

EVALUATION OF SURFACE WATER FOR IRRIGATION OF DIGHALIA UPAZILA IN KHULNA DISTRICT OF BANGLADESH

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Abstract: An investigation was conducted to find out the surface water quality and classify them according to their suitability for irrigation in Dighalia Upazila. The water samples from eighteen selected locations were collected and analyzed for pH, EC, Ca, Mg, Na, K, S, B, Zn, Fe, Cu, Mn, SAR, SSP and hardness (H_T). The pH values of water indicated neutral to alkaline in nature and chemical analyses of water samples reflected the concentration of most ions were within the safe limit except Mg, Na and K concentration those were higher in surface water than normal concentration. Classification on the basis of EC, SAR and H_T indicated safe limit for irrigation and only 22% water samples were within the permissible limit based on SSP for irrigation use.

Key words: Surface water, Water quality, Irrigation

Introduction

Irrigation has been practiced by mankind from the prehistoric time. It is claimed that there is a reference to irrigation in the literature and speeches of Hummurabbi of Babylon (Farouk, 1968). It may even be possible by irrigation to increase the availability of soil reserves of plant nutrients, so that fertilizer dressings could profitably be reduced. Utilization of water for irrigation purposes without quality control undoubtedly deteriorate soil productivity which adversely affects crop production. The quality of irrigation water is primarily determined by the chemical composition and concentration of dissolved substances that are present in water.

The annual average rainfall in Bangladesh ranges from 119.38 to 345.44 cm but its distribution is uneven. About 80 to 90 per cent of the rainfall occurs during the month from April to October leaving the most productive season (November to March) dry. It is evident that supply of irrigation water to meet the crop demand during November to March is a crucial one and irrigation is a must to overcome moisture stress situation.

The scarcity of suitable irrigation water is a serious problem in our country especially in coastal areas particularly in Khulna region. Presently, about 29% of the total cultivated lands of Dighalia Upazilla in Khulna are cultivated with irrigation of which about 14% water are used from surface water sources such as from river, pond, lake etc. Since irrigation has been practiced increasingly in Dighalia Upazilla, therefore, analysis of its chemical properties is of utmost important. Keeping the view in mind, the research work was undertaken to evaluate surface water quality for irrigation by determining and categorizing of water samples according to their chemical composition from selected locations of Dighalia Upazilla in Khulna district.

Materials and Method

Dighalia upazila of Khulna District was the study area. The upazila occupies an area of 77.16 sq.km. It is located between 22°51' and 22°5' north latitudes and between 88°33' and 89°40' east latitudes. The upazila is bounded on the north by Kalia upazila of Narail district, on the east by Terokhada upazila, on the south by Daulatpur, Kotwali and Rupsha upazilas and on the west by Khanjahan Ali thana. The upazila consists of 4 unions, 30 mauzas and 41 villages.

Eighteen irrigation water samples of surface water were collected from selected locations of Dighalia Upazila during the month of March/2000. The samples were collected during the running condition of power pumps. The collected water samples were kept in one liter plastic containers to its full capacity in order to avoid the presence of air bubbles and kept airtight. The water samples were immediately carried to the regional laboratory of the Soil Resources Development Institute (SRDI), Daulatpur, Khulna and preserved in refrigerator for chemical analysis. The samples were collected following the instructions outlined by Clesceri *et.al.* (1989).

The pH and electrical conductivity (EC) of the collected water samples were determined electrometrically using pH and EC meters, respectively following the instruction outlined by Petersen, 1999. Calcium, magnesium, sodium, potassium, copper, iron, manganese and zinc were determined directly by using Atomic Absorption

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Spectrophotometer (Page, 1982). Phosphorus was determined by molybdenum blue method using ascorbic acid as a reducing agent and the absorbance was measured by Spectrophotometer (Olsen, 1982). Sulfur was determined by turbidometry described by Tabatabai (1982). Boron determination was made by azomethine-H method and the absorbance was measured by a Spectrophotometer (Bingham, 1982).

In order to evaluate the water class ratings for the suitability of surface water for irrigation, sodium adsorption ratio (SAR), soluble sodium percentage (SSP) and hardness (H_T) were calculated using some standard equations after Ghosh *et al.* (1983). The equations are as follows.

$$SAR = \frac{Na^+}{\left[\frac{Ca^{++} + Mg^{++}}{2} \right]^{1/2}}$$

$$SSP = \frac{\text{Soluble sodium concentration (meqL}^{-1}\text{)}}{\text{Total cation concentration (meqL}^{-1}\text{)}} \times 100$$

$$H_T = Ca \times \frac{CaCO_3}{Ca} + Mg \times \frac{CaCO_3}{Mg}$$

Classification of water samples according to SAR and SSP were made, respectively on the basis of recommendation by Todd (1980) and Wilcox (1955). Hardness classification was made after Sawyer and Mc Carty (1967). In addition, suitability of water for irrigation was also determined with the help of standard criteria suggested by Ayers and Wescot (1985).

Results and discussion

The analytical results and quality classification of water samples have been presented in Table 1 and Table 2, respectively.

The pH of water samples varied from 7.2 to 8.5, indicating the waters were neutral to alkaline in nature. The alkalinity might be due to the presence of appreciable amount of exchangeable sodium, calcium and magnesium. The findings were in good agreement with the observation of Quddus and Zaman (1996). The results of electrical conductivity (EC) varied from 0.44 to 2.08 dSm⁻¹ and were low to medium salinity hazard. Calcium content of water samples was within the range of 0.08 to 0.10 meq 100 ml⁻¹ and had a very little harmful effect on surface water quality for irrigation according to Ayers and Wescot (1985). The amount of magnesium, sodium and potassium in water samples were 0.06 to 0.15 meq 100 ml⁻¹, 0.248 to 1.426 meq 100 ml⁻¹ and 0.0013 to 0.054 meq 100 ml⁻¹, respectively. The results indicated their high concentration in water than recommended level after Ayers and Wescot (1985). Considering the concentration of Mg, Na and K, the waters may not be used continuously for irrigation purposes.

The phosphorus and sulfur content were within the range of 0.002 to 0.062 µg ml⁻¹ and 0.40 to 4.61 µg ml⁻¹, respectively. The results were within the safe limit and did not have any influence on irrigation water quality. The findings confirmed the results of Zaman and Majid (1993). Boron (Trace to 0.271 µg ml⁻¹) and zinc (Trace to 0.02 µg ml⁻¹) concentration were below the recommended maximum limit for irrigation. The concentration of other micro-nutrients like copper (Trace to 0.01 µg ml⁻¹), iron (Trace to 0.22 µg ml⁻¹) and manganese (Trace to 0.03 µg ml⁻¹) were also far below than recommended maximum level of these elements in irrigation water and can safely be used continuously for irrigation purposes.

The calculated SAR values of the water samples were within the range of 2.22 to 13.92. The waters were classified as good to excellent based on SAR criteria after Todd (1980). Based on SSP results (46.27 to 86.01), the water samples from Bativita, Gazipara and Molladanga (N) were graded as unsuitable for irrigation; only 22% water samples were within permissible limit and rest of the samples were graded as doubtful for irrigation purposes according to Wilcox (1955). On the basis of hardness values (69.52 to 123.80), the waters were classified as soft to moderately hard after Sawyer and Mc Carty (1967). As regards to EC values, only water from Molladanga (S) was graded as doubtful and rest of the samples were graded as good to permissible level.

From the above discussion it may be concluded that the surface water for irrigation of Dighalia Upazila are mostly suitable for irrigating all agricultural crops based on EC, SAR, SSP and H_T . It may be recommended that the surface waters of Dighalia Upazila can be used without any harmful effect on soils and crops, but careful

attention should be given during irrigation with the waters unsuitable for irrigation regarding SSP value (Bativita, Gazipara and Molladanga N and S).

Table 1. Analytical results of surface water of Dighalia Upzila, Khulna District.

Location	pH	EC (dSm ⁻¹)	Ca ⁺⁺	Mg ⁺⁺	Na ⁺⁺	K ⁺	PO ₄ -P	SO ₄ -S	B ⁺⁺⁺	(μg ml ⁻¹)			
										Cu ⁺⁺	Fe ⁺⁺	Mn ⁺⁺	Zn ⁺⁺
Sonkura	8.5	0.48	0.08	0.07	0.527	0.014	0.005	1.22	0.044	0.01	Trace	Trace	0.02
Jangushia	8.4	0.48	0.08	0.07	0.527	0.016	0.007	1.24	0.042	Trace	0.07	0.01	Trace
Lakhohati (E)	8.5	0.71	0.08	0.09	0.589	0.019	0.024	1.35	0.002	Trace	0.18	0.01	0.02
Lakhohati (W)	8.4	0.91	0.09	0.10	0.713	0.019	0.004	1.75	0.122	0.01	0.14	Trace	Trace
Panigati (N)	8.1	0.88	0.09	0.07	0.465	0.042	0.006	2.60	0.054	Trace	0.06	0.01	0.02
Panigati (S)	8.0	0.44	0.08	0.06	0.434	0.022	0.004	0.40	0.063	0.01	0.20	Trace	Trace
Debnagar	8.2	0.69	0.08	0.08	0.713	0.022	0.011	1.64	0.111	Trace	0.15	0.01	Trace
Takimari	8.3	0.56	0.08	0.07	0.496	0.015	0.004	1.24	0.029	Trace	0.18	0.01	Trace
Barakpur	8.5	0.62	0.08	0.08	0.310	0.016	0.005	1.41	0.074	Trace	0.08	Trace	Trace
Mazudkhali	8.4	0.65	0.08	0.08	0.403	0.017	0.004	1.39	Trace	Trace	0.20	Trace	0.01
Bativita	8.4	1.98	0.09	0.13	1.178	0.026	0.002	1.77	0.094	Trace	0.18	Trace	Trace
Gazipara	8.2	1.53	0.08	0.13	1.085	0.054	0.062	1.67	0.142	Trace	0.22	Trace	Trace
Ketla (E)	7.7	1.77	0.09	0.15	1.085	0.034	0.041	1.77	0.157	Trace	0.03	Trace	0.01
Molladanga (S)	7.6	1.78	0.09	0.12	1.426	0.022	0.004	1.73	0.167	Trace	0.08	0.01	0.01
Ketla (W)	7.6	0.45	0.08	0.12	0.248	0.013	0.007	1.13	0.112	Trace	0.20	0.01	0.01
Bamondanga (N)	7.9	0.44	0.08	0.08	0.248	0.013	0.003	1.00	0.151	Trace	0.13	0.02	Trace
Bamondanga (S)	7.6	0.46	0.08	0.09	0.248	0.013	0.006	1.15	0.004	Trace	0.14	0.01	0.01
Molladanga (N)	7.2	2.08	0.10	0.15	0.248	0.038	0.027	4.61	0.271	0.01	0.13	0.03	0.01
Range	7.2 - 8.5	0.44 to 2.08	0.08 to 0.10	0.06 to 0.15	0.248 to 1.426	0.013 to 0.054	0.002 to 0.062	0.40 to 4.61	Trace to 0.271	Trace to 0.01	Trace to 0.22	Trace to 0.03	Trace to 0.02
Mean	-	0.94	0.08	0.10	0.608	0.023	0.013	1.62	0.091	0.003	0.03	0.007	0.007

E = East, W = West, N = North and S = South

Table 2. Quality classification of surface water for irrigation of Dighalia Upazilla, Khulna District.

Location	EC (dSm ⁻¹)	SAR	SSP	H _i	Water class based on			
					EC	SAR	SSP	H _T
Sonakura	0.48	6.09	76.27	74.44	Good	Excellent	Doubtful	Soft
Jangushia	0.48	6.09	76.05	74.44	Good	Excellent	Doubtful	Soft
Lakhohati (E)	0.71	6.39	75.71	84.28	Good	Excellent	Doubtful	Mod. hard
Lakhohati (W)	0.91	7.32	77.33	94.20	Permissible	Excellent	Doubtful	Mod. hard
Panigati (N)	0.88	5.20	69.72	79.44	Permissible	Excellent	Doubtful	Mod. hard
Panigati (S)	0.44	5.19	72.82	69.52	Good	Excellent	Doubtful	Soft
Debnagar	0.69	7.97	79.66	79.36	Good	Excellent	Doubtful	Mod. hard
Takimari	0.56	5.73	75.04	74.44	Good	Excellent	Doubtful	Soft
Barakpur	0.62	3.47	63.79	79.36	Good	Excellent	Doubtful	Mod. hard
Mazudkhali	0.65	4.51	69.48	79.36	Good	Excellent	Doubtful	Mod. hard
Bativita	1.98	11.23	82.72	108.96	Permissible	Good	Unsuitable	Mod. hard
Gazipara	1.53	10.59	80.43	103.96	Permissible	Good	Unsuitable	Mod. hard
Ketla (E)	1.77	9.90	79.84	118.80	Permissible	Excellent	Doubtful	Mod. hard
Molladanga (S)	1.78	13.92	86.01	104.04	Permissible	Good	Unsuitable	Mod. hard
Ketla (W)	0.45	2.42	52.65	104.04	Good	Excellent	Permissible	Mod. hard
Bamondanga (N)	0.44	2.77	58.91	79.36	Good	Excellent	Permissible	Mod. hard
Bamondanga (S)	0.46	2.69	57.54	84.28	Good	Excellent	Permissible	Mod. hard
Molladanga (N)	2.08	2.22	46.27	123.80	Doubtful	Excellent	Permissible	Mod. hard

E = East, W = West, N = North and S = South

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