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Effects of Industrial Effluents on the Water Quality of Bhairab River

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ABSTRACT
Industries play a vital role in a country's economy and the livelihood of common people. But a matter of concern is that most industries use toxic materials and hazardous chemicals and these dangerous materials are directly discharged into the river water along with the wastewater from the industries. The Bhairab is one of the most important rivers in Khulna that divides the city into two parts. People are highly dependent on this river for fishing and daily uses like cooking, farming, cleaning, and sometimes even drinking. But some industries are situated on the banks of this river, which might put this river at great risk by disposing of their wastes. In this regard, monitoring the quality of the river water and the impact of the industries on it has become of great importance for Khulna city. That's why around 27 km of the river was covered from Rupsha ghat to Fultala and samples were collected from the discharge point of Seven Rings Cement (SRC), a local bone breaking mill (LBBM), household waste mixing point (HHMP), and Superex Leather Ltd. All the samples had been collected around the 100-meter radius of the point sources. The water flow direction was the same for all sample collections. Water quality parameters including TDS, Hardness, ORP, Salinity, DO, p^H, Turbidity, BOD, etc. were determined using a digital water quality analyzer and laboratory test. After analyzing and calculating all the data according to the proper method and comparing with ADB, 1994, ECR, 1997, and EQS, 1997, 4 parameters- BOD, Turbidity, ORP, and Hardness were found below the standard. Such quality water is not suitable for drinking and household tasks. Based on the correlation of the parameters, the monitoring of the water quality of the river becomes easier and proper precautions can also be applied beforehand.

Keywords: Effluent, Wastewater, Bhairab River, Water Quality, Pollution control

1. Introduction

Water is one the most important elements of daily life, and a river plays a very important role in supplying water for the daily usage of people. Urbanization takes place beside the bank of a river as surface water can be used for irrigation, drinking, transportation, producing electricity, leisure activities, and, even as a source of disposal. Bangladesh is a riverine country, most of the major cities of Bangladesh are situated on the bank of the river and Khulna is one of them [1]. There are a total of four major river flows through the Khulna division including Bhairab, Bhadra, Pasur, and Moyur. Bhairab is one of the important rivers of khulan city [2]. The total length of this river is 250 kilometers [3]. A significant number of industries are located near the Bhairab River. Some of these industry uses the water of Bhairab for their production purpose. These industries use Bhairab as a product and raw materials transportation root as they connect those industries directly to the Mongla port which is one of the important import-export channels in Bangladesh [4]. Some of these industries discharge their effluent directly into the water without any proper treatment. That way the river is being contaminated by those industrial effluents. The people of Khulna uses the Bhairab river for daily household activities, agricultural purpose also, and transportation root [5]. Water contamination can affect the people of Khulna in many ways. Increasing the total dissolved solid can make the river water unusable for bathing and washing clothes [6]. Also, other types of pollution can affect the fish business and agricultural production of this region. An increasing number of industries can also lead to the declining water quality index of this river. The main objective of this research is to analyze the water parameters of the Bhairab River and analyze the impact of the industrial effluents on the water quality of Bhairab. This paper highlights the present concern regarding the water quality of Bhairab River so that necessary steps can be taken. The river is a very important source of daily life and ecology so river water quality and pollution have always been a great concern. The main reason for hazardous pollution is because of point sources like discharge points of industries and households. Unwanted toxic discharge cause contamination in river water that affects the river water quality and ecology very badly [7, 8].

A lot of research was done on the water quality of the rivers around Khulna City as nowadays river water is getting contaminated and ecology is being disturbed. Some research is discussed here in this section.

A research study was done on the water quality of Bhairab River by Md. Alhaz Uddin, published at the year of 2015. In this study, the water quality index was determined and found decreasing year by year which is an alarming situation for Bhairab River. Also, twelve out of twenty parameters were found that exceeded Bangladesh's standard limit. That indicated the poor water quality and thus this study recommends installing

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water treatment before discharge and more research on aqua-species as water pollution can be assumed by the presence of fish [9].

Another study on Bhairab River was done considering 6 different seasons by Abu Shamim Khan, Abdul Hakim, Waliullah, Mizanur Rahman, Bablu Hira Mandal, Abdullah-Al-Mamun & Firoz Ahammed, published at the year of 2019. According to this study river quality was found comparatively well in the rainy season because of the tidal flow of fresh water and during summer critical condition was found. Here though the arsenic level was found safe, manganese and iron contents were not in between the standard level which is bad for river water. So, central water treatment and wastewater treatment by industries before discharge is recommended here [4]. Research on physiochemical parameters of Rupsha river published at the year of 2018 by M Shahidul Islam, Suman C Mohanta, Bakar Abu, Md. Abu Bakar Siddique found that p^H, TDS EC were quite higher than the standard level which is an alarming situation for Rupsha river so, it needs strict monitoring and solution to reduce pollution [6]. In a study on the Turag river by Parvin Aktar & Mst Sabrina Moonajilin in 2017, around which one of the largest industrial areas, Tongi is situated, it was found that Turag river's situation was critical and the polluting tendency is increasing with time being passed as its getting highly contaminated by Industrial waste, oil spills, untreated sewage, wastewater & other solid and liquid pollutants Solid and liquid pollutants both enter the body of water [10].

This study emphasizes observing the water quality of Bhairab River at four pollution source points. It is a noble approach to know the impacts of the effluents discharged into the water directly from those industries. By observing the results, we can predict the impact and be aware of the responsible authority to reduce water pollution and save the environment through sustainable solutions. A scenario of hazardous substances already present is beyond scope of the paper due to a lack of time and available data.

2. Experimental Setup

The methodology section covers the process of this study. From sample area identification strategy, sample collection, and determination of the water parameters through the laboratory test. The flow chart is shown in Figure 1.

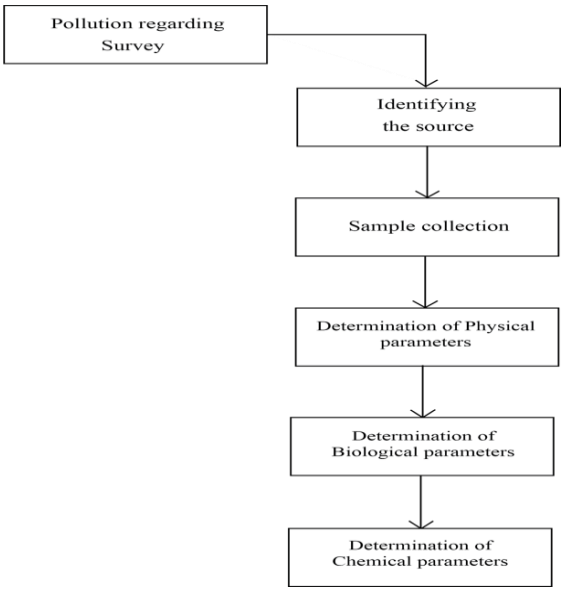

Fig. 1 Flow chart of the experimental setup

2.1 Sample Collection

The samples were collected from four different sources. Bhairab river water flow direction was from the Superex Leather Ltd. to the Seven Ring Cement. Four sample station covers a total of 27km of the river. Data for a water source 100m away from the source point was hard to obtain due to lack of transport, bad weather, and probable risk concerns. Hence, the research was limited to only 100m from the source point. Samples were collected in two different periods before the monsoon and at the monsoon. All the locations were marked on google earth for further evaluation (Figure 2).

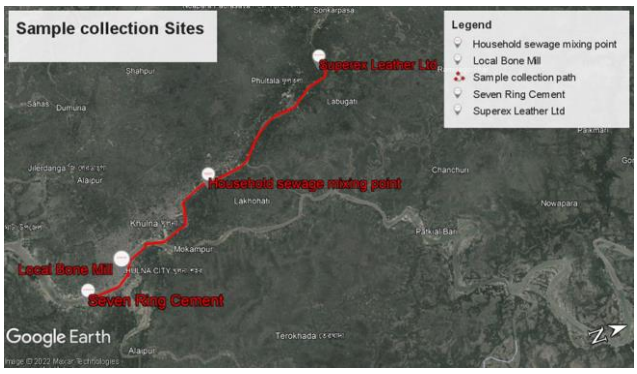

Fig. 2 Map of the sample collection sites (Source: google earth)

2.2 Characterization

Odor, color, p^H, and conductivity were examined before conducting other experiments. p^H has been measured by using a standard p^H meter (HANNA HI 98107 from Romania). Also, the p^H value was cross-checked by another p^H meter (Lutron PH-201 from Taiwan) for more accuracy. Around 10 ml of each sample has been examined for the primary physical

parameters determination. Turbidity was measured by using a standard turbidity meter. Most of these parameters were determined by using a Standard water quality meter (Lutron water quality meter BWA-2018SD from Taiwan).

BOD_5 is one of the important biological parameters of wastewater. The amount of oxygen (O2) that the aerobic microorganisms in the water sample consume to oxidize the organic matter and transform it into a stable inorganic form is typically used to characterize it. 300 ml BOD bottle had been filled with sample water, initial DO was measured. After that, the sample was kept in the incubator for 5 days to determine BOD_5. Total dissolved solids (TDS) and Oxygen reduction potential (ORP) have been determined in the laboratory by the standard method through a digital water quality meter and weighting, heating manually.

3. Results and Discussion

3.1 p^H Value of the Samples

The p^H of the Water has a crucial role since it influences the solubility and nutrients that are present and how they can be used by aquatic creatures. This measurement reveals whether the water is acidic or alkaline. A p^H value of 7 is regarded as "neutral" on a scale of 0 to 14. Readings Values below 7 imply an acidic environment, while readings above 7 determine if the water is basic or alkaline. The p^H of freshwater ranges from 6 to 8. The discharge source of the seven rings cement showed the highest p^H value which was 8, It indicated the p^H value within the range of standard p^H value for drinking, fisheries, and irrigation purpose [10]. The p^H of the other three sources showed a p^H of more than 7 also. It indicated that they are within the standard p^H range but little alkaline.

So, it indicated that the p^H value is within the range of standard p^H value for drinking, fisheries, and irrigation purpose [11]**.** The results are shown in Figure 3.

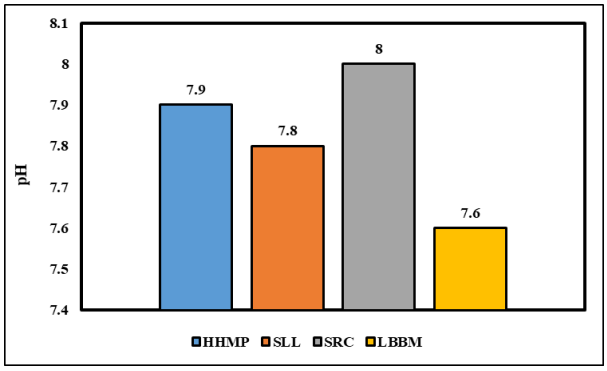

Fig. 3 p^H value of different samples

3.2 Turbidity of the Samples

The values for the turbidity of the samples were presented in the graph (Figure 4). Here the point source, Seven Ring Cement showed the highest turbidity which represented lower water quality. Turbidity is known as an optical property and the more the turbidity, the more it blocks light and damages river ecology [11]. Not only this source but also all the other samples' turbidity value was quite higher than the standard turbidity value for drinking, fisheries, and irrigation if we compare with the standard parameter table 1. Higher turbidity reduced the opaqueness of the water which represented a negative impact on the river's water quality and such water cannot be used as a source of drinking water and for irrigation purposes [12].

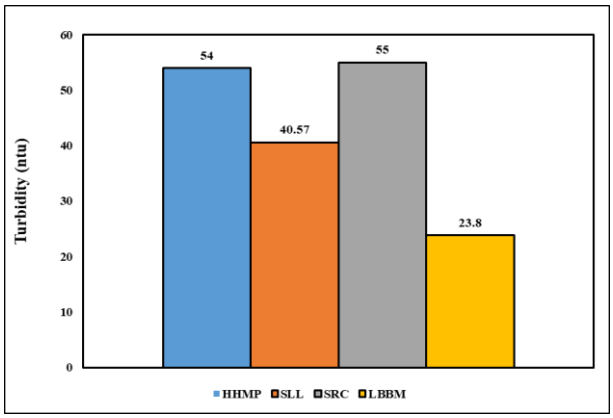

Fig. 4 Turbidity of different samples

3.3 Dissolved Oxygen

A good amount of dissolved oxygen in the river water is good for aqua life. But if it exceeds 110 percent then this high concentration of dissolved gas can cause "gas bubble disease" for fish though it's quite rare. Other aquatic lives can also get affected because of excessive DO [13]. According to table 1 standard values, dissolved oxygen in these 4 samples is quite found quite well. The sample from house hold mixing point has the highest value of DO which is quite good for water so that the waste can get degraded (Figure 5).

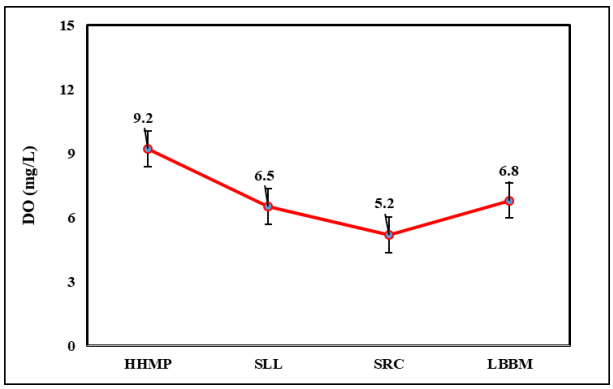

Fig. 5 Dissolved Oxygen level of different samples

3.4 Biological Oxygen Demand

The quantity of oxygen that bacteria will use while breaking down organic materials in aerobic environments is measured by the biochemical oxygen demand (BOD) [13]. The sample from the house hold mixing point has the highest BOD value which is a warning for the river as 11.8 BOD value is quite higher than all the standard values for drinking, fisheries, and irrigation purposes, though the samples from superex leather LTD and local bone mill is in the standard range for irrigation, they are not suitable for drinking purpose (Figure 6). Also, the seven ring cement sample indicates risk for fisheries in the river [14].

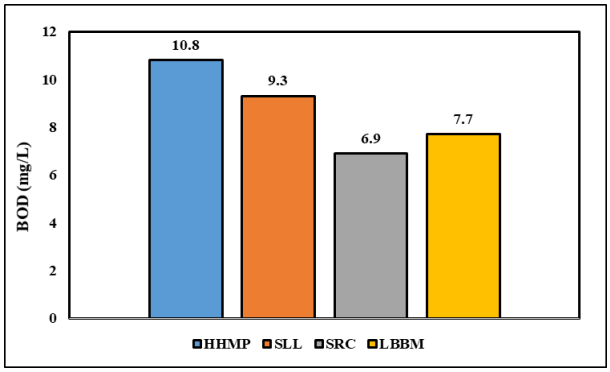

Fig. 6 BOD of different samples

3.5 Oxidized Reduction Potential

All the values of ORP are less than 300 mV which is very bad for a river. Oxidation-reduction potential (ORP) gauges a lake or river's capacity to purge or decompose waste materials including pollutants and extinct plants and animals. The amount of oxygen in the water is high when the ORP value is high. This implies that microorganisms that break down waste materials and pollutants can function more effectively. In general, the lake or river is healthier the higher the ORP value. For a healthy river, the ORP value should be (300-500) mV which is to compare the ability of the river to clean itself [15]. So, in the case of ORP Bharab river's water quality is below the standard (Figure 7).

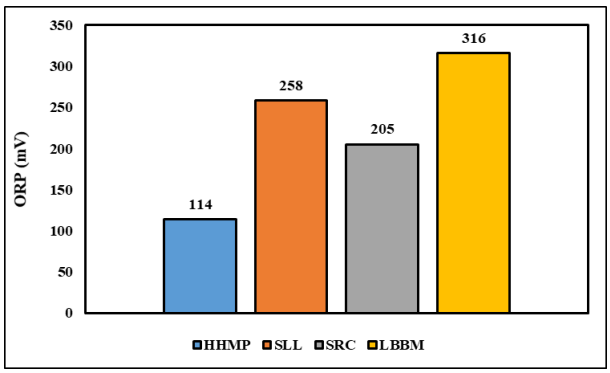

Fig. 7 ORP of different samples

3.6 Total Dissolved Solids

Total dissolved solids levels have a much greater impact on animals than on people. Higher concentrations of total dissolved solids frequently affect aquatic animals in water bodies like rivers. Numerous creatures depend on the mineral content of water, which is altered by TDS. In addition, dissolved salt can fatally dehydrate aquatic creatures' skin.

Though the TDS value of the sample from superex leather ltd is the highest it is in between the standard range of drinking, fisheries, and irrigation uses [14]. That is all the values are found within the standard range (Figure 8). The measurement was performed in a spreadsheet by taking the SD of each three sample values for a single source.

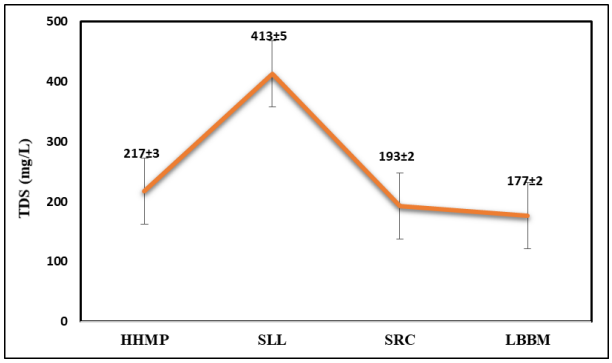

Fig. 8 TDS value of different samples

3.7 Hardness

Here, the sample from superex leather LTD has the highest hardness with 309 mg/l which is very bad for the river as it highly exceeded the standard values of hardness listed in table 1 (Figure 9). Though the samples from the house hold mixing point and local bone breaking mill point is in the range of standard hardness value for irrigation purposes but these cannot be used for fisheries and drinking purpose [16]. So, in case of hardness, the water of Bharab River is at risk.

The sum of calcium and magnesium hardness is the total hardness. The toxicity of various metals to aquatic life increases with water hardness. For primarily economic or aesthetically pleasing reasons, high levels of hardness are undesirable. If a stream or river is used as a source of drinking water, hardness might cause issues during the water treatment process. Here, the sample from superex leather LTD has the highest hardness with 309 mg/l which is very bad for the river as it highly exceeded the standard values of hardness listed in table 01. Though the samples from the house hold mixing point and local bone breaking mill point is in the range of standard hardness value for irrigation purposes but these cannot be used for fisheries and drinking purpose [16]. So, in case of hardness the water of Bharab River is at risk.

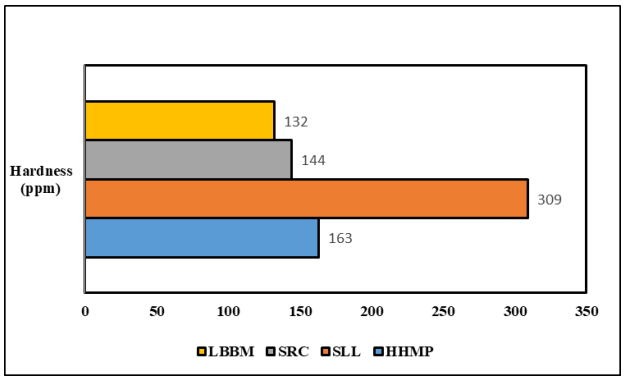

Fig. 9 Hardness of different samples

3.9 Salinity

According to WHO, 1996, the permissible amount of salinity in water is zero and all the collected values exceed this limit (Figure 10). Also, a high amount of salinity is not good for the health of a river and the collected values are not very high which is good for fisheries and irrigation [17, 18]. The region where Bhairab River is located has a high salinity level which can be a probable reason behind this.

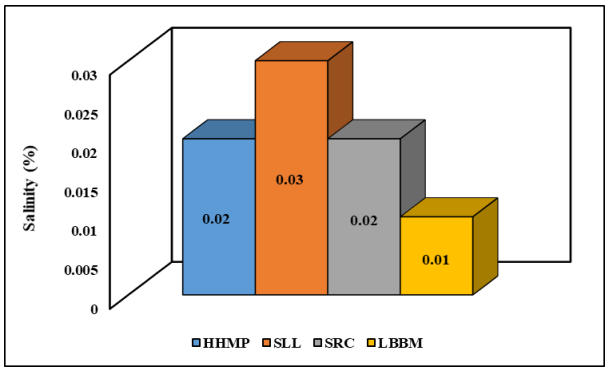

Fig. 10 Salinity percentage of different samples

3.10 Comparison with Standard Table

Here, the standard range of various water quality parameters are shown in table 1. The observed p^H range for all four samples were found between 7.6-8. It indicated that the p^H of the samples were within the range for drinking, fisheries, and irrigation. Observed DO for the samples were within the standard range also. But, there were severe issues with BOD, TDS, and Hardness value. The observed value of those parameters exceeds the standard limit. A similar type of results was found in some of the previous studies [18-21]. Those values indicated that the effluents from the pollution sources should not be directly discharged to the river and they should be treated through ETP initially.

Table 1 Standard water quality parameters for different uses

parameters	Drinking	Fisheries	Irrigation
p^H	6.5-8.5	6.5-8.5	6.5-8.5
DO (mg/L)	6	5 <	4.5- 8
BOD (mg/L)	0.2	<6	0-10
COD (mg/L)	4	-	-
Conductivity (µs/cm)	700	800-1000	1200
TDS	1000	0-1000	450-2000
Turbidity (NTU)	< 1	< 8	<5
Hardness (mg/L)	80-100	< 123	< 150
ORP (mV)	200-600	-	-

(**Source:** ADB, 1994; ECR, 1997; EQS, 1997)

4. Conclusion

According to the observation of the final result of the water quality parameters some values are found in between the permissible range and some are found to exceed or less than the standard range which is quite alarming for the health of Bhairab River. The p^H value from each sample is found within the standard range. On the other hand, though the DO and COD values are found unharmful, the very important parameter BOD value was not up to the standard level. Higher BOD indicates that the water is contaminated and polluted and bacteria need lots of oxygen to degrade the pollutants. Little salinity was found for all four samples which indicated that the water samples were not suitable for irrigation and drinking. Besides, the ORP values found from all four samples are very less than the standard value which indicates that the river's capability of cleaning itself is very low and it is quite an alarming situation for the river's health. Moreover, the values of turbidity exceeded the standard value which is dangerous for river water as higher turbidity blocks the light and reduces the oxygen level as well as damages the river ecology. So, these points' sources are contaminating the water of the Bhairab River. Based on the results, the water quality of the Bhairab River is being polluted by industrial effluent and discharges. The factories' wastewater treatment facilities were not investigated and are beyond the scope of this study. However, the authors tend to work on this issue in the future. Only Bhairab River was considered for the current study. More sources and rivers should be taken into account for future work for a better understanding of the scenario.

5. Reference

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