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Suitability of bore well water of Karaikal region for irrigation to crops

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Abstract : Thirty three bore wells were selected under different categories *viz.* Deep (>100m), Shallow (20 - 100m) and Filter points (<20m) covering the Fluvial land forms of Karaikal region where major cropping activities were undertaken. In about 90.9 per cent of the deep bore well samples, the EC ranged between 0.751 - 2.250 dSm^{-1}. However, in around 35.7 and 50 per cent of the shallow and filter point bore well samples, it ranged between 2.251 - 5.000 dSm^{-1}. Among the cationic composition, Na^{+} dominated in the deep and shallow bore wells while Na to other cation ratio was narrower in the filter points. Similarly, Cl^{-1} and HCO_3^{-} among the anionic composition dominated in all the categories of bore wells. On the basis of classification of Residual Sodium carbonate (RSC) concept, around 73, 69 and 100 per cent of deep, shallow and filter point bore wells, respectively were safe to medium in safe for irrigation to agricultural crops. The geological formation of the deeper bore well could able to yield a suitable and required quantity of water for irrigation but the marine beds of pleocene period in between the sand stone and surface of soil was blocked from mixing with the bore well water.

Key words: Bore wells, cationic composition, irrigation.

Introduction

Irrigated agriculture is dependent on an adequate water supply of usable quality. Water used for irrigation can vary greatly in quality depending upon type and quantity of dissolved salts. To avoid problems when using this poor quality water, there must be sound planning to ensure that the quality of water available is put to the best use.

The entire agriculture of Karaikal depends on the release of water from Mettur reservoir which is available from June to February. But due to non - availability of water in time and quantity, supplementary irrigation sources from ground water are exploited. However, due to proximity to sea, rich fossiliferous marine beds of the Pleocene age (at 54 to 77m) and Cuddalore sand stones of Miocene age (at 194 to 371m) (SSSO, 1987), the suitability of the bore well water is to be analyzed for sustainable cropping programme at this region.

Methodology

Thirty three bore wells were selected under different category *viz.* Deep (>100m), Shallow (20 - 100m) and Filter points (<20m) covering the Fluvial land forms of Karaikal region where major cropping activities were undertaken.

Table 1. Distribution of three groups of bore wells among four electrical conductivity classes.

Conductivity Range (dSm^{-1})	Group 1 (Deep)		Group 2 (Shallow)		Group 3 (Filter)	
	Total = 11		Total = 14		Total = 8	
	No.	%	No.	%	No.	%
< 0.250	0	0.0	0	0.0	0	0
0.251 - 0.750	0	0.0	0	0.0	0	0
0.751 - 2.250	10	90.9	9	64.3	4	50
2.251 - 5.000	1	9.1	5	35.7	4	50

Table 2. Distribution of three groups of bore wells among four SAR classes.

SAR	Group 1 (Deep)		Group 2 (Shallow)		Group 3 (Filter)	
	Total = 11		Total = 14		Total = 8	
	No.	%	No.	%	No.	%
< 10	8	72.7	13	92.9	8	100
10-18	3	27.3	1	7.1	-	-
18-26	-	-	-	-	-	-
> 26	-	-	-	-	-	-

The water samples from the individual sources were collected during February month and analyzed for the chemical composition *viz.* sodium, potassium, calcium, magnesium, chlorine, carbonate, bi-carbonate, and sulphate apart from pH and electrical conductivity as per the standard procedure of Richards (1968). The quality indices of irrigation water are worked out and classified as per the USDA system.

Results and Discussion

The pH of the bore well water was at neutral in all the categories of depth. However, electrical conductivity (EC) varied with the bore well and depth. In about 90.9 per cent of the deep bore well samples, the EC ranged between 0.751 - 2.250 dSm^{-1}. However, around 35.7 and 50 per cent of the shallow and filter point bore well samples, it ranged between

Table 3. Irrigation water quality and ionic composition of selected bore well waters of Karaikal region.

Sl.No.	Depth in m	pH	EC dSm^{-1}	Cations (c mol (p^+) lit^{-1})				Anions (c mol (p^+) lit^{-1})				SAR	RSC	Class
				Na^+	Ca^{2+}	Mg^{2+}	K^+	Cl^-	CO_3^{2-}	HCO_3^-	SO_4^{2-}			
1.	242	7.81	1.19	8.38	2.44	1.11	0.10	4.95	0.63	6.88	0.35	6.29	3.95	C_3S_2
2.	289	7.65	1.24	8.19	2.89	1.78	0.19	7.16	0.63	5.11	0.05	5.36	1.07	C_3S_1
3.	300	7.49	1.36	7.99	2.66	2.44	0.21	6.97	0.21	6.04	0.00	5.00	1.15	C_3S_1
4.	249	7.75	1.97	15.92	3.11	1.55	0.14	15.03	0.63	5.00	0.05	10.43	0.96	C_3S_3
5.	280	7.67	2.20	17.85	2.22	2.22	0.16	15.05	1.46	4.90	0.05	11.98	1.92	C_3S_3
6.	310	7.94	1.33	7.87	2.00	2.89	0.12	5.69	1.04	5.31	0.07	5.04	1.47	C_3S_1
7.	303	7.85	1.14	8.76	2.44	0.22	0.14	6.79	0.83	4.90	0.07	7.59	3.07	C_3S_2
8.	325	7.29	3.58	31.31	4.00	0.44	0.29	16.15	0.42	11.98	5.85	21.01	7.96	C_4S_4
9.	308	7.98	1.56	7.45	3.33	5.99	0.12	9.36	0.63	5.31	0.05	3.45	-3.38	C_3S_1
10.	191	7.95	1.05	6.11	3.11	2.00	0.19	4.95	0.83	4.79	0.05	3.83	0.52	C_3S_1
11.	257	8.17	1.28	6.79	2.00	4.22	0.10	7.34	1.25	4.90	0.05	3.85	-0.07	C_3S_1
12.	43	7.58	1.95	13.76	1.78	4.00	0.07	5.87	0.83	10.11	2.48	8.10	5.17	C_3S_2
13.	21	7.25	1.92	11.65	4.00	3.55	0.08	6.79	0.42	9.38	3.00	6.00	2.25	C_3S_2
14.	49	7.60	1.65	1.79	2.22	15.10	0.07	5.51	0.21	10.84	1.63	0.61	-6.27	C_3S_1
15.	35	7.69	1.95	12.73	2.00	3.11	0.07	6.06	0.21	9.48	1.80	7.97	4.58	C_3S_2
16.	58	7.74	2.79	22.11	3.33	0.00	0.20	11.38	1.25	10.52	3.62	17.13	8.44	C_4S_4
17.	49	7.03	2.70	12.56	4.22	10.21	0.12	11.74	0.21	10.94	5.03	4.68	-3.28	C_4S_2
18.	48	8.23	0.99	5.89	2.00	2.00	0.12	5.14	1.25	4.48	0.10	4.17	1.74	C_3S_1
19.	45	7.63	2.71	13.53	3.33	8.88	0.13	13.76	1.25	10.84	2.02	5.48	-0.12	C_4S_2
20.	54	7.72	1.30	8.92	1.78	3.11	0.05	4.77	1.88	7.92	0.88	5.71	4.91	C_3S_2
21.	68	7.86	1.30	8.62	1.78	2.66	0.09	7.52	0.42	6.04	0.05	5.79	2.02	C_3S_2
22.	66	7.25	2.64	16.81	7.55	2.22	0.09	13.03	0.21	10.52	2.91	7.61	0.96	C_4S_2
23.	30	7.36	2.17	6.78	2.44	12.88	0.07	9.18	0.83	9.38	1.50	2.45	-5.11	C_3S_1
24.	45	7.33	1.84	11.52	2.44	4.44	0.04	5.69	0.42	10.21	1.91	6.21	3.75	C_3S_2

Table 3. Contd...

Sl.No.	Depth in m	pH	EC dSm^{-1}	Cations (c mol (p^+) lit^{-1})				Anions (c mol (p^+) lit^{-1})				SAR	RSC	Class
				Na^+	Ca^{2+}	Mg^{2+}	K^+	Cl^-	CO_3^{2-}	HCO_3^-	SO_4^{2-}			
25.	18	7.26	2.37	11.32	5.33	7.10	0.07	10.09	0.21	10.73	4.05	4.54	-1.49	C_4S_2
26.	9	7.01	3.52	18.10	13.76	4.00	0.15	18.17	0.00	13.44	4.64	6.07	-4.32	C_4S_2
27.	6	7.09	2.76	13.27	1.33	11.77	0.15	18.35	0.00	6.15	0.43	5.19	-6.95	C_4S_2
28.	6	7.11	0.85	1.79	4.66	5.11	0.06	2.75	0.00	4.38	1.98	0.81	-5.39	C_3S_1
29.	9	7.03	1.62	4.96	6.66	6.22	0.14	7.52	0.21	7.82	2.52	1.95	-4.85	C_3S_1
30.	8	7.15	1.55	10.92	5.99	0.67	0.28	6.61	0.00	8.23	2.36	5.98	1.57	C_3S_2
31.	8	7.12	2.54	12.31	10.43	2.00	0.26	12.11	0.00	9.90	3.13	4.94	-2.53	C_4S_2
32.	10	7.05	2.66	7.74	8.88	9.77	0.87	12.29	0.00	10.21	5.17	2.53	-8.44	C_4S_1
33.	15	7.97	0.88	2.26	2.22	5.55	0.11	4.59	0.83	4.27	0.33	1.15	-2.66	C_3S_1

2.251 -5.000 dSm^{-1} (Table 1). None of the bore wells in Karaikal region fell in C_1 and C_2 salinity class with EC range of < 0.25 and 0.25 - 0.75 dSm^{-1}, respectively.

In case of SAR, almost 72.7, 92.9 and 100 per cent of the deep, shallow and filter point bore wells had less than 10 and fell under the category of S_1 as per the USDA classification (Table 2). Only a few of the deep and shallow bore wells (27.3 and 7.1 per cent) had the SAR of 10 - 18 (S_2). None of the bore well water samples of Karaikal region fell under the S_3 and S_4 category with 18-26 and > 26 values. Hence, as per Richards (1968), the S_1 category water could be used for irrigation on almost all soils with little danger on the development of harmful levels of exchangeable Na. The S_2 category water would add appreciable Na in fine textured soils especially under low leaching conditions but may be used on coarse textured and organic soils with good permeability.

By combining the salinity (EC) and sodicity (SAR) of the water and with the use of the semi algorithm developed by Richards (1968), about 64 per cent of the bore well water fell within the category of C_3S_1 and C_3S_2 and could be suitable for irrigation with suitable crop selection and agronomic management (Oster and Grattan, 2002; Sharma and Tyagi, 2004).

Among the cationic composition, Na dominated in the deep and shallow bore wells while Na to other cation ratio was narrower in the filter points (Table 3). Similarly, Cl^{-1} and HCO_3^- among the anionic composition dominated in all the category of bore wells.

On the basis of classification of Eaton (1950) using Residual Sodium Carbonate (RSC) concept, around 73, 69 and 100 per cent of deep, shallow and filter point bore wells were safe to medium in safe for irrigation to agricultural crops. The causation of potential salinity in different category of bore well was not apparent due to the almost equal amounts of chlorine and sulphate content within them.

As the geological formation of alluvium, blown sands, gravel, silt and clay that was recent and sub-recent in origin on the surface over the Cuddalore sand stones of Miocene and marine beds of Pleocene periods (SSSO, 1987), the deeper bore well could yield a suitable and required amount of water for irrigation provided the marine beds of pleocene period in between the sand stone and surface of soil is blocked from mixing with the bore well water. This was also indicated from the electrical conductivity and Residual Sodium Carbonate (RSC) of shallow bore well depth which taps water from the marine beds of Pleocene period.

However, being the soils are alluvium with plain contiguous topography, use of this water for agriculture purpose needs very careful consideration and management by selecting crops and cropping system, agro-techniques and proper irrigation management.

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