

Seasonal variation of water quality of the river Shitalakhya in Bangladesh

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Abstract

The present investigation was carried out from April 2002 to January 2003 in respect of pre-monsoon, monsoon and post monsoon periods to evaluate the status of water quality of the Shitalakhya river, Bangladesh. Some physio-chemical parameters such as water depth, air and water temperature, transparency, Dissolved Oxygen (DO), Ammonia (NH₃) Hydrogen ion concentrations (P^H), Nitrite (NO₂), Carbon-di-Oxide (CO₂), Alkalinity, Hardness, Thermal conductivity, Bio-chemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were observed. Significant seasonal variation was observed in water depth, transparency, DO, NH₃, NO₂, Conductivity, BOD and COD of water.

Introduction

The rivers near the urban areas of the world are relatively more polluted. The pollution of urban rivers has different dimensions. The problem of urban rivers is very complex in nature as the sources of pollution are of many types, these are varied and the facts about these are often poorly understood. Most of the urban rivers around the world are being polluted mainly because of rapid urbanization, industrialization and unplanned human settlements. In many countries, particularly in the developing countries, urban rivers are the dumping ground of untreated domestic and industrial solid and liquid wastes. In case of many urban rivers, it is not possible for fishes and other forms of aquatic life to survive in those rivers because of much polluted water.

Many factors are causing river pollution like economic, socio-cultural, behavioral factors and some natural factors also.

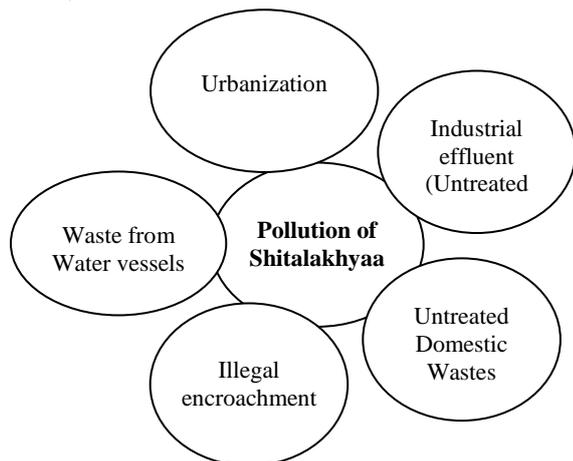


Figure -1, Causes of pollution at the river Shitalakhya (ESCAP, 1998)

Many industries such as pulp and paper mills, rayon mills, Oil refineries, paint and color factories textile mills, soap factories, tanneries, Jute mills, Fertilizer industries, Steel and iron mills, etc. use a large amount of water for their manufacturing process and machinery requirement. After use, this water with solid wastes and effluents are discharged into the rivers and coastal waters without any treatment. These large volume of organic and inorganic wastes change the chemical characteristics of the water body by producing large quantities of toxic substances

(sulphide and methane) and other products of decomposition (nutrients) and also by reducing the quantities of dissolved oxygen.

The present research work envisages evaluating water quality and its impact of pollution on different aquatic communities in this polluted river. The emanating results would be of high practical utility in understanding the degree and type of ecological imbalance caused due to various pollutants.

Material and Methods

Description of the Investigation Area

The river Shitalakhya originated from Padma has been stable over last few decade and maintains a good navigation channel all over the year. The river covers a large industrial belt of Polash, Ghorasal, Kaliganj, Detnra, Adamjee and Narayanganj. River Sitalakhya about 50 km in length and 0.4 km average width, is also a tributary of river Dhaleswari and meets it only 11 km downstream of Buriganga confluence.

For the present investigation five sampling Stations were selected

Nabinagor (S1) : Latitude is 23°34.166/ N and Longitude 90°32.083' E.
 Narayanganj (S2): Latitude is 23°36.546/ N and Longitude 90°30.434' E.
 Katchpur Bridge (S3) : Latitude is 23°42.024' N and Longitude 90°30.094' E
 Kaligonj (S4) : Latitude is 23°56.279' N and Longitude 90°37.063' E
 Ranigonj (S5): Latitude is 24°04.034' N and Longitude 90°37.898' E

Sample collection and preservation

Sub-surface river water sample were collected seasonally during the period of April 2002, August 2002 and January 2003, which were considered as the representative of pre-monsoon, Monsoon and Post monsoon respectively from the river Shitalakhya at different station. For Dissolved Oxygen (DO) and Bio-chemical Oxygen Demand (BOD) water samples were collected in BOD bottled of 300 ml Capacity. The sample were preserved for determination of different waters quality parameter's. For determination of DO, water samples were preserved by KI, MnSO₄ and the bottle were covered with Carbon paper to make dark. All the bottle with samples were then placed in to wooden box to avoid direct sunlight and thus the bottles and container's were transported to the were preserved at 4°C in a refrigeration before analysis (WHO, 1990).

Air and water Temperature

A Celsius thermometer was used to determine the air and water temperature.

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Transparency

To measure transparency a secchi disc was lowered into the water in shed until it was just disappeared and a depth measurement at this point was taken. Then the disc was raised until it was just reappeared and another depth measurement was taken following the methods. This process was repeated for three times and the average the of three measurements was considered as proper secchi disc reading for transparency of water.

Dissolved Oxygen (DO)

To determine the value of Dissolved Oxygen (DO) the collected 300ml water sample in BOD bottle was fixed and analyzed according to Azide Modification Method of Winkler (APHA, 1995)

Hydrogen ion concentration (PH)

To determine hydrogen ion concentration (PH), a glass electrode digital pH meter (Model PW 8 7409 Phillips) was used.

Ammonia (NH₃)

The amount of Ammonia was determined by following Neslerization Method (APHA. 1995)

Nitrite (NO₂): Nitrite was measured by following the ultra-violet Spectrophotometer method (APHA, 1995)

Carbon Dioxide (CO₂)

For measurement of Carbon dioxide, water sample was taken in a salinity bottle and kept it in a conical flask. Half drops of Phenolphthalein was added in the sample. This was then titrated against Na₂ CO₃ solution.

Total Alkalinity

10 ml of water sample was taken in a conical flask. Two to three drops of methyl red indicator was added in the sample. This was then titrated against 0.02N. HCL acid solution.

Electric Conductivity

For measurement of electrical conductivity of water a conductivity meter was used, ranged from 0-10,000 m-mhos/cm (Model RB 34R 104, SER 58833).

Hardness

The total Hardness was determined by EDTA Titrimetric Methods.

Bio-chemical Oxygen Demand (BOD)

The value of DO obtained was considered as the initial reading for determination of BOD, BOD bottle were immediately transported to the laboratory and were incubated at 20°C (in dark) for 5 days Later on Dissolved Oxygen of the BOD bottle was determined by the Azide Modification Method of Winkler (APHA, 1995). The value of final DO (After five days) was subtracted from initial DO to get BOD value.

Chemical Oxygen Demand (COD)

To measure the value of Chemical Oxygen Demand (COD), water samples of 50 ml were placed in a 500 ml-refluxing flask and 1 gm of mercuric sulphate (Hg SO₄) crystals and 5 ml of sulphuric acid (H₂SO₄) were added. Some boiling chips were added to prompt boiling. After that 25 ml of 0.25N Potassium di-

chromate (K₂Cr₂O₇) was again mixed. Then the refluxing flask was attached to condenser through which (condenser) 70ml of sulphuric acid (H₂SO₄) was added again. After well mixing of all (the reagents, the flask was heated from half an hour. The sample was cooled in room temperature and was titrated against 0.1250N Ferrous ammonium sulphate with Ferronindicator.

Results

The results of Physio-chemical parameters are presented table-1, 2

Water depth

Water depth varied from (1.9- 12. 8) m (figure-4) among the five stations at the river pa. The minimum and maximum water depth were recorded at station S₅ and S₃ during the post monsoon and monsoon periods respectively.

Water Temperature

Water temperature varied from (19.1-33.4)°C (figure-5) among the five sampling stations at the river Shitalakya. The minimum and maximum water temperature was recorded at station S₁ and S₄ during post monsoon and pre-monsoon periods respectively.

Air temperature

Water temperature varied from (17.5 -24.0)°C (figure- 6) among the five sampling station at the river Shitalakya. The minimum and maximum air temperature were recorded at station S₅ and S₃ during post monsoon and monsoon periods respectively.

Transparency

Transparency of water varied from 19-96 Cm (Figure - 7) among the five sampling station at the Shitalakya river. The minimum and maximum Transparency were recorded at station S₅ and S₄ during Post monsoon and pre monsoon periods respectively.

Dissolved Oxygen (DO)

The dissolved oxygen in water Samples varied from 70 — 7. 92 mg/l (Figure-8) among the five sampling station at the river Shitalakhya. The minimum and maximum DO were recorded at stations S₃ and S₅ during post monsoon periods respectively.

Hydrogen ion Concentration (PH)

PH value in water sample varied from 6.97 -7.1 8 (Figure - 9) among the five ling station at the river Shitalakya. The minimum and maximum PH were recorded at station S₅ and S₁ during monsoon and post monsoon periods respectively.

Ammonia (NH₃)

The value of ammonia in water samples varied from 0.4-6.5 mg/l (figure-10) among e five sampling station of the Shitalakya River. The minimum concentration were recorded at station S₁ during the monsoon and the maximum value were recorded at station S₃ during the post monsoon periods.

Nitrite (NO₂)

The value of Nitrite in water samples varied from 0.00-0.12 mg/l (Figure-11) among the five sampling station of the river Shitalakhya. The minimum value were recorded almost all stations. The maximum values were recorded at station S₃ during the period of post monsoon.

Carbon-di-Oxide(CO₂)

The value of CO₂ in samples varied from 2.32-8.9 mg/l (Figure-12) among the five sampling station at the river Shitalakya. The minimum and maximum value were recorded at station S₄ and S₃ during the periods of pre- monsoon and post monsoon respectively.

Alkalinity

The value of Alkalinity varied from 44.5-78.1 mg/l (Figure-13) among the five sampling Station at the river Shitalakya. The minimum and maximum value were recorded at Station S₂ and S₄ during The periods of monsoon and pre-monsoon respectively.

Hardness

The value of CaCO₃ Hardness varied from 43.2-58.2 mg/l (Figure-14) among the five sampling station at river Shitalakya. The minimum and maximum concentration were recorded at station S₃ and S₁ during the periods of Post monsoon and pre-monsoon respectively.

Conductivity

The thermal conductivity varied in water samples from 121-575 μS/cm (Figure -15) among the five sampling station at the river Shitalakya. The minimum and maximum value were recorded at station S₅ and S₁ during the periods of Pre-monsoon and post monsoon respectively.

Bio-chemical Oxygen Demand (BOD)

Content of BOD in water samples varied from 0-14 mg/l (Figure -16) among the five sampling station at the river Shitalakya. The minimum values were recorded at station S₂ and, S₃ during the post monsoon and the maximum value were recorded at station S₄ during the period of pre-monsoon.

Chemical Oxygen Demand (COD)

The value of COD in water samples varied from 6.00-60.0mg/l (Figure-17) among the five sampling Station of the river Shitalakya. The minimum and maximum value were recorded at station S₃ and S₂ during the periods of monsoon respectively.

Table 1. Seasonal variation of Physio-Chemical parameters in water samples of river Shitalakya at different stations.

Station	Season	Water depth (m)	Water Temp. (°C)	Air Temp (°C)	Transparency (cm)	DO mg/l	pH	NH ₃ mg/l
S ₁	Pre-Monsoon	6.05	32.5	33.9	59	3.80	7.12	1.7
	Monsoon	11.2	31.2	28.3	56	6.8	7.0	0.4
	Post Monsoon	9.8	19.1	25.2	65	4.70	7.18	5.8
S ₂	Pre-Monsoon	6.97	29.2	29.5	63	2.99	7.15	0.8
	Monsoon	11.8	31.7	31.4	26	5.01	7.11	0.8
	Post Monsoon	7.0	20.3	21.1	45	1.64	7.15	6.0
S ₃	Pre-Monsoon	9.83	29.0	33.1	55	2.04	7.09	2.4
	Monsoon	12.8	31.2	34.0	24	4.94	7.12	0.6
	Post Monsoon	5.5	22.5	22.7	36	0.70	7.21	6.5
S ₄	Pre-Monsoon	3.28	33.4	33.9	96	3.53	7.11	1.9
	Monsoon	4.9	30.7	30.7	22	4.13	7.00	0.8
	Post Monsoon	3.6	24.4	23.3	85	5.69	7.12	1.4
S ₅	Pre-Monsoon	2.77	30.2	32.8	62	7.34	7.05	1.0
	Monsoon	7.1	30.7	29.5	30	6.59	6.67	0.8
	Post Monsoon	1.9	19.5	17.5	19	7.92	7.01	1.4

Table 2. Seasonal Variation of Physio-Chemical Parameters in water samples of river Shitalakya at different stations.

Station	Season	NO ₂ (mg/l)	CO ₂ (mg/l)	Alkalinity (mg/l)	Hardness (mg/l)	Conductivity (μS/cm)	BOD mg/l	COD (mg/l)
S ₁	Pre-monsoon	0.00	5.2	64.0	58.2	389	3	20.0
	Monsoon	0.00	7.2	55.0	54.2	128	4	43.0
	Post monsoon	0.02	4.4	56.2	53.8	575	6	26.0
S ₂	Pre-monsoon	0.04	7.9	56.4	48.3	313	7	26.1
	Monsoon	0.00	7.9	44.5	45.3	170	4	60.0
	Post monsoon	0.00	4.4	49.3	95.2	139	0	45.3
S ₃	Pre-monsoon	0.12	7.9	56.4	48.3	435	110	48.0
	Monsoon	0.00	8.8	50.4	48.2	126	3	6.0
	Post monsoon	0.00	8.9	56.7	43.2	480	0	34.5
S ₄	Pre-monsoon	0.10	2.3	78.1	60.2	282	14	38.2
	Monsoon	0.00	2.5	42.5	45.2	129	3	55.0
	Post monsoon	0.00	4.4	44.2	49.2	250	7	53.5
S ₅	Pre-monsoon	0.02	4.2	68.3	56.4	121	8	48.0
	Monsoon	0.00	4.4	46.3	45.2	122	2	9.0
	Post monsoon	0.00	6.6	53.2	48.3	240	2	32.2

Discussions

Many physio-chemical parameters in water have been studied to evaluate the water quality. Physio-chemical parameter's like water depth, water temperature, Air temperature, transparency, PH, Ammonia, Nitrite, Carbon-di-Oxide, Alkalinity, Calcium Carbonate hardness, Thermal conductivity, Bio-Chemical Oxygen Demand (BOD) and Chemical oxygen Deman (COD) were analyzed seasonally in water sample collected from the shitakya river.

The value of water depth varied from (1.9-12.8) m. The maximum value were recorded at station S₃ during the monsoon and the minimum value were recorded at station S₁ during the periods of Post monsoon. The seasonal variation of water temperature varied from (19.1-34.4)°c. The minimum temperature were recorded at station S₁ during the periods of post monsoon and the maximum were recorded at station S₄ during the periods of pre-monsoon, which was slightly higher than recommended value of DKPC, (1980).

A marked monthly fluctuations of air temperature with positively significant with water temperature was observed in the present investigation. The maximum air temperature was recorded at station S₃ during the periods of monsoon and the minimum air temperature was recorded at station S₅ the periods of post monsoon. In present findings, The transparency of water varied from (19-96)cm . The maximum Transparency were recorded at station S₄ during the periods of pre-monsoon and the minimum were recorded at station 85 the post monsoon periods. The contents of DO in this river was influenced by waste disposal and surface runoff. The maximum value of dissolved oxygen (DO) was recorded as 7.92 mg/l during the periods of post monsoon at station 85 and minimum was recorded .70 during the periods of post monsoon at station S₃. Joseph (1992) was observed seasonal variation of DO content in Tungabhadra river in India the value is varied from (2-6.2) mg/l which was slightly similar with the present findings.

The pH value in water varied from 6.97-7.18 among the five sampling station of the river Shitalakya. The maximum value was recorded at stations S₁ during the periods of post monsoon and minimum was recorded at stations S₅ during the periods of monsoon. Joseph and Srivasta (1992) studied in Ennore estuary

at Madras, PH value varied from 7.4—8.1. K. O. Joseph (1992) was observed the Tungabhadra river, PH value varied from 6.77 to 7.5. In the present investigation, slightly similar with the aforesaid authors.

The value of ammonia in water samples varied from (0.4 to 6.5) mg/l among the five sampling stations. The maximum value was recorded at station 83 during the periods of post monsoon and the minimum value was recorded at stations S_f during the periods of monsoon. The Recommended values of NH₃ from DKPC, (1980) for fishing water in 0.50 to 3.0 mg/l. The value of NH₃ found in the present investigation is much higher than the recommended value of above Authority. It indicates that the area is highly polluted.

The value of Nitrite in water samples varied from (0.00-0.12) mg/l. The minimum value was recorded 0.00 mg/l during the periods of pre-monsoon and monsoon. The maximum value were recorded at 0.12 mg/l during the periods post monsoon, the value of nitrite might be happened due to rapid run-off, industrial effluent and organic deposition.

The value of carbon-dioxide varied from 2.32-8.9 mg/l among the five sampling stations. The maximum value were recorded at station S₅ during the periods of Pre-

monsoon and minimum value were recorded at stations S_i, during the periods of Pre-monsoon, which was slightly higher than the Recommended value of DKPC, (1980).

The value of Alkalinity varied from (44.5- 78.1) mg/l among the five Sampling Stations. The minimum value were recorded at stations 82 during the periods of pre-monsoon and the maximum value were recorded at station 84 during the periods of pre-monsoon. The author stated that higher Alkalinity was due to industrial and Urban sewage disposal or surface run off. So, the present investigation closely agrees with above statements.

The value of CaCO₃ Hardness varied from (43.5-58.2) mg/l among the five sampling stations. The minimum value was recorded at station 82 during the periods of post-monsoon and the maximum value was recorded at station S_i during the periods of pre-monsoon.

The thermal conductivity varied from (121 to 575) fS/cm among the five sampling stations. The minimum value were recorded at station S₁ during the post monsoon and the minimum value were recorded at station 85 during the periods of pre-monsoon. Rahaman *et al.* (1995) has reported (that heavy rainfall over the land and river of Bangladesh is the major factor to decrease the conductivity. The present investigation is agree with the above statements.

The value of Bio-Chemical Oxygen Demand (BOD) varied from (2.0 to 14.0) mg/l. The minimum value were recorded at station 82 and S₁ during the periods of post monsoon and maximum value were recorded at station 84 during the periods of pre-monsoon. The author stated, due to the presence of large quantities of organic wastes, the decomposition which utilized significant amount of dissolved oxygen from the respective water. This statement is similar with the present investigation.

The value of Chemical oxygen Demand (COD) varied from (6.00 to 60.0) mg/l. The minimum and maximum value were recorded at station 83 and 83 during the periods of monsoon respectively. The higher value of COD effluent discharge area was due to higher concentration of organic and inorganic Substances which consumed significant amount of Dissolved Oxygen for their chemical changes in the process of their neutralization.

Josheph and Srivasta (1992), studied on Ennor estuary in Madras the COD value varied from (18 to 23) mg/l, which was slightly lower than the present findings. But the present investigation, COD value is lower than the findings of Joseph (1992) Tungabhadra river in India.

Conclusion

The value of NH₃, BOD, COD and thermal Conductivity in some stations exceeded the DOE,(1991) Environmental Quality Standard value for river water, which indicates that the water is slightly polluted by NH₃, BOD, COD and thermal conductivity. Above all, natural and physical characters of the Shitalakhya river including length, flow, discharge, catchments etc. are also adversely changing mainly due to human interventions. These are severely polluting the water quality of the river.

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