

## Flood Risk Outreach and the Public's Need to Know

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**F**lood devastation continues to rise in the United States. We have continued to build in harm's way and harm has come. In the past five years alone, tens of thousands of our citizens have lost their homes, their livelihoods, and their belongings to floodwaters. When routinely big storms (billed as isolated events) now hit our ever-urbanizing seaboard, the costs can reach into the billions of dollars. Tropical Storm Allison, in 2001, cost \$5 billion in damages to Houston alone, where some thirty thousand people were displaced from their homes. The 2004 hurricanes that hit Florida (with most of the damage caused by flooding) may double or triple these numbers. Dozens of smaller events devastate American communities annually and, unaware of the relentless power of moving water, about 100 motorists die each year in flood events.

Historically, our national response to flooding has been dominated by technological approaches (i.e., building things): engineered concrete works, better floodplain maps, and more sophisticated rainfall prediction models. But today, with modern information technologies and creative documentary techniques, we now have a chance to "build" much needed public awareness of flood risk.

This paper explores a new architecture for public education of flood risk, suggesting regional programs and partnerships that leverage educational media technologies and combine historic, scientific, and journalistic approaches.<sup>1</sup> An example is made of the Flood Safety Project ([www.floodsafety.com](http://www.floodsafety.com)) I began in Central Texas. This educational program is based on a rich set of interconnected resources featuring a one-hour PBS documentary and study guide (supported by the website [floodsafety.com](http://floodsafety.com)) with instructional tips and interactive presentations, exhaustive flood histories, and USGS records for the

highest peaks at some 900+ gages in Texas. All of these data (over 1700 files and dozens of interviews with flood victims, rescuers, and subject matter experts) has been integrated into an educational DVD-ROM to be made available to the general public on a cost-recovery basis. The documentary "Texas Flood" will premiere on PBS affiliates in Texas. In spring 2005, we will distribute the DVD-ROM to communities, schools, fire stations, floodplain managers, and decision-makers around the state.

### Project Methodologies

The research and production work on the upcoming DVD-ROM was carried out over a five-year period. I personally talked with hundreds of flood victims, public officials, emergency managers and rescue personnel, and flood-related subject matter experts in Texas and the nation. In addition, I shot 40 hours of video interviews and researched accounts, photographs, and video footage of historic floods. I also obtained footage from more than two dozen news media organizations. This work was primarily funded with grants and contracts I obtained from local governments, river authorities, and flood control districts.

Perhaps the most notable thing I discovered in the course of the research was the extent of the flood problem in Texas and the lack of knowledge that the general citizenry was of this problem. Virtually none of the citizens and decision-makers I interviewed or talked with had any idea of the following facts (nor did I at the start of the project):

1. Central Texas has been identified as the most flash-flood prone area in the United States by the National Weather Service.

2. Texas holds 6 of 12 world record rainfall rates in 24 hours or less (USGA, #).
3. Texas leads the nation in flood-related deaths almost every year—averaging twice the next nearest state: California.
4. Texas leads the nation in flood-related damages most every year—sharing the distinction with Florida and Louisiana.
5. Some 20 million of Texas' 171 million acres are flood-prone—more than in any other state.
6. Texas has approximately 8 million structures in floodplains; 3 million of them are uninsured.
7. Texas leads the nation in the average number of tornadoes per year with 125, with Florida and Kansas being distant second and third.
8. Texas has 1.5 full-time employees to administer the National Flood Insurance Program (NFIP) program in 1000 communities.
9. Texas is among the top four states with repeat flood losses to the same properties.
10. Texas has the fewest numbers of state employees devoted to disaster preparedness of any of the most populous states,” Tom Millwee, past head of Texas Department of Public Safety and Chair of Blue Ribbon Committee. More Texas flood facts can be obtained from (2001 Blue Ribbon Committee Study—Texas Senate Concurrent Resolution 68).<sup>2</sup>

During my five-year research period alone, floods in Texas took over 100 lives, displaced more than 45,000 people, and cost over \$7.5 billion. I learned first hand, by visiting flooded communities, that many of those displaced had no flood insurance and were financially devastated. I also learned that Texas had no comprehensive flood safety education program of any kind.

The first half of this paper describes aspects of the lack of flood risk understanding and provides notes on both the difficulties and opportunities in communicating flood risk. The second half describes the aforementioned educational program in more detail.

## The Foreseeable Deaths

The National Weather Service (NWS) has stated that deaths from all natural disasters in this country are declining, except those from flooding. The most common scenario is a motorist in a rapid onset rainfall event. This person may well be in a hurried state (perhaps during rush hour) and may be contending with obscured visibility and some desperation to reach family members and/or get home. As they pause their vehicle at the flooded roadway, their next decision calls on their contextual sense of the danger around them. It is here that several questions arise as to this individual's knowledge and experience with such a situation: Has this person ever been exposed to an explanation of the deceitful power of moving water, the treachery of obstacles in the current or the deadly container that a flooded vehicle can quickly become? Furthermore, what other sources or images may sway the driver's decision at this vulnerable moment (such as SUV and truck commercials taunting with messages of vehicular invincibility). In light of the 60-70% vehicle-related flood fatality rate, it appears that American drivers have not been sufficiently engaged to consider the dangers of floodwaters.

We can certainly do more to improve this situation. But over the past five years while developing the program described below, I have run into more than one public official who casually shared that these rising fatalities are “just a result of people being stupid...and you can't change that.” Surely the task of public education is sizeable, but does this cynicism reflect, by default, our underlying public policy?

## Perpetuating Damage

As with flood-related deaths, property damage from flooding is growing, and the standards we have used to manage floodplains are problematic. For example, the renowned geographer Dr. Gilbert White has pointed out how damages from floods above the so-called “one hundred-year floodplain” are now greater than below it. Dr. White also expresses concern about how so many aspects of our nation's development mechanisms, including local governments, concentrate development right on the very border of this dubious line in the sand. His concerns are informed by first-hand knowledge of

the non-scientific process whereby the 100-year flood became the standard for the NFIP and virtually all building in floodplains since its inception. Ironically, this standard was set by administrators who thought it to be “easy to administer since it would be easy to understand.”

Ironically, what we have today is an extremely problematic interpretation of the term “100-year flood,” which is so mired in confusion across the entire flood-related industry that University of Arizona hydrologist Dr. Victor Baker has called it “the most spectacular failure of public communication for any scientific concept of our time.”

Is it inevitable that flood deaths and damages will simply rise in measure with urbanization? Or is it more like the comment made to me at the 2003 NFIP review meeting? After presenting a videotaped message from Dr. White urging more public education and a review of the 100-year flood standard, I was later told by a senior economist that “the system isn’t perfect but it’s working. The fact is we are a wealthy country and we can afford to keep paying for these floods.” This statement, while perhaps true, is quite troubling. Even if our current system is resigned to signing a blank check to rebuild again and again after floods, is there no obligation to use modern techniques to actively educate the hundreds of thousands of people living in or near our floodplains, many of whom have no flood insurance? <sup>3</sup>

For example, I recently visited a fire station in the Central Texas Hill Country. While waiting to interview a man who had made several high-risk rescues in a past flood, I observed 16 different brochures and publications on fire dangers but not one related to floods. This piqued my interest in light of the substantial floodplain encroachment in that particular town (with hundreds of homes in harm’s way) and a factoid from the U.S. Army Corps of Engineers stating that people living in a 100-year floodplain are 27 times more likely to experience a flood than a fire during a 30-year mortgage period (USACE).

A comparison to fire safety education is somewhat relevant since most of us have been exposed to a fire safety message that delivered an easily remembered phrase like “Stop, Drop, and Roll.” At times of crisis, such a menemonics can certainly be helpful and the NWS’s “Turn Around

Don’t Drown” slogan is clearly an attempt at such a memorable phrase. But flooding represents a more complex danger covering a much larger area. Flood scenarios also differ in that most flood victims die while actively attempting to move through a flood, not while trying to escape it.

The Flood Safety web site provides resources to help citizens better understand the risks of death and damage from floods including:

1. Statistics that show how dangerous moving water is to motorists and accounts from flood survivors.
2. Animations that show the dangerous forces at work and the four ways people consistently die in a flood trapped in vehicles, pinned on obstacles, drowned in open water, or overcome by hypothermia.
3. Maps of known regional flood hazard areas.
4. A chronology of major floods in the region with videos and photos and links to the streamflow peaks at USGS gages.
5. Tips to protect life and property, many of them based on real stories told by real victims and/or success stories from flood events.

The Flood Safety program takes the position that every driver and every person living in or near a floodplain in Texas, or any other high-risk area of the country, should be exposed to some version of this kind of information —whether it be in grade school curriculum, driver’s education training, videos, TV programs, web sites, or even in the documentation required for buying or renting in a floodplain.

## **Flood Events are “Teachable Moments”**

Not sharing more compelling information on a natural hazard like flooding is a missed opportunity. People are inherently interested in weather and the stories from flood events are very dramatic. Every flood victim/survivor is a potentially effective teacher. Every major flood event is an important lesson to be studied and documented for the benefit of others. Perhaps an even greater missed opportunity is the ability to capitalize on the media attention/public interest following an event. This is a key time for effective messaging, but there needs to be accurate, in-depth

information organized and publicized well in advance. For example, regional flood agencies should have pre-produced media kits in print and on-line that list regional flood histories and data as well as known problem areas (complete with graphics), so news teams can more easily report accurate stories and direct the public to follow-up information.<sup>4</sup>

## Impediments to Flood Risk Messaging

One impediment to the idea of flood education programs that practitioners need to be aware of is that flood safety messages can easily appear anti-growth or anti-business. For example, one of the most pervasive problems in floodplain management is that so many layers of business have profited substantially by developing (and later redeveloping) housing in floodplains. At the local level, the developer, the engineer, the hardware store owner, the realtor, and the banker have made money from this process (and, with no malice implied, the more repetitive the flooding, the more money they have made). Local governments have also profited greatly from the increased taxation on this whole chain of events. Most all these entities have the added luxury of not being liable for the ultimate flood risk, which is passed on to the homeowner (and the general taxpayer in the case of disaster declarations). The bottom line is that, by default, repetitive flood damages bring federal money into flood-prone regions and stimulate most every sector of the economy. Floods (and thousands of people living in “temporary housing”) are good for business.<sup>5</sup>

Outreach programs will have to use some diplomacy as they clearly identify and promote high-risk flood areas to their citizen-inhabitants. A fully successful program may effect property values but also help stimulate the buyout of the most vulnerable properties.

One last difficulty to mention here is that severe weather information and human drama are the bread and butter of news media. Any good regional outreach program will need to obtain broadcast quality flood footage to create compelling stories that stimulate viewer. Buying high quality footage can be costly and difficult to obtain. Only with several years of constant effort, was I able to acquire footage contributions from news media. This process is much better now that our program has a track record. With the support and

partnership of agencies, non-profits (or others) can more easily work with news organizations in a mutually beneficial program that essentially swaps good content for well-deserved credit.

## Regional Flood Risk

This paper has stressed the need for communicating *regional* flood risk, so some definition of it is warranted. The general idea is to show a collective flood risk for a geographic area sharing similar weather patterns (and flood risks) represented by the sum of all known flood events and their outcomes in that area. Central Texas, for example, is subject to large air masses stalling over a geologic uplift known as the Balcones Escarpment. This area is often ground zero for massive rainfalls (35 Texas storms have been recorded to have dropped more than 20 inches of rain). But once these storms have gathered, the vagaries of wind and weather can also shift them a few hundred miles in any direction. History clearly shows this. And so, a regional flood awareness program in any city in Central Texas should stress the historical flooding of all the cities (Austin, Dallas, San Antonio, etc.).<sup>6</sup>

## Agencies' Role in a Better Educational Model

There are some relatively simple steps the federal government can take to improve flood risk communication by fostering partnerships and distributing through with the information it already collects.

## Partnerships

The educational model explained in this paper involves innovative uses of new media and draws on a rich combination of journalistic, documentary, and interpretive historical approaches. Federal agencies generally do not do this type of work, but they can certainly help fund (and help direct) others to accomplish the task. Partnerships can be arranged through grants or contracts with local governments, non-governmental organizations (NGOs), or private firms. FEMA's Project Impact program, which was recently dismantled, was a good start at getting money to local governments to produce their own educational programs. Some semblance of this

program should be continued, especially in high-risk areas. Ultimately, federal and state money should funnel down to production teams that create these regional flood education resources.

## Information Follow-Through

Flood death and damage data and historic flood information does exist within our government, and efforts to collect and publish it (like NWS's Storm Data) are helpful but have not been thorough or consistent. This needs to improve, and the end results need to be integrated and organized into a form suitable for educational programs directed at citizens in high-risk areas. All of the following information should be published (and publicized) annually and distributed via the Internet in the modern forms of business communication.

## Recommendations

1. It would be of great value to publish all historic peak stream-flows from all USGS gages on the USGS web site. Links to a table with every annual peak should be shown right next to where the current real-time stream-flows exist.
2. We need more consistent and more easily accessible reports on cause of related flood deaths and causes and flood event descriptions (following the formatting description above).
3. I strongly suggest an annual inter-agency report identifying the most flood-prone (and flash-flood prone) areas of the country based on historical flood damage, flood deaths, rapid rainfall rates, known weather patterns, and other relevant factors. This report and all of its supporting data should be made publicly accessible and publicized through regional NWS offices, which should, in-turn, share this information with regional news media and outreach programs (like the Flood Safety Project). The high-risk regions identified in the inter-agency report would be the ideal place to replicate our model (or another dynamic public education model).

## Project Pedagogy

The pedagogical model that lies behind the FloodSafety Project is a shared archive of interdisciplinary information: scientific data, interpretive history, social issues, personal accounts, case studies, journalism, and much more. That means all the information is brought together in one place with an interface and formatting that makes navigation easy for the user.

A vital component of this archive (and our entire project's approach) is that interviews with real people—such as flood victims, emergency managers, and subject matter experts—be featured prominently throughout. Every significant event or collection of information should have some interpretation (usually in the form of a brief video interview).

Such an archive, if well designed, can serve numerous social needs and be continually updated by its managers, subject matter experts, and the user community. It is much more than an information repository. The goal of the collection is to provide a basis for a series of outreach programs, a “broadcast” point. Such a resource stands in stark contrast to the “narrowcasting” of science and technical information resources that are so commonly segmented off from the greater issues and specific populations they impact.

## Measuring Effectiveness, Usability, and User Information

At this point, there have not been any studies on the effectiveness of the web site ([www.floodsafety.com](http://www.floodsafety.com)). The DVD-ROM will be released with the airing of the movie on PBS affiliate stations in spring of 2005. Publicity of these events will bring users to the site. A pre- and post-survey in Central Texas communities would be useful, as would evaluation of the study guide use by students and local officials. Tracking survey respondents' use of the web site would be valuable for usability testing. We will also be gathering demographic information from those ordering DVD-ROMs from our web site.

## Summary

In summary, the work shown here is not expected to “solve” the flood problem but it is a starting point for efficient regional development of a flood-risk

outreach program that can ultimately help save lives and property and reduce human suffering. I am grateful to the project's sponsors and the media contributors who have helped support this public service effort. And we are indebted to the people and communities of Central Texas who agreed to be interviewed.

There can be little doubt that other areas of the country have similar problems (both from floods and the lack of education about the dangers). If there is any obligation of our society to improve safety precautions for a phenomenon like flooding, it begins with a forthright sharing of all the best, most compelling information we can produce with the most modern techniques that is then widely distributed and highly publicized to the general public. To put it in the bureaucratic vernacular: the public has "a need to know."

## DVD-ROM Contents

The basic architecture of this educational DVD-ROM is a dramatic movie that drives interest in the study guide questions, which are then supported by myriad links and the resources shown below. In the instructional technology world, this type of arrangement is generally regarded as "edutainment." For example, citizens living in Texas can watch the movie and go to specific information about their own areas. However, decision makers and others all over the country can learn about flood problems from the Texas case study as well as the model of information organization and

delivery the DVD-ROM represents. Information Architecture

### "Texas Flood" PBS Movie

This one-hour movie follows the lives of five Texans who rebuild after the great Central Texas flood of 1998. Their stories unfold to show how the rapidly growing corridor from Austin to San Antonio is the most flash-flood prone area in all of North America. Tens of thousands live in harm's way with no comprehensive program to address the issue.

The community of New Braunfels serves as a case study for several floodplain issues. New Braunfels actually lowered their floodplain (more than ten feet) in the mid-1980s and now has hundreds of homes in harm's way. All this was done despite a tremendous flood history, explained along with more than a dozen of Texas' 255 major and catastrophic floods via a great collection of historic flood footage and photographs. Our character's choices to rebuild and the larger issues behind such decisions are then highlighted in the dramatic repeat flood of July 2002 that reduced some of the rebuilt homes to concrete slabs.

"Texas Flood" was made as the initial model for a PBS series entitled "The Water's Edge" which will provide a national critique of the problems of continuing floodplain developments and the associated costs (personal devastation, tax payer burden, and loss of habitat). This series will also include a brief history of national flood losses, a critique of building practices and current policies, and a vision for the appropriate use of floodplains with issues like flood-proofing, open space and habitat restoration.

### Study Guide Questions: (building on questions raised in the movie)

1. How are we relaying flood risks to the public, and how can these measures be more effective?
2. In what ways do we subsidize the repetitive disaster that floods represent and in what ways do we discourage floodplain development?
3. How do technological prowess and "concrete solutions" affect flood losses, both positively and negatively? What are some hopeful new opportunities?
4. Who pays for floods? (floodplain economics)



Figure 1. Flood Safety DVD-ROM#1 Contents (screen shot in draft form)

5. Who profits from floods? (roles and motivations)
6. Are media trends and community messaging effective after floods? What specific changes would show improved communication?
7. What are alternatives to increased floodplain development? What methods have communities in the U.S. used to leave floodplains as open space. How can these methods be more broadly adopted?

walls and was open for business the following day.

**Flood Damage Sources:**

Federal Emergency Management Agency, National Flood Insurance Claims Data.

National Weather Service, Natural Hazard Statistics. See: <http://205.156.54.206/om/hazstats.shtml>

Slade, R. M. and John Patton. "Major and Catastrophic Storm and Floods in Texas." (*U.S. Geological Survey Open-File Report 03-193*). (produced with Marshall Frech and available at [www.floodsafety.com/USGSdemo](http://www.floodsafety.com/USGSdemo))

**Floodsafety.com Web Site (Texas):**

The web site has an online introduction via an interactive, narrated slideshow that explains the site's concepts, with screen shots to show its organization.

**Protect Your Life:**

1. Flood fatality statistics clearly show the higher risks: driving into water, walking along flooded creeks, electrocution, etc.
2. An interactive story graphically explains the four most common ways people die in vehicle encounters with floodwaters.
3. A real-life scenario includes an interview with a woman who barely survived being washed into a creek, where two others perished.

**Flood Fatality Sources:**

Centers for Disease Control and Prevention. "Storm-Related Mortality — Central Texas, October 17-31, 1998", *Morbidity and Mortality Weekly*, Atlanta, February 25, 2000.

National Climatic Data Center. "Storm Data," annual publication. See: <http://www7.ncdc.noaa.gov/SerialPublications/SDPubs?action=getpublication>

FloodSafety.com. Collection of news articles and obituaries following major Texas floods

U.S. Army Corps of Engineers. "Floods and Your Family," brochure.

**Protect Your Property:**

1. Statistics are shown about the actual risks of flood damage to home and steps you can take to protecting property.
2. An interactive story shows a successfully flood-proofed business that had been devastated in a past flood but recently survived three feet of water on its exterior

**A USGS Gage Data Example**

The Guadalupe River at New Braunfels, Texas has an average flow of just a few hundred cubic feet per second (CFS). But this beautiful river has a great flood history that has frequently been denied or forgotten by the local community, which built extensively in the attractive floodplain. FEMA's attempted to raise the floodplain in the mid '80s but developers and the City of New Braunfels fought FEMA and continued building based on a 100-year peak flow that a hired engineer set at approximately 26,000 CFS. Had this USGS data been organized and readily available for use, it would have clearly showed this level had been greatly exceeded many times.

**Table 1.** USGS Peak Stremflows for Texas<sup>1</sup>

Water Year	Date	Streamflow (cfs)
1932	July 3, 1932	95,200
1935	Jun. 15, 1935	101,000
1936	Sep. 28, 1936	52,800
1944	May 27, 1944	26,500
1952	Sep. 11, 1952	72,900
1957	Apr. 25, 1957	26,900
1958	May 3, 1958	47,900
1960	Oct. 5, 1959	35,700
1964	Canyon Dam is completed 20 miles upstream of New Braunfels	
1972	May 12, 1972	92,600
1985	New Braunfels continues with 100 year floodplain at apx. 26,000 cfs	
1999	Oct. 17, 1998	142,000
2002	July 4, 2002	88,000

<sup>1</sup>USGS 08168500 Gaudalupe River above Comal River at New Braunfels, Comal County, TX; Drainage Area: 1,518 square miles. Current 100 year floodplain based on flow of approximately 26,000 cfs.



In Cuero, Texas, the Lopez family had six feet of water over their house with no warning (as did their entire neighborhood) from a flood that started 48 hours earlier. The Lopez' who live over a mile from the Guadalupe River, are not in the floodplain and had no flood insurance. They decided to rebuild and now, with mounting medical bills, face foreclosure.



Linda Coble has property in the perilous "flood way." A house previously built there washed away in 1972. Heavy current washed her house away in 1998. She had flood insurance and rebuilt on 10-foot high metal stilts. The house was not bolted to the stilts. Her house washed away again in 2002. This time her flood insurance was ten days from coming into effect.



In the dark Sharon Zambrzycki was washed off the road by flood waters coming over a bridge. She careened 300 yards downstream then hung on to a tree in strong current for more than an hour. By the time she was rescued her head was under water and she had only a few moments left to live. Two other motorists perished. Brushy Creek is 15 miles from the site of a world-record 38-inch rainfall in Thrall, Texas in 1921. The bridge was not marked in any way.<sup>8</sup>

**Figure 2.** Personal Profiles



**Buyouts:** A survivor of previous floods, Fran Pierce had luckily agreed to be bought out of the floodplain in Austin's Onion Creek neighborhood before a 2001 storm. She would have lost everything a second time. Fran reports being very reluctant to sell and move but now feels that she was treated well and got a good deal.



**Beneficial Uses:** Relative to the death and damage we normally see, this debris-laden park bench is a "good" flood scene. Floodplains serve many beneficial uses for plants, and animals. Some municipalities are beginning to convert floodplains back to open space and parks and recreation areas, which if designed properly, can easily rebound from a flood with manageable costs.



**Floodproofing:** This building was devastated by Austin's 1981 flood. It changed owners, rebuilt, and subsequently floodproofed. The new owner worked with the City of Austin to meet more stringent floodplain building codes. In a 2001 flood, the building had three feet of water outside and was dry inside. The owner commented that floodproofing did not add much more cost to the building and paid for itself in just one event.

**Figure 3.** Solutions (success stories)



### Subject Matter Expert Video Interviews: (partial list)

- Arrellano, Joe. Meteorologist-In-Charge for the National Weather Service (NWS) Forecast Office - Austin/San Antonio. (Interview 2002).
- Baker, Victor. University of Arizona Department Head: Hydrology and Water Resources. (Interview 2002).
- Collier, Steve. Director - City of Austin Office of Emergency Management. (Interview 2003).
- David Conrad. National Wildlife Federation, lead author of the *Higher Ground* (Interview 2003).
- Gruntfest, Eve. University of Colorado Geography Professor and flood warning expert. (Interview 2002).
- Sheaffer, Jack. Water resource specialist; NFIP pioneer. (Interview 2003).
- Slade, Raymond. USGS Texas hydrologist and surface water specialist, retired. (Interviews 2002; 2003).
- White, Gilbert. Geographer and natural hazards expert, Professor Emeritus, University of Colorado at Boulder; NFIP pioneer (Interviews 2003).

### Author Bio and Contact Information

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### References

- 2001 *Blue Ribbon Committee Study Report* (Texas Senate Concurrent Resolution 68): available from Texas Department of Public Safety.
- Conrad, David. *Higher Ground, Washington, D.C.:* National Wildlife Federation *Ground*, 1998.
- Federal Emergency Management Agency. Flood Insurance Rate Map Online Tutorial [http://www.fema.gov/mit/tsd/ot\\_firmr.htm](http://www.fema.gov/mit/tsd/ot_firmr.htm).
- Rogers, J. David. "Say, What Is a 100-Year Flood? and Why Do We Have So Many of Them?" *Rolla: University of Missouri at Rolla*. San Francisco Insurance Claims Forum News Network, v. 2, n. 9, pp. 3-7 (May 1997).
- Texas peak streamflow data available at [www.floodsafety.com/USGSdemo](http://www.floodsafety.com/USGSdemo).
- U.S. Geological Survey. "100-Year Flood" USGS Fact Sheet: <http://water.usgs.gov/pubs/FS/FS-229-96/>.
- [www.geolith.com](http://www.geolith.com). A website on hurricane and flood safety.
- Strope, Leigh. "Disaster Cleanup Creates New Jobs — Rebuilding in the Wake of Four Hurricanes Bolsters Employment Growth." Associated Press, November 6, 2004.
- Urban Drainage and Flood Control District*. An Evaluation of the Boulder Creek Local Flood Warning System. Denver, Colorado, 2002. (<http://www.udfcd.org>).

### Notes

1. See the work of geographer and flood warning expert Dr. Eve Gruntfest whose study (*An Evaluation of the Boulder Creek Local Flood Warning System*) showed that increasing numbers of people in Boulder, Colorado were using the Internet and television to obtain information during flood events. Source: The Urban Drainage and Flood Control District of Denver, Colorado (<http://www.udfcd.org>)
2. Texas flood facts 5-10 come from 2001 Blue Ribbon Committee Study — Texas Senate Concurrent Resolution 68. Source: Floods Facts (from the National Wildlife Federation's *Higher Ground* Report). In the U.S., approximately 150,000 square miles (about the size of California) are flood prone, as defined by the 100-year floodplain. Some 30 percent of flood insurance claims come from outside of designated floodplains. Over the past 25 years, the federal government has spent \$140 billion in federal tax revenue preparing for and recovering from natural disasters. 70+ percent of these disasters have involved flooding. Annual flood losses in the United States have more than doubled since 1900 to an average of more than \$4 billion (in inflation adjusted dollars).
3. Source: *Floods and Your Family* brochure, U.S. Army Corps of Engineers
4. One of our program goals is to have the [floodsafety.com](http://floodsafety.com) web address posted in the TV crawler during flood warnings to advertise this rich and potential life-saving educational resource.
5. The 2004 Florida hurricanes have recently been noted in the press for "creating jobs."
6. Regional programs are also very cost effective since one archive explaining the history and rainfall patterns of the area can be shared by all entities.
7. A special note in appreciation of the USGS' long-standing efforts related to flood awareness. Budget cuts are now forcing the agency to remove vital gages around Texas which had about 500 gages in the 1960s but has only about 350 today.
8. These people, and most all others we've interviewed, have stated that they had no idea they live in (or downstream of the most flash-flood-prone area in this country.