DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
COMMONWEALTH OF PUERTO RICO
DEPARTMENT OF PUBLIC WORKS

HYDROLOGIC INVESTIGATIONS
ATLAS HA-446

FLOODS IN GUAYAMA AREA, PUERTO RICO

Floods occurred on most streams in Puerto Rico during the period October 5–10, 1970. The greatest floods, however, occurred in an area east of a line extending from Arecibo to Ponce, which is the eastern two-thirds of Puerto Rico. Higher floods have occurred in other years in some areas but the floods of October 1970 were outstanding because of their duration and multiple peaks (fig. 1). The volume of runoff was extraordinarily large. The floods resulted from rainfall that totaled as much as 35 inches at some places during the 6-day period. The rainfall came mostly in intense bursts.

The floods caused severe property damage and loss of life in Puerto Rico. At least 16 lives were lost. Hundreds of homes were damaged or destroyed and about 12,000 people were evacuated to shelters. Damage to bridges, highways, public structures, and farmlands was reported by Civil Defense to be $65 million. Highway travel in many areas was severely restricted in the eastern two-thirds of Puerto Rico. Principal and secondary highways were blocked by inundation and landslides. The main highway between Ponce and Guayama was closed for nearly 3 weeks because of high water and washouts.

This atlas is one of a series of four that covers the south coast of Puerto Rico between Ponce and Maunabo. (See HA–445, 447, and 448 under "Selected References.") This atlas shows the water-surface profiles and areas inundated by the October 1970 flood and contains information pertaining to previous floods that are hydrologically significant. The report has been prepared to provide a technical basis on which individuals, organizations, and governmental agencies can make decisions leading to development on the flood plain compatible with the degree of flood risk.

The investigation is part of a program financed through a cooperative agreement between the Departamento de Obras Públicas, Commonwealth of Puerto Rico, Dr. Antonio Santiago Vázquez, Secretario, and the U.S. Geological Survey.

This atlas was prepared under the direction of Dean B. Bogart, chief, Caribbean District, Water Resources Division, U.S. Geological Survey, with technical assistance from Karl G. Johnson.

Flood history.—The six south-coast streams in the Guayama area for which information is given—Río Seco, Río Melanía, Río Guamaní, Quebrada Branderi, Quebrada Corazón, and Río Nigua—are shown in figure 2. The streams are described separately in a west-to-east sequence.

The larger streams of the southern slope rise on the Cordillera Central, which is the primary drainage divide of Puerto Rico. The channels are very steep in the mountains, and their slopes become progressively less steep in the foothills and on the coastal plain. This is a common sequence for mountain streams, but it is significant in Puerto Rico because at no place between Ponce and Maunabo is the island divide more than 15 miles from Mar Caribe (Caribbean Sea). The peaks and main escarpment of the Cordillera Central range between 750 and 1200 meters (2,500 and 4,000 feet) above mean sea level.

The coastal plain has a slope of 19 to 50 meters per kilometer (30 to 80 feet per mile). Stream velocities during floods are high on the coastal plain.

Río Seco.—Río Seco is one of the smaller streams on the southern slope that rise in the foothills rather than on the Cordillera Central. The drainage area of Río Seco is 7.5 square miles where it enters the inland edge of the coastal plain and 11.4 square miles at the mouth at Mar Caribe. There are no reservoirs in the basin.

Profiles for the floods of August 1961 and October 1970 are shown in figure 3 and the area inundated by the 1961 flood is delineated on the map. In the upper part of the basin the flood of August 1961 was about 1 meter higher than the flood of October 1970. In the lower part near Mar Caribe the August 1961 flood was only a few tenths of a meter higher than the 1970 flood.

Río Melanía.—Río Melanía, a small stream that rises in the foothills, has a total drainage area of 4.6 square miles at its canalized mouth in the mangrove swamps east of Bahía de Jobos. A small reservoir is located on the main stem near the inland edge of the coastal plain, but it has a negligible effect on floods.

Floodflow was moderately high in October 1970. The principal effect was shallow inundation of a large part of the community of Jobos. The October 1970 flood delineated on the map was slightly higher than the August 1961 and August 1956 floods.

Río Guamaní.—Río Guamaní rises on the Cordillera Central. At the inland edge of the coastal plain it has a drainage area of 8.2 square miles; at its mouth at Mar Caribe, about 12.8 square miles. Water is diverted into the headwaters of Río Guamaní for hydroelectric power, but the diversion has a negligible effect on floodflow. There are no reservoirs in the basin.

The flood of August 1961, delineated on the map, was generally 1.5 to 2.5 meters higher than the flood of October 1970 (fig. 4). According to information from local residents, the 1928 flood was several meters higher than the 1961 flood in the vicinity of base-line station 4.8.

Peak discharge of the August 1961 flood at the Highway 15 gaging station was 13,000 cfs (cubic feet per second)—an average of 1,600 cfs per square mile. As a comparison, the peak discharge for the flood of October 1970 was 6,300 cfs.

Quebrada Branderi and Quebrada Corazón.—Quebrada Branderi has a drainage area at its mouth at Mar Caribe of about 2.7 square miles, most of which is on the coastal plain. The total drainage area of Quebrada Corazón is about 4.7 square miles, of which about 4 square miles is in the foothills.

The area inundated during the 1961 flood is delineated on the map. The profiles in figures 5 and 6 show that the flood of October 1970 generally was about 1 to 2 meters lower than the flood of August 1961.

Río Nigua.—Río Nigua rises in rugged foothills opposite a point where the coastal plain is narrow. The drainage area at its mouth at Mar Caribe is about 8.3 square miles, of which about 7.5 square miles is in the hills. There are no reservoirs in the basin.

The June 1957 flood is delineated on the map and is the highest known since 1928. It was from 1 to 2.5 meters higher than the flood of October 1970 (fig. 7). Río Nigua has developed a sizable alluvial fan, but most of the floodflow is contained in a narrow flood plain.

The peak discharge of the flood of October 1970 at Pitahaya was 5,800 cfs (an average of 980 cfs per square mile).

Flood discharge.—The rate of discharge of a stream is the volume of flow that passes a particular location in a given period of time. Discharge rates usually are expressed in units of cubic feet per second (cfs). Peak discharge, the maximum discharge attained during a flood, generally occurs at the time of the maximum height (stage) of the flood, but if a stream is affected by variable backwater, the time of the peak discharge may not coincide with that of the maximum stage.

Flood height.—The height of a flood usually is stated in terms of gage height or stage, which is the elevation of the water surface above a selected datum plane. Elevations shown on the map and flood profiles are in meters above mean sea level.

Major floods known to have occurred on Río Guamaní and Río Nigua, are shown in the following table. These data, arrayed in descending order of magnitude, provide a comparison of recent flood events.

Stream and location	Year of flood	Elevation above mean sea level (meters)
Río Guamaní at station 4.8 kilometers	1928	47.9
	1961	44.2
	1970	44.0
Río Nigua at station 5.7 kilometers	1957	69.4
	1924	69.2
	1928	69.0
	1961	68.9
	1960	68.7
	1962	68.7
	1970	68.2

The flood on Río Guayama in 1970 is the third highest in 43 years whereas the 1970 flood on Río Nigua has been exceeded 6 times in 47 years.

Extent of flooding.—The flood boundaries on the map were delineated using flood profiles based on elevations of floodmarks. Boundaries were defined by plotting the flood-profile elevation on the map interpolating between the contours where necessary. The flood boundaries were verified by field investigation.

Flood boundaries shown provide a historic record characteristic of channel conditions existing when the floods occurred. The inundation pattern of future floods may be affected by changes in channel conditions, waterway openings at highways, changes in runoff characteristics of the streams caused by increased urbanization, and other cultural changes. Protective works built after the floods shown may reduce the frequency of flooding in the area, but will not necessarily eliminate future flooding.

Flood profiles.—Profiles of the water surface for the floods of 1961 and 1970 on Río Seco, Río Guamaní, Quebrada Branderi and Quebrada Corazón are shown in figures 3–6, and profiles for the floods of 1957 and 1970 on Río Nigua are shown in figure 7. A profile of the ground along the base line is also shown.

The abrupt changes in the flood profiles shown at some road crossings indicate the difference in water-surface elevations at the upstream and downstream sides of channel constrictions. The drop in water surface through constrictions during future floods may be different from that shown.

A base line marked in kilometers along each principal stream is shown on the map. Base lines appearing on the map correspond to those shown for the flood profiles.

Water-surface contours.—Water-surface contours are imaginary lines of equal water-surface elevation, based on floodmark elevations. Generally they are at right angles to the direction of flow. Obstructions to flow, such as sugarcane or manmade obstacles and the expanding widths of valleys cause irregularities in the contours. The water-surface contours are shown on the map for the flood of June 1957 on Río Nigua, the flood of October 1970 on Río Melanía, and the flood of August 1961 on the other streams.

Depth of flooding.—The depth of flooding at any point can be determined by subtracting the ground elevation at the point from the flood elevation indicated by the profile or by the water-surface contour line. The approximate ground elevation can be determined from ground contours shown on the map, although more accurate elevations can be obtained by leveling to nearby bench marks.

Additional information and copies of this hydrologic atlas.—Additional information on floods in the Guayama area can be obtained from the U.S. Geological Survey in San Juan, Puerto Rico, and from the Sección de Control de Inundaciones of the P.R. Departamento de Obras Públicas in Santurce, Puerto Rico, and from the reports listed under "Selected References." Copies of this hydrologic atlas can be obtained from the U.S. Geological Survey in Washington, D.C., and from División de Mapas, Topografía y Fotogrametría of the P.R. Departamento de Obras Públicas in Santurce, Puerto Rico.

SELECTED REFERENCES

Haire, W. J., 1970, Floods in Patillas–Maunabo area, Puerto Rico: U.S. Geol. Survey Hydrol. Inv. Atlas HA–445.
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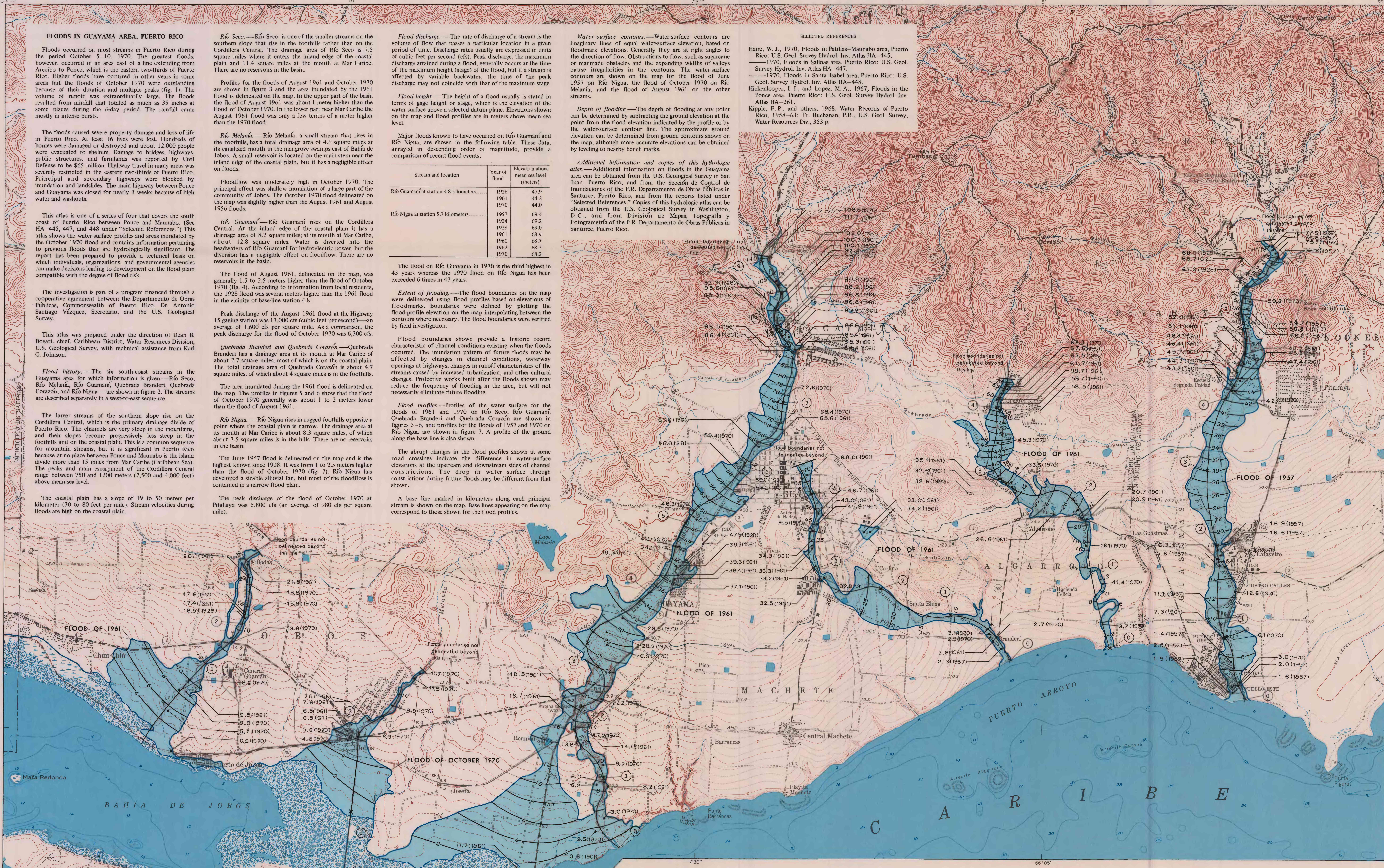
Hickenlooper, I. J., and Lopez, M. A., 1967, Floods in the Ponce area, Puerto Rico: U.S. Geol. Survey Hydrol. Inv. Atlas HA–261.
Kipple, F. P., and others, 1968, Water Records of Puerto Rico, 1958–63: Ft. Buchanan, P.R., U.S. Geol. Survey, Water Resources Div., 353 p.



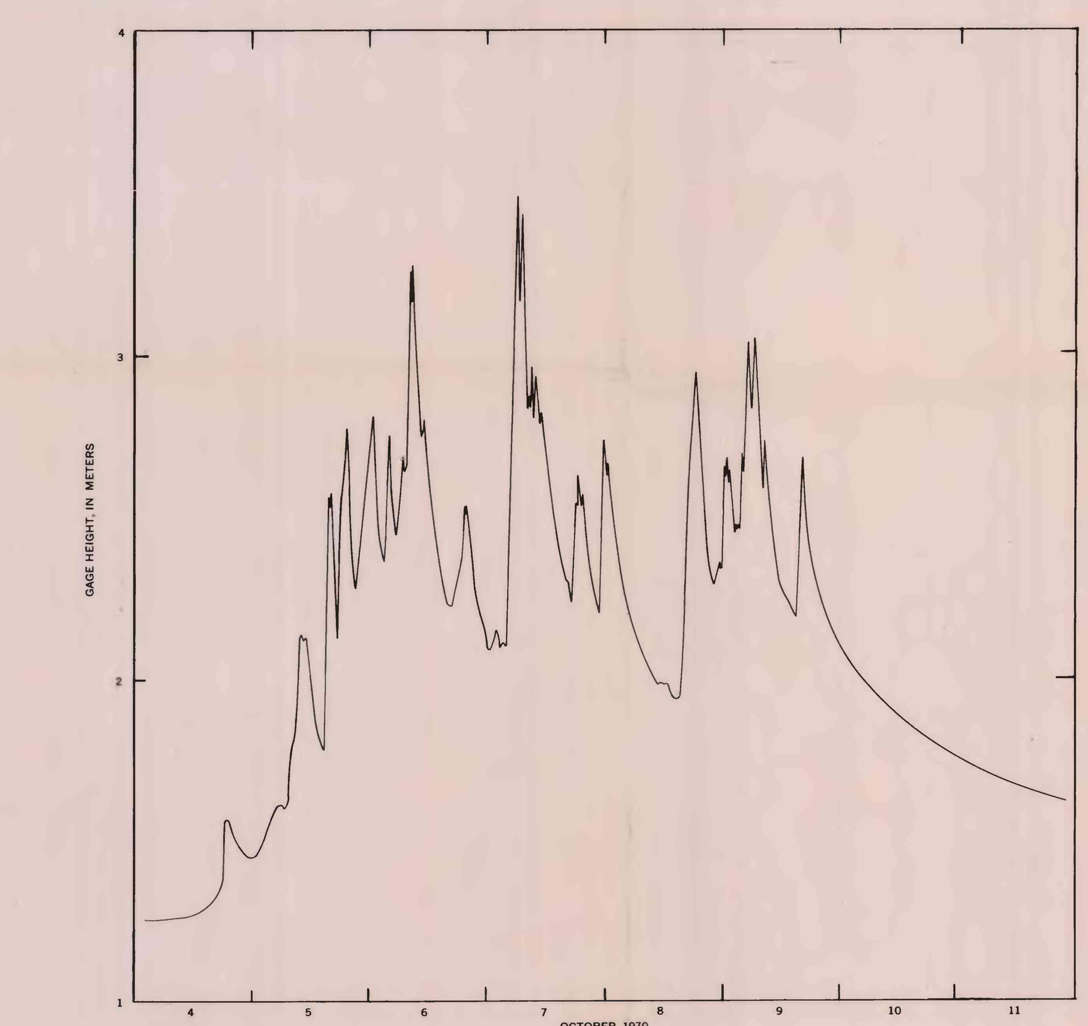


FIGURE 1.—Stage hydrograph of Río Grande de Patillas October 4–11, 1970, showing multiple peaks, typical of the 1970 flood on streams in the eastern two-thirds of Puerto Rico.

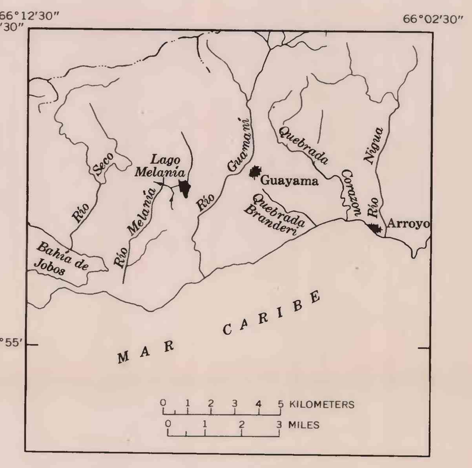


FIGURE 2.—Streams in the Guayama area for which flood information is provided.

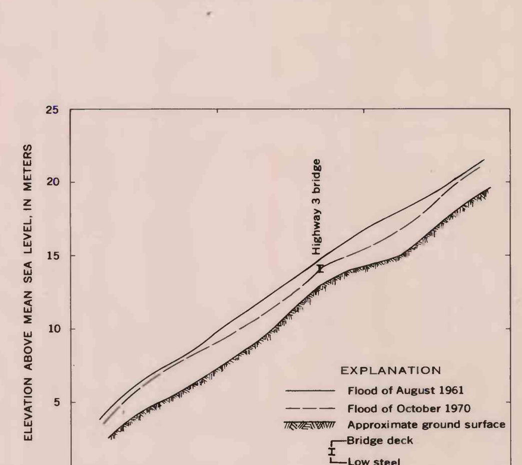


FIGURE 3.—Flood profiles, Río Seco.

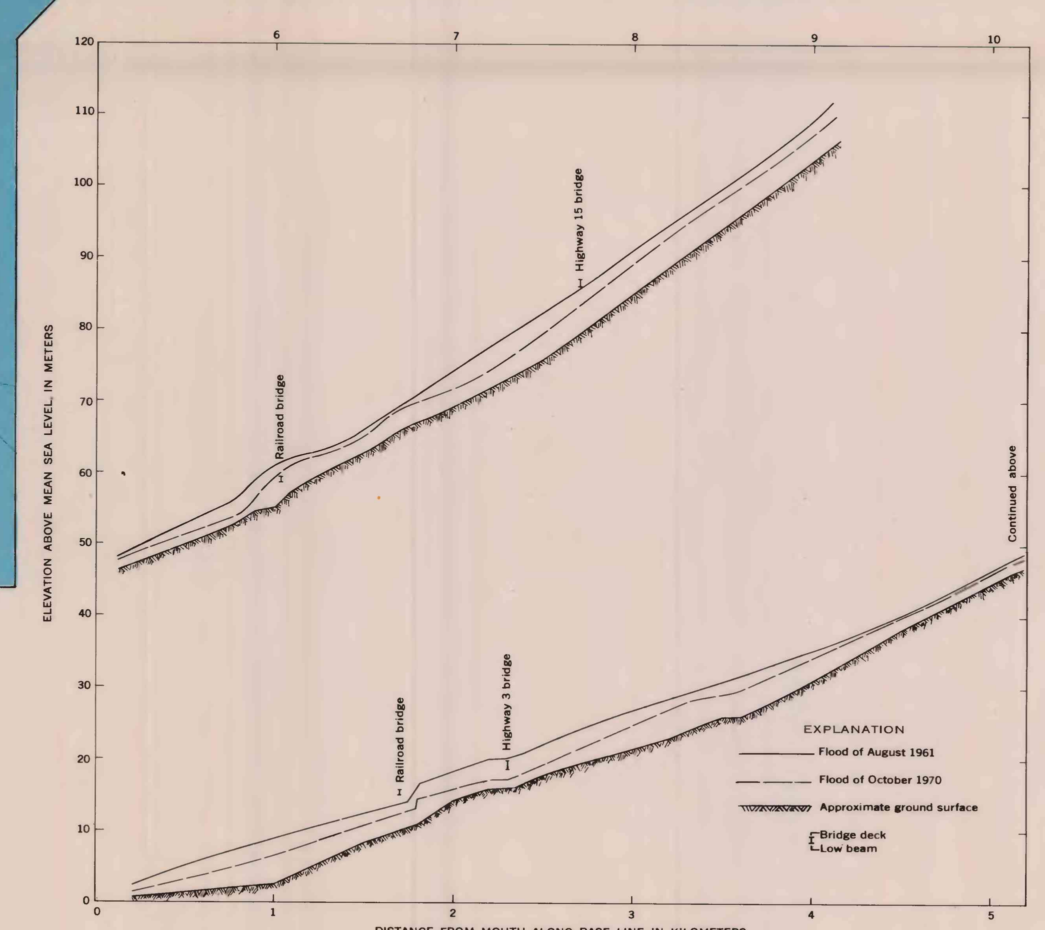


FIGURE 4.—Flood profiles, Río Guamaní.

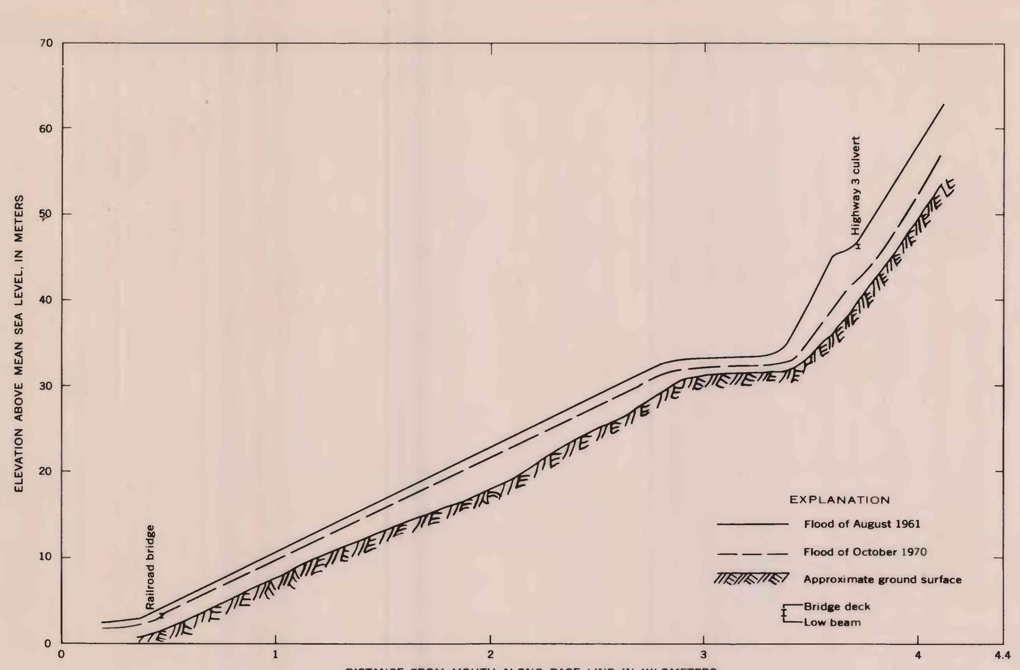


FIGURE 5.—Flood profiles, Quebrada Branderi.

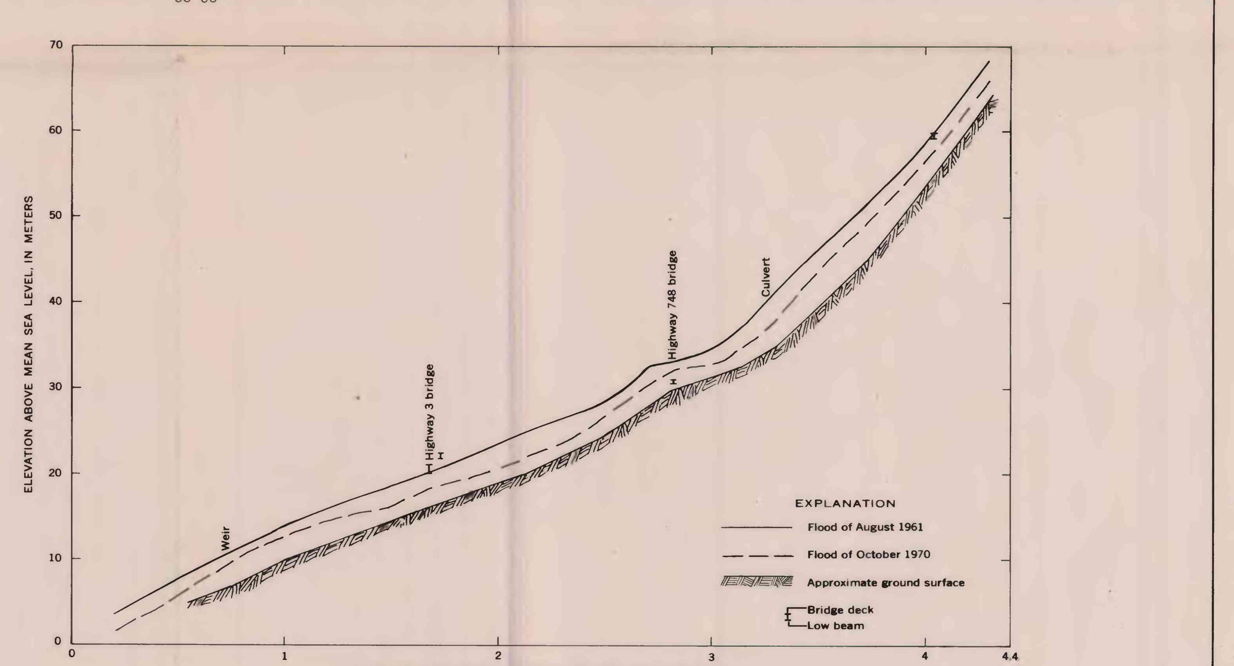


FIGURE 6.—Flood profiles, Quebrada Corazón.

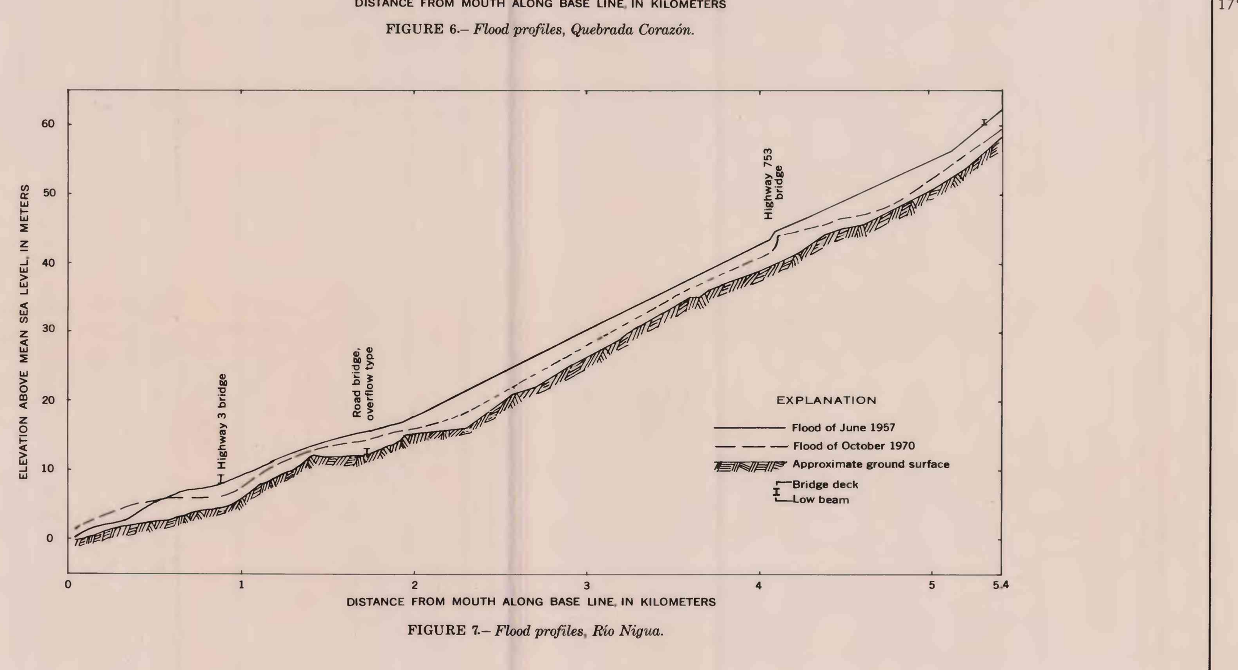


FIGURE 7.—Flood profiles, Río Nigua.

FLOODS IN GUAYAMA AREA, PUERTO RICO

By
William J. Haire

SCALE 1:20 000

CONTOUR INTERVAL 10 METERS
DASHED LINES REPRESENT 5-METER CONTOURS
DOTTED LINES REPRESENT 1-METER CONTOURS
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 0.2 METERS

1971

Base from U.S. Geological Survey topographic quadrangles

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