

## INTRODUCTION

The passage of hurricane Eloise near the north coast of Puerto Rico caused torrential rains September 15, 16, and 17, 1975, producing devastating floods in the southwestern part of the island.

The U.S. Geological Survey, in cooperation with the Puerto Rico Department of Natural Resources, has undertaken the task of documenting this outstanding event. This report provides hydrologic and hydrologic data for the Guanajibo Valley that will aid planners and designers in making effective decisions in the development of its flood plain. These data were obtained from field observation by the U.S. Geological Survey and from interviews with residents in the study area.

The Guanajibo Valley lies in southwestern Puerto Rico in an area of about 70 km<sup>2</sup>. The study area extends upstream from the mouth of the Rio Guanajibo about 36 km to Sabana Grande, about 27 km northwest of Ponce and includes the towns of San Gerardo, Cabo Rojo, and Hormigueros. The economy is mainly agricultural, and agriculture is the principal source of income. The climate is tropical with abundant vegetation. The average daily temperature ranges from 27°C in the summer to 24°C in the winter. The average annual precipitation ranges from 250 mm in the Cordillera Central to 1778 mm in the foothills.

Multiple SI units	By	To obtain inch-pound units
	Length	
meter (m)	3.2808	foot (ft)
centimeter (cm)	0.03937	inch (in)
kilometer (km)	0.62137	mile (mi)
square kilometer (km <sup>2</sup> )	0.3861	square mile (mi <sup>2</sup> )
	Discharge	
cubic meter per second (m <sup>3</sup> /s)	35.31	cubic foot per second (ft <sup>3</sup> /s)
	Temperature	
degrees Celsius (°C)	1.8 °C + 32	degrees Fahrenheit (°F)

## RIO GUANAJIBO BASIN

The Rio Guanajibo originates in the southwestern part of the Cordillera Central, about 10 km northwest of Sabana Grande. The river flows south, passing east of Sabana Grande, then turns to the west-northwest, flowing past San Gerardo on the north, and empties into Bahía de Mayaguez on the Caribbean Sea.

The main tributaries of Rio Guanajibo originate in the southern slopes of the Cordillera Central and flow in a southeasterly direction to the river. The tributary basins, in descending order of drainage area in km<sup>2</sup>, are: Rio Rosario, 62.5; Rio Homenaje, 35.4; Rio Drey, 20.7; Rio Cruzes, 19.9; Rio Cano, 16.4; and Rio Capone, 11.6. The drainage area to the south side of the basin consists of a small portion of the Rio Guanajibo basin.

The drainage area of Rio Guanajibo is 329 km<sup>2</sup> at its mouth, and 311 km<sup>2</sup> at gaging station 5013800 (fig. 1) operated by the U.S. Geological Survey.

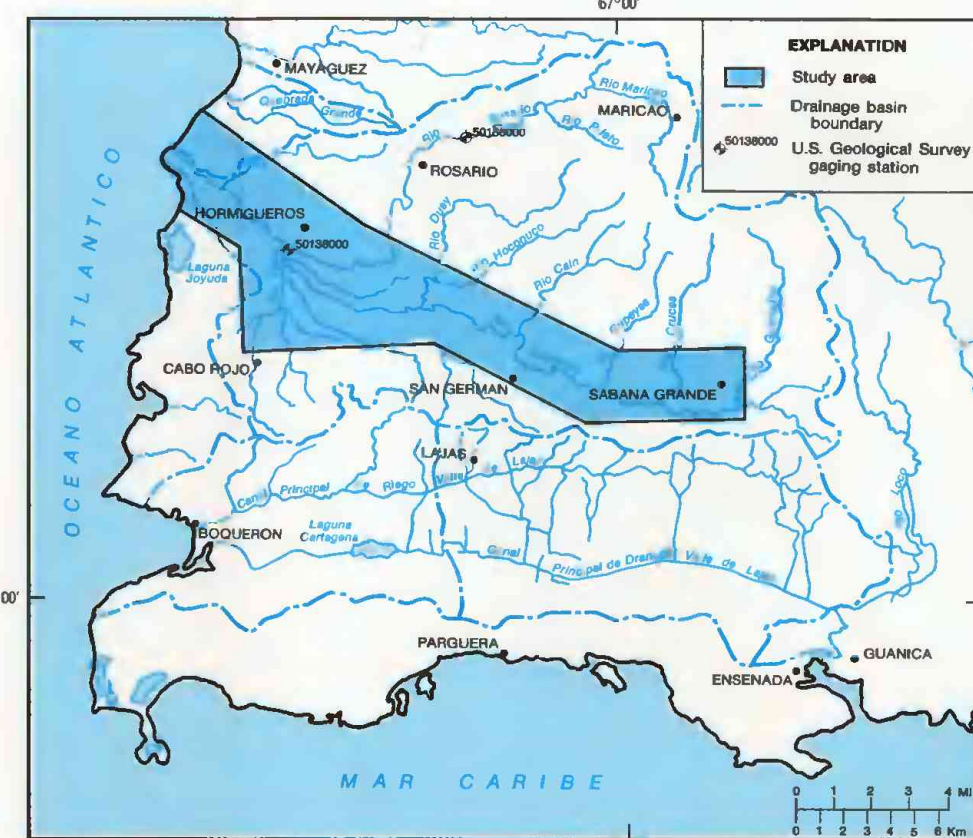


FIGURE 1. Rio Guanajibo basin and study area.

## FLOOD OF SEPTEMBER 16, 1975

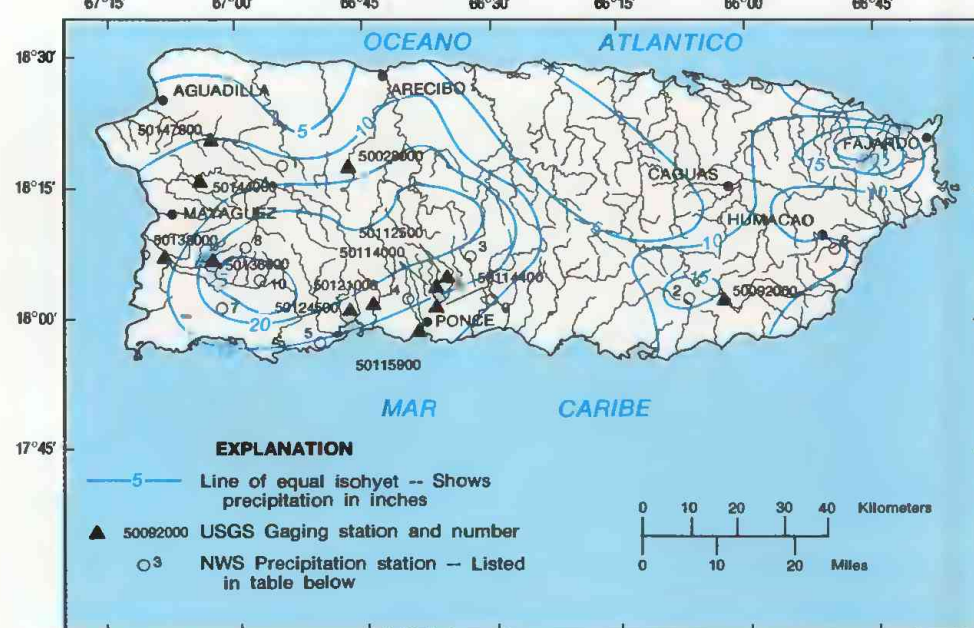
The torrential rains from hurricane Eloise produced severe floods in the Guanajibo Valley. Precipitation at 10 stations in Puerto Rico during September 15-17, 1975, and the distribution of precipitation throughout the island are shown in figure 2.

The entire Guanajibo Valley from Sabana Grande to the coast suffered its severest flooding since 1909. San Gerardo, Cabo Rojo, Hormigueros, and housing developments in the coastal lowlands suffered the most damage. Houses adjacent to the Rio Guanajibo, in urbanization Santa Maria in San Gerardo, were destroyed by the flood. After the floodwater receded, the U.S. Geological Survey recovered high-water marks on the flood plain and made an indirect measurement at the new Highway 100 bridge. A peak flood discharge of 3625 m<sup>3</sup>/s was computed.

Two bridges were destroyed by the floodwaters—old Highway 2 bridge (B) south of Sabana Grande, and old Highway 119 bridge (C) on the north side of San Gerardo. The three bridges between San Gerardo and Hormigueros on Highway 114 (old Highway 2) were severely damaged.

Photographs of selected sites in the Guanajibo area during the September 16, 1975 flood are shown in figures 3-16. The photograph locations are identified on the flood map by a circular symbol with an identifying letter and an arrow showing the direction in which the respective photograph was taken. A red mark in the flood map and a black arrow in the photograph indicate the depth of floodwater on each photograph.

The drainage area of Rio Guanajibo is 329 km<sup>2</sup> at its mouth, and 311 km<sup>2</sup> at gaging station 5013800 (fig. 1) operated by the U.S. Geological Survey.



NUMBER OF MAP	LOCATION	PRECIPITATION OF SEPTEMBER 15-17, 1975 IN INCHES		
		SEPT 15	SEPT 16	TOTAL
1	ADJUNTAS SUBSTATION	0.15	11.50	4.87
2	CARITE PLANT NO. 1	0.05	10.05	6.85
3	CERRO MARAVILLA	0.46	16.00	2.37
4	CORRAL VIEJO	0.10	7.20	8.26
5	ENSENADA	0.05	5.41	10.30
6	HORMIGUERO	0.40	8.02	5.22
7	LASAS SUBSTATION	0.29	3.10	12.26
8	MARICAO 2 SSW	2.32	4.05	14.10
9	PONCE 4E	0.00	2.90	7.78
10	SABANA GRANDE 2 ENE	1.20	14.00	11.50

FIGURE 2. Map of Puerto Rico showing locations for September 15-17, 1975. Location of selected precipitation and stream-gaging stations, and table showing the precipitation for the selected stations.



FIGURE 3. Flood height (noted by arrow) at old Highway 2 bridge over Rio Guanajibo north of Highway 114 (photograph A).



FIGURE 4. Flood height (noted by arrow) at old Highway 2 bridge, 6.3 km east of Highway 348 intersection (photograph B).

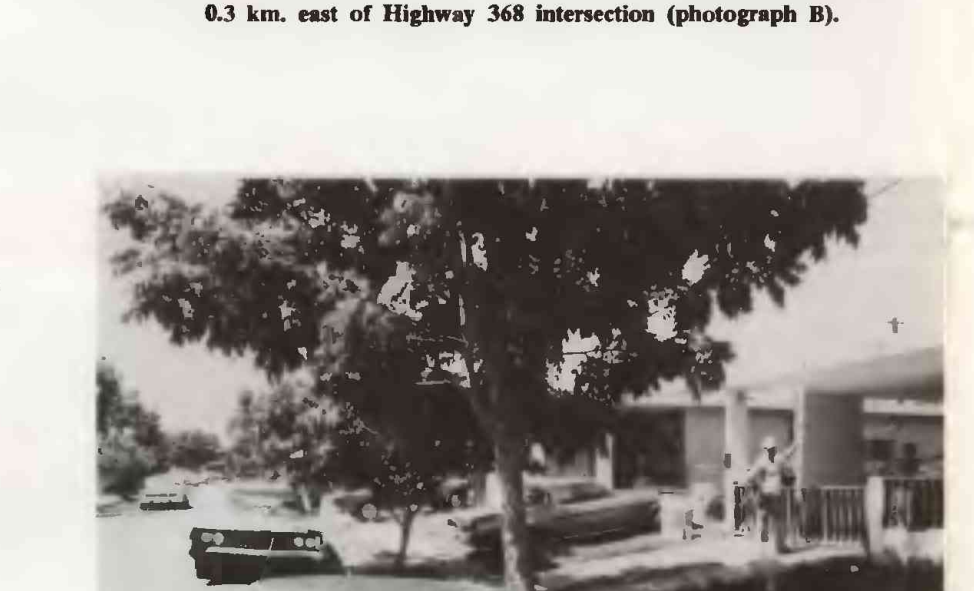


FIGURE 5. Flood height (noted by arrow) at Mr. Ortiz's front porch, Riverside Housing Development, Street 5, No. E-18, San Gerardo (photograph C).



FIGURE 6. Flood height (noted by arrow) at Palmetto Shell gas station, San Gerardo (photograph D).



FIGURE 7. Flood height (noted by arrow) at houses on Barrio road connecting highways 347 and 114, 1.0 km northeast of Highway 114 (photograph E).

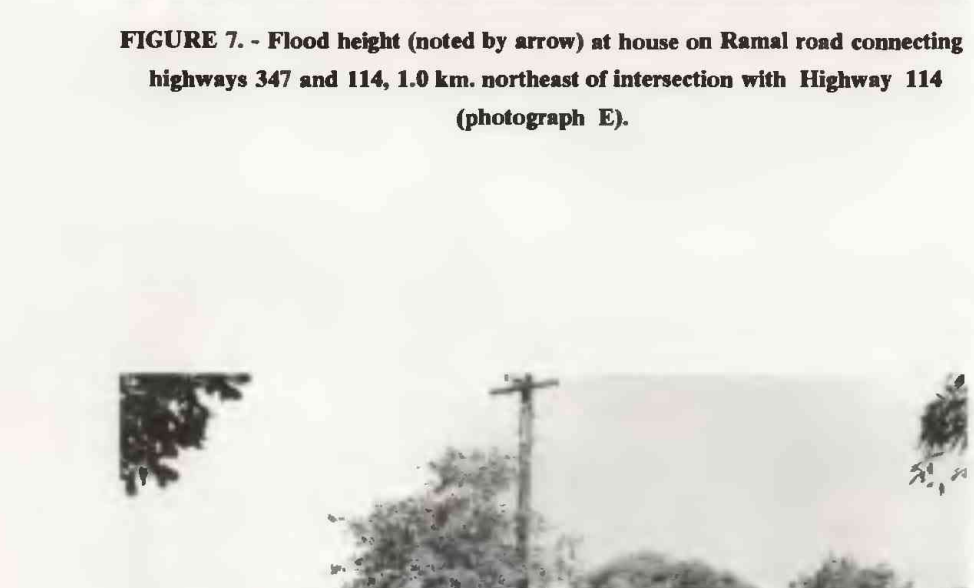


FIGURE 8. Flood height (noted by arrow) on road 207, 6.3 km south of intersection with Highway 114 (photograph F).

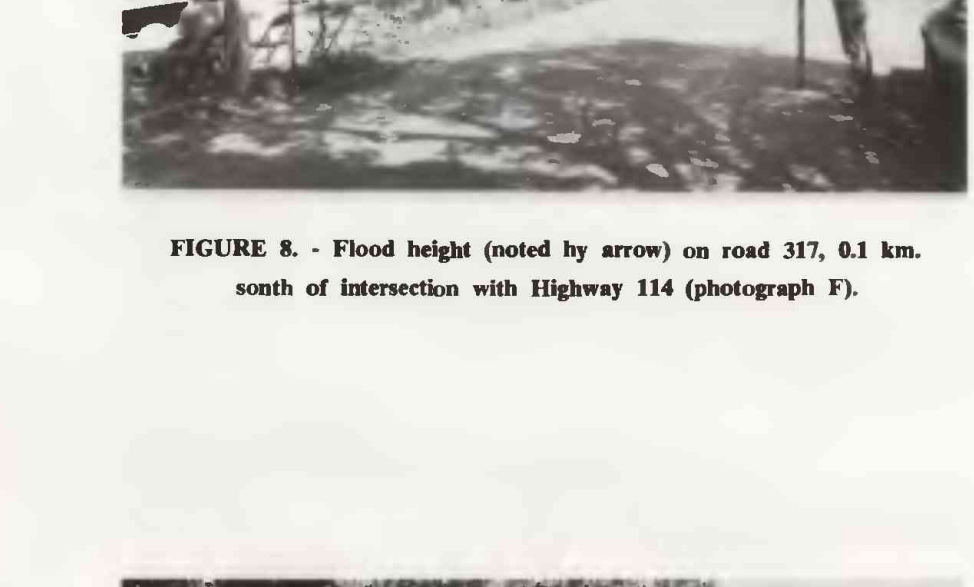


FIGURE 9. Flood height (noted by arrow) at abandoned house, San 5.2, Highway 114 (photograph G).

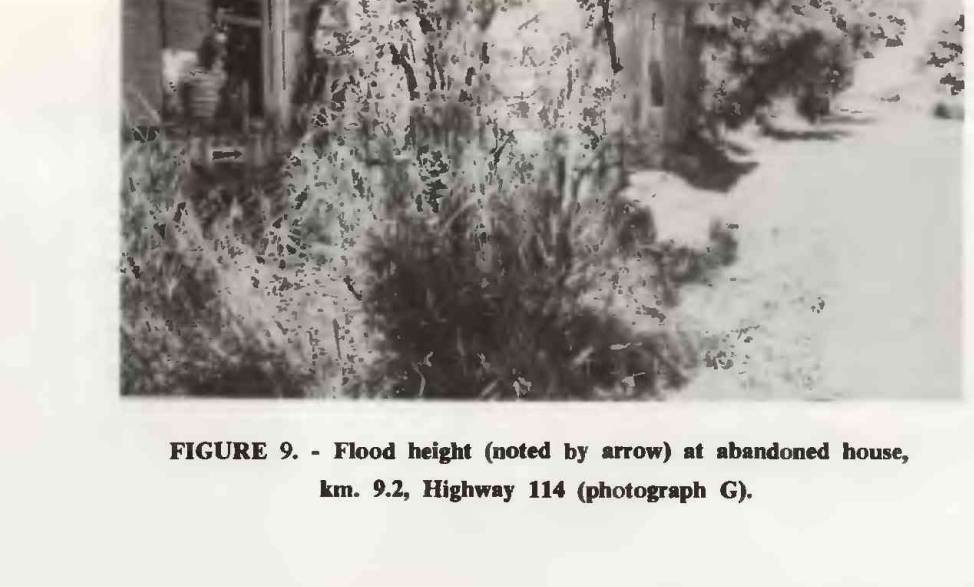


FIGURE 10. Flood height (noted by arrow) at Mrs. Gonzalez's house, Parcela San Romulo, K Street, Hormigueros (photograph H).

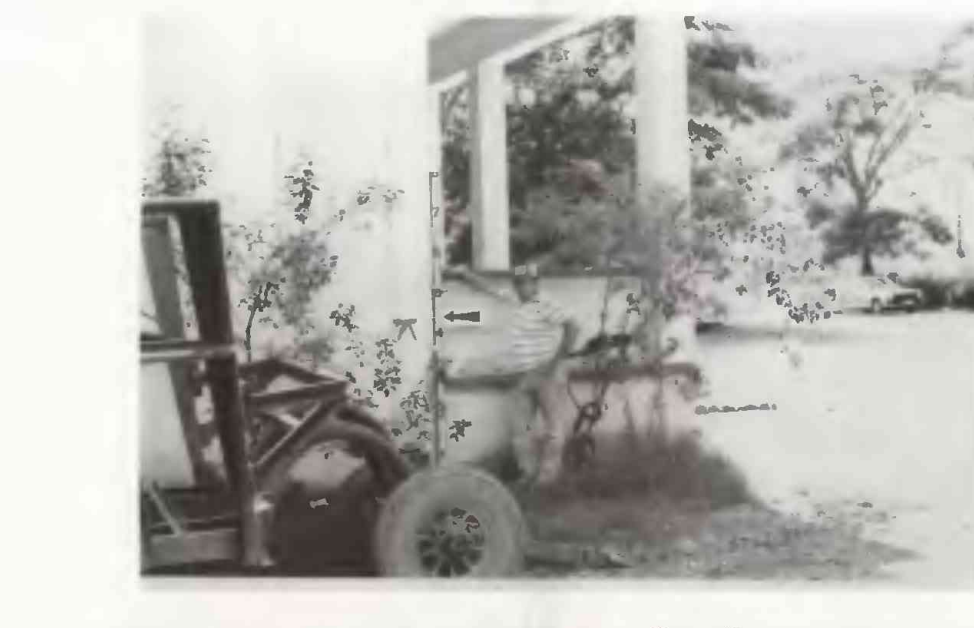


FIGURE 11. Flood height (noted by arrow) at field office of Central Bank Mill about 50 m. off access road and Highway 114 intersection (photograph I).



FIGURE 12. Flood height (noted by arrow) at Puerto Rico Energy Authority substation "Las Acacias" at intersection of Highway 180 and Highway 114 (photograph J).

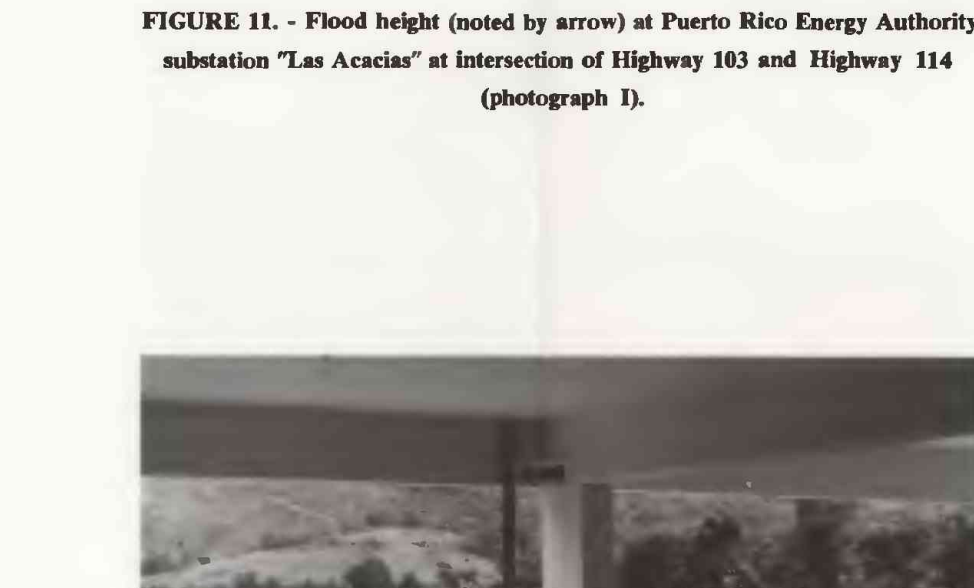


FIGURE 13. Flood height (noted by arrow) at water-treatment plant, E. Ramirez Public Street, Guanajibo House, Mayaguez (photograph K).

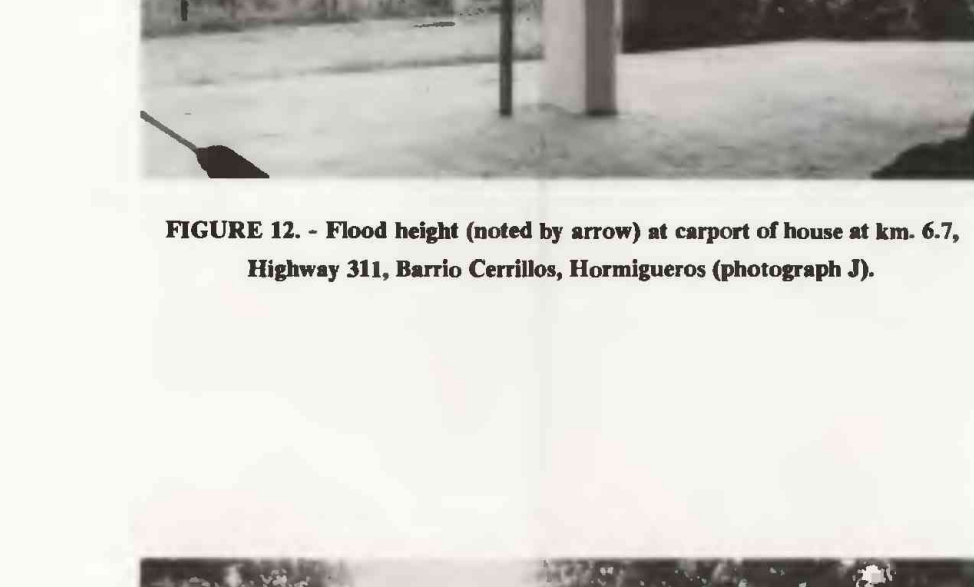


FIGURE 14. Flood height (noted by arrow) at Mr. Gonzalez's house, Parcela San Romulo, K Street, Hormigueros (photograph L).

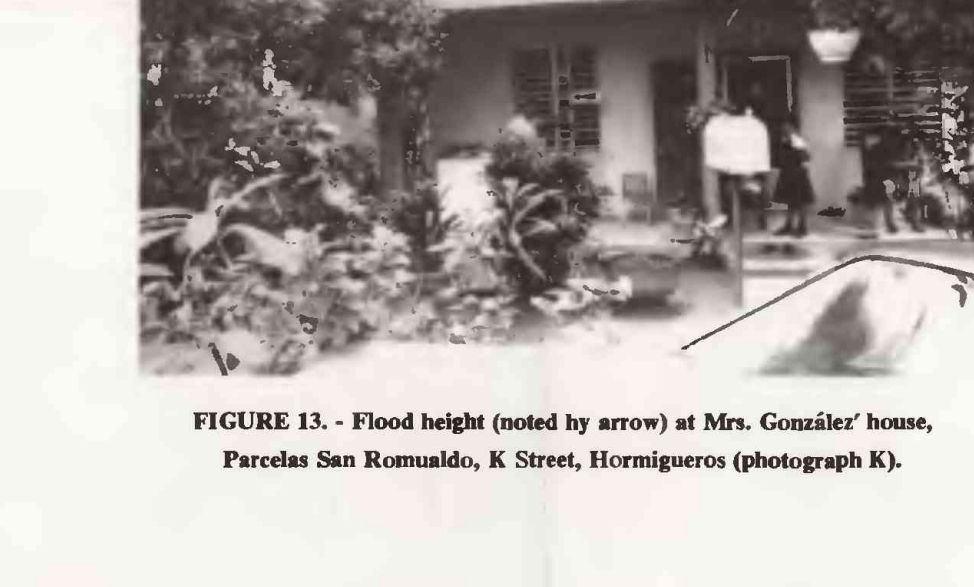


FIGURE 15. Flood height (noted by arrow) at Mrs. Gonzalez's house, Parcela San Romulo, K Street, Hormigueros (photograph M).



FIGURE 16. Flood height (noted by arrow) at old barracks, called "Tablones" about 8.5 km. east of Highway 347 and Highway 114 intersection (photograph N).



FIGURE 17. Flood height (noted by arrow) at Mr. Cardona's house, No. 34 M.M. Molina Street, Guanajibo House, Mayaguez (photograph O).

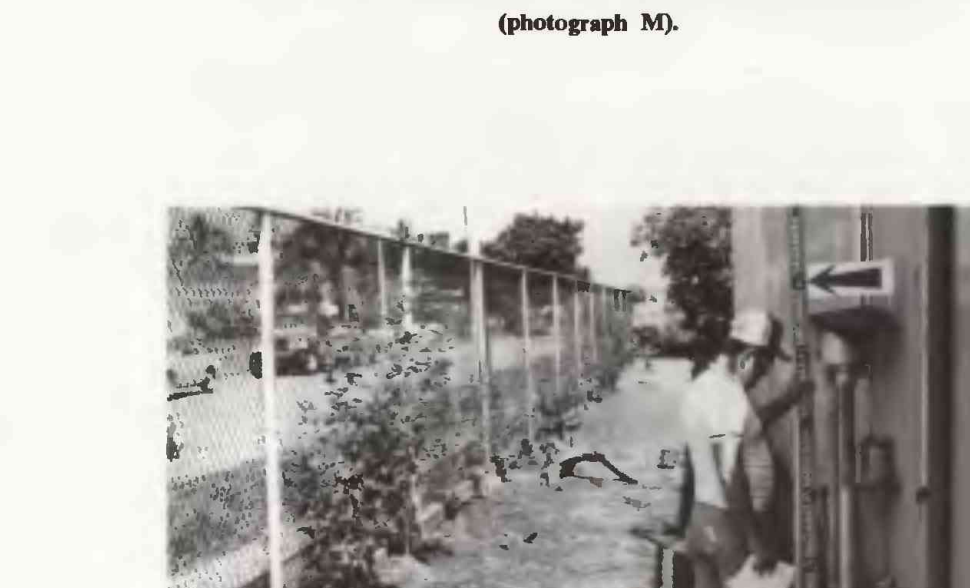


FIGURE 18. Flood height (noted by arrow) at water-treatment plant, E. Ramirez Public Street, Guanajibo House, Mayaguez (photograph P).

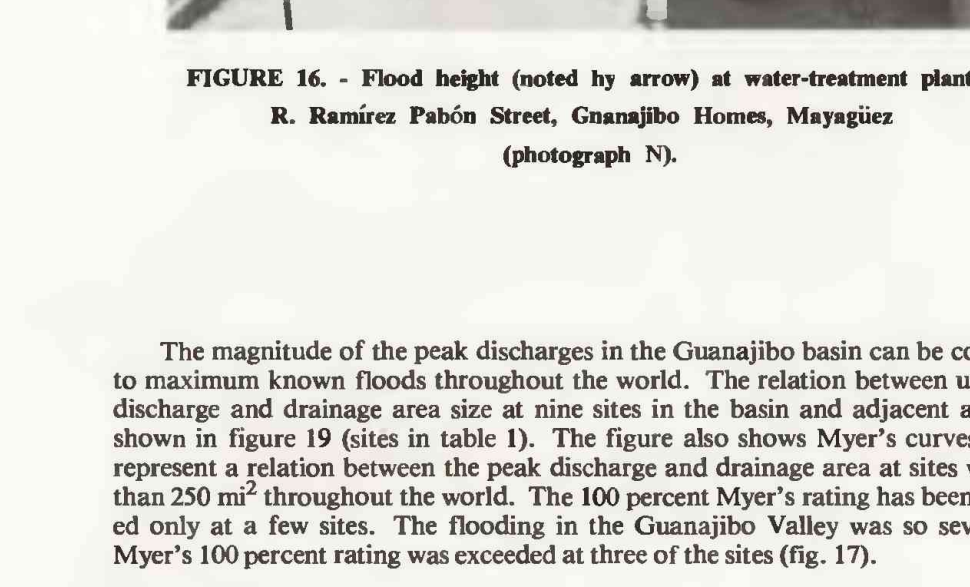


FIGURE 19. Flood height (noted by arrow) at Mr. Gonzalez's house, Parcela San Romulo, K Street, Hormigueros (photograph Q).

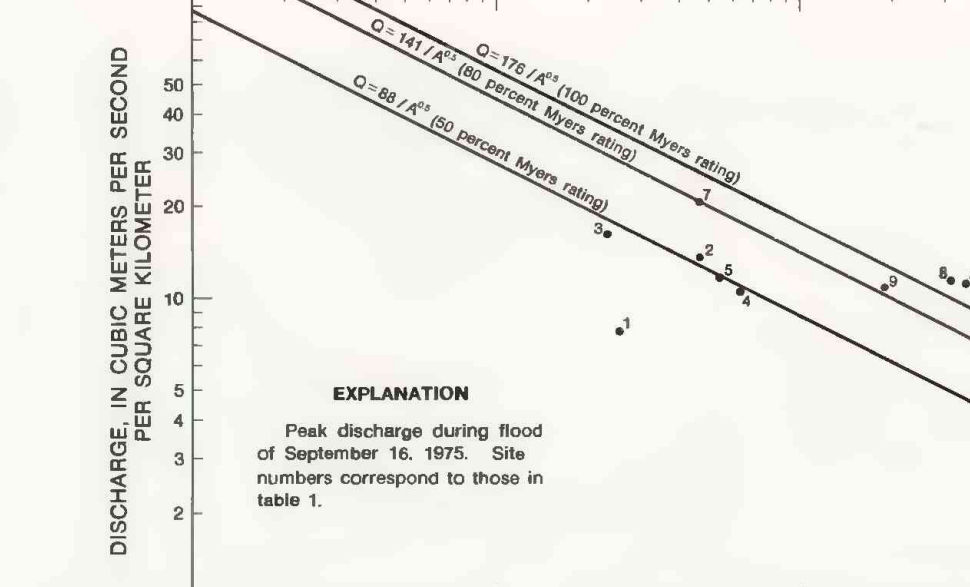


FIGURE 20. Flood height (noted by arrow) at Mrs. Gonzalez's house, Parcela San Romulo, K Street, Hormigueros (photograph R).

No.	Stream and place of destination	Station no.	Drainage area, km <sup>2</sup>	Date	Maximum previously known discharge		Maximum during Sept. 16, 1975, Flood discharge	
					cubic meters per second	cubic meters per second per square kilometer	cubic meters per second	cubic meters per second per square kilometer
1	Rio Sabana at Road	1125	25.1	Oct. 9, 1970	241	9.60	196	7.89
2	Rio Carriles near Ponce	1140	46.1	Oct. 9, 1970	329	5.62	434	13.8
3	Rio Peroteague near Ponce	1150	22.8	Oct. 9, 1970	301	13.2	371	16.3
4	Rio Talabara at Ponce	1210	62.7	Sep. 23, 1928	991	15.8	666	10.6
5	Rio Guanajilla at Guanajilla	1245	33.9	Aug. 8, 1899	1,100	20.4	434	11.8
6	Rio Guanajilla near Hormigueros	1280	311	Sep. 1, 1979	1,500	4.82	3,620	11.7
7	Rio Rosario at Rincón	1360	45.6	May 17, 1963	184	4.04	957	21.0
8	Rio Grande de Abasco near San Sebastián	1440	347	Oct. 26, 1971	575	2.36	3,960	11.4
9	Rio Sabana Grande at Hwy 404 near Moca	1478	184	Oct. 21, 1972	957	5.20	1,950	10.6

<sup>1</sup>Number for location purposes. See figure 17.

<sup>2</sup>U.S. Geological Survey map number for site identification. See figure 19.

## FLOOD HISTORY

According to previous publications of the U.S. Geological Survey and interviews with residents, significant flooding has occurred in the Guanajibo Valley at least 15 times since 1899.

The record of floods at Highway 360 at km 19.33 along the baseline at San Gerardo (table 2) shows that the highest elevation since 1899 was reached by the September 16, 1975 flood.

TABLE 2. Flood peaks of Rio Guanajibo at Highway 360 bridge directly Highway 119 at kilometer 19.33 along the baseline at San Gerardo, P.R.

Date of flood	Water surface elevation, in meters above MSL
August 6, 1899	42.8
September 13, 1920	42.8
August 4, 1962	41.3
September 23, 1952	41.5
September 5-6, 1954	41.4
March 6, 1958	40.5
December 3-4, 1960	41.6
May 17, 1963	41.1
July 30, 1963	41.2
November 27, 1966	39.6
September 16, 1975	43.0

A continuous stage record surface-water station, 5013800, was established in January 1973 by the U.S. Geological Survey at Highway 114 (formerly Highway 2) about 1.9 km west of Hormigueros (km 4.95 on the baseline on the topographic map). Annual peaks from 1973 to 1975 are shown in table 3, and the stage-discharge relation of the station is shown in figure 18.

TABLE 3. Annual peaks at U.S. Geological Survey gaging station 5013800, Rio Guanajibo near Hormigueros, P.R.

Date	Discharge, cubic meters per second	Elevation, meters above MSL	Recurrence interval in years
September 5, 1971 <sup>1</sup>	32	6.07	—
November 3, 1974 <sup>2</sup>	125	7.00	1.1
September 16, 1975	3,620	10.93	60
October 31, 1976 <sup>2</sup>	38	6.02	—
November 1, 1977	213	6.31	1.3
October 31, 1978	221	6.36	1.4
September 1, 1979	1,500	9.10	10

<sup>1</sup>Flood of September 16, 1975, eroded channel.

<sup>2</sup>Channel was encroached.

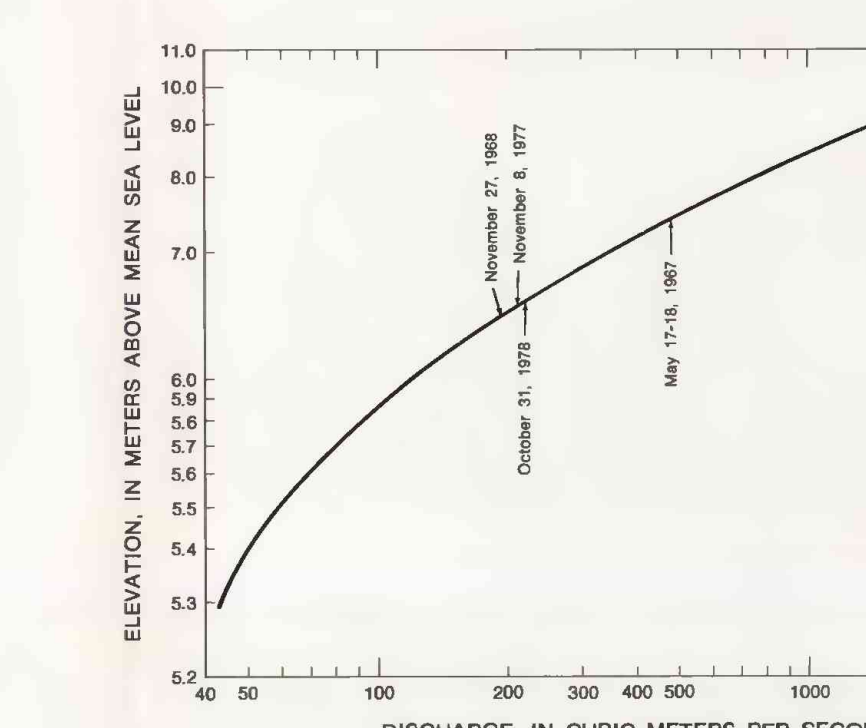


FIGURE 18. Stage-discharge relation of Rio Guanajibo near Hormigueros, P.R., station 5013800.

## FLOOD FREQUENCY

The date of occurrence of a flood exceeding a given magnitude cannot be predicted, but the probable number of exceedances during a long period of time can be estimated with reasonable accuracy given a long record. Recurrence interval is the average interval of time within which a given flood will be equaled or exceeded once. Thus a 50-year flood is expected to be exceeded at intervals averaging 50 years but the actual interval between successive floods greater than the 50-year flood range from one to over a hundred years. Stated differently a 50-year flood has one chance in fifty of being equaled or exceeded in any one year.

The length of record of Rio Guanajibo at gaging station 5013800 located on Highway 114 is not sufficient to compute reliable flood frequencies.

In order to estimate the frequency of the available historical data, the methodology described in U.S. Geological Survey Water Resources Investigations 78-141 was used to develop a magnitude and frequency relation for Rio Guanajibo at gaging station 5013800 (figure 17).

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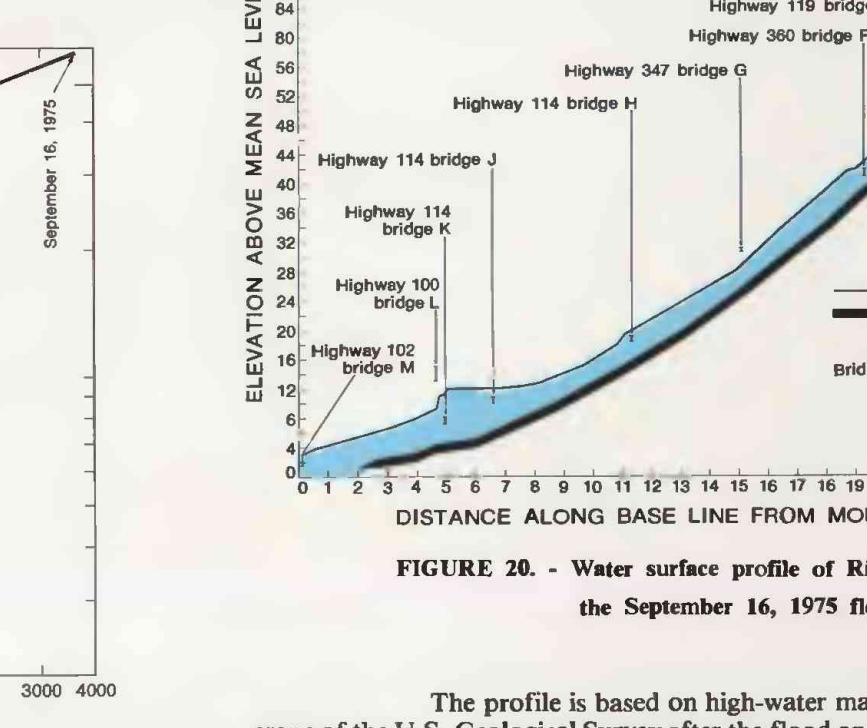


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## REFERENCE MARKS ESTABLISHED BY THE U.S. GEOLOGICAL SURVEY IN THE GUANAJIBO VALLEY

Reference mark no. (see topographic map)	Elevation above mean sea level, meters	Description
6	3.23	At bridge over Rio Guanajibo at mouth, Highway 102, kilometer 7.4. Chiseled square painted red on left upstream side of bridge on top of sidewalk.
7	5.41	At culvert over Quindana on Ave. Santa Teresa Juvet (Highway 144) kilometer 2.5 at Vain Termino station, 200 m. west of Sabana Grande. A brass disk stamped U.S. Geological Survey set in concrete on north side of culvert headwall.
8	15.58	At culvert on Highway 102, kilometer 2.6 and 2.2 kilometers east of Cabo Rojo. A brass disk stamped U.S. Geological Survey set in concrete on north side of culvert headwall.
10	23.04	At culvert on Highway 102, kilometer 4.1 and 4.7 kilometers east of Cabo Rojo. A brass disk stamped U.S. Geological Survey set in concrete on south side between two projects of road culvert.
12	7.47	At culvert on Highway 114, kilometer 4.1 and 2.8 kilometers west of Hormigueros. A brass disk stamped U.S. Geological Survey set in concrete on northwest corner of culvert.
13	8.93	At culvert on Highway 104, kilometer 2.1 and 2.3 kilometers north of San Gerardo. A brass disk stamped U.S. Geological Survey set in concrete on southeast side of culvert.
14	13.06	At bridge over Rio Rosario on Highway 380, kilometer 1.1 and 1.3 kilometers south of Hormigueros. A brass disk stamped U.S. Geological Survey set in concrete on upstream left abutment.
3	16.39	At small culvert on Highway 114 (old Highway 2), kilometer 3.4 and 4.0 kilometers southeast of Hormigueros, chiseled square painted red on top of wingwall.
18	23.87	At small culvert on Highway 114 (old Highway 2), kilometer 12.75 and 4.0 kilometers west of San Gerardo. A brass disk stamped U.S. Geological Survey set in concrete on north side of culvert.
15	32.82	At culvert on Highway 102, kilometer 7.8 and 2.3 kilometers north of San Gerardo. A brass disk stamped U.S. Geological Survey set in concrete on top of culvert.
21	31.15	At bridge over Rio Guanajibo on Highway 347, kilometer 3.3 and 1.4 kilometers west of San Gerardo. A brass disk stamped U.S. Geological Survey set in concrete on upstream right corner of bridge abutment.
22	33.85	At culvert on Highway 347