ASSESSMENT OF INDUSTRIAL EFFLUENT POLLUTION IN KARNAPHULI RIVER

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ABSTRACT
Industry is one of the main resources of a country's economic development. Different types of industries have different system of productions and use different types of chemicals and raw materials. The untreated effluent from the industries rapidly pollutes the surface water. Hence surface water quality is degrading, people are depended on ground water for their daily water related activities which creates scarcity of water. Again the use of polluted surface water results in serious health hazards.As Chittagong is the port city of Bangladesh, various types of industries are established here due to having favorable environment. Most of the industries are situated on the bank of Karnaphuli river and do not have proper effluent treatment plan (ETP).Thus this river is getting polluted continuously by the untreated effluent of these industries.Study has been conducted in 'Kalurghat Heavy Industrial Area, Chittagong' by collecting effluent from nine industries and three stationary points on Karnaphuli river. Investigation shows that many industries don't have ETP, some have but these are not in operation. Physiochemical results show that the amount of Turbidity and TSS is very high though the heavy metal parameters are within Bangladesh standards. Thus effluent should be treated in a proper way to dispose in the river.

Keywords: ETP (Effluent Treatment Plant); river pollution; health hazard; confluence

INTRODUCTION
Bangladesh is a developing country with a population of almost 160 million. Due to industrialization & low labor cost industries are growing rapidly in Bangladesh especially in Chittagong. Kalurghat is a Heavy Industrial Area which is situated on the bank of Karnaphuli River in Chittagong. Chittagong is the economic capital as well as the port city of Bangladesh. Karnaphuli River has great importance in Chittagong because its water is used in different purposes like drinking, bathing, fishing, navigation, hydraulic power generation, irrigation etc. According to these purposes river water quality should be satisfactory but it is a matter of sorrow that the river water quality is getting worsen day by day by the untreated effluent thrown to the Karnaphuli River from different industries.
Most of the industries in 'Kalurghat Heavy Industrial Area' don't have a waste management facility like Effluent Treatment Plant (ETP). Some industries have ETP but they aren't in operation or the capacity of ETP is inadequate with respect to the effluent. Among them some industries aren't properly maintaining & operating the ETP, thus standard quality of disposed effluent isn't be maintained. Again there is no Central ETP in the area that's why untreated or partially treated effluent come from all industries are directly disposed of in the river & river water get polluted when the effluent feeds the river. Polluted water creates adverse effect on environment, human health, aquatic life & thus ecological balance get disturbed.
There are three major industrial zones in Chittagong. One is 'Chittagong Export Processing Zone (CEPZ)', second one is Baized Bostami Industrial Area and another one is 'Kalurghat Heavy Industrial Area'. Study area of this project is 'Kalurghat Heavy Industrial Area' which is situated on the bank of Karnaphuli River. Various types of industries are polluting the river water such as Dying Industry, Oil Industry, Resin Industry, Beverage Industry, Sea Food Industry etc. The study has been selected for three categories of total nine industries out of over hundred industries in Kalurghat Area.
Different types of Chemicals such as Acetic Acid, Sosa Ash, Mercury etc. ; Raw Materials such as Crude Palm, Vegetable oil, Lin seed etc. ; Heavy Metals such as Arsenic, Lead, Manganese Ore, Iron

Ore etc. have been extensively used in different types of industries. The toxic effluents coming from those industries have an adverse effect on environment.
River water has been continuously polluted by the poisonous mix of different types of chemicals, raw materials along with heavy metals. It has an adverse impacts on river water, aquatic life, human health as well as recreational activities.
Many research work was conducted on various stream in Bangladesh, which is effected by industrial effluent. A research work has been done of water pollution of Karnaphuli River by Rahman and Islam. They found that standard CO_2 and Alkalinity are very large in Karnaphuli River which is harmful for human and aquatic life. Other researchers, Khownain and Chowdhury of CUET, conducted a thorough study over Karnaphuli River regarding quality of water. They applied mechanical, chemical and biological method to investigate. They found that suspended solid and BOD is not in tolerable limit. They suggested that, there should be minimum three monitoring station which must be established at the origin and exit point of each prime river of Bangladesh with proper lab facility and human resource.
The aim of the study is to evaluate the effect of effluent pollution in Karnaphuli river & to find out some remedial measures., This study has revealed that the industries are involve in serious environmental hazard. So, adequate preventive measures should be taken in industrial activities with a view to ensuring a healthy environment & to control the river water pollution. And thus to assess the quality of industrial effluent & river water, to determine necessary steps to control this pollution, the study is being selected.

METHODOLOGY

Industries untreated & partially treated effluent to the environment causing pollution of nearby canals & rivers. These effluent also pollute natural water systems as well as ground water endangering human health and aquatic lives. They contain heavy metals like As, Cd, Pb, Hg, Cr, Ag, Cu, Zn etc. Some of them are toxic to plants and some others to both plants and animals. Study has been done on economic & industrial zone of Chittagong. After Field survey of study area & some industries have been selected. For the study, samples are collected from discharge point of industries as well as from different points in Karnaphuli River. Standard procedure were used to analyze the physical, chemical & heavy metal parameters of the samples.

Work Flow Diagram

The total work has been done by the following ways.

Laboratory tests include physical (Turbidity, TS, TDS, TSS), chemical (PH, Alkalinity, DO, BOD) & heavy metal (Pb, Mn, Zn, Cu, Na, K, Cd) tests.

Selection of the Area

There are three major industrial areas in Chittagong. One is 'Chittagong Export Processing Zone (CEPZ)', second one is Baized Bostami Industrial Area and another one is 'Kalurghat Heavy Industrial Area'. Study area of this project is 'Kalurghat Heavy Industrial Area' which is situated on the bank of river Karnaphuli. Garments, textiles, washing, dying, chemicals, oil mills, plastic, painting, electronics, poultry, foods, cement etc. industries are present in this area. The industries dispose their effluent directly or indirectly in 'Ispahani Khal' which carries this effluent to the Karnaphuli River. The Study area has been presented in **Figure-1**.

Selection of the Industry

There are approximately eighty one industries are present in Kalurghat Heavy Industrial Area. The study has been carried out on nine industries categorized as dying industries which includes Choice Washing Plant, Sanji Textiles, C & A Textiles; chemical industries which includes Padma Resin, Hasan Oil Mills, S A Oil Refinery Ltd. and food industries which includes Meenhar Sea Foods Ltd., Chowdhury & Co., Polar Ice Cream.

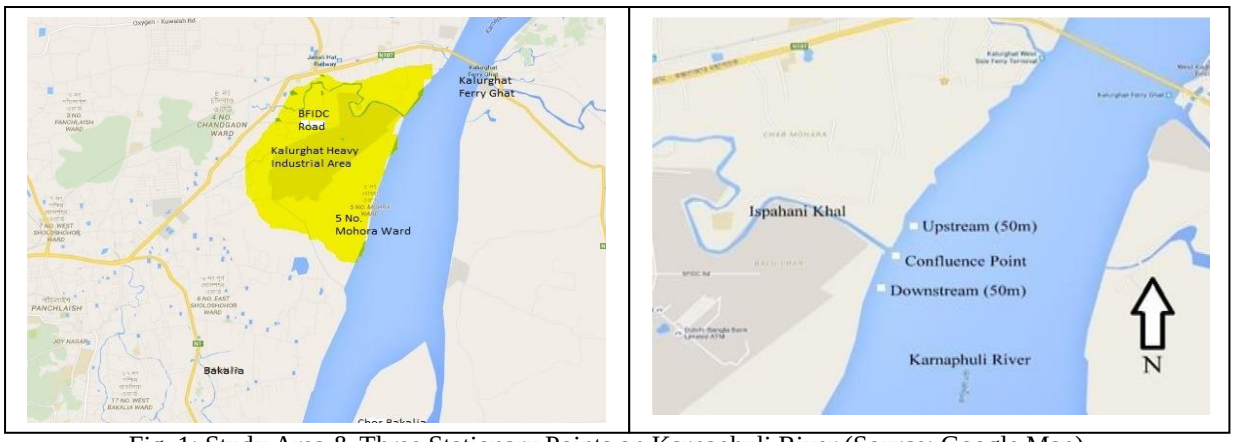

Fig. 1: Study Area & Three Stationary Points on Karnaphuli River (Source: Google Map)

Sample Collection

In order to evaluate the industrial effluent, samples are collected from the discharge point of different industries. To evaluate the river water quality, samples are collected from the confluence point of Ispahani khal & Karnaphuli River, 50m upstream & 50m downstream from the confluence point both at high & low tide condition as shown in Figure 1. Samples were collected in plastic bottles in pouring condition & those samples were tested in laboratory within 24 hours.

Laboratory Analysis of Effluent

1) Physical Parameters

***i)* Determination of Turbidity**

Turbidity may be due to organic or inorganic constituents. Organic particulates may harbor microorganisms. Thus turbid condition may increase the possibility for waterborne disease. Nonetheless, inorganic constituents have no notable health effects. The series of turbidity induced changes that can occur in water body may change the composition of an aquatic community. Turbidity is measured by 'Turbidity Meter' & expressed by the unit 'NTU'.

***ii)* Determination of Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS)**

These are very important parameters for water quality standards whose are evaluated within 24 hours. Unit of all these parameters are in mg/l.

Chemical Parameters

***i)* Determination of P^H**

P^H is the negative logarithm of the hydrogen ion activity in a solution, is determined by a potentiometric method, using a well-calibrated commercial P^H meter, as described in Standard Method 4500-H (Standard Methods, 1998). P^H measurements must be done at room temperature, or using a temperature compensating instrument. Samples are not filtered nor altered in any way prior to measuring. The result is reported as a number, usually to one decimal place. For the determination of P^H, P^H meter (for electrometric determination) was used. Sometimes P^H paper was used to determine P^H manually.

***ii)* Determination of Total Alkalinity**

The amount of alkalinity in water is typically determined by Standard Method 2320 (Standard Methods, 1998) and is reported as the equivalent amount of CaCO3 in milligrams per liter. The purpose of alkalinity testing is to assess the presence of alkaline materials or buffer systems that might interfere with desired chemical reactions, or might promote underside reactions, as discussed in the introductory section of this chapter.

***iii)* Determination of Dissolved Oxygen (DO)**

Standard Method 4500-O describes two methods for determination of dissolved oxygen (DO) in water: Winkler's iodometric method and the electrometric method (Standard Methods, 1998). The iodometric method is very accurate and precise, but the electrometric method is far more convenient for field use and produces an electronic output that can easily be converted to digital form for microprocessor monitoring or control of wastewater treatment systems.

***iv)* Determination of BOD**

One of the most important characteristics of wastewater is the amount of oxygen required to stabilize it. This quantity is called the oxygen demand, and is determined either as biological oxygen demand (BOD) or chemical oxygen demand (COD). BOD is the quantity of oxygen required to stabilize wastewater in the presence of bacteria that consume the chemical pollutants and oxygen in the sample and can be determined by Standard Method 5210 (Standard Methods, 1998).

Heavy Metal Parameters

There are many methods for metal determination (Standard Methods, 1998: section 3000). Some, for example as gravimetric, titrimetric or colorimetric methods are most effective at high metal concentrations. Others, for example atomic absorption (AA), inductively coupled plasma (ICP) or inductively coupled plasma mass spectrometry (ICPMS) are far more sensitive. The latter are used for typical textile applications, such as compliance testing for water quality or detection of trace impurities in high-volume raw materials. Metal ions of greatest interest in textiles are: antimony, arsenic, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, silver, sodium, tin, titanium and zinc (Madan, 1987).

RESULTS & DISCUSSIONS

Physical Assessment

Industry name, category, their function, presence of ETP and all other details of physical assessment are summarized in **Table 1**.

Table 1: Summary of Physical Assessment of Different Industries

Category	Name of Industry	Function	ETP Present or Not	ETP in Operation or Not
Dying	Choice Washing Ltd	Washing	No	-
	Sanji Textile Ltd	Coloring	Yes	Yes
	C & A Textile Ltd	Washing	Yes	Yes
Chemical	Padma Resin	Gum Producing	Yes	No
	Hassan Oil Mills Ltd	Oil Refining	No	-
	S A Oil Refinery Ltd	Oil Refining	No	-
Food	Polar Ice-cream Ltd	Cold Storage	No	-
	Meenhar Sea Foods Ltd	Sea Food Processing	Yes	Yes
	Chowdhury & Co.	Sea Food Processing	No	-

It has been seen from table that most of the industries do not have waste management facility like ETP. Some of the industries have ETP but they are not in operation. Thus the standard quality of effluent can't be maintained. Similarly, same scenario can be explained for the whole Kalurghat heavy industrial area as well as industries situated on the bank of river Karnaphuli.

Experimental Assessment

In experimental assessment physical, chemical & heavy metal parameters are evaluated in the laboratory and presented in **Table 2**, **Table 3** & **Table 4** respectively along with Bangladesh standard for industrial effluents (ECR, 1997).

Table 2: Assessment of Physical Parameters

Name of Industry	Turbidity (NTU)	BD Std.	TS (mg/l)	BD Std.	TDS (mg/l)	BD Std.	TSS (mg/l)	BD Std.
Choice Washing Ltd	63	22-45	490	2250	380	2100	110	150
Sanji Textile Ltd	6.44		1180		800		380	
C & A Textile Ltd	3.38		710		660		50	
Padma Resin	2.64		4060		3570		490	
Hassan Oil Mills Ltd	54.1		3680		3140		540	
S A Oil Refinery Ltd	67		4300		3760		540	
Polar Ice-cream Ltd	89.5		3470		2610		860	
Meenhar Sea Foods Ltd	34.6		1160		810		350	
Chowdhury & Co.	22		980		716		264	
Tidal Condition in Karnaphuli River								
Upstream (50m)	212		843		596		247	
Confluence Point	235		830		630		200	
Downstream (50m)	341		1670		1360		310	
Non Tidal Condition in Karnaphuli River								
Upstream (50m)	230		920		655		265	
Confluence Point	252		870		613		257	
Downstream (50m)	298		846		582		264	

Table 3: Assessment of Chemical Parameters

Name of Industry	PH	BD Std.	DO (mg/l)	BD Std.	BOD (mg/l)	BD Std.	Alkalinity (mg/l)	BD Std.
Choice Washing Ltd	8	6-9	2.2	4.5-8	37	50	250	600
Sanji Textile Ltd	8		8		10		300	
C & A Textile Ltd	7		8.4		10		110	
Padma Resin	7		6		43.4		780	
Hassan Oil Mills Ltd	8		3.2		64		653	
S A Oil Refinery Ltd	8		2.8		54.7		708	
Polar Ice-cream Ltd	8		4.2		2.12		110	
Meenhar Sea Foods Ltd	6		9.3		4.7		20	
Chowdhury & Co.	6		5.5		4.8		36	
Tidal Condition in Karnaphuli River								
Upstream (50m)	7		9.6		6.4		62	
Confluence Point	8		8.8		6.6		70	
Downstream (50m)	7		7		7		68.9	
Non Tidal Condition in Karnaphuli River								
Upstream (50m)	8		9.6		6.4		61	
Confluence Point	7		8.5		6.4		69	
Downstream (50m)	7		7.3		7.1		67	

Table 4: Assessment of Heavy Metals of Karnaphuli River in Non-Tidal Condition (Confluence Point)

Parameters	Unit (mg/l)	Bangladesh Standards for Industrial Effluents
Pb	-	0.1
Mn	0.14	5
Zn	0.08	5
Cu	0.11	0.5
Na	15.2	-
Ca	13.6	-
Mg	12	-
K	5.66	-
Cd	-	0.5

From the Tables, it has been found that, Physical & Chemical parameters has been creating hazardous impacts on river, discussed as follows:

Impacts on River Water Quality

In the investigation we found that the industries whose have ETP have relatively good water quality than the industries whose have not ETP or have but not in operation. The value of P^H of maximum industries are satisfactory. Turbidity of river water is very high because most of the industry have opaque liquid effluent. The value of BOD_5, dissolved oxygen and alkalinity is relatively good with respect to river water quality standards. But the amount of total solids, dissolved solids and suspended solids are very high in amount which causes serious pollution in river water.

Impacts on Aquatic Life

Aquatic life is considered to be an endangered species because of improperly disposed of liquid effluent into the river water. When a toxic effluent harms one organism, it can end up destroying an entire food chain of aquatic life. Improperly disposed effluent pollutes marine life and kills sea mammals, corals, and fish. At the same time, birds are affected because they eat the fish from the river. Another example of aquatic pollution is with acid rain, which is the result of certain chemicals present in the effluent. Acid rain is responsible for leaching the soils toxic aluminum.

Impacts on Recreational Activities

Color appearance of river water attracts the visitors most. But day by day the color of Karnaphuli river water get worsen i.e. convert into grayish color. Nuisance is another problem for the visitors. Again root of plants are rotten for the toxic industrial effluent which reduces the natural beauty of river side. That's why nowadays people gradually losing their interest for river riding which is a part of their recreation.

CONCLUSION

Export-Import of Bangladesh mainly depends on Karnaphuli River. Also it contributes in hydro-electrical power generation, fish industry, navigation and drinking water supply sectors. Whereas it is polluted by industrial effluents, waste water, oil dumping/spilling, silting, encroachment etc. for which industrial liquid effluent is the main reason, so a central ETP is now a crying need to save Karnaphuli River as well as to save the whole country. For each industrial area government can establish a Central Effluent Treatment Plant (CETP) and proper operation & maintenance of ETP should be monitored continuously. ETP must maintain the standard quality of effluent of all industries and adequate preventive measures should be taken in industrial activities to ensure a healthy environment.

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