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Physicochemical Evaluation of Ground and Surface Water of Mohanpur Upazila of Rajshahi District

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Abstract

Surface and ground water samples of Mohanpur Upazila of Rajshahi district have been analyzed in order to check its quality especially for drinking, fish culture, irrigation and industrial purposes. The water supplies were analyzed for pH, temperature, electrical conductivity, chloride, hardness, alkalinity, manganese (Mn), lead (Pb), cadmium (Cd) and arsenic (As). All water samples were tasteless at the time of collection. pH values for surface water were 7.72-8.61 and those of ground water were 6.87-710; Total hardness for surface water was112-181 ppm and ground water was 224-400 ppm as $CaCO_3^-$; Electrical conductivity (EC) for surface water was 233-645 μScm^{-1} and that of ground water was 750-987μScm^{-1}. Total dissolved solids (TDS) for surface water were 161.1-451.9 ppm and ground water were 490.7-690.9 ppm. Chloride content for surface water was 81.79-131.78 ppm and ground water was 13.06-57.36 ppm; alkalinity for surface water was 398.21-539.73 ppm HCO_3^- and ground water was 373.81-495.80 ppm HCO_3^- ; Nitrate for surface water and ground water was 2.10-5.20 ppm and 0.09-2.8 ppm respectively. Concentrations of Pb and As were within the permissible limit. Surface water was suitable for fish culture and agriculture purposes. However, a few water samples were found to be contaminated with Mn and Cd. It is concluded that the quality of ground water in the area is in general good for drinking, agriculture, industrial or domestic purposes.

Key word: Alkalinity, Atomic adsorption spectrophotometer (AAS), Chlorides and TDS, Hardness, Heavy metals, Toxicology

1. Introduction

Water pollution is a major problem in our country. Polluted water is responsible for water borne diseases. Its use makes problem when such water is used in industries, agriculture, fish culture etc. Water obtained from different sources is associated with a large number of impurities **(**Sharma, 1994). It becomes contaminated when mixed with sewage and industrial wastes. It pollutes the ground water through percolation. Arsenic contamination has been reported in ground water in 41 out of 64 districts in Bangladesh (Samanta *et. al,* 1994). The presence of other heavy metals also plays toxic roles to human health. Many of them exert cumulative effects. Past research reports indicate that physiochemical evaluation of ground and surface water of Mohanpur upazila is need reported so far considering the above views in mind. Mohanpur upazila of Rajshahi district has been considered as an investigation area. With the following objective. For the purpose, some important water quality parameters as well as the concentration of a few heavy metals have been measured.

2. Experimental

2.1 Equipments and reagent

The equipments used for the purpose are as follows: AAS (Model-AA-6800) Japan, UV-Visible Spectrophotometer (Model-T60) England, pH meter (Model-KRK,KP-5Z,Japan) Japan, Electric balance(Model-Chyo, MP-3000) Japan, Refrigerator (Model-Samsung) Korea, Hot Plate(Model-Stuart Scientific, SH) UK1-100 µl micro pipettes(Model-Huawei) China,10-1000 µl micro pipettes(Model-Huawei) China, Magnetic stirrer(Model-J-6, 90-1) China, Filter paper(Model-Whitman 41) China, Conductivity meter (Model-HANNA HI 9033) Singapur, Thermometer (Model-N/F BS 1740) England.

2.2 Reagents

All the chemicals used were reagent grade.

2.3 Sampling technique

For the purpose ten ground and ten surface water samples throughout the area were collected in plastic containers from hand tube wells and different ponds during the month of April – December of 2010. Clean, dry and sterilized plastic containers were used to get ground and surface water for sampling. Before collecting the ground water samples, the tube-wells were pumped 5/6 minutes to get the actual ground water. For surface water samples, from 1ft below the surface were collected carefully sealed.

2.4 WATER COLLECTION AND PRESERVATION

Ground water and surface water samples were taken from various locations of twenty points. The location of water sample collected has been shown in the map of the study area (Fig 1). For the determination of metallic constituents, water samples were acidified with HNO_3.

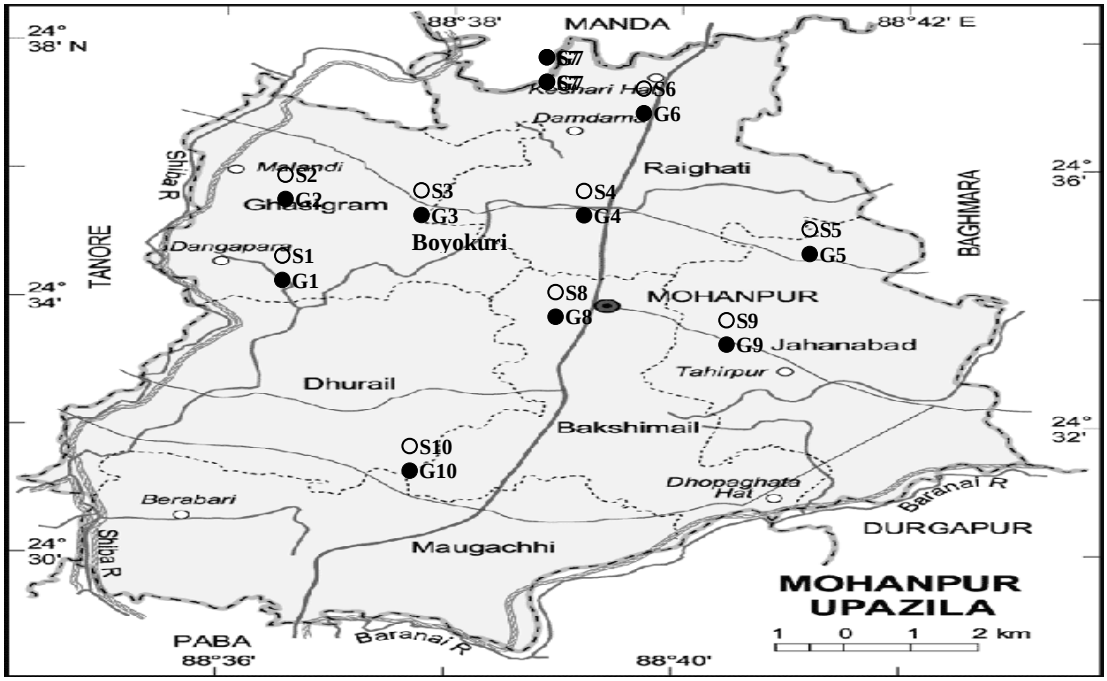

Fig: 1. Map of the study area of Mohanpur upazila

2.5 Labeling of samples

The containers were labeled with the following information during sampling

a) Date
b) Sample number
c) Exact point of sampling
d) Temperature

2.6 Electrical conductance (EC)

The conductivity of the water samples were measured as soon as possible after collection. A digital EC meter Model: HI 9033, HANNA, Singapore, was used for this purpose.

2.7 Total dissolved solids (TDS)

The total dissolved solids (TDS) of the samples were recorded by TDS probe of EC meter.In present investigation TDS were determined with the help of an equation (Metcalf *at. al*, 2003)

TDS (mg/L) = EC (µs/cm x 0.7)

2.8 pH

pH in the field and in the laboratory samples was measured by a digital pH meter (Model KRK, KP-5Z, Japan).

2.9 Total hardness

Total hardness of water samples were measured by EDTA titration. Sample was taken in a conical flask. To it 1mL of ammonia buffer solution and 2-3 drops of Eriochrome black T were added, the solution was turn into wine red. The content was titrated with 0.01 M EDTA the coolor was changed to blue at the end point (Tripathi, *et. al*, 2001)

2.10 Alkalinity

The alkalinity of water is due to dissolved hydroxide, carbonate and bicarbonate and determined by neutralization titration.

2.11 Chlorides

Chlorides in water as free ion is one of the major inorganic anions in water and measured by Mohr's method[13].

2.12 Determination of major cations by AAS

To determine the concentration of metal ions, a calibration curve was made with the standard solutions. Then the metal ion of the sample was found out from the calibration curve.

3. Results and Discussion

All the samples collected were found to be odorless and tasteless. Some ground water samples were yellowish red that might be due to the presence of iron. All surface water samples were shown pale green-blue in color. The ground waters are slightly acidic to neutral in nature and within the safe limit for drinking. Bangladesh water pollution control board

(BWPCB, 1976) and World health organization (WHO**,** 1971) have recommended the standard values of pH range 6.5 to 9.2 for potable water. On the other hand, the lowest and highest pH value of surface water in this area was 7.72 and 8.6 which indicates that the surface water of the area is slightly alkaline in nature.

Table 1. Odor, Color, pH, EC and TDS of surface and ground water

	No of Obs.	Odor	Color	pH in the field	pH in the lab	EC in (μScm^{-1})	TDS (ppm)
Surface Water	S_1	Nil	Light green	8.54	8.56	377	263.9
	S_2	Nil	Light green dirty	8.20	8.25	645	451.5
	S_3	Nil	Light green	8.36	8.55	382	267.4
	S_4	Nil	Pale green-blue	7.72	7.98	560	392
	S_5	Nil	Pale green-blue	8.33	8.32	233	161.1
	S_6	Nil	Pale green-blue	7.95	8.01	290	203
	S_7	Nil	Pale green-blue	8.25	8.3	470	329
	S_8	Nil	Pale green-blue	8.60	8.6	390	273
	S_9	Nil	Pale green-blue	8.59	8.7	555	388.5
	S_{10}	Nil	Pale green-blue	8.39	8.45	488	341.6
Ground water	G_1	Nil	Nil	6.97	7.19	867	606.9
	G_2	Nil	Yellowish	7.03	7.30	766	536.2
	G_3	Nil	Nil	7.08	7.10	910	637
	G_4	Nil	Nil	6.92	7.20	701	490.7
	G_5	Nil	Yellowish	6.87	7.25	950	665
	G_6	Nil	Nil	6.95	7.27	920	644
	G_7	Nil	Nil	7.00	7.14	810	567
	G_8	Nil	Nil	6.88	7.34	750	525
	G_9	Nil	Yellowish	7.10	7.18	956	669.2
	G_{10}	Nil	Nil	6.98	7.16	987	690.9

Water having a pH range **(**Anderws, 1972**)** from 6.7 to 8.6 will generally support a good fish culture when other parameters are favorable. So the present values of pH also indicates that the ground and surface water in this area is not objectionable to fish culture, irrigation, domestic, and other purposes. The electrical conductivity of ground water samples varies from 701 to 987 μScm^{-1}. This indicates high mineralization of the ground water. On the other hand the lowest and highest values of the surface water are 233 to 645 μScm^{-1}. These values indicate that the surface water of this area is slightly mineralized. The highest value of conductivity may be due to high concentration of ionic constituents present in the water bodies. The highest and lowest TDS values of ground water of Mohanpur Upazila were recorded as 490.7 to 690.9 ppm respectively. Water sample containing TDS value less than 1000 ppm is rated as fresh water. The maximum permissible limit (WHO, 1967) of TDS for drinking water is 1500 ppm. According to WHO standard all water samples considered in the present investigation are within the safe limit of TDS value. On the other hand the highest and lowest values of surface water samples of Mohanpur Upazila were 161.1 to 451.5 ppm. So the present values of TDS indicate that the ground and surface water in this area are not objectionable to irrigation purpose and fish culture.

Ground water hardness of the Mohanpur Upazila varies from 222 to 400 ppm as $CaCO_3$ which is safe for drinking purpose since the highest desirable (WHO, 1967) and maximum permissible limit of hardness values are 100 to 500 ppm as $CaCO_3$ respectively. According to the above mentioned view, the tube well water samples are classified as hard. On the other hand, surface water samples are classified as moderately hard. In general the ground water of the area is hard and associated with scale formation on boiler units, heating pipes etc and need to be softened if used for industrial purpose.

Table 2. Total Hardness, Alkalinity, Chloride and Nitrate in surface and ground water

	No of Obs.	Total Hardness	Alkalinity (ppm)	Chloride (ppm)	Nitrate (ppm)
Surface water	S_1	112	398.21	97.128	3.95
	S_2	124	500.68	131.78	5.154
	S_3	116	519.23	98.83	2.20
	S_4	174	528.99	92.58	2.85
	S_5	181	484.95	93.15	4.53
	S_6	112.8	539.73	120.98	2.10
	S_7	138.4	481.168	151.08	3.35
	S_8	128.8	534.85	106.78	5.20
	S_9	164.8	509.47	81.79	2.40
	S_{10}	120	499.71	116.44	5.20
Ground water	G_1	222	393.33	52.256	0.08
	G_2	301.6	416.75	23.86	0.30
	G_3	323.2	373.81	22.152	0.09
	G_4	360	394.304	27.26	0.09
	G_5	279.2	432.37	13.06	0.10
	G_6	364	446.03	41.46	0.24
	G_7	337.6	402.11	30.18	0.15
	G_8	400	421	36.35	2.80
	G_9	396	495.80	57.368	0.28
	G_{10}	272	373.80	38.62	0.25

The surface water also needs to be softened if it is used for industrial purpose in terms of hardness. The alkalinity of the ground water of the study area varies from 373.80 to 495.80 ppm. The concentration of bicarbonate in the ground water usually remains below 500 ppm. So the alkalinity of ground water in the study area expresses the suitability of water for drinking and irrigation purposes. On the other hand the alkalinity of surface water of the study area varies from 398.21 to 539.73 ppm. Results indicate that most of the surface water samples in the study area contain alkalinity beyond the acceptable level but a few water samples exceed the acceptable level. It is evident from the above results that chloride content of ground water samples of the study area vary from 13.06 to 57.37 ppm and surface waters are vary from 81.79 to 151.08 ppm. Water containing less than 250 ppm chloride, is suitable for drinking, agricultural and industrial purpose**s** (Anderson, 1966) . In the view of the above facts, the chloride content of both the ground and surface water in this investigation lies within the level recommended for drinking, household and other purposes. The concentrations of nitrate in ground and surface water samples vary from 0.09 to 2.80 ppm and 2.10 to 5.20 ppm respectively. It was observed that nitrate concentrations of surface water were higher than those of ground waters. Because the farmers use urea/nitrate fertilizers during cultivating and a portion of which might be leached out with the irrigation rain water and accumulated in water reservoir, pond and river. In the present investigation nitrate ion concentration in all water samples was found in the range of 0.09 to 5.20 ppm, which are far below the maximum acceptable limit. The acceptable level (Sharma, 1994) of NO_3/NO_2 is 10 ppm for drinking water and household purpose.

The concentrations of lead in ground and surface water samples vary from 13.63 to 15.79 ppb and 7.97 to 13.96 ppb respectively. Natural waters usually contain upto 20 ppb of lead, but in some cases, it might be as high (Sharma, 1994) as 400 ppb. The recommended value (WHO, 1967) of lead is 0.1 ppm**.** It is observed that lead content in the ground and surface water samples of Mohanpur Upazila of Rajshahi district are within the recommended values. The concentration of cadmium in ground and surface water samples varies from 0.0004 to 0.0190 ppm. National and international regulation agencies have recommended that the total Cd concentration should not exceed the maximum of 0.01 mg/L in drinking water supply **(**Hakanson, 1990).

Table 3. Concentration of Pb, Cd, Cr, Mn and As in surface and ground water

	No of Obs.	Lead (Pb) ppb	Cadmium (Cd) ppm	Manganese (Mn) ppb	Arsenic (As) ppb
Surface Water	S_1	8.3438	0.0008	2.8577	1.7153
	S_2	7.7919	0.0004	0.9036	2.5900
	S_3	8.3438	0.0080	1.0392	1.7886
	S_4	11.7962	0.0012	2.6794	2.4141
	S_5	5.3443	0.0067	1.6466	2.4434
	S_6	10.9149	0.0089	1.4906	2.7562
	S_7	11.0604	0.0092	1.5360	2.7855
	S_8	6.4681	0.0015	1.9091	3.0885
	S_9	12.8553	0.0055	1.9727	3.3524
	S_{10}	13.5951	0.0018	1.5891	2.5411
Ground water	G_1	13.9630	0.0123	0.7211	3.1471
	G_2	15.9034	0.0604	1.1967	3.1276
	G_3	15.4887	0.0037	3.6599	2.9663
	G_4	13.9509	0.0117	2.6415	2.0818
	G_5	15.1717	0.0077	1.1604	2.2577
	G_6	15.2000	0.0067	1.9064	2.2528
	G_7	13.6315	0.0110	1.8186	2.2528
	G_8	15.3132	0.0153	1.8792	3.1569
	G_9	14.5128	0.0190	1.7992	2.4141
	G_{10}	15.7902	0.0169	1.5360	2.8050

It is observed that out of 10 ground water samples, the cadmium content of 3 remains within the recommended limit and that for others exceeds it. Cadmium is very toxic and poisonous and traces of it may cause adverse change in arteries of human kidneys. It can be concluded from the present work that surface water is free from Cd concentration while ground waters contain Cd in alarming stage. The concentrations of manganese in ground and surface water samples vary from 0.074 to 1.90 ppb and 1.04 to 2.98 ppb (after dilution in 25 times). The recommended value of Mn in drinking water is 0.05-0.1 ppm. WHO specifies the permissible limit for Mn as 0.00 mg/L and highest limit 0.5 mg/L. It is obvious that the concentration of Mn in the study area is much higher than the recommended values and cannot be considered as suitable for drinking water in terms of Mn concentration. A daily intake of 2.5 to 5 mg of this metal by human beings contributes to the well-being of the cells because it acts as a co-factor in some enzymatic reactions. However, when exposed to higher levels, it gets accumulated in kidney, liver and bones and cause Manganese psychosis (Patil *et. al*, 2004). Although manganese is not very toxic metal, it imparts objectionable and tenacious stains to laundry plumbing fixture and causes various difficulties as described in the introduction. The recommended and tolerance limits of arsenic in water samples are 0.01 to 0.05 ppm respectively (WHO). The recommended value[10] for Bangladesh is 0.05 ppm**.** Therefore, almost all water samples in the study area are free from arsenic contamination.

The temperature of surface water of Mohanpur upazila at Rajshahi district varies from 31.5^0C to 33^0C and the ground water varied from 27.3 to 29.6^oCWithin this range of ground water temperature is suitable for drinking purpose. On the other hand the range of temperature is also suitable for industrial, fish culture, irrigation, domestic and other purposes.

4. Conclusion

From the results of the present investigation, it is concluded that the quality of surface and ground water in the area is in general good for utilization in drinking, agriculture, industrial or domestic purposes and fish culture. However a few water samples are found unsuitable specially due to high Cd and Mn contents. The present status should not let continue unconcerned for the situation may get critical in near future. Measures should be taken to regulate the water quality determining parameters as well as to minimize Mn and Cd contents at best in drinking water. Government and Public Health Departments may play vital role in Mohanpur Upazila of Rajshahi district.

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