Tennessee Twisters: Investigating Tornadic Hotspots in Western Tennessee from 1960-2022

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Abstract

This study examines tornado activity patterns and community vulnerability in Western Tennessee from 1960 to 2022. Using Geographic Information Systems (GIS) data and kernel density estimation (KDE), it identifies tornado-prone hotspots and evaluates their proximity to public storm shelters.

The findings reveal that counties like Shelby, Madison, Dyer, and Weakley have multiple high-density tornado hotspots, with Madison and Dyer counties showing frequent tornado touchdowns and paths. Many hotspots are more than 10 miles from the nearest storm shelter, placing them in a high-vulnerability category. Additionally, counties such as Benton, Decatur, and Fayette lack sufficient storm shelters, posing significant risks during tornado events. This study underscores the need for better tornado preparedness through strategic placement of shelters to reduce vulnerabilities and enhance safety. The data provides valuable insights for local governments, emergency management agencies, meteorologists, and citizens in mitigating tornado impacts.

Hypothesis

It is hypothesized that 20% of Western Tennessee counties would be highly vulnerable based on distance between tornado hotspot core and the nearest public storm shelter.

Data and Methods

By using tornado touchdown and tornado path data from the Storm Prediction Center SVRGIS database, I was able to use a Kernel Density Estimation (KDE) to identify statistically significant areas of heightened-tornado prone activity. Afterwards, public storm shelters were compiled for each county and examined the distance between the core of the hotspot and the average distance of each shelter to determine if it is possible for someone in the core area of the hotspot to reach a storm shelter in an appropriate amount of time. Afterwards, the average distance of shelters was analyzed to see how many counties had an appropriate distance to a storm shelter and ranked from low vulnerability to high vulnerability.

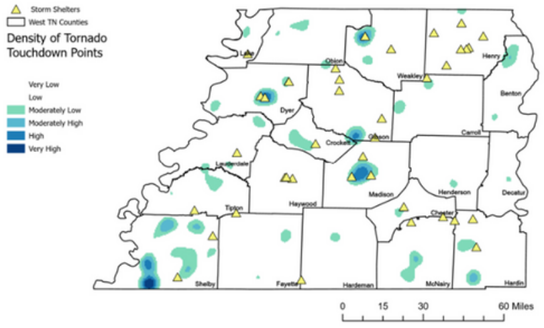


Image 1: Density of Tornado Touchdown Points in Western Tennessee. Darker colors indicate a greater density of tornado touchdown occurrences.

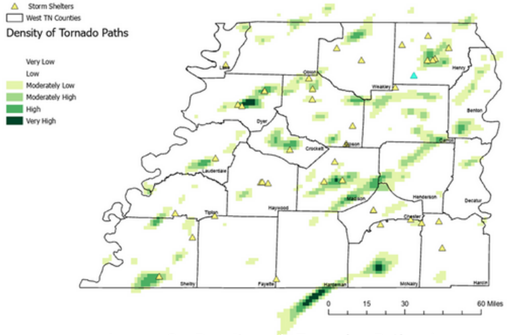


Image 2: Density of Tornado Paths in Western Tennessee. Darker green colors indicate a greater density of tornado paths.

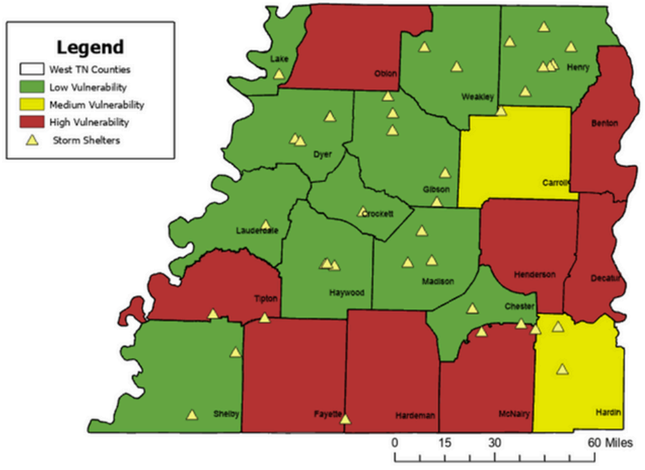


Image 3: Ranked counties from low vulnerability (green), medium vulnerability (yellow), and high vulnerability (red) based on the appropriate distance between core tornado hotspot and closest public storm shelter.

Counties	Avg Miles from Shelter
Dyer	3.48
Haywood	3.6
Crockett	4.23
Madison	4.38
Henry	4.58
Gibson	5.04
Chester	5.37
Weakley	5.99
Shelby	7.3
Lauderdale	7.77
Lake	8.87
Carroll	9.38
Hardin	9.94
Tipton	10.46
Fayette	11.22
McNairy	11.52
Obion	13.42
Henderson	14.75
Hardeman	18.45
Benton	19.1
Decatur	22.75

Image 4: List of each West Tennessee county and the average distance from hotspot core and public storm shelters.

Results and Conclusions

Western Tennessee has 39 public storm shelters, averaging 1.85 shelters per county, yet accessibility remains uneven. Five counties—Benton, Decatur, Fayette, Henderson, and Obion—lack public shelters entirely, leaving residents without local protection. Henry County has the highest number of shelters with seven, but only five shelters are near tornado touchdown hotspots. Shelby, Madison, Dyer, and Weakley counties have the highest density of tornado touchdown points, while McNairy, Dyer, Hardeman, and Madison show the highest density of tornado paths. Dyer and Madison consistently rank among the top four for both touchdown points and paths, underscoring their significant tornado activity.

Travel distances to shelters reveal critical vulnerabilities, with eight counties requiring trips exceeding 10 miles and six of these relying on shelters in neighboring counties. Decatur County has the longest mean travel distance at 22.75 miles, while Dyer County has the shortest at 3.48 miles. Haywood County, with no identified hotspots, had no travel needs. Overall, 38% of counties in Western Tennessee are highly vulnerable to tornado threats, exceeding the hypothesized 20%. These findings emphasize the importance of addressing gaps in shelter accessibility to help city officials, emergency management directors, and residents improve preparedness, mitigate risks, and enhance resilience against future tornado events.

Limitations

- Using a time period of 1960-2022
- Population density and size of public shelters
- FEMA approved shelters vs private or open shelters
- Structure of homes, mobile homes, two-story homes
- Proximity to a hospital

References

NCEI (2024, January 1). Storm Events Database - Tennessee. NOAA National Center for Environmental Information.
NWS (2024). Tennessee Tornado Stats.
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