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Determination of physico-chemical properties and selected heavy metals in ponds of Durg (CG)

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ABSTRACT: Five different ponds samples were collected from Durg district of Chhattisgarh in India, which is located just east of the Shivnath River and is part of a larger urban area that also includes Bhilai, 4 miles (6 km) to the east. North latitude is between- 20° 23 'and 22° 02'; and Eastern longitude is between- 80°46 'and 81°58' Meaning at sea level above altitude - 317.00 meters. The samples were tested for various physiochemical parameters and heavy metals i.e. pH, electrical conductivity (EC), alkalinity, TDS, chloride, ammonia, nitrate, fluoride, residual chlorine, lead and iron. Parameters like pH, alkalinity, chloride and residual chlorine are found to be in permissible range in all sampling sites. EC value is in range of 199.9 µS/cm-1500 µS/cm, total dissolve solids ranges from 119.9 – 900 mg/kg, fluoride range from 1- 1.5 µS/cm which is above permissible range. The concentration of iron ranged from 0.008 mg/l to 0.9846 mg/l. The values recorded at PWS2 (0.9846 mg/l) and PWS4 (0.5495 mg/l) were far higher than permissible limit of BIS (0.3mg/l). The concentration of lead was detected in all the samples ranged from 0.48 mg/l to 1.50 mg/l i.e. far more than the prescribed permissible limits of WHO and BIS (0.01 and 0.05 mg/l). Evaluation of NPI for physicochemical parameters indicates that the studied water is not good for drinking but suitable for commercial and irrigation purpose.

I. INTRODUCTION

Ponds are important part of urban ecosystem. Though relatively small in size, ponds perform significant environmental, social and economic functions, ranging from being a source of drinking water, recharging groundwater, acting as sponges to control flooding, supporting biodiversity and providing livelihoods [20]. According to an estimate about 70% of all the available water in our country is polluted due to the discharge of effluents from the industries, domestic waste, land and agricultural drainage [18].

The source of pollution in ponds varies from place to places, village ponds were mostly polluted by using for bathing and washing clothes, utensil and their domestic animals. In city, the pond water is mainly polluted by dumping of garbage, industrial waste and not used for a long period. A good knowledge of the chemical qualities of raw water is necessary so as to guide its suitability for use [21].

Due to increased human population, use of fertilizers in the agriculture and manmade activities and industrial effluents the natural aquatic resources are causing heavy and varied pollution in aquatic environment [16, 5, and 22]. The main aim of the present study was to assess the effect of industrialization and anthropogenic activities on pond water quality in Durg, Chhattisgarh and to assess the suitability of pond water for drinking/irrigation purpose.

II. GEOGRAPHIC LOCATION OF THE STUDY SITE

Durg district is a district situated in Chhattisgarh, India. The district headquarters is Durg. The district covers an area of 2,238 km². As of 2011 it is the second most populous district of Chhattisgarh after Raipur. It is located just east of the Shivnath River and is part of a larger urban area that also includes Bhilai, 4 miles (6 km) to the east. North latitude is between- 20 degrees 23 'and 22 degree 02'; and Eastern longitude is between- 80 degrees 46 'and 81 ° 58'. Durg gained importance as an industrial centre after the establishment of a large steel plant at Bhilai. Industries include brass working and bell-metal working, oil pressing, rice husking, and weaving. Location map of the proposed study area is given in figure 1 and 2.

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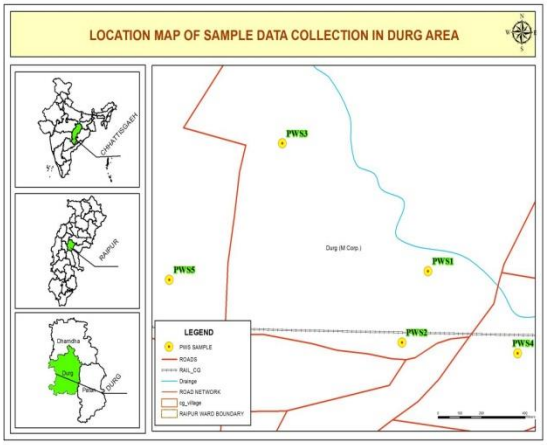
Map: 1 Location map of sampling sites in Durg



Map 2: Sampling sites superimposed on Google image

III. MATERIAL AND METHODS

All the standard solutions were prepared from analytical grade compounds of Merck Company. All the glassware used was of Borosil. Prior to all chemical analyses, the reagent bottles, beakers, and volumetric flasks were cleaned by soaking overnight in 2 N hydrochloric acid, rinsed with water and oven dried at 60°C. Instruments used in the investigation are UV VIS Spectrophotometer (Carry 100 of Varian) for the analysis of fluoride, AAS (AA 240 Varian) for iron and lead concentration and EUTECH pc510 pH and Conductivity meter was employed for all pH and EC measurements.

Pond water samples were collected from five ponds of Durg district, Chhattisgarh (India). Samples were analyzed for physico-chemical parameters including pH, electrical conductivity (EC), temperature, alkalinity , hardness, TDS, Chloride, ammonia , nitrate, nitrite, fluoride, iron, residual chlorine, lead. In the present paper, following main city ponds were selected for water quality testing; Harna bandha talab , Luchki talab, Kostha talab, Polsaypara talab, Naya talab. The samples for heavy metal analysis were collected in acid rinsed (2 N HCl) bottles then very thoroughly washed and rinsed with de-ionized water and were acidified with 1N nitric acid up to the pH > 2. Alkalinity, chloride, nitrate and residual chlorine were analyzed using TWAD Board Field Water Testing Kit, and other parameters were conducted following APHA (1995) [2].

IV.RESULT AND DISCUSSION

The values obtained for the physico-chemical characteristics of different pond water of Harna bandha talab (PWS1), Luchki talab (PWS2), Kostha talab (PWS3), Polsaypara talab (PWS4) and Naya talab (PWS5) from selected areas of Durg are reported in the table below and results are compared with standard limit recommended by Bureau of Indian Standards [6] and WHO (2004) [23].

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Table: 1 Physico-chemical characteristics of Pond Water samples at different sites (PW1 – PW6) and recommended limits of BIS and WHO

S. No.	Parameters	Sample Codes					Drinking water standards	
		PWS1	PWS2	PWS3	PWS4	PWS5	BIS	WHO
1.	Color	Clear	Clear	Clear	Clear	Clear	Clear	5Hazen
2.	Odor	None	None	None	None	None	None	Un-objectionable
3.	pH	7.8	7.5	7.7	7.8	8.0	6.5-8.5	6.5-8.5
4.	Conductivity µS/cm	199.9	583.0	1500	855.0	1240	300	NG*
5.	TDS	119.9	349.8	900.0	513.0	744.0	500	NG
6.	Alkalinity	160	100	140	120	100	200	NG
7.	Res. Chlorine	0.5	0.2	BDL	BDL	BDL	0.20	NG
8.	Chloride	80	60	140	80	120	250	250
9.	Fluoride	1.0	1.0	1.5	1.5	1.5	1.0	1.5
10.	Nitrate	100	100	45	75	75	45	50
11.	Iron	0.0080	0.9846	0.2165	0.5495	0.0583	0.3	NL*
12.	Lead	0.62	0.48	0.51	1.50	0.52	0.05	0.01

The pH value ranges from 7.5 to 8.0. The lowest value was recorded for PWS2 (7.5) and highest value was recorded for PWS5 (8.0). As per Bureau of Indian Standards, pH of all sites in the present study is as per the national standards. Electrical conductivity recorded during the study ranged from 199.9µS/cm to 1500 µS/cm with the exception of sample PWS1all the other showed EC values more than the BIS recommended values (300 mg/l). Similar results were observed by various workers [9, 14, and 19]. The high values of conductivity could be due to high ionic concentration, pollution status, tropic levels, some domestic effluents and other organic matter in water [1, 10]. The value of total dissolved solids ranges from 119.9 mg/l to 900.0 mg/l (Table 1). PWS3 (900.0 mg/l), PWS4 (513.0 mg/l) and PWS5 (744.0 mg/l) showed TDS above the values of BIS (500 mg/l). Anthropogenically, TDS is increased mostly by sewage waste, soap and detergent. It represents all the charged ions, cations and anions, as well as the uncharged and molecular species [17]. Jameel (2002) [15] also observed total dissolved solid concentration between 723 mg/l to 2918 mg/l in drinking water of Tiruchirapalli (Tamil Nadu).The highest value of alkalinity was recorded for PWS1 (160 mg/l) and lowest value was recorded for PWS2 and PWS5 (100 mg/l). All the values of the studied samples were within the recommended values of BIS. The results obtained from the present study were close conformity with the findings of Mishra et al., (2014) [17] and Arya et al. (2011) [3]. All the values of chloride for the studied samples were within the recommended values of BIS (250 mg/l). The nitrate value varies from 45 mg/l to 100 mg/l which is alarming situation the as the permissible limit is 45 mg/l.

The concentration of iron ranged from 0.008 mg/l to 0.9846 mg/l. The values recorded at PWS2 (0.9846 mg/l) and PWS4 (0.5495 mg/l) were far higher than permissible limit of BIS (0.3mg/l). The concentration of lead was detected in all the samples ranged from 0.48 mg/l to 1.50 mg/l i.e. far more than the prescribed permissible limits of WHO and BIS (0.01 and 0.05 mg/l). The increase in the lead level may indicate presence of old pipes and industrial pollution [11], effect of combustion of petrol [13] and gasoline [4]. The increased levels may cause damage to brain, kidney if taken in high concentration [12].

V.NEMEROW'S POLLUTION INDEX -NPI

Chen Jie et al., (2012) [7] intend to introduce a method by joining the improved Nemerow index method. The Nemerow index evaluation method used to analysis the quality of water. The pollution causing parameters are determined through Nemerow's pollution index using the average values of physico-chemical parameters indicated in Table 1. NPI is evaluated for all the parameters for each sample analyzed, thus identifying the pollution causing parameters. The equation used in evaluating the NPI is reproduced below:

NPI = Ci / Li,

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Where; Ci = observed concentration of i parameter
Li = permissible limit of i parameter.
In above expressions unit of Ci and Li should be identical. Each value of NPI shows the relative pollution contributed by single parameter. It has no units. Li values for different water quality parameters are indicated in Table 1. NPI value exceeding 1.0 indicate the presence of impurity in water. It indicates its presence in surplus amount in the water samples and particular parameter has the potential of contributing pollution to the water body or the underground water studied.
As per Nemerow's Pollution Index (NPI), the pollution parameters at each pond is calculated and presented in Table 2.

Table: 2 NPI values of different sampling stations

Parameters	PWS1	PWS2	PWS3	PWS4	PWS5
pH	0.918	0.882	0.906	0.918	0.941
Conductivity	0.666	1.943	5.000	2.850	4.133
TDS	0.240	0.700	1.800	1.026	1.488
Alkalinity	0.800	0.500	0.700	0.600	0.500
Res. Chlorine	2.500	1.000	-	-	-
Chloride	0.320	0.240	0.560	0.320	0.480
Fluoride	1.000	1.000	1.500	1.500	1.500
Nitrate	2.222	2.222	1.000	1.667	1.667
Iron	0.027	3.282	0.722	1.832	0.194
Lead	12.400	9.600	10.200	30.000	10.400

The analysis reveals that the quality of pond water at station 1 is polluted due to Residual chlorine, fluoride, nitrate and lead, as the NPI value of these parameters is more than 1(NPI>1). Similarly at station 2 the pollution is due to EC, Residual chlorine, fluoride, nitrate, iron, lead. At station 3, pollution is caused by EC, TDS, fluoride, nitrate, and lead. At station 4 EC, TDS, fluoride, nitrate, iron, lead were the cause of pollution and at station 5 TDS, EC, fluoride, nitrate and lead were the cause of pollution. Evaluation of NPI for physicochemical parameters indicates that the studied water is not good for drinking but suitable for commercial and irrigation purpose.

VI. CONCLUSION

Present study provides a base line data for the conservation and monitoring of the pond and can offer the requisite information for the authority to protect and conserve these small water bodies. According to the Davis and De Wiest (1966) [8] classification of pond water (Table 2) based on TDS, three out of five pond water samples are desirable for drinking (TDS <500 mg/l), three out of five is permissible for drinking (500–1,000 mg/l) and all the samples are suitable for irrigation purposes. Based on TDS values the two water samples PWS1 and PWS2 are not safe and suitable for drinking purposes but as per the values of other parameters like EC, fluoride, nitrate, iron and lead that exceeding the BIS value none of the pond water sample is suitable for human consumption. The maximum number of parameters in the studied ponds was above permissible limit prescribed drinking water standard of BIS (1993) and clearly indicates that the water is not good for human consumption.

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