Study of Physiochemical Analysis of Ground Water Quality in South Chennai Using GIS

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ABSTRACT

Groundwater samples were collected in South Chennai. In this study the groundwater samples were collected from 15 different locations at different sources and depth. *This* study *is used to analyze the physico chemical parameters of ground water collected from different locations. This study is used to create awareness about the water quality values to public has been determined by collecting ground water samples to a comprehensive physico chemical analysis*

1 Introduction

As the growth rate of urbanization and industrialization in the metropolitan cities such as Chennai are too fast, there is an increasing demand on water and equivalent increase on pollution of the groundwater and the degradation of the existing wetlands is noted overall. The pollution (Shanmugam *et al.* 2005) gets increasing day by day due to the ever increase of population. Thus the quality of the water must be expressed in mathematical or any other physical form in order to explore the character of the water. The water quality index (WQI) is an efficient method (Mishra *et al.* 2001, Naik *et al.* 2001, Singh 1992, Tiwari *et al.* 1985) in defining the characteristics of the water (Brown et al. 1972). In groundwater study, WQI helps in categorizing the water whether it is fit or unfit for drinking. The calculation of the water quality index originally started with Horton (1965) and Landwehr (1974). Indexing a perfect definition for the water quality was further developed by several researchers there onward. Brown and his colleagues (1972) developed a water quality index by assigning proper weightage for the parameters based on their analysis. The contaminants which alter the groundwater both physically and chemically can be altogether expressed in WQI. This index is the reduction of large amount of water quality data into a single numerical value (Ratnakanth Babu *et al.* 2011, Ramakrishniah *et al.* 2009).

In order to estimate the groundwater quality index, several parameters has to be analyzed and proper weightage must be assigned for each one. The most important parameters of the groundwater are pH, electrical conductivity, turbidity, total hardness, total dissolved solids, dissolved oxygen, total alkalinity, sodium, chlorides and iron. pH is the measure of hydrogen ion activity in the water or other solutions. Pure water has pH value close to 7 at 25°C. Solutions with pH less than 7 are termed as acidic and solutions with pH greater than 7 are termed as basic or alkaline. Exposure to extreme pH values (both low and high pH) results in irritation to the eyes, skin and mucous membrane for humans (WHO Guidelines for drinking water quality). Electrical conductivity is generally used as an indicator of the amount of salt and ion contents present in the water. The purer the water, lower the conductivity and higher the resistivity. Groundwater conductivity is measured in micro-mhos/cm.

Turbidity is the haziness of the water caused by the suspended individual particles. Groundwater can contain suspended solid mater of varying sizes. The heavier particles can quickly settle at the bottom whereas the suspended solids are not enough heavy to get settled up remain in suspension and lead to appear as turbid. The unit of turbidity is NTU (Nephelometric Turbidity Unit). The hardness of the water depends on the amount of minerals present in it. Hardness is caused by the compounds of calcium and magnesium and also by several other minerals. Water is an excellent solvent and readily dissolves the minerals which come in contact with it. As the groundwater moves through the soil and rocks, it dissolves very small amounts of minerals and holds them in solution. The dissolved calcium and magnesium in water are the two most common minerals that make the water 'hard'. Generally total hardness is measured in mg/l. Total dissolved solids are the inorganic substances that are present in the dissolved form. The sizes of these dissolved substances are even less than two micrometer and cannot be detected in the sieve tests. TDS is measured in parts per million (ppm).

Dissolved oxygen is a measure of the amount of gaseous oxygen (O_2) dissolved in the water. Oxygen gets into water by diffusion from the surrounding air, by aeration. Open wells contain high dissolved oxygen as they are exposed to open air whereas the bore wells have comparatively less exposed has low level of dissolved oxygen. Alkalinity can neutralize the acid

nature of the water. It is the sum of addition of all the bases present in the water. Bicarbonate is the dominant anion which contributes much larger part to alkalinity.

Sodium compounds are commonly found in the rocks and soil about a significant percentage. The groundwater gets sodium as they flow through it by dissolving. The rise in sodium in the groundwater acts one of the key components for the finding of saltwater intrusion in the coastal areas. It is measured in mg/l. Chlorine is never found in free form in nature and most commonly occurs as sodium chloride. As like sodium, the chlorine compounds are highly soluble in water and thus the groundwater gets chlorides by dissolving it. It is measured in mg/l. Iron is also an important composition of groundwater which is essential for drinking in small amounts. It is a naturally occurring metal present in many types of rock. Concentrations of iron in groundwater are often higher than those of measured in surface waters proves that the metal got in groundwater by dissolution. The drinking water limit of iron must be less than 0.3mg/l.

The objective of the current study is to discuss drinking water quality based on the water quality index.

2. STUDY AREA

The groundwater samples are collected in around south Chennai. It is geographically located at latitude of 13° 6' 40" N and Longitude of 80° 15' 53“ E.

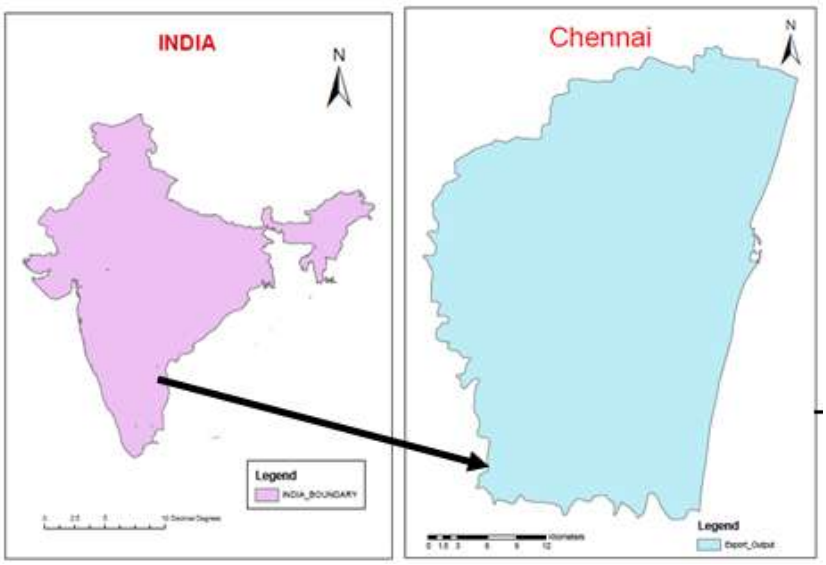

Figure 1:Study Area

3. DATA AND METHODS

3.1 Insitu data

The water samples were collected from fifteen different open and tube wells in the summer of 2013. During sampling care was taken as told in the standard procedures of measurement (APHA 1994). Parameters such as pH, electrical conductivity, total hardness, sodium, chlorides etc .. were analyzed to find the water quality index.

3.2 Determination of Water Quality Index:

Water Quality Index (WQI) is a most efficient method for assessing the quality of water. Water Quality Index (WQI) is a tool for communicating the information on overall quality of water and rates the quality of each sample locations. It acts as the perfect indicator of the quality of the water. It was first proposed by Horton (1965) to determine the suitability of the groundwater for drinking purposes. Analyzed groundwater sample data are tabulated in Table1. WQI is computed adopting the following formula.

$$WQI = \frac{\sum_{i=1}^{n} W_i q_i}{\sum_{i=1}^{n} W_i}$$

Where, W is the unit weightage factor computed using the following equation, $W_n = K / S_n$ and K is the proportionality constant derived from,

$$K = \left[\frac{1}{\sum_{n=1}^{n} \left(\frac{1}{S_i} \right)} \right]$$

where S_n and S_i are the Bureau of Indian Standard values of the water quality parameter (Table 2). Quality rating is calculated using the formula,

$$q_{ni} = \left[\frac{(V_{actual} - V_{ideal})}{(V_{s\tan dard} - V_{ideal})} \right] x100$$

Where, q_{ni} is the quality rating of ith parameter for a total of n number of water quality parameters. V_{actual} is the value of the water quality parameter obtained from laboratory analysis. V_{ideal} is the value of the water quality parameter can be obtained from the standard tables. V_{ideal} for pH is 7,and Dissolved Oxygen is 14.6 mg/lit and for other parameters it is equivalent to zero. $V_{s\tan dard}$ is the BIS standard of the water quality parameter. Based on the WQI values, the water quality is rated as excellent, good, poor, very poor, and unfit for human consumption (Table 3).

4. Results

The study area has pH as low as 7.1 and high upto 7.89. Stations 3 & 6 are spotted with high pH and station 11 has low pH . Stations 11, 14 and 15 fall under the range of normal pH. It is also noted that pH alone cannot be the ultimate factor which is fit for drinking but also many other parameters contributes to it to state whether the water is fit or not. The amount of hardness in the study are within the permissible limit.

Sulphate in the study area varies from 29 to 179. It is found to be not higher than the permissible limit. Similarly chlorides also have high values and are greater than the permissible limit (250 mg/l). Thus the level of the high chlorides portrays that the sea water has been intruded in this region. The nitrate level in the study area are within the permissible limit.

The water quality index of the study area varies from 20 to 73. The station 10 has the excellent water quality range and it is suitable for human Consumtion. The station 13, 14 and 15 has the good water quality index range. The other stations in the study area water quality index range falls under the category of poor to very poor range. The study indicates the ground water is not suitable for human consumption.

Conclusion

The study of the groundwater parameters and WQI are studied here. It is seen from the calculation that most of the stations fall under the poor range and some of them fall beyond good range of water quality index..

Table 2: Unit weightage based on the Bureau of Indian drinking water standard (IS: 10500, 1993)

Parameters	Vs	Videal	1/Si	k	Weightage(Wi)
pH	6.5-8.5	7	0.117647059	4.857451	0.571464855
Electrical Conductivity	300	0	0.003333333	4.857451	0.016191504
Total Dissoved solids	500	0	0.002	4.857451	0.009714903
Total Hardness	300	0	0.003333333	4.857451	0.016191504
Chlorides	250	0	0.004	4.857451	0.019429805
Nitrate	45	0	0.022222222	4.857451	0.107943361
Calcium	75	0	0.013333333	4.857451	0.064766017
Magnesium	30	0	0.033333333	4.857451	0.161915042
Sulphate	150	0	0.006666667	4.857451	0.032383008
		∑ 1/Si	0.205869281	∑ Wi= 1	

Table 3: Water quality index categories

WATER QUALITY INDEX	DESCRIPTION
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
>100	Unfit For Drinking

Table 1 Indian standards for physical and chemical parameters

S. NO	Parameter	Desirable limit	Permissible limits
1	PH	6.5-8.5	No relaxation
2	Total hardness(mg/l)	300	600
3	Chlorides (mg/l)	250	1000
4	Sulphate (mg/l)	200	400
5	TDS(mg/l)	500	1000
6	Nitrate(mg/l)	45	100
7	Total alkaline(mg/l)	200	350

Table 4: Physcio chemical characteristics of Ground water in South Chennai(2013)

Sample Station	Parameters								
S1	pH	Electrical Conductivity	TDS	Total Hardness	Nitrate	Chloride	Ca	Magnesium	Sulphate
S2	7.77	1830	1681	267	1.01	254	255	227	145
S3	7.89	1235	1160	215	0.931	155	167	178	70
S4	7.71	1500	1347	187	0.599	219	152	161	99
S5	7.65	1549	1400	260	0.91	204	235	200	59
S6	7.83	1545	1387	219	0.493	176	186	194	99
S7	7.49	1516	1322	175	0.81	159	185	154	179
S8	7.57	1624	1429	244	0.601	205	197	186	95
S9	7.6	1325	1137	199	0.81	214	174	147	48
S10	7.699	1620	1510	196	0.767	262	214	172	102
S11	7.1	1330	1180	210	0.721	223	179	192	29
S12	7.64	1497	1339	200	0.819	184	195	186	100
S13	7.6	1328	1198	220	0.532	174	195	134	112
S14	7.29	1158	973	188	0.534	159	178	165	52
S15	7.39	1096	959	189	0.341	119	145	152	66

Table 5:Water Quality Index Ranges in the South Chennai

Sample Station	Water Quality Index (WQI)
S1	73
S2	70
S3	58
S4	63
S5	65
S6	48
S7	54
S8	54
S9	62
S10	20
S11	59
S12	51
S13	34
S14	37
S15	35

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