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Research Article

Ground Water Quality Assessment of FCI Township post closure of FCI Sindri unit in year 2003

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Abstract

The ground water quality of Sindri township area has been studied with respect to twenty six physic-chemical characteristics. Out of twenty six characters, 07 nos. have been selected for graphical & statistical method for interpretation of the findings. The variation in water quality have been quantified by the both methods. The concept dataliers, Exceeding factor (EF) and Surrogate Number Level Exposure Factor (SNELF) have also been used for interpretation of results. Iron with EF value equivalent to 2.497and SNELF value equivalent to 2.14 appeared abnormally high. Among the seven parameters under detail study, the mean values of TDS, Total Alkalinity, Total Hardness and Iron have been found beyond the desirable limit of drinking water standard BIS:10500. Out of 14 ground water sample under study, 09 nos. of samples for water quality parameters for Total Dissolve Solid (TDS) and Total Hardness (TH), 13 nos. of samples for Total Alkalinity (TA) and 11 nos. of samples for Iron have been found to violet the desirable norms of drinking water standard.

Key words: *Skewness, Kurtosis, Data outliers, Exceeding Factor, Surrogate Number Level Exposure Factor etc.*

1. Introduction

Water in an integral part of the ecosystem of the planet. It exists in all the components of environment and transfer from one component to another component through 06 define processes of transformation. During transformation, it acts as an agent for balancing the natural bio-geo-physico chemical cycle of energy Water is a very good metabolic fluid for primary producer and support of life for other living beings. The quest for pure and fresh water crunch have lead us to recognize that water quality is equally important than its quantity. Water being an universal solvent is a good receptor of environmental impact due to developmental activities which may change the status of water quality leading to the threat to the survival of life on this planet or convergence of bio-diversity. The sustainability of life on this planet requires a comprehensive assessment and inventory of the ecological status and biodiversity with special reference to aquatic and terrestrial biotas. The status of biotas and bio-diversity is measured by determining the rate of growth, health developments reproduction, bio-mass generation, bio-stimulation, habitats construction/destruction etc. All these factors imperatives depend on quality of water. Similarly the use of water for industrial, domestic, drinking, bathing, swimming, recreation, assimilation of pollution selection of pollution control devices depend on water quality[7,8]. Thus the assessment of water quality is essential.

Objective

The prime objective of this paper is to assess the ground water quality and geo-chemical distribution pattern in ground water in Sindri Township area of Dhanbad District, post closures of FCI, Sindri Unit in 2003 and to establish a baseline information for selection and designing of waste water management practices for any incoming industrial / developmental projects.

The study will be used to relate the statuary and non-statutory related to environmental and ecosystem problems in micro-levels and some of the important objectives are as under:

- Establishing a baseline condition to support the developmental activities in line with calculation for National Pollutant Discharge Elimination System (NPDES).
- Providing justification for the site specific criteria.
- Developing dissolve or total recoverable translators
- Development of a basis for effluent trading
- Documenting the ground water quality of the affected area
- Determination of accumulative impact of past industrial activities

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- Predicting the environmental consequences of the proposed activities in consideration
- Preparing the best management practices for the proposed activities in consideration.

Location

The study area falls on the north bank of Damodar River in the Chhotanagpur plateau region of the Dhanbad district in the state of Jharkhand. Geographically, it is located around $23^0 37' 60''$N and $86^0 30' 08''$E. The study area is deprived of coal mines but it is surrounded by active coal mines of Jharia Coalfield. The coal mine deprived area is approximately 4000 acres of land under central Government. The land is infrastructurally suitable for establishment of giant grass root projects like Steel, Fertilizer, Thermal, etc. Sindri is at a distance from 28km from Dhanbad which is also known as coal capital India. The coalfield area in Dhanbad falls in ingenesious zone and the ground water level varies from 3.5mtr BGL to 7.3mt. BGL. (CGB, Patna 2008). The large scale of mining in Jharia coalfield area has some adverse impact on ground water movement and quality.

Sampling Locations

Location Code	Locations	Location Code	Locations
W1	Bhuja more	**W8**	Check Post Sindri
W2	Hatia	**W9**	Church, Sindri
W3	Jayhind more	**W10**	Police Station
W4	Rangamatia	**W11**	PDIL/BW
W5	KD-Last	**W12**	NAC
W6	GM-Bunglow/FD	**W13**	Vidyapati
W7	Tara Temple (Domgarh)	**W14**	Taltala

Material and method

Fourteen number of Ground water samples were collected on random basis from Sindri township area. The grab sampling method has been opted for collection of water samples from tube wells. The sampling and analysis methodology have been designed as per standard methods and practices. The physic-chemical characterization of 14 nos. of ground water samples have been conducted for 26 water quality parameters consisting of six nos., of physical parameters, 14 nos. of chemical / aggregate & quality parameters and six nos. of dissolved metallic contaminants.

Method of Presentation

The analytical results of the ground water quality has been presented and interpreted graphically as well as statistically.

The ground water quality variation pattern in tabular form is very difficult to interpret they are more than a few analysis are involved. To overcome the difficulties in presentation graphical methods has been made as a choice of presentation of result.

Statistical method is comprehensively more scientific method for interpretation of analytical results hence both graphical and statistical method have been adopted for interpretation and discussion of ground water quality under study.

Results and Discussion

The analytical result of ground water sample of Sindri Township area collected during summer season of 2012 from 14 nos. of location on random basis have been present in self-explanatory Table -1. The water quality table has been done with respect to 29 parameters.

Among the water quality characteristics seven parameters namely:

1. Total Dissolve Solid (TDS)
2. Total Alkalinity (TA)
3. Total hardness (TH)
4. Sodium
5. Chloride
6. Sulphate
7. Iron

Have been identified characteristic of ground water showing a very wide variation thus the interpretation of the result has been done on the basis of above mentioned seven characteristics.

Graphical interpretation

Fig-1A is represents the variation in water quality among the 14 nos. of samples for Total Alkalinity, Chloride & Sulphate. Fig- 1B represents the quality variation among the 14 samples with respect to Total Dissolve Solid, Total Hardness and Sodium. Fig- 1C is represent the quality variation among the 14 samples w.r.t Iron only.

The degree of variation in case of aggregate characteristics of ground water presented in Fig- 1A and 1B has been found more than chloride, sulphate & sodium, Fig 1C presents the water quality variation w.r.t Iron only. Out of the 14 samples of ground water sample under study only 3 nos. of ground water sample are in good agreement with drinking water standard BIS: 10500. Dissolve Iron concentration in 11 nos. of samples exceed the desirable limit of drinking water. In case of TDS, 9 nos. of sample violet the desirable limit of drinking water standard BIS: 10500. In case of alkalinity and hardness 13 nos. and 9 nos. of samples violet the norms of 200mg/l and 300mg/l respectively. Chloride and Sulphate are in good agreement with the standard. However, a degree of variation in both the cases has been recorded.

Statistical interpretation

The degree of water quality variation has been quantified by conduction of statistical analysis of the selected 7 water quality characteristics. The statistical analysis has been conducted w.r.t to 16 parameters and the result has been present in Table-2. The parameters namely

Table 1 Physico-Chemical Characteristics Of Ground Water Samples Period of Sampling :Pre-monsoon(Wherever not specified, characteristics are expressed in mg/l, maximum)

S.No.	Parameters	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1	Date	19-05-12	19-05-12	19-05-12	19-05-12	19-05-12	19-05-12	19-05-12	19-05-12	09-06-12	09-06-12	09-06-12	09-06-12	09-06-12	09-06-12
2	Time(Hrs)	9:10	9:20	9:35	9:40	9:45	9:50	10:00	9:10	9:15	9:30	9:40	9:45	9:30	9:30
3	Source	HP	HP	HP	HP	HP	HP	HP	HP	HP	HP	HP	HP	HP	HP
4	Temp. (^{O}C)	28	28	29	29	32	32	32	28	28	28	28	28	28	28
5	Colour, HU	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
6	Odour	None	None	None	None	None	None	None	None	None	None	None	None	None	None
7	Turbidity, (NTU)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
8	pH	7.6	7.5	7.5	7.5	7.5	7.5	7.7	7.6	7.6	7.5	7.7	7.3	8.5	8.2
9	TDS	620	700	620	930	530	550	540	620	440	500	470	580	490	450
10	Total Alkalinity as $CaCO_3$	320	320	330	400	220	260	210	360	250	270	240	190	340	280
11	Chloride as Cl	70	80	40	115	30	36	30	70	50	60	60	160	50	60
12	Sulphate as SO_4	120	150	130	200	150	130	170	70	60	70	80	80	40	40
13	Ammonical Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	Nitrate as NO_3	2.1	5.74	2.1	4.2	3.8	3.6	6.5	4.4	4.2	4.4	3.8	4	3.8	3.6
15	Fluoride as F	0.6	0.6	0.6	1.1	0.9	1	0.7	1	0.8	0.8	1	0.7	0.8	0.5
16	Total Hardness as $CaCO_3$	405	460	370	350	240	220	210	340	260	300	340	420	420	350
17	Cal. Hardness as $CaCO_3$	244	304	240	252	188	160	124	254	178	196	230	260	308	260
18	Mag. Hardness as $CaCO_3$	160	152	132	100	52	60	86	88	82	106	106	156	160	96
19	Sodium as Na	56	58	69	176	78	97	92	83	53	56	30	38	9	20
20	Potassium as K	8	8	10	25	6	7	7	6	4	4	3	4	1	2
21	Percent Sodium	22.7	21.3	28	49.9	40.6	47.9	47.7	34	30.3	28.4	16.1	16.4	4	10.8
22	SAR (meq/ lit)	1.2	1.2	1.6	4.1	2.2	2.8	2.8	2	1.4	1.4	0.7	0.8	0.2	0.5
23	RSC	NIL	NIL	NIL	0.88	NIL	0.8	NIL	0.44	NIL	NIL	NIL	NIL	NIL	NIL
24	Iron as Fe	0.54	0.56	0.6	0.56	0.24	0.64	0.1	0.5	0.5	1.1	1.6	2.25	0.05	1.2
25	Manganese as Mn	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
26	Zinc as Zn	0.2	0.21	0.23	0.21	0.22	0.21	0.21	0.2	0.2	0.23	0.22	0.21	0.2	0.23
27	Arsenic as As	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
28	Lead as Pb	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
29	Chromium as Cr^{6+}	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Exceeding Factor (EF), Surrogate Number Level Exposure Factor(SNLEF) and Data outliers are not common statistical analysis parameters. In this study they have been defined as follow:

$$\text{Exceeding Factor} = \frac{\text{Mean value of the 14 sample}}{\text{Standard}} \times \text{EF}$$

$$\text{Surrogate Number Level Exposure Factor (SNLEF)} = \frac{\text{Number of sample exceeding the norms}}{\text{Total number of sample under study}} \times \text{EF}$$

The outlier value have been calculated using the following equation:

$$\text{Outliers (Min.)} = (\bar{x} - x_L)/\sigma$$

$$\text{Outliers (Max.)} = (x_H - \bar{x})/\sigma$$

$\bar{x}$- Mean Value

x_H- Highest Value
x_L-Lowest Value
σ- Standard Deviation

Iron is a heptotoxic metallic contaminant, the mean value have been recorded equivalent to 0.74mg/l, EF equivalent to 2.497mg/l and SNALF equivalent to 2.140mg/l, the concentration of Iron in the Ground water is a matter of great concern if it is being used for drinking purpose for long time.

The outlier maximum values have been computed more than outlier minimum value in case of all the 07 nos. of water quality parameter under study. The outlier

Table 2 Statistical Analysis of Ground Water Quality

S. No.	Parameters	TDS	Alkalinity	Chloride	Sulphate	Total Hardness	Sodium	Iron
1	Minimum (in mg/l)	440	190	30	40	210	9	0.05
2	Maximum (in mg/l)	930	400	160	200	460	176	2.25
3	Range	190	210	132	160	250	167	2.2
4	Mean	574.29	285	65.21	106.43	334.64	65.36	0.749
5	Median	545	275	60	100	345	57	0.56
6	Mode	620	320	60	150	350	56	0.56
7	80th percentile	620	334	74	150	411	86.6	-1.16
8	Std. Deviation	126.9	61.61	35.27	50.32	79.14	41.19	0.607
9	Std. Dev.	122.28	59.37	33.98	48.49	76.26	39.69	0.585
10	Skewness	1.79	0.22	1.73	0.32	-0.21	1.38	1.35
11	Kurtosis	4.2	-0.79	3.38	-1	-1.01	3.3	1.713
12	% Co-effecient of Variance	22.09	21.61	54.08	47.77	23.64	63.02	
13	Outlier – Minimum	1.058	1.542	1.055	1.32	1.575	1.368	1.195
14	Outlier – Maximum	2.803	1.867	2.688	1.859	1.584	2.686	2.566
15	EF	1.148	1.425	0.261	0.532	1.115	1.307	2.497
16	SNLEF	0.9	1.323	0	0	0.7	0.934	2.14

Source: Table No. 1Note: Sodium Standard = 50 mg has been considered as per Canadian Standard[9,10].

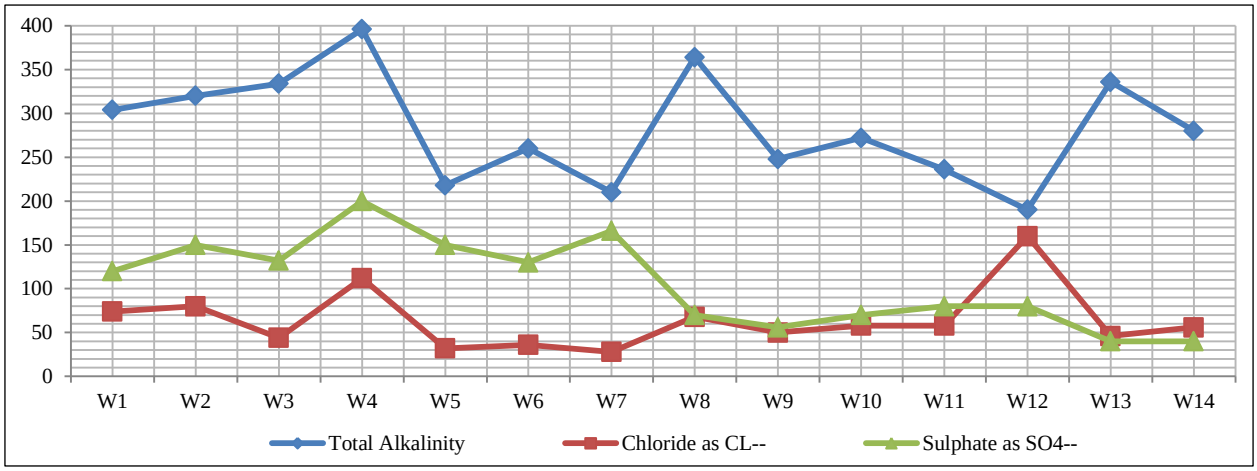

Fig 1 A Showing Variation in Water Quality

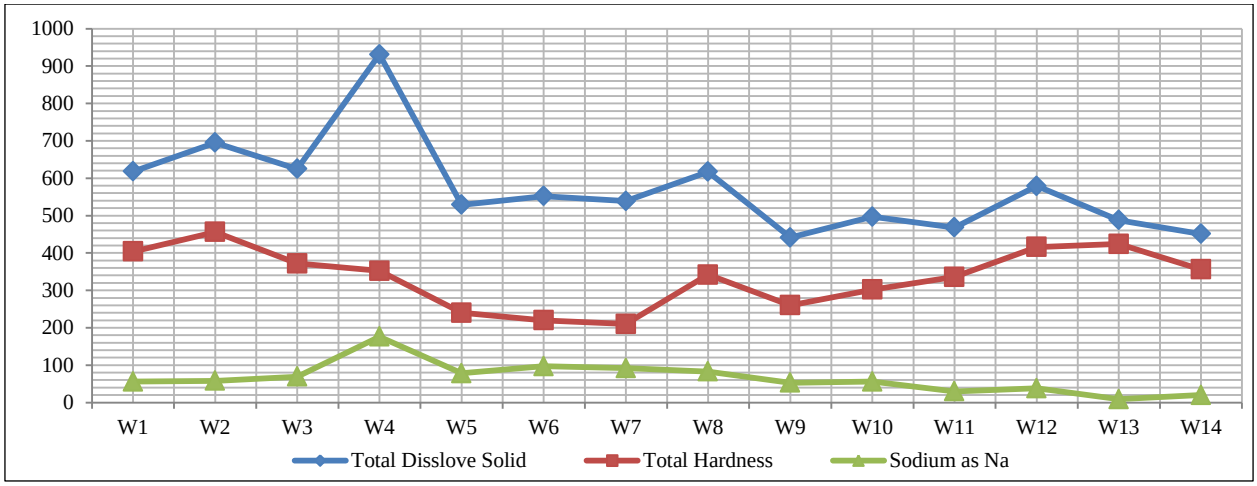

Fig 1B Showing Variation in Water Quality

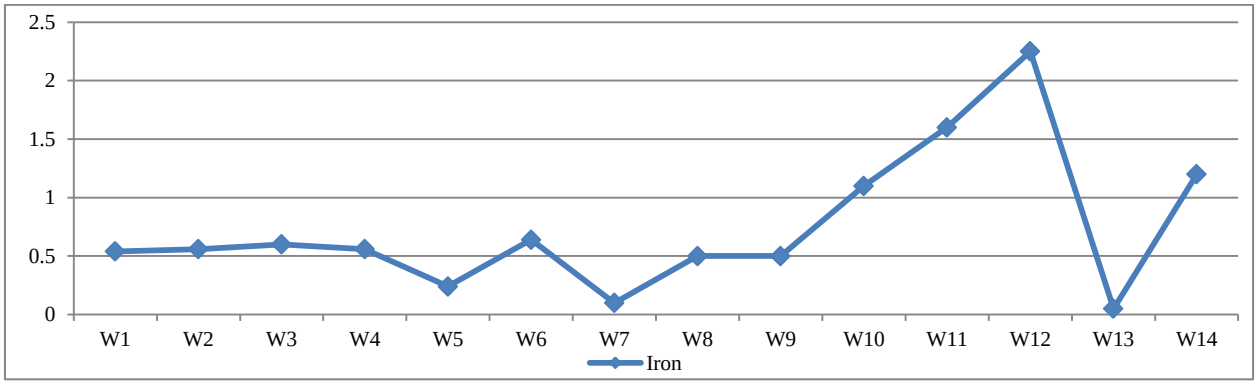

Fig 1C Showing Variation in Water Quality

maximum value have been found more than the critical value for the taste of discardency15 for 14 nos. of samples under study is 2.37. Thus the problematic area among the 07 nos. water quality parameters are TDS (2.803), Chloride (2.668), Sodium (2.686) and Iron (2.566), have been found to be a ground of rejection of data with the maximum value of TDS (930mg/l), Chloride (160mg/l), Sodium with (176mg/l) and Iron with a value of 2.25mg/l. The changes in exceeding factor have been found in the following descending orders:

\Iron (2.497) > Alkalinity (1.425) > Sodium (1.307) > TDS (1.148) > Total Hardness (1.115) > Sulphate (0.532) > and Chloride (0.261).

However, the Surrogate Number Exposure Level Factor does not away the same order. In case of Chloride and Sulphate the Surrogate Number Exposure Level Factor have been calculated equivalent to 0. The order in change of Surrogate Number Exposure Level are as follows:

Iron (2.140) > Alkalinity (1.323) > Sodium (0.934) > TDS (0.9) > Total Hardness (0.7) > and Chloride (0) = Sulphate (0).

The value of kurtosis which show the distribution pattern of dissolved mineral matter in the ground water have been computed in the following descending order:

TDS > Chloride > Sodium > Iron > Alkalinity > Sulphate > Total Hardness.

The Kurtosis values of Alkalinity, Sulphate and Hardness have been found negative. Similarly the Skewness which is one of the important methods for presentation of mineral distribution pattern w.r.t the mean value have been found. The following descending order:

TDS>Chloride>Sodium>Iron>Sulphate.

In this case Alkalinity & Hardness, have been found with the negative values.

Conclusion

The study will be used for designing the best management practices as per statutory and non statutory guidelines. It will help for development of basis for effluent trading. The use of ground water for industrial purpose does not appear techno-economically feasible. The ground water for use of drinking purpose requires some treatment including removal of Iron and softening. The Exceeding Factor and Surrogate Number Level Exposure Factor for iron has been found highest among the seven parameter under study. The value indicates the risk on its use on drinking water. Chloride and Sulphate are in good agreement on desirable limit of drinking water standard BIS-10500. The mineral matter present in ground water does not show a definite pattern of distribution a detail study has been made by the author in their paper metamorphic impact on ground water quality of Sindri Township Area20. The finding have been presented through goodness of fit test / probability plot for important water quality parameters.

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