

The December 2021 Tornado Outbreak: A Case Study

Introduction:

In December of 2021, an outbreak of tornadoes ripped across eight states including Kentucky, Arkansas, Mississippi, Missouri, Illinois, Georgia, Ohio, and Tennessee.¹ More than 60 tornadoes caused at least 90 deaths² and resulted in an estimated \$18 billion in combined damages and economic losses, making it the costliest tornado event in United States history.³ The severe damage and strength of the storm system raises concerns about increasing evidence linking climate change and increased severity of extreme weather events.

Facts of the Case:

Throughout the evening of December 10th, 2021, a large storm system moved across the central and southern parts of the United States.⁴ More than 60 tornadoes developed out of the two supercell thunderstorms, traveling more than 100 miles across eight states, and leveling buildings, destroying homes, and causing dozens of deaths.⁴ Losses of life and property damages were especially severe in Arkansas, Missouri, Tennessee, and Kentucky.⁴ As of December 17th, 2021, Kentucky's death toll stood at 77, making this tornado event the deadliest in the state's history.⁵ Following a formal request by the Kentucky Governor Andy Beshear, President Biden declared a federal disaster on December 12th, 2021.⁶

The town of Mayfield, located in western Kentucky, suffered severe devastation. The Mayfield Consumer Products candle factory was destroyed by the tornado, trapping an estimated 100 workers under many feet of debris, and exposing some to corrosive chemicals.⁷ Recovery efforts took days because of the extent of debris, leaving many survivors with lasting physical and psychological scars such as nerve damage, chemical burns, and significant mental health impacts.⁸

Epidemiological Aspects:

Given the recent nature of the tornado outbreak, data on the number of deaths and costs associated with this disaster remain varied. The exact number of confirmed tornadoes is also still disputed. However, the National Weather Service reports there were 66 confirmed tornadoes across eight states,⁴ and the National Oceanic and Atmospheric Administration (NOAA) reports a total of 93 deaths and \$3.9 billion in costs associated with the storms.⁹

Several climate and social conditions converged to result in storms capable of such significant destruction. According to U.S. Storm Prediction Center meteorologist Matthew Elliot, "the seeds of the outbreak were planted in weeks of mild weather... without the typical parade of cold fronts moving through the central U.S. to bulldoze low level moist air—a building block for tornadoes—into the Gulf of Mexico."¹⁰ Another factor that made these storms deadly was the hundreds miles length of the storm's path, establishing one of the longest supercell storm paths in recorded history.¹⁰ Two EF4 tornadoes, characterized by the Fujita Scale as "violent" and "devastating damage" producing, tore through 3 states.¹¹ The EF4 tornado in Kentucky leveled much of the town of Mayfield with estimated wind speeds of 190 mph.⁴ The other EF4 tornado, with estimated wind speeds of 170 mph, struck Craighead and Obion Counties in Arkansas and Tennessee.⁴

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Another factor making these storms especially damaging was their nighttime occurrence. In addition to warning systems being less effective when people are sleeping, nighttime atmospheric changes can increase the strength of storms. Stephen Strader, an atmospheric scientist and hazards geographer at Villanova University, explained how these atmospheric changes brought more low-level moisture up from the Gulf of Mexico, which fueled the strength of the December storms and increased their destructive capacity.¹² Additionally, social risk factors played an important role. According to Strader, population density and poverty in the southern U.S. increased the damage and loss of life that resulted from the tornado outbreak.¹²

Management of the Event:

On December 12th, one day after the storms dissipated, President Biden declared a federal emergency, leading FEMA to erect an Incident Support Base in Fort Campbell, Kentucky, which enabled the rapid deployment of necessary personnel and resources to aid in clean-up and disaster response efforts.¹³ According to FEMA, the declaration of a federal disaster provided “a wide range of federal assistance programs for individuals and public infrastructure, including funds for both emergency and permanent work.”¹⁴ Other agencies, including the American Red Cross, provided additional critical services, relief supplies, food, and shelter to those impacted by the storms.¹⁴

Communications of the Event:

The strength and likely paths of the storm system were well forecasted, and the National Weather Service reports that severe weather warnings were issued with above average lead times.⁴ The first tornado warning was issued in Memphis, Tennessee at 7:06pm.¹⁵ While warnings were issued well in advance and sirens alerted residents to the approaching tornadoes, civilian response to these warnings was likely too slow, especially since they occurred during the night when many people were sleeping.²

Conclusion:

The deadly December 2021 tornado outbreak highlights an urgent need for disaster reform in the United States, especially improved resiliency efforts. An enduring overreliance on FEMA and other organizations for recovery activities after a disaster takes place illustrates the exigent need for improved preparedness and resiliency.¹⁶ More tornado shelters, FEMA funding for safe rooms within residential homes, and fortified basements, all of which were a part of a build back better plan in Greensburg, Kansas following a EF5 tornado in 2007, are examples steps that communities can take to reduce deaths and improve resiliency against extreme weather events.¹⁶ While it remains difficult to definitively link tornado outbreaks to climate change, severe tornadoes in December are historically rare, but research by the NOAA confirms that extreme weather events are increasing in both scale and frequency.¹⁷

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