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Assessment of Irrigation Water Quality in Parambikulam-Aliyar River Basin of Tamil Nadu

K.M. Sellamuthu*, C. Mayilswami, A. Valliammai and S. Chellamuthu
*Department of Soil Science and Agricultural Chemistry,
Water Technology Centre,
Tamil Nadu Agricultural University, Coimbatore - 641 003

To assess the ground water quality and its suitability for irrigation, a study was carried out during April and June 2010 in Parambikulam Aliyar Basin, Tamil Nadu. Ground water samples were collected from open wells, bore wells and dug cum bore wells in the Parambikulam Aliyar Basin and their quality parameters were assessed. pH values ranged from 6.6 to 8.6; electrical conductivity values were ranged from 0.29 to 6.80 dSm^{-1} and most of the samples were under medium salinity class (C_2) (48.57%). Calcium, magnesium, sodium and potassium content ranged from 0.40 to 13.36 m.e L^{-1}, 1.04 to 26.16 m.e L^{-1}, 0.80 to 25.48 m.e L^{-1} and 0.05 to 2.52 m.e L^{-1} respectively. Most of the samples were found to be magnesium dominating and magnesium exceeds the calcium content in most of the water samples both during April and June 2010. Magnesium toxicity will be exhibited in continuous use of water to crops. Carbonates, bicarbonates, chloride and sulphate concentration varied from 0.0 to 4.00 m.e L^{-1}, 0.80 to 12.80 m.e L^{-1}, 1.20 to 45.20 m.e L^{-1} and 0.02 to 7.97 m.e L^{-1} respectively. The sequence of cations were found in the order of $Na^+ > Mg^{2+} > Ca^{2+} > K^+$ and anions followed the sequence of $Cl^- > SO_4^{2-} > HCO_3^- > CO_3^{2-}$. Total hardness in the study area varied from 6.26 to 140.66 m.e L^{-1}. Most of the samples were deficient of Ca and Mg category during both the seasons. RSC values varied from 33.12 to 8.56 meqL^{-1} and most of the samples are coming under safe category (71.43% - 80.0 %). Residual sodium bicarbonates also come under safe category. SAR values ranged from 0.49 to 13.21 and all the samples were found to be low sodium category (S_1). There is no sodicity problem exist among the irrigation waters. In the present study, Permeability Index ranged from 26.49 to 101.59 and majority of the samples exhibited that there is no permeability hazard.

Key words: Irrigation water quality, Parambikulam-Aliyar river basin, Tamil Nadu.

Deterioration of irrigation water quality is mainly anthropogenic through variety of industries. Contamination of the river has increasingly become a serious problem in many of the river basins of the State. River basins like Palar, Tamirabarani, Cauvery, Noyyal, Bhavani and Amaravathy face serious pollution problems due to industrial effluents. Industrialization caused series of problems relating to environmental pollution. The problems relating to the disposal of industrial solid wastes are associated with lack of infrastructural facilities and negligence of industries to take proper safe guards. The large and medium industries located in identified industrial areas have some arrangements to dispose solid wastes. However, the problem persists with small-scale industries. The industries are discharging their effluents directly into the water bodies or land. This may lead to indirect effect on environmental concerns of the basin and also cause serious problems to the aquatic life.

Industries like dairy unit, rubber factory, paper boards, spinning mill, pesticide units, soya factory, tea, Sugar factory, Vegetable oil, Chemicals, Cotton mills, Hatcheries, distilleries are located in the basin. Cottage industries like appalam production, cane furniture, country bricks and pottery are also done in the basin. The requirement of water for large and medium scale industries is taken as 2500 cum per day based on the norms prescribed by Director of Industries and Commerce department. The Municipalities and Panchayats along the bank of the river are letting the raw sewage directly into the water bodies.

Ground water quality is affected due to the discharge of poor quality water from various industries and urban waste water to the natural water courses. It leads to deterioration of ground water quality. Irrigation of poor quality water through the extraction of ground water from deep aquifers leads to salinisation of the agricultural soils. The impounded surface water from Upper Aliyar is also very soft with low mineral matter content but however shows somewhat higher figures compare to other dam sources. Surface water is getting contaminated due to coconut fibre soaking. The ground water

*Corresponding author email: kmsella75@yahoo.com

quality is generally alkaline with pH values ranging from 7.2 to 9. The poor quality of water is noted in Unjavelampatti, Chinnapoolanginar, Dhali, Udumalpet and Poosaripatti villages. The highest value of EC of >8.0 dSm^{-1} is observed in Chinnapoolanginar. (iamwarm.gov.in/Environment/annexures.pdf). Small towns are discharging the sewage directly into the drains and streams nearby. Majority of the villages are not having any proper drainage system. The sewage from the houses is opened out into the roads through small channels. Hence, an estimate on extent of quality of irrigation water will give a real picture for adopting management strategies for remediation.

Materials and Methods

Study area

There are about 34 river basins in Tamil Nadu which are grouped into 17 major river basins Out of 17 river basins, many basins are water deficient and some have surplus water (ENVIS, 2007). Parambikulam-Aliyar basin is located in the south western part of the Peninsular India, and covers area in Kerala and Tamil Nadu States. Aliyar river rises in the eastern slopes of Anamalai hills of the Western Ghats in Coimbatore district is at an elevation of 2250 m above MSL and flows in the north-westerly direction on its 45 km run from its

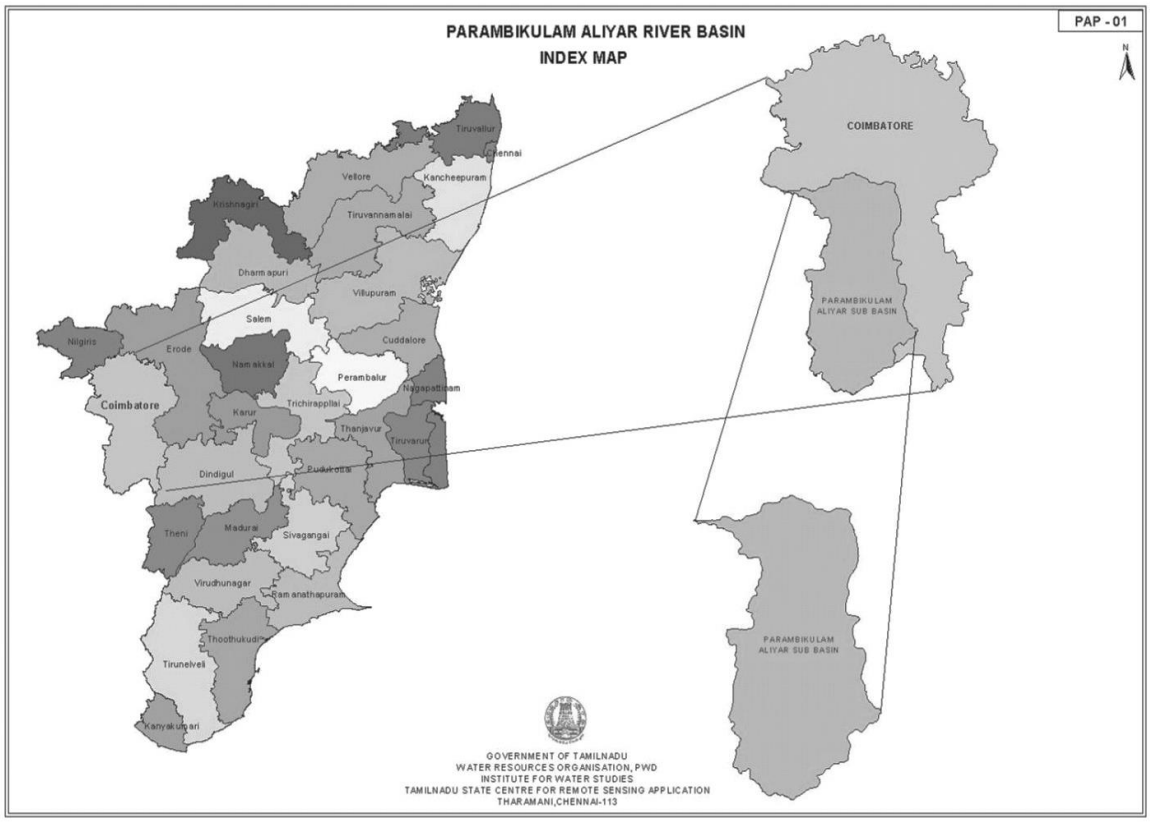

Fig. 1 Map showing the study area of PAP basin (Source:Anonymous, 2006).

origin. A tributary namely the Palar river joins this river on its right bank traversing by an other 15km west wards, it enters the Palaghat district of Kerala State through Palghat gap. Parambikulam river and Sholayar river are the tributaries of the Chalakudi river (flowing in Kerala State). It has its origin from the western slope of Anamalai hills of Western Ghats and flows in west – south westerly direction. Parambikulam-Aliyar river basin has an undulating topography with maximum contour elevation in the plain is 300m and the maximum spot height in the plain is 385m above MSL. One third of the basin area (822.73 sq.km) is covered with hills and dense forest cover. The total area of PAP basin is 2388.72 sq.km. This basin is bounded in north and east by Cauvery basin, south and west by Kerala State. This basin area lies (except the ayacut area) within the coordinates of between 10° 10' 00" N to 10°57'20" and 76°43'00" to 77° 12'30" E (Anonymous, 2006).

Thirty five water samples were collected from open wells, dug cum bore wells and bore wells and analysed for various chemical parameters. The water samples were analysed for quality parameters as per the standard procedure given by Richards (1969). Classification of quality of irrigation water was done as per standard procedures. Residual Sodium Carbonate (RSC) was classified as per Eaton (1950) and Wilcox, et. al. (1954) and salinity and sodicity classes were classified as per Richards (1969). Residual Sodium Bicarbonate was

calculated and classified based on Gupta and Gupta (1987). The results were also interpreted as per Ayers and Westcot (1994) where the quality of irrigation water was interpreted based on the degree of salinity, salinity and SAR to judge infiltration problems on soils and toxicity of ions.

EC and Sodium Adsorption Ratio (SAR)

EC and SAR were classified based on salinity and sodicity classes as per Richards (1969). SAR is calculated as follows.

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

Where Na^{+}, Ca^{2+}, Mg^{2+} are concentrations of respective ions in m.e L^{-1}

Magnesium hazard

Magnesium hazard was calculated by Mg^{2+} to Ca^{2+} ratio (Richards, 1969). If the value is <1.0, classified under non hazardous and the value exceeds 1.0 under hazardous category.

Total Hardness

Hardness is an indication of the amount of calcium and magnesium in the water and is expressed as m.e of $CaCO_3$ L^{-1}, or parts per million $CaCO_3$. The amounts of these two elements in irrigation water are variable. Water with hardness in the range of 100 to 150 mg $CaCO_3$ L^{-1} is considered desirable for plant growth. Plants tolerate high levels of these elements, so toxicity is not normally a problem. However, excessive hardness may cause foliar deposits of calcium or magnesium carbonate under overhead irrigation. Soft water (<50 mg $CaCO_3$ L^{-1}) may need additional calcium and or magnesium over and above that supplied by typical fertilizers to achieve good plant growth.

Residual Sodium Carbonate (RSC)

RSC was calculated as per Eaton (1950).

$RSC = (CO_3^{2-} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+})$

Where CO_3^{2-},HCO_3^{-},Ca^{2+},Mg^{2+} are concentrations of respective ions in m.e L^{-1}.

Wilcox *et. al*, (1954) classified the water based on RSC values as Satisfactory (< 1.25 me L^{-1}), Marginal (1.25 - 2.5 me L^{-1}) and Unsatisfactory (> 2.5 me L^{-1}).

Residual Sodium Bicarbonate (RSBC)

RSBC was calculated as HCO_3 – Ca and classified as satisfactory (< 5 me L^{-1}), marginal (5-10 me L^{-1}) and unsatisfactory (> 10 me L^{-1}) as per Gupta, (1983). When rainfall is appreciable, the effective salt balance is zero. High values of EC and SAR would reduce the suggested permissible limits. Higher water table and poor drainage which may also reduce the permissible limits.

Permeability index

Permeability index or Doneen's Permeability Index was calculated as per Doneen, (1966) as follows.

$$\text{Permeability Index} = \frac{Na^{+} + (HCO_3^{-})^{1/2}}{Ca^{2+} + Mg^{2+} + Na^{+}} \times 100$$

Where HCO_3^{-}, Ca^{2+}, Mg^{2+} , Na^{+} are concentrations of respective ions in m.e L^{-1}.

The index varies with soils having different initial permeability.

Results on Ground Water Quality of Parambikulam Aliyar Basin

Salinity (EC)

Electrical conductivity values were ranged from 0.3 to 5.19 dsm^{-1} and 0.29 to 6.80 dsm^{-1} during April and June 2010 respectively. The samples were classified under USSL classification (Richards, 1969).Most of the samples come under medium salinity class (C_2) (48.57%) followed by low salinity class (C_1), very high salinity class (C_4) and high salinity class (C_3) with 28.57, 14.29 and 8.57 per cent respectively in both seasons.

Table 1. Classification of irrigation water quality based on EC values

EC (dS/m)	Category	No. of samples	Frequency (%)
<0.25	Low Salinity Class (C_1)	10	28.57
0.25-0.75	Medium SalinityClass (C_2)	17	48.57
0.75-2.25	High Salinity Class (C_3)	3	8.57
>2.25	Very High Salinity Class (C_4)	5	14.29

pH

Natural waters will be having the pH values from 6 to 8.5. The water with pH values >8.5 may contain appreciable amount of sodium carbonates and bicarbonates. pH values ranges from 7.0 to 8.6 during April 2010 and 6.6 to 8.4 during June 2010.

Table 2. Classification of irrigation water quality based Mg/Ca ratio

Mg/Ca ratio	April-10		June-10	
	No.of samples	Frequency	No.of samples	Frequency
<1	3	8.57	4	11.43
>1	32	91.43	31	88.57

Cations

The samples were analysed for cations like calcium, magnesium, sodium and potassium. Calcium content ranged from 0.4 to 10.08 m.e L^{-1} and 0.64 to 13.36 m.e L^{-1} during April and June 2010 respectively. Magnesium content varied from 1.04 to 19.12 m.e L^{-1} and 1.2 to 26.16 m.e L^{-1} during April and June 2010 respectively. Sodium content was observed between 1.03 to 25.48 m.e L^{-1} and 0.80 to 22.39 m.e L^{-1} during April and June 2010 respectively.

Potassium content varied from 0.10 to 2.52 m.e L^{-1} and 0.05 to 1.09 m.e L^{-1} during April and June 2010 respectively. Most of the samples were found to be with magnesium dominating water. Magnesium

Table 3. Classification of irrigation water quality based on chloride content

Cl (m.e.L^{-1})		April-10		June-10	
		No.of samples	Frequency	No.of samples	Frequency
<5	Excellent	17	48.57	16	45.71
5 to 10	Good	8	22.86	12	34.29
>10	Injurious	10	28.57	7	20.00

exceeds the calcium content in most of the water samples both during April and June 2010. Magnesium toxicity will be exhibited in continuous use of water to crops.

Anions

Anions like carbonate, bicarbonate, chloride and sulphate were analysed in the water samples Carbonates varied from Nil to 4.0 m.e L^{-1} and Nil to

Table 4. Classification of irrigation water quality based on total hardness

Total Hardness	April-10		June-10	
	No.of samples	Frequency	No.of samples	Frequency
<50	34	97.14	32	91.43
>50	1	2.86	3	8.57

3.2 m.e L^{-1} during April and June 2010 respectively. Bicarbonates found to dominate and it ranged from 0.80 to 12.80 m.e L^{-1} and 1.6 to 12.8 m.e L^{-1} during April and June 2010 respectively. Chloride concentration varied from 1.2 to 36.4 m.e L^{-1} and 1.2 to 45.2 m.e L^{-1} during April and June 2010 respectively. Sulphate concentration varied from 0.02 to 7.31 m.e L^{-1} and 0.02 to 7.97 m.e L^{-1} during April and June 2010. Chloride concentration in irrigation water classified as excellent (<5 m.e L^{-1}) Good (5-10 m.e L^{-1}) and injurious (>10 m.e L^{-1}). Most of the samples (48.57% during April 2010 and 45.71% during June 2010) come under excellent category. Considerable number of samples (28.57 % during April and 20.0% during June) were under injurious category remaining under good category.

Total Hardness

Total hardness in the study area varied from 6.26 to 103.59 m.e L^{-1} during April and 8.03 to 140.66 m.e L^{-1} during June 2010. Most of the samples come under deficient of Ca and Mg category during both seasons.

Residual sodium carbonate (RSC) and Residual sodium bi carbonate (RSBC)

RSC values varied from -25.6 to 8.56 meL^{-1} during April 2010 -33.12 to 7.2 meL^{-1} during June 2010. RSC values were classified as safe (<1.25), moderate (1.25-2.5) and unsafe (>2.5). Most of the samples are coming under safe category (71.43% during April 2010 and 80.0 % during June 2010). Residual sodium bicarbonates come under safe category.

Sodium Adsorption Ratio (SAR)

SAR values ranged from 0.96 to 13.21 during April 2010 and 0.49 to 11.19 during June 2010. All the samples come under low sodium category (S_1 < 10). There is no sodicity problem exist among the irrigation waters.

Table 5. Classification of irrigation water quality based on RSC and RSBC

RSC (meL^{-1})	April-10		June-10	
	No.of samples	Frequency	No.of samples	Frequency
<1.25	25	71.43	28	80.00
1.25-2.5	5	14.29	1	2.86
>2.5	5	14.29	6	17.14

RSBC (meL^{-1})	April-10		June-10	
	No.of samples	Frequency	No.of samples	Frequency
<5	30	85.71	29	82.86
5-10	5	14.29	5	14.29
>10	0	0.00	1	2.86

Permeability Index

The soil permeability is affected by long term use of irrigation water. Sodium, calcium, magnesium and bicarbonate content of the soil influence it. Doneen evolved a criterion for assessing the suitability of water for irrigation based on the permeability index. Accordingly, waters can be classified as class I, Class II and Class III orders. Class I and Class II waters are categorized as good for irrigation with 75% or more maximum permeability. Class III water are unsuitable with 25% of maximum permeability. In the present study Permeability Index ranged from 27.78 to 101.59 during April and 26.49 to 89.14 during June 2010. Majority of the samples exhibit no permeability hazard.

Table 6. Classification of irrigation water quality based on SAR

SAR / SCAR	Category	No. of samples	Frequency (%)
<10	Low Sodium Class (S_1)	35	100.00
10-18	Medium Sodium Class (S_2)	0	0.00
18-26	High Sodium Class (S_3)	0	0.00
>26	Very High Sodium Class (S_4)	0	0.00

Conclusion

Thirty five water samples were collected from Parambikulam Aliyar basin from open wells, bore wells and dug cum bore wells and anlaysed for chemical properties like EC, pH, cations and anions.

Table 7. Results of water quality parameters analysed during April 2010 and June 2010

Sl. No.	EC (dSm^{-1})		pH		CO (m.e L^{-1})		HCO$_3$ (m.e L^{-1})		Cl (m.e L^{-1})		SO$_4$ (m.e L^{-1})		Na (m.e L^{-1})		K (m.e L^{-1})		Ca (m.e L^{-1})		Mg (m.e L^{-1})		Total Hardness (m.e L^{-1})		RSBC (m.e L^{-1})		RSC (m.e L^{-1})		SAR		Permeability Index		Mg/Ca		EC class	SAR class
	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10	Apr -10	Jun -10
1	1.24	1.48	7.70	7.30	3.20	3.20	1.20	3.20	5.60	6.40	0.90	0.84	5.83	6.62	0.17	0.16	2.16	1.04	3.52	6.00	19.83	27.20	-0.96	2.16	-1.28	-0.64	3.46	3.53	60.16	61.56	1.63	5.77	C2	S1
2	1.54	1.62	8.30	7.90	2.40	3.20	6.40	8.40	6.40	4.80	0.14	0.11	9.35	10.88	0.24	0.29	0.80	1.44	4.24	3.84	19.38	19.34	5.60	6.96	3.76	6.32	5.89	6.70	82.55	85.26	5.30	2.67	C2	S1
3	1.19	1.45	7.70	7.40	1.60	0.80	2.40	3.60	8.00	8.40	0.11	0.05	5.44	6.30	0.18	0.18	2.48	2.08	4.00	5.04	22.60	25.86	-0.08	1.52	-2.48	-2.72	3.02	3.34	58.65	61.08	1.61	2.42	C2	S1
4	0.88	0.90	7.90	7.40	1.60	1.60	2.80	4.40	4.40	3.60	0.02	0.02	5.22	4.13	0.10	0.05	0.96	2.08	1.52	3.20	8.63	18.32	1.84	2.32	1.92	0.72	4.69	2.54	89.52	66.18	1.58	1.54	C2	S1
5	0.93	1.09	8.30	8.40	1.60	2.40	4.40	6.80	3.20	3.20	0.13	0.03	3.83	5.25	0.45	0.46	1.20	0.80	4.80	5.36	22.68	23.98	3.20	6.00	0.00	3.04	2.21	2.99	60.29	68.86	4.00	6.70	C2	S1
6	1.21	1.28	7.90	7.60	0.80	1.60	7.20	4.00	6.00	6.00	0.18	0.27	7.31	5.97	0.98	0.50	1.68	1.28	4.80	4.80	23.88	22.88	5.52	2.72	1.52	-0.48	4.06	3.42	72.46	66.14	2.86	3.75	C2	S1
7	1.79	1.80	7.80	7.20	0.80	0.00	2.00	3.20	10.80	10.00	0.33	0.08	5.52	3.54	0.32	0.22	4.24	2.72	4.24	7.44	27.98	37.30	-2.24	0.48	-5.68	-6.96	2.68	1.57	49.52	38.89	1.00	2.74	C3	S1
8	1.19	1.47	8.20	7.70	4.00	1.60	1.60	6.40	3.60	5.60	1.05	1.52	5.57	9.63	0.25	0.15	1.28	0.64	3.60	4.00	17.96	18.00	0.32	5.76	0.72	3.36	3.56	6.33	65.39	85.22	2.81	6.25	C2	S1
9	0.61	0.76	8.20	7.60	1.60	0.80	5.20	4.80	1.60	2.00	0.08	0.05	2.89	2.06	0.12	0.15	0.88	1.04	4.00	4.16	18.60	19.66	4.32	3.76	1.92	0.40	1.85	1.28	66.55	58.53	4.55	4.00	C1	S1
10	2.15	1.67	8.60	7.90	2.40	0.80	6.40	7.20	12.00	8.00	3.28	2.17	13.99	9.91	2.52	1.06	1.04	0.88	7.36	6.00	32.78	26.80	5.36	6.32	0.40	1.12	6.83	5.34	73.78	75.00	7.08	6.82	C3	S1
11	0.73	0.94	7.60	7.20	1.60	0.80	2.00	4.00	4.40	4.80	0.03	0.36	3.83	3.62	0.15	0.12	1.60	3.20	2.56	2.96	14.50	20.14	0.40	0.80	-0.56	-1.36	2.66	2.06	65.66	57.47	1.60	0.93	C1	S1
12	1.72	1.69	7.90	7.00	3.20	0.00	1.20	5.20	12.40	10.00	0.83	0.44	12.11	8.76	0.51	0.46	1.12	2.00	4.72	3.60	22.15	19.76	0.08	3.20	-1.44	-0.40	7.09	5.23	73.57	76.88	4.21	1.80	C2	S1
13	0.79	0.29	7.80	7.50	2.40	0.00	4.00	2.00	2.40	1.60	0.65	0.38	8.25	1.37	0.18	0.09	0.80	0.72	1.04	1.52	6.26	8.03	3.20	1.28	4.56	-0.24	8.60	1.30	101.59	77.15	1.30	2.11	C2	S1
14	0.64	0.92	7.70	7.10	0.80	0.00	2.80	4.80	3.60	3.60	0.17	0.41	2.83	2.40	0.23	0.22	1.36	2.48	3.04	3.12	15.86	18.99	1.44	2.32	-0.80	-0.80	1.91	1.43	62.27	57.39	2.24	1.26	C1	S1
15	0.96	1.53	7.30	6.90	0.80	0.00	1.20	1.60	8.00	14.00	0.09	0.03	3.87	6.39	0.19	0.27	2.80	5.04	3.52	3.44	21.43	26.70	-1.60	-3.44	-4.32	-6.88	2.18	3.10	48.73	51.48	1.26	0.68	C2	S1
16	4.24	4.25	8.40	7.64	3.20	2.40	12.80	12.80	14.40	10.80	3.28	4.00	25.48	22.39	0.74	0.51	2.88	1.44	4.56	6.56	25.90	30.50	9.92	11.36	8.56	7.20	13.21	11.19	88.27	85.45	1.58	4.56	C4	S1
17	2.54	2.75	8.20	6.70	3.20	0.80	2.00	7.20	18.40	12.00	1.15	1.23	11.27	3.30	0.32	0.23	2.88	4.64	9.68	14.00	46.89	69.00	-0.88	2.56	-7.36	-10.64	4.50	1.08	53.24	27.29	3.36	3.02	C4	S1
18	1.08	1.38	7.90	7.50	0.80	1.60	3.20	3.60	6.80	8.00	0.13	0.06	3.70	5.92	1.13	1.09	1.84	1.84	3.60	4.48	19.36	22.97	1.36	1.76	-1.44	-1.12	2.24	3.33	60.05	63.86	1.96	2.43	C2	S1
19	2.86	3.31	7.70	6.60	1.60	0.80	4.00	4.80	14.80	17.60	6.09	7.20	14.62	14.93	0.34	0.22	4.00	4.64	8.00	10.32	42.80	53.91	0.00	0.16	-6.40	-9.36	5.97	5.46	62.43	57.27	2.00	2.22	C4	S1
20	1.43	1.42	7.00	6.85	0.00	0.00	1.60	2.40	8.40	9.20	2.97	3.03	2.62	2.04	0.29	0.19	5.28	5.20	6.08	6.32	38.13	38.91	-3.68	-2.80	-9.76	-9.12	1.10	0.85	27.78	26.49	1.15	1.22	C2	S1
21	0.59	0.82	7.80	7.07	1.60	1.60	2.00	4.00	2.40	2.40	0.08	0.05	1.38	1.94	0.49	0.34	1.12	1.12	2.96	3.68	14.94	17.89	0.88	2.88	-0.48	0.80	0.96	1.25	51.16	58.45	2.64	3.29	C1	S1
22	0.30	0.35	7.70	7.42	1.60	0.80	0.80	2.40	1.60	1.20	0.02	0.09	1.03	0.81	0.24	0.06	1.04	1.60	1.04	1.20	6.86	8.92	-0.24	0.80	0.32	0.40	1.01	0.68	61.94	65.34	1.00	0.75	C1	S1
23	1.82	1.97	7.40	6.70	0.80	0.00	2.40	4.00	10.80	10.40	0.91	0.69	8.45	6.01	0.24	0.31	4.08	3.44	3.44	4.64	24.30	27.62	-1.68	0.56	-4.32	-4.08	4.36	2.99	62.61	56.84	0.84	1.35	C3	S1
24	1.72	1.59	7.90	6.90	0.80	0.80	2.40	4.00	12.00	8.80	1.55	1.77	3.89	2.14	0.27	0.12	2.80	3.76	9.68	8.40	46.69	43.84	-0.40	0.24	-9.28	-7.36	1.56	0.87	33.21	28.95	3.46	2.23	C2	S1
25	0.55	0.76	7.70	7.48	1.60	0.80	4.40	5.20	2.40	1.60	0.13	0.41	3.35	1.53	0.25	0.06	0.96	1.20	2.88	4.40	14.21	21.04	3.44	4.00	2.16	0.40	2.42	0.91	75.77	53.44	3.00	3.67	C1	S1
26	0.46	0.73	7.80	7.24	0.80	0.00	3.60	4.80	1.20	2.00	0.11	0.13	1.35	0.80	0.27	0.06	0.80	1.20	2.64	4.24	12.82	20.38	2.80	3.60	0.96	-0.64	1.03	0.49	67.81	47.97	3.30	3.53	C1	S1
27	0.73	0.95	7.80	7.36	1.60	1.60	4.80	6.00	2.80	2.00	0.03	0.06	4.16	2.86	0.26	0.08	0.88	1.52	3.04	4.40	14.66	21.84	3.92	4.48	2.48	1.68	2.97	1.66	78.60	60.48	3.45	2.89	C1	S1
28	1.14	1.15	7.50	7.70	0.80	0.00	2.00	3.60	8.40	7.20	0.10	0.23	4.58	3.14	0.33	0.33	1.76	3.04	4.32	4.48	22.11	25.97	0.24	0.56	-3.28	-3.92	2.63	1.62	56.24	47.27	2.45	1.47	C2	S1
29	0.43	0.55	7.40	7.50	0.80	0.80	2.40	2.80	1.60	1.60	0.11	0.31	1.34	0.97	0.26	0.08	1.28	1.92	2.08	2.08	11.73	13.33	1.12	0.88	-0.16	-0.40	1.04	0.69	61.50	53.22	1.63	1.08	C1	S1
30	0.70	1.08	7.50	7.09	0.80	0.80	2.40	3.60	4.80	4.80	0.09	0.14	2.35	2.41	0.27	0.13	1.76	3.68	3.20	4.00	17.52	25.60	0.64	-0.08	-1.76	-3.28	1.49	1.23	53.33	42.68	1.82	1.09	C1	S1
31	3.52	2.81	7.66	7.83	0.80	1.60	5.60	6.40	13.60	11.20	7.31	6.84	15.47	16.40	0.94	0.96	1.12	1.52	9.68	7.84	42.49	35.94	4.48	4.88	-4.40	-1.36	6.66	7.58	67.90	73.49	8.64	5.16	C4	S1
32	0.98	0.95	7.75	7.96	1.60	0.80	6.40	7.20	2.80	3.60	0.06	0.06	6.98	7.07	0.51	0.53	0.40	0.72	2.88	3.52	12.81	16.23	6.00	6.48	4.72	3.76	5.45	4.85	92.69	86.23	7.20	4.89	C2	S1
33	5.19	6.80	7.36	7.62	0.80	1.60	2.80	4.80	36.40	45.20	7.28	7.97	18.30	20.22	0.50	0.50	10.08	13.36	19.12	26.16	103.59	140.66	-7.28	-8.56	-25.60	-33.12	1.82	1.51	42.04	37.52	1.90	1.96	C4	S1
34	1.06	0.73	7.58	7.83	1.60	1.60	4.80	4.00	4.00	2.40	0.19	0.19	7.83	5.22	0.88	0.92	0.72	1.28	1.44	1.60	7.70	9.76	4.08	2.72	4.24	2.72	7.53	4.35	100.31	89.14	2.00	1.25	C2	S1
35	1.28	1.69	7.30	7.55	0.80	1.60	1.60	2.80	4.00	5.20	6.61	6.48	6.11	5.85	0.16	0.17	3.52	8.88	3.20	2.08	21.92	30.73	-1.92	-6.08	-4.32	-6.56	3.33	2.50	57.49	44.75	0.91	0.23	C2	S1
Min	0.30	0.29	7.00	6.60	0.00	0.00	0.80	1.60	1.20	1.20	0.02	0.02	1.03	0.80	0.10	0.05	0.40	0.64	1.04	1.20	6.26	8.03	-7.28	-8.56	-25.60	-33.12	0.96	0.49	27.78	26.49	0.84	0.23		
Max	5.19	6.80	8.60	8.40	4.00	3.20	12.80	12.80	36.40	45.20	7.31	7.97	25.48	22.39	2.52	1.09	10.08	13.36	19.12	26.16	103.59	140.66	9.92	11.36	8.56	7.20	13.21	11.19	101.59	89.14	8.64	6.82		

Sodium dominated among cations followed by magnesium, calcium and potassium. Among the anions, chloride dominated followed by bicarbonate, carbonate and sulphate. Magnesium dominated water type were being observed in majority of the places. Total hardness values indicate that most of the samples deficient of Ca and Mg. Salinity persists in the basin and there is no sodicity observed among the samples. High salinity water can be used for irrigation for soils with very good drainage whereas very high salinity water is not suitable for irrigation for many of the soil groups. The farmers can have the strategies to remove salt encrustation in irrigation pipes and drip system wherever carbonates and bicarbonates are high.

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