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RESEARCH ARTICLE

Assessment of Sea Water Intrusion in Ground Water Samples of Selected Blocks of Cuddalore District, Tamil Nadu, India

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ABSTRACT

Coastal aquifers are increasingly threatened by seawater intrusion due to increased urbanization, groundwater exploitation, and global sea-level rise. A total of 161 ground water samples were collected during May 2017. Among the 13 blocks of Cuddalore district, only 4 coastal blocks viz., Parangipettai, Kumaratchi, Kurinjipadi and Bhuvangiri blocks were studied. Among the 4 coastal blocks studied (52 samples), Melathirukallipalai and Kavarapattu locations of Parangipettai block and Ammapettai, Erukkankattupadugai and Karuppur locations of Kumaratchi block of Cuddalore district were suspected for sea water intrusion based on their hydro geology parameters, molar ratios, piper plot facies, gibbs assessment. Bicarbonate and Chloride were the dominant anions, Magnesium and Sodium were the dominant cations found in the above mentioned locations. The ground water chemistry commonly found to be Ca-HCO_3 type. However NaCl is also the dominant water facies in the above mentioned locations. Regarding salt water intrusion, the high Mg/Ca ratio (>5.4) may be indicative of salt water contamination in these locations. According to $Cl/CO3^{2-} + HCO_3$- ratio (> 6.6) the screened locations have highly contaminated ground water (near sea water). Based on Na/Cl ratio (<0.86), the contamination may be due to marine source of origin.

Keywords: *Coastal blocks, ground water quality, Hydrology, ionic composition, piper plot.*

INTRODUCTION

Seawater intrusion threatens coastal freshwater resources globally, rendering groundwater non-potable and invariably forcing well abandonment or requiring costly treatment systems. This vulnerability is also expected to exacerbate by future climate change and associated sea-level rise up (Taylor *et al.* 2013). Seawater and freshwater have different hydrochemistry, with the former being characterized by nearly uniform chemistry where chloride (Cl^-) and sodium (Na^+) make up 84% of the total ionic composition. On the other hand, while freshwater composition varies widely, calcium (Ca^{2+}) and bicarbonate (HCO_3^-) commonly dominate. Mixing of these waters is traditionally depicted by increased Cl^- concentration within the aquifer, which is easily traceable due to the conservative nature of the anion (Panteleit *et al.* 2011). Similarly, the increase in Total Dissolved Solids (TDS) or Electrical Conductivity (EC) is a common simple indicator to identify an increase in salinity (Singhal and Gupta 2010). While seawater intrusion is recognized as the mixing of seawater into freshwater aquifers, it is a complex process due to influences of hydro geochemical reactions, shoreline geomorphology, biological processes, and aquifer flow. Processes indicative of seawater intrusion include cation exchange reactions, calcite dissolution and carbonate diagenesis, dolomitization, and sulfate reduction. There are many hydrochemical pattern diagrams (Durov 1948; Stiff 1951; Schoeller 1964). The most popular pattern diagram is the Piper (Piper 1944) diagram whereby water analysis results are presented on a trilinear plot consisting of cation and anion triangles. Results from multiple analyses, such as several groundwater wells in a region, can be plotted on the same diagram and then interpreted to identify the chemical character, or hydrochemical facies, in defined domains as well as possible mixing of fresh water with seawater key in seawater intrusion studies (Arslan *et al.* 2012). The location of Neyveli mining and Veeranam Lake in which ground water extraction is at its maximum fall in the environment (Anandhan 2005).

MATERIAL AND METHODS

Description of study area

The study was carried out in coastal blocks of Cuddalore district located in north eastern parts of Tamil Nadu, India. The district has a hot tropical

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climate. In summer season, this is very oppressive, from March to May. The southwest monsoon, which follows, lasts till September. October to December constitutes northeast monsoon season. January to February is the comparatively cooler period. The annual normal rainfall for the period (1901-2000) ranges from 1050 – 1400 mm. The normal annual rainfall over the district varies from about 1050 mm to about 1400 mm. The entire district can be broadly divided into following 3 zones. Western pediplains of entire area covered by Mangalur and Nallur blocks. This area is occupied by denudational landforms like shallow buried pediment, deep buried pediment and pediments. Central part of the district is characterized by sedimentary high grounds, elevation >80 m of Cuddalore sandstone of Tertiary age. This zone occupies part of Virudhachalam, Kammapuram, Kurinjipadi, Cuddalore and Kattumannarkoil taluks. Rest of the area in the district is covered by eastern coastal plain, which predominantly occupied by the flood plain of fluvial origin formed under the influence of Penniyar, Vellar and Coleroon river systems. Marine sedimentary plain is noted all along the eastern coastal region. Black soils are observed in the Chidambaram and Virudhachalam taluks. The sandy soils are seen along the coast in Cuddalore and Chidambaram taluks. Red sandy soil is seen covering the Cuddalore sandstone, laterite and lateritic gravels occur in parts of Virudhachalam, Panruti and Cuddalore taluks. (CGWB 2009).

Hydrogeology of study area

Ground water occurs in all the geological formations ranging in age from Archaean to recent which can be broadly classified into two hydrogeological units namely a) fissured and fractured formations b) porous formation (Plate-II). Tube wells tapping cretaceous formation are in the depth range of 100 to 250 m bgl with a yield of 8 lps. It can sustain a pumping of 6 hrs per day. It is generally used for drinking/irrigation purposes. The tertiary aquifer comprising Cuddalore Sandstone is the most productive aquifer and occurs in the depth range of 100 to 457 m. Laterite and lateritic gravels occur in major part of the extensive in occurrence as near Vadalur and district covering the Cuddalore sandstones.

Grid surveying

Fifty two well locations were chosen to collect ground water samples during May 2018 which cover the distance of 30 km from the coast in the four coastal blocks of Cuddalore district. The samples were collected from both dug wells (<15 m) and bore wells (>15 m). The time period of May was chosen as they represent the peak summer period when the distance of sea water intrusion is expected to be more due to excessive pumping of ground water. Ground water sampling was done through grid surveying having grid size of 10 sq. km the entire Cuddalore district map was divided into grids of 10 sq. km size so that each grid receive at least one bore well location. Samples were stored in airtight bottles.

Ionic ratios

The samples were collected after 10 minutes pumping and stored in polythene bottles.The pH, EC, TDS were measured by hand held pH, EC and TDS meter in the sampling location. The collected ground water samples were analyzed for major cations like Ca^{2+} and Mg^{2+} by Titrimetry and K^{+} and Na^{+} by Flame photometry, anions like Cl^{-}, $CO3^{2-}$, HCO_3^{-} by Titrimetry, $SO4^{2-}$ by UV spectrophotometer as per standard methods outlined by Richards 1954.

Working out inorganic charge balance

Inorganic charge balance is worked out by calculating the normalized inorganic charge balance which is defined as $\{\Sigma \text{ cation} - \Sigma \text{ anion} / \Sigma^{+} + \Sigma^{-}\}$ and represents the fractional difference between the total cations and anions (Edmond JM et al. 1995) as exemplified by Huh et al 1998, the measured major ions (Na^{+}, Ca^{2+}, Mg^{2+}, K^{+}, Cl^{-}, $SO4^{2-}$, $CO3^{2-}$, HCO_3^{-}) or generally give a charge balance.

Piper plot diagram

Piper plot (Piper 1944) is a way of visualizing the chemistry of ground water samples. It's comprised of three pieces: a ternary diagram in the lower left representing the cations, a ternary diagram in the lower right representing the anions, and a diamond plot in the middle representing a combination of the two.

Gibbs analysis diagram

Gibbs (1970) proposed a diagram to understand the relationship between the chemical components of waters from their respective aquifers lithologies. Three distinct fields namely, Precipitation dominance, Rock dominance and Evaporation dominance are shown in the Gibbs diagrams. The Gibbs Ratio I – $Cl / (Cl + HCO_3)$ for anion and Ratio II – $Na + K / (Na + K + Ca)$ for cation of the samples have been plotted separately against the respective values of TDS.

RESULTS AND DISCUSSION

The hydro geochemical parameters of coastal blocks of Cuddalore district, Tamil Nadu were studied and the results were presented in various forms viz., ionic ratios, inorganic charge balance, piper facies, Gibbs analysis inorder to assess the ground water chemistry as well as sea water intrusion if any in the ground water samples of study area.

Table 1.Hydrogeochemical data of coastal blocks of study area (May 2017)

Parameters	Minimum	Maximum
pH	6.52	8.72
EC (dS/m)	1.34	17.62
TDS (ppm)	921.6	11276.8
Ca (m.eq/l)	1.8	6.6
Mg (m.eq/l)	5.02	18.12
Na (m.eq/l)	3.46	99.24
K (m.eq/l)	0.52	10.99
Cl(m.eq/l)	4	210
CO (m.eq/l)	4	8
HCO_3(m.eq/l)	6	18
SO_4(m.eq/l)	0.25	7.47

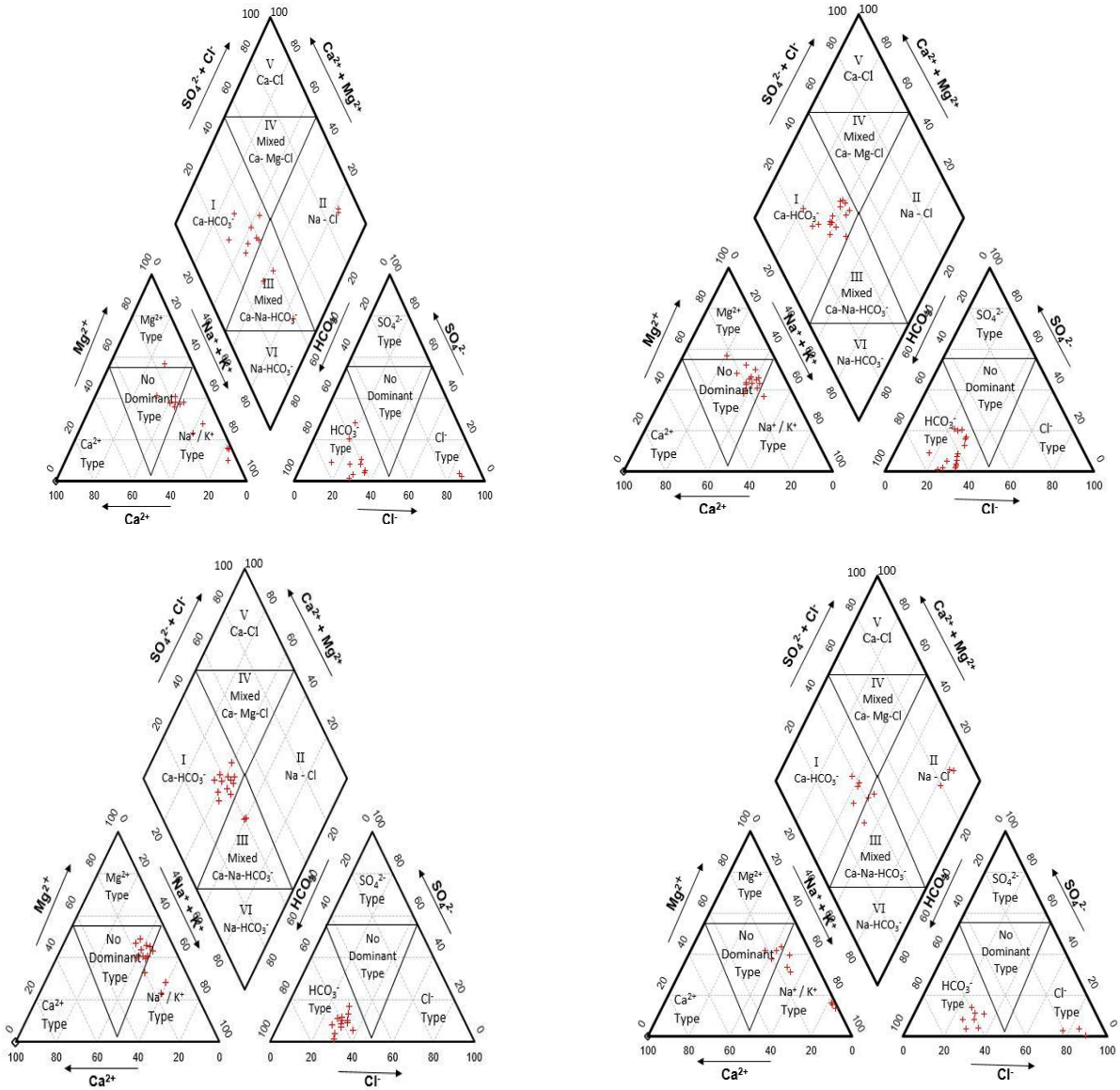

Figure 1. Piper diagrams of coastal blocks of Cuddalore district

Ionic charge balance

More than 90 per cent of ground water sample collected from coastal blocks showed an excess of net negative charge. Among the four anions studied, bicarbonate is the dominant anion followed by chloride (HCO_3^- > Cl^- > CO_3^{2-} > SO_4^{2-}) in Kurinjipadi and Bhuvanagiri blocks. The dominant cationic distribution order are as follows Mg^{2+} > Na^+ > Ca^{2+} > K^+ in the above said coastal blocks.

Table 2. Ground water chemistry of coastal blocks of Cuddalore district using inorganic charge balance (meq./l)

S. NO	Village name	Lattitude	Longitude	pH	EC	Ca^{2+}	Mg^{2+}	Na^+	K^+	TZ^+	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	TZ^-	Inorganic charge balance
1	Periyapattu	N11.560283	E079.72345	7.93	4.06	2.4	7.12	5.81	1.01	16.34	4	8	6	2.05	20.05	-0.10
2	Pudhuchathiram	N11.527267	E079.721433	7.72	4.26	4.8	6.73	5.62	10.59	27.74	4	10	6	0.66	20.66	0.15
3	Manikollai	N11.53515	E079.7159	7.49	2.32	6.4	11.56	6.98	10.42	35.35	8	12	8	0.40	28.40	0.11
4	Valangipattu	N11.5182	E079.719317	7.36	2.26	6.6	10.43	3.87	10.33	31.23	8	12	4	2.33	26.33	0.09
5	Kothatai	N11.53055	E079.720983	7.96	2.35	3.6	8.25	7.12	0.94	19.91	4	10	8	0.94	22.94	-0.07
6	Panjakuppam	N11.521767	E079.734733	8.14	2.14	3.2	8.94	7.84	2.30	22.28	4	10	8	1.20	23.20	-0.02
7	Parangipettai	N11.487267	E079.7497	8.72	2.25	6.4	11.23	8.95	2.20	28.78	8	12	10	2.65	32.65	-0.06
8	B.Muthur	N11.458217	E079.703767	7.35	4.03	2.8	10.75	5.83	6.34	25.72	8	8	6	1.98	23.98	0.03
9	Kuriayamangalam	N11.46325	E079.665467	8.43	2.3	3	7.24	3.72	1.66	15.62	4	8	4	6.35	22.35	-0.18
10	Keelamannakudi	N11.4741	E079.671467	7.76	4.63	4.2	8.84	5.47	2.02	20.53	8	8	6	1.99	23.99	-0.08
11	Ambigapuram	N11.369483	E079.741	7.92	4.43	5.6	11.97	5.29	4.68	27.54	8	12	6	6.63	32.63	-0.08
12	Melathirukallipallai	N11.384533	E079.75845	7.32	11.53	2.4	18.12	90.47	10.28	121.27	8	16	190	4.87	218.87	-0.29
13	Kavarapattu	N11.37635	E079.7499	7.16	10.6	1.8	17.45	84.83	8.98	113.06	8	14	160	6.55	188.55	-0.25
14	Andalmullipallam	N11.34596	E079.43453	8.34	2.47	2.8	6.93	5.73	3.44	18.90	4	8	6	1.68	19.68	-0.02
15	Kayalpattu	N11.3511	E079.43408	7.99	3.06	4.8	10.78	7.85	1.27	24.70	8	10	8	6.59	32.59	-0.14
16	Poovanikuppam(South)	N11.597551	E079.704273	7.51	2.79	2.8	5.02	3.48	1.40	12.70	4	6	4	3.74	17.74	-0.17
17	Thondamanatham	N11.652457	E079.726024	8.04	2.02	2.8	8.94	7.73	1.32	20.79	4	10	8	4.45	26.45	-0.12
18	Godhandranapuram	N11.63389	E079.716786	6.84	2.24	3.6	9.26	7.64	2.10	22.60	4	10	8	3.20	25.20	-0.05
19	Anukkampattu	N11.628702	E079.720199	8.52	3.02	3.2	10.83	5.75	0.95	20.73	8	8	6	0.44	22.44	-0.04
20	Ellappanpellai	N11.50390	E079.565436	8.49	2.16	2.8	8.24	5.63	1.11	17.78	4	8	6	0.33	18.33	-0.02
21	Maruvai	N11.52983	E079.567005	7.53	2.31	2.6	10.63	7.56	0.52	21.31	4	10	8	4.09	26.09	-0.10
22	Karungulyhi	N11.633257	E079.632841	8.58	2.44	2.8	7.46	5.52	0.55	16.33	4	8	6	0.53	18.53	-0.06
23	Kolakudi	N11.503901	E079.565436	7.64	2.28	2.2	8.24	5.37	2.04	17.85	4	8	6	1.01	19.01	-0.03
24	VadakkuMelur	N11.614580	E079.561069	7.47	2.06	4.8	10.72	5.25	1.36	22.13	8	10	6	0.25	24.25	-0.05
25	Kellur	N11.589046	E079.587768	6.52	1.98	5.2	8.54	7.36	1.17	22.27	4	12	8	0.92	24.92	-0.06
26	Pethanayakankuppam	N11.563591	E079.62528	6.84	2.29	3.2	6.87	5.24	0.72	16.03	4	8	6	1.37	19.37	-0.09
27	Kurinjipadi	N11.554913	E079.58739	6.82	3.06	4.4	11.26	3.52	0.63	19.81	8	10	4	2.15	24.15	-0.10
28	Kannadi	N11.561316	E079.642066	7.78	2.53	1.8	5.73	3.85	1.29	12.67	4	6	4	0.72	14.72	-0.07
29	Vadalur	N11.33618	E079.34634	7.53	2.27	3	7.65	5.37	1.63	17.65	4	8	6	4.61	22.61	-0.12
	Kumarachi block															
30	Ammapettai	N11.3769	E079.6964	7.28	9.26	2.2	17.67	86.93	2.17	108.97	8	16	90	3.11	117.11	-0.04
31	Perempattu	N11.364717	E079.725617	7.52	4.78	6	11.52	9.25	0.79	27.56	8	12	10	2.58	32.58	-0.08
32	Agaranallur	N11.351617	E079.69295	7.85	4.02	3.2	8.35	7.53	0.81	19.89	4	10	8	0.89	22.89	-0.07
33	Vallampadugai	N11.347617	E079.711917	8.12	4.37	4.4	9.52	5.37	10.99	30.28	8	8	6	1.92	23.92	0.12
34	Erukkangkattupadugai	N11.330617	E079.696617	7.49	15.73	1.8	17.46	99.24	8.45	126.95	8	16	210	0.72	234.72	-0.30
35	Karuppur	N11.314983	E079.680983	7.02	17.62	2.4	17.83	88.92	6.78	115.93	8	18	180	7.47	213.47	-0.30
36	Vennaiyur	N11.289991	E079.621053	8.34	4.36	4.4	9.84	9.27	5.86	29.37	4	12	10	3.12	29.12	0.00
37	Kiliyanur	N11.0439787	E079.6868902	8.12	4.15	5.6	10.26	7.42	3.95	27.23	8	10	8	4.23	30.23	-0.05
38	Sivapuri	N11.3726543	E079.71344	8.46	5.62	2.2	8.17	5.38	4.82	20.57	4	8	6	2.35	20.35	0.01
39	Poolamedu	N11.3394781	E079.6512169	7.25	4.38	2.6	8.93	5.69	3.26	20.48	4	10	6	0.73	20.73	-0.01
	Bhuvanagiri block															
40	Azhichikudi	N11.26808	E079.36156	7.83	1.44	3.6	5.94	5.72	2.64	17.90	4	8	6.00	1.73	19.73	-0.05
41	Clavadinatham	N11.26881	E079.35440	8.32	1.86	4.8	9.36	7.25	1.82	23.23	8	8	8.00	1.86	25.86	-0.05
42	C.Alampadi	N11.464407	E079.614644	7.93	3.02	2.6	9.27	7.19	1.10	20.16	4	10	8.00	2.19	24.19	-0.09
43	Ponthavarayanpettai	N11.448393	E079.627091	7.73	1.48	2.8	6.83	5.36	2.13	17.12	4	8	6.00	1.68	19.68	-0.07
44	Therkuthittai	N11.461847	E079.636780	7.72	1.98	3.4	8.96	7.43	0.67	20.46	4	10	8.00	4.53	26.53	-0.13
45	North thittai	N11.480821	E079.6410718	8.07	2.43	3.2	7.54	5.38	10.31	26.43	4	8	6.00	2.03	20.03	0.14
46	Chokkamkollai	N11.499055	E079.647188	7.71	3.83	4.8	11.36	7.64	4.26	28.06	8	10	8.00	0.41	26.41	0.03
47	Sathapody	N11.486356	E079.6493100	7.85	1.81	3.4	13.40	11.73	2.30	30.83	4	14	12.00	1.82	31.82	-0.02
48	Chithery	N11.426479	E079.678807	8.02	1.34	4.4	11.64	7.37	3.22	26.63	8	10	8.00	1.03	27.03	-0.01
49	C.Muttur	N11.426479	E079.678807	8.12	3.13	2.6	6.97	3.46	1.75	14.78	4	6	4.00	1.26	15.26	-0.02
50	Melamoongiladi	N11.426479	E079.665382	8.05	4.05	3.4	9.08	7.53	2.33	22.34	4	10	8.00	3.44	25.44	-0.06
51	Melabhuvangiri	N11.426479	E079.6495214	8.32	5.62	4.6	6.32	5.83	10.31	27.05	4	8	6.00	2.39	20.39	0.14
52	KeelaBhuvangiri	N11.426479	E079.6561529	8.08	1.42	3.8	12.74	7.52	2.05	26.11	8	10	8.00	3.30	29.30	-0.06
53	Aathivaraganatham	N11.426479	E079.631514	8.11	3.11	2.4	9.72	7.28	2.03	21.43	4	10	8.00	2.54	24.54	-0.07

In Parangipettai and Kumaratchi blocks, chloride is the dominant anion followed by HCO_3^-, CO_3^{2-}, and SO_4^{2-}. Whereas the cationic sequence are as follows $Na^+ > Mg^{2+} > K^+ > Ca^{2+}$. In general, pH of the ground water is alkaline in nature with average of 8.4 EC varies from 0 - 11.00 dS/m, TDS ranges from 1432-11536 (mg L^{-1}). The water samples of the study area are classified as fresh to brackish water in nature (Table 2).

Table 3. screening of sea water intruded well locations of Cuddalore district, Tamil Nadu

Villages	Geo coordinates	Distance from sea (Km)	Na+(m. eq./lit)	Cl-(m. eq./lit)	-HCO3(m. eq./lit)	Na/Cl	2-Cl / CO3- +HCO3	Mg/ Ca	Rating
Parangipettai block									
Melathirukallipalai	N11.3845º								
	E079.7584 º	4	90.47	190.00	16.00	0.48	7.92	7.55	Sea water intrusion
Kavarapattu	N11.3763 º								
	E079.7499 º	8	84.83	160.00	14.00	0.53	7.27	9.69	Sea water intrusion
Kumaratchi Block									
Ammapettai	N11.3769 º								
	E079.6964 º	10	86.93	90.00	16.00	0.51	7.08	8.03	Sea water intrusion
Erukkankattupadugai	N11.3306 º								
	E079.6961 º	11	99.24	210.00	16.00	0.47	8.75	9.70	Sea water intrusion
Karuppur	N11.3149 º								
	E079.6809 º	9	88.92	180.00	18.00	0.49	6.92	7.43	Sea water intrusion

Ground water chemistry

The geochemical evolution of ground water can be understood by ploting the concentration of major cations and anions in the piper (1944) trilinear diagram. Kurinjipadi block and Bhuvanagiri block represent 90 % of the ground water samples fall in the range of no dominant type however few samples fell in Mg/Na type in piper cation triangle, whereas all the samples fell in–HCO_3 type in piper anion triangle. The ground water chemistry of Kurinjipadi and Bhuvanagiri samples represented in the domain I i.e Ca-HCO_3 combination water of diamond field in piper diagram.

Parangipettai and Kumaratchi block represent 50 per cent of the ground water samples fell in the category of no dominant type and 50 per cent in Na / K type in piper cation triangle, whereas 90 per cent ground water samples fell in HCO_3 type, very few samples (10 %) in the category of Cl^- type in piper anion triangle. The ground water chemistry of Parangipettai samples around 70 per cent represented in the domain I i.e Ca-HCO_3 combination water, 20 per cent of ground water samples in domain III i.e Ca –Na –HCO_3^- combination water and 10 per cent of ground water samples in domain II i.e NaCl combination water of diamond field of piper diagram. (Figure 1).

Mechanism of weathering (Gibbs analysis)

Gibbs analysis relates the relationship between the chemical components of water from their respective aquifers lithologies. The Gibbs ratio I for anion and Gibbs ratio II for cation of the samples have been plotted separately against the respective values of TDS (Figure.2). In Parangipettai block, out of 13 samples collected, 6 samples fell in evaporation dominance, and the remaining 7 samples fall in the rock dominance category indicating the role of weathering of rocks i.e sand stone through carbonate weathering as the minor mechanism of controlling the anionic and cationic composition of ground water (Senthil Kumar *et al.* 2012).

In Kumaratchi block out of 10 ground water samples collected, 6 samples fell in rock dominance category, rest 4 samples fell in evaporation dominance in determining the anionic composition of ground water whereas all the samples having cationic composition from evaporation dominance. In Kurinjipadi block, both anionic and cationic composition of ground water samples is due to rock dominance (12 nos.) indicating carbonate weathering, and 4 nos. due to evaporation dominance. In Bhuvanagiri block, 4 samples fell in the Rock dominance category indicating the role of weathering of rocks as the minor mechanism of controlling the anionic composition of ground water, and the remaining 10 samples fall in evaporation dominance. Out of 14 samples, 7 samples having cationic composition from rock dominance and in remaining 7 samples, the cationic composition was due to evaporation dominance.

Sea water contamination

The abundance of cations like Na^+, anions like Cl^- and HCO_3^- over other ions in the ground water samples as well as ionic ratios like Na/Cl (< 0.86) Cl / CO_3^{2-} + HCO_3^- (> 6.6) and Mg / Ca (> 5.4) of Melathirukallipalai and Kavarapattu locations of Parangipettai block and Ammapettai, Erukkankattupadugai and Karuppur locations of

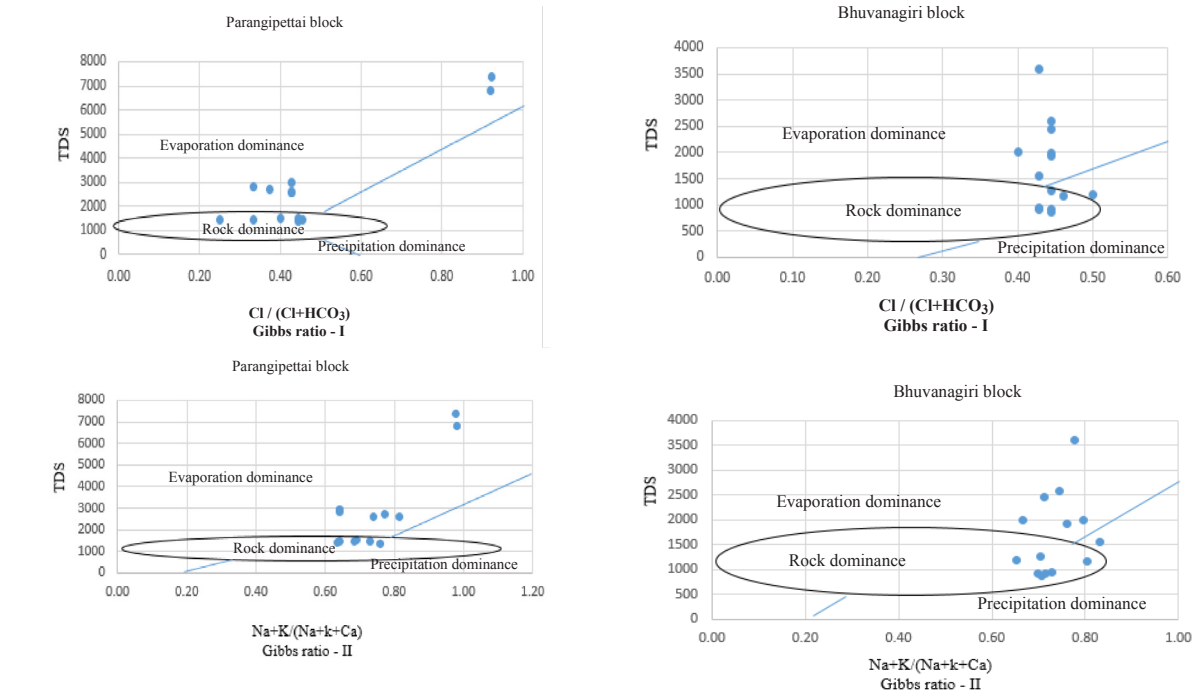

Figure 2. Gibbs diagrams of coastal blocks of Cuddalore district

Kumaratchi block of Cuddalore district indicates the possible sea water intrusion in the study area. (Table 3).

Seawater is recognized as the mixing of sea water into fresh water aquifer, it is a complex process due to influence of hydro geo chemical reactions, shoreline geo morphology, biological processes and aquifer flow, amongst others. Processes indicative of sea water intrusion include cation exchange reaction, calcite dissolution and carbonate diagenesis, dolomotization and sulfate reduction (Tomaszkiewicz *et al*. 2014). More than 90% of ground water samples collected from coastal blocks of Cuddalore district showed an excess of net negative (anionic) charge. Based on the ground water chemistry of four coastal blocks studied, bicarbonate is the dominant anion followed by chloride (HCO_3^- > Cl^- > $CO3^{2-}$ > SO_4^{2-}) in Kurinjipadi and Bhuvanagiri blocks of Cuddalore district whereas chloride is the dominant anion in Parangipettai and Kumaratchi blocks (Cl^- > HCO_3^- > CO_3^{2-} > SO_4^{2-}). The dominant cationic distribution order are as follows Mg^{2+} > Na^+ > Ca^{2+} > K^+ in Kurinjipadi and Bhuvanagiri blocks whereasthe dominant cationic distribution order are Na^+ > Mg^{2+} > Ca^{2+} > K^+ in Parangipettai and Kumaratchi blocks. The ground water chemistry of Kurinjipadi and Bhuvanagiri block samples revealed that the samples are under the category of shallow fresh ground water not observed with sea water intrusion whereas in Parangipettai and Kumaratchi blocks, the presence of shallow fresh ground water (70 %), sea water (10 %) and mixed

Ca – Na - HCO_3 (20 %).These findings are in line with the findings of Senthilkumar *et al* (2012). In Parangipettai block, out of 13 samples collected, six samples fall in evaporation dominance, and the remaining 7 samples fall in the rock dominance category indicating the role of weathering of rocks i. e sand stone through carbonate weathering as the minor mechanism of controlling the anionic and cationic composition of ground water (Senthil Kumar *et al.* 2012). In Kumarachi block out of 10 ground water samples collected, six samples fall in rock dominance category and the rest 4 samples fell in evaporation dominance.

The abundance of cations like Na^+, anions like Cl^- and HCO_3^- over other ions in the ground water samples as well as ionic ratios like Na / Cl (< 0.86) Cl / CO_3^{2-} + HCO_3^- (> 6.6) and Mg / Ca (> 5.4) of Melathirukallipalai and Kavarapattu locations of Parangipettai block and Ammapettai, Erukkankattupadugai and Karuppur locations of Kumaratchi block of Cuddalore district indicates the possible sea water intrusion in the study area (Mohan Babu *et al*. 2013).

CONCLUSION

The ground water samples collected from coastal blocks of Cuddalore district was analyzed for their suitability to irrigation. Among the 4 coastal blocks studied (52 samples), Melathirukallipalai and Kavarapattu locations of Parangipettai block and Ammapettai, Erukkankattupadugai and Karuppur locations of Kumaratchi block of Cuddalore district were suspected for sea water intrusion based on their hydro geology parameters, molar ratios, piper plot facies, gibbs assessment. Bicarbonate and Chloride were the dominant anion, Magnesium and Sodium were the dominant cations found in the above mentioned locations. The ground water chemistry commonly found to be Ca-HCO_3 type. However NaCl is also the dominant water facies in the above mentioned locations. Regarding salt water intrusion, the high Mg / Ca ratio (> 5.4) may be indicative of salt water contamination in these locations. According to Cl / CO_3^{2-} + HCO_3^- ratio (> 6.6) the screened locations have highly contaminated ground water (near sea water). Based on Na / Cl ratio (< 0.86), the contamination may be due to marine source of origin. Hence, construction of check dams in these areas across the rivers at frequent intervals will assist in mitigating the problems of sea water intrusion by increasing ground water recharge.

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