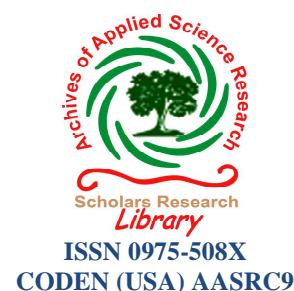




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Assessment of Water Quality Indices for Irrigation of Dynaneshwar Dam Water, Ahmednagar, Maharashtra, India

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ABSTRACT

The aim of the study was to determine the suitability of water for irrigation on the basis of the quality indices. The quality of water was assessed by testing parameters such as sodium [Na], calcium [Ca], magnesium [Mg], alkalinity HCO_3 and chlorine [Cl]. The quality indices were evaluated and ranged as Sodium Absorption Ration [0.17 to 3.87 epm], Soluble Sodium percentage [12.87 to 40.09 epm], Residual Sodium Carbonate [-0.3 to -8.0 epm], Schoeller Index [0.20 to 0.70 epm] and Kelly's Index [0.26 to 0.75 epm]. The results were compared to the USEPA standards. All the water quality indices were suitable for irrigation. The calculated indices were well in agreement with USEPA. The database includes information about the impact of the irrigation water quality on the agriculture.

Key word: Water quality indices, SAR, SSP, RSC, SI, KR, irrigation, Dynaneshwar dam.

INTRODUCTION

The irrigation of agricultural crops with water of poor quality decreases the yield. A system for assessing the suitability of the available water for irrigation of the different crops, taking in consideration the results of the chemical analysis is needed to avoid emerging problems at using inadequate quality water. The system issues recommendations how to use the water for irrigation on the base of analysis on the basis of information on cultivated crops, soil, and agro-climatic characteristics of the region. The objectives of the study are protection of water resources, soil resource, crops, and consumers, sustainable agricultural development etc. is a precondition for the crop production, which eliminates the health risks for the consumers.

Agriculture is the most important economic activity constitutes the major source of food and earning. The water is the major source for irrigation in India. The quality of water for irrigation also depends on the nature, composition of the soil, sub-soil, depth of the water table,

topography, climate, etc. The quality of water reflects inputs from the atmosphere, soil, water-rock weathering and pollutant sources. It required for irrigation depends up on the dissolved salts like Na, Ca, Mg & HCO_3 in water. The concentration of these salts and their ratio to one another are influence the quality of water for irrigation [11]. However, such water influences crops yield.

Irrigation water with high salt content can bring about displacement of cations like Ca and Mg from the clay minerals of the soil, followed by replacement of cation by sodium [7]. The main constituents affecting the quality of irrigation water are Ca, Mg, Na and alkalinity of water [11], The increased concentration of these constituents on irrigation water changes the soil quality and makes it unsuitable for cultivation of crop. But there is o literature from Dynaneshwar dam reservoir. Hence present assessment was undertaken to assess the suitability of water for irrigation.

Study Area

Dynaneshwar reservoir a 26 TMC man made water body is located $19^{\circ}20'$ to $19^{\circ}35'$ N latitude and $74^{\circ}25'$ to $74^{\circ}36'$ E longitude at Rahuri, Ahmednagar district MS. It was artificially built across the Mula River in 1971 and lies in Godavari [Tributary Mula] basin. It experiences an average rain fall 58 cm. The reservoir bottom is composed of detritus-mud layer in the littoral zone. The physiographic of basin is semi agricultural & semi-arid with cultivated top soil bank. The dam water has been used for drinking and irrigation by the people of the Ahmednagar city and districts.

MATERIALS AND METHODS

Collection of Samples: Water samples were collected early in the morning [7 to 9 am] from the selected twenty sites [site 1-20]. A plastic bottle [2 L] rinsed with perchloric acid & distilled water were used for the sample collection and brought to laboratory. The water samples were collected by monthly interval for the period of two year during 2009-10.

Analysis of Water Samples: The Major Constituents [Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K)-Cationic and Chloride (Cl)] were determined according to the standard methods [1] in the laboratory. The results of bimonthly analysis were averaged and mean, standard deviation, covariance, & sum of error are evaluated and presented in table 1.

Water quality indices analysis: The assessment of water quality suitability for irrigation was carried with the help of indices like Sodium Absorption Ration, Soluble Sodium Percentage, Residual Sodium Carbonate [11], Schoeller Index [8] and Kelly's Index [5] also converting result of ppm to epm [11] and presented in table 2.

RESULTS AND DISCUSSION

The water from the study area is extensively used for irrigation from all sites. Due to the importance of agriculture the evaluation of water quality indices are carried out that the water is suitable for irrigation or not. The suitability of water for irrigation reflects on indices

It is seen from table 1 that the dam water constituents are highly variable in respect to cationic &

anionic constituents. The constituents such as Ca, Mg, and Na ranged from 30.0 to 210.0, 13 to 97 and 17 to 80 ppm respectively. The anionic constituent's like CaCO_3 and Cl ranged from 110 to 265 and 97 to 198 ppm respectively. These constituents are used for the quality indices.

The result of water quality indices were analysis and presented in table 2. The Kelly Index of water sample was in range between 0.26 to 0.75 epm. The minimum value of Kelly Index was observed at site 19 while maximum at site 14.

The Residual Sodium Carbonate [RSC] value was varied between -0.31 to -0.80 epm. The minimum value of RSC was recorded at site 14 while maximum at site 12. The Soluble Sodium Percentages [SSP] value was ranged between 12.76 to 40.09 epm. The minimum value of SSP was recorded at site 14 while maximum at site 19. The Sodium Adsorption Ratio [SAR] value was noticed between 0.17 to 3.87 epm. The minimum value of SAR was recorded at site 14 while maximum was at site 19. The Schoeller Index [SI] value was ranged between 0.20 to 0.70 epm. The minimum value of SI was recorded at site 19 while maximum was at site 13.

Kelly's Index: The concentration of Na, Ca & Mg in water are represent the alkali hazard. The values of $\text{KI} < 1$ indicate good quality water for irrigation & > 1 indicate bad water [5]. The values of KI in the study varied from 0.26 to 0.75. Therefore, according to KI most of water samples were suitable for irrigation..

Residual Sodium Carbonate: When the excess carbonate [residual] concentration becomes too high, the carbonates combine with calcium & magnesium to form a solid material [scale] which settles out of the water [10]. The sodium with alkaline & the quantity of bicarbonate and carbonate in accessed of alkaline also influence the suitability of water for irrigation. This excess is denoted by residual sodium carbonate [RSC]. The water with high RSC has high pH and land irrigated by such waters becomes infertile owing to deposition of sodium carbonate as known from the black color of the soil [2]. Further, continued usage of high RSC waters affects crop yields [10].

The RSC value < 1.25 epm is safe for irrigation, a value between 1.25 & 2.5 epm is of marginal quality and a value > 2.5 epm is unsuitable for irrigation [10]. In the study, the RSC value was in the range of minimum -0.31 epm to maximum of -8.00 epm. However, water is suitable for irrigation in RSC point of view. Further the value of RSC is negative at all sampling sites, indicating that there is no complete precipitation of calcium and magnesium [7].

Soluble Sodium Percentage: The minimum SSP value was observed is 12.76 epm while maximum value was recorded 40.09 epm. The maximum value was at the site 19. The SSP value at site 19 only shows the doubtful quality of water for drinking purpose while all sites are within the permissible level for irrigation [11].

Schoeller Index: The values of Schoeller Index obtained after evaluation were in positive values showing the chloro alkaline equilibrium. Thus the water with base exchange reaction in which the alkaline have been exchanged for Na ions [$\text{HCO}_3^- > \text{Ca}^{2+} + \text{Mg}^{2+}$] may be referred to as base exchange softened water & those in which the Na ions have been exchanged for alkaline earth [$\text{Ca}^{2+} + \text{Mg}^{2+} > \text{HCO}_3^-$] may be referred to as base exchange hardened water [8,9].

Table1. Showing physico-chemical parameters of Dynaneshwar dam water

Parameters	Seasons			Statistical Parameters					
	R	S	W	Mean	Mn	Mx	SE	SD	CV%
PH	7.13	7.1	7.0	7.1	6.8	7.3	0.05	0.17	2.39
EC	682	711.3	686.3	693.2	550	830	27.61	95.5	13.77
TDS	440.3	528.0	585.8	518.0	338	764	43.03	148.9	28.75
TH	474.8	316.8	367.3	386.3	180	632	32.25	111.6	28.89
Ca	37.0	111.0	111.8	86.6	30.0	210	15.86	54.9	63.39
Mg	68.3	45.5	77.3	63.7	13.0	97.0	8.70	30.1	47.25
Na	50.0	59.3	31.5	46.9	17.0	86.0	0.17	0.60	1.28
K	1.15	1.30	2.15	1.53	0.7	2.5	14.02	48.5	31.76
Cl	133.8	135.0	168.8	145.9	97.0	198.0	12.86	44.5	30.50
HCO ₃	173.3	167.5	205.8	182.2	110	265	2.66	9.21	5.50
SO ₄	41.3	41.8	39.5	40.9	30.0	58.0	0.1	0.33	8.06
PO ₄	0.58	0.98	0.75	0.77	0.3	1.2	0.44	1.50	19.48
NO ₃	2.58	0.90	0.95	1.48	0.3	5.8	0.26	0.89	60.14
DO	3.03	3.23	3.58	3.28	2.0	4.9	0.26	0.89	27.34
BOD	31.0	21.0	9.75	20.58	7.0	64.0	4.51	15.6	75.80
COD	29.3	39.8	52.0	43.7	11.0	91.0	5.90	20.4	46.68

Table 2. Water quality indices for irrigation

Site No	KI	RSC	SSP	SAR	SI
1	0.38	-4.99	19.58	1.02	0.46
2	0.30	-4.96	14.91	0.72	0.60
3	0.37	-4.16	19.18	0.94	0.43
4	0.48	-4.14	27.68	1.51	0.40
5	0.36	-6.24	18.67	0.94	0.50
6	0.39	-3.80	23.73	1.19	0.45
7	0.49	-3.14	30.81	1.70	0.30
8	0.58	-4.57	31.46	1.77	0.24
9	0.41	-5.48	21.72	1.31	0.63
10	0.48	-5.36	34.77	2.23	0.30
11	0.53	-7.67	30.52	2.06	0.33
12	0.36	-8.00	18.64	1.06	0.45
13	0.30	-5.80	14.37	0.62	0.70
14	0.26	-0.31	11.76	0.17	0.69
15	0.38	-0.42	19.95	0.37	0.61
16	0.54	-1.31	30.62	1.21	0.47
17	0.59	-1.98	33.35	1.63	0.43
18	0.48	-2.10	27.73	1.06	0.20
19	0.75	-6.14	40.09	3.87	0.20
20	0.49	-7.16	26.11	1.84	0.50
Minimum	0.26	-0.31	12.76	0.17	0.20
Maximum	0.75	-8.00	40.09	3.87	0.70
*All values are in epm except Schoeller index					

Sodium Adsorption Ratio: The SAR of water samples was ranged from 0.17 to 3.87 epm. The water having SAR < 10 is good for irrigation. It was observed that all the sites studied were good for irrigation [11]. Sodium adsorption was stimulated when Na proportion increases as compared to Ca & Mg resulting in soil dispersion [3,4]. The SAR was also expressed as Sodium Hazard

[11]. In SAR the Ca and Mg ions are important since they tend to counter the effects of sodium. Continued use of water having high SAR leads to breakdown in the physical structure of the soil particles. Sodium would absorb & becomes attached to the soil particles. The soil then becomes hard & compact when dry and increasingly impervious to water penetration. The degree to which irrigation water tends to enter in to cations exchange reaction in soil can be indicated by the sodium absorption ratio. Sodium replacing adsorbed calcium & magnesium is a hazard as it causes damage to the soil structure [6].

The water quality indices studied showed water is suitability for irrigation. It indicates that the water from Dynaneshwar dam was suitable for irrigation. The indices like KI, RSC, SSP, SAR & SI are within the permissible limits for irrigation [11]. The continuous monitoring of water quality is necessary to help farmers & irrigation department for making water policy. Also water pollution should be monitoring regularly which help appropriate management & sustainable development.

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