Mausam, (1996), **47**, 1, 67-72

551.515.1

Reconstructing the great Bengal cyclone of 1737

A. K. SEN SARMA
B-7/175, Kalyani (West Bengal)
(Received 10 August 1994, Modified 6 April 1995)

सार — दक्षिण बंगाल के 1737 के ऐतिहासिक चक्रवात में मृतकों की संख्या तीन लाख तक होने की बात असत्य (सेन सरमा 1994) सिद्ध होने तथा इस तूफान के साथ एक भूकम्प आने की बात को एक कोरी कल्पना (सेन सरमा 1993, बिल्हम 1994) मान लेने के उपरांत उस चक्रवात की प्रचण्डता एवं उसकी विनाश लीला का नए सिरे से मूल्यांकन करना आवश्यक हो गया है।

समुद्री तूफानी लहरों की 40 फुट गणना करने की घोष की (1977) की स्कीम को आधार मानकर तूफान की प्रचंडता का मूल्यांकन किया गया तथा अपेक्षित इनपुट Δp ज्ञात किया गया है। एक अनुरूप की मदद से चक्रवात के मार्ग को दोबारा बनाया गया। 1970 में बंग्लादेश में आए चक्रवात (फ्रैंक एवं हुसेन 1971) के साथ इस उल्लेखनीय चक्रवात के दौरान उठी समुद्री तूफानी लहरों को अनुरूप में दर्शाया गया है। इस चक्रवात में मृतकों की सम्भावित संख्या का अनुमान बंगाल क्षेत्र के 1801 के आस-पास के दशक के चक्रवातों में मृतकों की संख्या के आधार पर लगाया गया है। अन्ततः इस चक्रवात में मृतकों की संख्या के अनुमानित आकलन के लिए आंध्र प्रदेश में 1977 के चक्रवात के दौरान मृतकों की संख्या से संबंधित उपलब्ध आंकड़ों को आधार माना गया है।

यह आकलन किया गया कि 1737 का चक्रवात टी 7 तीव्रता का था और इसमें 35,000 लोगों की मृत्यु हो गई (आकलन त्रुटि 10,000 तक)।

ABSTRACT. Having established that the figure of 300,000 quoted as the human casualty in the legendary south Bengal storm of 1737 was an implant (Sen Sarma 1994) and the simultaneous earthquake a myth (Sen Sarma 1993, Bilham 1994) it was necessary to freshly evaluate that storm as to its severity and destructive impact.

The strength of storm was assessed by using the reported surge of 40 ft as the output in Ghosh's (1977) surge computing scheme and arriving at the required input Δp. The probable track of the storm was reconstructed with the help of an analogue. The likely area inundated by 'significant' surge was demarcated by analogy with 1970 Bangladesh storm (Frank and Husain 1971). The affected population of that area was estimated from the decadal figures for Bengal area going backward from recent times to 1801. Finally, the number of lives lost was inferred from the available data on the mortality ratio in the Andhra cyclone of 1977.

It is estimated that the cyclone of 1737 was a T 7 storm and had taken 35,000 lives (the error margin being 10,000 on either side of that figure).

Key words — Cyclone, Storm surge, Natural disaster.

1. Introduction

One of the earliest of known "Killer" cyclones hit south Bengal in the year 1737. It is reputed (*e.g.*, Tannehill 1945) to have taken an estimated 300,000 lives and so is regarded as one of the worst natural disasters in history. However, a recent study (Sen Sarma 1994) has found that this casualty figure got into circulation from a distorted version of a report whose original mentions no number. The only estimate recorded at that time is 3,000 deaths in a part of the affected area.

The distorted version had also misled some into believing that the event was mainly seismical and the casualty, by implication, was mainly due to an earthquake. This undesirable equivocation about the nature of such a major event has been sought to be removed in other studies (Sen Sarma 1993, Bilham 1994). Evidences have been adduced to establish that there was no earthquake and the death and destruction was wrought entirely by a tropical cyclone by generated storm surge.

The present enquiry arises out of a perceived need to re-evaluate the event and to put it in proper perspective as to its severity and destructive impact, particularly the lives lost. To do that, it was necessary to reconstruct the storm, its intensity and track at landfall, the area and population affected by it and finally the toll it took in human lives. Use was made of information culled out mainly from three independent sources: the actual notice in Gentleman's Magazine (1738), an eyewitness account of the event as communicated to the Journal of Royal Asiatic Society, London, by Wilson (1898) and the contemporary records of English East India Company establishments at Calcutta as quoted, again, by Wilson (1906).

2. The likely intensity

Many of the descriptions confirm each other and together build up a fairly consistent picture of the aftermath of a major cyclone. They also provide many indicators as to the intensity of the storm. In all these, however, there are only two descriptions both in the Gentleman's Magazine (1738) note, which mention quantitative values for two of the storm effects. One is about the rainfall ("very heavy rain which raised 15 inches of water in 5 hours") and the other is about the storm surge ("the water rose in all 40 feet higher than usual"). Any quantitative assessment of the severity of the storm has to rely on these.

Unfortunately, it is not possible to relate, uniquely, the intensity of a particular storm to the intensity of the rainfall let alone that at one point. On the other hand, the basic storm surge at a designated part of a particular coast is uniquely related, at least in theory, to the sea level characteristics of the impinging storm, principally its intensity and vector movement. (The word 'basic' is introduced here to preclude the effects of surge-tide and surge-flood interactions). We are, thus, left with the depth of storm surge as the only index to the severity of the storm.

How dependable is the available estimate for the surge height? We can only say that in those days such estimates were made by mariners who were trained to assess fairly accurately the depth of water they were riding. The observations, "Barks of 60 tons were blown 2 leagues up the land over the tops of high trees" and "ships of 500 tons were thrown into a village above 200 fathoms from the bed of the River" (both in Gentleman's Magazine 1738), also support the assessment. Moreover, surges of this magnitude are not unknown in this part of the world. The most famous of them all was in association with a storm hitting the mouth of Hooghly in 1864. Its height was estimated by a reputed mariner whose storm driven ship cleared certain obstructions which it could not have unless the water had risen "at least 40 feet" (Eliot 1900). It may not be out of place to mention here that the present day surge estimates are hardly based on better evidences. We, therefore, take the figure of 40 feet, that is 12 m, as an acceptable estimate and try to find out the intensity of a storm which is capable of producing a surge of that peak value at that coastal strip.

There are quite a few objective methods of computing storm surge, each one having its own set of simplifying assumptions. We chose the one by Ghosh (1977) for the twin advantage of its having been developed for Indian coasts and having readymade nomograms for easy computation. Using this scheme in the reverse and choosing suitable values for other storm variables to arrive at a realistic storm compatible with the known impact we get a storm whose (a) radius of maximum wind (RMW) = 35 km, (b) speed of translation at landfall = 25 kmph and (c) pressure defect at the centre (Δp) = 100 hPa. That this value of Δp is not at all unrealistic for the area is confirmed by an earlier study (Jayanthi and Sen Sarma 1988) which found that the probable maximum value of Δp for the area and for a return period of 200 years is 90 hPa. The accompanying graph also indicates that for a return period of 400 years the probable maximum Δp is 100 hPa.

In Ghosh's (1977) scheme the maximum wind occurs at the central region of the eye wall. We assume the eye radius to be 25 km and wall cloud thickness to be 20 km (near average values both) to get RMW of 35 km. The assumed speed of translation of nearly 25 kmph is indeed on the higher side, but then most of the historical storms of this region speed up to such values nearing landfall. Accepting, then, that Δp was 100 hPa and using the standard Δp *versus* maximum sustained wind relationship for Indian seas (Gupta and Mishra 1976) we get a storm of intensity T 7 according to D'Vorak's (1984) classification.

3. The probable track

The fact that tidal effects of the storm were felt as far as Calcutta, 130 km inland, places the storm track definitely to the west of the river, nearly parallel to its course and at a distance almost certainly equal to the RMW of the storm.

To make the reconstructed track as realistic as possible, we fall back on yet another standard practice in cyclone warning operations. We search for an analogue storm, *i.e.* one which has passed close enough to affect Calcutta in a similar manner and during the same part of the year (that is, within a fortnight on either side of the date of occurrence of the storm). One storm fits our specifications best, the

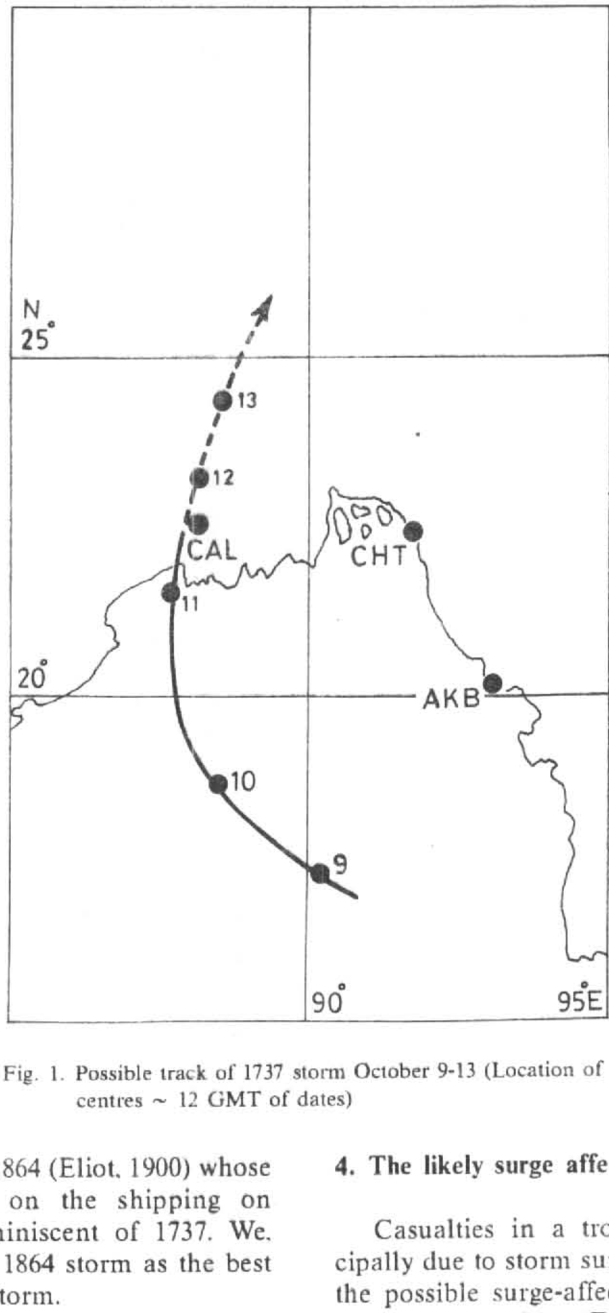

Fig. 1. Possible track of 1737 storm October 9-13 (Location of centres ~ 12 GMT of dates)

famed Calcutta cyclone of 1864 (Eliot, 1900) whose impact on Calcutta and on the shipping on Hooghly was strongly reminiscent of 1737. We, therefore, take the track of 1864 storm as the best possible tract of the 1737 storm.

The position of the centre of the 1864 storm at various intervals is given by Eliot (1900). The full violence of this storm was felt at Calcutta from 10 A.M. to 4 P.M. of 5 October, that is, from around landfall time through the next six hours. The 1737 storm on the other hand was felt at Calcutta during the "night between 11 and 12 October" (according to the current calendar), let us say between 10 P.M. of 11 to 4 A.M. of 12 October. We, therefore, suitably adjust the landfall time to arrive at the locations of the centre of 1737 storm at various intervals (Fig. 1).

4. The likely surge affected area

Casualties in a tropical cyclone being principally due to storm surge, we confine ourselves to the possible surge-affected area. A study of 1970 Bangladesh cyclone (Frank and Husain 1971) has presented a map showing the surge height isopleths over the affected area. This provides the qualitative framework when we try to delineate the likely area affected by surge generated by 1737 storm. The two storms not only correspond each other seasonally, the two affected areas are also similar in landform and coastal configuration. Ghosh's (1977) surge computing scheme also provides a method to arrive at the surge values (as a fraction of the peak) along the coast on either side of the landfall point. This forms our basis for the quantitative values assigned to the reconstructed surge isopleths. A number of descriptive passages from the official report on 1864 storm (Eliot 1900), our analogue of 1737 storm, are also used to validate the assigned values.

5. Possible number of threatened people

We presume that inundation becomes a risk to human lives only as it approaches one decimal five metre level and seriously threatens child population. We, thus, designate inundations of one and a half metres and more as significant and restrict our enquiry to this area.

We find that the area of 'significant inundation' thus designated covers what now constitutes parts of Haora, Medinipur and 24 Parganas districts of West Bengal. It also covers a part of Sundarban (Sen Sarma 1994, Appendix B) now in Bangladesh and practically uninhabited to this day. Population figure for this area in the year 1737 or thereabouts is non-existent. Systematic census operation in India commenced only in the year 1872. There was, therefore, no alternative but to estimate the population of this area under significant inundation in 1737 and for that the following approach suggested itself.

On the one hand, we had the total population figures for this area for all the censuses starting from 1872. On the other hand we had a series, presented alongwith the report of census 1961, giving population of the area covered by the erstwhile undivided province of Bengal from 1801 to 1961 at ten-year intervals. The starting point of this second series is quite close to 1737 and we extend it backwards to that year. We then assume that the ratio of this population to that of our area of interest had varied linearly with time.

The figure, thus arrived at for population in 1737 in the area under 'significant inundation' came to 227,000 (two hundred twentyseven thousand).

6. Likely casualty

What percentage of this number could have lost their lives immediately due to surge? The qualifier 'immediately' is used here to preclude some 'delayed' effects of surge, which we intend to consider a little later and separately.

The study of 1970 Bangladesh storm (Frank & Husain 1971), mentioned earlier, quotes figures indicating that 6.4% of the affected people lost their lives. A comparable figure of 6.6% is quoted as the percentage of affected people that lost their lives in an equally famous Bangladesh cyclone of 1876 (Islam *et al.* 1992). However, it is evident that in these reckonings the area affected includes areas of pure wind damage and thus inflate the number of people affected and correspondingly reduce the percentage loss of human lives.

A sociological study of November 1977 Andhra cyclone (Cohen and Raghavulu 1979) quotes, unexpectedly, some very relevant statistics. In a statement (ibid, Appendix A) is shown, among other things, the percentage of death to population in villages affected by storm surge of one Taluk. This Taluk alone accounted for about 70% of the total deaths in that storm (ibid, Appendix C). The statement shows that 9% of the total population affected by storm surge lost their lives. The list of villages includes some in which there were no deaths. Evidently these are the villages where inundation was not of a depth that could threaten life even of children (and we find our idea of 'significant inundation' vindicated). If we keep the number of people inhabiting these villages out of the total number affected we have a 10% loss of life.

But the Andhra cyclone of 1977 had a storm surge of 6 m peak height, whereas, we are dealing here with a peak surge twice this value. How would a doubling of surge height affect the percentage casualty? Higher peak surge would certainly mean larger area under 'significant inundation' and consequently a larger number of people affected. But that by itself won't increase the percentage casualty. An increase in peak surge would also mean an increased depth of inundation at any particular place resulting in increased mortality there and it would be this factor which will increase the percentage casualty. There must, of course, be a threshold value of surge height (a saturation value, so to say) any increase beyond which would not significantly affect the casualty figure. And in an area where there is no evacuation, horizontal or vertical, and housing consists overwhelmingly of mud-and-thatch cottages this threshold height should not be much more than 6 m. If this presumption is correct the immediate casualty due to surge in 1737 would not have substantially exceeded 10% of the poulation in the area of significant inundation. But if, on the other hand, we assume that a doubling of surge height at a place would double the mortality ratio (upto, of course, a maximum of 100%) and with that presumed increase in casualty recalculate the overall percentage, we get a figure of about 18%. We take this as the highest possible percentage of casualty among the surge affected people (10% being the lowest) in the entire area under 'significant inundation' during the 1737 storm.

To this we have to add possible deaths outside surge affected area which never exceed ten percent of the total casualty in major cyclones.

We, thus, get a figure for deaths in 1737 between 45,000 (19.8%) and 25,000 (11%) or 35,000 ± 10,000.

7. Delayed effects of surge

Beyond the immediate deaths due to drowning, surge leaves behind two more potential killers—contaminated drinking water sources and lost soil fertility due to saline incursion. The first, almost always, brings in waterborne diseases within a few days and the second very often triggers a famine due to crop failure in atleast the following cropping season.

Casualties due to the diseases have been recorded during our analogue storm of 1864 as also during the equally famous Bangladesh cyclone of 1876. In the former the death due to diseases number more than half that due to drowning and in the latter as many persons died of diseases as due to drowning. In 1737, when public health measures were almost non-existent, it seemed quite reasonable to expect a number comparable to cyclone casualty as death due to diseases. But there is no mention of this in contemporary accounts and we are left to conclude that by some happy accident the surge-affected areas escaped this scourge in 1737.

There was a major famine in 1866 in the area affected by the major storm of 1864. The 1737 storm was no exception. It is recorded (Wilson 1906) that a famine "raged all round the country best part of the year" following the storm. No figure has been quoted but we must record our apprehension that the famine following the 1737 storm must have extracted a considerable toll.

8. Conclusion

The 1737 storm in lower Bengal was of T-7 intensity in D'Vorak's (1984) scale. The loss of life due to this storm is estimated to be thirty five thousand with a margin of uncertainty of ten thousand on either side of that number. Experience of other major storms in the area, notwithstanding, the contemporary accounts do not mention any outbreak of diseases, though these usually follow flooding due to storm surge. The official records, however, speak of a famine as a consequence of the storm but do not give any figure for starvation deaths which must have been quite considerable.

Acknowledgements

I came across the question I have tried to answer here in a book on Calcutta in Bengali by Patree (1979), artist, poet, cineaste, Calcuttaphile and amateur historian. The Indian National Science Academy funded and the Centre for Atmospheric Sciences, University of Calcutta hosted a project of mine of which this work was a part. I received unstinted help from Dr. Durgaprasad Bhattacharya, the eminent social scientist and demographer on population estimates, Parimal Gupta of GSI for the maps, Dr. Amalendu Sen, the noted political historian, for initial direction to possible sources, J. C. Mandal of I. M. D. with computations.

I am indebted to all of them.

References

Bilham, Roger, 1994, "The 1737 Calcutta Earthquake and Cyclone Evaluated," Bull. Seismol. Soc. Am., **84**, 5, pp. 1650-1657.

Census of India, 1961, Report on the population estimates of India, Vol. III, Part B, pp. XLXI, SLXII, Ed. Durgaprasad Bhattacharya, Office of the Registrar General, Govt. of India.

Cohen, S. P. and Raghavulu, C. P., 1979, The Andhra Cyclone of 1977, Vikas Publishing House, New Delhi.

D'Vorak, V. F., 1984, Tropical cyclone intensity analysis using satellite data, NOAA, Tech. Rep. NESDIS 11, p. 47.

Eliot, J., 1900, Handbook of Cyclonic Storms in the Bay of Bengal for the use of Sailors 2nd Edn., India Meteorological Deptt., Calcutta, pp. 210-218.

Frank, N. L. and Husain, S. A., 1971, The Deadliest Tropical Cyclone in History?, Bulletin of American Meteorological Society, **32**, 6, 438 pp.

Gentleman's Magazine, 1738, The Gentleman's Magazine and Historical Chronicle (Monthly), E. F. Jefferies (Printers), London, Vol VIII, 1738, p. 321.

Ghosh, S. K., 1977, "Prediction of storm surge on the east coast of India." *Indian J. Met. Hydrol. Geophys.*, **28**, 2, pp. 157-168.

Gupta. G. R. and Mishra, D. K., 1976, "Estimation of maximum wind speed in tropical cyclone in Indian Seas." *Indian J. Met. Hydrol. Geophys.*, **27**, pp. 285-290.

India Meteorological Department, 1943, Indian Weather Review, Annual Summary, 1943, Part C, pp. 4-7.

Islam M. S. *et al.*, 1992, A case study on April 1991 Cyclone in Bangladesh, Report presented at the Asian Disaster Preparedness Centre, ICWRM Workshop, Dhaka.

Jayanthi, N., and Sen Sarma, A. K., 1988, "Extreme value analysis and the return period of tropical cyclone parameters over maritime States of India", *Mausam*, **39**, 2, pp. 193-196.

Patree, P., 1979, "Purano Kolkatar Kathachitra" (A pen-picture of old Calcutta) in Bengali, Dey's Publishing, Calcutta, p. 162.

Sen Sarma, A. K. 1993, "The Hooghly disaster of 1737—a seismic event ". *The Telegraph*, Calcutta, Oct. 8, p. 9.

Sen Sarma, A. K. 1994, "The Great Bengal Cyclone of 1737 : an enquiry into the legend", *Weather*, pp. 90-96.

Tannehill, I. R., 1945, Hurricanes, Princeton University Press, p. 32.

Wilson, C. R. 1898, "A Contemporary Account of the Great Storm at Calcutta", 1737, *J. R. Asiatic Soc.*, pp. 29-53.

Wilson, C. R., 1906, "Old Fort William in Bengal," John Murray, London, pp. 145-150.