Sanitation and Solid Waste Management in Dhaka City During the 1998 Flood

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Abstract

The degradation of environmental quality in the city of Dhaka was a major concern during the flood of 1998. The damages and disruption of sanitation and solid waste disposal facilities were mainly responsible for the deterioration of environmental quality of the city. This paper presents an overview of the sanitation and solid waste management facilities in Dhaka city, functioning of these essential facilities during flood and the alternative arrangements adopted by flood affected people. Water pollution, drinking water contamination and prevalence of diarrhoeal diseases due to failure of sanitation and solid waste management systems during the 1998 flood have also been presented in this paper.

INTRODUCTION

Flood in Bangladesh is an annual event, but flood of 1998 had been the most severe and devastating one in recent years. The peak flood levels of 1988 around Dhaka city were higher than those of 1998 but the severity of the flood 1998 was due to its longer duration. The maximum duration of flood above danger level at Mirpur in 1988 was 30 days, but in 1998 the duration was 69 days at the same location. The danger level at Dhaka is considered as 6 m above mean sea level as most of the urbanized areas of Dhaka city lie at elevations between 6 and 8 m. The area between the flood embankment and floodwall in the west and Pragoti Sarani in the east is considered as flood protected. But in real situation a large area within the flood-protected area was flooded due to poor management of flood protection and drainage facilities. An estimated 150 km^2 out of the total 275-km^2 area of Dhaka Metropolitan area was inundated during the 1998 flood.

Sanitation and solid waste management are essential service facilitates in densely populated urban centers. Safe and hygienic disposal of wastes is required for healthy living. Proper sanitation and solid waste management improve environmental quality and lack of these facilities results in a filthy condition detrimental to health and human well being. The population coverage by proper sanitation has been correlated with prevalence of disease, death and debility, particularly mortality of children and is considered as an indicator of development. Inundation of the sanitation and solid waste management facilities cause severe water pollution. Contaminated water in the surroundings due to damage and disruption of these essential facilities opens many routes of transmission of diseases. As a result, concern of outbreak of diseases, particularly of diarrhoeal diseases, is expressed in every flood and activities related to preventive and curative interventions are geared up towards effective control of such incidences.

The devastating flood of 1998 caused severe damages and disruptions to infrastructure. Disruption of these essential service facilities had serious implications on degradation of environmental quality and public health in the densely populated Dhaka city. Submergence of sewerage facilities, back flow of sewage and decomposition of garbage were mainly responsible for degradation of environmental quality particularly for deterioration of physico-chemical and bacteriological quality of floodwater and contamination of drinking water supplies. The extent of damage and disruption of sanitation and solid waster management system, alternative arrangements adopted by flood-affected people and its consequences were major environmental issues of the flood. This paper attempts to make an evaluation of some of these environmental concerns of the 1998 flood.

MATERIALS AND METHODS

The assessment of sanitation and solid waste management situation in flood affected areas of Dhaka City during the 1998 flood involved data collection from secondary sources, questionnaire survey to acquire primary data and analysis of data to synthesize the major findings. The available data from relevant organizations like DWASA, DOE, DCC, etc. were collected and reviewed for relevant information. These data primarily reflected the pre-flood conditions. The news items on flood in the news media were most important source of information about flood and these were regularly reviewed during the flood.

A questionnaire survey was conducted to acquire data regarding prevailing situation during the flood. The questionnaire originally prepared for the survey was tested in the field and some modifications were made on the basis of field inputs. In view of time constraint, the survey was mainly conducted in the severely affected eastern part of Dhaka city. Since this survey was conducted mainly in the flood-affected areas, the sanitation situation during the flood has been reflected in the findings.

The questionnaires survey to acquire information on solid waste disposal practices of 68 households during and before flood was conducted in the flood affected areas. The most important water quality parameters of samples collected during the flood and post-flood conditions were analyzed. The Faecal Coliform (FC) counts of 116 drinking water samples collected from various locations during the flood were compared with pre-flood data. The Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO) and Faecal Coliform counts of a large number of floodwater samples were analyzed. The main purpose of analysis of drinking and floodwaters was to assess the degree of water pollution by the discharge of sewage and solid waste in floodwater.

SANITATION

Sanitation Facilities and Practices

The sanitation system of the city of Dhaka is comprised of waterborne sanitary sewerage system, combined sewer system, small bore sewer (SBS) system, septic tank with soak well and pit latrine. The areas under different sanitation system have been shown in Fig.1. The sewer system of Dhaka was originally designed as separate systems i.e., sanitary sewer system for conveyance of wastewater from toilet (sanitary sewage) and storm sewer system for the discharge of storm and surface drainage (storm sewage). In the combined system both sanitary sewage and storm waters are conveyed through same sewer line. The SBS system receives effluent from septic tank for disposal by suitable means. At present, as shown in Fig.1, the sewered sections of the city is being covered by separate, combined and SBS systems.

The sanitary sewage is collected and transported by a network of sanitary sewer system having 23 sewage lifting stations to convey the sewage to treatment plant at Pagla. To prevent bacteriological contamination, the effluent of the treatment plan is chlorinated before disposal in the river Buriganga. The Waste Stabilization Ponds system at Pagla is capable of partial removal of pollution load from sewage. In the combined sewer area, sanitary sewage is discharged in the storm sewer in the absence of sanitary sewers. The sewage conveyed by combined sewer is discharged in water bodies in low-lying areas, natural *khals* and rivers with storm water for natural degradation. The effluent of the SBS system is also discharged in the low-lying area like storm drainage. Septic tank with soak well system is a very good sanitation initiative at the household level and covers largest number of population in the city.

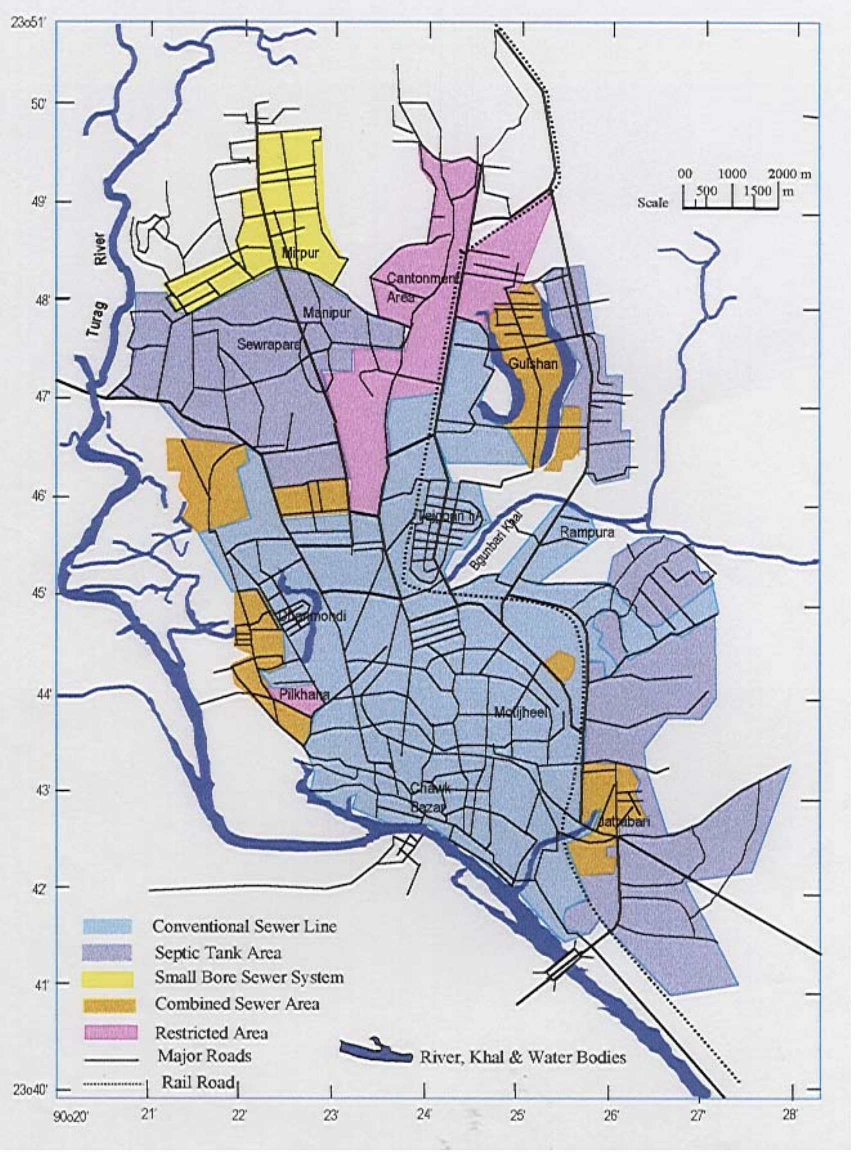


Figure 1: Area covered by different sanitation systems in Dhaka

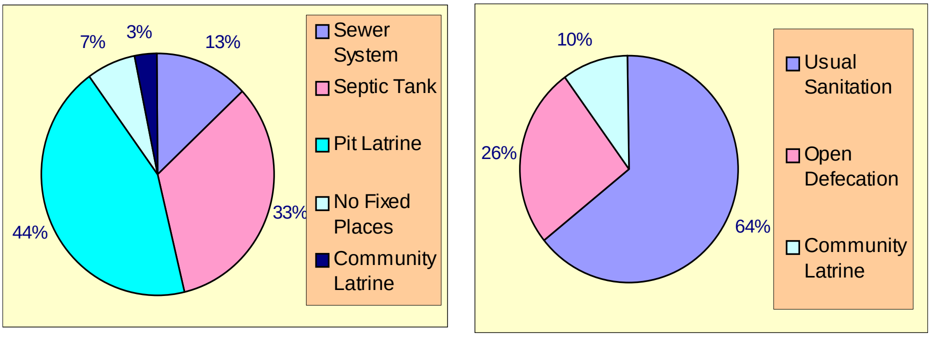
The top pre-consolidated clay layer beneath Dhaka City is not good for soak away of septic tank effluent. Many inhabitants have connected the effluent to surface drains or storm sewers where available to avoid overflow within the premises. This practice contributes to the deterioration of environmental quality in the locality and pollution of surface water sources. Sanitary pit latrines are low-cost sanitation system practiced in the low-income squatters and slums

Sanitary sewerage system covers about 18 % of the population and in the un-sewered section septic tank system covers 40 percent and sanitary pit latrines cover 15 percent of the population. The population coverage by SBS has been reported under septic tank system. The remaining 27 percent people of Dhaka city mainly living in urban slums do not have any acceptable sanitation system (MoLGRDC, 1994). Katcha Latrine is the common method of excreta disposal in the slum areas. It has been reported that some 87 percent of the inhabitants in slums and squatters in Dhaka city rely on low quality katcha latrines (CUS, 1988). The transient nature of settlement and poor awareness of health-sanitation relationship deter building of sanitary latrines in squatters and slums. Limited public sanitation facilities have been constructed by Dhaka City Corporation for use on payment basis. About 18 such facilities with latrine, shower and lavatories exist in densely populated areas in Dhaka city.

Impact of Flood on Sanitation

In the flooded area, all sanitation facilities were not functional. The sewer and storm water drainage systems were not functioning because of negative hydraulic gradient which in some cases caused back flow of sewage mixed flood water in the flood protected low lying areas. The only Sewage Treatment Plant (STP) situated at Pagla within the DND flood protected area has been reported to be functioning with a small sewage flow from old Dhaka. The main sewer trunk line leading bulk of sewage to STP was closed down to avoid flooding of DND area and damages to this large diameter brick sewer line. A total of 13 sewage-lifting stations out of 23 were closed because of entry of floodwater. Flood also caused severe damages to sewer lines and manholes. The repair and rehabilitation cost of DWASA sewerage system was estimated to be Tk. 620 million (DWASA, March, 1999). In the flooded areas, the contents of the pit latrines were mixed up with the floodwater and the flooded septic tanks and soak wells were oozing out their additional loads in floodwater. Back flow of faecal matter in flooded ground floor through toilets was common in the flooded areas. The upper floor residents in multistoried buildings were able to use the toilets but the additional loads caused overflow of sewers or septic tanks in the flooded areas.

During the flood, the problems encountered by the different socio-economic groups of the people were different. The sanitation facilities of the households surveyed during and before the flood are presented in Fig.2. It has been observed that sanitation facilities of all the households were more or less affected but 64 percent of the households were able to continue their usual practice by elevating level or adopting alternative facilities. About 26 percent of the household adopted the practice of open defecation and 10 percent used community latrines and other temporary facilities erected during the flood.



Sanitation before flood **Sanitation during flood**

Figure 2: Sanitation practices during and before flood

In medium-income areas where floodwater depth was such that the ground floor was submerged, the toilets were not useable at ground floor level. The residents of the ground floor of multistoried houses were compelled to use toilets of the upper floors. A sanitation practice by erecting temporary toilet on the roof due to flooding of ground floor is shown in Fig. 3. In low-income areas, the people were using pit latrines. These people had made temporary arrangement by erecting elevated platform for defecation thus releasing the faecal matter directly in floodwater.

Figure 3: Temporary latrine on roof in flooded area

SOLID WASTE MANAGEMENT

Solid Waste Management System in Dhaka City

The quantity of solid waste generated in the Dhaka Metropolitan area is about 3,500 Metric tons at the rate of 0.5 kg. per capita per day (Bhuiyan, 1999). About 49 percent of the waste originates from domestic source, 21 percent from commercial, 24 percent from industrial and 6 percent from hospital and clinical sources in the city. The responsibility of the individual households is to put their waste in the roadside dustbins, containers or garbage accumulation centers for collection and transportation to final disposal points by Dhaka City Corporation (DCC). To improve the situation local individuals and groups have come forward to organize their own collection system. There are about 130 local initiatives in 90 wards of the city to provide primary waste collection services from 10,000 households (Kazi, 1999). The garbage under these initiatives is collected from individual households and carried to the nearest DCC bins/containers.

Extensive unorganized recycling takes place in the city of Dhaka at various stages of collection and disposal system. In the first stage, the households set aside the waste of market value and sale it to the street Hawker and in the subsequent stages of recycling all wastes of immediate market value are picked up by *Tokais* from the dustbins and disposal sites. The salvaged wastes are processed and sold to the old materials' shops for recycling.

The waste accumulated in the dustbins is collected by DCC trucks for final disposal at the dumping sites. Dhaka City Corporation (DCC) can collect only about 52 percent of the total waste generated in the city. About 11 percent of the waste generated is recycled and the remaining waste goes into backyard, road sides drains and open spaces. The quantities of solid waste disposed off or recycled by different routes are shown in Fig.4. The solid waste collected by DCC is finally dumped at landfill sites located in low-lying area by open dumping. The three waste dumping sites at Matuali, Mirpur and Lalbagh were in operation during pre-flood periods. DCC practices crude dumping of solid waste at landfill sites in order to keep the disposal cost low at a great risk to soil and groundwater pollution.

Solid Waste Management During Flood

Solid waste is collected and transported by DCC in open trucks, closed trucks and container carriers. In addition to stationary dustbins, DCC has presently employed demountable hauled container system. Solid waste collection and transportation operations were totally disrupted in the inundated areas during the 1998 flood. The operation of vehicles over the flooded roads and within congested areas became increasingly difficult and finally solid waste collection and transportation from deeply flooded areas were discontinued. With the increase in flood depth, the operation of container system of collection was also suspended and the water soaked garbage in containers remained in place. A completely filled container located at the side of a road is shown in Fig 5.

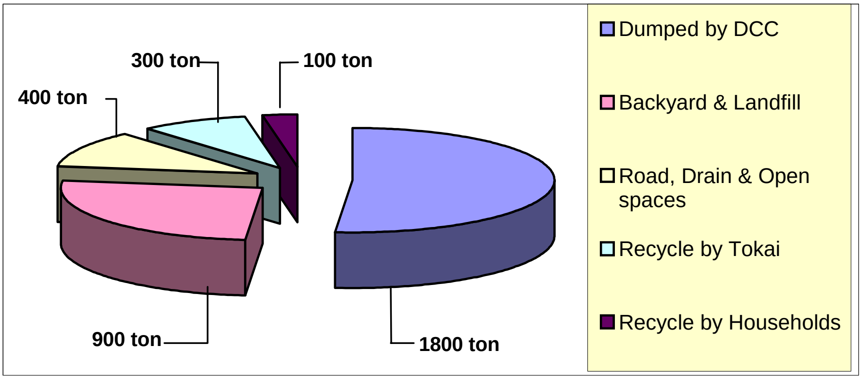


Figure 4: Solid waste disposal and recycling routes in Dhaka City

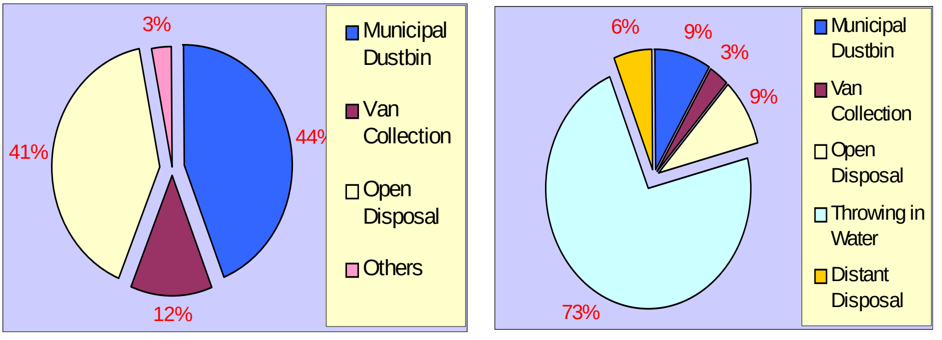
Figure 5: A completely filled solid waste container

The area of Dhaka City inundated by the 1998 flood is about 150 km^2. Sanitation and solid waste management facilities in these flooded areas were practically non-functional. The solid waste management service facility of DCC is extended over 350 km^2. It is estimated that about 43 percent of solid waste could not be collected and transported by DCC during peak flood period

Primary collection involving accumulation of solid waste in the nearest dustbin is the responsibility of households. Hence it is completely dependent on people's attitude and participation. The practice of placing the solid waste in the right manner and in the right place had never been satisfactory. The dumping of solid waste in floodwater became indiscriminate because of absence of solid waste collection system during flood. Soon garbage and polyethylene bags become a part of floodwater in many places. Dropping of garbage filled polyethylene bags in floodwater from upper floors of multistoried buildings was a common sight in flood-affected areas.

The results of the survey conducted in flood affected areas on solid waste disposal practices before and during flood are shown in Fig. 6. The results show that before the flood, 44 percent of the people used municipal dust bins for solid waste disposal, 12 percent used the good practice of van collection system, while the remaining people had the habit of open and backyard disposal. The survey results in Fig. 6 also show that during the flood the unhygienic practices of open dumping and throwing in flood were the modes of solid waste disposal of 82 percent of the people. Solid waste was also found to be dumped on a submerged access road to waste disposal site at Kazla.

In some residential areas, people selected an open plot of land with boundary walls as temporary garbage dump for the locality. The plot was used as a large bin for accumulation of solid wastes throughout the flood period for collection by DCC after the flood. This practice of solid waste accumulation innovated and adopted by local people helped prevention of littering of waste in the locality. However, the occurrence of septic condition in floodwater in the waste accumulation center by decomposing waste could not be avoided.



Practices before flood **Practices during flood**

Figure 6: Solid waste disposal practices before and during flood

DEGRADATION OF ENVIRONMENTAL QUALITY

Pollution Problems

The organic fraction of the solid waste dumped in the stationary as well as hauled containers under favorable temperature and water content started decomposing within days. The anaerobic process of decomposition produced bad smell in the surrounding areas and the leachate produced by the soaked waste was released in the floodwater. The accumulated waste in confined area also decomposed through anaerobic process causing blackish color and bad odor to water. The waste discharged in open floodwater caused depletion of dissolved oxygen in floodwater. Similar effects were exerted by sewage and human excreta that entered into floodwater due to disruption of sanitation facilities. The faecal bacterial load in floodwater was primarily added to flood water by human excreta.

The failure of sanitation system caused severe pollution of floodwater. Faecal matters in sewage and decomposing garbage were mainly responsible for contamination of floodwater. The degree of contamination was assessed by physical, chemical and bacteriological analysis of floodwater from different locations. The DO and BOD of floodwater are presented in Figs. 7 and 8 respectively (Ahmed and Ashfaque, 1999). It may be observed that 38 percent of the samples showed a DO lower than 4 mg/l of which septic condition prevailed in 4 percent of the samples. About 20 percent of the samples showed a BOD higher than 50 mg/l, which is equal to one-sixth of the usual strength of domestic sewage in Dhaka City.

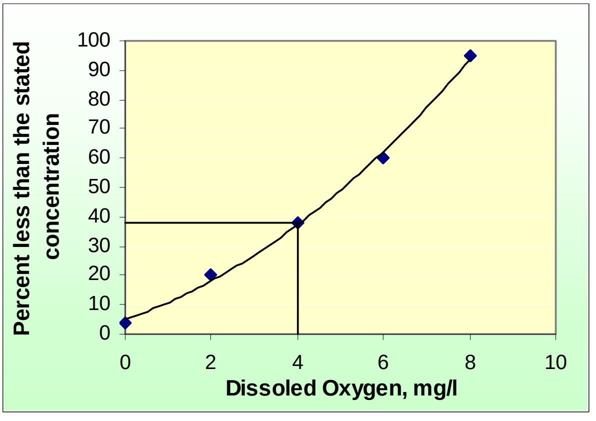


Figure 7: Dissolved oxygen content of floodwater

The bacteriological quality of floodwater indicated by Faecal Coliform (FC) count is shown in Fig.9 (Ahmed and Ashfaque, 1999). The FC distribution indicates that 50 percent of the sample had a count of more than 180/ ml. The minimum FC was found to be 5/ml or 500/100ml. The presence of FC in high concentrations is a definite indication that floodwater was polluted by faecal matters of domestic sewage. The bacteriological quality of water of the DWASA water supply before and during flood indicated by Faecal Coliform (FC) count has been shown in Fig.10. Contamination of drinking water supplied by Dhaka

WASA occurs due to leakage in the pipeline. Contaminants enter into the water distribution main through leaks due to negative (suction) pressure during non-supply hours (Ahmed, 1998). The Dhaka Water supply as shown in Fig. 10 is contaminated to a certain extent but the situation further deteriorated during flood. The bacterial contamination of water was within 0 – 100 FC/100 ml before flood but the number in some of the samples was found to be innumerable to count by Membrane Filter Technique. The median level of FC count increased from 20/100ml before flood to 65/100ml during flood. The bacteria-free water samples decreased to 4 percent during flood from 20 percent during pre-flood period.

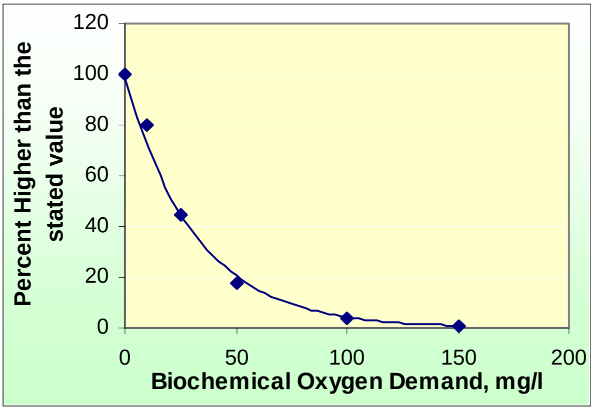


Figure 8: Dissolved oxygen content of floodwater

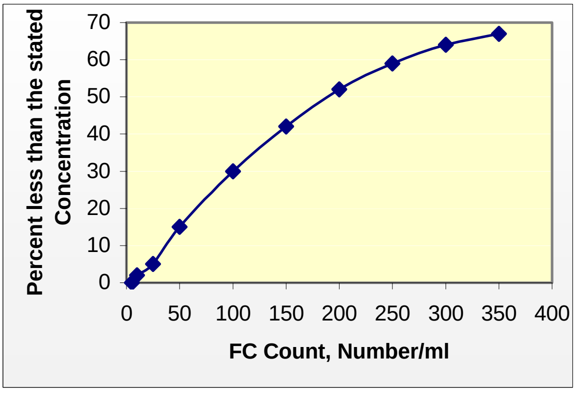


Figure 9: FC counts of floodwater in Dhaka City

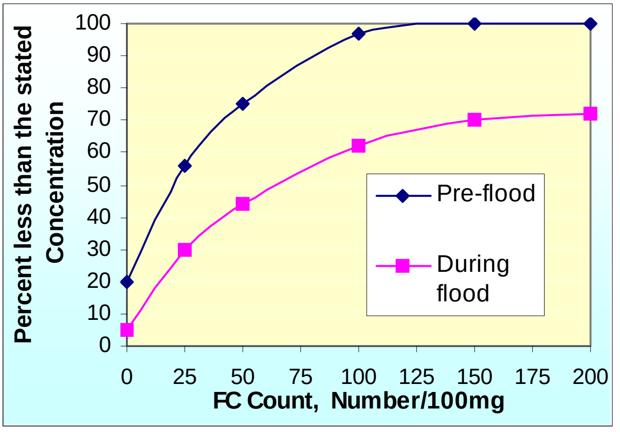


Figure 10: FC count of DWASA water supply during and before flood

Diarrhoeal Diseases

The prevalence of diarrhoeal diseases in the flood-affected areas is a major concern. The incidence of diarrhoeal diseases in the flood affected areas showed that about 26 percent of the people suffered from diarrhoeal diseases during flood, of which 22 percent had diarrhea once. At the national level, death among the diarrhoeal patient was reported to increase to 0.09 percent i.e., 0.9 death per 1000 cases of diarrhoeal attack. In an epidemic situation the death rate is 1 percent according to international standard (The Independent, 18 September, 1998). It appears that outbreak of large scale diarrhoeal epidemic was under control due to awareness of the people, massive health campaign and distribution of safe drinking water and good management of diarrheas.

CONCLUSIONS

The sanitation and solid waste management systems of Dhaka City were in most deplorable conditions during the 1998 flood. The sewer system, sewage treatment and disposal facilities and solid waste collection, transportation and disposal systems of Dhaka city were severely disrupted. All sanitation facilities in the flooded areas and partly in non-flooded areas were non-functional. The *katcha* and pit latrines were flooded, sewage was oozing out of septic tanks, soak wells and manholes. Solid waste collection and disposal in the deeply flooded areas were discontinued

Repair and rehabilitation of 10 sewage lifting stations, a part of the trunk line leading to Pagla sewage treatment plant, 500 km sewer line and large number of manholes in the flooded areas were required after the flood. The estimated cost of reconstruction and rehabilitation of infrastructures of DWASA sewerage system is Tk. 620 Million. The removal of decomposed and partly decomposed scattered solid wastes in the flooded areas was a gigantic post-flood task for DCC. The unused hand trolleys and waste containers were damaged mainly due to corrosion during the flood.

People in the flood-affected areas adopted different sanitation and solid waste disposal practices. About 26 percent of people adopted the practice of open defecation and 10 percent used community latrines and other temporary facilities erected during the flood. Most sanitation practices released part of the human excreta in floodwater. People practiced indiscriminate discharge of solid waste in floodwater to control accumulation in fixed places during the flood.

The waste released in floodwater caused severe pollution problem. The pollution of floodwater by overflow of sewage and decomposing garbage could be fully prevented. Proper covering of septic tanks and manholes, installation of community latrine and accumulation of solid wastes in fixed places could reduce water pollution to some extent. It has been observed that secondary interventions such as provision of safe water and hygiene education campaign and management of diarrheas can help avoid spreading of water-related diseases.

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