

Manufactured Homes FAQ

<p>Mobile Home: A prefabricated home (manufactured off-site) constructed prior to 1976</p>	<p>Manufactured Home: A prefabricated home constructed after 1976 in accordance with the HUD manufactured Home Construction and Safety Standards.</p>	<p>Site built Home: Any home that is not prefabricated, i.e., any home built on site. Site built homes may or may not be build to conform to a local building code depending on the local adoption and enforcement of building codes.</p>	<p>Stick Built Home: Any home, prefabricated or site built, that is constructed using an assemblage of dimensional sawn lumber for the structural system.</p>
<p>Modular Home: A prefabricated home designed and constructed to conform to the local building code in effect at the final location of the home. - Note: that the Alabama Building Commission includes Modular Homes within the general category of Manufactured Buildings, which are subjected to local building codes and specifically excludes Manufactured Homes.</p>			

Alabama does not have a mandatory statewide building code system. The Alabama Building Commission has adopted the 2015 International Building Code, but it only applies to state buildings, schools, hotels/motels, and movie theaters.

Building codes: Building codes for typical residential and commercial buildings must be adopted and enforced by the local jurisdiction, and therefore both adoption and enforcement vary throughout the state.

The ISO Building Code Effectiveness Grading System (BCEGS) rates building codes in individual communities and reports an average score of 48 out of 100 for the communities it has graded. No public studies exist that have compiled the wind resistant requirements in AL communities.

In 1976...

In 1974, Congress passed the Federal National Mfd. Housing Construction and Safety Standards Act commonly referred to as the HUD code. These new HUD codes were put into place on 5 June 1976. After this date “mobile” homes were now to be referred to as “manufactured” homes due to the changes in construction, design, performance, and installation. Homes that meet the post-1976 HUD codes are assigned a HUD tag proving that **“to the best of their (manufacturer) knowledge”** the home is built to the HUD requirements. A “data plate” is also placed on the home that can list equipment, wind zone, and other information.

HUD revised the codes in 1994 and 1999 which added more laws/regulations for manufactured homes (primarily foundation requirements).

According to the American Community Survey (ACS) 2017,
13.4% of all homes in Alabama are considered mobile or manufactured homes.

Determining the percentage of total population that lives in MHs is much more difficult. By Strader's estimates (based on the 2017 ACS data the average household size is 2.63 people and there are 298,911 AL MHs)
approximately 16% the entire Alabama population lives in MHs.

72% - of all tornado fatalities occur in homes (permanent, mobile, manufactured, etc)

54% - of housing fatalities occur in MHs despite MHs only making up 6% of the U.S. housing stock.

Prior research has indicated that MH residents are **15-20 times more likely to be killed** in MH compared to permanent home.

Typically complete destruction of a MH is expected for wind loads approximately **45%** of those expected to destroy a permanent home.

MHs in Alabama are **4x more likely** to be struck by a tornado compared to those in Kansas (i.e., classic "tornado alley").

Given tornado risk (i.e., tornado frequency, magnitude, etc.) similarities between the Central Plains and Southeast U.S., the difference in MH-tornado impact potential can attributed to **BOTH** a greater number of MHs as well as a more sprawling (i.e., dispersed) MH development pattern in Alabama compared to Kansas. This also holds true for comparing the entire Central Plains and Southeast U.S. regions.

Lay in a ditch vs riding it out in a MH...

The hope is that over the next few years researchers and IWT members can jointly develop answers to questions such as IF, HOW, and WHEN an intermediate product, an "in between" product that falls between a watch and warning, may result in MHs residents taking protective actions beyond their current efforts.

This is not necessarily true, but widely debated. Typically, laying in a ditch or ravine should be a last resort to sheltering from a tornado. This type of protective action is suggested to those outside who cannot make it to adequate shelter.

That being said, some groups (e.g., CDC) suggest that MH residents may actually be better off fleeing their homes and lying flat in a ditch or culvert. Other researchers (i.e., Tom Schmidlin; Kent State University) have noticed that vehicles may offer more protection than MHs during tornadoes as well. Either way, **all parties state that the best course of action is to flee the MH for sturdier protection.**

The information in this document will be updated periodically. For updated information, please visit

weather.gov/bm/x/birminghamiwt

and view the link "Mobile and Manufactured Housing (FAQ)"

Last updated 12/11/2019

HUD's Manufactured Home Construction and Safety Standards (MHCSS; 24 CFR 3280) and its Model Manufactured Home Installation Standards (24 CFR 3285) categorize the United States and many of its territories and protectorates into three wind zones:

Zone I, Zone II, and the highest wind zone, Zone III.



Wind zones were created by HUD with the 1976 changes. These wind zones are designed for horizontal wind speeds and uplift loads.

However, wind speed loads are more directly aimed toward tropical storm/hurricane safety, **not** tornadic winds with very strong vertical velocities in addition to debris loading and strong horizontal winds.

Typically the Wind Zone and associated requirements are listed on the MH's manufacturer/data plate.

Zone III – Designed to resist wind speeds up to 110 mph.

Zone II – Designed to resist wind speeds up to 100 mph.

Zone I – Designed for the interior of the country where hurricanes are not expected

The wind speeds and pressures associated with the Wind Zones are archaic, as they are based on ASCE 7-88, which uses fastest-mile wind speeds and a 50-yr recurrence interval. HUD S3280.306(a) requires that a 1.5 factor of safety be applied to the required wind pressures. Converting these wind speeds and pressures to equivalent modern day, ultimate wind speeds as would be seen in the most recent wind design standards (i.e., ASCE 7-16) gives the following:

A specific wind speed for **Zone I** is not directly given - rather design horizontal and vertical wind pressures are assigned which are generally taken to represent wind speeds of approximately 70 mph

	Wind Zone I	Wind Zone II	Wind Zone III
HUD S3280 Wind Speed (ASCE 7-88, fastest-mile)	70 mph	100 mph	110 mph
Equivalent Ultimate Wind Speed (ASCE 7-16, 3-sec gust)	108 mph	150 mph	163 mph

The HUD code states that all manufactured homes (post-1976) must be designed and built according to the standards for Wind Zones I, II, or III. Thus, the wind rating requirements are set by HUD and the manufacturer has to meet the requirements outlined in HUD's Manufactured Home Construction and Safety Standards (MHCSS; 24 CFR 3280) and its Model Manufactured Home Installation Standards (24 CFR 3285).

Link to HUD code –

<https://www.ecfr.gov/cgi-bin/text-idx?SID=6bd2584101863d49f18d6dd4f530307b&mc=true&node=pt24.5.3280&rgn=div5#sp24.5.3280.a>

Mobile and Manufactured Housing (MH) FAQ

1. If you live in a 'MH' home, what are the best sheltering options?

- Officially, the NWS, NOAA, and FEMA all suggest that mobile/manufactured housing residents **flee their homes for sturdier shelter**. (As mentioned in public-facing FEMA, NOAA, and Ready.gov documents)
 - However, this is not such an easy task for a large number of MH residents due to a number of factors. The following assumptions are often made in this situation:
 - Residents have a car
 - Residents know where sturdier shelter is located
 - Residents actually know WHAT "sturdier" shelter looks like
 - Residents know their own home's geographic location (in general and relative to the storm/storm movement)
 - Community shelter is open
 - Whether pets are allowed or not
 - Shelter is at capacity
 - Etc. etc. etc....
 - Recent research has shown that due to the greater number of MHs being located in rural locations with Alabama (>80%) community tornado shelters are often not the solution. **Rather, the retrofitting of existing structures so that they are more resistant to tornadic winds, may be more practical and financially feasible.**
 - Typical structural upgrades such as adding tie-downs and anchoring can be done so at a fraction of the total cost of a new MHs. (i.e., under \$2,000)
 - The expected benefit of these retrofits in terms of reduced damage and reduced injury risk has never been quantified, but is the focus of a VORTEX-SE proposal currently under review.
 - Many Southeast counties simply can't afford a community shelter even with FEMA's cost-sharing program. In fact, southern Alabama EMs often realize that community shelters aren't the best option because so many of their residents live in rural areas.
 - **MH resident sheltering best practices:** Have a sheltering plan. Know where your community shelters are located, how long it takes to get there, and a means of getting there. Currently, the best option is to begin moving towards your safer shelter at the tornado watch level.

2. Should you really lay in a ditch vs riding it out in a MH?

- Not necessarily, but this is still widely debated. Typically, laying in a ditch or ravine should be a last resort to sheltering from a tornado. This type of protective action is suggested to those outside who cannot make it to adequate shelter. That being said, some groups (e.g., CDC) suggest that MH residents may actually be better off fleeing their homes and lying flat in a ditch or culvert. Other researchers (i.e., Tom Schmidlin; Kent State University) have noticed that vehicles may offer more protection than MHs during tornadoes as well. Either way, **all parties state that the best course of action is to flee the MH for sturdier protection.**

3. What is the difference between a mobile home, a manufactured home, modular home, site built home, stick built home?

- **Mobile home** - a prefabricated home (i.e., manufactured off-site) constructed prior to 1976.

- **Manufactured home** - a prefabricated home constructed after 1976 in accordance with the HUD Manufactured Home Construction and Safety Standards.
 - **Modular home** - a prefabricated home designed and constructed to conform to the local building code in effect at the final location of the home.
 - *Note: that the Alabama Building Commission includes Modular Homes within the general category of Manufactured Buildings, which are subjected to local building codes and specifically excludes Manufactured Homes.*
 - **Site built home** - any home that is not prefabricated, i.e., any home built on site. Site built homes may or may not be built to conform to a local building code depending on the local adoption and enforcement of building codes.
 - **Stick built home** - any home, prefabricated or site built, that is constructed using an assemblage of dimensional sawn lumber for the structural system.
4. **Are there specific building codes for those listed in #1? Are codes based on national, state, local jurisdiction? Do you see a lot of community requirements?**
- Alabama does not have a mandatory statewide building code system. The Alabama Building Commission has adopted the 2015 International Building Code, but it **only applies to state buildings, schools, hotels/motels, and movie theaters**. Building codes for typical residential and commercial buildings must be adopted and enforced by the local jurisdiction, and therefore both adoption and enforcement vary throughout the state. The ISO Building Code Effectiveness Grading System (BCEGS) rates building codes in individual communities and reports an average score of 48 out of 100 for the communities it has graded. No public studies exist that have compiled the wind resistant requirements in AL communities.
5. **What happened in 1976? HUD changes?**
- In 1974, Congress passed the Federal National Mfd. Housing Construction and Safety Standards Act commonly referred to as the HUD code. These new HUD codes were put into place on 5 June 1976. After this date “mobile” homes were now to be referred to as “manufactured” homes due to the changes in construction, design, performance, and installation. Homes that meet the post-1976 HUD codes are assigned a HUD tag proving that **“to the best of their (manufacturer) knowledge”** the home is built to the HUD requirements. A “data plate” is also placed on the home that can list equipment, wind zone, and other information.
 - HUD revised the codes in 1994 and 1999 which added more laws/regulations for manufactured homes (primarily foundation requirements).
6. **What percentage of Alabama residents live in MHs? How does that compare to the national average?**
- According to the American Community Survey (ACS) 2017, **13.4% of all homes in Alabama are considered mobile or manufactured homes**. Determining the percentage of total population that lives in MHs is much more difficult. Based on the 2017 ACS data

with the average household size is 2.63 people per home and 298,911 MHs in Alabama, approximately 16% of the entire Alabama population lives in MHs.

7. How much more likely are you to be injured or killed based on what type of home (from question 1)?

- Historically, 72% of all tornado fatalities occur in homes (permanent, mobile, manufactured, etc.)
- 54% of these housing fatalities occur in MHs despite MHs only making up 6% of the U.S. housing stock.
- Prior research has indicated that MH residents are 15-20 times more likely to be killed in a MH compared to a permanent home.
- Typically complete destruction of a MH is expected for wind loads approximately 45% of those expected to destroy a permanent home.
- MHs in Alabama are 4x more likely to be struck by a tornado compared to those in Kansas (i.e., classic “tornado alley”). Given tornado risk (i.e., tornado frequency, magnitude, etc.) similarities between the Central Plains and Southeast U.S., the difference in MH-tornado impact potential can be attributed to BOTH a greater number of MHs as well as a more sprawling (i.e., dispersed) MH development pattern in Alabama compared to Kansas. This also holds true for comparing the entire Central Plains and Southeast U.S. regions.

8. Could we benefit from an ‘in between’ product that falls between a watch and a warning? I.E. is it unreasonable to expect MH residents to sit in a community shelter for hours?

- Planned future research (under review by NOAA for grant funding) by individuals such as Stephen Strader (Villanova University), Kevin Ash (University of Florida), and other researchers involved in the VORTEX-SE program will explicitly examine this question by working alongside IWTs across the Southeast. The current thinking is that yes, such a product would be useful if directed towards MH residents. Of course this is speculative, but the hope is that over the next few years researchers and IWT members can jointly develop answers to questions such as IF, HOW, and WHEN such an intermediate product may result in MHs residents taking protective actions beyond their current efforts.

9. What are the types of anchoring? Spacing of anchoring?

- HUD stipulates that tie-downs or anchoring is required for MHs located in Zones I and II. However, they do not indicate the type, number, or location of the tie-downs. Singlewide MHs require both diagonal and vertical ties, while doublewide MHs require only diagonal ties. (Below is the spacing of anchoring based on MH home length per Chapter 535-X-13 of the Alabama Administrative Code). The code allows alternative systems to be used beyond the traditional tie and ground anchor systems so long as they are approved by the Alabama Manufactured Housing Commission.

WIND ZONE II HURRICANE ZONE			WIND ZONE I NON-HURRICANE ZONE	
*Length of Mobile Home (ft)	**No. of Vertical Ties	No. of Diagonal Ties	***No. of Vertical Ties	***No. of Diagonal Ties
0 - 40	5	5	0	4
41 - 60	7	7	0	6
61 - 90	9	9	0	8

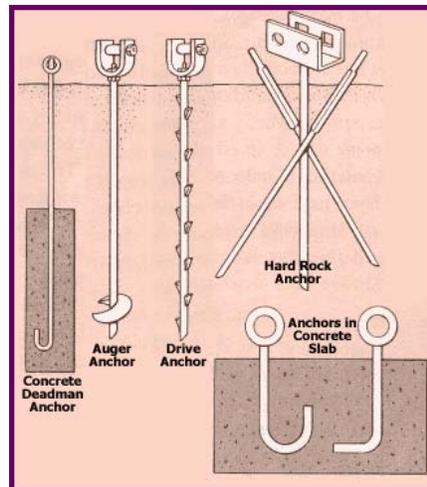
*Length of mobile home (as used in this table) means length excluding draw bar.

**The federal manufactured home construction and safety standards require all manufactured homes designed to be located in wind zones II and III to have a vertical tie installed at each diagonal tie location.

***If pier height is over 24", an additional diagonal tie must be added for every additional 12" or a portion thereof.

****Manufactured homes that do not have a HUD label must have three (3) vertical ties per side in zone 1.

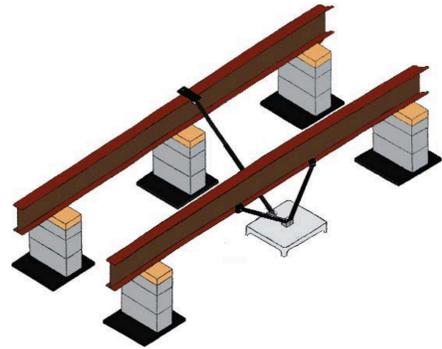
- **Types of tie-downs:** Many older (pre-1976) MHs have over-the-top tie-downs. In recent years, it has been more common for MHs to be secured with anchoring straps attached to the home's steel frame rails, called frame anchors. Diagonal frame anchors (also known as diagonal anchor ties) connect the steel frame to ground anchors typically installed along the perimeter of the home. Vertical anchor ties connect the exterior walls directly to the ground anchors along the perimeter of the home. Zone 1 typically only requires diagonal anchor ties, designed primarily to resist horizontal sliding, while Zone 2 typically requires diagonal and vertical anchor ties, which are used to resist wind uplift.
- **Types of anchors:** Available in different soil conditions, concrete slabs, etc.



- **Link to tie-down information sheet:**
<http://wchapa.org/wp-content/uploads/2013/02/Tie-Downs.pdf>
https://www.huduser.gov/Publications/PDF/foundations_guide.pdf
- **Alternative anchorage systems**

In detailed engineering assessments following tornadoes in the southeast in 2019, Roueche found that approximately 1/3 of manufactured homes utilize pan anchorage systems. These systems rely upon steel tubing to brace the manufactured home frame against a pan that either rests on bare ground or is set underneath one of the piers. The systems are effective against

horizontal loads only. They typically rely upon the self-weight of the structure to resist uplift and overturning forces, leaving no capacity to resist forces beyond design. The only tie-downs and anchors present in these systems are usually at the four corners, where they are installed to transfer lateral forces from the end shear walls to the ground. The figure below shows (left) an installed pan anchorage system installed on a single-wide home in Troy, AL, while the right shows a schematic from the HUD Guide to Foundation and Anchorage Systems for the same type of system. Note that the pan simply rests on the ground, it is not anchored in any way..



10. Are there wind ratings per manufacturer or ratings based on home types?

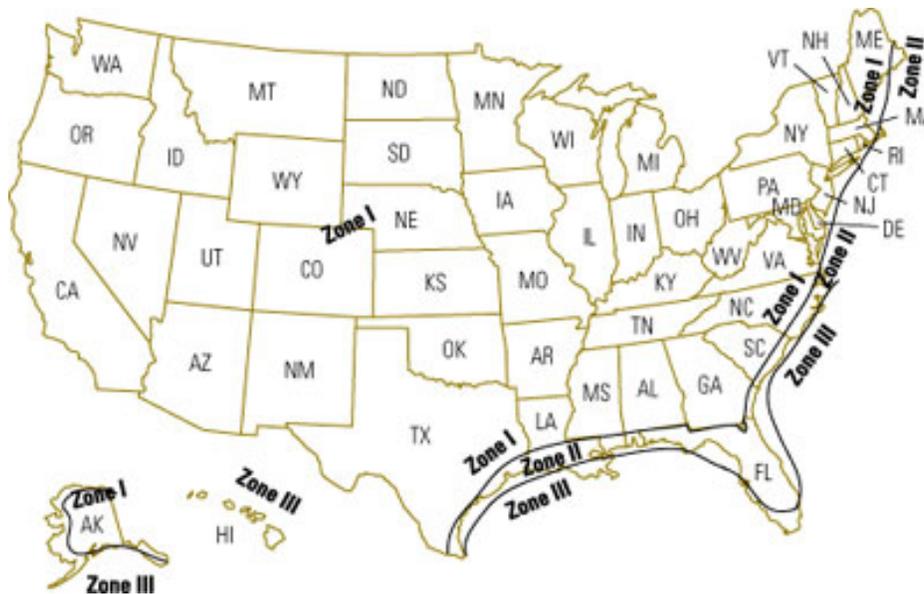
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11. What are the 'zones'? Zone I vs Zone II, etc?

- HUD's Manufactured Home Construction and Safety Standards (MHCSS; 24 CFR 3280) and its Model Manufactured Home Installation Standards (24 CFR 3285) categorize the United States and many of its territories and protectorates into three wind zones: Zone I, Zone II, and the highest wind zone, Zone III.
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on ASCE 7-88, which uses fastest-mile wind speeds and a 50-yr recurrence interval. HUD S3280.306(a) requires that a 1.5 factor of safety be applied to the required wind pressures. Converting these wind speeds and pressures to equivalent modern day, ultimate wind speeds as would be seen in the most recent wind design standards (i.e., ASCE 7-16) gives the following:

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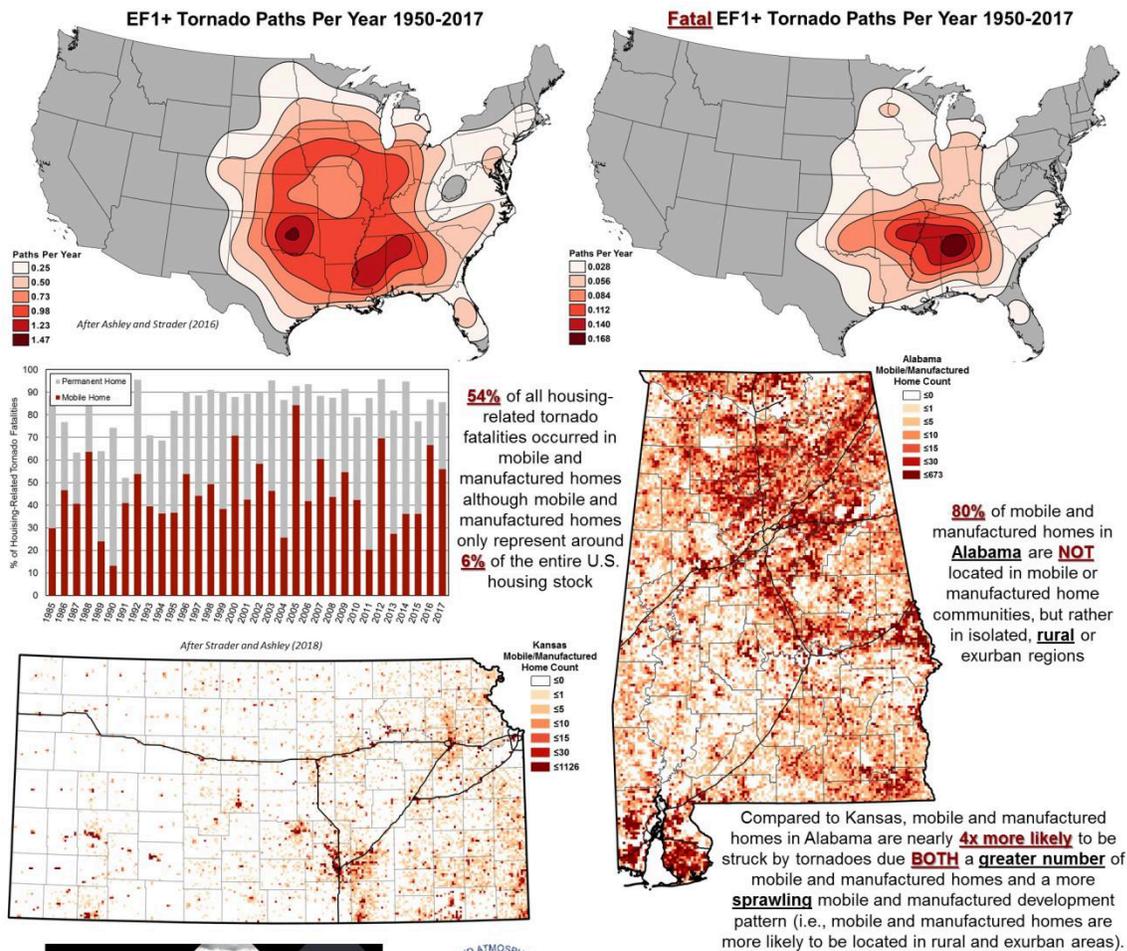


Tornadoes and Mobile Homes: An Inter-science Approach to Reducing Vulnerabilities and Improving Capacities for the Southeast's Most Susceptible Population

Stephen Strader¹, Walker Ashley², Kim Klockow-McClain³, Kevin Ash⁴, David Roueche⁵, Mike Egnoto⁶

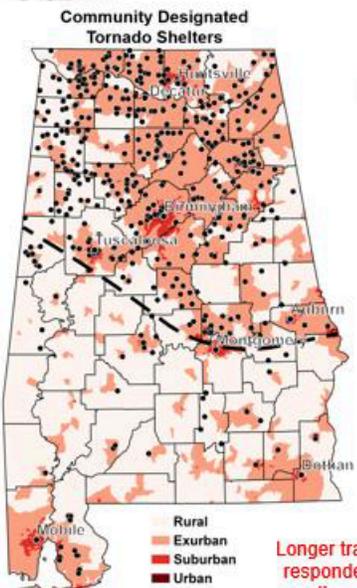
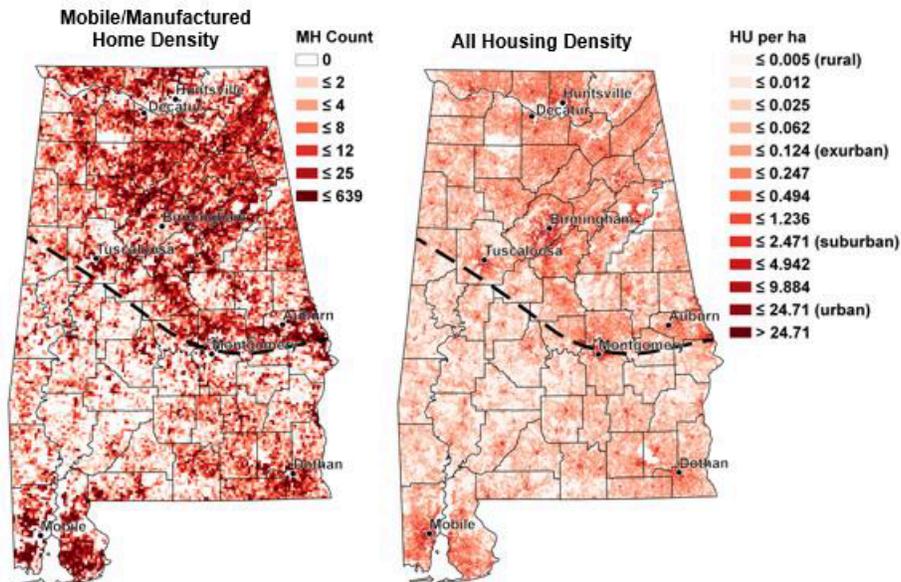
¹Department of Geography and the Environment, Villanova University, ²Department of Geographic and Atmospheric Sciences, Northern Illinois University, ³Cooperative Institute for Mesoscale Meteorological Studies, University of Oklahoma, ⁴Department of Geography, University of Florida, ⁵Department of Civil Engineering, Auburn University, ⁶W. Reed Army Institute of Research

Fine-scale assessment of mobile home tornado vulnerability in the Central and Southeast U.S.



Personnel: Stephen Strader (PI Contact, Villanova University), Walker Ashley (NIU), Kim Klockow-McClain (OU-CIMMS), Kevin Ash (UF), David Roueche (Auburn), Michael Egnoto (Walter Reed Army Institute)

Mobile Home Resident Evacuation Vulnerability and Emergency Medical Service Access During Tornado Events in the Southeast



The most socioeconomically and physically vulnerable populations (southern Alabama MH residents) in Alabama have fewer tornado sheltering options and are disproportionately less served by first responder services.

Mobile/Manufactured (MH) home and permanent home (PH) network analysis results for potential tornado shelters in northern and southern Alabama. Mean travel time (min) and distance (mi) are also given for each regional and housing type scenario.

Scenario (Destination)	Region	Housing Type (Origin)	Travel Time	Distance (km)
			Mean	Mean
Place of Worship	North	PH	8.4	5.2
		MH	13.8	8.9
Place of Worship	South	PH	7.8	4.9
		MH	11.4	7.5
Schools	North	PH	6.0	3.7
		MH	9.6	6.0
Schools	South	PH	6.6	4.4
		MH	10.8	7.3
Community Designated Tornado Shelters	North	PH	12.6	8.0
		MH	12.3	7.8
Community Designated Tornado Shelters	South	PH	31.8	24.7
		MH	33.0	25.4

Longer travel times from mobile homes to tornado shelters and from first responder stations to mobile homes exacerbates mortality potential for the most tornado-vulnerable populations in the Southeast U.S.

Policy makers, elected officials, engineers, and the manufactured housing industry should focus their efforts on **improving building and siting quality of individual MHS, rather solely concentrating their efforts on implementing new community tornado shelters** in regions (i.e., Southeast U.S.) where a large percentage of the total housing stock and MHS are located in isolated (i.e., rural areas).

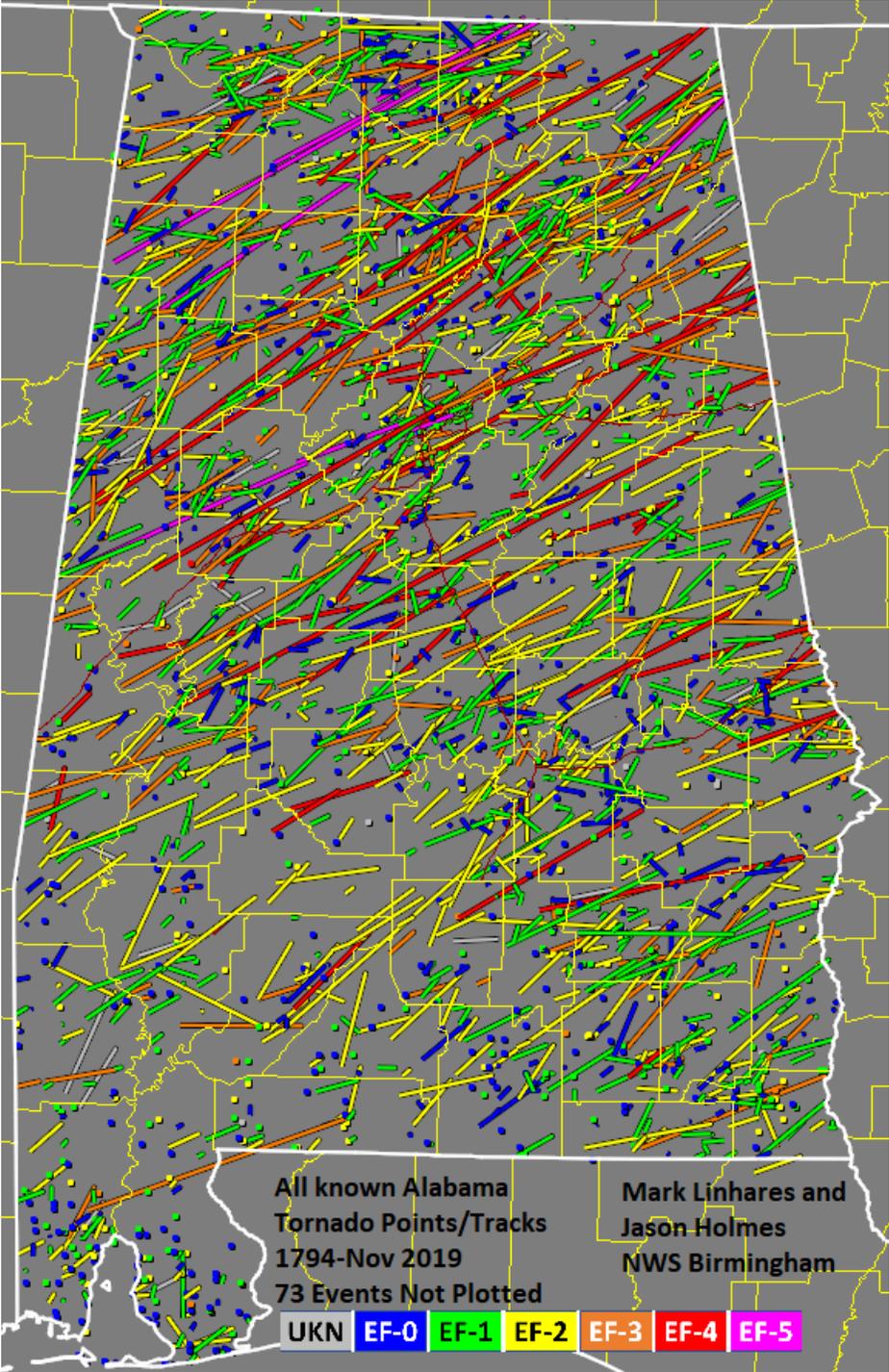
(Published in *International Journal of Disaster Risk Reduction*)

****Data available upon request****

Contact Info: Stephen Strader (stephen.strader@villanova.edu)

NWS Birmingham Alabama Tornado Database
Mark Linhares and Jason Holmes

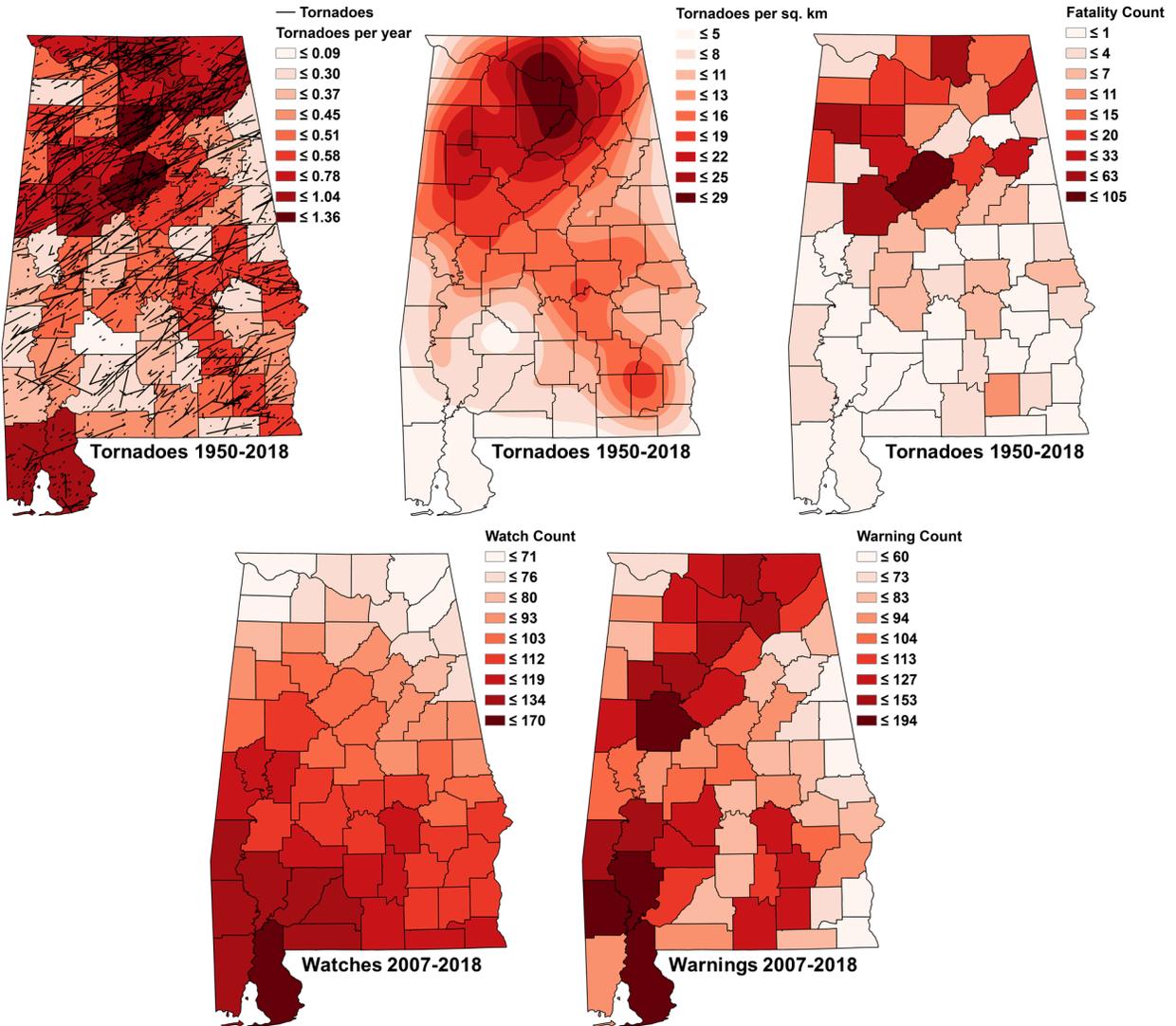
All known tornadoes 1794-November 2019
Locations for all but 73 tornadoes plotted



Alabama Tornado Event, Fatality, Watch, and Warning Climatology

Stephen Strader

(After Strader et al. 2018; *International Journal of Disaster Risk Reduction*)

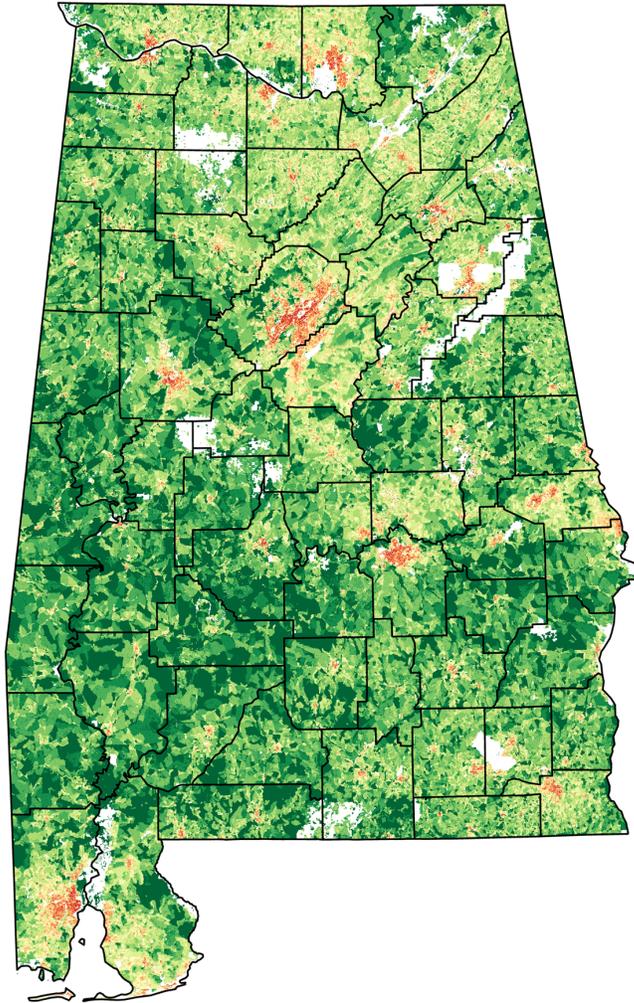


Alabama Housing Unit Density 2019

Stephen Strader

(After Strader and Ashley 2018; *Weather, Climate, and Society*)

Alabama Housing Density 2019



Housing Units per Hectare

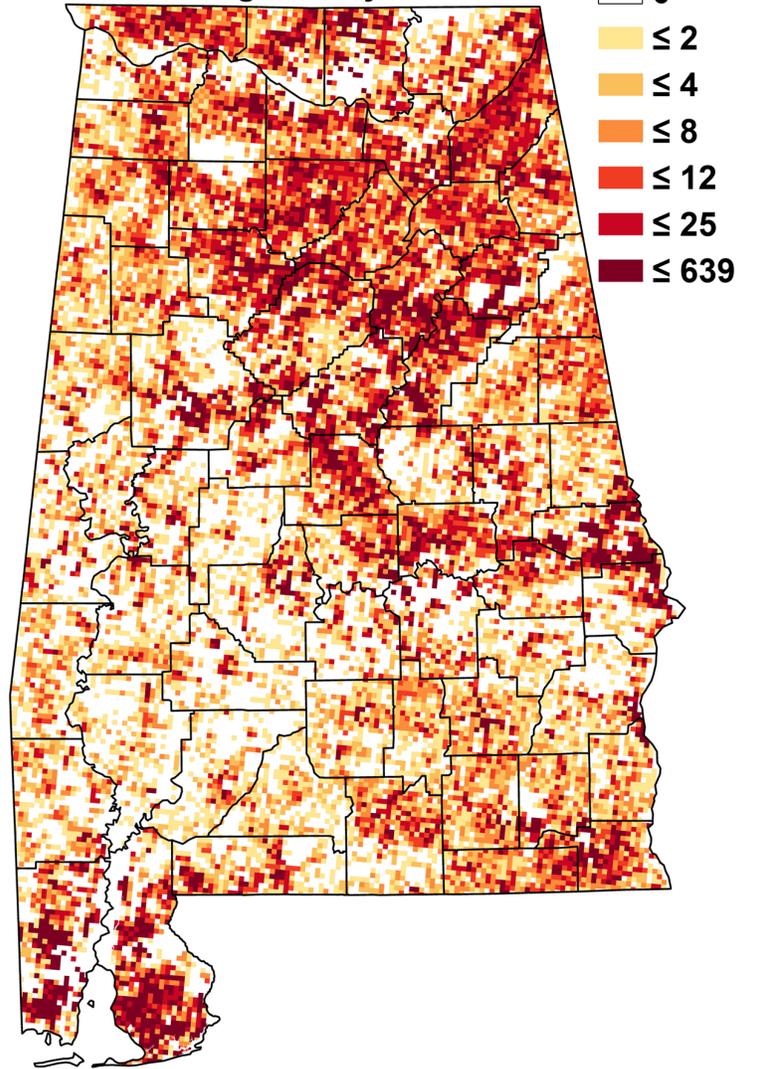
- ≤ 0.005 (rural)
- ≤ 0.012
- ≤ 0.025
- ≤ 0.062
- ≤ 0.124 (exurban)
- ≤ 0.247
- ≤ 0.494
- ≤ 1.236
- ≤ 2.471 (suburban)
- ≤ 4.942
- ≤ 9.884
- ≤ 24.71 (urban)
- > 24.71

Alabama Mobile and Manufactured Housing Density 2019

Stephen Strader

(After Strader and Ashley 2018; *Weather, Climate, and Society*)

Alabama Mobile and Manufactured Housing Density 2019



Alabama Community Designated Tornado Shelters and Land Use Density 2019

Stephen Strader

(After Strader et al. 2018; *International Journal of Disaster Risk Reduction*)

Community Designated Tornado Shelters

