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AN INVESTIGATION OF GEO-HYDRO-CHEMISTRY AND PHYSIOCHEMICAL PROPERTIES OF IRRIGATION WATER QUALITY OF FARIDPUR DISTRICT, BANGLADESH

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ABSTRACT

The important physico-chemical parameters of surface and groundwater of Faridpur District were analysed for the criteria of irrigation water quality.18 water samples were collected in the monsoon season (June-September) from different areas of Faridpur District. The study revealed that temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), sodium adsorption ratio (SAR), soluble sodium percentage (SSP), residual sodium carbonate (RSC) and Kelly's ratio of waters were found within the permissible limits for irrigation purposes. Any initiative for surface and groundwater development for planned irrigation practices is highly encouraged (13).

Keywords: Irrigation water (surface and groundwater); hydro geochemistry; groundwater; Faridpur district; water quality, sustainable agriculture

Introduction

Irrigation waters whether derived from springs, diverted from streams, or pumped from wells, contain appreciable quantities of chemical substances in solution that may reduce crop yield and deteriorate soil fertility. In addition to the dissolve salts, which has been the major problem for centuries, irrigation water always carry substances derived from its natural environment or from the waste products of man's activities (domestic and industrial effluents). Faridpur is the South-western district of the country where irrigation is the main criteria for food production except in the rainy season. Irrigation water can come from groundwater, surface water or from non-conventional sources like treated waste water and/or drainage water (12,). Water can be polluted by using different fertilizer and pesticides like diazinon into land for better food production (5).These substances may vary in a wide range, but mainly consist of dirt and suspended solids (SS) resulting into the emitters' blockages in micro-irrigation systems and bacteria populations and coli forms harmful to the humans and the animals (14). Faridpur district water have less chance to polluting water due to floodplain region. Floodplain region have less chances to

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pollute water than hill soil (23). On the same way, Padma river has less chance to riverbank erosion than other rivers like Jamuna (24).

Irrigation water quality directly affects soils and crops, and their management. It is possible to produce high quality crops only by using high-quality irrigation water when other inputs are kept optimal. Characteristics of irrigation water can vary with the source of the water and surrounding soil. Regional differences in water characteristics will result from variation of geology and climate and climatic parameters' are the most important factors related to irrigation. Water used for irrigation can also vary greatly in quality depending upon the type and quantity of dissolved salts in soil and water bodies. The soil of the South-western part (floodplain soil) of the country is fertile but in toxic level, so the water quality is also good in ground and surface water [16, 17]. Moreover, there may also be great differences in the quality of water available on a local level depending on whether the source is from surface water bodies (e.g., rivers and ponds) or from aquifers with varying geology, and whether the water has been chemically treated. The chemical constituents of irrigation water can affect plant growth directly through toxicity or deficiency, or indirectly by altering plant availability of nutrients.

Several research papers (14) have documented groundwater quality of various locations of Bangladesh. The deep aquifer of coastal region of Bangladesh has been contaminated by salinization due to the previously entrapped seawater. However, because of diversified geologic settings of Bangladesh, location- specific spatial distribution must be known to judge the groundwater quality for its suitability for irrigation usage (15).

In several studies carried out in the eighties on the various causes for the clogging of the emitters, the engineers, based on the three major interrelated factors contributing to that specific problem, classified the water according to the chemical quality, the physical and the biological properties (14).This classification although primary and simple seemed convenient for a more or less broad evaluation to cover the whole spectrum of irrigation waters quality for crop production. With the inclusion of reuse of treated municipal wastewater in agriculture during that period, the water quality considerations were broadened in order to cover all the physicochemical(metal like Cd accumulation which may causes diseases like Cancer),Biological and microbiological properties of water that may cause any impact on soil, plants, environment and the consumers, human or livestock (20). The water quality evaluation method in this chapter, although in brief, draws on the important parameters and criteria for a more or less practical evaluation of the chemical, the physical and the biological quality of the water for irrigation with pressurized techniques as follows (14). Chemical, (salinity/toxicity hazards for the soil, the plants and the irrigation system such as it is pipe corrosion and emitter chemical clogging), Physical (emitters blockages problems from suspended solid particles and other impurities

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content), Biological (problems from bacteria and other contents harmful for human and animal health as well as for the soil the plants and the irrigation systems) (14).

There have been calls to establish standards as a guide for judging the suitability of water for irrigation. Any classification should be based on the total concentration and the composition of salts. However, the suitability of water for irrigation also depends on other associated factors, such as the crop, soil, climate and

Fig. 1. Study area Map of Faridpur District, Bangladesh.

Management practices. The classification adopted by FAO in 1985 (after Maas), and proposed as an initial guide, has proved most practical and useful in assessing water quality for on-farm water use. The principal parameters for water classification (crop response to salinity, sodium hazard and toxicity) are quite clear and understood by both the extension engineers and the farmers themselves for proper irrigation management and follow-up purposes (14). Irrigation water quality is related to its effects on soils and crops and its management. High quality crops can be produced only by using high-quality irrigation water keeping other inputs optimal. Characteristics of irrigation water that define its quality vary with the source of the water. To

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evaluate the quality of irrigation water, we need to identify the characteristics that are important for plant growth, and their acceptable levels of concentrations (14).

Faridpur is located in the center of Bangladesh, Faridpur district lies under Dhaka division, with an area of 2,073 square kilometers. The main rivers are the Padma, Madhumati, Old Kumar, Arial Khan, Gorai, Chandana, Bhubanshwar and Lohartek. It is bounded by Narail, Magura and Rajbari districts on the west, Rajbari and Manikganj districts on the north, Gopalganj district on the south, and Dhaka, Munshiganj and Madaripur districts on the east (8).

2. MATERIALS AND METHODS

A field research was conducted to evaluate the suitability of groundwater for irrigated agriculture of Faridpur District. A total of 18 ground water samples representing extensively used STW and DTW area were collected from various sites in the cropping period of the peak dry season (January, 2017). Samples were collected from 4 deep tube wells, 4 shallow tube wells, 4 rivers and 6 canals. The high density PVC bottles were used for sampling. They were thoroughly cleaned by rinsing with 8N HNO3 and deionized water followed by repeated washing with water sample as suggested by De. Before sampling from a well, water was pumped out sufficiently so that the sample represents the groundwater from which the well is fed. The bottles were kept air tight and labeled properly for identification. Aeration during sampling was avoided by stoppering the bottle quickly (1, 2, 14). Natural waters are never pure; they always contain varying amounts of dissolved gases and solids. The major ionic species in most natural waters were analyzed in irrigation scheme and compared with water quality standards for irrigation set by FAO, US-EPA and many other scholars worldwide. In data analysis, the following points were considered: The water quality variability within the space from upstream to downstream); the physical parameters data directed measured in the field such as ToC, pH, ECw and TDS and the variation of ions among others anions and cations within the irrigation scheme. Some parameters were tested such as Temperature (ToC), Electrical Conductivity (ECw,), Total Dissolved Solid (TDS), Hydrogen ion concentration (pH), Sodium (Na+), Potassium (K+), Chloride (Cl-), Bicarbonate (HCO3-)(13). The pH, Temperature, ECw and TDS were determined directly on-site electrometrically using digital pH and digital conductivity meter (Model Hanna Conductivity meter). Bicarbonate (HCO3-), were determined by acidimetric titration method while chloride (Cl-) was determined by argent metric titration method.

3. RESULTS AND DISCUSSION

The Table represents the results of physico-chemical parameters of the irrigation water samples of the study area of Faridpur District. The Table reveals that the average temperature of irrigation water samples of the study area was 19.67°C and in the range of 18 to 21 °C. The pH value of

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irrigation water of the study area ranges from 6 to 7.9 with an average value of 6.9, which is within the permissible limit for irrigated agriculture [6, 7, 11].

The EC value of irrigation water of the study area ranges from 318 to 693 µS/cm with an average value of 544.5 µS/cm, which according to Wilcox (1955) (7] falls within the irrigation water quality classification stand 'excellent to good'. In terms of the 'degree of restriction on use', EC value of < 700 µS/cm refers the water to 'none'; 700-3000 µS/cm 'slight to moderate' and 3000 µS/cm 'severe' (3,13). The average TDS value is 325.5 and the ranges is about 206-559.The TDS values <450, 450-2000 and >2000 mg/l represent the irrigation water as 'none'; 'slight to moderate' and 'severe', respectively . So, like EC, the irrigation water of the study area, in term of TDS, is suitable for irrigation purpose (13). High SAR in any irrigation water implies hazard of sodium (Alkali) replacing Ca and Mg of the soil through cation exchange process, a situation eventually damaging to soil structure, namely permeability which ultimately affects the fertility status of the soil and reduce crop yield. The values of SAR of the collected water samples range from 0.11-0.55 to 0.45 with an average value of 0.24. All the irrigation water samples fell under low sodium hazards (S1) class (6, 7, 13).
The soluble sodium percentage (SSP) values were found to vary from 11.59 to 35.51 % with an average value of 21.49% depending upon locations. Based on the classification after Wilcox (1955) (7) for SSP, the water is suitable for irrigation. The Kelly's ratio of collected irrigation water samples ranged from 0.118 to 397 (Table-1). With an average value of 0.293 which showed all values were under acceptable range for irrigation purposes (3). Iron (Fe) content of irrigation water samples of the study area was from 0.002 to 0.2 ppm with an average value of 0.02 ppm. No Fe was detected in some samples. Highest Fe concentration was recorded in Kamarkhali from a Deep Tube well (DTW) (13).Chloride (Cl-) content of the 18 irrigation water samples of the study area varied considerably ranging from 1.03 to 3.22ppm with an average value of 1.63ppm (Table-1).

So, the overall assessment justifies the usability of irrigation water of Faridpur District. No toxic substance found in the water sampling sources in the present time. So, Farmer and other people can use it without further thinking about the water quality of irrigation. No toxic chemical and hazardous element cannot found in an excess able level due to absent of over capitalization, Industries, mills and garments factory. But, In the near future government are planning to found some industry, mills. As a consequence ground water, deep and shallow tube well water also can be polluted in the surrounding water that can damage our ecosystem, aquatic life, fish production, food and soil quality, biodiversity and human health. By the way, after a certain time of internal, assessment of irrigation water quality should be measured due to protect our bio resources and sustainability for food production.

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Table 1. Physico-chemical irrigation water quality of different point in Faridpur District

Sample no	Sampling area	Sources of sample	Temperature	EC (us/cm)	pH	TDS	SAR	SSP %	RSC	Kalley's Ratio	Fe ppm	Cl ppm	HCO_3 ppm
1	Digholia	STW	19	318	7.2	333	0.11	13.56	1.36	0.287	0.02	2.25	5.1
2	Boalia	STW	19	535	7.5	329	0.13	13.53	2.37	0.286	0.023	2.38	3.33
3	Padma	River	20	555	7	359	0.17	18.89	1.51	0.387	0	2.36	3.51
4	Padma	River	19	319	6.3	339	0.15	16.79	1.79	0.133	0.002	1.18	3.15
5	Madhukhali	DTW	20	633	7.9	319	0.55	15.55	2.17	0.193	0	2.9	3.13
6	Station Dighi	Canal	21	555	7.3	206	0.19	23.53	1.36	0.228	0	1.25	3.09
7	Kamarkhali	DTW	19	519	7.5	259	0.12	12.35	2.33	0.167	0.112	0.59	2.9
8	Arpara	DTW	20	558	7.6	559	0.13	11.59	1.37	0.127	0	2.29	5.53
9	Majhibari	DTW	20	533	7.3	329	0.18	15.53	2.5	0.133	0.2	3.22	2.19
10	Station Dighi	Canal	19	567	6	329	0.15	20.95	1.03	0.118	0.005	1.02	3.56
11	Gorai	river	19	567	6.2	339	0.19	35	1.91	0.27	0.003	0.79	3.58
12	Modhumati	river	21	567	6.1	326	0.28	35.51	1.27	0.297	0	0.2	5.33
13	Majhkandi	STW	18	517	6.1	303	0.13	16.57	1.32	0.197	0	1.03	5.67
14	Station Dighi	Canal	20	629	6.1	320	0.29	18.35	3.55	0.397	0	2.05	5.18
15	Station Dighi	Canal	20	558	7.3	319	0.39	28.27	1.31	0.589	0.002	1.3	5
16	Station Dighi	Canal	21	657	7.2	309	0.39	33.12	2.87	0.789	0	1.51	5.55
17	Station Dighi	Canal	19	693	7.5	355	0.55	32.21	3.35	0.396	0	2.01	5.1
18	Kanaipur	STW	20	529	7.2	228	0.32	25.53	1.33	0.28	0.005	1.15	3.27
	Average	-	19.67	544.9	6.9	325.5	.24	21.49	1.92	.293	.02	1.63	4.11
	Range	-	18-21	318-693	6-7.9	206-559	.11-.55	11.59-35.51	1.03-3.55	.118-.397	.002-.2	1.03-3.22	2.19-5.67
	SD	-	0.84	95.73	.63	71.16	.14	8.10	0.75	0.173	0.05	0.83	1.14
	CV%	-	4.2	17.6	9.1	21.9	58.3	37.7	39.1	59	25	50	25.9

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Table 2. Guideline for interpretation of water quality for irrigation (UCCC, 1974)[7]

Salinity (affects crop water availability)		**Degree of Restriction On Use**	
Potential Irrigation Problem	**None**	**Slight-Moderate**	**Severe**
EC µS/cm	<7000	700-3000 >3000	317-769
TDS mg/I	<450	450-2000 >2000	218-529
Infiltration (affects infiltration rate of water into the soil. Evaluate using EC and SAR together)			
SAR = 0.3 and EC =	> 700	700-200	<200
=3-6 =	>1200	1200-300	<300
=6-12 =	>1900	1900-500	<500
=12-20 =	>2900	2900-1300	>1300
=20-40 =	>500	5000-2900	<2900
Specific Ion Toxicity			
Sodium (Na) meq/1	<3	3-9 >9	0.69-3.09
Chloride (Cl) meq/l	<4	4-10 >10	0.59-5.63
Miscellaneous effect			
pH (Normal Range)	6.5-8.5		6.7-7.9

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4. CONCLUSION

Different physico-chemical properties of irrigation water of Faridpur District were compared with the national and international water quality standards set for irrigation. Electrical Conductivity (EC) of collected irrigation water samples fall in the class 'Good some samples which fall in the 'Excellent' class of EC; SAR, in 'Excellent', SSP in 'Good to Excellent' RSC in 'Good to Marginal' and Fe and CI-contents within the Maximum Allowable Concentration (MAC). On the basis of SAR, RSC, and SSP values, no permeability problem was found to exist in Faridpur District [1, 2, 13]. The overall water quality of the studied samples is far better quality than treated municipal Wastewater of the country [18].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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