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GROUNDWATER QUALITY ASSESSMENT FOR AGRICULTURAL SUITABILITY FROM PURNA RIVER SUB-BASIN AREA, MAHARASHTRA

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ABSTRACT
The suitability of water for irrigation should be evaluated on the basis of criteria indicative of its potential to create soil conditions. Irrigated agriculture has resulted in major environmental disturbances such as waterlogging, salinization, groundwater depletion, and pollution of water bodies, especially ground water that increased the health risks. Most of the problems of water logging and secondary salinization prevalent in irrigated lands are resulted from excessive use of water for irrigation, inefficient irrigation distribution system, poor on-farm management practices, inappropriate drainage management and the discharge of spent drainage water into good quality water supplies.Therefore, the need was felt to analyze the ground water samples for irrigation suitability. In the present paper, eleven ground water samples from different location of Purna Valley has been collected and analyzed for various physico-chemical parameters. The data shows that pH ranges between 7.5 and 8.9, whereas the EC varies from 1464 to 4850 micromhos /cm. The hardness of groundwater samples ranges between 220 and 800 mg/l. Suitability of groundwater for irrigation was evaluated based on Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC), US salinity diagram, Kelly's Ratio (KR) and Permeability Index (PI). Based on the results obtained it has been concluded that ground ater quality of Purna river sub-basin is not suitable for irrigation due its moderate to high saline/alkaline nature.

KEYWORDS: Groundwater quality assessment, agriculture, suitability indices, Purna Valley.

INTRODUCTION
Land is the most valuable asset blessed by nature and is prime resource survival of mankind. Land degradation will remain as an important global issue for the 21st century because of its adverse impact on agronomic productivity, food security and quality of life. The saline soil has the detrimental effect of soluble salts which limits the reclamation. Salt affected soils have been estimated to occur in 8.6 million ha, of which about 3.0 million ha are coastal saline soils. Salt affected soils in Punjab are 0.48 million ha; Haryana with 0.55 million ha; Uttar Pradesh 0.35 million ha suffering from water logging and salinity. 1.8 million ha area of Bihar suffer from surface accumulation of water and salinity; in Rajsthan total salt affected areas occupies 0.75 million ha; in Madhya Pradesh salt affected soils exist in 23 districts; Gujrat has both inland and coastal salinity; in Maharashtra, the salt affected soils exist in the coastal districts to an extent of 0.06 million ha (FAO, AGL, 2000). About 33,200 ha area in Maharashtra has been affected by salinity or alkalinity or both. Besides this, approximately 34,000 ha have been converted into 'Khar' land due to inundation of sea water (Zende, 1968). Out of total salt affected soils, 1.42 million ha are deep black to medium deep black (vertisol) in central penniunsular India (Abrol and Bhumla, 1971). Near about 14,500 sq km area has been covered by river alluvium and the extent of alluvial area is 4.7 % of the total area. In Maharashtra, mainly two alluvial areas are found a) alluvial basin of Tapi river spread in the district of Dhulia and Jalgoan and b) Purna river alluvium basin distributed in three districts of Vidarbha i.e. Amravati, Akola and Buldhana.

Salient Features of Purna River Sub-Basin
The Purna valley of Vidarbha region is an east-west elongated basin slight convexity to the south, occupying the part of Amravati, Akola and Buldhana district of Vidarbha and extends from 20^0 41' to $21^0$15' N latitude and $75^0$15' to $77^0$45' E longitude with east-west length of about 100-150 km. having width of about 10 to 16 km covering an area about 2.74 lakhs ha in 894 villages. Purna river originates at an elevation of 900 m in Gawilgarh hills of Satpura in Betul district of Madhya Pradesh and drain for 240 km before meeting Tapi. The total catchment area is about 18,929 km2. The important tributaries of Purna are Pedhi, Chandrabhaga, Shahnur, Wan, Katepurna, Nalganga, Gyanganga and Man. In Amravati district, talukas namely Anjangaon, Achalpur, Bhatkuli, Chandurbazar and Daryapur predominantly fall in the alluvial tract thus occupying about 3000 sq.km area. Adyalkar (1975), while discussing the probable causes of groundwater salinity holds the view that the Purna valley, in the past, was a part of Arabian Sea connected through Tapi valley. During course of time, silting processes in Tapi basin which served its connection with Arabian sea and Purna basin with its post fault and post volcanic basement in the Eocene series had come to stay in the from of salt water lake which later on filled with thick Basaltic layer. The major problems of this region are saline ground water, soil salinity and sodicity.

MATERIALS & METHODS

Water samples were collected from the bore wells and wells of degraded crop fields and analyzed by the standard method given in a manual of APHA, AWWA and WPCF (1975). Approximately 500ml of water samples were collected in a clean bottle with a leak proof cap. The bottles were thoroughly rinsed with distilled water before the sample collection. All these samples were properly labeled and used for analysis.

Groundwater analysis of the study area

In all, eleven ground water samples from different location of PurnaValley has been collected and analysed for its pH, EC, exchangeable cations, anions, TDS, hardness, and alkalinity. The data is included in Table 1.

TABLE 1: Quality analysis data of groundwater samples in the study area

Parameters	Chincholi S_1	Kokarda S_3	Kamalpur S_4	Walgaon S_{14}	Talwel S_{19}	Darapur S_{20}	Chandikapur S_{23}	Chandikapur S_{24}	Chandikapu S_{25}	Amala S_{33}	Amala S_{34}
Turbidity NTU	2	3	1	1	2	1	2	2	2	3	2
pH	8.5	7.9	8.0	8.9	7.5	8.2	8.2	8.9	7.9	7.9	8.4
Ec µmhos /cm	2830	2890	2260	1464	2080	3060	4110	4720	4850	1816	2330
T.D.S. mg/lit	1811	1850	1446	937	1331	1958	2630	3021	3104	1162	1491
Hardness mg/lit	220	320	380	300	230	350	800	500	600	450	280
Alkalinity mg/lit	525	425	390	710	500	800	360	710	750	300	515
Ca mg/lit	12	28	36	24	12	50	72	80	80	80	18
Mg mg/lit	46	48	70	58	48	54	149	72	96	60	62
Na mg/lit	310	250	150	260	210	340	310	530	550	90	310
K mg/lit	4	1	6	0	5	2	5	2	6	1	2
CO_3 mg/lit	80	50	20	20	100	40	20	0	0	40	80
HCO_3 mg/lit	445	375	370	690	390	760	340	710	750	260	435
CL mg/lit	280	252	210	176	98	175	770	580	560	193	280
SO_4 mg/lit	38	55	5	24	25	38	10	120	235	67	38

RESULTS & DISCUSSION

Electrical Conductivity (EC)

The electrical conductivity of an electrode is directly related with the ionic concentration. The value of electrical conductivity ranged from 1464 to 4850 micromhos/cms on the basis of standard classification for water given by U.S. salinity lab. It was observed that most of the water samples are under the class C3 (750-2250 micromhos/cms) and C4 (>2250micromhos/cms). Therefore it can be categorized as high salinity water and such type of water is unsuitable for irrigation and growth of plant (Fig.1).

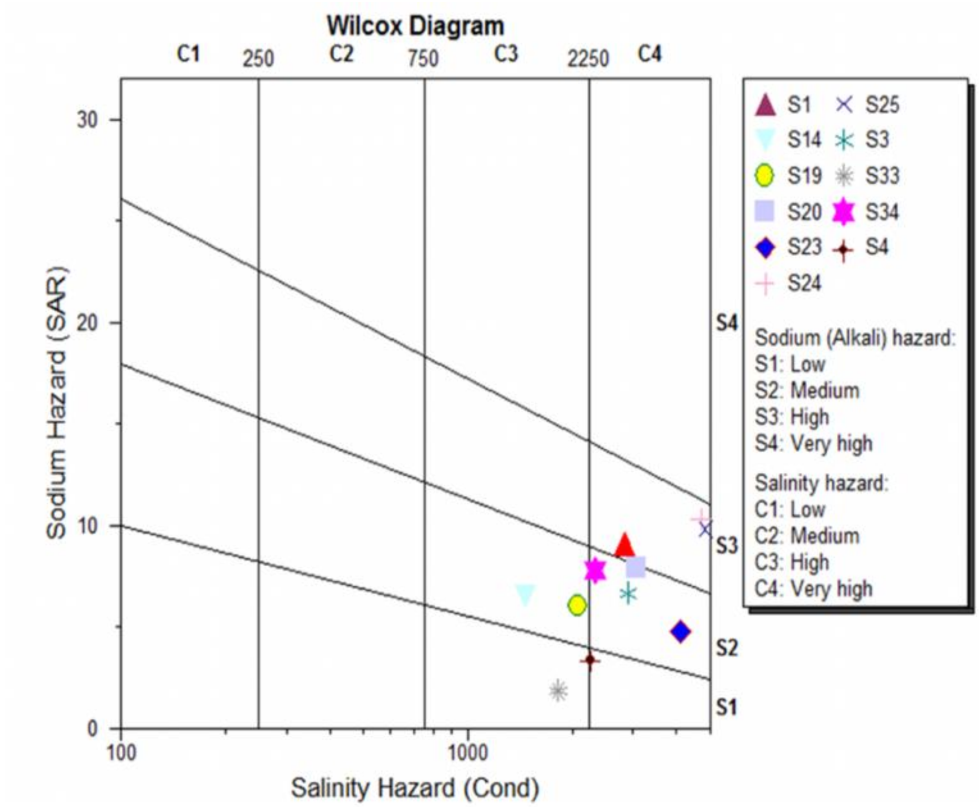

FIGURE 1: US Salinity Hazard diagram representing eleven groundwater samples.

Ionic composition

The ionic composition of water is mainly decided by interaction of dilution, evapotranspiration and mineral precipitation. The estimated values for cation like Ca, Mg, Na and K were tabulated in the table no.11. The dominant cations present in ground water were Na, Mg, Ca, K and their corresponding values were 90 to 550 mg/ lit, 48 to 149 mg/lit, 12 to 80 mg/ lit, 1 to 6 mg/lit respectively (Table 1). These results are reflected the dominancy of Na over Mg and Ca and this may be one of the geological causes for development of native sodicity in Purna valley soil. Excess of sodium and very high pH, promote the slaking of aggregates and the swelling and dispersion of clays which lead to soil crusting, loss of porosity and reduced permeability.The dominant anions present in this water were CO3, HCO3, SO4, and Cl and their respective values were up to 100 mg/ lit, 260 to 760 mg/lit, 98 to 770 mg/ lit, 5 to 235 mg/lit. The descending order of dominant anion present in groundwater were found to be HCO3>Cl>SO4>CO3.

Hydrochemical Facies

It is been depicted from the Piper Trilinear Diagram (Piper, 1944) that most of the groundwater samples in study area fall under the Ca2+ + Mg2+ – Cl- +SO42- groundwater facies (Fig. 3). The data depict that sample S23 falls under Na + Cl – CO3 + HCO3 groundwater facies.

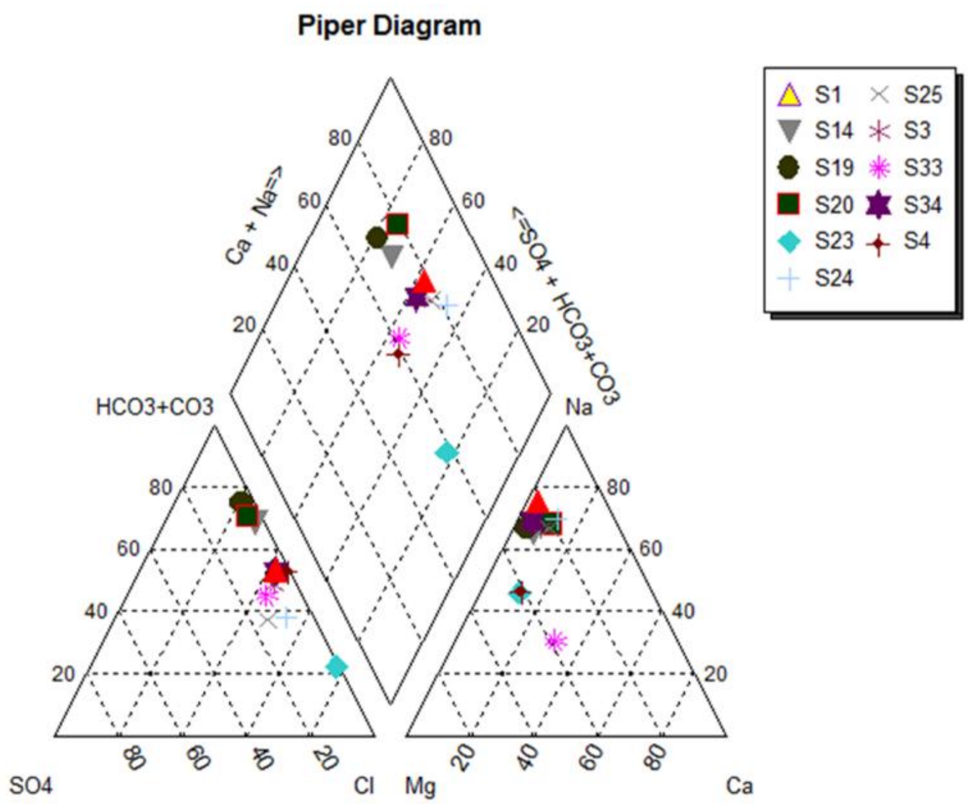

FIGURE 2. Piper's trilinear diagram showing hydrochemical facies for groundwater samples

Sodium Absorption Ratio (SAR)

According to USDA the groundwater having SAR values less than 10 are considered to be excellent, 10 to 18 as good, 18 to 26 as doubtful and above 26 are unsuitable for irrigation. The SAR values for all groundwater samples are falling under doubtful to unsuitable category.

Permeability Index (PI)

Doneen (1964) and WHO (1996) has mentioned the criterion for assessing the suitability of groundwater for irrigation based on this index, where the concentrations are in meq/l. The PI values above 75 are indicative of excellent quality of groundwater for irrigation; between 25 and 75 good quality and the values below 25 reflect unsuitability of groundwater for agriculture purpose.

Kelly's Ratio (KR)

Sodium measured against calcium and magnesium was considered by Kelly (1957) to calculate this parameter, in order to evaluate the suitability of groundwater for agricultural purpose. There are 03 samples falling in excellent category.

Soluble Sodium Percentage (SSP)

The values of SSP, if less than 50, indicate good quality of groundwater whereas above 50 unsuitability of water for agricultural purpose.

Residual Sodium Carbonate (RSC)

RSC has been calculated to determine the detrimental effect of carbonate and bi−carbonate on the quality of groundwater for agricultural purpose. When the RSC values are less than 1.25 epm, the groundwater is considered to be safe for irrigation. If the value is between 1.25epm and 2.5 epm then the water is marginally suitable, while the value above 2.5 epm indicate the groundwater unsuitability for irrigation.

TABLE 2. Values of SAR, PI, KR, SSP and RSC indices in groundwater samples

Sample ID	Location	%Na	SAR	PI	KR	SSP	RSC
S1	Chincholi	75.58	19.10	30.56	3.07	75.44	5.57
S3	Kokarda	67.06	16.64	22.29	2.03	67.01	2.46
S4	Kamalpur	46.889	23.35	53.79	0.86	46.30	2.82
S14	Walgaon	65.426	26.54	44.89	1.89	65.42	6.00
S19	Talwel	67.04	18.05	45.21	2.00	66.73	5.17
S20	Darapur	68.11	17.93	34.28	2.12	68.03	6.85
S23	Chandikapur	46.17	24.78	33.98	0.84	45.93	9.62
S24	Chandikapur	69.94	10.34	20.24	2.32	69.89	1.71
S28	Chandikapur	66.91	19.80	26.56	2.00	66.76	2.39
S33	Amala	30.58	21.85	46.51	0.43	30.44	3.34
S34	Amala	69.26	17.77	22.89	2.24	69.18	3.79

Pearson Correlation Matrix

A high correlation coefficient (near +1 or -1) shows a good relationship between two variables and a correlation value near zero means there is no considerable relationship between them. More precisely, when r has a value between 0.5 and 0.7 moderate correlation is said to exist whereas the parameters showing r> 0.7 are considered to be strongly correlated (Fig. 2).

CO_3	1							
SO4	-.472	1						
Cl	-.575	.415	1					
HCO_3	-.466	.524	0.151	1				
Na	-.440	.727*	0.636*	.756**	1			
K	-.029	.179	0.335	-.120	.168	1		
Ca	-.760**	.573	0.647*	.211	.384	.076	1	
Mg	-.522	.152	0.864**	-.049	.296	.447	.588	1
PARAMETER	CO_3	SO4	Cl	HCO_3	Na	K	Ca	Mg

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

FIGURE 3: Pearson Correlation Matrix significant at 0.01 and 0.05 level (2 tailed)

CONCLUSION

From the above results it is confirmed and concluded that ground water quality of Purna river sub-basin is unsuitable for irrigation due to its moderate to high saline/alkaline nature.

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