Assessment of Water Quality in Flood Affected Areas of Dhaka City

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Abstract

The impacts of 1998 flood on water quality in and around the eastern part of Dhaka city have been assessed. The floodwater has been found to be heavily polluted by organic wastes. High concentration of BOD_5 and COD have been found in the stagnant floodwater indicating accumulation of organic pollutants from a variety of sources including submerged sewerage system and direct discharge of human excreta and other household solid wastes. As the communication system of the affected areas was totally disrupted, people were directly exposed to such polluted floodwater that caused them to suffer from various skin diseases. The drinking water supply was also found to be heavily polluted by fecal coliform, which resulted in the outbreak of diarrhoea and other waterborne diseases.

BACKGROUND

Bangladesh, a fertile deltaic region, criss-crossed by numerous rivers, is subject to periodic and occasionally catastrophic flooding. The three large international rivers – the Ganges, the Brahmaputra and the Meghna and their tributaries and distributaries, dominate the hydrology of Bangladesh. These river systems constitute a large catchment area of about 1.72 million square kilometers lying mostly in India, China, Nepal and Bhutan and only 8% of the catchment area lies within Bangladesh (Nishat, 1993). As a result, a huge uncontrolled inflow of water enters into Bangladesh, which in combination with other factors, e.g., heavy monsoon rainfall over Bangladesh, low floodplain gradient, congested drainage channels, influence of tides and storm surges greatly contribute to the recurring flooding in Bangladesh.

The flood in 1998 was significant due to its prolonged duration (Islam, 1999) above danger level (see Fig. 1). The 1988 flood in Dhaka rose to the highest level on record with peak water level of 7.58 m above sea level and the water above the danger level mark of 6.0 m for 23 days (SWMC, 1998). This is comparable to the 1954 flood with 7.06 m peak water level that lasted for 46 days, and the 1955 flood with 7.09 m peak water level that remained above the danger level mark for 31 days. The 1998 flood on the other hand rose to a peak level of 6.70 m and remained above the danger level for more than 80 days. This prolonged flood which affected some 100,000 sq. km. areas out of the total area of Bangladesh of 148,000 sq. km., destroyed basic infrastructures like roads, bridges, houses, standing crops and killed birds, animals and cattle heads.

The long duration of the 1998 flood caused immense sufferings of the people in the affected areas. Disruptions of drinking water supply, sanitation, waste disposal, and disease transmission were among the major adverse impacts of the 1998 flood. This flood heavily affected the eastern part of the capital city, Dhaka. The residents of this part of the city suffered the consequences of this devastating flood. Embankments constructed after the devastation of 1988 flood however, protected the western part of the city. Most of the houses and roads in the eastern Dhaka were inundated by the floodwater (see Fig.2). The water supply system, the sewerage system, gas pipe network, underground electric and telephone cable system all remained submerged for the entire duration of the flood. About three million people in the affected areas of Dhaka got marooned. People had no other option but to use the manually driven small boats that replaced all the motorized and non-motorized vehicles on road.

The most serious problem encountered by the affected people was the quality of water, which deteriorated as a result of many factors. The floodwater, already fouled by the wash-aways from the upstream areas was further deteriorated by the complete submergence of the sewerage system, septic tanks and other sanitary facilities and by the direct disposal of human waste, kitchen waste and household refuse in the absence of sanitation and municipal facilities. The affected people were directly exposed to the polluted floodwater, which resulted in the outbreak of various skin diseases, in addition to serious diarrhoea and other waterborne diseases as a result of drinking contaminated water. This study was undertaken in order to assess the extent of deterioration of both the stagnant floodwater and the supplied drinking water quality.

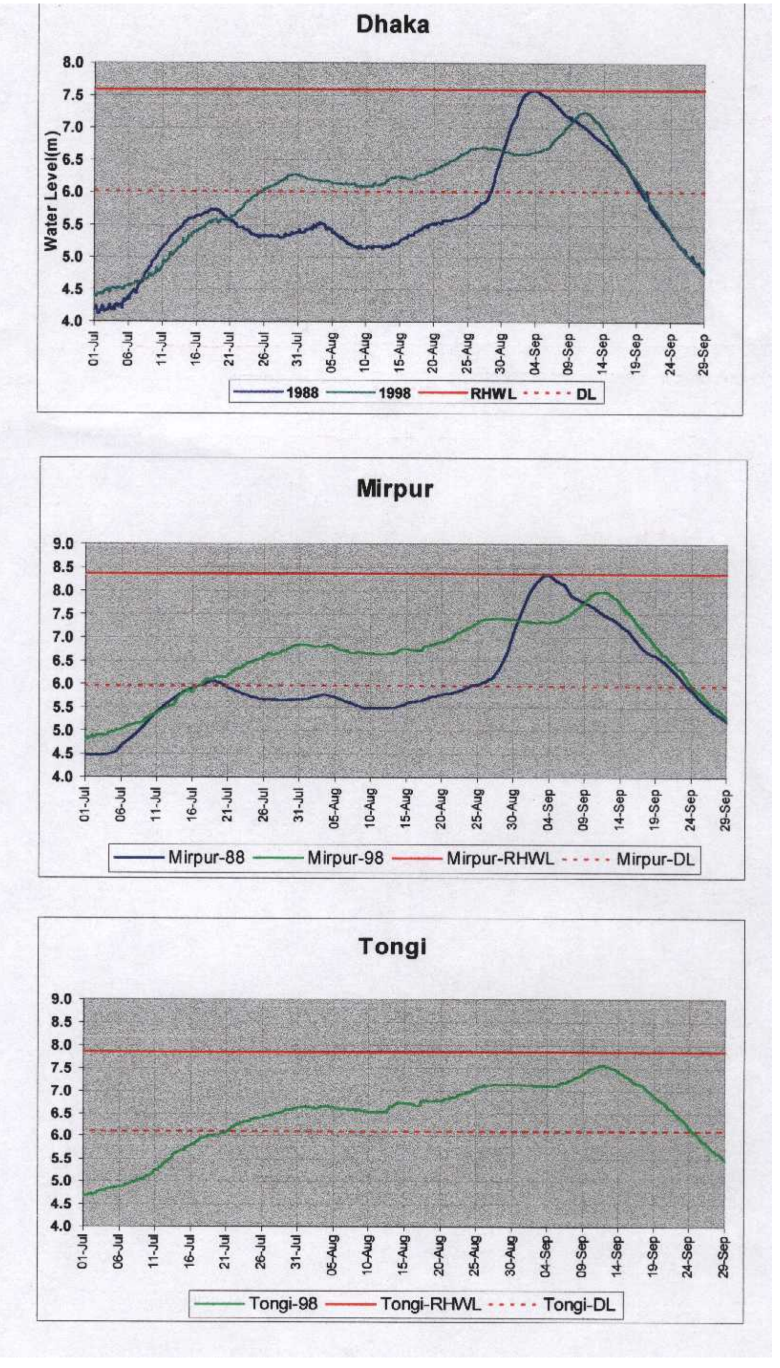


Figure 1: Comparison of the 1988 and 1998 Floods

(a)

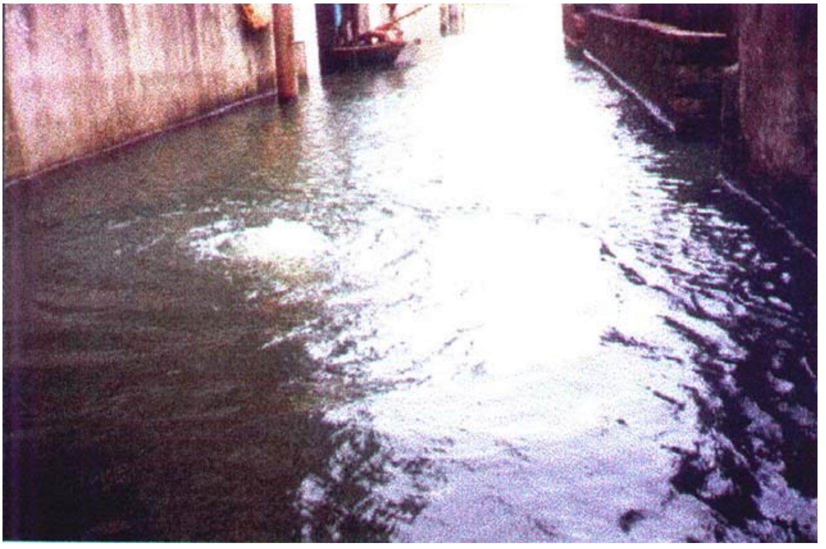
(b)

Figure 2: (a) The eastern part of Dhaka city during the 1998 flood, (b) Small boats plying on the roads in a flood-affected area

(c)

(d)

Figure 2: (c) Status of sanitation and solid waste disposal around residences in a flood-affected area, (d) Direct defecation in a flood-hit area



(e)

(f)

Figure 2: (e) Big bubbles coming from a manhole indicating mixing of sewage and floodwater, (f) Solid waste floating on floodwater

STUDY PROGRAM

Study Area

The affected area (see Fig. 3) of Dhaka city was confined within the eastern side of Airport road-Progati Sarani-Biswa road to the west and the Balu River on the east. The affected eastern part of Dhaka City was divided into four regions (see Table 1) for the study. These four regions covered almost the entire affected area. In order to assess the quality of water in the affected areas, two locations were then identified from each of these four regions for data and sample collection.

Table 1: Sub-division of the study area

Region A	Location-1	Shahjadpur
	Location-2	Nayabazar
Region B	Location-1	Khilgaon Crossing
	Location-2	Rampura Sluice Gate
Region C	Location-1	Moddhya Bashabo
	Location-2	Tilpa para
Region D	Location-1	Waste Disposal Site
	Location-2	Bibir Bagicha Gate

Methodologies

The study methodologies included field reconnaissance, questionnaire survey and water sample collection for subsequent laboratory analysis. Field situation was observed during and after the flood throughout the month of September. Field investigation included visual observations of the flood situation and its effects on the city life captured by still photography and questionnaire survey, that was designed to collect information on various impacts faced by the city dwellers, e.g., availability of food and drinking water, sanitation systems, solid waste disposal systems, communication, health and medical services. Samples of both floodwater and drinking water were collected from specified locations for laboratory analysis.

Collected water samples were analyzed in the Environmental Engineering Laboratory of Bangladesh University of Engineering and Technology (BUET). Floodwater samples were tested for Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD_5), Turbidity and Faecal Coliform (FC) to assess the extent of pollution. Drinking water samples were tested for FC and Turbidity in order to determine their suitability for drinking.

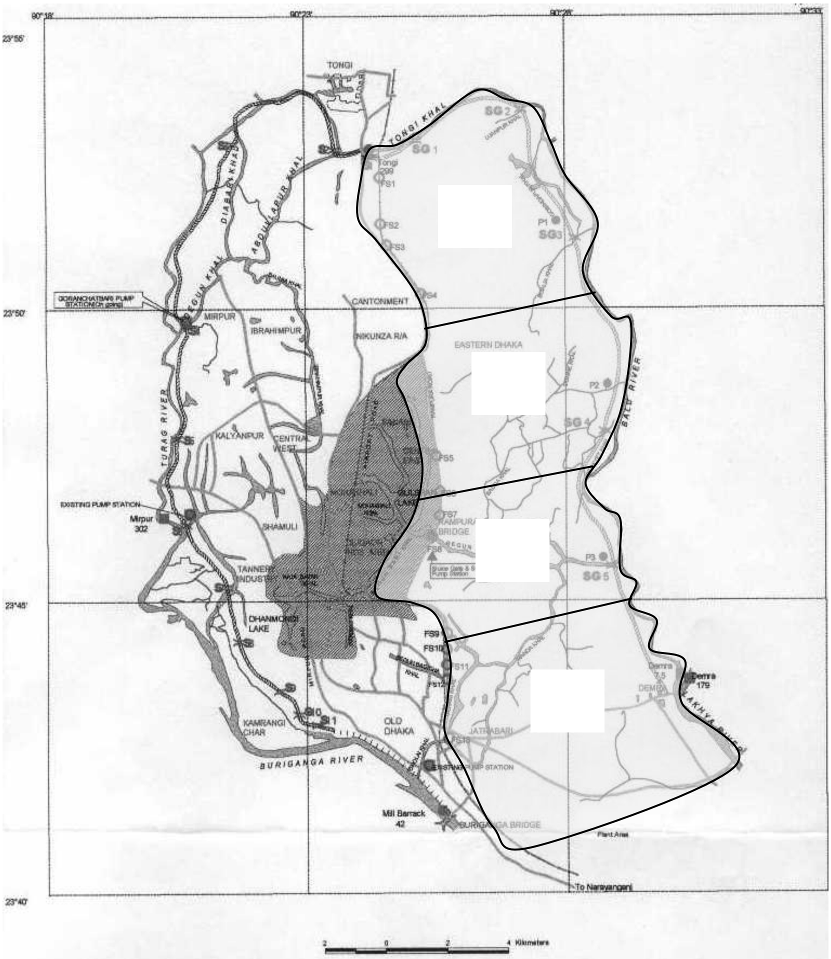


Figure 3: Dhaka city map showing flood-affected areas

RESULTS AND DISCUSSION

Quality of Floodwater

Floodwater samples were collected from eight locations and were analyzed for different water quality parameters. Figures 4 and 5 show BOD_5 and COD of floodwater as a function of time.

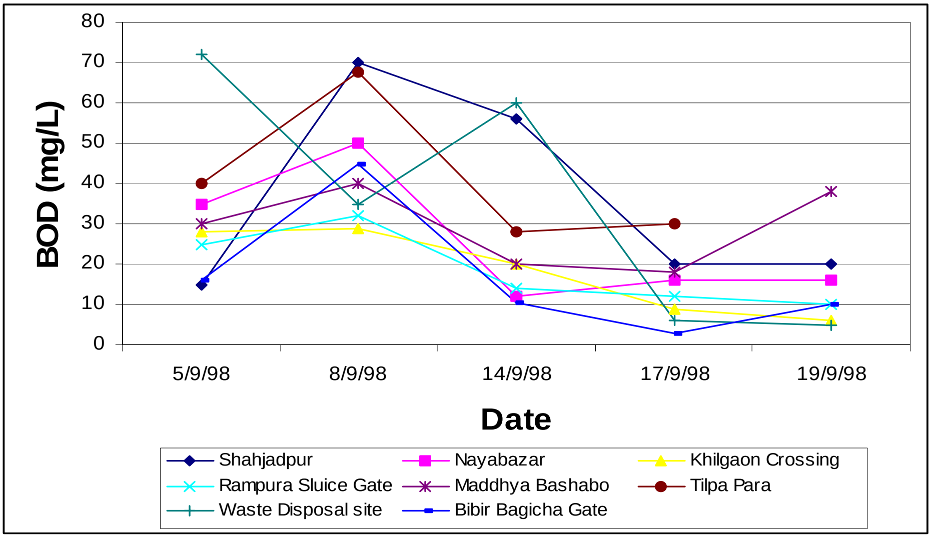


Figure 4: BOD_5 at different locations as a function of time

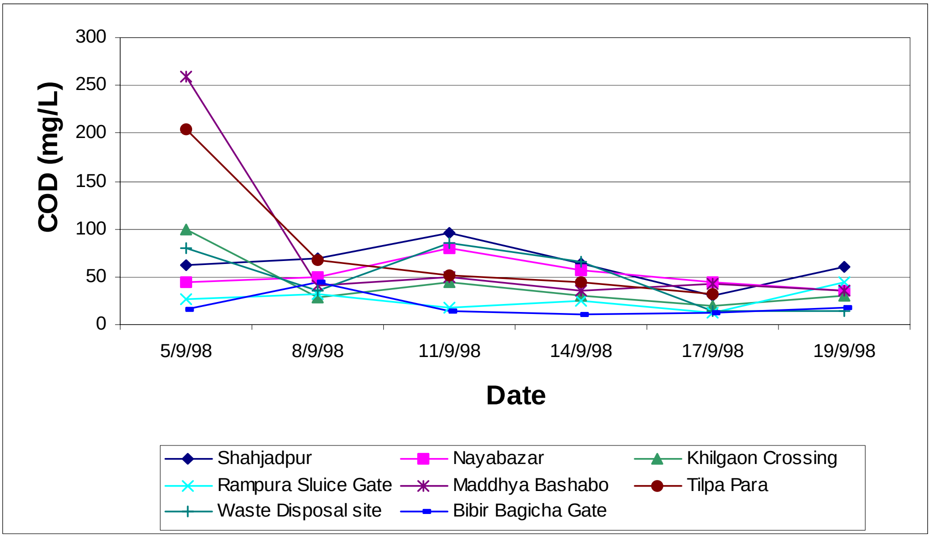


Figure 5: COD at different locations as a function of time

The figures show that BOD_5 and COD gradually increased gradually in the floodwater in all the areas and then declined after sometime. This trend is common for all the sampling locations. Generally very high concentrations of

BOD_5 and COD were found between 5th and 14th September. Looking back to Fig. 1, it can be seen that during this period the flood water level gradually increased until it reached the peak level sometime between the 9th and 14th September. The onrush of floodwater from the upstream catchment occurred at a much higher rate than the passage of floodwater downstream leading to a gradual increase in the flood water level, which remained stagnant for a long period of time. It appears that during this prolonged stagnation period, pollutants from a variety of sources accumulated in the floodwater resulting in high concentrations of BOD_5 and COD in floodwater. It may not be appropriate however, to suggest a strong correlation between high flood water level and high concentrations of BOD_5 and COD, given that the number of measurements were not sufficient for establishing such a correlation. In addition, there are inherent uncertainties, at least to some degree, in the measurement procedures.

In the inundated areas, the submerged sewerage system failed and sewage became mixed with the floodwater. The flow of floodwater was very slow and was almost stagnant during the entire flood-period. As a result, people in these areas became waterlogged and had no option but to discharge different types of wastes, including human excreta, sullage, and the household waste, in the floodwater. This appears to be the primary reason for the high BOD_5 and COD in floodwater.

Figures 6 and 7 clearly demonstrate a major disruption of the sanitation system in the affected areas. As evident from Fig. 7, about 60% of the people could not avail their normal sanitation services and had to resort to mostly unhygienic practices, e.g., open defecation (11%), direct defecation into flood water (19%) and defecation in polythene bags (10%) which were subsequently thrown into flood water. These practices contributed to the deterioration of the quality of the floodwater.

Figure 8 shows faecal coliform concentration in the floodwater samples. As shown in Fig. 8, faecal contamination of the floodwater was very high. As mentioned earlier, sewerage system in the inundated areas failed and became totally submerged under floodwater. As a result, there was mixing of sewage and floodwater. This caused the faecal coliform to rise in floodwater. Since the floodwater received all types of wash-aways including sewage and solid wastes, it was also found to be highly turbid.

Since the floodwater also received wastes from small and medium sized industries located within the city area, it is possible that the floodwater might have been contaminated by heavy metals like lead, cadmium, chromium and mercury. It was however beyond the scope of this study to assess the heavy metal contamination in floodwater.

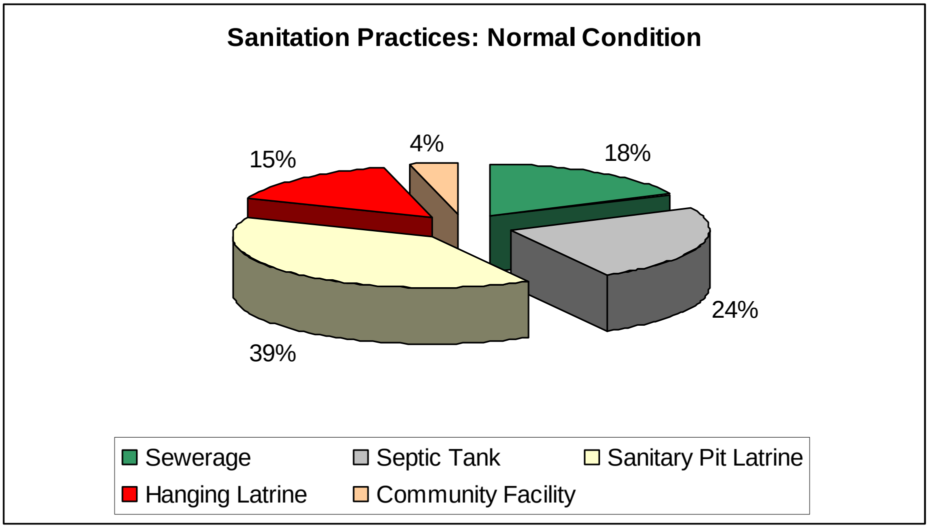


Figure 6: Percentage of population using different sanitation options under no-flood condition

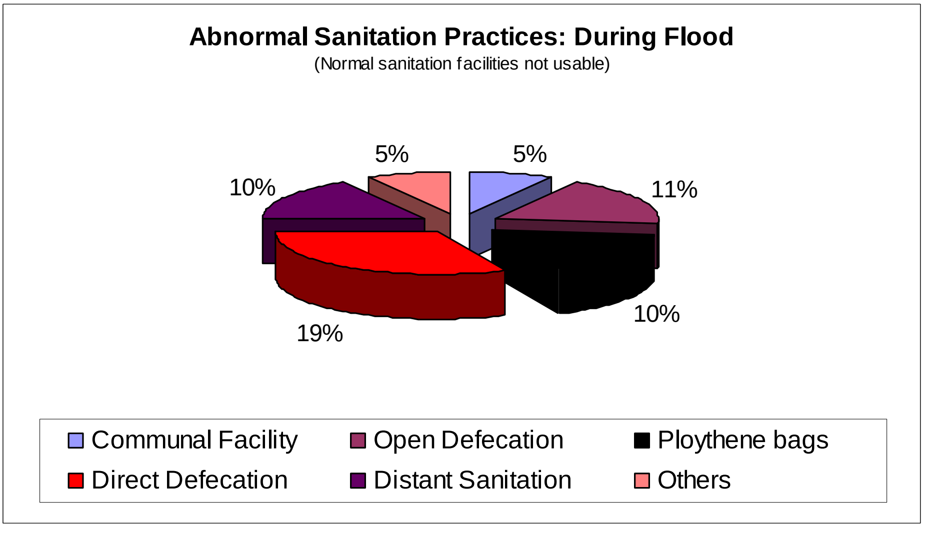


Figure 7: Sanitation practices by the people in flood-affected areas during flood

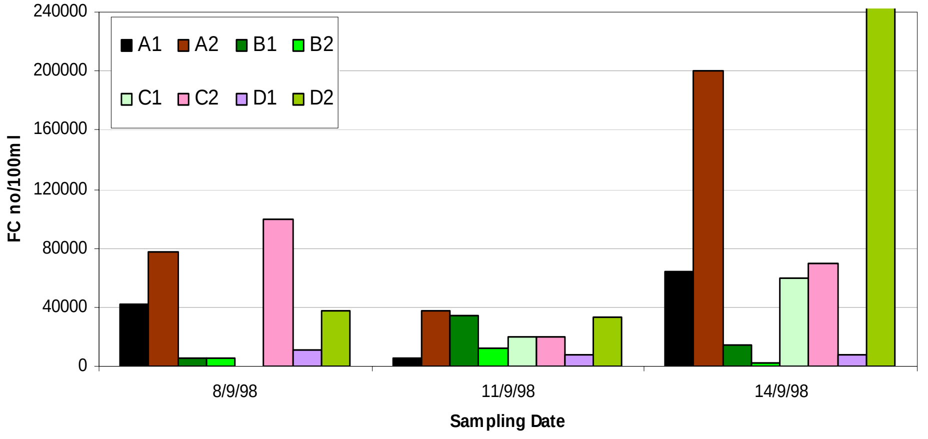


Figure 8: Faecal Coliform (FC) concentration in floodwater

Quality of Drinking Water

Drinking water samples collected from all the eight locations were tested for FC and the results are presented in Fig. 9. Presence of bacteriological contamination was observed in samples from all locations. Any water with presence of FC is recommended to be unsuitable for drinking. Presence of coliform in the drinking water supply appears to be the primary reason behind the outbreak of diarrhoea and other waterborne diseases during and after the flood.

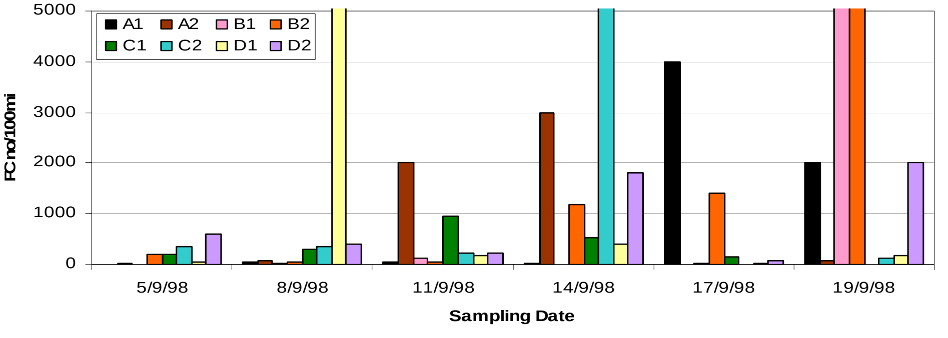


Figure 9: Faecal coliform concentration in drinking water

CONCLUSIONS

Floodwater as well as drinking water was found to be grossly polluted in the all flood affected areas of Dhaka. The quality of floodwater deteriorated due to prolonged stagnation of floodwater and accumulation of pollutants from different sources. Complete submergence of the sewerage system and direct discharges of human wastes and other household solid wastes further aggravated the quality of floodwater. The drinking water supply was also found to be contaminated, primarily because of the submergence of the water supply pipe network. No correlation however, could be established between the extent of bacteriological contamination of the floodwater and that of the drinking water. The polluted water added to the sufferings of the people in the affected areas. People in the flood-affected areas suffered from a variety of diseases, e.g., skin diseases due to exposure to polluted floodwater, and diarrhoea and other waterborne diseases due to drinking of contaminated water.

The long-term solution to the flood problems in Dhaka city would require construction of embankments along the eastern boundary of Dhaka. The economic loss suffered by the eastern part of Dhaka city would well justify the substantial investments for embankment construction. However, until the funds for embankment construction are made available, several short-term measures should be considered in order to minimize the adverse effects of flood with respect to water quality problems. For example, the submerged segments of sewerage system and piped water supply system within the affected area should be sealed and made inoperative during the flood period. Alternative supply of drinking water must be ensured to the flood affected area. Alternate options must also be considered for disposal of human excreta and household waste in the inundated areas. Industrial activities generating and discharging wastes into the floodwater must be stopped during flood.

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