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Water Pollution and its Impact on the Human Health

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Abstract:
River pollution has been one of the main topics in the environmental issue of urban Dhaka, the capital city of Bangladesh. This study was conducted to find out the pollution situation of Turag river and the health problem of the surrounding residents. The results clearly determine that the water quality of Turag river may not be in a position to sustain the aquatic life and not suitable for using domestic purpose. This is indicated by the very low dissoloved oxygen (DO) levels and other measured parameters in the river. The maximum recorded values of pH, color, turbidity, biochemical oxygen demand (BOD5), hardness, total dissolved solids (TDS), chloride (Cl-), carbon-di-oxide (CO_2) and chemical oxygen demand (COD) were 7.1 mg/L, 625 ptcu, 97.2, 4.65 mg/L, 1816 mg/L, 676mg/L, 5 mg/L, 15.5, and 78 mg/L, respectively. The maximum concentration of turbidity, BOD, hardness, TDS, and COD found in the Turag river is much higher than the standard permissible limit. The study also provides evidence that local communities are suffering from a variety of health problems including skin, diarrhea, dysentery, respiratory illnesses, anemia and complications in childbirth. Yellow fever, cholera, dengue, malaria and other epidemic diseases are also available in this area. Furthermore, the people are suffering by the odor pollution and respiratory problems.

Keywords:
Turag River;Pollution;Impact;Human Health

1. INTRODUCTION

Water is the most vital element among the natural resources, and is critical for the survival of all living organisms including human, food production, and economic development. Today there are many cities worldwide facing an acute shortage of water and nearly 40 percent of the world's food supply is grown under irrigation and a wide variety of industrial processes depends on water. The environment, economic growth, and developments are all highly influenced by water-its regional and seasonal availability, and the quality of surface and groundwater. The quality of water is affected by human activities and is declining due to the rise of urbanization, population growth, industrial production, climate change and other factors. The resulting water pollution is a serious threat to the well-being of both the Earth and its population.

Bangladesh is a deltaic land created and flown over by numerous rivers; the land is also consistently nourished by their water flows. Pollution of river bodies has become a major problem that is becoming critical because of inadequacy or non-existence of surface water quality protection measures and sanitation. Lagoons, rivers and streams

are sinks for wastes. Wastes are most often discharged into the receiving water bodies with little or no regard to their assimilative capacities. The discharge of raw sewage, garbage, as well as oil spills are threats to the diluting capabilities of the lagoons and rivers in the major cities. The natural purification of polluted waters in itself is never fast, while heavily polluted water may traverse long distance in days before a significant degree of purification is achieved [1, 2]. In addition, rivers and canals are becoming increasingly polluted from industrial wastewater dumped by factories, many of them in the textile industry. Leather tanneries are also a significant source of toxic pollutants to the air and water. The water pollution threatens food production and is raising both environmnetal and human health concerns [3–8].

Dhaka city is surrounded by a number of rivers and canals of which Turag, Buriganga, Dhaleshwari, Balu and Shitalakhya are the important ones. Because of the lack of the water resources management plan and policies, both the quality and quantity of water in these rivers have reached a very critical situation that does not allow its instant use. The rivers Buriganga, Shitalakhya, Turag, and Balu have been so extremely polluted that these have turned into the rivers of poison. The poisonous waters of these rivers have not only been killing all its aquatic life but also been posing health hazards to the dwellers of the city. These rivers receive partially treated and untreated sewage effluent, sewage polluted surface run-off and untreated industrial effluent from nearby residential and industrial areas. Sources of pollution of the water in these rivers also include various industrial discharge, domestic waste; indiscriminate throwing of pathological and commercial wastes, etc. Because of this, water quality of these rivers is deteriorating day by day [9–13].

River pollution has been one of the main topics in the environmental issue of urban Dhaka. The rivers surrounding the capital city, including the Turag have been steadily experiencing complicated problems like pollution and encroachment that have almost suffocated these valuable lifelines of the city [14–16]. The pollution of the Turag river found in two points with extreme pollution especially from the Buriganga third bridge to the Tongi bridge. These two pollution points of the river homing in on the sources and causes of pollution, its impacts on the surrounding environment and possible sustainable remedies. However, the specific objectives of the study were as follows:

1. To show the variations in different water quality parameters along a strip of the river due to the disposal of untreated industrial waste and season change (dry and wet); and
2. To analyze the health problems created by the pollution.

2. MATERIALS AND METHODS

2.1 Locale of the Study

This study was conducted in a 2 km long strip of Turag river (**Figure 1(a)** and **Figure 1(b)**) which started from Tongi bridge following the river parallel to the Ashulia road. The average width of the river along this section is 15-20 meters; average depth during wet season is 4-6 meters and during dry season 2-4 meters.

2.2 Sources of Data

The sources of data are divided in to two categories. The data which were collected from the field or study area are called the primary data. Primary data were collected by the interviewing the people of study area and/or by making survey on a topic of the study. The secondary data are the data which were collected from any books, journals, previous research paper or any other document which contain the topics related to the study.

(a) (b)

Figure 1. Study Area along the Turag River (a); A Closer View of the Study Area (b)

In this study the primary data were the pictures, sampling data, interviews of people, field observation etc. The field observation obtain the physical condition of the study. In case of secondary data, map and information has been collected from Department of Environment (DOE), Bangladesh Water Development Board (BWDB), Bangladesh University of Engineering and Technology (BUET) and Institute of Water Modelling (IWM). Also from the annual report of World Bank annual report of "Water quality and environment of Dhaka Bangladesh", special report from the Department of Fisheries (DoF), the Management of Aquatic ecosystem through Community Husbandry (MACH), and the Turag project of the Bangladesh Center for Advance Studies.

2.3 Data Collection Methods

The steps that have been adopted to attain the objectives of the study were as follows:

1. Primary data were obtained from field observation and this was needed to know about the existing physical and environmental condition of the study.
2. Secondary data have been collected from DOE, BWDB, BUET and IWM, special report from the DoF, MACH, the Turag project of the Bangladesh Center for Advance Studies.
3. Water Samples and photographs have been collected from different locations of the Turag river and water samples tested in the MIST Environmental Engineering laboratory.
4. Recent surface water quality data has been collected from DOE and Environmental laboratory in Civil Engineering department of BUET as test sample.
5. Water quality and pollution loads analyzed to find out the present water quality scenario, trend of water pollution and percent of increase in pollution loading. Besides, reports, thesis, journals and expert opinions were collected from different organizations and internet.
6. Focus group discussions (FGDs) and in-depth interviews with community members to identify their perceived current and historical health problems. The second involved the gathering of secondary data and the undertaking of interviews with health workers in the area to determine whether the perceived changes to health expressed by the local population matched the health trends observed by local health professionals. To collect this data, our tool was taking "Interview with the people" of this location. The respondent persons were fisherman, boatman, teacher, local people, farmer, health workers, health professionals and tourist.

Water quality data have analyzed by Microsoft Excel software.

The standard participatory rural appraisal (PRA) methods followed to analyze data, collected from the local people concerning their perception. Some questionnaires designed and used to interview the people. All the data were analyzed by Microsoft Excel software.

2.4 Sample Collection

Surface water samples of the rivers were collected from four different points of the river in two seasons during the period of April 2013 to July 2013 covering dry and wet periods. Various water quality parameters were monitored and a detailed field survey has been conducted within the study area. Proper sampling procedure was followed while collecting the samples.

2.5 Sample Handling and Preservation

Appropriate sample handling and preservation is essential to ensure data quality. Factors considered are listed as: (a) clean plastic containers are typically used for inorganic samples, with glass containers used for organic analyses; (b) proper sample preservation is important if accurate and representative results are to be obtained from the sampling efforts. In general, all samples are placed on ice in the dark and (c) analyses should be initiated as soon as possible after collection to avoid sample deterioration.

2.6 Sample Depths

Selection of sampling depth varies with the purpose of work and the parameter to be tested. In this study, the sampling depth was taken to be 15- 20 cm. This was because; the main point of focus of this study was surface water pollution. Generally, heavy metal concentration analysis needs sample from a deeper section.

2.7 Laboratory Testing and Standards

The experiment on a selected segment of the river was carried out for four months duration. The time was chosen as such that both dry season and wet season was there. To assess the water quality we conducted test on 13 water quality parameters. The lists of those parameters with the standards are listed below:

From the analysis of data it was observed that there is a distinct variation in water quality during dry and wet season. As the flow of water is less during dry season and water level goes down the quality of water become poor. As a result water remains more polluted during dry season. Again during wet season due to rainfall the flow is more, level of water increases and the water quality becomes relatively better.

2.8 Determination of Water Quality Parameters

Dissolved Oxygen (DO): The sample was taken in the bottle and diluted with the water. The probe of the multimeter was placed inside the bottle and the reading is taken.

Table 1. Limiting Values of Different Water Quality Parameters

Parameter	Standard
DO	6 mg/L
pH	6.5-8.5
Color	15 ptcu
Turbidity	10 NTU
BOD	0.2 mg/L
Hardness	200-500 mg/L
TDS	1000 mg/L
Cl^-	0.2 mg/L
CO_2	-
COD	4 mg/L

pH: The sample water is taken in small beaker then the probe of the pH meter is placed inside the water and kept for some time. The reading was shown on the pH meter but the final value took when the reading on the screen became static.

Color: The sample water is taken on the small beaker of the spectrophotometer. The spectrophotometer is set for the color test and it is zeroed by the distilled water. Then the sample water is placed inside the spectrophotometer and reading is taken.

Turbidity: The sample water was taken in the small tube of the turbidity meter. The switched was on and then the reading was taken from the meter.

Biochemical Oxygen Demand (BOD5): The sample was taken in the bottle and diluted with the water. The probe of the multimeter was placed inside the bottle and the reading was taken and finally the bottle was placed inside the refrigerator at 200 ˚ C of temperature for 5 days. After 5 days, the data was taken again trough the multi meter and the result was obtained.

Hardness: The 50 ml of sample water was taken in the beaker which was diluted with 50 ml of distilled water. Then 1 ml starch in a packet of reagent was added with the water which was then titrated. However, the reading was taken when the color become purple.

Total Dissolved Solids (TDS): The sample water was taken in the beaker and the probe of the multimeter was placed inside the beaker for few minute. The static result shown on the screen of the multimeter was the TDS of the water.

Chloride (Cl^-): Filled a square sample cell with 10 ml of sample and another one with deionozed water sample pipette 1.0 ml of Mercuric Thiocyanate solution into each sample. Sample was then swirl to mix. Pipette 0.5 ml of Ferric Ion solution into each sample cell and kept the sample for two minutes. After that two cells were placed inside the spectrophotometer and the results were obtained.

Carbon-di-Oxide (CO_2): First we took 100ml of the sample, 3 drops of the Phenaphtholen was added to the sample if the sample goes pink it represents no CO_2 is present, otherwise three drops of Methylorange was added with the sample. Later titration was done with NAOH. Five times of NAOH of titration was the amount of CO_2 present in the sample.

Chemical Oxygen Demand (COD): Turned on the reactor and pre heated to 150 ˚ C. Hold the vial at 45 degree angle and 2 ml of sample. Then the sample was mixed by inverting the vial. The sample was heated for two hours with a strong oxidizing agent. After the vial was placed inside, the spectrophotometer and compared it with the blank vial. Thus the result was obtained.

3. RESULTS AND DISCUSSION

The analysis of the samples collected and the available data indicate that the DO at different locations along the river is very low, often far less than the minimum level as suggested for inland surface water. The measured DO values varied from 0.76 mg/L to7.1 mg/L where the ECR 1997 standard is 6 mg/L. Maximum DO 7.1 mg/L was recorded on 15 June 2013 from point 1 and the minimum value 0.76 mg/L was recorded on 25 April 2013 from point 3. The value of pH varied from 6.14 to 8.79 where the ECR 1997 standard is 6.5-8.5. Maximum pH 8.79 was recorded on 25 April 2013 from point 4 and the minimum pH 6.14 was recorded on 20 April 2013 from point 2. The quantity of color in the water varied from 104 ptcu to 625 ptcu where the limiting value of ECR 1997 is 15 ptcu only. Maximum value of color was recorded on 18 April 2013 from point 2 and the minimum was recorded on 31 may 2013 from point 1. The value of turbidity in the water varied from 12.31 NTU to 97.2 NTU where the limiting value of ECR 1997 is 10 NTU only. Maximum value of turbidity was recorded on 18 April 2013 from point 2 and the minimum was recorded on 31 May 2013 from point 1. The BOD5 in the water varied from 0.7 mg/L to 4.65 mg/L where the limiting value of ECR in 1997 is 0.2 mg/L only. Maximum value of BOD5 was recorded on 25 April 2013 from point 3 and the minimum was recorded on 15 June 2013 from point 1. The amount of hardness in the water varied from 300 mg/L to 1816 mg/L where the limiting value of ECR 1997 is 200-500 mg/L. Maximum value of hardness was recorded on 18 April 2013 from point 2 and the minimum was recorded on 15 May 2013 from point 1. The quantity of TDS in the water varied from 118 mg/L to 676mg/L where the limiting value of ECR 1997 is 1000 mg/L. Maximum value of TDS was recorded on 18 April 2013 from point 2 and the minimum was recorded on 7 June 2013 from point 1. The quantity of Cl- in the water varied from 0.24 mg/L to 5 mg/L where the limiting value of ECR 1997 is 0.2 mg/L. Maximum value of Cl- was recorded on 18 April 2013 from point 2 and the minimum was recorded on 15 June 2013 from point 4. The amount of CO_2 in the water varied from 0 to 15. Maximum value of CO_2 was recorded on 7 June 2013 from point 2 and the minimum was recorded on 15 June 2013 from point 4. The quantity of COD in the water varied from 4 mg/L to 78 mg/L where the limiting value of ECR 1997 is 4 mg/L.

3.1 Health Problem

On this part of study the main target was to find out the health problems which are create by the industrial pollutant waste water discharged and flow into the river. The visions of this part of the study were:

1. Assess the prevalent health conditions of the people living around river and prepare a health profile;
2. Identify potential or evidence derived environmental factors associated with those prevalent health problems; and
3. Identify potential pollution related health indicators.

3.2 Community Perceptions of Health Profile

In an open question on predominant health problems in the community, the respondents mentioned that skin diseases, diarrhea, gastric ulcers, and respiratory illnesses (common cold, asthma) were the most common health problems amongst the population in the area. In addition, people also suffer from indigestion, hypertension, gout, rheumatism, conjunctivitis, pneumonia, malaria, tuberculosis and cancer. At least 70 percent of the people involved in the discussions reported that they were suffering from skin diseases, diarrhoea, gastric ulcers or other gastric problems at the time that the research was taking place.

Table 2. Average Score Given by Health Workers for Prevalence of Health Problems

Health problem	Sum of score	Mean ± SD	Rank
Skin disease	78	7.80± 3.52	1
Diarrhoea	76	7.60 ± 4.62	2
Gastric ulcer	75	7.50 ± 8.09	3
Fever	50	4.10± 5.67	4
Cold, cough	44	4.40± 5.82	5
Dysentery	40	4.00 ± 5.72	6
Cold cough and fever	8	0.80 ± 2.53	7
A.R.I	16	1.60± 5.06	8
Pneumonia	15	1.50± 3.17	9
Indigestion	14	1.40± 2.95	10
Amoebiosis	12	1.20 ± 3.7	11
Chicken pox	10	1.00 ± 3.16	12
Hypertension	10	1.00± 3.16	13
Acute abdomen	10	1.00± 3.16	14
Spermatorrhoea	8	0.80± 2.53	15
Gout	8	0.80± 2.53	16
Headache	5	0.50± 1.58	17

Notes:

SD- standard deviation

- In this interview cold, cough and fever was treated as a single health problem as even after questioning the health worker was unable to separate them and considered them to be a problem that always occurred together.

Qualitative information suggests that there may be a link between the pollution and health problems. Skin problems, allergic conditions, itching and other skin lesions are contact-type diseases. It found that the alkali water, which is likely to be attributable to the extensive use of the alkalis soda ash and caustic soda in the textile dyeing industry. This alkalinity is likely to be a key factor in the skin irritations reported by local communities as they reported that the symptoms manifest themselves when their skin has come into physical contact with water or sediment.

Skin problems were very widespread in the study area. Almost all participants of interview claimed to have experienced skin problems because of their frequent contact with water, and some participants were currently suffering from skin problems. They willingly showed the team the skin lesions in their bodies, particularly in hands and legs. While talking to the local doctors and village practitioners, it was found that the drugs for skin problems, both traditional and allopathic, were the highest selling drugs in the locality. The symptoms of the skin conditions include a rash, boils and irritation. There are two main reasons given by the communities as to the source of the problem. The first is that it is spread by contact especially among children who are living in unhealthy environments. The second and more frequently reported cause is contact with the chemicals used in the factories. The people here come into contact with the river water whilst using it for agricultural purpose or when they come for fishing [17].

The majority of the respondents also blamed the lack of proper sanitation systems, poultry farm waste and lack of knowledge about hygiene for diarrhoea and dysentery, which are frequent among children, slum dwellers and factory workers. Diarrhoea is one of the most prevalent health problems reported to be suffered by children.

Gastric ulcers have been identified as a common health problem for workers in the area, including factory workers. The doctors and health workers interviewed felt that this was due to irregular eating habits and the length of time between meals and the drinking unsafe drinking water. Respiratory disorder was highlighted as a major problem in the study area and participants in also mentioned the problem of asthma. Although this may be caused by a number of

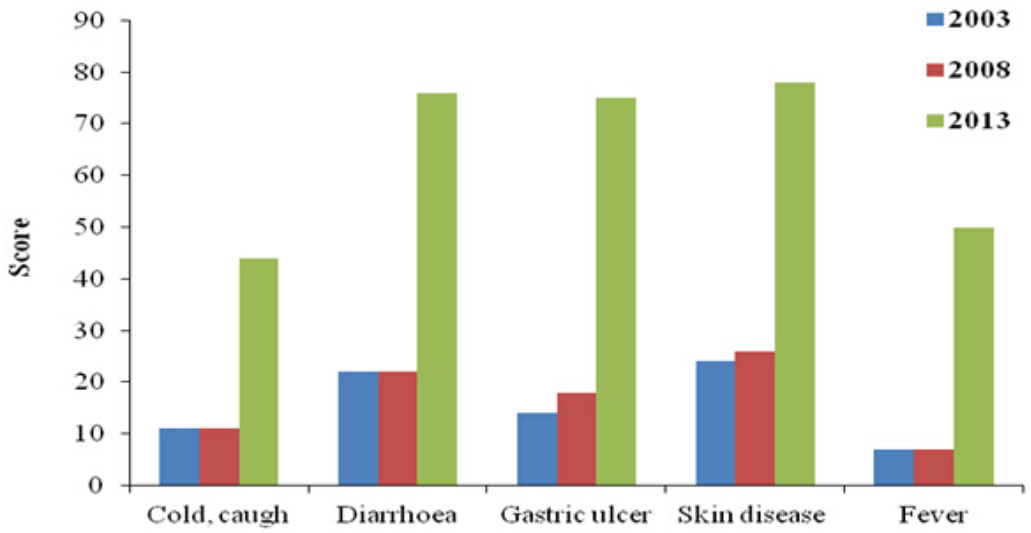

Figure 2. Trend of Health Problems in the Area according to Local Health Workers

factors studies have shown that occasional high concentrations of hydrogen sulphide found in community air samples were consistent with complaints of headaches, eye irritation, and sore throats. Exposure of 42 individuals to 2.5 to 5 ppm (3.5 to 7 mg/m3) hydrogen sulphide caused coughing and throat irritation after 15 minutes. In addition there is a large body of evidence that shows that textile dyes can act as respiratory sensitizers and can lead to choughs, respiratory tract irritation and asthma.

Specific questions asked about maternal health care suggested that there has been an increase in complications during childbirth. A total of 34 respondents in all stated that the number of pregnancy and childbirth complications had increased including: abdominal pain during pregnancy; labour pain but "delayed delivery" or births requiring caesarean, and sometimes still births. Swelling of the hands, feet and legs during pregnancy (edema); abnormal bleeding, anemia and malnutrition were also more common. There is medical evidence that suggest the view is at least plausible.

Currently more than 80 percent of the villagers were found to be using tube well water for drinking and day-to-day household activities. Culturally open water bodies have been the most common source of water for bathing. People generally bathe at least once a day. However, in the study area the communities complain that the river water is no longer of a quality in which people can bathe. The river was also used for cattle washing but people in the majority of the FGD's reported that cattle now suffer from "sore mouths" when they drink the river water and therefore many people are reluctant to use it even to wash livestock. The incidence of problems including diarrhoea, gastric ulcers, respiratory illnesses, hepatitis and anemia, are common amongst the study population although no comparison was made to a larger population size as national health datasets are limited. Studies have conclusively shown that these diseases can potentially occur due to intake of water contaminated with toxic industrial chemicals, as well as human excreta and organic wastes.

Turag have been steadily experiencing complicated problems like pollution and encroachment that have almost suffocated these valuable lifelines of the city. People wash dishes in pitch-black water of the Turag river to the west of Tongi bridge in Dhaka. This river is contaminated with toxic wastes as the pollution source could not be plugged; dissolved oxygen is still too low for aquatic lives to survive in the Buriganga and Turag. Pollutants enter food chain eventually killing birds, fish, and mammals. Pollution concentration here increases abruptly at the advent of the lean period as the water level of the river recedes a lot at this time but the rate of pollutant released into the river remains

identical. At this period, pollution is so acute that hardly any hydro-organisms can tolerate it and eventually, fish of many species are found floating dead in the river water. These dead fishes gradually get rotten and highly add to the further pollution of the river water.

4. CONCLUSIONS

The results of the sampling programme clearly determine that the water quality of Turag river may not be in a position to sustain the aquatic life as well as not suitable for using for domestic purpose. Due to lack of time and resources, the sampling programme was limited to four months duration, from April 2013 to July 2013. The water samples were analyzed that includes DO, pH, color, turbidity, BOD5, hardness, TDS, chloride, CO_2, COD etc. The disposal of industrial waste effluent into riverine system has given rise to heavily localized pollution and threatens seriously to the environment. The present data on the status of river water will help to establish water processing plants in future, the requirement of which increases at a tremendous rate due to growth of population, industrialization and arsenic contamination in ground water. The maximum concentration of turbidity, BOD, hardness, TDS and COD found in the Turag river is much higher than the standard permissible limit. The pollution level of the river is increasing sharply and can cause serious problem in near future. From this study, the surface water quality of the major rivers around Dhaka city, is a great threat to ecosystem though some parameters may not in the deteriorate level but the condition of the river side urbanization and industrialization may cause all kind of water pollution in the near future.

On the other hand, the study provides evidence that local communities are suffering from a variety of health problems that could be a direct or indirect result of the discharge and flow of waste water. Skin problems may for example be related to the high pH of the water, which could certainly irritate the skin and result in sores. The high pH levels are likely to be the result of the large quantities of caustic soda and soda ash used in the dyeing process. It is more difficult to attribute the stomach problems to industrial pollution as people in the area do not drink surface water. However gastric ulcers and other similar gastric problems may be related to diet and the impacts of the pollution on crops and fish consumed by people living around Turag river. It is also possible that groundwater is being polluted by infiltration of industrial effluent but similarly there has been no empirical research into this. The problems of diarrhoea and dysentery are unlikely to be caused directly by the industrial effluent, as they are usually the result of microbial contamination. However, the high level of in-migration to the area is putting considerable pressure on poor sanitation infrastructure and may be increasing the risk of contracting communicable diseases.

By using of river water for washing clothing and bath many water born disease spread man to man. However, yellow fever, cholera, dengue, malaria and other epidemic disease also available in this area. The people lives in the aria are also suffering by the odor pollution and by the respiratory problems. For the polluted situation of the river maternal and child health of nearby riverbank slam are in a danger position.

5. RECOMMENDATIONS

5.1 Pollution and Water Quality

In this study, four selective locations were used for water sampling. In future few locations that are more representative may be selected in addition to the defined stations.

1. While carrying out future studies, it should be planned to collect river water samples at different times of year, preferably at least once during wet season and other during dry season. Because the quality of river water

remains better during wet season due to rainfall and runoff from catchment areas but during dry season the quality gradually deteriorates and in the month of February or March (before the beginning of next monsoon) the condition is worst.

2. Heavy metal concentration in the river water samples like Mercury, Lead, Cobalt, Nicale etc may be measured the future studies at different locations where there is a wastewater outfall from industries.
3. Any inconsistency in the results may be attributed to the approach adopted in sample preservation, method of testing and expertise of the technicians. Standard approaches for such procedure should be ensured.
4. Samples should be tested as early as possible after bringing to the laboratory, preferably by 24 hours. If it is not possible, samples should be refrigerated appropriately.
5. Unavailability of adequate data required for trend analysis limits the use of such data. So, it is recommended that continuous water quality data be monitored and collected at important locations of the river system.

5.2 Health Problem

The findings have been confirmed with rigorous epidemiological studies. Further research studies, including epidemiological studies, are necessary to determine better the impact that industry is having on the environment and the people who interact with it. Such evidence is crucial in if policy makers and industry owners are going to be influenced to control and mitigate for environmental pollution. In order to improve the situation interventions both at the national and local levels are required. The implementation of legislation on safety precautions, banning toxic chemicals and pollutant concentrations in industrial discharges into water sources are all required. Currently, most dyeing units in the area and across Bangladesh are in breach of the Environmental Conservation Act. However, the Department of Environmental due to financial, human and political reasons does not act. An Information, Education and Communication campaign would be beneficial in providing an understanding in the community about risks and possible ways to minimize them, and to inform the Bangladesh public of the problems.

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