Determination of Water Quality Beside the Industrial Area of Turag River in Dhaka, Bangladesh.

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Abstract: The study deals with assessing water quality parameters including pH, total dissolved solids (TDS), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), temperature, transparency, and turbidity of the Turag River in Gazipur, Bangladesh based on the standards of the Department of Environment (DoE) in Bangladesh and the Environmental Quantity Standard (EQS). The chemical parameters of water were investigated for eight stations (S1 to S8) in the Turag River through laboratory experiments considering three different sources, i.e., discharge point (DP), contamination point (CP), and midpoint (MP). The average pH values ranged between 7.12 and 8.34, indicating that all values were within the standard limits (pH=6.5 to 8.5). The average values of TDS were 488 to 905 ppm, which discloses a low TDS condition. The average values of DO were 4.05 to 5.71 mg/l, indicating a low DO value from the standard level (4.0 to 6.0 ppm for domestic and 5.0 ppm for fish culture). The values of BOD were between 16.24 and 26.54 mg/l, indicating a higher condition than the expected value of BOD (6.0 ppm for fish culture and 10.0 ppm for irrigation). The average values of COD were between 30 and 51 mg/l which is higher than the permissible limit. The temperatures of water varied from 27 to 32.53ºC, indicating standard

temperatures (20 to 30ºC) for aquatic creatures. The average transparency values maintained the standard limits (≤15.75 inches) for aquatic organisms. Finally, the turbidity values indicate a higher condition than the standard limit (10 NTU, Nephelometric turbidity units). According to the investigation, the water quality of the Turag River mostly exceeds acceptable limits. Therefore, urging advising the government to do constant monitoring to reduce the level of pollution of the Turag River.

Keywords: TDS, Turbidity, BOD, COD, Transparency, Total Hardness, pH of Water.

1. Introduction

Almost 71% of the earth's surface is covered with water. Out of it, 1% is freshwater from rainfall, snow-melts and ground water that people need every day to live how much water Is There on, in and above the Earth. A major part of this water is available in streams, rivers, lakes and other inland water bodies. Only this freshwater is used randomly in domestic (drinking, food preparing, bathing, washing, gardening) industrial, agricultural and aquaculture purposes. Thus, freshwater is one of the most generous gift's of the nature (Afrin & Mobin, 2014). But, among all the natural resources, this water is the most poorly managed one in developing countries (Islam M. S., 2012). Even a lion's share of it is exploited by industrial work such as fabrication, processing, washing, dilution, cooling and even for transportation. Because, maximum solid wastes, waste waters from domestic works, untreated industrial effluents and toxic precipitates from agricultural fields often find their end result in the surface waters. Also, the oil spill from water vehicles is continuously polluting the river waters (Nawshin, 2016). Turag is one of the most important rivers in the capital city of Dhaka in Bangladesh which is used for various purposes and has a great influence on the economic, environmental, agricultural and industrial growth of the city as well as the country. Turag River originates from the Bangshi River, latter an important tributary of the Dhaleshwari River, flows through Gazipur and joins the Buriganga at Mirpur in Dhaka. Most of the industries are growing enormously on the bank of the river. The release of the waste water without proper treatment from the surrounding industries and municipalities, agricultural run-off and dumping of the wastage on the bank of the river leads to the increased pollution of the river water. Most of the industries are discharging their effluents directly or indirectly into the Turag without any treatment continuously causing pollution of its water. Moreover, the river is being used as the dumping ground of municipal sewerage and drainage systems and thus all kinds of solids, liquids and chemical wastes are continuously causing its pollution. Such heavy pollutions have become the mother of emitting noxious smells from its water (Islam M. S., 2013).

Lots of works were done to assess the Turag River water and its sediment parameters at different spots. The studies assessed color, odor, DO, BOD, COD, TDS, EC, pH, salinity and heavy metals as chromium (Cr), cadmium (Cd), copper (Cu), nickel (Ni), zinc (Zn), lead (Pb) etc. The study results apparently proved that the critical level of the above physicochemical parameters, suitable for living organisms, has been exceeded by the above mentioned pollutants (Afrin & Mobin, 2014, Ahmed, 2016, Sci, 2014). Different studies on Turag River water quality were carried out in different times by the Department of Environment (DoE), Government of Bangladesh (GoB) and the river has been declared as one of the ecologically critical areas (ECA) (DoE, Mobin, 2014).

During the dry season, the level of the water volume decreases and the condition of the water becomes worse than the wet season. The people living surrounding the river depend on the water of the Turag River in many ways such as domestic, fisheries, drinking and agricultural purposes. For these reasons, it is important to check the water quality of the Turag River. Therefore, the present study was aimed to assess water quality of Turag River beside the industrial area by measuring some standard chemical parameters.

Objective

- To determine the water quality of the Turag River.
- To compare the parameters with the standard value

2. Study Area

There are two major industrial areas in Dhaka. One is “Dhaka Export Processing Zone (DEPZ)” and the other is Tongi Heavy Industrial Area. Tongi Heavy Industrial Area it is situated beside the river Turag. Garments, Textiles, Washing, Dying, Chemicals, Oil mills, Plastic, Painting, Electronics, Poultry, Foods, Cement etc. industries are present in this area. The industries dispose of their effluent directly or indirectly in Turag River.Our study area starts from kodda bridge Gazipur to kamarpara Uttara Dhaka. The Area which is around at the latitude degree of 24.00ºN and longitude 90.34ºE.

Figure 2.1 Study Area-Station Point and Their Name

Table 2.1 Latitude and longitude of the station

Name of the station	Latitude	Longitude	Address
Station -01	23.894152	90.389231	Nishat nagar, Tongi
Station -02	23.899009	90.386806	Kathaldia ghat, Tongi
Station -03	23.897472	90.357451	Bhadam ghat, Tongi
Station -04	23.900341	90.355260	Bhakrail bridge, Tongi
Station -05	23.985143	90.325795	Kashimpur Bazar
Station -06	23.985544	90.325761	Nayapara, Kashimpur
Station -07	23.993181	90.327453	Jarun, Gazipur
Station -08	23.994286	90.328915	East jarun

3. Materials and Methods

The length of Turag River is 62.4 km. We are collecting samples from the industrial point where they throw water from their workplace. We select total 8 stations from Uttara, Dhaka to Kodda Bazar, Gazipur. Our research area was from the river bank near IUBAT to kodda bridge Gazipur. The Area we selected was about 24.30 km. We collected samples and take longitude and latitude from every station. Each Station contains three points:

1. Discharge Point: Which point from where water is discharged.
2. Contamination Point: Which point discharge water meets in river water.
3. Mid-Point: Mid-point of the river straight from the discharge point.

We did some instant tests like DO, pH, TDS, Transparency, Depth, and Temperature. Because these parameters may vary if we test them in the lab. Rest of the tests we did at our lab.

Work Flow Diagram

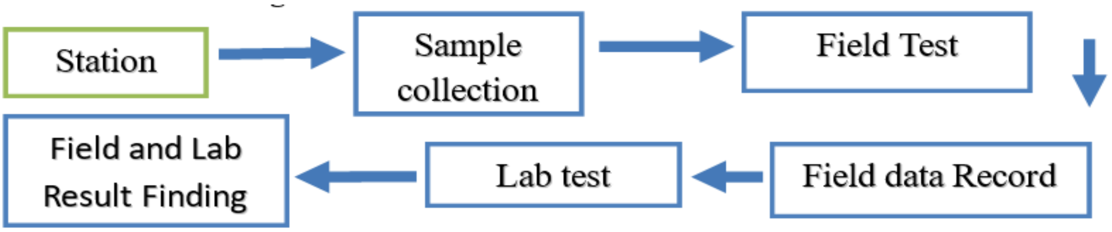

Figure 3.1 Work flow diagram

First of all, we were investigating sites from Kodda Bazar to the International University of Business Agriculture and Technology (IUBAT). Meanwhile, we selected nine stations and after that, we collected samples. While we collected the sample, some parameters need to test instant because if we wait for bringing the sample in lab it may happen that we did not get an accurate value. Then we did our lab test. From all test parameters, we got our result and did analysis of the result.

3.1 Sample Collection Process

- We selected all mineral water bottles for collecting the sample.
- We collect the sample from three points in every station. Those three points are the discharge point, contamination point, and mid-point.
- Some parameters may vary if we test them in the lab, we cannot get the accurate value that's why we tested them instantly.
- After collecting we are carrying them in the lab for performed rest of the test.

3.2 Sample Test

Some of tests we perform instantly and rest of the perform in civil engineering lab at the International University of Business Agriculture and Technology (IUBAT).

3.2.1 pH of Water

The standard range of pH for inland surface water, drinking water and irrigation water is 6.5 to 8.5 according to Bangladesh standards, FAO standards and Bangladesh Environment Conservation Rule (ADB (Asian Development Bank), 1994). pH is one among the important parameters to define water quality. pH extremes can render a river hostile to life. Immature fish and insects are especially susceptible to low pH. If pH level is less than 4 then it's tasted sour and if pH level is more than 8.5 then it tasted bitter. We test by pH meter instantly from the station. Because if we wait to check in lab, it's going to not same. Instantly we measure the worth and write it down.

3.2.2 Total Dissolved Solids.

Dissolved solids" indicate to any minerals, salts, metals, cations or anions dissolved in water. Total dissolved solids (TDS) comprise inorganic salts, principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates and a few small amounts of organic practical that are dissolved in water. Dissolved content like both organic and inorganic substances is called total dissolved solid. A suspended solid is little particle that remain as colloid or because of water transportation in suspension condition. And both dissolved and suspended solid which remain in water are called total solid. Total dissolved solid is expressed by parts per million.

3.2.3 Transparency

The transparency of water indicates to the depth that light will penetrate water. The transmission of sunshine into a body of water is extremely important since the sun is the primary source of energy for all biological phenomena. Light is vital for photosynthesis, a process that produces oxygen and food for consumers. the quantity of depth to which light may penetrate water is referred to as its transparency. Because the sun is that the major source of energy for all biological processes, light penetration into a body of water is critical. Light is required for photosynthesis, which generates oxygen and food for consumers.

Procedure:

Transparency is measured in situ at fixed stations by using a Secchi disk. The depth where the Secchi disk settles beyond visual recognition, Secchi depth, is an index of water transparency. When we went to Turag River that moment Sacchidisk enter the water until we saw the Sacchidisk then we measured the distance of visibility and got the Transparency value.

3.2.4 Temperature

Temperature is taken instantly from the station. We clean the temperature meter by distilled water before measuring every sample. Taken 200 ml sample in glass. Then enter the temperature meter into the glass and wait 10 sec. Got the value of temperature.

3.2.5 Chemical Oxygen Demand

For oxidize, organic components such as petroleum there required some dissolved oxygen and the amount of that dissolved oxygen is COD (chemical oxygen demand). It is a measure of the short-term influence of wastewater effluents on the oxygen levels of receiving waters. According to Bangladesh Environment Conservation Rules requirement of COD is 4 mg per litter for receiving water (DoE, 1997).

Procedure:

1. First we need an Erlenmeyer flask and that capacity should be 250 ml for 100 ml sample.

2. Then added 10 ml of each $KMnO_4$ and mix H_2SO_4.

3. Then we have to heat up the flask and it continued for half an hour and that heat helps speeds up the oxidation.

4. If our sample dissolution changes its color then we can understand that $KMnO_4$ has been used in the oxidation of organic materials. For this instance, we precede the same steps with 100 ml same mixed sample and add it with distilled water.

5. In the dissolution we mixed 10 ml [$(NH_4)2C_2O_4$] and heat up for half an hour. Now, this is the same as $KMnO_4$ that we mixed before.

6. For determine the amount of [$(NH_4)2C_2O_4$] that left we titration with $KMnO_4$. Titrate the flask contents with normal KMnO4 to the first pink coloring while the flask is heated. Keep track of how much potassium permanganate you used.

3.2.6 Biochemical oxygen demand

Biochemical oxygen demand is the amount of oxygen consumed by bacteria and other microorganisms while they decompose organic matter under aerobic conditions. The common lake or stream contains small amounts of oxygen in the form of dissolved oxygen (DO). Dissolved oxygen is a crucial component of natural water bodies, maintaining the aquatic life and quality aesthetic of streams and lakes.

3.2.7 Turbidity of Water

Turbidity defines as how much the water quality of being not clear. It is a large number of particles that we actually don't see with the only eye. The turbidity test is one of the main tests for water quality.

Procedure:

1.First, we have to prepare the reagents for evaluating the specified water sample. The turbidity meter must then be mark with a standard scale of reading.

2.then Fill the halfway cells with water that is sample water, wash lightly with limp tissue. Then set up the turbidity meter.

3.then we have to Check the turbidity meter for a reading. Wait until you obtain a consistent reading. According to Bangladesh Environment Conservation Rules (1997), Turbidity for receiving water is 10 NTU

4. Results and Discussion

The water color of the present study was light to dark black while the phytoplankton enriched dark greenish blue, red or brown color is good for fisheries. The study investigated bad organic odor of water which emits a noxious smell. Therefore, the water was unsuitable not only for aquaculture but also for domestic, industrial, or agricultural purposes. Table shows water quality parameters of Turag River investigated in this study the present study and the existing standards, respectively. The ranges and means of varied physicochemical parameters as well as heavy metal contents of Turag River's water are compared with the standard values of Bangladesh. The water quality of Turag River adjacent to Konabari industrial area, revealed a high level of water pollution in different aspects, when these are compared with the standard values of Bangladesh.

Table 4.1 Data of Station 1

Station	Point	Parameters	Month						Average	Standard	Reference
			Jan,22	Feb,22	Mar,22	Apr,22	Mav,22	Jun,22			
		Temperature	29.69	33.54	36.56	29.55	34.28	32.51	32.63	20 to 30 °C	EQS,1997
		pH	8.30	7.75	6.54	6.90	9.80	7.20	7.57	6.5 to 8.5	EQS,l
		DO (mg/I)	5.86	6.48	6.86	7.32	6.80	5.22	6.37	4.0 to 6.0	De,2005
	Discharge Point	BODS (mg/I)	20.42	20.54	19.34	20.48	19.25	21.23	20.27	6 ppm or less	ECR,1997
		COD (mg/I)	38.50	39.50	39.00	38.50	39.00	40.00	39	4 mg/l	DoE, 1997
		TDS (PPM)	590.00	640.00	570.00	600.45	620.00	580.00	600.00	lOOO PPM	ADB1994
		Turbidity	10.50	11.24	13.25	10.54	10.60	11.21	11.2	10 JTU	Bangladesh
		Transparency	4.20	4.60	4.70	5.10	3.60	5.40	4.60	l5.75 or less	Rahman,1992
		Temperature	29.10	31.21	30.13	30.60	32.48	29.80	30.63	20 to 30 °C	EQS,1997
		pH	8.21	7.56	8.23	7.52	6.27	7.60	7.66	6.5 to 8.5	EQS,l997;Das,l997
	Contamination Point	DO (mg/I)	5.90	5.35	5.30	5.40	5.18	5.09	5.31	4.0 to 6.0	De,2005
		BODS (mg/I)	20.31	19.75	20.35	19.51	19.60	19.86	19.94	6 ppm or less	ECR,1997
1		COD (mg/I)	32.00	34.60	34.60	34.56	31.80	30.50	33	4 mg/l	DoE, 1997
		TDS (PPM)	570.00	580.00	480.00	650.00	595.00	610.00	580.00	lOOO PPM	ADB1994
		Turbidity	9.70	10.65	9.60	8.56	9.48	9.50	9.54	10 JTU	Bangladesh
		Transparency	4.60	5.17	4.27	4.30	4.58	4.40	4.54	15.75 or less	Rahman,1992
		Temperature	30.52	29.80	28.64	29.45	27.80	27.20	28.83	20 to 30 °C	EQS,1997
		pH	9.60	8.60	8.00	7.80	7.20	6.54	7.97	6.5 to 8.5	EQS,l
		DO (mg/I)	5.25	4.90	5.75	5.20	5.10	5.18	5.14	4.0 to 6.0	De,2005
	Mid Point	BODS (mg/I)	20.60	21.50	20.80	20.50	22.40	20.60	21.06	6 ppm or less	ECR,1997
		COD (mg/I)	35.00	32.00	30.50	31.00	34.00	35.50	33	4 mg/l	DoE, 1997
		TDS (PPM)	620.00	550.00	600.00	595.00	580.00	595.00	590.00	lOOO PPM	ADB1994
		Turbidity	11.25	10.95	9.56	10.10	11.50	9.40	10.45	10 JTU	Bangladesh Standard

From this Table 4.1 it is visible that the average value of DO and temperature is not in acceptable limit according to the standard limit at the discharge point which is 6.37mg/l and 32.53°C, at the contamination point the average value of DOis in acceptable limit but the temperature is higher than the acceptable limit which is 5.31 mg/l (De, 2005)and 30.63°Cand at the midpoint the average value of DO and temperature is inacceptable limit which is 5.14mg/l and 28.83°C. That indicates in the matter of DO at the station 1midpoint is more contaminated than the discharge point and contamination point. Now, pH is in the acceptable limit. The value of pH is 7.58 at the discharge point where the standard limit of pH is 6.5 to 8.5 (EQS, 1997). At the contamination point and midpoint are respectively 7.66 and 7.97. This indicates that the water quality of station 1 is slightly alkaline. Where BOD5is required to be in 6 PPT or less than that in station 1 at all the points the BOD5 is way higher which is 20.27, 19.94 and 21.06 mg/l. The COD value is higher than the permissible limit which is 39, 33 and 33 mg/l. The permissible limit of COD for drinking purposes is within 4 mg/L (DoE, 1997). The same scenario can be seen in the case of turbidity. In the case of TDS, it is less than the standard limit.

Table 4.2 Data of Station 2

Station	Point	Parameters	Month						Average	Standard	Reference
			Jan,22	Feb,22	Mar,22	Apr,22	May,22	Jun,22			
2	Discharge Point	Temperature (°C)	27	25.1	28	27.89	28.87	30.42	30.71	20 to 30 °C	EQS,1997
		pH	8	6.96	8.43	7.84	8.23	7.87	8.15	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	5.87	6.7	5.73	5.42	4.3	4.6	4.05	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	19.5	21.32	20.47	20.36	21.44	22.47	22.46	6 ppm or less	ECR,1997
		COD (mg/l)	39	40	39	40	42	45	41	4 mg/l	DoE, 1997
		TDS (PPM)	560	440	940	660	670	840	866.00	1000 PPM	ADB1994
		Turbidity	13.34	12.7	13.72	12.7	13.25	14.12	13.31	10 JTU	Bangladesh Standard
	Contamination Point	Transparency (inc)	2.7	1.6	5	4.85	2	2.6	3.13	15.75 or less	Rahman,1992
		Temperature (°C)	30	24.2	27	30.1	30.1	28.5	28.32	20 to 30 °C	EQS,1997
		pH	7.4	6.86	7.23	7.87	8	8	7.56	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	4.4	6.1	4.96	7.1	5.2	6.5	5.71	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	16.5	16.2	19.36	21.45	20.12	23.41	19.51	6 ppm or less	ECR,1997
		COD (mg/l)	27	24	31	30	33	37	30	4 mg/l	DoE, 1997
		TDS (PPM)	550	340	830	800	610	900	671.67	1000 PPM	ADB1994
		Turbidity	9.36	9.4	10.24	11.2	12.55	11.4	10.69	10 JTU	Bangladesh Standard
	Mid Point	Transparency (inc)	2.7	3.3	4.57	5.62	4.62	4.12	4.16	15.75 or less	Rahman,1992
		Temperature (°C)	27	29.3	27	28.42	29.3	31.24	28.71	20 to 30 °C	EQS,1997
		pH	7.52	7.54	7.7	6.57	6.22	7.14	7.12	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	4.3	6.1	5.73	4.85	3.87	5.23	5.01	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	17.21	18.86	20.14	22.14	21.12	22.47	20.32	6 ppm or less	ECR,1997
		COD (mg/l)	28	32	34	42	29	42	35	4 mg/l	DoE, 1997
		TDS (PPM)	600	490	650	670	720	880	668.33	1000 PPM	ADB1994
		Turbidity	8.35	12.74	13.19	12.43	12.54	13.4	12.11	10 JTU	Bangladesh Standard

Table 4.3 Data of Station 3

Station	Point	Parameters	Month						Average	Standard	Reference
			Jan,22	Feb,22	Mar,22	Apr,22	May,22	Jun,22			
3	Discharge Point	Temperature (°C)	29	26.3	31.6	37.9	34.7	29.6	31.52	20 to 30 °C	EQS,1997
		pH	7.69	8.27	8.73	8	8.5	7.8	8.17	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	4.2	5.3	5.41	5.32	7.1	5.5	5.47	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	21.66	29.33	23.1	31.12	22.14	28.47	25.97	6 ppm or less	ECR,1997
		COD (mg/l)	43	57	46	62	44	52	51	4 mg/l	DoE, 1997
		TDS (PPM)	930	730	970	520	650	640	740.00	1000 PPM	ADB1994
		Turbidity	15.52	7.19	14.36	12.52	8.97	13.47	12.01	10 JTU	Bangladesh Standard
	Contamination Point	Transparency (inc)	5.21	5	4.7	3	6	5.23	4.86	15.75 or less	Rahman,1992
		Temperature (°C)	27	26.1	30.8	37.4	32.4	28.4	30.35	20 to 30 °C	EQS,1997
		pH	8.47	8.43	8.56	8.4	8.2	8	8.34	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	4.8	5.8	6.42	4.31	6.1	4.7	5.36	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	19.4	23.28	24.5	27.23	24.44	26.44	24.22	6 ppm or less	ECR,1997
		COD (mg/l)	32	30	38	51	40	53	41	4 mg/l	DoE, 1997
		TDS (PPM)	800	720	900	690	550	420	680.00	1000 PPM	ADB1994
		Turbidity	13.74	13.25	12.21	12.88	12.54	13.25	12.98	10 JTU	Bangladesh Standard
	Mid Point	Transparency (inc)	3	4.4	6	3.2	5.63	6.11	4.72	15.75 or less	Rahman,1992
		Temperature (°C)	28	26.1	30.3	31.6	29.7	28.3	29.00	20 to 30 °C	EQS,1997
		pH	7.99	8.6	8.56	8.1	8.1	8	8.23	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	5.2	4.3	6.12	4.1	6.5	5.7	5.32	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	18.74	21.41	19.36	24.56	25.42	21.52	21.84	6 ppm or less	ECR,1997
		COD (mg/l)	24	29	34	42	50	37	36	4 mg/l	DoE, 1997
		TDS (PPM)	770	560	940	610	410	430	620.00	1000 PPM	ADB1994
		Turbidity	13.58	13.03	13.8	13.93	12.4	13.55	13.38	10 JTU	Bangladesh Standard

Table 4.4 Data of Station 4

Station	Point	Parameters	Month						Average	Standard	Reference
			Jan,22	Feb,22	Mar,22	Apr,22	May,22	Jun,22			
4	Discharge Point	Temperature (°C)	29	30.4	31	32.2	36.5	28.2	31.22	20 to 30 °C	EQS,1997
		pH	7.78	7	7.12	7.9	8.3	7.7	7.63	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	3.1	3.9	5.4	3.2	7.5	5.7	4.80	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	21.14	25.3	23.7	26.53	22.42	20.45	23.26	6 ppm or less	ECR,1997
		COD (mg/l)	42	50	40	49	44	52	46	4 mg/l	DoE, 1997
		TDS (PPM)	940	900	800	510	550	600	716.67	1000 PPM	ADB1994
		Turbidity	6.23	6.47	7.12	5.24	6.34	8.47	6.65	10 JTU	Bangladesh Standard
	Contamination Point	Transparency (inc)	3	2.7	2.5	1.4	1.5	3.53	2.44	15.75 or less	Rahman,1992
		Temperature (°C)	26.8	25.8	31.44	31.5	30.5	28.5	29.09	20 to 30 °C	EQS,1997
		pH	8.87	7.05	7.35	7.9	8.5	7.7	7.90	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	4.8	4.5	6.32	3.75	6.7	5.3	5.23	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	12.14	21.45	20.1	25.4	20.41	22.42	20.32	6 ppm or less	ECR,1997
		COD (mg/l)	20	36	38	50	30	49	37	4 mg/l	DoE, 1997
		TDS (PPM)	800	670	640	470	530	580	615.00	1000 PPM	ADB1994
		Turbidity	9.4	8.22	9.79	10.7	8.95	9.12	9.36	10 JTU	Bangladesh Standard
	Mid Point	Transparency (inc)	4	3.8	3.7	2.4	2	3.42	3.22	15.75 or less	Rahman,1992
		Temperature (°C)	27	26.1	34	31.7	29.6	28.4	29.47	20 to 30 °C	EQS,1997
		pH	7.82	7.08	7.3	7.8	8.21	7.8	7.67	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	5.2	6.9	5.7	3.1	5.6	5.1	5.27	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	14.52	21.87	19.6	22.6	24.12	21.11	20.64	6 ppm or less	ECR,1997
		COD (mg/l)	22	28	37	30	48	32	33	4 mg/l	DoE, 1997
		TDS (PPM)	770	670	710	480	690	550	645.00	1000 PPM	ADB1994
		Turbidity	8.8	10.3	9.75	8.25	8.96	9.48	9.26	10 JTU	Bangladesh Standard

Table 4.5 Data of Station 5

Station	Point	Parameters	Month						Average	Standard	Reference
			Jan,22	Feb,22	Mar,22	Apr,22	May,22	Jun,22			
5	Discharge Point	Temperature (°C)	28.6	26.27	27.87	30	31.1	32.2	29.34	20 to 30 °C	EQS,1997
		pH	6.42	6.78	6.41	6.8	7.8	8.7	7.15	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	3.36	3.12	3.45	5.12	6.1	5.9	4.51	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	13.54	16.54	19.7	10.62	18.1	22.42	16.82	6 ppm or less	ECR,1997
		COD (mg/l)	27	31	39	21	32	39	32	4 mg/l	DoE, 1997
		TDS (PPM)	620	660	640	500	420	910	625.00	1000 PPM	ADB1994
		Turbidity	12.65	13.12	12.63	11.55	11.42	14.54	12.65	10 JTU	Bangladesh Standard
	Contamination Point	Transparency (inc)	3.6	3.14	3.2	4	6	4.52	4.08	15.75 or less	Rahman,1992
		Temperature (°C)	29	29.6	28	29.3	29.7	28.7	29.05	20 to 30 °C	EQS,1997
		pH	7.32	7.62	7.41	7.2	7.7	8.1	7.56	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	4.3	4.37	4.52	4.98	5.8	5.6	4.93	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	12.87	14.54	18.5	18.63	19.45	20.11	17.35	6 ppm or less	ECR,1997
		COD (mg/l)	20	23	37	34	31	36	30	4 mg/l	DoE, 1997
		TDS (PPM)	600	580	620	440	380	680	550.00	1000 PPM	ADB1994
		Turbidity	12.11	13.21	13.24	11.83	12.12	13.14	12.61	10 JTU	Bangladesh Standard
	Mid Point	Transparency (inc)	2.88	3.14	3.21	4.6	6	4.23	4.01	15.75 or less	Rahman,1992
		Temperature (°C)	26.7	28	29.1	31	28	28.3	28.52	20 to 30 °C	EQS,1997
		pH	7.11	7.63	7.41	7.2	8	8.7	7.68	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	4.8	4.63	4.54	5.134	5.9	4.8	4.97	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	12.6	16.2	18.62	12.12	20.1	21.41	16.84	6 ppm or less	ECR,1997
		COD (mg/l)	18	29	35	22	37	42	31	4 mg/l	DoE, 1997
		TDS (PPM)	560	590	600	410	450	720	555.00	1000 PPM	ADB1994
		Turbidity	9.16	11.62	10.14	11.64	12.47	12.1	11.19	10 JTU	Bangladesh Standard

Table 4.6 Data of Station 6

Station	Point	Parameters	Month						Average	Standard	Reference
			Jan,22	Feb,22	Mar,22	Apr,22	May,22	Jun,22			
6	Discharge Point	Temperature (°C)	30	31.9	35.7	36.2	34.1	29	32.82	20 to 30 °C	EQS,1997
		pH	7.72	7.13	9.2	8.2	8.2	6.7	7.86	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	4.3	4.5	4.42	4.1	3.8	4.11	4.21	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	14.09	21.21	21.4	27.8	22.75	21.41	21.44	6 ppm or less	ECR,1997
		COD (mg/l)	28	38	42	55	42	44	42	4 mg/l	DoE, 1997
		TDS (PPM)	410	900	1100	1090	1075	640	869.17	1000 PPM	ADB1994
		Turbidity	12.11	12.93	13.74	15.92	15.82	12.15	13.78	10 JTU	Bangladesh Standard
	Contamination Point	Transparency (inc)	3	8	4	2	3.54	2.41	3.83	15.75 or less	Rahman,1992
		Temperature (°C)	31	27.6	35.3	33.5	29.8	28.5	30.95	20 to 30 °C	EQS,1997
		pH	7.81	7.77	8.45	8.3	8.2	8.2	8.12	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	5.6	2.6	4.52	2.5	6.8	3	4.17	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	13.55	27.43	23.48	29.4	26.3	24.3	24.08	6 ppm or less	ECR,1997
		COD (mg/l)	27	50	43	58	49	40	45	4 mg/l	DoE, 1997
		TDS (PPM)	920	880	1020	940	770	900	905.00	1000 PPM	ADB1994
		Turbidity	14.85	10.3	15.14	16.74	14.88	13.03	14.16	10 JTU	Bangladesh Standard
	Mid Point	Transparency (inc)	3.4	7	7	3	2.12	4.23	4.46	15.75 or less	Rahman,1992
		Temperature (°C)	27	23.8	35.1	30.4	28.1	28.3	28.78	20 to 30 °C	EQS,1997
		pH	7.42	7.57	8.4	8.4	7.6	8.7	8.02	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	4.1	4.7	3.2	2.5	6.2	4.8	4.25	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	16.42	30.42	24.63	31.5	24.12	21.41	24.75	6 ppm or less	ECR,1997
		COD (mg/l)	28	60	33	52	48	34	43	4 mg/l	DoE, 1997
		TDS (PPM)	920	360	840	400	420	720	610.00	1000 PPM	ADB1994
		Turbidity	14.6	12.35	12.61	12.61	12.14	13.1	12.90	10 JTU	Bangladesh Standard

Table 4.7 Data of Station 7

Station	Point	Parameters	Month						Average	Standard	Reference
			Jan,22	Feb,22	Mar,22	Apr,22	May,22	Jun,22			
7	Discharge Point	Temperature (°C)								20 to 30 °C	EQS,1997
		pH								6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)								4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)								6 ppm or less	ECR,1997
		COD (mg/l)								4 mg/l	DoE, 1997
		TDS (PPM)								1000 PPM	ADB1994
		Turbidity								10 JTU	Bangladesh Standard
	Contamination Point	Transparency (inc)	3.1	11	4	6	6	3.44	5.59	15.75 or less	Rahman,1992
		Temperature (°C)	27	24.3	35.5	36.1	34.5	29	31.07	20 to 30 °C	EQS,1997
		pH	7.38	7.47	8.8	8.4	8	6.7	7.79	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	4.8	4	5.2	5.11	5.3	4.11	4.75	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	14.9	24.44	25.3	32.41	30.4	21.41	24.81	6 ppm or less	ECR,1997
		COD (mg/l)	24	30	45	57	60	36	42	4 mg/l	DoE, 1997
		TDS (PPM)	570	300	770	1030	1006	640	719.33	1000 PPM	ADB1994
		Turbidity	6.36	8.77	8.6	11.24	10.57	11.17	9.45	10 JTU	Bangladesh Standard
	Mid Point	Transparency (inc)								15.75 or less	Rahman,1992
		Temperature (°C)								20 to 30 °C	EQS,1997
		pH								6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)								4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)								6 ppm or less	ECR,1997
		COD (mg/l)								4 mg/l	DoE, 1997
		TDS (PPM)								1000 PPM	ADB1994
		Turbidity								10 JTU	Bangladesh Standard

Table 4.8 Data of Station 8

Station	Point	Parameters	Month						Average	Standard	Reference
			Jan,22	Feb,22	Mar,22	Apr,22	May,22	Jun,22			
8	Discharge Point	Temperature (°C)								20 to 30 °C	EQS,1997
		pH								6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)								4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)								6 ppm or less	ECR,1997
		COD (mg/l)								4 mg/l	DoE, 1997
		TDS (PPM)								1000 PPM	ADB1994
		Turbidity								10 JTU	Bangladesh Standard
	Contamination Point	Transparency (inc)	3	8.2	9	6.87	2.3	2.41	5.30	15.75 or less	Rahman,1992
		Temperature (°C)	29	24.1	28.3	29.74	27.8	28.5	27.91	20 to 30 °C	EQS,1997
		pH	7.2	7.37	7.6	6.74	8.3	8.2	7.57	6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)	5.6	6.7	4.3	4.65	5.4	3	4.94	4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)	13.21	23.77	20.14	24.16	26.45	24.3	22.01	6 ppm or less	ECR,1997
		COD (mg/l)	23	33	40	38	50	30	36	4 mg/l	DoE, 1997
		TDS (PPM)	310	400	600	640	810	900	610.00	1000 PPM	ADB1994
		Turbidity	9.57	12.14	13.81	16.52	15.87	16.43	14.06	10 JTU	Bangladesh Standard
	Mid Point	Transparency (inc)								15.75 or less	Rahman,1992
		Temperature (°C)								20 to 30 °C	EQS,1997
		pH								6.5 to 8.5	EQS,1997;Das,1997
		DO (mg/l)								4.0 to 6.0 ppm	De,2005
		BOD5 (mg/l)								6 ppm or less	ECR,1997
		COD (mg/l)								4 mg/l	DoE, 1997
		TDS (PPM)								1000 PPM	ADB1994
		Turbidity								10 JTU	Bangladesh Standard

From the sample, we tested for some water quality parameters and compare them with standard values. The outcome gained on some physicochemical parameters of the Turag stream water data and Industrial tributary. The merit of pH of the researched industrial data from eight stations are between 7.11 to 8.34. Those values remain between the standard values. For the TDS we took water data from eight stations that were between 488.33 to 905 ppm. The standard drinking value of Total Dissolved Solid is 1000 ppm. Because of the research we can audited that the concentrations of Total Dissolved Solid were between the acceptable limit. High Total Dissolved Solid values indicate the presence of a considerable number of bicarbonates, sulfates and chlorides of Cesium, Magnesium and Sodium. Enough stocks of dissolved Oxygen DO is necessary for the living of water-born organisms. Dissolved oxygen (DO) is required for waste wane and gangrene by microorganisms. The grade of DO of the explored manufacturer data is between 4.14 to 6.36 mg/l. Depending on the research, those grades we measured from the Turag stream are between the standard grades. The Biochemical oxygen demand of all obtained data from eight locations was between 16.24 to 26.54. Where the standard value is 6 or less. There is huge disparity from ideal value and this disparity is because of different manufacturing companies built beside the Turag stream. That’s why biological oxygen demand is very poor. All the data obtained from nine stations were between the temperatures 27.91 to 32.82°C and mean temperature is 29.26 degrees. The lowest data we found at station eight. The standard temperature for a hydrophytes’ life is 20 to 30 degrees for all seasons. It indicates that some points of Turag stream’s temperature are not in between the standard limit. Surface water temperature can be affected by elements such as geographical places, seasonality, diurnal period, air circulation, cloud cover amount, depth of water, and flow rate. The audited transparency data was taken from nine stations and found the value between 1.5 to 8 ft. It indicates the presence of pollutants in water. Standard value of transparency is 15.75.

4.1 Comparison between standard values with the observed value.

4.1.1 The pH value:

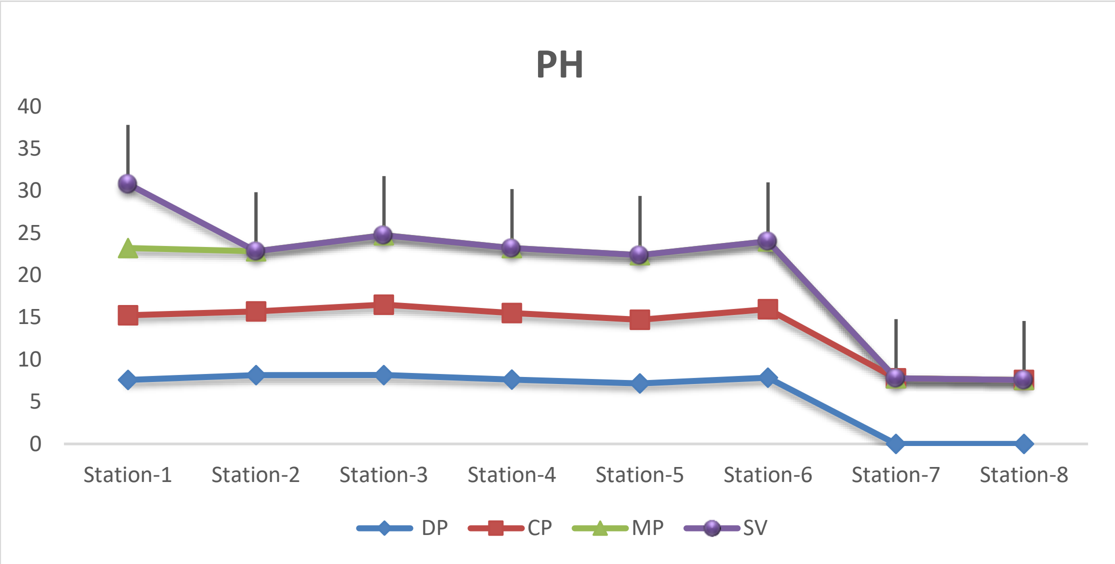

Figure 4.2 The pH value

The values of PH of the analyzed industrial samples are within the range of 6.5 to 8.5. This value remains within the Bangladesh standard. pH value of the rivers additionally within the tolerable limit. The pH value varied from 7.12 to 8.34 which is within the permissible limit for diverse uses like irrigation, domestic and recreational, consistent with the standard value of DoE (pH 6.5 to 8.5). The normal range for pH in surface water systems is 6.5 to 8.5 and for groundwater systems 6 to 8.5. pH greatly affects biological activity. It also affects some properties of the water body, the activity of organisms and the effects of toxic substances present within the aquatic environment.

In the station one, the average PH value of discharge point nearly under the marginal line means the PH value 7.4 to 7.5 it is permissible but why is this value, we clarify this we know that the value of PH getting less vice versa of it becoming alkaline, in the station one, the industry directly produces the waste water to the river and becoming the water alkaline. In our research we found that the value of PH is same due to the seasonal period because of this point directly through the water in the river and we collect the water at just mouth the discharge point so there is no chance for mixing the flood or rainfall water, therefore the PH value nearly same accordingly to January to June. In the station one, the average PH value of contamination point nearly over the marginal line means the PH value 7.7 to 7.9 it is permissible but why is this value, if we clarify this we know that the value of PH getting larger vice versa of its becoming acidic, in the station one, the industry directly produce the waste water to the river and mixing the waste water with the river water. In our research we found that the value of PH is nearly same due to the seasonal period because of this point mixing through the water in the river and we collect the water at just mixing at the contamination point so, there is chance for mixing the flood or rainfall water, therefore the PH value nearly above and changeable due to the accordingly to January to June. In the station one, the average PH value of midpoint over the marginal line means the PH value 8.2 to 8.4 it is permissible but why is this value, if we clarify this we know that the value of PH getting larger vice versa of its becoming acidic, in the station one, the industry directly produce the waste water to the river and mixing the waste water with the river water. In our research we found that the value of PH is not same due to the seasonal period because of this point mixing through the water in the river and we collect the water at just after mixing at the midpoint so, there is very chance for mixing the flood or rainfall water, therefore the PH value more above and changeable due to the seasonal variation.

4.1.2 The DO value:

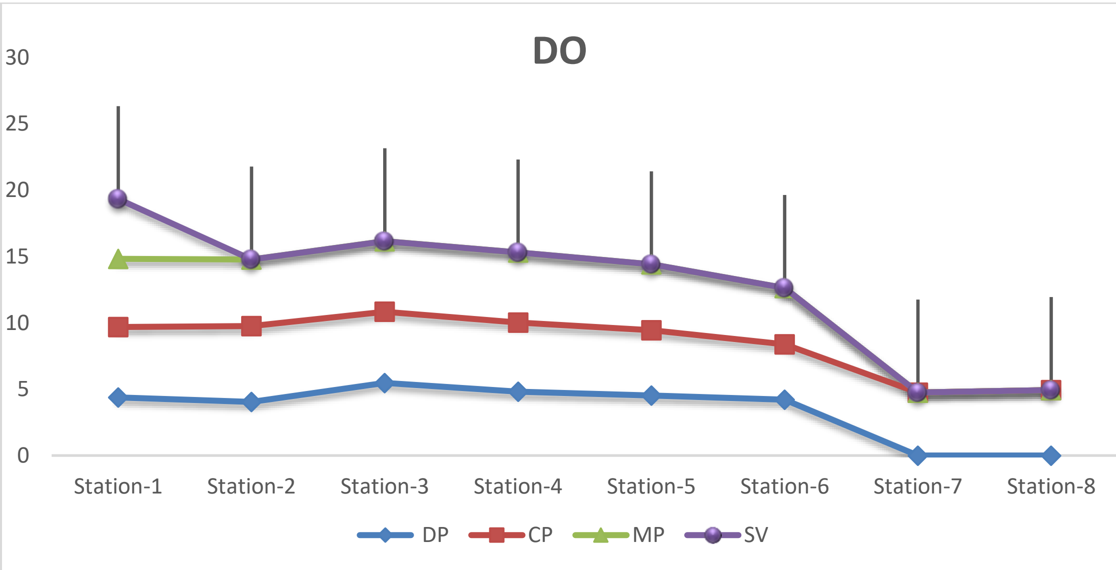

Figure 4.3 The DO value

The supply of dissolved oxygen is essential for the survival of the aquatic organism. Dissolved oxygen (DO) is needed for waste degradation and decomposition by microorganisms. Fish in water containing excessive dissolved gases may suffer from "gas bubble disease"; however, this is a very rare occurrence. The bubbles or emboli block the flow of blood through blood vessels causing death. On the other hand, the decrease of dissolved oxygen concentration is dangerous for aquatic life. The value of DO of the analyzed industrial samples are within the range of 4.14-6.36. In chemical industries DO value is lower than the standard. But in other conditions DO value is higher. DO value of the river is also lower than the Bangladesh standard. Dissolve oxygen (DO) values are found in the range of 4.14 to 6.36 mg/L. According to the environmental quality standard (EQS), the following requirements for DO are prescribed 6 mg/L for drinking, 4 to 5 mg/L for recreation, 4 to 6 mg/L for fish and livestock and 5 mg/L for industrial application. According to of environment (DoE), the following requirements for DO are prescribed 6 or more mg/L for drinking, 4 to 8 mg/L inland surface water. For irrigation its value is 5 or more.

In the station one, the value of DO in discharge point is 4.5 mg/l. the standard value of DO according to the DoE, are prescribed 6 or more mg/L for drinking water, 4 to 8 mg/L inland surface water. For irrigation its value is 5 or more. According to the environmental quality standard (EQS), the following requirements for DO are prescribed 6 mg/L for drinking, 4 to 5 mg/L for recreation, 4 to 6 mg/L for fish and livestock and 5 mg/L for industrial application. Here in station one at discharge point the value of DO is not fulfill the standard value because this waste water is not treated accurately. We collect the sample just at mouth of the discharge point so there in no possible to mixing the flood water and rainfall so that the value come inaccurate.

4.1.3 The BOD value:

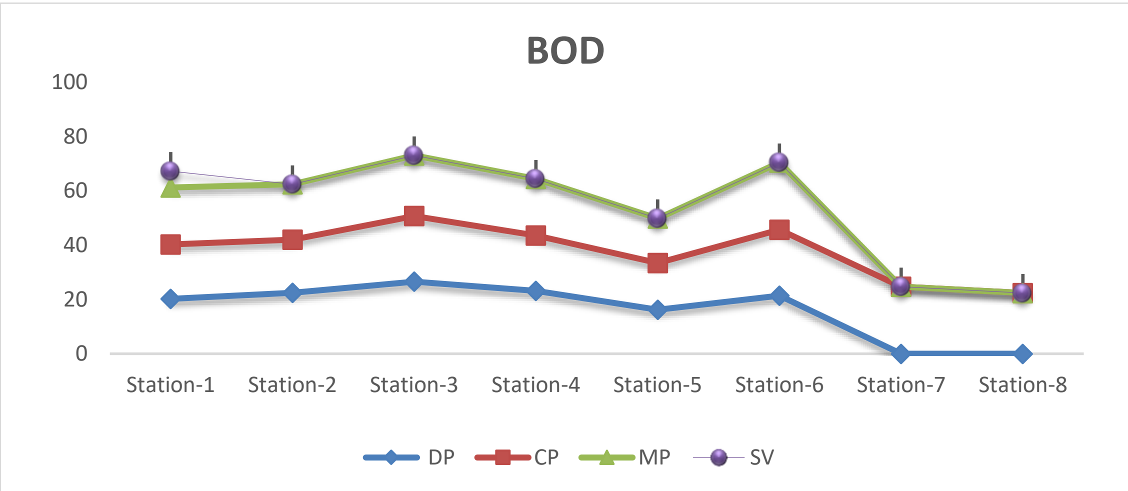

Figure 4.4 The BOD value

When BOD levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by the bacteria. Since less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive. If there is no organic waste present in the water, there would not be as many bacteria present to decompose it and thus the BOD will tend to be lower and the DO level will tend to be higher. The value of BOD of in the industrial sample ranges from 16.24 to 26.54. Higher BOD values were found in station 3 of the Turag River. The values BOD ranged from 16.24 to 26.54 mg/L. The permissible limit for BOD for drinking water is 0.2 mg/L, for recreation 3 mg/L, for fish 6 mg/L and 10 mg/L for irrigation. (Bangladesh standard) (DoE, Department of Environment, 1991, 1997). The biological oxygen demand (BOD) was high because most of the industries are situated near the bank of the river. They discharge organic material from sewage treatment works, storm overflows, domestic wastewater human waste, food waste and industrial wastewater from tannery, textile and food processing industries, agricultural slurry, and silage liquor. Moreover, municipal waste materials directly or within the sewerages are dumped into the bank of the river.

In the station one, discharge point, contamination point and midpoint are nearly same BOD value at 20 mg/l and the value is so more from standard value. In that figure we mentioned the average value of 6-month sequence data of BOD. The permissible limit for BOD for drinking water is 0.2 mg/L, for recreation 3 mg/L, for fish 6 mg/L and 10 mg/L for irrigation but found the BOD value at the station one on an average 20 mg/l which is very harmful for drinking, recreation, pisciculture and irrigation. for the reason we confirmed that when, When BOD levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by the bacteria. Since less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive. If there is no organic waste present in the water, there would not be as many bacteria present to decompose it and thus the BOD will tend to be lower and the DO level will tend to be higher.

4.1.4 The COD value:

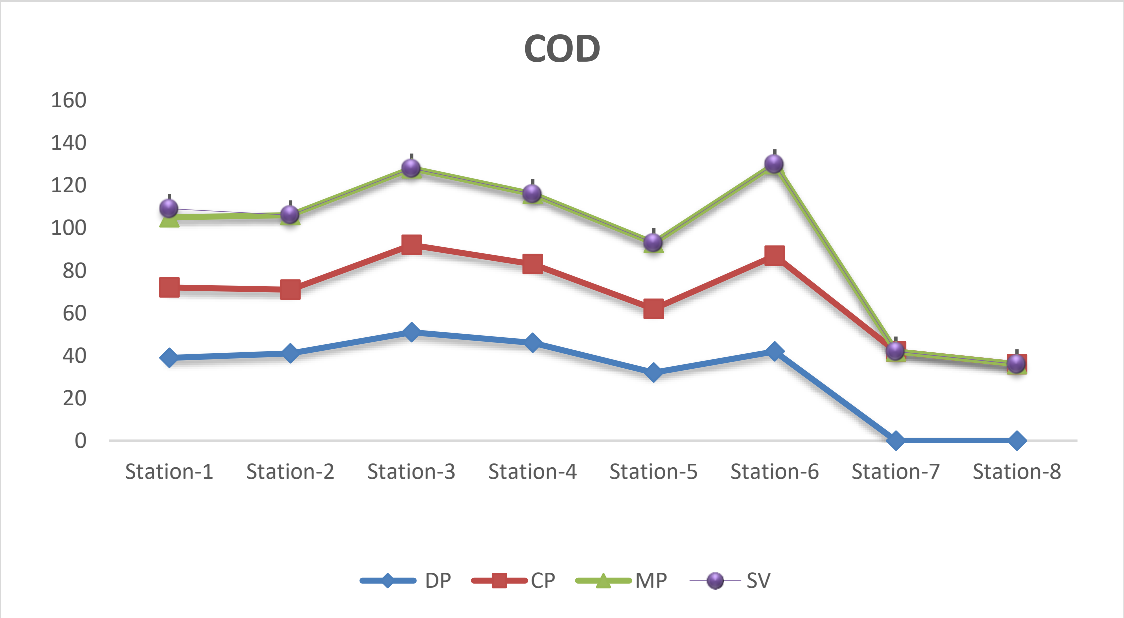

Figure 4.5 The COD value

The mean COD concentration in the present study varied between 30 and 51 mg/L, which was higher than the permissible limit of COD. This might be due to the industrial and municipal discharge loads. Additionally, organic chemical industries, pesticide industries, distilleries, and dyeing factories deteriorate the COD pollution in the river water. The permissible limit of COD for drinking purposes is within 4 mg/L according to the standards of DoE (1997), and DPHE (2019). USEPA (2012) determines the irrigation standard at 200 mg/L. It can be stated that the Turag River water was inappropriate for drinking as well as for agricultural purposes. The highest COD concentration in the Turag River was 51 mg/L at the station 3 discharge point, and the lowest was 30 mg/L at station 2 & 5 midpoints.

In station one, at the discharge point we got 6 months on an average value of COD is 39 mg/l. the whole period of research we observed that the discharge point COD mostly same as seasonal variation because of the discharge point from where we collect the sample are same. However, in that station the COD value is not permissible for drinking and irrigation process. The permissible limit of COD for drinking purposes is within 4 mg/L according to the standards of DoE (1997), and DPHE (2019). USEPA (2012) determines the irrigation standard at 200 mg/L. So in this point need to treat the waste water before forsake in the river. In station one, at the contamination we got 6 months on an average value of COD is 35 mg/l. the whole period of research we observed that the contamination point COD mostly changeable as seasonal variation because of the contamination point from where we collect the sample are not same at some time because of river water level ups and down and related industry some time off their activity. However, in that station the COD value is not permissible for drinking and irrigation process. The permissible limit of COD for drinking purposes is within 4 mg/L according to the standards of DoE (1997), and DPHE (2019). USEPA (2012) determines the irrigation standard at 200 mg/L. So in this need to treat the waste water before forsake in the river. In station one, at the midpoint we got 6 months on an average value of COD is 35 mg/l. the whole period of research we observed that the midpoint COD mostly changeable as seasonal variation because of the contamination point from where we collect the sample are not same at sometime because of river water level ups and down and sometime flood water mixing up with this. However, in that station the COD value is not permissible for drinking and irrigation process. The permissible limit of COD for drinking purposes is within 4 mg/L according to the standards of DoE (1997), and DPHE (2019). USEPA (2012) determines the irrigation standard at 200 mg/L. So, in this point need to treat the waste water before forsake in the river.

4.1.5 The TDS value:

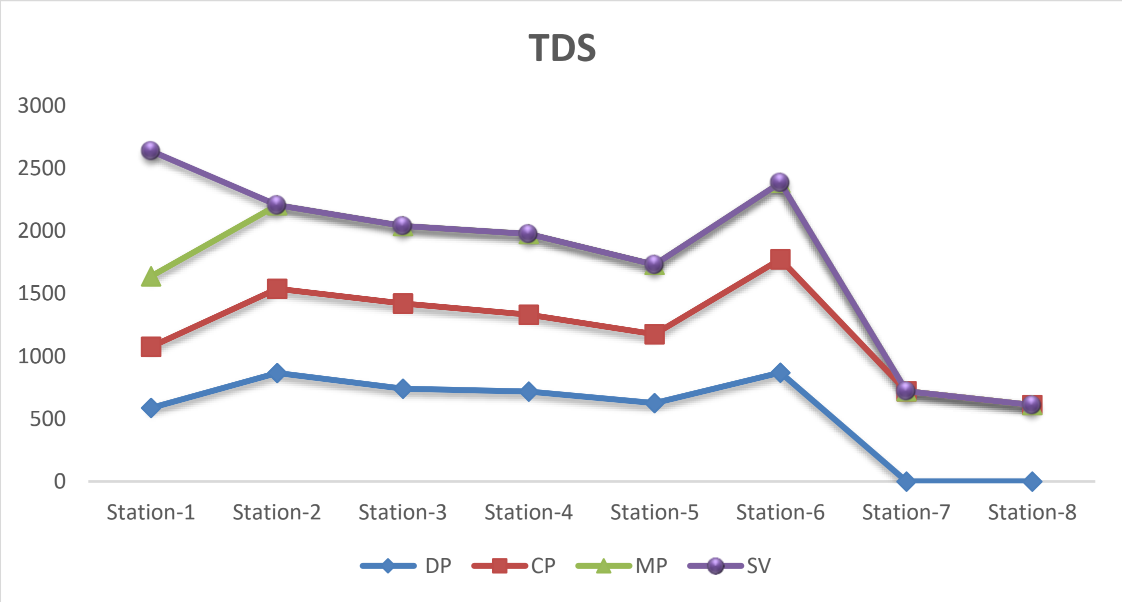

Figure 4.6 The TDS value

The total dissolved solids (TDS) mainly indicate the presence of various kinds of minerals like ammonia, nitrite, nitrate, phosphate, alkalis, some acids, sulphates and metallic ions etc. which are comprised both colloidal and dissolved solids in water. It is also an important chemical parameter of water. TDS values of the river water are within the standard. Some TS & TDS values are within the standard in different industries. The TDS values of the study area lies between 580 and 655 mg/L.

In station one, at discharge point the observed TDS value is nearly 600 ppm. Standard TDS value for drinking water 50 to 300 ppm. Excellent for drinking, 50 to 150 ppm. If TDS level over 1000 ppm it will be the unsafe and unfit for human consumption. So, this station we can see the TDS value is not perfect for human and animal consumption. Industrial waste water have more TDS and need perfect R.O method (Reverse Osmosis) and distillation, the process of boiling in the ETP plant. In station one, at contamination point the observed TDS value is nearly 580 ppm. Standard TDS value for drinking water 50 to 300 ppm. Excellent for drinking, 50 to 150 ppm. If TDS level over 1000 ppm it will be the unsafe and unfit for human consumption. So, this station we can see the TDS value is not perfect for human and animal consumption. Industrial waste water has more TDS and need perfect R.O method (Reverse Osmosis) and distillation, the process of boiling in the ETP plant. In station one, at midpoint the observed TDS value is nearly 590 ppm.

Standard TDS value for drinking water 50 to 300 ppm. Excellent for drinking, 50 to 150 ppm. If TDS level over 1000 ppm it will be the unsafe and unfit for human consumption. So, this station we can see the TDS value is not perfect for human and animal consumption. Industrial waste water has more TDS and need perfect R.O method (Reverse Osmosis) and distillation, the process of boiling in the ETP plant.

5. Conclusion

From the above study it can be concluded that most of the industrial pollutants are directly or indirectly discharged into Turag River. Turag river is polluted by industrial effluent, untreated sewage, wastewater, oil dumping, silt, encroachment etc. Pollutants entering the water body are both in solid and liquid forms. It could be concluded that pollution of Turag water reached critical point with increasing tendency day by day. Consequently, in order to decrease pollution from various sources appropriate steps must be taken immediately. If the necessary steps are not taken, very soon it would be a source danger point for water pollution. This study has revealed that the industries are involve in serious environmental hazard. Therefore, urging advising the government to do constant monitoring to reduce the level of pollution of the Turag River.

Author Contributions: Conceptualization, MD.A.T.; Formal Analysis, MD.A.T; Writing—Original Draft Preparation, H.A.R.; Writing—Review and Editing, H.A.R.; Visualization, H.A.R.; M.R.[1]; M.R.[2]; Supervision, H.A.R.; M.R.[1]; All authors have read and agreed to the published version of the manuscript.

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