International Research Journal of Natural and Applied Sciences
Volume-2, Issue-1 (January 2015) ISSN: (2349-4077)

ASSESSMENT OF IRRIGATION WATER QUALITY FROM VARIOUS SOURCES IN SURROUNDING AREA OF VAPI INDUSTRIAL COMPLEX, VALSAD (INDIA) IN RELATION TO ADVERSE EFFECT ON SOIL

Jiteshkumar B. Patel and Amaresh Das

Department of Soil Science, Navsari Agricultural University, Navsari – 396 450 (Gujarat)

ABSTRACT

Thirty two numbers of water samples were collected from 32 villages in the surrounding area of Vapi Industrial complex, Valsad (India) and located at various distances from it with an objective to assess their suitability for irrigation purposes. The results revealed that about 69 (9 nos.), 28 (22 nos.) and 3 (1 no.) per cent water sources were of neutral, slightly alkaline and moderately alkaline category respectively. About 19 (6 nos.), 50 (16 nos.) and 31 (10 nos.) % water sources belonged respectively to excellent (C_1 i.e. safe for irrigation), good (C_2 i.e. safe for irrigation but need moderately leaching) and permissible class (C_3 i.e. should not be used on soils with restricted drainage). In respect to sodium absorption ratio (SAR), about 22 (7 nos.), 59 (19 nos.), 16 (5 nos.) and 3 (1 no.) per cent water sources belonged respectively to safe (S_1 class), moderately safe (S_2 class), moderately unsafe (S_3 class) and un safe (S_4 class), while 97 % water sources were belonged to class III i.e. unsuitable for irrigation purposes. 6.25% sources belonged to "high SAR" category and 21.88% sources came under "alkali" and 71.87% sources belonged to "highly alkali" category. The overall results indicated that water sources with either of "high salinity" or "high SAR" or "highly alkali" category should not be used directly as source of irrigation to crops to avoid any detrimental effect on soil, crop yield and environment as well.

(***Key words***: Irrigation water quality, various water sources, Vapi industrial complex, possible adverse effect)

Introduction:

Quality of surface and ground water varies from place to place to certain extent due to leaching of soluble salt by high rainfall during monsoon. Irrigation water quality is the prime importance in irrigated agriculture for sustaining crop yield, soil health and environment as a whole. So, when surface and ground waters are being used as source of irrigation in agricultural crop production, assessment of their quality parameters such as, EC, pH, SAR, RSC, Cl^-, SO_4^{2-} is a must for its judicious use in order to obtain sustainable crop yield without deteriorating soil health and environment. Work on assessment of water quality on in different parts of India was carried out by Donga *et. al.* (2009) and Saxena and Saksena (2012). Valsad district is situated on an average 13 m above MSL and adjacent to Arabian Sea. So, intrusion or seepage of sea water to inland areas and rise of water table to ground level in coastal areas are of frequent phenomena that affects the surface and ground water quality. This is the reason as to why assessment of quality of irrigation water sources is much needed in order to avoid possible development of soil sodicity and salinity problem in soil, reduction in crop yield and deterioration of environment. Keeping all the above points in view, a research has been taken up for assessing the quality of major irrigation water sources in villages surrounding the area of Vapi industrial complex, Valsad.

Materials and methods

Valsad district is located in the southern part of Gujarat state. The major water resources in the district are tube well, bore wells, khadi, lake *etc*. which are currently being used for irrigation by the farmers in surrounding the area of Vapi industrial complex, Valsad. Total 32 no. of water samples (Table 1) were collected during 2011 in cleaned transparent polythene bottles (1000 ml capacity) from 32 villages in surrounding the area of Vapi industrial complex, Valsad following the standard sampling procedure (Richards, 1954). The analyses of pH and EC from water samples were done by use of Glass electrode- pH meter and EC- meter respectively as described by Jackson (1973). Na^+ ion content from water samples were determined by flame photometer as described by Jackson (1973), while content of Ca^{++} + Mg^{++} ions were determined by EDTA-titration method using NH_4Cl – NH_4OH buffer solution and EBT indicator as described by Richards (1954). CO_3^{2-} and HCO_3^- ions were determined by acid (0.01N H_2SO_4) neutralization titration method using phenolphthalein indicator for HCO_3^- and methyl orange

indicator for CO_3^{2-} as described by Richards (1954). SAR and RSC of water samples were computed using the formulae as below, where Na^+, Ca^{++} + Mg^{++}, CO_3^{2-} and HCO_3^- ions are expressed in me L^{-1}. Results were presented and discussed taluka-wise and for overall district.

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

$$RSC\ (me\ L^{-1}) = (CO_3^{2-} + HCO_3^-) - (Ca^{++} + Mg^{++})$$

Results and Discussion

Name of village and source of water, Distance of water sources from Vapi industrial complex, pH, EC, Total dissolved solid (TDS), SAR and RSC of major water sources in surrounding area of Vapi industrial belt, Valsad are presented in Table 1.

pH and EC

The result revealed that (Table 1) pH of thirty two water sources ranged from 6.31 to 8.06 (neutral to moderately alkaline) with a mean value of 7.34. Out of 32 villages, samples from twenty two (22), nine (9) and one (1) villages belonged to neutral, slightly alkaline and moderately alkaline category respectively (Table 2). The variation in pH of water sources seemed to be due to natural reason for type of parent materials / soils and their location. EC of thirty two water sources varied from 0.13 to 1.95 ds m^{-1} indicating excellent (C_1) to permissible (C_3) class i.e. safe for irrigation to can't be used on soils with restricted drainage (Table 1). The mean water EC of 32 samples was 0.61 dS m^{-1} i.e. good (C_2) category. Jamburi village situated at 600m distance and Eklaher village situated 700m distance from Vapi industrial belt recorded the lowest salinity (0.13 dS m^{-1}) and highest salinity (1.95 dS m^{-1}). six (18.75%) water sources belonged to excellent class (C_1) i.e. safe for irrigation, sixteen (50.00%) water sources belonged to good class (C_2) i.e. safe for irrigation but need moderately leaching and ten (31.25 %) water sources belonged to permissible class (C_3) i.e. can't be used on soils with restricted drainage (Table 2). The variation in salinity (EC) of water sources seemed to be a natural phenomenon due to type of associated parent materials / soils and their location.

pH and TDS of major water sources in assessing drinking water quality

Table 1 revealed that excepting two sources of water from Namdha (100m) and Jamburi villages (600m) which belonged to below permissible limit of pH, all other water sources from various villages came under the highest desirable category of pH (6.5 – 8.5) for drinking water quality. TDS of major water sources was computed from EC which revealed that it varied from 83.2 to 972.8 mg lit^{-1} with a mean value 350.1 mg lit^{-1}. The highest and the lowest TDS value recorded at Jamburi and Salvav village respectively. TDS value indicated that only seven water sources (from Dabhel, Varkund, Nahuli Salvav, Kocharva, Bhatkurvad and Nanitambadi villages) came under the maximum permissible limit of quality of drinking water, while rest of the water sources from other villages belonged to the highest desirable quality of drinking water.

SAR and RSC of major water sources

SAR of water sources varied from 7.32 to 29.31 i.e. with low sodium (S_1) to high sodium (S_3) with a mean value of 13.98 (Table 1). The highest SAR (29.31) and the lowest SAR (7.32) was recorded respectively at Jamburi and Aambavadi village. Only seven (21.87 %) water sources came under S_1 class (safe and suitable for irrigation purpose), Nineteen (59.37%) belonged to S_2 category (moderately safe and might be used on coarse textured soil), Five (15.62%) came under the category S_3 i.e. moderately unsafe or ordinarily unsuitable irrigation purpose and only one (3.12%) came under S_4 class (unsafe and not suitable at all for irrigation purpose) (Table 3). The variation of SAR value in different water sources was mainly due to type of sources, associated soil quality and their location. The RSC of water sources varied (Table 1) appreciably from 2.47 to 7.26 me L^{-1} which indicated that except one (from Khadivad village at 800m distance with RSC of 2.47 me L^{-1}) which was marginal for suitability of irrigation purposes, all the other water sources (97%) were belong to class III i.e. unsuitable for irrigation purposes (Table 3). Rata village at 900m distance registered the highest value of RSC. The variation of RSC value in different water sources was mainly due to type of sources, associated soil quality and their location.

Classification of irrigation water on the basis of "EC, SAR and RSC"

When all the water sources were categorized as based on "EC, SAR and RSC". 6.25% sources were found to belong to “high SAR” category and 21.88% sources came under “alkali” and 71.87% sources belonged to “highly alkali” category.

CONCLUSION

The results clearly indicated that 31% water sources with salinity class C_3 should not be used as irrigation on soil with restricted drainage. Further, water sources with SAR of S_2 (59%), S_3 (16) and S_4 (3%) were moderately safe, moderately unsafe and unsafe for irrigation purpose. ‘RSC’ based and ‘EC, SAR and RSC’ based classification indicated that about 97 and 72% water sources were respectively found ‘unsuitable’ and ‘highly alkali’ category for irrigation purposes and thus should not be used directly as source of irrigation to crops to avoid any detrimental effect on soil, crop yield and environment as well.

References

Donga, P. P., Korant, K. G. and Raman, S. 2009. Quality of ground water used for irrigation in Gujarat Management of water resources in Gujarat, SWMRU, NAU, Navsari.

Jackson, M. L. (1973) Soil Chemical Analysis. Prentice Hall of India (Pvt.) Ltd., New Delhi. Pp. 2nd, Edn.

Richards, L. A. (1954) Water conducting and retaining properties of soil in relation to irrigation. In: USDA Hand book No. 60, Pp. 112.

Saxena, M. and Saksena, D. N. 2012. Water quality and trophic status of Raipur reservoir in Gwalior, Madhya Pradesh**.** *J. Nat. Sci. Res.* **2**: 82-96.

Table 1: pH, EC, TDS, SAR and RSC of major water sources in surrounding area of industrial belt, Vapi.

Name of village and source of water	Distance of water sources	PH	EC (dS m^{-1})	TDS (mg lit^{-1})	SAR	RSC
Namdha (Borwell)	**100m**	6.35	0.38	243.2	25.08	3.70
Chandor (Borewell)	**200m**	7.32	0.73	467.2	24.95	2.65
Mohangam (Borewell)	**500m**	6.80	0.60	384.0	13.74	7.05
Jamburi (Well)	**600m**	6.31	0.13	83.2	29.31	4.60
Perere (Khadi)		7.18	0.77	492.8	10.84	5.40

Rangivada (Borewell)		7.40	0.50	320.0	19.81	6.25
Kachigam (Borewell)		7.42	0.47	300.8	16.65	4.32
Chiri (Borewell)		7.27	0.27	172.8	12.53	3.95
Charvada (Borewell)		6.75	0.28	179.2	12.96	5.23
Dabhel (Khadi)		7.03	1.11	531.2	9.70	6.58
Mean		7.05	0.50	297.14	15.97	5.19
Eklaher (Borewell)	**700m**	7.68	1.95	124.8	18.12	3.36
Patlara (Borewell)		7.19	0.23	147.2	9.14	5.21
Aambavadi (Well)		7.57	0.48	307.2	7.32	4.41
Varkund (Borewell)		7.61	1.02	652.8	13.52	3.12
Nahuli (Borewell)		7.38	0.95	608.0	12.66	2.95
Mean		7.49	0.93	368	12.15	3..81
Khadivad (Borewell)	**800m**	8.06	0.67	428.8	18.05	2.47
Salvav (Borewell)		7.31	1.52	972.8	11.06	3.96
Mean		7.69	1.10	700.8	14.55	3.21
Motidaman (Khadi)	**900m**	7.63	0.46	294.4	11.06	7.10
Tukvada (Khadi)		7.33	0.26	166.4	12.35	7.00
Rata (Khadi)		7.43	0.22	140.8	14.36	7.26
Dungra (Well)		7.54	0.36	230.4	15.80	6.87
Dadra (Borewell)		7.48	0.20	128.0	13.52	5.88
Mean		7.48	0.30	192.0	3.41	6.82
Dholar (Borewell)	**1000m**	7.96	0.51	326.4	8.36	4.10
Nanidaman (Borewell)		7.07	0.19	121.6	12.36	3.21
Barvadi (Khadi)		7.46	0.23	147.2	11.65	4.75
Sarodhi (Borewell)		7.90	0.76	486.4	7.89	5.74
Velvagad (Borewell)		7.39	0.56	358.4	16.12	3.21
Kocharva (Well)		7.93	1.03	659.2	9.32	4.02
Bhatkurvad (Borewell)		7.81	1.04	665.6	11.02	6.25
Nanitambadi (Borewell)		6.74	1.02	652.8	9.71	5.23
Karvad (Lake)		7.48	0.28	179.2	12.65	7.25
Valvada (Borewell)		7.14	0.36	230.4	15.60	3.65
Mean		7.49	0.60	382.7	11.47	4.74

Table 2: Categorization of water sources as based on pH and EC classes.

Distance of water sources (number of samples).	pH classes				EC (dS m^{-1}) classes				
	<7.5 (Neutral)	7.5 to 8.0 (Slightly	8.0 to 8.5 (Moderately alkaline)	>8.5 (Highly alkali)	(<0.25) (C_1) Excellent	(0.25 to 0.75) (C_2)	(0.75 to 2.25) (C_3) Permissible	(2.25 to 3.0) (C_4) Doubtfu	(> 3.0) (C_5) Unsuitable

		alkaline)				Goo d		l	
100m (1)	1	0	0	0	0	1	0	0	0
200m(1)	1	0	0	0	0	1	0	0	0
500m(1)	1	0	0	0	0	1	0	0	0
600m(7)	7	0	0	0	1	4	2	0	0
700m(5)	2	3	0	0	1	1	3	0	0
800m(2)	1	0	1	0	0	1	1	0	0
900m(5)	2	3	0	0	2	3	0	0	0
1000m(10)	5	5	0	0	2	4	4	0	0
Total	20	11	1	0	6	16	10	0	0

pH and EC classes of water quality are based on USDA (Richards, 1954)

Table 3: Categorization of water sources as based on SAR and RSC classes.

Distance of water sources (number of samples).	SAR classes				RSC (me L^{-1}) classes		
	S_1 (<10)	S_2 (10 to 18)	S_3 (18 to 26)	S_4 (>26)	<1.25	1.25-2.50	>2.50
100m(1)	0	0	1	0	0	0	1
200m(1)	0	0	1	0	0	0	1
500m(1)	0	1	0	0	0	0	1
600m(7)	1	4	1	1	0	0	7
700m(5)	2	2	1	0	0	0	5
800m(2)	0	1	1	0	0	1	1
900m(5)	0	5	0	0	0	0	5
1000m(10)	4	6	0	0	0	0	10
No. of Water sample(32)	7	19	5	1	0	1	31
Percent of water	21.87	59.37	15.62	3.12	0	3.12	96.88
Suitability for water	Safe	Moderatel y safe	Moderatel y unsafe	Unsafe	Suitable	Marginal	Unsuitabl e

SAR and RSC classes of water quality are based on USDA (Richards, 1954)