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Original Article

Assessment of Water Quality Index and Parameter of Chaktai Channel, Chattogram, Bangladesh

Ayesha Afrin[1]*, Ahnaf Tahmid[1], Sahab Uddin Shamim[1], A. J. M. Morshed[2]

[1]*Department of Applied Chemistry and Chemical Engineering, University of Chittagong, Bangladesh.*
[2]*Bangladesh Council of Scientific and Industrial Research, Chattogram, Bangladesh.*

[1]*Corresponding Author : aafrin.aec@cu.ac.bd*

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Abstract - *The Chaktai Channel is an important Channel connecting the Karnaphuli River, located in the Chattogram in the Chattogram City Corporation Area. Chaktai Channel is situated in a strategically significant sector of Chattogram City, close to numerous other enterprises. The Karnaphuli River receives the industrial wastewater dumped into it and flows down the channel. Samples were taken at several locations along the Chaktai Channel, which is connected to the river, to ascertain the quality of the water entering the Karnaphuli River. The samples were taken from the channel's most contaminated section, which is home to several enterprises. The study was conducted between the area of Chaktai Bridge (Location 1), Ashraf Ali Road (Location 2), Fishery ghat area (Location 3), Chaktai Ghat (Location 4) and Asadganj (Location 5), where industries discharge their untreated toxic wastewater. It involved the determination of physical and chemical parameters of surface water at different points. Physical parameters are colour, odour, temperature, turbidity, pH, and Electrical Conductivity (EC), and chemical parameters are Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), Total Alkalinity, Total hardness etc. The main objective of this study is to assess the water quality and parameters of Chaktai Channel in terms of the Water Quality Index (WQI) and the following order of water quality index (WQI) is Location 5 (Asadganj) > Location 1(Chaktai bridge) > Location 4(Chaktai ghat) > Location 2(Ashraf Ali Road) > Location 3(Fishery Ghat). The water quality index is higher at the channel's north side or upper stream near the industrial area. During the study period, the temperature fluctuated from 26.0°C to 31.5°C, while the water temperature ranged from 5.5 to 8.0. From L1 to L5 (L4<L5<L1<L2L4>L5>L2>L1), as well as the overall hardness of the sample (L3>L2>L5>L4>L1). Samples 1 and 2's COD, DO, and BOD are within the limit, whereas samples 3 through 5 are above the limit.*

Keywords - *Chaktai Channel, Chattogram, Karnaphuli River, Physical parameters, Water Quality Index.*

1. Introduction

Chaktai Khal called grief of Chattogram City. It is a most important part of the Chattogram seaport and Karnaphuli River. The largest and most significant river in Chattogram and the Chattogram Hill Tracts is the 667-meter-wide Karnaphuli in southeast Bangladesh. [1]. The Khal was dredged to divert Chaktai khal water from Chaktai Khal to rajarkhal to protect the Chattogram City from water logging [2], where Chattogram is the 2nd largest city corporation in Bangladesh and Its port city. Chaktai khal is essential to the city's drainage system [3]. It passes through inner city areas like Asadganj, Chaktai commercial area, Kotowali, etc. Chittagong is also known as Bangladesh's commercial capital. Chaktai is one of Chittagong's oldest commercial zones, known as Bangladesh's 'Business Capital'. The historic Chaktai canal runs through the commercial district, adding to the transit network for this site's economic operations. The Chaktai Canal Front has also been made available to surrounding residents as a waterfront public recreation space. Unfortunately, Chaktai is losing its former prominence as a central business area (CBD) that controls food commerce throughout Bangladesh. Large chemical and fertilizer industries have existed since achieving independence on the Karnaphuli on both of its banks. According to reports, these companies' effluents are discharged into this river.

The Karnaphuli River is being progressively polluted because of the massive amounts of solid waste and wastewater dumped into these canals: Chaktai. [4] Pathways serve as drain channels for surface water, playing an essential part in the water cycle. It has always been crucial for people to use water supplies. Cities, industrial hubs, and agricultural centres have all been built nearby.[5] Pressures on significant water resources and detecting abnormal water quality conditions have multiplied with time, population growth, and water resource usage [6-8]. Due to population increase, environmental pollution from runoff and the discharge of urban and industrial waste has accumulated and reduced the availability of water resources [9, 10]. Monitoring and analyzing surface waters is crucial to ensure the supply of high-quality water for its many purposes [11]. Environmental contamination has become a top worry for emerging nations in recent decades. Globally, there is an increasing sense of urgency surrounding the environmental contamination caused by various chemicals utilized in various activities. [12] Chaktai Khal, one of the central business hubs in the nation, is situated at 22°21’31 “N 91°50’36 “S. Chaktai Khal was most suitable for handling essential commodities. [13]

The natural waste disposal system for this industrial metropolis is provided by the Chaktai canal, which runs through the Chattogram municipality and empties into the river Karnaphuli.[14] The municipal and industrial pollutants passing through this canal are considered in the current study. A few physical and chemical characteristics of the canal’s water were investigated, and efforts were made to determine how these affected the aquatic life. It was discovered that the channel was severely polluted by industrial and municipal trash.[15] Variations in the abundance of various species along the canal’s length provided a clue as to the level of contamination. Some chemical industries like Al-Amin Chemical Industry, Mostofa Group of Industries, Chaktai salt industry and many other small industries near the Chaktai channel provide wastewater directly into the channel water. The primary goal of this study is to assess the water quality of the Karnaphuli River in terms of the water quality index (WQI) through Chaktai Khal.

2. Methodology

2.1. Materials and Methods

To evaluate the Chaktai Channel’s water quality, water was sampled twice a month at five locations. To achieve the best results, it is critical to collect the samples correctly. In this investigation, water samples were obtained manually from the water’s surface at around 0.5 meters. Stations were chosen based on accessibility and pollution sources along the Chaktai Channel and one of its tributaries.

2.2. Sampling Area Description

Chaktai channel passes by inside Chattogram City corporation area where the sampling area was in Chaktai area about 3 sq km along the channel. The sampling area was the southern part of the channel and the confluence of this channel and the Karnaphuli River. The sampling area starts at Longitude (N)$22^{0}\,20^{/}\,22^{//}$ N to $22^{0}\,19^{/}\,52^{//}$ N and Latitude (E)$91^{0}\,50^{/}\,48^{//}$ E to $91^{0}\,50^{/}\,57^{//}$ E. Sampling area: Location 1: Chaktai bridge, Location 2: Ashraf Ali Road, Location 3: Fishery Ghat, Location 4: Chaktai ghat, Location 5: Asadganj.

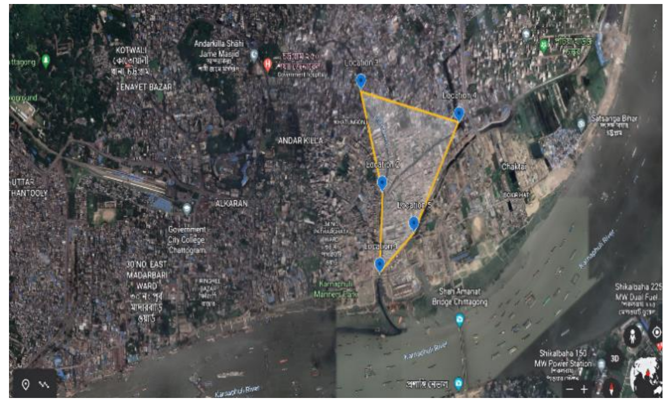

Fig. 1 Map of the sample study area

Table 1. Methods of analysis of different parameters

SL No	Parameters	Method of analysis
1	Temperature	Thermometry
2	Turbidity	Turbidity Meter
3	pH	pH meter
4	TS (ppm)	Oven Dry weight
5	TDS (ppm)	Oven Dry weight
6	TSS (ppm)	Oven Dry weight
7	EC	EC meter
8	DO	DO meter
9	COD	Complexometric titration
10	BOD	DO meter (after 5 days)
11	Total Alkalinity	Acid-base Titration
12	Total Hardness	Complexometric titration
13	Odor	Observation
14	Color	Observation

2.3. Sampling Procedure and Sample Preservation

The water sample was collected in a hard PET bottle with an airtight cap. Five water samples were collected from each sampling location in different depths with rinsing. The temperature, turbidity, pH, and EC were measured instantly, and the DO of the sample was measured within 24 hours of sample collection. The sample was preserved in dry, away from light, and in cold storage for further analysis.

2.3.1. Sample preparation

1. Portable pH/EC/TDS/Temperature Meter with CAL Check™ - HI9813-6 was used to determine pH, EC, TDS and Temperature. Firstly, wash the beaker with distilled water and take a sample water of 100ml in a beaker. The electrode or sensor was put into the water sample when the instrument was calibrated. Repeat it twice for one water sample and take the mean of three values.
2. Turbidity A nephelometric turbidimeter measures turbidity and expresses it in terms of NTU or TU. A TU corresponds to 1 mg/L of silica in suspension [16]. Turbidity was measured using a turbidity meter, the Lutron TU 2016. After calibrating the device, a 10 ml sample was utilized to test it.

3. Dissolved oxygen, or DO, is an essential indicator of water pollution [17]. The greater the water quality, the higher the dissolved oxygen concentration. HI-9146 Handheld Dissolved Oxygen Meter was used to measure DO. After washing the beaker with distilled water, take a sample of 100ml of water in a beaker. The electrode or sensor was put into the water sample when the instrument was calibrated. The process was repeated four times, and a mean value was taken.
4. Total solid (TS) is the sum of total dissolved solid (TDS) and total suspended solid (TSS). After drying the 50ml sample at 110℃ in an oven, the weight was taken and subtracted from the dry weight of the beaker and the TS was determined. For TDS, after filtration, 50ml of the sample dried at 110℃ in an oven took the weight and subtracted it from the dry weight of the beaker and determined the TDS. Here, TS = TDS + TSS. TSS = TS – TDS.
5. Chemical Oxygen Demand (COD): all organic materials, including biodegradable and non-biodegradable, are measured by the chemical oxygen demand (COD) parameter [18]. Lovibond® Thermo reactor RD 125 Reactor, 110/220VAC, Lovibond Water Tester was used to measure COD.
6. Biological Oxygen Demand $(BOD)_5$: To calculate the BOD, the laboratory samples some wastewater and then dilutes it in a BOD incubation bottle. The lab must measure the following data:

D_1 = oxygen diluted level in the diluted sample at t=0 (mg/l)

D_2 = oxygen diluted level in the diluted sample at t=5 days (mg/l)

B_1 = oxygen diluted level in the dilution water at t=0 (mg/l)

B_2 = oxygen diluted level in the dilution water at t=5 days (mg/l)

V_1 = volume of wastewater sampled for dilution (ml)

V_2 = volume of diluted sample (ml)

The BOD at 5 days can be calculated with the following formula:

$$BOD_5 = [(D_1-D_2) -(B_1-B_2) f]/P$$

Where, $f = (V_2-V_1)/V_2$, $P = V_1/V$

Calculation of BOD5: A plant sent a sample of its effluents to a lab. The lab dilutes 10 mL of water in a 250 mL BOD incubation bottle. The lab analyses the oxygen level in the diluted water and obtains 10 mg/l at t=0 and 2 mg/l at t=5 days; it also measures the diluted water and obtains 9.5 mg/l at t=0 and 8 mg/l at t=5 days. The lab wants to compute the BOD5 of the effluent.

7. Total alkalinity is the sum of all titratable bases that determines the alkalinity of water, which is its ability to neutralize acids [19]. By using a titrimetric method, we can measure alkalinity.

Reaction : $H_2SO_4 + CaCO_3 = CaSO_4 + CO_2 + H_2O$
Here,

1000 ml 1M H_2SO_4 = 100 g $CaCO_3$

1000 ml 1N H_2SO_4 = 50 g $CaCO_3$

1ml 1N H_2SO_4= 50 × 1000/1000 mg $CaCO_3$ = 50 mg $CaCO_3$

Bml N H_2SO_4 = 50×B×N mg $CaCO_3$

In Vml sample, Bml N H_2SO_4 = (50×B×N)/Vml of water sample mg/L as $CaCO_3$

In 1000ml sample, Bml N H_2SO_4 = (50×B×N×1000)/Vml of water sample mg/L as $CaCO_3$.

$$\text{Total alkalinity (mg/L) as } CaCO_3 = \frac{B \times N \times 50000}{mL\ of\ sample}$$

8. Total hardness, the characteristics of highly mineralized waters, is described by the term “hardness” [20]. The samples’ total hardness will be determined using the EDTA titrimetric method.

Calculation: Hardness as $CaCO_3 = (V_1 \times S \times 1000*100)/V$
Where V_1= Volume of EDTA required,

S = Molarity of EDTA solution,

V = Volume of Sample Water,

3. Result Discussion & Recommendation

3.1. Result Discussion

The table shows the mean value plus standard deviation of physicochemical parameters in the water column, such as dissolved oxygen (DO), pH, temperature, etc. The physicochemical characteristics are critical because they substantially impact the water quality. Furthermore, poor water quality harms aquatic life. Temperature is one of the most essential variables that affect aquatic ecology [16]. Temperatures ranged from 26.0°C and 31.5°C. The average water temperature was between 25 to 30°C, within the permitted limits of WHO (2004). pH indicates whether water is acidic or alkaline. The standard for any purpose in terms of pH is 6.5- 8.5; in that respect, the value of water lies between 5.5 to 8.0 during the study period. The concentration of EC, TS, TDS and TSS was gradually increased from L1 to L5 (L4<L5<L1<L2<L3) from the tables. The alkalinity of is higher in location 3 and least at location 1 (L3>L4>L5>L2>L1). The total hardness of the sample is higher in Location 3 and least at Location 1 (L3>L2>L5>L4>L1). The COD, DO, and BOD_5 of samples 1 and 2 have a limit, whereas 3, 4, and 5 exceed the limit.

Table 2. Data for Temperature

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	31	30.5	31.2	31	30.8	30.9	25
Ashraf Ali Road	30.8	29.8	30.2	29.6	29.3	29.94	25
Fishery Ghat	27.7	27.5	28.8	27.4	28.1	27.9	25
Chaktai Ghat	26.8	26.6	26.5	26.4	26.7	26.6	25
Asadganj	26.5	26.3	26.4	26.3	26.6	26.42	25

Table 3. Data for Temperature

Samples	Location-1	Location-2	Location-3	Location-4	Location-5
Sample-1	31	30.8	27.7	26.8	26.5
Sample-2	30.5	29.8	27.5	2.6	26.3
Sample-3	31.2	30.2	28.8	26.5	26.4
Sample-4	31	29.6	27.4	26.4	26.3
Sample-5	30.8	29.3	28.1	26.7	26.6
Average	30.9	29.94	27.9	26.6	26.42
Standard	25	25	25	25	25

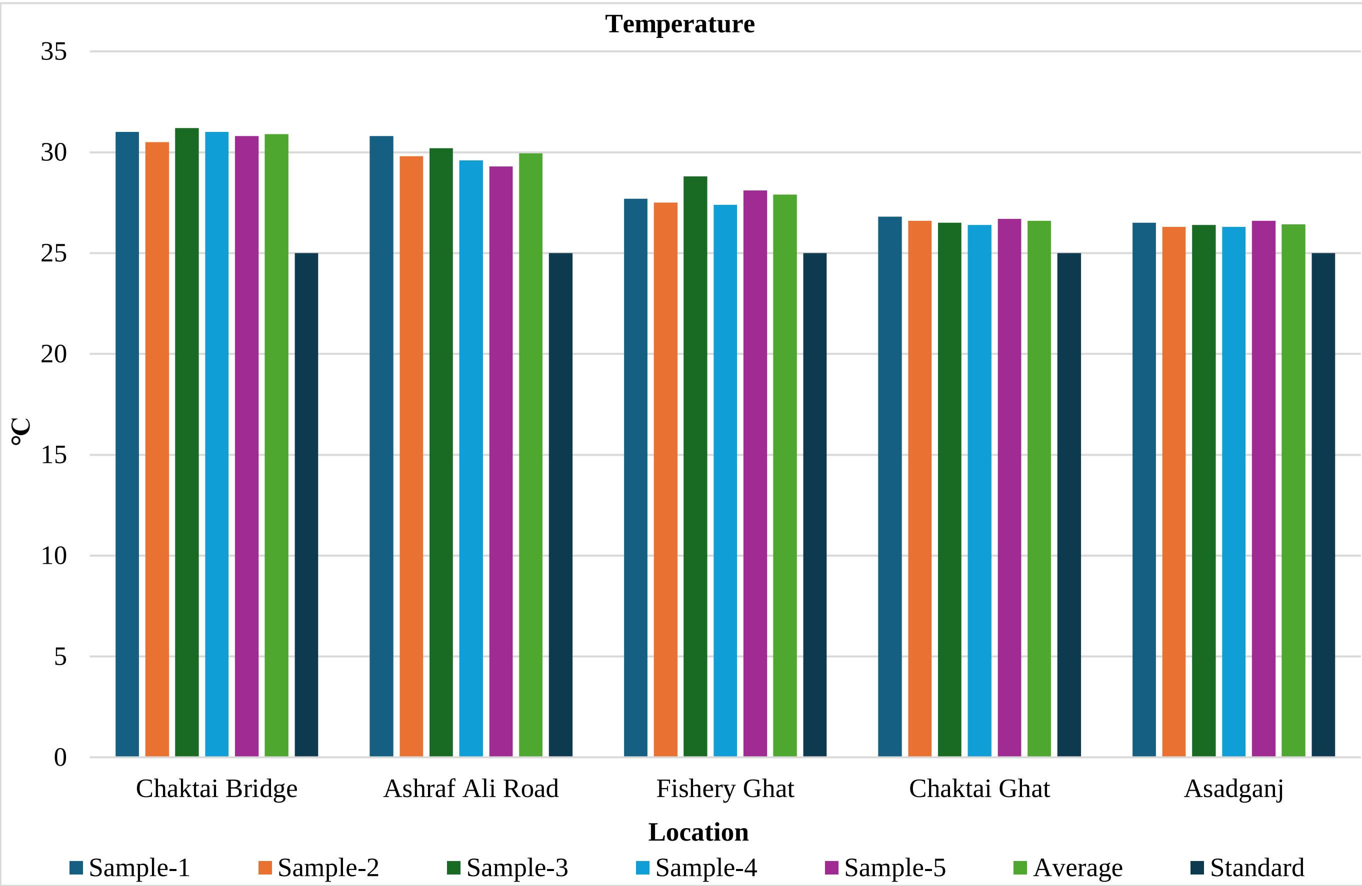

Fig. 2 Temperature Variations

Table 4. Data for pH

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	7.7	7.9	8	7.8	7.6	7.8	7
Ashraf Ali Road	7.8	7.5	8.1	7.9	7.7	7.8	7
Fishery Ghat	7.5	7.6	7.5	7.2	7.3	7.42	7
Chaktai Ghat	5.5	5.9	5.8	6.1	6.2	5.9	7
Asadganj	5.9	6.1	6	6.4	6.3	6.14	7

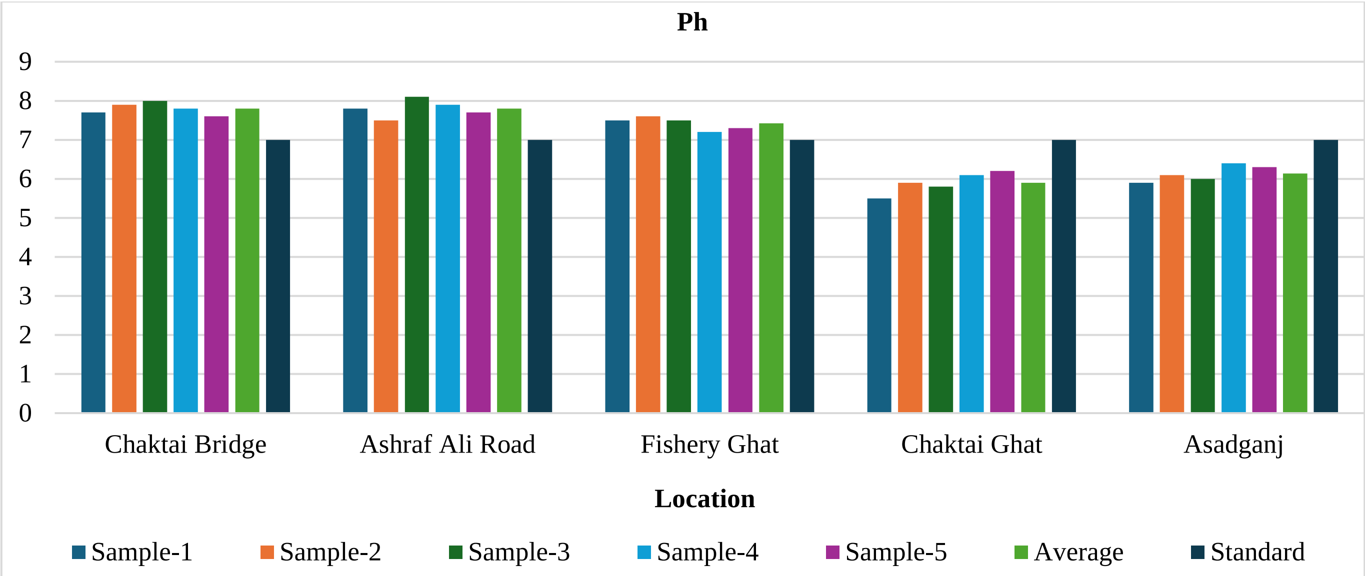

Fig. 3 pH Variations

Table 5. Data for EC

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	1.13	0.81	0.93	0.85	0.86	0.916	0.4
Ashraf Ali Road	1.24	1.18	1.31	1.3	1.26	1.258	0.4
Fishery Ghat	2.9	3.11	3.13	3.04	3.07	3.05	0.4
Chaktai Ghat	0.76	0.77	0.79	0.75	0.78	0.77	0.4
Asadganj	0.86	0.82	0.85	0.84	0.83	0.84	0.4

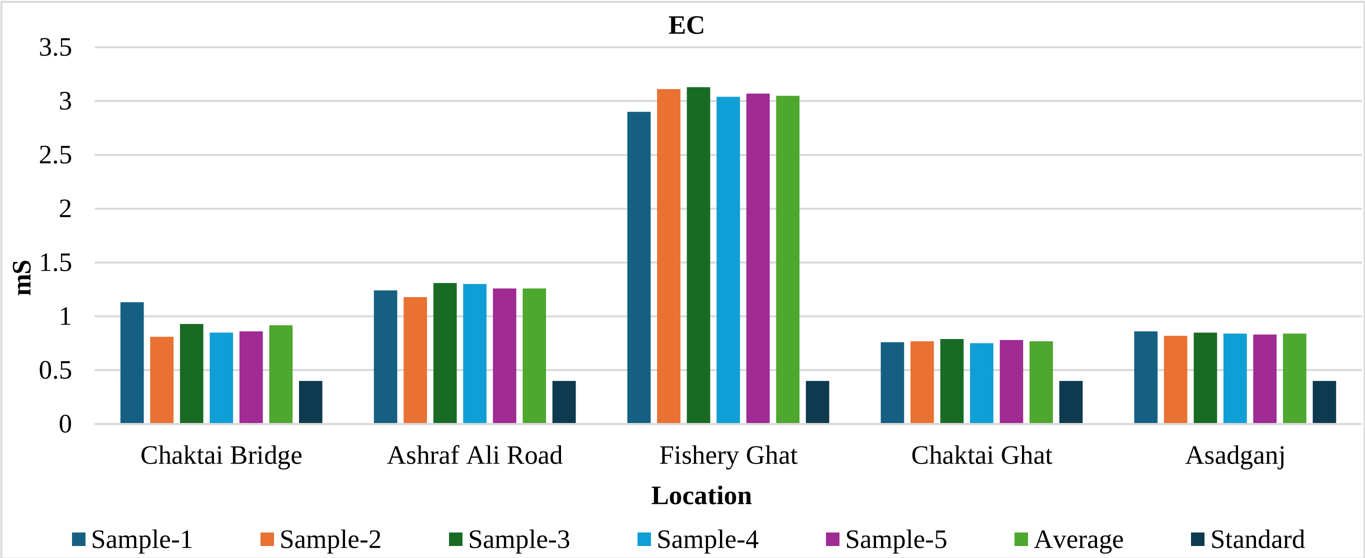

Fig. 4 EC Variations

Table 6. Data for TS

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	582	499	525	509	510	525	1500
Ashraf Ali Road	1444	1378	1510	1497	1400	1445.8	1500
Fishery Ghat	1834	1968	1980	1919	1924	1925	1500
Chaktai Ghat	482	490	488	490	492	488.4	1500
Asadganj	442	440	440	440	438	440	1500

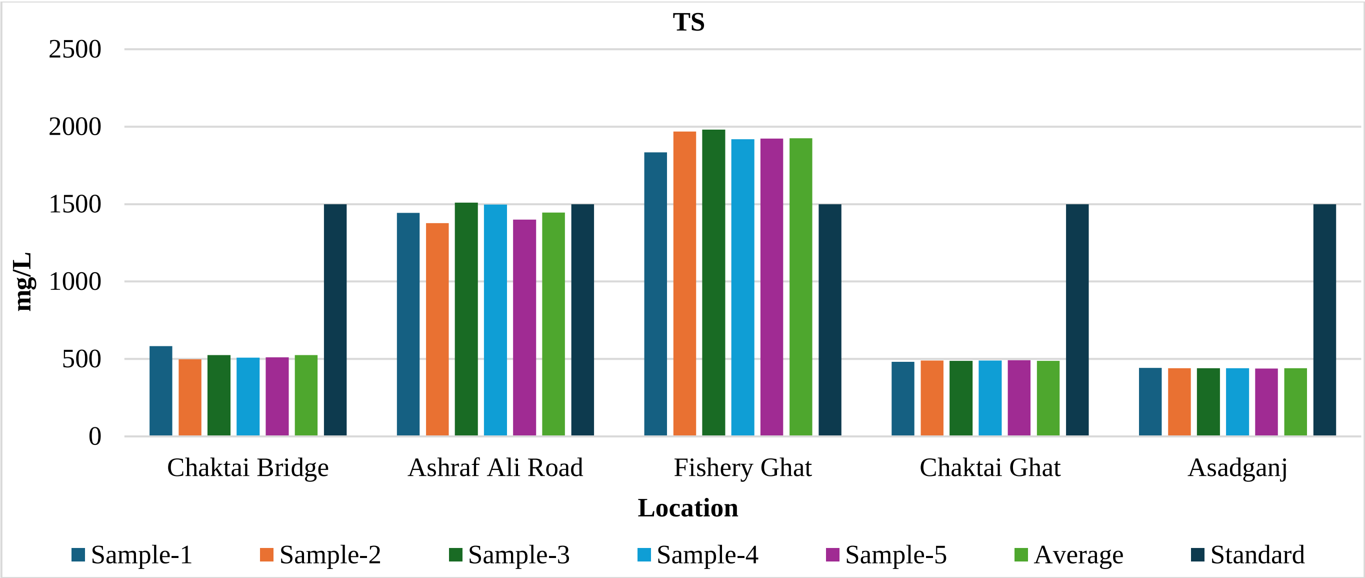

Fig. 5 TS Variations

Table 7. Data for TSS

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	130	150	136	144	140	140	500
Ashraf Ali Road	720	700	757	750	696	724.6	500
Fishery Ghat	20	23	24	21	22	22	500
Chaktai Ghat	164	159	153	151	146	154.6	500
Asadganj	64	66	70	75	78	70.6	500

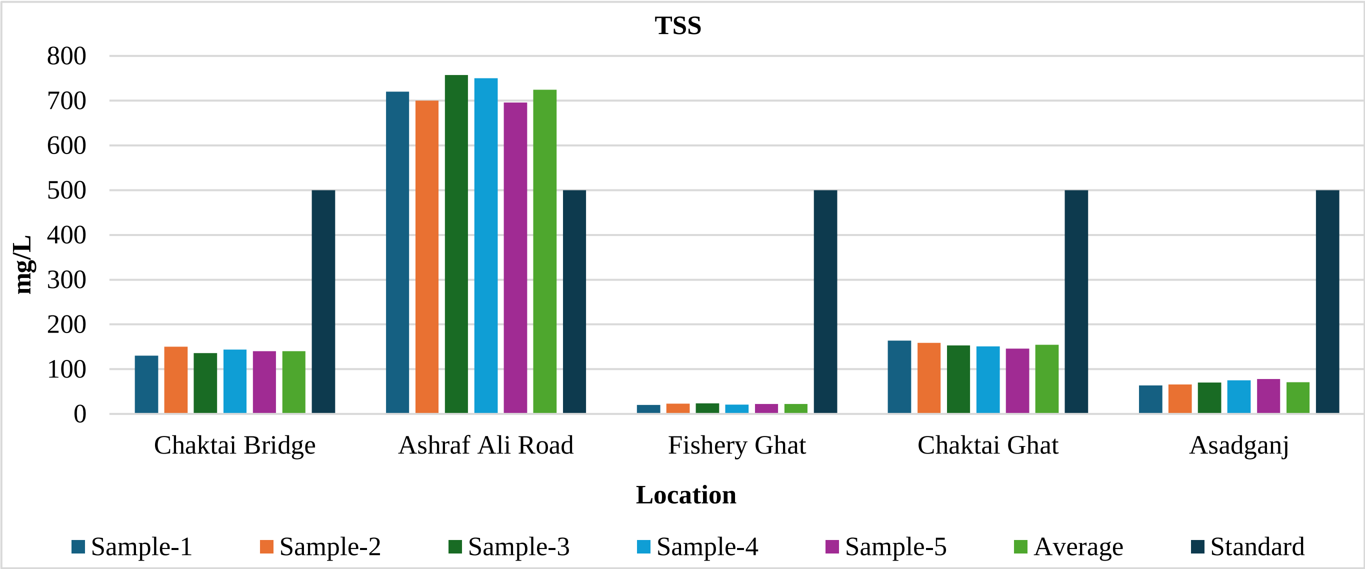

Fig. 6 TSS Variations

Table 8. Data for TDS

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	452	349	389	365	370	385	1000
Ashraf Ali Road	724	678	753	747	704	721.2	1000
Fishery Ghat	1814	1945	1956	1898	1902	1903	1000
Chaktai Ghat	318	331	335	339	346	333.8	1000
Asadganj	378	374	370	365	360	369.4	1000

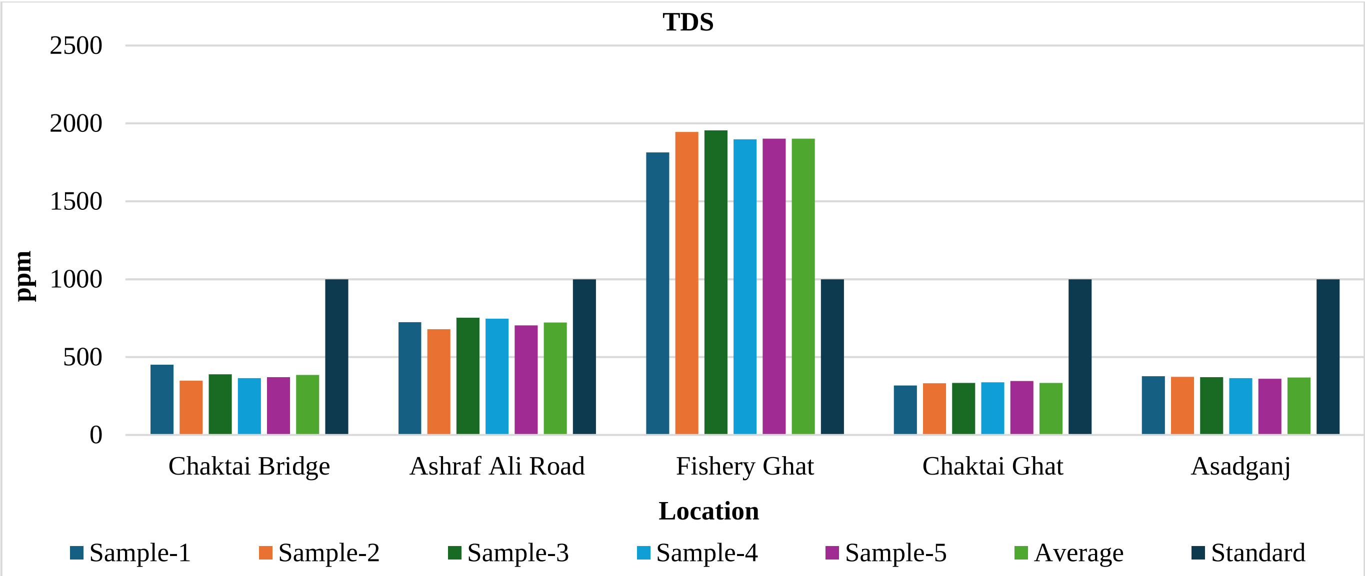

Fig. 7 TDS Variations

Table 9. Data for Turbidity

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	88	86	85	87	89	87	10
Ashraf Ali Road	84	83	84	82	79	82.4	10
Fishery Ghat	70	75	76	73	74	73.6	10
Chaktai Ghat	66	67	69	70	68	68	10
Asadganj	63	61	67	65	69	65	10

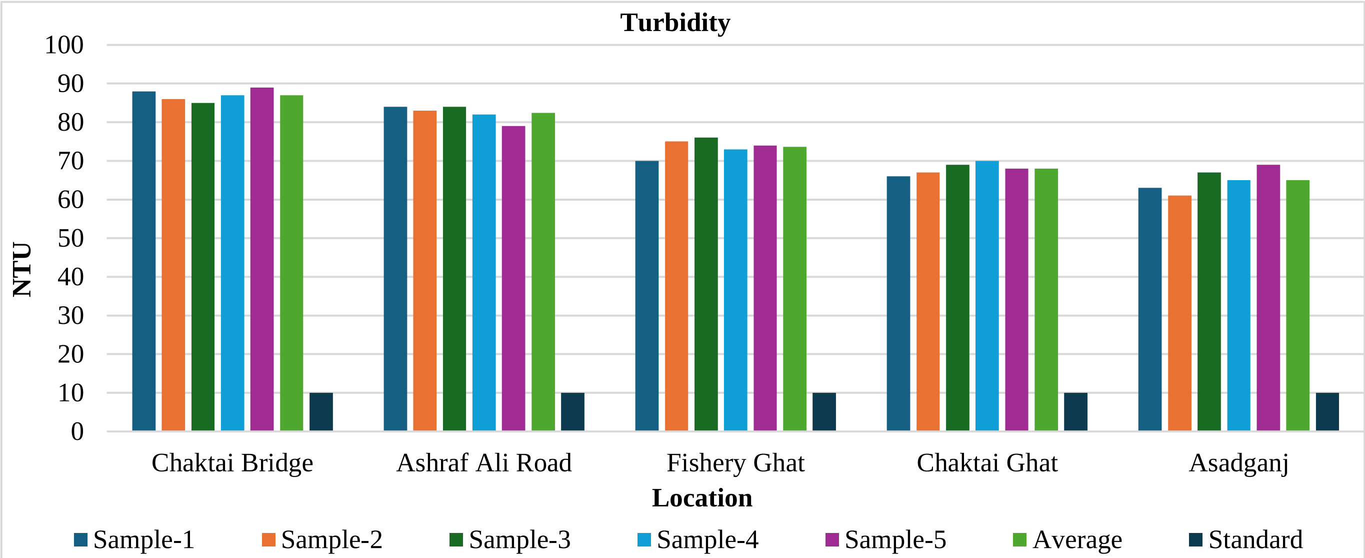

Fig. 8 Turbidity Variations

Table 10. Data for DO

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	6.558	6.498	5.39	5.788	5.382	5.9232	9
Ashraf Ali Road	5.536	3.55	3.558	4.212	2.918	3.9548	9
Fishery Ghat	2.488	2.762	3.36	2.644	2.56	2.7628	9
Chaktai Ghat	3.112	2.652	2.44	2.49	2.548	2.6484	9
Asadganj	4.21	2.984	2.746	3.084	2.492	3.1032	9

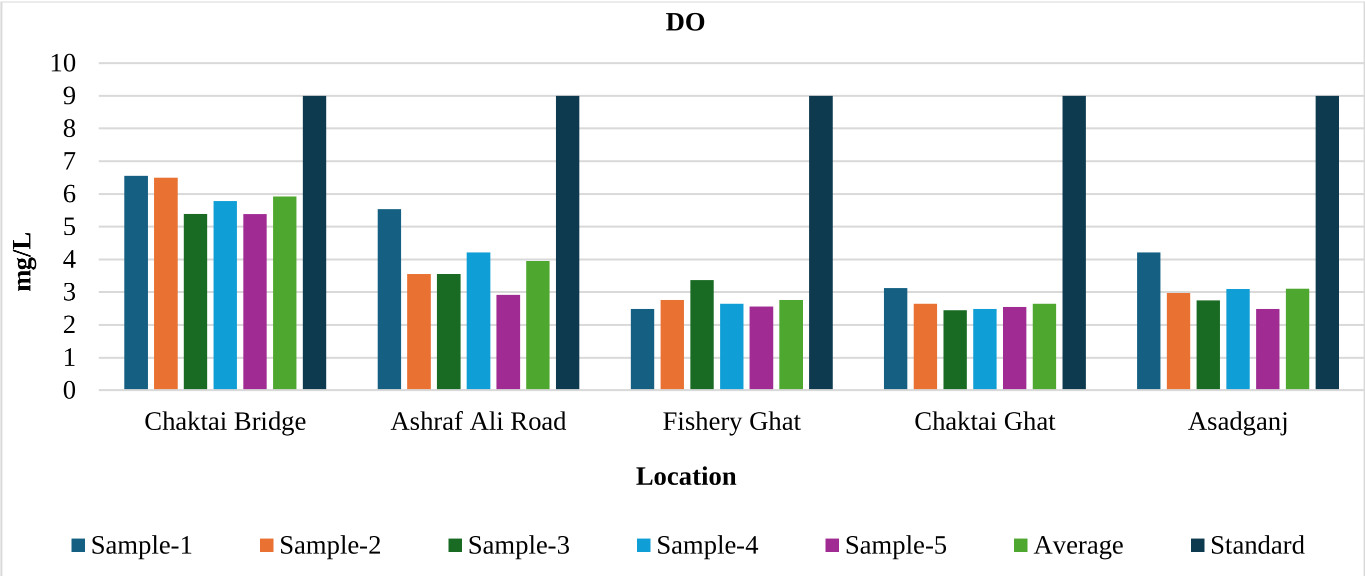

Figure 9. DO Variations

Table 11. Data for COD

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	9	2	4	3	3	4.2	4
Ashraf Ali Road	17	15	27	26	25	22	4
Fishery Ghat	132	196	198	182	194	180.4	4
Chaktai Ghat	28	28	29	30	29	28.8	4
Asadganj	0.2	0.2	0.2	0.2	0.2	0.2	4

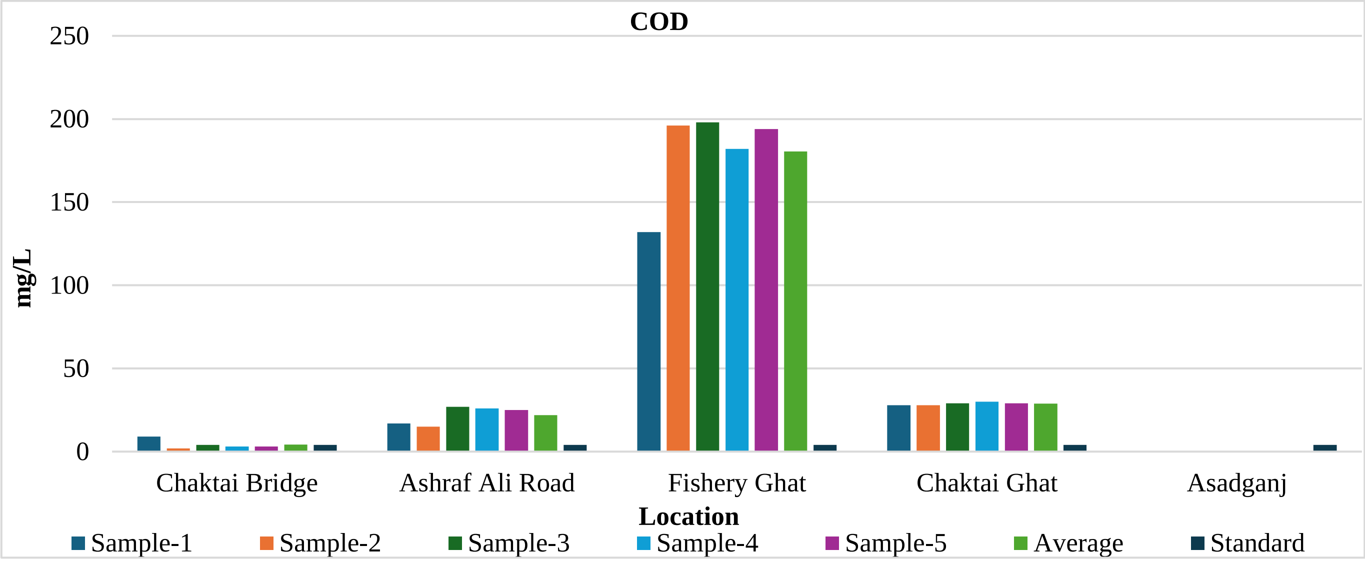

Fig. 10 COD Variations

Table 12. Data for BOD

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	1.366	1.37	1.055	3.029	1.78	1.72	2
Ashraf Ali Road	2.342	0.864	1.798	2.122	1.986	1.8224	2
Fishery Ghat	2.026	2.262	2.846	2.02	1.92	2.2148	2
Chaktai Ghat	2.042	2.004	1.972	1.808	1.096	1.7844	2
Asadganj	1.616	2.496	1.898	2.23	1.236	1.8952	2

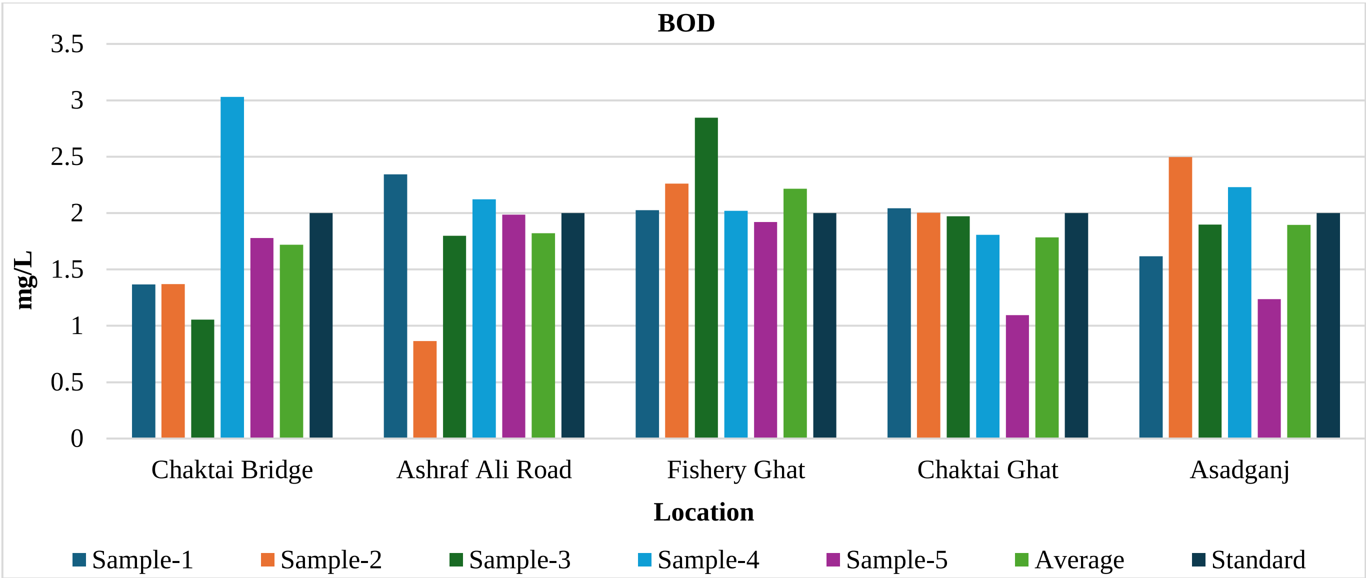

Fig. 11 BOD Variations

Table 13. Data for Total Alkalinity

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	80	60	70	60	60	66	100
Ashraf Ali Road	80	80	90	90	80	84	100
Fishery Ghat	600	620	620	610	610	612	100
Chaktai Ghat	270	280	280	270	280	276	100
Asadganj	190	180	190	180	180	184	100

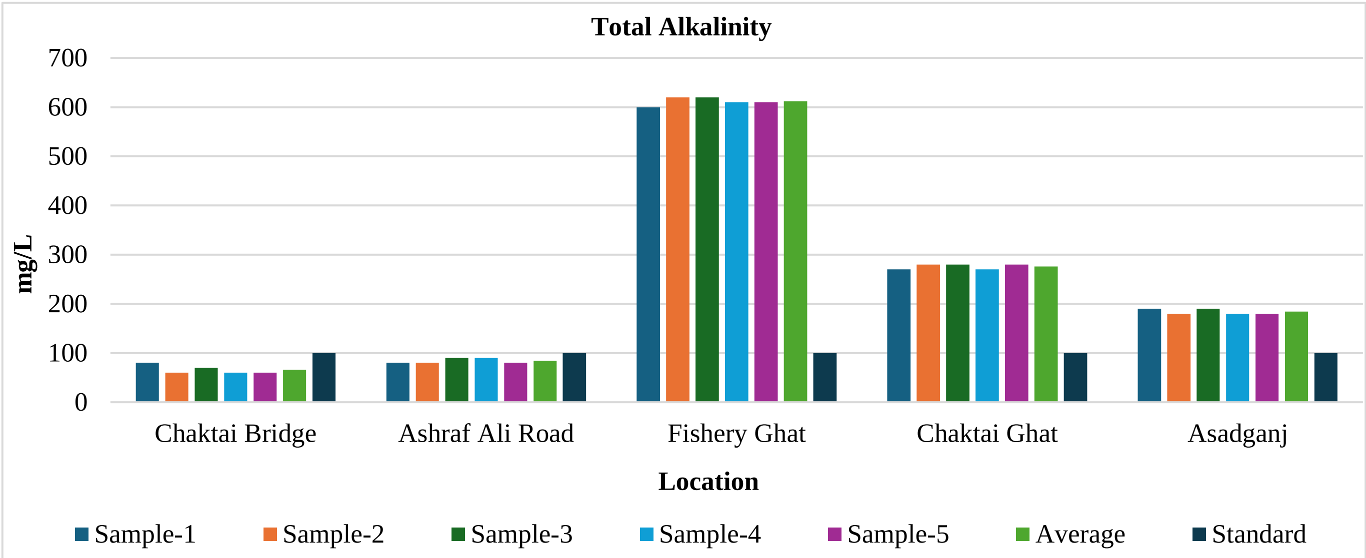

Fig. 12 Total Alkalinity Variations

Table 14. Data for Total Hardness

Location	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Average	Standard
Chaktai Bridge	**116**	**108**	**112**	**108**	**108**	**110.4**	**300**
Ashraf Ali Road	**184**	**184**	**188**	**188**	**184**	**185.6**	**300**
Fishery Ghat	**412**	**416**	**416**	**412**	**412**	**413.6**	**300**
Chaktai Ghat	**120**	**124**	**120**	**124**	**120**	**121.6**	**300**
Asadganj	**136**	**132**	**136**	**132**	**132**	**133.6**	**300**

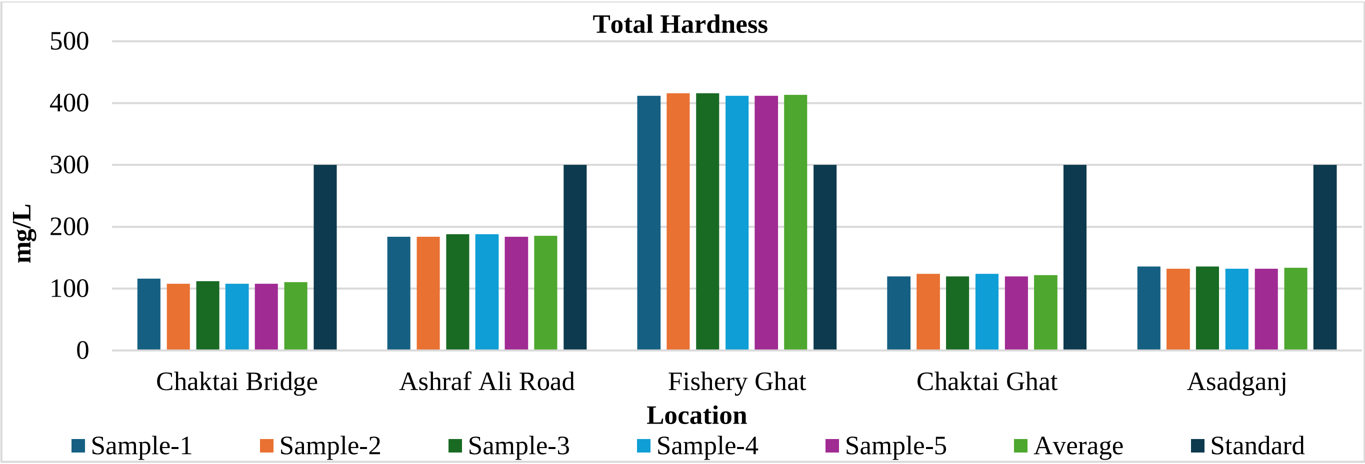

Fig. 13 Total Hardness Variations

Table 15. LOCATION-01: Chaktai Bridge (All values of five samples)

	Location 1						
Parameter	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Avg**	**Standard (BS)**
Temperature	31	30.5	31.2	31	30.8	30.9	25
Turbidity	88	86	85	87	89	87	10
pH	7.7	7.9	8	7.8	7.6	7.8	7
TS (ppm)	582	499	525	509	510	525	1500
TDS (ppm)	452	349	389	365	370	385	1000
TSS (ppm)	130	150	136	144	140	140	500
EC	1.13	0.81	0.93	0.85	0.86	0.916	0.4
COD	9	2	4	3	3	4.2	4
DO	6.558	6.498	5.39	5.788	5.382	5.9232	9
BOD	1.366	1.37	1.055	3.029	1.78	1.72	2
Total Alkalinity	80	60	70	60	60	66	100
Total Hardness	116	108	112	108	108	110.4	300

The water quality index for Location 1 (average of five samples),
WQI = $\sum Qi\, Wi / \sum Wi$
= 207.0014

≥100	**Unsuitable for drinking and food culture**	**Proper treatment is required before use**

Result: Location 1's water index falls on the worst quality, unsuitable for drinking and food culture, and proper treatment is required before use.

Table 16. LOCATION-2: Ashraf Ali Road (All values of five samples)

	Location 2						
Parameter	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Avg**	**Standard (BS)**
Temperature	30.8	29.8	30.2	29.6	29.3	29.94	25
Turbidity	84	83	84	82	79	82.4	10
pH	7.8	7.5	8.1	7.9	7.7	7.8	7
TS (ppm)	1444	1378	1510	1497	1400	1445.8	1500
TDS (ppm)	724	678	753	747	704	721.2	1000
TSS (ppm)	720	700	757	750	696	724.6	500
EC	1.24	1.18	1.31	1.3	1.26	1.258	0.4
COD	17	15	27	26	25	22	4
DO	5.536	3.55	3.558	4.212	2.918	3.9548	9
BOD	2.342	0.864	1.798	2.122	1.986	1.8224	2
T. Alkalinity	80	80	90	90	80	84	100
T. Hardness	184	184	188	188	184	185.6	300

The water quality index for Location 2 (average of five samples),
WQI = $\sum Qi\ Wi / \sum Wi$
= 294.669

≥100	**Unsuitable for drinking and food culture**	**Proper treatment is required before use**

Result: Location 2 water index falls on worst quality, which is Unsuitable for drink and food culture, and Proper treatment is required before use

Table 17. LOCATION-3: Fishery Ghat (All values of five samples)

	Location 3						
Parameter	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Avg**	**Standard (BS)**
Temperature	27.7	27.5	28.8	27.4	28.1	27.9	25
Turbidity	70	75	76	73	74	73.6	10
pH	7.5	7.6	7.5	7.2	7.3	7.42	7
TS (ppm)	1834	1968	1980	1919	1924	1925	1500
TDS (ppm)	1814	1945	1956	1898	1902	1903	1000
TSS (ppm)	20	23	24	21	22	22	500
EC	2.9	3.11	3.13	3.04	3.07	3.05	0.4
COD	132	196	198	182	194	180.4	4
DO	2.488	2.762	3.36	2.644	2.56	2.7628	9
BOD	2.026	2.262	2.846	2.02	1.92	2.2148	2
T. Alkalinity	600	620	620	610	610	612	100
T. Hardness	412	416	416	412	412	413.6	300

The water quality index for Location 2 (average of five samples),
WQI = $\sum Qi\ Wi / \sum Wi$
=272.0649

≥100	**Unsuitable for drinking and food culture**	**Proper treatment is required before use**

Result: Location 3's water index falls on the worst quality and is much higher, unsuitable for drink and food culture, and proper treatment is required before use.

Table 18. LOCATION-04: Chaktai Ghat (All values of five samples)

	Location 4						
Parameter	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Avg**	**Standard (BS)**
Temperature	26.8	26.6	26.5	26.4	26.7	26.6	25
Turbidity	66	67	69	70	68	68	10
pH	5.5	5.9	5.8	6.1	6.2	5.9	7
TS (ppm)	482	490	488	490	492	488.4	1500
TDS (ppm)	318	331	335	339	346	333.8	1000
TSS (ppm)	164	159	153	151	146	154.6	500
EC	0.76	0.77	0.79	0.75	0.78	0.77	0.4
COD	28	28	29	30	29	28.8	4
DO	3.112	2.652	2.44	2.49	2.548	2.6484	9
BOD	2.042	2.004	1.972	1.808	1.096	1.7844	2
T. Alkalinity	270	280	280	270	280	276	100
T. Hardness	120	124	120	124	120	121.6	300

The water quality index for Location 4 (average of five samples),
WQI = $\sum Qi\ Wi / \sum Wi$
=217.5486

≥100	**Unsuitable for drink and food culture**	**Proper treatment is required before use**

Result: Location 4 water index falls on worst quality, which is Unsuitable for drink and food culture, and Proper treatment is required before use.

Table 19: Location 5: Asadganj (All values of five samples)

	Location 5						
Parameter	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Avg**	**Standard (BS)**
Temperature	26.5	26.3	26.4	26.3	26.6	26.42	25
Turbidity	63	61	67	65	69	65	10
pH	5.9	6.1	6	6.4	6.3	6.14	7
TS (ppm)	442	440	440	440	438	440	1500
TDS (ppm)	378	374	370	365	360	369.4	1000
TSS (ppm)	64	66	70	75	78	70.6	500
EC	0.86	0.82	0.85	0.84	0.83	0.84	0.4
COD	0.2	0.2	0.2	0.2	0.2	0.2	4
DO	4.21	2.984	2.746	3.084	2.492	3.1032	9
BOD	1.616	2.496	1.898	2.23	1.236	1.8952	2
T. Alkalinity	190	180	190	180	180	184	100
T. Hardness	136	132	136	132	132	133.6	300

The water quality index for Location 5 (average of five samples),

WQI = $\sum Qi\ Wi / \sum Wi$

=180.6331

≥100	**Unsuitable for drinking and food culture**	**Proper treatment is required before use**

Result: Location 5’s water index falls on the worst quality, is unsuitable for drinking and food culture, and requires proper treatment before use.

4. Recommendations

Considering paramount importance in our economy, the environment of channel water should be free from all sorts of pollution. Based on the current study’s findings, the following recommendations are offered. Further research is required into pollutant concentrations, pollution sources and pathways, transport mechanisms, and possible dangers to humans and the environment. In terms of water analysis, more samples from the sample region and neighboring areas are required to offer qualitative and quantitative data that may be used to create improved risk models. Different water sample depths are required to understand the history of these pollutants and provide more accurate results when comparing water parameters and indexes. If all of the above-mentioned proposed research is undertaken, it would be possible to develop a model system for developing water quality, and the parameter will be limited to a lower water quality index. This model could assist in the development of policies and strategies to mitigate and prevent further sediment contamination. Some of these policies and strategies are discussed in the next section. There should be a water treatment plant around the area as the water of this channel falls into Karnaphuli River, which can badly affect its aquatic biosphere.

4.1. Hazardous Waste Management

Liquid and solid waste contain a wide range of components. Some can decompose spontaneously, whereas many others cannot. Industry authorities must now consider an industrial ecology approach, which would entail using waste from one part as a resource in another. This was once thought impossible, but it is gaining popularity because of modern integrated waste management principles such as reuse, reduction, recycling, composting, sanitary landfill, and waste-to-energy. Hazardous waste transportation requires a “cradle-to-grave” system to track the material’s transit from origin to final disposal. Hazardous waste must be stored properly since an inadvertent discharge can cause substantial harm to public health and environmental damage. [21, 17]

4.2. Channel and River Water Management Plan

The findings of this study suggest that heavy metals may bioaccumulate in the human food chain. [22] The following should be considered. Given the region’s sensitivities, a proper Channel-river water management plan in SIP and surrounding areas is critical to maintaining water quality and ensuring periodic monitoring of sensitive water parameters, including bio-monitoring programs to measure the levels of chemical substances in water and microorganisms that occur as a result of exposure to contaminated water [23].

4.3. Establish Water Policies

Water policies are the most widespread phenomenon in the new world, as many countries implement water management plans that allow steps to control the most common sources of pollution and rules on how to comply with the highest environmental requirements [24, 25]. Various industrial and commercial activities require environmental licenses. SIP should begin to plan the process of providing permits by established policies.

5. Conclusion

Bangladesh's most frequent water sources are channels, streams, ponds, lakes, and groundwater (boreholes and hand-dug wells). The physio-chemical analyses of water samples revealed that while several parameters surpassed the established norms, some were within permitted ranges. The majority of the water sources in the western part of the country are excellent and suitable for human consumption, except for instances of high levels of fecal contamination in some rivers, according to the results of the application of the water quality index (WQI) to determine the suitability of the water for the intended use. Most of the country's northern regions have poor or inadequate water quality that is unsafe for human consumption.

In the country's eastern and southern regions, the WQI score indicated that the food was of marginal quality and unfit for human consumption without treatment. This low quality could be attributed to the high quantities of nitrate and acidic pH found in most of the area's water bodies. Overall, it is suggested that water be thoroughly treated before consumption to minimize water-borne diseases and illnesses.

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References

[1] Arif Hossen, and Riaduddin Arafat Jishan, "Water quality assessment in terms of water quality index: a case study of the Halda River, Chittagong," *Applied Journal of Environmental Engineering Science*, vol. 4, no. 4, pp. 447-455, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[2] M. Jamaluddin Ahmed, M. Anisul Islam, and M. Edris Ali, "Physicochemical Assessment of Water Quality of the Karnaphuli River and its Impact on the Environment of Chittagong, Bangladesh," *North American Academic Research*, vol. 3, no. 7, pp. 110-152, 2020. [CrossRef] [Publisher Link]

[3] A. Hossain, "*Evaluation of surface water quality: A case study on Surma River*," B.Sc. Engineering thesis, Civil and Environmental Engineering Department, Shahjalal University, Sylhet, Bangladesh, 2001. [Google Scholar]

[4] George Tchobanoglous, Franklin L. Burton, and H. David Stensel, *Metcalf & Eddy Wastewater Engineering: Treatment and Reuse*, 4th ed., New Delhi, 2003. [Google Scholar] [Publisher Link]

[5] Silvia F. Pesce, and Daniel A. Wunderlin, "Use of Water Quality Indices to Verify the Impact of Cordoba City (Argentina) On Suquia River," *Water Research*, vol. 34, no. 11, pp. 2915-2926, 2000. [CrossRef] [Google Scholar] [Publisher Link]

[6] Ai-jun Wang et al., "Heavy Metal Accumulation During the Last 30 Years in The Karnaphuli River Estuary, Chittagong, Bangladesh," *Springer Plus*, vol. 5, no. 1, pp. 1-14, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[7] Ehsan Fathi, Rasool Zamani-Ahmadmahmoodi, and Rafat Zare-Bidaki, "Water Quality Evaluation Using Water Quality Index and Multivariate Methods, Beheshtabad River, Iran," *Applied Water Science*, vol. 8, no. 7, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[8] H. Hirsh et al., "Room Service, AI-style," *IEEE Intelligent Systems and Their Applications*, vol. 14, no. 2, pp. 8-19, 2002. [CrossRef] [Google Scholar] [Publisher Link]

[9] Enrique Sánchez et al., "Use of the Water Quality Index and Dissolved Oxygen Deficit as Simple Indicators of Watersheds Pollution," *Ecological Indicators*, vol. 7, no. 2, pp. 315-328, 2007. [CrossRef] [Google Scholar] [Publisher Link]

[10] World Health Organization, Guidelines for Drinking-Water Quality, 3rd ed., vol. 1, 2008. [Google Scholar] [Publisher Link]

[11] A.Héctor Hernández-Romero et al., "Water Quality and Presence of Pesticides in a Tropical Coastal Wetland in Southern Mexico," *Marine Pollution Bulletin*, vol. 48, no. 11-12, pp. 1130-1141, 2004. [CrossRef] [Google Scholar] [Publisher Link]

[12] Edris Hoseinzadeh et al., "Evaluation of Aydughmush River Water Quality Using the National Sanitation Foundation Water Quality Index (NSFWQI), River Pollution Index (RPI), and Forestry Water Quality Index (FWQI)," *Desalting Water Treat*, vol. 54, no. 11, pp. 2994-3002, 2014. [CrossRef] [Google Scholar] [Publisher Link]

[13] Ahmed Barakat et al., "Physicochemical and Microbial Assessment of Spring Water Quality for Drinking Supply in Piedmont of Béni-Mellal Atlas (Morocco)," *Physics and Chemistry of the Earth, Parts A/B/C*, vol. 104, pp. 39-46, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[14] R.W.R. Patra, and NA. Mohsin, "Some Observations on the Water Pollution of the Chaktai Canal, Chittagong, Bangladesh," *Proceedings of the 4th and 5th Bangladesh Science Conference*, Bangladesh, Rajshahi, Bangladesh, pp. 1-104, 1980. [Google Scholar] [Publisher Link]

[15] Faisal Mahmood and Md. Abdul Matin, “Assessment of Drainage Capacity of Chaktai and Rajakhali Khal in Chittagong City and Inundation Adjacent of Urban Areas,” *Proceedings 4th International Conference on Civil Engineering for Sustainable Development (ICCESD 2018)*, KUET, Khulna, Bangladesh, pp. 1-13, 2018. [Google Scholar] [Publisher Link]

[16] Tania Sultana et al., “Bioaccumulation of Heavy Metals in Some Shell Fishes and Soil from Polluted in Chaktai Khal of Karnafully River, Chittagong,” *Bangladesh Journal of Zoology*, vol. 43, no. 1, pp. 145-151, 2015. [Google Scholar] [Publisher Link]

[17] M. S. Hossain, and Y. S. Khan, “An Environmental Assessment of Metal Accumulation in the Karnafully Estuary, Bangladesh,” *Proceedings of the South Asia Regional Workshop on ‘Assessment of Material Fluxes to the Coastal Zone in South Asia and their Impacts*, Negombo, SriLanka, 2002. [Google Scholar]

[18] Mamta Tomar, *Quality Assessment of Water and Wastewater*, Boca Raton, 1st ed., 1999. [CrossRef] [Google Scholar] [Publisher Link]

[19] Hakan Tarras-Wahlberg, David Harper, and Nils Tarras-Wahlberg, “A First Limnological Description of Lake Kichiritith, Kenya: A Possible Reference Site for the Freshwater Lakes of the Gregory Rift Valley,” *South African Journal of Science*, vol. 99, no. 9, pp. 494-496, 2003. [Google Scholar] [Publisher Link]

[20] M Claes et al., “Comparison Study on river quality,” *The Science of the Total Environment*, vol. 207, pp 141-148, 1997. [Google Scholar]

[21] Shweta Tyag et al., Water Quality Assessment in terms of Water Quality Index,” *American Journal of Water Resources*, vol. 1, no. 3, pp. 34-38, 2013. [Google Scholar] [Publisher Link]

[22] Howard S. Peavy, Donald R. Rowe, and George Tchobanoglous, *Environmental Engineering*, McGraw-Hill, New York, pp. 1-719, 1985. [Google Scholar] [Publisher Link]

[23] Salman H. Abbas et al., “Biosorption of Heavy Metals: A Review,” *Journal of Chemical Science and Technology*, vol. 3, no. 4, pp. 74-102, 2014. [Google Scholar]

[24] C. White, J.A.Sayer, G.M. Gadd, “Microbial Solubilization and Immobilization of Toxic Metals: Key Biogeochemical Processes for Treatment of Contamination,” *FEMS Microbiology Reviews*, vol. 20, no. 3-4, pp. 503-516, 1997. [CrossRef] [Google Scholar] [Publisher Link]

[25] Warren Viessman, and Mark J. Hammer, *Water Supply and Pollution Control*, 7th ed., Upper Saddle River: New Jersey Pearson Prentice Hall, 1998. [Google Scholar] [Publisher Link]