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Determination of water quality index of Indraprastha estate region and the vicinity area in Delhi, India

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ABSTRACT

Water quality index (WQI) expresses overall water quality at a certain location and time, based on several water quality parameters reducing great amount of parameters to a number that expresses the acceptability of water to the user. In the present study an attempt has been made to determine the water quality index of industrial outlet and along river Yamuna in Delhi, India. For calculating the WQI, the following eleven parameters were considered: pH, electrical conductivity, total dissolved solids, salinity, dissolved oxygen, biological oxygen demand, total hardness, calcium, magnesium, total alkalinity and chloride. A disturbing observation was the level of dissolved oxygen in Yamuna River at Nizamuddin drain which was found to be nil. The water quality index of gas turbine station outlet was 202.9136 and that of thermal power plant outlet was 207.869. The water quality index of Yamuna River at Nizamuddin drain was found to be the maximum at 262.555 indicating very high level of pollution. The present study revealed that Yamuna River was in a critical condition and the extent of pollution was extremely high .

KEYWORDS

Water quality index | Yamuna | Nizamuddin drain | Dissolved oxygen

CITATION

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Introduction

Rapid industrial development in the last few decades has added huge loads of pollutants to our rivers. Water pollution is a major problem in India. The main causes of water pollution include discharge of industrial effluents, municipal sewage, oil spills, introduction of fertilizers and chemicals and mining. Discharge activities contribute the highest to water pollution. Only about 10% of the waste water generated is treated; the rest is discharged as it is into our water bodies. Due to this, pollutants enter into groundwater, rivers and other water bodies (Hindustan Times, March 2013).

River Yamuna is the largest tributary of River Ganga. The total length of Yamuna River from its origin at Saptrishi Kund to its confluence with Ganga at Allahabad is 1376 km traversing through Uttaranchal, Uttar Pradesh, Himachal Pradesh, Haryana, Rajasthan, Madhya Pradesh and NCT – Delhi. The main stream of river originates from the Yamunotri glacier (Saptrishi Kund) near Bander punch peaks in the Mussoorie range of the lower Himalayas in Uttarkashi district of Uttaranchal (Rani et al., 2013). Yamuna acts as the life line for the majority of the cities like Yamuna Nagar (Haryana), Panipat, Sonipat, Delhi, Noida, Faridabad, Mathura and Agra. There are unlimited numbers of industrial units, draining immense amount of untreated water in Yamuna existing in Delhi, Faridabad, Mathura and Agra. CPCB had estimated that there were approximately 359 industrial units, which directly or indirectly discharge their effluents in Yamuna (Misra, 2010).

It is estimated that about 92% of Yamuna river water is used for irrigation (CPCB, 2006). The river water is also used for bathing & washing. It is one of the most important uses of river water in the country. The river water is also used for washing clothes and utensils by nearby communities, and by the poor inhabitants along the banks. The cattle in most of the towns & villages are taken to the river for drinking and bathing. Agricultural runoff is also one of the main sources of contamination in the Yamuna River, which directly or indirectly affects river water quality through, ground and surface water runoff. Dumping of solid waste and garbage is one of the major problems in Yamuna River. Majority of people in small cities and towns do not have sanitation facilities. Thus most of the people use river catchment areas for defecation, which causes pathogenic and organic contamination in the river. People also have the habit of dumping unburnt bodies of human beings and animals into the river. Due to excessive industrialization and urbanization, river Yamuna especially in Delhi, Mathura and Agra has now become a drain. The water pollution of the river has gained large heights and it is necessary to develop awareness among masses, education and improved watershed management that will improve the water quality of this holy river (Misra, 2010; Matta, 2010; Matta, 2014).

Water quality index is a unit less number on a scale of 0 to 100. It provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters. The objective of water quality index is to turn complex water quality data into information that is acceptable and usable by the public (Yogendra and Puttaiah, 2008). There is no single measure that can describe overall water quality for any one body of water. Although there is no globally accepted composite index of water quality, some countries and regions have used, or are using, aggregated water quality data in the development of water quality indices.

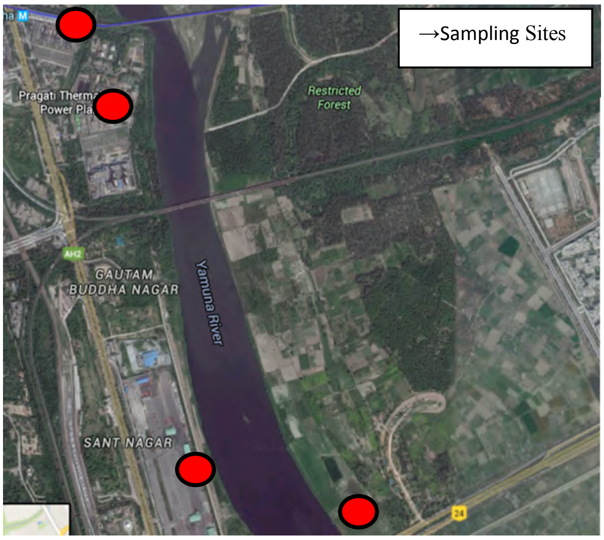
The present study is intended to determine the water quality index in vicinity of industries and along river Yamuna in Delhi. It also tries to make an attempt to assess the extent of pollution in the vicinity of industries.

Materials and methods

Study Area

Delhi, capital city of India, is a mega-metropolis situated on the banks of the river Yamuna. Yamuna River passing through 22 km in Delhi was once described as the lifeline of the city, but today it has become one of the dirtiest rivers in the country. According to the latest status of water quality in India (2007) released by CPCB the

Yamuna water quality at Okhla and Nizamuddin bridges has been described as the worst affected. In the present study three samples were collected each from the outlet of Gas Turbine Power Station (W1, W2, W3), outlet of Pragati Thermal Power Plant (W4, W5, W6), Yamuna river water from Nizamuddin Drain (W7, W8, W9), Ground Water near Nizamuddin Bridge (W10, W11, W12), Pond water near Nizamuddin Bridge (W13, W14, W15). The samples collected were analysed for Temperature, pH, Electrical conductivity (EC), Total Dissolved Solids (TDS), Salinity, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Total Hardness, Calcium, Magnesium, Alkalinity, Chloride, Sodium, Potassium. Physico-chemical analysis of the wastewater and river water was conducted by referring Standard Methods for the Examination of Water and Wastewater; APHA, AWWA and WEF, 21st Edition, 2005. All the results are compared with standard limits recommended by WHO (2004) and BIS (2003).



Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables (Kumar et al. 2015). The method has been widely used by the various scientists (Matta *et al.,* 2017; 2018) and the calculation of WQI was made by using the following equation:

$$WQI = \frac{\sum Q_i W_i}{\sum W_i}$$

The quality rating scale (Q_i) for each parameter is calculated by using this expression:

$$Q_i = 100 \left[\frac{(V_i - V_o)}{(S_i - V_o)}\right]$$

Where,

V_i = estimated concentration of i parameter in the analysed water

V_o = the ideal value of this parameter in pure water

V_0 = 0 (except pH =7.0 and DO = 14.6 mg/l)

$$W_i = \frac{K}{S_i}$$

S_i = recommended standard value of i parameter

The unit weight (W_i) each water quality parameter is calculated by using the following formula:

Where, K = proportionality constant

The drinking water standards and water quality index and status are given in table I and II resp. Table 1 gives the drinking water standards and

Table 1: Drinking Water Standards

S.No.	Parameter	Standard	Agency
1	pH	6.5-8.5	ICMR/BIS
2	Electrical Conductivity(μScm^{-1})	300	ICMR
3	Total Dissolved Solids(mg/L)	500	ICMR/BIS
4	Salinity (mg/L)	40	USPHS
5	Total Alkalinity (mg/L)	200	BIS
6	Total Hardness (mg/L $CaCO_3$	300	ICMR
7	Dissolved Oxygen (mg/L)	5	ICMR
8	Biological Oxygen Demand (mg/L)	5	ICMR
9	Chloride (mg/L)	250	BIS
10	Calcium (mg/L)	75	ICMR
11	Magnesium (mg/L)	30	ICMR
12	Sodium (mg/L)	200	WHO
13	Potassium (mg/L)	12	WHO

Table 2 gives the water quality index and status.

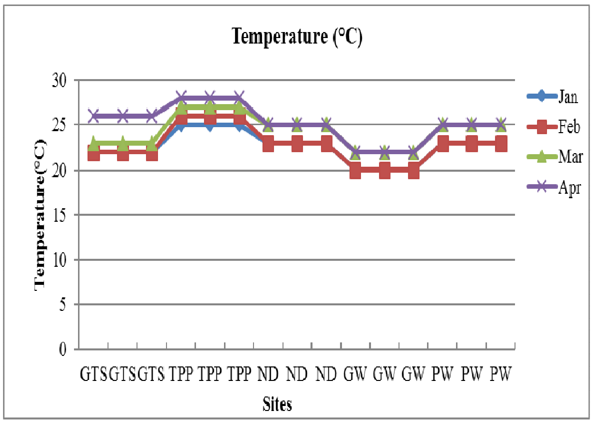
Water Quality Index	**Water Quality Status**
0-25	Excellent Water Quality
26-50	Good Water Quality
51-75	Poor Water Quality
76-100	Very Poor Water Quality
>100	Unfit for drinking

Table 2: Water Quality Index and Status (Chatterji and Raziuddin, 2007)

Results and Discussion

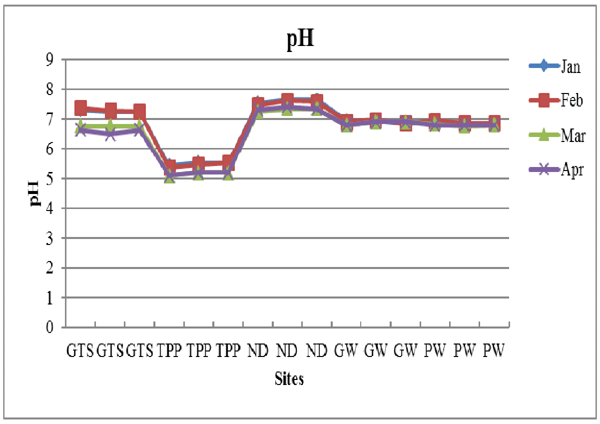
The results of the physico-chemical parameters and water quality index are given in Table 3, 4, 5, 6 and 7 resp.

Temperature is the most important physical property of surface water which determines its chemical properties. The temperature of the sites varied from 20°C to 28°C. The temperature of Yamuna river samples collected from Nizamuddin drain varied from 23°C to 25°C. The change in water



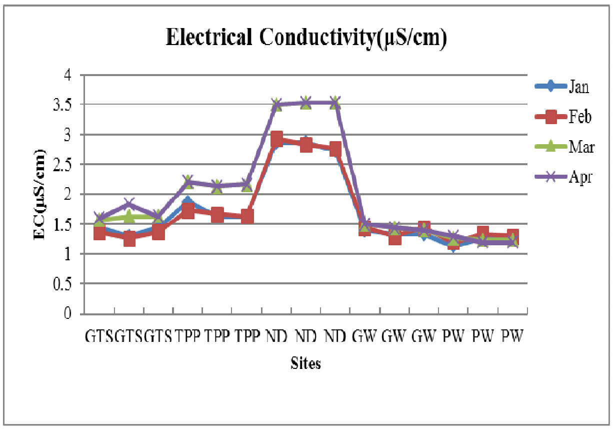
temperature could be attributed to runoff from streets, waste discharge and process waste water (Katyal *et al.*, 2012). The temperature of the effluent from thermal power plant varied from 26° C to 28°C. Kamdi *et al.*, (2012) reported that temperature of waste water is commonly high because of addition of warm water from various activities.

One of the important factors that serve as an indicator of pollution of water body is pH. The lowest value of pH 5.13±0.05 was observed at thermal power plant and the highest 7.63±0.05 at Nizamuddin drain in winter. In the summer season, the lowest was observed at thermal power plant at 5.1 and the highest 7.33±0.05 at Nizamuddin drain. The acidic nature of the industrial effluents is capable of stemming the pH of their respective receiving water bodies thereby, destabilizing fundamental properties such as alkalinity, metal solubility and hardness of water (Siyanbola *et al.*, 2011). Wang *et al.*, (2002) corroborate the fact that metabolic activities of aquatic organisms are also dependent on the pH values. The pH of



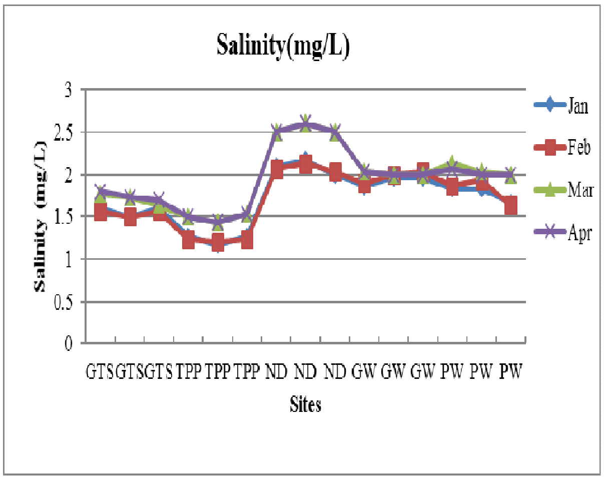
ground water and surface water are within the prescribed standards and fit for consumption.

Electrical conductivity of water is also an important parameter for determining the water quality. It is a measurement of water's capacity for carrying electrical current and is directly related to the concentrations of ionized substance in the water. Levels affected by the electrical conductivity of water are a direct function of its total dissolved solids, organic compounds and temperature (Jayalakshmi *et al.,* 2011). The lowest conductivity was that of pond water at 1.13±0.05 µS/cm and the highest was that of Yamuna River at Nizamuddin drain at 3.53±0.05 µS/cm. Natural water has low conductivity, but pollution increases it. Most of the salts dissolved in water can conduct electricity. Thus, the electrical conductivity



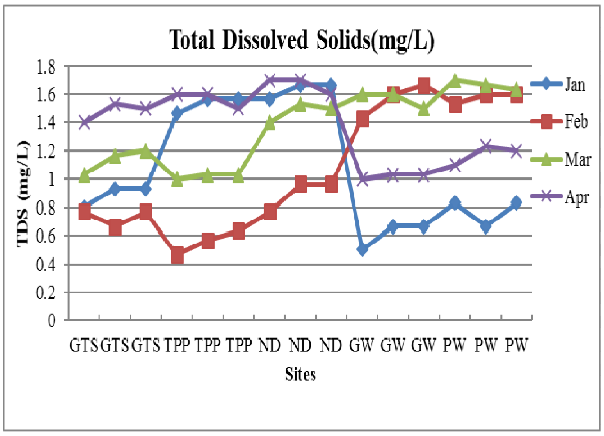
of water depends upon the concentration of ions and the status of nutrient in it (Jana *et al*., 2014).

Salinity in water is a measure of dissolved mineral salts. All water supplies naturally contain some salt, but agricultural, industrial, and residential water users often add more salt to the water they use. Too much salt in our wastewater can affect sensitive ecosystems and degrade the quality of our water supply for drinking, farming, industry, and recreation. The lowest salinity was observed at thermal power plant at 1.16±0.05 mg/



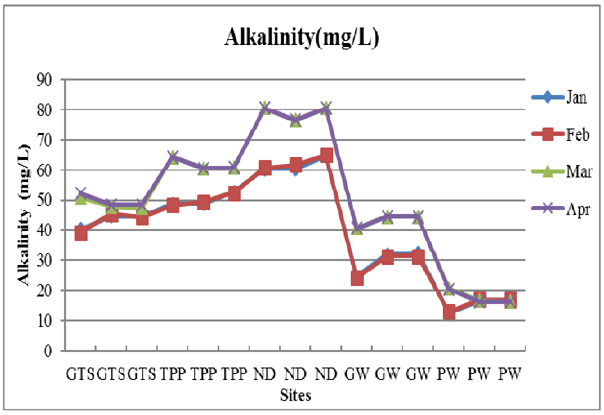
L and highest at 2.6±0.01 mg/L at Nizamuddin drain.

TDS includes dissolved solids, colloidal solids, and very small suspended particles which cannot be filtered. As the total dissolved solids values increase the conductivity values also increase (Siyanbola *et al*., 2011). Lowest TDS was that of ground water at 0.5±0 mg/L and the highest that



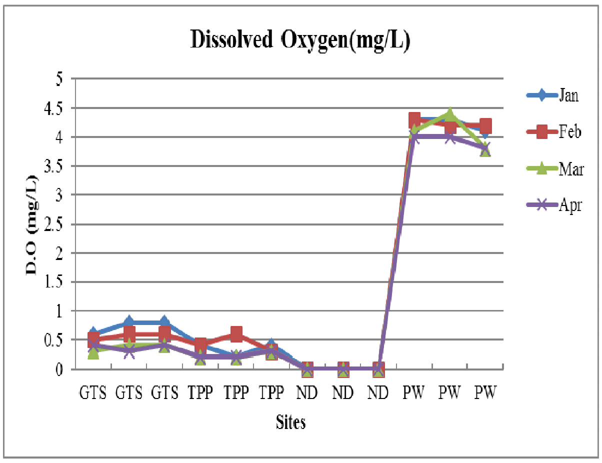
of Yamuna River at Nizamuddin drain at 2.5±0.05 mg/L.

Alkalinity denotes the acid neutralizing capacity of water. The solubility of various substances directly depends on the levels of alkalinity. Lowest alkalinity was that of pond water at 12.66±1.15



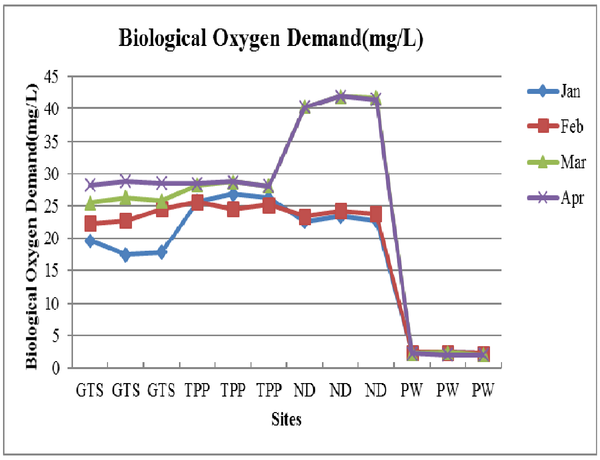
mg/L and highest that of Yamuna at 80.52±0.61 mg/L .

Dissolved Oxygen is one of the important parameter in water quality assessment. It indicates the health of water. The dissolved oxygen (DO) is one of the most important parameters of water quality assessment. Low level of DO is indicative of the polluted nature of a water body. Dissolved



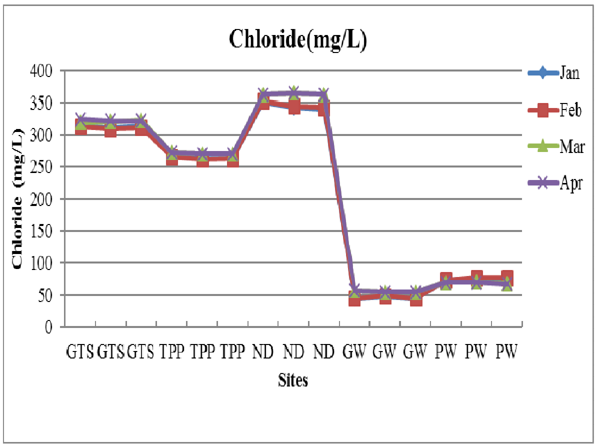
oxygen for Yamuna at Nizamuddin drain was found to be 0 mg/L. Whereas for that of pond water it was found to be 4.4 mg/L. Delhi for most of the year at all the study location sees DO level around Zero (Laxmi *et al*., 2015). Sharma and Chhabra (2015) reported that after Wazirabad the DO level starts declining drastically and most of times the DO level touches duck at different Delhi downstream sites; it may be due to Shahdara drain and Hindon River discharging discarded water at these sites. It indicates a very high level of pollution.

Biological Oxygen Demand (BOD) quantifies the amount of oxygen consumed by creatures in the river and other water bodies to decay the organic matter obtained by the industrial wastes. Higher value of BOD specifies that the level of dissolved oxygen is dipping, thereby endangering the river's aquatic species and biodiversity. It is triggered by the occurrence of elevated level of nitrate levels and organic toxins in water body (Sharma and Chhabra 2015; Matta *et al.,* 2014).



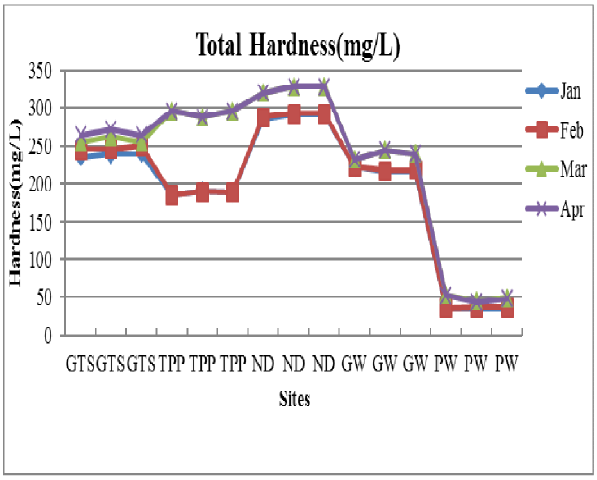
BOD varied from 2.0 mg/L in pond water to 42.0 mg/L in Yamuna River. Sharma and Chhabra (2015) reported that BOD level is between 3 and 51 mg/L from Nizamuddin Bridge to Agra downstream.

Chlorides are not utilized directly and indirectly for aquatic plant growth and hence its existence in the aquatic systems is regarded as pollution. The high content of chloride in the aquatic systems is responsible for a large amount of organic matter which in turn causes eutrophication (Lakshmi *et al*., 2011). Chlorides varied from 44.49±0.20 mg/L in ground water to 364.54±0.30 mg/L in Yamuna. The high concentration of chloride can be attributed to the mixing of industrial effluents in sewage which build up high amounts of organic and inorganic ions like chlorides. The presence of chloride in natural waters can be attributed to dissolution of salt deposits, discharges of effluents from chemical industries, oil well operations and seawater intrusion in



coastal areas. Each of these sources may result in local contamination of both surface water and groundwater.

Water Hardness is a measure of capacity of water to precipitate the soap. Soap is precipitated mainly by calcium and magnesium present in polyvalent cation and they often are in complex forms frequently with organic constituents. Total hardness is defined as the sum of calcium and magnesium concentration in mg/L (Lakshmi et

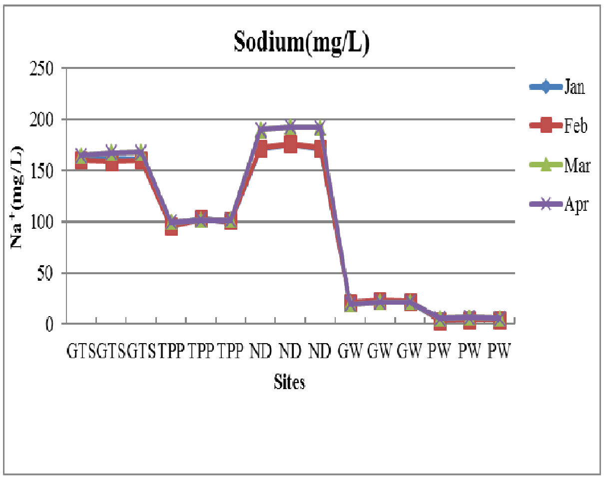


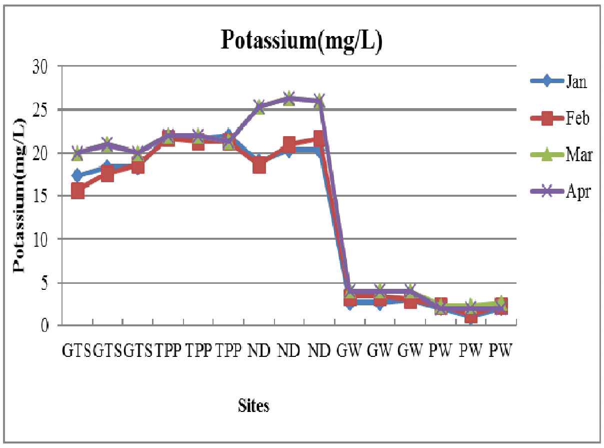
al., 2011). Total hardness varied from 36.43±0.09 mg/L in pond water to 328.59±0.26

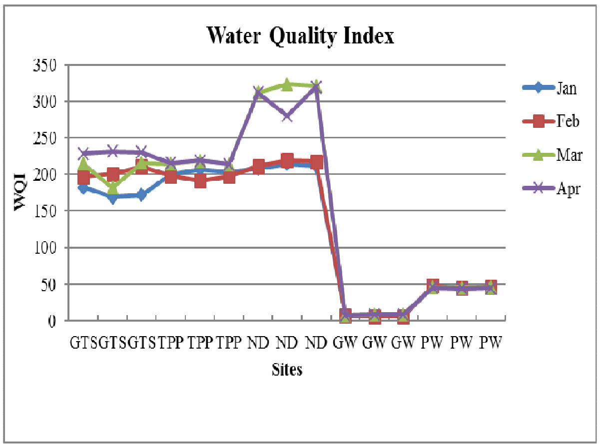
mg/L in Yamuna.

Among the major cations (Na, K, Ca^2, or Mg^2), sodium appears to be the most mobile ion leading to groundwater pollution (Grasso and Strevett, 1993). The value of sodium ranged from 5.66±0.57 mg/L in pond water to 192.66±0.5 mg/L in Yamuna. Potassium ranged from 1±0 mg/L in pond water to 22±0 mg/L in thermal power plant effluent.

Water quality index summarizes large amount of water quality data into simple terms (e.g. excel-







Sites	January	February	March	April	Mean
GTS	182.2775	196.9441	214.8907009	228.6243913	
GTS	169.1934	200.3228	181.923793	231.7884116	202.9136
GTS	171.8507	210.9109	216.0926566	230.1441083	
TPP	199.6202	197.9929	214.9001832	216.045597	
TPP	207.1733	191.7508	218.8709376	218.8712621	207.869
TPP	203.676	197.6423	213.9422149	213.942482	
ND	207.8374	211.4857	311.7278024	311.7279741	
ND	214.7139	219.7415	280.011092	323.5475238	262.5559
ND	211.3869	217.8528	319.4601589	321.1777071	
GW	6.676781	7.089972	7.265289978	7.264946457	
GW	6.567606	5.880588	8.46809497	8.467770534	7.276751
GW	6.307894	6.367437	8.482446836	8.482179653	
PW	46.80776	48.31914	45.83715713	45.40053527	
PW	45.07279	44.58456	45.29242799	44.20132939	45.63713
PW	45.5769	46.19433	45.52795244	44.83073292	

Table 3: Water Quality Index

lent, good, poor, etc.) that expresses the level of

Sites	Temp (°C)	pH	EC (µS/cm)	Salinity (mg/L)	TDS (mg/L)	Alkalinity (mg/L)	D.O (mg/L)	B.O.D (mg/L)	Chloride (mg/L)	TH (mg/L)	Ca² (mg/L)	Mg² (mg/L)	Na (mg/L)	K (mg/L)
GTS	22	7.3±0.1	1.43±0.05	1.6±0.1	0.83±0.05	40.33±0.5	0.6	19.6	314.27±0.7	235.59±0.22	50.22±0.31	26.53±0.28	161.33±0.5	17.33±0.5
GTS	22	7.23±0.05	1.3±0.1	1.5±0	0.93±0.05	44.66±1.15	0.8	17.4	310.77±0.38	239.79±0.07	49.42±0.12	25.57±0.33	162.33±0.5	18.33±0.5
GTS	22	7.23±0.05	1.43±0.05	1.6±0.1	0.93±0.05	44.66±1.15	0.8	17.8	313.69±0.51	239.79±0.41	51.62±0.36	27.45±0.34	161±0	18.33±0.5
TPP	26	5.43±0.05	1.86±0.05	1.26±0.05	1.46±0.05	48.66±1.15	0.4	25.7	266.39±0.38	186.23±0.25	49.36±0.34	17.28±0.15	96±0	22±0
TPP	26	5.53±0.05	1.63±0.05	1.16±0.05	1.56±0.05	48.66±1.15	0.2	26.8	262.57±0.21	190.50±0.24	48.5±0.26	16.48±0.36	103.66±0.5	21.66±0.5
TPP	26	5.53±0.05	1.63±0.05	1.26±0.05	1.56±0.06	52.66±1.15	0.4	26.2	263.55±0.20	188.5±0.11	49.38±0.23	17.39±0.16	100.33±0.5	22±0
ND	23	7.53±0.05	2.86±0.05	2.1±0	1.56±0.07	60.33±0.5	0	22.6	351.33±0.38	286.63±0.41	55.51±0.26	37.43±0.18	172±0	19±0
ND	23	7.63±0.05	2.86±0.05	2.16±0.05	1.66±0.05	60.33±0.5	0	23.4	342.74±0.17	292.23±0.22	54.64±0.37	36.57±0.27	175.33±0.5	20.33±0.5
ND	23	7.63±0.05	2.73±0.05	2±0	1.66±0.06	64.66±1.15	0	22.8	340.69±0.48	292.53±0.22	54.37±0.22	37.23±0.01	171.66±0.5	20.33±0.5
GW	20	6.93±0.05	1.4±0.1	1.86±0.05	0.5±0	24.66±1.15	N.D.	N.D.	44.49±0.20	222.12±0.13	58.50±0.26	14.69±0.40	22±0	2.66±0.5
GW	20	6.93±0.05	1.33±0.05	1.96±0.05	0.66±0.05	32±0	N.D.	N.D.	48.25±0.29	216.35±0.12	57.4±0.16	13.65±0.38	23±0	2.66±0.5
GW	20	6.86±0.05	1.33±0.05	1.96±0.05	0.66±0.06	32.66±1.15	N.D.	N.D.	44.85±0.71	216.65±0.38	59.46±0.20	14.34±0.03	22±0	3±0
PW	23	6.93±0.05	1.13±0.05	1.83±0.05	0.83±0.05	12.66±1.15	4.3	2.4	74.35±0.31	36.43±0.09	12.61±0.34	1.62±0.01	4±0	2±0
PW	23	6.86±0.05	1.26±0.05	1.83±0.05	0.66±0.05	16.66±1.15	4.3	2.4	77.35±0.11	36.48±0.24	11.53±0.23	1.52±0	5±0	1±0
PW	23	6.86±0.05	1.26±0.05	1.66±0.05	0.83±0.05	16.66±1.15	4.1	2.2	77.50±0.32	36.65±0.17	13.37±0.34	1.68±0	5±0	2±0

Table 4: Physico-Chemical Characteristics of Sites in January

Sites	Temp (°C)	pH	EC (µS/ cm)	Salinity (mg/L)	TDS (mg/L)	Alkalinity (mg/L)	D.O (mg/L)	B.O.D (mg/L)	Chloride (mg/L)	TH (mg/L)	Ca² (mg/L)	Mg² (mg/L)	Na (mg/L)	K (mg/L)
GTS	22	6.63±0.05	1.6±0	1.8±0.1	1.4±0	52.29±0.38	0.4	28.2	324.51±0.38	264.39±0.35	56.33±0.34	32.63±0.16	165.33±0.5 7	20±0
GTS	22	6.5±0	1.83±0.05	1.73±0.05	1.53±0.05	48.41±0.31	0.3	28.8	322.52±0.36	272.28±0.17	54.51±0.27	32.67±0.10	168±0	21±0
GTS	22	6.63±0.05	1.63±0.05	1.7±0	1.5±0	48.38±0.17	0.4	28.5	322.52±0.36	264.42±0.28	54.52±0.15	31.93±0.07	168.33±0.5	20±0
TPP	26	5.18±0	2.2±0	1.5±0	1.6±0	64.28±0.41	0.2	28.4	272.59±0.24	296.47±0.33	52.40±0.32	40.26±0.15	100±0	22±0
TPP	26	5.29±0	2.13±0.05	1.43±0.05	1.6±1	60.61±0.33	0.2	28.7	270.4±0.20	288.47±0.32	52.17±0.33	40.54±0.23	102±0	22±0
TPP	26	5.29±0	2.16±0.05	1.53±0.05	1.5±0	60.69±0.21	0.3	28	270.4±0.20	296.48±0.32	52.31±0.17	40.62±0.32	102±0	21.33±0
ND	23	7.23±0.05	3.5±0	2.5±0	1.7±0	80.52±0.61	0	40.3	362.29±0.16	320.45±0.32	86.30±0.20	27.74±0.26	190.33±0.5	25.33±0.5
ND	23	7.33±0.05	3.53±0.05	2.6±0	1.7±0	72.47±0.33	0	42	364.54±0.30	328.19±0.26	85.57±0.19	27.70±0.27	191.66±0.5	26.33±0.5
ND	23	7.43±0.05	3.53±0.05	2.5±0	1.6±0	80.47±0.26	0	41.5	362.29±0.16	328.09±0.26	85.67±0.07	21.93±0.06	191±0	26±0
GW	22	6.8±0	1.5±0	2.03±0.05	1±0	40.70±0.55	N.D.	N.D.	57.51±0.31	232.38±0.21	69.5±0.31	16.37±0.19	20±0	4±0
GW	22	6.9±0	1.43±0.05	2±0	1.03±0.05	44.42±0.30	N.D.	N.D.	55.01±0.31	244.38±0.16	68.67±0.49	16.65±0.26	22±0	4±0
GW	22	6.9±0	1.4±0	2±0	1.03±0.06	44.41±0.28	N.D.	N.D.	55.31±0.31	240.35±0.34	69.5±0.31	16.65±0.26	22±0	4±0
PW	25	6.8±0	1.3±0	2.06±0.05	1.1±0	20.43±0.32	4	2.2	70.30±0.24	52.44±0.38	15.47±0.25	2.53±0.05	6±0	2±0
PW	25	6.8±0	1.2±0	2±0	1.23±0.05	16.38±0.23	3.8	2.2	70.30±0.24	44.51±0.27	14.94±0.06	2.62±0.08	7±0	2±0
PW	25	6.8±0	1.2±0	2±0	1.2±0	16.41±0.29	4	2	68.49±0.22	48.62±0.32	15.58±0.13	2.73±0.21	6±0	2±0

Table 5: Physico-Chemical Characteristics of Sites in February

Sites	Temp (°C)	pH	EC (µS/cm)	Salinity (mg/L)	TDS (mg/L)	Alkalinity (mg/L)	D.O (mg/L)	B.O.D (mg/L)	Chloride (mg/L)	TH (mg/L)	Ca² (mg/L)	Mg² (mg/L)	Na (mg/L)	K (mg/L)
GTS	23	6.76±0.11	1.56±0.05	1.76±0.11	1.03±0.05	50.88±0.87	0.3	25.5	319.18±0.34	254.72±0.53	55.33±0.66	32.63±0.16	165.33±0.57	20±0
GTS	23	6.96±0.56	1.63±0.05	1.73±0.05	1.16±0.05	47.86±0.35	0.4	26.3	320.86±0.84	262.28±0.17	52.51±0.27	32.67±0.10	168±0	21±0
GTS	23	6.76±0.05	1.63±0.05	1.63±0.05	1.2±0	47.38±0.94	0.4	25.8	323.19±0.79	254.42±0.28	52.18±0.71	31.93±0.07	168.33±0.57	20±0
TPP	27	5.15±0	2.2±0	1.5±0	1±0	64.28±0.41	0.2	28.2	272.59±0.24	296.47±0.33	296.47±0.33	40.26±0.15	100±0	22±0
TPP	27	5.22±0.1	2.13±0.05	1.43±0.05	1.03±0.05	60.61±0.33	0.2	28.7	270.4±0.13	288.47±0.31	52.17±0.33	40.54±0.23	102±0	22±0
TPP	27	5.2±0	2.16±0.05	1.53±0.05	1.03±0.05	60.69±0.21	0.3	28	270.42±0.20	296.48±0.32	52.31±0.17	40.62±0.32	102±0	21.33±0.57
ND	25	7.33±0.05	3.5±0	2.5±0	1.4±0	80.22±0.61	0	40.3	362.19±0.16	320.15±0.32	86.30±0.20	27.74±0.26	190.33±0.57	25.33±0.57
ND	25	7.23±0.05	3.23±0.05	2.6±0.1	1.53±0.05	76.17±0.33	0	42	364.24±0.30	328.19±0.26	85.57±0.19	27.70±0.27	192.66±0.57	26.33±0.57
ND	25	7.33±0.05	3.53±0.05	2.5±0	2.5±0	80.47±0.26	0	41.8	362.29±0.16	328.5±0.26	85.67±0.07	21.92±0.04	192±0	26±0
GW	22	6.8±0	1.5±0	2.03±0.05	1.6±0	40.70±0.55	N.D.	N.D.	57.31±0.31	232.38±0.21	69.5±0.31	16.37±0.19	20±0	4±0
GW	22	6.9±0	1.43±0.05	2±0	1.6±0.1	44.42±0.30	N.D.	N.D.	55.21±0.31	244.38±0.16	68.67±0.49	16.65±0.26	22±0	4±0
GW	22	6.9±0	1.4±0	2±0	1.5±0	44.41±0.28	N.D.	N.D.	55.11±0.33	240.35±0.34	69.5±0.31	16.65±0.26	22±0	4±0
PW	25	6.83±0.05	1.26±0.05	2.13±0.05	1.7±0	20.77±0.33	4.1	2.2	70.64±0.81	53.11±1.52	15.81±0.80	2.6±0.17	5.66±0.57	2.33±0.57
PW	25	6.76±0.04	1.23±0.11	2.03±0.05	1.66±0.05	16.71±0.71	4.4	2.4	70.97±1.39	45.84±2.54	15.61±1.18	2.69±0.10	6.66±0.57	2.33±0.57
PW	25	6.8±0	1.23±0.05	2±0	1.63±0	16.41±0.29	3.8	2	69.15±1.06	49.29±1.38	16.25±1.27	2.83±0.16	5.66±0.57	2.66±1.15

Table 6: Physico-Chemical Characteristics of Sites in March

Sites	Temp (°C)	pH	EC (µS/ cm)	Salinity (mg/L)	TDS (mg/L)	Alkalinity (mg/L)	D.O (mg/L)	B.O.D (mg/L)	Chloride (mg/L)	TH (mg/L)	Ca^2 (mg/L)	Mg^2 (mg/L)	Na (mg/L)	K (mg/L)
GTS	26	6.63±0.05	1.6±0	1.8±0.1	1.4±0	52.29±0.38	0.4	28.2	324.51±0.38	264.39±0.35	56.33±0.34	32.63±0.16	165.33±0.5 7	20±0
GTS	26	6.5±0	1.83±0.05	1.73±0.05	1.53±0.05	48.41±0.31	0.3	28.8	322.52±0.36	272.28±0.17	54.51±0.27	32.67±0.10	168±0	21±0
GTS	26	6.63±0.05	1.63±0.05	1.7±0	1.5±0	48.38±0.17	0.4	28.5	322.52±0.36	264.42±0.28	54.52±0.15	31.93±0.07	168.33±0.5	20±0
TPP	28	5.13±0	2.2±0	1.5±0	1.6±0	64.28±0.41	0.2	28.4	272.59±0.24	296.47±0.33	52.40±0.32	40.26±0.15	100±0	22±0
TPP	28	5.23±0	2.13±0.05	1.43±0.05	1.6±1	60.61±0.33	0.2	28.7	270.4±0.20	288.47±0.32	52.17±0.33	40.54±0.23	102±0	22±0
TPP	28	5.23±0	2.16±0.05	1.53±0.05	1.5±0	60.69±0.21	0.3	28	270.4±0.20	296.48±0.32	52.31±0.17	40.62±0.32	102±0	21.33±0
ND	25	7.23±0.05	3.5±0	2.5±0	1.7±0	80.12±0.61	0	40.3	362.09±0.16	320.45±0.32	86.30±0.20	27.74±0.26	190.33±0.5	25.33±0.5
ND	25	7.33±0.05	3.53±0.05	2.6±0	1.7±0	76.27±0.33	0	42	364.14±0.30	328.19±0.26	85.57±0.19	27.70±0.27	192.66±0.5	26.33±0.5
ND	25	7.33±0.05	3.53±0.05	2.5±0	1.6±0	80.27±0.26	0	41.5	362.29±0.16	328.59±0.26	85.67±0.07	21.93±0.06	192±0	26±0
GW	22	6.8±0	1.5±0	2.03±0.05	1±0	40.70±0.55	N.D.	N.D.	57.11±0.31	232.38±0.21	69.5±0.31	16.37±0.19	20±0	4±0
GW	22	6.9±0	1.43±0.05	2±0	1.03±0.05	44.42±0.30	N.D.	N.D.	55.51±0.31	244.38±0.16	68.67±0.49	16.65±0.26	22±0	4±0
GW	22	6.9±0	1.4±0	2±0	1.03±0.06	44.41±0.28	N.D.	N.D.	55.51±0.31	240.35±0.34	69.5±0.31	16.65±0.26	22±0	4±0
PW	26	6.8±0	1.3±0	2.06±0.05	1.1±0	20.43±0.32	4	2.2	70.30±0.24	52.44±0.38	15.47±0.25	2.53±0.05	6±0	2±0
PW	26	6.8±0	1.2±0	2±0	1.23±0.05	16.38±0.23	3.8	2.2	70.30±0.24	44.51±0.27	14.94±0.06	2.62±0.08	7±0	2±0
PW	26	6.8±0	1.2±0	2±0	1.2±0	16.41±0.29	4	2	68.49±0.22	48.62±0.32	15.58±0.13	2.73±0.21	6±0	2±0

Table 7: Physico-Chemical Characteristics of Sites in April

acceptability to the user. The higher the value of the index, lower the quality of water. The water quality index of Yamuna River at Nizamuddin drain was found to be the maximum at 262.5559. Water quality index of the effluent discharged from gas turbine power station was 202.9136 and that of thermal power plant was 207.869.

Conclusion

The present study revealed that Yamuna River is in a critical condition and the extent of pollution is extremely high. All the discharge activities contribute the highest to its pollution. DO was observed to be zero in Yamuna at Nizamuddin drain which is a great concern for aquatic life. With fast urbanization & industrialization the generation of wastewater has taken a phenomenal growth. Due to paucity of resources the wastewater is not being treated adequately before disposal to Yamuna River which can be a threat for ground water. However the ground water and nearby pond water are not that affected and are fit for consumption.

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