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Effect of Salinity/Sodicity on Soil Fertility Status of Northern Saurashtra Coastal Region of Gujarat

Kiran Yadav[1*], K B Parmar[2] and Bhorania Nirali[3]
[1]Ph.D. Scholar, Department of Soil Science and Agricultural Chemistry, College of Agriculture, JAU, Junagadh (Gujarat), India.
[2]Associate Director of Research, JAU, Junagadh (Gujarat), India.
[3]Ph.D. Scholar, Department of Soil Science and Agricultural Chemistry, College of Agriculture, JAU, Junagadh (Gujarat), India.

(Corresponding author: Kiran Yadav)*
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ABSTRACT: In present time, salinity and alkalinity of the soils are serious problems in India as well as in Gujarat. These soils are usually supposed to be originated as a result of high water table, arid and semi-arid weather, ingress the sea, water, saline nature of barren materials, poor drainage and salt deposition through wind-blown particles. This poor quality of water decrease the soil productivity and finally reduce the crop yield. Looking to the importance of above views, an investigation was carried out to study the quality of underground wells/tube wells water and their effect on soil properties of Northern Saurashtra coastal region (Jamnagar, Devbhumi Dwarka and Porbandar district) of Gujarat by collecting grid based 141 surface soil samples and each 285 irrigation water samples on pre and post monsoon from the farmer's cultivated field during May, 2019 at the distance (0-5, 5-10, 10-15, 15-20 km) from coastal line. To study the fluctuation in water quality, only water samples were collected twice *i.e.* pre-monsoon (May, 2019) and post-monsoon (December, 2019).

All the soil samples were analyzed for EC and pH from saturated and dilute (1:2.5) extract. The EC, pH were determined as per the methods described by Richards (1954). Saturation paste of soil was prepared as described by Richards (1954) and found that in salinity parameters, EC, ESP, SSP and SAR were decreased, while pH was slightly increased with increasing the distance from sea coast. The overall highly significant correlation of EC_e with $EC_{2.5}$ (r = 0.8012) and pH_s with $pH_{2.5}$ (r = 0.4004**) were observed. The highly significant correlation coefficient between SOC and N (r = 0.7798**), ESP and EC_e (r = 0.6531**), ESP and $EC_{2.5}$ (r = 0.6050**) were observed in soil samples.**

The correlation among fertility parameters (SOC, available N, P_2O_5, K_2O and S) and salinity/sodicity parameters ($EC_{2.5}$, EC_e, $pH_{2.5}$ and pH_s) in soils of 0 to 20 km distance from sea coast indicates that $EC_{2.5}$ was significant and positively correlated with EC_e, SSP, SAR and ESP and $pH_{2.5}$ was significant and positively correlated with pH_s, SOC, available N, K_2O and S.

Keywords: EC, SOC, $pH_{2.5}$, fertility and correlation.

INTRODUCTION

In India the dwindling per capita availability of land that decreased from 0.5 to 0.15 ha in 1999-2000 because of population escalation, is likely to reduce further to 0.08 ha in 2020 AD (Yadav and Singh, 2000). Soil fertility and plant nutrients are two closely related subjects that emphasize the forms and availability of nutrients in the soil, their movement and uptake by plant roots and the utilization of nutrients within plants. In present time, salinity and alkalinity of the soils are serious problems in India as well as in Gujarat. Poor performance of crops in salts affected soil may be due to excessive quantities of soluble salts and or higher exchangeable sodium percentage, which consequently resulted in nutritional disorders in plants. Around 6.72 million ha area in India is salt-affected, of which 2.95 million ha is saline and the rest 3.77 million ha is sodic (Arora *et al*. 2016). Nearly 75% of salt-affected soils in the country exist in the states of Gujarat (2.23 million ha), Uttar Pradesh (1.37 million ha), Maharashtra (0.61 million ha), West Bengal (0.44 million ha) and Rajasthan (0.38 million ha) (Mandal *et al.* 2018).

The soils of Saurashtra region have possess the longest coastal area in India which contains variety of soil constraints like shallow to medium depth land, calcareous in nature, soil erosion, undulating topography, soil salinity/alkalinity and poor quality irrigation water. The quality of well and tube well water become saline and sodic day by day. Recently, in the state, soil degradation through salinity has caught hold over 1.2 m ha of land out of which, about 0.3 m ha

occurs in the coastal area and rest 0.9 m ha comprises the inland saline area (Rao *et al.*, 2001). The excessive withdrawal of groundwater disturbs hydrodynamic equilibrium that exists between the freshwater–seawater in the aquifer and causes upward movement of the seawater. This poor quality of water decrease the productivity of soil and finally reduce the crop yield. This causes depletion in the available fresh groundwater resources in coastal areas (Alfarrah and Walraevens, 2018).

Salt build-up in soils and water are major constraints for human habitat, sustainable development, soil health and crop productivity (Mimura, 2013) due to severe problem of water and soil salinity in the coastal regions (Rao *et al*., 2019). The yield of different crops are varies with variation in soil fertility. Soil provides a significant source of nutrients for crop growth and production (Ashman and Puri, 2013). Soil nutrients provide a crucial role for the sustainability of soil quality, crop production and environmental quality (Andrews *et al.,* 2004). Soil properties such as pH, EC, nutrient biogeochemical and physiochemical processes regulate the bioavailability of soil nutrients and salinity is recognized as a serious challenge in land cultivation (El-Ramady *et al.,* 2018).

Hasanuzzaman *et al.,* (2013) argued that salinity in soil act as important abiotic stress causing a remarkable decrease in crop production. Soil salinization deteriorates one or more functions of soil that emerges as a major environmental constraint impeding soil productivity, agricultural sustainability and food security (Cuevas *et al.,* 2019). The brackish water irrigation aggravates the degree of soil salinization and alkalization (Singh *et al.,* 2021). Soil survey provides useful information for planning of proper soil, water and nutrient management. It is highly imperative to have the knowledge of the soil fertility levels and quality of underground water and their effect on soil properties in coastal districts of Jamnagar, Devbhumi Dwarka and Porbandar, as identified North coastal region of Saurashtra which will help the cultivators in sight and guidance for adoption of suitable soil and crop management practices.

MATERIALS AND METHODS

Study had been performed in Northern Saurashtra coastal region of Gujarat by collecting grid based each 285 irrigation water samples on pre and post monsoon from distance demarcation of 0-5, 5-10, 10-15 and 15-20 km from sea coast through use of GPS. The samples were collected from each taluka viz. Jodiya, Jamnagar and Lalpur talukas of Jamnagar district, Khambhalia, Dwarka and Kalyanpur talukas of Devbhumi Dwarka district and Porbandar taluka of Porbandar district of Northern Saurashtra Coastal region of Gujarat during the summer season of year 2019. The EC, pH were determined as per the methods described by Richards (1954). Saturation paste of soil was prepared as described by Richards (1954). The extract was obtained after transferring the paste on the Buchner funnel under vacuum. These extract were utilized for determination of EC_e and pH_s. Available nitrogen was determined by alkaline $KMnO_4$ method as described by Subbiah and Asija (1956), available P was estimated by Olsen reagent (Olsen *et al*. 1954), available K by flame photometry as described by Jackson (1973) and available S by Heat soluble as described by Williams and Stainbergs (1959).

(1) Soluble Sodium Percentage (SSP)

$$SSP = \frac{Na^+}{(Na^+ + Ca^{++} + Mg^{++} + K^+)} \times 100$$

(Concentration of all cations are in me L^{-1})

(2) Sodium Adsorption Ratio (SAR)

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

(Concentration of all cations are in me L^{-1})

(3) Residual Sodium Carbonate (RSC)

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

(All ionic concentrations are in me L^{-1})

The correlation coefficient ('r' value) was used to measure the relationship between dependent and independent variables. The data were generated by analysis of soil and water samples and these were statistically analyzed for correlation studies as per method given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The ranges of chemical constituents of irrigated soils of different talukas of Northern saurashtra coastal region are reported in Table 1. The pH is important parameter for determining acidity, neutrality or alkalinity of water. **Electrical conductivity ($EC_{2.5}$).** The perusal of data mentioned in Table 1 revealed that $EC_{2.5}$ of soils ranged from 0.37 to 3.56 dS m^{-1} with the average value of 1.08 dS m^{-1} in Jamnagar, 0.32 to 3.67 dS m^{-1} with the average value of 1.34 dS m^{-1} in Jodiya, 0.29 to 3.13 dS m^{-1} with the average value of 0.86 dS m^{-1} in Lalpur, 0.23 to 5.60 dS m^{-1} with the average value of 1.13 dS m^{-1} in Kalyanpur, 0.24 to 4.33 dS m^{-1} with the average value of 1.05 dS m^{-1} in Khambhalia, 0.36 to 5.97 dS m^{-1} with the average value of 1.78 dS m^{-1} in Dwarka and 0.30 to 4.80 dS m^{-1} with the average value of 1.39 dS m^{-1} in Porbandar taluka. Similar results were also obtained for Girnar toposequence by Gandhi (2013), for Patan district by Patel *et al*. (2016); Reddy and Naidu (2016) for Kapada district of Andhra Pradesh, Wagh *et al*. (2016) for Nagpur district of Maharashtra, Singh *et al.* (2021) for Nagaur district of Rajasthan and Bhorania *et al.* (2021) for Southern saurashtra of Gujarat.

Exchangeable Sodium Percentage (ESP). The highest ESP of irrigated soils was recorded from 6.61 to 21.20 in Jamnagar with the mean value of 13.52 and 4.74 to 32.14 in Dwarka with the mean value of 14.61. Similar findings were also recorded by Chauhan and Polara (2015a) for Gir Somnath district, by Hadiya and Polara (2017) for Devbhumi Dwarka district of Gujarat, by Singh *et al.* (2021) for Nagaur district of Rajasthan and by Bhorania *et al.* (2021) for Southern saurashtra of Gujarat.

Table 1: Salinity/Sodicity indices of irrigated soils in different talukas of Northern Saurashtra coastal region.

Talukas	EC_e (dS m^{-1})	pH_s	$EC_{2.5}$ (dS m^{-1})	$pH_{2.5}$	ESP	SSP	SAR
JAMNAGAR							
Max	10.40	8.19	3.56	8.21	21.20	86.92	13.78
Min	0.52	6.91	0.37	7.20	6.61	58.90	3.21
Mean	2.03	7.56	1.08	7.76	13.52	68.59	6.02
JODIYA							
Max	12.04	8.11	3.67	8.20	18.53	77.12	15.04
Min	0.49	7.01	0.32	7.22	5.41	54.64	3.06
Mean	2.74	7.53	1.34	7.70	12.38	67.62	6.37
LALPUR							
Max	10.27	7.94	3.13	8.07	18.80	82.71	14.01
Min	0.56	7.14	0.29	7.37	8.34	44.06	1.53
Mean	1.83	7.63	0.86	7.78	12.77	63.58	4.90
KALYANPUR							
Max	17.03	7.88	5.60	8.14	30.24	78.54	14.01
Min	0.54	6.97	0.23	7.28	6.01	33.67	1.15
Mean	3.30	7.54	1.13	7.66	11.60	64.97	5.43
KHAMBHALIA							
Max	15.17	8.14	4.33	8.12	20.28	74.31	10.85
Min	0.67	6.82	0.24	7.21	5.03	40.32	1.86
Mean	3.09	7.60	1.05	7.76	9.88	62.44	4.96
DWARKA							
Max	18.22	8.36	5.97	8.59	32.14	88.38	21.57
Min	0.78	7.13	0.36	7.44	4.74	51.87	3.10
Mean	5.56	7.58	1.78	7.96	14.61	68.12	7.66
PORBANDAR							
Max	12.20	8.08	4.80	8.19	18.81	82.17	16.35
Min	0.66	7.14	0.30	7.36	5.54	45.95	2.14
Mean	3.90	7.65	1.39	7.80	13.15	67.25	6.89

Soluble Sodium Percentage (SSP). The SSP values of various talukas were recorded from 58.90 to 86.92 with mean value of 68.59 in Jamnagar, 54.64 to 77.12 in Jodiya with the mean value of 67.62, 44.06 to 82.71 with mean value of 63.58 in Lalpur, 33.67 to 78.54 with average value of 64.97 in Kalyanpur, 40.32 to 74.31 with average value of 62.44 in Khambhalia, 51.87 to 88.38 in Dwarka with mean value of 68.12 and 45.95 to 82.14 with mean value of 67.25 in Porbandar. Overall the value of SSP in coastal soils of Northern Saurashtra region was recorded higher than its safe limit (60.00).

This finding is in conformity with the findings of earlier work done for Gir Somnath district of Gujarat by Polara and Chauhan (2015), for Devbhumi Dwarka district of Gujarat by Hadiya and Polara (2017), for Kheda district of Gujarat by Vaghela (2017), for Nagaur district of Rajasthan by Singh *et al.* (2021) and for Southern saurashtra of Gujarat by Bhorania *et al.* (2021).

Pre-monsoon water samples. The ranges of chemical constituents of pre and post-monsoon irrigation water of different talukas of Northern saurashtra coastal region are reported in Table 2.

Electrical conductivity (EC). The highest value of EC in irrigation water samples was recorded in Kalyanpur from 0.49 to 7.35 dS m^{-1} with the mean value of 2.19 dS m^{-1} followed by Jodiya from 0.64 to 6.05 dS m^{-1} with the mean value of 2.59 dS m^{-1}. The lowest value of EC in irrigation water samples was recorded in Lalpur from 0.37 to 2.89 dS m^{-1} with average value of 1.41 dS m^{-1}. Salinity hazard of irrigation water is the cause of the development of secondary salinization in the soils of Northern Saurashtra coastal region. Similar findings were also reported for Porbandar district by Hadiyal (2005), for Junagadh district by Sojitra (2010), for Kheda district of Gujarat by Vaghela (2017), for Nagaur district of Rajasthan by Singh *et al.* (2021) and for Southern saurashtra of Gujarat by Bhorania *et al.* (2021).

Sodium Adsorption Ratio (SAR). Data revealed that the highest (6.64) and the lowest (3.31) mean SAR values were registered in Dwarka and Lalpur talukas, respectively. All the talukas of Northern Saurashtra coastal region at different distances (0 to 5, 5 to 10, 10 to 15 and 15 to 20 km) had mean SAR values less than 10. These findings are in conformity with Rajput and Polara (2013); Polara and Chauhan (2015); Hadiya and Polara (2017); Vaghela (2017); Singh *et al.* (2021); Bhorania *et al.* (2021).

Post-monsoon water samples

Electrical conductivity (EC). The data revealed that the lowest mean value of EC (1.28 dS m^{-1}) in water samples after monsoon was obtained from the samples of Lalpur taluka of Jamnagar district and the highest mean value of EC (2.78 dS m^{-1}) was registered in the samples of Dwarka taluka of Devbhumi Dwarka district. The value of EC was decreased with increased the distance from sea coast in irrigation water samples of Northern Saurashtra coastal region after withdrawal of monsoon. Similar findings were also reported for Porbandar district by Hadiyal (2005), for Junagadh district by Sojitra (2010), for Bhavnagar district by Rajput and Polara (2013), for Latur district of Maharashtra by Patil *et al.,* (2014), for Gir Somnath district by Polara and Chauhan (2015), for Nagaur district of Rajasthan by Singh *et al.* (2021) and for Southern saurashtra of Gujarat by Bhorania *et al.* (2021).

Sodium Adsorption Ratio (SAR). The highest value of SAR in irrigation water samples was recorded in Jodiya from 1.60 to 13.05 with the mean value of 4.14

followed by Dwarka from 2.76 to 12.17 with the mean value of 5.89. The lowest value of SAR in irrigation water samples was recorded in Lalpur from 0.98 to 7.52 with average value of 2.87. These findings are in conformity with Rajput and Polara (2013); Polara and Chauhan (2015); Hadiya and Polara (2017); Vaghela (2017); Singh *et al.* (2021); Bhorania *et al.* (2021).

Table 2: Salinity/Sodicity indices of pre and post-monsoon wells/tube wells water samples in different talukas of Northern Saurashtra coastal region.

Talukas	Pre-monsoon				Post- monsoon			
	EC ($dS\ m^{-1}$)	pH	SAR	SSP	EC ($dS\ m^{-1}$)	pH	SAR	SSP
JAMNAGAR								
Max	5.59	7.80	15.20	78.61	4.66	8.40	7.64	73.75
Min	0.57	6.45	1.95	21.63	0.48	7.20	1.21	14.94
Mean	2.26	7.21	5.02	49.67	2.06	7.68	3.55	40.14
JODIYA								
Max	6.05	7.93	14.23	78.28	5.46	8.30	13.05	74.81
Min	0.64	6.62	2.09	21.71	0.52	7.20	1.60	17.25
Mean	2.59	7.18	5.27	49.70	2.43	7.71	4.14	42.81
LALPUR								
Max	2.89	8.47	7.83	71.51	2.92	8.60	7.52	70.64
Min	0.37	6.84	1.13	21.95	0.28	7.40	0.98	18.44
Mean	1.41	7.33	3.31	44.41	1.28	7.88	2.87	40.93
KALYANPUR								
Max	7.35	7.60	13.51	75.02	6.83	8.80	11.60	70.57
Min	0.49	6.59	1.80	20.27	0.27	7.00	0.60	14.08
Mean	2.19	7.06	5.18	51.50	1.83	7.75	3.86	44.52
KHAMBHALIA								
Max	4.87	8.18	15.91	82.56	4.46	8.13	11.75	78.00
Min	0.25	6.58	0.95	25.61	0.18	7.30	0.47	15.01
Mean	1.68	7.31	5.97	53.60	1.45	7.73	3.93	47.56
DWARKA								
Max	5.94	7.86	13.96	73.55	5.46	8.90	12.17	74.49
Min	1.03	6.70	3.13	33.52	0.64	7.20	2.76	38.65
Mean	2.98	7.11	6.64	55.05	2.78	7.76	5.89	51.87
PORBANDAR								
Max	6.03	8.18	12.85	70.41	5.64	8.30	10.92	66.32
Min	0.44	6.76	1.92	29.01	0.26	7.30	1.14	22.80
Mean	2.37	7.24	4.92	49.37	2.16	7.66	4.26	46.13

Correlation among and between fertility and salinity/sodicity indices of irrigated soils- The correlation among fertility parameters (SOC, available N, P_2O_5, K_2O and S) and salinity/sodicity parameters ($EC_{2.5}$, EC_e, $pH_{2.5}$ and pH_s) in soils of 0 to 20 km distance from sea coast were worked out, presented in Table 3 and data indicates that $EC_{2.5}$ was significant and positively correlated with EC_e, SSP, SAR and ESP and $pH_{2.5}$ was significant and positively correlated with pH_s, SOC, available N, K_2O and S. The higher content of salts adversely affect the soil organic carbon content. The available N, P, K and S content of soil decreased significantly with increasing levels of SSP and SAR. This may be explained on the basis that increasing SAR, pH of soil also increased accordingly resulting into decreased availability of plant nutrients in soil but increased the availability of Na. The higher amount of Na may adversely affect the physico-chemical and biochemical properties of soil. Similar relationship were also observed by Maliwal and Timbadia (2000); Prasad and Prasad (2001); Rajeshwar and Mani (2014); Singh *et al.* (2021); Bhorania *et al.* (2021).

Inter-relationship between properties of irrigation water and irrigated soils-

Pre-monsoon. The correlation between different properties of pre-monsoon irrigation water (EC_{iw}, pH_{iw}, RSC_{iw}, SSP_{iw} and SAR_{iw}) and properties of irrigated soils ($EC_{2.5}$, EC_e, $pH_{2.5}$, pH_s, SAR_s, SSP_s, and ESP_s) of 0 to 20 km distance from sea coast indicates that EC_{iw} was observed significant and positively correlated with SAR_{iw}, EC_e, $EC_{2.5}$, ESP_s, SSP_s and SAR_s and pH_{iw} was significant and positively correlated with RSC_{iw}, pH_s and $pH_{2.5}$ (Table 4). Similar results was also observed by Prasad and Prasad (2001); Kabaria (2004); Shirgire (2012); Rajput and Polara (2013); Singh *et al.* (2021); Bhorania *et al.* (2021).

Post-monsoon. The correlation between different properties of post-monsoon irrigation water (EC_{iw}, pH_{iw}, RSC_{iw}, SSP_{iw} and SAR_{iw}) and properties of irrigated soils ($EC_{2.5}$, EC_e, $pH_{2.5}$, pH_s, SAR_s, SSP_s, and ESP_s) of 0 to 20 km distance from sea coast indicates that EC_{iw} was observed significant and positively correlated with SAR_{iw}, EC_e, $EC_{2.5}$, ESP_s, SSP_s and SAR_s and pH_{iw} was significant and positively correlated with RSC_{iw}, pH_s and $pH_{2.5}$ (Table 5). Similar results was also observed by Prasad and Prasad (2001); Kabaria (2004); Shirgire (2012); Rajput and Polara (2013); Singh *et al.* (2021); Bhorania *et al.* (2021).

Underground water quality classification for irrigation purpose. The groundwater quality of Northern Saurashtra coastal region was classified into different classes for irrigation purpose and details are presented in Table 6 and Fig. 1 and 2. The 12.28% samples were of medium salinity class and 51.23% of highly salinity after monsoon. The 85.61% samples were found under safe class of SSP after monsoon. The quality of underground water was increased with increasing the rainfall in that region.

Table 3: Correlation co-efficient among and between fertility and salinity/sodicity indices of soils of Northern Saurashtra coastal region.

0 to 20 km	$EC_{2.5}$	EC_e	$pH_{2.5}$	pH_s	SSP	SAR	ESP	SOC	N	P_2O_5	K_2O	S
$EC_{2.5}$	1.000											
EC_e	0.954**	1.000										
$pH_{2.5}$	-0.467**	-0.423**	1.000									
pH_s	-0.578**	-0.558**	0.776**	1.000								
SSP	0.312**	0.300**	-0.128	-0.217**	1.000							
SAR	0.689**	0.705**	-0.317**	-0.434**	0.760**	1.000						
ESP	0.595**	0.625**	-0.223**	-0.344**	0.184*	0.389**	1.000					
SOC	-0.596**	-0.557**	0.365**	0.458**	-0.380**	-0.560**	-0.374**	1.000				
N	-0.405**	-0.421**	0.295**	0.387**	-0.321**	-0.416**	-0.305**	0.780**	1.000			
P_2O_5	-0.259**	-0.254**	0.137	0.158	-0.231**	-0.305**	-0.153	0.369**	0.353**	1.000		
K_2O	-0.359**	-0.298**	0.338**	0.332**	-0.394**	-0.396**	-0.341**	0.736**	0.580**	0.459**	1.000	
S	-0.543**	-0.510**	0.311**	0.401**	-0.458**	-0.550**	-0.364**	0.857**	0.692**	0.391**	0.779**	1.000

*,** Significant at 5% & 1 % level, respectively

Table 4: Correlation co-efficient among and between salinity/sodicity indices of soil and pre-monsoon irrigation water of Northern Saurashtra coastal region

0 to 20 km	EC_{iw}	pH_{iw}	SSP_{iw}	SAR_{iw}	RSC_{iw}	EC_e	pH_s	$EC_{2.5}$	$pH_{2.5}$	ESP_s	SSP_s	SAR_s
EC_{iw}	1.000											
pH_{iw}	-0.414**	1.000										
SSP_{iw}	0.080	0.017	1.000									
SAR_{iw}	0.431**	-0.146	0.832**	1.000								
RSC_{iw}	-0.640**	0.340**	0.340**	-0.093	1.000							
EC_e	0.521**	-0.318**	0.160	0.422**	-0.417**	1.000						
pH_s	-0.427**	0.305**	-0.054	-0.301**	0.415**	-0.551**	1.000					
$EC_{2.5}$	0.538**	-0.327**	0.120	0.411**	-0.508**	0.955**	-0.598**	1.000				
$pH_{2.5}$	-0.343**	0.252**	0.071	-0.135	0.400**	-0.411**	0.801**	-0.462**	1.000			
ESP_s	0.334**	-0.098	0.074	0.213*	-0.230*	0.653**	-0.339**	0.605**	-0.168	1.000		
SSP_s	0.301**	-0.323**	-0.003	0.169	-0.316**	0.309**	-0.225*	0.326**	-0.147	0.237*	1.000	
SAR_s	0.527**	-0.363**	0.078	0.324**	-0.412**	0.711**	-0.437**	0.690**	-0.307**	0.429**	0.762**	1.000

*,** Significant at 5% & 1 % level, respectively

Table 5: Correlation co-efficient among and between salinity/sodicity indices of soil and post-monsoon irrigation water of Northern Saurashtra coastal region.

0 to 20 km	EC_{iw}	pH_{iw}	SSP_{iw}	SAR_{iw}	RSC_{iw}	EC_e	pH_s	$EC_{2.5}$	$pH_{2.5}$	ESP_s	SSP_s	SAR_s
EC_{iw}	1.000											
pH_{iw}	-0.541**	1.000										
SSP_{iw}	0.048	0.019	1.000									
SAR_{iw}	0.414**	-0.178	0.829**	1.000								
RSC_{iw}	-0.671**	0.479**	0.213*	-0.211*	1.000							
EC_e	0.478**	-0.326**	0.249**	0.474**	-0.371**	1.000						
pH_s	-0.417**	0.262**	-0.101	-0.329**	0.374**	-0.551**	1.000					
$EC_{2.5}$	0.494**	-0.348**	0.211*	0.462**	-0.463**	0.955**	-0.598**	1.000				
$pH_{2.5}$	-0.353**	0.278**	0.027	-0.161	0.312**	-0.411**	0.801**	-0.462**	1.000			
ESP_s	0.294**	-0.137	0.154	0.280**	-0.164	0.653**	-0.339**	0.605**	-0.168	1.000		
SSP_s	0.310**	-0.203*	-0.023	0.160	-0.346**	0.309**	-0.225*	0.326**	-0.147	0.237*	1.000	
SAR_s	0.501**	-0.336**	0.104	0.345**	-0.432**	0.711**	-0.437**	0.690**	-0.307**	0.429**	0.762**	1.000

*,** Significant at 5% & 1 % level, respectively

Table 6: Classification of underground irrigation water on the basis of EC and SSP.

EC (dS m^{-1} at 25°C)	Quality Class	Percent of water samples	
		Pre-monsoon	Post-monsoon
0-0.25	Low- C_1	0.35	0.70
0.25-0.75	Medium- C_2	5.96	12.28
0.75-2.25	High- C_3	52.28	51.23
2.25-5.00	Very high- C_4	41.40	35.79
SSP			
<60	Safe-S_1	74.74	85.61
>60	Unsafe-S_2	25.26	14.39

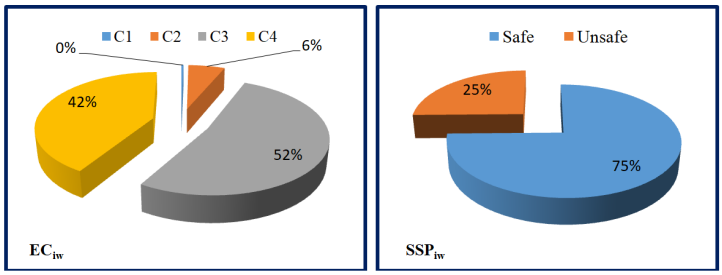

Fig. 1. Overall percentage of pre-monsoon EC_{iw} and SSP_{iw} in samples of Northern Saurashtra coastal region.

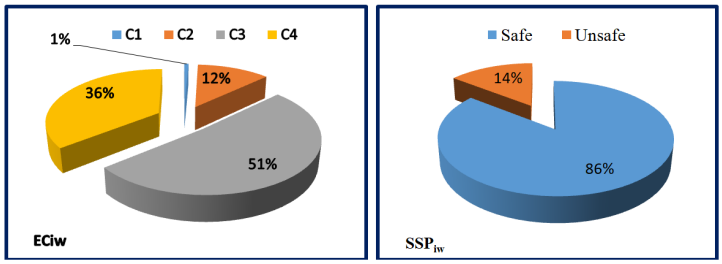

Fig. 2. Overall percentage of post-monsoon EC_{iw} and SSP_{iw} in samples of Northern Saurashtra coastal region.

CONCLUSION

Present study indicates that groundwater of study area is contaminated, so reclamation of water is essential to do before its use for agriculture production. Almost all well/ tube well water samples (Pre & Post monsoon) of Northern Saurashtra coastal region having higher amount of soluble salts mainly due to dominance of Na and Cl ions, however, all the quality parameters *viz*., EC, pH, SSP, RSC and ESP of collected well/tube well water samples after monsoon were improved as compared to the samples collected before monsoon.

FUTURE SCOPE

This study will help to understand the salinity status and quality of soil and water after application of underground irrigation water and will help to understand the relationship between fertility and salinity under different grid based samples.

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