THE TORNADO DAMAGE RISK ASSESSMENT
PREDICTING THE IMPACT OF A BIG OUTBREAK IN DALLAS-FORT WORTH, TEXAS

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1. Introduction

How would an urban area fare if it had over 30,000 structures and 80,000 residents in the direct path of a monster class violent tornado? The tremendous damages in the suburbs of Oklahoma City, in 1999, forced many urban areas to consider just that. North Central Texas took particular notice. Many wondered how the Dallas-Fort Worth Metroplex, an even larger and certainly overdue target in tornado alley, would have fared under that outbreak. The development of urban geographic information systems (GIS) makes it possible to estimate the impact. Although it is virtually impossible to predict the magnitude of every variable that would contribute to the final cost from such an event, computer technology can take some of the mystery out of the "what-if" scenario.

2. The Project

In the Spring of 2000, The North Central Texas Council of Governments and the National Weather Service in Fort Worth put together a “Tornado Damage Risk Assessment”. It estimated the results of multiple scenarios in which the May 3, 1999 Oklahoma tornadoes were transposed across the Metroplex. Five of the scenarios mapped 53 of the damage paths from the Oklahoma tornadoes atop Metroplex geographical data. This mapping included the actual damage/wind contours from the "Moore" tornado near Oklahoma City, provided by the National Severe Storms Laboratory. The paths were moved together as a group slightly North-South and East-West across the Metroplex (See Figure 1) and a unique statistical profile of each impacted area was generated.

Appraisal records, land use classifications, demographic data, employment centers, building locations, and data from aerial photographs were merged into a 400,000+ record base data set upon which the tornado paths were overlaid. The data set featured an extensive blend of detailed densities, structure values, wind velocity contours, parcels, and other data to provide small-scale area descriptions (See Figure 2). Transportation modeling was used to estimate the number of vehicles crossing major routes in the paths. By providing a best guess of how much property, how many people, and how much traffic would be in the path of the tornadoes, a good understanding of the region's risk could be developed.

In addition to the five primary scenarios, a smaller subset of tornado paths (which featured the "Moore" tornado) was mapped 50 times, side by side in 2.5-mile increments across the core of the Metroplex. The 50 tornadoes were divided into two groups of 25, with the second group mapped 10 miles north of the first group. This group of 50 tornadoes would significantly tap into the sprawling urban geography of the Metroplex. Structures and population in the path were estimated for each group.

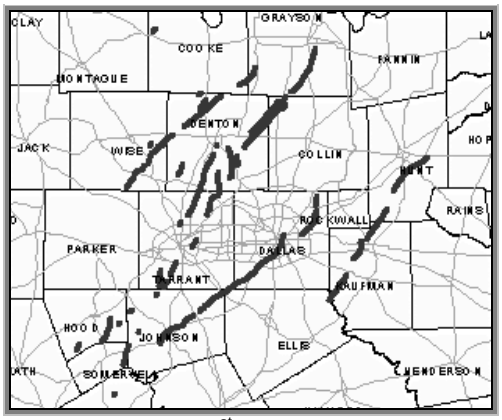

Figure 1. Map of the 1st Scenario. Paths from the Oklahoma tornadoes are laid atop Dallas-Fort Worth.

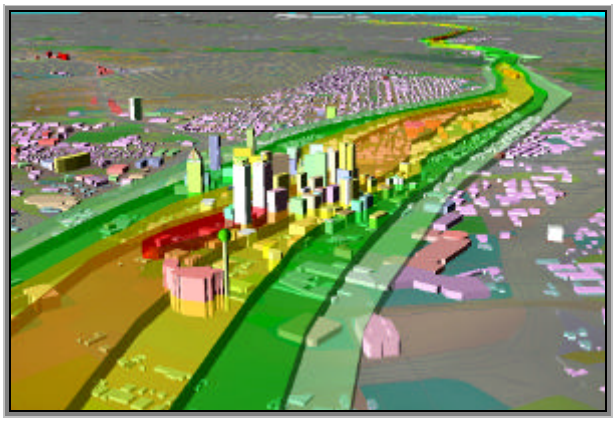

Figure 2. Modeling GIS data of urban structures in Dallas with F-Scale path contours from the "Moore" tornado.

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3. The Results

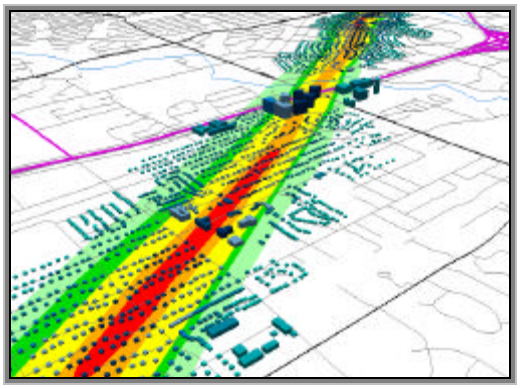
There is little doubt that a large violent tornado path through the urban core of the Metroplex would result in the largest tornado damage total in U.S. History. This would likely be the case in many urban areas. Dallas-Fort Worth stands out because it is both geographically at risk from such storms, and has so many different paths that would likely produce huge totals. Of the 55 total path scenarios tested, 44 had more than $1 Billion of estimated appraisal-based property in their path. Twelve of the paths had more than $5 Billion -- some reaching almost $8 Billion. This does not include automobiles, city infrastructure, and other potential source categories that would increase the damages. When Fujita-Scale damage multipliers are applied, 23 $2 Billion damage paths are indicated. Four damage paths would have reached well into the $4 Billion category.

The number of housing units and commercial structures impacted exceeded 10,000 in 44 of the 55 path scenarios. No less than 14 of the paths approached or exceeded 30,000. Of the 55 path scenarios, 28 would have at least 50,000 people living in the impacted residential structures.

For the five full-outbreak scenarios, employee estimates and traffic modeling numbers were included in the analysis. The scenarios that passed through the urban core of the Metroplex found between 65,000 and 95,000 employees working in the buildings that were in tornado paths. These numbers did not require a downtown impact to be high. Dallas-Fort-Worth is a classic multi-center urban area, with many major employment centers located in areas far away from downtown. Traffic across tornado paths varies greatly based upon traffic flow conditions. During the time of each tornado, around 2,000 vehicles should normally cross the tornado path on freeways and major roadways. If congestion occurs, and the roads become backed-up, the numbers escalate to about 87,000.

4. Conclusion

Although the "Moore" tornado will never somehow "reinvent" itself and move across the Metroplex, a storm like it is conceivable. Specialists have repeatedly pointed out just how fortunate the Dallas-Fort Worth region has been to avoid the violent outbreaks that many of its neighbors have experienced. If such an outbreak were to occur, it would be very difficult for a large tornado not to cause tremendous damages. A tornado of the class of the "Moore" storm would have an almost countless number of paths to choose from and still cause over $2 Billion of damage, impact 30,000 structures, threaten 50,000 people, hit structures containing 50,000 employees, and trap over 2,000 people on any one backed-up freeway. The warning and response implications of those figures are clear -- a lot of people would have to be well informed at multiple stages in the process. The number of people in the path is relatively easy to calculate, but maximizing the number that will actually do the right thing when it matters most may be the biggest challenge facing a large susceptible area like Dallas-Fort Worth.



For more information and maps, the study results can be found at http://www.dfwinfo.com/weather/study.html.

5. References

Stumpf, G. 1999: Tornadoes of May 3, 1999. Presentation Graphics of Damage Survey

Grazulis, T. P. 1991: Significant Tornadoes--1680-1991

Church, C. 1993: *THE TORNADO: Its Structure, Dynamics, Prediction, and Hazards*. American Geophysical Union Monograph

Impact Estimates From the Five Full-Outbreak Scenarios

Scenario	Residents	Employees	Structures *	Property Value in Path	Potential Damages
1	34,600	10,400	17,070	$1,630,613,000	$811,000,000
2	34,000	19,000	14,363	$1,652,263,000	$790,000,000
3	51,300	64,600	23,380	$4,188,993,000	$2,652,000,000
4	69,350	94,100	30,887	$5,013,443,000	$2,808,000,000
5	84,000	65,900	38,463	$5,064,222,000	$2,859,000,000

* An Individual Apartment Unit is Considered a Single Impacted Structure in the Summary