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Preliminary Assessment of Quality of Water in Gazipur District, Bangladesh

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Total 26 water samples were collected in BSMRAU campus and in Gazipur District where BSMRAU is situated, Bangladesh, in March (the late dry season) 2001. Samples were taken from surface water (river, pond, lake, canal and reservoir) and ground water. Ground water was found to be suitable to drinking or irrigation. Quality of surface water varied with sampling locations and water sources. Among surface-water samples, the concentration of NO_3^- -N was highest for water taken from the Turag River (3.6 mg/L) followed by water from the Belai River (2.5 mg/L). The P concentration was also highest for water of the Turag River (0.34 mg/L). Discharge of municipal waste water from houses along the river, in addition to inflow of N fertilizer applied to agricultural fields, was proposed to the contamination of the Turag River. Progress of eutrophication or pollution in small rivers in Gazipur District may cause a serious impact on environment and human health in future. Detailed and comprehensive assessment is strongly requested.

INTRODUCTION

Dhaka is the capital of Bangladesh. Population of Dhaka City has rapidly increased in recent years and is now estimated to be about 10 million. The rapid population growth, its concentration to Dhaka City, and rising in the living standard have led to substantial increase in the quantity and diversity of waste products, particularly municipal solid waste and sewage sludge. Economic development in Dhaka City has driven industrialization, but waste water and solids from factories have been increasingly discharged to environment. There is huge motorization in addition, which produces much exhaust gas. The rapid growth and concentration of population, industrialization and motorization in big cities parallel development and modernization of the country but bring about serious air, water and soil pollution. This is now breaking out in Asian countries and is most typically revealed in Vietnam (Ho *et al.*, 1998).

Gazipur District is neighboring on the north of Dhaka District. It comprises 6 Thana (meaning police station), and DC office is located at Joydebpur. Population is about

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2 million and is increasing. Total land area is 1,741 km². The district is based on agriculture, but recently there is development in different industries. Textile and chemical industries are in operation in some areas. Several food companies have been shifted from Dhaka City. Poultry farming in farmers' and commercial levels is increasing. Construction of roads is progressing, leading to enhanced motorization.

Gazipur District is situated in Madhupur Tract, a Pleistocene upland terrace (5 to 25 m above MSL), and is lacking in natural water resources. For this reason, many ponds of different sizes have been constructed in Gazipur District. These ponds have multi-purpose. Irrigation is a main purpose. They have been used by local people for cooking, washing and bathing in daily life and for ablutions in the religious event, along with rivers, canals and lakes depending on the availability in the areas. In recent years, however, eutrophication or pollution of these water bodies is feared to bring about the serious impact on environment and human health. Following factors are considered as possible causes bringing about eutrophication or pollution: over-application of chemical fertilizers and agricultural chemicals to the fields, followed by contamination of water bodies due to overflow or runoff of surface soil on the time of heavy rainfall or through percolation into ground water; increase in the discharge of municipal waste water from surrounding houses and restaurants due to growth and concentration of population and to rising in the living standard; explosion of poultry farming, which may have a serious impact on environment if proper management or treatment of waste materials is not executed; and increase in the discharge of industrial waste water and solids without trapping and chemical treatments. Sustaining of quantity and quality of water is a first-priority national project in Bangladesh.

Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU; former Institute of Postgraduate Studies in Agriculture (IPSA)) is situated in Gazipur District and has high educational, research and outreach activities of agricultural fields in Bangladesh. As a technical cooperation to BSMRAU in "IPSA Project Aftercare", quality of surface and ground water sampled at several sites in BSMRAU campus and at several locations in Gazipur District was assessed. This is a report of the water analysis performed in Soil Science Department of BSMRAU in March 2001.

MATERIALS AND METHODS

Water samples

Water samples collected in BSMRAU campus and Gazipur District are briefly described in Table 1. The samples were collected during March 18 and 25, 2001. Because no rainfall occurred since November 2000, water level was quite low at the time of sampling. In sampling of surface water, 50 mL of water was taken from the 0–15 cm depth by a can at five spots and was mixed into a 250-mL bottle. They were brought to the laboratory and filtered through Whatman No. 1 filter paper before analysis. In addition, 250 mL of ground water was collected from shallow and deep tubewells. Shallow and deep ground water was clear and analyzed without filtration.

Nine surface water samples were collected from all water bodies (1 reservoir, 4 lakes and 4 ponds) in BSMRAU campus. The reservoir is a pond for reserving irrigation water. Two out of 4 ponds were used for washing of clothes or bathing of water-buffalos at the

time of sampling, and bathing of local people was seen in another pond later. Waste water is known to have been discharged from houses to some of the lakes. Fifteen surface water samples were collected at 3 rivers, 1 canal, 7 ponds (big-, small- and mini-) and 2 lakes in Sripur and Gazipur sadar Thanas of Gazipur District. They were used at the time of sampling by local people for bathing, for washing of dishes and pans, and/or for washing of body and hair, or were told to be in use by farmers who came to see water sampling.

Analytical methods

Following methods or equipment were used for the analysis.

pH: pH meter (Horiba).

Electrical conductivity (EC): conductivity meter (Eutech Instrument).

Ca, Mg, K and Na concentrations: atomic absorption spectrophotometer (Hitachi).

NO₃⁻ concentration: RQflex 2 (Merck). This is part of the Reflectoquant system.

According to the principle of reflectometry (remission photometry) reflected light from the slip is measured. Like in photometry, the difference in the intensity of emitted and reflected light allows a quantitative determination of specific analytes (quoted from the instruction book). Reflectoquant NO₃⁻ test paper with a range of 3–90 mg NO₃⁻/L was used.

P concentration: ascorbic acid method. Intensity of blue color was measured at 710 nm by spectrophotometer (Hitachi).

RESULTS AND DISCUSSION

Analytical data for surface and ground water samples collected in BSMRAU campus and Gazipur District is shown in Table 2.

BSMRAU campus

In BSMRAU, ground water from a deep tubewell (sample No. 11) is used for drinking.

Table 1. Brief description of water samples.

BSMRAU campus		
Sample No.	Water source	Conditions and remarks
1	pond	slightly turbid; used for bathing
2	lake	covered with waterhyacinth in the 1/3 to 1/2 part of water surface
3	lake	covered with waterhyacinth in the whole water surface
4	reservoir	reserving irrigation water ; not clear with some tree leaves in water
5	pond	slightly turbid; used for washing of clothes
6	pond	slightly turbid
7	lake	covered partly with waterhyacinth; turbid with green color
8	pond	slightly turbid; used for bathing of water–buffalos
9	lake	covered with waterhyacinth in the 1/3 part of water surface
10	ground water	collected from a shallow tubewell; clear
11	ground water	collected from a deep tubewell as tap water; clear

Gazipur District*Sripur Thana*

Sample No.	Location	Water source	Conditions and remarks
12	Barmi bazar	river	collected from a launching site in the Shitalakha River; slightly turbid; used for bathing
13	Barmi bazar	river	collected from the site of a drain from poultry farming in the Shitalakha River; water is dark purple in color and slightly turbid; used for bathing
14	Barmi bazar	river	collected from a no-affected site in the Shitalakha River; no turbid; used for bathing
15	Hhadhia	pond	big-pond; slightly turbid; used for bathing
16	Sripur sadar	pond	small-pond; partly covered with waterhyacinth and some other plants; slightly turbid; used for bathing
17	Maona	pond	Pear Ali Degree College pond (big-pond); slightly turbid; used for bathing

Gazipur sadar Thana

18	Nagapara	pond	big-pond; slightly turbid; used for bathing and washing of dishes and pans
19	Kodda	river	collected from the Turag River under the Kodda bridge; water is dark purple in color and slightly turbid; a few waterhyacinthes; used for bathing, washing of dishes and pans, and washing of body and clothes
20	Naozore	lake	turbid with dark green color; used for bathing, washing of dishes and pans, and washing of clothes; bathing of water-buffalos and cows
21	Keshorti	river	collected from the Belai River near the bamboo bridge; slightly turbid; partly covered with waterhyacinth
22	Joydebpur, Razbari	lake	turbid with dark green color; used for bathing, washing of dishes and pans, and washing of clothes
23	Joydebpur, Shibbari	pond	small-pond; turbid with dark green color; pond for fish culture; used for bathing and washing of dishes and pans by some people
24	Palashtoli	canal	used for irrigation; slightly turbid; a few waterhyacinthes; used for bathing
25	Salna	pond	mini-pond; turbid with green color; used for washing of dishes and pans; used for bathing only in the monsoon season
26	Salna	pond	mini-pond; turbid with green color; used for washing of dishes and pans; used for bathing only in the monsoon season

The NO_3^- -N concentration was <0.7 mg/L. It was below the detection limit of the instrument and was quite low compared to the international criterion as drinking water (10 mg NO_3^- -N/L). The pH was in the normal range of 6.6 to 8.5 as drinking water. Ground water from a shallow tubewell (sample No. 10) is used for irrigation to the fields in BSMRAU farm and was in the same magnitude or range in individual item as ground water from a deep tubewell. Sodium adsorption ratio (SAR: $[\text{Na}^+](\text{meq/L})/\{([\text{Ca}^{2+}] + [\text{Mg}^{2+}])/2\}^{1/2} (\text{meq/L})$) was calculated for sample No. 10. The calculated SAR was 2.9, and the water was regarded as "excellent" (S1) for crop irrigation and would not cause soil deterioration (Sarker *et al.*, 2000). Electrical conductivity (EC) was 0.33 dS/m and was found to be "good" for

Table 2. Selected properties of water samples.**BSMRAU campus**

Sample No.	pH	EC (dS/m)	Cations (mg/L)				NO ₃ ⁻ -N (mg/L)	P (mg/L)
			Ca	Mg	K	Na		
1	6.7	0.068	8	1.2	1.8	37	0.7	0.05
2	7.7	0.313	30	2.7	1.5	53	0.7	0.07
3	7.4	0.341	30	2.7	2.2	53	1.1	0.05
4	7.7	0.269	22	2.7	2.3	55	<0.7	0.04
5	7.1	0.073	11	1.2	2.6	23	<0.7	0.04
6	7.4	0.168	16	1.8	1.6	53	<0.7	0.04
7	9.0	0.400	25	2.7	6.0	55	1.8	0.27
8	8.2	0.277	37	2.5	3.2	55	0.7	0.03
9	7.8	0.291	36	2.6	2.0	55	<0.7	0.03
10	7.4	0.330	22	2.6	2.2	55	<0.7	0.05
11	7.3	0.317	24	2.7	2.8	54	<0.7	0.06

Gazipur District*Sripur Thana*

Sample No.	pH	EC (dS/m)	Cations (mg/L)				NO ₃ ⁻ -N (mg/L)	P (mg/L)
			Ca	Mg	K	Na		
12	7.9	0.334	50	3.0	4.0	50	0.9	0.05
13	7.7	0.337	44	2.9	3.8	50	0.7	0.04
14	8.1	0.332	47	2.9	3.6	50	<0.7	0.05
15	7.7	0.129	30	1.6	4.2	38	<0.7	0.04
16	7.6	0.138	20	1.5	6.0	44	<0.7	0.04
17	7.8	0.261	37	2.2	11.0	51	1.1	0.07

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18	7.5	0.183	43	2.0	5.0	49	0.7	0.05
19	8.1	1.128	50	2.8	9.8	51	3.6	0.34
20	7.6	0.317	50	2.6	7.0	51	0.7	0.05
21	8.6	0.540	50	2.9	7.2	51	2.5	0.04
22	8.4	0.397	47	2.8	10.4	54	<0.7	0.18
23	7.8	0.633	56	2.8	9.0	53	0.7	0.07
24	7.8	0.458	42	2.8	4.0	53	1.1	0.07
25	7.5	0.258	47	2.3	10.2	53	<0.7	0.07-0.04*
26	7.9	0.515	63	2.7	12.5	54	<0.7	0.07-0.04*

*The concentration was calculated as 0.12 and 0.18 mg/L for samples No. 25 and No. 26, respectively, from the reading of absorbance. But, this is due to turbidness of water, because no visible blue color development was noticed. Therefore, P concentration was estimated to be 0.07-0.04 mg/L.

irrigation use (Sarker *et al.*, 2000). Total hardness (H_T (mg/L): $[Ca^{2+}] \times 2.5 + [Mg^{2+}] \times 4.1$) was calculated as 66, indicating the “soft” category of the water and suitability for irrigation (Sarker *et al.*, 2000). As a whole, ground water of a shallow tubewell in BSMRAU was evaluated to be suitable for crop irrigation.

Concerning surface-water samples, pH was in a range of 6.7 to 8.2, except for sample No. 7. EC was lower for samples No. 1 and No. 5, and this was ascribable to their lower Ca and Na concentrations. The Ca concentration was somewhat variable with samples, but the concentrations of the other three cations were in a relatively narrow range and were nearly equal to or lower than the corresponding concentrations in ground water. Exception was the K concentration of sample No. 7. Exception or difference of sample No. 7 from the other samples was also indicated for the NO_3^- -N and P concentrations. The NO_3^- -N concentration was 1.8 mg/L for sample No. 7, followed by 1.1 mg/L of sample No. 3, while was at or below the detection limit (0.7 mg/L) for the remaining samples. The P concentration was again higher for sample No. 7 (0.27 mg/L).

The averaged NO_3^- -N concentration of canal and pond water of Narayanganj District, Bangladesh, was reported to be 0.55 mg/L with a variation of 0.04 to 1.27 mg/L (Sarker *et al.*, 2000). The averaged value and variation of the P concentration was 0.10 mg/L and 0.01 to 0.74 mg/L, respectively, but the P concentration was mostly around or below 0.10 mg/L (Sarker *et al.*, 2000). The NO_3^- -N and P concentrations of sample No. 7 were a little but distinctly higher than the concentrations reported for canal and pond water of Narayanganj District, while the NO_3^- -N and P concentrations of the other samples were in the concentration ranges reported for them.

The relatively high NO_3^- -N and P concentrations of sample No. 7, along with the K concentration exceeding the concentrations of the other samples, indicate progress of eutrophication in sample No. 7. This sample was collected from a small lake which was covered partly with waterhyacinth and was turbid with green color (Table 1). Discharge of waste water to the lake from surrounding houses is known. Green color was found to be due to green algae in vigorously growing. The pH of 9.0 is ascribable to the formation of sodium hydrogencarbonate, in which CO_2 was supplied through respiration of green algae. No progress of eutrophication was indicated for the remaining 3 lakes (samples Nos. 2, 3 and 9) from the present assessment of the quality of water, but growing of waterhyacinth may be a sign of eutrophication.

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Concerning the quality of water of the Shitalakha River, values of individual item of the 3 different-site samples were quite similar with one another. Impact of drainage from poultry farming on the quality of water was not detected, probably due to dilution effect of river water. The Shitalakha River has a width of about 100 m at the sampling sites in Barmi bazar, and is not so small river even in Bangladesh. The averaged values for the Shitalakha River in Barmi bazar were as follows: pH, 7.9; EC, 0.334 dS/m; cations, Ca 47, Mg 2.9, K 3.8 and Na 50 mg/L; NO_3^- -N, 0.7 mg/L; and P, 0.05 mg/L.

Among water-samples from 3 ponds, pH was similar with one another, but EC and the concentrations of cations, NO_3^- -N and P were slightly but consistently higher for sample No. 17 than for samples No. 15 and No. 16. Samples No. 15 and No. 16 showed

similar values for respective items with each other, irrespective of the size of ponds. Their EC was low compared to the EC of water in the Shitalakha River, probably due to the lower concentrations of Ca and Na. The concentrations of NO_3^- -N and P were low, and the quality of water of the samples No. 15 and No. 16 ponds was regarded as "best" among the samples in the present examination. Sample No. 17 was taken at Pear Ali Degree College pond in Maona village. Its high K concentration without the corresponding rise in the Ca concentration can be ascribed to the contribution of cattle excretions, because there is a big cattle market near the pond. This speculation, along with the slightly higher NO_3^- -N and P concentrations, may indicate some progress of eutrophication in the sample No. 17 pond.

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Among 9 water-samples collected in Gazipur sadar Thana, the quality of water of sample No. 18 was evaluated to be "best" following to samples No. 15 and No. 16 in Sripur Thana. Except for sample No. 18, EC of water of ponds and lakes in Gazipur sadar Thana was considerably higher than that for ponds in Sripur Thana. The highest EC was recorded at sample No. 19 from the Turag River. The NO_3^- -N concentration exceeding 1.1 mg/L was measured for only river and canal water (samples Nos. 19, 21 and 24). These rivers and canal are small with the width of 10 to 2 m at the sampling sites. Nitrate in the river and canal flowing through agricultural land mainly originates from N compounds applied as fertilizer to agricultural fields. Nitrogen compounds enter the river and canal as contaminants due to overflow or runoff and ammonium is oxidized to nitrate before or after entering. The high NO_3^- -N concentration in the two rivers at the level of 2.5 to 3.6 mg/L can produce a serious impact on environment and human health. In addition, use of NO_3^- -rich water of the river for irrigation may cause adverse effects on the crop growth and production.

In water from the Turag River (sample No. 19), both the NO_3^- -N and P concentrations were remarkably high compared to other samples and the K concentration was also in the highest range of about 10 mg/L. Such high concentrations of all NO_3^- -N, P and K are surely ascribed to the discharge of municipal waste water from houses along the Turag River, in addition to inflow of N fertilizer. The river water was dark purple in color and appeared dirty at the time of sampling. The quality of water of the Turag River was worse than that of sample No. 7 of a small closed lake in BSMRAU campus. In contrast with the Turag River, water of the Belai River (sample No. 21) was only high in the NO_3^- -N concentration. Entering of N fertilizer is a main event in the Belai River.

Among the cations, the Na concentration was least variable with samples with a narrow range of 49 and 54 mg/L. The Mg concentration showed the rather fixed value of 2.0 to 2.9 mg/L. In contrast, the K concentration considerably varied with samples. In washing of dishes and pans in ponds and lakes, people usually use wood ashes for cleaning them. Therefore, the higher K concentration accompanied with the higher concentration of Ca may come from the long-time use of ashes in washing of dishes and pans. This is the case for most of ponds and lakes in Gazipur sadar Thana (samples Nos. 20, 22, 23, 25 and 26). The reason why the P concentration of sample No. 22 was high compared to other ponds and lake is not clear at present. Sample No. 22 was taken from the Razbari lake at Joydebpur. This lake has been used by many people for bathing and

washing of clothes. Use of cleaning material or a detergent containing P is mentioned as a possibility.

Eutrophication or pollution of ponds and lakes in Gazipur District which have been used by local people was not clarified from the present water analysis but with some indications for samples No. 17 and No. 22. However, most of ponds and lakes in Gazipur sadar Thana were turbid and showed green or dark green color; they were dirty in appearance. This color is ascribed to green algae and may be an indication of eutrophication. In contrast to ponds and lakes, eutrophication or pollution was clearly indicated for small rivers. The total N or NH_4^+ -N concentration should be determined, but there was no time due to a tight schedule. As a next step, biological oxygen demand (BOD), chemical oxygen demand (COD), and the concentrations of heavy metals should be assessed to water bodies in the region. The first target is the Turag River. The quality of the whole river should be made clear by sampling water at different locations having various situations.

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