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Investigating of River Water Quality Parameters: a Case Study in Khulna City

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ABSTRACT

The rivers of Bangladesh have a vital role as a valuable natural resource that sustains an economy focused on agriculture. It is very important to make sure the water is safe for many uses, like drinking, cooking, growing, and keeping marine life alive. The rivers Moyur, Bhairab, and Rupsha are very important to the people who live in Khulna City. The water bodies are getting worse because of things like fertilizers, oil, garbage that hasn't been cleaned, and industry waste. For ten months, from August 2022 to May 2023, researchers kept an eye on how polluted the river was. Every month, 18 samples of water were taken from six different places in the three rivers. Each sample was taken one foot below the water's surface. The data showed that during the rainy season, the BOD, TDS, salt, DO, and pH levels in the Bhairab and Rupsha rivers stayed the same. But according to the rules set by ECR (1997) and WHO (2004), the amounts of COD, chloride, total TSS, Total Dissolved Solids (TDS), and turbidity during the dry season were higher than what is good for people and aquatic environments. On the other hand, the Moyur River had chloride, pH, and TDS levels that were within permissible ranges. Problems regarding the water's health arose, however, because DO, BOD, COD, TSS, and turbidity concentrations continuously surpassed clean water limits during the study period.

Keywords: Water Quality, Rupsha Rivers, Bhairab Rivers, and Mayur River

1. INTRODUCTION

In terms of deltaic countries, Bangladesh is the largest deltaic country all over the world. These rivers typically flow in a southerly direction [1]. In the past, there were around 700 rivers, but at the present time, there are approximately 230 rivers following in the country, including 54 international rivers. A significant portion of the water used for agricultural purposes comes from the bigger river, which also serves as the primary conduit for commercial transit. Moreover, rivers provide a source of fish, which is a significant source of protein. According to Begum et al. [2] , water has evolved into a commodity that is needed not just for the growth of industrial and agricultural production but also for the continued existence of all living things, including humans, animals, plants, and anything else that is alive. In the Khulna District, the city of Khulna, which is one of the largest cities in Bangladesh and In the terms of coastal zone, Khulna is the second largest, can be found on the banks of the Rupsha and Bhairab Rivers.

Moreover to being a significant economic and industrial hub, it serves as the capital of the Khulna Division. The Khulna City Corporation (KCC) region has a population of around 1.7 million people, and the growth rate is 5%. This growth rate is mostly due to migration from rural areas to urban areas. According to the Bureau of Business Statistics (2007), the service sector accounts for 54% of the region's economic activity, followed by agriculture (26%), and then industry (20%). River water in Khulna city is severely contaminated as a result of the extremely rapid expansion of the city's economy. Bhairab and Rupsha Rivers are located on the eastern side of Khulna city, and they are the primary factors that separate Khulna city from Digholia and Rupsha Upazilla. It is the responsibility of this river to collect all types of industrial waste water that are located on or close to the banks of the Bhairab and Rupsha rivers. There is a dead river known as the Moyur River that is located on the western side of Khulna city. This river is significant for the fishing industry. In the form of sewage outfall, the Moyur River is exposed to a wide variety of organic and inorganic pollutants. This is because the river receives all types of city garbage. To determine the river water quality in Khulna city, the present research aims to analyze a number of selected water quality parameters, including COD, pH, BOD, Turbidity, Total Dissolved Solids (TDS), Total Solids (TSS), COD, dissolved oxygen (DO), and chloride levels in the Bhairab, Rupsha, and Moyur rivers.

2. METHODOLOGY

2.1. The Selection of Critical Stations for Water Testing:

On the basis of the reconnaissance study that was carried out in the Rupsha Rivers, the Bhairab Rivers, and the Mayur River, a total of six sample sites became available for selection. Within the span of ten months, beginning in August 2022 and ending in May 2023, water was collected. According to the recommendations that are considered to be standard (UNEP/WHO, 1996), a total of ten water samples were taken, with one sample coming from each sampling location and a monthly gap between each consecutive sampling.

At the station, samples of water were taken from a depth of 0.30 meters below the surface of the water when they were collected. The samples were held on ice in an ice box at a temperature of less than 4 degrees Celsius and then brought to the lab the same day. Then, they were leveled correctly and packed safely before being moved.

2.2. Laboratory testing and analytical approach

Water samples were gathered in order to conduct an investigation of the river water quality in the Mayur River. On the basis of the water sample that was taken, experiments were carried out in order to determine the physical, biological and chemical characteristics of the water. Phosphorus, TSS, TDS, and turbidity were all determined by a physical examination that was carried out. BOD, Chloride, and COD were investigated through the use of chemical analysis to determine the composition of the water. It was determined that the study of all of the physico-chemical parameters, that it be done in a way that follows the steps explained in the Standard Methods for the Examination of Water and Wastewater [3].

Table 1. Methods of Analysis and Water quality parameters

No	Parameters	Unit	Method of Analysis	Measured
1	Chloride	mg/l	Titration Method	Laboratory
2	TSS	mg/ l	Titration Method	Laboratory
3	DO	Mg /l	DO meter	On Site
4	TDS	mg/ l	Gravimetric Method	Laboratory
5	BOD	Mg /l	Incubation and Winkler	Laboratory
6	pH	-	pH meter	On-site
7	COD	mg/ l	Incubation and Winkler	Laboratory
8	Turbidity	NTU	Turbidity meter	Onsite

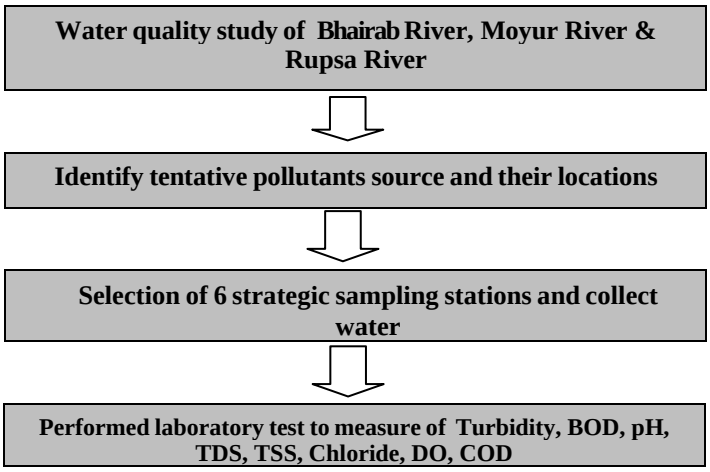
Table 2. Study the area around the Rupsha, Bhairab, and Mayur rivers

Sample Station	Area and Location	Latitude	Longitude
S1	Railgate Ferry Terminal	22°58′20″N	89°52′24″E
S2	Daulatpur bazaar	22°56′32″N	89°54′24″E
S3	RupshaOld Ferry Terminal	22°45′19″N	89°34′12″E
S4	Rupsha Bridge	22°42′28″N	89°33′27″E
S5	Sonadanga (near the bus station)	22°43′36″N	89°27′10″E
S6	Gallamari (close to Khulna University)	22°42′19″N	89°30′20″E

Table 3. The Standard Value of the Parameters from ECR'97 and WHO

Parameter	ECR'97 Standard	WHO standard
BOD	5 mg/l	**0.2 mg/l**
Turbidity	25NTU	**10 NTU**
TDS	500mg/l - 1000mg/l	**1000 mg/l**
Chloride	250 mg/l	**150mg/l - 600mg/l**
TSS	500mg/l	**-**
Chloride	250 mg/l	**150 mg/l - 600mg/l**
DO	5 mg/l	**6mg/l**
COD	200 mg/l	**-**
pH	**6.5 - 8.5**	**6.5 - 8.5**

2.3. *Methodological approach*



3. RESULTS AND DISCUSSIONS

After collecting samples, the relevant laboratory tests were completed to establish the specified Water Quality parameters for each sample over the duration of the study. The assessed WQ characteristics were then contrasted with the norm for potable water and aquatic ecosystems.

3.1. pH

Figure 1 shows that the pH levels of samples taken from three different rivers fall within the acceptable range (6.5-8.5). Since the same or greater chemical waste is discharged into the Rupsha River at Rupsha Bridge station in November (8.21) despite the lower water level that occurs throughout the winter, this is not surprising. The Bhairab River near RailgateFarigate registered 6.73 in January, the lowest reading of any month. Figure 1 shows that in the middle of winter, in the month of January, the pH value drops at all stations.

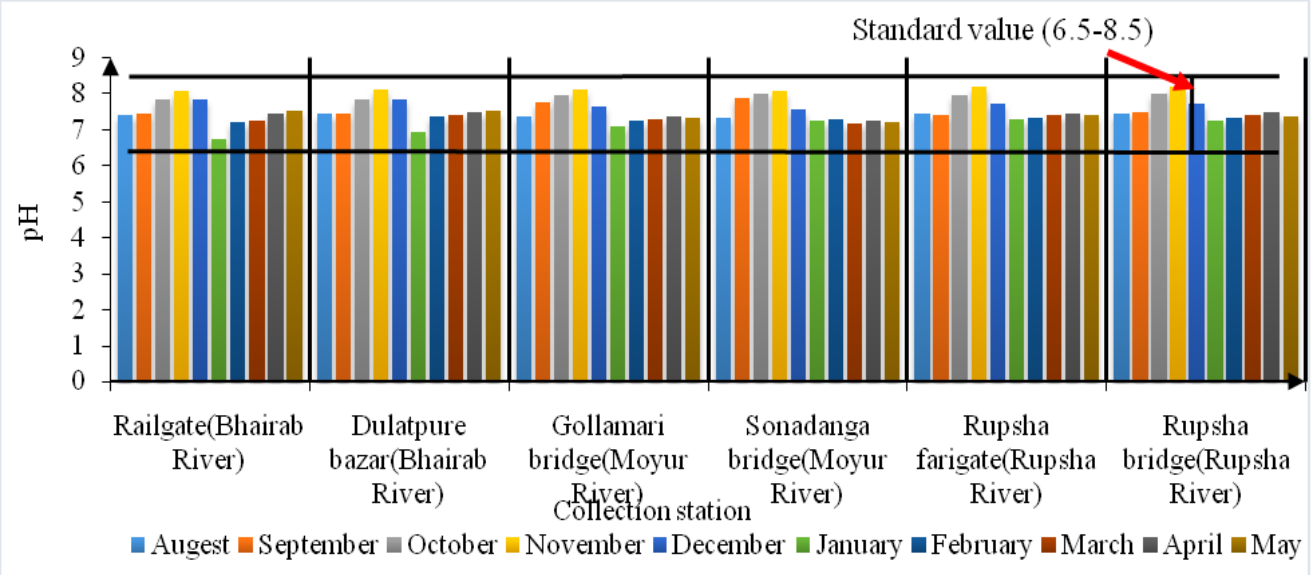


Figure 1. Monthly variation of pH at six locations of three rivers in Khulna City

3.2. TURBIDITY

The turbidity levels of the Bhairab River ranged from 172 NTU to 742 NTU, the Moyur River from 26.6 NTU to 113 NTU, and the Rupsha River from 140 NTU to 797 NTU. Figure 2 shows that in the month of May, the turbidity ranged from a high of 797 NTU at the Rupsha Bridge station to a low of 26.6 NTU in the Moyur River. While 10 NTU is the suggested level for use in a drinking water supply, no such guideline has been established for an aquatic ecosystem.

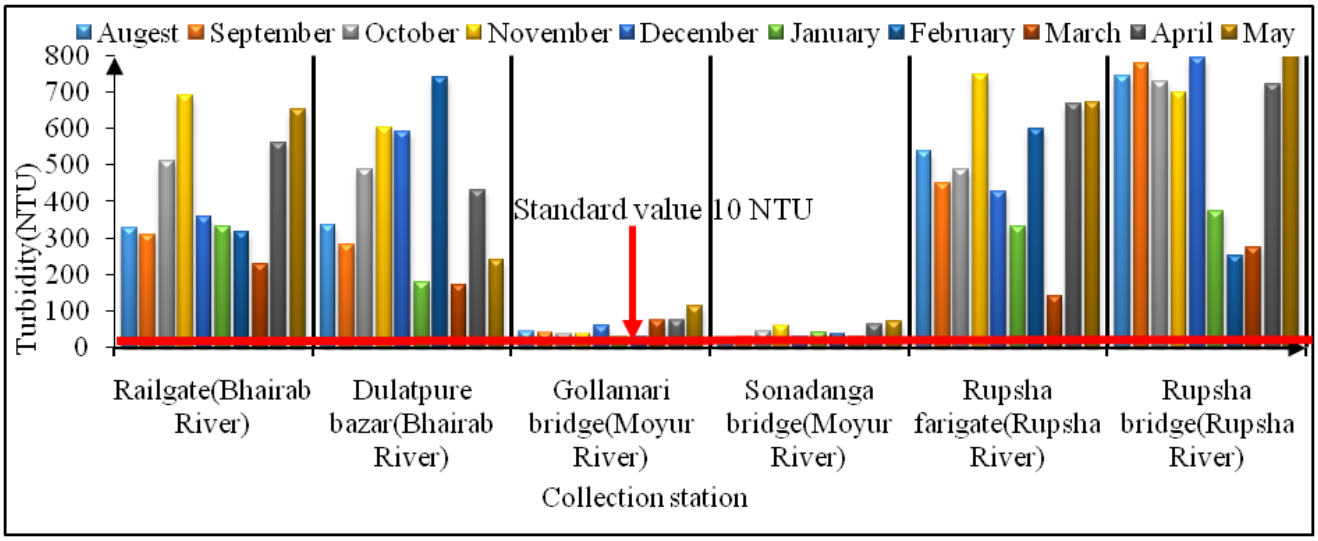


Figure 2. Turbidity varies monthly at six places along three rivers in Khulna.

3.3. TOTAL DISSOLVED SOLID (TDS)

The Bhairab River's TDS ranged from 140 to 12965 mg/l, the Moyur River's from 230 to 1790 mg/l, and the Rupsha River's from 140 to 15570 mg/l. Figure 3 shows that the greatest TDS measured in the Rupsha River was measured at Rupshafarigate in May, at 15570 mg/l, while the lowest value was measured at Rupshafarigate, at 140 mg/l, in August. In aquatic ecosystems, a TDS value of 1000 mg/l is considered normal. Figure 4 demonstrates that the TDS value is low from August through January. Figure 4 shows that the Bhairab and Rupsha rivers have elevated TDS levels during the months of February through May. In this scenario, the chloride concentration is quite important.

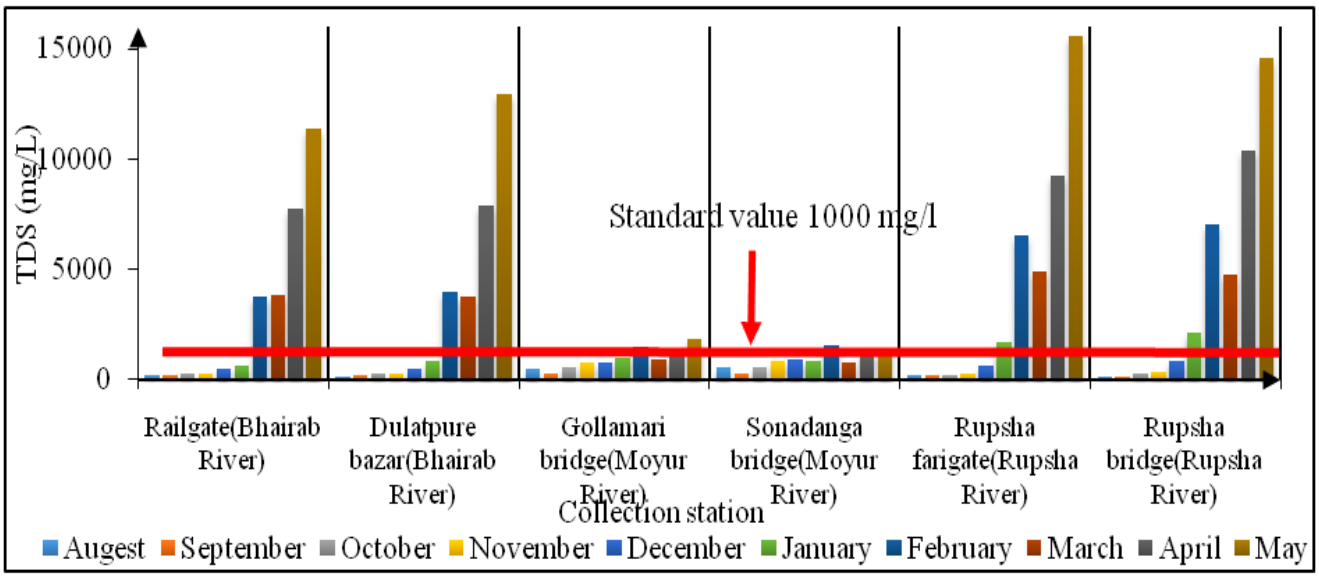


Figure 3. Monthly variation of TDS at six locations of three rivers in Khulna city

3.4. TOTAL SUSPENDED SOLID (TSS)

Bhairab River's TDS ranged from 200 to 1630 mg/l, Moyur River's from 20 to 250 mg/l, and Rupsha River's from 240 to 1920 mg/l. Figure 4 shows that the TSS in the Rupsha River at Rupshafarigate was the greatest (at 1920 mg/l) in February, while the TSS in the Moyur River at Sonadanga Bridge was the lowest (at 20 mg/l) in August. TSS in drinking water must not more than 10 mg/l. There is no established limit for TSS in aquatic environments or on aquatic life. However, there are a number of issues that might arise from a TSS surplus.

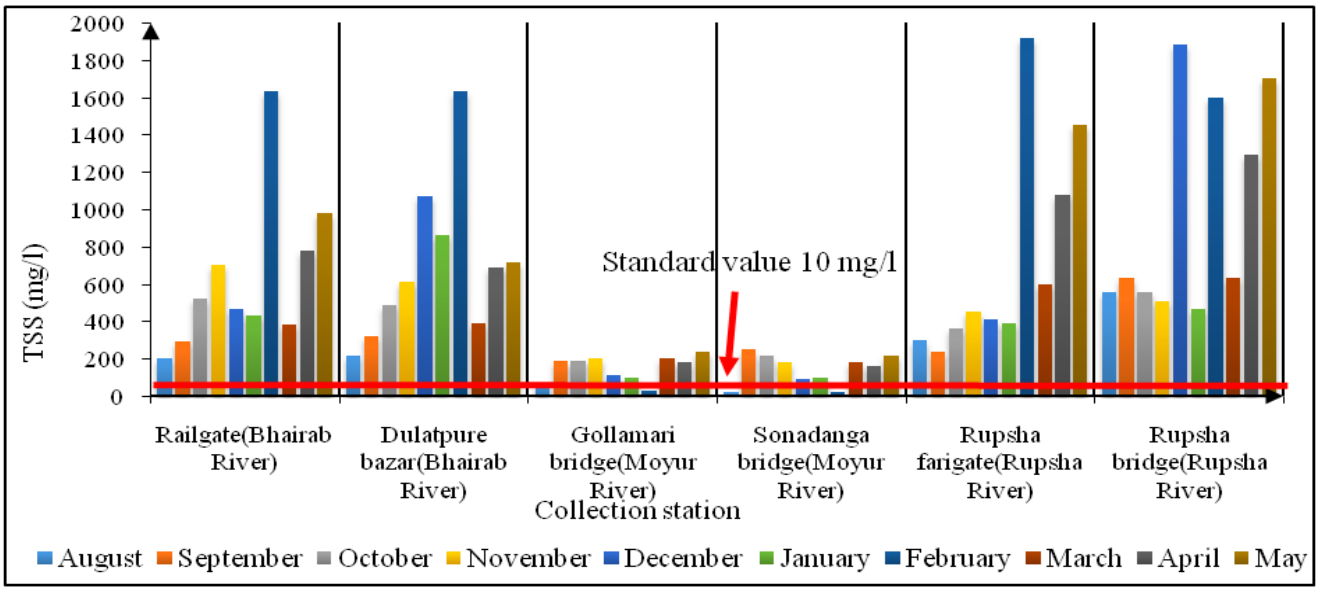


Figure 4. Monthly variation of TSS at six locations of three rivers in Khulna city

3.5. BIOCHEMICAL OXYGEN DEMAND (BOD)

The BOD5 levels in the Bhairab River ranged from 1.02 mg/l to 3.03 mg/ l, those in the Moyur River from 15.08 mg/ l to 41.0 mg /l, and those in the Rupsha River from 1.04 mg/l to 2.2 mg/l. Figure 5 shows that the greatest BOD5 value was recorded in May at Sonadanga Bridge on the Moyur River, while the lowest was recorded in February at Rupshafarigate on the Rupsha River, both locations being in Bangladesh. In aquatic ecosystems, the recommended level of BOD5 is 6 mg/l (ECR-1997). A high BOD5 measurement indicates that the water is highly polluted.

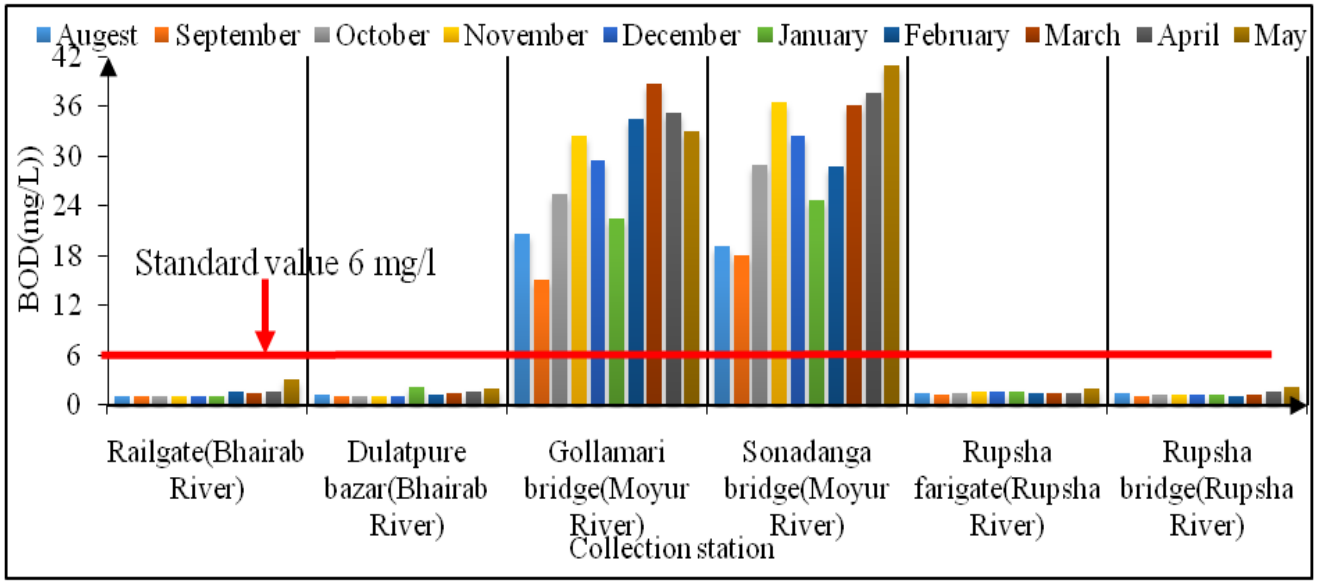


Figure 5. Monthly variation of BOD5 at six locations of three rivers in Khulna city

3.6. CHEMICAL OXYGEN DEMAND (COD)

Bhairab River has a COD between 144 and 288 mg/l, Moyur River between 160 and 304 mg/l, and Rupsha River between 128 and 272 mg/l. Figure 6 shows that in May, the COD in the Rupsha River near Rupshafarigate is 272 mg/l, while the value is only 128 mg/l in January of the same year. For healthy aquatic ecosystems and organisms, a COD concentration of 4 mg/l is considered optimal.

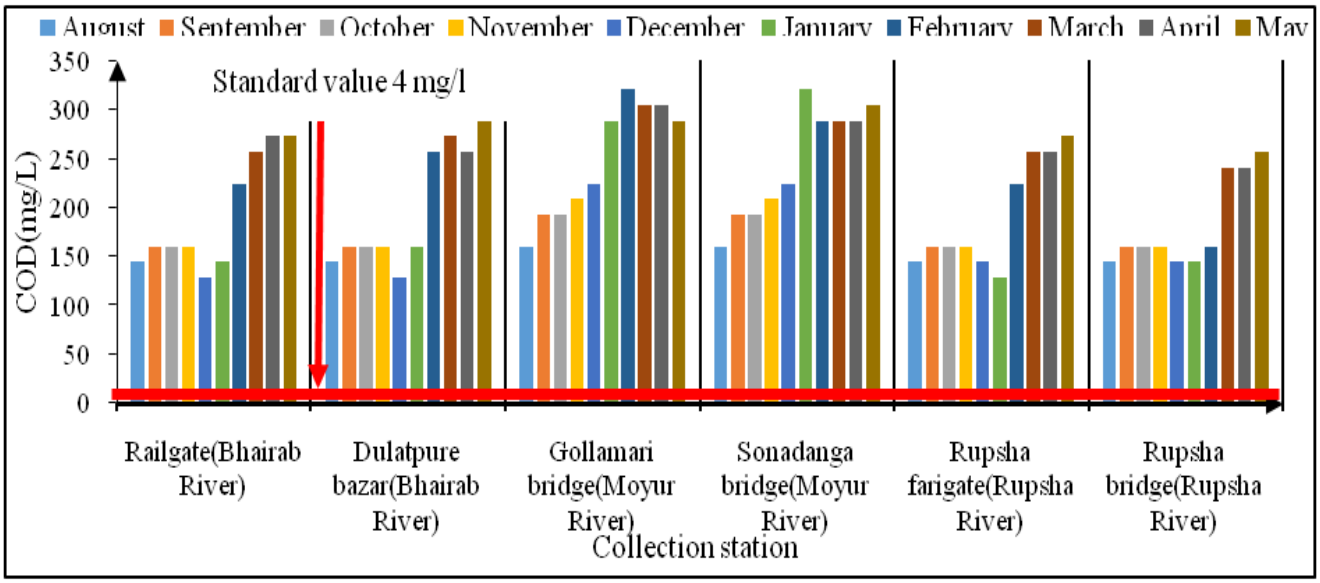


Figure 6. Monthly variation of COD at six stations of three rivers in Khulna city

3.7. DISSOLVED OXYGEN (DO)

The DO in the Bhairab River ranged from 5.22 mg/l to 7.85 mg/l, while in the Moyur River, it was 0.15 mg/l to 1.02 mg/l, and in the Rupsha River it was 5.13 mg/l to 7.4 mg/l. Figure 7 shows that in December, at Railgate, the dissolved oxygen concentration in the Bhairab River was 7.85 mg/l, whereas in March, at Sonadanga Bridge, the dissolved oxygen concentration in the Moyur River was just 0.15 mg/l. The optimal concentration of DO for aquatic ecosystems and living organisms is 5 mg/l.

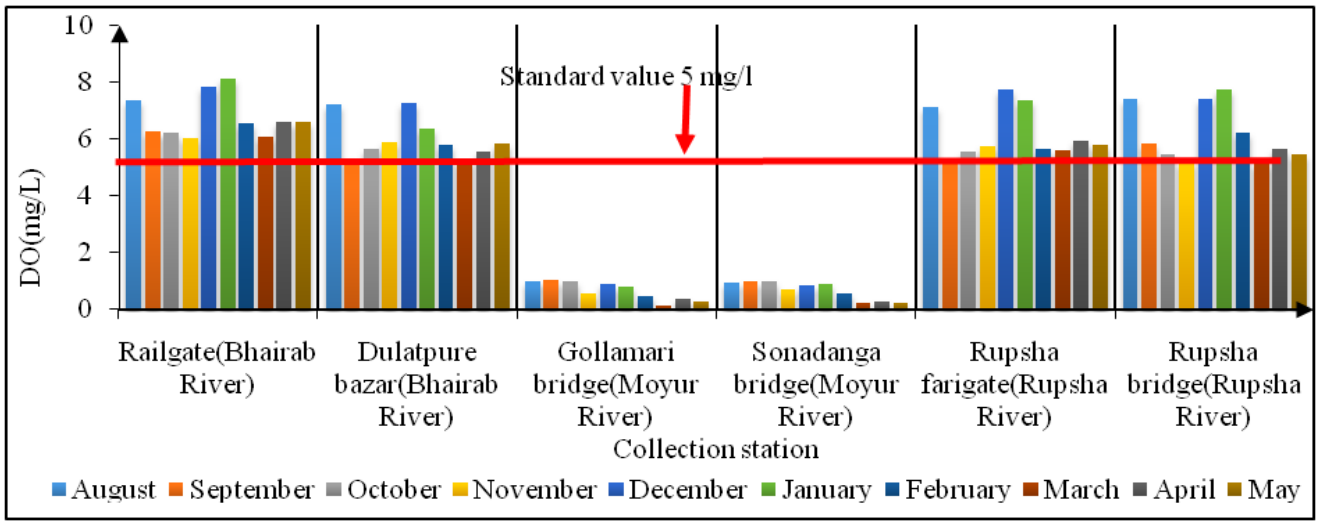


Figure 7. Monthly variation of DO at six locations of three rivers in Khulna city

3.8. CHLORIDE

Chloride levels ranged from 70 to 7200 micrograms per liter (mg/l) in the Bhairab River, 125 to 920 mg/l (mg/l) in the Moyur River, and 80 to 8860 mg/l (mg/l) in the Rupsha River. Figure 8 shows that in May, in Rupshafarigate, the Chloride concentration in the Rupsha River was 8860 mg/l, but in August, at Railgate, the concentration in the Bhairab River was just 70 mg/l. Surface water quality standards set the chloride level at between 150 and 600 mg/l [4- 15] The aquatic ecosystem and its inhabitants are not assigned a monetary value.

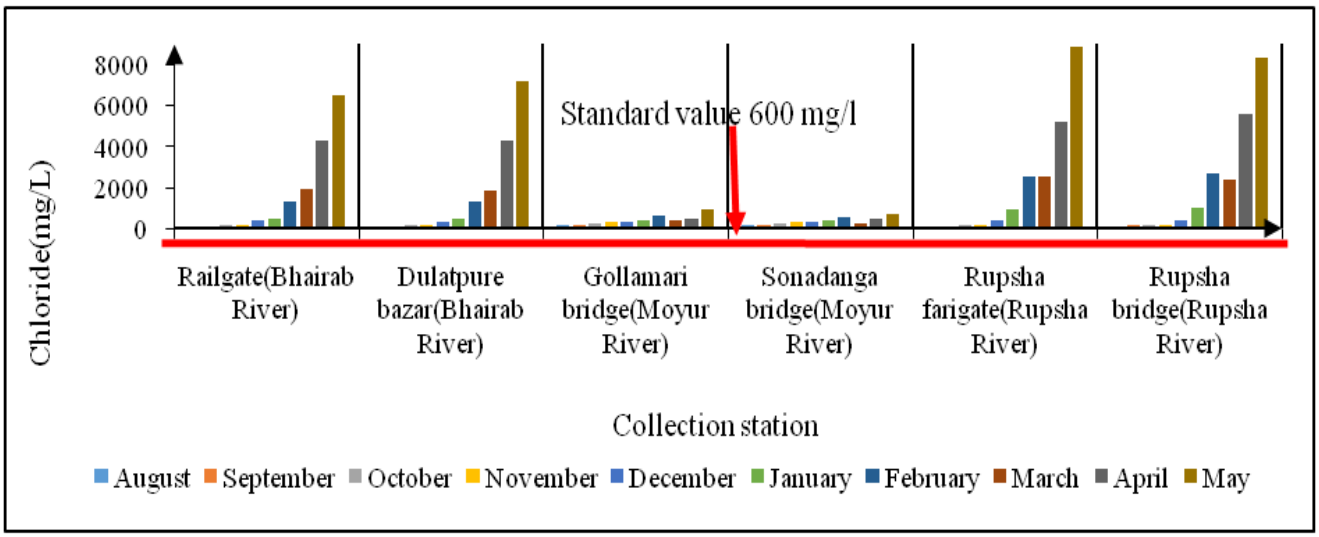


Figure 8. Monthly variation of Chloride at six Stations of three rivers in Khulna City

4. CONCLUSIONS

Each month from August 2022 to May 2023, scientists sampled water from the Bhairab, Rupsha, and Moyur rivers and analyzed it for a variety of quality indicators. Researchers compared the monthly value found in the lab to the norm for human consumption, aquatic ecosystems, and biological species. The water quality of the Bhairab and Rupsha Rivers is sufficient for aquatic ecosystems and life for the vast majority of the year. From February through May, the Bhairab and Rupsha rivers have exceptionally high TDS and chloride concentrations. The Moyur River has a deficient dissolved oxygen (DO) value and a very high biochemical oxygen demand (BOD5) value, making it an inappropriate environment for aquatic ecosystems and life. According to the research done, both the Bhairab and Rupsha Rivers have relatively high-quality water that is good for aquatic life. However, the Moyur River has extremely poor water quality, making it unfit for aquatic life and other forms of life.

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ONFLICT OF INTEREST
The author (s) declared no potential conflicts of interests with respect to the authorship and/or publication of this paper.

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