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Der Chemica Sinica, 2013, 4(2):177-181

Pelagia Research Library
ISSN: 0976-8505
CODEN (USA) CSHIA5

Assessment of surface and waste water quality for irrigation suitability: A case study of Jalgaon Urban area, Maharashtra (India)

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ABSTRACT

A field investigation was carried out to determine the Physical and chemical characteristics of municipal and industrial waste water with reference to irrigation suitability of Jalgaon area, Northern Maharashtra, India. The surface water samples were collected from different location around Jalgaon city, where rampant use of waste water to irrigation. Water sampling was carried out in two season of the year for post monsoon 2010 and pre monsoon 2011. The collected water samples were analyzed their water chemistry including physicochemical parameters by standard analytical methods. After geochemical analysis of surface water samples evaluation of irrigation water quality parameter. The quality of waste water shows that the water is not suitable for agricultural purposes. The irrigation quality is evaluated based on salinity SAR, RSC, SSP, ESP, MR, Na % and permeability index. Entire area surface water can be used without treatment for irrigation they may be hazardous. Continuous use of waste water to irrigation in this area increases salinity hazard problems. Therefore the use of waste water for irrigation after treatment is a one the good option for solved the problems.

Keywords*:* Waste/surface water, Irrigation water quality, salinity hazards, Jalgaon area, Maharashtra, India

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INTRODUCTION

Recent year water pollution is an important issue for the environmental aspects especially in urban areas. Now day's the prime need of assessment of water pollution, due to excess use of waste water in irrigation. Since we have carried out the field investigation to determine the chemical characteristics waste water from Jalgaon area of Northern Maharashtra, India. Water sampling was carried out in two season of the year for post monsoon 2010 and pre monsoon. Geologically study area is covered by Deccan volcanic rocks of cretaceous to Eocene age showing vesicular and amygdaloidal basalts [3]. Sources of waste water from Jalgaon city, industries and medical waste. Location map of the study area shown in figure1.

MATERIALS AND METHODS

Chemical analysis of water samples followed by [4] standard techniques and procedure in the laboratory. pH, EC and TDS were measured on digital water analysis kit. The total hardness and calcium determined by standard EDTA (0.01 M) titrimetric method. Carbonate and bicarbonate determined by standard hydrochloric acid (0.01 N) titrimetric method. The chloride ion determined by standard silver nitrate titrimetric method. The Sulphate, Nitrate

and Phosphate estimation was done by the standard colorimetric method. Boron was analyzed colorimetric method using carmine solution. Sodium, Potassium and Magnesium analyzed by Atomic Absorption Spectrometer (Thermo Scientific) using acetylene gas and hollow cathode lamps. The precise locations of sampling points were determined in the field through Global Positioning System (GPS) GARMIN and give the exact latitude, longitude and altitude. Sampling locations given in the Table 1.

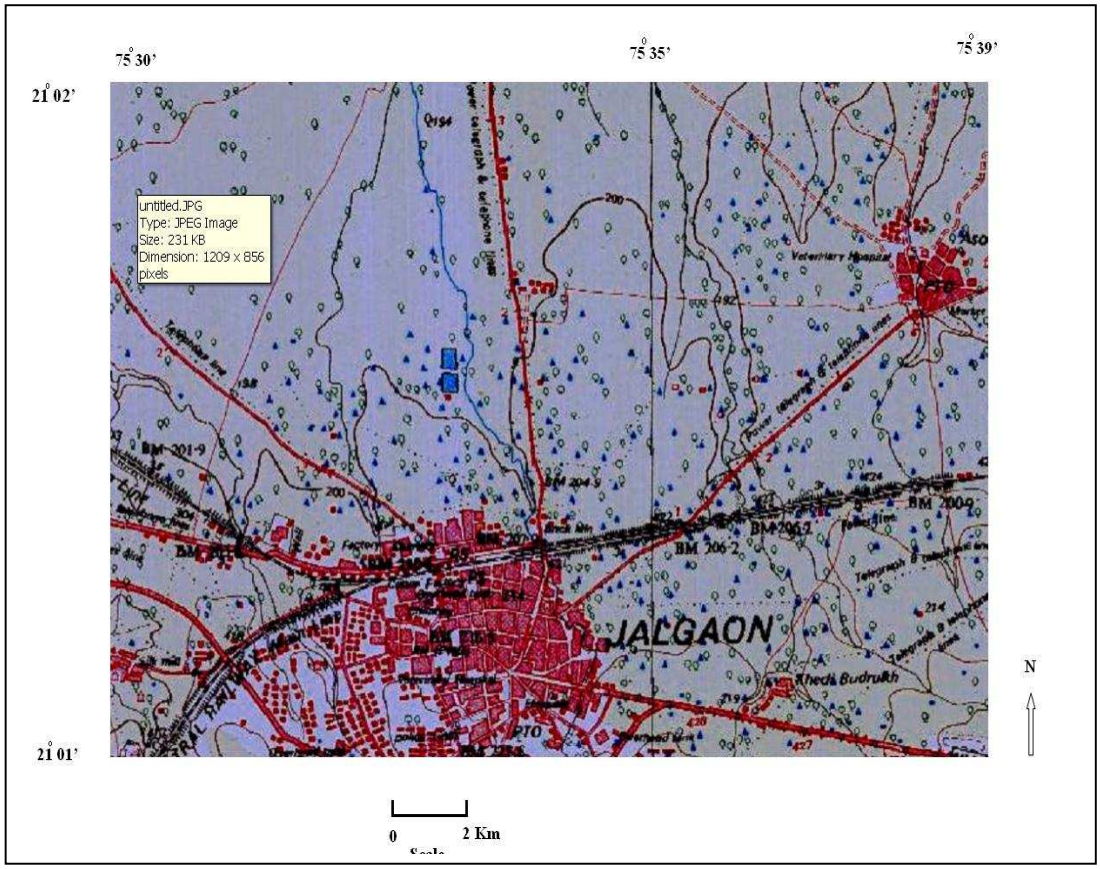

Table 1.Sampling stations and physicochemical parameters of waste water from Jalgaon area (Post and pre monsoon 2010-11)

Sample ID	Location	Latitude	Longitude	Altitude	PH post	PH pre	EC post	EC pre
1	Lendi Nala Middle	21 00 53 N	75 34 26 E	211.5	7	6.5	1245	1516
2	Lendi Nala	21 00 19 N	75 34 30 E	217.6	7.7	7	2140	2510
3	Tambapura	20 59 35 N	75 34 17 E	221.2	7.2	6.6	980	1230
4	Lendi Nala	21 01 24 N	75 34 19 E	210	7	7.5	1166	1612
5	Kathora	21 04 45 N	75 48 14 E	193.8	8	7.1	800	960
6	Medical College	21 01 23 N	75 42 18 E	203.9	7	7	528	813
7	Vaktuki	21 05 41 N	75 22 24 E	176.1	8.5	7.7	1679	1823
8	Asoda	21 03 04 N	75 36 21 E	198.4	8.5	7.7	2580	1986
9	MIDC Waste Water	21 01 31 N	75 35 19 E	206	8.2	6.1	4100	7430
10	Khedi Nala	21 00 19 N	75 35 21 E	215.8	7.5	6.5	11290	4150
11	Khadki BK	20 54 20 N	75 24 57 E	233.7	6.5	6.1	3850	2489

(Where Alt- Altitude from above Mean sea level, EC in µmohs/cm)

RESULTS AND DISCUSSION

Cation and Anion meq/l values of surface/waste water given in the table 2 and irrigation parameters given in the table3. pH range varies from 6.5 to 8.5 for the post monsoon and pre monsoon from 6.1 to 7.7 which is alkaline.

Salinity Hazards
The Electrical conductivity value for post monsoon varies from 528 to 11290 µmohs/cm and pre monsoon period from 813 to 7430 µmohs/cm which is indicates the surface and waste water is not suitable to rampant use of irrigation.

Sodium absorption ratio (SAR)
SAR is express as [6], $SAR = \frac{Na}{\sqrt{(Ca+mg)/2}}$ (1)

Classification of water with reference to the SAR [5] suggest that the all sample of the study area excellent for irrigation because SAR vales is less than suggest that the 10. Classification of water with reference to the SAR [5] is presented in (Table 5). If SAR value is less than 10 water is excellent for irrigation suggest that the all samples of post monsoon and pre monsoon fall under the excellent category.

Residual sodium carbonate (RSC)
The residual sodium carbonate (RSC) values is calculated as per Eaton, (1950) all ions in meq/L

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

The waste water RSC values (post monsoon) ranges from -3.02 to 11.35 and pre monsoon value ranges from -2.57 to 12.99, [8] have classified irrigation water based on RSC as Suitable (< 1.25), marginal (1.25 to 2.5) and not suitable (> 2.5). Accordingly the waste water is not suitable for irrigation because of RSC value > 2.5.

Magnesium Ratio
Magnesium Ratio is express as, $MR = (Mg \times 100) / (Ca + Mg)$ (3)

Magnesium ratio observed in waste water range from 18.44 to 99.44 for the post monsoon and 16.58 to 132.33 in the pre monsoon period. If the value of magnesium ratio less than 50 it is suitable for irrigation purpose [2]. Suggest that the magnesium ration waste water samples is higher than the limit indicates that the not suitable to irrigation purposes. Sodium concentration is an important criterion for defining the type of irrigation.

Sodium percentage
The sodium percentage [1] is calculated by using following formula, where all ionic concentration are expressed in meq/l

$$Na\ \% = \frac{Na}{ca+mg} \quad (4)$$

Sodium percentage for post monsoon in waste water varies from 13.72 to 58.23 and pre monsoon season varies from 10.94 to 90.47.

Permeability Index (PI)
The Permeability Index (PI) was calculated according to [1] employing the given equation, where all ionic values in meq/l

$$PI = \frac{Na+\sqrt{HCO3}}{Ca+Mg+Na} \times 100 \quad (5)$$

Permeability index values ranges for post monsoon varies from 31.49 to 143.42 and pre monsoon season varies from 31.24 to 134.27.

Soluble sodium percentage
The soluble sodium percentage calculated by using following formula, where all ionic concentration is expressed in meq/l.

$$SSP = \frac{Na \times 100}{Ca + Mg + Na} \quad (6)$$

The values of SSP less than 50 indicates good quality of water and higher values shows that the unsatisfactory quality of water for irrigation [7] It is observed that, the SSP values are lower than 50 in all samples in the study area.

Exchangeable sodium percentage

The Exchangeable sodium percentage is an important parameter for irrigation. Higher values of ESP are generally associated with soils, slow permeability loss, a major problem with the crop productions. The ESP is calculated by using following equation,

$$ESP = \frac{100\,(-0.0126 + 0.01475 \times SAR)}{1 + (-0.0126 + 0.01475 \times SAR)} \quad (7)$$

Higher values of ESP indicates that, cation-anion of soil are not in steady state. This is due to concentration of salts by evaporation of water from root zone and selective precipitation of Ca + Mg salts during evapotranspiration. The ESP values for post-monsoon season (2010) – 0.83 to – 0.29 and pre-monsoon season (2011) – 0.90 to -0.30.

Table 2.Cation and Anion (in epm) values of surface/waste water from Jalgaon urban area (Post and pre monsoon 2010-11)

Sample ID	Ca	Ca	Mg	Mg	Na	Na	K	K	Cl	Cl	CO_3	CO_3	HCO_3	HCO_3	SO_4	SO_4
Season	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre
1	3.4	3.55	1.17	1.16	0.78	0.8	0.42	0.5	6.48	4.59	1	1	4.3	9	0.52	0.92
2	6	9.65	1.53	1.46	0.77	0.81	0.29	0.29	10.48	8.39	1	1	3.51	8.49	1.17	1.9
3	3.9	3.45	1.18	1.11	0.7	0.7	0.38	0.44	3.38	3.18	1.6	1	4.2	7	0.33	*0.4*
4	3.1	3.35	1.15	1.17	0.73	0.79	0.41	0.44	4.51	4.59	2	2	3.9	9	0.42	0.77
5	1.15	0.9	1.13	1.18	0.65	0.8	0.12	0.08	4.11	4	1.6	2	3.39	3.51	0.35	0.44
6	1.4	1.5	1.11	1.04	0.71	0.74	0.09	0.17	2	3.01	1	1	2.61	4	0.1	0.25
7	1.15	1.5	1	1.02	0.84	0.87	0.03	0.03	4	3.77	1.6	2	11.9	13.51	0.21	0.29
8	4.3	4.66	1.45	1.62	0.8	0.72	0.05	0.12	10.39	8.2	0	0	16.49	10.49	0.17	0.75
9	7.4	8.8	1.27	1.77	0.83	0.82	0.4	0.06	19.52	23.61	0	0	8	8	0.08	1.83
10	6.3	7.35	1.28	1.35	0.87	0.8	0.47	0.08	22.79	19.8	0	2	15	5.2	0.16	2.81
11	4.35	5	1.2	1.2	0.68	0.6	0.18	0.02	2.85	2.2	0	2	6.51	3.51	0.07	0.5

Table 3.Irrigation water quality parameters and characteristic indices of surface/waste water from Jalgaon area (Post and pre monsoon 2010-11)

Sample ID	SAR	SAR	RSC	RSC	MR	MR	Na %	Na %	PI	PI	SSP	SSP	ESP	ESP
Season	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre
1	0.39	0.39	0.72	5.29	35.65	33.95	25.26	25	53.28	68.92	14.54	14.5	-0.68	-0.68
2	0.29	0.25	-3.02	-1.62	27.08	16.58	15.35	10.94	31.79	31.24	9.22	6.78	-0.83	-0.89
3	0.33	0.35	0.72	3.44	31.45	33.43	20.21	22.54	47.55	63.55	12.11	13.29	-0.77	-0.74
4	0.38	0.4	1.65	6.48	38.16	36.16	25.99	25.89	54.39	71.33	14.74	14.82	-0.69	-0.67
5	0.49	0.65	2.71	3.43	99.49	132.3	58.23	90.47	85.01	92.79	22.11	27.66	-0.53	-0.29
6	0.51	0.52	1.1	2.46	80.15	70.44	52.53	51.52	72.25	83.53	22.04	22.63	-0.51	-0.49
7	0.66	0.61	11.35	12.99	87.96	68.78	75.22	59.59	143.4	134.3	28.17	25.58	-0.29	-0.36
8	0.36	0.31	10.74	4.21	35.19	36.45	20.9	17.86	74.2	56.52	12.21	10.24	-0.73	-0.81
9	0.29	0.26	-0.67	-2.57	18.44	21.89	13.72	11.93	38.51	32.01	8.74	7.17	-0.83	-0.88
10	0.33	0.28	7.42	-1.51	21.58	19.75	16.5	13.06	56.16	32.38	10.33	8.37	-0.77	-0.85
11	0.3	0.25	0.95	-0.69	28.9	25.13	17.66	13.82	51.81	36.39	10.88	8.82	-0.81	-0.89

(Where SAR - Sodium Absorption Ratio, RSC - Residual Soluble Carbonate, MR - Magneasium Ratio, Na % - Sodium Percentage, PI - Permeablity Index, SSP - Soluble Sodium Percantage, ESP - Exchangeable sodium percentage)

CONCLUSION

Surface water quality of Jalgaon city, Northern Maharashtra India revealed that majority of samples are not suitable for various purposes. According to RSC value waste water is not suitable for irrigation use. The Na % values are also exceeds than limits suggest that the waste water are not suitable for irrigation. Most of the water samples electrical conductivity greater than 1400 µmohs/cm, since this area increases the salinity hazard problems due to rampant use of waste water for irrigation purposes.

Acknowledgement
The financial assistance in the form of a Major Research Project (SR/S4/ES-328/2008) by Department of Science and Technology (DST) Govt. of India, New Delhi is thankfully acknowledged. The co-operation of North Maharashtra University officials is also acknowledged.

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