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Full Length Research Paper

Surface water quality and risk assessment in the vicinity of Sylhet City

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This paper is aimed to determine the surface water quality in an around Sylhet City. We used surface water for our keen purpose. Surface water as well as ground water has been contaminated by humans. Nowadays, water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy **at all levels. In addition to the acute problems of water pollution in developing countries, developed countries continue to struggle with pollution problems as well. Discharges from various contaminated sources are a very common thing in city life which deteriorates the water quality of any main water source and necessary treatment is required to make water potable. Sylhet, one of the six divisional cities of Bangladesh is suffering from shortage of domestic water supply and adequate sewerage lines, drainage and solid waste disposal problems. This paper will focus on evaluation of the existing condition of surface water in Sylhet City and investigating some physical and chemical quality of water throughout the year 2008 to 2009. The selected parameters for assessing the water quality are pH, total dissolved solid (TDS), biochemical oxygen demand (BOD), dissolved oxygen (DO), ammonia nitrogen, nitrate and turbidity in the vicinity of Sylhet City.**

Key words: Ammonia, biochemical oxygen demand (BOD), coliform, dissolved oxygen (DO), treatment, pH.

INTRODUCTION

Water quality assessment is the process of overall evaluation of the physical, chemical and biological nature of the water. The need to verify whether the observed water quality is suitable for intended uses is the main reason for the assessment of the quality of aquatic environment. Water is one of the major components of the life environment. The growing global awareness in the maintenance of a “clean world”, public and private agencies have come to realize the importance of surface water to a national economy. Knowledge of water quality thus plays a significant role in the development of water quality control and management (Lohani and Todino, 1984). Sylhet City, one of the rapidly developing urban areas is located in the northeast region of Bangladesh and situated at 28.85° latitude and 98.80° longitude. The region is in the hilly portion of the country. The city occupies a total area of 26.5 km^2 with a population of around 0.5 million (Sylhet City Corporation, 2005). A total of nine natural drainage channels (locally called chara) are responsible for draining storm water from city area to the Surma and Khushiara River. The main study area Originated from Lakkatura tea graden, it passes over Baluchar, Shibgang, Sobhani Ghat, Chalibondar, Chararpar. At Masimpur the chara falls in the Surma and Khushiara River. As the quality of waste water is not satisfactory, problems like pollution to Surma and Khushiara River and the streams, deterioration of the environment and health sanitation have become serious. The water quality criteria are developed on the basis of pollutants upon a specific use of water. The criteria, therefore, are defined as the acceptable levels of concentration of pollutants for a particular use and describe the water quality requirements for protecting aquatic life. Therefore, the present study has been undertaken to assess water quality parameters which will

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help to evaluate the potential risks, as well as to suggest measures for the prevention of the water pollution.

MATERIALS AND METHODS

The steps that have been adopted to attain the objectives of the study are as follows: Primarily recent stream water quality data, photos and information of surface water in and around Sylhet City has been procured from field observation and analyzed to assess the present water quality scenario. For this study, field observation was needed to know about the existing physical and environmental condition of the study area. During the study of the water quality of surface water in and around Sylhet City, a laboratory test program was under taken to monitor the different parameters which were the main causes of water pollution.

Sample collection

The most important task of water quality analysis is sampling. In order to get the information about the water quality of differents Chara and Surma, Khushiara river grab sampling procedure is applied. Water samples were collected in plastic containers with stopper from surface and from two feet below the top of water surface from different sampling points at second week in every month over the year. Plastic containers of capacity greater than 2000 cm^3 were used for sampling, and 2000 cm^3 of each sample in each location was collected for the study. Water samples were collected from seven locations namely Baluchar, Shibgonj, Uposhahar, Chalibondar, Masimpur, Surma River and Khushiara River.

Water quality testing

The water collected from different points in and around Sylhet City was tested monthly throughout the year. The sample was tested for the parameters like pH, ammonia, dissolved oxygen, BOD_5, and fecal coliform. For fecal coliform testing, membrane filter technique was used. The potable pH meter HI 8014 by HANNA Instruments was used to test pH. For turbidity testing, microprocessor turbidity meter HI 93703 by HANNA Instruments was used. Iron and manganese were tested using HACH UV Spectrophotometer DR/4000U. Suspended solids, dissolved solids, dissolved oxygen were tested by standard Methods developed by The American Public Health Association (APHA), American Water Works Association (AWWA), Water Pollution Control Federation WPCF (1998).

Field visit and questionnaire survey

All the sampling points were visited by walking and by Rickshaw and photograph taken with camera. Questionnaire surveys were distributed to key informants and interviews were done by group discussions with the people living along the Chara.

RESULTS AND DISCUSSION

pH

The standard pH value of surface water is 6.5 to 8.5 (WHO), in that respect, pH at all the points are within the range. The highest value of Goalichara is 7.18 and Surma River is 7.2. The following figure shows the pH data of different points. The highest pH was found at Baluchar and the lowest at Uposhahor. From Figure 1 we see that Goalichara downstream and Surma downstream pH is decreasing. pH decrease at downstream due to acidic waste which are produced from different sources. For these reason we get pH lower at downstream than upstream.

Fecal coliform

Average fecal coliform at Baluchar is 15.5/100 ml, at Shibgonj 26.03/100 ml, at Uposhahor 30.5/100 ml, at Chalibonbar 36.25/100 ml, at Masimpur 48.91/100 ml, at Surma u/s 29.66/100 ml, and at Surma d/s 36.66/100 ml. Highest number of fecal are present in Masimpur at Goalichara d/s and lowest are present at Baluchar at Goalichara u/s. Highest fecal coliform at Goalichara due to domestic sewage discharged to the channel directly polluting water continuously. Figure 2 shows the fecal coliform at seven points. Open defecation, sanitary sewage and domestic sullage water are the main causes of fecal coliform at this point. Fecal coliform at goalichara D/S are higher than Goalichara U/S, when the channel flows through Sylhet city. Sanitary wastes are disposed into the channel which carry high amount of fecal coliform. Fecal coliform to Surma River increases while Goalichara channel falling into it should be zero. At every sampling location, fecal coliform exceeded the limit of Environment Conservation Rules (ECR) (1997). Because of urbanization impact fecal coliform of Goalichara d/s is greater than Goalichara u/s.

Dissolved oxygen

The main reason DO levels might fall is the presence of organic waste. Organic waste comes from something living or that was once living. It comes from raw or poorly treated sewage; runoff from farms and animal feedlots; and natural sources like decaying aquatic plants and animals and fallen leaves in water. Warmer water holds less oxygen than cold water. The time of yearly and many other factors also affect the amount of DO in water. DO levels can also fall to any human activity that heats the water. Average dissolved oxygen at Baluchar is 6.24 mg/ L, at Shibgonj 5.41 mg/ L, at Uposhahor 5.71 mg/L, at Chalibonbar 5.61 mg/L, at Masimpur 5.28 mg/ L, at Surma u/s 6.88 mg/ L, at Surma d/s 6.22 mg/L. The normal limit of DO in rivers is 6.0 mg/ L. Dissolved oxygen is highest at Baluchar of Goalichara u/s and lowest at Masimpur of Goalichara d/s. Highest dissolved oxygen is reduced because oxygen is consumed by bacteria to degrade waste. Figure 3 shows the dissolved oxygen at seven points. DO at Goalichara u/s is high but

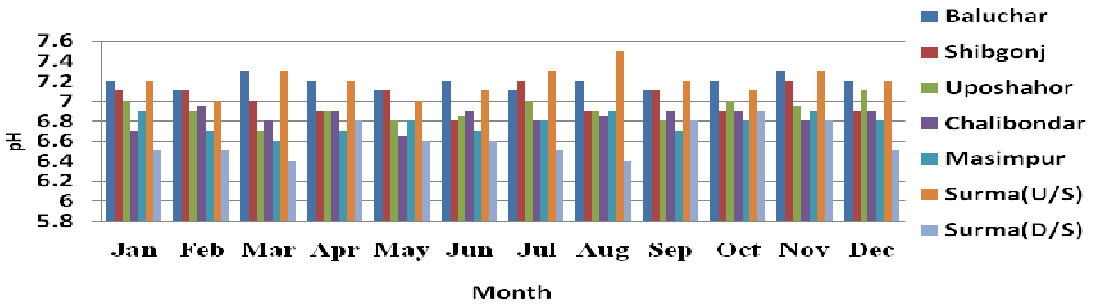

Figure 1. Variation of pH at different location.

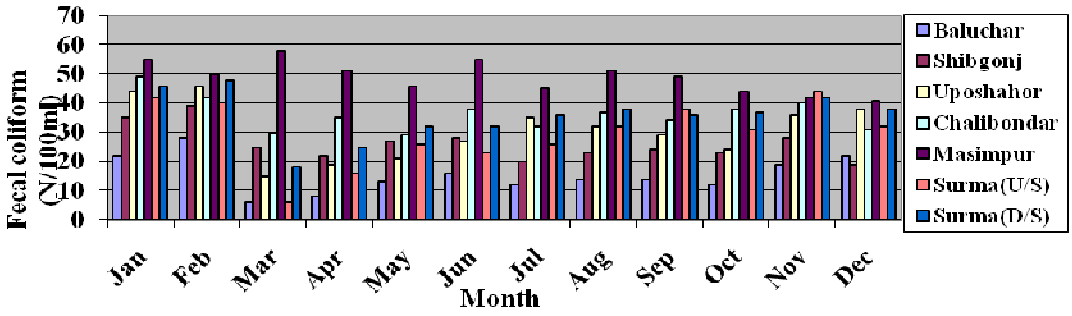

Figure 2. Variation of fecal coliform at different location.

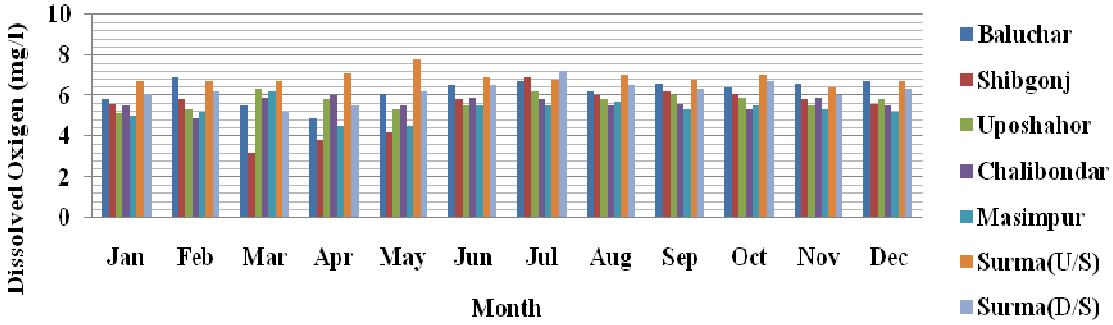

Figure 3. Variation of Dissolved Oxigen at different location.

it gradually decreases when Goalichara channel flows through the Sylhet City. Flowing to the downstream, at Masimpur it becomes low because of high amount of waste at Goalichara are being degraded with the passage of time at different locations.

Biochemical oxygen demand

The water of Surma River is not suitable for drinking purpose. Average BOD at Baluchar is 27.33 mg/L, at Shibgonj 33.83 mg/L, at Uposhahor 34.83 mg/L, at Chalibonbar 42.42 mg/L, at Masimpur 44.33 mg/L, at Surma u/s 39.5 mg/L, at Surma d/s 47.17 mg/L. BOD at Goalichara channel and Surma river is higher than 2 mg/L permissible value of Environment Conservation Rules (ECR) (1997) due to high concentration of sewage discharged directly to the water. Figure 4 shows the BOD at seven points. BOD at Goalichara u/s is comparatively low but it becomes high at Goalichara d/s may result from domestic or industrial waste water discharge. BOD at Surma river is also high because of various pollution sources are connected with the river (Table 1). Because of urbanization impact BOD of Goalichara d/s is much greater than Goalichara u/s.

Ammonia

The water of Surma River is not suitable for drinking purpose. Average ammonia at Baluchar is 0.512 mg/L, at Shibgonj 1.025 mg/L, at Uposhahor 1.652 mg/L, at

Table 1. Test results of different pollution parameters.

Place	Parameter of various months											
	January	February	March	April	May	June	July	August	September	October	November	December
							BOD_5 (mg/L)					
Baluchar	33	38	10	16	16	25	32	29	32	32	35	35
Shibgonj	38	44	15	24	24	32	35	38	34	38	40	44
Uposhahar	44	41	21	32	38	35	31	39	38	33	33	33
Chalibondar	48	51	24	38	46	40	42	42	42	45	47	44
Masimpur	55	42	32	46	35	50	43	48	49	41	50	41
Surma(U/S)	51	53	25	35	40	38	35	42	36	42	38	39
Surma(D/S)	65	60	42	45	45	41	43	48	46	46	42	41
							DO (mg/L)					
Baluchar	5.8	6.9	5.5	4.9	6.1	6.5	6.7	6.2	6.6	6.4	6.6	6.7
Shibgonj	5.6	5.8	3.2	3.8	4.2	5.8	6.9	6.0	6.2	6.1	5.8	5.6
Uposhahar	5.1	5.3	6.3	5.8	5.3	5.5	6.2	5.8	5.6	5.9	5.5	6.8
Chalibondar	5.5	4.9	5.8	6.0	5.5	5.9	5.8	5.5	5.3	5.3	5.9	5.8
Masimpur	5.0	5.2	6.2	4.5	4.5	5.5	5.5	5.7	6.8	5.5	5.3	5.2
Surma(U/S)	6.7	6.7	6.7	7.1	7.8	6.9	6.8	7.0	6.3	7.0	6.4	6.7
Surma(D/S	6.1	6.2	5.2	5.5	6.2	6.5	7.2	6.5	6.3	6.7	6.0	6.3
							NH_3 (mg/L)					
Baluchar	0.42	.88	.45	.3	.35	.38	.28	.25	.29	.25	.45	.8
Shibgonj	1.1	1.6	.85	.55	.45	.45	.38	.55	.41	3.39	.55	1.2
Uposhahar	1.6	1.9	2.03	1.08	1.2	.89	.83	1.2	1.1	1.5	1.5	1.5
Chalibondar	1.85	2.5	3.08	2.03	2.2	1.87	2.1	1.8	1.75	1.65	1.75	2.3
Masimpur	2.4	2.95	2.51	2.1	2.5	1.98	1.75	1.9	1.65	1.45	1.85	2.54
Surma(U/S)	2.85	3.5	1.85	1.92	1.85	2.5	2.2	2.62	2.2	2.1	2.25	2.86
Surma(D/S)	3.11	3.85	4.05	4.35	3.5	3.65	3.25	3.85	3.25	2.75	3.75	3.33
							pH					
Baluchar	7.2	7.1	7.3	7.2	7.1	7.2	7.1	7.2	7.1	7.2	7.3	7.2
Shibgonj	7.1	7.1	7.0	6.9	7.1	6.8	7.2	6.9	7.1	6.9	7.2	6.9
Uposhahar	7.0	6.9	6.7	6.9	6.8	6.85	7.0	6.9	6.8	7.0	6.95	7.1
Chalibondar	6.7	6.95	6.8	6.9	6.65	6.9	6.8	6.85	6.9	6.9	6.8	6.9
Masimpur	6.9	6.7	6.6	6.7	6.8	6.7	6.8	6.9	6.7	6.8	6.9	6.8
Surma(U/S)	7.2	7.0	7.3	7.2	7.0	7.1	7.3	7.5	7.2	7.1	7.3	7.2
Surma(D/S)	6.5	6.5	6.4	6.8	6.6	6.6	6.5	6.4	6.8	6.9	6.8	6.5
							Turbidity (NTU)					
Baluchar	6.2	6.4	6.4	6.5	6.8	8.1	8.9	7.3	7.1	6.6	6.5	6.3
Shibgonj	5.4	5.5	5.3	5.4	6.8	6	6.4	6.5	6.5	6.8	6.1	5.4
Uposhahar	4.5	5.1	5.1	5.2	5.8	5.9	5.8	6	6.1	5.4	4.9	4.4
Chalibondar	5.4	5.4	5.7	5.8	5.5	6.3	6.4	6.5	6.2	6.1	5.8	5.4
Masimpur	5.5	5.7	5.8	5.9	5.8	6.3	6.6	6.8	7	6.4	6.1	5
Surma(U/S)	7.5	7.9	8.3	8.5	6	8.8	8.5	8.6	8.9	9	8	7.5
Surma(D/S)	8.5	8.4	8.3	8.5	8.6	8.8	8.5	8.6	8.9	9	8	7.5

Chalibonbar 2.365 mg/L, at Masimpur 2.49 mg/L, at Surma u/s 2.53 mg/L, at Surma d/s 3.84 mg/L. At every point except Goalichara u/s, ammonia contents are higher than expected. Following Figure 5 graphically shows the ammonia content at seven sampling points. Ammonia at Goalichara d/s is higher than Goalichara u/s due to animal waste, open defecation, chemical (particularly chemical fertilizer) and domestic waste water

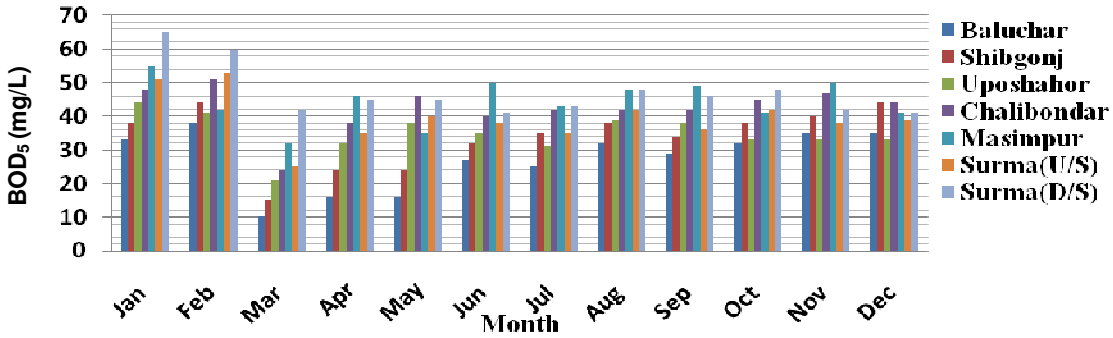

Figure 4. Variation of BOD_5 at different Location.

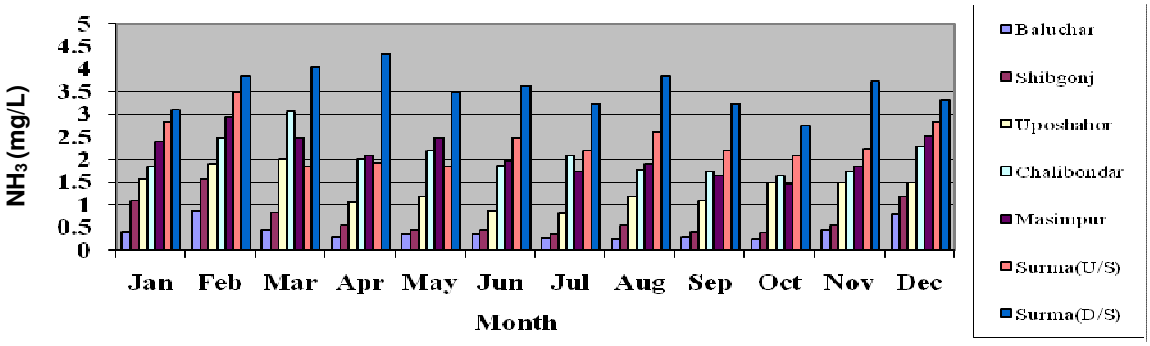

Figure 5. Variation of NH_3 at different location.

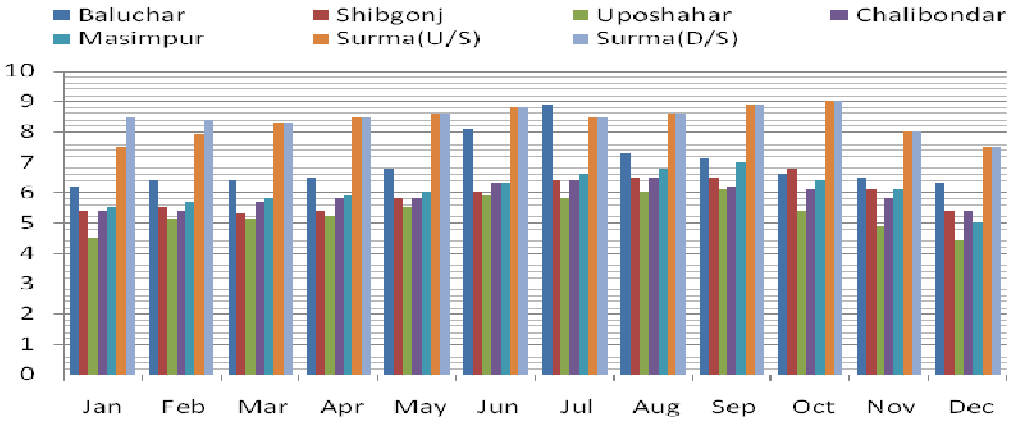

Figure 6. Variation of Turbidity (NTU) at different location.

discharged from household and hospital waste water discharge. At rainy season, concentration of ammonia decreases than the dry season. Desired value of ammonia according to Environment Conservation Rules ECR (1997) is 0.5 mg/L. At Goalichara u/s ammonia value is within the desired value but Goalichara d/s this value are higher than desired value because of urbanization impact.

Turbidity

Turbidity in and around Sylhet City ranges from 4 to 10 variation of turbidity (NTU) (Figure 6). Turbidity varies with season and usually remains high in flood period. Turbidity data procured by Institute of water modeling (IWM) from Department of environment DOE show significant variation between that of 2009 and 2011.

Encroachment

Encroachment of Goalichara is the main cause of reducing the width of the chara. Encroachment has occurred in the urban catchment of the chara. Local peoples are also reducing the channel width by filling the side of the channel with soil to meet the accommodation needs or for other purposes. In Baluchar, Shibgang, Uposhahor, Chalibandar and Masimpur encroachment have been found at the time of survey work.

Sewage and waste water disposal

As the sewerage system has not been established in the city, on site septic tank has been used for sewage treatment. However along the Goalichara, middle class, low income and temporary householders have been found to discharge sewage directly into the chara. In Baluchar and Uposhahor, waste water of TB Hospital and other private clinic is discharged directly into Goalichara deteriorating the quality of receiving waters.

Open defecation

Lack of proper maintenance and awareness people are not using the channel properly in many region of the channel; people are using channel as a place of defecation. They think it is less harmful and they are also habituated to this action. Children's open defecation in the Chara is a common scenario along the long way of Chara throughout the city. Lack of proper knowledge open defecation practices is very common to the children that can be easily reduced if parents of children are well conscious. Poor people of Chalibandar and Masimpur are evenly habituated with the open defecation in the channel.

Conclusion

The main waste water quality parameters such as DO, BOD_5, fecal coliform, ammonia and turbidity etc. have greatly exceeded the acceptable level of a good water source for water supply. The obtained values for pH ranges from 7.18 to 6.6, for total dissolved solids ranges from 162.75 to 328.75 mg/L, for dissolved oxygen from 6.24 to 5.28 mg/L, ammonia from 0.155 to 0.3333 mg/L, fecal coliform from 15.5 to 48.91N/100 ml and turbidity from 4 to 10 NTU. The results from data analysis show that, the water is certainly unfit for drinking purposes without any form of treatment.

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