A Study of Irrigation Water Quality in Cauvery Delta Areas of Mayiladuthurai Taluk of Nagapattinam District in Tamil Nadu, India.

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Abstract

This research paper is to assess the irrigation water quality of cauvery delta area of Mayiladuthurai Taluk of Nagapattinam District in Tamil Nadu and the influence of basic physico-chemical parameters on soil fertility.The water quality index SAR, RSC, Geo-chemical types, classification, suitability of water for irrigation purpose.

A total Number of 30 Bore Well irrigation water samples were collected, which covers 10 cauvery delta revenue villages in Mayiladuthurai Taluk by collecting 3 samples from each Revenue village. Most of the farmers utilize ground water for irrigation. All the physico - chemical parameters like pH, EC, Ca, Na ,K, SO_4, Cl, Mg , CO_3, and HCO_3 are determined by standard methods and by using standard instruments. Then the irrigation water quality results are compared with standard values Recommended by World Health Organization (WHO), Bureau of Indian Standards (BIS) and Indian Council of Medical Research (ICMR). The proposed work is very essential not only for crop production but also to maintain soil fertility, to maintain hazardous free environment and to enhance the living standard and in turn to uplift our Agriculturist. Cultivation of alternate crop systems are suggested to those formers lands which are affected by saline water in the coastal area.

Keywords: Water analysis, cauvery delta, mayiladuthurai taluk ,Nagapattinam district,Tamil Nadu

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Introduction

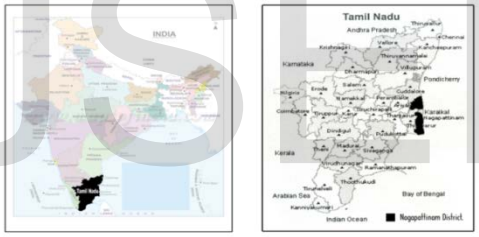
Cauvery River is main water source of south India in Tamilnadu state. Many districts depends upon the Cauvery River for irrigation.Last few years lack of rainfall, increasing population, necessity of water usage as such people using ground water from deep bore well by heavy motor. Hence the ground water level is decreased day by day. Cauvery delta zone farmers mostly using bore well ground water for irrigation purpose in agriculture land area, some time ground water contaminated by disposal waste from industry at the same time sea water move towards both surface and underground level, so underground fresh water affected by salinity, it may produce negative effect in agriculture crop and crop productivity, so the irrigation water quality parameter is essential for agriculture. Irrigation is the largest water using up to 85 percent of the available water in the developing countries [1].

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 into the coastal aquifers [2].Water samples analyzed by standard methods [3-7].Total concentrations of soluble salts, relative quantity of sodium to other cations, concentrations of boron or other elements that can toxic to plants, and the bicarbonate concentration related to the concentration of calcium plus magnesium are important characteristics determining the quality of irrigation water. Salinity of irrigation water may limit the choice of crops that can be grown. The most influential water quality guideline on crop productivity is the water salinity hazard as measured by electrical conductivity.[8]

Study Area

The study area is Mayiladuthurai Taluk of Nagapattinam district coastal region in the southern Tamilnadu State located in the coastal region of Bay of Bengal 11.0290373 Latitude and 79.8506815 Longitude. This taluk is spread over in 27,726 hectares of Agriculture land. Fig.1 shows the study area.

FIG.1. LOCATION MAP
Mayiladuthurai Taluk in Nagapattinam District



Materials and Methods

Irrigation water samples were collected randomly in a systematic manner covering cauvery delta areas in Mayiladuthurai taluk of Nagapattinam district. A total 30 samples were collected from bore wells in clean plastic cans of 1 liter capacity. The bottles are tagged individually for sufficient information similar to date, location, deepness of well. The results of the average mean value of irrigation water quality parameters are shown in Table10.The percentage of irrigation water quality parameters are shown in Table 11.

Quality of irrigation water analyzed in the laboratory determined many parameters such as pH, EC, Ca, Na, K, SO_4, Cl, Mg, CO_3, and HCO_3 are determined by standard methods and by using standard instruments.Then the irrigation water quality results are compared with standard values Recommended by World Health Organization (WHO), Bureau of Indian Standards (BIS) and Indian Council of Medical Research (ICMR).

Important water quality ratings:

Important water quality ratings that merit consideration are detailed below from table 1 to 8. These ratings could be used as guidelines when recommendations are given.

Table. 1 Water Quality Based on EC, SAR, RSC

Water Quality Ratings	EC (dsm^{-1})	SAR (Meq/lit)	RSC (Meq/lit)
Good	Less than 2.0	Less than 10.0	Nil
Marginal water	2-4	Less than 10.0	Less than 2.5
Saline water	More than 4.0	Less than 10.0	Nil
Sodic water	Less than 4.0	More than 10.0	Usually more than 2.5

Table. 2 Water Quality Based on Sodium

Low sodium water	Could be used in almost all soils.
Medium sodium water	Considerable sodium hazard in high clay soils and low organic matter under low discharge conditions unless gypsum is present in the soils.
High sodium water	Sodium hazard is significant in non-gypsiferous soils. Good drainage, good discharge and organic matter are wanted. Chemical amendments may be used for transferable sodium replacement expect for high salinity water.

Table. 3 Water Quality Based on Electrical Conductivity

Low salinity water	0-250 (dsm^{-1})	Used for most crops on most Soils with little possibility of Salinity some leaching is required.
Moderate salinity water	250-750 (dsm^{-1})	All the crops except extremely salt sensitive crops, when grown on soils of high to medium permeability. Leaching precaution and moderate salt tolerant crops.
Medium to high salinity	750-2250 (dsm^{-1})	Should be used only on soils of moderate to good permeability. Regular leaching and plants with moderate to good tolerance to salinity.
High salinity water	2250-6000 (dsm^{-1})	To be used only on soils of good permeability with regular leaching. Plants with high tolerance.
Excess salinity water	More than 6000 (dsm^{-1})	Should not be used.

Table. 4&5 Salinity classification

Low to moderate salinity	0-750	NaCl -1	$MgCl_2$ - 1
Medium to high salinity	750-2250	NaCl -2	$MgCl_2$ -2
High salinity	2250-4000	NaCl -3	$MgCl_2$ -3
Very high salinity	4000-6000 and above	NaCl -4	$MgCl_2$ -4

Low to medium	0-2250	$CaCl_2$.1
High	2250-4000	$CaCl_2$.2
Very high	4000-6000	$CaCl_2$.3
Excessive	More than 6000	$CaCl_2$.4

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 (EC)[9].

Table. 6 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.

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

Table.7 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

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

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. 8 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

Table.9- Irrigation water quality parameters of cauvery delta area of mayiladuthurai taluk in Nagapattinam district.

S.No	Villages	No of sample	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	Manakudi	3	7.0	0.92	0.3	4.8	4.1	-	8.9	1.9	4.1	3.0	0.2	9.2	-	1.73	$Mg HCO_3$	$C_1S_1R_1$
			8.3	0.31	1.0	1.1	1.0	-	2.1	0.7	1.8	0.44	0.16	3.1	-	0.39	$Mg HCO_3$	$C_1S_1R_1$
			7.4	1.7	-	9.5	7.5	-	17	5.3	6.6	4.63	0.47	17	-	1.90	$Mg HCO_3$	$C_2S_1R_1$
2	Mannampandal	3	8.3	0.82	0.6	4.5	3.1	-	7.6	2.7	1.5	3.76	0.24	8.2	0.9	2.16	$NaHCO_3$	$C_1S_1R_1$
			7.4	2.2	0.2	9.0	12.8	-	21.8	8.5	8.7	4.57	0.24	22.01		1.56	$MgCl_2$	$C_3S_1R_3$
			7.4	1.5	0.2	9.6	5.2	-	14.8	3.4	4.9	6.01	0.69	15	1.5	2.96	$NaHCO_3$	$C_2S_1R_2$
3	Dharmadanapuram	3	7.1	2.0	0.8	10.2	9.0	-	19.2	5.5	5.1	8.9	0.5	20	0.4	3.87	$NaHCO_3$	$C_2S_1R_1$
			7.0	0.98	-	6.3	3.5	-	9.8	4.7	2.5	3.32	0.18	10.7	-	1.88	$Ca HCO_3$	$C_1S_1R_1$
			7.4	2.5	0.6	10.1	14.3	-	24.4	6.5	8.7	9.6	0.15	24.95	-	2.49	NaCl	$C_3S_1R_1$
4	Pattamanglam	3	7.8	0.68	0.2	3.9	2.7	-	6.6	1.1	2.1	3.3	0.3	6.8	0.9	2.61	$NaHCO_3$	$C_1S_1R_1$
			8.3	0.67	0.6	3.7	2.4	-	6.1	0.9	1.3	3.2	0.3	5.7	1.1	2.53	$NaHCO_3$	$C_1S_1R_1$
			7.6	0.70	0.6	3.9	2.5	-	6.4	1.8	1.9	3.0	0.3	7	0.8	2.21	$NaHCO_3$	$C_1S_1R_1$
5	Mayiladuthurai	3	7.5	0.80	0.1	6.8	1.1	-	7.9	1.1	1.7	5.0	0.18	7.98	4.1	6.23	$NaHCO_3$	$C_1S_1R_1$
			7.4	1.94	0.9	7.6	10.9	-	18.5	4.9	5.3	9.0	0.2	19.4	-	3.99	NaCl	$C_2S_1R_1$
			7.4	1.27	-	7.1	5.6	-	12.7	5.2	2.9	4.38	0.22	12.7	-	2.17	$NaHCO_3$	$C_2S_1R_1$
6	Anathandavapuram	3	7.4	0.82	-	5.1	3.1	-	8.2	3.5	2.4	2.10	0.15	8.15	-	0.23	$Mg HCO_3$	$C_1S_1R_1$
			7.5	0.82	-	5.5	2.7	-	8.2	3.3	1.8	2.92	0.24	8.26	0.4	1.84	$NaHCO_3$	$C_1S_1R_1$
			7.6	0.65	-	4.9	1.6	-	6.5	1.7	1.7	2.92	0.15	6.47	1.5	2.24	$NaHCO_3$	$C_1S_1R_2$
7	Uluthukuppai	3	8.1	0.58	0.3	3.2	2.3	-	5.5	1.8	2.1	1.74	0.18	5.82	-	1.25	$Mg HCO_3$	$C_1S_1R_1$
			7.7	0.88	0.2	3.7	4.9	-	8.6	2.7	2.2	3.73	0.21	8.84	-	2.39	NaCl	$C_1S_1R_1$
			7.7	2.2	0.6	1.2	20.2	-	21.4	3.0	7.8	10.9	0.3	22	-	4.7	NaCl	$C_3S_1R_1$
8	Vellalagaram	3	7.9	1.4	1.4	1.0	11.6	-	12.6	0.8	4.1	8.8	0.3	14	-	5.62	NaCl	$C_2S_1R_1$
			7.7	1.13	0.3	7.9	3.1	-	11	1.4	1.9	7.83	0.17	11.3	-	6.12	$NaHCO_3$	$C_2S_1R_1$
			7.4	0.83	0.1	4.7	3.5	-	8.2	2.5	2.9	2.7	0.23	8.33	0.6	1.64	$Mg HCO_3$	$C_1S_1R_1$
9	Sitharkadu	3	7.4	1.27	0.1	2.4	10.2	-	12.6	2.6	3.6	6.3	0.2	12.7	-	3.58	NaCl	$C_2S_1R_1$
			7.3	1.36	0.1	3.4	10.1	-	13.5	5.4	1.6	6.4	0.2	13.6	-	3.42	NaCl	$C_2S_1R_1$
			7.3	1.32	0.1	2.6	10.5	-	13.1	2.8	3.6	6.5	0.3	13.2	-	3.6	NaCl	$C_2S_1R_1$
10	Chozhanpettai	3	7.5	1.64	0.2	2.3	13.9	-	16.2	3.0	5.6	7.5	0.3	16.4	-	3.62	NaCl	$C_2S_1R_1$
			7.6	0.95	0.2	5.6	3.7	-	9.3	2.7	3.1	3.5	0.17	9.47	-	2.06	$NaHCO_3$	$C_1S_1R_1$
			7.5	1.56	0.1	5.4	10.1	-	15.5	4.8	5.7	4.9	0.18	15.58	-	2.14	$MgCl_2$	$C_2S_1R_1$
MEAN			**7.56**	**1.21**	**0.40**	**5.23**	**6.57**	**-**	**11.80**	**3.20**	**11.80**	**5.02**	**0.25**	**12.1**	**1.2**	**12.12**	**Nacl**	**$C_1S_1R_1$**

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 [10]. 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[11]. Sodium percent in water is a parameter computed to evaluate the suitability for irrigation[12]. Excess sodium water develop the unwanted effects of changing soil properties and reducing soil permeability[13], the irrigation water tends to enter into cation-exchange reactions in soil can be indicated by the sodium absorption ratio[14]. Salinity orginates of rocks and leaching from top soil,anthropogenic sources alon with minor influence on climate [15]. The irrigation water status of mayiladuthurai taluk were given figure 2 to 5.

Table 10: Average mean value of irrigation water quality parameters of cauvery delta area of mayiladuthurai taluk in Nagapattinam district.

Sl.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	MAYILADUTHURAI TALUK	**7.56**	**1.21**	**0.40**	**5.23**	**6.57**	**-**	**20.34**	**3.20**	**3.6**	**5.02**	**0.25**	**12.1**	**1.2**	**2.77**	**$C_1S_1R_1$**	**Nacl**

Table 11: Percentage of irrigation water quality parameters of cauvery delta area of mayiladuthurai taluk in Nagapattinam district.

Sl.No	NAME OF THE TALUK	$NaHCO_3$	$MgHCO_3$	$CaHCO_3$	NaCl	$MgCl_2$	$CaCl_2$	C1	C2	C3	S1	S2	S3	R1	R2	R3
1	MAYILADUTHURAI TALUK	**40.0**	**20.0**	**3.33**	**30.0**	**6.66**	**-**	**50.0**	**40.0**	**10.0**	**100**	**-**	**-**	**90.0**	**6.66**	**3.33**

IRRIGATION WATER STATUS OF MAYILADUTHURAI TALUK

Figure.2 ELECTRICAL CONDUCTIVITY RATING

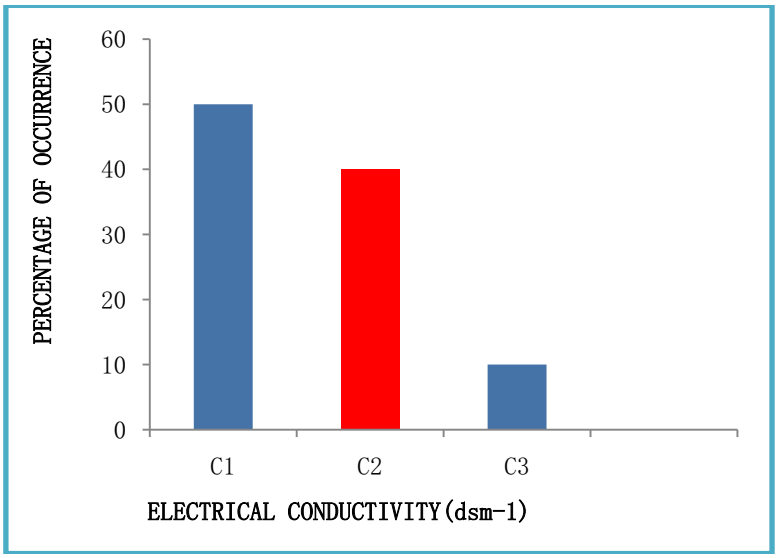


Figure.3 RESIDUAL SODIUM CARBONATE RATING

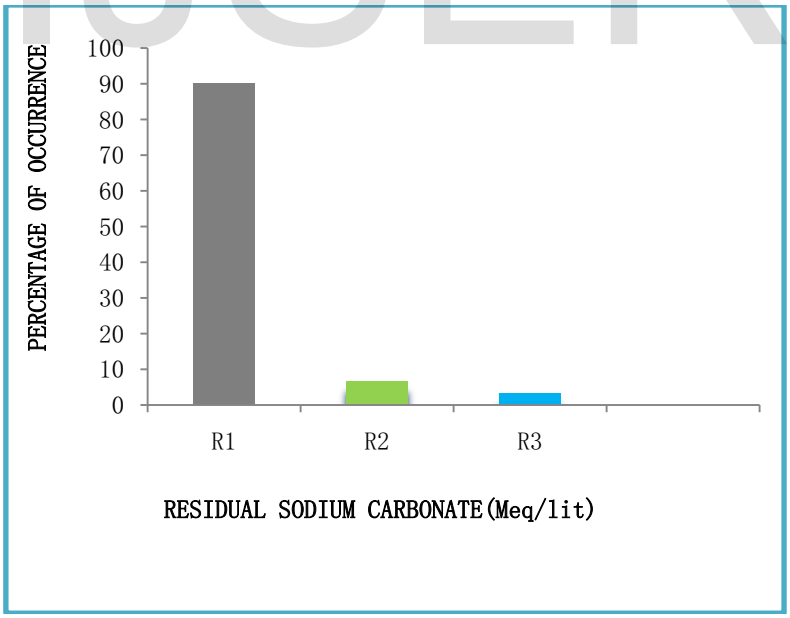


Figure.4 SODIUM ABSORPTION RATIO RATING

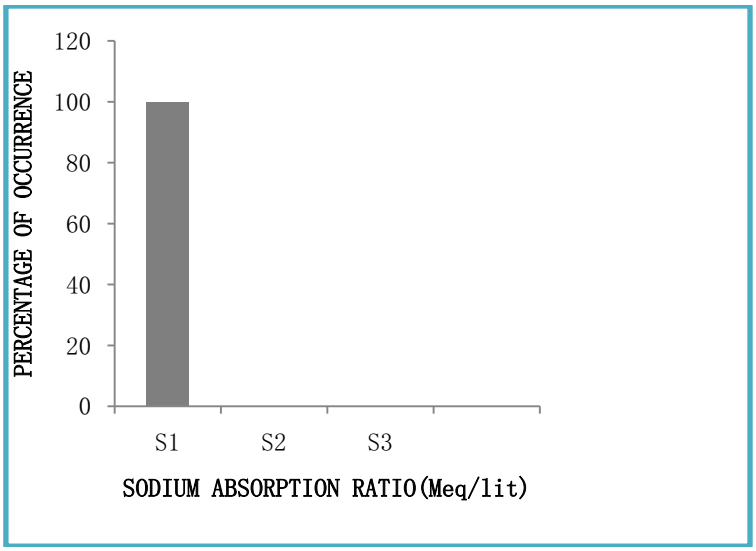
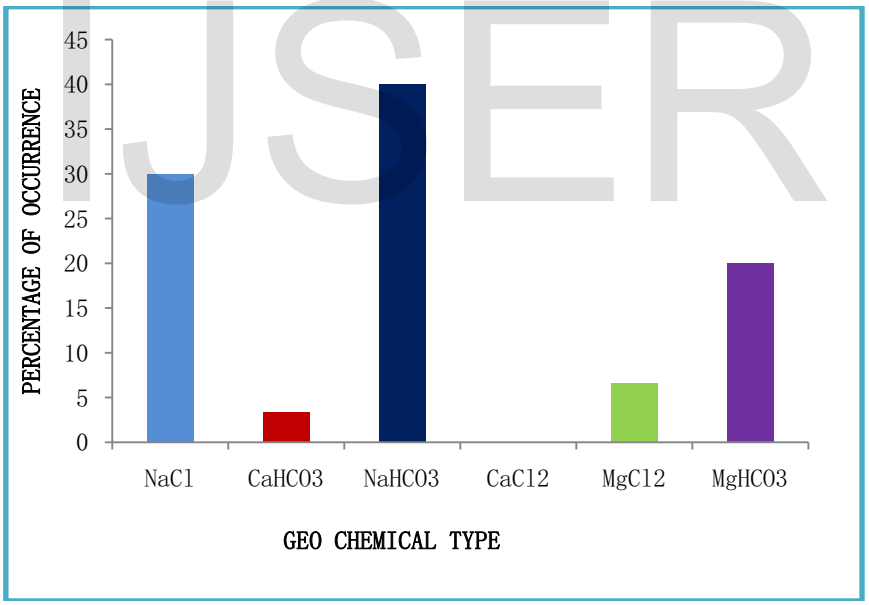


Figure.5 GEO CHEMICAL TYPE RATING



Result and Discussion

Assess the 30 irrigation water samples collected from 10 revenue villages in Mayiladuthurai taluk by collecting 3 water samples per village revealed that water analysis parameter in Mayiladuthurai Taluk, water samples with mean status of the C_1 S_1 R_1 classification (table.9 and fig.2 to 5).

The irrigation water status of Mayiladuthurai taluk is given in Table 1 and 2, fig.2 to 5.Based on the electrical conductivity classification, 50 % of villages covers under C_1 classification, 40 % of villages covers under C_2 classification, and C_3 classification is 10 %. In Mayiladuthurai taluk, 50 % of villages cover under C_1 classification due to basin area. Based on Sodium Absorption Ratio classification, 100 % of villages cover under S_1 classification. S_2 and S_3 classifications are not found. In 100 % villages covers S_1 classification due to non-saline water.Based on Residual Sodium Carbonate classification, 90 % villages cover under R_1 classification, 6.66 % for R_2 and 3.3 % for R_3 classification.

Conclusion

The present study assess the water quality status of Mayiladuthurai taluk exposed that they have become an significant trouble (Yield limiting factor) in Mayiladuthurai taluk.Hence the suggestion for different type of water for better yield. Sodium and chloride such water could be improved by gypsum application. Chemical amendments are aimed at to introduce favorable cationic ratios. If water contains high sodium and magnesium bicarbonates, gypsum can be added to irrigation water. Soils irrigated with poor quality water are low in fertility particularly nitrogen. Nitrogen response in good when is applied along with manure, under saline and alkaline soils, should be avoided due to nitrogen loss.

References

[1] Plusquellec H., Burt C. and wolter H.W. modern water control in irrigation.World Bank Technical paper no.246-Irrigation and Drainage series,Washington D.C(1994).

[2] B. Chandrasekaran, S Anbazhagan (2007),Variability of soil–water quality due to Tsunami-2004 in the coastal belt of Nagapattinam district, Tamilnadu.

[3] APHA standard methods for examination of water and waste,American Public Health Association,Washington D.C.(1998).

[4] Manual on water and waste water analysis,NEERI Publications(1998).

[5] D.R Khanna. Ecology and pollution of Ganga River,Ashish Publishing House,Delhi,1(1993).

[6] Korfali and jurdi.Int.J.Environmental and pollution, 19,271(2003).

[7] Manual on water and waste water analysis,NEERI Publications(1998).

[8] S.S. Ahmed, Q.H. Mazumder, C. S.Jahan, M.Ahmed and S.Islam. Journal, Geological society of India, 60, 411 (2002).

[9] Langenegger O (1990) Ground water quality in rural areas of western Africa, UNDP project INT/81/026:10.

[10] Galan P, Arnaud MJ, Czernichow S, Delabroise AM, Preziosi P, Bertrais S, et al. Contribution of mineral waters to dietary calcium and magnesium intake in a French adult population. J Am Diet Assoc. 2002;102:1658– 62.

[11] D.K Todd., Groundwater Hydrology, 2nd Ed. John Wiley and Sons, New York .p-535. (1980).

[12] P.C. Mishra. Thesis- Some aspects of water quality of water in and around Rourkela. Department of Chemistry, National Institute of Technology, Rourkela (2005).

[13] S.N. Biswas, H. Mohabey and M.L. Malik. Asian J. Chem., 16, (2002).

[14] V.Sing and C.C.P. Singh. Asian J. Chem., 18, 2813 (2004). Table-1 : Irrigation water characteristics in winter season.

[15] Tijani J (1994) Hydrochemical assessment of groundwater in Moro area. Kwarastate, Nigeria, Environmental Geology. 24:194–202.