The Climate of Miami, Oklahoma

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The goal of this report is to provide a concise summary of the climate and extreme weather events that affect the City of Miami. This information could be used to help inform planning and preparedness for extreme weather events now and in the future.

OVERVIEW

Ottawa County, in far northeastern Oklahoma, is where Oklahoma's prairies give way to the Ozark Highlands, a mountainous, forested area with many caves, springs and rivers. The Central Irregular Plains, to the west, are more gentle hills and much less forested, with a transition into grasslands.[1]

Miami lies along the Neosho River, just northwest of its confluence with Spring River to form Grand Lake. Tar Creek runs through Miami and joins the Neosho along the southern edge of the city. The city lies within jurisdictions of the Ottawa, Miami and Peoria tribes.

The general climate of the region is characterized by mild winters with relatively hot summers. The air is humid continental, meaning rainfall is frequent and the air usually moist. Thunderstorms occur frequently through the spring, summer, and fall. The area is occasionally affected by tropical storm remnants traversing northward from the Gulf of Mexico, bringing heavy rainfall and posing flooding risks.

TEMPERATURE

The average annual temperature in Miami is 57.6 degrees, with an average high temperature near 69 degrees and an average low of 46 degrees. July and August are the hottest months with average daytime maximum temperatures of 91 degrees. January is the coldest month with average maximum temperatures of 45 degrees and nighttime lows dipping to 22 degrees.

Temperatures over 100 degrees in summer are not uncommon, with on average six days of 100 degrees or higher each summer. About 2 in 10 years record a temperature as high as 107 degrees. Likewise, temperatures can fall below zero, with 2 in 10 years recording a low of -7 degrees. On average, about 3 days below zero can be expected each year. The highest temperature recorded in Miami was 116 degrees on July 14, 1954; the coldest temperature was -25 degrees on January 22, 1930.

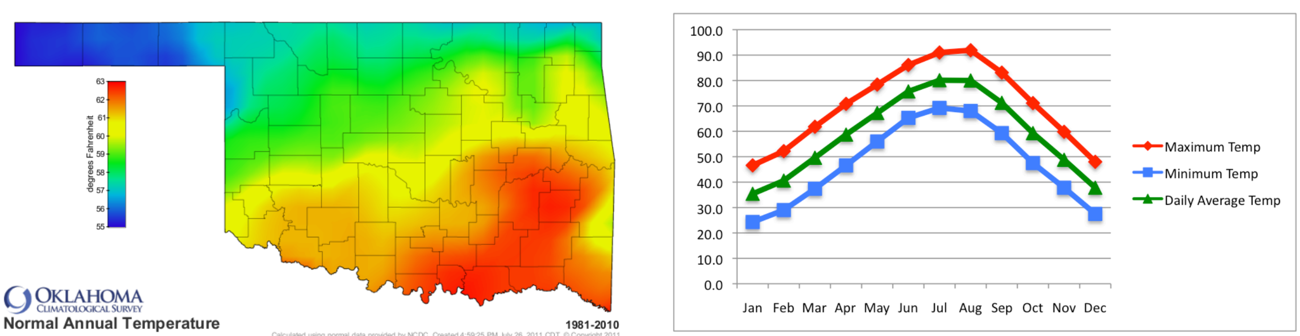

Figure 2. Oklahoma average annual temperature (left) and the seasonal variation in maximum (red), minimum (blue), and daily average (green) temperature, in degrees F.

[1] Source: Level 3 Ecoregions, EPA. https://www.epa.gov/eco-research/ecoregions

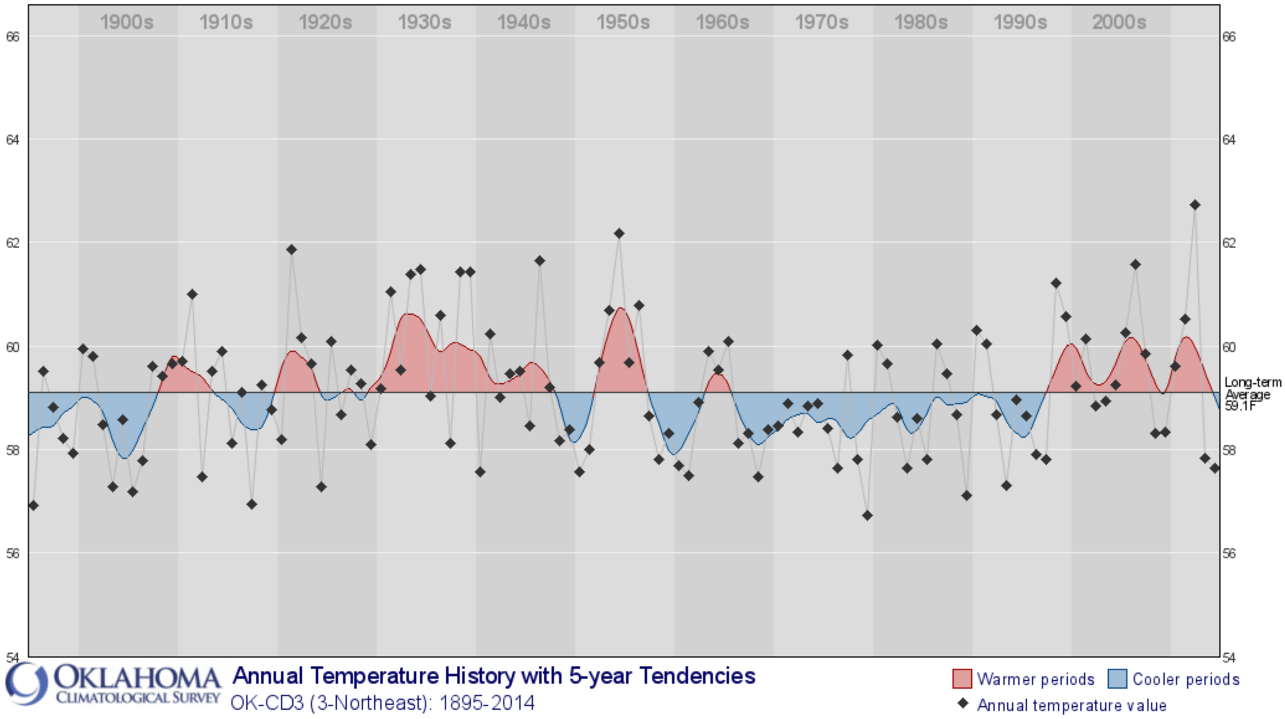

Figure 3: Average annual temperatures for northeastern Oklahoma. Dots indicate annual average temperature for each calendar year, 1895-2014 (degrees F). Colors indicate a 5-year weighted mean temperature above (red) or below (blue) the long-term average.

Ottawa County averages a growing season of 201 days, but plants that can withstand short periods of colder temperatures may have an additional five weeks added to their growing season.

Annual average temperatures can be variable, with temperatures as much as 3 degrees above or below the long-term (1895-2014) average. Although there is large inter-annual variability, the climate record shows extended periods of relatively warmer or colder temperatures. Since the late 1990s, temperatures have generally been running above the long-term mean, following three decades of below-average temperatures, although individual years during warm periods can still end below normal and during cold periods can be above normal. The hottest year on record in northeastern Oklahoma was 2012 and the coldest year on record was 1979.

PRECIPITATION

Across Ottawa County, average annual precipitation (combined rainfall and liquid equivalent of snowfall) is 44.51 inches. Most years average between 35 and 50 inches of precipitation. May and September are the wettest months with an average of more than five inches each, but the area generally receives abundant rainfall from March through November. Measureable rainfall occurs on average 86 days per year, with 13 days, on average, experiencing more than one inch of precipitation. The greatest daily rainfall was 9.15 inches recorded on July 7, 1958. The most rainfall in a single month was 18.81 inches that same month. The greatest annual rainfall was 66.85 inches in 1973.

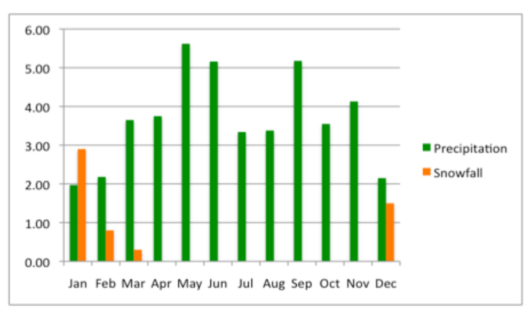

Figure 4: Average monthly precipitation (green) and snowfall (orange) for Miami (inches).

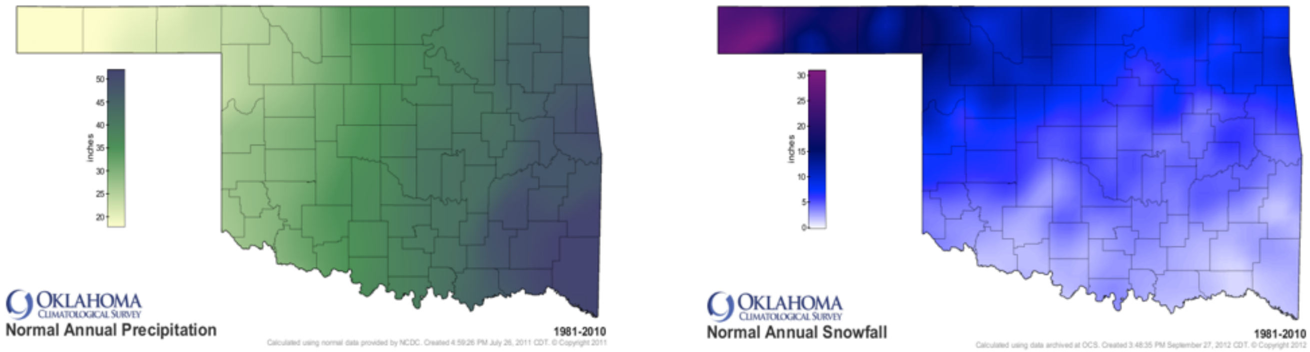

Figure 5. Average annual precipitation (left) and snowfall (right) for the state of Oklahoma. Averages are based on data from 1981-2010 (inches).

At least one inch of snow falls during most winters, and 10 or more inches fall every four years or so. The overall average is 5 inches per year, falling on about 4 days per year. The most snow on a single day was 16.3 inches on February 1, 2011, with a total of 28.8 inches for that month.

OTHER VARIABLES

Winds from the south are dominant, averaging less than eight miles per hour. Winds average greater than 15 mph about 9% of the time. The highest recorded wind gust was 86 mph on May 7, 1961 and May 7, 1967. Recently, the Mesonet site at Miami recorded a 74 mph gust on April 14, 2001.

Relative humidity, on average, ranges from 50% to 92% during the day. Humidity is comparatively high year-round, with a slight decline in late winter to early spring. Winter months tend to be cloudier than summer months. The percentage of possible sunshine ranges from an average of less than 50% in winter to about 75% in summer.

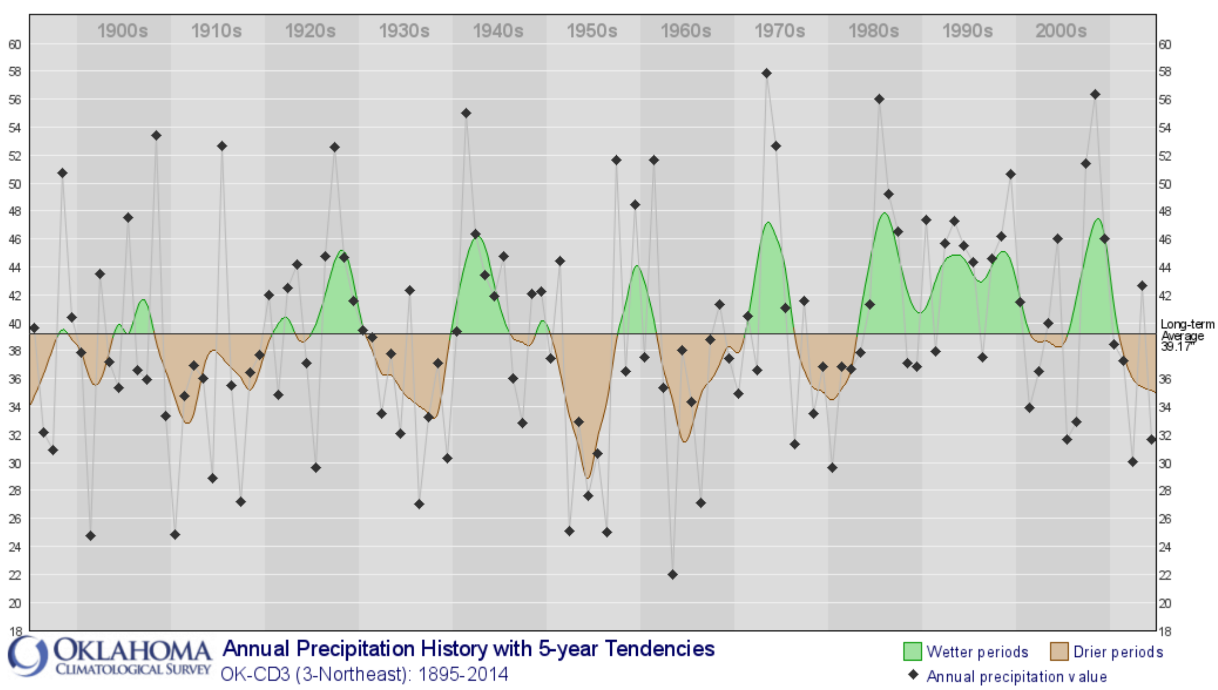

Figure 6. Annual precipitation for northeastern Oklahoma. Dots indicate total annual precipitation for each year from 1895-2014 (inches). Colors show weighted 5-year mean above normal (green) or below normal (brown).

EXTREME WEATHER EVENTS

Like most of Oklahoma, Miami is subject to a range of extreme weather events. It is located far enough north to get cold fronts in the fall, winter and spring, and close enough to the Gulf of Mexico to have a plentiful supply of moisture to fuel storms. This combination produces severe storms, tornadoes, heavy rainfall with associated flooding, and winter storms. When the Gulf moisture cannot make it far enough north, Miami may experience drought, heat waves, and wildfires.

Tornadoes

On average, the Miami area experiences one tornado day per year (a tornado occurring within 25 miles of Miami).[2] From 1950-2003, 32 tornadoes were reported in Ottawa County, although neighboring counties reported nearly 50 each. Significant tornadoes (defined as EF2 or greater on a scale from EF0 to EF5) are rarer, occurring on average once every 5 years. Only two "violent" tornadoes (EF4 or EF5) were reported in Ottawa County since 1950.

Miami had a close call with a violent tornado on May 10, 2008. Long-lived supercell thunderstorms formed across eastern OK and northwest AR. One storm produced a combined 60-mile path length along the OK-KS border, striking Picher and north Quapaw. The tornado was one-mile-wide east of Quapaw and destroyed 200 homes in the community of Picher. Overall, the tornado caused 21 fatalities, 350 injuries, and $60M in property damage.

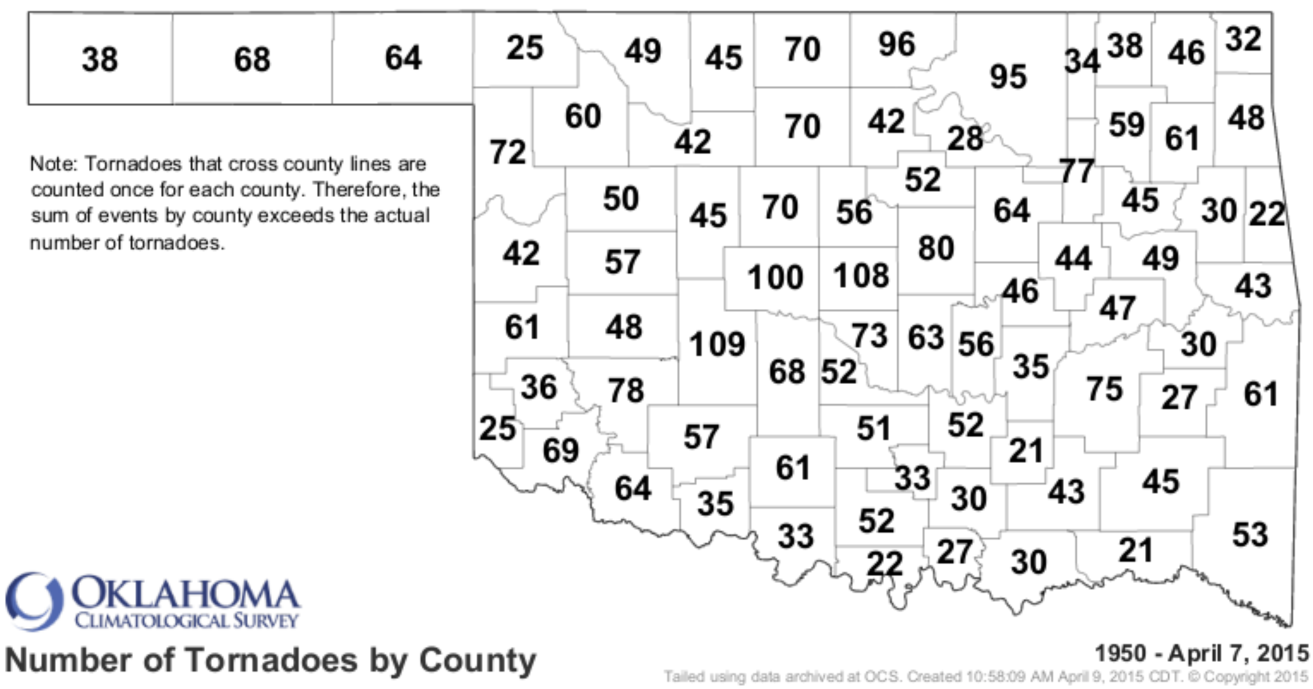

Figure 7. Number of tornadoes by county in Oklahoma since official record-keeping began in 1950.

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[2] www.nssl.noaa.gov/projects/hazard

Table 1. Significant tornadoes (F2/EF2 intensity or greater) occurring in Ottawa County since 1880. Information on tornadoes prior to 1950 is not as complete because the National Weather Service did not begin systematic record keeping until later. Source: NCEI Storm Events Database

Date	Time	Magnitude	Length	Width	Deaths	Injuries
04/24/1904	-	F4	15 miles	-	5	35
10/9/1914	-	F4	15 miles	-	6	14
1/4/1922	-	F2	7 miles	-	0	12
2/24/1935	-	F2	15 miles	-	1	40
5/29/1938	-	F2	0.5 mile	-	0	0
04/03/1956	00:10	F4	19.5 miles	400 yards	0	46
05/05/1960	18:50	F2	28 miles	500 yards	0	0
08/07/1960	23:15	F3	4.7 miles	200 yards	0	0
05/21/1961	19:40	F2	-	33 yards	0	0
07/22/1961	12:18	F2	-	33 yards	0	0
05/15/1965	15:00	F2	5 miles	33 yards	0	0
01/25/1967	23:03	F2	2 miles	33 yards	0	6
09/24/1973	19:10	F3	3.6 miles	100 yards	0	14
09/24/1973	19:20	F3	9.5 miles	100 yards	0	0
04/07/1980	17:30	F3	1.9 miles	33 yards	0	0
05/10/2008	16:25	EF4	24 miles	1760 yards	6	150
05/20/2013	17:25	EF2	10 miles	800 yards	0	0
04/27/2014	16:29	EF2	7.1 miles	325 yards	1	12

Thunderstorms

Thunderstorms occur on about 53 days each year, predominantly in the spring and summer. Most of these are not severe. Severe thunderstorms are defined as having hail of one-inch diameter or larger, winds of 50 knots (57 mph) or greater, or tornadoes. Of these, wind is the most common threat. Severe wind speeds occur within 25 miles of Miami on about 6 days per year.[3] According to records from the Storm Prediction Center, 162 severe thunderstorm wind events were recorded on a total of 92 days between 1955 and 2014.[4] The highest recorded non-tornado wind speed in Ottawa County was 93 mph in Pitcher in 1996.

Typically, there are about two days per year of hail exceeding one inch in diameter. From 1955-2014, 235 severe hail reports were recorded in Ottawa County, occurring on 117 days. Very large hail of 2-inch

[3] www.nssl.noaa.gov/projects/hazard
[4] www.ncdc.noaa.gov/stormevents/

diameter or greater accounts for less than 15% of events, with 34 recorded events on 11 days. The largest hailstone was 4.25 inches in diameter, recorded in Miami in 2003.

As information collection improves, the number of severe storm events has increased. This is attributable to more systematic reporting, proliferation of observers (including media and storm chasers), and easier reporting methodologies such as smart-phone apps. Consequently, trends in the number of tornadoes, hail or wind events should be investigated closely and not necessarily attributed to changes in the actual frequency of events.

Flooding

Flooding is a recurrent feature in Miami, due to the confluence of the Neosho and Spring Rivers and Tar Creek. Flooding has occurred about every 5 years since 1986. Major floods recently occurred in 2007 and 2015. In addition to the nearby rivers, Miami is susceptible to tropical moisture-laden air from the Gulf of Mexico, which interacts with elevation changes in the Ozark Plateau to enhance rainfall locally.

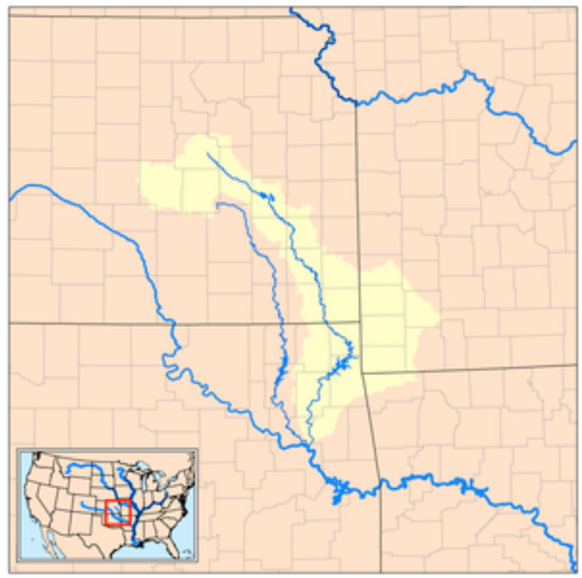


Figure 8. The Neosho watershed (highlighted in yellow) begins in Kansas and ends where it flows into the Arkansas River. Along the way additional rivers (such as Spring River) and creeks (such as Tar Creek) join it.

Flood risk is often stated as "return periods", or the probability of having a flood of a given magnitude occur once in a specified number of years. For example, the 100-year flood would be an event that would be expected to occur no more than once every century, or a 1% chance in any given year. Because flood risk is a statistical measure, the occurrence of a large flood does not mean that another will not occur shortly after. Like flipping a coin, the probability of successive events (such as the coin landing heads-up twice in a row) is smaller than a single event but it is never zero.

Furthermore, the statistics may change over time, due to changes in the landscape, building levees and retention ponds and lakes, straightening or lining channels, variability and change of climate, or upstream development. Any of these could increase or decrease the probability of a similar weather event having a greater or lesser impact than the one that occurred sometime previously. Return periods are useful as a guidance tool, such as for how much water a lake should be able to store, in order to build sufficient capacity to reduce impacts from likely events but keeping costs of construction as low as possible. While rainfall amounts can be measured precisely, flooding impacts are much more difficult to anticipate due to factors such as the capacity to store water (such as runoff ponds), stream channel characteristics, preceding wetness of the soil, upstream rainfall patterns, and permeability of soil in the watershed.

Table 2. Recurrence Intervals for Miami, also known as return periods, are based on the average number of times a rainfall of the indicated magnitude would occur in the indicated accumulation period (duration). For example, a 7-day rainfall accumulation of 13.20 inches or greater could be expected to occur once in 100 years, while a rainfall amount of 10.40 inches or greater would be expected to occur 4 times, or about every 25 years if evenly spaced. Values shown are inches.

Duration	Average Recurrence Interval for Rainfall (years)			
	10	25	50	100
1 day	5.73 in.	9.92	7.88	8.88
2 days	6.60	7.91	8.96	10.00
3 days	7.12	8.53	9.65	10.80
7 days	8.71	10.40	11.80	13.20
10 days	9.70	11.50	13.00	14.50
20 days	12.30	14.40	16.00	17.60
30 days	14.60	16.80	18.50	20.10
45 days	17.60	20.10	21.90	23.70
60 days	20.30	23.10	25.10	26.90

The strongest response between heavy rainfall and high flow rates is along Tar Creek for 2 or 3-day rainfall accumulation. The relationship is slightly stronger when Grand Lake is at or above its normal conservation pool. The chances of high flow rates (and likely flooding) appear to increase if 2-day rainfall exceeds 2.7 inches or 3-day rainfall exceeds 3.5 inches, although instances of flooding have occurred with lower rain rates and rainfall accumulations of 5-6 inches have at other times failed to produce flooding.

Along the Neosho River, extended rainfall over 7-30 days is best related to high flow rates and potential flooding, although the relationship is weaker than it is for the shorter-duration events along Tar Creek. For the Neosho, rainfall of 3.8 inches over 7 days, 4.4 inches over 14 days, or 7.5 inches over 30 days appears to have the greatest potential to cause high flows and flooding. The Spring River southeast of Miami responds more quickly to the 3 to 14-day rainfall events. Unlike with Tar Creek, high flows in the Neosho or Spring Rivers do not appear to be strongly related to high levels in Grand Lake; however, when Grand Lake is below its normal conservation pool elevation, high flows are rarer.

Table 3. Top ten 7-day rainfall totals for Miami, OK (1918-2015)

Rank	Total (in.)	Ending Date
1	14.82	1958-07-12
2	14.60	1959-10-04
3	11.54	1986-10-02
4	10.94	1948-06-27
5	10.93	2011-05-24
6	9.70	1985-11-18
7	8.95	1936—0-27
8	8.80	1945-09-28
9	8.20	1926-09-09
10	8.19	2001-10-09

Because the Neosho begins in eastern Kansas, heavy rainfall in Kansas has the potential to cause flooding along the Neosho in Miami, even if rainfall locally is much lower than the identified thresholds. However, this relationship is difficult to determine because of upstream flood control structures, the length of time it takes for water to move down the river channel, infiltration rates of water into the streambed and surrounding soil, and other management factors.

Historically, there have been at least two 7-day rainfall events that have exceeded the "100-year return period" criteria of 13.20 inches. Because this is a statistical measure, it is possible to have more than one event in a 100-year period, and even have 100-year events in successive years (or even the same year) as was the case in Miami in 1958 and 1959.

The flood of 2007 was among the worst on record. Flooding began on May 7 along the Neosho River, cresting at 19.92 feet and flooding Riverview Park and Highway 125. Additional rains in early June caused another round of flooding, bringing the Neosho back to 18.67 feet. On June 13, the river crested at 20.51 feet, causing further moderate flooding. The Spring River also rose to a record 32.18 feet. The flooding reached its maximum extent from June 29-July 9, when the Neosho crested at 29.25 feet, displacing 2,500 residents and inundating 574 structures, some up to 3 feet deep. The flood damaged 148 homes and businesses beyond repair. Nearly all highways and 40 city streets in Miami were closed causing limited access to the city. This flood was an example of sustained rainfall over an extended time; the wettest year on record (1973) similarly had extended periods of rainfall but also had several large events superimposed on top of those.

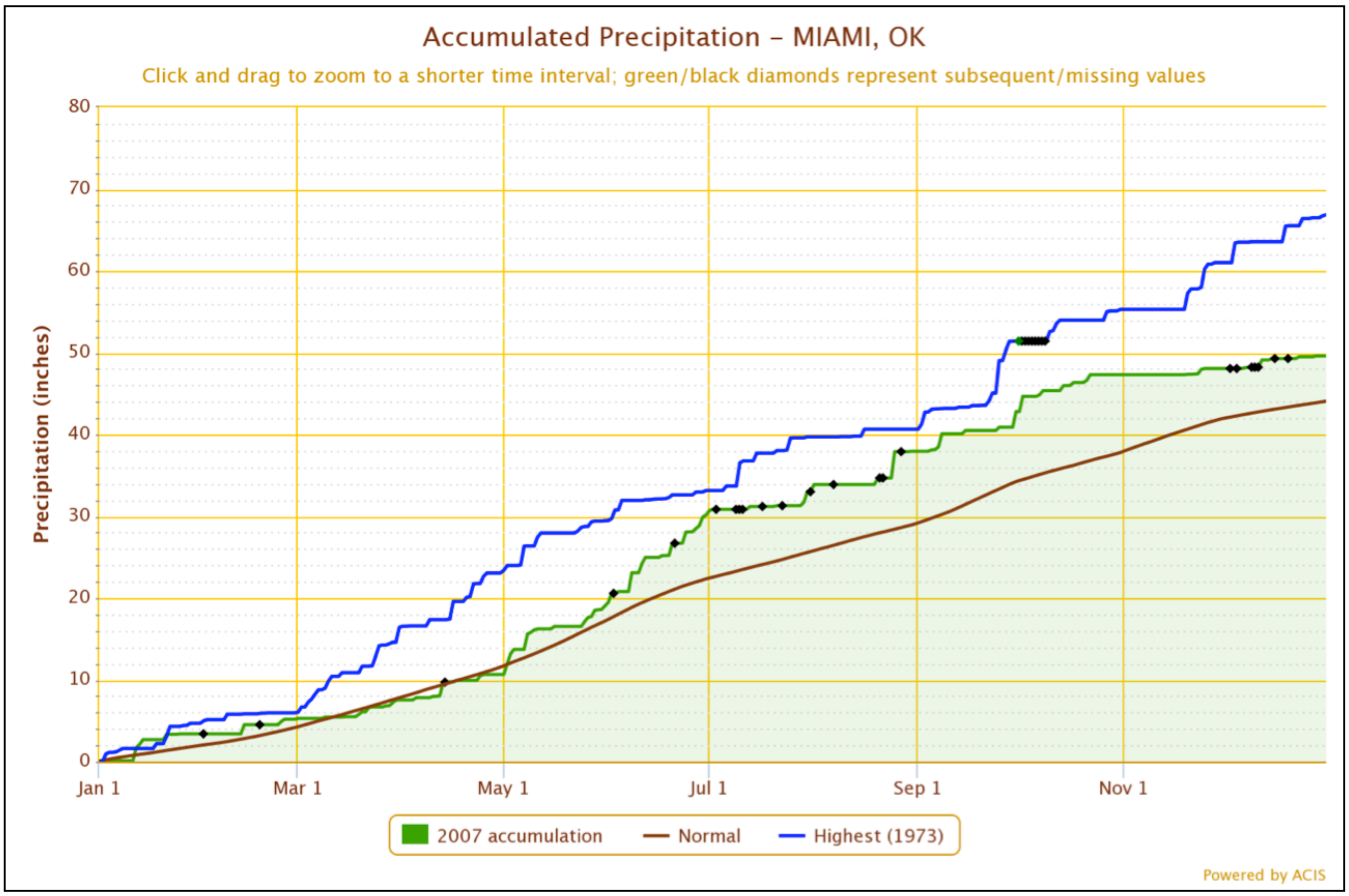


Figure 9. Rainfall accumulation for 2007 (shown in green) and for 1973 (blue line). The brown line indicates the 30-year normal (1981-2010 average).

Winter Storms

Snowfall events of several inches are fairly common. There have been five major snowfall events in the last 16 years. The greatest annual snowfall on record for Miami occurred during the winter of 2010-2011, when nearly 30 inches fell, 20.2 inches of it during a single event. This one event had a greater total than any entire season other than 1967-1968. Miami typically has 2-4 days each winter with at least an inch of snow falling, although some years, especially since 2000 have recorded zero events with an inch or more per day. Accumulations of 4 inches or more in a single day are rarer, with one day each in 2000 and 2008 and 2 days in 2011. Other years since 2000 have not met this threshold.

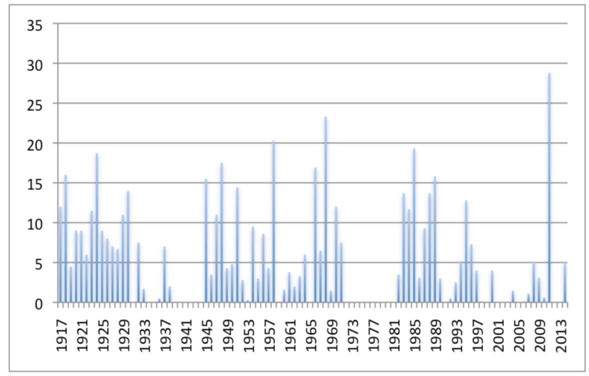


Figure 10. Annual snowfall total (inches) from 1917-2014. Values are for the season ending in the indicated year (for example, 2011 is for the period October 2010 - April 2011).

Table 4. Snowfall events of eight inches or greater in Miami since 1917. Descriptions of impacts were not routinely recorded in the Storm Event Database by the National Centers for Environmental Information before 1996. Events may have accumulated over more than one day; the date indicates the date on which the event ended.

Amount (in)	Date	Impacts
20.2	2011-02-03	Blizzard, 5-foot drifts, roads impassable for days, $30M damage
~15.0	1999-03-13	More than 10,000 without power
14.0	1968-03-12	
~13.5	2000-12-12	A thin layer of freezing rain followed by heavy snowfall
12.0	1917-12-09	
9.5	1989-03-06	
9.0	1966-12-23	
9.0	1951-11-06	
8.6	1988-01-07	
8.5	1923-11-29	
8.4	2011-02-09	27 inches recorded at Spavinaw (state record); temperatures plunged to -31 in Nowata afterward (-20 in Miami)
~8.0	2003-02-23	30-car accident on I-40
8.0	1987-12-15	

While heavy snowfall can impede city operations for an extended time, it typically does not cause much damage to infrastructure. Older structures and those not built to hold the weight of much snow could collapse in the heaviest events. Tree limbs may catch the snow, especially if it occurs while leaves are still on trees, causing limbs to break resulting in power outages and a threat to those walking underneath. Ice storms, however, are capable of doing much more extensive damage. Snow and sleet will not stick to power lines, while freezing rain will coat the lines, causing them to collapse under the added weight. Two large recent ice storm events occurred in 2000 and 2007, with each producing 1-2 inches of ice across the region and causing more than $100M in damages in the state. There seems to have been an increase in frequency since 2000 of ice storms, although records are limited prior to 1996.

Table 5. Major freezing rain and sleet events affecting northeastern Oklahoma since 1996. *Source: NCEI Storm Events Database*

Date	Impacts
Jan 1, 1999	A "thick layer of ice" with ½-inch of snow on top from a glancing blow on a major Midwest winter storm
Dec 25, 2000	1-2 inches of ice East Central OK; 200,000 without power (some more than a week), $169M damages
Nov 29, 2006	Freezing rain, sleet and heavy snowfall across northeastern Oklahoma caused the roof of a boat manufacturing facility in Ottawa County to collapse, destroying 40 boats worth more than $1 million
Dec 8, 2007	Several periods of freezing rain, 1-2 inch accumulation along I-44, nearly 1,000,000 without power (up to 2 weeks), could be most costly weather-related disaster in Oklahoma history
Feb 11, 2008	Up to ½-inch freezing rain
Dec 24, 2009	Up to 1 inch of sleet followed by heavy snow and near-blizzard conditions
Dec 20, 2013	Up to ¾-inch freezing rain, numerous power outages and tree damage

The presence, or lack of, a layer of warm air between the surface and the cloud govern winter precipitation type. If there is an intervening layer of air that is above freezing, that may be sufficient to allow snowflakes and ice crystals falling from the cloud to melt. These liquid drops then re-freeze in the cooler air near the surface. If the warm layer is thin and the cold air near the surface is sufficiently deep, the liquid drops have time to re-freeze before reaching the surface, resulting in sleet or ice pellets. If the warm layer is thicker and the cold layer near the surface is shallow, the liquid drops do not have time to re-freeze and instead freeze on contact with objects on the surface, resulting in freezing rain. Structures above the ground are most susceptible to freezing rain because residual heat stored in the soil may cause the ground to remain above freezing, even as objects just a few inches above the soil are below freezing.

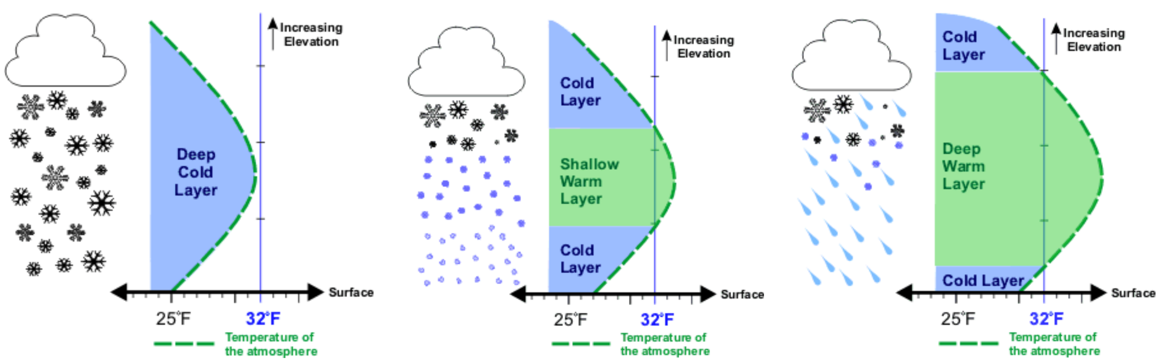


Figure 11. Snow (left) versus sleet (center) versus freezing rain (right) atmospheric profiles. For snow events, the temperature is below freezing throughout the entire layer from the cloud to the ground while for sleet events, there is a shallow layer of warm air that allows snow to melt and then re-freeze into ice pellets. Freezing rain occurs when the cold layer near the ground is too shallow to allow enough time for melted drops to freeze as they fall through; these drops then freeze on contact with the cold surface. *Source: National Weather Service*

Winter precipitation type is difficult to forecast because there is little real-time data on the vertical profile of the atmosphere. Without this information, the depth or location of a warm layer cannot be determined in advance. Further, cold fronts often stall across the region, roughly along Interstate 44, causing air to rise along the front, creating precipitation.

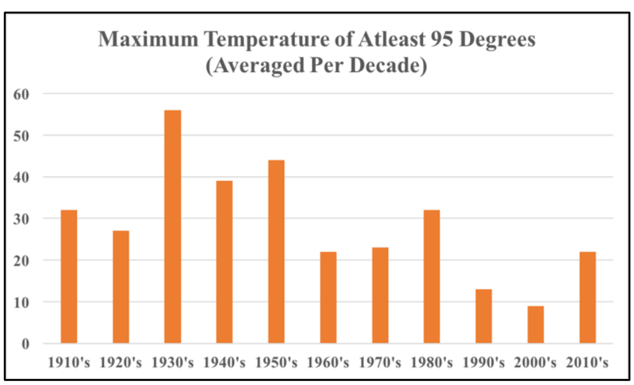
Extreme Heat

The climate and landscape of Oklahoma are conducive for excessive heat to occur. During the summer, large areas of high pressure commonly sit over this region, leading to sunny skies and limited rainfall. As these conditions persist and temperatures continue to remain hot, they form heat waves. On average, Miami experiences 4 days at 100 degrees or higher per year. More commonly highs will reach 95 degrees, an average of 17 days per year. The trend of experiencing 100-degree days have occurred in waves dating back to the 1900's. Excessive heat was prominent during portions of the 1910's, 1930's through 1950's, and 1980's (Figure 12). All of the top 10 consecutive days at 100 degrees or higher occurred during these periods, with a record 31 days occurring in 1954.

Table 6: Record consecutive days with high temperatures of 100 degrees or greater for Miami (1917-2015)

Rank	Most Consecutive Days of 100 Degrees or Greater
1	31 (July 1 - July 31, 1954)
2	22 (August 7 - August 28, 1936)
3	21 (July 2 - July 22, 1980)
4	19 (July 29 - August 16, 1934)
5	19 (July 8 - July 26, 1934)
6	15 (June 21 - July 5, 1934)
7	13 (August 29 - September 10, 1947)
8	13 (July 30 – August 11, 1947)
9	13 (June 21 - July 3, 1933)
10	11 (August 31 - September 10, 1939)

More recently, numerous state heat records were broken in 2011 including hottest August and hottest summer (June-August) on record, and hottest July recorded for any state. The heat returned in 2012 and resulted in the hottest year on record for the state. Although hot summers are a known reality of living in this region, it does not lessen the impacts to the area. The longer the excessive heat lasts the more complications occur such as adverse health effects, water issues, agricultural impacts, and the onset of drought. These impacts can be more severe when high heat indices, which result from high humidity levels, are present.



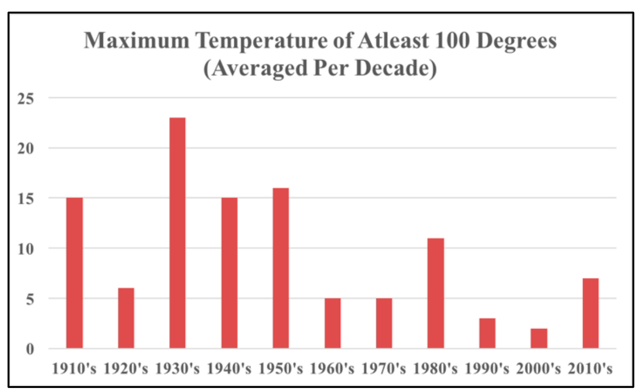


Figure 12. Number of days at or above 95 degrees (left), and number of days at or above 100 degrees (right). Both graphs are averaged per decade, from 1917-2015.

Drought

One of the major derivatives of excessive heat in Oklahoma is the historically persistent drought. Northeastern Oklahoma has a highly variable climate, varying between wetter and drier than normal periods. Drought conditions can strike Miami during any season and have frequently impacted the region throughout history. 1963 was the driest year on record, when only 19.88 inches of rain fell. Recently only 33.69 inches were recorded in 2012, compared to the average annual amount of 44.51 inches. Northeastern

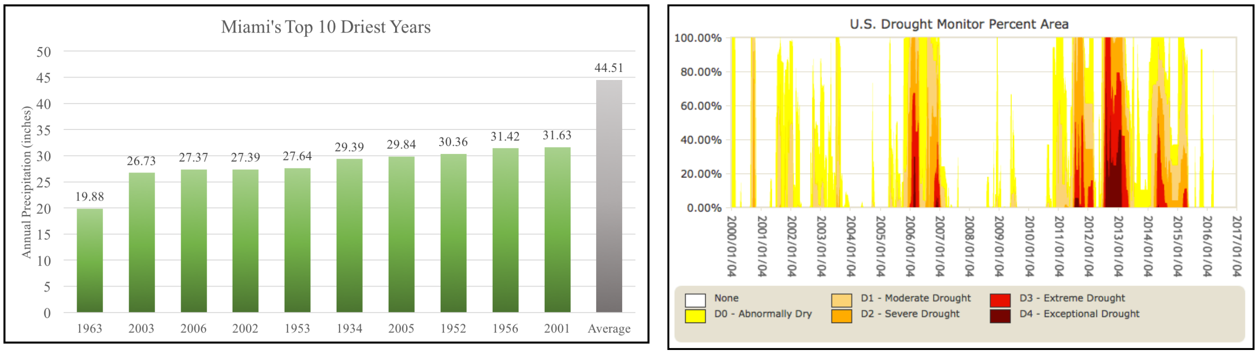


Figure 13. Miami's top 10 driest years represented by annual precipitation amounts compared to average (left), and the percent of area within northeastern Oklahoma classified in a D0-D4 drought category (right) from 2000-2016.

Oklahoma experienced 111 periods of drought between the years of 1895 and 2014, each lasting 5 months on average. The longest drought during this period lasted 47 consecutive months, from May 1953 until March 1957.

Some of the most severe droughts on record for the state occurred from 1909-18, the 1930's, 1952-1958, 1962-1972, and 2010-2015. Most recently, 2011 ranked amongst the top 5 in the state for driest summer (June-August), as well as individually for June and July.

The presence of drought has a lasting impression as the region experiences multiple periods of severe drought (D2) or higher. Based on drought records between 2000-2015, northeast Oklahoma experiences severe drought (D2) or greater for an average of 12 weeks per year. Similarly, extreme drought (D3) or greater is experienced on average 7 weeks per year, and exceptional drought (D4) is experienced on average 3 weeks per year.

Although the complexity of drought limits the ability to model conditions exactly, indices such as the Standardized Precipitation Index (SPI) and the Palmer Drought Severity Index (PDSI) are used to help monitor drought. The SPI is based on measuring precipitation only, comparing the actual precipitation to the historical distribution of precipitation for the same time period. Alternately, the PDSI is calculated by both precipitation and temperature data, categorizing regions between levels of wetness and dryness. Both of these indices display an alternating trend between positive and negative values for Miami, signifying periods of both dryness and moisture.

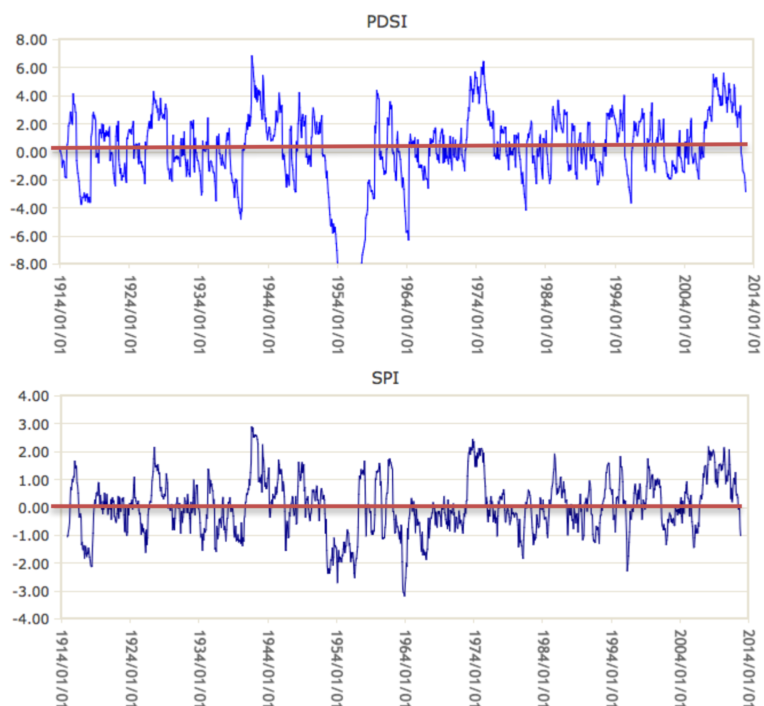


Figure 14. (top) The Standardized Precipitation Index (SPI) and (bottom) the Palmer Drought Severity Index (PDSI) for northeast Oklahoma. These graphs show the different observed stages compared to normal (red line). *Source: Drought Risk Atlas, National Drought Mitigation Center*

Wildfires

Hot and dry conditions across Oklahoma, when paired with high winds, may cause wildfires to form. Occurring most often during the months from January through April, these conditions are fueled by dry brush. Ottawa County experienced 513 wildfires of varying sizes between the years of 1992-2013, as recorded by federal, state and local fire organizations.[5] During this time, the county averaged 24 wildfires per year, although an anomalously high number of fires occurred in 2010, which distorts the average a bit. The largest wildfire to occur within Ottawa County since 1992 was on November 28 through December 1, 2005 when three different fires burned a total of 2,580 acres.

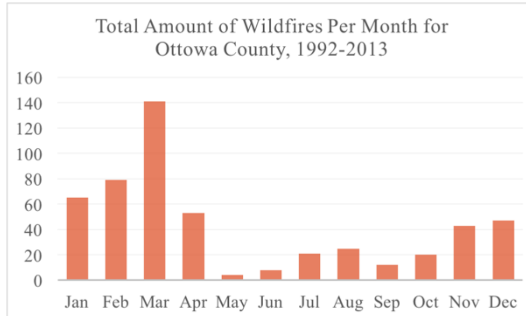


Figure 15: Wildfire occurrences in Ottawa County from 1992-2013.

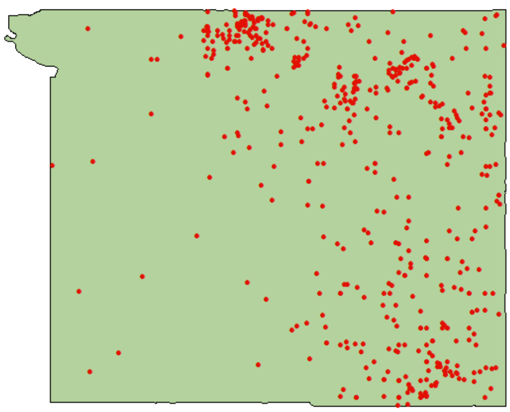


Figure 16: Wildfire occurrences in Ottawa County from 1992-2013.

Wildfires are a natural component of the physical land, providing environmental benefits by shaping vegetation and ecological communities. Fire can be a beneficial tool in maintaining the health of pastures and controlling invasive species such as juniper. Even in extreme drought, prescribed fire can be used safely when daily weather conditions allow. However, these events become a hazard when the damages affect life or property. Since 1992, records show that the frequency of large wildfires has increased. Throughout these years, the increase of development within susceptible areas may attribute to the greater risk in damages.

[5] Short, Karen C. 2015. Spatial wildfire occurrence data for the United States, 1992-2013 [FPA_FOD_20150323]. 3rd Edition. Fort Collins, CO: Forest Service Research Data Archive. http://dx.doi.org/10.2737/RDS-2013-0009.3

About the Project

The Issue

Many cities already experience a variety of extreme weather and climate related events from ice storms and floods to heat waves and droughts. Frequently, when they look at projections of future environmental conditions, those projections present either *a)* averages that do not help with the wide swings in extreme events that will actually cause problems, or *b)* such wide differences between minimum and maximum values that planning is difficult. One way to address this challenge is to use the concept of thresholds. The threshold concept helps users define at what points weather events have caused problems historically, determine when projected future changes could cause problems, and helps translate climate projections into decision and action points that managers can use on a daily basis.

The Project

Thanks to the generous support of the National Oceanic and Atmospheric Administration (NOAA), the City of Miami worked collaboratively with the project team over a one-year period to identify critical extreme weather thresholds for the City and community, analyze the best available climate projections to identify potential future changes relative to those thresholds, interpret that information, and develop and implement strategies to prepare for those impacts.

The Project Team

In addition to City leadership and expertise, this project brings together an experienced team from six organizations:

- ***Adaptation International*** and the ***Institute for Social and Environmental Transition (ISET)***, two organizations experienced in working with communities to increase climate resilience and prepare for the impacts of a changing climate;
- Three of NOAA's Regionally Integrated Science and Assessment Programs (RISAs): the ***Western Water Assessment (WAA)***, the ***Climate Assessment of the Southwest (CLIMAS)*** and the ***Southern Climate Impacts Planning Program (SCIPP)***;
- ***ATMOS Research***, with extensive experience in developing and applying high-resolution climate projections to impact analyses in cities, regions, and states across the United States.

The Results

Miami received relevant climate and extreme weather information that is customized and specific to the thresholds identified during the project, an opportunity for multi-sector and inter-departmental collaboration convened and facilitated by an outside organization, and seed funding to facilitate use of thresholds in a climate preparedness project. Community leaders and city staff can use the climate and extreme weather information to support climate action, motivate participation, increase general climate literacy, and ultimately increase community resilience.

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