A Study on Physico-Chemical Properties of Ground Water Quality of Various Locations of Kanpur City

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Abstract: ***The quality of groundwater depends on a large number of individual hydrological, physical, chemical and biological factors. Generally higher proportions of dissolved constituents are found in groundwater than in surface water because of greater interaction of ground water with various materials in geologic strata. The water used for drinking purpose should be free from any toxic elements, living and nonliving organism and excessive amount of minerals that may be hazardous to health. Some of the heavy metals are extremely essential to humans, for example, Cobalt, Copper, etc., but large quantities of them may cause physiological disorders. The contamination of groundwater by heavy metals has assumed great significance during recent years due to their toxicity and accumulative behavior. These elements, contrary to most pollutants, are not biodegradable and undergo a global eco-biological cycle in which natural waters are the main pathways. The determination of the concentration levels of heavy metals in these waters, as well as the elucidation of the chemical forms in which they appear is a prime target in environmental research today. The Kanpur Nagar District is part of Indo Gangetic Plain. The silt, gravel, and sands of different grades are main water bearing formations. The ground water occurs under unconfined condition in phreatic zones and under confined condition in deeper zones. The sedimentological constitution of the subsurface granular zones shows remarkable variation in the depth and the nature of occurrence in north and southern part of the district. The ground water of Kanpur Nagar district is colourless, odourless and slightly alkaline in nature.***

Keywords: Groundwater, Water quality index, physico chemical analysis, alkaline water

1. Introduction

Groundwater is part of the water cycle. It is water that is located beneath the earth's surface in pores and crevices of rocks and soil. Because it is beneath the ground it cannot be seen. This presents different challenges for quantifying and managing the groundwater in comparison with surface water. Groundwater is an important part of the environment. It flows into rivers and wetlands, often sustaining them during the summer months or in drought. Trees, shrubs and grasses may also rely on groundwater as their key source of water particularly during times of drought. People pump groundwater for lots of reasons. Groundwater provides drinking water for more than 80 cities and towns in Uttar Pradesh. It is also used to irrigate crops, provide drinking water for stock and to support industry. In some parts of UP, groundwater is pumped-out to evaporation basins or mixed with other water for reuse, to protect crops, pastures and waterways from salinity. Mining industries also remove groundwater to keep mines safe from collapse.

The Kanpur Nagar district lies in middle of Uttar Pradesh State. It lies between 25°55' and 27° North latitude and 79°30' and 80°35' East longitudes in Survey of India Toposheet No. 54N and 63B. The total geographical area of the district is 3155 sq.km. with three number of Tehsil and the numbers of blocks viz. Kalyanpur, Bidhnu, Sarsaul, Bilahaur, Kakawan, Sivrajpur, Chaubepur, Patara, Bhitrgaon and Ghatampur. The major parts of the area is almost a flat plain with some minor undulations. The river Ganga and Yamuna with their tributaries form the drainage system (Dendritic type). As per census of 2001 the total population of the district is 4167499 persons having 2247216 male and 1920783 female. In year 2005-06 the Net sown area is 185667 hectare and Net Irrigated area is 130333 hectare. The area irrigated by Canal is 32308 hectare where as by ground water is 96636 hectare (74%). The total length of Canal in the district is 822 km. The total number of state tube wells and boring wells are 293 and 54160 respectively. Kanpur has been one of the highly industrial urban centres of India. Along with unbridled unbanisation coupled with intense industrial activities, the city plays host to innumerable environment related problems. These include urban solid waste, industrial effluents and emissions besides hazardous solid waste dumbing from the industrial sectors which ultimately lead to ground water contamination.

1.1 Drinking Water Status

The city exploits both surface water (75 per cent) and groundwater sources (25 per cent). The Ganga River and the Lower Ganga Canal constitute the surface water sources. The tapping of groundwater is most common in industrial areas.

Water quality index (WQI) is a dimensionless number that combines multiple water quality factors into a single number by normalizing values to subjective rating curves . Conventionally it has been used for evaluating the quality of water for water resources such as rivers, streams and lakes, etc. Factors included in WQI vary depending upon the designated water uses of the waterbody and local preferences. Some of the factors include dissolved oxygen (DO), pH, biological oxygen demand (BOD), chemical oxygen demand (COD), total coli form bacteria, temperature, and nutrients (nitrogen and phosphorus), etc. These parameters are measured in different ranges and expressed in different units.

2. Experimental Work

The present study was carried out at the different twenty locations of Kanpur as shown below (encircled) in the map of Kanpur city with the aim of assessing the drinking water quality.

The study also indicates the possible source of contamination in drinking water. Ground water samples collected in a poly propylene plastic bottles from different locations of Kanpur city were analyzed for different physico-chemical parameters like pH, TDS, Total hardness, chloride, Nitrates as per the method described in “standard methods for the examination of water and waste water”[1]. The observed values of various physico-chemical parameters of water samples were compared with standard values recommended by World health Organization and Indian Standard. Significant correlation has been verified.

Table 1: Analytical data of the groundwater of the study area of Kanpur city

S.No	*pH*	*Temp*	*Turb.*	*TDS*	*T.A*	*EC*	*T.H*	*Cl*	*F*	*NO_3*	*Na*	*K*
1	7.2	30.5	2.0	236	220	450	147	46	0.17	19	30	08
2	6.9	31.4	2.8	632	245	1224	184	57	0.10	24	34	10
3	7.1	30.8	1.6	546	235	889	170	35	0.12	27	22	09
4	6.8	31.5	0.5	325	302	754	138	19	0.08	14	06	02
5	7.2	30.0	0.7	585	336	1141	206	39	0.13	18	24	03
6	7.3	31.5	2.0	667	386	1245	228	59	0.25	28	36	03
7	6.8	30.5	4.0	876	414	768	330	45	0.16	17	31	10
8	7.0	31.8	3.6	742	432	866	185	39	0.32	29	55	02
9	7.2	32.0	4.2	716	485	932	209	42	0.28	09	41	04
10	6.9	30.0	1.8	396	286	1122	196	32	0.12	06	18	06
11	6.8	32.5	2.2	416	618	646	212	34	0.09	08	21	05
12	7.0	32.0	5.0	618	745	946	245	88	0.82	18	54	03
13	7.3	31.5	3.6	386	330	750	650	69	0.50	15	52	03
14	7.2	30.0	2.9	488	616	884	284	70	0.60	19	55	02
15	7.0	32.0	4.7	816	550	815	215	74	0.59	17	40	06
16	6.8	31.5	6.2	618	446	915	240	80	0.82	20	44	11
17	6.9	30.0	0.9	294	330	650	218	38	0.30	12	26	03
18	7.0	32.0	1.8	316	315	817	236	48	0.58	14	33	02
19	7.2	31.8	3.6	615	496	1120	335	80	0.89	09	41	10
20	7.3	32.0	2.8	584	375	1360	346	92	0.88	10	45	05

3. Result and Discussion

The temperature of ground water in regional area was in the range of 30-33oC. According to the table 1, pH analysis of ground water samples ranges from (6.8-7.5), which indicates that water is slightly alkine and the Indian Environmental Protection Agency has determined that drinking water should have a pH between 6.5 and 8.5 in order to limit the concentration of dissolved contaminants from acidic waters or the buildup of scale deposits from alkaline water.

Total dissolved solids value vary between 235 mg/L to 1000 mg/L with a mean value of 618 mg/L. The most important aspect of TDS with respect to drinking water quality is its effect on taste. The palatability of drinking water with a TDS level less than 600 mg/L is generally considered to be good. Drinking water supplies with TDS levels greater than 1200 mg/L are unpalatable to most consumers.

Turbidity was measured using specialized optical equipment in a laboratory or in the field. A light is directed through a water sample, and the amount of light scattered is measured. The unit of measurement is called a Nephelometric Turbidity Unit (NTU), which comes in several variations. The greater the scattering of light, the higher the turbidity. Low turbidity values indicate high water clarity; high values indicate low water clarity. Turbidity of the water sample was also found to be less at most of the point and range from 0 to 7 NTU which itself indicates high water clarity.

The total hardness of the studied water sample range from 145 mg/L to 350 mg/L with an average value of 248 mg/L. The taste threshold for the calcium ion is in the range 100–300 mg/l, depending on the associated anion, but higher concentrations are acceptable to consumers. Hardness levels above 500 mg/litre are generally considered to be aesthetically unacceptable, although this level is tolerated in some communities.

The electrical conductivity of the water was determined in a quick and inexpensive way, using portable meters. The EC values of the collected water samples varied from 450 to 1360 (µS/cm) with an average value of 905 µS/cm and this value is much higher than the prescribed standard limits (600 µS/cm) recommended by Indian Standard.

Chloride values for the collected sample varied between 19-92 mg/L with an ave4rage value of 56 mg/L. Saskatchewan’s Drinking Water Quality Standards and Objectives and Health India`s Guidelines for Drinking Water Quality both establish an aesthetic objective (AO) of less than 250 mg/L of chloride in drinking water. Drinking water with levels of chloride above 250 mg/L may cause corrosion in distribution systems and may be detectable by taste. The level of 250 mg/L of chloride is sufficient to reduce agricultural yield particularly from some fruit and berry bearing plants.

Sodium content in the sample was in the range of 06 to 55 mg/L with an average value of 31 mg/L which is much lesser than the prescribed WHO standard (200 mg/L). Although it is generally agreed that sodium is essential to human life, there is no agreement on the minimum daily requirement. However, it has been estimated that a total daily intake of 120–400 mg will meet the daily needs of growing infants and young children, and 500 mg those of adults. In general, sodium salts are not acutely toxic because of the efficiency with which mature kidneys excrete sodium.

Nitrate content varied from 06 to 55 mg/L with an average value of 31 mg/L. When nitrate levels in drinking-water exceed 50 mg/l, drinking-water will be the major source of total nitrate intake. The fluoride content of the sample varied from 0.08 to 0.89 mg/L which is on further compared with the standard value 1.0 mg/L, ground water sample is having low concentration of fluoride as compared with WHO limit. The potassium content was analyzed for physicochemical analysis of ground water ranged from 02 to 11 mg/L which is further compared with standard value, showing high concentration of potassium as compared with the standard range.

4. General Analysis

4.1 Relation between Turbidity and Total Dissolved Solids

This graph shows a direct correlation between the amount of Turbidity and the amount of TDC in a body of water. This is expected because when there is high level of TDS that means there is a lot of suspended and dissolved solids in the water. When there are a lot of this then light reflects off of them more creating the water cloudy and making the water have a high Turbidity Level

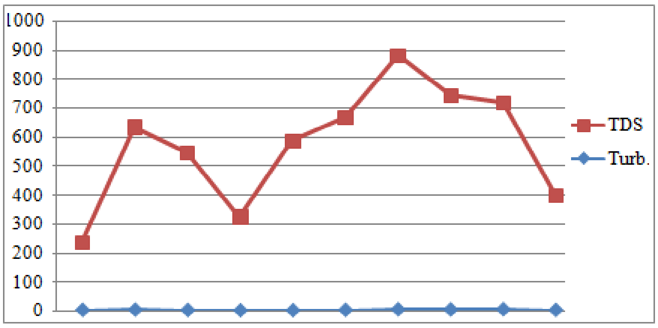

Figure 1: Graph for relation between turbidity and TDS

4.2 Relation between Turbidity and Temperature

Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen (DO) because warm water holds less DO than cold. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis.

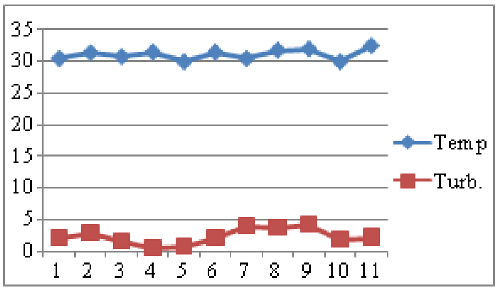

Figure 2: Graph for relation between turbidity and Temperature

4.3 Relation between Total Dissolved Solids and Electrical Conductivity

The TDS and the electrical conductivity are in a close connection. The more salts are dissolved in the water, the higher is the value of the electric conductivity. The majority of solids, which remain in the water after a sand filter, are dissolved ions. Sodium chloride for example is found in water as Na+ and Cl-. High purity water that contains in the ideal case only H2O without salts or minerals has a very low electrical conductivity. The water temperature affects the electric conductivity so that its value increases from 2 up to 3 % per 1 degree Celsius.

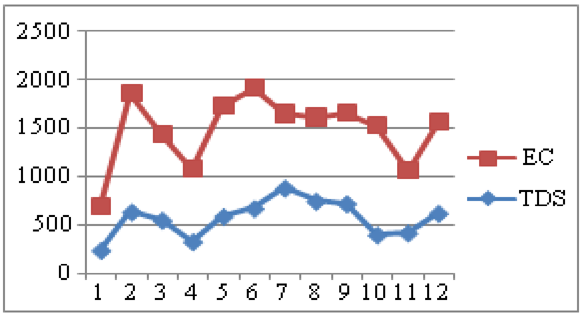

Figure 2: Graph for relation between TDS and EC

5. Conclusion

Contaminants of drinking water has become a major concern to the Environmentalist in the developing countries. As more and more people are exposed to the contaminants of drinking water, many issues arise that not only involve premeditating the contaminated water but also preventing similar situations from occurring future. On the basis of the above study and discussion, results indicates that the water in this area is of very poor quality and is not fit for drinking purpose. It may also be concluded that total dissolved solids, turbidity and electrical conductivity are significantly correlated with most of the parameter so they are an important water quality parameter.

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