

Coastal Flooding: The Meghna Estuary, Bangladesh 1991

By the British Geographer

Situation

The Meghna Estuary located at the mouth of the River Meghna to the east of the Bay of Bengal in Bangladesh. The estuary is at a confluence with two other great Asian rivers, the Ganges and the Brahmaputra.



Figure 1.

The Physical Causes

Coastal flooding is a complex event caused by many interrelating factors. The root cause of coastal flooding is a sudden increase in the tidal level above that of the mean tide level. This is normally the result of tidal surges associated with atmospheric storms or tsunamis that result from a displacement of water by a fault movement of large mass movement. In the case of the 1991 flood, in the Meghna estuary, a tidal surge of 6 metres was caused by the tropical cyclone Gorky.

Tropical cyclones are seeded by the warm tropical oceans of the Indian Ocean. Tropical cyclones are vast, low-pressure systems that draw heat from evaporating oceans. This rising air creates strong thermals and condensation generates latent heat, which further strengthens the storm. This process of strong thermal uplift literally raises the ocean. This can be seen in figure 2.

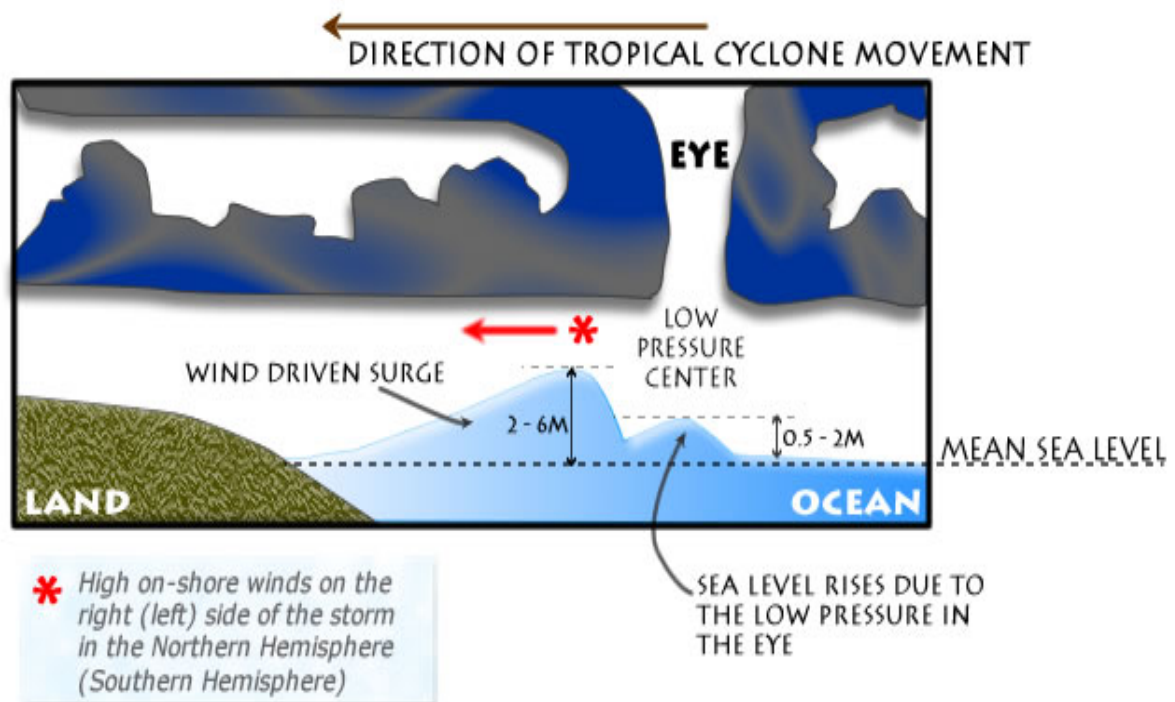


Figure 2.

The storm surge will then be influenced by a number of different factors that include the angle of the storm track with respect to the coastline, the tidal conditions at the time. E.g. whether it is low tide or high tide, offshore and nearshore depth, slope and relief of the land, the shape and curvature of the coastline, width and depth of the river mouth through which the surge will travel; presence of islands and chars, land topography and land use and surface resistance including the presence of mangrove forest. All of these factors are at play to create localized variations in severity, The key point is to recognize that the timing and direction of the track in relation to the factors will largely determine the magnitude and extent of the flood and therefore the severity of the human impact. Figure 3 shows the track of Cyclone Gorky in 1991.

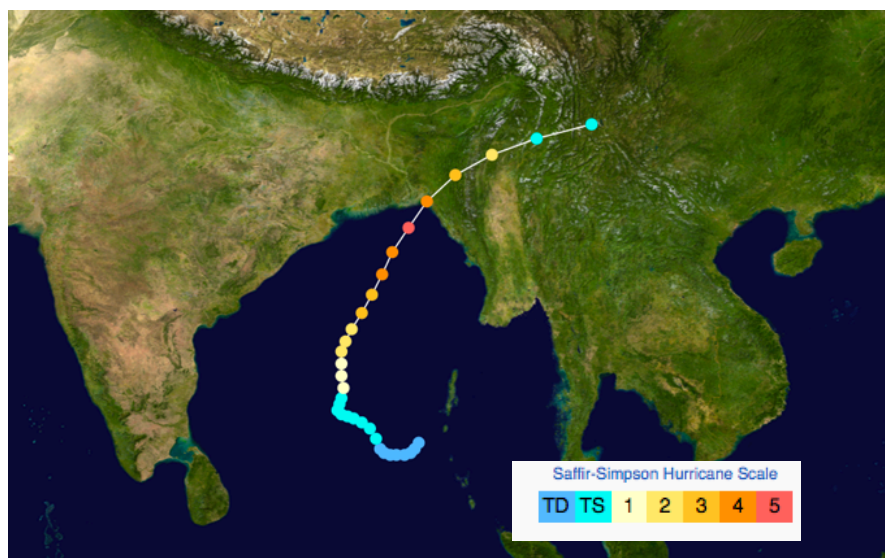


Figure 3: Gorky track and magnitude

The direction of the track is north northeast and the system strengthens on its approach. For a brief moment the cyclone reached a scale 5 on the Saffir Simpson Scale before dropping to a 4 on landfall. The direction of the track funnels the storm surge into a narrower and narrower bay, which further increases the size of the tidal surge. Its track takes a head on course with the Meghna Estuary. Figure 4 explain how coastal topography would have influenced the tidal surge.

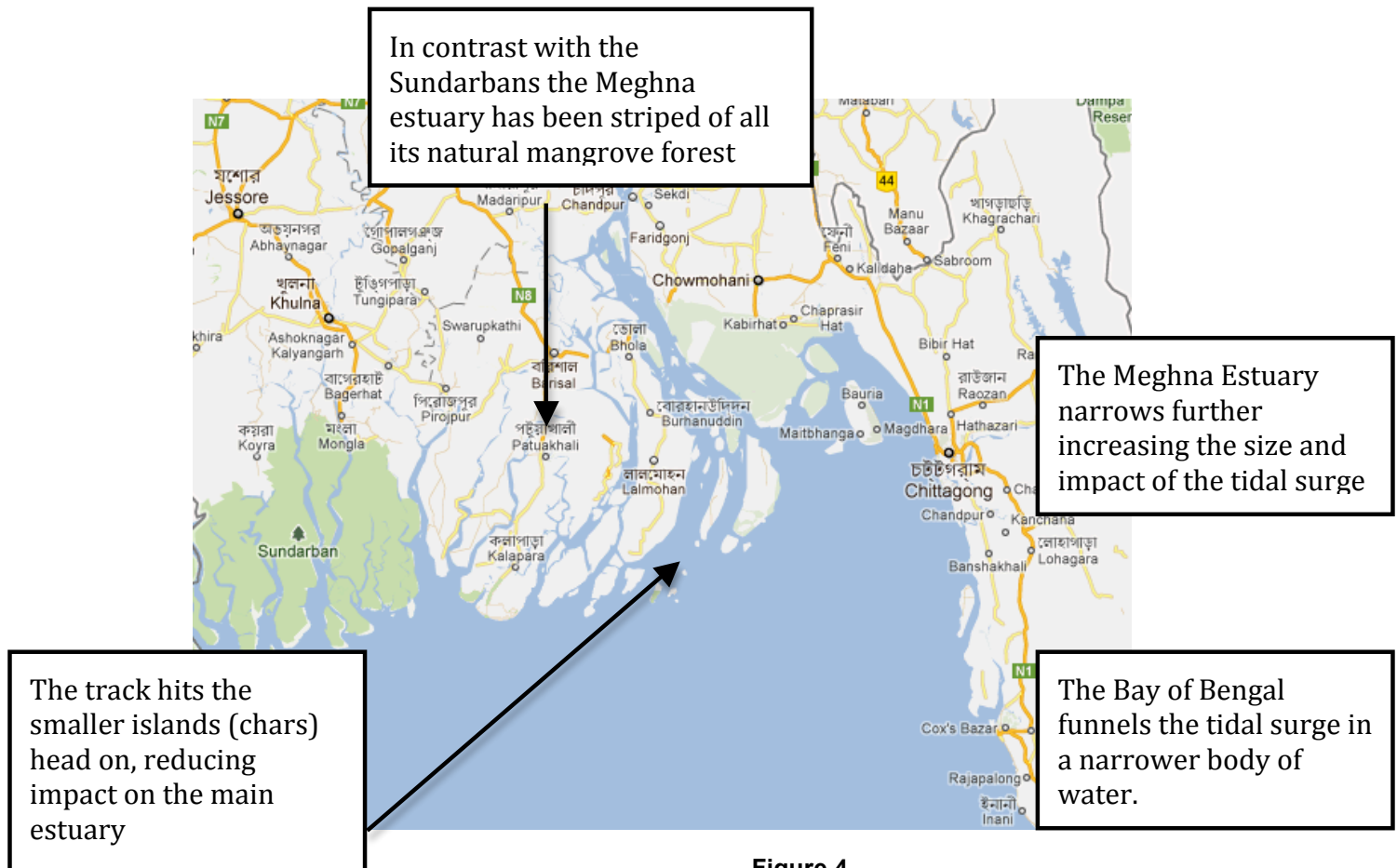


Figure 4.

In addition the coastal orientation and features, other physical factors influenced the severity of this event. Bangladesh is extremely low lying. The land surface is deltaic and occupies a vast network of distributaries including three major rivers. In addition to the dense river system the main land use is rice farming. This requires large pooled fields, which would have only acted to reduce friction and speed up the inland movement of the tidal surge. Variations in local relief determine explain the localized variation in inundation; this can be seen in figure 5.

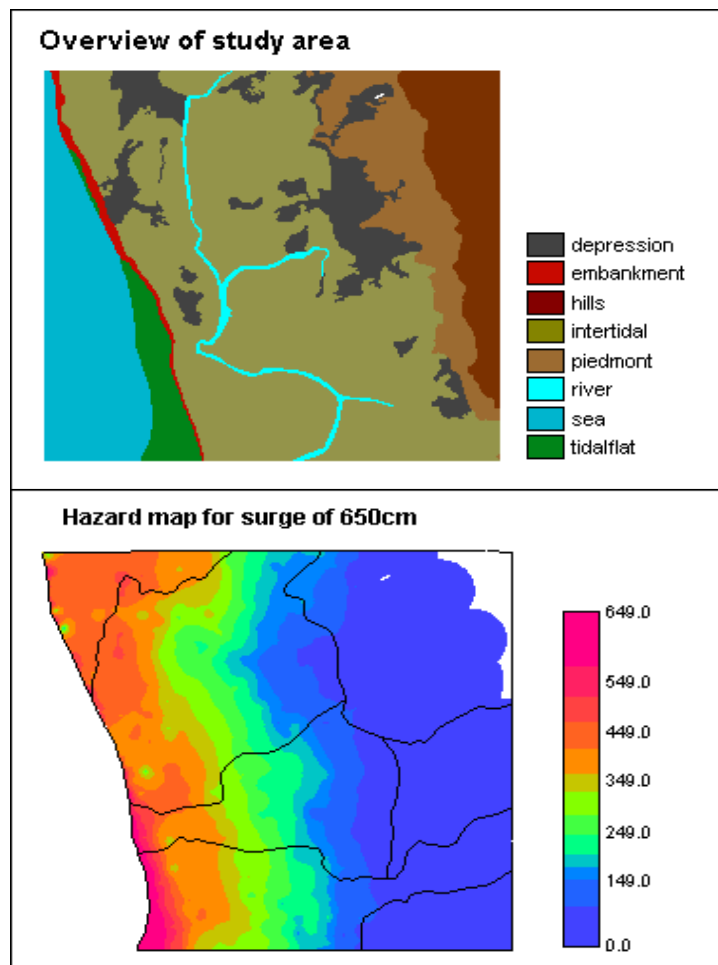


Figure 5

As you can see the depth of inundation corresponds to the type of land use and relief. Due to the low elevation in many parts of Bangladesh, the storm surge was able to travel very far inland and caused greater damage. However, a spatial variation in casualty rate was recorded. In the immediate coastal belt, villages experienced a 70% casualty rate, this dropped to 35% in the belt away from the coast.

The Human Influences

The major human influence on the severity of the impacts relates directly to population pressure. Bangladesh is amongst the most populated countries in the world with extensive regions of the country boasting over 1000 people per square kilometer. Figure 5 shows the population density of the estuary with the track.

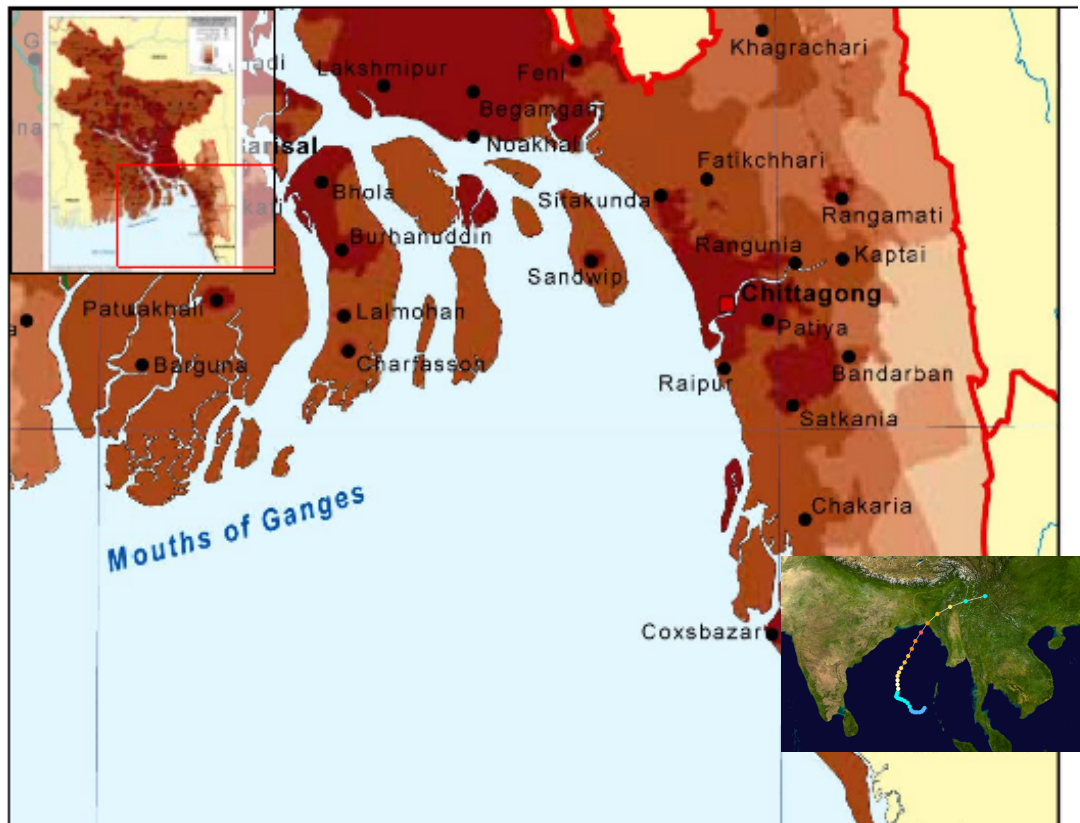


Figure 6

This population places enormous pressure on both the land and water resources. The natural mangrove forest has been largely deforested in this region for agricultural development. This would be a first point of contact with tidal surges and would act as natural buffer. Without such forests people are exposed to the full 6metre surge with little to no protection. Nepalese and Tibetan deforestation as well as urbanization and agricultural run-off has choked the already alluvial rich distributaries with sediment and this just acts to exacerbate the impacts of tidal surge inundation.

Short Term Impacts

138 000 people died of which, 50%, were children, 25% women, 15% were elderly and 10% were men. WE shouldn't be too surprised by these figures given that Bangladesh is a developing country with high natural increase and a youthful population structure. The interesting demographic in the casualties lies more with the number of women compared to men. This is probably explained by tradition gender roles. Women were probably more likely to be at home, whilst the men were working in the fields. It is inevitable that many women died attempting to rescue the elderly and children.

10 million people were left homeless with 1 million homes being completely washed away. Farm crops were destroyed. For 3 weeks after the storm farmers suffered rapid soil erosion further destroying livelihoods. Fishing boats were sunk and prawn stock destroyed. Millions of livestock were drowned. The impacts were thought to be greater because of the influx of

migrant workers into the region for the rice harvests. Although it is uncertain migration is thought to increase the population by 30% at this time.

Long Term Impacts

Food scarcity and loss of livelihood had long lasting impact. Water and land resource were polluted with sewage and salt water. This would take at least 2 years to cover from leading to a long-term reliance on food aid and support

Although a concrete levee was in place near the mouth of the Karnaphuli River in Patenga it was washed away by the storm surge. The cyclone uprooted a 100-ton crane from the Port of Chittagong, and smashed it on the Karnaphuli River Bridge, effectively breaking it into two partitions. A large number of boats and smaller ships ran aground. The Bangladesh Navy and Bangladesh Air Force, both of which had bases in Chittagong were also heavily hit. The Isha Khan Naval Base at Patenga was flooded, with heavy damages to the ships. Most of the fighter planes belonging to the air force were damaged.

Management Issues.

2 million people were evacuated ahead of the tidal surge. There were cyclone shelters built following the Bhola disaster of 1970 but these were not nearly enough and they were concentrated in the Bhola Delta rather than Meghna Estuary. The surge hit in the early hours of the morning when most were still in bed; many were only given a couple of hours warning and so the heightening of risk perception and communication strategy was close to non-existent.

Cyclone Gorky was a catalyst for change in Bangladesh and awakened the international community to the terrible consequences of tidal surges. This led to multilateral and NGO funding of infrastructure and cyclone management systems. A massive cyclone shelter-building programme was undertaken. The total quantity of cyclone shelters in the coastal area is now more than 1800, which are still less than they need. They are built 7 metres above the ground and each can accommodate 1000 people. More sophisticated communication strategies were designed, educated and implemented. Remote villages are informed via radio, supplied by agencies like Oxfam. More remote areas are reached by motorbike and each village has a person responsible for disseminating information and providing early warning.

1991 is important because these cyclone management methods just weren't in place before. In 1997 Bangladesh was hit by another significant cyclone. Fatalities were massively reduced to 111 lives lost. It would be ridiculous to suggest that this was entirely down to improved cyclone management because as we have learned, there are so many factors that influence the severity of cyclones and tidal surges. However, it does provide us with an indicator that Bangladesh as a result of the apocalyptic events of 1991 were now in a better position to protect its people from coastal flooding.