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THE CHEMICAL COMPOSITION OF SOME DUNE SLACK WATERS OF PURI, ORISSA

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ABSTRACT

Analyses of pH, total dissolved solids, $CO_3^{=}$, HCO_3^-, Cl, $SO_4^{=}$, Ca^{++}, Mg^{++}, Na^+ & K^+ are presented for dune slack water samples of Puri. From these analyses sodium percentage, residual sodium carbonate and sodium-adsorption-ratio are calculated. It is found from these data that alkali or salinity hazard is low in these waters which can therefore be utilised for irrigation purposes.

INTRODUCTION

Very little is known about the chemical composition of dune slack waters except those in Rameswaram island, Madras (*Aggarwal et al.*, 1963) and Digha shore, West Bengal (*Rao et al.*, 1968). In course of some ecological studies of Puri coast the author came across a series of dune slacks on the west of Puri town and nearly a furlong away from the sea. The approximate area of the largest one is 10,000 sq. metre and the smallest one is 3,000 sq. metre containing nearly 60-90 cm deep water in them. Water samples were collected from seven slacks in the latter part of October, 1967. They are analysed with the object of ascertaining their suitability for irrigational purposes.

METHODS

To investigate the chemical composition of the soluble salts of the slacks, water samples were collected from seven slacks at a depth of about 15 cm.

The water samples were analysed by the standard methods outlined below and the data are expressed in milli-equivalents/litre in respect of ionic composition in Table I. pH was determined by Cambridge pH meter and total dissolved solids were estimated gravimetrically by the standard method of A.O.A.C. (1950). Chloride was estimated by titration of an aliquot of water sample against standard $AgNO_3$ solution using K_2CrO_4 as an indicator and carbonate and bicarbonate by titrating an aliquot against $N/20H_2SO_4$, using phenolphthalein and methyl orange as indicators, by the methods described by Jackson (1958). Sulphate was estimated gravimetrically as $BaSO_4$ (*Scott*, 1939). Calcium and magnesium estimations were made by precipitation method described by Jackson (*loc. cit.*), sodium and potassium were estimated by the determination of combined weights of their chlorides and total chlorine and consequent calculation of two ions individually by the method devised by Division of soils, University of Nebraska and described by Jackson (*loc. cit.*). Sodium percentage, residual sodium carbonate and sodium-adsorption-ratio are presented in Table II*.

RESULTS

pH: The average pH value of these slack waters is 7.5 which indicates that these are moderately alkaline. The highest pH value of 8.2 is of a slack which is surrounded by big mobile sand dunes.

Total dissolved solids: Total dissolved solids are not very high and range between 100 and 250 p.p.m. (average 171 p.p.m.).

Sodium and chloride: With the exception of sample no. 5, sodium ions range between 1.12 and 2.23 milli-equivalent/litre (average 1.58 m.e./litre) and chloride ion concentrations vary between 1.52 and 1.96 m.e./litre (average 1.87 m.e./litre).

Calcium and bicarbonate: Calcium ions range between 0.50 and 0.81 m.e./litre (average 0.64 m.e./litre) and bicarbonate ions range between 0.41 and 1.33 m.e./litre (average 0.68 m.e./litre) except sample no. 7.

Potassium: Potassium ions range between 0.24 and 0.44 m.e./litre (average 0.34 m.e./litre) except sample nos. 5 & 6.

Magnesium: Soluble magnesium is very low in these water samples ranging between 0.01 and 0.02 m.e./litre (average 0.01 m.e./litre) except sample nos. 3, 4 & 6.

Sulphate: No sulphate ions are present in these water samples.

*The sodium percentage is the percentage of Na meq of the total meq of cations by analysis. The "residual Na_2CO_3" of water is defined as follows: Residual $Na_2CO_3 = (CO_3^{=} + HCO_3^-) - (Ca^{++} + Mg^{++})$ when all quantities are expressed as meq/litre. The sodium-adsorption-ratio $=$ meq $Na^+ / \sqrt{\frac{\text{meq } Ca^{++} + Mg^{++}}{2}}$.

TABLE I

Water sample No.	Location	pH	Total dissolved solids p.p.m.	*Milli-equivalents/litre* $CO^{=}_3$	HCO^-_3	Cl^-	$SO^{=}_4$	Ca^{++}	Mg^{++}	Na^+	K^+	Na/Cl ratio	Mg/Cl ratio	Ca/HCO$_3$ ratio
1	Slack very near to *Casuarina* plantation	7.6	170	—	1.33	1.96	—	0.66	0.01	2.23	0.38	1.14	0.007	0.49
2	Slack a few yards west of slack no. 1	7.6	180	—	1.02	1.96	—	0.50	0.01	1.72	0.44	0.80	0.007	0.49
3	Slack a few yards west of slack no. 2	7.6	200	—	0.92	1.96	—	0.66	0.01	1.86	0.24	0.95	0.004	0.71
4	Slack surrounded by very big mobile sand dunes, a furlong west of water tank	7.3	180	—	0.51	1.96	—	0.66	0.01	1.31	0.37	0.66	0.004	1.29
5	Slack through which water pipe is passing	7.3	100	—	0.41	0.49	—	0.56	0.01	0.20	0.06	0.42	0.029	1.36
6	Slack near the transformer	7.3	120	—	0.41	1.52	—	0.63	0.01	1.12	0.03	0.73	0.004	1.54
7	Slack a few yards west of slack no. 6	8.2	250	0.41	0.20	1.96	—	0.81	0.02	1.24	0.26	0·63	0.013	1.32
Average		7.5	171	—	0.68	1.87	—	0.64	0.01	1.58	0.34	0.76	0.009	1.03
World average for fresh water					1.71	0.23	0.37	1.49	0.42	0.36	0.08	1.57	1.83	0.87

TABLE II

Water sample No.	Sodium percentage	Residual Na_2CO_3	Sodium-adsorption-ratio
1	67.8	0.66	3.85
2	64.0	0.50	3.37
3	67.0	0.25	3.27
4	55.7	0.15	2.29
5	24.6	0.16	0.32
6	62.2	0.23	2.0
7	53.1	0.59	1.94
Average	61.6	0.40	2.78

Carbonate : There are no carbonate ions in these water samples except in sample no. 7 which contains 0.41 m.e./litre..

With the exception of one sample (no. 5), sodium percentage ranges between 53.1 and 67.8 (average 61.6), residual Na_2CO_3 ranges between 0.16 and 0.66 (average 0.40) except sample no. 4, and sodium-adsorption-ratio ranges between 1.94 and 3.85 (average 2.78) except sample no. 5.

DISCUSSION

In 'ordinary' fresh waters pH is in large part determined by the CO_2-bicarbonate-carbonate system (*Hutchinson,* 1957). It is evident that in these slack waters the bicarbonate system plays the main part in determining the pH which is moderately alkaline. According to Jackson (*loc. cit.*), the quality of irrigation water can be evaluated in terms of the salinity and sodium-adsorption-ratio on the one hand and in terms of salinity, sodium percentage and residual sodium carbonate on the other. If the quantity of total soluble salts is low, sodium-adsorption-ratio is less than 10, sodium percentage is less than 65 and residual sodium carbonate is less than 1.25, it is an excellent to good water for irrigation.

From the above facts and the results of analyses in tables I & II it appears that these slack waters may be utilised by the farmers of Balia Panda, who are residing very near to these slacks, to irrigate their lands during winter months for growing crops like carrot, cabbage, radish, sugar beet, barley etc. which are tolerant to moderate alkalinity (*Britton,* 1966). Moreover, as sodium is the most abundant cation of these slack waters, gypsum may be used to check sodium accumulation in the clay complex.

The order $HCO^-_3 > SO^{=}_4 > Cl^-$ may be regarded as the normal order for fresh water (*Hutchinson, loc. cit.*). In these slack waters the order of anions is $Cl^- > HCO^-_3 > CO^{=}_3$. There is evidence from the saline lakes of Australia that loss of sulphate by bacterial reduction to H_2S in the mud at the times of low water can produce chlorocarbonate waters from concentration of wind borne salt of marine origin (*Hutchinson, loc. cit.*). Alternatively, concentration of slack waters during summer will first result in the precipitation of calcium carbonate. This will lead to a relative enrichment of chloride and sulphate in the remaining liquid phase. As sulphate accumulates the solubility product of calcium sulphate will finally be exceeded and gypsum will begin to precipitate. The solution will therefore be enriched in chloride relative to the other anions, so that the normal sequence appears to be from carbonate to sulphochloride to chloride waters. The exact path taken by any given water will depend on the amount of calcium present at the time when most of the carbonate has precipitated (*Clarke*, 1924).

The cause responsible for the absence of sulphate and carbonate ions and chloride enrichment in these slack waters requires further investigation.

The order of abundance of cations is $Na^+ > Ca^{++} > K^+ > Mg^{++}$ except in slack no. 5 where $Ca^{++} > Na^+$. Calcium is nearly being equivalent to bicarbonate except in slack nos. 1, 2 & 3 where excess bicarbonate ions are being satisfied by other cations. Sodium emerges as the most important cation in these slack waters, a feature to be expected in soft water areas. The ratio Na/Cl (0.76) is lower than sea water (0.85) except in sample no. 1 and much lower than the world average for fresh water (1.57). And the ratio of Mg/Cl (0.009) is lower than this ratio for sea water (0.20) and much lower than the world average for fresh water (1.83). The low ratio of Na/Cl may be due to chloride enrichment as stated before and Mg/Cl may be caused by adsorption of Mg by the bottom soil (*Gorham*, 1958). The probable source of potassium which is moderate in amount is feldspar particles present in the soils of the surrounding area.

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