PHYSICO-CHEMICAL ANALYSIS OF GROUND WATER SAMPLES OF SARGUJA DISTRICT (C.G.) INDIA

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Abstract

Water is most abundant, precious and essential compound to sustain the life on the earth. Owing to random using of the natural source continuously deteriorates the basic quality. Present study has been carried out to assess the ground water quality of the tribal and rural district; Sarguja in the Chhattisgarh state. For this purpose, we have selected ten sampling locations (site code no. SD-1 To SD-10) from all the seven blocks of Sarguja district for collection of water samples in the month of November 2022. The collected water samples are subsequently analyzed by the standard methods for some selected water quality parameters. The obtained results were compared with the standard values prescribed by the water monitoring agency WHO (2011) and BIS (2012). The experimental results were also interpreted by statistical means. The finding results for sodium is 23.3 mg/L To 134 mg/L, Potassium, 0.32 mg/L To 13.1 mg/L, Iron was seen 0.312 mg/L To 2.95 mg/L while Chromium was reported in the ranges from 0.004 mg/L To 0.027 mg/L. The concentration of Fluoride was foun 0.8 mg/L To 15.35 mg/L. The result of some parameters especially P^H value, Fluoride; and the Iron value were found above the permissible limits. The selected ground water sources are highly contaminated by the light and heavy metallic and non-metallic elements. People of study area are also suffering from different kinds of fluorosis. Therefore, the purification of the water sources by indigenous and cheapest techniques are mandatory before using of water for different human development purpose.

Keywords: Ground Water, Chromium, Fluoride, Sodium, Indigenous, P^H value.

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DOI: 10.48047/ecb/2023.12.si13.152

1. INTRODUCTION

Water is the most precious and important natural resource on the earth [1]. Life is not possible without it. About 97.2% of water on earth is salty and only 2.8% is present as fresh water in which about 20% constituents ground water [2]. Groundwater is water that occupies the pores or cervices in sand, sand stone, lime stone and other rocks [3]. Ground water is used for drinking, irrigation, industrial purposes all over the world. The importance of ground water for the existence of human society cannot be overemphasized [4]. Ground water is highly useful and often abundant resource, however over exploitation can cause major problems to human being and to the environment [5]. Discharge of industrial, agricultural and domestic wastes, land use practices, geological formation, rainfall pattern and infiltration rates affect the ground water quality and once contamination of ground water in aquifers occurs, it persists for hundreds of years because of very slow movement in them [6-9] the quality of ground water is of vital concern for mankind since it is directly linked with human welfare and sustainable development [10-12]. Therefore, the quality of ground water needs to be regularly monitored. Thus, the present study is aimed to assess the quality of ground water of Sarguja district of Chhattisgarh state of India.

Study area

Sarguja District is located in the northern part of Chhattisgarh state [13] with the geographical location between Latitude 23°37'25" to 24°6’17" N and longitude. 81° 34' 40" to 84°4’40" E. The district is biodiversity rich area dominated by tribal communities. The head quarter of district is Ambikapur. The area of the district is spread up to 5732 Km² with the population of 2359886 as per 2011 census. About 58% of the area is occupied by high dense forest. In Sarguja rainfall varies

between 100-200 cms, mean annual temperature 26°-27 °and humidity 60-80%. The district comprises rock formation of archean to Eocene age. Granitiods and the metasedimrnts belonging to the Chhotanagpur gneissic complex form the basement of overlying Gondwana sediments lameda beds and Deccan traps. These rocks are richest sources of metallic and non-metallic elements. Owing to geological features of the study field, the ground water sources are highly additive hence we have taken the extensively study of the ground water sources in perspective of physico-chemical and selected light and heavy toxic metallic and non -metallic elements.

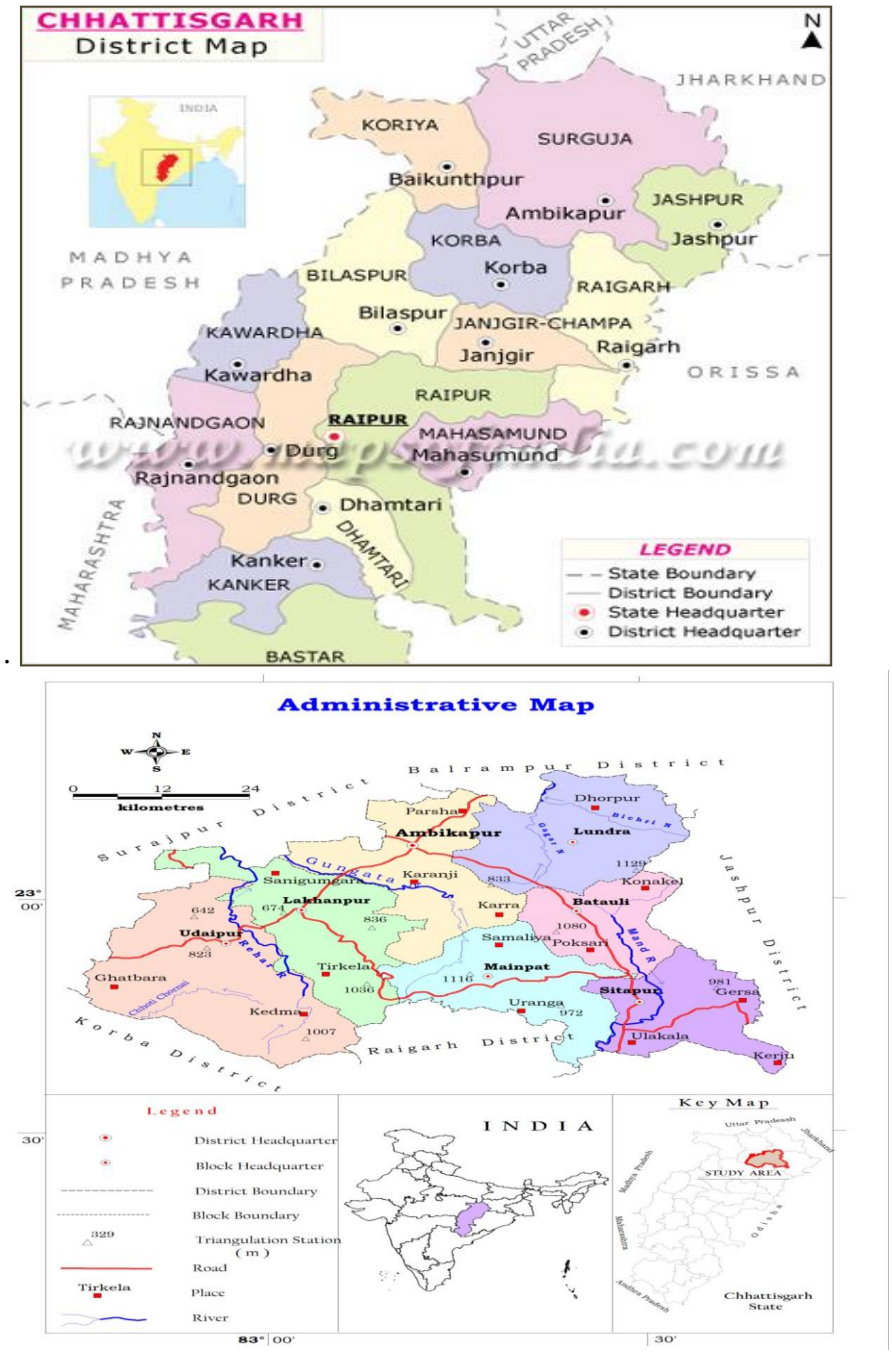

Fig: Study area of Surguja , Chhattisgarh Map

2. MATERIAL AND METHODS

Ground water samples were collected from all the seven blocks of Sarguja district. On the basis of environmental significance point of view, total ten sampling spots from ten villages of different blocks were selected from entire district after field survey and these sampling spots were assigned as SD-1 To SD-10. The samples were collected in the post monsoon session of 2022 during the month of November. Water samples were collected in pre cleaned plastic containers of 1 L capacity. The collected water samples were preserved properly by keeping in refrigerator at 4^0C and adding of con. Nitric acid.

2.1 General Procedure and Detection Method

Collected ground water Samples were analyzed for different physico-chemical parameters such as, temp., pH, electrical conductivity (EC), total dissolved solids (TDS), Turbidity, Total Alkalinity (TA), Total Hardness (TH), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Nitrate, Fluoride, Iron, Chromium, Lead, Cadmium, Chloride, Sodium, Potassium and Sulphate by using standard methods as recommended by APHA [14] , Trivedi and Goyal [15] , and NEERI manual[16] . The procured results were compared with the standard values stipulated by the BIS (2012) [17] and WHO (2011) [18] standards.

3. RESULTS AND DISCUSSION

3.1 Temperature

The temperature of the selected water samples was measured spontaneously by electronic nine parameter analyzer. The measured temperature of samples ranges from 20.2 ^{0} C (SD-8) to 21.3 ^{0} C (SD-7). Temperature is one of the most essential parameters in the water. It has significant impact on growth and activity of environmental life and it greatly affects the solubility of such as dissolved oxygen in water.

3.2 pH Value

The pH is a measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. It has no direct adverse effect on health [19]. How ever a low pH value below 4.0 will produce sour taste and normal value above 8.5 shows alkaline taste. A pH range of 6.5-8.5 is normal acceptable as per guidelines suggested by WHO. The pH value of selected water samples varied between 7.0-9.50 which showed nature of water is slightly alkaline in nature. During the study period the highest value was found 9.03 for SD-1 while lowest value was found 7.50 for SD-10.

3.3 Electrical conductivity (EC)

Electrical conductivity is a measure of water capacity to convey electrical current [20]. It signifies the amount of total dissolved solids. High EC value indicates the presence of high amount of dissolved inorganic substances in ionized form. EC values were in the range of 117 microm/cm (SD-8) to 476 microm/cm (SD-9).

3.4 Total dissolved solids (TDS)

The dissolved ions are reflux by the TDS. During the study the range were spread from minimum 75 mg L^{-1} (SD-8) to maximum 305 mg L^{-1} (SD-9). None of the sample showed above the excessive permissible limit as per BIS (2012), 500-2000 mg L^{-1} and WHO (2012), 500-1500 mg L^{-1} .

3.5 Turbidity

Measurement of turbidity reflects the transparency in water. It is caused by the substances present in water in suspension. In natural water, it is caused by clay, slit, organic matter and other microscopic organism. The prescribed limit for turbidity for drinking water is 5-10 NTU. The value of turbidity was found from 1.21 (SD-1) to 32.3 (SD-4) NTU.

3.6 Total alkalinity (TA)

The alkalinity of water is acid neutralizing capacity. It is the sum of all the titrable base. Alkalinity gives information to decide mode of treatment of water. The permissible limit as per BIS (2012) is 300-600 mg/liter and as per WHO (2011) it is 200-600 mg/liter. The concentration of total alkalinity was found within the permissible limit in all the samples.

3.7 Total Hardness (TH)

The total hardness is defined as the sum of calcium and magnesium concentration expressed both as the calcium carbonate hardness in milligrams per liter. The standard value for TH is 300-600 mg L^{-1} as per BIS 2011whereas as per WHO 100-500 mg L^{-1} . during the observation, the minimum TH was found at the sampling site no. SD-2, 9.5 mg L^{-1} while the maximum TH was found at sampling site no. SD-5,127.3 mg L^{-1}. These results indicated; the total hardness didn't get imparting in the contamination of ground water sources.

3.8 Calcium

Calcium is a major component of natural water. It dissolves from rocks and soils which cause hardness [21]. In the study area, the minimum concentration of calcium ions was found at sampling site no. SD-3, 2.28 mg L^{-1} while maximum concentration at sampling site no. SD-5, 35.72 mg L^{-1}. The acceptable range as per BIS is 75 mg L^{-1} to 200 mg L^{-1}.

3.9 Magnesium

Magnesium ions play a key role in total hardness. Magnesium generally occurs in lower concentration than calcium because of dissolution of magnesium is slow process and calcium is more abundant in earth crust [22] . At the time of investigation, the minimum value was found at sampling site SD-2, 0.46 mg L^{-1} and maximum value at sampling site SD-4, 9.23 indicating the low concentration of magnesium ions. The

acceptable range is 30 to 150 mg L^{-1} as per BIS 2011.

3.10 Sulphate (SO_4^{2-})

Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals [23]. Discharge of industrial wastes and domestic sewage tends to increase its Concentration. The Sulphate concentration varied between 12.0 mg/L (SD-8) to 156.2 mg/L(SD-10). and Found within the prescribed limit.

3.11 Nitrate (NO_3^-)

Groundwater contains nitrate due to leaching of nitrate with the percolating water. Groundwater can also be contaminated by sewage and other wastes rich in nitrates [24]. The acceptable limit for Nitrate concentration is 45 mg/L. The nitrate content in the study area varied in the range BDL (SD-2,5,6,7,9) to 15.0 mg/L (SD-10) and found within the prescribed limit.

3.12 Fluoride (F^-)

The balanced amount of fluoride ion is beneficial for human body health but in imbalance concentration it is leading to teeth and bone metabolic disorder. A concentration of up to 1.0 mg/L is desirable for dental health but higher concentration causes deleterious effect on health [25]. During observation, concentration of fluoride was found between 0.8 ppm (SD-10) to 15.35 ppm (SD-1) which is below and above the permissible limits.

3.13 Iron

Iron is a heavy metallic element and a certain amount of this metallic element is useful for blood formation. The average level is 1 mg/liter. Above this, it causes staining of laundry and ceramics ware. In our observation we have found 0.312 mg/L (SD-4) to 2.950 mg/L (SD-10) which is below and above the desirable limit.

3.14 Chloride

During the observation, the concentration of chloride was found from 26 mg/liter (SD-8) to 76 mg/liter (SD-9) which is below the permissible limit. Chloride is associated with pollution as an index, its excess concentration imparts a salty taste to water and people who are not accustomed to high chloride can be subjected to laxative.

3.15 Sodium

Sodium ion concentrations were found in between 23.3 mg/L (SD-5) to 134.0 mg/L (SD-9). Sodium ion concentration for all the investigated samples was found within the prescribed limit.

3.16 Potassium

The major source of potassium in natural water is weathering of rocks but the quantities increase due to disposal of waste water. Potassium ion concentration was found in the range of 0.32 mg/L (SD-1) to 13.1 mg/L (SD-10).

3.17 Chromium

Cr is one of the most widely distributed heavy metal in the earth's crust [26]. The acceptable limit for Cr is 0.005 mg/L. During the study period the concern. of Cr was found between 0.004 mg/L (SD-5) to 0.027 mg/L (SD-10).

3.18 Cadmium

The concentration of Cadmium was found to vary between 0.003 to 0.016 mg/liter.

3.19 Lead

During our observation, the concentration of Lead was found in the ranges of BDL to 0.15 mg/liter.

Table 1: Analytical results of selected parameters for ground water sources

Parameter	SD-1	SD-2	SD-3	SD-4	SD-5	SD-6	SD-7	SD-8	SD-9	SD-10
Temp.	21	20.3	20.4	20.9	20.7	21.0	21.3	20.2	20.8	20.6
pH	9.03	9	9	8.5	8.5	8.5	8.5	7.8	8.5	7.5
EC	304	164	320	289	390	140	250	117	476	351
TDS	195	105	205	185	250	90	160	75	305	225
Turbidity	1.21	1.94	1.27	32.3	2.32	1.46	1.32	11.29	1.59	5.06
TH	20.9	9.5	15	86	127	9.5	34	32	40	62.7
Ca^{2+}	4.56	3.04	2.28	24.32	35.72	2.28	2.28	6.84	13.28	23.56
Mg^{2+}	2.30	0.46	2.30	6.0	9.23	0.92	6.92	3.69	1.38	0.92
TA	71.07	51.86	90.38	138.31	234.36	48.02	78.76	65.31	156.68	122.94
F^-	15.35	2.09	10.83	2.08	2.10	6.37	13.68	2.10	3.94	0.80
SO_4^{2-}	31.0	80.05	54.83	20.99	68.0	24.83	18.92	12.0	48.0	156.2
Cl^-	50.0	41.0	53.0	35.0	35.0	34.0	40.0	26.0	76.0	70.0
NO_3^-	3	BDL	3	2	BDL	BDL	BDL	3	BDL	15
Fe	1.108	2.175	0.555	1.827	0.312	0.453	0.375	2.428	0.673	2.95
Na	83.6	42.7	46.4	32.8	23.3	47.4	87.2	26.9	134	106

K	0.32	1.12	1.04	1.71	1.16	0.83	0.73	0.61	1.12	13.1
Cr	0.009	0.008	0.006	0.007	0.004	0.005	0.011	0.010	0.017	0.027
Pb	BDL	0.01	BDL	0.03	0.03	0.06	0.06	0.09	0.10	0.15
Cd	0.008	0.007	0.008	0.003	0.006	0.002	0.014	0.015	0.016	0.004

Except Temperature (^{0}c), pH, EC (micromhos/cm), Turbidity (NTU), all parameters have been measured in mg/L

Table-2 Statistical analysis of selected parameters of ground water samples

PARAMETER	MIN.	MAX.	MEAN	SD	SE	CV(%)
Temp.	20.3	21.3	20.72	0.349	0.110	1.684
pH	7.5	9.03	8.48	0.502	0.159	5.918
EC	117	476	280.10	114.668	36.261	40.938
TDS	75	305	179.50	73.464	23.231	40.927
Turbidity	1.21	32.3	5.98	9.763	3.087	163.371
TH	9.5	127.3	43.70	38.011	12.020	86.981
Ca^{2}+	2.28	35.72	11.82	11.996	3.793	101.520
Mg^{2}+	0.46	9.23	3.41	2.994	0.947	87.744
TA	48.02	234.36	105.77	58.243	18.418	55.066
F^-	0.8	15.35	5.93	5.397	1.707	90.957
SO_4^{2-}	12	136.2	49.48	37.901	11.985	76.595
Cl	26	76	46.00	16.289	5.151	35.411
NO_3^-	BDL	15	5.20	5.495	2.458	105.682
Fe	0.312	2.95	1.29	0.976	0.309	75.905
Na	23.3	134	63.03	37.450	11.843	59.416
K	0.32	13.1	2.17	3.857	1.220	177.425
Cr	0.004	0.027	0.01	0.007	0.002	66.339
Pb	BDL	0.15	0.07	0.046	0.016	68.906
Cd	0.003	0.016	0.01	0.005	0.002	60.920

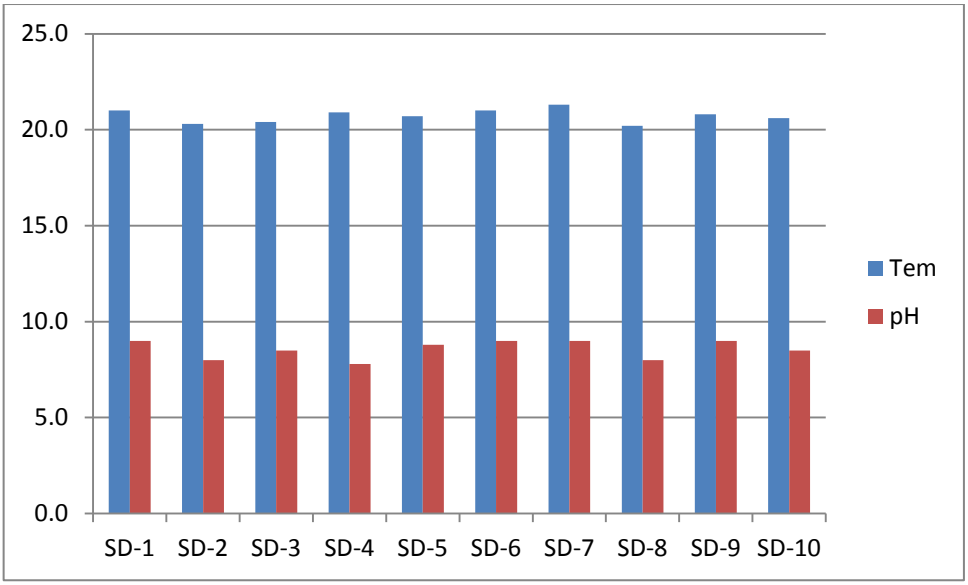

Figure 1. Variation of Temp. And pH at different sampling spots

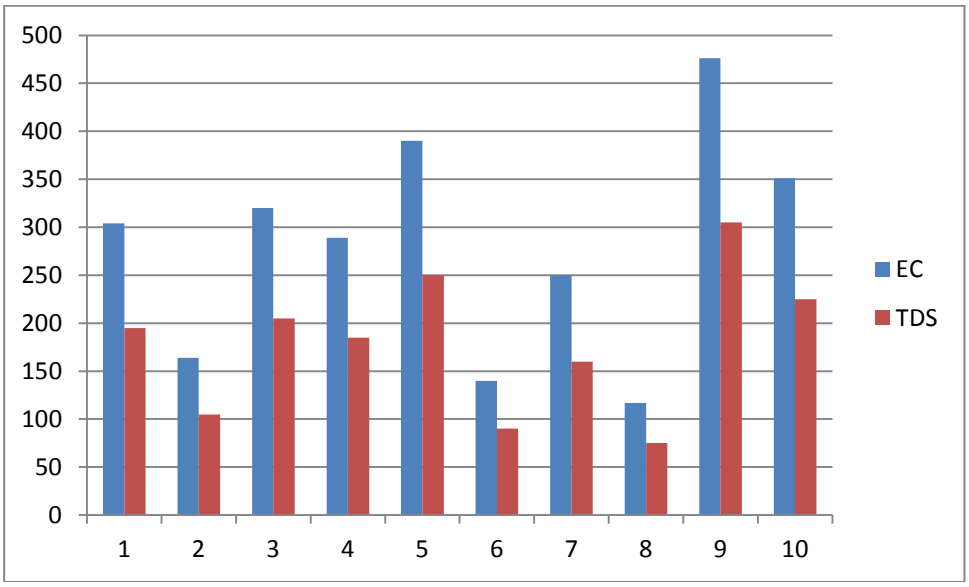

Figure 2. Variation of EC and TDS at different sampling spots

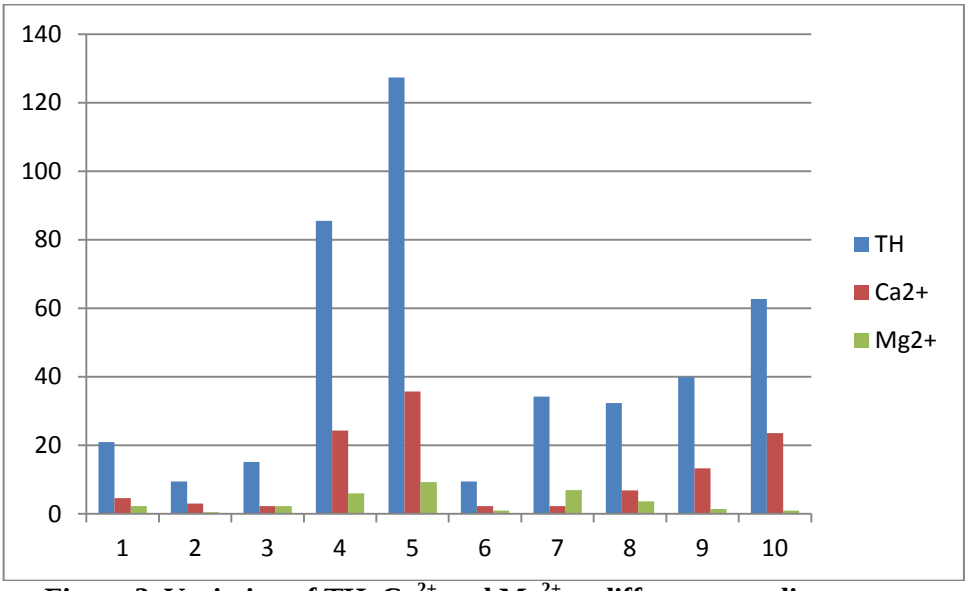

Figure 3. Variation of TH, Ca^{2+} and Mg^{2+} at different sampling spots

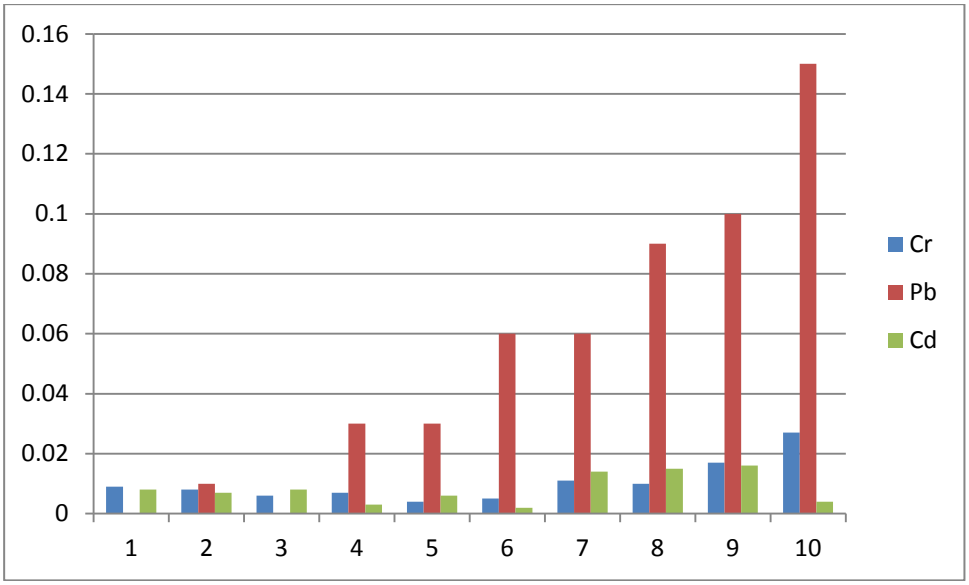

Figure 4. Variation of Cr, Pb and Cd at different sampling spots

4. CONCLUSION

In this present work, we have analyzed the physico-chemical qualities of ground water sources in Sarguja district. We have also focused the fluoride, iron, and some other toxic metallic ion concentration in different ground water sources. Sodium (134 mg/L), potassium (13.1 mg/L), fluoride (15.35 mg/L) and iron (2.95 mg/L) concentration were detected up to alarming level. The procured values were above the excessive the permissible level as per standard values prescribed by WHO and BIS. The concentration of all these elements is created adverse effect on human being. People residing of study field area are also suffering by the bone, teeth and gastrointestinal metabolic disorder. The water is mandatory to purify by the indigenous technique and also awareness program should be organize among local people by campaign.

5. ACKNOWLEDGEMENT

The authors are highly thankful to Chhattisgarh Council of Science and Technology (CGCOST), Raipur (C.G.) for providing necessary research facilities cum estimation of metal ions by AAS.

6. CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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