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INVESTIGATIONS OF PHYSICO-CHEMICAL STATUS OF GROUND WATER OF SINGRAULI DISTRICT, MADHYA PRADESH, INDIA

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ABSTRACT

Ground water is the most preferred water source in current scenario. Once believed to be safe from pollution as it is available many band below the surface, is now provided to be prone to pollution by research investigators. Various causes associated for the contamination of ground water. The major cause of the contamination of ground water may be due to improper disposal of industrial waste. The effort was made to assess the quality of ground water and thrash out the portability of ground water by physico-chemical temperament. Present study was carried out to assess the ground water quality of Singrauli district an energy hub station of Madhya Pradesh state of India Study was conduct in year 2012 by selecting 13 different spots, covered all the four directions of Singrauli. Ground water samples were taken from different sources such as bore well, well water, municipal supplier water etc. Investigations of Physico-chemical characteristics of groundwater quality based on Physico-chemical parameters have been taken up to evaluate its suitability for different objects. Quality analysis has been made through in terms of pH, EC, TDS, Total Hardness, Sodium, Potassium, Calcium, Magnesium, Chloride, Sulphate, Nitrate, Fluoride and Alkalinity. Comparative studies of collected samples indicated that there is no appreciable change in the different parameters during sampling season. The results were compared with standards prescribed by WHO and ICMR. The results showed that high total hardness content indicating the need of some treatment for minimization. Other investigated samples were found within the water quality standards but the quality of water is not completely favorable as per standard human requirement. Water is not completely fit for drinking purpose due to improper management of disposal of industrials, mines waste or garbage in these local energy hub environments.

INTRODUCTION: Pollution of water bodies is one of the areas of major concern. Water quality is an index of health and well being of a society.

A well-known method of expressing water quality that offers a simple, stable and reproducible unit of measure is the water quality index which responds to changes in the principal characteristics of water [1]. It is regarded as one of the most effective way to communicate water quality [2-3].

Singrauli, a district of Indian state of Madhya Pradesh emerging as India's Energy capital covered coal mine, electricity generation power plants, and dense forests

inhabited by wild animals. Population is around 185,580 were calculated according to current census with the density of about 85/km^2 (220 /sqm). The eastern part of Madhya Pradesh and the adjoining southern areas of Sonbhadra district of Utter Pradesh state are collectively known as Singrauli region. Many energy generating industries like Singrauli super power plant, Vindhyanchal Super Thermal Power Plant, Northen Coal Limited, Kanoria Chemicals are regularly increases the quantity of pollution via disposing of organic, inorganic, degradative non degradative materials in the local environment which affect the human health. Pollution sources like sewerage, organic and other waste dumps, and chemical dumps too cause considerable ground water pollution particularly in the industrialized zone. The quality of public health depends to a greater extent on ground water quality, which should be permissible.

In India, population is dependent on groundwater as it is the only source of drinking water supply. Ground water is believed to be comparatively cleaner and free from pollution than surface water. Modern civilization and prolonged discharge of industrial effluents, domestic sewage and solid waste dump cause the groundwater to become polluted and created health problems [4]. As the water is the most important component of eco-system, any imbalance created in term of amount, which is presence of impurities added to it can harm the whole eco-system [5-7]. Hence, there is always a need for and concern over the protection and management of groundwater quality [8]. Any imbalance in its physical or chemical properties beyond permissible limit would be harmful for eco-system.

Groundwater plays a vital role in the development of arid and semi-arid zones and extremely essential for survival of all livings. Quality of water is concern for mankind since it is directly linked with human welfare. The degradation of water quality in water body creates a condition so that water cannot be used for intended beneficial application including bathing, recreation and as a source of raw water supply[9]. Water and source containing living, nonliving, organic, inorganic, soluble and insoluble substances subsequently its quality is likely to change gradually and varies from source to source. Any change in natural quality and concern sources may affect the equilibrium system and would become unfit for designated uses.

The availability of water by exterior and ground water resources has become serious. Only 1% part is available for drinking, agriculture, domestic power generation, industrial consummation, transportation and waste disposal [10-12]. This section deals with water quality of tube wells, dug wells, as well as municipal water with special reference to suitability of water for drinking purpose. Evaluation of ground water quality is as important as quantity, since the usability of water is determined by its chemical nature. The literature survey reveals that no water quality management studies are made in this industrial region so far. Hence the present study was planned and undertaken.

Looking to the above aspects of groundwater contamination, the present study was undertaken to investigate the current status of physico-chemical parameters of ground water.

MATERIAL AND METHODS:

SAMPLING CRITERIA: Samples were collected from 13 different sampling sites during the month of March-April of the year 2012. The water sample were collected from all the targeted stations at 11.00 am to 12.00 noon for physico-chemical examinations, methods of collection and handling were adopted based the standard procedures [13]. It was ensured that the concentrations of various water quality parameters do not changes in time that elapses between drawing of samples and the analysis in the laboratory. The samples were collected in plastic bottle of 2.5 liters capacity without any air bubbles.

The bottles were thoroughly cleaned with Hydrochloric acid and then washed with tape water rendered free of acid and than washed with distilled water twice and again rinsed with the water sample to be collected and then filled up the bottle with the sample leaving only a small air gap at the top, stopper and sealed the bottle with paraffin wax. All the glassware's were first cleaned with tape water thoroughly and finally with de-ionized distilled water. The temperatures of collected samples were recorded in field itself during the sampling time. Some samples which were turbid or containing suspended matter were filtered at the time of collection [14]. The samples were kept in refrigerator at 4^{o}C for further investigations. pH was measured with the help of pH meter (Model no. 101 E) of Electronic

India , standardized with pH buffer 4,7 and 9.2. TDS was estimated by evaporation method at 180C, Alkalinity, Hardness, D.O., Chloride, CO_2 and all parameters were analyzed by standard procedure mentioned in APHA [15]. The elemental analysis carried out by digital flame photometer. Samples were analyzed and results presented in **Table 1**.

TABLE: 1 SAMPLING LOCATIONS OF SINGRAULI DISTRICT FOR ASSESSMENT OF PHYSICO-CHEMICAL PARAMETER STATUS OF GROUND WATER

S. No.	Name of station	Station code	Sources	Observations				Sample code
				(Oil and Grease)	Temp. in ^oC	Colour	Odor	
1	Near VSTPP (Vindhyanchal Super Thermal Power Plant)	W1/S1/S/12	Well water	+	32	Colourless	Odorless	S1
2	Near Surya Nallah	W2/S2/S/12	Bore well water	+	33	Colourless	Odorless	S2
3	Near Balia Nallah	W3/S3/S/12	Bore well water	+	33	Colourless	Odorless	S3
4	Amlori Chowk	W4/S4/S/12	Bore well water	-	34	Colourless	Odorless	S4
5	SSTPP (Singrauli Super Thermal power Plant)	W5/S5/S/12	Well water	+	36	Colourless	Odorless	S5
6	Waidan Town	W6/S6/S/12	Bore well water	-	36	Colourless	Odorless	S6
7	Near Kanoria Chemical	W7/S7/S/12	Bore well water	+	38	Colourless	Odorless	S7
8	Shakti Nagar (Town ship)	W8/S8/S/12	Bore well water	-	38	Colourless	Odorless	S8
9	Vindhya Nagar (Town Ship)	W9/S9/S/12	Well Water	-	35	Colourless	Odorless	S9
10	Near Rihand Dam	W10/S10/S/12	Well Water	-	37	Colourless	Odorless	S10
11	Nigahi (Town ship)	W11/S11/S/12	Supply water	-	38	Colourless	Odorless	S11
12	Obra (Town ship)	W12/S12/S/12	Supply water	-	38	Colourless	Odorless	S12
13	Renukut (Town ship)	W13/S13/S/12	Bore well water	+	39	Colourless	Odorless	S13

Physico-Chemical Analysis: Parameters for water quality such as temperature, colour, odour, pH, electrical conductivity, total dissolved solids (TDS), turbidity, total hardness, calcium, Mg, total alkalinity, bicarbonate, Na, K, Ca, Mg, Cl, F, nitrate and sulphate were examined using standard method [16]. All The chemical and reagent preparation used for the analysis were AR grade and double distilled water was used for preparation of solutions.

RESULTS AND DISCUSSION: The physicochemical parameters of the above mention sites in Singrauli district can be calculated and it is describe as bellow.

Temperature (T): Temperature is an important biologically significant factor, which plays crucial role in the metabolic activities of organism. The temperature was ranging from minimum 32°C at S1 to maximum 38°C at 13 different stations during the study period. Property of water change with the temperature, water density varies and it becomes less with warming up and more with cooling. Colour having the colourless and odour having odourless for all investigated samples.

Turbidity and pH: Turbidity was evaluated as basic physiochemical parameters. It is essential due to colloidal and extremely fine dispersions. The values varied between 0.1 to 0.4 NTU and found within the limits prescribed by WHO [17]. The value of pH range among 7.4 to 8.8 and It is in the prescribed limit of ICMR**.** A little bit increase in pH level may depress the effectiveness of the disinfectants like chlorinations thereby requiring the additional chlorines. The pH of a solution represents the negative base 10 log of hydrogen ion action in moles/l. At pH 7, the concentration of H^+ or OH^- ions is equal. Highest desirable limit of pH as per WHO standards for drinking purpose is 6.5 to 8.5. The values of pH for all water samples were within maximum permissible limits i.e., water samples were slightly alkaline in nature.

Electrical Conductivity (EC) and Total Dissolved Solid (TDS): Electrical conductivity (EC) is a measure of water capacity to convey electric current. It signifies the amount of total dissolved salts [18]. EC values were in the range of 500 micro-ohms/cm to 1848 micro-ohms/cm. High EC values were indicating the presence of high amount of dissolved inorganic substances in ionized form.

The Electrical conductivity of samples S1 (1583), S5 (1530), S7 (1612), S10 (1456) and S11 (1520) mg/dl were evaluated and found below the highest permissible limit whereas the other stations samples were differentiated variably. The EC value was fluctuated due to flow or movement of water and directly and indirectly affection was also encountered due to variable turbidity and pH.

The value of total dissolved solid total dissolved solid is disturbed due to high dissolved salts of Ca, Mg and Fe it requires specific cation and anion analysis. The desirable Total Dissolved Solid (TDS) range for drinking water is 500 to 2000. The TDS values of all the samples were within the permissible limits. In the present investigation the TDS range was recorded as 529mg/l to 1532 mg/l.

Total Hardness (TH) and Total Alkalinity (TA): The hardness values shown range from 132 mg/l to 192 mg/l. Water hardness depends upon the amount of calcium or magnesium salts or both contents. The values for sample from all point were varied and below the prescribed limit. Hardness is the property of water which prevents the lather formation with bicarbonated reactive substitute and increases the boiling points of water [19]. The results suggested the all stations water is favorable as domestic exploitations.

Alkalinity of water having capacity to neutralize a strong acid and it is normally owing to the existence of bicarbonate, carbonate and hydroxide compound of calcium, sodium and potassium. Total alkalinity values for all the investigated samples were found to be in the standard limit during course of investigation. It is in range of 200mg/l to 600 mg/l. Total alkalinity of samples were S1, S5, S7, S10 and S11 samples were out of maximum permissible limit its were accounted 660, 643, 657, 619 and 676 respectively.

Calcium (Ca^{2+}) and Magnesium (Mg^{2+}): Calcium is directly related to hardness concentration recorded between 80 mg/l to 243.00 mg/l and found below the permissible limit of WHO in samples stations S2, S4, S6, S8, S9, S12 and S13. Whereas the data of sample S1, S3, S5, S7, S10 and S11 marked above the permissible limit (**Table 2**). Hypercalcemia and hypocalcaemia is usually associated with calcium and concern abnormalities.

Similarly magnesium is directly related to hardness of water [20]. Magnesium content in the investigated water samples was ranging from 39.00 mg/l to 130 mg/l. It is below at point S2, S4, S6, S8, S9, S12 and S13 than the prescribed limit whereas Magnesium content was higher S1, S3, S5, S7, S10 and S11 (126, 104, 116, 124, 139 and 123) mg/l samples respectively (**Table 2**).

Presence of magnesium is totally unhygienic causes diarrhea, nausea, vomiting and irritations in gastro-intestine tracts. The industrial effluent and sewage water of this region easily affected to the fresh water bodies due to interacting elements of calcium and magnesium in environment [21].

Bicarbonate (HCO_3^-) and Chloride (Cl^-): This electrolyte is an important component of the equation that keeps the acid-base status of the body in balance. The lungs regulate the amount of carbon dioxide, and the kidneys regulate bicarbonate (HCO_3^-). This electrolyte helps buffer the acids that build up in the body as normal byproducts of metabolism [22].

It is in range of 103 mg/l. to 321 mg/l. The chloride concentration serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to laxative effects [23]. The chloride concentration was found in range of 68 mg/l to 282 mg/l (Table-2). All the values are below the limit except water sample collected from sites S5, S10, S11 was 261, 282 and 254 mg/l respectively.

Sodium (Na^+) and Potassium (K^+): Its concentrations were found in between 58 mg/l to 167 mg/l. sampling of all sites showed the concentration prescribed limit by WHO. The major source of potassium in natural fresh water is weathering of rocks but the quantities increase in the polluted water due to disposal of waste water [24].

An essential element for both plants and animals, principal sources of potassium are orthoclase, microline, biotrite, lencite etc. these sources are abundantly available due to mines areas and energy hub zones. Potassium content is less than sodium in water. Potassium content in the water samples varied from 1.00 mg/l to 20.00 mg/l.

TABLE 2: MEAN VALUES OF WATER SAMPLES OF THE SINGRAULI DISTRICT IN TERMS OF PHYSICO-CHEMICAL PARAMETERS

Station code	Sample	Turbidity	pH	EC	TDS	TH	Ca	Mg	TA	HCO_3	Cl	Na	F	K	SO_4	NO_3
W1/S1/S/12	S1	0.4	7.9	1583	1467	148.2	232	126	660	103	83	167	0.61	4	273	34
W2/S2/S/12	S2	0.2	8.6	1234	985	192.0	165	39	260	183	57	76	0.53	6	198	28
W3/S3/S/12	S3	0.3	7.9	1423	1295	168.0	243	104	297	166	63	93	0.42	7	146	43
W4/S4/S/12	S4	0.1	7.4	543	687	176.0	174	56	265	120	68	90	0.93	9	186	24
W5/S5/S/12	S5	0.3	8.8	1570	1432	175.8	240	116	643	175	261	13	1.63	11	86	43
W6/S6/S/12	S6	0.2	8.3	697	1295	157.0	183	46	356	187	134	98	0.23	20	59	25
W7/S7/S/12	S7	0.1	8.2	612	1532	148.0	212	124	657	173	157	145	1.62	13	79	41
W8/S8/S/12	S8	0.2	7.8	1326	1435	132.0	174	78	543	122	143	106	0.51	10	163	43
W9/S9/S/12	S9	0.1	7.9	984	1283	148.0	128	123	324	137	162	135	0.85	16	172	18
W10/S10/S/12	S10	0.2	8.2	1456	1367	156.0	221	139	619	156	282	154	0.59	13	273	29
W11/S11/S/12	S11	0.2	8.4	1520	1404	178.0	208	123	676	112	254	143	1.33	19	204	26
W12/S12/S/12	S12	0.1	6.8	857	529	167.0	187	112	519	134	160	88	0.66	12	241	31
W13/S13/S/12	S13	0.3	7.8	953	754	179.0	164	62	594	321	84	58	0.43	11	101	39
WHO Standard Highest desired limit		5	6.5	500	500	300	75	30	200	-	250	-	1	-	200	1
Max. Permissible limit		10	8.5	2000	2000	600	200	100	600	-	1000	200	1.5	-	400	45

EC = Electrical Conductivity, TDS = Total Dissolved Solid, TA = Total Alkalinity, TH = Total Hardness. **All the values expressed in mg/l except pH and Electrical Conductivity.**

Fluoride (F^-), Sulphate (SO_4^{2-}): and Nitrate (NO_3^-): As per WHO Standards 1.0mg/l is the desirable limit whereas 1.5mg/l is the permissible limit in absence of an alternate source. Above 1.5mg/l. It causes dental fluorosis disease. In the present analysis, fluoride concentration was noticed in all taken samples within prescribed limit i.e. 0.42 mg/l to 1.63mg/l. The concentration of fluoride in ground water is increases due to solubility of fluoride bearing minerals like fluorite, cryolite, topaz, mica etc specially in mines areas.

As the ground water passes through the minerals, concentration of sulphate is possible. Recommended desirable limit is 200 mg/l and the maximum limit for drinking purposes is 400 mg/l. Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals [25]. The sulphate concentration varied between 59mg/l and 273 mg/l and found within the prescribed limit.

The ground water sulphate contents were increased due to regular applicability and explosion of sulphate based inorganic fertilizers.

Nitrogen is a major constituent of atmosphere. Soil bacteria convert it into nitrite and nitrate. Nitrate is a minor constituent of rocks. Part of the nitrate is fixed by the plants before the rain water percolates below the root zone. Natural ground water contains less than 5mg/l of nitrates [26]. But the polluted waters contain high concentrations of nitrate. The concentration of nitrate range from minimum 18 mg/l to maximum 43 mg/l, whereas the WHO norm, the nitrate concentration up to 45 mg/l is desirable limit for drinking.

CONCLUSION: From the analysis data in Table 2, it is concluded that the water samples are well within the prescribed limit. However a few parameters like total hardness, Ca, Mg, Cl shows marginal increase or decrease from the specific limit.

The sampling point S1, S2, S5, S7, S10 and S11 showed high total hardness content indicating the need of some treatment for minimization of the parameters. The physico-chemical parameters are appeared to be a normal, but it requires a thorough investigation of biological parameters except few sampling sites. Other sites samples under investigation were originate parameters within the quality standards and the quality of water is acceptable and it is applicable for drinking or domestic purposes.

The study carried out in Singrauli district on ground water samples conform that the pH level was within limit except S2 and S5. Maximum samples and their values were indicated, that sampling water sources are not suitable for drinking purpose. Excess fluoride may lead to tooth decay and kidney disease. In 2 samples (S5 and S7) the fluoride was found more than maximum permissible limit.

Therefore need to establish some new institutional approach, which deals with current and other associated emerging problems. These problems have been addressed by various agencies in different states. Parameters values will help in selecting proper treatment to minimize groundwater pollution.

The results of the physico-chemical examination of this district could be helpful in the management of its water quality.

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