

# FLOODS OF OCTOBER 9, 1970, AND SEPTEMBER 16, 1975 AT JAYUYA, PUERTO RICO

By

Karl G. Johnson and Ramón A. Carrasquillo

DEPARTMENT OF  
 THE INTERIOR  
 UNITED STATES  
 GEOLOGICAL SURVEY  
 WATER RESOURCES  
 INVESTIGATIONS  
 OPEN-FILE REPORT  
 81-346



## INTRODUCTION

This report provides hydrologic and hydraulic data for the October 9, 1970, and September 16, 1975 floods in the Jayuya, Puerto Rico, area. Information presented will furnish a technical basis on which individuals, organizations and government agencies can make rational decisions leading to development of the flood plain of the Rio Grande de Jayuya.

The study area is a 5-km long segment of the valley of the Rio Grande de Jayuya in the vicinity of the town of Jayuya, Puerto Rico (fig. 1).

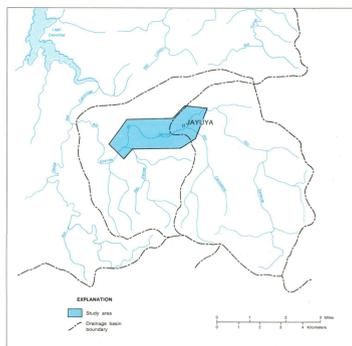


FIGURE 1. - Rio Grande de Jayuya drainage basin and study area.

The topography consists of rugged hills with steep slopes and small valleys with relatively gentle gradients.

The economy is agricultural, augmented by some light industry. The main crops are tobacco and coffee.

The climate is rainy tropical with a mean annual precipitation of about 2,100 mm and an average temperature of 20°C. The rainy season in Jayuya occurs in two periods, one in the spring and the other in the hurricane season between August and November.

Data are generally referred to in SI (International System) units. The SI units can be converted to inch-pound units by multiplying the units given by the factors shown:

Multiply SI units	By	To obtain inch-pound units
meter (m)	3.2808	foot (ft)
millimeter (mm)	0.03937	inch (in)
kilometer (km)	0.6214	mile (mi)
square kilometer (km <sup>2</sup> )	0.3861	square mile (mi <sup>2</sup> )
cubic meter per second (m <sup>3</sup> /s)	35.31	cubic foot per second (ft <sup>3</sup> /s)
degree Celsius (°C)	1.8°C + 32	degree Fahrenheit (°F)

## RIO GRANDE DE JAYUYA DRAINAGE BASIN

The Rio Grande de Jayuya originates in the Cordillera Central and flows in a westerly direction through steep-sided valleys and empties into Lago Caonillas.

The drainage area of the basin at the Highway 144 bridge, about four km downstream from the town of Jayuya, is 62.9 km<sup>2</sup>. The bridge is also the approximate downstream limit of the study area. A natural rock-contracted reach occurs about 1.7 km upstream from the bridge. The contraction causes backwater that extends about 150 m upstream during the 1970 flood. A comparison of the contraction and natural open channel about 300 m upstream is shown in figure 2.

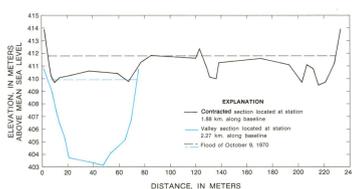


FIGURE 2. - Section of natural contraction compared to valley section as shown on Figure 14 and map.

## FLOOD HISTORY

The Jayuya Valley has been severely inundated at least three times since 1956. The floods in order of decreasing magnitude occurred on October 9, 1970, September 16, 1975 and September 11, 1956.

The flood of October 9, 1970 was caused by a slow moving tropical depression that stalled about 400 km south of Puerto Rico. As a result, rain started falling on October 5 and continued for 6 consecutive days until October 10. The highest accumulated rainfall total for the 6 days was 976 mm recorded in Jayuya (table 1). Rainfall distribution over the island during the period October 5-10, 1970 is shown in figure 3.

The passage of hurricane Eloise near the north coast of Puerto Rico caused torrential rains on September 15, 16, and 17, 1975, producing destructive floods in the southwestern part of the island. Jayuya was on the fringe of the area receiving the greatest rainfall. Precipitation at the town totaled 534 mm. The flood crest of the Rio Grande de Jayuya at Jayuya was about 0.5 m less than that of the October 9, 1970 flood.

Table 1.—Daily rainfall at rain gage at Jayuya, P.R. for October 5-10, 1970 (U.S. Department of Commerce, 1971). (For location of gage see fig. 3.)

Date in October, 1970	24-hour total, millimeters	Accumulated total, millimeters
5	61.7	61.7
6	27.2	88.9
7	66.3	155.2
8	187.5	342.7
9	292.9	635.6
10	340.4	976.0

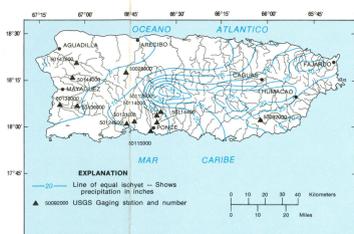


FIGURE 3. - Rainfall distribution for storm of October 5-10, 1970. (Adapted from U.S. Dept. of Commerce, 1971.)

The peak discharge for Rio Grande de Jayuya during the 1970 flood at the study site was not determined. A comparison of unit peak discharges at seven sites in adjacent basins (Haire, 1972) shows a significant range among the basins (fig. 4). A narrower range in the comparison would allow a reasonable estimate of the peak discharge at Jayuya. An estimate from this relation could be significantly in error.

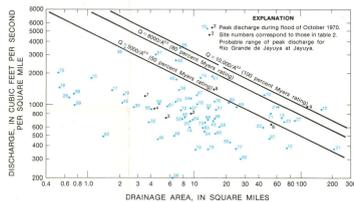


FIGURE 4. - Relation of unit-peak discharge to size of drainage area (from Haire, 1972).

Table 2.—Summary of stage and discharge of basins adjacent to the Rio Grande de Jayuya basin (from Haire, 1972).

No.	Stream and place of determination	Drainage area (sq mi)	Period of record	Maximum previously known			Maximum during October 1970 flood			Recurrence interval (yrs)			
				Date	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)	Day	Gage height (ft)		Discharge (cfs)		
2	Rio Pelletas nr Utuado (0215) <sup>a</sup>	9.55	1969-70	Sept. 24, 1969	13.2	4,200	440	2.6	9	14.82	7,700	806	8
3	Rio Vivi nr Central Pelletas (0250)	5.66	1969-70	May 21, 1969	—	5,300	530	2.5	9	9.4	4,200	742	4
4	Rio Juncos nr Jayuya (0250)	4.44	1965-70	—	—	—	—	—	9	12.5	4,000	901	5
6	Rio Grande de Manatín nr Morovis (0312)	55.2	1965-70	Dec. 9, 1965	18.3	30,000	543	5	9	20.3	35,000	634	11
7	Rio Sana Muerto nr Orocovis (0315)	3.68	1965-70	May 8, 1969	13.2	9,100	2,470	1.12	9	10.1	5,000	1,360	11
8	Rio Bautá nr Orocovis (0340)	16.6	1969-70	Nov. 9, 1969	17.2	14,000	844	13.7	9	21.9	25,000	1,510	b 1.05
9	Rio Grande de Manatín at Ciales (0350)	128	1946-53 1956-70	Sept. 6, 1960	19.0	77,300	604	30	9	24.0	125,000	976	b 1.24

<sup>a</sup>Number for location purpose in this report only. See figure.

<sup>b</sup>U.S. Geological Survey downstream order number for site identification.

<sup>c</sup>Rain of peak discharge to that of a 50-year flood, i.e. Long term records are not available to support frequencies greater than the 50-year flood. A ratio of the peak discharge to the 50-year flood is given as an indication of the magnitude of the flood in relation to the computed recurrence interval of 50 years.

<sup>d</sup>Correction of data published in Haire (1972).

<sup>e</sup>Estimated.

Photographs of selected sites in the Jayuya area during the October 9, 1970 flood are shown in figures 5-13. 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 feet and a black arrow is used to point out the depth of floodwaters on each photograph.



FIGURE 5. - Flood height (noted by arrow) at Grocery store on Esteres Street, No. 11 (photograph A).



FIGURE 6. - Flood height (noted by arrow) at Round house on Libertad Street, No. 9 (photograph B).



FIGURE 7. - Flood height (noted by arrow) in front of the Arroyo house on Libertad Street, No. 41 (photograph C).



FIGURE 8. - Flood height (noted by arrow) at culvert of small tributary beside Jayuya Fire Department (photograph D).



FIGURE 9. - Flood height (noted by arrow) in front of the González-Soto house, Barrio Santa Barbara (photograph E).



FIGURE 10. - Flood height (noted by arrow) in back of the Vargas house, Barrio Santa Barbara (photograph F).



FIGURE 11. - Flood height (noted by arrow) in back of the Córdova-Echeverri house at kilometer 18.8, Highway 144 (photograph G).



FIGURE 12. - Flood height (noted by arrow) at retaining wall on Highway 144, Barrio Jayuya Abajo (photograph H).



FIGURE 13. - Flood height (noted by arrow) at Rivers house, Barrio Jayuya Abajo (photograph I).

## FLOOD FREQUENCY

The recurrence interval of the 1970 flood is not known, but information from local residents suggests that it is the highest of record since 1899.

## FLOOD PROFILES

Flood profiles were developed on the basis of elevations of high-water marks recovered by the U.S. Geological Survey, and from data provided by local residents. Water-surface profiles for the October 9, 1970, and September 16, 1975 floods are shown on figure 14. They are referred to the arbitrary baseline shown on the flood map. The baseline, and therefore the profile, is not confined to the configuration of the channel but follows a smoother path along the flood plain in the general direction of the floodflow. Three of the five bridges in the study area (table 3) were overtopped by the 1970 and 1975 floods.

Table 3.—Elevation of selected bridges in the Jayuya study area.

Map symbol	Stationing along bridge, in kilometers	Location of bridge	Elevation above mean sea level, in meters	
			Top deck	Low beam
A	0.22	Highway 144 bridge over Rio Grande de Jayuya	390.4	389.5
B	3.93	Footbridge over Rio Grande de Jayuya	431.5	431.3
C	3.95	Highway 144 overflow bridge over Rio Grande de Jayuya	428.5	428.2
D	4.34	Highway 144 bridge over Rio Grande de Jayuya	433.1	432.9
E	4.73	Highway 141 bridge over Rio Grande de Jayuya	440.5	439.0

\*Bridge replaced by higher bridge after 1970 flood.

Table 4.—Reference marks established by the U.S. Geological Survey in the Jayuya study area.

Reference mark number (see flood map)	Elevation above mean sea level, in meters	Location
RM-1	390.60	Jayuya, 3.1 km southwest of, and 20 meters northwest of intersection of Highways 144 and 528, along Highway 144, on downstream left side of bridge over Rio Grande de Jayuya, on top of second concrete block, chiseled square painted red.
RM-2	396.09	Jayuya, 2.9 km southwest of, at km 17.69 of Highway 144, on upstream side of culvert headwall, chiseled square painted red.
RM-3	414.36	Jayuya, 1.8 km west of, at km 19.55 of Highway 144, on right downstream side of culvert headwall, chiseled square painted red.
RM-4	435.02	Jayuya, 250 meters west of town square, and 100 meters southeast of intersection of Highways 144 and 532, on left downstream side of culvert headwall, chiseled square painted red.
RM-5	435.54	At Jayuya, 60 meters southeast of town square, at intersection of Highways 144 and 141 on sidewalk beside Farmacia Hernández stairway, spike embedded in sidewalk.

All elevations shown in the study are referenced to mean sea level. Permanent reference marks were established at selected points throughout the study area (table 4) and are shown on the flood map.

## WATER-SURFACE CONTOURS

Water-surface contours are based on the elevations of high-water marks recovered after floods. The contours represent equal elevations of the water surface and are normal to the direction of flow. Obstruction to the flow by sugarcane fields, manmade obstacles, and debris that accumulated under bridges caused irregularities in the contours. The approximate depth of flooding at any point in the inundated area can be estimated by subtracting elevation of the ground-surface contour from that of the water-surface contour. Intermediate estimates of depth can be obtained by interpolation.

## INUNDATED AREA

The area inundated by the October 10, 1970 flood has been delineated on a topographic map with a 10-m contour interval, scale 1:20,000. The flood boundaries were delineated using the high-water marks and field inspection of the flooded area immediately after the inundation. The area flooded by the September 16, 1975 flood was about the same as that of the October 10, 1970 and was not delineated on the topographic map. The pattern of inundation of future floods, even of the same magnitude, will be affected by new highways and bridges, new buildings, landfills, or by relocation or excavation of the stream channel.

## COOPERATION AND ACKNOWLEDGMENTS

This report was prepared by the U.S. Geological Survey in cooperation with the Puerto Rico Department of Natural Resources.

## ADDITIONAL INFORMATION

Additional information related to this report can be obtained from the U.S. Geological Survey, GPO Box 4424, San Juan, Puerto Rico 00936.

## REFERENCES

Haire, W.J., 1972, Flood of October 5-10, 1970 in Puerto Rico: Puerto Rico Water Resources Bulletin 12, 42 p.

U.S. Department of Commerce, 1971, Climatological data, Puerto Rico and Virgin Islands, October 1970, with special weather summary by R.J. Calvesbert: National Oceanic and Atmospheric Report v. 16, no. 10.

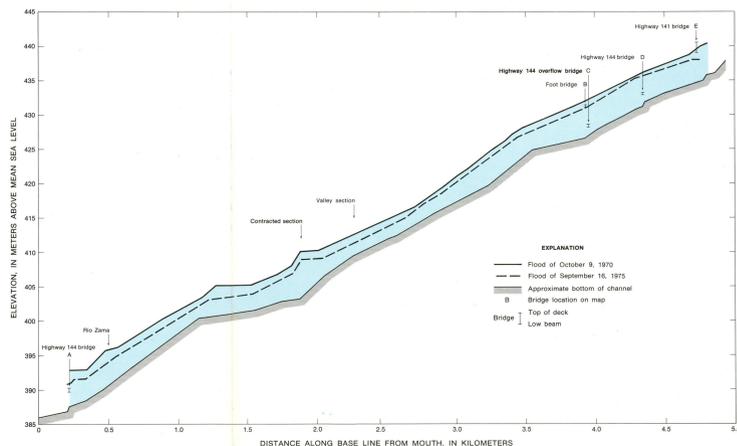


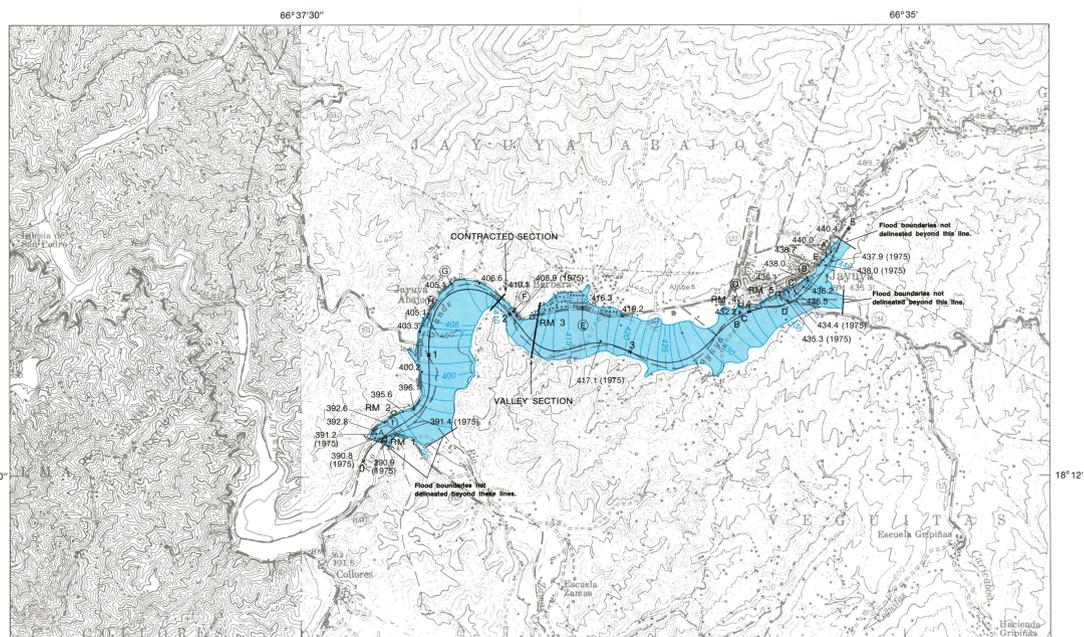
FIGURE 14. - Water-surface profiles of Rio Grande de Jayuya during floods of September 16, 1975 and October 9, 1970.

# FLOODS OF OCTOBER 9, 1970, AND SEPTEMBER 16, 1975 AT JAYUYA, PUERTO RICO

By

Karl G. Johnson and Ramón A. Carrasquillo

1982



Base from U.S. Geological Survey maps: Adjuntas - 180, Jayuya - 180

## EXPLANATION

- Area flooded, October 9, 1970 and September 16, 1975
- Boundary of the 1970 flood
- Water-surface contour for the 1970 flood, in meters. Contour interval 1 meter
- Elevation of flood marks, in meters, of 1970 flood and of (1975 flood)
- Bridge locations, refer to table 3 and profile
- Base line and distance from mouth of river, in kilometers
- Reference marks established by the U.S. Geological Survey refer to table 4
- Photographs showing depth of water at different sites in the valley as a result of the October 9, 1970 flood

