

Large areas of land in the municipalities of Vega Alta and Vega Baja, Puerto Rico, have been inundated repeatedly by floods on Río Cibuco and its tributary, Río Indio. This report provides a record of known floods. The information presented can lead to more rational decisions regarding land use in the areas subject to inundation.

The area inundated by the flood of December 11, 1965, was delineated on the topographic base map on the basis of floodmarks. The pattern of inundation reflects the condition of the valley at the time of the flood.

In the area shown by the map, Río Cibuco is crossed by Highways 675, 676, 2, and 688 and by a rural road, and Río Indio is crossed by Highway 160. Sections of all these roads and of Highways 686, 689, and 690, that run from Highway 2 northward to the coast, are subject to inundation.

The area comprising Ciénaga Prieta to the east of Ceiba is drained by a canal that was constructed during the period 1953-58. A byproduct of the canal was a spoil bank with interspersed openings that facilitate local drainage. The 1965 flood did not overtop this spoil bank, and flow in that part of the valley was restricted to the openings or diverted to the west.

Most of the area flooded by Río Cibuco is now agricultural and is planted in sugarcane or used as pasture for cattle. During the 1965 flood, however, part of a new urbanization in the town of Vega Baja was inundated. In 1966 a drainage canal was constructed from the urbanization to the channel of Río Cibuco. The spoil was placed along the east and south side of the canal for the distance shown on the map. This spoil bank will restrict future floodflow in that part of the valley to two openings or divert the flow to the east. Alteration of the channel or floodplains by man-made structures or by substantial changes in the type of agriculture will result in patterns of inundation different from those shown for the 1965 flood.

**Drainage basin.**—Río Cibuco and its tributaries originate in the northern foothills in Puerto Rico at an elevation of about 400 meters. Except for Río Indio, the tributaries join Río Cibuco south of a band of rugged hill country composed of karst topography—magotes<sup>1</sup> and sinks. Ríos Cibuco and Indio flow northward through the rugged hill country by way of deep, narrow valleys to the vicinity of Vega Alta and Vega Baja where floodplains become of economic value. Río Indio flows into Río Cibuco near to and south of Highways 676 and 2. Río Cibuco enters a wide coastal flood plain north of Highway 2 and then flows to the Atlantic Ocean through a mouth no more than 100 meters wide. The drainage areas of Río Cibuco and Río Indio are indeterminate, a large part of each being in cavernous limestone. The locations of the drainage basin and of the study area, determined from topographic relief, are shown in figure 1.

<sup>1</sup>Steep-sided hills.

**Flood occurrence.**—The flood of December 11, 1965, on Río Cibuco reached an elevation of 5.6 meters at Central San Vicente, near highway 688, and was the highest known. The next highest known flood occurred on April 8, 1915, and reached an elevation of 5.5 meters at about the same location. Precipitation records indicate that these floods were probably higher at Central San Vicente than any flood since at least 1899. On the basis of this evidence, floods will reach stages of 5.6 and 5.5 meters at Central San Vicente on the average of once each 68 years and 34 years, respectively.

More comprehensive flood data are available for the crossing of Highway 2 since the flood of May 4, 1959. These data are tabulated below:

Date of flood	Elevation above mean sea level at the downstream side of Highway 2 (meters)	Discharge (cubic feet per second)
Apr. 8, 1915	—	—
May 4, 1959	7.40	6,800
Sept. 6, 1960	7.26	4,600
Dec. 6, 1961	7.32	9,100
Oct. 14, 1962	—	—
May 23, 1963	7.34	6,000
April 1964	<6.50	<2,600
Dec. 11, 1965	8.00	28,000
Apr. 30, 1966	7.83	19,000

**Flood contours.**—Water-surface contours are imaginary lines of equal water-surface elevation. In a narrow, unobstructed valley the contours are practically straight lines across the valley. Obstructions to flow, such as sugarcane or matted obstacles, and the expanding width of valleys cause irregularities in the contours. The water-surface contours shown on the map were based on floodmarks for the flood of December 11, 1965.

**Flood profiles.**—A flood profile depicts the crest water-surface elevations of a stream with respect to an arbitrarily chosen base line. Because, generally, floodflow is not confined to the configuration of the channel, the profile base lines for Río Cibuco and Río Indio were drawn to conform with the general direction of flow of the flood of December 11, 1965. The base lines are measured in kilometers beginning at the mouth of Río Cibuco. The profiles for the 1965 flood are shown in figure 2.

**Depth of flooding.**—The maximum depth of flooding for the 1965 flood can be estimated for any point in the inundated area. This can be done by subtracting the ground elevation, shown on the map by ground contours, from the water-surface elevation at the same location, shown by water-surface contours. The water-surface elevations can be estimated by interpolation between water-surface contours, and the ground elevations can be estimated by interpolation between ground contours or can be determined by levels from a bench mark.

**Additional information.**—Additional information relating to floods on Río Cibuco can be obtained from the U.S. Geological Survey, San Juan, Puerto Rico, or from the Sección de Control de Inundaciones, Puerto Rico Departamento de Obras Públicas, Parada 22a, Avenida Ponce de León, Santurce, Puerto Rico.

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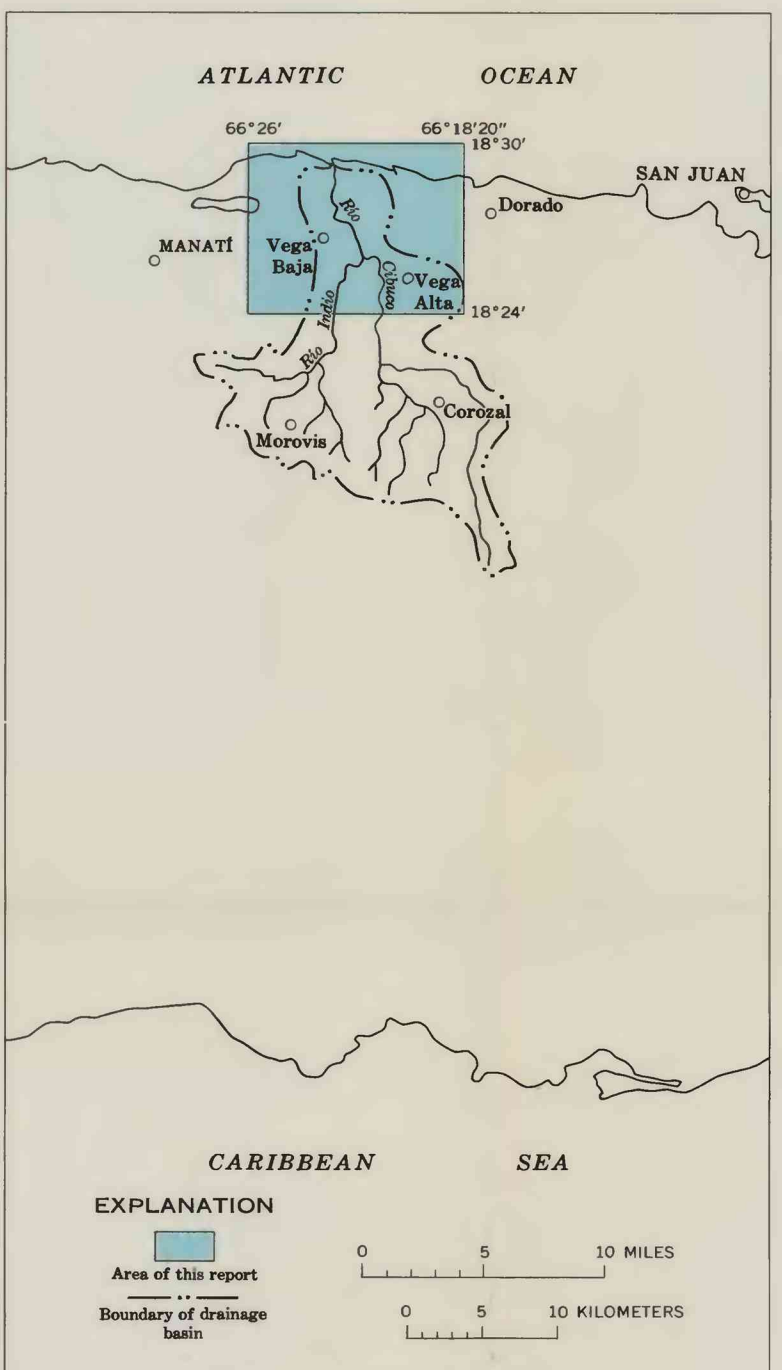


FIGURE 1.—Location of drainage basin and study area.

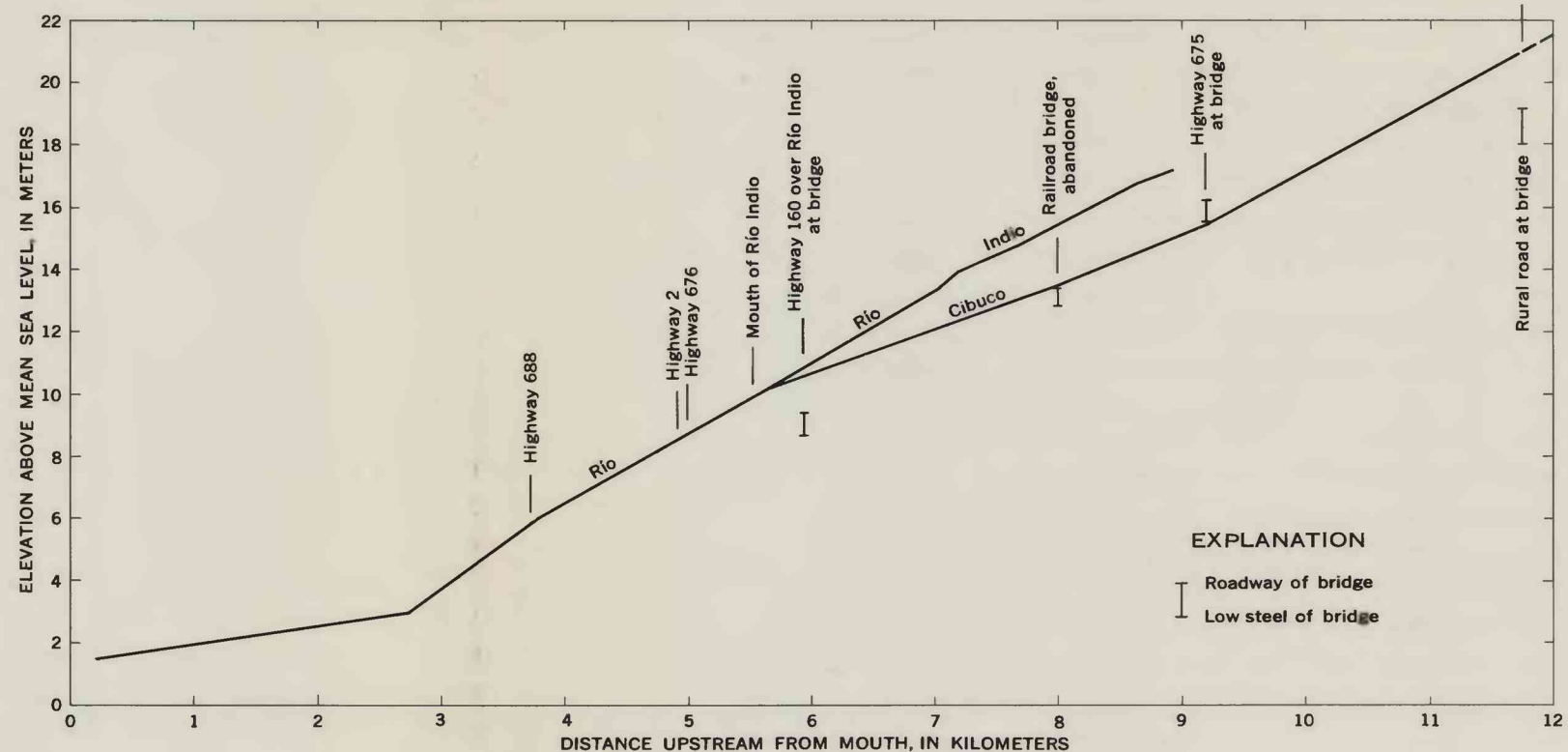


FIGURE 2.—Flood profiles of Río Cibuco and Río Indio.

## FLOODS IN THE AREA OF VEGA ALTA AND VEGA BAJA, PUERTO RICO

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