The Analysis of Ground Water Quality Status using Linear Regression Method

Rahane Prashant Bhausaheb [1], Dr. M. V. Jadhav [2]
[1] PG Scholar, Dept. of Civil Engineering, College of Engineering, Kopargaon, Maharashtra, India
[2] Professor, Dept. of civil Engineering, College of Engineering, Kopargaon, Maharashtra, India

***Abstract*—** *Availability of ground water in Sangamner Taluka is ranging in between 5.5 and 10.25 m below ground level, out of the available ground water sources about 75 % is unfit for drinking purpose. Scenario becomes worse during the summer. Most of the groundwater sources are contaminated due to intensive irrigation and effluent discharge by Sugar Factories in the Pravara river basin. Ground water is depleting day by day leading to increased concentration of contaminant such as TDS, Alkalinity , Hardness , Ca, Mg ,Cl. Rural areas are facing drinking water scarcity due to increased use of available ground water sources for irrigation use and deteriorating water quality due to intensive irrigation, excessive use of fertilizer and other anthropogenic sources.*

Overall ground water quality scenario is not bright. Looking to situation the samples were collected for the study area from dug well, bore well, hand pump and percolation well during Pre monsoon and Post monsoon period. Collected samples were analyzed by physic-chemical method recommended by NEERI. Obtained results were further used for assessing the ground water quality status by using NSFWQI method.

Normal statistic of the parameters is computed and tabulated. Moreover, Correlation Coefficient is calculated amongst the all water quality parameters obtained during the analysis. These results are further used for regression analysis. The parameters which are strongly correlated with each other are selected for developing the Regression Equation. The equation thus formed provides the mathematical tool for assessing the Water Quality and to frame the Management Plan accordingly.

I. Introduction

Various resources of freshwater on Earth surface are ponds, lakes, rivers, run off, streams, polar ice mass, snow, glaciers and in the form of groundwater and underground streams. Generally fresh water does not contain high concentrations of dissolved salts and other total dissolved solids except water. The fresh water does not mean potable water. Out of the total fresh water on earth surface and ground water, most of the water is not suitable for drinking because it is contaminated by chemical and biological contaminants.

Freshwater is the most important environmental resource for which there is no substitute. From the total freshwater resource, majority of the freshwater is converted in the form of ice in ice caps and remaining 90% is groundwater. Overlying soils and geologic sediments prevents contamination of groundwater. It indicates that groundwater resources can be used for drinking purpose. According to census of India 2011, India's human population is 121 crore. Groundwater resources play important role in the survival of people in India. But water tables are decreasing dangerously all over the India. It may lead to water crisis in future. Therefore it is desirable to analyze physical and chemical properties of groundwater. It also gives stress upon environmental pollution.

Environmental activities and human interference are the main causes of change in the ground water quality. As per the reports of WHO, most of the infectious diseases in human beings are water born. It becomes imperative to analyze the water for physiochemical parameters (pH, conductivity, sulphate, turbidity, chloride, iron, hardness, calcium, fluoride, magnesium, alkalinity and total dissolved solids) by standard methods and means to make it safe for potable and other uses. Water quality is analyzed to judge the suitability of groundwater for the consumption of human.

II. Materials And Methods

This topic consist about Selected Eastern Rural Area in Sangamner Tehsil for analyze groundwater parameter. Different water quality parameters were determined using the following methods:

3.1 Study Area: Sangamner city and a Municipal corporation is located in the Ahmednagar District of Maharashtra state in India. It is located on the bank of Pravara River. The name Sangamner represents *sangam* (confluence) of three rivers: Pravara, Mhalungi, and Mahanuti. Sangamner is located at 19.57°N 74.22°E, on the banks of the Pravara River. The elevation is 549 meters (1,801 Ft.) from mean sea level. It ranks second in terms of population after Ahmednagar City. There are around 172 villages in Sangamner tehsil of Ahmednagar district of state of Maharashtra.

Groundwater samples are randomly collected from Kasarwadi village viz. Kasarwadi which are situated in Sangamner taluka in Ahmednagar district .The samples were collected from dug well, tube well, HP. etc. during the pre-monsoon and post monsoon period i.e.(March 2015 and Nov.2015) , above collected samples were analyzed for different water quality parameters viz. pH, Alkalinity , Total Hardness , Fluoride , Chloride, & TDS etc.

Table 1: Details of Sampling Locations in rural areas of Sangamner

Sr No	Location name	Location details	Source details
	KASARWADI		
1	S1	Dairy farm	Hand Pump
2	S2	Manglapur Phata	Tube well
3	S3	Aangan wadi	Hand Pump
4	S4	Pawar Wasti	Hand Pump
5	S5	Wale wasti	Tube well
6	S6	Mahatmanagar	Tube well
7	S7	Gaothan	Hand Pump
8	S8	ZP School	Production well
9	S9	Sarpanch Wasti	Tube well

III. Results And Discussions

Ground water quality parameter analyzed in Sangamner Taluka for Kasarwadi village. These samples were analyzed during pre-monsoon (March 2015) and post monsoon (Nov.2015) period for below mentioned water quality Parameters by using Water Quality Index, Statistics Method and Correlation Regression Model. The results are tabulated as below:

Table 2 :Results of Kasarwadi Groundwater Sample (Pre-monsoon)

SN	Parameter	S1	S2	S3	S4	S5	S6	S7	S8	S9
1	Temperature ^{0}C	28.3	28.6	29.2	28.8	30.1	29.6	29.0	28.8	29.3
2	pH	8.45	7.50	7.36	7.51	7.40	7.0	7.32	7.56	7.72
3	Alkalinity	386	410	62	449	531	436	125	618	230
4	DO	6.59	6.21	6.86	6.54	5.88	5.26	7.10	6.80	7.0
5	(TDS)	1212	1478	1660	1356	1150	2238	1640	1365	1753
6	Total Hardnes s	1095	1738	1892	1962	1665	2402	2102	1988	1269
7	Calcium	55.68	122	334	63.63	48.30	110.36	361.2	241.08	63.44
8	Magnesium	33.99	73.2	204.9	38.64	29.28	67.91	216.6	145.22	37.47
9	Chloride	145	90.97	261	139	210	104	284	167	110
10	Fluoride	0.34	0.40	0.30	0.15	0.48	0.34	0.40	0.35	0.46

Physico-chemical analysis of ground water quality parameters during Pre-Monsoon:

1. Tempurature:

Cold water is normally more drinkable than hot water. Microbes grow vigorously in water with high temperature It may alter taste, odor and corrosion problems to the surrounding material. The temperature for above samples was found in between 28.3 to 30.1^{0}C. The higher values of temperature are noticed mainly for pre-monsoon calculations.

2. pH:

It is clear from the table 2 that the pH value of water samples were varying from 7.0 to 8.45 and these values are within the limits prescribed by ISI, ICMR and WHO.

3. Alkalinity:

The acceptable limit at presence of alkalinity like hydroxides, carbonates and bicarbonates should be between 200 to 600 mg/l .The alkalinity values were found between 62 to 618 mg/l, which is higher side.

4. Dissolved Oxygen:

It is up to 4 mg/l for Survival of aquatic life, From Table 2 Samples were found D.O 5.26 to 07.10 mg/l.

5. Total Dissolved Solids:

TDS is represents organic and inorganic contains of groundwater. TDS of groundwater is chiefly because of decaying vegetables, vaporization, disposal of sewage and chemical weathering of rocks. In the present studies the TDS level was found up to1150 to 1753 mg/l which is very higher values than admissible limit. As per Standard, greater than 600 mg/l is not acceptable for drinking purpose.

6. Total Hardness:

Hard water with soap forms only scum in the form of white precipitate and do not form lather. From practical point of view, hardness is one of the important feature of groundwater for different purposes. For drinkable water the TH should be limited up to 300 mg/l & maximum admissible value is 600 mg/l. Table 2. Indicates 1095 to 1962 mg/l which has indicated higher values in groundwater.

7. Calcium: Calcium is an essential nutrient required for organism. Calcium values recorded in the range 48.30 – 361.20 mg/l for pre monsoon season are higher than permissible limits.

8. Magnesium: Concentration of magnesium values observed 33-216 in S1 & S9 respectively, for pre monsoon season are higher sides.

9. Chloride (Cl^-)

The advisable value of Chloride content is 250 mg/l .Above taken samples were found concentration of chloride vary from 90.97-261 mg/l .Obtained range which is slightly higher than permissible limits.

10. Fluoride:

The fluoride content in the groundwater shows in between 0.15 to 0.48 mg/l (Table 2). In all samples fluoride concentration is in permissible limit. According to recommendation of WHO maximum permissible level of fluoride should be below 1.5 mg/l.

Table 3 :Results of Kasarwadi Groundwater Sample (post-monsoon)

SN	**Parameter**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
1	Temperature ^0C	26.22	27.1	25`.6	26.53	26.10	27.26	27.3	26.8	26.8
2	pH	6.88	7.15	6.50	6.20	6.23	6.33	6.5	6.82	6.68
3	Alkalinity	330	226	295	330	356	380	304	252	304
4	DO	7.50	6.54	7.52	8.17	6.21	5.88	6.30	5.23	7.20
5	(TDS)	34.6	52.8	33.8	59.8	41.7	35.40	32.8	36	42.2
6	Total Hardness	1577	1864	3197	3052	2138	2880	3268	2952	2491
7	Calcium	81.2	79	57	72.1	127	125	121	127	111
8	Magnesium	49.42	48.19	38.86	43.92	77.47	76.71	73.84	77.47	67.93
9	Chloride	410.1	230.7	274.3	269.1	230.7	192.2	307.6	294.78	283.2
10	Fluoride	0.459	0.50	1.33	1.10	0.458	0.34	0.50	0.356	0.41

Physico-chemical analysis of ground water quality parameters during Post-Monsoon:

1. Tempurature:

The temperature for above samples was found in range between 25.60 to 27.30 ^{0}C.The lower values of temperature are observed mainly for post-monsoon computations.

2. pH:

It is clear from the table 3 that the pH value of water samples were varying from 6.20 to 7.15 and these values are within the boundaries authorized by ISI, ICMR and WHO.

3. Alkalinity:

The acceptable limit at presence of alkalinity like hydroxides carbonates and bicarbonates should be between 200 to 600 mg/l .The alkalinity values ranges from 226 to 380 (S6) mg/l, which is slightly in higher side.

4. Dissolved Oxygen :

It is up to 4 mg/l for Survival of aquatic life, From Table 3 Samples were found D.O 5.23 to 8.17 mg/l.

5. Total Dissolved Solids:

In the present studies the TDS level was found in between to 32.80 to 59.80 mg/l which is within permissible limit. As per Standard greater than 600 mg/l unacceptable for drinking purpose.

6. Total Hardness:

For drinking purpose, TH of water should be restricted upto 300 mg/l & maximum permissible value is 600 mg/l. table 3 indicates that all Samples are above permissible limits i.e. range in between 1577 to 3268mg/l which has indicated higher hardness in groundwater.

7. Calcium:

Calcium serves as an essential element for organism. Calcium values recorded for post monsoon season are in between 57 to 127 mg/l.

8. Magnesium:

Concentration of magnesium values observed for post monsoon season are in between 48.19 to 77.47 mg/l where desirable limit is 30 mg/l.

9. Chloride (Cl^-):

The desirable value of Chloride content is 250 mg/l. above taken samples was found concentration of chloride varying from 192 to 430 mg/l. which shows higher than permissible limits. Elevated chloride concentrations impart a salty taste to water.

10. Fluoride:

The fluoride content in the groundwater is in between 0.11 to 2.4 mg/l (Table 3). S11 samples show higher fluoride concentration. According to recommendation of WHO maximum permissible level of fluoride should be below 1.5mg/l.

Table.4.6. Water Quality Classification based on WQI Values

Sample no.	Village Name	Location of Samples	WQI of Samples	Water Quality
S1	Kasarwadi	Dairy farm	229.88	Very Poor water
S2	Kasarwadi	Manglapur Phata	372	Water unsuitable for Drinking
S3	Kasarwadi	Aangan wadi	752.63	Water unsuitable for Drinking
S4	Kasarwadi	Pawar Wasti	272.96	Very Poor water
S5	Kasarwadi	Wale wasti	242.63	Very Poor water
S6	Kasarwadi	Mahatma nagar	396.87	Water unsuitable for Drinking
S7	Kasarwadi	Gaothan	798.68	Water unsuitable for Drinking
S8	Kasarwadi	ZP School	602.65	Water unsuitable for Drinking
S9	Kasarwadi	Sarpanch Wasti	248.39	Very Poor water

Linear Regression Model:

Correlation coefficient for all the water quality parameters during Pre Monsoon and Post Monsoon are calculated by using Pearson's Correlation Coefficient formula.

$$R = \frac{\sum (X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum (X - \bar{X})^2 \sum (Y - \bar{Y})^2}}$$

IV. CONCLUSIONS

Settlement of Kasarwadi Villages is near bank of Pravara River. River is completely dry for eight months i.e. pre monsoon period during this period Groundwater level depth gets depleted so there concentration of Hardness, Alkalinity and Total dissolved solids increased beyond its permissible limits. .Though, analyses were conducted in summer season (Pre-monsoon) and Rainy season (Post-monsoon) and most of the sampling locations shown the increased values of the tested parameters. Results of samples collected in pre monsoon and post monsoon were obtained that Ground water quality shown by the Kasarwadi villages were very bad to unsuitable categories for drinking purposes. In summer season, the ground water is stagnant and the source of contamination was only the natural source of rock-water. Nearly all ground water samples in both seasons were found in the range of poor category. In the case of post-monsoon the water quality parameters such Chloride, Total Hardness obtained increased due to anthropogenic activities and other geological parameters, where Ca, Mg, decrease as compare pre monsoon. Over all Alkalinity, TDS, TH, Cl, Ca and Mg saw higher values which is beyond BIS recommendations permissible limits for Drinking water.

The WQI for pre-monsoon for 09 samples ranges from 229.88 to 798.68 where in post monsoon range 244.23 to 365.82. From obtained results water quality got improved in post monsoon period in range of unsuitable to poor water. WQI of groundwater samples seen all higher values because of presence of Alkalinity, TDS, TH, Cl, Ca and Mg where all parameter indicates that water Hardness so need ground water some degree of treatment to reduce Alkalinity, Total Hardness and also need to be protected from the contamination. At present current scenario of ground water quality in the some part of the rural area of Sangamner taluka is at mark.

The statistical regression analysis among different water quality parameters having significant correlation with each other's, provides a mathematical model which can be effectively used for prediction and forecasting the realistic situation of ground water quality. Here, Correlation Coefficient among all the water quality parameters are calculated from obtained results and are used to develop the mathematical model. Regression

Equation is effective for predict and forecast the water quality at particular location and also helpful to evaluate related parameters. The developed model during Pre-monsoon and Post-monsoon from Kasarwadi villages will help us to predict the Water Quality in future and also facilitates to frame the Ground Water Quality Management Plan.

Moreover, by using Low cost herbs treatment stated above can bring ground water parameters like Alkalinity, Total Hardness, Total Dissolved Solids, Calcium Magnesium and Chloride within permissible limits which make water potable for small community area. Therefore, suitable cost-effective indigenous treatment technologies should be searched out and adopted to soften the hard water in the study area.

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