HURRICANE MITCH: Peak Discharge for Selected River Reaches in Honduras

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INTRODUCTION

Hurricane Mitch began as a tropical depression in the Caribbean Sea on 22 October 1998. By 26 October, Mitch had strengthened to a Category 5 storm as defined by the Saffir-Simpson Hurricane Scale (National Climate Data Center, 1999a), and on 27 October was threatening the northern coast of Honduras (fig. 1). After making landfall 2 days later (29 October), the storm drifted south and west across Honduras, wreaking destruction throughout the country before reaching the Guatemalan border on 31 October.

According to the National Climate Data Center of the National Oceanic and Atmospheric Administration (National Climate Data Center, 1999b), Hurricane Mitch ranks among the five strongest storms on record in the Atlantic Basin in terms of its sustained winds, barometric pressure, and duration. Hurricane Mitch also was one of the worst Atlantic storms in terms of loss of life and property. The regionwide death toll was estimated to be more than 9,000; thousands of people were reported missing. Economic losses in the region were more than $7.5 billion (U.S. Agency for International Development, 1999).

Post-Hurricane Mitch remnants of a newly constructed highway bridge across the Río Choluteca north of Choluteca. The bridge was designed to convey floodflows through the main span.

Honduras suffered the most widespread devastation during the storm. More than 5,000 deaths, and economic losses of more than $4 billion, were reported by the Government of Honduras. Honduran officials estimated that Hurricane Mitch destroyed 50 years of economic development. In addition to the human and economic losses, intense flooding and landslides scarred the Honduran landscape—hydrologic and geomorphologic processes throughout the country likely will be affected for many years.

Figure 1. Storm track of Hurricane Mitch from 26 October to 1 November, 1998. Modified from Reich and others (2001).

As part of the U.S. Government's response to the disaster, the U.S. Geological Survey (USGS) conducted post-flood measurements of peak discharge at 16 river sites throughout Honduras (fig. 2). Such measurements, termed "indirect" measurements, are used to determine peak flows when direct measurements (using current meters or dye studies, for example) cannot be made. Indirect measurements of peak discharge are based on post-flood surveys of the river channel (observed high-water marks, cross sections, and hydraulic properties) and model computation of peak discharge. Determination of the flood peaks associated with Hurricane Mitch will help scientists understand the magnitude of this devastating hurricane. Peak-discharge information also is critical for the proper design of hydraulic structures (such as bridges and levees), delineation of theoretical flood boundaries, and development of stage-discharge relations at streamflow-monitoring sites.

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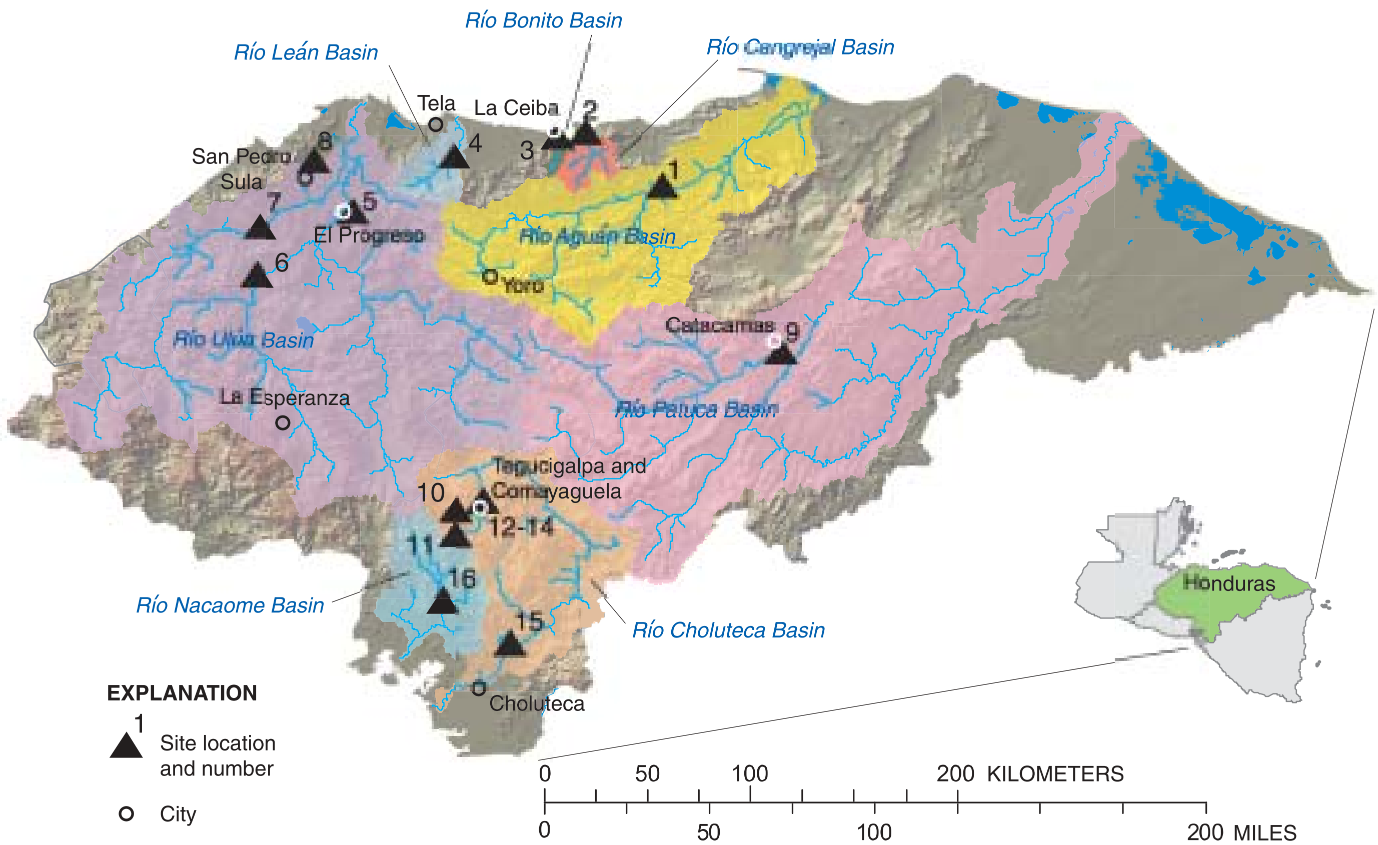

Figure 2. Indirect measurements were conducted in the major drainage basins and other selected areas of Honduras.

HYDROMETEOROLOGICAL CHARACTERISTICS

Pre-Hurricane Mitch Rainfall

Northern Honduras typically receives large amounts of rainfall during the rainiest months of September and October. Tropical storms and hurricanes routinely affect the northern coast, whereas the central and southern regions of the country rarely experience extreme rainfall and flooding as that which occurred during Hurricane Mitch. In northern Honduras, the long-term rainfall average (1967–97) at La Ceiba is 214 millimeters (8.43 inches) for September and 407 millimeters (16.0 inches) for October. In central and southern Honduras, long-term rainfall averages for September are 173 millimeters (6.81 inches) at Tegucigalpa and 377 millimeters (14.8 inches) at Choluteca; long-term rainfall averages for October are 112 millimeters (4.41 inches) at Tegucigalpa and 301 millimeters (11.9 inches) at Choluteca (Servicio Meteorológico Nacional de Honduras, written commun., 1998).

A comparison of pre-Hurricane Mitch rainfall (1–30 September and 1–24 October 1998) and the long-term averages for the same period are shown in figure 3. The plots show that the period prior to the hurricane was somewhat drier than normal on the north coast (La Ceiba). However, pre-hurricane conditions generally were wetter than normal in central and southern Honduras (Tegucigalpa and Choluteca). This situation exacerbated the flooding caused by Hurricane Mitch in central and southern Honduras by saturating the soil and filling reservoirs to near capacity.

Rainfall Associated with Hurricane Mitch

Total rainfall measured during Hurricane Mitch reportedly was as much as 1,905 millimeters (over 75 inches) in some areas affected by the storm (National Climate Data Center, 1999b). Daily rainfall totals for 25–31 October 1998 at selected recording stations in Honduras are shown in figure 4. The northern regions of the country were the first to experience the effects of the storm. From 25–31 October, La Ceiba received 875 millimeters (34.4 inches) of rainfall; Yoro in the Aguán Valley received 520 millimeters (20.5 inches); Tela received 565.5 millimeters (22.3 inches); and San Pedro Sula (La Mesa) received 368 millimeters (14.5 inches) (Servicio Meteorológico Nacional de Honduras, written commun., 1998).

Heavy rains battered central Honduras as Hurricane Mitch moved south from the coast. From 25–31 October 1998, La Esperanza (Intibucá Department) received 167 millimeters (6.57 inches) of rainfall; Catacamas (Olancho Department) received 257 millimeters (10.1 inches) of rainfall; and the capital, Tegucigalpa, received 254 millimeters (10.0 inches). The storm caused extensive flooding in Tegucigalpa and Comayaguela. Additionally, the heavy rainfall triggered numerous landslides including the extremely destructive El Berrinche landslide, which destroyed hundreds of homes in the Colonia Soto of Tegucigalpa. The slide at El Berrinche displaced approximately 5 to 7 million cubic meters of material (Edwin L. Harp, U.S. Geological Survey, written commun., 1999).

The heaviest rainfall occurred in south-central Honduras, as the slow-moving Hurricane Mitch collided with a front situated in southwest

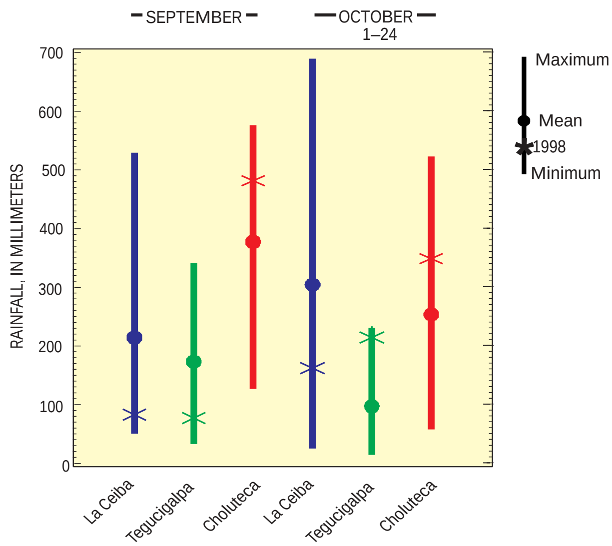

Figure 3. Rainfall for September 1998 and for the first 24 days of October 1998 compared with the long-term (1967–97) mean, maximum, and minimum rainfall for the same periods at selected cities.

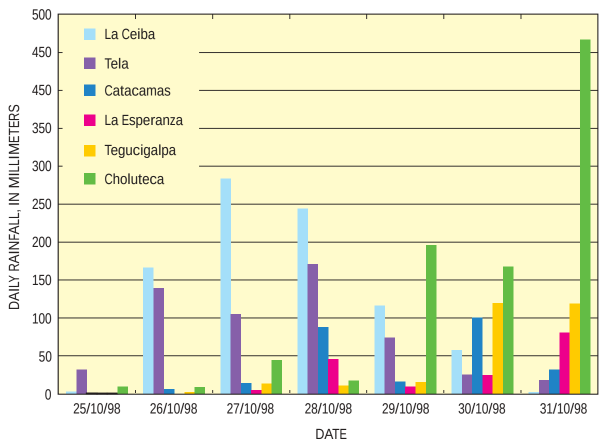

Figure 4. Daily rainfall during 25–31 October 1998 at selected sites.

Honduras. The city of Choluteca received 893 millimeters (35.2 inches) of rainfall during 25–31 October, most falling on the 29th through the 31st (fig. 4). The heavy rainfall caused extensive flooding, channel erosion, and deposition of sediment in the Choluteca area. In addition to the loss of many bridges and roads, it is estimated that 4,400 homes were destroyed and 6,600 homes were damaged in the Department of Choluteca (USAID/Honduras, written commun., 1999).

Watershed Characteristics

Watershed and river characteristics vary dramatically throughout the country. River systems that begin in the central mountains of Honduras drain either north to the Caribbean Sea or south to the Pacific Ocean. Several major river systems flow from the mountainous interior of the country to the Caribbean Sea. Along the north coast of the country numerous rivers—including the Río Cangrejal, Río Bonito, and Río Perla—drain the steep, coastal mountain range near the city of La Ceiba. In northeastern Honduras, the Río Aguán flows to the Caribbean Sea and supports extensive fruit plantations owned by commercial producers. The Río Patuca (fig. 2), formed by the confluence of the Río Guayape and Río Guayambre, drains the remote eastern-most department of Honduras called Gracias a Dios.

The Río Ulúa, formed by several major tributaries in northwestern Honduras, drains the mountainous region surrounding the Sula Valley and empties into the Caribbean Sea. The Sula Valley is one of the most important agricultural regions of Honduras and supports San Pedro Sula, the second largest city in Honduras.

Principal river systems that flow south to the Pacific Ocean include the Río Choluteca and the Río Nacaome. The upper Río Choluteca basin is situated in mountainous terrain, with elevations ranging to more than 2,290 meters (7,510 feet). The Río Choluteca is formed by the confluence of the Río Guacerique and the Río Grande, in the capital city of Tegucigalpa, which is situated in a mountainous valley at an elevation of about 1,000 meters (3,280 feet).

The Río Choluteca flows north from Tegucigalpa, then turns south and flows to the city of Choluteca before draining to the Pacific Ocean. The Río Nacaome basin is located west of the Río Choluteca basin and also flows to the Pacific.

INDIRECT MEASUREMENTS OF HURRICANE MITCH FLOODING

The USGS conducted 16 indirect measurements of peak discharge associated with Hurricane Mitch flooding in 8 river basins of Honduras (fig. 2). Measurement sites were selected on the basis of flood impacts on population centers, on the hydrologic characterization of flooding throughout the country, and on the need for data to be used in reconstruction planning and design. Selection of the specific reach for measurement was based on hydraulic suitability and channel stability; because of the magnitude of flooding, few ideal reaches were found. Standard USGS techniques for indirect measurement of peak discharge were used (Benson and Dalrymple, 1967), including slope-area analyses (Dalrymple and Benson, 1967), width-contraction (bridge) analyses (Matthai, 1967), and culvert analyses (Bodhaine, G.L., 1968). Peak discharges, hydraulic properties, and channel characteristics were computed in English Units, converted to International System of Units (metric), then rounded to three significant figures for presentation in this report.

A summary of computed peak discharges, contributing drainage areas, the approximate date and time of the peaks (if known), and hydraulic characteristics of flooding are shown in table 1. A description of hydraulic conditions at selected sites follows.

Table 1. Peak discharge determined for selected river reaches

[km^2, square kilometers; m^3/s, cubic meters per second; dd/mm/yy, day/month/year; m/s, meters per second; m, meters; m/m, meter per meter; PM, afternoon]

Site	Site name	Latitude/ longitude (decimal degrees)	Drainage area (km^2)	Peak discharge (m^3/s)	Date of peak discharge (dd/mm/yy)	Estimated time of peak (0000–2400)	Average velocity (m/s)	Average width (m)	Average depth (m)	Hydraulic slope[1] (m/m)
1	Río Aguán near Clifton	N 15.4949 W 86.3733	7,460	19,700	Not known	Not known	3.34	1,660	3.59	0.0017
2	Río Cangrejal near La Ceiba	N 15.7482 W 86.7572	483	6,680	29/10/98	0000–0600	7.16	108	8.69	0.0106
3	Río Bonito near La Ceiba	N 15.6980 W 86.8548	81.1	3,710	Not known	Not known	5.99	75.0	8.86	0.0408
4	Río Leán near Arizona	N 15.6416 W 87.3254	737	2,740	Not known	Not known	[2,3]2.06	[2,3]359	[2,3]2.68	0.0083
5	Río Pelo near El Progreso	N 15.3909 W 87.7810	35.2	309	29/10/98	1200–1500	5.33	14.3	4.10	0.0301
6	Río Ulúa near Chinda	N 15.1078 W 88.2027	8,510	11,000	29/10/98	PM	6.13	159	12.5	0.0035
7	Río Chamelecón near El Tablón	N 15.3208 W 88.2044	2,680	4,700	29/10/98	2330	5.47	131	6.58	0.0041
8	Río Choloma at Choloma	N 15.6185 W 87.9547	79.7	490	29/10/98	PM	2.92	114	1.69	0.0084
9	Río Guayape near Catacamas	N 14.7611 W 85.8398	7,940	8,890	Not known	Not known	5.22	156	11.1	0.0032
10	Río Guacerique upstream from Los Laureles Reservoir	N 14.0713 W 87.2825	179	1,260	31/10/98	0000	5.56	53.1	4.31	0.0086
11	Río Grande upstream from Concepción Reservoir	N 13.9983 W 87.3120	102	1,190	31/10/98	0300	6.18	43.4	4.48	0.0139
12	Río Grande near Tegucigalpa	N 14.0717 W 87.2111	421	[4]2,340	31/10/98	0000–0200	[3]2.87	[3]103	[3]7.93	0.0140
13	Río Chiquito at Tegucigalpa	N 14.1044 W 87.1993	77.8	167	31/10/98	0000	[3]2.46	[3]23.2	[3]2.93	0.0285
14	Río Choluteca near Tegucigalpa	N 14.1222 W 87.2107	802	[4]4,360	31/10/98	0030	5.83	105	7.29	0.0097
15	Río Choluteca at Colonia Apacilagua	N 13.4744 W 87.0739	6,350	14,300	30/10/98–31/10/98	2300–0300	5.90	235	10.9	0.0051
16	Río Nacaome near Pespire	N 13.6698 W 87.3656	1,390	7,000	30/10/98	2100	4.76	180	8.24	0.0026

[1]Hydraulic slope based on high-water mark profile.
[2]Hydraulic properties shown are for portion of flow within the main channel (1,980 m^3/s).
[3]Hydraulic properties of approach cross section (bridge-measurement site).
[4]Peak discharge possibly affected by upstream reservoirs.

North Coast

Several river systems drain the steep mountain range situated along the north coast of Honduras. Severe flooding of these rivers during Hurricane Mitch caused road and bridge damage along the coastal highway. Overland access to the city of La Ceiba was cut off for several days after the flood (however, the airport remained open).

The Río Cangrejal and the Río Bonito are characteristic of the steep rivers of the northern coast. Both rivers drain the steep coastal mountain range just south of La Ceiba.

Peak discharge for the Río Bonito (Site 3) was measured in the confined canyon, upstream from the point of discharge onto the coastal plain (which can be characterized as a cobble/boulder alluvial fan). The river

Looking downstream at the bedrock and large boulders that compose the channel of the Río Bonito (Site 3).

channel is composed of a series of steep pool-and-riffle reaches confined by steep rock walls. The bed consists of bedrock and large boulders 1.5 to more than 9 meters (4.9 to more than 30 feet) in diameter. The reach apparently was not affected by deposition of smaller material (sand and gravel).

The computed peak discharge of 3,710 cubic meters per second (m^3/s) (131,000 cubic feet per second, ft^3/s) is subject to rather large uncertainty (more than 25 percent) because of the steep, non-uniform channel conditions. Computed flow velocities ranged from 4.33 to 7.65 meters per second (14.2 to 25.1 feet per second). Top width of the flood channel ranged from 56.4 to 93.6 meters (185 to 307 feet), and the hydraulic slope (based on surveyed high-water marks) was 0.0408 meter/meter.

Río Aguán

The Aguán Valley is home to extensive banana, palm, and other fruits plantations. Hurricane Mitch destroyed at least 70 percent of the crops, and fertile fields were inundated with sediment. The economic losses were devastating.

Looking left to right at the upstream cross section of the study reach of the Río Aguán (Site 1). Width of flow at this cross section was 1,800 meters (5,900 feet).

The Aguán Valley is wide and flat, flanked by steep mountains; runoff from these mountains flows directly into the Río Aguán from steep canyons along the entire length of the valley. All bridges in the valley were either destroyed or heavily damaged, and erosion/sedimentation processes altered the channel substantially.

Because of the wide, unconfined valley, few suitable reaches for measurement were available. The flood was confined to a width of about 1.7 kilometers in the vicinity of Clifton, upstream from the town of Sabá and just downstream from the confluence with the Río Jaguaca. Three cross sections were surveyed in the confined reach (just less than a 1.3 kilometers in length) and peak flow was computed by using the slope-area method (Site 1). The peak discharge of 19,700 m^3/s (696,000 ft^3/s) was the largest flow measured in Honduras by the USGS. Top width of the flood channel averaged 1,660 meters (5,460 feet), and the hydraulic slope was 0.0017 meter/meter.

Río Ulúa basin and the Sula Valley

Four measurements of peak discharge in the Río Ulúa basin were made to help characterize flooding in the Sula Valley. The low-lying Sula Valley experiences substantial flooding annually during the rainy season, but flooding caused by Hurricane Mitch was an event of record magnitude. Measurements of peak discharge were made on the mainstem of the Río Ulúa, and on the Ríos Chamelecón, Choloma, and Pelo (all part of the Río Ulúa basin).

Looking downstream at the study reach of the Río Ulúa near Chinda (Site 6). Note the scour on each bank, indicating the extent of the flood.

Measurement of flooding of the Río Ulúa was made near the town of Chinda (Site 6). The site is located in the mountainous terrain upstream from the Sula Valley where the river is confined to an incised, fairly uniform channel; the photograph shows the measurement reach and the scoured banks left by the flood. Drainage area at the site (8,510 km^2; 3,280 mi^2) is less than half the drainage area of the lower river basin (20,600 km^2; 7,950 mi^2, at the streamflow-monitoring station Río Ulúa at Guanacastales), but measurement of flow in the valley itself was impossible because of the expanse of the inundated area. Computed peak discharge near Chinda was 11,000 m^3/s (388,000 ft^3/s), by the slope-area method; peak discharge of combined flows in the lower valley was much larger. Top width of the flood channel near Chinda averaged 159 meters

(522 feet), and the hydraulic slope was 0.0035 meter/meter. The straight reach was well suited for slope-area measurement. The channel generally was uniform through the reach and was not substantially affected by erosion/sedimentation during the flood.

Upper Río Choluteca basin

Three peak-flow measurements were made in the upper Río Choluteca basin, upstream from Tegucigalpa. Measurements of the Río Guacerique upstream from Los Laureles Reservoir (Site 10) and the Río Grande upstream from Concepción Reservoir (Site 11) characterize peak flows of the two principal river systems that drain the mountainous, upper Río Choluteca basin. These watersheds exhibit rapid rainfall-runoff response typical of mountainous terrain. Peak discharges were similar in magnitude (table 1) and were not influenced by upstream storage or diversion. The channels of both rivers are fairly well incised, and flood peaks caused by Hurricane Mitch were confined to the main channel in each study reach. The surveyed channel of the Río Guacerique (Site 10) generally was trapezoidal and was composed of cobbles and small boulders. Top width during the flood averaged 53.1 meters (174 feet), and the hydraulic slope was 0.0086 meter/meter. The surveyed channel of the Río Grande (Site 11) was nonuniform, composed primarily of bedrock with some large boulders. Top width during the flood averaged 43.4 meters (142 feet), and the hydraulic slope was 0.0139 meter/meter.

A second measurement of the Río Grande (Site 12) was made in the suburbs of Tegucigalpa, downstream from Concepción Reservoir and just upstream from the confluence with the Río Guacerique. Peak discharge at this site was affected by storage of the Concepción Reservoir, which released a maximum flow of 850 m^3/s (30,000 ft^3/s) over the spillway (Servicio Autónomo Nacional de Acueductos y Alcantarillados, written commun., 1998). However, tributary inflow from the Río San José also contributed to the measured peak of 2,340 m^3/s (82,500 ft^3/s). The flood was confined in the main channel, 103 meters (337 feet) wide at the approach to the Bulevar de las Fuerzas Armadas bridge. The channel is composed of sand, gravel, and some cobbles, and was subject to substantial aggradation during the flood.

Tegucigalpa and the lower Río Choluteca basin

The Río Choluteca is formed by the confluence of the Río Guacerique with the Río Grande in Tegucigalpa. A measurement of peak discharge of the Río Choluteca was made just downstream from Tegucigalpa (Site 14); the computed peak was 4,360 m^3/s (154,000 ft^3/s). Peak discharge probably was affected by reservoir storage upstream on both the Río Grande (Concepción Reservoir) and the Río Guacerique (Los Laureles Reservoir). The channel in the study reach generally was straight and uniform, and flow was confined to the main channel. Top width averaged 105 meters (343 feet), and the hydraulic slope was 0.0097 meter/meter.

Peak-flow measurements of the Choluteca River downstream from Tegucigalpa (Site 14), the Río Chiquito at Tegucigalpa (Site 13), and the Río Grande near Tegucigalpa (Site 12), provide insight into the distribution of peak flows in the upper Choluteca basin. However, timing of flood peaks in the vicinity of Tegucigalpa undoubtedly was affected by storage at Concepción and Los Laureles Reservoirs.

Looking downstream at the study reach of the Río Choluteca near Tegucigalpa (Site 14).

Peak flow of the lower Río Choluteca was measured at Colonia Apacilagua (Site 15), upstream from the city of Choluteca. Choluteca, an important population center of 80,000, is situated on the left bank of the Río Choluteca. The city suffered extensive flood damage during Hurricane Mitch. The peak-flow measurement site at Apacilagua is about 25 river kilometers (16 river miles) upstream from Choluteca and was selected because the flood waters were confined to a width of less than 183 meters (600 feet) between two vertical rock cliffs. Several houses upstream from Apacilagua were destroyed, but the town itself, perched atop the 15-meter (49-foot) cliff on the right bank of the river (looking downstream), was not flooded.

The computed peak flow of 14,300 m^3/s (506,000 ft^3/s) was measured using a three-section slope-area computation. Average top width of the channel was 235 meters (772 feet); the hydraulic slope of measured high-water marks was 0.0051 meter/meter. According to local residents, the peak occurred late Friday night, 30 October. This information indicates that peak flow at Apacilagua was the result of rainfall-runoff in the lower basin, rather than downstream progression of the flood wave that affected Tegucigalpa. Peak flooding in Tegucigalpa occurred early Saturday morning, 31 October.

Looking downstream at the study reach of the Río Choluteca at Colonia Apacilagua (Site 15). The depth of the flood water nearly reached the top of 15-meter cliff (center of the photograph).

Other Measurement Sites

In an effort to characterize the flooding produced by Hurricane Mitch throughout the country, peak-flow measurements also were made on the Río Nacaome (Site 16) in southern Honduras, on the Río Guayape (Site 9) in east-central Honduras, and on other tributary rivers of the principal drainage basins (table 1). All sixteen measurements, in addition to other available flow and rainfall data, contribute to the overall hydrologic understanding of Hurricane Mitch and its effects in Honduras.

UNCERTAINTIES ASSOCIATED WITH THE PEAK DISCHARGE MEASUREMENTS

Hurricane Mitch caused extreme flooding that tested the limits of indirect measurement techniques. Several factors undoubtedly affected the quality and reliability of the measurements (Costa and Jarrett, 1981; Flaxman, 1974; Jarrett, 1986; Randall and Humphrey, 1984). First, because of the time that elapsed between the flood and field surveys, subsequent rains and deterioration of high water marks caused uncertainty in identifying maximum flood levels. In any large flood, high water marks are subject to some interpretation because of standing waves, debris blockages, and so on. The quality of high water marks varied considerably, and the analyses often were subject to the interpretation of USGS hydrologists.

Sediment loads carried by the floods also affected measurement quality. Ideal study reaches—stable, uniform channels with little erosion or sedimentation—often could not be found. At sites where substantial sediment movement was apparent, channel geometry might have been quite different during the flood peak. Therefore, such sites are subject to additional uncertainty in measured flows.

Selection of roughness coefficients is another source of uncertainty. Floods of the magnitude of Hurricane Mitch are beyond the limitations of many conventional criteria for flood analysis. For example, roughness coefficients that reflect the movement of car-size boulders in the steep, rock channel of the Río Bonito likely are subject to large uncertainties.

Finally, Hurricane Mitch affected the stability of river systems throughout Honduras. Many rivers changed course or otherwise adjusted their channel configurations to accommodate flood flows produced by Hurricane Mitch. Post-peak channel changes or partial diversion of flow during the peak would affect the reliability of computations based on post-flood conditions.

MAGNITUDE OF HURRICANE MITCH FLOODING

A number of the flood peaks caused by Hurricane Mitch in Honduras appear to be among the world's largest. A graph of the world's largest recorded flood peaks in relation to basin drainage area is shown in figure 5. An empirical "envelope" curve characterizes maximum peak discharge as a function of contributing drainage area, based on maximum floods observed in river basins of various sizes. Costa (1987) defined the envelope curve for record floods in the United States (fig. 5) and compared those floods with the largest recorded floods in China and in the world (Rodier and Roche, 1984). As shown in the figure, the Hurricane Mitch flood peaks plot in the vicinity of record floods observed throughout the world. The flood peak for the Río Bonito (Site 3) in northern Honduras (computed discharge 3,710 m^3/s;

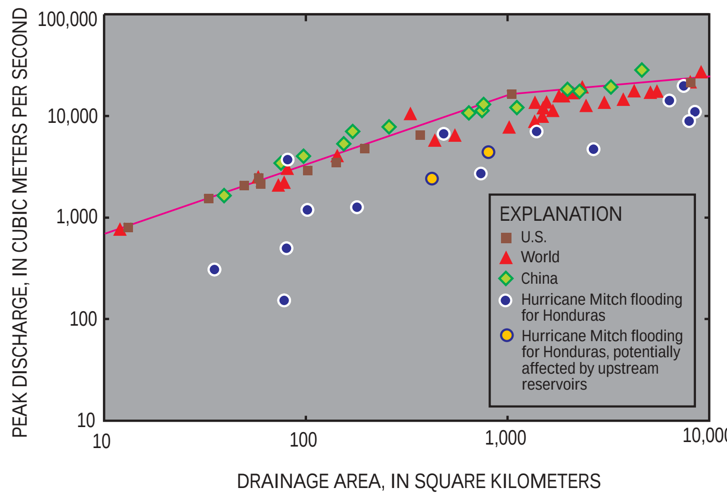

Figure 5. Comparison of Hurricane Mitch flood peaks with the largest recorded floods in the world. The empirical envelope curve, developed for documented floods in the United States, characterizes maximum peak discharge in terms of contributing drainage area.

drainage area 81.1 km^2) exceeds the envelope and may qualify as a world-record flood. Of course, the uncertainties described in the previous section become increasingly relevant during such extreme events.

Accounts from officials and residents throughout Honduras confirmed that Hurricane Mitch flood levels were higher than any remembered during the 20th century. USGS personnel interviewed residents in many areas of the country. Hurricane Mitch flood levels reportedly exceeded those documented during Hurricane Greta (1978), Hurricane Fifi (1974), Hurricane Hattie (1961), and earlier 20th-century storms. These eye-witness accounts, in addition to the graphical comparison of peak discharges shown in figure 5, emphasize Hurricane Mitch's historic significance in Central America and its hydrologic significance in terms of world-record flooding.

SUMMARY AND CONCLUSIONS

Hurricane Mitch ranks among the worst Atlantic storms on record. Honduras suffered the most widespread devastation, as the storm traversed the entire country. In addition to the staggering human and economic losses, intense flooding and landslides have drastically altered hydrologic and geomorphologic processes throughout Honduras.

The U.S. Geological Survey, in cooperation with the U.S. Agency for International Development, conducted 16 peak discharge measurements of flooding produced by Hurricane Mitch in 8 river basins of Honduras. Measurement sites were selected on the basis of flood impacts on population centers, hydrologic characterization of flooding throughout the country, and the need for data to be used in reconstruction planning and design. The results of these measurements provide Honduran authorities and international organizations with valuable hydrologic information for the mitigation of future flood damage, for the design and reconstruction of the national infrastructure, and for long-term management of the nation's water resources.

Based on comparison with the largest recorded floods in the world, flooding from Hurricane Mitch in Honduras certainly qualifies as an extremely rare hydrologic event. Although analysis of the statistical magnitude of these floods (100-year, 500-year, and so on) is beyond the scope of this study, the documentation of Hurricane Mitch flood peaks contributes to the understanding of a natural disaster that will affect the Honduran landscape and the people of Honduras for many years to come.

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