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INVESTIGATING TORNADO SCARS IN TEXAS

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Academic literature contains little on the long-term imprints of tornadoes upon the built landscape. "Tornado scars" describes lingering visual evidence of the impact of strong and violent storms upon the constructed landscape. This study identifies 17 different types of tornado scars for the first time based upon fieldwork across 19 locations affected by 15 tornadoes occurring between 1950 and 1999. These tornadoes are among the most infamous for Texas. Each storm killed ten or more people and/or produced at least eight million dollars in damages. Historical damage paths were located and later examined by car and on foot. In addition to compiling frequencies of different types of tornado scars, a typology was later developed with four categories: *foundational remnants*, *remnants of tragedy*, *reconstructive*, and *relics of disaster*. Tornado scars are enduring features in Texas and can last up to at least five decades, raising a number of geographic and hazard-oriented questions. *Keywords: tornado scars, severe storms, hazards, Texas, Fujita scale.*

The visual effects of past tornadoes in the current constructed landscape have not been addressed in academic literature, and there are compelling reasons to approach the topic. This research explores these physical, visible "tornado scars," answering the fundamental questions of what forms they take and their longevity. A field study conducted during the autumn of 2001 investigates 19 sites impacted by 15 strong and violent tornadoes (Table 1) occurring between 1950 and 1999 to locate and document evidence of the past storm damage upon the landscape. This study of the long-term imprints of disaster upon the built landscape identifies 17 different types of tornado scars and scar elements for the first time and classifies them into four groups. This research provides a baseline for future work that might determine whether the powerful images of tornado scars are lasting reminders in social memory of the potential strength of natural hazards, and whether they are indelible markers of cultural history in a community.

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Table 1. Fujita Scale of Damage (after Fujita and Pearson 1973).

WEAK	**F-0**	*Light Damage*: 18–32 ms^{-1} (40–72 mph) Damaged chimneys and antennas, broken branches, uprooted shallow-rooted trees, signboard damage
	F-1	*Moderate Damage*: 33–49 ms^{-1} (73–112 mph) Roof surfaces peeled off, windows broken, manufactured housing pushed or overturned, trees on soft ground uprooted, some trees snapped, moving automobiles pushed off road
STRONG	**F-2**	*Considerable Damage*: 50–69 ms^{-1} (113–157 mph) Roofs torn off frame houses with strong walls standing, outhouses and manufactured homes demolished, boxcars pushed over, large trees snapped or uprooted, cars blown off highways, cinder-block structures damaged, light object missiles generated
	F-3	*Severe Damage*: 70–92 ms^{-1} (158–206 mph) Roofs torn off with some walls of frame houses destroyed, trains overturned, hangers and warehouses torn, cars lifted and rolled, most trees in area snapped, uprooted, or leveled, cinder-block structures often leveled, poorly constructed rural buildings flattened and destroyed
VIOLENT	**F-4**	*Devastating Damage*: 93–116 ms^{-1} (207–260 mph) Well-constructed frame houses leveled, piles of debris left behind, structures with weak foundations torn, lifted, and blown some distance, gravel flies in high winds, trees debarked by small, flying debris, cars thrown or rolled considerable distance, large missiles generated
	F-5	*Incredible Damage*: 117–142 ms^{-1} (261–318 mph) Strong frame houses lifted and carried and disintegrated, steel-reinforced concrete structures badly damaged, automobile-sized missiles fly long distances, trees debarked completely

The concept of a tornado scar is derived from a bodily injury, where the constructed landscape is represented by the skin, and reconstructive healing takes place gradually, merging over a period of time, albeit not necessarily seamlessly. For example, long-term spatial evidence of past events may take the form of a discontinuity between the older, unscathed portion of the landscape and tornado-ravaged structures that may or may not have been rebuilt. Particular individual tornado-scar "elements" on the landscape might include objects imbedded by high winds, empty foundations and old driveways, different types of bricks used to repair damaged sections of buildings, damaged or destroyed business signs, visibly reinforced buildings, and abandoned storm shelters. They might include a remaining fireplace or rogue, spindly structural supports. Logically, tornado scars and scar elements, much like scars to humans or trees, may undergo changes over time, and there may be more than one across a given area.

The concept of scars from other natural processes, such as ice jams and river flooding, is not foreign to physical geography (Gottesfeld and Gottesfeld 1990). Tree-scar analyses have been conducted to reconstruct the magnitude and frequency of historic occurrences (Alestalo 1971; Shroder 1981), providing proxy evidence of ice elevation and flood levels during extreme hydrologic events (Harrison and Reed 1967; Smith and Reynolds 1983; Begin and Payette 1988). Ice-jam scars occur when ice and other objects impact trees, locally destroying the wood-producing (cambium) tissue. This process causes a temporary cessation of growth in the immediate area, producing a natural record of the height and time period of the damage (Fanok and Wohl 1997).

Flood scars can be found in wooded regions along rivers where waters near and at peak flood stage transported logs. In addition to wounds to channel margin trees from the force of impact, sequestered logs along the banks produce abrasion wounds on trees through friction and the rising and falling (sloshing) of water levels (Gottesfeld 1996). Eventually, the undamaged callus tissue starts to grow incrementally over the scars, and although it may still be visible for years, the outward expression of such scars gradually diminishes (Fanok and Wohl 1997).

The frequency of scars on trees sometimes proved a better indicator than the height of the scars above ground level for determining historic, spring flood-levels (Tardif and Bergeron 1997).

While the concepts of ice-jam and flood scars to trees are not new, tornado scars represent a newer avenue of research, requiring an understanding of the varying character of the circumstances that produced them. A tornado has long been described as a rapidly rotating air column of considerable concentrated physical force extending downward from a thunderstorm that makes ground contact with the potential for great destruction and loss of life (Huschke 1959). Only approximately 1 percent of thunderstorms in the United States produces a tornado, and of the approximately 1,000 tornadoes in this country each year, most last a few minutes or less and are relatively weak, affecting a rather small area (Schaefer and Edwards 1999).

The term "significant tornado" describes the potentially more dangerous tornado with wind speeds greater than 50 ms^{-1} or at least 113 miles per hour (mph) (Grazulis 1993). The most powerful of these storms, termed "violent" tornadoes, may possess wind speeds greater than 93 ms^{-1} (207 mph) (Fujita and Pearson 1973). Violent tornadoes are considered low-probability, high-consequence events (Rayner and Cantor 1987); they account for only 2 percent of all tornadoes, yet they cause approximately two-thirds of all tornado-related deaths (Grazulis 1993). These larger and more powerful storms create extensive and concentrated damage during their often-longer life spans. They destroy most types of residences and commercial buildings in a matter of seconds, excepting structures composed of steel-reinforced concrete (Kessler and White 1981; NOAA 1988).

Most death and destruction occurs in outbreaks of at least six tornadoes (Galway 1977). Tornado outbreaks pose a clear threat to life, businesses, and personal property on the plains of Texas. For the 39-year period from 1953 through 1991 across the U.S., the large state of Texas ranked first in both the number of deaths and the total number of tornadoes. These statistics included Florida, where many tornadoes are weaker. Violent tornadoes devastated portions of Waco, Dallas, Lubbock, Wichita Falls (twice), and Jarrell in Texas during this period (Grazulis

1993). Only house foundations remained in some instances (Moore 1958; Mehta et al. 1971; NOAA 1998).

Disasters occur when the event magnitude is extreme, amidst either a large population or a vulnerable human-use system (Burton et al. 1993; Steinberg 2000). This research raises some intriguing questions for the hazards and geographic communities to later answer. For example, which places rebuild quickly after a disaster, which do not, and why? How does insurance or lack thereof factor into the decision to rebuild or relocate? Also, what impact do visible tornado scars have on people's perceptions of place?

Methods and Data

Emphasizing those storms that had the greatest impact in terms of death and destruction, this section describes the procedures, data, and analysis used to investigate the types and longevity of visible tornado scars upon the constructed landscape. The tornadoes chosen for this study possessed the appropriate characteristics to produce stark visual contrasts upon the landscape due to their relatively local nature, high intensity according to the Fujita scale (Fujita 1971), and defined damage areas, especially when compared to other, more widespread events such as hurricanes or earthquakes. This research includes 19 Texas study sites affected by 15 strong or violent (see Table 1) tornadoes during the last half of the twentieth century.

Investigating tornado scars includes retracing the historical tornado tracks by foot and automobile and looking for visible scars at each study site. Evidence of past events appears on the landscapes as a discontinuity between storm-induced reconstruction along the historical tornado path and older, unscathed areas, as well as many other, more discrete scar elements relating specifically to storm damage. It is expected that tornado scars' elements change somewhat over time. The full extent and variety of lingering storm damage upon the constructed landscape were largely unknown *a priori*. There was no particular known order of importance or frequency attached to hypothetical, individual scar elements.

To determine appropriate study sites, tornado data from 1950 through 1999, inclusive, were examined to obtain a perspective on damages and deaths from significant tornadoes in Texas. Prior tornado documentation and its inherent limitations are of some importance to this project because the strengths of U.S. tornadoes remain difficult to assess and quantify (McDonald 2001). And although the Fujita scale provides rather coarse resolution of "atmospheric truth" with regard to tornado strength, it does possess utility for researchers concerned with producing a viable study relating to the actual damage. So, with the acknowledgment of some limitations (Schaefer et al. 1986), the official and popular F-scale was used as the appropriate measure of tornado intensity. The F-3, F-4, and F-5 tornadoes were considered for this research because of their considerable potential for destruction of businesses and homes as well as the ability to produce important and meaningful changes upon the landscape, including, possibly, tornado scars and scar elements. Also, more historical path information existed relating to the extreme tornadic events.

The early 1950s were used as a beginning point for this search of historical tornadoes because the National Weather Service (NWS) began taking a pronounced interest in tornadoes, started issuing tornado watches when conditions were favorable for such storms, and commenced systematically verifying and logging their occurrences (Tecson et al. 1983). Also, a period of half a century allows for the investigation of tornado scars at various stages, likely providing a necessary time span to comprehend their longevity. For information about tornado incidence, storm strengths, deaths, and damage totals, two tornado databases were consulted. First, the Grazulis (1993, 1997) database of significant tornado activity was primarily referenced to research the majority of the tornado history from 1950 to 1995. The year 1995 represents the current limit to this database, which reconciles and combines the Storm Prediction Center's records on tornadoes with Fujita's University of Chicago tornado data. Secondly, the National Climatic Data Center's (NCDC) publication *Storm Data* was referenced online to ascertain tornado occurrences, strengths, damages, and deaths for the remaining short period from 1996 to 1999 (NOAA 2000). Based upon natural breaks in fatality and damage data for F-3 through F-5 storms, locations with eight million dollars' worth of damage and/or ten or more deaths were included as study sites. Even when adjusting tornado damage figures for inflation (Brooks and Doswell 2000), by considering the eight-million-dollar threshold as based in the mid-point of the study period, 1975, and a Consumer Price Index that at most approximately doubled during some decades over the last half-century, the resulting criteria and list remains the same. However, the list was refined further to include only those tornadoes that have impacted more urbanized areas with populations greater than 300 (U.S. Census Bureau 2002) and that produced areas of extensive or concentrated damage to residential and commercial property.

Specifically, tornadoes propagating across extremely remote areas of the countryside were not appropriate to this study investigating tornado scars upon the constructed landscape, though such storms can damage mobile home parks, industrial and oilfield locations, and occasionally isolated farmhouses. Additionally, tornadoes associated with hurricanes and occurring along coastal areas were not suitable for this research because of the potential confusion with hurricane-induced damages and changes. Hurricanes often produce tornado outbreaks when they landfall; however, most of the hurricane-spawned tornadoes in the U.S. are weak and brief (Stiegler and Fujita 1982; Gentry 1983).

Therefore, the final list of major storms and study sites chosen for research of the long-term imprints of disaster in Texas includes 15 storms across 19 locations, with damages rounded to the nearest one-half million dollars (Table 2). The storms occurred primarily along the Caprock Escarpment (eastern edge of the Llano Estacado) in the Texas Panhandle, the Cross Timbers region of north Texas, and along the Balcones Escarpment in the central portion of the state (Figure 1).

Procedures included first identifying individual tornado paths. Over the course of the last several decades, ground and aerial surveys of violent tornadoes' damage paths have become more common (Grazulis 1993). NWS disaster survey reports and personnel, souvenir magazines, historical books, newspapers, Internet sites, and informal personal accounts helped to locate historical damage paths through cities and towns, the locations most affected, and the nature of the damages (Moore 1958; Hoecker et al. 1960; Mehta et al. 1971; Grazulis 1993; Marshall

Table 2. Fifteen tornadoes across 19 locations in Texas, with damages in millions of dollars.

LOCATION	DATE	F-SCALE	DAMAGES	DEATHS
Knox City	3/13/53	4	0.5	17
San Angelo	5/11/53	4	3.0	13
Waco	5/11/53	5	41.0	114
Dallas	4/02/57	3	1.5	10
Silverton	5/15/57	4	1.0	20
Wichita Falls	4/03/64	5	15.0	7
Hale Center	6/02/65	4	8.0	4
Lubbock	5/11/70	5	135.0	28
Vernon	4/10/79	4	27.0	11
Wichita Falls	4/10/79	4	400.0	42
Paris, Reno, Blossom	4/02/82	4	50.0	10
Balch Springs, Mesquite *	12/13/84	3	22.5	0
Fritch	6/27/92	4	35.5	0
Jarrell	5/27/97	5	40.0	27
De Kalb	5/04/99	3	125.0	0

* Tornado weakened substantially and dissipated over Garland.
Data from Grazulis 1993,1997; NOAA 2000.

and Hoadley 1998; NOAA 1998).

After obtaining the appropriate city maps for each of the study sites, the tornado paths were marked and various transects were identified. After driving as close as possible to the perimeter of the old area of F-3 or greater damage, transects were navigated by both foot and car while searching for tornado scars and discreet scar elements street by street. Damage rated F-3 and higher destroys exterior walls of residences (see Table 1), likely requiring structures to be abandoned, razed, or rebuilt, thus increasing the likelihood of finding scars and scar elements. For storms where the F-scale gradations across the tornado paths remain uncer-

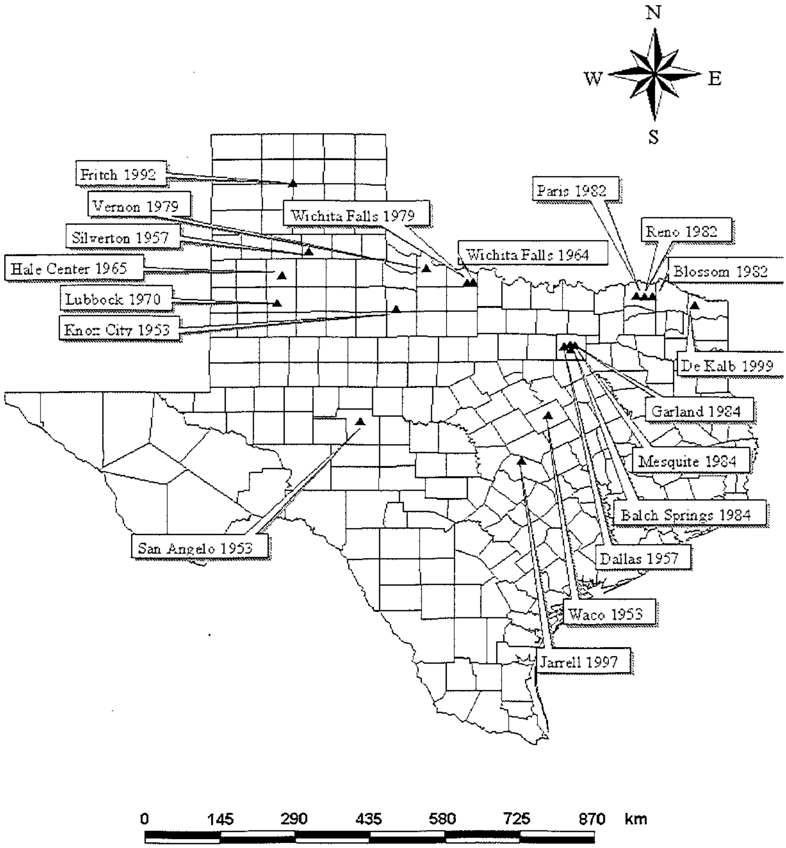

Figure 1. Locations of 15 tornadoes across 19 locations included in study.

tain, the entire tornado paths were considered, with an emphasis on the inner core areas where wind speeds are known to be greater than in the peripheral zones (NOAA 1988). Repeated transects and documentation of streets, structures, and landscapes along the historical tornado paths were completed for each storm event.

Tornado scars and scar elements, their longevity, and visible changes to the landscape along the historic path locations were meticulously noted. A Sony MVC-CD200 aided in documenting street addresses and other important information by permitting digital photographs as well as the recording of voice memos. Informal conversations (not structured interviews) with local residents occasionally disclosed some additional information about poorly documented paths and shed some light upon the nature of the landscape along the tornado path before and after the tornado. The frequency of tornado scars and elements for each tornado study site were later tallied, and a typology was created based upon common characteristics.

The number of tornado scars and elements at each study site and the length of time elapsed in years since each event were analyzed using Spearman's non-parametric test for rank correlation. This test was used because tornado scar and scar-element frequency is a discrete, non-normally distributed variable. Also, the frequency of scars and scar elements were compared to study-site population, race and ethnicity, median household income, and median home value from the census (U.S. Census Bureau 2002) to determine possible associations. Such variables likely play a role in the extent and speediness of recovery and reconstruction, and therefore the pervasiveness of scar phenomena.

Results: Frequency, Type, and Categorization

Tornado scars and scar elements do exist in a variety of forms in Texas, and their longevity spans the last five decades of the twentieth century in some instances. At least 17 different types exist across 15 of the 19 study sites in Texas. A complete listing of their frequencies, from the most commonly observed to the least, is given in Table 3. Concrete foundations, old driveways, and house-design tornado scars (adjacent homes of differing styles because of new construction) occur relatively frequently. Imbedded objects and visibly reinforced buildings were only seldom seen. A total of 259 tornado scars and scar elements were noted for 14 out of the 15 tornadoes. The average number of tornado scars and scar elements among study sites is approximately 14, ranging from zero to 43, with a median quantity of six. Since some tornadoes hit more than one study site, the

Table 3. Types and frequencies of scars/elements.

House Foundations	91
Different Adjacent House Designs	51
Old Driveways	50
Old Sidewalks	15
Structural Remnants	8
Different Bricks and Patterns in Structure	8
Abandoned Storm Shelters	6
Damaged Business Signs	6
Old Concrete Steps	5
Porch Slab with Steps	5
Damaged Structures	4
Dented, Crumpled Structures	2
Incomplete Reconstruction	2
Relict Metal Fences	2
Different Adjacent Telephone Poles	2
Imbedded Object	1
Visibly-Reinforced Building	1

average number of scar phenomena *per tornado* is approximately 17, also ranging from zero to 43, with a median value of 13.

No tornado scars or scar elements were noted for four of the 19 study sites. Specifically, the area primarily impacted in Reno by the 1982 Paris/Reno/Blossom tornado in northeast Texas exhibited complete reconstruction with no visible trace of the tornado's effects. Furthermore, although there was one incident of incomplete, professional reconstruction at Mesquite, there was no evidence of the same 1984 tornado at Balch Springs, or, for that matter, Garland, where that tornado had substantially weakened and dissipated. Lastly, the Jarrell subdivision that had largely been destroyed by the very slow-moving 1997 storm has been rebuilt during the approximately four years after the storm. In fact, construction of a residence on the last remaining empty foundation was completed during the summer of 2001.

After completion of fieldwork, several general categories were developed into a typology of tornado scars and scar elements. These have been titled *foundational remnants, remnants of tragedy, reconstructive* scars and scar elements, and *relics of disaster* (Table 4). The first category, *foundational remnants*, is characterized by fundamental in-ground portions of the structure with little vertical extent, including old driveways, home foundations, old steps, porch slabs with steps, and old sidewalks. This category has the highest frequency of tornado scar elements of all five categories and includes more than 90 home foundations, 50 old driveways, and 15 old sidewalks. The next category, *remnants of tragedy*, includes damaged structures and dented and crumpled structures that are largely intact and ostensibly still useful (Figure 2). It also includes areas of structural remnants from residential and commercial properties such as supports, beams, or perhaps old fireplaces with partial chimneys. A third category of tornado scar elements, *relics of disaster*, includes those discrete items not specifically part of the actual residential and commercial buildings or their reconstruction and not found in the other categories. This includes abandoned outdoor storm shelters, embedded objects, damaged business signs, and relict metal fences (Figure 3). Abandoned storm shelters and damaged business signs topped the list in this category (Figure 4). The last category, *reconstructive* tornado scars and scar elements, includes house-design tornado scars, different bricks and patterns in structure, incomplete reconstruction, different adjacent telephone poles, and visibly reinforced buildings (Figures 5 and 6). In this category characterized by post-disaster reconstruction, house-design tornado scars are plentiful, with more than 50 occurrences.

Overall, tornado scars and scar elements were found from tornadoes occurring as early as 1953 and as recently as 1999; the categorical and study-site totals varied widely over the years and among study sites (Table 4). While 15 tornadoes across 19 locations is not a normal sample of the population of all tornadoes and

Table 4. Tornado scar/element typology and frequencies, by site.

Study Site	Event Year	Foundational Remnants	Remnants of Tragedy	Reconstructive Scars/Elements	Relics of Disaster	Site Totals
Knox City	1953	1	1	-	1	3
San Angelo	1953	-	2	2	-	4
Waco	1953	17	-	8	-	25
Dallas	1957	19	-	7		26
Silverton	1957	7	2	1	1	11
Wichita Falls	1964	4	-	1	1	6
Hale Center	1965	-	-	-	1	1
Lubbock	1970	33	1	2	2	38
Vernon	1979	7	1	-	5	13
Wichita Falls	1979	38	-	5	-	43
Paris	1982	10	-	32	-	42
Blossom	1982	1	-	-	-	1
Mesquite	1984	-	-	1	-	1
Fritch	1992	9	4	-	1	14
De Kalb	1999	20	3	5	3	31
TOTAL	-	166	14	64	15	259

possible sites, little relationship appears evident between the number of years that have passed since the events and the total frequencies of tornado scars and scar elements at the individual study sites. Spearman's nonparametric test for rank correlation yields no statistically significant correlation at α equals 0.05. Also, no pattern of the frequency of tornado scars and scar elements at study sites appears evident with respect to the selected U.S. Census data. (Frequency of scar phenomena at sites was not standardized to km^2 of tornado paths.)

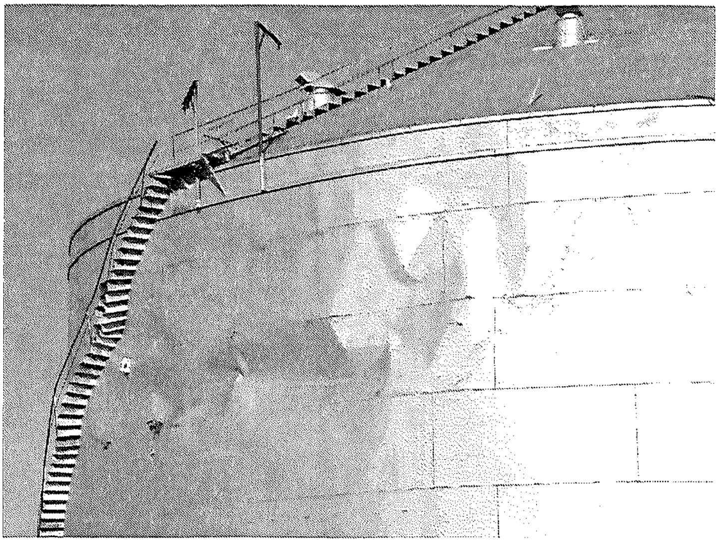

Figure 2. Dented and scratched by airborne tornadic debris or "missiles," this gin in Silverton survived a 1957 F-4 tornado and remains in use; note stairs to the left for scale.

Figure 3. A chair from a destroyed church across the street was embedded above the window and below the roof on the front of this home after a 1965 F-4 tornado impacted Hale Center, north of Lubbock.

Figure 4. Tornado devastation and meager rebuilding in an affluent neighborhood includes structural remnants, foundation, and an abandoned storm shelter more than 30 years after the F-5 Lubbock tornado of 1970.

Figure 5. The structure on the left, in De Kalb, damaged by a 1999 F-3 tornado, stands in contrast to the repaired home next to it; note the newer lighter-colored replacement telephone pole next to the darker (unused) pole.

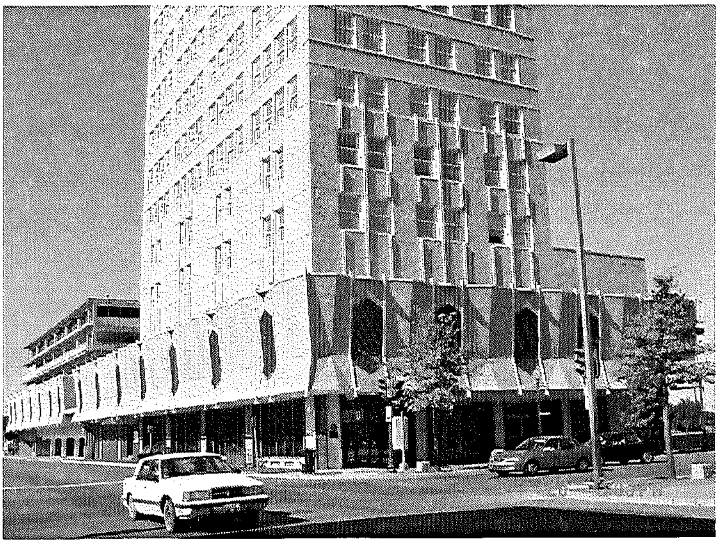

Figure 6. The Alico Building in downtown Waco needed strengthened after surviving a 1953 F-5 tornado, so the lower level is reinforced by a unique façade skirting the perimeter that extends around a parking garage.

Examination and Discussion of the Findings

Some of the oldest and most common evidence of past damaging storms includes foundational remnants, including those that formed when structures were blown away by fierce tornadic winds and those that remained after sites were cleared after the storm. House-design tornado scars also appear to be frequent at a large number of study sites, where reconstruction after the storm resulted in a demarcation between the old and the new. The frequency and type of tornado scars and scar elements at a given location *immediately* after a tornado are primarily related to the length, width, and strength of the intense, inner portion of the tornado, the engineering and strength of structures in the main path, and the duration of the event. As intended and expected, there is little distinction among F-3, F-4, and F-5 tornadoes in their ability to create long-lasting foundational remnants, remnants of tragedy, reconstructive tornado scars and elements, and most relics of disaster.

A difference *may* exist with respect to F-5 tornadoes' tendency to impart significant stress on multi-story steel and concrete structures such that they may later require reinforcement, possibly visible, or risk abandonment. The Alico Building on the corner of Austin Avenue and Fifth Street in downtown Waco needed strengthened after surviving a 1953 F-5 tornado, so the lower levels have been reinforced by a unique façade skirting the perimeter (Figure 6). Also, the 1970 Lubbock F-5 tornado deformed the top of the Great Plains Life Building 12 inches to the east, causing it to exceed allowable tolerances for being out-of-plumb (Mehta et al. 1971). Several years passed before that building's deformation was repaired and offices were occupied again (Grazulis 1993). However, no obvious changes in the appearance of the prominent Lubbock building due to reinforcement were noted in 2001.

The existence of the tornado scars and scar elements generally appears scattered, random, and chaotic. The De Kalb study site two and one-half years after the 1999 F-3 tornado remains an exception. The central portion of the De Kalb study site is still missing commercial buildings and appears highly impacted with a concentrated string of empty foundations extending for several blocks. Foundations of homes and old driveways are particularly common tornado-scar elements at all study sites, reinforcing the notion that the proper engineering and strength of structures is paramount for buildings and people to survive violent tornadoes.

In fact, based upon the 3 May 1999 tornadoes in central Oklahoma, F-5 damage can occur to residential structures with wind gusts as low as 58 ms^{-1} or 130 mph (Gardner et al. 2000). Such storms still rate F-5 based upon damage assessments, not wind speeds. So, conducting vulnerability analyses of locations and strength assessment of structures before significant tornadoes strike appears logical. Also, the presence of largely intact, abandoned storm shelters at some study sites reinforces the notion that underground shelters offer some of the best protection available from tornadoes. Interestingly, many early tornado scars in some populated areas were probably buried under the ground, particularly in Dallas, Lubbock, and Waco. Such large mounds along historic tornado tracks are not part of a natural evolution of the landscape; they are post-tornado mini-landfills, and exactly what lies beneath them is unclear.

Conclusion

This is one of the first systematic studies describing and categorizing the phenomenon known as "tornado scars." Detailing the visual effects of historic storms in the present-day constructed landscape, it sheds light upon the different forms that they take and their frequency, and addresses the issue of maximum longevity. Tornado scars and scar elements remain relatively enduring and recurring features on the Texas landscape, according to fieldwork at 19 study sites impacted by 15 strong and violent tornadoes occurring during the last half of the twentieth century. The storms represent some of the worst tornadoes in Texas; they killed at least ten people and produced a minimum of eight million dollars in damage. Many of the study sites experienced "signal events," rife with meaning that there may be reasons for significant public concern about the higher-order impacts of hazards (Slovic 1987).

Four general categories of a new typology for 17 types of tornado scars and scar elements include *foundational remnants*, *remnants of tragedy*, *reconstructive* scars and scar elements, and *relics of disaster*. The longevity of tornado scars and scar elements spans the last five decades of the twentieth century in some instances. Their presence typically appears scattered and random along the path of historical tornadoes beyond approximately three years. Generally, tornadoes have a cleansing effect upon substandard housing and set the stage for neighborhood and urban renewal (Minnis and McWilliams 1971) much like a forest fire prepares wooded areas for new growth.

Thematic perception tests can be appropriate research tools for future studies. Such tests, displaying various pictures of tornado-scar elements to inhabitants of tornado-prone areas requesting that they write a paragraph about what they see, might clarify any meaning that they hold for people. Tornado scars might also provide an opportunity to educate and communicate to residents of tornado-prone areas the significant impact of severe convection. Additionally, continued searches for tornado scars and maximum possible longevity provide unique opportunities for the collection of unusual and ephemeral oral histories of storms. Studying tornado-ravaged landscapes in different states also has merit, in a continuing investigation of violent storms as agents of change and renewal upon the landscape.

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