conditions, amount of stock water, and potential for forest fires. The Palmer Drought Severity Index depicts prolonged (in months or years) abnormal dryness or wetness and is slow to respond, changing little from week to week. It also reflects long-term moisture runoff, recharge, and deep percolation, as well as evapotranspiration.

Table 4.2.2: Palmer Drought Severity Index Classifications and Federal Drought Categories

Palmer Drought Severity Index	Category	Description
-1.0 to -1.9	D0	Abnormally Dry
-2.0 to -2.9	D1	Moderate Drought
-3.0 to -3.9	D2	Severe Drought
-4.0 to -4.9	D3	Extreme Drought
-5.0 or less	D4	Exceptional Drought

The Palmer Drought Severity Index is a standardized index with values typically falling between -4.0 and +4.0, although extreme conditions can be greater in value (including federal drought categories). Negative values indicate drought conditions while positive values represent wet conditions. Values around zero represent near normal conditions.

Abnormally dry (D0) and moderate drought (D1) conditions occur frequently and typically do not adversely affect agricultural activities unless conditions are sustained in nature. Severe and extreme drought (D2 and D3, respectively) conditions begin to impact agricultural crops, leading to potential economic losses. These more severe events also may impact drinking water resources, especially if the source is a lake or reservoir. Sustained severe droughts may alter the ability of the soil to absorb water, leading to potential flash flooding when rainfall resumes.

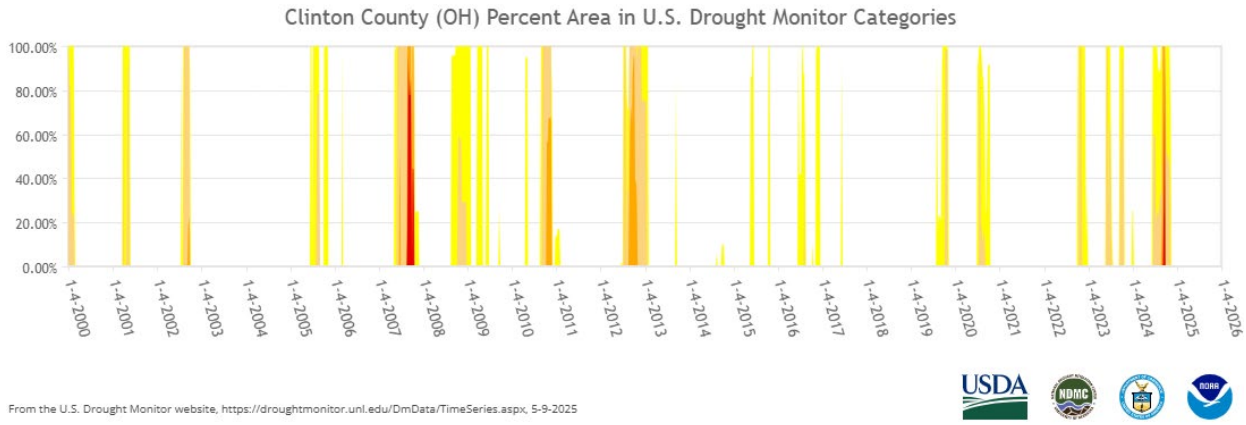
History

U.S. Drought Monitor (USDM) describes severe drought as a time when crops suffer, the numbers of wildfires are high and the soil is dry, cracked and pulling away from foundations. In an extreme drought, yields are minimal, livestock are stressed, and lawns go dormant. Data shows that Clinton County has spent 275 weeks in abnormally dry conditions, 140 weeks in moderate drought, 36 weeks in severe drought, 10 weeks in extreme drought, and zero in exceptional drought since 2000 (**Table 4.2.3**) (Source: U.S. Drought Monitor). **Figure 4.2.4** depicts the drought monitor history for Clinton from 2000 through January 2025.

Table 4.2.3: Weeks in Drought per Year for Clinton County

Year	Abnormally Dry (D0)	Moderate Drought (D1)	Severe Drought (D2)	Extreme Drought (D3)	Exceptional Drought (D4)
2000	9	7	0	0	0
2001	9	4	0	0	0
2002	11	8	3	0	0
2003	0	0	0	0	0
2004	0	0	0	0	0
2005	15	4	0	0	0
2006	1	0	0	0	0
2007	29	21	11	8	0
2008	19	11	0	0	0
2009	15	0	0	0	0
2010	18	11	6	0	0
2011	7	0	0	0	0
2012	28	24	10	0	0
2013	6	3	0	0	0
2014	4	0	0	0	0
2015	6	0	0	0	0
2016	16	1	0	0	0
2017	1	0	0	0	0
2018	0	0	0	0	0
2019	14	6	0	0	0
2020	15	7	0	0	0
2021	0	0	0	0	0
2022	12	3	0	0	0
2023	15	10	0	0	0
2024	25	20	6	2	0
2025	0	0	0	0	0
Grand Total	**275**	**140**	**36**	**10**	**0**

Figure 4.2.4: Drought in Clinton County from 2000 to 2025



Source: U.S. Drought Monitor

Clinton County has not had a disaster declaration for extreme heat or droughts. However, the County has spent four weeks in an extreme drought and 24 weeks in severe drought since 2000. The droughts are detailed below.

Abnormally Dry to Extreme Drought (D0 – D3), June 18, 2024 – November 25, 2024:

On June 18, 2024, 100 percent of Clinton County was experiencing abnormally dry conditions. Within one week the drought conditions worsened and 60 percent of the County was experiencing moderate drought conditions. The moderate drought conditions lasted for eight weeks, worsening again on August 20, 2024. Within four weeks, 100 percent of the County was in a severe drought and on September 17, 2024, 27 percent of the County was in an extreme drought. A week later, 99 percent of the County was in an extreme drought. The drought conditions regressed to a moderate drought on October 1, 2024, lasting another eight weeks. The drought ended on November 25, 2024.

Abnormally Dry to Extreme Drought (D0 – D2), June 19, 2012 – February 4, 2013:

On June 19, 2012, approximately two percent of Clinton County was experiencing abnormally dry conditions. Within four weeks the drought conditions worsened and 100 percent of the County was experiencing moderate drought conditions. The moderate drought conditions lasted for six weeks, worsening again on August 28, 2012, and resulting in approximately 40 percent of the County experiencing a severe drought. The severe drought conditions lasted for 10 weeks before regressing back to a moderate drought. The County remained in a moderate drought for 11 more weeks, followed by two more weeks in abnormally dry conditions. The drought ended on February 4, 2013.

Abnormally Dry to Severe Drought (D0 – D2), August 31, 2010 – December 6, 2010:

On August 31, 2010, 100 percent of Clinton County was experiencing abnormally dry conditions. Within two weeks the drought conditions worsened and 100 percent of the County was experiencing moderate drought conditions. The moderate drought conditions lasted for five weeks, worsening again on October 19, 2010, and approximately 57 to 68 percent of the County was in a severe drought for six weeks. The drought ended a week later on December 6, 2010.

Abnormally Dry to Extreme Drought (D0 – D3), May 15, 2007 – December 3, 2007:

On May 15, 2007, approximately 98 percent of Clinton County was experiencing abnormally dry conditions. Within three weeks the drought conditions worsened and 100 percent of the County was experiencing moderate drought conditions. The moderate drought conditions lasted for 10 weeks, worsening again for one week on June 26, 2007, and then again on June 28, 2007. Approximately one percent of the County was in a severe drought and within two weeks it spread to 100 percent of

the County. On August 28, 2007, approximately 32 percent of the County was in an extreme drought. The extreme drought conditions lasted for eight weeks. On October 23, 2007, the extreme and severe drought conditions regressed back to a moderate drought. The drought conditions lasted for another five weeks before ending on December 3, 2007.

Abnormally Dry to Severe Drought (D0 – D2), July 23, 2002 – October 7, 2002:

On July 23, 2002, 100 percent of Clinton County was experiencing abnormally dry conditions. Within two weeks the drought conditions worsened and one percent of the County was experiencing moderate drought conditions. The moderate drought conditions lasted for four weeks, worsening again for one week on September 3, 2002, and for two weeks on September 17, 2002. The drought ended a week later on October 7, 2002.

Extreme Heat

There have been three excessive heat events and three heat events in Clinton County since January 1, 1995. All events are listed individually in Appendix A.

Excessive Heat Event, July 19 – July 20, 2019:

High temperatures and high humidity caused the heat index to rise into the triple digits for two days in July 2019. Some places in Clinton County reported temperatures of 105 degrees.

Heat Event, June 28 – July 7, 2012:

In late June 2012, a warm airmass traveled through southern Ohio, bringing high temperatures. Several locations reported triple digit temperatures. The heat wave lasted around two weeks.

Excessive Heat Event, August 7 – August 10, 2007:

High temperatures and high humidity caused the heat index to rise into the triple digits for three days in August 2007. Some places in Clinton County reported temperatures of 105 degrees.

Heat Event, July 20 – July 31, 1999:

High temperatures in the 90's across Clinton County and northern Ohio were recorded for the month of July 1999. Several counties reported temperatures in the 100's.

Probability

Clinton County has experienced droughts in the past, and the potential exists for the County to experience droughts in the future. Clinton County has spent 461 weeks in abnormally dry to extreme drought conditions since 2000. Clinton County has a 35 percent chance of having a drought and/or experiencing abnormally dry conditions each year based on historical data. Clinton County had three heat and three extreme heat events between 1995 and 2023. Heat events can occur during any year.

Seasons of drought and extreme heat have the potential to occur during any particular year when necessary conditions are met. According to the Midwest Chapter of the Fifth National Climate Assessment, the frequency of major heat waves in the Midwest has increased over the last six decades. In addition, it is predicted that as the climate gets warmer, there will be an associated increase in the number and severity of summer droughts and extreme heat events.

Vulnerability Assessment

Drought projections suggest that some regions of the U.S. will become drier and that most will have more extreme variations in precipitation. Even if current drought patterns remain unchanged, warmer temperatures will amplify drought effects. Drought and warmer temperatures may increase risks of large-scale insect outbreaks and wildfires, in addition to accelerating tree and shrub death and changing habitats and ecosystems in favor of drought-tolerant species. Forest and rangeland managers can mitigate some of these impacts and build resiliency in forests through appropriate management actions.

Infrastructure Impact

Drought does not have a significant impact on infrastructure or structures. The greatest impacts of drought are on agricultural interests, as crops may fail, and livestock may not have sufficient water resources. For social vulnerability, the FEMA National Risk Index indicates that the agricultural (crop only) in Clinton County has a score of 52.4 (relatively low). This risk is only based on agricultural impacts and not population impact. The index indicates an expected annual loss of $33,000 due to drought events with two events occurring per year.

Population Impact

Populations most at risk during prolonged heat events include older adults, individuals with chronic health conditions, low-income households, and those with limited mobility or access to transportation. Clinton County's long-term care facilities—such as skilled nursing and assisted living centers—are of particular concern due to their concentration of high-risk individuals and reliance on mechanical cooling systems for health and safety.

The August 25, 2023, extreme heat event and power outage in Blanchester highlighted a critical vulnerability: HVAC systems in some long-term care facilities were not supported by emergency generator power. This created hazardous conditions for dozens of elderly residents. While neither facility exceeded the Ohio Department of Health's 81°F indoor threshold for mandatory relocation, multiple residents required close monitoring, and one was transported to the hospital for evaluation. In another facility, the backup generator failed due to overheating, emphasizing the fragility of contingency systems in a high-heat scenario. These events underscore the importance of assessing and upgrading emergency power systems to include HVAC functionality in healthcare and congregate care settings.

For social vulnerability, the National Risk Index indicates that the population in Clinton County has a score of 61.8 ("relatively moderate") for heat wave. The index indicates an expected annual loss of $153,000 due to heat wave events with 1.1 events occurring per year.

Property Damage

During extreme heat events, utility failure may occur due to overuse of electricity for cooling. Property damage is a possibility due to extreme heat. Vehicles are at risk of breaking down from excessive heat, as heat can reduce battery life and reduce the efficiency of the cooling system resulting in overheated engines. Extreme heat can also cause a home to dry out and prematurely age. Excessive heat in combination with lack of rainfall (drought) can cause soil to shrink and crack, which puts stress on a home's foundation that can be costly to fix. Drought and warmer temperatures may increase the risks of large-scale insect outbreaks and wildfires. Drought and warmer temperatures may also accelerate tree and shrub death, changing habitats and ecosystems in favor of drought-tolerant species.

Table 4.2.5 below shows the census tracts for Clinton County ranked from the highest total EAL (expected annual loss) for buildings, population ($11.6 million for each fatality or 10 injuries), and agriculture per census tract for heat wave. EAL rates, calculated by FEMA, identify the total value of loss expected each year for a particular community, in this case the census tracts for Clinton County.

Table 4.2.5: Structure and Population Vulnerability from Heat Wave

Census Tract	Expected Annual Loss (Building)	Expected Annual Loss (Population Equivalence)	Expected Annual Loss (Agriculture)	Expected Annual Loss (Total)
39027964700	$70	$19,765	$253	$20,088
39027964400	$67	$17,765	$2,057	$19,889
39027964900	$34	$17,244	$263	$17,541

Census Tract	Expected Annual Loss (Building)	Expected Annual Loss (Population Equivalence)	Expected Annual Loss (Agriculture)	Expected Annual Loss (Total)
39027964800	$34	$16,702	$734	$17,470
39027965100	$44	$14,640	$2,197	$16,881
39027965000	$32	$13,478	$1,443	$14,953
39027964300	$27	$12,658	$1,087	$13,772
39027964501	$22	$11,519	$96	$11,637
39027964502	$26	$10,232	$121	$10,379
39027964600	$20	$9,917	$0	$9,937
Grand Total	**$376**	**$143,920**	**$8,251**	**$152,547**

Source: FEMA National Risk Index

Loss of Life

Loss of life is possible during drought and extreme heat events, especially for young children, the elderly, and individuals with respiratory conditions.

While no fatalities were reported during the August 2023 event, the circumstances represent a clear near-miss scenario. The combination of extreme heat and loss of mechanical cooling presented a potentially life-threatening situation for over 80 residents across two facilities. Had the outage extended further into the evening or occurred later in the season when HVAC demand remains high but situational awareness may be lower, the risk of heat-related illness or death would have been significantly elevated. The lack of adequate backup power for cooling systems in high-risk settings represents a known gap in hazard mitigation and emergency preparedness.

Proactive mitigation—such as revising building codes, requiring HVAC coverage under backup systems, or providing rapid-deploy cooling assets—should be prioritized to reduce the future risk of preventable deaths in vulnerable populations.

Economic Losses

Economic losses are a threat from extreme heat and droughts in Clinton County. Crops and livestock may be compromised during prolonged extreme heat events. Human productivity can also be affected when working conditions become too hot. According to the 2022 Census of Agriculture developed by the U.S. Department of Agriculture (USDA), top crop items based on acreage for Clinton County include soybeans for beans, corn for grain, wheat for grain, forage-land used for all hay and haylage, and vegetables harvested. Based on data from the USDA, Clinton County's crop yields were not impacted from previous drought events. Acreage farmed for Corn (Grain), Soybeans, and Wheat increased, while acreage for Hay & Haylage decreased between 2017 and 2022. Yield per acre increased in 2022 versus 2017 for all crops except Hay & Haylage **(Table 4.2.6**). Agricultural land use can be seen on the land use map in Chapter 1 (**Figure 1.2.1).**

Table 4.2.6: Clinton County Crop Yields 2017 - 2022

Commodity	2017		2022	
	Acres	Crop Yield	Acres	Crop Yield
Corn, Grain	63,591	12,721,835 bushels	68,880	14,031,011 bushels
Hay & Haylage	5,071	13,360 tons	4,186	9,245 tons

Commodity	2017		2022	
	Acres	Crop Yield	Acres	Crop Yield
Soybeans	115,103	6,151,759 bushels	131,362	7,195,908 bushels
Wheat	2,758	183,502 bushels	4,766	395,238 bushels

Source: United States Department of Agriculture Census

Future Trends

Land Use and Development Trends

Drought and extreme heat are most likely to impact agriculture land uses and land uses that house or serve vulnerable populations, such as schools, daycares, hospitals, and nursing homes. Fewer people can mean generally fewer people vulnerable to extreme heat/drought events. However, the increase of people aged 65+ from 2017 (6,611) to 2023 (7,608) could mean more vulnerability to Extreme Heat for that population group. Increase of agricultural land use, crop yields, and livestock cash receipts can mean more vulnerability to drought in those areas.

Shifting Weather Patterns and Environmental Trends

Shifting weather patterns may increase the frequency and/or the severity of the impacts from drought and extreme heat events. As the weather changes, there could be an associated increase in the number and severity of droughts and extreme heat events. Warmer global temperatures may be associated with a prolonged growing season, but this trend may also increase the risk of crop stress due to excessive heat and crop damage due to increased pests and disease. The longer growing season may help some crops but crops like corn and soybean would be negatively affected by the severe heat in the summer, which would decrease these crops' yields. Additionally, increased frequency and severity may negatively impact infrastructure. For example, dams and levees may be compromised after a prolonged drought if drying, reduction of soil strength, erosion, subsidence, or ground cracking occurs. Shifting weather patterns are expected to increase the occurrence and duration of heat waves in the coming years.