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A Comparative Study on Water Quality Criteria between Industrial and Non-Industrial Zones of Karnaphuli River of Bangladesh

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Abstract: *The study was conducted to assess the pollution load released from industrial units to the Karnaphuli River Two water samples were collected from each of five different, namely Hakkhani paper industry, T.K paper industry, Small ship yard, Regent textiles and Salt industry. One sample was at the point industrial waste water discharge and another sample was from 100 meter upstream to the point and the samples were analyzed for pH, DO, COD, BOD, Conductivity, Turbidity, Alkalinity, Cu, Cr6+, Fe, Mn, Zn and As. The study revealed that the water quality parameters of industrial zone variedfrom non industrial zone. The pH value of all sampling sites was within the range of 7.42-8.8. The DO level was very low (4.83 mgl-1) at the point of discharge from Textile industry. In all sampling sites COD level remained above the average limit than the COD of non industrial zone. The level of BOD of three stations was higher than the safe limit of non industrial zone. Highest chloride (59.33 mgl-1), alkalinity concentration (184.33 mgl-1) and conductivity (386.34 mgl-1) were found at Textile industry. Highest iron (2.3 mgl-I), manganese (2.0 mgl-I) chromium (0.087 mgl-I) and arsenic (0.24 mgl-1) were found ar Small ship yard. Highest concentration of copper (1.5mgl-1) was found at Regent textiles and zinc (1.2mgl-1) at Salt industry. Heavy metal concentration of As, Cu, Cr 6+, Fe, Mn, Zn were found to be higher compared to the non-industrial zone for safe limit in case of surface water The study may conclude that the Karnaphuli river water quality at industrial zone is not quite suitable for aquatic flora and fauna as well as for the environment.*

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Introduction:

Total water supply of the world is about 326 million cubic miles of which about 60,000 cubic miles of water are stored as fresh water in lakes, inland seas and rivers (De, 2005). River water is the lotic type of water i.e. flowing water body that is running and the whole water body is flowing in a definite direction. (Chhatwal et al. 1999). Bangladesh is an in-advanced country in terms of industrialization having only 6,000 large and medium scale industries (Das, 2001). Environment and industrial development are intimately related. Industrial activities may affect environment in different ways. The wastes that these industries produce are mostly biodegradable but the problems of the hazardous wastes exist. The careless disposal of industrial effluents and other wastes may contribute to the degradation of water quality due to the presence of a wide variety of inorganic and organic pollutants like oil, grease, plastic, metallic wastes, suspended solids, phenols, toxins, acids, and salts, dyes, cyanides, DDT in these effluents (Kumar and Kulkarni, 2000; Chindah et al, 2004). Effluents from industrial establishments cause the alteration of physical, chemical, and biological properties of aquatic environment by counting change in temperature, odor, noise, turbidity, and to the original properties that is harmful to public health, livestock, wildlife, fish, and other biodiversity (Haque et al., 2002). There are three main industrial zones in Bangladesh namely Chittagong, Dhaka and Khulna. Most of the effluent streams in Chittagong zone are discharged into the Karnaphuli River with proximity to urban areas having large population, which are directly or indirectly dependent on the waters of this river as a source of water supply for Chittagong City, source of irrigation water and fisherman's livelihood (ADB, 2010). But the water of the River is being contaminated day by day by the direct and indirect disposal of the industrial waste water, solid wastes, domestic and municipal sewage and agricultural run-off to the river (Islam, et al., 2011). So, it is of utmost importance to monitor the pollution status or to assess the water quality specially the surface water along with soil of this discharging area of different types of industries. With this consideration in mind, the present study was conducted to investigate the effects of industrial pollution on the quality of the Karnaphuli River water with respect to some chemical parameters including some heavy metals.

The Karnaphuli River:

The Karnaphuli River, the largest and most important river in Chittagong and the Chittagong Hill Tracts, originates in the Lushai hills in Mizoram State of India. It travels through 180 krn of mountainous wilderness making a narrow loop Atrangamati and then follows a zigzag course. The Rangamati and the Dhuliachhari loops are now under the reservoir of the Kaptai earth-filled dam. After coming out from the Kaptai loop the river follows another stretch of tortuous course through the Sitapahar hill range and flows across the plain of Chittagong after emerging from the hills near Chandraghona. The Karnafuli is narrow and straight from Prankiang Towaggachhari along Kaptai-Chandraghona road. The main tributaries of the Karnafuli are the kasalong, Chengi, halda and Dhurung on the right and the Subalong, Kaptai, Rinkeong and Thega on the left. The study area is situated near Kalurghat Bridge. It was extended from Kalurghat Bridge to Raikhali Canal at the south and it covers about three kilometers area. The site was divided into five stations named Kalurghat, Small ship yard, Paper industry, Textile industry, Salt industry. At the east side of the area, there are many industrial set up. They are mainly paper, textile and salt industries. A small ship yard is also existed at the same side.

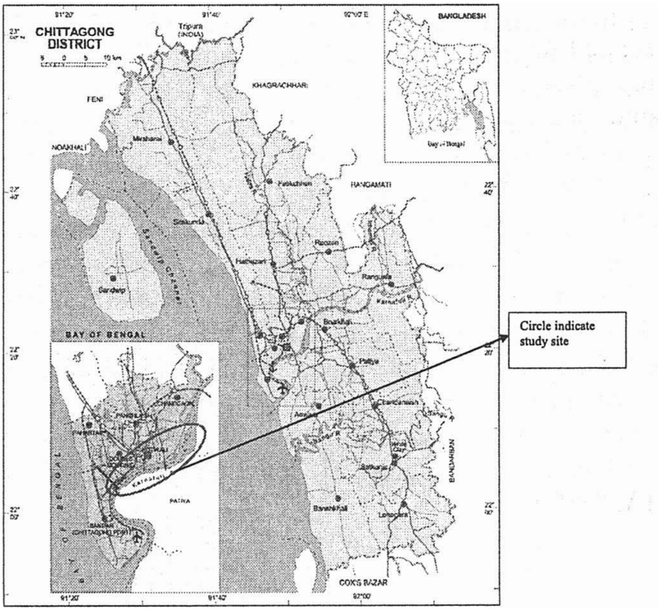

Figure: Map of the study area

Methodology:

From Kalurghat to Rakhali khal five points of Karnaphuli River were selected for industrial water sampling and five points were selected of 100 m upstream of industrial waste discharging point for non-industrial zone. The selected sampling sites for industrial area are:

1. Hakkhani paper industry,
2. T.K paper industry,
3. Small ship yard,
4. Regent textiles and
5. Salt industry

An ideal sample should be one which is both valid and representative. These conditions are meet by collection of samples through a process of random selection. The sample water was collected in the morning at the time of low tide. From each point five samples, were collected. For each point, first sample was collected where waste, water largely containing the industrial effluent, are being readily discharging into river water, downstream water of the effluent containing water and the **two other samples were collected at 20 m interval from the original** point where the effluents usually reach to the river and two samples were collected from 100 m upstream where industrial effluent were absent. In the same way, the five samples were collected from each of the selected sampling sites. Sample water was kept in a 112-liter clean and dry plastic bottle and filled the total volume (1000ml) of the container and cap was locked sufficiently so that no air space can be remained inside to minimize the chemical changes (Dhungana and Yadav, 2009). The collected water samples were then carefully brought and preserved in refrigerator for laboratory analysis in the laboratory of Chittagong Water Supply and Sewerage Authority (CWASA) and the testing of different parameters was done within the next 48 hours, which is recommended for better result minimizing the quality change (Chhatwal, 1996). The standard analytical methods that were used for determination of physico-chemical parameters of water and wastewater were from American Public Health Association series of Standard Methods of Examination of Water and Effluent (APHA, 1999).

Results:

The present investigation revealed that the copper and chromium levels were varying insignificantly (? > *0.05)* among the sampling sites in industrial zone. At the point of Regent textiles, the amount of copper was found the highest in concentration (Fig 1) whereas the chromium concentration was found highest at the point of Small Ship Yard (Fig. 2). Comparatively the lowest concentration of copper was found at the point of Small ship yard and lowest concentration of chromium was at the point of T.K paper industry. The study showed a significant variation between the station of ship yard and others. Comparatively the lowest chromium was found at the point of T.K paper industry. However the amount of chromium of the points of industrial zone exceeds the average limit of non industrial zone. This may be an indicative inference that industrial operation is responsible for the pollution of the river water.

The present investigation revealed that the iron levels are varying insignificantly (? > *0.05)* among the sampling sites in industrial zone. In the point of Small ship yard, the amount of iron is the highest (Fig. 3). This may occur due to the discharging of waste water from nearby ship yard. The study showed an insignificant variation between the station of ship yard and others. Comparatively the lower iron was found at the point of regent textiles. However the amount of iron of the points of industrial zone exceeds the average limit of non industrial zone. The study showed that the level of manganese at all points of industrial zone exceeds that of non industrial zone. There was an insignificant (? > *0.05)* variation among sampling station. The highest manganese was found at the point of small ship yard (Fig. 4). Minimum level of manganese was found at the point of regent textiles in comparison to other stations.

The concentration of zinc was found highest at the point of all industry (Fig. *5)*. Comparatively the lower zinc was found at the point of small ship yard. However the amount of zinc of the points of industrial zone exceeds the average limit of non industrial zone. The study showed that the level of arsenic at all points of industrial zone exceeds that of non industrial zone. There was an insignificant (? > *0.05)* variation among sampling station of industrial zones. The highest arsenic was found at the point of Small ship yard (Fig. 6). Minimum level of arsenic was found at the point of T.K paper industry in comparison to other stations. However the amounts of arsenic of the points of industrial zone exceed the average limit of non industrial zone.

Industrial zone   Non-Industrial

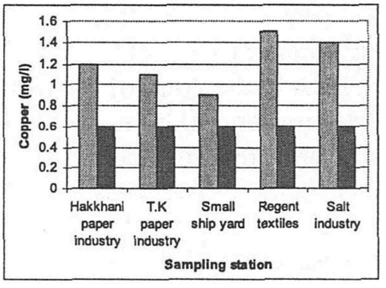

Figure 1: Comparative copper levels at industrial and non-industrial zone

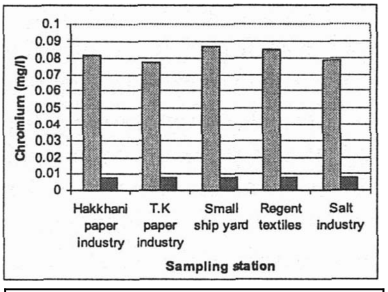

Figure 2: Comparative chromium levels at industrial and non-industrial zone

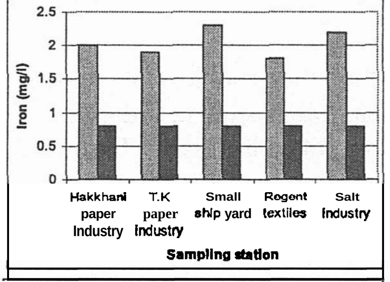

Figure 3: Comparative Iron levels at **industrial** and non-industrial zone

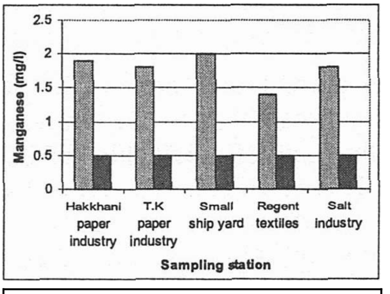

Figure 4: Comparative Manganese levels at industrial and non-industrial zone

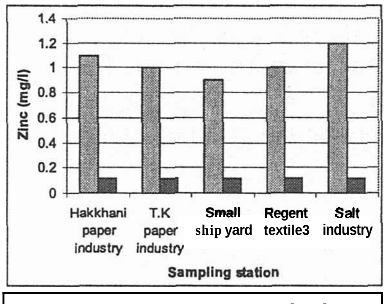

Figure 5: Comparative Zinc levels at industrial and non-industrial zone

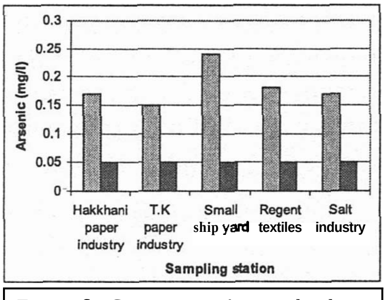

Figure 6: Comparative Arsenic levels at industrial and non-industrial zone

Discussion:

River water receives numerous kinds of chemicals, gasoline and other petroleum products, agricultural fertilizer, insecticides, herbicides, fungicides, construction debris, paints and solvent, changed car oil, sediments, plastic bags, fishing line, hypodermic needles, industrial pollutants. These contaminants pollute the water and make the water unsuitable for domestic and other uses. Since water is very important resource for mankind and usable amount of water is limited, it is very important to protect water from pollution by these ingredients (Ignacimuthu, 1998). The present level of DO in the industrial zone of river water Karnaphuli confirms that the river is moderately polluted. The most significant source of pollution appears to be from textile, paper industries in Karnaphuli area. In the dry season the level of dissolve oxygen becomes low and Toxicity occurs (Banglapedia, 2008). Fish population is also decreasing day by day due to industrial pollution. The BOD level of three points of industrial zone exceeds the average limit of non industrial zone. From the study it is revealed that highest BOD (13.12 mgl-1) was found at the station of T.K paper industry.

Turbidity refers to how clear the water is. This study revealed that the level of turbidity of industrial zone exceeds the level of non industrial zone. It is due to the deposition of more amounts of solid particles at upstream area. The highest turbidity (430 NTU) was found at the point of regent textiles. The COD level of the Industrial zone exceeds the lower level of COD of non industrial zone. The study revealed that the highest level of COD (100.67 mgl-1) was found at T.K industry and it is obviously due to the discharge of organic effluent by nearby paper industries. The pH level was found to cross the average level of non industrial zone. It may occur due to the presence of more alkali producing plants in this area. The highest value of pH (8.8) was found at the point of Regent textile. The study also revealed that the level of conductivity of the water of industrial zone exceeded that of non industrial zone. This is due to mix up of more amounts of impurities with water from nearby industrial plants.

The highest zinc was found at the point of Salt industry. It may occur due to the effluent discharged by the nearby industry. Minimum level of zinc was found at the point of Small ship yard in comparison to other stations. The highest iron and chromium were found at the point of Regent textile. Minimum level of iron was found at the point of Regent textiles in comparison to other stations. Comparatively the lower arsenic was found at the point of T. K. paper industry. However, each points of industrial zone exceed the average value of zinc of non-industrial zone. It was found that there is a great difference between the water quality of non industrial zone and industrial zone. In non industrial zone all types of water quality parameters are within the safe limit. But in case of industrial zone maximum water quality parameters are beyond the safe limit. There are a number of paper, textile, salt industries at the south side of Kalurghat Bridge. These plants don't possess any ETP, so they discharge their all types of effluent directly to the river Karnaphuli. Thus the water quality becomes poor and gradually polluted.

The Karnaphuli River bears a great importance in terms of its geographical location and economic benefit generation. Due to the continuous increase of pollutants load in this river from the industrial establishments, the quality of its water will be beyond the condition for consumption. The effects of various industrial effluents on the seed germination, growth and yield of crop plants have captivated the attention of many workers (Rahman et al., 2002; Street et al., 2007). These heavily toxic effluents were discharging directly to adjacent soils and rivers (Khan, 2006). This will also undoubtedly deteriorate soil productivity and adversely affect crop production in the surrounding land. Industrial effluents had remarkable changes in the distribution of ions and their concentrations in wheat and bean plants (Wafa, 2001). So it is clear that if the contamination increase successively, there will have a significant socio-economic and livelihood disturbance of the river dependent communities.

Conclusion:

Water is life. Pure water is most necessary for the neat and clean life as well as for environment. This water resources need to be managed both qualitatively and quantitatively due to its importance for economic development and the physical and social environments. Particularly in Bangladesh, where water is intricately linked with the lives of people and economy, its value has increased with competing demand. But at present, water pollution of Bangladesh is reaching into anxiety level by manmade sources. Effluent is the main source of river pollution. There is a proverb "Prevention is better than cure." This proverb also holds well in pollution control. It is obvious that the Karnaphuli river of Bangladesh is directly or indirectly becoming polluted due to the addition of industrial effluent by KPM and other industries. So for the greater interest of the nation we should follow technological innovation to reduce the pollution. Effective monitoring provides the basis for proper decision-making about water quality management. Present study demands a healthy water environment regarding the pollution status. It has been found that the water of the east bank of Karnaphuli River was severely polluted due to industrial waste discharge. A noticeable effect of the chloride, pH, conductivity, turbidity, COD, BOD, Arsenic, Copper, Chromium, Zinc, Iron, and Manganese was observed at the water samples of the east bank. Therefore, it needs to take effective measure to mitigate the pollution by the concern authority such as recycling industrial waste, establishment of effluent treatment plant to save the river water from further deteriorating of the quality.

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