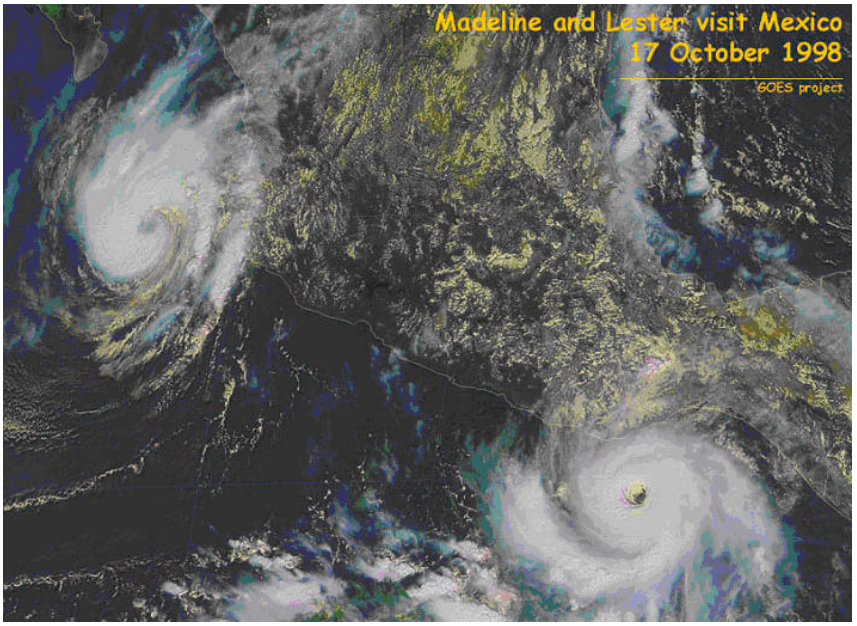
WHEN IT RAINS, IT POURS – AND THAT CAN MEAN TROUBLE FOR THE MOST FLOOD-PRONE STATE IN THE NATION. IS TEXAS READY FOR THE NEXT BIG ONE?

by Todd H. Votteler, Ph.D.



At 5 a.m. on Oct. 17, 1998, Regina Campbell was awakened in her Cuero, Texas home by heavy thunderstorms. The rain continued to fall into the next day, when Campbell received a call from her mother, who was in Louisiana. Her mother had heard on the television that there would be flooding around Cuero. Regina mentally calculated her distance from the Guadalupe River –two miles –and decided to ignore the warnings. By that time, the waters were already massing for the coming assault.

BY DAWN ON OCT. 17, the storms that would later swell the Guadalupe had soaked an area from Hondo to New Braunfels with four to six inches of rain. An unusual combination of meteorologic conditions – a cold front, a low-pressure system and Pacific hurricanes Madeline and Lester – conspired to drop heavy rains. At the same time, a ridge of high pressure developed to the east, extending from the North Atlantic Ocean to the Yucatan Peninsula. Moisture was piling up over south-central Texas.

By noon some areas had received 15 inches of rain, with the heaviest rainfall extending into Hays and Travis counties. The soils, hardened from drought and high temperatures the previous spring and summer, quickly became saturated. By the time the rain passed, the San Jacinto, San Bernard, Colorado, Lavaca, Guadalupe, and San Antonio rivers were flooding their banks.

The Nature of Texas Floods

A torrential rainfall like the one that fell on Oct. 17, 1998, is not an unusual event in Texas, where there is truth to the statement that when it rains, it pours. Unlike in most of the United States, where annual rainfall comes from a larger number of small precipitation events, Texas receives much of its annual rainfall in a few large storms. Automated U.S. Geological Survey (USGS) stream-flow monitoring stations have measured data on river flows that grew from zero to nearly half a million cubic feet per second in a single year. To get a picture of what that looks like, imagine a dry streambed surging over the course of a year to contain a flow equal to that of the Mississippi River as it passes New Orleans. These extremes make predicting flood size and frequency in Texas a complicated proposition.

Why does Texas experience so many floods? The diversity of climate and geography renders the state vulnerable to both extreme droughts and floods. In this ancient climatic battlefield, cool, dry air moves in from the Rocky Mountains and confronts warm moisture from the Gulf of Mexico in the spring. The resulting thunderstorms have created world-record rainfall rates, such as the 38 inches that fell in 24 hours near Thrall in 1921. Heavy rains in the spring are particularly likely to cause flash flooding, because the ground is still cold and hard, and new foliage has yet to emerge. But even at other times of year, the clay-rich soils absorb water poorly, adding to the runoff produced during storms.

During the summer and fall, storms more often target the coast. Tropical cyclones spawned in the warms of the Gulf of Mexico, the Bay of Campeche, the Caribbean Sea – and occasionally the Pacific Coast off Mexico – can create two types of threats: storm surges along the coast and inland flooding. The storm surge produced by the Galveston Hurricane of 1900 – in which 6,000 to 10,000 people perished, made that hurricane the deadliest natural disaster in U.S. history.

But inland flooding can be equally destructive. In 1979, Tropical Storm Claudette dumped 43 inches of rain on Alvin, in Brazoria County. When Tropical Storm Allison struck Houston in 2001, inland flooding caused 40 deaths and $4 billion in damage. With advances in technology and the field of meteorology, storm surges are unlikely to catch forecasters by surprise. As a result, inland flooding now accounts for most flood fatalities from tropical cyclones.

"EARLY ON THE MORNING of Saturday, Oct. 17, we knew that we had a major flood event on our hands," says Bob Corby, a hydrologist for the National Weather Service's (NWS) West Gulf River Forecast Center in Fort Worth. The NWS uses rainfall data, radar when available, and USGS stream-flow data for models that predict the magnitude and timing of a flood peak. When NWS anticipates a flood, its regional offices issue warnings. "While we were expecting heavy rains over the weekend, the rain began earlier than we had anticipated," says Corby. "The Austin/San Antonio Weather Service Forecast Office in New Braunfels quickly responded by issuing flash-flood warnings and river flood warnings for much of that area."

Cuero was one of the epicenters of the October 1998 flood. "Flooding along the Guadalupe River, from Gonzales through Cuero and Victoria, was the most extreme," says Corby. The heavy rains that pounded the New Braunfels area on Saturday morning created a flood wave that surged downstream along with the storm, compounding the event's severity.

Some of the heaviest rains fell over Peach Creek, a tributary without a USGS stream-flow gauge, which fed the flood crest at Cuero.

"The river became a giant chute," says Corby, "and flood waters that normally follow the meandering floodplain began to flow on a direct path to the Gulf." Consequently, he says, the flood crest reached Cuero faster than had ever been observed – in less than three days. "By the time the rainfall ended on Sunday," Corby continues, "we were getting rainfall reports of up to 20 inches in some areas in the Guadalupe basin." An area south of San Marcos received 30 inches of rainfall.

Flash Flood Alley

Historically, 70 to 80 percent of all natural disasters in the United States have involved flooding. Some 20 million of Texas' 171 million acres are flood-prone – more than in any other state. Flash floods are the number-one weather-related cause of death in Texas. Most victims of flash floods fall into two categories: drivers trying to cross flooded areas, and children and young adults playing in or near floodwaters.

Because thunderstorms typically form during the most intense heat of the day, the resulting flash floods occur afterward – between late afternoon and early evening, when it is too dark to see the danger clearly. Even during the day, floodwaters may hide hazards such as damage to roadways, tree stumps, fire hydrants and other obstacles.

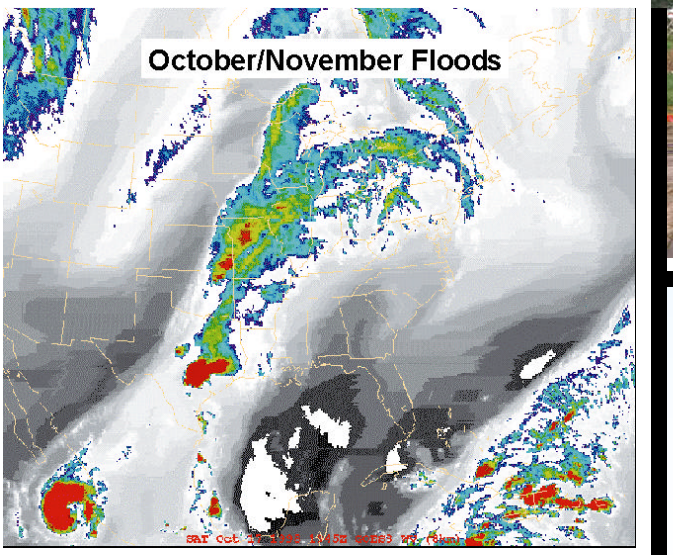
On a sunny day, a flood can sweep through neighborhoods from rain falling far upstream from a local watershed. Pushing a wall of debris made up of trees, cars and all manner of flotsam, flash floods become battering rams against houses, bridges and anything else that lies in their path.

While flash floods are known to occur throughout the state, the Hill Country is known as "flash flood alley." According to Richard Earl, a geographer at Southwest Texas State University, the Hill Country is even more susceptible to flooding because of its thin soils with large areas of exposed bedrock and relatively sparse vegetation, which produce rapid runoff. The Balcones

The Waters Rise

By the afternoon of Oct. 19, the flood had advanced on Cuero. Campbell's husband called her at home and convinced her to take the children to higher ground. As she left, she could see the water approaching from down the street. A policeman ordered her to evacuate. Thirty minutes later, she returned to check on a friend. The water had risen to a depth of two feet and seemed to be coming from all directions. It was difficult to walk as the current pushed against her. She dodged garbage cans and dumpsters that were being carried down the street by the flood. Later in the day, she saw a house floating down another street.

Escarpment is also a trigger for storm formation. William Asquith, a hydrologist with the USGS, believes that the steep slopes of the Hill Country produce some of the highest runoff rates in the United States – and possibly the world. The region is an elephant's graveyard for tropical cyclones, which crash into the Texas Gulf Coast and often stall over the Hill Country where they spend themselves, releasing raging torrents as they die.



Leon Creek. Normally docile Leon Creek in San Antonio can become a raging torrent when storms strike the Texas Hill Country, known as "flash-flood alley"

ALTHOUGH CANYON RESERVOIR CAPTURED almost 43 billion gallons of floodwater, nearly all of the runoff measured at Cuero and Victoria was the result of the peak rainfall, which occurred downstream of the reservoir. At Cuero, where the San Marcos River joins the main stem of the Guadalupe, runoff was calculated at nearly 600 billion gallons. About 43 percent of the homes in Cuero were flooded, even those two miles from the Guadalupe like Campbell's. The flood was three miles wide by the time it reached Victoria, where the peak streamflow was nearly three times the previous record in 1833. The rain falling in the upper watershed of the Guadalupe and San Antonio Rivers created floods that converged where the rivers merged below Victoria. After the floods merged they

eventually drained into the Guadalupe Estuary and San Antonio Bay, providing a massive freshwater pulse to the brackish marine environment.

By the time the 1998 flood was finally over, records had been established at Cuero and Victoria. Thirty-one people had died; many of those drowned while attempting to drive through low-water crossings. More than 10,000 people were displaced. Property damage totaled some $750 million. As severe as this flood was, many lives were saved – and property was protected – because the flood began during daylight hours and people heeded the warnings.

The 1998 flood was probably the third-largest flood on the upper Guadalupe since records have been kept – only the 1913 and 1869 floods were larger. But it was not by any means the worst flood Texas has seen. While the flood established some records, says Earl, "the October 1998 flood in south-central Texas was probably not the 500-year flood." According to Asquith, "Many storms with similar or greater amounts of rainfall have occurred over much of central and south Texas during the past 100 years."

Indeed, the Guadalupe itself has experienced frequent major floods. "There have been 20 major floods on the Guadalupe since 1900," says Tommy Hill, chief engineer for the Guadalupe-Blanco River Authority. On average, a major flood occurs every five years. Annual flood losses in Texas average $32 million.

Canyon Reservoir spillway. During the flood of 1998, peak rainfall occurred downstream of Canyon Reservoir. In July of 2002, record rains filled the reservoir to capacity and the emergency spillway was used for the first time.

The Aftermath

When the flood subsided, Regina Campbell returned to Cuero to visit her home and her business, a nearby beauty salon. At each place she found a similar sight: The force of the water had piled all the furniture and equipment inside against the main entry-way, blocking the doors. The floors were covered with three inches of mud. In Regina's church, the water had lifted the communion table over a four-foot banister and set it down. On the table, the cross, candles and tablecloth were all undisturbed.

Campbell had no flood insurance, and in the weeks after the flood, she discovered that she didn't qualify for a federal loan to rebuild her business. That week she moved with her husband and their five children to Yoakum, into a small, three-bedroom house with five other people. Despite the abundant company, she was hit by an overwhelming feeling of isolation. "When the flood is coming, they tell you to leave, get out! The Lord will provide," she says, "But after the flood, it was like I was set on an island by myself, with no one around me, with all the troubles piled on my shoulders."

When the Next Flood Comes

Is Texas prepared for the next major flood? In 1999 the Texas Legislature appointed a blue-ribbon committee to study that question. Some of the problems the committee identified are easy to understand. "Texas has the fewest numbers of state employees devoted to disaster preparedness of any of the most populous states," explains Tom Millwee, state coordinator for the Division of Emergency Management. "An average large state has about 160 employees dedicated to state emergency management. California currently has more than 600. Texas has 62. Yet Texas is number one in tornado and flooding events, and second in tropical events."

Because of declining federal and state budgets, the number of gauges in Texas has diminished from a maximum of 650 in the 1960s to about 330 today. In addition, the National Weather Service's weather radio transmits watches and warnings to only 196 of Texas' 254 counties; 124 of these 196 counties are only partially covered.

How can Texas avoid the worst impacts of flooding? Traditionally, the solution has been to build a dam, to modify the waterway – or, most often, to build a levee. Levees have saved countless lives and protected property from raging waters; however, by relying heavily on levees, we have encouraged the unwise development of our nation's

Some problems are more difficult to address. Earl believes floodplain maps tend to underestimate flood potentials. "First, the models that predict them use too low of precipitation amounts for the 100- and 500-year flood," he says. "Second, flood maps are political documents that are subject to modification under political pressure." The accuracy of floodplain maps concerns Asquith as well. "Potential error in estimation of the 100-year flood flow can approach 40 percent or even higher."

Other problems are self-inflicted. USGS must have a funding partner for each of their stream-flow gauges.

USGS gaging station on Helotes Creek

flood plains. The more we try to confine water between levees, the more it wants to escape. Levees often make the flooding more severe downstream where the levees end. Levees also have had severe impacts on aquatic ecosystems. For these reasons, flood researchers now believe that levees are not monuments but tools – tools that are no longer the answer to every flood-related problem.

Other tools to reduce flood risks include wetland restoration and flood-warning systems. However, even with these alternatives, some portions of the landscape flood with such frequency that the placement of permanent structures there makes little sense. And so the question becomes: Is it right for the public to finance risky decisions and poor judgment by providing money to continually rebuild in the most high-risk areas? Zoning to limit building in floodplains and buyouts of property in high-risk areas address this question.

While there is much we can do to avoid the most serious consequences, floods will always be a part of life in Texas. With little or no warning, the rising waters will reclaim the former wetlands and low areas, and for a brief time take the uplands and hold them until the bulk of the flood passes. Afterward, the torrent will ease, and the water will return, often reluctantly, to its confinement within the river channel, waiting for its next opportunity to escape and go on the rampage again. ★

Floodplains: Disputed Territory

Floodplains are the land next to rivers, creeks, streams and lakes that experience flooding. These floodplains are dynamic features of the landscape where sandbars, oxbows and cutbanks come and go. They convey excess flow that cannot be handled by the normal channel. The animal and plant communities found there are adapted to the perpetual changes.

People are also attracted to floodplains when they seek a home or business with a beautiful waterside view. Some 8 million structures in Texas are located in floodplains. However, only 5 million of these are covered by insurance, such as the National Flood Insurance Program administered by the Federal Emergency Management Agency. Texas is among the top four states that have the highest number of repeated losses to the same properties and structures.

What does it mean when they say a structure is in the 100-year floodplain? The 100-year floodplain is the area that statistically has a one percent chance of being flooded during any given year. It does not mean that an area will experience a flood once every 100 years. There are many examples of 100-year floods occurring in consecutive, or even in the same, years. “There is a one percent chance in any and every year that a flood will equal or be in excess of the 100-year level,” says Asquith. In part because of the confusion caused by the term 100-year flood, the Federal Emergency Management Agency is now using the term “base flood” instead.

Wetlands have traditionally provided the first line of defense against flooding. Because it is typically the peak flows that cause flood damage, wetlands reduce the force of flooding by collecting the water and slowly releasing it to larger streams and rivers. Now that more than half of Texas’ wetlands have been eliminated, a much larger volume of water pours into the state’s rivers within a shorter period of time. Like traffic on I-35 as it hits Austin or Dallas at rush hour, the water stacks up – and then it backs up. Drainage ditches and mechanically straightened stream channels speed the movement of water out of low areas, adding to the magnitude of floods.