

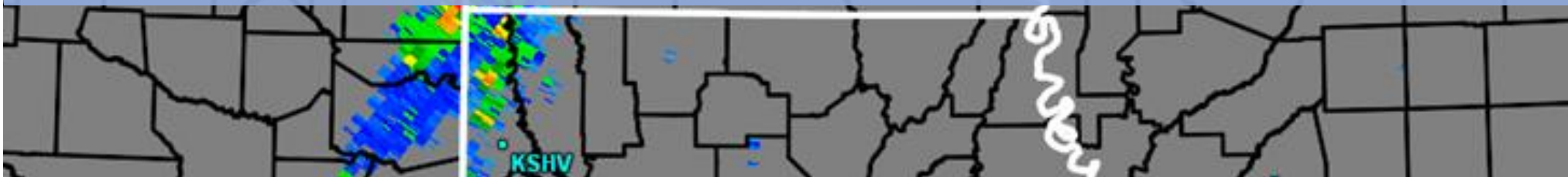
SIMPLE PLANNING TOOL

FOR ARKANSAS CLIMATE HAZARDS

VERSION 1.7 (FEBRUARY 2023)



Climate Adaptation
Partnerships
Formerly RISA



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Front Cover Photo: NEXRAD Level 2 image from the Super Tuesday tornado outbreak of 6 February 2008 displayed in Gibson Ridge GRLevel2 software. [Available online at: <https://s3.amazonaws.com/noaa-nexrad-level2/index.html>]

Back Cover Photo: Snow covered and hazardous road conditions in Pulaski County during the winter storm on December 25-26, 2012 (National Weather Service 2012).

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About the Simple Planning Tool

This tool is a compilation of relatively easy-to-use online interactive tools, maps, and graphs to assist planners and emergency managers in the state of Arkansas who are assessing their long-term climate risks, both historically and in the future. It is primarily designed for decision-makers who serve small- to medium-sized communities, but may also be of interest to those who serve larger areas. This tool was developed with input from local and state emergency managers and planners. While it may not answer every question one has about hazard climatologies and future trends, it aims to cut through the internet clutter and point to relatively simple data tools that can be used during planning processes and in plans. The *Simple Planning Tool for Arkansas Climate Hazards* was produced by the Southern Climate Impacts Planning Program (SCIPP, www.southernclimate.org).

The tool may be accessed online at <https://www.southernclimate.org/wp-content/uploads/SPTAR.pdf>

For tool assistance or questions, please contact scipp@southernclimate.org

About SCIPP

The Southern Climate Impacts Planning Program (SCIPP) is one of several National Oceanic and Atmospheric Administration (NOAA) Climate Adaptation Partnership (CAP) teams, formerly Regional Integrated Sciences and Assessments (RISA). SCIPP is a climate hazards and research program for the south central United States and focuses on increasing the region's resiliency and level of preparedness for weather extremes now and in the future. The area SCIPP serves includes the 4-state region of Oklahoma, Texas, Arkansas, and Louisiana.

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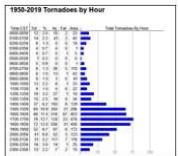
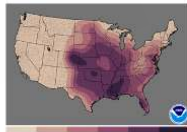

Darrian Bertrand, SCIPP Climate Assessment Specialist, University of Oklahoma

User Instructions

This document is alphabetically organized by climate hazard (p. 5-22) and three other hazards (p. 23-25). A table is included for each hazard and describes the data limitations, historical climatology tools, and projected future trends. See the example table below and corresponding descriptions to the left for more details on how each table is organized.

Table Components

1. This section describes known data limitations for the hazard. Knowing limitations can help one interpret data results more accurately.
2. The historical climatology rows show several tools that provide freely-available historical data relevant to each hazard.
3. For each individual tool, this column provides its name, period of record of the data used (some tools use multiple periods), and the source.
4. This column provides the information that can be obtained from the tool and instructions on how it can be found.
5. This row provides the website link to access the tool. (Note: In the event of a URL change, search the web using the accompanying information.)
6. This column shows an image of the tool's final product (i.e., map, graph, table).
7. This section shows tools that include climate projections and future trends of the hazard (if available). It also includes a concise summary of the state-of-the-science on whether the hazard is projected to be influenced by climate change, and if so, how.

Tornado				
Data Limitations: Tornado reports prior to around 1980 were compiled from written records. Consequently, many tornadoes may have gone unreported or multiple tornadoes may have been listed as a single event. Tornado tracking is unique as occurrences are recorded either by damage assessments or visual accounts (Kossin et al. 2017). Advanced radar technology, increases in population in high-risk areas, usage of video and social media, emphasis on documentation, and improvements in communication have resulted in an increase in the number of reports, especially among weaker (EF0-EF1) tornadoes. As these systematic biases are present, use caution when using long term trends as they are based solely on the number of reports.				
2 Historical Data	Tornado Tracks Tool (1950-2019) Midwest Regional Climate Center	This is an interactive tool that shows historical tornado track details by track location or county. Consider nearby storm tracks, even if they do not pass through your location, because small changes in storm motion can bring a tornado into your town. 1. Select area of interest either by zooming or entering a location into the search box. 2. Use panel on left side of screen to select variables of interest. Options include by <i>Magnitude, Year Range, Month, and Casualties</i> . 3. For more information, select either <i>Track</i> or <i>County</i> and click on area of interest on the map. Tool Link: http://mrcc.purdue.edu/gismaps/cntyrtorn.htm#		
	Tornado Risk Assessment (1950-2019) NOAA/National Weather Service Storm Prediction Center	This site is a series of graphs that shows tornado occurrences and statistics based on a given point. Statistics include F/EF scale frequency and probabilities of strikes occurring per month and time of day. 1. Click on black bar at top of page (bar includes location, radius and time period information) and provide zip code of interest. 2. Click <i>Run</i> . 3. Details about tornadoes that have occurred in selected area are displayed on page. Tool Link: https://www.spc.noaa.gov/climo/online/plots/?zip=028&radius=100		
	Tornado Days Maps (1986-2015) NOAA/National Weather Service Storm Prediction Center	These static maps show the average number of tornado days per year for all magnitudes (separate maps show EF1+, EF2+ and EF4+ days) within 25 miles of a point from 1986-2015. Tornado frequencies at a given location can be compared to nearby and national locations. 1. Click on the link below to go to the website. 2. Select one of the four <i>Tornado Climatology</i> maps to view a larger image: <i>All Tornado Days, EF1+, EF2+, or EF4+ Tornado Days</i> . Tool Link: https://www.spc.noaa.gov/wcm/#30yrclimo		
	Tornado Watch Climatology Map (1993-2012) NOAA/National Weather Service Storm Prediction Center	This map shows your 20-year climatology of tornado watches. From this map you can get a sense of the approximate number of days each year you can expect to have a tornado watch issued for your county(ies). 1. Under the <i>Storm Prediction Center WCM Page</i> banner near the top of the page, click on the <i>Watch Frequency Maps</i> link. 2. Scroll down a bit until you see <i>20y SPC Watch Climatology</i> . 3. Click on <i>Average number of tornado watches per year</i> image to view it in larger form. Note: This WCM page contains a lot of other statistics about the hail, severe thunderstorm, and tornado products that come out of the NWS Storm Prediction Center if you are interested in digging deeper into data. Tool Link: http://www.spc.noaa.gov/wcm/		
7 Future Trends	Records over the past 40 years show that there has been an increase in the frequency of days with a large number of tornadoes (i.e. tornado outbreaks) and an eastward shift in locations (Gensini and Brooks 2018). However, there has also been a decrease in the frequency of days with tornadoes (Kossin et al. 2017). In other words, increasingly, when tornadoes do occur they are more likely to occur in conjunction with a tornado outbreak. It is currently difficult to account for tornadoes in climate models because they occur on a very small scale. Therefore, more research is needed to understand how climate change is influencing tornadoes (Walsh et al. 2014). Progress has recently been made, however, in understanding how the large-scale climate system relates to the conditions that support tornadoes. As such, climate models project an increase in the frequency and intensity of severe thunderstorms, which can include tornadoes. However, confidence in the details of this projected increase remains low (Kossin et al. 2017).			

A Note About Climate Data Availability

Data availability differs among weather variables. Some variables are easier and less costly to observe than others. For example, temperature and liquid precipitation have longer and more complete periods of record than tornadoes and freezing rain. In addition, it is not scientifically appropriate to analyze long-term trends for some hazards due to reporting differences over time. For example, the long-term trends of tornadoes, severe wind, and hail reports are biased due to population increases and advances in the ability to detect and communicate information. **Refer to the data limitations portion of each hazard section for more details.**

In an ideal world, every city or county in Arkansas would have detailed, long-term climate records. However, even though modern science and technology have greatly advanced data collection, there are limitations which are noted above. Data products such as tables, graphs, and maps are commonly produced from single point observations, analyses that interpolate between data points (for those locations that do not have individual records), or by averaging (such as across climate divisions). **Users should be aware that this document references tools that show observational points, some that show interpolation analyses, and some that show averages.**

Although individual stations are often favored as they provide local data, it might not be the best choice to use a single station's data for long-term risk analysis if it is of poor quality (i.e., has data gaps or has not been calibrated) or has a short period of record. For example, some stations have long-term temperature records that begin in 1895. Other stations, such as personal weather stations, may have a high spatial density within a densely populated area but have temporal data gaps and/or are uncalibrated. **Depending on user needs, it may be more appropriate to look at data from a station that is relatively close to the desired location (i.e., not in the exact city or county) if it has a longer period of record.** In other words, if a user is looking to assess a location's long-term risk, a nearby station with 60 or 100 years' worth of data may be more valuable than a local station that only contains 15 years of data or has long periods of missing data. Furthermore, if a nearby station does not have a long-term record, it may be more valuable to focus on the tools with interpolated analyses or averages. These tools are acknowledged by atmospheric science professionals, including climatologists, to represent accurate and relevant data when locations are under-represented.

Using point data may also miss important events that pose a risk to the city. For example, if a strong tornado passed close to a city, using only historical tracks from within city limits would not include the event and therefore under-estimate risk. **It is wise to consider nearby areas along with the particular location of interest when assessing hazard risk.**

For more information on data limitations or questions regarding suspect data, contact the Arkansas State Climatologist, Whitney Montague, at Whitney.Montague@arkansas.gov or 501-682-3969.

A Note About Climate Change

The future trend portion accompanying each hazard section in this document provides concise summaries of the most up-to-date scientific knowledge regarding how climate change currently is or is expected to impact each hazard. The science is clear that the global climate is changing at a rate which we have not experienced before in modern times, and increasing evidence shows that humans are a primary influence behind this rate of change. However, the changes we are experiencing and can expect to experience in Arkansas are nuanced. In many cases, only descriptive information about likely changes can be given, as climate models are currently not capable of providing skillful magnitudes of the changes. For example, models may be able to examine changes in environmental conditions favorable to storms but lack the resolution to determine likely storm severity. For information that is more in-depth than that which accompanies each hazard section in this tool, please visit the resources listed in Appendix C.

A Note About Impact Data

Understanding the detailed impacts of weather and climate on cities and counties is an important and necessary step to be able to reduce risks and costs. Impacts of events are dependent upon characteristics of the location such as low-lying areas susceptible to flooding, soil types, housing construction, and resources available to respond and rebuild. Given disparate data sources, however, gathering comprehensive impact data and including it in the Simple Planning Tool was beyond the scope of this project and the expertise of the authors. If future resources support further research, additional versions of the *Simple Planning Tool for Arkansas Hazards* may include impact data.

Cold Extremes

Data Limitations: Arkansas generally has good quality long-term data records for cold temperature values, however, the consistency of cumulative years on record vary by station. The majority of stations consist of a large record dating back up to the 19th century, however, some station locations include gaps in records that could be subject to technical issues or changes in monitoring location.

Historical Data

Temperature Trends Dashboard

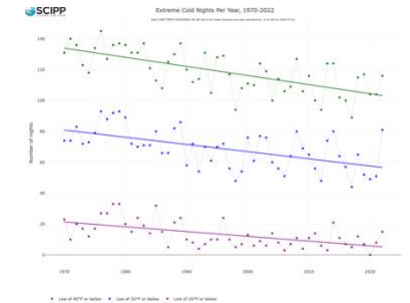
(1970-2022)

Southern Climate Impacts Planning Program

This tool shows temperature trends at individual stations across Arkansas, including trends in extremely cold nights, seasonal extreme and average high/low temperatures, and heating degree days, since 1970.

1. At the top of the tool, click the *Extreme Cold, Heating and Cooling Degree Days, Seasonal Averages, or Seasonal Extremes* tab. 2. The default station is in Abilene, TX. To choose a station nearest to you, use the map on the right. Zoom in and click any of the blue dots to change stations. You can also select a station under the *Station* drop-down menu on the left of the page 3. Use the graph to determine the trend (if any) for your selection. Solid lines represent significant trends. 4. Mouse over individual data points to view more information. 5. For seasonal selections, make sure *Winter* is selected in the *Season* drop-down menu on the left of the screen.

Tool Link: https://scipprisa.shinyapps.io/SCIPP_temp_dash/



Record Low Temperatures

(Period of record varies by station; up to ~140 years)

Southern Regional Climate Center

The SRCC's Climate Extremes Tool displays the lowest temperature ever recorded at individual stations.

1. Under *Product*, select *All-Time Records*. 2. Under *Variable*, select *Low Min Temperature*. 3. Click *Submit*. 4. Temperature record is displayed on the map (pan, zoom-in or -out if needed). Mouse over station to determine its period of record and day on which the record occurred.

Tool Link: <https://www.srcc.tamu.edu/extremes/>



Average Freeze Dates

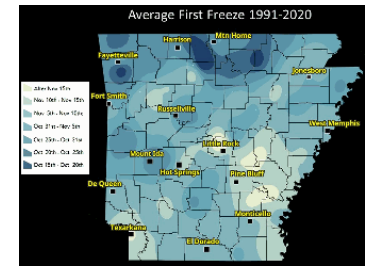
(1991-2020)

National Weather Service-Little Rock, AR

This static map shows the average date of the first freeze (Fall) across Arkansas. A link to a map of the average date of the last freeze (Spring) is located below the map. The maps can be used to understand the times of the year in which you might experience temperatures below freezing for your area.

1. Scroll to middle of page to view the maps. 2. Click on map of interest from the following: *First Freeze (Fall)* or *Last Freeze (Spring)*. 3. You can also obtain frost and freeze information for individual stations by scrolling down the page a bit and clicking on the drop-down menu, then *Get Info!*

Tool Link: <https://www.weather.gov/lzk/frostfreeze.htm>



Wind Chill Days and Hours

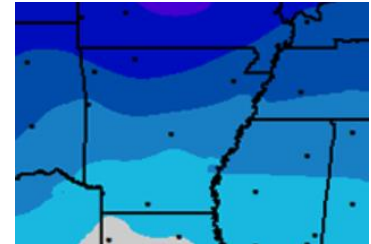
(1973-2019)

Midwest Regional Climate Center

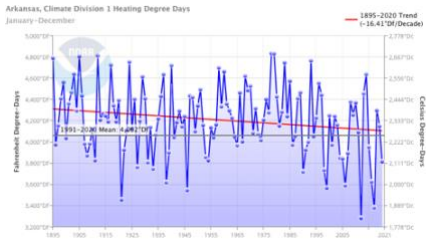
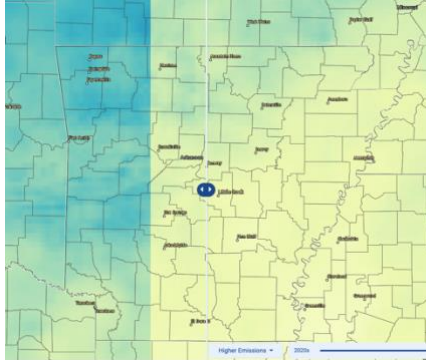
This set of maps depict the average number of days, day with 3 or more hours, and average number of hours per year with wind chill values at or below a variety of thresholds (e.g., 15°F, 0°F, -10°F).

1. Near the top of the page, click on the map link of interest out of the three options: *Average Number of Days*, *Days with 3 or More Hours*, or *Average Number of Hours*. 2. Right above the map, mouse over the wind chill temperature value of interest to view the corresponding data on the map. 3. To interpret the colors, see the legend on the top-right side of the map.

Tool Link: <https://mrcc.purdue.edu/clim/windChill/index.jsp>



Cold Extremes (Continued)

Historical Data	<p>Average Annual Heating Degree Days (1895-present)</p> <p>NOAA National Centers for Environmental Information</p>	<p>This graph shows the average annual heating degree days (HDD) and trend over time, a measurement used to quantify the demand for energy needed to heat buildings.</p> <p>1. Within the <i>Parameter</i> drop-down menu, choose <i>Heating Degree Days</i>. 2. Within <i>Time Scale</i>, choose <i>Annual</i>. 3. Within <i>Start Year</i>, choose desired start year. 4. Within <i>State</i>, choose <i>Arkansas</i>. 5. Within <i>Climate Division</i>, choose desired region of interest. 6. Under <i>Options</i> box, check <i>Display Base Period</i> and select 1991 and 2020 to show the most recent 30-year trend. 7. Check <i>Display Trend</i>, select <i>per Decade</i>, 1895, and present year to show the long-term trend and decadal change. 8. Click <i>Plot</i> button. Note: A few seconds are required to generate the graph.</p> <p style="text-align: center;">Tool Link: https://www.ncdc.noaa.gov/cag/divisional/time-series</p>	
Future Trends	<p>Climate Explorer – Climate Maps and Graphs Tools (1950-2099)</p> <p>NOAA Climate Program Office and National Environmental Modeling and Analysis Center</p>	<p>The Climate Explorer is an interactive tool that allows you to view and compare the annual heating degree days and the average number of days per year with a maximum or minimum temperature below 32°F for the historical period and in the future under both higher and lower emissions scenarios.</p> <p>1. Type in the city or parish you are interested in. 2. Click <i>Climate Maps</i>. 3. Using the drop-down menu in the upper-left corner, select the variable of interest (<i>Days w/ max temp <32°F</i>, <i>Days w/ min temp <32°F</i>, or <i>Heating Degree Days</i>). 4. Next to the drop-down menu, select <i>Map</i>. 5. Use the middle slider on the map to compare averages between the historical period (1961-1990) and future decades (2020s-2090s) under lower and higher emissions scenarios. (Use the bottom drop-down menus to choose variables and the slider on the bottom right to choose a decade to compare with.) On the map, zoom in to the parish level and click a parish to view the associated values. 6. To view this information over time (1950-2099) for a single location, click the <i>Graph</i> tab at the top of the map and type a location at the top.</p> <p style="text-align: center;">Tool Link: https://crt-climate-explorer.nemac.org/</p>	
	<p>According to Vose et al. (2017), Arkansas’s average temperature has not changed much overall the past 120 years, and the southern half of the state has cooled slightly. However, its coldest temperature of the year has warmed by about 2 to 6°F. Climate change is projected to decrease the frequency and intensity of cold waves (Vose et al. 2017), and by mid-century, Arkansas is projected to experience 15 to 25 fewer days below 32°F, with a greater reduction of up to 30 fewer days across the northwest portion of the state. Warmer winters signify that the cold season will shorten, which will subsequently lead to a longer frost-free period and growing season. Extreme cold events will continue to impact Arkansas; however, they will occur less frequently and with less intensity (Vose et al. 2017). Read more about future cold extremes in the resources found in Appendix C.</p>		

Drought

Data Limitations: Drought cannot be assessed by a single indicator. Unlike many other hazards where impacts are immediate and apparent, drought has a slow onset, sometimes goes undetected, and affects different sectors on different timescales. Consequently, it is important to assess drought using a variety of indicators, some which respond better to short-term conditions, such as for agriculture, and others that respond to longer-term conditions, such as water resources. Many indicators are combined into the weekly U.S. Drought Monitor, however, these only dates back to 2000.

Historical Data

U.S. Drought Risk Atlas

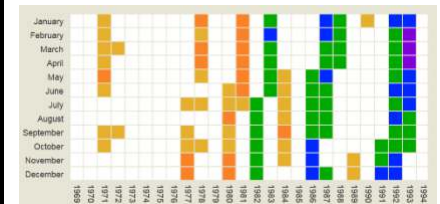
(Period of record varies by station; up to ~130 years)

National Drought Mitigation Center

This interactive tool provides historical drought indices at a local level and can identify drought periods at different levels of severity, duration, and frequency.

1. On the left side, select *Arkansas* to search by state or zoom in on the map, then search by location. **2.** Scroll down to select a station from the *Station List* on the right or choose a station from the map. Then, click *Update Selection*. **3.** Below, there are a variety of drought indicator tabs to explore. Choose which indicator you would like to view. **3a.** The *Precip & Temp* tab provides weekly, monthly, or annual averages of total precipitation and minimum and maximum temperature, shown in graphs. Select a date range or select a decade or the period of record from the drop-down menu. Select weekly, monthly, or annual information from the *Aggregate* drop-down menu. **3b.** The *Drought Monitor* tab shows values from the U.S. Drought Monitor, which began in 2000. Select a date range and a *Boundary* (state, county, etc.). There are three ways to view the information. Select *Time Series* to view a graph of U.S. Drought Monitor values over time, averaged over the boundary you selected, *Table* to view a table of weekly drought monitor values, or *Heat Map* to view weekly values by year (use the slider to scroll through the weeks). **3c.** The *Trends* tab shows various trends in several drought indicators and how statistically significant those trends are. Under the *Index* drop-down menu, select precipitation or a drought indicator. For any indicator, select a *Start Year* and *Significance* level. Some indicators require you to also select a *Season*, and the *Precipitation* indicator requires a *Precipitation Threshold* in inches. After you make the selections, click *Trends Chart* on the right. A graph will display with the trend in the selected indicator over time. A blue dashed trendline represents an increasing trend in that indicator, a red dashed trendline represents a decreasing trend, and a black dashed trendline represents no trend. The trend value per decade is shown in text underneath the graph.

Tool Link: <https://droughtatlas.unl.edu/Data/Climate.aspx>



Historical Climate Trends Tool

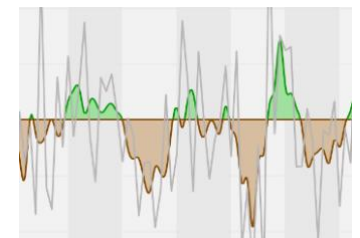
(1895-present)

Southern Climate Impacts Planning Program

This interactive graphing tool shows precipitation trends, of which prolonged, very dry periods are a drought indicator.

1. On the left side column (moving from top to bottom) choose *Arkansas* → *Climate Division of Interest* → *Season of Interest* → *Precipitation*. **2.** Hovering the cursor over a point will display the year and total rainfall for the selected season. **3.** For more information on how to interpret the chart, click on *Chart Info*.

Tool Link: <http://charts.climate.lsu.edu/trends/>



U.S. Drought Monitor Time Series

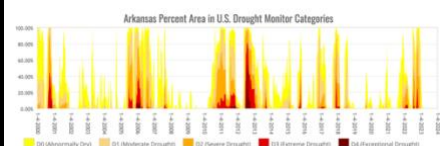
(2000-present)

National Drought Mitigation Center

This interactive graphing tool shows the frequency of drought conditions since 2000, along with each drought's maximum intensity and duration (shown by color scale). The U.S. Drought Monitor is the official source for aid decisions by the USDA and several other agencies and programs.

1. In the banner, next to *Area Type* select either *Climate Division* or *County*. **2.** Next to *Area*, either type in (AR) to jump to climate division (CD) of interest or type in county of interest (to determine CD of interest, visit <https://psl.noaa.gov/data/usclimdivs/data/map.html>). **3.** Next to *Index*, select *USDM*. **4.** You can zoom in by clicking inside the graph and dragging over a specific time-period.

Tool Link: <https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx>



Drought (Continued)

Future Trends

Precipitation Projections

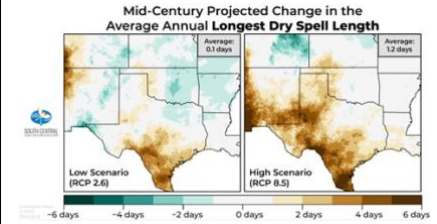
(2036-2099)

South Central Climate Adaptation Science Center

This webpage includes several precipitation projections, including the projected average annual number of days with rain and longest dry spell length, for the south-central U.S. for the mid-century (2036-2065) and end-of-century (2070-2099) time frames under low and high emissions scenarios.

1. The projections are grouped by mid-century and end-of-century. Scroll down to *Projected Change in the Average Annual Number of Days with Rain* or *Projected Change in the Average Annual Longest Dry Spell Length* for the time frame you're interested in. These two variables relate to drought from a precipitation perspective. **2.** The maps in the middle of the page show the projections under a low emissions scenario on the left and high emissions scenario on the right. The average value in the top right of each map represents the average for the entire region, so use the legend below the map to estimate the value for your area. **Note:** Click the map to view a larger version. **3.** On either side of the page is a text summary of the projections for both emissions scenarios. **Note:** You can use these maps to view the range of projected values, as the future value will likely fall somewhere in between the low and high emissions scenarios.

Tool Link: <https://southcentralclimate.org/resources/climate-projections/precipitation-projections/>



Arkansas has historically experienced flash droughts, which are droughts that develop quickly. Drought conditions come and go but have not been as long and intense as further west, such as in Oklahoma and Texas. However, droughts are projected to increase in severity and frequency due to rising temperatures and increased evaporation. Models project that Arkansas will experience a decrease in soil moisture across all seasons by the end of the century, with the greatest decrease in the summer (Carter et al. 2014; Wehner et al. 2017). Rising temperatures will also lead to an increased demand for water and energy which could stress natural resources (Shafer et al. 2014). Read more about future drought in the resources found in Appendix C.

Hail

Data Limitations: Hail data are not of sufficient quality to robustly determine historical trends and is of poorer quality than even the tornado dataset. This can be attributed to the increases in non-meteorological factors such as population and storm spotter coverage over time, as well as the uncertainty in reported hail size. However, the recent acknowledgement to assess the number of hail days as a way to investigate frequency instead of individual hail reports has mitigated some of the biases.

Historical Data

Severe Hail Days Per Year

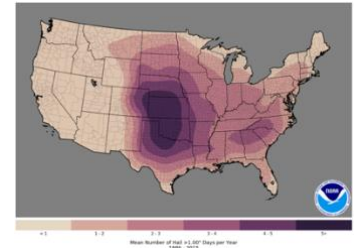
(1986-2015)

NOAA/National Weather Service Storm Prediction Center

This map shows the average number of days per year in which severe hail reports were received in your area during the period noted. The map gives you a sense of the approximate number of days each year that you can expect to see severe hail (1-inch or greater in diameter) in your area. The 2-inch or greater map is also available for viewing.

1. Click on the link below to go to the website. **2.** Select *Hail Climatology – New Severe Hail (Greater Than 1.00"* or the similar map for *Greater Than 2.00"*. **3.** Interpret map as needed.

Tool Link: <https://www.spc.noaa.gov/wcm/#30yrclimo>



Severe Hail Reports

Hail:
(1955-present)

Southern Regional Climate Center

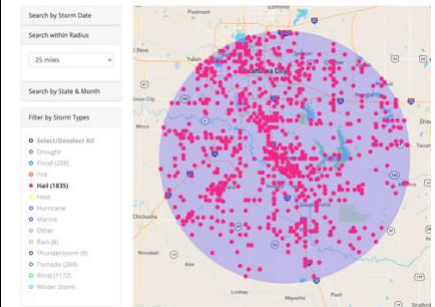
This interactive tool shows you the historical record for individual severe hail reports in your area within a 25 or 50 mile radius. It is especially useful to determine the largest hail reported.

1. On left side of screen, click on *Search with Radius*. **2.** Choose the diameter of the area of which you want to investigate (25 or 50 miles). **3.** Select *Hail* (de-select Tornado and Wind). **4.** Pan, zoom, and then click on the map area of interest. **5.** Reports are displayed on the map and in two tables below the map.

Map: Mouse over individual storm reports for details.

Tables: There are two tables, *Recent Storm Data* and *Historical Storm Data*. Click on column header to sort by column of interest. For example, to view the dates in which the largest hail occurred, click on the *Scale* column headers to sort by the largest hail values.

Tool Link: https://www.srcc.tamu.edu/storm_reports/



Storm Events Database

Hail:
(1950-present)

NOAA National Centers for Environmental Information

This interactive tool shows you the historical record for individual severe hail reports *by county*. It can be used to determine hail events that have impacted your area or close to your area.

1. On the bottom left, under *Select State or Area*, choose *Arkansas* → *Search*. **2.** From top to bottom, select a specific *Begin* and *End Date*, as well as *County* of interest. **3.** Under *Event Type(s)*, select *Hail*. **4.** Under *Advanced Search and Filter Options* → *Hail Event Type Filter*, select hail size of interest. **5.** Press *Search*. Summary results are presented in a table. **Note:** *This tool can be used to analyze a variety of additional hazards with various time periods, and hail data goes as far back as 1955.*

Tool Link: <https://www.ncdc.noaa.gov/stormevents/>

Location	County	Date	Time	Size	Type	Scale	DB	DB	DB
Totals:									
Noble	CLEVELAND CO.	05/06/2017	21:55	CS1-6	Hail	1.00 in.	0	0	0.00K
Noble	CLEVELAND CO.	05/06/2017	22:50	CS1-6	Hail	1.00 in.	0	0	0.00K
LAKE THUNDERBOLT DAM	CLEVELAND CO.	05/06/2017	22:09	CS1-6	Hail	1.00 in.	0	0	0.00K
NORMAN	CLEVELAND CO.	04/25/2017	09:15	CS1-6	Hail	0.75 in.	0	0	0.00K
NORMAN	CLEVELAND CO.	04/25/2017	07:22	CS1-6	Hail	1.00 in.	0	0	0.00K
MOORE	CLEVELAND CO.	04/25/2017	21:09	CS1-6	Hail	1.25 in.	0	0	0.00K
MOORE	CLEVELAND CO.	04/25/2017	21:10	CS1-6	Hail	1.00 in.	0	0	0.00K
NORMAN	CLEVELAND CO.	04/25/2017	21:15	CS1-6	Hail	1.00 in.	0	0	0.00K
Noble	CLEVELAND CO.	04/25/2017	21:22	CS1-6	Hail	1.00 in.	0	0	0.00K
Noble	CLEVELAND CO.	04/25/2017	21:25	CS1-6	Hail	1.00 in.	0	0	0.00K
NORMAN	CLEVELAND CO.	04/25/2017	21:25	CS1-6	Hail	1.50 in.	0	0	0.00K
LAKE THUNDERBOLT DAM	CLEVELAND CO.	04/25/2017	21:43	CS1-6	Hail	1.00 in.	0	0	0.00K
LAKE THUNDERBOLT DAM	CLEVELAND CO.	04/25/2017	20:31	CS1-6	Hail	1.75 in.	0	0	0.00K
MOORE	CLEVELAND CO.	04/25/2017	19:45	CS1-6	Hail	1.00 in.	0	0	0.00K
MOORE	CLEVELAND CO.	04/25/2017	19:47	CS1-6	Hail	1.00 in.	0	0	0.00K
MOORE	CLEVELAND CO.	04/25/2017	19:50	CS1-6	Hail	1.00 in.	0	0	0.00K
MOORE	CLEVELAND CO.	04/25/2017	19:52	CS1-6	Hail	1.00 in.	0	0	0.00K
Totals:									

Future Trends

Hail is commonly associated with severe thunderstorms. Climate models project an increase in the frequency and intensity of severe thunderstorms, and events with *large* hail are projected to increase (Kossin et al. 2017). At the same time, models project an overall decrease in the number of days with hail per year (Brimelow et al. 2017). Confidence in the projections is currently low, however, due to the isolated and sporadic nature of hail events and limited comprehensive datasets which make it difficult to track long-term trends (Wuebbles et al. 2017a).

Heat Extremes

Data Limitations: Arkansas generally has good quality long-term data records for temperature values, however, the consistency of cumulative years on record vary by station. The majority of stations consist of a large record dating back up to the 19th century, however, some station locations include gaps in records that could be subject to technical issues or changes in monitoring location.

Historical Data

Temperature Trends Dashboard

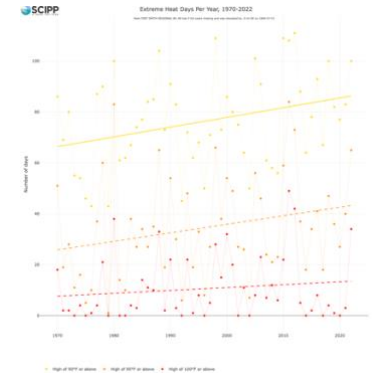
(1970-2022)

Southern Climate Impacts Planning Program

This tool shows temperature trends at individual stations across Arkansas, including trends in extremely hot days, warm nights, seasonal extreme and average high/low temperatures, and cooling degree days, since 1970.

1. At the top of the tool, click the *Extreme Heat, Warm Nights, Heating and Cooling Degree Days, Seasonal Averages, or Seasonal Extremes* tab. 2. The default station is in Abilene, TX. To choose a station nearest to you, use the map on the right. Zoom in and click any of the blue dots to change stations. You can also select a station under the *Station* drop-down menu on the left of the page. 3. Use the graph to determine the trend (if any) for your selection. Solid lines represent significant trends. 4. Mouse over individual data points to view more information. 5. For seasonal selections, make sure you select a season in the *Season* drop-down menu on the left of the screen.

Tool Link: https://scipprisa.shinyapps.io/SCIPP_temp_dash/



Climate Extremes Tool -Temperature

(Period of record varies by station; up to ~140 years)

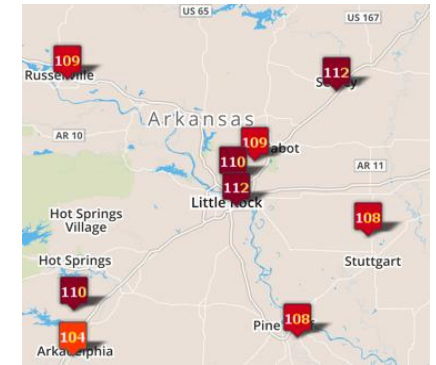
Southern Regional Climate Center

This interactive tool shows temperature records at point locations. Below are two ways the tool can be used to analyze heat extremes. If a station does not exist for your community, consider a nearby station.

(a) High temperature records by month: 1. On left side of screen (from top to bottom) select *Records For A Month* → *High Max Temperature* → *Month of Interest* → *Go*. 2. Mouse over icons for record details including station name, date of occurrence, and station period of record.

(b) All-time records: 1. Select *All-Time Records* → *High Max Temperature* → *Go*. 2. Mouse over icons for record details including station name, date of occurrence, and station period of record. Note: For more information, select the *Help* or *About* tabs.

Tool Link: <https://www.srcc.tamu.edu/extremes/>



Heat Index Days and Hours

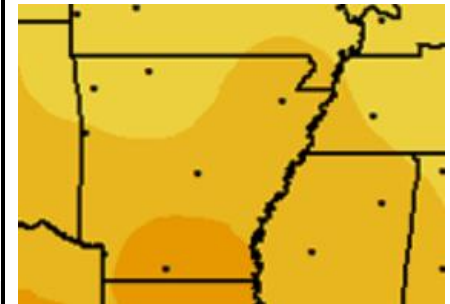
(1973-2018)

Midwest Regional Climate Center

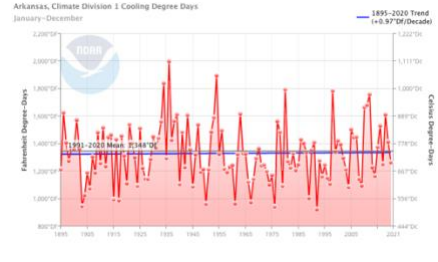
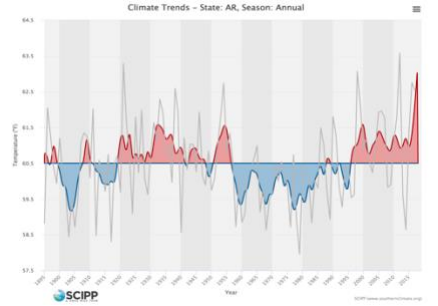
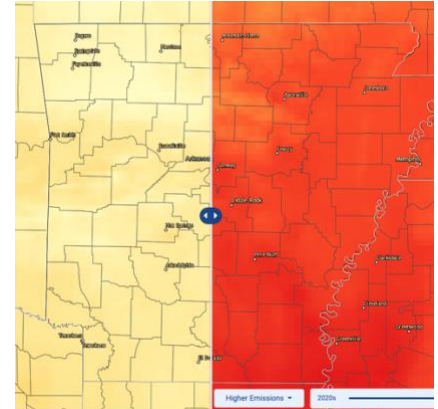
This set of maps depict the average number of days, day with 3 or more hours, and average number of hours per year with heat index values at or above a variety of thresholds (e.g., 95°F, 110°F, 105°F).

1. Near the top of the page, click on the map link of interest out of the three options: *Average Number of Days, Days with 3 or More Hours, or Average Number of Hours*. 2. Right above the map, mouse over the heat index value of interest to view the corresponding data on the map. 3. To interpret the colors, see the legend on the top-right side of the map.

Tool Link: <https://mrcc.purdue.edu/clim/heatIndex/index.jsp>



Heat Extremes (Continued)

Historical Data	<p>Average Annual Cooling Degree Days (1895-present)</p> <p>National Center for Environmental Information</p>	<p>This graph shows the average annual cooling degree days (CDD), a measurement used to quantify the demand for energy needed to cool buildings.</p> <p>1. Within the <i>Parameter</i> drop-down menu, choose <i>Cooling Degree Days</i>. 2. Within <i>Time Scale</i>, choose <i>Annual</i>. 4. Within <i>Start Year</i>, choose desired start year. 5. Within <i>State</i>, choose <i>Arkansas</i>. 6. Within <i>Climate Division</i>, choose region of interest. 7. Under <i>Options</i> box, check <i>Display Base Period</i> and select <i>1991 and 2020</i> to show the most recent 30-year trend. 8. Check <i>Display Trend</i>, select <i>per Decade</i>, <i>1895</i>, and present year to show the long-term trend and decadal change. 9. Click <i>Plot</i> button. Note: A few seconds are required to generate the graph.</p>	
	<p>Historical Climate Trends Tool (1895-present)</p> <p>Southern Climate Impacts Planning Program</p>	<p>This interactive graphing tool shows annual, seasonal, and monthly temperature trends by state and climate division. It can be used to gain a general understanding of temperature trends and show previous periods of higher temperatures, as well as years of extreme temperature.</p> <p>1. On left side of screen select <i>Arkansas</i> → <i>Climate Division of Interest</i> → <i>Season of Interest</i> → <i>Temperature</i>. 2. For more information on how to interpret the chart, click on <i>Chart Info</i>. 3. Note that the graphs can be viewed by season, month, or annually.</p>	
Future Trends	<p>Climate Explorer – Climate Maps and Graphs Tools (1950-2099)</p> <p>NOAA Climate Program Office and National Environmental Modeling and Analysis Center</p>	<p>The Climate Explorer is an interactive tool that allows you to view and compare the average number of warm nights, extremely hot days, and cooling degree days per year for the historical period and in the future under both higher and lower emissions scenarios.</p> <p>1. Type in the city or county you are interested in. 2. Click <i>Climate Maps</i>. 3. From the drop-down menu, select <i>Days w/ max temp > 90</i> (or other option up to <i>105°F</i>), <i>Days w/ min temp > 80°F</i> (or <i>90°F</i>), or <i>Cooling Degree Days</i>. 4. Next to the drop-down menu, select <i>Map</i>. 5. Use the middle slider on the map to compare averages between historical, lower, and higher emissions scenarios. (Use the bottom drop-down menus to choose variables and the slider on the bottom right to choose a decade to compare with.) On the map, zoom in to the county level and click a county to view the associated values. 6. To view this information over time (1950-2099) for a single location, click the <i>Graph</i> tab at the top of the map and type a location at the top.</p>	

Heat Extremes (Continued)

Future Trends

Killer Heat Tool

(1971-2099)

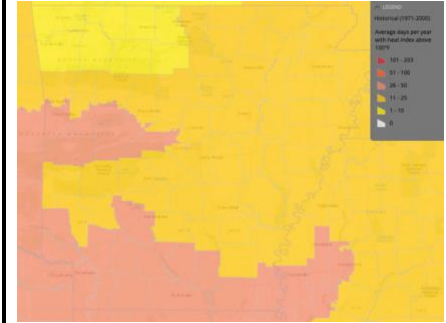
Union of Concerned Scientists

This interactive mapping tool shows the number of days with maximum heat index above 90°F, 100°F, 105°F, and 'off the charts' (exceeding the upper limits of the NWS heat index scale) for each U.S. county over the historical baseline (1971-2000), mid-century (2036-2065), and late century (2070-2099). Future projections include scenarios for no action, slow action, and rapid action on climate change.

1. At the top of the tool, click the *Above 90*, *Above 100*, *Above 105*, or *Off the Charts* tab. 2. Zoom in to the desired area on the map. The default map displays historical number of days above the threshold. 3. Click the county of interest to view the historical number of days per year above the selected heat index threshold. 4. On the left panel, scroll through the text and select a future scenario *with no action on climate change*, *with slow action on climate change*, or *with rapid action on climate change* for the *Midcentury* or *Late Century* time frame. 5. Click the county of interest to view the number of days per year above the selected heat index threshold for the scenario and time frame selected. 6. This information is also available for military bases in the U.S., accessible through the *Military Bases at Risk* tab at the top of the page.

Tool Link:

<https://ucsusa.maps.arcgis.com/apps/MapSeries/index.html?appid=e4e9082a1ec343c794d27f3e12dd006d>



Temperature Projections - Heatwaves

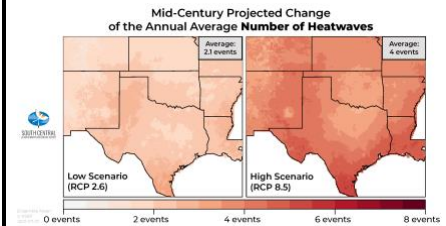
(2036-2099)

South Central Climate Adaptation Science Center

This webpage includes several temperature projections, including the projected number of heatwaves per year, for the south-central U.S. during the mid-century (2036-2065) and end-of-century (2070-2099) time frames under low and high emissions scenarios.

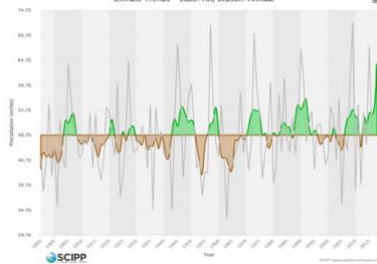
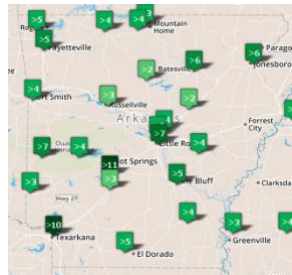

1. The projections are grouped by mid-century and end-of-century. Scroll down to *Projected Change of the Annual Average Number of Heatwaves* for the time frame you're interested in. 2. The maps in the middle of the page show the projections under a low emissions scenario on the left and high emissions scenario on the right. The average value in the top right of each map represents the average for the entire region, so use the legend below the map to estimate the value for your area. **Note:** Click the map to view a larger version. 3. On either side of the page is a text summary of the projections for both emissions scenarios. **Note:** You can use these maps to view the range of projected values, as the future value will likely fall somewhere in between the low and high emissions scenarios.

Tool Link: <https://southcentralclimate.org/resources/climate-projections/temperature-projections/>



Fewer extremely hot days (100°F or greater) were observed in Arkansas in the 2nd half of the 20th century than during the 1st half (Runkle et al. 2017). The statewide temperature experienced a cooling period from the 1960s to 1980s, although it was followed by a warming period starting in 2010 with annual temperatures reaching levels comparable to the warmest period on record, the 1930s. Additionally, further warming is projected during the 21st century. By mid-century, models project 40 to 50 more days per year above 90°F (Vose et al. 2017) and about 30 more days per year above 95°F (Kunkel et al. 2013). Arkansas is also projected to experience an additional 20-30 nights per year exceeding temperatures equivalent to the top 7 warmest annual nighttime temperatures (nighttime temperatures staying above 67-75°F, dependent on location within the state) (Shafer et al. 2014). Read more about future heat extremes in the resources found in Appendix C.

Heavy Rainfall and Flooding

Historical Data	<p>Historical Climate Trends Tool</p> <p>(1895-present)</p> <p>Southern Climate Impacts Planning Program</p>	<p>Shows precipitation trends and its average over the period of record by state and climate division, annually, seasonally, and by month. Years, seasons, or months with high precipitation totals may be indicative as years with flood events during one or more parts of the year, however, must be correlated with other data.</p> <ol style="list-style-type: none"> 1. On the left side of screen select <i>Arkansas</i>. 2. Select climate division of interest or entire state. 3. Select annual, season, or month of interest. 4. Select <i>Precipitation</i>. 5. The horizontal line indicates the average annual amount of precipitation. The brown and green lines represent 5-year averages and indicate wetter and drier periods within the record. <p>Tool Link: http://charts.climate.lsu.edu/trends/</p>	
	<p>Climate Extremes Tool - Precipitation</p> <p>(Period of record varies by station; up to ~140 years)</p> <p>Southern Regional Climate Center</p>	<p>This interactive map shows precipitation extremes at airport weather stations, which can be used to show some previous heavy rainfall occurrences (i.e., the highest rainfall totals within a single storm do not necessarily occur at airport weather stations).</p> <ol style="list-style-type: none"> 1. Pan and zoom to location of interest. 2. To obtain <i>High precipitation records by month</i>: On left side of screen select <i>Records In A Month</i> → <i>High Precipitation</i> → <i>Month of interest</i> → <i>Go</i>. 3. Measurement unit is inches. Mouse over icon for record details (date of occurrence and station record). 4. To obtain <i>All-time records</i>: Select <i>All-Time Records</i> → <i>High Precipitation</i> → <i>Go</i>. <p>Tool Link: https://www.srcc.tamu.edu/extremes/</p>	
	<p>FEMA Flood Map Service Center</p> <p>Federal Emergency Management Agency</p>	<p>Website can be used to locate and identify flood hazard zones in a jurisdiction and produce maps for inclusion in a hazard mitigation plan. When combined with other map layers it can provide a spatial relationship between flood hazard zones and critical facilities and infrastructure. Note that the 100-yr floodplain is an estimate used for insurance and regulatory purposes. Floods can and do occur outside of the areas depicted. <i>Note: This tool is a little more involved than some of the others and it is helpful to use a larger computer screen because of the amount of data shown.</i></p> <ol style="list-style-type: none"> 1. Enter an address, place, or coordinates in the search bar near the top of the page. 2. Click <i>Search</i>. 3. Click <i>Streets</i> view in upper right corner of the map. 4. The panel of land outlined in light blue is the one that will be mapped. If you need a different panel, click on the one of interest (Zoom out if needed. It may take a few seconds for it to be selected.). 5. Zoom in to view details in map such as those shown at right. Note legend below map and effective date noted on the map. 6. To download a black & white static image of full original FIRM panel, click on <i>Map Image</i> icon. 7. To access a colored map, click on <i>Dynamic Map</i> icon. You may need to disable your browser's pop-up blocker. <p>Tool Link: https://msc.fema.gov/portal</p>	

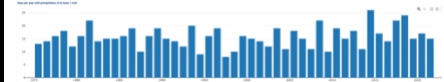
Historical Data

NOAA Climate Program
Office and National
Environmental
Modeling and Analysis
Center

The Climate Explorer is an interactive tool that allows you to view the number of extreme rainfall events per year for a station's period of record.

1. Type in the city or county you are interested in. 2. Click *Extreme Events*. 3. From the top menu, select a *Threshold* in inches (e.g., 1 in). 4. You can choose whether or not to select an option from the *Percentiles* drop-down menu, from the 10th to 90th percentile. 5. Choose *at least* (\geq) from the next drop-down menu. 6. Select a *Duration* in days (e.g., 1 day). 7. Choose a station (red dot) on the map. 8. The resulting plot displays a bar chart with days per year (or multiday duration you chose) with precipitation reaching your selected threshold. Hover your mouse over the bars to view yearly information. Under the chart on the right side is a *Plain-language description* that summarizes the number of times the threshold was reached over the station's period of record and the yearly average occurrence.

Tool Link: <https://crt-climate-explorer.nemac.org/>



National Weather
Service Arkansas-Red
Basin River Forecast
Center

This interactive tool shows a summary of flood impacts for location of interest. It can be used to show the extent of flood events.

1. On map, click forecast center of interest, Arkansas Red Basin or Lower Mississippi. A new page will load.
2. On map, pan and zoom to area of interest.
3. Double-click on stream gauge of interest (small circle) on the map.
4. Click *River at a Glance* tab near top of page.
5. Left column: Select gauge of interest. Right column: At a minimum, select *Flood Impacts*, *Location Map*, *Record Crest History*.
6. Click *Make my River Page!*
7. Information you selected will be displayed on a new page.

Tool Link: <https://water.weather.gov/ahps/rfc/rfc.php>

44 Expect near catastrophic flood depths up to 19 feet to wreak havoc shores of Lake Texoma. Many homesteads are flooded or cut off or threatened. Flood levels nearly match those of the flood crest of Mx 43

43 Expect near catastrophic flood depths up to 18 feet to cause destru County... to the shores of Lake Texoma. Many homesteads are for highways and railroads are threatened.

42 Expect near catastrophic flood depths up to 17 feet to cause destru County... to the shores of Lake Texoma. Many homesteads are for highways and railroads are threatened.

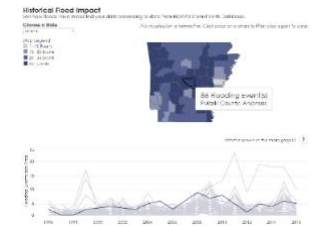
41 Flood depths up to 16 feet will cause destruction in the Washita Riv in Johnston County. Many homesteads may be flooded or cut off or threatened.

Federal Emergency
Management Agency

Map and graphs show state and county flood events that are documented in NOAA's Storm Events Database. It shows the number of flood events by county and costs of flooding based on average National Flood Insurance Program and FEMA's Individual and Household Program payments.

1. Under *Choose a State*, select *Arkansas*. **2.** Arkansas statistics will be displayed on the page. **3.** If you wish to view statistics by county, click on a county on the map displayed on the page.

Tool Link: <https://www.fema.gov/data-visualization-floods-data-visualization>



NOAA
Hydrometeorological
Design Studies Center

Interactive tool shows rainfall frequency estimates for select durations (e.g., 3-, 12-, and 24 hours) and recurrence intervals (e.g., 100-, 500-, and 1000-years) with 90% confidence intervals. Probable maximum precipitation (PMP) values are not represented in this tool. Such values will be available through an additional tool in the near future.

1. Click on *Arkansas* from the map. A new screen will open. 2. To select a location, either enter the desired location, station, or address manually OR select a station from the interactive map. 3. Precipitation frequency estimates will be displayed in both table and graph forms below. 4. For additional help, select *FAQ* from the left-hand menu, then refer to the *Section 5* link under section 1.1.

Tool Link: <https://hdsc.nws.noaa.gov/hdsc/pfds/index.html>

POE-based population projection estimates with 95% confidence intervals (in inches)																												
Series	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1-14	0.020	0.041	0.062	0.083	0.103	0.123	0.143	0.163	0.183	0.203	0.223	0.243	0.263	0.283	0.303	0.323	0.343	0.363	0.383	0.403	0.423	0.443	0.463	0.483	0.503	0.523	0.543	0.563
15-64	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
65+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	0.020	0.041	0.062	0.083	0.103	0.123	0.143	0.163	0.183	0.203	0.223	0.243	0.263	0.283	0.303	0.323	0.343	0.363	0.383	0.403	0.423	0.443	0.463	0.483	0.503	0.523	0.543	0.563
1-14	0.020	0.041	0.062	0.083	0.103	0.123	0.143	0.163	0.183	0.203	0.223	0.243	0.263	0.283	0.303	0.323	0.343	0.363	0.383	0.403	0.423	0.443	0.463	0.483	0.503	0.523	0.543	0.563
15-64	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
65+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	0.020	0.041	0.062	0.083	0.103	0.123	0.143	0.163	0.183	0.203	0.223	0.243	0.263	0.283	0.303	0.323	0.343	0.363	0.383	0.403	0.423	0.443	0.463	0.483	0.503	0.523	0.543	0.563
1-14	0.020	0.041	0.062	0.083	0.103	0.123	0.143	0.163	0.183	0.203	0.223	0.243	0.263	0.283	0.303	0.323	0.343	0.363	0.383	0.403	0.423	0.443	0.463	0.483	0.503	0.523	0.543	0.563
15-64	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
65+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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65+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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65+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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65+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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65+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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65+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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65+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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Heavy Rainfall and Flooding (Continued)

Future Trends

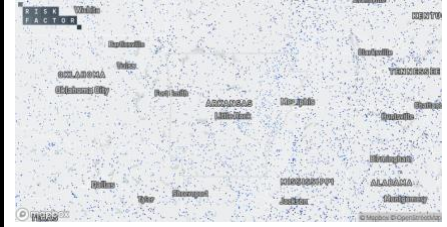
Risk Factor

(Present risk and 30-year future projections)
First Street Foundation

This tool provides information on flood risk and how it is changing. It shows the trend in number of properties at risk, a specific property's flood risk score, the flood history of an area, how an area's flood risk is expected to change in the next 30 years, and community solutions for flood mitigation.

1. Type in the address, zip code, or city of interest **2.** Click the *Flood Factor* tab near the top of the page. **3.** Scroll down and use the tabs on the left side of the page or scroll to the topic of interest.

Tool Link: <https://riskfactor.com/>



Climate Explorer – Climate Maps and Graphs Tools

(1950-2099)
NOAA Climate Program Office and National Environmental Modeling and Analysis Center

The Climate Explorer is an interactive tool that allows you to view and compare the average number of days with precipitation greater than 1", 2", or 3" per year for the historical period and in the future under both higher and lower emissions scenarios.

1. Type in the city or county you are interested in. **2.** Click *Climate Maps*. **3.** From the leftmost drop-down menu, select *Days w/ 1" Precipitation* (2" and 3" thresholds are also available). **4.** Next to the drop-down menu, select *Map*. **5.** Use the middle slider on the map to compare averages between historical, lower, and higher emissions scenarios. (Use the bottom drop-down menus to choose variables and the slider on the bottom right to choose a decade to compare with.) On the map, zoom in to the county level and click a county to view the associated values. **6.** To view this information over time (1950-2099) for a single location, click the *Graph* tab at the top of the map and type a location at the top. **Note:** *Precipitation projections have a high range of uncertainty.*

Tool Link: <https://crt-climate-explorer.nemac.org/>



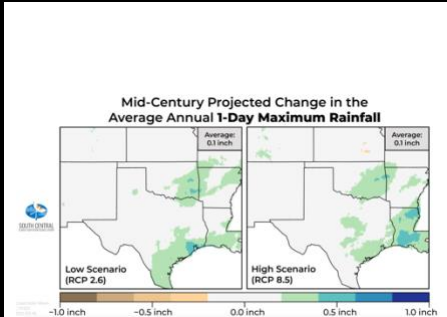
Precipitation Projections

(2036-2099)
South Central Climate Adaptation Science Center

This webpage includes several precipitation projections for the south-central U.S. during the mid-century (2036-2065) and end-of-century (2070-2099) time frames under low and high emissions scenarios.

1. The projections are grouped by mid-century and end-of-century. Scroll down to *Projected Change in the Average Annual 1-Day (or 5-Day) Maximum Rainfall* for the time frame you're interested in. **2.** The maps in the middle of the page show the projections under a low emissions scenario on the left and high emissions scenario on the right. The average value in the top right of each map represents the average for the entire region, so use the legend below the map to estimate the value for your area. **Note:** *Click the map to view a larger version.* **3.** On either side of the page is a text summary of the projections for both emissions scenarios. **Note:** *You can use these maps to view the range of projected values, as the future value will likely fall somewhere in between the low and high emissions scenarios.*

Tool Link: <https://southcentralclimate.org/resources/climate-projections/precipitation-projections/>



Heavy rainfall and flooding have always been part of Arkansas' climate. Annual precipitation has increased for all but east central Arkansas. The largest increase in rainfall has occurred in the fall and the largest decrease has occurred in the summer (Easterling et al. 2017). Heavy rainfall (the top 1% of annual events) in the Southeast U.S. increased by 27% between 1958 and 2016. Seasonally, precipitation is projected to slightly increase in winter and spring in Arkansas, and slightly decrease in summer and fall by the end of the 21st century. The projected seasonal changes are small compared to natural variations, however. Yet, scientific confidence is strong that there will continue to be an increase in the frequency and intensity of heavy rainfall events over the 21st century (Easterling et al. 2017), which increases the chance of flooding. Note that flooding is a locally complex phenomenon and can be exacerbated by human action (or inaction) as much as it can be caused by atmospheric conditions. Read more about future heavy rainfall and flooding in the resources found in Appendix C.

Lightning

Data Limitations: Historically, most lightning data have been proprietary; therefore, climatological records of the hazard are limited. However, a new NOAA satellite became operational in late 2017 and contains a significant technological advancement called the Geostationary Lightning Mapper (GLM). The GLM can detect the presence of total lightning, including in-cloud, cloud-to-cloud, and cloud-to-ground. While this advancement will not provide historical lightning data, it will add to the climatological record as time goes on.

Historical Data

Lightning Climatology Tool

(1995-2019)

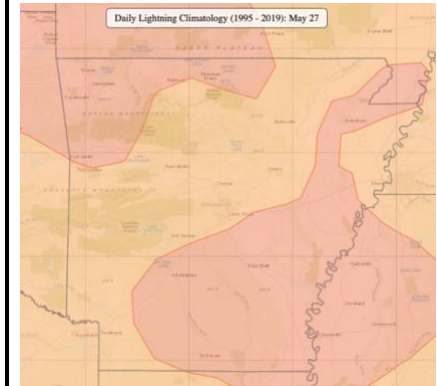
NOAA/National
Weather Service
Storm Prediction
Center

This tool provides a daily and hourly lightning climatology, showing the probability of at least one cloud-to-ground (CG) lightning strike occurring each day of the year or each 1-hour or 4-hour period throughout the day. It can be used to assess the time of day and time of year with the highest probability of CG lightning.

1. Zoom in to your area of interest on the map. **2.** The default map shows the daily (24-Hour) lightning probability on January 1, as indicated in the map title. To select a 1-Hour or 4-Hour climatology, hover your mouse over the *Lightning* tab at the top of the page and select *1-Hour* or *4-Hour*. To view other days or hours, move the horizontal scroll bar under the map. **Note:** the map title and scroll bar show hours in UTC format. **3.** Click your area of interest on the map to view the probability of CG lightning occurring on that day or hour for that area. **4.** Click the *Time Series* button within the pop-up box to view a graph of average CG lightning probability for your selected daily/hourly option. You can use this graph for a quick assessment of the time of year/day that location experiences the most CG lightning. Hover your mouse over the graph for details. **Note for hourly options:** the box shows local time, unlike the map title. The 4-hour graph will show the probability of at least one CG lightning strike occurring within a 4-hour window (e.g., the value for 12pm will show the probability of lightning occurring between 8am-12pm). **5.** If you selected the 1-hour or 4-hour option, click the *Heat Map* button within the pop-up box to view a graph of 1-hour or 4-hour lightning climatology by both day of year (horizontal axis) and time of day (vertical axis). Darker colors represent a higher probability. Hover your mouse over the graph to assess what time of year and day that lightning is more likely to occur in your area.

Tool Link:

<https://www.spc.noaa.gov/climo/dataviewer/?mode=climo&category=ltg&product=ltgday>



Annual and Monthly Distributions of Cloud-to-Ground Lightning

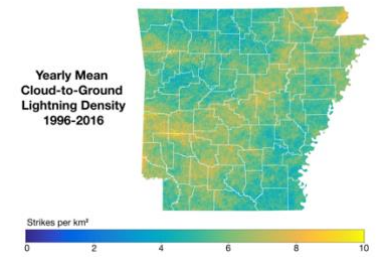
(1996-2016)

NOAA National Severe
Storms Laboratory/
Cooperative
Mesoscale
Meteorological
Studies

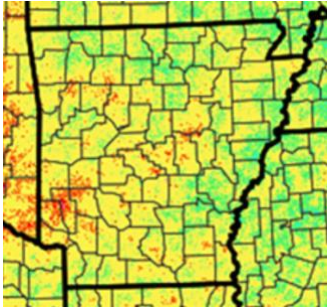
These static maps show the cloud to ground lightning density (strikes per km²) over Arkansas, averaged over the years 1996-2016. There are five maps on the website that display annual and seasonal (winter, spring, summer, and fall) densities.

1. Click on the link to access the *Arkansas Lightning Maps* pdf, hosted on SCIPP's website. **2.** Select lightning map(s) of choice from the following: *Yearly Lightning Density*, *Winter Lightning Density*, *Spring Lightning Density*, *Summer Lightning Density*, *Fall Lightning Density*. **3.** Analyze your lightning frequency based on county lines.

Tool Link: https://www.southernclimate.org/wp-content/uploads/AR_Lightning_Maps.pdf



Lightning (Continued)

Historical Data	<p>Vaisala Annual Lightning Report</p> <p>(Varies by year of report)</p> <p>Vaisala</p>	<p>This static report has been updated annually since 2017 and includes maps of average cloud-to-ground flash density and total lightning density for the previous 5-10 years in the U.S. It offers high-resolution local and county-level maps and information.</p> <p>1. Click on the link to access Vaisala's homepage. 2. In the search bar at the top of the page, type <i>annual lightning report</i> then click the button. 3. In the list of search results, scroll to find the most recent lightning report, such as <i>Annual Lightning Report 2020</i>. 4. Select your desired report and click the title to download the PDF. Scroll down the document to view U.S. Cloud-to-Ground Flash Density Maps in high resolution and aggregated by county.</p> <p>Tool Link: Vaisala.com</p>	
Future Trends	<p>Lightning is associated with thunderstorms, so as more favorable environments for thunderstorms are expected across the United States, increases in lightning are also projected. Studies have shown an increase in lightning associated with severe storms (Schultz et al. 2011). Climate models project an increase in the frequency and intensity of <i>severe</i> thunderstorms (Kossin et al. 2017), therefore, lightning occurrences are likely to increase. Confidence in the projections is currently low, however, due to the isolated and sporadic nature of lightning events and limited comprehensive datasets which make it difficult to track long-term trends (Wuebbles et al. 2017a).</p>		

Severe Thunderstorm Winds

Data Limitations: Population and temporal biases (i.e., greater number of reports in recent decades), a limited number of weather stations that record wind speed, and the fact that severe thunderstorm winds can be very localized, mean that data are not of sufficient quality to robustly determine whether there have been trends over a long period of time (e.g., 100+ years).

Historical Data

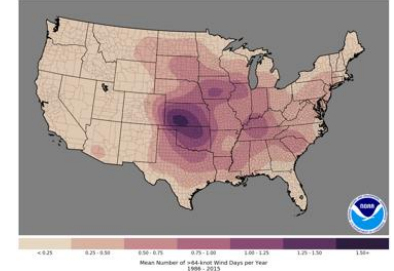
Severe T-Storm Wind Days Per Year (1986-2015)

NOAA/National Weather Service Storm Prediction Center

This map shows you the average number of days per year in which severe thunderstorm wind reports were received in your area. The map gives you a sense of the approximate number of days each year that you can expect to see severe thunderstorm winds (57 mph or greater) in your area.

1. Click on the link below to go to the website. **2.** Select any of the three *wind climatology* maps to view a larger image: *Greater Than 50 Knots & Less Than 64 Knots*, *Greater Than 64 Knots*, or *All Wind Greater Than 50-Knots*. **Note:** 50 knots is equal to 57 mph; 64 knots is equal to 73 mph.

Tool Link: <https://www.spc.noaa.gov/wcm/#30yrclimo>



Severe T-Storm Wind Reports

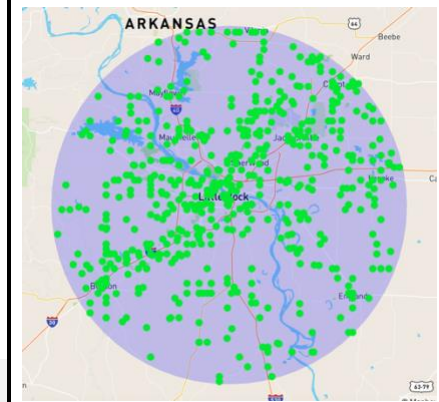
Wind: (1955-Present)

Southern Regional Climate Center

This interactive tool shows you the historical record for individual severe thunderstorm wind reports (gust of 57 mph or greater) in your area. It can be used to determine severe thunderstorm wind events that have impacted your area or close to your area.

1. On left side of screen, click on *Search within Radius*. **2.** Choose the diameter of the area of which you want to investigate (25 or 50 miles). **3.** Select *Wind* (de-select *Torn* and *Hail*). **4.** Pan, zoom, and then click on the map area of interest. **5.** Reports are displayed on the map and in two tables below the map. **6.** Map: Mouse over individual storm reports for details. **7.** Tables: There are two tables, *Recent Storm Reports* and *Historical Storm Reports*. Click on column header to sort by column of interest. For example, to view the dates in which the highest wind occurred, click on the *Scale* column headers to sort by the highest wind value.

Tool Link: <https://www.srcc.tamu.edu/storm-reports/>



Severe T-Storm Watch Climatology Map

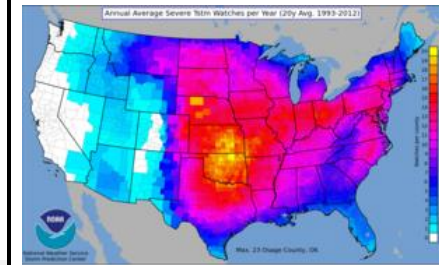
(1993-2012)

NOAA/National Weather Service Storm Prediction Center

This map shows you a 20-year climatology of severe thunderstorm watches. From this map you can get a sense of the approximate number of days each year you can expect to have a severe thunderstorm watch issued for your county(ies).

1. Under the *Storm Prediction Center WCM Page* banner near the top of the page, click on the *Watch Frequency Maps* link. **2.** Scroll down a bit until you see *20y SPC Watch Climatology*. **3.** Click on the *average number of severe thunderstorm watches per year* image to view it in larger form. **Note:** this WCM page contains a lot of other statistics about the hail, severe thunderstorm and tornado products that come out of the NWS Storm Prediction Center if you are interested in digging deeper into data.

Tool Link: <http://www.spc.noaa.gov/wcm/>



Future Trends

Damaging winds in Arkansas are associated with severe thunderstorms. More favorable environments for severe thunderstorms are expected and increases in severe wind occurrences are projected. Climate models project an increase in the frequency and intensity of severe thunderstorms in the United States. Uncertainty remains, however, in the assumption that the favorable environments will reach their potential of producing damaging winds (Kossin et al. 2017).

Tornado

Data Limitations: Tornado reports prior to around 1980 were compiled from written records. Consequently, many tornadoes may have gone unreported or multiple tornadoes may have been listed as a single track. Tornado tracking is unique as occurrences are recorded either by damage assessments or visual accounts (Kossin et al. 2017). Advanced radar technology, increases in population in rural areas, usage of video and social media, emphasis on documentation, and improvements in communication have resulted in an increase in the number of reports, especially among weaker (EF0-EF1) tornadoes. As these systematic biases are present, use caution when using long term trends as they are based solely on the number of reports.

Historical Data

Tornado Tracks Tool

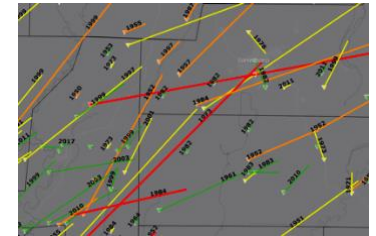
(1950-2021)

Midwestern Regional Climate Center

This is an interactive tool that shows historical tornado track details by track location or county. Consider nearby storm tracks, even if they did not hit your location, because small changes in storm motion can bring a tornado into your town.

1. Select area of interest either by zooming or entering a location into the search box. 2. Use panel on left side of screen to select variables of interest. Options include by *Magnitude*, *Year Range*, *Month*, and *Casualties*. 3. For more information, select either *Track* or *County* and click on area of interest on the map.

Tool Link: <http://mrcc.purdue.edu/gismaps/cntytor.htm#>



Tornado Risk Assessment

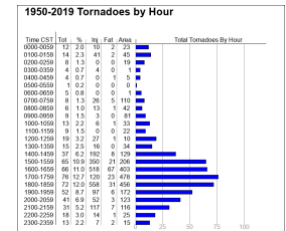
(1950-2019)

NOAA/National Weather Service Storm Prediction Center

This site is a series of graphs that shows tornado occurrences and statistics based on a given point. Statistics include F/EF scale frequency and probabilities of strikes occurring per month and time of day.

1. Click on black bar at top of page (bar includes location, radius and time period information) and provide zip code of interest. 2. Click *Run*. 3. Details about tornadoes that have occurred within selected area are displayed on page.

Tool Link: <https://www.spc.noaa.gov/climo/online/probs/?zip=72002&rad=100>



Tornado Days Maps

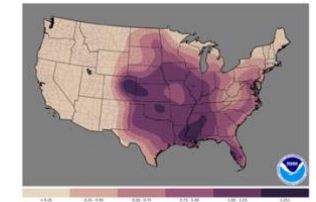
(1986-2015)

NOAA/National Weather Service Storm Prediction Center

These static maps show the average number of tornado days per year for all magnitudes (separate maps show EF1+, EF2+ and EF4+ days) within 25 miles of any point from 1986-2015. Tornado frequencies at a given location can be compared to nearby and regional locations.

1. Click on the link below to go to the website. 2. Select any of the four *Tornado Climatology* maps to view a larger image: *All Tornado Days*, *EF1+*, *EF2+*, or *EF4+ Tornado Days*.

Tool Link: <https://www.spc.noaa.gov/wcm/#30yrclimo>



Tornado Watch Climatology Map

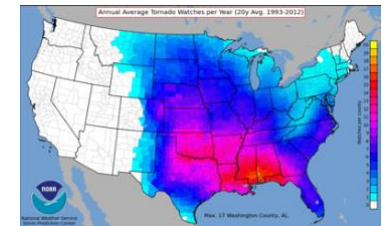
(1993-2012)

NOAA/National Weather Service Storm Prediction Center

This map shows you a 20-year climatology of tornado watches. From this map you can get a sense of the approximate number of days each year you can expect to have a tornado watch issued for your county(ies).

1. Under the *Storm Prediction Center WCM Page* banner near the top of the page, click on the *Watch Frequency Maps* link. 2. Scroll down a bit until you see *20y SPC Watch Climatology*. 3. Click on *Average number of tornado watches per year* image to view it in larger form. **Note:** This WCM page contains a lot of other statistics about the hail, severe thunderstorm, and tornado products that come out of the NWS Storm Prediction Center if you are interested in digging deeper into data.

Tool Link: <http://www.spc.noaa.gov/wcm/>



Future Trends

Records over the past 40 years show that there has been an increase in the frequency of days with a large number of tornadoes (i.e., tornado outbreaks) and an eastward shift in locations (Gensini and Brooks 2018). However, there has also been a decrease in the frequency of days with tornadoes (Kossin et al. 2017). In other words, increasingly, when tornadoes occur, they are more likely to occur in conjunction with a tornado outbreak. It is currently difficult to account for tornadoes in climate models because they occur on a very small scale. Therefore, more research is needed to understand how climate change is influencing tornadoes (Walsh et al. 2014). Progress has recently been made, however, in understanding how the large-scale climate system relates to the conditions that support tornadoes. As such, climate models project an increase in the frequency and intensity of severe thunderstorms, which can include tornadoes. However, confidence in the details of this projected increase remains low (Kossin et al. 2017).

Wildfire

Data Limitations: A systematic, national collection of wildfire reports did not begin until the early 1990s. Many analyses are based on only a few years of data, which may not capture multi-year variability or trends. Further, fires accounted for by local jurisdictions may not always translate into national databases.

Historical Data

Wildland-Urban Interface

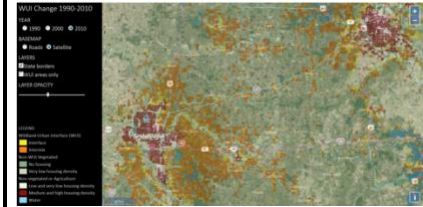
(1990, 2000, 2010)

University of Wisconsin Spatial Analysis for Conservation and Sustainability Lab

This interactive tool shows WUI (Wildland-Urban Interface) in 1990, 2000, and 2010 for locations of interest.

1. Zoom into desired location(s) on map. **2.** On left side of screen, select *year* → *base map* → and *layer opacity* of interest. **Note:** Arkansas-specific data and map files (down to the county level) are available by scrolling down the page.

Tool Link: <http://silvis.forest.wisc.edu/data/wui-change>



Southern Wildfire Risk Assessment Portal

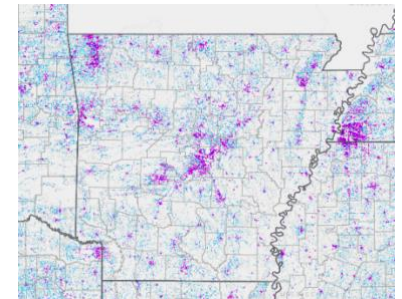
(Wildfire Ignition Density: 1997-2002; other layers based on various risk assessments)

Southern Group of State Foresters

This interactive tool can be used to identify areas within and/or near a city that are at greatest risk of wildfire. It is especially useful for identifying risk areas in the wildland-urban interface and to help prioritize areas where tactical analyses, community interaction, or mitigation treatments might be necessary to reduce risk. **Note:** There is a learning curve associated with this tool and it requires Flash. Public Viewer accessible to anyone. Professional Viewer is also free but requires account request.

1. Click on the link and select *Public Viewer* near the bottom of the screen. **2.** Pan and zoom-in on the map to area of interest. **3.** Click on *Map Themes* in the upper left-hand corner. **4.** Under the *Wildfire Risk* section on the left side of the screen, select the layer you want to view. Details about each layer can be found by hovering over the circular “i” icon. **5.** Pan and zoom-in or -out on map as needed. **Note:** Data are displayed at a very fine (25-meter) resolution.

Tool Link: <https://www.southernwildfirerisk.com/>



Wind Rose Plots

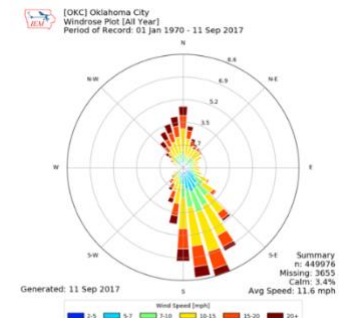
(Period of record varies by station; up to ~80 years)

Iowa Environmental Mesonet

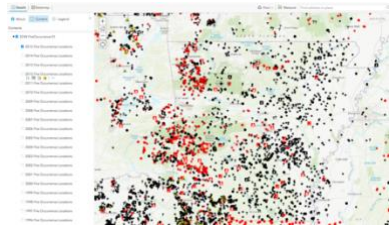
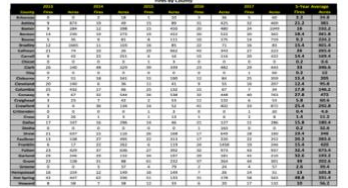
View common and prominent wind speeds and directions for your area. Plots can be viewed either by month or by the full years on record. This tool can be used to describe general climate and the predominant direction in which air pollutants flow. It may also be useful for understanding how wildfire events may evolve or play out in a community.

1. In the *Select By Network* section, choose *Arkansas ASOS* then click *Switch Network*. **2.** Select station of interest, either from list or map, then click *Select Station*. **3.** You will be brought to a new page. Near the top of the page, click on the *Wind Roses* tab. **4.** Yearly climatology is displayed at the top of the page, monthly climatologies are displayed below that.

Tool Link: <https://mesonet.agron.iastate.edu/sites/locate.php>

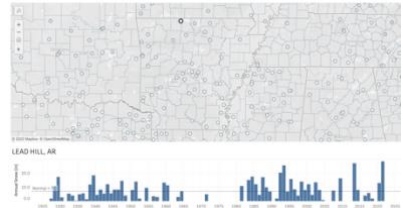
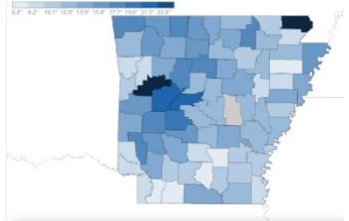



Wildfire (Continued)

Historical Data	<p>National Interagency Fire Occurrence (1992-2018) K. C. Short/ U.S. Department of Agriculture Forest Service</p>	<p>This interactive tool can be used to show locations of reported fire occurrences between 1992-2015, in and near a county or city. Individual years can be viewed to determine relative risk. Many fires in urban areas are not reported to the U.S. Forest Service database, however, so it may under-represent fire risk in urban areas. Note: <i>There is a learning curve associated with this tool and it is helpful to use a larger computer screen because of the amount of data shown.</i></p> <p>1. Click on the <i>Map View</i> link below. 2. Next to <i>View In</i>, click <i>ArcGIS Online map viewer</i>. A new internet browser window will open. 3. On the left side of the screen, under <i>Contents</i>, expand <i>EDW FireOccurrence 01</i> by clicking the arrow to the left of the name. Make sure you click on the top <i>EDW FireOccurrence 01</i> with the triangle next to it, not the bottom one. 4. Select year(s) of interest or <i>All Years</i> (last in the list). 5. Zoom in on map if data are not shown. 6. To view Arkansas fires only, hover mouse over year of choice and click on the flashlight (filter) icon. 7. Select <i>STATE</i> in left drop-down menu → In far-right box enter <i>AR</i> → Click <i>APPLY FILTER</i>. 8. A table containing the details of each fire can be viewed by clicking the table icon (two icons left of the flashlight icon). 9. The map symbols represent varying causes of wildfire occurrences. To view the legend, click on the legend button directly above and to the far right of <i>Contents</i>. 10. To view data on an individual fire, click on the fire symbol of interest, then in the top right-hand corner of the table, click on the three horizontally lined tab and select <i>Center on Selection</i>. Details of the selected fire will be displayed in the table. 11. Refer to the paper linked below for table column definitions. Note: <i>Additional filters can be applied by clicking on the flashlight icon again and choosing desired selections (e.g., The column <i>STAT_CAUSE_DESCR</i> describes the cause of the fire).</i></p> <p style="text-align: center;">Map View: https://apps.fs.usda.gov/arcx/rest/services/EDW/EDW_FireOccurrence5thEdition_01/MapServer Original Paper (open access): https://www.fs.fed.us/rm/pubs_other/rmrs_2014_short_k001.pdf</p>	
	<p>Fires by County (2013-2019) Arkansas Department of Agriculture</p>	<p>This table displays the frequency of fires and acres burned, per county in Arkansas, for the years 2013-2019. Also displayed is the average for both variables, per county. This tool can be used to assess the trends and averages for wildfire size and occurrence over the recent years.</p> <p style="text-align: center;">Tool Link: https://www.agriculture.arkansas.gov/wp-content/uploads/2020/05/Wildfire_By_County.pdf</p>	
Future Trends	<p>Wildfires in Arkansas are dependent upon weather conditions, seasonal climate patterns, vegetation conditions, and an available source for ignition (such as a spark, flame, or intentional). The frequency and number of acres burned across the state has decreased over the last 50 years. Those trends may partially be attributed to the increase in volunteer fire departments, who often respond to fires quickly and reduce the acreage, and an underreporting of smaller fires, which are not always accounted for in the national database (AAD 2018). Little is known how climate change may affect wildfire conditions across Arkansas, given its complex relationship. However, projected increases in temperatures that can dry fine fuels such as grasses and enhanced wet/dry cycles that promote vegetation growth and drying or dormancy, coupled with population growth along the wildland-urban interface, suggests the risks of wildfires is likely to increase. Read more about future wildfire risk in the resources found in Appendix C.</p>		

Winter Storm (Ice, Sleet, Snow)

Data Limitations: Ice storm/freezing rain data are very limited due to the complexity of observational accounts (e.g., rain, freezing rain, and snow can occur at a single station during a single event).

Historical Data	<p>Snowfall Climatology Toolbox</p> <p>(Period of record varies by station; ~30-140 years)</p> <p>Midwestern Regional Climate Center</p>	<p>This interactive tool shows normal (1991-2020) annual and monthly snowfall, average annual number of days with snow totals at certain thresholds, average first and last snow date, and record 1-day snowfall. The map displays normal values while the graph below it shows the variable by year.</p> <p>1. Position map to area of interest or choose AR in the <i>State Selection</i> drop-down menu on the right. 2. On the top of the screen, select a variable you're interested in (e.g., <i>Annual Snowfall</i>). Some variables have options on the right side of the screen to select, such as a month to display for monthly snowfall or a snow threshold. 3. For most variables, the map displays the normal/average value for the variable you selected. For <i>Record 1-Day Snowfall</i>, it shows the record value at each point. The legend for the colored points is on the top-right side of the screen. 4. The graph below the map shows more details, such as the values per year instead of an average. Note: <i>The map default shows stations with data from at least 1991-2020. If you'd like to see longer time frames, you can move the slider under the Data Available Since option on the right. When you select a different start year, it will only show stations with available data.</i></p> <p>Tool Link: https://mrcc.purdue.edu/mw_climate/snowfallClimatology/snowfallClimatology.html</p>	
	<p>Snowfall Extremes</p> <p>(Period of record varies by location; up to ~140 years)</p> <p>NOAA National Centers for Environmental Information</p>	<p>This interactive static map shows the 1-Day, 2-Day, and 3-Day snowfall maximums by county.</p> <p>1. Select the day(s) of interest on the top right side of the map. 2. Mouse over county of interest for information on the maximum snowfall event on record. 3. A table below the map shows location (by county and station), date of event, and snowfall total details.</p> <p>Tool Link: https://www.ncdc.noaa.gov/snow-and-ice/snowfall-extremes/AR</p>	
	<p>Ice Storm Climatology</p> <p>(1948-2000)</p> <p>Changnon and Karl, 2003 (open access)</p>	<p>These are static images within a scientific report. Shows the average annual number of days with freezing rain (Fig. 2) and month of highest average number of freezing rain days (Fig 9). For reference when viewing these figures, Arkansas typically sees 1-4 freezing rain events per year, most commonly in January.</p> <p>To view, 1. Click on the <i>Full Text</i> tab and scroll to the bottom of the page. 2. View full sized images of Fig 2. and Fig. 9 by clicking on respective images.</p> <p>Figures in <a href="https://doi.org/10.1175/1520-0450(2003)042<1302:TASVOF>2.0.CO;2">https://doi.org/10.1175/1520-0450(2003)042<1302:TASVOF>2.0.CO;2</p>	
Future Trends	<p>Years consisting of a large number of snowfall days declined across the southern United States between 1930 and 2007 (Easterling et al. 2017). Models suggest that although the number of snowfall events will likely continue to decrease given overall atmospheric warming, when snow does occur, accumulations will be greater due to increases in atmospheric moisture (Krasting et al. 2013). There is significant uncertainty surrounding the future of ice storms in Arkansas. Observational data limitations and the complexity of the events themselves make it difficult to determine with much specificity whether patterns have and/or will change. Models show that by mid-century there will generally be a northward shift of the rain, sleet, and snow dividing line across the central and eastern United States. This shift will add to the complexity of determining precipitation type for winter events (rain, ice or snow) in Arkansas, however, the increase in atmospheric moisture may bring an increase to the amount of precipitation that does fall (Easterling et al. 2017).</p>		

Dam or Levee Failure

Data Limitations: The tools below do not provide dam or levee failure information but rather information on the locations of and pertinent details about dams and levees in Arkansas. The dam inventory is limited to dams with a height of at least 25 feet and exceed 15 acre-feet in storage or at least 50 acre-feet of storage and exceed six feet in height. The state of Arkansas regulates all dams that have a height of 25 feet and storage of 50 acre-feet.

Historical Data

National Inventory of Dams by State

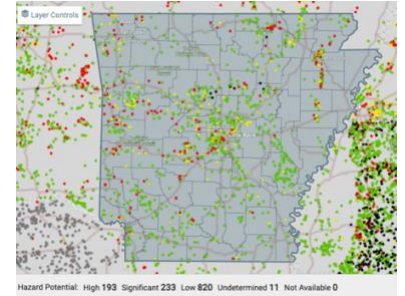
(1900-present)

U.S. Army Corps of Engineers

This tool provides you with an overview of the dams in Arkansas, including the number by hazard potential, height, owner type, primary type, primary purpose, and completion date.

1. On the drop-down menu to the left of the map, select *Arkansas*. For specific counties, you can then select a county within Arkansas from the same menu. 2. The map then zooms in to Arkansas and shows all dam locations. A summary of dams in the state are visible on the top of the results page. 3. To view dams by hazard potential, click the *Layer Controls* button on the top left of the map, then click *Categorize by* and choose *Dams by Hazard Potential*. The number of dams in each category are shown under the map. Other categories can be mapped as well. 4. Click *Browse These Dams* above the map to access a list of dams with more information.

Tool Link: <https://nid.sec.usace.army.mil/>



National Inventory of Dams – Dam Details

(1900-present)

U.S. Army Corps of Engineers

This tool allows you to view the details of individual dams within the state of Arkansas.

1. At the top of the page, click on the *Advanced Search* tab. 2. On the top left of the page in the *Location* box, select *State* for the *Geography Type*, then type *Arkansas* in the space below. Click *UPDATE RESULTS* above this area. 3. Click the *DAM DETAILS* tab near the top of the page to access a chart of all Arkansas dams and associated information. 4. Choose which columns to display by clicking *Columns*, then select/de-select the columns as needed. 5. To sort by column, click the arrow to the right of the column header. **Note:** You can narrow results by selecting additional options on the left of the page (such as *Hazard Potential Classification* to view high hazard dams). Click *UPDATE RESULTS* for any changes made to update the list.

Tool Link: <https://nid.sec.usace.army.mil/>

Dam Name	NID ID	Hazard Potential Classification	SMP Prepared
Bull Shoals Dam	AR00140	High	Yes
Greene Ferry Dam	AR00173	High	Yes
Hayfork Dam	AR00155	High	Yes
Wabash Mountain Dam	AR00152	High	Yes
Reaser Dam	AR00174	High	Yes
Lake Ft Smith Dam	AR00445	High	Yes
Harmon Dam	AR00154	High	Yes
Deepman Dam - Subdike C	AR01201	High	Yes
Deepman Dam - Subdike A	AR01201	High	Yes
Deepman Dam - Subdike B	AR01201	High	Yes

National Levee Database

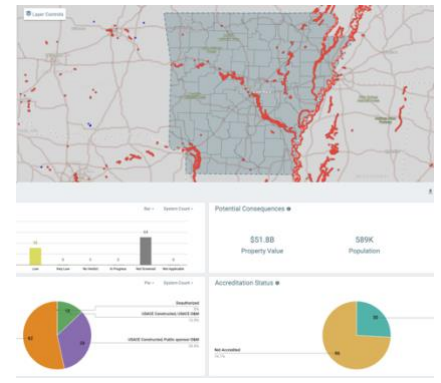
(Levee Inventory: 1882-present)

U.S. Army Corps of Engineers

This tool allows you to explore levees in your area, including location, year constructed, length, number of people and structures at risk should failure occur, property values in the risk area, and more.

1. At the top of the page, click *Dashboard*. 2. On the left drop-down menu, click *Arkansas*. 3. The results page shows a map of all Arkansas levees, and the dashboard provides information about systems at risk, potential consequences, authorization type, and other measures. A summary of levees in the state are visible above the map. 4. Explore the map as you see fit or click on the county of interest on the left side of the page to update the dashboard. 5. To view more details about each levee, click *BROWSE THESE LEVEES* above the map. 6. Click the *DETAILS* tab near the top of the page to access a chart of all Arkansas levees and associated information. 7. Choose which columns to display by clicking *Columns*, then select/de-select the columns as needed. 8. To sort by column, click the arrow to the right of the column header. **Note:** You can narrow results by selecting additional options on the left of the page (such as *Authorization Category*). Click *UPDATE RESULTS* for any changes made to update the list.

Tool Link: <https://levees.sec.usace.army.mil/>

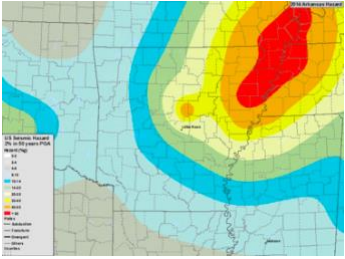
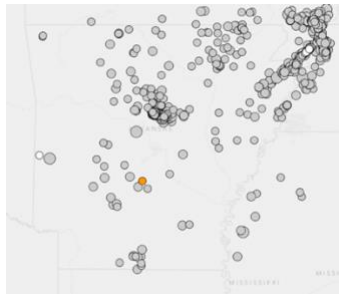

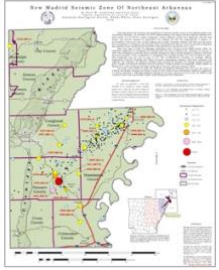


Future Trends

Increases in extreme rainfall (Easterling et al. 2017) may increase the likelihood of dam failure, however, this is highly dependent upon the quality of the structures. Most dams are at or near their 50 year design life, so the probability of failures increases with time. Dams that are not well maintained have an increased likelihood of failure. Washed out spillways, deteriorated primary spillway conduits, collapsed riser structures, and slope instability can lead to a dam breach. However, dam failures across Arkansas are few since owners are required to perform routine inspections and maintenance (ANRC 2018).

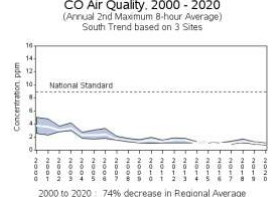
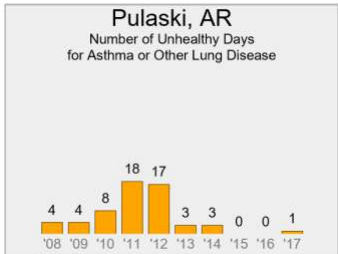
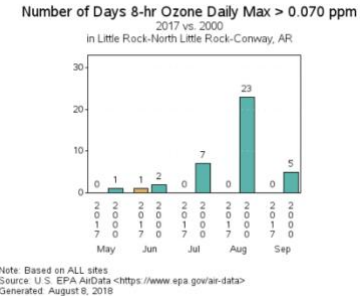
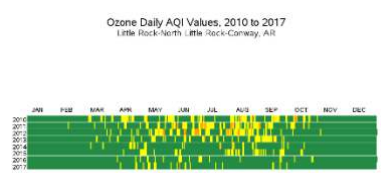
Earthquake

Data Limitations: Globally, scientific understanding of earthquake processes is somewhat limited, and the available history of seismicity is typically too short to establish reliable spatiotemporal patterns of large earthquake occurrences (Stein et al. 2012).

Historical Data	Arkansas Seismic Hazard Map (2014) U.S. Geological Survey	<p>This static map shows the probabilistic peak earthquake ground acceleration with a two percent probability of exceedance in 50 years. This map consists of the most current assessment of earthquake acceleration probabilities and can be used when assessing potential seismic provisions.</p> <p>1. Using the legend on the left, identify area of interest and associated probability risks.</p> <p>Tool Link: https://www.usgs.gov/media/images/2014-seismic-hazard-map-arkansas</p>	
	Earthquake Catalog (Period of record varies by location; up to ~70 years) U.S. Geological Survey	<p>Shows past earthquakes on a zoomable map and can be used to show previous occurrences.</p> <p>1. Under <i>Basic Options</i>, select the Magnitude, the Date and Time, and the Geographic Region to plot. You can select a <i>Custom Geographic Region</i> and draw a rectangle over Arkansas by using the + button to zoom to the state. 2. Click <i>Search</i>. 3. A map with all earthquakes meeting your chosen criteria are shown and a list of earthquakes are on the left of the page. 4. View the map legend by clicking the key icon on the top right of the map area. To learn more about specific events, click any point on the map or select an event from the list. You can also sort by date or magnitude.</p> <p>Tool Link: https://earthquake.usgs.gov/earthquakes/search/</p>	
	Arkansas Earthquake Information Page U.S. Geological Survey	<p>Additional information about earthquakes in Arkansas. Click on links of interest.</p> <p>Tool Link: https://www.usgs.gov/natural-hazards/earthquake-hazards/science/information-region-arkansas?qt-science_center_objects=0#qt-science_center_objects</p>	
	New Madrid Seismic Zone of NE Arkansas (Last Update: 2008) Arkansas Geological Survey	<p>This map shows locations and magnitudes of earthquakes in the New Madrid seismic zone of Northeast Arkansas.</p> <p>1. View map on screen. 2. Legend and associated information are found on the PDF.</p> <p>Tool Link: https://www.geology.arkansas.gov/docs/pdf/maps-and-data/geohazard_maps/new-madrid-seismicity-map.pdf</p>	
Future Trends	<p>Between 1811-2013, Arkansas experienced on average 1-2 earthquakes per year that were magnitude 3.0 or greater. Additionally, the state often experiences smaller magnitude earthquakes per year, although they are often not felt. The state lies within the New Madrid seismic zone (NMSZ), an active earthquake zone that has produced some of the largest earthquakes within the continental borders. The NMSZ has experienced recent seismic events as late as 2005 and is still considered active and is potentially capable of generating powerful earthquakes (AGS 2015).</p>		

Poor Air Quality (Dust, Pollutants, Smoke)

Data Limitations: Geographical and spatial gaps exist, especially in rural areas. However, areas distant from monitoring stations typically experience consistently good air quality. Also, there is no single air pollutant relevant to every discussion, so there is no single way to express air quality (Tracking California 2021). Monitoring frequency varies by pollutant (e.g., carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead). Tools often display data for the five air pollutants that make up the Air Quality Index (AQI): carbon monoxide, nitrogen dioxide, ozone, particulate matter (PM10 and PM2.5) and sulfur dioxide.

Historical Data	Air Trends (Period varies by pollutant; up to 1980-2021) U.S. Environmental Protection Agency	This static image displays the annual national and regional trends for the 5 AQI pollutants as well as for lead. 1. To obtain graphs, scroll down page slightly and click on pollutant link of interest in the <i>Air Quality Trends</i> section on the left side of the page. 2. Scroll to the bottom of the page to the <i>Regional Trends</i> Section. 3. Select South from the list. 4. Graph will display on the bottom of the page. AR_airtrends Tool Link: https://www.epa.gov/air-trends	
	Air Compare (2012-2021) U.S. Environmental Protection Agency	This interactive map displays county-based trends for the five AQI air pollutants that may affect human health. For data limitations specific to this tool, including the pollutants that are accounted for in the analyses, click on the <i>Basic Info</i> tab at the top of the page, then <i>Data Limitations</i> on the right side of the page. Note: For information on the predominant directions in which air pollutants flow, refer to the <i>Wind Rose Plots</i> tool in the <i>Wildfire</i> section, p.20. 1. Scroll down until you see the U.S. map. 2. In the upper left-hand corner of the map, click on <i>Trends</i> , then select group of interest. 3. Click county of interest to obtain graph of annual statistics. 4. For data broken down into months, click on <i>Seasons</i> in upper left-hand corner, then select group of interest. Tool Link: https://www3.epa.gov/aircompare/#trend	
	Ozone Exceedances (1980-present) U.S. Environmental Protection Agency	This interactive graphing tool compares 8-hour ozone exceedances between two years or multi-year periods for a city or county. Comparisons are shown by day, month and year. The ozone exceedance level for this tool is 0.070ppm. 1. Under <i>Geographic Area</i> , select a City or County (Arkansas cities listed: Arkadelphia, Fayetteville-Springdale-Rogers, Fort Smith, Harrison, and Little Rock-North Little Rock-Conway) 2. Under <i>Baseline Period</i> , select either a single year or a multi-year period and the year(s) in which you are interested. 3. Under <i>Comparison Period</i> , select either a single year or a multi-year period and the year(s) in which you are interested in. 4. You may need to uncheck <i>Use ALL Monitors</i> when comparing time periods if data aren't available for both periods. 5. Click <i>Plot Data</i> Tool Link: https://www.epa.gov/outdoor-air-quality-data/air-data-ozone-exceedances	
	Outdoor Air Quality Data (Period varies by pollutant; up to 1980-present) U.S. Environmental Protection Agency	This multiyear tile plotting tool shows the daily AQI pollutant values for a specific location or time period. Each tile represents one day of the year and is color-coded based on the AQI level for that day. 1. Under <i>Pollutant</i> , select pollutant of choice. (ex: Ozone, All AQI Pollutants) 2. Under <i>Period</i> , select a beginning and ending year 3. Under <i>Geographical Area</i> , select a city or county (Note: cities available are listed in the <i>Ozone Exceedances</i> tool above; will depend on each pollutant) 4. Click <i>Plot Data</i> . Tool Link: https://www.epa.gov/outdoor-air-quality-data/air-data-multiyear-tile-plot	
Future Trends	Arkansas generally meets all federal air quality standards for criteria pollutants (UA 2023). However, the EPA's Cross-State Air Pollution Rule Update from 2022 requires Arkansas's power plants to reduce nitrous oxide emissions that can cross state lines and contribute to ground-level ozone (EPA 2022). Hotter temperatures can increase the formation of ground-level ozone, which has a variety of health effects including asthma and respiratory problems (EPA 2016). Ground-level ozone pollution is projected to increase across Arkansas due to warming summer temperatures (Carter et al. 2014). Air quality may also worsen during wildfire periods (EPA 2016). Continued technological innovation and enforcement of federal regulations should result in additional air quality improvement (ODEQ 2018).		

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Appendix A - Hazard Definitions

Cold Extremes

Definition: A cold wave is generally characterized by a sharp and significant drop of air temperature near the surface (maximum, minimum, and daily average) over a large area and persisting below certain thresholds for a localized minimum number of days (WMO 2016).

Note: There is no universally-recognized metric for what constitutes a cold extreme. The World Meteorological Organization recommends characterizing a cold wave by its magnitude, duration, severity, and extent. Magnitude is defined as a temperature drop below certain threshold(s), either as an absolute value or percentiles. These values must be determined by the local climatology.

Description: Cold extremes occur when polar and arctic air is displaced from polar regions toward the equator. The lack of sunlight in polar regions during winter allows the buildup of cold, dense air. Wiggles in the jet stream allow equator-ward (southward in the Northern Hemisphere) transport of cold air into the continental United States. High-amplitude jet-stream patterns (a series of large troughs and ridges in the upper atmosphere around the globe) allow air masses to move from their source regions.

Drought

Definition: A deficiency of moisture that results in adverse impacts on people, animals, or vegetation over a sizeable area (NWS 2009).

Description: Drought impacts vary based on the duration and intensity of the event. A few dry weeks may affect crops and lawns, while droughts lasting months or years may significantly impact large water resources. At its extreme, nearly decade-long droughts may lead to farm and business foreclosures and mass migration. Some conditions that may lead to drought development include a large-scale, stationary high-pressure system which inhibits precipitation, feedback from dry soils accelerating warming of the air, La Niña which displaces jet streams, or large-scale ocean circulations in the Pacific and Atlantic Oceans. Droughts may happen in any location and at any time of year. Impacts often become severe more quickly for drought occurring during the summer, when evaporative loss is high; however, slower-evolving droughts in the fall and winter can have tremendous economic impacts on winter crops and livestock. Droughts are more frequent in areas where annual evaporation may exceed annual precipitation.

Drought is rated by the weekly U.S. Drought Monitor (2018) on a scale from D0 (abnormally dry) to D4 (exceptional drought). D0 occurs, on average, in any given location about 21-30% of the time. D1, moderate drought, occurs on average 11-20% of the time, or roughly once every 5-10 years. D2, severe drought, occurs 6-10% of the time, or about every 10-20 years. D3, extreme drought, occurs 3-5% of the time and D4, exceptional drought, occurs 0-2% of the time, or about every 50 years. Severity is based upon a variety of drought indicators, impacts, and input from local experts.

Hail

Definition: Showery precipitation in the form of irregular pellets or balls of ice more than 5mm (0.2 inches) in diameter, falling from a cumulonimbus cloud (NWS 2009).

Description: Hail forms by the collision of supercooled drops – raindrops that are still liquid even though the air around them is below freezing. The hailstone grows, supported by the updraft, until it is too heavy to remain aloft. Stronger updrafts generally produce larger hail size. Because obtaining large hail sizes requires a strong updraft, the timing of large hail is related to the lifecycle of large cumulonimbus clouds, which peak in intensity during late afternoon and evening hours. Updrafts may also be supported by vertical motion along a boundary, such as a front or mountains.

Hail severity is rated by the diameter of the largest hailstones in a storm. Hail of 1-inch diameter or greater is considered severe.

Heat Extremes

Definition: A heat wave is an occurrence of unusual hot weather (maximum, minimum, and daily average) over a region persisting at least two consecutive days during the hot period of the year based on local climatological conditions, with thermal conditions recorded above given thresholds (WMO 2016).

Note: There is no universally-recognized metric for what constitutes a heat extreme. The World Meteorological Organization recommends characterizing a heat wave by its magnitude, duration, severity, and extent. Magnitude is defined as a thermal measurement such as maximum temperature, or combination of several measurements, exceeding certain threshold(s). These values must be determined by the local climatology. Other studies have used thresholds based on human physiological response to heat, such as consecutive days of maximum or minimum temperatures above a threshold.

Description: Heat extremes in the central United States occur when a dominant large-scale high-pressure system prevents movement of other air masses into a region. The high-pressure contributes to intense heating from solar radiation, due to a lack of cloud cover, and light winds preventing the dispersion of heat, especially from urban areas. This results in both higher than average maximum and minimum temperatures.

Heavy Rainfall and Flooding

Definition: Heavy rainfall is rain with a rate of accumulation exceeding a specific value that is geographically dependent (AMS 2012). Flooding is any high flow, overflow, or inundation by water which causes or threatens damage (NWS 2009).

Description: Heavy rainfall is a subjective term, but is rain falling at a rate more than the underlying surface can handle, causing runoff, inundation of low-lying areas, and flooding. This may include short-duration thunderstorms lasting a few hours or rainfall accumulating over several days. Flooding is the result of heavy rainfall but also the underlying surface. The rate of infiltration (how quickly it is absorbed by the soil), how quickly runoff reaches the creeks and rivers, if there had been prior rainfall, if the ground is frozen, and other local factors affect runoff and flooding. Consequently, a rainfall of a given rate and amount may cause flooding in one circumstance but not in another. Flooding is most likely in low-lying areas, along the edges of water bodies (ponds, lakes, rivers), and over impermeable surfaces (such as streets and parking lots). Primary causes include slow-moving thunderstorms and storms that track over a location in rapid succession, or tropical systems. Flash flooding may occur with intense thunderstorms while river flooding usually requires rainfall accumulated over a longer duration.

Rainfall accumulations may be compared against previous occurrences through the concept of “return-period values”. This is a statistical assessment of the frequency with which similar amounts have been recorded in the past at a specific location. These return periods, such as 1 in 25 years (a 4% chance of occurring in any given year), are not predictive tools – a large event occurring in the recent record does not prevent another similar or larger event occurring shortly after. Also, if heavy rainfall has already occurred, stormwater retention systems may be filled to capacity allowing a smaller event to cause flooding impacts similar to a much larger event. Rainfall rates and accumulations are usually greatest during the spring, summer, and fall, when warm air can hold more water vapor to produce greater rain rates. River flooding is most likely in spring or fall, when fronts may stall giving a focus for thunderstorm development. Tropical systems, either from the Gulf of Mexico or from the Pacific Ocean, can produce among the highest rainfall rates in the state.

Lightning

Definition: A visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground or between the ground and a cloud (NWS 2009).

Description: Lightning forms from charge separation within thunderstorms, usually cumulonimbus clouds. Lightning is essentially a large spark of static electricity, similar to touching a doorknob on a dry day (although much more powerful). Most lightning forms from streamers that work their way down from the charge centers of clouds toward the ground. When it gets close to the ground, a return stroke is initiated, which we see as a flash of light. Thunder is created by a shock wave from rapid heating of the air to 18,000 degrees – hotter than the surface of the sun.

Lightning is capable of striking as far as 10 miles away from a storm. Distance can be estimated by counting the seconds between the flash and the sound of thunder. It takes 5 seconds for the shockwave to travel one mile. Lightning severity is not rated, although new detection systems allow accurate identification of lightning strikes allowing analysis of lightning frequency.

Tornado

Definition: A violently rotating column of air, usually pendant to a cumulonimbus, with circulation reaching the ground. (NWS 2009)

Description: Tornadoes generally form from severe thunderstorms, particularly supercell thunderstorms – those that are isolated with unimpeded inflow of moisture and enhanced by wind shear. Tornadoes may also form along squall lines or in bands of storms associated with hurricanes. Tornadoes require moist air, instability (warm air rising), a source of lift such as a front, dryline, or heating, and wind shear (change in wind direction and speed with height).

Tornadoes can occur at any time of the year in Arkansas and at any time of the day. Arkansas experiences an uptick in tornadoes in the spring, but they also see tornadoes in the fall and winter as the jet stream moves toward the south.

Tornado intensity is rated by the damage they produce, on a scale from EF0 (weak) to EF5 (violent). Strong (EF2-EF3) and Violent (EF4-EF5) tornadoes account for only about one-third of all tornadoes, but 97% of fatalities and the vast majority of economic impacts. Tornadoes along squall lines and hurricane bands are more likely to be weak, although widespread severe straight-line winds may accompany these types of storms.

Wildfire

Definition: Any free burning uncontrollable wildland fire not prescribed for the area which consumes the natural fuels and spreads in response to its environment (NWS 2009).

Description: Wildfires occur when weather conditions meet with sufficient fuel and an ignition source. Weather conditions include warm temperatures, low humidity, strong winds, and a period without precipitation allowing fuels to dry. Fuels are vegetation ranging from fine fuels such as grass and pine needles to large woody materials such as trees, dead and decaying logs, and organic material in the soil. Large woody materials are difficult to ignite; the presence of fine fuels allows fire to get started and become intense enough to ignite larger materials. Ignition sources may be natural such as lightning or human-caused such as sparks from equipment, power transformers, a chain dragging behind a vehicle, or heat sources such as discarded cigarettes.

Usually wildfires occur when the state experiences a drought, but they can still happen at any time. Fires are a common occurrence during a drought when dried vegetation provides fine fuels and warm, windy, dry days provide weather conditions that allow ignition and spread. Summer has higher temperatures that can allow fires to become very intense, but there is typically less wind and consequently less spread. Fire spread may be increased on south-facing slopes, which are usually drier and warmer because of exposure to the sun, windy locations such as canyons, and along steep slopes. Very intense fires may become “crown fires” if they burn to the tops of trees, allowing embers to spread farther and create spot fires. Crown fires are almost impossible to extinguish without cooler, wetter weather conditions.

Fire danger is measured on a Burning Index scale, ranging from 0 to 110+. Values below 20 are considered low fire potential, 40-80 is high, and 110 or higher is extreme. The burning index combines potential energy release (fire intensity), flame length, and rate of spread. The National Weather Service issues Red Flag Warnings when weather conditions are favorable for ignition and spread of wildfires. Another popular index is the Keetch-Byrum Drought Index (KBDI) that considers weather and vegetation conditions. The scale ranges from 0 to 800; values below 200 indicate high fuel moisture making ignition unlikely; values above 600 are indicative of intense wildfire conditions with any that develop capable of downwind spotting (starting new fires).

Winter Storm (Ice, Sleet, Snow)

Definition: A winter storm is a winter weather event that produces impactful accumulations of freezing rain (ice), sleet, and/or snow (NWS 2018).

Description: Winter storms may include heavy snowfall, blowing and drifting snow, high winds, extreme cold, or ice storms. Among the greatest hazards associated with winter storms are traffic accidents. The most extreme instance is a blizzard, which is defined as winds greater than 35 mph, visibility less than ¼ mile, lasting at least 3 hours. New snowfall is not necessary for a blizzard, and blowing snow can similarly obscure visibility.

Winter storms are measured by snowfall accumulation or ice thickness. Winter storms occur in Arkansas between November and March and are usually created by large low-pressure systems moving rapidly across the country. In Arkansas, ice storms are a greater threat than blizzards. Access to moisture from the Gulf of Mexico falling over shallow cold air near the surface can produce ice accumulations of two inches or greater with tremendous damage to power distribution.

Dam or Levee Failure

Definition: Catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water or the likelihood of such an uncontrolled release. It is recognized that there are lesser degrees of failure and that any malfunction or abnormality outside the design assumptions and parameters that adversely affect a dam's primary function of impounding water is properly considered a failure. These lesser degrees of failure can progressively lead to or heighten the risk of a catastrophic failure. They are, however, normally amenable to corrective action (USSD 2018).

Description: Dams help address the complex challenge of controlling and distributing water. They have been recognized as a key water management practice dating back to early civilizations of the Americas, ancient Egypt, and China. As water is a part of the hydrologic cycle, dams work to conserve water through reservoirs to prohibit flow back to the ocean. With the advancement of civilization and a growing population, water withheld in such reservoirs are an integral part of society and is a necessary source for energy, drinking water, irrigation practices, etc. Dams also protect areas of development and civilization from floods through flood control measures. Dam safety and maintenance standards have increased over time.

Earthquake

Definition: A sudden slip on a fault, with resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth (USGS 2018).

Description: Earthquakes occur from the sudden release of stress in the Earth's crust. Stress is built up by the motion of tectonic plates. Stress may also be built up through the injection of fluids. During an earthquake, rocks on either side of a fault line move either horizontally or vertically. This movement creates three types of waves: Primary, Secondary and Rayleigh waves. Primary waves spread outward from the epicenter (source of the fracture) as compression, like a spring. Secondary waves vibrate at right angles to the direction of travel; these are the most damaging. Rayleigh, or surface, waves move vertically, giving an undulating motion. While strong earthquakes are not common in Arkansas, the state is positioned over the New Madrid fault line. An earthquake caused by the New Madrid fault, situated in the Mississippi Valley, would greatly impact Arkansas.

Earthquake intensity is measured on the Moment Magnitude Scale. Each point represents a 10-fold increase in the wave amplitude and a 32-times increase in energy release.

Poor Air Quality (Dust, Pollutants, Smoke)

Definition: A measure of the monitored natural and man-made pollutants in an area.

Description: Air quality problems result from the accumulation of aerosols, such as dust, pollen, smoke, salt, or human-produced chemically-active compounds that build up in an area over time. Under normal conditions, winds disperse these aerosols and compounds, but sustained periods of light winds can allow buildup to unhealthy levels. Many aerosols are produced naturally but may have artificially elevated concentrations through burning (concentration of smoke and carbon monoxide) or agriculture. Industrial activities and urban environments add other sources of pollution, including photochemical smog, which is produced from the interaction of sunlight with nitrous oxides (primarily from automobile engines) and volatile organic compounds. Ozone is a component of this smog.

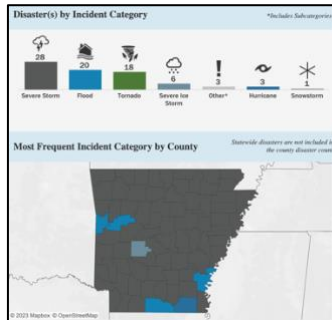
Air quality problems occur when dispersion – the ability of the atmosphere to spread pollutants over a large area – is inhibited. Temperature inversions, where a warm layer of air aloft prevents upward motion, and light winds, such as a large high-pressure system, provide favorable conditions for air quality events. Some pollutants, such as ozone, occur in higher concentrations during higher temperatures and more intense sunlight while others, such as smoke or dust, can accumulate in high concentrations any time of the year. Local and regional landscapes, such as mountain valleys, can also “trap” pollutants. Warmer summertime temperatures are likely to increase the concentration of pollutants such as ozone.

Concentrations of pollutants are measured and averaged over time. A time-averaged concentration is used because exposure to a high concentration of pollutants during a short time might have an impact equivalent to an exposure to a lower concentration over a longer time (American Meteorological Society). When the average exceeds public health regulations over a defined period, such as several hours or a day or a number of days per year, the area is noted as being noncompliant. One way to assess air quality for your location is to look at the daily Air Quality Index (AQI) issued by the U.S Environmental Protection Agency. AQI is calculated for five major pollutants including ground-level ozone, particle pollution (particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide.

Appendix B - Historical FEMA/Presidential Disaster Declarations by State or County

The below data visualization interactive reference page displays statistics of disaster declarations for states dating back to 1953.

Disaster Declarations for States and Counties: <https://www.fema.gov/data-visualization-disaster-declarations-states-and-counties>



This page contains an interactive tool that allows the exploration of historic federal disaster declarations by state, county, hazard, and year. To access information from this page, first select a date range and state/territory from the menus. Information on federally declared disasters within the selected region will be displayed below.

The tool provides the following information:

- Number of disasters by hazard type, county, year, and month,
- The cumulative number of disasters by hazard type, and
- The complete list of federal disaster declarations.

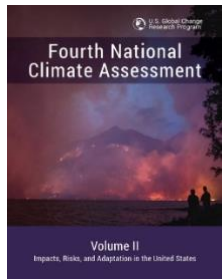
Appendix C - Climate Change Science and Projection Resources

The *Simple Planning Tool* v.1.7 is geared towards providing Arkansans with the most accurate and trustworthy data sources. The tool also identifies future climate trends for each hazard. As noted in the *A Note About Climate Change* (p. 5) section, below is a list of credible, up-to-date climate change science resources to consider for additional information beyond what the *Simple Planning Tool* provides.



Arkansas State Climate Summary (2022): <https://statesummaries.ncics.org/chapter/ar/>

This report from the NOAA National Centers for Environmental Information (NCEI) provides a state-specific summary of observed and projected changes in Arkansas's climate, including the change in extreme weather events that affect the state. Three key messages of the summary highlights are provided at the beginning of the report. The NOAA State Climate Summaries were originally created to put National Climate Assessment information into a state-level context, and the report is updated each year.



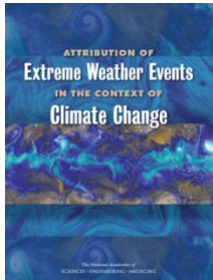
NCA4 Volume II: Impacts, Risks and Adaptation in the U.S. (2018): <https://www.globalchange.gov/nca4>

The National Climate Assessment is the most accurate state-of-the-science agreed upon in the science community. This report was produced by a team of more than 300 experts guided by a Federal Advisory Committee, which was extensively reviewed by the public and experts including federal agencies and a panel of the National Academy of Sciences. Released in November 2018, it represents the second of two volumes of the Fourth National Climate Assessment (NCA4) and builds upon the work of the three previous assessments. Focusing on regional chapters, the NCA4 Volume II is a technical scientific assessment of climate change-related impacts, risks, and adaptation in the United States, as described in the NCA4 Volume 1: Climate Change Special Report (CSSR).



NCA4 Volume I: Climate Science Special Report (2017): <https://science2017.globalchange.gov>

This stand-alone report is an authoritative assessment of the science relating to climate change and its physical impacts, with a focus on the United States. Released in November 2017, it was led by NOAA, represents the first of two volumes of the NCA4, and is mandated by the Global Change Research Act of 1990. The CSSR is designed to serve as the foundation for efforts to assess climate-related risks and inform decision-making about responses. The report provides 1) an updated detailed analysis of the findings of how climate change is affecting weather and climate across the United States; 2) an executive summary and other materials that provides the basis for the discussion of climate science found in the second volume of the NCA4; and 3) foundational information and projections for climate change, including extremes, to improve “end-to-end” consistency in sectoral, regional, and resilience analyses.



Attribution of Extreme Weather Events in the Context of Climate Change (2016):

<https://www.nap.edu/catalog/21852/attribution-of-extreme-weather-events-in-the-context-of-climate-change> (To access for free, report can be viewed online or a PDF can be downloaded by creating a free account.)

This National Academies of Sciences, Engineering, and Medicine report examines the current state of science of extreme weather attribution and identifies ways to move the science forward to improve attributing capabilities. The following infographic provides an overview of the report and how climate change is affecting extreme weather: <https://www.nap.edu/resource/21852/extremeweather-infographic.pdf>.

Appendix D - Incentive and Action Programs for Hazard Risk Reduction

Below is a list of resources providing information on incentive and action programs intended to assist in reducing hazard risk for your community. The list is not necessarily comprehensive. Please reference the provided links for more information on each program.

All Hazards

Integrating Hazards into the Comprehensive Plan - Webinar (<https://www.planningforhazards.com/webinars>, scroll to bottom of page): This one-hour webinar focuses on how local governments and communities can reduce their risk and vulnerability by integrating hazard risk reduction strategies into their comprehensive plan. Colorado planners describe the processes, practices used, and lessons they learned when integrating hazards into their comprehensive plans. This webinar was developed in consideration for Colorado, but concepts can be similarly applied and adapted for Arkansas.

Natural Hazard Mitigation Saves: 2019 Report (<https://www.nibs.org/projects/natural-hazard-mitigation-saves-2019-report>): The National Institute of Building Sciences issued this report to highlight the benefit of four broad avenues for implementing mitigation strategies. (1) The Institute's project team analyzed 23 years of federally funded mitigation grants and found that hazard mitigation funding can save the nation \$6 in future disaster costs for every \$1 spent. (2) The team looked at scenarios that focus on designing new buildings to exceed provisions of the 2015 model building codes, and the findings revealed that investing in exceeding these building codes can save the nation \$4 for every \$1 spent. (3) They analyzed benefits of adopting 2018 I-Codes vs. 1990-era design for buildings and found that there's a national benefit of \$11 for every \$1 spent. (4) The team looked at private-sector retrofit for older buildings. Utilizing more modern retrofitting on existing residential buildings produces \$4 of national benefit for every \$1 invested.

Flooding

National Flood Insurance Program (NFIP) (<https://www.fema.gov/national-flood-insurance-program>): This program "aims to reduce the impact of flooding on private and public structures by providing affordable insurance and encouraging communities to adopt and enforce floodplain management regulations. These efforts help mitigate the effects of flooding on new and improved structures...and reduces the socio-economic impacts of disasters."

NFIP Community Rating System (CRS) (<https://www.fema.gov/national-flood-insurance-program-community-rating-system#>): CRS "is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements." As a result, community participation reduces policy holder flood insurance rates and ultimately flood damage to insurable property.

Reduce Flood Risk (<https://www.reducefloodrisk.org/>): This tool was built by the Flood Science Center at the Association of State Floodplain Managers (ASFPM) and was designed to help property owners, buyers, and renters understand what actions they can take to reduce their property's flood risk. The ASFPM compiled a variety of flood mitigation resources into one simple, interactive platform. It offers a guided search by asking if you're a property owner, buyer, renter, government official, etc., what type of property you have, the foundation of the property, and more. You can also explore strategies by category. The tool ultimately points users to actions they can take to reduce their property's flood risk with detailed descriptions about those actions.

Severe Thunderstorms: Wind (Tornadic and Straight-Line) and Hail

Insurance Institute for Business and Home Safety (IBHS) Fortified Homes Program (<https://disastersafety.org/fortified/resources/>): This program is a set of engineering and building standards designed to help strengthen new and existing homes through system-specific building upgrades to minimum building code requirements that will reduce damage from specific natural hazards. Relevant to Arkansas hazards, their research includes standards for high winds and hail. Some insurance companies offer discounts for having wind-resistant construction and/or hail-resistant shingles. Contact local insurance providers for more information and applicability.

Wildfire

Community Planning Assistance for Wildfire (CPAW) (<https://cpaw.headwaterseconomics.org/resources/>): The CPAW program provides communities with training and technical resources to improve land use planning in the wildland-urban interface. Their list of provided materials includes webinars, presentations, handouts, and posters. Note: As this is a national program, some of these materials may not be applicable to Arkansas conditions.

Wildfire Risk to Communities (<https://wildfirerisk.org/reduce-risk/>): This website provides a list of resources and programs for communities to reduce and manage wildfire risk. The available topics include home ignition zone, home hardening, land use planning, wildfire preparedness, community health, wildfire prevention, wildfire response, fuel treatments, and post-fire recovery. Under any of these topics, users can view relevant information and community tools, including programs available to take action for the community.

Appendix E – Other Miscellaneous Resources

Below is a list of resources that did not fit into any of the other sections, but the authors still felt were useful to include:

Plans

Arkansas Water Plan (<http://arkansaswaterplan.org/plan/ArkansasWaterPlan/2014AWPWaterPlan/AWPFinalExecutiveSumm.pdf>): This report provides details of the current (2014) Arkansas Water Plan, created by the Arkansas Natural Resources Commission. The mission of the plan is to be “the state’s comprehensive planning process for the conservation, development, and protection of the state’s water resources, with a goal of long-term sustainable use for the health, well-being, environmental, and economic benefit of the state.” The report outlines several goals of the plan, including meeting the drinking, agricultural, and industrial water needs of the state, improving existing and aging infrastructure, and optimizing the use of surface and groundwater for the state. Other aspects of the report include key findings, issues and recommendations, implementation, and a framework for water management.

Surveys

USDA Web Soil Survey (<https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>, click *Start WSS* button towards top of page): With this tool, you can select an area of interest (less than 100,000 acres) and view the type of soil in that area. This provides information on not only what the soil types are in that area, but the qualities and properties of each kind of soil, and how much of that area is made up of each kind of soil. Soil information can be valuable for several types of planning.

National Wetlands Inventory Wetlands Mapper (<https://www.fws.gov/wetlands/data/Mapper.html>): This U.S. Fish and Wildlife Service tool allows users to view wetland types in extreme detail. Simply zoom and pan to, then click on the area of interest. In a popup window, the tool will give you the type of wetland for that area. There is a detailed description of the wetland types as well as reports that are relevant to that area.



Southern Climate Impacts Planning Program

University of Oklahoma • Louisiana State University • Texas
Sea Grant • Adaptation International

www.southernclimate.org



SCIPP
A NOAA CAP TEAM



**Climate Adaptation
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