Assessment of Ground Water Quality Index in Sirkali Coastal Block of Nagapattinam District

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***Abstract* - The ground water is an essential and valuable source of water supply all over the world. To meet the rising demand it is decisive and recognizes the fresh water resources to find out remedial methods for improvement of water quality the present study aims in determining the ground water quality in and around the coastal area. Water quality index (WQI) of groundwater based on the data of nine groundwater samples collected from coastal area of Sirkali block in Nagapattinam District, Tamilnadu was assessed using seven physio-chemical parameters viz. pH, Total Dissolved Solids, Total Hardness, Calcium, Chloride, Magnesium and Electrical conductivity. The WQI value 379 is maximum and the value 57 is minimum during pre-monsoon period and 224 is maximum and 29 is minimum value achieved during post-monsoon period in the study area. The computed WQI shows that 0% of groundwater sample fall in the 'excellent' water category during both monsoon periods and moreover maximum groundwater samples falls on category unfit for drinking purposes, indicating that the groundwater is not suitable for direct consumption and require treatment. After treatment, the water can be used for drinking purpose.**

***IndexTerms* - Groundwater, salinity, water quality index**

I. INTRODUCTION

Groundwater is used for domestic and industrial water supply and irrigation all over the World. In the last few decades, there has been a tremendous increase in the demand for fresh Water due to rapid growth of population and the accelerated pace of industrialization. Human Health is threatened by most of the agricultural development activities particularly in relation to excessive application of fertilizers and unsanitary conditions. Rapid urbanization, especially in developing countries like India, has affected the availability and quality of Groundwater due to its overexploitation and improper waste disposal, especially in urban areas. As per the latest estimate of Central Pollution Control Board, about 29,000 million litre/day of wastewater generated from class-I cities and class-II towns out of which about 45% is generated from 35 metro-cities alone (Mangukiya et al., 2012). According to WHO organization, about 80% of all the diseases in human beings are caused by water. WQI is calculated from the point of view of the suitability of groundwater for human consumption. The water quality index (WQI) provides information about water quality in a single value. WQI is defined as a rating reflecting the composite influence of different water quality parameters.

II. LITERATURE REVIEW

Patrick Debels et al. (2005) have calculated Water Quality Index (WQI) in Chillan river (central chile) using nine physicochemical parameters. The results showed that the upper and middle parts of the watershed, water quality was good but in downstream, due to effects of the urban wastewater discharge, water quality conditions were critical during the dry season

Rashmi Sisodia (2006) evaluated water quality index and impact of industries, agriculture and human activities of wetland Kalakho lake of Rajasthan, India. The results revealed that dumping of wastes from municipal, domestic sources and agricultural runoff increase the value of WQI than acceptable levels at all the sampling stations

Yidana et al. (2009) studied Water Quality Index to illustrate the hydrochemistry of groundwater from the northern part of the Volta region of Ghana. Result implies that geology has an impact on the WQI of groundwater in the area. A groundwater sample shows higher WQI value than samples taken from surface water sources in the area.

Reza and Gurdeep (2010) assessed groundwater quality through Water Quality Index method in Orissa, India. Result indicates that water quality is poor during post monsoons as compared to summer season due to more seepage and movement of groundwater during post monsoon

J.M.Ishaku (2011) evaluated groundwater quality index for Jimeta YZXSalo area, northeastern Nigeria. Result indicates that high value of WQI mainly from chloride, nitrate, dissolved oxygen, chromium and EC. The source of these contaminated is attributed to anthropogenic origin.

P.J.Puri et al. (2011) assessed surface water (lake) quality of Nagpur city by using WQI. Results showed that the quality of water is fair in monsoon which then changed to medium in winter and poor in summer.

Chowdhury et al. (2012) evaluated the water quality index of water bodies along Faridpur- Barisal road in Bangladesh and concluded that the values of WQI at the maximum stations are poor and very poor in condition, few of them can be referred to as good, and among all water stations only one of the stations contains excellent water quality parameter for human consumption and other uses. The results revealed that although WQI of most of the water bodies were beyond acceptable limit but could be used for domestic and household purpose after purification.

Khalik et. al., (2012) studied seasonal variability and physico-chemical characteristics of groundwater at Azamgarh, U.P., India, during pre monsoon and post monsoon seasons. According the study, it was found that in pre monsoon season turbidity was not impart but in post-monsoon season, color and turbidity were developed in most of the groundwater samples. It was observed that post-monsoon samples were highly polluted in comparison to pre-monsoon season and chloride concentration was found high in both the seasons.

Lamare et al. (2014) assessed the ground water quality of dug wells in west Jaintia hills district, Meghalaya, India, using water quality index and revealed that although dug well water samples were found acidic and rich in iron content but fall under good water characteristics considering other parameters.

Kumar et. al., (2014) studied hydro-geochemistry and application of water quality index for groundwater quality assessment, Anna Nagar, Chennai city, Tamil Nadu, India. According the study, majority of the samples were falling under excellent to good category and suitable for drinking water purposes based on WQI. The Piper trilinear diagram shows that groundwater in study area was Na+ -Cl- and mixed Ca2+-Mg2+-Cl- type. [126] Md. studied hydro-geochemistry and application of water quality index for groundwater quality assessment, Anna Nagar, Chennai city, Tamil Nadu, India. According the study, majority of the samples were falling under excellent to good category and suitable for drinking water purposes based on WQI. The Piper trilinear diagram shows that groundwater in study area was Na+ -Cl- and mixed Ca2+-Mg2+-Cl- type. [126] Md.

III. STUDY AREA

Sirkazhi is located at 11.23°N 79.73°E, which runs along the Kollidam River. Sirkazhi has an average elevation of 5.18 m above sea level and is located at 13 km west of Bay of Bengal. It is located 95 km North-East of Thanjavur, 24 km North of Mayiladuthurai and 20 kilometres South of Chidambaram.

The town experiences long summers and short winters and receives an average yearly rainfall of 1,250 mm mainly from the north-east monsoon between October and December. Its close proximity to the sea means that Sirkazhi receives more rainfall than neighbouring towns. Sirkazhi is part of the Cauvery delta region and has irrigation channels, called the Kollidam channels, which carry water from the rivers and provide a rich deposit of fertile silt before reaching the sea. The soil is black and contains fertile alluvial sediment. The area's main crop is rice and other crops grown in the area are coconut, tamarind and neem. The landscape mostly consists of plain lands with fields and small portions of scrub jungle. Antelope, spotted deer, wild hog, jackal and fox are present in the jungles and outlying areas of the town. Crow and ordinary game birds are found in large numbers in the town.

The 2004 Indian Ocean earthquake was an undersea megathrust earthquake that occurred on 26 December 2004, with an epicentre off the west coast of Sumatra, Indonesia, triggering a series of devastating tsunamis along coastal fringes of the Indian Ocean. Nagapattinam district was the most affected part of Tamil Nadu, accounting for 6,064 off the 8,009 casualties in the state. Sirkazhi remained mostly unaffected by the tsunami, but the groundwater quality deteriorated where aquifers were close to the water bodies. There was heavy salt water intrusion inland.

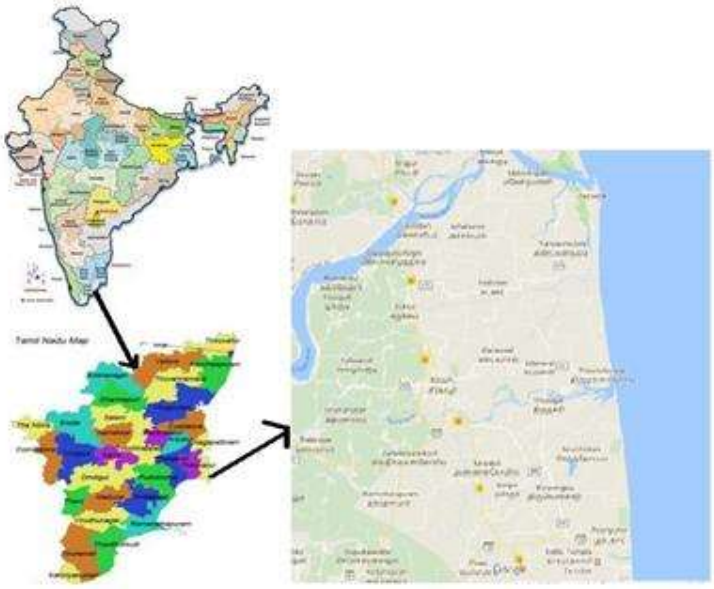

Fig. 1 Location Map of Study Area

IV. MATERIALS AND METHOD

A total of 9 water samples were collected during pre monsoon and post monsoon seasons. The samples were collected as per the standard method prescribed for sampling. Sampling was carried out without adding any preservative. The details of sampling locations are given in Table 1.

Table 1. Details of Sampling Locations

Sl. No	Sample place (Area)	Lattitude	Longitude
1	Kodiyampalayam	11.2423	79.4843

2	Pudupattinam	11.2133	79.4916
3	Thandavakulam	11.1908	79.4924
4	Vettangudi	11.1722	79.4926
5	Thirumullai vaasal	11.1523	79.4956
6	Thennampattinam	11.1315	79.5013
7	Perunthottam	11.1150	79.5026
8	Kaveripoompattinam	11.0955	79.5051
9	Vanagiri	11.0750	79.5056

Samples were analyzed to determine the concentration of pH, EC, Total alkalinity, Total hardness, carbonate, Bi carbonate, Chloride, Sulphate, Sodium, Calcium, Potassium, Magnesium, TDS, Nitrate, Na% in the Environmental laboratory of Annamalai University. All the tests were conducted in accordance with the techniques described by Bureau of Indian standards (BIS):10500 pH was measured by digital pH meter model no: 335, make in systronics – Ahmadabad India. Electrical conductivity (EC) and total dissolved solids (TDS) were measured with analyzed digital EC model no: 304, Type CD:10, Nitrate and Sulphate were determined by spectrophotometer (model no: 106). Sodium, Calcium, Potassium, Magnesium was analyzed for Flame photometer model no: 126 and FPM –compressor 126, Type no: 126. Salinity was analysis for the hand refract meter. The Water quality index method to analyses of the experimental data were performed using Microsoft Excel 2007.The results of the water quality parameters were analyzed and their water quality index is calculated to understand the quality suitability of ground water. The prescribed under Indian standard drinking and irrigation water specification BIS: 10500-2012.

V. RESULTS AND DISCUSSION

WQI is commonly used for the detection and evaluation of water Quality and it may be defined as the reflection of composite influence of Different quality parameters on the overall quality of water. The WQI of the Study area during pre monsoon and post monsoon seasons are analyzed. The overall water qualities during pre monsoon and post monsoon seasons with Representing of Sirkali block coastal villages are compared with BIS Standards. Table 2 Considerable deviations are observed in the water quality parameters from the standard desirable limits. WQI and corresponding water quality status is given in Table 3. Groundwater quality parameters in pre-monsoon and post monsoon are presented in Tables 4 and 5. Ground water quality parameter with their unit weights is given in Table 6. Ground water quality index values for the selected sample location in pre-monsoon and post-monsoon are given in Tables 7 and 8 and Figs 2 and 3.

Table 2 Ground water quality parameter in BIS and ICMR desirable limits

Parameter	**Recommended Limit (Si)** (desirable limits)
Ph	6.5–8.5 (BIS)
Total dissolved solids	500 (BIS/ICMR)
Calcium	75 (BIS/ICMR)
Magnesium	30 (ICMR/BIS)
Total Hardness	300 (BIS)
Electrical Conductivity	300 (ICMR/BIS)
Chloride	250(ICMR/BIS)

Table 3 WQI and corresponding water quality status

S. No	**WQI**	**Status**	**Possible Usage**
1.	0-25	Excellent	Drinking, Irrigation and Industrial
2.	25-50	Good	Domestic, Irrigation and Industrial
3.	51-75	Fair	Irrigation and Industrial
4.	76-100	Poor	Irrigation
5.	101-150	Very Poor	Restricted use for Irrigation
6.	Above	Unfit for Drinking	Proper treatment required before use

Table 4 Groundwater Quality parameters in pre-monsoon

Parameters	**pH**	**TDS**	**calcium**	**Mg**	**T H**	**EC**	**Chloride**
Kodiyampalayam	7.30	1222.00	182.45	292.32	468.00	1880.00	480.00
Pudupattinam	7.31	897.00	178.67	297.31	476.00	1380.00	296.00
Thandavakulam	7.14	513.50	106.60	177.38	284.00	790.00	160.00
Vettangudi	7.21	403.00	75.07	124.92	200.00	620.00	112.00
Thirumullai vaasal	7.65	1885.00	138.12	229.84	368.00	2900.00	896.00
Thennampattinam	7.30	4030.00	360.35	599.62	960.00	6200.00	2408.00
Perunthottam	7.02	1235.00	225.22	374.77	600.00	1900.00	616.00
Kaveripoompattinam	7.95	981.50	82.57	137.40	220.00	1510.00	400.00
Vanagiri	7.24	2080.00	90.07	149.88	240.00	3200.00	1056.00

(All values except pH and Electrical conductivity are in mg/L)

Table 5 Groundwater Quality parameters in pre-monsoon

Parameters	pH	TDS	calcium	Mg	T H	EC	Chloride
Kodiyampalayam	6.98	533.00	140.35	167.39	268.00	820.00	208.00
Pudupattinam	6.99	91.00	12.85	87.44	140.00	140.00	64.00
Thandavakulam	7.15	188.50	27.25	99.92	160.00	290.00	76.00
Vettangudi	7.01	305.50	43.35	117.47	188.00	470.00	80.00
Thirumullai vaasal	7.52	2860.00	67.50	307.29	492.00	4400.00	1736.00
Thennampattinam	6.92	2015.00	6.19	479.68	768.00	3100.00	1092.00
Perunthottam	6.96	1365.00	45.60	404.72	648.00	2100.00	640.00
Kaveripoompattinam	7.78	897.00	25.05	74.92	120.00	1380.00	400.00
Vanagiri	7.32	1560.00	60.25	144.89	232.00	2400.00	840.00

(All values except pH and Electrical conductivity are in mg/L)

Assessment of Water Quality Index (WQI)

The water quality index (WQI) of the study area is calculated using the formula

$$WQI = \Sigma qiWi / (\Sigma Wi)$$

Where,

Wi = Unit weight for the ith parameter

qi = Quality rating index for ith water quality parameter (i =1,2,3…etc)

qi is calculated using the following formula,

$$qi = 100(Vi / Si)$$

Vi = Measured value of the ith parameter at a given sampling location

Si = Standard permissible value for the ith parameter.

Wi is calculated using the following formula,

$$Wi = K/ Si$$

K = Constant of proportionality and it is calculated by using the expression given in Equation

K = 5.65

Where,

$$K= [1/(\Sigma 1/Si=1,2…..n)]$$

The unit weight of chemical parameters which are used to assess the water quality index.

Table 6 Ground water quality parameters with their unit weights

Parameter	Recommended Limit (Si)	Unit Weight (Wi)	K Value
Ph	6.5–8.5 (BIS)	0.66475	5.65
Total dissolved solids	500 (BIS/ICMR)	0.01130	5.65
Calcium	75 (BIS/ICMR)	0.07534	5.65
Magnesium	30 (ICMR/BIS)	0.18834	5.65
Total Hardness	300 (BIS)	0.01883	5.65
Electrical Conductivity	300 (ICMR/BIS)	0.01883	5.65
Chloride	250(ICMR/BIS)	0.02260	5.65

Table 7 WQI for the samples during pre-monsoon

S. No	S1	S2	S3	S4	S5	S6	S7	S8	S9
WQI	144	129	77	57	161	379	170	90	149

Table 8 WQI for the samples during post-monsoon

S. No	S1	S2	S3	S4	S5	S6	S7	S8	S9
WQI	81	29	37	47	224	206	160	67	120

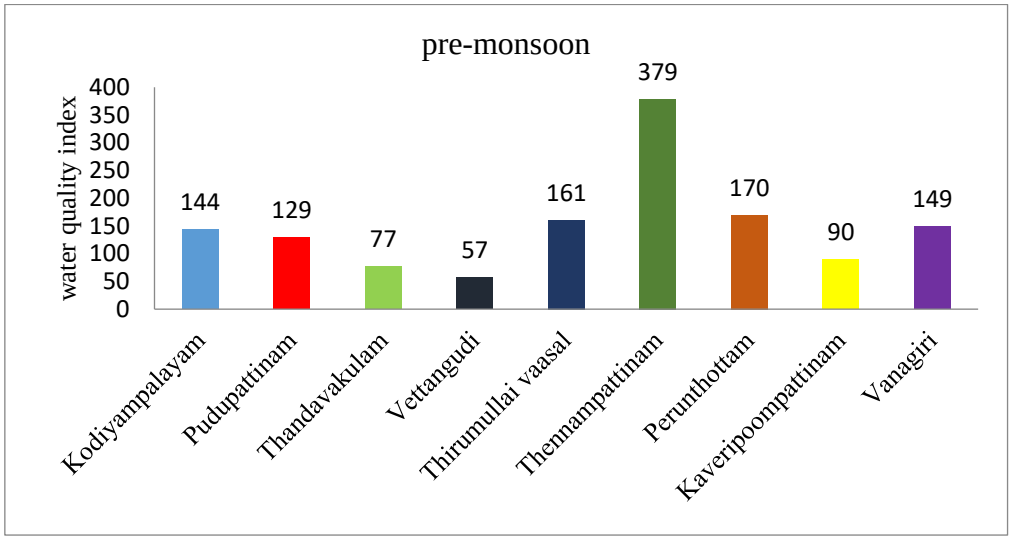

Fig. 2 WQI for the samples during pre-monsoon

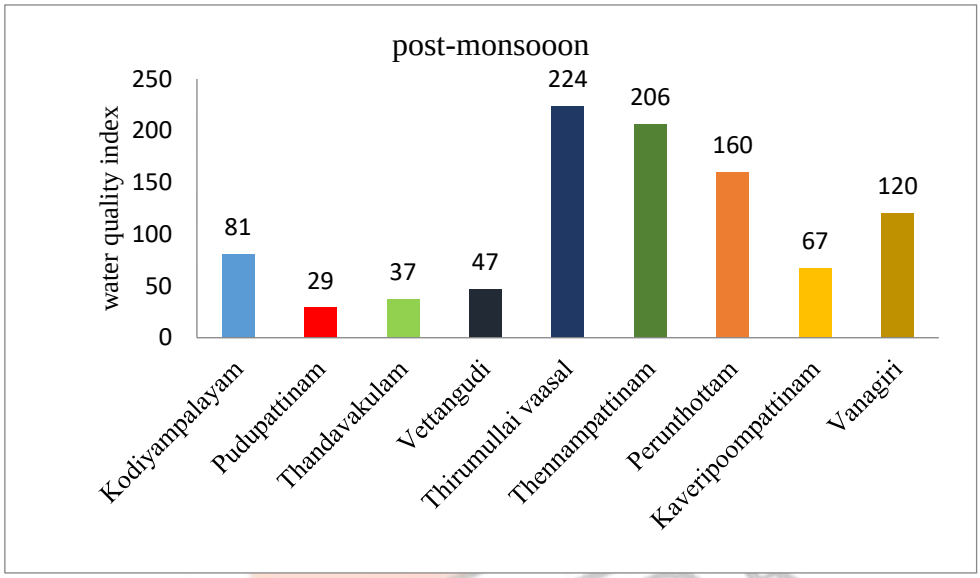

Fig. 3 WQI for the samples during post-monsoon

Table 9 WQI values of pre-monsoon and post-monsoon samples

S. No	Recommended limits(BIS)	WQI	Status	Representing pre-monsoon samples	Representing post-monsoon samples
1	6.5–8.5 (BIS)	0-25	Excellent	NIL	NIL
2	500 (BIS/ICMR)	25-50	Good	NIL	S1,S2,S3
3	75 (BIS/ICMR)	51-75	Fair	S4	S7
4	30 (ICMR/BIS)	76-100	Poor	S3,S8,	S9
5	300 (BIS)	101-150	Very Poor	S1,S2,S9	S8
6	300 (ICMR/BIS)	Above	Unfit for Drinking	S5,S6,S7	S4,S5,S6

The WQI of pre monsoon state that 0% of the total ground water samples are excellent, 0% good, 11.11% are fair, 22.22% are poor, 33.33% are very poor, 33.33% are unfit for drinking purposes. And the WQI of post monsoon sample state that 0% of the ground water samples are excellent, 33.33% are good, 11.11% are fair, 11.11% are poor, 11.11% are very poor, and 33.33% are unfit for drinking purposes. The ground water is better during pre monsoon season than post monsoon season.

VI. CONCLUSIONS

The ground water samples were collected from nine different places of coastal area in Sirkali block of Nagapattinam District. The samples were subject to physio-chemical analysis. The results were showed most of the physio-chemical parameters like pH, TH, TDS, COD, BOD, EC and Clare well above the permissible limit set by BIS. In this study, the application of water quality index technique is used for the determination of ground water quality in around Sirkali block. Assembling different parameters in to one single number leads an easy interpretation of water quality. However, the water quality index values in the present investigation varied from 29 to 379 indicating that the water is and unfit for drinking and domestic purpose. So

people should be made aware of the water quality importance on sanitation and economical water treatment methods to avoid waterborne disease. The remedial measure must be taken immediately to safeguard and conserve the precious water resources from pollution for future generation.

VII. RECOMMENDATIONS

- Rainwater Harvesting must be provided and should be made compulsory for each residential unit as it is considered as the economical solution.
- Consideration of scheme to construct artificial recharge structure.
- Provision of ground water owned treatment units like reverse osmosis, desalination, ion-exchange process etc. to prevent consumption of marginal quality water.
- A ground water assessment and estimation study should be conducted each year for better understanding of ground water variation.
- Public awareness programs need to be developed for sustainable management of ground water.

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