

Editor's Letter:

Attached is a referee report on your submission to the *Journal of Risk and Uncertainty*, "The Effects of Nearby Tornadoes on Self-Protection Investments." The referee thought that the paper utilizes a superb data set, is well executed, and deserves to be published somewhere. However, the referee did not recommend publication of the paper in the *JRU* based on the absence of **strong general lessons** for our journal's readership regarding **how people make choices under uncertainty**. Thus we have a problem of "fit."

Notwithstanding the reviewer's negative overall assessment, I think that the paper has promise since what you have already done is of such high quality. I would like to highlight ways in which the paper might be amended to better address issues of concern to the *JRU* audience. For example, based on your results do we have any sense of **whether people adequately perceive, prepare, and respond to natural hazards?** What is the **nature of any bias in risk perceptions?** **Is it that a recent tornado provides information, which the referee believes it does not,** or does it **stimulate the acquisition of information about the cost and effectiveness of shelters?**

RESPONSE: I think that the underlying probability of a tornado "hit" may be increasing (or at least changing) as the climate changes. Our paper highlights the importance of risk salience for people's decisions about when to take advantage of the opportunity for a subsidy for installing a tornado shelter. If people were reacting merely to historical risks for their zip code or county, or seasonality in the risk of being hit by a tornado, then a panel data model with seasonal and zip/county fixed effects would entirely explain people's decisions to install a shelter for which they request a subsidy.

If shelter installation decisions were driven entirely by the general severity of the current tornado season elsewhere in the country, then month fixed effects would entirely absorb the information about general severity. We show that even after controlling for zip code fixed effects and time fixed effects at the level of months, a recent tornado in the household's own county has a positive effect on shelter installation decisions, but only for a few months. Compared to tornados in other counties (with centroids within 50 miles of the centroid of the household's own county), own-county effects are positive but other-county effects are negative (perhaps reflecting the difficulty of finding a shelter contractor in this county when their services are required in other counties).

Consider referencing the following more-recent literature:

Ripberger, Silva, Jenkins-Smith, Carlson, James et al. (2015). "False Alarms and Missed Events: The Impact and Origins of Perceived Inaccuracy in Tornado Warning Systems." *Risk Analysis* **35**: 44-56.

"We find that subjective perceptions are in part a function of objective experience, knowledge, and demographic characteristics."

Scott and Liang (2015). "Evaluation of shelter performance following the 2013 Moore tornado." *Wind and Structures* **21**: 369-381. *ordered via ILL 12/10/2016*

“Results showed a marked increase in the number of exterior underground shelters as well as the popularity of a new in-garage floor underground shelter design. All of the units provided protection for their occupants with no loss of life reported.”

Howe, Boudet, Leiserowitz and Maibach (2014). "Mapping the shadow of experience of extreme weather events." *Climatic Change* **127**: 381-389.

“(2) how characteristics of different extreme events shape the geographic area within which people are likely to report they have experienced it-the event's perceived "shadow of experience." We overlay geocoded survey responses indicating personal experience with hurricanes, tornadoes, and drought-from a 2012 nationally representative survey (N = 1,008) of U.S. residents-on maps of recorded event impacts. We find that reported experiences correspond well with recorded event impacts, particularly for hurricanes and tornadoes. Reported experiences were related to event type, proximity, magnitude and duration.”

Senkbeil, Scott, Guinazu-Walker and Rockman (2014). "Ethnic and Racial Differences in Tornado Hazard Perception, Preparedness, and Shelter Lead Time in Tuscaloosa." *Professional Geographer* **66**: 610-620. [Senkbeil_etal_ProfGeog14.pdf](#)

“Furthermore, results were still significant for perception after controlling for the effects of age, education, and experience.”

Suls, Rose, Windschitl and Smith (2013). "Optimism Following a Tornado Disaster." *Personality and Social Psychology Bulletin* **39**: 691-702.
[Suls_etal_PersSocPsychBull13.pdf](#)

“Effects of exposure to a severe weather disaster on perceived future vulnerability were assessed in college students, local residents contacted through random-digit dialing, and community residents of affected versus unaffected neighborhoods.”

Wallace, Keys-Mathews and Hill (2015). "The Role of Experience in Defining Tornado Risk Perceptions A Case from the 27 April 2011 Outbreak in Rural Alabama." *Southeastern Geographer* **55**: 400-416. [Wallace_etal_SEGeographer15.pdf](#)

“...while 40 percent of the study population reports a change in perceived tornado risk, direct experience was less a driver of change than was anticipated. The amplified or diminished perception, in fact, may be based on a more shared social experience. This study found that experience extends beyond direct experience.”

Perhaps the paper could foster greater understanding of who self-protects and why they self-protect. These are just a few ideas of how you might be able to broaden the substantive conclusions of the paper to make it publishable in the *JRU*.

RESPONSE: We could attempt a model of how applications for shelter subsidies reflect the sociodemographics of the neighborhood (census tract 5-year ACS in 2010 for everyone, or county 1-year ACS for each year, for a more limited set of variables).

Sociodemographic heterogeneity in tornado risk perception or sheltering behavior:

Chaney, Weaver, Youngblood and Pitts (2013). "Household Preparedness for Tornado Hazards: The 2011 Disaster in DeKalb County, Alabama." *Weather Climate and Society* **5**: 345-358. *ordered via ILL 12/10/2016*

"older residents (60+ yr) and households without children were significantly less likely to have participated in a tornado drill, lower income residents were significantly less likely to have a tornado-resistant shelter on the premises or a plan for seeking shelter, and mobile home residents were significantly less likely to have a plan for seeking shelter. Locus of control and past experience were not significantly associated with adoption of hazards adjustments, but suspected reasons for these results are discussed."

Fuller (2014). "The Effect of Prenatal Natural Disaster Exposure on School Outcomes." *Demography* **51**: 1501-1525.

"...that children exposed to hurricanes prenatally have lower scores on third grade standardized tests in math and reading. Those exposed to flooding or tornadoes also have somewhat lower math scores. Additionally, results suggest that these negative effects are more concentrated among children in disadvantaged subgroups, especially children born to black mothers."

Jaurnic and Van Den Broeke (2016). "Perceptions of tornadoes, tornado risk, and tornado safety actions and their effects on warning response among Nebraska undergraduates." *Natural Hazards* **80**: 329-350.

Jaurnic_VanDenBroeke_NaturalHazards16.pdf

"Those who responded to the highest proportion of warnings were from the Great Plains, perceived the local city as equally likely to be affected by a tornado compared to the surrounding region, and reported learning tornado-related information primarily from their parents. International students and those gaining most of their tornado-related knowledge from school responded to fewer warnings and took less safe actions overall."

Luo, Cong and Liang (2015). "Number of Warning Information Sources and Decision Making During Tornadoes." *American Journal of Preventive Medicine* **48**: 334-337.

Luo_Cong_Liang_AmJPrevMed15.pdf

"Having an emergency preparation plan in both cities and being white in Tuscaloosa significantly increased the odds of taking protective action, whereas being divorced in Joplin reduced these odds. Conclusions: Receiving warnings from more warning information sources might be more beneficial in places with less previous exposure to tornadoes and for populations with lower awareness of a potential tornado and higher probability of receiving no warnings."

Paul, Stimers and Caldas (2015). "Predictors of compliance with tornado warnings issued in Joplin, Missouri, in 2011." *Disasters* **39**: 108-124.

"Multivariate logistic regression identified four statistically significant determinants of compliance with tornado warnings: number of warning sources, whether respondents were at home when the tornado struck, past tornado experience, and gender."

Ripberger, Silva, Jenkins-Smith, Carlson, James et al. (2015). "False Alarms and Missed Events: The Impact and Origins of Perceived Inaccuracy in Tornado Warning Systems." *Risk Analysis* 35: 44-56.

“Why do some people perceive that their warning system is accurate, whereas others perceive that their system is error prone? We find that subjective perceptions are in part a function of objective experience, knowledge, and demographic characteristics.”

Senkbeil, Scott, Guinazu-Walker and Rockman (2014). "Ethnic and Racial Differences in Tornado Hazard Perception, Preparedness, and Shelter Lead Time in Tuscaloosa." *Professional Geographer* 66: 610-620. [Senkbeil et al ProfGeog14.pdf](#)

Second time: “...significant differences in risk perception, preparedness, and shelter lead time among the three ethnic and racial groups. Furthermore, results were still significant for perception after controlling for the effects of age, education, and experience.”

Stokoe (2016). "Putting people at the centre of tornado warnings: How perception analysis can cut fatalities." *International Journal of Disaster Risk Reduction* 17: 137-153. [Stokoe IntlJDisasterRiskRed16.pdf](#)

“Interviews were conducted with officials and an online survey marketed through Facebook was undertaken, receiving 547 responses. Results showed white men were particularly vulnerable to tornadoes as they were more likely to ignore warnings. Hispanics, older people and those with tornado experience were also at higher risk if they heard an alert from an EWS they distrusted or did not understand.”

Trainor, Nagele, Philips and Scott (2015). "Tornadoes, Social Science, and the False Alarm Effect." *Weather Climate and Society* 7: 333-352. [ordered via ILL 12/10/16](#)

“Findings provide a number of important insights. Most notably, it is found that 1) there is a wide degree of variation in public definitions of false alarm, 2) actual county FAR rates do not predict perception of FAR, 3) actual county FAR rates do predict behavioral response, and 4) planning and family characteristics are also influential.”

Since your paper would require **repositioning** and **new substantive content to better address concerns of interest to the JRU readership**, I'll hold off on any specific editorial suggestions. I don't know if you think these kinds of changes in the paper are feasible, but if you think they are, we would be **delighted to review a revision** of the paper. Should you choose to prepare a revision, please include a cover memo specifically describing the changes you have made.

Referee's Report:

This paper uses data from the Arkansas tornado shelter rebate program from May 2006 through 2010 to estimate a model of the response of self-protective behavior to nearby, recent tornadoes. The authors have assembled a large quantity of data, including the exact address of installation a complete history of recent tornadoes in Arkansas and surrounding states, and information on the contractor used in the installation.

The authors use the data to estimate a model of the dynamic response of self-protection, or rebates granted, to local, recent tornadoes using rebates per week in a county as the unit of observation. Both nonparametric and parametric models of the dynamic response are estimated, and Poisson, negative binomial and ZINB models are estimated. The basic pattern is relatively robust – rebates granted peak about 10 weeks after a tornado within 50 miles, and the rate of installation (at least rebates granted) remains elevated for about 9 months afterwards.

RESPONSE:

The analysis is very well done. The bigger issue with the paper is **exactly what we learn from the exercise**. The self-protective behavior examined here is clearly related to risk perception and whether people adequately prepare for natural hazards. But it is not clear **how the pattern of self-protective investments over time is related to the adequacy of preparation**. Does the pattern identified here **refute or confirm** the under-preparation hypothesis? I am unsure myself, which is why I suspect the authors equivocate. **A recent tornado event from a climatological perspective provides no new information about the underlying tornado risk – there is no Bayesian updating of the risk should be occurring. It would be less expensive to install an above-ground safe room if a house is being rebuilt after a tornado, and so this could still account for a clustering of installations after a tornado.** There needs to be more learned from the analysis for the paper to be publishable at the *JRU*.

RESPONSE: I don't think we have any information about whether the house that retrofits the shelter was actually damaged by the tornado, unfortunately. But we do have the proximity-to-track information.

The lack of a close connection between risk perception and the dynamic response to tornadoes **questions the need for using the week as the temporal unit of analysis**. The analysis could alternatively be done with rebates aggregated to the **month**, or even just **cross-sectional totals over the period, for zip codes instead of counties**. Because the dynamic response seems difficult to relate to risk perception and under-preparation for hazards (or overreaction), perhaps the data have more to say about **who** mitigates or prepares, with the exact timing less important. The week strikes me as too fine a temporal scale, especially given the noise involved in using the date of rebate approval.

RESPONSE: Could we (do we?) use county-level sociodemographics to explain the decision to invest in a shelter? Arkansas has 75 county FIPS codes: http://www.nws.noaa.gov/mirs/public/prods/maps/cnty_fips_arkansas.htm. ACS 1-year data are available for all of these counties. Alternatively, if there is no time dimension to the sociodemographics, we could use the 2010 5-year ACS records for even more variables. We could use counties intersected by a linear tornado path in a given month as the treated group and those counties not intersected by a linear tornado path as the control group. For each county-month, we could build a dependent variable that is the number of applicants for the subsidy at any time during the (year?) after that month.

The data assembled on the identity of the contractor is great. This clearly involved painstaking work. It would allow for a very interesting investigation of the supply side of the shelter market.

As it stands now, **nothing much emerges from Table 4 and 5**. It would be interesting to know how the proportions of local recognizable contractors, non-local recognizable contractors, obscure contractors, and self-installations **vary between say rural and urban counties**, and for different events, for instance in 2008 after the February outbreak vs. 2009 and 2010. The **number of different contractors who installed shelters** and **concentration of the supply side** seem like relevant questions for investigation. The price sensitivity analysis in Section 5.4 is weak because there is really no price variation. **This should be dropped**. Of the 10% of rebates for less than \$1,000, were these units self-installed? If so, then even the price variation observed isn't valid since the product or service isn't the same.

RESPONSE: At best, we would have to acknowledge these concerns in a footnote. Almost certainly, we cannot, at this point, reconstruct a time-series of all of the companies offering tornado retrofit services in or around Arkansas. If this was a specific NAICS code, it might be possible to buy the NETS data for Arkansas for "tornado shelter contractors," which would show the names and addresses of all establishments in Arkansas over this period, but I'm not sure the codes in the NETS data are that finely disaggregated. We know that you cannot identify a retrofit firm just by its name. I don't think we know whether the retrofit was self-installed when the price was less than \$1000. We would have to punt on this one.

The **supply constraint analysis in Section 5.5 distinguishes tornadoes by their impacts** (damage and casualties) yet the main dynamic response models treat all tornadoes equivalently. It is hard to imagine all tornadoes have an equivalent effect on shelter installation. Evidence of this is in the appendix model with year effects included. Instead of focusing on tornadoes in 0-50, 50-100, and 100-150 mile radii, it would be more interesting to distinguish based on impacts, say F2 or stronger, killer or injury tornadoes.

RESPONSE: Do we have that information for each tornado in the sample. Could we add indicators for these three categories, and also interact them with the distance indicators? This would allow us to test for statistically significant differences in retrofits after tornadoes of different strengths, and also the influence of distance for tornadoes of different severity?

Were there any additional eligibility criteria for the rebates? Some state rebate programs provide priority to homes that have been damaged; if so, this would explain some of the clustering of rebates near tornadoes. Also, were funds available for rebates throughout the period of the program? Many state shelter incentive programs are funded using FEMA Hazard Mitigation Grant funds, which become available after a Presidential disaster declaration. And were rebates granted for all shelters installed in the state over the period? **On page 8, the first two sentences in the first paragraph seem to use rebates and applications interchangeably.**

RESPONSE: Can we learn any more about the incentive program from somebody who was there? Could we still talk to your original contact person at the agency?

It would be nice to have more description of the data. For instance, **what was the proportion of zero observations?** Are there weeks when **no rebates** were granted across the state? Figure 3 as

presented was less helpful, since it averages events by week over the five years of the sample. A [graph of the time series of total tornadoes and rebates in the state by week](#) would afford the reader a better opportunity for ocular least squares.

RESPONSE: This sounds do-able. I'll have to see if I can find all the raw data and the Stata programs again....

NEW REFERENCES:

Chaney, P. L., G. S. Weaver, S. A. Youngblood and K. Pitts (2013). "Household Preparedness for Tornado Hazards: The 2011 Disaster in DeKalb County, Alabama." *Weather Climate and Society* 5(4): 345-358.

This paper contributes to existing knowledge on factors that influence adoption of hazards adjustments for tornadoes. The Protective Action Decision Model provides the theoretical basis for the study, which was conducted after the 2011 disaster in DeKalb County, Alabama. Most of the 124 survey participants had received public safety information on how to prepare for a tornado, understood the definition of a tornado warning, had participated in a tornado drill, and had a plan for seeking shelter. Few owned a NOAA weather radio or had a tornado-resistant shelter on the premises. Demographic analysis found that older residents (60+ yr) and households without children were significantly less likely to have participated in a tornado drill, lower income residents were significantly less likely to have a tornado-resistant shelter on the premises or a plan for seeking shelter, and mobile home residents were significantly less likely to have a plan for seeking shelter. Locus of control and past experience were not significantly associated with adoption of hazards adjustments, but suspected reasons for these results are discussed. Many plans that involved evacuating to another location included excessively long travel distances, and several mobile home residents planned to seek shelter inside their residence. Failure to adopt effective preparedness actions in each of these areas could serve as a situational impediment to making an appropriate protective action decision when a tornado threatens the household. The results identify aspects of household preparedness where there is opportunity for improvement, which would reduce vulnerability and enhance community resilience.

Fuller, S. C. (2014). "The Effect of Prenatal Natural Disaster Exposure on School Outcomes." *Demography* 51(4): 1501-1525.

This study looks at the impact of exposure to natural disasters during pregnancy on the educational outcomes of North Carolina children at the third grade level. A broad literature relates negative birth outcomes to poor educational performance, and a number of recent studies have examined the effect of prenatal exposure to natural disasters on birth outcomes. This study takes the next step by considering how prenatal exposure affects later outcomes. Combining North Carolina administrative data on births and school performance with disaster declarations from the U.S. Federal Emergency Management Agency (FEMA) allows for the identification of children who were exposed to disasters during prenatal development. These children are compared with other children born in the same county who were not exposed to disasters while in utero. Regression results suggest that children exposed to hurricanes prenatally have lower

scores on third grade standardized tests in math and reading. Those exposed to flooding or tornadoes also have somewhat lower math scores. Additionally, results suggest that these negative effects are more concentrated among children in disadvantaged subgroups, especially children born to black mothers. However, no evidence exists that these effects are mediated by common measures of birth outcomes, including birth weight and gestational age.

Howe, P. D., H. Boudet, A. Leiserowitz and E. W. Maibach (2014). "Mapping the shadow of experience of extreme weather events." *Climatic Change* **127**(2): 381-389.

Climate change will increase the frequency and/or intensity of certain extreme weather events, and perceived experience with extreme weather may influence climate change beliefs, attitudes, and behaviors. However, the aspects of extreme events that influence whether or not people perceive that they have personally experienced them remain unclear. We investigate (1) the correspondence of reported experience of extreme weather events with documented events, and (2) how characteristics of different extreme events shape the geographic area within which people are likely to report they have experienced it-the event's perceived "shadow of experience." We overlay geocoded survey responses indicating personal experience with hurricanes, tornadoes, and drought-from a 2012 nationally representative survey (N = 1,008) of U.S. residents-on maps of recorded event impacts. We find that reported experiences correspond well with recorded event impacts, particularly for hurricanes and tornadoes. Reported experiences were related to event type, proximity, magnitude and duration. The results suggest locations where disaster preparedness efforts and climate change education campaigns could be most effective after an extreme weather event.

Jauernic, S. T. and M. S. Van Den Broeke (2016). "Perceptions of tornadoes, tornado risk, and tornado safety actions and their effects on warning response among Nebraska undergraduates." *Natural Hazards* **80**(1): 329-350.

A survey of 613 undergraduates at a large public university in Nebraska was used to study how participants perceive tornadoes, tornado risk, and appropriate safety actions. Questions were asked to gauge participants' overall tornado knowledge and response to tornado threat. Many students sought more information before responding to warnings and reported this additional confirmatory information would be necessary for them to respond to future warnings. Some variables were found to be positively or negatively associated with having safety plans and sheltering decisions. Those who responded to the highest proportion of warnings were from the Great Plains, perceived the local city as equally likely to be affected by a tornado compared to the surrounding region, and reported learning tornado-related information primarily from their parents. International students and those gaining most of their tornado-related knowledge from school responded to fewer warnings and took less safe actions overall. Many myths about tornado behavior and tornado safety were found to be prevalent.

Luo, J. J., Z. Cong and D. A. Liang (2015). "Number of Warning Information Sources and Decision Making During Tornadoes." *American Journal of Preventive Medicine* **48**(3): 334-337.

Background: Taking proper protective action upon receiving tornado warnings is critical to reducing casualties. With more warning information sources becoming available, how the number of such information sources affects decision making should be quantitatively investigated. Purpose: To examine how the number of warning information sources affected individuals' decisions to take protective action during tornadoes. Methods: A telephone survey

using random sampling was conducted in 2012 with residents in Tuscaloosa AL and Joplin MO, resulting in a working sample of 782 respondents. Both cities were struck by violent tornadoes (Enhanced Fujita Scale [EF]4 and EF5) in 2011. The analysis was conducted in 2013. Results: Logistic regression analysis showed that relative to having only one warning information source, having two and three or more warning information sources significantly increased the odds of taking protective action in Joplin but not in Tuscaloosa; having three or more sources had a significantly stronger effect on taking protective action in Joplin than in Tuscaloosa. Having an emergency preparation plan in both cities and being white in Tuscaloosa significantly increased the odds of taking protective action, whereas being divorced in Joplin reduced these odds. Conclusions: Receiving warnings from more warning information sources might be more beneficial in places with less previous exposure to tornadoes and for populations with lower awareness of a potential tornado and higher probability of receiving no warnings. Emergency management agencies and public health officials should give priority to these places and populations when formulating disaster mitigation decisions and policies. (C) 2015 American Journal of Preventive Medicine

Paul, B. K., M. Stimers and M. Caldas (2015). "Predictors of compliance with tornado warnings issued in Joplin, Missouri, in 2011." *Disasters* **39**(1): 108-124.

Joplin, a city in the southwest corner of Missouri, United States, suffered an EF-5 tornado in the late afternoon of 22 May 2011. This event, which claimed the lives of 162 people, represents the deadliest single tornado to strike the US since modern record-keeping began in 1950. This study examines the factors associated with responses to tornado warnings. Based on a post-tornado survey of survivors in Joplin, it reveals that tornado warnings were adequate and timely. Multivariate logistic regression identified four statistically significant determinants of compliance with tornado warnings: number of warning sources, whether respondents were at home when the tornado struck, past tornado experience, and gender. The findings suggest several recommendations, the implementation of which will further improve responses to tornado warnings.

Ripberger, J. T., C. L. Silva, H. C. Jenkins-Smith, D. E. Carlson, M. James and K. G. Herron (2015). "False Alarms and Missed Events: The Impact and Origins of Perceived Inaccuracy in Tornado Warning Systems." *Risk Analysis* **35**(1): 44-56.

Theory and conventional wisdom suggest that errors undermine the credibility of tornado warning systems and thus decrease the probability that individuals will comply (i.e., engage in protective action) when future warnings are issued. Unfortunately, empirical research on the influence of warning system accuracy on public responses to tornado warnings is incomplete and inconclusive. This study adds to existing research by analyzing two sets of relationships. First, we assess the relationship between perceptions of accuracy, credibility, and warning response. Using data collected via a large regional survey, we find that trust in the National Weather Service (NWS; the agency responsible for issuing tornado warnings) increases the likelihood that an individual will opt for protective action when responding to a hypothetical warning. More importantly, we find that subjective perceptions of warning system accuracy are, as theory suggests, systematically related to trust in the NWS and (by extension) stated responses to future warnings. The second half of the study matches survey data against NWS warning and event archives to investigate a critical follow-up question: Why do some people perceive that their warning system is accurate, whereas others perceive that their system is error prone? We find

that subjective perceptions are in part a function of objective experience, knowledge, and demographic characteristics. When considered in tandem, these findings support the proposition that errors influence perceptions about the accuracy of warning systems, which in turn impact the credibility that people assign to information provided by systems and, ultimately, public decisions about how to respond when warnings are issued.

Scott, P. L. and D. A. Liang (2015). "Evaluation of shelter performance following the 2013 Moore tornado." *Wind and Structures* **21**(4): 369-381.

Moore, Oklahoma was hit by an EF5 tornado on May 20, 2013. The tornado track slightly overlapped with two previous tornadoes that occurred on May 3, 1999 and May 8, 2003 respectively. A research team from Texas Tech University was deployed to investigate the performance of shelters based on observation of their post-storm conditions. Sixty-one shelter units were further documented by size, manufacturer, and date of installation if available. Then they were cross-referenced with the external databases to determine their compliance with design and construction standards by the International Code Council/National Storm Shelter Association and/or criteria from the Federal Emergency Management Agency publications. Wind intensity was estimated for each shelter location using the EF scale. Results showed a marked increase in the number of exterior underground shelters as well as the popularity of a new in-garage floor underground shelter design. All of the units provided protection for their occupants with no loss of life reported. However, one older shelter had a door failure due to neglect of maintenance. Recommendations were made to improve future performance of shelters.

Senkbeil, J. C., D. A. Scott, P. Guinazu-Walker and M. S. Rockman (2014). "Ethnic and Racial Differences in Tornado Hazard Perception, Preparedness, and Shelter Lead Time in Tuscaloosa." *Professional Geographer* **66**(4): 610-620.

The 27 April 2011 EF4 Tuscaloosa tornado directly impacted more than 50,000 residents, causing forty-five fatalities within the city and sixty-five in total. It was a rare urban tornado with varying impacts on the three major ethnic and racial groups within the city. A hybrid survey and interview of open-ended and closed questions was conducted with 211 Tuscaloosa area residents in a two-week period after the tornado. Results indicate significant differences in risk perception, preparedness, and shelter lead time among the three ethnic and racial groups. Furthermore, results were still significant for perception after controlling for the effects of age, education, and experience.

Stokoe, R. M. (2016). "Putting people at the centre of tornado warnings: How perception analysis can cut fatalities." *International Journal of Disaster Risk Reduction* **17**: 137-153.

Despite improvements in tornado Disaster Risk Reduction (DRR), since the 1990s the number, and proportion, of people dying in tornadoes in America has increased. This paper examines how people rely, understand and trust tornado alerts and the Early Warning Systems (EWS) that disseminate them, if socio-demographics cause specific groups to experience greater risk, whether these factors have affected the rise in fatalities and what mitigation measures could reverse this. Ford County, Kansas, was selected as a case study. Interviews were conducted with officials and an online survey marketed through Facebook was undertaken, receiving 547 responses. Results showed white men were particularly vulnerable to tornadoes as they were more likely to ignore warnings. Hispanics, older people and those with tornado experience were

also at higher risk if they heard an alert from an EWS they distrusted or did not understand. Population growth in these groups and technology changes have helped cause the recent fatality rise and, unless changes are made to the EWS, the continued increase in size of these groups will lead to more people becoming at risk from, or perishing in, tornadoes. Recommendations to prevent this include federal regulation and improved education materials for sirens, alerts translated into Spanish, discontinuing NOAA radio and developing an official forecast and alerting app. (C) 2016 Elsevier Ltd. All rights reserved.

Suls, J., J. P. Rose, P. D. Windschitl and A. R. Smith (2013). "Optimism Following a Tornado Disaster." *Personality and Social Psychology Bulletin* **39**(5): 691-702.

Effects of exposure to a severe weather disaster on perceived future vulnerability were assessed in college students, local residents contacted through random-digit dialing, and community residents of affected versus unaffected neighborhoods. Students and community residents reported being less vulnerable than their peers at 1 month, 6 months, and 1 year after the disaster. In Studies 1 and 2, absolute risk estimates were more optimistic with time, whereas comparative vulnerability was stable. Residents of affected neighborhoods (Study 3), surprisingly, reported less comparative vulnerability and lower "gut-level" numerical likelihood estimates at 6 months, but later their estimates resembled the unaffected residents. Likelihood estimates (10%-12%), however, exceeded the 1% risk calculated by storm experts, and gut-level versus statistical-level estimates were more optimistic. Although people believed they had approximately a 1-in-10 chance of injury from future tornadoes (i.e., an overestimate), they thought their risk was lower than peers.

Trainor, J. E., D. Nagele, B. Philips and B. Scott (2015). "Tornadoes, Social Science, and the False Alarm Effect." *Weather Climate and Society* **7**(4): 333-352.

Despite considerable interest in the weather enterprise, there is little focused research on the false alarm effect. Within the body of research that does exist, findings are mixed. Some studies suggest that the false alarm effect is overstated, while several recent efforts have provided evidence that FAR may be a significant determinate of behavior. This effort contributes to the understanding of FAR through a sociological analysis of public perceptions and behavioral responses to tornadoes. This analysis begins by addressing public definitions of FAR and then provides two statistical models, one focused on perception of FAR and one focused on behavioral response to tornado warnings. The authors' approach incorporates a number of sociological and other social science concepts as predictors in both of these models. Findings provide a number of important insights. Most notably, it is found that 1) there is a wide degree of variation in public definitions of false alarm, 2) actual county FAR rates do not predict perception of FAR, 3) actual county FAR rates do predict behavioral response, and 4) planning and family characteristics are also influential. Another major contribution is to illustrate the significant complexity associated with analysis of false alarms. Conclusions discuss the limits of this analysis and future direction for this type of research.

Wallace, Z. C., L. Keys-Mathews and A. A. Hill (2015). "The Role of Experience in Defining Tornado Risk Perceptions A Case from the 27 April 2011 Outbreak in Rural Alabama." *Southeastern Geographer* **55**(4): 400-416.

This research examines the ways tornado experience influences an individuals' risk perceptions. The work uses the 27 April 2011 Southeastern United States tornado outbreak to

investigate perceptions of individuals in three Alabama towns. Surveys administered in Phil Campbell and Hackleburg, two towns that sustained severe losses, are compared with survey responses from Red Bay, a town without sustained loss. The purpose of this study is to determine if direct experience with a tornado influences tornado risk perception. Comparison of survey responses using common statistical analyses suggest that while 40 percent of the study population reports a change in perceived tornado risk, direct experience was less a driver of change than was anticipated. The amplified or diminished perception, in fact, may be based on a more shared social experience. This study found that experience extends beyond direct experience.