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Assessment of Surface Water Quality for Irrigation in and around Bibinagar, Telangana State, India.

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ABSTRACT

Some important water quality parameters of surface waters in and around Bibnagar, Nalgonda district, Telangana state were evaluated for the criteria of irrigation purpose. Eight samples were collected from different lakes in the study area. Parameters like Electrical Conductivity (EC), Total Dissolved Solids (TDS), Sodium Absorption Ratio (SAR), Soluble Sodium Percentage (SSP), Residual Sodium Carbonate (RSC) Permeability Index(PI) and Total Hardness(TH) . Major ions and physical parameters were compared with the Indian standard (as per IS 2296) for surface waters.

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Introduction:

Irrigated agriculture is dependent on adequate water supply of usable quality. Irrigation water quality is related to its effects on soil and crops and its management, characteristics of irrigation water that defines its quality vary with the source of water. There are regional differences in water characteristic, based on mainly on geology and climate. There are many differences in the quality of water available on local level depending on whether the source is from surface water bodies (river, lakes, ponds) or ground. Agriculture water sources may be of poor quality because of natural causes, contamination or both and often required treatment before it is acceptable for a given use. The water quality in watershed is directly affected by vegetative cover, agriculture and other management practices. The chemical constituents of irrigation water can affect the plant growth directly through toxicity or deficiency or indirectly by altering plant availability of nutrients (Ayers and Westcot, 1985; Rowe et al.,1995). This situation is now changing in many areas. Intensive use of nearly all good quality supplies means that new irrigation projects and old projects seeking. New or supplemental supplies, must rely on lower quality and less desirable sources (cuena, 1989). Water quality concerns have often been neglected because good quality water supplies have been plentiful and readily available (shamsad and Islam, 2005 Islam et al.,1999)

Materials and Methods:

Pre-cleaned High density Polyethylene (HDPE) bottles were used to collect surface water samples from eight different lakes distributed throughout the area of Bibinagar and numbered sequentially (Table 1). The bottles were rinsed with the same water which is to be taken as sample to avoid possible cross contamination and every other precautionary measure was taken for the best result. The water samples were then analyzed for major ion chemistry employing standard methods (APHA,1995).

The pH and conductivity were measured with respective meters. Total hardness as $CaCO_3$ and (Ca^{+2}) were analyzed titrimetrically using standard EDTA. (Mg^{+2}) was computed taking the reference between TH and (Ca^{+2}) values. Carbonate ($CaCO_3^{-2}$) and Bicarbonate (HCO_3^-) were estimated by titrating with standard H_2SO_4. Chloride (Cl^-) was estimated by standard $AgNO_3$. Sodium (Na^+) and Potassium (K^+) were measured by Flame Photometer. Sulphates (SO_4^{-2}) were measured by Spectrophotometry. Nitrate (NO_3^-) and Fluoride (F^-) were analyzed using a Ion-Selective Electrodes. Total Dissolved Solids (TDS) calculated

from Electrical Conductivity (EC) using an empirical equation. All the parameters are expressed in mg/lit except for pH and EC. EC is expressed in micro Siemens/cm .All ionic concentrations are expressed in terms of meq/l.

Results and discussions:

The quality of 8 water samples consider to determine its suitability for agriculture irrigation purposes depending on the specific standards (IS 2296) standards was the basis for water sample quality elevated for irrigation purposes.

Physical and chemical parameters: The PH of the water samples in study area ranges from 7.5 to8.0 with a mean of 7.7 hence, 100% of water samples within the permissible limits. EC of the water samples ranges from 1200µs/cm to 2400µs/cm with a mean of 1450µs/cm. 100% of water samples within the permissible limits. The dissolved solids of water samples in the study area varying from 768 to 1536mg/l with a mean of 928mg/l. Total hardness in the study area varies from 150 to 260mg/l with an average of 210mg/l. Calcium concentrations are varying from 16 to 50mg/l with an average of 43mg/l. Magnesium concentration varies from 15 to 34mg/l with a mean of 24mg/l. Sodium concentration ranges from 88 to 198mg/l with a mean of 113mg/l. Potassium concentration varies from 7 to 312mg/l with an average of 85mg /l. Carbonates concentration varies from 0 to 18mg/l with an average of 8.25mg/l. Bicarbonates concentration ranges from 280 to 451mg/l with a mean of 378mg/l . Chlorides (Cl^-) concentrations are varying from 170 to 550mg/l with an average of 267mg/l. All the water samples were with the limits. Sulphates (SO_4^{-2}) concentration ranges from 91 to228mg/l with a mean of 167mg/l the irrigation water standards for SO_4^{-2} is specified as1000 mg/l according to IS 2296.Hence all the water samples falls within the permissible limits. Fluoride (F^-) concentration of the water samples in study area ranging from 0.8 to 5.5mg/l with a mean of 1.5mg/l. Nitrate (NO_3^-) concentration of the study area ranging from 11.96 to 101.2mg/l with an average of 42.91mg/l.

The results are presented in (Table1) and summarized in (Table2).

Table: 1. Summary of the analytical data

S. No	Locations	pH	EC	TH	TDS	Ca^{+2}	Mg^{+2}	Na^+	K^+	CO_3^{-2}	HCO_3^-	SO_4^{-2}	NO_3^-	Cl^-	F^-
1	Bibinagar lake	7.8	2400	150	1536	16	26	198	7	0	384	176	18.92	550	5.5
2	Palvaigudem lake	7.7	1500	210	960	50	20	137	7	18	451	173	13.86	298	1.4
3	Raghavapuram lake	7.7	1300	260	832	48	34	94	9	15	439	175	19.14	230	1.1
4	Brahmanpally lake	8	1400	240	896	42	32	103	12	18	390	172	11.96	276	1.6
5	Venkiryala lake	7.9	1300	205	832	50	19	106	11	6	408	228	51.04	216	1.0
6	Edulabad lake	7.7	1300	245	832	48	30	93	11	9	384	177	42.24	220	0.95
7	Rudravelli stream	7.5	1200	185	768	42	19	90	312	0	280	91	84.92	170	0.88
8	Peddaravulapally stream	7.5	1200	185	768	48	15	88	312	0	293	146	101.2	181	0.9

Table: 2. Comparison with Indian standards

Parameters	minimum	maximum	average	IS 2296
pH	7.5	8	7.7	8.5
EC	1200	2400	1450	2500
TH	150	260	210	------
TDS	768	1536	928	2100
Ca^{+2}	16	50	43	---
Mg^{+2}	15	34	24	----
Na^+	88	198	113	----
K^+	7	312	85	----
CO_3^-	0	18	8.25	----
HCO_3^-	280	451	378	-----
SO_4^{-2}	91	228	167	1000
NO_3^-	11.96	101.2	42.91	-----
Cl^-	170	550	267	600
F^-	0.8	5.5	1.5	-----

Experimental:

Sodium Absorption Ratio (SAR):

Sodium absorption ratio is an important parameter to determine the suitability of irrigation water and is calculated by the following formula

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

Residual Sodium Carbonate (RSC)

The concept of residual sodium carbonate is employed for evaluating high carbonate waters and calculated by the formula given below

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

Soluble Sodium Percentage (SSP):

Doneen method is used to calculated the sodium percentage

$$SSP = \left[\left(Na^+ + K^+\right)*100\right] / \left[Ca^{2+} + Mg^{2+} + \right.$$

Permeability Index(PI):

Permeability index is calculated the method suggested by domenico and schwartz

$$PI = \frac{Na + \sqrt{HCO_3}}{Ca + Mg + Na} \times 100$$

SAR:

SAR is an important parameter for the determination of suitability of irrigation water because it is responsible for the sodium hazard. The waters were classified in relation irrigation based in the ranges of SAR values. Water with SAR ranging from 0 to 10 is considered excellent with greater than 10 good. In the present study SAR was found to be 1.3 to 2.7, hence waters are excellent to use. The low value of SAR for study area can be categorized as water excellent category. It can be used for irrigation on almost all soil types.

RSC:

The concentrations of bicarbonate also influence the suitability of water for irrigation purpose one empirical approaches is based on the assumption that all ca^{2+} and mg^{2+} precipitate as carbonate. Considering this hypothesis, Eaton proposed the concept of Residual Sodium Carbonate for assessment of high carbonate waters. According to U.S salinity laboratory RSC values less than 1.25meq/l is safe for irrigation. A value between 1.25 to 2.5meq/l is of marginal quality and value more than 2.5meq/l is unsuitable for irrigation. In the present study RSC values are below 1.25meq/l for two samples which were good and four samples were between 1.25 to 2.5meq/l suitability for irrigation. Finally two samples fall in the range greater than 2.5meq/l were unsuitable for irrigation purposes.

TDS:

Water with TDS less than 450mg/ml is considered good and that with greater than 2000mg/l is unsuitable for irrigation purpose. In the present study area the values ranging from 150mg/l to 1536mg/l with an average of 928mg/l so the all the samples are suitable for irrigation purpose.

SSP:

SSP is another important factor to study sodium hazard. It is calculated as the percentage of sodium and potassium against all cationic concentrations. It is also used for adjusting the quality of water for irrigation purpose. SSP in water is a parameter computed to evaluate the suitability for irrigation. In the present study around six samples were falling in the range of permissible, one in excellent and other on good.

PI:

The soil permeability is affected by long term use of irrigation water. Sodium, calcium, magnesium and bicarbonate content of the soil influence it. Doneen evolved a criterion for assessing the suitability of water for irrigation based on the permeability index. Accordingly waters can be classified as class I and class II orders. Class I waters are categorized as good for irrigation with 75% and class II are unsuitable with maximum permeability. In the present study PI is ranging from 59 to 111meq/l with an average of 79meq/l hence 50% of samples are following in class I and class II each.

EC:

The most influential water quality guidelines on crop productivity is the water salinity hazard as measured electrical conductivity (s.s Ahmed, Q.H.Mazumder, c.s.jahan, M.ahmed and s.Isam journal, geological society of India, 60, 411(2002)).

Table: 3. Classification of water classes

Parameters	Range	Water class	Number of Samples Exceed
SAR	10	Excellent	All
	18	Good	Nil
	18-26	Fair	Nil
	26	Unsuitable	Nil
RSC	>1.25	Good	Two
	1.25-2.50	Doubtful	Four
	2.5	Unsuitable	Two
TDS	0-1000	Fresh	SEVEN
	1000-10,000	Brackish	ONE
	10,000-1,00,000	Saline	Nil
	>1,00,000	Brine	Nil
SSP	20	Excellent	ONE
	20-40	Good	ONE
	40-60	Permissible	SIX
	60-80	Doubtful	NIL
	80	Unsuitable	NIL
PI	<75	Class I	FOUR
	75-150	Class II	FOUR
EC	250	Excellent	NIL
	250-750	Good	NIL
	750-2000	Permissible	ALL
	2000-3000	Doubtful	Nil
	>3000	Unsuitable	Nil

Conclusion:

The analysis revealed that most of the constituents in the water samples are within the prescribed limits they are SAR, TDS, SSP, EC. Based on RSC and PI values of study area found to have little problem.

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