

THE TROPICAL CYCLONE PROBLEM IN EAST PAKISTAN

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East Pakistan was struck by three severe tropical cyclones and another which was small but intense between October 10, 1960, and May 30, 1961. The centers of all four storms crossed a comparatively narrow section of the coastline less than 80 statute miles wide (fig. 1). This number is amazing since cyclones of all intensities (winds 39 m.p.h. or more) in this region average less than one every other year and major tropical cyclones average only one every 5 to 15 years. Statistics on cyclone frequency in the Bay of Bengal and Arabian Sea are rather uncertain since it has been the practice to include cyclones of depression intensity, as well as some which were cold-core, in the storm totals.

Fatalities in the two October 1960 tropical cyclones are believed, on the basis of a careful government count, to be somewhat in excess of 16,000 although unofficial estimates placed the death toll much higher. These two storms were not exceptionally severe and the storm surge in the October 31 storm occurred at the time of normal astronomical low tide. The famous and more severe October 31–November 1, 1876 “Bakarganj Cyclone,” when the population density was much less, caused 100,000 fatalities by drowning and 300,000 more persons subsequently died from starvation and disease [1]. The Chittagong cyclone of October 31, 1897, is supposed to have caused 175,000 fatalities [2].

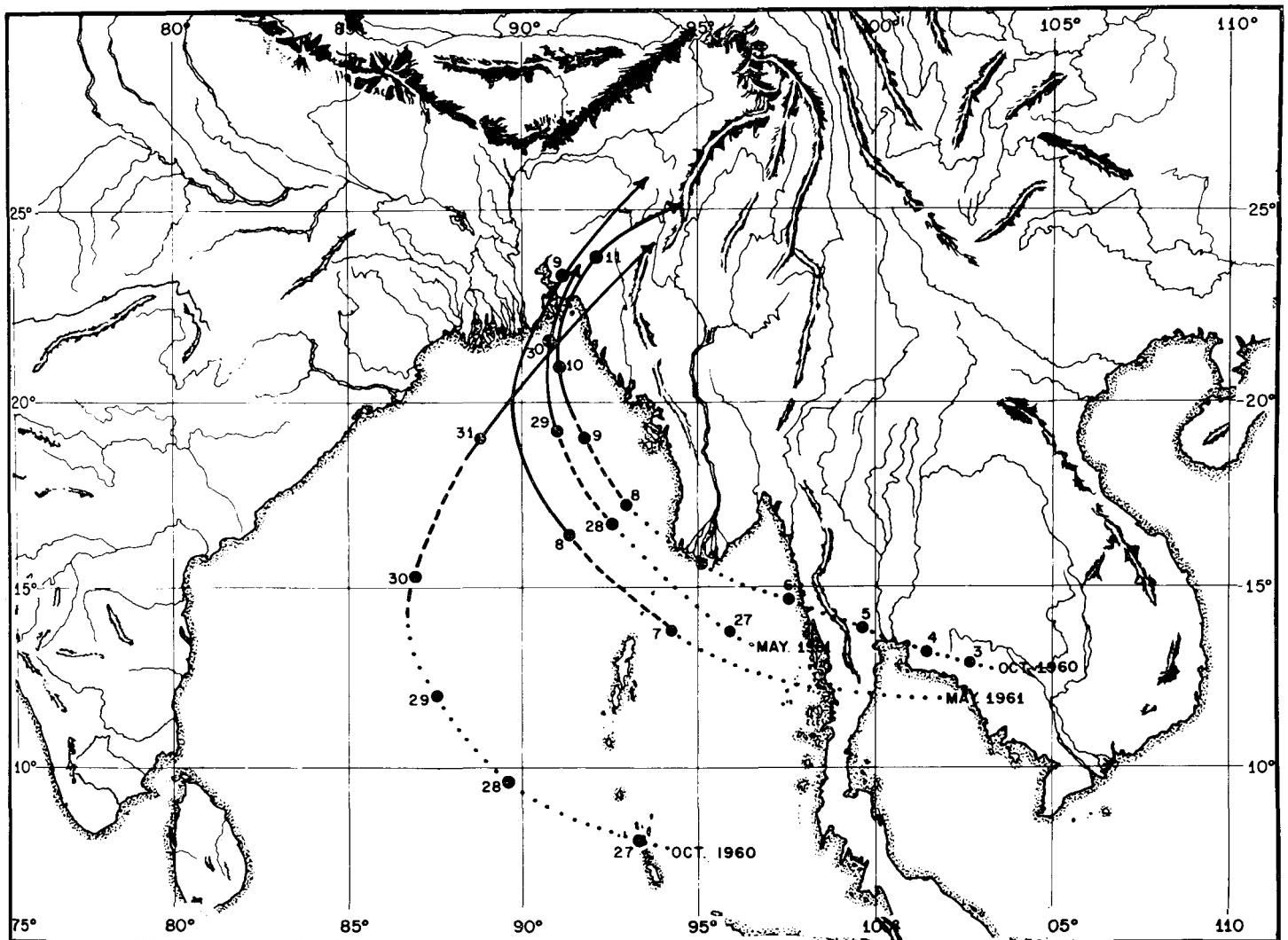


FIGURE 1.—Paths of the four tropical cyclones of October 1960 and May 1961 in East Pakistan. Dotted track indicates tropical disturbance stage; dashed track, tropical storm; and solid track, hurricane intensity. Points give 0000 GMT positions.

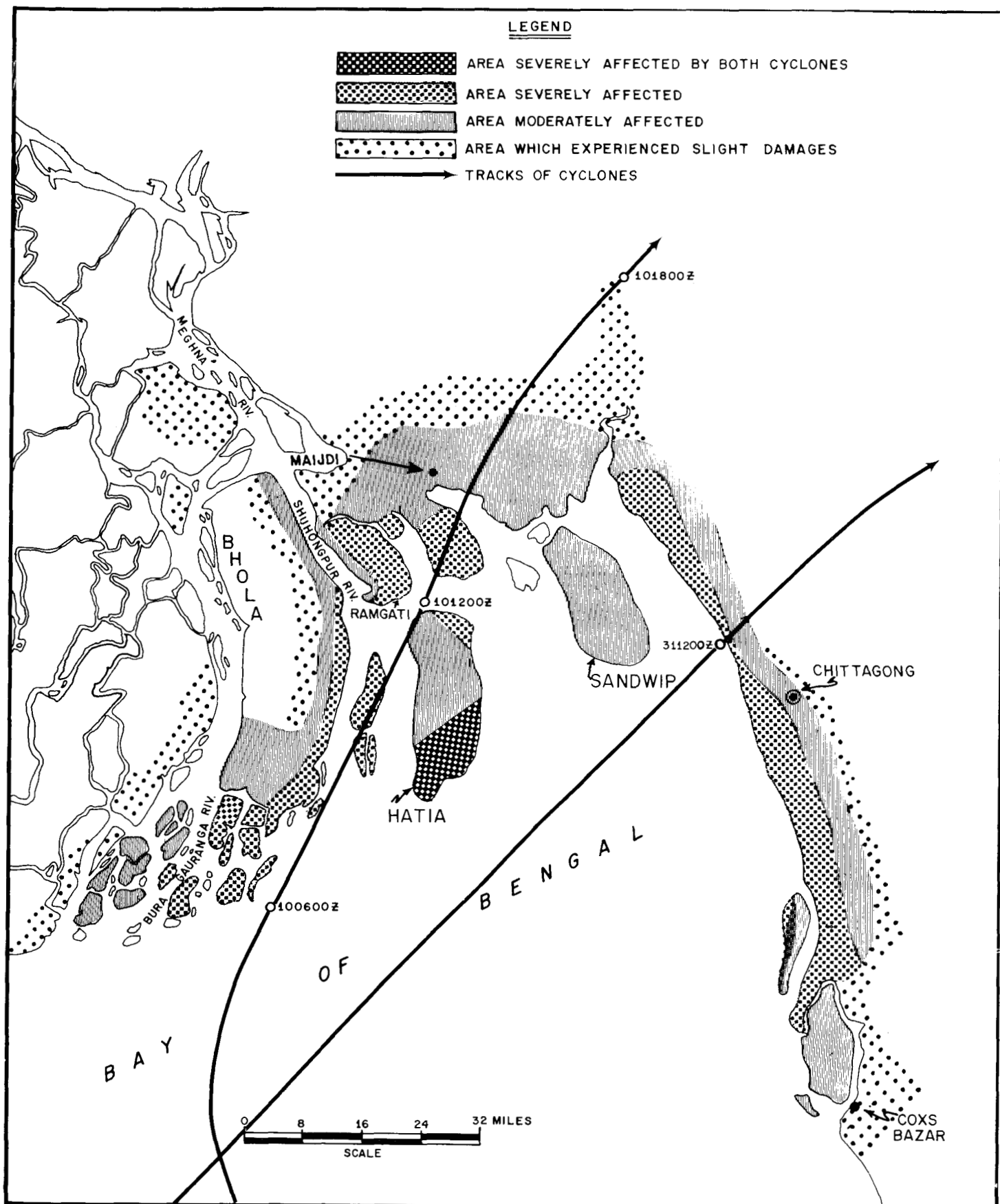


FIGURE 2.—East Pakistan areas affected by cyclones of October 10 and 31, 1960.

At the head of the Bay of Bengal, there are some four large islands and numerous small islands, inhabited by almost one million people. The islands are without telephones or electricity and there are only a few roads. Most of the area is thought to be less than 15 feet MSL, although much of the area has never been surveyed. Conditions here combine to produce the highest known storm surges of any area in the world, as well as occasional storm waves whose origin is not clearly understood.

The first tropical cyclone moved slowly north-northwestward off the Burma and Chittagong coasts October 8-10 and recurved northeastward reaching the mainland just east of Maijdi around midnight October 10 with the eye passing over portions of the islands of Bhola, Hatia, and Ramgati (fig. 2). According to reports at Maijdi, a wall of water 10 to 15 feet high came across the coast during the height of the storm but played out before reaching the town, which is about 4 to 5 miles inland during the dry season. There was no lull at this point. On Hatia, there was a lull from 5:30 to 6:00 p.m. and shortly thereafter the island was totally submerged but only slightly so on the highest elevated areas. Maximum storm tide was estimated at 12-13 feet. About 3,457 persons were drowned on Hatia. Maximum winds at both Maijdi and Hatia were estimated at 100 m.p.h.

On Ramgati Island, mostly north of the eye, maximum winds were 100 m.p.h. plus and the storm surge was 15 feet in the village of Ramgati and 20 feet on the northeast and east coasts. The rise of the water was fairly rapid at the height of the storm but no particular wave was noted. About 2,764 persons were drowned here.

On Sandwip Island, south of the center, the maximum storm surge was 10 to 15 feet on the south and southeast sides and it penetrated only about 1 mile inland. Maximum winds were 80 to 100 m.p.h.

Consensus of reports indicated the storm surge occurred in normal fashion with maximum height at about the time of lowest pressure and the possibility of a storm wave is discounted.

The October 31, 1960, cyclone accelerated as it recurved northeastward toward the Chittagong coast and the eye crossed the coast just north of Chittagong at about 6:30 p.m. EPST. The storm came and went in 3 to 4 hours with maximum winds estimated at 120 m.p.h. and lowest barometer about 28.55 in. At the time the storm passed inland, dry air was rapidly entering the inner portion of the cyclone. All observers agreed that under the wall cloud only a few sprinkles of rain fell although the air was full of salt spray blown in from the sea. The storm almost completely dissipated within 4 hours after it crossed the coastline. Many observers reported a red glow in the sky and attributed it to some obscure electrical phenomenon. However, it is certain the glow was light reflected on the clouds from burning buildings.

Between 8:00 and 8:30 p.m., after the storm was about over, a storm wave swept over the Chittagong coastline with devastating effect. In general, it appeared there were three successive waves about 1 minute apart, the

second and third moving on top of the preceding wave. The surge remained at maximum height about 15 minutes, then dropped some 5 feet, and then receded gradually during the next 6 to 8 hours. Only one measured storm surge height was obtained—22 feet above MSL at Halishahar in Chittagong. Some 1,000 feet inland, heights of 9.5 feet above normal high tide were estimated generally and heights of 6 feet some 2 miles inland. Other data were obtained as follows:

Anwhara Police District: 18-foot storm tide.

Sandwip Island: Estimated maximum wind 150 m.p.h. Tide was running about 5-8 feet above normal when at 7:30 p.m. a wave 7 to 8 feet high swept in. Two more waves $\frac{1}{2}$ to 1 minute apart followed but less than 10 percent of the island was inundated. A lull of 10 minutes was experienced on the southern end of the island.

Coxs Bazar: One or more fairly large waves came in about 5:30 p.m. resulting in tide about 10 feet above normal.

Hatia Island (south end): One wave appeared to approach from the south-southeast and a series of three waves from the southwest with maximum storm surge 18 feet. 1,377 persons drowned.

Kutubdia Island: Maximum tide observed during storm 5 feet. At about 8 p.m., with storm over and wind light, three waves appeared from the southwest resulting in a maximum surge of 10 to 15 feet on the west coast of the island. The high water mark in the lighthouse on the northwest corner of the island was about 20 feet MSL.

Banskhali: Maximum storm surge 18 feet above ground level. There were three waves, first up to knees, second waist deep, third to roof of mosque. In 15 minutes surge receded to knee deep, then fell slowly to normal. Storm surge extended inland 4 to 5 miles. Storm wave arrived at coastline between 6:00 and 6:30 p.m.

The SS *Charles C. Dunaif* in its log reported, "At approximately 1400, the barometer reached a low of 29.48 in. and steadied—Vessel in cyclone center—Being swept by 20 to 30 foot waves—Winds 130 m.p.h.—Laboring to keep off lee shore and dangerous shoals 15 to 18 miles to the eastward—Plainly visible on radar screen—At 1407 a tidal wave estimated to be 40 feet high bore down on vessel and swept completely over her from bow to stern—Cargo floodlights on foremast washed away as well as fashion boards on top of flying bridge wheelhouse. . . ." The wave was estimated by the observer to be traveling at 15 m.p.h. The ship's position was estimated at about 28 miles slightly north of due west from Coxs Bazar. The time used by the ship is thought to be East Pakistan Standard Time but could have been Calcutta local time. If EPST, the wave moved only 8 to 9 m.p.h., and if Calcutta time, only slightly faster, which seems much too slow. However, the times of arrival of the wave on the coastline as described by the inhabitants are, while not exact, consistent. The *Dunaif* was never in the center but the storm wave occurred at the time of lowest pressure when the ship was closest to the center, and possibly, as the tropical cyclone accelerated, it went off and left the wave.

