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EXPLORATION OF PHYSICO-CHEMICAL PARAMETERS AND IONIC CONSTITUENTS FROM GROUNDWATER USED IN IRRIGATION OF TANGAIL DISTRICT, BANGLADESH

Elina Aziz, Md. Younus Mia* and Nowara Tamanna Meghla

Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Santosh, Tangail-1902, Bangladesh

***Corresponding author:** Md. Younus Mia, E-mail: mdmia1998@gmail.com

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ABSTRACT

The study was conducted for exploration of physico-chemical parameters and ionic constituents of groundwater used in irrigation of four upazilas namely Tangail Sadar, Kalihati, Delduar and Nagarpur upazila of Tangail district during the months of March, April and May of 2015. The physico-chemical parameters (pH, EC and TDS), ionic constituents (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, CO_3^{2-}, HCO_3^{-}, PO_4^{3-} and SO_4^{2-}) and trace metal (Fe and Mn) were analyzed to assess the quality of irrigation in relation to soil properties and crop growth. The pH of groundwater indicates slightly alkaline in nature. As regards to EC the groundwater was in 'good' class and medium salinity hazards in quality for irrigation and the concentration of TDS indicates water as fresh water. The concentration of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, CO_3^{2-}, HCO_3^{-}, PO_4^{3-} and SO_4^{2-} of groundwater were recorded within the permissible limit for irrigation and these ions might not create hazardous impact on soil ecosystem for growing crops. The trace amount of Fe and Mn was detected in irrigation water. In the study area, the groundwater was within the recommended limit and would not create problem for irrigation and that have not long term effects on irrigating agricultural crops which could be safely used for irrigation purposes.

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INTRODUCTION

Groundwater is an important source of fresh water for irrigation use in many regions of Bangladesh and is a component of the nation's freshwater resources. About 75% of cultivated land is irrigated by groundwater and the remaining 25% by surface water. Groundwater about 70-90% is used for agricultural purposes and the rest for drinking and other water supplies (BBS, 2006). The chemical quality of groundwater is considered as an important criterion for long-term irrigation because of containing the relatively high content of various ions as dissolved chemical constituents as compared to surface water (Ayers and Westcot, 1985). All water contain varying amount of different types of ion (cations and anions). Among them the main soluble constituents are Ca^{2+}, $Mg^{2+,}$ Na^{+} and K^{+} as cations and Cl^{-}, SO_4^{2-}, PO_4^{3-}, CO_3^{2-} and HCO_3^{-} as anions. Out of the soluble constituents, Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, and HCO_3^{-} are of prime importance in judging the water quality for irrigation (Golterman, 1971). If the polluted groundwater is applied for irrigation, some ions may accumulate in soils as well as crops and deteriorates soil environment ultimately affecting crop production (Ayers and Westcot, 1985). The quantity and quality of different ions in groundwater and surface water system influences its better utilization for irrigation. Nowadays, agrochemicals are applied indiscriminately under intensive agriculture and as a result, lead to ionic contamination of groundwater and surface water (Lal and Stewart, 1994; Schwartz and Zhang, 2012). Recently, the increased attention has been paid in water for monitoring and management of these ions for using safe water.

Tangail region groundwater is mainly applied for irrigation. During the dry season farmers are completely depended on groundwater for irrigation. The cropping sequences like HYV rice, vegetables and rabi crops are found to be cultivated under irrigation. For this purpose, the quality of irrigation water must be evaluated and to identify the concentrations of ionic compounds that are important for plant growth. Keeping the above fact in judgment, the study was conducted to explore physico-chemical parameters and ionic constituents from groundwater and to evaluate the suitability of water with irrigation standard for crop production.

MATERIALS AND METHODS

Study area

The study area was located at the four upazilas namely Tangail Sadar, Kalihati, Delduar and Nagarpur upazila of Tangail district (Figure 1) that occupies an area of 33426, 29560, 18454 and 26270 acres respectively. The total land areas of Tangail district are 835422 acre in which cultivable area 577701 acre and irrigated area 285914 acre (BBS, 2012).

Sample collection

Groundwater samples were collected during the months of March, April and May (2015) from four upazilas of Tangail district. The each of four upazilas were divided into threes sampling points and from each points twelves samples were collected from each of three months (March, April and May) and finally total thirty six groundwater samples were collected from the agricultural sites of the study area. Groundwater samples were collected from 12 shallow tubewells. At the time of sampling, all groundwater samples were free from colour, odour and unpleasant taste. All samples were filtered through filter paper to remove undesirable solids and suspended materials before chemical analysis. The collected groundwater samples were tightly sealed as quickly as possible to avoid air exposure and analyzed immediately.

Sample Analysis

The pH, EC (Electrical conductivity) and TDS (Total Dissolved Solids) of groundwater were measured by pH, EC and TDS meter, respectively (APHA, 2012). The concentrations of Ca^{2+} and Mg^{2+} in water samples were estimated by EDTA tritimetric method (Page *et al.,* 1982) whereas K^{+} and Na^{+} contents were determined by flame photometric method (Ghosh *et al*., 1983). The concentrations of Cl^{-}, CO_3^{-} and HCO_3^{-} in water samples were analyzed by titrimetric method (Tandon, 1995). The content of PO_4^{3-} and SO_4^{2-} in water samples were determined by spectrophotometric method (Tandon, 1995) where as the trace metal Fe and Mn were analyzed by atomic absorption spectrophotometric method (APHA, 2012).

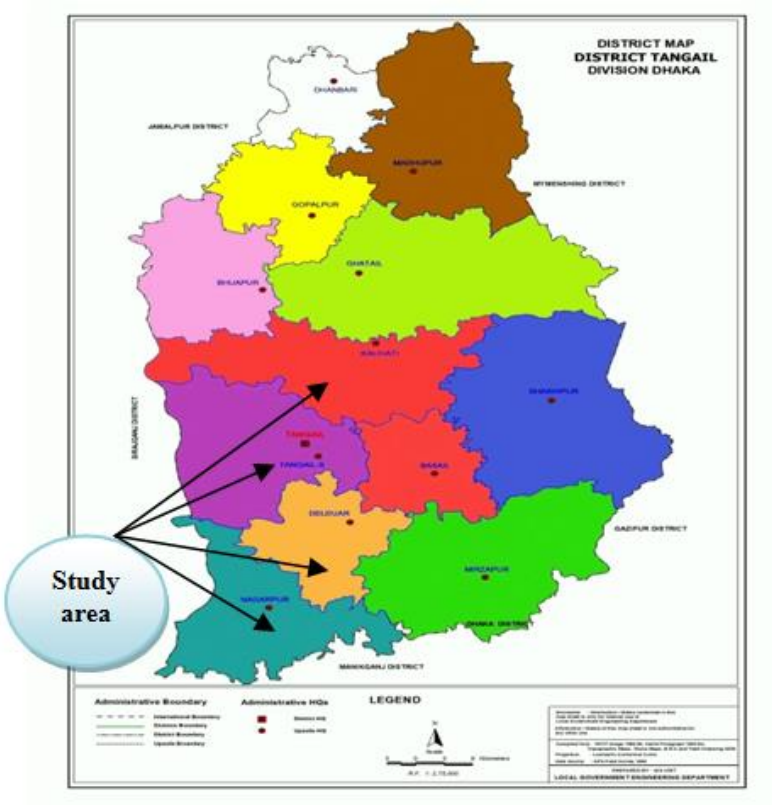

Figure 1. Map showing the study area at the four upazila in Tangail district (Banglapedia, 2008)

RESULTS AND DISCUSSION

The pH of all groundwater samples were ranged from 7.53±0.05 to 8.07±0.06 which indicating slightly alkaline in nature and was suitable for crop production (Table 1) where as the acceptable limit of pH in groundwater for irrigation is from 6.50 to 8.40 (Ayers and Westcot, 1985). The higher value of pH represent that there is high chloride, carbonate, bicarbonate etc. (Michael, 1978).

As regards to electrical conductivity (EC) of all groundwater samples was found within the limit of 373.67±34.64 to 463.33±20.21 μScm^{-1} (Table 1). All groundwater samples were considered as medium salinity hazard (C2, EC= 250-750 μScm^{-1}) and could be safely used for crops growing on soils with moderate level of permeability and leaching as mentioned by Richards (1968).

Table 1. The average value of physico-chemical parameters of groundwater for irrigation

Parameters	Sampling period	Sampling Site				Min. Max
		Tangail Sadar	Kalihati	Delduar	Nagarpur	
pH	March	7.63±0.04	7.53±0.05	7.81±0.05	7.90±0.04	7.53±0.05
	April	7.69±0.03	7.60±0.04	7.89±0.02	7.98±0.02	8.07±0.06
	May	7.74±0.04	7.64±0.03	7.94±0.04	8.07±0.06	
EC (μScm^{-1})	March	406.33±25.11	463.33±20.21	395.00±27.84	456.67±36.53	373.67±34.64
	April	388.67±23.03	446.67±17.56	382.00±30.45	435.33±39.00	463.33±20.21
	May	382.00±25.63	439.00±16.22	373.67±34.64	427.33±27.56	
TDS (ppm)	March	288.33±7.64	233.33±12.58	233.33±12.58	273.67±12.66	210.00±5.57
	April	272.67±14.19	240.33±18.18	218.33±7.64	255.33±12.66	288.33±7.64
	May	261.67±7.64	229.33±13.01	210.00±5.57	242.00±15.36	

The measured total dissolved solids (TDS) varied from 210.00±5.57 to 288.33±7.64 ppm (Table 1). All groundwater samples were considered as fresh water (TDS < 1000 mg L^{-1}) in quality (Freeze and Cherry, 1979) and that could be used for irrigation purposes.

The concentration of Ca^{2+} of all groundwater samples were ranged from 34.01±1.50 to 63.38±3.58 mg L^{-1} (Table 2). Irrigation water containing less than 100 mg L^{-1} of Ca content is "suitable" for raising crop plants, as mentioned by Todd (1980). On the basis of this acceptable limit, Ca^{2+} status of all collected groundwater was not treated as contaminants for irrigation purpose. According to Ayers and Westcot (1985), irrigation water containing below 121.5 mg L^{-1} (20 me L^{-1}) of Mg^{2+} is suitable for irrigating crops. The measured Mg^{2+} content of groundwater samples were varied from 21.52±0.30 to 40.04±0.46 mg L^{-1} (Table 2) that was within the acceptable limit and could safely be used for irrigation.

Table 2. The average values of ionic constituents of groundwater for irrigation

Parameters	Sampling period	Sampling Sites				Min. Max
		Tangail Sadar	Kalihati	Delduar	Nagarpur	
Ca^{2+} (mg L^{-1})	March	40.46±2.42	34.01±1.50	45.34±1.61	53.09±2.45	34.01±1.50
	April	48.64±2.41	42.23±2.30	52.59±4.02	59.97±3.19	63.38±3.58
	May	52.23±3.27	45.78±2.27	55.86±3.85	63.38±3.58	
Mg^{2+} (mg L^{-1})	March	32.05±0.34	28.45±0.58	35.42±0.63	40.04±0.46	21.52±0.30
	April	27.70±0.82	23.48±0.31	31.89±1.34	34.90±0.56	40.04±0.46
	May	24.60±0.92	21.52±0.30	29.36±1.86	32.85±1.00	
Na^{+} (mg L^{-1})	March	19.26±0.31	28.32±1.12	20.94±0.78	22.78±0.94	19.26±0.31
	April	23.72±0.88	23.49±1.06	23.79±1.00	25.07±0.80	26.10±0.78
	May	25.60±0.33	22.89±1.12	24.63±1.49	26.10±0.78	
K^{+} (mg L^{-1})	March	0.69±0.08	0.63±0.06	0.78±0.06	0.76±0.05	0.63±0.06
	April	0.76±0.07	0.69±0.08	0.87±0.08	0.82±0.05	0.92±0.06
	May	0.82±0.05	0.73±0.07	0.92±0.06	0.87±0.04	
Cl^{-} (me L^{-1})	March	0.65±0.03	0.57±0.07	0.70±0.03	0.77±0.03	0.57±0.07
	April	0.71±0.04	0.64±0.04	0.76±0.02	0.84±0.04	0.88±0.03
	May	0.76±0.03	0.68±0.05	0.80±0.02	0.88±0.03	
HCO_3^{-} (me L^{-1})	March	0.72±0.11	0.64±0.09	0.89±0.10	1.07±0.08	0.64±0.09
	April	0.77±0.10	0.70±0.11	0.96±0.13	1.14±0.05	1.17±0.06
	May	0.81±0.11	0.73±0.13	1.00±0.14	1.17±0.06	
PO_4^{3-} (mg L^{-1})	March	0.16±0.02	0.19±0.01	0.20±0.02	0.21±0.02	0.15±0.01
	April	0.17±0.01	0.20±0.02	0.21±0.01	0.22±0.02	0.22±0.02
	May	0.15±0.01	0.18±0.01	0.18±0.02	0.20±0.02	
SO_4^{2-} (mg L^{-1})	March	2.21±0.08	2.25±0.10	2.52±0.11	2.73±0.07	2.14±0.05
	April	2.14±0.05	2.17±0.06	2.43±0.13	2.60±0.09	2.73±0.07
	May	2.18±0.08	2.20±0.09	2.47±0.09	2.65±0.10	

In groundwater samples, the status of Na^{+}, K^{+} and Cl^{-} ions ranged from 19.26±0.31 to 26.10±0.78 mg L^{-1}; 0.63±0.06 to 0.92±0.06 mg L^{-1} and 0.57±0.07 to 0.88±0.03 me L^{-1}, respectively (Table 2). On the basis of Ayers and Westcot (1985), the accepted usual limits of Na^{+}, K^{+} and Cl^{-} ions are 920.00 mg L^{-1}, 2.00 mg L^{-1} and 4.00 me L^{-1} respectively. Considering these limits, all groundwater samples containing these ions had no remarkable impact on soil properties and crop growth when applied to soil as irrigation water.

The concentration of CO_3^{2-} did not get in all the groundwater samples. So the pollution of irrigation water by this ion dose not arises at all. Bohn et al. (1985), as reported that the concentration of CO_3^{2-} should be negligible at pH < 9.0 which might be the reason of finding the samples carbonate free, as because the pH of all groundwater samples varied from 7.53 to 8.07. The concentration of HCO_3^{-} of all groundwater samples were ranged from 0.64±0.09 to 1.17±0.06 me L^{-1} (Table 2) where as the recommended maximum limit of HCO_3^{-} for irrigation water used continuously on soil is 1.50 me L^{-1}, as mentioned by Evangelou (1998). So, the groundwater of study area was suitable for irrigation on the basis of HCO_3^{-} content and has no possibility of soil hazard.

The concentration of PO_4^{3-} ion in all groundwater samples were measured from 0.15±0.01 to 0.22±0.02 mg L^{-1} (Table 2) and was within the recommended limit (2.0 mg L^{-1}) as reported by Ayers and Westcot (1985). The groundwater is not hazardous for long-term irrigation and showing no impact on soil properties and crop growth. In all groundwater samples, the SO_4^{2-} content ranged from 2.14±0.05 to 2.73±0.05 mg L^{-1} (Table 2) and was not problematic when applied to soil as irrigation water, because of persisting below the permissible limit (20.00 mg L^{-1}) for irrigation (Ayers and Westcot, 1985).

In the study area, trace amount of Fe and Mn (<0.01 mg L^{-1}) were detected in all groundwater samples. Ayers and Westcot (1985), reported that the maximum recommended concentration of Fe and Mn in water used for irrigation is 5.0 mg L^{-1} and 0.20 mg L^{-1}, respectively that indicate the groundwater as fresh water and no ionic constituents are considered as hazardous to crop growth for irrigation

CONCLUSION

From the investigation, it can be concluded that groundwater of the study area would not create any problem for irrigation which related to soil properties and crop growth and that have not long term effects on irrigating agricultural crops, that could be safely used for irrigation purpose in Tangail district, hence all of the groundwater samples were within the standard limit. Finally it can be recommended that, the water quality must be tested with time interval for better planning of any irrigation system to sustain the crop production.

REFERENCES

1. APHA (American Public Health Association), 2012. Standard Methods for the Examination of Water and Waste water. 19th ed., Washington DC, USA, pp. 1-30, 40-175.
2. Ayers RS and Westcot DW, 1985. Water Quality for Agriculture. FAO Irrigation and Drainage Paper, 29: 196.
3. Banglapedia, 2008. National Encyclopedia of Bangladesh, Asiatic Society of Bangladesh.
4. BBS, 2006. Statistical Yearbook of Bangladesh, Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.
5. BBS (Bangladesh Bureau of Statistics), Cultural survey report of Tangail Zila, June, 2012.
6. Bohn HL, McNeal BL and 0' Conner GA, 1985. Soil Chemistry. 2nd ed., John Wiley and Sons, New York, pp. 239-245.
7. Evangelou VP, 1998. Environmental Soil and Water Chemistry: Principles and Applications. John Wiley and Sons, Inc., New York, USA, pp. 478-485.
8. Ghosh AB, Bajaj JC Hasan, R and Singh D, 1983. Soil and Water testing Methods: A Laboratory Manual. Division of Soil Science and Agricultural Chemistry, IARI, New Delhi, India, pp. 1-48.
9. Golterman HL (ed.), 1971. Methods for Chemical Analysis of Fresh waters. Blackwell Scientific Publications, Oxford, pp. 41-42.
10. Lal R and Stewart BA (ed.), 1994. Soil Processes and Water Quality. Lewis Publishers, Boca Raton, Florida, USA, pp. 2-3.
11. Michael AM, 1978. Irrigation: Theory and Practice. Vikas Pub. House Pvt. Ltd. pp. 448-452.
12. Page AL, Miller RH and Keeney DR (eds.) 1982. Methods of Soil Analysis. Part-2. 2nd edn., American Society of Agronomy, Wisconsin, USA, pp. 98-765.
13. Richards LA (ed). 1968. Diagnosis and Improvement of Saline and Alkali Soils. Agricultural Hand Book 60, USDA and IBH. Publishing Co. Ltd. New Delhi, India, pp. 98-99.
14. Schwartz FW and Zhang H, 2012. Fundamentals of Ground Water. Wiley India Pvt. Ltd. New Delhi, India, pp. 374-377.
15. Tandon HLS (ed.), 1993. Methods of Analysis of Soils, Plants, Waters and Fertilizers. Fertilizer Development and Consultation Organization, New Delhi, India, pp. 90-91.
16. Todd DK and Mays LW, 2004. Ground water Hydrology. 3rd ed., John Wiley and Sons Inc., New York, USA.