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Review

Present Techniques of Tropical Storm Surge Prediction

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Storm surges caused by a severe tropical cyclone impinging on a coast have greater potential for heavy loss of life than any other meteorological phenomenon. A few years ago (in 1970), a single cyclone caused death of as many as two hundred thousand people in Bangla Desh. But such a great disaster is not necessarily a contemporary event. Over a hundred years ago, one of the most destructive cyclones in history, known as the Bakhergunge cyclone, killed with its storm surge, a hundred thousand people of India in 1876. Another hundred thousand people lost their lives due to disease directly attributable to the flood caused by the storm surge. Pronounced storm surges have also been reported to affect the Gulf of Mexico and the east coast of USA, the northern coast of Australia, the coastal areas and islands of Japan, the Phillippines, the western coast of Korea, Thailand, Hongkong and the island of La Reunion in the south Indian Ocean. Loss of life due to such calamities can be minimized by evacuation of people, if an efficient prediction system for storm surges can be evolved. In fact, such systems have already been formulated in some countries, notably U.S.A., Japan and India, over the past few years, by means of studies applicable to coastal regions of individual countries.

The publication under review provides a comprehensive account of findings of the studies along with background and guidance material which may be used with advantage by other countries affected by storm surges. It consists of seven chapters dealing with different aspects of storm surges and an Annex on astronomical tides. The text on storm surges has been written by three acknowledged experts, *viz.*, Dr. P. K. Das of India, Dr. M. Miyazaki of Japan and Dr. C. P. Jelesnianski of U.S.A. The Annex on astronomical tides has been authored by Professor Zickwolff of Deutsches Hydrographisches Institut, Hamburg.

The material on storm surges has been divided into seven chapters. The first chapter gives a brief history of pronounced storm surges in different parts of the world.

Chapter 2 deals with the physics of storm surges generation and mentions the role of the different forces which generate surges. The importance of the various storm parameters, *e.g.*, pressure drop, radius of maximum wind, vector storm motion, maximum wind and angle of inflow has been emphasized. Effects of tangential stress at the sea surface and of bottom stress, breaking waves, refraction, earth's rotation and of tides and rivers have been lucidly explained. The fact that the peak surge envelope widely varies has been clearly brought out by giving examples of two contrasting hurricanes, '*Garla*' of 1961 and '*Camille*' of 1969.

The need to obtain meteorological and tide data operationally has been mentioned in Chaper 3. It has been stated briefly that estimates of meteorological input parameters required for storm surge computation are obtainable with the help of observations from weather satellites, radar and reconnaissance aircraft. A more detailed description with a few worked-out examples would have been welcomed by readers, as accuracy of storm surge prediction depends to a large extent on accurate estimates of meteorological parameters. Methods to obtain tide data have, however, been adequately dealt with.

The fourth chapter mentions empirical formulae employed for surge prediction in Hongkong and Japan.

Chapter 5 gives, in detail, dynamical-numerical surge prediction techniques used for the coastal regions of U.S.A., Japan and the north Bay of Bengal. The techniques deal mostly with peak surges generated in open coasts. Procedures for surge prediction in embayments in Japan have also been discussed. This chapter is considered to be the most useful for practical surge forecasting.

In the next chapter is given a synopsis of very recent studies on risk evaluation of storm surges. Such studies are required to ascertain the extent to which a coastal segment is vulnerable to storm surges so that the element of risk could be converted into an estimate of likely damage. Knowledge of such estimate is required to insure coastal

buildings and installations against damage from surges. The joint probability analysis of storm surge and astronomical tide, as described in this chapter, is illuminating.

A tide gauge network is never sufficient to give an accurate surge envelope as surges are known to vary largely within a coastal stretch of even a kilometre. It is, therefore, imperative that a field survey is undertaken immediately after coastal inundation. The procedure to undertake such a survey has been described in a simple and adequate manner with illustrations in the last chapter.

The Annex dealing with tides and tidal predictions gives briefly an account of the astronomic and the hydrodynamic theory of astronomical tide.

The publication is well written and presents an up-to-date description of techniques in storm surge prediction. The quality of paper is good and printing is of high standard despite a few minor typographical errors. The binding is, however, unsatisfactory.

There are a few minor inaccuracies. The lowest central pressure ever recorded is 876 mb, observed on November 19, 1975 inside typhoon '*JUNE*' as reported by Chares Holiday in *Monthly Weather Reveiw*, September 1976. This surpasses the figure 887 mb stated in the manual, which was probably based on earlier records. The meteorological department of India was officially established in 1875, it is not clear whether the Bakhergunge cyclone was responsible for its further expansion, but this could have been one of the contributing factors.

The publication, on the whole, is considered to be extremely useful and is recommended to be kept for reference in the shelves of all those connected with storm surge forecasting.

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