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–447

FLOODS IN SALINAS 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 severly restricted in the eastern two-thirds of Puerto Rico. Principal and secondary highways were blocked by unundation 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, 446, 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 two south-coast streams in the Salinas area for which information is given—Río Jueyes, 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 Jueyes.—Río Jueyes 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 Jueyes is 7.4 square miles where it enters the inland edge of the coastal plain and 8.6 square miles at the mouth at Mar Caribe. There are no reservoirs in the basin.

The profile for the flood of October 1970 is shown in figure 3 and the area inundated by the 1970 flood is delineated on the topographic map.

Floodflow was moderately high in October 1970, but no data on historic floods are available for comparison.

Río Nigua:—Río Lapa and Río Majada rise on the Cordillera Central and have drainage areas of about 9.9 and 22 square miles, respectively, at their mouths at the inland edge of the coastal plain. The rivers join at Rabo del Buey to form Río Nigua. The drainage area of Río Nigua is about 53 square miles at the mouth at Mar Caribe. Río Nigua flows across one of the most distinctive alluvial fans on the south coast. There are small diversion structures in Río Lapa and Río Majada for irrigation and water supply, but their storage capacity is negligible.

The profile for the flood of October 1970 is shown in figure 4 and the flooded area is delineated on the map. The flood of August 1956 was slightly higher than the 1970 flood. The September 1928 flood, however, was 1 to 1.5 meters higher than the 1970 flood in the upper part of the coastal plain and from 0.5 to 1 meter higher near the coast.

The peak discharge of Río Lapa near the mouth during the flood of October 1970 was 7,300 cfs (cubic feet per second), an average of 737 cfs per square mile of drainage area. The peak discharge of Río Majada near its mouth was 13,000 cfs, an average of 580 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.

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 and 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.—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 shown on the map are for the flood of October 1970.

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 Salinas 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.

SELECTED REFERENCES

Haire, W.J., 1970, Floods in Guayama area, Puerto Rico: U.S. Geol. Survey Hydrol. Inv. Atlas HA–446.

———1970, Floods in Patillas–Maunubo area, Puerto Rico: U.S. Geol. Survey Hydrol. Inv. Atlas HA–445.

———1970, Floods in Santa Isabel area, Puerto Rico: U.S. Geol. Survey Hydrol. Inv. Atlas HA–448.

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.

Photograph courtesy of EL MUNDO newspaper.

Hundreds of homes along the southern coast of Puerto Rico required extensive rehabilitation as a result of the floods of October 1970.

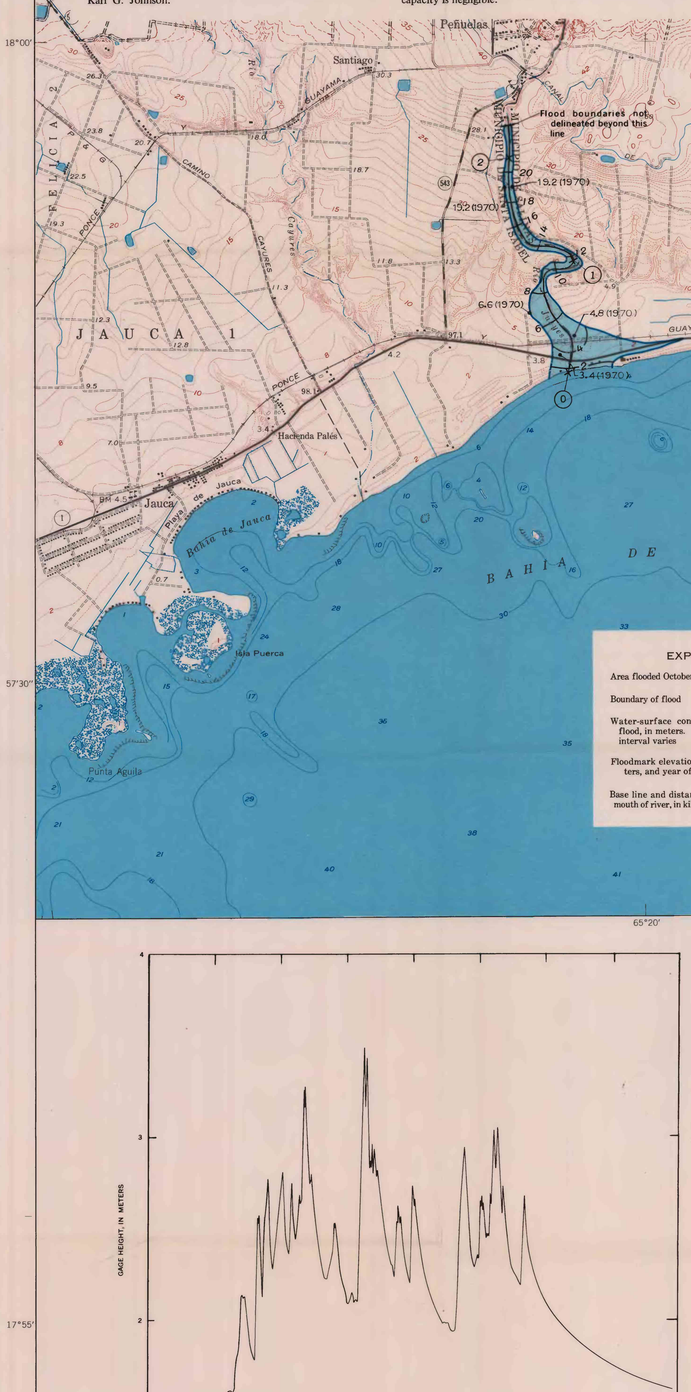

FIGURE 1.– *Stage hydrograph of Río Grande de Patillas October 4–11, 1970, showing multiple peaks, typical of the 1970 flood on streams in the eastern two-thirds of Puerto Rico.*

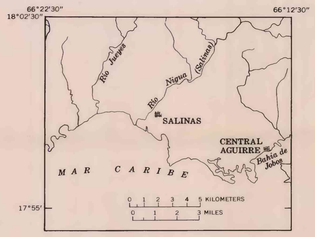

FIGURE 2.– *Streams in the Salinas area for which flood information is provided.*

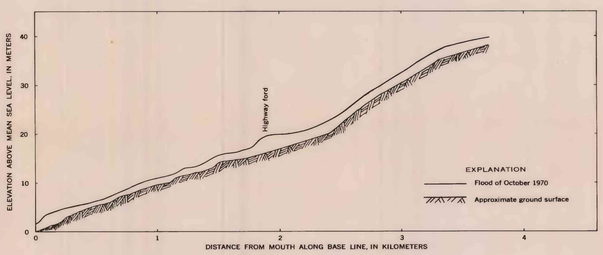

FIGURE 3.– *Flood profile, Río Jueyes.*

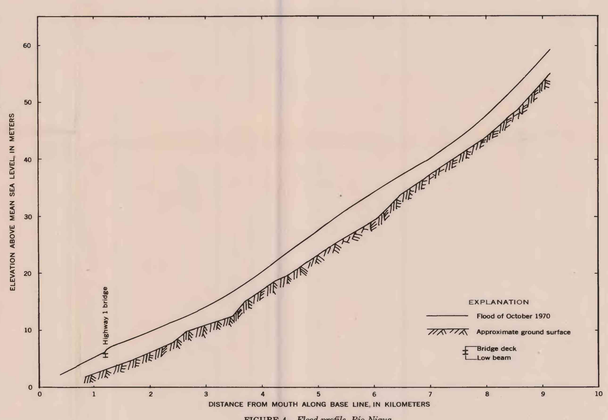

FIGURE 4.– *Flood profile, Río Nigua.*

FLOODS IN SALINAS AREA, PUERTO RICO

By

William J. Haire

SCALE 1:20 000

1 0.5 0 1 2 KILOMETERS

1 ½ 0 1 MILE

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

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1971—W71159

For sale by U.S. Geological Survey, price $1.00