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RESEARCH ARTICLE

ASSESSMENT OF GROUND WATER QUALITY USING PHYSICO-CHEMICAL PARAMETERS AND WATER QUALITY INDEX AROUND RUNNING MINES OF DHANBAD DISTRICT, JHARKHAND.

***Akosh Chhoker, Sudesh Kumar, Praful Kose and Ajay Kumar Singh.**
Department of Environment Engineering, Projects & Development India Limited, Sindri, Dhanbad, Jharkhand.

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Corresponding Author
Akosh Chhoker.

Abstract

Groundwater has become an alternative source for domestic and irrigational uses at present in most places, due to insufficient availability of clean surface water. Limited availability and supply of potable water, people have started using groundwater for drinking and other domestic purposes. This study was aimed to estimate physico-chemical properties in ground water samples collected from different sources around coal mines of Dhanbad. A total number of 25 ground water samples have been collected during the post monsoon season (October, 2015 - December, 2015). This study reveals that physico-chemical properties like pH, TDS, Alkalinity, Total Hardness, Chloride, Sulphate, Nitrate, Fluoride, Iron and Zinc showed considerable variation due to metamorphic impact but were found within the permissible limit prescribed by IS 10500: 2012 Second Revision. Water Quality index (WQI) value ranged from 23.9 to 260.3. It showed that 48% of the water samples fall in the category of good water and 52% of the water sample falls in the category of poor water which were due to elevated iron content but fall under good water characteristics considering other parameters. The ground water for use of drinking purpose requires some treatment including removal of Iron.

Introduction:-

Water is one of the most important of all natural resources. Water is the main component of any life form, without which life would be impossible. Approximately 97% of the water on the earth surface is in the ocean. However, only 3% of the water was held as freshwater sources. Out of which, groundwater constitutes about 30.1% of the total fresh water resources[1]. Availability and quality of ground water varies seasonally from place to place and stratum to stratum depending on the topography gradient, amount and intensity of rainfall received and geological formation of an area[2].Groundwater is a major source for drinking water and irrigation. It is generally considered the least polluted water resources compared to other inland water. However, different studies have indicated that ground water is not totally free from pollution [3].

Anthropogenic activities and natural processes are the primary cause of the ground water contamination. Water-availability problems arise locally when the demand for water exceeds the supply. In some areas, water must be imported from other areas by pipelines to satisfy the demand. When development increases, the demand for fresh surface water and groundwater also increases, which causes contamination and depletion of the water resources. The main objective of the study is to assess the physical and chemical properties of groundwater & water quality index of the study area.

Experimental analysis:-

Materials and Methods:-

Twenty five nos. of groundwater samples were collected from 25 villages around coal mines falls under Dhanbad District, during October, 2015 to December, 2015 (Post monsoon season) (**Fig.:II**).

Sample collection and preservation:-
The samples collected and stored in thoroughly washed and sterilized bottle, acidified with nitric acid to a pH below 2.0 and brought to the laboratory for detailed physico-chemical analysis as per the procedures specified in 'Standard Methods for the Examination of Water and Waste Water' published by American Public Health Association (APHA) 22nd Edition, 2012 [4].

About Study Area:-
Dhanbad district lies in the mid eastern part of Jharkhand state. Giridih bound it in the North, Bokaro in the West, Purulia district in the South and Jamtara district in the East. The district has total area of 2074 sq. km. and is located between 23^0 26'- 24^0 01' North latitude to 86^0 10'-86^0 48' East longitude. The Dhanbad district consist of 8 blocks namely Baghmara, Baliapur, Dhanbad, Govindpur, Jharia, Nirsa, Topchanchi & Tundi. Dhanbad is famous for its coal mining, has some of the largest mines in India and is called Coal Capital of India. Tata Steel, Bharat Coking Coal Limited (BCCL), Eastern Coalfields Limited (ECL) and Indian Iron and Steel Company (IISCO) are some of the companies who operate coal mines in the district (**Fig.:I**). Ground water samples were collected from buffer zone of selected coal mines.

Physico- Chemical Parameters:-
pH:- pH is termed as negative logarithm of the Hydrogen ion concentration. The pH is determined by ELICO, digital pH meter.

Total dissolved solids:- Fifty milliliters of water sample is filtered through ordinary filter paper and water is collected in the evaporating dish of known weight. Further it is heated and water is totally evaporated. Whatever dissolved solid matter is present gets accumulated at the bottom of evaporating dish. The evaporating dish is cooled and weighed. By weight difference method the total dissolved solids is determined.

Total Hardness:- Fifty milliliters of water sample is titrated against 0.01M EDTA (Disodium salt) solution by using Ericochrome Black T as an indicator.

Total Alkalinity:- The alkalinity of water sample is determined by titrating it against standard H_2SO_4 acid (0.02N) solution using indicators like phenolphthalein and methyl orange.

Chloride:- The chloride is determined by Argentometric Method. Water sample is titrated against 0.0141 N silver nitrate solution using potassium chromate as an indicator.

Sulphate content:- Sulphate content in the water sample is determined by turbid metric method.

Nitrate:- UV light having 220 nm wavelength is passed through the sample. The absorbance obtained is directly proportional to the concentration of NO_3^- ions.

Fluoride:- Determination of Fluoride By Scott- Sanchis Method. Fluoride decolourizes the zirconium alizarin complex & the de-colourization is proportional to fluoride concentration.

Zr-alizarin lake + 6 F^- ⟶ Alizarin + ZnF_6
(Reddish) (Yellow)

Iron & Zinc:- Determination of Fe and Zn is carried out by Atomic Absorption Spectrophotometer (AAS) method.

Water Quality index (WQI):- Water quality index is an important tool for getting an idea about the quality of water for drinking purpose. One of the most effective ways to communicate information regarding water quality trends to policy makers and the general public or citizens. Six physicochemical parameters viz. pH, TDS, Total hardness, Nitrate, Fluoride and Iron have been taken for calculating WQI. The quality index does not show exact degree of pollution, rather it is used to assess water quality trends for the management purpose. The WQI is a very useful and efficient method for assessing the quality of Water[5].

Formula and steps for calculating WQI:-
Step: 1. Calculate the unit weight (Wi) factors for each parameters by using the formula

$$Wi = \frac{K}{Si}$$

Where,

$K = \frac{1}{\frac{1}{S1}+\frac{1}{S2}+\cdots\frac{1}{Si}} = \frac{1}{\sum\frac{1}{Si}}$

Si = Standard desirable value of the ith parameters
On summation of all selected parameters unit weight factors, Wi = 1(unity)

Step: 2. Calculate the Sub-Index (Qi) value by using the formula

$Qi = \frac{(Vi-V0)}{(Si-Vo)} x100$

Where,
Vi = mean concentration of the ith parameters
Si = Standard desirable value of the ith parameters
Vo = Actual values of the parameters in pure water (generally Vo = 0, for most parameters) except for pH

$QpH = \frac{(VpH-7)}{(8.5-7)} x100$

Step: 3. Combining Step 1 & Step 2, the overall WQI is calculate by aggregating the unit weight index with the sub-index values as follow

$WQI = \frac{\sum WiQi}{\sum Wi}$

Water quality index value is given in Table-3.

Results and Discussion:-

The physico-chemical parameters and heavy metals analysis of ground water samples collected from different locations of Dhanbad showed considerable variation (pH 6.7-8.2, TDS 314-552 mg/l, Total Hardness 164-428 mg/l, Total Alkalinity 66-350 mg/l, Cl^- 26-138 mg/l, SO_4^{2-} 20-168 mg/l, NO_3^- 1.1-1.5 mg/l, F^- <0.4-0.7 mg/l, Fe 0.04-1.0 mg/l and Zn 0.12-0.20 mg/l) **(Table-1).** The concentration of Fe in maximum nos. of ground water samples exceeds the limit of IS-10500:2012.The remaining analyzed parameters were within acceptable limit as per IS-10500:2012 **(Table-1, Fig.:III).** The WQI value of water samples ranges from 23.9 to 260.3 and water quality of 32% samples is found to be excellent, 32% samples is found to be very poor, 20% samples is found to be poor and 16% samples is found to be good which is mainly due to high Fe concentration **(Table-3, Fig.:IV)**. The variation in ground water quality is primarily due to the various stages of metamorphism of Gondwana rocks present in this locality. The ground water must be treated before use as drinking purpose.

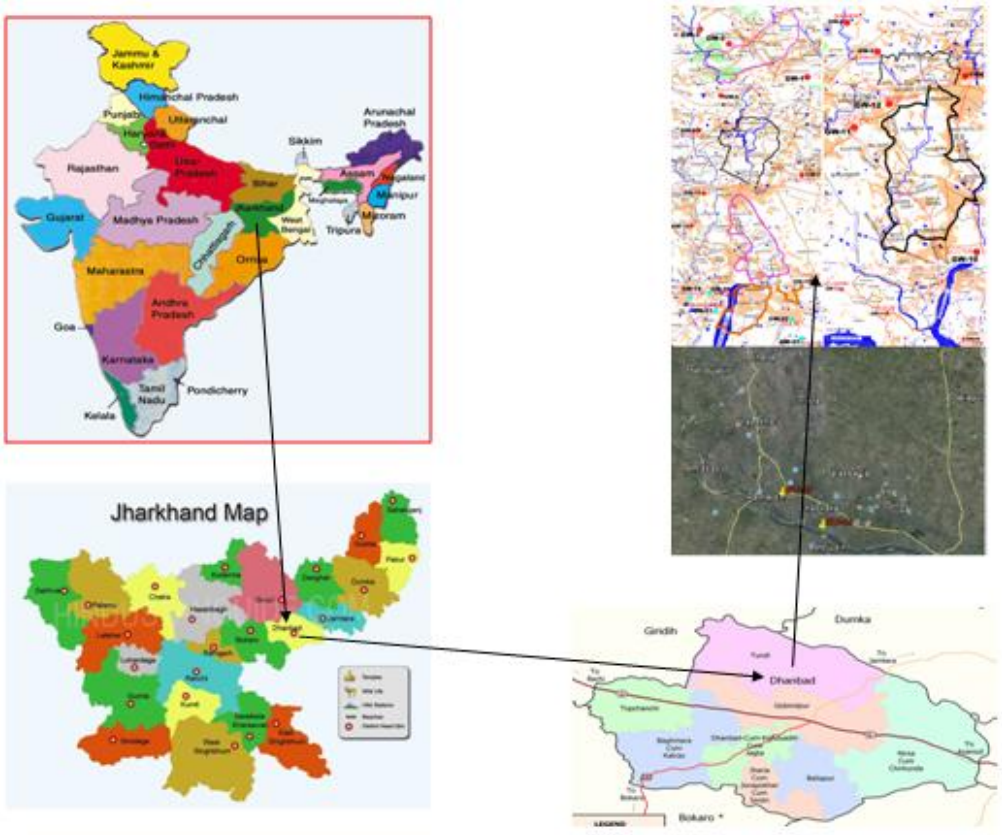

Fig.: I:- Index Map.

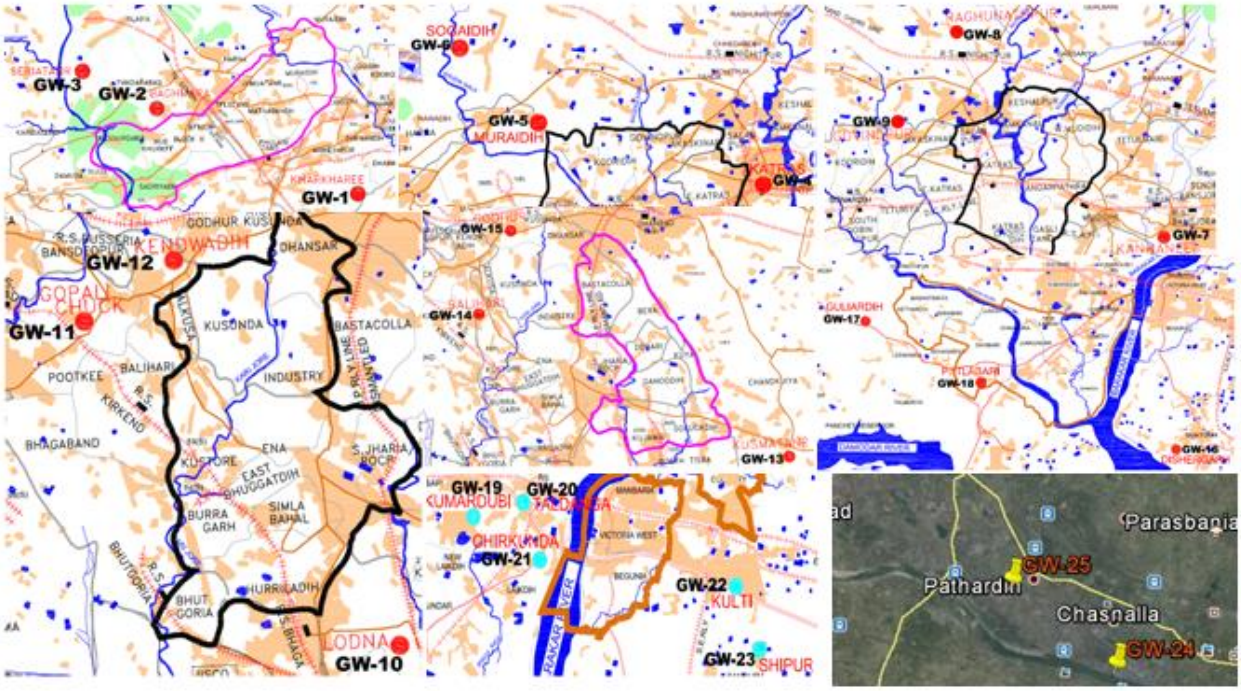

Fig.: II:- Sampling Locations.

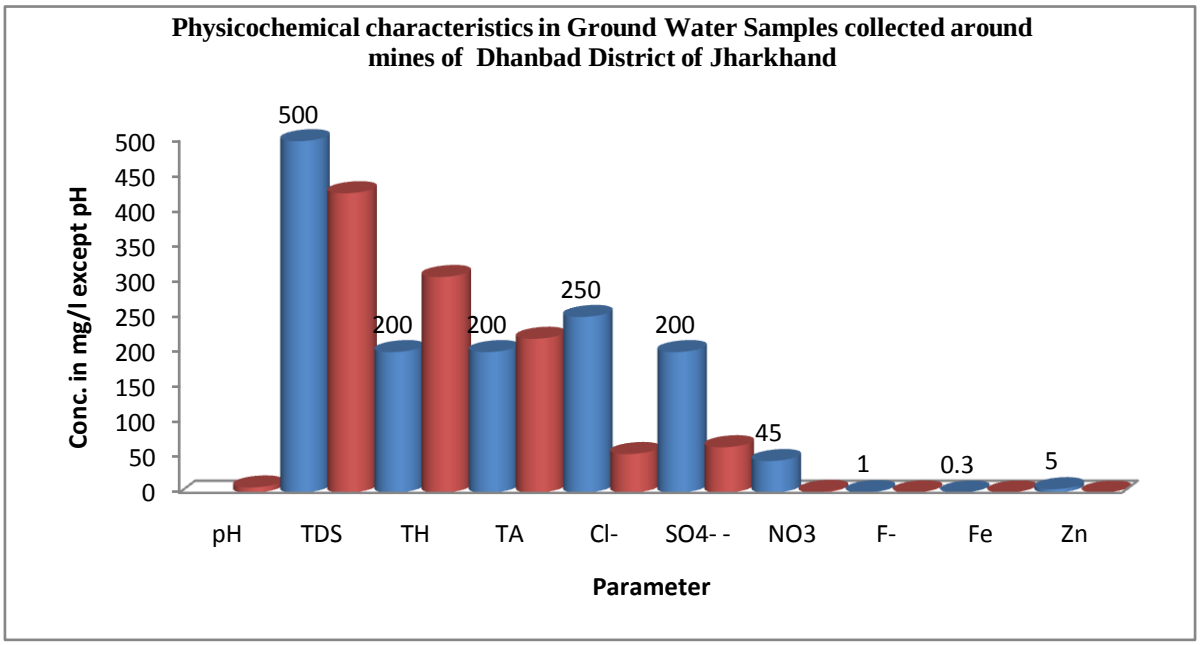

Fig.: III

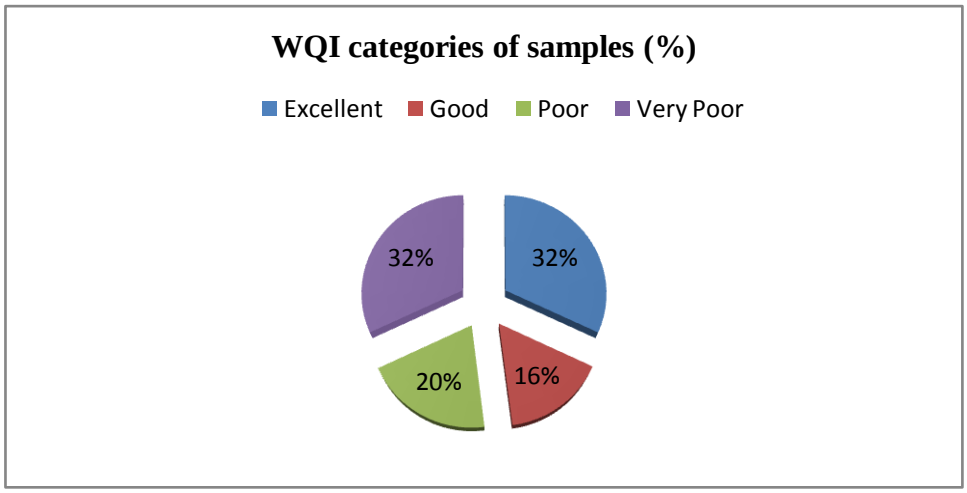

Fig.: IV

Table 1:- Sampling locations and Physico-chemical parameters of Ground water samples.
(Results are expressed in mg/l except pH)

Sl. No.	Location	Parameter									
		pH	**TDS**	**TH**	**TA**	**Cl^-**	**$SO4^{--}$**	**NO_3^{--}**	**F^-**	**Fe**	**Zn**
1	Kharkharee Village	7.8	450	364	230	60	74	1.2	0.5	0.2	0.16
2	Baghmara Village	7.3	456	346	214	72	66	1.3	0.5	#0.4	0.18
3	Seriatanr Village	7.7	460	362	160	104	90	1.2	0.4	#0.5	0.14
4	Katras Township	8.2	500	384	212	44	146	1.3	0.6	0.08	0.14
5	Muraidih Village	7.6	552	386	184	64	168	1.4	0.5	#0.8	0.16
6	Sogiadih Village	7.8	330	164	66	26	134	1.2	0.5	0.3	0.14
7	Kankanee Village	6.9	314	218	124	36	76	1.1	0.5	0.04	0.14
8	Ragunathpur Village	7.1	340	242	156	52	54	1.2	0.4	0.1	0.16
9	Govindpur Village	7.3	328	236	146	44	60	1.3	0.5	0.3	0.16
10	Lodna Village	7.9	452	386	350	30	28	1.5	0.5	#0.8	0.12
11	Gopalichuk Village	7.4	440	340	296	36	45	1.1	0.4	#0.5	0.14
12	Kendwadih Village	7.6	460	292	216	52	36	1.2	0.5	#0.9	0.14
13	Kusmatanr Village	7.9	342	270	186	34	60	1.5	0.5	#0.8	0.12
14	Balihari Village	7.6	400	316	210	58	56	1.4	0.5	#0.6	0.12
15	Godhur Village	7.6	546	428	192	138	84	1.2	<0.4	#1.0	0.14
16	Dishergarh Village	7.2	370	280	230	32	46	1.1	<0.4	#0.9	0.14
17	Guliardih Village	6.7	380	268	242	36	36	1.2	<0.4	0.08	0.12
18	Patlabari Village	7.4	410	290	270	46	28	1.3	<0.4	#0.6	0.14
19	Kumardhubi Township	7.6	453	300	246	64	58	1.4	<0.4	0.06	0.12
20	Taldanga Village	7.3	429	290	254	52	46	1.3	0.6	0.08	0.12
21	Chirkunda Township	7.6	404	230	226	56	38	1.3	0.6	#0.8	0.16
22	Kulti Village	7.1	448	304	238	56	68	1.2	0.7	0.06	0.18
23	Shipur Village	7.4	484	386	224	88	72	1.2	0.5	0.04	0.14
24	Chhasnala	7.8	532	348	330	70	28	1.5	<0.4	#0.9	0.2
25	Patherdih	7.4	370	242	272	26	20	1.2	<0.4	0.3	0.2
IS:10500 Acceptable/ Permissible Limits		**6.5-8.5**	**500/ 2000**	**200/ 600**	**200/ 600**	**250/ 1000**	**200/ 400**	**45**	**1.0/ 1.5**	**0.3**	**5.0/15**

Note: (1) TDS-Total Dissolved Solid (2) TH-Total Hardness (3) TA-Total Alkalinity (4) # - Exceeds acceptable limit

Table 2:- Water quality index.

Index Value	Water Quality
< 50	Excellent
50-100	Good
100-200	Poor
200-300	Very Poor
> 300	Unfit for drinking

Table 3:- Water quality index value of different locations of Dhanbad

Sl. No.	Location	WQI	Water Quality Status
1	Kharkharee Village	64.2	Good
2	Baghmara Village	113.6	Poor
3	Seriatanr Village	136.4	Poor
4	Katras Township	36.9	Excellent
5	Muraidih Village	212.9	Very Poor
6	Sogiadih Village	88.7	Good
7	Kankanee Village	23.9	Excellent
8	Ragunathpur Village	41.8	Excellent
9	Govindpur Village	88.6	Good
10	Lodna Village	212.9	Very Poor
11	Gopalichuk Village	136.2	Poor
12	Kendwadih Village	237.5	Very Poor
13	Kusmatanr Village	212.7	Very Poor
14	Balihari Village	163.2	Poor
15	Godhur Village	260.3	Very Poor
16	Dishergarh Village	230.8	Very Poor
17	Guliardih Village	31.7	Excellent
18	Patlabari Village	160.9	Poor
19	Kumardhubi Township	27.2	Excellent
20	Taldanga Village	36.2	Excellent
21	Chirkunda Township	214.7	Very Poor
22	Kulti Village	33.5	Excellent
23	Shipur Village	24.5	Excellent
24	Chhasnala	235.5	Very Poor
25	Patherdih	86.5	Good

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