# Water pollution due to industrial effluents and the subsequent impact on human health: A comparative study between two distinctive areas of Bangladesh

Imran A. Shohel[1], Sabiha Sultana[2], Kazi M.B Ali[3], Md Abu Taleb[4]

[1,3]*Department of Geography and Environmental Studies, University of Chittagong, Hathazari, Chittagong, 4331, Bangladesh*

[2]*Centre for General Education, Manarat International University, Gulshan, Dhaka-1216 Bangladesh*

[4]*Department of Forestry and Environmental Science, Rangamati Science and Technology University, Rangamati, Bangladesh*

**Abstract: This study was conducted to investigate the level of water contamination in Kalurghat industrial area and Chandgaon residential area of Chittagong city of Bangladesh and its consequences on human health. This was evaluated using a socio-economic survey and experimental analysis. Samples were randomly collected from the rivers of the studied areas. Results of the experimental analysis in Kalurghat industrial areas showed that the maximum recorded value of TDS, dissolved oxygen (DO), biological oxygen demand (BOD) and salinity were 915, 6.3, 36 and 1.3 mg/L respectively, were lower than the recommended limit but temperature, electrical conductivity (EC), pH, and COD were 42 0C, 2063 μS/cm, 8.8 and 212 mg/L respectively, exceeded the limits. On the other hand, for Chandgaon residential area, the maximum temperature, EC, pH, DO, TDS, BOD, COD, and salinity were 20 0C, 873 μS/cm, 4.6, 0.4 mg/L, 416 mg/L, 32 mg/L, 67 mg/L, 0.35 mg/L respectively, were lower than the standard permissible limit. This research also reveals that Diarrhea, Dysentery, Dengue, Skin diseases, Gastric problems are the most common water-borne diseases in Kalurghat industrial area and Chandgaon residential area. Furthermore, gastric diseases are the top problem for Kalurghat residents while skin diseases represent the most prominent in Kalurghat industrial area.**

**Keywords: Kalurghat industrial area, Chandgaon residential area, Human Health, Water pollution**

## 1. INTRODUCTION

Environmental pollution is a global problem and is now receiving worldwide attention [1-5]. Industrial development and the environment are initially related.

Industrial activities may affect the environment in different ways [2]. Pollution of land, water and air from industrial waste and depletion of resource base due to the extraction of industrial raw material has major environmental impacts [3]. Bangladesh is an early stage of industrialization but this does not mean that problems of industrial pollution are necessarily less. Being a very densely populated country, pollution from a single source can affect a large number of people [6]. Several unplanned industries located within or close to the residential areas which adversely influence human health and the surrounding environment [7]. The groundwater and river is a significant water source in Bangladesh, most especially for the people in rural areas [8]. Unfortunately, the rivers are constantly contaminated mainly by the activities of humans and industries, also the groundwater is not safe due to arsenic contamination which is high all over the country [9]. Water used by industry has a significant impact on the quality of surrounding water bodies. Among the water used for domestic and industrial sectors over three-fourth of the amount return to surface water bodies and or in the groundwater as domestic sewage and industrial effluents [10-15]. The lack of sanitary dumping sites and poorly equipped plants leads to an ad-hoc manner to the environment. Water pollution became a serious health threat for the people of Bangladesh [16]. It was reported that diseases such as cholera, hepatitis A, dysentery, etc. are all related to unhygienic and contaminated potable water [17-22]. The second-largest city in Bangladesh, Chittagong is a

major hub for a number of industries, including 19 tanneries, 26 textile mills, over 50 other large chemical industries, several soap and detergent factories, and numerous light industrial units that directly discharge untreated toxic effluent into the Karnaphuli River, contaminating the water [9]. The Department of Environment has identified 12 kinds of chemical compound which pollute the water of the Karnaphuli river and that is used for bath or in household needs causes various skin diseases, cancer, leukemia, irritation in lungs and eyes. Contaminated water increases the incidence of waterborne diseases like dysentery, jaundice, and 15% of skin diseases. A recorded 8.5% of the total death in Bangladesh was related to unhygienic water issues [9].

One of the ways to solve environmental pollution due to industrial effluents in Bangladesh is enacting laws that will restrict contamination at the industry source. The environmental conservation act responsible to enact a law addressing this issue has not been very effective in this regard. The Department of environment (DoE) is responsible for enforcing the environmental legislation that may curb pollution of water resources by industrial activities; some of the reasons for the failed enforcement are due to lack of human resources, information, funds, etc. This paper was aimed to investigate the intensity and magnitude of pollution levels in the study area. This study was especially highlight the present status of water quality; the impact of water pollution on human health; and finally provide some effective recommendations to ensure the water quality in the study area.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

In Bangladesh's Chittagong Division, Chandgaon is a thana of Chittagong City. Chandgaon is made up of the Chandgaon residential area, which is adjacent to the Zia park named for the late Shaheed Zia ur Rahman, and the Chandgaon industrial area, which stretches to Moulvipara and includes businesses such the Chandgaon Community Centre. The coordinates of Chandgaon are 22.3833°N 91.8667°E. The planned Chandgaon residential area has been developed by CDA. On the other hand, The Kalurghat industrial area is situated at the north eastern corner in the city. It has been developed as a planned industrial area. Between Kalurghat road and the Karnaphuli river, an area of

about 440 acres was developed for the citing of heavy industries. Chittagong as the second largest city of Bangladesh is situated on the banks of Karnaphuli river having numerous industries, such as 19 tanneries, 26 textile mills, more than 50 different chemical industries, several soap and detergent factories including huge numbers of unplanned light industries. The untreated industrial effluents are discharged directly into the Karnaphuli river and subsequently contaminates the river water. Residents of this area consumes the contaminated water without any treatment, causing chronic public health diseases. Therefore, the areas; Kalurghat industrial area and Chandgaon residential area (Fig 1) have been selected and studies were conducted to find out the present state of water quality and potential threat on public health.
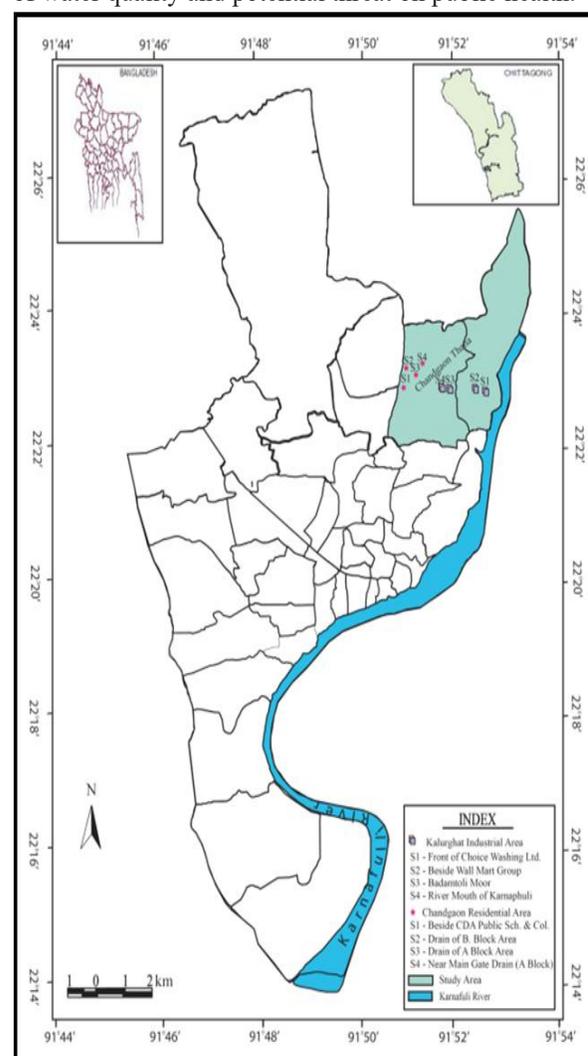


Fig.1. Map showing the location of the Study area and sampling stations (Bangladesh, Chittagong, and

Chandgaon Thana) Source: Base Map collected from CDA, 2013

## 2.2 Instrumentation

The collected samples were analyzed to identify the physical and chemical parameters such as temperature, EC, pH, DO, TDS, BOD and COD etc. The temperature of water samples was measured using 0°-50°C range mercury thermometer. The portable EC meter was used for the determination of electrical conductivity (EC). DO meter, COD and BOD meter were used for the respective measurement. The gravimetric method was followed to identify the total dissolved solids (TDS).

## 2.3 Methodology

The research involved two key elements. The First involved experimental analyses of the collected water samples. Eight (8) water samples were collected from both of industrial and residential areas of the studied locations (Map-1) during the dry season. The Sampling technique followed a random selection and ensured the water bases of vicinities. After collection, samples were preserved in an icebox and transferred to the Environmental laboratory of Chittagong university of Bangladesh for physical and chemical analysis. Clean, dry, and airtight polyvinyl chloride (PVC) bottles which were properly labeled were used for carrying the water samples and standard procedures were maintained to avoid any other foreign contaminants.

The second involved the administration of questionnaires. To collect the socio-economic status, health conditions including citizen perception. 200 semi-structured questionnaires (100 questionnaires for industrial area and 100 questionnaires for the residential area) were used to collect data from the surveyed areas using random sampling. Collected data were analyzed, plotted, depicted and illustrated using standard tools.

## 3. RESULTS AND DISCUSSION

### 3.1 Demographic and Socio-economic characteristics of the respondents

Socio-economic characteristic is an important parameter to understand the real scenario of a respondent. Environmental health and socio-economic condition are co-related because the changing environment has a direct positive or negative impact on the environment.

### 3.1.1 Age

The age of respondents is an important issue for any research. Age structure has divided into four categories (0-20, 20-40, 40-60, 60+) as depicted in Fig 2. Most of the respondents in this study are adult age structures such as 75% is (20-40) age in Klaurghat industrial area and 52% in Chandgaon residential area. The rest of the respondents of 40-60 years and 60+ years of age group are 18% and 7% respectively in Kalurghat industrial area. On the other hand, 36% is (40-60) age structure and 12% is (60+) age in Chandgaon residential area.

### 3.1.2 Educational Status

The educational level depends on the economic condition and consciousness of respondents in the study area. Better economic support can ensure basic needs such as food, shelter, clothing, health, and other luxury needs and as a result access to more education. Respondents are 22% primary, 45% secondary, 14 % illiterate, and 19% graduate in Kalurghat industrial area. On the other hand, these percentages are 18%, 6%, 2% and 74% respectively in Chandgaon residential area.

### 3.1.3 Occupational status

Most of the respondents depend directly or indirectly on the industry in Kalurghat industrial area. This study revealed that people are engaged 30% service holders, 11% business and 59% labor in Kalurghat industrial area. On the other hand, most of the people of Chandgaon residential area are either service holders (46%) or businessmen (27%). Only 14% women are housewives and 13% of respondents are students in this area.

### 3.1.4 Monthly Income of Family

Income level is one of the parameters to measure the socio-economic condition of respondents. About 61 % respondents of Kalurghat industrial area earn below 10,000 taka but only 7.81 % respondents earn this money in Chandgaon residential area. The majority of respondents of Chandgaon residential area are rich and their income level is high in the society. About 40.53 % respondents earn above 40,000 taka and rests of them earn 20,000-30,000 taka (21.27 %) in Chandgaon

residential area. On the other hand, this percentage is only 1 % Kalurghat industrial area.
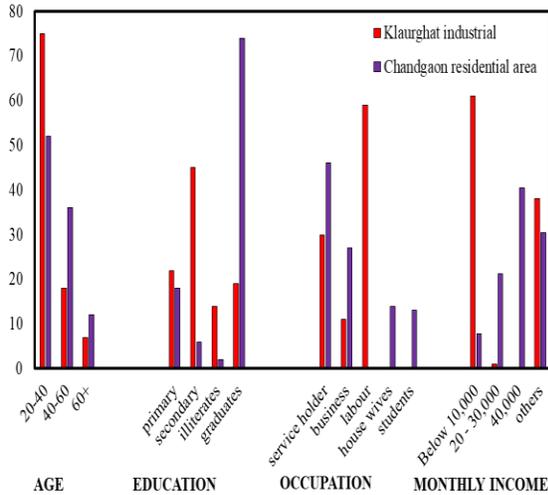


Fig. 2. Demographic and socio-economic comparison of the respondents showing Age, Education. Occupation and monthly income in Klaurghat Industrial and Chandgoan residential area

3.2 Causes of Water Pollution in the Study Area

The land-based activities are the main sources of water pollution. In the Kalurghat industrial area, most of the industries drain out effluents directly into the rivers without any treatment. About 89% of industrial waste is responsible for water pollution in Kalurghat industrial area. This discharged water mainly a complex of hazardous chemicals, both organic and inorganic. On the other hand, 82 % domestic or household waste is the main responsible for water pollution in Chandgaon residential area. Waterlogging is also cause of water pollution in Kalurghat industrial area and Chandgaon residential area (7% and 5% respectively).

3.3 Types of Diseases Due to Water Pollution

Water pollution is very severe in Kalurghat industrial area and it is responsible for water-borne diseases in this area. The result is displayed in Fig. 3. Due to water pollution in Kalurghat industrial area, skin diseases 29 %, gastric problem 23 %, diarrhea 11 %, dysentery 7%, vomiting 5%, stomach ache 19% and dengue 8%. On the other hand, more than 44 % people suffer gastric problems in Chandgaon residential area which is far higher than Kalurghat industrial area. Other diseases like diarrhea, dysentery, dengue, stomach ache and skin diseases are 13 %, 6 %, 9 %, 22 % and
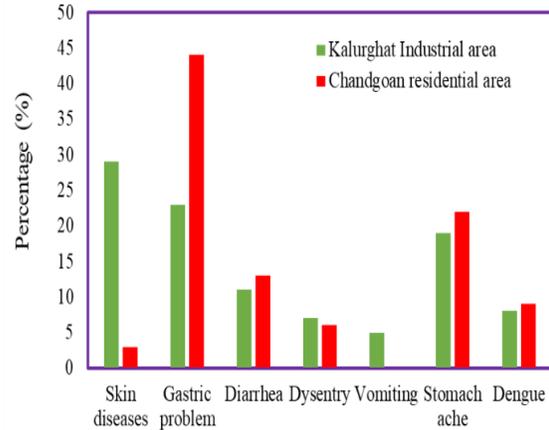
3 % respectively.



Fig. 3. Percentage of diseases caused by water pollution in Kalurghat Industrial area and Chandgoan residential area of Bangladesh

3.4 Intensity of diseases

The intensity of diseases depends on the intensity of pollution. Industrial people are suffered from waterborne diseases for a long time because they cannot use masks and gloves in the working period. Highly hazardous and unhygienic elements are also present in the industrial environment. In the Kalurghat industrial area, the intensity of diseases due to water pollution is high 55%, moderate 29% and low 13% when these percentages are1%, 4% and 95% respectively.

3.5 Process of Water Quality Measurement and Analysis

After analyzing the data, both physical and chemical parameters were compared between the Kalurghat industrial area and Chandgaon residential area and displayed in Table 1 and Table 2. The collected data indicate that the temperature ranges varied from 22 $^0$C to 42 $^0$C in Kalurghat industrial area and 19 $^0$C to 20 $^0$C in Chandgaon residential area but the maximum temperature value of Kalurghat industrial area crossed the Chandgaon residential area. The maximum Electrical Conductivity (EC) value of the Kalurghat industrial area was recorded from station-1 (2063 µS/cm) which was far higher than the maximum value of the Chandgaon residential area (831 µS/cm). The value of pH varied from 6.85 to 8.8 in Kalurghat industrial area and 4.1 to 4.6 in Chandgaon residential area where the ECR 1997 standard is 6.5-8.5. TDS value varied from 146 mg/L to 915 mg/L in the

Kalurghat industrial area and 374 mg/L to 437mg/L in the Chandgaon residential area whereas the limiting value of ECR 1997 is 1000 mg/L. The measured DO values varied from 4.5 mg/L to 6.3 mg/L where the ECR 1997 standard is 6 mg/L. Maximum DO 6.3 mg/L was recorded from station 2 in Kalurghat industrial area and DO value ranges from 3.2 mg/L to 4.4 mg/L in Chandgaon residential area. The maximum DO value of the Kalurghat industrial area was higher than Chandgaon residential area. Salinity in water varied from 0.1 to 1.3 in Kalurghat industrial area and 0.3 to 0.4 in Chandgaon residential area. Different water quality parameters are represented below:

Table 1: Water Quality measurement and analysis in the sampling station (Kalurghat Industrial Area)

| Name of the parameter | Standard Value | Experiment value | | | | |
|---|---|---|---|---|---|---|
| | | Station-1 | Station-2 | Station-3 | Station-4 | Average |
| EC | 1200 micro S/cm | 2063 | 1223 | 1259 | 228 | 1193.25 |
| Temperature | 40 $^0$C | 29 | 42 | 23 | 22 | 29 |
| pH | 6.5-8.5 | 7.1 | 7.2 | 8.8 | 6.85 | 7.48 |
| TDS | 1000 mg/L | 915 | 464 | 655 | 146 | 545 |
| DO | 6 mg/L | 4.6 | 6.3 | 4.5 | 4.6 | 5.0 |
| BOD | Below 50 mg/L | 36 | 32 | 41 | 25 | 33.5 |
| COD | Below 200 mg/L | 212 | 164 | 162 | 151 | 172.25 |
| Salinity | - | 1.3 | 0.1 | 0.6 | 0.1 | 0.52 |
| Alkalinity | - | 100.3 | 61.48 | 114.48 | 91.69 | 92.08 |

Table 2: Water Quality measurement and analysis in the sampling station (Chandgaon Residential Area)

| Name of the parameter | Standard Value | Experiment value | | | | |
|---|---|---|---|---|---|---|
| | | Station-1 | Station-2 | Station-3 | Station-4 | Average |
| EC | 1200 micro S/cm | 747 | 748 | 873 | 831 | 799.7 |
| Temperature | 40 $^0$C | 19 | 20 | 20 | 19 | 19.5 |
| pH | 6.5-8.5 | 4.4 | 4.1 | 4.6 | 4.3 | 4.35 |
| TDS | 1000 mg/L | 374 | 374 | 437 | 416 | 400 |
| DO | 6 mg/L | 3.8 | 3.8 | 3.2 | 4.4 | 3.8 |
| BOD | Below 50 mg/L | 28 | 32 | 25 | 21 | 26.5 |
| COD | Below 200 mg/L | 67 | 58 | 58 | 63 | 61.5 |
| Salinity | - | 0.3 | 0.3 | 0.4 | 0.4 | 0.35 |
| Alkalinity | - | 31.8 | 40.28 | 66.78 | 86.39 | 56.31 |

3.6 People Perceptions Regarding Health Problems Due to Water Pollution

A total of 200 questionnaires were administered to know the impact of water pollution on human health. After collecting the data, it was found that about 82% of people of Kalurghat industrial area suffered water-borne diseases which far exceeded Chandgaon residential area with only 57%. Most of the respondents of Kalurghat industrial area mentioned that gastric problem was the most common problem (22.61%) due to consumption of meals in an unhealthy and dirty environment. On the other hand, 38.24 % people suffered the same problem in Chandgaon residential area. Near about 18.72 % people suffered skin diseases which was the second highest problem in Kalurghat industrial area whereas it ranked the fourth position in Chandgaon residential area. In contrast, stomach aches stood the second position in Chandgaon residential area approximately 21.53% while more than one-fifth people endured the same problem in Kalurghat industrial area. Diarrhea and dysentery were two common waterborne diseases in Kalurghat industrial area and Chandgaon residential area. The surprising matter is that the total percentage of both diseases in Chandgaon residential area exceeded in Kalurghat industrial area. Although diarrhea was not the most common disease in both areas, 48.14 % respondents of Kalurghat industrial area claimed that it was a very serious problem for them. On the other hand, more than 50 % of people thought that it was not

a serious problem due to the low intensity of pollution in Chandgaon residential area. Skin problems were very widespread in Kalurghat industrial area. Almost 67 % people told that it was a very serious problem because most of the industries released toxic effluents which were mixed with the water. Another reason is that most of the industrial workers were not aware to use gloves while doing their work. On the other hand, a significant portion of people (83.33%) marked that it was not a serious problem for them because of the less presence of toxic elements in the water. Waste generation due to the expansion of industrial activity in Kalurghat industrial area had a serious negative impact on the water. That's why stomach ache was a serious problem (55.17%) in the industrial area and it was not a serious problem (80%) in the residential area (Table 3).

Table 3. Level of seriousness due to water pollution

| Diseases | Level of seriousness | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Industrial area (in percentage) | | | | Residential area (in percentage) | | | |
| | Very serious | Serious | Somewhat serious | Not serious | Very serious | Serious | Somewhat serious | Not serious |
| Diarrhea | 48.14 | 37.03 | 11.11 | 3.70 | 11.76 | 17.64 | 11.76 | 58.82 |
| Dysentery | 14.28 | 57.14 | 7.14 | 28.57 | - | - | 50 | 50 |
| Vomiting | 8.33 | 66.66 | 16.66 | 8.33 | - | - | 25 | 75 |
| Dengue | 7.96 | 73.08 | 15.38 | 3.84 | - | 33.33 | 50.00 | 16.66 |
| Stomach ache | 55.17 | 36.20 | 6.89 | 3.72 | - | - | 20 | 80 |
| Skin diseases | 66.21 | 30.98 | 7.04 | 1.40 | - | - | 16.66 | 83.33 |
| Gastric | 25 | 50 | 25 | - | - | 33.33 | 26.66 | 40.00 |
| Cold fever | 32.12 | 9.64 | 52.11 | 6.13 | - | - | 75 | 25 |

## 4. RECOMMENDATION AND CONCLUSIONS

### 4.1. Recommendation

Although the local government has taken some necessary steps to control water pollution but it is not sufficient. Some more important steps may be taken to reduce water pollution as well as to improve health conditions in the study area.

*For the Kalurghat industrial area:*
1. Strict rules and penalties should be imposed on those who pollute our natural environment.
2. The immediate establishment of Effluent Treatment Plant (ETP) in all industries and regular monitoring should be done by the Department of Environment (DoE) whether ETP is available or not.
3. All industrial workers should be bound to use gloves and mask while doing their duty.
4. Industries should not throw their industrial waste into the canal or river/water bodies.
5. Free medical treatment should be provided for industrial workers in Kalurghat industrial area and
6. The Government and NGO have the scope to make research in this field to measure, monitor, mitigate, or control industrial river pollution in Kalurghat industrial area.

*For Chandgaon residential area:*
1. A strong management committee should be made for monitoring water pollution-related problem.
2. The size of drain should be increased to solve the water logged problem.
3. Consciousness program should be increased in Chandgaon residential area for minimizing water pollution.
4. The government should provide adequate funds to the Chittagong City Corporation for making water pollution more effective.
5. A monitoring and evolution system to be maintained under the umbrella of the Environmental Management System.

### 4.2 Conclusions

Environmental issues should be taken as major concerns due to its impact on public health and the development of Bangladesh. This research paper explores the causes, effects and suggestions for controlling water pollution in Kalurghat industrial area and Chandgaon residential areas of Chittagong city.

Water pollution due to releasing of industrial effluents from industries has a negative impact on human health and the environment in the industrial area. On the other hand, household waste and waterlogging are the main causes of water pollution in residential areas where the impact is low due to the low intensity of pollution. Diarrhea, dysentery, vomiting, stomach ache, skin diseases and gastric problem are the results of water pollution. A widespread social awareness among people including government officials is in urgent need to prevent the long term health risk associated with water pollution.

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