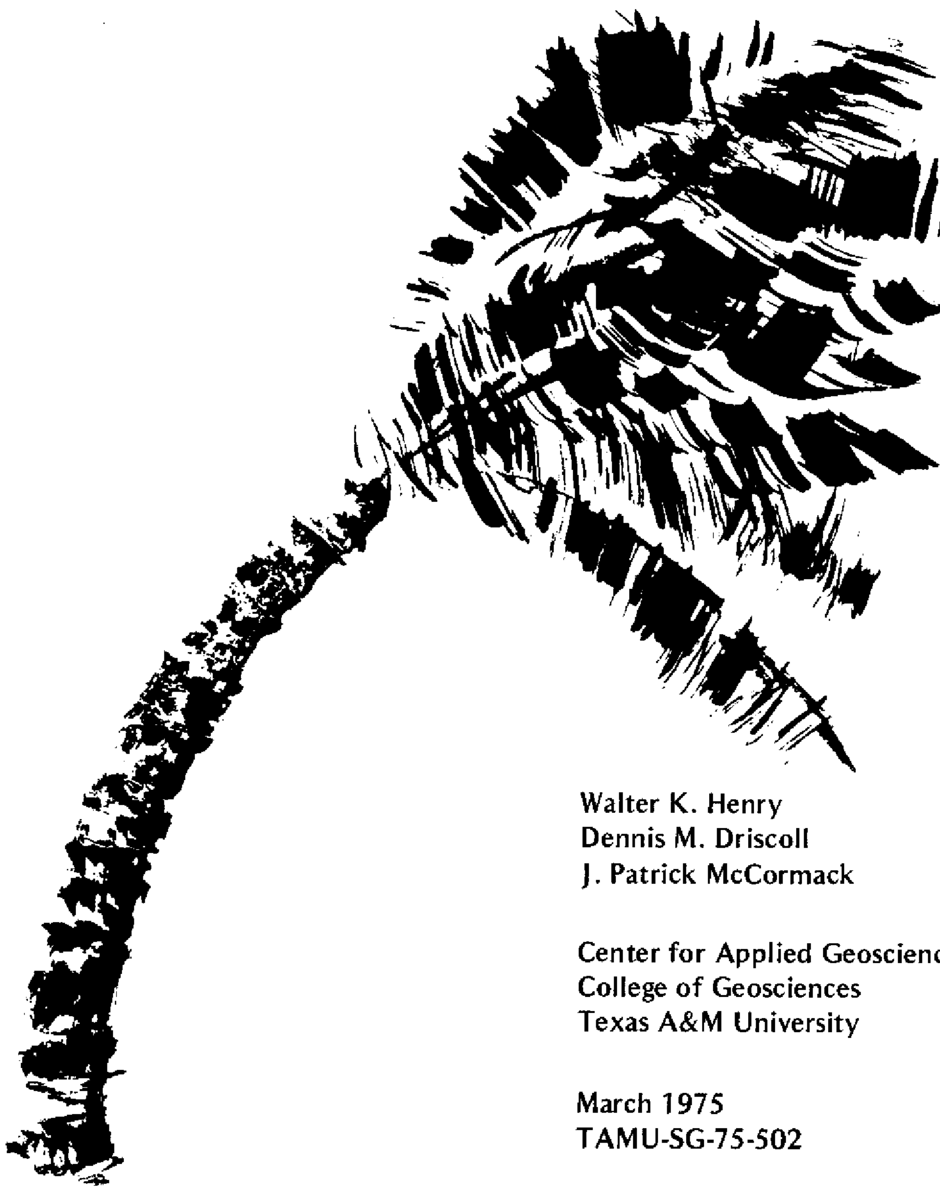
HURRICANES
on the Texas Coast

The Destruction



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I. FOREWORD

This booklet is the second in a series of three discussing tropical storms and hurricanes, and their effects. This series is designed primarily for residents of the Texas Gulf coast and is intended to increase awareness of the potential destructiveness of hurricanes so that plans can be prepared and actions taken to reduce casualties and property damage.

The first booklet, which describes the hurricane from birth through maturity, presents facts and figures on Texas' most destructive hurricanes. Historical listings of tropical cyclones and their probabilities of occurrence along 50-mile segments of the Texas coast also are included.

This booklet describes and explains the types of damage a hurricane can cause along the Texas coast and adjacent, inland areas. Hurricane-related events, such as storm surge, heavy rains, high winds, tornadoes, and resulting hazards, such as floods and downed electrical wires, are discussed. Special emphasis is given to types of destruction that occurred during previous hurricanes.

The third booklet provides guidelines and checklists to help individuals plan for safety and specifies actions taken by government and civilian agencies before, during, and after a hurricane. Responsibilities of local governments and individuals in preparing for hurricanes also are discussed.

II. ACKNOWLEDGMENTS

We extend our most sincere appreciation to Dr. Cecil Gentry and Dr. Neil Frank of the National Hurricane Center for their helpful comments and suggestions. We wish to thank Dr. James R. Scoggins, Director of the Center for Applied Geosciences, Texas A&M University, for his continued guidance and support throughout this project. We would like to acknowledge the help of Mr. Joseph Pelissier of the National Hurricane Center, who furnished background information, and Ms. Teena Conklin of the Texas Highway Department for assistance in obtaining many photographs used in this study. Special thanks are extended to Ms. Polly Luther for her professional typing of the many drafts.

III. THE GREATEST STORM ON EARTH

The hurricane, rightfully called "the greatest storm on earth," is one form of tropical cyclone--a swirling mass of air and precipitation that can cause extreme damage. In the United States, hurricanes have caused more damage than any other type of natural disaster. During the first 60 years of this century, 17,000 lives were lost and property damage amounted to $5 billion (Maunder 1970). The Galveston Hurricane in 1900 caused the most deaths (6,000 to 8,000), and, in Texas, Hurricane Celia (1970) was responsible for the greatest estimated damage of property ($500 million). Appendices II and III detail costs of the most recent Texas hurricanes.

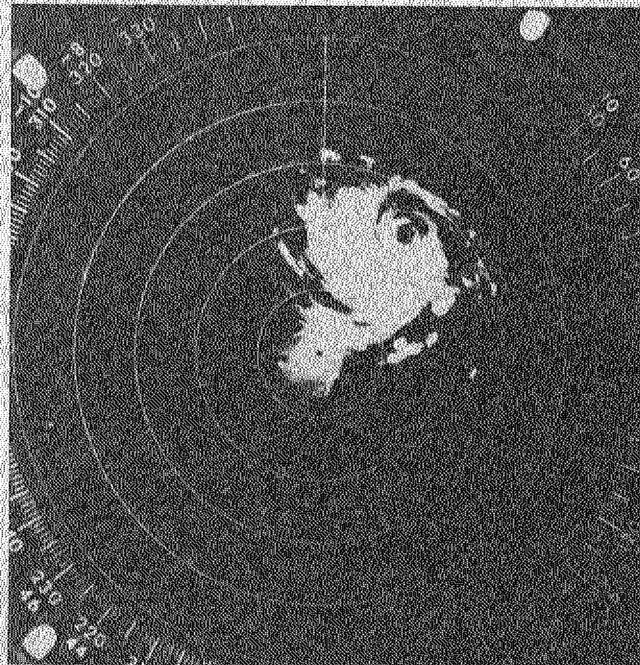

Fig. 1. This picture of Celia was taken from the Brownsville radar. The eye of the hurricane is the black hole to the northeast at the second ring from the center of the radar scope. The white area represents the heavy cloud and rain area. (Photo courtesy of the National Hurricane Center.)

Dollar damages soar with almost every hurricane due to increases in coastal populations and property values. Yet the death toll generally has decreased because of better warning systems. With radar and satellites to make remote observations, it is improbable that a hurricane could arrive unannounced at the Texas coast. The combination of radio and television alerts together with local warning networks should provide sufficient notice so that everyone can be prepared.

A glossary of hurricane terms is presented in Appendix I for convenient reference.

IV. DAMAGE BY WINDS

Tropical cyclones are classified by their central pressure (see glossary in Appendix I) and by the speed of their winds. The tropical depression contains winds of less than 39 m.p.h. Tropical storms contain winds of 40-73 m.p.h. Hurricanes have sustained winds of 74 m.p.h. or more. When winds are between 100 and 135 m.p.h., the hurricane is designated as a major hurricane, and if the winds are greater than 135 m.p.h., as an extreme hurricane. The strongest gusts in a hurricane may exceed 200 m.p.h. but occur rarely.

In the recent history of hurricanes along the Texas coast, Celia (August 1970) is the outstanding example of damage caused by extremely high winds. As Celia moved inland just north of Corpus Christi, the peak gust at the airport was measured at 161 m.p.h. The anemometer (wind-measuring instrument) at Aransas Pass was blown away at 150 m.p.h.; later the wind was estimated at 180 m.p.h.

Hurricane Carla (September 1961) was another extreme hurricane. Carla had all the features (high winds, heavy rains, extensive storm surge, and tornadoes) that cause damage. Her strongest winds were estimated to be 170 m.p.h. at Port Lavaca.

The "eye" is the focal point of a hurricane. Fig. 1 is a picture of Celia taken from the radar scope at Brownsville. The eye is identified easily as the cloudless, circular area in the upper right (northeast) portion of the cloud mass. As in most cases, the eye is not centered in the cloud mass and the winds are not distributed uniformly around the eye. In the satellite picture of Hurricane Beulah (September 1967) shown in Fig. 2, the eye is barely visible. Hurricanes are eccentric, and each has different characteristics.

The general structure of hurricane winds is shown in Figs. 3 and 4. Fig. 3 illustrates the schematic wind distribution around an extreme hurricane like Carla (1961). Fig. 4 represents a smaller hurricane with hurricane-strength winds in only one sector of the cyclone. This hurricane is more representative of those found on the Texas coast than is the extreme hurricane of Fig. 3. Both are represented on the same scale so that comparisons can be made.

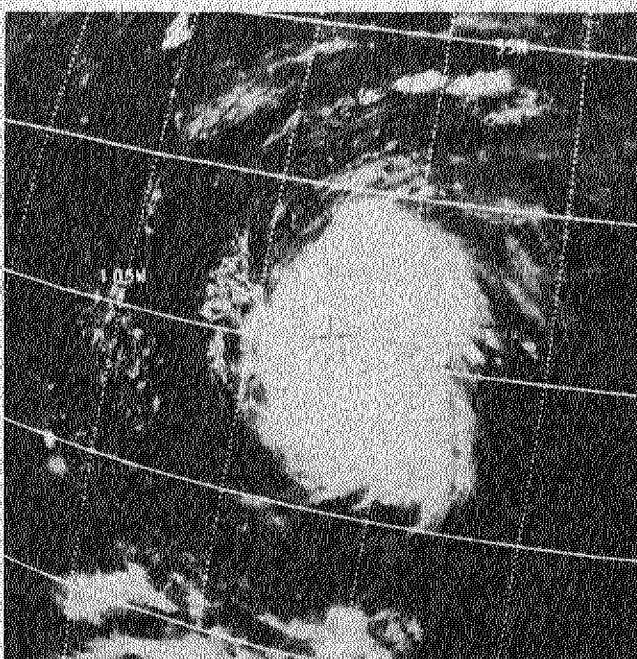

Fig. 2. A satellite picture of Hurricane Beulah over the Gulf of Mexico. The eye is the small black dot just below the + in the center of the picture. The white areas are clouds. The size of the hurricane and the general circulation features are illustrated well. (Photo courtesy of the National Hurricane Center.)

At wind speeds between 35 and 40 m.p.h., twigs are broken from trees and walking against or with the wind is difficult. With speeds in the 40's, slight structural damage occurs; shingles can be blown off roofs, and unsecured trash cans are scattered. When wind speeds reach 49 to 56 m.p.h., tree branches can break and significant damage can occur to structures.

The wind force applied to any object increases with the square of the wind speed (Fig. 5). Consider a house 100 feet long and 10 feet high with a 100 m.p.h. wind blowing against it. Since wind at 100 m.p.h. exerts a force of about 40 pounds per square foot, the total force exerted against one side of the house would be 40 x 100 x 10 or 40,000 pounds! With a wind of 160 m.p.h., this force would be 100 x 100 x 10 or 100,000 pounds! When rain is driven by the wind, the force exerted on the side of a building is even greater. Few buildings are designed to withstand such force without damage. Figs. 6 and 7 illustrate damage by high winds to buildings.

Trees also are blown over or uprooted by hurricane-force winds (Fig. 8), and whole forests may be leveled. During Hurricane Camille (1969, Mississippi), trees to the west of the eye (where winds were from the north) were lying parallel to each other with their crowns pointed south. To the east of the eye (where winds were from the south), the trees were lying parallel with crowns pointed north.

Overhead power and telephone lines frequently are broken by strong winds. These downed electric lines are a hazard if the power is on. Furthermore, blowing debris from destroyed buildings can cause extensive damage to other structures, and serious injuries to people not in shelter.

V. DEVASTATION BY STORM SURGE

Storm surge, an abnormal rise in the level of the sea, causes the greatest concentration of death and destruction in a hurricane. The continual pounding of the storm surge (which may reach heights up to 20 feet) with waves superimposed can destroy almost any manmade structure. Fig. 9 shows the storm surge during Hurricane Carla.

Many people who stayed in their homes near the coast during the Great Galveston Hurricane of 1900, and during the Indianola hurricanes of 1875 and 1886, were buried in the resulting rubble. Some persons who left during the height of the storm, because their homes were being destroyed, were washed away and never found. When Hurricane Camille hit the Mississippi coast near Pass Christian in 1969, her storm

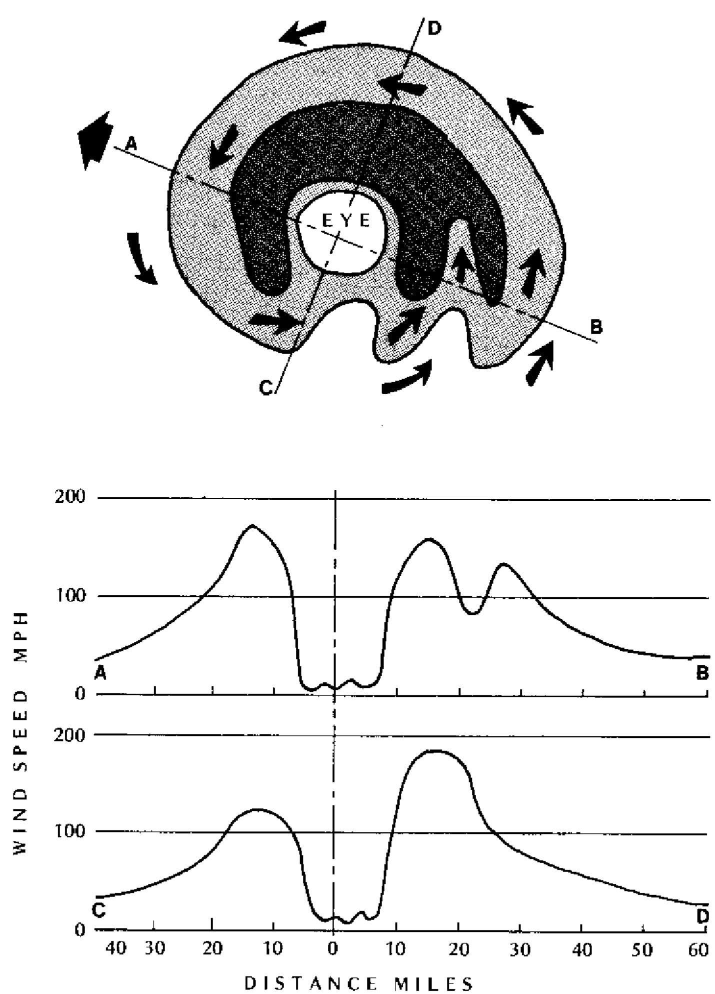

Fig. 3. A schematic representation of the wind distribution around the eye of an extreme hurricane like Carla or Celia. The large arrow pointing to the upper left indicates the direction of hurricane movement. The smaller arrows indicate the wind direction within the hurricane. The light hatching indicates the area of hurricane-strength winds. The darker hatching indicates the area of winds greater than 136 m.p.h. The graphs indicate the variation of wind strength along the lines A-B and C-D.

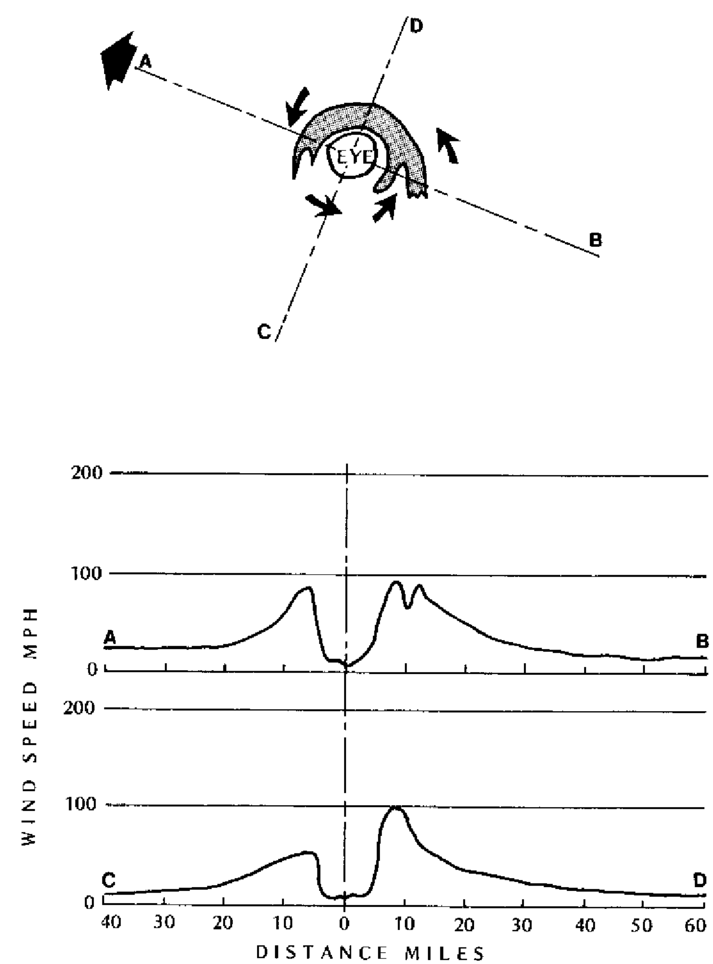

Fig. 4. A schematic representation of the wind distribution around the eye of a small hurricane. The large arrow pointing to the upper left indicates the direction of hurricane movement. The light hatching indicates the area of hurricane-strength winds. The smaller arrows indicate the wind direction within the hurricane. The graphs indicate the variation of wind strength along lines A-B and C-D.

surge destroyed numerous structures, including a three-story, 40-unit apartment building. Only the foundation of the apartment building remained. About a dozen tenants held a hurricane party during the storm--their bodies were never found.

In some areas of the world, the storm surge can reach heights of 40 feet or more. A few years ago an extreme hurricane (called cyclones in the Indian Ocean) hit the islands off the coast of Pakistan (now Bangladesh). The storm surge killed an estimated one million people and destroyed almost all the crops and housing on the low, flat islands.

Another hazard of the storm surge was demonstrated by Hurricane Audrey, which hit the west Louisiana coast near Cameron in June 1957. Even though a hurricane watch had been issued two days in advance and hurricane warnings were issued 14 hours before high winds and high tides reached the coast, few people evacuated the area. Many people who stayed were drowned. It is thought that the majority of people who drowned sought safety by climbing into high trees and then fell into the rising flood waters after they were bitten by snakes also taking refuge in the trees.

The storm surge is highest where onshore winds are strongest--in the right front quadrant of the hurricane. Fig. 10 (Harris 1963) shows the distribution of storm surge height above mean sea level at varying distances from the eye of Hurricane Audrey (1957). Audrey was moving northward so the highest storm surge occurred to the right (east) side of the eye. (Note that a storm surge greater than eight feet high can extend 150 miles along the coastline.) Surf conditions and riptides also are dangerous for hundreds of miles along the coast.

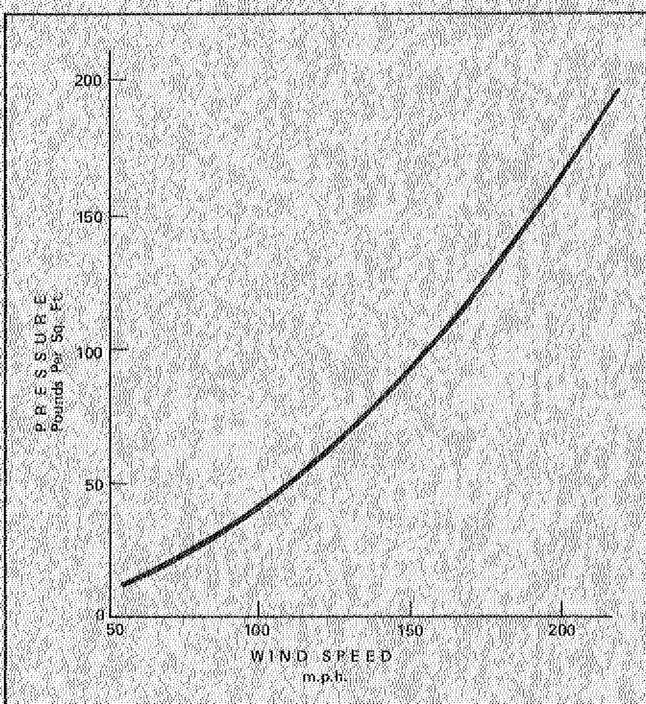

Fig. 5. The wind pressure exerted on a surface perpendicular to the wind flow varies with the wind speed, as shown.

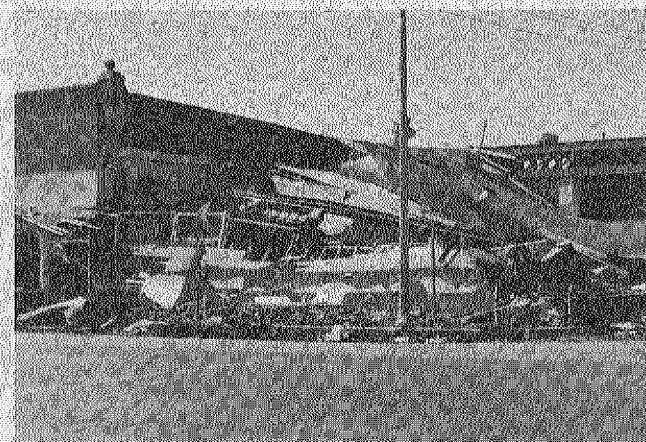

Fig. 6. After the masonry wall in Corpus Christi yielded to the winds of Hurricane Celia (1970), the roof fell. (Photo courtesy of the Texas Highway Department.)

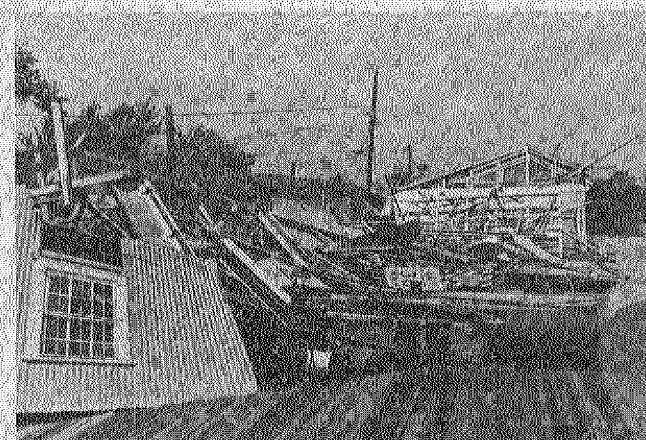

Fig. 7. Hurricane Celia left the Patricio County road sign shop, some 20 miles inland, a matchstick shamble. (Photo courtesy of the Texas Highway Department.)

The height of the storm surge depends on a variety of factors. In addition to hurricane size and intensity, the angle at which the storm strikes the coast is one factor. Storms that move onshore at right angles to the coast will cause a higher storm surge than those that hit obliquely. The height of regularly occurring tides can add to or subtract from the storm surge. The slope and profile of the shoreline and ocean bottom near the beach are important because they can create a bottleneck effect, causing much higher storm tides. Barrier islands, inlets, and estuaries also affect size of the storm surge, as do the amount of vegetation and construction in the impact area. Because many complex factors are involved, height forecasts for the storm surge in a given area are not always accurate.

Flood waters of the storm surge usually come in like a high tide but rise much faster. Sometimes in bays the storm surge starts a series of fast-moving waves that oscillate from one side of the bay to the other. The condition is illustrated by trying to carry water in a flat pan; the rush of water from one end of the pan to the other represents the oscillation in bays. This water movement is called a "seiche" (pronounced sayche). Survivors have described the sudden inflow as "great walls of water which swept all before them." Forecasts of this condition are beyond present capability.

Tannehill (1956) gives an account of a seiche at Coringa on the Bay of Bengal that illustrates the destructiveness of the storm surge, during which the town and 20,000 inhabitants disappeared:

> Coringa was destroyed in a single day. A frightful phenomenon reduced it to its present state. In the month of December 1789, at the moment when a high tide was at its highest point, and that the northwest wind blowing with fury, accumulated the waters at the head of the bay, the unfortunate inhabitants of Coringa saw with terror three monstrous waves coming in from the sea, and following each other at short distances. The first, sweeping everything in its passage, brought several feet of water into the town. The second augmented these ravages by inundating all of the low country, and the third overwhelmed everything.

Damage by the storm surge occurs along the coastline for hundreds of miles from the center of the hurricane. Far from the eye, the storm surge is evidenced by numerous Portuguese men-of-war or increased seaweed and other debris washed up on beaches. Closer to the center there is vast erosion of some beaches and considerable deposition of debris on others. Marine and shore equipment, as well as boats, often are torn from their moorings and washed hundreds of yards inland (Fig. 11). Fig. 12 shows houses lifted from their foundations and floated onto the road. Often during the evacuation before a hurricane, livestock must be left to become victims of the storm surge (Fig. 13).

Fig. 8. Thousands of trees were snapped by the winds of Hurricane Celia. (Photo courtesy of the Texas Highway Department.)

After the hurricane passes, authorities must dispose of the carcasses before they become health hazards.

Along the Texas coast areas of land subsidence are more vulnerable to destruction by the storm surge. During the last 30 years, some places have sunk as much as seven feet, and subsidence is expected to continue at about the same rate. If the storm surge from Carla (1961) was two feet where the land has since subsided two feet, a similar storm today could cause the storm surge to be four feet deep. Areas that survived previous storm surges may not be safe today. Locations lower than 20 feet above mean sea level must be considered prime areas to be flooded by the storm surge, and areas higher than 20 feet above mean sea level are not always secure from flooding.

According to some specialists, the effects of the storm surge are not always detrimental. Bays are flushed of pollutants, and sand is transported from the continental shelf onto beaches to replenish previously lost sand. Sometimes this shifting of sand exposes old shipwrecks and artifacts.

Fig. 9. This view shows land inundated by the storm surge during Hurricane Carla (1961). The winds have diminished, but the floods remain. (Photo courtesy of the Texas Parks and Wildlife Department.)

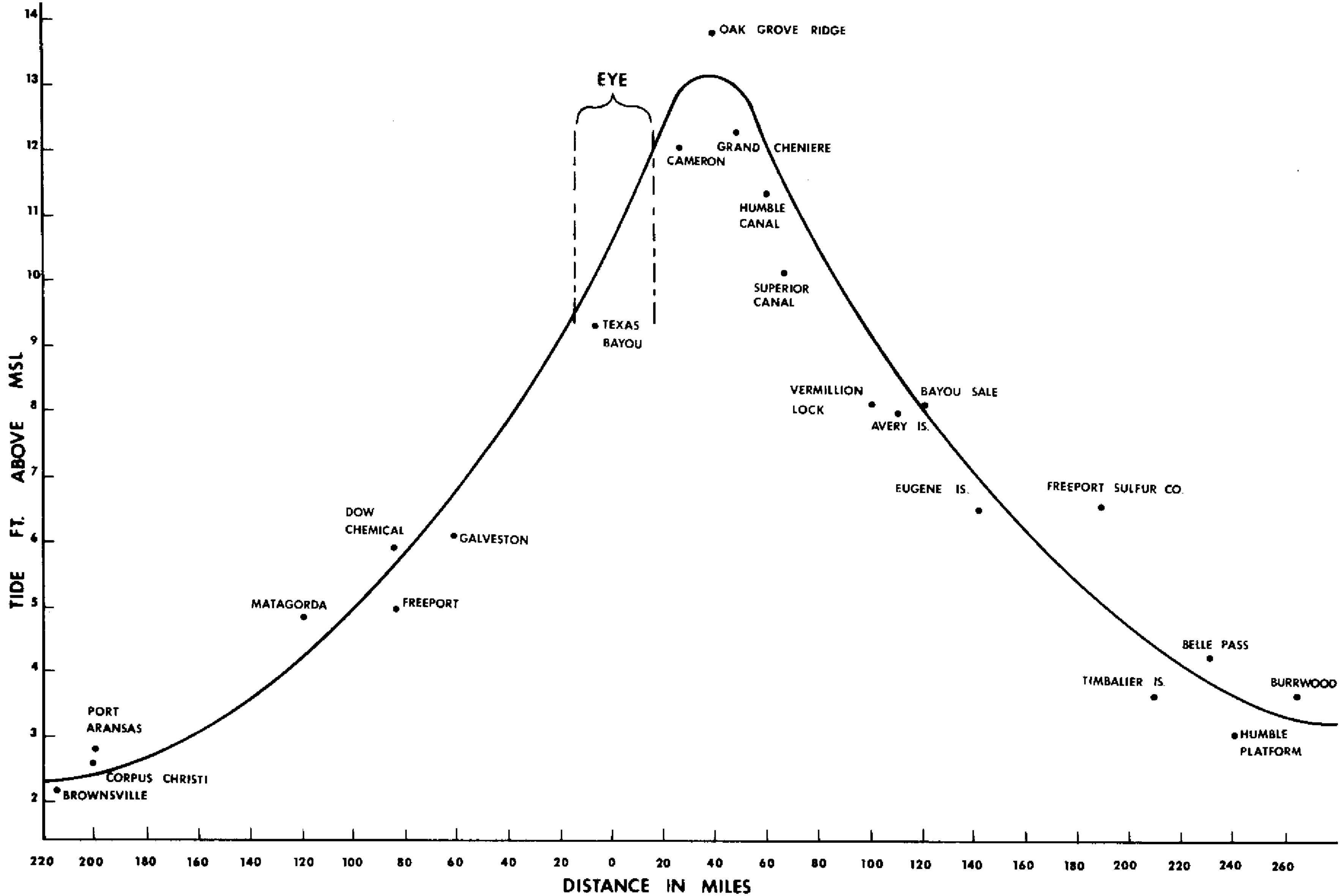

Fig. 10. This chart shows the distribution of maximum tide heights above mean sea level (MSL) recorded during Hurricane Audrey of 1957 (Harris 1963).

Fig. 11. This is one of three large boats that were washed almost half a mile inland from Lavaca Bay onto Texas State Highway 316 between Indianola and Port Lavaca during Hurricane Carla. (Photo courtesy of the Texas Highway Department.)

VI. DISASTER FROM RAINFALL AND FLOODING

Rainfall from tropical cyclones is *extremely* variable, and depends on the diameter of the rainy area and the speed of cyclone movement. Total rainfall is greatest for large hurricanes that move slowly. But even a tropical depression that is not named can drench a vast area.

The world record for 24-hour rainfall (73.62 inches) was associated with a typhoon in the Philippine Islands. Although hurricanes of the Texas coast have not produced such spectacular rainfall, heavy rains have occurred.

Heavy rainfall can cause flash floods and river system floods, both of which can produce extreme damage. The flash flood, which lasts 30 minutes to four hours, is caused by heavy rainfall over a small area where drainage cannot carry away excess water without overflow. For example, a dry stream bed can fill with water and overflow low bridges, underpasses, or low-lying areas. Danger to local residents occurs in areas usually not subject to high water. The strong current can carry cars off the road, erode road-beds, and wash out bridges.

The river system flood (Fig. 14) develops more slowly. Larger rivers may overflow their banks as they gather run-off, including that from flash floods. This type of flood, which may not start until two or three days after the hurricane, may persist for a week or more. Although the current in the river channel is strong, most of the flood-water is overflow with comparatively weak currents. While the flash flood may be the killer, the river flood covers such an extensive area that destruction of property and crops is greater. After the water retreats, buildings are full of mud, furniture is warped, and rugs are unusable.

Wind-driven rain also causes damage. Rain can enter buildings around windows, through cracks, and under shingles, causing damage to interiors. Fig. 15 shows the driving rains of Hurricane Carla.

Hurricane Beulah (1967) caused the most extensive flooding from rainfall of any reported tropical cyclone in Texas. Beulah struck the coast just north of Brownsville, moved northward to a location close to Alice, Texas, turned toward the southwest and moved slowly into Mexico, where she dissipated.

The total rainfall from Beulah exceeded 30 inches at some places (Falfurrias reported 36 inches). The greatest 24-hour rainfall, an estimated 15 inches, was at Sebastian. Although not close to world records, these amounts did cause severe flooding of river systems throughout south Texas and northcentral Mexico. Rivers that flooded during Beulah and some details about the floods are given in Appendix IV. Fig. 14, taken after Hurricane Beulah, shows the Rio Grande overflowing its banks near Los Ebanos.

Fig. 12. Houses struck by the storm surge were floated and blown onto Texas State Highway 35 near Palacios city limits during Hurricane Carla. (Photo courtesy of the Texas Highway Department.)

VII. DEADLY TORNADOES

Two significant features of the hurricane-spawned tornado are its reduced size (about half the size of its Great Plains cousin) and its short duration (usually minutes). Consequently, the area affected is small, usually 200 to 300 yards wide and less than a mile long. Nevertheless, this area often is ravaged completely.

Generally tornadoes occur to the right of the direction of hurricane movement. The area within angles of 10 to 120 degrees from the direction of movement includes 94 percent of the tornadoes, most of which occur between 60 and 240 miles from the eye and outside the area of hurricane-force winds. Tornadoes occur more frequently when a hurricane moves northward, less frequently when it moves westward. Hurricane Beulah (1967) was a notable exception.

In recent years, reporting systems have improved so that some general knowledge exists of the number and geographical extent of hurricane-generated tornadoes. In the United States, Beulah holds the record for hurricane-associated tornadoes with more than 100; Carla (1961) is second with 26. Because Beulah's tornadoes hit sparsely populated areas, the death toll and property damage were small. If these small but deadly tornadoes hit larger cities during future hurricanes, casualty lists and property damage can increase.

Fig. 13. Livestock were left in the wake of Hurricane Carla's storm surge on Texas State Highway 35 near Karankawa Bay. This sight was common along the Texas coast in September 1961. (Photo courtesy of the Texas Highway Department.)

Fig. 14. These flood waters from Hurricane Beulah are near Los Ebanos. The double row of trees in the foreground mark the beds of two creeks. (Photo courtesy of the Texas Highway Department.)

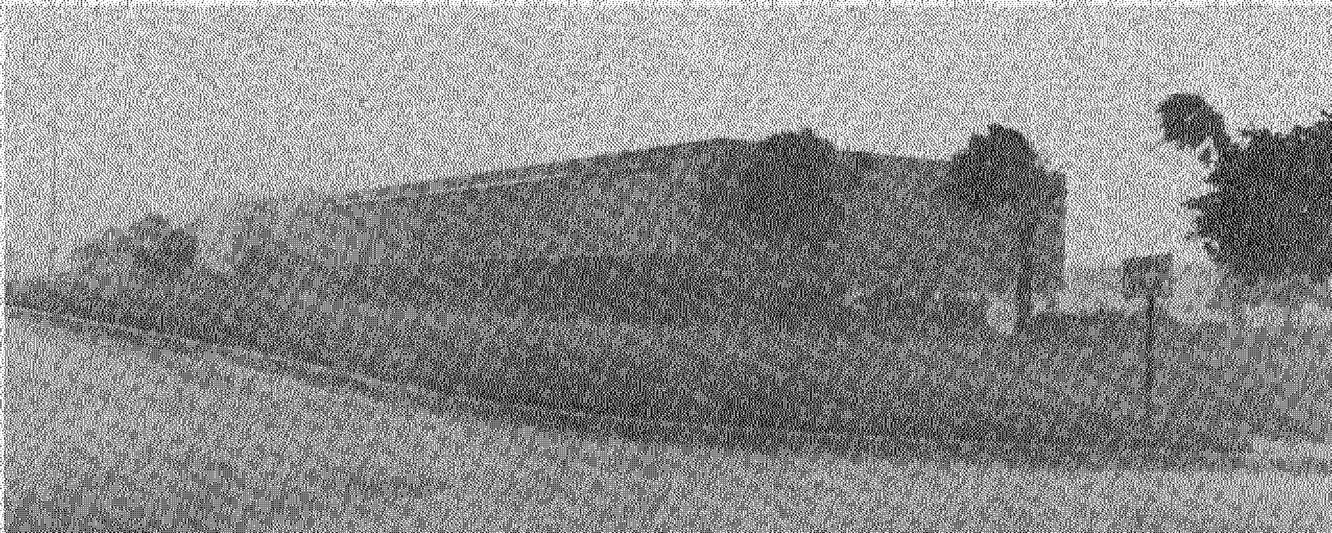

Fig. 15. The wind and rain of Hurricane Celia is shown near the District Highway Office at Corpus Christi. No pictures were taken outside during the height of the storm because of the danger. (Photo courtesy of the Texas Highway Department.)

VIII. DELAYED DANGERS

When a hurricane strikes, the immediate danger is caused by flooding and strong winds. But secondary or residual dangers continue after the major damage has occurred.

Utility systems may not be operating. There is danger of shock from electric power lines that have been blown down. Power for any use, from light to refrigeration, may not be available. If telephone and telegraph lines also have been blown down, direct communication can be limited to battery-powered radios.

Transportation systems can be inoperative. Bridges and roads can be washed out or flooded. Debris can block roads. Movement of food, medical supplies, and necessary equipment can be impeded. Water systems can be flooded and polluted. Sewage and waste cannot be disposed of as usual.

Drowned animals, lack of drinking water, failure of sewage systems, and living in shelter conditions are conducive to outbreak of disease. Numerous problems, including the threat of epidemics, confront public health services.

Snakes driven from their natural habitats by the high water (Fig. 16) also can cause a minor problem. During almost every hurricane people are bitten by snakes and have difficulty getting medical attention because of transportation and communication breakdowns. Snakes, which are strong swimmers, will be along roads, in the remains of buildings, in trees, and in other high and dry places.

Finally, there is man. During every disaster there are people who take advantage of the confusion and misery to loot and pilfer.

IX. SURVIVAL AND RECOVERY

The hurricane, the greatest storm on earth, is a killer, and each person in its potential path should take precautions to minimize damage and to save lives. The third volume of this series discusses ways an individual can protect himself, his family, and his property. The role of various government agencies and civilian organizations in helping citizens prepare for and recover from hurricanes also are considered.

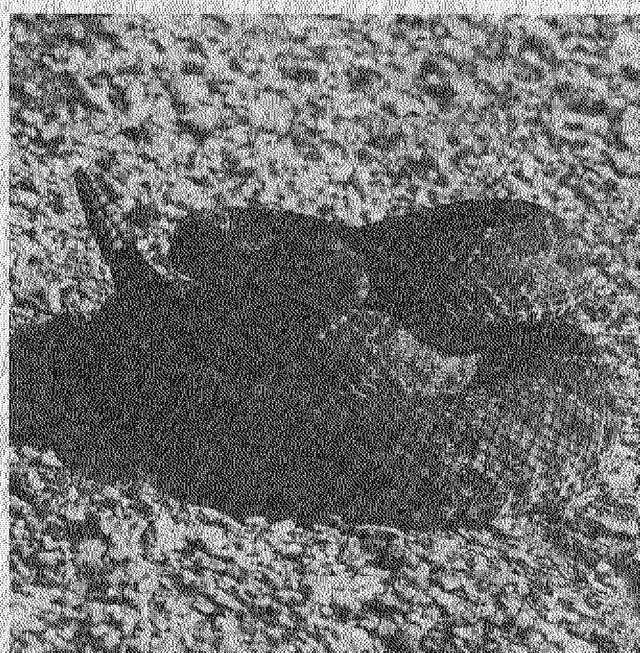

Fig. 16. This large rattlesnake moved to the shoulder of the highway to escape the flood waters of Hurricane Carla. (Photo courtesy of the Texas Highway Department.)

APPENDIX I

Hurricane terms are defined in the following glossary.

Bulletin: A public release from a Weather Service Hurricane Warning Office issued at times other than those when advisories are required. A bulletin is similar in form to an advisory but includes additional general newsworthy information.

Cautionary Advice to Small Craft: When a hurricane is within a few hundred miles of a coastline, small craft operators are warned to take precautions and to avoid entering the open sea.

Cyclone: A closed system of cyclonic (counterclockwise direction) circulation characterized by low pressure and inclement weather.

Extreme Hurricane: A tropical cyclone with maximum winds of 136 m.p.h. (118 knots) or higher and minimum central pressure of 28.00 inches Hg (711.20 mm Hg or 948.19 mb) or less.

Eye: The roughly circular area of comparatively light winds and fair weather at the center of a hurricane.

Gale Warning: A notice added to small craft advisories when winds of 38-55 m.p.h. are expected.

Hurricane: A tropical cyclone with sustained winds of 74 m.p.h. (64 knots) or greater.

Hurricane Warning: A warning that within 24 hours or less a specified coastal area may be subject to (a) sustained winds of 74 m.p.h. (64 knots) or higher and/or (b) dangerously high water or a combination of dangerously high water and exceptionally high waves, even though winds expected may be less than hurricane force.

Hurricane Watch: The first alert when a hurricane poses a possible, but as yet uncertain, threat to a certain coastal area, or when a tropical storm threatens the watch area and has a 50-50 chance of intensifying into a hurricane. Small craft advisories are issued as part of a hurricane watch advisory.

Land Subsidence: The sinking of the land, caused mainly by the withdrawal of underground water from wells supplying cities and industries. This phenomenon may cause coastal areas to become more vulnerable to tropical storm flooding.

Local Action Statement: A public release prepared by a Weather Service Office in or near a threatened area giving specific details for its area of responsibility on weather conditions, evacuation notices, and other precautions necessary to protect life and property.

Major Hurricane: A tropical cyclone with maximum winds of 101 m.p.h. to 135 m.p.h. (88 to 117 knots) and a minimum central pressure of 28.01 to 29.00 inches Hg (711.45 to 736.60 mm Hg or 948.53 to 982.05 mb).

Seiche: A series of fast-moving waves that sometimes are superimposed upon the storm surge. This phenomenon may cause total destruction and great loss of life.

Storm Surge: An abnormal rise in the level of the sea produced by the hurricane. This inundation is usually responsible for the greatest loss of life and destruction of property.

Storm Warning: A notice added to small craft advisories when winds of 56-73 m.p.h. are expected. Both gale and storm warnings indicate the coastal area to be affected and the expected intensity of the disturbance.

Tornado: A violently rotating column of air, nearly always observable as a funnel cloud.

Tornado Forecast Information: An advisory stating that conditions are such that tornadoes may occur.

Tornado Warning: An advisory stating that a tornado actually has been sighted by human eye or indicated by radar.

Tropical Cyclone: A general term for the nearly circular cyclones that originate over tropical oceans. It includes tropical storms, tropical depressions and all types of hurricanes.

Tropical Cyclone/Hurricane Advisories: Messages issued simultaneously by the Hurricane Warning Offices and the National Hurricane Center in Miami every six hours describing the storm, its position, anticipated movement, and prospective threat.

Tropical Depression: A tropical cyclone with sustained winds of less than 39 m.p.h. (34 knots).

Tropical Storm: A tropical cyclone with sustained winds of 39 to 73 m.p.h. (34 to 63 knots).

APPENDIX II

This summary lists the largest number of deaths and the greatest amount of dollar damage caused by hurricanes affecting the Texas coast.

Largest Number of Deaths

Hurricane and Date	Texas Deaths	Dollar Damage
Great Galveston Hurricane 8-10 September 1900	6,000-8,000	$30-40 million
Corpus Christi Storm 14 September 1919	284	20 million
Galveston Storm 16-19 August 1915	275	56 million
Indianola Storm 15-18 September 1875	176	No estimate

Greatest Amount of Dollar Damage

Hurricane and Date	Texas Deaths	Dollar Damage
Celia 3-4 August 1970	11 5 outside Texas	500 million No estimate outside Texas
Carla 11-14 September 1961	34 12 outside Texas	400 million 25 million outside Texas
Beulah 8-21 September 1967	15 44 outside Texas	200 million No estimate outside Texas
Galveston Storm 16-19 August 1915	275	56 million No estimate outside Texas
Great Galveston Hurricane 8-10 September 1900	6,000-8,000	30-40 million No estimate outside Texas

APPENDIX III

Estimated costs of the last three extreme hurricanes are listed by type of damage.

HURRICANE	COSTS
Carla (1961)	
Damage by storm surge	$200,195,000
Damage by wind, rain, and tornadoes	203,584,000
Cost of rescue efforts	4,511,000
TOTAL	$408,290,000

Acres flooded -- 1,560,565

Beulah (1967)	
Damage by storm surge	$ 5,449,000
Damage by wind, rain, and tornadoes	46,491,000
Damage by floods (river system and flash)	108,158,000
Cost of rescue efforts	8,746,000
TOTAL	$168,844,000

5 deaths and $2 million damage by tornadoes
Acres flooded by storm surge -- 630,000
Acres flooded by overflow from 50 streams -- 1,400,000

Celia (1970)	
Damage by storm surge	$ 27,570,000
Damage by wind, rain, and tornadoes	439,738,000
Cost of rescue efforts	32,692,000
TOTAL	$500,000,000

APPENDIX IV

Rivers and creeks flooded by rainfall during Hurricane Beulah (1967) are given.

Aransas River Basin: Flooded Beeville, Sinton, and Odem.

Guadalupe River Basin: Coleto Creek flooded roads and washed out bridges, flooded Yorktown; Gohle Creek flooded Cuero; Guadalupe River flooded parts of Victoria.

Lavaca River Basin: Flooding not severe.

Los Olmos Creek Basin: Flooded large rural area and covered roads.

Mission River Basin: Mission River set new records for flooding at Refugio; Medio Creek set new high levels.

Nueces River Basin: Nueces River set new flood records and flooded Tilden, Three Rivers, and Mathis; extensive flooding throughout the area.

Oso Creek Basin: Flooded Robstown.

Palo Blanco Creek Basin: Flooded Falfurrias (worst in history) and much rural land.

Petronila Creek: Severe flood at Driscoll.

Rio Grande River Basin: Flooded three to five miles wide in the areas of San Benito, La Grulla, Los Ebanos, Rio Grande City, and other places.

San Antonio River Basin: Nichols Creek flooded Kenedy; San Antonio River flooded parts of San Antonio and set new records at Goliad.

San Fernando Creek Basin: Flooded Alice, Bishop, and the countryside south of Kingsville.

The U. S. Floodway System: Flooding at Mission and Harlingen; overflow from floodway canals flooded parts of McAllen, Edinburg, Elsa, LaVilla, Sebastian, Lyford, Raymondville, San Perlita, and adjacent rural areas.

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