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Emphasizing the Quality of Some Selected Ground Water Samples of Kanyakumari District, India Using Quality Index Assessment

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Abstract

The Quality Index assessment method is used to monitor the pollution status of water samples by integrating the water quality variables. The aim of this work is to monitor the pollution level of ground water samples from different places of kanyakumari district. For calculating the Quality Index the following18 water quality variables such as EC, TDS, DO, TH, pH, alkalinity, calcium, sodium, magnesium, sulphate, phosphate, potassium, chloride, fluoride, manganese and nitrate have been considered. The different ground water samples of Kanyakumari district have quality index values ranging from 8.45 *to* 162.3. *In this present work the status of water quality is found to be good for consumption and other purposes except Kalkulam bore well water sample.*

Keywords: Ground water, water quality variables, quality index assessment, Kanyakumari district.

Introduction

India is facing a serious threat on the availability of natural water resources due to population growth and rapid economic development[1]. In many ways, human beings and their welfare are directly related to fresh waters. Regarding worldwide concern, it was found that the important natural water source is the groundwater. Its use in irrigation, industrial and domestic usage continues to increase where perennial surface water sources are absent. The modern civilization, over exploitation, rapid industrialization and increased population leads to fast degradation of our environment. The quality of ground water may depend upon geology of a particular area, seasonal changes, composition of dissolved salts depending on the source and from soil surface interaction. The ground water quality is mainly affected due to drastic pollution activities that are taking place on surface waters[2]. In India, most of rural and urban areas depend on ground waters as their major water source. Based on the utility importance of ground waters their quality assessment came into effect[3].

Water quality index assessment describes the overall quality of the water based on several water quality variables. The objective of water quality index assessment is to give information to mankind regarding the quality of a particular water body for multipurpose usages. In general, water quality index assessment method gets data from several water quality variables into a mathematical equation and rates out the quality of water in terms of a number[4].

Objective of Present Work: The objective of the present work is to emphasize on the quality of a water body based on quality index assessment to describe about its suitability for human consumption and other commercial purposes.

Study Area: For the present study, different places from four taluks of Kanyakumari district were selected (figure-1). In India, Kanyakumari District lies at its southernmost tip. This district is bounded by sea on three sides and with Western Ghats bordering on the northern side. The National Geographic has suggested that Kanyakumari district is one of India's Six Hidden Gems. The geographical position of Kanyakumari district lies between 77° 15' and 77° 36' east and 8° 03' and 8° 35' north. This district comprises of four taluks: Agastheeswaram Vilavancode, Kalkulam and Thovalai.

Material and Methods

The ground water samples from four open wells and four bore wells, one sample from each taluk was collected for a period from August 2011 to August 2012 (table-1) and water quality variables analysis was done as per the standard procedure of APHA[5].

Results and Discussion

pH: The pH value of natural water changes due to biological activity and industrial contamination. High pH value indicates the formation of toxic trihalomethanes. The pH values of present investigation are within the Standard limit.

Electrical Conductivity (EC): Electrical conductivity value usually depends on the concentration of total dissolved salts in water[6].The EC values of present investigation are within the Standard limit except K- BW. The presence of most of the metals in the water sample indicates high level of conductivity.

Table-1
Variations of Physico-Chemical Parameters during the study period

Sl. No	Parameters	Standard Limits	SAMPLING STATIONS							
			V-OW	K-OW	T-OW	A-OW	V-BW	K-BW	T-BW	A-BW
1	pH	6.5-8.5	7.00	7.50	7.40	7.60	6.30	6.60	7.02	7.40
2	Electrical conductivity (EC)	300-1500	480.5	801.6	807	587.4	551.9	1505.4	761.3	753.7
3	Turbidity	5-10	1.5	2.4	1.6	1.9	2.2	68.3	1.7	1.9
4	Total dissolved solids(TDS)	500-2000	320.9	535	495.3	392.3	368.5	1004.2	470.3	503.6
5	Total hardness (TH)	300-600	98.7	196.8	201.8	160.8	114.9	400.5	222.1	195.5
6	Total Alkalinity(TA)	200-600	23.7	100	230.9	180	31.2	84.8	236.8	205.9
7	Dissolved Oxygen (DO)	4-7	5.6	6.5	5.04	5.2	5.8	1.4	4.8	5.1
8	Biological Oxygen Demand (BOD)	2	0.7	0.6	0.7	0.67	0.7	1.6	0.4	0.6
9	Calcium	75-200	1.2	2.5	2.6	2.3	1.4	5.2	3.03	2.6
10	Magnesium	30-100	0.8	1.4	1.5	0.97	0.9	2.9	1.4	1.3
11	Sodium	200	2.6	3.6	3.6	2.5	2.8	6.4	2.8	3.2
12	Potassium	1.4	0.1	0.3	0.2	0.12	0.2	0.5	0.1	0.2
13	Iron	0.3-1.0	0.007	0.009	0.007	0.007	0.007	0.1	0.007	0.007
14	Manganese	0.1-0.3	0	0	0.03	0	0	0.02	0.003	0.004
15	Free Ammonia	< 0.2	0.02	0.02	0.01	0.02	0.01	0.03	0.01	0.01
16	Nitrate	45	0.1	0.1	0.1	0.1	0.1	0.15	0.1	0.1
17	Nitrite	0.5	0.002	0.004	0.001	0.002	0.001	0.001	0.001	0.006
18	Chloride	250-1000	3.8	4.8	2.9	1.7	4.4	12.3	2.2	2.9
19	Fluoride	1-1.5	0.006	0.02	0.02	0.02	0.005	0.02	0.01	0.02
20	Sulphate	200-400	0.3	0.8	0.4	0.3	0.3	0.5	0.4	0.4
21	Phosphate	< 0.05	0.01	0.02	0.01	0.02	0.01	0.015	0.02	0.02

All the values are expressed in mg/L except pH and EC (µS/cm), Turbidity (NTU). Stations –V: Vilavancode, K: Kalkulam, T: Thovalai, A: Agastheeswaram, OW: Open Well; BW: Bore Well.

Turbidity: The turbidity is an indicator of water pollution. Turbidity causes adverse health hazards on human beings due to the presence of pathogenic micro organisms in turbid waters[7]. Turbid waters are unfit for human consumption and many other industrial uses. Except station K-BW, the turbidity values of all other stations lie within the standard limit.

Total Dissolved Solids (TDS): TDS values are mainly due to carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates etc[8]. Usually TDS in water does not cause harm to humans, but high concentration can cause heart and kidney diseases. From most of the study results it was found that usually bore well as well as hand pump water has high dissolved salts compared with open well water. The TDS values of present investigation are within the Standard limit.

Total Hardness (TH): Hardness in water is mainly due to calcium and magnesium salts in it. It is also due to the entry of industrial and other domestic effluents into the water source. The TH values of present investigation are within the Standard limit.

Alkalinity: The main source for alkalinity is due to weathering of rocks. Higher alkalinity value contributes sour and saline taste to water. The TA values of present investigation are within the Standard limit.

Dissolved Oxygen (DO): Dissolved oxygen is an essential entity to maintain water quality. Habitat of fishes in aquatic system will be affected, if their DO value is low. The dissolved oxygen is almost needed by all plants and animals for respiration[9]. The water quality will be good, if DO value is above 6mg/L. Almost all values of present investigation except K-BW are near to the above prescribed standard value.

Biological Oxygen Demand (BOD): BOD is an indicator of organic water pollution. The BOD value depends on the amount of biochemically oxidisable carbonaceous matter[10]. The water quality will be considered bad if the BOD values are greater than 3mg/L. The BOD values of present investigation are well below the Standard limit.

Calcium: High Calcium values indicate hardness of water. The calcium values of this investigations are too low than the desirable limit.

Magnesium: Magnesium values are usually found to be lower than calcium values in any water sample[11]. Magnesium serves as a limiting factor for phytoplankton growth and chlorophyll

formation[12]. The magnesium values of present investigation are well below the Standard limit.

Sodium: Sodium values are taken into account for detecting the usage of water for irrigation purposes because it increases the hardness of the soil and reduces its permeability[13]. The sodium values of this investigations are too low than desirable value.

Potassium: The potassium in water is due to weathering of rocks and disposal of waste water into the water body[14]. Low potassium values decrease the growth rate and photosynthetic activity of algae especially blue green algae whereas high values suspect for nervous and digestive disorders[15]. The potassium values of present investigation are well below the Standard limit.

Iron: One of the essential element in human body in iron[16]. Even high concentration does not have any ill effect on health hazard[17]. The contribution of iron in ground water is due to corrosion on pipelines and its nonusage for very long time, this can be eliminated by continuous monitoring and cementing them properly[18]. The high concentration of iron in ground water may be due to fluvic compounds formation as a result of bacteriological degradation of organic matter[19,20]. The iron values of this investigation are too low than the desirable limit.

Manganese: The main source of manganese in groundwater is due to weathering of manganese bearing minerals and rocks. High manganese values gives undesirable appearance and unpleasant taste to water. The manganese values of present investigation are well below the Standard limit.

Ammonia: At high pH, ammonia exists in its gaseous form which is harmful for fishes and other aquatic species, whereas at low pH ammonia is converted to ammonium ions therefore its toxicity is reduced. Ammonical nitrogen value more than 1.2 mg/L ensures the water quality to be bad. The ammonia values of present investigation are within the Standard limit.

Nitrate: Nitrate values are used to assess the self purification property of the water source[21]. The main source of nitrate in water body is due to decaying of plant and animal materials[22]. reater amount of nitrate causes methemoglobinemia in infants. The nitrate values of this investigation are too low than the desirable limit.

Nitrite: The least concentration of nitrite was found during winter due to increase of primary productivity of phytoplankton and utilization of nitrite as nutrient. The nitrite values of present investigation are well below the Standard limit.

Chloride: The main sources of chloride in water are due to discharge of domestic sewage, industrial effluents, and agricultural fertilizers[23]. The chloride content is an indicator of organic pollution[11]. The chloride values of this investigations are too low than the desirable limit.

Fluoride: Fluoride is an essential element for human body[24]. Most of fluoride enters into human body only during water consumption[25]. The fluoride values of this investigations are too low than the desirable limit.

Sulphate: The main source of sulphate is duo to leaching from gypsum and other common minerals. High concentration of sulphate around 1000mg/L causes gastro intestinal irritation[26]. The sulphate values of this investigations are too low than the desirable limit.

Phosphate: Generally phosphate is found very low in ground waters and they do not impose any health problems, because their solubility from native phosphate minerals is negligible and soils easily retain them[27]. The localized mode of phosphate contamination is observed in the river waters, particularly for orthophosphate since it is attached to setting particles. The phosphate values of present investigation are well below the Standard limit.

Water Quality Index (WQI): The quality assessment is very important for proper conservation and management of water resources[28] (table-2). The WQI values were investigated using Indian drinking water standards and calculated by adopting the methods of Brown and coworkers[29].

Table-2
Water Quality Classification Based on WQI Value

Class	WQI Value	Water Quality Status
I	<50	Excellent
II	50-100	Good Water
III	100-200	Poor water
IV	200-300	Very poor water
V	>300	Water unsuitable for drinking

WQI values were calculated using the following three steps given below and the calculated values are tabulated (tables- 3 and 4). The pictorial representation for WQI values obtained from eight ground water samples is shown below (figure–2).

Step 1(Calculation of Unit Weight)

$W_n = k / S_n$

K --- Proportionality constant;

$$k = {}^{1}\Big/_{\sum_{i=1}^{n} {}^{1}\Big/_{(S_1 + S_2 + S_3 + - - - - - + S_n)}}$$

S_n --- Standard values

Step 2 (Calculation of Quality rating)

$$q_n = 100\, {}^{[S_{obs} - S_{ideal}]}\Big/_{[S_n - S_{ideal}]}$$

S_{obs} ---- Observed Values

S_{ideal} ---- Ideal Values

(Exceptions for pH = 7, DO =14.6, Fluoride =1)

Step 3 (Calculation of Water Quality Index)

$$WQI = {}^{\sum_{i=1}^{n} q_n W_n}\Big/_{\sum_{i=1}^{n} W_n}$$

Table-3
Drinking Water Standards and Unit Weights

Sl.No	Parameters	Standard Permissible Value (S_n)	Recommended Agency	Unit Weight
1	pH	8.5	BIS	0.01
2	Electrical conductivity (EC)	300	ICMR	0.0002
3	Turbidity	10	BIS	0.01
4	Total dissolved solids(TDS)	500	BIS	0.0001
5	Total hardness (TH)	300	BIS	0.0002
6	Total Alkalinity(TA)	200	BIS	0.0003
7	Dissolved Oxygen (DO)	6	CPCB	0.011
8	Calcium	75	ICMR	0.001
9	Magnesium	30	BIS	0.002
10	Sodium	200	WHO	0.0003
11	Potassium	1.4	CPCB	0.05
12	Iron	0.3	BIS	0.22
13	Manganese	0.1	CPCB	0.66
14	Nitrate	45	BIS	0.0015
15	Chloride	250	BIS	0.0003
16	Fluoride	1.5	BIS	0.044
17	Sulphate	200	BIS	0.0003
18	Phosphate	0.05	BIS	1.32

Table-4
WQI values for Individual Sampling Stations

Sl.No.	Sampling Stations	ΣW_n	$\Sigma q_n W_n$	WQI
1	V-OW	2.3312	19.75	8.47
2	K-OW	2.3312	47.52	20.39
3	T-OW	2.3312	40.47	17.36
4	A-OW	2.3312	46.89	20.12
5	V-BW	2.3312	19.70	8.45
6	K-BW	2.3312	378.4	162.3
7	T-BW	2.3312	48.38	20.75
8	A-BW	2.3312	49.72	21.33

Conclusion

The above results indicate that all the Water Quality Variables lie well within the standard limit and the quality index assessment results suggest that except K-BW sample, all other station water samples are good and are suitable for drinking and other domestic purposes. Therefore K-BW water sample should be subjected to appropriate treatment before it is used for domestic purposes.

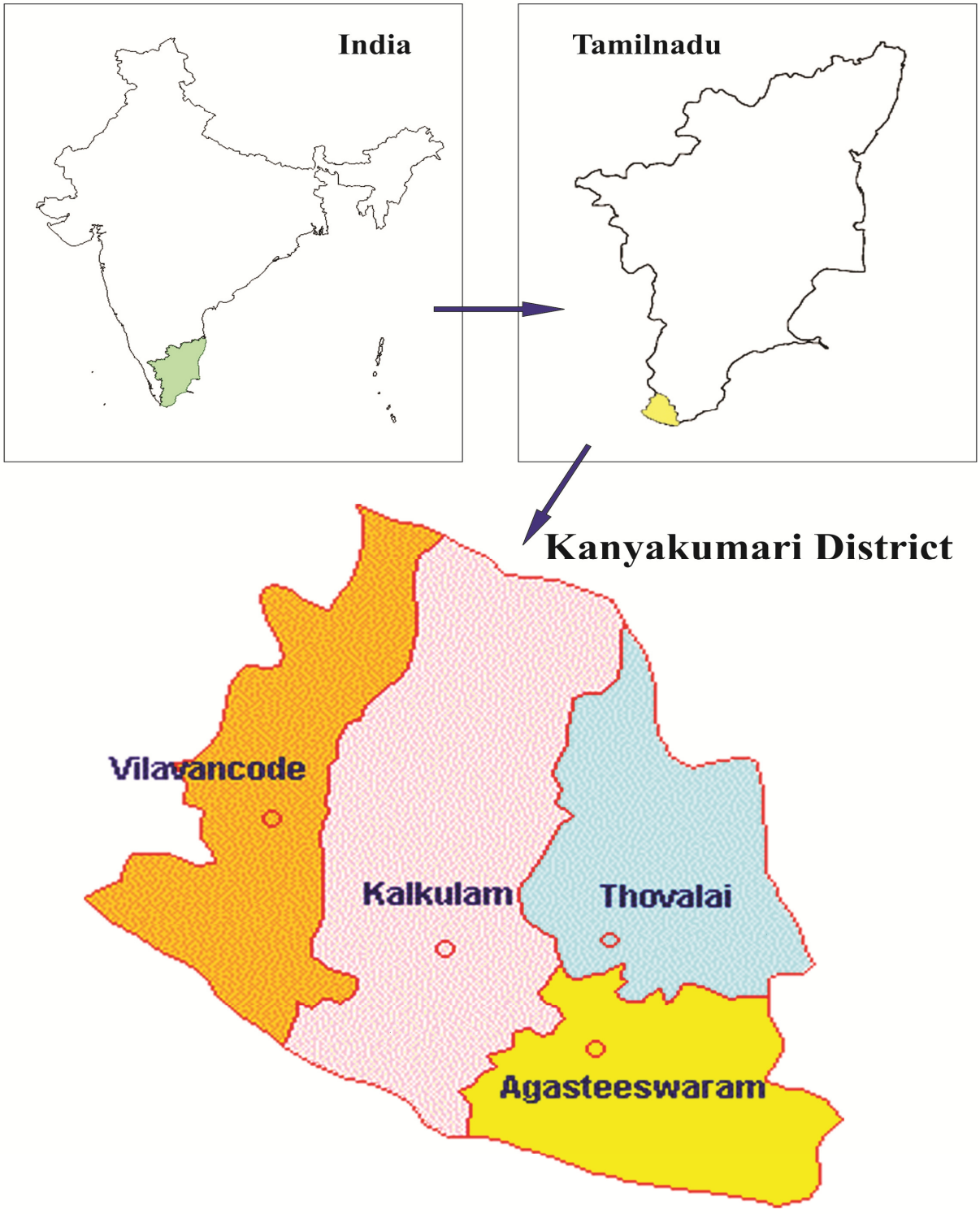

Figure-1
Study area

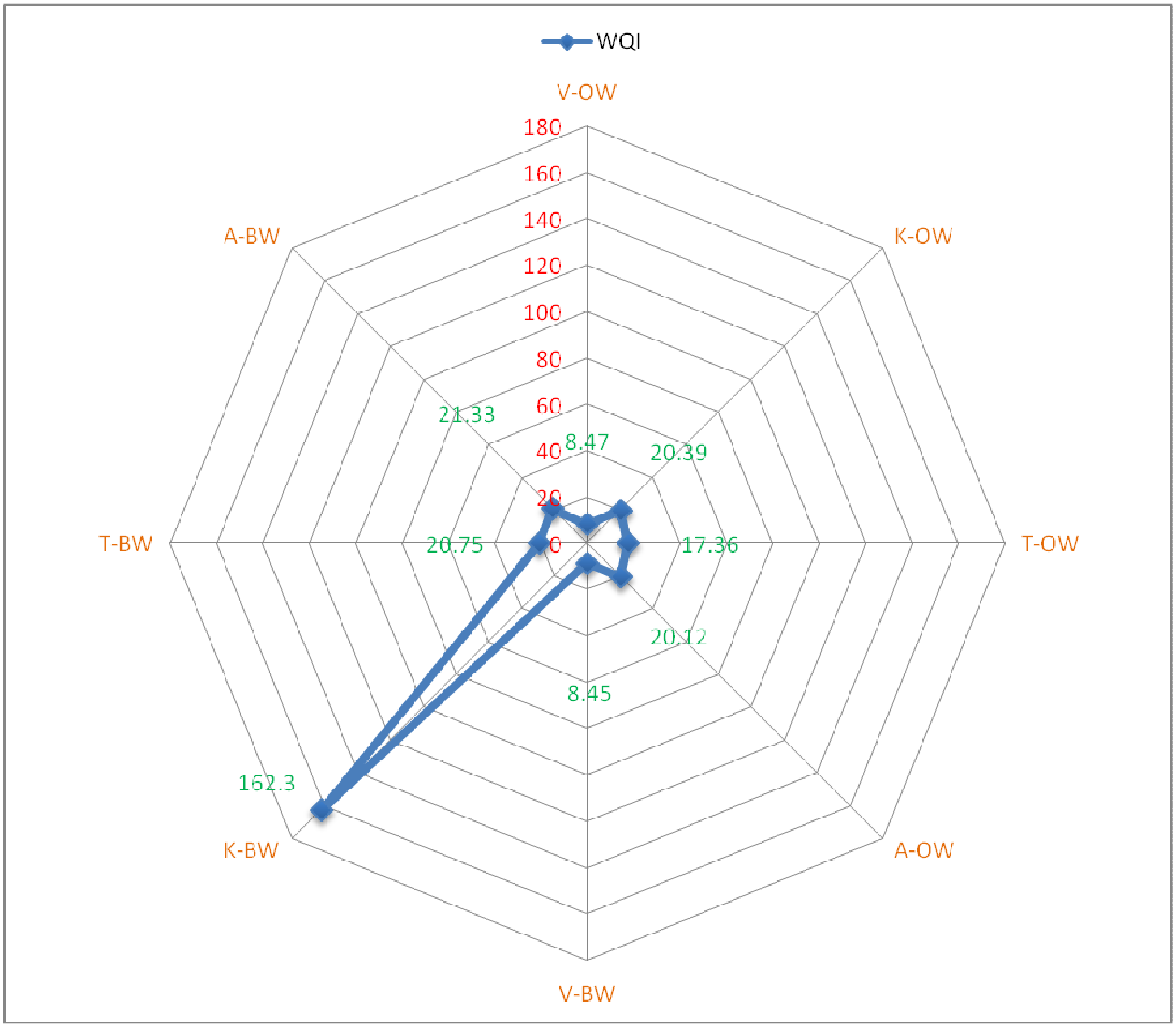

Figure-2
Water Quality Index values of various stations

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