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Assessment of Water Quality Indices for Groundwater in the Singanallur Sub-Basin, Coimbatore, India

Priya KL[1]*, Nalini Jebastina[1] and Prince Arulraj G[2]

[1]Assistant Professor, School of Civil Engg, Karunya University, Coimbatore 641114, India

[2]Director, School of Civil Engg, Karunya University, Coimbatore 641114, India

Abstract

Groundwater quality of Coimbatore city needs greater attention because it is the alternative source of water for domestic and agricultural purposes. The problem relating to groundwater is not restricted to Coimbatore, but in many regions of the world. The present study was attempted to access the groundwater quality of Singanallur in Coimbatore. The technology adopted combines field investigations and GIS (Geographical Information System) [1]. Water Quality Index, has been calculated for the Singanallur sub-basin and the entire sub-basin was zoned to study the suitability of water for drinking purposes using the software ArcGIS and the results showed that the ground water quality was unfit for drinking in some of the areas scoring a water quality index greater than 100. The least water quality index of 51 was scored by Lakshmipuram from where the water can be used for domestic purposes.

Keywords: Groundwater monitoring; Water quality index; GIS; WHO/BIS/ICMR standards; India

Introduction

For the past few decades, there has been an acute demand for water resources. Industrial growth, population growth, and other developmental activities have resulted not only in a high demand for water, but also in the degradation of quality, which aggravated the water crisis. Water pollution is a growing hazard in many developing countries including India. A polluted environment has a detrimental effect on the health of people, animal life and vegetation [2]. Groundwater is an important source for domestic, agricultural and industrial use. Due to this fact, it becomes essential for continuous monitoring of the quality of groundwater so that ground water pollution can be minimized by preventing unscientific practices.

There are different ways for accessing water quality, one of which is the Water quality Index (WQI) [3]. WQI is an efficient tool on communicating the overall quality of water [1]. GIS (Geographical Information System) is an effective tool in decision making for managing spatial and attribute data. GIS has wide application in water quality mapping using which informative and user-friendly maps can be obtained. The present study was aimed to obtain a decision support system for the sub-basin by integrating WQI and ArcGIS.

Coimbatore city, called as the Manchester of India is situated on the banks of river Noyyal, a part of Cauvery basin. Of the various tanks fed by Noyyal river, Singanallur tank is one of the biggest and the most polluted tanks. The Singanallur sub-basin has been selected for the present study. The hydrogeological studies revealed that the formation of the strata is of consolidated type, fissured zones and the age group of Pre-cambrian group. The lithological characteristics include gneiss and other basic intrusives. The ground water is restricted to a depth of around upto 20 m in the study area. The water table is at a depth of 400 m above Mean Sea Level. The aquifer of the area is discontinuous with secondary intergranular porosity and fractures. (Central Ground Water Board) [4].

Materials and Methods

Survey of India (SOI) toposheets on 1:50,000 scales were used to prepare the base map of the study area. The toposheets were scanned and digitized using ArcGIS software in order to obtain the baseline data. The sub-basin of the tank was prepared from the contour and drainage map using AUTOCAD 2007. Twenty one sampling locations were identified from the study area for the purpose of mapping the ground water quality [5] (Figure 1). Water samples (Table 1) were collected from open and bore wells, Singanallur tank and Noyyal river during the month of March 2009 and were analysed for various physiochemical per American Public Health Association (APHA) [6] standard methods. A hand held GPS was used to obtain the latitude and longitude of the sampling stations.

Results and Discussion

The water quality indices were calculated to determine the suitability of water for drinking purposes form the analysis results (Table 3). The pH was slightly alkaline in all stations except in Periyathottam and Nathamedu thoppu. It was within the permissible limit as per BIS standards [5]. The chlorides contents were high in all areas except
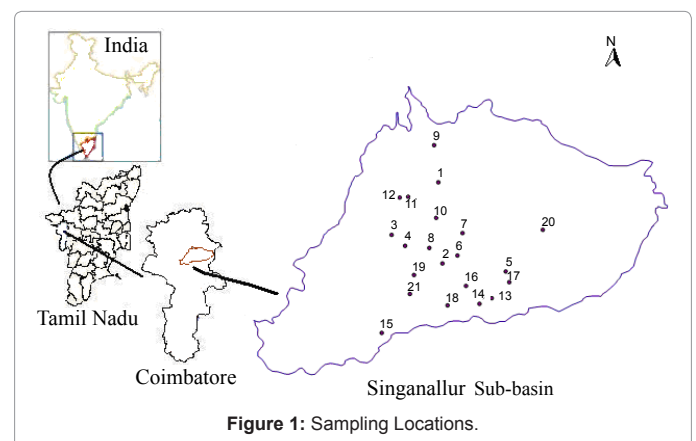

Figure 1: Sampling Locations.

*Corresponding author: Priya KL, Assistant Professor, School of Civil Engg, Karunya University, Coimbatore 641114, India, Tel: 04222614450; Fax: 91 422 2615615; E-mail: piya_kl@yahoo.co.in

Sample point	Location	Type of well
1	Uppilipalayam	BW
2	Tank (West)	T
3	Central studio	BW
4	LCC	OW
5	Vellarore road	OW
6	Tank (North)	T
7	LC road	OW
8	Kallimadai	BW
9	Lakshmipuram	BW
10	Kasturinagar Thottam	OW
11	Rajiv Nagar	BW
12	Periyathottam	OW
13	Asokanagar 1	OW
14	Asokanagar 2	OW
15	LG Vellalore	OW
16	Tank (South)	T
17	Noyyal	R
18	Back of tank	OW
19	Kamachiamman Kovil	BW
20	Vivekananda nagar	BW
21	Nathamedu thoppu	OW

The WQI was calculated as per the following method.
WQI = antilog $\Sigma n\ i = 1\ W_i \log_{10} q_i$, where W_i is the weightage for each parameter and q_i is the quality rating. Weightage is calculated as, $W_i = K / S_i$, where K is the proportionality constant given by $K = 1 / \Sigma n\ i = 1\ (1 / S_i)$, S_i is the standard value as per WHO / BIS / ICMR for each parameter. The quality rating, $q_i = 100 * \{(V_{actual} - V_{ideal}) / (V_{standard} - V_{ideal})\}$, where Vactual and Videal are the observed value and ideal value for each parameter respectively and Vstandard is the standard value for each parameter as per BIS/ICMR standards. Videal for pH is taken as 7 and that for DO is taken as 14.6 mg/l for all other parameters, its value is 0

Table 1: Details of Sampling Stations.

in Lakshmipuram. The quality of water from Lakshmipuram was better compared to other stations and hence it scored the best. Total Dissolved solids varied from 400 mg/l in Lakshmipuram to 6400 mg/l in Kasturinagar thottam showing a high variation. Total hardness, Ca

WQI	0 - 20	21 - 40	41 - 60	61 - 80	81 - 100	>100
Rating	Highly desirable	Desirable	Moderately suitable	Poorly suitable	Very Poor	Unfit for drinking
Ranking of WQI	1	2	3	4	5	6

The WQI so obtained forms the attribute database, which is linked to the spatial sampling location in ArcGIS. The spatial and attribute database generated are integrated in ArcGIS for obtaining the spatial distribution maps to easily identify the variations in WQI for the study area. The classification of groundwater based on WQI is given in Table 2.

Table 2: Classification of Water based on WQI.

and Mg hardness were found to be high in Uppilipalayam, Tank (West), Vellarlore, LC road, Kasturinagar thottam, Rajiv Nagar, Periyathottam, Asokanagar, LG Vellalore, Kamachiamman Kovil, Vivekananda nagar and Nathamedu thoppu [7]. The high amount of chlorides, TDS and hardness is due to the geological formation of the area. The minerals of the soil and rock get dissolve in the ground water leading to high concentrations of dissolved solids. The area mainly consists of residential and agricultural land. The contaminants get added up due to unscientific practices of agriculture and letting of sewage into water bodies without treatment. The surface water ie. tank and river has slightly high hardness and chlorides due to the presence of domestic sewage. The domestic sewage was discharged at the northern side of the tank and there was a site for the disposal of solid waste. Alkalinity varied between 200 mg/l to 830 mg/l, the minimum being at Lakshmipuram. The alkalinity was mainly due to bicarbonates, while carbonate alkalinity was found to be zero. Sulphates was less in many areas except in Uppilipalayam, Rajiv Nagar, and Asokanagar. The Ca and Mg hardness in many places show high values which indicate that the soil is high in Calcium chloride and Magnesium chloride. The tank water and river water showed low DO due to the presence of domestic sewage. The Noyyal river was filled with domestic sewage near the tank area. The tank had a flow from the North towards South. There was an inlet of domestic sewage near the station point 6 (Tank North), resulting in a very low DO of 0.2 mg/l. As the water flowed from point 6 to station point 17 (Tank South), there was a marginal increase in DO

Sample	Cl	TDS	TH	Ca	Mg	DO	pH	Alk	Sulp	WQI	Rating
1	1731.903	5760	1910	800	1110	4.9	7.46	670	260	111	UFD
2	560.616	1600	650	240	410	1.2	7.44	650	115	110	UFD
3	630.693	1600	560	200	360	6.8	7.48	830	137	84	VP
4	530.583	1600	440	170	270	5.1	7.41	770	120	86	VP
5	1401.54	2800	950	250	700	5.3	7.11	580	175	64	PS
6	520.572	1200	460	120	340	0.2	7.55	610	115	117	UFD
7	1081.188	3600	1070	400	670	4.1	7.35	520	85	97	VP
8	400.44	1600	370	140	230	5.4	7.59	730	115	92	VP
9	80.088	400	150	40	110	5.3	7.16	200	5	51	MS
10	1031.133	6400	820	340	480	4.4	7.12	660	190	67	PS
11	1992.189	6000	1250	480	770	5.7	7.11	560	415	65	PS
12	1541.694	4000	1100	380	720	4.3	6.93	680	215	60	MS
13	1952.145	4120	1540	590	950	6.8	7.34	520	245	88	VP
14	1281.408	2120	1130	440	690	6	7.4	540	150	92	VP
15	780.858	2640	750	280	470	6	7.12	540	120	60	MS
16	390.429	640	330	50	280	2.8	7.61	430	95	102	UFD
17	360.396	1200	450	100	350	1.8	7.34	550	40	92	VP
18	430.473	1600	520	170	350	4.9	7.34	610	40	82	VP
19	1261.386	5200	890	340	550	6.2	7.39	690	185	88	VP
20	640.704	3200	680	210	470	5.6	7.09	660	130	56	MS
21	2482.728	4800	1500	490	1010	5.3	6.93	680	185	59	MS

Note : WQI – Water Quality Index, UFD – Unfit for drinking; VP – very poor; PS – poorly suitable; MS – moderately suitable; D – desirable; HD – highly desirable

Table 3: Water Quality Indices.

due to the self purification of the water. On the southern part of the tank, the area is made extensively of agricultural land. The unscientific agricultural practices adopted by the farmers resulted in the leachate of chemicals to ground water thereby polluting ground water.

The water quality indices were calculated to determine the suitability of water for drinking purposes. For the locations, Uppilipalayam, tank (North), Tank (West) and Tank (South), WQI is greater than 100 and hence unfit for drinking. The water quality index map showed that the sampling stations Lakshmipuram, Periyathottam, LG Vellalore, Vivekanandanagar and Nathamedu thoppu came into the category of 3 which indicates that water is moderately suitable for drinking. However, this water can be used for domestic purposes like flushing, washing etc. The water may be used for drinking if necessary, after filtration and boiling. The quality of samples Vellalore road, Kasturinagar thottam, Rajiv Nagar was very poor.

From the WQI map (Figure 2), it is evident that the areas on the southern part of the tank fall into the category of very poor quality, due to the leachate from agricultural land as mentioned before. The tank water having less DO, due to the discharge of domestic sewage, obtained a quality rating as unfit for drinking. The Noyyal river water falls under the category of very poor.

Conclusions

The WQI map prepared for the study area can be used as a tool for decision making, regarding the usage of water for drinking and other domestic purposes. Proper sewerage system followed by an effluent treatment plant; collection, treatment and disposal of solid waste by the municipality; usage of biofertilizers are some of the methods to be developed to safeguard the quality of surface and ground water of Coimbatore city. The method adopted can be implemented in other areas having similar water related problems so that water pollution can be prevented, thereby opening a way to face the water crisis of the whole world.

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