Anticipating future climate impacts to natural disaster risks in Ohio

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Ohio is Familiar with Extreme Weather

1913 Flood

Blizzard of 1978

2012 Derecho
Ohio’s Natural Hazards & Detecting Extremes

2016 Franklin County Emergency Management and Homeland Security Risk Assessment

1) Tornadoes
4) Flooding
9) Severe Winter Weather
12) Severe Summer Weather
15) Extreme Heat
19) Drought
Have to Ask the Right Questions!

“Did climate change cause a particular event to occur?”

Bad Question!

“Are events of this severity becoming more or less likely because of climate change?”

“To what extent was the storm intensified or weakened, or its precipitation increased or decreased, because of climate change?”
A Global Context
Increased Greenhouse Gases Elevate Temperatures and Feedbacks

NOAA Climate.gov, adapted from Figure 2.12 in State of the Climate in 2013.
### Impact: Record Warmth

![Graph showing probability of occurrence of cold, average, and hot weather](image)

<table>
<thead>
<tr>
<th>Period</th>
<th>High Max</th>
<th>High Min</th>
<th>Low Max</th>
<th>Low Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last 7 Days</td>
<td>51</td>
<td>193</td>
<td>46</td>
<td>8</td>
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<tr>
<td>Last 30 Days</td>
<td>1485</td>
<td>3925</td>
<td>941</td>
<td>171</td>
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<tr>
<td>Last 365 Days</td>
<td>30022</td>
<td>41083</td>
<td>19798</td>
<td>13382</td>
</tr>
</tbody>
</table>
We Expect more of What We’ve Seen!

National and Regional Impacts

- **Rising Temperatures**
  U.S. average temperature has increased by 1.3°F to 1.9°F since record keeping began in 1895. Warming has been the greatest in North and West while some parts of the Southeast have experienced little change.

- **Extreme Precipitation**
  Heavy downpours are increasing nationally, especially over the last three to five decades. The largest increases are in the Midwest and Northeast.

- **Floods**
  Floods have been increasing in parts of the Midwest and Northeast.

- **Droughts**
  Drought has increased in the West. Over the last decade, the Southwest has experienced the most persistent droughts on record.

- **Wildfires**
  Wildfires in the West start earlier in the spring, last later into the fall, and burn more acreage.

- **Sea Level**
  Sea levels along the Mid-Atlantic and parts of the Gulf Coast have risen by about 8 inches over the last half century.

- **Heat Waves**
  Heat waves have become more frequent and intense, especially in the West.

- **Cold Waves and Winter Storms**
  Cold waves have become less frequent and intense across the Nation. Winter storms have increased in frequency and intensity since the 1950s and their tracks have shifted northward.

- **Hurricanes**
  The intensity, frequency, and duration of North Atlantic hurricanes, as well as the frequency of the strongest (category 4 and 5) hurricanes, have all increased since the early 1980s.

**Source:** https://health2016.globalchange.gov/climate-change-and-human-health
Annual average temperature over the contiguous United States has increased by 1.2°F (0.7°C) for the period 1986–2016 relative to 1901–1960 and by 1.8°F (1.0°C) based on a linear regression for the period 1895–2016: National Climate Assessment CCSR: https://science2017.globalchange.gov/
A Look at Ohio Temperature Changes

Observed Number of Very Cold Nights

Observed Number of Very Hot Days

 NOAA

https://statesummaries.ncics.org/oh
What is Happening in Summer?

National Climate Assessment CCSR: https://science2017.globalchange.gov/

- The 1930s Dust Bowl era
- Agricultural intensification may have suppressed the hottest extremes in the Midwest. (Muller et al, 2016: Nature Climate Change; Science http://www.sciencemag.org/news/2018/02/america-s-corn-belt-making-its-own-weather)
Impacts: Urban Heat Island

- Additional stress on humans and livestock:
- Increased need for adequate cooling
- With increased moisture (humidity) we see sustained heat index

[Link to Climate Central](http://www.climatecentral.org/news/urban-heat-islands-threaten-us-health-17919)
Local Impacts from Increasing Temperatures: Shifting Growing Zones
Other Local Temperature Impacts

- Increased pressure from invasive plant species and weeds
- Pests shifting northward – potential disease transmission
- Ag impacts including rapid advancement of phenological state; increased susceptibility to late season freeze/frost; reduced quality of sensitive crops; reduced chilling hours needed for production of some crops
Annual precipitation has decreased in much of the West, Southwest, and Southeast and increased in most of the Northern and Southern Plains, Midwest, and Northeast. A national average increase of 4% in annual precipitation since 1901 mostly a result of large increases in the fall season. National Climate Assessment CCSR: https://science2017.globalchange.gov/
Closer to Home: Seasonal Precipitation Changes
Observed changes in extreme precipitation

• Extreme precipitation events are generally observed to increase in intensity by about 6% to 7% for each degree Celsius of temperature increase.

• Change in seasonal maximum 1-day precipitation (1948-2015)

National Climate Assessment CCSR: https://science2017.globalchange.gov/
Multiday Events

- Number of 2-day precipitation events exceeding the threshold for a 5-year recurrence
- Well above average for the last 3 decades
- 2012 Drought Impact
- Index value for 2015 was 80% above the 1901–1960 reference period average (3rd highest value after 1998 and 2008).

National Climate Assessment CCSR:
https://science2017.globalchange.gov/
Other Heavy Precipitation Metrics

- Maximum daily precipitation totals were calculated for consecutive 5-year blocks from 1901.

- The total precipitation falling in the top 1% of all days with precipitation.

National Climate Assessment CCSR: https://science2017.globalchange.gov/
Ohio’s Changing Precipitation

Observed Annual Precipitation

Observed Number of Extreme Precipitation Events

https://statesummaries.ncics.org/oh
Impacts: Farm Fields to Transportation

North Edge of Arcanum: July 6, 2017
Photos Courtesy of Sam Custer/Janelle Brinksneader

Photos courtesy of Ohio DOT:
Flooding of I-70 through Licking County in Central Ohio on July 14, 2017
Flooding and Water Quality

Photo credit: Toledo Blade
# Modeling the Future

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2046–2065 Mean and likely range</th>
<th>2081–2100 Mean and likely range</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCP2.6</td>
<td>1.0 (0.4 to 1.6)</td>
<td>1.0 (0.3 to 1.7)</td>
</tr>
<tr>
<td>RCP4.5</td>
<td>1.4 (0.9 to 2.0)</td>
<td>1.8 (1.1 to 2.6)</td>
</tr>
<tr>
<td>RCP6.0</td>
<td>1.3 (0.8 to 1.8)</td>
<td>2.2 (1.4 to 3.1)</td>
</tr>
<tr>
<td>RCP8.5</td>
<td>2.0 (1.4 to 2.6)</td>
<td>3.7 (2.6 to 4.8)</td>
</tr>
</tbody>
</table>

![Graph showing concentration of CO₂-equivalent (incl. all forcing agents) over time from 2000 to 2100 with different lines representing different scenarios.](image)
Future Climate

- 2021-2050: 2.5°F warmer for lower scenario and 2.9°F for higher scenario
- Near-term average is comparable to the hottest year in historical record (2012)

https://science2017.globalchange.gov/
Future Climate

- “Increases in water vapor, together with changes in circulation that are the result of expansion of the Hadley cell, bring more moisture to northern latitudes while maintaining or increasing the frequency of precipitation-producing weather systems.”

https://science2017.globalchange.gov/
Change in Annual Number of Days > 90°F

Lower Emissions
Change in annual #days Tmax > 90F by mid 21st century

Higher Emissions
Change in annual #days Tmax > 90F by mid 21st century

Ohio (1976-2005): 20-40 days per year

https://scenarios.globalchange.gov/locaviewer/
Change in Annual Number of Days < 32°F

Lower Emissions
Change in annual # of frost days by mid 21st century

Higher Emissions
Change in annual # of frost days by mid 21st century

Ohio (1976-2005): 80-160 days per year

https://scenarios.globalchange.gov/loca-viewer/
Change in Mean Annual Days with Precipitation > 2”

Lower Emissions
Change (%) in annual #days > 2 inches by mid 21st century

Higher Emissions
Change (%) in annual #days > 2 inches by mid 21st century

Ohio (1976-2005): < 1 day

https://scenarios.globalchange.gov/loca-viewer/
Change in Annual Maximum 5-Day Precipitation

**Lower Emissions**

Change (%) in annual max 5-day precip by mid 21st century

**Higher Emissions**

Change (%) in annual max 5-day precip by mid 21st century

Ohio (1976-2005): 2-4”

https://scenarios.globalchange.gov/loca-viewer/
Change in Annual Max Number of Consecutive Dry Days

Lower Emissions

Higher Emissions

Change in annual max # of consecutive dry days by mid 21st century

Ohio (1976-2005): < 20 days

https://scenarios.globalchange.gov/locaper/
Extreme Precipitation Risks

Greater Flood Risk (Increased Frequency of Flooding)
• Increased risk (damage to water infrastructure and changing floodplains \(\text{roads, floodwalls, dams, electric grid, water intakes, etc.}\))
• Health risks associated with floods \(\text{mold, exposure to chemicals and waterborne pathogens, vector control, drinking water and food contamination}\)
• Increased transportation issues \(\text{major disruptions to local economy, difficult for police and ambulances to respond to emergencies when areas are flooded}\)

Reduced Water Quality
• Intensity means more \text{runoff and potential contamination}\n• Increased need for water treatment due to deteriorated water quality.
• Potential for summer droughts and seasonal water shortages, particularly for agricultural and industrial use.
Ohio of the Future

Based on temperature, humidity, and precipitation, future summers in Ohio might resemble those in Arkansas, and winters may become similar to those in Virginia.
THANK YOU!

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