

Assessment Of Irrigation Water Quality Of Borewells Water Of Nagapattinam District In Tamil Nadu - India

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Abstract: Water used for irrigation should be essentially in good quality to grow good quantity crops, for the maintenance of soil productivity and for the protection of the environment. Physical and mechanical properties of soil, soil structure and permeability are very sensitive to the type of exchangeable ions present in irrigation water. Irrigation water quality is determined by physical and chemical methods of analysis. The most important factors determining the suitability of water used in agriculture are pH, EC, Salinity hazard, Sodium hazard, Sodium Adsorption Ratio (SAR), Carbonate, Bicarbonates in relation with Ca, Mg content and other cations and anions. In this point of view, present study is designed to monitor all the parameters by measuring the quality of irrigation bore well water in major rice growing area of Nagapattinam District. Nagapattinam district consists of eight taluks and five hundred and eighteen revenue villages. Most of the farmers utilize ground water for irrigation. In this juncture it is very essential to monitor the quality of irrigation water. In this proposed work water samples have been collected in all eight taluks of Nagapattinam District to monitor irrigation water quality parameters.

Key Words – Ground water, Water quality standards, Nagapattinam District, Tamilnadu.

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I. Introduction

Even though river is the main water source of many districts in Tamilnadu. South India depends upon bore wells for irrigation. Last few years due to very low rainfall, increasing population and necessity of water usage for domestic purpose, people using ground water from deep bore wells. Hence ground water level rapidly decreased day by day. Farmers of Cauvery delta zone mostly depends on bore wells ground water for irrigation purpose for their agricultural activities. Due to uncontrolled disposal of industrial solid waste effluents. Solid waste and waste water from house hold activities, saline water intrusion in coastal areas are the primary causes for ground water contamination. Rainfall patterns and infiltration rate are reported to affect the quality of ground water in an area [1]. India depends on ground water asserts for drinking, household, industrial and agricultural uses [2]. This may leads to negative effect in crop productivity. Now a days paddy growing area was decreased in this District, so the analysis of irrigation water quality parameters are essential to solve the problems faced by the farmers in agriculture in the major rice growing area of Nagapattinam District.

The chemistry of sub surface water is controlled by many natural as well as anthropogenic factors, Natural factors which have control over water chemistry include geological features of watershed and aquifer, meteorological factors and various rock water interaction process in the aquifer [3-5]. The concentration and composition of dissolved salts in water decides its suitability for irrigation, degradation of ground water quality of the aquifers causing sea water interference in to the coastal aquifers [6]. Water samples analysed by standard methods [7-11].

II. Study Area

Nagapattinam District (Fig.1) the land of religious harmony, known for its rich religious heritage was carved out by bifurcating the composite Thanjavur District on 18.10.1991. This District is spread over eight taluks with a total geographical extent of 2715.83 sq. km with the head quarter at Nagapattinam. This District lies on the shores of the Bay of Bengal between Northern Latitude 10.7906 degrees and 79.8428 degrees Eastern Longitude. The District capital 'Nagapattinam' lies on the eastern coast, 350 kilometres down south from the

state capital 'Chennai' and 145 kilometers East from Tiruchirappalli, a central place of the state. It comprises of eight Taluks and eleven Panchayat Unions, spread over in 2,32,257 hectares of land and has four hundred and eighteen revenue villages.



Figure 1. Location Maps of Nagapattinam District

III. Materials And Methods

Three samples are collected from every major rice growing revenue villages in Nagapattinam district. Irrigation water samples are collected from agriculture bore wells in a clean plastic cans of one liter capacity. These plastic cans are tagged individually with sufficient informations. The physico - chemical parameters such as pH, EC, TDS, Na⁺, K⁺, Ca²⁺, Mg²⁺, SO₄²⁻, Cl⁻, CO₃²⁻, HCO₃⁻, and Geo chemical types are determined by following appropriate methodology and instruments. Then the irrigation water quality results are compared with standard values recommended by World Health Organization (WHO), Beauraw of Indian Standards (BIS) and Indian Council for Medical Research (ICMR).

Electrical Conductivity (EC):

Electrical conductivity expressed in dsm⁻¹ represents the total salt content of irrigation water. The major anions are carbonates, bicarbonates, sulphate and chloride with low concentric of fluoride and nitrate. Water quality classification based on electrical conductivity [12]. Standard water quality parameters were given table 1 to 3.

Table 1. Classification of irrigation water based on Electrical Conductivity

Class	E.C (dsm ⁻¹)	Salinity status	Suitability
C ₁	0.0-1.0	Low salinity water	Excellent
C ₂	1.01-2.0	Medium salinity water	Good
C ₃	2.01-4.0	Salinity water	Doubtful
C ₄	4.01-6.0	High salinity water	Injurious
C ₅	>6.0	Very high salinity water	Unsuitable

Sodium Absorption Ratio (SAR)

The ratio of sodium contents to that of calcium and magnesium in the water is called Sodium Absorption Ratio. Sodium Absorption Ratio also denotes sodium hazard.

$$SAR = \frac{Na^{2+}}{\sqrt{Ca^{2+} + Mg^{2+}}} / 2$$

Table 2. Classification of irrigation water based on Sodium Absorption Ratio

Class	SAR	Suitability
S1	<10	Safe
S2	10.01-20.0	Moderate
S3	>20.0	Unsafe

Residual Sodium Carbonate (RSC)

Residual Sodium Carbonate indicates bicarbonate hazard. It is determined by the proportion of carbonate ions to that of calcium and magnesium ions

$$RSC \text{ (Meq/lit)} = (CO_3^{2+} + HCO_3^{2+}) - (Ca^{2+} + Mg^{2+})$$

The increased Residual Sodium Carbonate value leads to alkali formation because of the precipitation of calcium and magnesium carbonate/ bicarbonate or sodium and bicarbonate

Table 3. Classification of irrigation water based on Residual Sodium Carbonate

Class	RSC (Meq/lit)	Suitability
R1	<1.25	Safe
R2	1.26-2.50	Moderate
R3	>2.50	Unsafe

Geo chemical type

Calcium bicarbonate and calcium sulphate waters contain the lowest conductance. Sodium chloride water has the highest conductance. When calcium and magnesium more than half of the total cations it is considered calcium/ magnesium type. The health effects of hard water are mainly due to the effects of the salts dissolved in it, primarily calcium and magnesium [13]. When sodium and potassium is more than half of the total cations, the water is considered sodium type, if bicarbonate, carbonate is than 50% of the total anions, it is considered bicarbonate type. The content of chloride plus sulphate exceeds 50% of the total anions it is considered chloride type. Problems associated with some Geo chemical types of water. Geo chemical type refers to predominate soluble salt present in the irrigation water. The wide Geo chemical types are chloride water, sulphate water, bicarbonate water. Associating with different cations, the Geo chemical type varies. Magnesium content is the important in determining the quality of irrigation water, sodium is another essential factor to study sodium hazard. The high percentage of sodium water stunts the plant growth, sodium react with soil to decrease its permeability[14]. Sodium percent in water is a parameter computed to evaluate the suitability for irrigation[15]. Excess sodium water develop the unwanted effects of changing soil properties and reducing soil permeability[16], the irrigation water tends to enter into cation-exchange reactions in soil can be indicated by the sodium absorption ratio[17]. Salinity originates of rocks and leaching from top soil, anthropogenic sources along with minor influence on climate [18]. Excessive sodium in waters produces the undesirable effects of changing soil properties and reducing soil permeability[19]. SAR is an important parameter for the determination of the suitability of irrigation water because it is responsible for the sodim hazard[20]. The irrigation water status of Nagapattinam district were given figure 2 to 5.

Table 4. Average mean value of irrigation water quality parameters of Nagapattinam District

S.No	Name of the Taluk	pH	EC(ds m^{-1})	ANIONS (meq/lit)					CATIONS (meq/lit)					RSC	SAR	Type	Class
				CO ₃	HCO ₃	Cl	SO ₄	Total	Ca	Mg	Na	K	Total				
1.	THARANGAMBADI TALUK	7.60	0.99	0.70	6.34	3.12	0.31	9.68	3.18	2.98	3.27	2.58	4.13	3.97	3.86	NaHCO ₃	C ₁ S ₁ R ₁
2.	SIRKAZHI TALUK	7.75	1.04	0.37	5.56	4.98	0.48	10.98	3.15	3.20	4.47	0.13	10.97	0.48	2.52	NaHCO ₃	C ₁ S ₁ R ₁
3.	MAYILADUTHURAI TALUK	7.51	1.25	0.42	5.43	6.78	0.22	21.07	3.50	3.97	4.83	0.24	12.55	1.38	2.46	NaCl	C ₁ S ₁ R ₁
4.	KUTHALAM TALUK	7.6	0.89	0.46	6.31	2.26	0.15	8.72	2.7	2.2	3.80	0.083	8.887	1.62	2.37	NaHCO ₃	C ₁ S ₁ R ₁
5.	KILVELUR TALUK	7.61	1.50	0.8	6.2	7.89	0.4	14.4	3.8	4.6	5.5	0.2	14.3	1.3	2.8	NaCl	C ₁ S ₁ R ₁
6.	THIRUKKUALAI TALUK	7.75	1.34	0.68	7.35	5.41	0.3	13.4	4.3	3.4	5.36	0.23	13.40	1.76	3.04	NaHCO ₃	C ₁ S ₁ R ₁
7.	NAGAPATTINAM TALUK	7.31	0.89	0.57	5.54	8.32	0.52	14.42	3.92	4.51	5.54	0.27	14.23	1.30	2.87	NaCl	C ₁ S ₁ R ₁
8.	VEDHARANYAM TALUK	8.1	1.33	0.81	1.49	10.54	2.54	15.16	1.25	4.77	6.45	0.63	13.12	-	3.92	NaCl	C ₁ S ₁ R ₁
MEAN		7.65	1.15	0.60	5.52	6.16	0.61	13.47	3.22	3.70	4.90	0.54	11.44	1.68	2.98	NaCl	C ₁ S ₁ R ₁

Table 5. Percentage of irrigation water quality parameters of Nagapattinam District

Sl. No	Name of the Taluk	NaHCO ₃	MgHCO ₃	CaHCO ₃	NaCl	MgCl ₂	CaCl ₂	Cl	C2	C3	C4	C5	S1	S2	S3	R1	R2	R3
1.	THARANGAMBADI TALUK	31.81	18.18	40.15	6.81	1.51	1.51	58.33	41.66	-	-	-	99.24	0.75	-	67.42	16.66	15.90
2.	SIRKAZHI TALUK	38.3	13.3	15.0	15.0	5.0	13.3	56.6	43.3	-	-	-	100	-	-	100	-	-
3.	MAYILADUTHURAI TALUK	42.66	14.66	5.33	22.6	14.66	-	50.66	34.66	14.66	-	-	100	-	-	90.66	4.0	5.33
4.	KUTHALAM TALUK	70.0	10.0	20.0	-	-	-	63.3	36.6	-	-	-	100	-	-	46.6	43.3	10.0
5.	KILVELUR TALUK	37.25	3.92	7.84	23.52	19.60	7.84	37.25	39.21	23.52	-	-	100	-	-	80.39	19.60	-
6.	THIRUKKUALAI TALUK	44.4	5.55	31.94	11.1	-	6.94	43.05	54.16	2.77	-	-	97.22	2.77	-	69.44	22.22	8.33
7.	NAGAPATTINAM TALUK	27.77	-	9.25	31.48	16.66	14.81	37.03	42.59	20.37	-	-	100	-	-	83.33	16.66	-
8.	VEDHARANYAM TALUK	-	-	-	48.88	51.11	-	64.44	20.0	15.55	-	-	100	-	-	100	-	-
MEAN		41.74	10.93	18.50	22.7	18.09	8.88	51.33	39.02	9.60	-	-	99.55	1.76	-	79.73	20.40	9.89

Irrigation Water Status Of Nagapattinam District

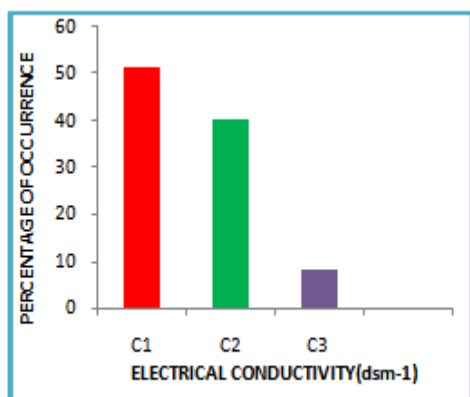


Figure 1. Electrical conductivity rating

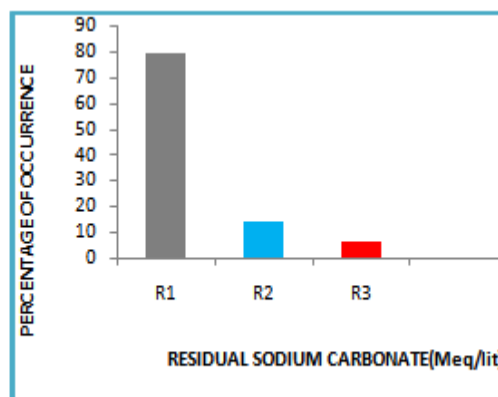


Figure 2. Residual sodium carbonate rating

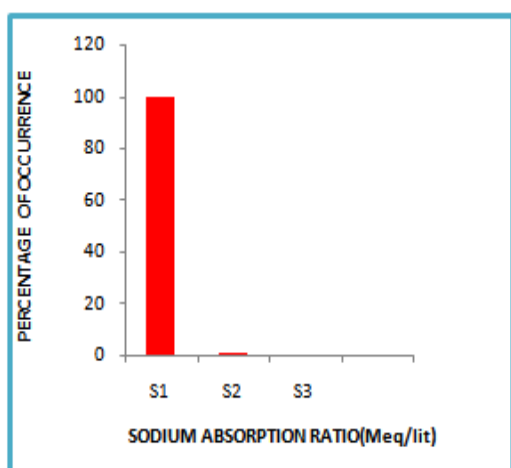


Figure 3. Sodium absorption ratio rating

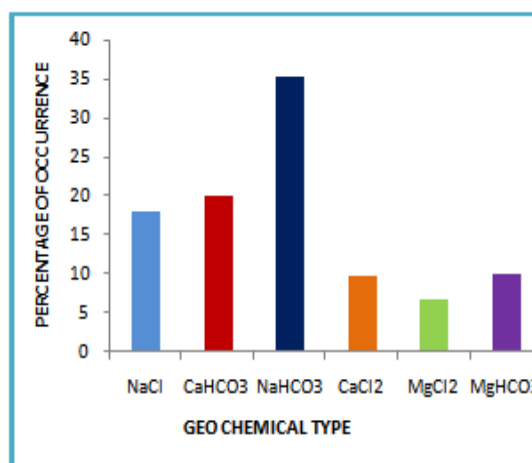


Figure 4. Geo chemical type rating

IV. Results And Discussion

In this present work the irrigation water quality of five hundreden seventy six bore wells covering the study area and assess the physical and chemical parameters represented in the Table .1. The percentage of irrigation bore well water quality represented in Table.2. The PH of the ground water samples are neutral the ranges from 7.31 to 8.1 which are within permissible limits 6.5-8.5 given by Indian standards of 7.0-8.0 given by WHO [21].

Based on Geo chemical type 41.74 % of samples cover under NaHCO₃ type, 22.7% for NaCl, 18.50 for CaHCO₃, 10.93 for MgHCO₃, 15.91% for CaCl₂ and 11.48% of samples covers under MgCl₂ type. In kuthalam taluk 70.0% of sample covers under NaHCO₃ type followed Thirukkuvilai taluk 44.4% and Mayiladuthurai taluk 42.66%.

From the table the irrigation water status of Tharangambadi taluk , based on electrical conductivity rating 58.33 % of samples cover under C1 classification 41.66% of samples cover under C2 classification. C3, C4 and C5 classifications are not found. In case of Sodium Absorption Ratio classification 99.24% of samples cover under S1 category and S2 category covers 0.75% only. According to Residual sodium carbonate ratio most of the samples 67.42% cover under R1 classification, in the remaining samples 16.66% and 15.90% categorized as R2 and R3 respectively. Based on Geo chemical type 40.15% of samples cover CaHCO₃ type followed by NaHCO₃ 31.81%, MgHCO₃ 18.18%, NaCl 6.81%. 1.51% for CaCl₂ and MgCl₂ equally.

The irrigation water samples collected from sirkazhi taluk reveals that, the rating of electrical conductivity 56.6% of samples cover C1 classification, 43.3% occupies C2 classification, C3 and C4 classification are not found. In the rating of Sodium Absorption Ratio 100% of samples covers under S1 category . S2 and S3 classification are not found. Residual sodium carbonate rating R1 class cover 100% R2 and

R3 are not found. Based on the Geo chemical type the predominant type is NaHCO_3 38.3%. 15.0% for NaCl and CaHCO_3 are equally present and 5.0% for MgCl_2 type.

The irrigation water quality status of Mayiladuthurai taluk, viewed that, 50.66% of the sample occupies C1 classification, where as 34.66% for C2 and 14.66 for C3. C4 and C5 classifications are not found. In cause of Residual carbonate rating 90.66% of samples cover R1 classification, 4.0% samples cover R2 classification. 5.33% for R3 classification. Analysing Geo chemical type of the taluk 42.66% occupies NaHCO_3 type followed by NaCl type 22.66%. The remaining percentage of 5.33% for CaHCO_3 . 14.66% for MgCl_2 and MgHCO_3 are equally present.

The quality analysis of Bore well irrigation water of Kuthalam taluk observed that the rating of electrical conductivity are as follows 63.3 occupies C1 class, 36.6% occupies C2 class. C3 and C4 are not found. In case of Sodium Absorption Ratio rating all the samples occupies S1 class. Residual sodium carbonate rating 46.6% of the samples comes under R1 class, 43.3% for R2 class and 10.0% of the samples cover R3 class. By viewing the Geo chemical type, the major Geo chemical type is NaHCO_3 70.0%. Next to NaHCO_3 CaHCO_3 type 20.0% followed by MgHCO_3 10.0%, NaCl , MgCl_2 and CaCl_2 types are not present.

In Kilvelur taluk the percentage occurrence of electrical conductivity rating are 37.25 % for C1 class 39.21% for C2, 23.52% for C3 class, C4 and C5 classes are not found. 100% samples for S1 class of Sodium Absorption Ratio, in cause of Residual sodium carbonate rating 80.39% of samples occupies R1 class, 19.60% occupies R2 class and R3 class are not found. In case of Geo chemical type 37.25% falls on NaHCO_3 , 23.52% falls on NaCl and 19.60% falls on MgCl_2 type. Whereas 7.84% equally distributed for CaHCO_3 and CaCl_2 , 3.92% for MgHCO_3 type.

The quality parameter for irrigation water in Thirukkuvali taluk, rating of electrical conductivity occupies 54.16% samples for C2, 43.05% for C1 and 2.77% for C3 respectively. Rating for Sodium Absorption Ratio S1 class occupies 97.22% and only 2.77% occupies S2. In cause of Residual sodium carbonate rating 69.44% for R1 class, 22.2% for R2 class and 8.33% for R3 class. By viewing the Geo chemical type 44.4% of samples covers NaHCO_3 type. 31.94% of samples occupy CaHCO_3 . 11.1% for NaCl type 6.94% and 5.55% for CaCl_2 and for MgHCO_3 type. MgCl_2 types are not found.

The water sample analysis report of Nagapattinam taluk, reveals that the rating for the three important parameter are as follows, for electrical conductivity rating about 42.59% for C2 classification and 37.03 % for C1 classification. 20.37% for C3 classification, for Sodium Absorption Ratio rating about 100% of samples covers S1 class S2 and S3 are not found. For Residual sodium carbonate rating about 83.33% for R1 class 16.66% for R2 class. R3 classes are not found. For Geo Chemical type 31.48% for NaCl type and 27.77% for NaHCO_3 type. 16.66% for MgCl_2 type. 14.81% and 9.25% respectively CaCl_2 and CaHCO_3 type. MgHCO_3 types are not present.

The Bore well irrigation water quality parameter of Vedharanyam taluk 64.44% of samples covers C1 classification, 20.0% for C2 classification, 15.55% for C3 classification. Rating for Sodium Absorption Ratio 100% of samples cover S1 classification. S2 and S3 are not found. In case of Residual sodium carbonate rating 100% of the samples occupies R1 classification R2 and R3 classes are not found. For Geo Chemical type 48.88% for NaCl type and 51.11% for MgCl_2 type. NaHCO_3 , CaHCO_3 , MgHCO_3 and CaCl_2 types are not present in the taluk.

V. Conclusion

Bore well water samples in Nagapattinam District mean status of the C₁ S₁ R₁ classification. Based on the electrical conductivity classification, 52.17 % of samples covers under C₁ classification, 38.19 % of samples covers under C₂ classification, and C₃ classification is 15.36% . C₄ and C₅ classifications are not found. Based on Sodium Absorption Ratio classification, 99.55% of samples cover under S₁ classification. 1.76% samples cover S₂ classifications. S₃ and S₄ classifications are not found. Based on Residual Sodium Carbonate classification, 79.73% villages cover under R₁ classification. 20.40% samples cover R₂ classification. 9.89% for R₃ classification. 41.74% of samples cover NaHCO_3 type water. 22.77% of samples cover NaCl type water. 18.50% of samples cover CaHCO_3 type water. 8.88 % of samples cover CaCl_2 type water. 18.09 % of samples cover MgCl_2 type water. 10.93 % of samples cover MgHCO_3 type water. The present study of ground water samples in Nagapattinam District generally neutral nature. The ground water quality of irrigation water is compared based on electrical conductance, 51.33% of water is useful for irrigation without any adverse impacts on the soil and 39.02% of water moderately suitable for irrigation. 9.60 % of water is not suitable for agriculture purpose. Paddy and vegetables particularly medium salinity tolerane plants are advised to cultivate to this area.

Application of river sand to clay loam and clay soils to improve the soil texture. Liberal application of Farmyard manure, compost, green leaf manure to improve the soil structure. Maintaining perfect level of water to avoid stagnant. Application of 250 Kg of gypsum per acre. Application of 50 kg of sulphate of potash per acre. Application of 1 kg of CuSO_4 mixed with sand to be added MgCl_2 type of water. Recommendations or suggestions to alleviate the problem. For sea water intrusion affected areas or other than C1S1R1 geochemical

type areas some kind of adaptation can be followed based on the data analysis. Leaching is the basic management tool for controlling salinity. By cultivating susbenia in summer we solve two major problems that is evaporation and salinity. Its also increase soils nitrogen level. The plant named purslane which has slightly salty taste in whatever condition it grows there is no salt water. The banana fibre also absorbs salts from water and purified the water. When use in large quantity for irrigation Banana fibre can be used in nano form. The powder of drumstick seeds purifies the salt water. Also palm nuts and spikenard are very useful to purify our elixir.

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