Storm-Related Mortality in Central Texas

October 17-31, 1998

An Epidemiologic Investigation

by the

Injury Epidemiology and Surveillance Program

Bureau of Epidemiology

Texas Department of Health

February, 1999

Acknowledgments

This report would not be possible without the support, assistance, and guidance from many people.

Special acknowledgment to all the medical examiners, sheriffs, county judges, DPS officers, and administrative personnel that took the time and effort to collaborate with us.

We also want to make note of the assistance of John Roberts of the Lower Colorado River Authority, Joe Baskin of the National Weather Service Austin-San Antonio Weather Forecast Office, and Bill Read of the National Weather Service Houston Weather Forecast Office.

Thanks to Dr. Dennis Perrotta of the Bureau of Epidemiology, and David Vaughan of the Division of Emergency Management for their editorial assistance.

Thanks also to Kenneth Mills and John Underwood for assistance with the GIS mapping of this investigation, and Maria Velasquez for assistance with creation and formatting of graphics.

Authors

Christine Kremer, R.N., M.S.N. (c)

David F. Zane, M.S.
Director, Injury Epidemiology & Surveillance Program
Texas Department of Health

Introduction

On October 17, 1998, a series of upper level disturbances moved across the Central Texas and South Texas regions. This unusual storm system resulted from a slow moving cool front which stalled over central Texas combined with moisture from the Gulf of Mexico and two pacific hurricanes, Lester and Madeline, off the western Mexico coast (1,2,3). The resulting storms dropped more than 15 inches of rain in many areas and spawned several tornados. For San Antonio, the greatest single calendar day=s rainfall of record of 11.26 inches (1885 to present), was recorded on October 17, 1998. Rainfall in areas of Bexar and Comal counties reached as high as 22 inches (4).

Sixty Texas counties (24% of counties) reported flooding between October 17 and 19 as a result of this storm system (5). Thirty-six counties became eligible for federal and or state assistance as a direct result of damages suffered from this storm system October 17-31(6). Estimated damages from the October floods were reported at just over $900 million including damage to almost 12,000 homes, 700 businesses, and public property (7).

Flood related deaths were reported in nine Texas counties for a total of 31 deaths. These deaths occurred in 24 separate incidents. This report summarizes findings of an epidemiologic investigation of deaths associated with the storm system. The findings may be used to support the development of specific interventions aimed at preventing future storm-related mortality in South Central Texas.

Methods

Data collection activities were conducted by staff of the Bureau of Epidemiology Injury Epidemiology and Surveillance Program. Epidemiologic information was obtained from the Bexar and Travis County Medical Examiners, as well as from offices of Justice of the Peace and Department of Public Safety officers in outlying counties. Data was supplemented in some cases by information provided by the Bureau of Vital Statistics.

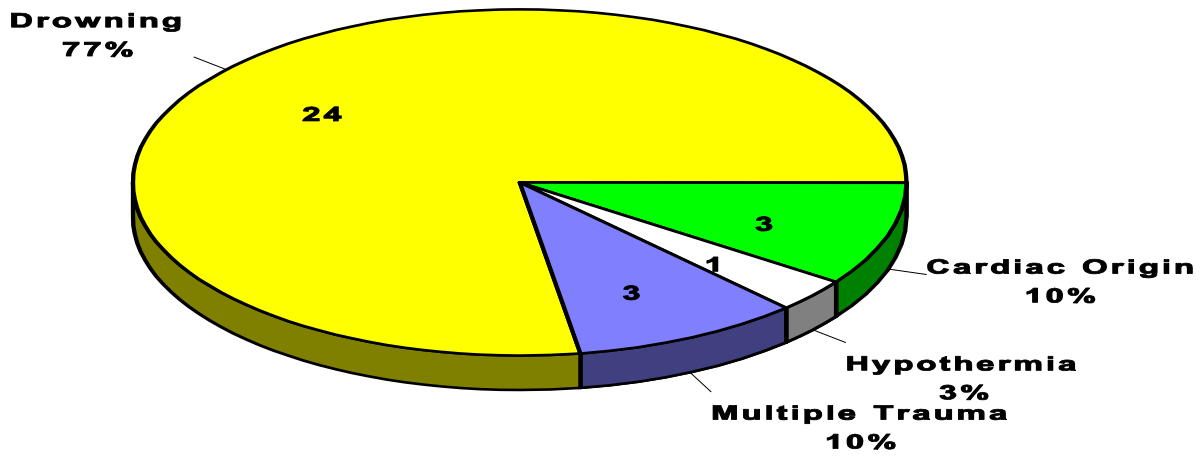
A case was defined as a death directly or indirectly related to the storm system that occurred October 17 through October 20, 1998. To capture all storm related deaths, traumatic deaths occurring between October 17 and October 31 were considered. A directly-related death was defined as one that resulted from physical contact with storm product, such as flood water, hail, lightning, or wind. An indirectly related death is defined as one that did not result from physical contact with a storm product, but would not have happened if the storm had not occurred. An example of an indirectly-related death would be one resulting from a storm-related activity, such as electrocution due to post-flood cleanup.

Results

Thirty-one deaths met the above criteria as directly or indirectly related to the storm. These deaths occurred in 24 separate incidents. Thirty of the victims were Texas residents, and one was a Louisiana resident visiting in Texas. The deaths occurred in nine Texas counties.

As illustrated in Figure 1, cause of death for the 31 decedents is as follows: Drowning 77% (24/31), Cardiac Origin 10% (3/31), Multiple Trauma 10% (3/31), and Hypothermia 3% (1/31).

Figure 1: Cause of Death

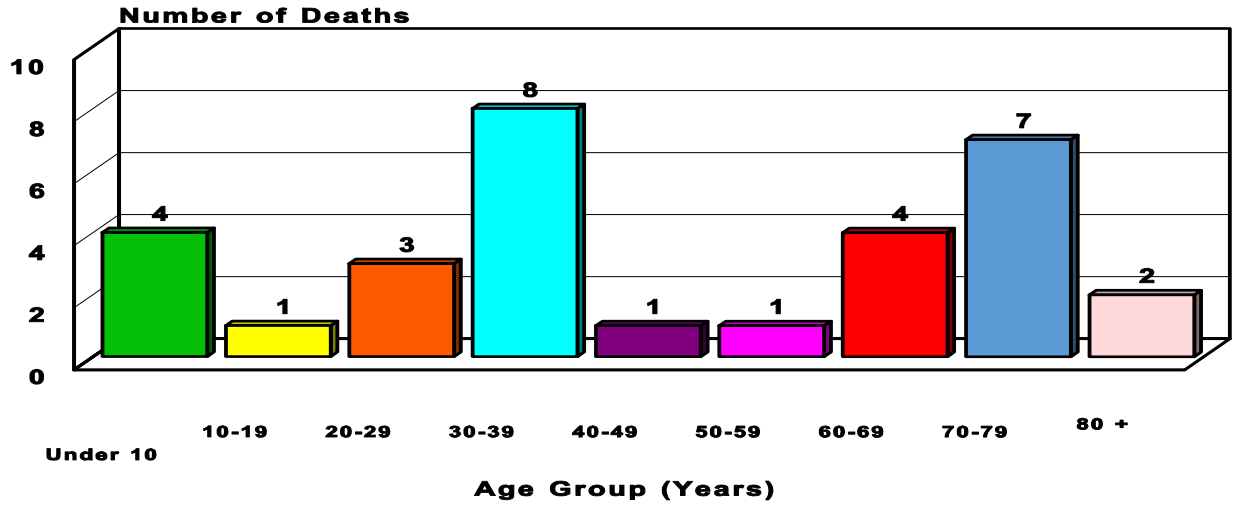


Twenty-nine of the deaths (94%) were **directly** related to the storm. Drowning was the cause of death in 83% (24/29) of the directly related cases. Three persons died of multiple trauma (one case was related to flash flooding, the remaining two cases were caused by tornados in Navarro and Waller counties), one person died of hypothermia after submersion in water, and one died of cardiac arrhythmia induced after he became trapped in a water crossing.

Two of the deaths were **indirectly-related** to the storm (6%). One man died while awaiting rescue by EMS who were unable to reach his residence because of area flooding. The second man died in his truck in a water crossing on his property. The exact circumstances of this death are unclear. It has been included among indirectly related cases because the flooding may have contributed to his death and because the local media as well as other agencies have included his case among reported flood deaths.

As Figure 2 shows, age was available for all victims. Decedents ranged in age from 2 months to

Figure 2: Deaths by Age



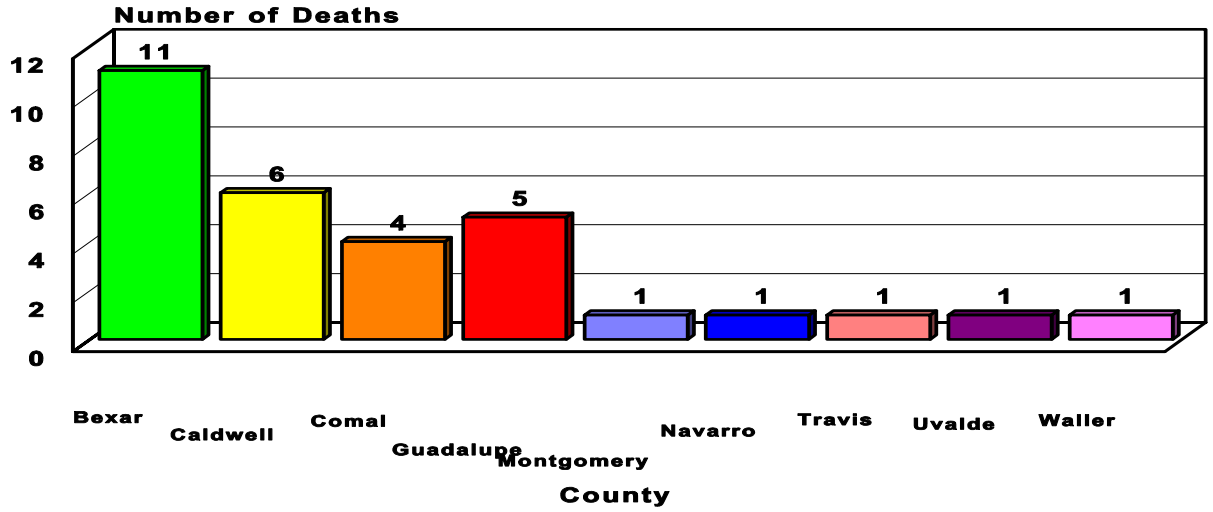
83 years.

Males (65%) outnumbered females (35%) among the 31 decedents (20 males, 11 females). All 31 decedents were white with 26% (8/31) having Hispanic surnames. Deaths occurred in nine Texas counties as illustrated in Figure 3. Map 1 illustrates deaths by county by declared disaster areas.

The circumstances surrounding the deaths were known for all cases but two (29/31). Twenty-two of the 29 cases (76%) with known circumstances occurred because a vehicle was driven into high water. These deaths occurred in 16 separate incidents. Four of these incidents resulted in multiple deaths (three incidents resulted in two deaths each, the fourth resulted in four deaths). Map 2 illustrates fatalities by incident by county.

Of the 16 water-crossing incidents, 10 (63%) occurred where water crossed a ground level surface. Two incidents (13%) occurred when a car was washed off of a bridge. Two incidents (13%) occurred at the junction of a bridge and a road. In two incidents (13%), the exact point at which the car was washed of the road was unknown. Of the 16 water crossing incidents, 11 (69%) occurred at locations known to reporting authorities to have a history of flooding. These 11 incidents accounted for 77% (17/22) of the deaths in motor vehicles. The five remaining incidents occurred at locations not known to the reporting agency to have a history of flooding.

Figure 3: Deaths by County of Occurrence

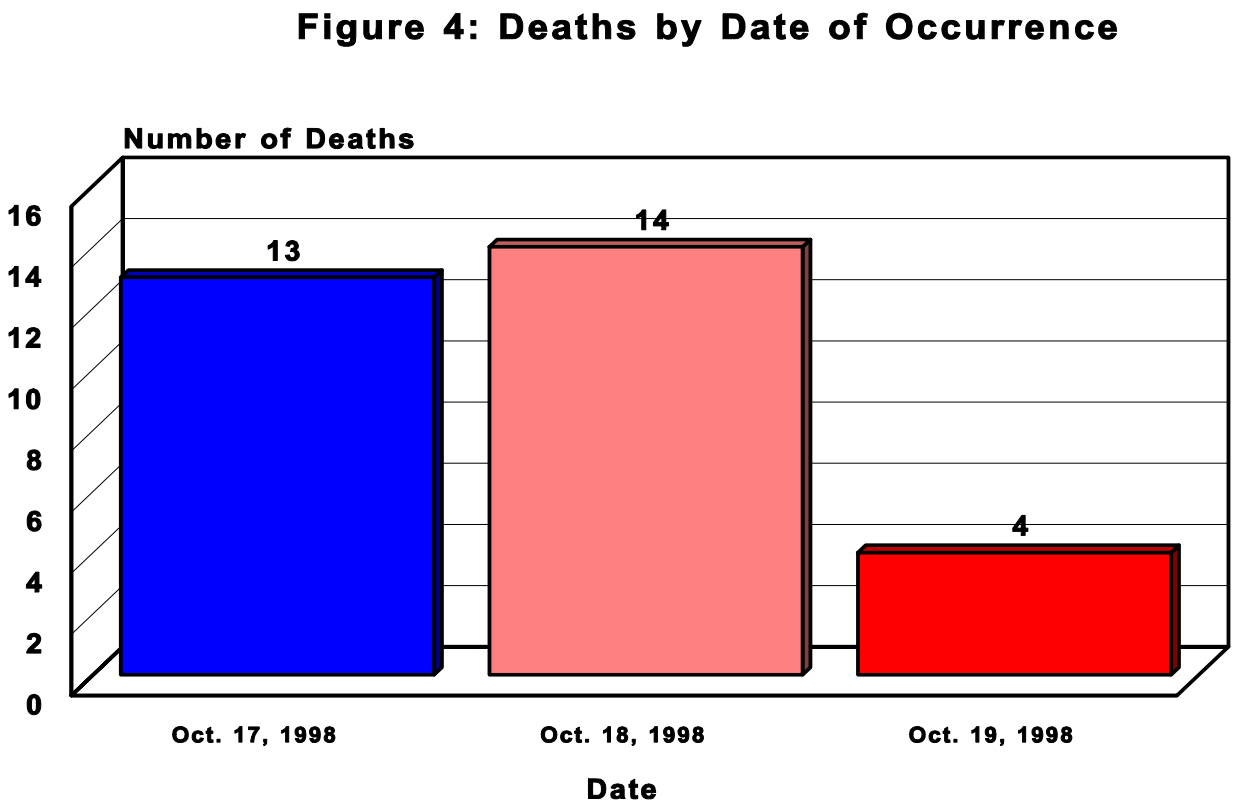


The type of vehicle driven is known for all 16 of the water-crossing incidents. Of these 16 vehicles, 10 (63%) were trucks, Jeeps, or sport-utility-vehicles. The largest of these vehicles was a produce truck swept off of the road into the Olmos Dam reservoir.

Ninety-one percent (20/22) of the vehicle related deaths were due to drowning. One death resulted from hypothermia after water submersion, and one death resulted from stress-induced cardiac arrhythmia after the decedent became trapped in a water-crossing.

Twenty-four percent of the remaining deaths with known circumstances (7/29) were not water-crossing incidents. Three individuals drowned in their homes (two of these in the same incident), and one drowned near the boat dock on his property. Two cases resulted from tornado related trauma in Navarro and Waller counties. One man died of a heart attack when phone service was out and Emergency Medical Services were unable to reach his home because of flooding.

A body of water was directly involved in 90% (26/29) of the cases with known circumstances. Twenty-four deaths (92%) occurred in 18 separate incidents involving rivers, creeks, or dry creek beds. The greatest number of incidents and cases occurred at Salado Creek in San Antonio. Three incidents occurred at Salado Creek resulting in six deaths. The second greatest number of incidents and deaths occurred at Plum Creek near Luling with two incidents resulting in four deaths. These incidents are illustrated in Maps 3 and 4. Of the remaining bodies of water, one death occurred at a natural lake (Lake Dunlop), and one at a reservoir basin (Olmos Dam



reservoir basin).

As Figure 4 illustrates, the majority of deaths (45% or 14/31) occurred on the second day of the storm. Forty-two percent (13/31) of the deaths occurred in the first day of the storm system (October 17, 1998). The last four deaths (13%) occurred on October 19. No deaths were reported after October 19, though rain and flooding persisted through October 31. Map 5 illustrates the temporal distribution of deaths across Central Texas.

Time of incident leading to death is known for 72% of cases with known circumstances (21/29). Of these cases, the earliest death occurred near Olmos Dam in San Antonio at 9:00 AM on October 17. The last case occurred at 2:00 AM on 10/19 in Magnolia at Spring Creek. Ninety

percent of the deaths (19/21) occurred within a 24 hour period, near the beginning of the storm, between 9:00 AM October 17 and 9:00 AM October 18. One third of the deaths (7/21) occurred during the early morning hours (midnight to 4:00 AM).

Discussion

Floods are the most common type of natural disaster worldwide. They account for an estimated 40% of all natural disasters. Flash flooding is the leading cause of weather related mortality in the United States, accounting for approximately 200 deaths per year (8).

Floods can be divided into two forms, each with a different significance for injury prevention. The first form, flash floods, occurs within a few minutes or hours of excessive rainfall, or dam or levee failure, and historically accounts for most fatalities (9,10). The second form, flooding, is a longer term event, and may last a week or more after the initial weather event, causing fewer deaths. There is more time to reroute traffic and provide emergency shelter and information during flooding.

Nationally, the most common cause of flood-related deaths is drowning (11). More than half of flood-related drownings in this country occur when a vehicle is driven into hazardous flood waters (10, 11, 12). As detailed above, 76% of the deaths with known circumstances in this investigation occurred because a motor vehicle was driven into flood waters.

Beginning October 17, 1998, a series of upper level disturbances moved across the Central Texas and South Texas regions. This unusual storm system dropped record levels of rainfall over many areas of Central Texas, with areas of Bexar and Comal counties reporting as much as 22 inches of rain in a 24 hour period. San Antonio received record rainfall beating the previous 24 hour rainfall record by more than six inches.

The heavy rains quickly created widespread flash flooding throughout the Central Texas region. Because much of South Central Texas is located atop the Edwards Plateau, a massive uplifted limestone outcropping where rocky hills and sparse vegetation do not absorb rain, tremendous runoff occurs. The rocky hills funnel water quickly through the region. Massive amounts of water move at high velocities through the region overwhelming rivers, streams, and lakes (3).

Many area rivers and creeks crested at record levels. Flooding was reported along the entire Colorado River basin. A listing of historic river and creek flood levels, and historic high rainfall amounts is included in Appendix A.

The South Central Texas region has historically been susceptible to damage and loss of life due to heavy rains for reasons discussed above. This period of flooding was the second most costly in terms of lives lost (33 died in flooding August 1-4, 1978; 29 died related to flooding during this storm period); and the most costly in monetary terms ($900 million in this flood period compared to a previous record of $110 million in 1978)(7, 13).

The National Weather Service (NWS) issued the first flash flood watch for all of South Central Texas for this storm system on Saturday, October 17 at 5:30 AM indicating that conditions were favorable for flash flooding. At 6:28 AM the same morning, this alert was upgraded to a flash flood warning, stating that flash flooding was in progress, for Bexar county. Bastrop, Caldwell, Lee, Williamson, Hays, Travis, and Comal counties were added to the flash flood warning list by 10:41 AM. The last flash flood warning for the Central Texas area expired on Monday, October 19 at 5:20 PM (14,15). All flash flood-related deaths with known times occurred after the flash flood warnings had been issued and before the flash flood warnings had expired.

It is known that the National Weather Service appraised all counties of the weather conditions as they progressed. Warning and response systems varied by county, but it is known that 11 of the 16 vehicle-related incidents (69%) occurred at areas known by reporting authorities to be prone to flooding. Rescue activities and safety measures introduced by each county differed.

The focus of this investigation was on storm-related deaths. No attempts were made to collect data on the numbers of survivors or rescue attempts in these areas. However, it is known that in four of the 16 fatal motor vehicle incidents, 11 passengers were able to escape from the vehicles and survive.

Investigators attempted to gather information related to the use of barricades around water-crossings in roads. This information proved to be difficult to gather as it was not consistently

recorded and many of the cases were not witnessed. It is known, however, that at least one death in Montgomery County occurred after an individual disregarded roadway barriers.

The problem associated with the collection of barrier-related data can be illustrated by a single incident in a rural county. This death occurred at a rural site where authorities had placed a barrier in the north-bound direction of the road, but were unable to reach the south-bound side to place barriers due to flooding. A vehicle was subsequently driven into the water-crossing from the south-bound direction.

A factor which may have contributed to the number of deaths resulting from this storm-system may be its occurrence on a weekend. It is known that at least two vehicle-related incidents (resulting in 6 deaths) occurred when families were driving home from events in other regions of Texas into the storm conditions of Central Texas. Though weather warnings were issued throughout the Central Texas region, it is possible that Texas residents traveling long distances from other regions may not have been aware of inclement weather conditions at their destination.

Water-crossing incidents occurred in vehicles ranging in size from a full-sized produce truck to a compact car. It is interesting to note that the majority of vehicle related incidents (63%) occurred in trucks, Jeeps, or sport-utility-vehicles. Reasons for this are unknown at this time, but may reflect an increased number of large vehicles driven in times of inclement weather, the belief that larger vehicles provide a greater margin of safety, or the prevalence of larger vehicles in this region. The number and type of vehicles driven at the time of this flooding is not known.

Neither vehicle type nor driving habits are known to have been examined in any previous flood-related mortality survey.

Four deaths resulting from cardiac factors were observed. Two men suffered myocardial infarctions (Heart Attacks), one man died as a result of cardiac arrhythmia, and cardiac factors contributed to the death of another individual. This observance is consistent with the results of previous studies indicating that cardiac deaths are more likely to occur during or immediately after strenuous activity (16), during times of increased emotional stress (17, 18, 19, 20), and during natural disasters, and for a period of several days after a natural disaster (17, 18, 19, 20, 21). Investigators did not attempt to collect data on the total number of cardiac deaths during this storm and storm-aftermath period. The cases indicated above were those reported by local authorities as directly or indirectly related to the flooding.

This report has documented the public health impact of the October 1998 storm-event in Central Texas. The findings may be used to support the development or strengthening of interventions aimed at preventing future storm related deaths in the area.

Recommendations of the Texas Department of Health on life-saving precautions regarding floods are listed below (22).

! If you encounter flood waters, stop, turn around and go another way

- Do not drive in flood water over one foot deep or into water of unknown depth. Be aware that most cars will float in two feet of water. Be aware that the road may not be intact under flood waters
- Abandon your vehicle immediately and seek high ground if it stalls in rising flood waters. If your vehicle stalls and begins to float, climb to the roof. Deaths often occur because people mistakenly believe vehicles provide protection from rising, swiftly-moving flood waters
- If your vehicle stalls in flood water that is not rising, or is receding, stay inside your vehicle
- Comply with all detour signs. Never try to go around a detour sign
- Do not walk or bicycle in flood water over one foot deep or into water of unknown depth. Even 6 inches of fast-moving water can knock you off your feet
- Do not allow children to play in flood water of any depth. Children should never play around storm drains or viaducts
- Evacuate to high ground if floods rise around your home
- Be aware that most flood deaths occur close to home
- Be especially cautious at night when it is harder to recognize flood dangers
- Do not enter flooded buildings unless electricity is known to be shut off
- If you are elderly or have a history of heart disease, do not over exert. Get help for strenuous tasks. Stress and over exertion increase the likelihood of heart attack and death for persons with underlying heart disease

- Avoid the use of alcohol and other intoxicating substances in areas where flooding has occurred
- Do not explore caves during rainy or flood-prone weather

References

1. National Weather Service. Mid October Heavy Rain Event over Central and South Central Texas; November 2, 1998. Available at <http://www.srh.noaa.gov>.

2. National Hurricane Center. Hurricane Advisory Archives: 1998; November 30, 1998. Available at <http://www.nhc.noaa.gov>.

3. Bragg, R. AClimate, geology set the stage for flooding disaster@. *San Antonio Express News*. October 24, 1998. http://www.expressnews.com/news/saflood98/2516alja.shtml

4. Press Release. Division of Emergency Management, Texas Department of Public Safety. October 19, 1998, 3:00 P.M.

5. Walt, K., Gonzalez, J. ARelentless Downpour Swamps Texans@. *Houston Chronicle.* October 19, 1998. http://www.chron.com/contents/story.html/page1/124273

6. Press Release. AFour More Counties Included For Federal and State Disaster Recovery Assistance@. Federal Emergency Management Agency, November 20, 1998.

7. Press Release. Division of Emergency Management, Texas Department of Public Safety. November 10, 1998.

8. Centers for Disease Control. Public health consequences of a flood disaster-Iowa, 1993. *Morbidity and Mortality Weekly Report*. 1993;42: 653-656.

9. French, JG, Holt, KW. Floods. In: Gregg MB, ed. *The public health consequences of disasters:1989*. Atlanta, GA: US Department of Health and Human Services, Public Health Service, CDC, 1989:69-78.

10. Nojie, E., States, C., Orengo, J.C., Malilay, J., and Rulan, J. Deaths due to flash floods in Puerto Rico, January, 1992: Implications for prevention. *International Journal of Epidemiology*. 1994; 23: 968-975.

11. Frazier, K., The violent face of nature: severe phenomena and natural disasters. New York: William Morrow and Company, Inc., 1979

12. Anonymous, From the Center for Disease Control and Prevention, Flood-related mortality-Georgia, July 4-14, 1994. *JAMA*. 1994; 272: 508-509.

13. West Gulf Coast River Forecast Center, National Weather Service. Significant floods in the WGRFC area, 1866-1997; November 20, 1998.Available at <http://www.srh.noaa.gov/wgrfc>.

14. Personal communication, National Weather Service, Austin-San Antonio Weather Forecast Office, December 21, 1998

15. Personal communication, National Weather Service, Houston Forecast Office, January 7, 1998

16. Anonymous. No excuse for sloth. *Harvard Health Letter*. 1994;19:8.

17. Leor, J., Kloner, R.A. The Northridge Earthquake as a trigger for acute myocardial infarction. *American Journal of Cardiology*. 1996; 77: 1230-2.

18. Leor, J., Poole, W.K., Kloner, R.A. Sudden cardiac death triggered by an earthquake. *New England Journal of Medicine*. 1996; 334: 413-9.

19. Trichopoulos, D., Katsouyanni, K., Zavitzanos, X. , et al. Psychological stress and fatal heart attack: the Athens (1981) earthquake natural experiment. *Lancet* . 1983; 836: 441-4.

20. Trevisan, M., Celentano, E., Meucci, C., et al. Short-term effect of natural disasters on coronary heart disease risk factors. *Arteriosclerosis*. 1986; 6: 491-4.

21. Kloner, R.A., Leor, J., Poole, W.K., et al. Population based analysis of the effect of the Northridge Earthquake on cardiac death in Los Angeles County. *Journal of the American College of Cardiology*. 1997;30: 1174-80.

22. Texas Department of Health, Public Information Office, various news releases, October 1994, related to flood and disaster precautions.

23. National Weather Service, Austin-San Antonio Weather Forecast Office. October 1998 Daily Data. November 2, 1998. Available at <http://www.srh.noaa.gov>.

24. Personal communication, Lower Colorado River Authority, November 11, 1998

25. Lower Colorado River Authority. AColorado River Summary Report@.1998. Http://www.lcra.org/water/riversum.html (October 21, 1998).

26. United States Geological Survey in Texas. October Floods in Central and Eastern Texas. December 18, 1998. Available at <http://tx.usgs.gov>.

Appendix A

Table 1:
Daily Weather Conditions For Austin, and San Antonio, Texas
October 16, 1998 through October 20, 1998

Location	Date	Precipitation in Inches	Weather Conditions	Peak Wind in M.P.H.
Austin	10/16/98	Trace	Fog	32
	10/17/98	6.24 #	Fog reducing visibility to 1/4 mile or less; thunder	24
	10/18/98	1.46	Fog reducing visibility to 1/4 mile or less	25
	10/19/98	1.02	Fog	24
	10/20/98	0.10	Fog	20
	Monthly Total	12.39 *		
San Antonio	10/16/98	0.00	Fog	33
	10/17/98	11.26 +	Fog reducing visibility to 1/4 mile or less; thunder	32
	10/18/98	3.16	For reducing visibility to 1/4 mile or less	30
	10/19/98	1.19	Fog	24
	10/20/98	0.03	Fog	15
	Monthly Total	18.07 ~		

Eighth greatest single day precipitation total recorded.
* Third wettest October recorded.
+ Greatest single day precipitation total recorded.
~ Wettest month recorded.

National Weather Service, Austin-San Antonio Weather Forecast Office (23)

Colorado River Crests
Table 2:

Location	Date and Time of Peak for October 1998	Stage Peak (ft.)	Flood Stage (ft.)	Historic High After Mansfield Dam (ft.)
Colorado River at Austin	10/17/98; 14:48	24.42	29	25.9; 5/25/81
Colorado River at Bastrop	10/18/98; 22:38	32.26	25	37.5; 12/22/91
Colorado River above La Grange	10/20/98; 04:00	45.49 *	32	43.4; 12/23/91
Colorado River at Columbus	10/21/98; 05:00	43.66 *	34	41.4; 12/24/91
Colorado River at Wharton	10/23/98; 10:20	48.72 *	39	46.1; 12/27/91
Colorado River at Bay City	10/24/98; 02:40	41.04 *	44	38.7; 12/27/91

* New record high

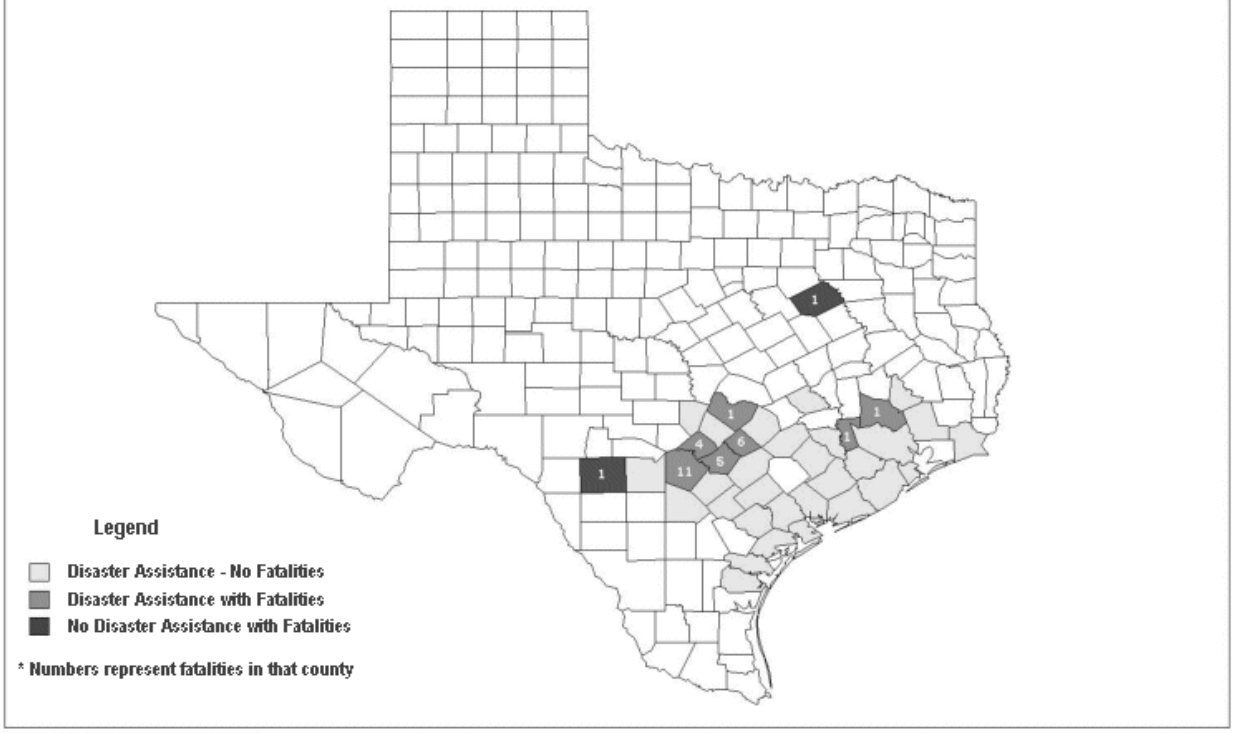
Lower Colorado River Authority (24)

Table 3:
Area Creek and River Crests

Location	Date and Time of Peak for October 1998	Stage Peak (ft.)	Historic High (ft.)
Bull Creek	10/17/98; 1200	8.2	5/13/82; 11.0
Barton Creek	10/17/98; 1300	12.7	5/21/81; 15.0
Walnut Creek	10/17/98; 1500	24.4	5/25/81; 25.8
Onion Creek at Hwy 183	10/17/98; 1830	31.98 *	12/21/98; 30.5
Onion Creek at Bastrop	10/18/98; 1000	32.2	12/22/9; 37.0
Onion Creek at Smithville	10/18/98; 1100	34.6	12/22/91; 37.0
Onion Creek at La Grange	10/19/98; 0400	45.5 *	12/23/91; 43.0
Onion Creek at Driftwood	10/17/98; 0200	24.9 *	6/9/97; 17.56
Cibolo Creek at Falls City	10/19/98; 0100	39.53 *	9/28/73; 35.44
San Antonio River at Loop 410	10/17/98; 1630	36.15 *	7/15/70; 32.20
San Antonio River at Elmdorf	10/17/98; 1130	64.5 *	7/5/86; 53.06
San Antonio River at Goliad	10/21/98	53.0	9/23/67; 53.7
Guadalupe River at New Braunfels	10/17/98; 1800	39.3 *	5/12/72; 36.4
Guadalupe River at Seguin	10/18/98; 0100	36.3 *	5/12/72; 32.5
Guadalupe River at Gonzales	10/18/98; 1800	51.8 *	12/22/91; 35.0
Guadalupe River at Cuero	10/19/98; 1900	48.89 *	9/11/81; 41.83
Guadalupe River at Victoria	10/20/98; 1400	33.1 *	9/2/81; 31.1
Guadalupe River at Tivoli (San Antonio Bay)	10/13/98	33.0 *	11/24/85; 20.89
San Marcos River at Luling	10/17/98; 2400	36.50 *	10/19/94; 28.45
Plum Creek at Lockhart	10/17/98; 1800	20.94 *	
Sandy Creek at Jackson City	10/19/98; 0100	29.66 *	

* New record high

Compiled after multiple sources: National Weather Service, West Gulf River Forecast Center (13); Lower Colorado River Authority (24, 25); United States Geological Survey in Texas (26)



Map 1. Declared Disaster Areas with Numeric Representation of Fatalities per County

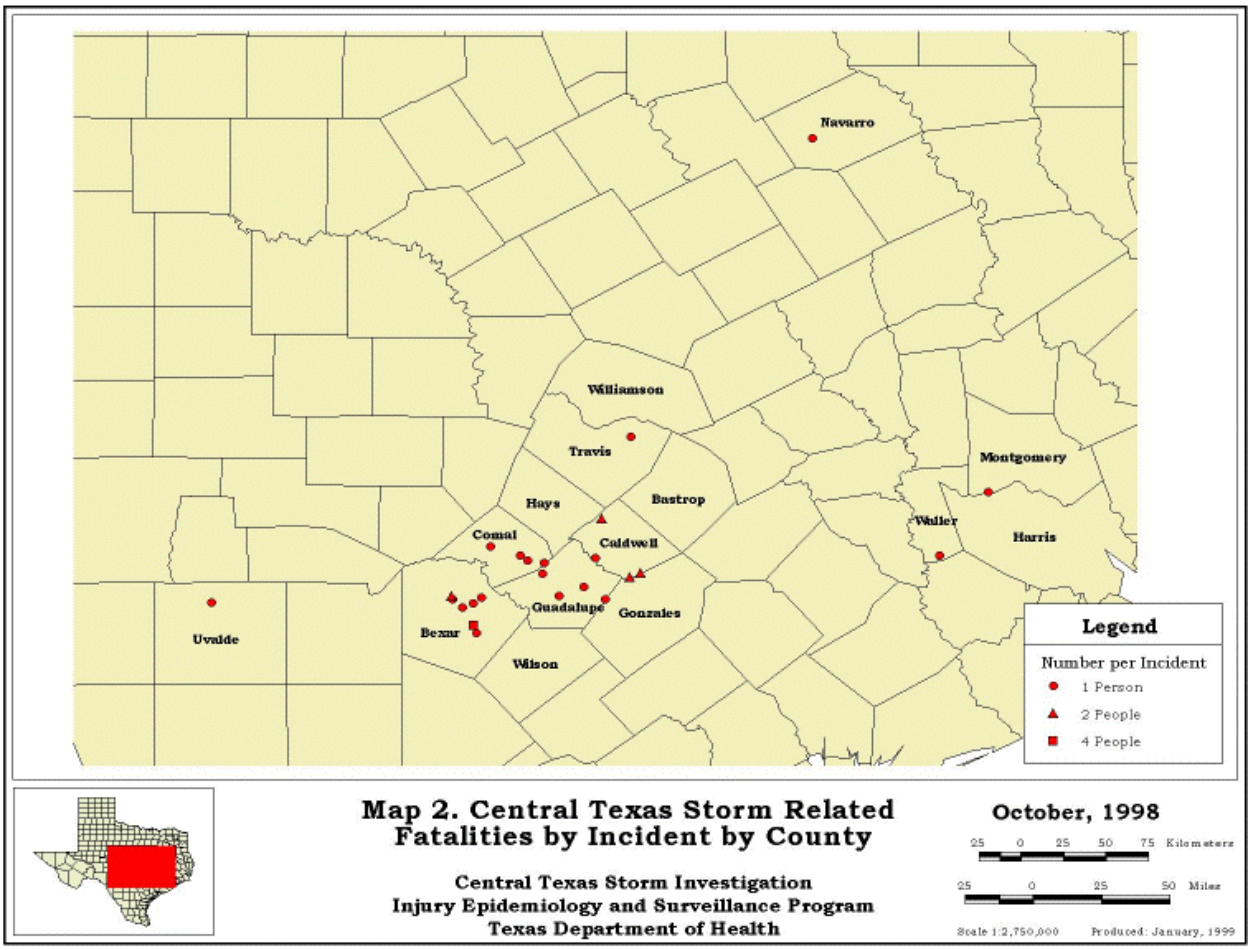
October, 1998

Central Texas Storm Investigation
Injury Epidemiology and Surveillance Program
Texas Department of Health

75 0 75 150 225 Kilometers

75 0 75 150 Miles

Scale 1:9,000,000 Produced: January, 1999



Map 2. Central Texas Storm Related Fatalities by Incident by County

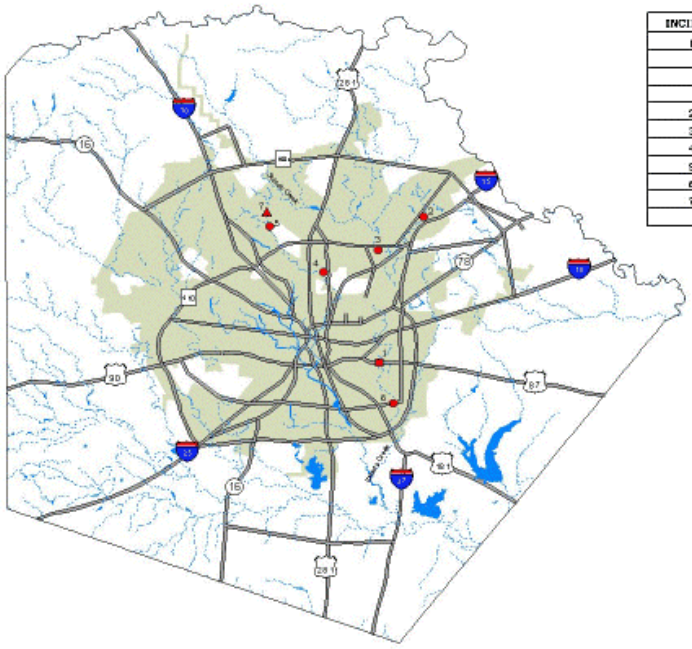
Central Texas Storm Investigation
Injury Epidemiology and Surveillance Program
Texas Department of Health

October, 1998

25 0 25 50 75 Kilometers

25 0 25 50 Miles

Scale 1:2,750,000 Produced: January, 1999



INCIDENT	GENDER	AGE	LOCATION	CAUSE OF DEATH
1	M	47	Road	Drowning
	F	65	Road	Drowning
	F	2 months	Road	Drowning
	F	20	Road	Drowning
2	M	55	Road	Cardiac
3	F	31	Road	Drowning
4	M	37	Road	Drowning
5	F	79	Unknown	Trauma
6	M	67	Road	Hypothermia
7	M	31	Road	Drowning
	F	30	Road	Drowning

Legend

Number per Incident

- 1 Person
- 2 People
- 4 People
- Rivers and Streams
- Interstates and Highways
- City of San Antonio
- Lakes and Ponds

Map 3. Bexar County

Central Texas Storm Investigation
Injury Epidemiology and Surveillance Program
Texas Department of Health

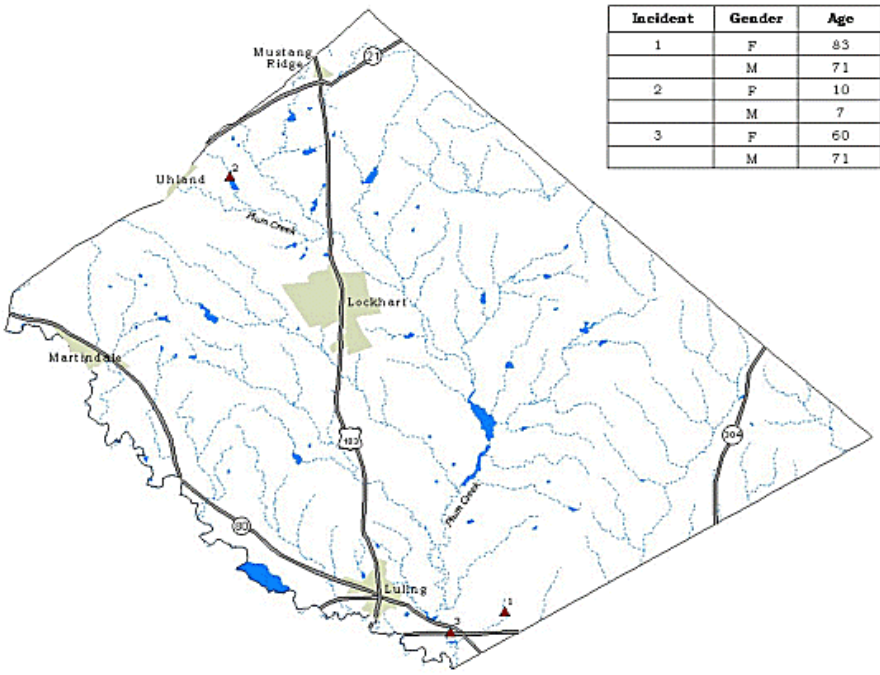
October, 1998

5 0 5 10 15 Kilometers

5 0 5 10 Miles

Scale 1:500,000 Produced: January, 1999

Incident	Gender	Age	Location	Cause
1	F	83	Residence	Drowning
	M	71	Residence	Drowning
2	F	10	Road	Drowning
	M	7	Road	Drowning
3	F	60	Road	Drowning
	M	71	Road	Drowning



Legend

Number per Incident

- 2 Persons
- Interstates and Highways
- Rivers and Streams
- Cities
- Lakes and Ponds

Map 4. Caldwell County

October, 1998

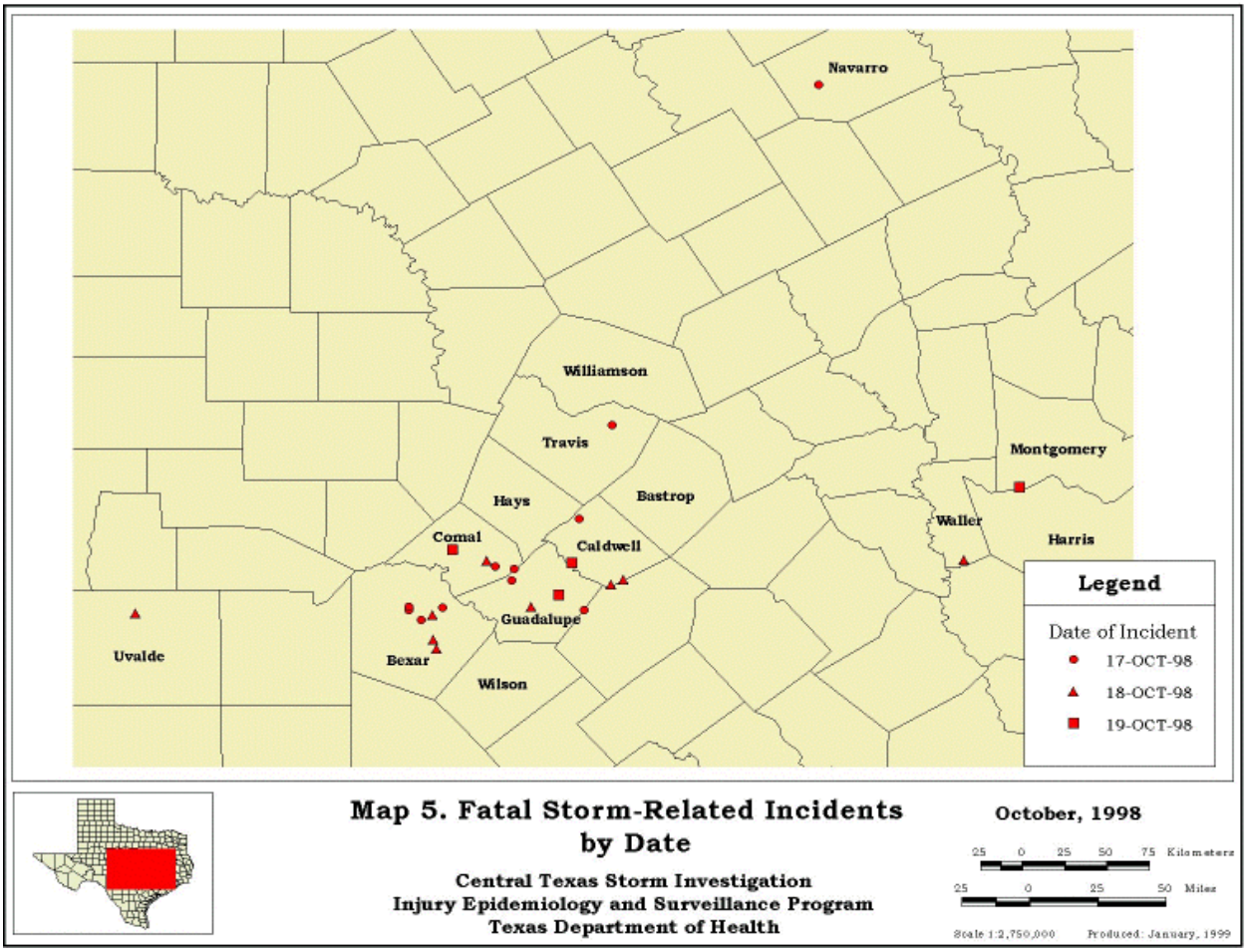
Central Texas Storm Investigation
Injury Epidemiology and Surveillance Program
Texas Department of Health

3 0 3 6 9 12 Kilometers

3 0 3 6 9 Miles

Scale 1:350,000

Produced: January, 1999



Map 5. Fatal Storm-Related Incidents by Date

October, 1998

Central Texas Storm Investigation
Injury Epidemiology and Surveillance Program
Texas Department of Health

25 0 25 50 75 Kilometers

25 0 25 50 Miles

Scale 1:2,750,000 Produced: January, 1999