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POST DISASTER SITUATION OF WATER SUPPLY AND SANITATION

Md. Mujibur Rahman[1] and Md. Khoda Bux[2]

Abstract : Instant damages by cyclones and storm surge disasters in the coastal region of Bangladesh are usually massive. Human lives are swept away as well as livestock along with their shelters and food. A major challenge faced by the surviving population immediately after cyclones and tidal surges is the scarcity of pure drinking water and lack of sanitation facilities with subsequent outbreak of waterborne diseases which poses threat to their existence. This paper primarily identifies major problems associated with water supply and sanitation during post cyclone periods and suggests several mitigatory measures. A simple operation of sealing tubewells prior to the occurrence of cyclones and storm surges can restore the water supply system back to normal immediately after receding of the surge water. It also emphasizes that certain behavioral changes in the defecation practice can significantly improve environmental sanitation situation during post disaster periods.

KEY WORDS : Disaster, water supply, sanitation, coastal region, tubewell sealing

INTRODUCTION

Bangladesh is known to be a naturally disaster prone country. Floods, droughts, cyclones and storm surges of varying intensity hit the country almost every year. Of these, cyclones associated with storm surges are instant, heavily destructive and usually cause massive damages to the affected areas. Human lives are swept away as well as livestock along with their shelters and food. Damages to agricultural sector specially to standing crops, forestries and fisheries, to industrial sector and physical infrastructures including roads, bridges, culverts, electric supply, water supply and other utitlity services are all enormous.

A major challenge faced by the surviving population immediately after cyclones and tidal surges is the scarcity of pure drinking water which poses threat to their existence. Water and sanitation facilities are damaged, tubewells are either broken or partially damaged and become unusable due to submergence. Ponds and other water bodies are all contaminated by the onrush of saline water thereby leading to serious crisis of drinking water. As a result, outbreak of waterborne diseases e.g., cholera, diarrhoea in the affected areas claim numerous human lives. While the death toll in the April 1991 devastating cyclone, according to the Ministry of Relief and Rehabilitation, Government of Bangladesh, was 138, 882, thousands of people got diarrhoea within days due to deficiency of safe water and proper sanitation facilities.

In general the coastal region of Bangladesh is directly affected by cyclones and tidal surges although, at times, other parts of the country

1 Department. of Civil Engineering, Bangladesh University of Engineering & Technology, Dhaka - 1000, Bangladesh.
2 Department of Public Health Engineering, Govt. of Bangladesh.

are also affected. The coastal belt of the country comprises the complex delta of Ganges-Brahmaputra-Meghna river system constituting about 25% of the total area of the country and includes the districts of Khulna, Bagerhat, Satkhira, Noakhali, Laxmipur, Feni, Patuakhali, Borguna, Barisal, Jhalakathi, Perojpur, Bhola, Chittagong and Cox's Bazar as shown in Figure 1. The area under coastal region is estimated at 36,078 square kilometers with a population of about 25.0 million (Bux & Rahman, 1994)

This paper, based on a research project aimed at assessing water supply and sanitation situation in the coastal region of Bangladesh

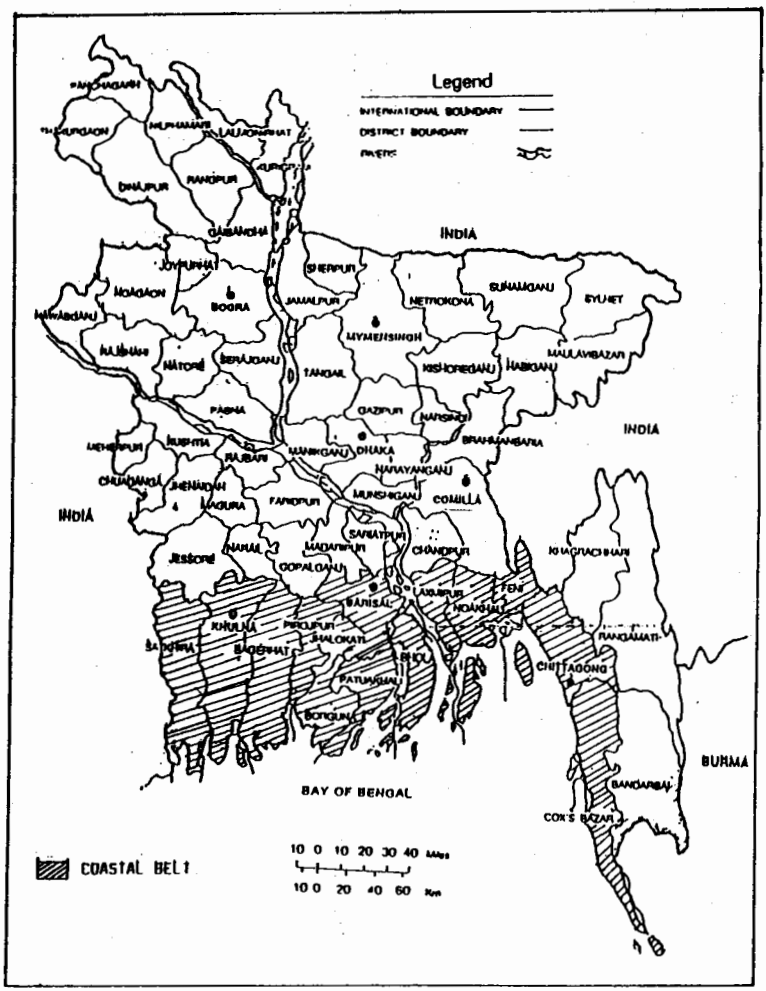

Fig 1. Bangladesh Map Showing the Coastal Belt

during normal as well as post cyclone periods, attempts to identify the major problems during post-cyclone situation and suggests remedial measures to overcome the crises.

WATER & SANITATION IN THE COASTAL REGION

Bangladesh has achieved commendable success in the provision of water supply for its people. More than 85% of the rural and about half the urban population have access to safe water. Sanitation coverage lags behind, yet progress has been significant with rural sanitation coverage increasing to 33% and urban to 42% (Rashid, Rahman and Turnquist, 1994). Despite high population coverage however, there exists regional disparity. While 85% of the rural households are within 150 meters from a source of safe water, more than 20% people in the coastal belt have to travel over 200 meters to fetch clean water. Water supply coverages also vary sharply due to hydrogeological conditions, e.g. from an average 79 persons per operating tubewell in the shallow water table area to 216 persons per operating tubewell in the saline coastal region and 326 persons per operating tubewell in low water table area, specially the northern part of Bangladesh (Bux and Rahman, 1994).

The coastal belt of Bangladesh is identified as saline area where complex hydrogeological situation makes drinking water supply difficult compared to other parts of the country. The environment of the coastal region is characterized by excessive salinity in both ground and surface waters resulting in poor coverage in the coastal belt. Because of the paucity of drinking water diarrhoeal diseases break out several times every year in the coastal belt causing death to hundreds of people.

In the coastal belt, surface water is brackish and groundwater suffers from salinity intrusion. Upper aquifers are often saline, usually requiring deep tubewells to reach sweet water although some potable pockets of shallow aquifers are found and tapped with handpumps. The saline belt extends about 60 km inland and groundwater is generally saline down to about 250 meters (IWACO, 1985). There are 84 salinity prone thanas in the coastal belt with an affected population of about 8.0 million (Mitra, 1992). Ponds which store rainwater are the principal sources of water in these underserved areas. Water from these ponds is used for all purposes and is susceptible to a high degree of pollution (Rashid, Rahman and Turnquist, 1994).

Sanitation situation in the coastal region is not much different from other parts of the country. In Bangladesh about 61% of rural households possessed latrines in 1991, of which only 26% possessed sanitary latrines (Mitra, 1992). The remaining latrines generally drain into water bodies or ditches. Sanitation coverage, however, is on the increase to about 33% by 1993 (UNICEF, 1994). In the coastal region, as in other parts of the country, latrines are traditionally built over ponds, canals, and rivers. These latrines termed as 'hanging latrines' allow the excreta to fall on the water bodies and is a source of pollution of the surface waters.

WATER AND SANITATION TECHNOLOGIES

A variety of water technologies have been developed and used to serve in different hydrogeological conditions as well as to keep costs at the lowest level. Water supply technologies in the coastal region of Bangladesh include Shallow Tubewells (STW), Deep-set Handpumps or Tara Tubewells, Deep Tubewells (DTW), Shallow Shrouded Tubewells

(SST), Very Shallow Shrouded Tubewells (VSST), and Pond Sand Filters (PSF). Shallow tubewells are installed in some areas of the coastal belt where groundwater at upper aquifers are of acceptable qualities. A total of about 146,000 STWs are operating in the coastal districts (Bux and Rahman, 1994). Deep tubewells are usually installed in the coastal saline belt as the fresh water aquifers in many places, are located at much greater depths, upto about 350 meters below ground level. The DTWs are, however, expensive and STWs are not successful everywhere in the coastal region and people resort to other technologies e.g., SSTs, VSSTs and PSFs.

Shrouded Tubewells (SSTs & VSSTs)

Shallow shrouded tubewells (SSTs -depth varying between 15 to 20 meters) and very shallow shrouded tubewells (VSSTs -depth varying between 6 to 15 meters) are appropriate to certain areas in the coastal saline belt and are very inexpensive. SSTs or VSSTs rely on two very specific conditions for its success: they can operate only where a pocket of fresh water exists, and where a sand layer exists within this fresh water zone. These two conditions however., are not favourable throughout the saline belt of the coastal region. A typical diagram of a shrouded tubewell is shown in Figure 2, the main feature of which is that the strainer of the tubewell is shrouded with coarse sand of appropriate size in order to prevent fine sand pumping with water. Shrouded tubewells are installed with ordinary handpumps and their performances are similar to conventional shallow or deep tubewells. Installation of a SST costs about Tk. 2000 to 2500 (US$50 to 62) and that of a VSST costs about Tk. 1500 to 2000 equivalent to US $ 38 to 50 (Bux & Rahman, 1994). A shrouded well can serve about 75 to 100 people.

Pond Sand Filters (PSFs)

Where freshwater aquifers are not readily available in the coastal region, an alternative is a pond sand filter which uses a handpump to deliver pond water into a small sand filter unit in which the water quality is significantly improved. It is simple to construct and operate, but performance depends primarily on beneficiary motivation for regular cleaning (Rashid, Rahman & Turnquist, 1994). The PSFs are being installed by the DPHE in some parts of the coastal region. A typical PSF costs about Tk. 10,000/-to Tk. 16000/- (US $ 250 to 400) depending on the size , availability and cost of costruction materials (Bux & Rahman, 1994). A PSF can serve about 100 persons.

Sanitation Technologies

Sanitation technologies in Bangladesh are largely limited to on-site options with the exception of Dhaka city which partially enjoys the facilities of conventional sewerage. In urban areas of the coastal region sanitation technologies include septic tanks, bucket latrines, communal facilities, pour-flush latrines and simple pit latrines. The primary sanitation method adopted in the entire rural Bangladsh including the coastal region is the single pit water sealed sanitary pit latrine. A single pit water sealed latrine (Figure 3) consists of a concrete platform, pan and a lined pit underneath and costs about Tk. 1400/- (US $ 35). When the pit

fills up, a new pit has to be dug and superstructure relocated, or the pit has to be emptied. Certain pit latrines are also vulnerable in areas which are annually flooded or where water tables rise during the monsoon. The usual practice is to elevate the slab using the soil excavated from the pit. The single pit water sealed latrine, however, is the only sanitary option being promoted in the rural areas of the country including coastal region.

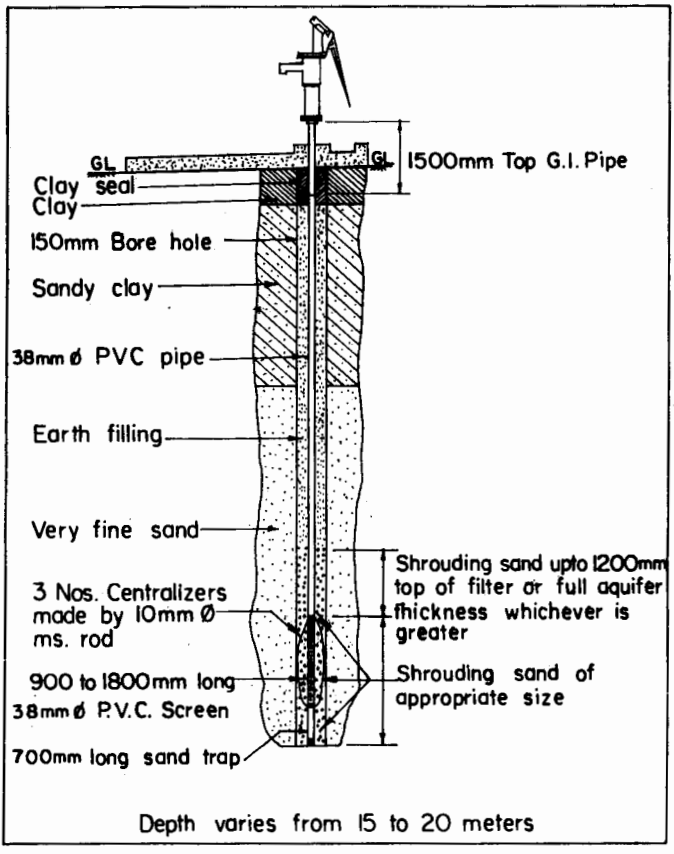

Fig 2. Typical Diagram of a Shrouded Tubewell

EXISTING FACILITIES IN THE COASTAL REGION

An estimated 2.4 million tubewells are installed in rural Bangladesh, of which about 90,000 are public tubewells (Bux and Rahman, 1994). Despite considerable achievements in total coverage, regional disparity still exists. The coastal region has low coverage primarily due to complex hydrogeological situation, e.g. excess salinity in the upper aquifers resulting in failure of sinking shallow tubewells.

Deep tubewells are expensive and yet these are not feasible in many areas because fresh water aquifers are not available.

Table 1 shows the total number of operating tubewells in various districts of the coastal belt. Besides, there are some non -conventional technologies such as SSTs, VSSTs and PSFs which are being promoted in the coastal districts where feasible. Table 2 shows an account of these non-conventional technologies being used in some coastal districts.

Sanitation coverage in the coastal region is poor as it is elsewhere in the country . However, the DPHE, through various water supply and sanitation projects, is providing single pit sanitary latrines at subsidized costs. Private production centres are also being promoted for production and selling of water-sealed latrines to improve coverage. Table 3 shows the status of sanitation coverage by low cost water sealed latrines in different coastal districts.

Table 1 Number of Tubewells in the Coastal Region (DPHE, 1994)

Coastal districts	Population as per 1991 census	Total number of tubewells operating	Persons per operating tubewell
Khulna	2131638	12310	126
Bagerhat	1476190	12814	116
Satkhira	1652807	13830	109
Noakhai	2345713	17760	120
Laxmipur	1382677	12393	107
Feni	1156069	9695	121
Patuakhali	1298152	7085	200
Borguna	792534	4476	188
Barisal	2202160	21317	109
Jhalokathi	697108	65950	107
Perojpur	1102985	10664	110
Bhola	1489415	7038	215
Chittagong	5729740	30967	137
Cox's Bazar	1465022	10699	114
Total	24922210	177643	134 (av.)

Table 2 Status of Non -conventional Technologies in the Coastal Districts (Bux & Rahman, 1994)

Coastal districts	SSTs, Nos.	VSSTs, Nos.	PSFs, Nos.
Khulna	42	146	91
Bagerhat	100	-	-
Satkhira	68	680	149
Borguna	-	-	114
Noakhali	13	728	-
Laxmipur	-	245	-
Total	223	1799	354

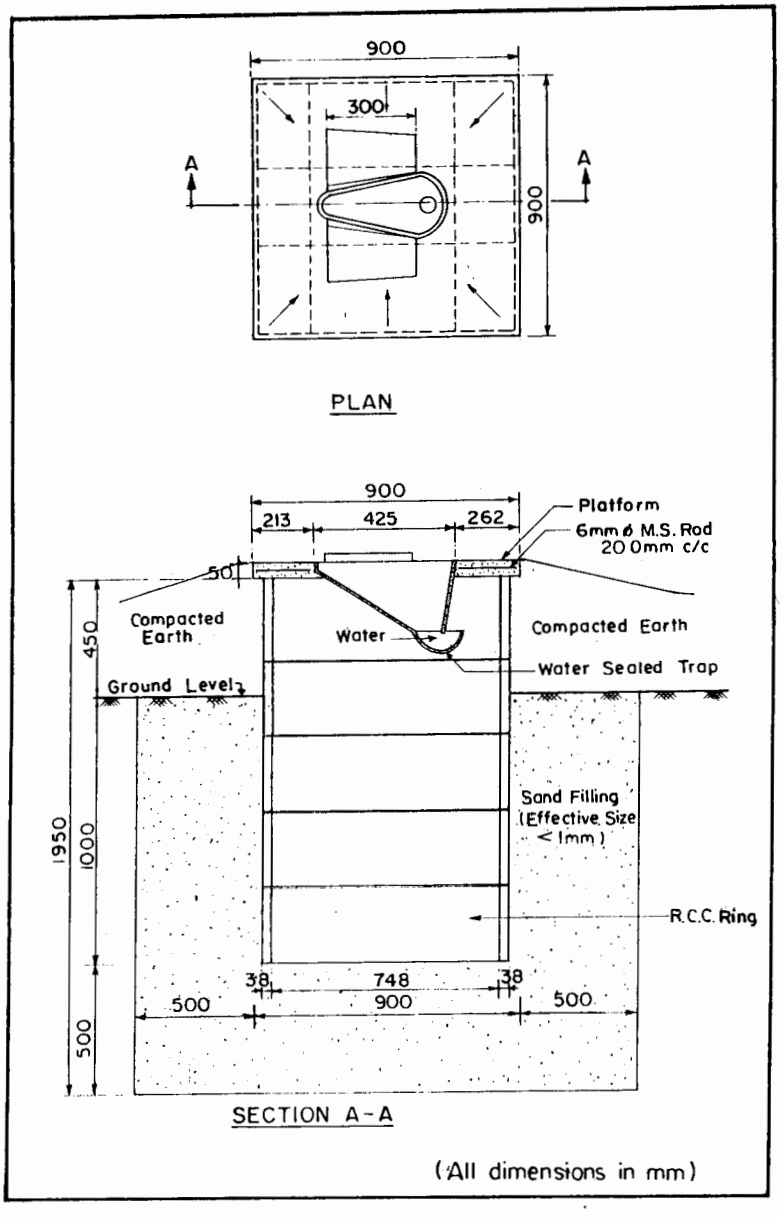

Fig 3. Typical Single Pit Pour-Flush Latrine

Table 3 Sanitation in Different Coastal Districts (DPHE, 1994)

Name of coastal districts	Number of sanitary latrines	Percent population coverage
Khulna	40869	12
Bagerhat	29491	12
Satkhira	38778	15
Noakhali	23712	7
Laxmipur	11494	5
Feni	19659	7
Patuakhali	25165	11
Borguna	20148	14
Barisal	25093	6
Jhalokathi	14276	12
Perojpur	21015	11
Bhola	18301	7
Chittagong	53812	8
Cox's Bazar	21416	11

POST-DISASTER SITUATION

Cyclones associated with tidal surges seriously affect water supply and sanitation in the coastal region of the country. The field survey conducted in the coastal district of Cox's Bazar (Bux & Rahman, 1994) revealed that the people who survived the devastating 1991 cyclone immediately faced the following problems with respect to drinking water supply and sanitation:

i) most hand tubewells in the affected areas were inundated by the tidal surge resulting in saline water intrusion in the well pipe thereby ceasing supply of potable waters;

ii) handpumps of many tubewells were detached and swept away by the strong storm surge;

iii) pond sand filters and iron removal plants were badly damaged;

iv) natural surface water sources such as ponds and canals were inundated by saline waters thus making them unusable;

v) in the municipal areas, serious damages were caused to the pump houses, street hydrants, treatment plants, distribution system and the power supply causing disruption to urban water supply;

vi) the cyclonic storm surges also damaged all kinds of latrines - sanitary or unsanitary;

vii) office buildings, stores and godowns, latrine production centres were all affected causing problems in restoring normal situation; and finally,

viii) the overall environmental situation was deteriorated through pollution of land and water by human excreta in absence of sanitary latrines coupled with the decomposition of dead human and animal bodies.

The problems described in relation to water supply and sanitation demonstrate the extreme sufferings of the people who survive cyclones and tidal surges. Lack of physical facilities immediately after cyclones coupled with lack of people's awareness of the linkage between water, sanitation and health results in the outbreak of diarrhoeal and other water borne diseases during post cyclone periods.

MITIGATORY MEASURES

The present practice of facing the crisis of drinking water supply in the affected coastal areas includes providing pure water in bottles or plastic cans from unaffected areas by numerous voluntary organizations, individuals, political parties, various educational, professional and socio-cultural institutions. On the other hand, the government organizations, e.g., the Department of Public Health Engineering and many non-government organizations (NGOs) attempt to restore the affected water supply facilities through repairing and disinfecting the damaged tubewells and also by sinking temporary tubewells. All these efforts do help but appear to be inadequate and in some cases take long time to establish normal water supply system.

In the light of the responses of the field questionnaire survey and discussions with people from affected area (Bux and Rahman, 1994) the following measures are recommended for effective mitigation of the water supply and sanitation crises immediately after the cyclone and tidal surges.

Sealing of Tubewells

As already mentioned, most tubewells in the coastal area are damaged by the cyclones and tidal surges. The handpumps are detached from the wells by tidal surges causing ingression of saline water into wells. Such damages can be prevented by simply dismantling the pumps from the wells and sealing the wells by seal caps just prior to the occurrence of cyclones and storm surges. Screwed GI or PVC seal caps of the same diameter as the tubewell pipe are available in the market and also in the stores of DPHE. A GI seal cap costs only about Tk. 40 (US $ 1.0) and a PVC seal cap costs only Tk.10 to 15 (US $ 0.25 to 0.30).

Dismantling the pump from the tubewell involves very simple operation of just unscrewing the pump and can be done by an adult member of a family which can then be preserved safely in a house, or in a nearby shelter. As the disaster is over and as the surge water recedes, the pumps can again be installed after removing the seal cap thus restoring the water supply in no time. It therefore, appears that sealing tubewells prior to the occurrence of cyclones is the most simple, cheaper and effective method of restoring drinking water supply immediately after the disaster. It requires no repair of tubewells and the aquifers are not polluted as the tubewells are sealed against the ingression of saline surge waters.

Sinking more Tubewells

The difficult hydrogeological condition in the coastal region makes water supply difficult and expensive. Shallow tubewells, shallow shrouded tubewells and very shallow shrouded tubewells are not always feasible as they are subject to availability of shallow fresh water aquifers. Deep tubewells are mostly successful but expensive. As mentioned earlier, the coastal region has low coverage compared to other parts of the country. The post disaster situation therefore, futher deteriorates as many tubewells are damaged and are washed away. So to improve the post disaster situation, the normal water supply coverage in the region needs to be improved which can be done by sinking more deep tubewells as well as STWs, SSTs, VSSTs and PSFs where appropriate.

Repairing Damaged Tubewells

A large number of tubewells are damaged by severe cyclones and storm surges. The damages include blowing of handpumps; damages to small parts of the handpump such as handle, bucket or seat valve; and entrance of saline water into tubewells. The damaged tubewells may be brought to restoration by simple maintenance operation by local caretakers or DPHE tubewell mechanics. The tubewells then need about 30 minutes of constant pumping to get the saline water out of wells. In some cases, disinfecting agents, usually bleaching powder of appropriate quantity, are added to make the tubewell water free from contamination.

Improving Sanitation Facilities

As mentioned earlier, the overall sanitation situation of the country is not very encouraging. In the coastal region most rural people use unsanitary hanging latirnes, kutcha latrines or resort to open defecation. Use of sanitary latrine facilities in the region is very limited. In urban areas, people use sanitary means such as septic tanks and water sealed latrines, yet many people use unsanitary latrines of some sort. Cyclones and strom surge however, destroy most of the sanitation facilities except a few pucca structure. There are two ways of improving post disaster sanitation situation. Firstly, immediately after cyclone and storm surge people need to defecate in a proper manner in absence of sanitary facilities, e.g., covering excreta with soil or sand after defecation and no defecation on any open water bodies. Secondly, improving sanitation coverage in the coastal region using appropriate sanitation technologies, e.g., water-sealed sanitary latrine with elevated platform. Other technologies must be tried and assessed for their appropriateness.

Waters and Sanitation in Cyclone Shelters

A large number of cyclone shelters have been built in the coastal areas for people to take shelter during cyclone disasters. There are about 850 shelters at present, and construction of more shelters are being planned. However, many of these existing shelters do not have adequate water supply and sanitation facilities. The situation needs to be improved. All cyclone shelters must be provided with adequate facilities

for water supply and sanitation. Required number of tubewells must be installed. In case of difficult aquifer situation, shelters should be designed to catch rainwater on its roof and store in underground reserviors for later use. Such options however, need further study for their feasibility and long term sustainability. Adequate sanitation facilities should also be provided in all shelters. Communal sanitation facilities with multiple toilets discharging in septic tanks or a number of simple underground pits can be considered. Cyclone shelters with adequate water supply and sanitation facilities could significantly minimize deterioration of the environmental quality during the post-disaster periods.

Educating the People

Despite the growing access to safe drinking water, water-related diseases remain a common occurrence in Bangladesh. From 122 deaths for every 1000 live births in 1981, the infant mortality rate has come down by only 12 to 110 in 1990 (Rashid, Rahman & Turnquist, 1994). The incidence of diarrhoeal diseases persists at a high level. This reflects that the awareness among people of linkage of health to water and sanitation is still poor. The full range of benefits from water supply and sanitation interventions cannot be realized unless accompanied by health education programs. Such programs are particularly important for people in the coastal region during post-disaster period in order to prevent the break-out of diarrhoeal epidemics which claim thousands of lives. Health education programs should constitute a significant part of the overall disaster preparedness program. Social motivational programs can be undertaken through mass media to educate people for measures to be taken prior to and after cyclone disasters in respect of water supply and sanitation.

CONCLUSIONS

The absence of adequate water supply and sanitation facilities during the post cyclone period is largely responsible for outbreak of epidemics such a diarrhoea, cholera and other waterborne diseases which cause loss of lives of thousands of people. The coastal people have to live with natural disasters like cyclones and tidal surges. The damages caused by such disasters however, can be minimized by adopting certain measures. Some important measures are as follows.

i) The drinking water supply system can be restored back to normal just within hours after the cyclone is over and surge water recedes simply by dismantling the pump head and sealing the well pipe with a seal cap prior to occurrence of the cyclone. This is the simplest and the most effective measure for restoration of water supply during post-cyclone period. This also prevents the aquifers from getting polluted by the ingression of saline water.

ii) To improve the post-disaster sanitation situation, the most important step is to bring about behavioral changes among people in the coastal region. Covering excreta with soil after defecation

and prohibiting defecation in open water bodies can lead to improved post-cyclone sanitation situation. The task of educating people must be performed well ahead of disasters.

iii) All cyclone shelters should be provided with adequate water supply and sanitation facilities which could significantly improve post-disaster environmental quality.

iv) Appropriate technological options must be adopted in order to improve water supply and sanitation coverage of the coastal people during normal period so that the post-disaster situation is not worsened.

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