CORRESPONDENCE

Comments on "Tornado Damage Patterns in Topeka, Kansas, June 8, 1966"

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I found the paper by Eagleman [1] interesting as, to my knowledge, it is the only paper that has attempted a statistical check of the areas of safety within dwellings. I do not know where and when the "traditional southwest corner" for safety came into being, but I have reason to believe it was well before the turn of the century. Of the more recent writers, Flora [2] is probably the most explicit. He said, "Next to the storm cave, the southwest corner of the basement of a frame house is recommended as the best place of safety from a tornado. When one of these storms approaches from the southwest, as they usually do, it is advisable to crouch against the wall. The terrific wind will either blow the house and debris entirely away or drop them on the far side of the basement. Practically no debris is ever dropped into the side of the basement next to the approach of the storm."

The work of Eagleman and of Weather Bureau disaster teams has shown that the last part of this statement is not true. Because of these efforts, the 1967 version [3] of the tornado safety rules (Eagleman's reference [2] is the 1966 version) does not specify a particular geographic area of the basement, but instead recommends that one "Seek shelter under a sturdy workbench or heavy table if possible." The Palm Sunday [4] and Topeka tornadoes have clearly shown that people in basements usually will escape major injury in spite of devastation around them, and getting extra protection from falling or flying objects by getting under a sturdy table or being surrounded by heavy furniture or filled boxes or barrels should improve things even more.

While Eagleman's effort to check the traditional rule has value, his paper is misleading because of his method, his statistics, and his style. For example, the emotionalized "Introduction" concerning the partial collapse of MacVicar Hall (a stone building) immediately suggests the southwest corner as a poor bet. But even Flora, in the sentence immediately following the quote above said, "The basement of an ordinary brick or stone house is a death trap. Collapsing walls are likely to send tons of brick or stone crashing through the lower floors with fatal consequences to anyone caught under them." Even being downwind from a brick or stone chimney, especially if it is outside a frame dwelling, is very dangerous. However, Eagleman doesn't cancel this early impression until the end of the paper (p. 374) where he states, "The number of buildings (on the Washburn campus) was insufficient for an evaluation, however."

In the section on "Full Basements," he is not statistically sound in his statement that "there was no statistical difference in the distribution of unsafe areas in different parts of the storm." He should have indicated the number of dwelling units in each sector of the storm path. From his table 1, where there is a total of 91 sections in 28 basements, we can see that there was most likely quite a few unsafe sections in at least some basements, so he could have had as few as one dwelling in the southeast third of the path. The chi-square test is inconclusive with this small amount of data in the one sector. Even the evaluation for "First Floors" is questionable in spite of more cases in the southeast third.

A subjective determination upon which the whole paper rests is that one can determine safe and unsafe areas by examination of only the dwellings at some time after the event. The fact that the time delay was not specified nor its effect discussed makes any result questionable, as cleanup gets underway within a few hours. Eagleman is correct in stating (p. 370) that it would be more difficult to check on the locations of people when they were injured, but this would not give less information, as he said, for from these people one could determine where the "unsafety" actually existed, as well as the relative safety of areas.

The assumption of a positive correlation of the amount of debris with the amount of "unsafety" is very questionable. Consider the analogy of snow flakes or leaves. They settle where the wind lightens and where their horizontal

speed goes to zero. Where they are moving fast (it is fast moving boards that are more likely to injure) they don't settle. They thus settle in protected areas and blow clear of unprotected areas. Why would debris in a tornado act differently? At least this point should be discussed. An example that shows the weakness or even incorrectness of Eagleman's assumption is a house examined by the Weather Bureau disaster team on their second visit about 7 weeks after the tornado. The house was near the center of the path and was overturned, projecting into and filling the northeast corner of the basement and fully exposing the remainder of the basement. The basement was nearly full of light debris, although some could have been added in the cleanup after the storm. However, a neighbor explained to the team how he had helped five people out from under the debris in the southwest portion of the basement. The people came out uninjured.

The paper brings out some worthwhile points; however, these are not always explicitly stated. It does suggest that being in a basement is not enough for safety and that being surrounded by things like *filled* barrels or boxes, and covered by something solid like a table, would give considerable added protection against blowing debris. He also found that basement walls of stone or concrete block are relatively little protection (reinforced concrete is best) and that being near basement windows, like all others, is dangerous. His point about small interior rooms being relatively safer on the first floor is well worth knowing if you need protection and have no basement. It has been noted that such rooms in basements are also safer.

The Eagleman paper thus suggests that a long-standing rule appears to be without verification, but unfortunately verification with such limited and questionable data is inconclusive.

REFERENCE

1. J. R. Eagleman, "Tornado Damage Patterns in Topeka, Kansas, June 8, 1966," *Monthly Weather Review*, vol. 95, No. 6, June 1967, pp. 370–374.
2. S. D. Flora, *Tornadoes of the United States*, University of Oklahoma Press, Norman, 1953, 194 pp.
3. Environmental Science Services Administration, "Tornado Safety Rules," *ESSA/PI* 660030, May 1967, 1 p.
4. U.S. Weather Bureau, *Survey Team Report of Palm Sunday Tornadoes of 1965*, Washington, D.C., May 1965, 64 pp.

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Reply

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My reply will be directed toward the comments of Mr. Hughes concerning the methods and statistics in the article on damage patterns in the Topeka Tornado [1]. I maintain that the statement "there was no statistical difference in the distribution of unsafe areas in different parts of the storm" is correct statistically. The reader may draw his own conclusions as to the number of observations involved. It should be pointed out in this connection, however, as it was in the paper that the effects of location of the dwelling within the storm path should be most pronounced on the first floor of structures since these are exposed to the full effects of the wind. Therefore the emphasis in the paper was placed on the first floor investigation with regard to the effects on the distribution of unsafe areas within dwellings caused by different locations within the storm path.

I believe that the assumption of a positive correlation between the amount of debris and the degree of unsafety in a dwelling is a very good one. This is undoubtedly better than checking on the location of injured persons since this would give valid information on the protection offered by various locations in a dwelling only if there were an equal number of persons located in each room of each dwelling during the tornado. This assumption of equal distribution of people is certainly not valid. The fact that some persons were not seriously injured even though they were in areas that had more debris does not diminish the results of the paper if the probability of injury remains greater for areas with more debris. This should certainly be the case if the debris were moving at a high speed during the tornado. Some of these effects were included when determining the unsafe areas during the investigation by noting the degree of scarring and puncturing of the floors or remaining walls of damaged structures.

REFERENCE

1. J. R. Eagleman, "Tornado Damage Patterns in Topeka, Kansas, June 8, 1966," *Monthly Weather Review*, vol. 95, No. 6, June 1967, pp. 370–374.

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