CHARACTERIZATION OF SELECTED INDUSTRIAL EFFLUENT AND THEIR EFFECTS ON NAROD RIVER OF NATORE, BANGLADESH

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ABSTRACT

Bangladesh had always been predominantly an agriculture based country and in early days pollution wasn't major issue in this region. Industrial development is important for economic growth of Bangladesh, but has brought with it a range of problems one of which is water pollution. Natore is a historical city situated in the North-Western part of Bangladesh. The Narod is the most important river in Natore which passes through the heart of the city. There are three industries in the upstream of the Narod river and the Natore city is situated in the downstream side of the river. In the study, in order to investigate the impact of these three industrial effluents on Narod river, a detailed water sampling and analysis were carried out for these three industrial effluents and river water at various upstream and downstream locations both for January and April in a year. The water quality parameters of the sampling water such as pH, dissolved oxygen, bio-chemical oxygen demand (BOD_5), chemical oxygen demand (COD), total solids, total suspended solids, total dissolved solids, nitrate, ammonia nitrogen, alkalinity, chloride, sodium, sulfate, iron and manganese were analyzed at both stages of time. In January, the observed BOD_5 in this river was in the range of 42-66 mg/L, COD was 560-1340 mg/L, pH was 6.17-7.88 and in April, the observed BOD_5 in this river was in the range of 48-74 mg/L, COD was 960-1410 mg/L, pH was 6.62-7.72. The other results found from these analysis indicating that the river water becomes severely polluted with these three industrial effluents.

Keywords: *Sugar mill effluent, jamuna distillery effluent, pran agro effluent, river water and pollution.*

1. INTRODUCTION

It has been suggested that water pollution is the leading worldwide cause of deaths and diseases (Pink and Daniel, 2006) and that it accounts for the deaths of more than 14,000 people daily (West, 2006). Industrial development is essentially a prerequisite for the socio-economic development of a nation. On the other hand, it is intimately related to the environment. Now-a-days Bangladesh is promoting to rapid industrial development and simultaneously industries are contributing serious pollution problems. A large number of industries discharge their wastes having potentially toxic substances without any treatment directly into the river. Elevated water temperatures decrease oxygen levels, which can kill fish and alter food chain composition, reduce species biodiversity and foster invasion by new thermophilic species (Goel, 2006). Due to the multitude of products and production methods in industrial plants, there is also a wide range of different wastewater flow fractions for which the respective industrial branches have coined their own particular terms. Hence, environmental degradation due to indiscriminate disposal of industrial wastes has become a growing concern in Bangladesh.

Contamination of surface water from industrial waste is a result of various types of industrial processes and disposal practices. Industries that use large amounts of water for processing have the potential to pollute waterways through the discharge of their waste into streams and rivers, or by run-off and seepage of stored wastes into nearby water sources. Other disposal practices which cause water contamination include deep well injection and improper disposal of wastes in surface impoundments.

Industrial waste consists of both organic and inorganic substances. Organic wastes include pesticide residues, solvents and cleaning fluids, dissolved residue from fruit and vegetables and lignin from pulp and paper to name a few. Effluents can also contain inorganic wastes such as brine salts and metals. The Clean Water Act has

standards for the permitted release of a limited amount of contaminants into waterways. This is an incentive for industry to pre-treat their water by neutralizing the chemically active components, recycling, dilution or extraction and collection for proper disposal.

Natore is a historical city situated in the North-Western part of Bangladesh. The Narod is the most important river in Natore which passes through the heart of the city. This part of the country has been repeatedly suffering from drought since few years back. Moreover, there are three industries (a Natore Sugar Mills Limited, a Jamuna Distillery Limited and a Pran Agro Limited) in the upstream of the Narod river and the Natore city is situated in the downstream side of the river. As a result, the river suffers from severe pollution these days near to the city center of Natore. The specific aims of this study are: (a) Characterize the effluent quality of a Natore Sugar Mills Limited, a Jamuna Distillery Limited and a Pran Agro Limited in Natore, Bangladesh, (b) Investigation of Narod river water quality at different distances from the effluent disposal points, (c) Proposal for an urgent remedial measure to minimize the pollution level in Narod river.

2. METHODOLOGY

The Narod river originates from the Rajshahi a larger water basin in the north from Natore district goes from center of Natore town. Pran Agro Limited and Natore Sugar Mills Limited are discharging their effluent direct on the Narod river, on the other hand Jamuna Distillery Limited discharging their effluent 500 meters from the Narod river on a drain which is directly connected to the Narod river. Figure 1 shows the map of study area indicating industries, river and sampling station.

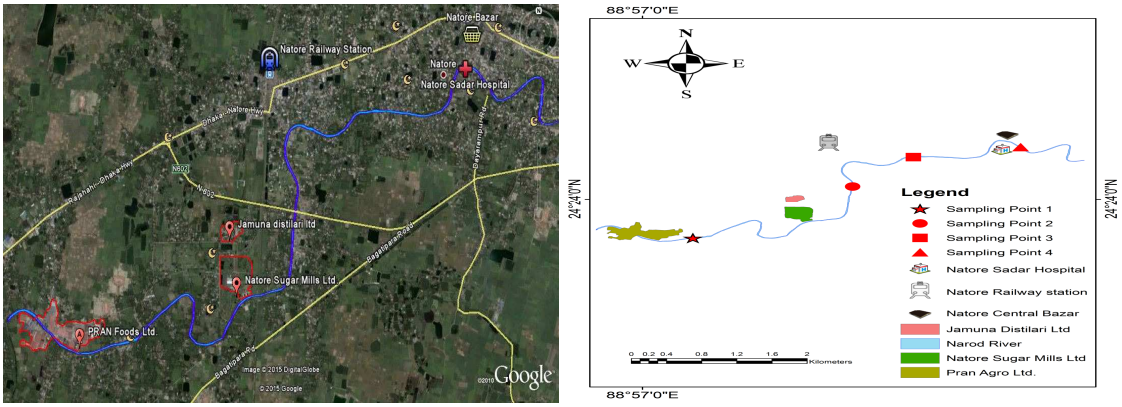

Figure 1: Map shows the study area indicating industries, river and sampling station.

Samples were collected from selected three industrial effluent disposal points and four different points of Narod river. Among these four river sampling stations, sampling station 1 in the upstream and sampling station 2, 3 and 4 were in the downstream which were respectively 0.5, 2.5, 3.5 and 5.0 km from the Pran Agro Limited. The samples were collected both at January and April. The Natore Sugar Mills Limited started their factory at 21 November, 2014 and turned off their factory at 5 Feb, 2015. So, at the month of April it turned off and samples from it wasn't collected.

3. RESULTS AND DISCUSSIONS

3.1 Tables

The three industries named Natore Sugar Mills Limited (NSML), Jamuna Distillery Limited (JDL) and Pran Agro Limited (PAL) effluent test results with ECR'97 standard for industrial unit at January month are shown below in Table 1.

The Natore Sugar Mills Limited (NSML) runs near about three months in a year. This year they started their factory at 21 November, 2014 and turned off their factory at 5 Feb, 2015. So, the two industries named Jamuna Distillery Limited (JDL) and Pran Agro Limited (PAL) effluent test results with ECR'97 standard for industrial unit at April month are shown below in Table 2.

Table 1: Industrial effluent quality parameters (January)

Parameters	Unit	Sampling Station			Bangladesh Standards ECR(1997) for Industrial Unit
		NSML	JDL	PAL	
pH	-	7.61	7.64	5.81	6-9
BOD_5	mg/L	192	38	52	50
COD	mg/L	1150	260	988	200
TS	mg/L	870	1070	1120	2250
TSS	mg/L	130	90	180	150
TDS	mg/L	740	980	940	2100
Nitrate	mg/L	5.8	2.1	1.3	10
Alkalinity as $CaCO_3$	mg/L	490	440	310	-
Chloride as Cl^-	mg/L	300	140	260	600
Sodium as Na^+	mg/L	190	90	170	-
Sulfate	mg/L	54	32	96	-
Iron	mg/L	1.97	0.54	1.58	2
Manganese	mg/L	0.3	0.2	4.7	5

Table 2: Industrial effluent quality parameters (April)

Parameters	Unit	Sampling Station			Bangladesh Standards ECR(1997) for Industrial Unit
		NSML	JDL	PAL	
pH	-	Off	7.48	5.99	6-9
BOD_5	mg/L	Off	43	68	50
COD	mg/L	Off	410	870	200
TS	mg/L	Off	1020	1430	2250
TSS	mg/L	Off	110	160	150
TDS	mg/L	Off	910	1270	2100
Nitrate	mg/L	Off	1.9	1.45	10
Alkalinity as $CaCO_3$	mg/L	Off	390	410	-
Chloride as Cl^-	mg/L	Off	180	240	600
Sodium as Na^+	mg/L	Off	110	190	-
Sulfate	mg/L	Off	33	84	-
Iron	mg/L	Off	0.4	1.46	2
Manganese	mg/L	Off	0.5	3.6	5

The collection points of river water are respectively 0.5, 2.5, 3.5 and 5.0 km from the Pran Agro Limited indicating point no. 1, 2, 3 and 4 respectively. At different distances Narod river water test results are shown in following Table 3 and Table 4 for January and April respectively.

Table 3: River water quality parameters (January)

Parameters	Unit	Sampling Station				Bangladesh Standards ECR('97) for surface water
		Point-1	Point-2	Point-3	Point-4	
PH	-	6.17	7.24	7.42	7.88	6.5-8.5
DO	mg/L	1.82	1.51	1.71	1.59	5 or more
BOD_5	mg/L	42	66	53	60	6 or less (fisheries) 10 or less (irrigation)
COD	mg/L	970	1340	1120	560	-
TS	mg/L	770	1130	930	980	-
TSS	mg/L	140	230	210	230	-
TDS	mg/L	630	900	720	750	-
Nitrate	mg/L	1.1	1.9	1.3	2.8	-
Ammonia Nitrogen (NH_3-N)	mg/L	3.07	4.64	4.02	3.68	-
Alkalinity as $CaCO_3$	mg/L	370	410	360	660	-
Chloride as Cl^-	mg/L	140	230	130	160	-
Sodium as Na^+	mg/L	110	140	80	110	-
Sulfate	mg/L	68	64	28	37	-
Iron	mg/L	0.34	0.42	0.21	0.25	-
Manganese	mg/L	2.64	1.47	1.23	2.0	-

Table 4: River water quality parameters (April)

Parameters	Unit	Sampling Station				Bangladesh Standards ECR('97) for surface water
		Point-1	Point-2	Point-3	Point-4	
PH	-	6.62	7.28	7.57	7.72	6.5-8.5
DO	mg/L	1.76	1.49	1.55	1.38	5 or more
BOD_5	mg/L	48	69	63	74	6 or less (fisheries) 10 or less (irrigation)
COD	mg/L	960	1410	1070	970	-
TS	mg/L	1180	1240	980	1060	-
TSS	mg/L	170	320	240	230	-
TDS	mg/L	1010	920	740	830	-
Nitrate	mg/L	1.2	2.4	1.6	3.2	-
Ammonia Nitrogen (NH_3-N)	mg/L	3.26	5.11	4.39	3.92	-
Alkalinity as CaCO3	mg/L	420	490	440	510	-
Chloride as Cl^-	mg/L	160	240	220	180	-
Sodium as Na^+	mg/L	130	160	140	110	-
Sulfate	mg/L	59	74	52	48	-
Iron	mg/L	0.46	0.53	0.36	0.29	-
Manganese	mg/L	2.26	1.92	1.89	2.35	-

3.2 Figures and Graphs

Biochemical Oxygen Demand (BOD_5) is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. The term also refers to a chemical procedure for determining this amount. In the present investigation, the test results of BOD_5 for selected three industrial effluents are shown in Figure 2. The standard of BOD_5 for industrial unit effluent is 50 mg/L. In the present investigation the BOD_5

value of the JDL effluent is under the allowable limit but PAL effluent is greater than the allowable limit and NSML effluent is far greater from the allowable limit.

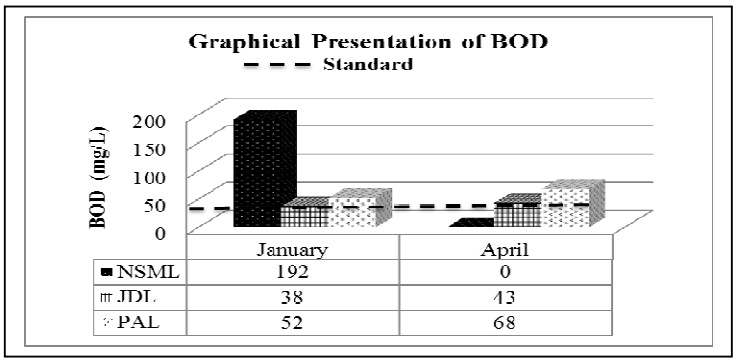

Figure 2: Variation of BOD_5 for January and April of selected industries.

The Chemical Oxygen Demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers) or wastewater, making COD a useful measure of water quality. In the present investigation, the test results of COD for selected three industrial effluents are shown in Figure 3. The standard of COD for industrial unit effluent is 200 mg/L. In the present investigation the COD value of all the industrial effluent is greater than the allowable limit both for January and April, among them NSNL effluent is far from the standard limit.

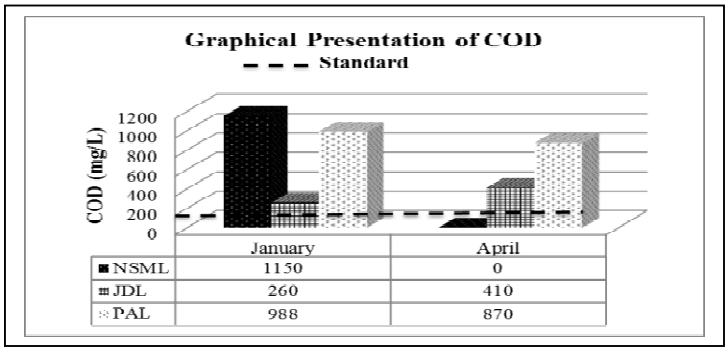

Figure 3: Variation of COD for January and April of selected industries.

Biochemical oxygen demand (BOD_5) is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. The term also refers to a chemical procedure for determining this amount. The need of BOD_5 for irrigation and fish culture are respectively less than 10 and 6 mg/L. But, in the present investigation the BOD_5 value of the Narod river was 42, 66, 53 and 60 mg/L in January and 48, 69, 63 and 74 mg/L in April; in the location point 1, 2, 3 and 4 respectively, which is very far from the standard. Variation of BOD_5 for January and April at different distances is shown in following Figure 4. Here the BOD_5 value for April month is greater than January month in all of the points. From the figure, it can be seen that the BOD_5 value abruptly increased at point 2 which denotes Tebaria, which is very near to the Tebaria Hat. The BOD_5 value also increased at point 4, which is near to the city center and also to the Nicha Bazar. This high level of BOD_5 refers that large amount of organic matter present in water at the downstream of the river which impacting on the downstream ecosystem.

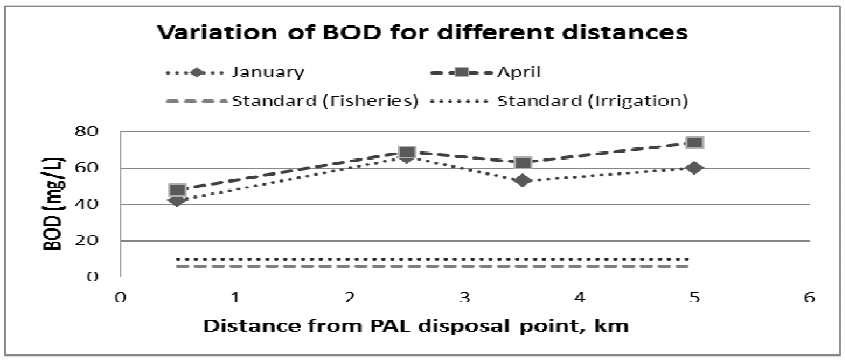

Figure 4: Variation of BOD_5 for January and April at different distances of Narod river.

The chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers) or wastewater, making COD a useful measure of water quality. In the present investigation, the COD value of the Narod river was 970, 1340, 1120 and 560 mg/L in January and 960, 1410, 1070 and 970 mg/L in April; in the location point 1, 2, 3 and 4 respectively shown in Figure 5. According to ECR'97 there is no standard of COD for irrigation and fisheries but 4 mg/L for drinking purpose. The values are ranges from 560 to 1410, which is far away from the drinking standard and should be also far for irrigation and fisheries. From the figure it can be seen that, the COD value abruptly increased at point 2 which denotes Tebaria, which is very near to the Tebaria Hat. The COD value for April month is greater than January month in most of the points.

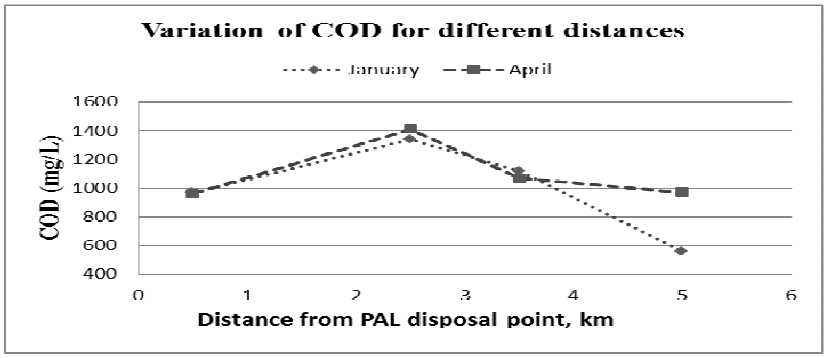

Figure 5: Variation of COD for January and April at different distances of Narod river.

Minor change in the industrial production and waste handling process can produce substantial reductions in wastewater volume and pollutant load. Industrial pollution has adversely affected biodiversity for the last two centuries and continues to increase globally. The effect most closely correlated with loss of ecosystem services is toxification of environmental sites, whereby the organisms living in the ecosystem are damaged because of the poisonous nature of many pollutants. As many toxicants (poisonous materials) can act even with very minimal exposure, it is almost impossible and economically infeasible to remove dissolute pollution from the environment with modern technical methods. Below there are some proposals to minimize the level of pollution:

- Both JDL and PAL have Effluent Treatment Plant (ETP), but they are not using it all of the year properly. They should use it throughout the year as a mandatory.
- Each industry should follow the environmental policies, regulations and environmental protection acts to conserve the environment
- Industry should be installed in low laying areas away from the public locality.
- Industrialists should use such raw materials which will maximum good products and less toxic waste.
- Industrialists should check their instruments to avoid leakage.

- Elimination of refuse, pieces of can and suspended dirt before industrial effluent discharge can decrease in the BOD load.
- Segregation of oils from effluents will allow for the recovery and reuse of lubricating oil and reduce soil contamination when waste water is applied for irrigation.
- Each industry should have effluent treatment plant to treat the effluents, which can be further used for other purpose (agriculture purpose).
- Improving technology may be the best strategy in the context of reducing water pollution level.

4. CONCLUSIONS

It has been observed that, most of the effluent quality parameters of NSML, JDL and PAL do not always maintain Bangladesh Standard (ECR, 1997) for industrial effluents. It has been concluded that all the three industries maintained the standard for TS, TDS, Nitrate, Chloride, Iron and Manganese both for January and April while discharging their effluent. Iron value of NSML and Manganese value of PAL are very near the standard limit at January. According to Bangladesh Standard (ECR, 1997), there is no industrial units or projects waste standard for Alkalinity, Sodium and Sulfate. The effluent pH value of NSML and JDL are between standard limit, but PAL discharging below the standard limit both of the times. The effluent BOD_5 value for JDL is under the allowable limit, but NSML and PAL discharging very high value of BOD_5 compare to standard limit. NSML and JDL effluents are maintaining standard limit for TSS, but PAL doesn't for both of the times. All of the three industries discharging very high value of COD and the values are far from the standard limit.

As April month is drier than January so most of the test results for Narod river of different parameters are higher for April than January. NSML turned off at first week of February, which discharging high effluent parameter value; it can be the reason of April test results become not so higher than January. According to Bangladesh Standard (ECR, 1997) there is no standard value of COD, TS, TSS, TDS, Nitrate, Ammonia Nitrogen, Alkalinity, Chloride, Sodium, Sulfate, Iron, Manganese for fisheries and irrigation which are tested in this study. All of the point maintaining standard limit for pH except point no.1, which is very near the PAL and its discharging very low value of pH both of the times. The most important two parameters such as DO and BOD_5 value of all of the points both for January and April are far from the acceptable limit according to Bangladesh Standard (ECR, 1997) for fisheries and irrigation. DO value of all the samples for Narod river are below 2mg/L, so no fish can survive along these location.

Some proposals have been given to minimize pollution level of river water. Since, any toxic effluent is very much dangerous to the environment thus, its safe disposal is necessary to have a good environment. The effluents should be treated by proper treatment process (different unit process such as sedimentation, filtration or coagulation etc.) and then, discharging to the river. The use of Effluent Treatment Plant (ETP) before discharging would minimize the environmental burdens of the aquatic ecosystem.

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