Reprinted from THE LANCET, *May* 13, 1972, *pp.* 1029-1036

EAST BENGAL CYCLONE OF NOVEMBER, 1970

EPIDEMIOLOGICAL APPROACH TO DISASTER ASSESSMENT

ALFRED SOMMER WILEY H. MOSLEY*

Epidemiology Program, Center for Disease Control, U.S. Public Health Service, Atlanta, Georgia 30333, U.S.A., and Epidemiology Division, Cholera Research Laboratory, Dacca, Bangladesh

Summary Two medical relief assessments were carried out in the southern coastal region of East Bengal affected by the cyclone and tidal bore of November, 1970. The first, a rapid 18-site survey, documented the adequacy of existing water supplies and absence of significant post-cyclone morbidity or exceptional levels of epidemic diseases. The second, wider in scope, was done 2 months later, between Feb. 10 and March 4, 1971. Seventy-nine unions in the nine most affected thanas were visited, and 2973 families, comprising 1·4% of the area's population, were studied. Age-specific cyclone mortality ranged from highs of 29% and 20% in the 0–4-year and 70+ age-groups, respectively, to a low of 6% in 35–39-year-olds. Females fared worse than males in all but the youngest age-groups. Mean mortality was 16·5%, representing a minimum of 224,000 deaths. More than 180,000 homes were destroyed by the cyclone, and at the time of the survey 600,000 people were still without adequate shelter. Although post-cyclone morbidity, mortality, and nutritional status compared favourably with a control area, 1,000,000 people were still dependent on outside food relief for survival. At least 123,000 draft animals and 127,000 ploughs were needed before the region could begin to regain agricultural self-sufficiency. The surveys prove the value of early on-the-spot assessments in getting an accurate picture of requirements in disaster areas.

* Present address: Department of Population Dynamics, Johns Hopkins School of Hygiene and Public Health, Baltimore, Maryland 21205, U.S.A.

Introduction

ON the night of Nov. 12–13, 1970, a cyclone and massive tidal bore struck the southern coastal regions of East Bengal in Bangladesh (formerly East Pakistan) (fig. 1), resulting in widespread loss of life and property. Because of difficulties in transportation and communication the severity of the storm went unrecognised by both Government officials and Press in Dacca. When news did reach the outside world, relief supplies and volunteers poured in, but no-one knew the magnitude or geographic distribution of losses and needs. Newspapers reported widespread famine, cholera, and smallpox[1]: if these had been true, they might have meant an even greater disaster than the cyclone. East Bengal is one of the most densely populated and impoverished areas in the world (average per-caput income is less than $70). Medical

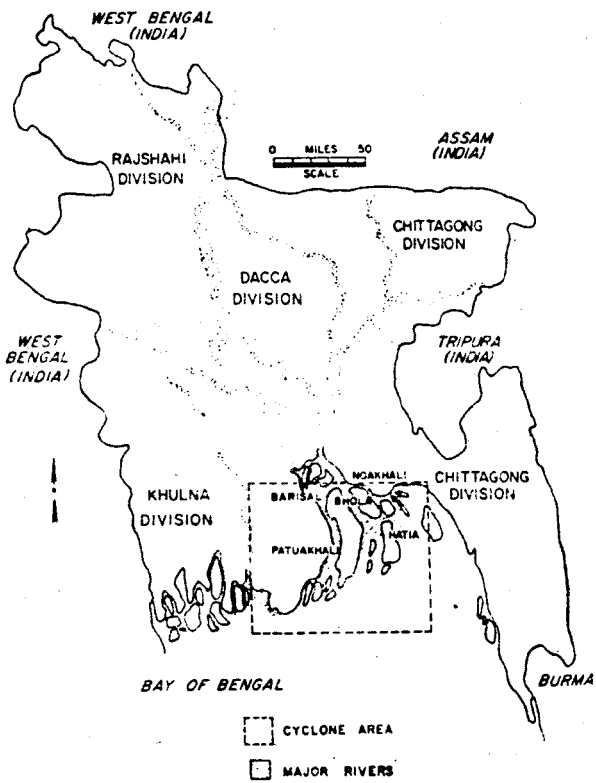

Fig. 1—Cyclone area, Bangladesh.

resources are scarce and, although the soil is surprisingly fertile, the population has long outstripped the area's agricultural capacity.[1]

To permit more rational planning of relief operations, teams from the Epidemiology Division of the (Pakistan-SEATO) Cholera Research Laboratory (C.R.L.) conducted two surveys of the cyclone-affected region. The first, between Nov. 28 and Dec. 2, 1970, was concerned with water supplies and immediate medical needs. It also provided rough estimates of cyclone mortality and housing and livestock losses. The second survey was done between Feb. 10 and March 4, 1971—a delay of 2 months to allow conditions in the cyclone region to stabilise. Designed to serve as the basis for long-range relief and recovery planning, it was much more detailed and embodied the following aims: to compile detailed information about the effects of the cyclone, especially loss of life, housing, and livestock; to assess post-cyclone morbidity, mortality, and nutritional status; to see how effective the recovery programmes had been and to establish guidelines for further relief efforts; and to check on the findings of the first survey and to determine its efficacy as a survey tool.

Materials and Methods

First Survey

The first survey was done by four two-man teams—a Pakistani member of the C.R.L.'s field staff and a medical epidemiologist from the Center for Disease Control in Atlanta, Georgia. The field director (W. H. M.) flew over the entire cyclone region daily, plotting affected areas with respect to remaining population and selecting sampling sites where there were sufficient survivors to warrant investigation.

Teams were transported to these selected areas, usually to centrally located relief centres, where they interviewed individuals about personal losses, village losses, and immediate needs. Conditions and supplies were discussed with local relief officials, and all available ill and injured were examined clinically. Rivers, ditches, ponds, and open wells—the usual sources of drinking-water—were tested for saline content by measurements of electrical conductivity.

Teams summarised their findings each afternoon, and these summaries were collated, edited, and issued nightly to Government authorities. A summary was issued at the end of the survey.

Logistical support was provided by a U.S. Army STRICOM helicopter.

Second Survey

The second survey was done, under the direction of A. S., by ten two-man teams drawn from the C.R.L.'s Bengali field staff.

Cluster sampling was used to ensure uniform coverage of the most severely affected area. Each team spent an entire day in a village, studying at least 20 non-adjacent families (selected to cover an area of 4 sq. miles) and measuring the nutritional status of all village children. Two non-contiguous villages were studied in each of the seventy-two most severely affected unions. The villages were chosen to ensure sampling sites near and distant from relief centres, along the coast and farther inland, and within and outside the embankments, when present. A control area, Gazaria Thana in Dacca District, was surveyed in exactly the same manner for comparison.

The basic unit of study was the family, defined as all members of a household who ate together. Each family underwent a detailed interview with questions chosen to avoid exaggeration, hearsay, and guesses. The questionary had been pretested in a rural area near Dacca, and all questions found to be ambiguous, misleading, or culturally inappropriate had been altered or removed.

Teams made their own assessments of the standing crop, adequacy of housing, and nutritional status of the population. Nutritional status was gauged by means of the "quac stick", a device for comparing the arm-circumference/height relationship in children,[3] the age-group most susceptible to malnutrition.[4] "Norms" were established before the survey by measuring 10,000 children in the C.R.L.'s vaccine field-trial area in Matlab Thana, an area near Dacca unaffected by the cyclone. Two scales of expected arm circumference for height were derived, one for the 50th and the other for the 9th percentile. These correspond to the 84th and 75th percentiles, respectively, of European arm-circumference standards.[5] Each child was assigned to one of three categories—"well nourished", "moderately malnourished", or "severely malnourished".

Logistical support was provided by two small river steamers that served as living quarters, a large sail-driven countryboat for transport of fuel, and five speedboat water taxis. Except when villages were far inland, all teams returned to the launches at night to compare results, discuss problems, and standardise techniques.

The information was coded while we were in the field and the data punched and analysed in Dacca.

Background

Much of the region struck by the cyclone and tidal bore was originally part of the Sundarbans, and had been cleared and settled only over the past 60 years. Silt deposited by the Ganges has made this an agriculturally rich area and has added numerous offshore "chars" (islands), which are now inhabited.

The cyclone area is divided administratively into villages, unions (two to fifty villages), and thanas, containing from two to twenty-five unions. The surveyed area, representing the most severely affected region, covered 2000 sq. miles and contained a precyclone population of about 1,700,000, over 80% of whom are farmers. They depend, for the most part, on the amman paddy, the major rice crop harvested in October and November. Approximately 12% are fishermen, and the rest are clerks, factory workers, and shopkeepers. Their houses, usually with only one room, are constructed of jute sticks and bamboo, with a bare mud floor and roof of straw or, rarely, corrugated iron. Doctors are scarce (about 1 per 110,000 persons), latrines are virtually non-existent, and the only safe water is from relatively scarce tube wells. Most people obtain drinking-water from contaminated surface sources. Only the major towns have electricity.

The area is regularly subjected to cyclonic storms and tidal waves, which usually originate in the Bay of Bengal in the spring and summer. The unseasonal occurrence of the 1970 disaster compounded the tragedy by striking when the rice crop was being harvested, and while 100,000 migrant labourers were living in the fields.

Results

FIRST SURVEY

We sampled eighteen sites, approximating two per thana. The teams usually spent no more than 5 hours at any one site.

Mortality was estimated at 14·2% (240,000); losses of housing and cattle stood at approximately 60%. Cyclone-related morbidity was largely limited to minor bruising, cuts, and an occasional fracture, although one clinical entity, dubbed "cyclone syndrome", was quite common. This consisted of severe abrasions of the chest, arms, and thighs, and testified to the tenacity with which survivors had clung to trees to withstand the buffeting of the tidal bore. There was no evidence of excess smallpox, cholera, or respiratory or other diarrhœal diseases.

Except for one thana, Sudharam, where the surface water was almost undrinkable (0·25–0·5% salt), the salt content was always less than 1 g. per litre, and usually significantly so. In most cases, conductivity of surface water was comparable to that of shallow artesian-well water deemed drinkable by the local populace.

This first survey indicated that food, clothing, and shelter were needed most; water, field hospitals, and vaccinations were far less urgent.

TABLE I—AREA, POPULATION, AND INDIVIDUALS SURVEYED

Thana	Area (sq. miles)	Pre-cyclone* population	Families inter-viewed	Indi-viduals surveyed	% sur-veyed
Noakhali District:					
Hatiya ..	242	219,000	394	2165	1·0
Ramgati ..	251	217,000	391	2686	1·2
Sudharam (part)†	132	35,000	98	648	1·9
Patuakhali District:					
Kalapara ..	165	88,000	392	2339	2·7
Amtali (part)‡	85	41,000	192	1032	2·5
Galachipa ..	423	319,000	754	4951	1·6
Barisal District:					
Tazumuddin ..	129	104,000	95	879	0·8
Lalmohan ..	140	171,000	309	2119	1·2
Char Fasson	210	167,000	348	2406	1·4
Total cyclone area	1777	1,360,000	2973	19,225	1·4
Dacca District: Gazaria .. (control)	40	98,000	475	2904	3·0
Total	1817	1,459,000	3448	22,129	1·5

* To the nearest 1000; estimated by applying a crude growth-rate of 3% per annum to 1961 census data.
† Two unions surveyed.
‡ Three unions surveyed.

SECOND SURVEY†

Sampling Data

This survey was conducted in seventy-two unions in the nine most affected thanas. Population sampling data are presented in table I. Surveyors interviewed nearly 3000 families comprising 1·4% of the estimated precyclone population. In addition, seven unions in Gazaria Thana, an unaffected area, were surveyed for comparison; there, 475 families (3% of the estimated precyclone population) were interviewed.

Cyclone Mortality

Each family interviewed was required to list by name, age, sex, and occupation all members killed in the cyclone, all members still living together, and all members who had been sick, had died, or migrated into or out of the family unit since the cyclone. Thus, we avoided hearsay, guesses, and exaggerations, but arrived at minimum figures, since several groups in which the mortality is presumed to have been extremely high were not represented. These include migrant workers helping with the harvest, families with 100% mortality, and families whose few survivors had left

† Further details, in the form of tables and/or figures, are available from W. H. M.

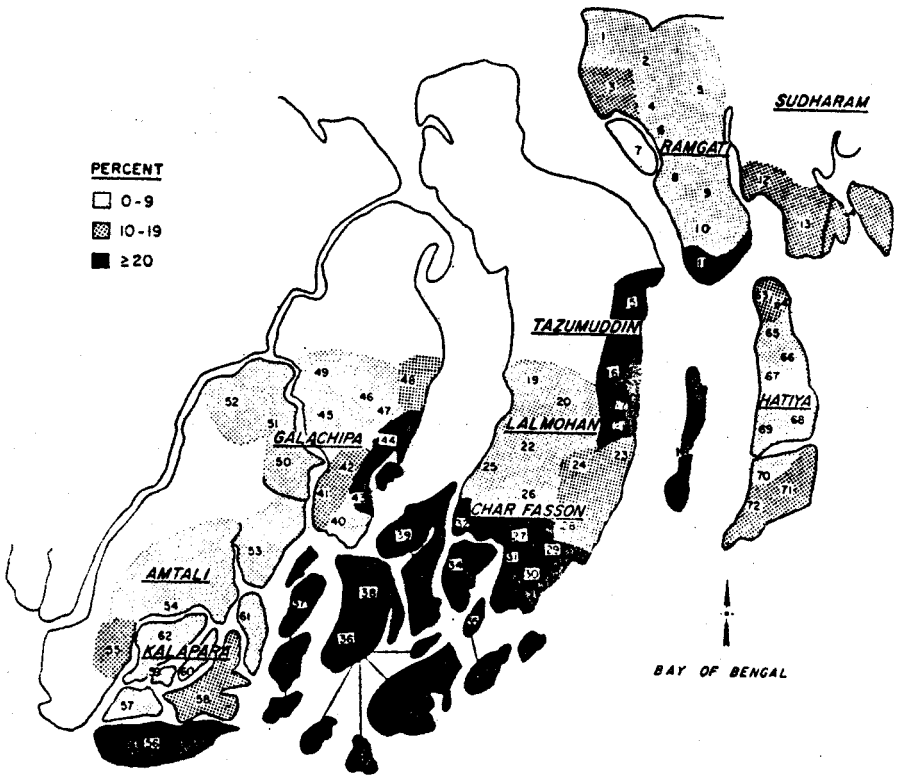

Fig. 2—Cyclone mortality by union.

the cyclone area. 2942 deaths were recorded among the surveyed families.

Mortality ranged from 4·7% in Amtali to 46·3% in Tazumuddin, with a mean for the area as a whole of 16·5%. Total deaths would therefore have numbered, at an absolute minimum, 224,000. By subtracting these deaths from the estimated precyclone population, we estimated the post-cyclone population for the area as 1,136,000. Fig. 2 shows mortality by union.† The areas of highest mortality lie along the Bay of Bengal, the mortality shading probably indicating the path of the tidal bore. On many of the offshore islands everyone died.

The age-specific cyclone mortality-rate for surveyed families is shown in fig. 3. More than half of the deaths were of children under ten, whereas this age-

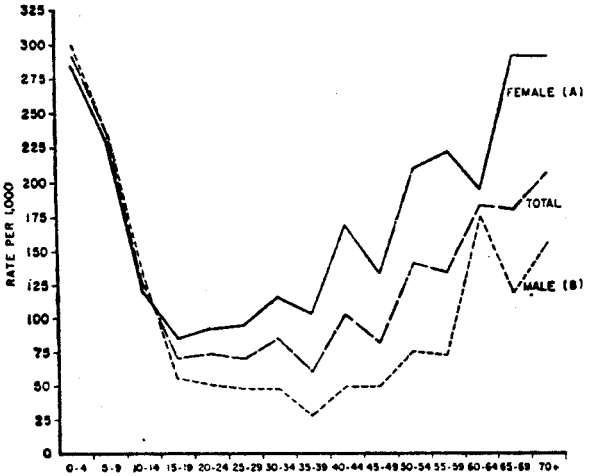

Fig. 3—Age-specific mortality-rates in cyclone-affected area.
(A) Figures for females are based on 1583 enumerated deaths.
(B) Figures for males are based on 1359 enumerated deaths.

group represented only a third of the precyclone population. Males fared better than females in all but the youngest age-groups. The highest survival-rate was that for adult males aged 15–49, which is consistent with the impression that those too weak to cling to trees—the old, young, sick, and malnourished, and females in general—were selectively lost in the storm.

Post-cyclone Morbidity and Mortality

Post-cyclone morbidity and mortality were both relatively low, based on expected experience in East Pakistan. Morbidity was confined primarily to the usual diarrhœal and respiratory-tract diseases.

Mortality for the 3 months after the cyclone and tidal bore ranged from 0·2% in Tazumuddin and Sudharam to 0·6% in Galachipa. During the same period, mortality in Gazaria, the control thana, was 0·5%. Age-specific post-cyclone mortality-rates for the cyclone-affected and control areas were similar, except for the higher mortality for middle-aged residents of the control area.† This probably reflects the elimination of sickly middle-aged individuals from the cyclone area's population at the time of the storm.

Post-cyclone Migration

In the non-affected region more males and females

migrated out of existing families; the reverse was true in the cyclone region. There, more migrated "into" families than out, especially females (ratio 3·5/1).

Fig. 4 emphasises the uniqueness of female migration within the cyclone region. Only females had net migrations "into" families at all ages, the result of family units having lost their male heads seeking the security of kindred families. This illustrates the role of the "extended family" as the Subcontinent's equivalent of social security.

Housing Losses and Needs

Table II presents estimates of housing losses and needs. The total number of families was estimated for each thana by dividing its affected post-cyclone population by the average family size of its surveyed sample. Assuming one house per family provides us with the estimated total number of houses required for minimal shelter. This is an understatement, however, because one family unit often occupies more than one house.

According to villagers' claims, 85% of homes in the surveyed area were severely damaged by the cyclone, compared with 5% in the control area; and we calculated that at least 176,000 homes were severely damaged or entirely washed away. Greatest destruction occurred along the coast and fits the pattern of cyclone mortality.

The teams also made direct assessments of the status of the housing. The average rural Bengali home

TABLE II—HOUSING CONDITIONS

Thana	Pre-cyclone houses*	% of houses severely damaged at time of cyclone	% of houses inadequate at time of survey	Individuals in inadequate housing (to nearest 1000)
Amtali (part)	7800	94·3	66·7	26,000
Hatiya	39,600	89·3	42·4	85,000
Kalapara	14,700	84·4	66·3	53,000
Ramgati	30,900	62·6	31·7	61,000
Lalmohan	24,800	90·3	52·7	80,000
Galachipa	49,000	86·1	65·4	179,000
Sudharam (part)	5200	87·8	48·0	14,000
Char Fasson	23,700	92·5	54·9	62,000
Tazumuddin	10,800	97·9	58·9	33,000
Total	206,500	85·3	52·5	593,000
Gazaria (control)	16,100	5·0	2·7	2600

* Estimated at 1 for each surviving family unit, and rounded to nearest 100.

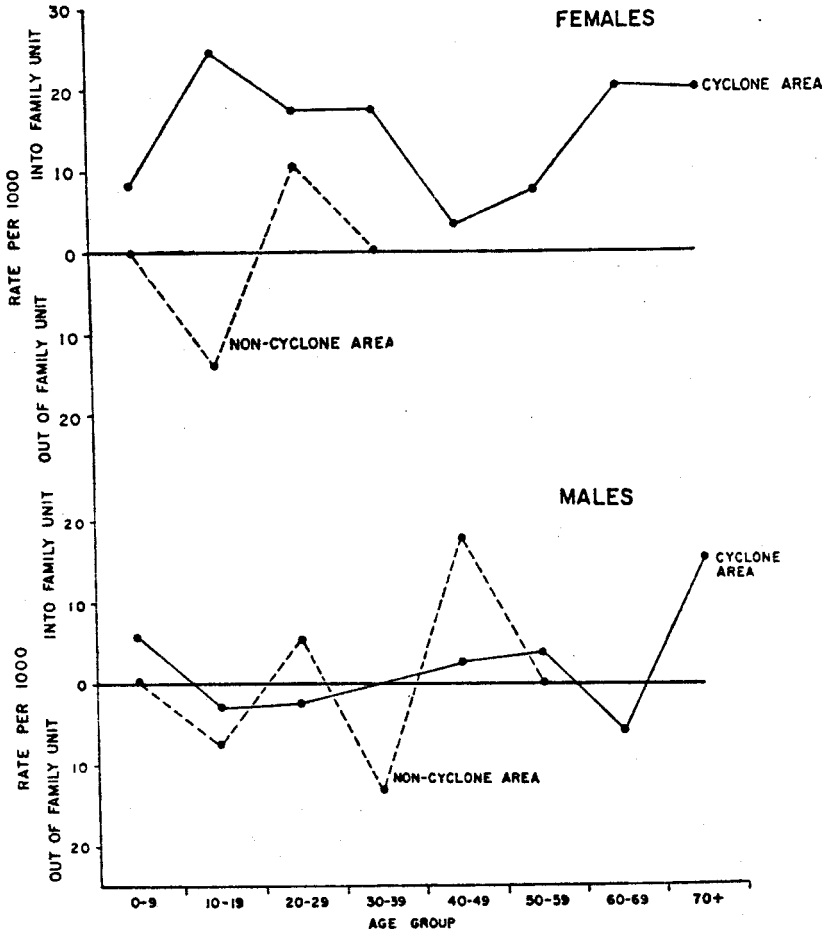

Fig. 4—Age-specific net migration-rates into and out of family unit.

was used as the standard of comparison. " Inadequate housing " usually indicated tiny grass huts, 3 or 4 ft. high and perhaps 6 ft. long. The percentage of inadequate homes ranged from 32% in Ramgati to 67% in Amtali, with a mean for the area of 53%. This represents a need for at least 108,000 new houses. The number found inadequate is approximately two-thirds of what villagers claimed, retrospectively, to have been destroyed or severely damaged in the cyclone. Although some of this discrepancy undoubtedly represents exaggeration, many of the homes that had

TABLE III—SOURCE OF FOOD AND NUMBER OF MEALS EATEN

Thana	Receiving food from relief		Receiving > 50% of food from relief		Mean meals preferred	Mean meals eaten
	%	No.	%	No.	No.	No.
Amtali (part)	76·6	30,000	14·1	5500	2·9	1·9
Hatiya	50·5	102,000	2·5	5000	3·0	1·6
Kalapara	98·5	79,000	14·0	11,200	2·9	2·0
Ramgati	50·9	98,000	2·8	5400	2·9	2·2
Lalmohan	93·2	141,000	20·4	30,900	3·0	1·9
Galachipa	88·5	243,000	16·0	43,900	2·9	2·2
Sudharam (part)	93·9	27,000	43·9	12,600	3·0	2·3
Char Fasson	69·8	79,000	17·5	19,900	3·0	2·0
Tazumuddin	100·0	56,000	42·1	23,600	3·0	2·0
Total	75·2	854,000	13·9	157,900	2·9–3·0	2·0
Gazaria (control)	0·8	790	0·2	200	2·7	2·1

been destroyed had also been rebuilt, especially in the more northerly, less affected areas. While the bamboo and sheeting distributed by the Government proved adequate to repair the roof or side of a house in the areas to the north, they were wholly inadequate for rebuilding the entire structure, as was necessary in the more devastated areas. Fig. 5 maps the percentage of houses found inadequate on a union-by-union basis.

Nutritional Status

To assess the nutritional status of the population we asked questions about the number of people on food relief and how dependent they were on it. The results are shown in table III. 75% of the population (854,000) were receiving food relief regularly, and 158,000 were receiving more than half of their food supply in this way. If " meals eaten per day " reflects the level of food intake, then there was no difference between the cyclone-affected and the control areas, suggesting that the food-relief programme was adequate.

This interpretation is supported by the results of the more objective assessment of nutritional status made by means of the quac-stick (table IV). Every child measured was placed in one of the three nutritional categories based on European standards. The most reliable data in table IV are probably the percentages of children with " normal nutrition ". The cyclone-affected and Gazaria control areas both appear to be better nourished than the Matlab vaccine field-trial area. There are probably two reasons for this relatively

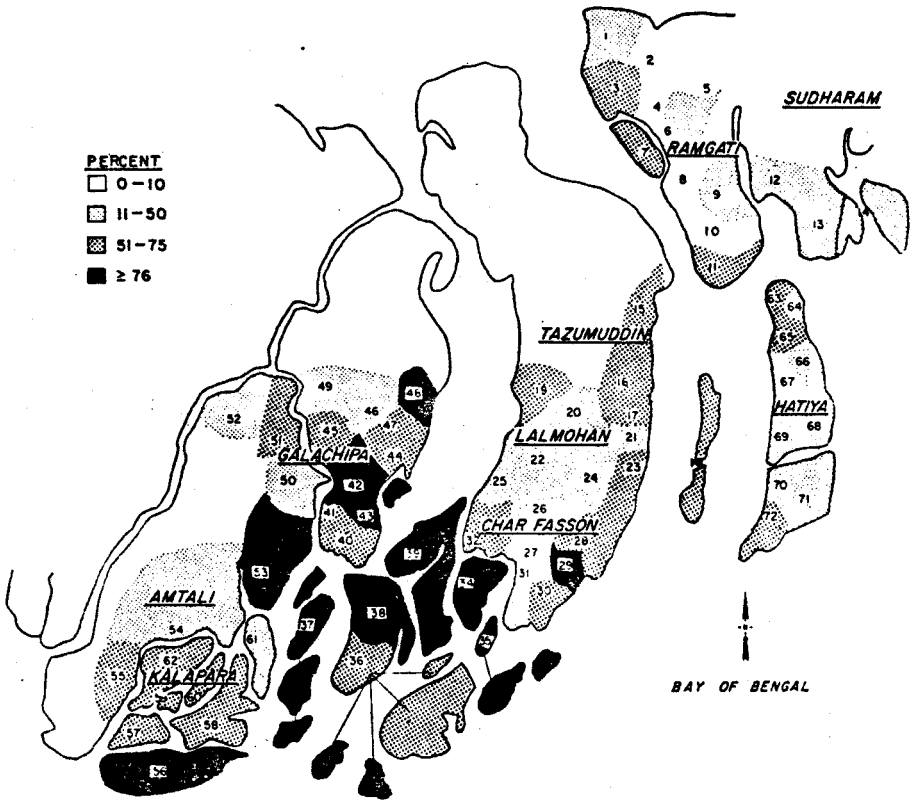

Fig. 5—Percentage of housing found inadequate.
The unions are numbered 1–72.

good showing in the cyclone region compared with the Matlab "norms"—the coastal region is a richer, rice-surplus area, and the population was better nourished than the Matlab Thana before the cyclone, and the cyclone had washed away the sickest and least well-nourished children, leaving a relatively healthy population behind. Indeed, the surviving children in the cyclone area seemed to be the healthiest and best nourished we had ever seen in East Bengal.

The percentage of people claiming to have had some protein intake during the week before the survey † was also relatively uniform, with an average of 84% of the population in the cyclone area having eaten fish or eggs, compared with 86% in the Gazaria control area.

TABLE IV—QUAC STICK ASSESSMENT OF NUTRITIONAL STATUS

Thana	Children measured	Nutritional status* (%): Normal nutrition	Moderately mal-nourished	Severely mal-nourished
Amtali (part)	623	59·6	33·1	7·4
Hatiya	1948	65·2	30·8	4·0
Kalapara	1205	63·7	31·9	4·4
Ramgati	3043	52·1	41·1	6·8
Lalmohan	769	59·4	33·6	7·0
Galachipa	3267	60·9	34·3	4·7
Sudharam (part)	497	59·4	34·0	6·6
Char Fasson	1227	60·0	36·8	3·3
Tazumuddin	..	..	..	..
Total	12,579	60·0	34·5	5·5
Gazaria (control)	2134	60·3	33·0	6·7
East Bengal "norms"	10,000	50·0	41·0	9·0

* ≥84% of European standard for arm circumference ("normal"), 75–83% ("moderately malnourished"), <75% ("severely malnourished").

Rarely did anyone admit to having eaten meat during the past month, but this is not atypical for rural East Bengal.

Agricultural Potential†

Before the cyclone the land holding was 1 acre per person in the cyclone-affected area but only 0·3 acre per person in the control area, consistent with the fact that the cyclone-affected area is more recently settled and still retains a relatively low population den-

TABLE V—LAND CULTIVATION

Thana	Decimals* cultivated per person	Decimals* in rice per person
Amtali (part)	1·08	0·00
Hatiya	4·40	0·00
Kalapara	2·53	0·27 (*10·6%*)
Ramgati	14·40	0·05 (*0·4%*)
Lalmohan	10·12	2·12 (*20·9%*)
Galachipa	7·84	0·35 (*4·5%*)
Sudharam (part)	5·05	0·02 (*0·4%*)
Char Fasson	10·85	0·00
Tazumuddin	8·48	1·67 (*19·8%*)
Mean for cyclone area	8·30	0·48 (*5·5%*)
Gazaria (control)	6·24	1·97 (*31·6%*)

* 100 decimals equal 1 acre.

sity (by East Bengal standards). The percentage of land under cultivation at the time of the survey is rather striking: 21% in the control area, but only 6·4% in the cyclone region.

Land cultivated per survivor in the cyclone area compares favourably with that being cultivated in the Gazaria control area (table v), but the area planted in rice, the dietary staple of the population, was much lower for the cyclone area than for Gazaria. The remaining cultivated land in the cyclone-affected area was primarily sown in lentils and mustard, which do not require ploughing.

The reasons given for the lack of cultivation varied from a belief, or actual demonstration, that the land had been ruined by the saline and would no longer support crops, to the claim that labourers preferred receiving free food relief to working in the fields. The most common explanation, however, was a lack of seed, ploughs, and, most importantly, bullocks and buffaloes. The proportions of farmers with no draft animals ranged from 30% in Ramgati Thana to 80% in Tazumuddin, with a mean of 57% for the cyclone area as a whole, and 17% for Gazaria. A somewhat more objective and quantifiable estimate of the needs are also presented in table VI. Rather than ask each farmer to list the numbers of bullocks and buffaloes that he lost in the storm, or the ones that he would need in order to cultivate his land (all of which would be open to exaggeration), we counted bullocks and buffaloes owned by each farmer. By comparing these figures with land owned or worked, we derived the

TABLE VI—REQUIREMENTS FOR DRAFT ANIMALS AND PLOUGHS

Thana	% of farmers with no draft animals	Draft animals/ 100 acres	Ploughs/ 100 acres	Animals required for 25/ 100 acres*	Ploughs required for 20/ 100 acres*
Amtali (part)	53·7	8·8	3·4	25,100	25,700
Hatiya	43·0	20·2	10·7	6600	12,800
Kalapara	60·3	12·6	6·9	12,700	13,400
Ramgati	30·1	19·8	10·8	4000	7100
Lalmohan	65·7	12·2	8·4	9200	8400
Galachipa	59·3	14·6	8·6	22,500	24,600
Sudharam (part)	62·5	7·8	6·4	8400	6700
Char Fasson	76·5	5·4	4·0	19,800	16,000
Tazumuddin	79·7	5·5	3·4	14,800	12,600
Mean for cyclone area	56·9	12·8	7·4	123,100	127,400
Gazaria (control)	16·9	25·1	20·0	..	..

* Calculated to nearest hundred.

ratio of the bullocks and buffaloes available per 100 acres, and found it to be 12·8 bullocks and buffaloes per 100 acres for the cyclone-affected area. To attain the draft-animal and plough density of the control area the cyclone-affected thanas would require at least 123,000 animals and 127,000 ploughs.

Fishing Potential

The percentages of working heads of household who were fishermen were similar for the two areas, as were the percentages of fishermen who were not fishing at the time of the survey (table VII). On the other hand,

TABLE VII—STATUS OF FISHING INDUSTRY

Thana	% head of household fishermen	% of fishermen not fishing	% of those not fishing for lack of equipment
Amtali (part)	6·9	61·5	100·0
Hatiya	10·9	22·5	100·0
Kalapara	11·0	46·3	100·0
Ramgati	16·1	21·7	53·8
Lalmohan	10·8	36·7	100·0
Galachipa	10·5	44·7	91·2
Sudharam (part)	2·2	100·0	50·0
Char Fasson	9·5	64·5	90·0
Tazumuddin	10·3	22·2	100·0
Mean for cyclone area	11·1	38·7	87·7
Gazaria (control)	8·8	26·3	30·0

when asked the reason for not fishing, 88% in the cyclone area claimed it was for a lack of boats and nets, while only 30% of those in the control area made that claim. The similarity in percentage of fishermen not fishing in the cyclone and control areas suggests that a large percentage of these claims were exaggerated.

Relief and Rehabilitation

It was impossible to assess the degree of rehabilitation achieved, since we lacked detailed data on the levels of destruction and dislocation at the time of the cyclone. What we were able to assess was the present self-sufficiency in food production, adequacy of housing, and future needs on a union and thana basis. These data have already been presented. In addition, we asked questions about the numbers of people receiving and the amounts received of money, bamboo, sheeting, draft animals, and so on.† Except for

money the amount received was either unquantifiable or negligible (no-one reported having received ploughs or draft animals). The major relief distributed, besides food, was money dispensed for specific purposes, such as purchase of seed or building materials, but in fact spent on food. The percentage of those receiving money was 76% in the cyclone-affected area versus 2·5% in Gazaria. Approximately 24 million rupees ($2·4 million, £1 million) was distributed in the cyclone area.

Discussion

While the magnitude of the disaster in East Bengal was unusual, its occurrence was not; it is not uncommon for natural and man-made disasters to strike areas of high population density and low communication and transportation capabilities. In the past, these logistical difficulties, combined with the relative poverty of the countries involved, precluded active intervention on any meaningful scale. This is no longer the case. The international community has become increasingly committed to relief activities (as evidenced in Nigeria [4] and now the Subcontinent), while modern means of transport (amphibious craft, helicopters, landing barges) can assure delivery of supplies under the most difficult field conditions.

What these new relief capabilities need are rapid, accurate methods of assessing the extent of damage and immediate medical and supportive needs of an area. In addition, disasters with long-term relief and rehabilitative consequences require continued monitoring and repeated reassessments long after the initial relief phase has ended.

Faced with just such a disaster in East Bengal, involving 1,500,000 people spread over 2000 sq. miles, we utilised two very different approaches to these problems. In the initial survey, carried out by four teams in as many days, reports were issued the day an area was surveyed, and a final summary report within 1 week. Primary concerns were the urgent medical questions of cyclone-related morbidity and post-cyclone epidemics; with their absence documented, large sums of money were diverted from the establishment of unnecessary field hospitals to the more important needs of food, clothing, and shelter. In addition, the survey provided relatively accurate

TABLE VIII—COMPARISON OF RESULTS OF FIRST AND SECOND CYCLONE SURVEY

Thana	Mortality (%)		Housing loss (%)	
	Survey 1	Survey 2	Survey 1	Survey 2*
Kalapara	15	9	80	84
Amtali	5	5	90	94
Galachipa	20	14	90	86
Tazumuddin	30	46	90	98
Hatiya	5	8	20	89
Ramgati	10	11	50	63
Sudharam	25	17	80	88
Lalmohan* / Char Fasson	15	22	50	91
Mean for cyclone area	14·2	17·5	60·4	85·3

* Said to have been lost at the time of the cyclone.

estimates of cyclone mortality and housing losses. These are summarised in table VIII along with the findings of the second study for comparison.

By delaying the second, detailed survey by 2 months, to permit stabilisation of conditions within the cyclone region, we were better able to establish baseline conditions and the requirements for outside relief. The initial survey had demonstrated significant lack of housing and rampant despair throughout the area, but 2 months later we found that the housing situation had improved considerably, especially in the more northerly areas, and that large numbers of farmers and fishermen had returned to work.

This study, requiring 3 weeks of field work by ten teams, visited 180 villages and studied 3500 families. While this represents a total duration of only 5 weeks from outset to final report, the time could have been further shortened by changes in transportation and interview technique. More than half the time in the field was spent in moving the slow river steamers from place to place and travelling miles inland on foot. While this demonstrated the feasibility of using locally available means of transport, it slowed our progress.

The number of sites and individuals required for adequate sampling is a function, not only of the size and extent of the disaster, but also of the administrative and geographic levels at which information is required. The first, rapid study covered only eighteen areas and arrived at reasonably accurate estimates of mortality,

losses, and relief requirements for the affected region as a whole, as well as for the individual thanas. The second survey covered ten times as many locales and provided information down to the union level. This more detailed approach is necessary when contemplating or supporting major relief operations.

Lessons learned in the course of our work relevant to the planning of future disaster surveys are worth reviewing. All interview questions were pretested for clarity, quantifiability of answers, and cultural compatibility. The teams were trained by one person, who reviewed their work daily for at least 3 days to ensure standardisation of techniques. Maps of the area were studied beforehand and the villages were chosen to include a variety of conditions within each union, with inaccessible areas being specifically visited rather than avoided.

Surveying a control area for comparison proved essential in determining the agricultural capabilities and requirements, nutritional status of the population, and post-cyclone morbidity, mortality, and migration patterns within the affected region. The quac stick provided a rapid means of assessing the nutritional status of the population and baseline levels against which future measurements could be compared.

The first survey was conducted with the help of Colonel Rex Davis, M.C., U.S. STRICOM, and Dr. Paul B. Dean, Dr. John N. Lewis, and Dr. John M. Leonard, Epidemic Intelligence Service (E.I.S.) officers from the Center for Disease Control, Atlanta, Georgia. Dr. Matthew S. Loewenstein, of the E.I.S., established arm-circumference standards used in the second survey, while Dr. Kenneth Bart, C.R.L., participated in both surveys. The following members of the C.R.L.'s staff offered inestimable service: Mr. K. M. A. Aziz directed the local field workers; Mr. Alauddin Chowdhury carried out the demographic and statistical analysis; and Mr. Nuran Nabi coordinated administrative activities.

Requests for reprints should be addressed to W. H. M.

REFERENCES

1. *New York Times*, Nov. 22, 1970.
2. McClure, R. S. Disaster Relief memo no. 4: East Pakistan—Civil Strife and Cyclone Victims. U.S. Agency for International Development, Aug. 23, 1971.
3. Arnhold, R. *J. trop. Pediat.*, 15, monograph no. 8, p. 243.
4. Foege, W., Conrad, L. IKOT IBRITAM Nutritional Project: report to the International Committee of the Red Cross, March, 1969.
5. Jelliffe, D. B. *W.H.O. Monogr. Ser.* 1966, no. 53.
6. Aall, C. *J. trop. Pediat.* 1970, 16, monograph no. 9.