REPORTS AND COMMENTS

Environmental Health and the 1991 Bangladesh Cyclone

BILQIS A. HOQUE, R. BRADLEY SACK, MIZAN SIDDIQI, ALAM M. JAHANGIR, NAZRUL HAZERA and ALI NAHID

A brief post-disaster study was undertaken soon after the cyclone of 1991 in Bangladesh to make a preliminary assessment of existing environmental health conditions. Eighty affected people and 26 relief personnel from the affected areas were interviewed. Faecal coliform counts, salinity conductivity and pH values were determined for 43 water samples from tubewells and ponds. The quality of 32 samples of water purifying tablets was also tested.

Water scarcity was acute, especially water used for washing and personal hygiene. The situation was made worse by the fact that the surface water sources (ponds) which were commonly used for domestic purposes other than drinking were flooded, highly contaminated and regarded as unusable. The user load on existing tubewells doubled, indicating a significantly increased demand for the tubewell water which is commonly used for drinking purposes only. The majority (63 per cent) of the water purifying tablets were found to have lost potency. Sanitation was very poor in households as well as in field clinics and shelters. Most people, including relief personnel, lacked environmental health knowledge. Suggestions regarding immediate preparations for disaster relief include: restoring water systems (tubewells and ponds), training courses for relief personnel, standardizing of water purifying tablets, promoting appropriate water use and its treatment, maintaining sanitation in clinics and shelters and improving the skills and resources of local people to enable them to cope with the situation.

The United Nations General Assembly, through its Resolution 44/236 of 22 December 1989, proclaimed the International Decade for Natural Disaster Reduction, beginning 1 January 1990. In accordance with this recognition and interest shown by the international community, countries like Bangladesh, where cyclones, floods and tornados are almost annual events, are encouraged to undertake short-term and long-term programmes to control disaster-related problems.

One such disaster related problem is the frequent occurrence of post-disaster diarrhoea epidemics (Siddique et al., 1991; Kafiluddin, 1991; Aziz et al., 1990; Nehal, 1992; Woodruff, et al., 1991). The association between water, sanitation and diarrhoea transmission is well known (Esrey et al., 1985; Briscoe, 1981; Shuval et al., 1981).

The presence of high quality water or the provision of clean drinking water will not, alone, prevent diarrhoea out-breaks in areas where parallel routes of diarrhoea transmission exist (Briscoe, 1981; Shuval et al., 1981), such as food, soil, fomites and hands. These relationships gain extra importance after a disaster when many of the normal sanitary provisions have been destroyed or disrupted (Kafiluddin, 1991).

In this paper we describe the environmental health situation in specific areas of Bangladesh after the 1991 cyclone. We focus on the following issues: (1) the effect of the cyclone on the availability and use of domestic water; (2) the quality of the available water as perceived by the users and as measured according to specific microbiological and chemical parameters; (3) the treatment of the water being used; (4) the prevailing sanitation; and (5) the level of knowledge and the attitudes of relief personnel regarding appropriate environmental health measures. All of these issues have health implications and the findings may be useful in planning disaster preparedness and management programmes.

BACKGROUND

Bangladesh is situated at the northern end of the Bay of Bengal and is directly in the pathway of pre- and post-monsoon cyclones that are generated by tropical atmospheric conditions at sea. Statistics available from 1958 show that the country has been affected by many severe natural disasters and that on at least 25 occasions the loss of human life has exceeded 500 (Ministry of Health and Family Welfare, 1992).

Diarrhoea is endemic in Bangladesh and is the single greatest cause of death among children under 5 years of age (UNICEF, 1987). Although surface water is abundantly available and conveniently accessible for domestic purpose throughout most of the year, it is heavily contaminated with faecal matter and bacteria (UNICEF, 1987; Rahim et al., 1985). The recommended source of domestic water is therefore tubewells (UNICEF, 1987).

A recent survey showed that more than 80 per cent of people take drinking water from tubewells and use surface water for other domestic purposes, like bathing, washing, cooking. A public tubewell serves, on the average, 60 people in rural areas but as many as 123 in coastal areas (Mitra and Associates, 1992). Private tubewells also make significant contributions to the water supply (UNICEF, 1987; Mitra and Associates, 1992). Fewer than 70 per cent of people dispose of excreta in sanitary ways.

On the night of 29 April, 1991 a large cyclone and tidal wave hit the coastal belt of the country. The central overcast cloud had a diameter exceeding six hundred kilometres making it more than twice the size of Bangladesh (Ministry of Health and Family Welfare, 1992). The maximum wind speed (estimated from the NOAA — II satellite picture) at 13.88 on 29 April was about 240 km per hour. Although almost the entire coastal belt of the country felt the effects of this fury, the north-eastern part of the country suffered the most. Morbidity and mortality within the first 3 weeks of the cyclone were mostly related to a large number of drownings and injuries (138,849), diarrhoeal diseases (more than 100,000 cases with almost 780 recorded deaths due to diarrhoea in the affected areas) and nutritional deficiency diseases (a rise of about 20 per cent in the most affected areas) (Ministry of Health and Family Welfare, 1992). It is estimated that nearly 140,000 people lost their lives during this cyclone. The maximum number of casualties was reported from the Division of Chittagong and from Cox's Bazar and Noakhali districts (Ministry of Health and Family Welfare, 1992; Operation Sheba, 1991).

METHODS

We visited some specific cyclone-affected areas of Chittagong Division on May 11–14

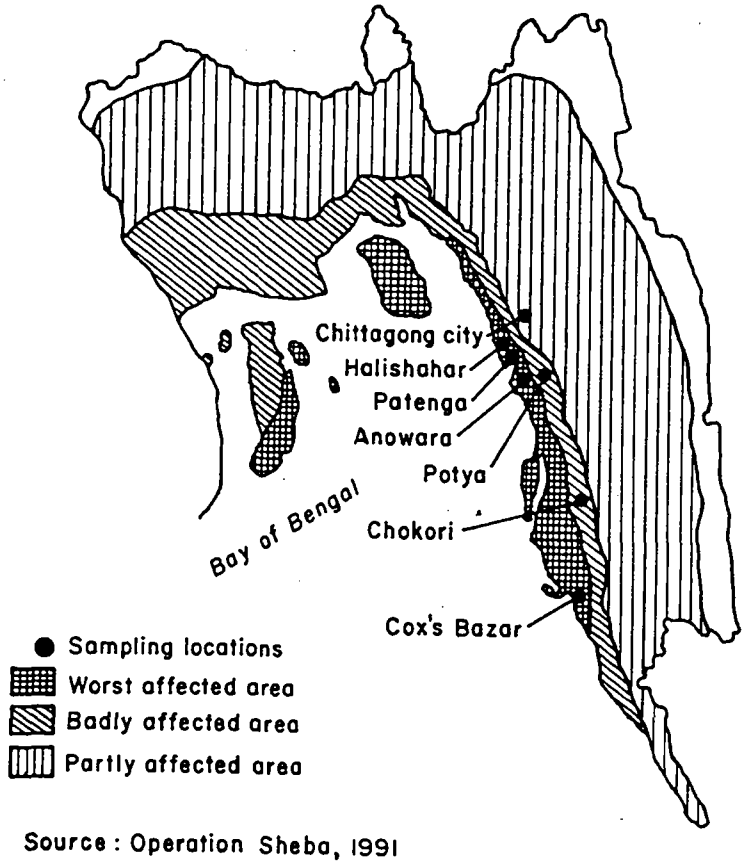

FIGURE 1 *The area affected by the 1991 cyclone and tidal surge, Chittagong Division, Bangladesh*

and again on 18–21, 1991. After the cyclone the government of Bangladesh had identified and graded areas, in descending order, according to the severity of the damage (Operation Sheba, 1991). Based on logistic provisions and accessibility to the areas we selected several sites from the worst affected areas (Grade I): Anowara, Cox's Bazar, South Patenga, and South Halishahar; from badly affected areas (Grade II): Potya and Chokori; and from partly affected areas (Grade III): sites located within Chittagong City. Sites in Anowara, Cox's Bazar, Potya and Chokori were in rural areas and the rest were in urban areas (Figure 1).

We interviewed 26 relief personnel from governmental and non-governmental organizations (NGOs) whom we met at Division Headquarters and at the affected sites. Using an open-ended interview these personnel from government administration, public health, engineering and medical institutions and NGOs were asked to comment on existing environmental health conditions, related needs, and appropriate measures required to improve the situation.

We interviewed 80 local people in shelters and clinics (field clinics and Chittagong City Children's Hospital) and 17 in households (housewives or other female members), using a semi-structured questionnaire. We asked these people to comment on their existing water supplies and sanitation-related provisions and practices.

We noted the following water sources in the affected areas: 12 flooded tubewells, 15 non-flooded tubewells, 11 flooded ponds,

5 dewatered ponds and 5 piped water taps. We collected water samples from these sources and performed the following specific water quality tests which were feasible under the existing conditions: pH, faecal coliform counts, conductivity and salinity. Faecal coliform counts were done following standard techniques (American Public Health Association, 1985). Salinity, conductivity and pH measurements were determined by using portable metres. These tests were done on-site or at a special temporary laboratory established at the Environment Pollution Control Office, Chittagong City. Some equipment, and chemicals and media were brought from the International Center for Diarrhoeal Disease Research, Bangladesh (ICDDR, B), which is located in Dhaka about 120 miles away from the affected areas, and we shared locally available equipment.

In order to determine the quality of the water purifying tablets which had been distributed, we collected sample tables (16 lots in all), from all the organizations visited and from local people who still had them at home. Two tablets, considered as one unit, were selected randomly from each lot and tested separately. A lot was recorded as acceptable if both of the tablets showed acceptable results. This test was done by determining their residual chlorine, (in chlorine based tablets) and determining their ability to reduce bacterial counts in water from commonly used non-flooded ponds. A tablet was considered to have lost potency when it showed no residual chlorine and/or failed to disinfect water to the acceptable standard of nil faecal coliforms per 100 ml of water. The tablets which were distributed by ICDDR,B and were designated as acceptable, were found to reduce the counts in pond water from 10^5 faecal coliform per 100 ml to nil faecal coliform per 100 ml.

WATER SUPPLY AND USE

Tubewells

Scarcity of water was observed and reported in all the affected areas. It was more prominent in the areas where the surface water sources were flooded. During our visit an average of 430 people depended on a single tubewell in Grade I areas, 364 in Grade II areas, and 112 in Grade III areas. Before the cyclone, these averages were 182, 156 and 89 respectively.

After the cyclone, people in Grade I areas and in areas where the ponds were flooded used tubewell water for all purposes. It was reported that more than 70 per cent of people normally used tubewell water for drinking purposes and less than 20 per cent for other domestic purposes. Surface water was used for most purposes other than drinking. Long queues and long distances to tubewell sites were cited as common problems. Of the five tubewell sites visited in Anowara, water was being sold at two privately owned ones. The owners said that they were collecting the money that they had spent on repairing their tubewells and that after recouping their losses, they would not continue to sell water.

The average number of people per tubewell was smaller in the city (78) than in rural areas (360), but water was still being transported by trucks or tankers from the Chittagong relief centre, which had been established near the Stadium. Whenever transported water was available it was stored and used for drinking, while tubewell water, which could have been made available, was discarded.

Many tubewells were damaged during the cyclone and tidal surge. We could not determine the number of existing and damaged tubewells, but published data suggest that out of 223,750 tubewells in the affected areas, 84,362 (38 per cent) were affected (Ministry of Health and Family Welfare, 1992). This resulted in a substantially increased load on existing tubewells and, ultimately, a severe shortage of water.

We were informed by the local Public Health Offices and NGOs in the affected

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Water source
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Non-flooded tubewells (15)
Flooded ponds (11)
Dewatered ponds (3)
Non-flooded ponds (5)

* Measured in microm
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areas that tubewell repairs, resinking and installation activities were being undertaken round the clock at greatly increased levels. Preference was being given to the installation or repair of public tubewells; private tubewells were mostly being repaired by their owners. In general, however, there was a lack of local resources and people depended on external help for spare parts and skilled labour.

Surface water

Local attempts to restore surface water were noted in several locations. NGOs helped to dewater four ponds, three in Anowara and one in Patenga. Dewatering involves pumping out the ponds and allowing them to refill naturally. People were seen to be using water from the dewatered ponds as they would during normal periods.

WATER QUALITY

In flooded ponds the normal colour of the surface water changed to brownish or blackish and appeared to be grossly contaminated. Corpses were seen in a few ponds. These ponds were considered by the local people to be unusable for any purpose; any contact with the water was thought to cause skin diseases.

The physico-chemical measurements of the water samples from different sources clearly indicate that the quality of the water was markedly affected by flooding (Table 1). It is possible that the quality of the water from flooded tubewells improved as large volumes were pumped out (UNICEF, 1988). The ponds showed the highest salinity (and contamination); there were no outlets from those sources, and the sea water and other contaminated water was trapped. As expected, the quality of the water samples from dewatered ponds was better than from flooded ponds.

The bacteriological quality of the water samples from different water sources is shown in Figure 2. Although the quality of water from flooded tubewells was poorer than from non-flooded tubewells, it was far better than from either flooded or dewatered ponds. The faecal coliform counts of water in dewatered ponds and

TABLE 1
Specific physico-chemical qualities of water in flooded and non-flooded areas

	pH		*Conductivity**		*Salinity***	
Water source	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*
Flooded tubewells (12)	7.40	0.3	3542	2113	1.7	10
Non-flooded tubewells (15)	6.7	0.2	1052	292.7	0.4	0.2
Flooded ponds (11)	7.4	0.2	22708	4615	12.2	3
Dewatered ponds (3)	7.4	0.3	1762	1530	3.0	1
Non-flooded ponds (5)	—	—	396	108.3	—	—

* Measured in micromhos per centimetre
** Measured in parts per thousand

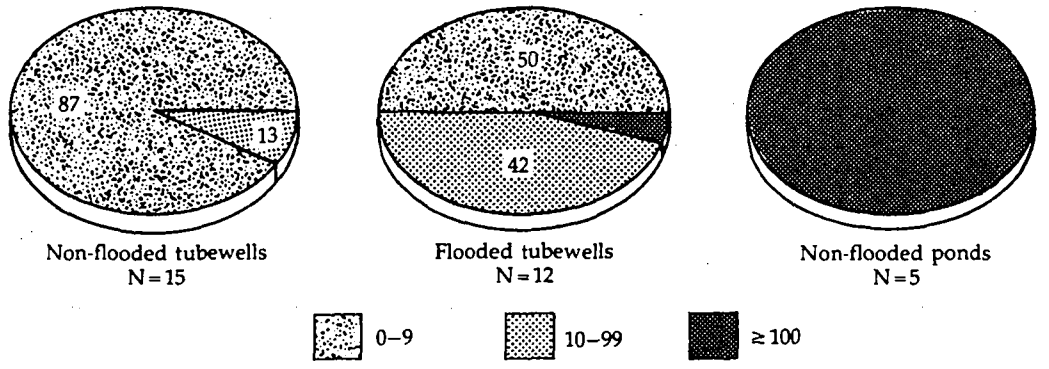

FIGURE 2 *Percentage distribution of faecal coliform concentrations (colonies/100 ml.) by source of water*

non-flooded ponds were similar to flooded ponds, ranging from $10^4 - > 10^6$/100 ml.

At the water transporting centre (in Chittagong City) we saw containers being filled with piped water without having been cleaned properly; we did not test the quality of the water but tested the quality of piped water from 5 different taps at different locations in the affected areas of the city. The piped water is supplied by the Chittagong Water and Sanitation Authority. These tests showed faecal coliform counts of 8–20/100 ml (mean = 12 colony/100 ml) and nil concentration of residual chlorine. Piped water, like any water with no residual chlorine, carries the risk of higher bacteriological contamination with the passage of time and if the containers are contaminated the quality may become as bad as other water.

WATER TREATMENT

Most of the people were aware of water purifying tablets. The majority of those interviewed (62 per cent) had received some tablets but they were inadequately distributed and handled. Between 1 and 10 tablets were received per family. People could not give us an accurate number because family members often received them separately.

The tablets were of many different strengths and were assigned to be used with different quantities of water and contact times. About 56 per cent of the tablets were to be used in 25 or more litres of water, 33 per cent in 1 litre of water, and the rest in 5 and 10 litres of water. Sixty-three per cent of the tablets required 30 minutes of contact time, 21 per cent required 10 minutes and the rest less than 10 minutes. Sixty-three per cent of the 32 tablets from 16 lots tested were found to have lost potency in spite of the fact that all of them had expiry dates beyond 1991. There were three cases of members of the same family using tablets from the same lot in different ways. One woman, for example, said that she used 1 tablet in 25 litres while another member of the same family drank a glass of water with 1 tablet. Different contact times were also reported.

The boiling of water was reported to have been promoted through the public media but it was rarely practised. Because the majority of people in the severely affected areas were still displaced, they found it impossible to boil water. The majority of people reported that they could not afford to boil water and were unaware of other household water treatment methods, such as the use of bleaching powder or alum.

SANITATION AND HYGIENE

Sanitation was generally very poor. Sanitary household latrines were rarely seen and

even those houses which had recently been reconstructed with help from the relief organizations did not have them. Personal and kitchen hygiene were less than optimal because of the shortage of usable water. More than 70 per cent of people in Grade I and Grade II areas reported that, for several days, they had not practised, or had practised inadequately, such personal hygiene measures as hand washing, bathing, washing clothes and washing utensils.

None of the three shelters or five relief centres visited, which could hold several hundred people, had sanitary provisions for defecation or waste disposal. Furthermore, the two field medical clinics visited, which were treating in-patients with diarrhoea, did not have sanitary latrines or sanitary mechanisms for the disposal of effluent or waste from patients.

ENVIRONMENTAL HEALTH KNOWLEDGE AND THE ATTITUDES OF RELIEF PERSONNEL

Relief personnel helped mainly in repairing and sinking tubewells, distributing water purifying tablets and cleaning corpses. Interviewees admitted that they had not promoted, and/or were inadequately knowledgeable about, environmental health measures appropriate to the situation. Those who were distributing water purifying tablets did not know how they should be used. In Halishar and Aonowara relief centres and Chokori clinic we saw loose containers and open packets of tablets, which had been sent to them in bulk quantities, lying on tables. The tablets were being distributed loose and with no instructions about storage. Bleaching powder was present in all clinics and several local offices of relief organizations. It was presumably intended to disinfect living areas, wells and ponds. The powder was stored loose, however, and was often wet from rain. Those interviewed were also unaware how to treat water sources with bleaching powder.

DISCUSSION

Interventions following the 1991 cyclone were similar to those following previous natural disasters. These included the dispatching of medical teams, the organization of water transport, the supplying of water purifying tablets, drugs, food, and clothing and the repairing of tubewells. Appreciable national and international efforts were involved in this assistance (Ministry of Health and Family Welfare, 1992; Operation Sheba, 1991; Haider, et al., 1991) but these efforts lacked environmental health components. It might be expected that a disaster prone country like Bangladesh would have appropriate disaster management and preparedness programmes. A recent regional workshop noted that, although remarkable progress has been made in global water supply and sanitation during the last decade, disaster situations have been inadequately targeted (Hoque, et al., 1991).

We visited the area about 2 weeks after the cyclone, having little knowledge of the existing situation. We have focused on some specific situations which need attention from workers in the disaster field. This information may help to identify gaps in knowledge and identify priorities in policies, implementation strategies and technical knowledge that will be useful in short-term as well as long-term environmental health disaster programmes in Bangladesh.

Water supply and use

Although special attention was given to the rehabilitation and installation of new tubewells in affected areas, there was an acute shortage of domestic water. Our results show that the number of users per tubewell increased significantly after the cyclone. Before the cyclone, tubewell water was used mainly for drinking (UNICEF, 1987; Mitra and Associates, 1992) but after the cyclone it was used for all domestic purposes. This resulted in an unmanageable load on the

tubewells. Government programmes emphasized public tubewells only. This hindered the rehabilitation of private tubewells, which serve a large population (UNICEF, 1987; Mitra and Associates, 1992). Although the owners of private tubewells are generally of higher socio-economic status, the cyclone affected their ability to restore and repair them.

Local people should be encouraged and trained to maintain their pumps and to stock pile spare parts. This would help the owners of private tubewells also and have both short-term and long-term water supply implications. Limited efforts were made to restore normal water supplies, such as by dewatering ponds. As the surface water became unusable, the availability of water for purposes of personal and domestic hygiene was severely curtailed. This may have implications for water-borne diseases (Cairncross and Feachem, 1983; Khan, 1982). Considering the quality of available water, tubewell water was the most appropriate option for drinking, whether the well had been flooded or not. When the quality of transported water is no better than tubewell water, there is no need to encourage the transportation of water to areas where tubewells are available. It is important that the pre-disaster water systems are restored and, if possible, improved. Research is needed into how this may be done most effectively.

Water treatment

We were most concerned to find that the water purifying tablets which had been distributed were of poor quality and were not properly used, especially since people believed that they would protect them from disease (UNICEF, 1987). Since the majority of rural people are illiterate, instructions for using the different types of tablets could not be followed. Again it may be difficult to collect or carry (and get containers for) more than 10 litres of water in an emergency. Quality control at the manufacturing level may be adequate, but the use of the tablets should be standardized and controlled by concerned international, as well as national, bodies. Our results clearly question the effectiveness of water purifying tablets alone in ensuring the treatment of water in mass disaster situations.

It was discouraging also that, apart from the use of water purifying tablets and the boiling of water, no other water treatment was promoted. The disinfectant potentials of water treatment by alum and bleaching powder (Khan, 1984; Hoque and Sack, 1991) should be further studied under normal and disaster conditions. Alum and bleaching powder are affordable and locally available but the maintenance of the quality of bleaching powder requires special attention (Hoque and Sack, 1991). Advocacy of this treatment, then, would need appropriate educational efforts.

Sanitation

Although the sanitary disposal of faeces is infrequently practised in households in Bangladesh, the indiscriminate disposal of faecal wastes from diarrhoea patients in clinics is unacceptable. It is also important that aid for the reconstruction of damaged houses be used to promote the construction of sanitary latrines. All these strategies would have both short-term and long-term health effects.

Knowledge, attitudes and practices of relief personnel

Throughout our study we noted that, while relief personnel realized the importance of environmental health measures, they implemented them inadequately or neglected them. They were concerned about the supply of safe water but were unaware of the different options available for providing adequate water and of the need for adequate sanitation and personal hygiene. It is important that relief personnel be trained

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