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Assessment of Ground Water Quality and Statistical Analysis of Various Parameters in Banda City (U.P)

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ABSTRACT: Ground water quality of many hand pumps at different locations of Banda city was evaluated. The correlation relationship were found among physico-chemical parameters likes temperature, turbidity, pH, D.O, T.D.S, total solids, alkalinity, total hardness, calcium hardness, magnesium hardness, chloride and iron of the ground water in District Banda (U.P.). In the light of above facts, the above study was designed to monitor the quality of ground water of Banda city. The parameters investigated were temperature, turbidity, color, test, odour, transparency, D.O, pH, T.D.S, total solids, alkalinity, total hardness, calcium hardness, magnesium hardness, chloride and iron. The results were compared with drinking water quality standards prescribed by Bureau of Indian Standards and WHO. Most of the water samples were founds to have high alkalinity, total hardness, calcium hardness and magnesium hardness values more than their permissible level. The more concentration of alkalinity and hardness were found of ground water in District Banda is due to the natural accumulation of contents of calcium and magnesium ions and salts or both. It is resulting from more solubility of calcium and magnesium salts under anaerobic conditions. The high concentration of alkalinity, total hardness, calcium hardness and magnesium hardness may have health complications and therefore they need attention.

KEYWORDS: Ground water quality, T.D.S, alkalinity, total hardness, chloride, Iron.

I. INTRODUCTION

Water is an essential natural resource and an absolute necessity for sustaining life. Water is not only the most significant constituent of all animals, plants and other organisms but it is also pivotal for the survivability of the mankind in the biosphere. It is the lifeblood of the environment. Human beings solely depend upon the availability of fresh water for living and livelihood and in its natural state it is a 'savior of life'. Today, by ignoring these facts, man is indiscriminately polluting water and unknowingly providing nature a complex situation.

Water is an essential requirement of human life and activities associated with industry, agriculture, and others, and it considers one of the most delicate parts of the environment. In the last few decades, the accelerated pace of industrial development and progressive growth of population caused in tremendous increase in the demand of fresh water. The quality of surface and groundwater is identified in terms of its physical, chemical, and biological parameters. The water quality of rivers is characterized by a high level of heterogeneity in time and space, because of the distinction of cover-land around. This often creates difficulties to identify water conditions and pollution sources, which is necessary to control effectively pollution in addition to construct successful strategies for minimizing of contamination resources. Anthropogenic pollutants related to land use result in drastic deterioration of aquatic systems in watersheds. Additionally, the rivers play an important role in assimilating municipal and industrial effluent as well as runoff from agricultural land and the surrounding area in a watershed. On the other hand, rivers comprise the most important water resources for irrigation, domestic water supply, industrial, and other purposes in a watershed, thereby tending to stimulate serious hygienic and ecological problems. Consequently, prevention and controlling of river pollution and reliable evaluation of water quality are an imperative stipulation for effective management.

According to Chow et.al, (1988) about 96.5 percent of all the earth's water is in the ocean. If the earth were a uniform sphere, this quantity would be sufficient to cover it to a depth of about 2.6 km. of the reminder, 1.7 percent is in form of polar ice, 1.7 percent as ground water and only 0.1 percent is as surface and atmosphere water. The atmospheric water system, the driving force of surface water hydrology, contain only 12,900 km² of water, or less than one part in 100,000 of all the earth's water. Of the earth's fresh water, about two-third is polar ice and most of the remainder is ground



water going down to a depth of 200 to 600 m. Only 0.006 percent of fresh water is contained in rivers. Biological water, fixed in the tissues of the plants and animals, makes up about 0.003 percent of all fresh water, equivalent to half the volume contained in river.

Water is the most vital resource for the living organism to survive. It possesses a number of physical and chemical properties that help the molecule to act as best suited medium for the life activities. Most of the biochemical reactions those occur in the metabolism and growth of living cell involve water hence it has been referred to as universal solvent. Ground water is the biggest source of fresh water in the world. It is estimated that about 80% human population live in villages and use ground water for domestic, agriculture and drinking purposes. Even within the human body (75% water by volume) water is critical in maintaining uniform body temperature. According to Asthana and Ashthana, 2001, Estimated ground water quantities in world in the atmosphere is given in Map 1.

Pearson product-moment correlation analysis was conducted to evaluate the relationship of water quality parameters and revealed a significant between salinity, conductivity, dissolved solid and BOD, COD and nitrogen in form of ammonia. Partial correlation analysis (r_p) results showed that there is a strong relationship between salinity and turbidity (0.930) and BOD and COD (0.839) controlling for the linear effects of conductivity and ammonia, respectively (Adamu et.al., 2013).

Banda is a district place situated at $25^{\circ}30^1$ N latitude and $80^{\circ}18^1$ E longitude and it is at the bank of river Ken. Banda is famous for its historical, mythological and religious significance. Wastewater produced by domestic activities contributes about 45% organic waste along with inorganic materials and trace metals. Often this wastewater is discharged without any treatment into ground water with gravitational force by seepage. The pollution in Banda city is increasing resulting from increases in organization and development.

STUDY AREA

Six handpumps of Banda city were selected for the study. These were of Madhianaka, Bhuragarh, Jail road, Awas Vikas, Katra and Balkhandi Naka. Detailed of hand pumps were given in Table 1. The ground water sampling was done in May, 2015. High grade plastic bottles of one liter capacity were used for sampling, which were thoroughly cleaned prior to filling with water samples.

II. MATERIAL AND METHODS

The temperature, pH and dissolved oxygen(D.O.) were analyzed at sampling sites while other parameters like T.D.S, total solids, alkalinity, total hardness, calcium hardness, magnesium hardness, chloride were estimated in the laboratory. Glassware's and chemicals used in the study were of high quality and supplied by Scott Duran and Qualigens/ Merck respectively.

All parameters were analyzed as per the prescribed standard methods for examination of water and wastewater (APHA and AWWA).

III. RESULTS AND DISCUSSION

Details of ground water locations were given in table 1. The results of physico-chemical monitoring of ground water samples of the selected handpumps were mentioned in table 2. The results obtained for correlation coefficient (r) among various water quality parameters is showed in tables 3. The basic statistics such as mean, standard deviation, coefficient of variation obtained in statistical analysis are presented in table 4. Drinking water standards prescribed by W.H.O. and BIS were summarized in table 5.

Colour- It was estimated that all water samples were colourless. Colour adversely affects the water quality and also it is not aesthetically acceptable.

Odour- It is a physical property of water and from the results it was found that the water samples of all locations had not detectable, which is desirable for drinking purpose. Thus, the water samples were acceptable for drinking purposes.

Temperature- It recorded ranged from 25 to 27⁰C in all cases (table 2), and the coefficient of variance was observed 3.0% only. Temperature affects the aquatic life due to dissolved oxygen percentage in water bodies. Rise in temperature decreases the dissolved oxygen(table 2).

Turbidity- It is an important parameter of water quality analysis. It is responsible for aesthetic acceptance of water as well as photosynthesis. It is caused due to presence of a lots of number of suspended substances like peat, sludge, organic and inorganic matter, soluble colour organic compound, plankton and other micro substance etc in water. The value of turbidity in the aforesaid water samples was found to be 2.1 to 2.5 NTU (Figure 1), and the coefficient of variance was observed 6.4% only.

pH- It was observed from the pH value that water samples were slightly in alkaline nature, varying from 8.0 to 8.3, and the coefficient of variance was observed 1.5% only. These values were within the limits prescribed by WHO and BIS (table 2).

TDS- Content of total dissolved solids varied from 320 to 370 mg/l, and the coefficient of variance was observed 5.0% only. It was more than the limit prescribed by Bureau of Indian Standards (BIS).

Total hardness- It varied from 200 to 341 mg/l (Figure 2), and the coefficient of variance was observed 19.6% only. Hardness of water is seemed to be the capacity of water for reducing and destroying the soap lather. Hardness in water is due to the natural accumulation of contents of calcium ions and magnesium ions and salts or both. The sum of the calcium and magnesium hardness is called total hardness. The high value of total hardness was found due to the availability of limestone rocks in the surrounding area consequently more solubility of calcium and magnesium salts under anaerobic conditions (Singh and Kumar, 2004 and Kumar et. al., 2006).

Calcium hardness- It ranged from 122 to 195 mg/l, and the coefficient of variance was observed 17.9% only. Rao et.al. (2006) reported that hardness in water was due to the natural accumulation of contents of calcium and magnesium and salts. Such water is not safe for drinking purposes. Calcium hardness varied from 58 to 96 mg/l.

Magnesium hardness- It varied from 88 to 161mg/l, and the coefficient of variance was observed 20.0% only.

DO- Dissolved oxygen values were found in range of 4.7 to 5.2 mg/l (Figure 1), and the coefficient of variance was observed 3.7% only. The deep depth of hand pumps prevents low aeration results in short amount of dissolved oxygen (Gnana, 2005).

Chloride- The values of chloride were found in range of 25 to 36 mg/l, and the coefficient of variance was observed 12.6% only. The amount of the chloride present in the ground water samples was under the permissible limit. High chloride reacts with sodium and makes water salty in taste, which is unacceptable for human consumption. It also increases the total dissolved solid values thereby affecting the quality of water.

Iron- The values of iron were found in range of 0.08 to 0.21 mg/l, and the coefficient of variance was observed 34.4% only. The values of iron concentration in all the samples were within the its prescribed limit for potable water. Iron concentration in water more than 2.0 ppm causes staining on clothes, sanitaryware and imparts bitter astringent taste. Taste and odour are problem that may be caused by organisms that prey on iron compound (Raval and Malik 2010).

Alkalinity- It varied from 120 to 240 mg/l (Tables 2), and the coefficient of variance was observed 23.7% only. The carbonate alkalinity was found to be absent indicating that the total alkalinity recorded was due to accumulation of bicarbonate only (Jameel and Hussain, 2007).

The linear correlation coefficient (r) has a value between +1 & -1. The value of +1 represents a perfect positive correlation and -1 represents a perfect negative correlation. The correlation between the parameters is characterized a strong when it is in the range of +0.8 to +1.0 and -0.8 to -1.0, moderate, when it is having value in the range of +0.5 to +0.8 and -0.5 to -0.8, and weak it is in the range of 0.0 to +0.5 and 0.0 to -0.5 (Bathusa and Safetharan, 2007).



The correlation coefficients (r) among various water quality parameters were calculated and the value of correlation coefficient (r) is given in Table 4. Out of the 66 correlation coefficient, 19 strong correlation between temperature and turbidity (0.888), temperature and pH (0.968), temperature and TDS (0.939), temperature and alkalinity (0.873), turbidity and pH (0.859), turbidity and TDS (0.974), pH and TDS (0.918), total hardness and calcium hardness (0.870), total hardness and magnesium hardness (0.924), total hardness and chloride (0.943), total hardness and iron (0.961), magnesium hardness and calcium hardness (0.826), alkalinity and calcium hardness (0.926), chloride and calcium hardness (0.880), iron and calcium hardness (0.853), alkalinity and magnesium hardness (0.823), chloride and magnesium hardness (0.884), iron and magnesium hardness (0.826), alkalinity and chloride (0.870) were found.

Correlation coefficient between temperature and total hardness (0.562), temperature and calcium hardness (0.651), temperature and magnesium hardness (0.642), turbidity and alkalinity (0.688), pH and chloride (0.664), pH and alkalinity (0.764), total hardness and alkalinity (0.774), TDS and chloride (0.675), TDS and alkalinity (0.764), iron and alkalinity (0.774) were found to be of moderate correlation. Correlation coefficient between turbidity and iron (0.443), pH and total hardness (0.414), pH and calcium hardness (0.456), pH and iron (0.480), TDS and total hardness (0.392), TDS and magnesium hardness (0.402) were found to be weak correlation. Dissolved oxygen was found with strong negative correlation with other parameters.

IV. CONCLUSION

The above study indicated that ground water quality of the selected hand pumps was almost good consequently water was fit for drinking and other domestic purposes. Occurrence of lime stone and dolomite rocks produced hardness in the study area.

These results must be shared with people of the area and necessary remedial cure must be suggested to them to improve the water quality more. These data may also be shared with public health engineering authorities in order to upgrade the quality of water for a safe and healthy life.

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Table-1. Details of Handpumps Locations, Banda City (U.P.)

S.N.	Location	Depth of handpump (Feet)
1.	Madhianaka	125
2.	Jal-Kal office ,Bhuragarh	115
3.	Jail colony, Kyotara	125
4.	Vikas Bhavan,Avas vikas	120
5.	Moti Bhavan, Katra	110
6.	Maheshwari Devi Temple, Balkhandi Naka	130

Table-2. Result of Physico-chemical Parameter Analysis of Water of the Handpumps

S.N .	Location	Madhian aka	Bhurag arh	Kyotara	Avas Vikas	Katra	Balkhandi Naka
Parameter							
1.	Colour (Hazen unit)	Nil	Nil	Nil	Nil	Nil	Nil
2.	Odour	Odour less	Odour less	Odour less	Odour less	Odour less	Odourless
3.	Temperature (0 ⁰ C)	27	25	26	26	27	27
4.	Turbidity (NTU)	2.3	2.1	2.2	2.2	2.4	2.5
5.	pH	8.3	8	8.1	8.2	8.3	8.3
6.	T.D.S (mg/l)	351	320	340	342	361	370
7.	Total hardness (mg/l)	341	200	340	250	262	280
8.	Calcium hardness (mg/l)	180	122	195	131	178	165
9.	Magnesium hardness (mg/l)	161	88	145	119	132	115
10.	Dissolved oxygen (mg/l)	4.7	5.2	4.8	5.1	5	4.9
11.	Chloride (mg/l)	36	25	35	30	32	34
12.	Iron (mg/l)	0.21	0.08	0.2	0.11	0.13	0.18
13.	Alkalinity (mg/l)	230	120	220	160	240	210



Table 3: Correlation Coefficient (r) among Various Water Quality Parameters

	Temperature	Turbidity	pH	TDS	TH	CaH	MgH	DO	Chloride	Iron	Alkalinity
Temperature	1	.888	.968	.939	.562	.651	.642	-.655	.786	.635	.873
Turbidity		1	.859	.977	.276	.466	.260	-.399	.570	.443	.688
pH			1	.918	.414	.456	.541	-.507	.664	.480	.744
TDS				1	.392	.535	.402	-.481	.675	.516	.764
TH					1	.870	.924	-.971	.943	.961	.774
CaH						1	.826	-.861	.880	.853	.926
MgH							1	-.895	.884	.826	.823
DO								1	-.950	-.984	-.800
Chloride									1	.956	.887
Iron										1	.774
Alkalinity											1

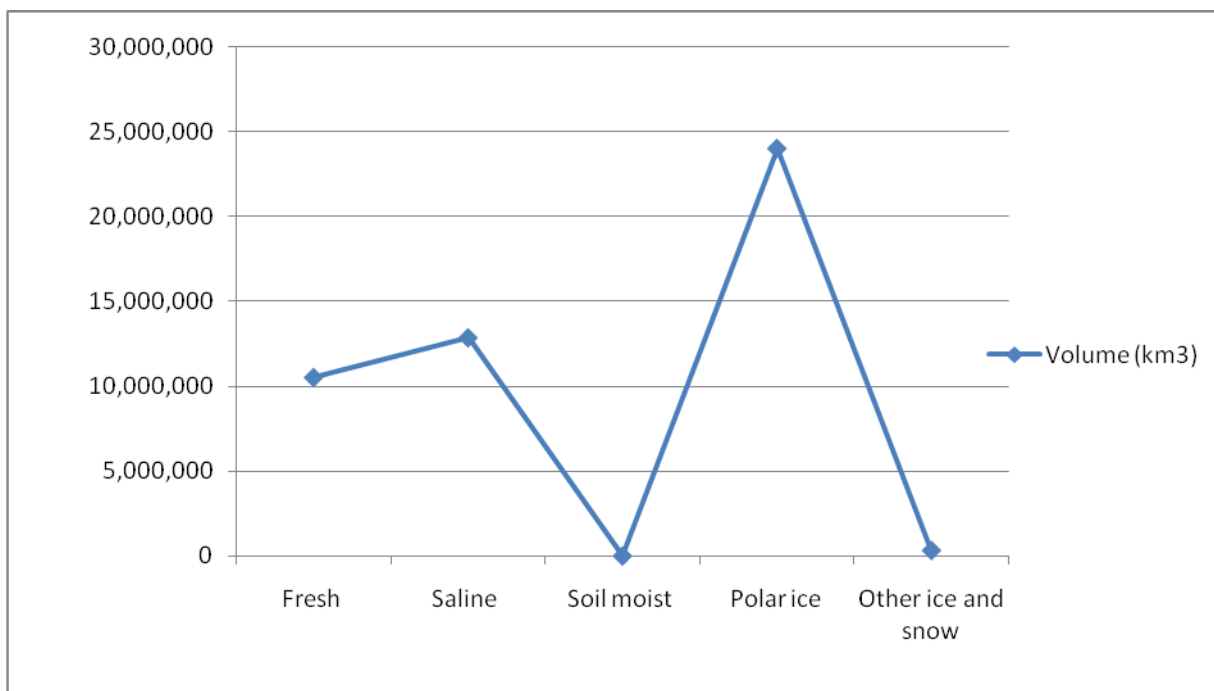
Table 4: Basic Statistics for Parameters Monitored

S.N	Parameter	Range	Mean	Std. Deviation	Coefficient of variation (%)
1.	Temperature (0 ⁰ C)	25-27	26.3333	0.81650	3.0
2.	Turbidity (NTU)	2.1-2.5	2.2833	0.14720	6.4
3.	pH	8.0-8.3	8.2000	0.12649	1.5
4.	T.D.S (mg/l)	320-370	347.3333	17.56891	5.0
5.	Total hardness (mg/l)	200-321	278.8333	54.65681	19.6
6.	Calcium hardness (mg/l)	122-195	161.8333	29.11643	17.9
7.	Magnesium hardness (mg/l)	88-161	126.6667	25.42964	20.0
8.	Dissolved oxygen (mg/l)	4.7-5.2	4.9500	0.18708	3.7
9.	Chloride (mg/l)	25-36	32.0000	4.04969	12.6
10.	Iron (mg/l)	0.08-0.21	0.1517	0.05269	34.4
11.	Alkalinity (mg/l)	120-240	196.6667	46.76181	23.7



Table-5. Drinking Water Quality Standards

S.N.	Parameters	Permissible Limit	
		World Health Organization (WHO. 1994)	Bureau of Indian Standards (BIS 10500: 1991)
1.	Colour, (Hazen unit, Max)	Nil	5.0
2.	Turbidity (NTU)	5.0	5.0
3.	Odour	Nil	Unobjectionable
4.	pH	7.0-8.5	6.5-8.5
5.	Dissolved solids (mg/l)	500	500
6.	Total hardness (mg/l)	100	300
7.	Calcium hardness (mg/l)	75	75
8.	Magnesium hardness(mg/l)	30	30
9.	Alkalinity (mg/l)	200	200
10.	Dissolved oxygen (mg/l)	4-6	4-6
11.	Chloride (mg/l)	250	250
12.	Iron (mg/l)	0.3	0.3



Graph 1: Estimated Ground Water Quantities, World Water Balance and Water Resources of the Earth, Copyright, UNESCO (1978)

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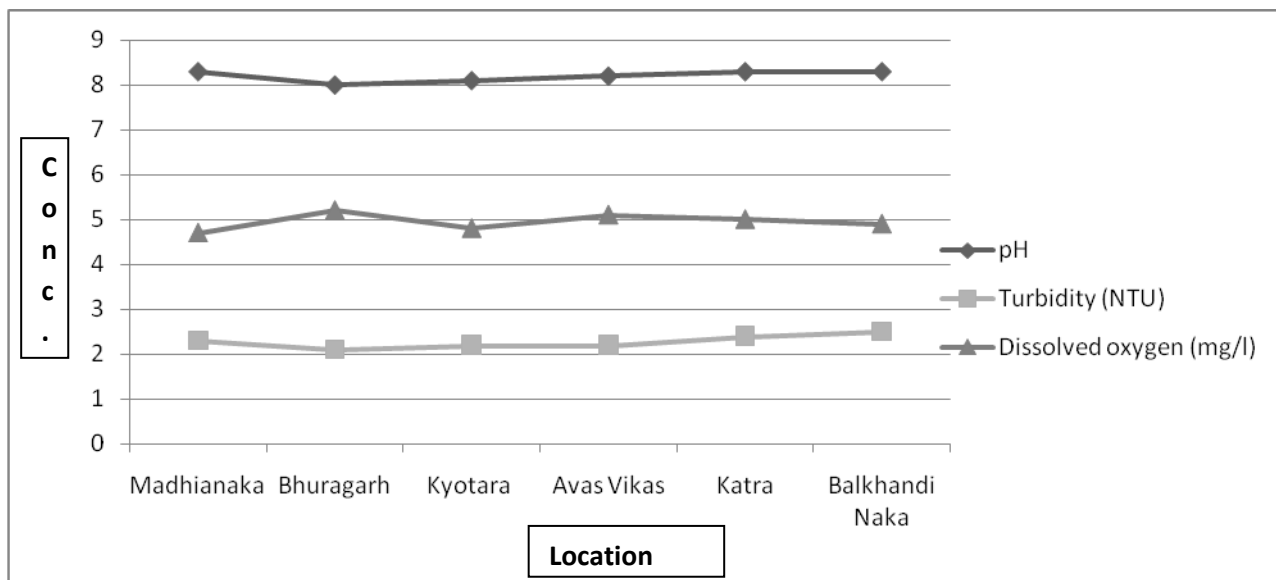


Figure 1. Amount of pH, turbidity and D.O. in the selected locations

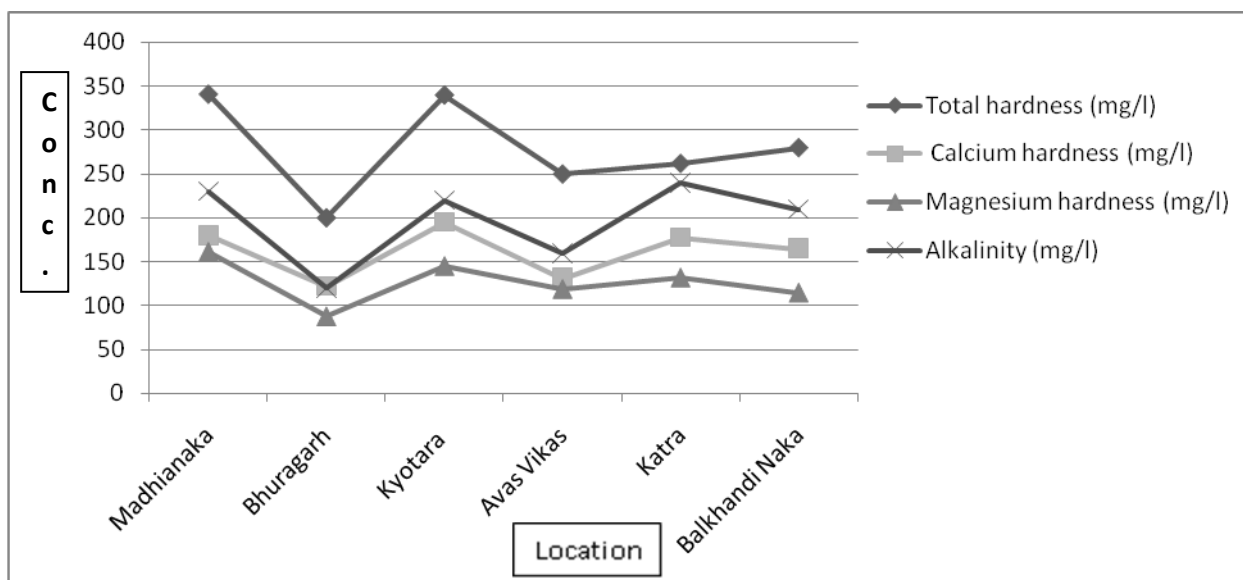


Figure 2. Amount of total hardness, calcium hardness, magnesium hardness and alkalinity in the selected locations



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